First Results with the Calice ECAL Prototype

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France

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Outline

1. Cosmics
   - Calibration
   - Coherent Noise
2. Electron Test Beam

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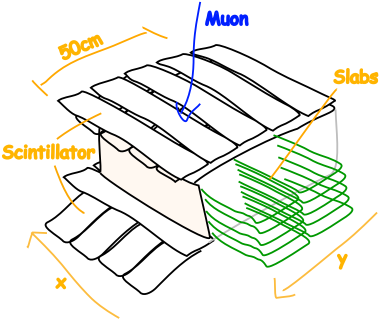
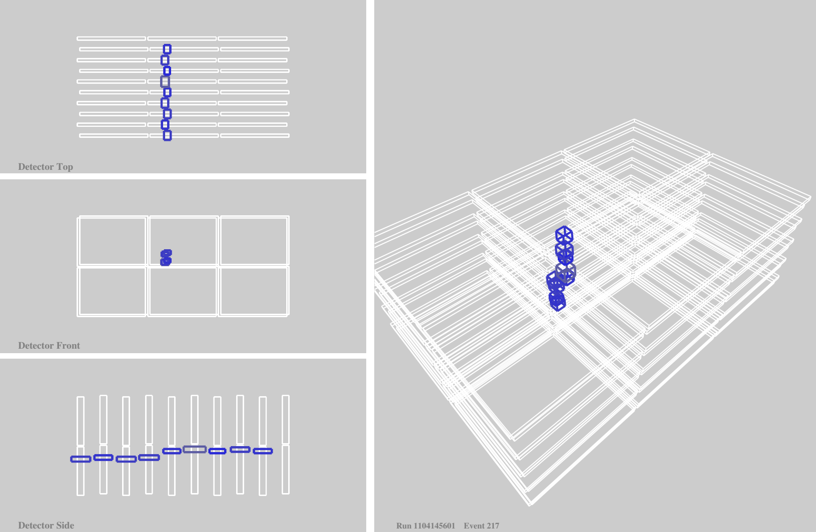
   - Calibration
   - Coherent Noise
2. Electron Test Beam

Cosmics

- 15 days **continuous** data taking.
- $\sim$ 1 million events



Event Display - Muon



Selection - Muons

Analysis:

- Pedestals/Noise are slowly adjusted.
- Signal selection:
  - $S/\bar{N} > 5$
  - 2 layers with hits: $\Delta x, \Delta y \leq 1\mathrm{pad}$

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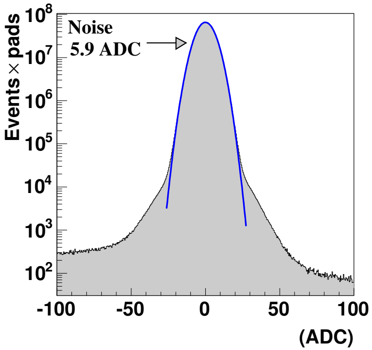

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$\rightarrow$ Noise $\sim 6\,\mathrm{ADC}$

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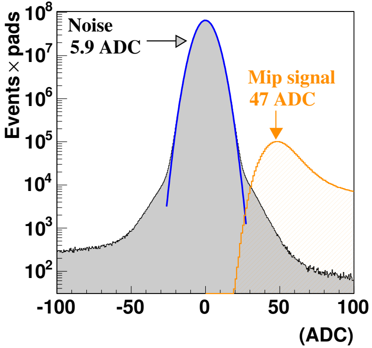

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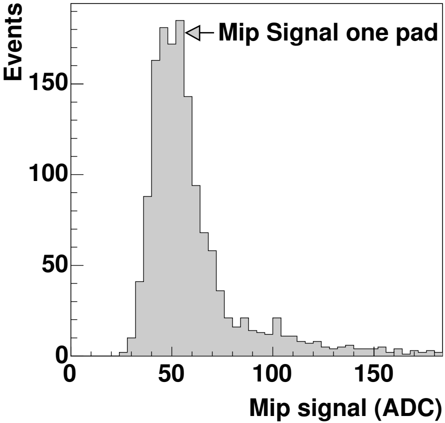
  - $S/\bar{N} > 5$
  - 2 layers with hits: $\Delta x, \Delta y \leq 1\mathrm{pad}$

$\rightarrow$ Noise $\sim 6\,\mathrm{ADC}$

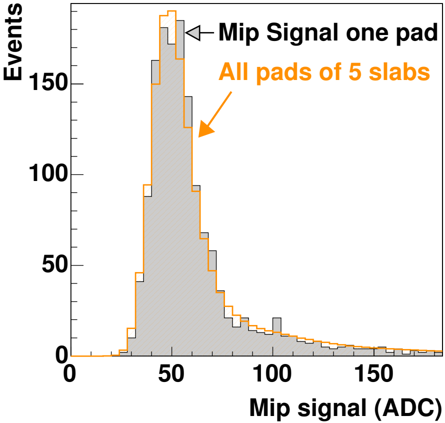
$\rightarrow$ Mip signal $\sim 47\,\mathrm{ADC}$

$(S/N \sim 8)$

Signal Distribution

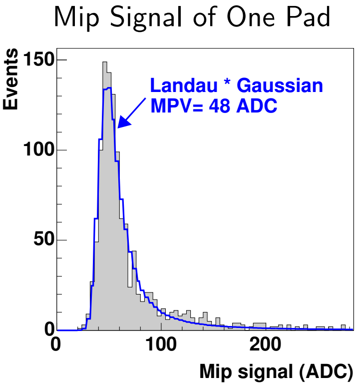


Signal Distribution



$\rightarrow$ Small dispersion.

Calibration

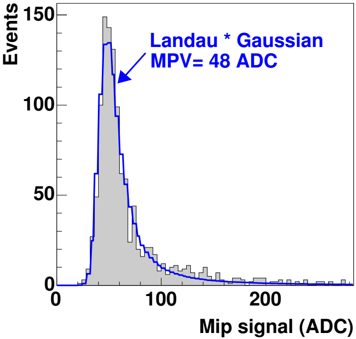


Strategy:

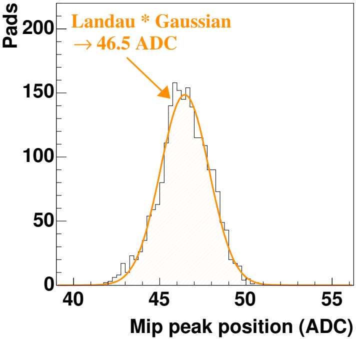
- Use position of mip peak
- Fit function:
  Landau $*$ Gaussian

Calibration

Mip Signal of One Pad



Dispersion



(All pads of all layers)

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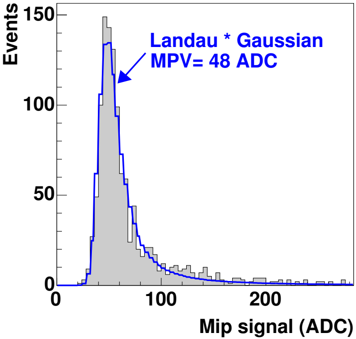

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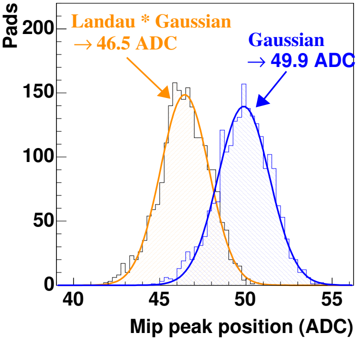

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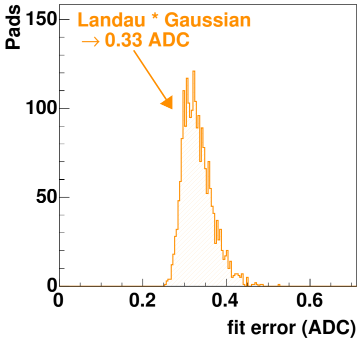
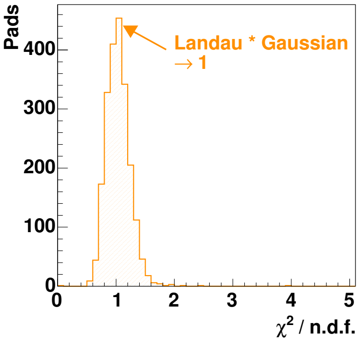
Calibration - Error

Error of Calibration



Fit χ^2



→ **Calibration error $< 1\%$ with 1 million cosmics.**

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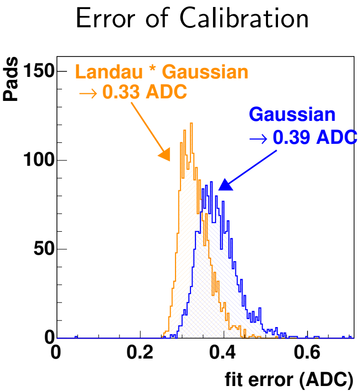

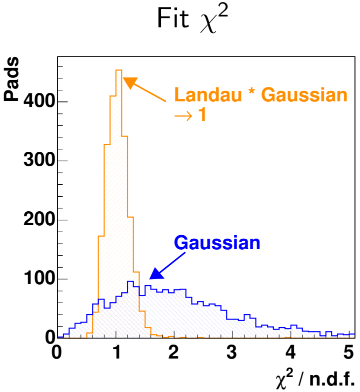

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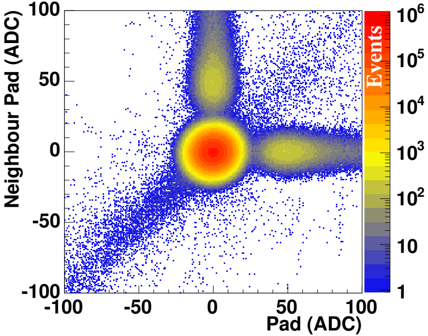
Correlation between Neighbour Pads



(Similar correlation between pads of different half wafers / wafers.)

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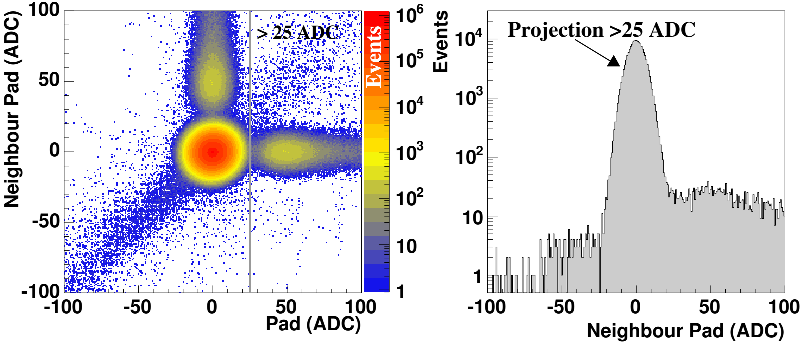

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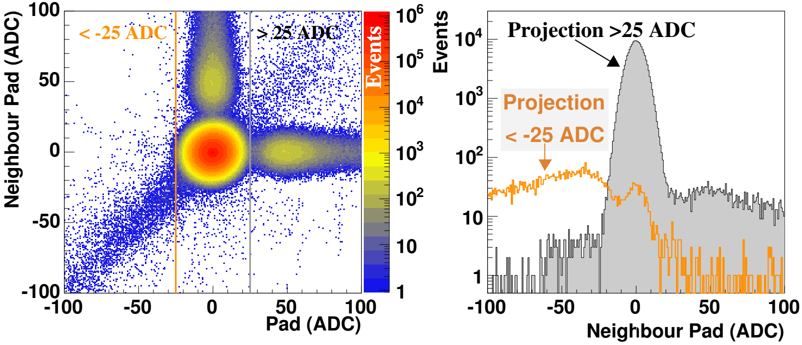

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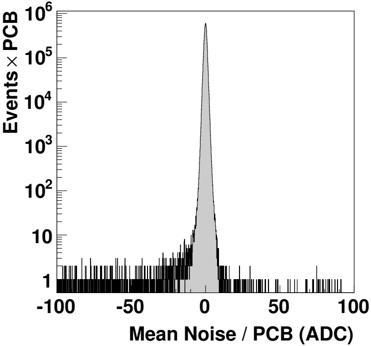
Coherent/Common Mode Noise

Average value / PCB:



- 15 days $\rightarrow 10^6 events$
- Signal $(S/N > 5)$ excluded.

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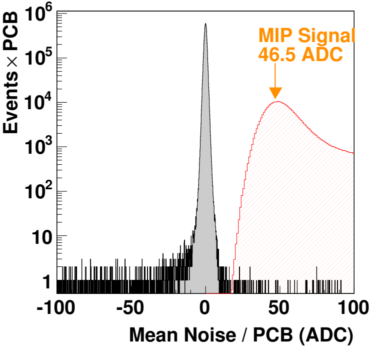

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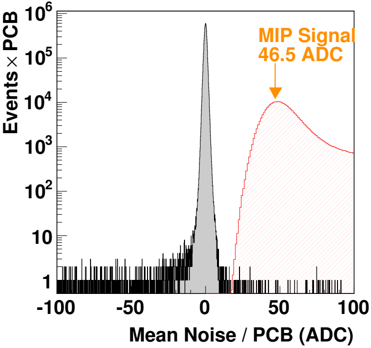
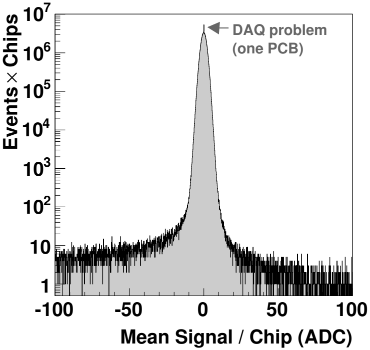


Average value / half wafer:



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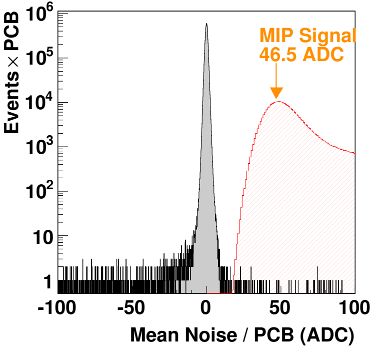

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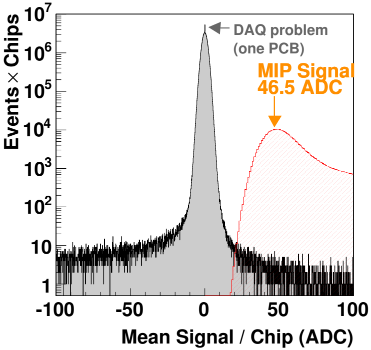
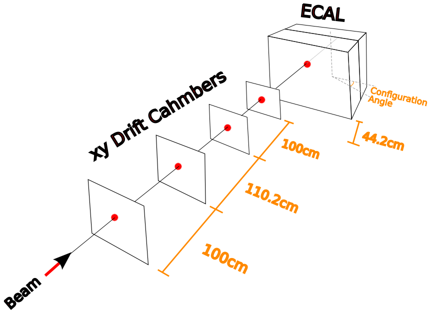


→ Coherent noise per half wafer $\lesssim 2\,\mathrm{ADC}$

Electron Test Beam

- Electrons 1 . . . 6 GeV
- Angles 0 °, 10 °, 20 °, 30 °
- Various x/y impact positions.
  (Wafer border/centre, . . .)

→25 Mevents (230 GB)
in 2 weeks (→∼ 30 Hz)



Drift Chambers courtesy of **Tsukuba**.
Many Thanks to **K. Kawagoe** *and* **Y. Tamura**!

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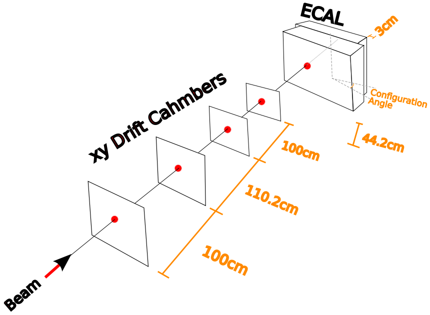

(Configuration with angle)

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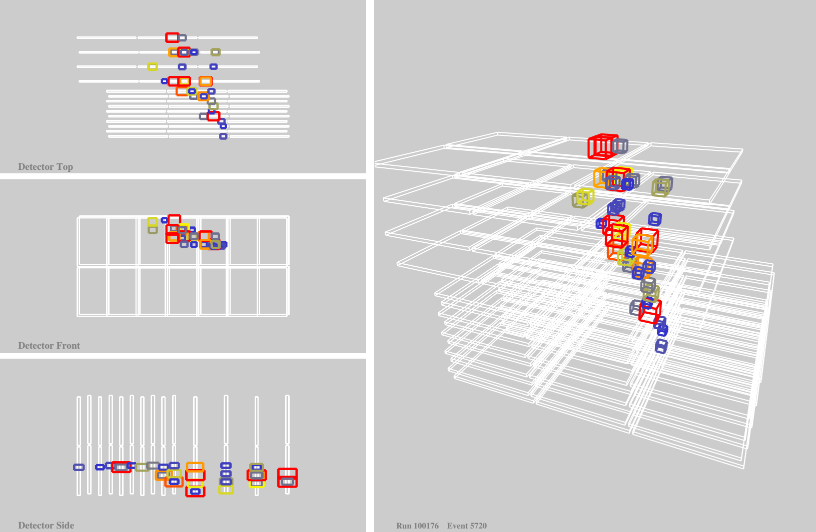
Event display - Electron 2 GeV



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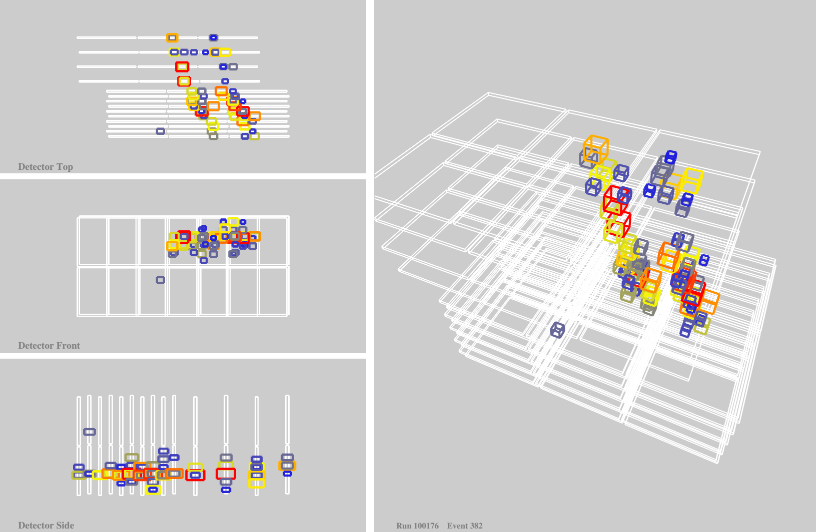
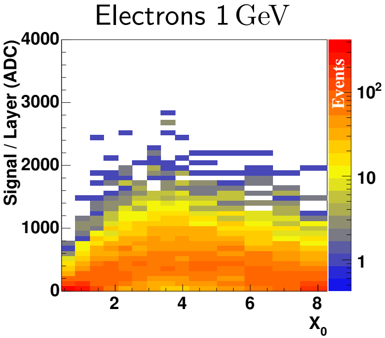


Mean Signal per Layer



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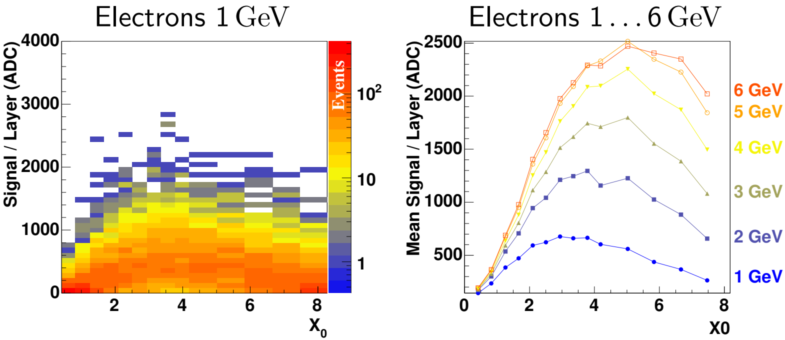
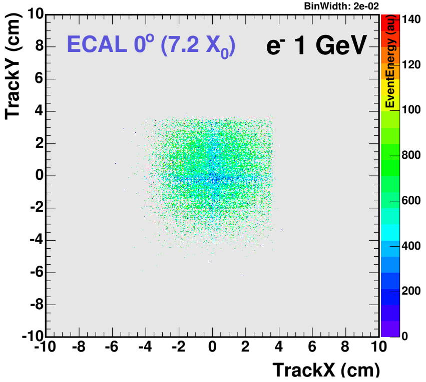


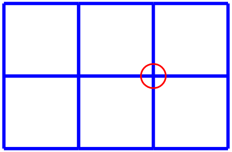
Total Energy vs Position



(G.Mavromanolakis)

Electrons $1\,\mathrm{GeV}$, 0 °

Beam Position:



Summary

- Small dispersion between pads ($\sim 2\,\mathrm{ADC}$)
- 1 million cosmics $\rightarrow$ calibration error $< 1\%$
- Coherent noise is small ($\sim 2\,\mathrm{ADC}$)
- First electron test beam results.
  (230 GB of data to be analysed in detail $\rightarrow$ room for people to join.)

Planned Test Beam Program (FNAL-TM-2291)

- ECAL standalone (+ $2 \times 0.9\lambda_I$) tungsten blocks)

  e^-: $6\,\mathrm{GeV}$ to $\sim 25\,\mathrm{GeV}$ (5 energy points **min.**),
  3 angles (2 energy points **min.**)

  π: $\sim 1\,\mathrm{GeV} \ldots \sim 65\,\mathrm{GeV}$

  p: $\sim 1\,\mathrm{GeV} \ldots 120\,\mathrm{GeV}$

- A-HCAL + ECAL (+tail catcher)

  π: $\sim 1\,\mathrm{GeV} \ldots \sim 65\,\mathrm{GeV}$ (15 energy points),
  3 angles (5 energy points)

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  ...

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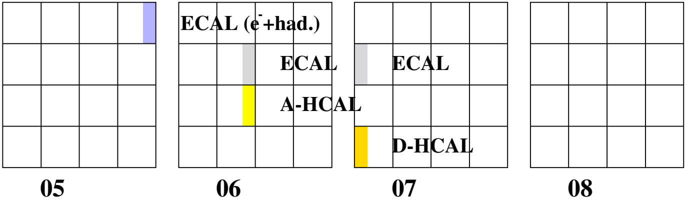
  ...

Per configuration 10^6 events $\longrightarrow \mathcal{O}(10^8)$ events

Schedule - Calice Test Beam Program



- MTBF @ FNAL (now): 0.6 sec spill / 10 sec, 90% duty cycle
- **Minimum** program and **optimal** running conditions.

DAQ limitations: continuous data taking rate 100 Hz, maximum rate 1 kHz for 2000 events then 20 sec dead time.

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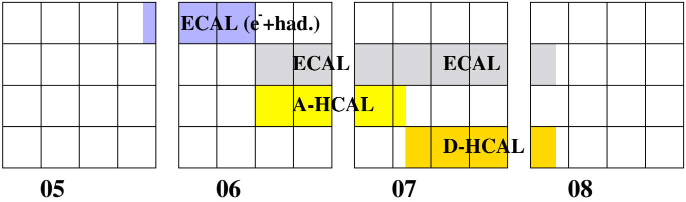

- MTBF @ FNAL (soon): 5 sec spill / 120 sec, 90% duty cycle
- **Minimum** program and **optimal** running conditions.

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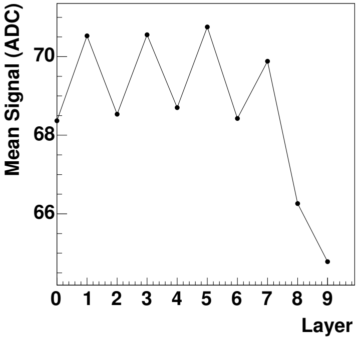
Acknowledgements

Univ. of Tsukuba and Kobe for providing the drift chambers, and in particularly **K. Kawagoe** and **Y. Tamura** for the installation of the latter.

DESY for the test beam infrastructure and in particular **N. Meyners** for copious on site help. Last but not least, the **A-HCAL group** in particular for doing $\sim 30\%$ of the shifts.

Even/Odd Asymmetry

Even/Odd Asymmetry



(Pads are calibrated)

- 3% difference Even/Odd.

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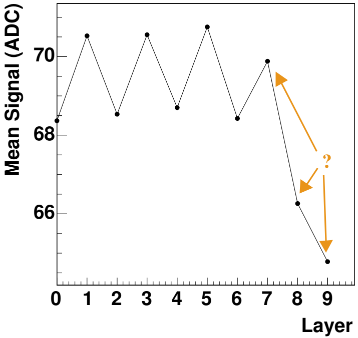

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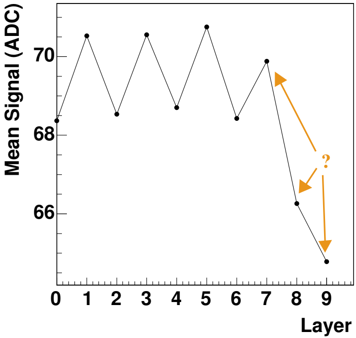
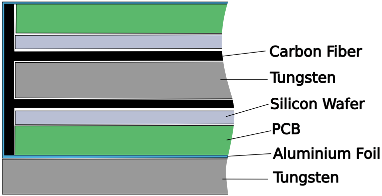


(Pads are calibrated)

- 3% difference Even/Odd.
- X_0 between layers:
  (Geant4, structure 1)
  - even $\longrightarrow$ odd: $0.40\,X_0$
  - odd $\longrightarrow$ even: $0.44\,X_0$



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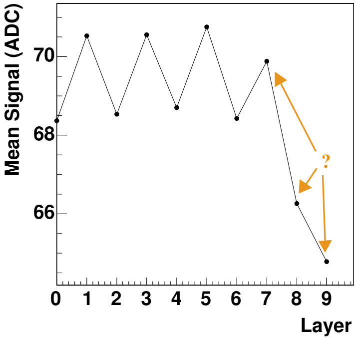

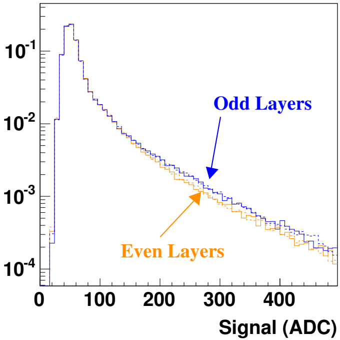

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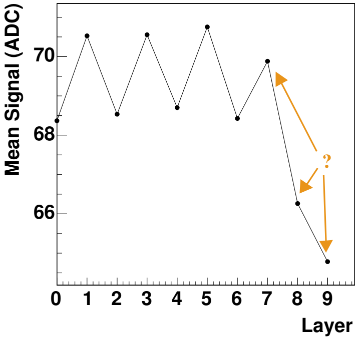

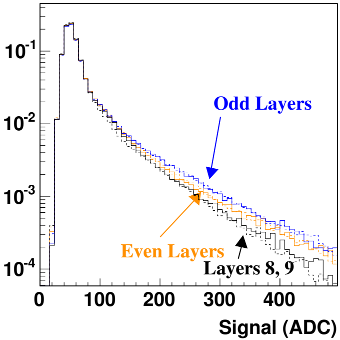

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