Detector Development for the ILC

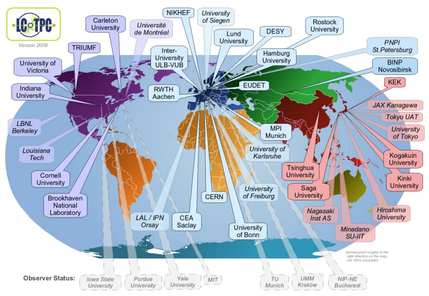
HELMHOLTZ GEMEINSCHAFT

PHYSICS AT THE TERA SCALE Helmholtz Alliance

DESY

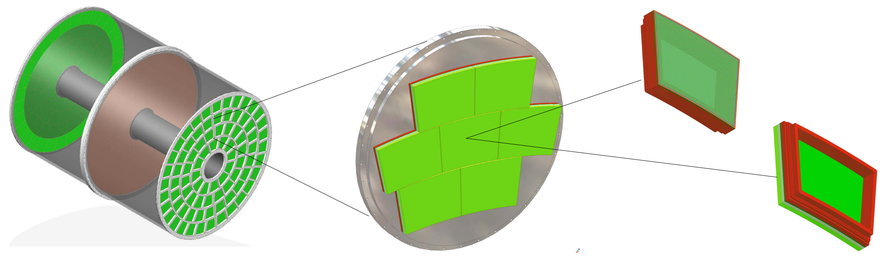
Research and Development for a Linear Collider Time Projection Chamber

The Collaboration

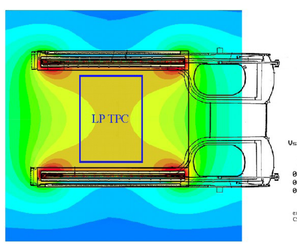


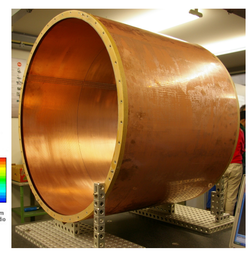
The LCTPC collaboration is developing a TPC for an ILC detector. As part of the current consolidation phase a Large Prototype TPC has been designed and built. Currently located at the DESYII test beam area different amplification and readout systems are tested for evaluation. Six institutes from the Alliance play a major role within this collaboration and at the Large Prototype. Alliance members run the magnet (DESY), constructed support structures (DESY), are responsible for the high-voltage system (Siegen), contribute to the trigger and DAQ system (Bonn and Freiburg), work on the development of alternative readout electronics (Rostock) and installed the silicon envelope (Karlsruhe).

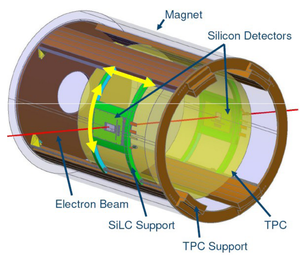
The Large Prototype design



The Large Prototype is one half of the ILD TPC. The readout plane is designed to host seven modules of similar shape as the planned ILD. The modules are interchangeable.

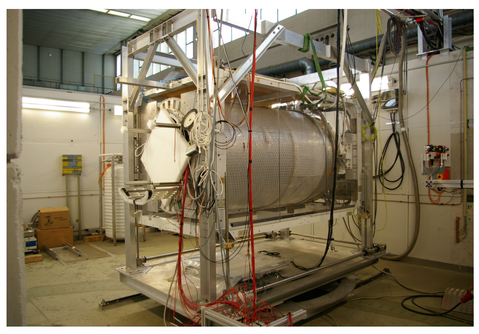




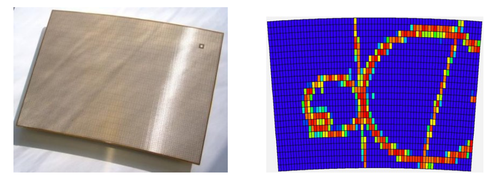


The field cage is designed to fit into the PCMAG with space allowing for a silicon envelope. The superconducting magnet can deliver fields up to 1.25 T.

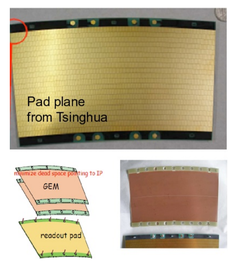
Support structures for the TPC inside the magnet and a movable stage for the whole magnet have been designed and built by Alliance engineers.

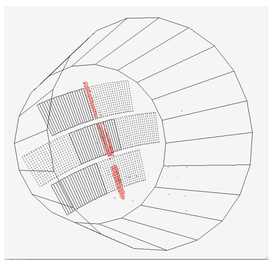


Measurements

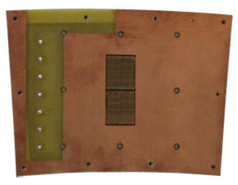


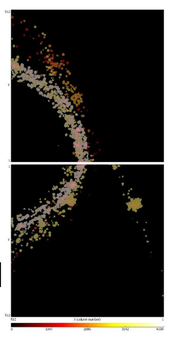
The first tests was performed in 2008 with a MicroMegas module with pad readout.





In spring 2009 tests continued with 3 double-GEM modules with pad readout.





In summer 2009 two TimePix chips were tested with a triple-GEM amplification structure.

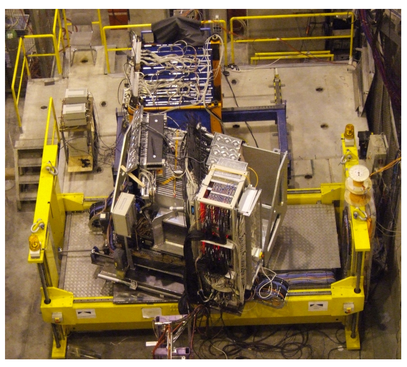
CALICE Collaboration: Prototypes for the ILC AHCAL

Physics Prototype

Combined Test beam program at DESY, CERN & FNAL (2006-09) to evaluate calorimetry technologies for ILC:

- **ECAL** (Silicon-W and Scintillator-W)
- **AHCAL** (Scintillator-Fe with SiPM readout) →Coming up (RPC-Fe)
- **Tail Catcher / Muon Tracker** (Scintillator-Fe)

All detectors have a highly granular readout: Provide detailed 3D info on hadronic showers to constrain shower models



AHCAL Physics Prototype:

1m³ instrumented volume
- 38 layers, 2 cm iron absorber per layer
- Active layers using scintillating tiles, → in total 7608 channels
- 216 cells per layer, ranging from 3 x 3 cm² to 12 x 12 cm²

14 analysis notes released so far
Detector paper in publication

Technological Prototype

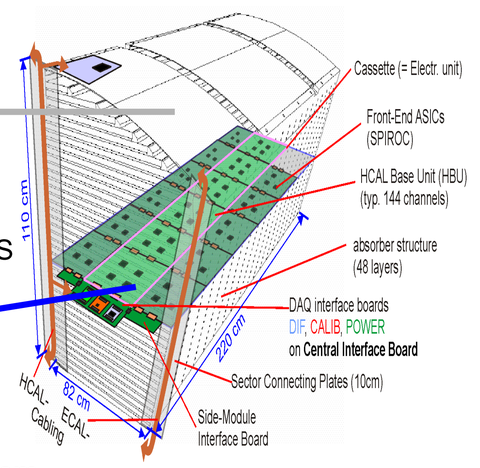
Goal: Demonstrate feasibility to build calorimeter with fully integrated electronics meeting constraints of a real detector

Barrel Absorber: for mechanical studies (real size)

HBU
- Size: 36x36 cm²
- 144 tiles
- 4 SPIROC2 ASICS
- 2 modules ready

Power Module enables ILC power pulsing

LED Calib System



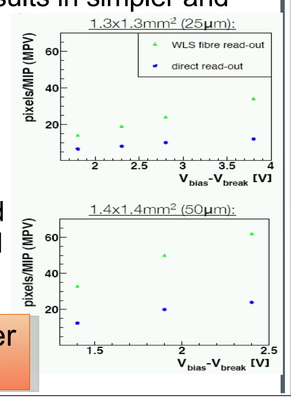
The SiPM Virtual Laboratory

DESY Hamburg: Tile-SiPM Coupling

Recent blue light SiPMs don't require WLS → direct coupling results in simpler and cheaper assembly

WLS fibre vs direct coupling

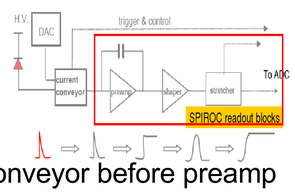
mip spectra recorded for different tile-SiPM configurations



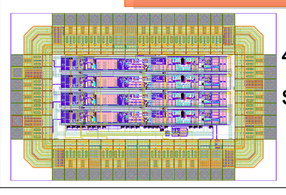
Direct readout lower but sufficient

KIP Heidelberg: SiPM Readout Chip

Improve SPIROC readout for SiPM with low gain ($2.5*10^5$): → add current conveyor before preamp



S/N increased to 10



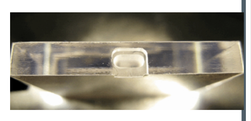
4 test channels submitted in Oct09

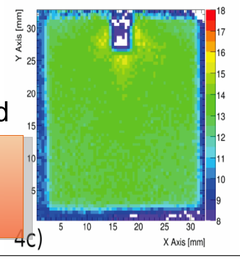
MPI Munich: Tile Non-Uniformity

Direct tile-SiPM coupling decreases the uniformity of light collection (highest response close to SiPM)

Strategies:
- reduce material close to device
- embed SiPM

→ About 50 different tile geometries investigated





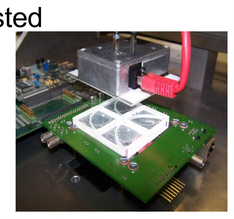
Sizeable improvement of response uniformity found

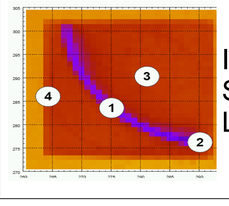
Uni Wuppertal: LED Calibration System

Develop embedded calib system → LED + driver placed over each tile

Several LED types tested

XY stage built to find best location for LED source





In SiPM pixel spectrum S/N varies according to LED location

Analysis on going

Calorimeter for ILC

Riccardo Fabbri, for the CALICE Collaboration

Christoph Rosemann, for the FLC-TPC Group

LC-TPC

Mid-Term Evaluation of the Helmholtz Alliance, Nov. 2009