IACHEC: International Astronomical Consortium for High Energy Calibration

Defining High Energy Calibration Standards and Procedures

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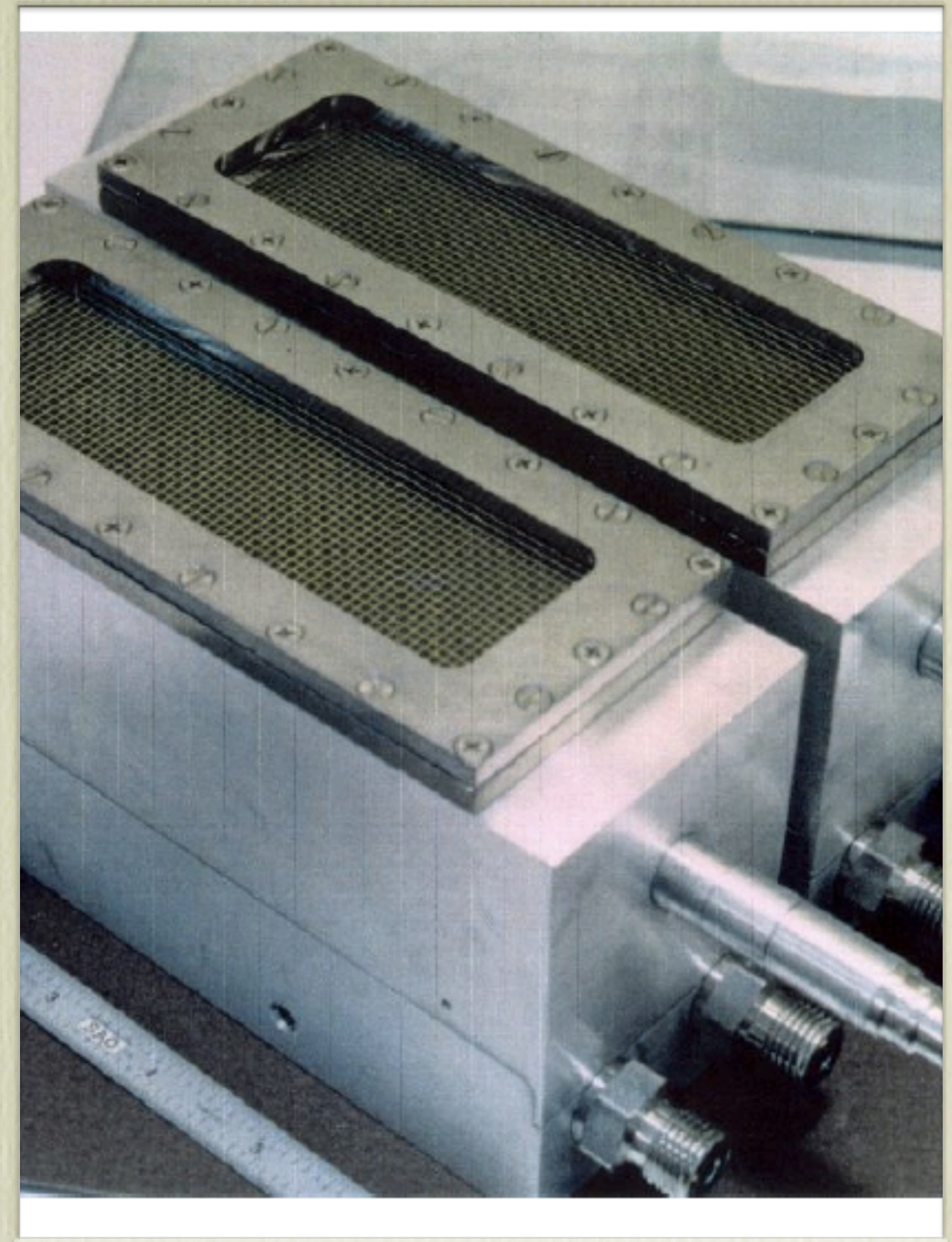
Where We Were

- X-ray Astronomy is 50 yr old — Mature!
- Advanced ground calibration
  - Component & system tests
  - GEANT for detector models
- Flight cal'n prior to IACHEC
  - Flight observations: refine response functions with Crab
  - Crab Nebula: constant, bright, PL spectrum, pulsed



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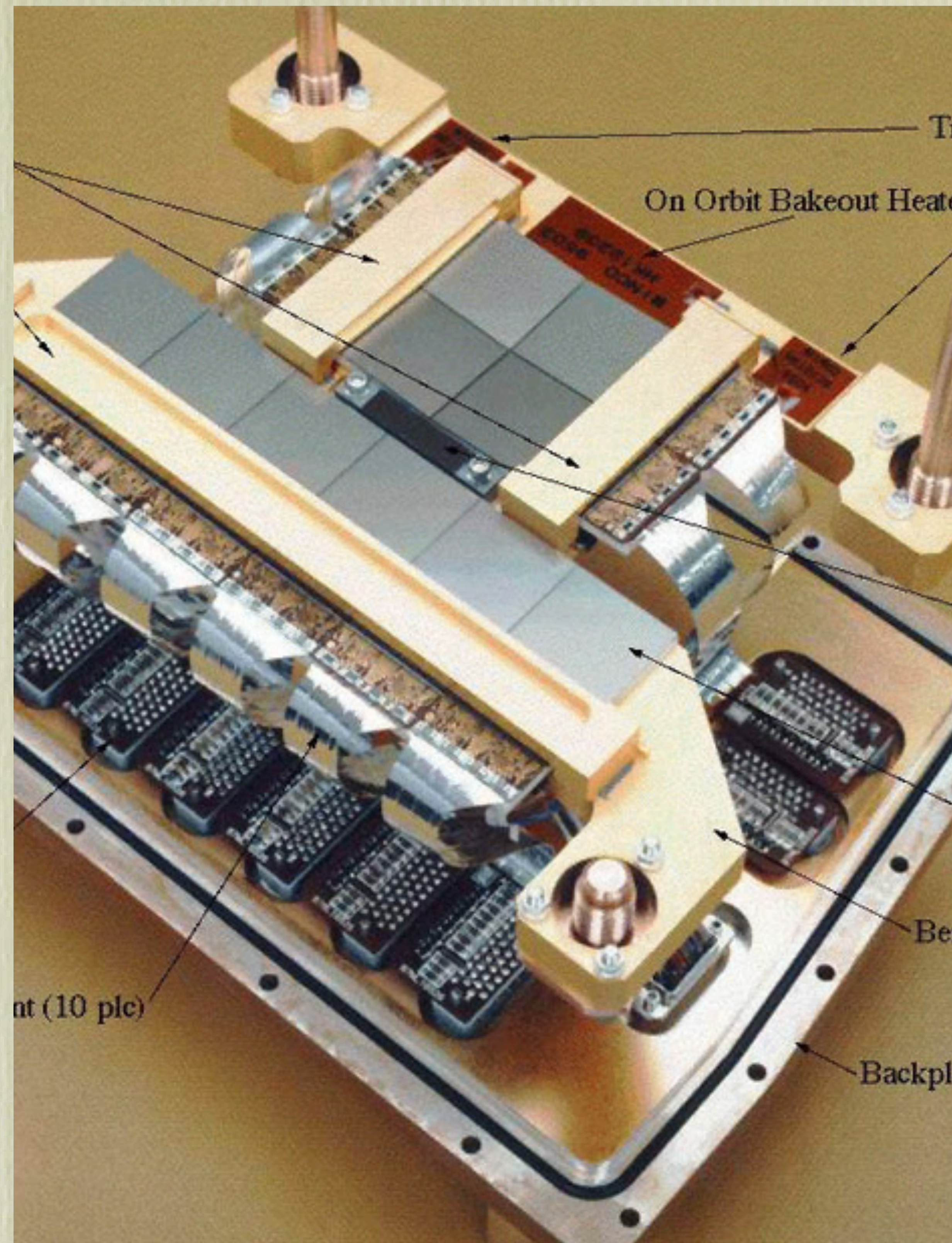
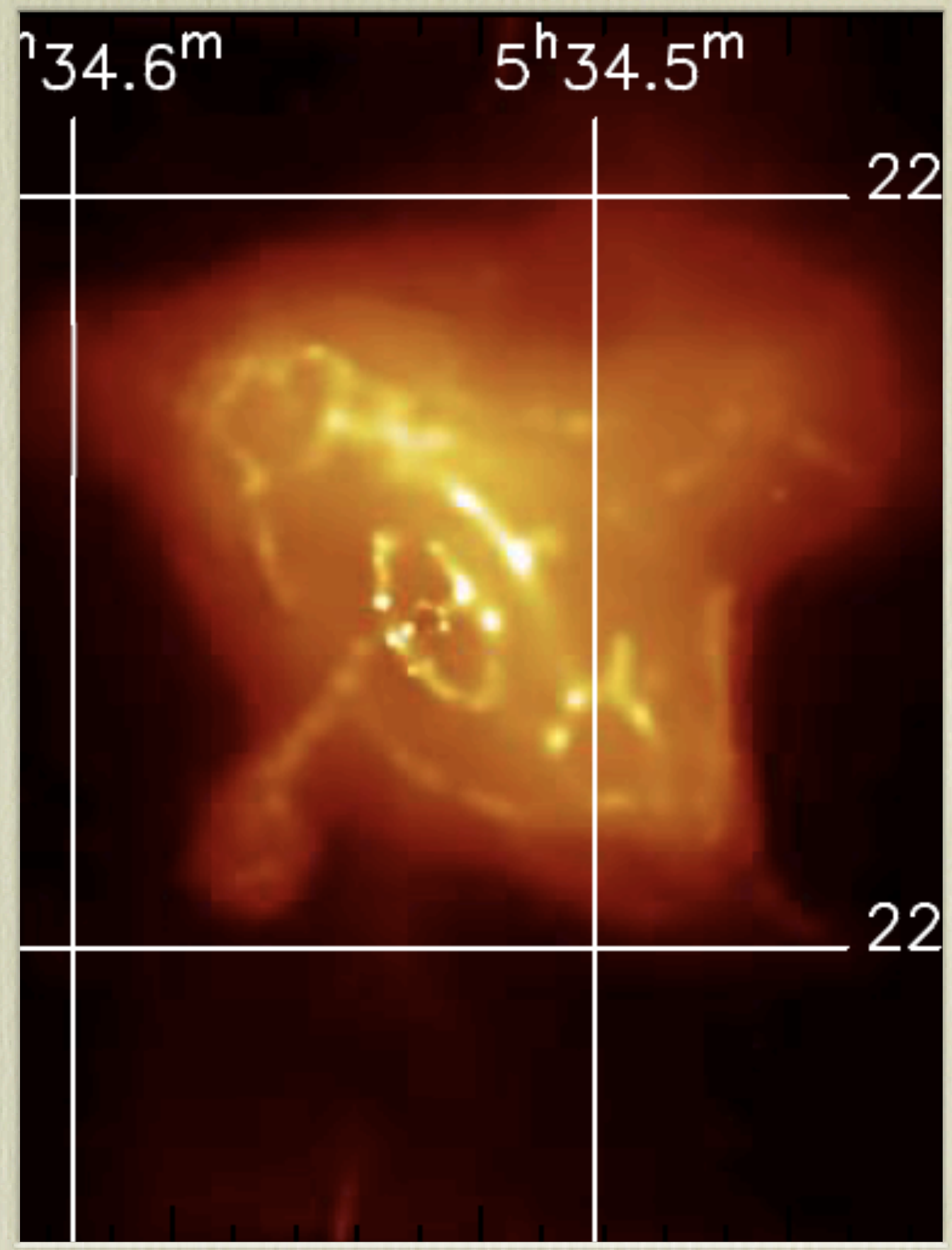


What Changed?

- Observatory multiplicity
  - Chandra, XMM-Newton, Suzaku
  - INTEGRAL, Agile, & Fermi
  - HESS, MAGIC, & VERITAS
- User committees are diverse
  - Coordinated observations
- Instruments change at > 1% level
  - Contamination
  - Degradation of MLI, detectors
  - Charge extraction
- 2011: Crab Nebula flares!



IACHEC Overview

- Annual international meetings (since 2006)
  - Started by 2 largest X-ray groups (Chandra & XMM)
  - Support comes from projects (XMM, Suzaku, etc.)
  - Most recent meeting: Napa, CA (3/26-29/12)
- Meetings involve <u>work</u>!
  - Two half-days for working group sessions
  - Telecons between meetings maintain progress
- All major X- & gamma-ray missions represented
- 35-45 attendees/meeting, 70% give talks
- 3 papers published (2010-11), 4 expected (2012-13)
- URL: http://web.mit.edu/iachec/ with Wiki

Working Groups

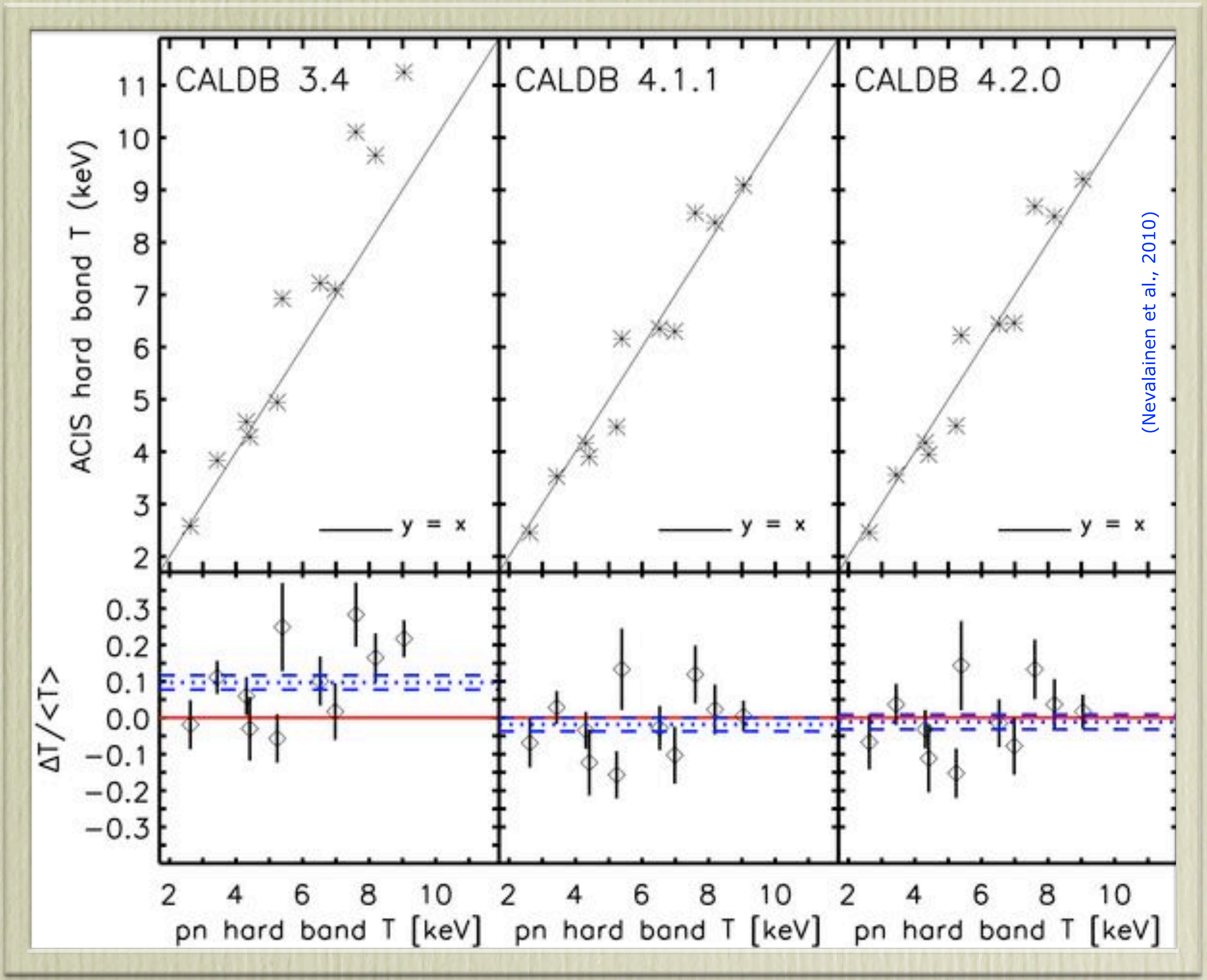
- Methods
  - Background (particles, “space weather”, cosmic sources)
  - CCD detectors
  - Coordinated observations
  - Emission line identifications, wavelengths
  - Statistics
- Sources
  - Clusters of galaxies
  - Nonthermal SNR (e.g. Crab)
  - Thermal SNR
  - WDs and isolated neutron stars

What IACHEC Does

- Reviews ground calibration plans for new missions
  - This year: NuSTAR (5-80 keV, 40" imaging)
- Reviews flight calibration plans and results
  - Investigate optics and detector physics
  - Examine methods, systematic errors
- Define new calibration standards
  - Characterize sources physically
  - Compare results from different missions
  - Publish results
- Arrange coordinated observations
- Consider infrastructure: statistics, archives

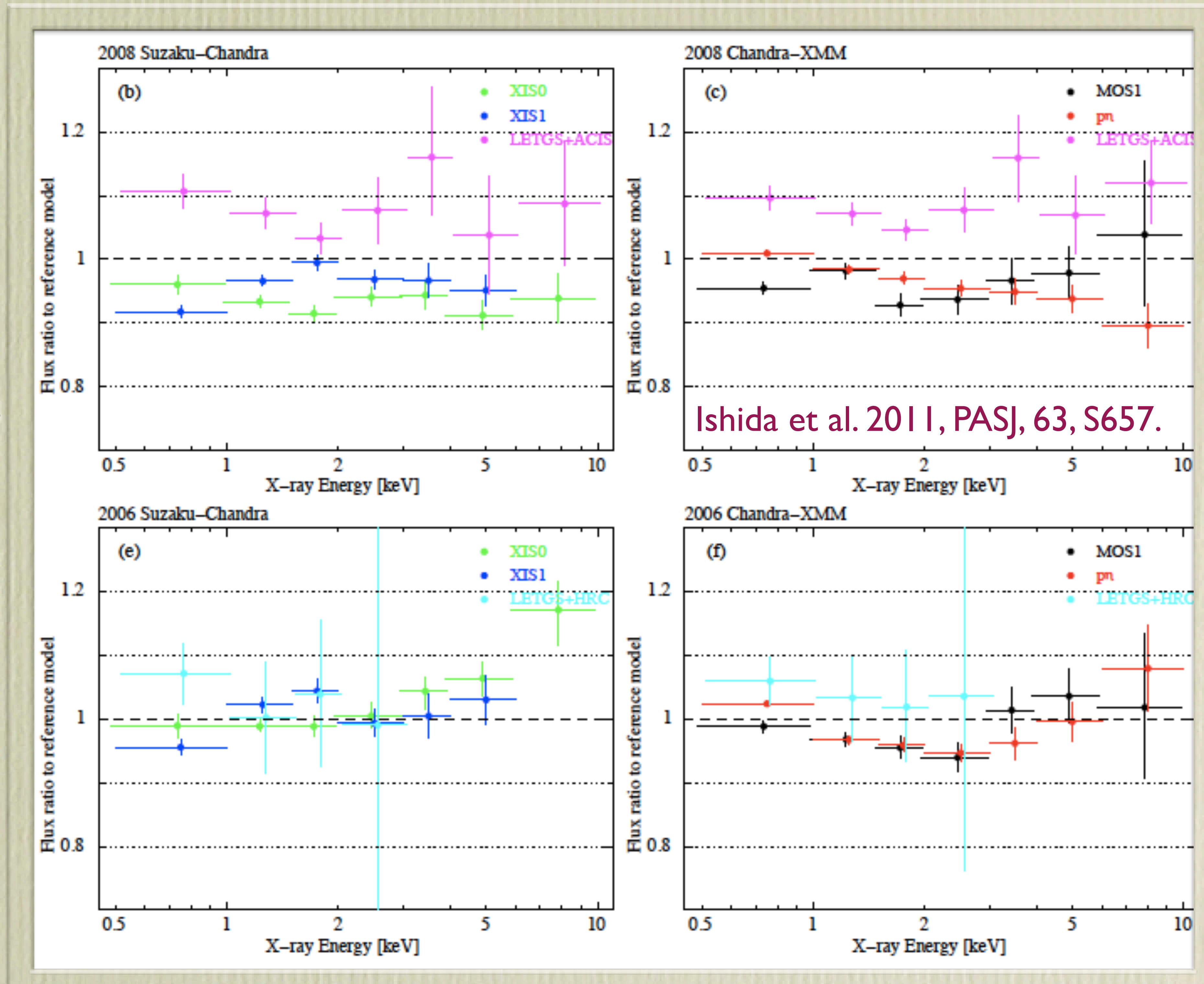
Examples — 1

- Galaxy clusters = hot gas balls
- Measured kT with 2 telescopes
- Validated XMM (pn) kTs with Fe line flux ratios
- Fixed Chandra optics model
- Project started at 2nd IACHEC meeting



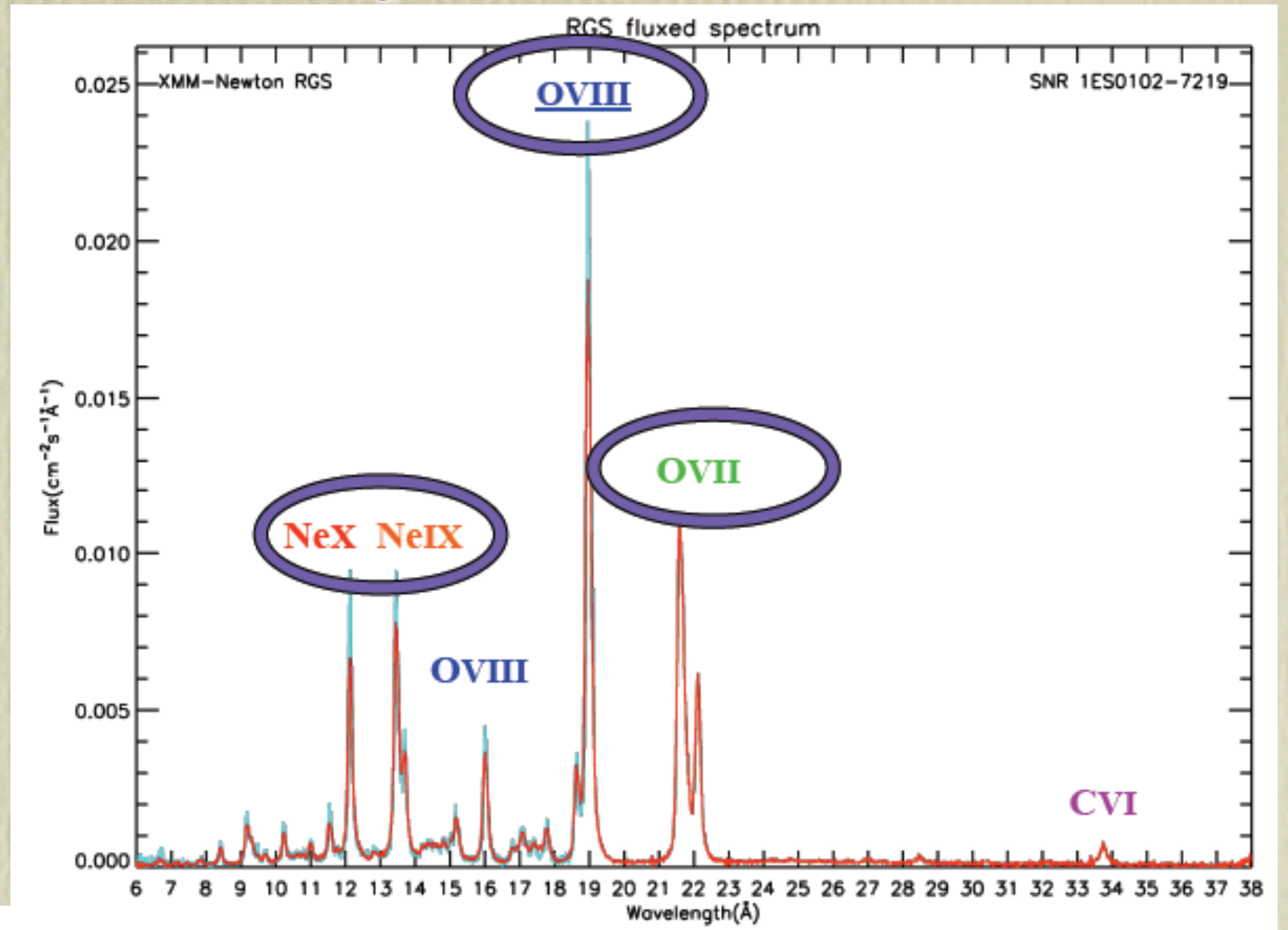
Examples — 2

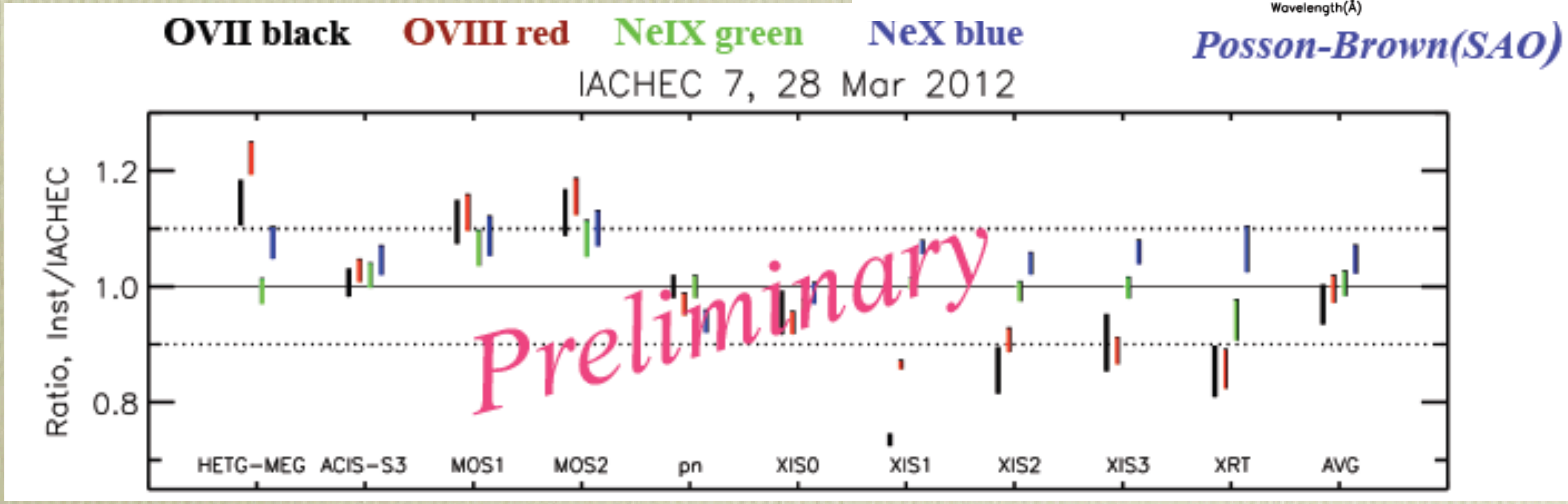
- Joint observations of a BL Lac object
- Technical issues:
  - only joint times
  - fluxes from PL fits in narrow bands
  - relative to joint fit
- Published as an IACHEC project
- Elucidated instrument differences



Examples — 3

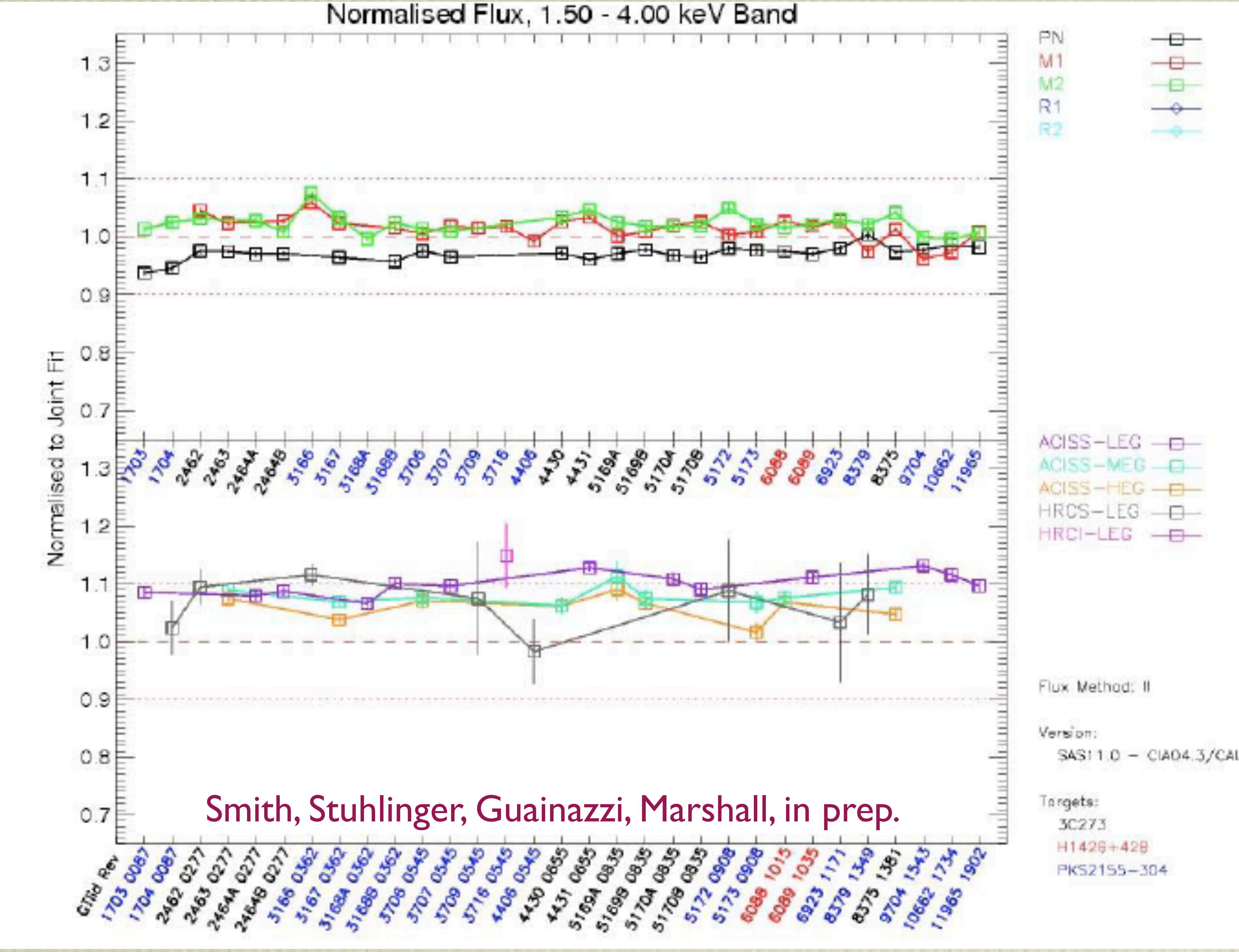
- Thermal SNR group: results for 1E0102-7219
- Spectrum is simple, stable
- Set reference fluxes
- Provides comparison of instruments





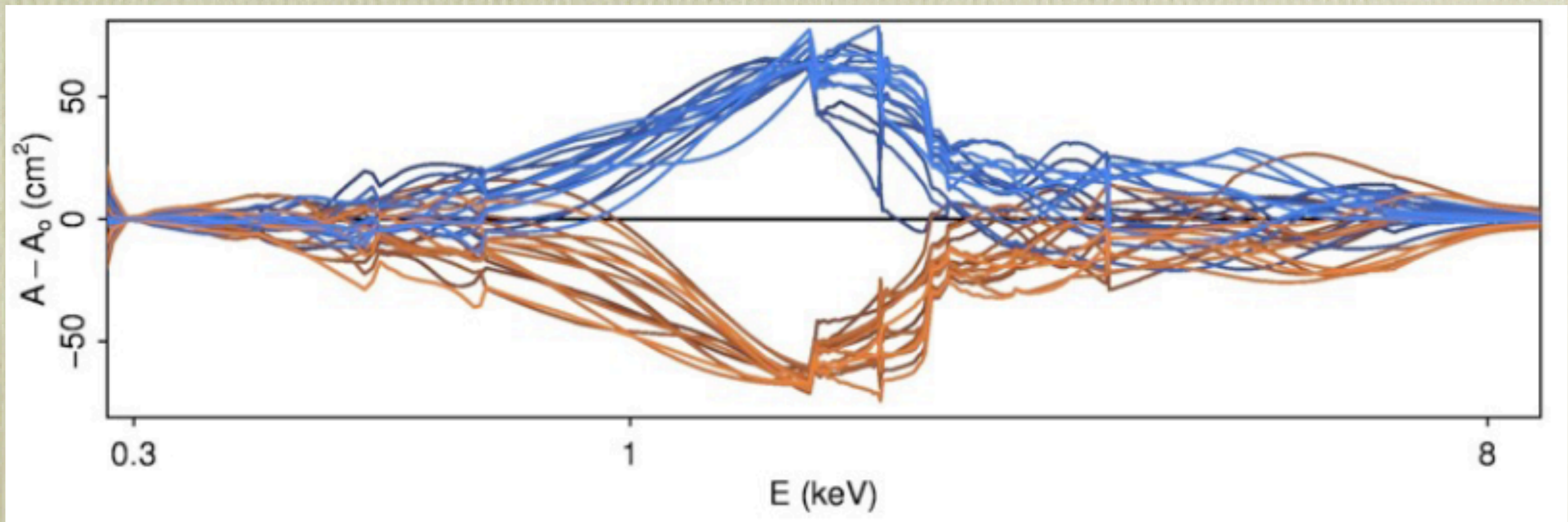
Examples — 4

- Fluxes in bands compared
- XMM (top) and Chandra (bottom)
- Simultaneous observations used
- IACHEC paper in progress



Examples — 5

- Encode systematic error estimates in ensemble of cal files
- Fit model to data using each cal file set
  - Markov Chain Monte Carlo enables process
  - Populate parameter space with viable solutions
- Examine distributions of parameters
- Implemented for Chandra: pyBloCXS



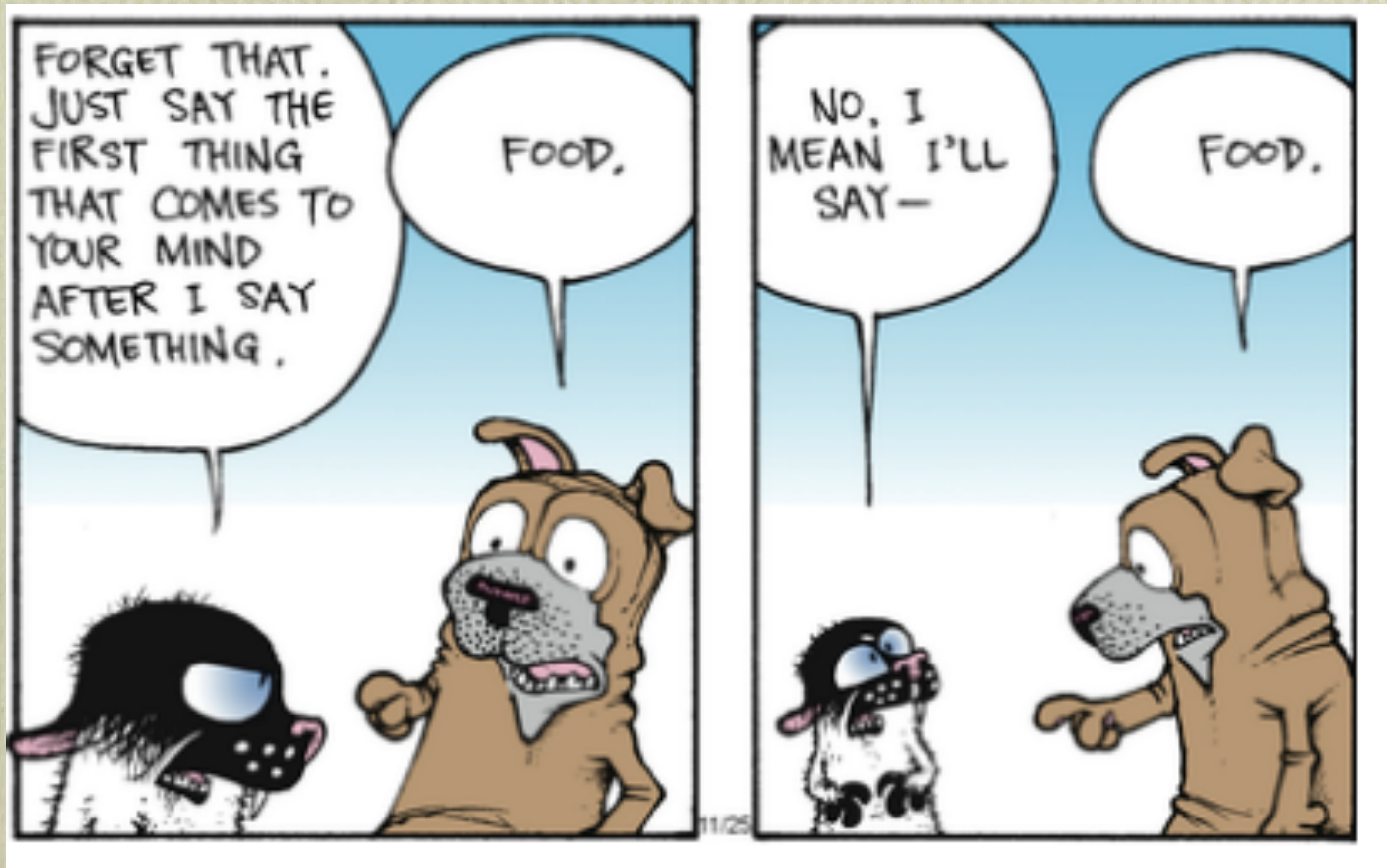
See http://hea-www.harvard.edu/AstroStat/pyBLoCXS/

Examples — 6+

- HXMT (China): will collaborate to use Panter facility (Germany)
- For NuSTAR: coordinating new observations of 3C 273 with Chandra, XMM, Suzaku
- Study of N132D, an SNR in LMC
- Use of HZ 43, Sirius B, & PKS 2155-302 to correct QE of spectrometer on Chandra
- Use of BL Lac objects to measure contamination
- Switching over to ML statistics (from χ^2)
- Posting and maintaining wiki pages

Summary

- IACHEC effectively coordinates calibration
- IACHEC papers improve visibility of work
- IACHEC meetings effect progress
- New high energy missions are joining IACHEC



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