EUDET
Detector R&D towards the Status and Plans

Roman Pöschl
LAL Orsay
on behalf of the EUDET Project(s)

4th EIC Workshop Hampton, VA May 2008
Introduction to EUDET

- EU funded program supporting ILC detector R&D in Europe

- Project duration:
  - Jan 2006 to Dec 2009

- Budget:
  - 21.5 million Euro total
  - 7.0 million Euro EU contribution

- Manpower:
  - \(\approx\) 57 FTE total (= 230 man years)
  - \(\approx\) 17 FTE funded by EU

- 23 (31) partner institutes in Europe provide own commitments & receive EU funds
- 27 associated institutes worldwide contribute to design & construction of infrastructures interested in later exploitation
EUDET Structure

- Integrated Infrastructure Initiative (I3)
- I3 projects based on three pillars (mandatory):

  - Network
  - Transnational Access
  - Joint Research Activities

  - Management
  - Detector R&D Network
  - Access to DESY Test Beam
  - Access to Detector R&D Infrastructures
  - Test Beam Infrastructures
  - Tracking Detectors
  - Calorimeter

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

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

Tracking Detectors:
- Large TPC prototype
- Silicon TPC readout
- Silicon tracking
Joint Research Activities

**JRA1: Testbeam Infrastructure**

- **Large bore magnet:**
  - 1 Tesla, $\Phi \approx 85$ cm, stand-alone He cooling, supplied by KEK
  - infrastructure (control, field mapping, etc.) through EUDET

- **Pixel beam telescope**
  - 6 layers of MAPS detectors
  - CCD and DEPFET pixel detectors for validation
  - DAQ system

Note: all EUDET infrastructures are movable

- construction & initial tests at DESY
- later exploitation at CERN, FNAL etc. possible

Below a few examples to illustrate the project and its status
JRA1 Magnet

- Magnet supplied by KEK (PCMAG)
  low mass coil, stand-alone He cooling, 1 Tesla
- Infrastructure (power, control, He) designed and constructed in close collaboration KEK & DESY
- Now operational at DESY testbeam

- First version of field map
- Precision goal: $10^{-4}$
Beam Telescope

- **1\textsuperscript{st} version of pixel beam telescope:**
  - analogue readout, reduced speed
  - tested & commissioned at DESY
  - now in CERN testbeam

- **2\textsuperscript{nd} version in preparation**
  - digital readout and zero suppr.
  - Testbench results of new Chip
  - Promising are promising
  - Chip ready towards end of 2008

- **Performance:**
  - test with DEPFET detectors
  - 3.4 µm resolution
    (intrinsic + telescope)
  - in good agreement with expected DEPFET resolution (3 µm)
The EUDET Telescope – At your Disposal

- **All-inclusive package**
  - The two arm telescope with different geometries with the possibility to add one extra high resolution sensor plane.
    - The telescope comes with all the mechanics and the cooling system.
    - Operating support: mainly remote but also local in some circumstances.
  - The DAQ system both hardware and software.
    - You can connect your device to our TLU, or (better) help is provided to integrate your R/O in our DAQ software.
  - The analysis and reconstruction software.
    - As for the DAQ, you can rely on our output track file, or integrate your device in the main analysis stream.
  - To be rented to five different user groups during 2008
    - Eligibility for usage - See later
Joint Research Activities

JRA2: Tracking Detectors

- **Large TPC prototype:**
  - low mass field cage (for JRA1 magnet)
  - modular endplate system for large surface GEM & µMegas systems
  - development of prototype electronics for GEM & µMegas

- **Silicon TPC readout:**
  - development MediPix → TimePix
  - TPC diagnostic endplate module incl. DAQ

- **Silicon tracking:**
  - large & light mechanical structure for Si strip detectors
  - cooling & alignment system prototypes
  - multiplexed deep submicron FE electronics
**TPC**

- **Fieldcage design based on light small prototype TPC**
- **Prototype electronics**
  - FADC based on ALTRO
  - TDC type readout
- **Well defined interfaces to readout plane**
  - mechanics
  - electronics

**Dimensions:**
- 60 cm length
- 80 cm diam.

- **few 1000 channels under construction**

**TPC in PCMAG**
- Development of TimePix Chip
  - Medipix (2-d) → TimePix (3-d)
  - First prototype operational since end 2006

- Postprocessing of chips
  - “add” μMegas grid

- Future:
  - Development of a TPC diagnostic endplate module (incl. DAQ)
    O(100) chips = 200 cm²
TimePix Modules

With GEMs:

gas amplification:
  3 standard GEMs (60/70/140)

transfer and induction gap:
  1mm

readout: 2 Quad-boards
  (4 TimePix chips each)

J. Kaminski, Univ. of Bonn
TimePix Modules

With MicroMEGAS (Saclay- NIKHEF)
Joint Research Activities

JRA3: Calorimeter

- **ECAL:**
  - scalable prototype with tungsten absorbers
  - Si-sensors & readout chips

- **HCAL:**
  - scalable prototype
  - multi-purpose calibration system for various light sensing devices

- **Very Forward Calorimeter:**
  - laser-based positioning system
  - calibration system for silicon and diamond sensors

- **FE Electronics and Data Acquisition System**
  for the calorimeters
SiW EUDET Prototype

Logical continuation to the physical prototype study which validated the main concepts: alveolar structure, slabs, gluing of wafers, integration

- Techno. Proto: study and validation of most of technological solutions which could be used for the final detector (moulding process, cooling system, wide size structures,...)
- Taking into account industrialization aspect of process
- First cost estimation of one module

**Short detector slabs (x14)**
- 3 structures: $24X_0$
  - sizes: $380 \times 380 \times 200$ mm$^3$
  - Thickness of slabs: 8.3 mm (W=1.4 mm)
  - VFE outside detector
  - Number of channels: 9720 ($10 \times 10$ mm$^2$)
  - Weight: $\sim 200$ Kg

**Complete Tower of 4 wafers = 18x18 cm$^2$**
- 1 structure: $\sim 23X_0$
  - sizes: $1560 \times 545 \times 186$ mm$^3$
  - Thickness of slabs: 6 mm (W=2.1 mm)
  - VFE inside detector
  - Number of channels: 45360 ($5 \times 5$ mm$^2$)
  - Weight: $\sim 700$ Kg

**Long detector slab (1)**
Analogue Hcal

To common Calo DAQ

Calorimeters Inside Coil
Mechanical Interface between Ecal and Hcal

Large Scale Integration
VFE Electronics
and
Calibration System
Interleaved with Absorber
Networking Activities

Very important part of the project!

- Information exchange and intensified collaboration:
  - web based information system
  - annual workshops
  - open for everyone!

- Common simulation and analysis framework:
  - development of common software framework
    (testbeam analysis & ILC simulation)
  - small grid based computer cluster

- Validation of simulation:
  - improved GEANT4 shower simulation

- Deep submicron radiation-tolerant electronics:
  - access through CERN contracts
  - customized design kit
  - training courses
Simulation and Analysis Framework

- Common software framework for ILC
- Development supported by EUDET
- First version exists & operational
- Used by all EUDET activities
  - e.g. CALICE and pixel telescope
  - Testbeams analysed on Grid

EUDET/LDC SW-Framework

- LCIO – persistency/data model
- Generator
- Simulation
  - Mokka
  - Geant4
- Reconstruction
  - Marlin - framework
  - MarlinUtil, CED, MarlinReco, ...
- Analysis
- Gear - geometry description
- LCCD – conditions data

Examples:
- EUTelescope @CERN

TPC studies:
- MarlinTPC

Documentation: http://ilcsoft.desy.de
Transnational Access

- Imposed by the EU to open trans-European access to research facilities
- Not really necessary in High Energy Physics

However, we could take advantage of it:
- Some travel support for European groups
  - TA1: using the DESY testbeam (as of 2006)
  - TA2: using the EUDET infrastructures (as soon as available):
    - beam telescope  Started already!
    - TPC
    - Si TPC
    - Si tracking
    - calorimeter

- Not restricted to ILC but all kind of scientific activities are invited
Call for applications
- see advertisement in CERN courier

EUDET can supply travel funds
- for DESY testbeam
- for use of EUDET infrastructures
  (beam telescope etc.)

Conditions & requirements:
- European institute
- not from country of infrastructure

send short scientific proposal to Joachim.Mnich@desy.de

+ some forms to fill ...

EUDET is a project supported by the European Union in the Sixth Framework Programme (FP6) structuring the European Research Area. This project aims at creating a coordinated European effort towards research and development for the next generation of large-scale particle detectors. EUDET comprises 23 European partner institutes and 24 associated institutes working in the field of High Energy Physics.

EUDET provides in the framework of the Transnational Access scheme travel support for groups from the EU and countries associated to FP6 using the following infrastructures:

TA1: Experiments at DESY testbeam (http://testbeam.desy.de)
TA2: Experiment using infrastructure developed in the EUDET project: high precision beam telescope; large, low mass TPC field cage; silicon based TPC readout system; infrastructure for development of SI-Strip detectors; infrastructures for development of granular calorimeters.

TO APPLY FOR EC FUNDED ACCESS

visit our web site http://www.eudet.org to get more information about the modalities of application.
Summary & Conclusions

- EUDET is an EU funded infrastructure programme for detector R&D
  - well defined programme
  - embedded in international detector R&D collaborations such as CALICE, LCTPC etc.

- Provides additional funds for European institutes
  - to help in the next phase of ILC detector R&D from small to larger prototypes

- Even more important
  - EUDET fertilises collaboration between institutes ("community building")
  - EUDET can help to raise additional funds at national agencies

- Can provide some support for other European groups
  → Transnational Access

- EUDET is now at 2/3 of its funding term
  - project is on track with major milestones achieved
  - more exciting work ahead of us
  - still open for contributions from new interested groups

More information at www.eudet.org
Backup Slides
**EUDET Partner Institutes:**

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<th>EUDET</th>
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**EUDET Partner Institutes:**

+ 27 associated institutes