Poster ID: 114-243

Waveform Analysis of a 240 pixel TES for X-rays and charged particles using a function of triggering neighboring pixels

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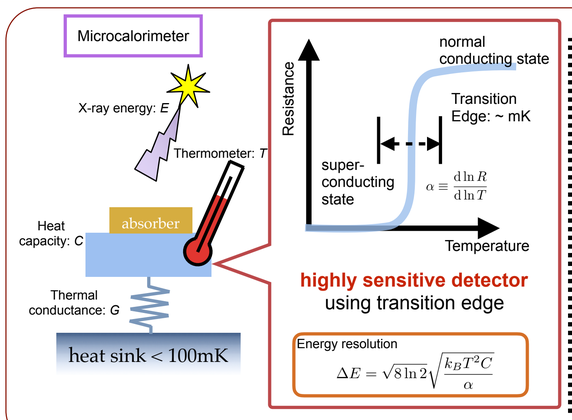
1. TMU, 2. RIKEN, 3. NIST, 4. JAEA, 5. Osaka Univ., 6. Rikkyo Univ., 7. ISAS/JAXA

1. Introduction



Transition-Edge-Sensor (TES) & HEATES project

Results of experiments

- ✓ Performance assessment test of 160pixels TESs. (September, 2013)
- ✓ Succeed in measuring 6keV X-rays from pionic-carbon with an energy resolution of 7eV at PSI. (October, 2014)
- ✓ Archive energy resolution of 6.7eV FWHM (on-beam), 5eV (off-beam) at 6keV X-rays.
- ✓ Succeeded in measuring X-ray emission from kanoic-He(June,2018)

Tatsuno et al. 2015
Hashimoto et al. 2016

The points of HEATES project

- ✓ Improving the technical readiness levels (TRL) of TESs for future satellite missions (e.g., ATHENA, Lynx, and super-DIOS) equipped with TESs.
- ✓ Unique probe of the K- nucleus strong interaction at the threshold energy
- ✓ Clarifying the role of the strange quark and its composites in the equation of state of a neutron star.

S. Okada et al. JLTP, 176, 1015,1021, 2014
H.Tatsuno et al. JLTD,184,3,930,2016

Refer to T. Hashimoto et al., (Oral, 26 Jul. 10:45-)

TES bilayer materials	Mo/Cu
Size	300um x 320um
Num. of pixels	**240**
Effective area	23mm²
Absorber	Bi (4um)
Transition Temp.	100mK

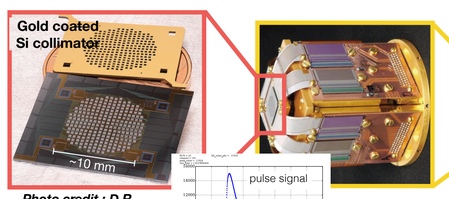
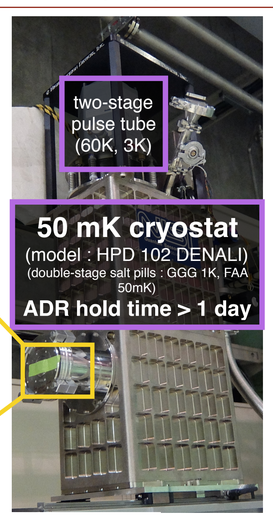
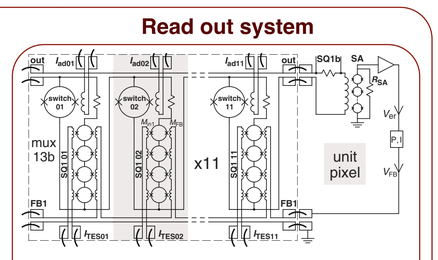


Photo credit : D.R. Schmidt, NIST



TES system

Read out system



Time Division Multiplex : TDM

- Switching time: 240ns
- Taking time to reload the same channel: 7.2us *W.B. Doriese et al. JLTD, 184, 1, 389, 2016*
- Developing for backup method in ATHENA mission planned to use Frequency Division Multiplexing (FDM) system

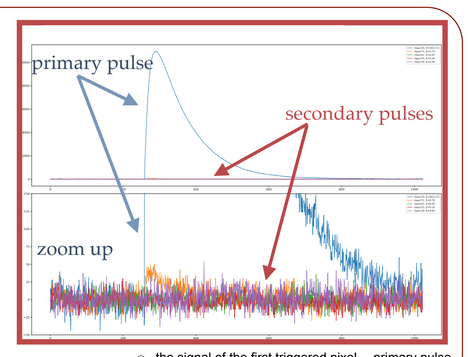
2. Group Trigger Function

a channel is triggered
↓
trigger the neighboring pixels at the same time
↓
store the waveforms

Refer to S. Yamada et al. (Poster, 117-61)

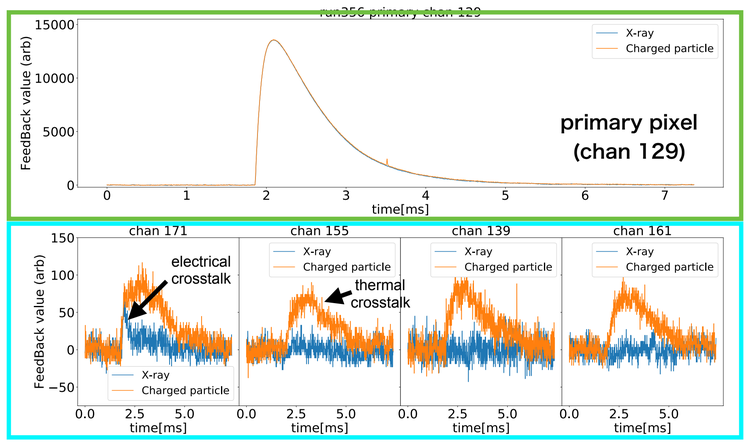
Process flow of the group trigger

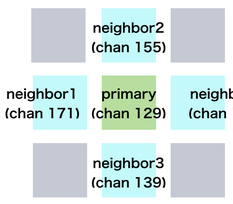
Useful method for reducing the crosstalk and restore energy resolution
using the waveforms of neighboring pixels



- the signal of the first triggered pixel… primary pulse
- the nearby four pixels' signals… secondary pulses

group trigger function



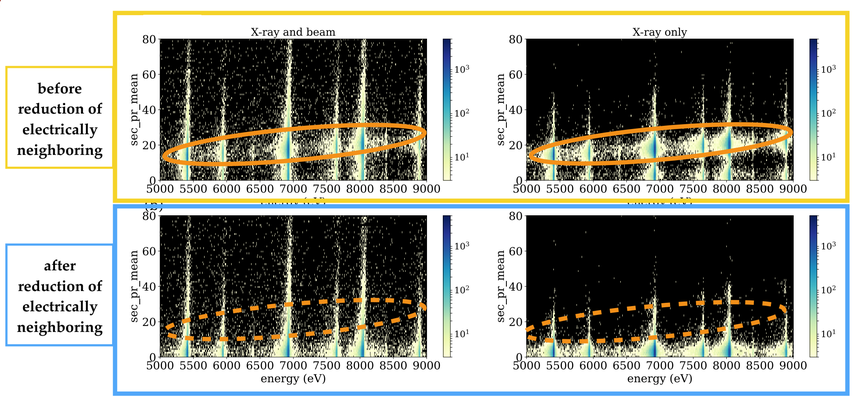


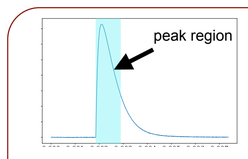
thermal and electrical crosstalk can be seen

Event reduction and improve S/N ratio

Waveforms and channel distribution for the analysis in this poster

3. Waveform Analysis with Group Trigger



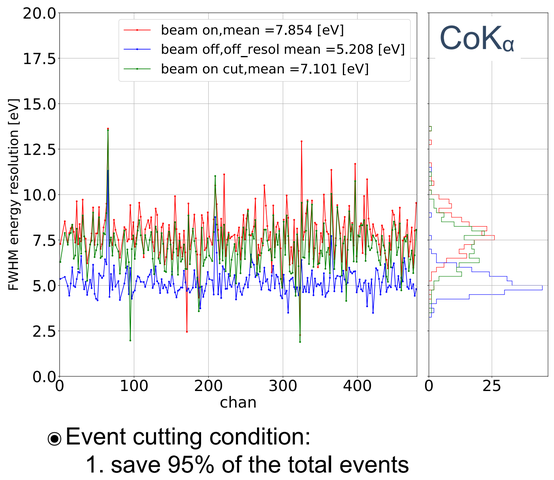


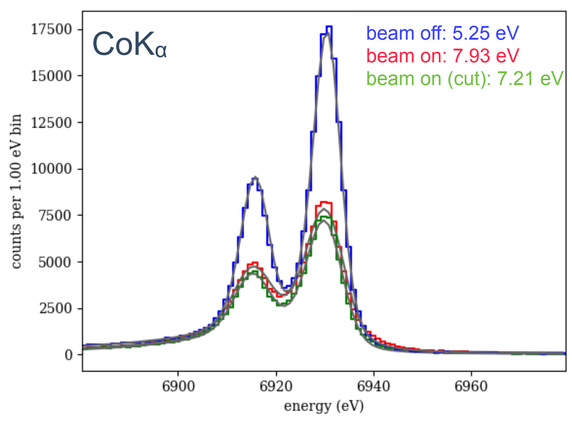
1. calculate each averages of peak region for the secondary pulses
2. The maximum of the 1. in the nearby four pixels is called "sec_pr_mean"

sec_pr_mean

◉After reduction of the electrically neighboring pixels, the energy correlated component has disappeared
→ We could distinguish the events which are really piled up by the charged particle effect.

Waveform feature of the secondary pulses





◉Event cutting condition:
1. save 95% of the total events
2. parameter (sec_pr_mean) is optimized for maximum S / N ratio

Refer to S. Yamada et al. (Poster, 117-61)

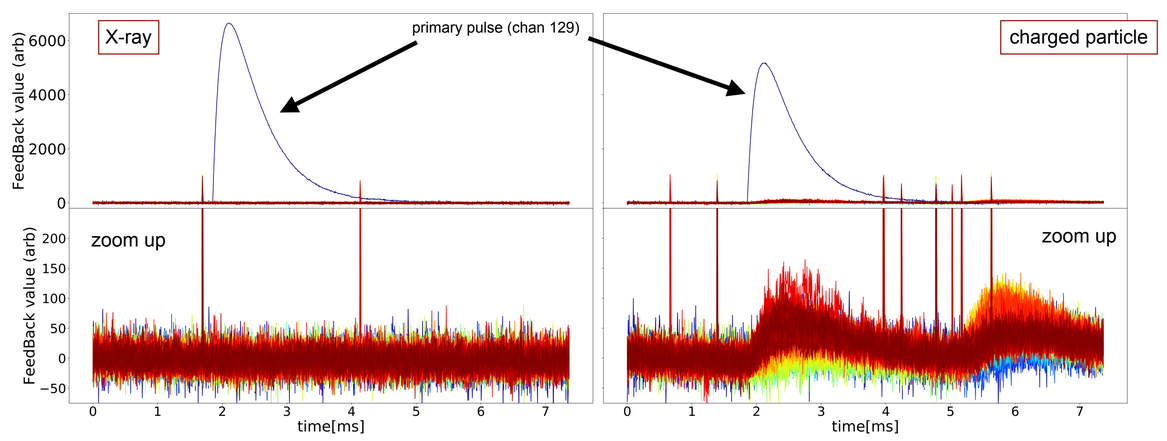
➡◉FWHM energy resolution is improved for ~ 0.7 eV
by using group trigger cut (sec_pr_mean < 24)

Still room to improve energy resolution and S/N ratio

Refer to H. Tatsuno et al. (Poster, 104-203)

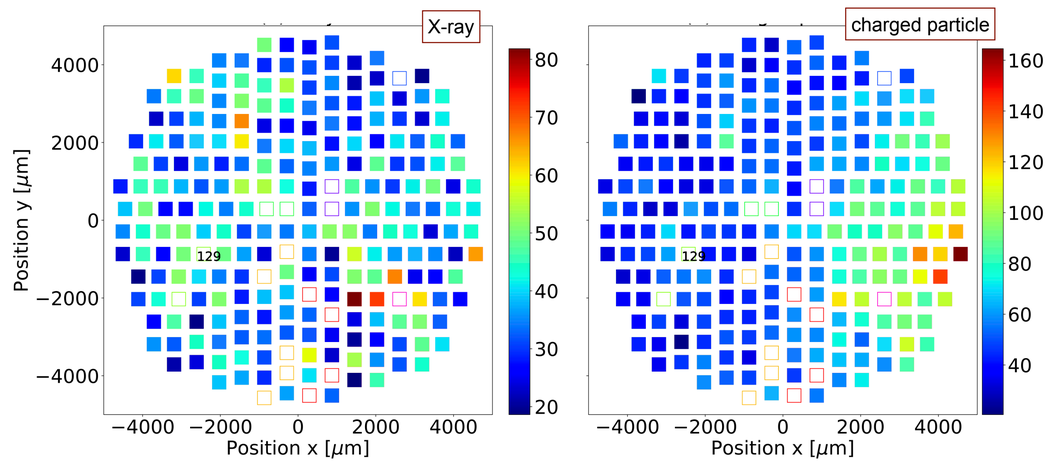
Improvement of energy resolution

4. Data Acquisition with grouping entire pixels



◉Thermal crosstalk can be seen at many pixels in the TES array
◉piled-up secondary pulses were almost simultaneously with primary pulse
◉some spikes in the waveforms: electrical noise

Waveforms of whole active pixels



◉X-ray signal: maximum of the peak region is random → heat penetration is not occurred
◉Charged particle signal: right side is higher than left → heat penetrated from right
➡succeeded in identifying the input particles using spacial energy distribution

Distribution of max. of peak region

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