The ひとみ (Hitomi) in-flight calibration plan

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JAXA
H-IIA
F30
NIPPON


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Hitomi instruments' synopsis

(Takahashi, 2013, MmSAI, 84, 776)

Parameter	Hard X-ray Imager (HXI)	Soft X-ray Spectrometer (SXS)	Soft X-ray Imager (SXI)	Soft γ-ray Detector (SGD)
Detector technology	Si/CdTe cross-strips	micro calorimeter	X-ray CCD	Si/CdTe Compton Camera
Focal length	12 m	5.6 m	5.6 m	–
Effective area	300 cm^2 @30 keV	210 cm^2 @6 keV 160 cm^2 @ 1 keV	360 cm^2 @6 keV	>20 cm^2 @100 keV Compton Mode
Energy range	5 –80 keV	0.3 – 12 keV	0.5 – 12 keV	40 – 600 keV
Energy resolution (FWHM)	2 keV (@60 keV)	< 7 eV	150 eV (@6 keV)	4 keV (@40 keV)
Angular resolution	<1.7 arcmin	<1.3 arcmin	<1.3 arcmin	–
Effective Field of View	$\sim 9 \times 9$ $arcmin^2$	$\sim 3 \times 3$ $arcmin^2$	$\sim 35 \times 35$ $arcmin^2$	0.6×0.6 deg^2 (< 150 keV)
Time resolution	several 10 μs	several 10 μs	4 sec	several 10 μs
Operating temperature	−20°C	50 mK	−120°C	−20°C

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High-resolution spectroscopy

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High-resolution spectroscopy **Imaging up to 80 keV**

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High-resolution spectroscopy **Imaging up to 80 keV** **Wide band, high sensitivity**

ひとみ news

- 17 February 2016: successful launch, and mission christened (?) ひとみ (*Hitomi*)

- 18 February 2016: confirmation of orbital insertion with parameter consistent with original specifications: altitude: ~575 km, inclination ~31°
    - (*Suzaku*: ~568 km, ~32°)

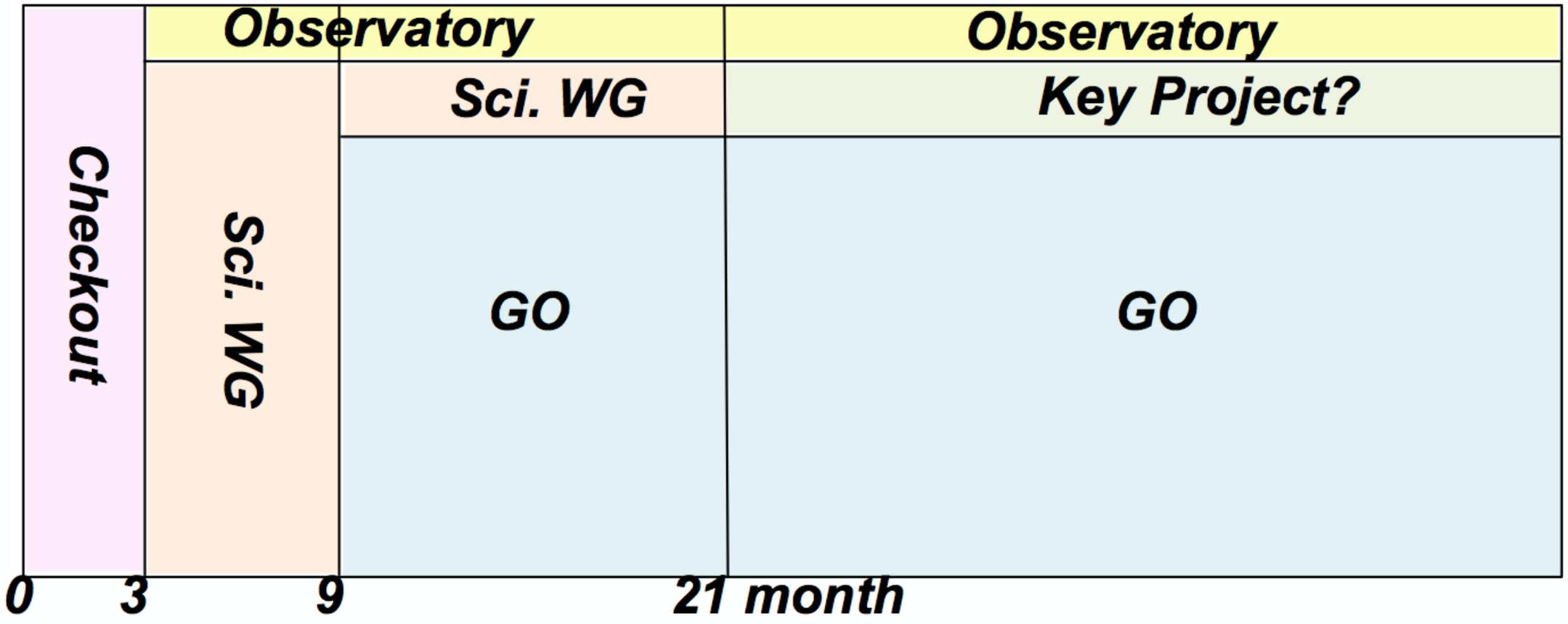
- 24 February 2016: the SXS can be operated at the nominal temperature of 50 mK

ASTRO-H Operation

Courtesy T.Takahashi (JAXA)

Phase 0 : 3 Months : Satellite/Instruments Check out (including Calibration))
Phase 1 : 6 Months : SWG 90 % (PV Phase) Observatory 10 %
Phase 2 : 12 Months : SWG Carry Over 15 %, GO 75 %, Observatory 10 %
Phase 3 : Rest of the mission : KeyProject 15 % (TBD) , GO 75 %, Observatory 10 %

Observatory 10 % = Calibration + TOO + Director's Time



Data policy among J/Europe/US in the GO time, would be similar to the Suzaku case. But we are planning to introduce key-project type and/or early-data-released type observations from early phase of the mission.

The Hitomi:

We do have a:

ASTRO-H	INFLIGHT CALIBRATION PLAN	Doc. no. : JAXA-ASTH-SOT-001 Issue : 1.0 Date : 2 February 2016 Cat : Public document Page : 1 of 144

Title : ASTRO-H in-flight calibration plan

- shared effort of the Instrument Teams, Software and Calibration Team, Science Operation Team, and Science Working Group (~25 scientists), coordinated by the *Calibration Advisory Board (J.-W. den Herder, K.Ishibashi, R.Petre)*

- 15 months of development, 7 meetings, ~10^2 actions, several 10^4 of simulation runs

- Inputs: a) *Suzaku* experience; b) ASTRO-E II XRS plan; c) IACHEC experience; d) *Chandra* experience with the analysis of diffuse sources

- Time allocation: ~3 Ms

The Hitomi IFCP sources

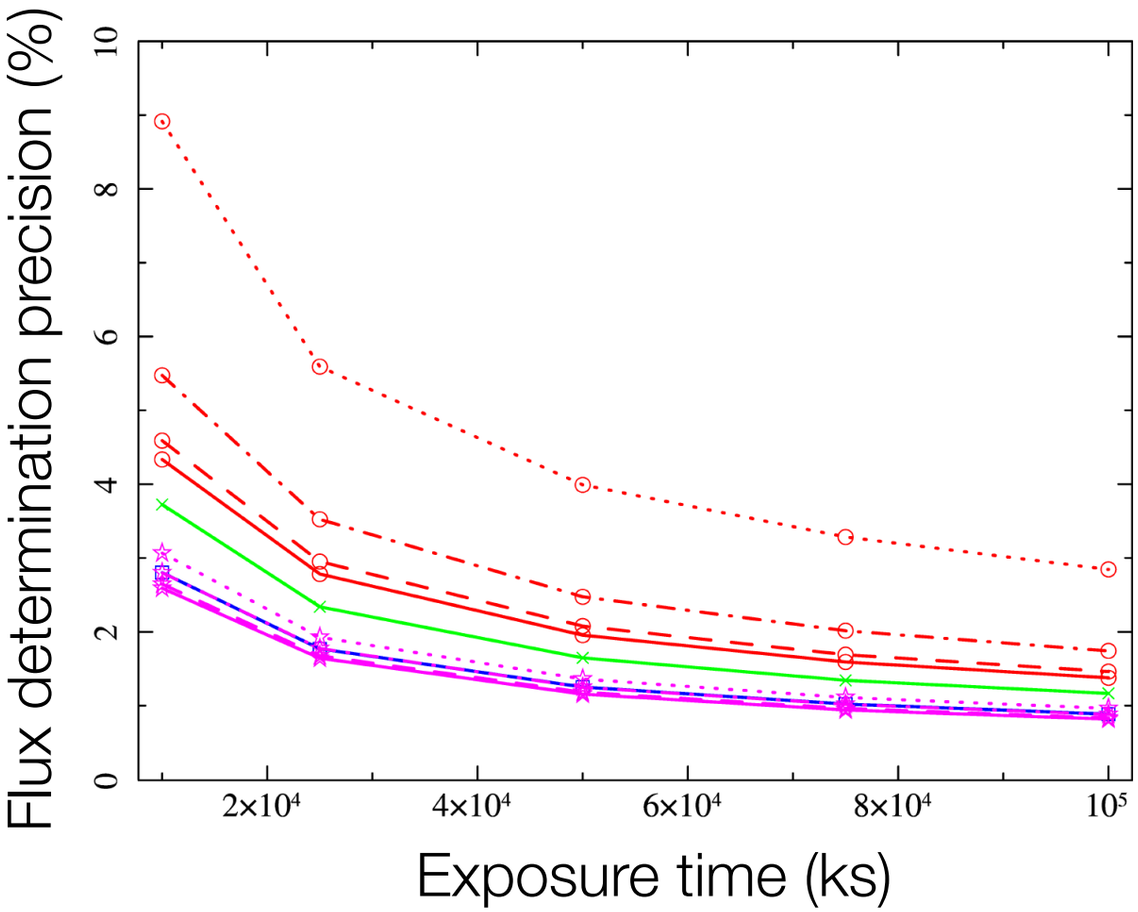
(Guainazzi et al., 2016, ASTH-SOT-001)

Calibration item	SXS/SXT-S	SXI/SXT-I	HXI/HXT	SGD
Optical axis	LMCX-1	1E0102-72	Crab	NA
PSF	NA	PV target	CygX-1	NA
Straylight	CygX-2	Crab	Crab	NA
Energy scale/LSF/RMF	ABDor, Capella, HR1099	Cygnus Loop, Perseus	Perseus	NA
Effective area (on-axis)	3C273, CenA, G21.5-0.9	G21.5-0.9	3C273, G21.5-0.9, CenA, CygX-1, Crab	CygX-1. Crab
Effective area (off-axis)	NA	Abell478	Crab	NA
Contamination	RXJ1856-3754, 1E0102-72	RXJ1856-3754, Cygnus Loop	NA	NA
Filter transmission	1E0102-72	NA	NA	NA
Branching ratios	Rapid Burster	NA	NA	NA
Background	North Polar Spur	NA	NA	NA
Timing	PSR0540-69	PV target	Crab pulsar	Crab Pulsar
Polarisation	NA	NA	NA	Crab

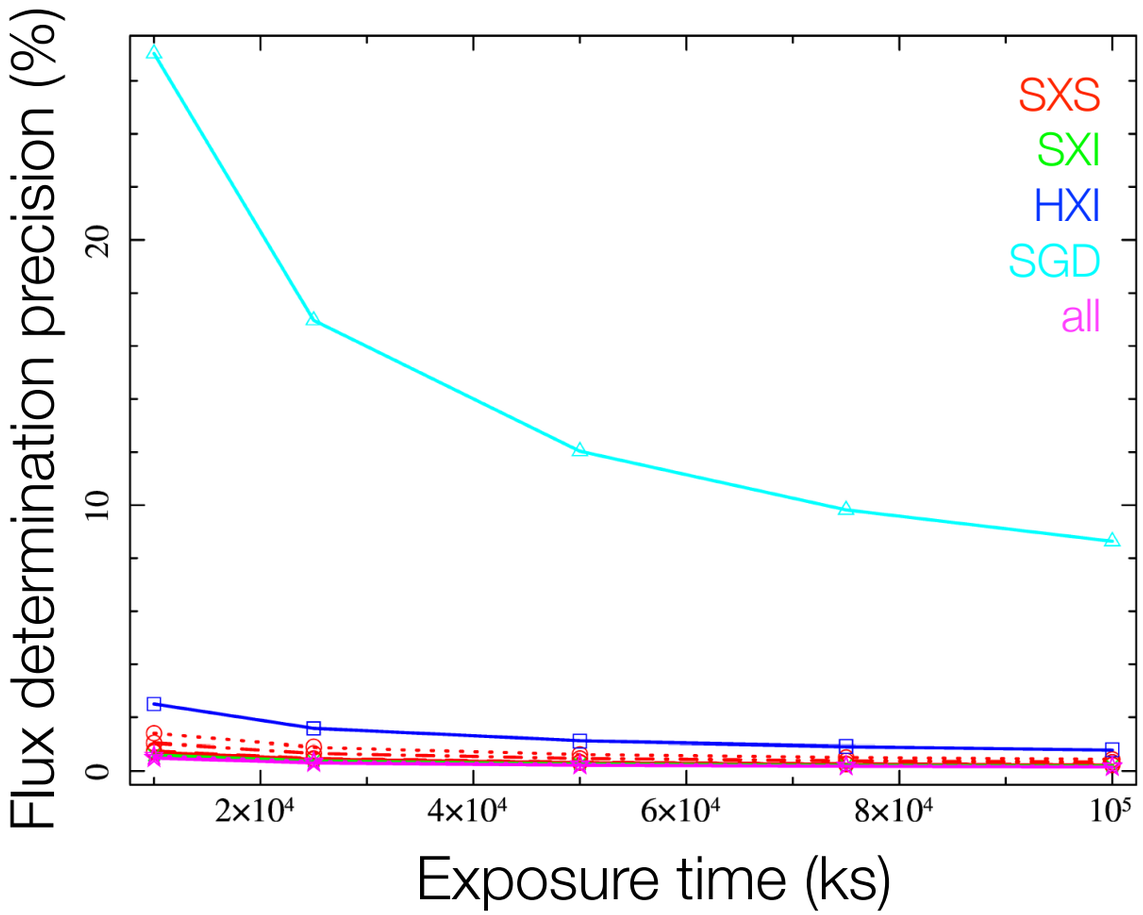
IACHEC legacy - I.

(Guainazzi et al., 2016, ASTH-SOT-001; simulations by L.Brenneman, CfA)

"Traditional" IACHEC broad band effective area calibrators



G21.5-0.9

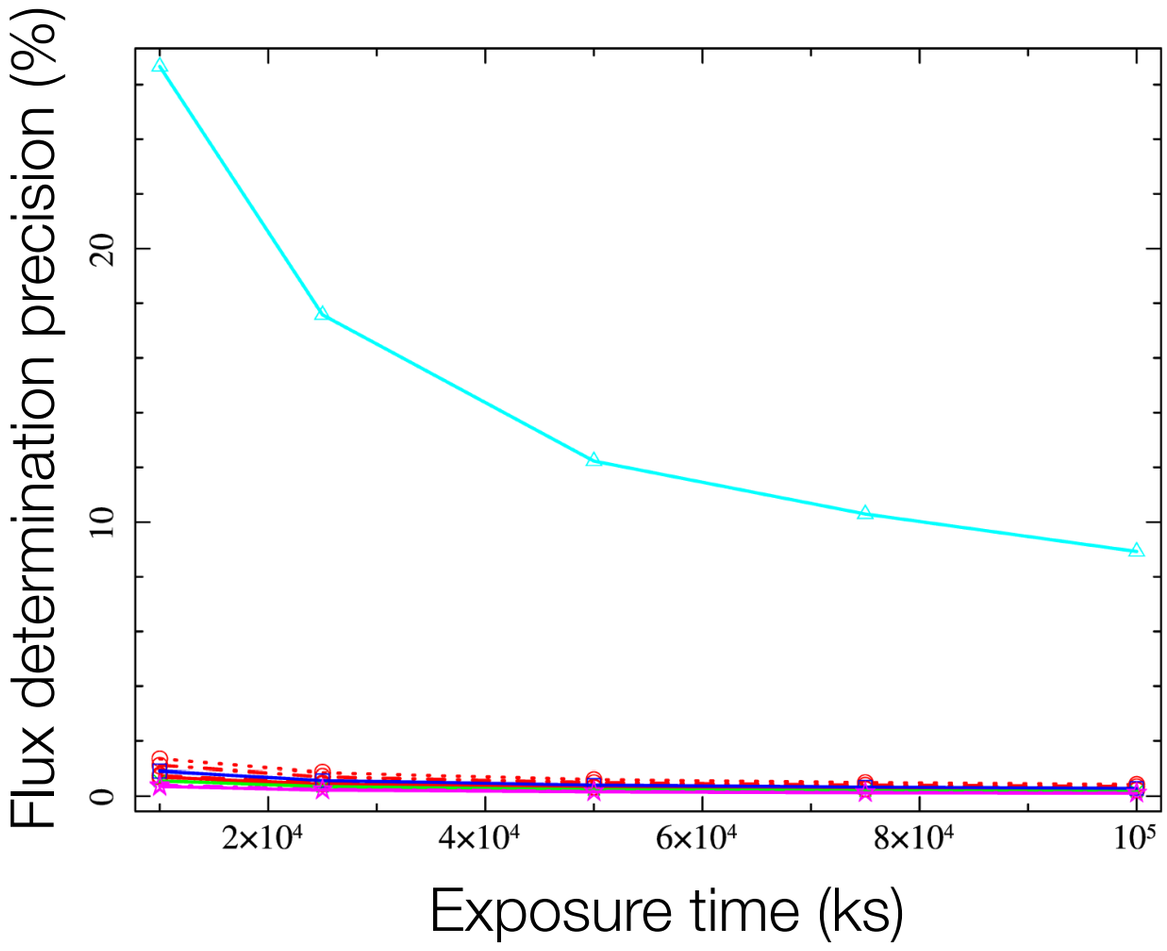


3C273

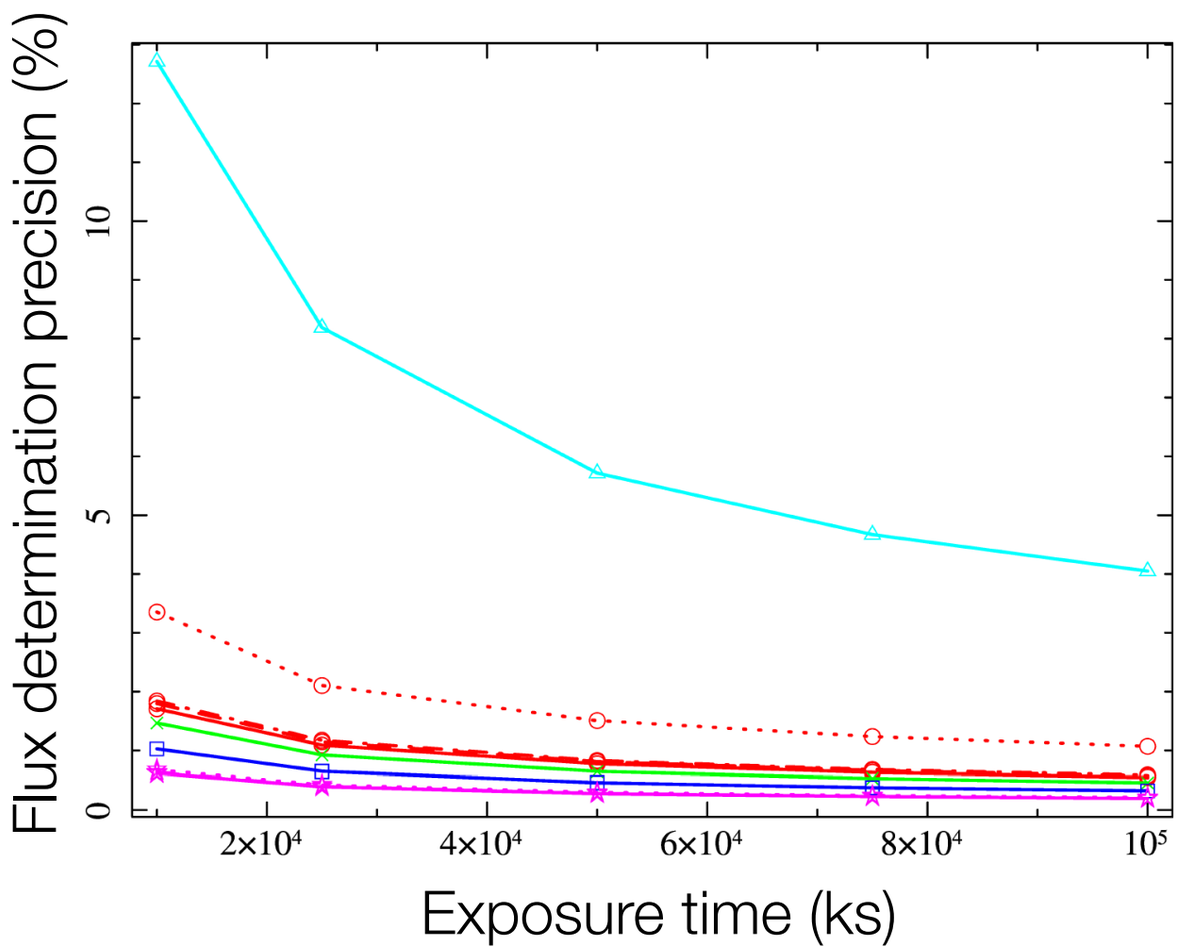
Beyond the IACHEC legacy

(Guainazzi et al., 2016, ASTH-SOT-001; simulations by L.Brenneman, CfA)

"New" broad band effective area calibrators



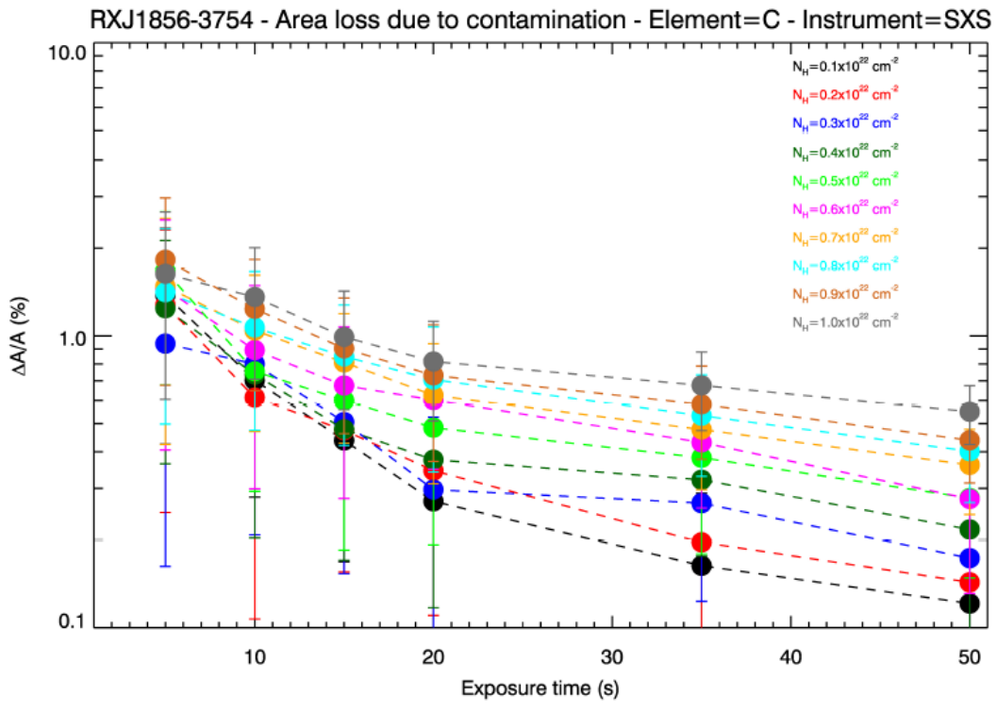
PSR1509-58

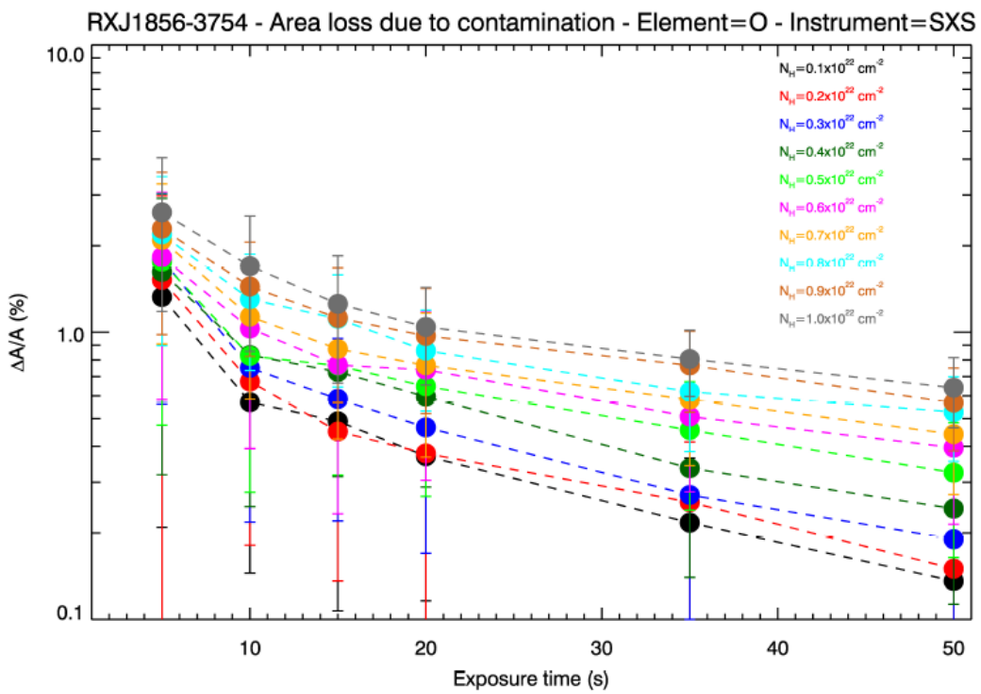


Centaurus A

IACHEC legacy - II.

(Guainazzi et al., 2016, ASTH-SOT-001)





- RXJ1856-3754, ~SXI on + 4 days
- RXJ1856-3754, ~SXS/GVO -1d.
- RXJ1856-3754, ~SXS/GVO + 1d.
- RXJ1856-3754, ~SXS/GVO + 4d.

- RXJ1856-3754, ~L+1month

- Cygnus Loop*, ~L+2 months
- Cygnus Loop, ~L+3 months
- 1E0102-72, ~July
- RXJ1856-3754, ~October

[… to be reviewed if we - alas! - detect contamination]

*SXI gain/CTI observation

New challenge: gain/LSF SXS calibration

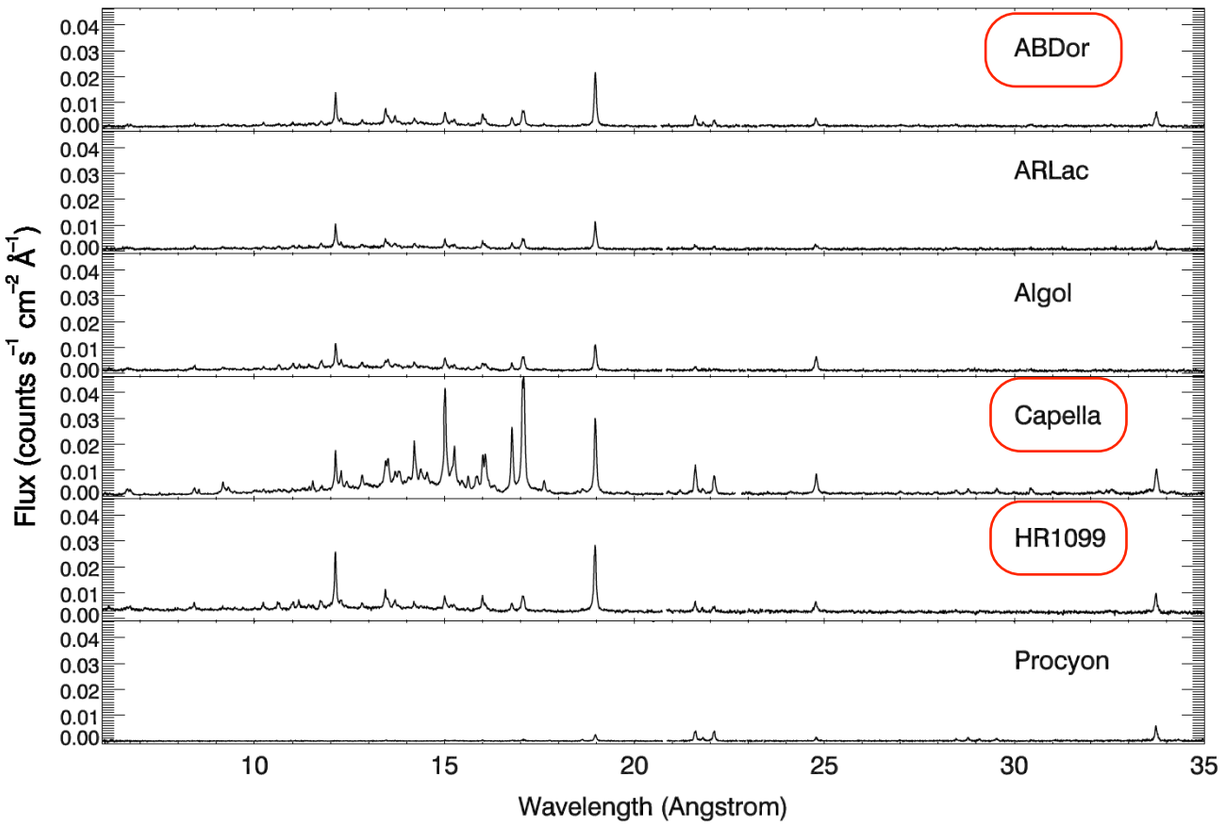
- Internal calibration sources
  - Calibration pixel: ^{55}Fe source, sky-blind, always on
  - Filter Wheel: ^{55}Fe source
  - Modulated X-ray sources (MXS): Cr-K/Cu-K, ~1ms period, 1-3% duty-cycle
- Astrophysical sources:
  - SNR: complex morphology and velocity structure
  - Heavily obscured HMXRB: lines possibly produced in the OB wind
  - Coronal stars: careful consideration of thermal broadening, orbital and rotational motions

SXS gain/LSF sky calibrators

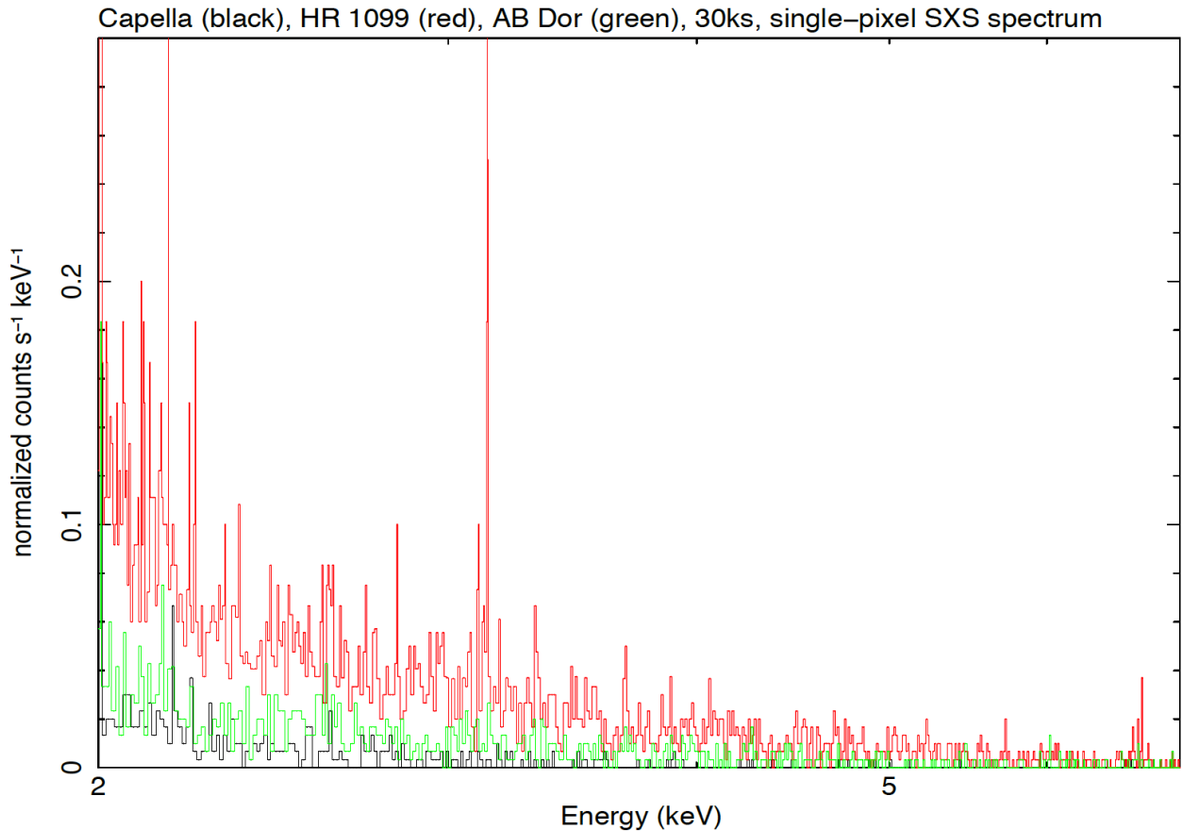
(Guainazzi et al., 2015, JATIS, 1(4), 047001)

(Guainazzi et al., 2016, ASTH-SOT-001; simulations by M.Audard, University of Geneva)

RGS spectra of coronal stars



SXS expected hard spectra of coronal stars



= chosen targets for the *Hitomi* calibration plan

Conclusions

- *Hitomi* is in orbit

- Ground-based calibration results support science requirements

- The in-flight calibration plan is the results of extensive analysis, discussion and simulations. The IACHEC experience has been a *key factor* in shaping it

- First science results likely to be presented at the 15th HEAD (Naples, Florida, 3-7 April 2016)