ILD Status Report

Graham W. Wilson for the ILD Concept Group

University of Kansas,

ILC PAC, Fermilab, May 16th 2012

Introductory Remarks

ILD recently reported to IDAG (International Detector Advisory Group) and presented the status of the concept at the KILC12 meeting in Daegu, Korea (April 2012).

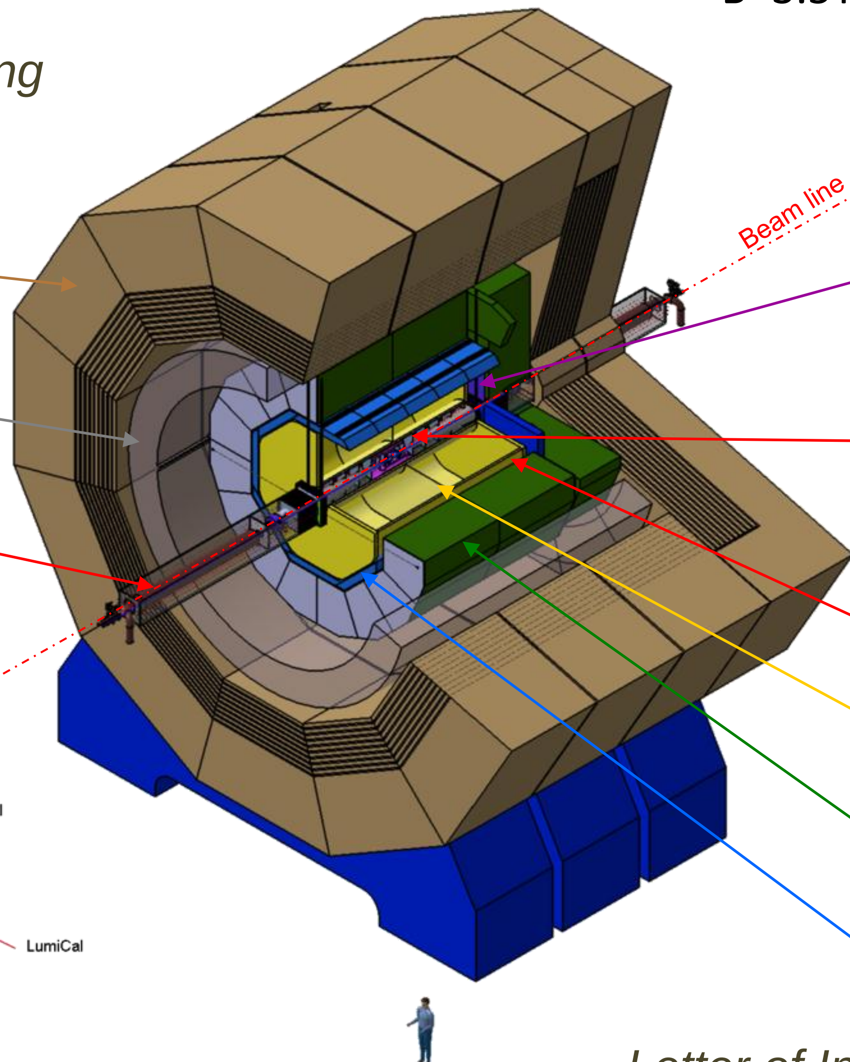
This presentation borrows heavily from the presentations by Tomohiko Tanabe and Ties Behnke at KILC12.

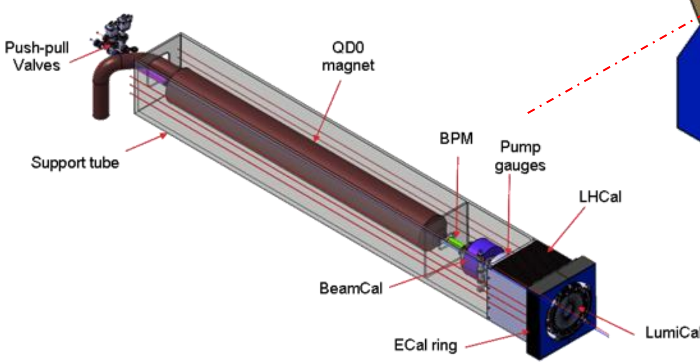
ILD will have a major workshop next week in Kyushu, Japan.
We expect to make significant progress en route to finalizing the elements of ILD's input to the Detailed Baseline Document, and have a significant review of all sub-systems.

International **L**arge **D**etector

*Detector optimized for **particle flow**, with highly granular calorimeters and superb tracking and vertex finding capabilities. Central tracker = TPC.*

B=3.5T (designed for 4T)



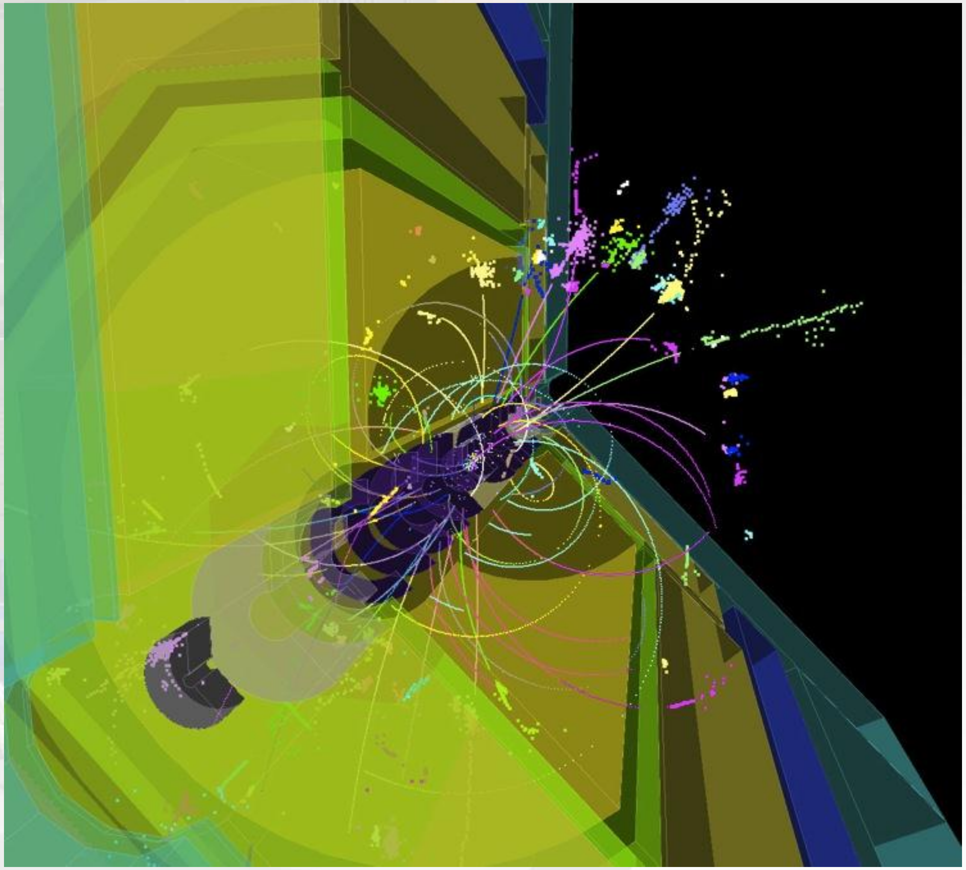


Letter of Intent in 2009.

*Invited by IDAG to work towards a **DBD for 2012.***

Towards a Detailed Baseline Design

ILD is intensifying its efforts as the deadlines for the DBD near. Areas in which significant progress are being made are:



Component R&D

- Construction of prototypes, testing and validation of technologies, test beam results, power-pulsing operation…

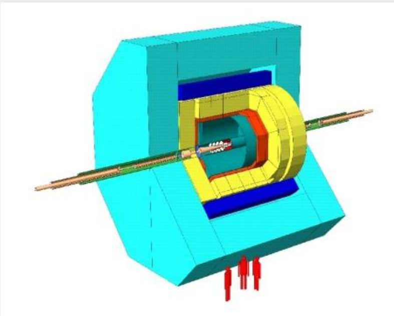
Simulation tools

- Implementation of simulation detector models with increased realism, improvement in event reconstruction software

Physics studies

- Benchmark processes, other processes to enrich the ILC physics case

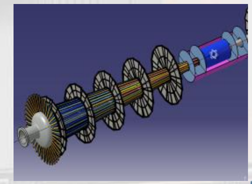
The Steps towards the DBD

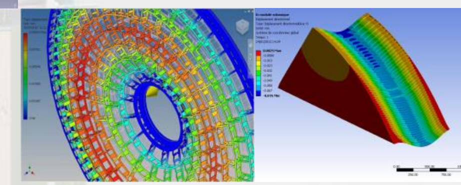


LOI detector

Technologies

Validation
Scalability
Simulation & Reconstruction





Engineering design:

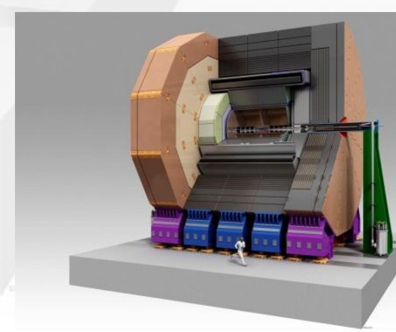
Conceptual design of the overall system with a focus on integration aspects

DBD detector

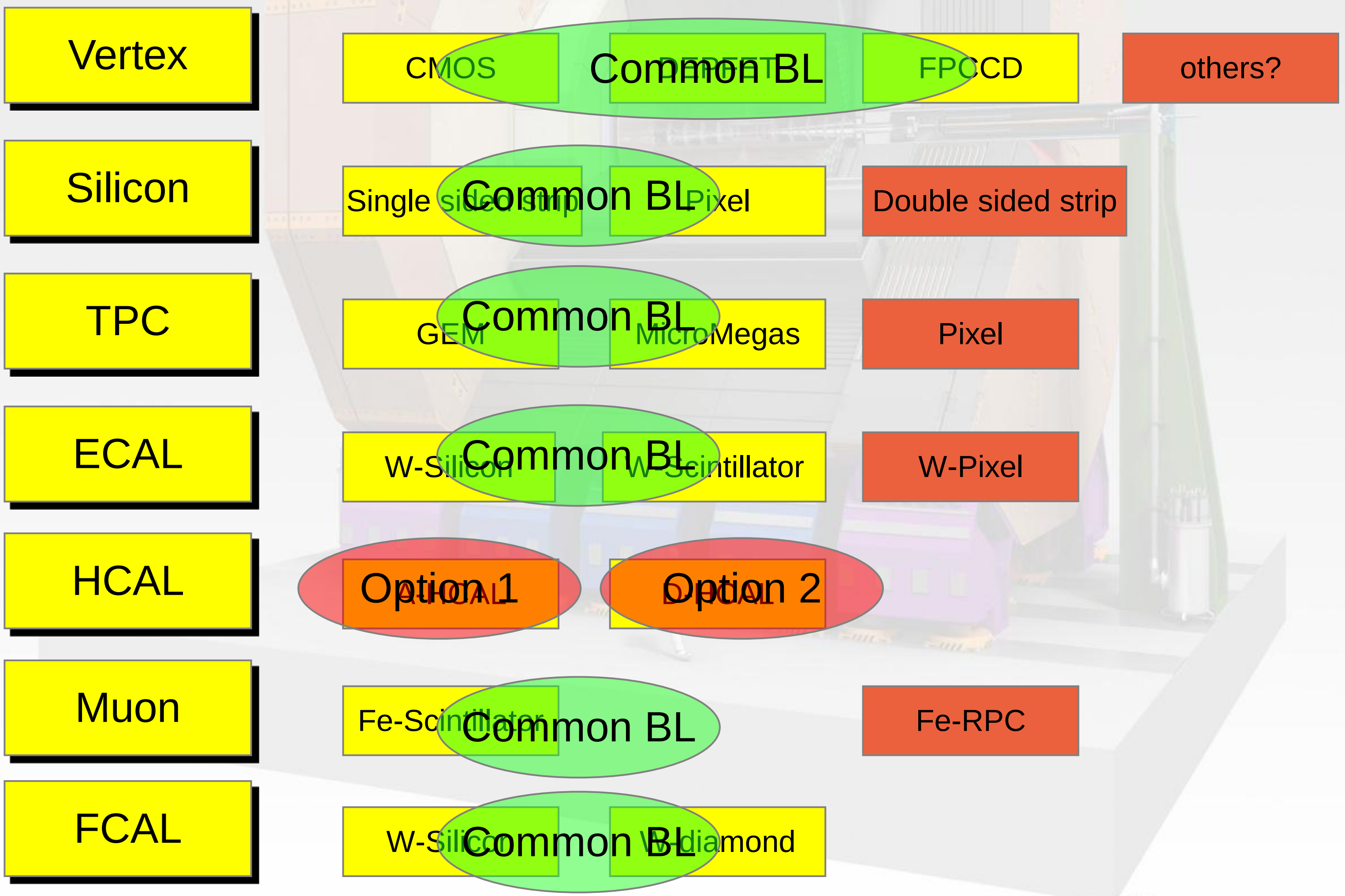
- Options
- Alternatives
- Issues

Criteria to be accepted as an option:

- Establish performance
- Validated simulation
- Operational experience
- Scalable technology solutions
- Open R&D issues



ILD: baseline detector
The current picture



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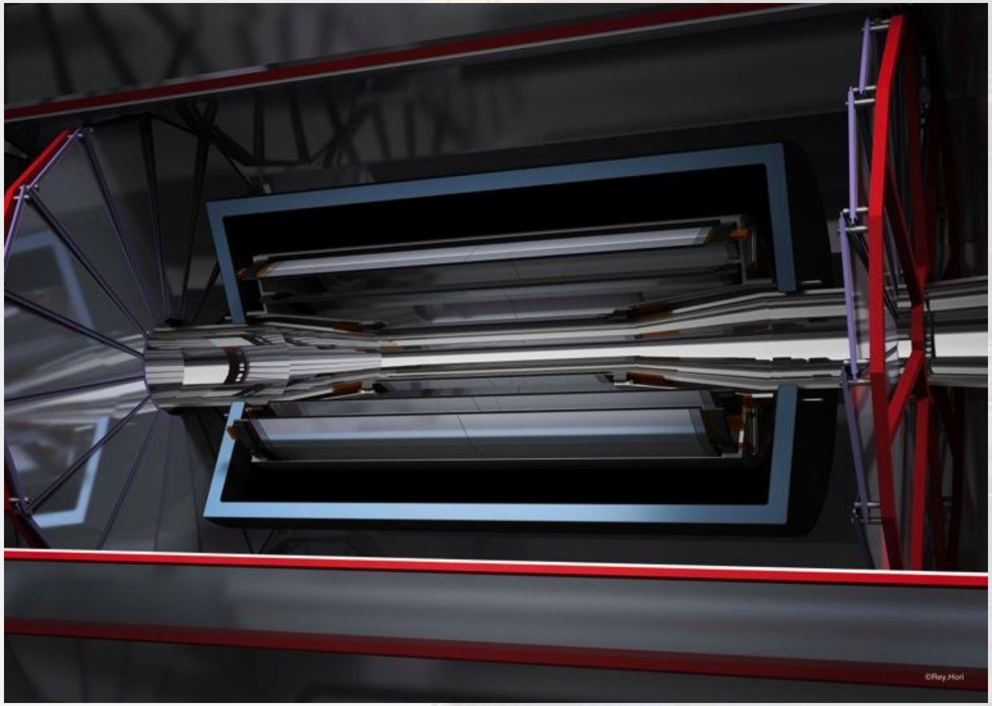
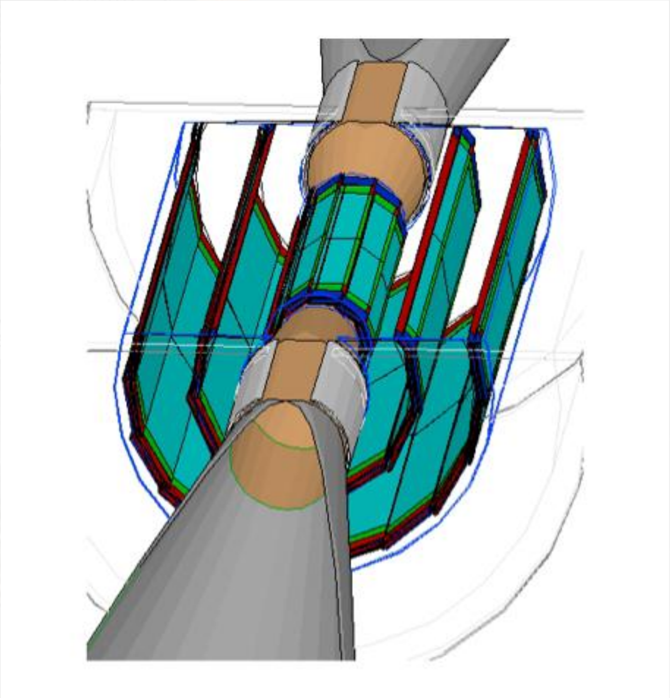
Vertex Detector

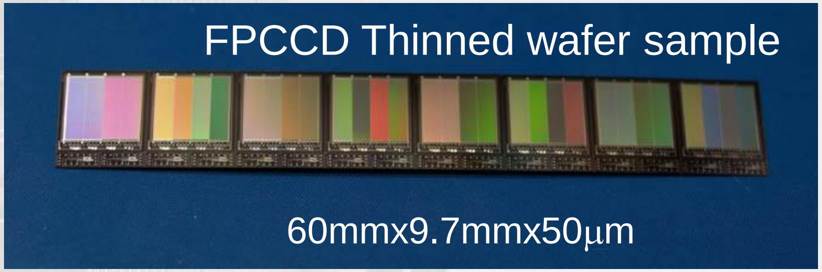




- ✓ Key to flavor tagging by reconstructing vertices
- ✓ Aim for unprecedented performance: σ_b (μm) < 5 $\oplus$ 10/($p\beta \sin^{3/2}\theta$)
  - ✓ Spatial resolution < 3 μm
  - ✓ Material budget 0.2-0.3% X_0 per layer
  - ✓ Sufficiently low occupancy
- ✓ Cope with large beam backgrounds
- ✓ Options: FPCCD, DEPFET, CMOS…

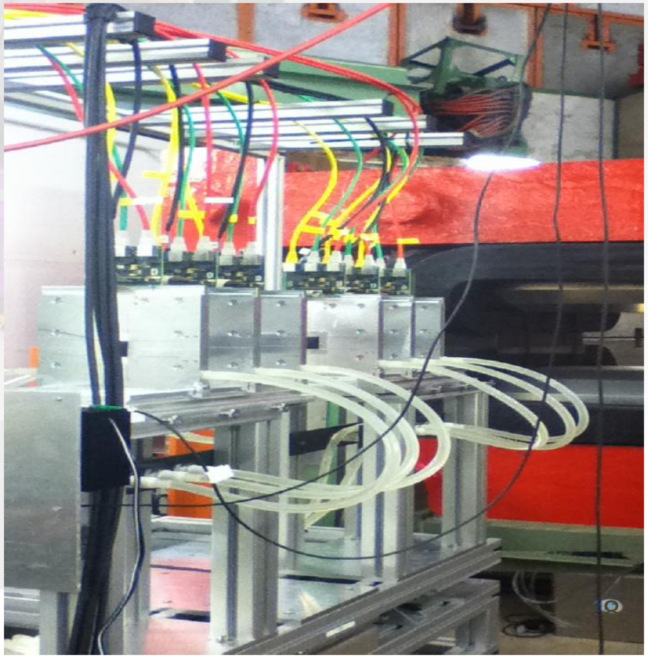
Vertex Detector

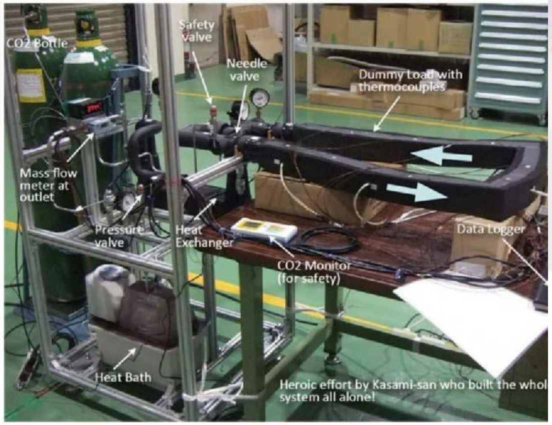
- **CMOS Sensor architecture developed in 0.35** μm **technology validated :**
  - Complies with ILD specifications
  - Experimentally validated in series of test experiments (EUDET etc.)
  - Final prototype to be validated this year
  - Transition to 0.18 μm under way
  - Baseline for STAR vertex detector

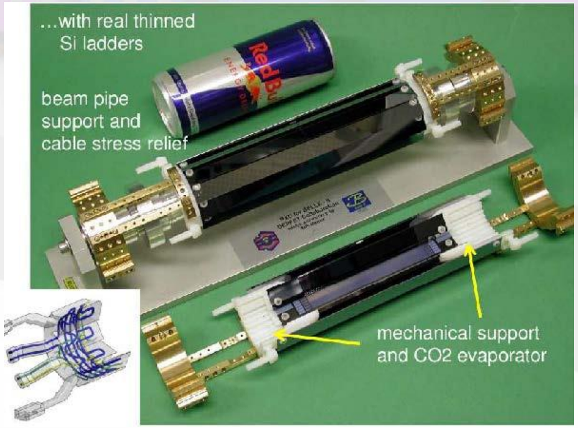


- **FPCCD: fine pixel CCD Technology**
  - First large chip (1x6cm^2) expected in 2012
  - CO_2 cooling plant prototyped
- **DEPFET Technology**
  - Baseline for BelleII detector, will profit from this

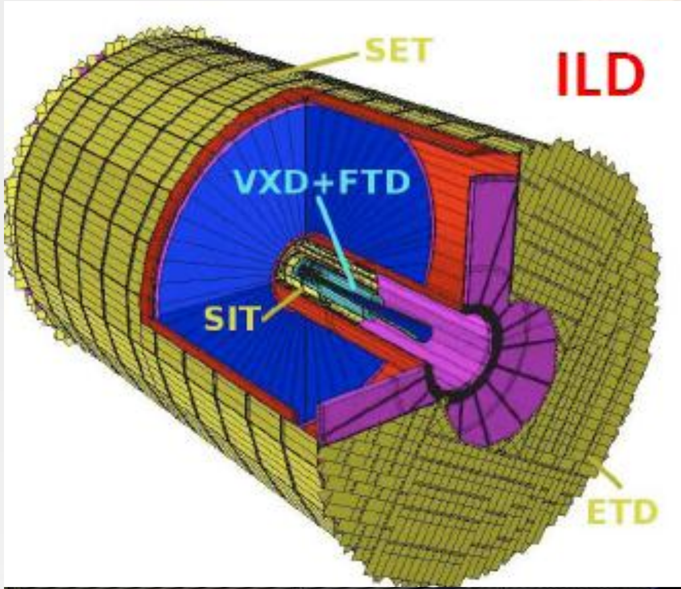
EUDET Telescope

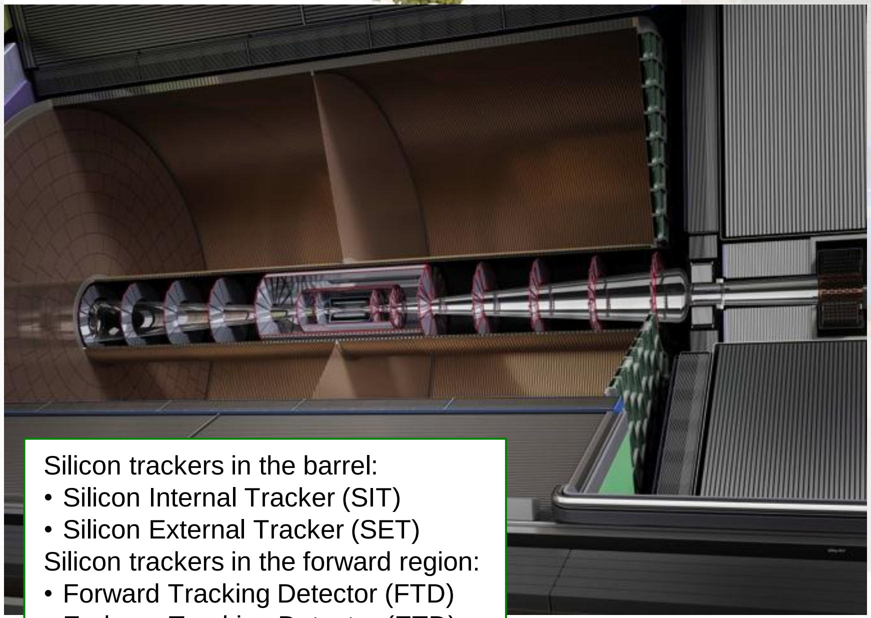






Silicon Tracking





Silicon trackers in the barrel:
- Silicon Internal Tracker (SIT)
- Silicon External Tracker (SET)

Silicon trackers in the forward region:
- Forward Tracking Detector (FTD)
- End-cap Tracking Detector (ETD)

- Extra silicon trackers are added to provide:
  - Better angular coverage
  - Improve momentum and position resolution
  - Calibration of distortions
  - Alignment
  - Time stamping
  - Redundancy and robustness
- R&D by SiLC collaboration
  - FEE based on 130 nm CMOS technology
  - New on-detector electronics connection
  - New support architecture
- Challenge:
  - Material reduction
  - Low power consumption
  - High spatial resolution

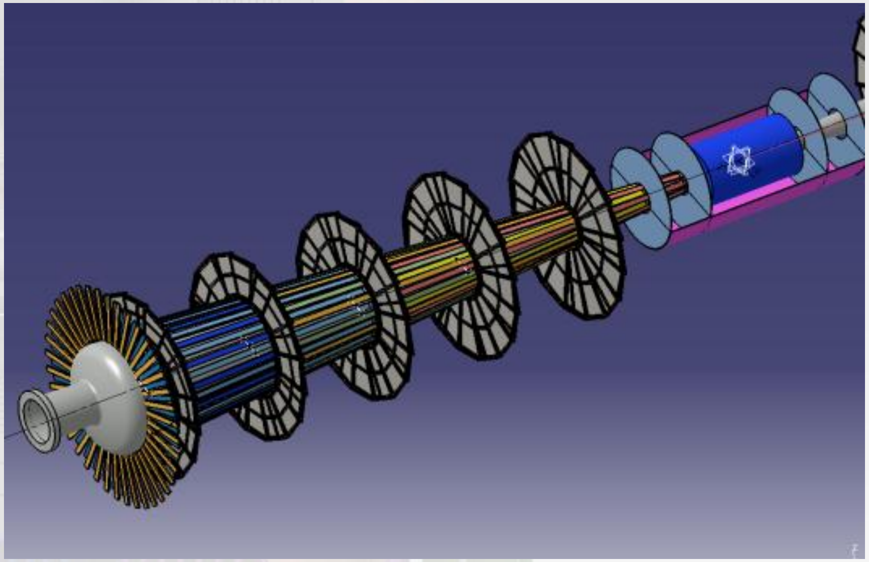
Forward Silicon

System of pixel and strip disks in the forward direction

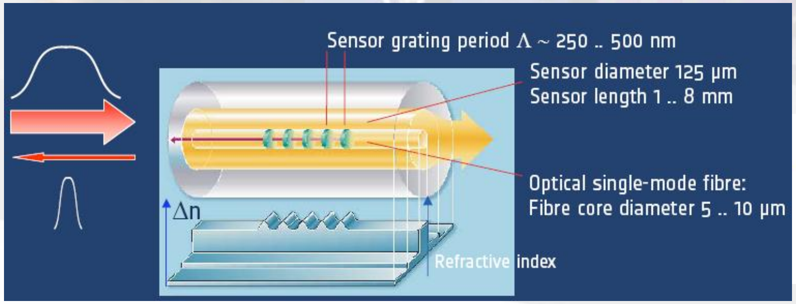
- First realistic mechanical design done
- Significant work on alignment issues

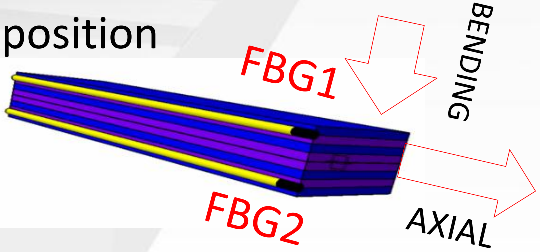
Issues

- Mechanical design
- Powering
- Cables
- Overall mechanical integration into ILD

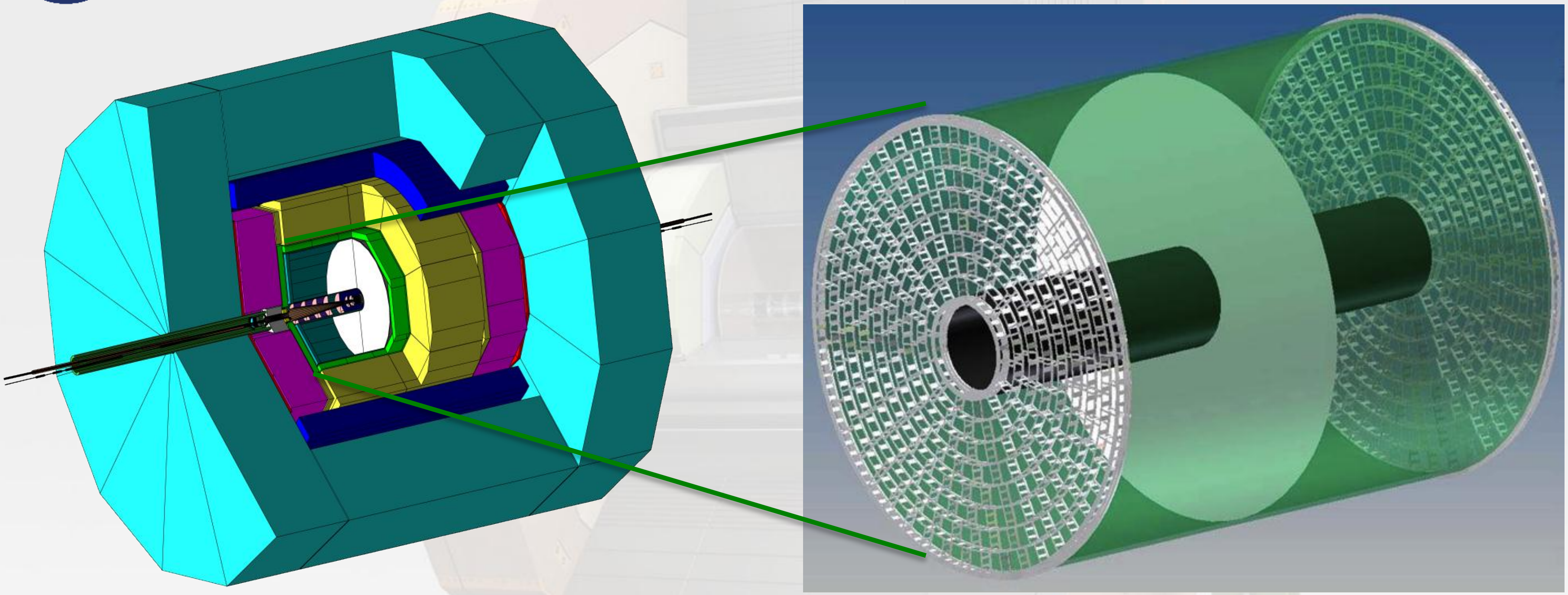


Looking at fibers with strain and T dependent refractive index to monitor position





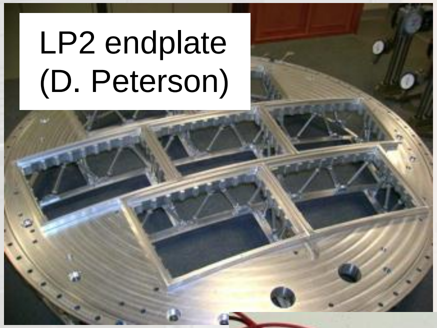
Time Projection Chamber



- TPC is the central tracker for ILD
- Large number of 3D space points allows for continuous tracking
- Offers particle identification via *dE/dx*
- Low material budget inside the calorimeters important for particle-flow
  - Expect maximum of 25% X_0 including electronics/cooling (endplate studies by D. Peterson)
  - ILD inner fieldcage with 1.2% X_0 and outer fieldcage of 2% X_0
- 3 readout schemes: GEM, Micromegas, pixel

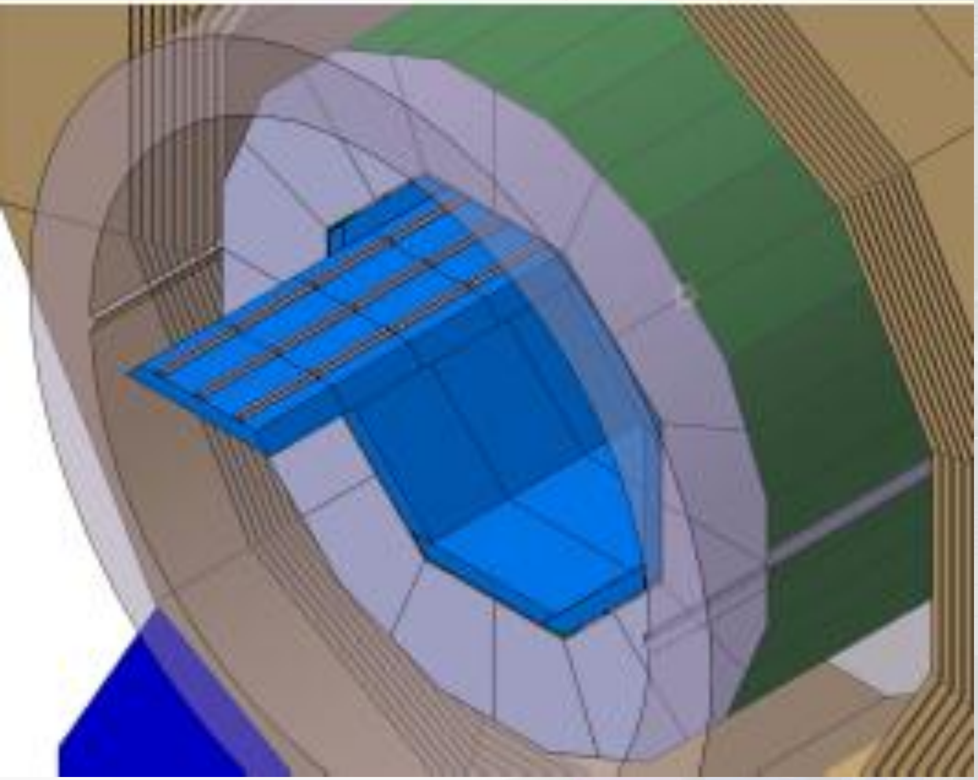
Time Projection Chamber

- LP2 endplates built & tested → good rigidity, agrees with simulation. **Space-frame design viable**.
- PCMAG upgrade completed, shipped from KEK to DESY; LP movable stage upgraded @ DESY.
- TB this summer: 7 new Micromegas modules in June/July, followed by GEM modules (DESY and Asia)



- S-ALTRO16 readout shows nice results, **power-pulsing at the chip-level**; will be implemented in LP
- New readout chip being developed: more compact, lower power consumption
- Effect of ions in gating devices understood better

Calorimeters

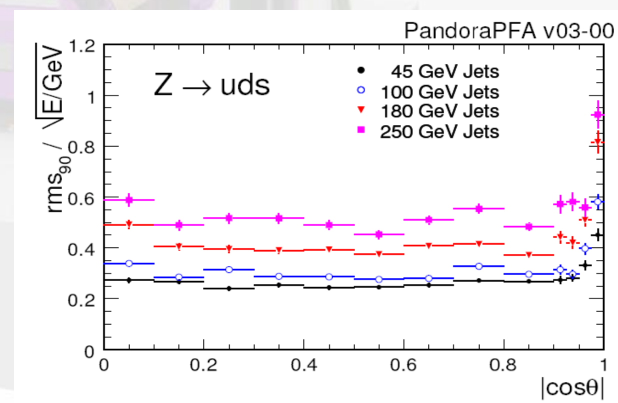


ECAL
- Tungsten as absorber material
- X_0=3.5mm, R_M=9mm. λ=96mm
- Narrow showers, compact design
- Silicon and/or scintillator as active material

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

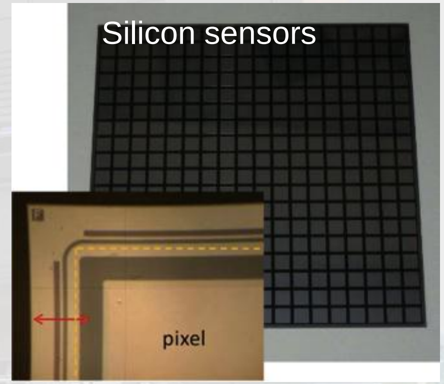
Forward Cal
- Luminosity Calorimeter (LumiCal)
- Beam Calorimeter (BeamCal)

Particle flow approach promises to deliver unprecedented jet energy resolution.

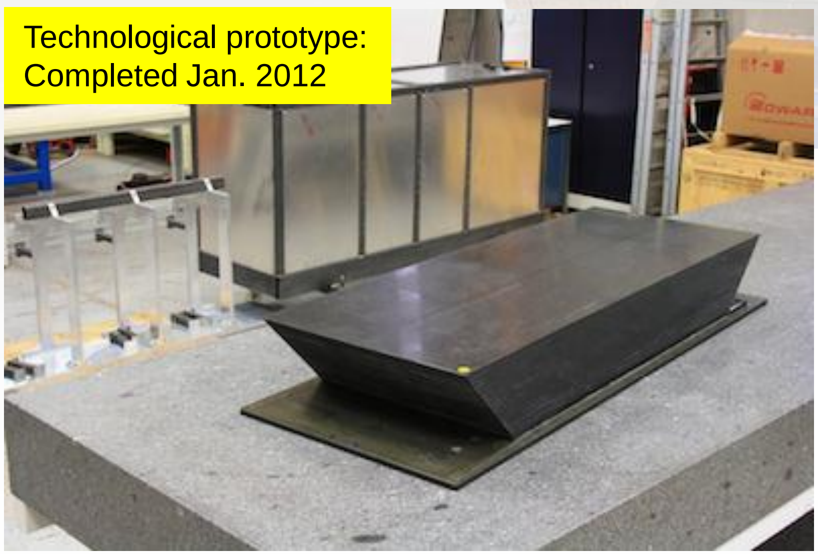


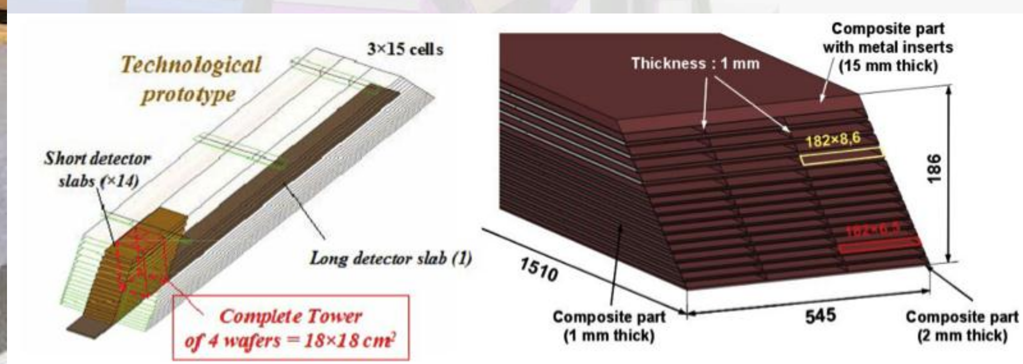
SiECAL

- Sensor R&D: reduced/modified guard ring structure, aspects of large scale production
- Readout ASIC: 35μm SiGe, 64ch/ASIC, low power (~1.5 mW/ch), produced and tested. Power pulsing test July TB
- **Technological prototype completed (Jan 2012)**: alveolar composite/tungsten structure, 15 slabs with integrated FE chips, available for TB



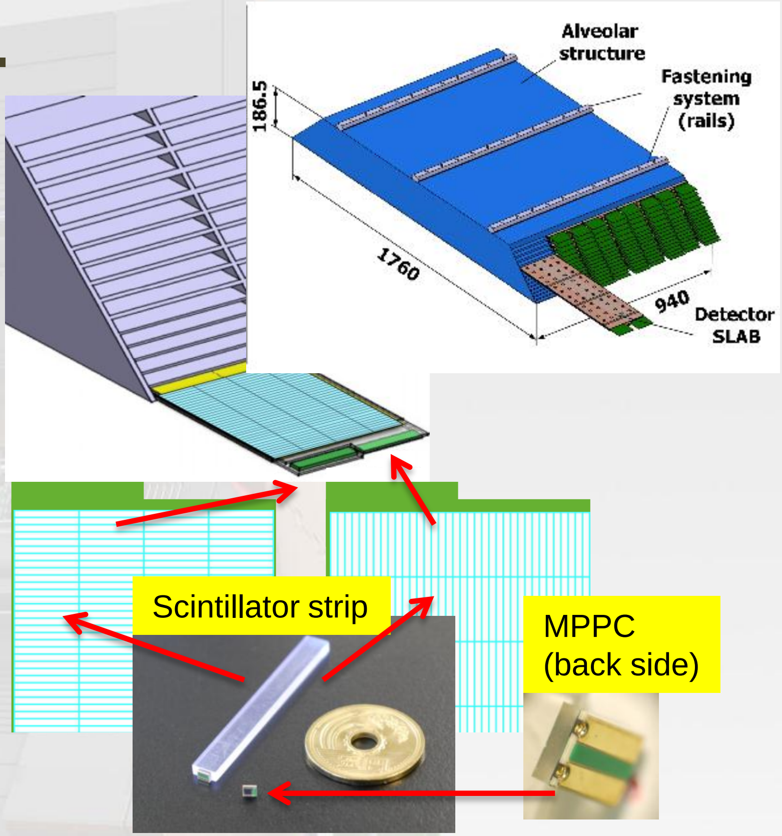
5mm x
5mm pixels


Technological prototype:
Completed Jan. 2012

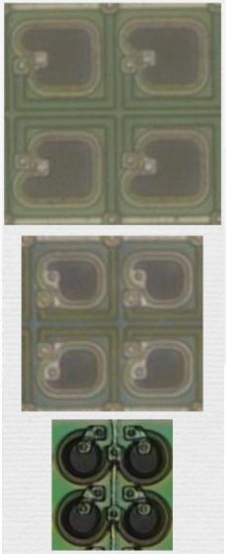


ScECAL

- Scintillator strips as (partial) alternative to silicon pads → help reduce cost of detector
- Analysis of physics prototype 2009 TB
  - after temperature correction, good linearity (<1.5%) and good energy resolution
- One-layer ScECAL **technical prototype under construction**, to be tested at DESY TB September
- Jet energy reconstruction with ***strip splitting algorithm***: performance quite good.
- Saturation in MPPC: addressed by increasing number of pixels



MPPC by HPK

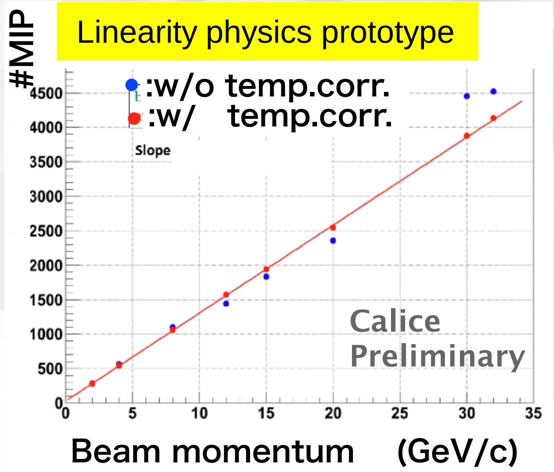


25 μm pitch 1600 pix/mm²

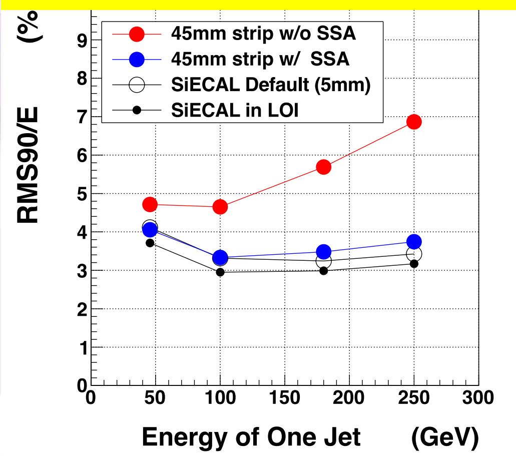
20 μm pitch 2500 pix/mm²

15 μm pitch 4400 pix/mm²

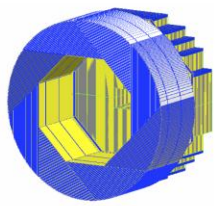
Linearity physics prototype



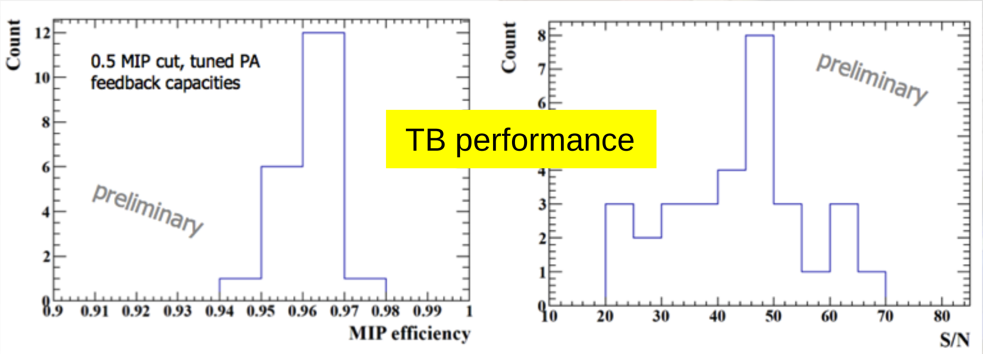
Strip splitting performance with "Si" strips

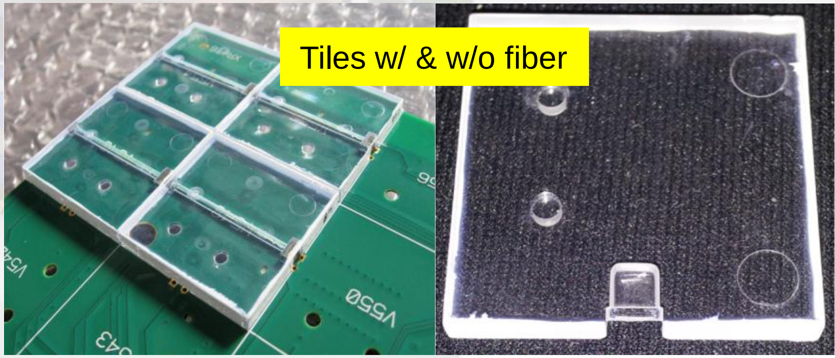


AHCAL



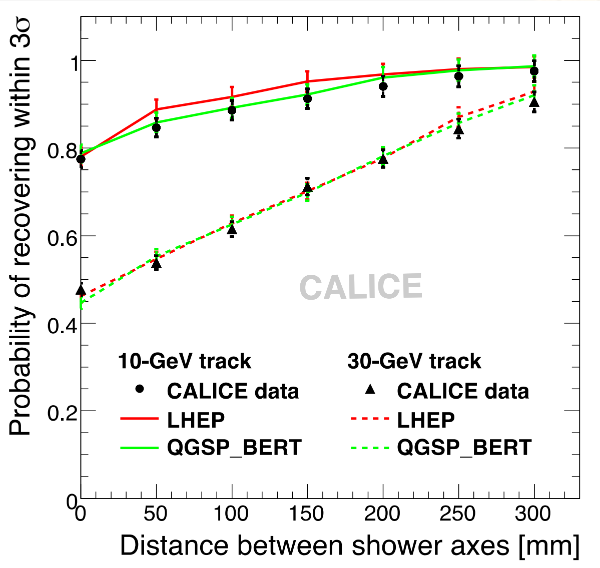
- Engineering and simulation model
  - Simulation model updated, realistic interfaces and services
  - Second version of barrel geometry implemented
- **Technological demonstrator** for ILD
  - Embedded electronics, power pulsing, zero suppression
  - Auto-trigger and gain equalization established at module level in TB
  - Full length slab test in preparation: thermal issues, scalability
  - One or two layer beam test in tungsten stack planned, fall 2012
  - Tiles and SiPMs for direct coupling with mass production technology



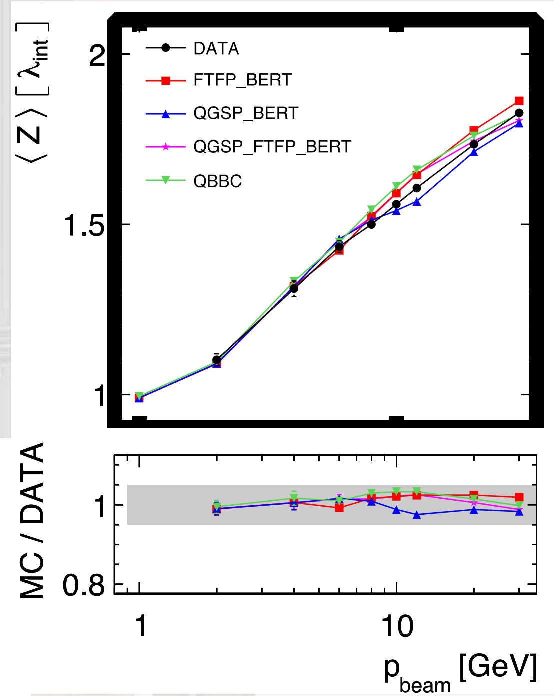


- Test beam results
  - Two particle separation with Pandora (+ECAL)
  - More in editorial boards: Geant4 validation low (2-20GeV) and high (8-80GeV) energy data, resolution with software compensation, tracks in showers

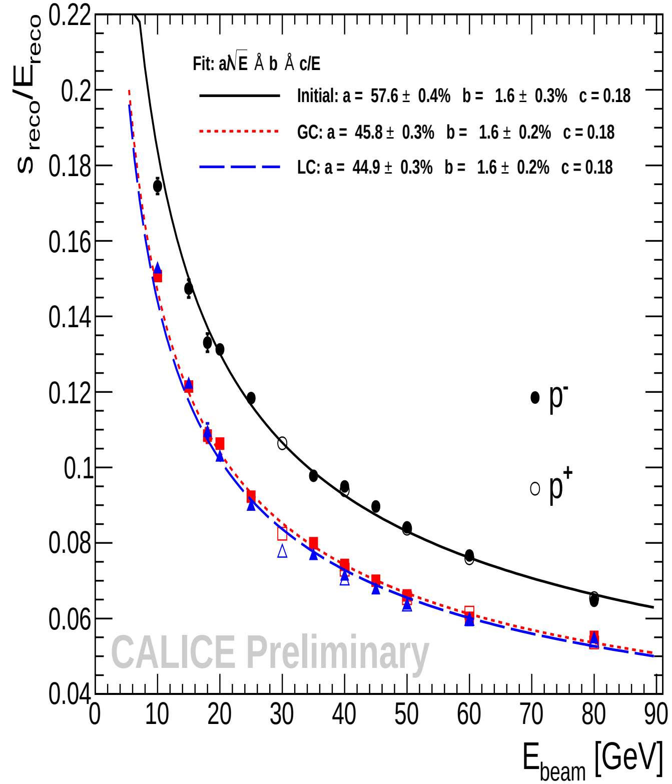
AHCAL test beam results



Two particle separation with Pandora
Published:
JINST 6, P07005 (2011)



Geant4 comparison of shower profiles from 2 to 80 GeV (publication draft)

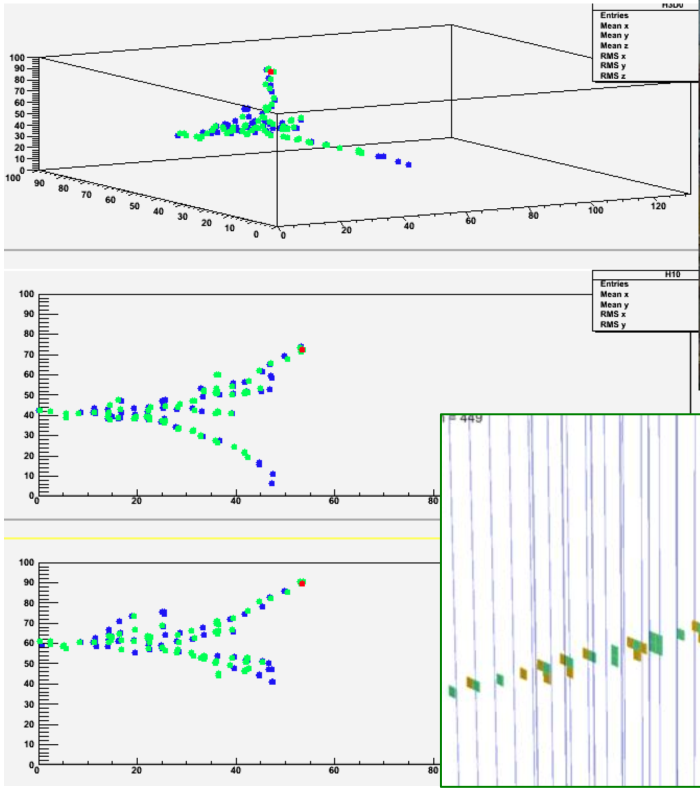


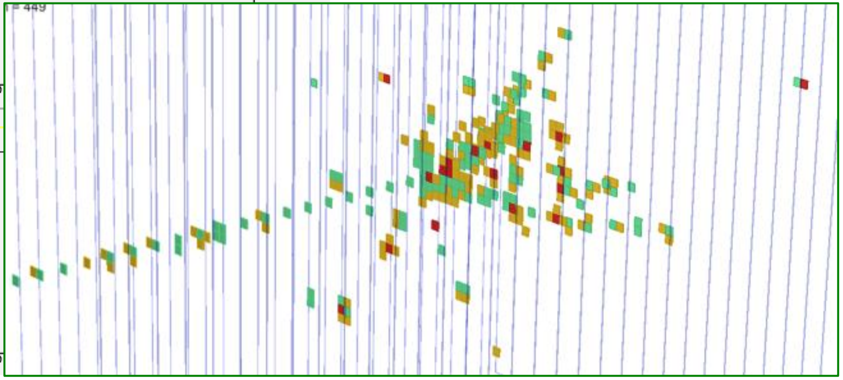
Resolution with software compensation: Improves also jet energy resolution (publication draft)

SDHCAL

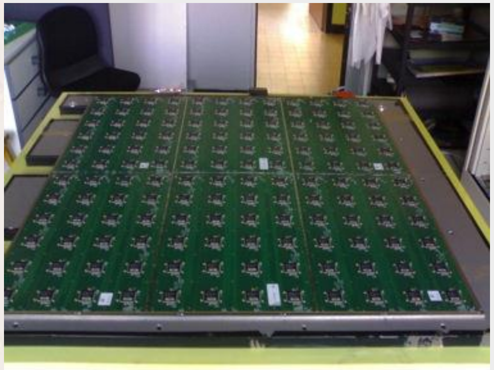
- Technological prototype
- - builds on DHCAL experience
  - – compact, reduced dead zone, self-supporting structure, **power pulsing**
- Currently in **TB** at CERN (4/20~), promising first results

10 GeV pion events from CERN-PS

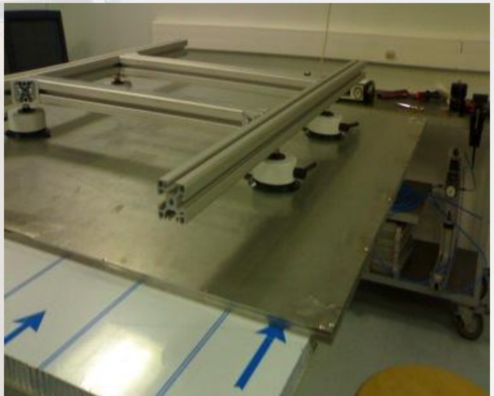




Green: ~100 fC. Blue: ~5 pC. Red: ~18 pC



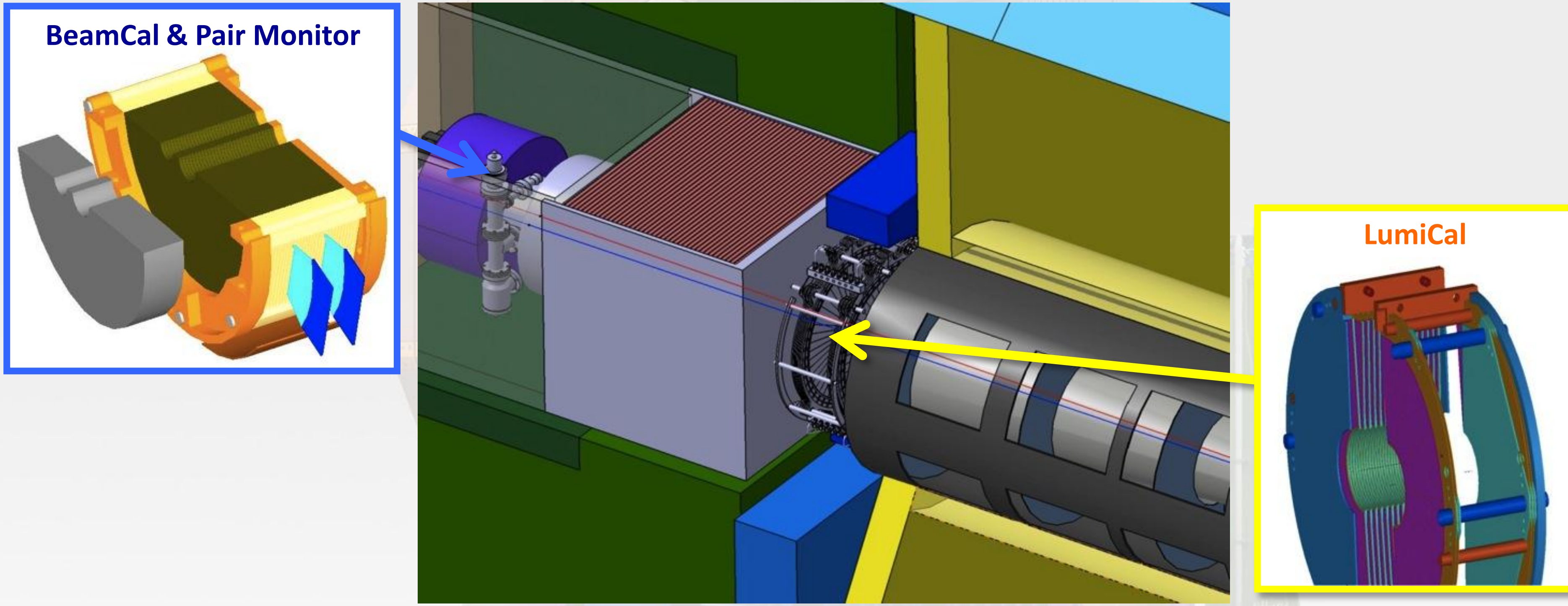
144 ASICs= 9216 channels/1m^2



6mm(active area) + 5mm(steel) = 11 mm thickness

First technological prototype 50 units (>6 λ_I) working with power-pulsing

Forward Calorimeters



Forward Calorimeters

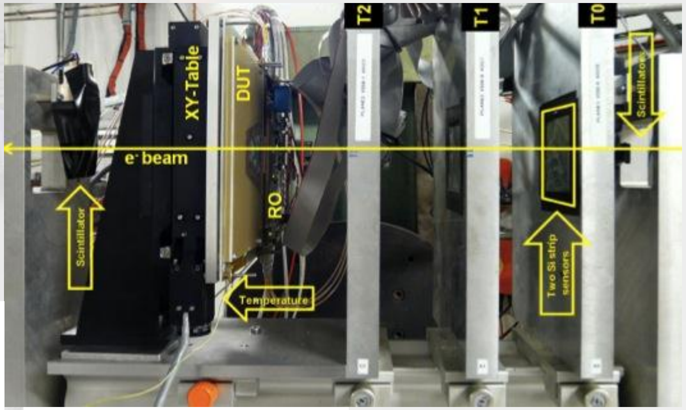
- Precise luminosity measurement
- Hermeticity (particularly electron and photon detection at low polar angles),
- Assisting beam tuning (fast feedback of BeamCal data to machine)

Challenges:

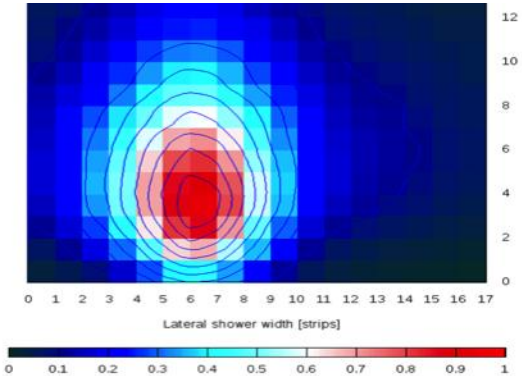
- Radiation hardness (BeamCal), high precision (LumiCal) and fast readout (both)

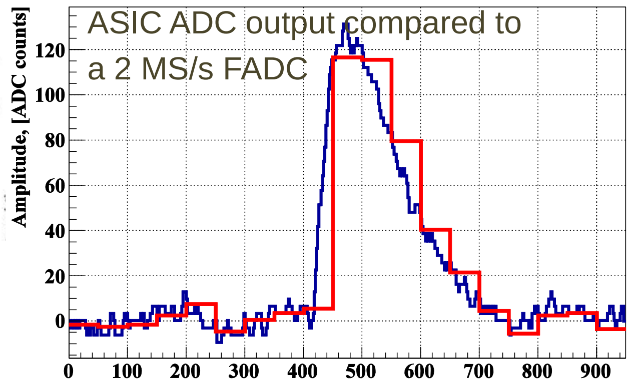
Forward Calorimeters

- TB of fully assembled sensor planes in Nov 2011 (32 channels); 50 million trigger for several areas of LumiCal and BeamCal sensors
- Data analysis ongoing; first results very promising.

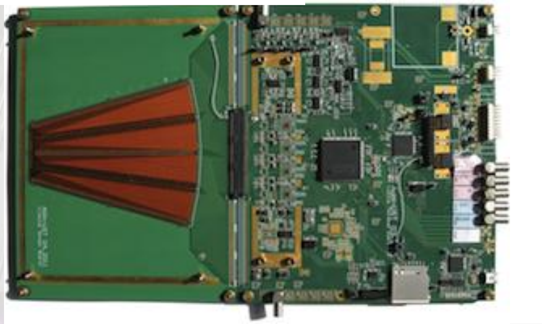


Electromagnetic shower profile measured behind 1X0 absorber



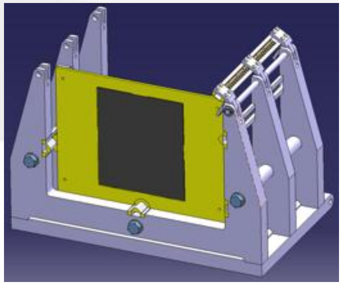


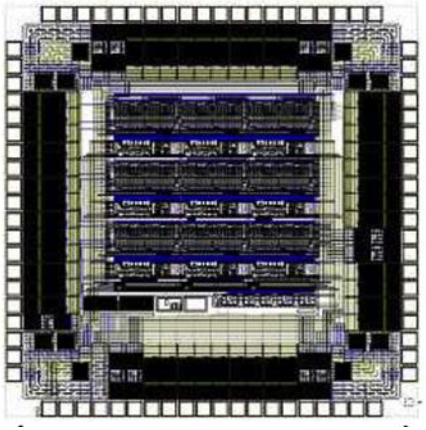
LumiCal module



Future plan: prototype calorimeter (AIDA)

- Flexible frame with tungsten absorber planes
- FE and ADC ASICs in 130 nm technology
- Power pulsing
- DAQ (ILD standard)

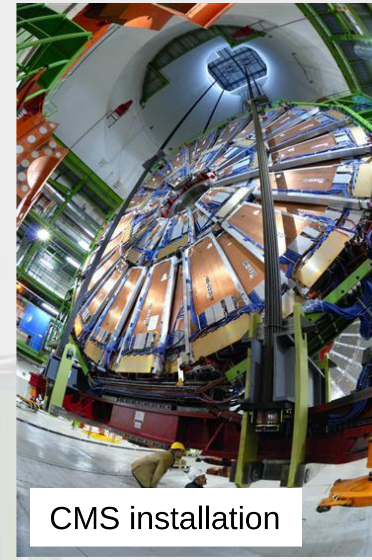




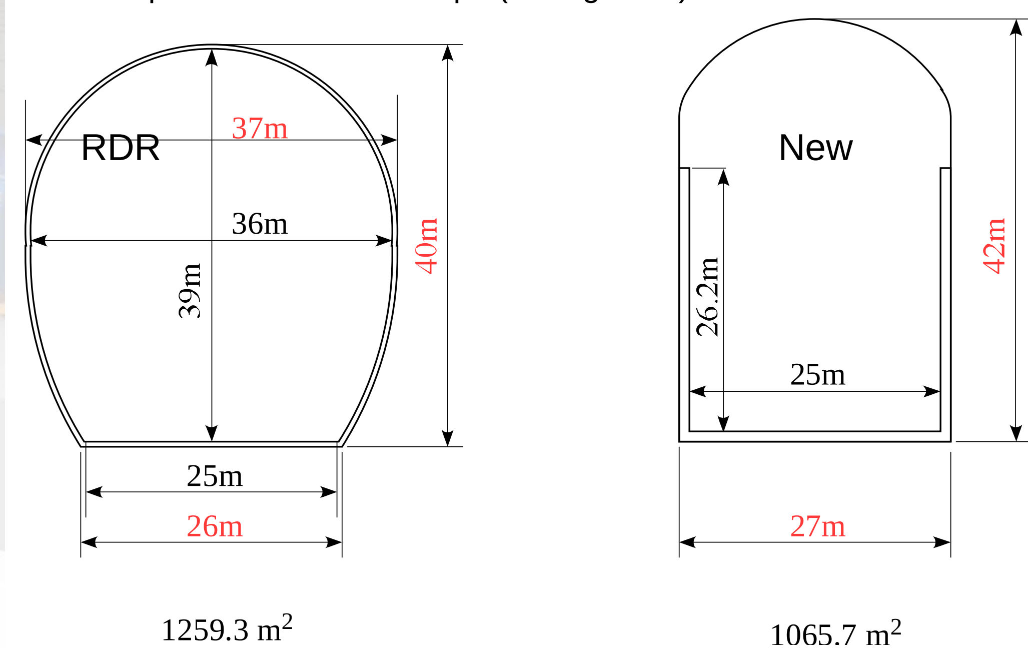
Pair Monitor prototype sensor with integrated ASIC (SoI, 200 nm technology, Tohoku University)

Integration: Site Hall

- **ILD assembly is site specific**
  - Non-mountain site: build & test on surface as much as possible, then lower into detector hall (like CMS)
  - Mountain site: **limited by horizontal access** tunnel, require underground assembly of many parts.
- Since ILD is the larger of the two, it requires more space. The shape of the assembly area is being optimized to **keep cost containment** while securing **assembly space.**

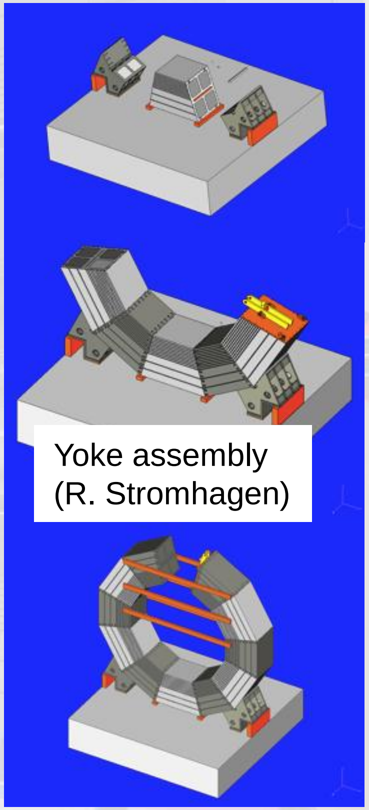

CMS installation

Comparison of cavern shape (Y. Sugimoto)

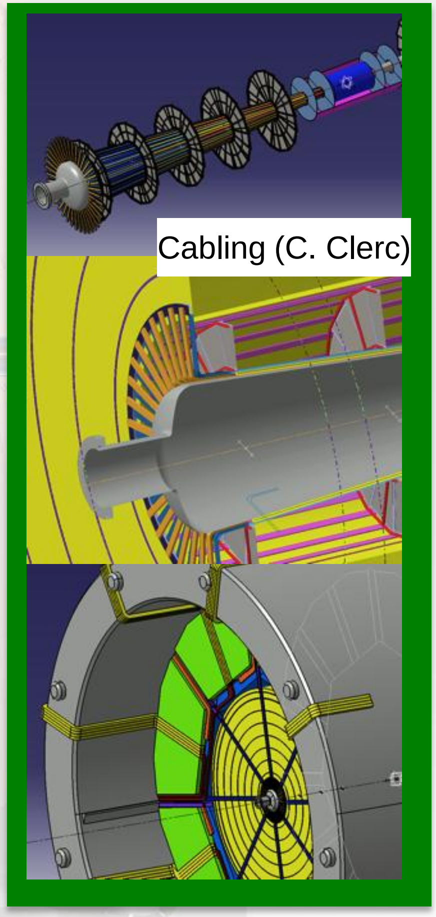


Integration: Detector Assembly

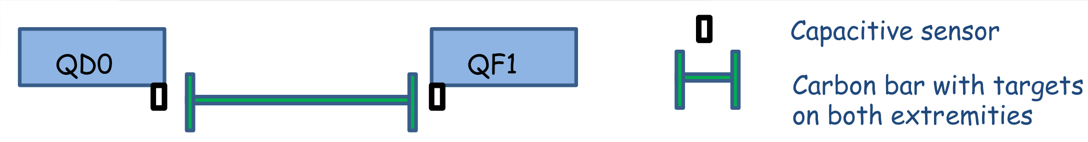
- Rigidity of mechanical structure (both detector and support material) is checked with simulations (FEA)
- Cooling options: leak-less water and/or gas for calorimeters. Requires space.
- Estimation of services (cables and patch panels, etc) from power requirements and geometric constraints
- Precise alignment of the innermost detectors by a common support structure. Needs hardware monitors, which requires access.
- QD0 magnet alignment: working with CLIC experts; they deal with much tighter requirements.



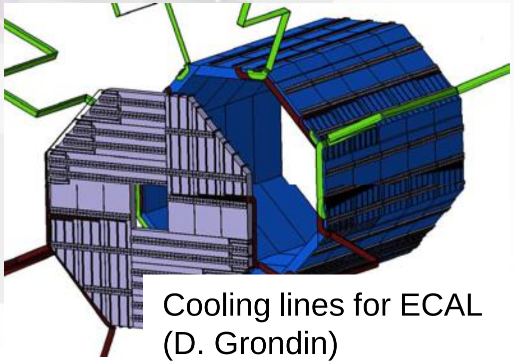
Yoke assembly (R. Stromhagen)



Cabling (C. Clerc)



(H. Mainaud Durand, for CLIC)

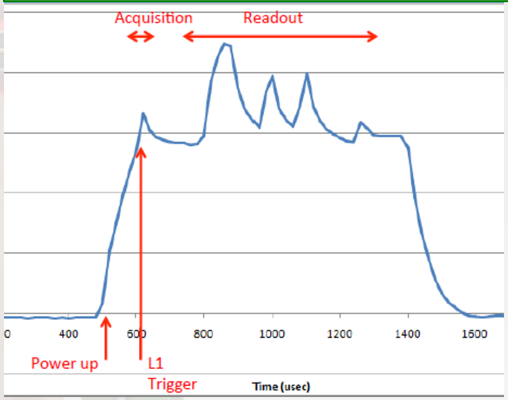


Cooling lines for ECAL (D. Grondin)

Common issue: Power Pulsing

S-ALTRO16

TPC: S-ALTRO16 power pulsing (M. De Gaspari)



Power pulsing is an essential part of many sub-detectors.

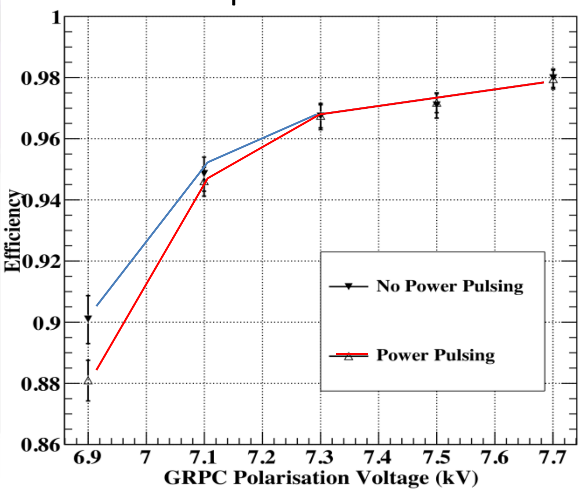
Since LOI significant progress in understanding power pulsing:

VTX: demonstrated for some technologies (DEPFET)

TPC:
- design of readout for power pulsing ongoing (AIDA project)

HCAL:
- AHCAL
- SDHCAL: system test of power pulsing in magnetic field successfully performed
- Recent test beam activities with power-pulsed readout

SDHCAL operation in B field



Costing

Update compared to the LOI:

chapter	LoI	revised	
Magnet yoke	68.4	**80.4**	
Magnet coil	47.6	54.5	
Magnet ancillaries	11.0	15.1	
AHCal / DHcal	48.3	33.3	This is for the AHCAL
Si-Ecal	112.0	**190**	164 with more realistic price
Si tracking	21.6	inner 2.3 outer 23.0	
Vertex	2.9	3.1	
TPC	34.3	36.9	
Forward calorimeter	5.3	5.7	
Muon	8.4	9.0	
Beam tube	1.6	0.6	
Integration	1.7	1.8	
Global DAQ	1.2	1.3	
Transport	13.0	14.0	

----

471 MILCU

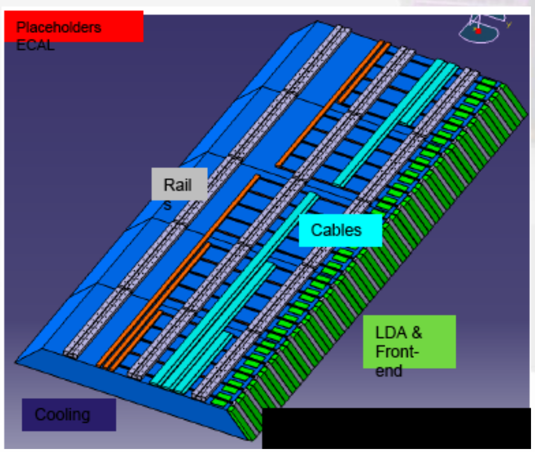
Offline computing 30.0

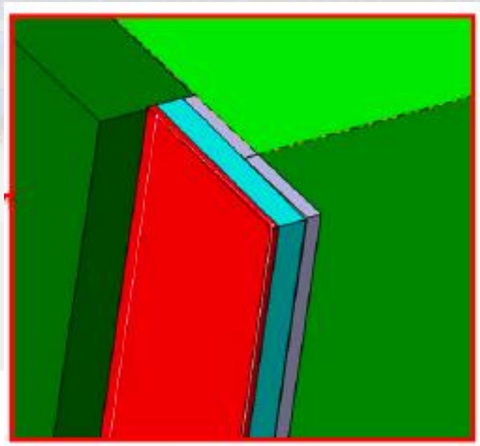
Software/ Reconstruction

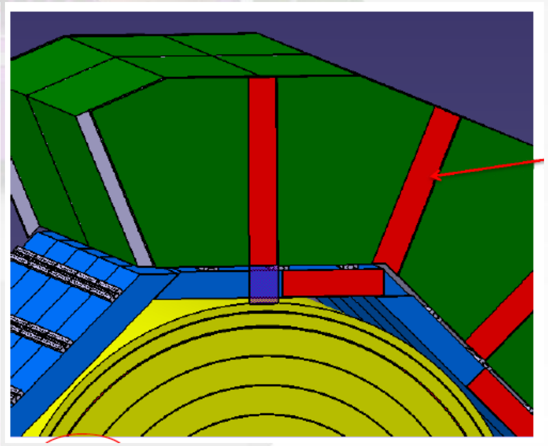
Ambitious upgrade program compared to the LOI

- Much more realism in most detectors
- Serious effort to include dead material, cracks etc.
- Complete rewrite of the tracking software
- Rewrite of the LCFI secondary vertex software
- Rewrite of the Pandora PFA software
- Added more capabilities to include background
- Numerous smaller changes and updates

Have profited greatly from CLIC and the CDR effort.



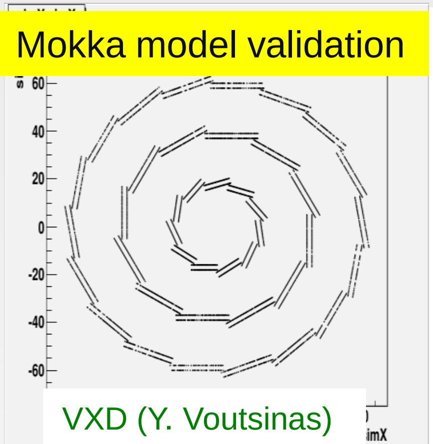




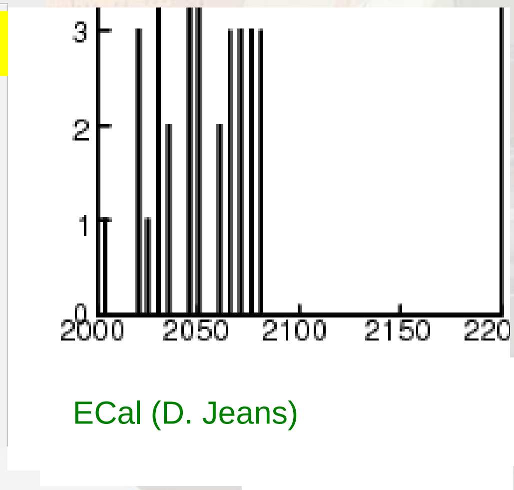
Software Validation

- Mokka models implemented, ***considerably improved realism*** → start validation
  - ILD_o1_v02: simulation model for DBD using SiW ECAL + AHCHAL
  - ILD_o2_v02: simulation model for DBD using SiW ECAL + **SDHCAL**
  - ILD_o3_v02: simulation model for DBD using **SciW ECAL** + AHCAL

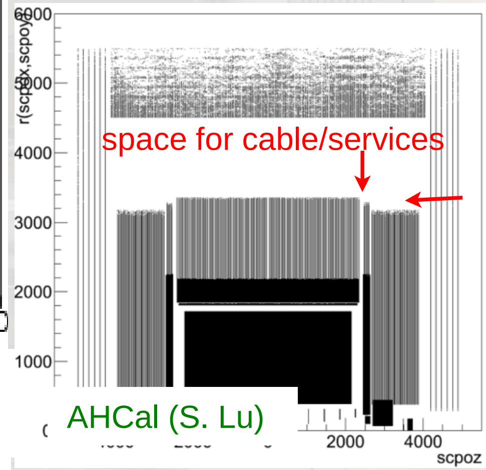
Mokka model validation



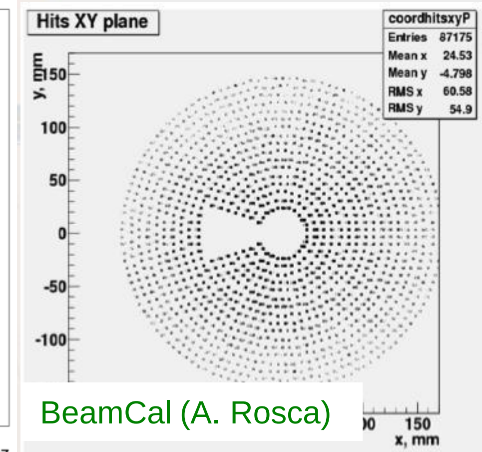
VXD (Y. Voutsinas)



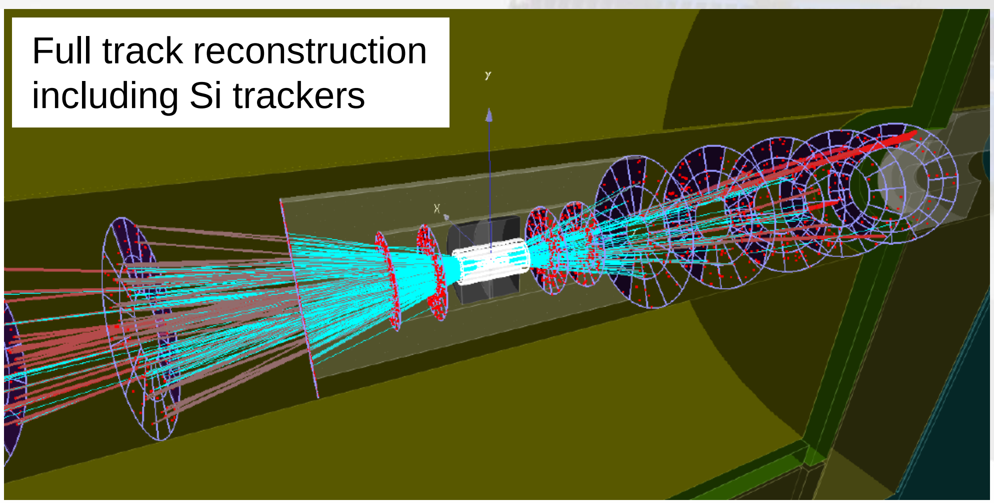
ECal (D. Jeans)



AHCal (S. Lu)

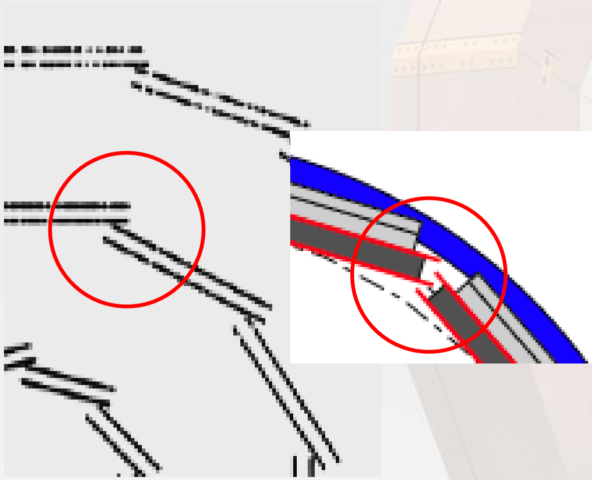


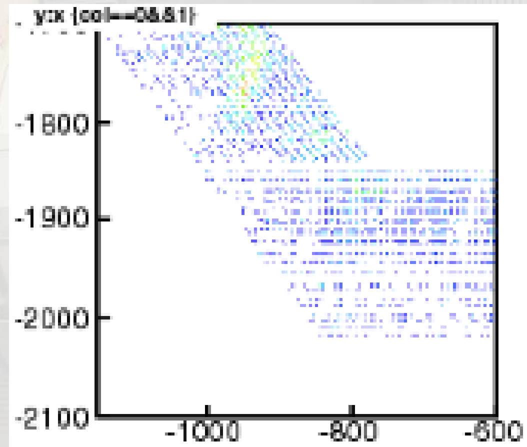
BeamCal (A. Rosca)


Full track reconstruction including Si trackers

- Rewrite of tracking code to cope with background
- Next steps:
  - validate tracking → calibrate PandoraPFA → optimize LCFIPlus
  - Start mass production

ILD Model and Reconstruction

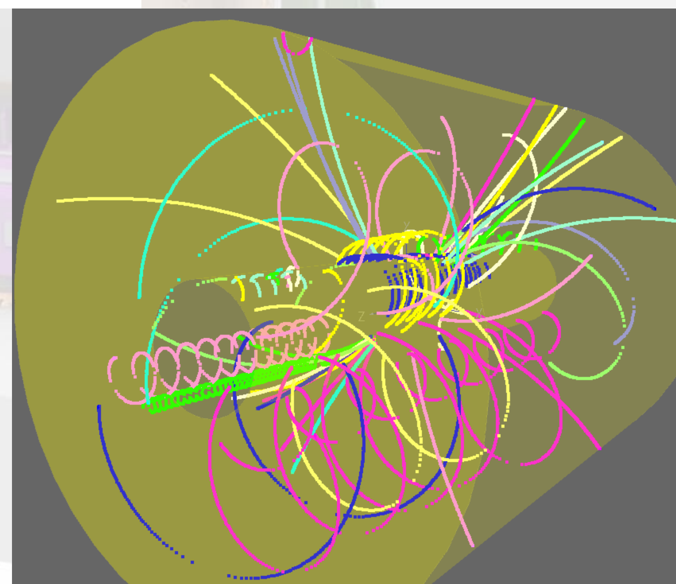




Detailed validation of the simulation ongoing, comparison to R&D

Significant new reconstruction developments are part of the new software:

Example: complete re-write of the tracking



DBD Benchmark Processes

- In the ILD DBD, the Performance chapter will describe the benchmark processes
- As a reminder, the benchmark processes that will be studied by both ILD and SiD are:
  - $e^+e^- \to \nu\nu h^0$ at E_{CM}=1 TeV with a SM Higgs with m_H=120 GeV, in the final states $h^0 \to \mu^+\mu^-$, bb, cc, gg, WW^*. The goal is to measure the cross section times branching ratio.
  - $e^+e^- \to W^+W^-$ at E_{CM}=1 TeV, considering both hadronic and leptonic (e, μ) decays of the W. The goal is to use the forward W pair production cross section to measure in situ the effective left-handed polarization.
  - $e^+e^- \to tth^0$ at E_{CM}=1 TeV with a SM Higgs with m_H=120 GeV, in the final state $h^0 \to bb$. The reaction involves the 8 jet mode and the 6 jet + lepton mode. The goal is to measure the Higgs boson Yukawa coupling to tt.
- In addition, repeat one analysis from the 2009 LOI using the final detector configuration and up-to-date simulation software.
  - ILD has chosen ***tt*** at 500 GeV.
- ILD will also update:
  - Higgs self-coupling measurement ***Zhh*** at 500 GeV
- The DBD benchmark processes are covered well.

Analysis will be carried out by:

NDU + KEK

DESY

Birmingham + KEK

LAL

KEK + Tokyo

Physics Studies with ILD

For DBD

Analysis using ILD Full Simulation	Main Analysts	Institution
Measurement of BR(H->bb,cc,gg) at 250 GeV	Hiroaki Ono	Nippon Dental University
Measurement of BR(H->WW*,ZZ*) at 250 GeV	Hiroaki Ono	Nippon Dental University
Measurement of BR(H->gamma+gamma,gamma+Z) at 250 GeV	Constantino Calancha	KEK
Higgs BR measurements with nunuH at 1 TeV	Hiroaki Ono	Nippon Dental University
	Constantino Calancha	KEK
Measurement of Higgs self coupling at 500 GeV	Junping Tian	KEK
	Taikan Suehara	ICEPP, The University of Tokyo
Top Yukawa coupling at 500 GeV	Hajrah Tabassam	Quaid-i-Azam University, Islamabad
	Ryo Yonamine	Sokendai/KEK
Top Yukawa coupling at 1 TeV	Tony Price	University of Birmingham
	Ryo Yonamine	Sokendai/KEK
WW at 1 TeV	Aura Rosca	DESY
Precision measurement of Higgs couplings to gauge bosons at 500 GeV	Junping Tian	KEK
Top pair analysis at 500 GeV	Jeremy Rouene	LAL
	Marcel Vos	IFIC Valencia
Measurement of Higgs total decay width at 250 GeV	Claude Duerig	University of Bonn
Triple gauge couplings and polarization at 500 GeV	Ivan Marchesini	DESY
Very light gravitino with stau NLSP at (500 GeV + threshold scans)	Ryo Katayama	The University of Tokyo
Bilinear R-parity violation SUSY (500 GeV)	Benedikt Vormwald	DESY
Model-independent WIMP characterization (500 GeV)	Christoph Bartels	DESY
Measurement of CP Violation in the MSSM Neutralino Sector (500 GeV)	Mark Terwort	DESY
Mass degenerate Higgsinos in Hidden SUSY (500 GeV)	Hale Sert	DESY
Chargino / Neutralino -> W / Z + LSP (500 GeV)	Madalina Chera	DESY
Full study of an MSSM scenario with rich (SPS1a'-like, but not LHC excluded) ILC phenomenology (500 GeV + threshold scans)	Mikael Berggren, Stefano Caiazza, Nicola d'Ascenzo	DESY

All performed in ILD full simulation!

Some studies currently use LOI samples.

ILD Workshops

Next week: Kyushu Workshop, May 22-25th 2012
(with visit to Sefuri mountain site)

Summary and Conclusions

ILD is en route to deliver the DBD at the end of this year

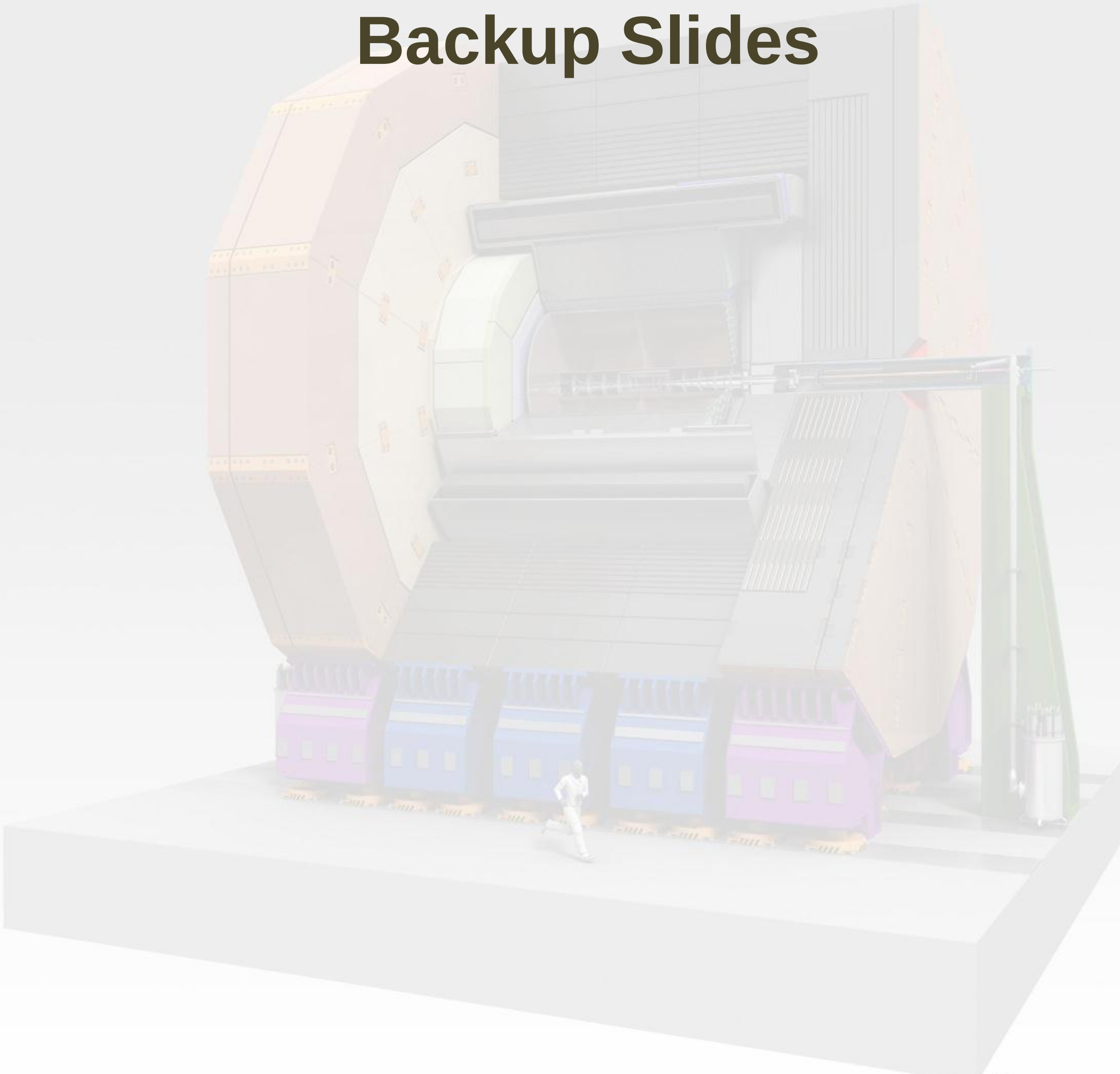
Significant progress on many systems

- Wide ranging test beam program in collaboration with the R&D collaborations
- Significant progress in the software representation of ILD and its reconstruction
- Intense effort to understand and develop the overall ILD integration
- DBD space (150 pages) will be tight to fully acknowledge all aspects

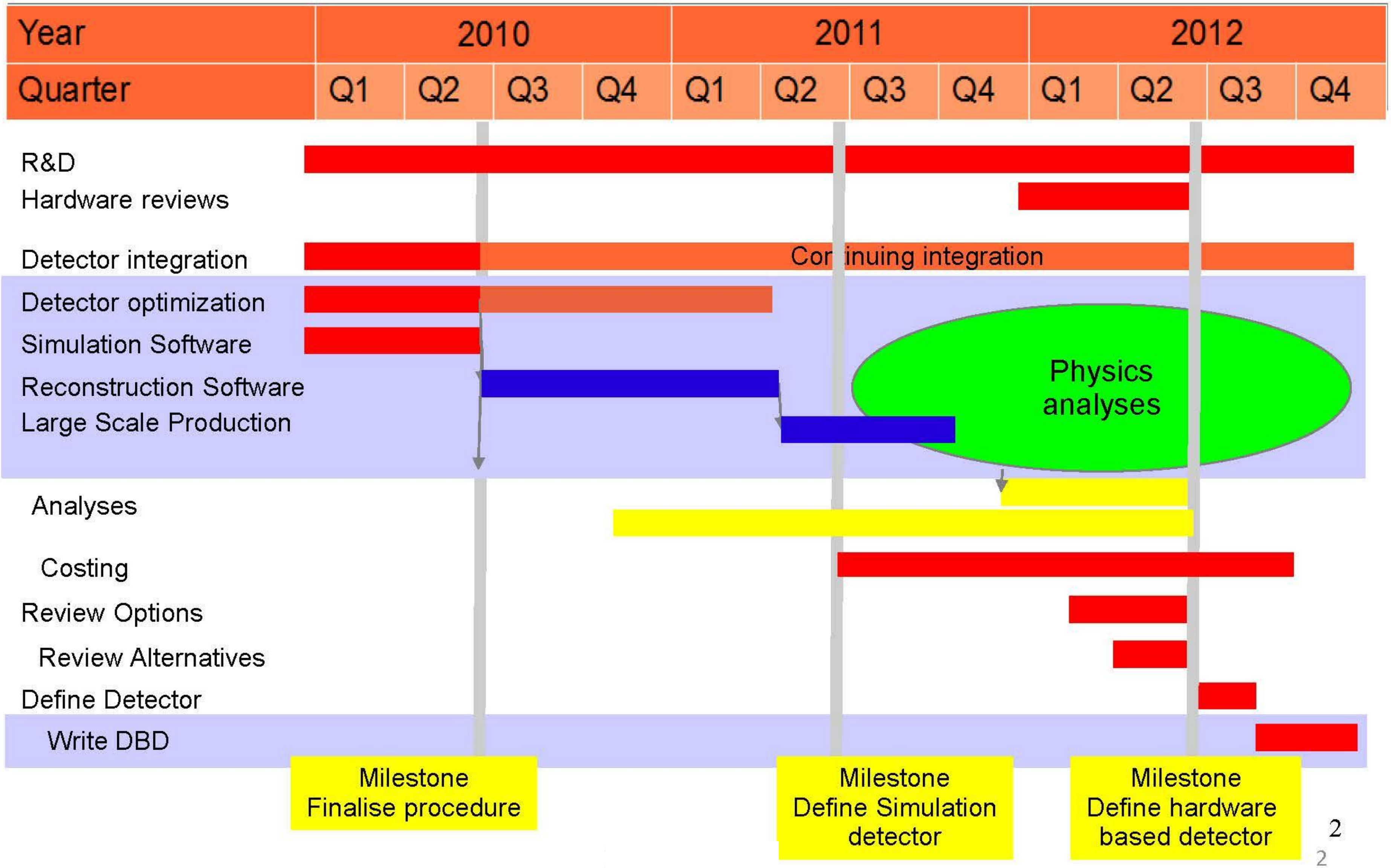
Compared to our original goals:

- Significantly less overall engineering
- Overall more or less on track on technology developments
- Some systems lost significant support since the LOI
    - VTX (UK effort disappeared)
    - SI tracking

Backup Slides



ILD Timeline



Important Milestones

- Simulation baseline:
  - Code freeze: end of December 2011
  - Material description: end of January 2012
  - Validation: started February 2012

- Reconstruction code
  - Release December 2011
  - Software validation: January- April 2012: ongoing

- Start of mass production:
  - Planned for May 2012

- Towards the detector baseline

  - Discussions within the subdetector groups / R&D collaborations: -> May 2012
  - Discussions on baseline defitintion: ILD meeting May 2012

- Analyses
  - Final results during summer/ fall 2012: last deadline for contributions: LCWS2012 in Arlington

DBD milestones

- Define DBD outline: January 2012
- Define DBD editors and chapter editors: 15.2.2012
- Setup technical infrastructure etc.: 31.2.2012

- Extended outline: 30.3.2012

ACFA meeting March 2012:
Present DBD sceleton to IDAG

- Start writing the “general” chapters: April 2012
- Deadline first draft for chapters: 30.6.2012
- Complete first draft for circulation: 30.8.2012
- First complete draft for review by IDAG: 30.9.2012

- Last possibility for “new” input: 15.11.2012

In particular the physics and results sections will be incomplete at this time!

- Final draft for circulation: 15.12.2012

DBD Philosophy

DBD should describe the ILD detector concept

- complete, not only an extension of the LOI
- Self contained with the exception of overall topics like push – pull
- Due to the page restrictions cannot be too detailed: backup material?

Common sections:

- Push-pull and hall issues which are common with SiD
- Beam instrumentation issues: energy measurement, polarization

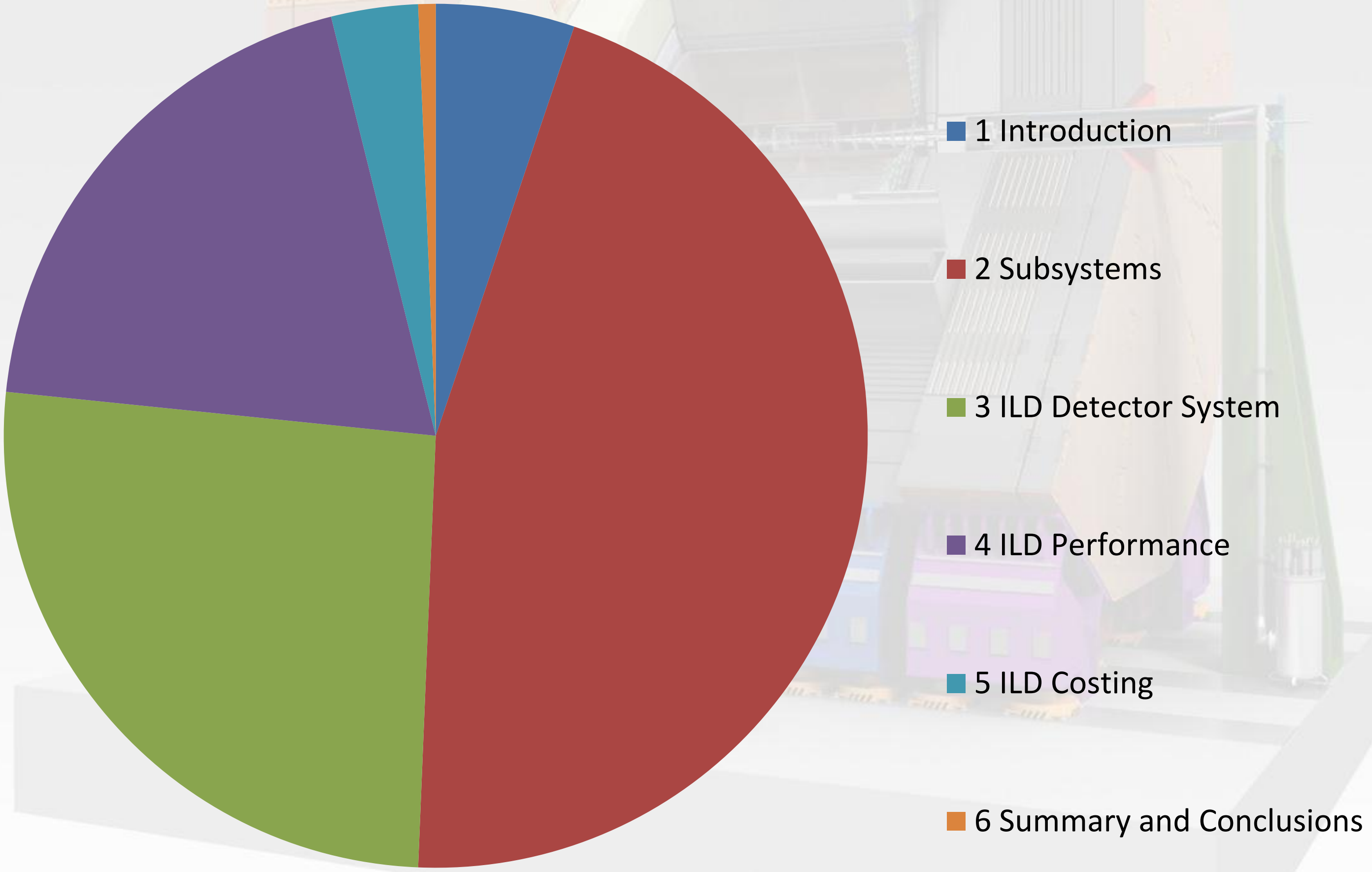
Given the uncertain future of the detector concept work we see the DBD as a preliminary but important report summarizing and documenting the work done for ILD.

Overall Structure

Common Section
- general discussion
- MDI issues
- Beam instrumentation issues

ILD (150 p)
- Introduction (5 p)
- Sub Detector Systems (69 p)
  - Technological discussion of the systems, including options and alternatives
  - System aspects as long as they are specific to this one system
- Detector integration (40 p)
  - Overall integration issues, mechanical concept
  - DAQ
  - Coil
- ILD Performance (30 p)
- Costing (5 p)
- Summary (1 p)

DBD layout


1 Introduction
2 Subsystems
3 ILD Detector System
4 ILD Performance
5 ILD Costing
6 Summary and Conclusions

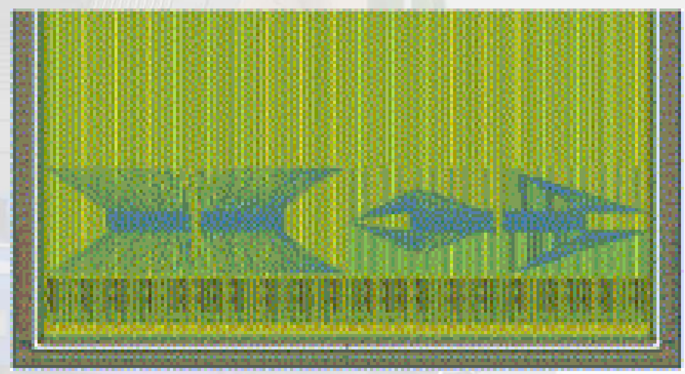
Silicon Tracking

ILD has rather extensive Silicon System:

- Inner Silicon (SIT, FTD) as an integral part of the precision tracking
- Outer Silicon (SET, ETD) to support tracking and alignment

Key issues:

- Sensor design
  - Edge-less sensors
  - Integrated pitch adapter
  - Power and speed
- Overall design
  - Material budget
  - Power
  - Alignment



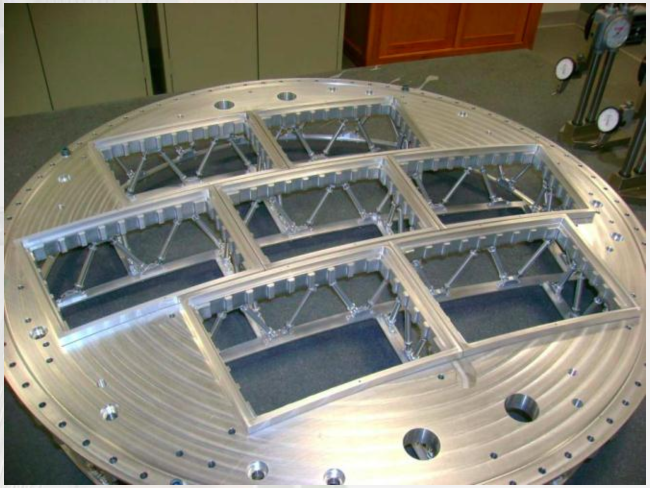
IPA in a second metal layer

LC research at the moment is taking a back seat
(only very little funding left)
LHC research is pushing the field, we profit from this

TPC

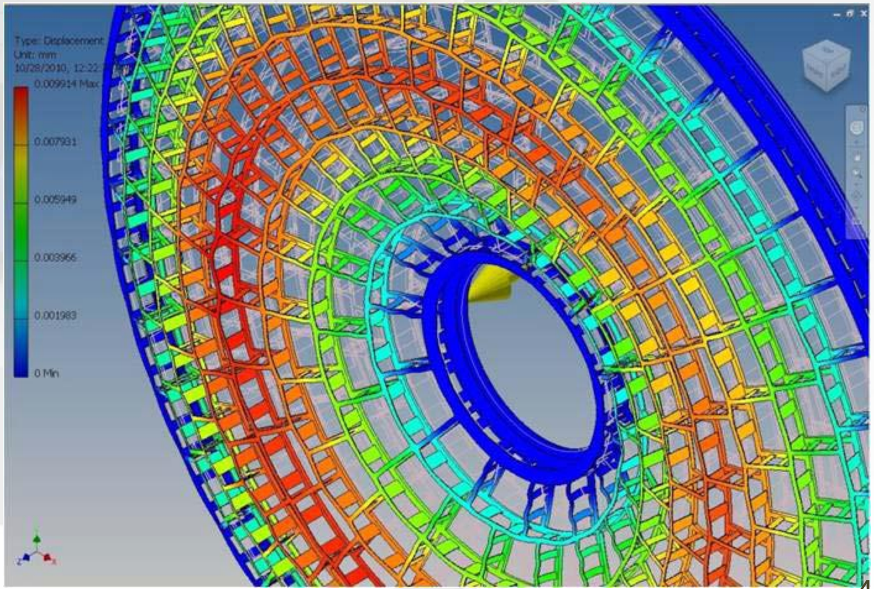
Test beam effort driven by LC-TPC collaboration very active:

- Resolution demonstrated
- GEM, Micro-Megas technologies validated
- Pixel technologies demonstrated



Significant progress on mechanical design:

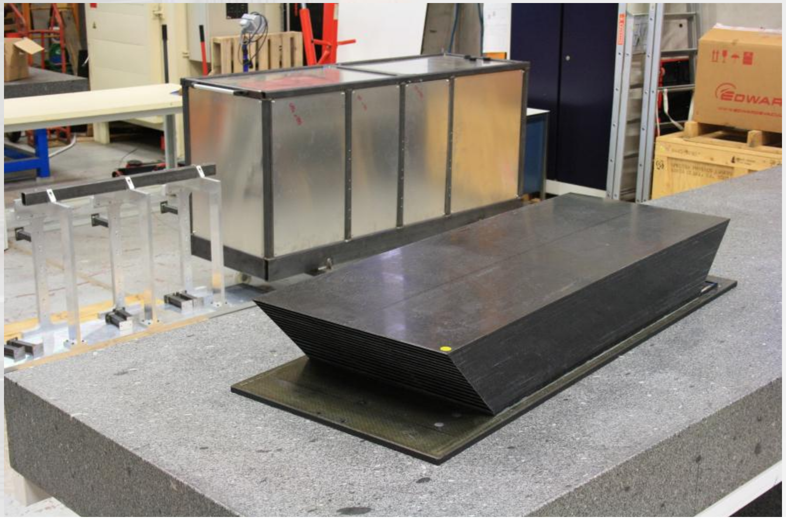
- Realistic endplate design
- Realistic fieldcage properties
- Open: cathode design
- Support design under way



ECAL

Si-W ECAL

- Performance validated
- Mechanical concept validated
- Power pulsing to be tested soon
- Integration into ILD ok

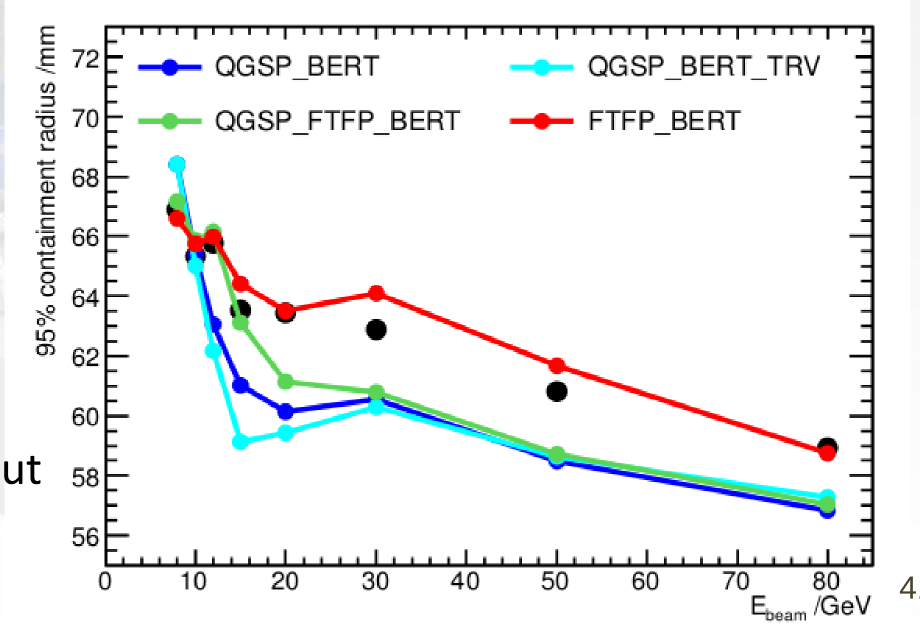


Scintillator ECAL making progress

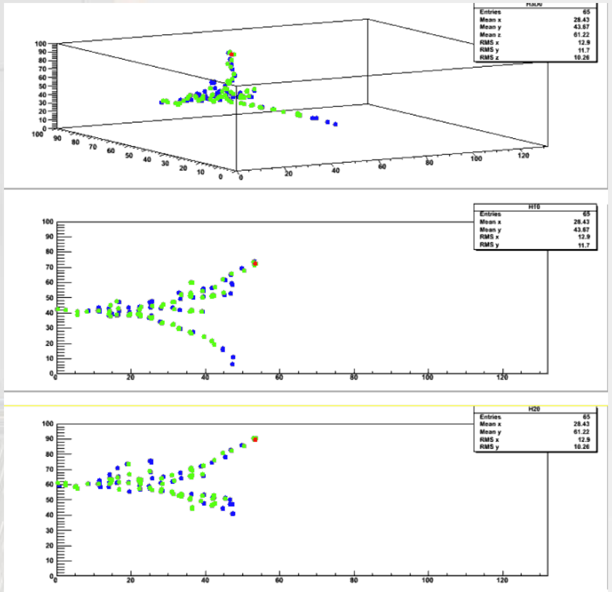
- Proof of principle done
- Test beam effort of larger scale planned in the near future

MAPS based ECAL

- Activities have ceased due to funding cut
- First results look promising



HCAL



Picture of an event from the SDHCAL 2012 test beam

2 fundamentally different technologies pursued

- Analog HCAL (scintillator read-out by SiPM)
- Digital HCAL (fully or semi-digital) based on RPC

Both technologies have seen significant test-beam

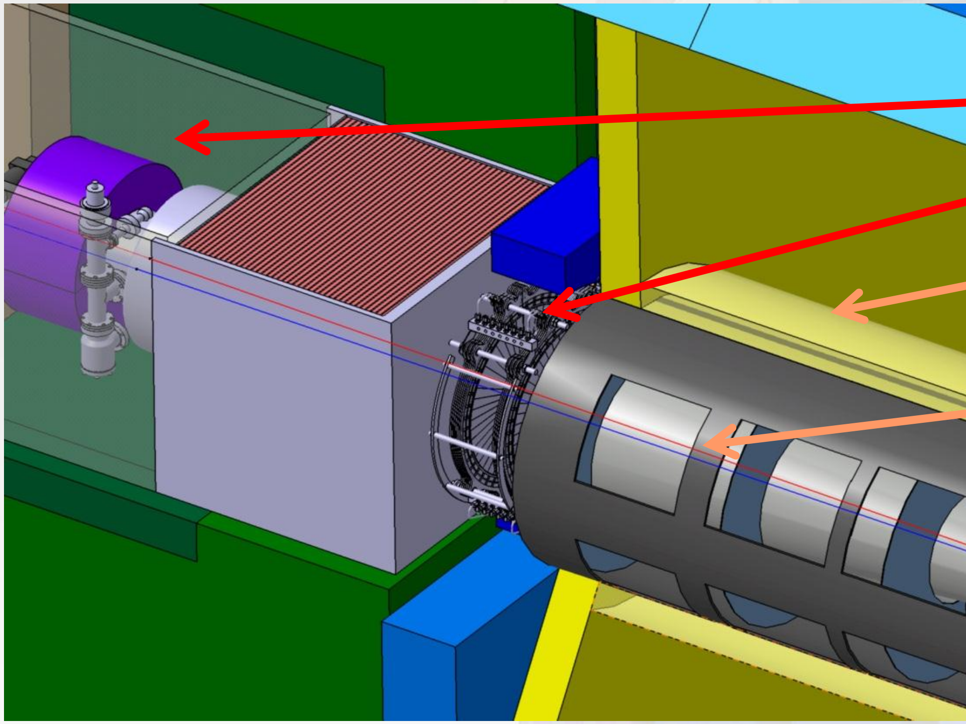
- Large amount of data for the analog HCAL have been taken and analyzed to understand the system in quite some detail
- Test beam campaign with semi-digital prototype (which includes realistic engineering, integrated readout, power pulsing have recently been successfully started

Both technologies are pursued as options within ILD

The CALICE collaboration is still strongly committed to both ECAL and HCAL technologies and supports ILD strongly (and SiD and CLIC)

Calorimeter for ILC

Forward Instrumentation



Good progress on overall system design

- Prototyping
- System tests
- Sensor tests

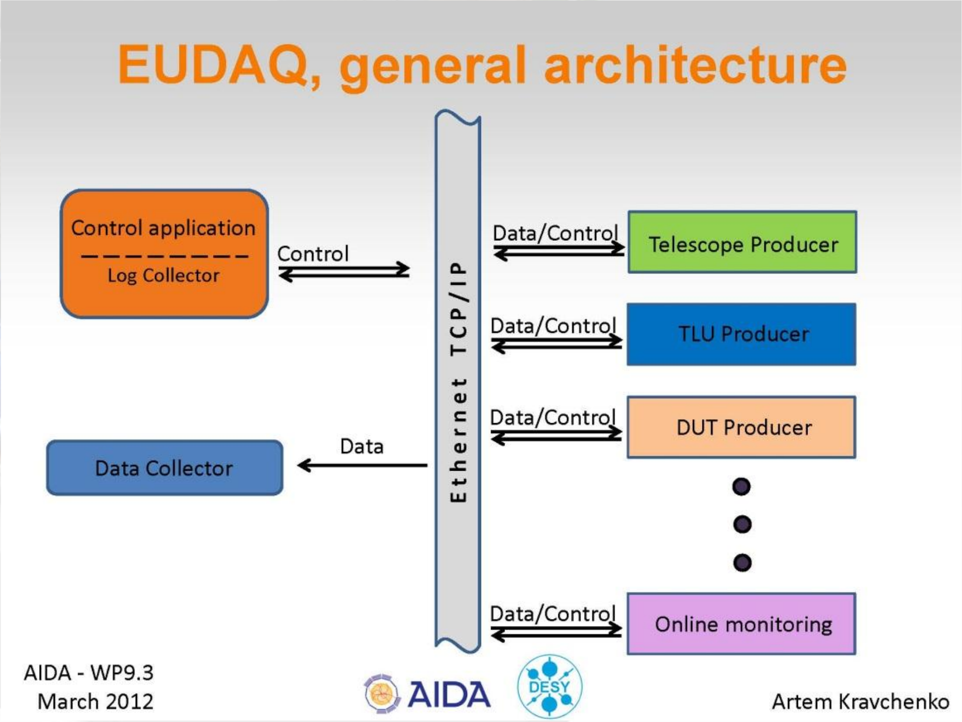
Close cooperation with LHC
Close cooperation between
ILD, SiD and CLIC on this system.

DAQ

Dedicated DAQ effort within ILD at the moment has stopped

but its state has been documented.

Effort is concentrating on the development of an generic test beam DAQ based on a project within AIDA as a follow up to EUDET.



ILD MDI

Push-Pull

- Common push-pull movement system with SiD and ILD
- Common integration into the hall

Hall

- Realistic layout of the hall footprint for several site options.
- Study done with particular emphasis on its impact on costing

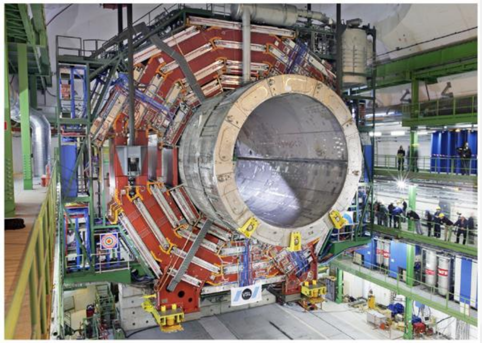
ILD

- Overall detector integration concept being worked out
- Asian site offers significant differences to “standard” site: start to understand its impact.

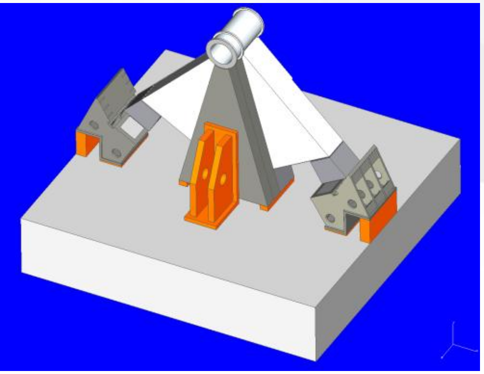
Hall Design

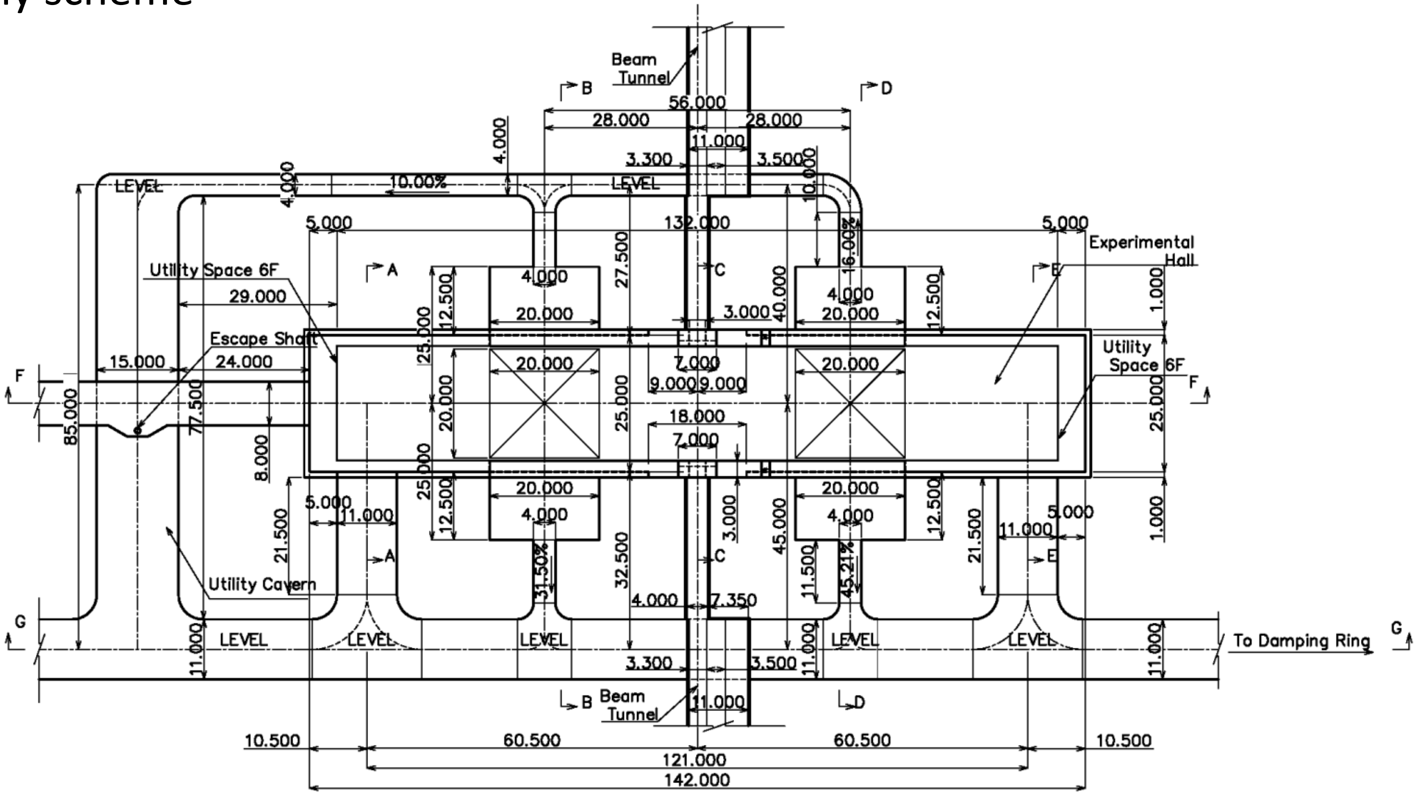
Hall design for Japanese mountain site

- Horizontal access
- Changed assembly scheme



YB0 landing in the CMS experiment hall

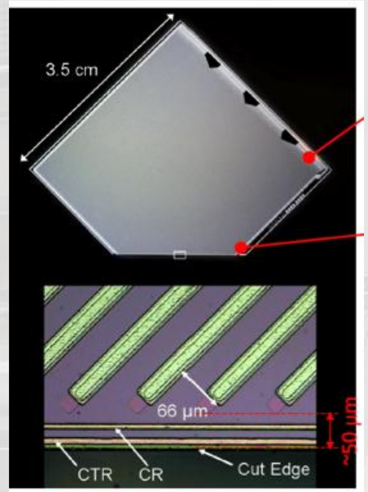




Plan

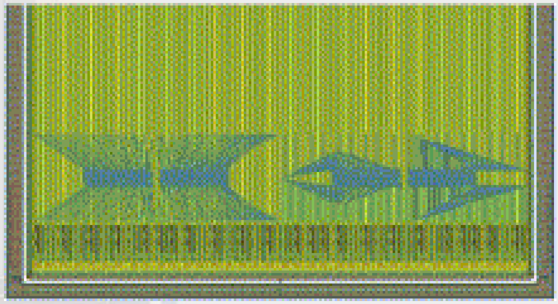
Silicon Tracking (2)

- Solution to limited resources: **ILC-LHC synergy.** Technologies initially developed for the ILC actively pursued for the LHC upgrade, e.g. ***edgeless sensors*** and ***integrated pitch adapters***. ILC will benefit from this in ~2013
- Established 130 nm CMOS technology for mixed mode analog-digital FEE readout → active development for LHC upgrade. ILD design will be improved for DBD. Use of 65nm technology actively being developed (e.g. timepix or FEI4)
- Use of ***intelligent devices****: both* support *and* other functions (cooling, services, positioning) at LHC, originally pioneered by ILC → Full architecture of the DAQ signal processing will be updated and included in DBD

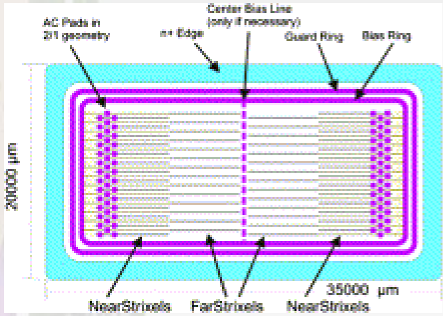


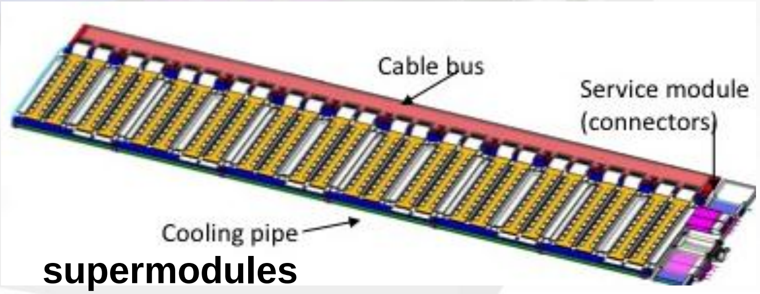
Only 50µm from end of strip to end of sensor!!!

IPA in a second metal layer



Strixels with IPA

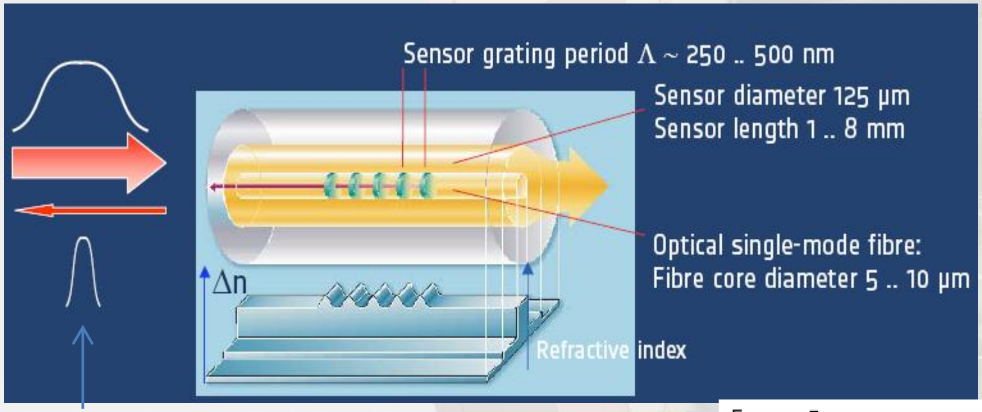


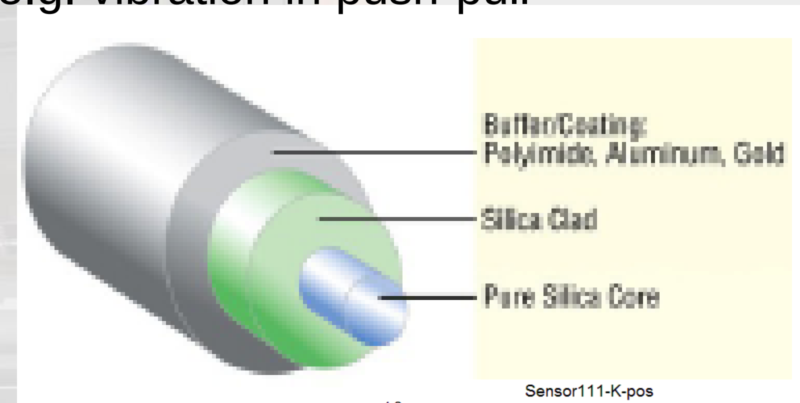


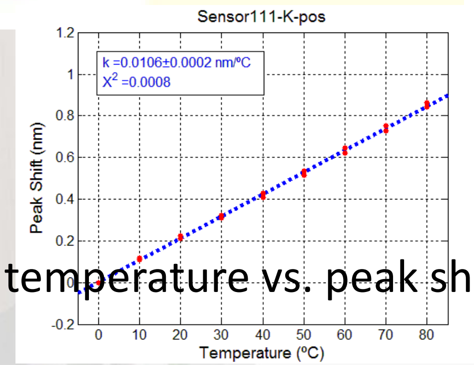
supermodules

Silicon Tracking (3)

FTD monitoring with fiber optics sensors (FOS) embedded in the sensor (AIDA): monitors environmental variables in real time, e.g. vibration in push-pull



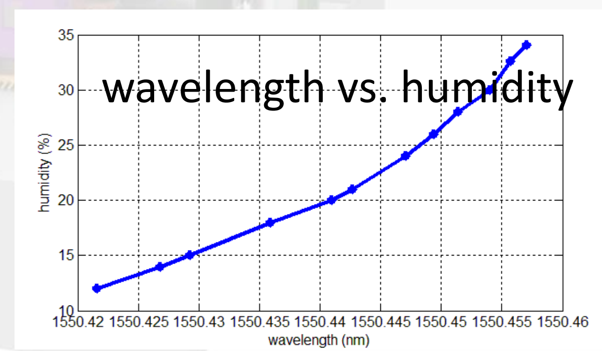


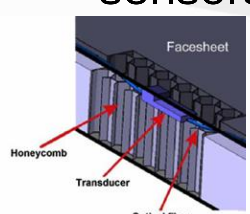


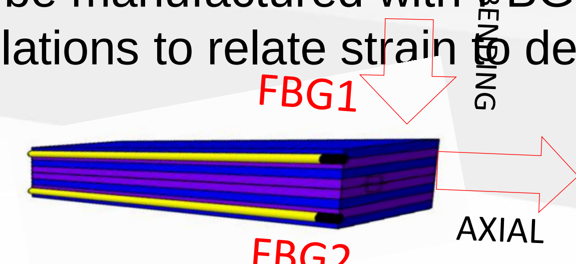
- λ_B is sensitive to strain and T:

$$\left[\frac{\Delta\lambda_B}{\lambda_B}\right] = C_S\epsilon + C_T\Delta T \quad \begin{cases} \sim 10 \text{ pm/K} \\ \sim 1 \text{ pm}/\mu\varepsilon \end{cases}$$

- Other quantities (humidity, $\%CO_2$, magnetic field, …) can be measured using coatings sensitive to them.
- FOS are light-weight, small, flexible, immune against EM fields, HV, wide range of operating temperature (4~900K)
- New prototype will be manufactured with FBG sensors; FEA simulations to relate strain to deformity

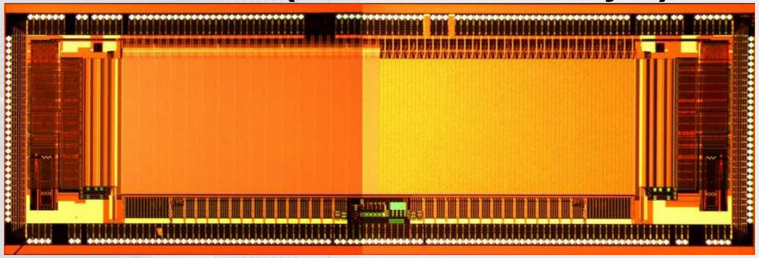






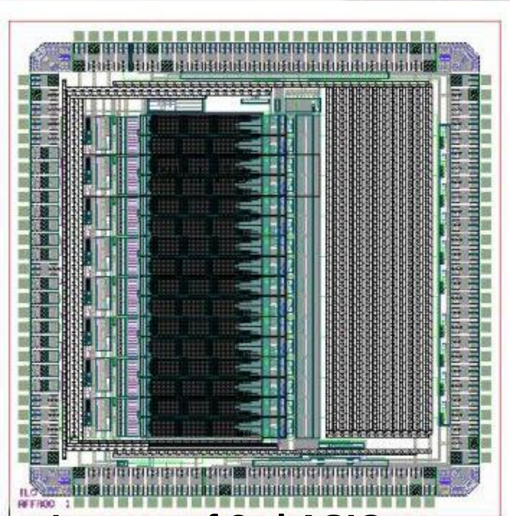
Vertex Detector

MIMOSA-30 (VXD innermost layer)



FPCCD R&D:

- 8μm pixel prototype developed
- Technology to thin down to 50μm established
- Large prototype with 6μm pixel in FY2012
- Readout ASIC: 3rd prototype delivered in a few months, 10 Mpix/s, ~5mW/ch



Layout of 3rd ASIC

CMOS pixel R&D:

- MIMOSA-30 (inner) and MIMOSA-31 (outer) fabricated Q4/2011. 10μs read-out (inner) confirmed, TB in June/July.
- PLUME (0.6% X_0) **double-sided ladder prototype** shows good performance. New version (0.35% X_0) under construction, TB scheduled June/July → ***technology validation***
- New 0.18μm process could reduce read-out to 1-2μs → **1 TeV**. MIMOSA-32 fabricated in Q4/2011, being tested.