

# FoCal PAD status in Japan

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June 1, 2016

ALICE Calo Meeting in Tokyo 2016



筑波大学  
*University of Tsukuba*

# Test beam members for FoCal PAD (JP)

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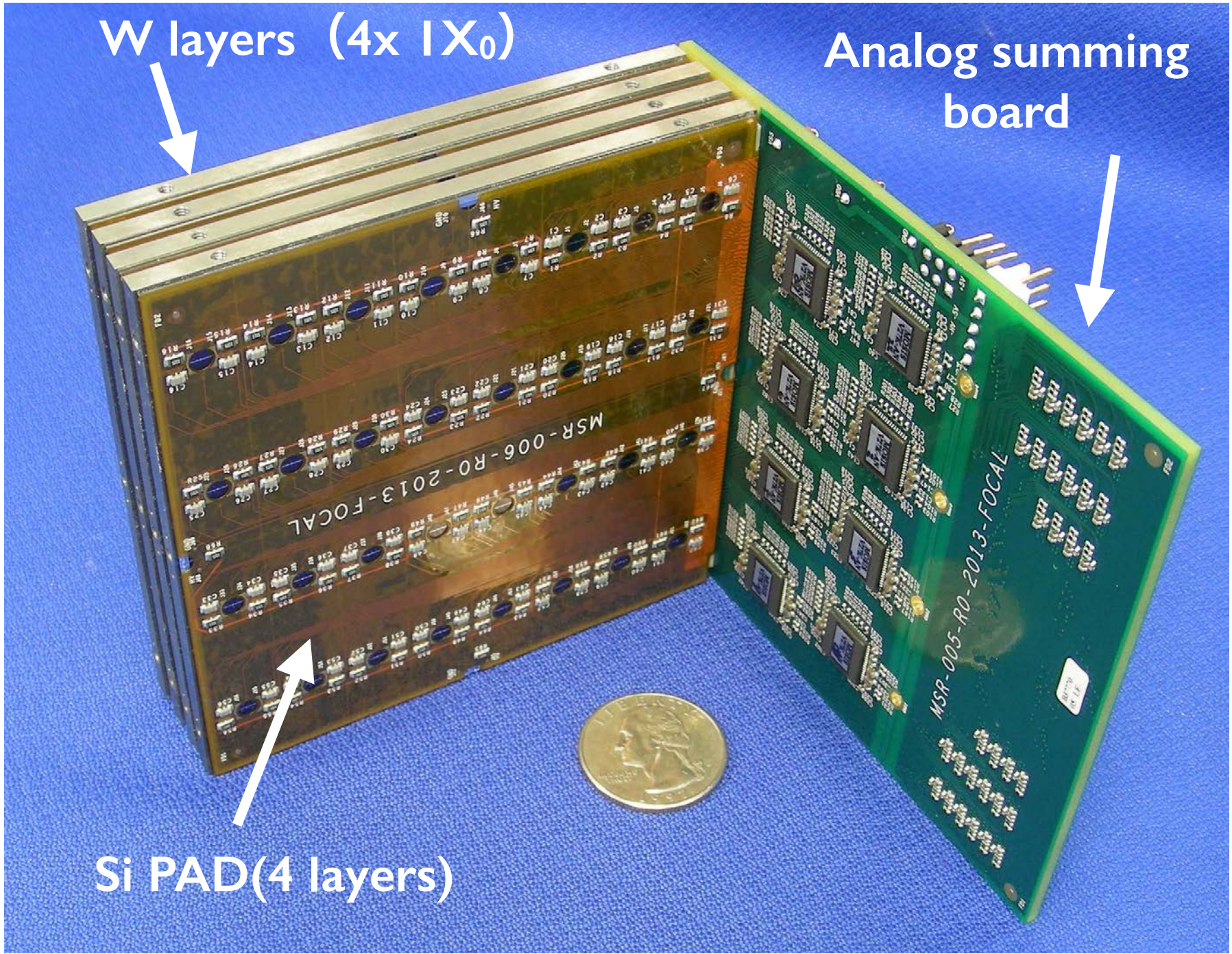
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Motoi Inaba <sup>2</sup>, Kyoichiro Ito <sup>1</sup>, Byung Chul KIM <sup>1</sup>,  
Sakiko Kudo <sup>1</sup>

with the support by MAPS group

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Thomas Peitzmann <sup>3</sup>, Hongkai Wang <sup>3</sup>, Chunhui Zhang <sup>3</sup>

1. University of Tsukuba
2. Tsukuba University of Technology
3. Utrecht University, NIKHEF

*Data analysis for 2015 test beam has been done by M. Hirano (master thesis 2016)*

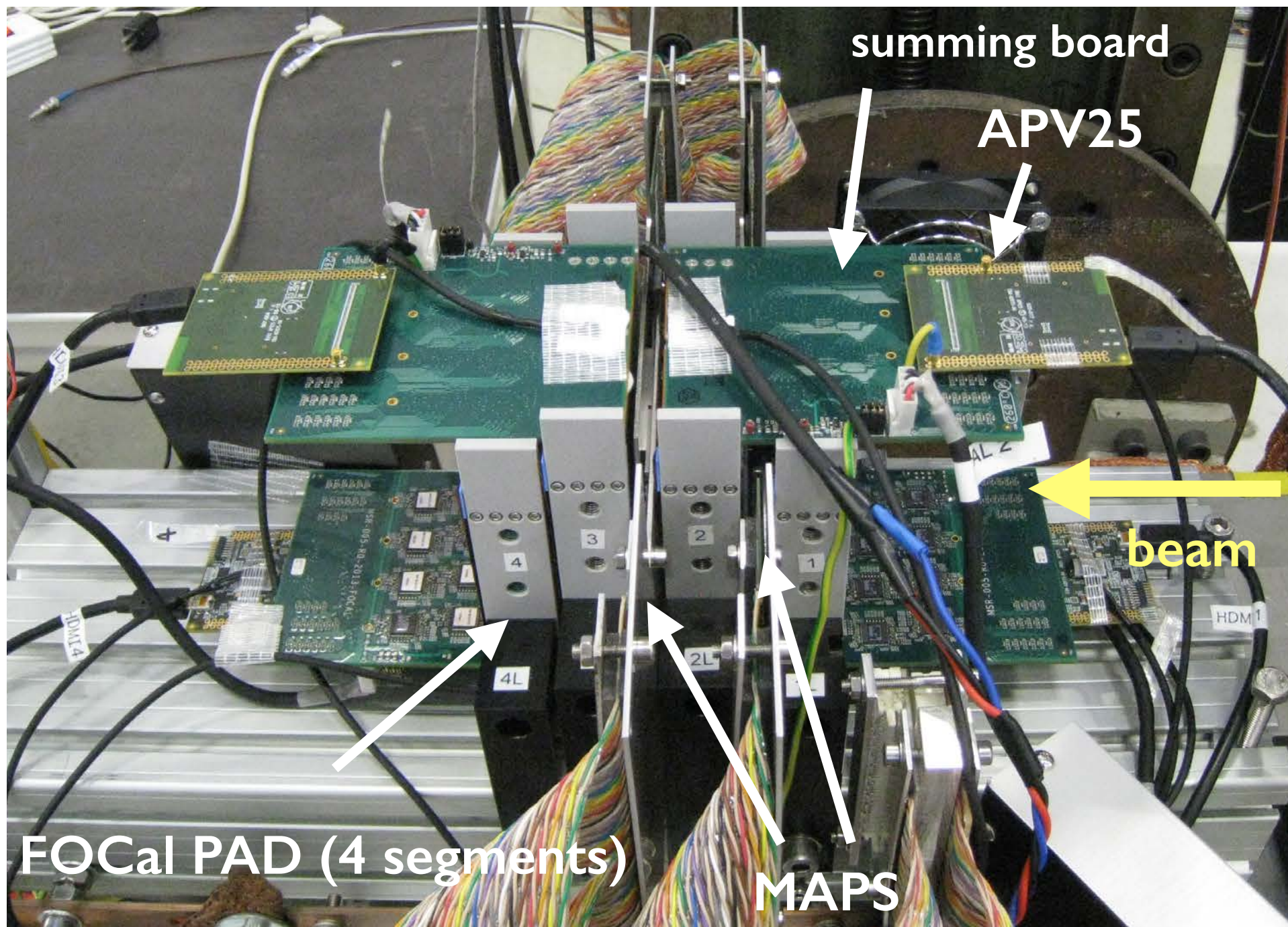


W layers (4x 1X0)

Analog summing board

Si PAD(4 layers)

**FoCal PAD proto type, 1 segment (ORNL)**

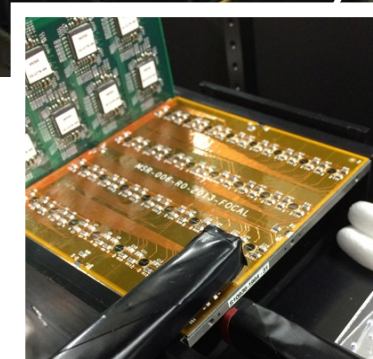


**Test beam setup @ PS (same for SPS) in 2015**

# FoCal test bench @ Tsukuba



- SRS readout system + APV 25 hybrid readout system.
- Same system has been used for the PS/SPS test beam.



Si with cosmic ray measurements

# 2015 Data summary (PS)

Beam energy (GeV/c)	Trigger*	No. of events
-0.5	e	23k
-1.0	e	15k
-1.0	h	7.5k
-2.0	e	15k
-2.0	h	20k
-3.0	e	19k
-3.0	h	10k
-4.0	e	7.6k
-4.0	h	7.7k
-6.0	e	0.6k
-6.0	h	32k
-8.0	e	0.5k
-8.0	h	26k
-10.0	e	1.4k
-10.0	h	5.0k

\*e: e<sup>-</sup> trigger (CH ON)

h: hadron trigger (CH OFF)

# 2015 Data summary (SPS)

## Taking data(SPS)

•electron beam

Energy(GeV/c)	events	trigger	output
+5	100274	P,F	Negative(100%)
+5	2803	P,F,H,V	Positive(100%)
+10	183553	P,F	Negative(80%)
+20	71470	P,F	Negative(80%)
+30	196645	P,F	Negative(80%)
+40	610386	P,F	Negative(80%)
+50	90058	P,F	Negative(80%)
+60	55374	P,F	Negative(80%)
+70	611	P,H,V	Negative(80%)

•hadron beam

+30	2925	P,H,V	Negative(80%)
+120	27214	P,H,V	Negative(80%)

•electron beam(without 2layer at LGL2)

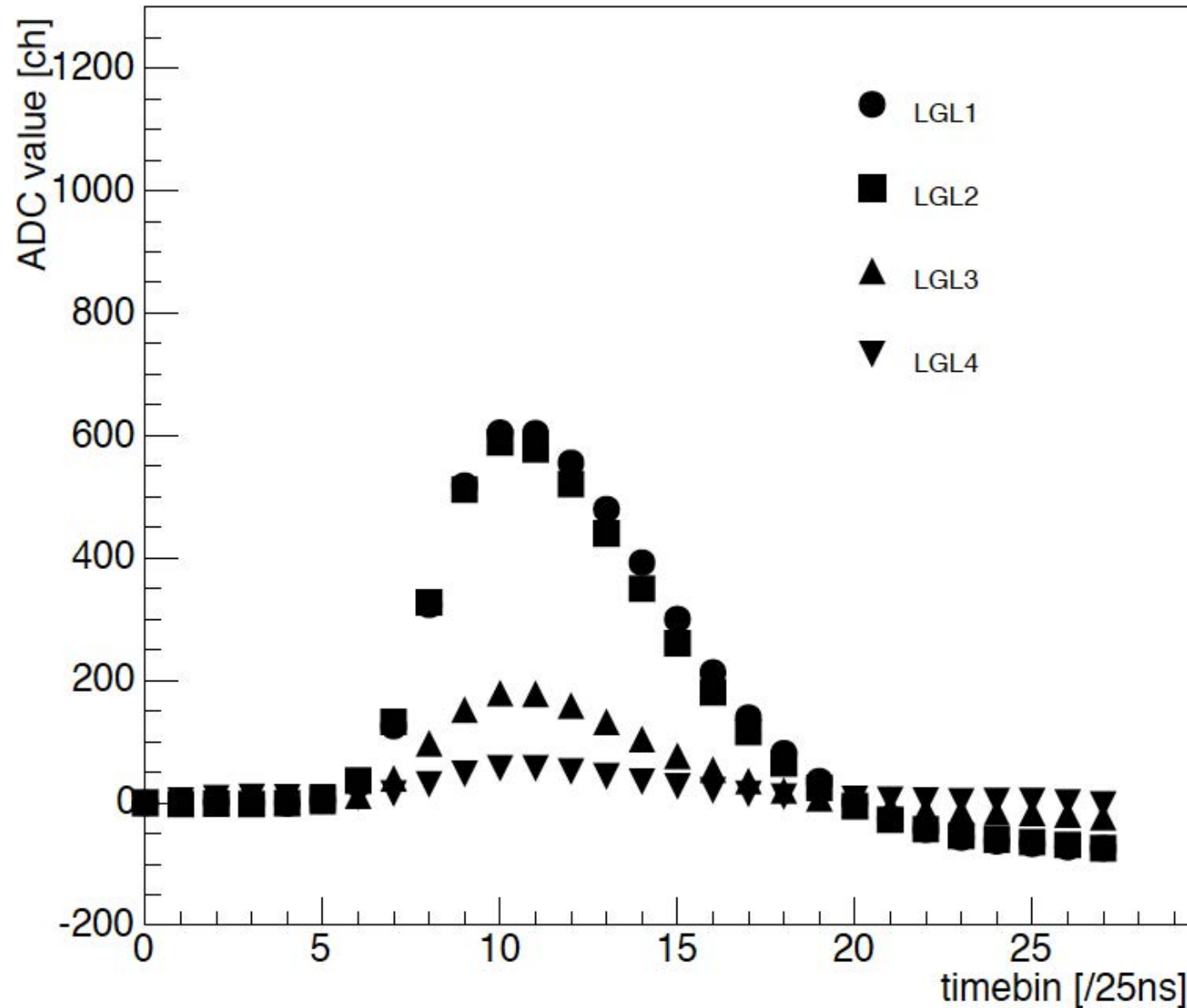
+60	4844	P,H,V	Negative(80%)
+70	6457	P,H,V	Negative(80%)
+80	17575	P,H,V	Negative(80%)
-120	18824	P,H,V	Negative(80%)
-150	4722	P,H,V	Negative(80%)

We have Position scan data at 20GeV.

# Pulse shape

Analog signal measured by by APV25

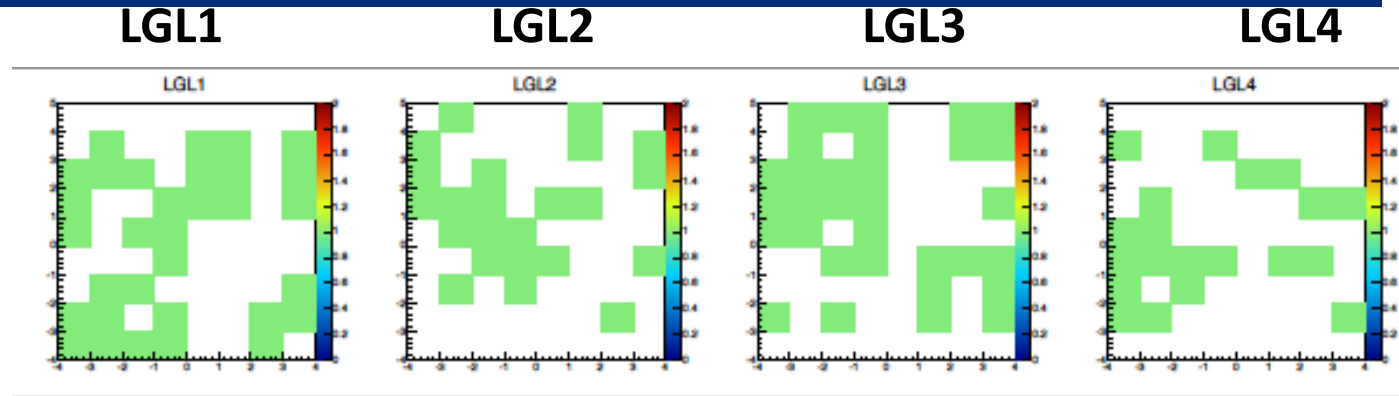
2 GeV/c, e<sup>+</sup> beam @ PS (2015)



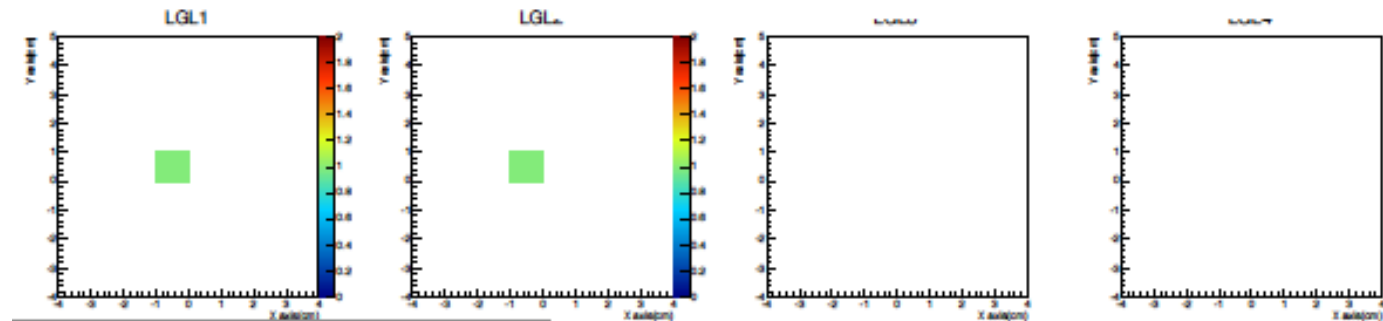


# Electron signal & noise rejection

Hit distribution  
before pedestal cut



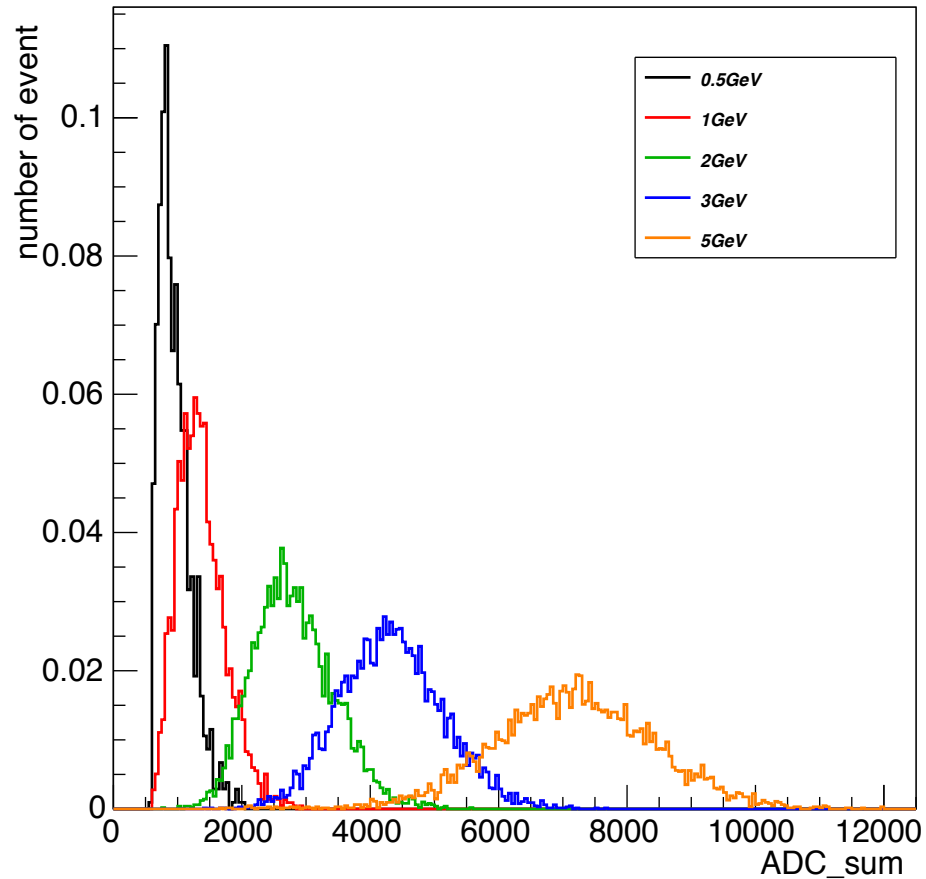
Hit distribution with  
 $q_{max} > 4\sigma + pedestal$



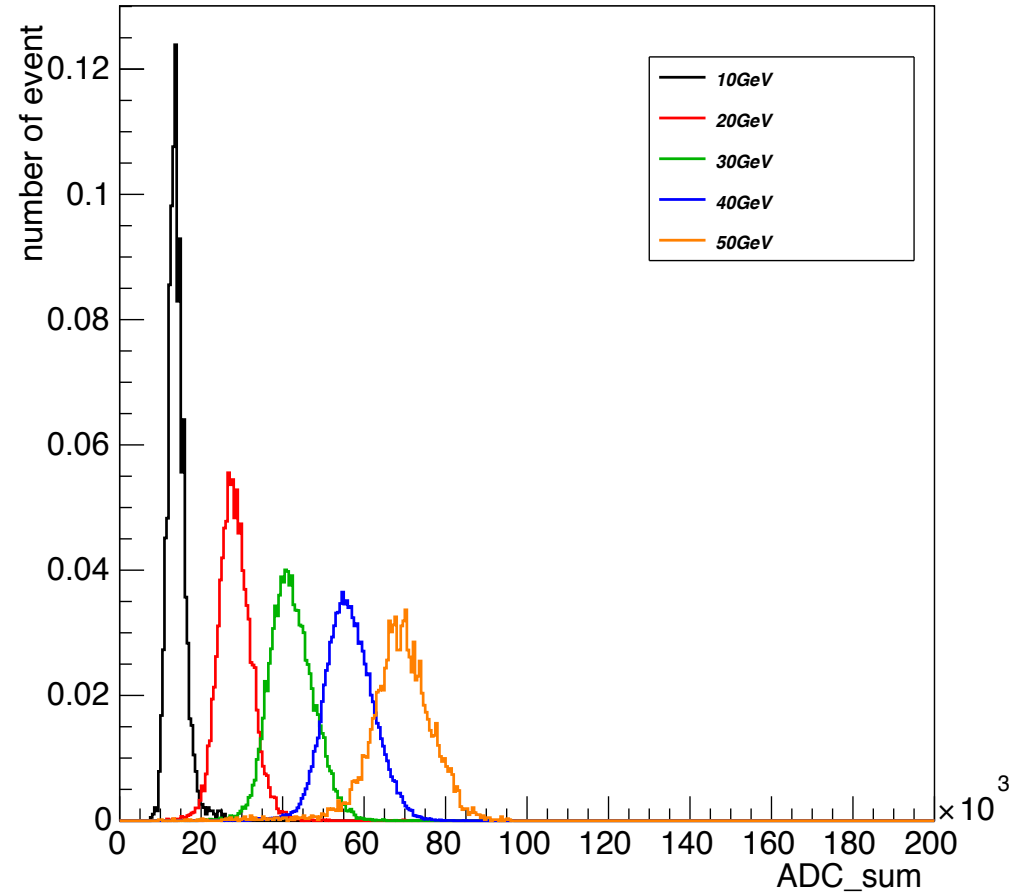
- **Signal selection:**

- 1) Time bin cut (select  $q_{max}$  region) for each LGL
- 2) Straight line ( $q_{max}$ ) through from LGL1 to LGL4, avoiding dead channel area
- 3) 3 x 3 clustering around a channel of  $q_{max}$ .
- 4) Noise event rejection.

# Pulse high distributions (beam energy dep. @ PS/SPS)

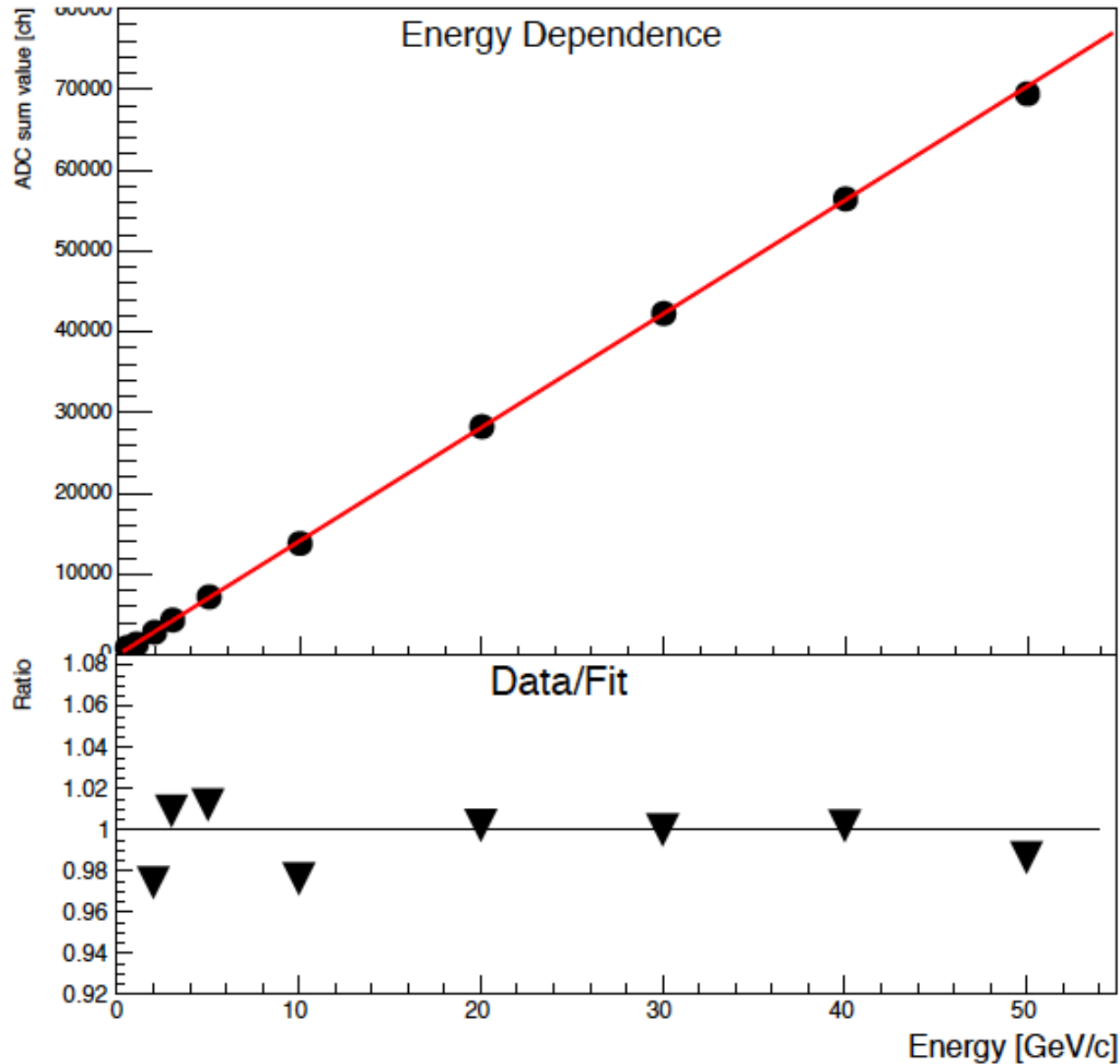


**PS (0.5 - 5 GeV/c)**



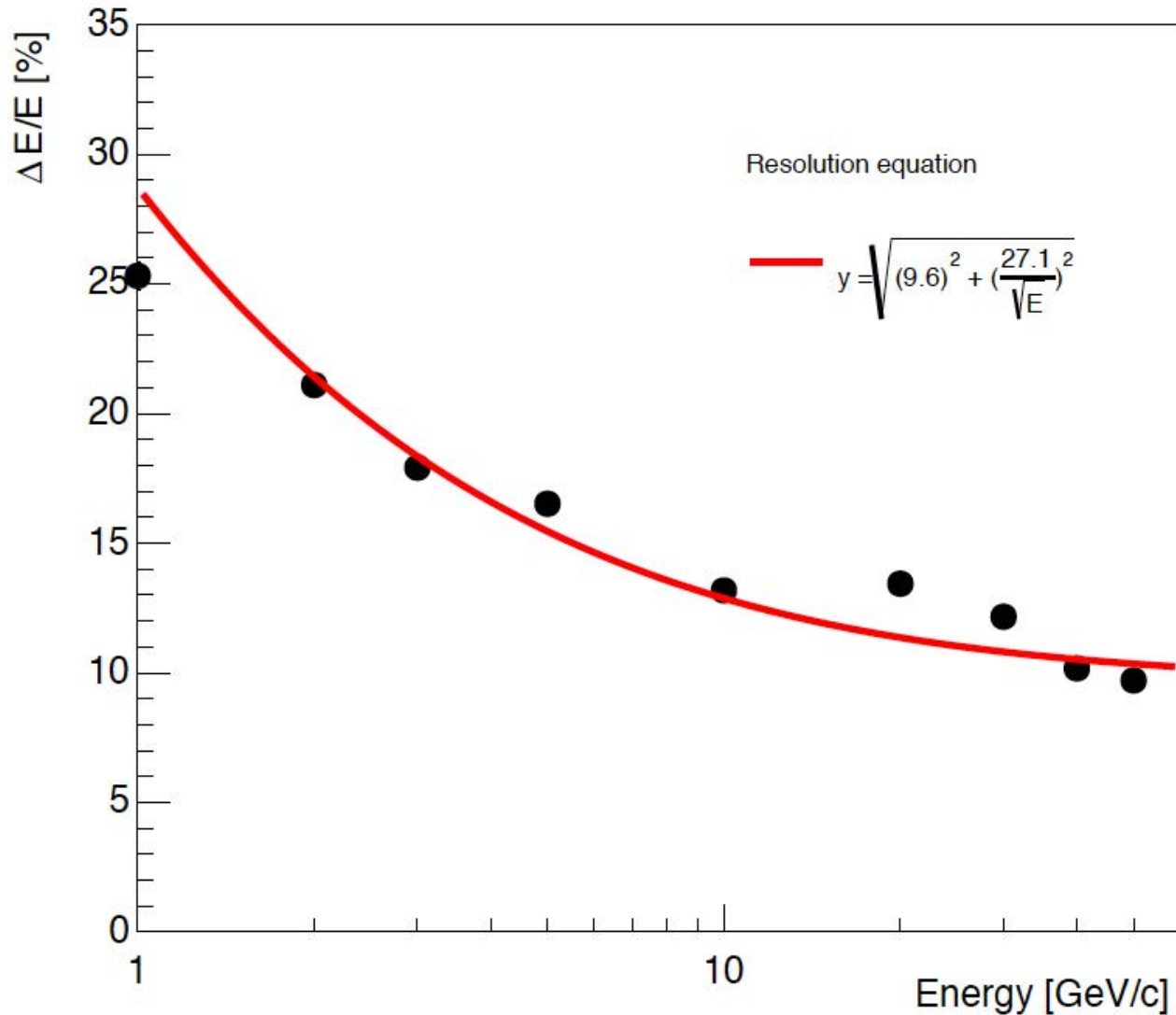
**SPS (10 - 50 GeV/c)**

# Linearity



- Good linearity within  $\sim 3\%$  from PS to SPS energies.

# Energy resolution



Stochastic term: close to the expected value.

Constant term: < 10%

- trying to reduce it by removing noise on electronics...

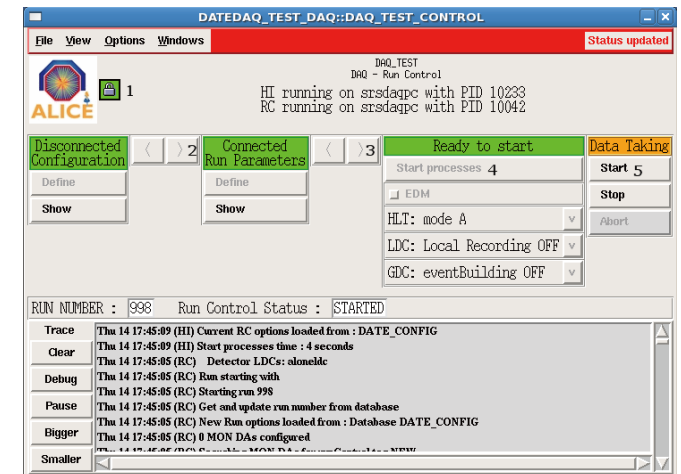
# Next steps:

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- NIM publication using 2015 data.
- Preparation of the SPS test beam (Sep 7-13, 2016).
  - New summing board (M. Inaba) to reduce the noise.
  - Readout with wider dynamic range (above 60 GeV/c up-to 150 GeV/c).
  - Matching of MAPS data.
  - More test on VMM2/3 @ CERN RD51.
- New detector design for Mini-FoCal.
- New budgeted request in 2016 (stronger physics cases, Lol, schedule for construction & physics measurement).

# Tsukuba joined RD51 collaboration

- R&D and test for VMM2 and VMM3 hybrid boards with SRS + DATE (ALICE DAQ) system.
- R&D of combined design; on-board VMM2/3 on FoCal summing board, and modification for FoCal needs (dynamic range & trigger capability)
- Joined collaboration in 2015, Oct.
  - Finish R&D in 2 years (2016 - 2018)
  - Production in 2019 for FoCal.



ALICE DATE for VMM (developed by RD51)



# FoCal collaboration in Japan



- **University of Tsukuba & Tsukuba Tech. Univ.**

- Representative: Tatsuya Chujo\*
- Members: Oliver Busch, Tatsuya Chujo, Shinichi Esumi, Motoi Inaba\*\*, Yasuo Miake
- Responsibility: Project management for FoCal Japanese institutes, PAD (LGL) Detector design & construction, Detector performance evaluation, simulation, Readout system (SRS, APV/VMM), summing board

\* Contact person of FoCal Japan

\*\* Tsukuba University of Technology

- **Hiroshima University**



- Representative: Toru Sugitate
- Members: (same as Representative)
- Responsibility: Mechanical structure design, Integration, Detector performance evaluation

- **Nagasaki Institute of Applied Science (NiSA)**



- Representative: Ken Oyama
- Members: Hideki Hamagaki, Ken Oyama
- Responsibility: Readout system (SAMPAs, CRU)

- **Nara Women's University**



- Representative: Maya Shimomura
- Responsibility: test beam experiment, data calibration

**4 (5) institutions, 8 faculty members,  
~ 7 graduate/under grad. students  
(as of June 1, 2016)**

# Summary

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- Encouraging results from the 2015 test beam data.
- Expected improvements in 2016 test beam by the new summing board w/ wider dynamic range.
- Joined RD51 to continue R&D for readout.
- Evolving FoCal collaboration in Japan.
  - Tsukuba, Tsukuba Tech, Hiroshima, Nagasaki, Nara Women's.