
# EUDET: Infrastructure for ILC detector R&D

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ILC detector test beam workshop
at Fermilab
January 17-19, 2007


# Outline

- The EUDET initiative and ILC detector R&D
- EUDET activities: status and plans


# EUDET

- EUDET is an "Integrated Infrastructure Initiative (I3)" within the **EU funded** "6th framework programme"
  - an example of the high recognition of the ILC by the European Union
- Support improvement of **infrastructure for detector R&D** with larger prototypes - but not the R&D itself
  - Example: TPC field cage for R&D on end plates, calorimeter structure for R&D on novel sensors,…
- EUDET is **not a collaboration** and not a closed club
  - Other institutes (EU, non-EU) can contribute and exploit the infrastructure
  - Infrastructure can be re-located
- EUDET brings some fresh **money** – but not enough
  - Additional resources required to exploit infrastructure
  - No free lunch: administrative work and **timelines**

# EUDET Partner Institutes:


Charles University Prague
IPASCR Prague

HIP Helsinki

LPC Clermont-Ferrand
LPSC Grenoble
LPHNE Paris
Ecole Polytechnique Palaiseau
LAL Orsay
IReS Strasbourg
CEA Saclay

DESY
Bonn University
Freiburg University
Hamburg University
Mannheim University
MPI Munich
Rostock University

Tel Aviv University

INFN Ferrara
INFN Milan
INFN Pavia
INFN Rome

NIKHEF Amsterdam

AGH Cracow
INPPAS Cracow

CSIC Santander

Lund University

CERN Geneva
Geneva University

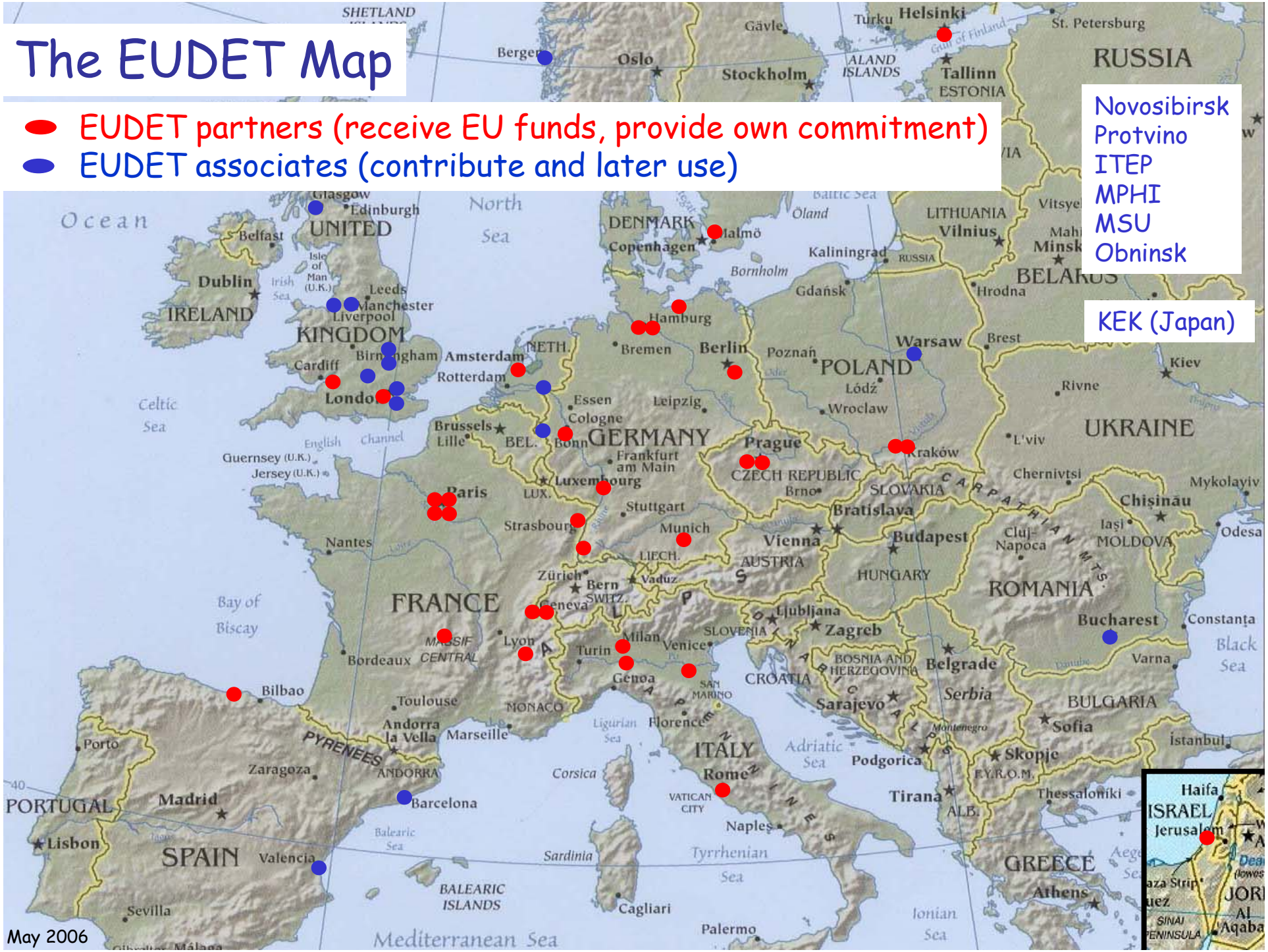
Bristol University
UCL London



+ 22 associated institutes

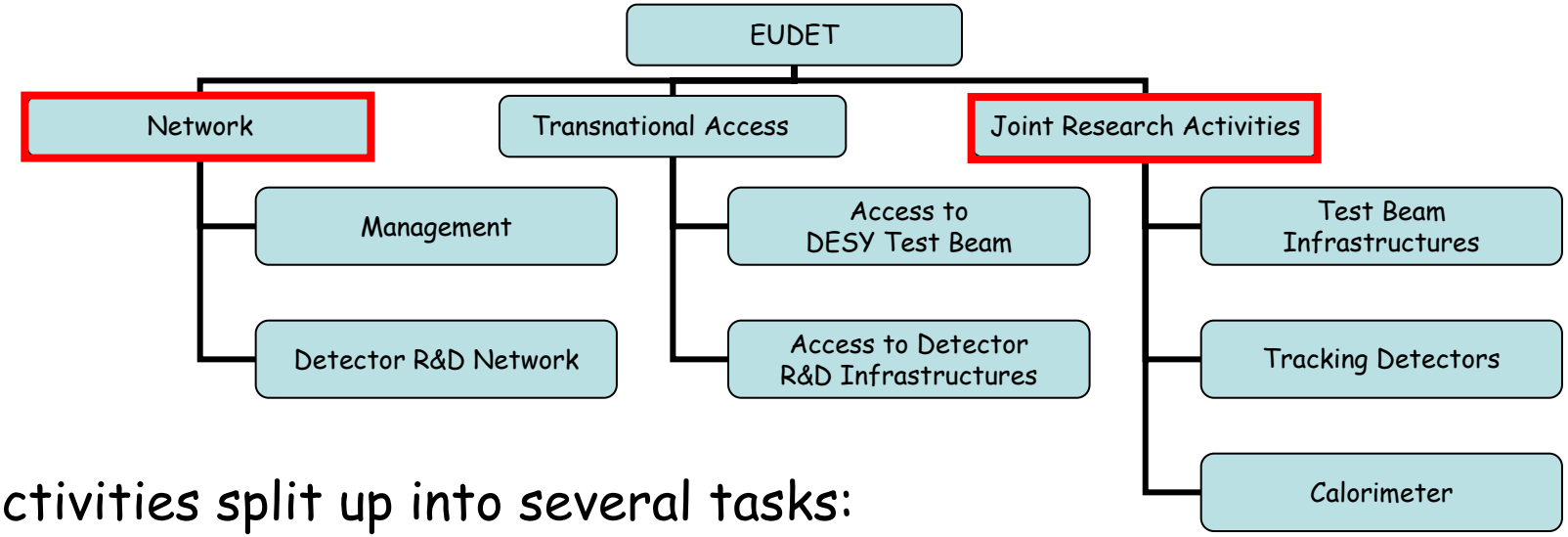
# The EUDET Map

- EUDET partners (receive EU funds, provide own commitment)
- EUDET associates (contribute and later use)



# EUDET Struture

I3 projects based on three pilars (mandatory):




Activities split up into several tasks:

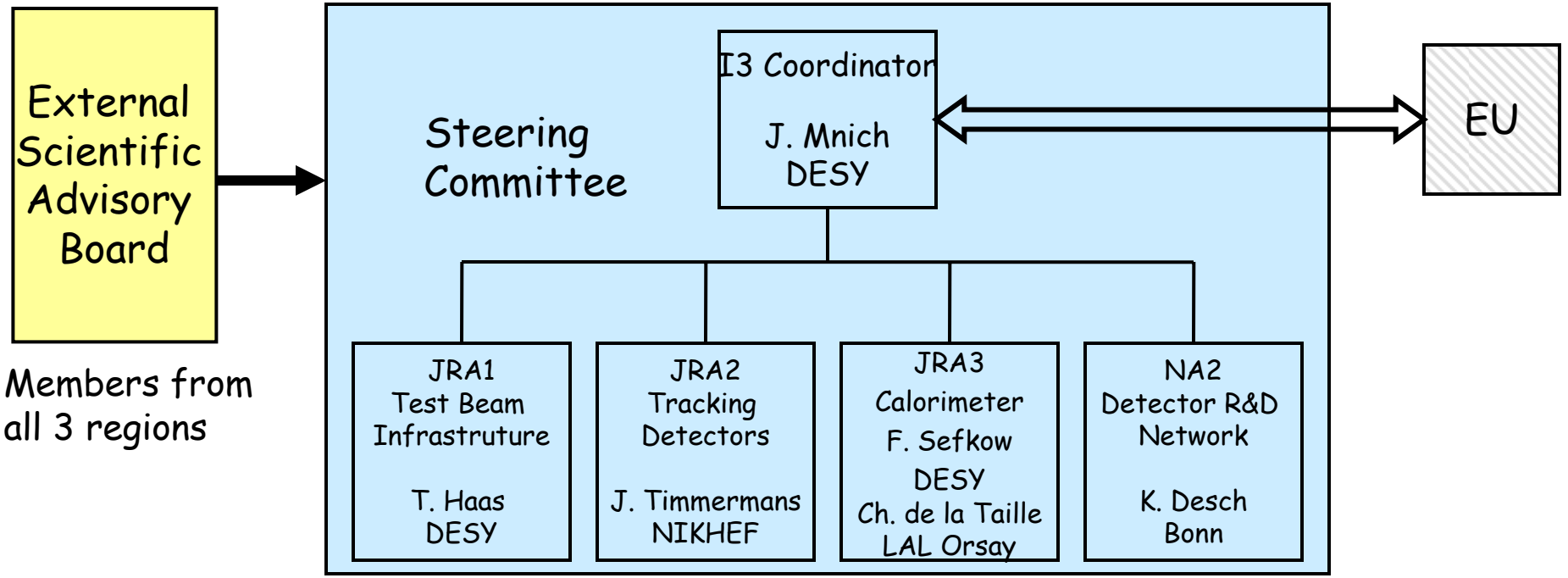
Detector R&D Network:
- Information exchange and intensified collaboration
- Common simulation and analysis framework
- Validation of simulation
- Deep submicron radiation-tolerant electronics

Test Beam Infrastructure:
- Large bore magnet
- Pixel beam telescope

Tracking Detectors:
- Large TPC prototype
- Silicon TPC readout
- Silicon tracking

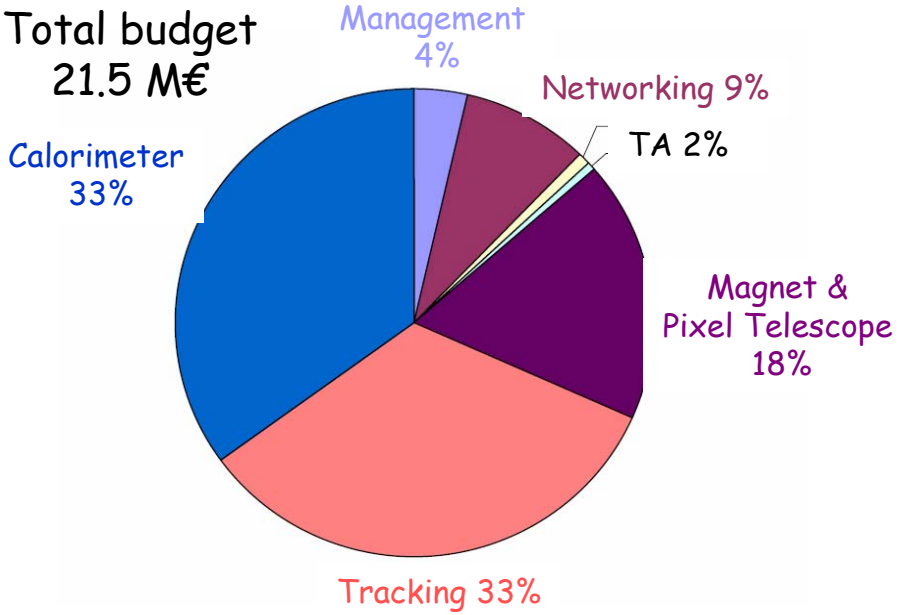
Calorimeter:
- ECAL
- HCAL
- Very Forward Calorimeter
- FE Electronics and Data Acquistion System

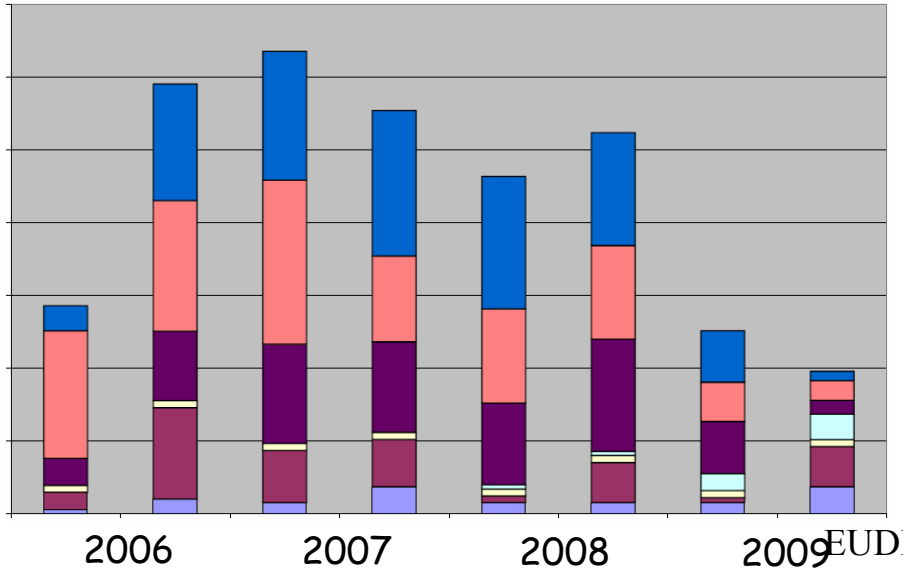
# EUDET Management




- Task leaders have been assigned for the various work packages
- Annual EUDET meetings and workshops

# EUDET Budget and Time Profile




Budget:

- 21.5 million Euro total
- 7.0 million Euro EU contrib.

Manpower:

- ≈ 57 FTE total
- ≈ 17 FTE funded by EU

➔ most of the resources for the development of the infrastrutures

- duration of 4 years
- ramp-up first half 2006
- full swing activities for 2.5 years
- last year: phase-out and exploitation of infrastrutures

# Transnational access

- Imposed by EU to foster trans-European access to research infrastructure

- Take advantage of it: apply for travel money!
  - For travel to DESY test beam
  - For travel to use any of the infrastructure created within the EUDET initiative
    - Magnet, beam telescope
    - Field cage, SiTPC, Si tracker
    - Calorimeter structure, readout, test stands

- Open to any European group
  - EUDET or not
- For non-European groups somewhat more complicated

# EUDET and R&D collaborations

- EUDET may be seen as a sort of large virtual "institute" in the overall worldwide ILC detector R&D "collaboration"
  - Provides resources, takes responsibilities
  - Make optimal use and avoid duplication on international scale
- On sub-detector level, the EUDET activities (JRA's) are closely coordinated with the R&D collaborations
  - e.g. LCTPC, SiLC, FCAL, CALICE

- EUDET is a contract between partner institutes and EC with well defined milestones and deliverables
  - Needs some own management structure, meetings
  - Somewhat reduced flexibility
- Most challenging impact: need to **synchronize** the timelines


# Outline

- The EUDET initiative and ILC detector R&D
- EUDET activities status and plans
  - Test beams
  - Vertex detector R&D
  - Tracking R&D
  - Calorimeter R&D
  - Networking

# JRA1: Test beam infrastructure

- Activity organized in 5 tasks
  - Large bore magnet
  - Environmental support
  - Pixel beam telescope
  - DAQ
  - Evaluation (integration of pixel detector test devices)

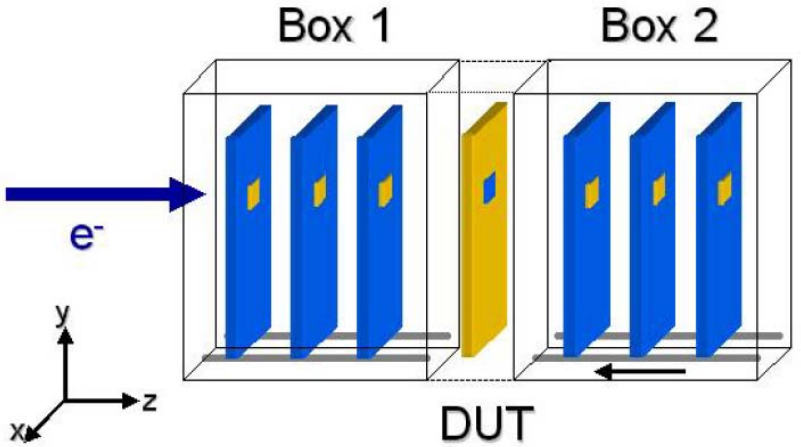
- All EUDET infrastructure is movable
  - Construction and initial tests at DESY
  - Later use at CERN, FNAL etc possible

*See also talks by I. Gregor*

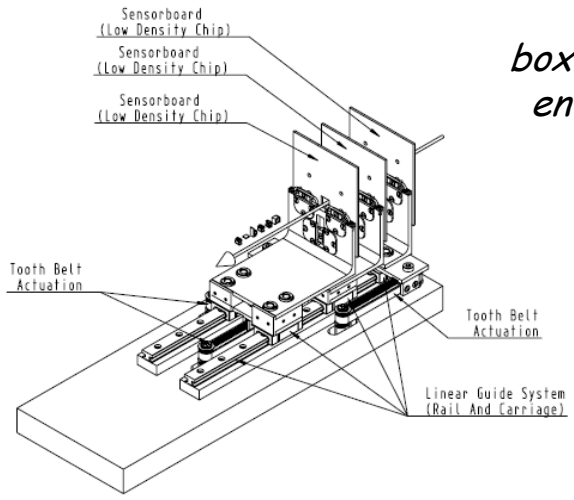

- PCMAG (on loan from KEK)
  - SC high field magnet: **1.2 T**
  - Large bore **80cm** diameter
  - Thin cryostat (**0.2 $X_0$**)
  - Independent cryogenics
  - Re-commissioned at KEK

# JRA1: beam telescope

- Telescope
  - Flexible geometry (for diff. beams)
  - 1 μm precision on device under test
  - DUT positioner



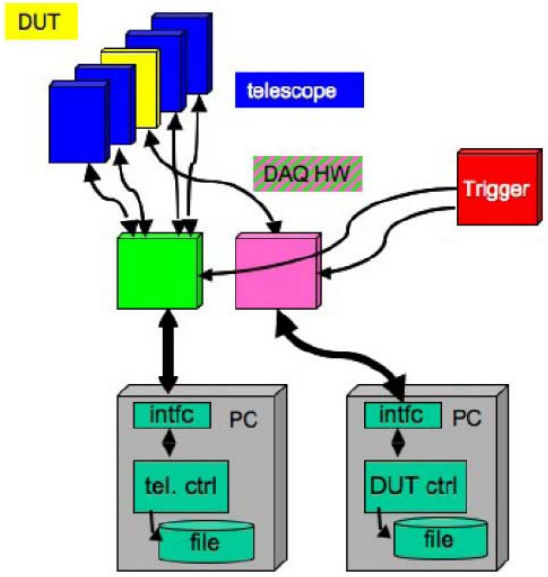

*Design ready, boxes with independent environments /cooling*



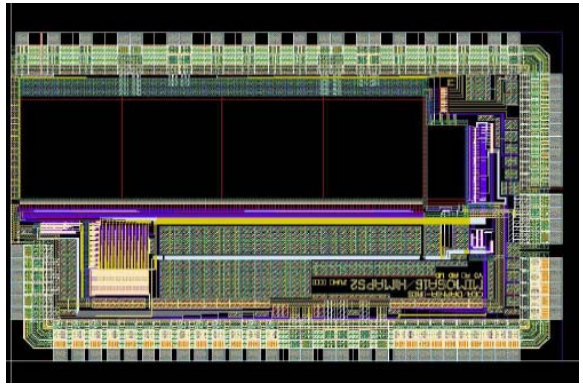

Sensor Box Content

# JRA1: beam telescope sensors

- Sensors
  - MAPS technology
  - 2007: demonstrator, 10 kF/s
  - 2009: final, 10x faster, 20x10mm$^2$
- DAQ:
  - DUT integration scheme



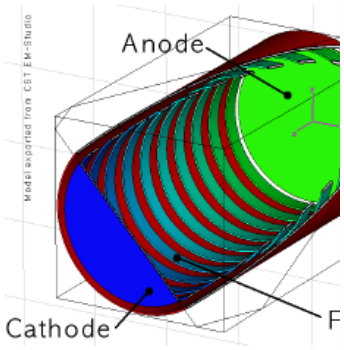

*Demonstrator small prototype (MIMO*2)*

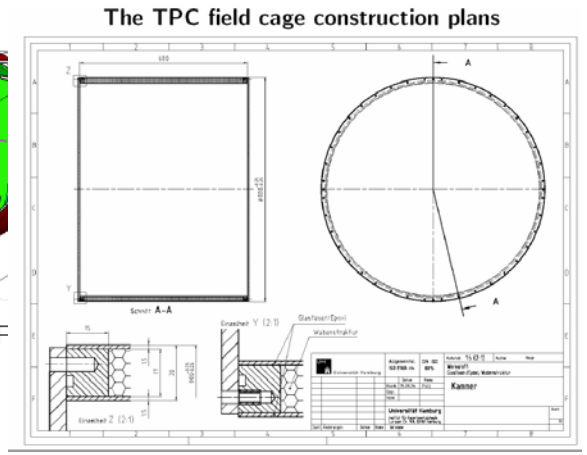


*Layout of MIMOSA16 (prototype for final,) under test*

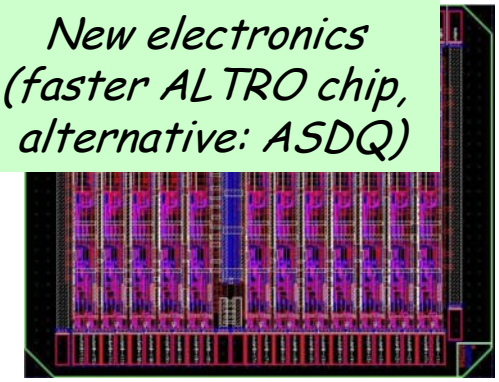
# JRA2: Tracking; TPC

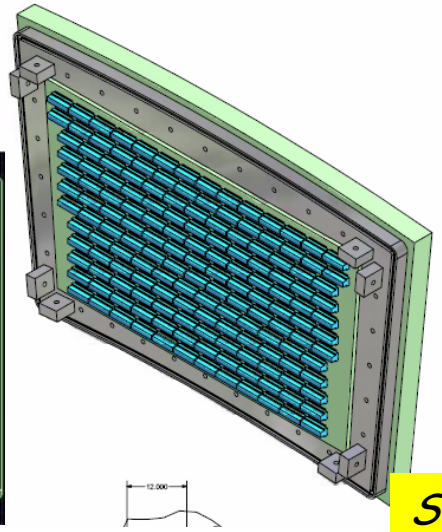
- 3 tasks
  - **Large TPC prototype**
    - **field cage, end plate interface, readout**
  - Si TPC readout
    - Timepix chip, diagnostics plane
  - Si tracking
    - Mechanics, cooling, electronics

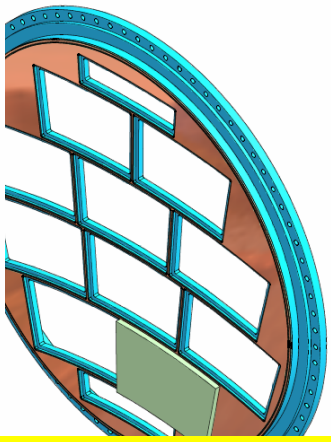


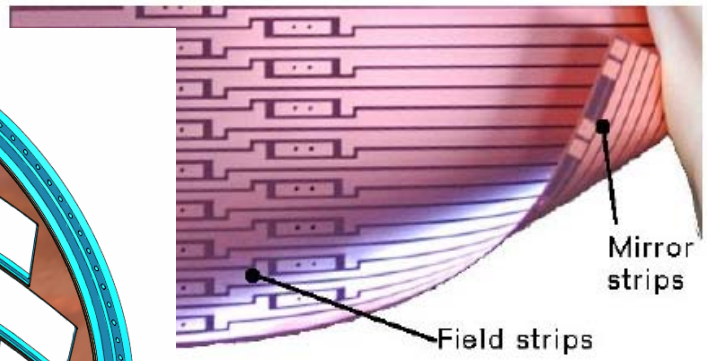




*2009*
*New electronics (faster ALTRO chip, alternative: ASDQ)*









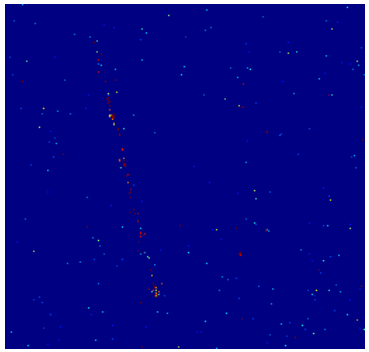

*2007: FC construction*

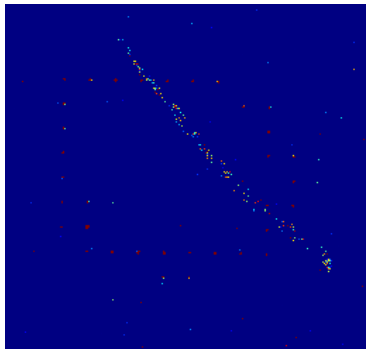
*See also talks by M.Dixit, A.Savoy-Navarro*

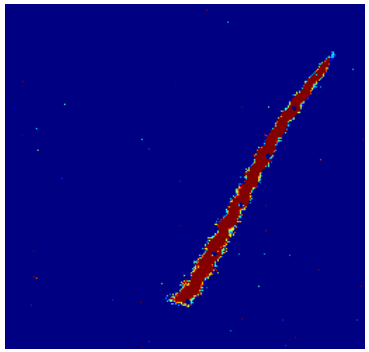
# SiTPC: First Tracks with Timepix

Timepix covered with 4μm of amourphous Silicon
with a standard Micromegas in He/$C_4H_{10}$ (80/20)

cosmics



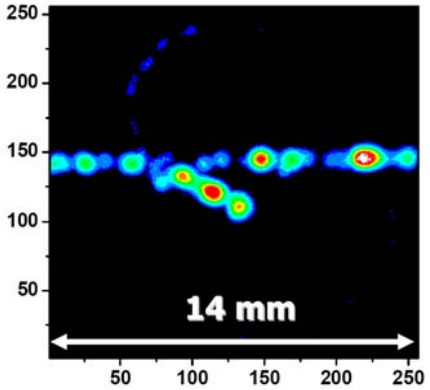




α particle

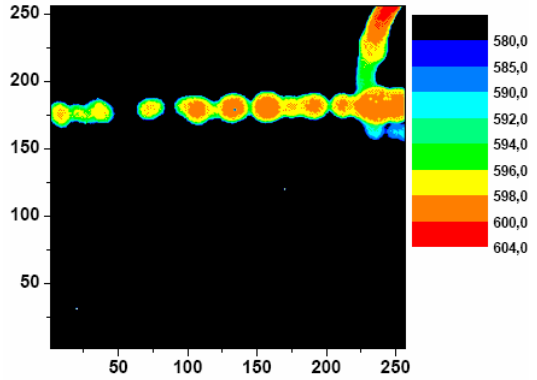
TOT-mode
of Timepix

Timepix in a 3-GEM detector at DESY testbeam




5GeV $e^-$ track
with δ-electron(s)

← in TOT mode
in TOF mode →

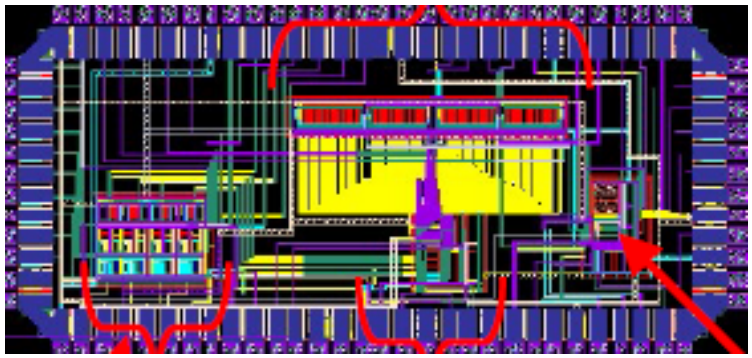


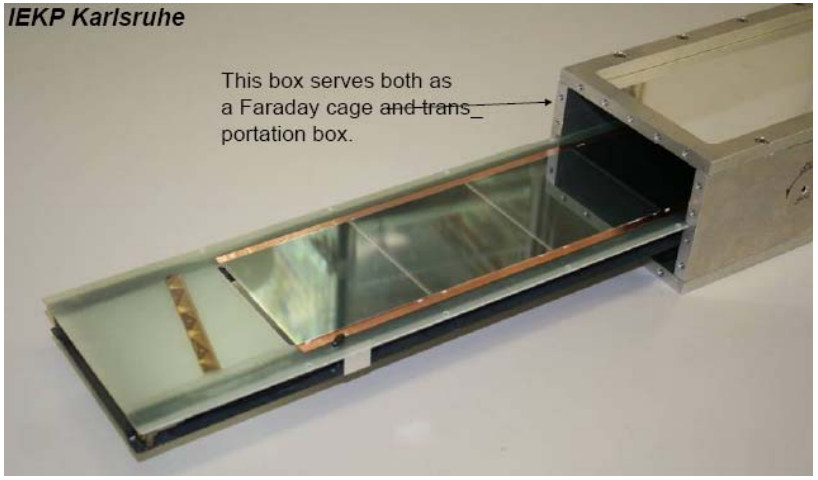
# JRA2: SiTracking

Ambitious test beam programme

Diverse activity

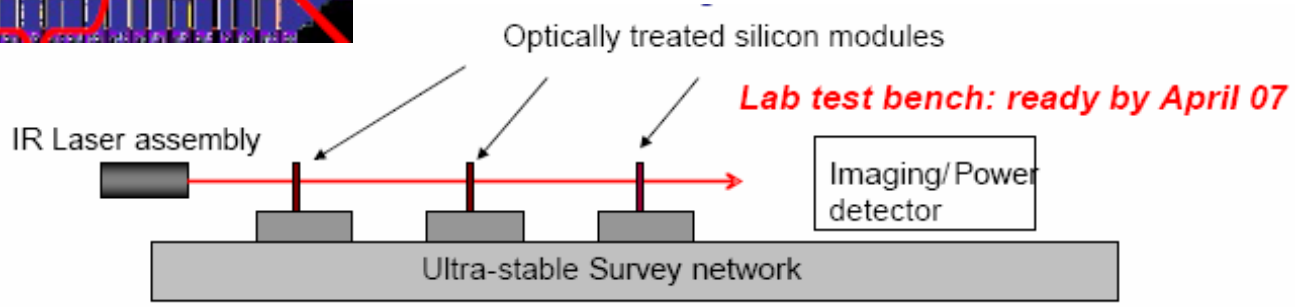
*DSM (130 nm) Front end electronics 4ch analog & digital prototype under test*





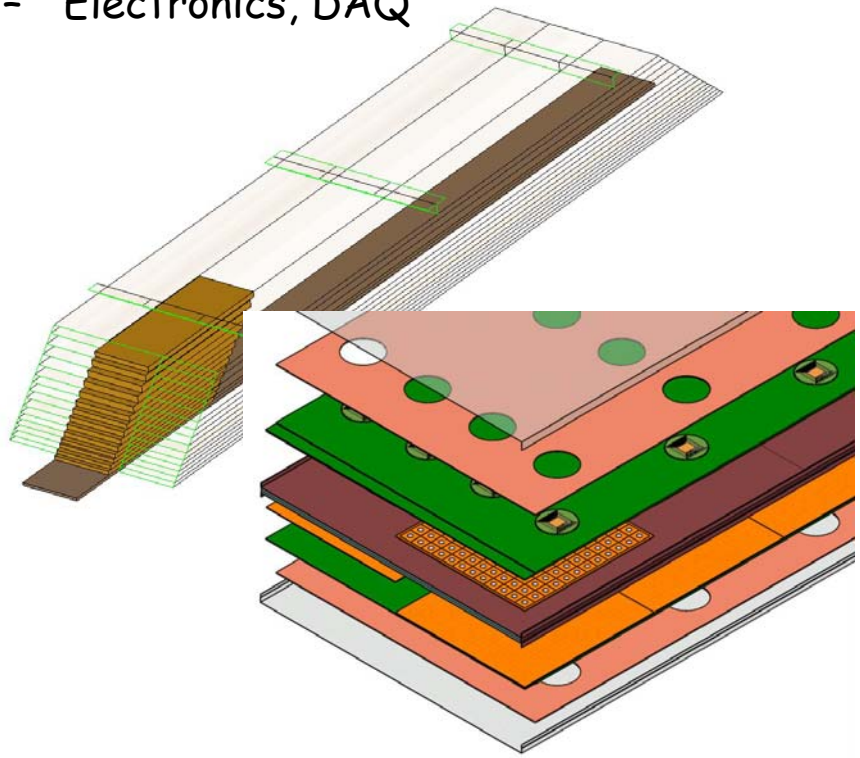

*support for large sensor R&D*

*Alignment system*



# JRA3: Calorimeter; ECAL

- 3 + 2 tasks
  - **ECAL**, HCAL, VFCAL
  - Electronics, DAQ



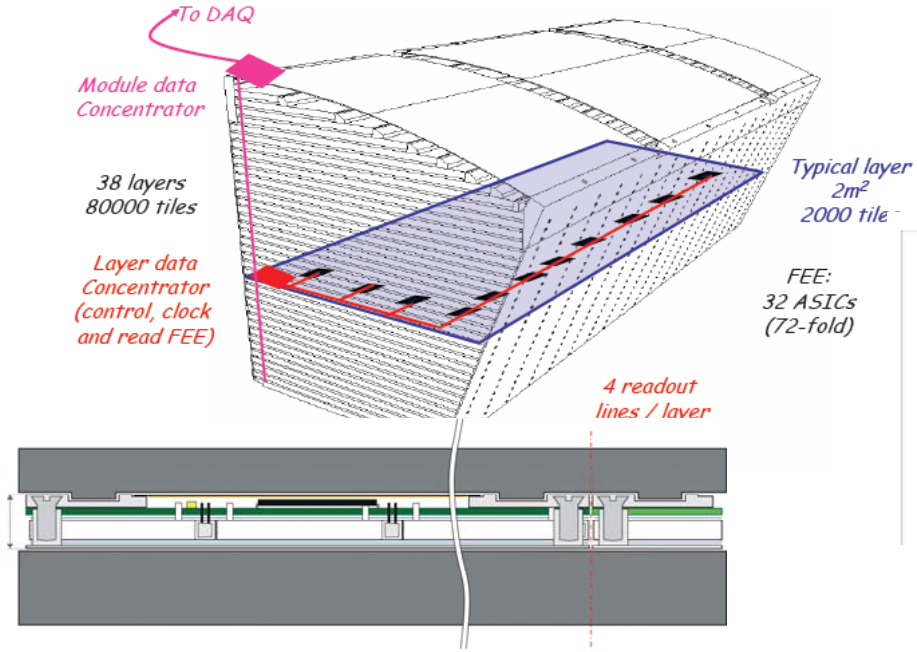
- The ECAL "EUDET module 0"
  - barrel module prototype
    - 0.4t tungsten, 1.8m long
  - ~1/6 instrumented (12k ch.)
    - One tower for e test beam
  - Embedded electronics
    - 1.5mm gap (PCB + wafer + ASIC)
    - Power pulsing
  - Test full scale mechanics, cooling, communication

CALICE Calorimeter for ILC

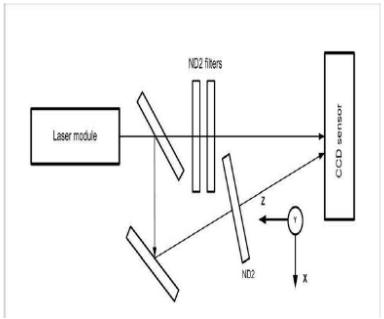
*See also talks by R.Frey, L.Xia, W.Lohmann*

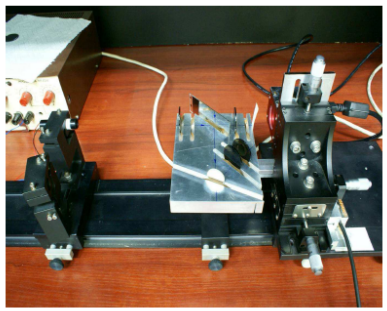
# JRA3: HCAL, VFCAL

- HCAL
  - Realistic structure
  - Integrated electronics
  - Readout architecture like ECAL
  - Calibration system, test stand



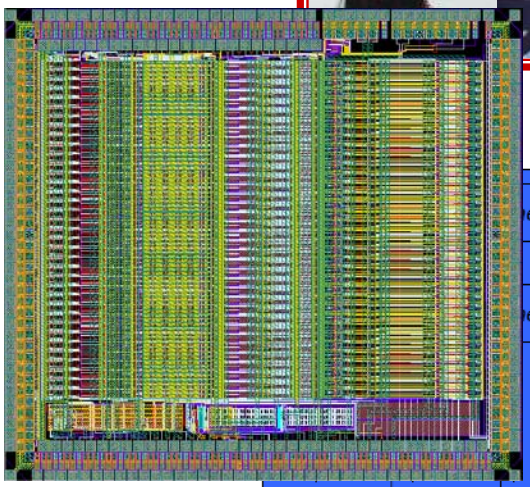

- VFCAL
  - Sensor test stands
  - Irradiation test beam infrastructure
    - Already used
  - Readout electronics
  - Laser alignment system
    - μm level precision

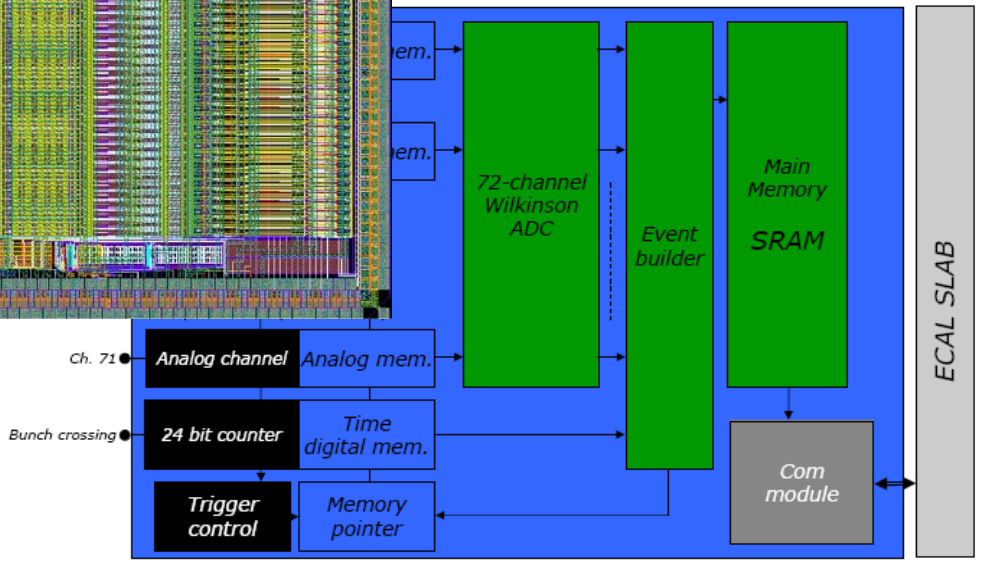


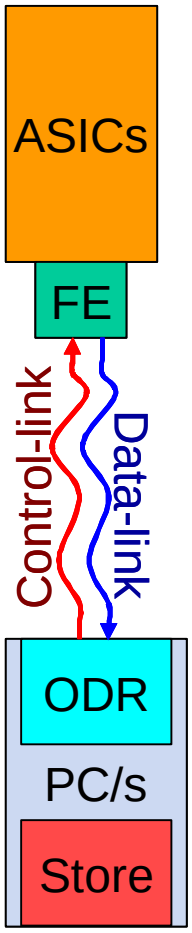
# JRA3: Calorimeter electronics

- Electronics
  - Integration is key
  - Digital part next to sensitive analogue FE
  - Power pulsing, stability
- HaRDROC
  - 64 ch digital HCAL chip
  - Under test
- SKIROC
  - 36ch ECAL chip
  - At foundry (0.35 AMS)
- SPIROC
  - 36ch analoge (SiPM) HCAL chi
  - Under design
- More versions in the pipeline

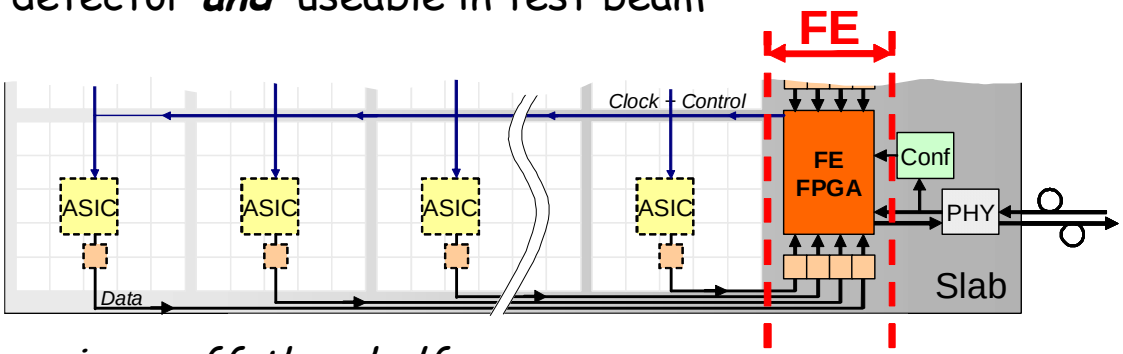




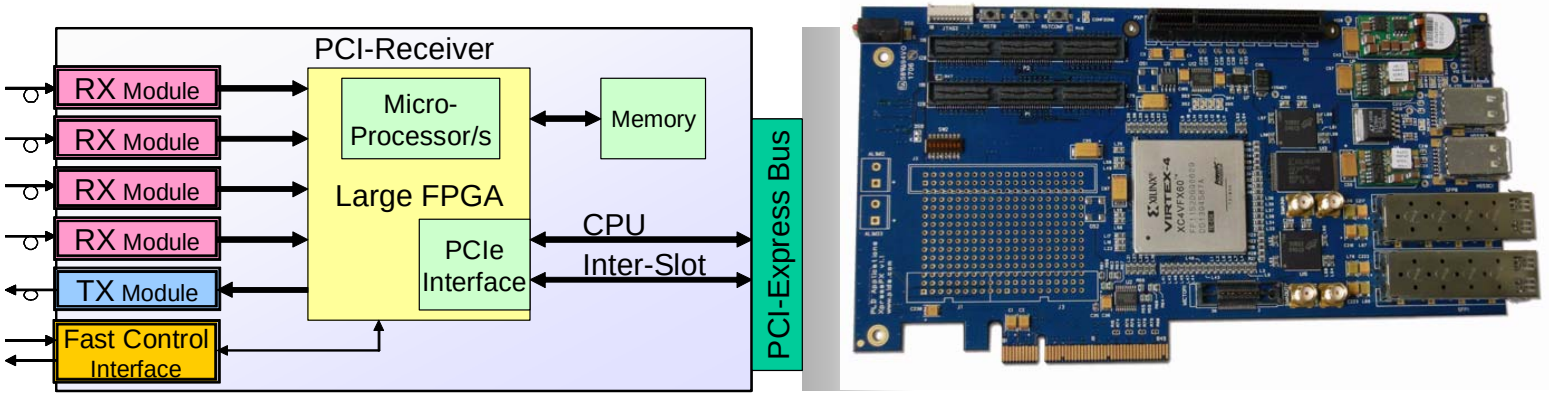
# JRA3: (calorimeter) DAQ




- Scalable DAQ system
  - Commercial hardware where possible
  - Prototype for full detector ***and*** useable in test beam




*e.g. off-detector receiver: off-the-shelf*



# Networking activity

- Information exchange
  - Web site www.eudet.org
  - Annual workshops (open to everyone)
- Computing and analysis
  - Grid based computer cluster
  - Common software for test beams and ILC simulations
  - **Not EUDET specific**; embedded in ILC software & simulation effort, already used
  - See also talk by R.Poeschl
- Shower simulation
  - Support from Geant4 team
- Deep sub-micron rad-hard electronics
  - Access through CERN contracts


EUDET Annual workshop,
MPI Munic, Oct 18-20, 2006h


# Conclusion

- EUDET is Added Value to test beams
- The initiative provides resources which help to proceed towards the next phase of ILC detector R&D
  - Infrastructure for larger and/or more realistic prototypes
  - Mobile and open to everyone
- EUDET is embedded in the international ILC detector effort
  - Active synchronization with R&D collaborations
- Start in 2006: first milestones met, first deliverables delivered

# Outlook

- If EUDET reaches its goals, it will generate increased demands for high precision test beams
  - Clean, well defined beams of identified particles
  - For high statistics data collection
  - Over large energy range 1-100 GeV
- … to get precision devices for precision physics under one roof