Verification of the compton-PET and a new approach to SPECT

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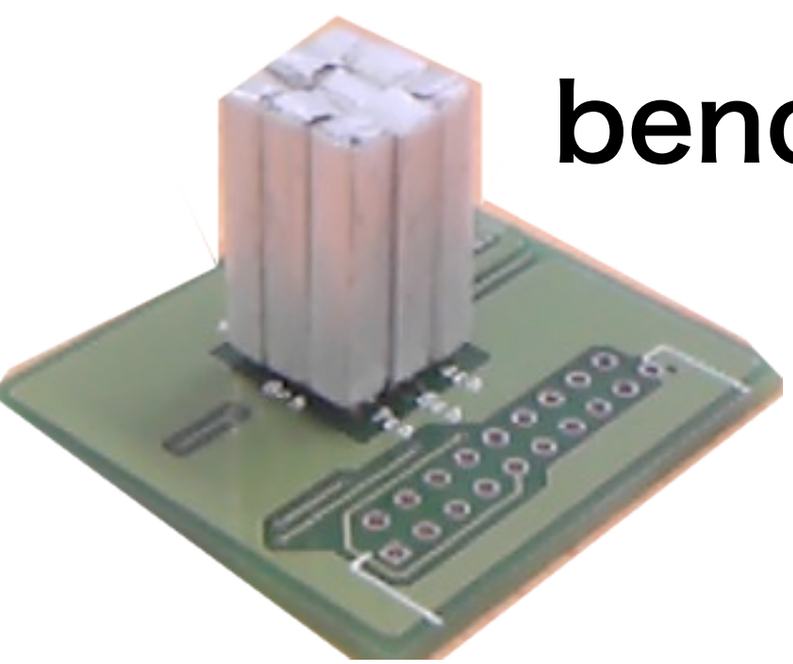
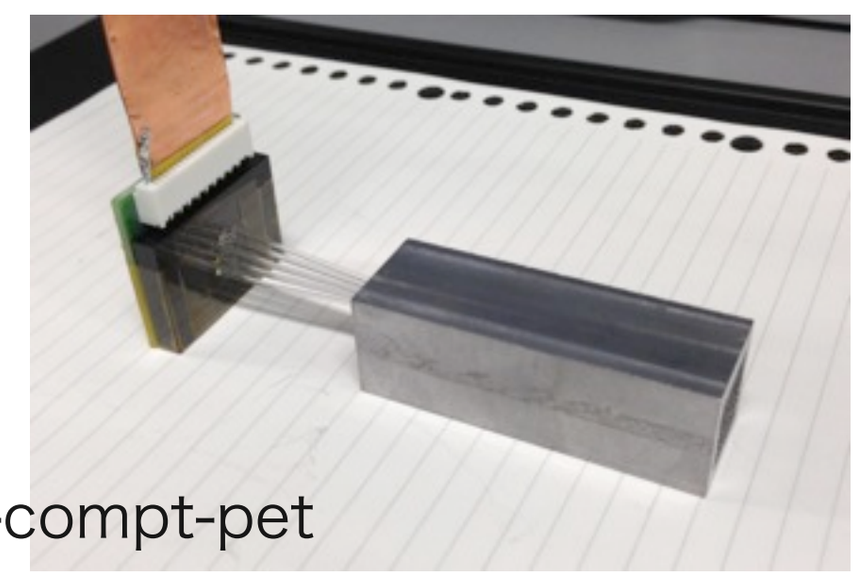
Y.Miyashita, K.Sako

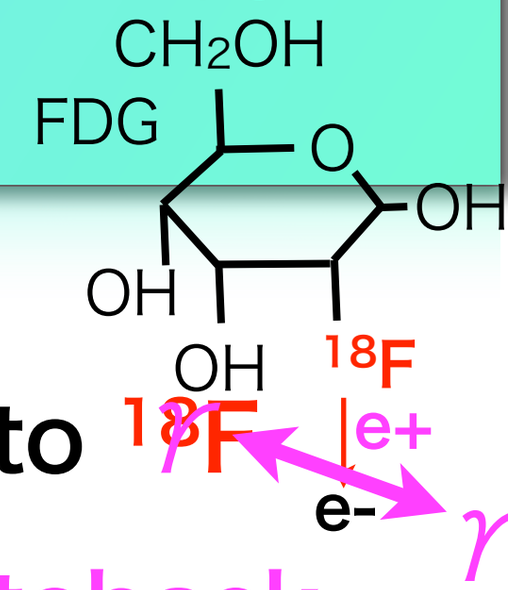


Compton-PET
bench test and simulation
SPECT
bench test



PET

18F fluorodeoxy glucose

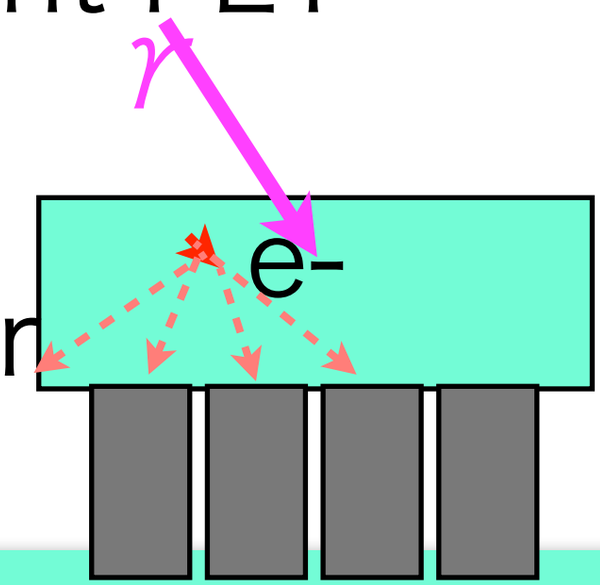


- Positron Emission Tomography
- cancers love glucose: OH is substituted to
  hydro-oxyl
- $^{18}F \rightarrow {}^{18}O + e^+ + \nu$, $\tau \sim 110$min.: $e^+e^- \rightarrow 2\ \gamma$ backtoback
  0.511MeV
- earlier discover requires smaller cancer
- spatial resolution 5 mm(now)>> 1 mm

current PET

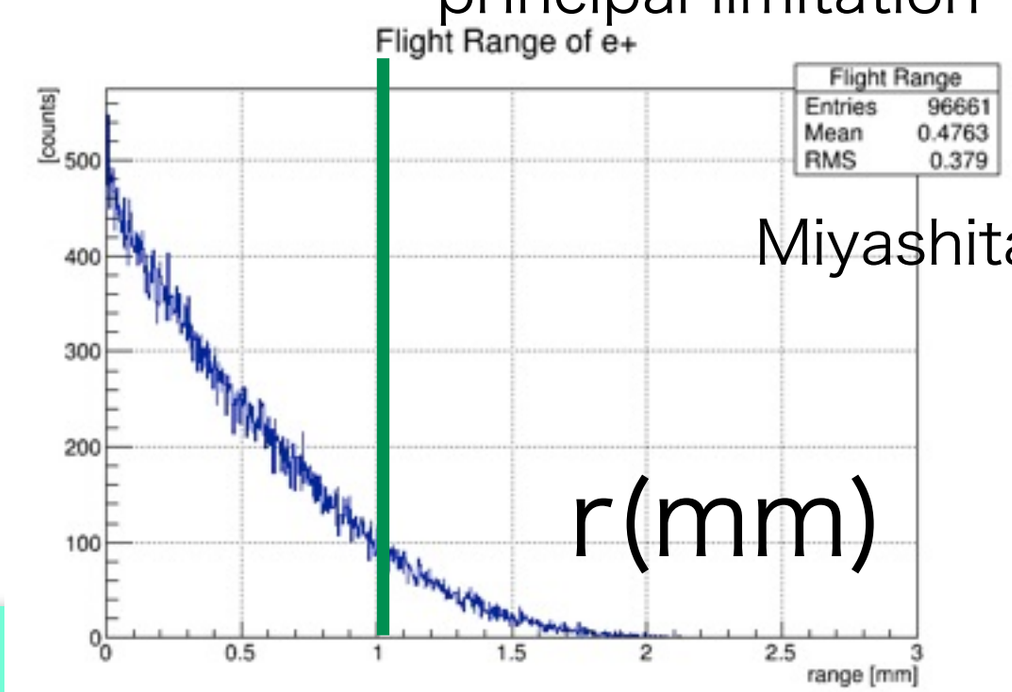
big scintillator

PMT



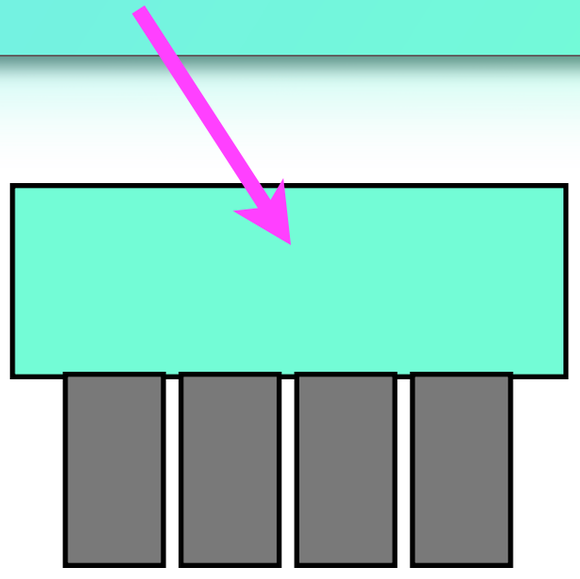
center of gravity

principal limitation



Miyashita

Requirements for next-PET



- spatial reso. ~ 1 mm
  2011 Yamazaki et. al
- not only center ~ 1mm
- gammas come from whole body
- layer into longitudinal dir.
  - PMT is too thick
  - silicon photo-sensor

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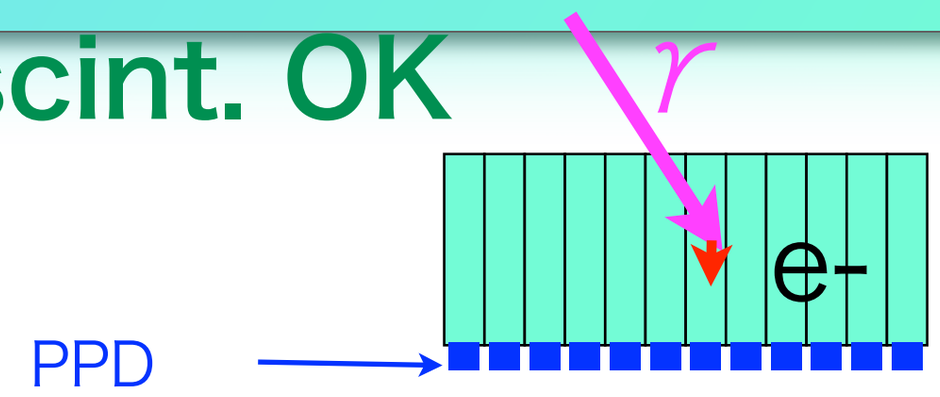

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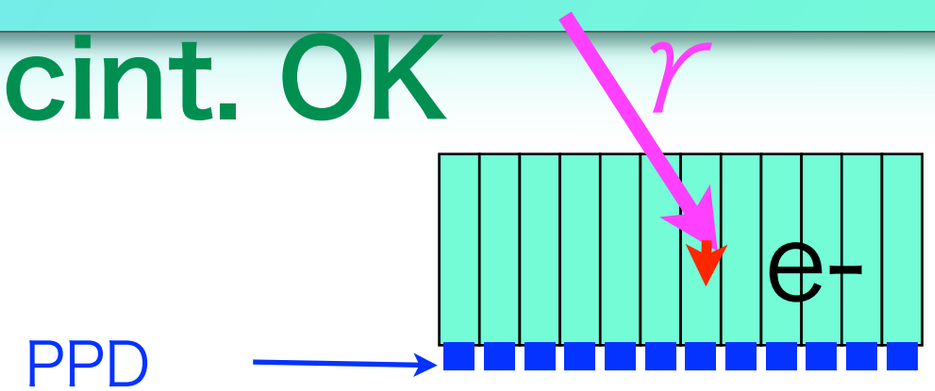

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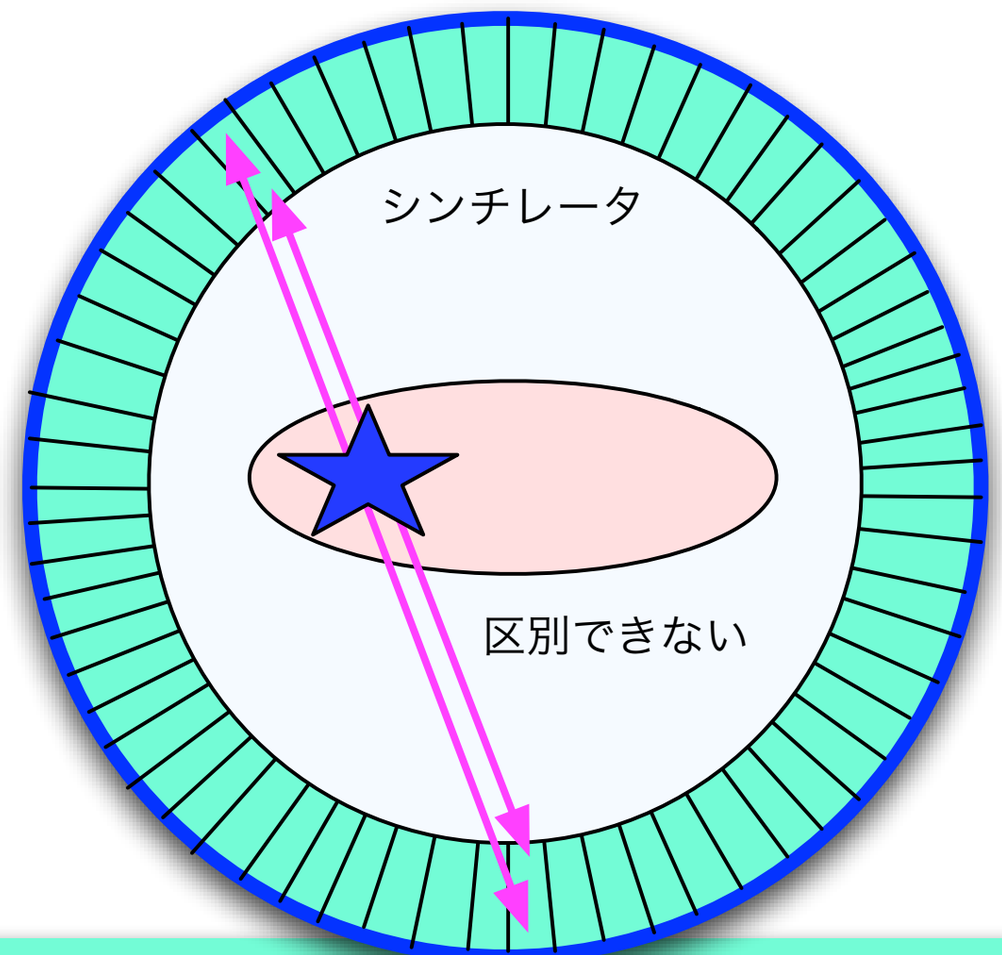

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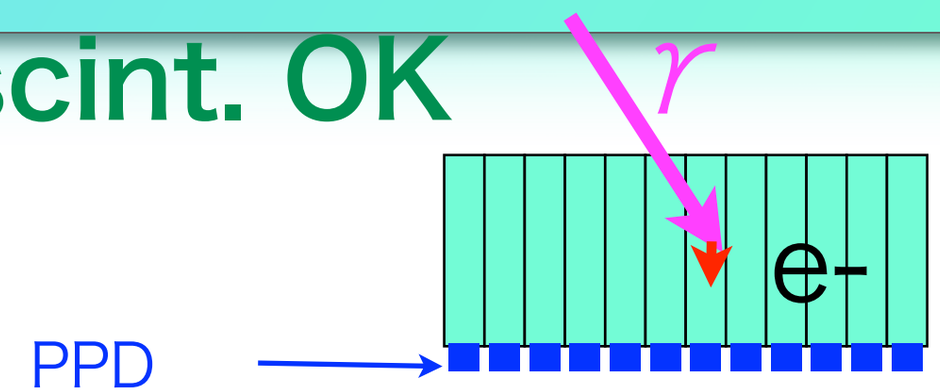

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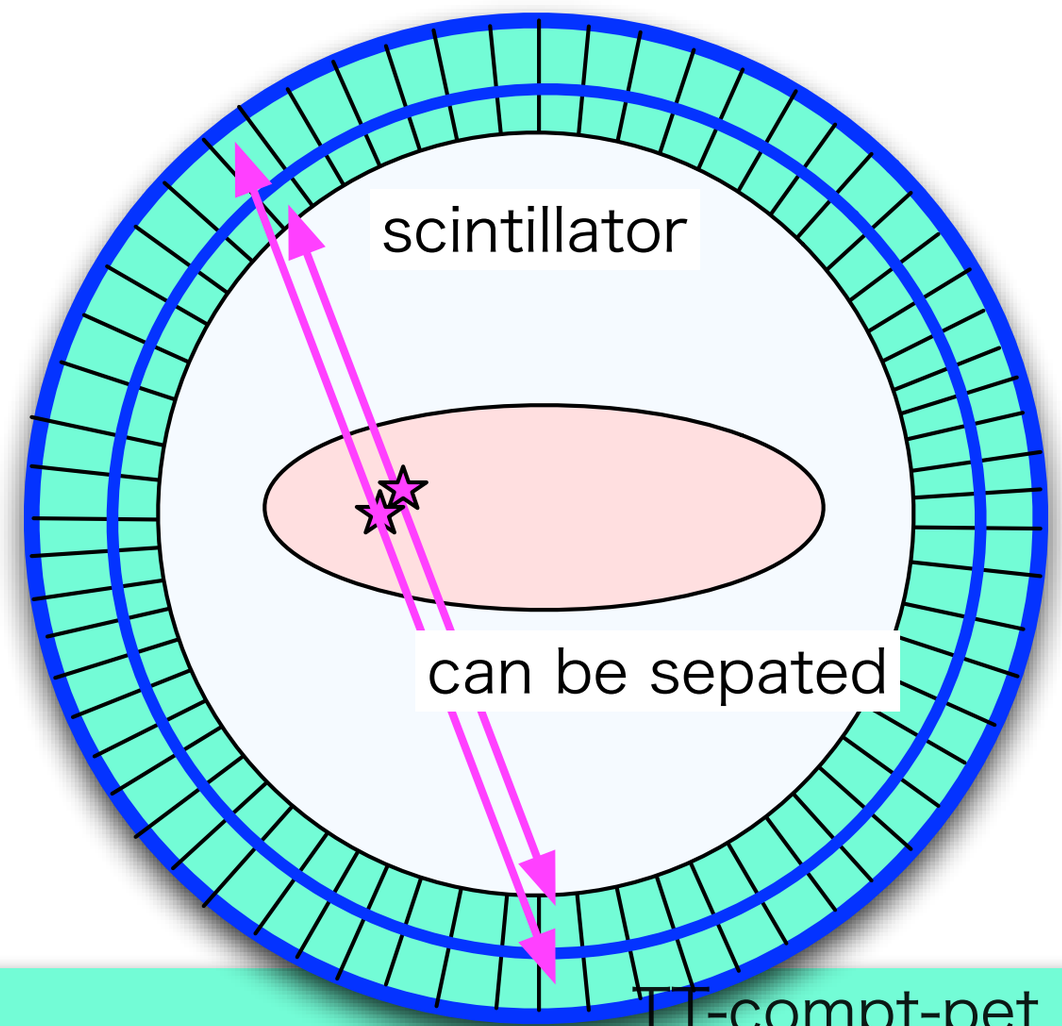
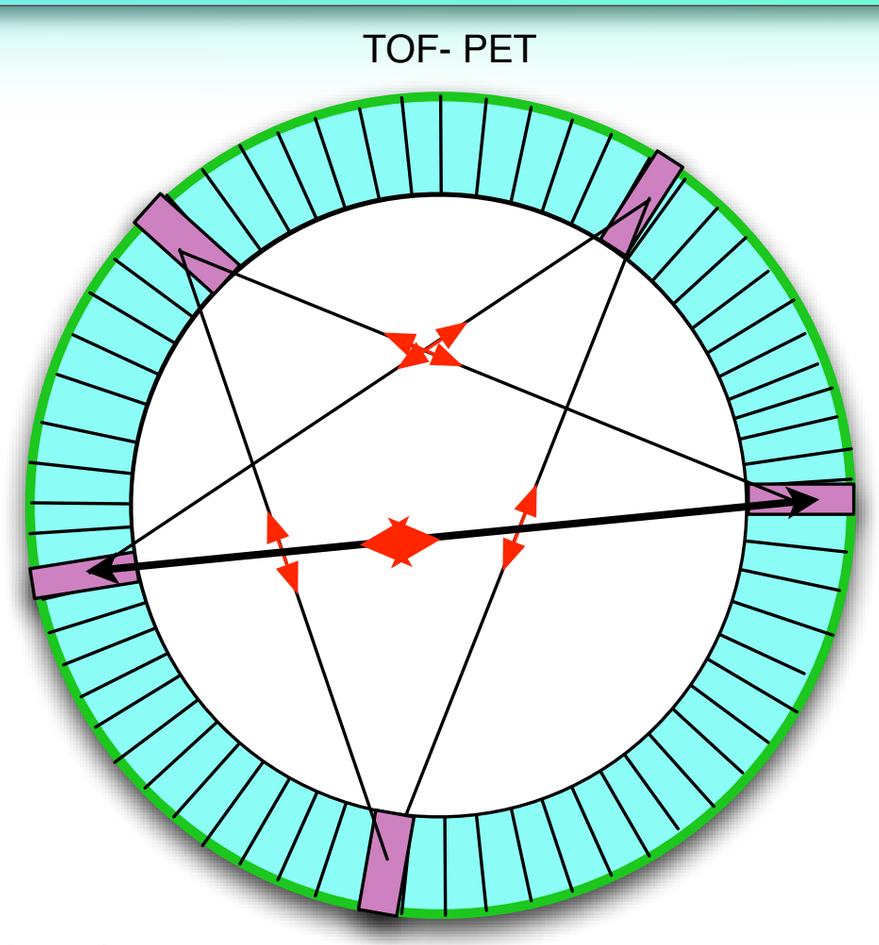
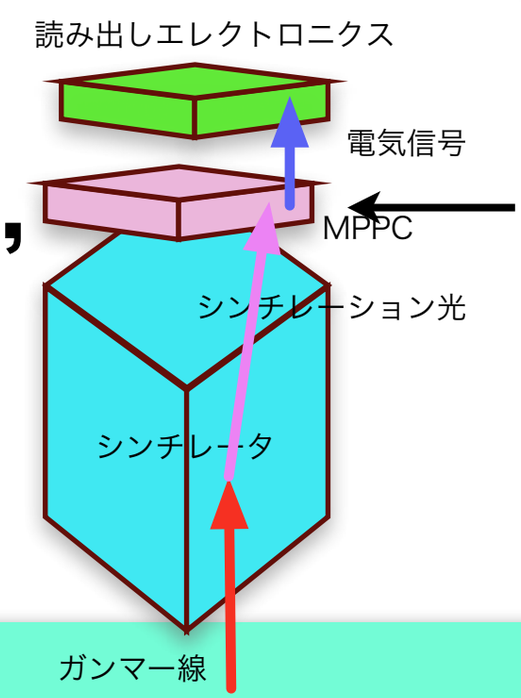


To achieve next PET

- TOF res. ~ 0.5ns (15cm)
  >> 0.1ns (3cm)
  2012 Yamazaki et. al
- reduce BG
  - rapid scint. LFS<40ns
  - rapid MPPC
  - increase clock Freq,
  - reduce rad. dam.





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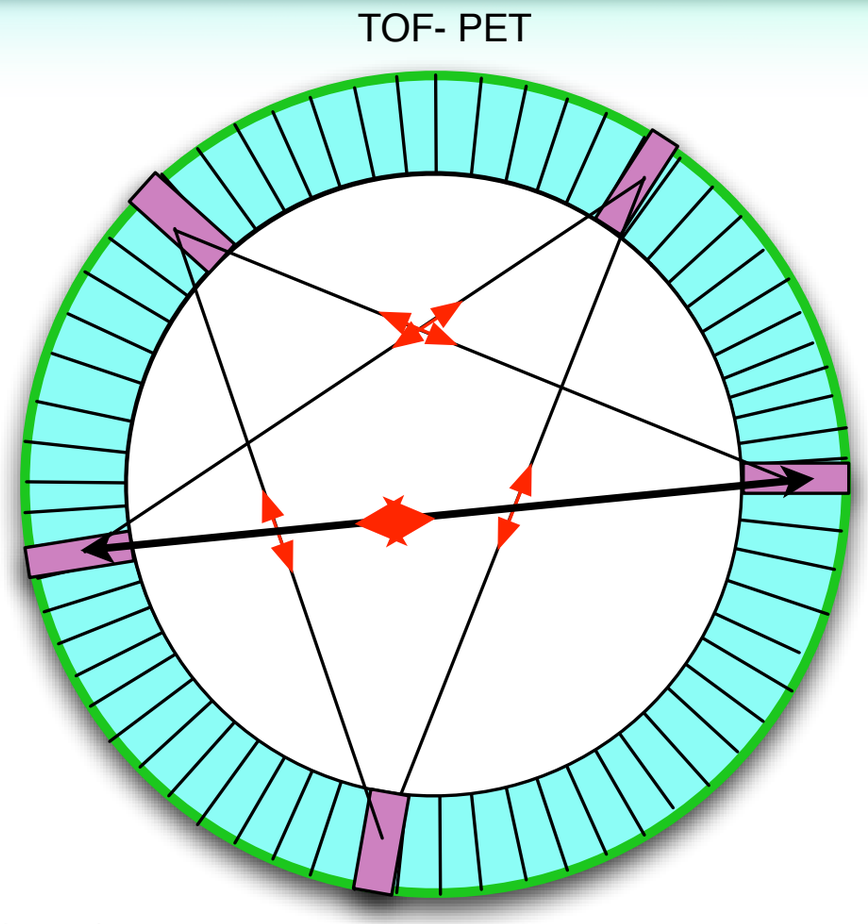
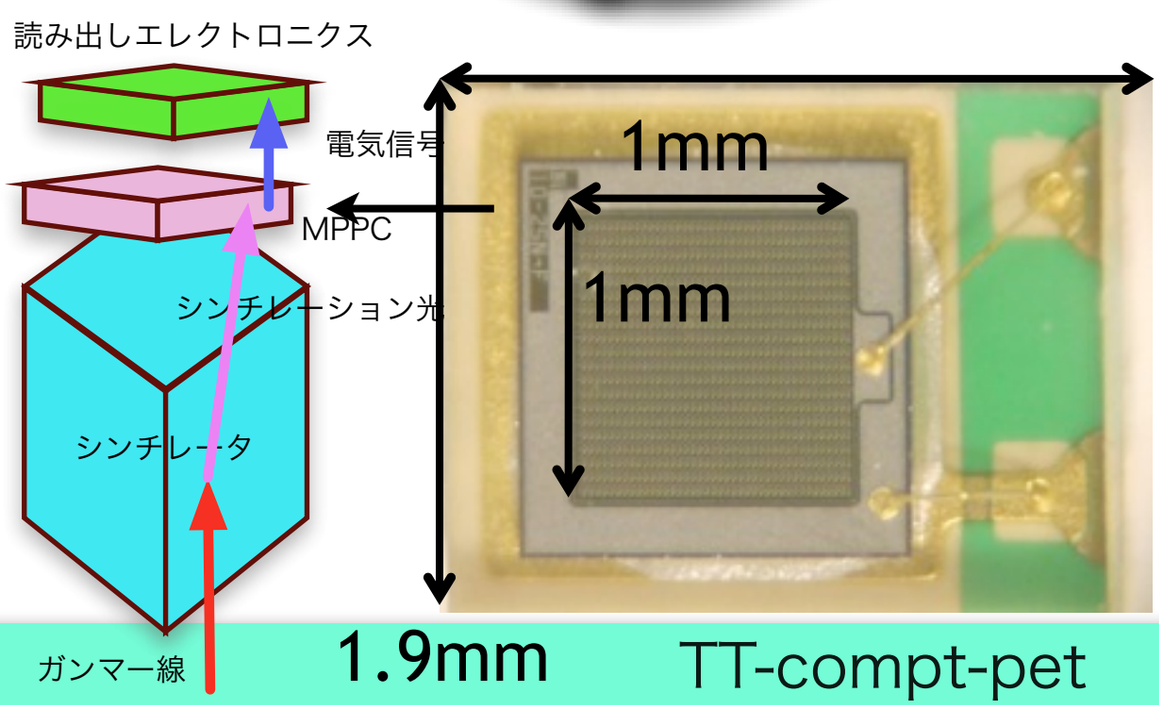
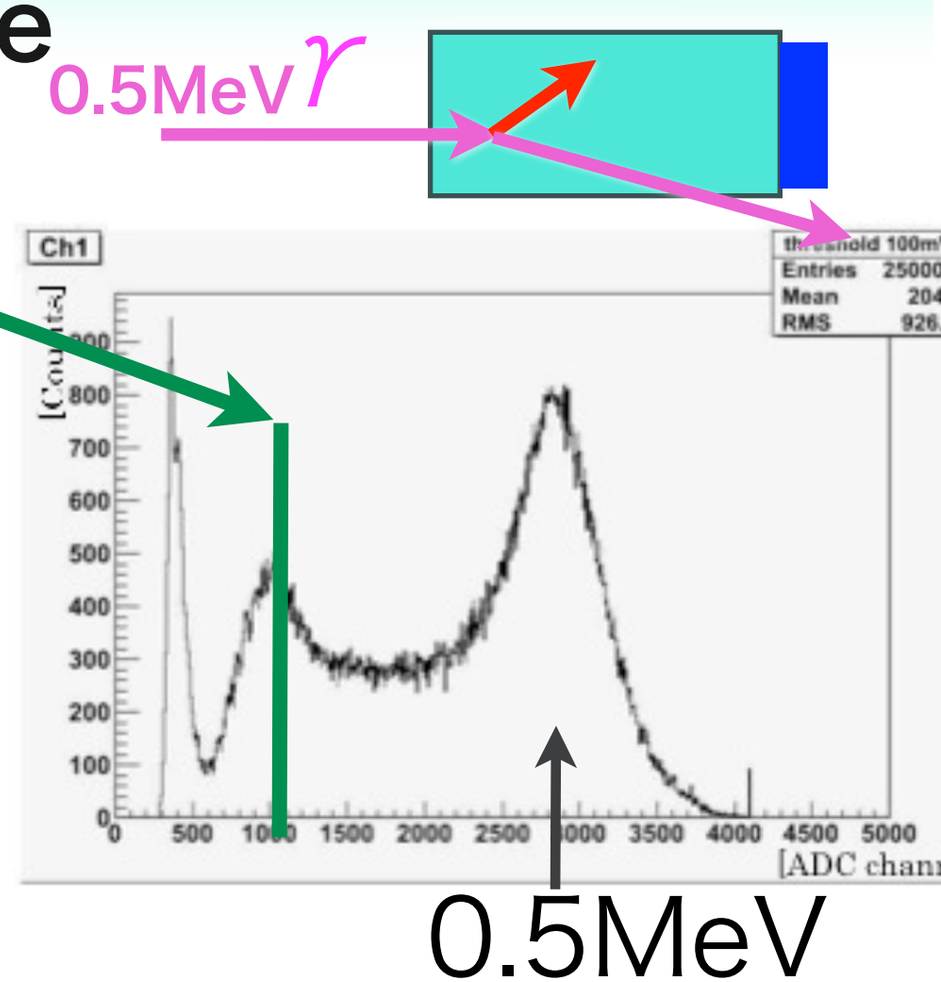
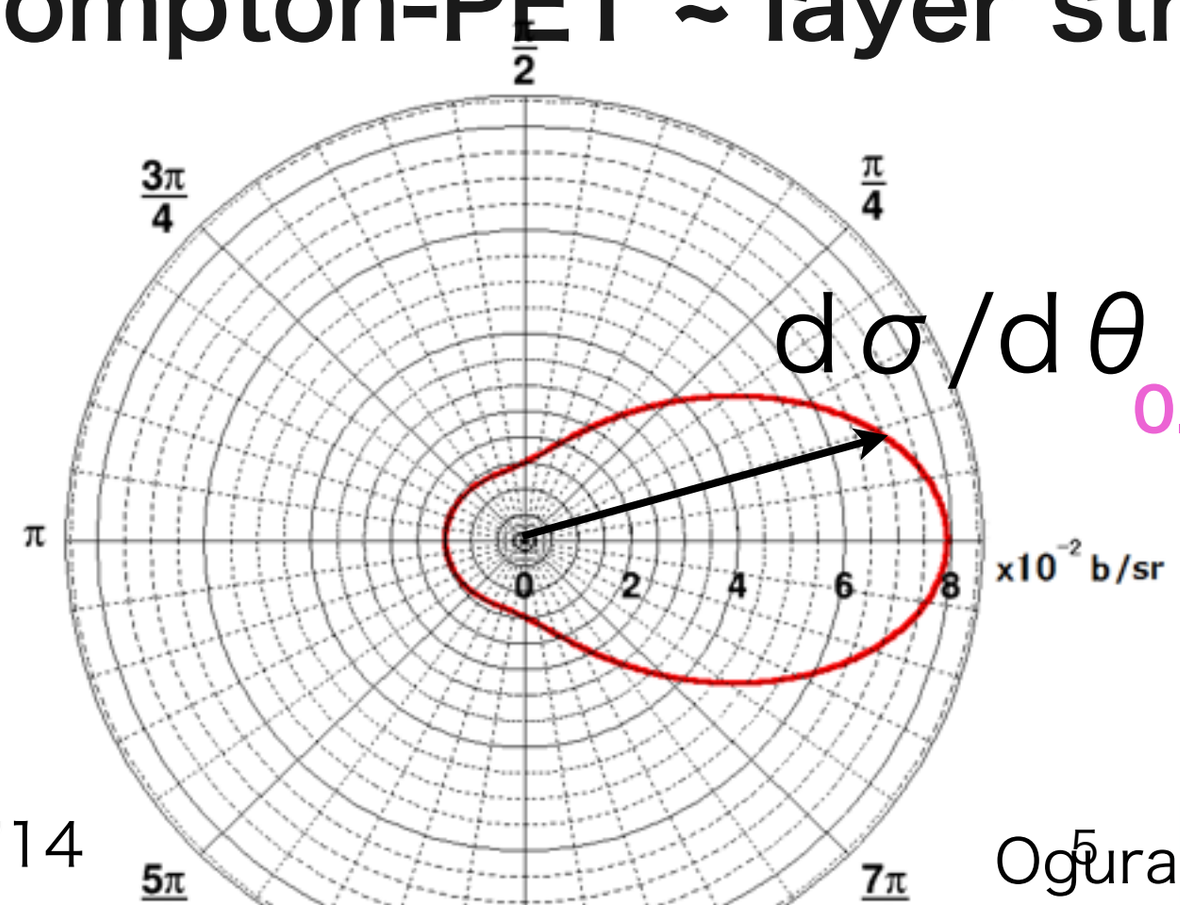


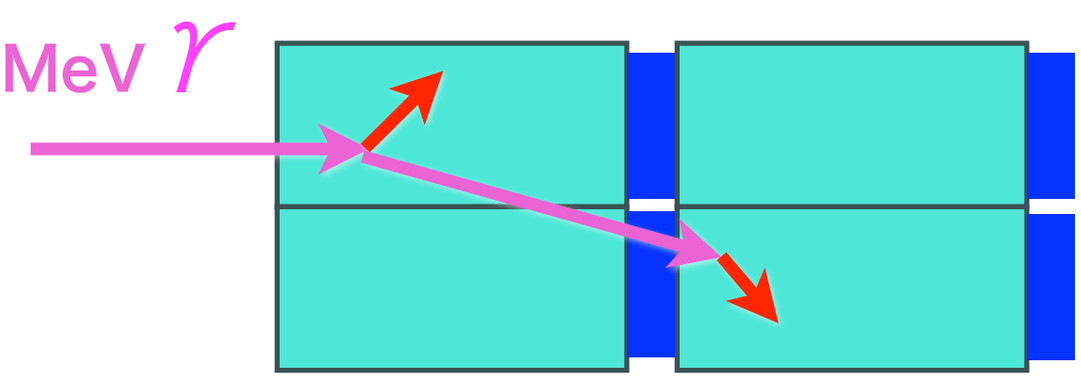


Issues of fine segmented PET

- Compton events could escape
  half/side
- lower threshold with ADC
  current ~ 0.4MeV
- sum of two ~0.5MeV
- Compton-PET ~ layer struct.



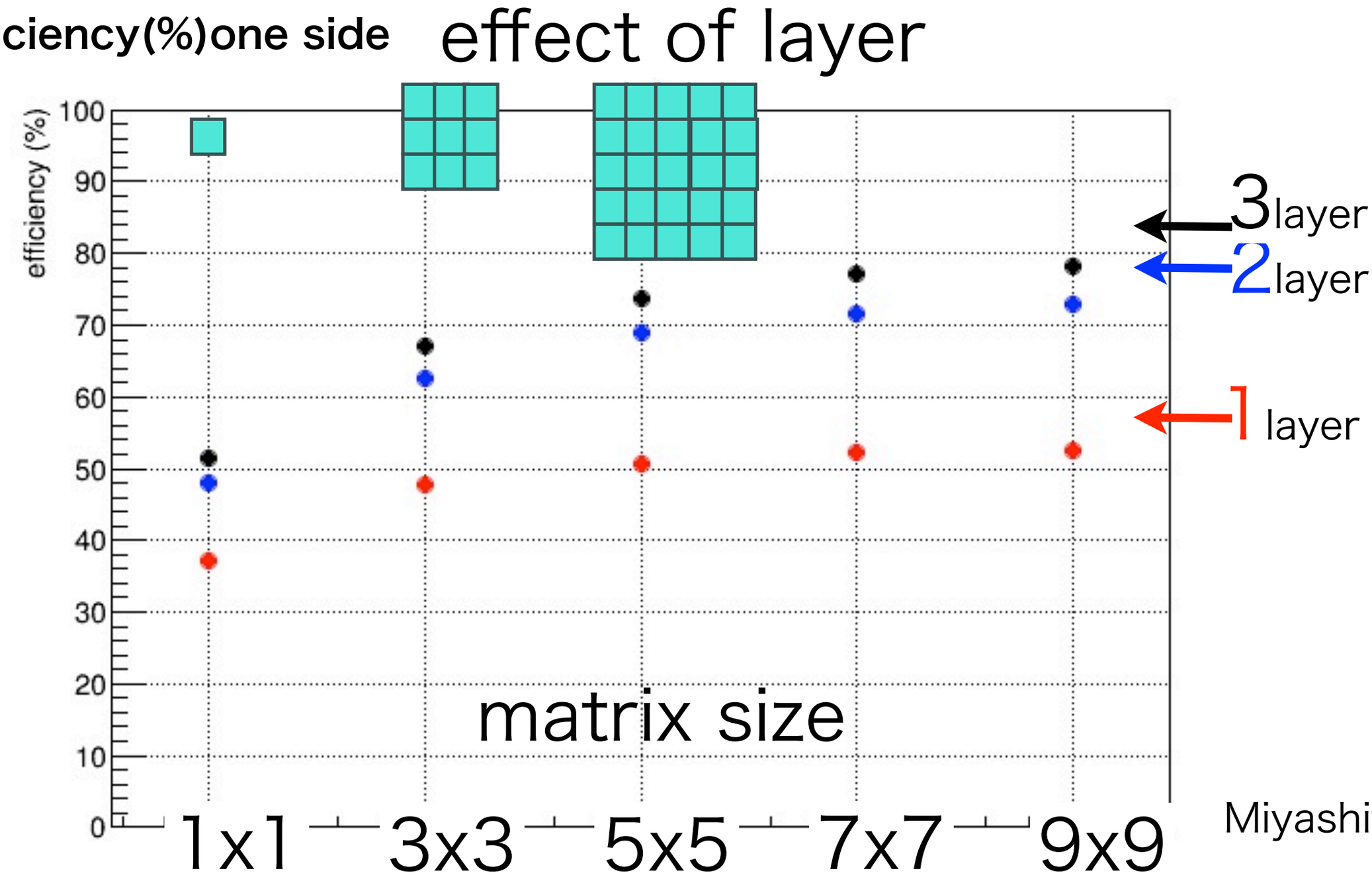




Compton-PET simulation

- 3mmx3mmx15mm LSO scintillator +1mmMPPC

efficiency(%)one side



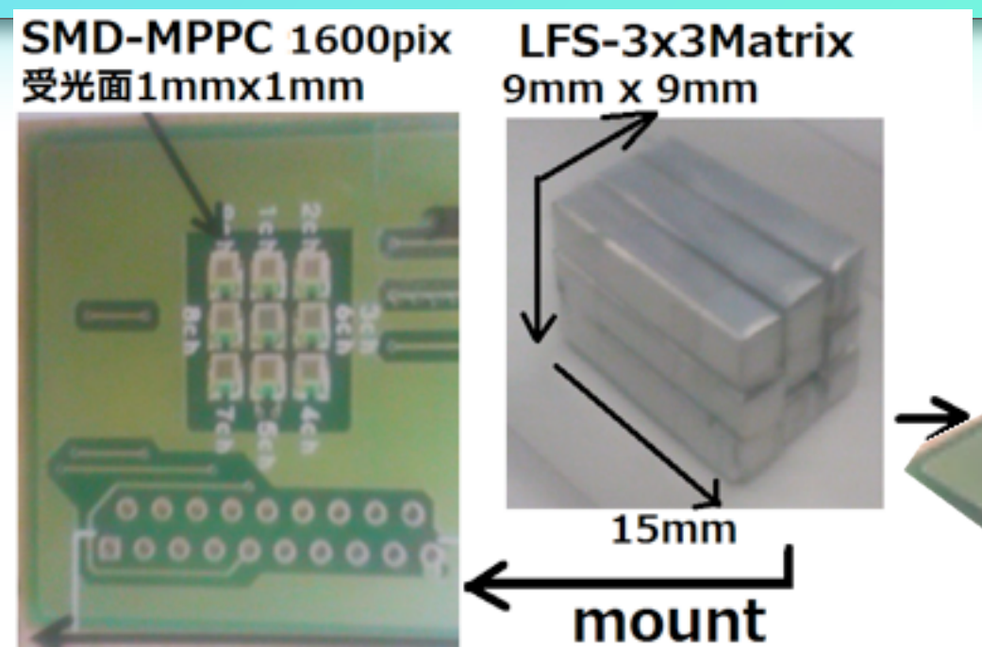
Miyashita

- 2 layers 5 x 5 matrix is good enough around a hit

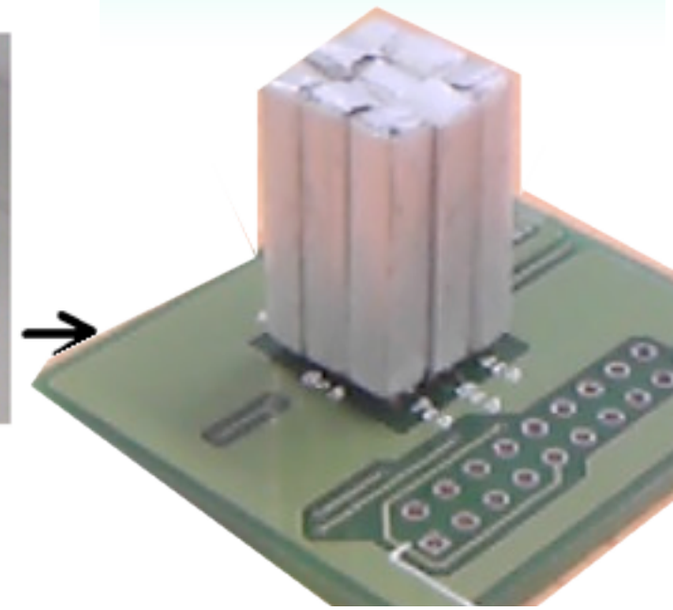
verification of Compton-PET

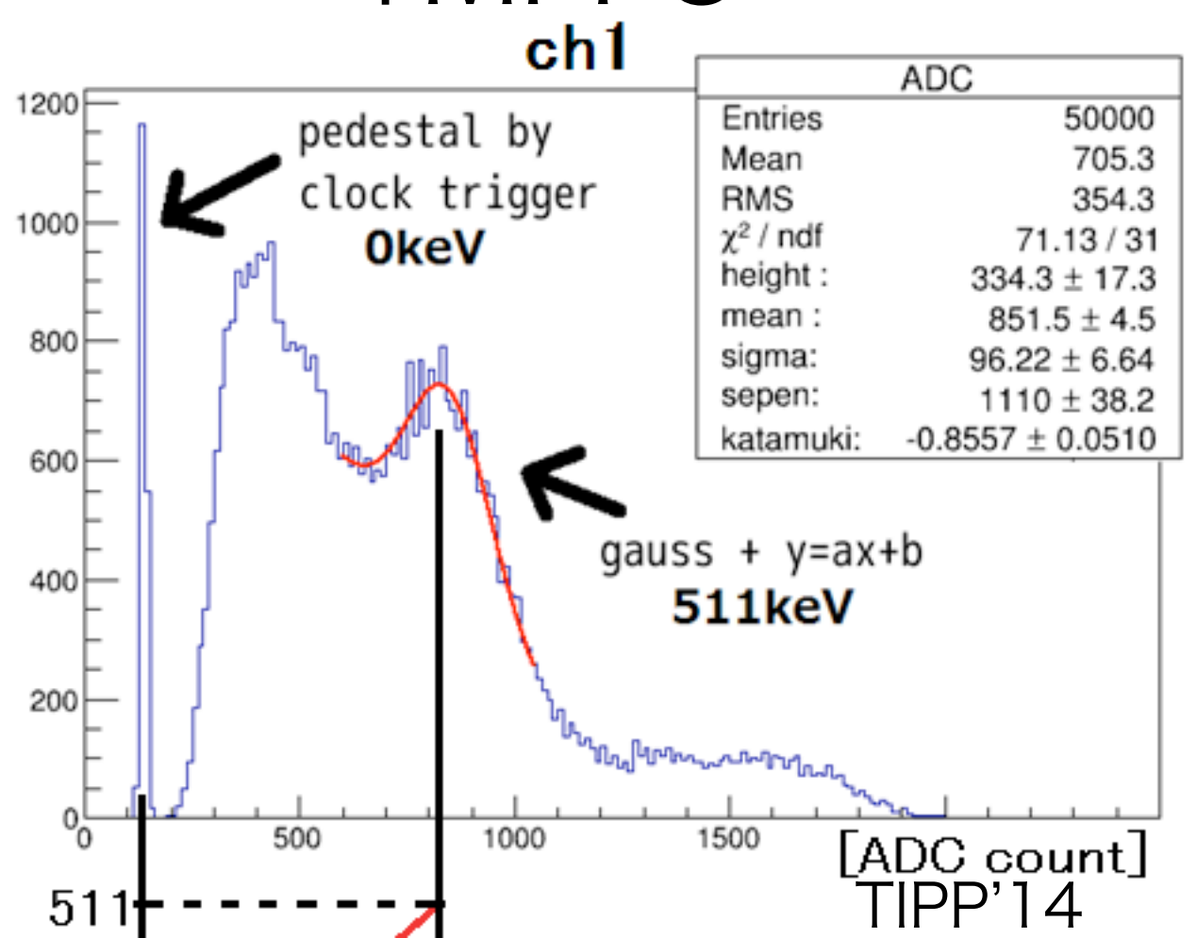
- **setup and calibration**

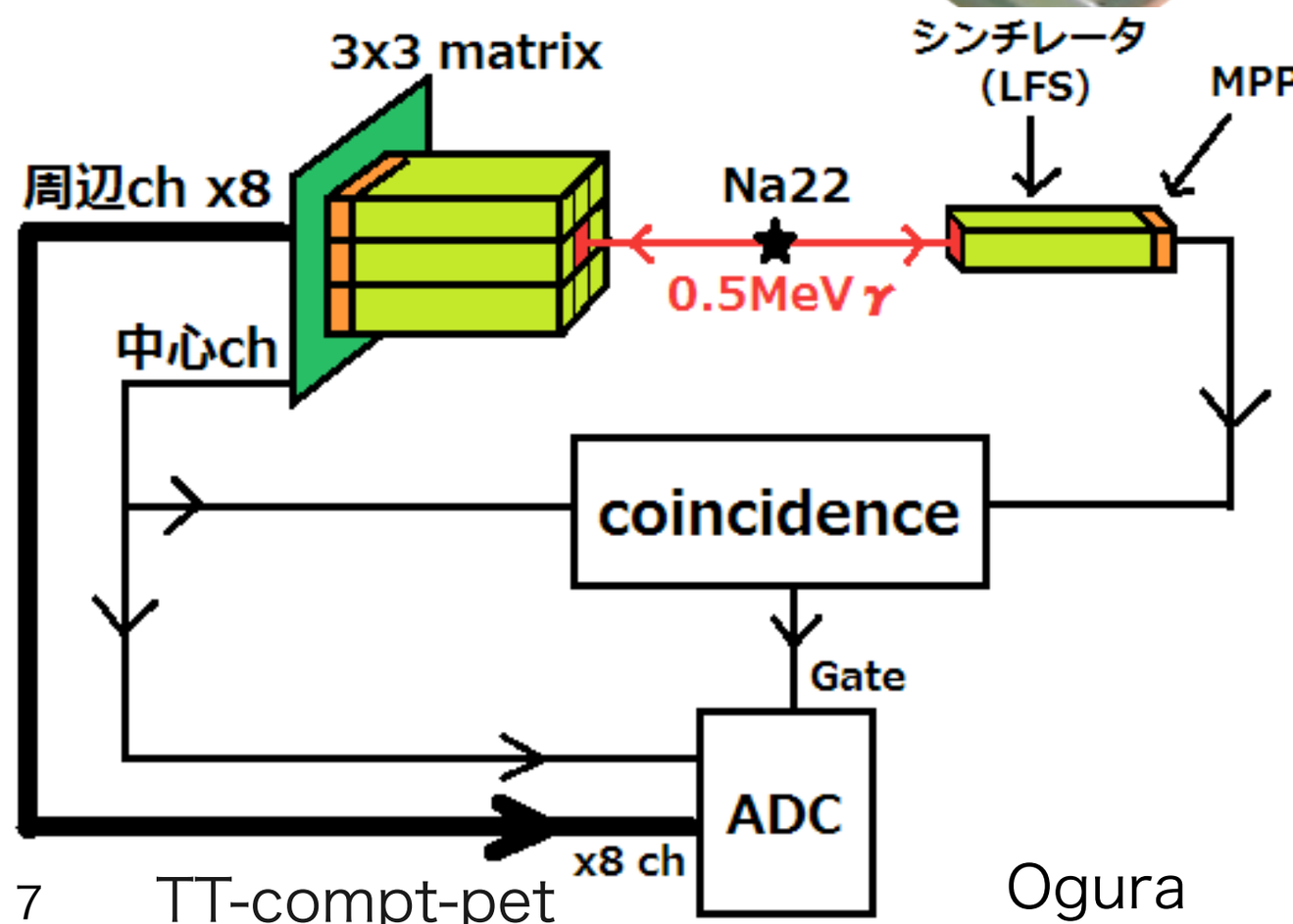
  ^{22}Na e^+ source
  single crystal
  +MPPC



3x3 matrix



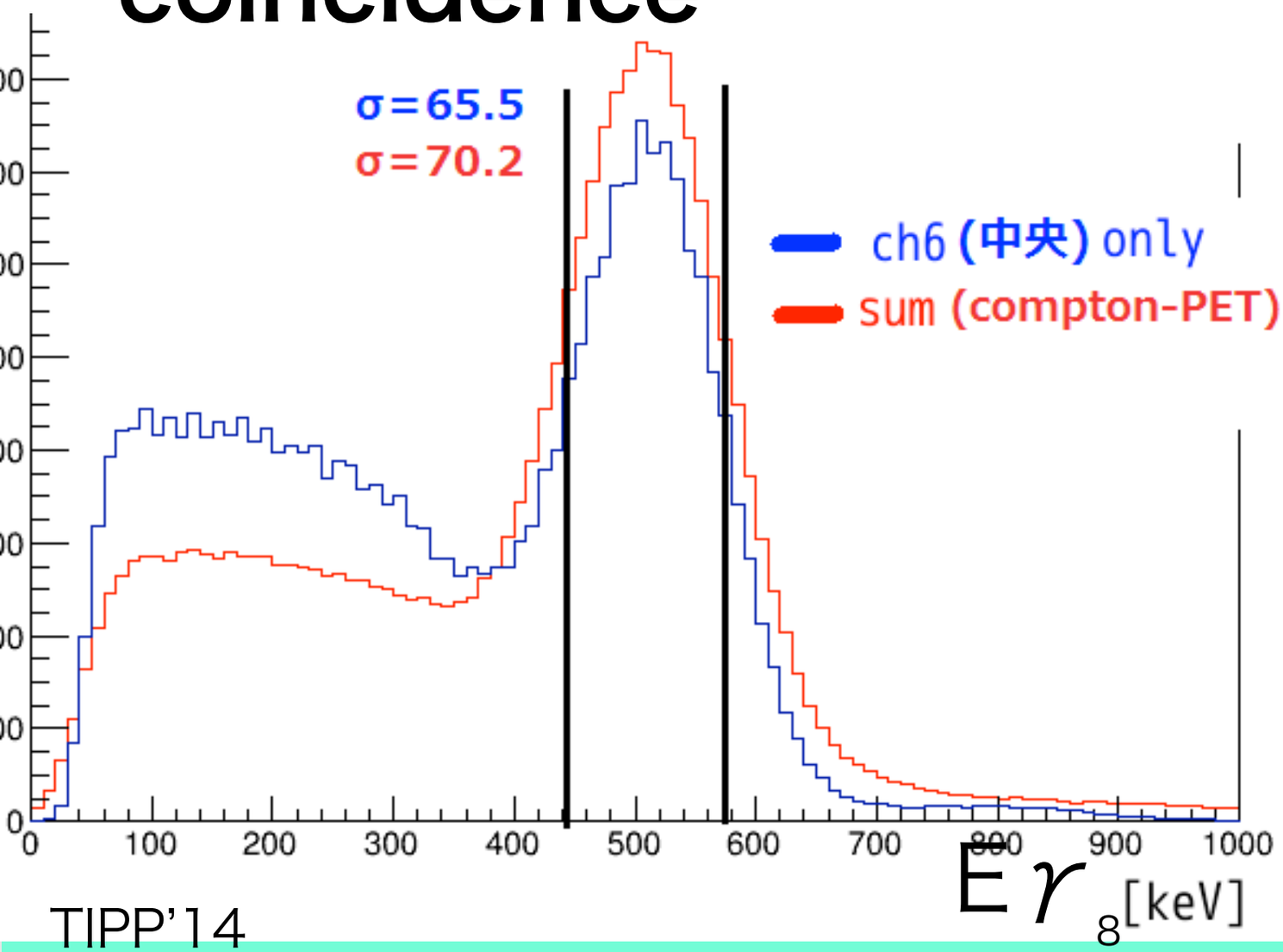


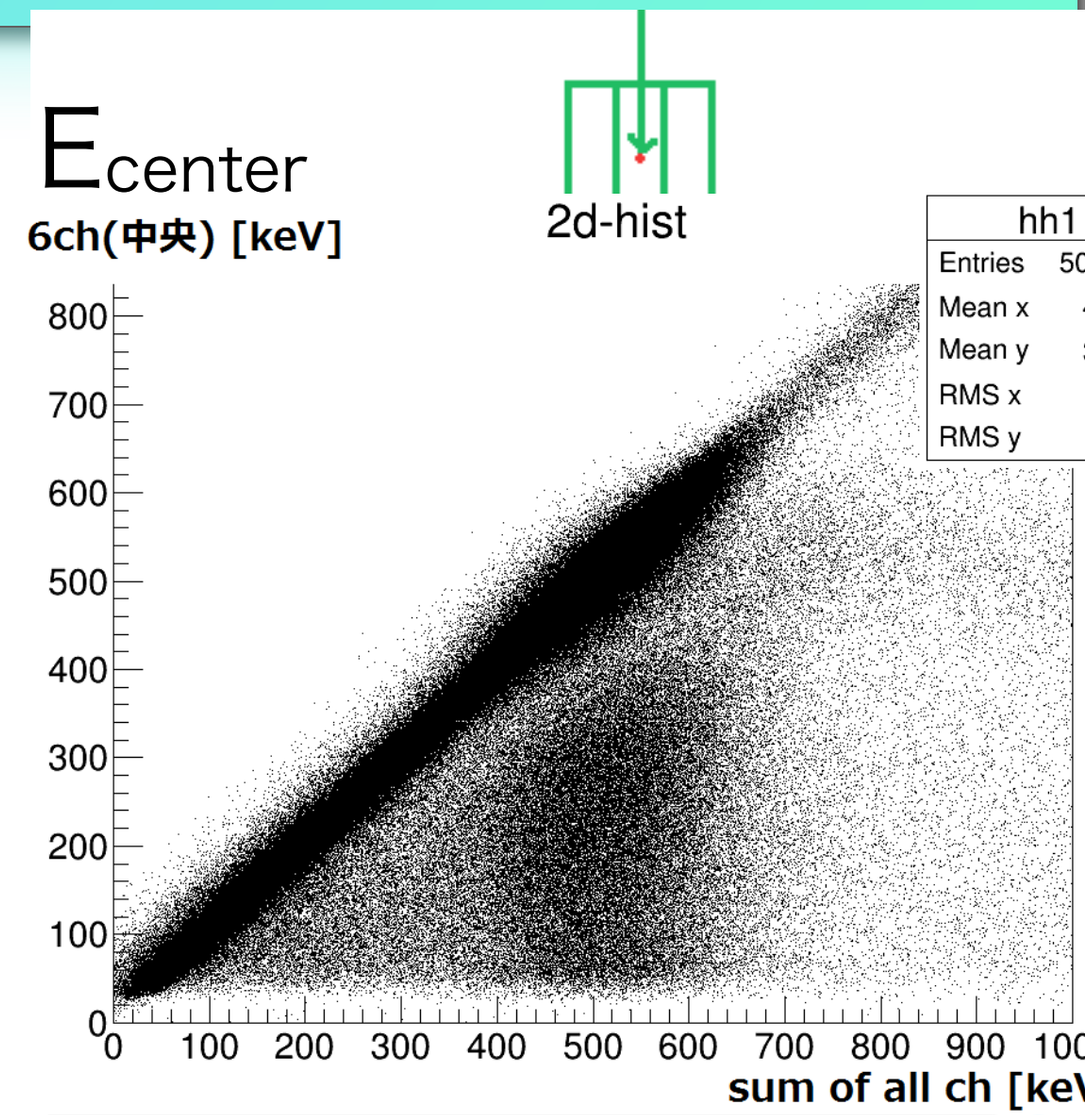


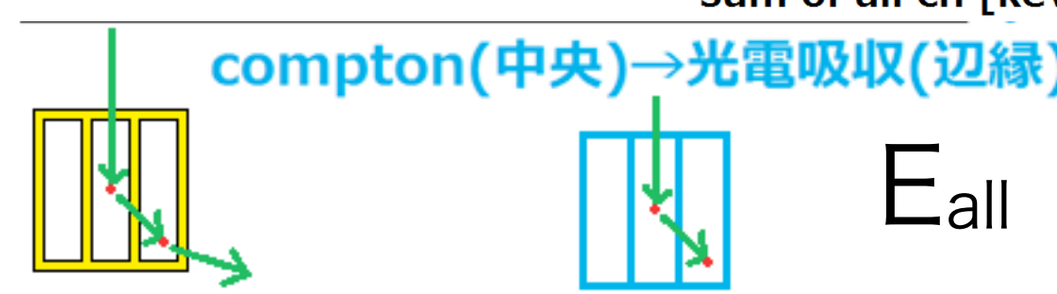
TIPP'14

Compton-PET results

- E_{center} vs E_{all}
- $E\gamma$ distribution
- increase 23% events in the first layer coincidence







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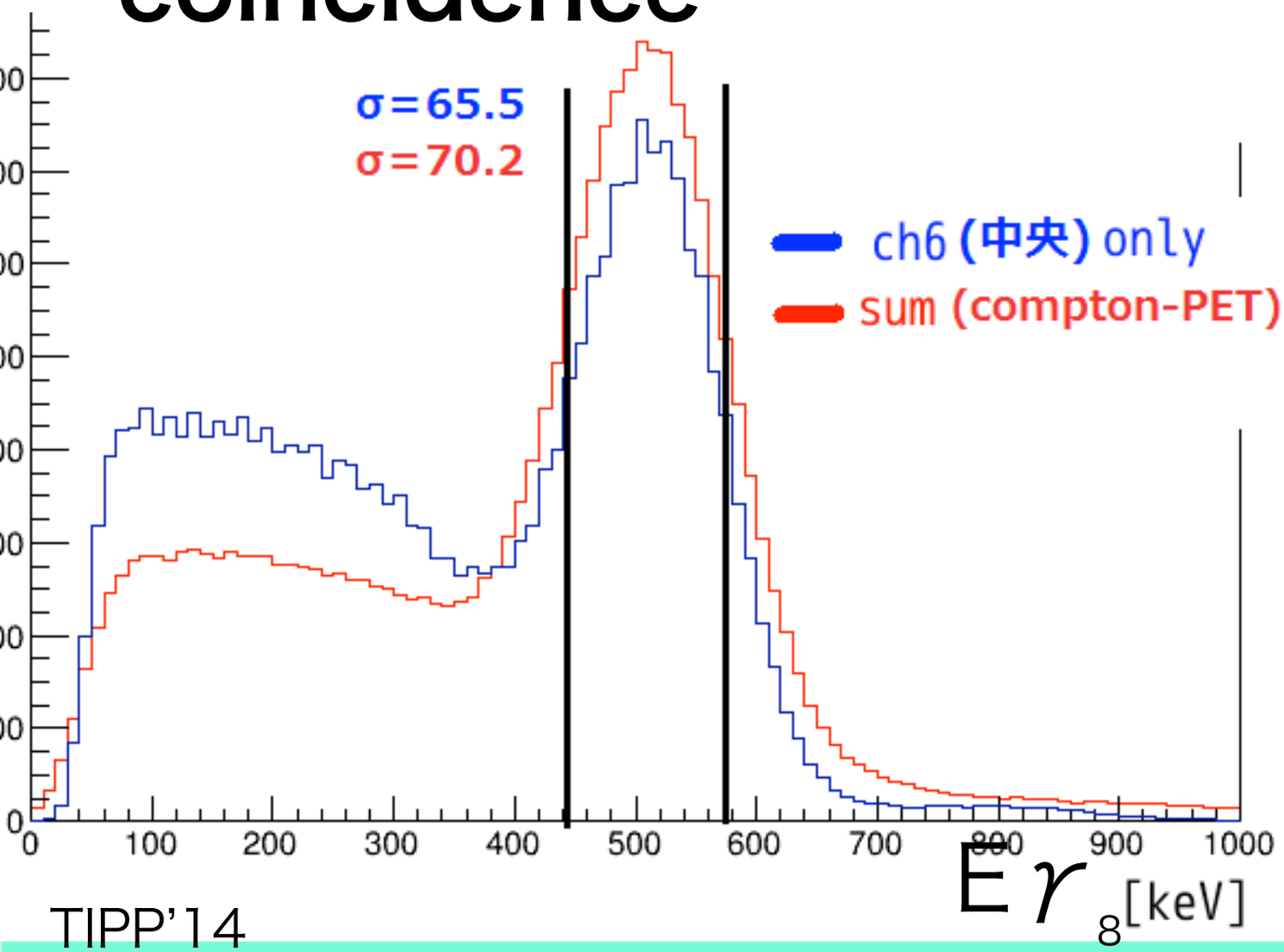
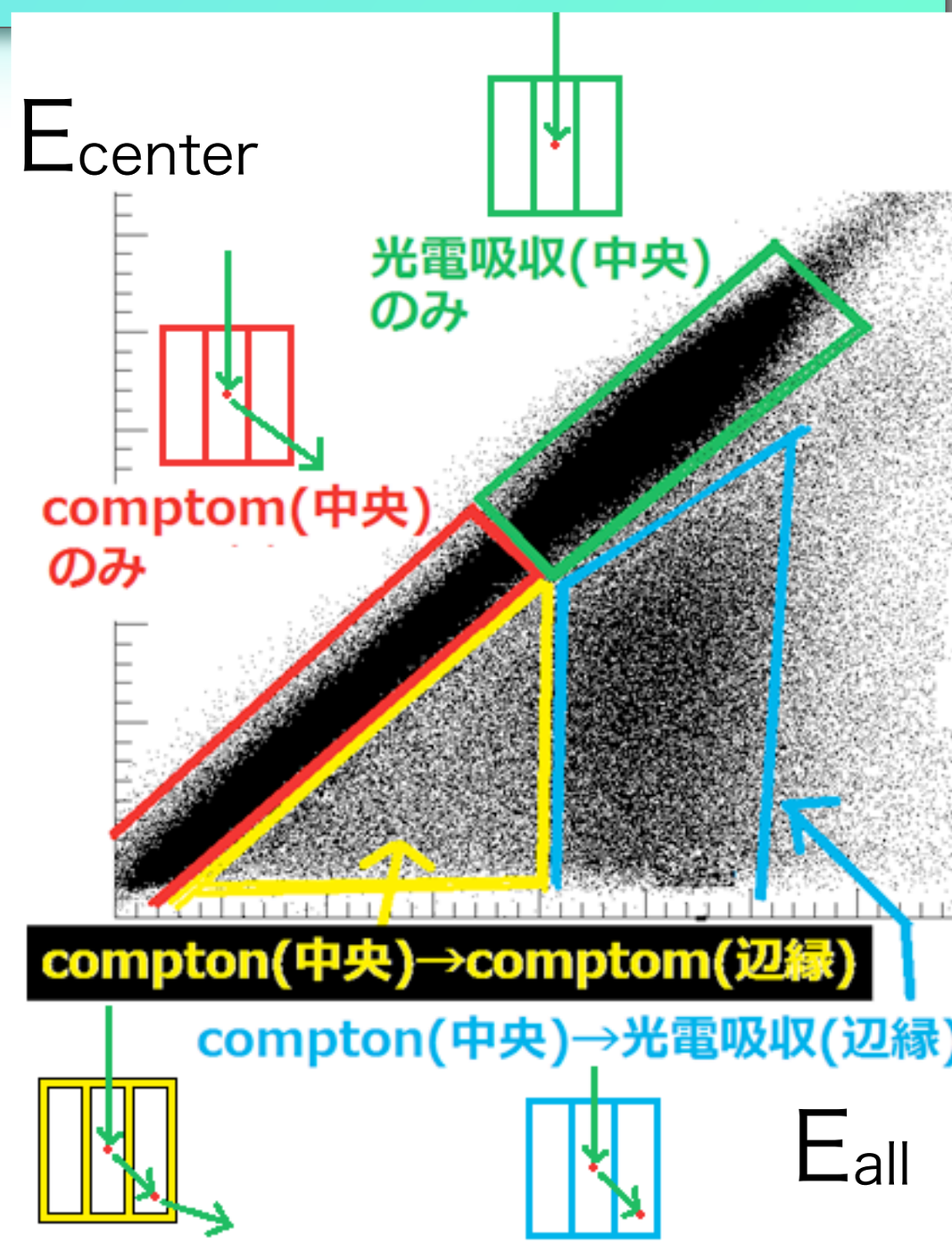
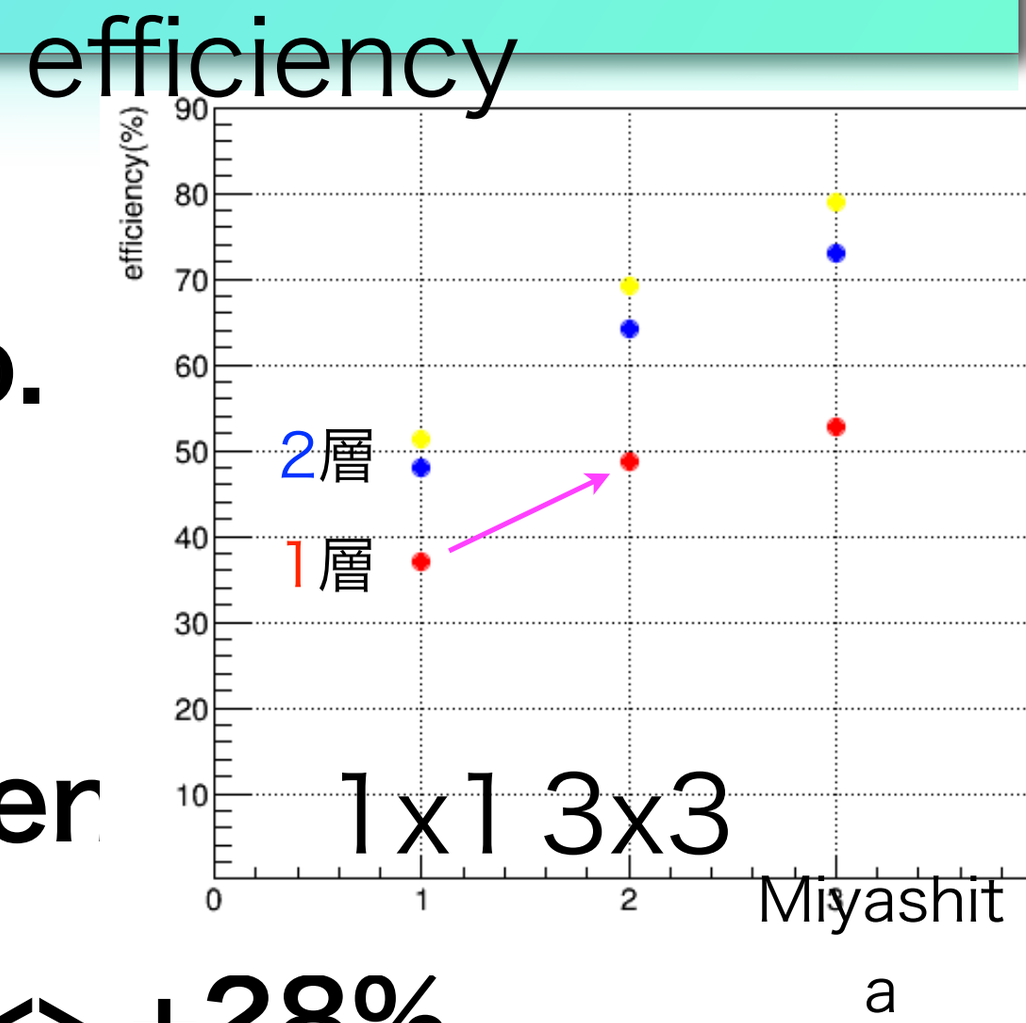




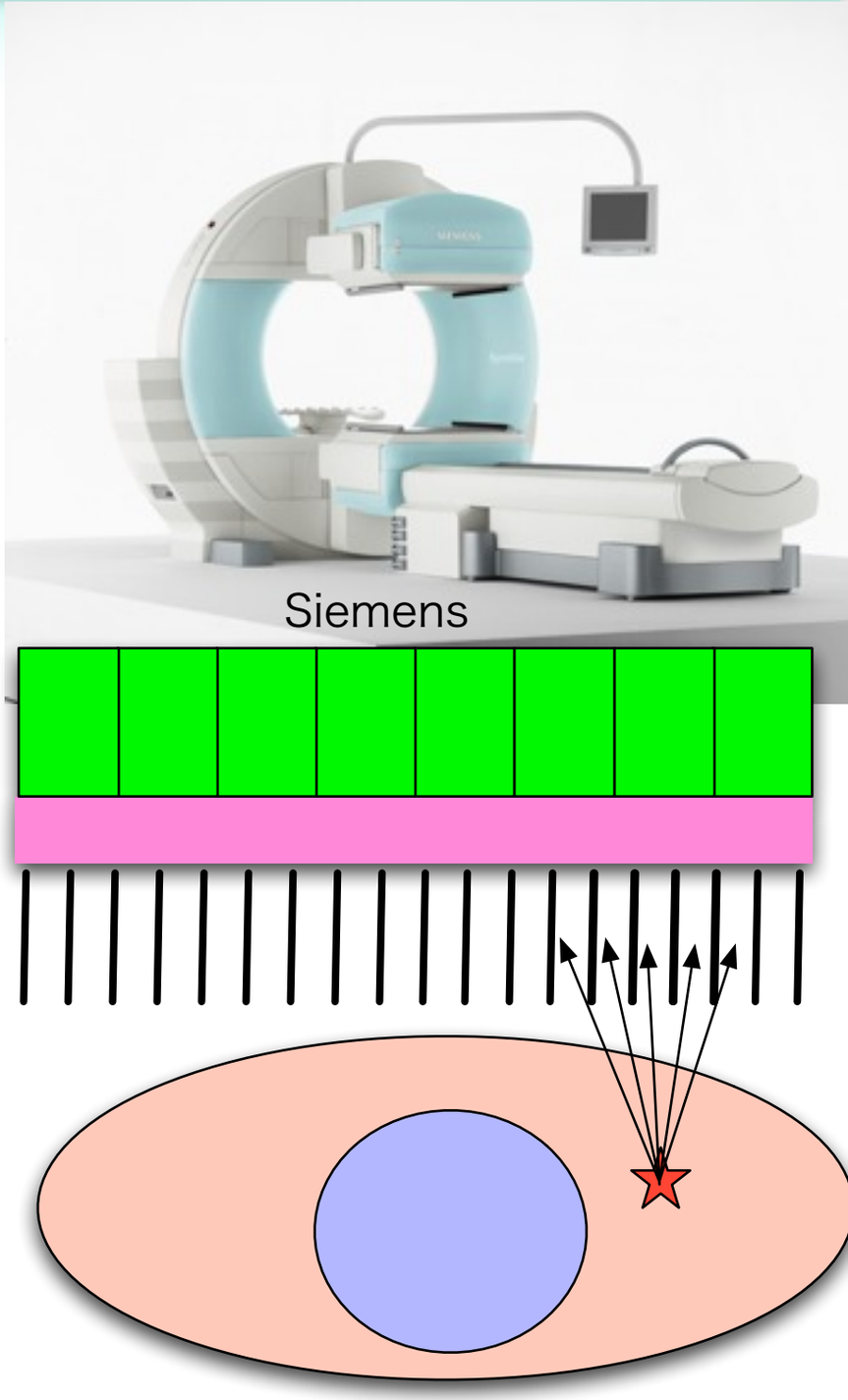
Compton-PET

- fine segmented PET
- good spatial / time reso.
- Compton-PET
- simulation and experimer
- 3x3x1layer +23%(exp) <> +28% (sim)
- 2nd layer will be added



SPECT study

- Single Photon Emission CT
- ~150KeV gamma ^{99m}Tc
- photo-electric absorption
- with collimator
- small scintillator +MPPC
- independent R/O : HEP
- better spacial resolution
  5mm >> 1mm
- BG free : rapid circuit



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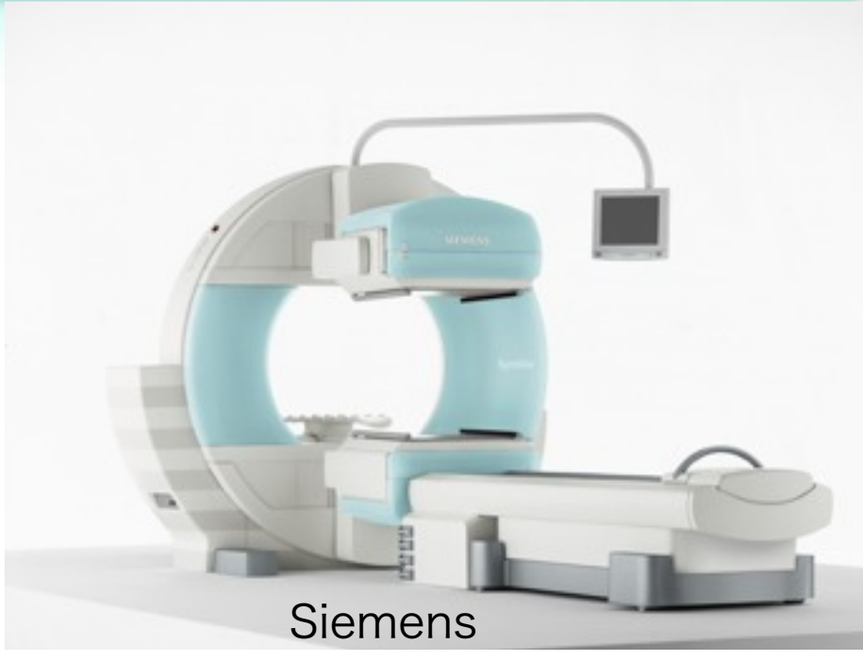
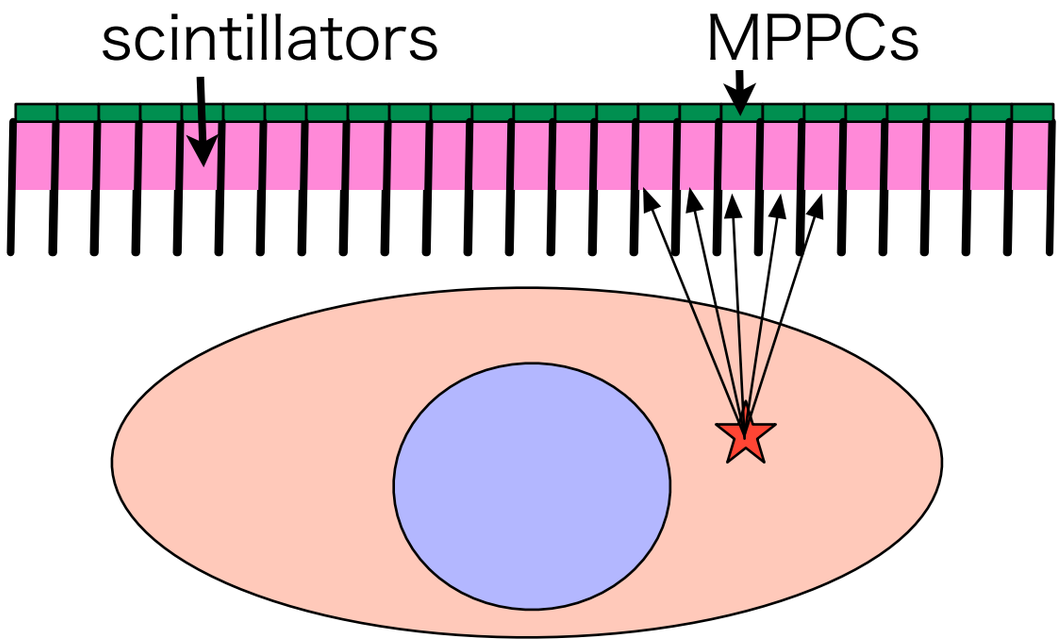
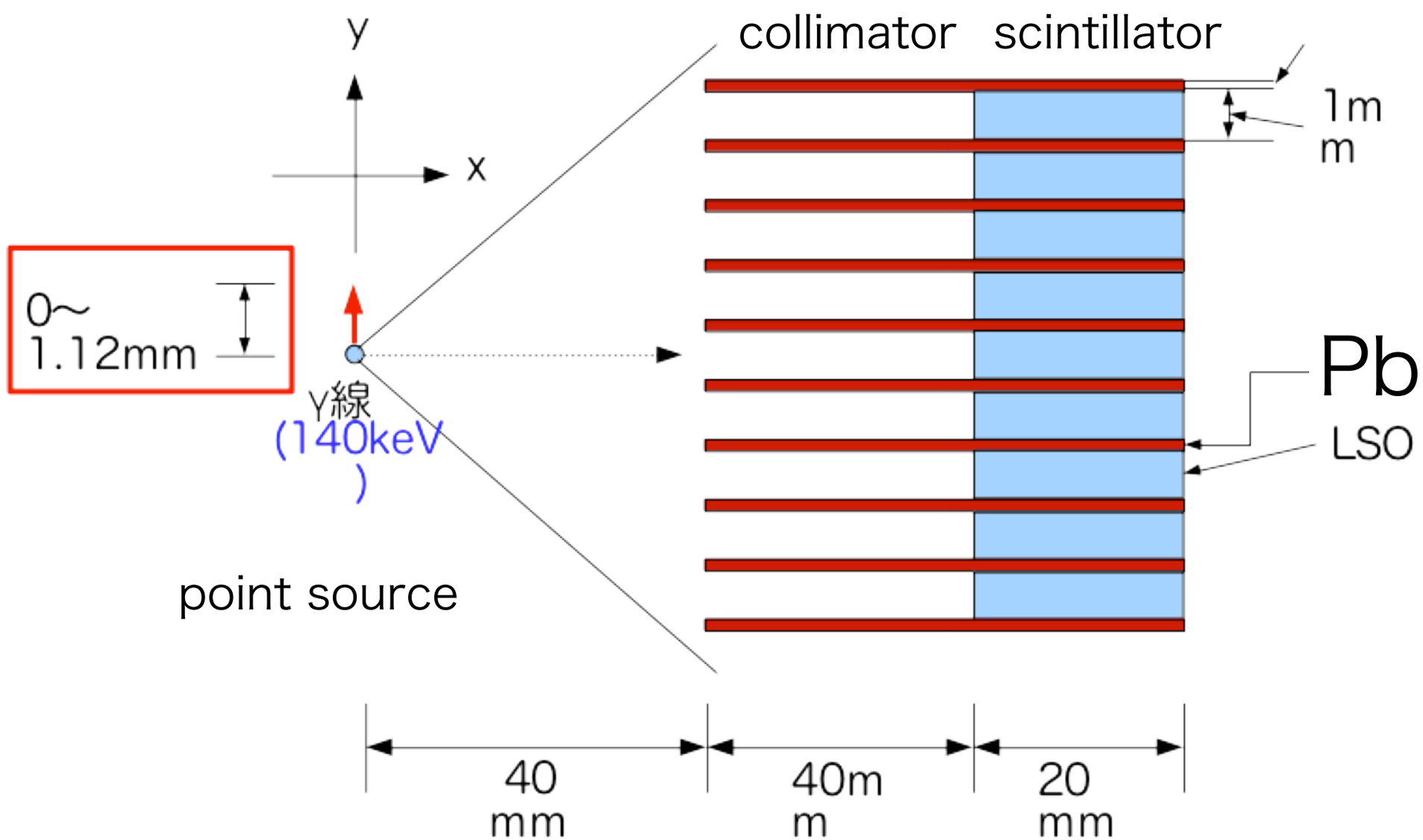




SPECT sim.

Sako

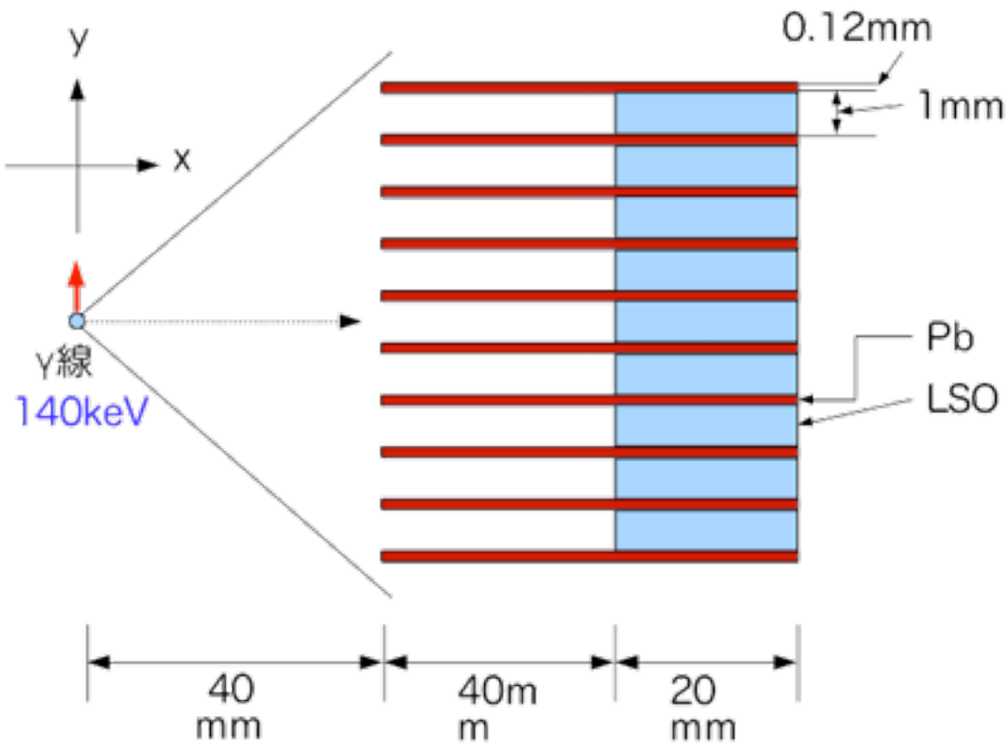
- sim. set up with 9x9 matrix

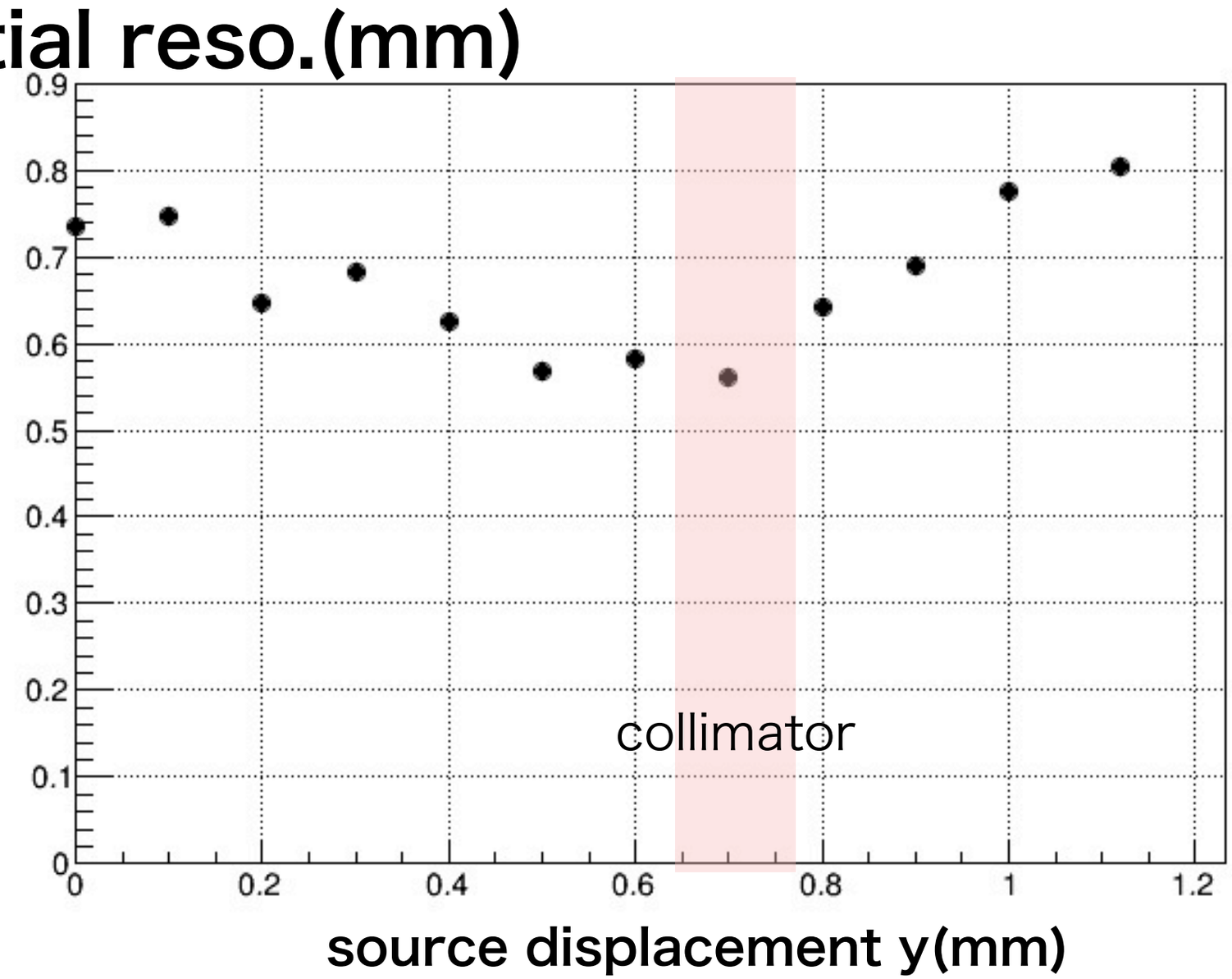


sim. spatial reso.

Sako

- in y direction : ~0.7mm

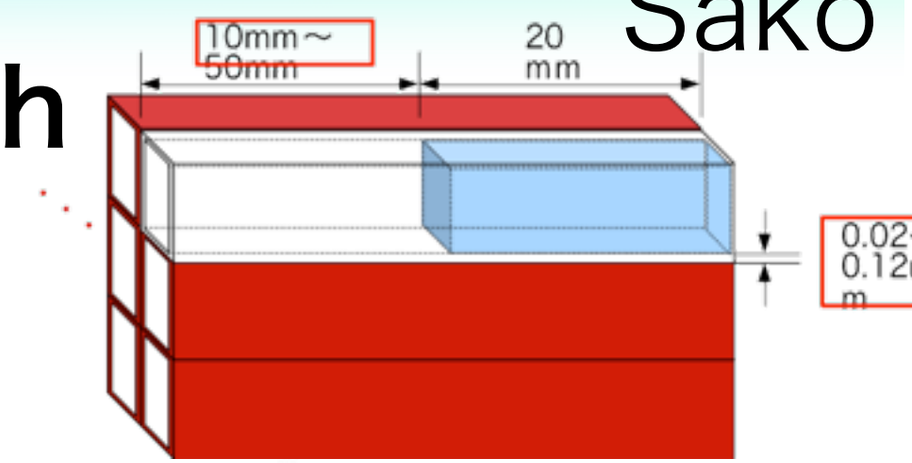




sim. collimator length

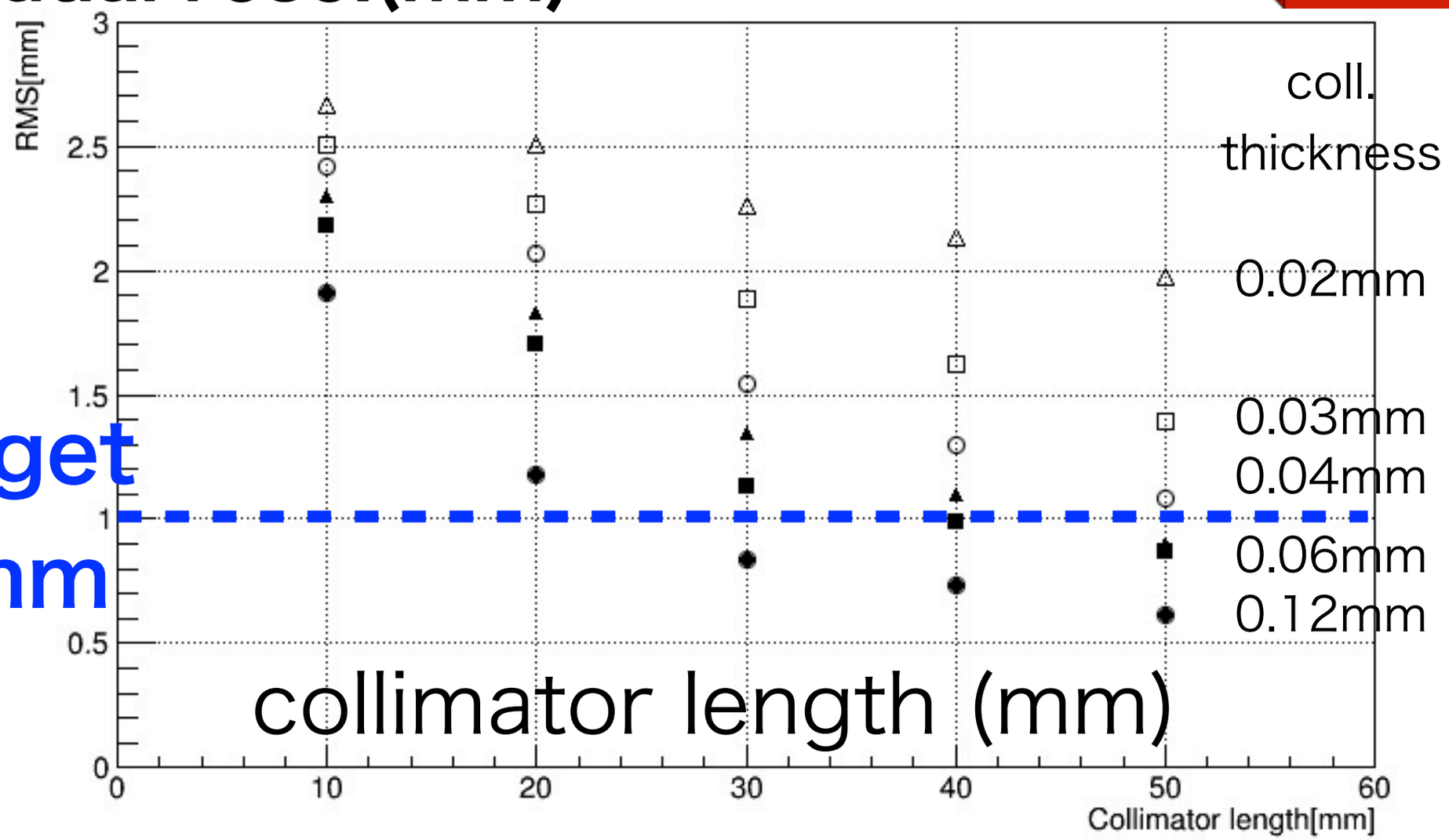
Sako

- spatial reso. vs coll. length



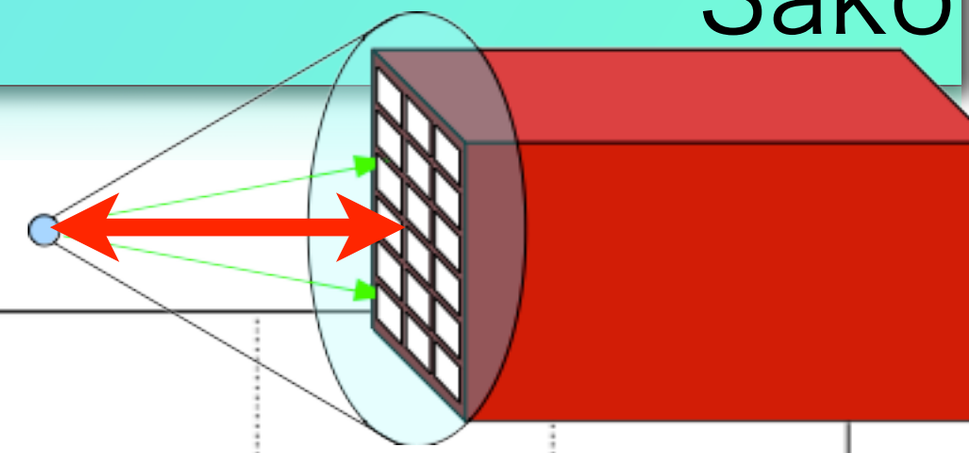
spatial reso.(mm)

target
1mm



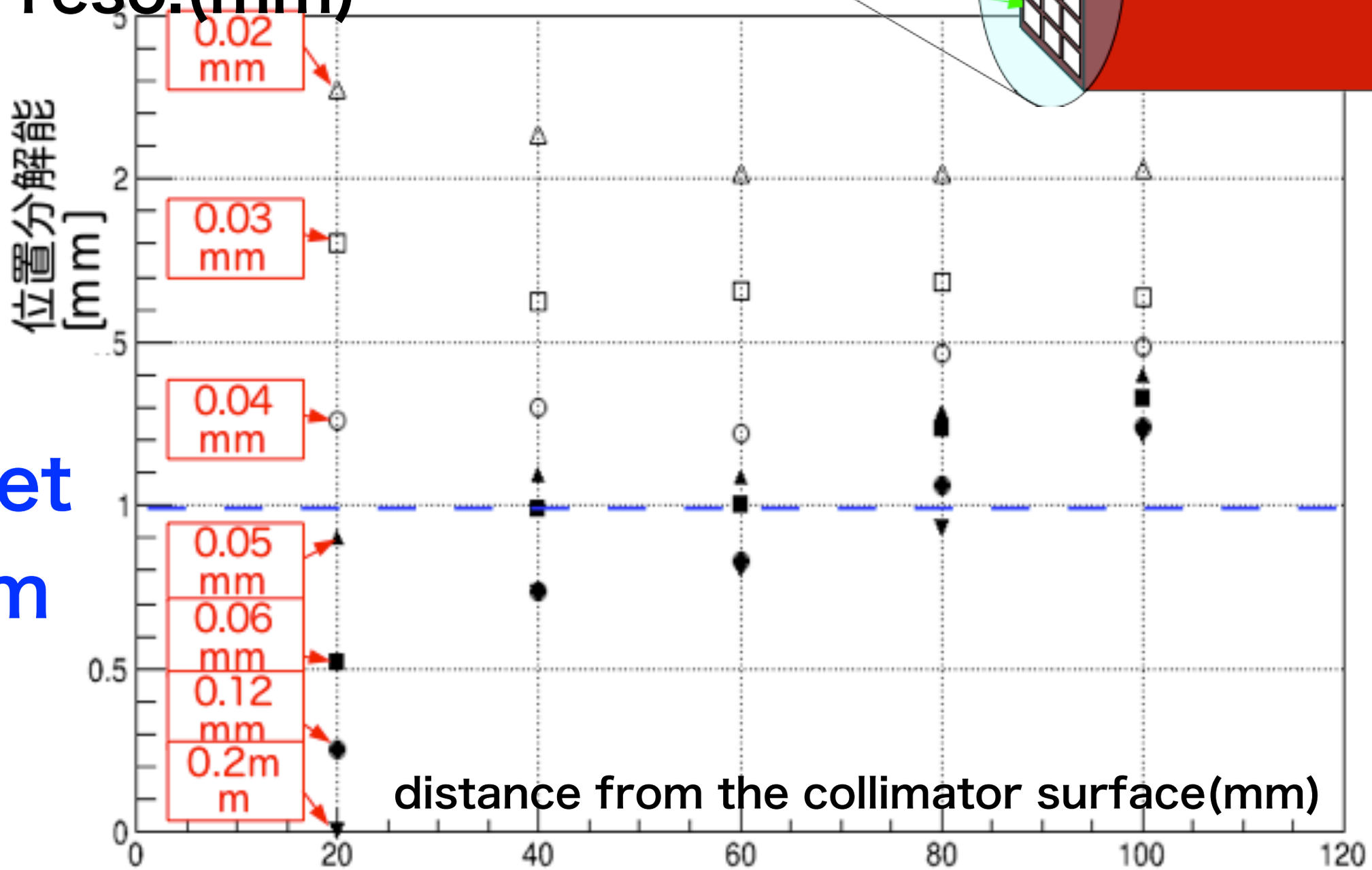
sim. distance from surface

Sako



spatial reso.(mm)

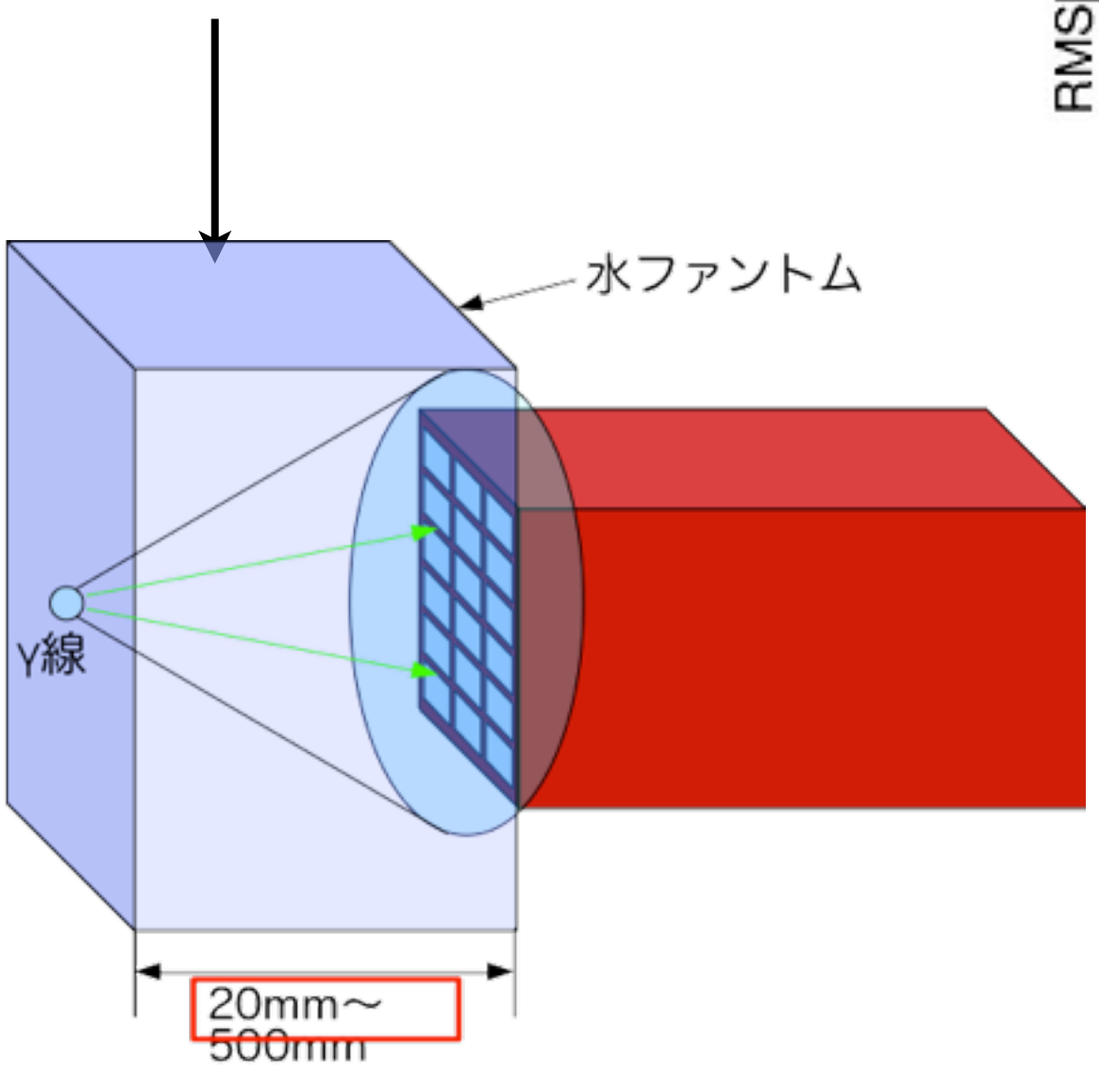
target 1mm

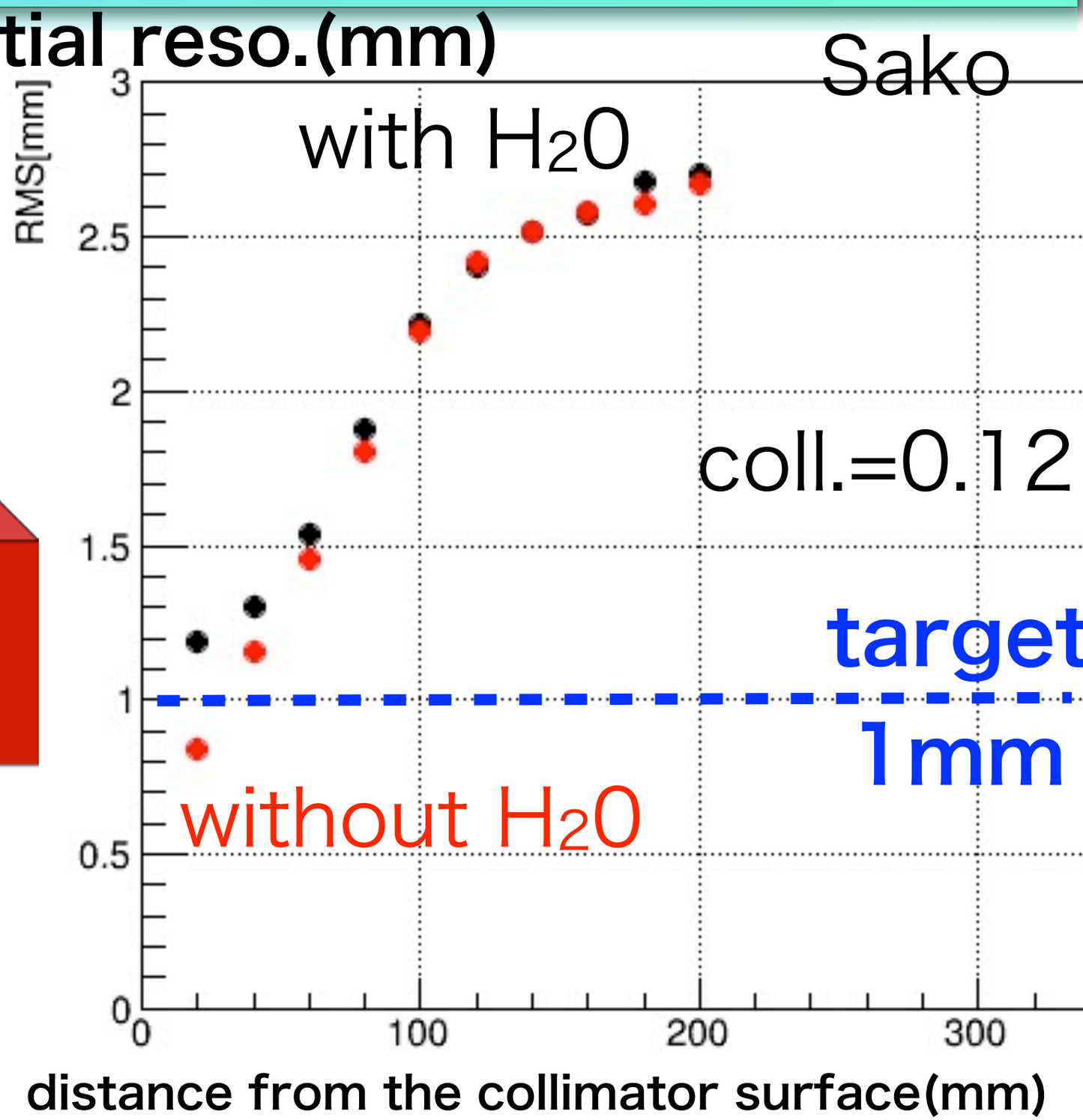


collimator thickness

sim. water phantom

- H_2O phantom

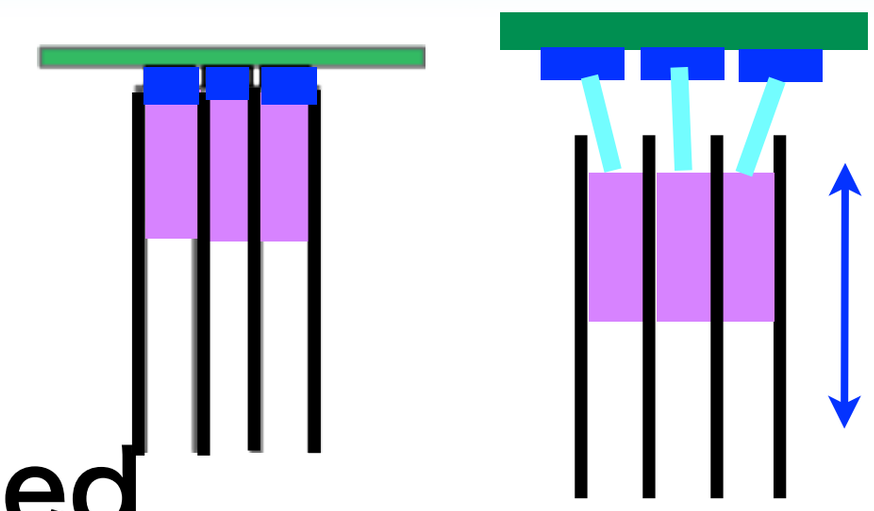




SPECT test exp.

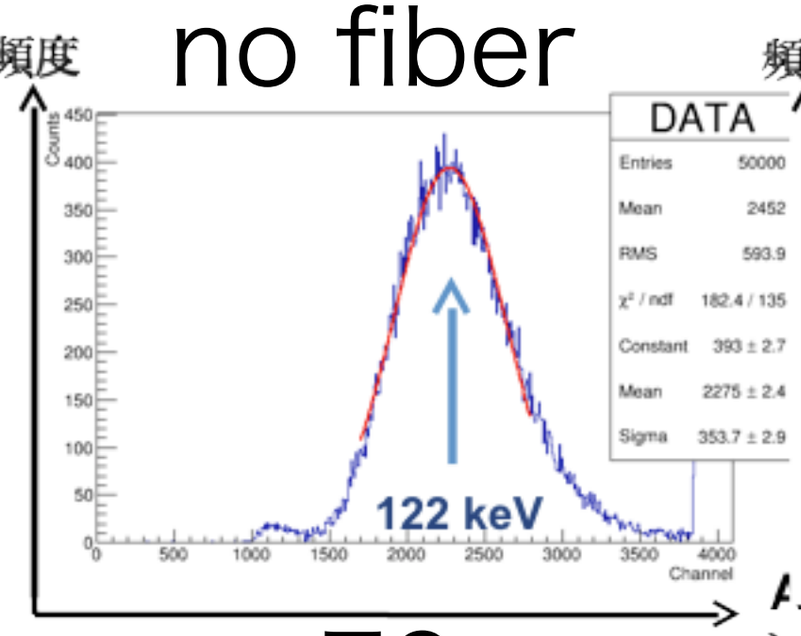
Tsuchimoto

- LSO 1mmx1mmx20mm
- MPPC 1mmx1mm
- with clear fiber connected



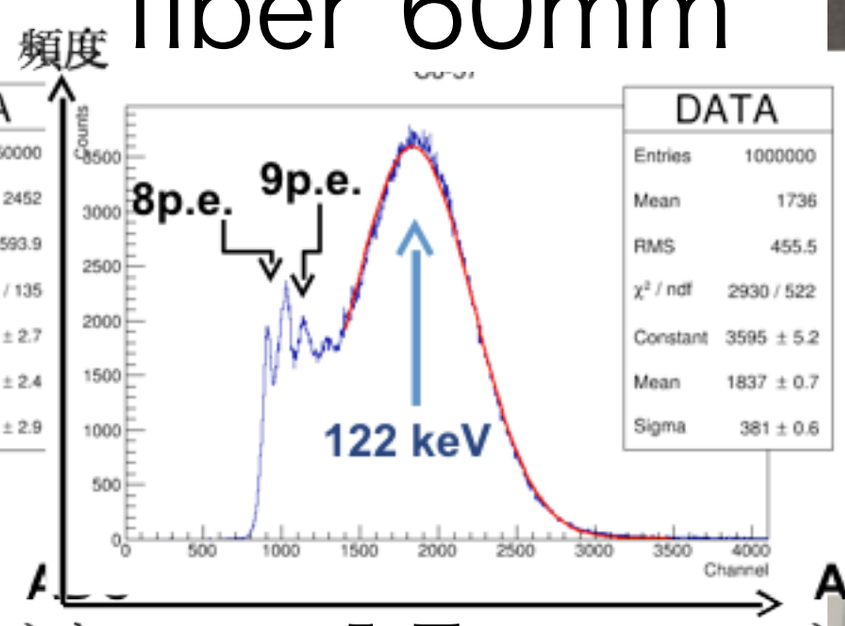
collimator 0.18mm

no fiber



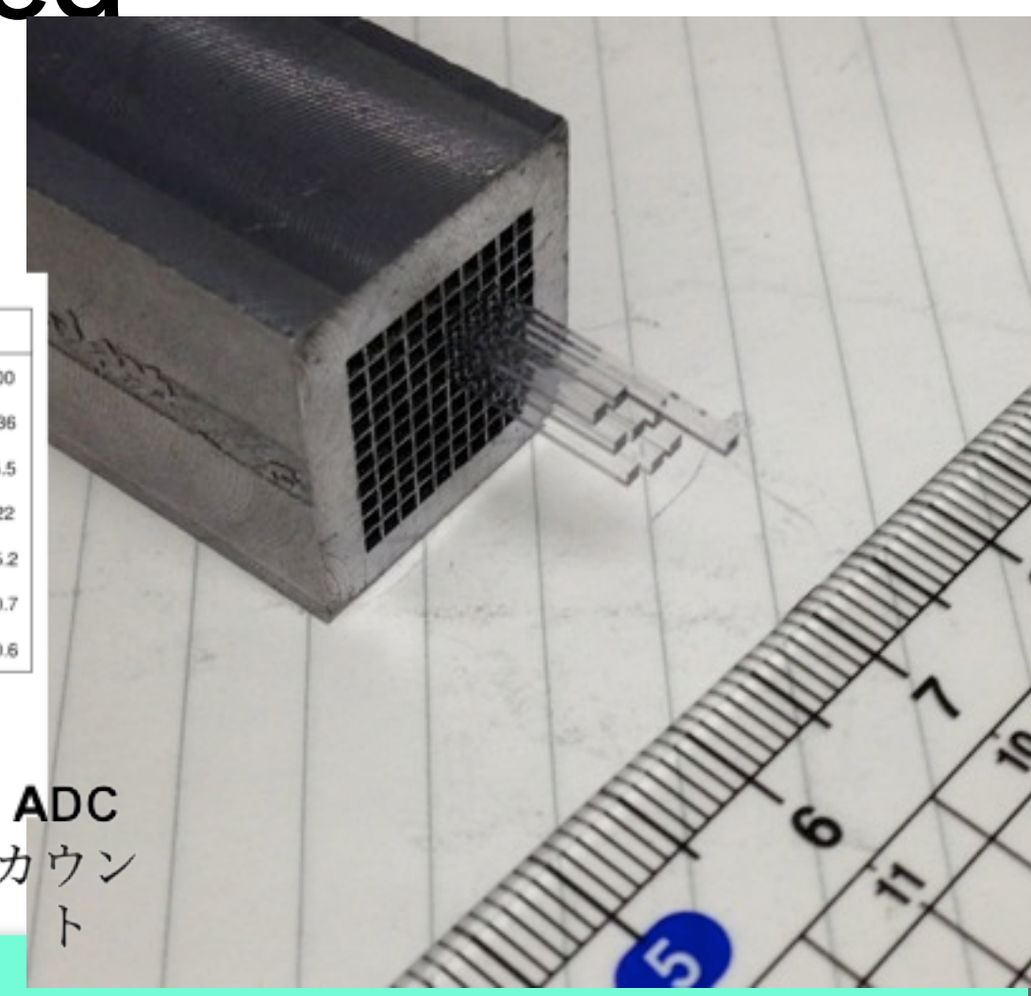
70p.e.

fiber 60mm



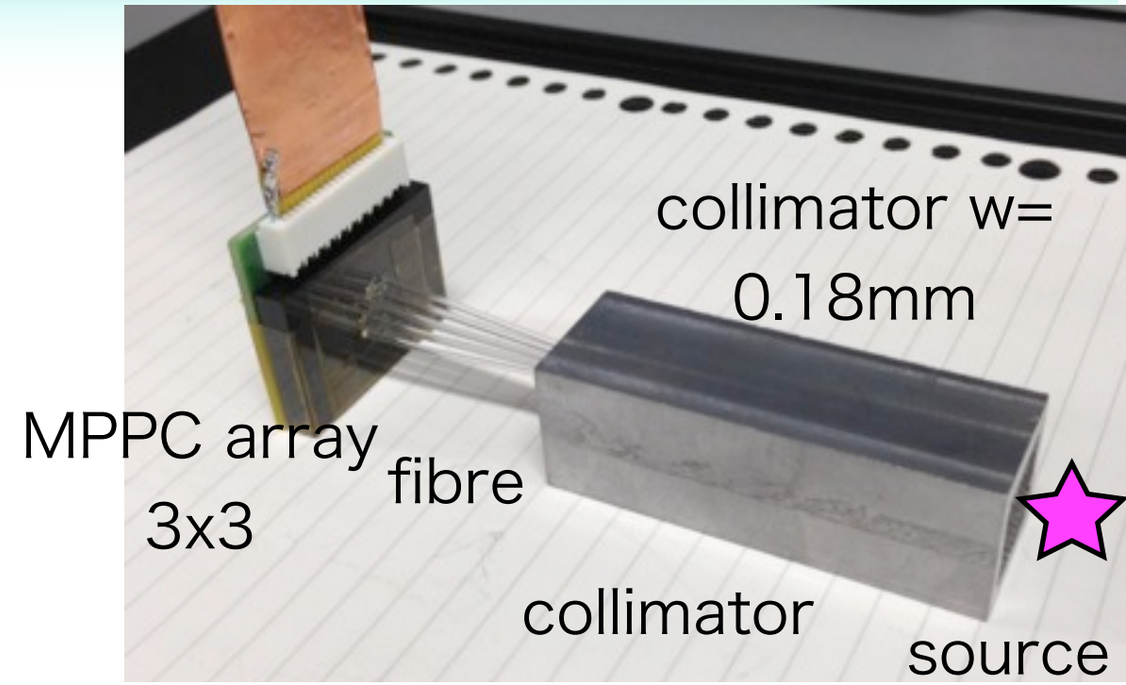
ADC
カウント

15p.e.

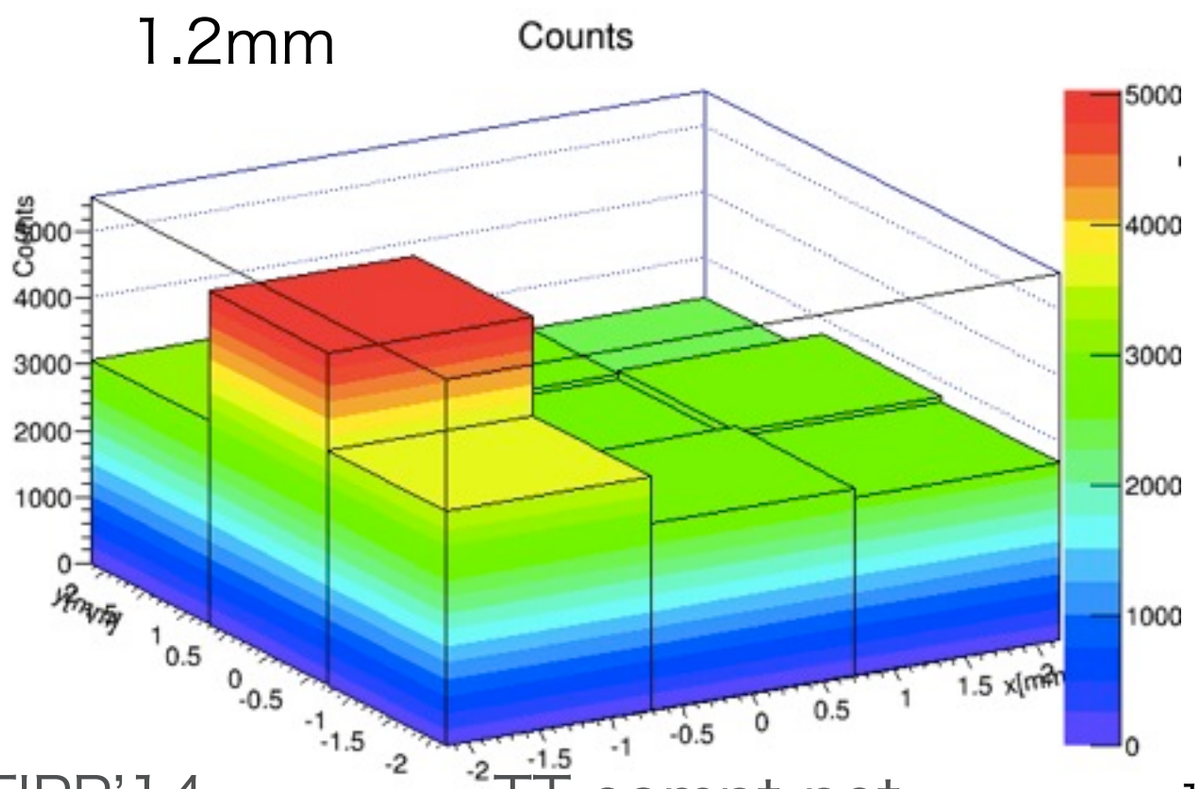


SPECT test exp.

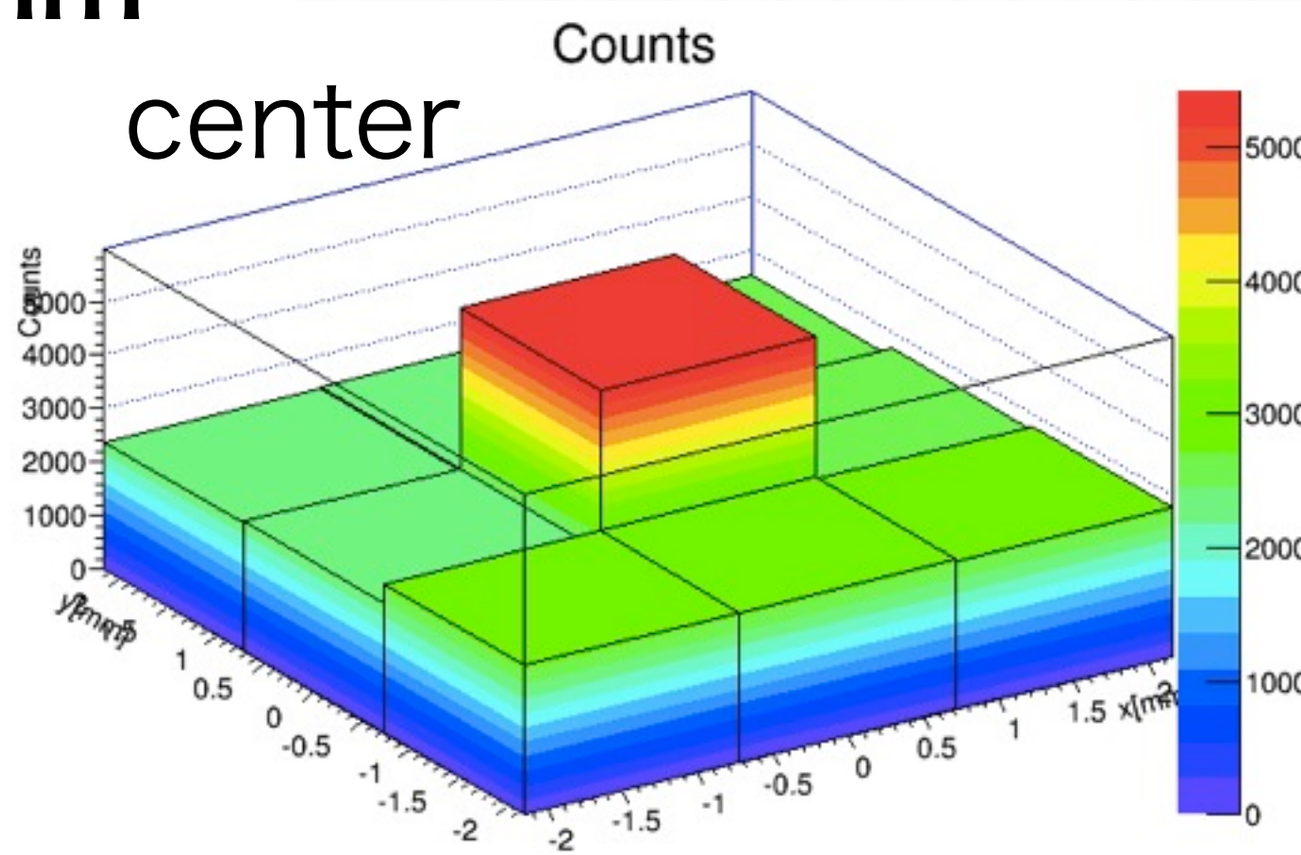
- ^{57}Co source 4mm from collimator top
- 3x3 matrix tested
- 1x9 tested ~1.09mm



1.2mm



center



summary & outlook

- next generation PET
- fine spatial and time resolution with layered structure
- basic concepts are verified with small and heavy scintillator and MPPC
- new SPECT idea can have spatial resolution ~1mm

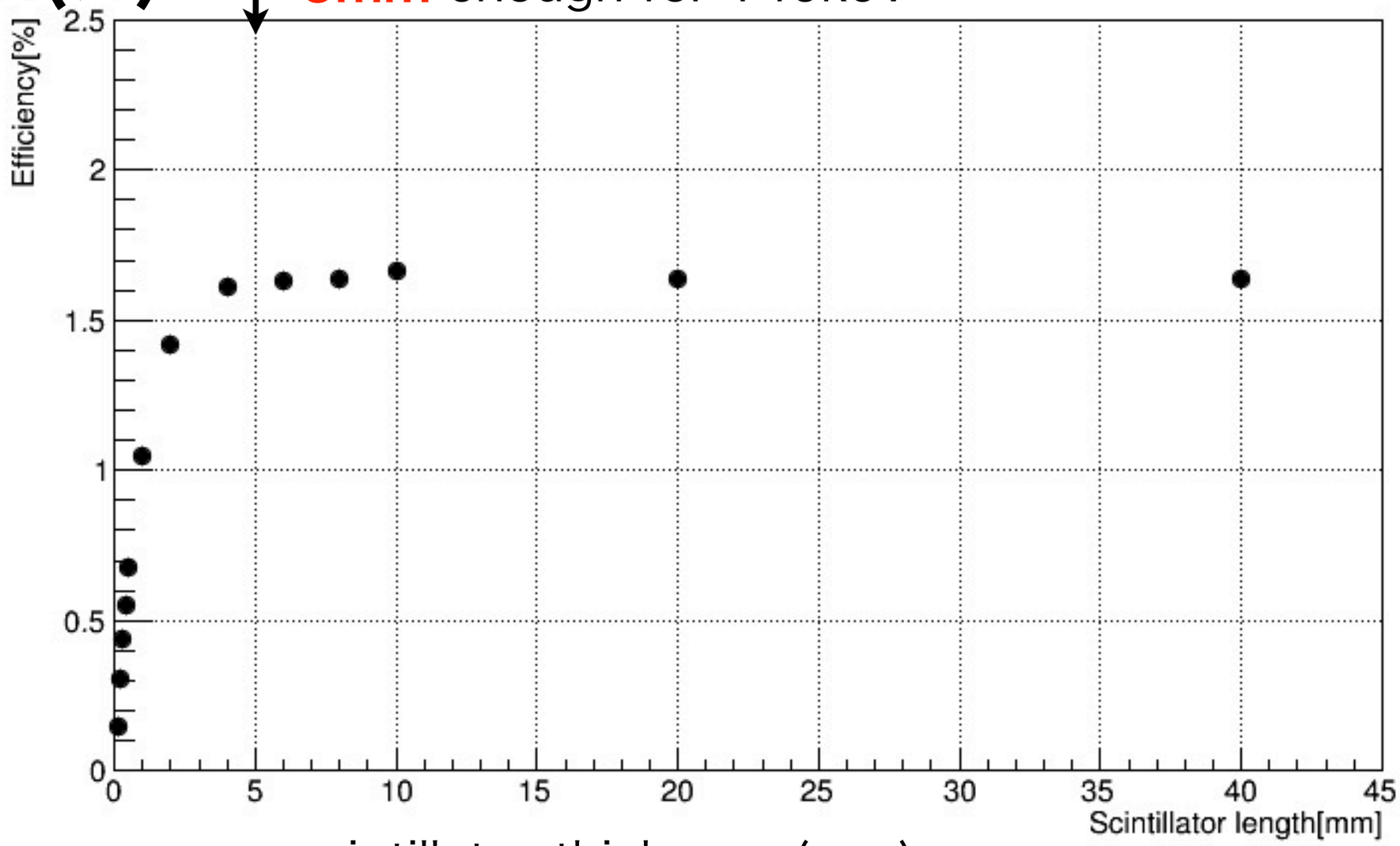
scintillator : LSO

Sako

- **scintillator thickness**

eff.(%)

5mm enough for 140keV



scintillator thickness (mm)