Proposal full title	**Detector R&D towards the International Linear Collider**
Proposal acronym	**EUDET**

Participants Cost Model	Total Expected Budget (k€) (incl. AC participants internal costs)	Requested EC Contribution (k€)
FC	1662.682	717.082
FCF	8162.214	2436.414
AC	13431.006	5517.382
TOTAL	23255.903	8670.879

Schematical Overview

Table 1: List of participants of the Integrated Infrastructure Initiative (I3)

Participant No.	Organisation (name, city,country)	Short name	Short description	Specific role in the I3
1	Deutsches Elektronen-Synchrotron, Hamburg and Zeuthen, Germany	DESY	One of the leading institues in the world for high energy physics, accelerator physics and research with photons.	Coordination of the I3, Coordination of JRA1 and JRA3, Participation in all activities.
2	AGH University of Science and Technology, Cracow, Poland	AGH-UST	Polish university.	Participation in NA2, JRA3.
3	Albert-Ludwigs Universität Freiburg, Germany	ALU-FR	German university.	Coordination of NA2, Participation in NA2, JRA2.
4	Commissariat a l'Energie Atomique, Paris, France	CEA	Leading French organisation for research, development, and innovation in the fields of energy, defense, information technologies, communication, and health.	Participation in NA2, JRA1, JRA2.
5	Centre National de la Récherche Scientifique/Institut National de Physique Nucléaire et de Physique des Particules, Paris, France	CNRS/IN2P3	Leading French organisation for fundamental research.	

Participant No.	Organisation (name, city,country)	Short name	Short description	Specific role in the I3
	Laboratoire Leprince-Ringuet, Ecole Polytechnique, Palaiseau, France	*CNRS-EP*	*One of the leading French institutes for High Energy Physics research.*	*Participation in NA2, JRA3.*
	Institut de Recherches Subatomiques, Strasbourg, France	*CNRS-IReS*	*One of the leading French institutes for High Energy Physics research.*	*Participation in NA2, JRA1.*
	Laboratoire de l´Accélérateur Linéaire, Orsay, France	*CNRS-LAL*	*One of the leading French institutes for High Energy Physics research.*	*Coordination of JRA3, Participation in NA2, JRA3*
	Laboratoire de Physique Corpusculaire, ClermontFerrand, France	*CNRS-LPC*	*One of the leading French institutes for High Energy Physics research.*	*Participation in NA2, JRA3.*
	Laboratoire de Physique Nucléaire et de Hautes Energies, Paris, France	*CNRS-LPNHE*	*One of the leading French institutes for High Energy Physics research.*	*Participation in NA2, JRA2.*
6	**Consejo Superior de Investigaciones Científicas, Madrid, Spain**	**CSIC**	**Main Spanish research organisation.**	**Participation in NA2, JRA2.**
7	**Charles University, Prague, Czech Republic**	**CUPRAGUE**	**Czech university.**	**Participation in NA2, JRA2.**
8	**Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam, Netherlands**	**FOM/NIKHEF**	**The funding agency for Fundamental Research on Matter, of which NIKHEF is one of the major research institutes. NIKHEF coordinates and supports all activities in experimental subatomic (high energy) physics in the Netherlands.**	**Coordination of JRA2, Participation in NA2, JRA2.**

Participant No.	Organisation (name, city,country)	Short name	Short description	Specific role in the I3
9	Helsinki Institute of Physics, Helsinki, Finland	HIP	Leading Finnish institute in theoretical and experimental subatomic physics.	Participation in NA2, JRA2.
10	The Henryk Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Cracow, Poland	INPPAS	Institute with nearly fifty years experience in the field of nuclear and high energy physics, collaborates with many scientific research centres in the world.	Participation in NA2, JRA3.
11	Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic	IPASCR	Leading institute in Czech Republic in physics research for high energy physics, plasma physics, optics and solid state physics.	Participation in NA2, JRA3.
12	Max-Planck-Institut für Physik, Max-Planck-Gesellschaft, Munich, Germany	MPI	One of almost 80 autonomous research institutes of the Max-Planck-Society, devoted mainly to studies of the fundamental constituents of matter, their interactions, and the role they play in astrophysics.	Participation in NA2, JRA1.
13	Tel Aviv University, Israel	TAU	Israeli university.	Participation in NA2, JRA3.
14	Universität Bonn, Germany	UBONN	German university.	Participation in NA2, JRA1.
15	University College London, UK	UCL	UK university.	Participation in NA2, JRA3.
16	Universität Hamburg, Germany	UHAM	German university.	Participation in NA2, JRA2, JRA3.
17	Lunds Universitet, Sweden	ULUND	Swedish university.	Participation in NA2, JRA2.
18	Universität Mannheim, Germany	UMA	German university.	Participation in NA2, JRA2, JRA3.

Participant No.	Organisation (name, city,country)	Short name	Short description	Specific role in the I3
19	Université de Genève, Switzerland	UNI-GE	Swiss university.	Participation in NA2, JRA1.
20	Bristol University, UK	UNIVBRIS	UK university.	Participation in NA2, JRA1.
21	Universität Rostock, Germany	UROS	German university.	Participation in NA2, JRA2.

The proposal includes nine institutes participating as associates to the I3 - cf. Table 1bis. These self-supporting institutes are active in the topic of research of the JRAs. It is thus in the interest of the consortium to maintain close contact to these developments. It is foreseen to invite the associates to the regular annual meetings and workshops to receive their scientific and technological input and to enable them to assist in the experimental progress as required. The respective travel costs have been absorbed in the requested budget of - and are managed by - the hosting institutes.

Table 1-bis: List of Associates of the Integrated Infrastructure Initiative (I3)

Organisation (name, city,country)	Short name	Associated to	Short description	Specific role in the I3
Budker Institute of Nuclear Physics, Novosibirsk, Russia	BINP	DESY	One of the leading Russian laboratories for High Energy Physics and Accelerator Science.	Participation in JRA2.
Imperial College London, London, UK.	ICL	UCL	UK university.	Participation in NA2, JRA3.
State Research Center of Russian Federation Institute for High Energy Physics, Protvino, Russia	IHEP	DESY	Leading Russian centre for High Energy Physics and Accelerator Science.	Participation in JRA3.
Alikhanov Institute for Theoretical and Experimental Physics, Moscow, Russia	ITEP	DESY	Russian centre for research and education on the fundamental properties of matter.	Participation in JRA3.

Organisation (name, city,country)	Short name	Associated to	Short description	Specific role in the I3
Moscow Engineering Physics Institute, Moscow, Russia	MEPHI	DESY	Russian centre for research and education on engineering and fundamental science.	Participation in JRA3.
High Energy Accelerator Research Organisation, Tsukaba, Japan	KEK	UHAM	One of the leading institutes in the world for high energy physics and accelerator physics.	Participation in JRA1, JRA2.
Royal Holloway and Bedford New College, Egham, UK	RHUL	UCL	UK university.	Participation in NA2, JRA3.
The Chancellor, Masters and Scholars of the University of Cambridge	UCAM	UCL	UK university.	Participation in NA2, JRA3.
The University of Manchester, Manchester, UK	UMAN	UCL	UK university.	Participation in NA2, JRA3.

Table 2: List of activities of the I3

Activity Number	Descriptive Title	Short description of specific objectives of the activity
Networking activities		
NA1	Management of I3	Coordination of the development of an integrated European infrastructure for ILC detector R&D and it's exploitation by the partners of the consortium
NA 2	"Detector R&D Network"	This activity aims at coordinating and integrating the activities of the particle physics community interested in the development of novel detector technologies for the ILC. Tools to facilitate this integration include meetings, conferences and a centralized access to computing resources.
Access activities		
TA1	"Access to DESY Test Beam Facility"	The DESY test beam infrastructure, which will be improved under this proposal, will be made available to a wide community of physicists involved with detector developments. Central support of the infrastructure at the test beam should be available to assist the visiting scientists.
TA2	"Access to Detector R&D Infrastructure"	Infrastructure developed and constructed in the framework of this proposal will be made available to the community to test new detector technologies. The infrastructure will be made available for new groups joining the ILC detector development, for other particle and nuclear physics groups as well as for groups from other fields of science.
Research activities		
JRA1	"Test Beam Infrastructure"	This JRA aims at providing and improving a general test beam infrastructure for detector R&D. The main objectives are to develop and build a large bore magnet, a novel general purpose pixel detector test stand and telescope which improve the test beam infrastructure.

Activity Number	Descriptive Title	Short description of specific objectives of the activity
JRA2	"Infrastructure for Tracking Detectors"	This JRA wants to integrate the efforts of European institutions working on tracking detectors for the ILC. This includes the improvement of existing infrastructures for tracking detectors, the developments of common prototypes, and the development of novel techniques for SI based tracking detectors.
JRA3	"Infrastructure for Calorimeters"	Calorimeter developments for the ILC rely on sophisticated structures, which can be used to test novel readout schemes. This JRA aims at improving the existing calorimeter prototype stack. This includes the development of novel stack instrumentation, and of novel readout systems to be provided at the infrastructure.

Table 3: Summary table of expected budget and of the Community contribution requested.

		Participant number													
	Amounts (k€)	**1**		**2**		**3**		**4**		**5**		**6**		**Total expected budget (k€) Sub-total**	**Max. Community contribution requested (k€) Sub-total**
		exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.		
Networking activities	NA1	277.080	277.080	4.800	4.800	12.000	12.000	4.800	4.800	57.000	12.000	4.800	4.800	**360.480**	**315.480**
	NA2	220.023	220.023	5.280	5.280	184.108	184.108	9.262	9.262	92.294	92.294	7.700	7.700	**518.667**	**518.667**
	Sub-total Networking	*497.103*	*497.103*	*10.080*	*10.080*	*196.108*	*196.108*	*14.062*	*14.062*	*149.294*	*104.294*	*12.500*	*12.500*	***879.147***	***834.147***
Access activities	TA1	351.086	351.086											**351.086**	**351.086**
	TA2	162.000	162.000											**162.000**	**162.000**
	Sub-total Access	*513.086*	*513.086*											***513.086***	***513.086***
Research activities	JRA1	264.780	264.780					394.440	190.440	609.000	309.000			**1268.220**	**764.220**
	JRA2	192.420	192.420			314.064	314.064	780.330	282.330	1743.660	303.660	461.350	217.750	**3491.824**	**1310.224**
	JRA3	590.520	590.520	109.200	109.200					4736.736	1316.736			**5436.456**	**2016.456**
	Sub-total Research	*1047.720*	*1047.720*	*109.200*	*109.200*	*314.064*	*314.064*	*1174.770*	*472.770*	*7089.396*	*1929.396*	*461.350*	*217.750*	***10196.500***	***4090.900***
	Total expected budget (k€)	**2057.909**		**119.280**		**510.172**		**1188.832**		**7238.690**		**473.850**		**11588.733**	
	Max. Community contribution requested (k€)		**2057.909**		**119.280**		**510.172**		**486.832**		**2033.690**		**230.250**		**5438.133**

Table 3: continued

		Participant number													
	Amounts (k€)	**exp. budget Sub-total**	**req. budget Sub-total**	**7**		**8**		**9**		**10**		**11**		**Total expected budget (k€) Sub-total**	**Max. Community contribution requested (k€) Sub-total**
				exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.		
Networking activities	NA1	**360.480**	**315.480**	4.800	4.800	103.200	12.000	4.800	4.800	4.800	4.800	4.800	4.800	**482.880**	**346.680**
	NA2	**518.667**	**518.667**	14.124	14.124	10.714	10.714	10.560	10.560	5.280	5.280	9.350	9.350	**568.695**	**568.695**
	Sub-total Networking	***879.147***	***834.147***	*18.924*	*18.924*	*113.914*	*22.714*	*15.360*	*15.360*	*10.080*	*10.080*	*14.150*	*14.150*	***1051.575***	***915.375***
Access activities	TA1	**351.086**	**351.086**											**351.086**	**351.086**
	TA2	**162.000**	**162.000**											**162.000**	**162.000**
	Sub-total Access	***513.086***	***513.086***											***513.086***	***513.086***
Research activities	JRA1	**1268.220**	**764.220**											**1268.220**	**764.220**
	JRA2	**3491.824**	**1310.224**	170.460	170.460	809.610	380.010	64.080	64.080					**4535.974**	**1924.774**
	JRA3	**5436.456**	**2016.456**							109.200	109.200	182.400	182.400	**5728.056**	**2308.056**
	Sub-total Research	***10196.500***	***4090.900***	*170.460*	*170.460*	*809.610*	*380.010*	*64.080*	*64.080*	*109.200*	*109.200*	*182.400*	*182.400*	***11532.250***	***4997.050***
	Total expected budget (k€)	**11588.733**		**189.384**		**923.524**		**79.440**		**119.280**		**196.550**		**13096.911**	
	Max. Community contribution requested (k€)		**5438.133**		**189.384**		**402.724**		**79.440**		**119.280**		**196.550**		**6425.511**

Table 3: continued

	Amounts (k€)	**exp. budget Sub-total**	**req. budget Sub-total**	**Participant number 12**		**13**		**14**		**15**		**16**		**Total expected budget (k€) Sub-total**	**Max. Community contribution requested (k€)**
				exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.		
Networking activities	NA1	**482.880**	**346.680**	4.800	4.800	4.800	4.800	4.800	4.800	4.800	4.800	4.800	4.800	**506.880**	**370.680**
	NA2	**568.695**	**568.695**	3.960	3.960	47.280	47.280	3.960	3.960	20.416	20.416	13.200	13.200	**657.511**	**657.511**
	Sub-total Networking	***1051.575***	***915.375***	*8.760*	*8.760*	*52.080*	*52.080*	*8.760*	*8.760*	*25.216*	*25.216*	*18.000*	*18.000*	***1164.391***	***1028.191***
Access activities	TA1	**351.086**	**351.086**											**351.086**	**351.086**
	TA2	**162.000**	**162.000**											**162.000**	**162.000**
	Sub-total Access	***513.086***	***513.086***											***513.086***	***513.086***
Research activities	JRA1	**1268.220**	**764.220**	131.400	131.400			131.400	131.400					**1531.020**	**1027.020**
	JRA2	**4535.974**	**1924.774**									184.800	184.800	**4720.774**	**2109.574**
	JRA3	**5728.056**	**2308.056**			131.400	131.400			477.840	477.840	7.200	7.200	**6344.496**	**2924.496**
	Sub-total Research	***11532.250***	***4997.050***	*131.400*	*131.400*	*131.400*	*131.400*	*131.400*	*131.400*	*477.840*	*477.840*	*192.000*	*192.000*	***12596.290***	***6061.090***
	Total expected budget (k€)	**13096.911**		**140.160**		**183.480**		**140.160**		**503.056**		**210.000**		**14273.767**	
	Max. Community contribution requested (k€)		**6425.511**		**140.160**		**183.480**		**140.160**		**503.056**		**210.000**		**7602.367**

Table 3: continued

		Participant number													
	Amounts (k€)	**exp. budget Sub-total**	**req. budget Sub-total**	**17**		**18**		**19**		**20**		**21**		**Total expected budget (k€)**	**Max. Community contribution requested (k€)**
				exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.	exp. budget	req. contrib.		
Networking activities	NA1	**506.880**	**370.680**	4.800	4.800	4.800	4.800	4.800	4.800	4.800	4.800	4.800	4.800	**530.880**	**394.680**
	NA2	**657.511**	**657.511**	8.844	8.844	2.640	2.640	7.920	7.920	5.280	5.280	8.844	8.844	**691.039**	**691.039**
	Sub-total Networking	***1164.391***	***1028.191***	*13.644*	*13.644*	*7.440*	*7.440*	*12.720*	*12.720*	*10.080*	*10.080*	*13.644*	*13.644*	***1221.919***	***1085.719***
Access activities	TA1	**351.086**	**351.086**											**351.086**	**351.086**
	TA2	**162.000**	**162.000**											**162.000**	**162.000**
	Sub-total Access	***513.086***	***513.086***											***513.086***	***513.086***
Research activities	JRA1	**1531.020**	**1027.020**			81.600	81.600	286.800	286.800	163.200	163.200			**2062.620**	**1558.620**
	JRA2	**4720.774**	**2109.574**	243.223	243.223							236.160	236.160	**5200.157**	**2588.957**
	JRA3	**6344.496**	**2924.496**											**6344.496**	**2924.496**
	Sub-total Research	***12596.290***	***6061.090***	*243.223*	*243.223*	*81.600*	*81.600*	*286.800*	*286.800*	*163.200*	*163.200*	*236.160*	*236.160*	***13607.273***	***7072.073***
	Total expected budget (k€)	**14273.767**		**256.867**		**89.040**		**299.520**		**173.280**		**249.804**		**15342.279**	
	Max. Community contribution requested (k€)		**7602.367**		**256.867**		**89.040**		**299.520**		**173.280**		**249.804**		**8670.879**

Figure 1: Overall Implementation Plan

ID	Task Name
1	**NA1: MNGMNT**
2	Phase 1
3	Annual Meeting
4	Preparation of Annual Report
5	Annual Report
6	Phase 2
7	Annual Meeting
8	Preparation of Annual Report
9	Annual Report
10	Phase 3
11	Annual Meeting
12	Preparation of Annual Report
13	Annual Report
14	Phase 4
15	Annual Meeting
16	Preparation of Annual Report
17	Annual Report

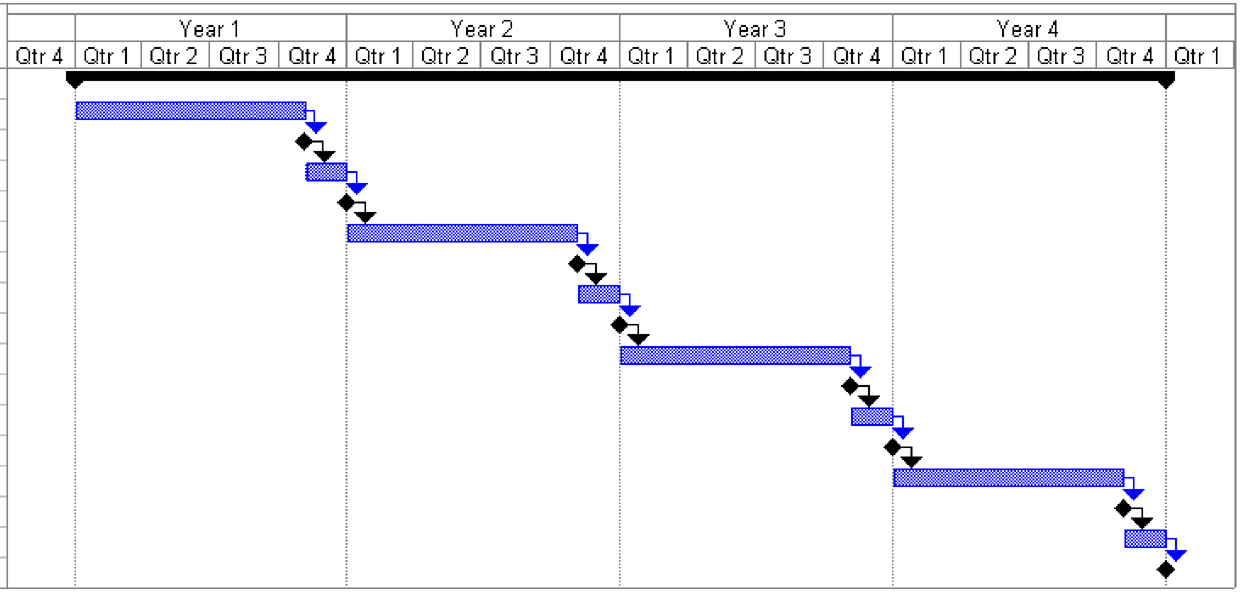

Figure 1: continued

ID	Task Name
18	**NA2: DETNET**
19	**Information exchange**
20	Phase 1
21	1st EUDET Workshop
22	Phase 2
23	2nd EUDET Workshop
24	Phase 3
25	3rd EUDET Workshop
26	Phase 4
27	4th EUDET Workshop
28	**Computing network**
29	Installation of 1st stage
30	1st stage ready
31	Installation of 2nd stage
32	2nd stage ready
33	Installation of 3rd stage
34	Full cluster available
35	Production run
36	Final report
37	**Analysis framework**
38	Framework development
39	Version 1.0 roll-out
40	Production run
41	Final report
42	**Electronic information system**
43	Information system development
44	Version 1.0 roll-out
45	Production run
46	Final report
47	**TA1: TBEAM**
48	Testbeam access
49	**TA2: Access to detector R&D infrastructures**
50	Infrastructure access

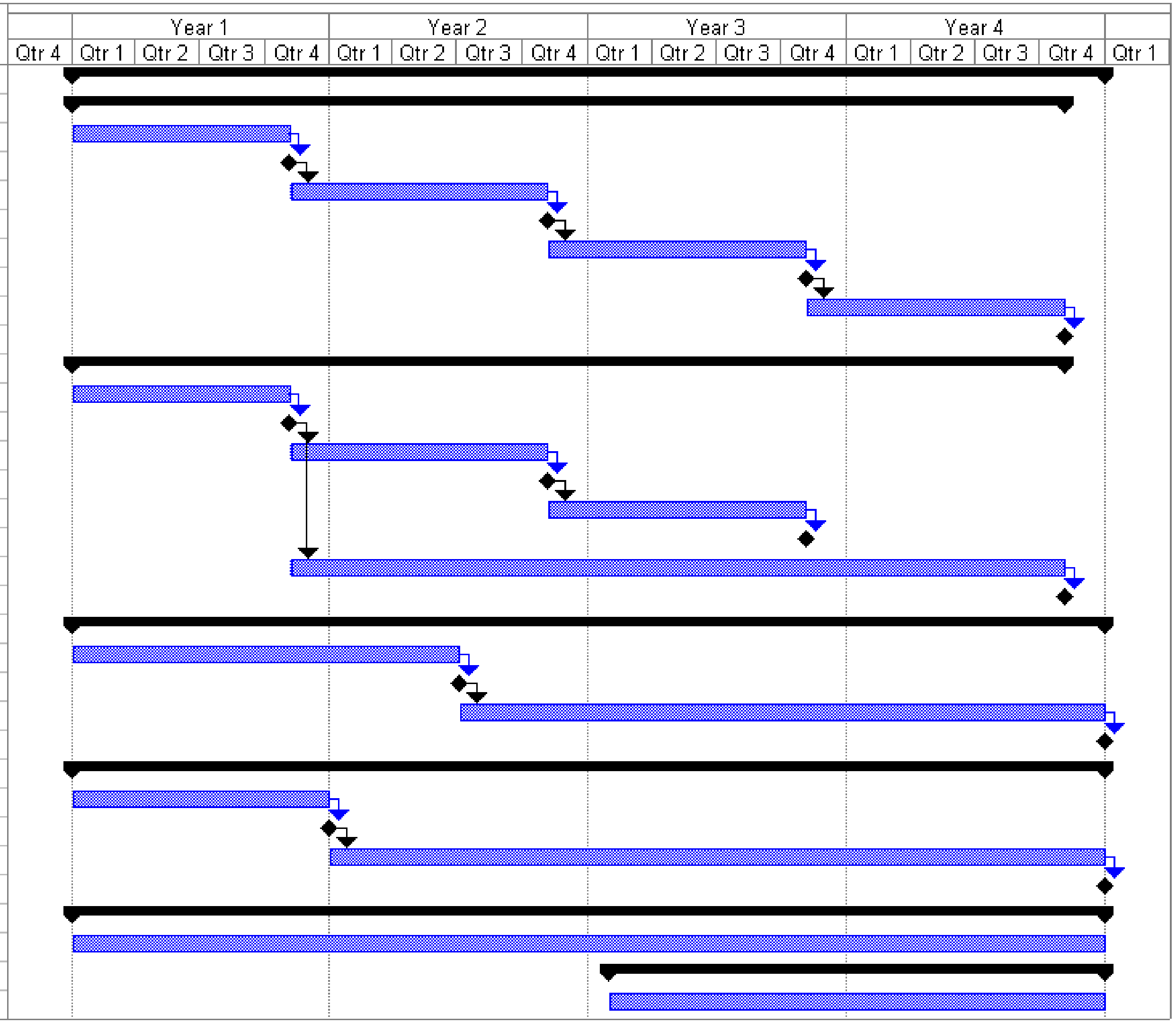

Figure 1: continued

ID	Task Name
51	**JRA1: TBINF**
52	**Magnet**
53	Delivery and installation
54	Magnet ready for operations
55	Magnet available
56	Development of field measurement system
57	Report about field mapping
58	**Environmental support**
59	Design of support system
60	Installation of mounting infrastructure
61	Installation of cooling infrastructure
62	Environmental support ready
63	Environmental support available
64	Final report
65	**Pixel Telescope**
66	Protoyype analog telescop
67	SDC prototype 1 design
68	SDC prototype 1 delivery
69	SDC prototype 1 test
70	SDC prototype 2 design
71	SDC prototype 2 delivery
72	SDC prototype 2 test
73	IDC prototype design
74	IDC prototype delivery
75	IDC prototype test
76	TC design
77	TC delivery
78	Telescope commissioning
79	Telescope ready
80	Telescope available
81	Final report

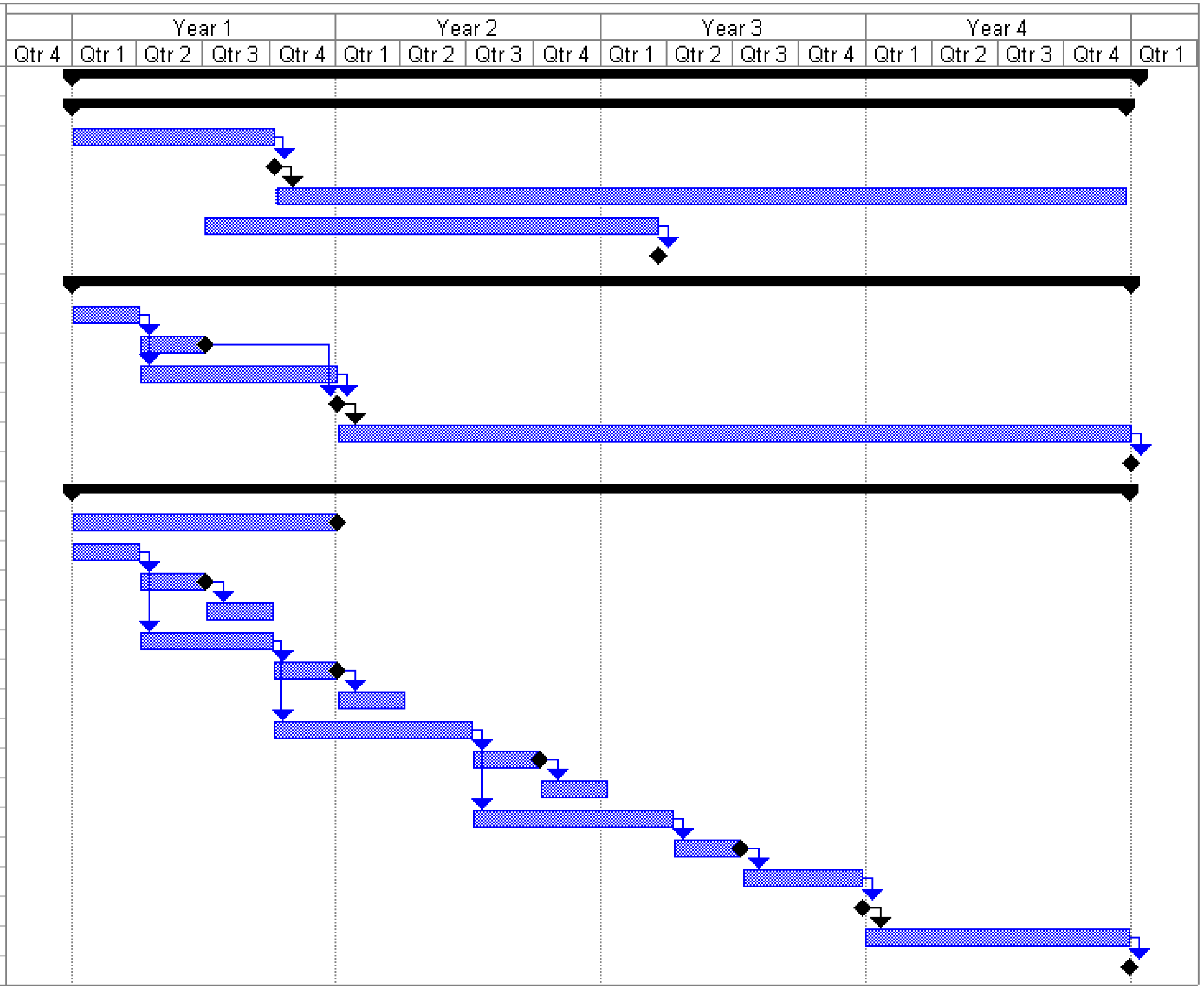

Figure 1: continued

ID	Task Name
82	**Data acquisition**
83	System development
84	Readout for prototype available
85	Development of final readout
86	Final readout ready
87	Tracking software development
88	Software available
89	Readout system available
90	Final report
91	**Validation of Infrastructure**
92	Integration with prototype telescope
93	Tests with prototype telescope
94	Integration with final telescope
95	Tests with final telescope
96	Final report

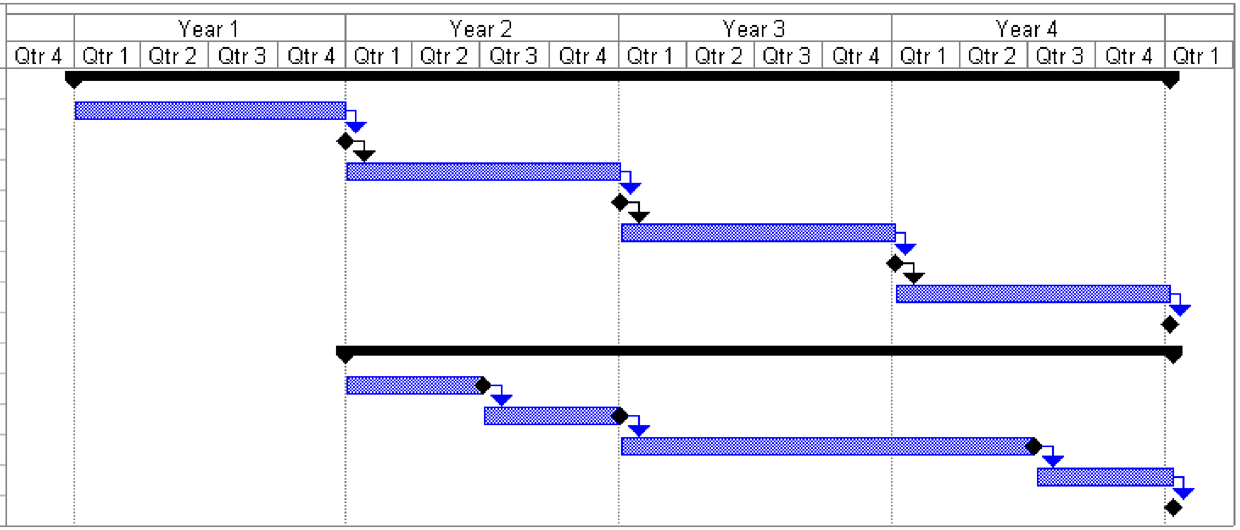

Figure 1: continued

ID	Task Name
97	**JRA2: TDET**
98	**TPC**
99	Fieldcage design
100	Fieldcage construction and test
101	Fieldcage available
102	TPC development infrastructure available
103	Preamplifier development
104	Preamplifier board prototype
105	Production of 1000 channels
106	Integration into FADC/TDC system
107	1000 channel DAQ ready
108	Development of integrated preamplifier and TDC
109	DAQ infrastructure available
110	Final report
111	**SiTPC**
112	Development of TimePix
113	TimePix operational
114	Beam tests
115	MIP signals in TimePix and GEM chamber
116	MIP signals in TimePix and MicroMegas chamber
117	Endplate development
118	Endplate infrastructure available
119	DAQ development
120	SiTPC infrastructure ready for operation
121	SiTPC infrastructure available
122	TPC Simulation
123	Final report

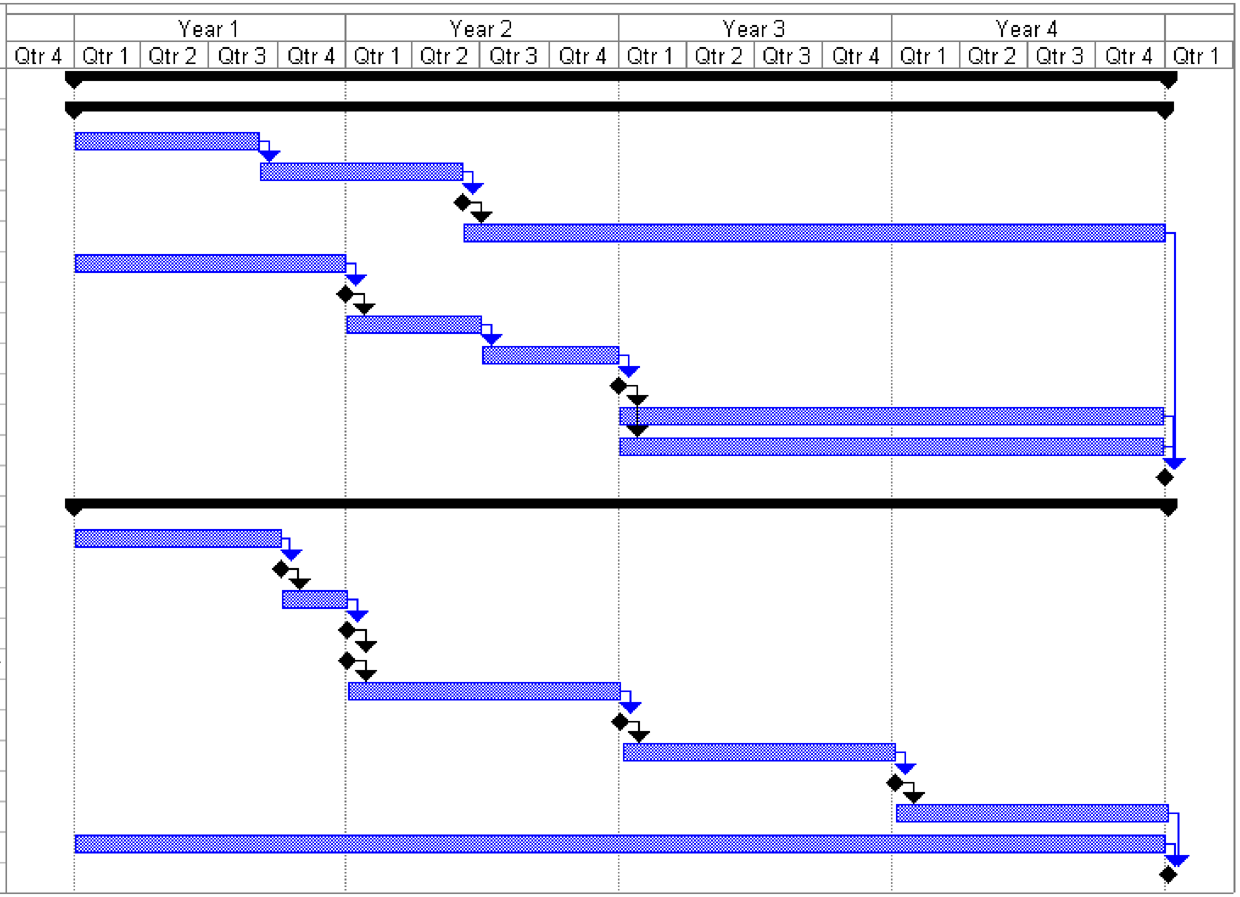

Figure 1: continued

ID	Task Name
124	**Silicon Tracking**
125	Mechanical developments
126	Motorised 3D table ready
127	Cooling system development
128	Convection prototype
129	Cooling system development
130	Conduction prototype
131	Front-end electronics development
132	FE chip version 1
133	Front-end electronics development
134	FE chip version 2
135	Off-detector readout system development
136	Central tracker prototype assembly
137	Central tracker prototype
138	Forward tracker prototype assembly
139	Forward tracker prototype
140	Infrastructure available
141	Final report

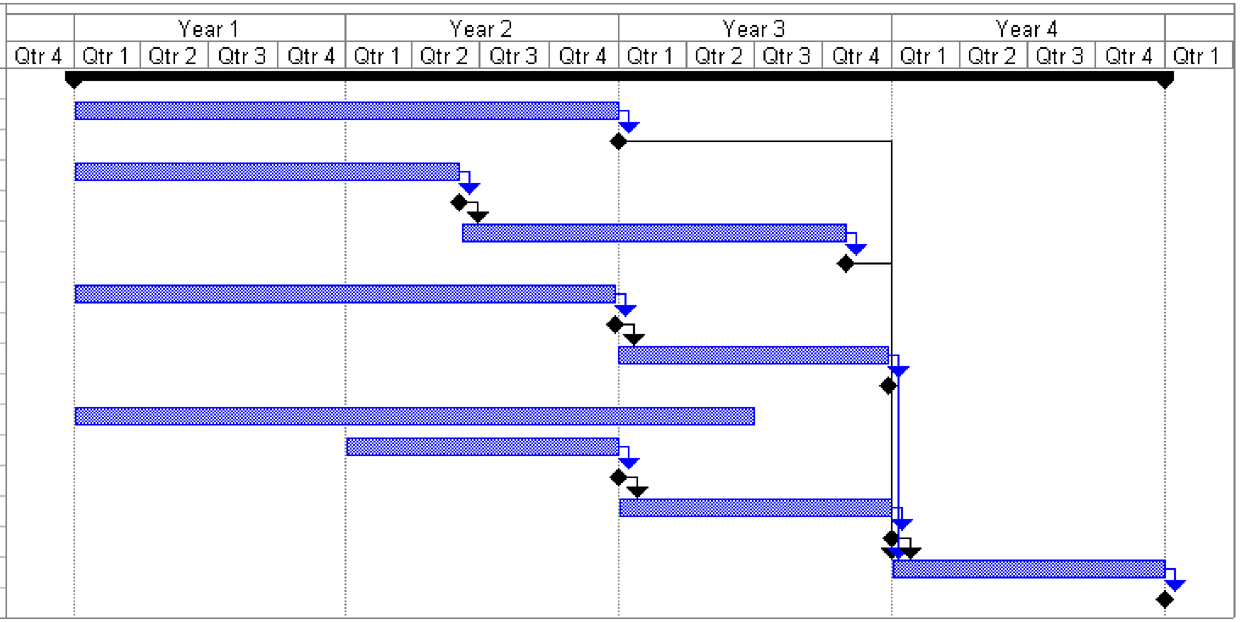

Figure 1: continued

ID	Task Name
142	**JRA3: CALO**
143	**Forward calorimeter**
144	Design of laser positioning system
145	Prototype of laser positioning system
146	Development of sensor test facilities
147	Sensor test facilities ready
148	Development of test facility for partially assemblec
149	Detector test facility ready
150	Development of readout electronics
151	Design of readout electronics
152	Production of readout electronics
153	Test of readout electronics
154	Final report
155	**Electromagnetic calorimeter**
156	Concept validation
157	Finalise process definition
158	Final construction
159	Construction complete
160	Final report
161	**Hadronic calorimeter**
162	Design improved calo stack
163	Improved stack design
164	Stack modification
165	Integration of electronics
166	Integrated system available
167	Module beam test
168	Final report

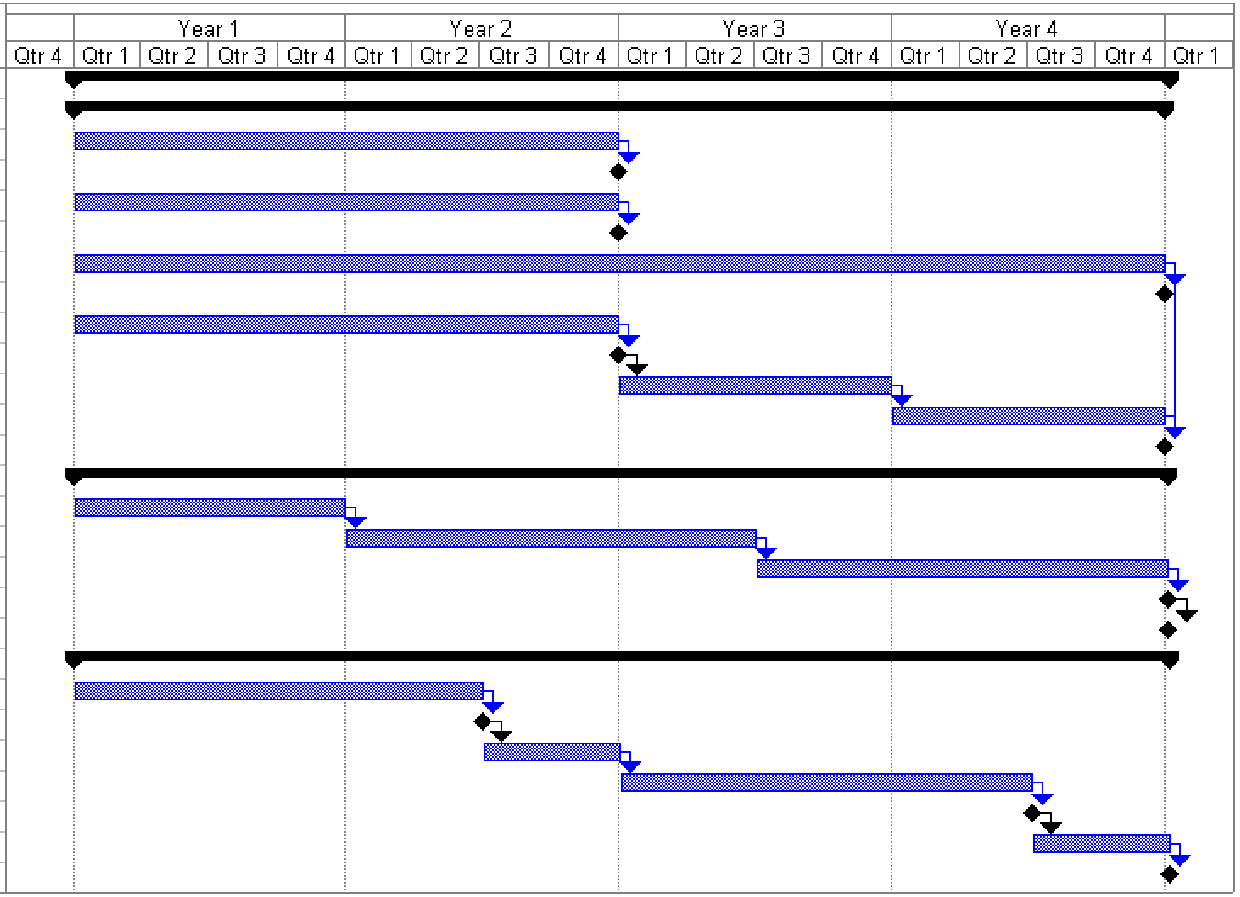

Figure 1: continued

ID	Task Name
169	**Front-end electronics**
170	Design analog ASIC prototype
171	Analog ASIC prototype 1
172	Characterisation of ASIC protoype 1
173	Design of prototype 2
174	Analog ASIC prototype 2
175	Characterisation of ASIC prototype 2
176	ASIC PCB integration
177	Integrated ASIC available
178	AHCAL FE board development
179	AHCAL FE board prototype
180	AHCAL FE boards production
181	AHCAL FE board production ready
182	Conceptual design of DHCAL VFE
183	DHCAL VFE concept
184	DHCAL VFE engineering design
185	DHCAL VFE engineering design available
186	Front-end electronics infrastructure available
187	Final report
188	**Data acquisition**
189	Build and test PCI card prototype
190	Prototype available
191	PCI card production
192	System test
193	Develop final DAQ system for prototypes
194	Final DAQ system
195	Final DAQ system available
196	Final report

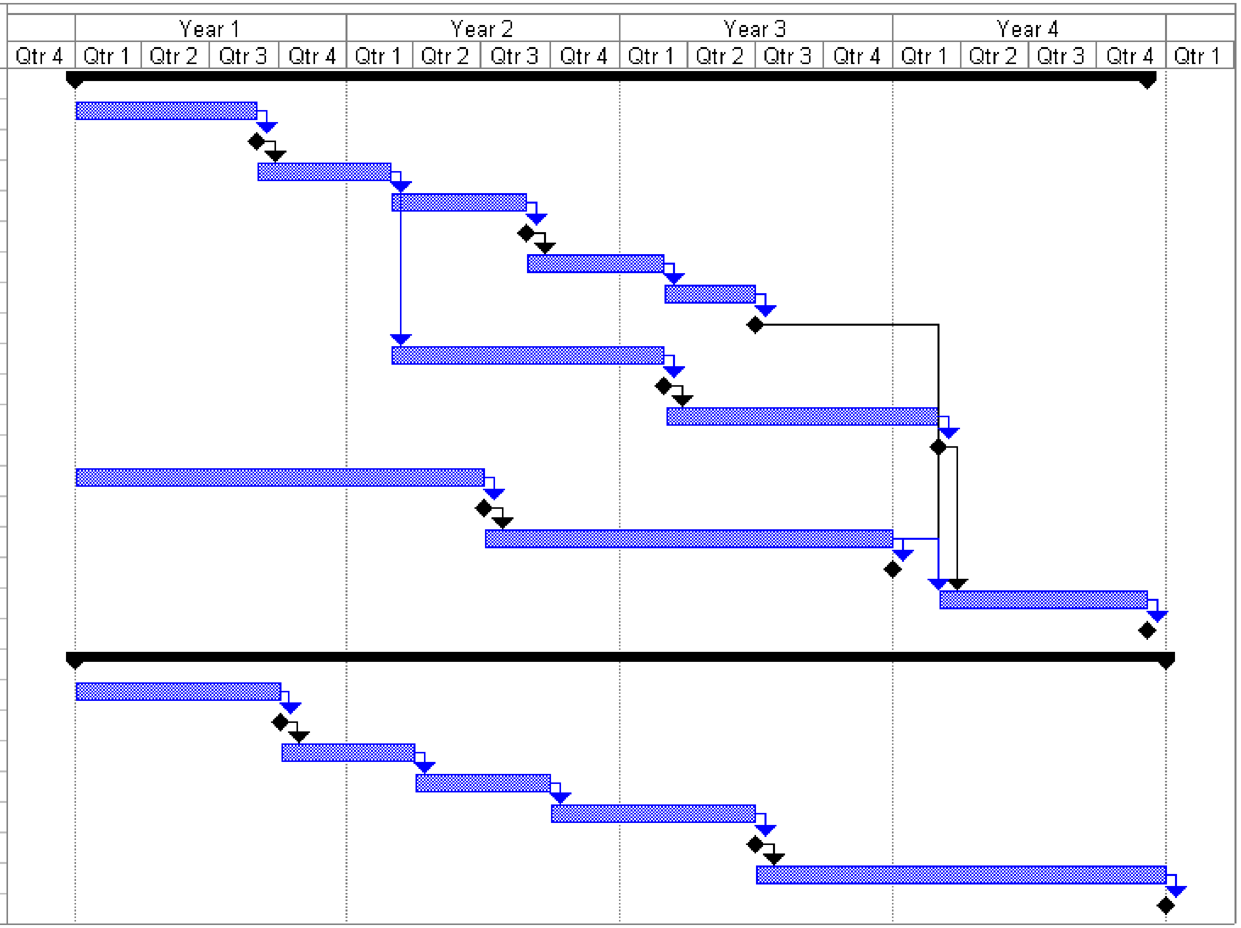

Table 4: Implementation plan for the transnational access activities.

Participant number	Organisation short name	Short name of infrastructure	Installation		Operator country code	Cost model for access	Unit of access	Unit cost (€)	Min. number of access to be provided	Estimated number of users	Estimated number of projects
			number	Short name							
1	DESY	DESY test beam	1	DESY-TB	DE	User Fee	TB week	9203	40	50	10
1	DESY	Beam Telescope	2	BTELE	DE	AC	Week	4500	5	15	5
1	DESY	TPC field cage	3	TPC	DE	AC	Week	4500	10	30	10
1	DESY	Si-TPC monitor	4	SI-TPC	DE	AC	Week	4500	5	15	5
1	DESY	Si strip infrastructure	5	SI-STRIP	DE	AC	Week	4500	5	15	5
1	DESY	Calorimeter infrastructure	6	CALO	DE	AC	Week	4500	5	15	5

Fundamental Objectives

1. Objectives of the Proposed I3 Project and Relevance to the Scheme

1.1. Overall objectives

This proposal aims at creating a coordinated European effort towards research and development for the next generation of large-scale particle detectors. New and advanced detector technologies are needed to fully exploit the potential of future accelerators like the International Linear Collider (ILC) which is being designed in an emerging worldwide collaboration. The importance of the ILC as the next international large scale accelerator facility has been emphasised by the Global Science Forum, which brings together science policy officials from OECD countries[1]. The scientific case for the ILC is strongly supported by the worldwide community of High Energy Physics[2].

We propose a programme to develop infrastructures to facilitate experimentation and to enable the analysis of data using shared equipment and common tools. Our proposal is based on the use of existing facilities and on plans to improve them as required.

While R&D on advanced detector technologies is already being pursued in several institutes their impact is limited by the lack of resources for coordination, networking and common infrastructure. Extensive R&D on detector concepts took place in the past in preparation for the LHC,. The thrust and emphasis of that work were very different from the ones needed for the International Linear Collider mainly with respect to resolution and radiation dependence. With this proposal we aim to rectify the situation through three actions:

- The establishment of a **European detector development network** will improve communication and interaction between groups involved in detector R&D. Within the network, workshops are organised to improve the information exchange between groups. Tools developed within the network will facilitate the easier exchange of data and improve the access to information for participants. The creation of a network for central management for detector R&D will help in coordinating the different activities within Europe and will maintain and intensify the relations with the worldwide detector R&D community beyond EUDET.
- The establishment of three dedicated **Joint Research Activities** with specific actions will coordinate and improve existing infrastructures. This will significantly simplify the participation of European groups in this enterprise and enable them to contribute promptly and significantly to detector developments, and thus to the International Linear Collider project.
- The instrument of **Transnational Access** is used to grant interested groups access to the different infrastructures provided through this initiative. The improvements achieved as a result of this initiative will thus be made available to a much broader physics community.

In summary the proposal if approved will help to maintain and extend Europe's position in advanced detector R&D required for the ILC and beyond.

[1] Report of the OECD Global Science Forum Consultative Group on High Energy Physics, available at http://www.oecd.org/dataoecd/2/32/1944269.pdf.
[2] See http://sbhep1.physics.sunysb.edu/~grannis/lc_consensus.html

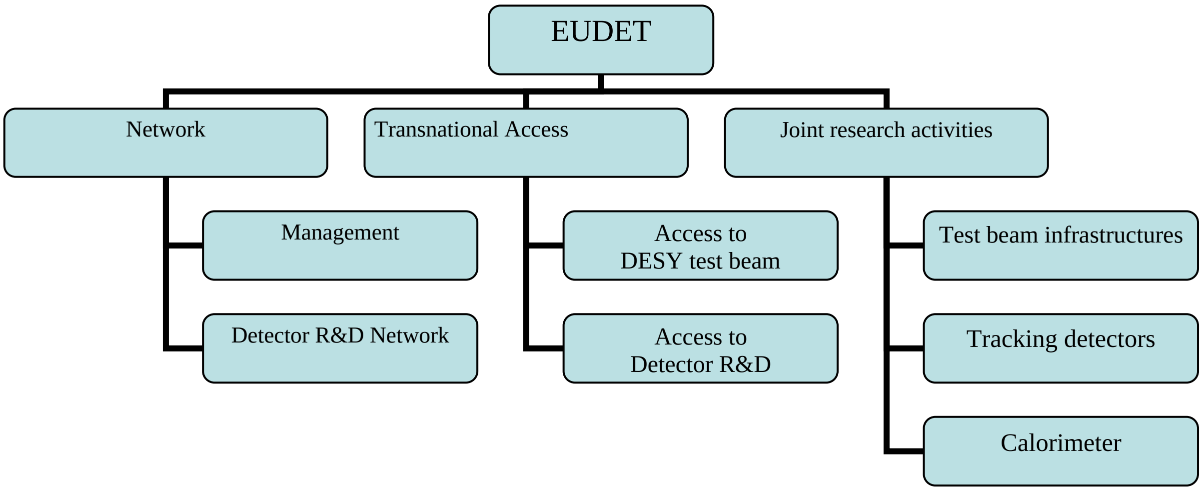

Figure 2: Structure of the I3 "Detector R&D for the International Linear Collider, EUDET"

1.2. Integration

The EUDET proposal will integrate within Europe the research activities, the infrastructures and the expertise of the participating institutions. The research subjects of the initiative pave the way for European institutions to contribute significantly to the areas of detector R&D that are relevant to the next large particle physics projects. They encompass the key technologies needed for the development of tracking detectors, of vertexing, and address the need for a much improved calorimeter system at the next generation of colliders. The proposal comprises many of the infrastructures currently available in Europe for this type of research. It includes a test beam facility at a large European accelerator laboratory (DESY), and nearly all of the laboratories active in the field. This allows the creation of an infrastructure of knowledge and human resources to advance and integrate the European activities.

Of particular importance to this proposal are prototype infrastructures, which enable R&D on advanced detector concepts. The groups participating in EUDET constitute the most active groups in Europe in the field of detector R&D for a linear collider. Thus a large body of know-how is available between the members of the proposal, with a strong commitment by the groups to this type of research. In consequence, the establishment of this initiative will significantly strengthen the European research area on detector R&D far beyond the individual capabilities of each of the participating institutions. It will stimulate the European contribution at the forefront of detector technologies and thus advance the overall state of European technology.

The **Joint Research Activities** of this proposal will serve to develop and build infrastructures which will enable the groups to build and instrument various prototypes to test advanced aspects of the detector concepts for the ILC. With improved **Networking** the ties between the involved EU countries will be strengthened and conditions will be approved which allow the development of an overall and coordinated concept for a detector at the ILC. The **Transnational Access** is realized by providing access to development and to test facilities of the partners for detector development work.

The partners of this proposal have considerable experience in working in large international collaborations as exemplified by their participation in large experimental facilities at CERN, DESY and elsewhere.

1.3. Current status in the scientific area

The ILC planning is progressing rapidly after the decision of the International Technology Recommendation Panel (ITRP) of August 2004. It was recommended that the linear accelerator be built in superconducting acceleration technology. Since then the international community has decided to set up a global design effort team, GDE[3]. Milestones for the effort to realize the International Linear Collider were defined in the fall of 2004. They foresee the delivery of a technical design report for 2007/2008, and first collisions in the machine for 2015. For the detector, parallel steps are proposed so that progress on the detectors will follow in an appropriate and timely manner, such that accelerator and detectors will be ready at the same time. The detector steps were proposed by the organising committee of the worldwide study group (WWSOC) on the Physics and Detectors for the ILC, and accepted by the International Committee on Future Accelerators (ICFA) and the community. An international panel on detector R&D is currently being set up, to coordinate the international activities in the field, with the goal of selecting experiments at the ILC towards the end of this decade. This coincides very well with the proposal activities within this I3, which has a scope of 4 years, if approved.

R&D efforts for detectors at a linear collider have started more than a decade ago. Several concepts using advanced particle detector technologies to match the challenging requirements at the ILC have been developed since then, and European institutes have played leading role in this worldwide effort. This is demonstrated by the Technical Design Report (TDR) for the detector of the TESLA linear collider concept[4] which is mainly based on ideas developed in Europe. Since the publication of the TESLA TDR in 2001 these concepts have evolved and their potential has been verified in many experiments with small-scale prototypes.

Examples for recent research activities of members of our consortium in this field are numerous. Prototypes of vertex detectors based on three different technologies of micro pixel devices have been developed and successfully tested. Small time projection chambers based on different types of new micro pattern gas detectors have been constructed and their potential as main tracking device has been demonstrated. An alternative for this detector component – a long strip Si detector – has been investigated. A first prototype of an integrated calorimeter with high granularity to exploit the promising concept of particle flow algorithms is currently under test[5].

These achievements of the members of our consortium provide a solid base to enter the next phase of the R&D programme in which larger prototypes must be developed and tested to verify the extraplotaion to a large system. The proposed three JRAs target at the development of the necessary infrastructure which enable the required experimentation. They are complemented by the development of a European Detector R&D Network (NA2) which provides the basis for an optimum exploitation of the infrastructure through a common and coherent preparation and analysis of future experiments, and a broad transnational access scheme, to open the infrastructure to all interested groups.

1.4. Mobilization and integration of resources

Our consortium comprises the majority of European institutes working on R&D for the ILC detector. All 21 partners will contribute with their resources to develop and construct the necessary infrastructures to continue and intensify the research towards the ILC. The participants are firmly committed to the project and contribute more than 60% of the total

[3] Report of the ILCSC Task Force for Establishment of the International Linear Collider Global Design Effort http://www.fnal.gov/directorate/icfa/04-03-31_GDI_TF_Report.pdf

[4] TESLA Technical Design Report, Part IV, DESY-01-011, ECFA 2001-209 (2001) http://tesla.desy.de/new_pages/TDR_CD/start.html

[5] http://www.desy.de/f/prc/html/documentation.htm

budget (see table on front page). In addition, we strongly believe that new institutes in Europe will join this effort in the next years as the plans for the ILC will become more and more concrete.
The proposed I3 will improve the communication and collaboration among the partner institutes. Together with the sharing of common infrastructure this will lead to a better synchronization of the developments across different technology choices. A cross-fertilization will take place which will lead to improved detector performance. In addition, with three important components of the ILC detector – vertexing, tracking and calorimetry – contained in the programme, the interplay between them can be studied resulting in an optimum overall detector concept for the ILC.

2. Long Term Sustainability and Structuring Effect

The International Linear Collider has been recognized as the next big project with the highest priority by the High Energy Physics communities around the world. The decision for the superconducting technology for the accelerator itself has very much focused the communities and spurred activities on an unprecedented level on the accelerator side. The laboratories and groups involved are very much committed to make this project a reality within the next ten years. To match this pace in the accelerator community, work on advanced detector concepts needs to start now, to be ready in time for a concrete proposal for a detector at the linear collider at the end of this decade. All the groups involved in this activity are very much committed to this time scale and this programme, and are highly motivated and interested to ensure their participation.
The R&D for the International Linear Collider experiment has so far been mostly concentrated on a few large institutions, which will continue to receive support from their countries. The funds from the EU through this proposal, if approved, will allow them to extend their involvement. More importantly though smaller institutions, who up to now did receive only marginal support from their national funding sources for these activities, will profit greatly from the improved infrastructures and improved networking and from the funds made available through the EU.
The different JRAs proposed will help to build strong collaborative structures within the European research area and thus prepare the way for the eventual exploitation of the next large research infrastructures like the International Linear Collider. The activities proposed will seed larger, more ambitious collaborations for designing and building the large scale detectors of the future. Thus the proposed activities are strongly rooted in the community and build on existing and expanding structures.
The activities in Europe are closely linked to those of the international partners from around the world. The management will put in place structures which will ensure the close interaction with the relevant detector R&D bodies on the international floor, which are currently being setup in the process of defining the global design effort (GDE) team.
The infrastructures developed in this project and the Transnational Access to them will be of importance much beyond the time scale of the proposal. The large ILC detectors will continue to require access to test beams and other facilities of this proposal during the construction phase. Experience from previous large accelerators shows that many functional tests and calibrations of components will be needed in which the facilities developed in this proposal play an important role.

3. Complementarity with Projects funded under previous FP6 Calls

The European Union is providing funds for several projects of the European High Energy Physics community:

1. CARE: Coordinated Accelerator Research in Europe
2. EUROTeV: European Design Study Towards a Global TeV Linear Collider

Both existing programmes support research on and development of particle accelerators and colliders. In addition the European Union is providing funds within the context of ISTC to institutes of the former Soviet Union.

The primary goal of CARE is to integrate the existing infrastructure and expertise on particle accelerators in European laboratories. Therefore it encompasses ongoing research activities on important future accelerator projects, i.e. electron linear accelerator and collider, muon and neutrino beams as well as a high intensity proton accelerator.

The EUROTeV programme will lay the foundations in Europe for the design of a future Electron-Positron Collider in the TeV energy range. There is a large consensus among the international high energy physicists that this collider should be the next large facility running concurrently to the Large Hadron Collider (LHC) at CERN and complementing the physics reach of the LHC. Under the name International Linear Collider (ILC) this project is pursued in an emerging worldwide collaboration.

The ISTC (International Science and Technology Centre)[6] programme is funding part of the contribution by a number of Russian institutions to the developments of novel calorimeter techniques for the linear collider. They are done in close cooperation with Russian scientific and industrial partners. Ties to European institutions do exist, with DESY being a member in the ISTC project on the Linear Collider.

To fully exploit the potential of the ILC particle detectors of unprecedented performance are required which will have to be developed in parallel to the design of the accelerator facility. This proposal is targeting at this indispensable R&D work by supporting an improved and coherent European research on particle detectors focussing on the requirements of the ILC. It will allow the European partners and the international associated institutes to bundle their resources by creating in a research network the necessary infrastructure and to accomplish the R&D work for the ILC detector.

People and resources entering into the programmes described in this proposal are different from the ones used for CARE or EUROTeV. All participating and associated institutes have been performing R&D work for the ILC detector based on independent financial budgets from various national sources. Support from these national sources for detector R&D is expected to continue to enable the participants to contribute to the planned network and infrastructure improvements and to perform experiments at these facilities.

In summary, the programme on detector R&D proposed here ideally complements the European efforts on accelerator developments and prepares a particularly strong European Research Area in a coordinated manner.

[6] For information on the ISTC see http://www.istc.ru

Networking Activities

I. Overall Information

The consortium of this proposal comprises a large part of the European laboratories which have been working over the last years on detector developments for a linear collider.
The development of suitable technologies to design and eventually construct a large scale particle detector requires an intensified collaboration between the European and the international institutes. In particular it is becoming more and more important to focus the available resources into those areas needing most R&D, and to avoid as much as possible the development of duplicate structures. Progress in detector technology relies on the availability of specific infrastructures, needed for the development and for the testing of technologies and prototypes. Through the proposed detector R&D network, the sharing of such infrastructures and the exchange of information between partners will be improved. In addition the network will be designed and operated in such a way that it is as transparent as possible to the outside, and in this way making it easy for groups not yet part of the detector R&D consortium to utilize and profit from the structures put in place.
A very important goal of the proposal is to improve the infrastructure needed to do tests of larger scale prototypes to complement the local R&D efforts. Such experiments however require adequate infrastructure as well as the merging of human and financial resources.
The scheme proposed here is tailored to the needs of the European researchers to intensify their work towards the ILC detector and to enable them to play a very significant role on the international scale. It will allow the improvement and creation of the required infrastructure in Europe and, through the networking, the strengthening of the collaboration between institutes.
The synergy effects through the proposed Management and Detector R&D Network are two-fold. The common analysis framework will intensify the collaboration and accelerate the progress towards obtaining the optimum solution for each individual component of the ILC detector. In addition, the optimization of the detector as a whole for the best possible physics results will be aided by this programme because all major detector elements for which R&D is required to achieve the necessary performance are part of this I3. The framework for simulation and analysis will permit common experiments of multiple detector components. Overall we expect that, if approved, the networking structures put into place will stimulate further the advanced detector research for an ILC in Europe.

II. Activity NA1 – Management of the I3

1. Description of the Management Structure and Tasks

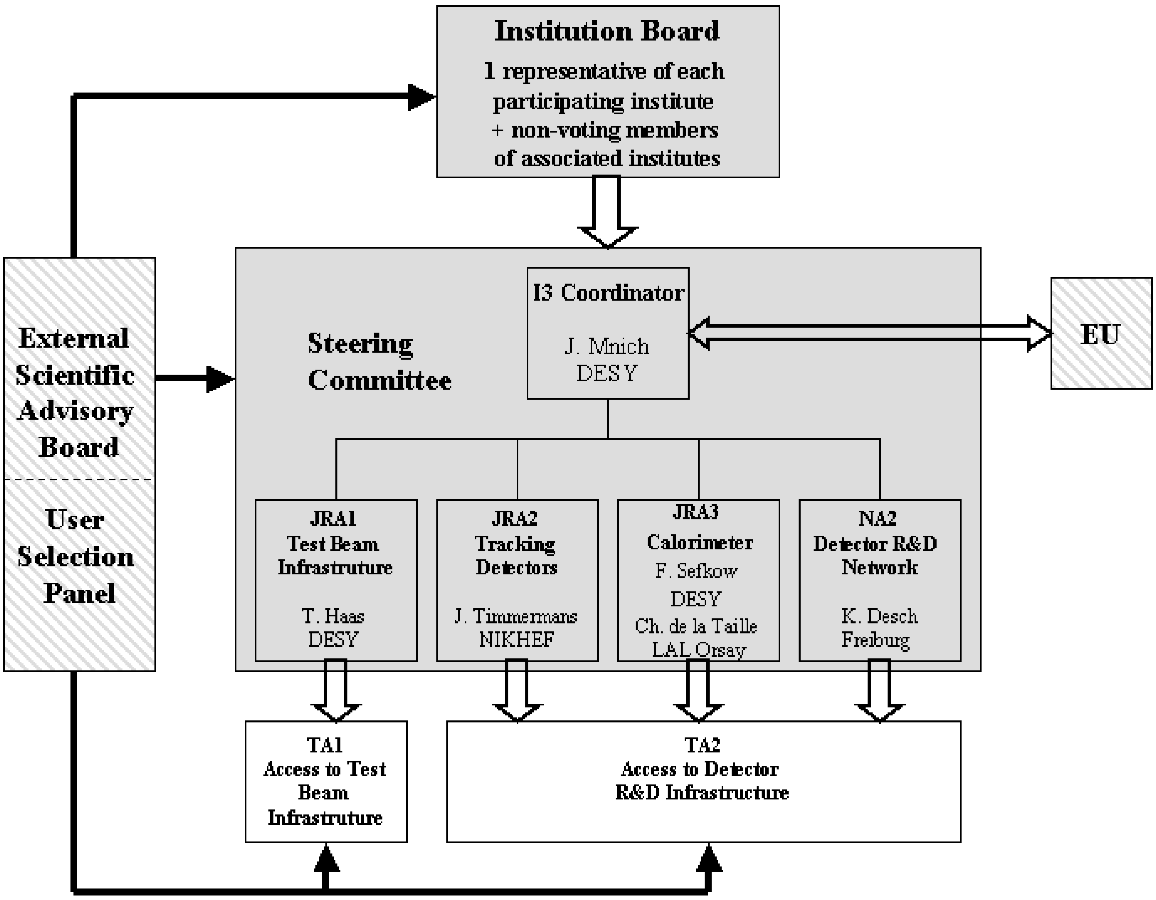

Figure: Overview of the proposed management structure of the I3

EUDET will be coordinated by a central coordinator, who will be assisted and guided by two bodies: the Institution Board and the External Scientific Advisory Board. The participating institutes of EUDET will form a consortium comprising 21 research institutions in Europe, and nine associate institutions from Europe and outside. It is the goal of the proposed management structure to integrate the individual expertise of the participating institutions while maintaining an effective control and decision making process. The managerial structure of EUDET is sketched in the above figure. Its key elements are the Institution Board (IB), the Coordinator of the I3 (IC), and the Steering Committee (SC) composed of the IC and the Activity Coordinators (AC) of the JRAs and the Detector R&D Networking activity. In addition an international External Scientific Advisory Board (ESAB) will advise the management on scientific and strategic questions and provide an important link of the consortium to the international ILC detector community.

At the beginning of the project the participating institutes will formally conclude a Consortium Agreement which sets forth the terms and conditions pursuant to which the participants agree to function and cooperate in the performance of their respective tasks in the Project.

Institution Board (IB):
The IB represents the participating institutes of EUDET. It constitutes the principal body of the Consortium and its decisions are legally binding for all participants. The IB will meet regularly during the Annual Meeting of the Consortium and more often if necessary.
The 21 participating institutes are represented by one voting member each. Associated institutes may attend as non-voting members. The IB elects a chair from within its voting members. The chair convenes the meetings. The I3 Coordinator is a non-voting ex-officio member.
The IB is an arbitration and strategic decision body. It is competent to decide on the orientation of the project and significant changes to the programme. The IB approves the activity and financial report of the past period. It discusses and agrees to the forthcoming budget and its implementation plan for the coming reporting period, after requesting adjustments if necessary. It settles all disputes in the case of failure to meet project assignments. The IB delegates executive power and responsibility to the IC in accordance with the EC contract.

I3 Coordinator (IC):
The IC is the single point of contact between EUDET, the European Commission and third parties. The IC is a representative from DESY, which is the coordinating institute.
The IC is held responsible for the overall management of the project. He acts as the intermediary between the Consortium and the Commission and assures that the Consortium fulfils its duties in accordance with the European Commission Contract. The IC may request topics to be considered by the IB.
The IC receives the budgetary information from the participating institutes and reports to the IB. He receives and allocates financial resources in accordance with the EC contract. The IC chairs the Steering Committee. He informs the IB of the decisions in the SC and conveys the directives of the IB to the SC. The IC may nominate a Scientific Assistant to aid him in his duties.

Activity Coordinators (AC):
The EUDET project divides into three JRAs, the Detector R&D Network that are coordinated by one or two ACs, and the transnational access schemes. These entities themselves are subdivided into individual tasks to which a Task Leader will be attached.
The ACs are charged to track and monitor the progress in their respective activity. They report to the SC on the compliance of the parties with the milestones and deliverables agreed with the European Commission and inform the IC of the status. They are responsible for maintaining good communications inside their tasks, between different activities and contact the IC for specific assistance. They make the results of the work in their activity available to the Consortium.
The ACs, together with the Task Leaders, are also responsible for integrating the tasks of the JRAs into the Transnational Access schemes.

Steering Committee (SC):
The SC is the executive board of EUDET. It is responsible for reviewing and ensuring the implementation of the project (subject to the approval by the IB). It is composed of six voting members: the I3 Coordinator and the five ACs of the JRAs and the Detector R&D Network. The Chair of the ESAB may participate as a non-voting member. The IC chairs the SC.
The SC meets a few times a year in person or through electronic means to receive the report of the ACs on the progress of the individual tasks in their activity. The SC oversees and reviews the work progress and decides on overall technical matters, prepares proposals for approval by the IB, prepares the Consortium budget, consolidates the reports received from

the ACs and prepares the reports and deliverables to be submitted to the European Commission.
The SC proposes to the IB the inclusion and exclusion of scientific tasks and decides on the regrouping of sub-tasks therein. The SC nominates replacement Coordinators if and when necessary and submits their nomination for approval to the IB. The SC nominates the members of the ESAB.

External Scientific Advisory Board (ESAB):
The ESAB will be asked to independently assess the progress of the various tasks and their scientific excellence. The members of the ESAB will be nominated by the SC and include renowned international experts on detector developments. The international community plans to setup an international detector R&D review panel. Once in place, at least one member of the ESAB should at any time be also a member of this international detector R&D panel, to ensure a close coordination between the European and the worldwide activities.
The members of the ESAB will be asked to relate the efforts in EUDET to efforts elsewhere and to critically review the contribution of the project towards the design of detectors for the ILC and possible other applications of interest. The advisors will be invited to participate in the Annual Meeting of the Consortium and base their recommendations on the presentations made at that occasion.
The ESAB will elect a chair from its membership. The Chair of the ESAB participates in the meetings of the SC as a non-voting member.

Annual Meeting of the Consortium
The Annual Meeting assumes a vital role for the Consortium. It serves the following purpose:

- To critically review the scientific progress of the consortium.
- To inform the members of the IB.
- To inform the members of the ESAB and receive their input.
- To address any outstanding organizational issues for the consortium

The Annual Meeting consists of comprehensive presentations of the achievements of the individual activities and tasks. It includes a meeting of the Institution Board. The Annual Meeting will be hosted by different partners organised towards the end of a 12 month period of the project in conjunction with the Annual Scientific Workshop. In case of approval the SC will organize a kick-off meeting of the consortium at the earliest convenience to launch the intensified collaboration and plan the work of the first year.

Quality of the management

The designated I3 Coordinator is a scientist from DESY with a long-standing experience in managing scientific collaborations. During the operation of the LEP collider he coordinated for two years all scientific analyses of the L3 experiment at CERN involving more than 100 physicists. For five years he led a university group contributing to the R&D effort for the ILC detector. Currently he is chairing a large group of researchers in the CMS experiment at the LHC collider which is in charge of the preparation of an important part of the physics analyses. The other members of the SC are physicists with an international reputation and recognized leadership. They have been involved with R&D for the ILC for many years, and thus are well integrated into the subject and into the community.

User selection

The European members of the ESAB will act as User Selection Panel for the Transnational Access activities under this proposal. The following criteria will be applied in the user selection procedure:

- Scientific excellence
- Scientific relevance for the development of advanced particle detectors
- Optimal use of the infrastructure.
- Attracting new user groups from outside the consortium

The SC is responsible for guaranteeing a transparent, fair and impartial access to the infrastructures. It has to report to the Institution Board and the External Scientific Advisory Board about the implementation and progress of the TA activities at the Annual Meetings. The IC and the coordinating institute DESY will be charged with the administrative duties of the user selection.

2. Resources for the Management of the I3

According to the proposed structure the main part of the management tasks will be delivered by the six members of the Steering Committee. These members are leading physicists elected among the partners of the consortium. During their term in the SC these physicists are expected to spend a significant portion of their working time on their management tasks.
The total human effort provided by the participants for the management of the I3 in the SC is detailed in Table 5. This contribution of the partners to the management corresponds to 72 professional person months (ppm) for the four year duration of the programme.

Table 5: Total human effort of the participants in the management of the I3

Human effort for the management of the I3					
		Name	Partner institute	Percentage of working time	Person month
Co-ordinator of the I3		J. Mnich	DESY	50	24
Administrative Secretary		NN	DESY	50	24
Co-ordinators	JRA 1	T. Haas	DESY	25	12
	JRA 2	J. Timmermans	FOM/NIKHEF	25	12
	JRA 3	F.Sefkow	DESY	12.5	6
		Ch. de la Taille	CNRS	12.5	6
	Detector R&D network	K. Desch	ALU-FR	25	12

The management of the programme is assisted by an Administrative Secretary (AS) to aid the SC. The AS will aid the coordinator in administrative tasks, in the correspondence with the EU and the members of the SC and IB as well as in the organization of management meetings. He or she will organize the annual meetings of the consortium and the annual

scientific workshop. The AS will also assist the management in the task of dissemination of knowledge. The administration and the regular update of the web pages of the I3 will be part of the charges. The funding for 0.5 FTE is part of the request.
The regular meetings of the management bodies cause travel expenses for the members. We estimate a total annual expenditure for management meetings per member of 1500 € for the SC, 700 € for the Institution Board and 700 € for the ESAB (5 members) resulting in a total request of 106 K€.
We include in our request a budget of 30 K€ for additional travel money at the disposal of the SC. This budget is to cover visits of the management to participating laboratories, to invite in case of need external experts to the laboratories and other necessary actions of the management. The consortium wants to support the organisation of topical conferences on particle detector developments for instance by providing grants for international participants. To this end a budget item of 20 K€ is requested at the disposal of the SC.
The required auditing will cause total costs of 84 K€ for the participating institutes, assuming a bi-annual audition cycle. A flat rate of 15 K€ for consumables is required. The total budget for the management is summarized in Table 6.

Table 6: Cost summary for the Management Activity (NA1) per participant

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
DESY	AC	Personnel	24.00 ppm	125.000
		Travels	Management, SC Meetings, ESAB Meetings, IB Meetings	86.900
		Consumables	Auditing, Management Software	19.000
		Indirect Costs	20% of all costs above	46.180
			Total	**277.080**
			EC requested contribution	**277.080**
			AC participants estimated internal costs	**262.500**
AGH-UST	AC	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
			Total	**4.800**
			EC requested contribution	**4.800**
			AC participants estimated internal costs	**0.000**
ALU-FR	AC	Personnel		0.000
		Travels	SC Meetings	6.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	2.000
			Total	**12.000**
			EC requested contribution	**12.000**
			AC participants estimated internal costs	**89.280**
CEA	FC	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs		0.800
			Total	**4.800**

		EC requested contribution		**4.800**
CNRS/IN2P3	**FCF**	Personnel	6.00 ppm	37.500
		Travels	SC Meetings	6.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	9.500
		Total		**57.000**
		EC requested contribution		**12.000**
CSIC	**FC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.800
		Indirect Costs	20% of all costs above	0.000
		Total		**4.800**
		EC requested contribution		**4.800**
CUPRAGUE	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
		Total		**4.800**
		EC requested contribution		**4.800**
		AC participants estimated internal costs		**0.000**
FOM/NIKHEF	**FCF**	Personnel	12.00 ppm	76.000
		Travels	SC Meetings	6.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	17.200
		Total		**103.200**
		EC requested contribution		**12.000**
HIP	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
		Total		**4.800**
		EC requested contribution		**4.800**
		AC participants estimated internal costs		**0.000**
INPPAS	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
		Total		**4.800**
		EC requested contribution		**4.800**
		AC participants estimated internal costs		**0.000**
IPASCR	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
		Total		**4.800**

		EC requested contribution		**4.800**
		AC participants estimated internal costs		**0.000**
MPI	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
		Total		**4.800**
		EC requested contribution		**4.800**
		AC participants estimated internal costs		**0.000**
TAU	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
		Total		**4.800**
		EC requested contribution		**4.800**
		AC participants estimated internal costs		**0.000**
UBONN	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
		Total		**4.800**
		EC requested contribution		**4.800**
		AC participants estimated internal costs		**0.000**
UCL	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
		Total		**4.800**
		EC requested contribution		**4.800**
		AC participants estimated internal costs		**0.000**
UHAM	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
		Total		**4.800**
		EC requested contribution		**4.800**
		AC participants estimated internal costs		**0.000**
ULUND	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
		Total		**4.800**
		EC requested contribution		**4.800**
		AC participants estimated internal costs		**0.000**
UMA	**AC**	Personnel		0.000

		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
			Total	**4.800**
			EC requested contribution	**4.800**
			AC participants estimated internal costs	**0.000**
UNI-GE	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
			Total	**4.800**
			EC requested contribution	**4.800**
			AC participants estimated internal costs	**0.000**
UNIVBRIS	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
			Total	**4.800**
			EC requested contribution	**4.800**
			AC participants estimated internal costs	**0.000**
UROS	**AC**	Personnel		0.000
		Travels		0.000
		Consumables	Auditing	4.000
		Indirect Costs	20% of all costs above	0.800
			Total	**4.800**
			EC requested contribution	**4.800**
			AC participants estimated internal costs	**0.000**
Grand Total NA1			**Total** (incl. estim. internal costs of AC part.)	**882.660**
			EC requested contribution	**394.680**

3. Plan for the Use and Dissemination of Knowledge

For the internal exchange of information we intend to organize an Annual Scientific Workshop where scientists are supposed to give reports of the status and plans of their work within the different tasks. This will be supplemented by overview talks which summarize the achievements of the individual tasks, activities and the project as a whole. Write-ups of the oral presentations will be prepared which then form the basis of an annual progress report. In addition regular meetings of sub-groups will be organized to discuss day-to-day affairs inside and between the various tasks and activities. We plan to use modern telecommunication technologies where applicable to reduce time and costs spent for travelling. To this end also the rapid development of a web-based information exchange system as part of the NA 2 activity will be essential.

The strategic goal of this I3 proposal to create a common infrastructure for advanced detector R&D will stimulate the formation of inter-institutional groups performing common experiments. The preparation and analysis of these experiments will be performed inside the common software framework which is another focal point of our networking activities. Naturally this tight collaboration will lead to the spreading of skills and information and the sharing of the achievements of the consortium. It should be noted that large scale international collaborations are nowadays typical in High Energy Physics and that all partners in this consortium have a long-standing successful experience in working in such kind of international environment.

The results and achievements of our consortium will be communicated to the interested community outside freely and without charges as it is the tradition in this kind of fundamental research. One measure to spread information and to interact with the scientific community working on the ILC is the active participation in conferences on the ILC as organized on a European scale by the European Committee on Future Accelerators (ECFA) and internationally in the framework of the Linear Collider Workshops (LCWS). These meetings will be used to actively discuss developments and trends with international colleagues. We believe that our consortium can have a large impact on the design decisions for the ILC detector and this way help to prepare a leading role for European participants in its construction and later exploitation.

Because the results of our activities are not limited to the ILC detectors we intend also to participate at international conference on detector technologies, e.g. the IEEE conference series or other international conferences where advanced detector technologies are part of the programme, and interact with the scientific community. We will give reports on the progress of the intended infrastructure developments, spread information on its capabilities to attract new potential users and present the developments on detector technologies achieved by the consortium. Members of the consortium will also give lectures on developments in advanced particle detectors at schools organized for students.

We intend to financially support the organization of topical conferences to stimulate the discussions on an international level. These could be specialized workshops organized by a small number of people to tackle an urgent problem. Informal notes will be written and publicized through the web pages to quickly spread information. Finally, all relevant achievements of the consortium will be submitted for publication to scientific journals.

Many aspects investigated are not restricted to the ILC detectors but can be applied to other future collider experiments, and detector applications beyond the immediate area of high energy physics experiments. Even more generally the programme is tailored to create and improve infrastructure for tests of advanced particle detectors and might have impact and application in fields beyond High Energy Physics. For example the Si-TPC pixel CMOS readout ASICs are being studied for their application in large gaseous detectors, but there exists a large synergy between their development and the needs of such systems in new generations of e.g. industrially produced X-ray (medical) imaging detector systems.

The results of our research projects will be freely communicated and therefore we will not apply for patents or licences or conclude business agreements.

III. Activity NA2 – Detector R&D Network DETNET

Networking Activity description: Detector R&D Network DETNET								
Activity number	**NA2**	**Start month**	**1**			**End month**		**48**
Activity Title	Detector R&D Network							
Participant number	3	1	2	4	5	6	7	8
Participant short name	ALU-FR	DESY	AGH-UST	CEA	CNRS/ IN2P3	CSIC	CUPRAGUE	FOM/ NIKHEF
Total person month	51	30						

Activity Title	Detector R&D Network							
Participant number	9	10	11	12	13	14	15	16
Participant short name	HIP	INPPAS	IPASCR	MPI	TAU	UBONN	UCL	UHAM
Total person month			5		12			

Activity Title	Detector R&D Network							
Participant number	17	18	19	20	21			**TOTAL**
Participant short name	ULUND	UMA	UNI-GE	UNIV BRIS	UROS			
Total person month								**98**

Objectives and expected impact:

An essential part of this project is to create a network of European institutions which are participating in detector R&D for the ILC. This network will strengthen the European part of the worldwide efforts towards a detector at the ILC. Thus an important aspect of this proposal, apart from networking within the participating institutes, is to ensure close cooperation with other activities around the world.
The main objective here is to provide a common framework for the exchange of information and a platform for coherent R&D on particle detectors in Europe. This network has therefore two components: Firstly through the organisation of workshops, through travel to partner institutions and common experimental programmes, a human network will be created. Secondly a common software framework will be developed to simulate and analyse the experiments with prototype detectors at test beam and other facilities.
All partners of the consortium will actively participate in this activity. This includes the use of the common computer hardware and software infrastructure to exchange data and to perform common analyses and simulations. Visits of partner institutes and the participation at the Annual Scientific Workshop are other aspects of this activity to which all members of the consortium contribute. Four institutes – ALU-FR, DESY, IPASCR and TAU – will contribute to the creation of this networking infrastructure.
We expect that the proposed Detector R&D Network will have a very positive impact on the international research efforts for the ILC. It facilitates the exchange and the common use of software for simulation, reconstruction and interpretation of experiments and thus avoids parallel developments for identical and similar tasks. Acquired data can be easily compared and analysed by different groups. The network encompasses all sub-components for which massive R&D efforts are necessary and thus is the pre-requisite to achieve an optimum design for the overall ILC detector performance.

The Activity Coordinator is responsible for the monitoring of the success and impact of the network. He or she will report on results and the compliance with milestones and deliverables to the Steering Committee. The AC is aided in this process by the Task Leaders.

Description of work:

The work necessary to arrive at the proposed network consists of the following tasks:

A. A high performance dedicated computer cluster for the common data analysis and simulation work must be set up. This cluster will be located at the three contributing institutes Freiburg University, DESY and Tel Aviv University making use of their infrastructure and data network connections. These centres will be interconnected and connected to the rest of the consortium using GRID technology enabling transparent sharing and coherent use of the resources in the consortium. The technical infrastructure needed to operate the computer and the technical service will be provided by the three laboratories. The amount of computing power and storage space will increase over the course of our programme. We assume a constant spending profile for the first 3 years of the programme such that the full computing capacity is available in the fourth year when all infrastructure projects are operational. Participants contributing own funds to this task are ALU-FR, DESY, IPASCR, TAU.

B. The development of a common data analysis and simulation infrastructure. This tasks sub-divides into
   - Design of a software framework using modern software technology to exchange test beam data and software for common analysis and comparison of measurements;
   - Design of a software framework for the simulation of test beam experiment needed for the interpretation of the measurements;
   - The creation of a repository for experimental and simulation data;
   - Embedding into existing GRID infrastructure to allow easy exchange of data and a transparent exploitation of other available computing resources.

   Documentation and its regular update are of utmost importance here to spread the information and to enable all potential users to profit from the developments. The participants in this Networking Activity will contribute by properly defining the requirements of the framework, providing and interfacing simulation and reconstruction software for the various detector technologies and by testing the framework. We expect to have a first version of the common data analysis and simulation framework ready after 18 month. This development however must continue throughout the whole duration of the project to cope with the increasing demands caused by the accumulation of data and the expected increasing complexity of the experiments. Participants contributing own funds to this task are DESY, IPASCR.

C. The development of a web-based information system to exchange information between the partners and to provide easy access to documents. Likewise it will facilitate the interaction with other international partners. The participants will contribute to these tasks by providing information in a suitable form. We believe that a first useable version of this system can be created within one year but that it must be maintained and improved over the full duration of this project. One participant contributes own funds to this task: TAU.

D. In addition to the electronic information exchange personal contact and discussions between all participating researchers will be very important. To this end we foresee to encourage visits of physicists at partner institutes to intensify the collaboration and the organisation of an Annual Scientific Workshop where all participants are supposed to present the status of their work. To enhance the information exchange with the international community we will support the participation of members of our consortium at important international conference where matters related to our project are discussed.

Milestones:

We consider the following events to be important milestones in the assembly of the proposed Detector R&D Network:

Milestone	Date	Task
1st stage of computing network installed	10	1
1st EUDET workshop	10	4
Version 1.0 of electronic information system ready	12	3
Version 1.0 of analysis framework ready	18	2
2nd EUDET workshop	22	4
2nd stage of computing network installed	22	1
Full computer cluster available	34	1
3rd EUDET workshop	34	4
Final EUDET workshop	46	4

Deliverables:

Deliverable No	Deliverable title	Deliverable date	Nature	Task
D1	Version 1.0 of electronic information system	12	Software	C
D2	Proceedings of 1st EUDET workshop	12	Report	D
D3	Version 1.0 of analysis framework	18	Software	B
D4	Proceedings of 2nd EUDET workshop	24	Report	D
D5	Full computer cluster	34	Hardware	A
D6	Proceedings of 3rd EUDET workshop	36	Report	D
D7	Final report	48	Report	A
D8	Final report	48	Report	B
D9	Final report	48	Report	C
D10	Proceedings of last EUDET workshop	48	Report	D

Resources:

Adequate computing and data storage resources are a key element to successfully implement the idea of the European Detector R&D Network. The computing requirements are driven by the need of sophisticated reconstruction algorithms necessary to fully exploit the potential of new detector technologies. The large scale prototypes do require detailed simulations by Monte Carlo techniques to prepare the experiments and to correctly interpret the experimental data. All participants do have large expertise in this field through participation in large scale collider experiments and through the preceding R&D studies on new detector technologies.
We orientate the design of this computing infrastructure along the lines of the Grid technology which is used already successfully in large international experiments of high energy physics and will be the backbone of the experiments at the LHC and later at the ILC. Several members of the participating institutes are involved in experiments using Grid technology for their computing needs and we estimate the requirements for this proposal based on their experience.
The total required hardware resources for computing are estimated to be 87 kSI2000[7] units of CPU power and 60 TeraByte (TB) of disk space with fast network connections plus 75 TB of backup storage space on tape. To set the scale this corresponds to about 10% of the estimated computing needs for 100 physicists working at an LHC experiment. In our estimate we include the anticipated reduction in computer hardware costs which is expected to continue to follow Moore's law for CPU power for the next years but to reach saturation for storage media.
The proposed build up of the computing infrastructure follows a constant spending profile during the first three years of the project allowing an immediate start of software development and testing. Most of the hardware is purchased at lower unit prices in later years such that the full infrastructure is available for exploitation in the fourth year when the full infrastructure of this I3 project is available. Details of the requested support for computing hardware are given below.

All costs given in k€

Requirements for computing hardware											
	Unit	Expected total needs (2008)	Expected unit price in 2006 (k€)	Request							
				2006		2007		2008		**Sum**	
				units	cost	units	cost	units	cost	**units**	**Cost**
CPU	kSI2000	87	0.6	20	12	27	12	40	10	**87**	**34**
Disk	TB	60	1.2	15	18	20	18	25	15	**60**	**51**
Tape	TB	75	0.25	20	5	25	5	30	5	**75**	**15**
Network switches					2		2		3		**7**
Sum					**37**		**37**		**33**		**107**

The technical services, including approximately 0.5 FTE of person power, required to operate this computer cluster will be provided by the computer centres of the participating institutes where the hardware will be located. A professional software engineer is needed to design, create and document the common software framework over the full duration of the project. Funding for a total of 36 ppm is included in our request. For the support and installation of the WEB based information system we include a request of 6 ppm.

[7] A Pentium IV Xeon processor at 2.8 MHz corresponds to about 1 kSI2000

Table 7 Cost summary for the Networking Activity DETNET (NA2) per participant

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
DESY	**AC**	Personnel	18.00 ppm	93.750
		Travels	1.1 k€ per total part. FTE (12ppm)	51.353
		Consumables	Computer hardware	38.250
		Indirect Costs	20% of all costs above	36.671
			Total	**220.023**
			EC requested contribution	**220.023**
			AC participants estimated internal costs	**75.000**
AGH-UST	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	4.400
		Consumables		0.000
		Indirect Costs	20% of all costs above	0.880
			Total	**5.280**
			EC requested contribution	**5.280**
			AC participants estimated internal costs	**0.000**
ALU-FR	**AC**	Personnel	18.00 ppm	93.750
		Travels	1.1 k€ per total part. FTE (12ppm)	21.423
		Consumables	Computer hardware	38.250
		Indirect Costs	20% of all costs above	30.685
			Total	**184.108**
			EC requested contribution	**184.108**
			AC participants estimated internal costs	**207.000**
CEA	**FC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	9.262
		Consumables		0.000
		Indirect Costs		0.000
			Total	**9.262**
			EC requested contribution	**9.262**
CNRS/IN2P3	**FCF**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	76.912
		Consumables		0.000
		Indirect Costs	20% of all costs above	15.382
			Total	**92.294**
			EC requested contribution	**92.294**
CSIC	**FC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	6.417
		Consumables		0.000
		Indirect Costs		1.283
			Total	**7.700**
			EC requested contribution	**7.700**
CUPRAGUE	**AC**	Personnel		0.000

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
		Travels	1.1 k€ per total part. FTE (12ppm)	11.770
		Consumables		0.000
		Indirect Costs	20% of all costs above	2.354
			Total	**14.124**
			EC requested contribution	**14.124**
			AC participants estimated internal costs	**0.000**
FOM/NIKHEF	**FCF**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	8.928
		Consumables		0.000
		Indirect Costs	20% of all costs above	1.786
			Total	**10.714**
			EC requested contribution	**10.714**
HIP	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	8.800
		Consumables		0.000
		Indirect Costs	20% of all costs above	1.760
			Total	**10.560**
			EC requested contribution	**10.560**
			AC participants estimated internal costs	**0.000**
INPPAS	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	4.400
		Consumables		0.000
		Indirect Costs	20% of all costs above	0.880
			Total	**5.280**
			EC requested contribution	**5.280**
			AC participants estimated internal costs	**0.000**
IPASCR	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	7.792
		Consumables		0.000
		Indirect Costs	20% of all costs above	1.558
			Total	**9.350**
			EC requested contribution	**9.350**
			AC participants estimated internal costs	**18.000**
MPI	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	3.300
		Consumables		0.000
		Indirect Costs	20% of all costs above	0.660
			Total	**3.960**
			EC requested contribution	**3.960**
			AC participants estimated internal costs	**0.000**
TAU	**AC**	Personnel	6.00 ppm	25.000
		Travels	1.1 k€ per total part. FTE (12ppm)	4.400
		Consumables	Computer hardware	10.000

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
		Indirect Costs	20% of all costs above	7.880
			Total	**47.280**
			EC requested contribution	**47.280**
			AC participants estimated internal costs	**57.600**
UBONN	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	3.300
		Consumables		0.000
		Indirect Costs	20% of all costs above	0.660
			Total	**3.960**
			EC requested contribution	**3.960**
			AC participants estimated internal costs	**0.000**
UCL	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm) plus travel money for associates (ICL, RHUL, UCAM, UMAN)	17.013
		Consumables		0.000
		Indirect Costs	20% of all costs above	3.403
			Total	**20.416**
			EC requested contribution	**20.416**
			AC participants estimated internal costs	**0.000**
UHAM	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	11.000
		Consumables		0.000
		Indirect Costs	20% of all costs above	2.200
			Total	**13.200**
			EC requested contribution	**13.200**
			AC participants estimated internal costs	**0.000**
ULUND	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	7.370
		Consumables		0.000
		Indirect Costs	20% of all costs above	1.474
			Total	**8.844**
			EC requested contribution	**8.844**
			AC participants estimated internal costs	**0.000**
UMA	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	2.200
		Consumables		0.000
		Indirect Costs	20% of all costs above	0.440
			Total	**2.640**
			EC requested contribution	**2.640**
			AC participants estimated internal costs	**0.000**
UNI-GE	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	6.600

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
		Consumables		0.000
		Indirect Costs	20% of all costs above	1.320
			Total	**7.920**
			EC requested contribution	**7.920**
			AC participants estimated internal costs	**0.000**
UNIVBRIS	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	4.400
		Consumables		0.000
		Indirect Costs	20% of all costs above	0.880
			Total	**5.280**
			EC requested contribution	**5.280**
			AC participants estimated internal costs	**0.000**
UROS	**AC**	Personnel		0.000
		Travels	1.1 k€ per total part. FTE (12ppm)	7.370
		Consumables		0.000
		Indirect Costs	20% of all costs above	1.474
			Total	**8.844**
			EC requested contribution	**8.844**
			AC participants estimated internal costs	**0.000**
Grand Total NA2			**Total (incl. estim. internal costs of AC part.)**	**1048.639**
			EC requested contribution	**691.039**

Transnational Access Activities

I. Overall information

The project provides access to the improved infrastructures at DESY and at other laboratories for the participating and associated institutes. This includes all improvements to infrastructure and all prototypes of the JRA and the Networking Activities. During the programme also engineering and development capacities in mechanics and electronics will be exchanged between the partners. Embedding of the computing activities into the GRID will lead to an effective mutual sharing of computing resources.

The schedule for the ILC together with the completion of the construction of the large LHC experiments at CERN in 2007 makes it very likely that other European and international groups with experience on advanced detector technologies will soon join the R&D effort for the ILC detector. The infrastructure provided through this I3 proposal will ease their entrance into the ILC detector effort and allow new groups to quickly make significant contributions. The experimental facilities of the proposed JRAs and the common software infrastructure to be created by the Networking Activities will provide the basis for that.

The consortium is prepared to open up for these groups using the tool of the Transnational Access scheme. Groups not yet working on the ILC detector and therefore not partners of this I3 will be able to participate in common experiments or to test their own prototypes at the facilities. Naturally the Transnational Access will not be restricted to groups working on the ILC but the infrastructures will be opened for other research groups in particle and nuclear physics or from other sciences. In particular for such groups the well defined and documented infrastructure together with an existing simulation and analysis framework will be very helpful. On the other hand the consortium will profit from an intensified and stimulated scientific discussions beyond the borders of our field.

We propose two Transnational Access Activities: In TA1 the DESY test beam facility will be made available to a larger community. Next to CERN this is the only facility in Europe which provides a high energy, i.e. larger than 1 GeV, particle beam. The improvements of this infrastructure, namely the large bore magnet and the high precision fast beam telescope, will make it unique in Europe in many aspects. Secondly, in TA2 we want to facilitate the entry of new groups in the European, and therewith in the worldwide, R&D effort towards the detector for the ILC. The infrastructures upgraded in JRA2 and JRA3 to permit experiments with larger scale detector prototypes will be opened to new groups. The peculiarity here is that some of the infrastructure improvements are not bond to be operated at a fixed location. They can be used at test beam facilities in Europe (CERN and DESY) or abroad as well as at university institutes using cosmic rays.

The two sets of infrastructure subject to the proposed TA activities are required for the R&D on advanced detector technologies. Their common availability through the proposed programme will facilitate the inclusion of new groups in the R&D efforts because it will allow these groups to perform the necessary experiments with their detector concepts. For example the programme will allow test beam experiments using infrastructures to operate larger detectors. In particular the common analysis and simulation framework which we plan to create in NA2 will make it very attractive and easy for outside groups to join. This way the service quality for researchers on advanced detector technologies will be improved.

II. Activity TA1 – Access to DESY Test Beam Facility

TA1 Access to DESY Test Beam Facility	
Location (town, country)	Hamburg, Germany
Web-site address	http://www.desy.de/ Detailed information at http://adweb.desy.de/~testbeam/welcome.html
Legal name of organisation operating the infrastructure	Deutsches Elektronen-Synchrotron
Location of organisation (town, country)	Hamburg and Zeuthen, Germany
Approximate investment/replacement cost of the infrastructure to which access is offered (€)	150 000 000
Annual operating costs (excl. investment costs) of the infrastructure (€)	242283
Funding sources that cover those operating costs	DESY (city of Hamburg (10%) and Federal Republic of Germany (90%))
Contract number under FP5 and/or FP6, if any	N/A

1. Description of the Infrastructure, Relevance and S&T Excellence

1.1. General Description

DESY presently operates at Hamburg several particle accelerators of worldwide relevance. The largest facility is HERA which provides since 1992 collisions of 920 GeV protons with 27.5 GeV electrons. DORIS is an electron storage ring which previously was operated as e^+e^--collider and is since 1993 exclusively used under the name DORIS III as synchrotron light facility. For both machines the DESY II synchrotron is used as pre-accelerator and in addition delivers in parallel electron or positron beams to up to three fixed target experiments. Access to these beam lines with the improvements in infrastructure according to JRA1 and JRA2 are the subject of the Transnational Access Activity discussed here.
DESY II can provide electron or positron beams with an energy variable between 1 GeV and 7 GeV, a small energy spread of about 5% and intensities of up to 1000 particles per cm^2 and second. Next to CERN which has beam facilities for even higher energies and different particles (hadrons, muon and neutrinos) DESY is currently the only laboratory in Europe which can deliver high energetic particles in the multi-GeV range.
The test beam areas provide sufficient space for the installation of larger scale detector prototypes. They are equipped with huts to house data acquisition and control electronics and data connections to the DESY computer center exist. The beam areas are shielded providing working space for operators. Safety equipment is in place such that gaseous detectors can be used even with flammable gases. Translation stages are available for remote controlled positioning of test equipment in the beam lines.
Work done within the context of this proposal will significantly improve the quality of the infrastructure by equipping it with a high field superconducting magnet, a high precision SI

pixel beam telescope, and a range of general purpose equipment for data acquisition. While the basic infrastructure is available immediately, the improved one will become available two years after the start of EUDET. This TA activity will start in month one and last until the end of the the four-years programme. The anticipated closure of HERA and the conversion of PETRA III into a synchrotron light facility will have no impact on this TA activity. The short name for the installation is DESY-TB.

1.2. Quality of Research at the Infrastructure

Time in high energy particle beams for tests of equipment and novel technologies is very much in demand in the international particle physics community. Recently a survey was conducted by the international linear collider study group, in which the needs by the different communities were confronted with available beams at the different accelerator laboratories around the world. The document[8] has been submitted to the worldwide community and to main accelerator laboratories, to stress the need for high quality test beam infrastructure.
This existing infrastructure makes the DESY II beam facility one of the few places in Europe where R&D for particle detectors can be performed. It has been extensively used in the past for the development of new detectors and prototype tests. In recent years the DESY test beam played an important role for the ILC detector R&D. Several groups performed experiments with calorimeter prototypes and small pixel detectors at the facility which contributed very significantly to the current state of this R&D effort. Also the HERA collaboration extensively used this facility for the successful detector upgrades for the HERA II programmed which started in 2002. Many groups performed experiments with prototypes as well as calibration measurements with detector components which were later installed in the experiments.

1.3. New Opportunities

The proposed JRA together with the implementation of the Transnational Access scheme will significantly improve the infrastructure. The upgraded infrastructure will allow the partners to continue their research programme at the DESY test beam and to perform new and mandatory measurements, by offering a new range of possible experiments. Therefore it is very likely that it will not only serve the future needs of the partners of our consortium but also attract other groups working on the development of particle detectors. This includes groups working in particle or nuclear physics but it would also serve groups working on the instrumentation in medicine or environmental science if they require particle detection in high magnetic fields or with very high spatial resolution. Particularly the fact that we aim for a standardized, well documented and ready-to-use implementation of the infrastructure upgrades will be very helpful for small groups which otherwise do not have the means to exploit the infrastructure or researches who can only spend a limited time at DESY. Community funding would provide the means for the users to use the upgraded facilities. Through the existence of this facility European researchers will be given the opportunity to participate in frontline research and have access to world-class facilities.

2. Management of the Access Provided

2.1. Access to the Test Beam

As described in the management section the European members of the ESAB will form the User Selection Committee for the TA activities. It will select from the applications the users based on the scientific merit of the proposed experiment The SC will advertise the infrastructure on the WEB and in suitable scientific media, at least once a year. The I3

[8] Worldwide linear collider test beam group, “Report on Worldwide Linear Collider Test Beam Effort”, see http://www-lc.fnal.gov/lc_testbeams/tbpage.html

Coordinator in charge of the TA administration negotiates with the selected applicants the date and the length of access, in close cooperation with the DESY test beam coordinator, who is appointed by the DESY directorate.
The typical length of access to the test beam is between two and eight weeks with an average of about four weeks. The average size of user groups is about five researchers.

2.2. Support Services

The DESY test beam coordinator is the contact person for the experimenter at DESY, and ensures the proper support of the experimenter during the time at DESY. This includes access to technical services, safety instructions, assistance during the setup up and dismantling phase. DESY provides access to shop services according to the standard conditions for DESY users, access to stores, office and IT infrastructure.
In addition to the test beam coordinator, who is responsible for all three DESY beams, EUDET provides assistance to the user in the special improved beam area, assigned to EUDET. This person instructs and supports the user in the use of the additional equipment. During the planning stages he is available to ensure that the interfaces are properly designed, so that optimal use can be made of the infrastructure.
User accounts for the central computing facilities are granted on request including internet access. A scientific library is on site. There are several guesthouses on the DESY site providing accommodations at cost price. External users are an integral part of the life and are invited to seminars and other scientific events at the laboratory. They profit from the highly international and stimulating atmosphere at the laboratory.

3. European added value

3.1. European Interest in the Infrastructure

3.1.1. User Community

Detector R&D relies heavily on the provision of high quality test beams. The number of available beams in Europe and around the world is very limited. In recent years the DESY test beam was used by approximately 20 different groups per year. The research groups and their members came from many different countries demonstrating that there is a widespread interest in this facility. The recent international note on test beams for international linear collider detector R&D clearly demonstrates the needs of the community. The improvement to the infrastructure proposed here will ensure that the beams can be optimally used also for future detector R&D projects, in particular but not limited to an experiment at the international linear collider.
As the construction of the large LHC experiments at CERN comes to an end in a couple of years we expect that a large number of groups involved in this effort with experience in detector research, design and construction will direct their interest towards the ILC detector. With the proposed network in place the integration of these groups will be straightforward leading to a very efficient organization of the European ILC detector groups.

3.1.2. Advertisement of the Facility

This consortium will actively participate in workshops and conferences on new detector technologies and report the progress of this project. This will spread the information about the new experimental possibilities at this facility to the international community and invite interested researchers. A web site will be created which describes the facility and its potential in detail to invite also new users outside the particle and nuclear physics communities.

We intend to publicize this regularly also in scientific journals.

3.2. Access Offered by the Infrastructure

3.2.1. Multi annual implementation plan

Access to users outside of the consortium and through this TA1 activity is granted for 10 weeks each year. Access will be available from the beginning of the project, though the improvements to the infrastructure will only be available in the last two years.

Table 8: Implementation Plan

Implementation Plan						
Short name of installation	Unit of access	Unit cost	Min. quantity of access to be provided	Estimated number of users	Estimated number of days spent at the infrastructure	Estimated number of projects
DESY test beam	TB week	8777 EUR	40	50	1400	10

3.2.2. Units of access

The unit of access to this infrastructure is one week of beam time (TB week). This includes the preparatory work of the external group at the facility, assembling and disassembling of experimental set up as well as radiation and general safety briefings as required by local laws.
A TB week comprises 7 days of 24 hours access to the experimental installation. In general technical and scientific support is provided during normal working hours, i.e. 5 days a week for 8 hours during day-time. An on-call service is in place to assist in urgent problems at any moment. The DESY II accelerator is operated for approximately 10 month per year and the remaining two months are scheduled shut-down time when the facility is not available.
During DESY operational periods the beam is available at the experimental areas for about 50% of the time. The remaining time is needed to refill the accelerator replacing the spent beam and to synchronize with the other accelerators on the DESY site. The overall dead time of 50% includes also all losses due to technical problems of the machine. The operation of the beam and therefore access to the test beam area is under the control of the experimenter.
The TB week includes the time needed to assemble, test and disassemble the experimental set-up in the beam line. Depending on the complexity of the apparatus the installation of the experiment may take several days during which the beam line is not available for other users. This holds for the dismantling, too.

3.2.3. Resources

We calculate the request on the basis of user fees for the operation of the DESY II synchrotron. Management and administrative costs are covered by the requests in NA1. In addition we request a sum of 75 k€ travel costs to be able to support external groups in their travel to the facility. During the beam time EUDET will be the main user of the facility. Still we expect a small fraction of users not connected to EUDET to also utilise the area. We have therefore charged the costs for operating the test beam only to 75%. The total resource request for TA1 therefore amounts to 351090.

Table 9 Justification of User Fees

Access to DESY Test Beam facility				***TA1***
A. Average annual direct costs of providing access (excluding personnel)	Describe all items included in the full direct eligible access costs excluding personnel cost (e.g. maintenance, utilities, consumable costs)			**(€)**
	Cost for running the DESYII synchrotron if the DESY accelerator complex is operating (cost for electricity, etc)			**232283**
	Fraction of maintenance and repair for access			**10000**
	Total A			**245200**
	In which subcontracting (A')			
B. Average annual personnel costs required to provide access	Category of staff (scientific and technical only)	Number of hours	Hourly rate	**(€)**
	Scientific	100	60	**6000**
	Technical	120	40	**4800**
	Total B			**10800**
C.	Indirect eligible costs = 20% of (A-A'+B)			**50616**
D.	Total average annual access costs = A+B+C			**303699**
E.	Total annual quantity of access usually provided by the infrastructure (i.e. to both internal and external users)			**33**
F.	Unit cost = D/E			**9203**
G.	Fraction of the Unit cost charged to the proposal[9]			**75%**
H.	Quantity of access offered (over the whole duration of the project)[10]			**40**
User Fees = F x G x H				**276090**

[9] If only a fraction of the calculated unit cost is being charged, please indicate the value of this fraction in line G. If not, write 100%.

[10] Please ensure consistency with Table 5.

III. Activity TA2 – Access to Detector R&D Infrastructure

TA1 Access to Detector R&D Infrastructure	
Location (town, country)	N/A
Web-site address	A web site with information on the infrastructure will be created: http://eudet.desy.de/
Legal name of organization operating the infrastructure	Various larger laboratories of the consortium: DESY, FOM/NIKHEF, CEA, CNRS-EP, CNRS-LAL, CNRS-LPNHE
Location of organization (town, country)	DESY (coordinating institute), Hamburg and Zeuthen, Germany
Approximate investment/replacement cost of the infrastructure to which access is offered (€)	
Annual operating costs (excl. investment costs) of the infrastructure (€)	
Funding sources that cover those operating costs	
Contract number under FP5 and/or FP6, if any	N/A

1. Description of the Infrastructure, Relevance and S&T Excellence

1.1. General Description

Infrastructure developed and constructed in the framework of this proposal will be made available to the community to test new detector technologies. This infrastructure allows experimentation with larger scale prototype detectors and it relevant for most of the major detector components relevant for a large experiment at a future collider: vertexing, central tracking and calorimetry through the particle flow approach. In particular the components are:

1. BTELE: A high precision beam telescope with fast readout capabilities (JRA1). It will be developed and originally installed at the DESY test beam but can later be moved to other facilities.
2. TPC: A large and low mass field cage for a TPC providing a highly homogenous electric field (JRA2, task A). It includes high voltage and gas supplies and a fast readout system suited for modern micropattern gas detectors.
3. SI-TPC: A silicon based system to precisely measure the amplification and charge transfer properties of gaseous detectors (JRA2, task B).
4. SI-STRIP: Readout, mechanical structure, cooling and alignment systems for the development of Si-strip tracking detectors (JRA2, task C).
5. CALO: The installation to test composite calorimeter prototypes consists of an electromagnetic shower detector, an absorber for the hadronic part and the DAQ system.

1.2. Quality of Research at the Infrastructure

Support from the EU for this TA will facility the entry of new groups into the detector R&D effort for new colliders. New creative ideas developed by an external research group can be examined much faster by supporting their access one of the above mentioned infrastructures. The access to expensive systems for readout, gas and HV supply, cooling etc. will reduce the threshold in particular for smaller university groups to test their ideas and developments under real experimental conditions and evaluate their possible applications.
The hardware infrastructure will be accessible at various larger laboratories of our consortium like DESY, FOM/NIKHEF, CEA, CNRS-EP, CNRS-LAL or CNRS-LPNHE. In these laboratories detectors for large experiments at CERN, DESY, FNAL and SLAC have been built in the past and large groups of experts on detectors, microelectronics and other exist at these places. These experts will act as consultants for smaller university groups which want to join the ILC detector R&D now or at a later stage. Their expertise is part of the infrastructure and will be shared with new user groups.

1.3. New Opportunities

Like in TA1 the access to these infrastructures for prototype testing will significantly reduce the efforts necessary for new groups to join the R&D for novel detectors and enable them to make scientific contributions on a smaller time scale. Also the provision of a framework for data analysis and simulation will facilitate the inclusion of newcomers and smaller research groups.

2. Management of the Access Provided

2.1. Access to the Infrastructures

The members of our consortium represent a large part of the European institutes working on ILC detector developments. Our community constantly grew over the last years. New groups were joining the effort, as they realized that their research is of interest for the ILC detector R&D and they can contribute to it. We believe that the interest in the ILC will continue to grow and that more European and international groups should join in order to develop a convincing concept for the detector.
The consortium is therefore open to new groups utilizing the infrastructures and sharing the knowledge. New users of the common infrastructure will have the same impact on the scheduling of common experiments as the other participants. Decisions on priorities will be taken as outlined in the description of the management. Every new group has a complete autonomy in deciding on which detector component or technology choice it wants to contribute. Even though our project is target mainly at the ILC detector as the probable next large collider facility to be constructed all the above applies equally well to groups working on R&D for other detector applications. They may apply if access to the infrastructures is of use and interest to them.

2.2. Support Services

In general new users will be invited to perform common experiments with members of the consortium to become acquainted to the use of the infrastructure. They will profit from documentation and from the common analysis and simulation framework. As it is the custom in large High Energy Physics collaborations knowledge will be shared among all participants and support will be given in the same way as among other collaborators. New groups are invited to visit participating laboratories to prepare experiments. They will be invited to participate at the Annual Scientific Workshop present results and discuss problems and to prepare future experiments.

3. European added value

3.1. European Interest in the Infrastructure

3.1.1. User Community

Our consortium consists of institutes from 9 different EU countries plus participants from Israel and Switzerland, demonstrating the widespread interest in the project. It comprises most of the laboratories which were performing R&D studies for the ILC in the past. We expect that the R&D effort will significantly increase in the next years and it that it will include also institutes from European countries not part of the consortium. The support requested here – travel and transport costs – to use the detector R&D infrastructures will make it easier for new groups to join the effort and the programme will attract new users as it would allow them to make contributions at an early stage.

3.1.2. Advertisement of the Facility

The consortium will actively spread the progress of the project and the available infrastructures in international workshops and conferences on new detector technologies. This is the most efficient way to inform potential new users and discuss the project. European and international workshops on the ILC physics and detector developments take place at least twice a year and provide an ideal forum. The ILC is and will become even more an important topic at international conferences on High Energy Physics which will be used to inform an even wider audience of the activities of the consortium and the possibility of participation.

3.2. Access Offered by the Infrastructure

3.2.1. Multi annual implementation plan

The five installations in this TA activity will be set-up during the first years of this programme and therefore only available in year three and four (TPC field cage) and the rest in year four. The installations will be offered for experimentation to outside groups for at least five weeks per year and per installation. We treat the five installations on the same footing such that a total of 30 weeks of access will be offered.

Implementation Plan						
Short name of installation	Unit of access	Unit cost	Min. quantity of access to be provided	Estimated number of users	Estimated number of days spent at the infrastructure	Estimated number of projects
Beam Telescope	Week	4500 €	5	15	75	5
TPC field cage	Week	4500 €	10	30	150	10
Si-TPC Monitor	Week	4500 €	5	15	75	5
Si-Strip infrastruture	Week	4500 €	5	15	75	5
Calorimeter infrastructure	Week	4500 €	5	15	75	5

3.2.2. Unit of access

Access to the infrastructure will be typically a visit to a participating institute of one or several weeks for common experimentation or analysis of a previously performed experiment. The institute would provide a working place for the guests and support in technical and scientific questions.

3.2.3. Resources

We do not require fees for the usage of the installations. Consumables will be provided by the partner at which the installation is located and operated. Likewise personal to assist new users will be provided by the local institute. We therefore request only support for the travel and transport costs of users from out side the consortium.
For users from outside the consortium we apply for travel money using the same estimate as for consortium members in the JRA requests, i.e. 1.5 k€ per person and week of access. With a total number of 30 access units and an average of three researchers per external group the request amounts to 145 k€

Joint Research Activities

I Overall information

1. Synergies between research participants

The focus of this I3 is the development and improvement of an European infrastructure to support and enhance advanced detector R&D for the ILC. The activities are based on three Joint Research Activities, described in this section. These activities cover the improvement of a general purpose test beam facility, located at DESY, to better serve the needs of the growing community, and two distributed infrastructure activities focussed on the developments of more specific detector technologies. The latter JRAs deal with tracking detectors and calorimetric detectors, thus covering all relevant technologies. Together these three JRA will significantly improve the quality of the European research infrastructure for groups interested in advanced detector developments for the International Linear Collider.
The achievement of the objectives of the individual JRAs is largely independent. The only interference is caused by the fact that nearly all R&D activities at some point will want to utilise the test beam infrastructure. Global coordination between the JRAs, the networking activities and the access activities will be ensured through the management of this proposal, in particular, through the Steering Committee. This body in combination with the strong emphasis put on the exchange of information will produce strong synergies between the participants wherever possible.

2. Competence of the participants

Members of the consortium are without exceptions groups who look back on many years of research in the area of experimental particle physics. All groups are experienced in working in large, international collaborations, and as such are used to the sharing of resources, of information and distributing of responsibilities.

List of recent publications on relevant topics of the participating institutes:

DESY :
DESY is the national German centre for particle physics and one of the leading laboratories in the world in this field. DESY is operating the HERA storage ring, and has been one of the leaders in the development of the International Linear Collider, both for the machine and for the experimental programme. DESY has since about 10 years participated in the conceptual design of a detector at the ILC. Since 1998 DESY has an active detector development programme for the ILC detector, participating in work for the TPC, the hadronic calorimeter, and the very forward calorimeters.

1. P. Wienemann, “A TPC for a future linear collider", IEEE Trans. Nucl. Sci. 51 (2004) 1497
2. T. Behnke, J.D. Wells, P.M. Zerwas “Physics with e^+e^- Linear Colliders”, Prog.Part. Nucl. Phys. 48:363-447, 2002.
3. F. Sefkow et al., “A High Granularity Scintillator hadronic calorimeter with SiPM readout for a linear collider detector”, DESY-04-027, subm. to NIM.

4. W. Lohmann et al., “Design considerations for the very forward calorimeter of the TESLA detector”, contribution to the international linear collider workshop, LCWS 2002, Jeju Island, Korea, published in Seogwipo 2002, Linear Colliders, 604.

AGH-UST:

The Department of Elementary Particles and Detectors at AGH-UST is involved over 50 years in high energy physics research. It participates in high energy experiments at DESY(ZEUS) and CERN(DELPHI, ATLAS, LHCB). The group is experienced in luminosity measurement, being a task of VFCAL. AGH-UST together with INPPAS designed and built the luminosity monitor for the ZEUS experiment at HERA and developed methods of luminosity calculations.

1. J. Chwastowski, J. Figiel, A. Kotarba, K. Olkiewicz, L. Suszycki, "Aerogel Cherenkov detectors for the luminosity measurement at HERA", Nucl. Instr. and Meth. A 504 (2003) 222 .
2. L. Suszycki, "Experimental Aspects of Precision Luminosity Measurement", LCWS04, Paris, April 2004.
3. H. Abramowicz et al., "Instrumentation of the Very Forward Region of a Linear Collider Detector", IEEE Transactions on Nuclear Science 51 (2004) 2983.

ALU-FR:

The physics department at ALU-FR has a long tradition and broad involvement in accelerator-based particle physics. Current Projects are the construction of major parts of the ATLAS detector, participation in the Compass experiment at CERN and ZEUS at DESY as well as R&D for the ILC. Furthermore the department is involved in the MediPix project, an X-ray imaging Silicon pixel detector. Members of the group participating in this proposal have broad experience in the operation of GEM's as gas-amplification devices for a TPC. Also experience with operation and readout of MediPix system is present. A first prototype setup of a double-GEM structure with Pixel-Readout has been successfully operated.

1. K. Desch et al., “The linear collider physics case: International response to the technology independent questions posed by the International Technology Recommendation Panel”, arXiv:hep-ph/0411159.
2. M. Titov, “Radiation damage and long-term aging in gas detectors”, ICFA Instrum. Bull. 26 (2004) 002, arXiv:physics/0403055.
3. A. Bamberger et al., “Experimental Study of Double GEM Readout Using MediPix2 CMOS Chip”, Meeting on ILC Dectectors with Gaseous Tracking. ILCD 2005: 13 to 15 January 2005 - Ecole Polytechnique, Palaiseau, France
4. M. Campbell et al., ”The detection of single electrons by means of a Micromegas-covered MEDIPX2 Pixel Readout Circuit”, Sep 2004, Submitted to Nucl. Instr. and Meth.A

CEA:

The institute has been working for 4 years on the development of detectors for the ILC. Currently the laboratory is devoting the effort of 6 FTE per year and more than 100 K€ per year in R&D for Monolithic Active Pixel Sensors (MAPS) and Micromegas Time Projection Chambers.

1. P. Colas et al., “The readout of a GEM or Micromegas equipped TPC by means of the Medipix2 CMOS sensor as direct anode”, Nucl. Instr. and Meth. A 535 (2004) 506.
2. P. Colas et al., “First test of a Micromegas TPC in a magnetic field”, Nucl. Instr. and Meth. A 535 (2004) 181.

3. Y. Degerli et al., "Low-power autozeroed high-speed comparator for the readout chain of a CMOS monolithic active pixel sensor based vertex detector", IEEE Trans. Nucl. Sci.,vol 50, no.5, October 2003, pp. 1709.
4. Y. Degerli et al., "A fast Monolithic Active Pixel Sensor with pixel-level reset noise suppression and binary outputs for charge particle detection", presented at IEEE 2004 Nuclear Science Symposium, Roma and submitted to IEEE Trans. Nucl. Sci.

CNRS-EP:
The LLR-Ecole Polytechnique has a long history in developing calorimetry from the point of view of the detector structure, data acquisition, simulation and reconstruction. It has been heavily involved in the design and construction of the ALEPH calorimeter and more recently in the H1 luminometer, the CMS electromagnetic calorimeter and the structure of the GLAST calorimeter, to be launched in 2007. It has been at the origin of silicon-tungsten calorimeter developments for the International Linear Collider (ILC) and of the digital option for the hadronic part. The most widely used simulation tool for the ILC detector (MOKKA) has been initiated at LLR.

1. P. Mora de Freitas, H. Videau, “Detector simulation with MOKKA/GEANT4: Present and future”, International Workshop on Linear Colliders (LCWS 2002), Jeju Island, Korea, 26-30 Aug 2002, p. 5, Published by Sorim Press, Editors: J.S. Kang and S.K. Oh, July 2003.
2. A. Karar, Ch. De la Taille, “Silicon diode, readout and front end electronics of the proposed W-Si ECAL”, LC-DET-2001-059, Feb 2001, in 2nd ECFA/DESY Study 1998-2001, 2286.
3. H.Videau, J-C. Brient, “Calorimetry optimised for jets”, Calorimetry in Particle Physics Pasadena California USA, 25-29 March 2002, p. 14, Published by World Scientific , Editor Ren-Yuan Zhu 2002.

CNRS-IReS:
The group has accumulated a long and diversified experience in the design and characterisation of low power, low noise, analogue and digital micro-circuits, as well as in probing and commissionning semi-conducting tracking devices. It has in particular provided major contributions to the tracker of the CMS and ALICE experiments at the LHC. It pioneered the concept of CMOS sensors for charged particle tracking in 1999, and has acquired a leading expertise in the field. It demonstrated the outstanding performances of these innovative position sensitive devices for a wide range of applications, and initiated the concept of a vertex detector equipped with CMOS sensors for the ILC experiment.

1. R. Turchetta et al., "A monolithic active pixel sensor for charged particle tracking", Nucl. Instr. Meth. A458 (2001) 677.
2. G. Deptuch et al., "Development of monolithic active pixel sensors for charged particle tracking", Nucl. Instr. Meth. A511 (2003) 240.
3. M. Winter et al., "High precision thin CMOS sensors for future vertex detectors", Proceedings of the 8th conference on astroparticle, particle and space physics, detectors and medical physics applications, Como, Oct. 2003, Ed. M. Barone et al., World Scientific (2004).

CNRS-LAL:
The LAL/Orsay electronic service comprises a team of 60 persons very specialized on analogue and digital front end electronics, specifically for calorimetry. For international experiments like ATLAS and LHCb, LAL is acting as a coordinator for electronics. For the prototype of the electromagnetic calorimeter planned for the future linear collider, LAL is the

major player in the field. It should also be noted that LAL has already provided expertise for other detectors planned for the ILC.

1. S. Manen et al., "Front end electronics for a silicon tungsten calorimeter", Prepared for the International Workshop on Linear Colliders (LCWS 2002), Jeju Island, Korea, 26-30 Aug 2002, Published in Seogwipo 2002, Linear colliders 577.
2. A. Lucotte et al., "A front-end read out chip for the OPERA scintillator tracker", Nucl. Instr. and Meth. A521 (2004) 378.
3. A. Karar, Ch. De la Taille, " Silicon diode readout and front end electronics of the proposed W-Si ECAL",LC-DET-2001-059, Feb 2001, in 2nd ECFA/DESY Study 1998-2001, p. 2286.

CNRS-LPC:

The LPC electronic service comprises a team of 14 persons very specialised on analogue and digital front end electronics, specifically for calorimetry. In field of the R&D for the Very Frond End electronics of the electromagnetic calorimeter planned for the future linear collider, ILC, LPC plays a major role with LAL/Orsay.

1. S. Manen et al., "Front end electronics for a silicon tungsten calorimeter", Prepared for International Workshop on Linear Colliders (LCWS 2002), Jeju Island, Korea, 26-30 Aug 2002, Published in Seogwipo 2002, Linear colliders 577.
2. S. Manen et al., "Dedicated front-end electronics for the next generation of linear collider electromagnetic calorimeter",Journal-ref: Conference: 10th Workshop On Electronics For LHC and Future Experiments (2004-09-13 to 2004-09-17), Boston e-Print Archive: physics/0501063.

CNRS-LPNHE:

The institute has a high expertise in mechanics to design and build high precision and large detectors for high energy physics including integration issues. Highly skilled electronic staff, both in analogue front-end, digital readout and data processing, including new expertise in deep submicron technology. Large experience exists in developing appropriate fully automated test bench systems.

1. Abdallah J, Abreu P, Adam W, et al. "Coherent soft particle production in Z decays into three jets", Phys. Lett. B 605 (2005) 37.
2. Abdallah J, Abreu P, Adam W, et al., "Photon events with missing energy in e^+e^- collisions at root s=130 to 209 GeV", E. Phys. J. C 38 (2005) 395.

CSC:

The Institute of Physics of Cantabria (IFCA) is a joint Institution of the University of Cantabria and the CSIC (National Research Centre in Spain). IFCA is oriented towards basic research in the fields of Particle Physics, Astrophysics and non-linear Systems. The High Energy Physics group is formed by 7 senior physicists and 4 senior research assistants and 7 doctoral students. The group has participated actively in the DELPHI experiment at LEP and is now involved in the CDF experiment at Fermilab, the CMS experiment at CERN and several grid computing projects. In all these research areas the group has performed both hardware and analysis tasks. The group is responsible for the global alignment system of the tracking detectors for CMS.

1. A.L. Virto et al., Nucl. Instr. and Meth. A 497 (2003) 397.
2. M. G. Fernández et al., Nucl. Instr. and Meth. A 440 (2000) 372.

CUPRAGUE:

The Silicon group of the institute has been actively participating in design and construction of ATLAS strip detectors and radiation hard detector developments (RD48-50). It is equipped with key facilities for silicon detector development and testing (clean room environment, cooling, DAQ, source and laser test systems, etc.). Members are experienced particularly in the field of detector and module testing and quality assessment (laser, source, beam test), DAQ, data analysis, and detector simulations.

1. F. Campabadal et al., “Beam tests of ATLAS SCT silicon strip detector modules”, Nucl. Instr. and Meth. A 538 (2005) 384.
2. Y. Unno et al.,” Beamtest of non-irradiated and irradiated ATLAS SCT microstrip modules at KEK”, IEEE Transactions on Nuclear Science, 49 (2002) 1868.

FOM/NIKHEF:

The FOM institute NIKHEF ("Nationaal Instituut voor Kernfysica en Hoge Energie Fysica") coordinates and supports all activities in experimental high energy physics in the Netherlands and participates in many of the major particle physics experiments. The NIKHEF physicists participating in this proposal have been and are making major contributions in the LEP experiments DELPHI and L3, in Atlas at the LHC and to the MediPix project for X-ray imaging based at CERN. The institute has well equipped mechanical and electronics design departments and workshops and several clean room facilities for handling, probing and measuring complex semiconductor devices. Last year the group succeeded in a first demonstration of detection of minimum ionising particles in a gaseous detector using the CMOS MediPix2 pixel sensor as readout device.

1. P. Colas et al.,"The readout of a GEM or Micromegas equipped TPC by means of the Medipix2 CMOS sensor as direct anode", Proceedings of the 10 th Vienna Conference on Instrumentation, Vienna, Feb 2004, Nucl. Instr. and Methods A 535 (2004) 506.
2. M. Campbell et al.,"The detection of single electrons by means of a Micromegas-covered MediPix2 pixel CMOS readout circuit", accepted by Nucl. Instr. and Methods A, http://www.arxiv.org/physics/0409048 .

HIP:

The group has a large expertise in semiconductor detector fabrication, testing and assembling. It has developed advanced infrastructure for semiconductor technology R&D and it has close connections to industry. The group is involved in searching for new semiconductor detector technologies and materials (3D silicon detectors) and nanotechnologies. It is actively pursuing applications to new low-dose medical imaging methods like MediPix and others.

1. R.S. Lu, T. Akimoto, M. Aoki, et al., “CDF run IIb silicon: Design and testing”, IEEE Transactions on Nuclear Science 51 (2004) 2209.
2. P. Merkel, P. Azzi, N. Bacchetta et al., “CDF Run IIb silicon detector: The innermost layer”, IEEE Transactions on Nuclear Science 51 (2004) 2215.

INPPAS :

The members of the INP PAS taking part in the VFCAL task acquired experience over many years of work in the high energy experiments (like ZEUS, D0). The INP PAS together with AGH-UST accomplished the luminosity measurement in the ZEUS experiment (for HERA I in the past and recent HERA II running period): design, building of prototypes (with beam-test studies) and final detectors, readout electronics, DAQ, detectors simulations. The group is taking care of the luminosity detector monitoring and calculations.

1. H. Abramowicz at al., "Instrumentation of the Very Forward Region of a Linear Collider Detector", IEEE Transactions on Nuclear Science, Vol. 51 (2004) 2983.
2. L. Zawiejski, "Review of the forward calorimetry", LCWS04, Paris, April 2004.
3. B. Pawlik "Simulation of Lumical with Strip Sensors", Simulation meeting, DESY, December 2004.

4. W. Wierba, "Design of a Forward Calorimeter with Silicon Sensors", Workshop-Machine-Detector-Interface (MDI), SLAC, January 6-8, 2005.

IPASCR :
The institute contributed to calorimeters of the H1 experiment at HERA, in particular the production of read-out boards for the liquid argon (LAr) calorimeter and participation in the construction of the spaghetti calorimeter SPACAL and its trigger electronics. The group contributed with electronics for the Si-trackers of the H1 vertex detectors FST and BST and with pre-amplifiers for APDs in the tile calorimeter prototype MiniCal. Further participations of the institute are the DELPHI and ATLAS experiments, and the CERN RD19, RD48, RD50 programmes in instrumentation of experiments with Si detectors.

1. Gorelov et al., “Electrical characteristics of silicon pixel detectors”, Nucl. Instr. and Meth. A 489 (2002) 202.
2. G. Lindstroem et al., “Radiation hard silicon detector-developments by the RD48 (ROSE) collaboration”, Nucl. Instr. and Meth. A 466 (2001) 308.
3. J. Cvach, “Calorimetry at a future e^+e^- collider”, Proceedings of ICHEP 2002, Amsterdam, The Netherlands, p. 222.

MPI :
The MPI Halbleiterlabor ("Semiconductor Laboratory") has been founded in 1992 as a common research facilitiy of the Max-Planck-Institut für Physik in Munich and the Max-Planck-Institut für extraterrestrische Physik in Garching . Its aim is to provide commercially not available silicon detectors for particle physics and X-ray astronomy. The complete silicon technology of the HLL is adapted to the special requirements of semiconductor radiation detectors. Important features are in particular the ability to build wafer size defect free double sided detectors on ultra pure silicon. The DEPFET active pixel detector has been invented by researchers of this laboratory.

1. L. Andricek, G. Lutz, M. Reiche, R.H. Richter, ”Processing of Ultra-Thin Silicon Sensors for Future e+e- Linear Collider Experiments”, IEEE Trans. Nucl. Sci., Vol. 51, No. 3, pp. 1117-1120, June 2004.
2. R.H. Richter et al., “Design and technology of DEPFET pixel sensors for linear collider applications”, Nucl. Inst. and Meth. A 511 (2003) 250.
3. J. Treis et al., “First results of DEPFET based Active Pixel Sensor prototypes for the XEUS wide field imager”, Proceedings of SPIE, Vol. 5501, p. 89 (2004).
4. P. Holl, et al., “Active Pixel Sensors for Imaging X-ray Spectrometers”, Proceedings of SPIE Vol. 4851, p. 770 (2003).

TAU:
The experimental group of Tel Aviv University has participated in the last twenty years in all major experimental HEP enterprises is Europe, such as OPAL at LEP, ZEUS at HERA and presently ATLAS at the LHC. It has a strong physics background in lepton and hadron interactions. The senior physicists in the group have played major roles in the coordination of the experiments in which they participated. The group has in the past contributed to the construction of detectors and in the last five years has developed a laboratory with a cosmic muon spectrometer for testing and efficiency mapping of the Thin Gap Chambers on which the forward muon trigger of the ATLAS detector is based. The forte of the group is in physics analysis and in developing innovative and reliable analysis tools. In line with its own interests, the group has been instrumental in pushing the Israeli Academia into adopting the grid technology and is actively involved in ensuring the existence of a proper infrastructure for its present and future activities.

1. H. Abramowicz et al., "Instrumentation of the very forward region of a linear collider detector", IEEE Trans. Nucl. Sci. 51 (2004) 2983.
2. H. Abramowicz, A. Caldwell, R. Sinkus, "Neural network based electron identification in the ZEUS calorimeter", Nucl. Instr. and Meth. A 365 (1995) 508,
3. A. Bamberger et al., "The ZEUS forward plug calorimeter with lead-scintillator plates and WLS fiber readout", Nucl. Instr. and Meth. A 450 (2000) 235.
4. S. Goers et al, "The Straw-Tube Tracker of the ZEUS Detector at HERA",
5. Proc. of the IEEE Instrumentation and Measurement Technology Conference, Lake Como, Italy, May 2004.
6. E. Etzion et al, "The cosmic ray hodoscopes for testing thin gap chambers at the Technion and Tel Aviv University", IEEE Trans. Nucl. Sci. 51 (2004) 2091.

UBONN:

The institute has more than 10 years experience in the development of semiconductor pixel detectors and dedicated ASIC pixel chip electronics. This comprises the development and construction of the large ATLAS pixel detector for LHC with about 10^8 individually amplified channels, the development of X-ray counting pixel detectors together with industry (Philips medical) and – relevant for this proposal – the development of DEPFET pixel detectors and full detector systems, as well as the design and development of dedicated readout chips. For test beam measurements also a beam telescope using silicon microstrip detectors with high rate capability has been developed. The group has the technological infrastructure to develop and produce complex and large pixel detectors, as demonstrated for the ATLAS pixel detector at LHC.

1. N. Wermes et al., "New Results on DEPFET Pixel Detectors for Radiation Imaging and High Energy Particle Detection", IEEE Trans. Nucl. Sci. Vol. 47 No. 3 (2004) 1121.
2. N. Wermes, "Trends in pixel detectors: Tracking and Imaging", IEEE Trans. Nucl. Sci. Vol. 51, Nr. 3 (2004).
3. M. Trimpl et al.,"A fast readout using switched current techniques for a DEPFET pixel vertex detector at TESLA", Nucl. Instr. and Meth. A 511 (2003) 257.
4. R. Kohrs et al,"Development of a Prototype Module for a DEPFET Pixel Vertex Detector for Linear Collider", submitted to IEEE Trans. Nucl. Sci. (Nov 2004).

UCL:

The current prototype calorimeter for the ILC detector R&D uses a DAQ system designed and maintained by UCL, along with Imperial College. The group has proposed to the UK research council to continue to aggressively develop ideas and push forward our strategy for the DAQ. It has a conceptual design which should be able to provide a solution for the final calorimeter, but is also generic enough to provide the infrastructure for prototypes built in the next few years.

1. M. Warren, "A 96 channel, 16 but, 500 kHz ADC and bus LVDS-based VME readout system for the CALICE electromagnetic calorimeter", poster presented at IEEE/NSS04, Rome, October 2004.
2. P.D. Dauncey, "Thoughts on Si-W ECAL DAQ", ECFA04 Workshop, Durham, September 2004.

UHAM:

The physics department has a long standing tradition in the development and operation of detectors for particle physics experiments. Groups participated in the design and building of many of the large detectors at DESY, and made strong contributions to basic detector developments. In the past years group members have been actively involved in the preparations of a linear collider, both through research and by advancing the international organisation. Since 1998 UHAM is involved in R&D work for the linear collider detector, with strong contributions to the TPC and the hadronic calorimeter.

1. R.D. Heuer et al., "Linear Collider Detector R&D", contribution to the international linear collider workshop, Jeju Island, Korean, 2002, published in Seogwipo 2002, 787.
2. K. Desch et al., "Impact of hadronic backgrounds on selected Higgs physics analyses at a linear collider", LC-PHSM-2004-009.

UNI-GE:

The group has a track record in excess of 15 years concerning the design, manufacture and exploitation of silicon tracking detectors for particle physics. Recent projects include the central tracking chamber and the silicon vertex detector for the L3 experiment at CERN, the silicon tracker for the NASA AMS-01 experiment and a silicon strip detector for GSI Darmstadt. In addition, the group has an ESA contract for a standard radiation monitor to be used on multiple ESA space missions.

1. M. Acciarri et al., "The L3 silicon microvertex detector", Nucl. Instr. and Meth. A 360 (1995) 103.
2. AMS collab., W. Wallraff et al., "The Si tracker for the AMS-02 experiment on the space station", Nucl.Instr. and .Meth.A 511 (2003) 76.
3. G. Deptuch et al. , "2001-2004 R & D programme on monolithic active pixel sensors for charged particle tracking at a future linear collider vertex detector", DESY-PRC-RD-01-04.

UNIVBRIS:

The particle physics group at Bristol University has a strong tradition of detector development. The ZEUS first level trigger and flash-ADC based readout electronics were designed and built by Bristol in collaboration with other UK institutes. The Babar Electromagnetic Calorimeter Trigger and drift chamber trigger upgrade electronics were also designed at Bristol. Members of the group have coordinated test beam work for the CMS ECAL and are designing and building the electronics for the CMS Global Calorimeter Trigger. The group is also a member of the LCFI collaboration, carrying out research and development into sensor technologies for a vertex detector at the ILC. Successful tests have been carried out with fast, column-parallel CCD devices.

1. D. Cussans, "An Initial Look at a CMS Level-1 Trigger for an Upgraded LHC", Proceedings of the 10^{th} Workshop on Electronics for the LHC and Future Experiments, Boston 2004, p. 73.
2. D. Newbold, "Design and Implementation of the Global Calorimeter Trigger for CMS", Proceedings of the 10^{th} Workshop on Electronics for the LHC and Future Experiments, Boston 2004, p. 287.
3. M. Apollonio et al., "The Performance of Prototype Vacuum Phototriodes in the First Full Sized Supercrystal Array for the CMS ECAL Endcaps", Nucl. Instr. and Meth. A 484 (2002) 287.
4. P.D. Dauncey et al., "Design and performance of the Level-1 Calorimeter Trigger for the BaBar detector", IEEE Trans. Nucl. Sci. 48 (2001) 541.

ULUND :

The Lund group has a long experience in developing electronics for advanced detectors, which over recent years includes readout electronics for the TRT detector in ATLAS, for the TPC in the ALICE experiment and for the pad chambers in the PHENIX detector. The group has also developed trigger electronics for the forward muon spectrometer in the H1 experiment and constructed a radiation monitor, including data acquisition. Previously the group has contributed to the read-out system for the VSAT detector in the DELPHI experiment.

1. K. Adcox et al., “Construction and performance of the PHENIX pad chambers”, Nucl. Instr. and Meth. A 497 (2003) 263.
2. T. Akesson et al., ATLAS TRT Collab. , “Status of design and construction of the transition radiation tracker (TRT) for the ATLAS experiment at the LHC”, Nucl. Instr. and Meth. A 522 (2004) 131.
3. L. Favart et al.,”Proposal for installation of a very forward proton spectrometer in H1 after 2000”, DESY PRC 01/00 and H1-5/00-582.

UMA:

The members of the group of circuit design have given major contributions to the development of integrated readout electronics for strip- and pixel detectors. Examples are the pixel readout chip for the ATLAS experiment implemented in a 0.25 µm technology, several counting pixel readout chips (MPEC) for biomedical imaging applications and steering ('Switcher') and read-out chips ('Carlos') for DEPFET pixel sensors. Several different chip technologies, suited for the design goal, have been used.

1. P. Fischer, E. Kraft, “Low Swing Differential Logic for Mixed Signal Applications”, Nucl. Instr. and Meth. A518, (2004) 511.
2. P. Fischer et al., “Readout Concepts for DEPFET Pixel Arrays“, 9th European Symposium on Semiconductor Detectors, Schloss Elmau, Germany, 23-27 Jun 2002, Nucl. Instr. and Meth. A512 (2003) 318.
3. P. Fischer, “Design Considerations for Pixel Readout Chips”, 10th Intl. Workshop on Vertex Detectors (Vertex 2001), Brunnen, Switzerland, 23-28 Sep 2001, Nucl. Instr. and Meth. A501, (2003) 175.

UROS:

The University of Rostock has been involved in experiments at major accelerator centres for many years. Its strength is in the development of novel readout schemes, as has been demonstrated by contributions to the HERA-B experiment and more recently the OPERA experiment. Since about 5 years the group is involved in the development of a novel TPC readout scheme, based on GEMs. They are developing a compact readout electronics based on TDC rather than the more conventional FADC readout.

1. H. Schroeder, G. Wagner, “Neutron background studies at the TESLA collider”, LC-DEST-2001-048.
2. A. Kaukher, H. Schroeder, “A GEM TPC with TDC readout”, contribution to the ECFA workshop on physics and detectors at a linear collider, Durham, UK, September 2004.

3. European Added value

International research on detectors for a Linear Collider has been ongoing for several years. In Europe much of this work was done in the framework of a series of ECFA/DESY workshops since 1995**.** So far this work has been limited to small scale experiments which however allowed the investigation of new detector technologies and to test if their capabilities could match the requirements at the ILC. Over the last years promising technology candidates for the various components of the ILC detector have emerged.

The important next step is to investigate if these technologies can actually be applied for a large collider experiment and, if alternatives remain, to select the best. Prototypes of larger scale must be developed and constructed to investigate mechanical and electrical engineering aspects. Their performance in real particle beams must be proven together with their long term reliability and stability. Likewise the important issues of data acquisition and data reduction can be addressed meaningfully only in prototypes significantly larger than the ones so far constructed.

In addition to the hardware developments software tools are needed to simulate and understand the results from the measurements. A worldwide effort over the last ten years has resulted in the GEANT4 tool, a simulation toolkit used not only in particle physics but also in many other areas, where the interaction between particles and matter is investigated. Examples are medical and space applications. Many of the aspects of this tool have not yet been fully tested experimentally. This is particularly true for the development of hadronic showers. One of the important contributions of the programme therefore will be a comprehensive comparison between simulation and data. The results of this will be made available to the community.

Because such kind of experimental programme is far beyond the capabilities of individual institutions - even not on a national scale - the participants of this proposal want to join their resources and to create the required infrastructure. The support of the European Union is mandatory as collective available resources are insufficient to upgrade the existing infrastructure to the required level. On the other hand the proposed programme, if supported, is adequate to enable the European laboratories and institutes to continue the so far successful work and to keep their leading positions in the international collaboration towards a detector for the ILC.

It should be noted that several of the new technologies under consideration for the ILC detector components have been invented and developed in Europe. Prominent examples are micro pattern gas detectors which have the potential to lead to the required performance of the central tracking chamber if used as gas amplification system instead of the classical proportional wires. The two technologies considered here are MicroMegas[11] detectors invented by the group of Y. Giomataris at Saclay in 1996 and Gas Electron Multiplier (GEM) foils[12] invented by the group of F. Sauli at CERN in 1997. From the early eighties onwards Europe has been at the forefront of the development of Si-based position sensitive detectors. Si-strip detectors were used extensively for the first time at the LEP detectors at CERN, and have become a standard feature in detectors at all currently operating accelerators. Different types of pixel solid state sensors (DEPFET, MAPS) have been invented in Europe, and are now being actively investigated for use in the International Linear Collider. The most successful vertex detector that has taken data is, to date, the CCD based VXD3 of the SLD collaboration[13]. This device was designed and built with major European input. Progress made by groups in Europe over the past few years has dramatically increased the speed at which data can be read-out from CCD devices (so called column-parallel CCDs, CPCCDs), to the point where we are confident that CPCCDs developed by European groups are not only world-leaders in the technology, but are also a compelling choice for the technology to be used in the vertex detectors at the ILC.The solid state photon-detectors, SiPM, which are vigorously investigated for use in the hadronic calorimeter, were developed in cooperation between European and Russian institutions. European groups made major contributions to define the basic set of parameters and boundary conditions for a large detector at the ILC. The concept for a particle flow based detector for the International Linear Collider was first suggested by European groups, and has led to many important developments in particular in the area of calorimeter detectors.

These European inventions are important corner stones of the ILC detector design. The proposed programme will allow the continuation in Europe of the development of these

[11] Y. Giomataris et al., Nucl. Instr. and Meth. A 376 (1996) 29
[12] F. Sauli, Nucl. Instr. and Meth. A 386 (1997) 531
[13] SLD Collaboration, Nucl. Inst. Meth. A400, 287-343 (1997)

technologies by providing the infrastructure for the next steps in the R&D programme. Without the support for this programme the continuation of the R&D work in Europe for their application in large scale collider experiments is jeopardized.

It is clear that the research work for a high performance ILC detector is now entering into a new decisive phase requiring large scale facilities and augmented resources. European institutes have so far been at the forefront of the R&D activities for the detector. Through the proposed programme the European institutes can continue to play an important role in the international design effort and at a later stage in the construction of the detector and the harvest of the anticipated discoveries in physics.

The main infrastructure operator of this I3 proposal, DESY, is participating in all activities.

II Description of Joint Research Activities

JRA1 – Test Beam Infrastructure

Activity Number	**JRA1**		**Start month**		**1**	**End month**		**48**
Activity Title	**Test Beam Infrastructure (TBINF)**							
Participant number	1	4	5	12	14	18	19	20	
Participant short name	DESY	CEA	CNRS/ IN2P32	MPI	UBONN	UMA	UNI-GE	UNIV BRIS	**TOTAL**
Total person month	82.2	45.6	60	36	36	24	72	48	**403.8**

Objectives and expected impact:
The goal of this JRA is to provide a test beam with a large bore high field magnet and a high precision, fast beam telescope by upgrading an existing facility in Europe.
Beam tests of future detectors in a magnetic field are crucial to determine the characteristics of these devices in a realistic environment. In addition an optimal determination of the spatial resolution of the device under test is among the most important tasks in this context. Currently no facility with quick and easy access for the different European groups developing these detectors exists.
Facilities at DESY and at CERN have been used so far. DESY provides electron beams up to 6 GeV. CERN has beams with electrons up to 100 GeV and hadrons up to 180 GeV. Groups that presently use these beams have to bring their own dedicated testing equipment. This greatly increases the effort and the time required to do these measurements and it makes the results difficult to compare between groups and competing technologies. In addition the usefulness has been limited by the lack of a sufficiently strong magnetic field, and the absence of a high precision beam telescope.
The DESY test beam facility has already been intensively used for the test and development of different detector components for the ILC. At the moment three multi-purpose beam areas are available for work at DESY. We propose to set aside one of them and specially equip it for ILC related work. The proposed upgrade of the DESY test beam facility will hence enable participating institutes to perform necessary tests of their detector developments.
After the completion and commissioning, an initial round of experiments is foreseen at the DESY test beam within the four years duration of this proposal. However, the proposed infrastructure upgrade is movable so that it can later be used at other laboratories like CERN.
This JRA consists of the following parts:

A. **Magnet**: Integration of a large bore high field magnet into the existing test beam line.
B. **Environmental Support**: Improvement of the mounting and cooling infrastructure so that a wide range of different devices can be quickly installed and easily operated.
C. **Pixel Telescope**: Development and construction of an ultra high precision beam telescope that allows to fully evaluate the precision properties of new devices. One of the candidate pixel technologies for the ILC vertex detector should be used in this device.
D. **Data Acquisition and Evaluation Software**: Development of a general purpose read out system that can be quickly adapted to individual devices under test and that provides fast concurrent readout of the beam telescope and the device under study.

E. **Validation of Infrastructure**: The full test beam infrastructure will be evaluated by collaborating with research teams developing competing pixel detector technologies to test their devices in the newly developed infrastructure.

The Activity Coordinator is responsible for the monitoring of the success and impact of the JRA. He or she will report on results and the compliance with milestones and deliverables to the Steering Committee. The AC is aided in this process by the Task Leaders.

Description of work:

A. Magnet

A superconducting, large bore magnet (inner radius 86 cm, active length 100 cm, max. B-field 1.5 T) will be installed in the test beam. It will be equipped with an appropriate iron return yoke, and mounted on a movable platform to allow easy repositioning of the magnet relative to the beam.

The magnet will be provided to the consortium through one of its associate members, KEK, for the duration of the project and beyond. The device planned to be used can be operated with a minimum of cryogenic infrastructure. The main installation needed is a proper control system, which will be installed based on standard components.

The main R&D needed for this project is the development of a method to map and monitor the field quality of the magnet. To fully exploit the beam and to be able to really test the different detectors at the precision needed the field needs to be known to better than a few times 10^{-4}. This requires R&D to develop a proper measurement device and algorithm. Once available the magnet will be a major asset of the test beam infrastructure and allow detailed studies of large scale prototypes for the ILC detector in a large magnets field.

One participants contributes own funds to this task: DESY.

Risk assessment:

The main risks are driven by the magnet itself. The magnet will be provided free of charge by one of the associated institutes of this proposal, KEK. Negotiations with the KEK laboratory about the lending of the magnet are proceeding well. The field mapping will be of central importance, and failure to deliver a device with adequate precision will certainly hamper the programme. However the existence of a high precision telescope, as proposed in task C of this JRA, which provides an external reference should minimize the impact of such a failure, as this device can be used to measure the field map with data.

B. Environmental Support

The existing mounting and cooling infrastructure has to be improved to become a truly general purpose, mobile test environment. In particular for silicon pixel detectors these requirements are stringent. A wide range of different sensors will be accommodated. Transverse positioning of the sensors with a precision of 1 µm and angular positioning with a precision of 0.1 mrad will be provided. Devices under test can be operated in a well controlled environment under a nitrogen atmosphere at constant temperatures ranging from room temperature to -70 centigrade. Mobility of the facility will be ensured by modular construction so that it can be disassembled and reassembled in a different location.

One participants contributies own funds to this task: DESY.

C. Pixel Telescope

A beam telescope with four measurement planes will be constructed. Each plane will be equipped with monolithic active pixel detectors constructed in CMOS technology. This particular technology is chosen because it is one of the competing technologies for a vertex detector for the ILC. Several members of the consortium are already actively involved in R&D with these devices and the technology is advanced enough so that the telescope can be

built within the timeframe of the project. However, some additional R&D on the devices themselves as well as on thinning and on mounting has to be performed within the project.
In order to minimize the risk, the construction of the telescope will proceed in two stages. In the first stage existing CMOS pixel sensors with an analogue read out will be used. Analogue to digital conversion and signal processing will be realized using fast processors in the read out front end. These devices will not satisfy the final requirements with respect to readout speed. However, they will be necessary for two reasons:

- A first test facility will be available quickly to satisfy the immediate and urgent test needs of various research groups working on pixel detectors in Europe.
- The risk involved to fully understand all the aspects of the facility will be minimized by this iterative approach.

The final beam telescope will be constructed using CMOS chips with fully digital readout and with integrated “Correlated Double Sampling” and data sparsification. In order to reach this goal for a full size 20x20 mm device three intermediate test chips and one final chip are foreseen within the project, 2 small scale devices with 128 x 32 pixels, one intermediate chip with 128 x 128 pixels and the final large chip with 1024 x 1024 pixels. The consumable spending in this subpart of the JRA is allocated to producing the masks for these prototype chips and for financing the chip production of the final telescope chip.
Participants contributing own funds to this task are CNRS-IReS, DESY.

Risk assessment:
The most serious risks are problems with the chip production.The risks are minimized by an iterative approach with several prototypes and intermediate chips. Problems with the chips can delay the project. The different stages of the project are planned such that even if the production of the final chip fails a telescope can be build with the intermediate chip. Of course this would seriously compromise the power of the device but it could still be used for application requiring the precise definition of narrow beams.

D. Data Acquisition and Evaluation Software
A general purpose data acquisition system with state of the art interfaces will be designed and built. As far as the beam telescope is concerned, the system will communicate with the front-ends of the CMOS pixel sensors to trigger the readout, filter data on the fly and extract cluster features for each significant hit. It will also define tracks by a simple algorithm such that on-line extrapolation to the sensor under study is feasible.
As far as the sensor under study is concerned, the system will accommodate a wide range of different pixel sensors that will be studied at test beams. The viability of the system will be demonstrated by supporting two competing pixel sensor technologies, namely DEPFETs and CCDs. In contrast to the beam telescope, these sensors will be fully read out to allow detailed studies of cluster formation and feature extraction.
The data acquisition is developed synchronously with the beam telescope. Therefore, on top of the final readout additional components to handle the analogue read out of the first telescope prototype will be developed.
One participant contributes own funds to this task: UNI-GE.

E. Validation of Infrastructure
A systematic validation of the test beam infrastructure is foreseen as part of the project. The objective here is to ensure that the infrastructure fully satisfies the goals. For that purpose it will be shown that the system can be used to full advantage by pixel devices with a different technology. Two technologies, CCDs and DEPFETs are used. These differ significantly from the MAPS technology used for the telescope and are therefore ideally suited to validate its performance.

The Participants contributing own funds to this task are CEA, MPI, UBONN, UMA, UNIVBRIS.

Risk assessment:
There is a certain risk that this task is delayed by a couple of weeks if additional interfaces in hardware or software have to be provided. By close communication of all involved groups throughout the entire project this risk will be minimized.

Milestones:

Milestone	Date	Task
SDC prototype 1 ready	6	C
Magnet available	10	A
Readout for prototype available	12	D
Environmental support available	12	B
SDC prototype 2 ready	12	C
IDC prototype ready	21	C
Tracking software available	24	D
Integration with final telescope	24	E
Field map available	27	A
Telescope available	36	C
Readout system ready	36	D

Deliverables:

Deliverable No	Deliverable title	Deliverable date	Nature	Task
D1	SDC prototype 1	6	Prototype	C
D2	Environmental support	12	Hardware	B
D3	Analogue telescope prototype	12	Prototype	C
D4	SDC prototype 2	12	Prototype	C
D5	Readout for prototype	12	Hardware	D

Deliverable No	Deliverable title	Deliverable date	Nature	Task
D6	IDC prototype	21	Prototype	C
D7	Tracking software	24	Software	D
D8	Report about field mapping	27	Report	A
D9	Final telescope	36	Hardware	C
D10	Readout system	36	Hardware	D
D11	Final report	48	Report	C
D12	Final report	48	Report	B
D13	Final report	48	Report	D
D14	Final report	48	Report	E

Resources:

Table 10: Cost summary JRA1: TBINF per participant

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
DESY	**AC**	Personnel	16,20 ppm	84,375
		Travels	1.5 k€ per total part. FTE (12ppm)	10,275
		Consumables	Cryogenics control (30 k€), misc (6 k€), pixel telescope developments (90 k€)	126,000
		Indirect Costs	20% of all costs above	44,130
			Total	**264,780**
			EC requested contribution	**264,780**
			AC participants estimated internal costs	**610,500**
CEA	**FC**	Personnel	45,60 ppm	228,000
		Travels	1.5 k€ per total part. FTE (12ppm)	5,700
		Consumables	Chip production (85k€), readout cards (10k€)	95,000
		Indirect Costs		65,740
			Total	**394,440**
			EC requested contribution	**190,440**
CNRS/IN2P3	**FCF**	Personnel	60,00 ppm	300,000
		Travels	1.5 k€ per total part. FTE (12ppm)	7,500
		Consumables	Chip production (180k€), readout cards (20k€)	200,000

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
		Indirect Costs	20% of all costs above	101,500
			Total	**609,000**
			EC requested contribution	**309,000**
MPI	**AC**	Personnel	18,00 ppm	90,000
		Travels	1.5 k€ per total part. FTE (12ppm)	4,500
		Consumables	masks, chemicals, SIMS measurements	15,000
		Indirect Costs	20% of all costs above	21,900
			Total	**131,400**
			EC requested contribution	**131,400**
			AC participants estimated internal costs	**126,000**
UBONN	**AC**	Personnel	18,00 ppm	90,000
		Travels	1.5 k€ per total part. FTE (12ppm)	4,500
		Consumables	Hybrid and PC boards, testing equipment, FPGA electronics	15,000
		Indirect Costs	20% of all costs above	21,900
			Total	**131,400**
			EC requested contribution	**131,400**
			AC participants estimated internal costs	**126,000**
UMA	**AC**	Personnel	12,00 ppm	60,000
		Travels	1.5 k€ per total part. FTE (12ppm)	3,000
		Consumables	Chip testing equipment, probe needles	5,000
		Indirect Costs	20% of all costs above	13,600
			Total	**81,600**
			EC requested contribution	**81,600**
			AC participants estimated internal costs	**78,000**
UNI-GE	**AC**	Personnel	36,00 ppm	180,000
		Travels	1.5 k€ per total part. FTE (12ppm)	9,000
		Consumables	DAQ	50,000
		Indirect Costs	20% of all costs above	47,800
			Total	**286,800**
			EC requested contribution	**286,800**
			AC participants estimated internal costs	**276,000**
UNIVBRIS	**AC**	Personnel	24,00 ppm	120,000
		Travels	1.5 k€ per total part. FTE (12ppm)	6,000
		Consumables	PCI-VME controller, cabling, computer	10,000
		Indirect Costs	20% of all costs above	27,200
			Total	**163,200**
			EC requested contribution	**163,200**
			AC participants estimated internal costs	**156,000**

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
Grand Total JRA1			**Total (incl. estim. internal costs of AC part.)**	**3435,120**
			EC requested contribution	**1558,620**

JRA2 – Infrastructure for Tracking Detectors

Activity Number	**JRA2**		**Start month**		**1**		**End month**	**48**
Activity Title	**Infrastructure for Tracking Detectors (TDET)**							
Participant number	8	1	3	4	5	6	7	9	16
Participant short name	FOM/ NIKHEF	DESY	ALU-FR	CEA	CNRS/ IN2P3	CSIC	CUPRA-GUE	HIP	UHAM
Total person month	85.4	108.3	101.16	55.44	224.4	70	128.4	96	72
Participant number	17	21							
Participant short name	ULUND	UROS							**TOTAL**
Total person month	80.4	80.4							**1101.9**

Objectives and expected impact:
The proposed detector for the international linear collider contains several advanced tracking detectors. Both Silicon (SI) -based technologies and advanced time projection chamber (TPC) designs are considered. The objective of this JRA is to develop and provide the means that efficient R&D on these different technologies can be performed. This encompasses the development of novel and advanced monitoring techniques and devices, particularly to be used for the investigation of the gaseous tracking detectors, the development of prototypes structures, which can be used to test new tracking systems, and the provision of a broad range of services needed to further develop and test Si-based tracking devices. Altogether the actions will help to integrate the different European activities and help maintain their leading role within the worldwide activities. We propose three projects to improve the infrastructures for developing such devices: A general purpose TPC development facility, a Si-TPC based monitoring facility, and a Si-tracking development facility.
The Activity Coordinator is responsible for the monitoring of the success and impact of the JRA. He or she will report on results and the compliance with milestones and deliverables to the Steering Committee. The AC is aided in this process by the Task Leaders.

A. TPC development facility
A large TPC is one of several proposals for the central tracking system at the ILC detector. A TPC at the ILC needs to have a particularly thin field cage, provide excellent resolution (both single hit and double track resolutions) and be able to operate extremely reliable and robustly. Current R&D concentrates on the development of novel readout gas amplification schemes for a TPC, based on micro-pattern gas detectors like GEMs or Micromegas.

The goal of the TPC development facility is to provide a commonly available field cage and readout electronics infrastructure, which can then be used by the participants and other groups to test and study different readout systems, develop novel instrumentation of the endplates, and understand the integrated system field cage – end plate.
The field cage will be built as a light composite structure, to minimize the material and optimize the mechanical and electrical strength. R&D is needed to optimize the isolation properties of the field cage for extremely high voltages, while maintaining the required electrical and mechanical properties. A structure will be developed and engineered to meet both the electrical and the mechanical requirements. It will then be built at DESY using the existing workshop infrastructure. In close cooperation with the other members of the consortium and its associated members, the layout of the interface between the field cage and the endplate will be defined to provide maximum flexibility.
External services needed to use the field cage encompass a High Voltage system, capable of providing up to 100 kV to the cathode, and a second system used to power the anodes at somewhat lower voltages. Both will be setup and integrated in a test-DAQ system, to allow ease of operation and a high degree of availability to the user. One of the core requirements is that the anode HV system is capable of supplying voltage to the anode with floating ground. This will require special developments, which will be done in cooperation with the technical department at DESY and be based on previous experience. The field cage will be equipped with an extensive slow controls monitoring system, to allow close monitoring of its performance.
The field cage will be supplemented by a general purpose readout system and DAQ, which will be developed with a view on usability for a wide range of TPC endplate technologies. One of the challenges of the readout electronics for such devices is to provide many channels at low cost and with a very high packing density. It is foreseen to develop and construct a 1000 channel system. New developments will include a specialised preamplifier. In a first iteration the system will be installed based on existing digitizer modules. In a further development the preamplifier will be further integrated with a TDC to provide a digital output to the DAQ. While for the test facility the final goal of a footprint of a complete channel below $1mm^2$ will not be needed, still significant reductions compared to currently available systems are required to allow the efficient operation of large scale prototypes in the magnet provided by JRA1 and at other test installations. The readout system will be developed either based on conventional FADC technology, or on a – for TPCs – novel approach using TDC and time-to-charge conversion techniques.
Participants contributing own funds to this task are DESY, UHAM, ULUND, UROS.

Risk assessment:
The main risk associated with the development and building of the new and generic TPC prototype field cage are the following:

- Failure to deliver the appropriate HV stability of the field cage:
  As we aim for a very thin and light structure, novel materials should be used to optimize the HV stability and behaviour. In case these material to not deliver on their promises, fall-back solutions based on conventional materials are available. They would result in a slightly increased material budget of the field cage, which will not seriously hamper the project. Careful monitoring of the progress during the design phase will make sure that no significant delays are encountered in such cases
- Failure to attract sufficient person power to construct this device:
  The proposed projects depends on person power from the main contributor, DESY, and some person power to be financed through the project. If the full amount of person power is not available, the project will be delayed accordingly.

The main risks connected with developing and providing a central DAQ are:

- Failure to attract sufficient person power into the project
- There are no other major risks associated to this part.

B: Si-TPC based monitoring system

The optimization of the TPC based tracking detector depends critically on the detailed understanding of the properties of gases and of the understanding of the charge transfer properties within a TPC and its associated gas amplification systems. The SI-TPC task aims to do the R&D needed to construct a precision diagnostic device to measure the electron cloud arriving at the readout plane of a TPC with unprecedented accuracy both spatially and time resolved. This will be achieved by equipping a TPC like detector with highly pixelated integrated CMOS amplifiers and digitization ASIC's as replacement for the conventional pad plane. Once developed such readout system can either be used for diagnostics purpose in the generic TPC system, developed with task A of this JRA, or it can be implemented into a dedicated monitoring TPC. Results from this device will be of broad interest to each group involved in the development work of a TPC at the ILC, and more generally to the gaseous tracking detector community as a whole.

In such a setup, the charge is directly collected at the input gate of a charge-sensitive amplifier attached to each pixel. Since the Si-sensor directly forms the endplate unprecedented pad sizes of a few $10 \times 10\ \mu m^2$ are possible. First small scale tests of this approach using both Micromegas and GEM's have been successful[14]. These tests use the MediPix2 readout chip as charge-sensitive device. While clear signals both from Fe55 sources and minimum ionizing particles have been observed, the MediPix2 chip does not offer the possibility to detect the charge time-resolved. For operation in a TPC, this feature is mandatory.

In order to arrive at the proposed diagnostic infrastructure the following steps have to be undertaken:

1. Development of a modified MediPix2 chip (TimePix) which is capable of registering the arrival time of the signals.
2. Implementation of the TimePix chip into diagnostic endplate systems both using Micromegas and GEM's as gas amplification device.
3. Perform initial measurements of the performance of the systems within the test infrastructure at DESY.
4. Develop a simulation framework for these systems which can be easily employed by the users of the EUDET test infrastructure.
5. Develop a data acquisition system and integrate this system into the overall DAQ system of the EUDET test infrastructure.

Participants contributing own funds to this task are ALU-FR, CEA, FOM/NIKHEF.

Risk assessment:

Although being a novelty in TPC readout, the SiTPC project is of very limited risk. This is due to the availability of prototypes for all necessary components and due to viable alternatives in case of failure of one component. Furthermore the already existing R&D results on prototypes both for MicroMegas and GEMs are very encouraging.

Possible risk factors are:

- Failure of a submission of the TimePix chip: unlikely since modifications w.r.t. the MediPix chip are small. Nevertheless in case of a failure this may lead to a delay in TimePix delivery by a few months.

[14] P. Colas, et al., The readout of a GEM or Micromegas equipped TPC by means of the MediPix2 CMOS sensor as direct anode, Proceedings of the 10th Vienna Conference on Instrumentation, Vienna, Feb 2004, Nucl. Instr. and Methods A 535 (2004) 506-510
M. Campbell et al., The detection of single electrons by means of a Micromegas-covered MediPix2 pixel CMOS readout circuit, Accepted by Nucl. Instr. and Methods A, http://www.arxiv.org/physics/0409048

- Cross talk or noise level too high in TimePix: very unlikely since high-frequency signals are also present on Medipix which do not lead to prohibitive noise levels. It may need a redesign of TimePix (several months delay) or investigation of alternatives, e.g. pixel chips of LHC experiments ATLAS and CMS.
- Unstable operation of double-GEM or MicroMegas structures: option to move to triple-GEM structures or improved MicroMegas structures.

C: Silicon Tracking :

Impressive progress over the past ten years has led to the use of Silicon tracking technology to build large tracking systems able to meet the requirements of major experiments like ATLAS or CMS. Within the ILC detector Si-tracking is investigated as an option to supplement or replace the information in the detector available from the TPC-based tracking. Compared to previous Si tracking detectors the reduction of the material present in the detector, while maintaining the excellent resolution, is the main differences and requires R&D effort. This leads to the proposal of Si-detectors with very long and thin ladders. The goal of this task is to enable groups to contribute to the development of such challenging detector components by providing common tools needed to test and simulate these sensors under real life conditions. The main issues to be addressed in these developments and to be tested at the test beam set-up are:

- A very light and large size mechanical structure where the tiles and long strips modules will be located. Performances of this structure with respect to vibrations, magnetic fields, humidity, temperature changes etc. will be studied and compared to simulations.
- A highly multiplexed, deep submicron front-en electronics with low power consumption and the possibility for power cycling will be developed. It will be used to equip part of these detectors. Another part will be equipped with conventional reference electronics. This FE readout electronics will be connected to the DAQ chain that we assume will be standardized at a certain point for all the sub-detectors.
- Prototypes of the cooling systems that we are studying and intend to test in a realistic environment will be made available. They include both cooling by convection and by conduction.
- A prototype of the alignment system to work out the alignment challenges, the distortions handling and calibrations for the overall tracking system. The alignment prototype will be based on a system developed for LHC, using laser beam and Si-sensors to measure the detector position with high precision.
- Study of the effect of the magnetic field on the response of the detectors (Lorentz angle). Thus it will be requested to place the Si-tracking prototypes within a very high value magnetic field.
- Development of a front-end chip readout system.

Participants contributing own funds to this task are CNRS-LPNHE, CSIC, CUPRAGUE, HIP.

Risk assessment

No particular risks are expected in this area. The development of the front end chip might be influenced by the very short development cycle in the commercial chip market. However as two different versions of the chip are going to be developed there is a fall back option in case one fails. Silicon strip detectors in general have proven to be very reliable and robust in general.

Milestones:

Milestone	Date	Task
TimePix operational	9	B
Preamplifier prototype	12	A
MIP signals in TimePix and GEM/MicroMegas	12	B
Convection cooling system prototype	18	C
Field cage available	18	A
3D Table available	24	C
1000 channel DAQ available	24	A
Central tracker prototype	24	C
Endplate infrastructure available	24	B
SiTPC infrastructure available	36	B
Conduction cooling system prototype	36	C
Forward tracker prototype	36	C
Silicon tracking infrastructure available	36	C
Forward tracker prototype	36	C

Deliverable:

Deliverable No	Deliverable title	Deliverable date	Nature	Task
D1	TimePix chip	9	Prototype	B
D2	Preamplifier prototype	12	Hardware	A
D3	TPC fieldcage	18	Hardware	A
D4	Convection cooling system prototype	18	Prototype	C
D5	1000 channel DAQ available	24	Hardware	A
D6	Endplate	24	Hardware	B

Deliverable No	Deliverable title	Deliverable date	Nature	Task
D7	Motorised 3D table	24	Hardware	C
D8	Central tracker prototype	24	Prototype	C
D9	FE chip version 1	24	Prototype	C
D10	SiTPC Infrastructure	36	Hardware	B
D11	Forward tracker prototype	36	Prototype	C
D12	Conduction cooling system prototype	36	Prototype	C
D13	Silicon tracking infrastructure	36	Hardware	C
D14	FE chip version 2	36	Prototype	C
D15	Final report	48	Report	A
D16	Final report	48	Report	C

Resources:

Table 11: Cost summary for JRA2: TDET per participant

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
DESY	AC	Personnel	24.30 ppm	126.563
		Travels	1.5 k€ per total part. FTE (12ppm)	13.538
		Consumables	Field cage (10 k€), HV system (10 k€)	20.250
		Indirect Costs	20% of all costs above	32.070
			Total	**192.420**
			EC requested contribution	**192.420**
			AC participants estimated internal costs	**586.680**
ALU-FR	AC	Personnel	29.16 ppm	151.875
		Travels	1.5 k€ per total part. FTE (12ppm)	12.645
		Consumables	TimePix chip (70 k€), readout (10 k€), DAQ (10 k€), mechanics (4 k€), GEM (3 k€)	97.200
		Indirect Costs	20% of all costs above	52.344
			Total	**314.064**
			EC requested contribution	**314.064**
			AC participants estimated internal costs	**468.000**
CEA	FC	Personnel	55.44 ppm	317.760
		Travels	1.5 k€ per total part. FTE (12ppm)	18.930

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
		Consumables	TimePix chip (175 k€), readout (10 k€), endplate (10 k€), DAQ (10 k€)	205.800
		Indirect Costs	Overheads	237.840
			Total	**780.330**
			EC requested contribution	**282.330**
CNRS/IN2P3	**FCF**	Personnel	224.40 ppm	1317.000
		Travels	1.5 k€ per total part. FTE (12ppm)	28.050
		Consumables	Readout chips (60 k€), cooling components (25 k€), 3D table components (15 k€), misc. comp. (8 k€)	108.000
		Indirect Costs	20% of all costs above	290.610
			Total	**1743.660**
			EC requested contribution	**303.660**
CSIC	**FC**	Personnel	70.00 ppm	220.000
		Travels	1.5 k€ per total part. FTE (12ppm)	8.750
		Consumables	Readout chips (60 k€), alignment components (37.4 k€)	72.000
		Indirect Costs		160.600
			Total	**461.350**
			EC requested contribution	**217.750**
CUPRAGUE	**AC**	Personnel	32.40 ppm	48.600
		Travels	1.5 k€ per total part. FTE (12ppm)	16.050
		Consumables	Readout chips (60 k€), cooling components (10 k€), misc. comp. (7,4 k€)	77.400
		Indirect Costs	20% of all costs above	28.410
			Total	**170.460**
			EC requested contribution	**170.460**
			AC participants estimated internal costs	**220.800**
FOM/NIKHEF	**FCF**	Personnel	85.40 ppm	498.000
		Travels	1.5 k€ per total part. FTE (12ppm)	32.675
		Consumables	TimePix chip (105 k€), readout (10 k€), DAQ (10 k€), prototype (15 k€), Micromegas (4 k€)	144.000
		Indirect Costs	20% of all costs above	134.935
			Total	**809.610**
			EC requested contribution	**380.010**
HIP	**AC**	Personnel		0.000
		Travels	1.5 k€ per total part. FTE (12ppm)	12.000
		Consumables	Readout chips (30 k€), cooling components (5 k€), misc. comp. (6.4 k€)	41.400
		Indirect Costs	20% of all costs above	10.680
			Total	**64.080**

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
			EC requested contribution	**64.080**
			AC participants estimated internal costs	**554.400**
UHAM	**AC**	Personnel	24.00 ppm	125.000
		Travels	1.5 k€ per total part. FTE (12ppm)+ 20 k€ travels for associate (KEK)	29.000
		Consumables		0.000
		Indirect Costs	20% of all costs above	30.800
			Total	**184.800**
			EC requested contribution	**184.800**
			AC participants estimated internal costs	**324.000**
ULUND	**AC**	Personnel	32.40 ppm	174.636
		Travels	1.5 k€ per total part. FTE (12ppm)	10.050
		Consumables	FADC (10 k€), preamps (8 k€)	18.000
		Indirect Costs	20% of all costs above	40.537
			Total	**243.223**
			EC requested contribution	**243.223**
			AC participants estimated internal costs	**310.464**
UROS	**AC**	Personnel	32.40 ppm	168.750
		Travels	1.5 k€ per total part. FTE (12ppm)	10.050
		Consumables	VME equipment (10 k€), TDC (8 k€)	18.000
		Indirect Costs	20% of all costs above	39.360
			Total	**236.160**
			EC requested contribution	**236.160**
			AC participants estimated internal costs	**330.000**
Grand Total JRA2			**Total (incl. estim. internal costs of AC part.)**	**7994.501**
			EC requested contribution	**2588.957**

JRA 3 – Infrastructure for Calorimeters

Activity Number	**JRA3**		**Start month**	**1**		**End month**		**48**
Activity Title	**Infrastructures for Calorimeters (CALO)**							
Participant number	5	1	2	10	11	13	15	16	
Participant short name	CNRS/IN2P3	DESY	AGH-UST	INPPAS	IPASCR	TAU	UCL	UHAM	**TOTAL**
Total person month	548.64	232.8	48	48	80	36	99.6	48	**1141.04**

Objectives and expected impact:

The calorimeter plays a central role in the detector for a linear collider. The proposed designs feature unprecedented detector granularities which require the exploration of novel technologies (e.g. for photo-sensors) and the collection of large test beam data samples to validate the simulations. Significant developments are ongoing in the world to develop these technologies. In particular the CALICE collaboration has formed over the past few years, with the goals of building and testing a first version of a “particle flow” calorimeter. First results from tests are expected to be available within about a year from this writing.
A comprehensive optimization of the calorimeter for the ILC depends on a number of factors. The ansatz of a “particle flow” calorimeter first proposed for the ILC by a European group requires to obtain the best possible separation between photons, neutral and charged hadrons. For the first about 20 radiation lengths of calorimeter a baseline solution exists based on the use of tungsten as absorber and Si-sensors for the readout. For the largest part of the calorimeter however many different options exist, with very different trade-offs between performance and cost. Progress in the field of large area readout systems, either through gaseous systems like resistive plate chambers (RPC) or through scintillator based systems, is extremely rapid. Groups in this consortium and groups associated to the consortium are involved in key positions in the development of novel sensor systems.
To support these developments and to enable more and different technologies to be developed and tested we propose to setup a calorimeter test infrastructure, consisting of a fully equipped electromagnetic calorimeter, and a complete infrastructure for testing novel schemes for a granular calorimeter, including a versatile calorimeter stack, a readout system and a data acquisition system. The complete infrastructure will be developed in such a way that it is portable and can be combined e.g. with the tracking infrastructure described in JRA2, brought to the test beam presented in JRA1, or used at other facilities available worldwide.
A special role within the calorimeters for the ILC detector is played by the very forward calorimeters. The instrumentation in this region is particularly challenging in terms of precision and radiation hardness. This implies the development and use of special, radiation hard and extremely fast sensors, and the related readout systems. For these purposes we propose to develop a common infrastructure containing assembly and test-facilities for such sensors, and the equipment for beam tests to be shared then between all participating laboratories.
In addition to the experimental improvement we propose to use the infrastructure to study in detail the simulation of particle showers in particular in hadronic interactions. The knowledge about the detailed structure of hadronic showers is still rather incomplete, and the available simulation tools far from perfect. With the granular calorimeter prototypes available in the

course of this project it will be possible to accumulate a body of data of unprecedented detail on hadronic shower development. These data will be used to tune and adjust the models in the main shower simulation package, GEANT4, and make them available to the community.
Together these actions will allow the European partners in the proposal to maintain their central role in the development of novel calorimeter technologies for the international linear collider. The facilities proposed will ease the route for new institutes to participate in this exciting and challenging area of detector R&D in the future. The community as a whole will profit from the dissemination of the results of the detailed simulation of particle showers.

Description of work:
A: Electromagnetic Calorimeter
A central part of the proposed infrastructure is the development of a compact and dense electromagnetic prototype, equipped with Tungsten absorbers, Si sensors and readout chips. Compared to existing systems the mechanics needs to be significantly improved to allow for a denser overall design, to provide a prototype which presents the adequate properties of compactness and granularity. In front of possible hadronic calorimeters, this will provide information on hadronic shower developments, longitudinal and transverse sizes, cell occupancies etc.
This requires, apart from an improved mechanical engineering concept, new and highly integrated front end electronics, which is properly interfaced to the common calorimeter DAQ developed under task D of this JRA.
In detail, there will be developed:

- A new structure made of tungsten slabs wrapped in carbon-fiber ,
- Detector slabs with a tungsten core and, on both sides, silicon diodes connected to an electronic chip.

One participant contributes own funds to this task: CNRS-EP.

Risk assessment:
The main risk in the ECAL construction is ageing of the glue connecting Si-wafers to the readout board. Failure of the proposed technique might result in delays of a few months, to develop alternative methods.

B: Hadronic Calorimeter
To allow the efficient test of different readout technologies, a general purpose hadronic calorimeter stack will be developed and built. Compared to existing ones, the absorber structure should be significantly improved, made denser, mechanically more flexible, and generic enough that it can be used easily by different groups for widely different readout technologies.
An important part of every calorimeter is a proper calibration and monitoring system. The large number of channels needed for a granular calorimeter, and the wide dynamic range required by the various calibration functionalities present a sizeable challenge. We propose to develop a multi purpose calibration system, which can be used for a wide variety of light-sensing calorimeter readout schemes. A LED based light distribution system will be provided, which will present a clear interface to the detector developer.
Participants contributing own funds to this task are DESY, IPASCR.

Risk assessment:
The main risks connected with the readout and the calibration system is connected with the photo detectors. These devices are being developed by groups from Russia, associated to this proposal. The industrialization of the sensor production is ongoing at present, such that the quality and delivery schedule are still subject to uncertainties. Depending on the quality of the

sensors, the requirements on the front end electronics and on the stability of the calibration system might increase significantly. In this case extra funding will be needed to develop front end electronics with lower noise and higher gain, and calibration systems with improved stabilities. The risks will be controlled by a close and careful monitoring of the progress and the quality of the sensors, to constantly update the requirements of the system.

C: Very Forward Calorimeter

The instrumentation of the very forward region is a particular challenge in terms of precision and radiation hardness. To properly instrument the forward region, calorimeters have to be fast and very resistant to radiation. At the same time the devices need to be compact and have a very fine segmentation. Several technologies are currently under study, among them industrially produced diamond sensors.

To support the R&D for radiation hard and fast calorimetry we propose to develop and build up a common infrastructure which will support all participating institutions:

- Laser-based positioning and position monitoring of large area sensors with sub-micrometer precision.
- Facility for the measurement of the homogeneity and linearity of the response from silicon and diamond sensors.
- Test facility for functionality diagnostics and parameter measurements on partly assembled detectors.
- Highly specialised integrated readout electronics with high linearity and large dynamic range for test beam measurements of calorimeter prototypes.

Participants contributing own funds to this task are DESY, INPPAS, AGH-UST,TAU

Risk assessment:

Depending on the properties of commercially available sensors the readout electronics might require a redesign. This would cause a delay of the programme which we will try to minimize by careful monitoring of the progress of this task.

D: Data acquisition

The design for a calorimeter for a future ILC detector poses challenges to the data acquisition system mainly due to the large number of channels to be read out. The goal of this task is to develop and build a DAQ system which can be used for a large variety of calorimeter readout systems. It should be generic to provide the data acquisition for new prototype calorimeters in general, and to serve as a basis for a common DAQ system for the international linear collider. Within this proposal a suitable number of readout channels will be made available in the context of the calorimeter development infrastructure.

In the UK, a conceptual design has been formulated for the DAQ system. One of the underlying design considerations is to use as much as possible commodity components, supplemented by special developments only where necessary. This will allow for ease of scalability and simple procurement of additional pieces of equipment.

Data from the front-end electronics will be transferred, via a switch, to an off-detector receiver which will be PCI cards in a PC farm. The switch will ensure a very high up-time of the system, as it selects only available nodes. The system will provide a means to synchronize to an external clock, to time the readout with the collisions in the accelerator. This requirement is a particular challenge to meet, as it means that time critical information has to be integrated into a by nature asynchronous system.

Participants contributing own funds to this task are UCL and the associated UK institutes.

Risk assessment:

The risks associated with this part of the proposal are considered to be rather small. As the system depends nearly entirely on commercial components, the main condition to successful completion is adequate funding for both material and manpower, to perform the necessary developments. In case the funding is not adequate either the size of the proposed system and/or the time scale will be adjusted.

E: Front-end electronics

One very difficult and completely new aspect of the proposed analog calorimeters is that the electronics readout will be embedded inside the detector. This greatly reduces the electronics noise by reducing the parasitic capacitance and minimizes the number of connections to the outside, bringing only out one digital data line per 100 channels. Furthermore this design keeps dead space to a minimum, thus minimizing the Molière radius and allowing more compact showers which is essential for the particle flow algorithm.

This puts severe constraints on the front-end electronics which must handle large dynamic range signals with extremely low electronics noise while operating at extremely low power, through a scheme of pulsed power mode. Also digitization will be performed inside the front-end chip to minimize the transmission of sensitive analog signals and preserve data integrity. This results in a complex and sophisticated read-out ASIC, which will advance the state of the art of calorimeter front-end electronics. This newly developed front-end ASIC would be adapted to different detectors, e.g the Si detectors of the proposed ECAL or the SiPM photo detectors for the proposed analogue HCAL. Two prototypes are foreseen in 0.35 µm SiGe AMS (Austrian foundry) and several blocks have already been tested by the micrelectronics groups in CALICE.

Depending on the application the chips will be integrated into different types of readout boards. For the ECAL they will be inside the active area, for the HCAL they will be mounted very close to the active planes, at the side of the device. The chip will be designed as being highly configurable, so that it can be adapted to a wide range of analogue HCAL readout systems.

The digital version of the hadronic calorimeter needs a much simpler read out, the signal from a gaseous detector being kept in one or two bits. The idea for the one bit read out is to use comparators and do the zero suppression and the formatting in FPGAs; a digital ASIC for this purpose is also under consideration. These in turn will be read through a token ring. For the prototype the number of pads will be few 100 000.

Participants contributing own funds to this task are CNRS-EP, CNRS-LAL, DESY.

Risk assessment:

Locating the readout inside the active area might put the electronics at risk inside high energetic showers. The thermal management of the electronics might put high strains on the device. In either case careful and close monitoring of the progress will alert us of potential problems, in time to redesign the chips if necessary. The allocated time to this task is such that even a slight redesign should not delay the project.

Milestones:

Milestone	Date	Task
Analogue ASIC prototype 1 available	6	E
PCI card prototype available	9	D
AHCAL FE board prototype ready	18	E
Modified stack available	18	B
DHCAL VFE conceptual design ready	18	E
Analogue ASIC prototype 2 available	19	E
Prototype of laser positioning system ready	24	C
Sensor test facility ready	24	C
Readout electronics design ready	24	C
Integrated ASIC available	30	E
Final DAQ system available	30	D
DHCAL VFE engineering design ready	36	E
Front-end electronics infrastructure available	36	E
AHCAL FE boards produced	39	E
Integrated system available	42	B
Detector test facility ready	48	C
Construction complete	48	A

Deliverables:

Deliverable No	Deliverable title	Deliverable date	Nature	Task
D1	ASIC prototype 1	6	Prototype	E
D2	PCI card prototype	9	Prototype	D
D3	DHCAL VFE concept	18	Report	E

Deliverable No	Deliverable title	Deliverable date	Nature	Task
D4	Modified stack	18	Hardware	B
D5	ASIC prototype 2	19	Prototype	E
D6	Readout electronics design	24	Report	C
D7	Laser positioning system	24	Hardware	C
D8	Sensor test facility	24	Hardware	C
D9	Integrated ASIC	30	Hardware	E
D10	Final DAQ system	30	Hardware	D
D11	DHCAL VFE engineering design	36	Report	E
D12	Integrated system	42	Hardware	B
D13	Final report	48	Report	C
D14	ECAL construction	48	Hardware	A
D15	Final report	48	Report	A
D16	Detector test facility	48	Hardware	C
D17	Final report	48	Report	B
D18	Front-end electronics infrastructure	48	Hardware	E
D19	Final report	48	Report	E

Resources

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
DESY	**AC**	Personnel	64.80 ppm	337.500
		Travels	1.5 k€ per total part. FTE (12ppm)	69.100
		Consumables	Electronics (37 k€), printed circuits (10 k€), calibration system (10 k€), laser system (10 k€), computing (10 k€), materials (8,5 k€)	85.500
		Indirect Costs	20% of all costs above	98.420

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
			Total	**590.520**
			EC requested contribution	**590.520**
			AC participants estimated internal costs	**1348.800**
AGH-UST	**AC**	Personnel	24.00 ppm	70.000
		Travels	1.5 k€ per total part. FTE (12ppm)	6.000
		Consumables	Electronics (5 k€), printed circuits (5 k€), calibration system (5 k€)	15.000
		Indirect Costs	20% of all costs above	18.200
			Total	**109.200**
			EC requested contribution	**109.200**
			AC participants estimated internal costs	**116.400**
CNRS/IN2P3	**FCF**	Personnel	548.64 ppm	3226.500
		Travels	1.5 k€ per total part. FTE (12ppm)	68.580
		Consumables	Tungsten sheets (60 k€), carbon fibre wrapping (8 k€), structure computing (22 k€), moulds (70 k€), Si wafers (65 k€), DHCAL VFE (16 k€), R&D ASICs (100 k€), ASIC+PCB prod. (161 k€)	652.200
		Indirect Costs	20% of all costs above	789.456
			Total	**4736.736**
			EC requested contribution	**1316.736**
INPPAS	**AC**	Personnel	24.00 ppm	70.000
		Travels	1.5 k€ per total part. FTE (12ppm)	6.000
		Consumables	Electronics (5 k€), printed circuits (5 k€), laser system (3 k€), materials (2 k€)	15.000
		Indirect Costs	20% of all costs above	18.200
			Total	**109.200**
			EC requested contribution	**109.200**
			AC participants estimated internal costs	**116.400**
IPASCR	**AC**	Personnel	13.00 ppm	13.000
		Travels	1.5 k€ per total part. FTE (12ppm)	10.000
		Consumables	Microscope+camera (20 k€), Si sensor devel,+prod. (34 k€), electronics test stand (30 k€), calibr. electronics (30 k€), computing (15 k€)	129.000
		Indirect Costs	20% of all costs above	30.400
			Total	**182.400**
			EC requested contribution	**182.400**
			AC participants estimated internal costs	**209.000**
TAU	**AC**	Personnel	18.00 ppm	75.000
		Travels	1.5 k€ per total part. FTE (12ppm)	4.500

Participant	Cost Model	Budgetary Post	Justification	Costs in k€
		Consumables	Electronics (18 k€), printed circuits (3 k€), computing (3 k€), materials (6 k€)	30.000
		Indirect Costs	20% of all costs above	21.900
			Total	**131.400**
			EC requested contribution	**131.400**
			AC participants estimated internal costs	**136.800**
UCL	**AC**	Personnel	36.00 ppm	225.000
		Travels	1.5 k€ per total part. FTE (12ppm) plus travel money for associates (ICL, RHUL, UCAM, UMAN)	23.200
		Consumables	Computing equipment	150.000
		Indirect Costs	20% of all costs above	79.640
			Total	**477.840**
			EC requested contribution	**477.840**
			AC participants estimated internal costs	**810.000**
Grand Total JRA3			**Total (incl. estim. internal costs of AC part.)**	**9381.896**
			EC requested contribution	**2924.496**

Other Issues

There are no gender issues involved in the activities of the consortium. All participating institutes are equal opportunity, affirmative actions employers and encourage the applications from women.

Ethical issue form A:

Does your proposed research raise sensitive ethical questions related to:	**YES**	**No**
Human beings		No
Human biological samples		No
Personal data (whether identified by name or not)		No
Genetic information		No
Animals		No

Ethical issue form B:

Confirmation: the proposed research involves none of the issues listed below	**YES**	**NO**
	Yes	

- Research activity aimed at human cloning for reproductive purposes,
- Research activity intended to modify the genetic heritage of human beings which could make such changes heritable,
- Research activity intended to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer.