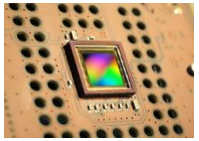
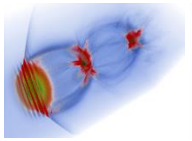
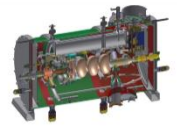
Matter and Technologies

Prototype for a Highly Granular Analogue Hadron CALorimeter

Future detector at ILC

Olin Lloyd Pinto, Katja Krüger, DESY

Matter and Technology, Berlin, 11 June 2018

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Outline

- International Linear Collider
- Brief description of the AHCAL detector design
- AHCAL technological prototype commissioning and CERN beam tests
- Conclusion

What next ?

The recent discovery of Higgs Boson in 125 GeV range at LHC has completed the Standard model.

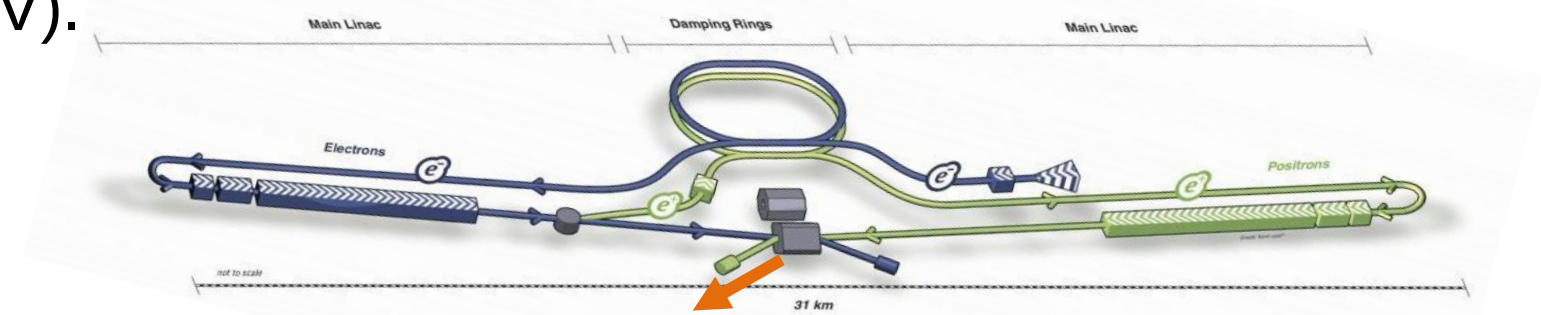
Further to explore at high energies and with high precision:

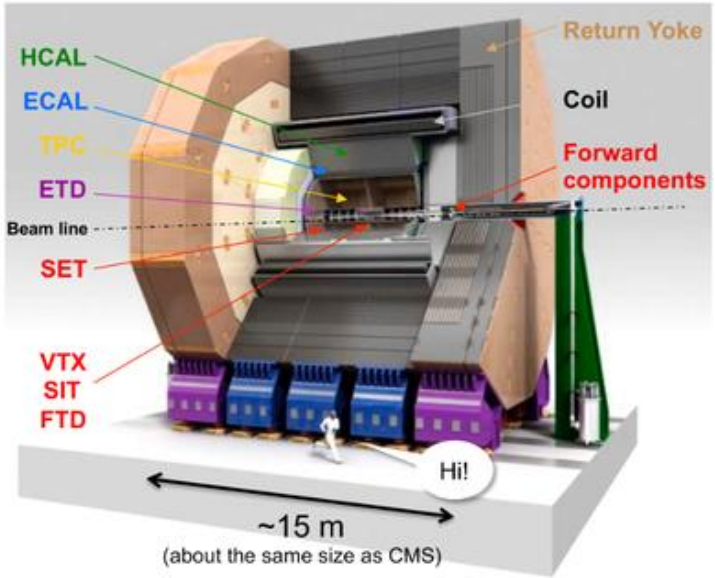
- properties of the Higgs boson.
- search of new particles beyond standard model.
- top mass measurements (at higher energies).

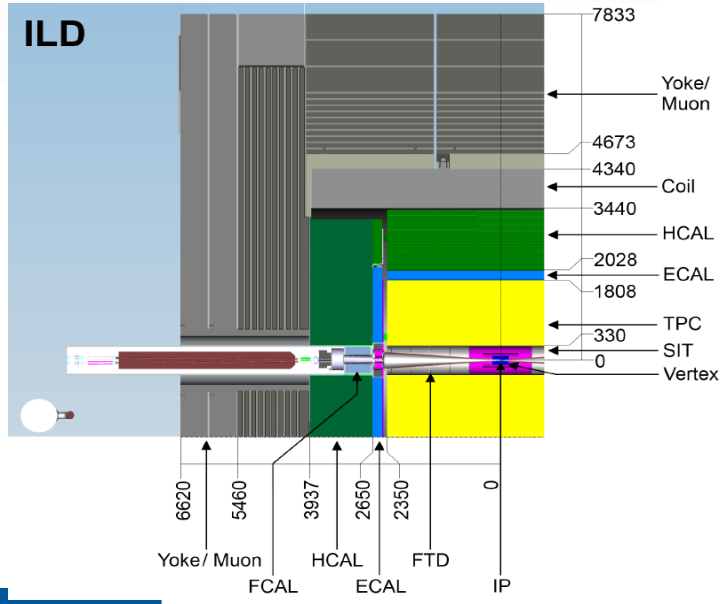
can be better studied at **International Linear Collider.**

International Linear Collider

- e^+ e- collider: complementary to the LHC
- $\sqrt{s}$ = 250 GeV (staging scenarios to 500GeV and 1TeV).







Need for good Jet Energy Resolution

Objective of ILC: aim for a jet energy resolution of 3-4%.

- **In a typical jet:** 60% charged hadrons, 30% photons, 10% neutral hadrons

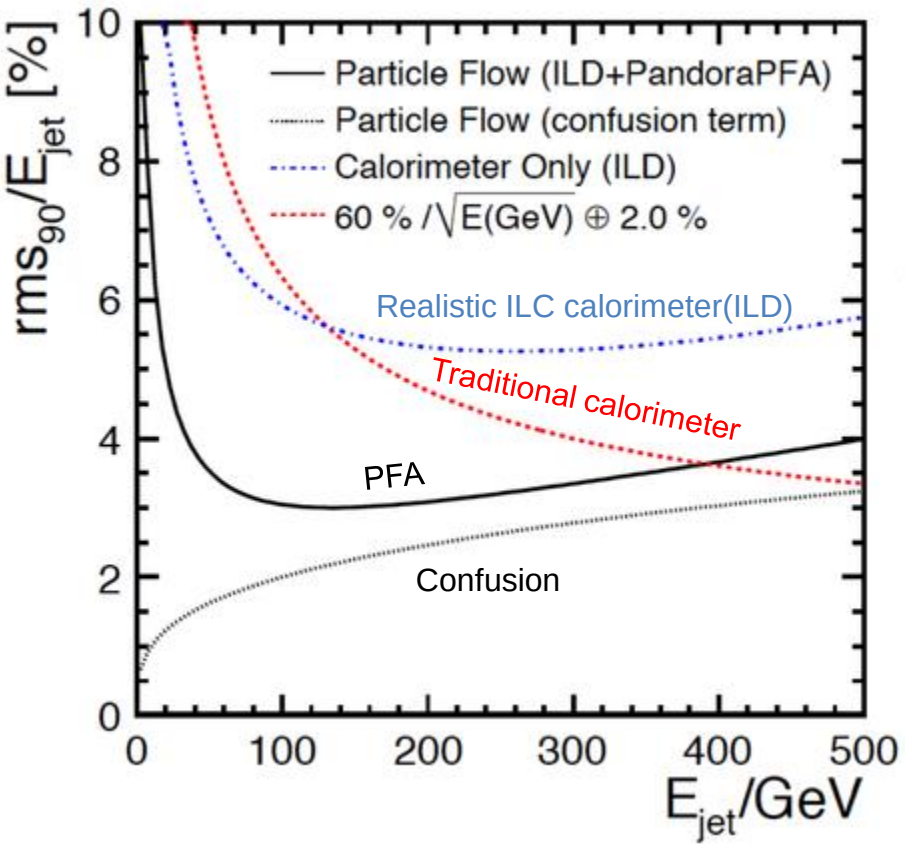
Classical calorimeter: rather limited resolution

- Measure **all** the components of jets in the calorimeters
- ~70% of the energy is measured in HCAL
- The poor HCAL resolution limits jet energy resolution

Particle Flow Approach

Promising solution to achieve the best resolution.

- Trace individually all the particles in an event.
- Reduce the dependence on poor HCAL resolution.
  - Measuring charged particles in tracker.
  - Photons measured in ECAL.
  - Neutral hadrons in HCAL.



- At high jet energy: correct association between tracks and clusters – **high granularity needed.**
- At low energy: hadronic calorimeter with **good energy resolution.**

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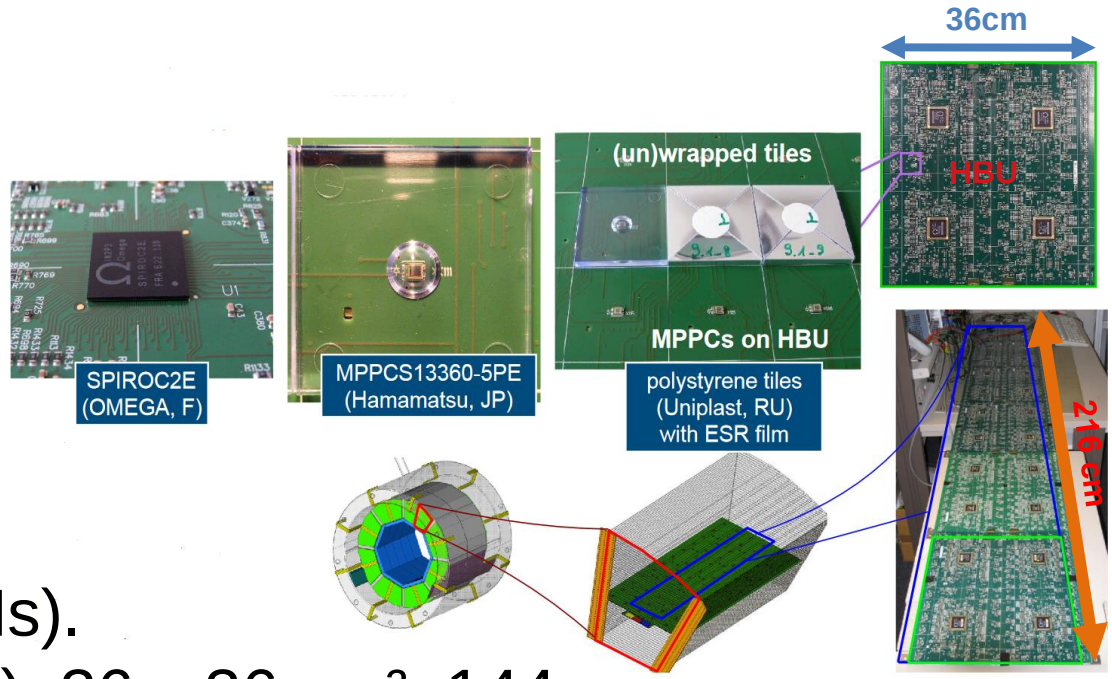
CALICE Collaboration

Such highly granular calorimeters optimized for PFA are being developed and tested by the CALICE collaboration.

Analog Hadron Calorimeter

- Sandwich calorimeter based on scintillator tiles (3 × 3 cm²) read out using Silicon Photomultipliers (SiPMs).
- HCAL Base Unit (HBU): 36 x 36 cm², 144 channels (4 ASICs).
- With electronics embedded in the active layers.
- In total 8M channels for the large detector.



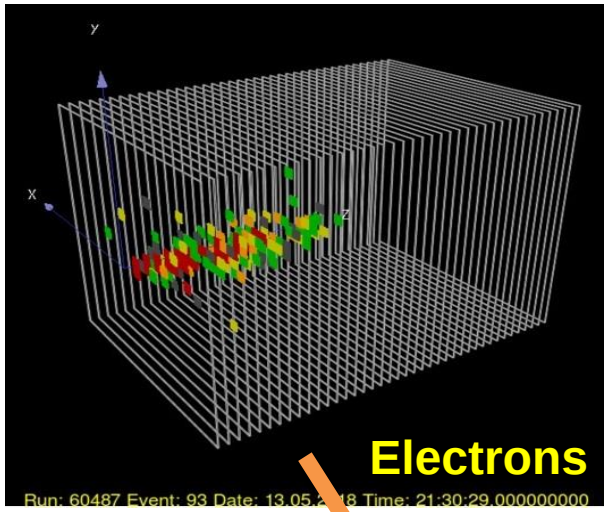
Test Beam Campaign at CERN / SPS 2018 May

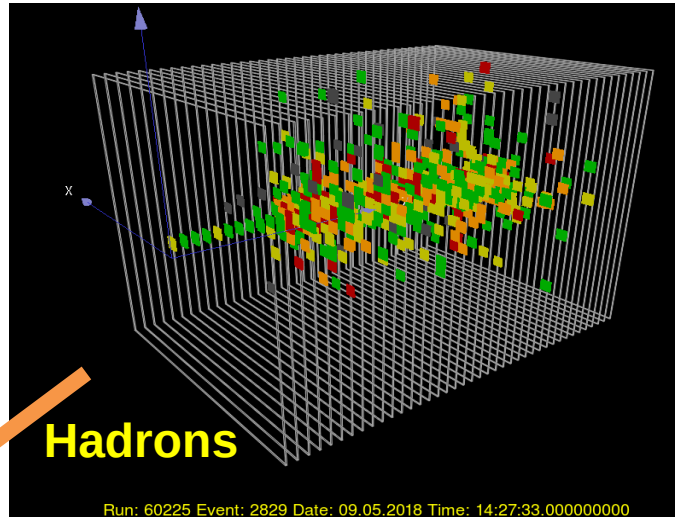
- CERN / SPS H2 beam line (9.5.18 - 23.5.18).
- Installation of 38 layers (nearly 22,000 channels).

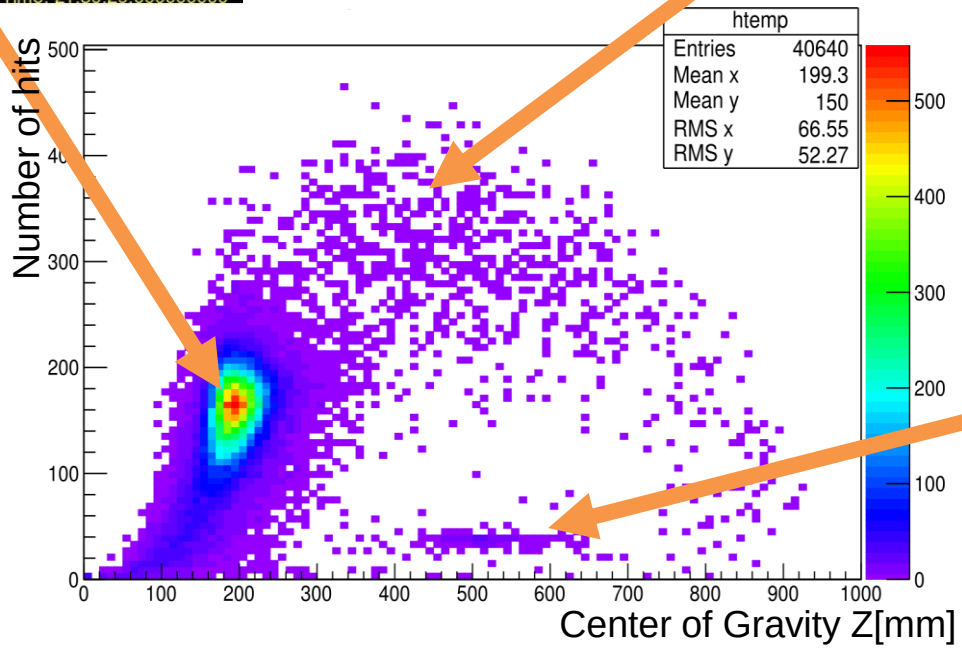
Goals:

- To demonstrate the SiPM-on tile calorimeter concept with scalable detector design.
- Energy linearity and resolution for electrons and pions.
- Cross check of calibration with muons.
- Measure shower profile and hit time correlation for pions.

First glance into data







Muons

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Summary

- Design and procedures for construction of AHCAL are scalable to a full collider detector.
- Successful commissioning and first beam test of CALICE AHCAL prototype with 38 layers in total.
- Upcoming testbeam in June, including a layer with larger (6 x 6 cm^2) tiles.

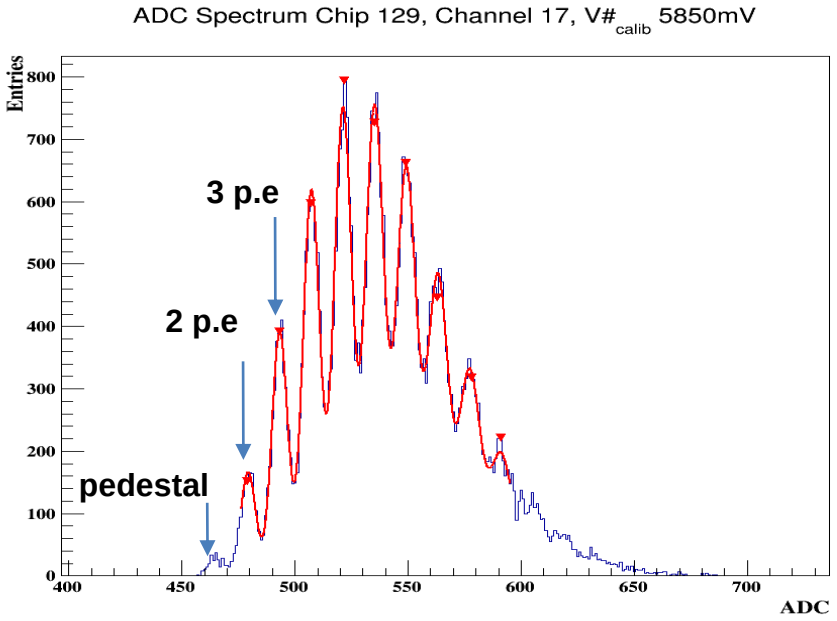
THANK YOU

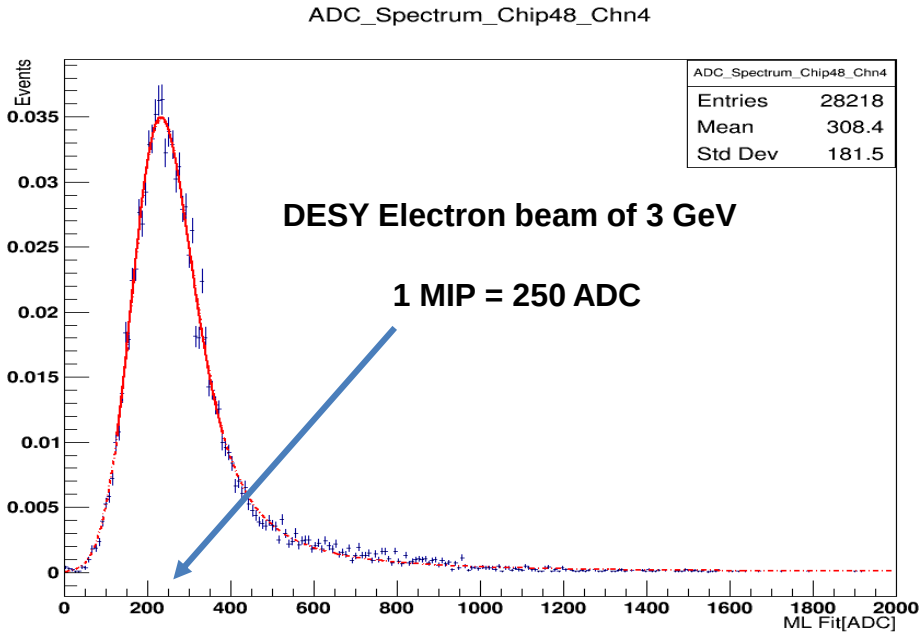
BACKUP

Gain and MIP calibration

The gain constant is extracted for each channel individually from the average distance between two peaks.

The MIP constant is extracted for each channel individually from the MPV of the langaus fit function.

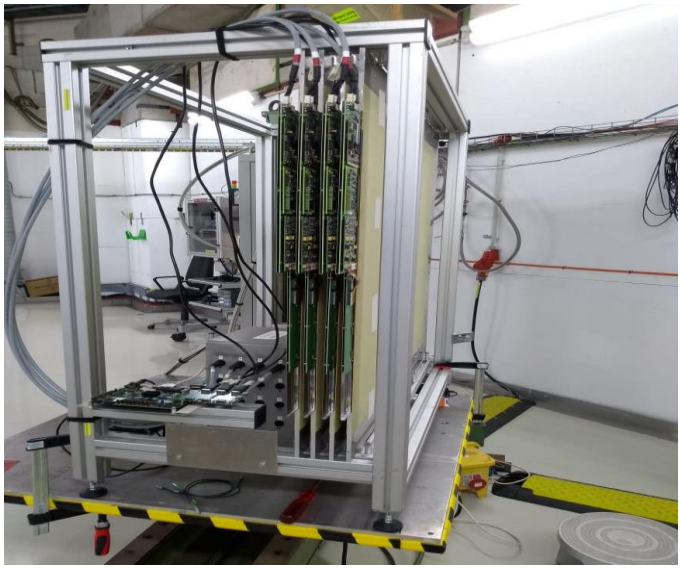


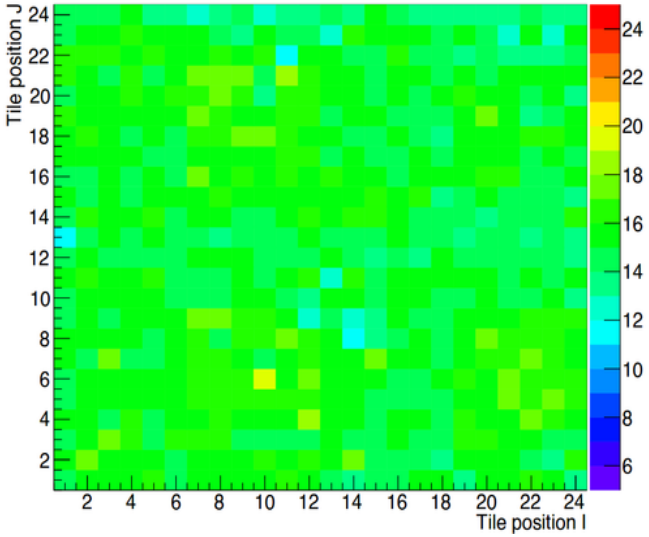


AHCAL technological prototype commissioning @ DESY

Aim: To perform gain calibration using low amplitude LED light and MIP calibration using 3 GeV electron beam at DESY

- 4 layers at a time in “air stack"
- automatic scan for all channels





$$\text{Light Yield [pixels/MIP]} = \frac{\text{MIP Constant}}{\text{Gain Constant}}$$

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