

scintillator based ECAL status

T.Takeshita (Shinshu)



status & current issues

- we are concentrating on

- ECAL Base Unit (EBU)

SPIROC(Ω) 18cmx18cm

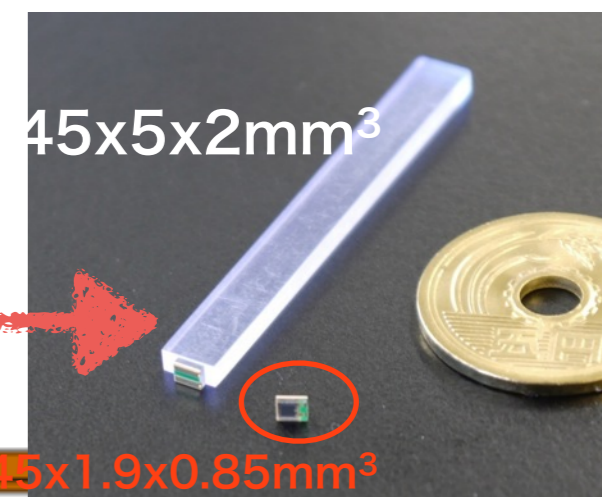
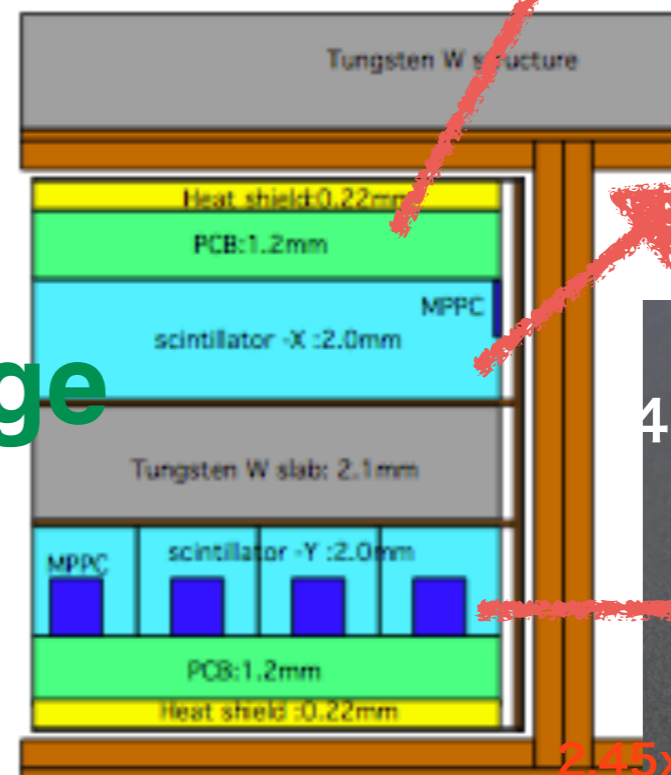
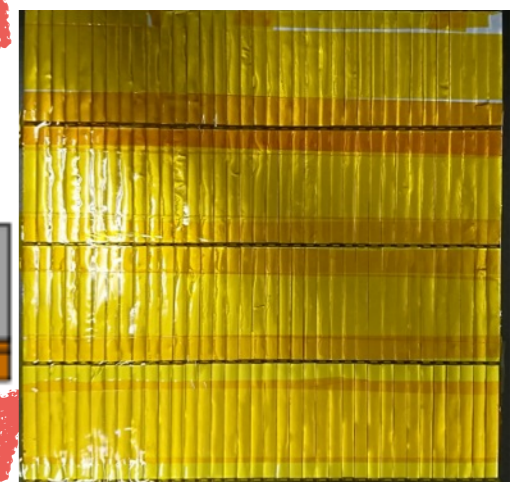
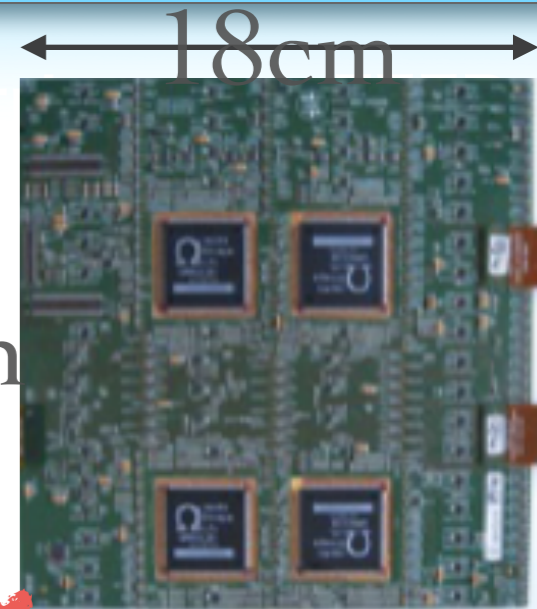
- with **smaller pixel** photo-sensor

smaller signal

- need relevant care to treat signals

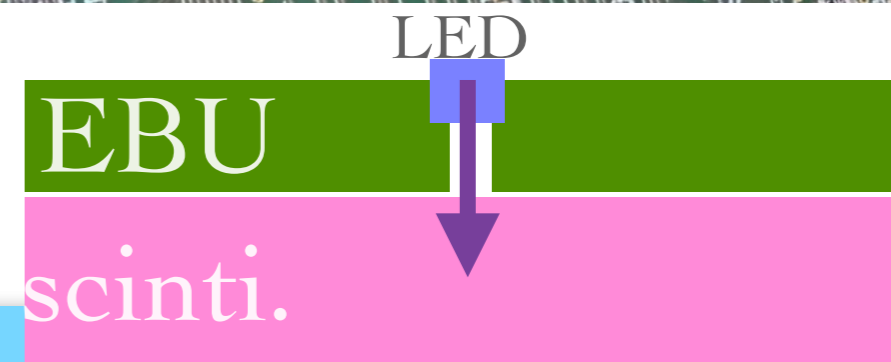
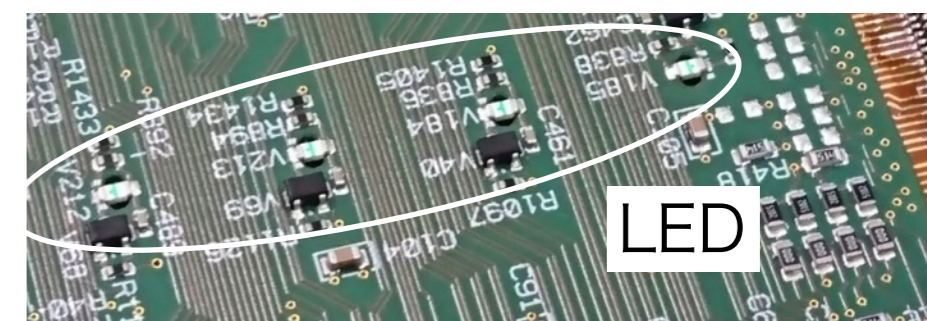
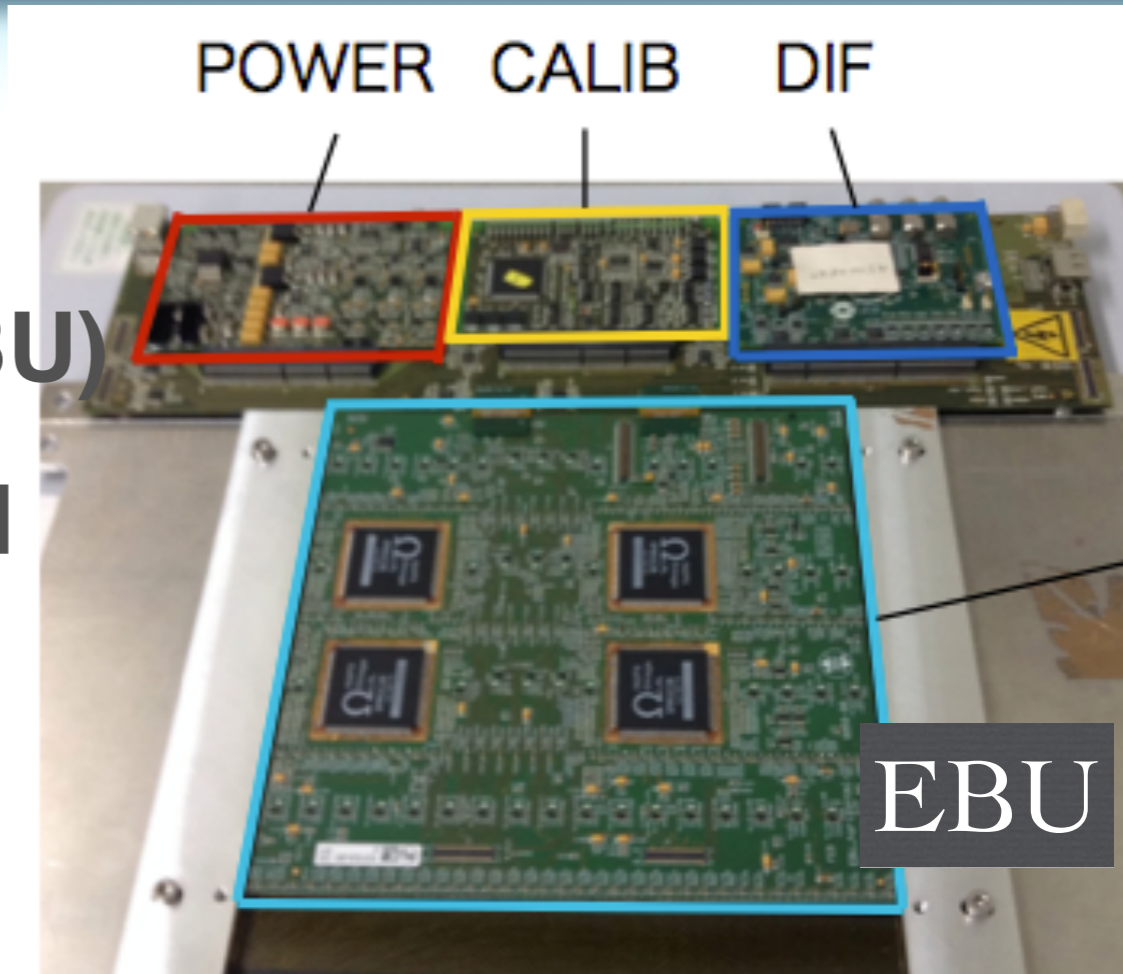
- separate **MIPs** from noise

- keep enough **dynamic range**



Ecal Base Unit : EBU

- integrated layer of scintillator, photo sensor & FE elec.
- 144 strips in 18x18 cm² unit (EBU)
- front end electronics embedded
- four **ASICs** (**SPIROC2b** 36ch)
 - Amp/shaper/ADC/memory
 - **optimized for AHCAL read out**
 - auto-trigger mode with threshold setting
- bias voltage control
- **LEDs for calibration purpose**



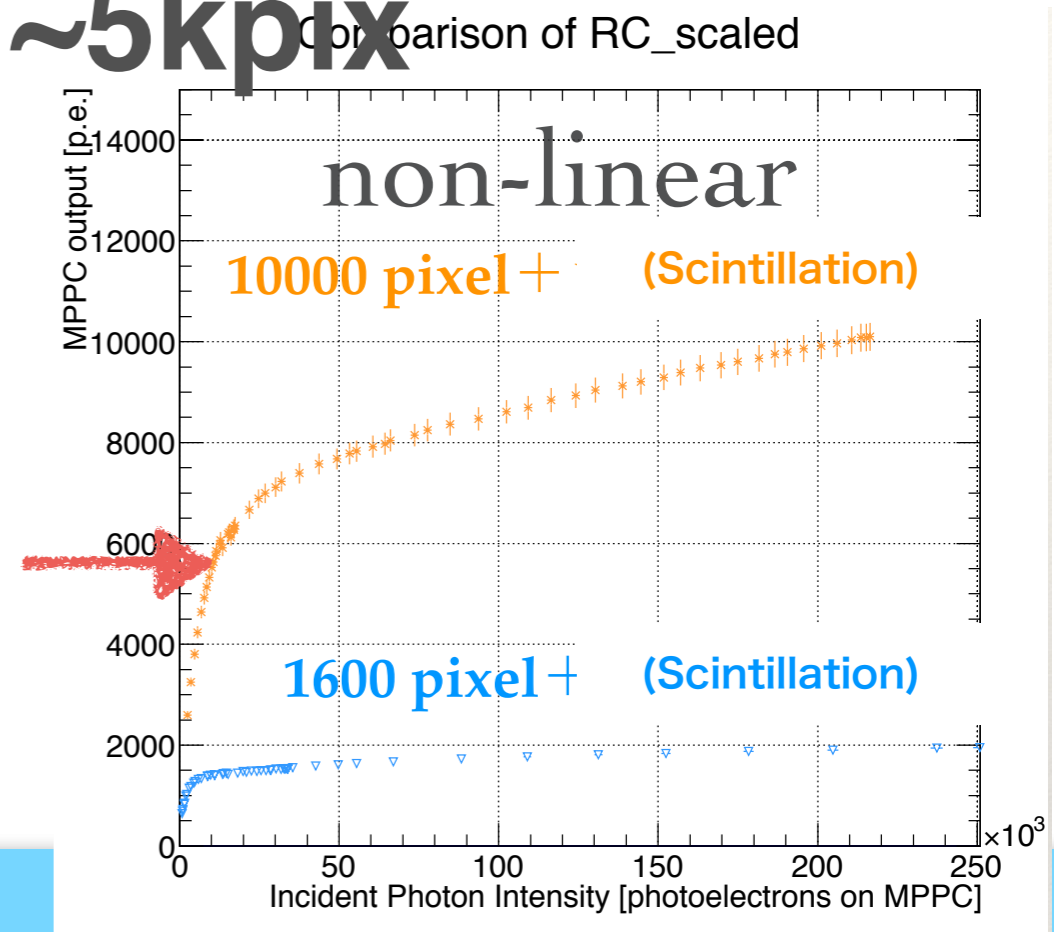
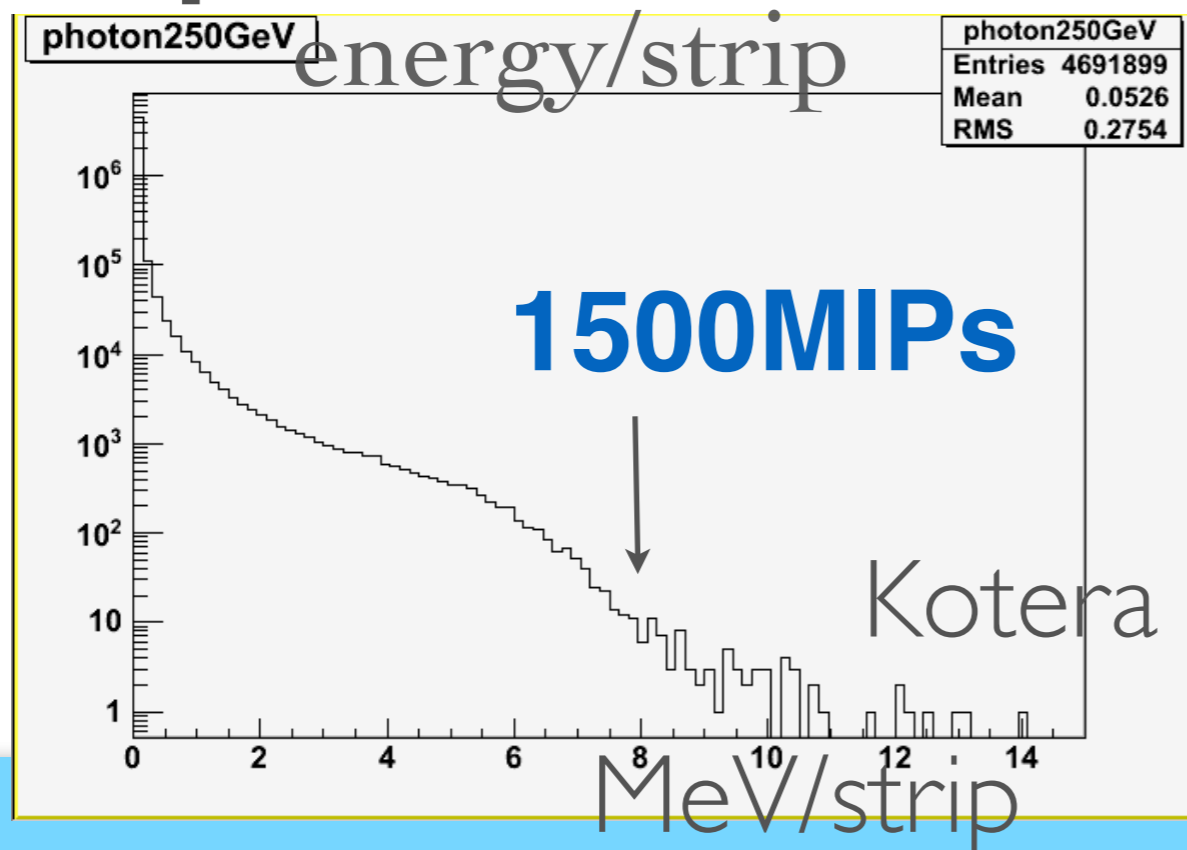
DYNAMIC RANGE

max energy/strip $\sim < 800$ MIPs at **Higgs Factory** (250GeV) for Bhabha events

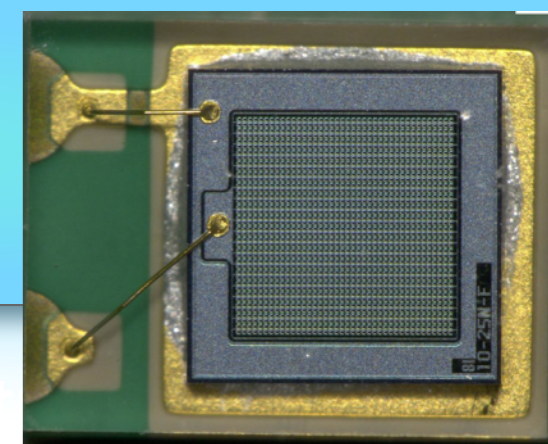
800MIPs \sim 5600 pixels (7p.e./MIP)

10um pitch in 1mmx1mm = 10kpix

15um pitch in 1mmx1mm \sim 5kpix

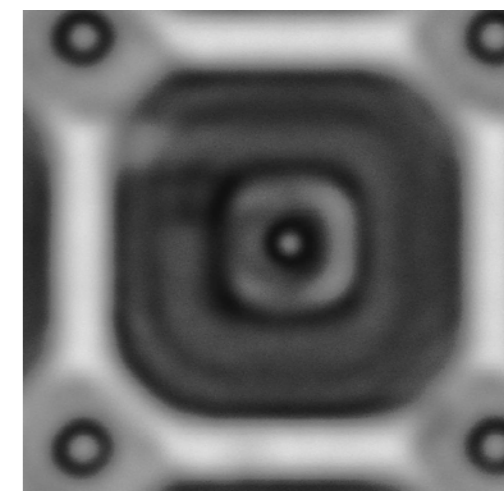


MPPPC on EBU



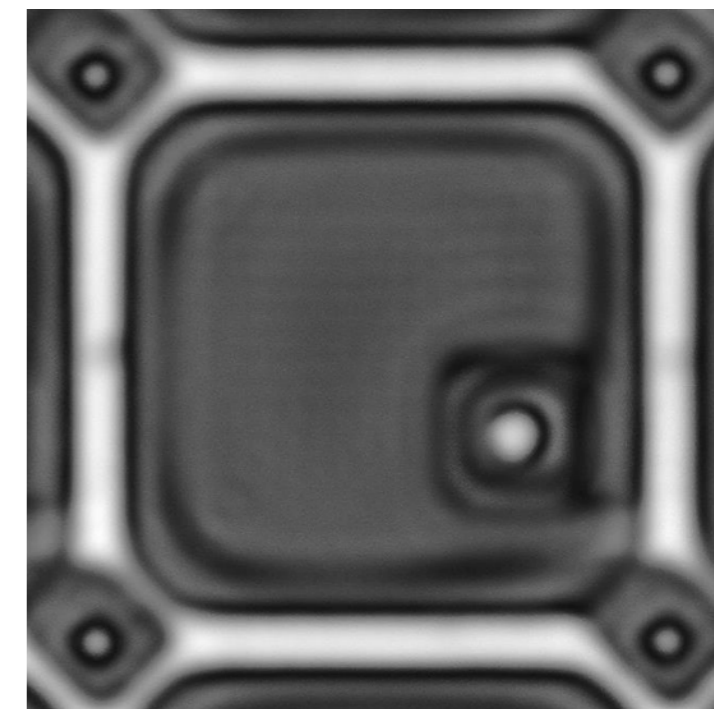
1mmx1mm

- **SPIROC(2b) in EBU is designed to fit 25um pitch's signals ~AHCAL**
- **smaller 10/15um pitch sensor give smaller signal and higher noise rate (no trench)**
- **with maximum amplification of SPIROC**



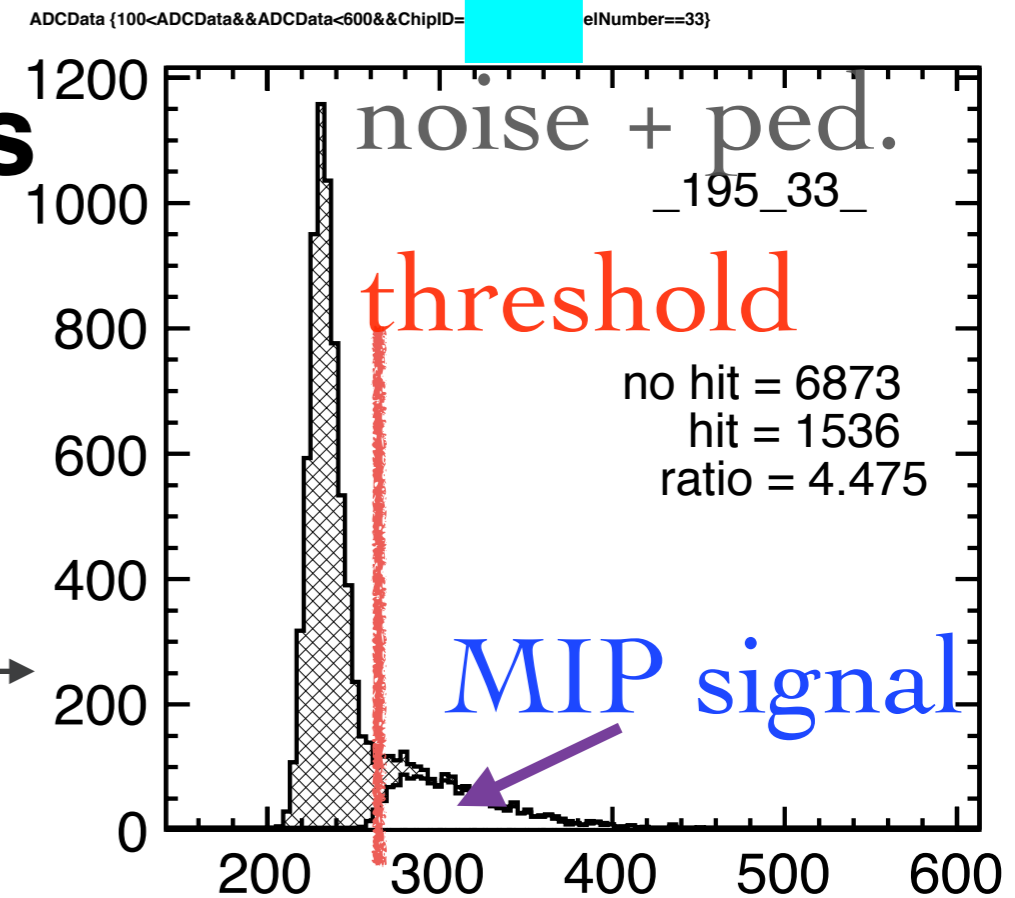
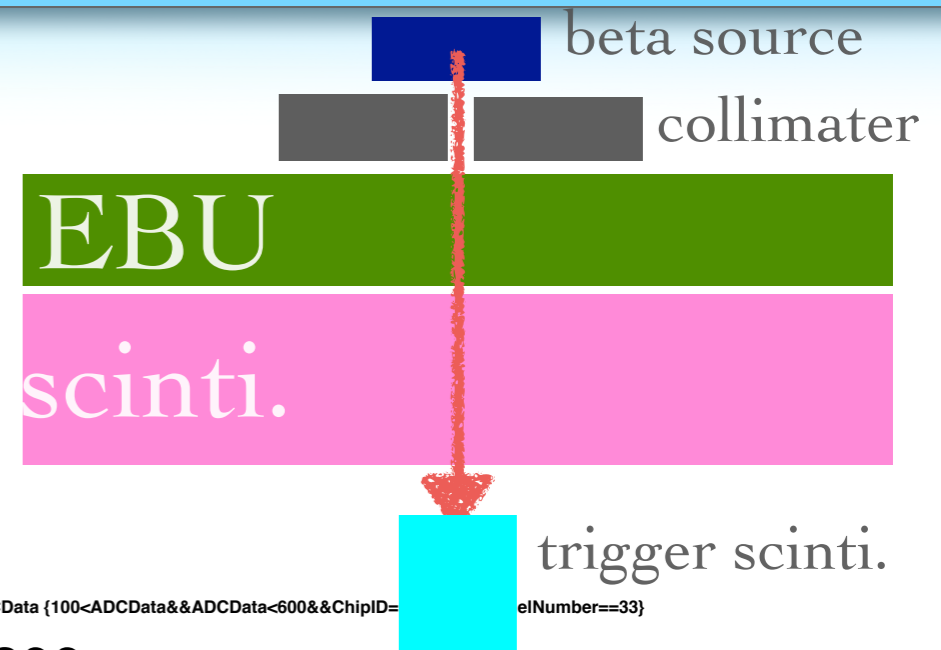
10um

10-15um Noise rate=300kHz
25um Noise rate=50kHz



beta ray with EBU

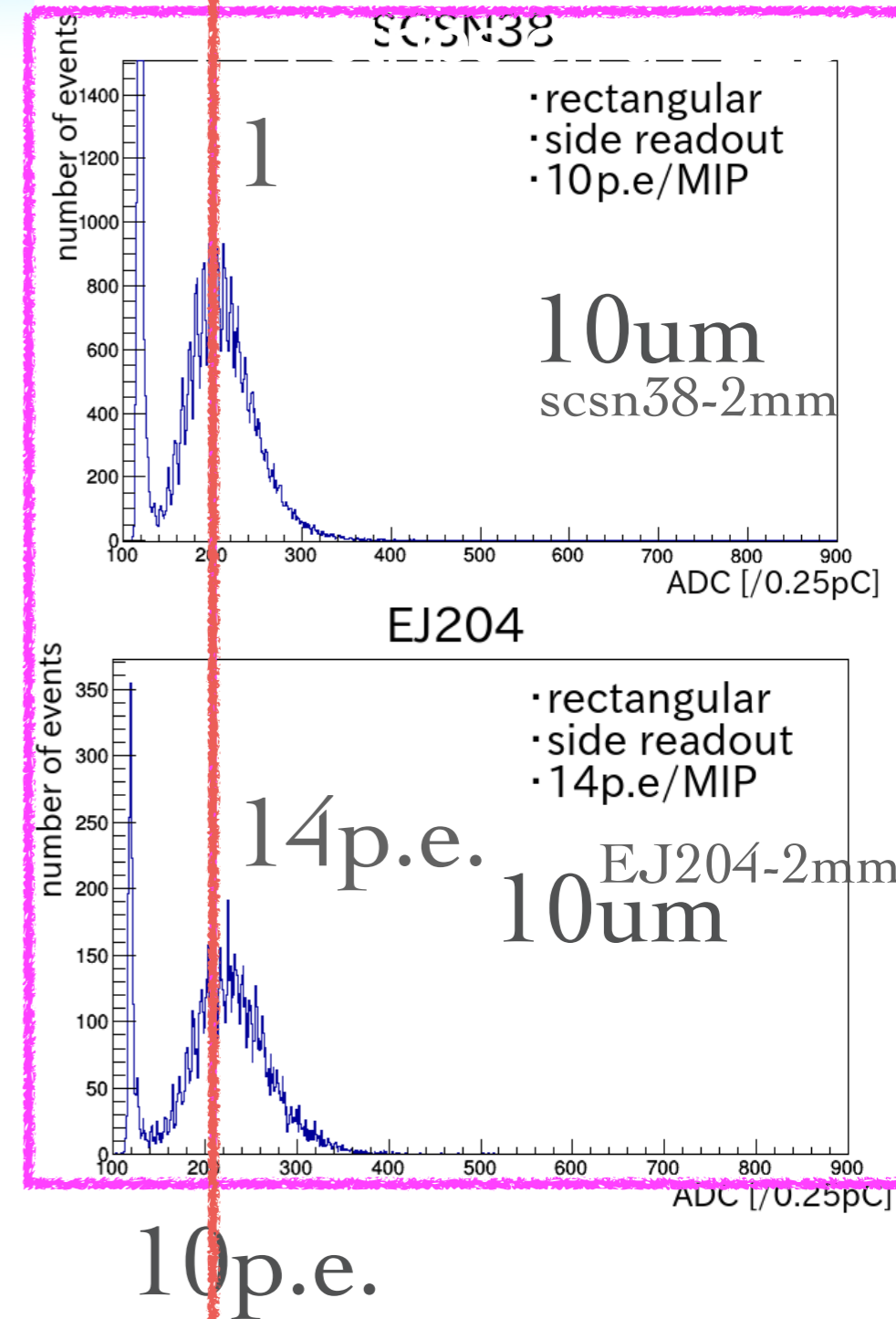
- tuning is following
- increase voltage
- → increase gain and noise
- **threshold** setting cuts noises
- MIP is verified by trigger signal
- **scsn38** scintillator was unsuccessful



10um + EBU

better separation 1

- increase **light yield**
- using different scintillator
- scsn38 to **EJ204**
- NIMamp+camac ADC results with 10um pitch MPPC

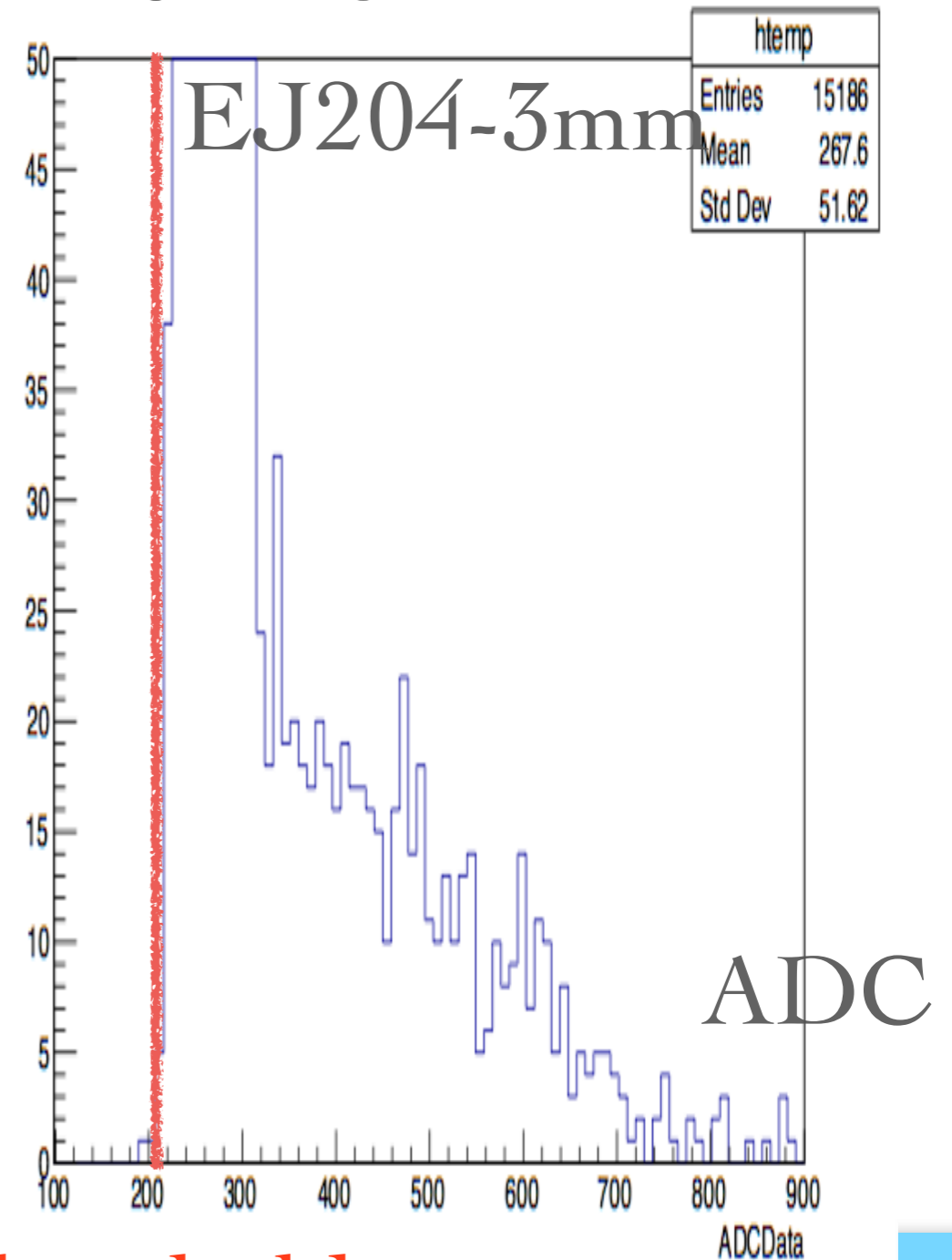
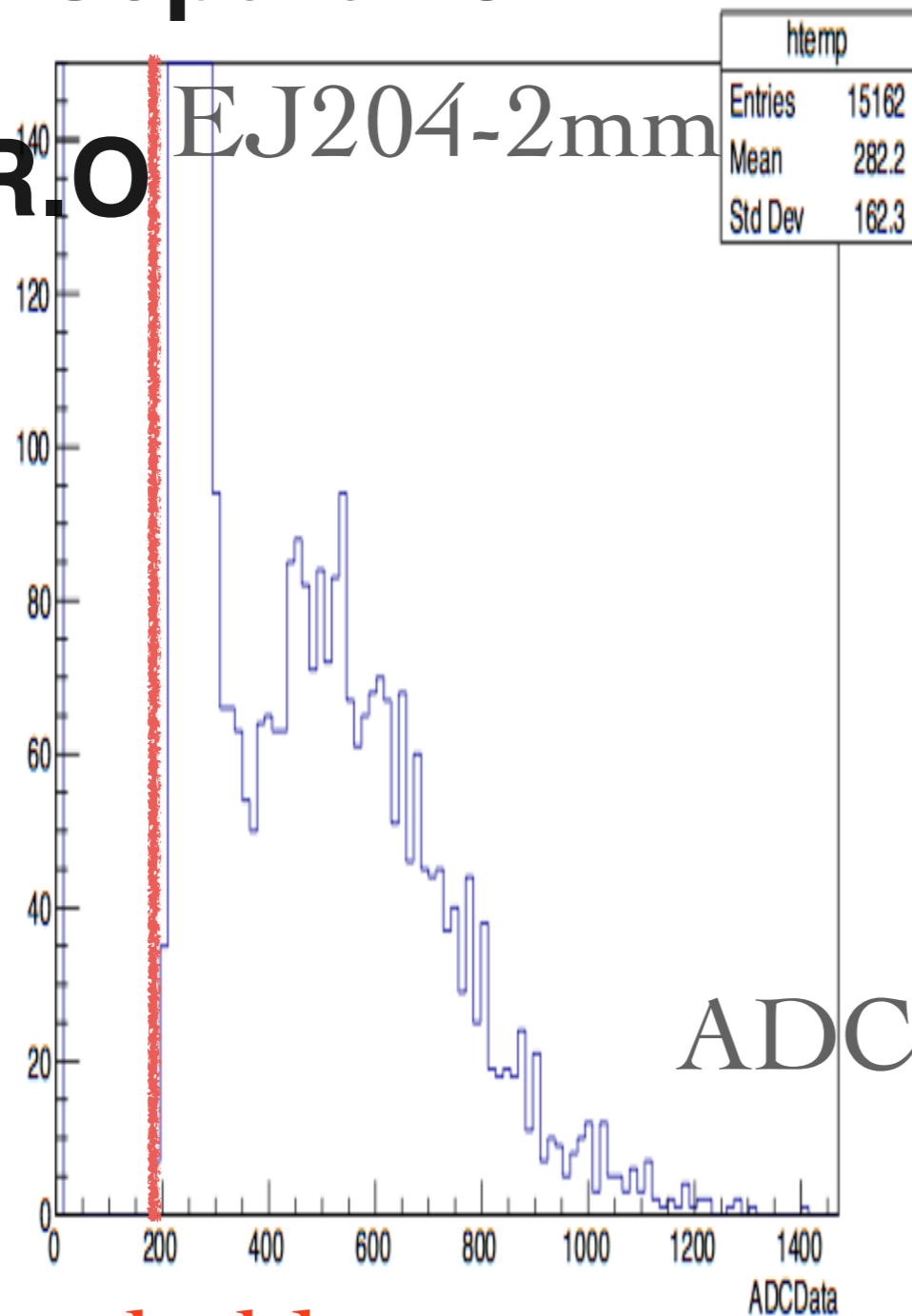


scintillator + EBU

- beta ray with 10um pitch MPPC with EBU at lab.

- better separation in 2mm thick EJ

- side R.O



threshold

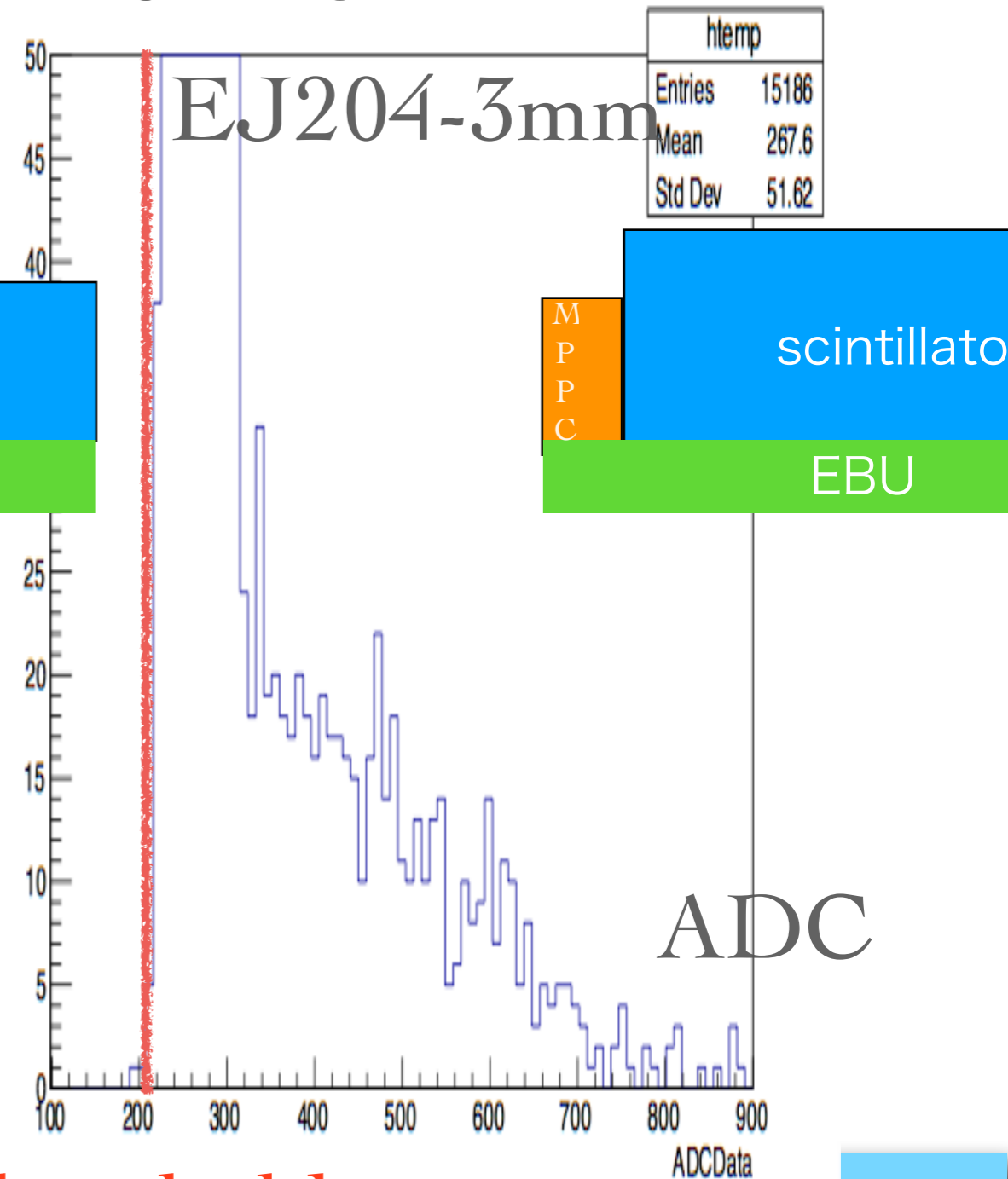
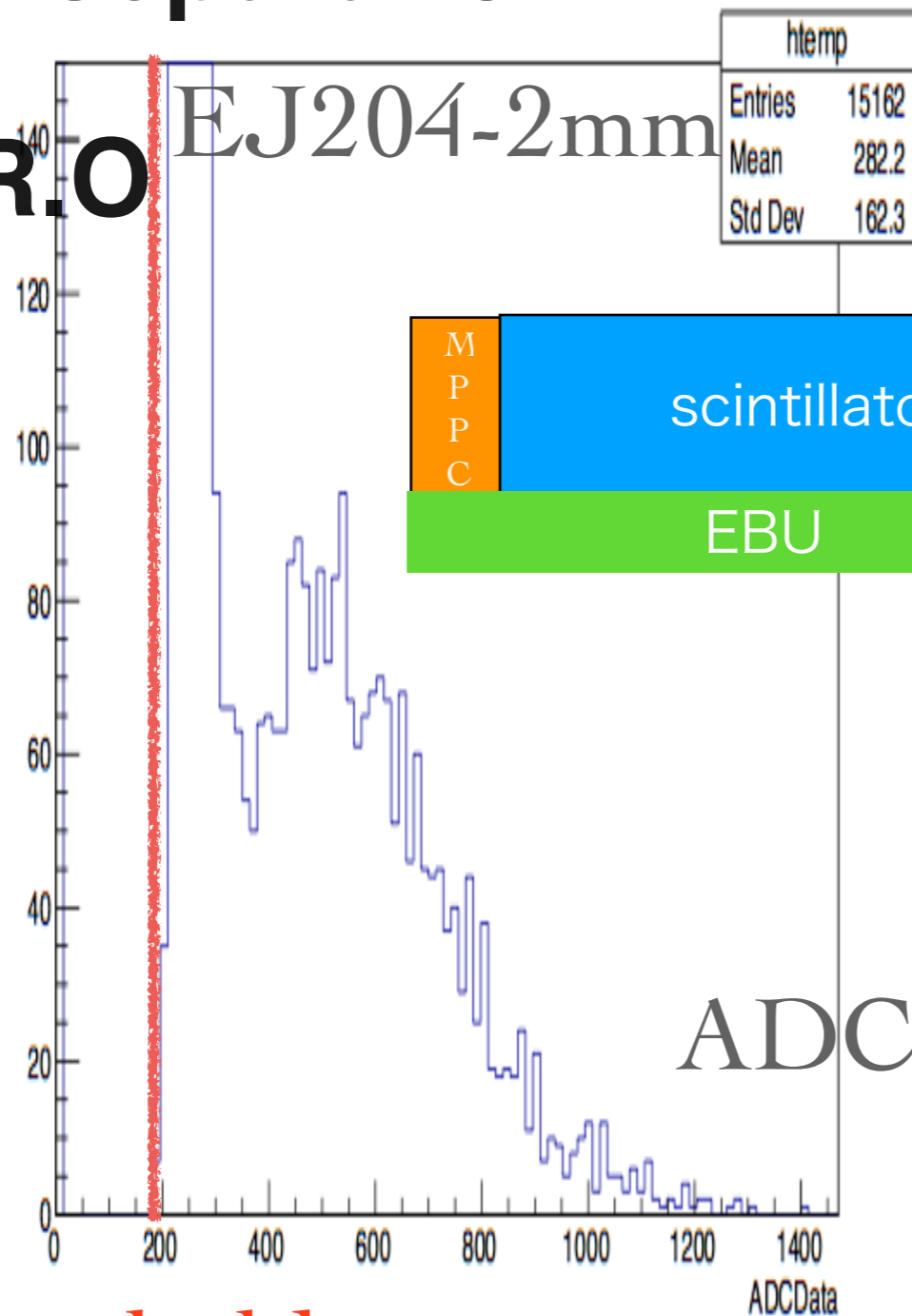
threshold

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threshold

threshold

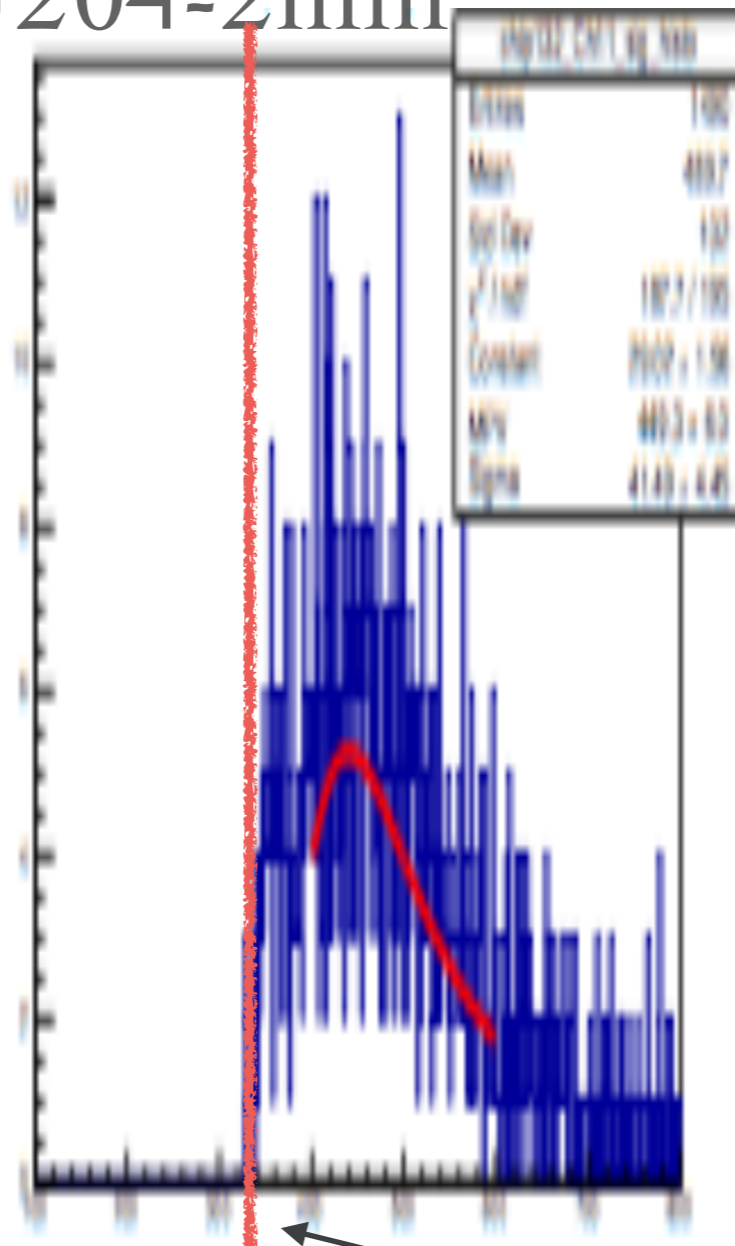
scintillator + EBU

- EM shower events with 10

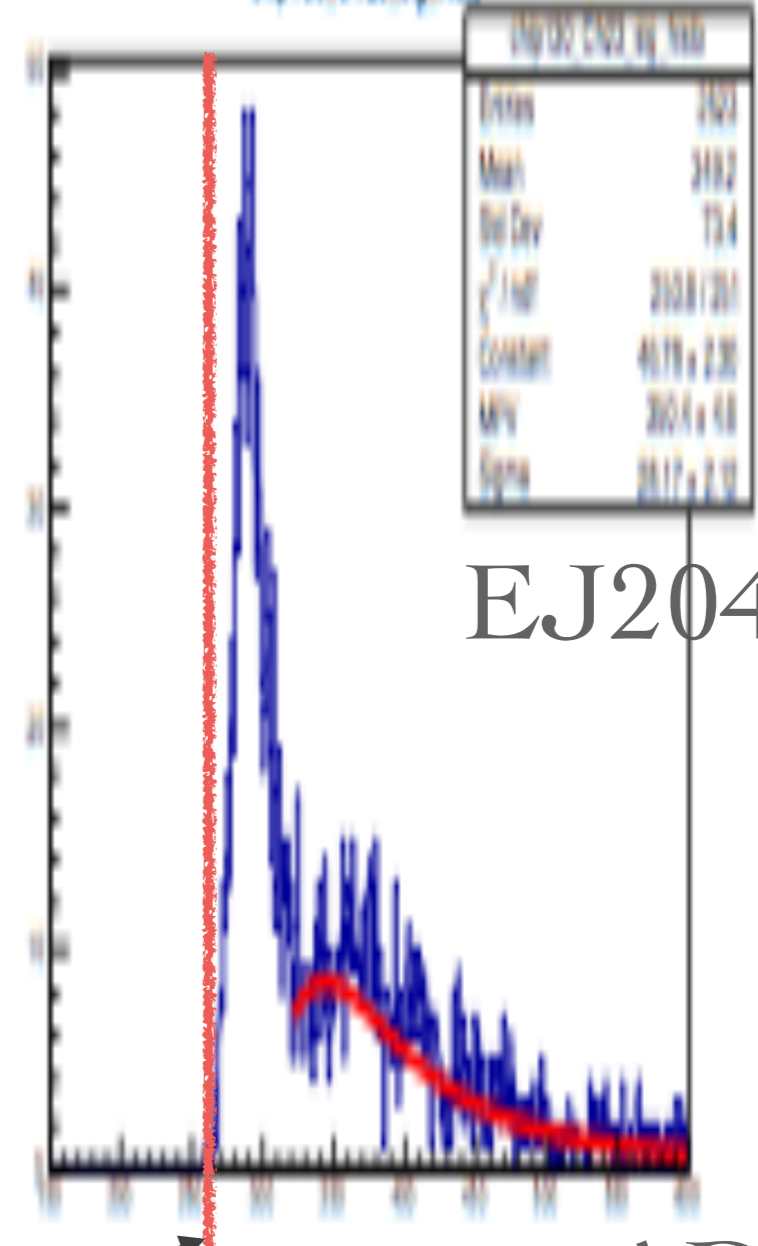
EJ204-2mm

- side R.O

- one of best results



EJ204-3mm



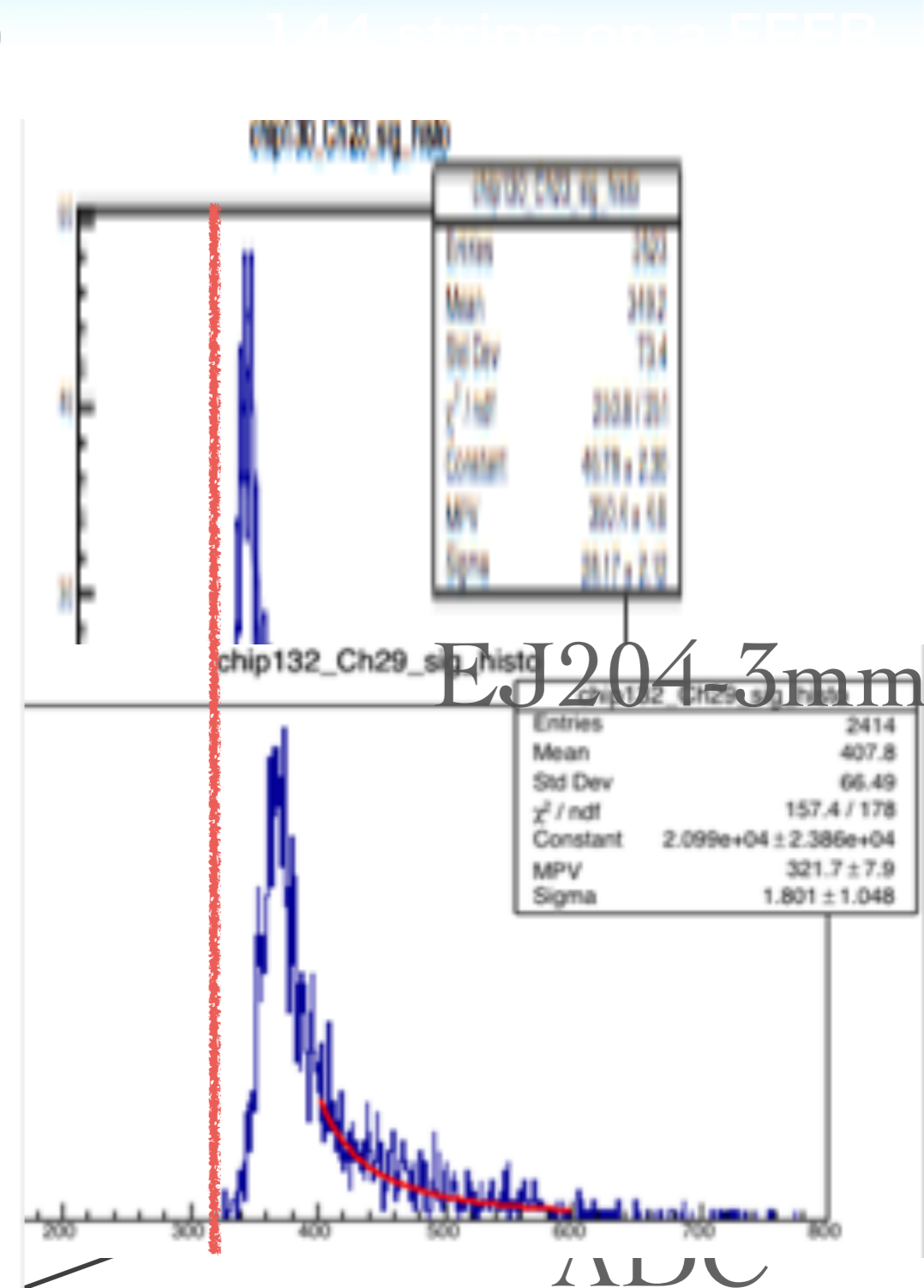
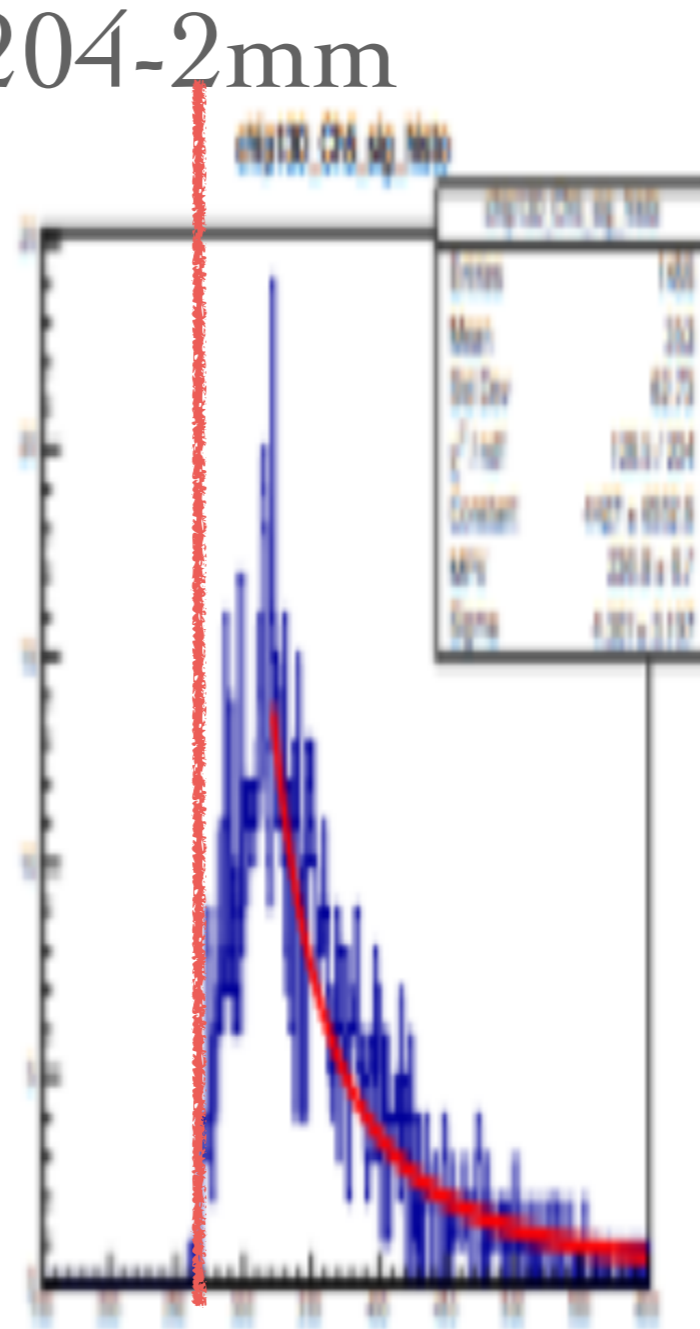
EJ204-3mm

ADC

threshold

scintillator + EBU

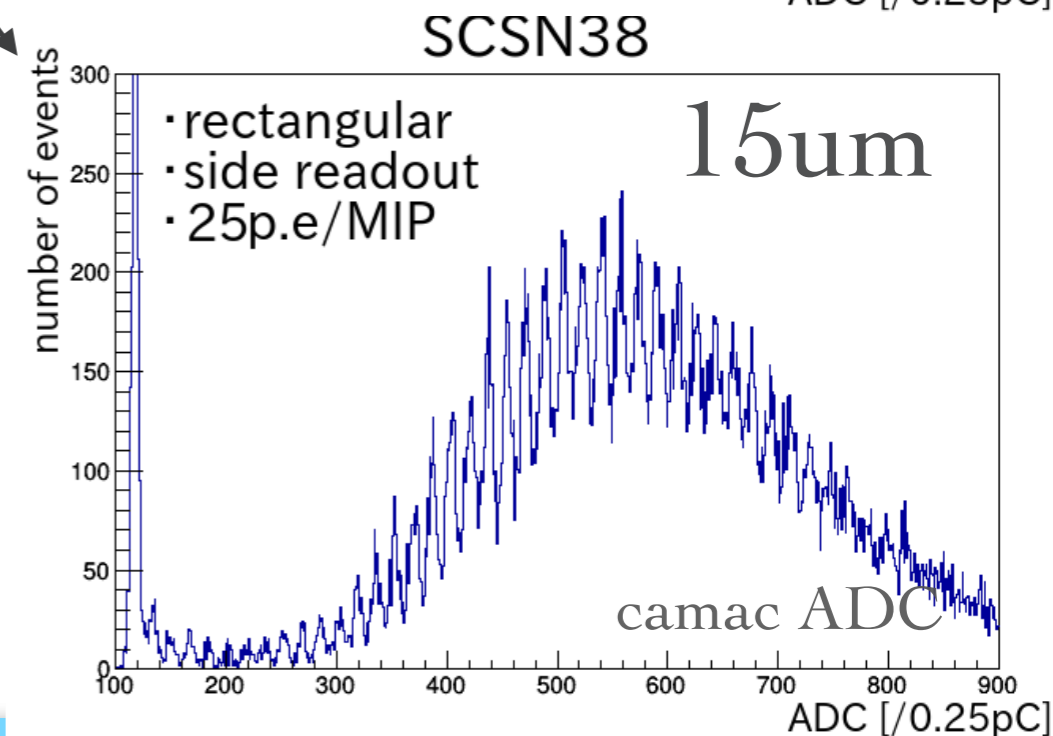
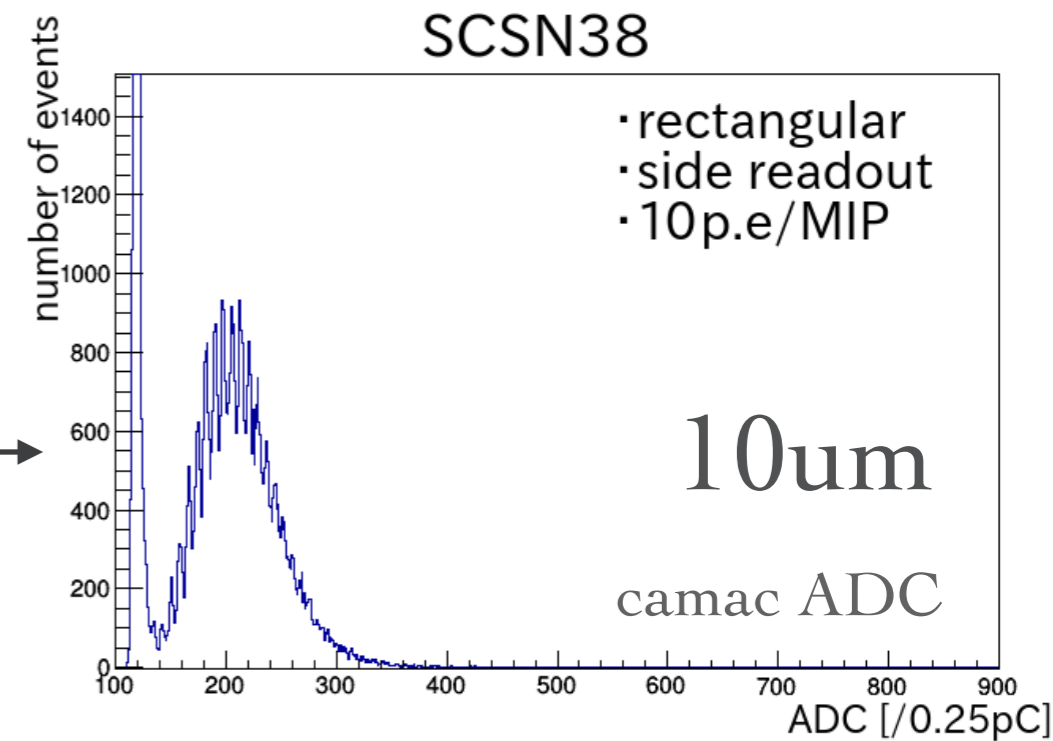
- EM shower events with 10 EJ204-2mm
- side R.O
- one of best results
- others



threshold

better separation 2

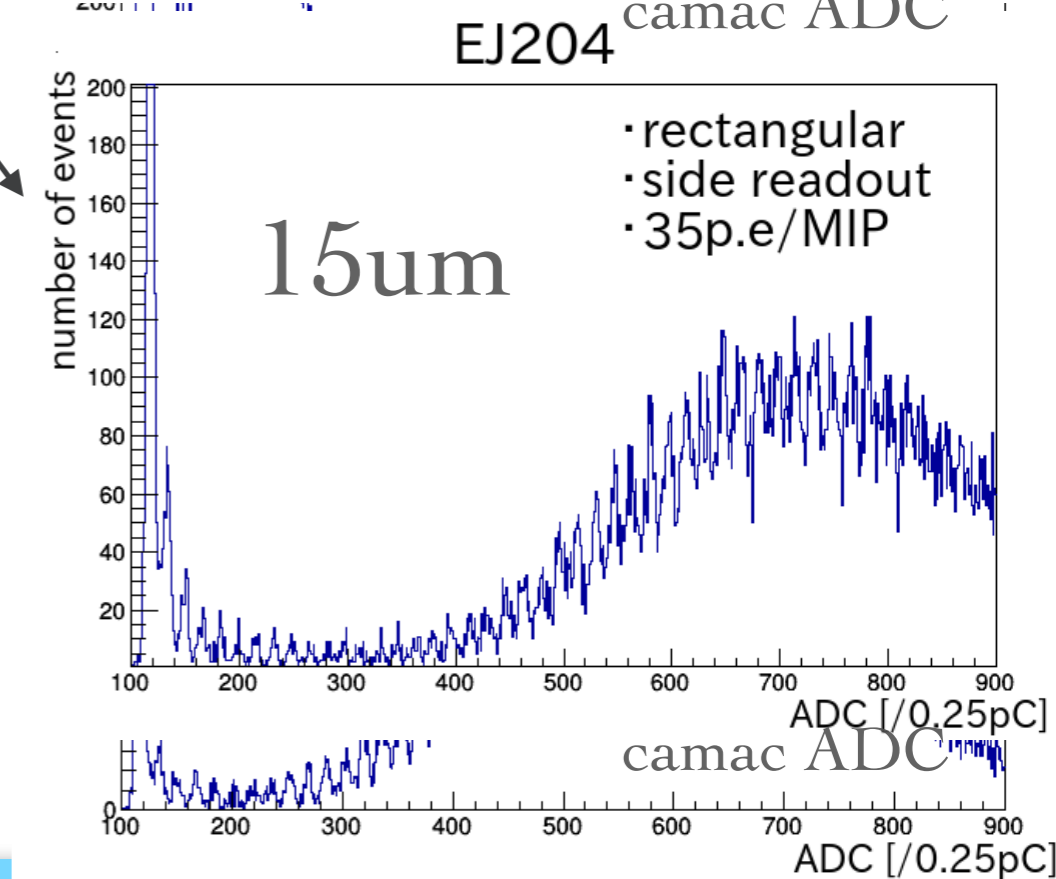
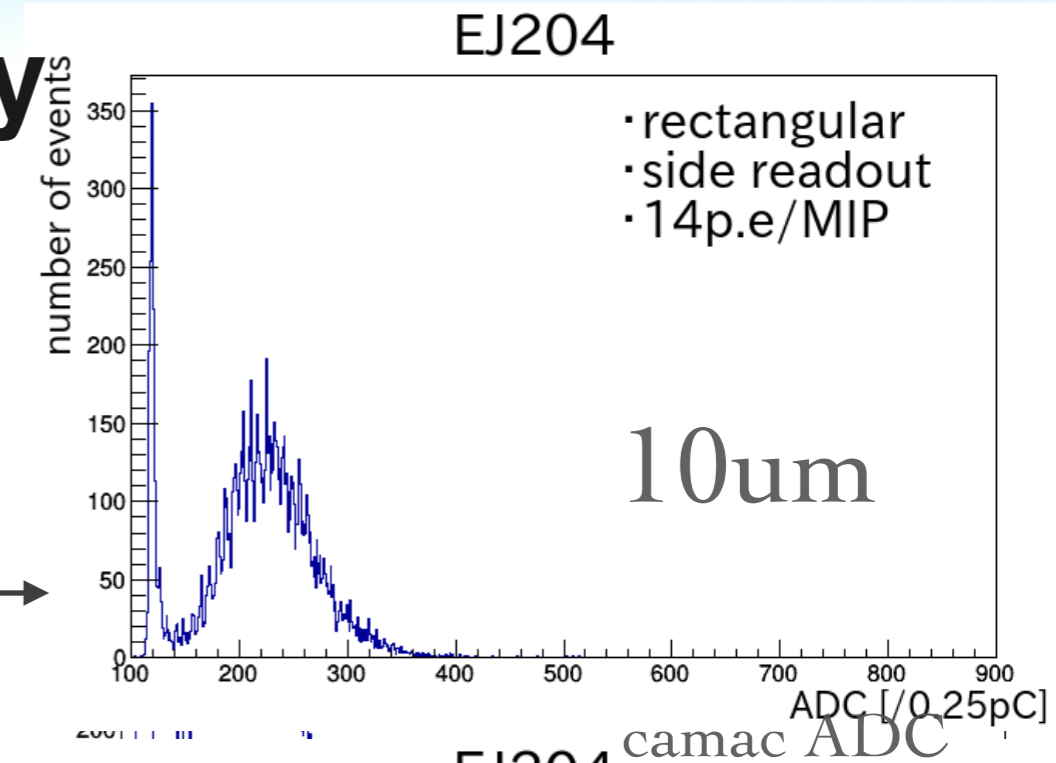
- increase detection efficiency
- using bigger pixel MPPC
 - 10 >
- NIMamp+camac ADC
- increase detection area



LY (p.e.)			
MPPC pitch (um)	rect. side R.O scsn (p.e.)	rect. side R.O EJ204 (p.e.)	wedged bottom R.O EJ204 (p.e.)
10	10	14	10
15	25	35	21

better separation 2

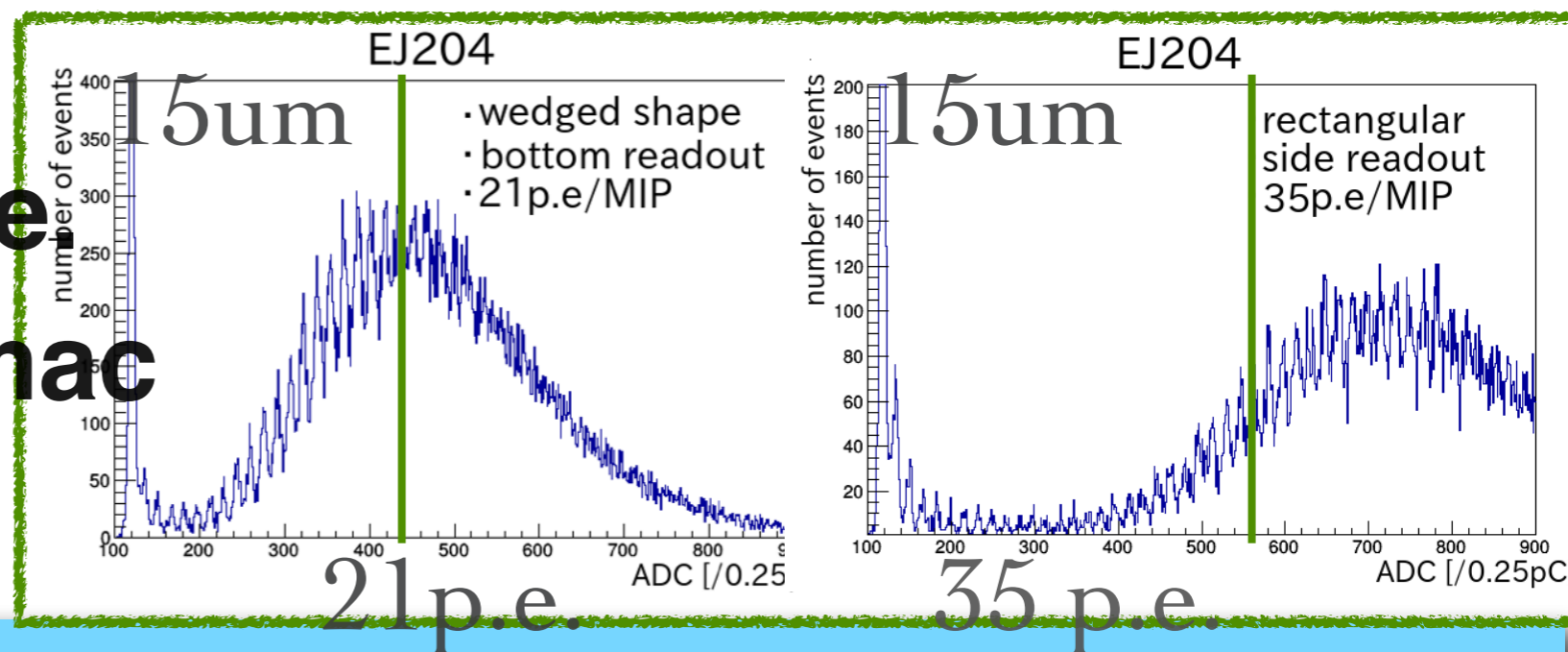
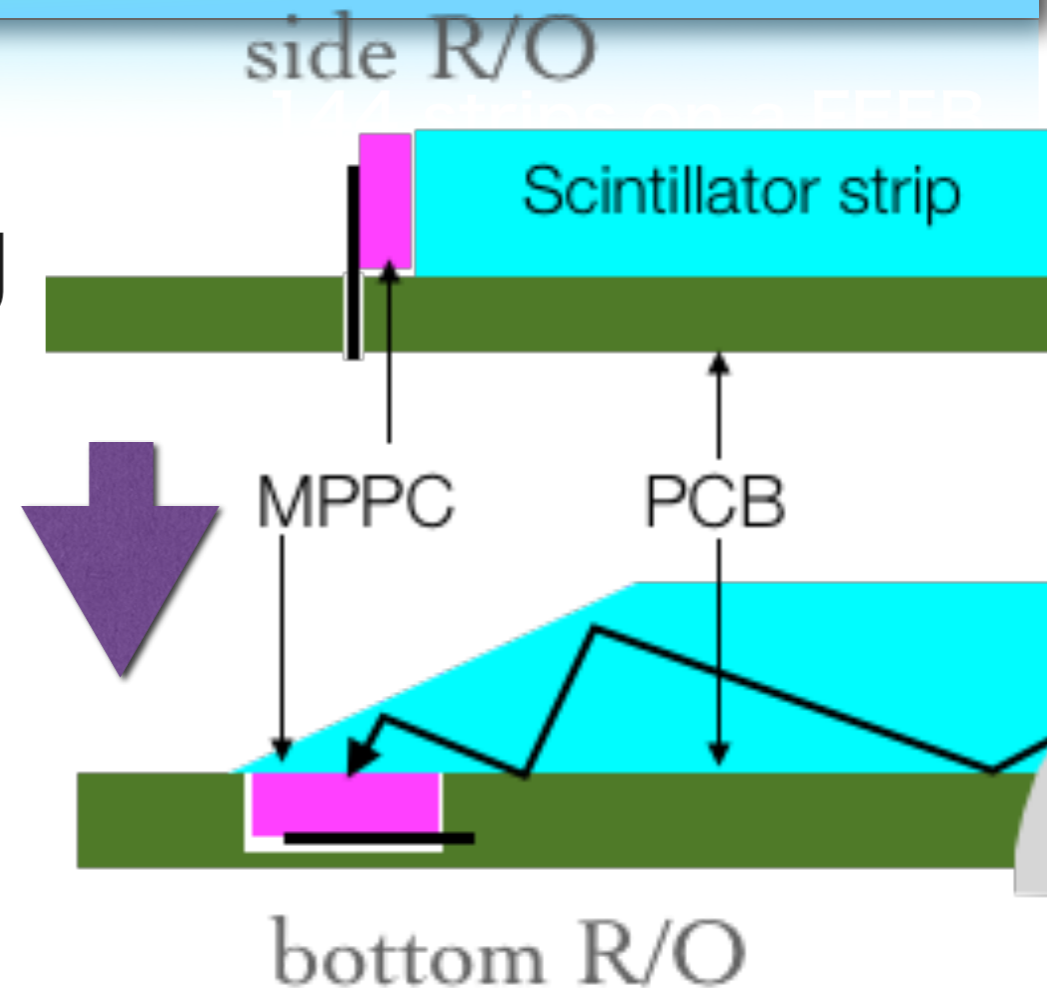
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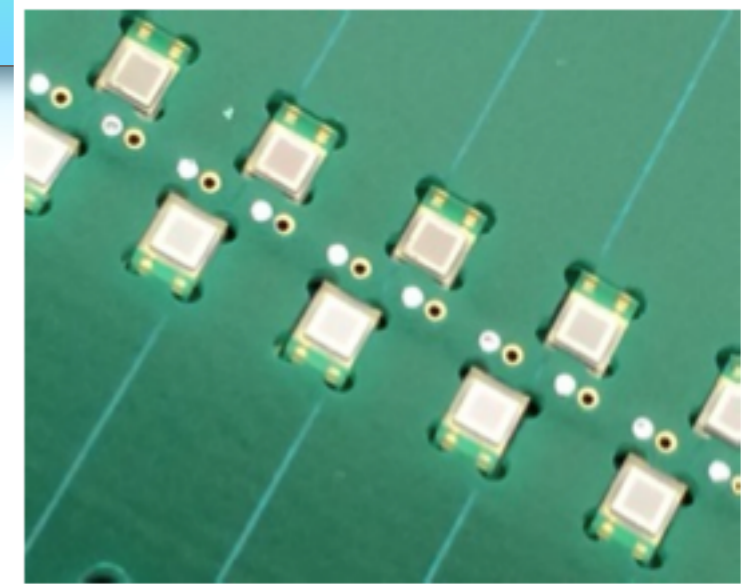
EBU:bottom read

- **bottom read out**
- **easy installation by soldering**
- **no dead space by photo-sensor**
- **use wedged shape strip**
- **bottom read out is less photons**
- **side R.O ~ 35p.e.**
- **bottom R.O ~ 21p.e.**
- **with NIMamp+camac**

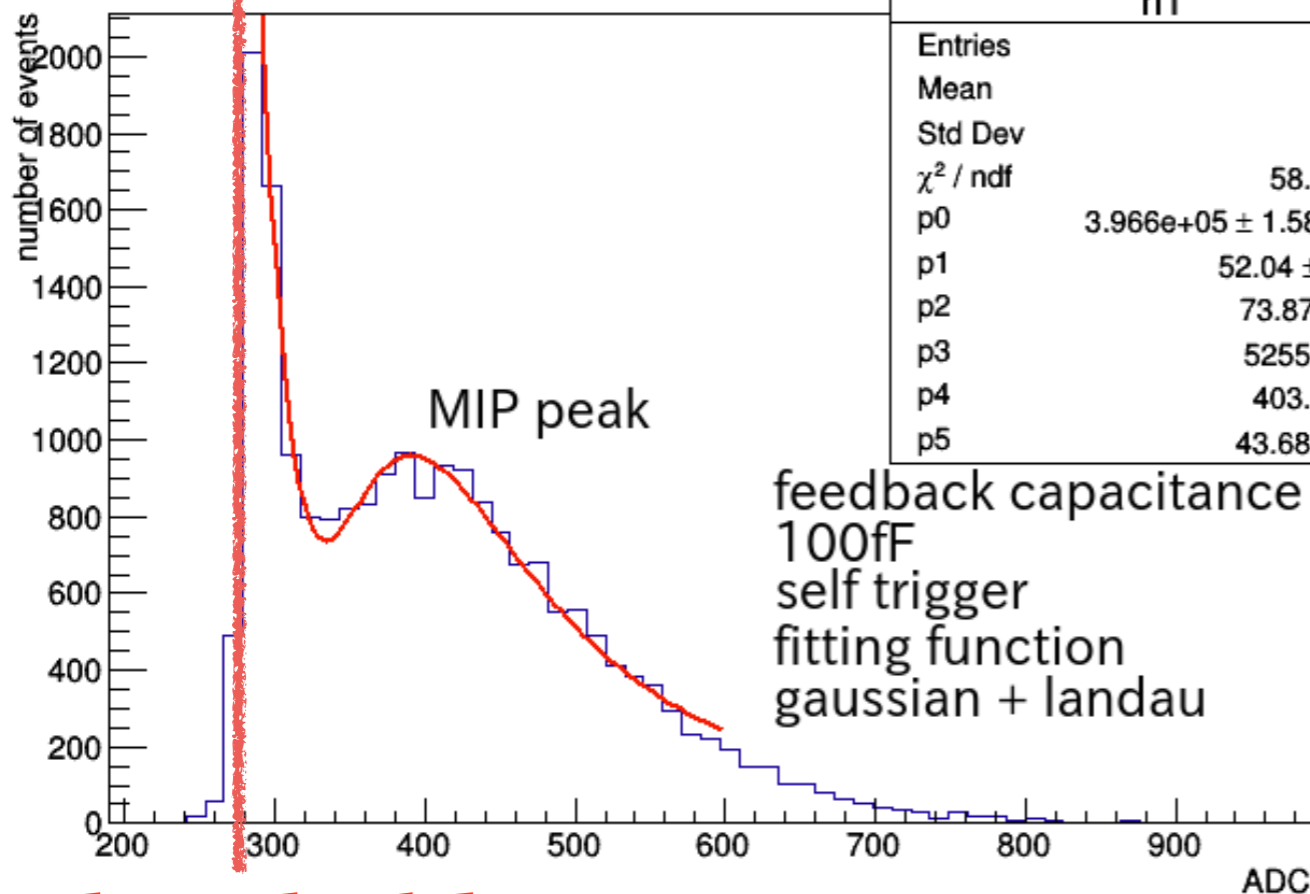


scintillator + EBU

- wedged shape scintillator strip
- beta ray with 15um pitch MPPC
- enough LY with 2mm thick



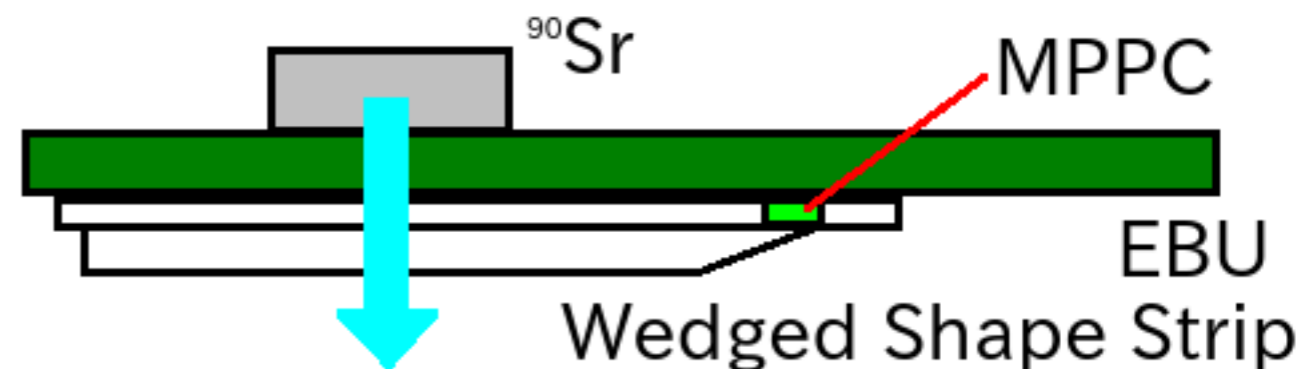
EBU ⁹⁰Sr test



threshold

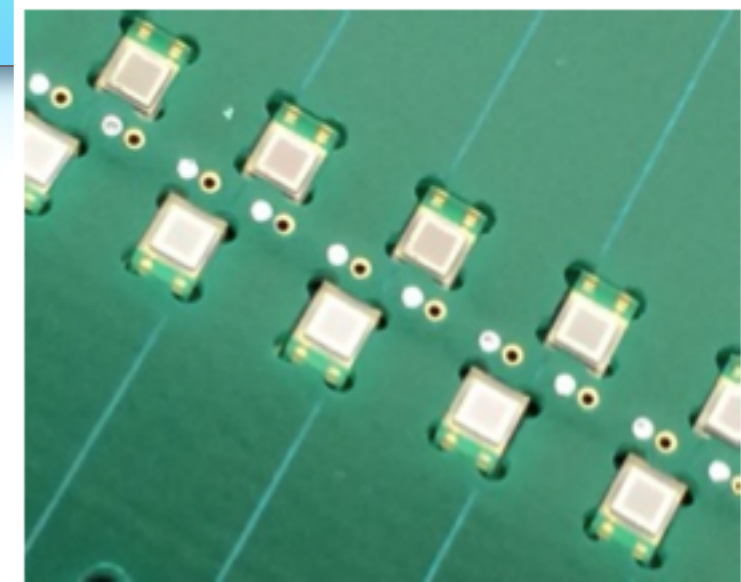


4.9: Single tapered wedge

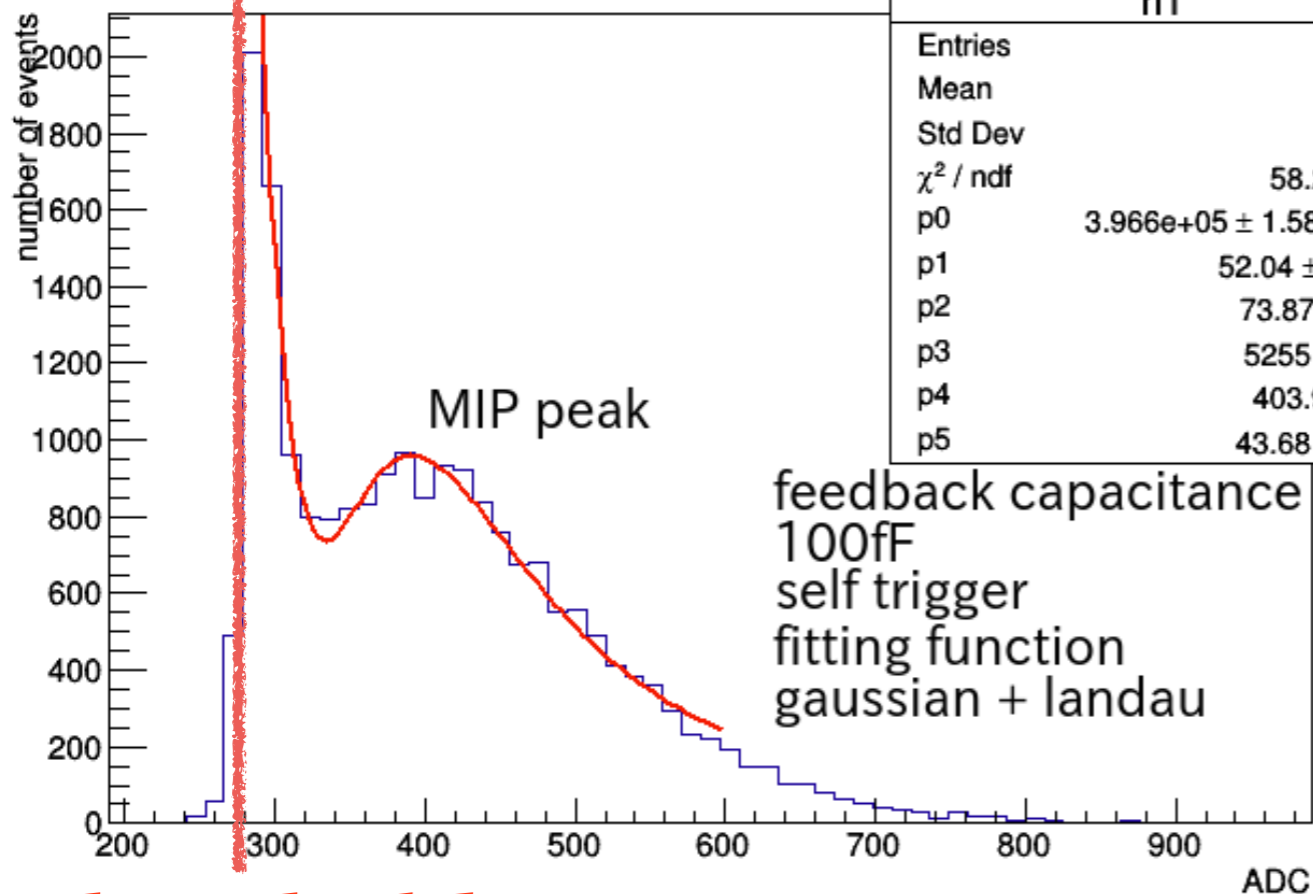


scintillator + EBU

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EBU ⁹⁰Sr test



threshold

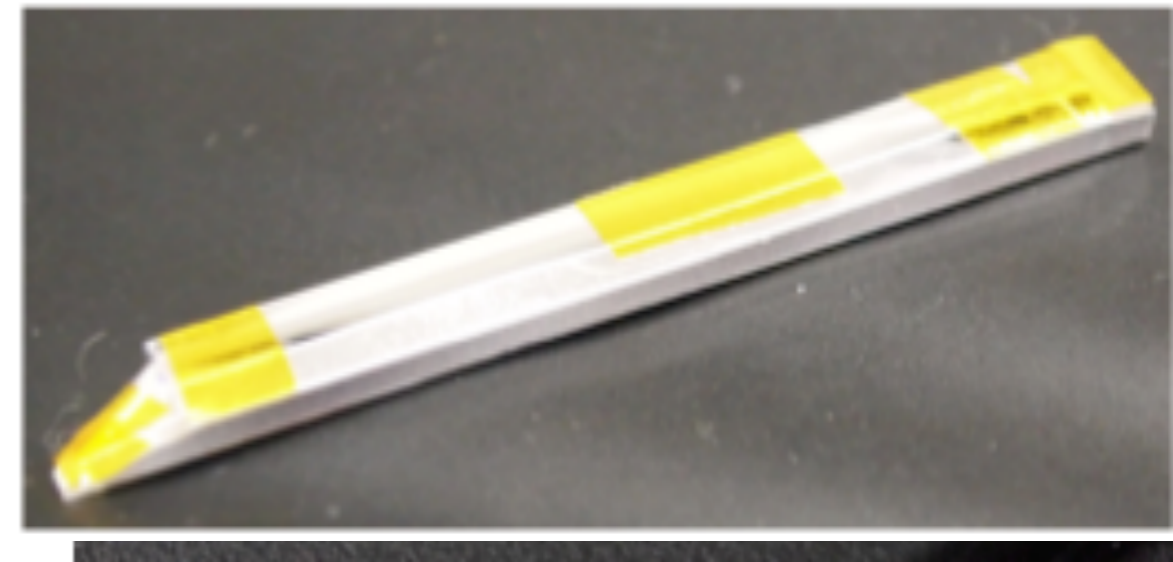
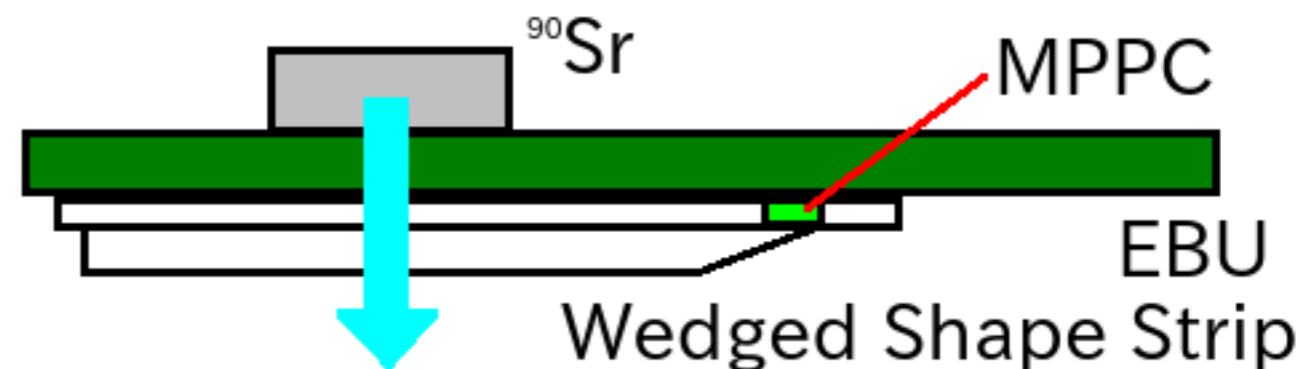


Fig 4.9: Single tapered wedge

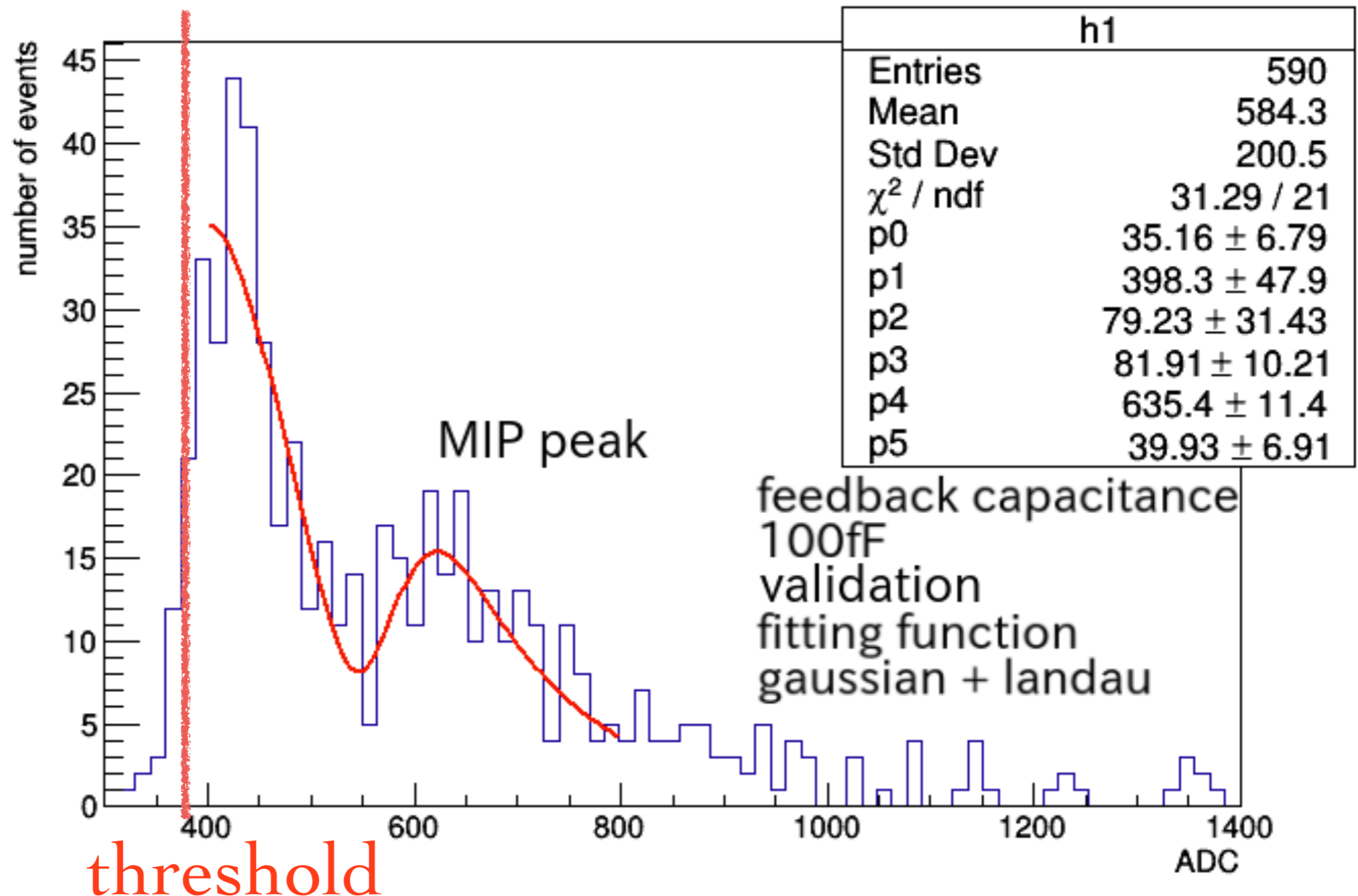


scintillator + EBU

- EM shower events with
- with bottom read out

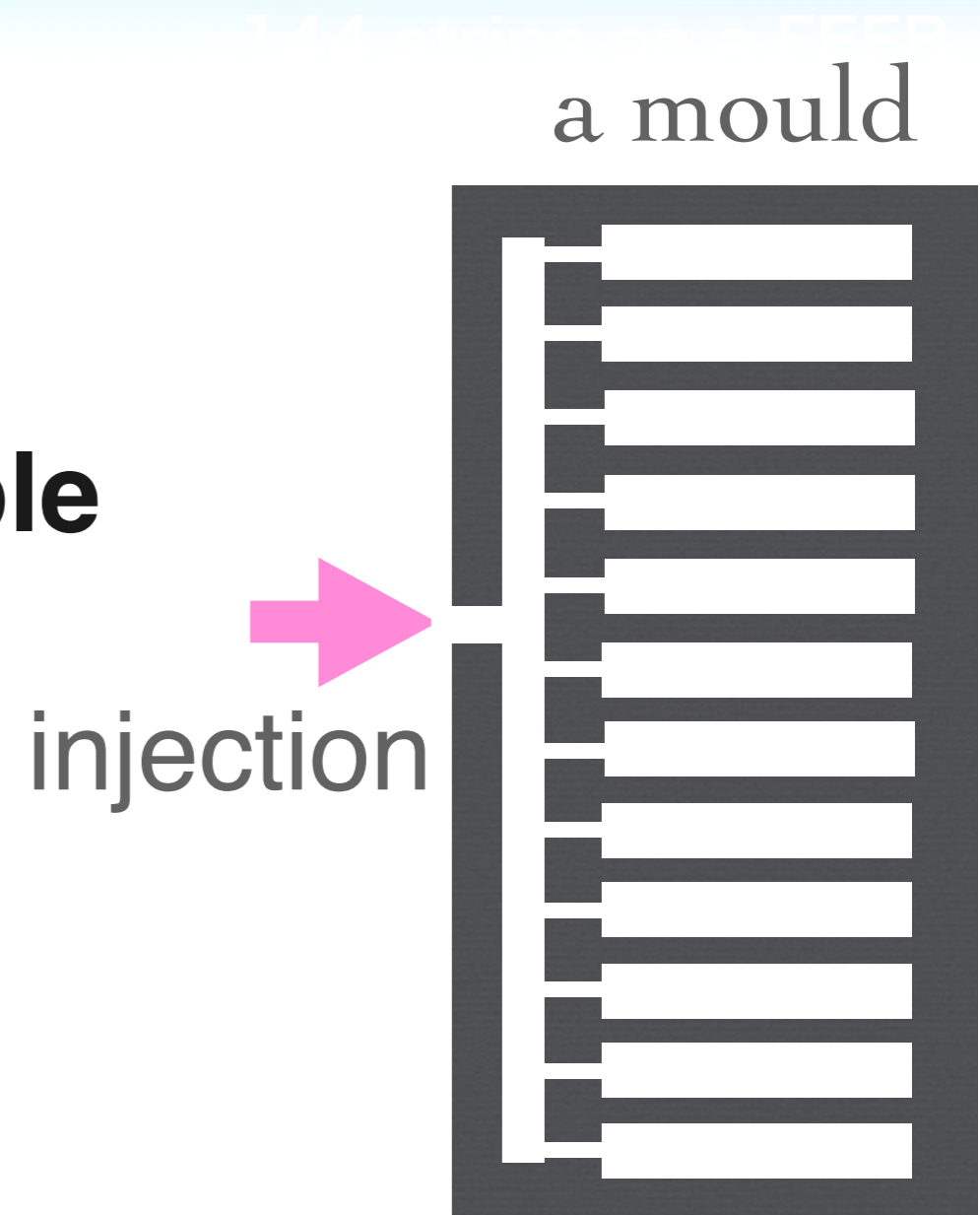
14th Workshop on EPP

10ch.s
success
out of
36ch.s



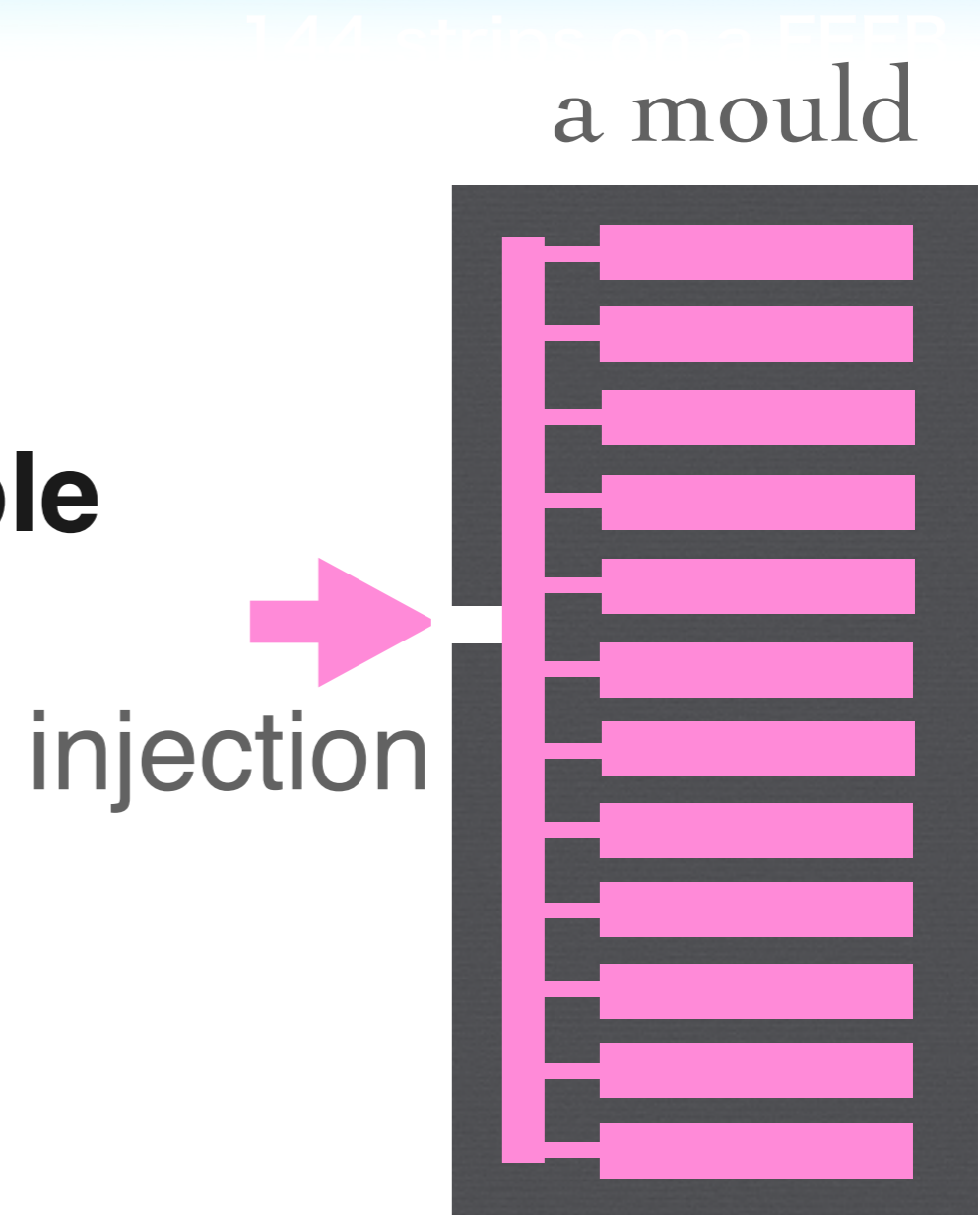
scintillator production

- for mass production
- **injection moulding**
- poly vinyl toluene is suitable to make
- scintillator strips simultaneously
- trial production



scintillator production

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scintillator prod.

- LY comparison with 2mmt
at center position
- EJ:25p.e.
- p-Terphenyl+POPOP: 17p.e.
- PPO+POPOP:18p.e.

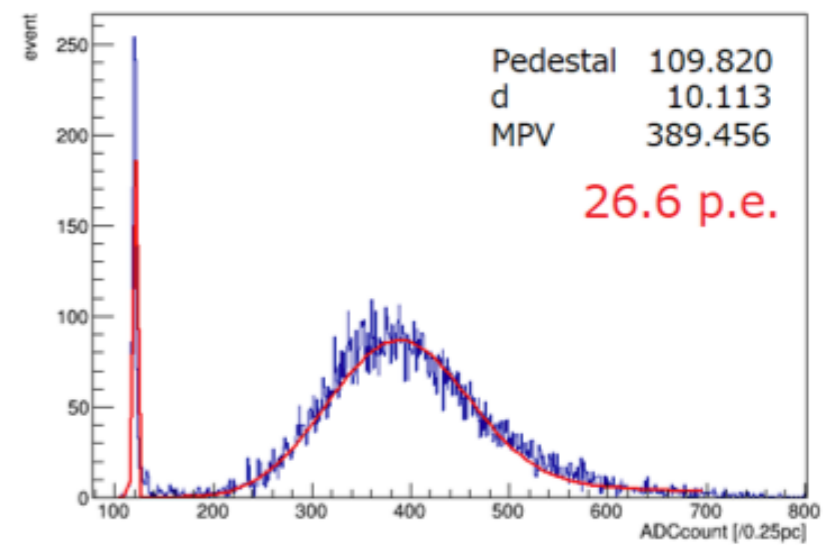


図11 EJ204 2mm厚

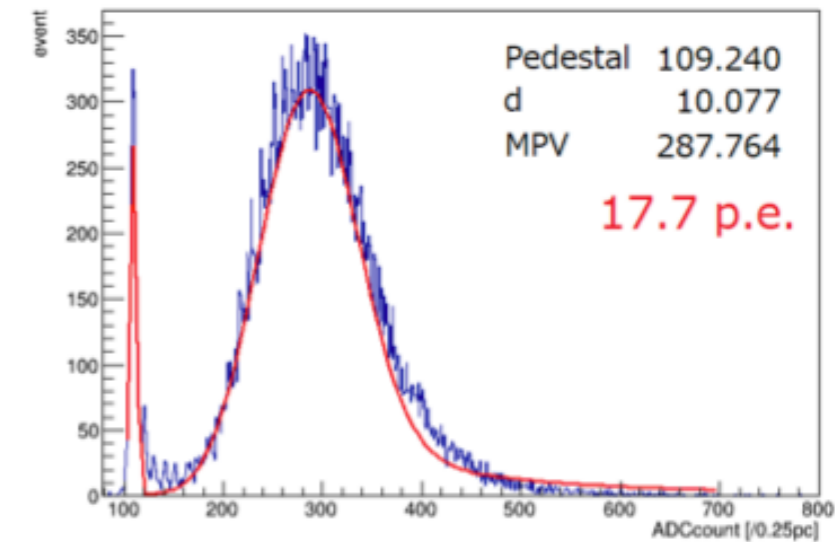


図12 (p-Terphenyl,POPOP)=(3%,0.1%) 2mm厚

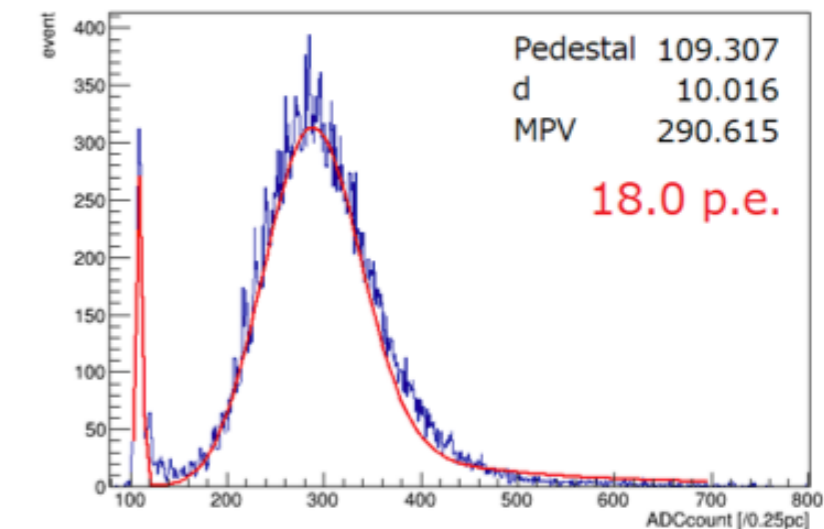
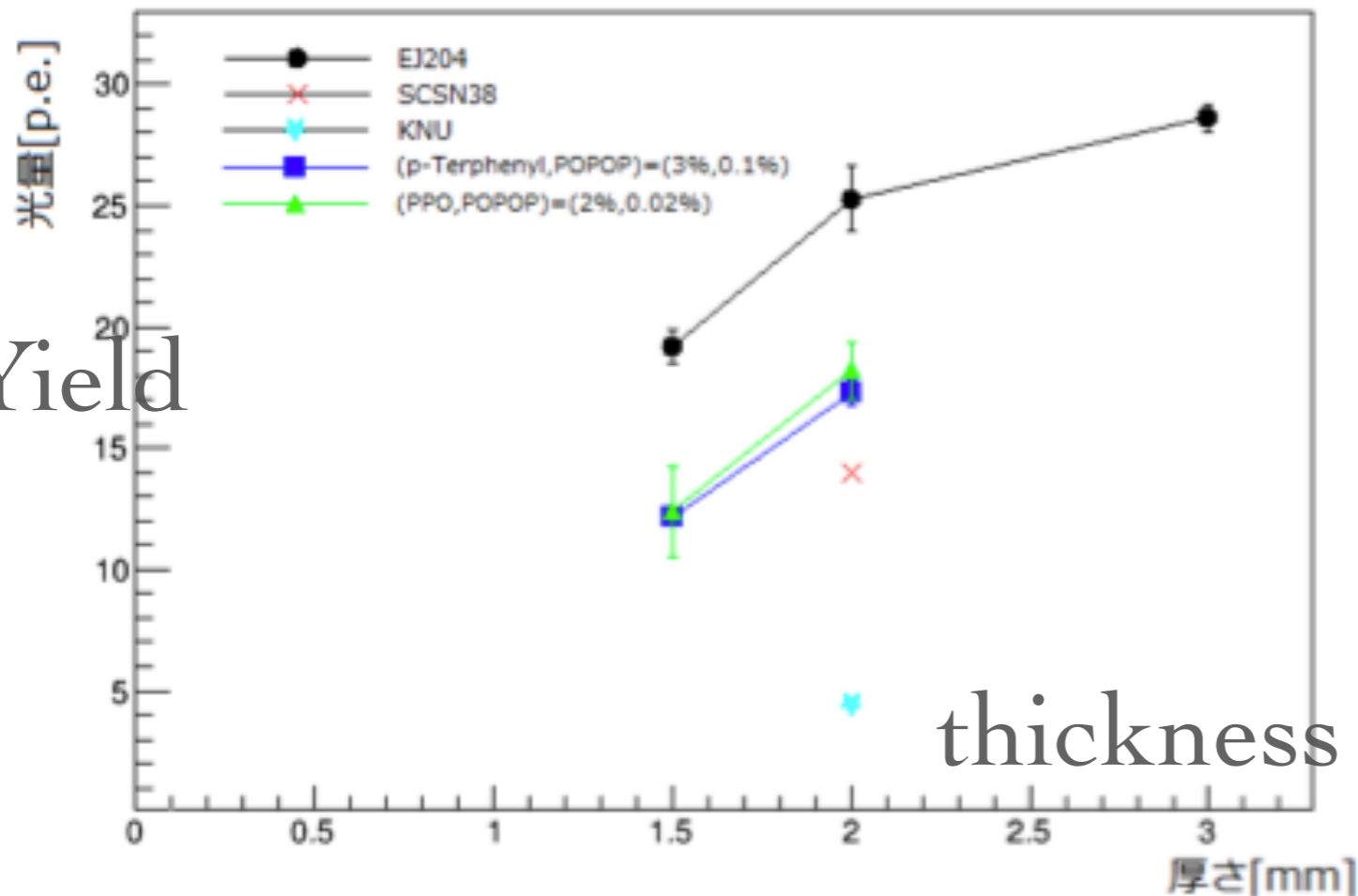


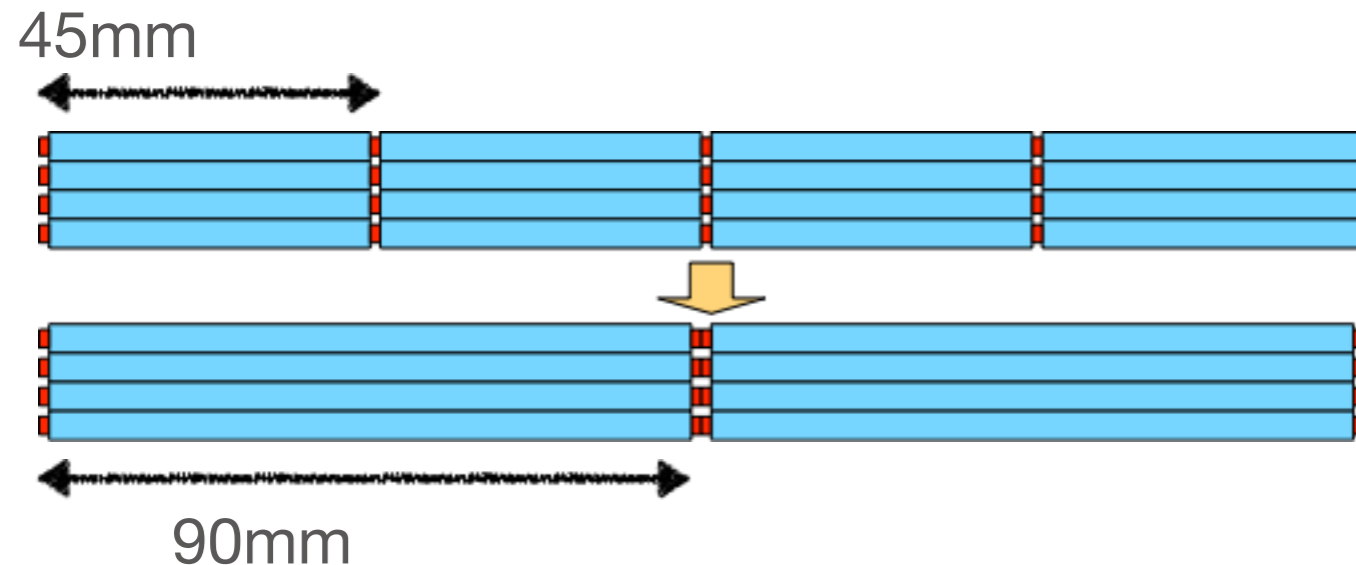
図13 (PPO,POPOP)=(2%,0.02%) 2mm厚



Light Yield

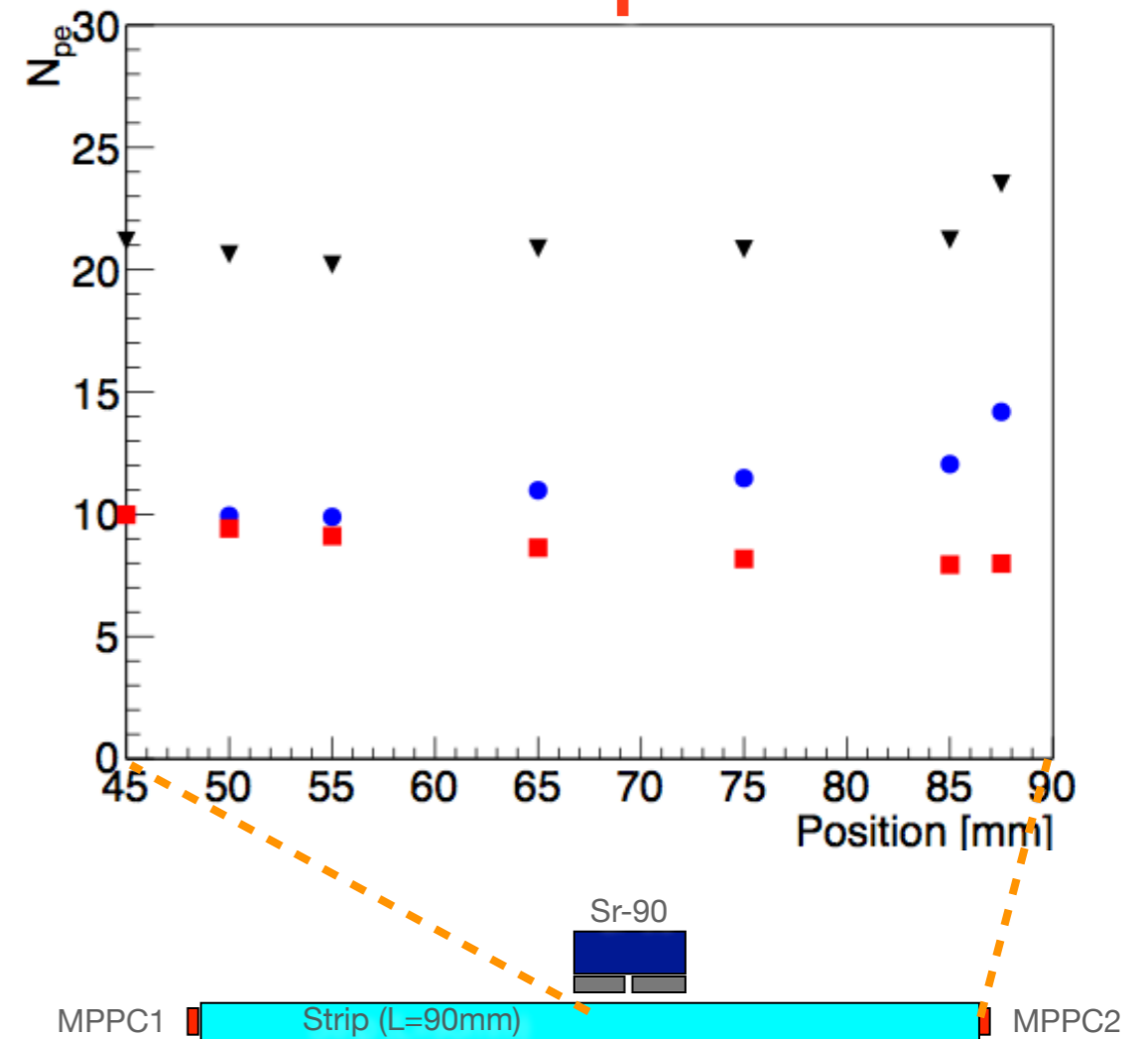
double light read out

- **double sided read out**
coincidence reduce N_{noise}
- **with 10 μm pitch MPPC**
- **keeping the same numb.**
= N_{ch}
- **with longer strips**



EJ212~BC400

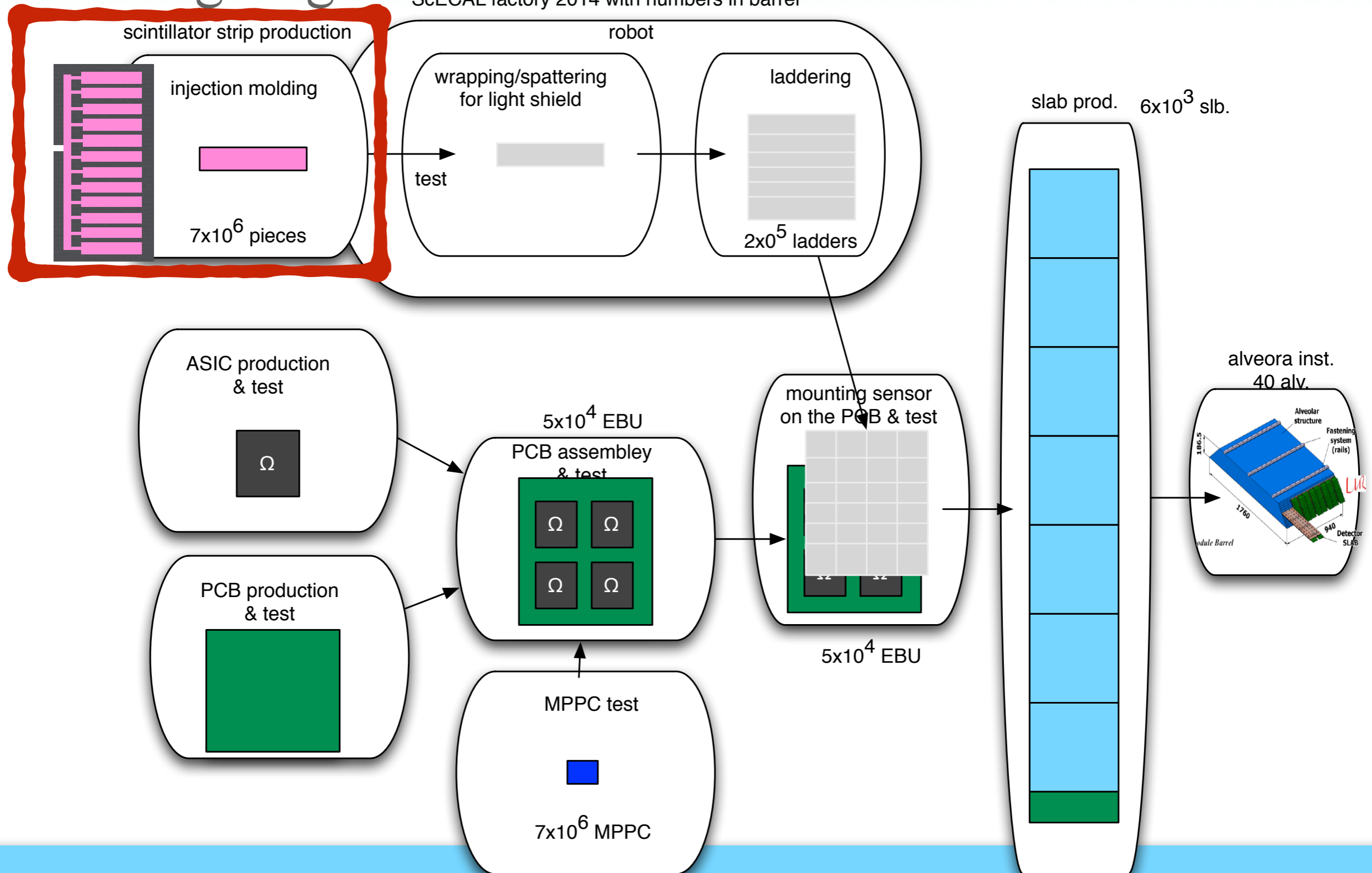
$LY > 20 \text{p.e.}$



production preparation

on going

ScECAL factory 2014 with numbers in barrel

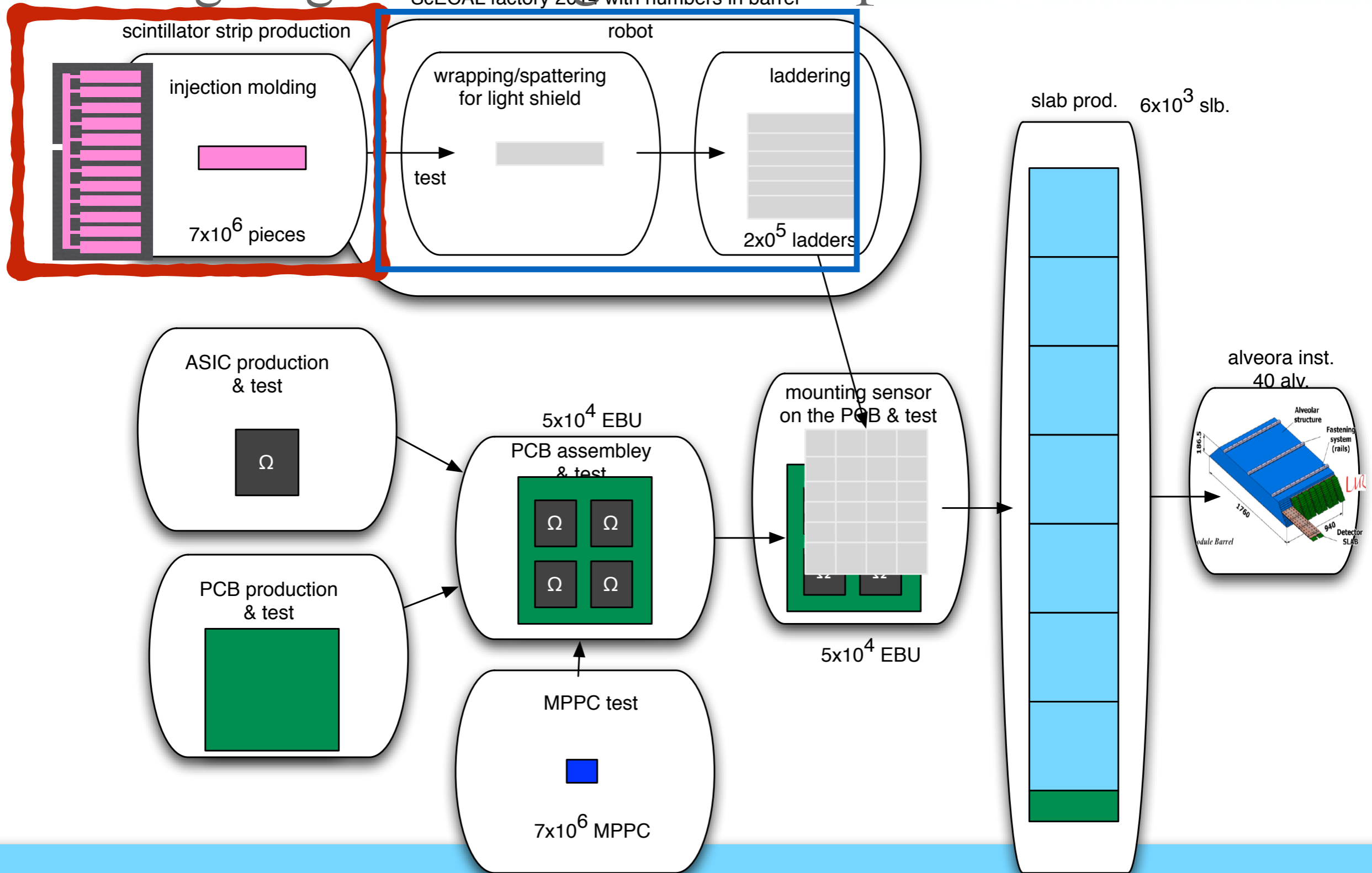


production preparation

on going

talking with companies

ScECAL factory 2014 with numbers in barrel

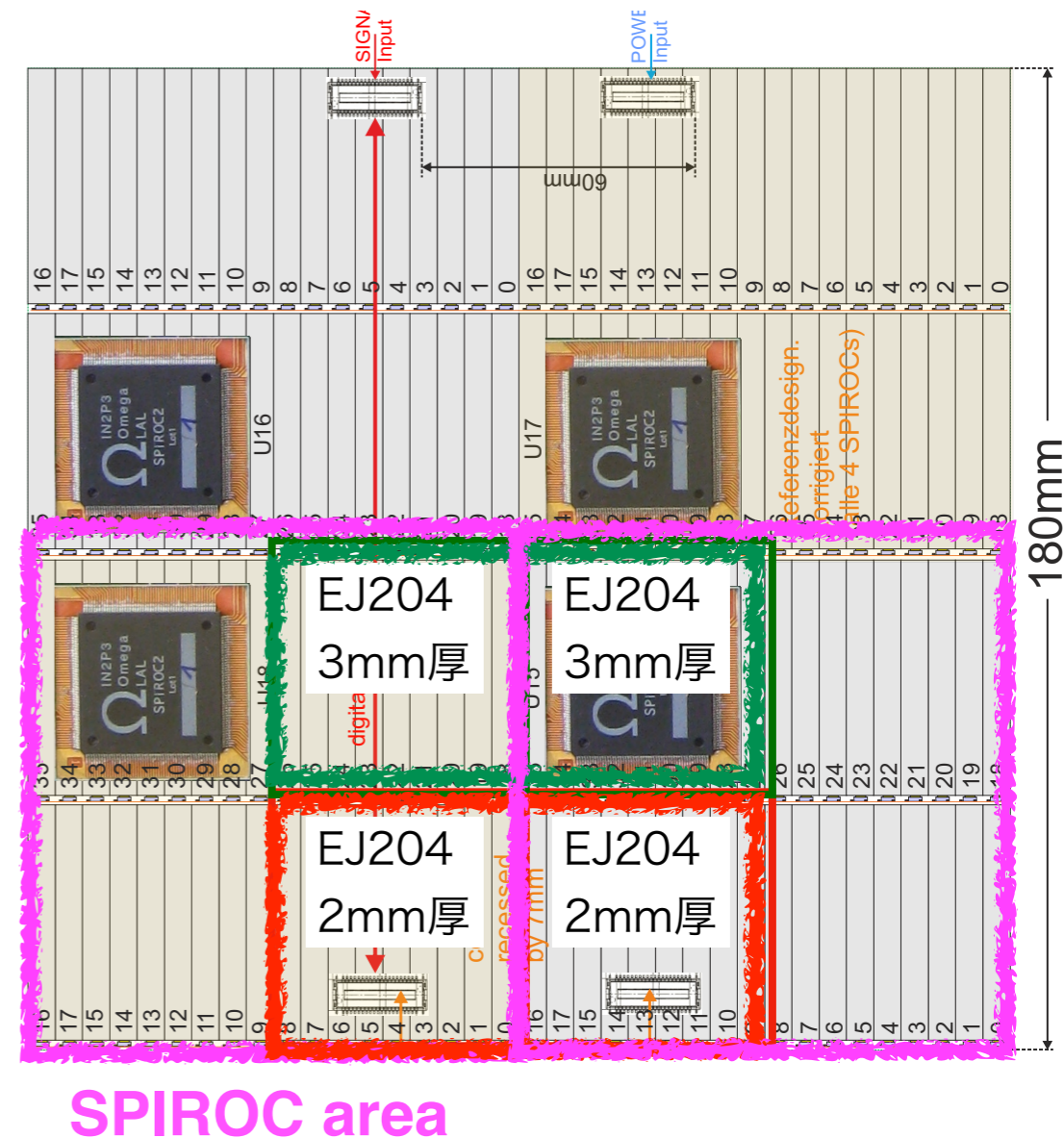


summary & outlook

- **sc-ecal development is in progress**
- **for photo-sensor and scintillator strip**
- **with current EBU (SPIROC2b)**
- **better matching between EBU and sensor (MPPC + scintillator) is under explored**
- **suitable Front End electronics is essential**
- **for smaller signal and higher noise rate photo-sensor**

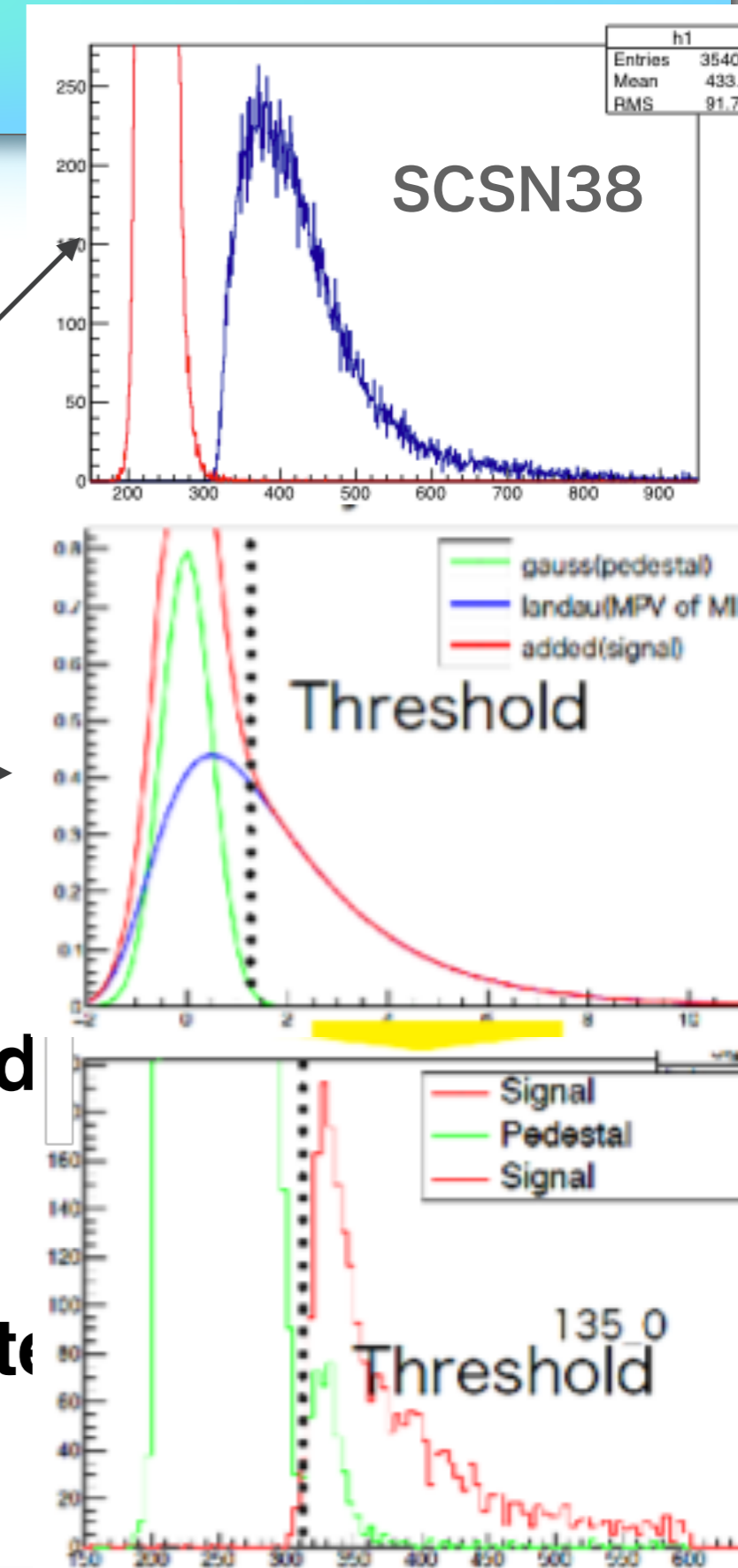
EBU at beam

- an EBU is governed by four SPIROC2b's
- with the same threshold
- we can not control threshold voltages independently channel by channel
- we would like to decrease threshold for 2mm strips, however ...it should be



EBU

- EBU with four SPIROC2b's equipped
- tested and worked well with 25um pitch MPPC (with SCSN38 scintillator)
- test with 10um pitch MPPC is unsatisfactory
- due to its smaller output (though increased amp gain)
- thus 15um pitch MPPC is another candidate

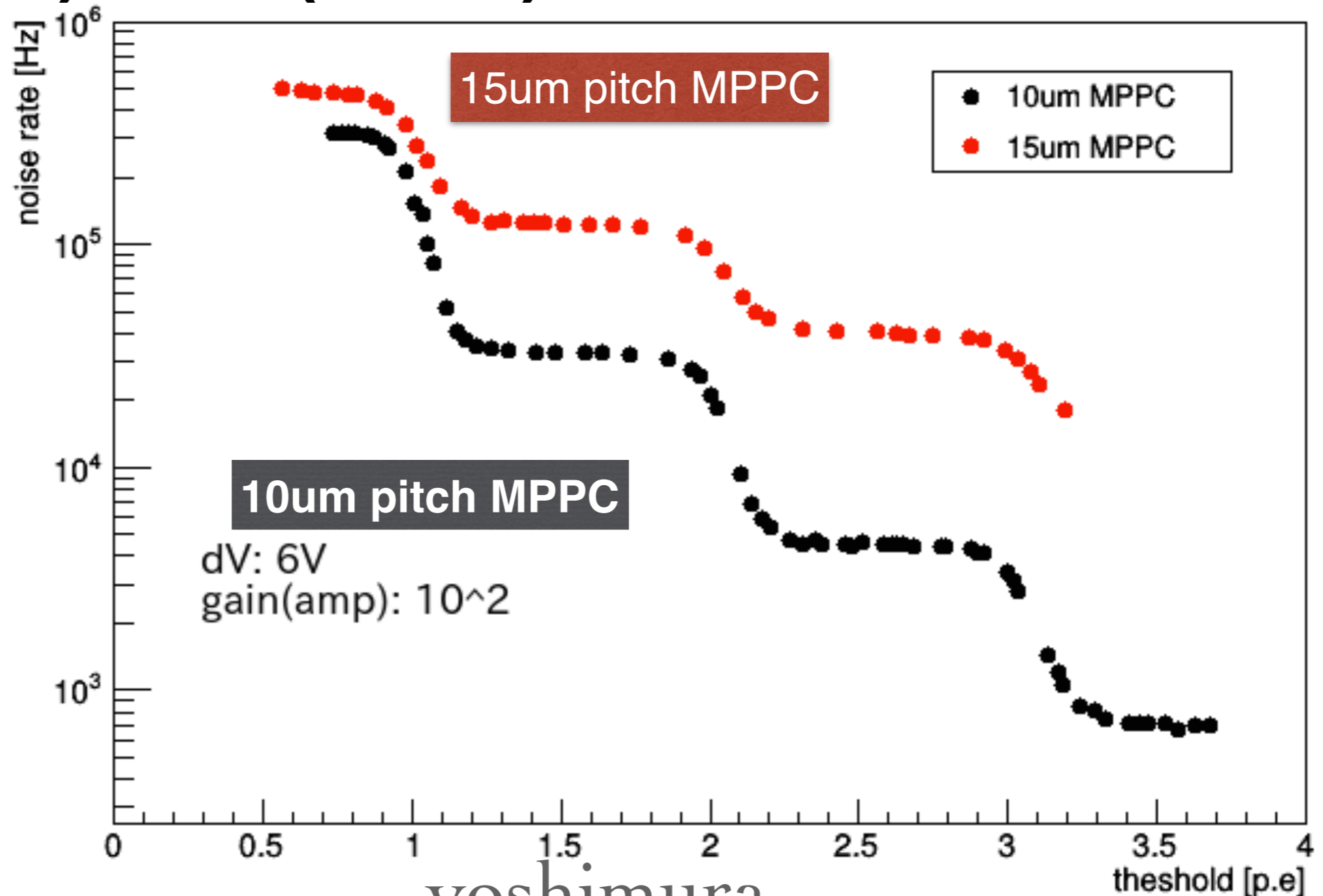


10um vs 15 um pitch

- threshold curve: Noise rate $\sim 300\text{kHz}$

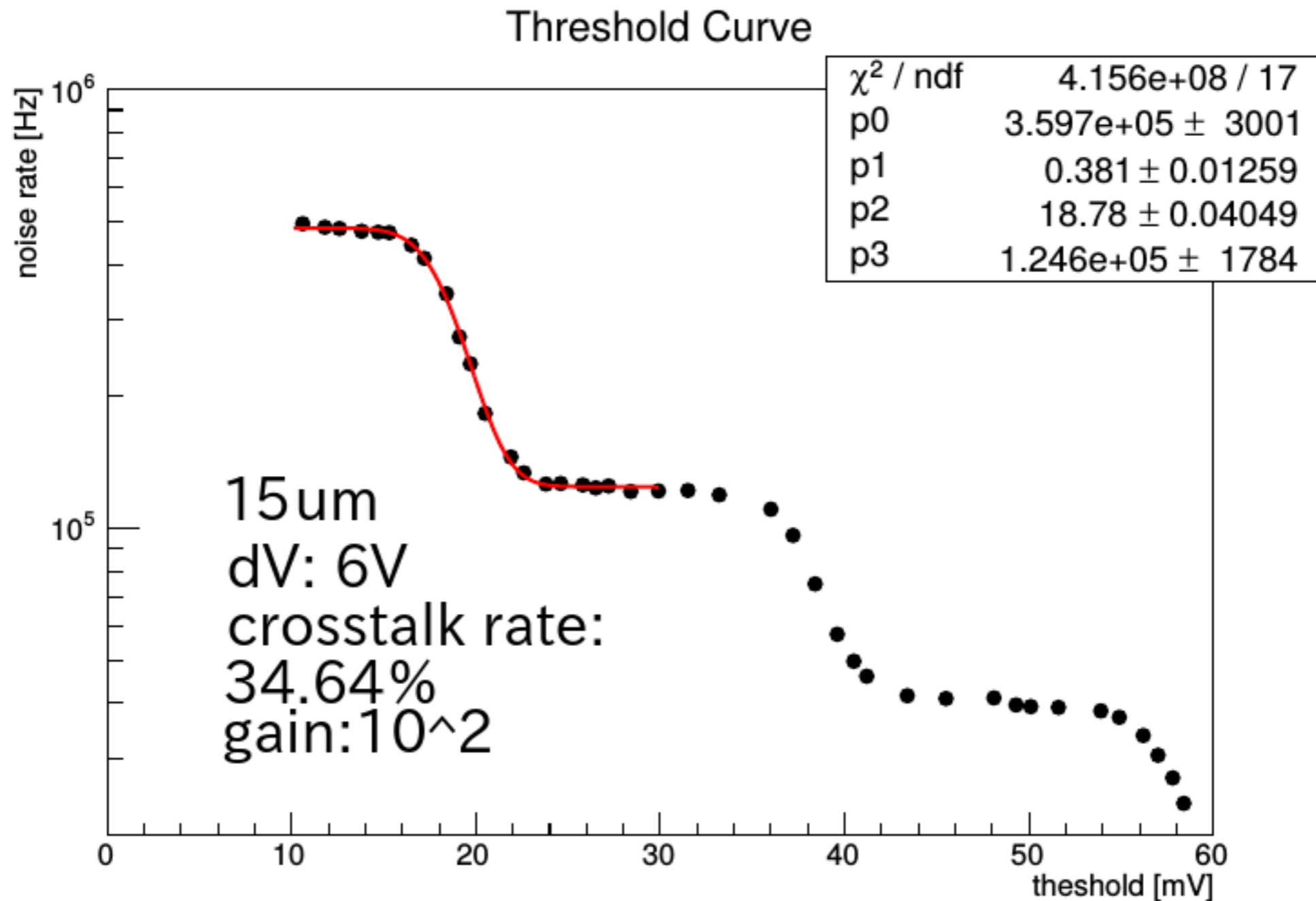
- $\text{NR}(10\mu\text{m}) \ll \text{NR}(15\mu\text{m})$ Threshold Curve

$dV=6V$



15um pitch MPPPC

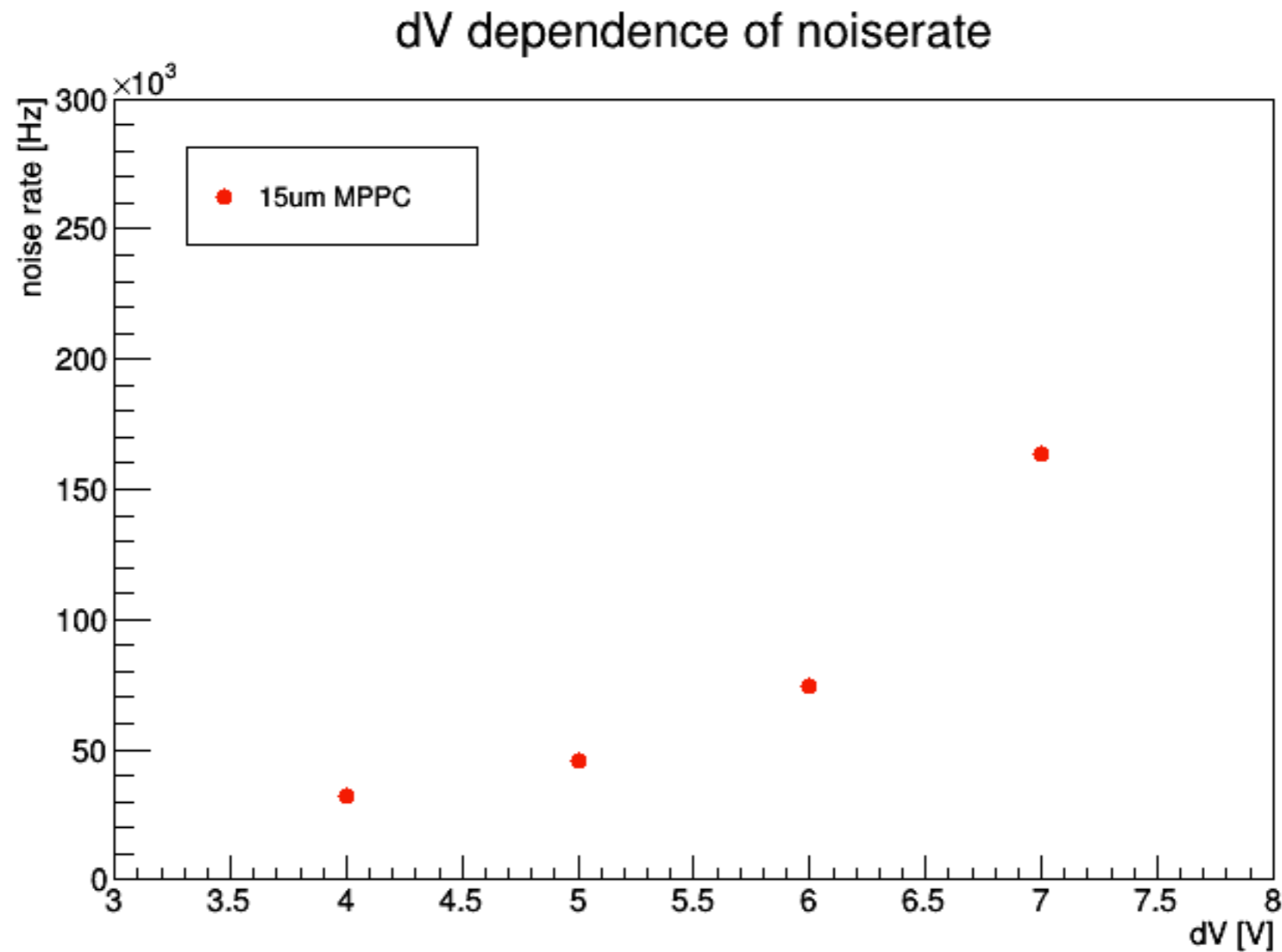
- threshold curve: Noise rate ~360kHz



15um pitch MPPC

- Noise rate vs dV

344 strings on a FEED



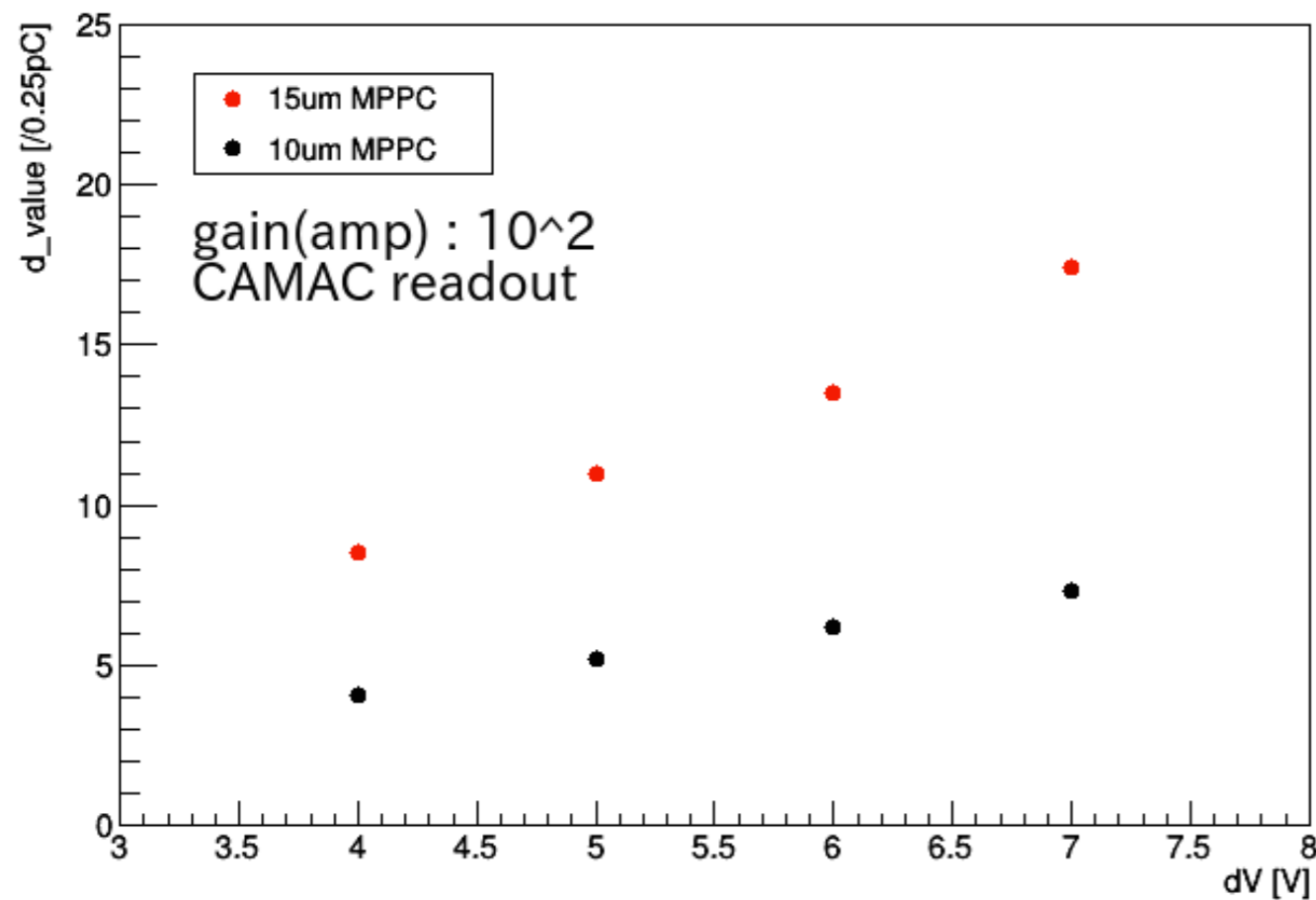
15um vs 10 um MPPC

- comparisons : gain and PDE

14th Workshop on PDE

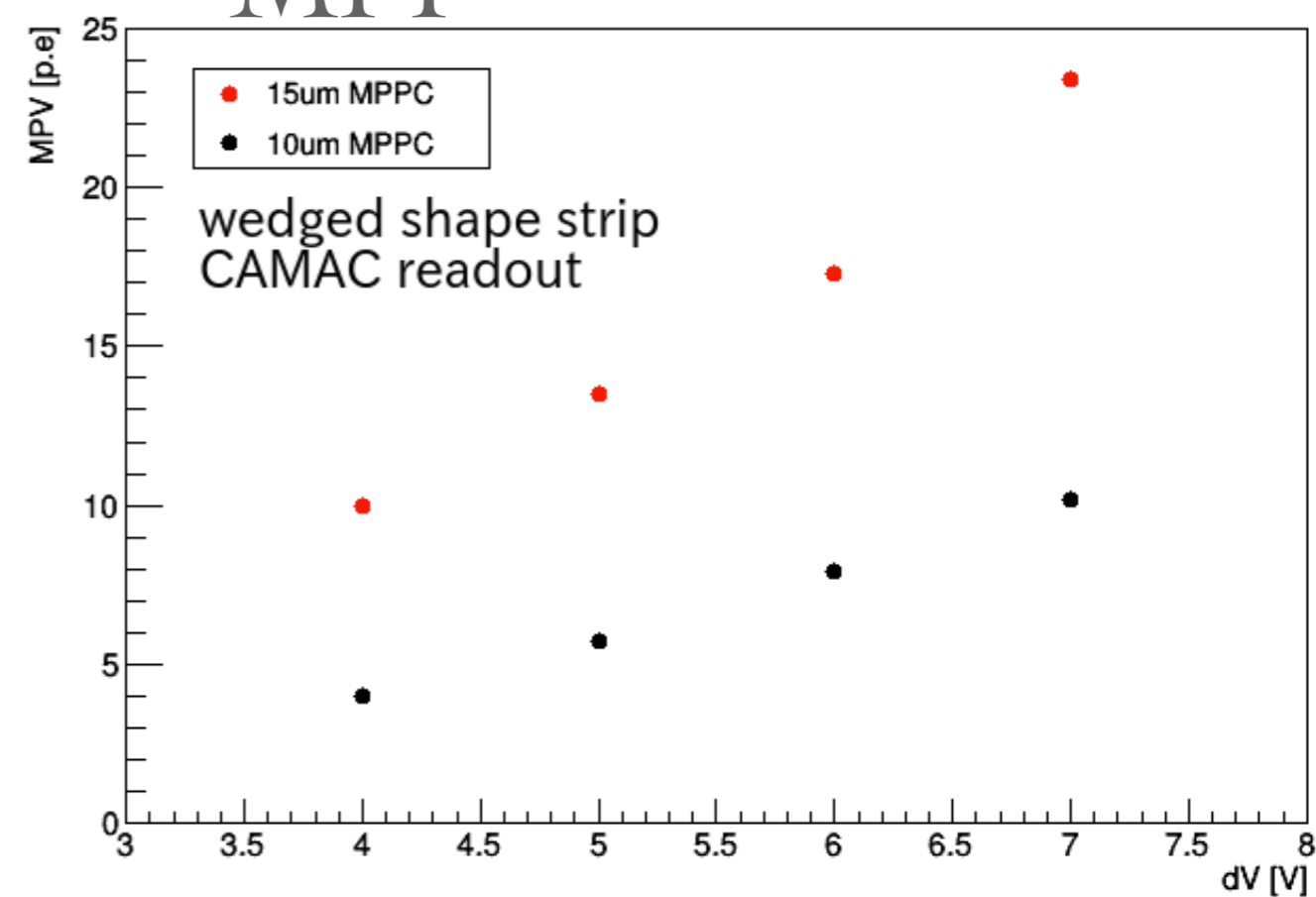
LED

dV vs d_value



MPI

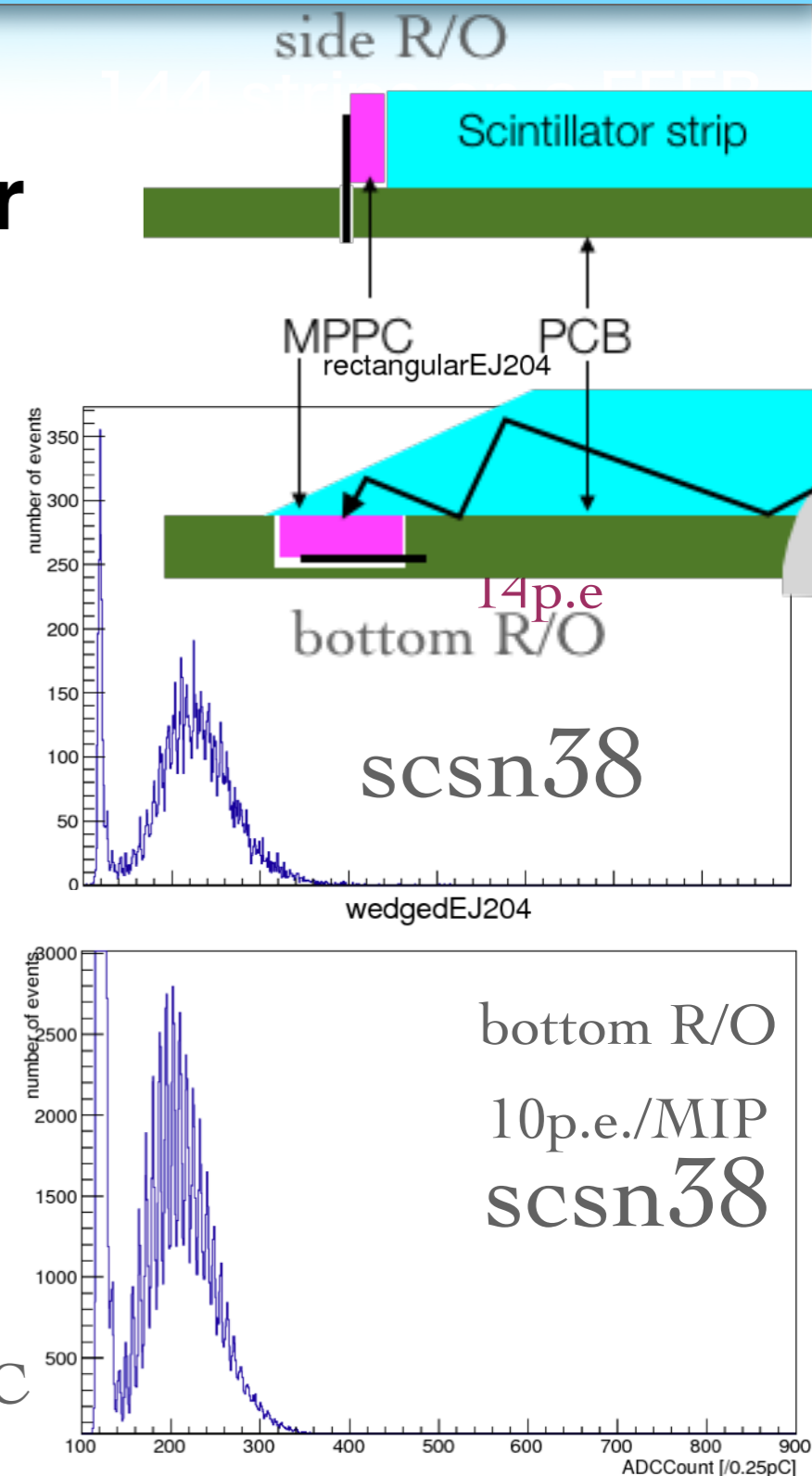
dV vs MPV



light coupling

- between photo-sensor and scintillator
- side R/O : much light with dead volume = 2%
- bottom R/O : slightly less light with no dead vol.
- both have enough light, need with EB to verify

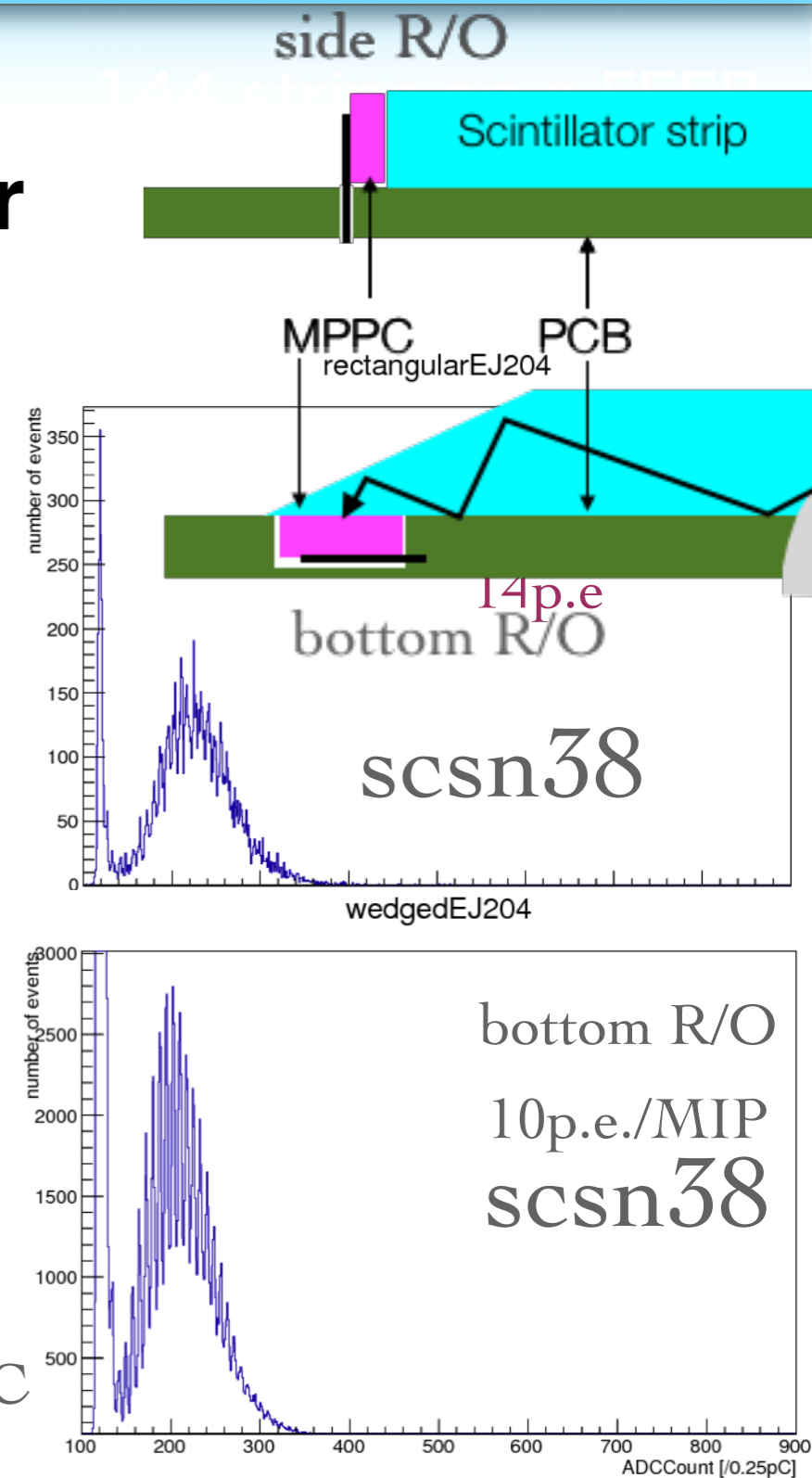
10um pitch MPPC + PMTamp+camac ADC



light coupling

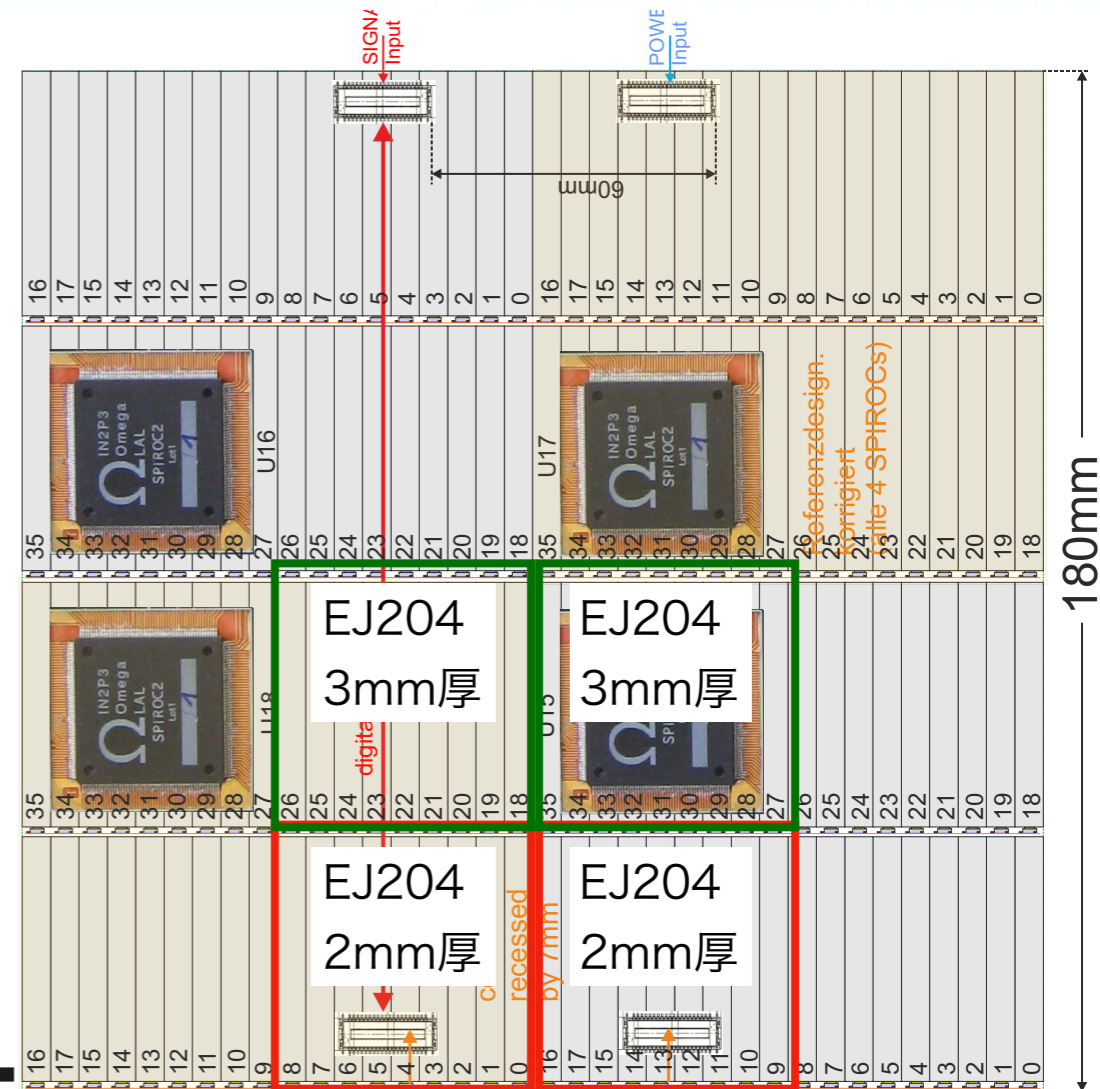
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10um pitch MPPC + PMTamp+camac ADC



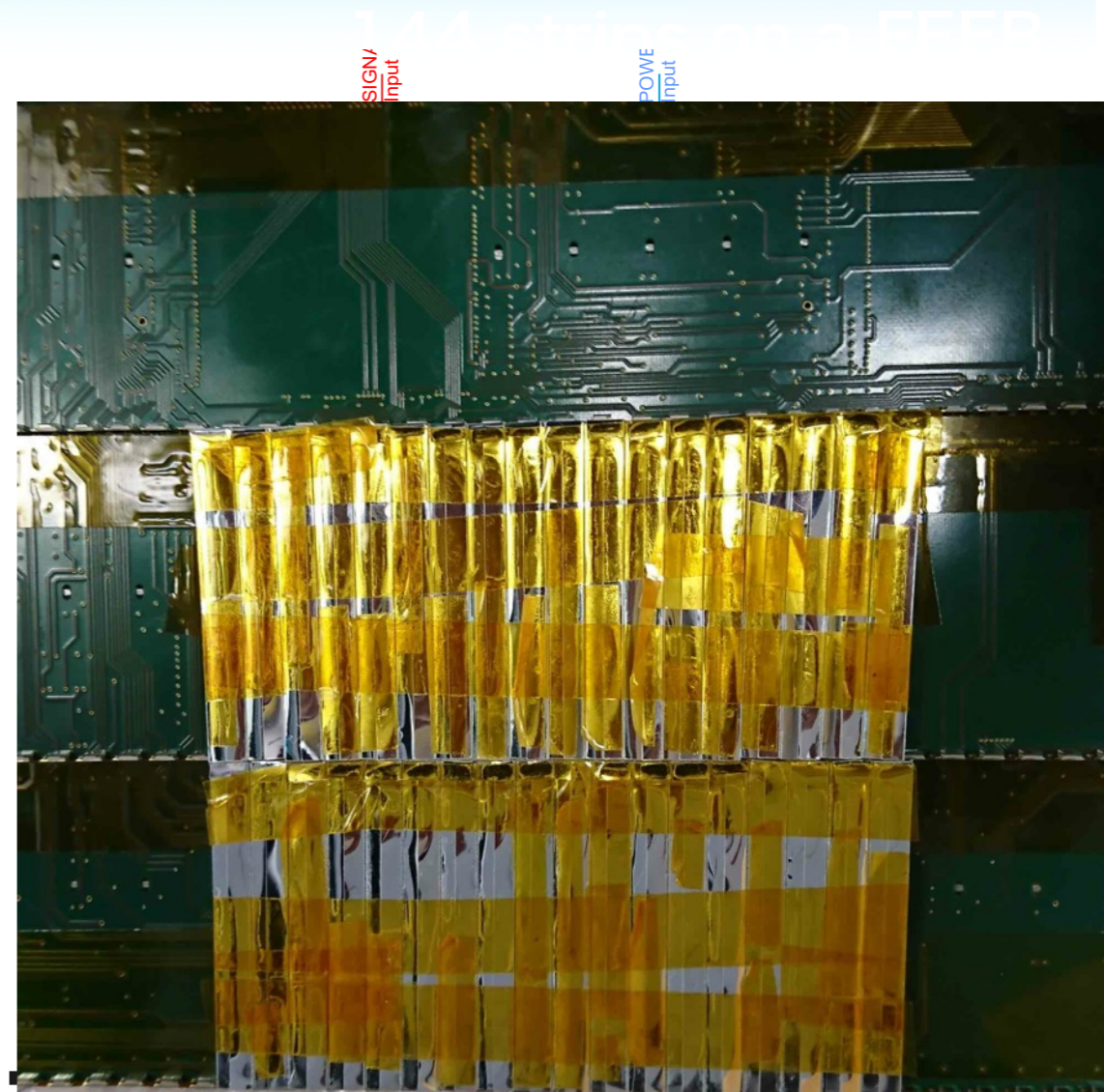
Beam test at ELPH

- installation on an EBU
- 3mm and 2mm strips
- for mechanical stability
- but wrong for threshold tuning
- common in a SPIROC chip



Beam test at ELPH

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strip ECAL concept

common mechanical structure with
SiWECAL

scintillator-strip

5mm x 45mm x 2mm

X-Y combination gives 5x5mm

front end electronics embedded

good timing resolution

robust and low cost

