

The Schrödinger's cat

Or, “On the IACHEC Heritage Working Group”



Matteo Guainazzi (ESA/ESTEC)

IACHEC Heritage Working Group (HWG) Chair



Scope of the WG

Preserve the IACHEC corpus of knowledge, know-how and best practices for the benefit of future missions and the community at large

- provide a platform for the discussion of experiences coming from operational missions
- facilitate the usage of good practices for the management of pre- and post-flight calibration data and procedures, and the maintenance and propagation of systematic uncertainties (the latter task in strict collaboration with the "Systematic uncertainties" IACHEC Working Group)
- document the best practices in analysing high-energy astronomical data as a reference for the whole scientific community
- ensure the usage of homogeneous data analysis procedures across the IACHEC calibration and cross-calibration activities
- consolidate and disseminate the experience of operational missions on the optimal calibration sources for each specific calibration goal

from the WG charter ...

Otherwise: we do the dirty jobs for you that you don't have time to do because you are busy analysing data



WG activities

- Transmit knowledge on the in-flight calibration plan
 - JATIS paper on in-flight calibration sources
 - Support the elaboration of calibration plans of “future” missions
- Maintain calibration documentation
- Document data analysis best practices
 - Statistical methods are covered by CalStat WG
- IACHEC data repository



JATIS paper

Guainazzi et al., 2015, JATIS, 1, 7001

- Overview of celestial source classes used in the in-flight calibration plans of X-ray observatories
- Covers: rationale, comparative performance
- Aiming at being a reference for “future missions”
- Needs update (cf. K.Forster’s GoogleDoc)

Journal of Astronomical Telescopes, Instruments, and Systems

AstronomicalTelescopes.SPIEDigitalLibrary.org

On the in-flight calibration plans of modern x-ray observatories

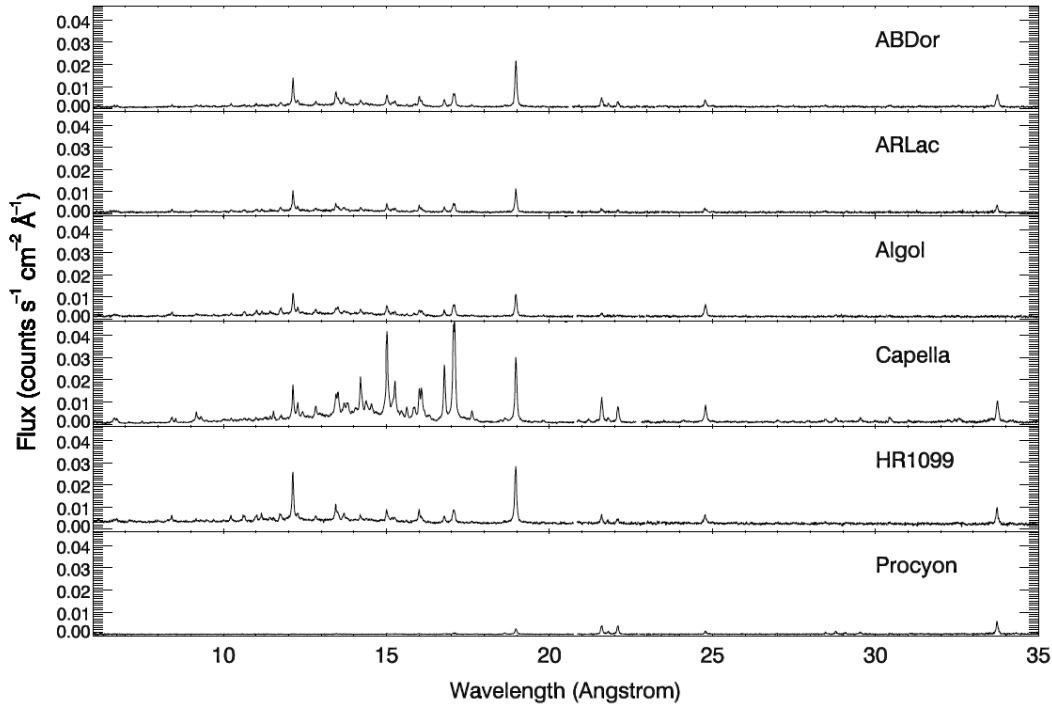
Matteo Guainazzi
Laurence David
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Eric Miller
Lorenzo Natalucci
Jukka Nevalainen
Robert Petre
Marc Audard



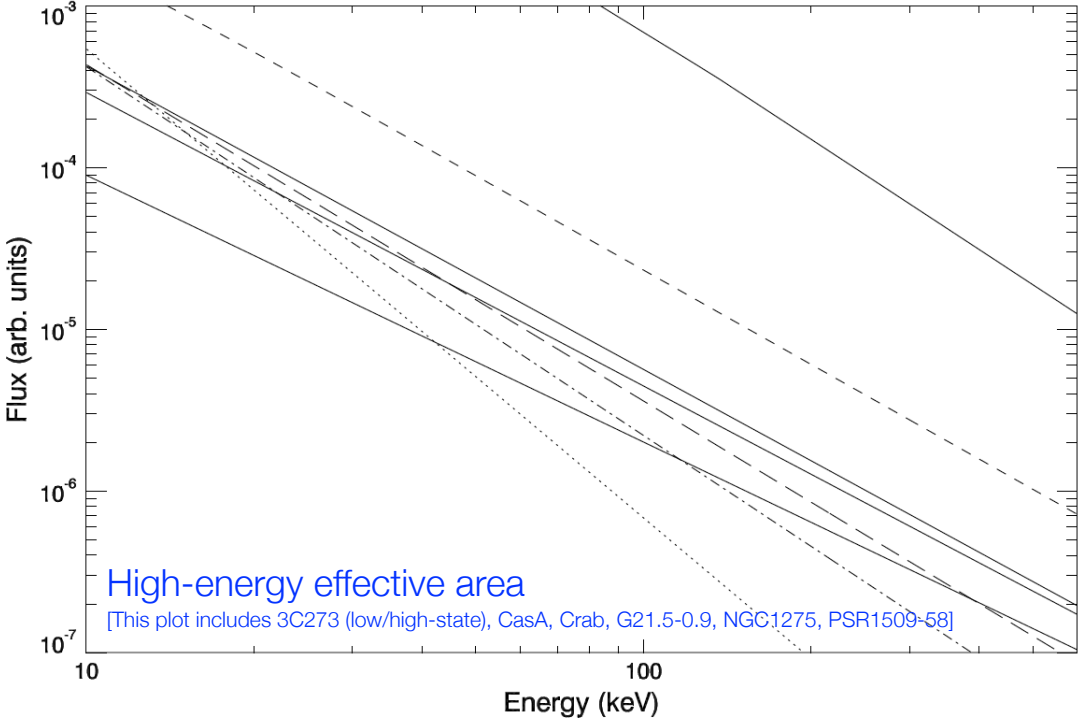
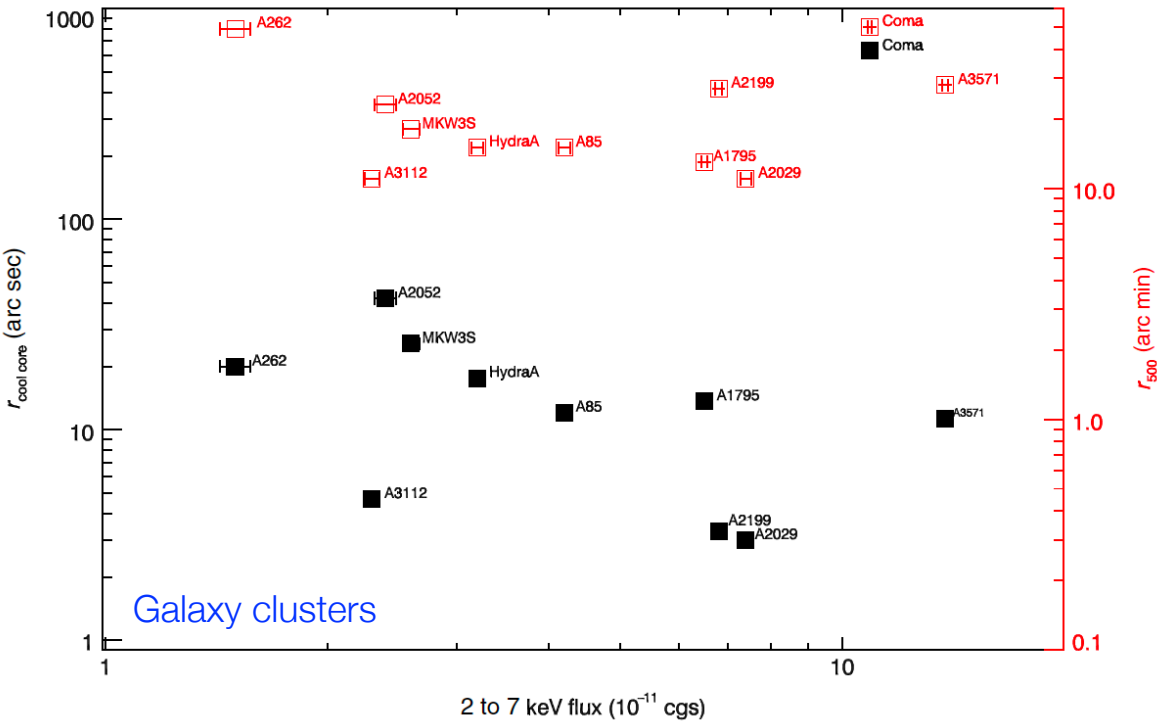
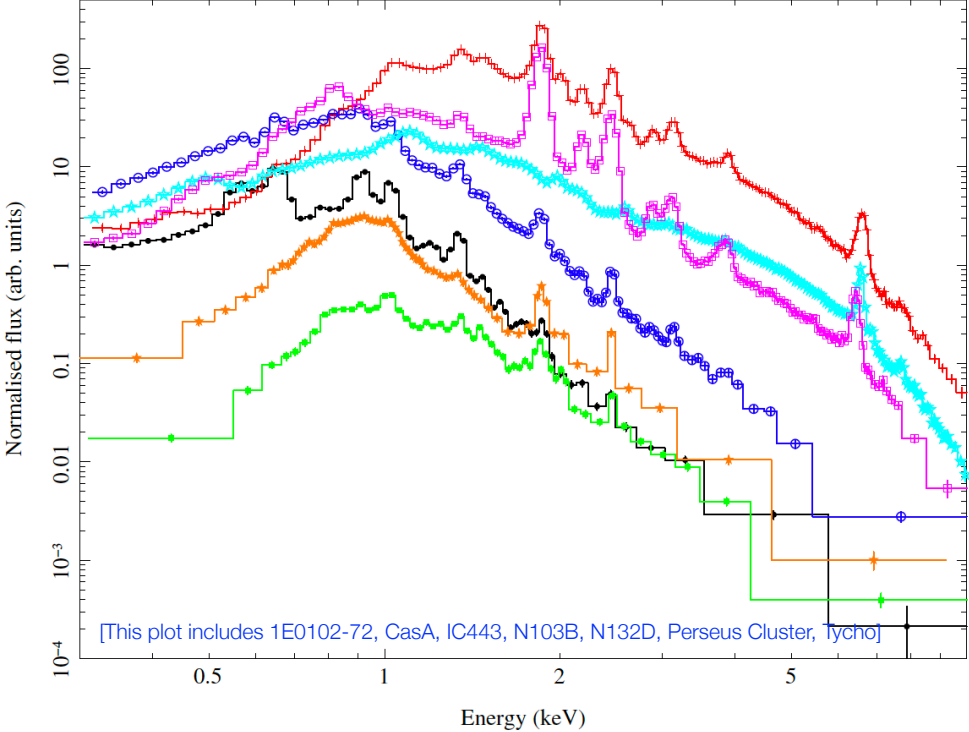
JATIS paper content

Guainazzi et al., 2015, JATIS, 1, 7001

Active stars (gratings' energy scale and gain)



Extended sources for CCD CTI/gain/redistribution



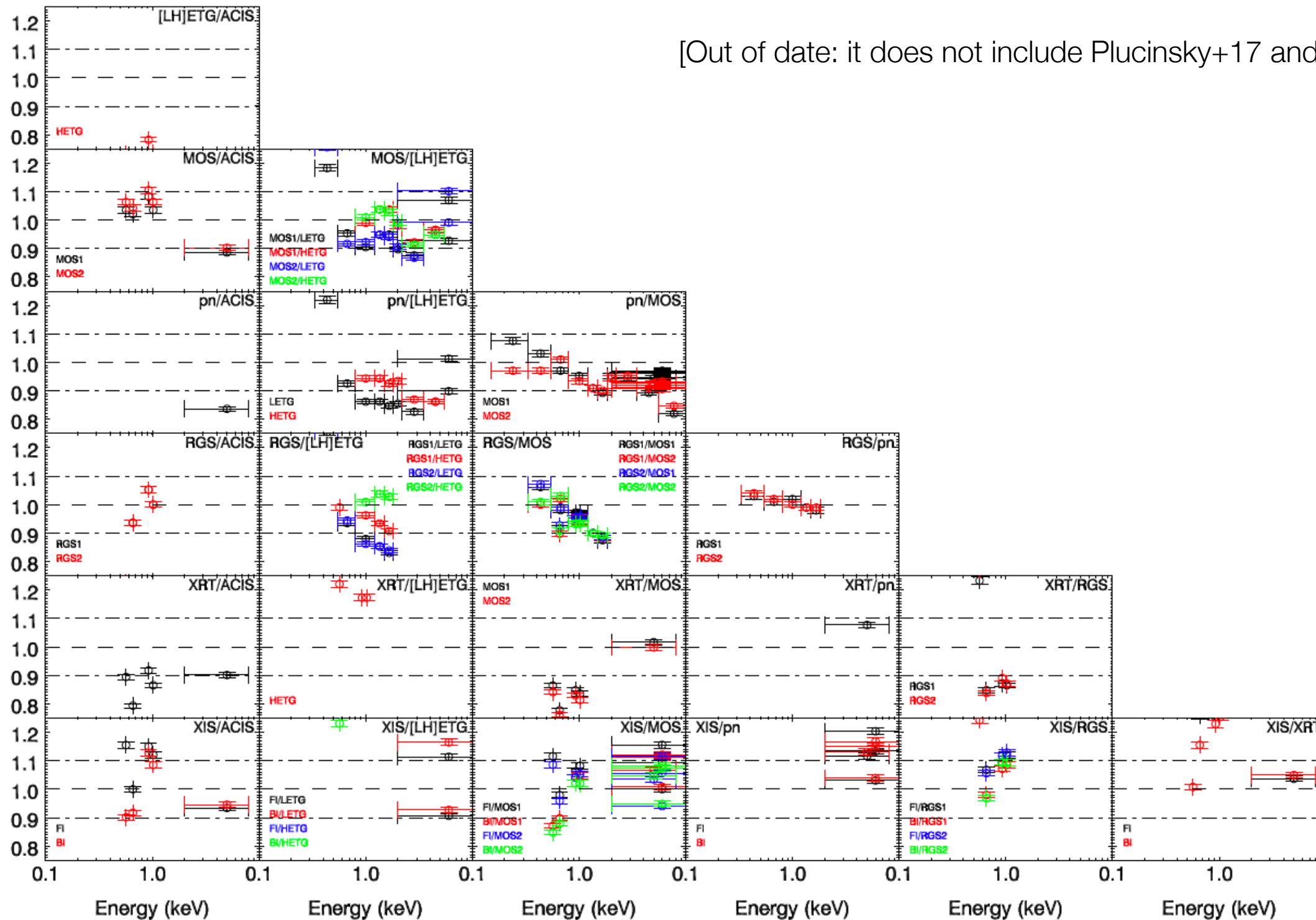
... and PSF, timing etc.



A synoptic view of the cross-calibration status

Guainazzi et al., 2015, JATIS, 1, 7001


[Out of date: it does not include Plucinsky+17 and Madsen+17]





Support to “future” missions

- The *Hitomi* in-flight calibration plan drew heavily from the IACHEC experience
 - Project-level decision by JAXA
- Many sources therein are “IACHEC standard candles”
- Draft plans discussed at each IACHEC meeting
- [Coordinated observations dealt with by the corresponding IACHEC WG]
- Similar approach for XRISM (cf. E.Miller’s IACHEC plenary)
- Relations with other missions less structured

 ASTRO-H	INFLIGHT CALIBRATION PLAN	Doc. no. : JAXA-ASTH-SOT-001
		Issue : 1.1
		Date : 16 March 2016
		Cat : Public document
		Page : 1 of 144

Title : **ASTRO-H in-flight calibration plan**

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 Yukikatsu Terada
 Brian Williams
 Takayusi Yuasa

Date : 16 March 2016



IACHEC source data repository

<https://iachecdb.iaps.inaf.it>



Home • Working Group • File upload • Querying • Register for upload
• Tutorial

- Concept: a single repository of the data used in IACHEC papers
- Funded over ~2 years by AHEAD, working prototype available
- Requirements and interface iterated at three IACHEC meetings
- Database never populated
- The project has not taken-off



Document data analysis best practices

- Question: which are the “correct” choices of photoelectric absorption model and cross sections, and elemental abundance tables?
- Survey among experts to define standards
- HWG offered a pool of scientists to apply standards to IACHEC calibration data, and evaluate systematics
- Applied so far only on the radio-loud AGN paper (trivial result: ~no impact)
- Application to high-resolution data awaiting next IACHEC paper (N132D? 1E0102-72 came too early)

IACHEC survey outcome			
Item	Photoelectric absorption model	Photoelectric absorption cross-sections	Elemental abundances
	tbnew (XSPEC) hot+amol (SPEX)	Verner & Yakovlev (1995)	Lodders & Palme (2009)

IACHEC CROSS-CALIBRATION OF *CHANDRA*, *NuSTAR*, *SWIFT*, *SUZAKU*, *XMM-NEWTON* WITH 3C 273 AND PKS 2155-304

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ABSTRACT

On behalf of the International Astronomical Consortium for High Energy Calibration, we present results from the cross-calibration campaigns in 2012 on 3C 273 and in 2013 on PKS 2155-304 between the then active X-ray observatories *Chandra*, *NuSTAR*, *Suzaku*, *Swift*, and *XMM-Newton*. We compare measured fluxes between instrument pairs in two energy bands, 1–5 keV and 3–7 keV, and calculate an average cross-normalization constant for each energy range. We review known cross-calibration features and provide a series of tables and figures to be used for evaluating cross-normalization constants obtained from other observations with the above mentioned observatories.

Key words: space vehicles: instruments



Repository of calibration documentation

<https://wikis.mit.edu/confluence/display/iachec/IACHEC+Heritage+Working+Group>

- Concept: single repository of calibration documents for past and operational missions
- Entries for most missions
 - Some still missing
- Simple-minded interface - no underlying database allowing smart searches
- Inhomogeneous
- Not up-to-date (~2018)

Dashboard
> IACHEC
> ...
> IACHEC Heritage Working Group

IACHEC Heritage Working Group

26 Added by Eric D Miller, last edited by Koji Mori on Apr 26, 2018 23:56 (view changes)

The last meeting of the IACHEC **Heritage Working Group** was held on the 2nd of March 2016 (11th IACHEC). The outcome of the discussion is summarized in the following documents:

- Heritage Working Group Charter
- Summary of the 1st Working Group meeting at the 9th IACHEC
- Introduction to and summary of the 2nd Working Group meeting at the 10th IACHEC
- Introduction to and summary of the 3rd Working Group meeting at the 11th IACHEC
- Summary of the 4th Working Group meeting at the 12th IACHEC
- List of actions
- On the in-flight calibration plans of modern X-ray observatories (JATIS paper, [accepted version](#), 29 December 2015)

Library of ground-based and in-flight calibration documents:

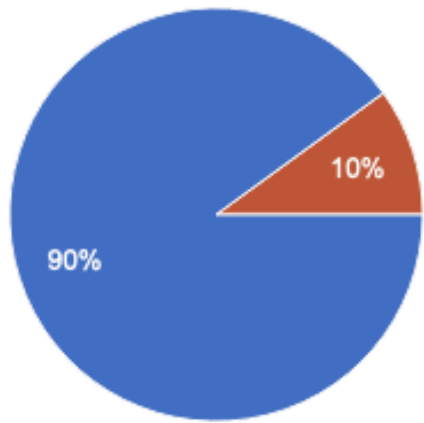
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 - Hitomi (in-flight calibration plan)
 - SXS + SXT-S
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 - de Vries, C. et al. "Calibration sources and filters of the soft x-ray spectrometer instrument on the Hitomi spacecraft", JATIS 4(1), 011204 (2017).
 - Leutenegger, M. A. et al. "In-flight verification of the calibration and performance of the ASTRO-H (Hitomi) Soft X-ray Spectrometer", JATIS 4(2), 021407 (2018)
 - Eckart, M. E. et al. "Ground calibration of the Astro-H (Hitomi) soft x-ray spectrometer", JATIS 4(2), 021406 (2018)
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 - Porter, F. S. et al. "In-flight performance of the soft x-ray spectrometer detector system on Astro-H", JATIS 4(1), 011218 (2018)
 - Okajima, T. et al. "First peek of ASTRO-H Soft X-ray Telescope (SXT) in-orbit performance", Proc. of SPIE, 99050Z (2016)
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 - Timing
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 - Quadrini, E.M. et al., "IBIS Veto System: Background rejection, instrument dead time and zoning performance", A&A 411, L153-L157 (2003)
 - Natalucci, L. et al., "Systematic effects induced on IBIS detectors by background and inhomogeneity of the spatial response", A&A 411, L209-L213 (2003)
- NuSTAR
 - NuSTAR in-orbit calibration paper: "Calibration of the NuSTAR High-energy Focusing X-ray Telescope", K. K. Madsen et al. [ApJS, 220, 8, 2015](#)
 - SPIE telescope articles:
 - "In-flight PSF calibration of the NuSTAR hard X-ray optics", H. An et al. 8144, 1, 2014
 - "NuSTAR on-ground calibration: I. Imaging quality", N. J. Westergaard, 8443, 2012
 - "NuSTAR on-ground calibration: II. Effective area", N. Breinholt et al. 8443, 2012
 - "Coatings for the NuSTAR mission", F. Christensen et al. 8147, 2011
 - "NuSTAR ground calibration: The Rainwater Memorial Calibration Facility (ReMcAF)", N. Breinholt et al. 8147, 2011
 - "First results from the ground calibration of the NuSTAR flight optics", J. Koglin, 8147, 2011
 - "Fabrication of the NuSTAR flight optics", W. Craig et al. 8147, 2011
 - "Optimizations of Pt/SiC and W/Si multilayers for the Nuclear Spectroscopic Telescope Array", K. K. Madsen et al. 7437, 16, 2009
 - "Evaluation of epoxy for use on NuSTAR optics", H. An et al. 7437, 2009
 - "NuSTAR hard X-ray optics design and performance", J. E. Koglin et al. 7437, 2009
 - "Manufacture of Mirror Glass Substrates for the NuSTAR Mission", W. Zhang et al. 7437, 2009
 - "W/SiC and Pt/SiC multilayers for the NuSTAR hard X-ray telescope", C. P. Jensen et al. 5900, 2005
 - SPIE detector articles:
 - "In-flight performance and calibration of the NuSTAR CdZnTe pixel detectors", T. Kitaguchi et al. 8144, 2014
 - "Spectral calibration and modeling of the NuSTAR CdZnTe pixel detectors", T. Kitaguchi et al. 8145, 2011
 - "Development of focal plane detectors for the Nuclear Spectroscopic Telescope Array (NuSTAR) mission", V. Rana et al. 7435, 2009
 - SPIE operations articles:
 - "NuSTAR observatory science operations: on-orbit acclimation", K. Forster et al. 9149, 2014
 - "Highly automated on-orbit operations of the NuSTAR telescope", B. Roberts et al. 9149, 2014
 - SPIE mast articles:
 - "NuSTAR: System engineering and modeling challenges in pointing reconstruction for a deployable X-ray telescope", D. I. Harp et al. 7738, 2010
- Suzaku (list of suzaku memo)
 - XIS
 - Koyama et al. "X-Ray Imaging Spectrometer (XIS) on Board Suzaku", PASJ, 2007, 59, S23
 - Yamada, S. et al. "Data-Oriented Diagnostics of Pileup Effects on the Suzaku XIS", PASJ, 2012, 64, 53
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 - Kokubun, M., et al., "In-Orbit Performance of the Hard X-ray Detector on Board Suzaku", PASJ 59, S53-S76 (2007)
 - Fukazawa, Y., et al., "In-flight calibration and performance of the Hard X-ray Detector (HXD) onboard Suzaku", Proceedings of SPIE, Vol. 6266, pp.75-86 (2006)
 - Terada, Y., et al., "Development of a Monte Carlo Simulator for the Astro-E2 Hard X-ray Detector (HXD-II)", IEEE TNS Vol. 52, Issue 4, pp. 902-909 (2005)
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 - Yamaoka, K., et al., "Design and In-Orbit Performance of the Suzaku Wide-Band All-Sky Monitor", PASJ 61, ppS35-S53 (2009)
 - Yamaoka, K., et al., "In-orbit performance of the Suzaku wide-band all-sky monitor", Proceedings of SPIE, Vol. 6266, pp. 626643-1-626643-12 (2006)
 - Ohno, M., et al., "Preflight Calibration and Performance of the Astro-E2/HXD-II Wide-Band All-Sky Monitor", IEEE TNS Vol. 52, Issue 6, Part 2, pp. 2758-2764 (2005)
- Swift (in-flight calibration plan)
 - XARM
 - Resolve (formally SXS)
 - Xend (formally SXI)
 - XMM-Newton:
 - EPIC public calibration documents
 - RGS public calibration documents
 - telescopes' calibration documents



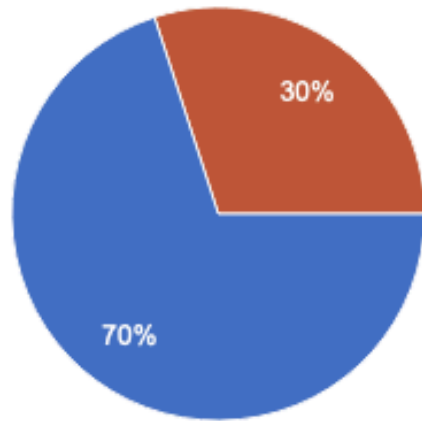
Useful?

Small questionnaire prior to this meeting (still open): 10 replies

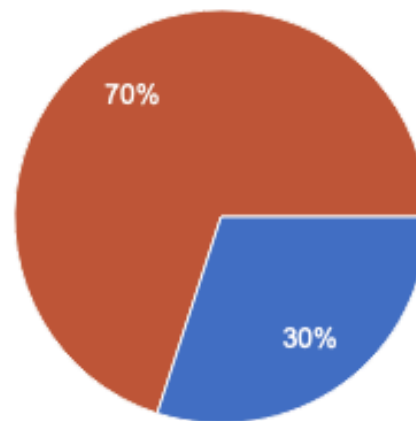
Essential/Useful/Irrelevant/Wasted time



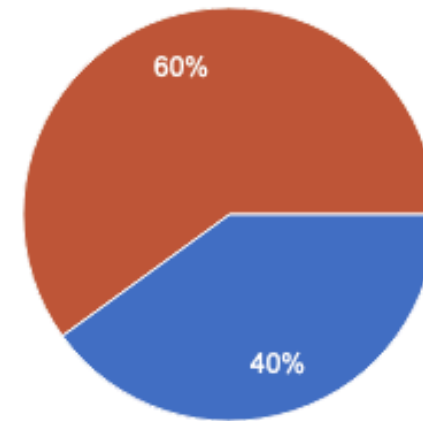
Knowledge transmission



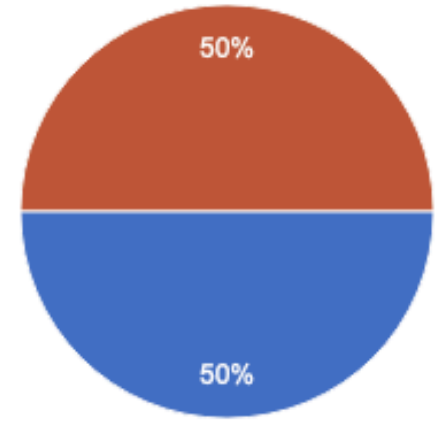
Standards' definition



Data repository



JATIS paper



Documentation repository

The concept of the Heritage Working Group seems sound
(small number statistics notwithstanding)

[cf. also the comment by K. Kuntz yesterday.]



... but it does not work any longer

The Heritage Working Group has been dormant in the last ~3 years

- The activities would need a (small) pool of dedicated calibration scientists, that the IACHEC cannot afford
- They are even less glamorous than analysing calibration data - difficult to motivate people
- Funding on a “ad hoc” project basis is basically not existent for the IACHEC - AHEAD window of opportunity is now closed
- The HWG depends on “standard candle” WGs providing inputs. However, last IACHEC paper is ~4 years old
- Some “future” (now operational) missions are still not well integrated in the IACHEC. Others have sufficient “in-house” expertise
- The Chair changed job description and has almost no time available for IACHEC work

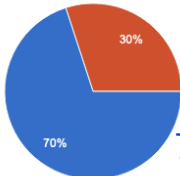


Suggestions for further activities

- Promoting the creation of a “Background WG”
 - Now covered by the “CCD and Background” WG
- Promoting the creation of an “X-ray optics WG”
- Creating (and maintain) an IACHEC knowledge database ([an idea by K. Forster](#))
- Update and optimise past activities
 - JATIS-like paper and associated calibration sources' list
 - Data repository (populate database, version control, enhanced functionalities)
 - Document repository (true database, smart interface)
 - Data analysis standards and systematics evaluation applied to future IACHEC papers



Way forward

- A virtual meeting is deemed not efficient: defer the discussion to the first face-to-face IACHEC meeting
- Identify *one new activity* and *one highest-priority past activity* to be updated
- Identify a small pool (3-4) of IACHEC scientists willing to actively work in the HWG 

70% of responders are willing to increase their involvement in the HWG
- A new Chair would help (but nobody has volunteered so far)
- In the meantime, some knowledge transmission to future mission still possible parasitically through XRISM/*Athena*