FCAL Activities in AIDA
Status report

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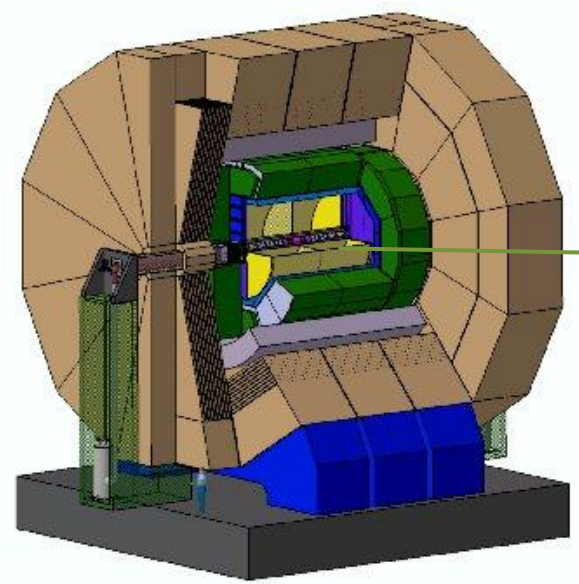
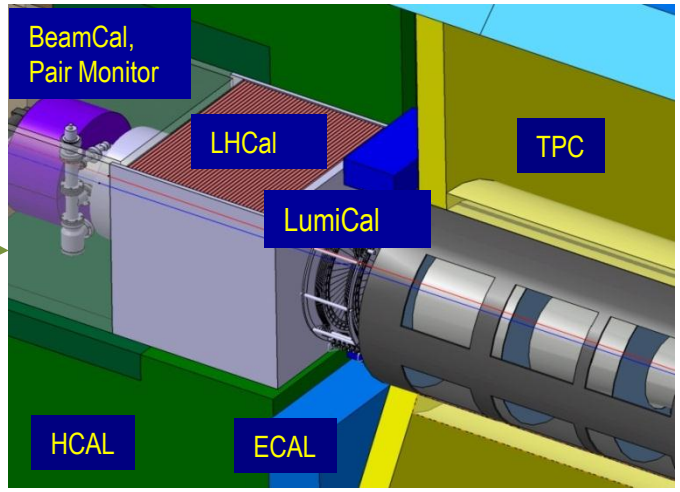
On behalf of FCAL Collaboration
(DESY ,CERN, AGH-UST, IFJPAN, TAU)

- AIDA Infrastructure for FCAL
- DAQ – towards the global DAQ system
- Laser positioning system

FCAL detectors

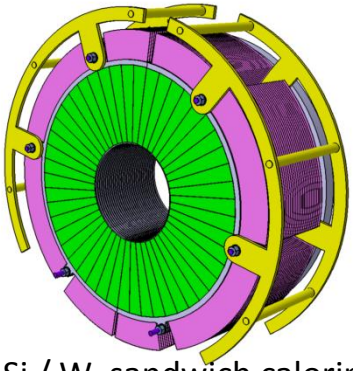


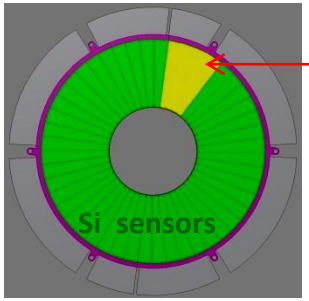
Example: ILC / ILD
- very forward calorimeters



LumiCal :
- precise measurement of the luminosity
- can be useful also in physics analises ?

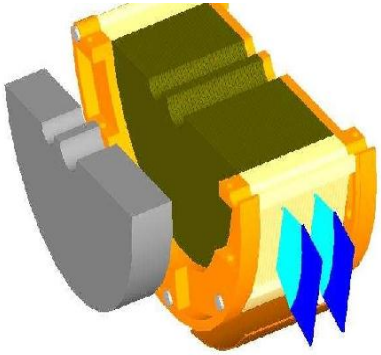
BeamCal + Pair Monitor -
determination of the beam parameters, helps to reduce the background in physics studies, detection of high energy electrons at low polar angles

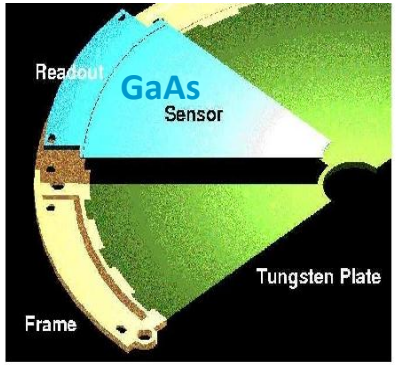




Used in
itest beams

Si / W sandwich calorimeter :
30 layers -
W (3.5 mm), Si (320 μm)





Similar structure with GaAs (Gallium Arsenide) as sensors

Some modifications are expected for CLIC

AIDA Infrastructure for FCAL calorimeters

FCAL + CERN Physics Department – Detector Technology Group

(Konrad Elsener, Francois-Xavier Nuiry
E. David, C. Bault, A. Catinaccio + … others)

AIDA FCAL activity : compact electromagnetic calorimeter with tungsten absorber and flexible mechanical structure is under a final construction given by CERN PH-DT group (design and build).
The calorimeter will be used in near future test beams for study the showers development to find the most efficient method their reconstruction - important for luminosity and physics processes measurements.

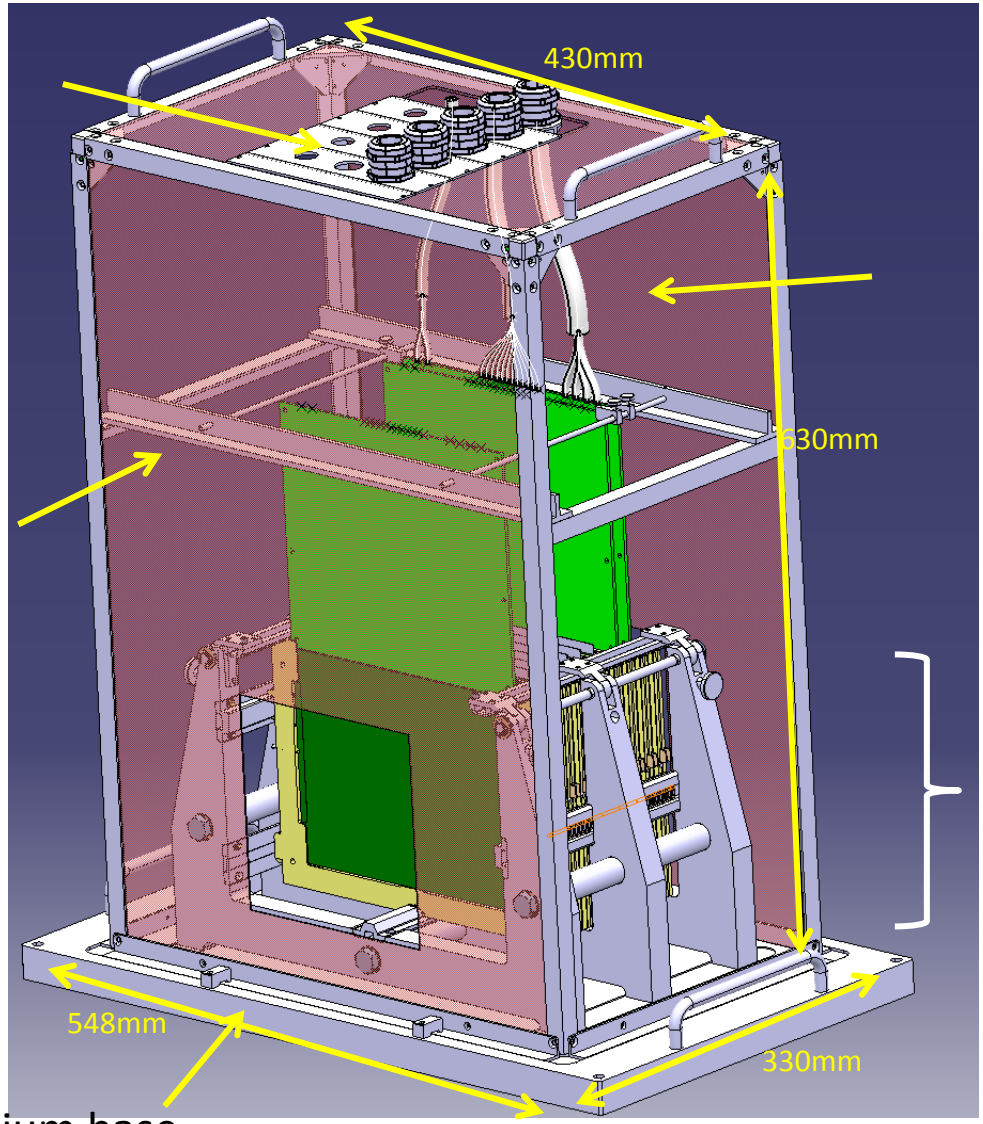
General requirements:

- → 30 tungsten plates and sensor layers (LumiCal or BeamCal sensors) have to be aligned in a compact structure.
- → Three configurations: 2mm, 1mm, and 0.5mm gap, accuracy +/-50 microns, between each plate.
- → Removing or adding tungsten plates or sensor layers can be done easily

Global design

Services entry

Aluminium panels



Aluminium base

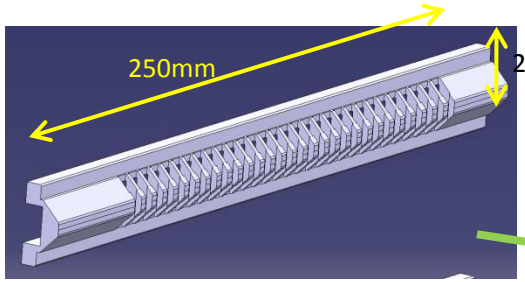
Hood (light filter, faraday cage, and services holder)

Air-cooling system will be supply to AIDA „box”

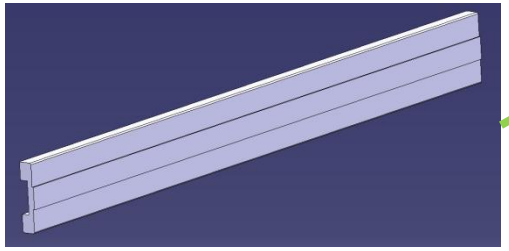
Tungsten + Sensors

Mechanical design

Combs

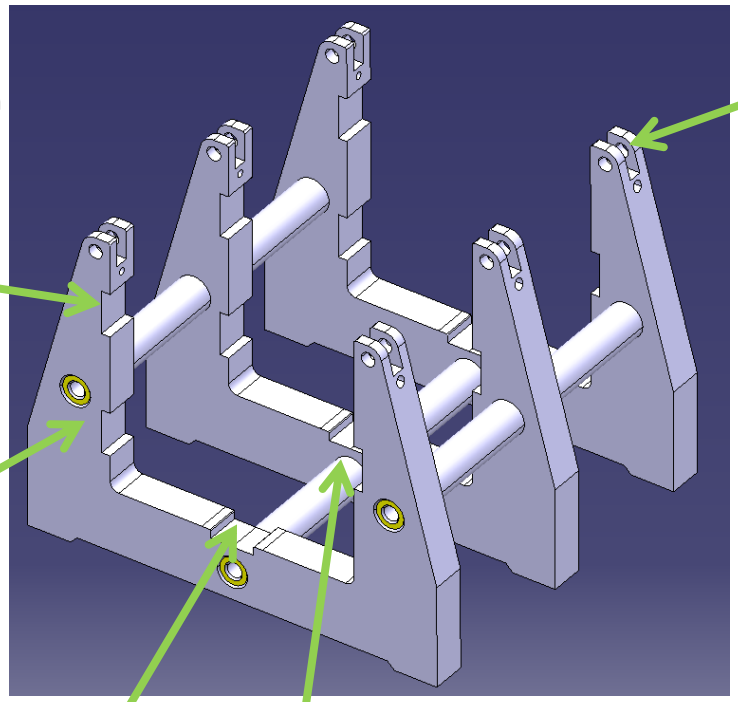


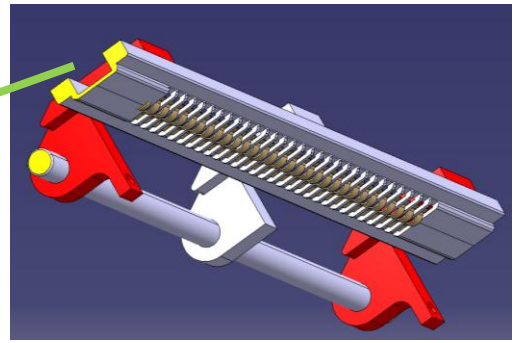
Left comb



Left plan

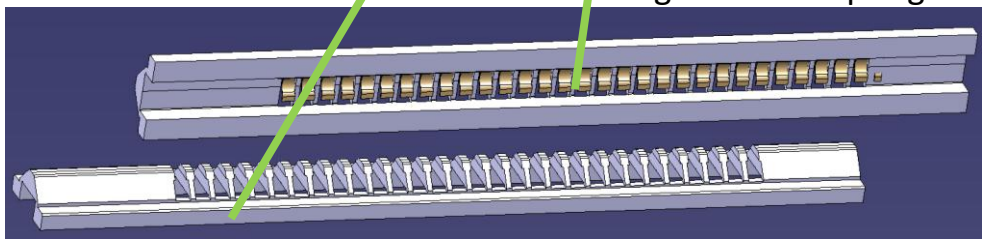
Aluminium alloy frame





Top comb + spring (x2)

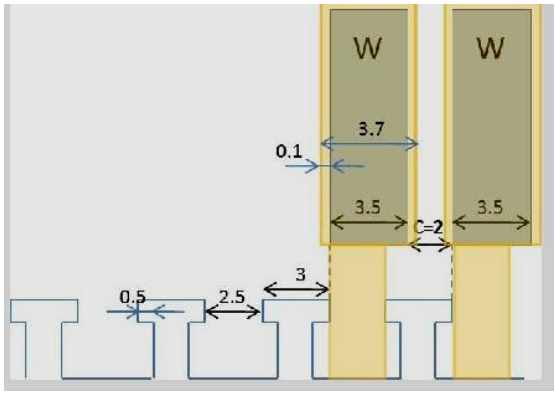
Right comb + spring



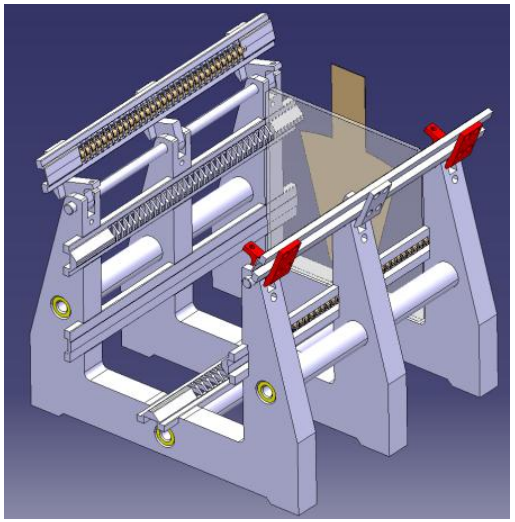
Bottom comb

The basic concept:
use three precisely machined combs, mounted with high precision on a solid, aluminium alloy base frame.
They are equipped with brass springs.
Two additional combs are on the top of device, they are flipped open to insert the tungsten plates and sensors.

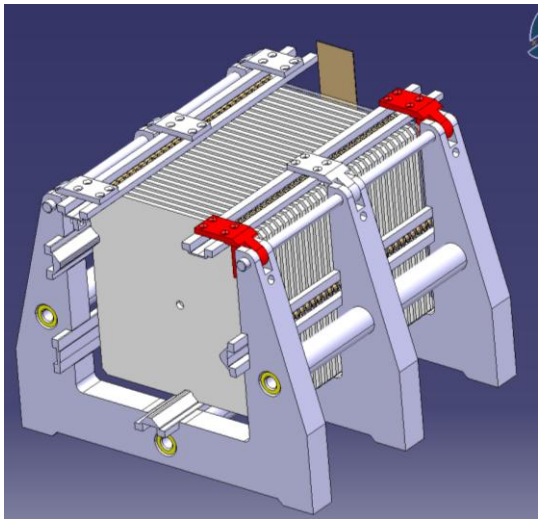
Tungsten plates installation



Comb structure with neighbouring tungsten plates.
C value characterizes the gap between tungsten plates



Insert the first Tungsten



Insert all Tungsten + Si detectors and close 2 top combs

Tungsten holder

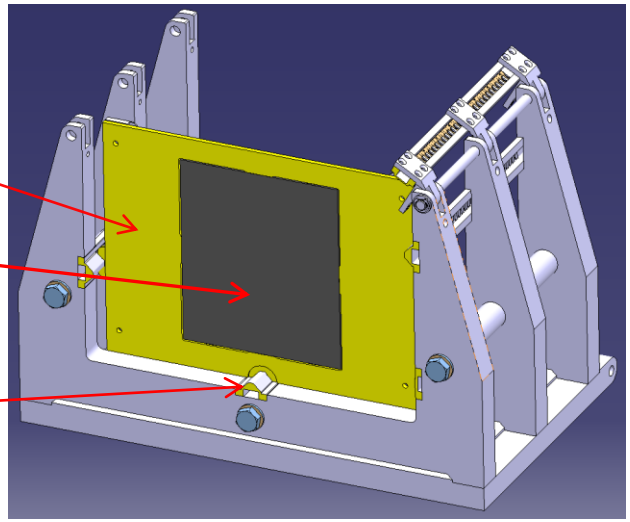
Tungsten plate is glued in the Permaglas frame

Permaglas frame:

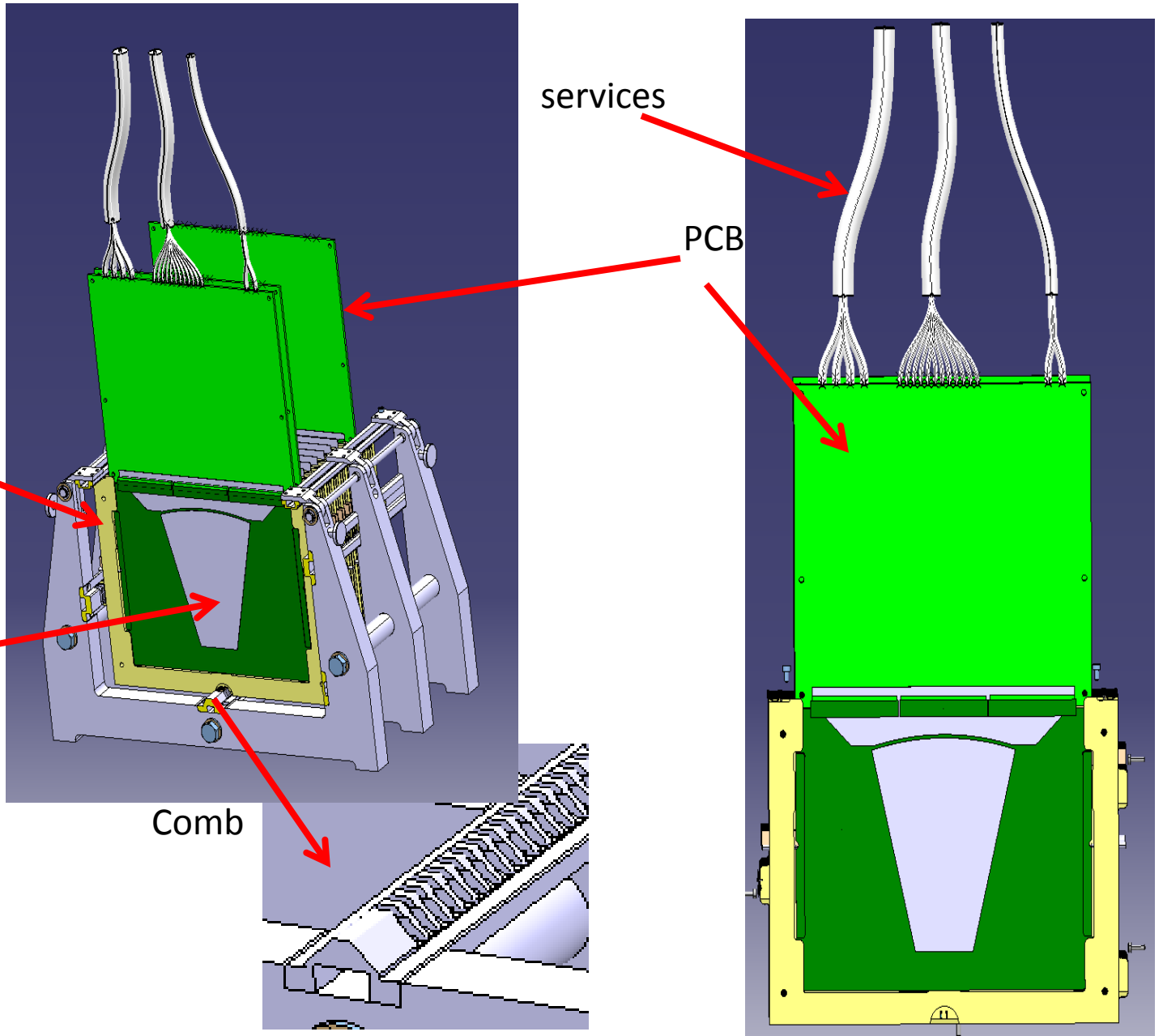
Glass fibres in epoxy resin

Tungsten

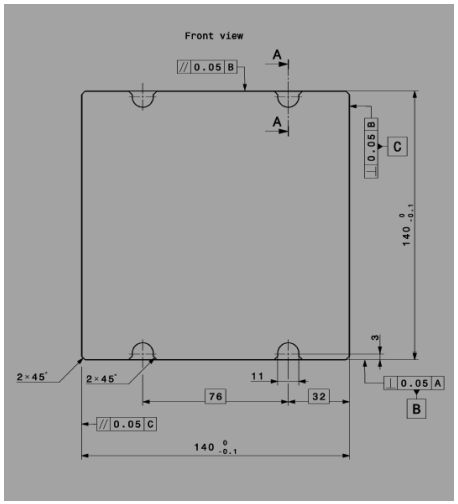
Comb



The existing electronics board, is inserted in a Permaglas frame [*RESARM company*]

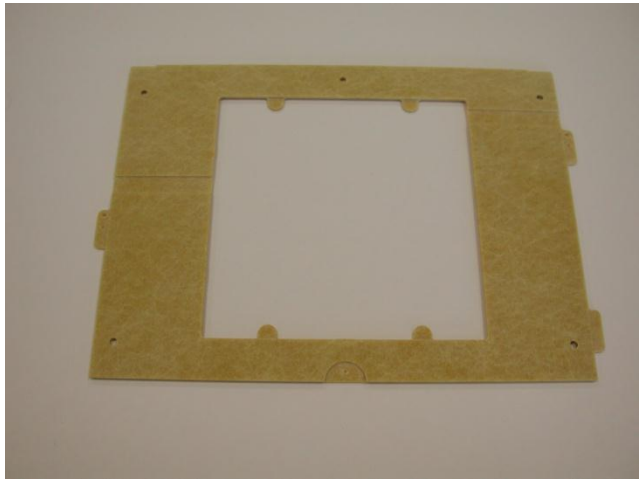


2mm gap and 1mm gap :
Status

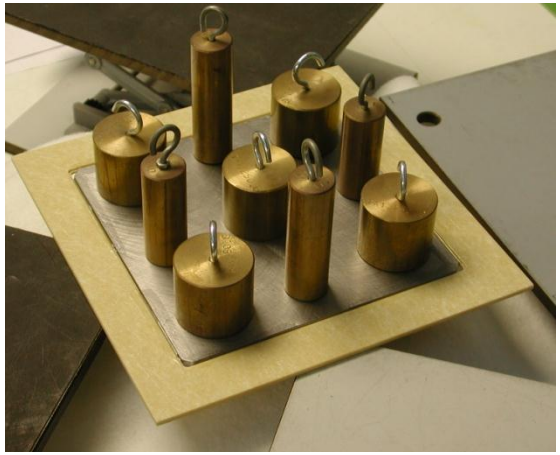


Tungsten plates (alloys : 93-95 % W + Ni + Cu) are now ordered. (Plansee and MG Sanders companies)

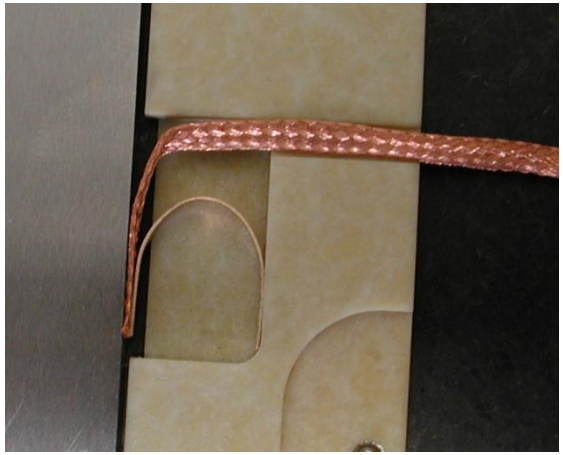
The aluminium frame is done



First permaglas plates are currently machined

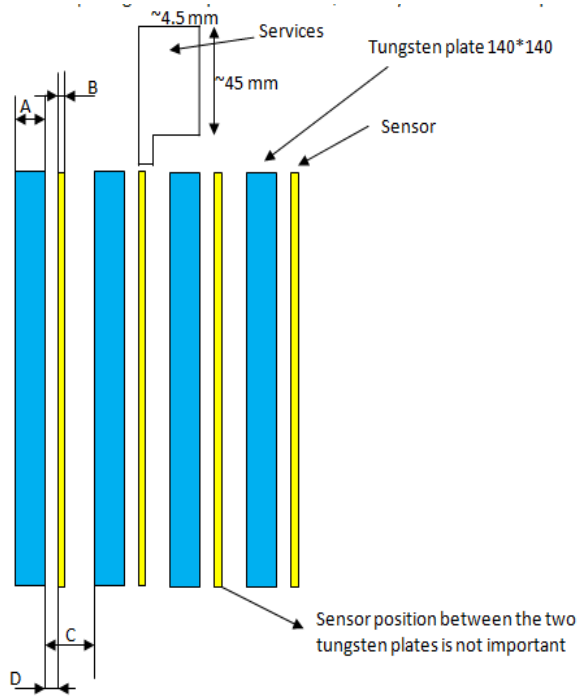


Tungsten plate bonding in permaglas has been tested



Grounding connection tests have been performed

Future: C = 0.5mm between each tungsten plates



The idea:

-Used the same tungsten plates

-One could use the same Permaglas frame (in white in this picture)

- Glued the Si detector + the read-out on the Permaglas frame

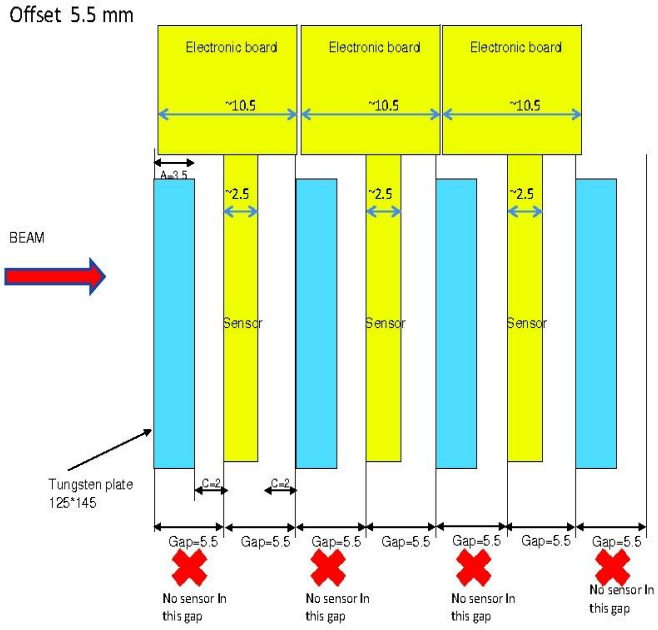
-One could realise a sliding kinematic between each tungsten plate, in order to reach the 0.5mm gap between each W plate.

-A new mechanical frame is mandatory

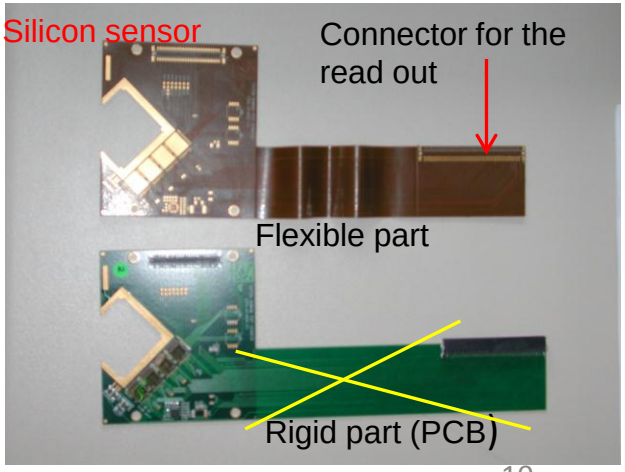
AIDA infrastructure - summary

- 2mm and 1mm gap configurations are in a production phase. The final mounting should be realised in July 2012 (delivery date for **first 10 tungsten plates**)
- Ready for first beam tests before end 2012

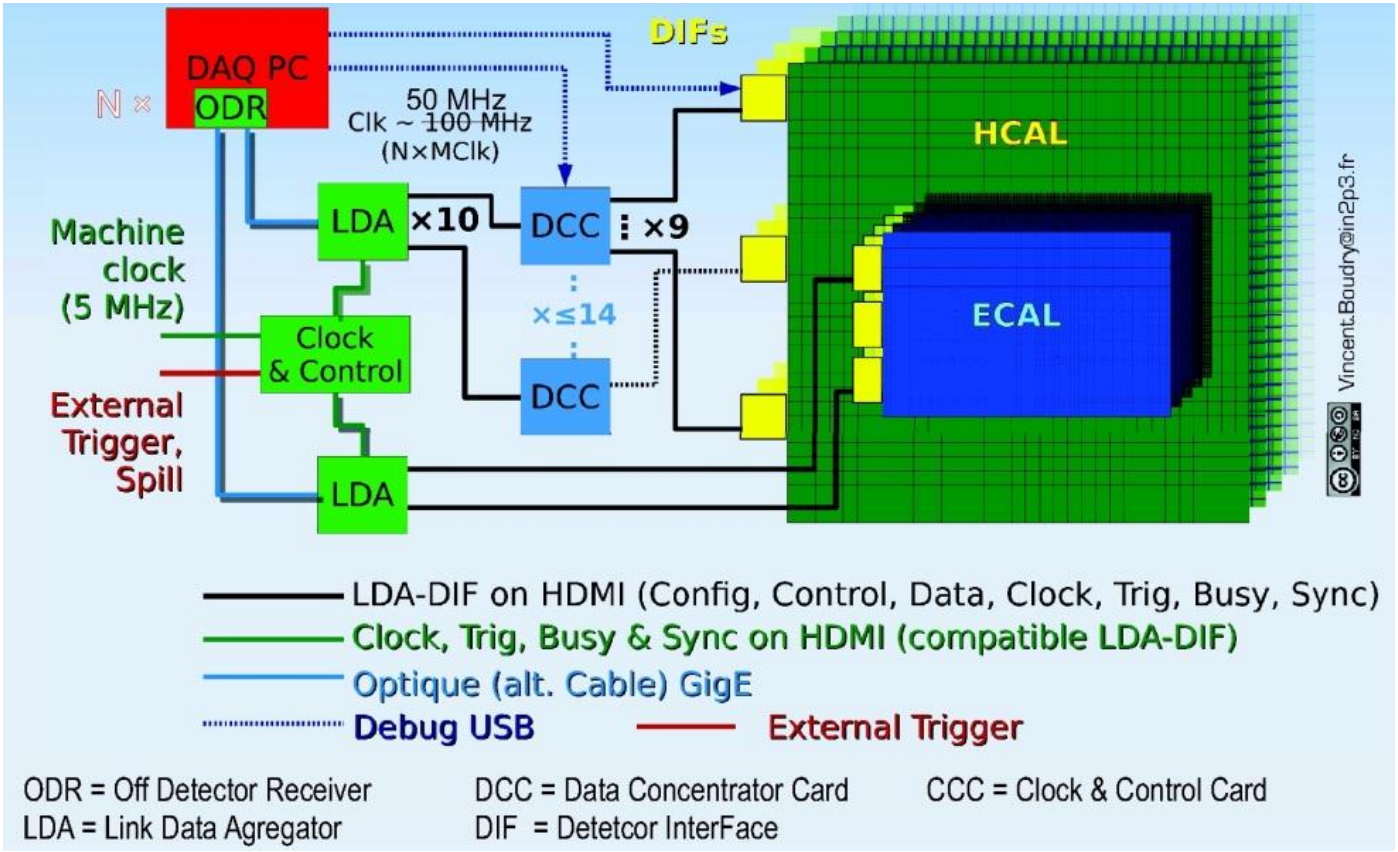
- Ordering remaining tungsten plates asap



- A concept exists for 0.5mm gap, but it has to be developed
- The most important for us:
- Realising a flexible link between the sensor and the read out.
- Something similar to this example:



Prototype DAQ system - CALICE DAQv2 scheme



Further developments of DAQv2 are continued and one can expect good news from ongoing CALICE test beam.

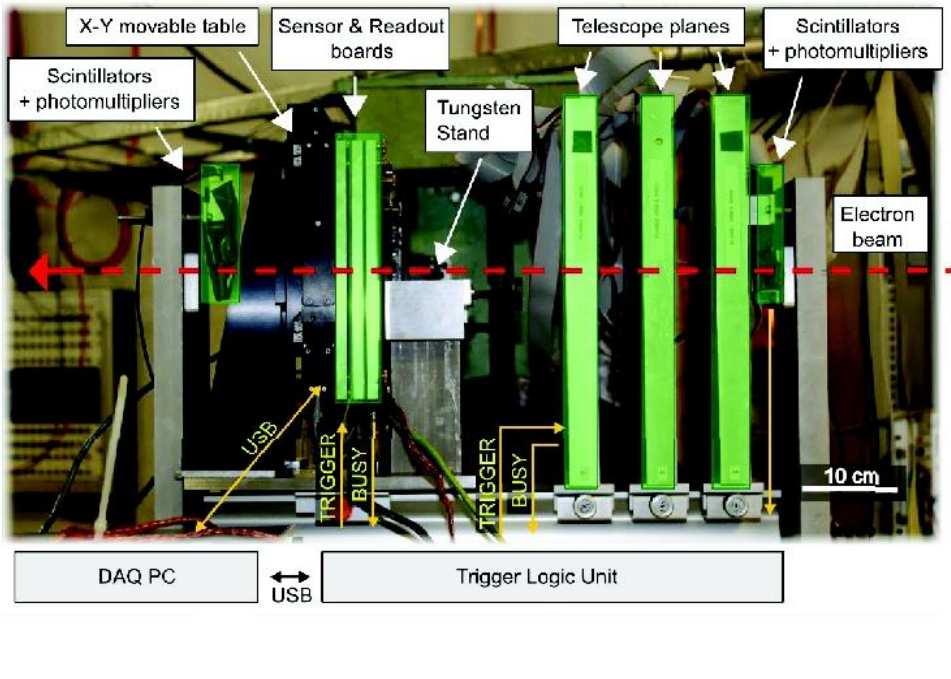
FCAL DAQ goal :

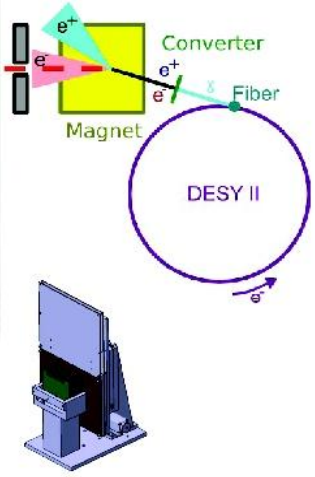
- works inside this system

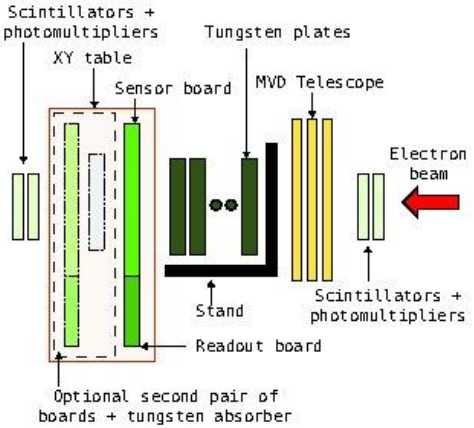
FCAL DAQ status

Present FCAL DAQ system for LumiCal and BeamCal prototypes was closely connected to test beams measurements

Two test beams at DESY in 2011 in July / November - partially supported by AIDA TA

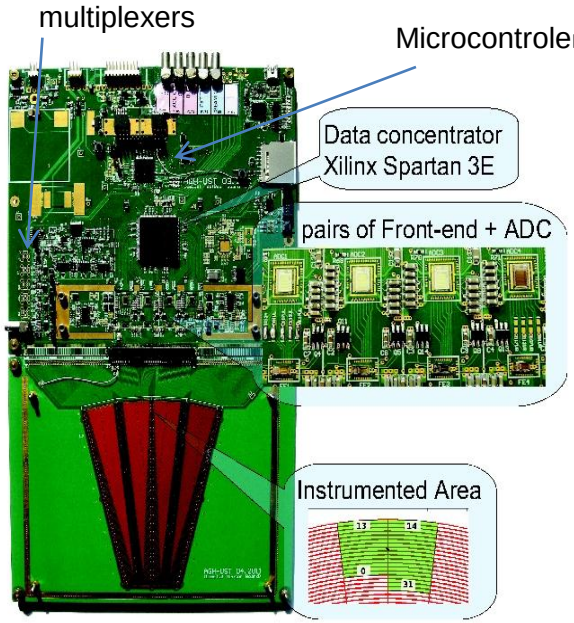






Readout and sensor boards

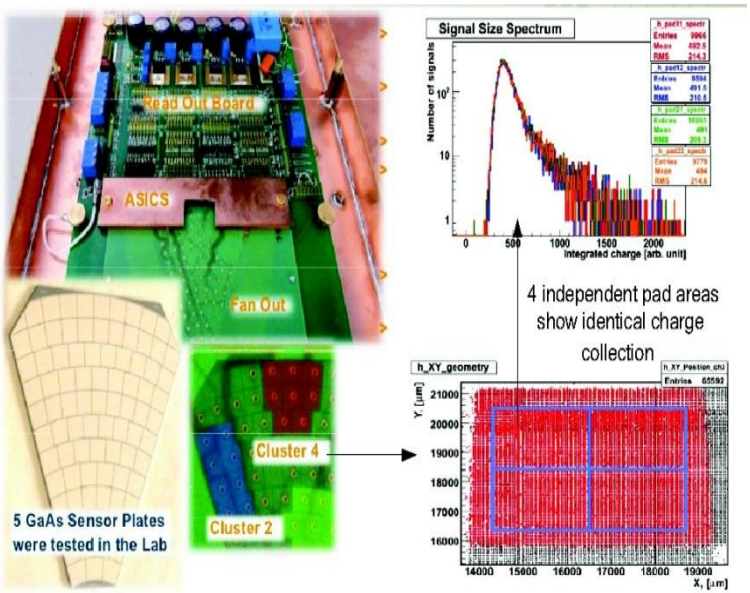
LumiCal



- 32 channels fully equipped channels (Front-end +ADC)
- ADC sampling rate is up to 20 MS/s (6.4 Gbps)
- Extended trigger mechanism
  - External CMOS / LVDS
  - Self triggering on ADC values
  - Software
- Data can be transferred using USB
- Signal handshaking with Trigger Logic Unit (TLU)
- ADC Clock source
  - Internal (asynchronous with beam operation)
  - External (beam clock used to synchronize with beam) ILC mode

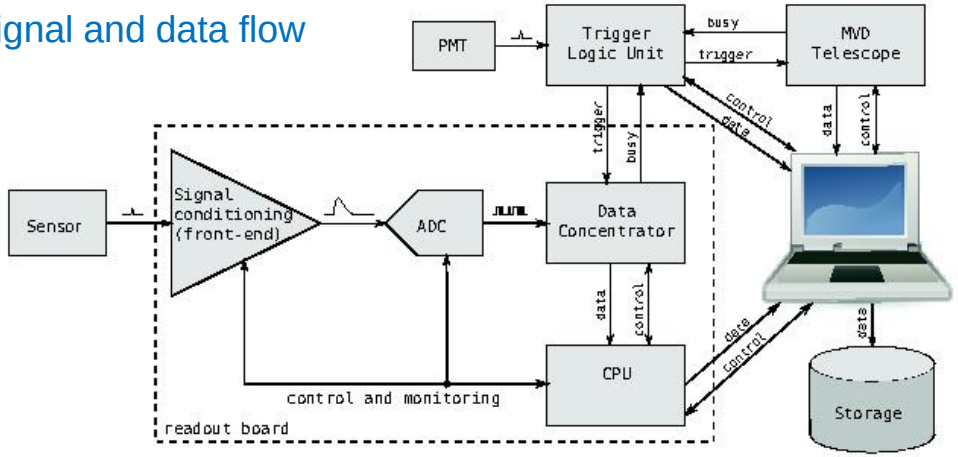
Sensor board with glued sensors and kapton fan-out wire bounded

BeamCal



FCAL DAQ system

Signal and data flow



Acquisition software used in test beams (based on EUDAQ) allow to

- Sending configuration
- Collecting data (events, monitoring)

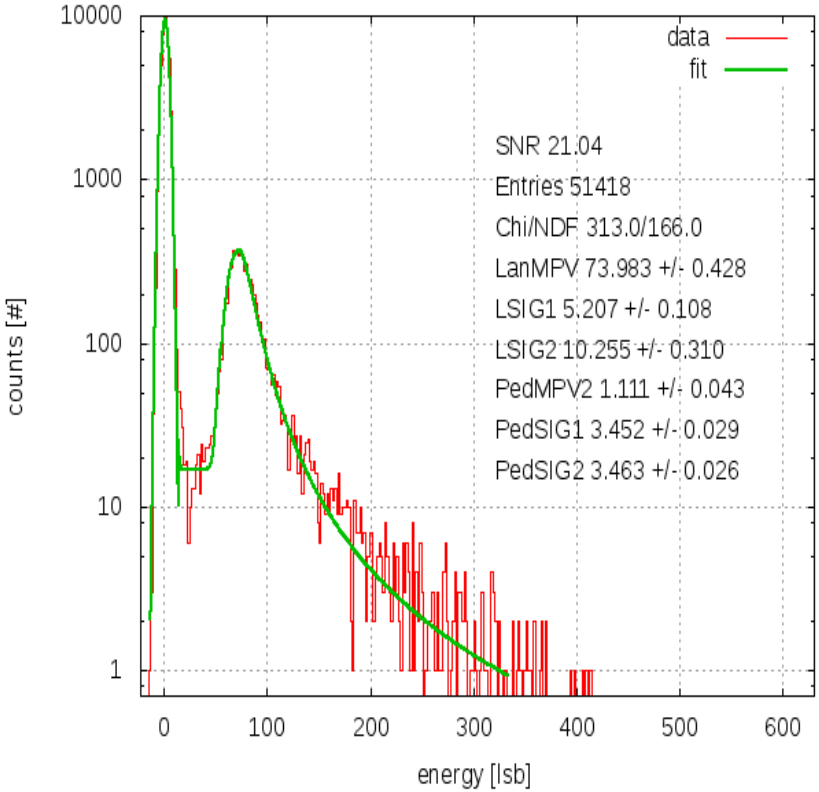
ROOT monitor allows on-line monitoring

TB 2011 results : no tungsten absorber

Results of test beams have proven proper operation of complete multichannel detector modules ,comprising of all components : sensors, fan-out , readout ASIC

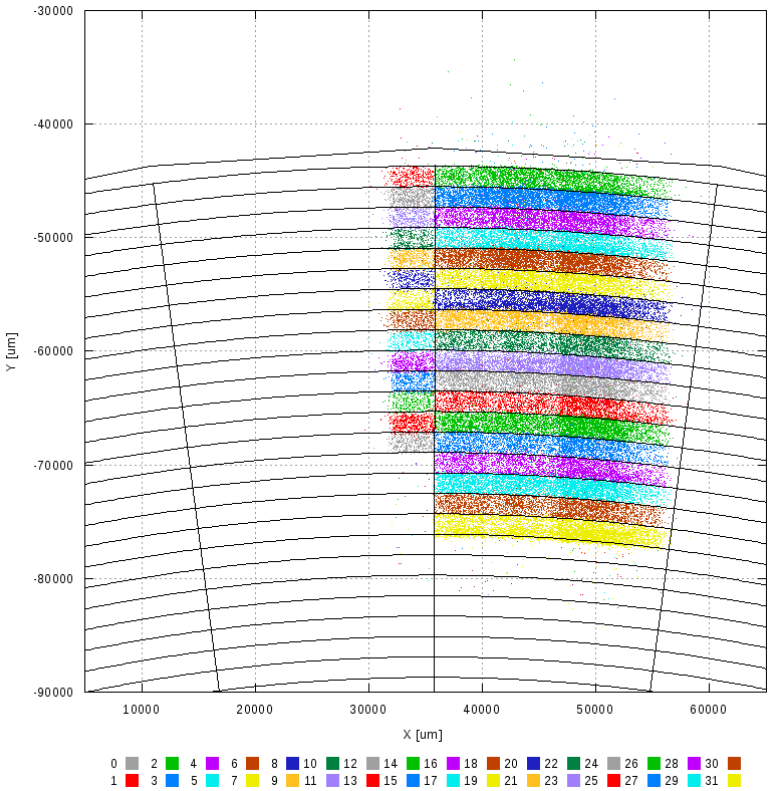
Examples :

Energy spectrum



Signal size spectrum:
S/N in channels were above 20 for LumiCal / BeamCal
Fit: Gauss + Landau

Sensor pads structure:
used combined events from LumiCal sensors and ZEUS telescope - each dot corresponds to single event

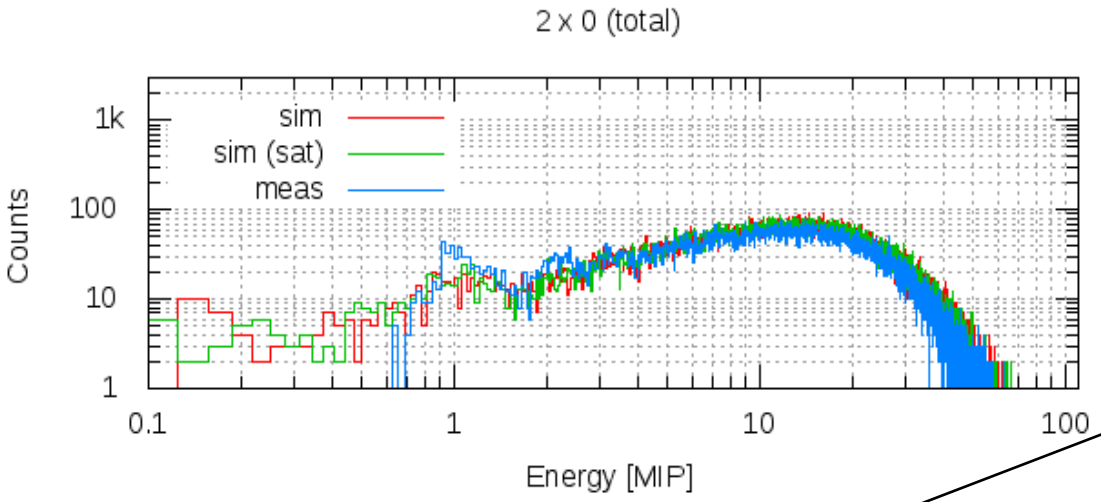


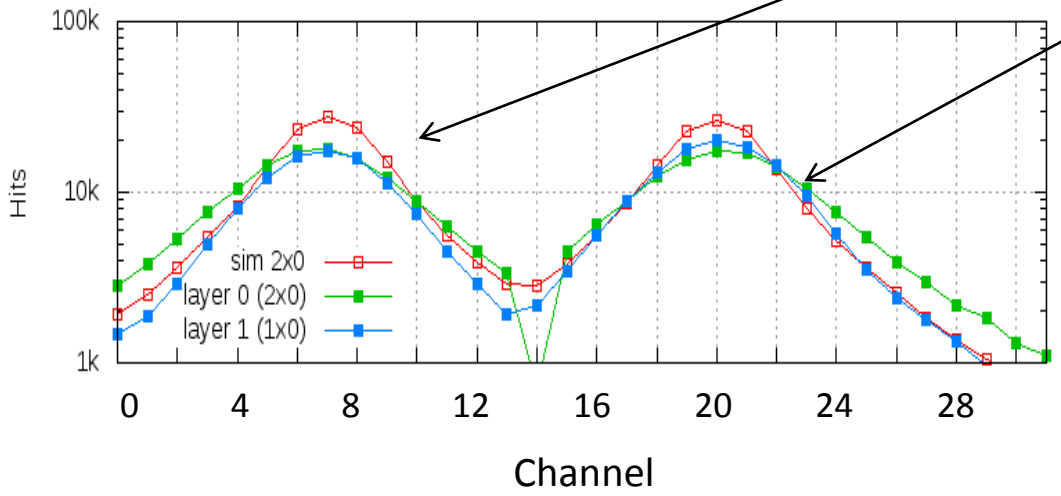
Visible pad structure: sensor geometrical structure is reflected on reconstructed electron tracks

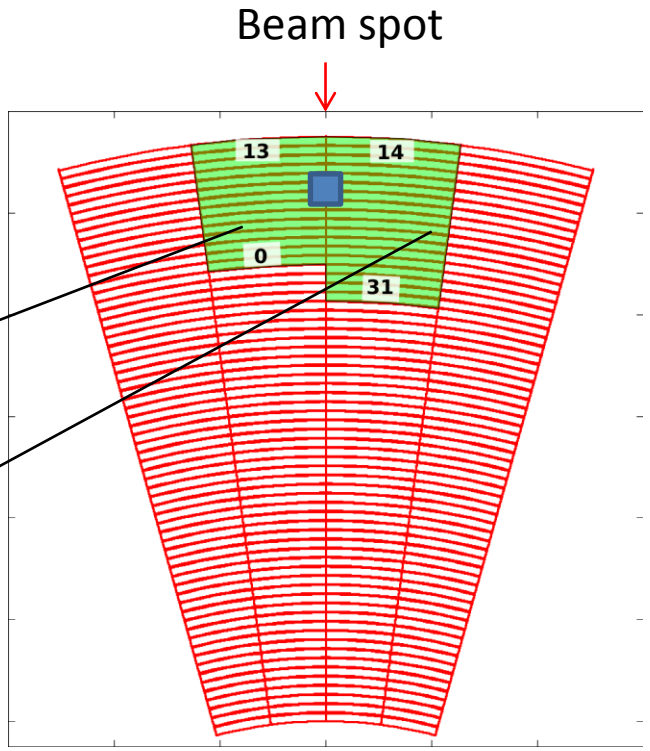
TB 2011: sensors and tungsten

Tungsten layers before sensors: shower development studies

Example: 2 Xo

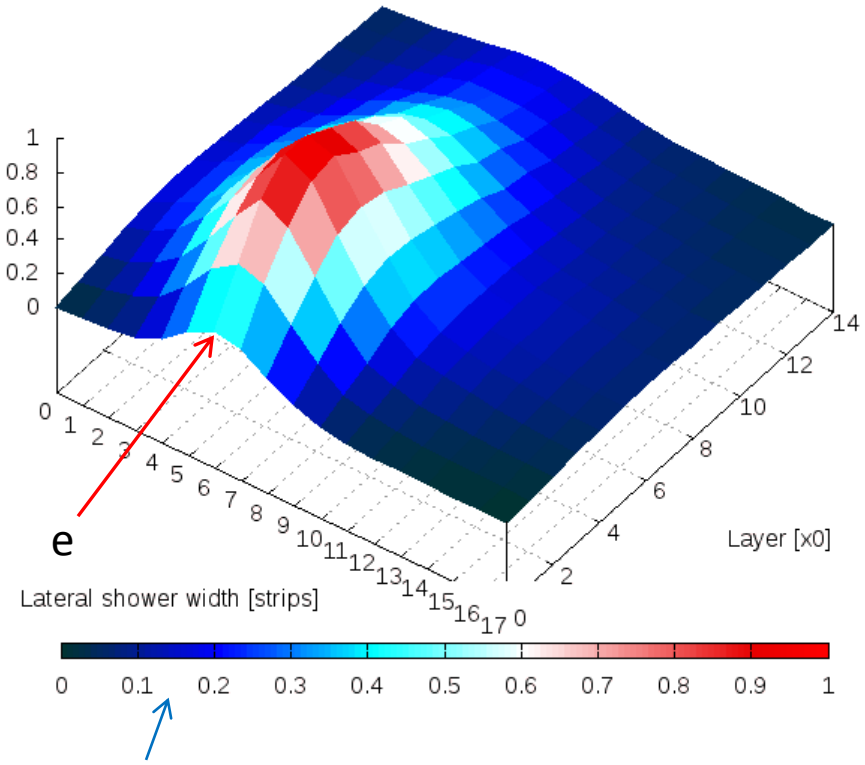






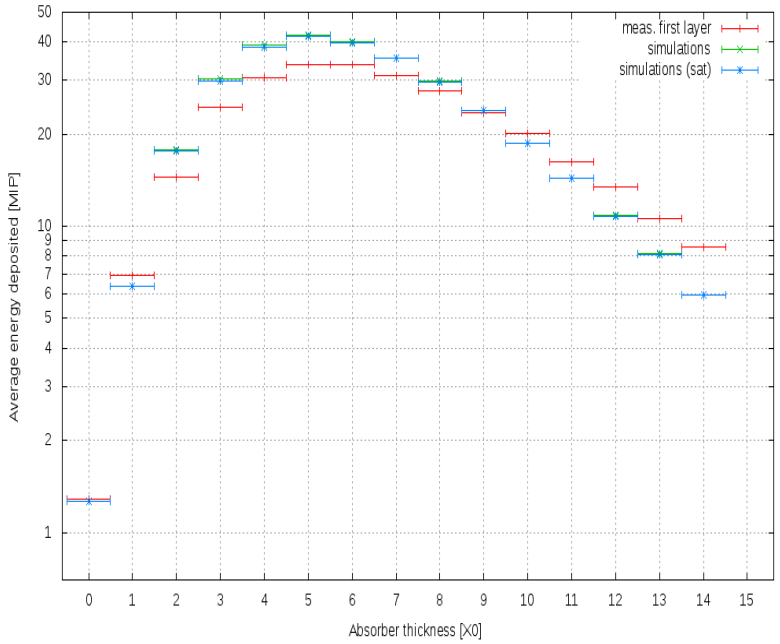
TB 2011 : shower profile studies

Tungsten absorber had in total 14 Xo



Energy deposited (normalized-arbitrary units)

Mean energy deposited under particular tungsten layer



FCAL DAQ status and next steps

FCAL DAQ system used in test beams will be modified to meet with the global DAQ system (CALICE scheme).

- The first step in this direction was done. For studies purposes:
  - 4 DIF units were ordered for FCAL (SDHCAL), available in April;
  - 1 LDA we borrowed from AHCAL (DESY) with Python scripts
    many thanks to Mathias, Remi, Vincent and other!!;
- Problem to find free CCC, (from colleagues from UK institutions ?)
  - for the first studies it is not indispensable - clock and trigger signals from external source;
- Need to have dedicated FCAL DIF;
- Need to start XDAQ (+USB) study;

There are several HW prototype questions (take into account new HW development):

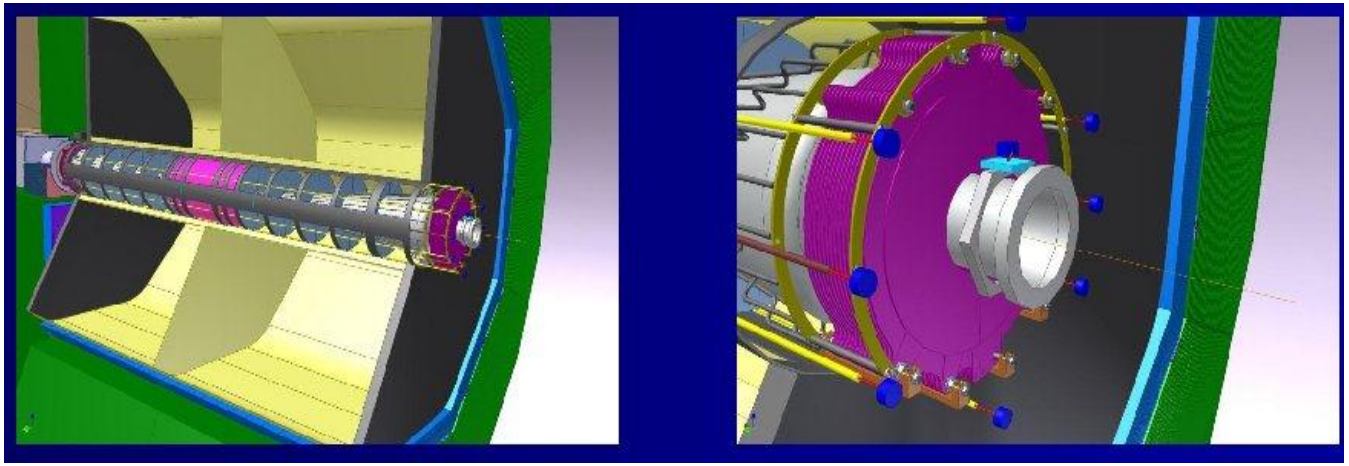
- how many channels for ASIC's (32/64)?
  ASIC's for DIF (2/4/8) ?
  DIFs in prototype ?
- data rate from all DIFs?
- how many LDA / CCC (GigaDCC) ?
- what about ODR, DAQ computer?

Laser positioning system

High accuracy in luminosity measurements at ILC/CLIC ($\Delta L/L \sim 10^{-3}$) require precisely measurement of the luminosity detector displacements :
below 100 μm in X,Y, Z directions and a few microns for internal silicon sensor layers

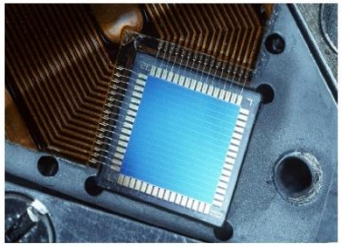
Goal within AIDA project:

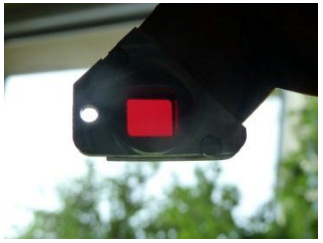
improve and extend the optical alignment system developed in EUDET project for LumiCal and possible other inner detectors
The first step in this direction is to build the prototype of the laser positioning system and integrate it with AIDA calorimeter module



Positioning system

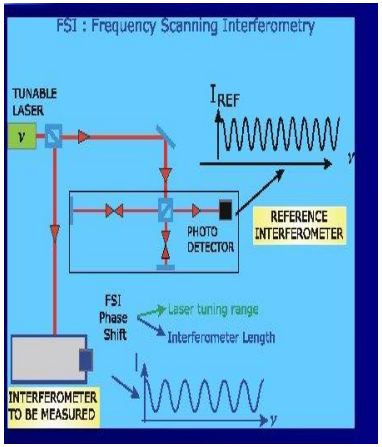
The laser positioning system will contain the main components:
- infra-red laser beam and transparent silicon position sensors
- tunable laser(s) working within Frequency Scanning Interferometry (FSI) system

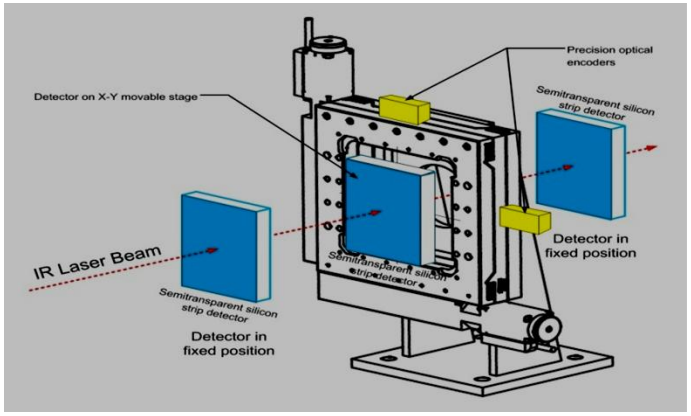




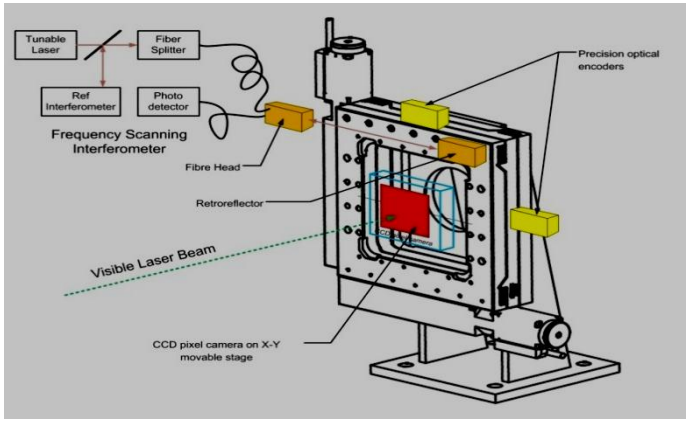
Transparent amorphous sensors , DPSD-516
(above ~780 nm laser wavelenght),
ZEUS MVD–Oxford University), X,Y accuracy ~10 μm
LumiCal displacement measurement of the internal sensor layers

FSI – can be used
for measurement of the absolute distance between
LumiCal calorimeters by measurement of interferometer optical path differences using tunable lasers.





Status: problem with restart the system prototype based on Oxford elements running under VME OS9 system - hope to solve this problem soon



Status: work on design, wait for decision if financial support from local financial institution will be possible