IACHEC ACTIVITIES

International Astronomical Consortium for High Energy Calibration

E. JOURDAIN FOR THE IUG MEETING NOVEMBER 2018

- The IACHEC aims to provide standards for high energy calibration and supervise cross calibration between different missions. This goal is reached through working groups, where IACHEC members cooperate to define calibration standards and procedures. The scope of these groups is primarily a practical one: a set of data and results (eventually published on refereed journals) will be the outcome of a coordinated and standardized analysis of references sources ("high-energy standard candles"). Past, present and future high-energy mission can use these results as a calibration reference.

- http://web.mit.edu/iachec/meetings/2018/index.html

Active Observatories involved

- Chandra
- Integral
- MAXI
- NuSTAR
- Swift
- XMM-Newton

+

- Insight-HXMT
- Astrosat
- Nicer
- Polar

+

- IXPE
- Athena
- E-rosita
- Xarm (= Hitomi2)
- Smile

Working Groups

- Methodology
  - Detectors and background
  - Calibrations uncertainties
  - Contamination
  - **Coordinated observations**
  - **Heritage**
  - High Resolution (lines)
- Standard Candles
  - Clusters of Galaxies
  - **Non-Thermal SNR**
  - Thermal SNR
  - White Dwarfs and Isolated Neutron Stars

Main topics

- Status of instrument (calibration, performance…):
  issues, investigations, solutions
- Comparison between current missions
- ‘old’ mission lessons for future missions

Presentations, discussions → share of experience, new ideas ?
To understand, to improve, to be more confident

- Report on instr calibration

  Isgri by Volodymyr, NuSTAR (gain) , Nicer, Swift/BAT, Astrosat

- Ground calibrations

  INSIGHT,

  plans for future missions

- Cross calibration works

  * Soft X rays: For different objectives (area : simple continuum, energy resolution: lines , gain…..

  * X durs, mainly Crab

  Presentation by K Madsen of a NuSTAR/NuSTAR Calibration

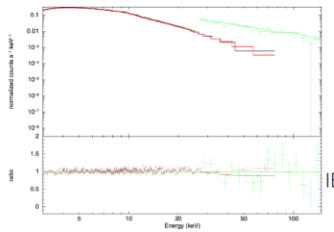
  with and without mirrors 12% discrepancy

  + 3C273 soft and hard X rays

NuSTAR-INTEGRAL joint fitting (3-110 keV)

model: const*wa$_s$*po

Year	Γ	$C_{FPMA/ISGRI}$	$C_{FPMB/ISGRI}$	$F^{ISGRI}_{20-40keV}$ (10^{-11}erg cm^{-2}s^{-1})	$F^{FPMA}_{20-40keV}$ (10^{-11}erg cm^{-2}s^{-1})	$F^{FPMB}_{20-40keV}$ (10^{-11}erg cm^{-2}s^{-1})	$\Delta\chi^2$
2012	1.669±0.003	$0.995^{+0.07}_{-0.06}$	$1.024^{+0.07}_{-0.06}$	6.49	6.46	6.65	0.994
2015	1.739±0.012	$1.196^{+0.411}_{-0.244}$	$1.211^{+0.416}_{-0.247}$	3.74	4.47	4.53	1.012
2016	1.608±0.005	1.069±0.06	1.087±0.06	11.73	12.54	12.75	1.094
2017	1.677±0.007	$0.861^{+0.09}_{-0.07}$	$0.88^{+0.09}_{-0.08}$	6.62	5.70	5.84	1.055



IBIS-NuSTAR 2017

- Comparisons of simultaneous observations from different instruments

  * Swift/XRT and NuSTAR on MAXI 1820, Her X-1, GRO 1744, GRS 1915, J1658, GX13+1

  by K. Madsen → very variable agreement, complex case

- background handling/study

- Some 'courses' on data analysis deep meaning:

  * statistics, optimal binning,
  * new methodologies on data analysis like gaussian process
  * .....

WG HERITAGE
Resp : M; Guainazzi

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 …

Concordance project resp : H. Marshall

Concordance:
In-Flight Calibration of
X-ray Telescopes
without
Absolute References

- Idea : to compare data taking into account uncertainties on data AND instrument responses

- Method determines "best" $\underline{F}_j$ and "better" EAs $\underline{a}_i = a_i^w (C_{ij}/\underline{F}_j)^{1-w}$
  - $w = 1/(1+M\tau^2/\sigma_{ij}^2)$, τ = "a priori" st.dev. in ln(a)
  - w = 0 means data dominate, drive change in EA
  - w = 1 means data are mediocre, EA isn't changed
  - brings $\underline{f}_{ij} = C_{ij} / \underline{a}_i$ closer to *but not precisely* to $\underline{F}_j$

- CONCORDANCE MATRIX
- Inputs from instrument teams.

The Matrix

	Chandra ACIS	Chandra HETGS	Chandra LETGS	XMM pn	XMM MOS1,2	ROSAT PSPC
.15-.33	3	-	5	2	20	10
.33-.54	3	-	7	2	10	10
.54-.8	3	10	7	2	6	10
.8-1.2	3	5	7	2	6	10
1.2-1.8	2.6	4	7	2	6	10
1.8-2.2	3.3	4	7	2	6	10
2.2-3.5	3.3	4	7	2	6	-
3.5-5.5	4.9	5	10	2	6	-
5.5-10	5	7	10	3	10	-

Concordance - 4/10/18 1/4

The Matrix

	Suzaku XIS1	Suzaku XIS0,1,3	Astrosat SXT	Swift PC/WT	XMM RGS
.15-.33	-	-	-		-
.33-.54	20	-	15	15	8
.54-.8	15	15	15	10	5
.8-1.2	10	10	10	7.5	5
1.2-1.8	10	10	10	7.5	5
1.8-2.2	15	15	10	10	-
2.2-3.5	5	5	10	5	-
3.5-5.5	5	5	10	5	-
5.5-10	5	5	10	5	-

The Matrix

	Astrosat LAXPC	Astrosat CZTI	Suzaku HXD	Swift BAT	Fermi GBM
2.2-3.5	-	-	-	-	-
3.5-5.5	15	-	-	-	-
5.5-10	15	-	-	-	-
15-25	15	20	20	15	?
25-50	15	20	20	4	?
50-100	20	20	20	4	?
100-300	-	25	20	12	?

4/4

The Matrix

	RXTE PCA	RXTE HEXTE	INTEGRAL IBIS	INTEGRAL SPI	NuSTAR
2.2-3.5	5	-	-	-	-
3.5-5.5	10	-	-	-	4
5.5-10	3	-	-	-	3
15-25	3	5	-	-	3
25-50	10	5	8	5	15
50-100	50	5	15	5	20
100-300	-	-	20	5	-

Concordance - 4/10/18 3/4

An IACHEC DATABASE
resp : J. RODI

- The IACHEC Source Database (ISD) is part of the Heritage group
- (http://iachecdb.iaps.inaf.it/)

- The goal of it is to collect "high-level scientific data and data analysis procedures used in IACHEC published papers" for cross-calibration analyses.

- It is also a collection of standard calibration sources for future missions.

- The database is for the general public to use, not just for IACHEC people.

Cross-calibration consensus forum (Jukka Nevalainen's presentation)

- Action initiated in 2016 IACHEC meeting
- A forum for dedicated discussion between the different working groups
- Utilise the collective experience of IACHEC to go beyond the WG tasks
- Attempt to understand the instruments as a whole
- Verify that WGs are consistent
- Ask and answer questions like:
  - How do the analyses of different types of objects look when put together?
  - Are the residuals btw two given instruments similar, independent of the object type? Should they be similar?
- Experts on the calibration of different instruments could try to understand the cross-cal patterns. Find and test different sources of calibration problems. (Complementary to Concordance Calibration, PyBLocks)

Interface to the community

DEAR ALL,

THE FACEBOOK GROUP HAS BEEN CREATED. (…)

HTTPS://WWW.FACEBOOK.COM/GROUPS/274799816701988/

FOR MORE DETAILS, SEE GUILLAUME