International Large Detector
for the International Linear Collider

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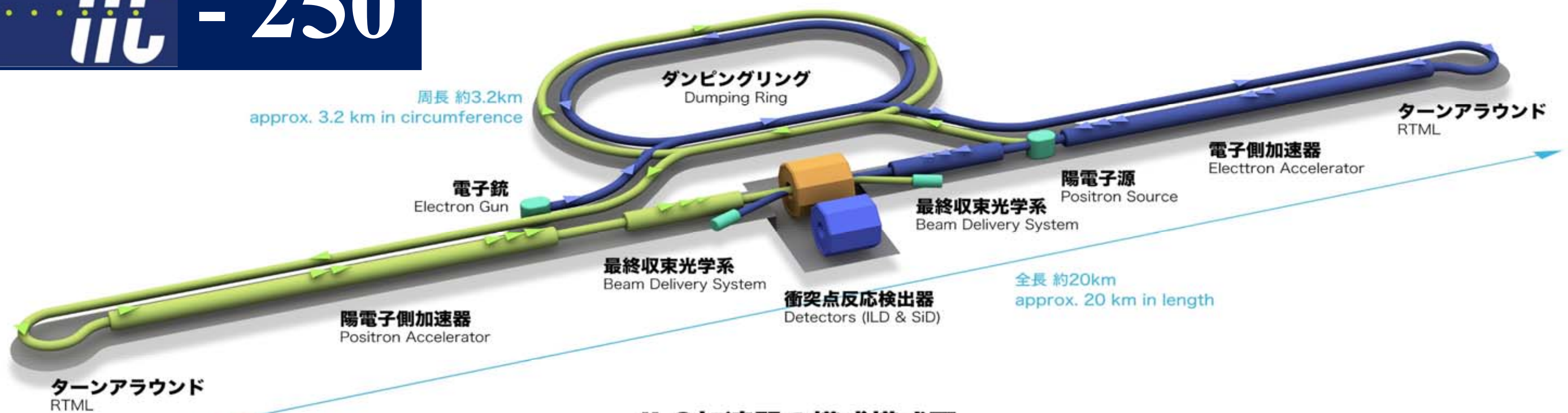
Laboratoire Leprince-Ringuet
CNRS- IP Paris

on behalf of ILD collaboration

ilc - 250



ILC加速器の構成模式図
Schematic illustration of ILC

There is now a large consensus for an e+e- machine (Higgs factory) as the next particles large collider

- **ILC (250)** is an e+e- machine for the detailed study of EW symmetry breaking … W, Z, Higgs … e+e- $\rightarrow$ WW, ZZ, ZH .

- Following machine experts, the design of this machine is well advanced and it could be ready for construction within few years

- **WITH MODEL INDEPENDENT** measurement Higgs coupling to Z e+e- $\rightarrow$ ZH $\rightarrow$ ee,$\mu\mu$ +X (using **Missing Mass squared**…. Need **VERY PRECISE** tracker devices)

HOWEVER

Z to	Fraction
$\ell^+ \ell^-$	6%
qq (jets)	70%

W to	Fraction
$\ell^\pm \nu$	32%
qq' (jets)	68%

H (close to SM) to	Fraction
$\ell^+ \ell^-$	<15%
qq(jets) ,WW,ZZ	>85%

There is now a large consensus for an e+e- machine (Higgs factory) as the next large particles collider

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Optimal use of luminosity needs to reconstruct and tag the bosons through their hadronic decays

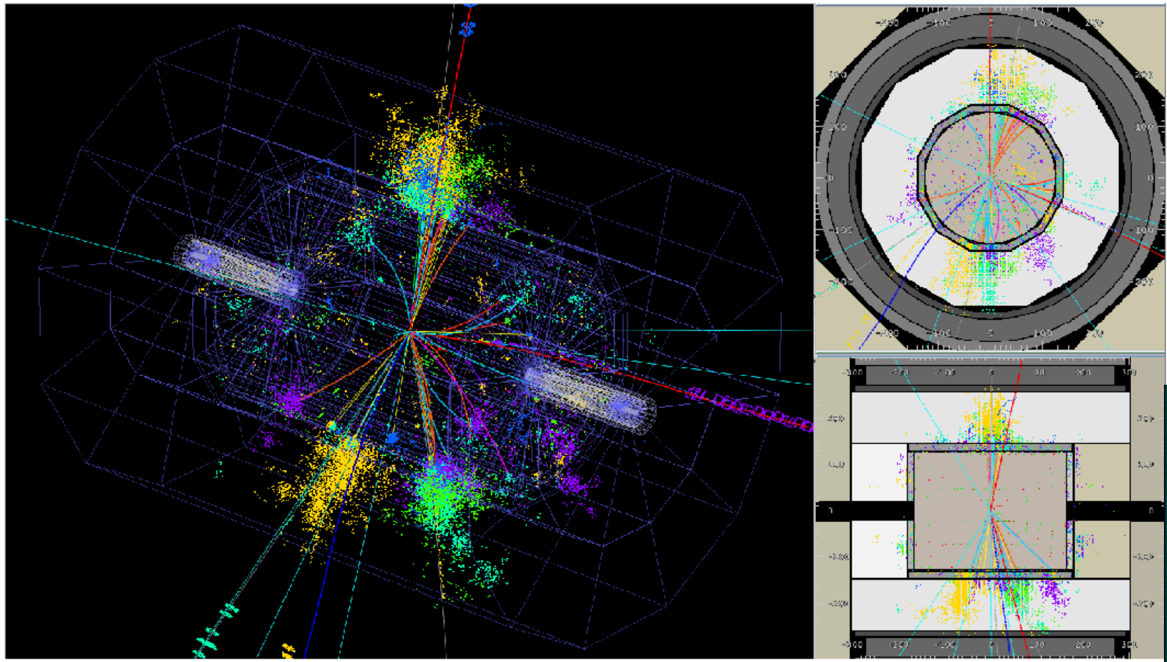
Particle Flow Algorithm (PFA)

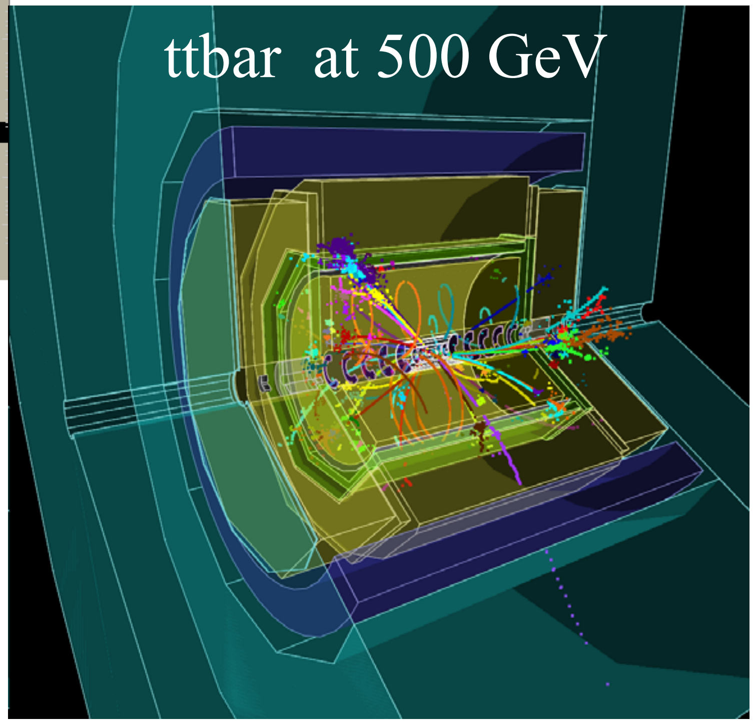
Imaging calorimetry

This conclusion has also been adopted by CLIC, FCCee and CEPC for at least one detector option

* **Using $\sqrt{s}$**

Imaging calorimetry

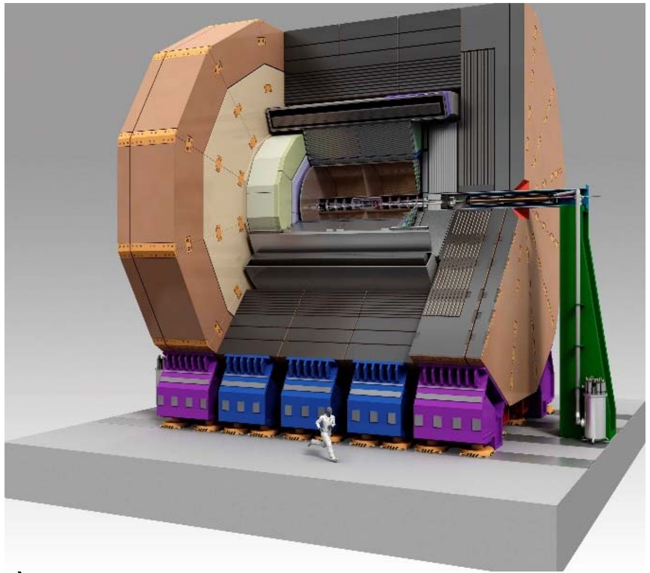




From G4 simulation,
the expected performances are a convolution
of the detector design and recons. software !!!

Detector design

From key requirements from physics: (**GOALS** of the design concept)



- **Tracking resolution**

$\sigma(1/pt) = 2 \times 10^{-5}\ \mathrm{GeV}^{-1} \oplus 1 \times 10^{-3} / (pt\ \sin^{1/2}\theta)$

- **vertexing** ($H \rightarrow bb/cc/\tau\tau$)

$\sigma(d0) < 5 \oplus 10 / (p[\mathrm{GeV}]\ \sin^{3/2}\theta)\ \mu m$

- **PFA capability**

  jet energy resolution 3-4%
  ($H \rightarrow$ invisible/bb/cc/$\tau\tau$, WW, ZZ tagging)

  Tau as a polarimeter (Higgs CP, search for Z', …)

- **hermeticity** θmin = 5 mrad and no escape area
($H \rightarrow$ invis, BSM)

Consequences for the detector

- **low mass tracker:**
  - main device: **Time Projection Chamber** (dE/dx !)
  - add. silicon: eg VTX: 0.15% rad. length / layer)
- **high granularity calorimeters**

  optimised for particle flow

What to do to go for such a detector

Design (G4 and **Reconstruction**)

PANDORA
ARBOR

Prototypes , tests beam, analysis

We are here

- **Industrial design**
- **Costing**
- **Engineering**
- **Organization at the stage of pre-construction**

CONSTRUCTION

Organisation, resp. sharing,
Risks mitigation, industrial constraints,
Final design, etc…

Color code
Well advanced
In progress
Not really started

A large effort has been made on the organization
In such a way that ILD is ready to be a real collaboration

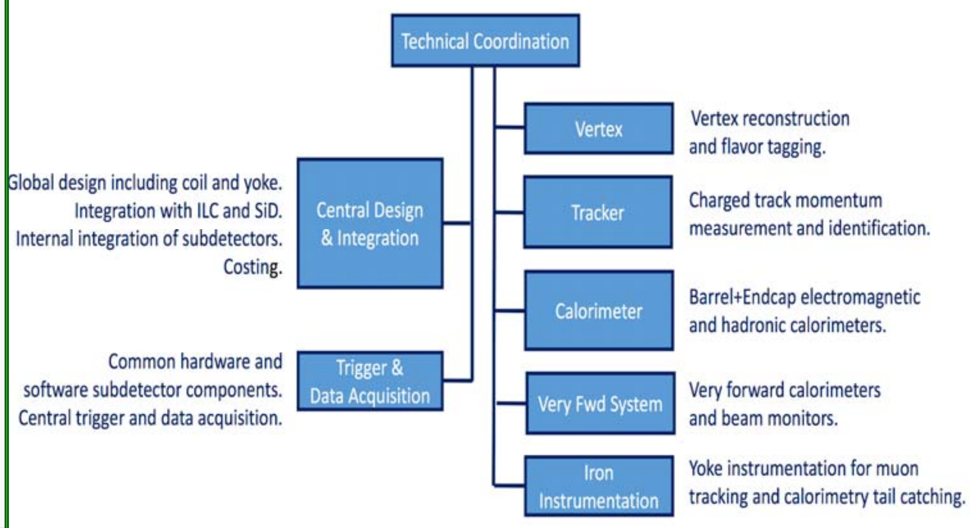
ILD spokesperson : Ties Behnke (DESY)
Deputy spokesperson: Kiyotomo Kawagoe (Kyushu Univ.)

Physics Coordinator: Keisuke Fujii (KEK)
Technical coordinator : Claude Vallée (DESY)
Sofwatre/recons: coordinator: Frank Gaede (DESY)

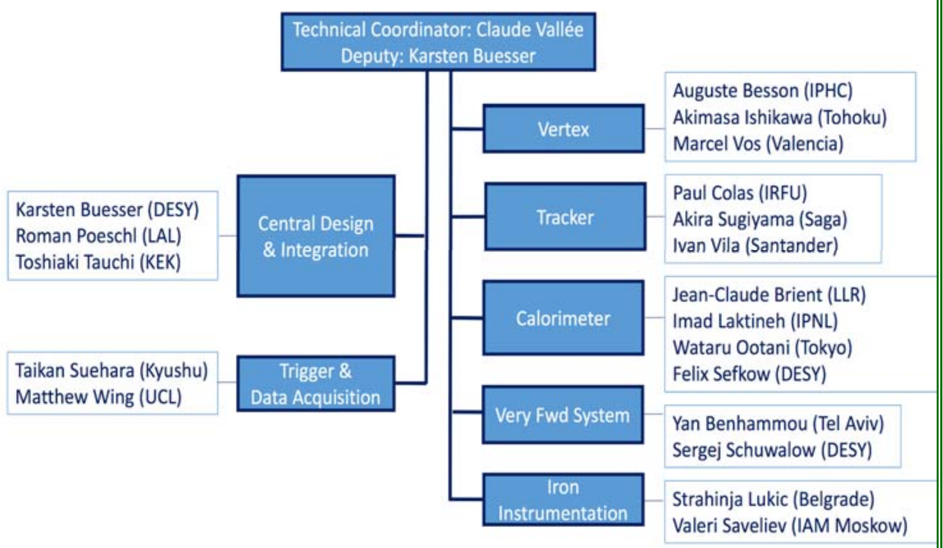
ILD executive team:
Alberto Ruiz (Spain-Santander), Yasuhiro Sugimoto (Japan-KEK), Henri Videau (France-LLR), Graham Wilson (USA-Kansas)

ILD institute assembly
Chair : Marc Winter (IPHC Strasbourg)

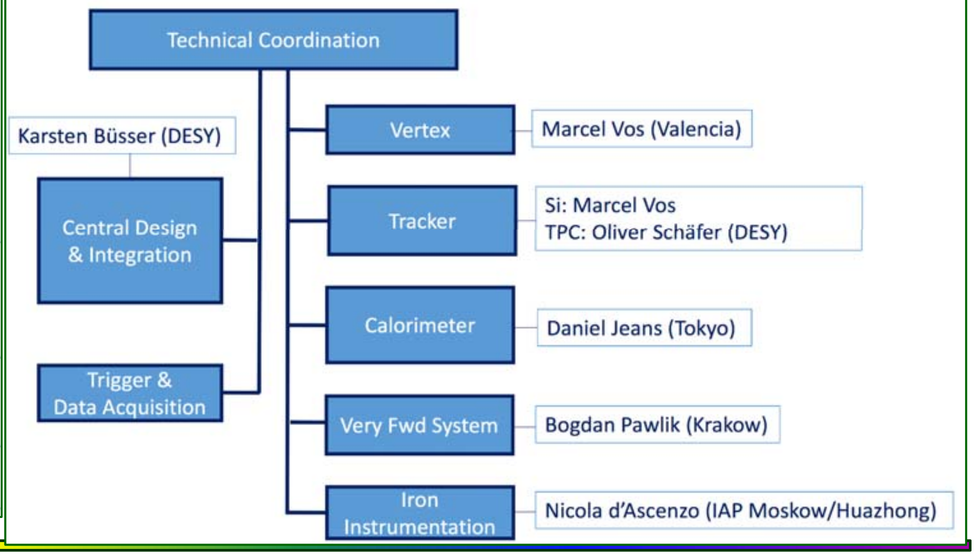
Working Group boundaries



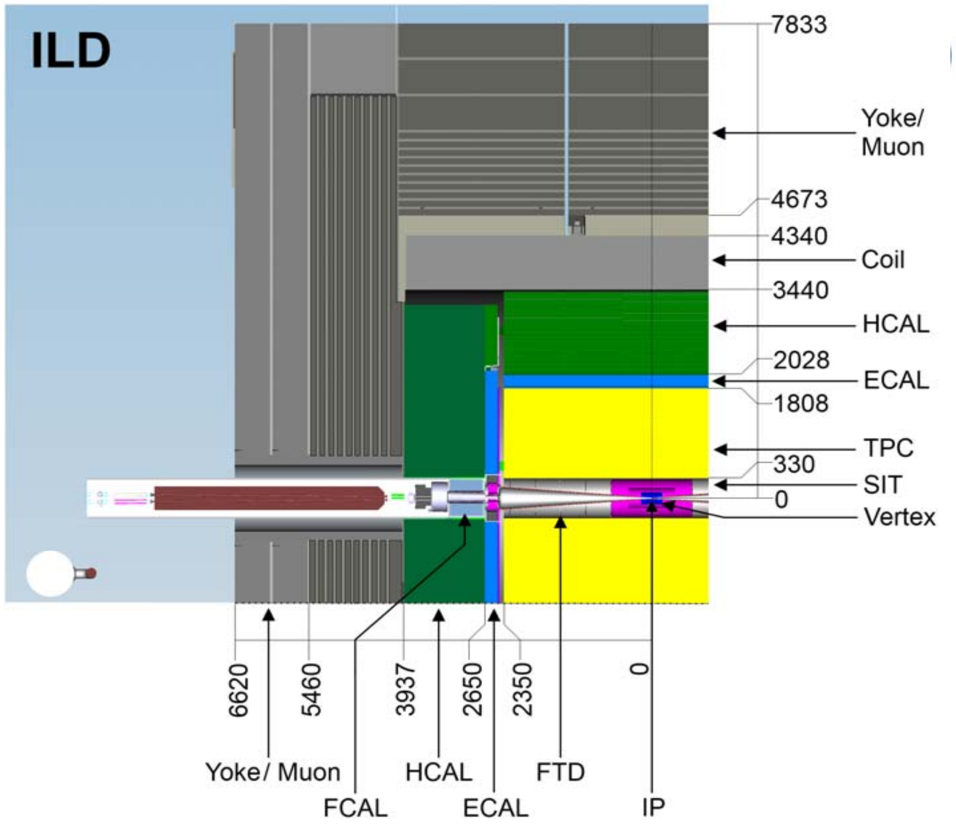
ILD technical convenors



SUBDETECTOR SOFTWARE CONTACTS



Choices of technology



Magnet 3-4 T ("a la CMS")

VDET : pixel … CMOS, DEPFET, etc…

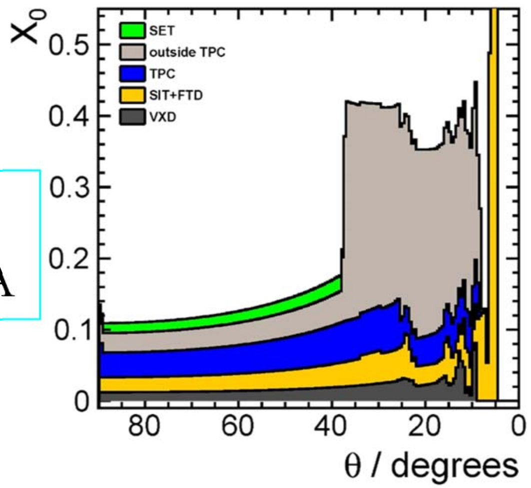
Trackers : TPC (GEM,micromegas, Pixels)
silicon pixels/strips

ECAL : silicon or scintillator – Tungsten -
Pixels : 5x5 mm² or 5x45 scint. strip
O(50M) channels → Stability, S/N, etc…

HCAL : Scint. Tile or gas RPC – Stainless steel
Pixels : 1x1 cm² (Gas RPC) or 3x3 cm² (Tile)

Constraints on the design

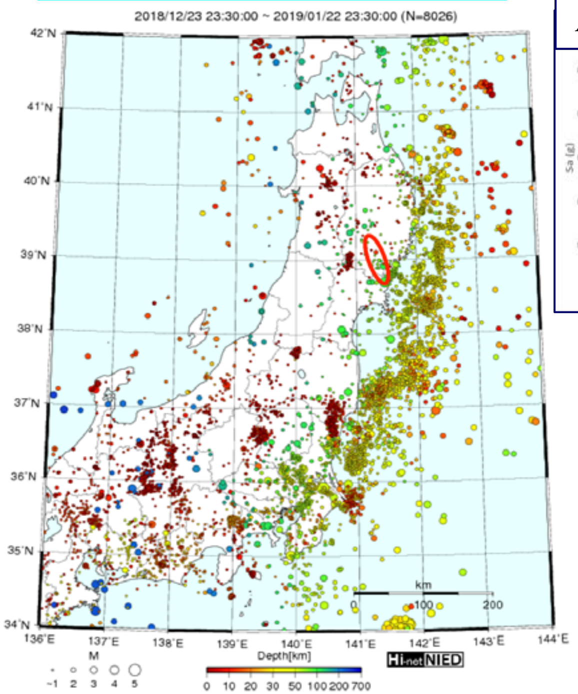
Material budget Constraint from PFA



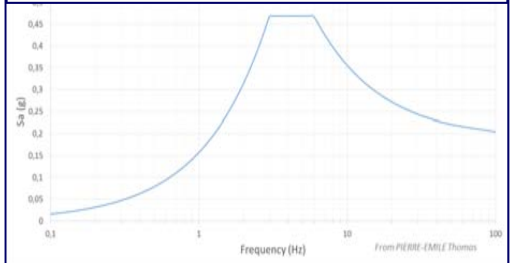
Constraint on UGCAL

- S/N in calorimetry
- Stability response
- Compactness

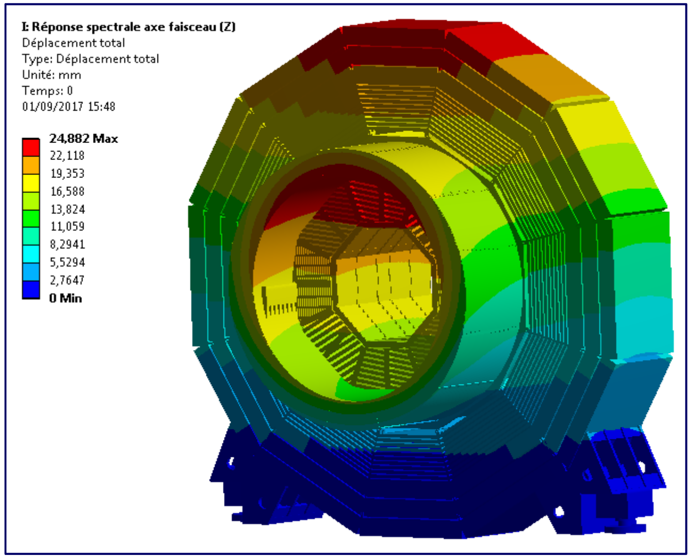
Mechanical constraint from geography



Acceleration response spectrum



earthquake peak : 2-6 Hz
(maximum stresses)



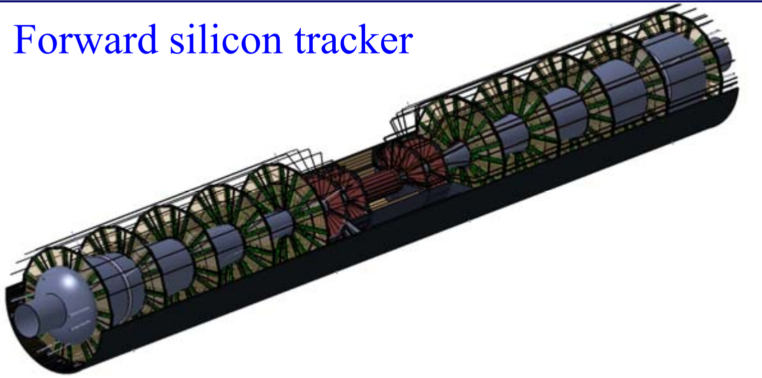
Maximum displacement: **24,9 mm**

Smallest gap between ECAL rings along z: **0,98 mm**

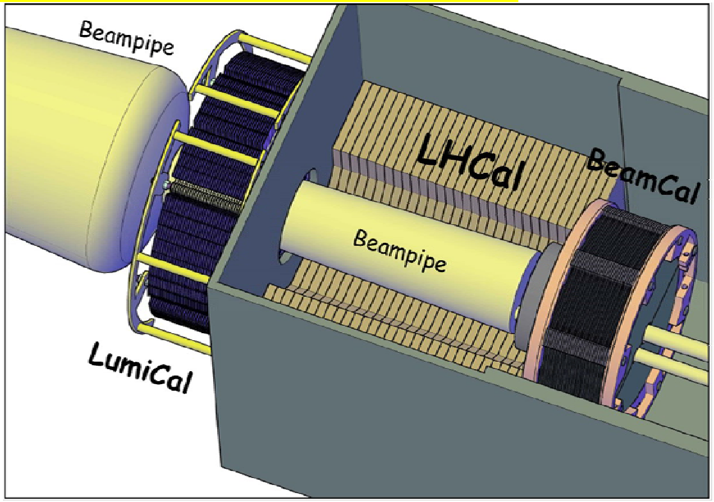
Smallest gap between ECAL module along phi: **2,29mm**

TRACKERS

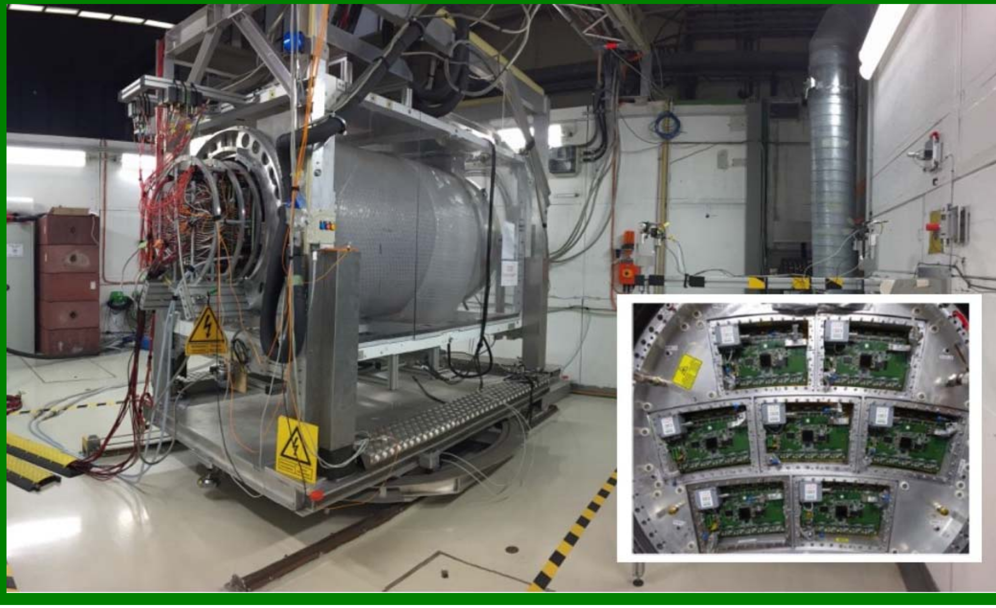
Forward silicon tracker

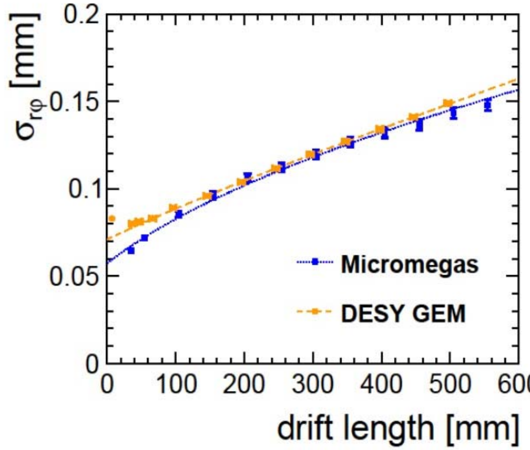


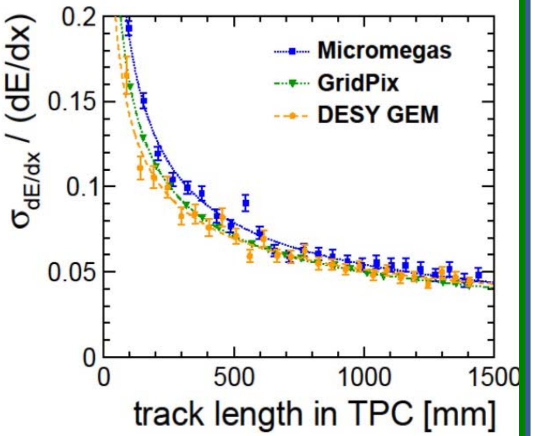
Low angle devices



TPC





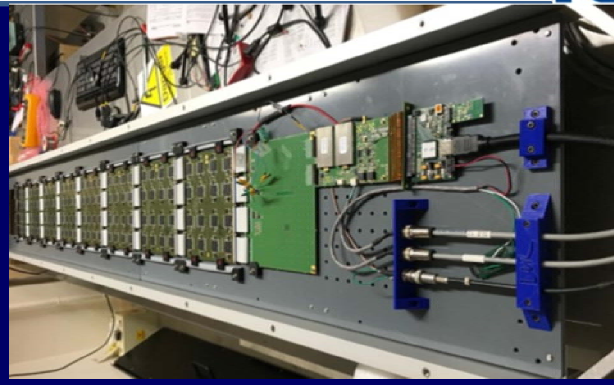


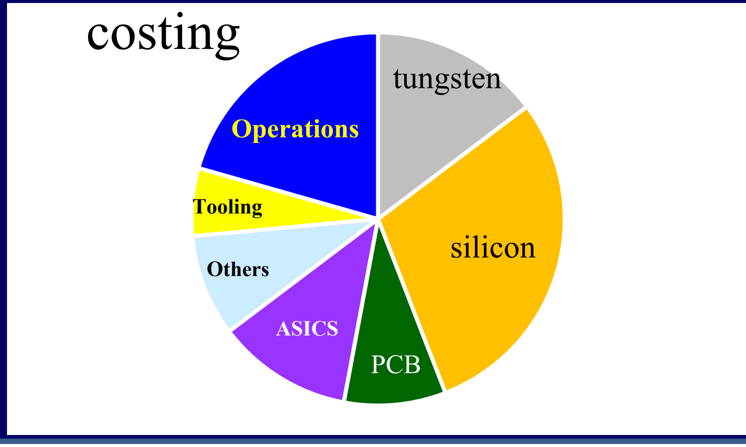
Ultra Granular ECAL

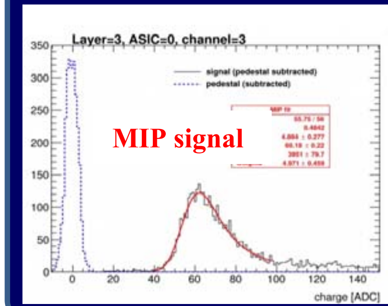
Silicon ECAL

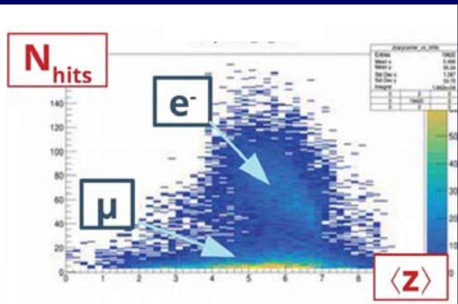
Test beam @DESY/CERN

Tungsten
Silicon diode
5x5 mm²
26-30 layers

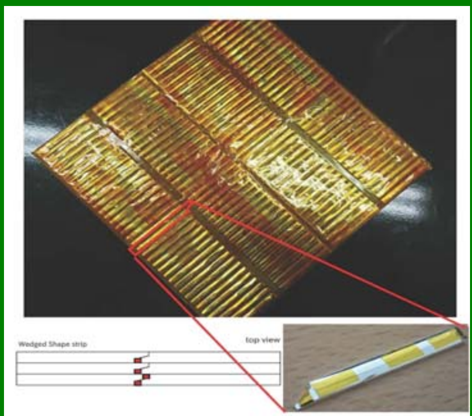




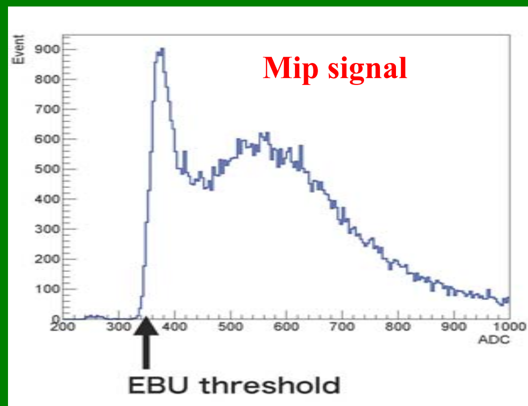




Scintillator strip ECAL



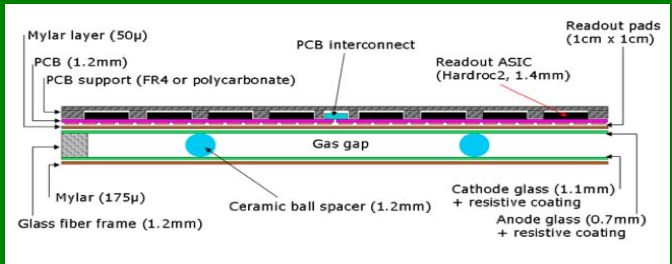
Tungsten
Scintillator strips- SiPM
45x5 mm²
26-30 layers



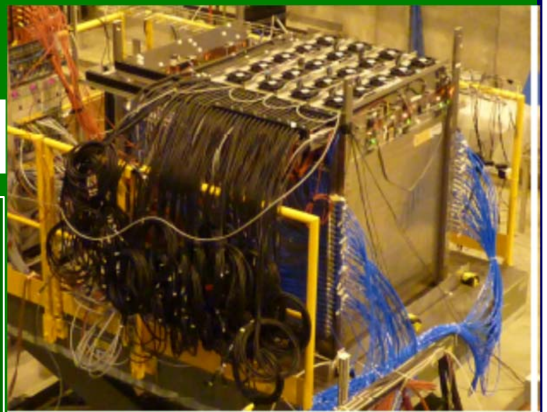
High Granular HCAL

Leprince-Ringuet

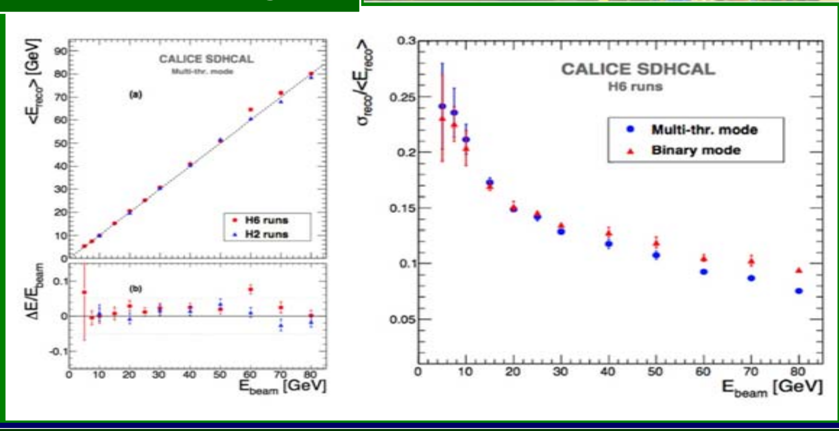
Gas/RPC HCAL



Test beam @CERN

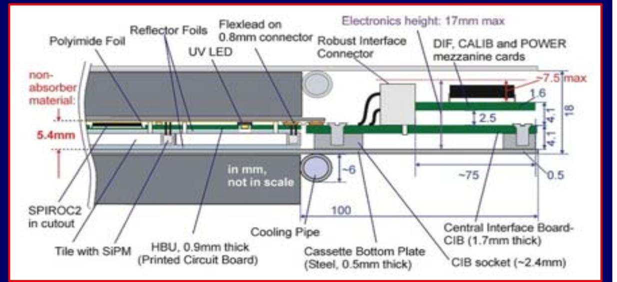


1x1 cm²
Glass RPC
Stainless steel
Readout semi-digital

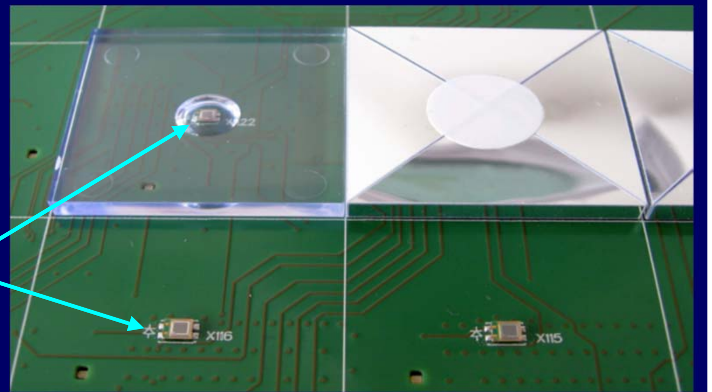


Tiles HCAL

3x3 cm²
SiPM
Stainless steel
Analog readout
45 layers



SiPM

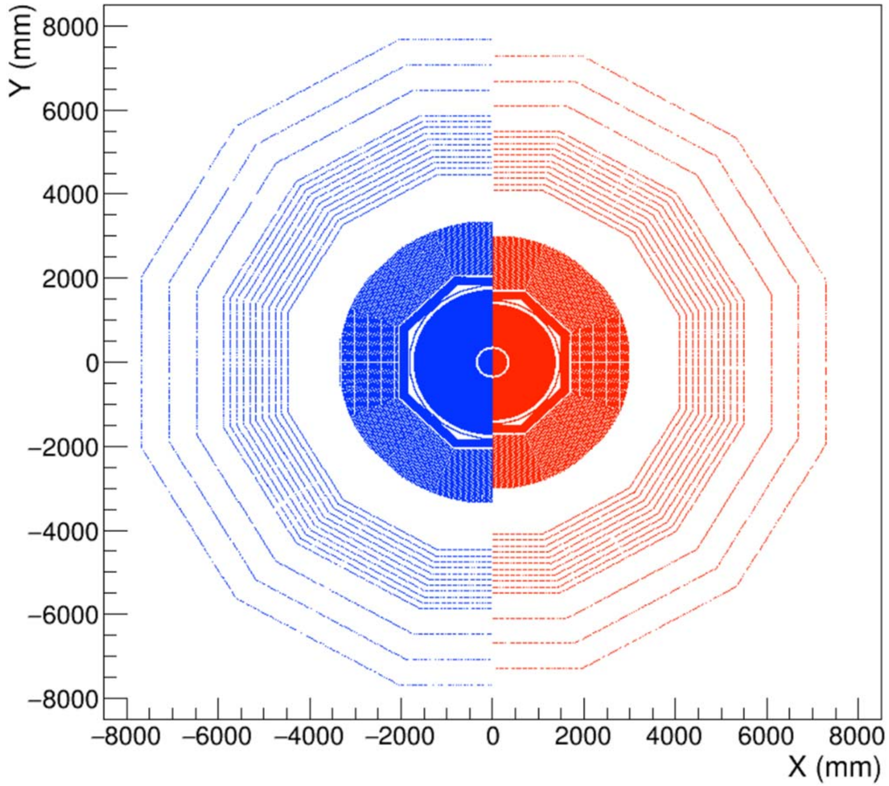


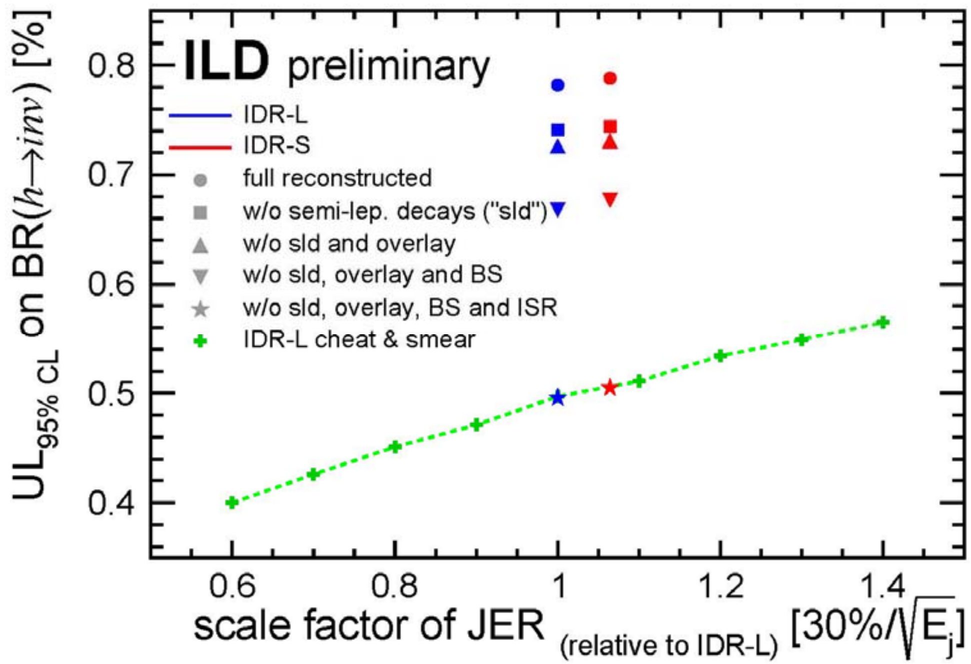
Robot for tiles HCAL construction

A HUGE EFFORT has to be made for the optimization of the detector, the reconstruction, the engineering , the relations with industry, the cost…
More precisely :

- Establish the performances versus a physics benchmarks list
- Establish the best efficient design versus cost (see next slide)
- Make technological choices (ECAL, HCAL, VDET, TPC- endplate) and establish the final design for construction
- Make the best use of the detector (i.e. Fractal dimension for PID in calo) improving the reconstruction
- Integrate all possible improvements (i.e. PID with TOF, timing in shower, 5D PFA, …)
-
-
-

"LARGE" versus "SMALL"





Summary

- e+e- collider is the future machine for Higgs precision (and more)

- ILC is still alive !!

- ILD is a design well understood for 10 years of works, and
it improves continuously (release of ILD-IDR end of the year)

There is a lot of opportunities in the ILD collaboration

- Reconstruction (i.e. 5D PFA, Lepton ID with TOF , etc…)
- Engineering (from proto to real detector- industrial "product")
- Analysis , software, hardware, etc…

CMS or ATLAS was built by > 1000 active researchers, engineers ….

ILD is today about 100 active people … it is OK for this stage, but clearly not to proceed to the next step