



# "ISAI" Investigating Solar Axion by Iron-57 : the commissioning and the first run



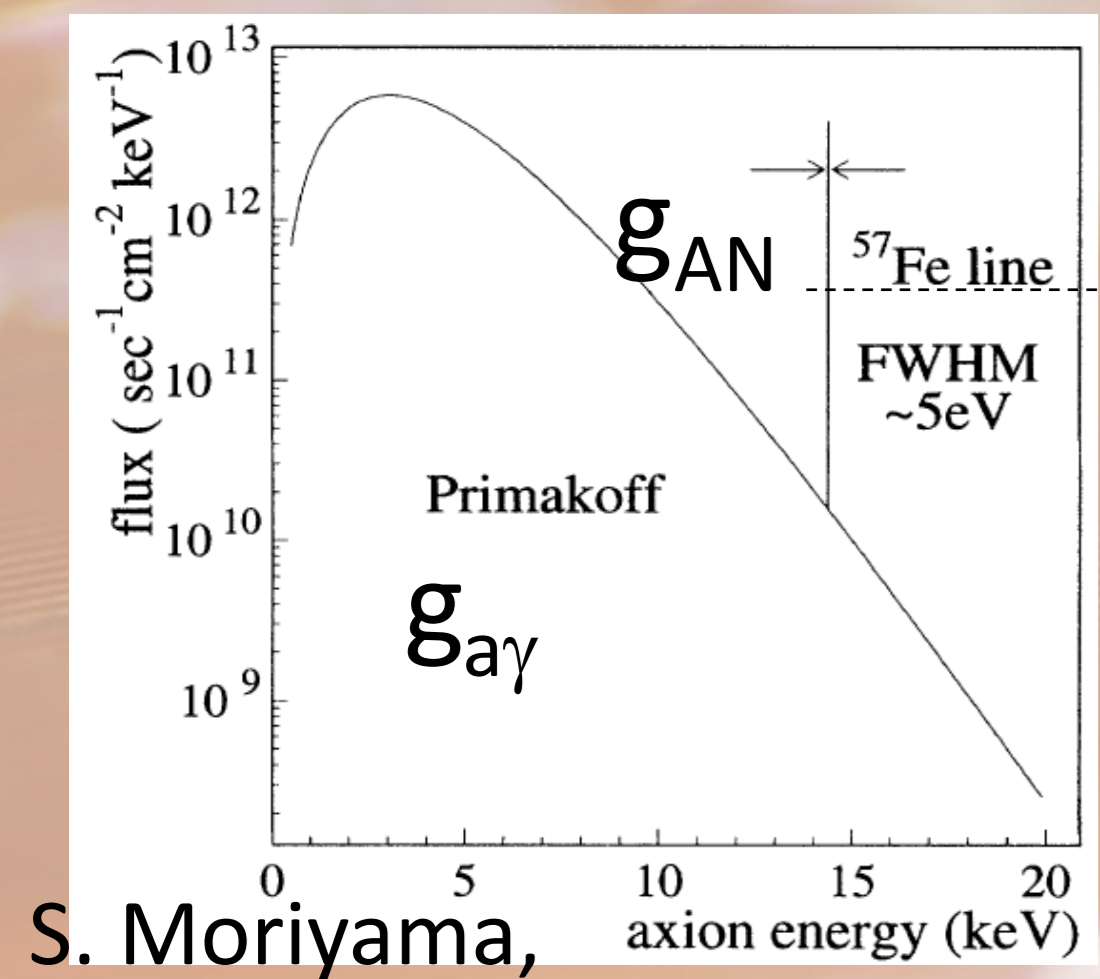
Yoshiyuki Onuki on behalf of ISAI collaboration

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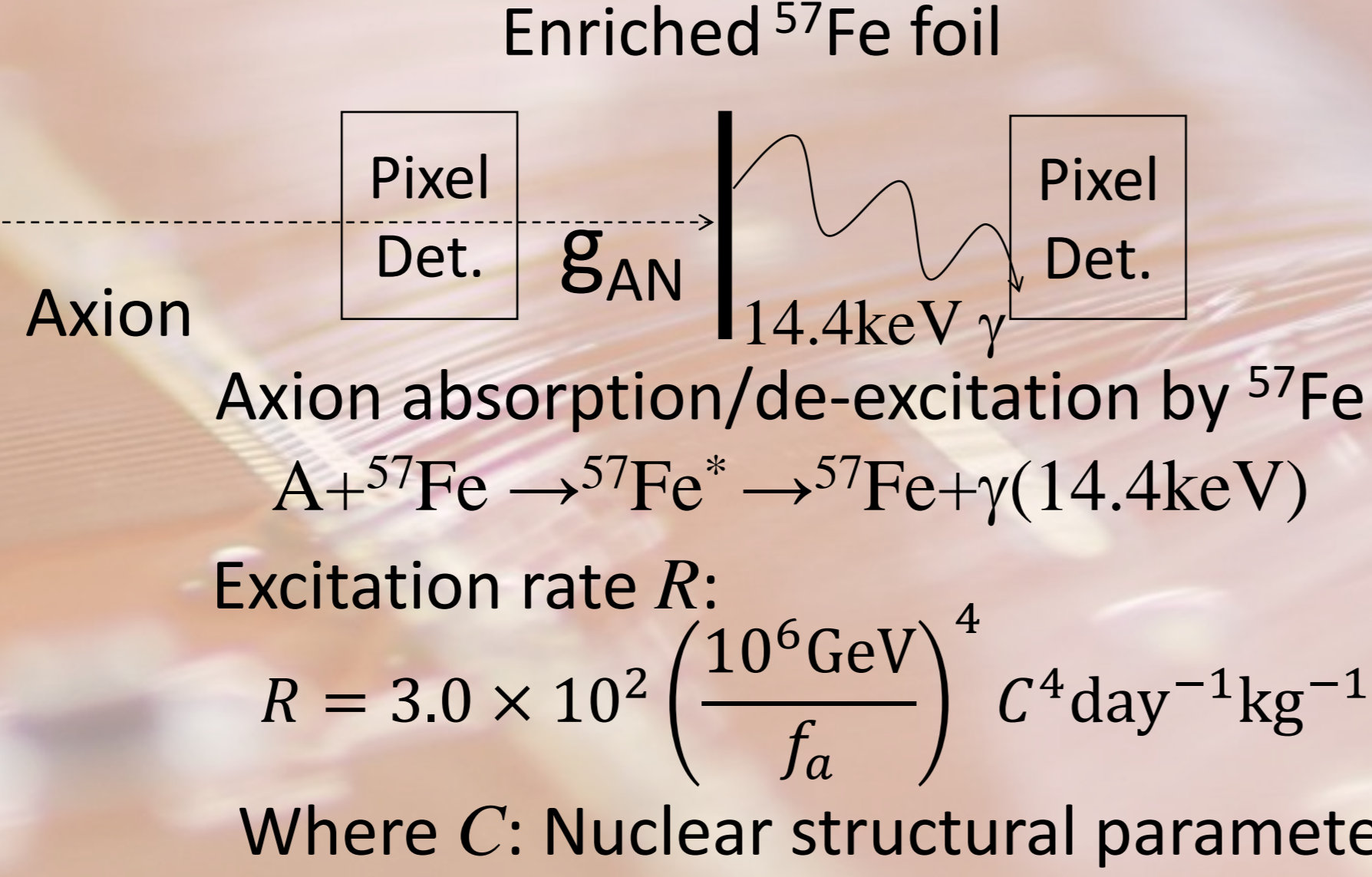
This work was supported by JSPS KAKENHI Grant-in-Aid for Challenging Research (Pioneering) 21K18151

## Core in the Sun



S. Moriyama, Phys.Rev.Lett,75(1995)3222

## Measurement on the Earth



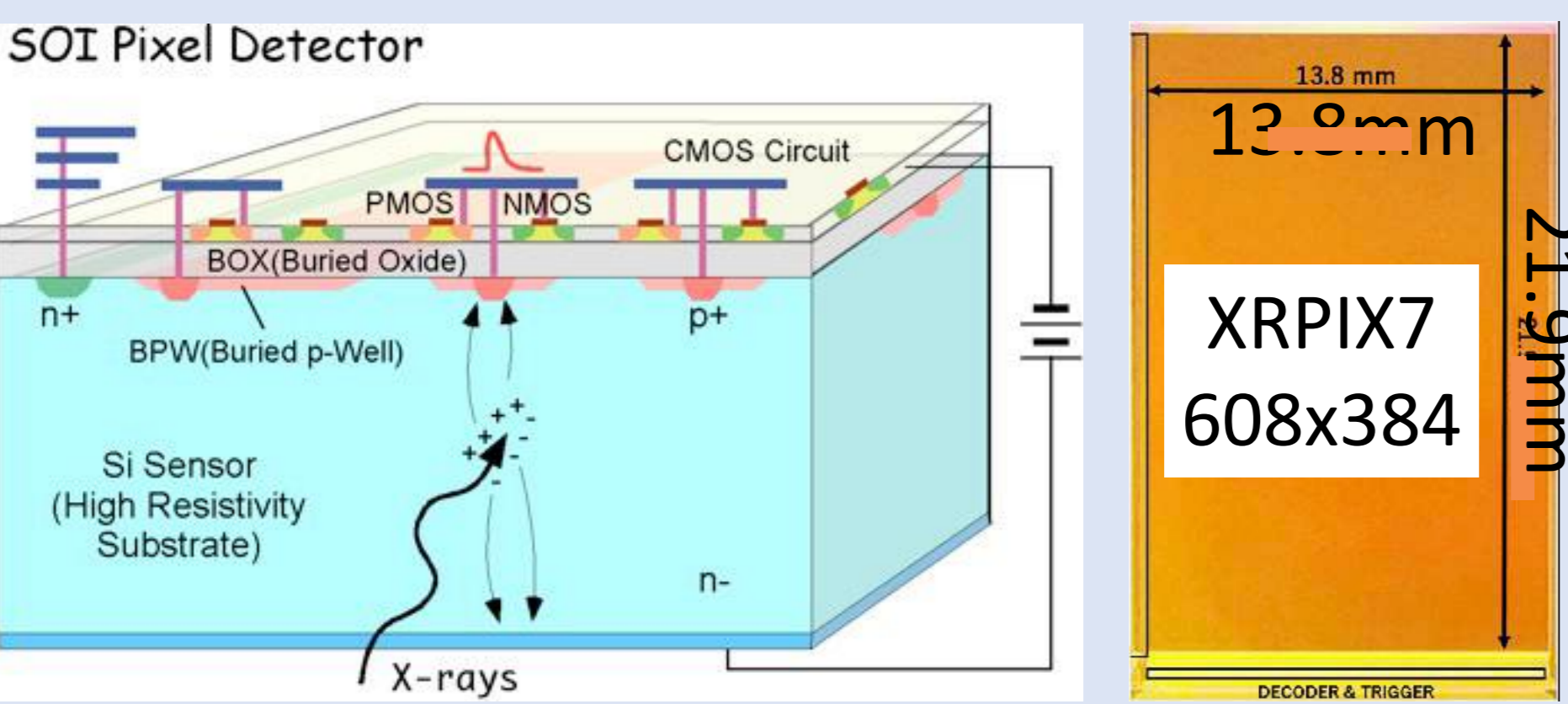
$$m_A = 5.55 \times \left( \frac{R_d}{1 \text{ day}^{-1} \text{ kg}^{-1}} \right)^{1/4} \text{ eV}$$
$$R_d = \frac{N}{M \eta \epsilon}$$

$R_d$ : <sup>57</sup>Fe de-excitation rate  
 $N$ : count rate  
 $\eta$ : ratio of  $\gamma$  emission, 0.105  
 $\epsilon$ : Efficiency

## Current constraints by <sup>57</sup>Fe Experiment on Earth

T. Namba, Phys. Lett. B **645**(2007) 398.  
 $m_A < 216 \text{ eV} @ 95\% \text{ C.L.}$   
A.V.Derbin, Phys. Atom. Nucl. **74**(2011)596  
 $m_A < 145 \text{ eV} @ 95\% \text{ C.L.}$   
C.f. More stringent constraints  $m_A < \sim 1 \text{ eV}$  by Cosmological/astrophysical observation and SN1987A.

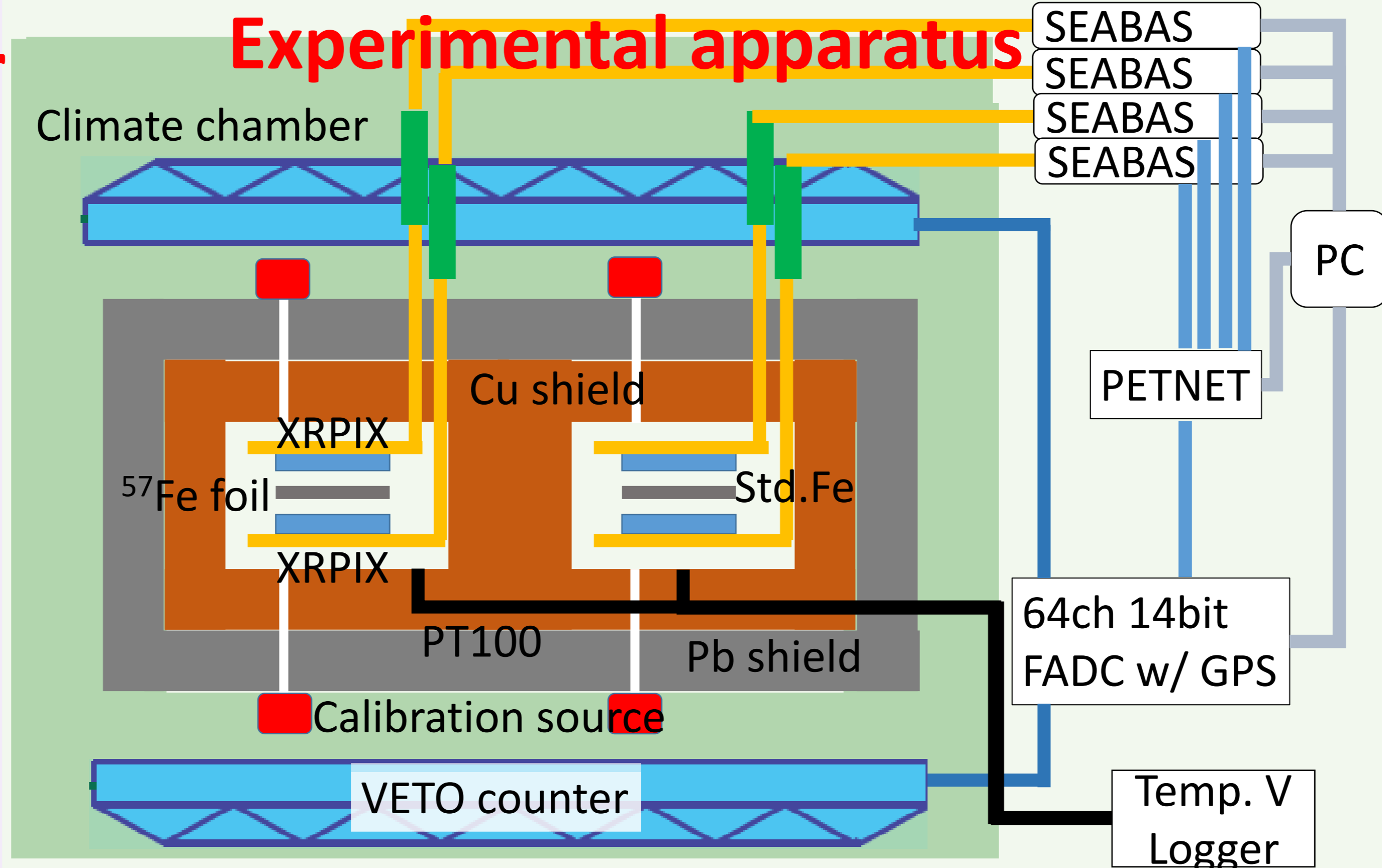
## XRPIX, SOI X-ray pixel sensor



- SOI pixel sensor for X-ray detection
- Developed by Kyoto-U and KEK.
- 36  $\mu\text{m}$  pixel with a trigger output
- Region of Interest readout.

T.G. Tsuru et al., Proc. SPIE 10709,(2018)

## Experimental apparatus



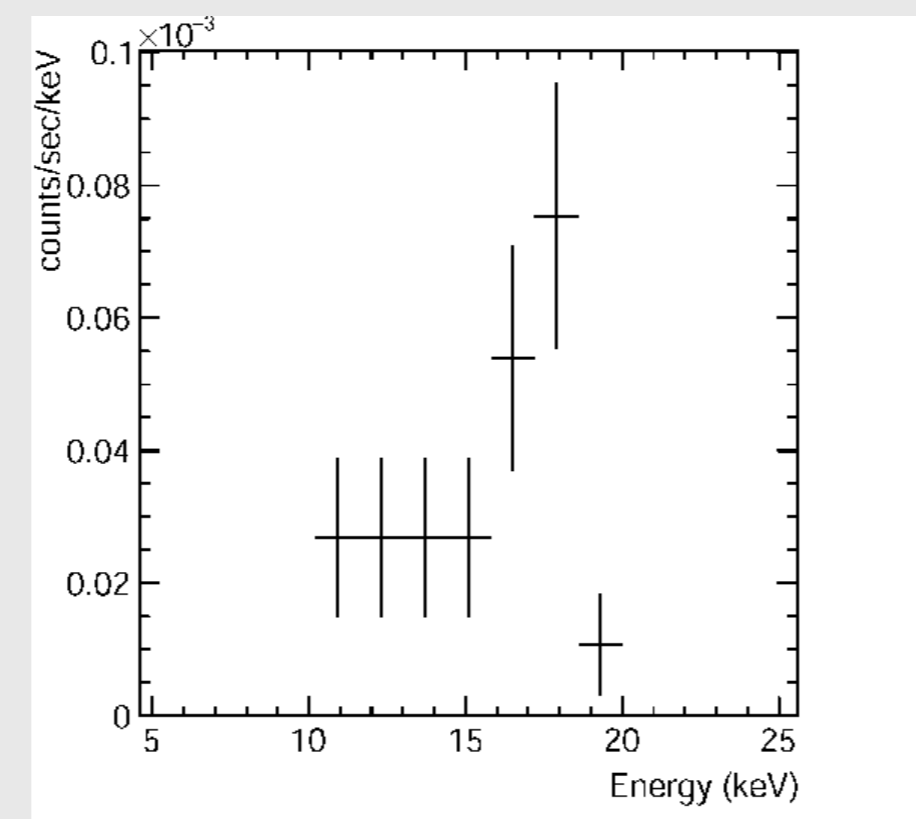
## Temp. Voltage logger

- PT100 sensor x2
- Voltage monitor x16
- Monitored by Grafana

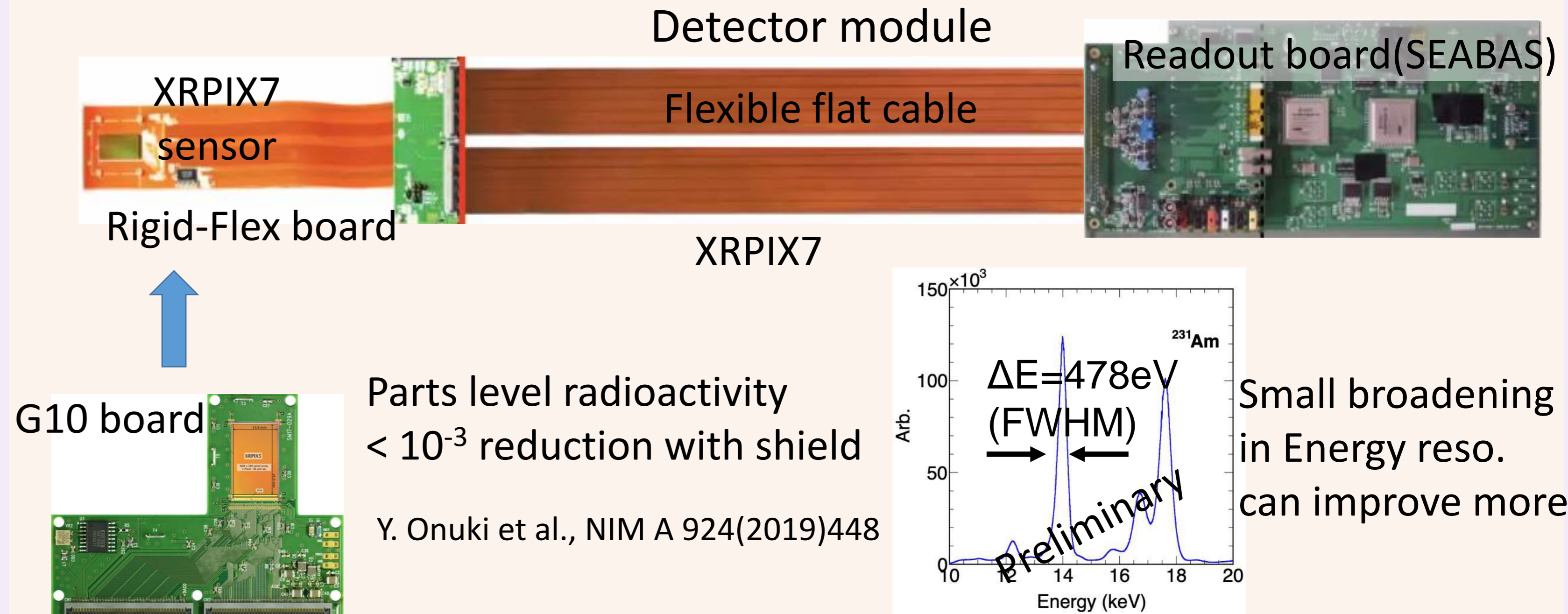


## BG run

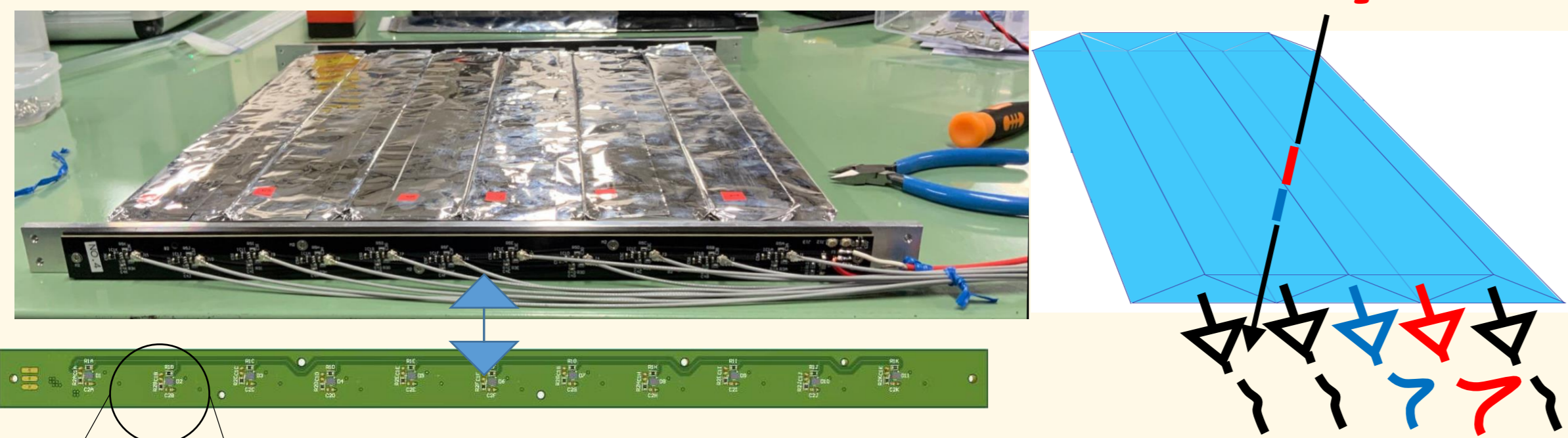
- the latest BG run.
- Half ISAI system without VETO.
- 2023 13-July to 18-July.
- Obtained  $\sim 4.3 \text{ counts/day}/2.8 \text{ keV} @ 14.4 \text{ keV}$ .
- Comparable bg rate in leading experiment.



## Low radioactive BG detector

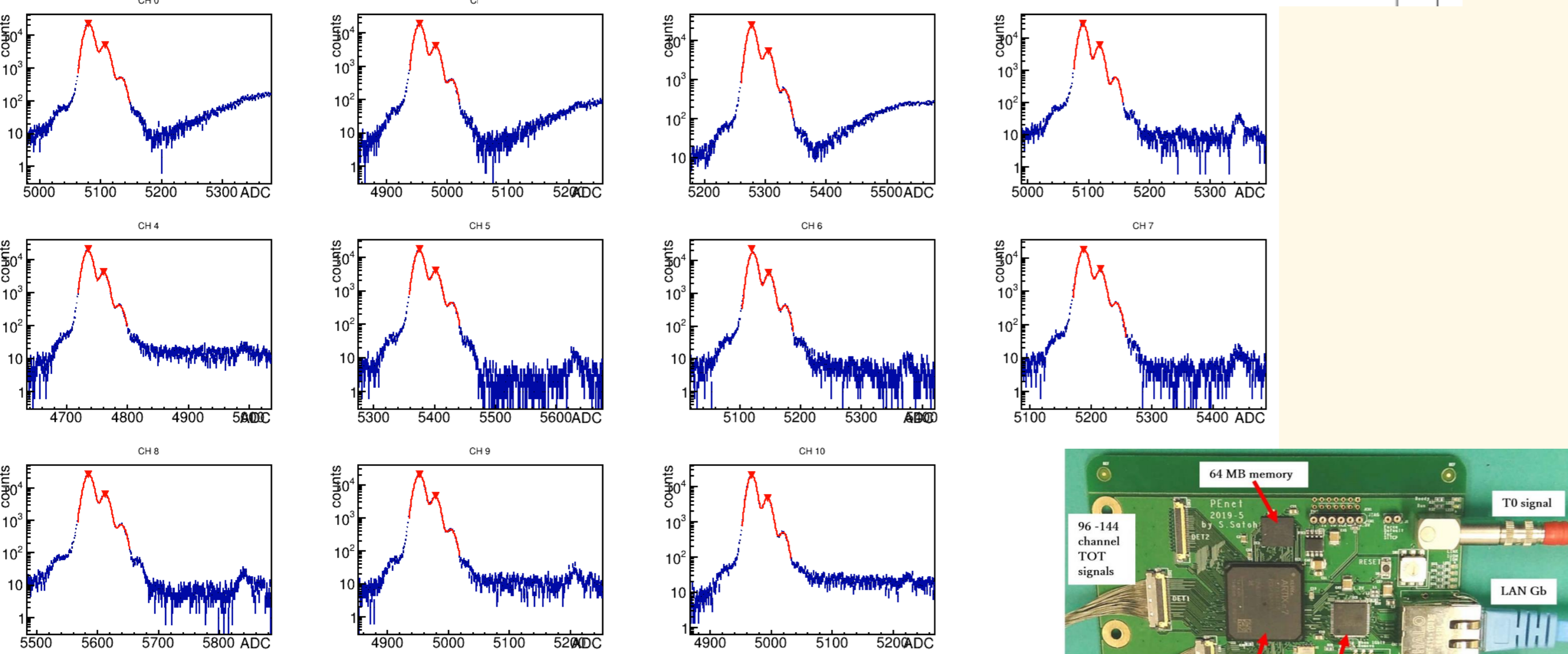


## Veto counter for cosmic ray BG



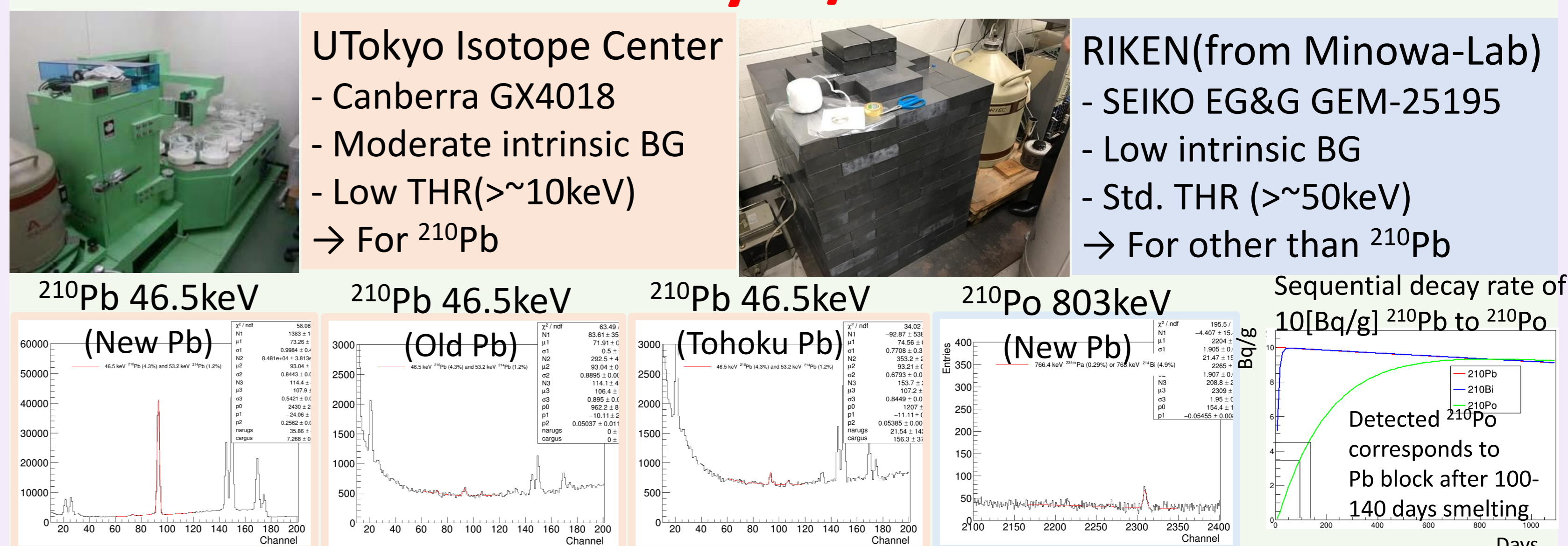
- Triangular scinti bar with WLS fiber lead to MPPC.
- Module consists of orthogonal two layers of 11 bars.
- Two modules placed top and bottom of Pb shield.
- 3/4 production completed.

## S13360-1375PE



Readout of single layer succeeded by PETNET  
Setsuo Sato et al., IEEE Trans. on Nucl. Sci. 68.8 (2021): 1801-1806.

## Low BG Pb survey w/ HPGe detectors



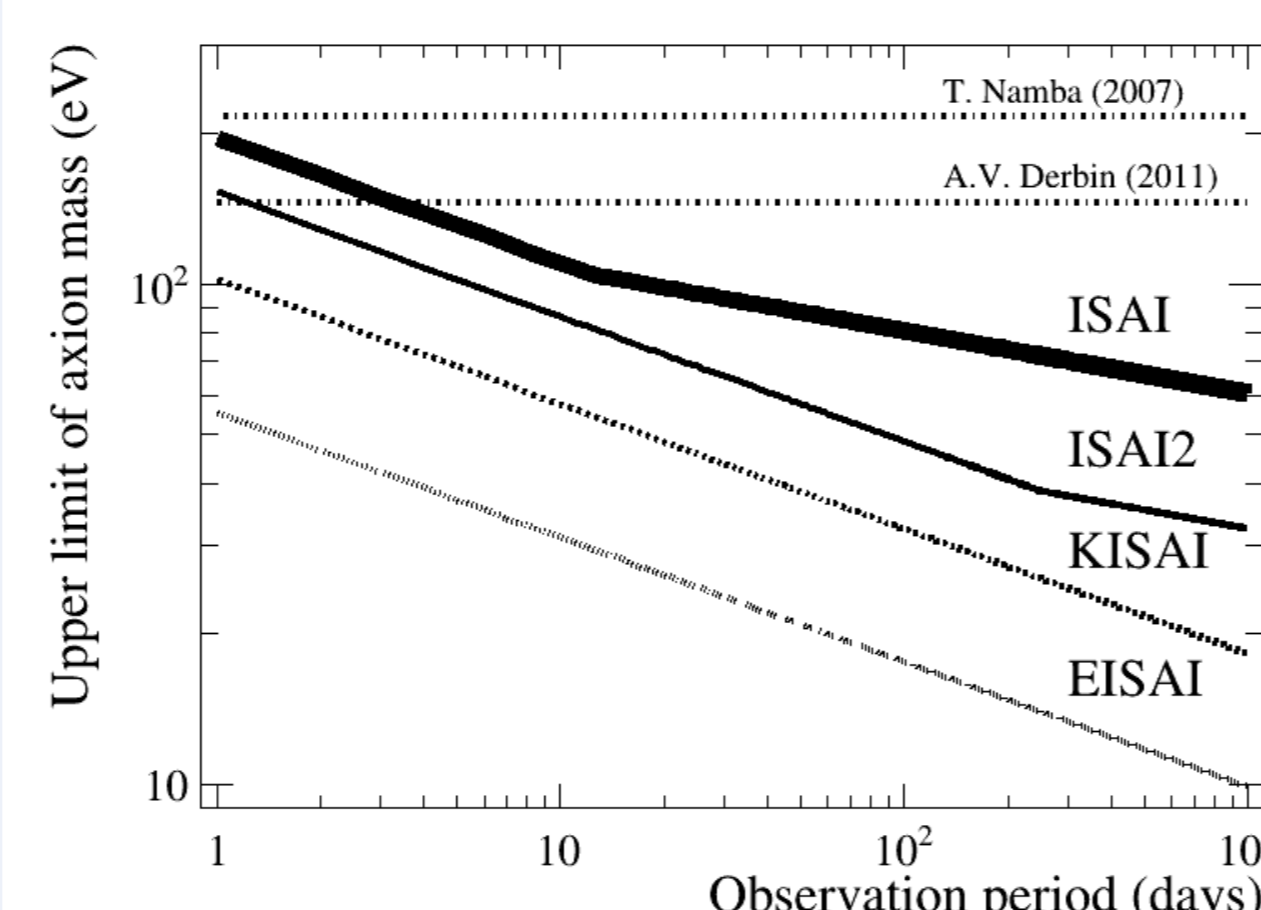
Radioactives	<sup>210</sup> Pb 46.5keV [Bq/g]	<sup>210</sup> Po 803keV [Bq/g]	<sup>238</sup> U, <sup>232</sup> Th, <sup>40</sup> K [Bq/g]
New Pb(Fresh)	9.51 ± 0.13	4.4 ± 0.5	-
Old Pb(>50y)	0.035 ± 0.006	0.12 ± 0.30	-
Tohoku-U* 0.005Bq/g	0.017 ± 0.003	-	-

We obtained low BG Pb blocks for Pb shield material !

\*Borrowed from Ichimura-san, Tohoku-U. for the reference. Many thanks !  
- means the value not yet determined but looks not significant.

## Expected sensitivity

- <sup>57</sup>Fe mass : 127 mg
- Detection eff. :14.9% @14.4keV
- E resolution : 250eV(FWHM)@14.4 keV
- Assuming internal  $N_{BG} = 0.004 \text{ counts/day}$ .
- EISAI has 10 times target mass in future work
- $C = -0.27$  assumed (e.g. D=0.77, F=0.48, S=0.45, z=0.56)



## Summary

- 1/2 ISAI will start observation soon.
- Stacking Std. Fe and <sup>57</sup>Fe sandwiched by two XRPIXs.
- Though half efficiency, still useful for the rehearsal.
- Full ISAI experiment
- The last implementation of XRPIX on rigid-flex is on-going.
- Working hard to start the observation in this year.

