Measurement of X-ray, UV, optical transmission of Contamination Blocking Filter on board Hitomi SXI

Takayoshi Kohmura (Tokyo Univ of Science, Japan)

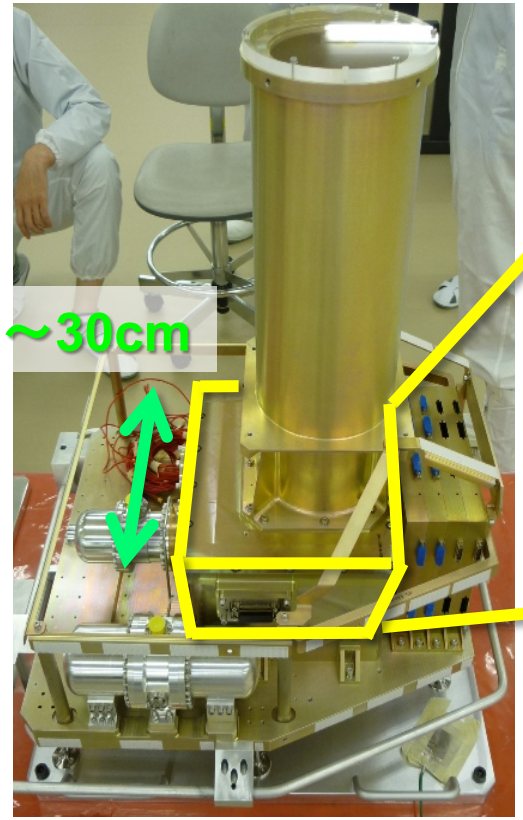
K. Hagino, M. Hayasida., T. Tsujikawa (Tokyo Univ. of Science, Japan), K. Hayashida., H. Matsumoto, H. Noda (Osaka Univ, Japan), H. Tomida, T. Dotani (JAXA, Japan), T.G. Tsuru, T. Tanaka, H. Uchida (Kyoto Univ, Japan), K. Mori (Univ of Miyazaki), H. Nakajima（Kanto Gakuin Univ, Japan）, H. Murakami (Tohoku Gakuin Univ, Japan) and XRISM SXI team

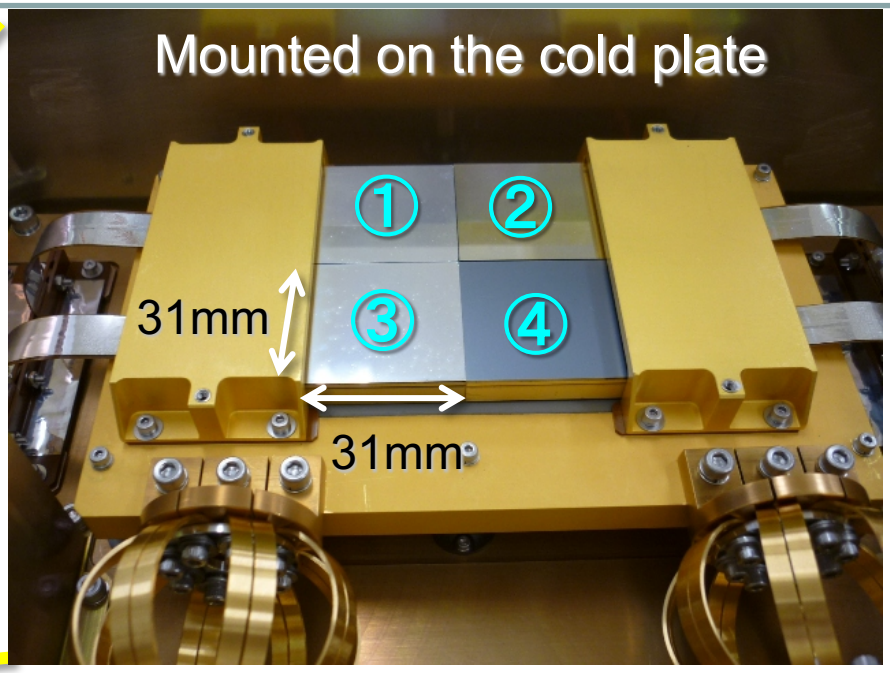
14th Workshop of International Astronomical Consortium for High Energy Calibration
20- 23, May 2019, Shonan Village Center

Outline of this talk

1. Hitomi SXI
2. Contamination Blocking Filter (CBF)
3. Optical transmission of CBF
4. X-ray and UV transmission of CBF
5. Discussion
6. Conclusion

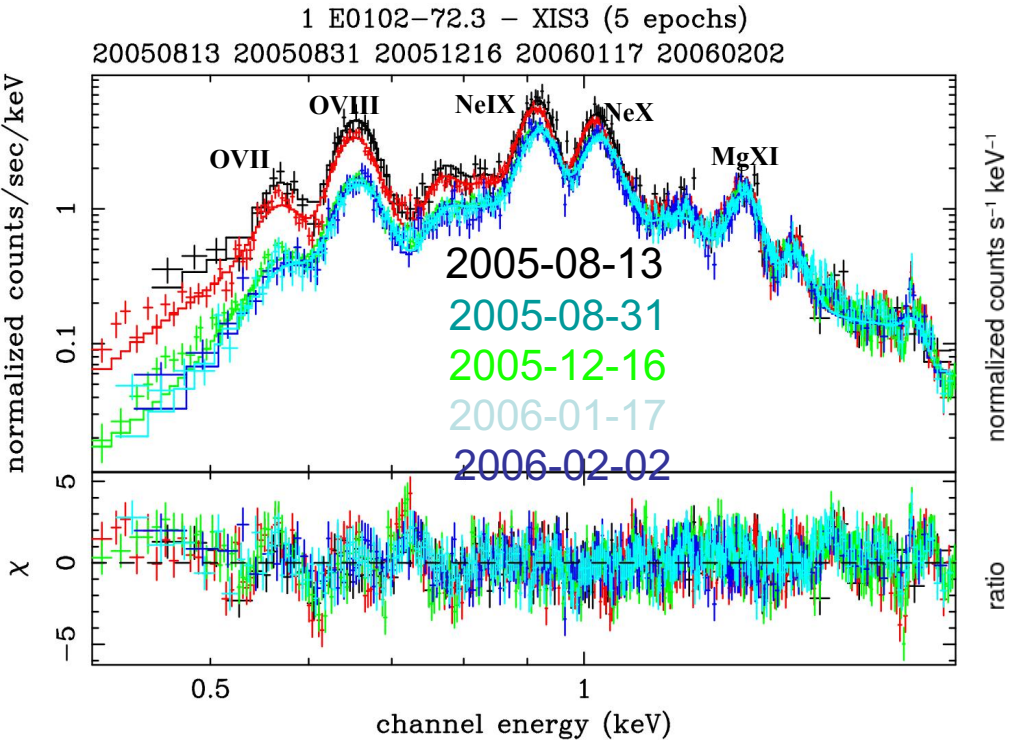
1. Hitomi SXI

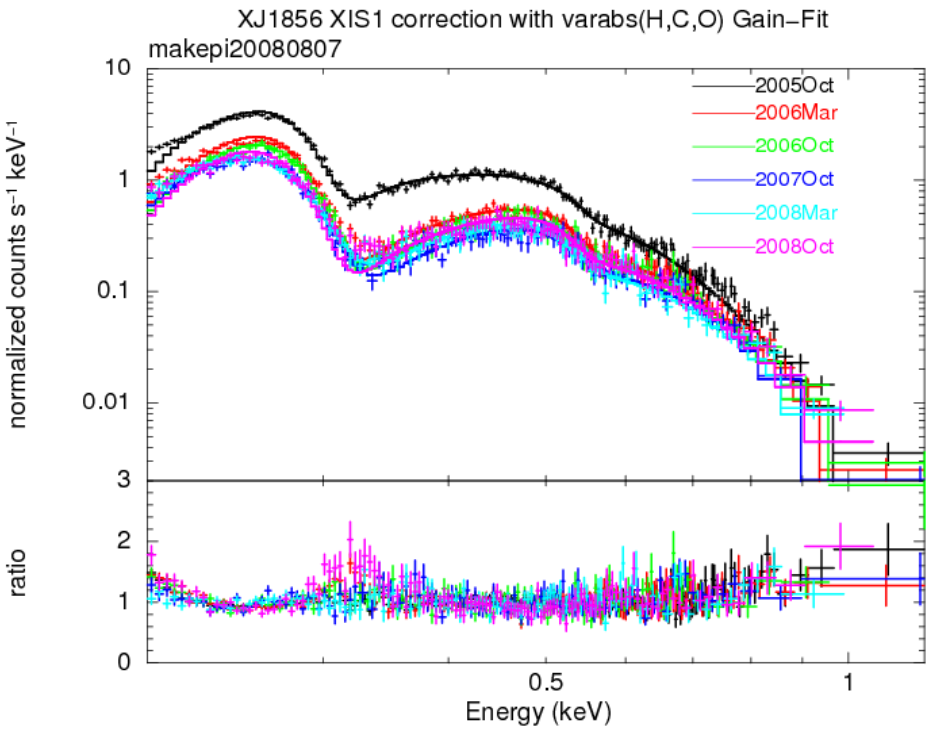




- P-channel CCD manufactured by Hamamatsu Photonics
- BI with depletion layer of 200μm
- 24μm square pixel
- ~62mm x 62mm

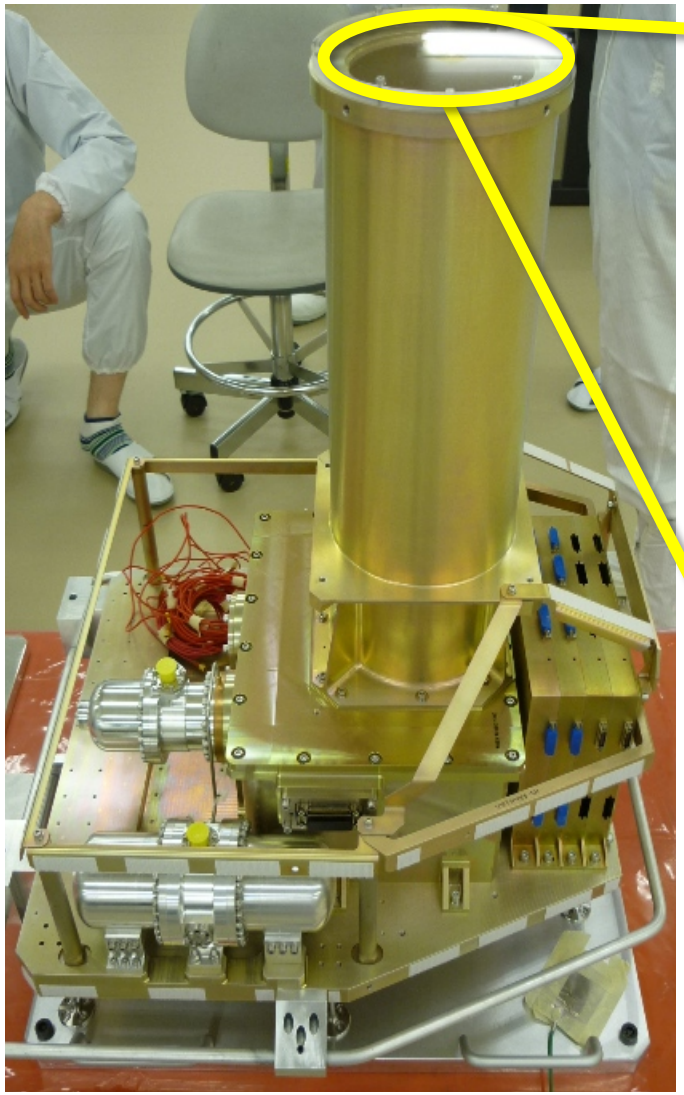
2. Contamination Blocking Filter

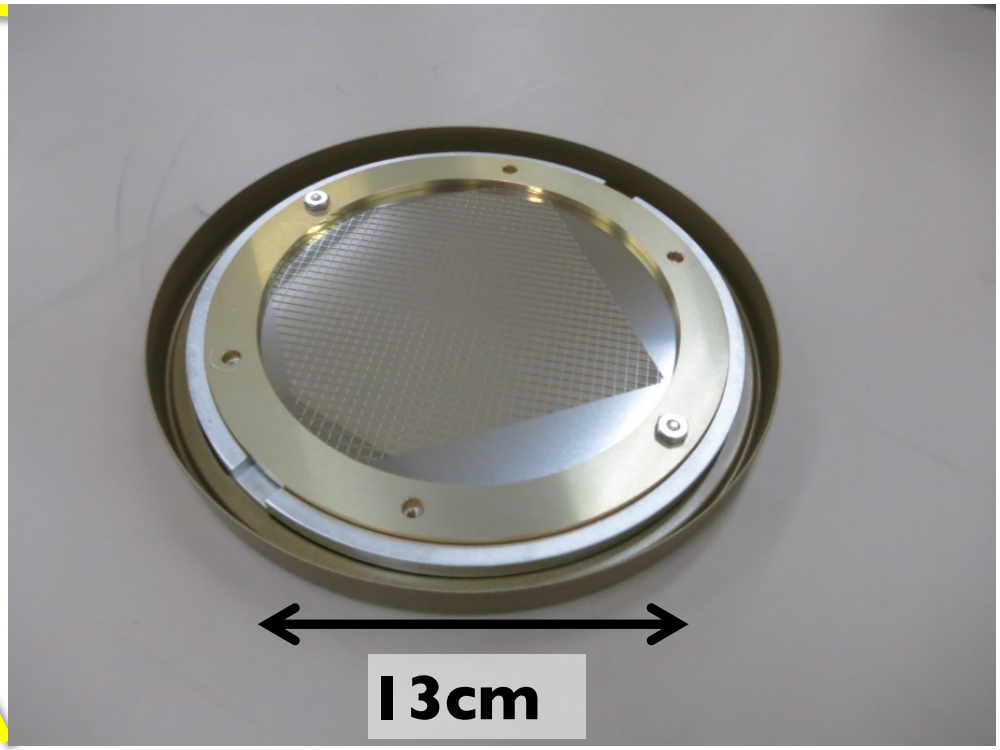




- From our Suzaku XIS experiment in space, we noticed the degradation of QE due to the contamination of material in the satellite.

2. Contamination Blocking Filter





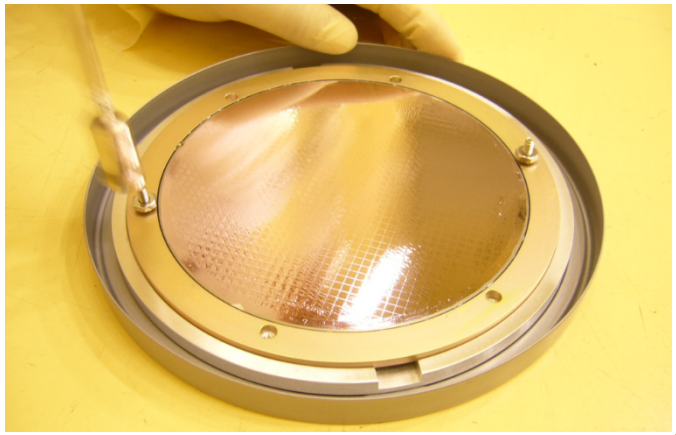
CBF（**C**ontamination **B**locking **F**ilter）
was made by Luxel CLDT
Al ; 80nm and 40nm
Polyimide ; 200nm

2. Contamination Blocking Filter

【 EUV shielding 】

- **CBF**: **C**ontamination **B**locking **F**ilter
- **Pre-FM (before 2015)**

  200nm thick Polyimide was covered with **30nm thick Al layers**.



【 Optical Blocking 】

- **OBL**: **O**ptical **B**locking **L**ayer
- **100nm thick Al** is directly coated over the BI-CCD wafer manufactured by Hamamatsu.

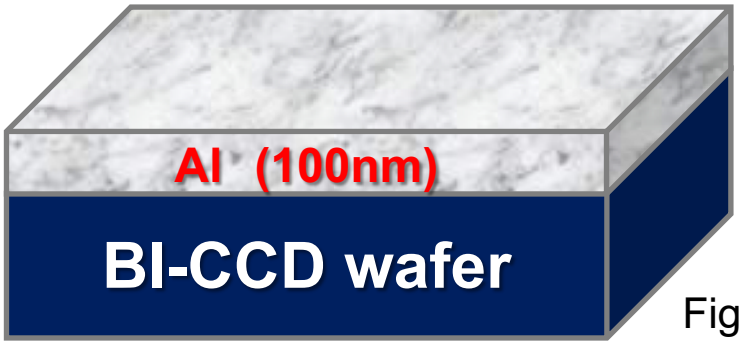
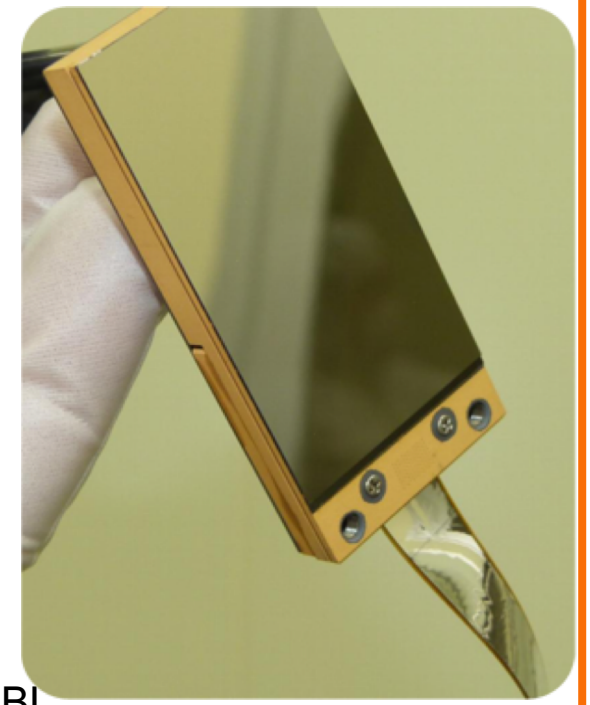
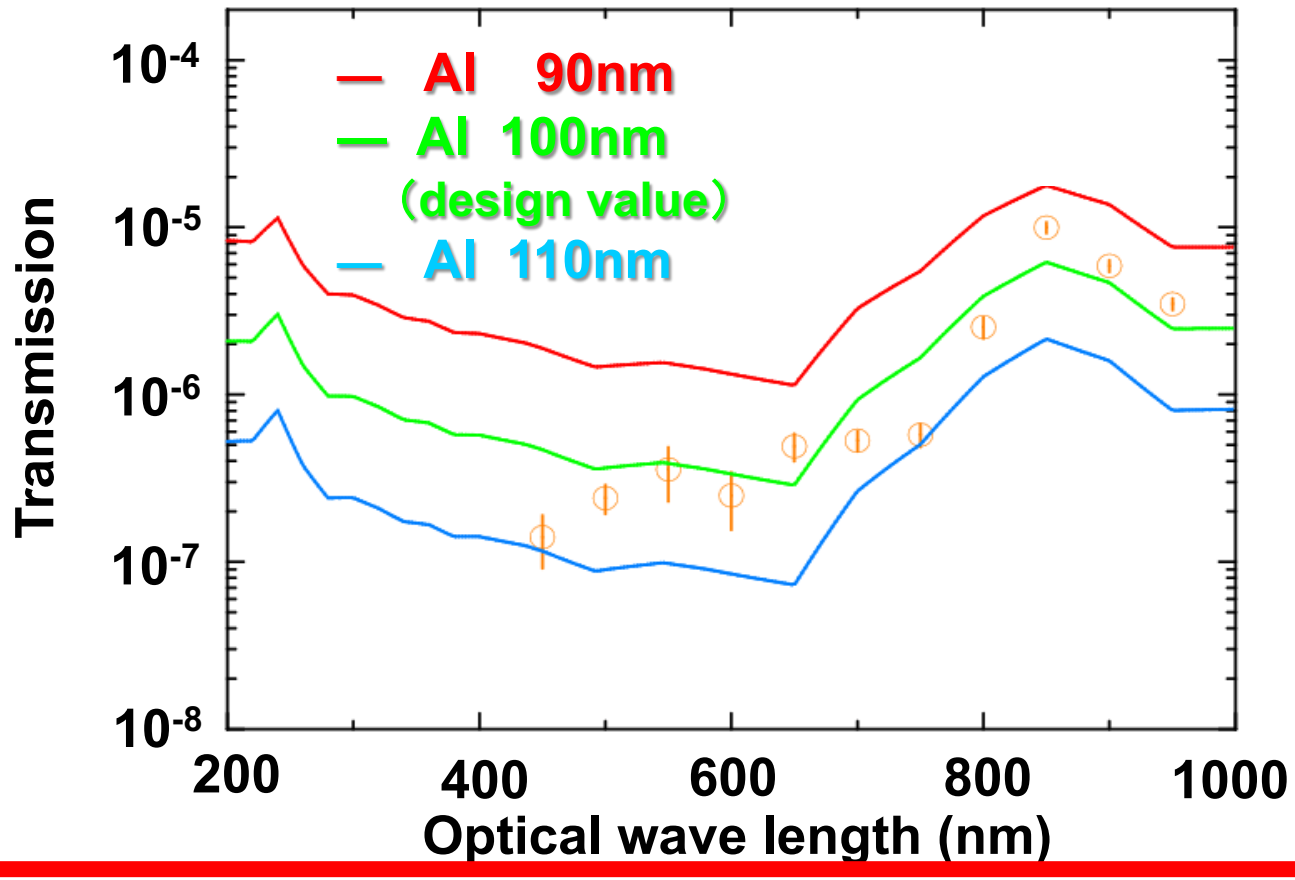


Figure. Schematic view of OBL



2. Contamination Blocking Filter

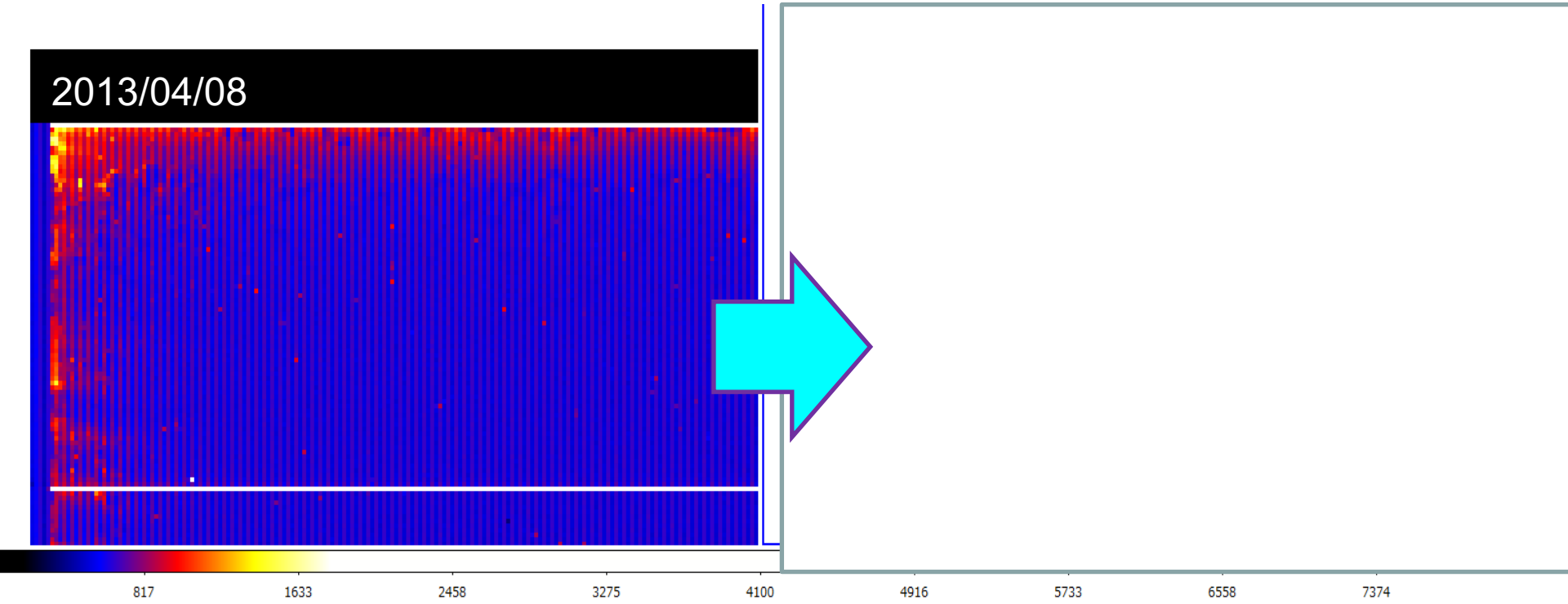
Optical transmission of **OBL**



- We found the optical transmission was < **~10^{-5}** which was equivalent value that we had expected from the design thickness of OBL.

2. Contamination Blocking Filter

Pinholes in Al Coating of **OBL** for Hitomi Satellite

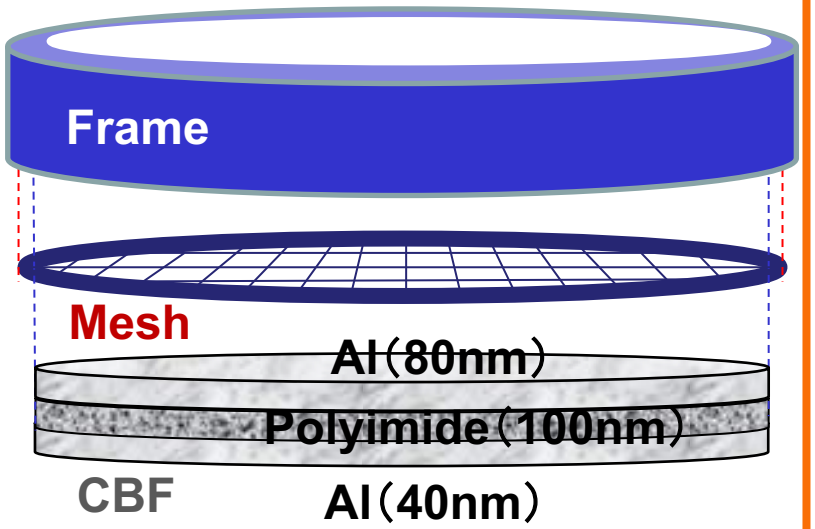


- We had checked the pin holes on OBL by irradiating the optical light.
- But, the number of pin holes was increasing during five months.
- We decided to make the thickness of CBF thicker to block the optical light.

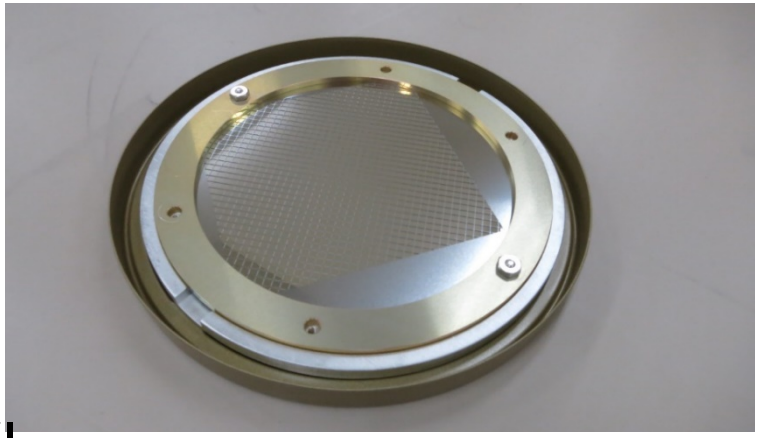
2. Contamination Blocking Filter

FM-CBF (after 2015)

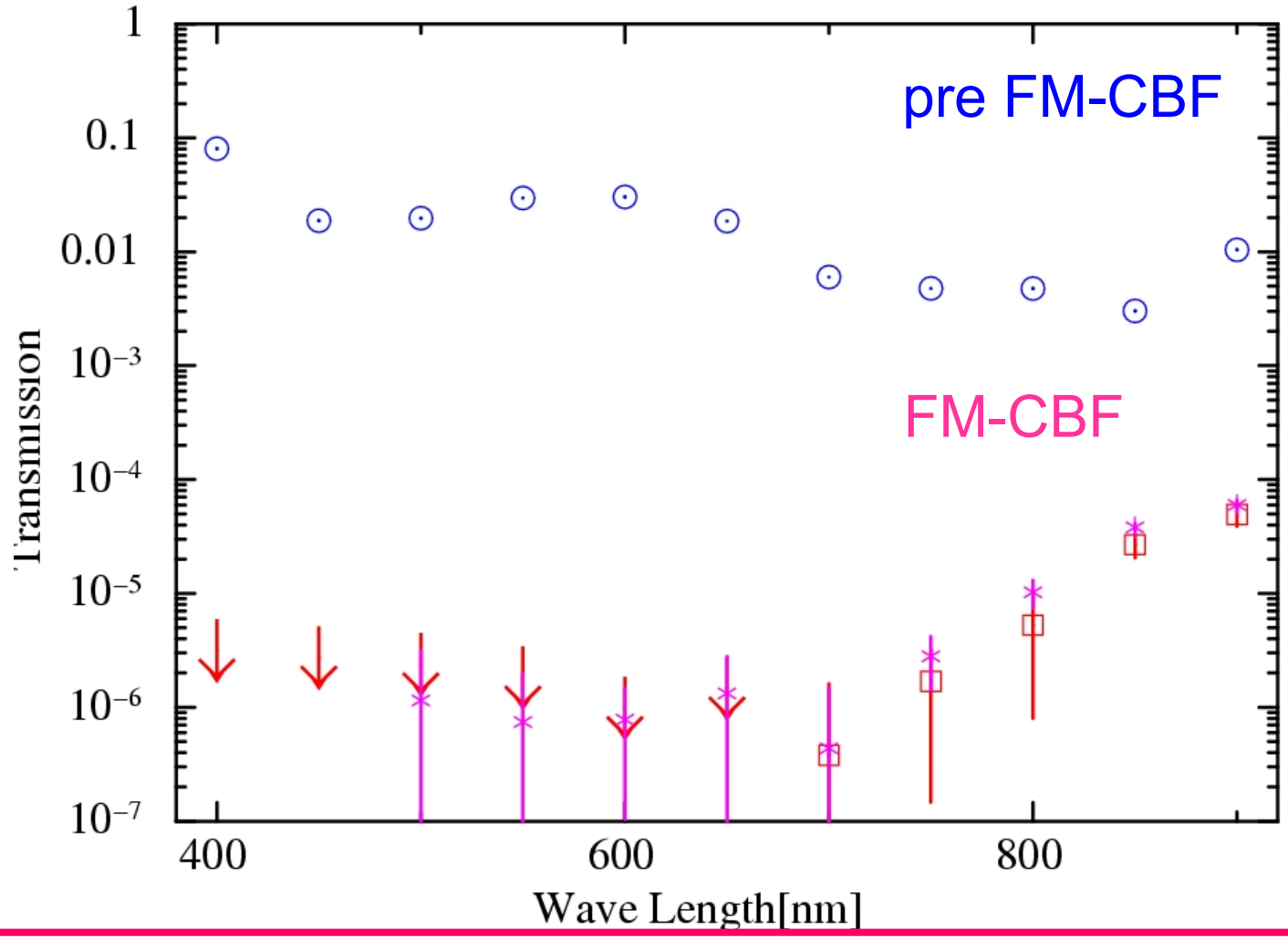
	Pre-FM-CBF	FM-CBF[nm]
Al	30	80
Polyimide	200	200
Al		40



- CBF was supported by the mesh with guard to block solar X-ray scattered middle plate in the satellite.
- The thickness of mesh was 0.3mm, and its interval and width of mesh was 3mm and 0.15mm, respectively.
- This guard did not cut the field of view of SXI.



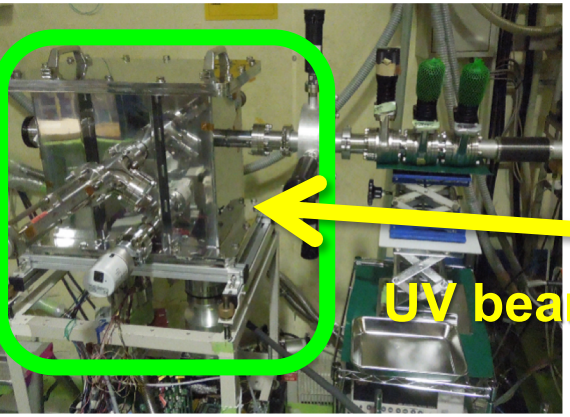
3. Optical Transmission of CBF



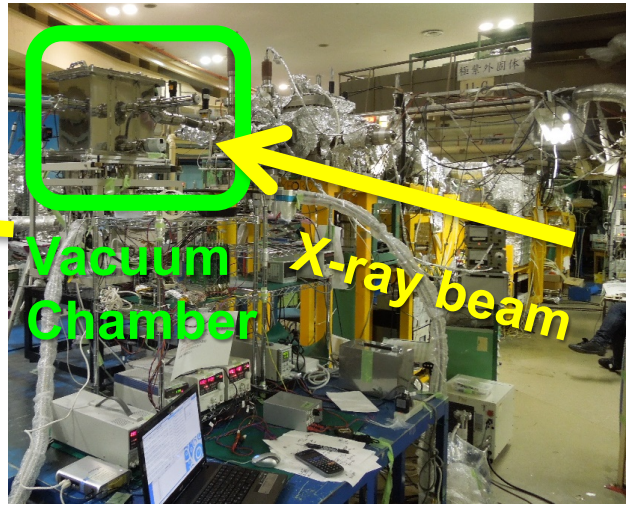
- We confirmed the optical transmission was <∼5x10^{-5} which was expected from design thickness of new CBF.

4. X-ray and UV Transmission of CBF

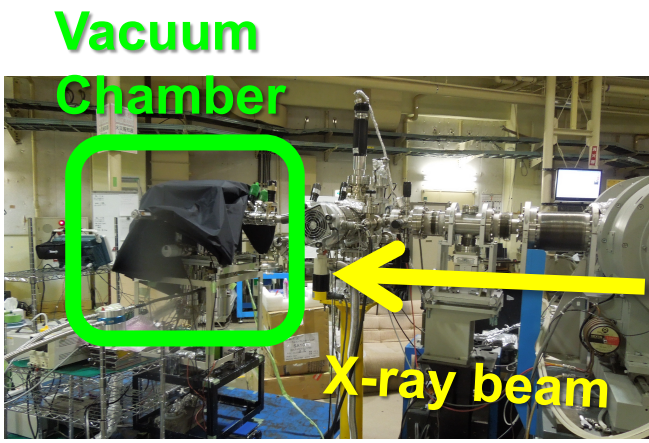
- We measured Soft X-ray and UV transmission of FM-CBF at the synchrotron facility in Japan (KEK Photon Factory).



Fig：BL-20A (20-60eV)



Fig：BL-11A (150-1800eV)

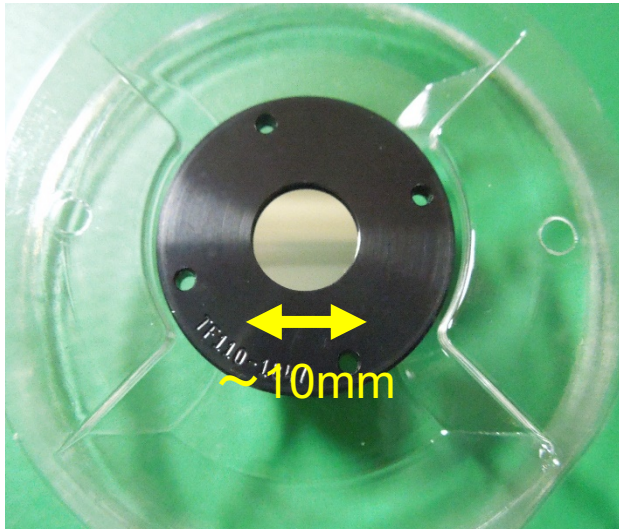


Fig：BL-11B (1730-5000eV)

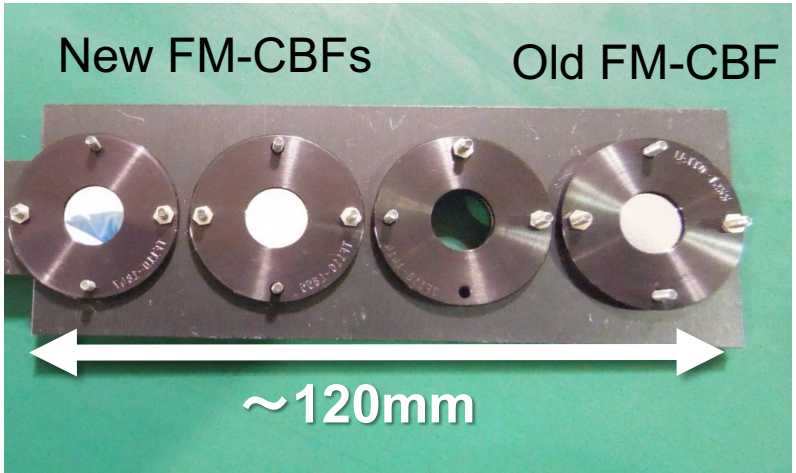
We measured the X-ray (UV) flux using photo diode with/without CBF, and calculated the X-ray (UV) transmission of CBF derived from the flux ratio between two them.

4. X-ray and UV Transmission of CBF

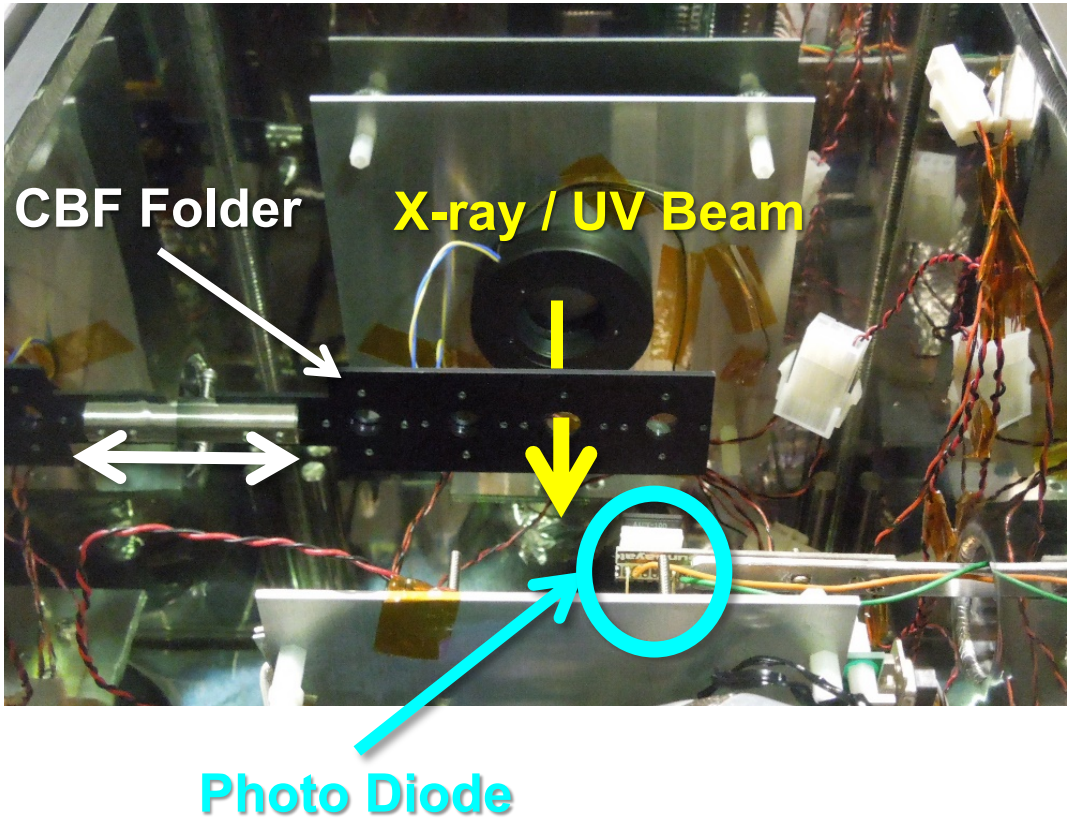
Witness Filter



CBF folder

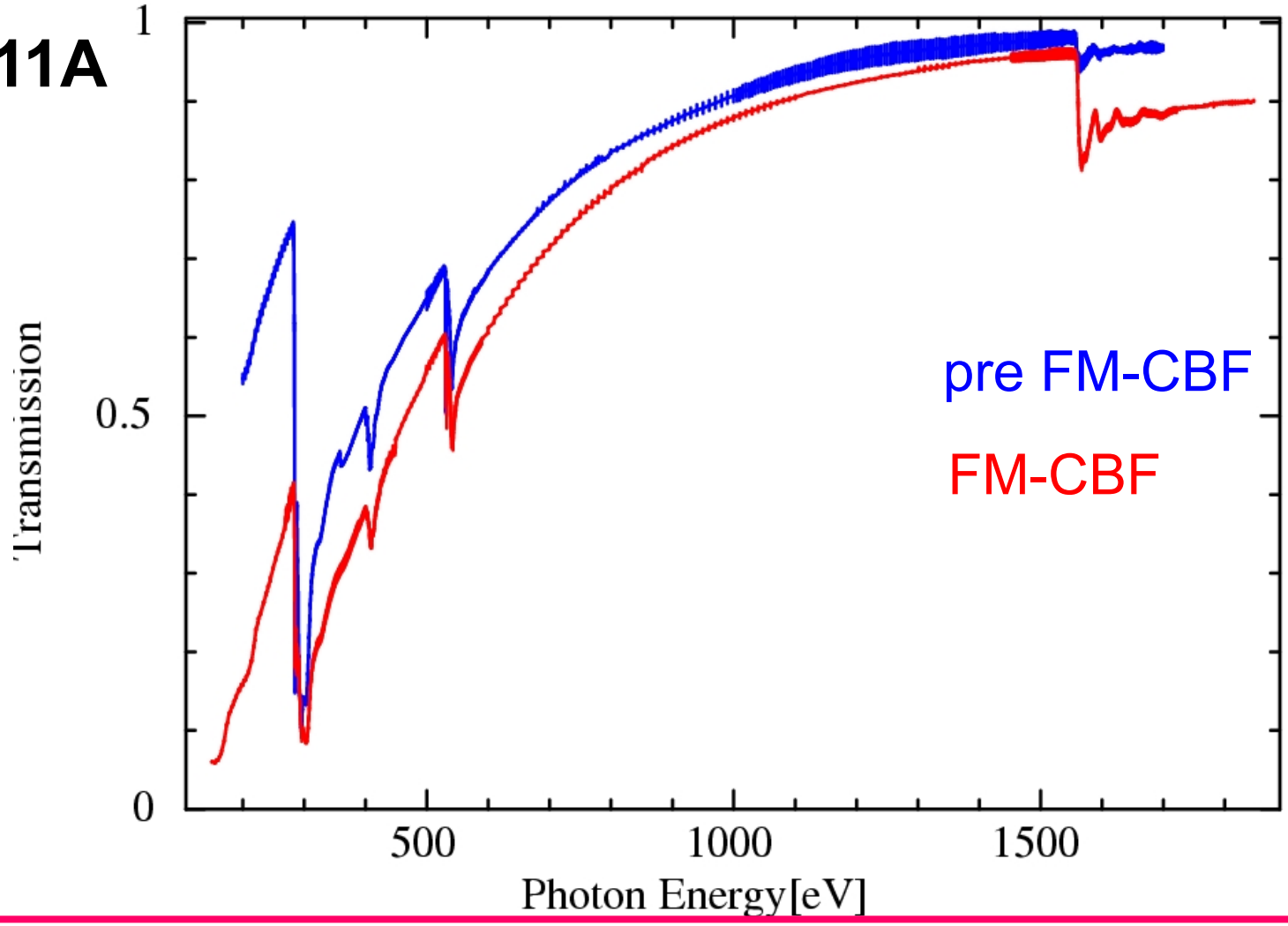


Experimental Set up



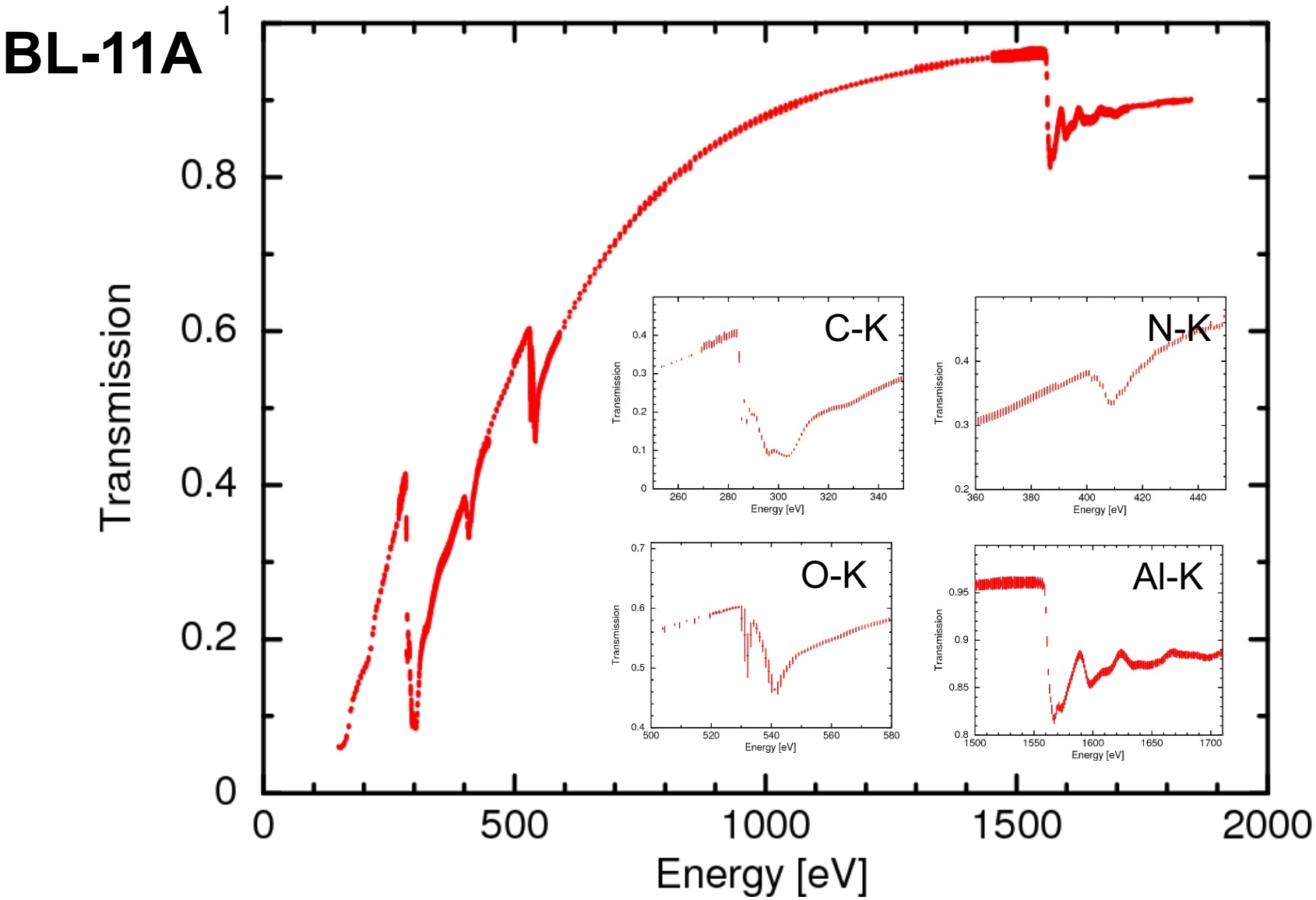
4. X-ray and UV Transmission of CBF

BL-11A



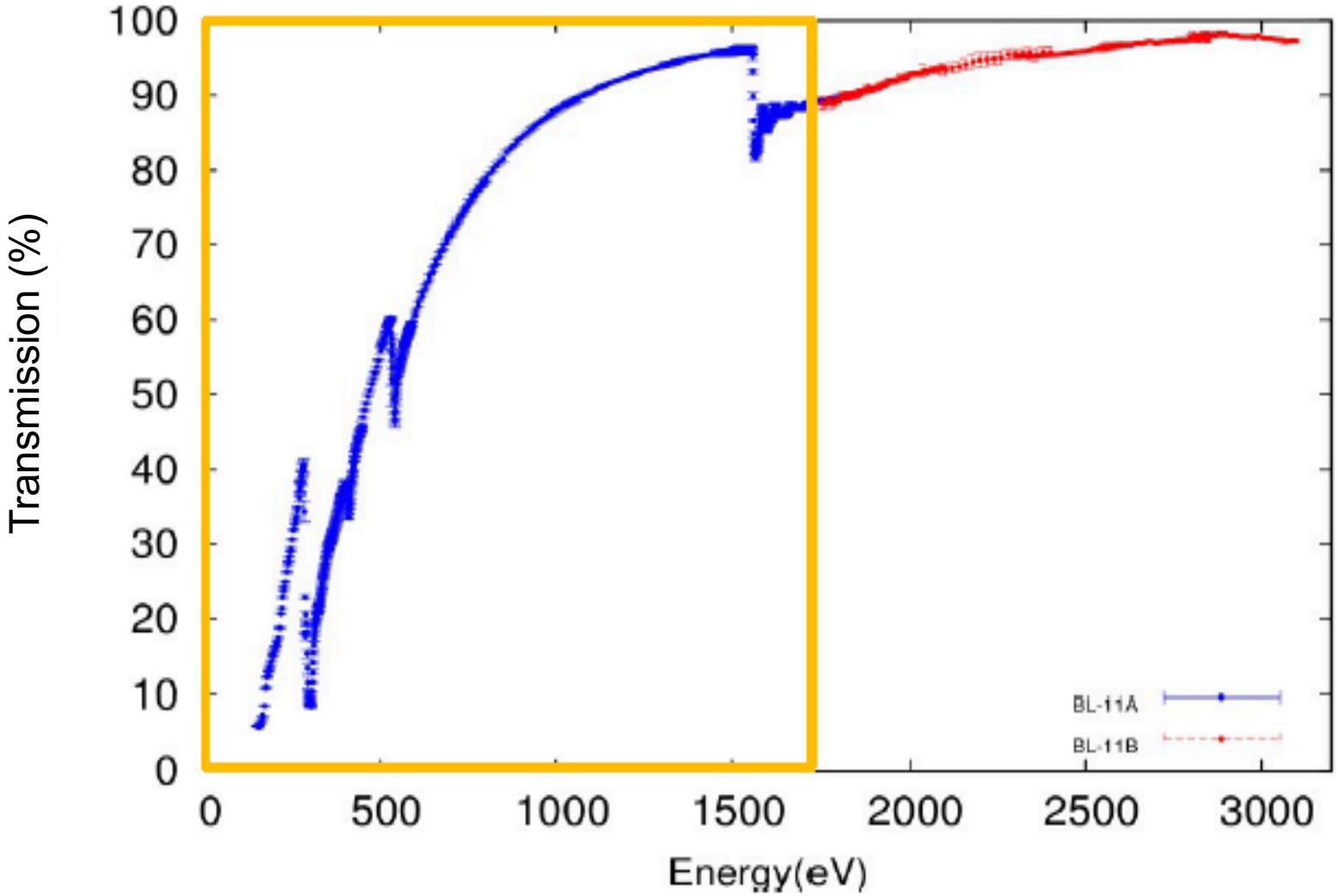
- The X-ray transmission of new FM CBF was lower than old CBF by ～10% at O-K due to the thicker Al.
- The X-ray energy was calibrated using absorption edges of old FM-CBF as a reference

4. X-ray and UV Transmission of CBF



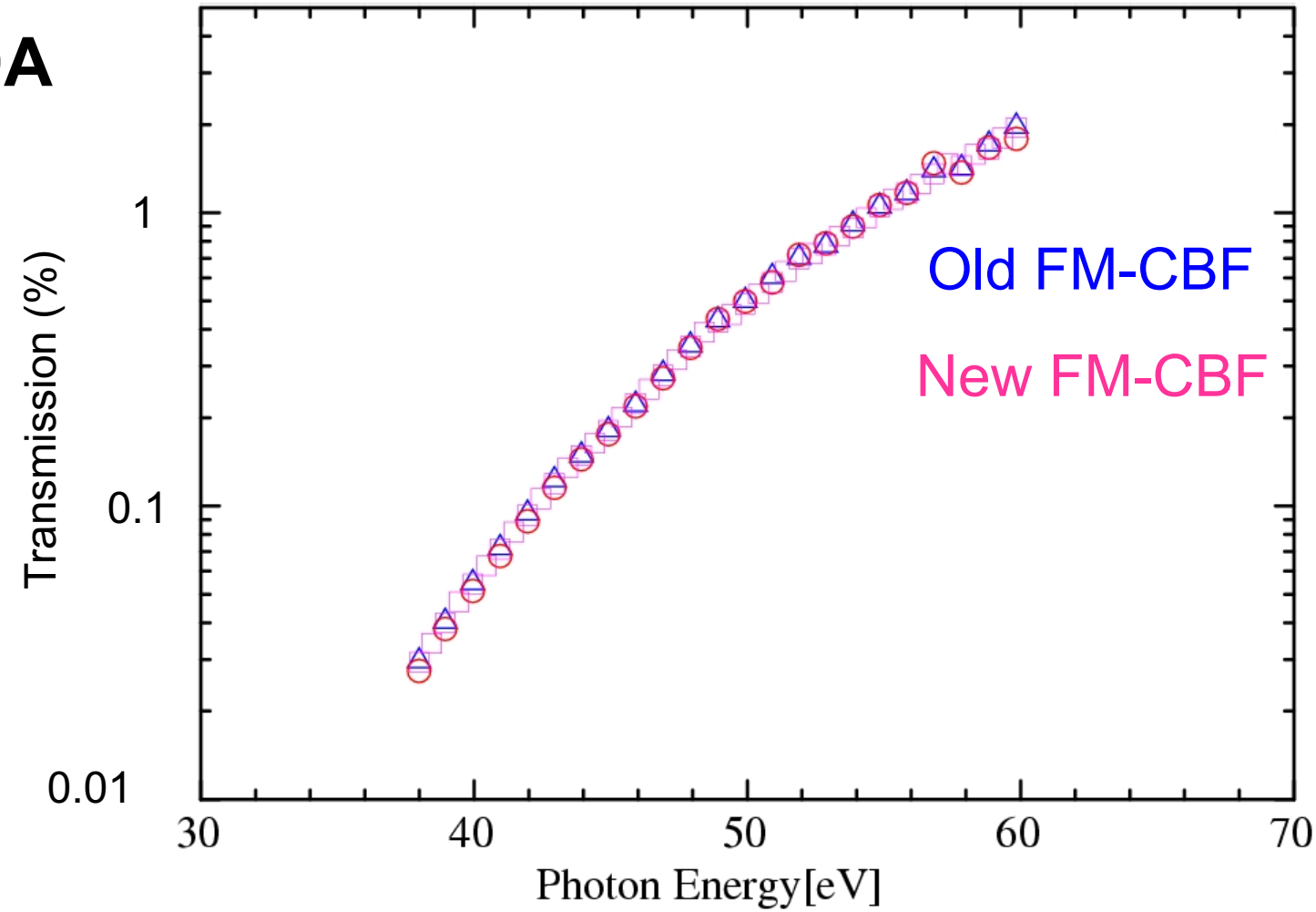
4. X-ray and UV Transmission of CBF

BL-11A+BL11B



4. X-ray and UV Transmission of CBF

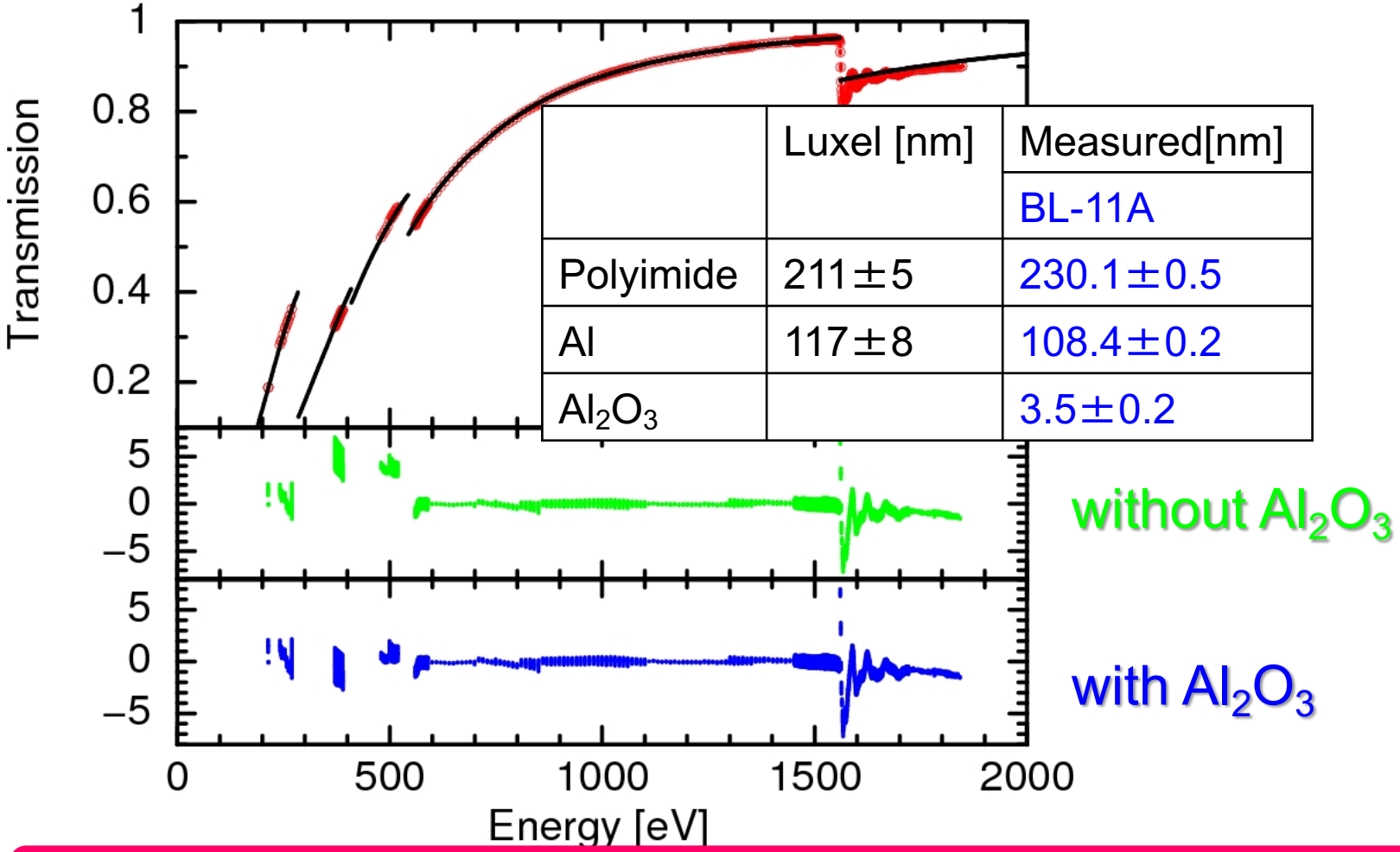
BL-20A



The UV transmission of new FM CBFs was same as its old ones because the thickness of polyimide was not changed.

4.Discussion

BL-11A



	Luxel [nm]	Measured[nm]
		BL-11A
Polyimide	211±5	230.1±0.5
Al	117±8	108.4±0.2
Al_2O_3		3.5±0.2

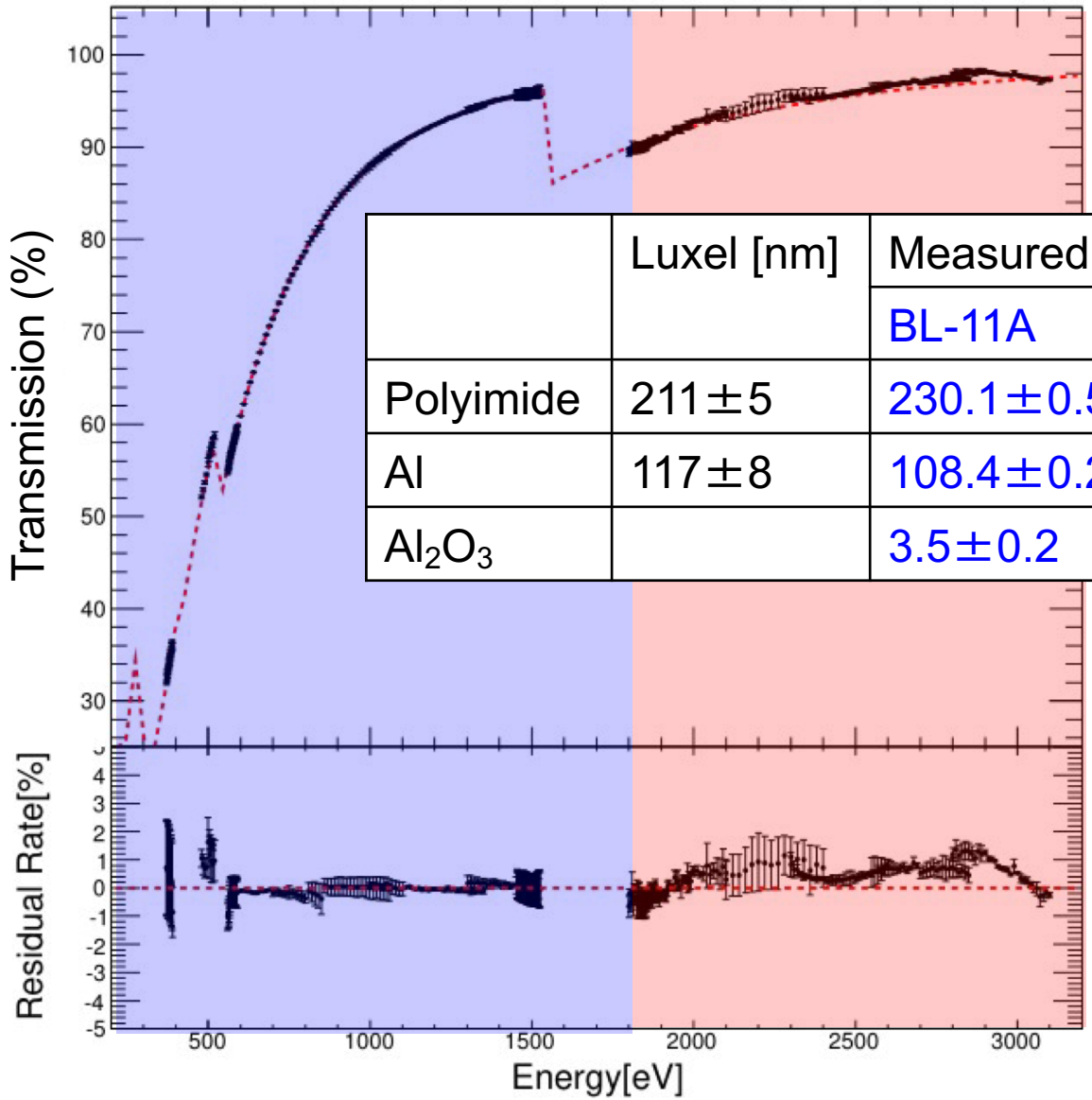
The thickness of polyimide and Al were slightly thicker and thinner value than their reported from Luxel Co LTD.

4.Discussion

BL-11A

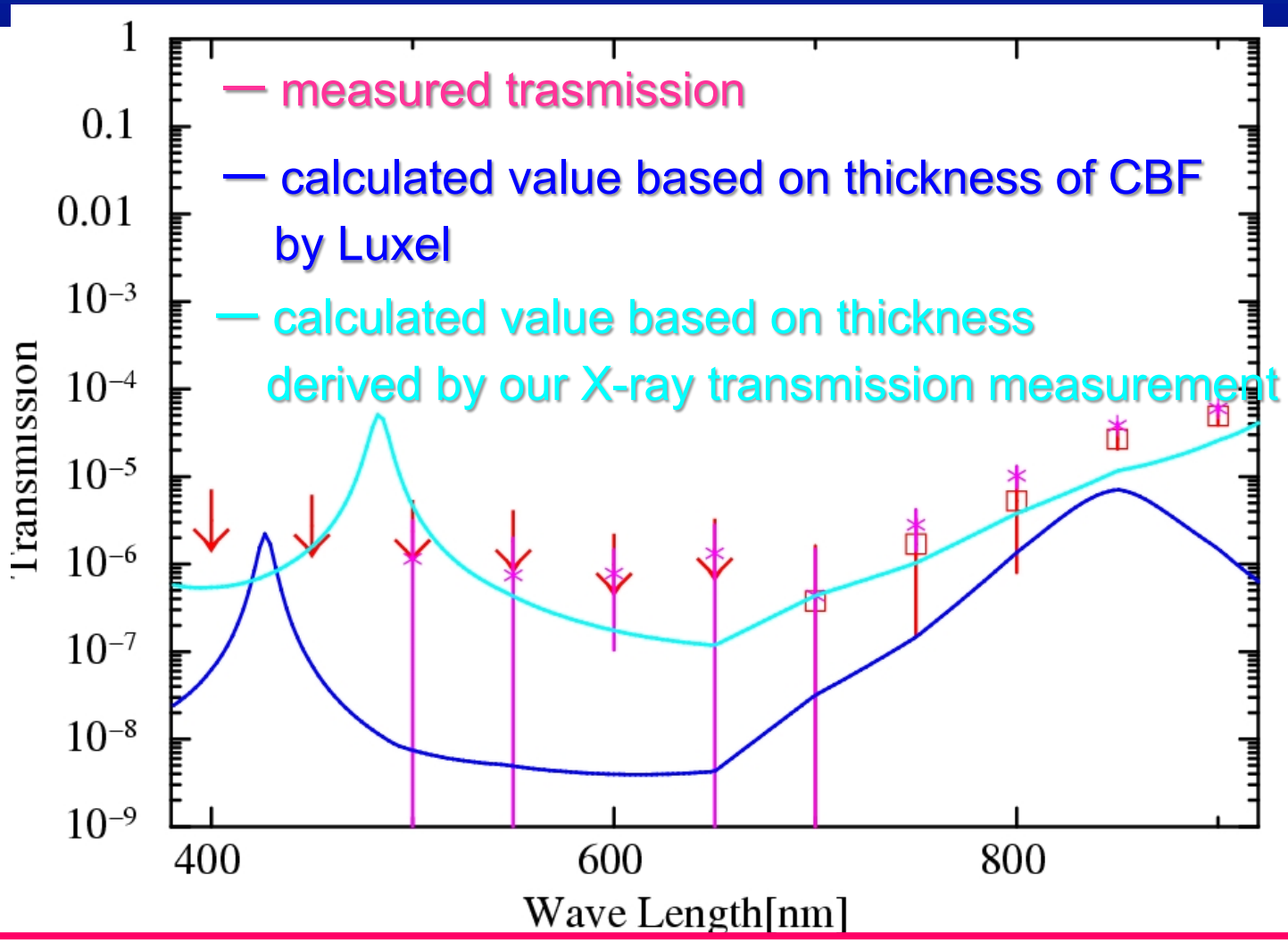
+

BL-11B



	Luxel [nm]	Measured[nm]	
		BL-11A	BL11A+BL11B
Polyimide	211±5	230.1±0.5	231.7±0.5
Al	117±8	108.4±0.2	107.6±0.2
Al_2O_3		3.5±0.2	3.2±0.2

4.Discussion

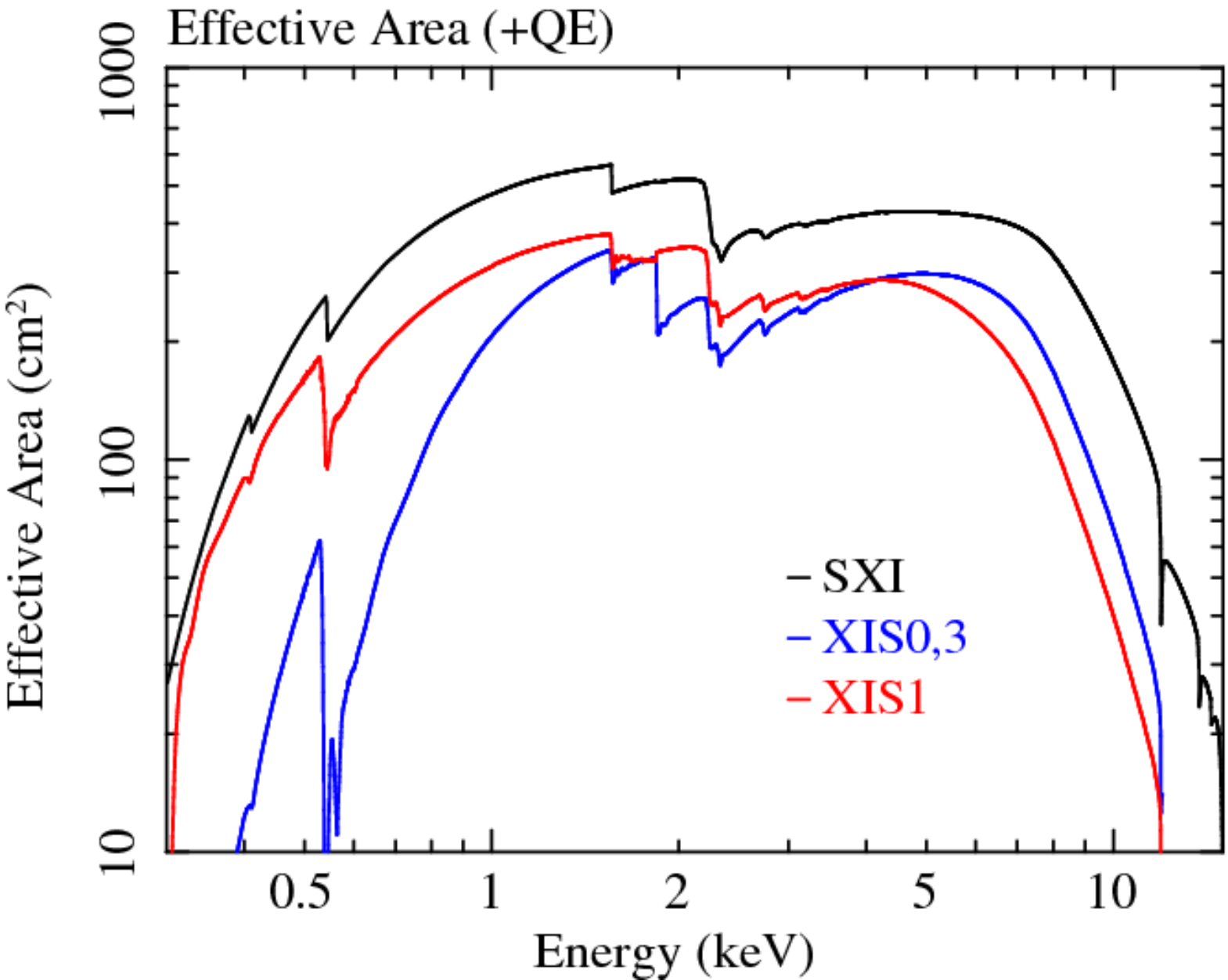


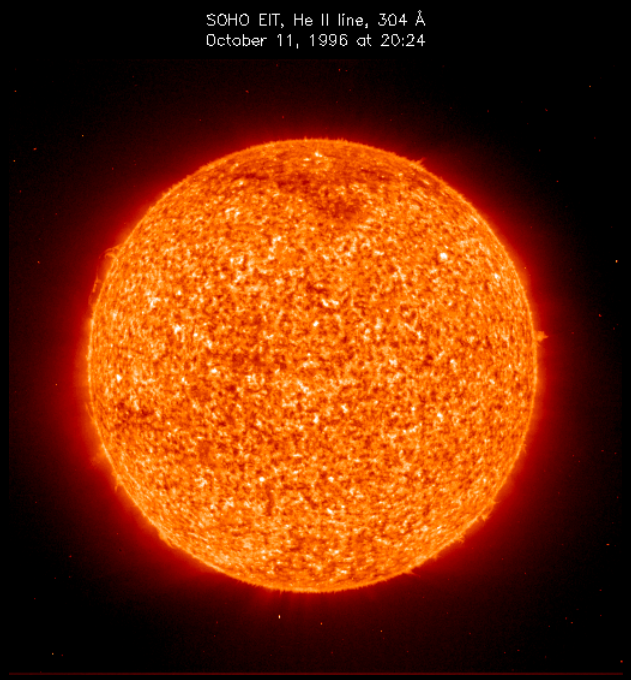
- The optical transmission was higher than what we expected from Al thickness reported from Luxel Co LTD.
- The thickness Al was thinner which we derived from both X-ray and optical transmission measurement.

5. Conclusion

1. We remanufactured Contamination Blocking Filter of SXI due to the increase in the number of the pin holes on the OBL.
2. We measured the optical, soft X-ray, and UV transmission of FM-CBF for Hitomi SXI.
3. The optical transmission of FM-CBF were lower than 5×10^{-5}. This result meets the requirement of optical shield of SXI, but slightly higher than we expected from Luxel design thickness.
4. The X-ray transmission was also measured precisely including XAFS structure around C, N, O and Al absorption edges, and this results also suggests the thinner Al thickness which predicted the optical transmission.
5. We also measured the UV transmission and confirmed the low transmission in order to block the 304A UV light from sunlit atmosphere.
6. We will adopt CBF for XRISM SXI of the same design as FM-CBF Hitomi SXI.

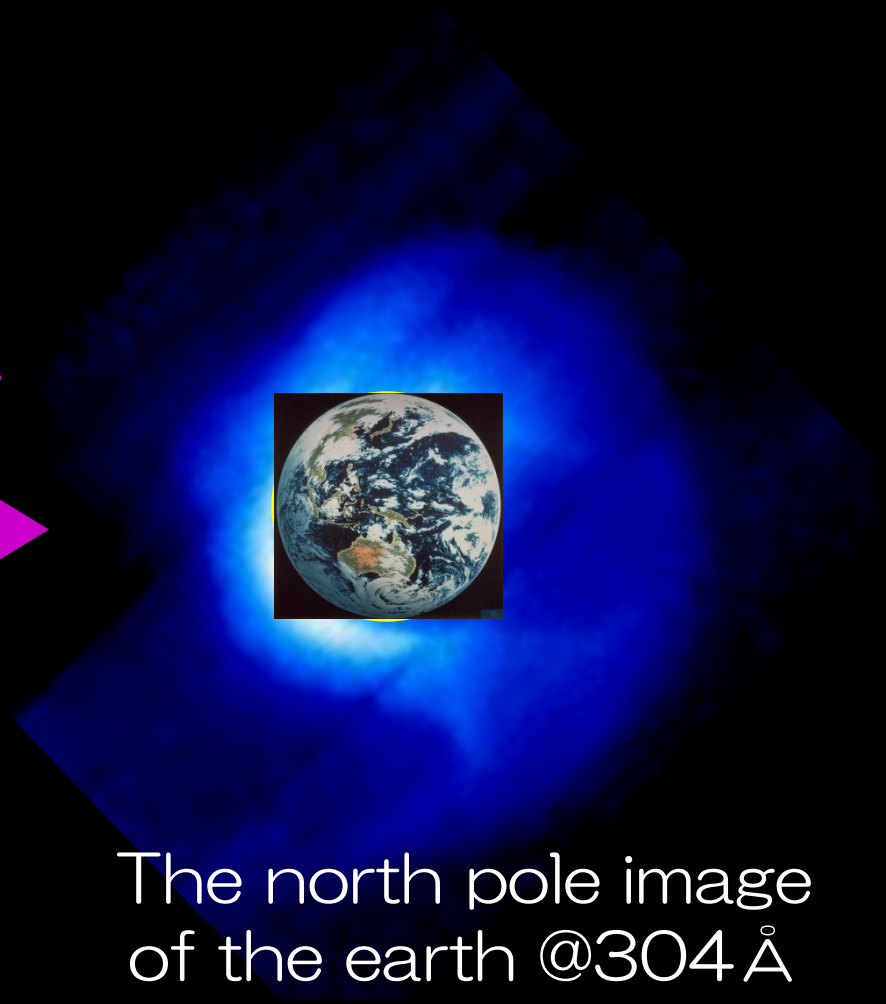
Back up slide





Sun @ 304 Å observed with SOHO satellite

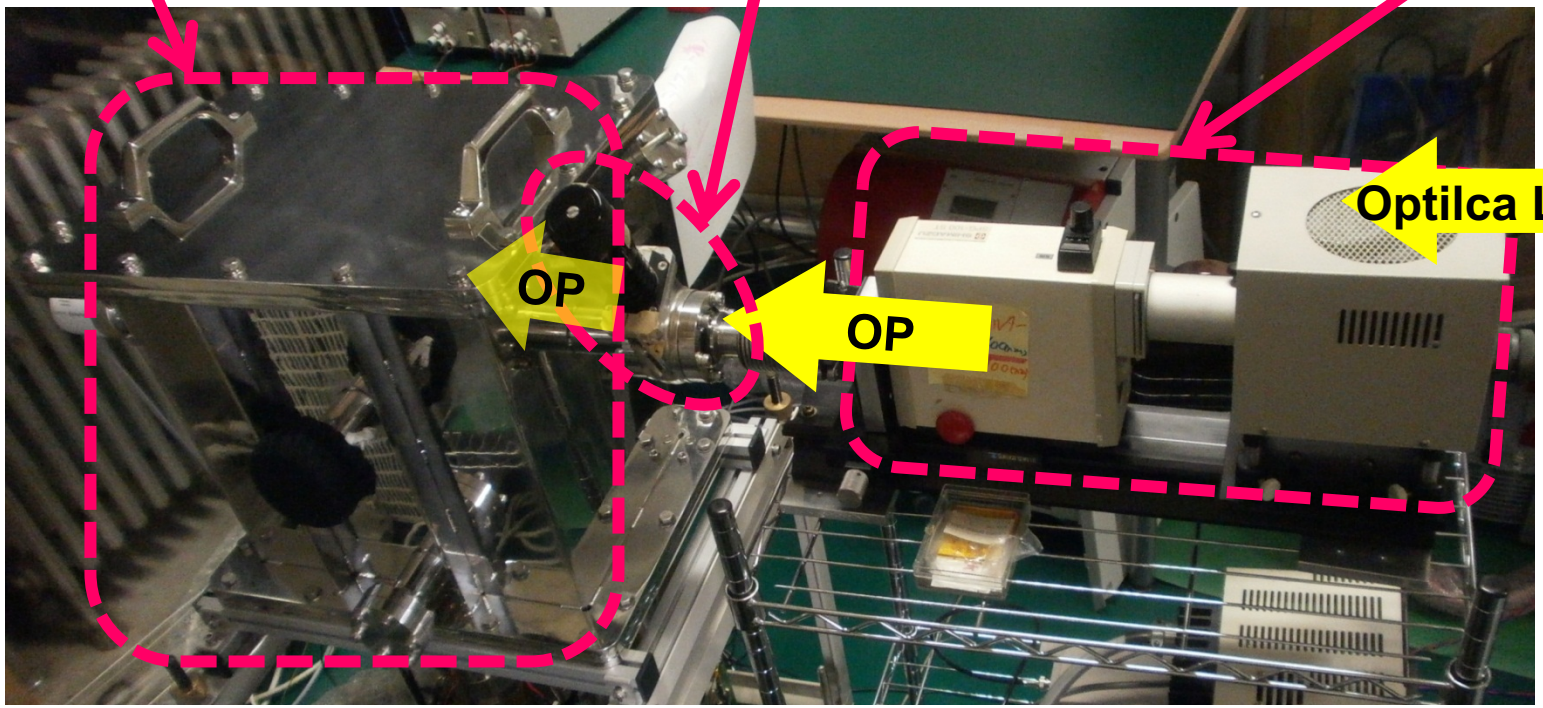
EUV



The north pole image of the earth @304 Å

In order to observe X-ray in space, we have to block this EUV light from Sunlit atmosphere as well as the optical light from objects.

3. Optical Transmission of CBF



- We measured the optical flux using photo diode with/without CBF, and calculated the optical transmission of CBF derived from the flux ratio between two them.