ILD concept status

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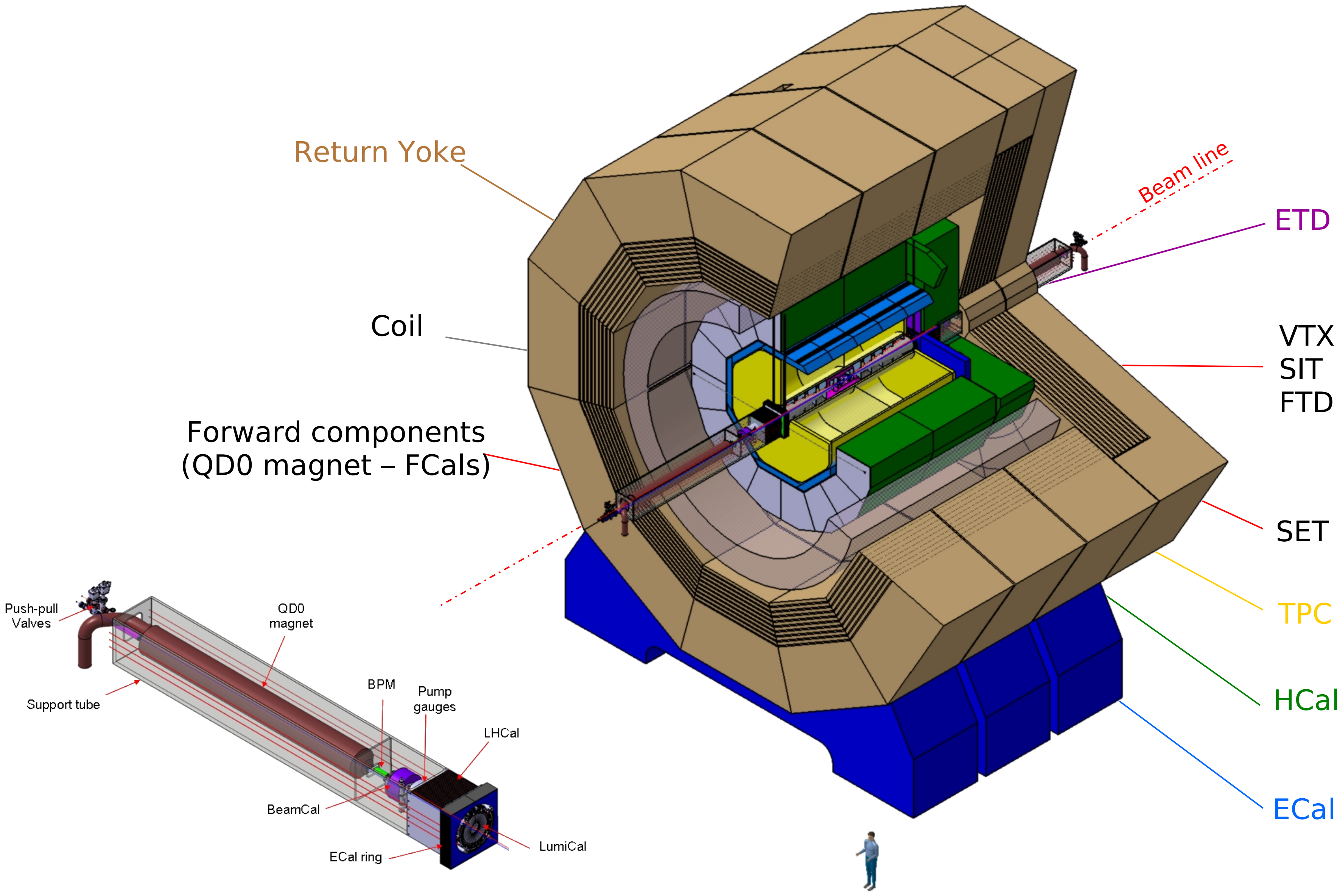
ALCPG Workshop Eugene/OR March 2011

The ILD Proposal



Letter of Intent in 2009 – Invited by IDAG to work **towards a DBD for 2012**

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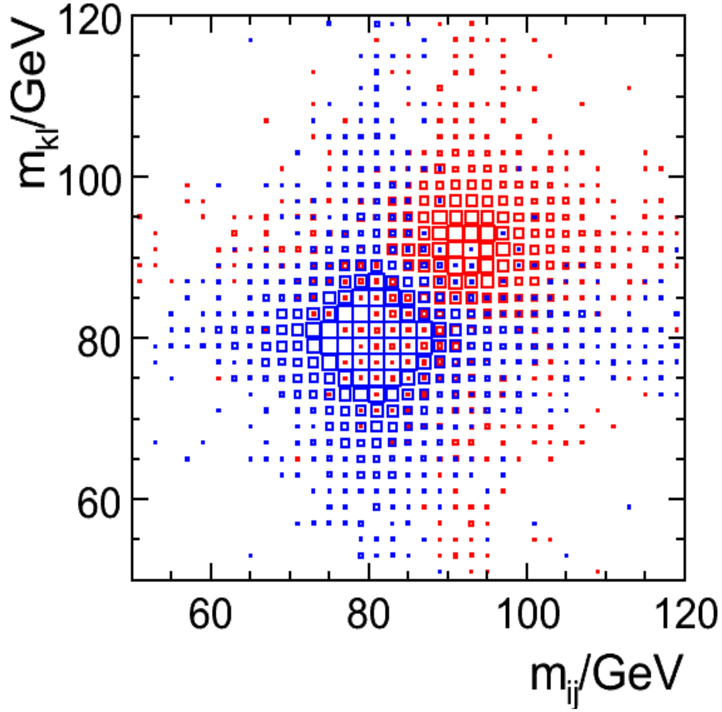
Particle flow detector

W, **Z** pair separation in the ILD detector
in multijet final states



Remember: $M_Z - m_W \approx 10$ GeV

The guiding lines

- Interplay of very advanced detector components
- Developped in R&D collaborations

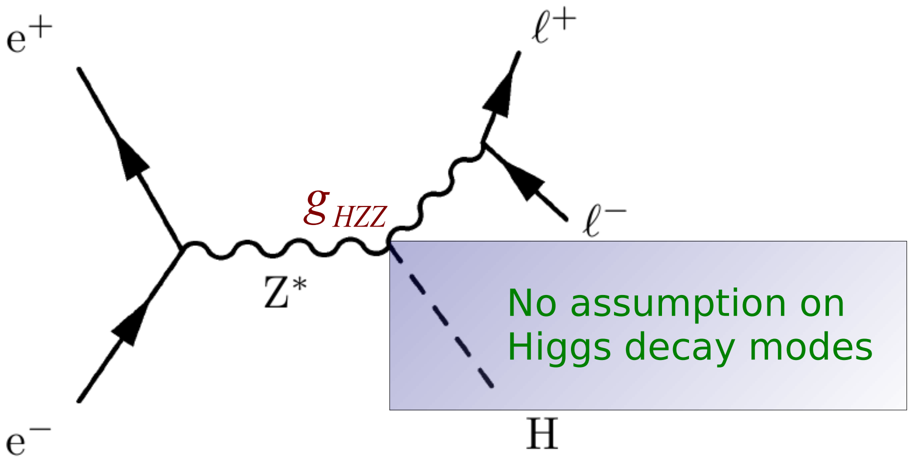
- LOI validated in 2009 by IDAG

- Move towards DBD in 2012
  No technology decision!!!!

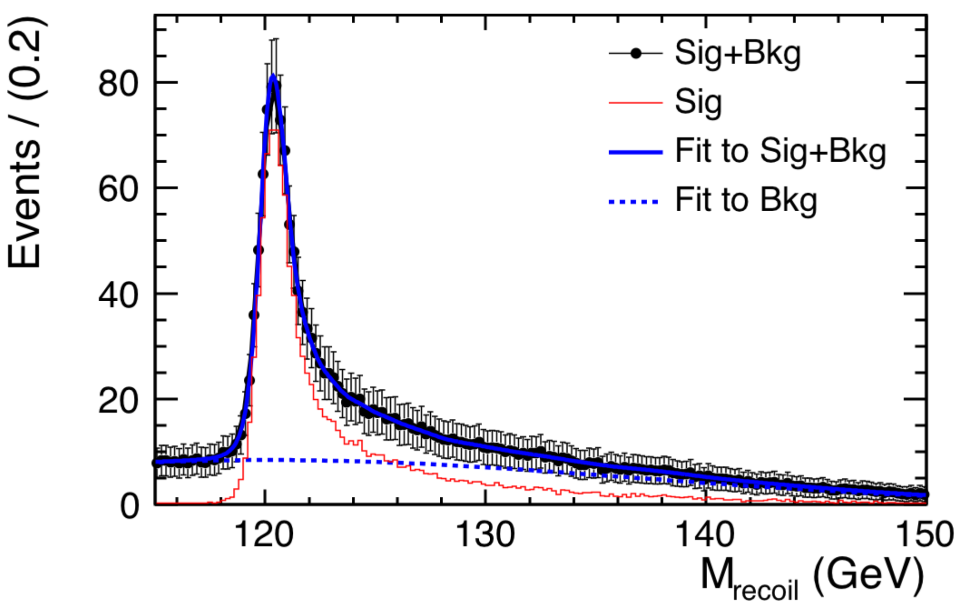
- Integrate 'realism' in detector simulation

Physics results with ILD

Higgs production at @ 250 and 350 GeV



Recoil Mass: $M_h^2 = M_{recoil}^2 = s + M_Z^2 - 2\,E_Z\sqrt{s}$



Higgs branching ratios

Preliminary results

	Ecm	ΔBR(cc)/BR(bb)
Neutrino (nnH)	250	20.7%(28.9%)
	350	14.2%
Hadron (qqH)	250	23.0%→18.7% (31.3%→26.0%)
	350	16.4%→16.6%
Muon (mmH)	250	39.5%(45.3%)
	350	43.9%
Electron (eeH)	250	47.5%(50.9%)
	350	37.8%
Combined	250	13.7%(18.0%)
	350	10.0%

Ongoing analysis

ILD studies as input for communication with machine developers!!!

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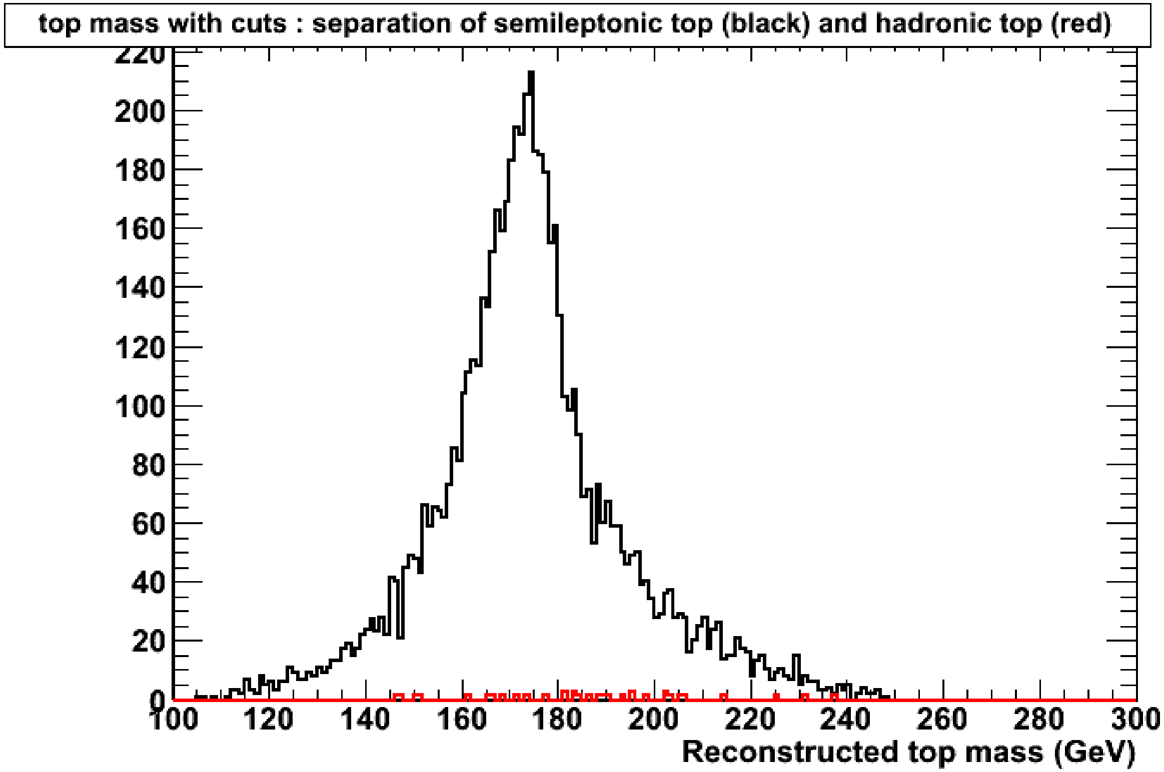
Example for ongoing analysis

Top quark physics:



Example: Top mass

- Top quark exists(!!!)
- Large mass hierarchy among fermions
- Compositeness, extra dimensions
- Aim measure AFB, ALR (polarised beams)

Towards DBD

Simulation baseline: To react to new benchmark scenarios at 1 TeV
Will be used for mass simulation and reconstruction

Scenarios: $e^{+}e^{-} \rightarrow \nu\bar{\nu}h^{0}$

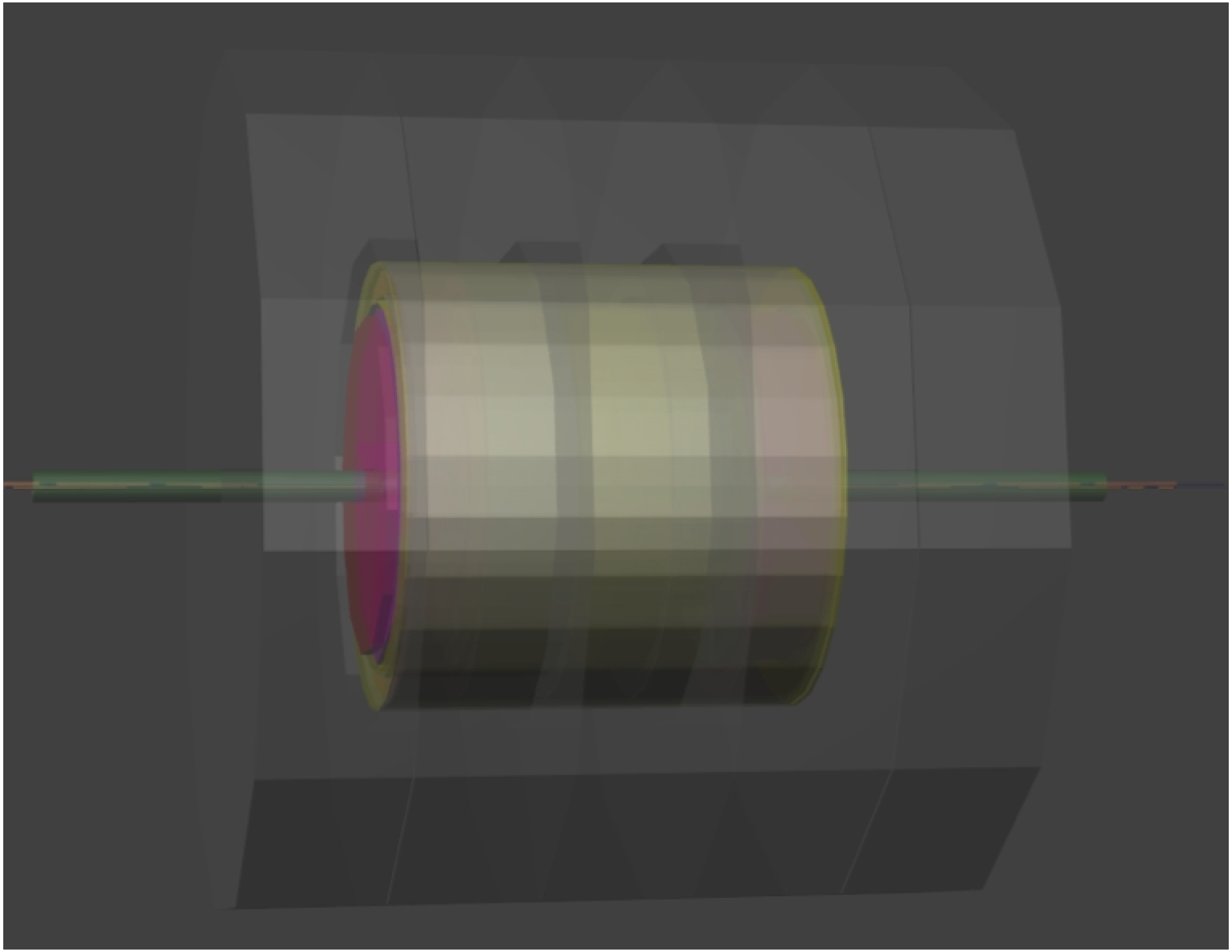
$e^{+}e^{-} \rightarrow W^{+}W^{-}$

$e^{+}e^{-} \rightarrow t\bar{t}h^{0}$

Technology baseline: Propose sub-detector technologies which (in principle could) be used for detector construction
Rely on input from R&D collaborations
No technology decision in DBD
"Less mature" technologies will be considered, too
Detailed simulation of physics processes?

Timeline: Next iteration at ILD group meeting at KEK
Baseline by LCWS 2011 @ Grenade

Preparation of DBD studies - Model ILD01



Detector as implemented in Mokka – ILD simulation software

Different options: ILD_01pre00, ILD_01pre01 and ILD_01pre01fw

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Important changes in Mokka

- A scalable Ecal mixing silicon and/or scintillator sensitive layers
- Analog Hcal with electronics inside
- Pad-row-based TPC with Endplate of 25 percent X0
- Improved implementation of Sit, SET, ETD by the SiLC Collaboration
- Ftd - First mechanical design with micro-strips (disks 3,4,5,6,7) and pixel (disks 1,2) technologies by Jordi Duarte.
- Coil using Coil Cryostat with detector instrumentation by Valeri Saveliev
- first implementation of services (cables, cooling, etc)
- improvements in implementation of: LumiCal, Tube, Mask, Yoke, BeamCal, Magnetic field,

- Available (but not included by default in the new ILD models): improved implementation of digital (GRPC) Hcal (that follows the design suggested by Henri Videau), and a new implementation that replaces, in the Analog Hcal, the scinillator layers and their associate components with GRPC layers identical to those in the GRPC Hcal, by Ran Han.

Software framework

MARLIN for reconstruction:

Access to reconstruction packages such as PandoraPFA, LCFI etc.

ilcinstall makes it (relatively) easy to get going (Own experience ;-))

Grid technology for data processing and storage
ILC (-> ILD) present at all major IT centres

Software development

- some improvements in core tools (LCIO, GEAR, CED)

  - many (small) improvements in reconstruction tools (MarlinReco):
    -> slide 8
  - active work on reconstruction for technology options:
    - FPCCD digitizer
    - SciEcal strip clustering
    - SDHcal reconstruction

  - started to develop new tracking code (C++, based on KalTest)

  - improved realism in Mokka simulation:

    - SIT, ETD, SET and FTD drivers rewritten: proper wavers (and strips) as opposed to simple cylinders

    - introduced more realistic description of cabling and services

DESY: Some progress with the tracking and some bug fixes and improved build tools.

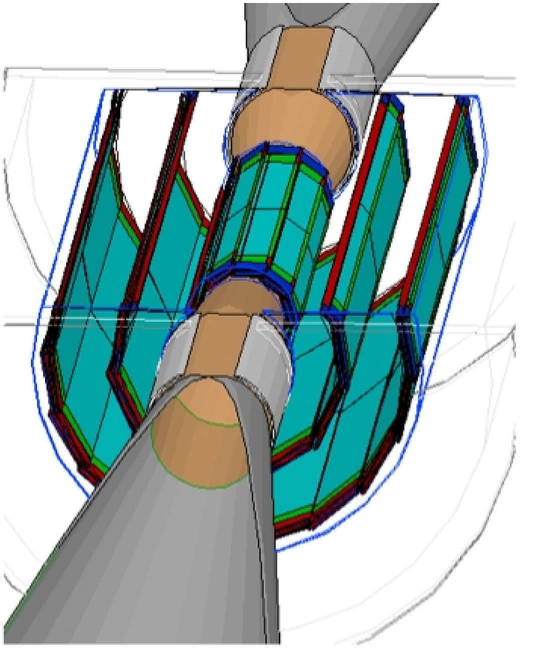
New release v01-11-pre03 (mainly targeted at the CLIC CDR)

Question RP: $\gamma\gamma$ background?

Subdetector components I – Vertex detectors

Aim to equip three doubled sided layers

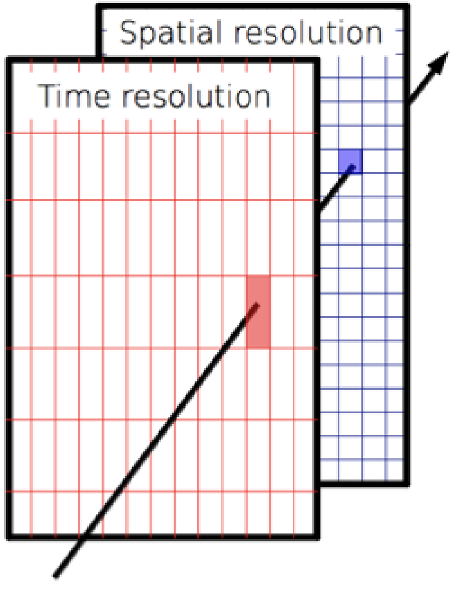
Sensor development



Inner double layer inner radius
- binary charge encoding
- 16x16 mum^2 pitch => < 3mum resol.
- r/o time 40-50 mus

Inner double layer outer radius
- binary charge encoding
- 16x64 mum^2 pitch => 5mum resol.
- r/o time 10-12 mus

Outer layers
- 35x35 mum^2 pitch => < 3mum resol.
- charge encoding with 4 bit ADC
  => expected resolution 3-4 mum
- r/o time < 100 mus



Design of prototypes meeting these specs ongoing
Fabrication in danger due to short funding

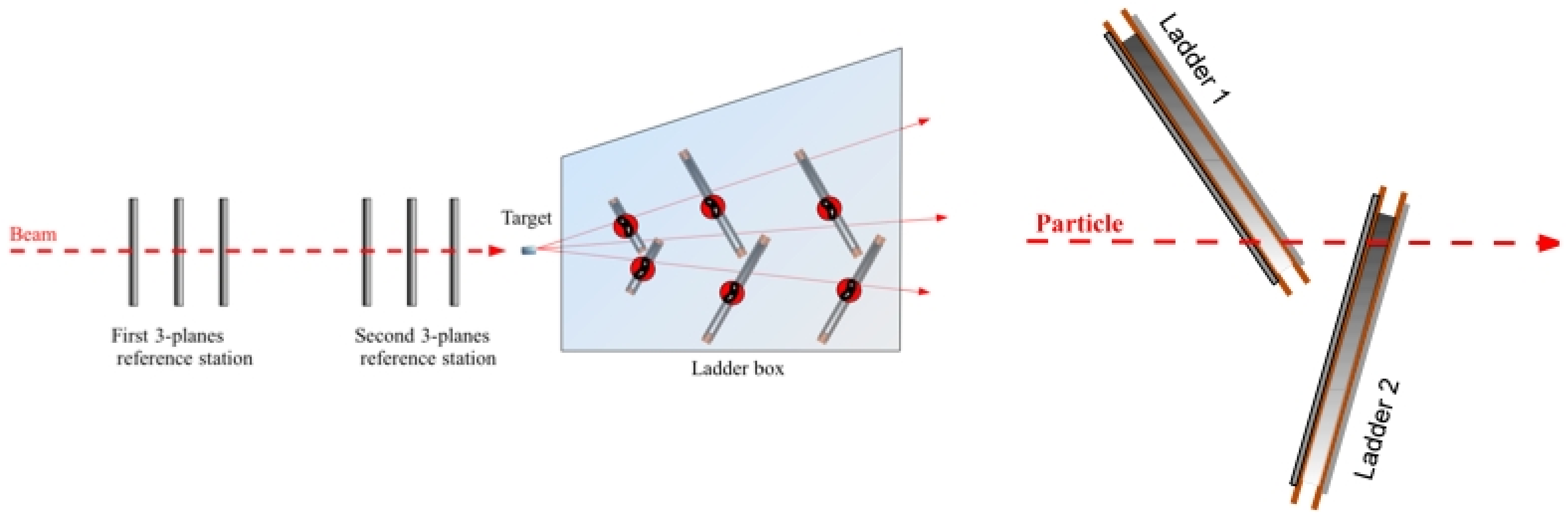
Subdetector components I – Vertex detectors cnt'd

PLUME collaboration:
Development of double sided ladders with MIMOSA 26 sensors

Material budget 0.6%X0

Further studies to reduce material budget to 0.4% for DBD

Tentative test beam setup for 2011-2012



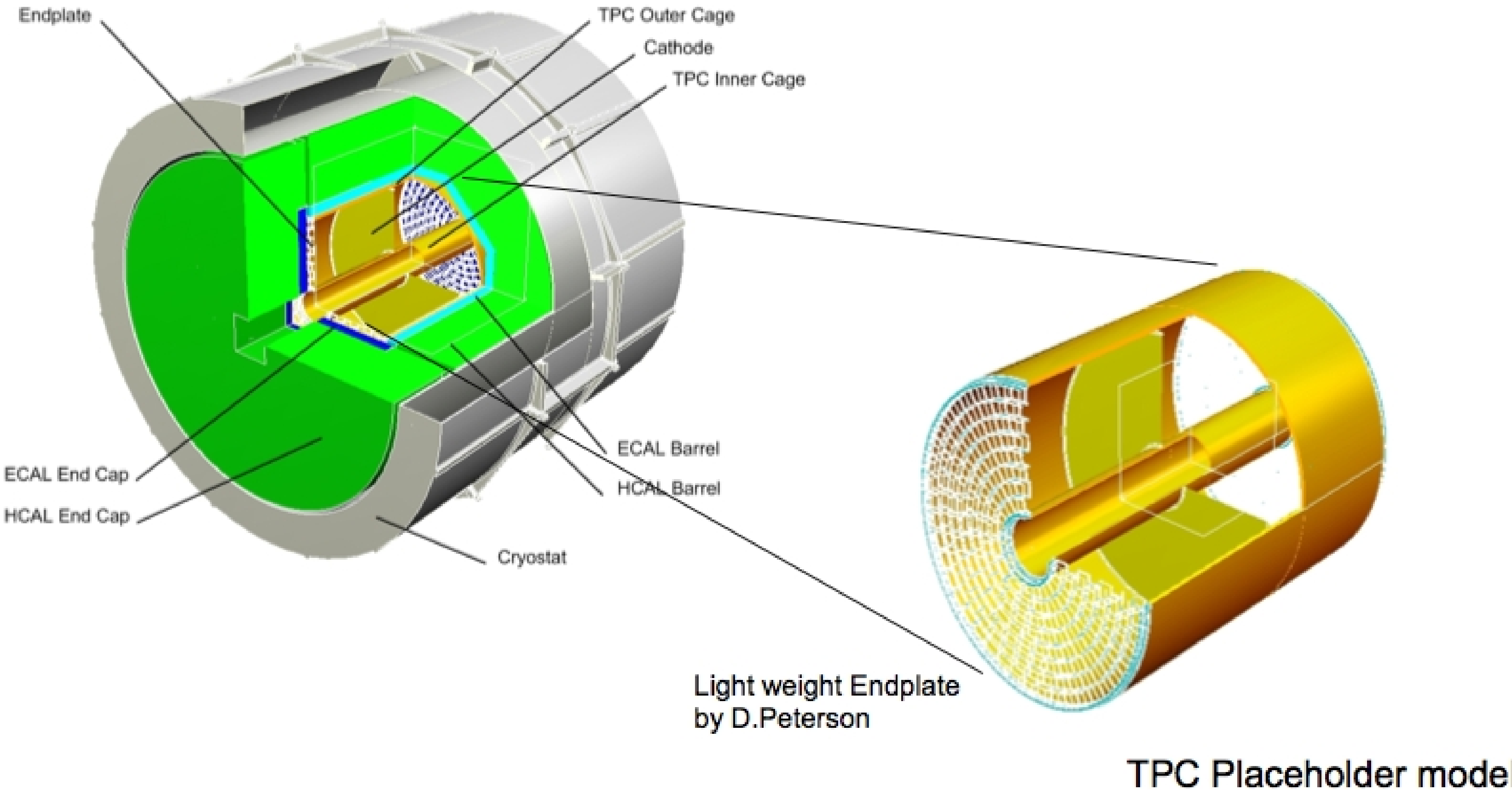
R&D has to continue beyond 2012

Subdetector components II – Silicon inner tracking

Aurore, Alberto and Marcel contacted

Subdetector components III - TPC

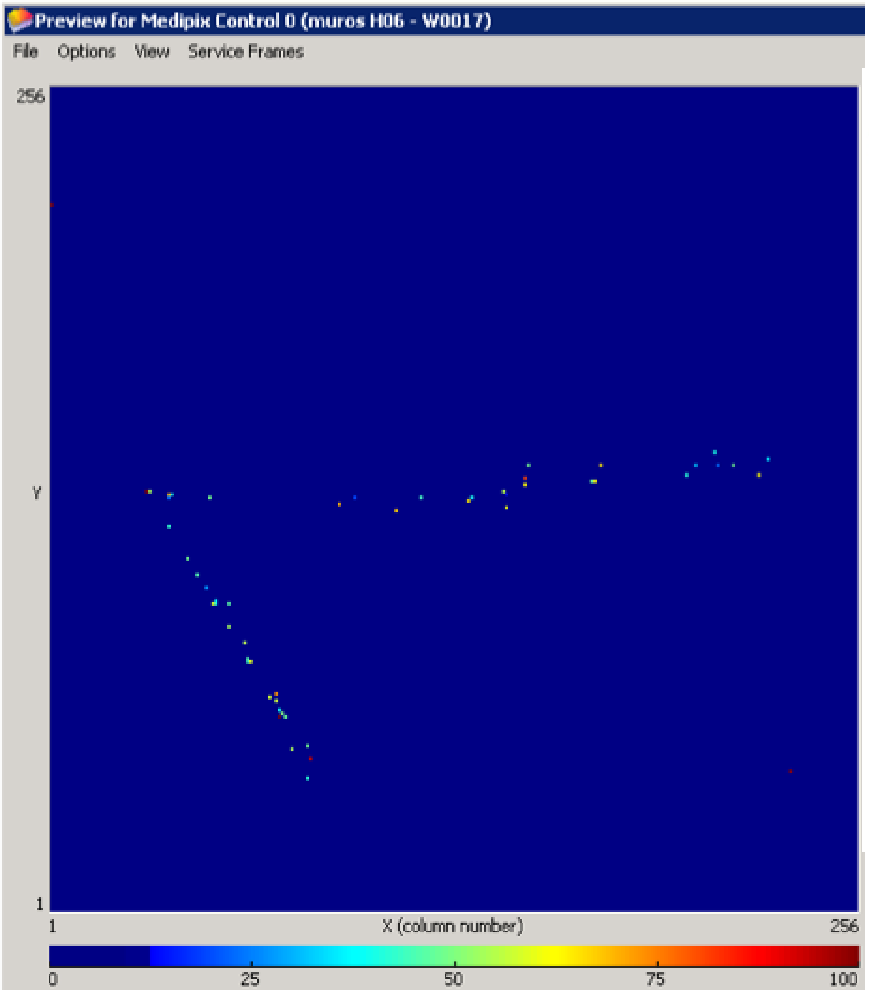
Central tracking in ILD based on TPC

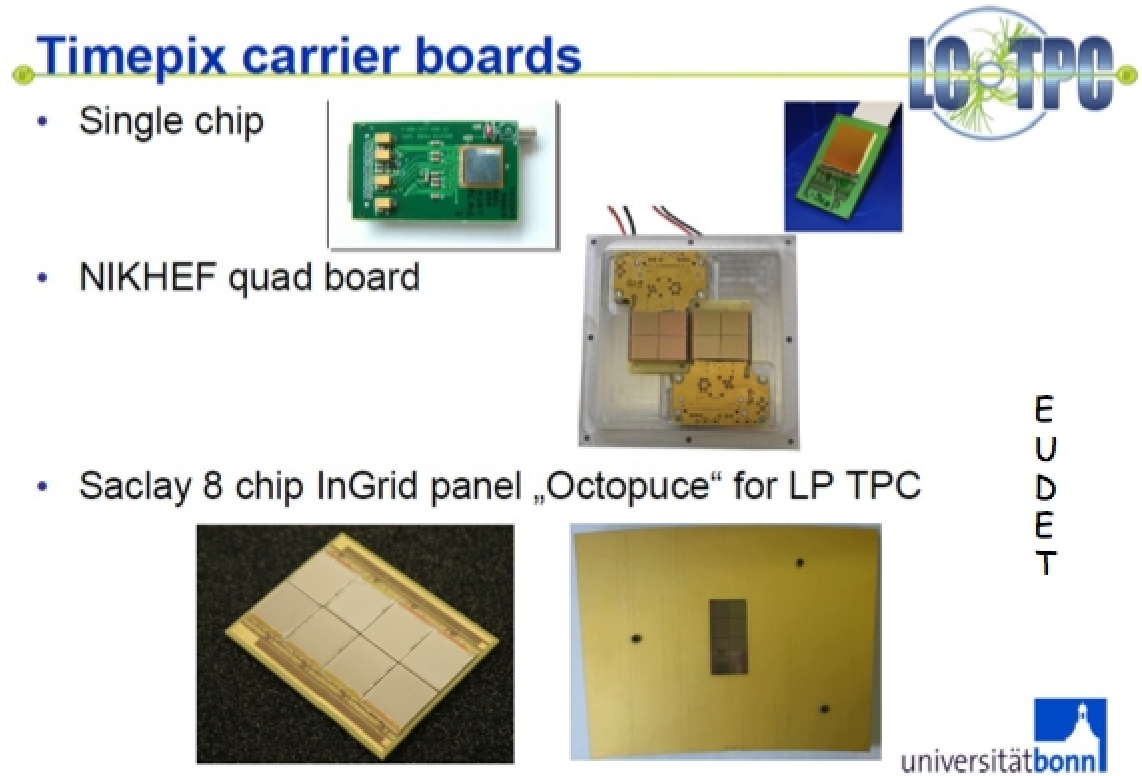


Integration of TPC into full detector is challenging
Close collaboration between R&D groups and (mechanics) integration experts – True also for all other components

Subdetector components III – TPC cont'd

Pixel r/o for Micro Pattern Gas Detectors - GEMs, Micromegas

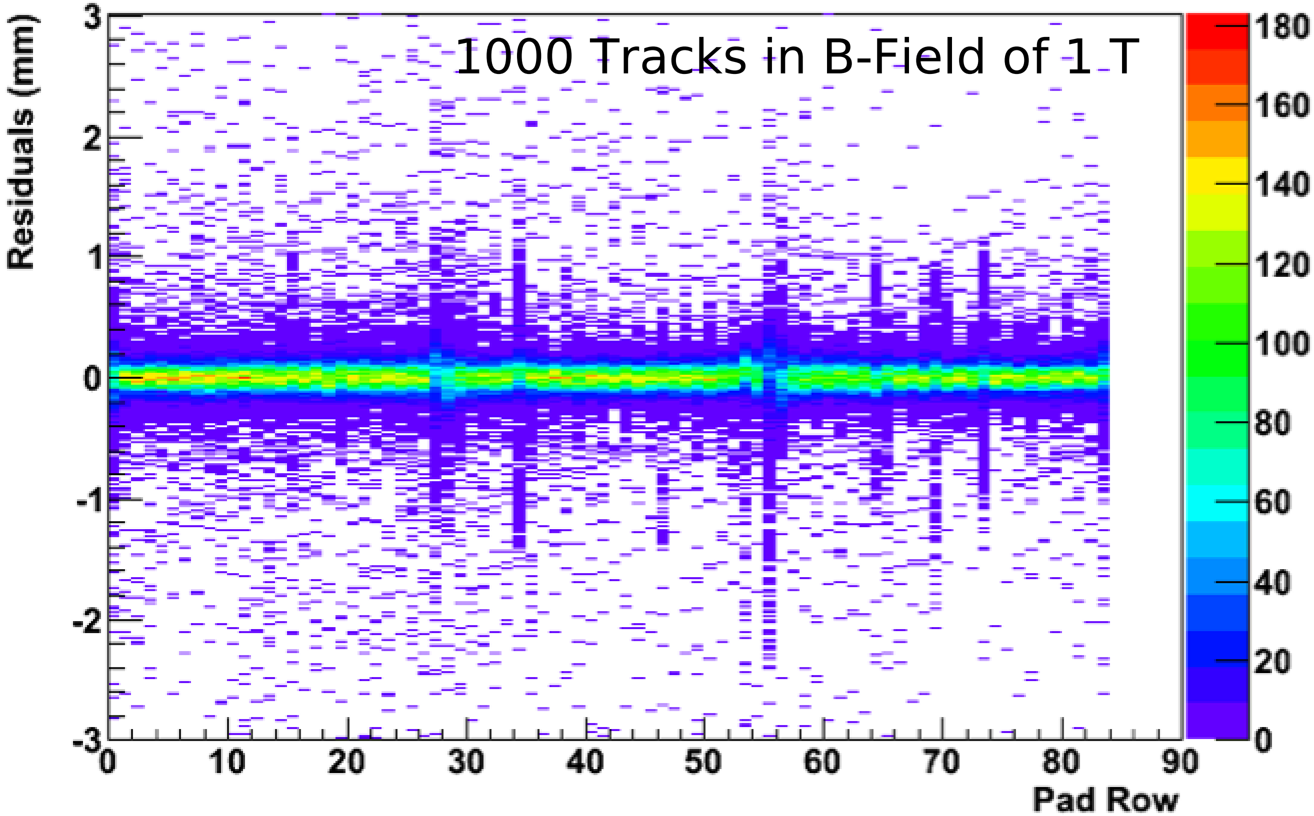




Intensive R&D within LCTPC Collaboration

Subdetector components III – TPC cont'd

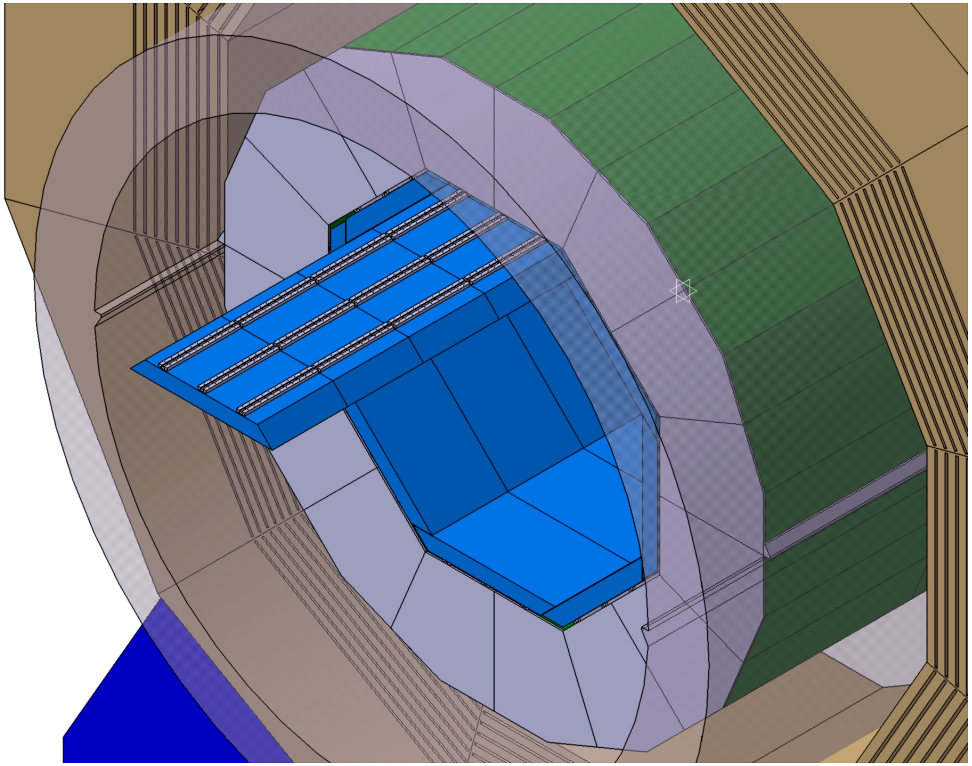
Track reconstruction based on cluster algorithm
Millipede fit to account for misaligned pad rows



- Results on point resolution show that σ_y at zero drift is about 0.0613 ± 0.0006 mm and σ_z at zero drift is about 0.259 ± 0.002mm.
- Result on momentum resolution is $\sigma(1/p_t) \approx 9.2x10^{-3} \pm 0.0002 GeV^{-1}$ at a drift length of 15 cm

Subdetector components Iv - Electromagnetic calorimeter

The SiW Ecal in the ILD Detector



Basic Requirements

- Extreme high granularity
- Compact and hermetic

Basic Choices

- Tungsten as absorber material
  - X0=3.5mm, RM=9mm. ll=96mm
  - Narrow showers
  - Assures compact design
- Silicon as active material
  - Support compact design
  - Allows for pixelisation
  - High signal/noise ratio

SiW Ecal designed as Particle Flow Calorimeter
R&D within CALICE Collaboration

Detector Optimisation – Number of Layers/Sensitive Material

Models under study:

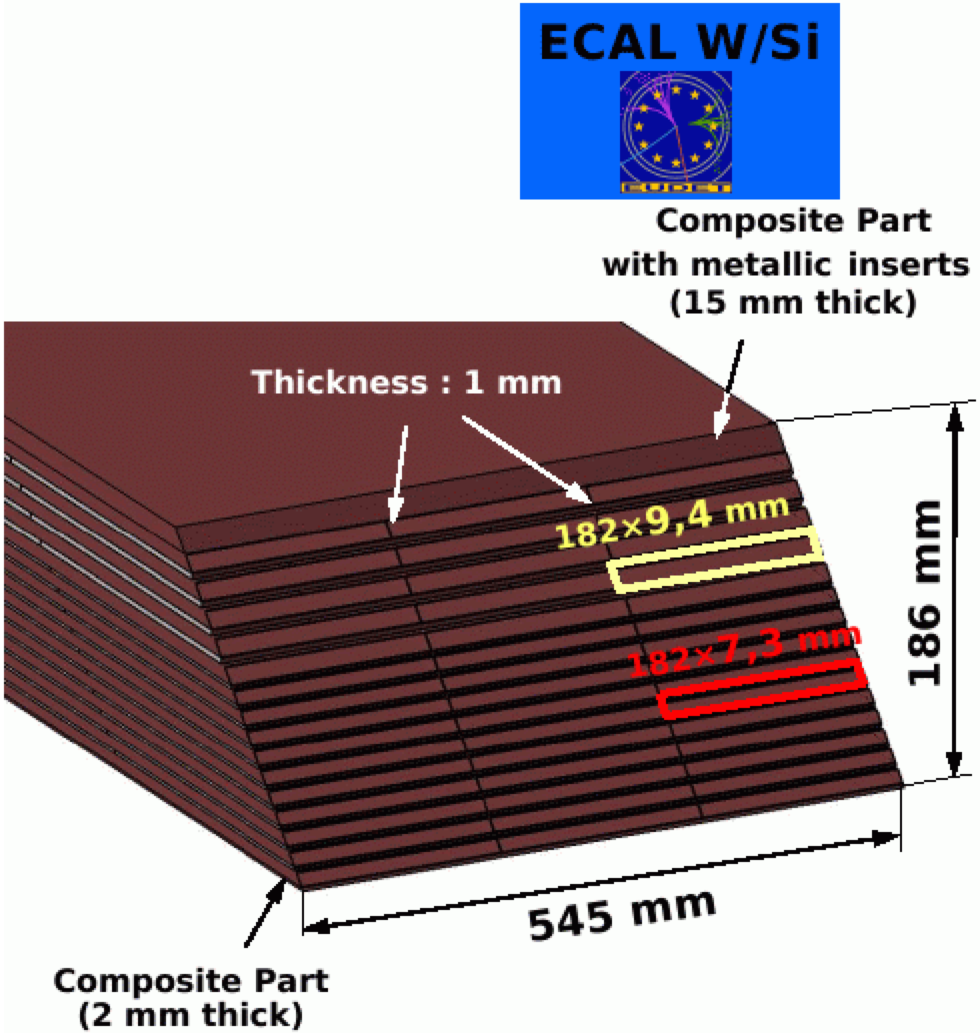
1) A pure SiW Ecal Calorimeter with 20 < N < 30 Layers

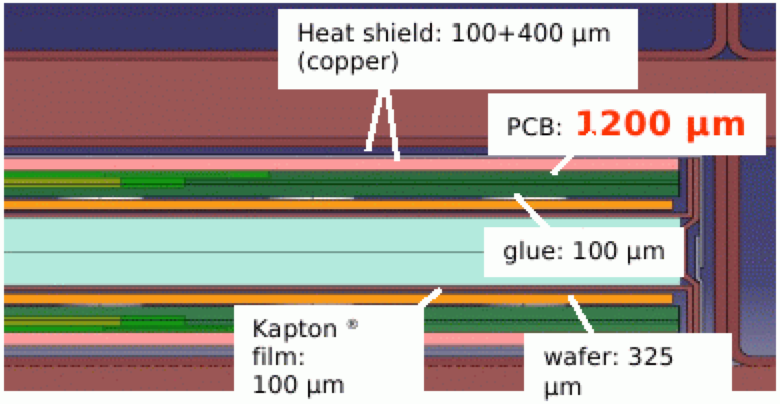
2) A pure Scintillator Ecal

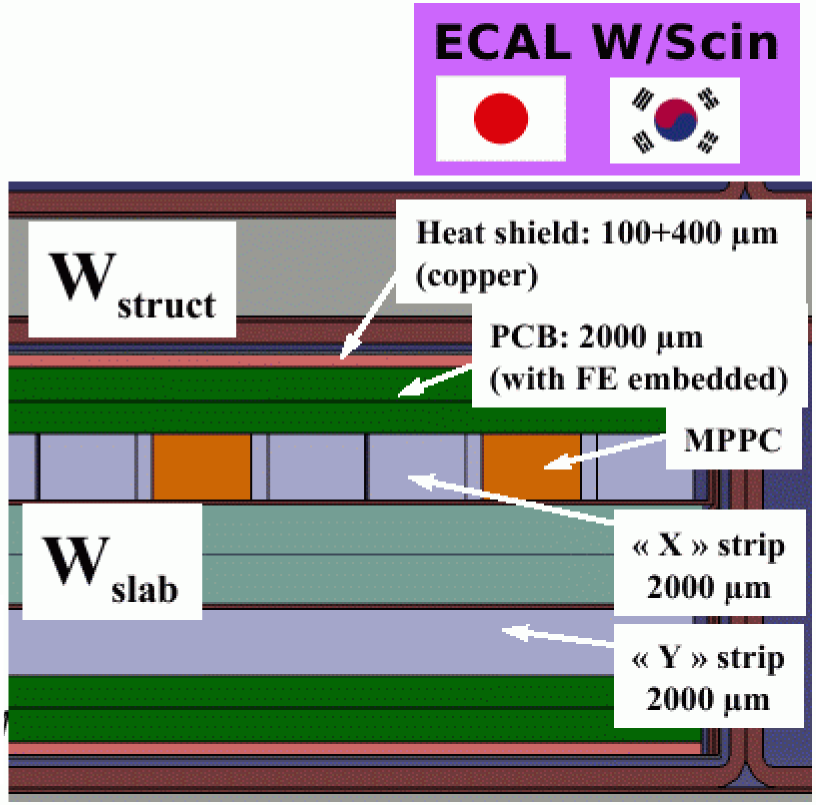
3) A hybrid solution
   e.g. first 20 layers Si with rear part of calorimeter equipped with Scintillator

PFA studies for hybrid calorimeter ongoing

Technological prototypes and alternative Ecal technologies



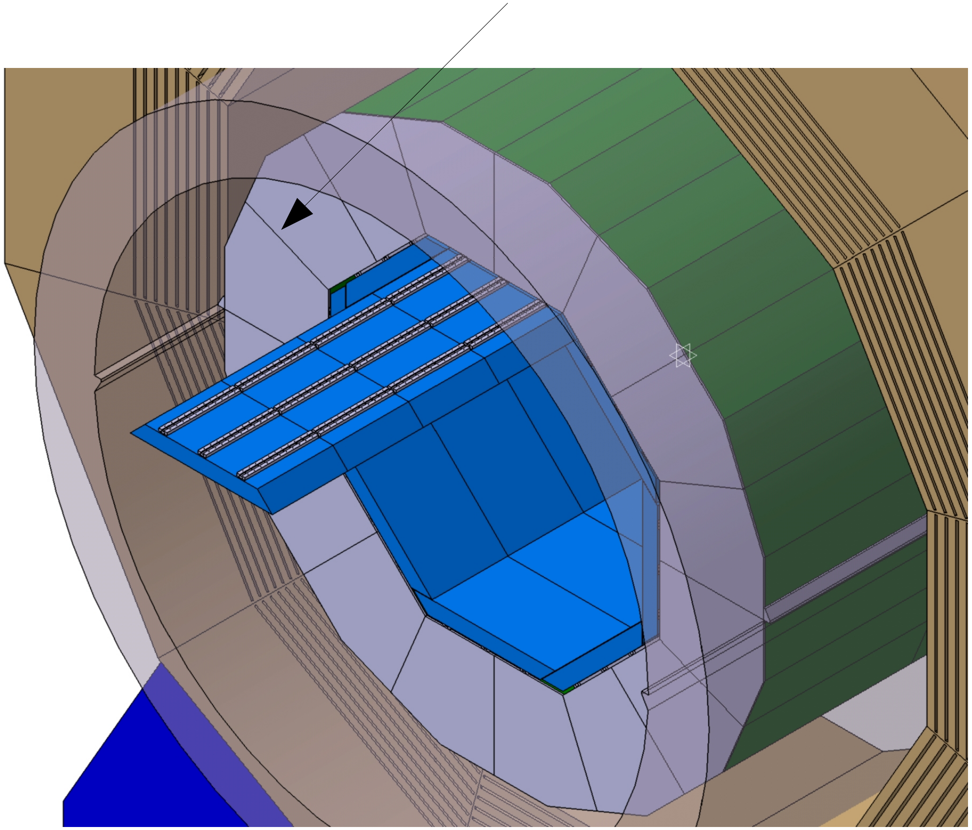




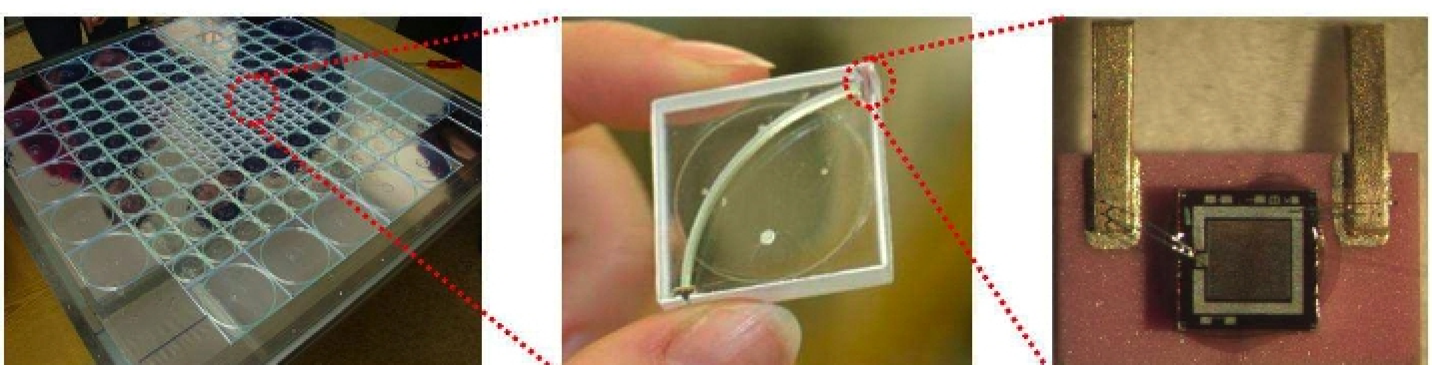
Technological prototype to address engineering challenges of detector construction

Subdetector components v - Hadron calorimeters

(Analogue) Hcal

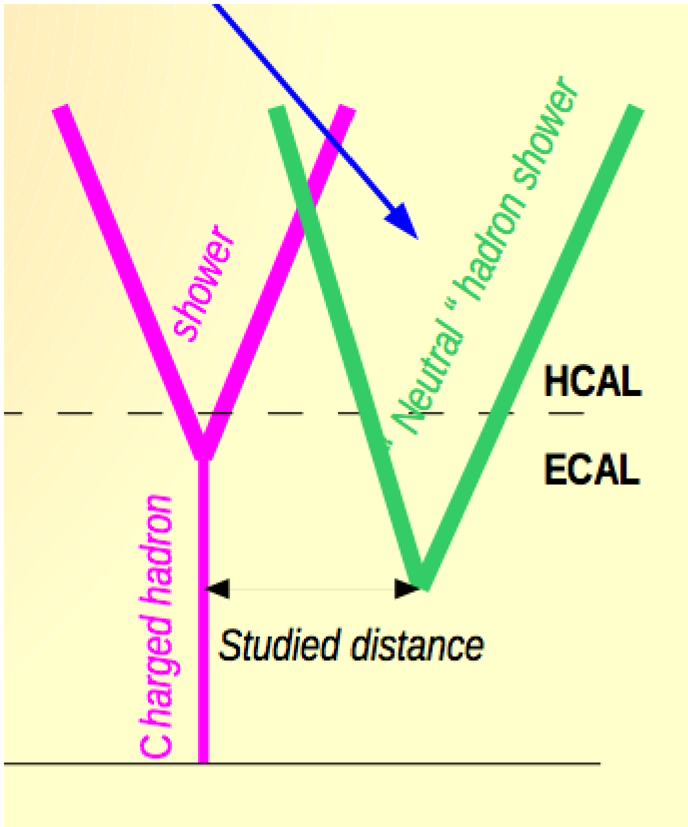


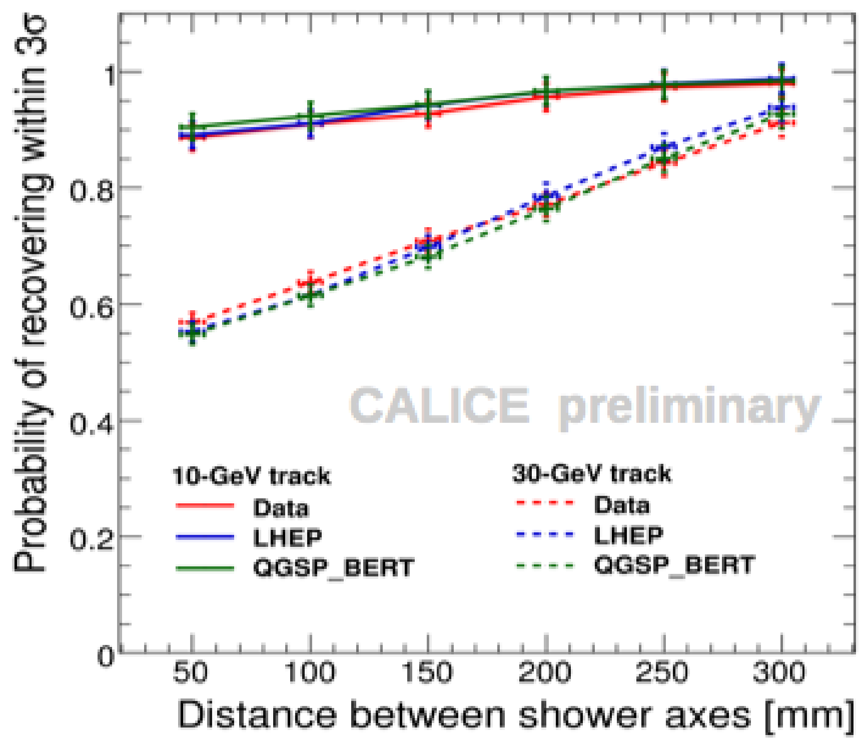
- Steel/scintillating tiles
- Size 3x3 cm^2
- r/o by silicon pms
- Large scale testbeam program within CALICE



Testbeam results

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





Transport of beam test data into physics studies

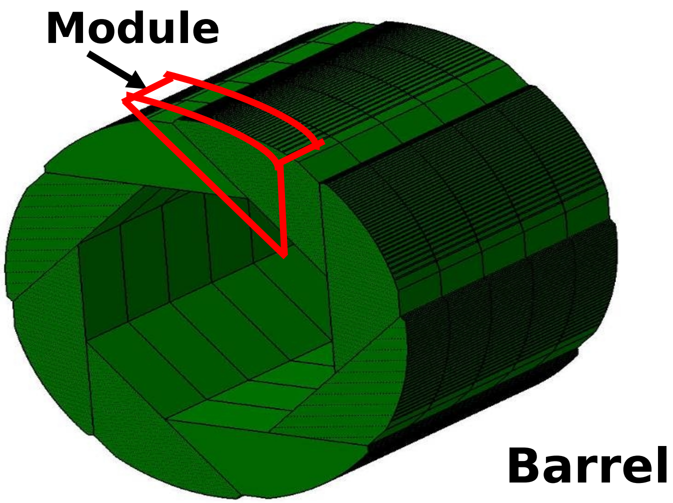
Successful Application of PFA to real data with highly granular calorimeters

Semi digital Hcal

Goal : to build a prototype of very compact, ultra-granular HCAL using GRPC with semi-digital embedded readout electronics→ **PFA**

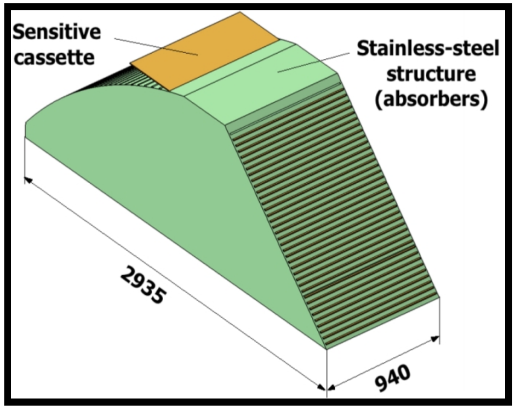
1m3 prototype in 2011 – Testbeams at CERN

- → Self-supporting mechanics
- → Minimized dead zone
- → Minimized thickness
- → One-side services
- → Power pulsed electronics



The prototype will be made of up to 48 layers. Each layer is made of :

1.5+.5 cm absorber
+ 0.6 cm sensitive medium



1 cm^2 transversal granularity
Up to **6 λ_I** and **442368/m^3** channels

Towards CALICE input to DBD

- Considerable experience in operating highly granular calorimters
  Ecals, Ahcal, (S)DHCAL

- Feasilbility of detector construction
  - First successful power gating in magnetic field - SDHCAL beam tests
  - Embedding of front end electronics w/o compromising
    data precision – SiW Ecal beam tests
  -> see Calo session at ALCPG

- Definiton of technology readiness criteria until CALICE collaboration meeting in May
  Review by DESY PRC in April

- CALICE report will be prepared until spring 2012

Subdetector components v - Forward calorimeters

Wolfgang contacted, material expected from Marek and Halina

Detector integration “ Internal”

- Interplay with detector simulation – Common tool EDMS

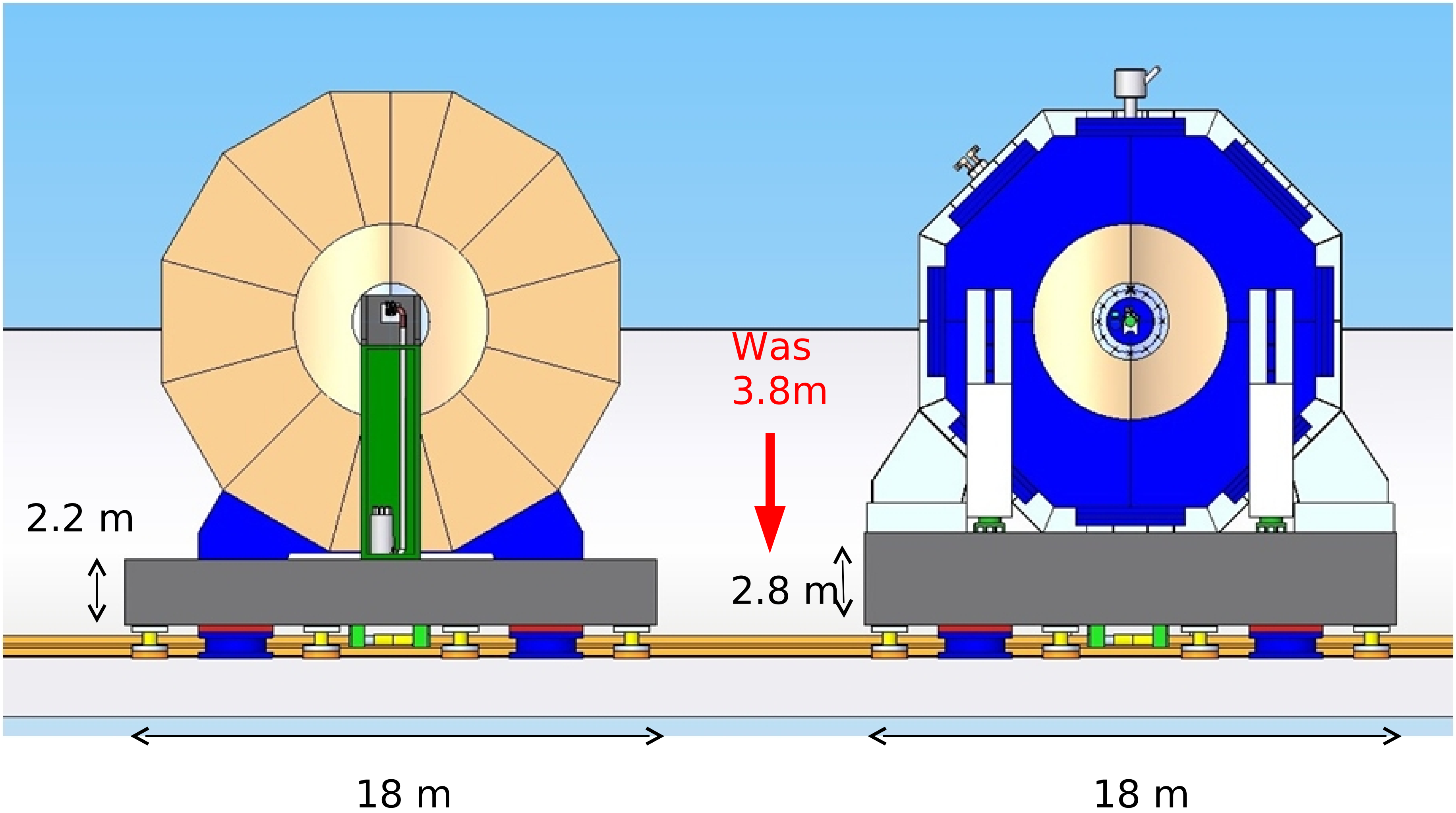
- Definition/integration of service parts

- Progress on inner region

- Power delivery and pulsing workshop at LAL in May 2011
  Will comprise all ILC and CLIC detectors
  Communication with (S)LHC community

Detector integration " External"

ILD and SiD on a common platform



ILD lowered by 1m due to changes to yoke feets
=> SiD platform less thick
Common beam height of 8m

Main Milestones