The ILD concept;
session summary & DBD plans

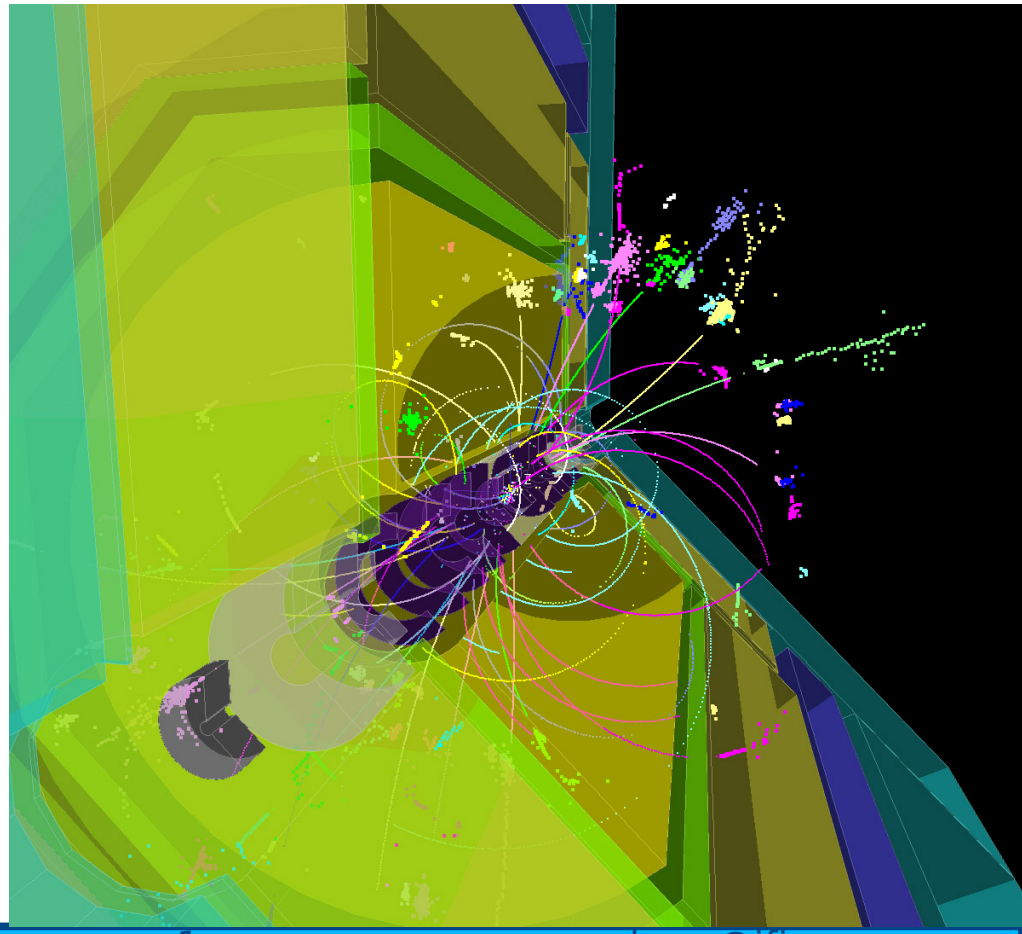
LCWS11,

Granada,

September 25-30 2011

Marcel Vos (IFIC – U. Valencia/CSIC)

on behalf of the ILD detector concept



ILD

Thanks to the speakers in the ILD session

Introduction: Ties Behnke

Physics studies: Tomohiko Tanabe

Engineering: Catherine Clerc

Software: Frank Gaede / Akiya Miyamoto

VTX: Marc Winter / Yasuhiro Sugimoto

SiTRK: Aurore Savoy Navarro

Forward Tracking: Alberto Ruiz

TPC: Jan Timmermans

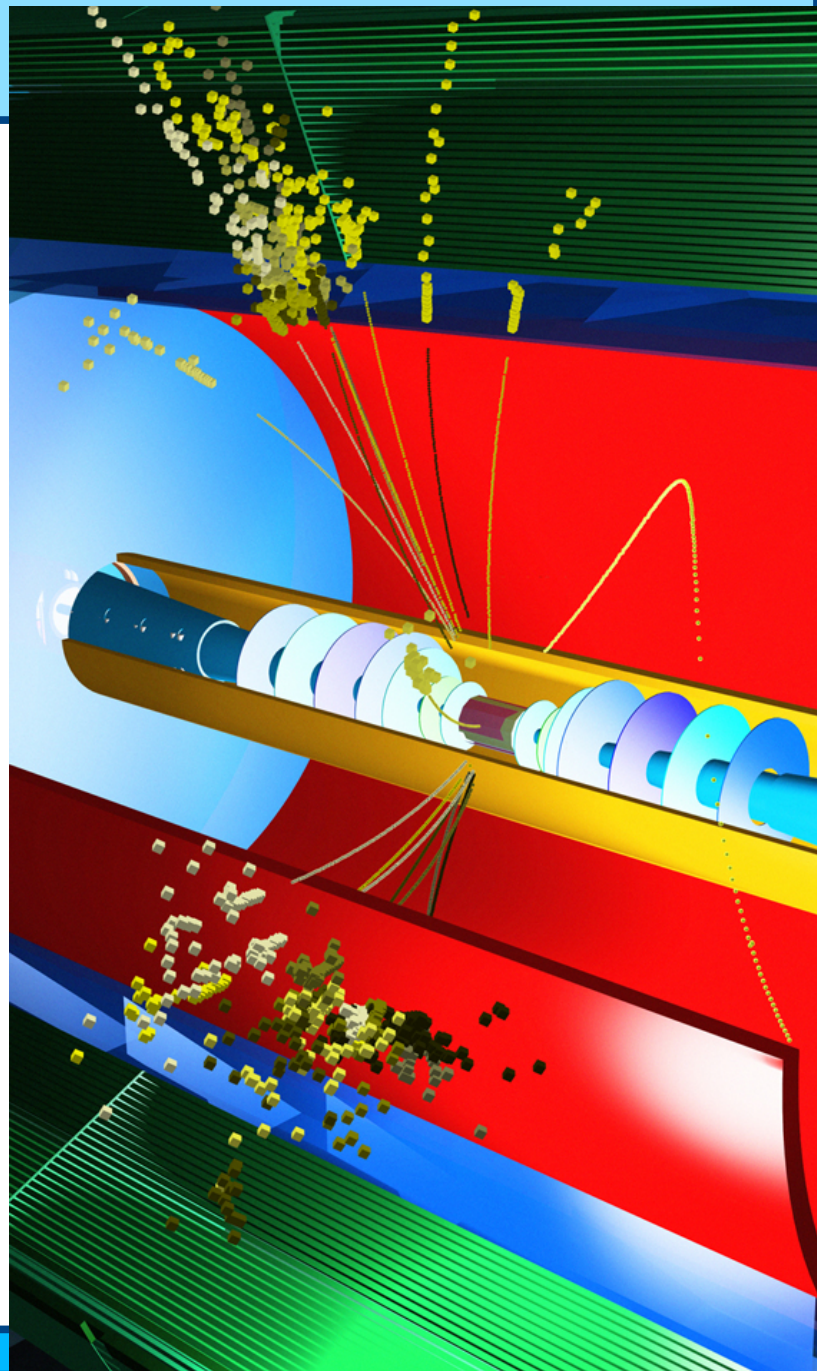
ECAL: Roman Poeschl

SDHCAL: Vincent Boudry/ Manqi Ruan

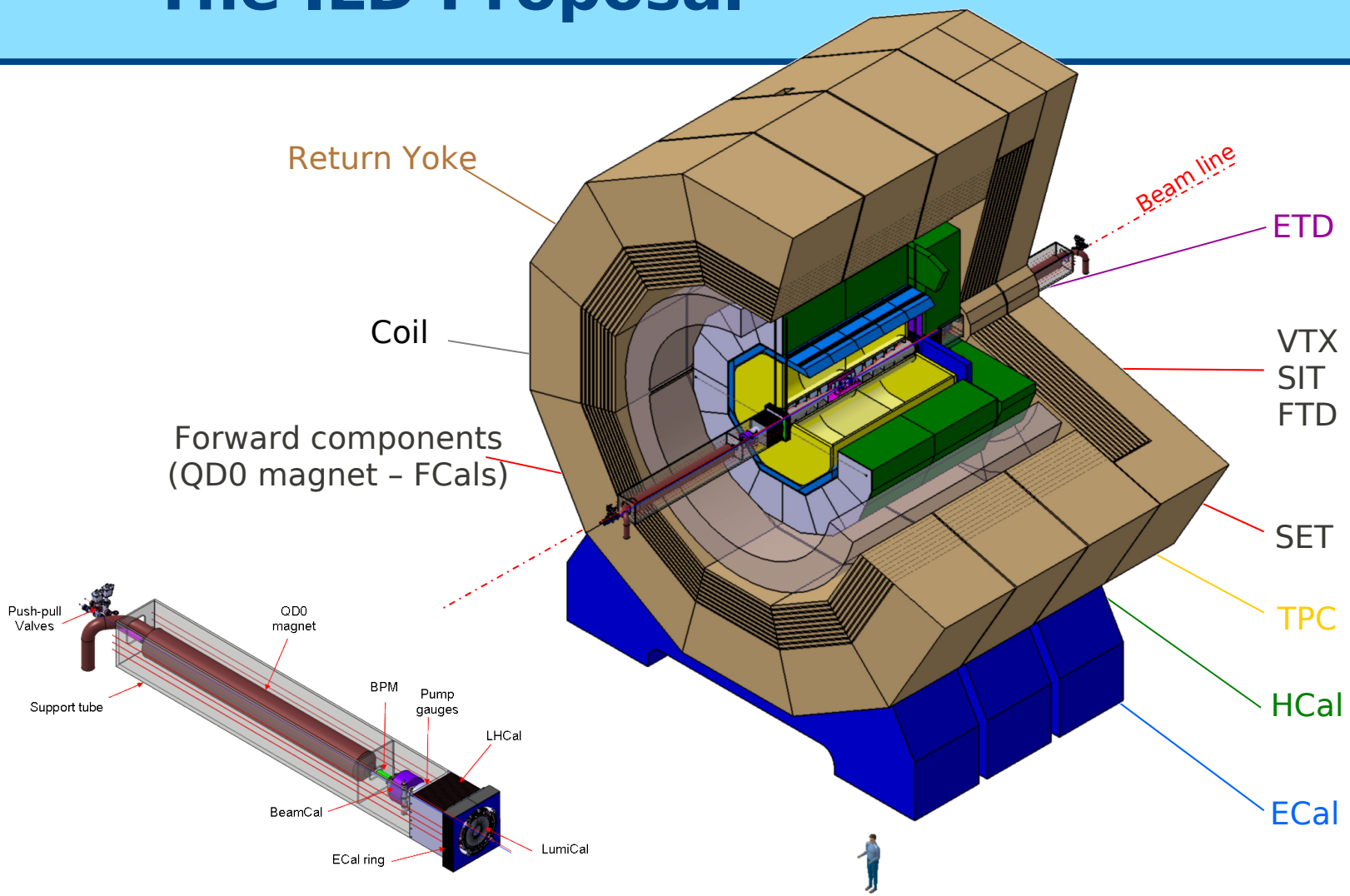
AHCAL: Shaojun Lu

FCAL: Konrad Elsener

Discussion/planning: Ties Behnke



The ILD Proposal



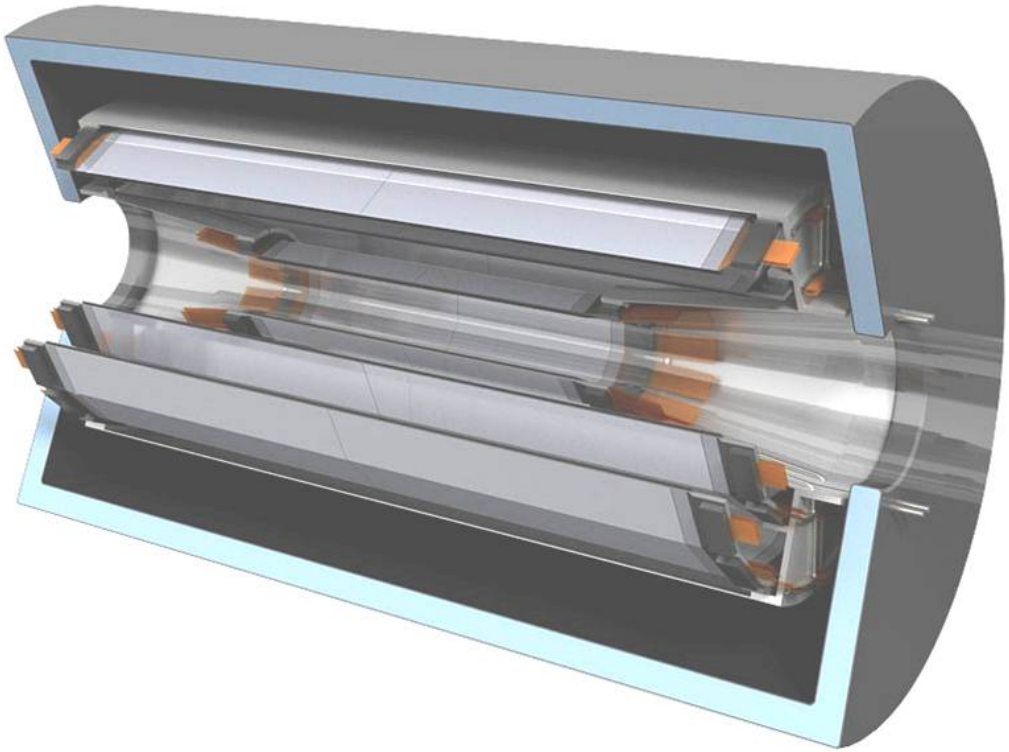
A relatively large detector, designed for particle flow, with a highly granular calorimeter, state-of-the-art gaseous+solid state tracker/vertex detector
Letter of Intent in 2009 – Invited by IDAG to work **towards a DBD for 2012**

Vertex detector

- ✔ Reconstruct primary and secondary vertices, flavour tagging
- ✔ Full polar angle coverage
- ✔ Cope with machine background
- ✔ Aim for unprecedented performance:
  - ➔ $\sigma(d_0) < 5 \oplus 10/(p \sin^{3/2}\theta)$

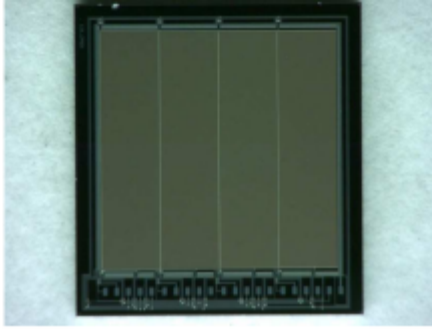
Stringent requirements

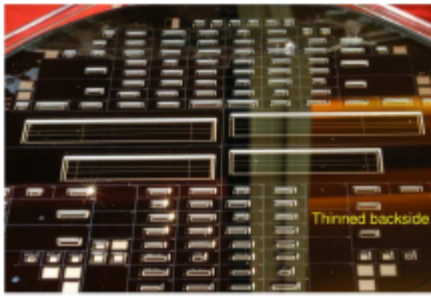
- ✔ Precision (20 x 20 μm^2)
- ✔ Read-out speed (25/100 μs)
- ✔ Material: 0.1...% / layer

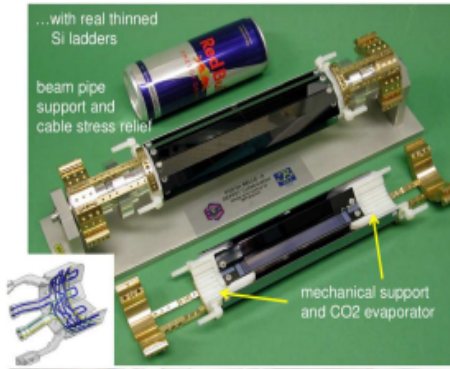


VXD

- **Sensor production:**
  - FPCCD: 6x6 mm^2, pixel sizes 6x6 to 12x12 μm^2, thinned to 50 μm, tests ongoing. Large area expected FY2012
  - DEPFET: Belle-II and ILC design sensors thinned to 50 μm and tested with fast read-out (TB next week)
  - CPS: Development common with ALICE/CBM/AIDA. MIMO30 (resolution) and 31 (power) should attain all VXD specs by summer 2012. Moving to 180 nm in 2012.
- **Full ladder production/integration:**
  - PLUME/CPS double sided: demonstrated 3 μm resolution, 100 μs/frame, 0.6% X_0/double layer, to be beam tested in November, aiming to halve material budget in 2012
  - PLUME/CPS single sided: 0.37 % X_0/single layer for STAR (data taking next year)
  - DEPFET: 0.2 % X_0/single layer for Belle-II (2015)
  - Unsupported “ladders” → SERWIETTE
  - CO_2 cooling project (-40 C) for FPCCD

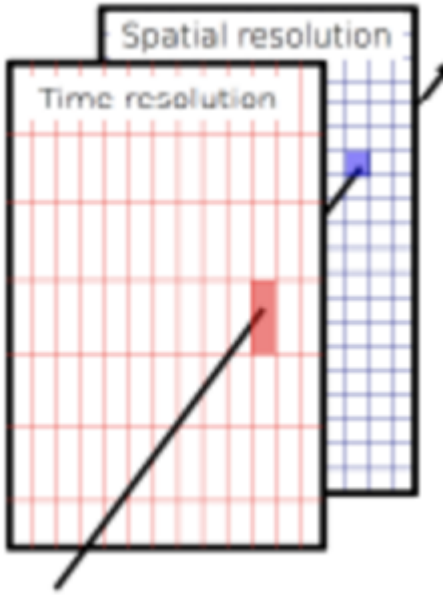


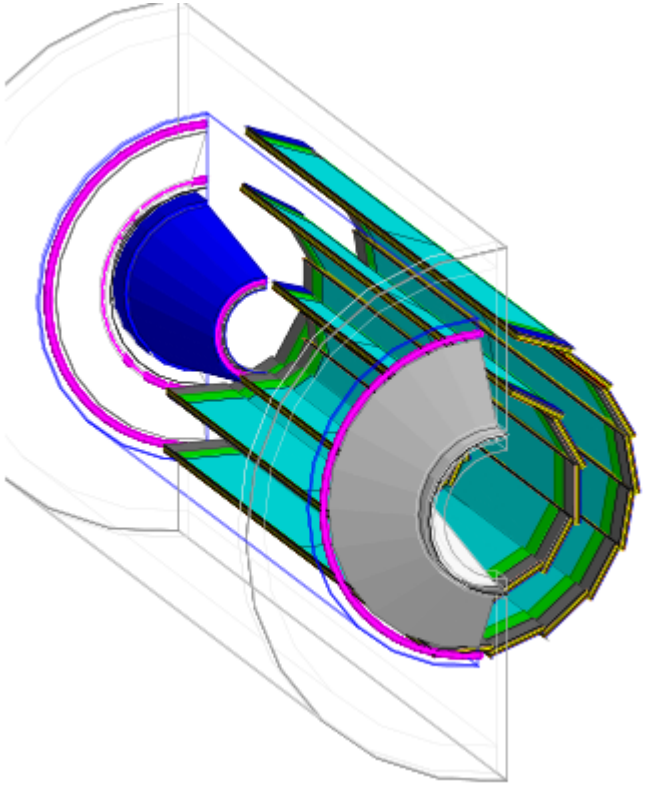




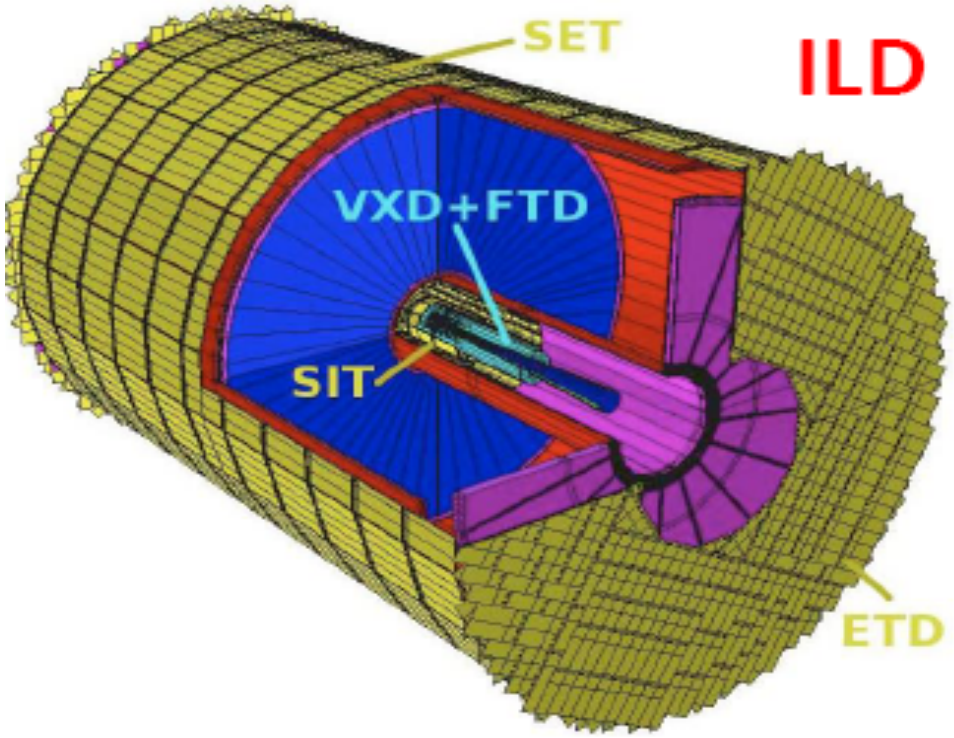
VXD

- ✔ Increased realism in simulation
  (more realism = more material: from 0.16 % X_0/double layer in LOI to 0.3 % X_0/double layer)
- ✔ Support and services (including liquid cooling for FPCCDs)
- ✔ Consider alternating “specialized” layers, with with complementary precision in time and spatial domain... (i.e. MIMOSA 20x80 μm^2 pixels)



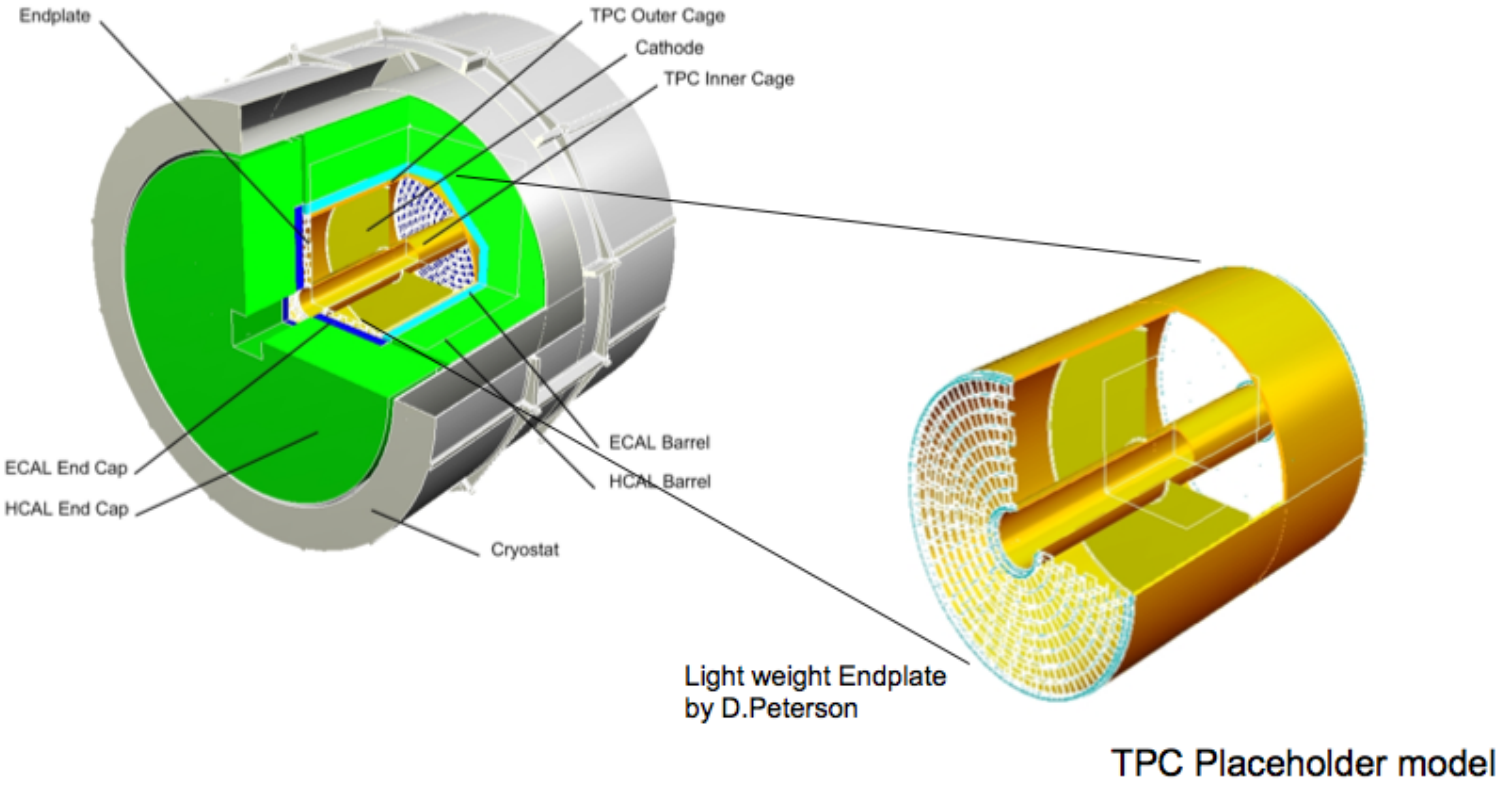


ILD tracker



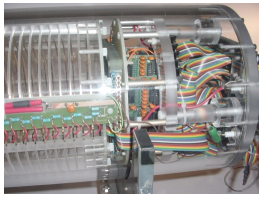
- ✔ Tracking: VXD, SIT/FTD, TPC, SET/ETD
- ✔ Fully efficient and clean track reconstruction over all track polar angles and momenta
- ✔ Achieve a momentum resolution beyond state of the art; $\Delta(1/p) \sim 2 \times 10^{-5}$
- ✔ Again: no material

Time Projection Chamber



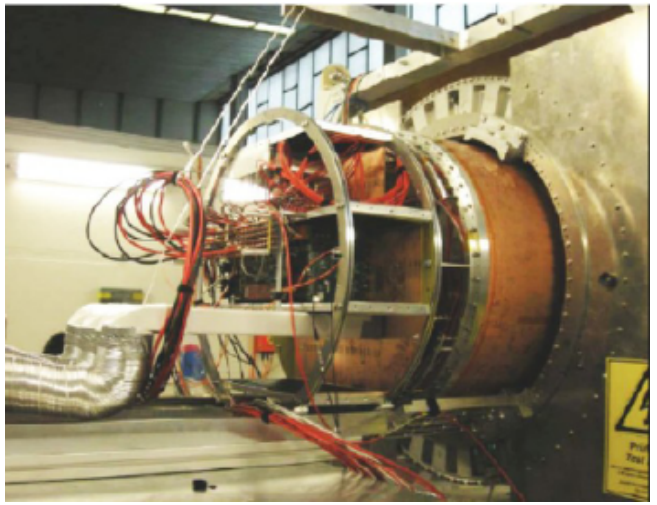
Large number of space points, good point resolution
High efficiency tracking and pattern recognition
Important for particle flow
Particle identification additional benefit

LCTPC



Small TPC prototypes

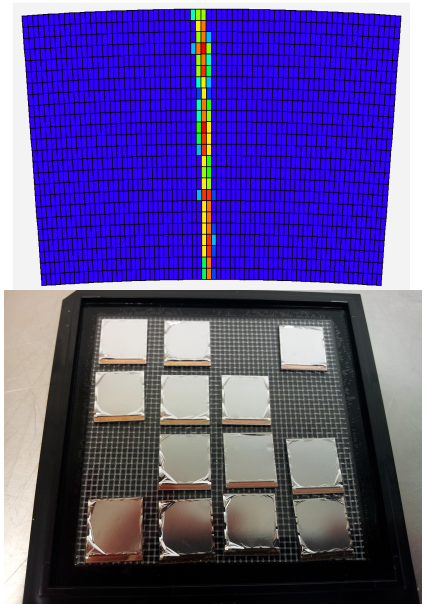
< 2011



2011

Three read-out schemes:
GEM, MicroMegas, pixels

- The PCmag magnet has been sent from DESY to KEK for adding 2 He compressors
- A first module test with compact electronics has been carried out. The production of 9 modules (7 to fill the prototype plus 2 spares) is starting.
- Working InGrids have been implemented by IZM Berlin on a TimePix wafer and tested.



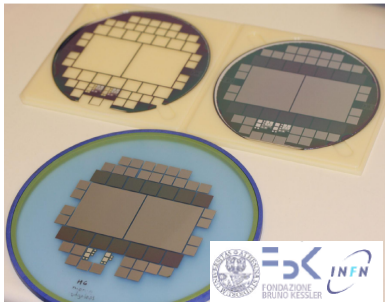
Silicon Tracking

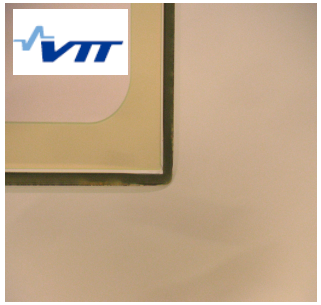
Baseline sensor technology: Single sided strips

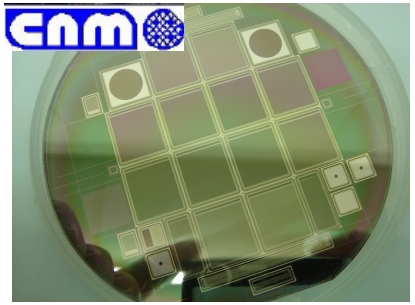
- Interconnection: integrate pitch adapter on second metal layer
- *Follow LHC developments on ways to bring in power*
- *Interesting development on use of charge sharing to measure coordinate along the strip*
- New planar single sided strips technology, large sensors (6’’), edgeless and high transmittance (IR laser alignment) options

Benefit from involvement in shorter term experiments for keeping/developing expertise & for funding and from synergy with (s)LHC.

New edgeless sensors

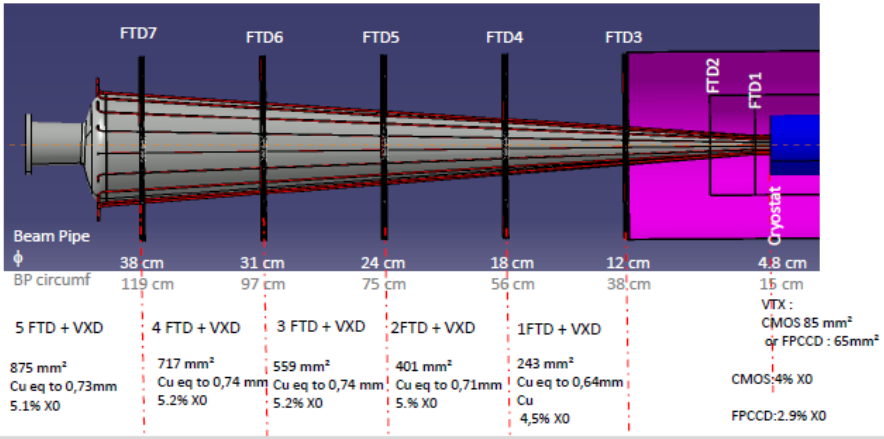






High transmittance sensors
Goal: T~70%; Already now: 50%

Integration

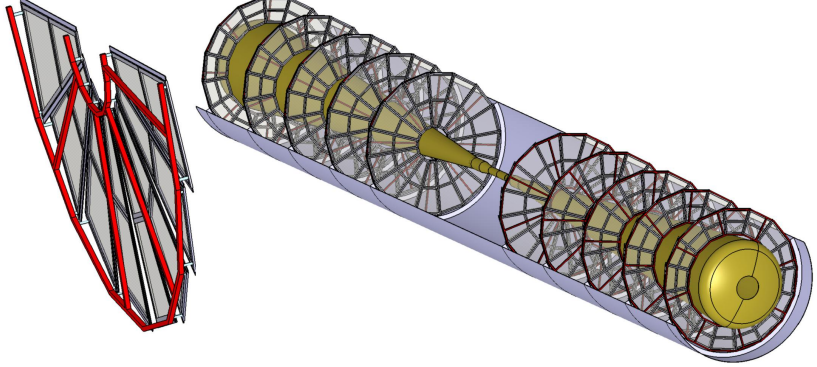


So, with actual data : about 5% of X0 all along the beam pipe.

That means also

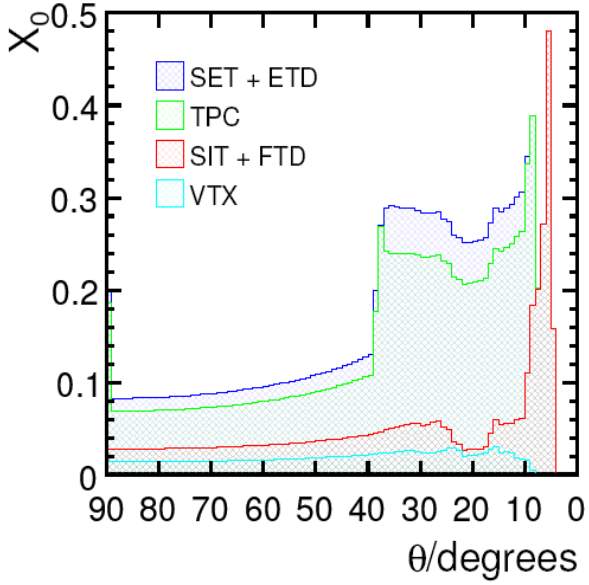
- *about 9 kg of material on each side*
- *a minimum gap between FTD supports and beam pipe of 2 cm for path of all the cables....*

And SIT/ FTD1&2 services not included...



Services and supports for Inner tracker & vertex detector are addressed from a “global detector” point of view

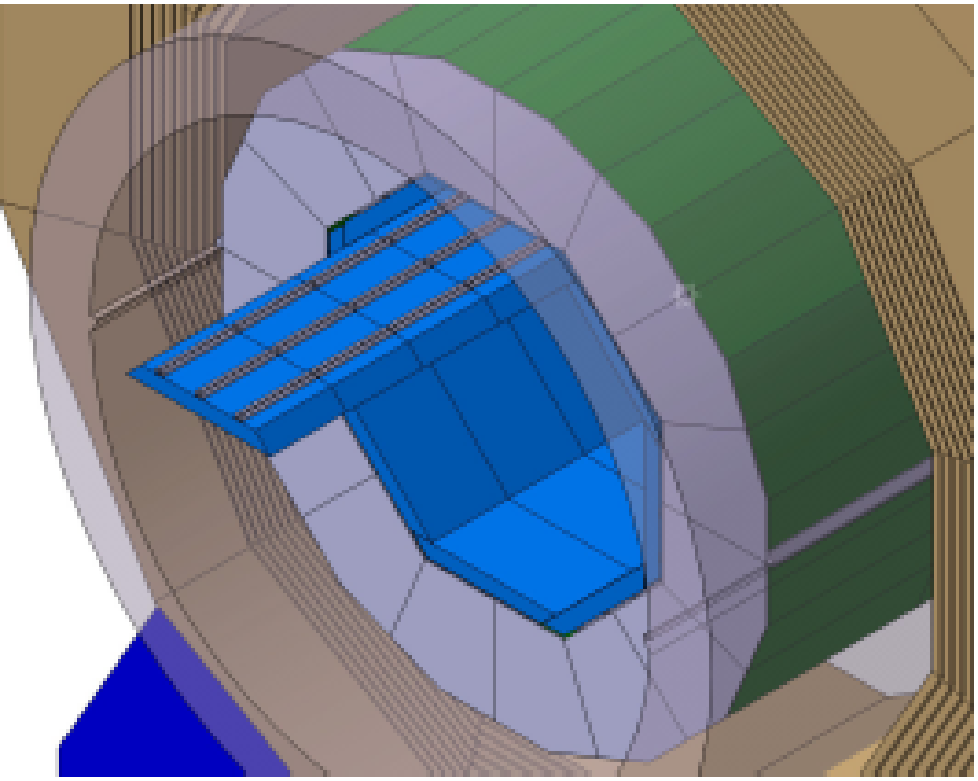
From: ILD LOI



The painful path from a “paper detector” to a fully engineered design and on to a real one...

The material in the tracker increases, even in the central region. Smarter solutions to mitigate this must be explored and the impact on overall physics performance must be assessed.

Calorimeter



E(lectromagnetic)CAL

- ✔ Tungsten as absorber material
- ✔ X_0=3.5mm, RM=9mm. λ=96mm
- ✔ Narrow showers, compact design
- ✔ Silicon or scintillator as active material (or both)

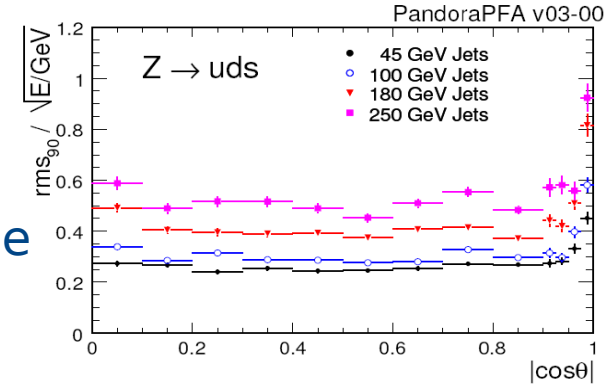
H(adronic)CAL

- ✔ Digital, Semi-digital: RPC/MicroMegas
- ✔ Analog: scintillator tiles read-out by SiPM

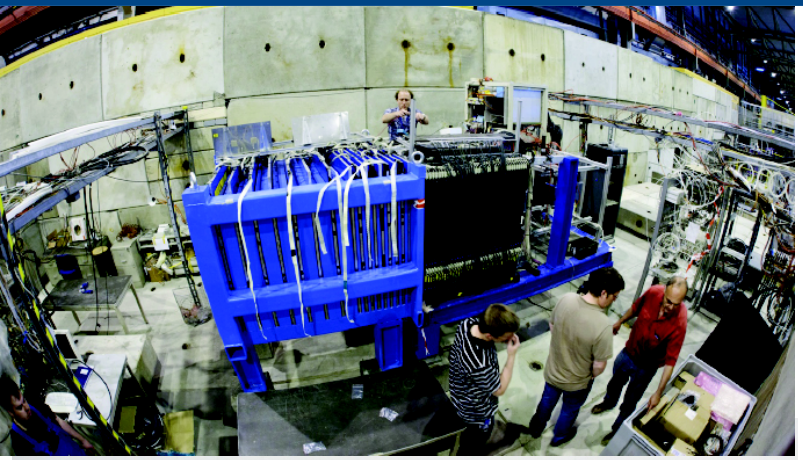
F(orward)CAL

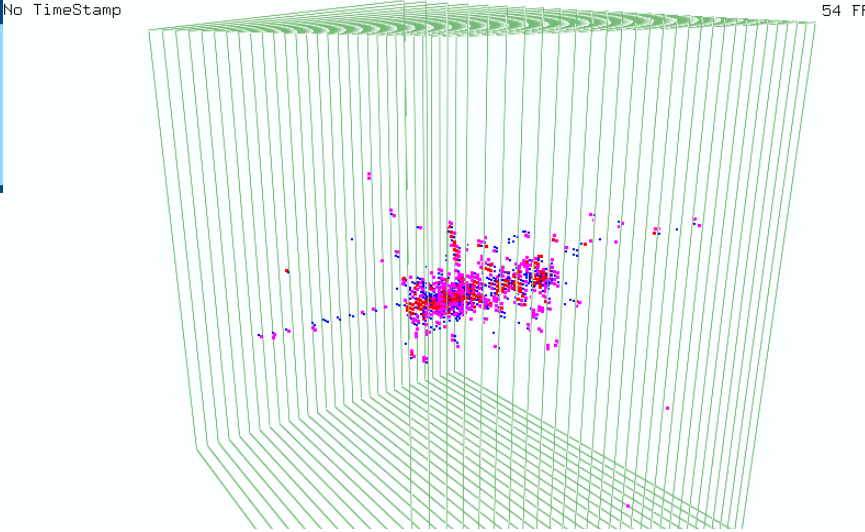
- ✔ Luminosity Calorimeter
- ✔ Beam Calorimeter

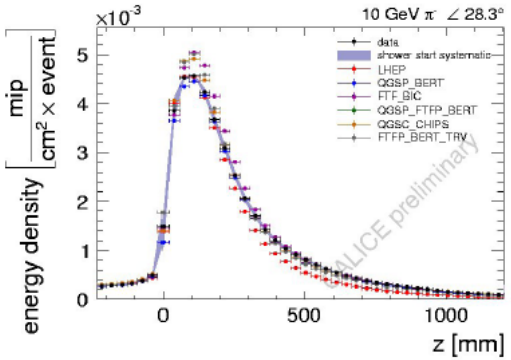
Particle flow jet energy measurement proven to outperform old-fashioned calorimetry
There's much more to a jet than energy: expect the gain to be more pronounced for jet substructure!

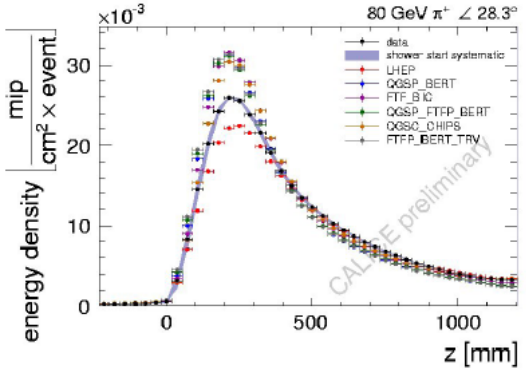


Calorimeter: the 1 m³ era









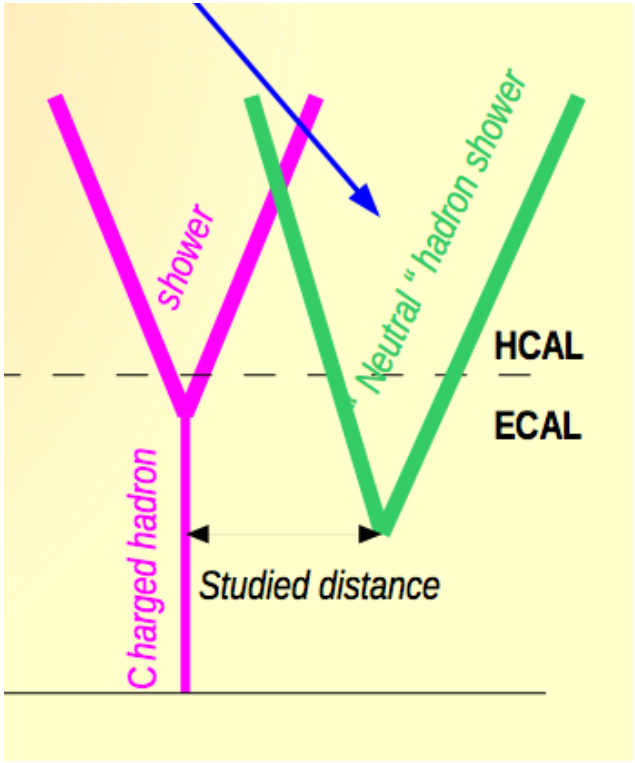
1 m³ tungsten and stainless stacks instrumented with different options in beams at CERN

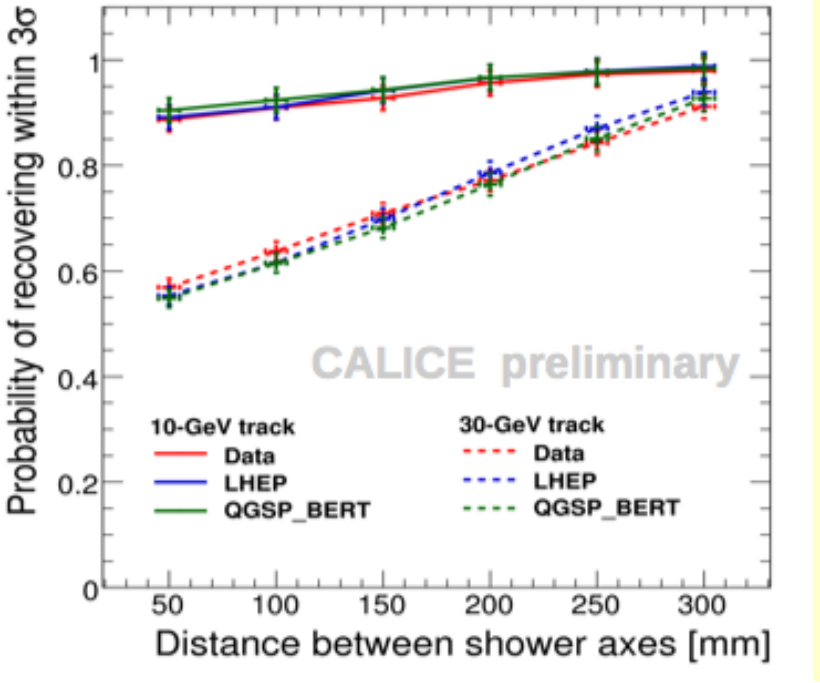
http://arxiv.org/pdf/1003.1394

http://arxiv.org/pdf/1105.0511

Calorimeter: testbeam results

CALICE **Data** mapped onto ILD detector to test PFA





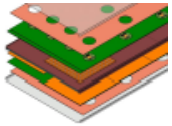
Transport of beam test data into physics studies

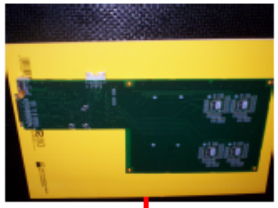
Successful application of PFA to real data with highly granular calorimeters

Calorimeter: fully integrated (technological) prototypes

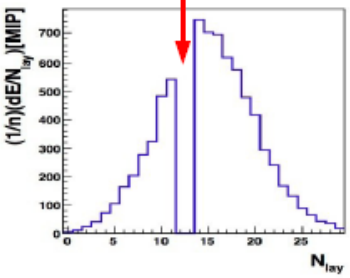
Embedded electronics - Parasitic effects?

Exposure of front end electronics to electromagnetic showers



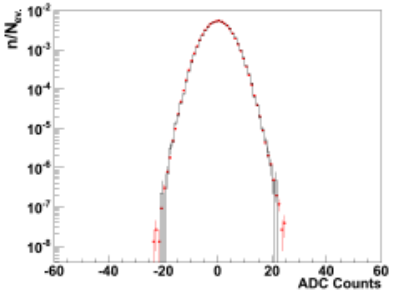


Chips placed in shower maximum of 70-90 GeV e.m. showers



Possible Effects: Transient effects
Single event upsets

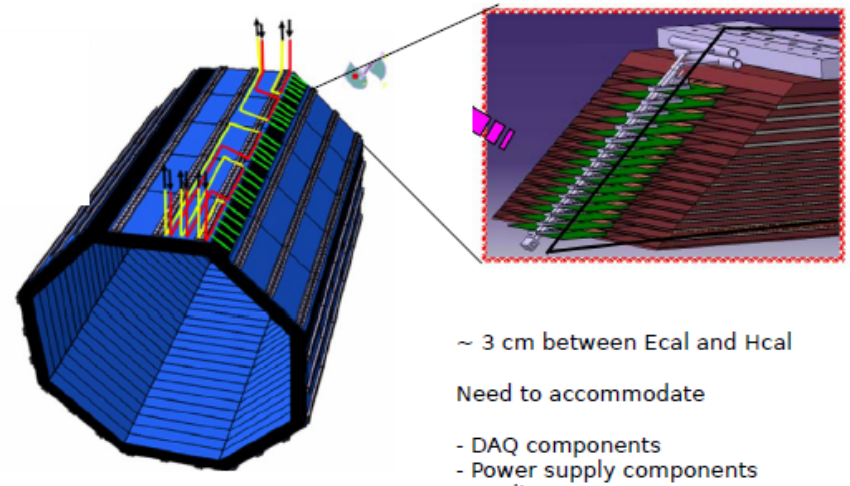
Comparison: Beam events
(Interleaved) Pedestal events



- No sizable influence on noise spectra by beam exposure
  ΔMean < 0.01% of MIP ΔRMS < 0.01% of MIP
- No hit above 1 MIP observed
  => Upper Limit on rate of faked MIPs: ~7x10^{-7}

ILD@LCWS11 Sept. 2011

R&D for Technological Readiness – Peripherals



~ 3 cm between Ecal and Hcal

Need to accommodate

- DAQ components
- Power supply components
- Cooling

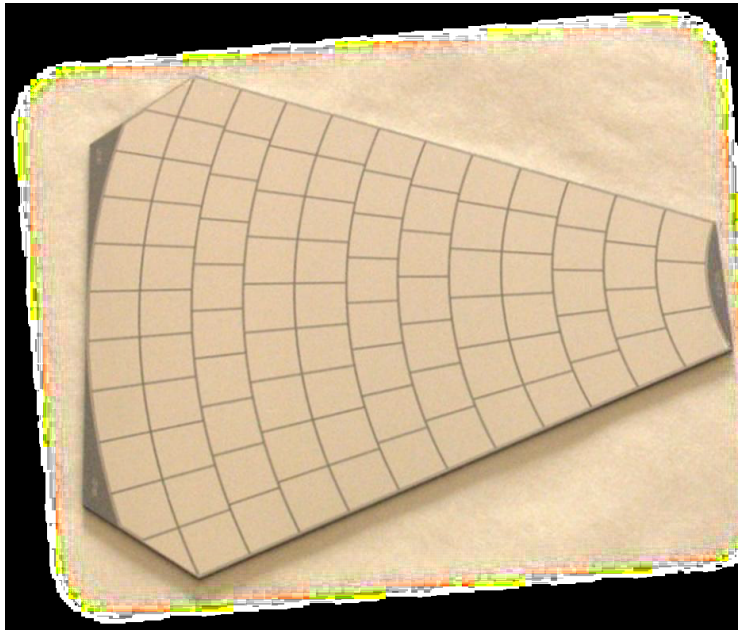
Issues are addressed and at least we will come up with a list of open issues and proposals how to address these

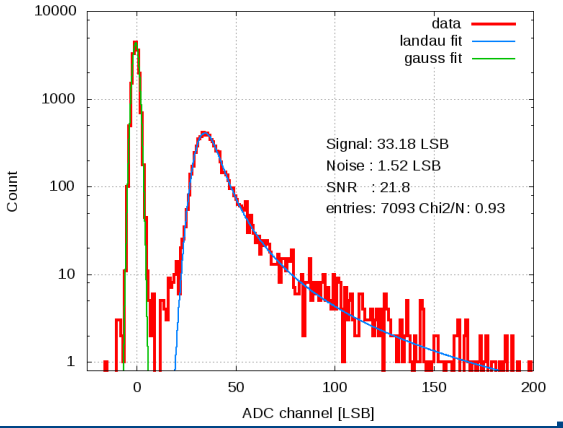
ILD@LCWS11 Sept. 2011

LumiCal TB DESY: July 2011

LumiCal Sensor +
32 Channels of ASICs

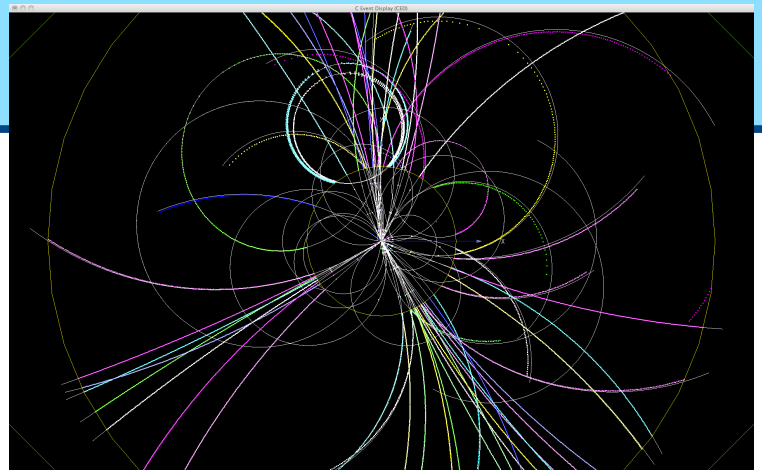
(incl. ADC – first time complete chain !)





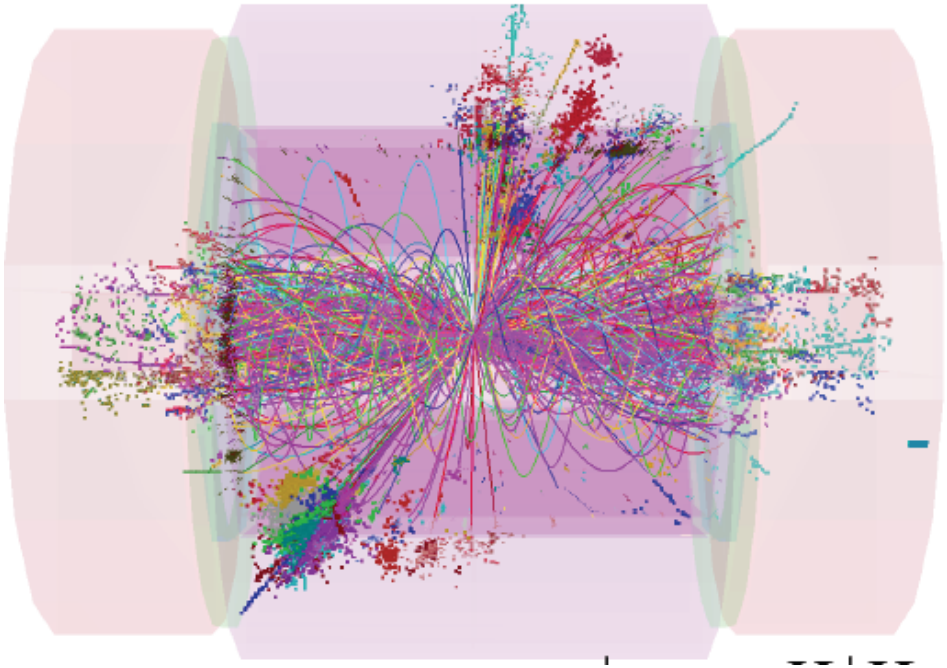
BeamCal: GaAs sensor pads will be read out by th
full Cracow electronics chain - as LumiCal
(FE ASICS plus ADC ASICS)

Software



A LOT of progress:

- ✔ LCIO2
- ✔ Detector drivers to cope with detailed geometry
- ✔ New tracking code (Fortran-free)
- ✔ PandoraPFA expected to work at 1 TeV
  - ✔ Shown to work at 3 TeV
  - ✔ Possibly some calibration/tuning
- ✔ LCFIVertex greatly improved



The major developments for the DBD are completed. Faster than anticipated!

Physics Analysis

Analysis at 1 TeV

- ✔ $e^+e^- \rightarrow \nu\nu H$
  - ➔ m_H=120 GeV, with H→bb, cc, gg, μμ, WW*
- ✔ $e^+e^- \rightarrow WW$
  - ➔ measurement of beam polarization
- ✔ $e^+e^- \rightarrow t\bar{t}H$, $H \rightarrow b\bar{b}$
  - ➔ (a) 6 jets + lepton and
  - ➔ (b) 8 jets configuration

Analysis at 500 GeV

- ✔ ZHH
- ✔ ttbar
- ✔ SUSY point5-like

+ a bunch of other analyses, just because we think they're interesting

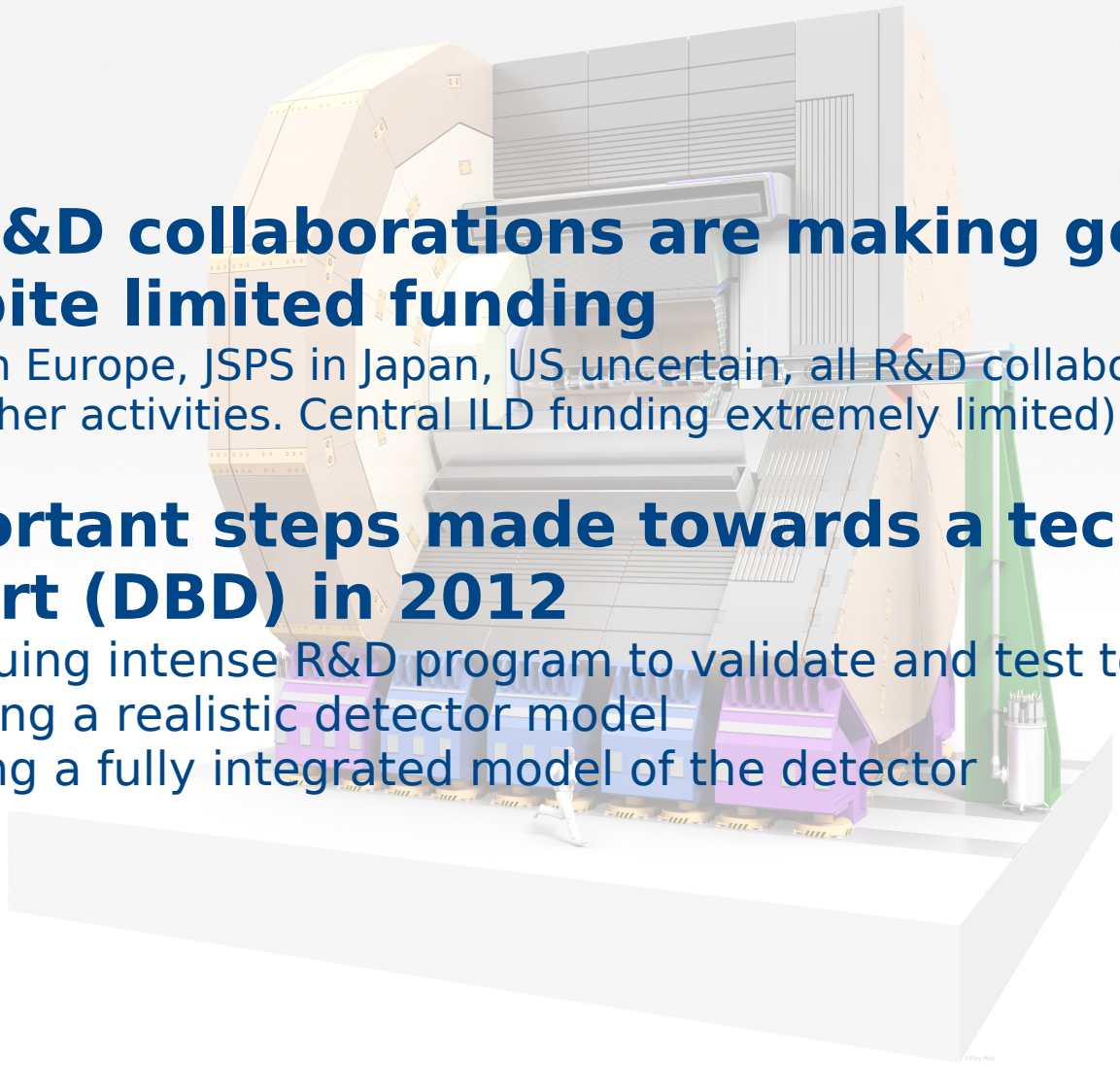
Subdetector Technologies

- Demonstrate technology by test beam in a realistic prototype
- Demonstrate basic performance by analysis of test beam data
- Demonstrate ILD performance by integration into simulation with realistic model
- Demonstrate integration into ILD by 1st level engineering solutions
  - Per subdetector
  - Globally for ILD

We think it is too early to exclude any technology, or to select a bas

Note: R&D for ILD is done by the R&D collaborations in close cooperation and coordination with ILD.

ILD: The next steps



All R&D collaborations are making good progress, despite limited funding

(AIDA in Europe, JSPS in Japan, US uncertain, all R&D collaborations leverage funds from other activities. Central ILD funding extremely limited)

Important steps made towards a technical design report (DBD) in 2012

Continuing intense R&D program to validate and test technologies
Providing a realistic detector model
Creating a fully integrated model of the detector

Google: ILD

A pretty ambitious program, but we're in good company:

ILD, Institute for liberty and democracy: helping to create an...
ILD's solutions help businesses make money, not just save it.
ILD :: Creating a New World
Welcome to the ILD web site — ILD www.ilcild.org/
ILD - Innovation Lighting Design