DARK MATTER SEARCH WITH PICO-LON

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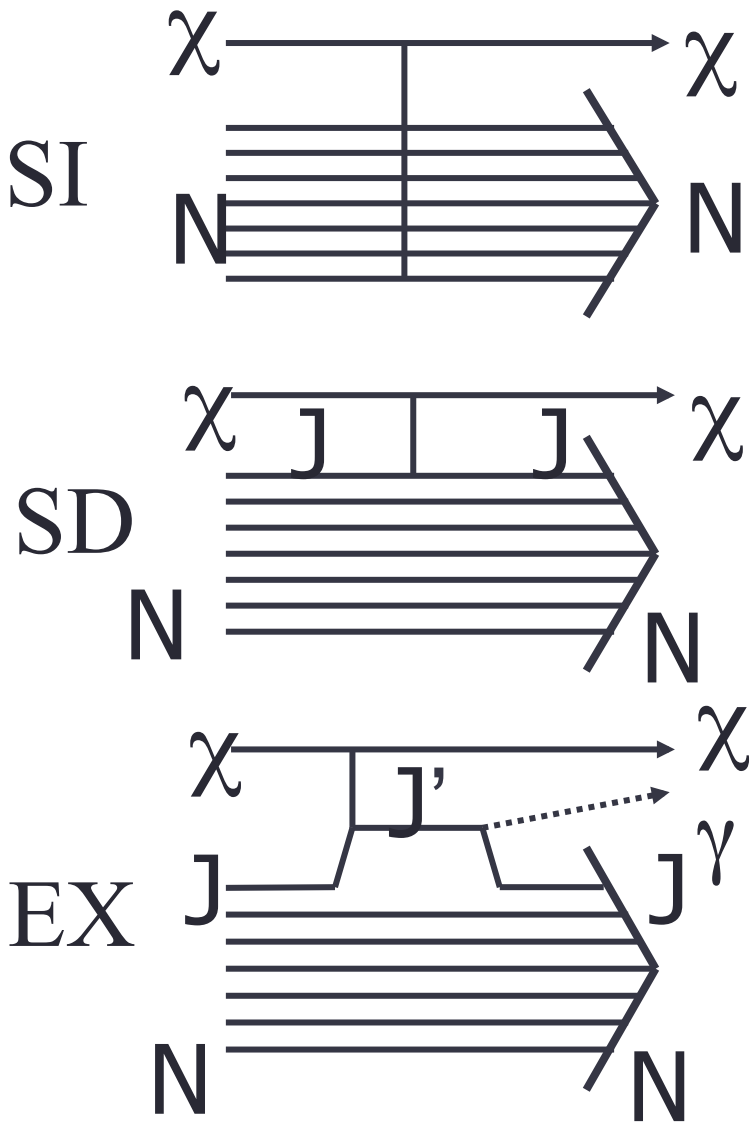
WIMPs interactions to be studied

- NaI(Tl) is sensitive to all types!!



$$\sigma \propto A^2$$

$$\sigma \propto C\lambda^2 J(J+1)$$

$$\sigma \propto \sqrt{\frac{2J'+1}{2J+1}} \frac{1}{g_M} \left\langle A \left| M1 \right| A^* \right\rangle$$

PICO-LON for WIMPs search

- Planar
- Inorganic
- Crystal
- Observatory for
- LOw-background
- Neutr(al)ino

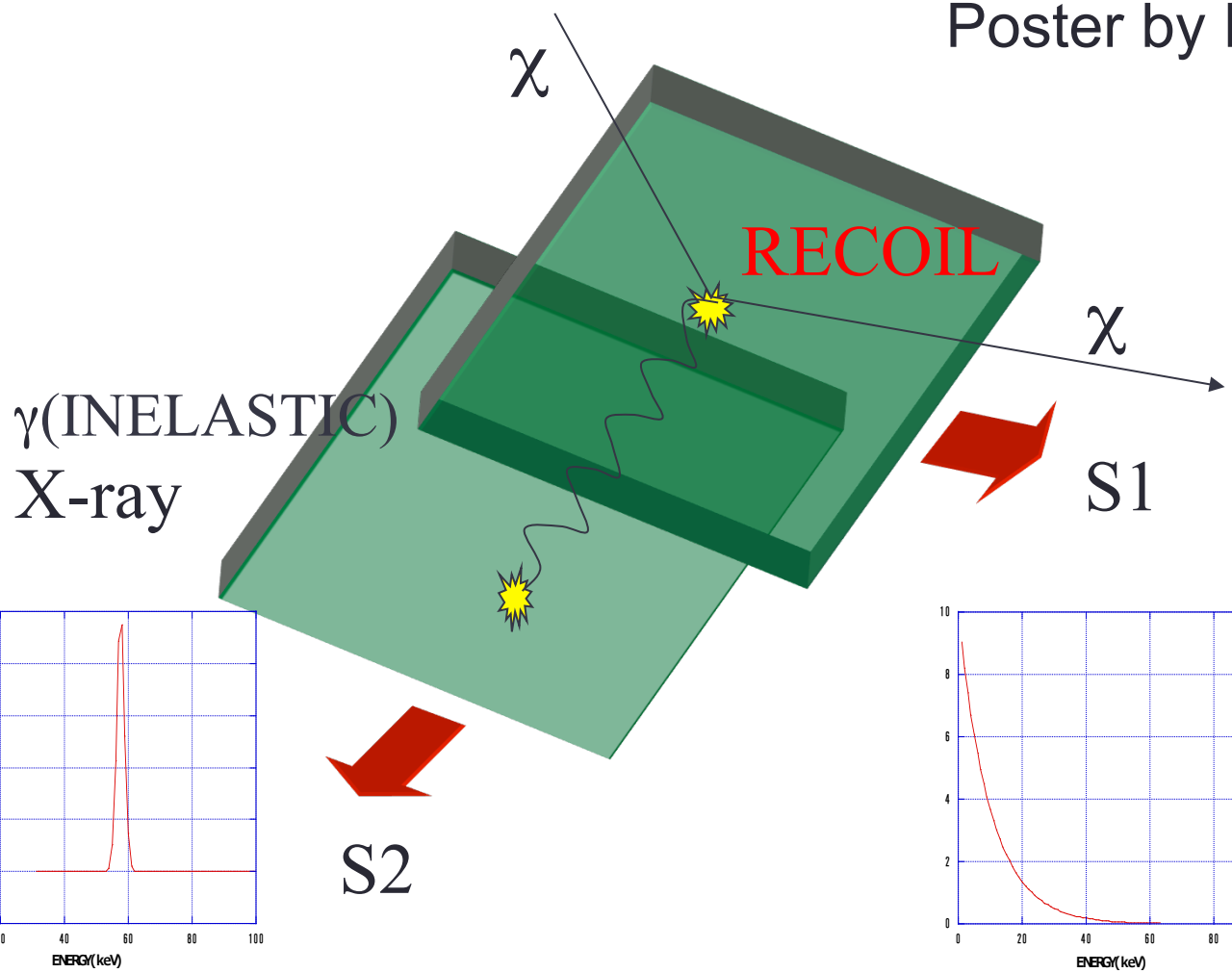
- High selectivity
- Background reduction

- Sensitive to
- Elastic scattering (SI+SD)
- Inelastic scattering (SD)

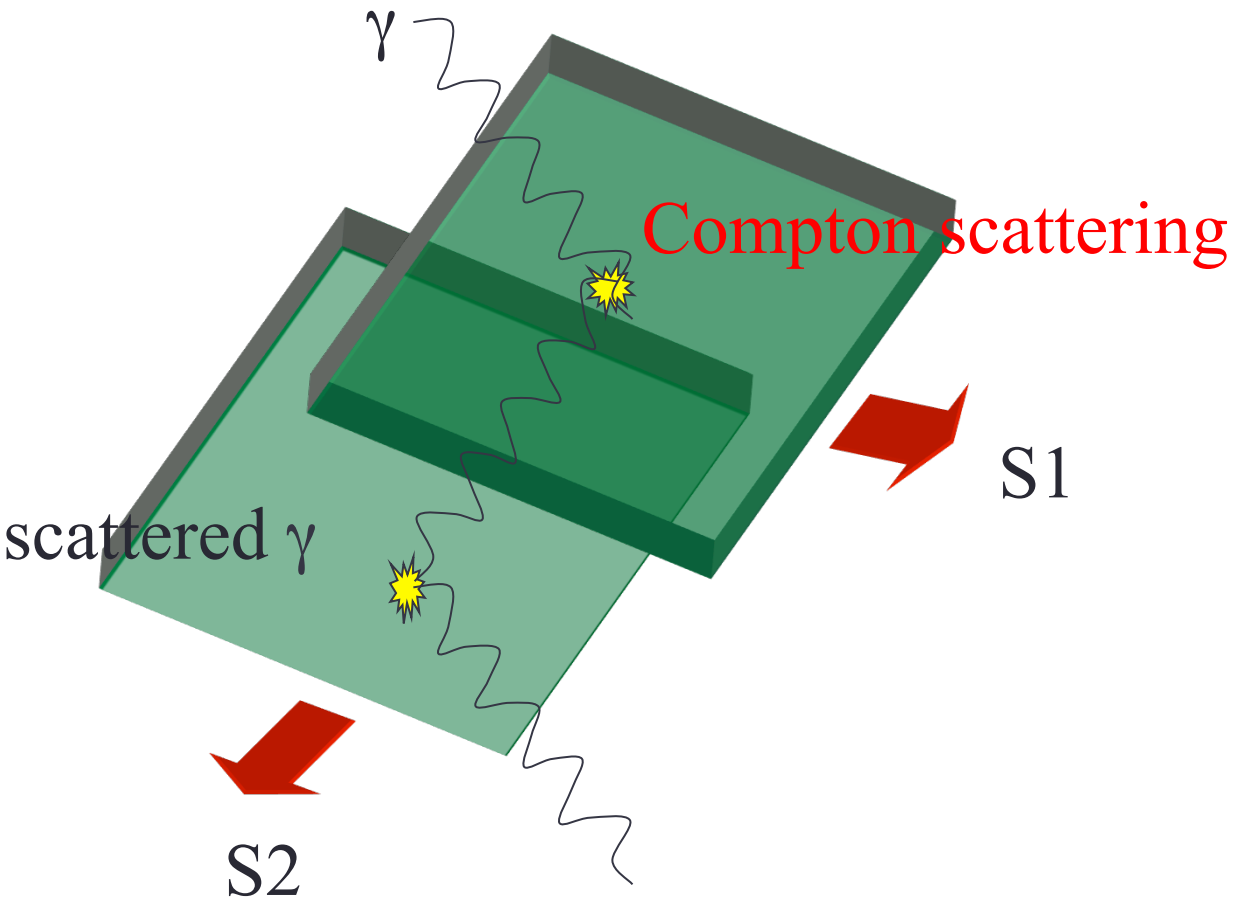
- Study the interaction type of WIMPs

Concept of PICO-LON detector

Poster by R.Sugawara



Background reduction



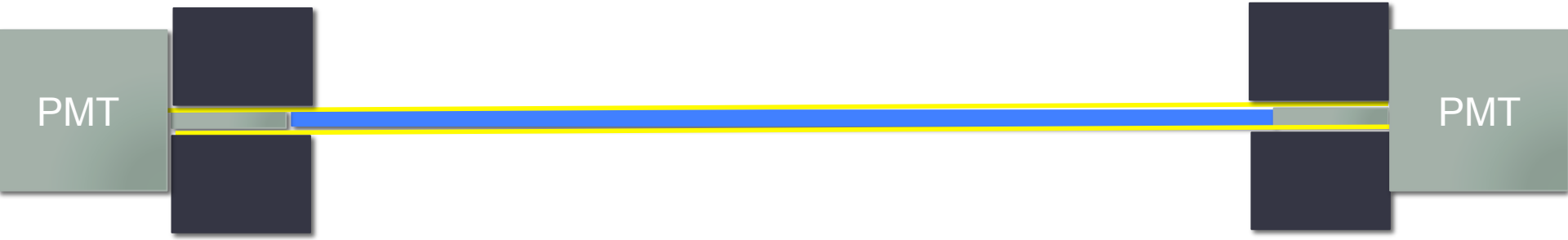
Segmented detector → Remove Compton scattering

Design of PICO-LON

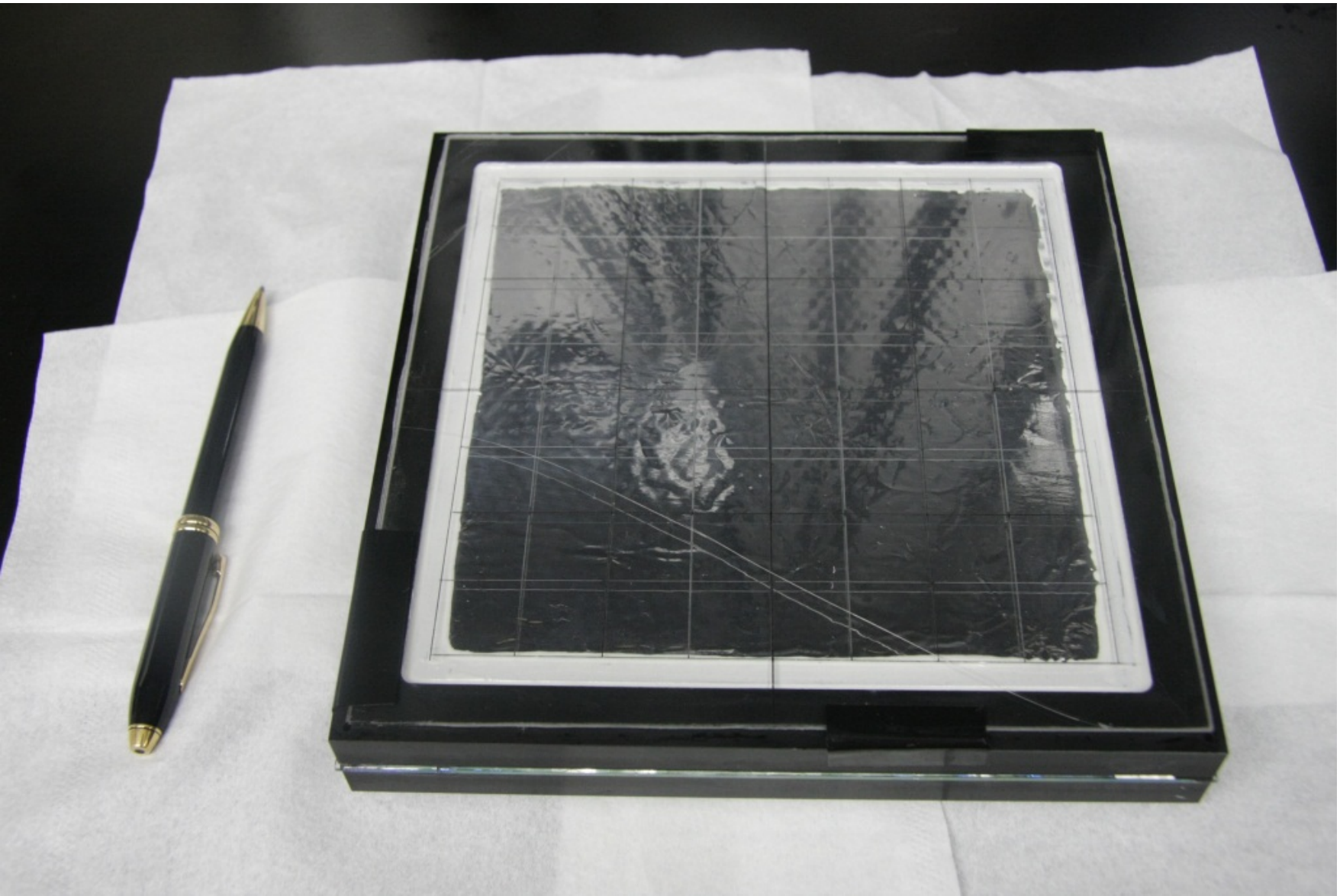
- Requirements

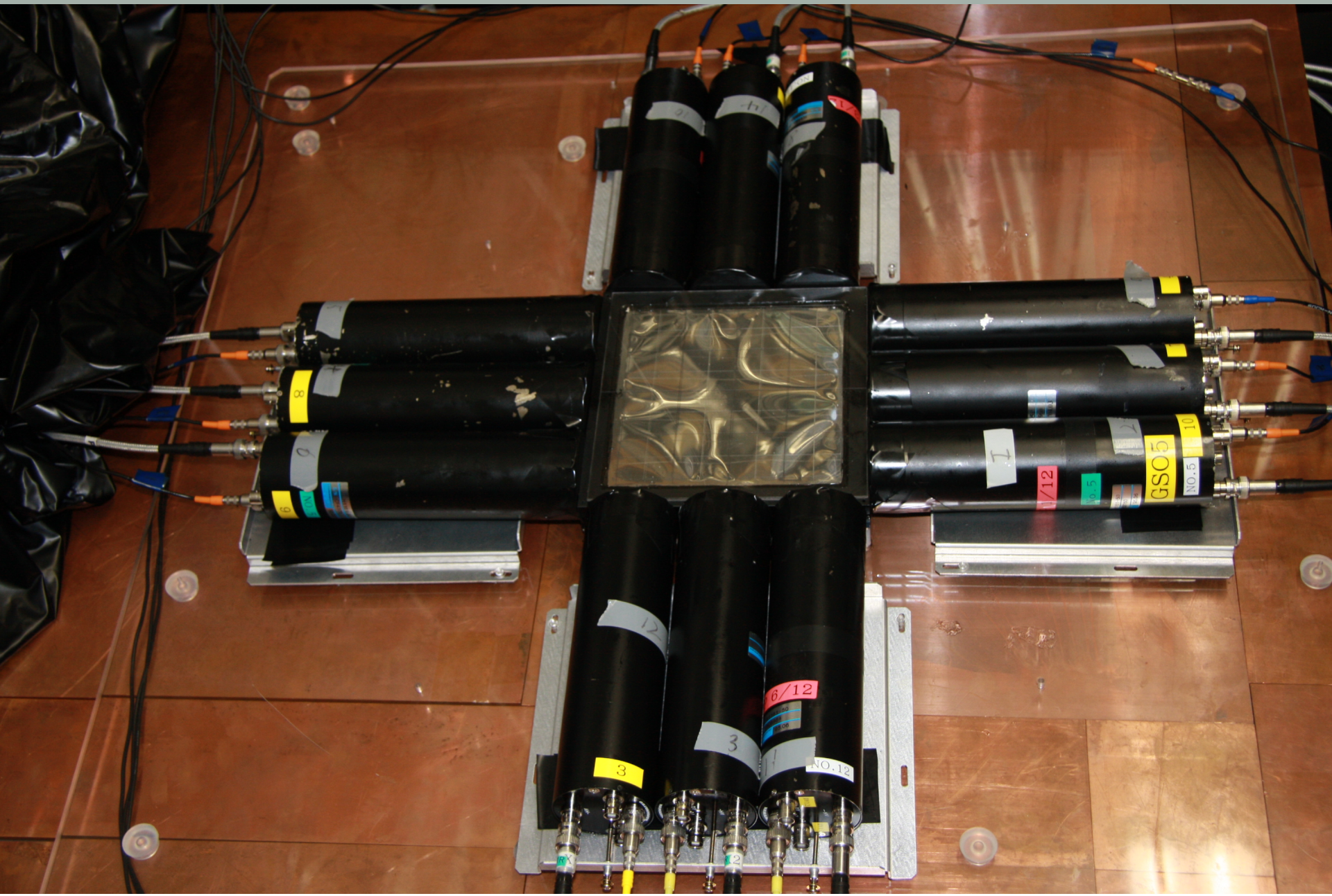
- Coincidence measurement of ^{127}I gamma ray
  - Thin NaI(Tl) crystal 0.1cm
- Low energy threshold
  - Low energy WIMPs signal $E_{ee} < 5\mathrm{keV}$
- Good energy resolution
  - Background by ^{210}Pb at 46.5keV $\Delta E_{ee} = 12\mathrm{keV}$
- Large acceptance
  - Wide area crystal 10cm square ~ 18cm square
  - Pile up modular detectors

PICO-LON module



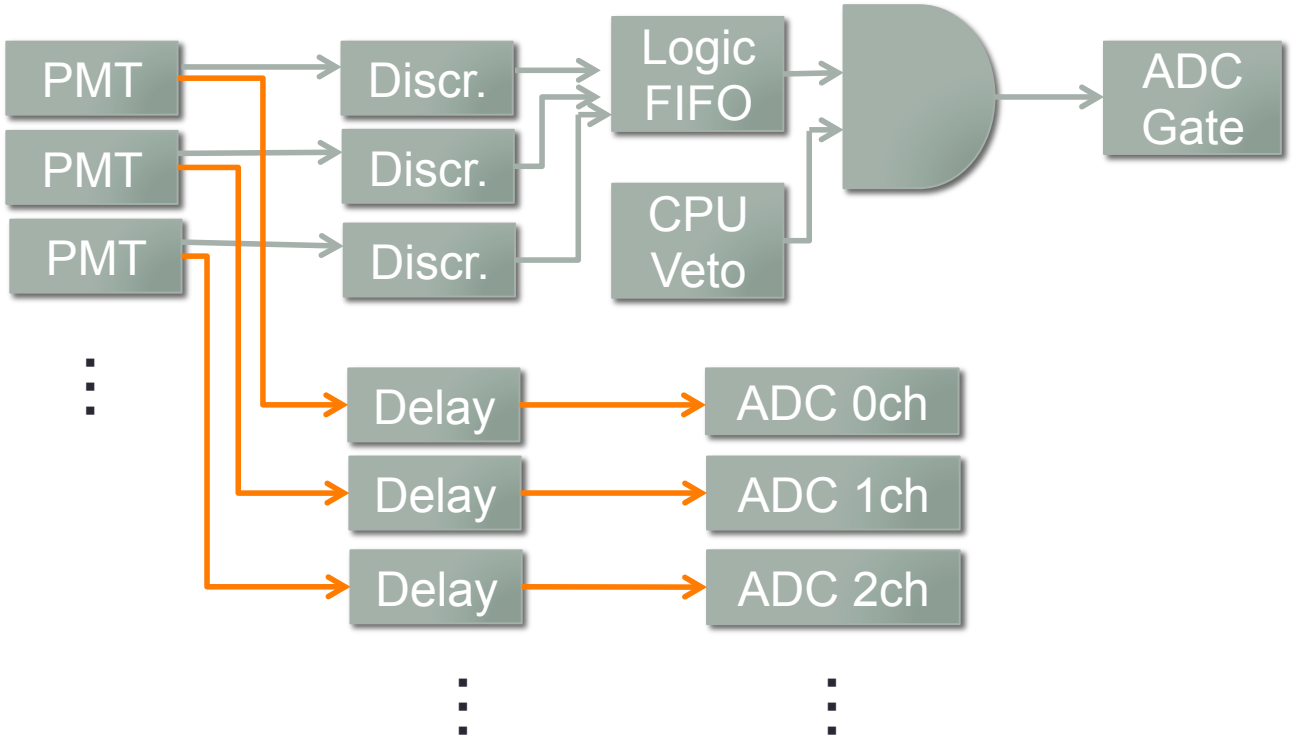
PICO-LON single layer module

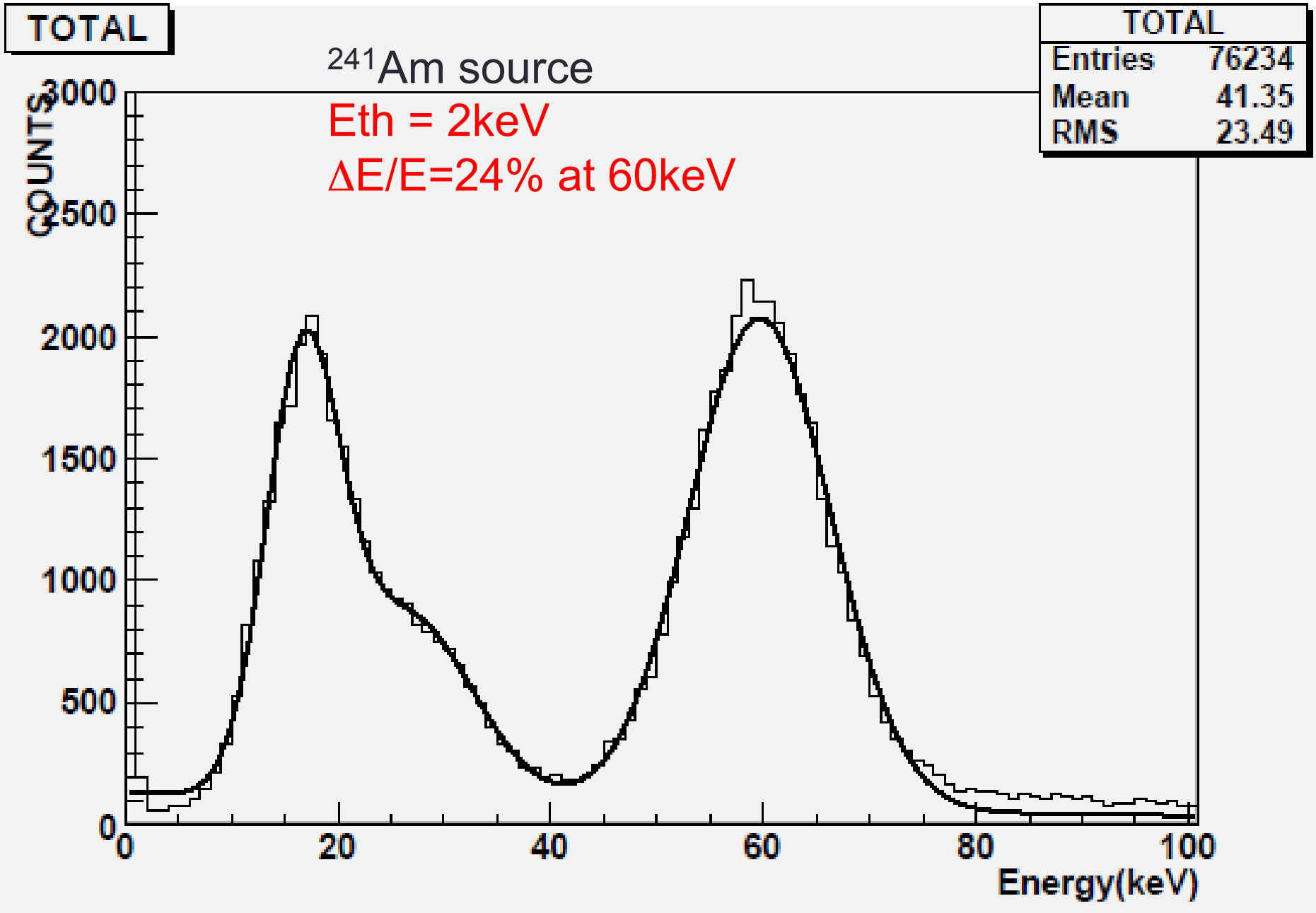



GSO5
NO.5
NO.12
6/12

Performance test

- Gains of 12 PMTs was adjusted.
- High voltages for PMTs were individually supplied.
- Current outputs were individually collected by CSADC.



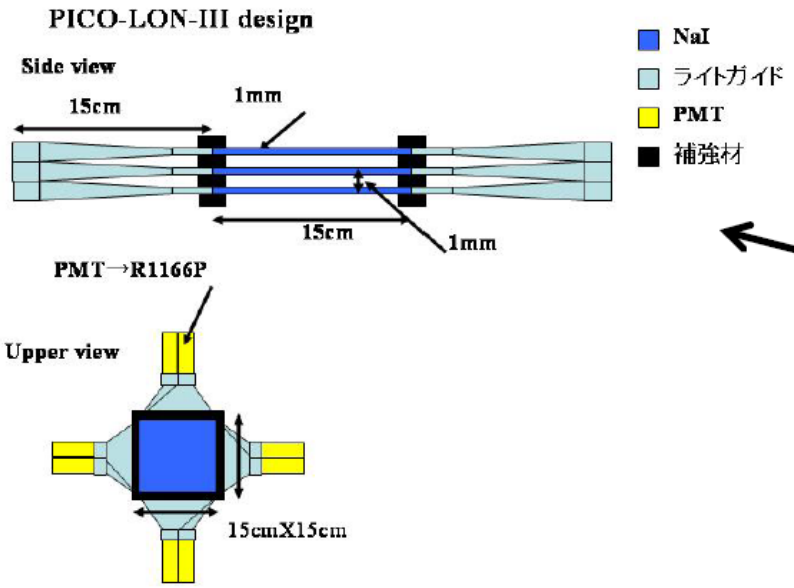

TOTAL
^{241}Am source
Eth = 2keV
ΔE/E=24% at 60keV
TOTAL
Entries 76234
Mean 41.35
RMS 23.49
COUNTS
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
Energy(keV)

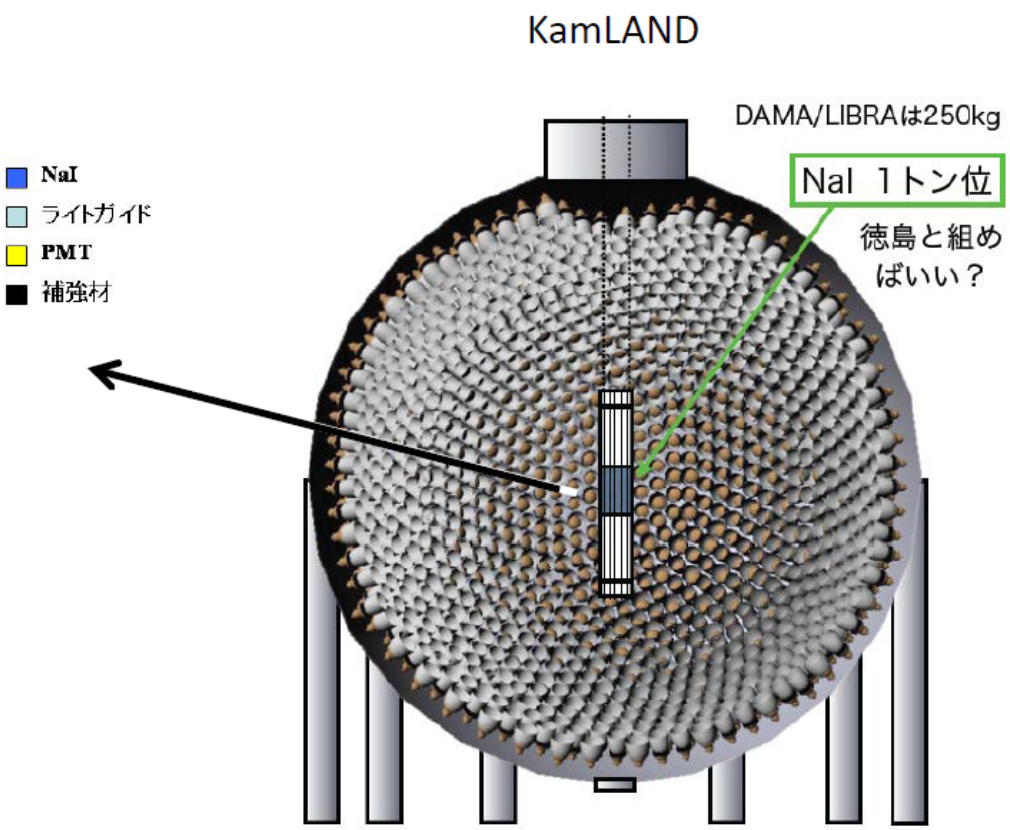
Results for performance

- Good energy threshold
  - Lower than 3keV electron equivalent.
- Energy resolution should be improved
  - Intrinsic energy resolution in NaI(Tl) plates
  - → Position dependence
- Good detection efficiency
  - Not suffered by analysis
  - confirmed by Monte Carlo simulation

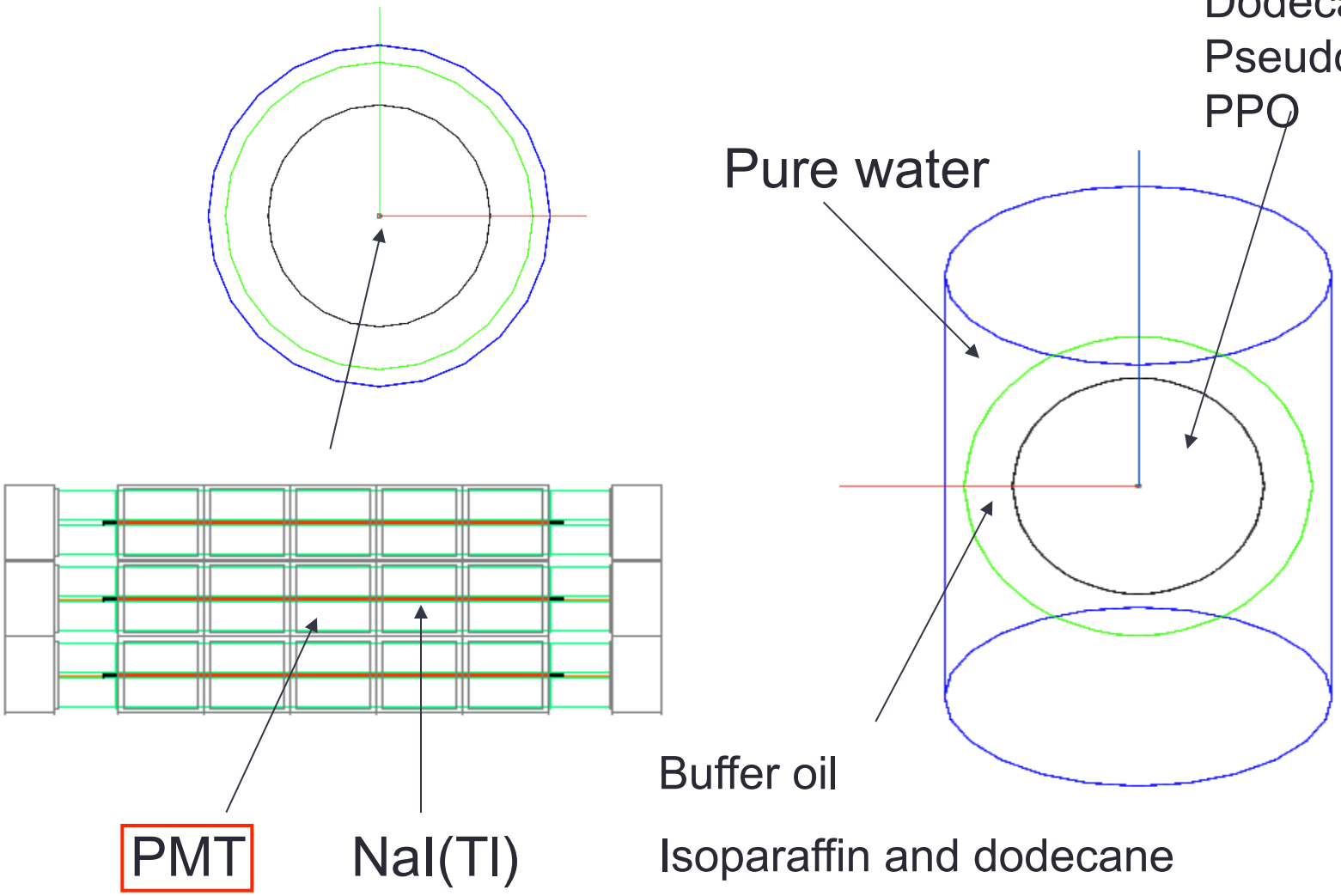
KamLAND-PICO

- Install PICO-LON detector into KamLAND
- KamLAND is an ideal active shield.

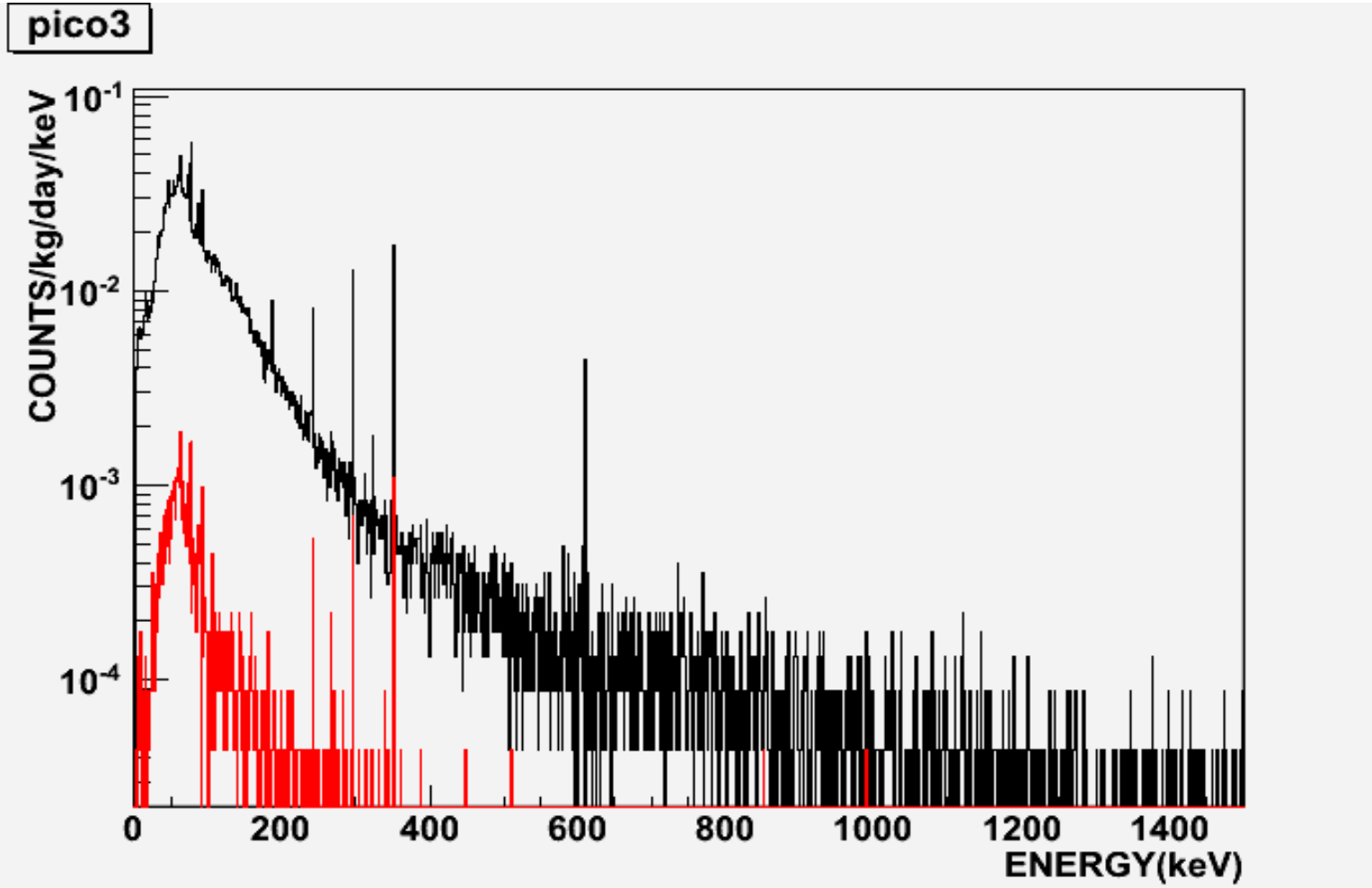




BG Simulation of KamLAND-PICO



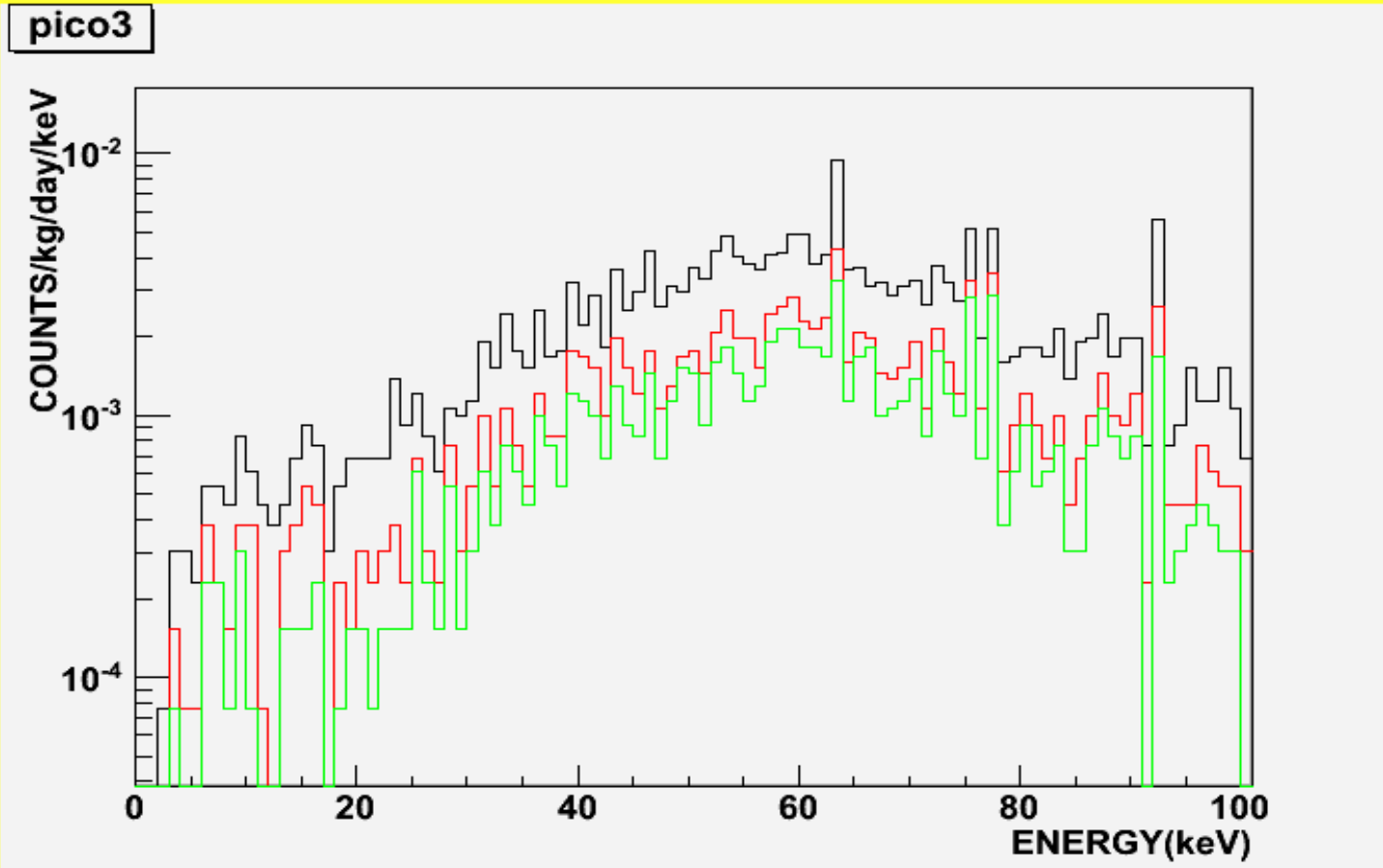
Preliminary! U-chain 0.7mBq/kg in PMT glass



Raw data detected by one layer

Anticoincidence another layer and KamLAND

Low energy region



Energy threshold of KamLAND

100keV 180keV 400keV

6.Estimated background (Preliminary!!)

events/kg/day/keV	
^{40}K PMT glass	5.3×10^{-5}
^{232}Th PMT glass	2.7×10^{-4}
^{40}K PMTcase	2.7×10^{-4}
^{210}Pb NaI(Tl)	6×10^{-2}
^{212}Pb NaI(Tl)	1×10^{-4}
^{40}K NaI(Tl)	3×10^{-1}
^{40}K light guide	9×10^{-2}
^{232}Th light guide	2.7×10^{-7}
^{40}K reinforcement	5×10^{-2}
^{232}Th reinforcement	5.5×10^{-7}

DAMA

BG~1/kg/day/keV

KamLAND-PICO (E_{th}=100keV)

BG ~ 0.5/kg/day/keV

Summary

- PICO-LON for WIMPs search
- High sensitivity to all the types of interaction.
  - Elastic scattering for SD+SI
  - Inelastic scattering for SI
- Good performance for WIMPs search
- KamLAND-PICO has been funded.
  - 15Myen/4year
  - Low background study for NaI(Tl) with 4π active shield.