

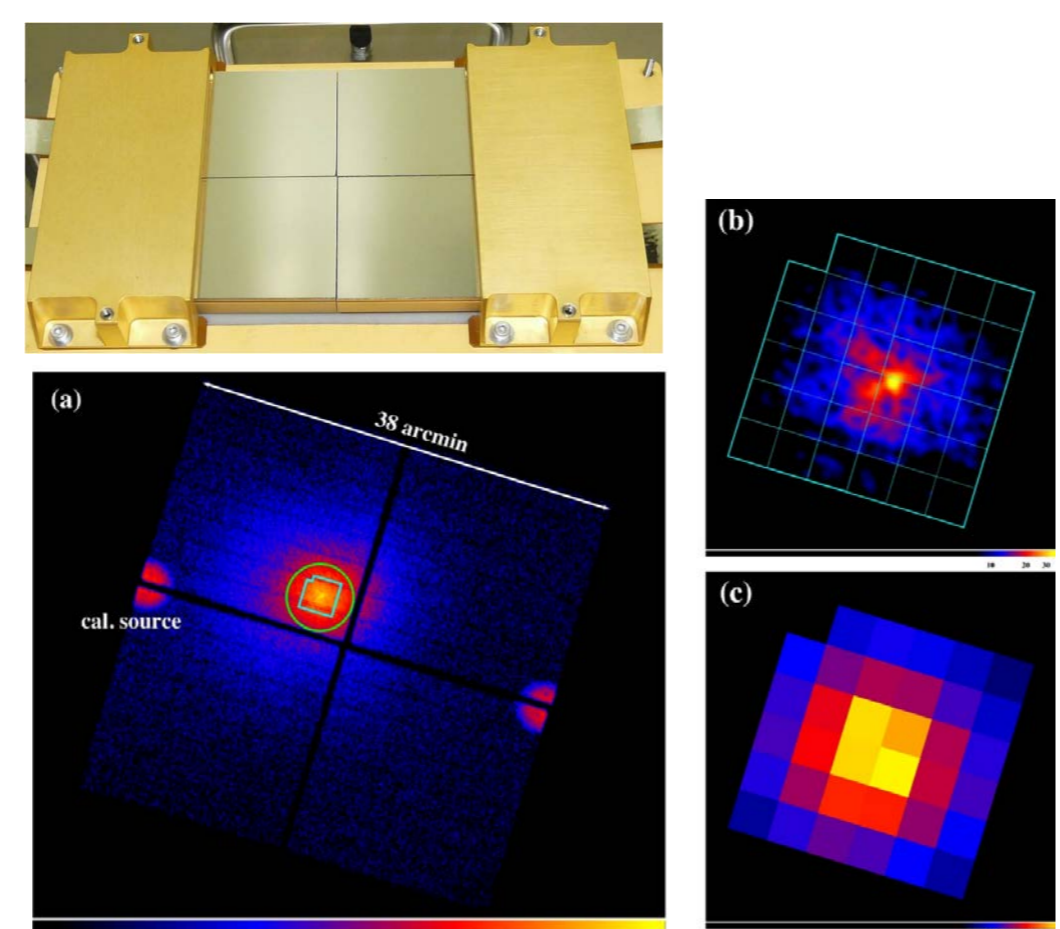
Screening and calibration of XRISM/Xtend flight model CCD

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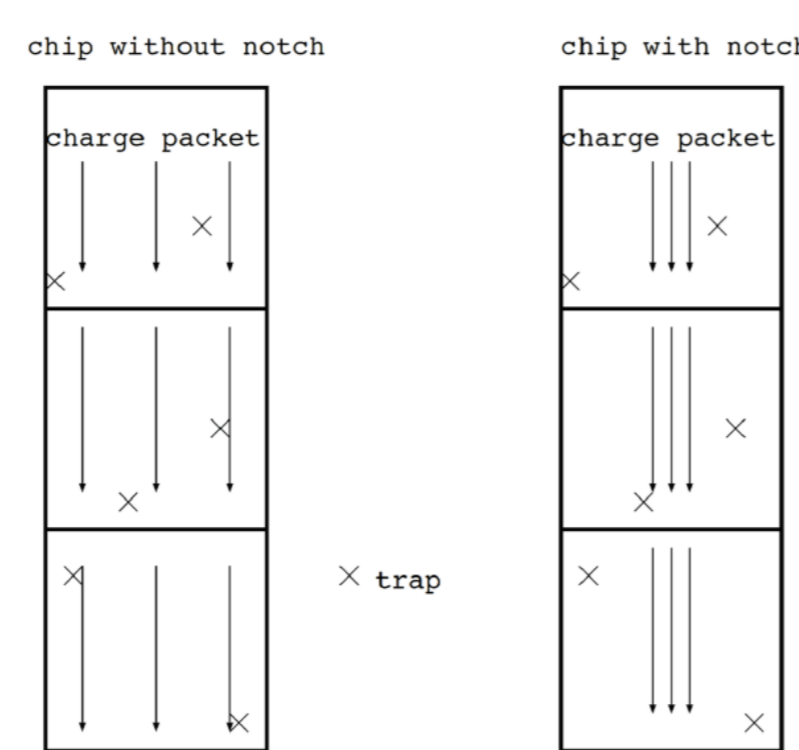
X-ray Imaging and Spectroscopy Mission (XRISM) will be launched in Japanese fiscal year 2021. XRISM has two mission instruments; one is "Resolve", a soft X-ray micro-calorimeter. Another is "Xtend", a soft X-ray CCD camera with a wide field of view of 38' x 38'. Xtend CCDs are designed almost the same as those of Hitomi (ASTRO-H/SXI), whereas some improvements have applied. In 2019, we have performed screenings to choose four flight-model (FM) CCD chips for Xtend from twelve FM candidates provided by Hamamatsu Photonics K. K. After that, we performed on-ground calibration for the selected FM CCD chips to construct CALDB. In this presentation, we report procedures for screening/calibration and results of them.

CCD chips for XRISM/Xtend

- Xtend^[1] is a combination of X-ray Mirror Assembly (XMA) and Soft X-ray Imager (SXI; X-ray CCDs). Xtend has a band pass of 0.4–13 keV with 38' x 38' of field of view.
- CCD chips are basically designed as those of Hitomi/SXI^[2,3]. However, three improvements prompted by SXI's on-orbit performance are applied:
 - a notch implant in charge transfer path to reduce increment of Charge Transfer Inefficiency (CTI) by radiation damage;
 - enlargement of an Al-coated area at the outer boundary of the wiring area to reduce a light leakage from the CCD edge;
 - double layer coating of aluminum on the Optical Blocking Layer (OBL) to reduce pinholes on it.
- Hamamatsu Photonics K. K. (HPK) have fabricated the Flight-Model (FM) candidates CCDs, from which we select 4 FM CCDs ("screening") and perform on-ground calibration for them in Osaka University (OU).

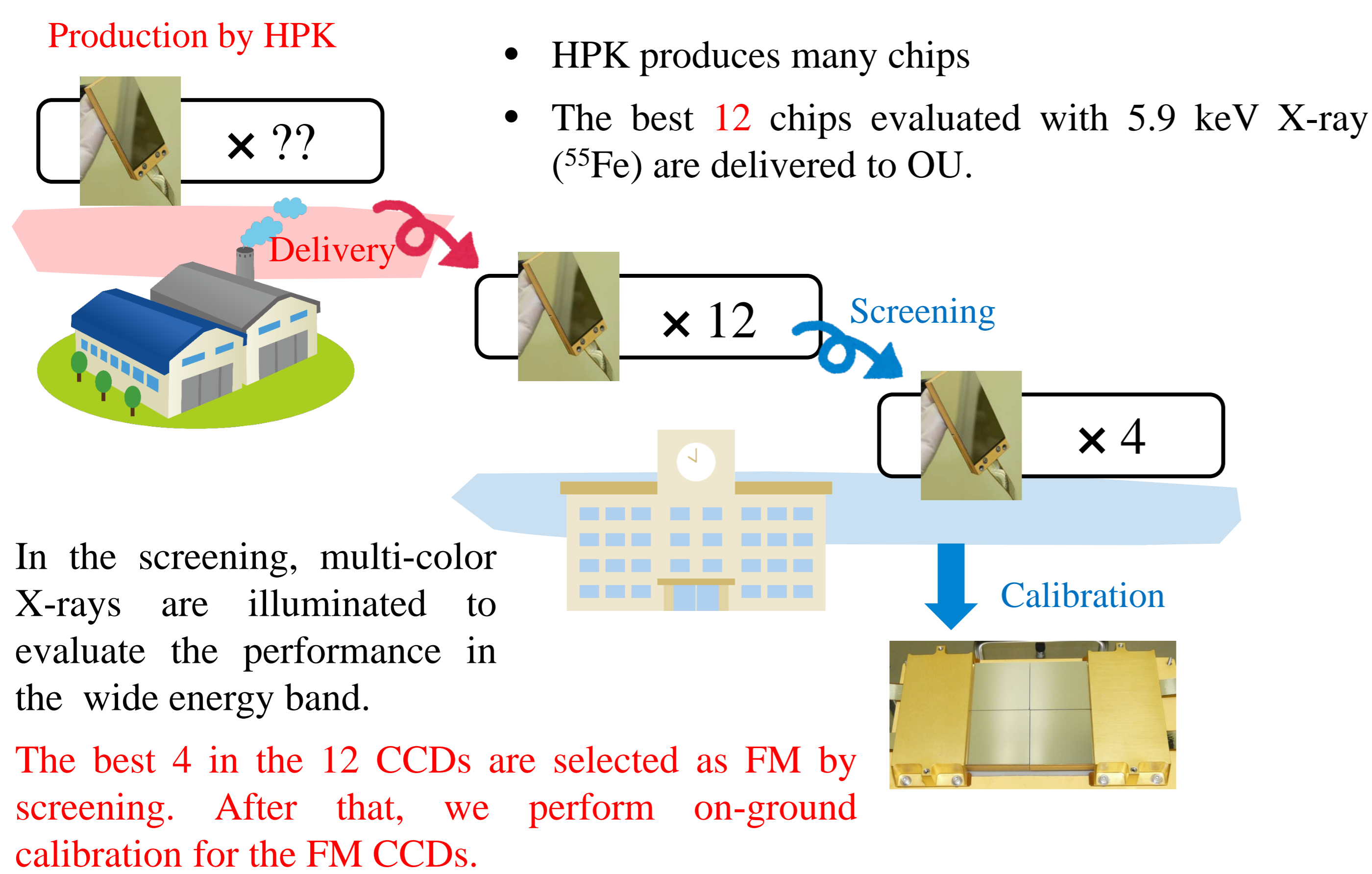


Hitomi/SXI (upper left) and its images (a,b) compared with SXS image (c)

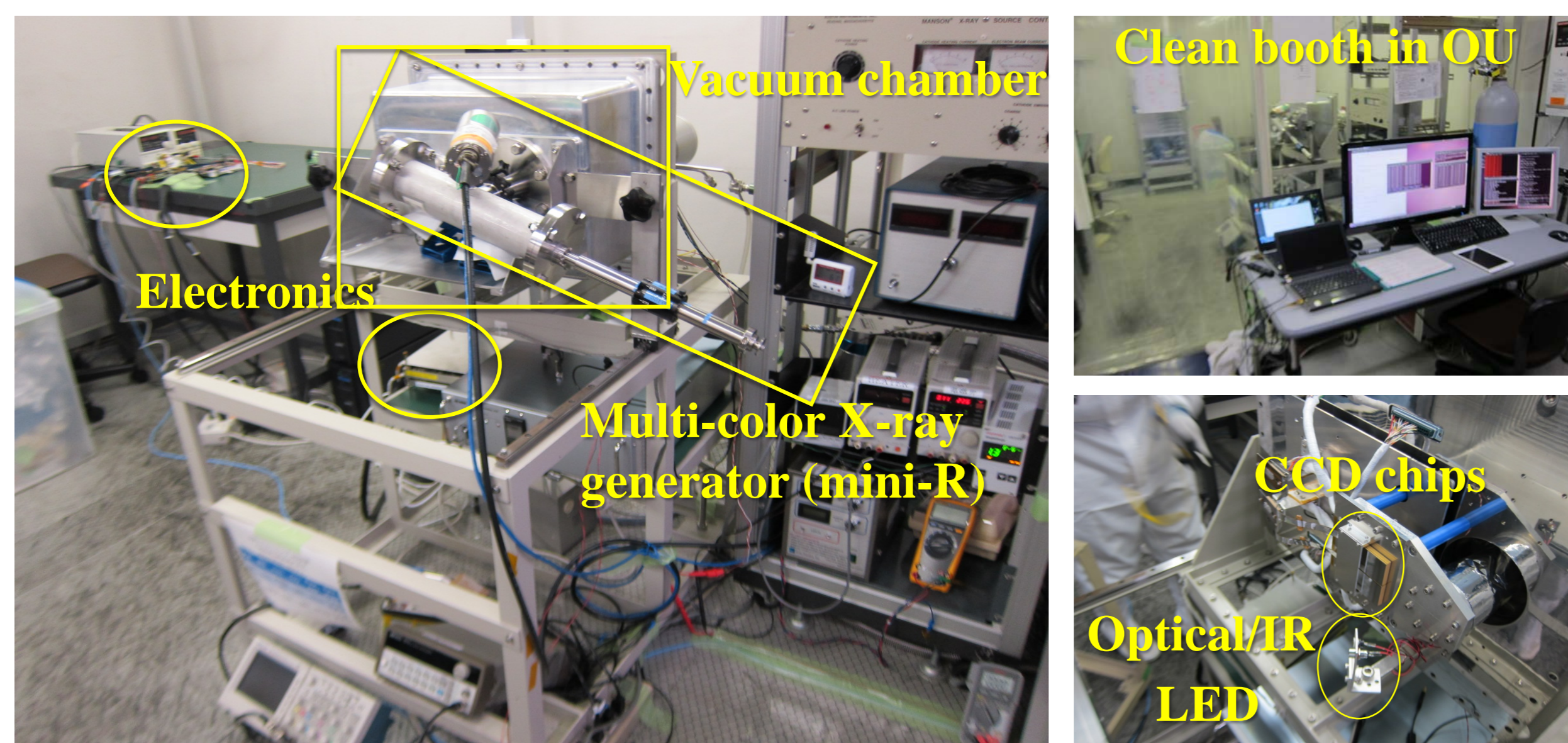


A notch implant

Strategy for the screening & on-ground calibration



Screening/Calibration system



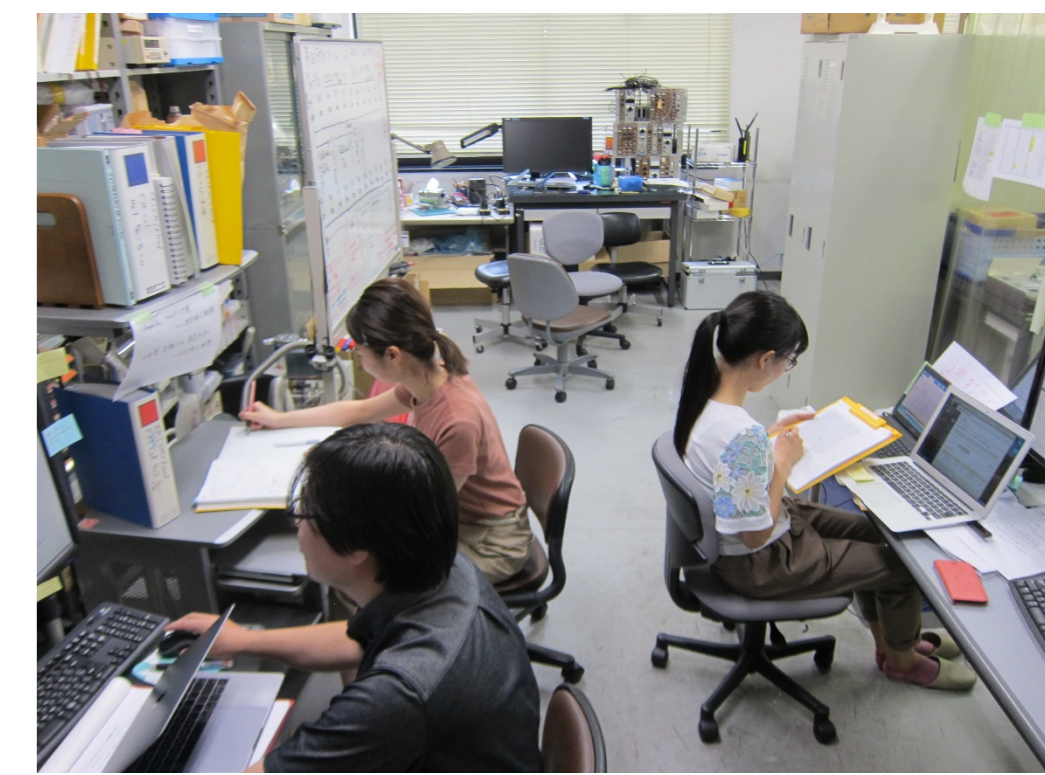
- Can measure 2 CCDs at the same time.
- Mainly using EM electronics of Hitomi/SXI.
- CCDs are operated in -110 deg C to be illuminated multi-color X-ray (⁵⁵Fe, ²⁴¹Am, SiO₂, LiF, and Al) and optical/IR LEDs
- to measure the performances, "CTI", "Energy Resolution", "Soft-X-ray efficiency", and "Optical/IR light leakage".



A CCD package delivered from HPK

Screening/calibration history

2019	Experiments	CCD ID
Mar. 1st	1st rehearsal for FM screening	Hitomi FM candidates
Apr. 15th	2nd rehearsal for FM screening	Hitomi FM candidates
Apr. 18th	1st FM screening	FM02-01, FM02-02
Jun. 20th	2nd FM screening	FM02-01, FM02-02
Jun. 28th	3rd FM screening	FM02-03, FM02-04
Jul. 5th	4th FM screening	FM02-05, FM02-06
Jul. 11th	5th FM screening	FM02-07, FM02-08
Jul. 22nd	6th FM screening	FM02-09, FM02-10
Jul. 29th	7th FM screening	FM02-11, FM02-12
Aug. 20th	8th FM screening	FM02-13
Aug. 30th - Sep. 5th	1st FM calibration	FM02-09, FM02-10
Sep. 24th - Sep. 29th + Dec. 9th	2nd FM calibration	FM02-02, FM02-13



Data acquiring



Operating mini-R

- Screenings have been performed in Apr. - Aug. 2019.
- One more chip has joined to candidates; its too long story to describe here.
- Calibrations have been performed in late Aug. - Sep. 2019.
- Experiments are completed!**

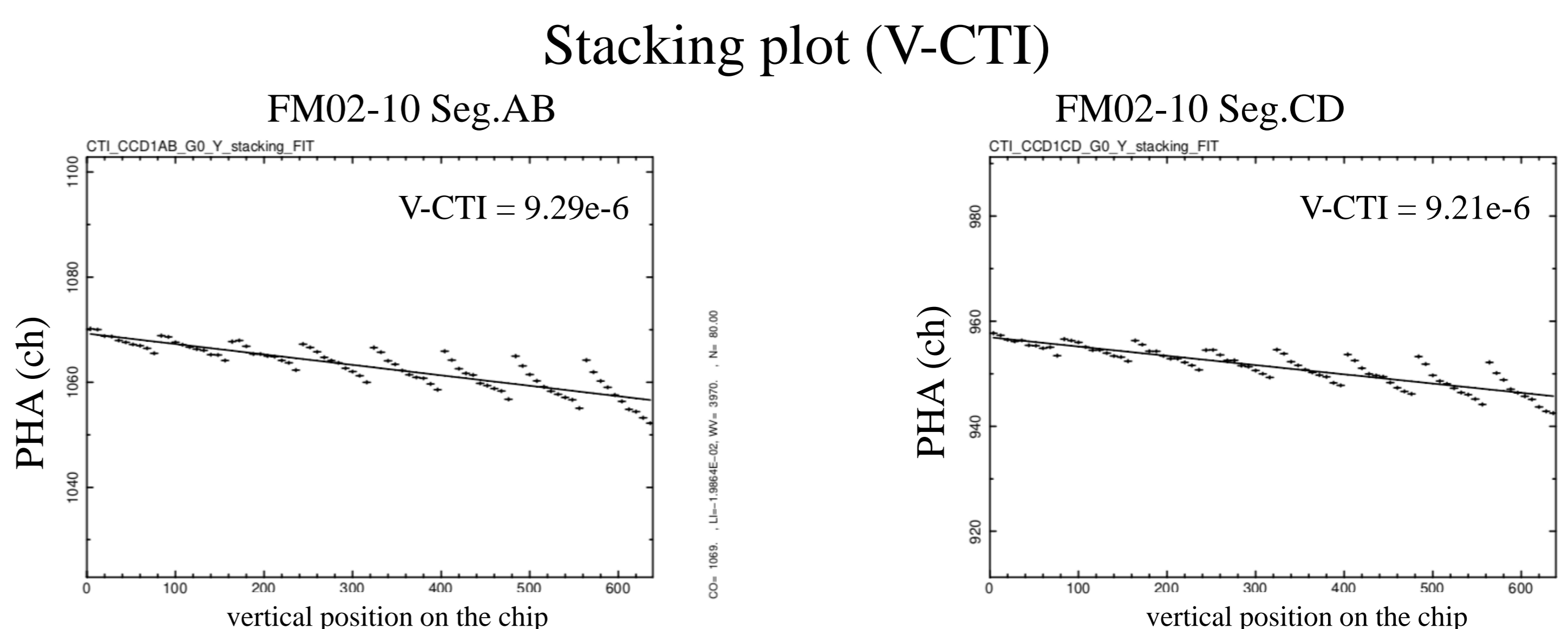
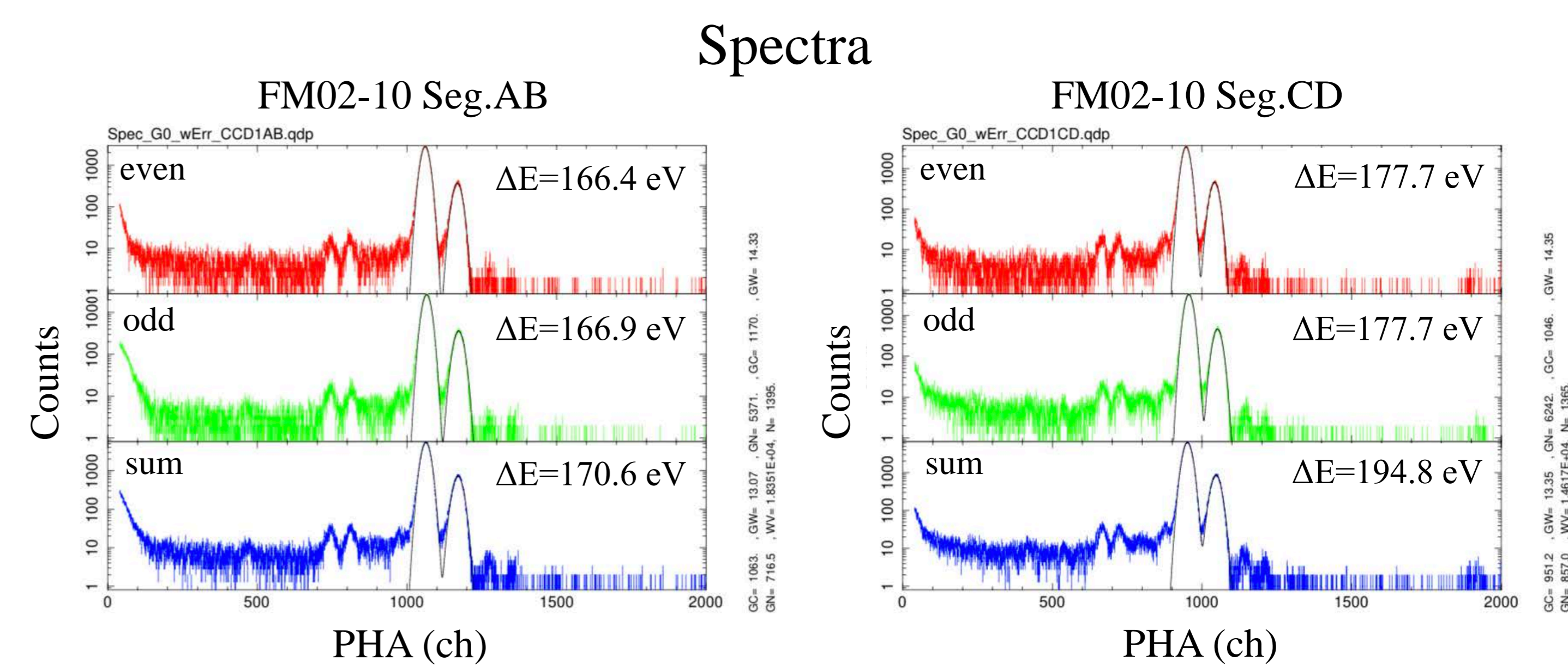
Results

- Quantitating several factors measured in the screenings (CTI, energy resolution etc.), 13 CCDs are ranked.
- The best 4, **FM 02-02, 09, 10, and 13 are selected to be FM.**
- FM CCDs show better/comparable performance than/with those onboard Hitomi. We confirm that they satisfy the requirements to Xtend CCDs (for example, OBL light leakage; see a poster by Uchida et al.).
- Analysis of calibration data are on-going to construct CALDB; to make Redistribution Matrices File (RMF), to obtain CTI correction parameters (see a talk by Kanemaru et al.) and so on.

CCD ID	Score
02	36.9
11	35.9
10	35.1
13	32.6
09	31.2
04	30.6
03	28.6
06	26.7
12	24.9
08	24.6
05	23.9
07	22.7
01	17.9

Performance ranking of the FM candidates

Examples (⁵⁵Fe, grade 0 only, no correction, 2 hours)



Summary

- The best 4 CCD chips was selected for Xtend FM CCDs from 13 candidates.
- On-ground calibration was performed for the 4 FM chips.
- Analysis to construct CALDB is now on-going.
- Many grad. school students work hard!

Reference

- [1] Hayashida, K. et al., SPIE Proc, 10699 [3] Nakajima, H. et al., 2018, PASJ, 70, 21
 [2] Tanaka, T. et al., JATIS, 4(1), 2018