Report on SDHCAL

I.Laktineh

Outline

- SDHCAL status
- Road map for the two coming years
- Some personal ideas on the selection of the baseline HCAL

SDHCAL Status

-SDHCAL is the first option of ILD that has built a complete **TECHNOLOGICAL** prototype : All requirements concerning compactness, robustness and power-recycling were fully fulfilled;

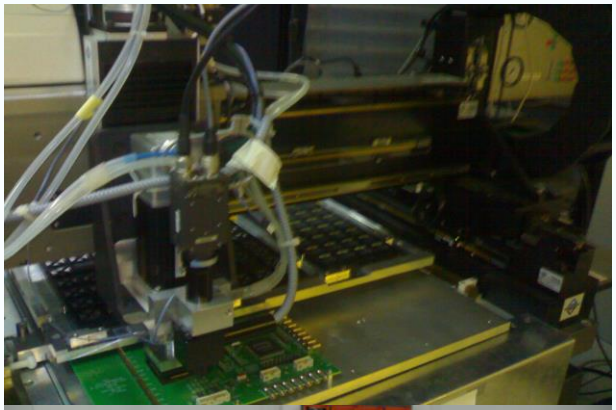
-Energy resolution results obtained with TB are very good and new techniques to improve on are being constantly developed/improved. Tracking capabilities are demonstrated;

-Description of SDHCAL included in the ILD simulation is the one of the prototype. Digitizer is based on prototype studies. No future surprise

-Physics studies based on SDHCAL are limited. Applying PANDORA in optimized way is needed. Arbor developments are ongoing.

SDHCAL prototype construction

- ✓ 10500 ASIC were tested and calibrated using a dedicated robot that was used by CMS (IPNL, OMEGA) (ASICs layout : 93%).
- ✓ 310 PCBs were produced, cabled and tested (IPNL). They were assembled by sets of six to make 1m^2 ASUs
- ✓ 170 DIF(LAPP), 20 DCC(LLR) were built and tested.
- ✓ 50 detectors were built and assembled with their electronics into cassettes. Cassettes were tested by sets of 6 using a cosmic test bench (IPNL).
- ✓ The mechanical structure was built in CIEMAT.
- ✓ HV, cooling services were built by UCL, Gent.
- ✓ Full assembly took place at CERN.



Prototype @TB

3 periods of TB in 2012 (5 weeks)

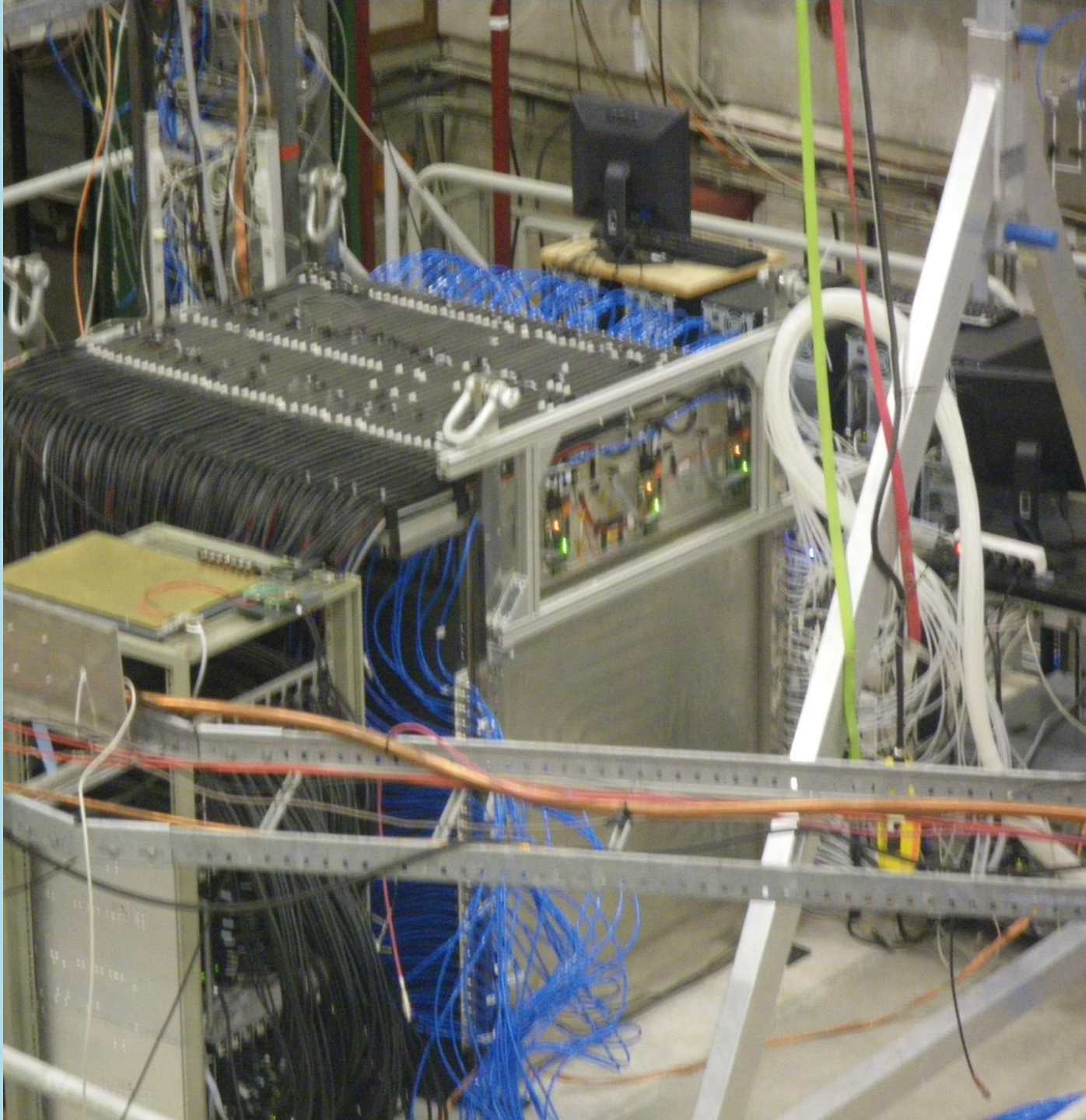
→ SDHCAL Commissioning with Trigerless, Power-Pulsing modes;

→ Thresholds choice optimization;

→Muons run calibration;

→ Pion, electron runs to study EM and hadronic showers;

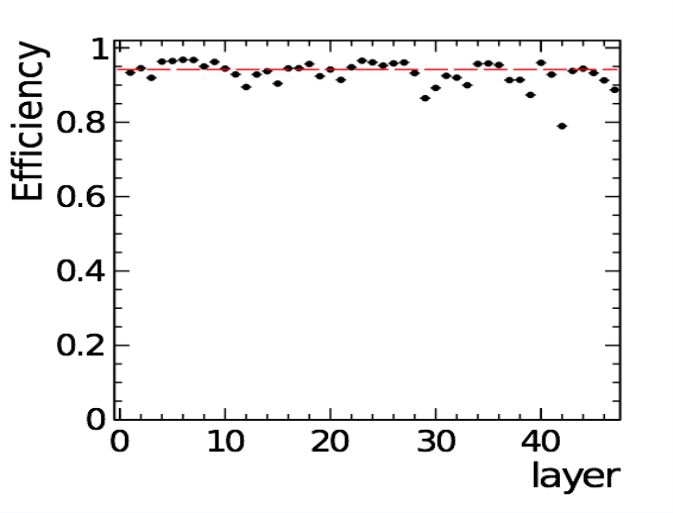
→No particle identification detector was used.



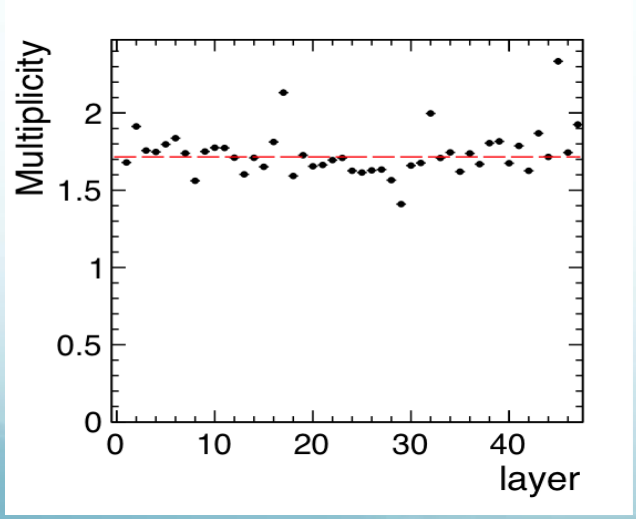
First results on linearity and energy resolution

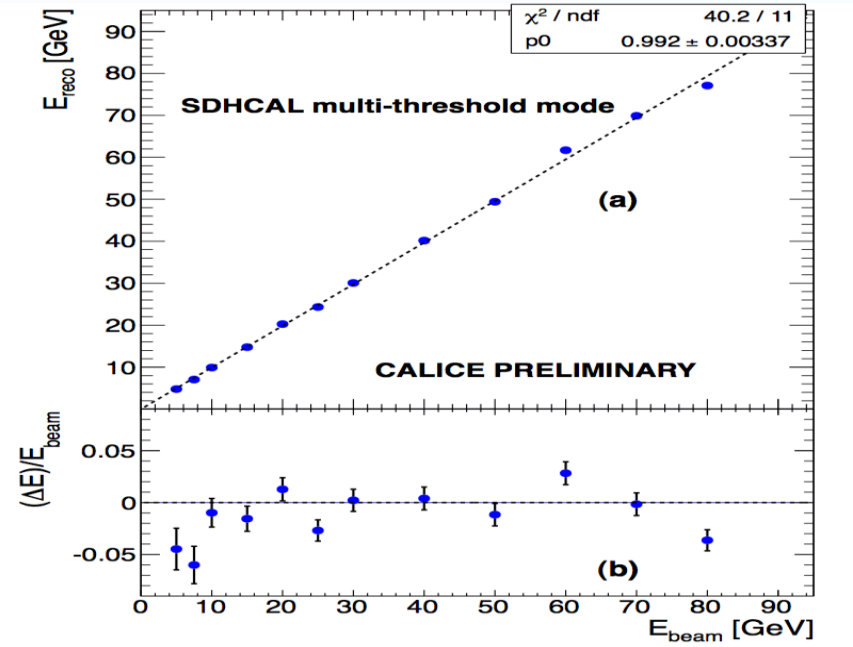
with no calibration and with no gain correction,
No tail-catcher

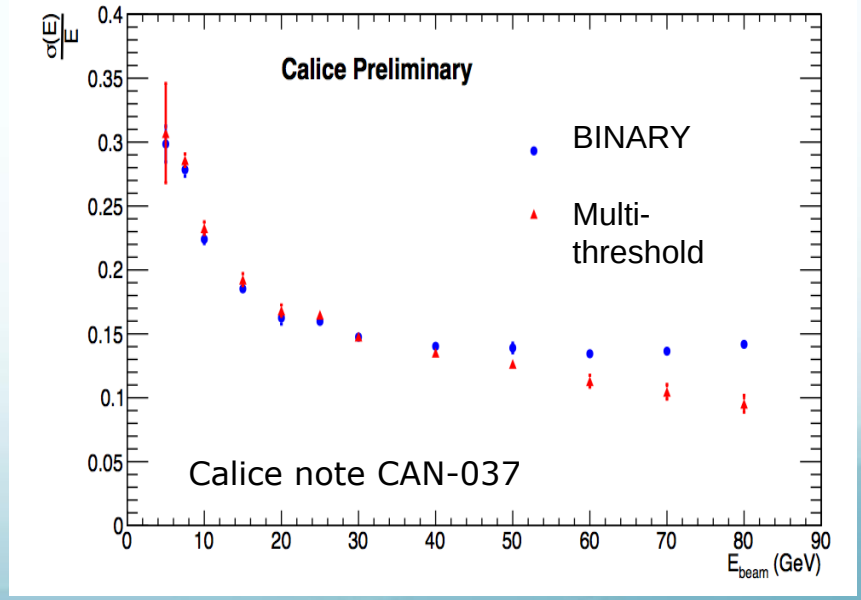
Efficiency



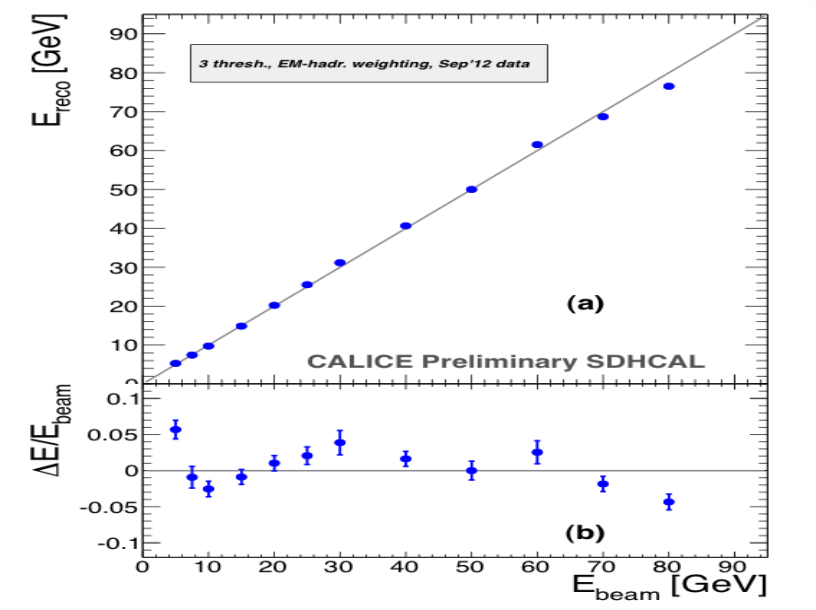
Pad multiplicity

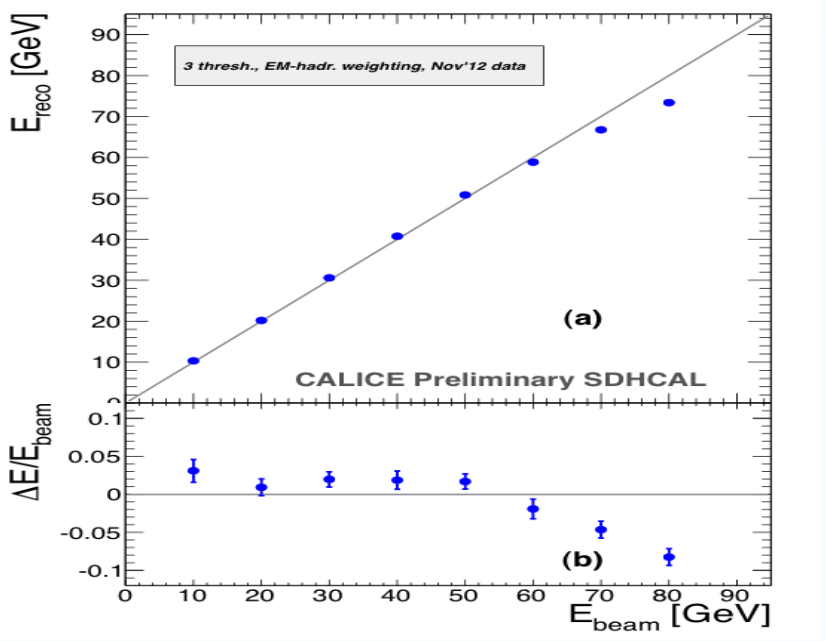


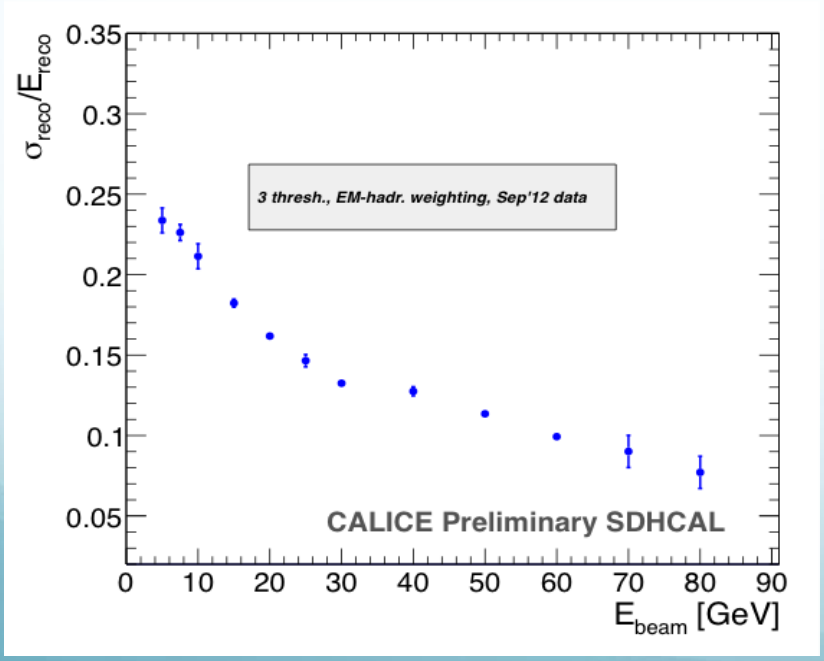


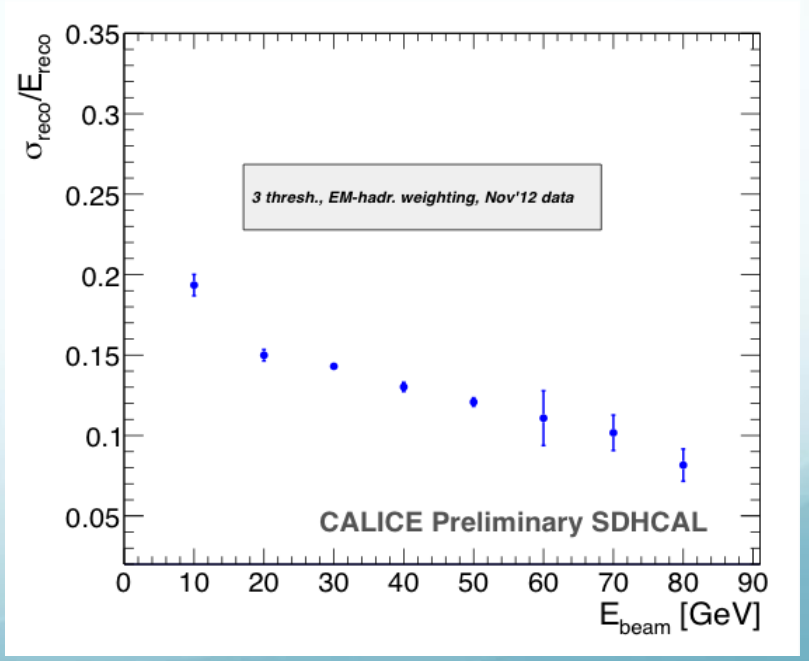


Semi-digital improvement with respect to digital version.

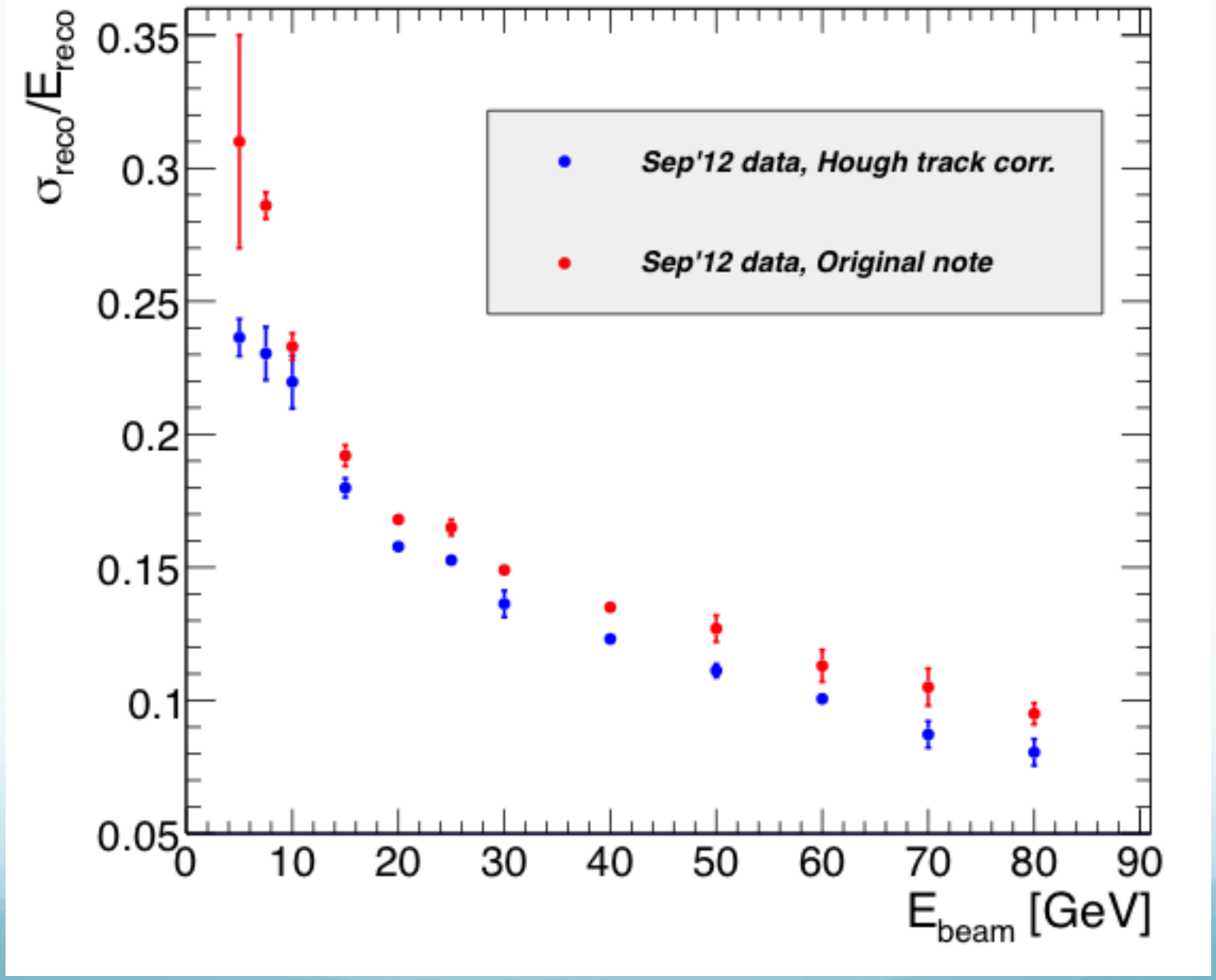

3 thresh., EM-hadr. weighting, Sep'12 data
E_{reco} [GeV]
(a)
CALICE Preliminary SDHCAL
$\Delta E/E_{beam}$
(b)
E_{beam} [GeV]


3 thresh., EM-hadr. weighting, Nov'12 data
E_{reco} [GeV]
(a)
CALICE Preliminary SDHCAL
$\Delta E/E_{beam}$
(b)
E_{beam} [GeV]


3 thresh., EM-hadr. weighting, Sep'12 data
σ_{reco}/E_{reco}
CALICE Preliminary SDHCAL
E_{beam} [GeV]


3 thresh., EM-hadr. weighting, Nov'12 data
σ_{reco}/E_{reco}
CALICE Preliminary SDHCAL
E_{beam} [GeV]

Improvement of energy resolution

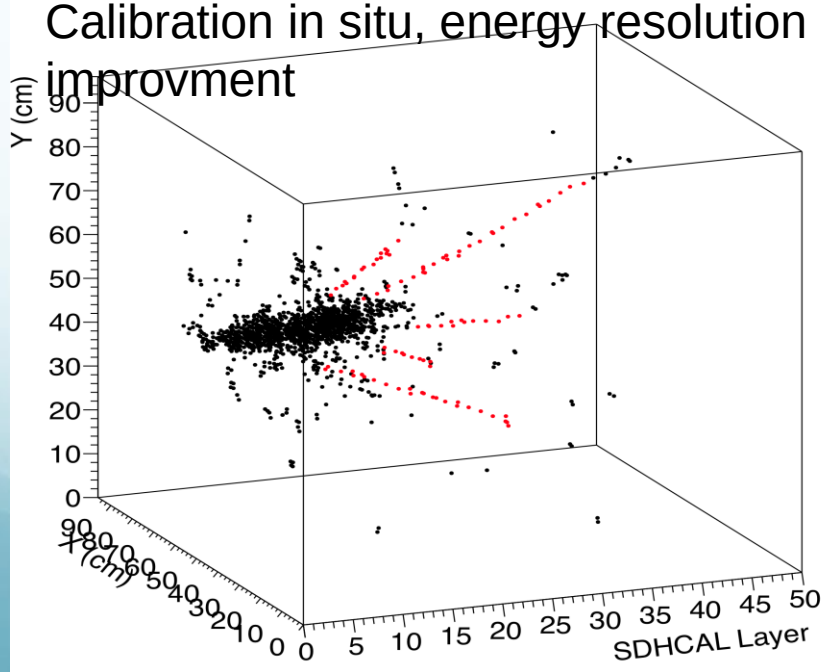


Ongoing analyses

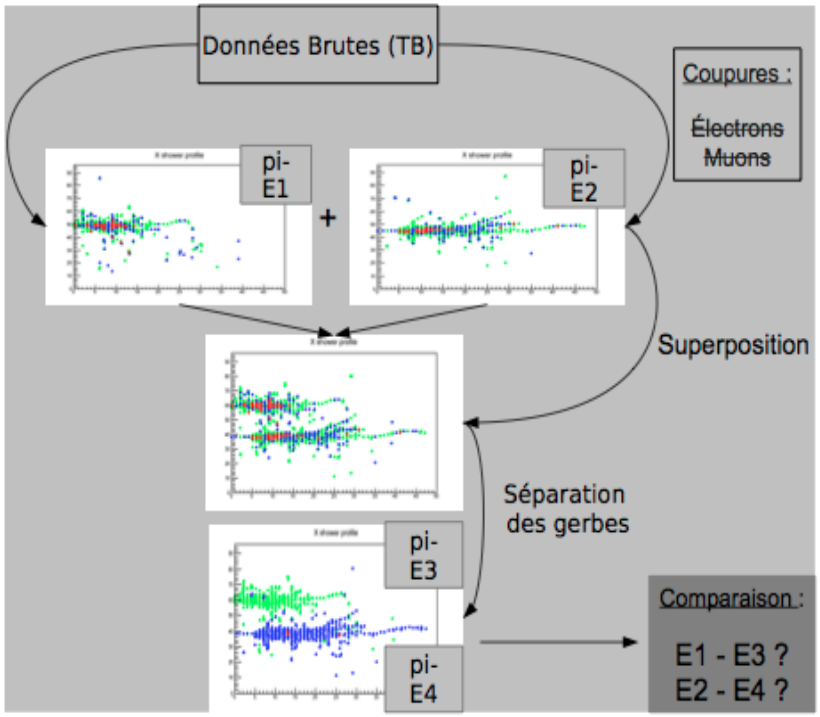
→ Calibration study;
→Electron-Pion separation;
→ Energy resolution improvement by taking into account hadronic shower structure and calibration correction: *an improvement of up to 20 % already achieved with respect to the preliminary ones obtained immediately after TB;*
→ Imaging algorithm developments (HT, Arbor, MST) → PFA

Hough

Calibration in situ, energy resolution improvment



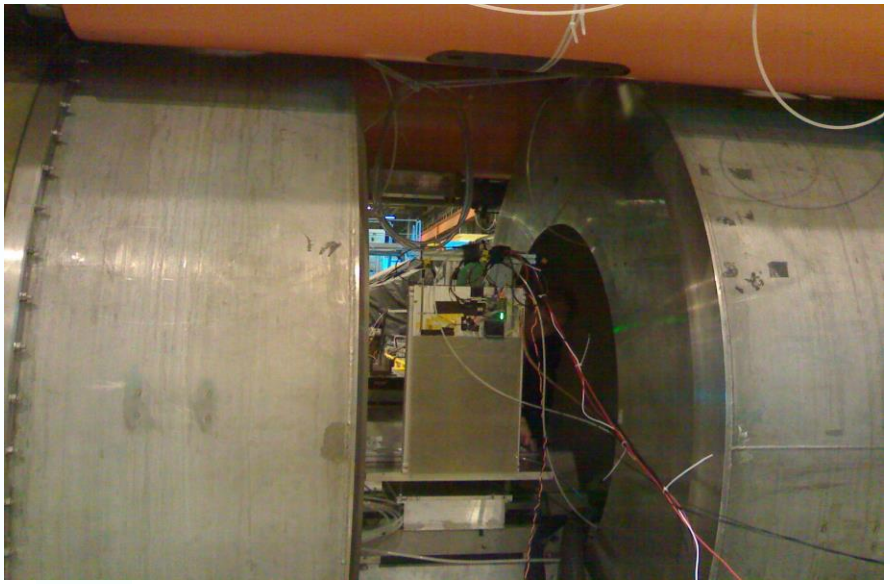
Arbor, Pandora, MST..

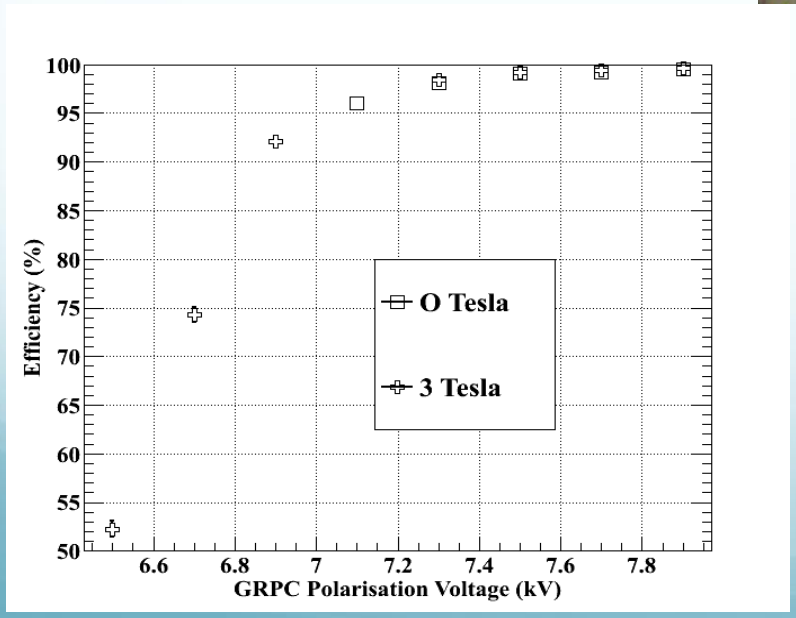


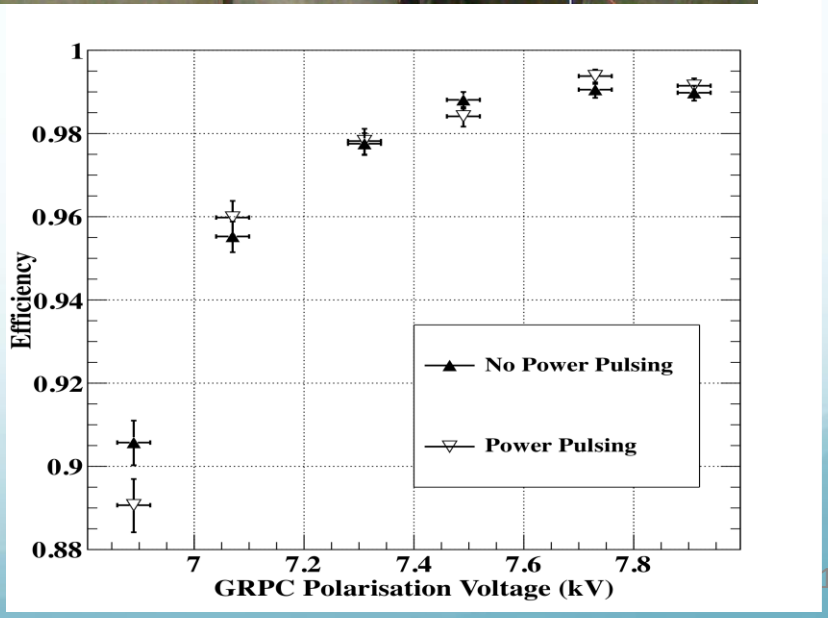
Power-Pulsing mode was tested in a magnetic field of 3 Tesla

The Power-Pulsing mode was applied on a GRPC in a 3 Tesla field at H2-CERN
(2ms every 10 ms)
No effect on the detector performance

ILC duty cycle :
1ms (BC) every 200 ms



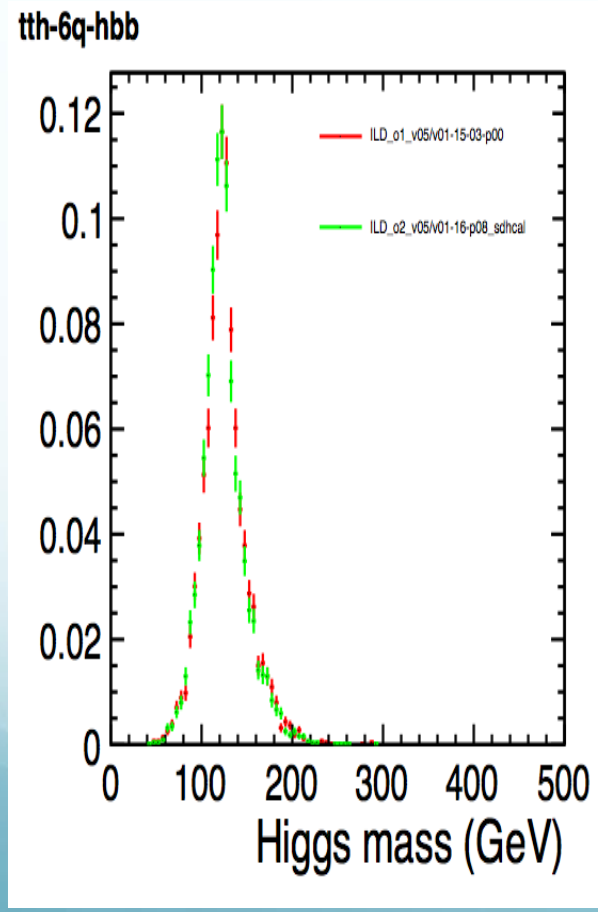


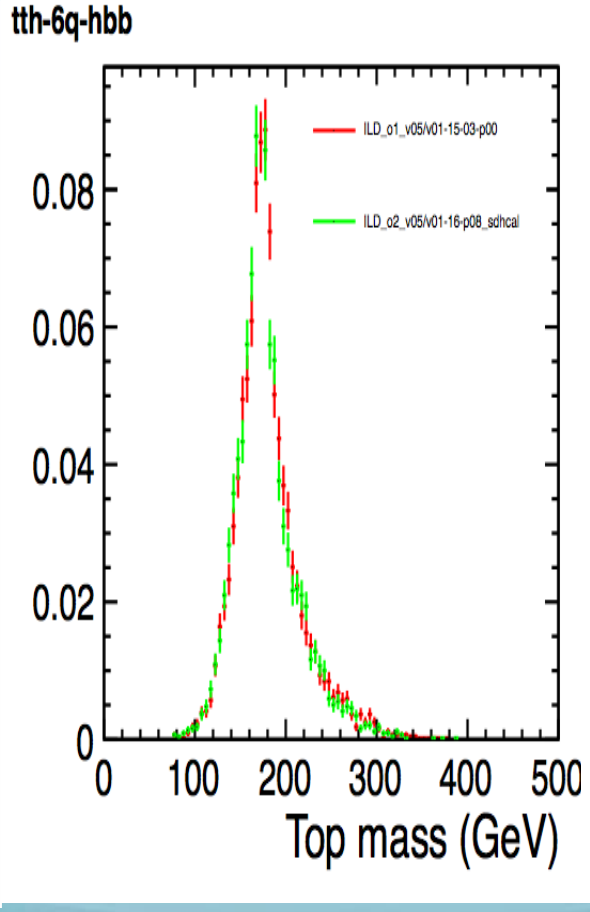


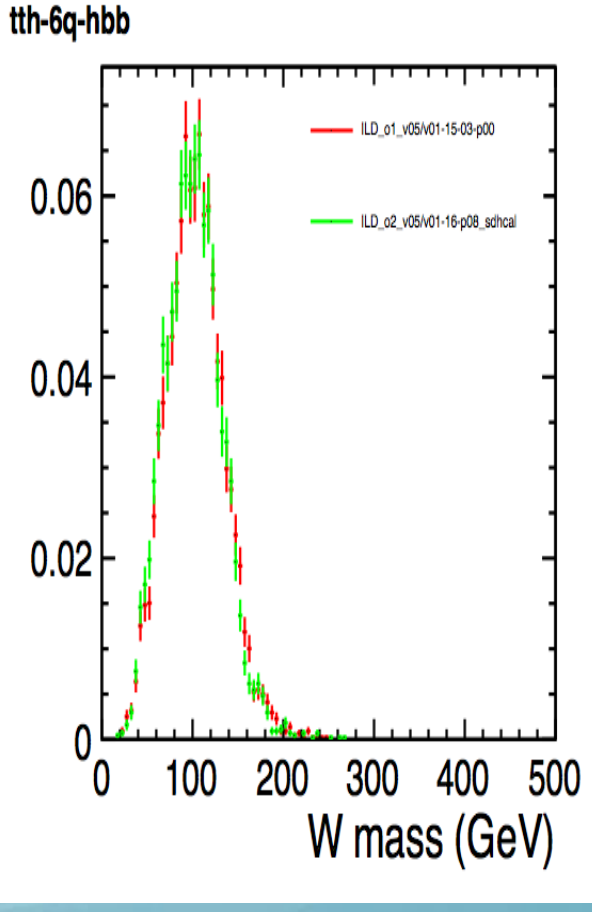
Simulation and optimization studies

The SDHCAL simulation was re-performed taking into account the constraints and the results of the prototype. The new version was used for the DBD studies, showing that same performance are obtained as for the AHCAL (albeit the PFA optimization was done for the AHCAL topology)

Higgs, top and W in the tth 8jet mode (1000 GeV).



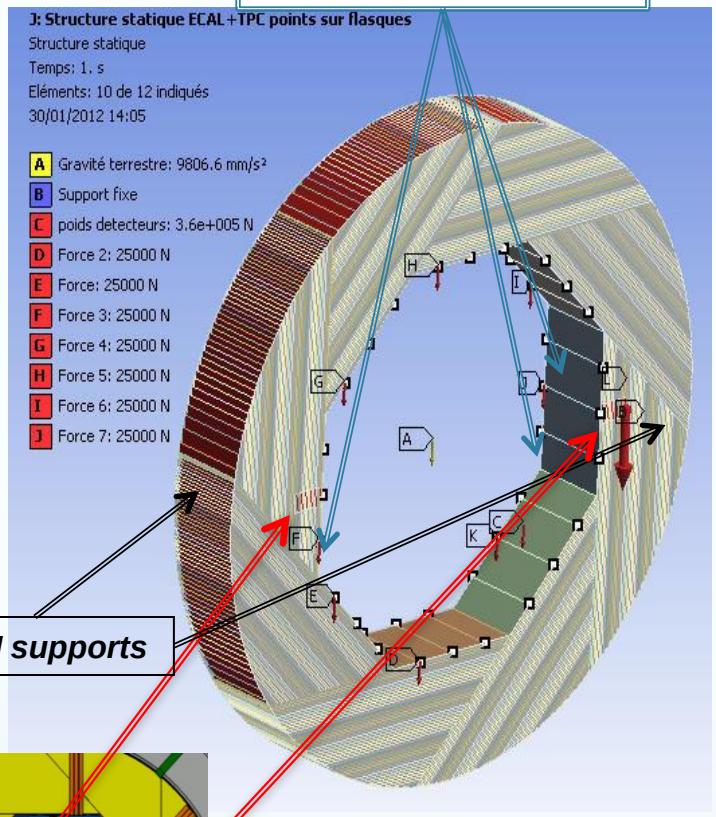




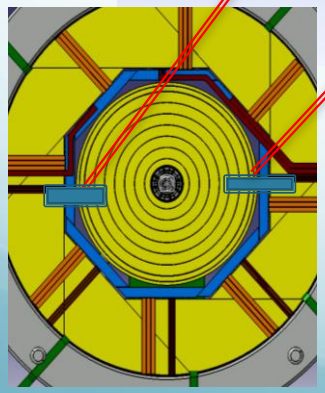
Tomohiko Tanabe

Mechanical, integration, service studies

ECAL Loads on points



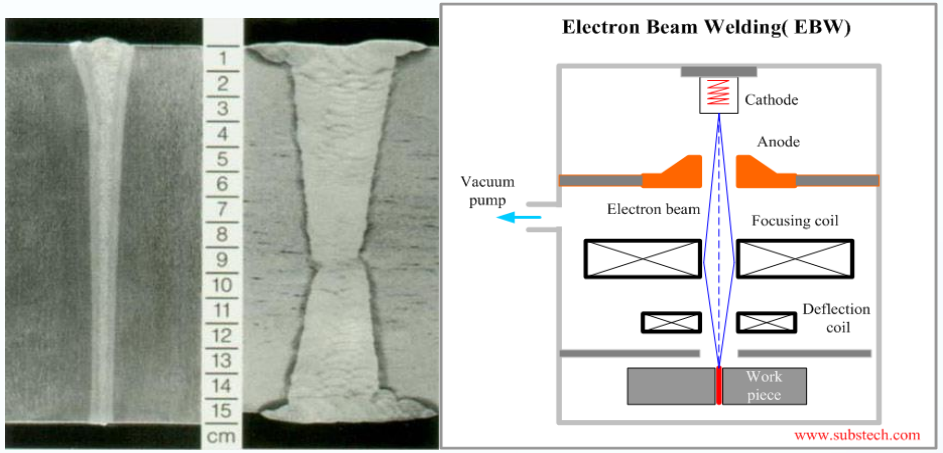
9-15H supports



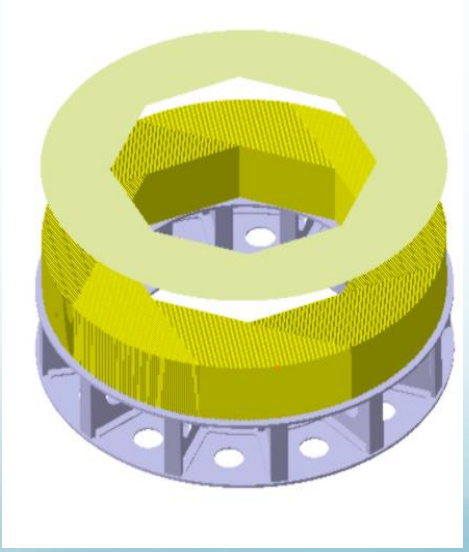
DHCAL with 8 x ECAL modules (8x2.5 t)

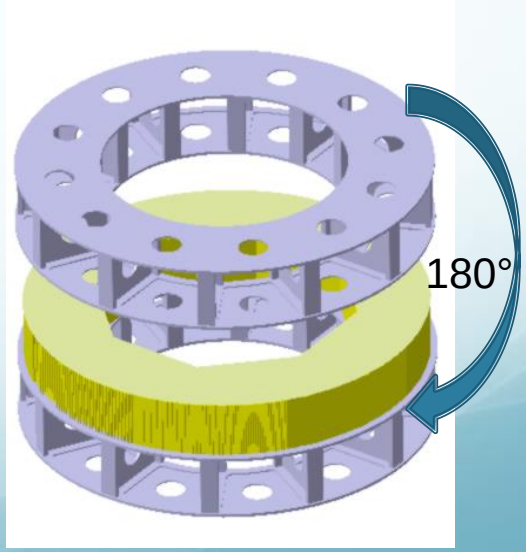
And TPC (4t)

Welding techniques



Building scenarios

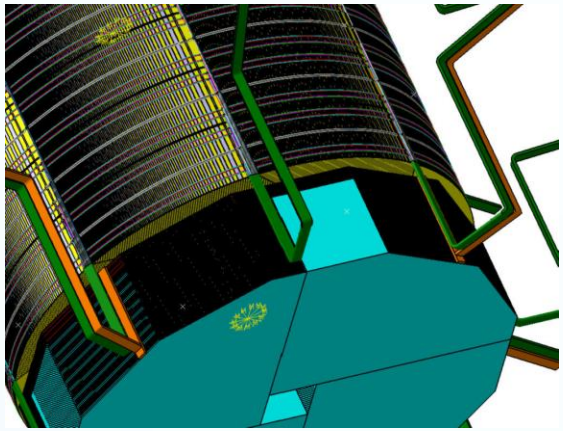


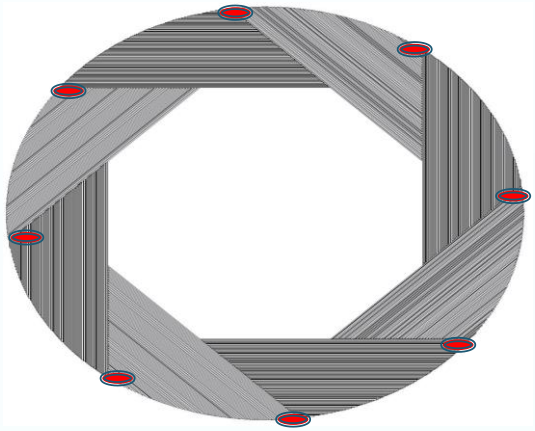


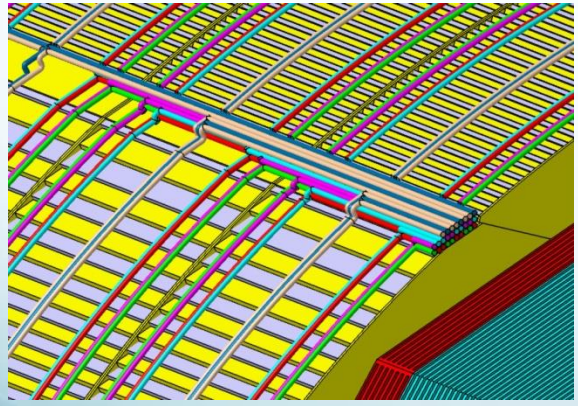
Deformation max SDHCAL + ECAL + TPC = 0,4 mm

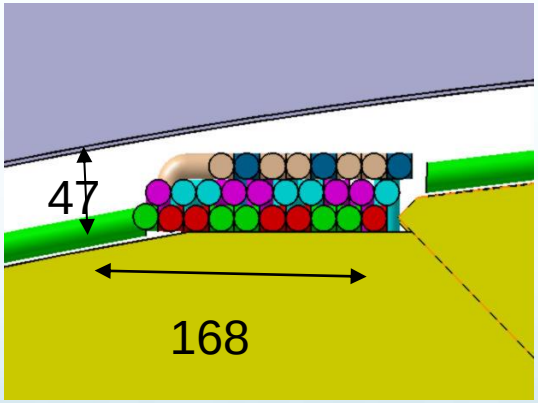
Mechanical, integration, service studies

Services were studied in detail to provide a realistic model for the ILC DBD

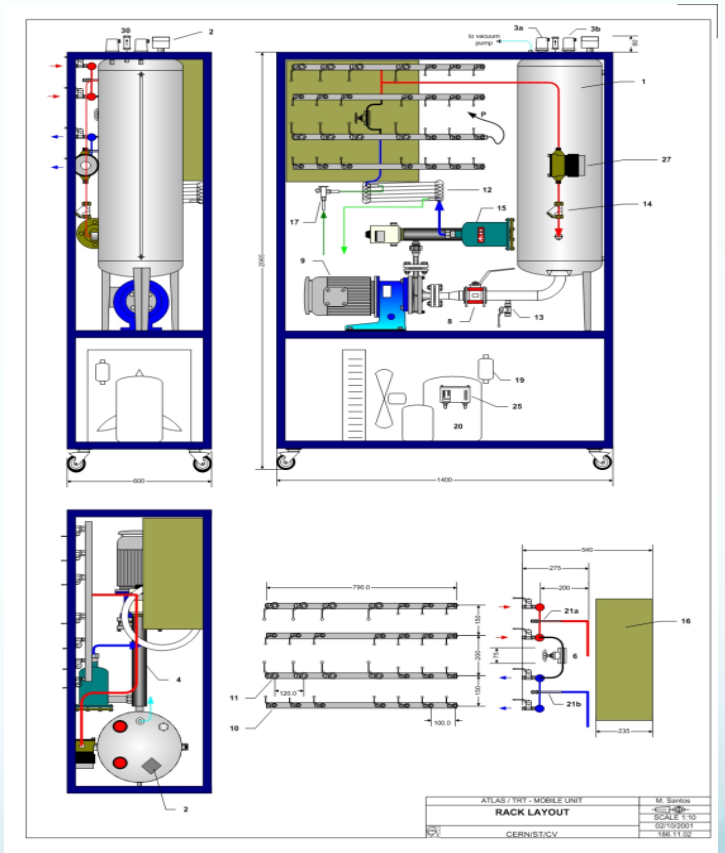








Few cooling scenarios were studied and compared with each other



Mono-phasic gas like C6F14 : limited effect in case of leak, good quality/price ratio, adapted to low heat extract, simple to use

Road map in the 2 coming years

-Improve on the energy reconstruction using new techniques;
-Improve on simulation (digitizer) and compare hadronic shower models to data;
-Develop PFA techniques to be used to separate close-by hadronic showers;
-Perform combined TB (…+ECAL+SDHCAL+…);
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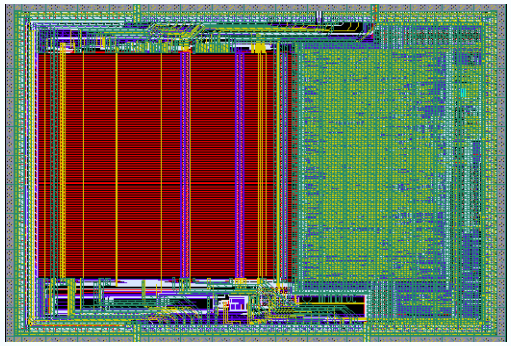
-Build few very large GRPC detectors (2-3 m2) : gas circulation system, thickness…;

-Test the new version of electronics (I2C, ..) ;
-Adapt the ASU architecture to read the large GRPC (up to 3 m^2);
-Develop a new DIF (low consumption, reduced size, new functionalities);
-Build a small mechanical prototype to host the few large chambers and test it.

New version of the readout electronics

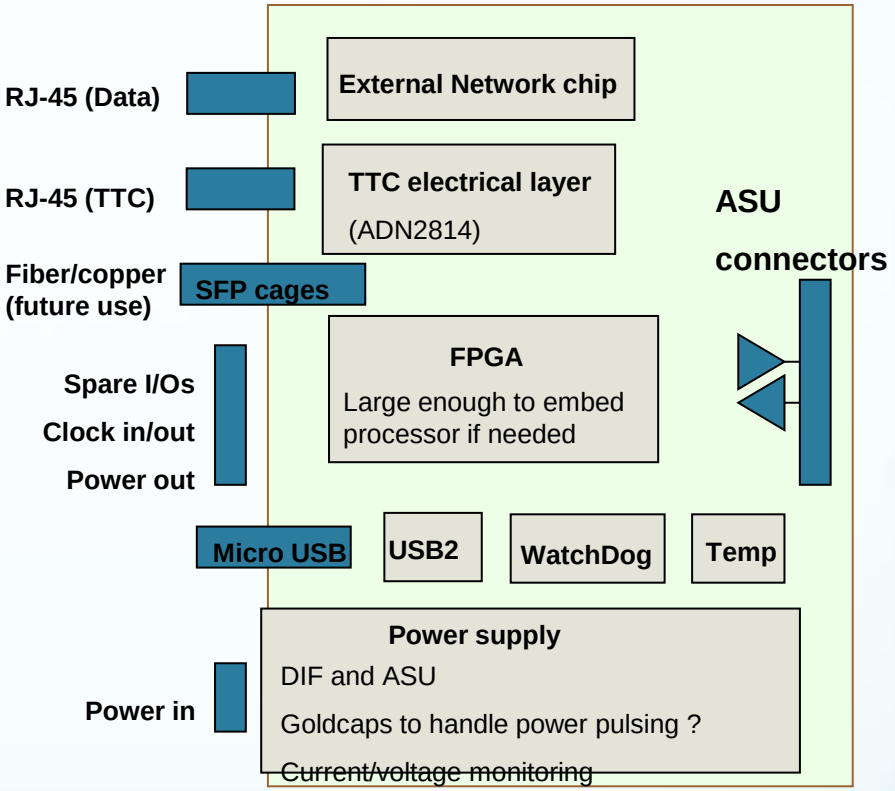


The new version improves on the previous one:
→Independent channels and zero suppression;
→Independent ASICs (I2C);
→Better dynamic range (up to 50 pC).

successfully tested. Production of ASICs to equip at least one large detector is foreseen for next year

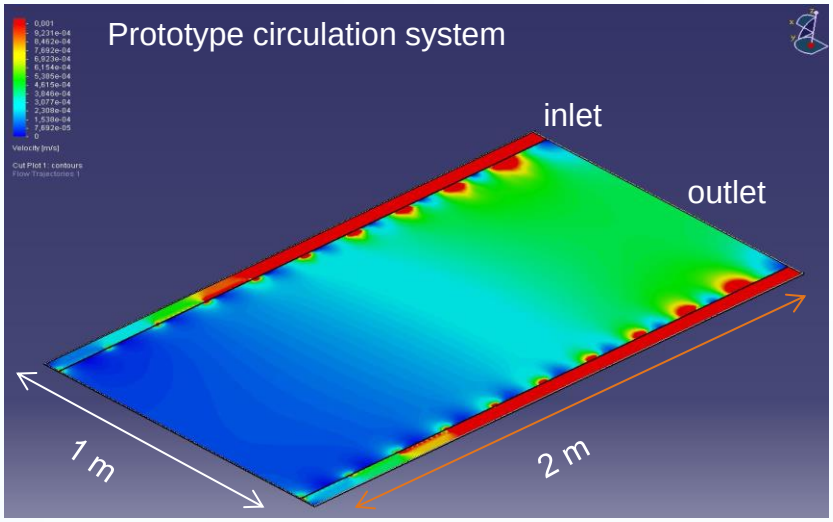
New ASU design for large detectors under study

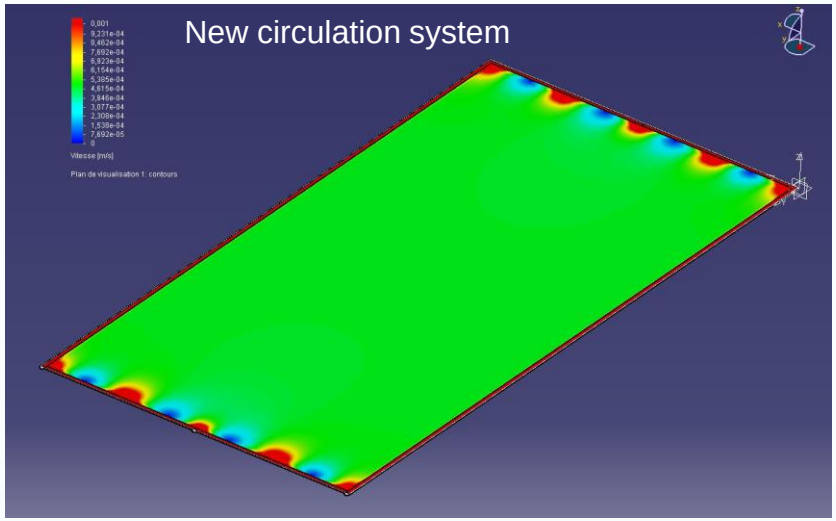
New features in the DAQ boards



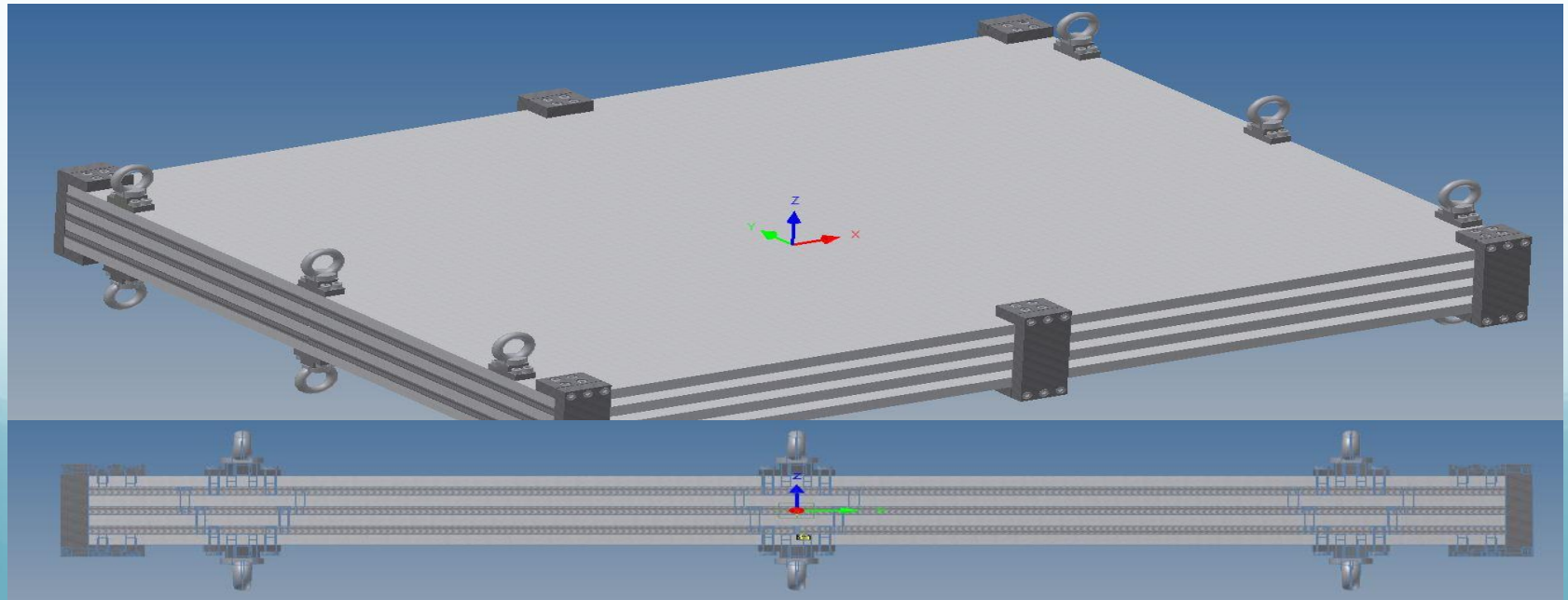
→ Only one DIF per plane. For the maximum length plane (1x3m) the DIF will handle 432 HR3 chips;
→ Slow control through the new HR3 I2C bus;
→ Data transmission to DAQ by Ethernet using commercial switches;
→ Clock and synchronization by TTC.

Detector improvement : to achieve same performances with very large GRPCs





Mechanical structure : to be built with EBW techniques and to host few large detectors GRPCs



A few personal ideas about the selection of the baseline option

To be able to select one technology as the baseline option :

1- The comparison should be based on ILC-like prototypes.

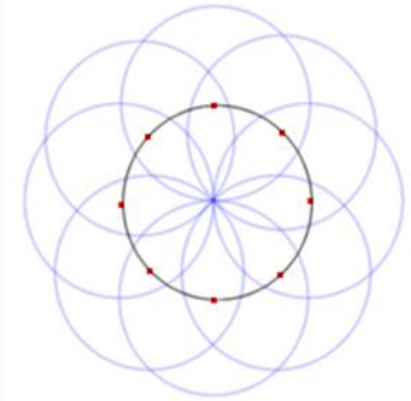
Results are relevant only in the conditions of ILC (power-pulsing, compactness…)

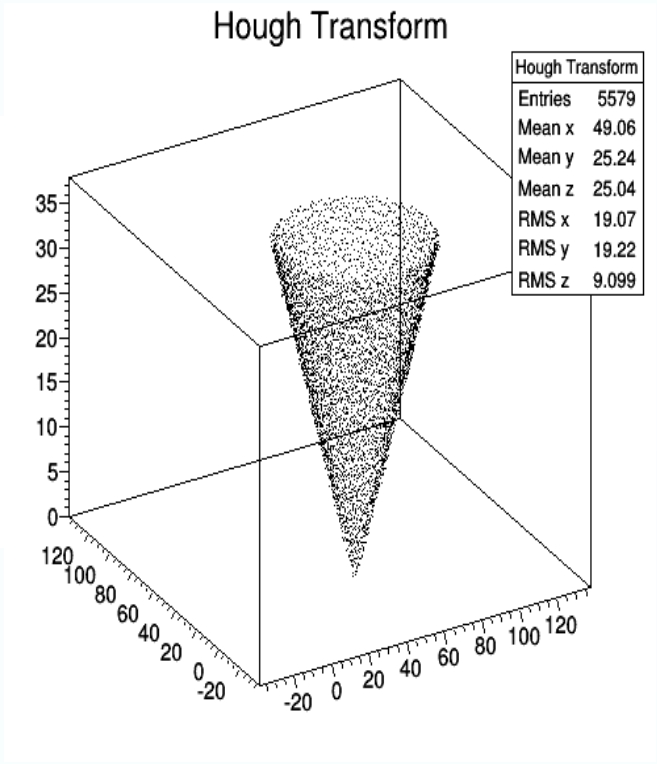
2- The options should be compared according to their PFA&physics performances. This takes into account the role of other detectors. Combined tests are of big importance to clarify things.

3- If PFA&physics performances are similar then the cost becomes an issue. In this case cost estimate should be based only on the one of the TDR time.

4- If all aspects are similar one should take into account the robustness of the collaboration to support the different options.

5- Finally, one should be able to change the baseline even after the TDR if the if the previous criteria change.




Hough Transform
Hough Transform
Entries 5579
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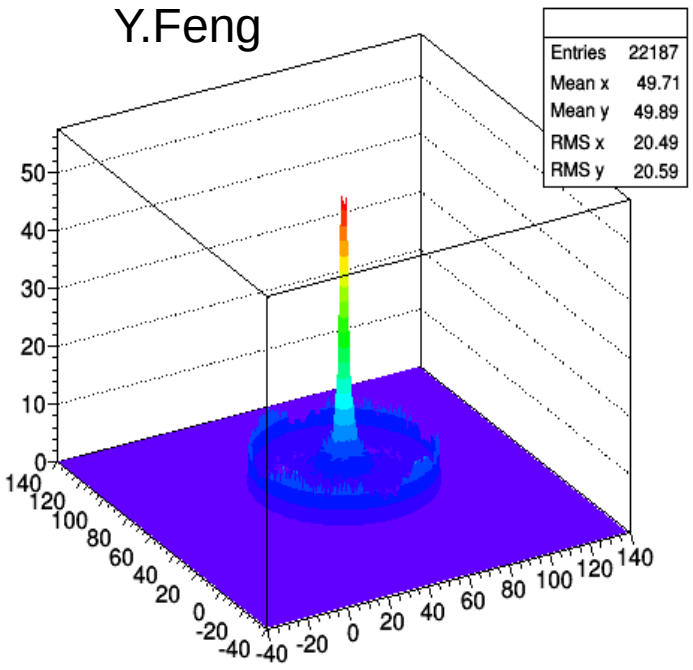
Mean y 25.24
Mean z 25.04
RMS x 19.07
RMS y 19.22
RMS z 9.099


Y.Feng
Entries 22187
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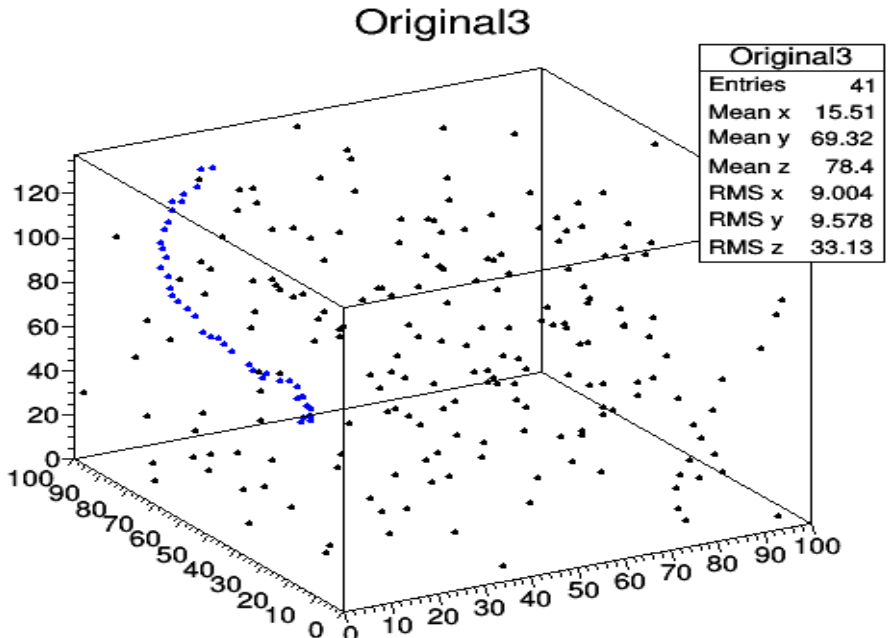
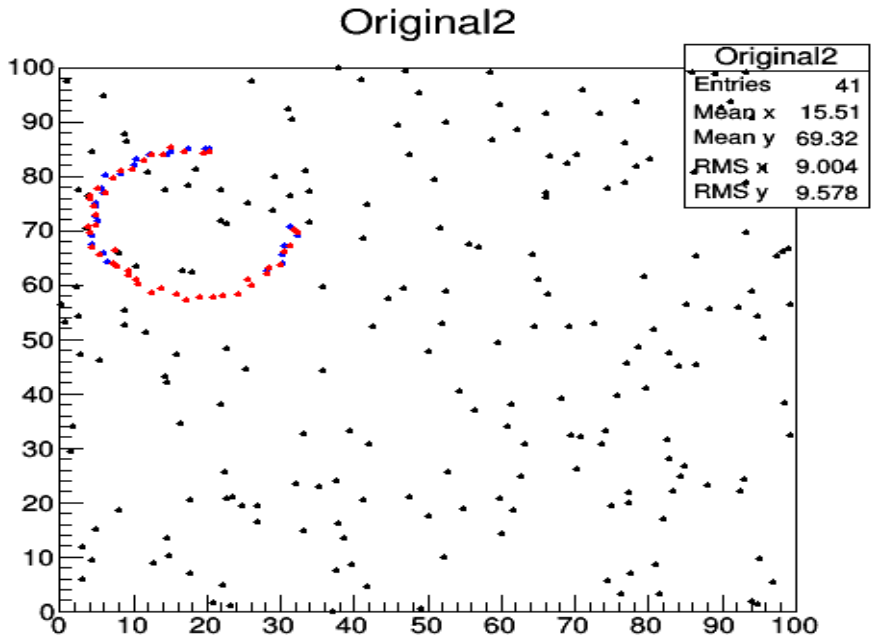
Mean y 49.89
RMS x 20.49
RMS y 20.59


Original3
Original3
Entries 41
Mean x 15.51
Mean y 69.32
Mean z 78.4
RMS x 9.004
RMS y 9.578
RMS z 33.13


Original2
Original2
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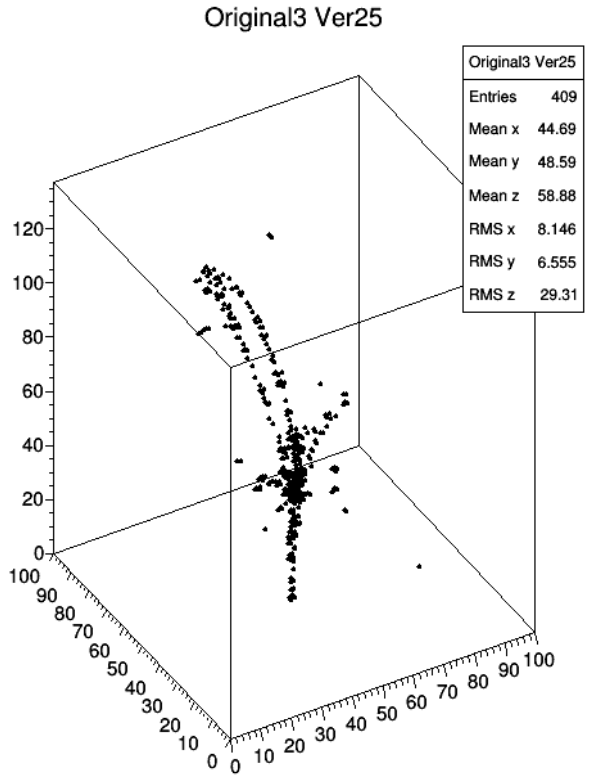
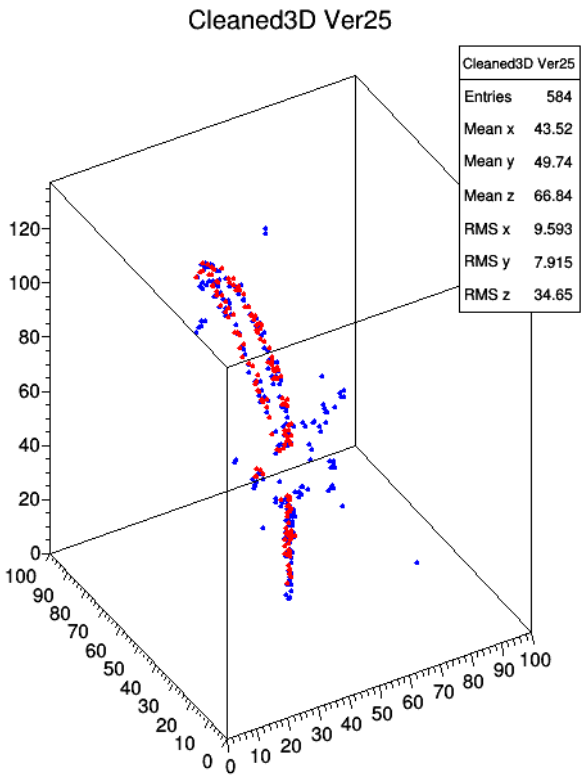
Mean y 69.32
RMS x 9.004
RMS y 9.578

Y.Feng


Original3 Ver25
Original3 Ver25
Entries 409
Mean x 44.69
Mean y 48.59
Mean z 58.88
RMS x 8.146
RMS y 6.555
RMS z 29.31


Cleaned3D Ver25
Cleaned3D Ver25
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Mean z 66.84
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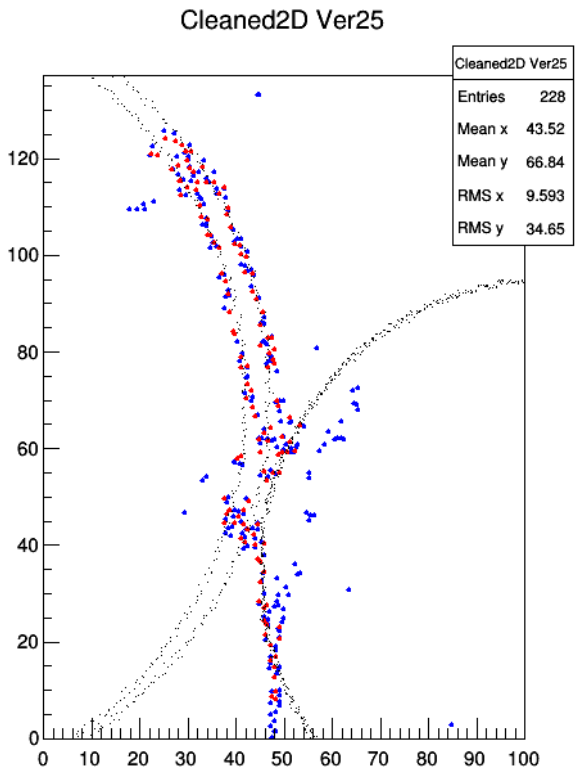
RMS y 7.915
RMS z 34.65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Cleaned2D Ver25
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Mean y 66.84
RMS x 9.593
RMS y 34.65