Report on ScW-ECAL DESY beam test and future plans

17th December 2012

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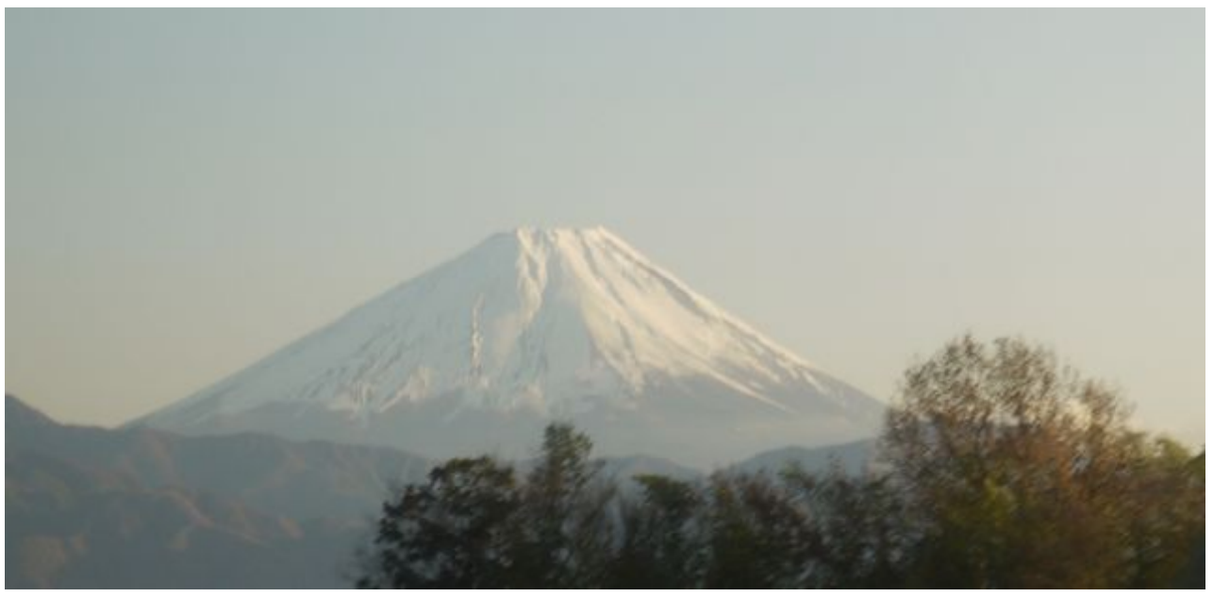
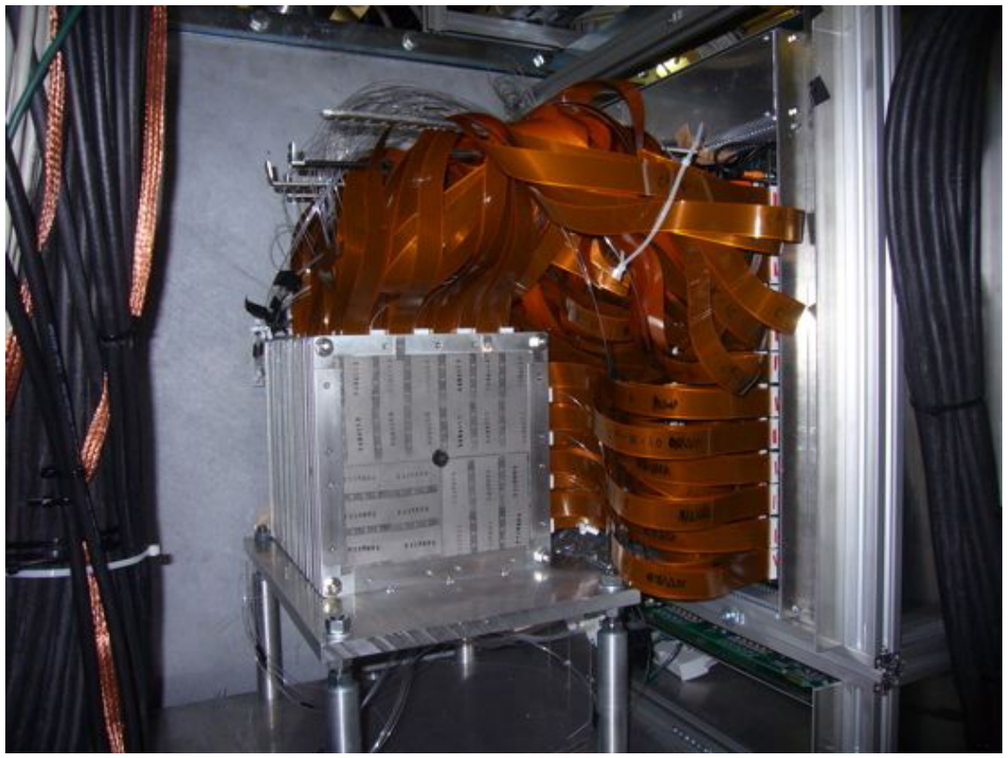
Shinshu University



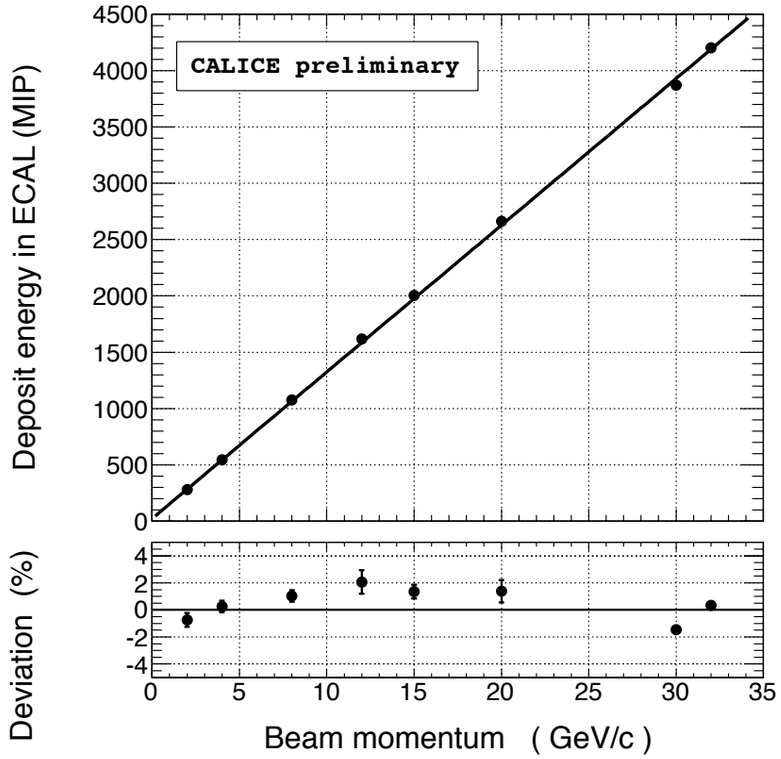
Yesterday, I've taken this through the window of Azusa train when I moved from Shinshu to Tokyo.

Contents

Purpose of technological ScECAL



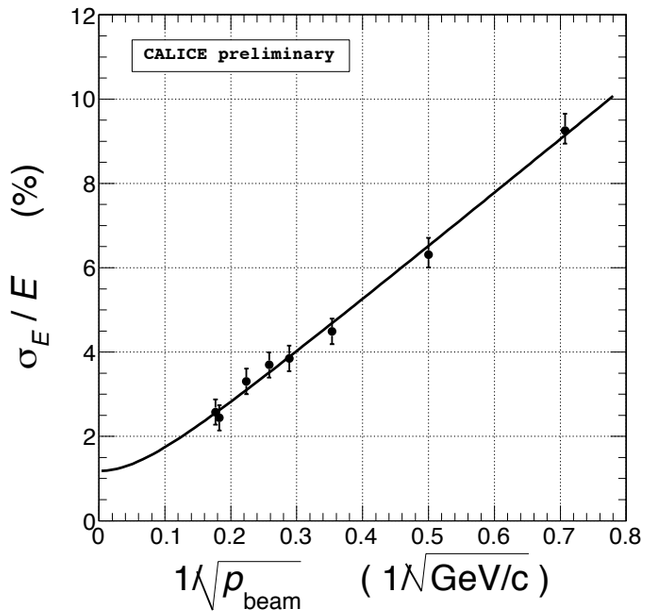
ScECAL physics prototype in front of the AHCAL at FNAL



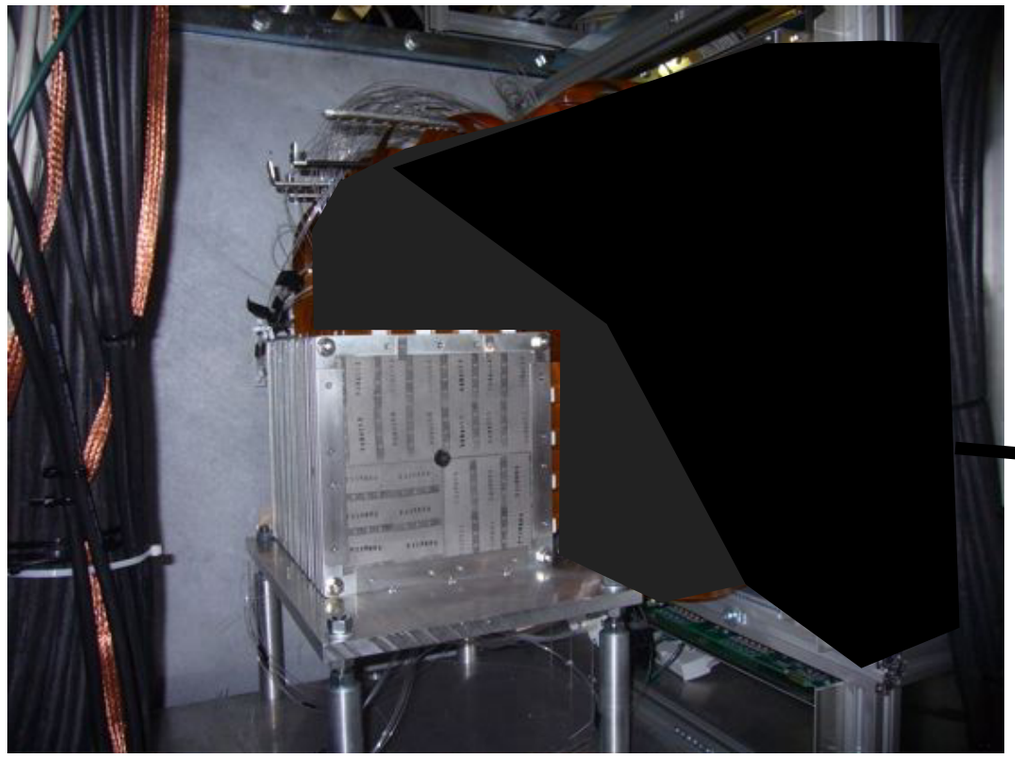
Linearity:
deviation < 2%

Resolution:
Stochastic 12.9±0.4%
Constant 1.2 $^{+0.4}_{-1.2}$ %

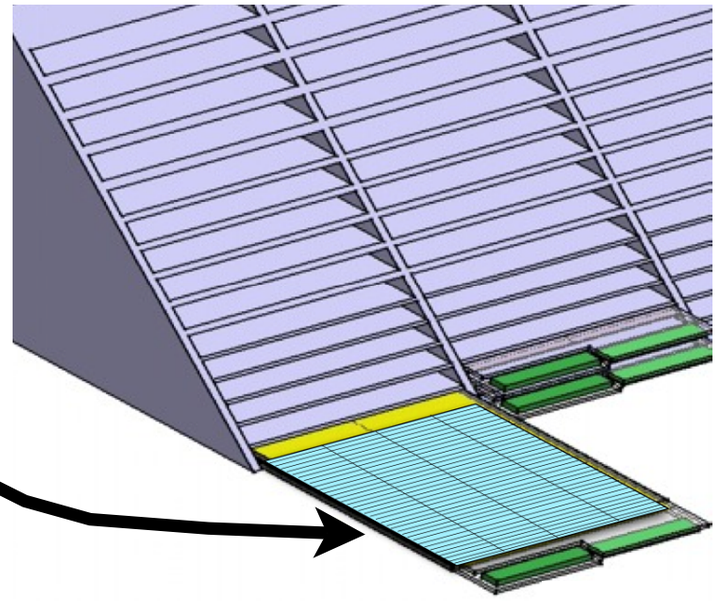
Nice performance of Physics prototype



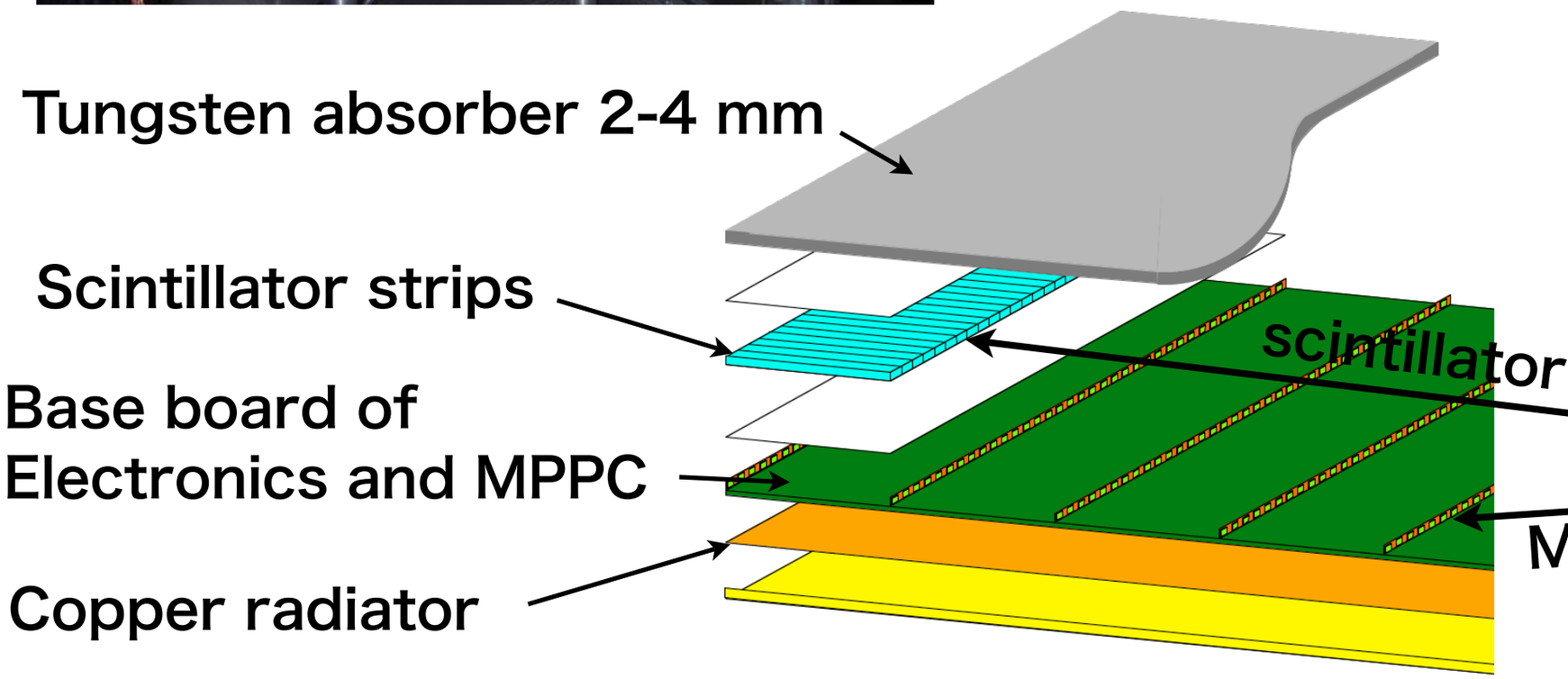
Purpose of technological ScECAL

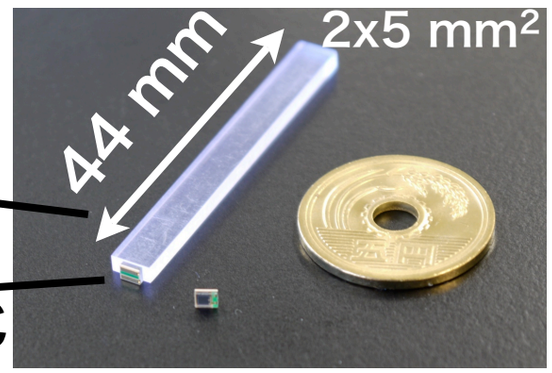


Electronics should be put in between sensor layers for ILD



this carton is not true because electronics should cover the sensor

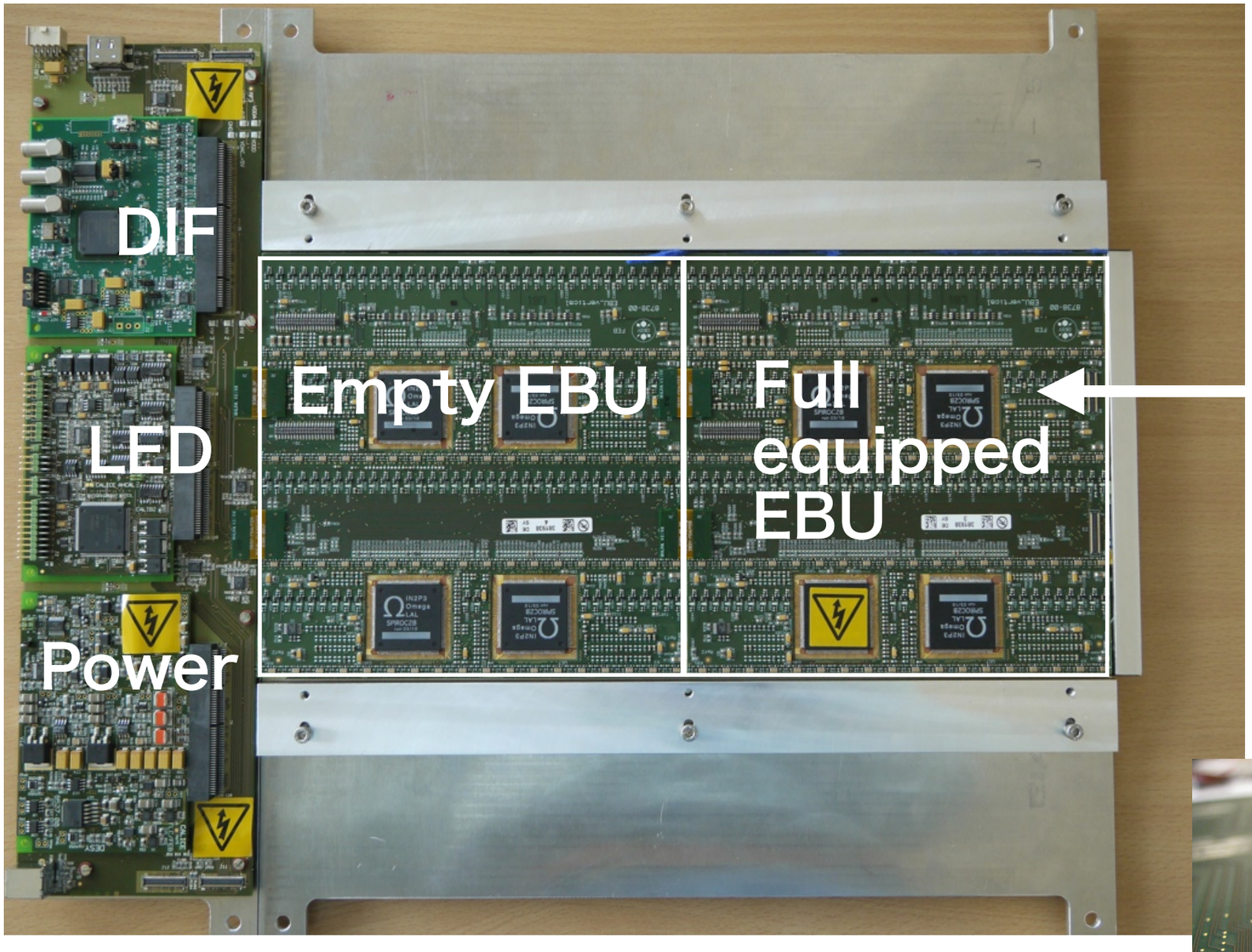




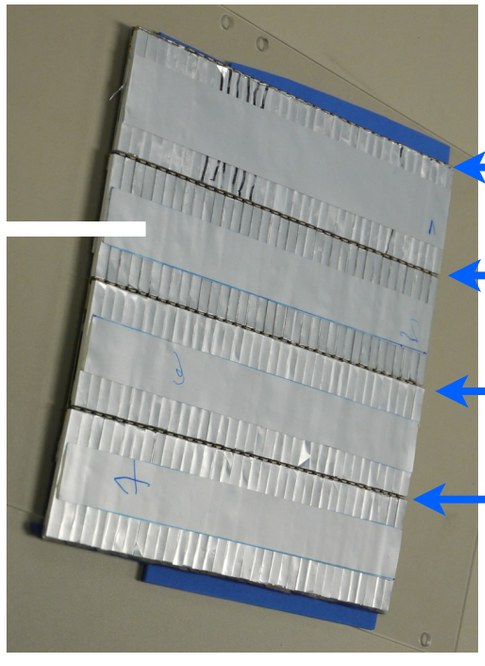
To Show how the technology works well

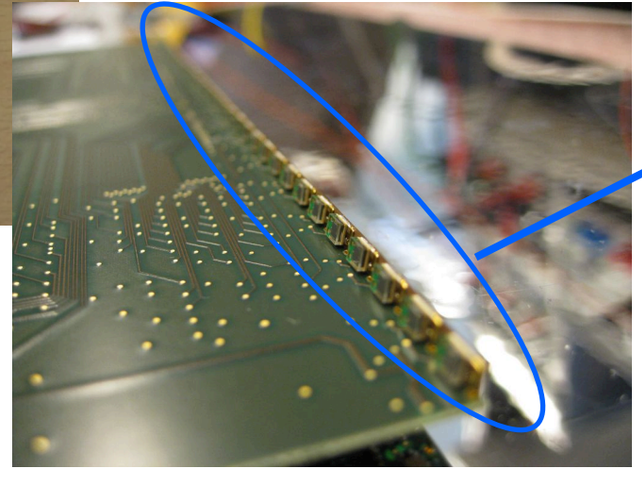
ScECAL technological prototype

- One layer one base board (EBU) prototype so far.
- Four SPIROC2b (ASIC) on an EBU controls 144 MPPCs.



The other side.

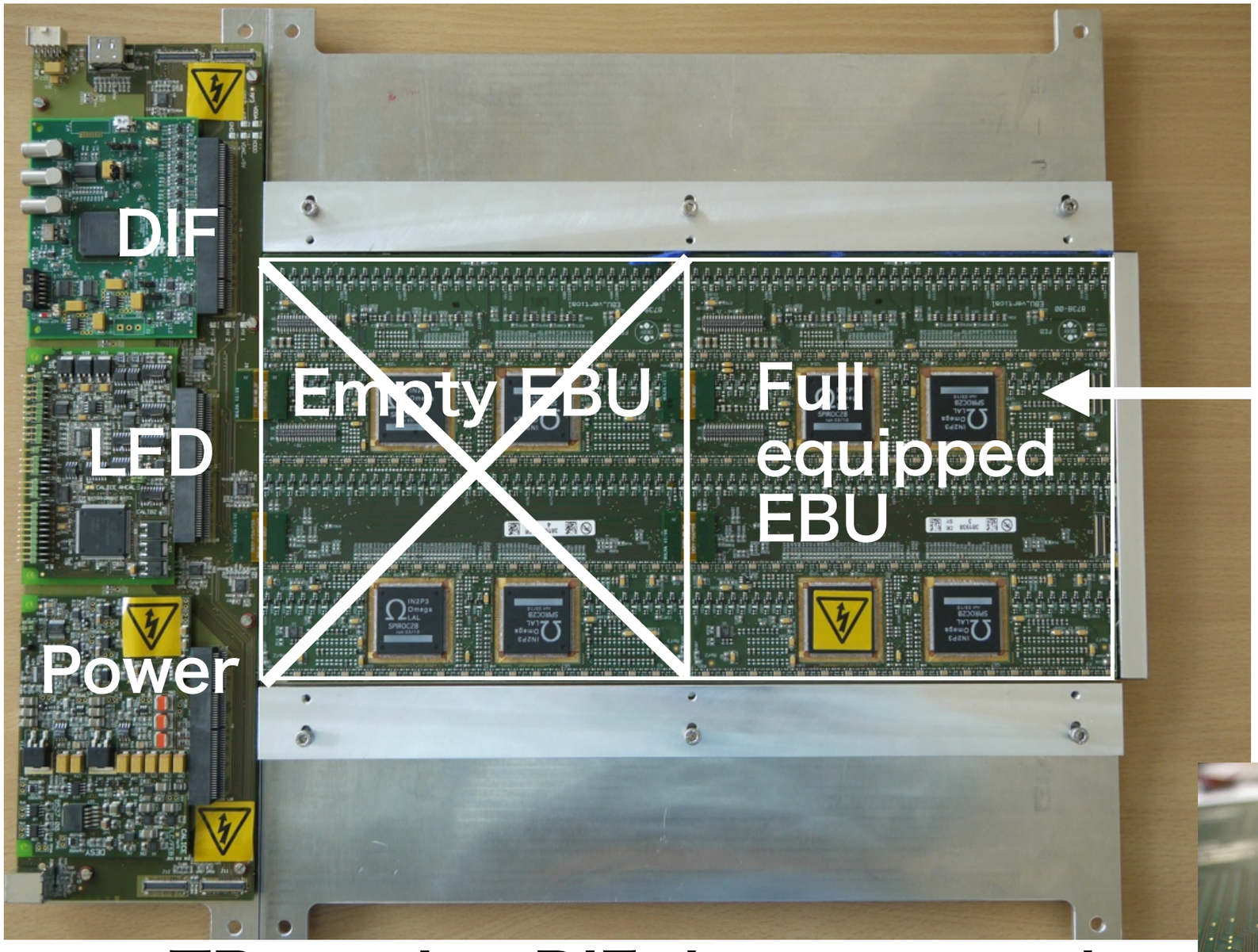




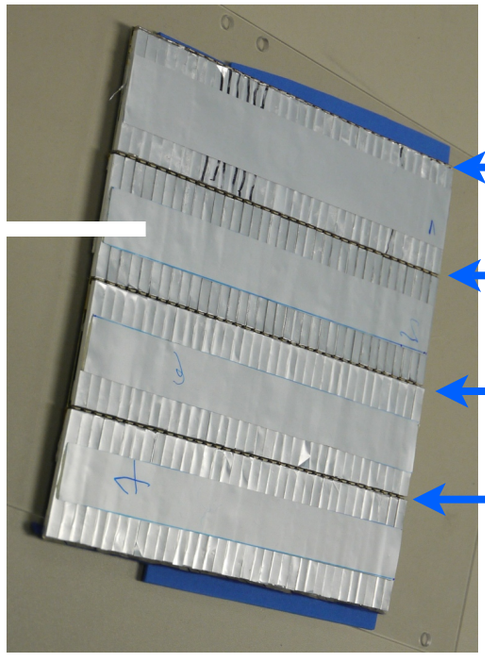
DIF, LED controller, and Power controller are the same technology as the AHCAL HBU

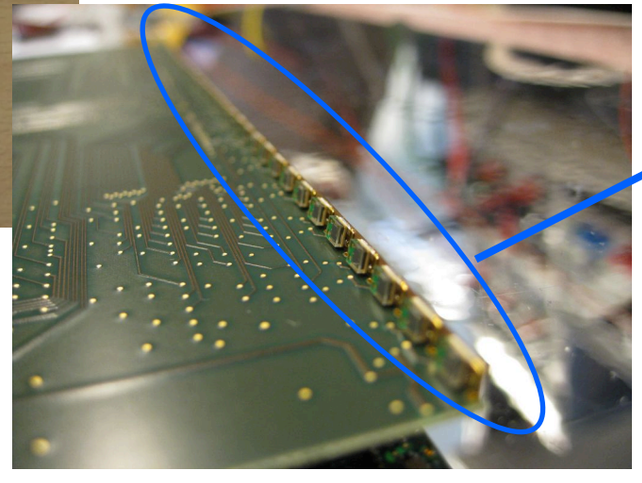
ScECAL technological prototype

- One layer one base board (EBU) prototype so far.
- Four SPIROC2b on an EBU controls 144 MPPCs.



The other side.

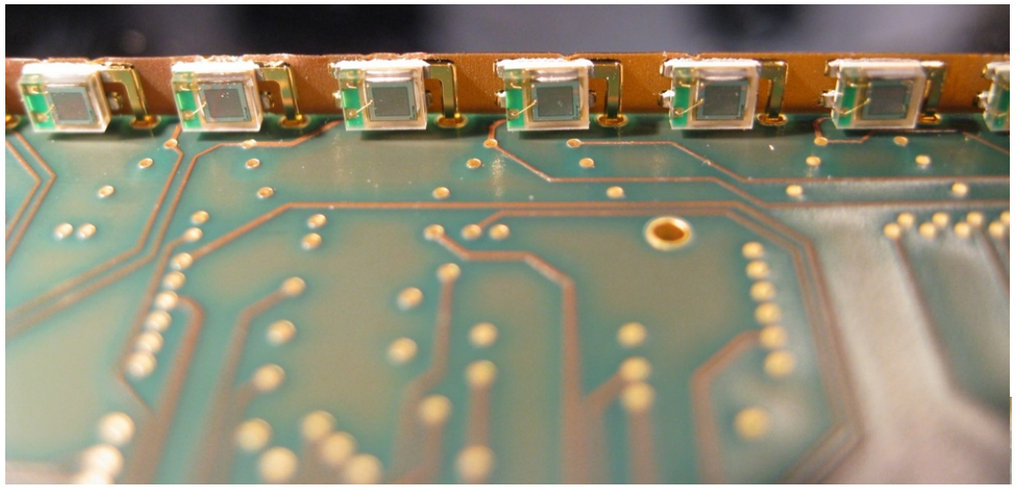


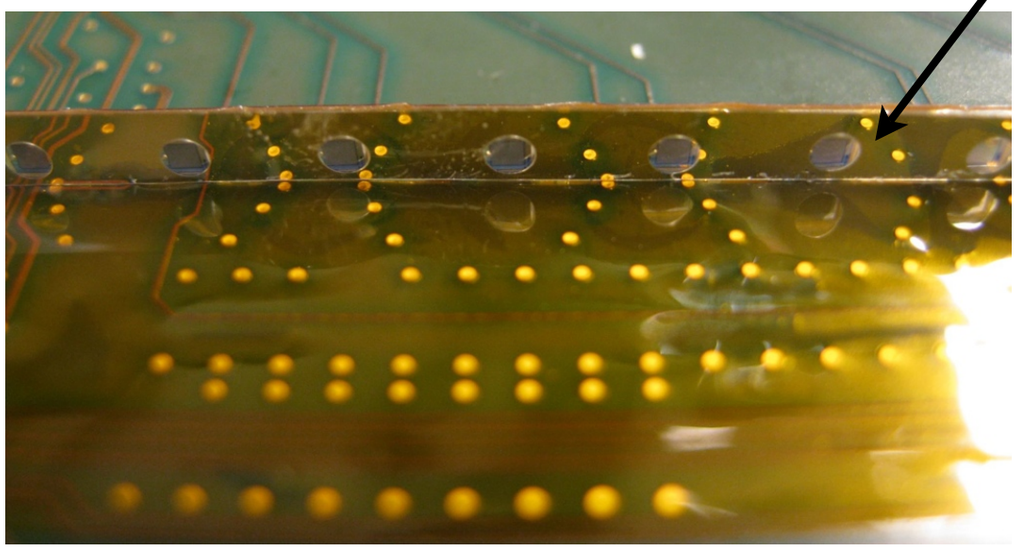


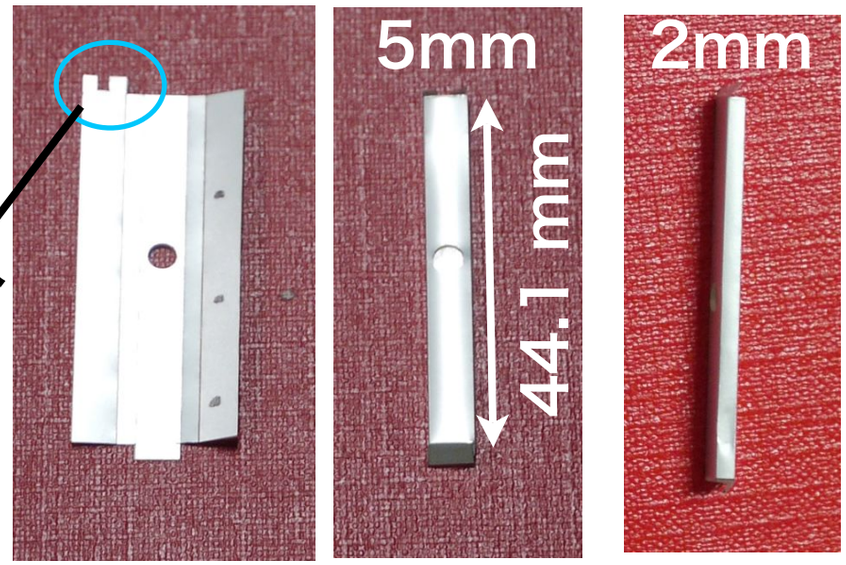
TB version DIF does not work with two EBU. We gave up to use two EBU.

MPPC-scintillator strip

- 36 MPPCs/row on a polyimide ribbon.
- The polyimide ribbon is for only mechanical support.

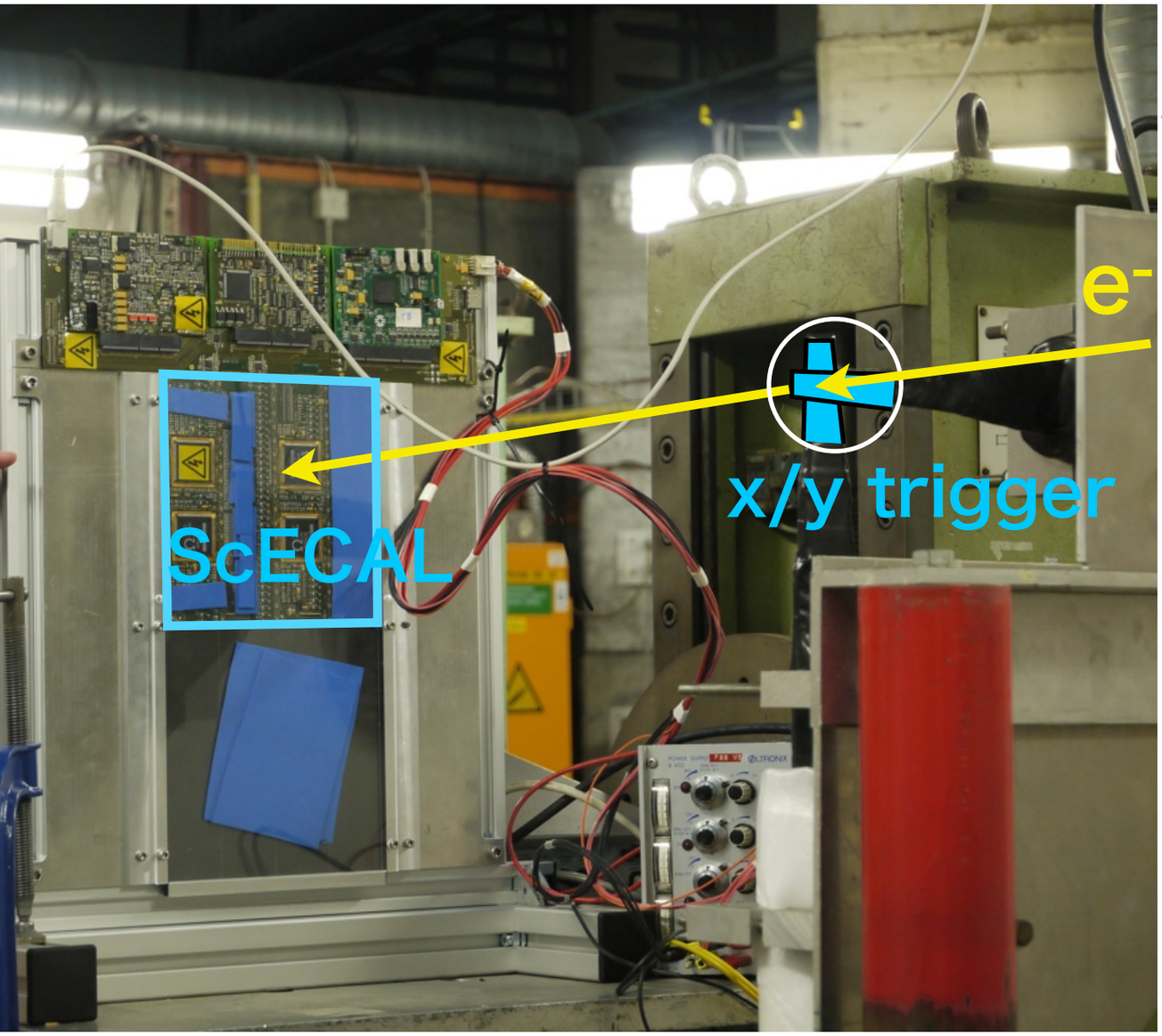


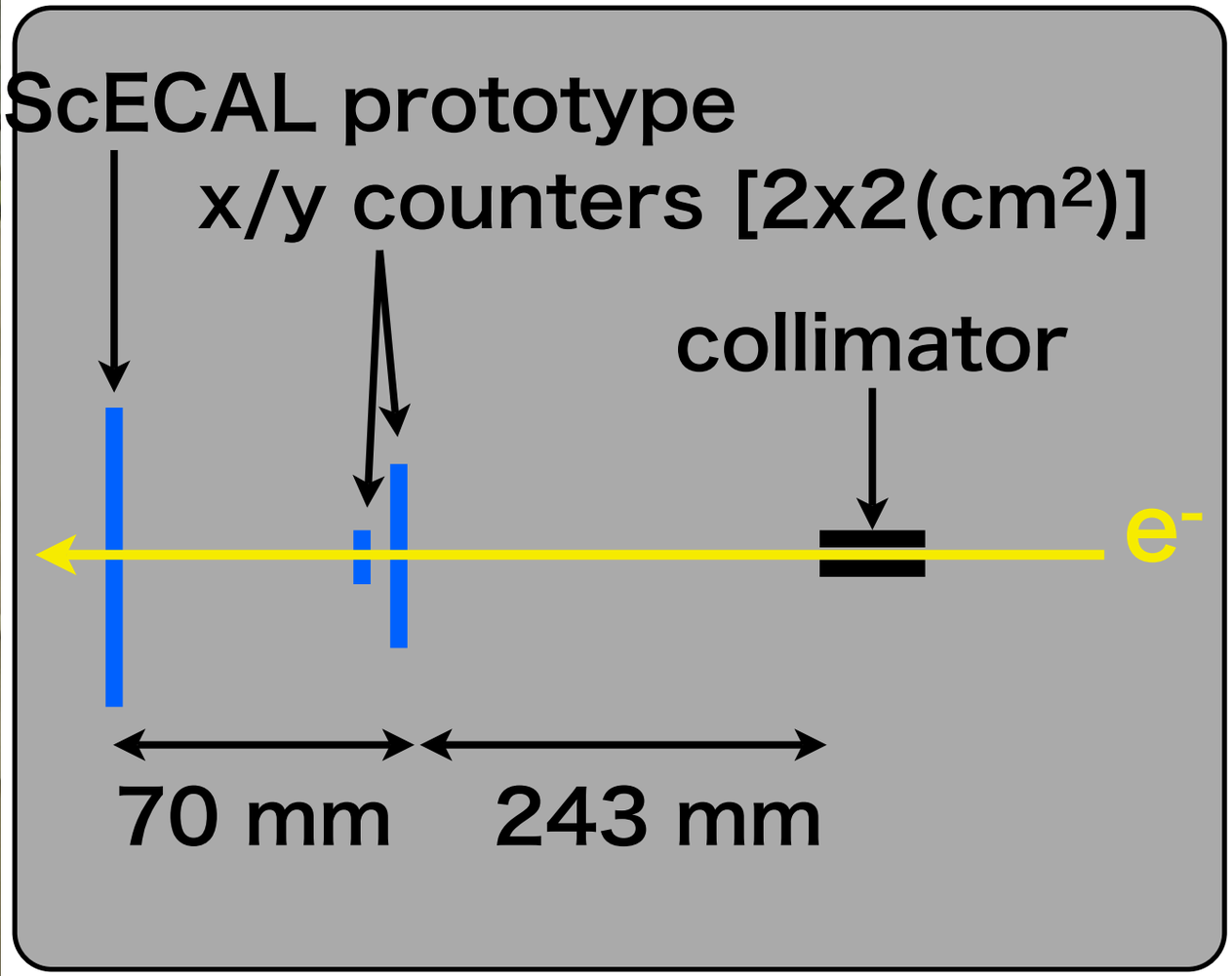




- A reflector ribbon with holes as MPPC windows is put in front of MPPCs
- Polyimide sheets are put on the EBU (only in front of MPPC).

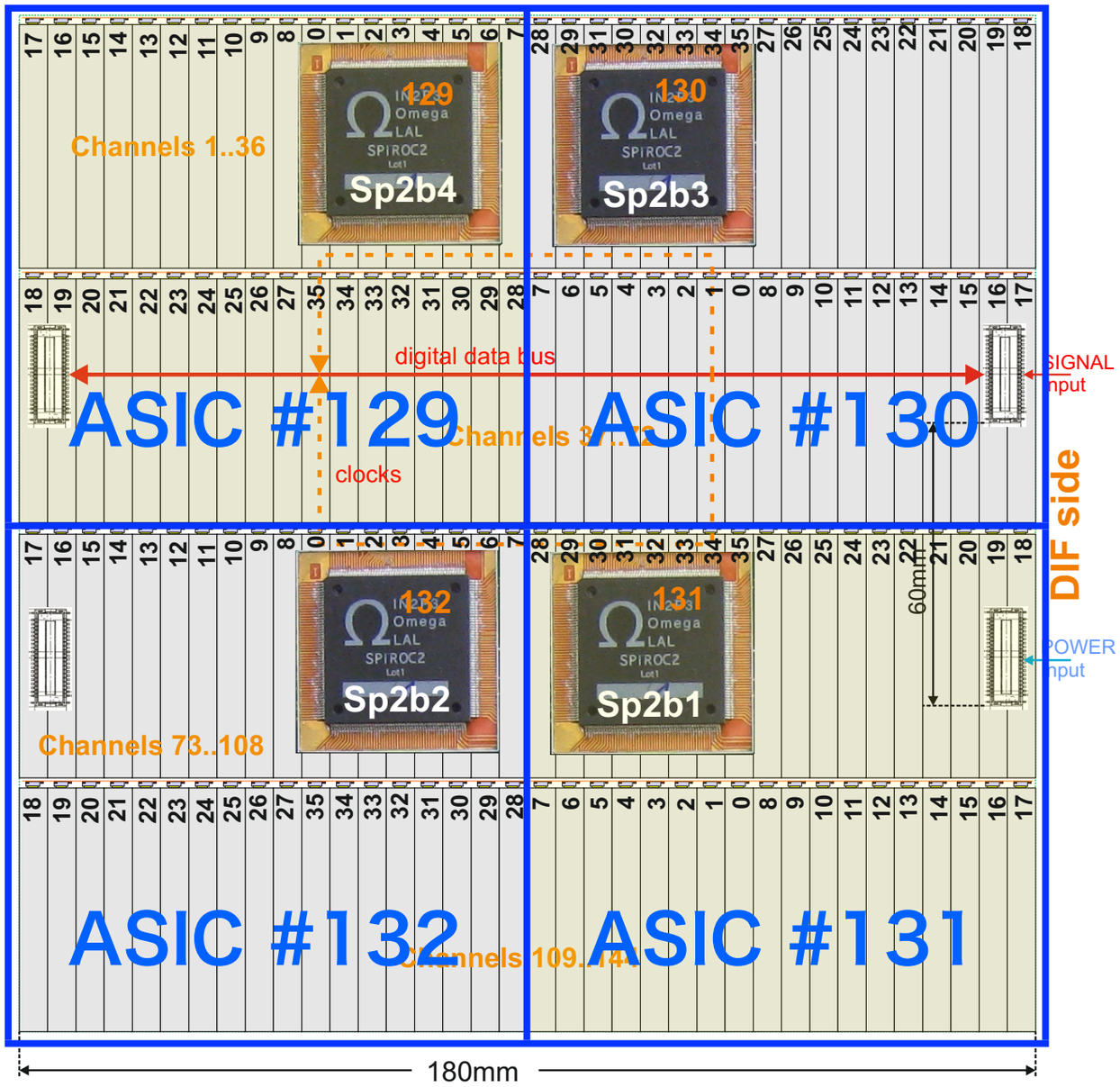
Test beam at DESY with 1-6 GeV e⁻





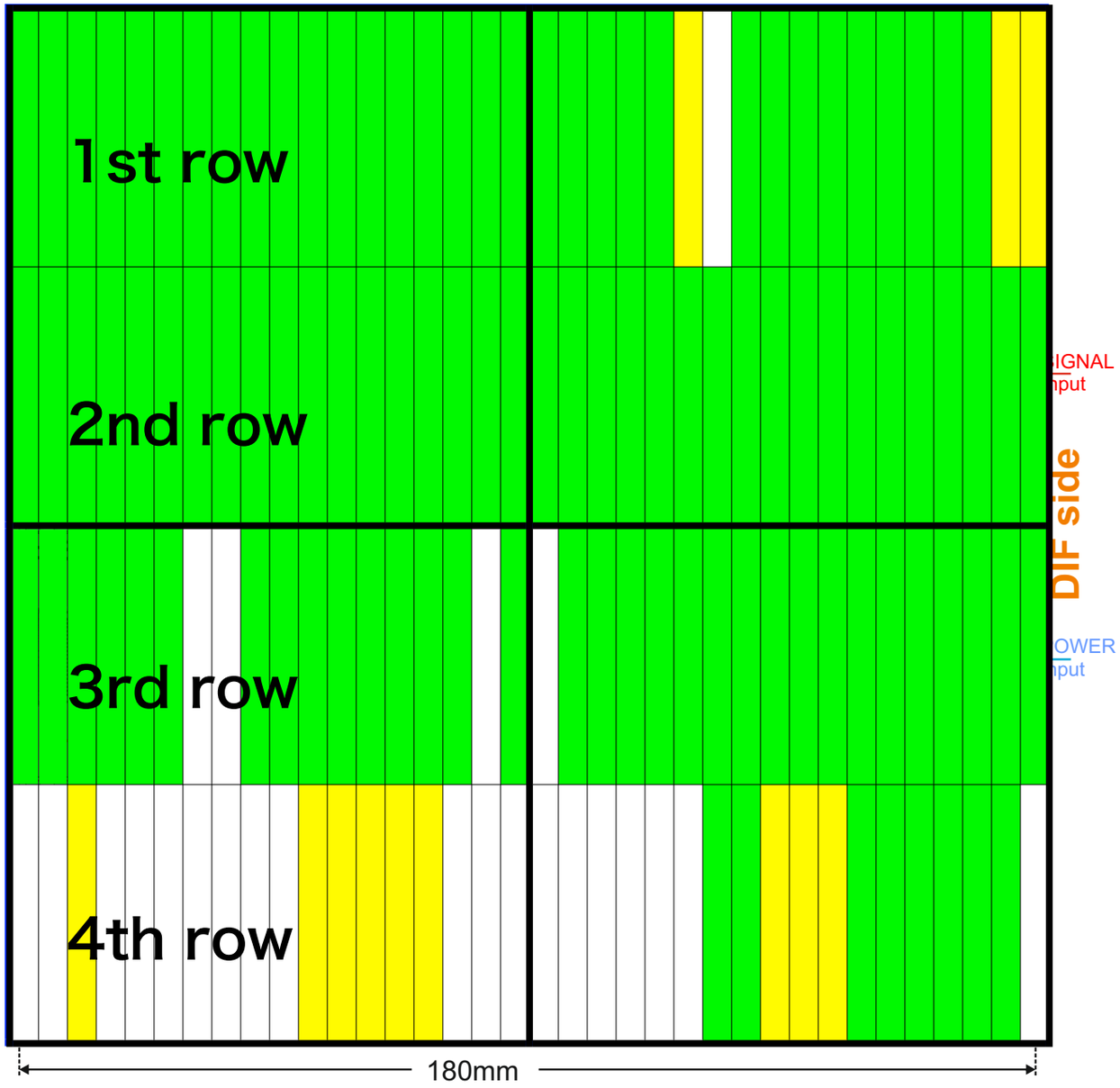
24th beam line

Address of channels

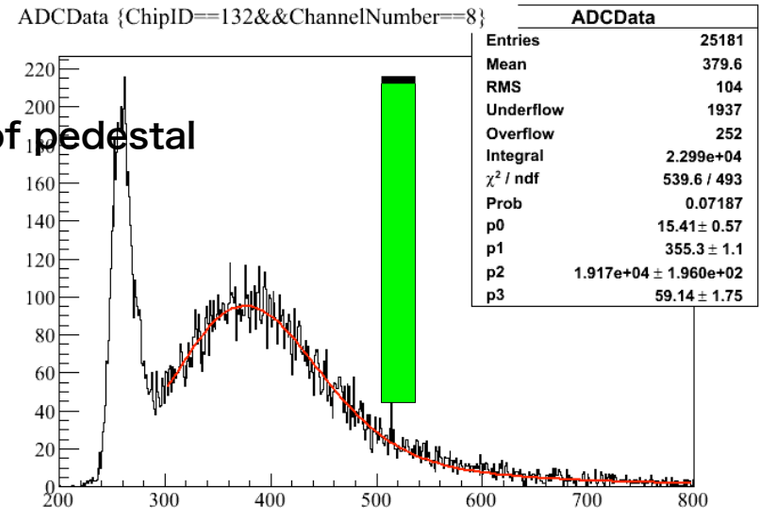


Sp2b1: Channels 91:108, 127:144
Sp2b2: Channels 73:90, 109:126
Sp2b3: Channels 19:36, 55:72
Sp2b4: Channels 1:18, 37:54

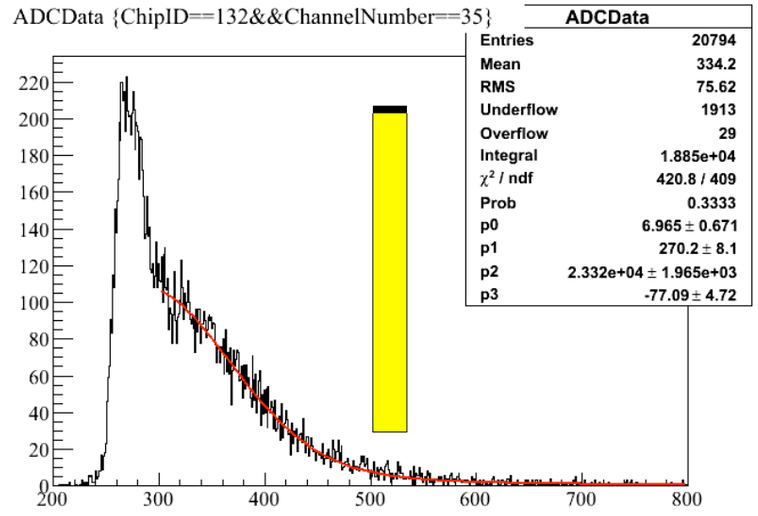
Response to MIP events



Part of pedestal



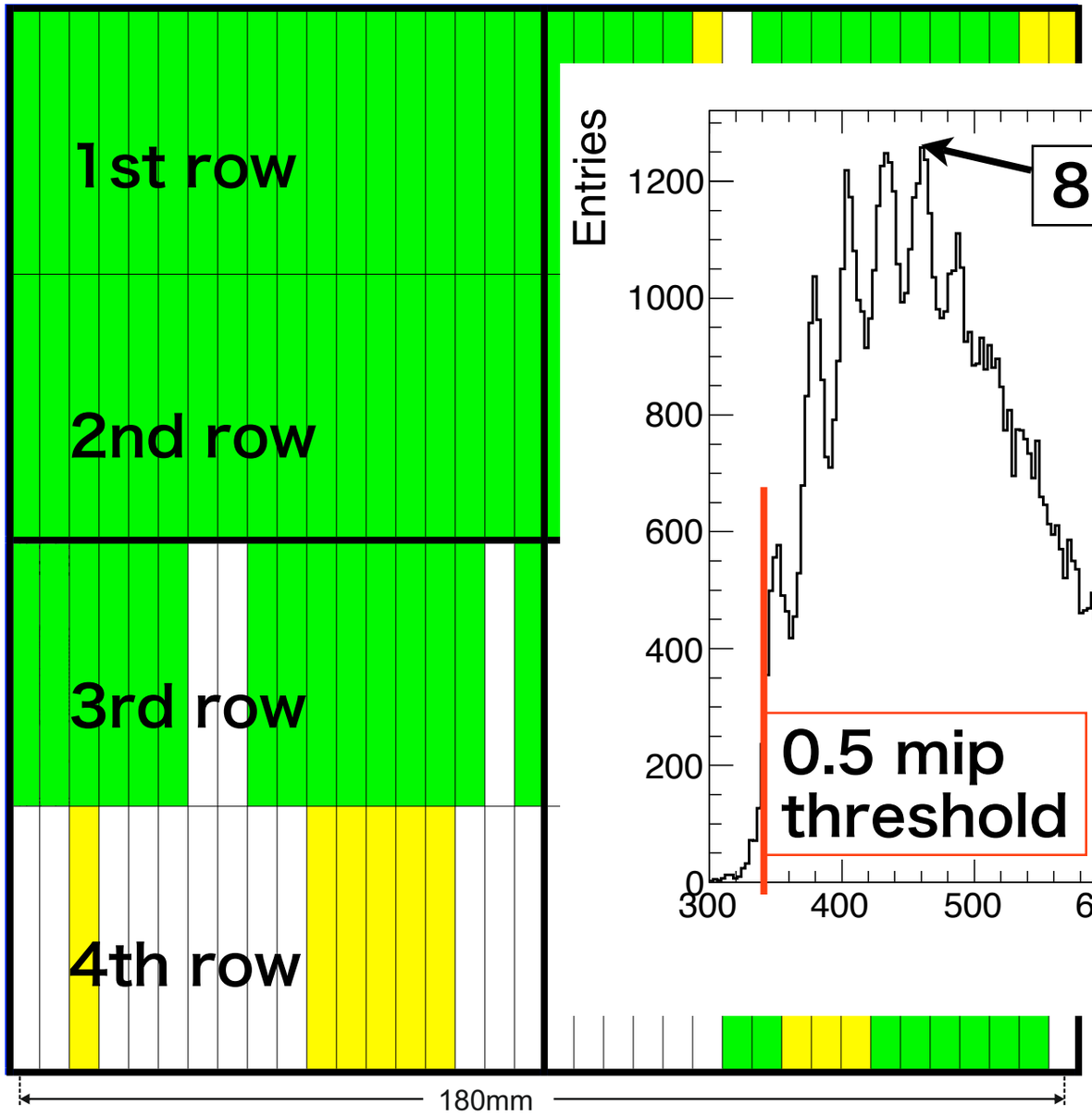
Trigger threshold << 0.5 MIP

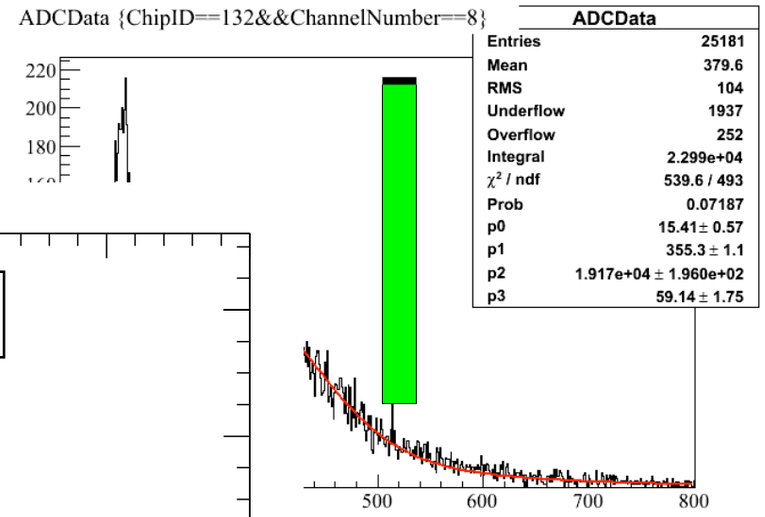


75% channels have succeeded to have good MIP distribution

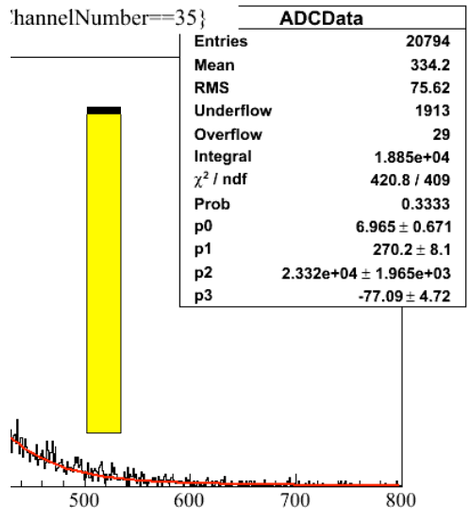
: no signal or large noise

Response to MIP events





reshold << 0.5 MIP



75% channels have succeeded to have good MIP distribution

: no signal or large noise

Shower events

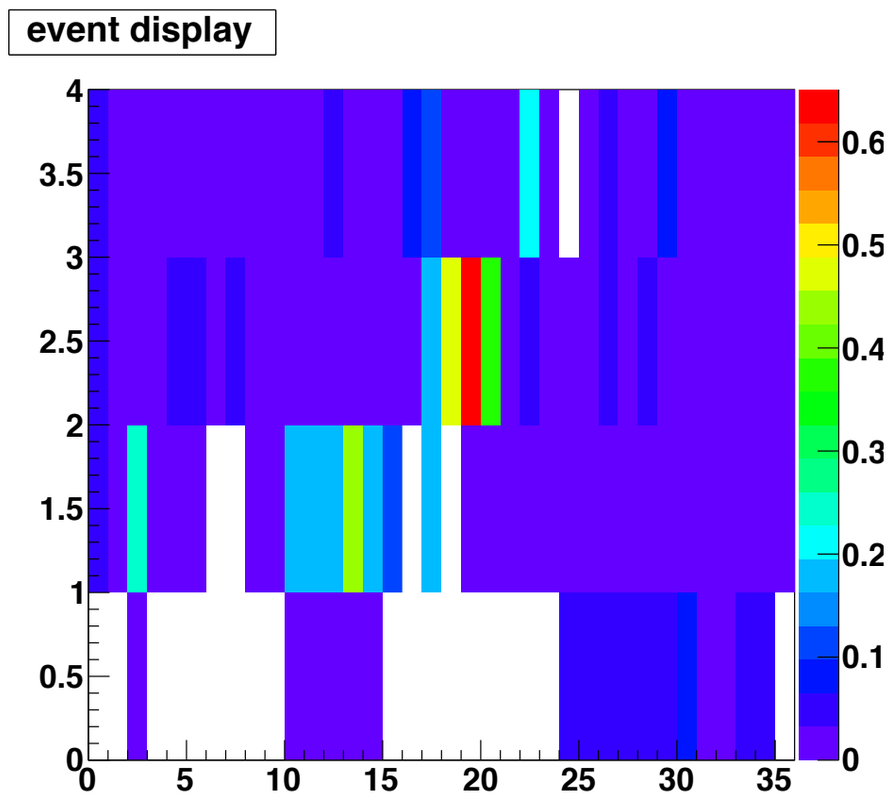
0.7 X_0 × (1 - 14) layers

Response of ScECAL behind

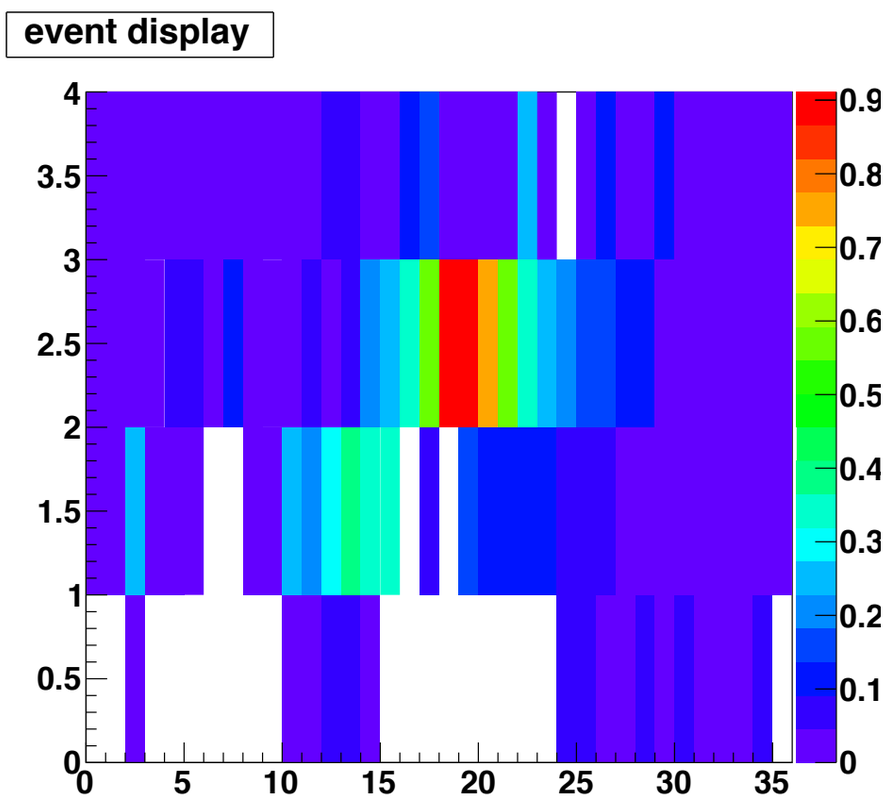
1. 0.7 X_0 Tungsten absorber
2. 6.4 X_0 Tungsten absorber

3 GeV e^- events

Mean of Energy deposit in each channel

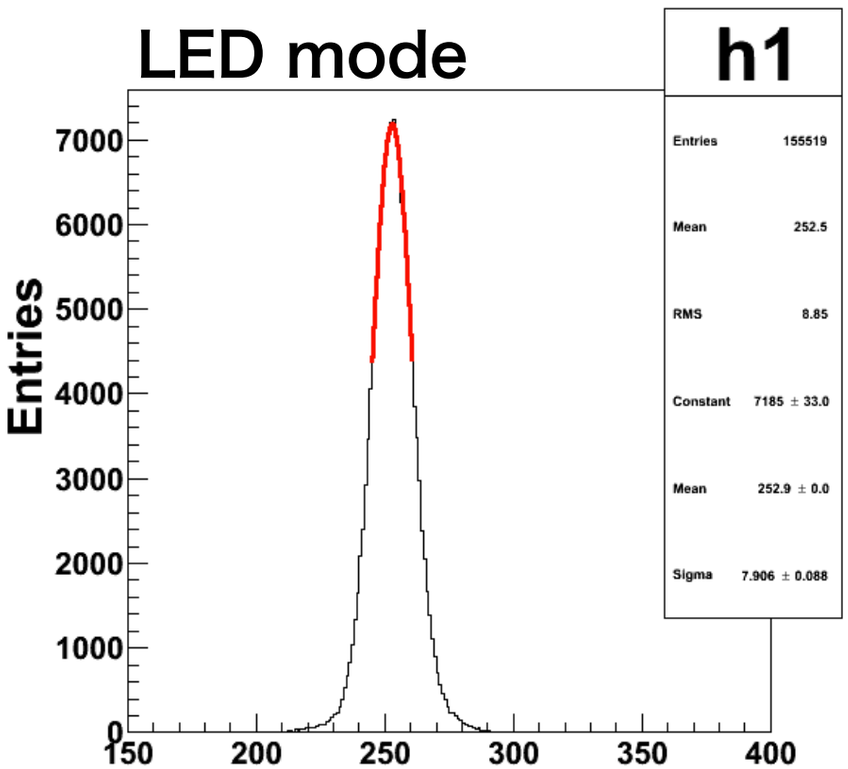


3 GeV e^- w/ 0.7 X_0 absorber.

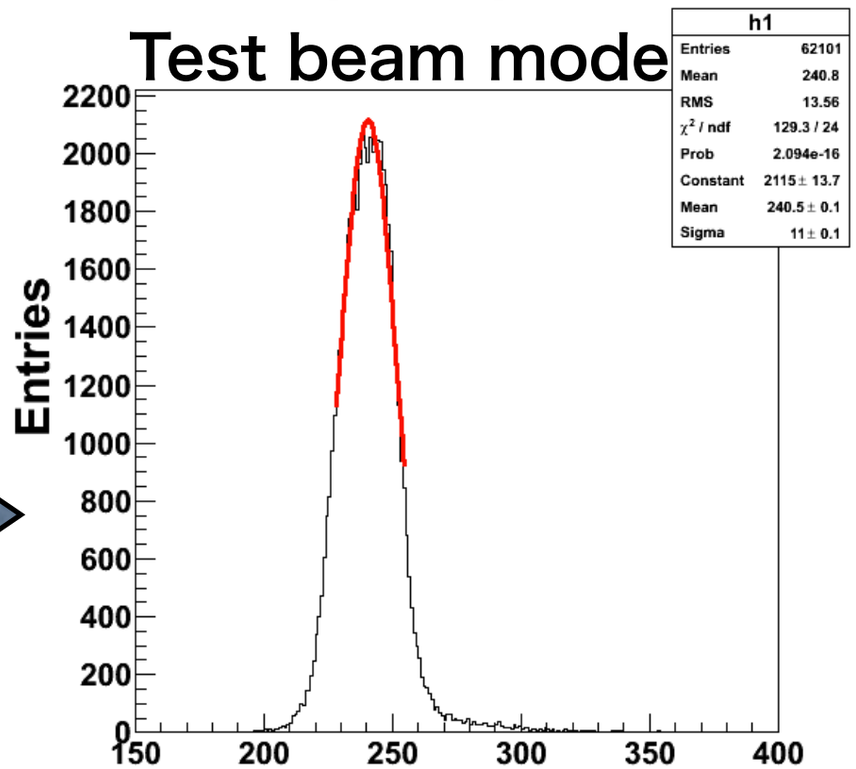


3 GeV e^- w/ 6.4 X_0 absorber .

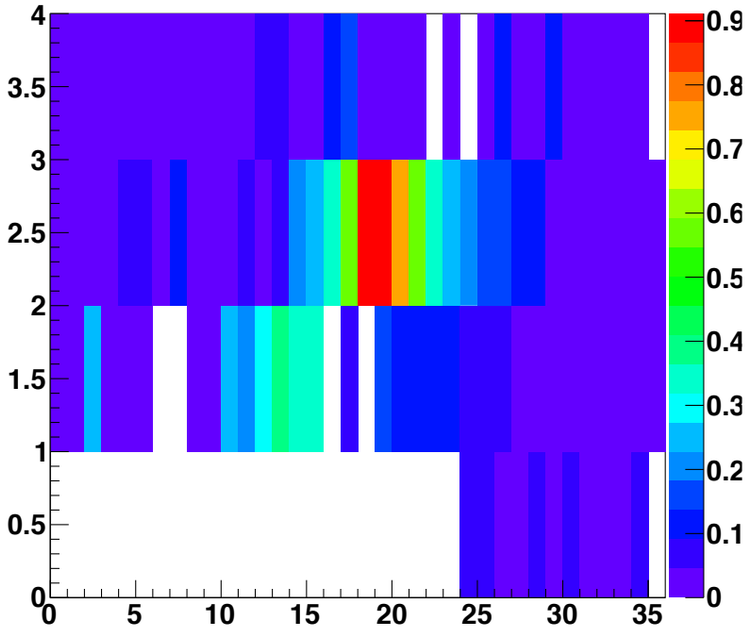
Pedestal shift between LED mode and TB mode



Shift to lower side

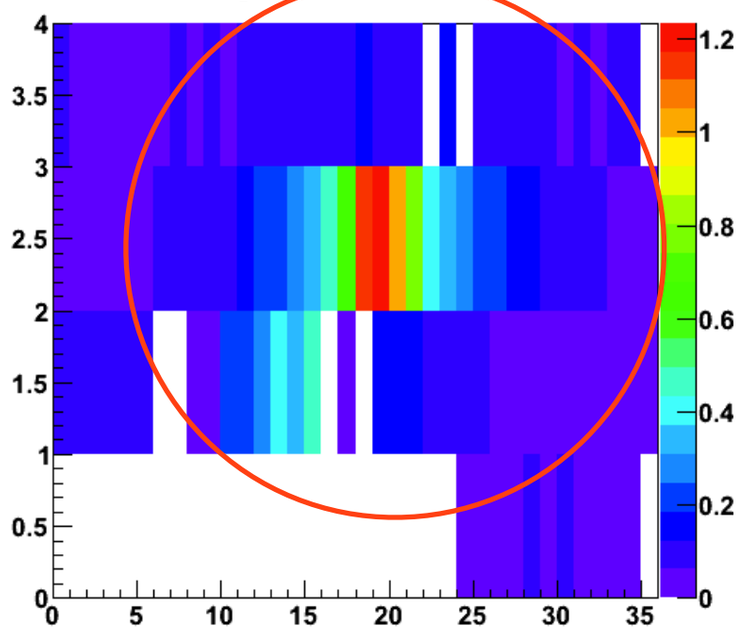


3 GeV e^- w/ 6.4 X_0 absorber .



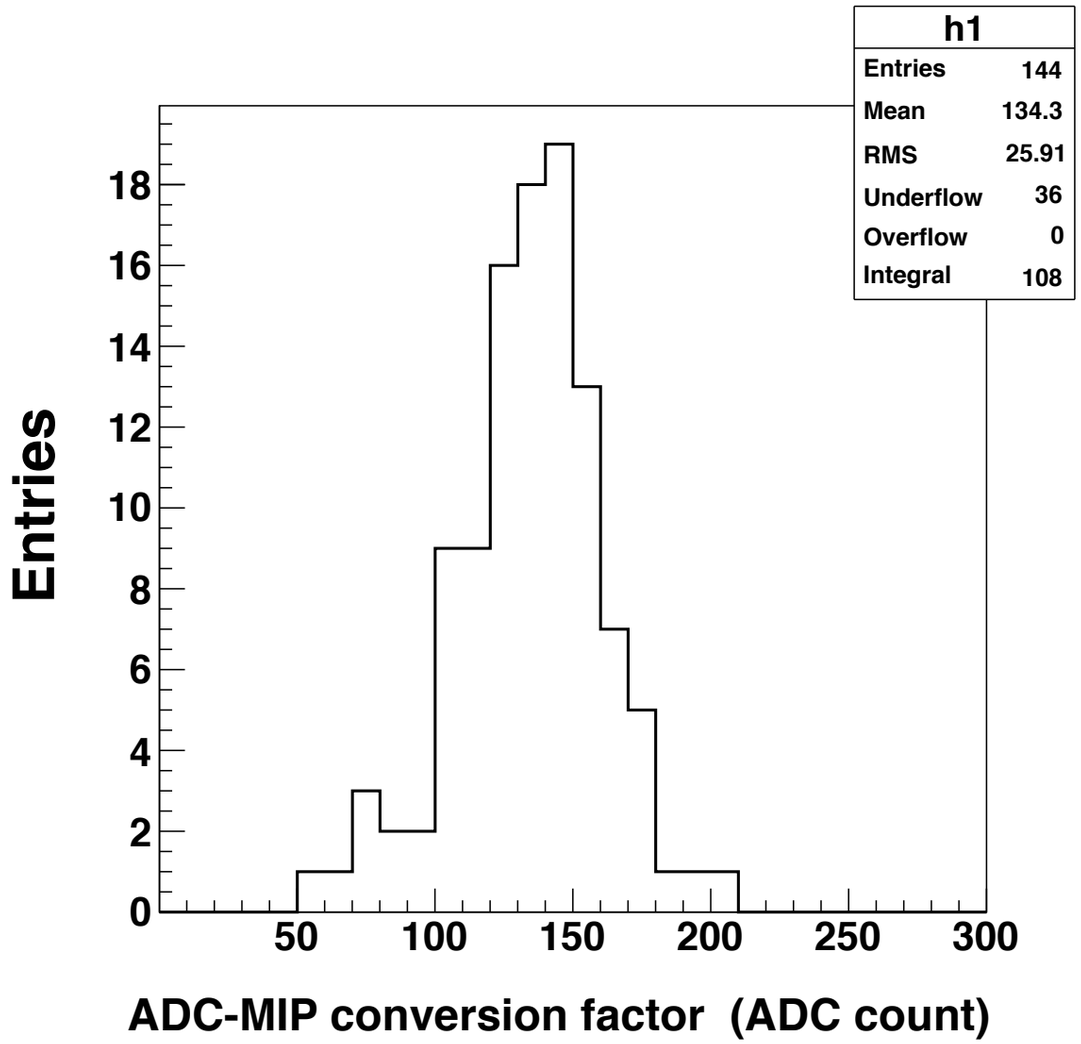
Using pedestal in TB mode, we can see the tail spread or the halo of beam

3 GeV e^- w/ 6.4 X_0 absorber .



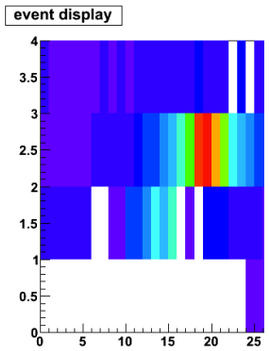
ADC/MIP conversion factors

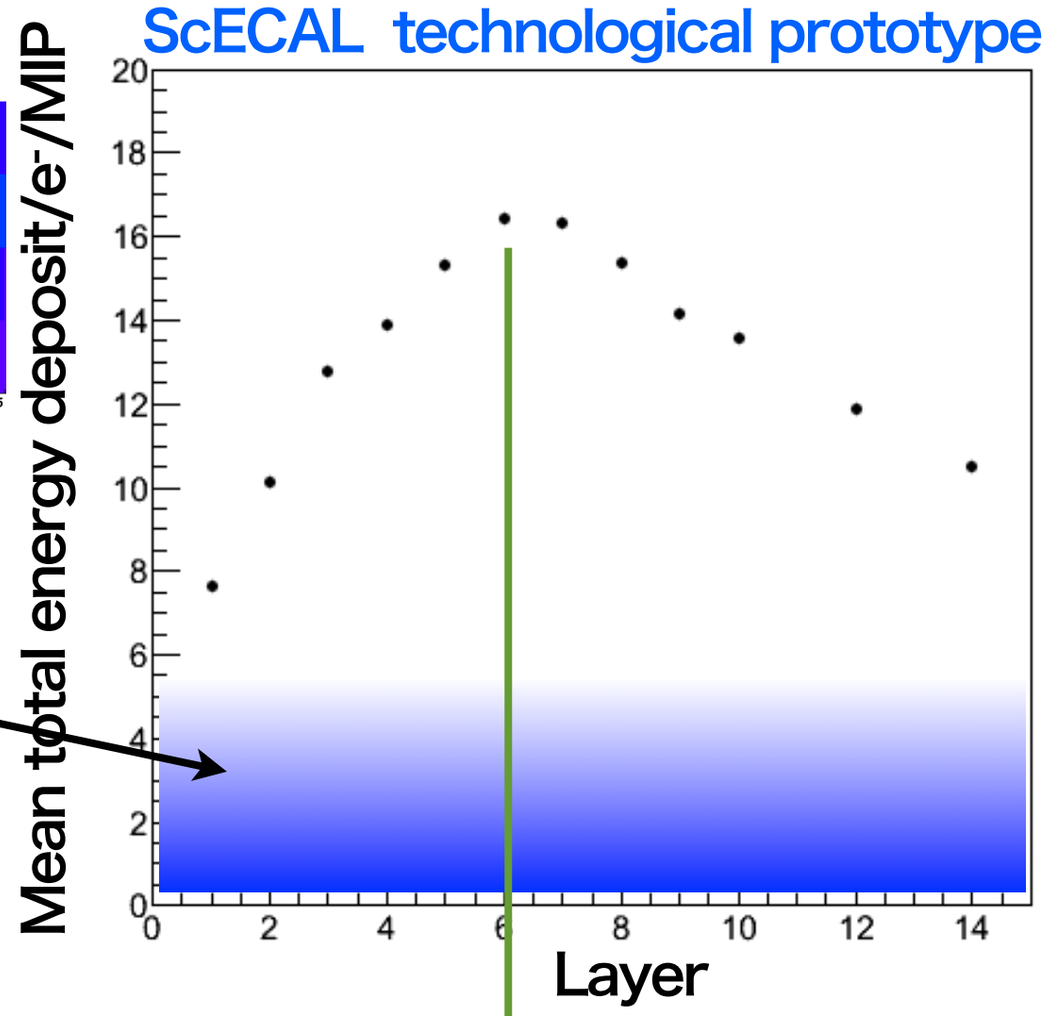
- Using pedestals taken in the test beam mode.
- 108 entries of available channels (75%).
- RMS/Means = 19.3% (This is the same as in the case of FNAL physics prototype .... accidentally?)

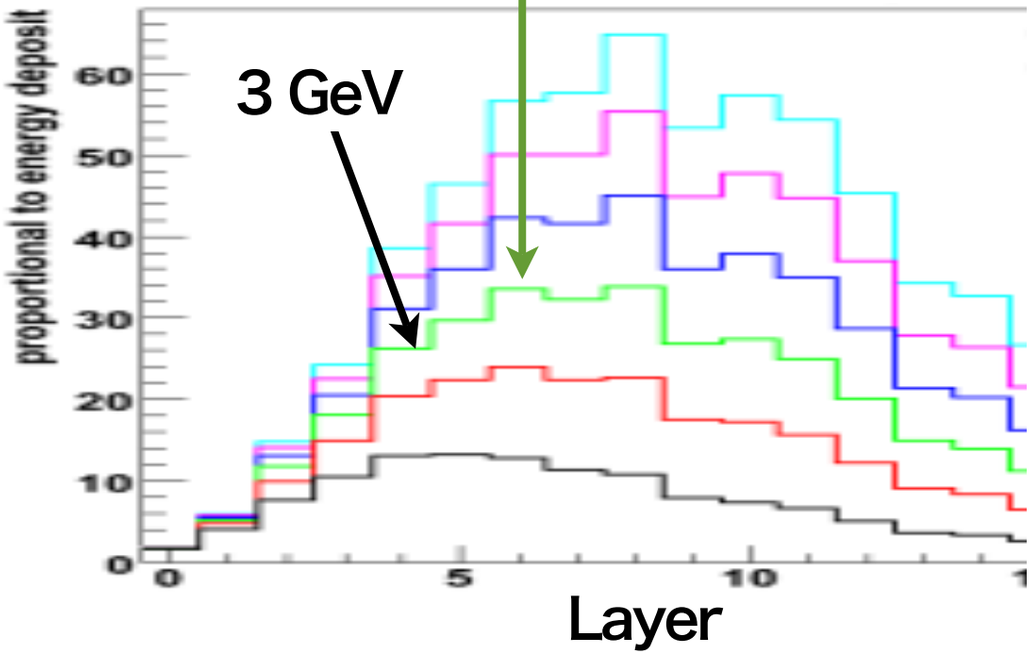


Pseudo-Multilayer ScECAL

- Longitudinal shower profile is plotted.
- Shower maximum is reasonable 6-7.
- Some amount of offset comes from noise will be estimated.
- Zero absorber data will be added from the mip measurements.

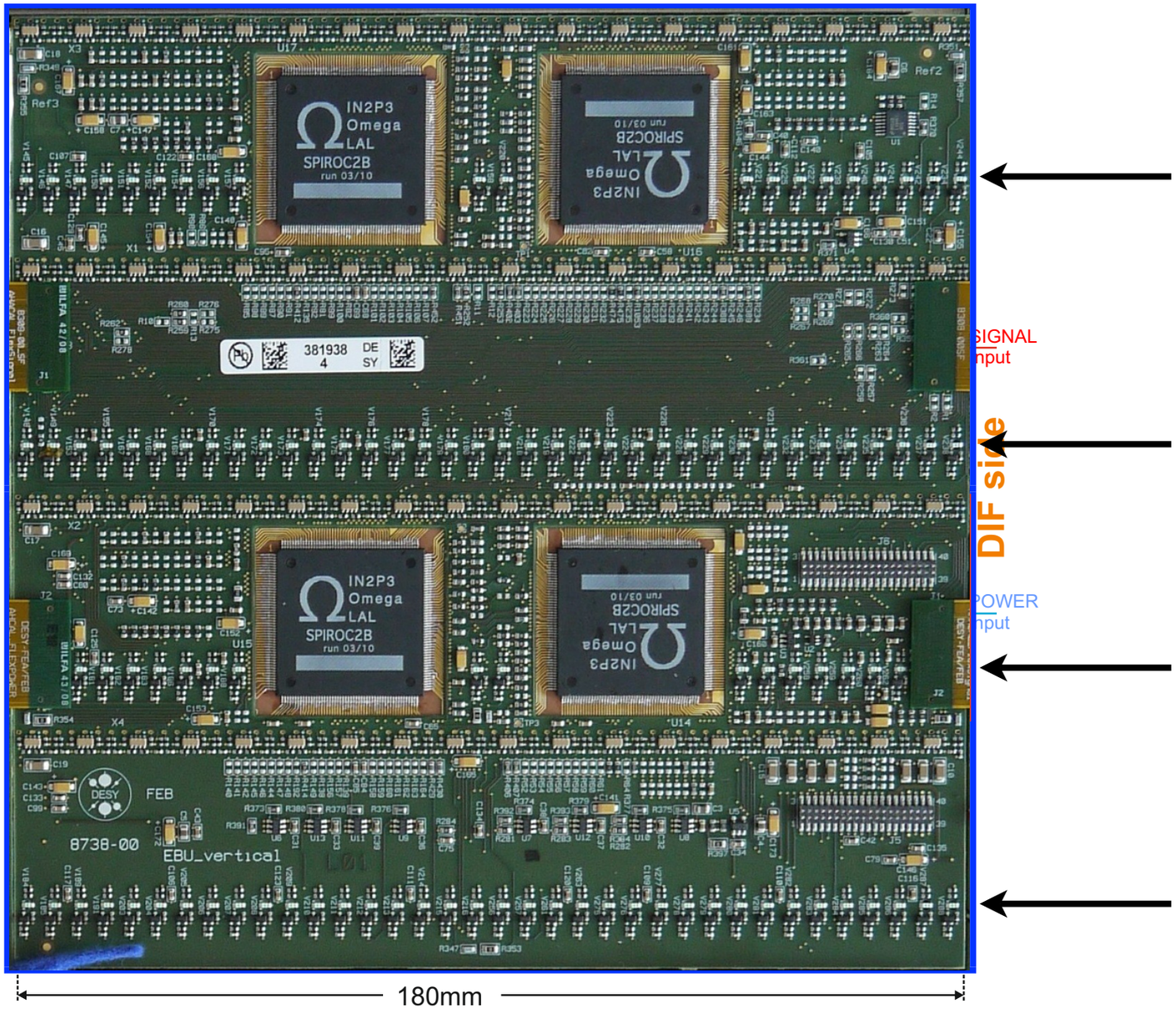


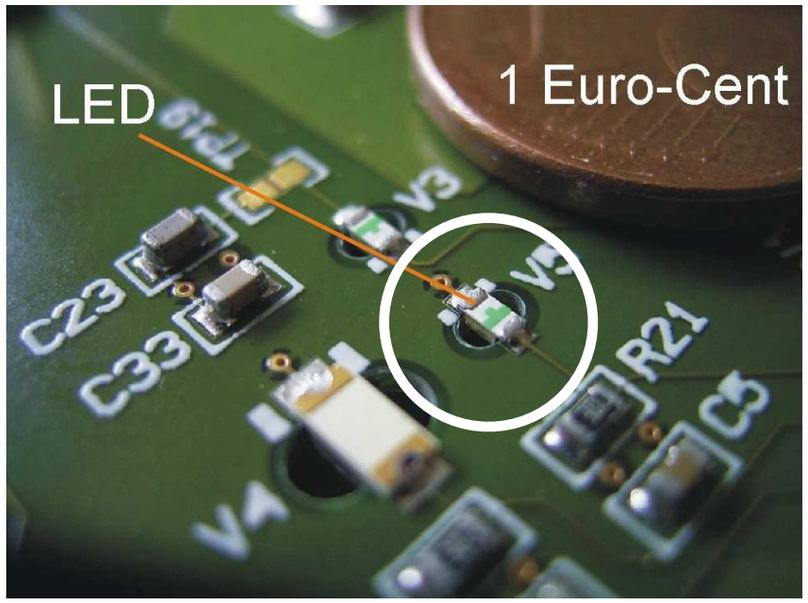




- From the result of physics prototype tested at DESY(2007)

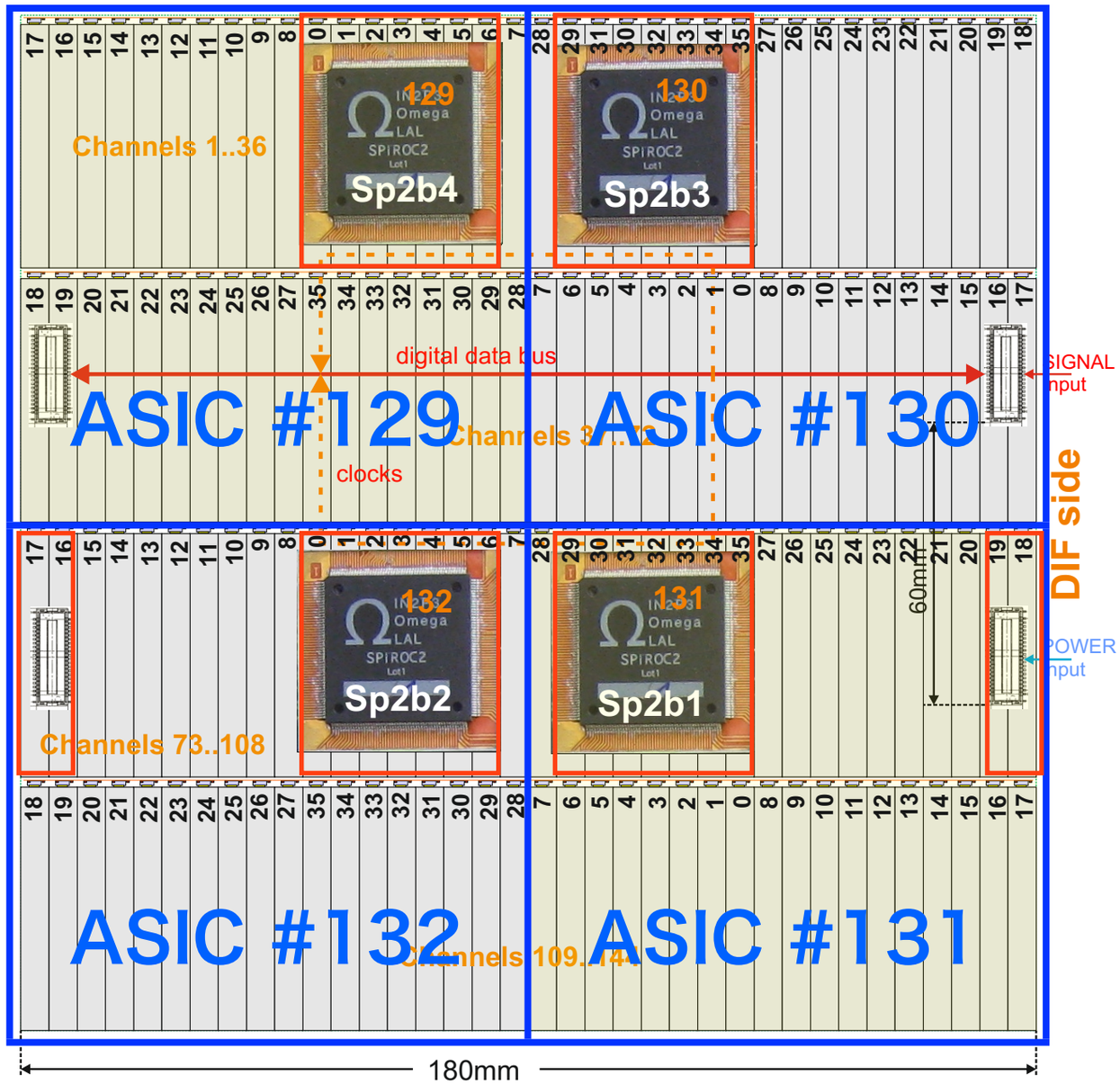
LED lights for gain monitoring

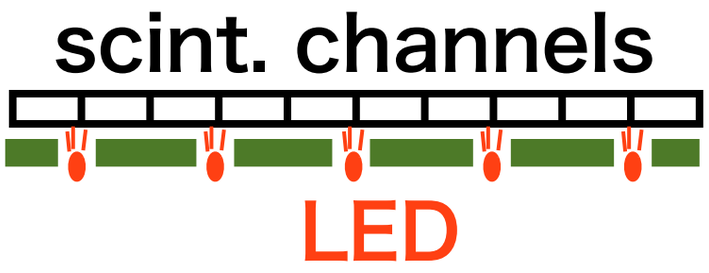




EBU has LEDs for each channel

LED lights for gain monitoring





No space for LED

7 x 4 for ASICs.

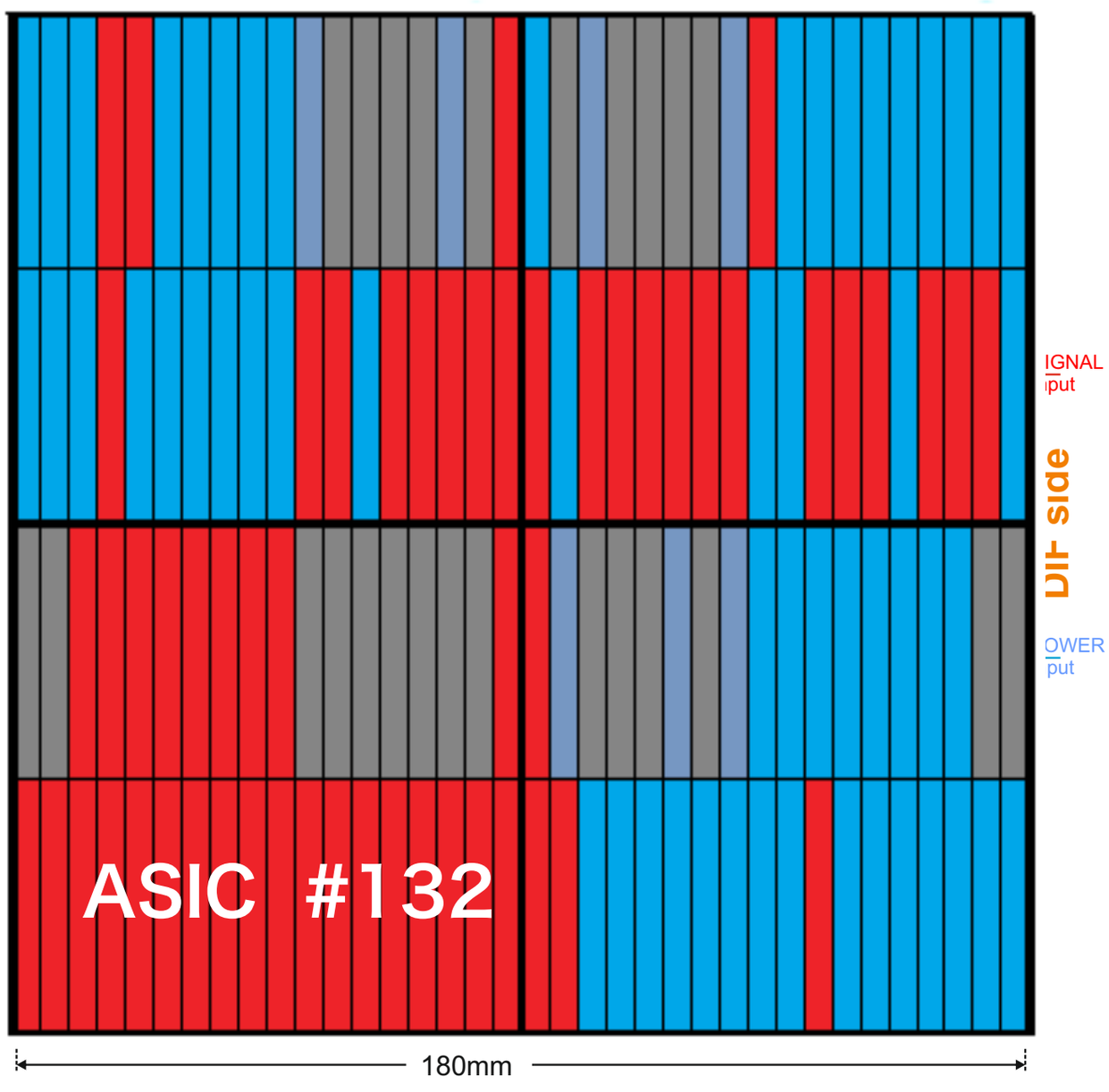
2 x 2 for power connectors.

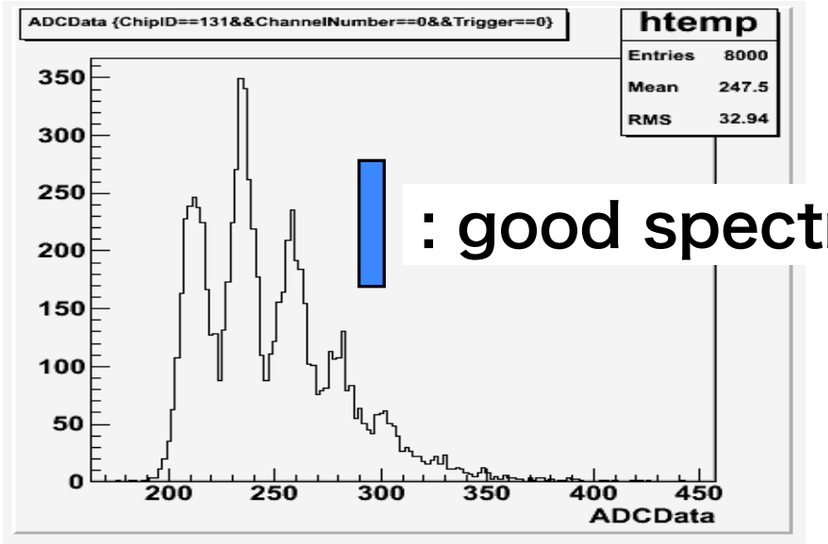
32 channels have no LED.

We need to ask to reduce the size of SPIROC package not only in thickness but also in area by using some package technique.

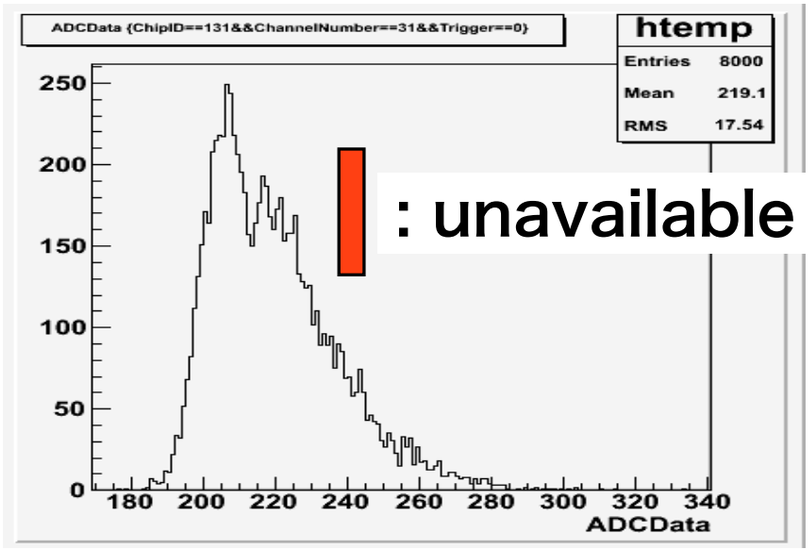
Next time,we can reduce the number of LED by sharing an LED with more than two channels

LED lights for gain monitoring





: good spectrum

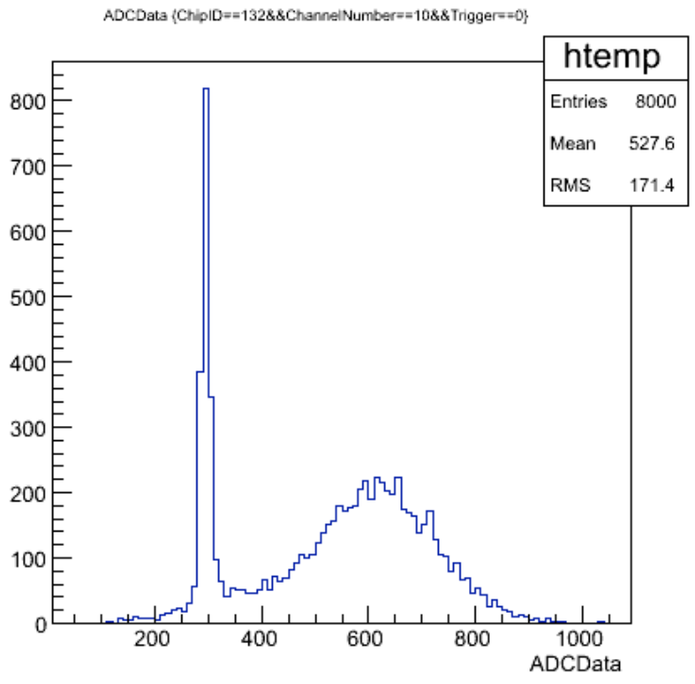


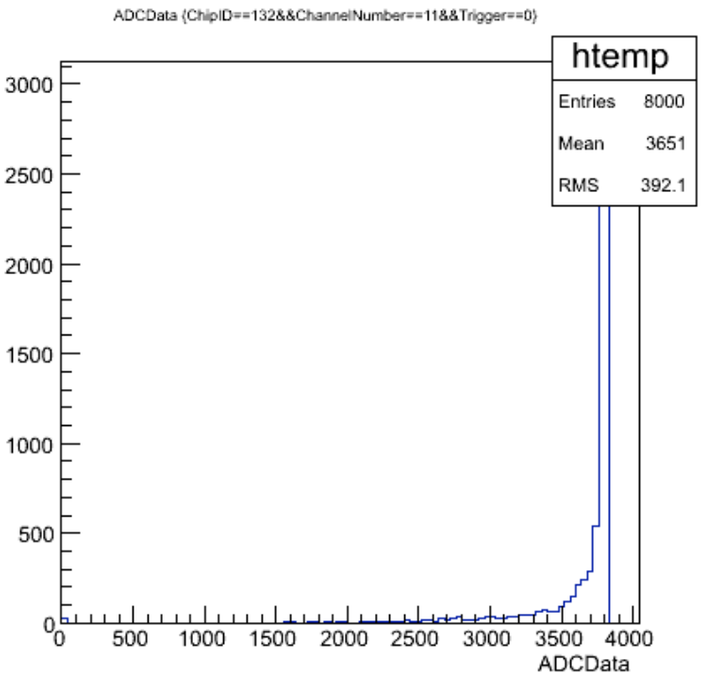
: unavailable

: no LED by ASIC or connector

- (#good channels)/(144-32) = 50%.
- There is no any good LED channel on ASIC132.

ASIC 132 LED on (but we can see normal pedestal with 0 V LED ▶ LED current makes noise?)





Summary

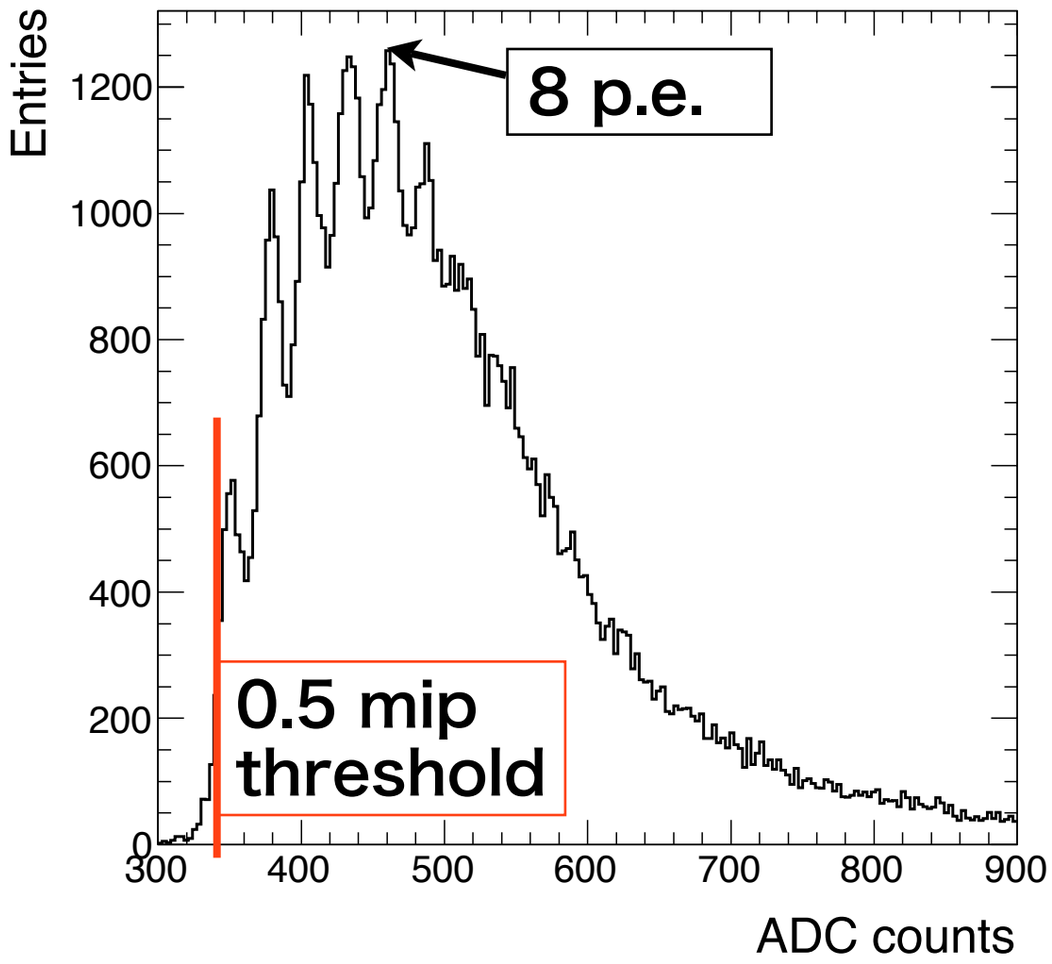
1. We have haven the test beam experiment for the ScECAL 144 channel technological prototype using electron beam at DESY.
2. We have seen the distribution of MIP energy deposit with MPV of around 7 p.e. for 75% of channels.
3. The number of successful channels of gain monitor with LED system is 50% of channels which have LED light, so far.
4. We recognize problems as in the following page...

Problems we recognized

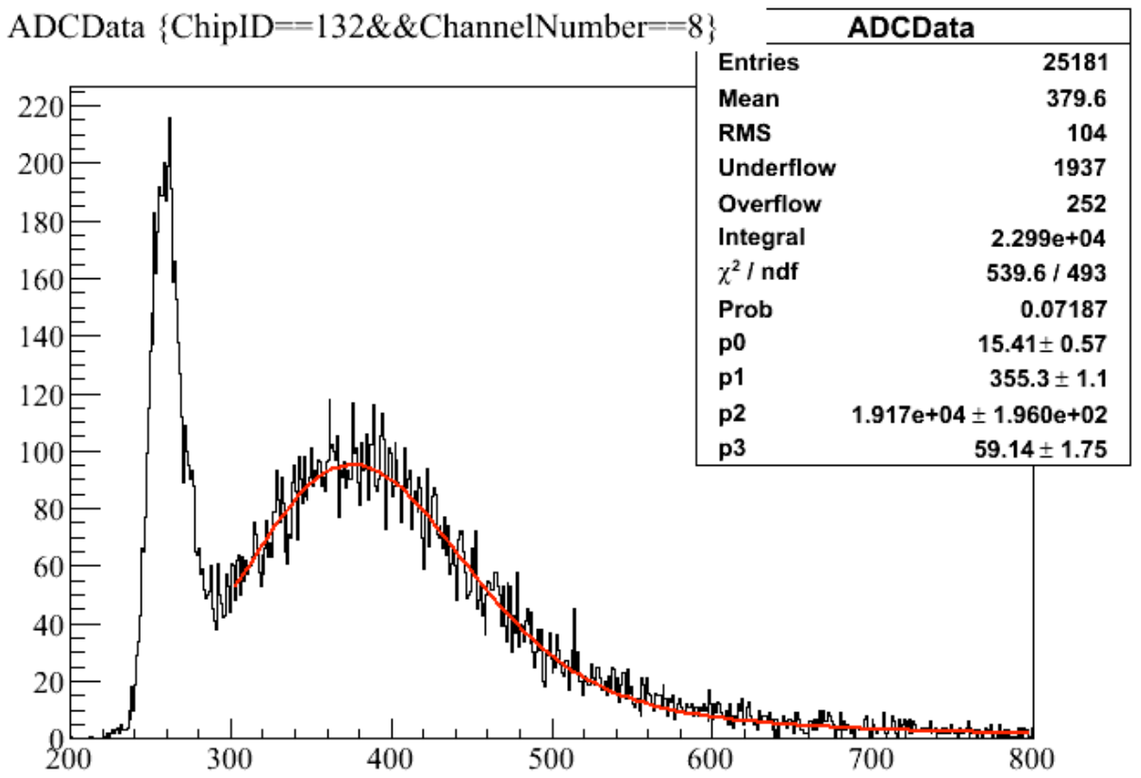
1. DIF cannot control multiple EBU for the TB mode so far.
2. Individual threshold cannot be available so far.
3. A SPIROC2b has 16 analog memory cells. This means that 16 events can be taken for a spill and the conversion factors between the analog memory cell and ADC has difference by memory cell by memory cell.

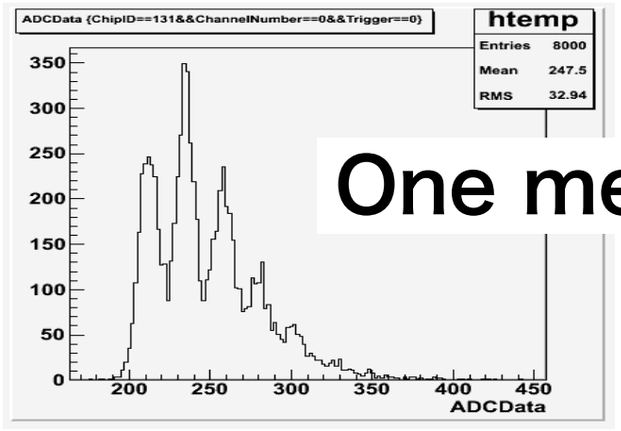
Response changes depending on 16 memory cells

MIP distribution of ch.24 of SPIROC 130, 131 every memory cells together



The p.e. peaks are smeared for most of other channels





One memory cell.

We can clearly see the p.e. peaks.

Problems we recognized

1. DIF cannot control multiple EBU for the TB mode so far.
2. Individual threshold cannot be available so far.
3. A SPIROC2b has 16 analog memory cells. This means that 16 events can be taken for a spill and the conversion factors between the analog memory cell and ADC has difference by memory cell by memory cell.
4. Some events have a triggered channel which has small ADC counts than the true one.
5. Many unavailable LED channels.
6. LED system makes strange noise on #132.
7. We need more photon yields.
8. ・・・

Future plan

1. Near Future:
    1. Two layer (x and y type) ScECAL prototype,
    2. Combined with Si-W-ECAL prototype (Hybrid ECAL),
2. Further more,
    1. Fix the technology and design of Scintillator-MPPC unit,
    2. more compactification of electronics.
        1. ASIC,
        2. Central detector interface.

back up

Plan of the analyses

1.Precise analysis of MIP and pedestal.

2.Precise analysis of gain with LED run data.

3.Study on the fluctuation of memory cells by measuring LED p.e.-ADC depending on memory cells (data has a flag).

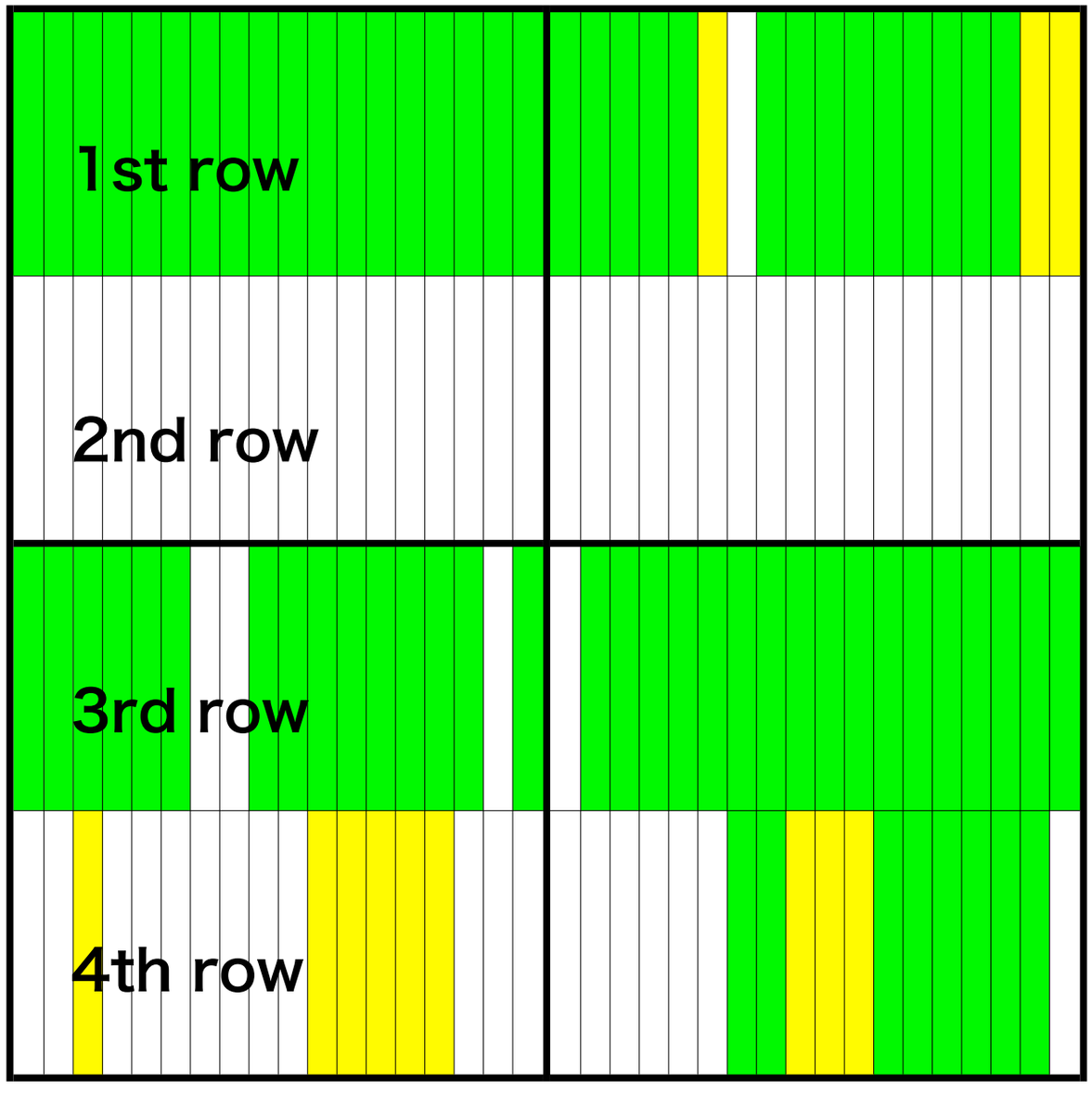
4.Study on LED system using EBU at Shinshu [We have brought two EBUs including one full equipped EBU, central interface board (DIF, LED, Power)] and its frame.

5.TDC analysis (we have data)

6.Power pulse study in our lab in shinshu and in the next TB.

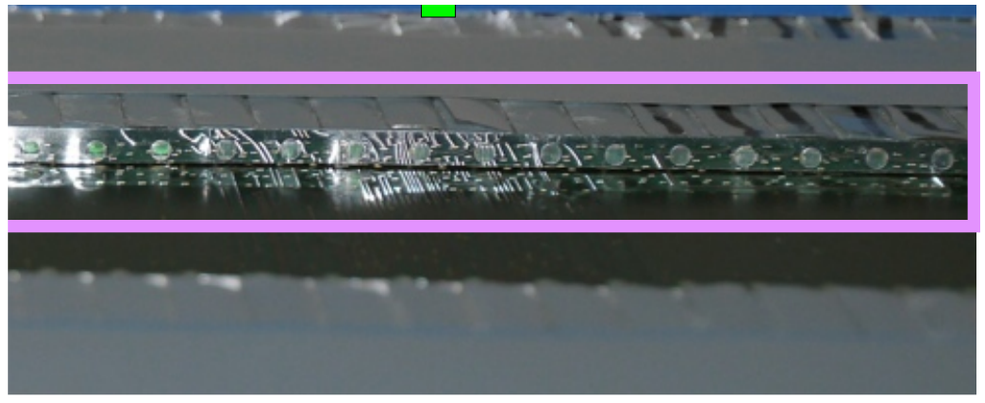
7.More EBUs, more layers, and Hybrid ECAL.

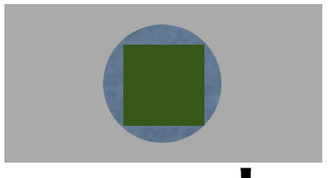
Response to MIP events



75% channels have succeeded to have good MIP distribution

We checked MPPC-Window matching

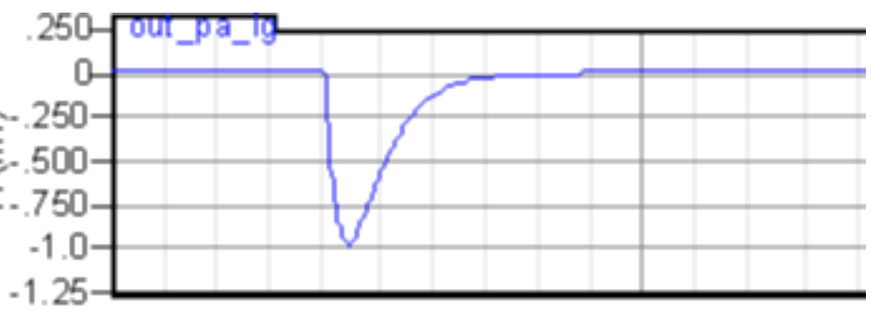




window/MPPC matchings were good

Nevertheless we removed the reflector ribbon and 2nd row came back!

SPIROC2b logic for auto trigger mode



MPPC analog signal

IN

Slow Shaper

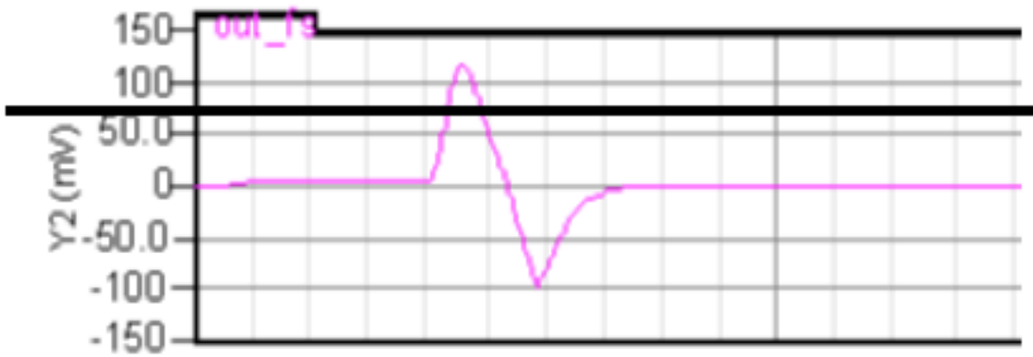
16
Analog memory

ADC

Fast Shaper

Valiable Delay

Discri



Threshold

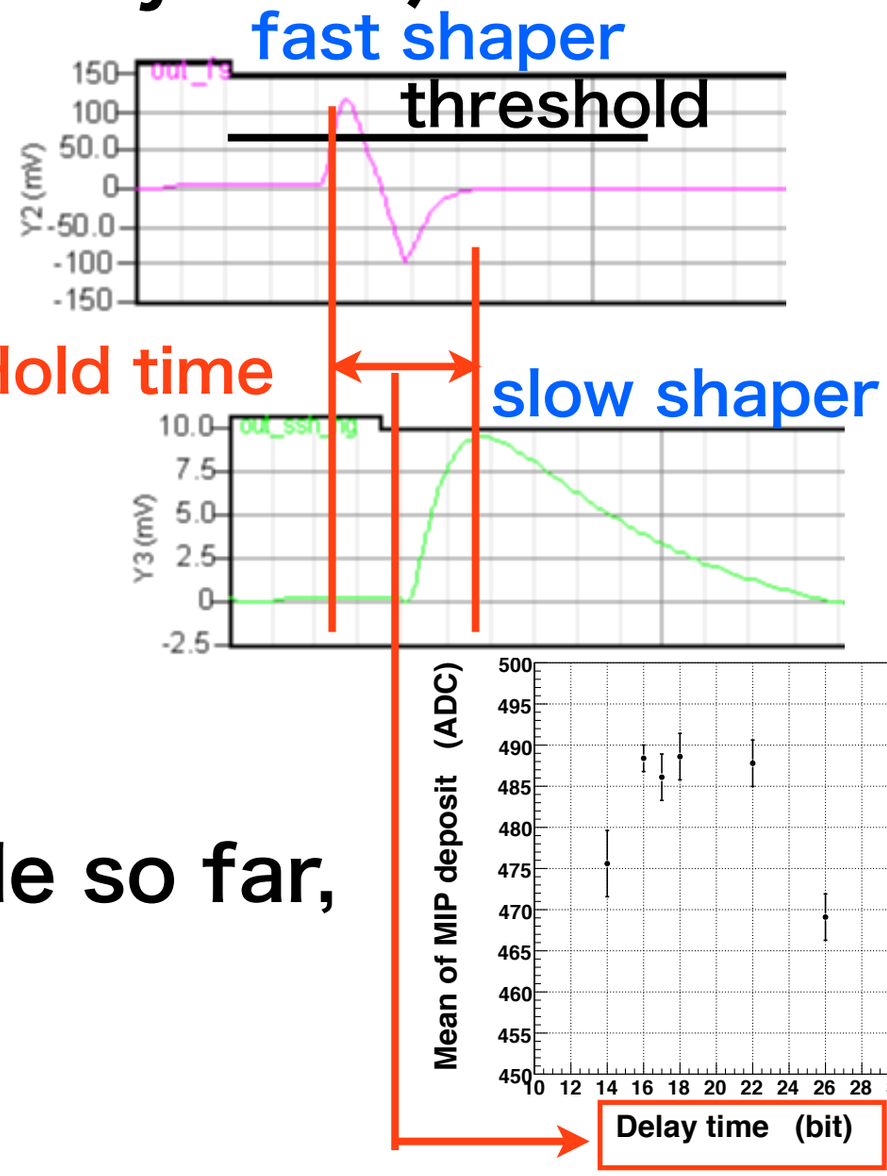
TDC

Fast Shaper for triggering (dif)

Issues should be optimized

- Shaping time (like gate length, ASIC by ASIC)
  - we tuned to 100 ns
- Delay time (ASIC by ASIC)

- Spill signal delay
- Bias voltage (channel by channel)
- Threshold for auto trigger
  - global (ASIC by ASIC) : we used
  - channel by channel : not available so far,
- Preamplifier (channel by channel)
  - maximum value in this TB
  - in future, tune this value to have 0.5 MIP threshold at the same DAC value for all channels.



Logics

spill signal

TTL to NIM

Gate Generator

40 ms

NIM to TTL

Beam

40 ms

validation mode

beam makes it

x counter

y counter

coin.

Gate Generator

10 ns

NIM to TTL

10 ns

EBU

Validation mode (like triggering)

40 ms

EBU can work

spill signal

4 μs clock

validation failed

max meas.length or16 events

delay spill sig.

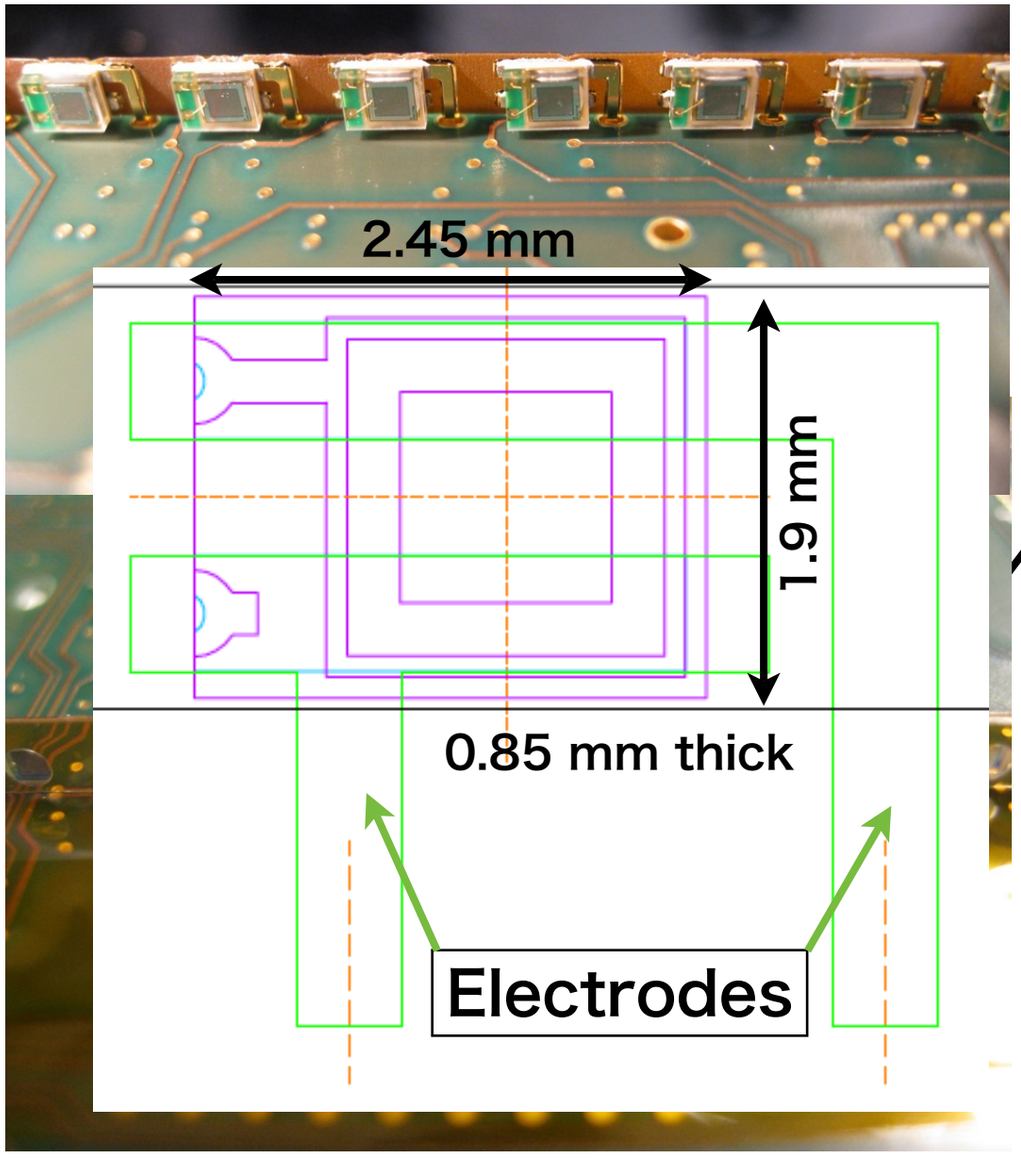
40 ms

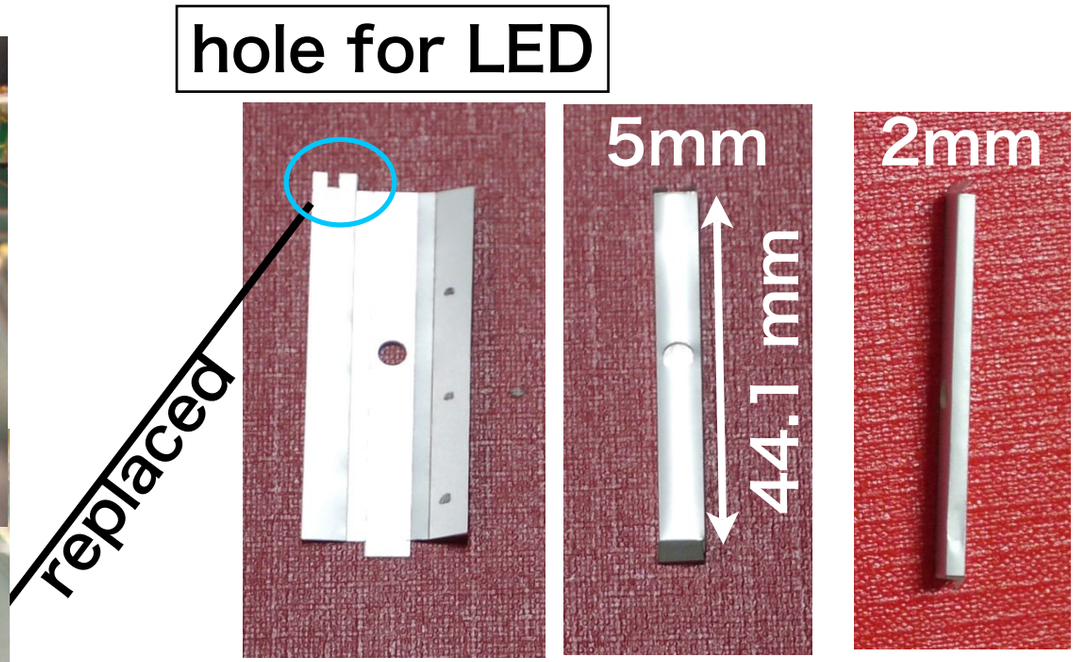
EBU can work

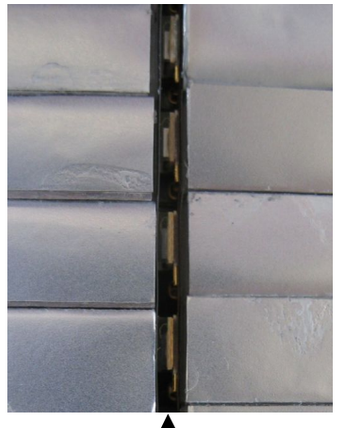
validated!

MPPC-scintillator strip

- 36 MPPCs/row on a polyimide ribbon.
- The polyimide ribbon is for only mechanical support.







Precision of alignment of scintillators is not enough. we can fix this next time.

Purpose of technological ScECAL

- To check feasibility of one layer unit and its control unit. [To check if we can control two ECAL base board unit (EBU) from one control unit.]
- Detail test issues:
  1. Performance on energy measurement.
     1. Verification of MIP measurement ability.
        1. stability of procedure,
           - scintillator-MPPC-amplifier-charge-ADC
        2. separation from noise
     2. Gain measurement with builtin LED system.
  2. Other functions.
     1. TDC,
     2. power pulsing system .... next TB...

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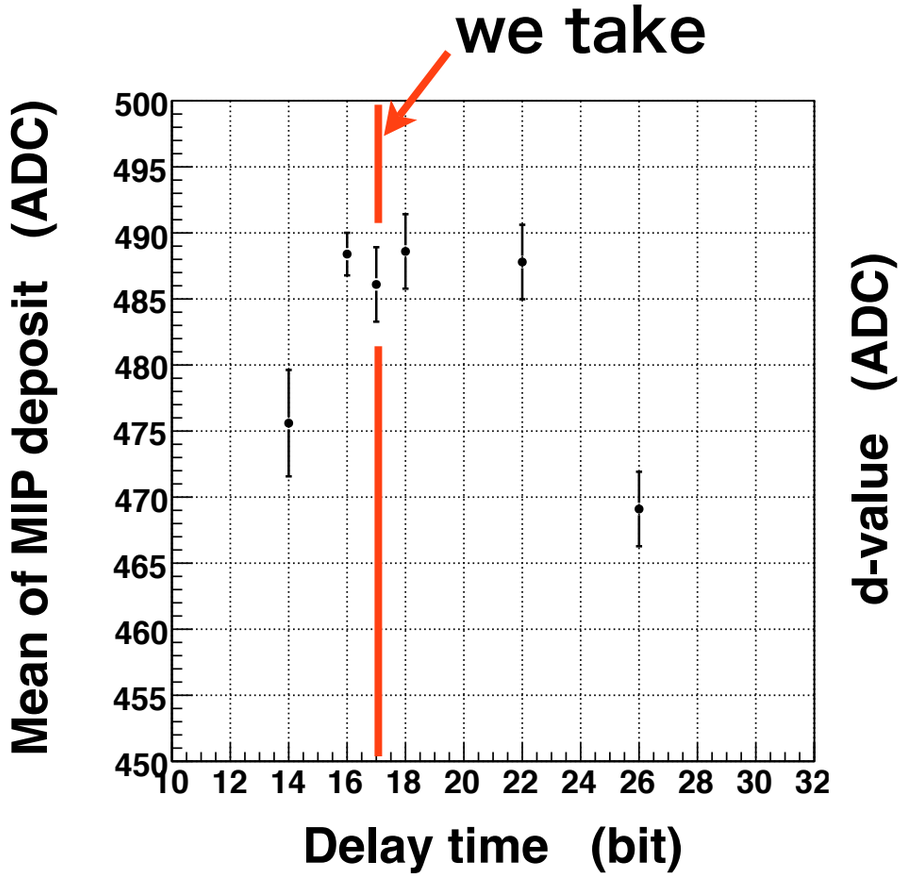
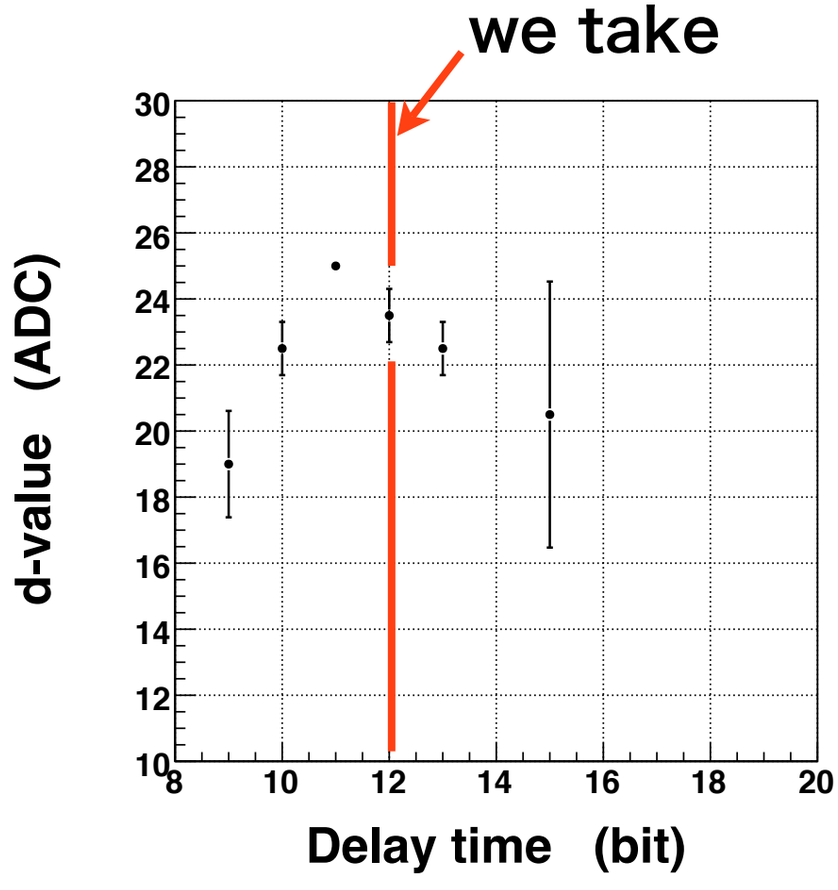
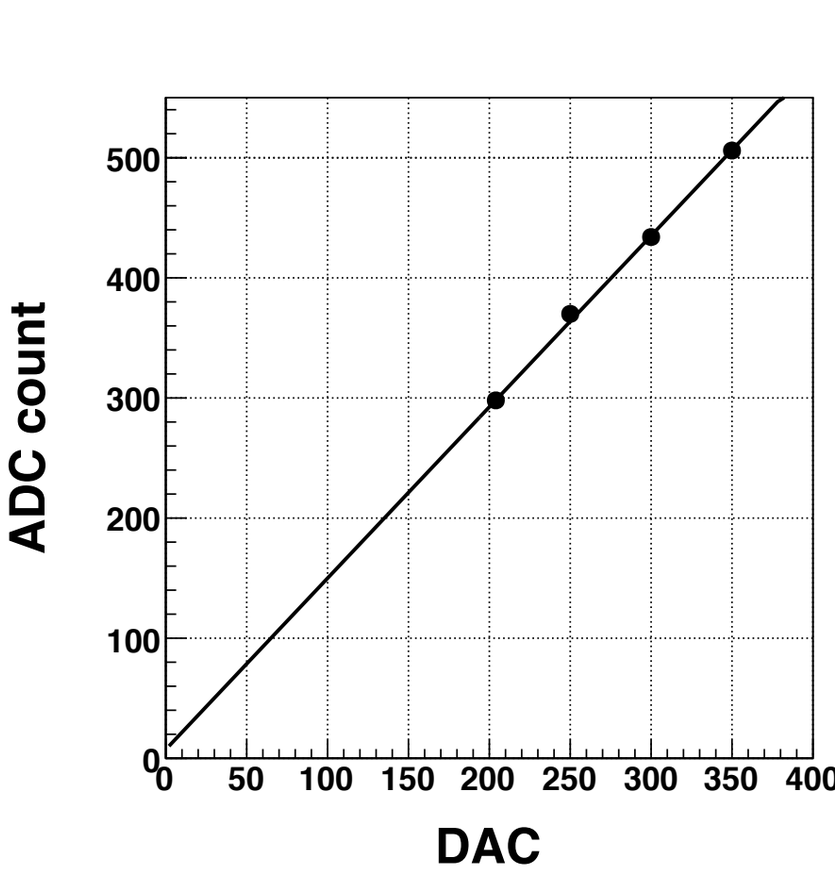
Done: some tunings

9. Others
    1. large statistics of:
        1. MIP measurement with 0.5 MIP threshold
    2. delay time for TB run and LED run
    3. DAC-ADC relation







Purpose

in laboratory

1. System test in lab (2.5 weeks).
   - ADC, TDC, auto trigger, power pulsing
2. LED calibration in lab. including noise monitoring (0.5 weeks)

on beam line

3. installation (0.5 week)
4. noise run (2 days)
5. LED calibration (2 days)
6. 3 GeV electron run w/o absorber (2 days)
7. electron run w/ absorbers (0.5 week)
   - one absorber, two absorbers, three absorbers, ...
   - x 1 GeV, 3 GeV, 6 GeV
8. withdraw