

# **XRSAG Update to PhysPAG**

## **Jay Bookbinder**

AAS Meeting

2013-01-06

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# Outline

- X-ray Mission Concepts Study summary
- XRSAG working group status
  - NWNH science case
  - XRSAG/COPAG common interests
  - PATR process improvement
  - Costing WG (defunct)
  - Technology Development Plans
- Technology Development Work
  - Optics
  - Detectors (limited to calorimeters)
- International efforts
- Near term plans

# X-ray Mission Concept Study Summary

- X-ray observatories in the \$1B class that address most or all of the IXO science objectives are feasible for start within this decade, but only if technical risk is controlled by prior development of key technologies to TRL-6.
- The CST determined that a high throughput calorimeter would introduce the most fundamental new capability
  - *AXSIO* has the highest effective area and both a calorimeter and a grating spectrometer which together provide the highest science yield among the notional missions
  - *N-CAL* has the minimum effective area deemed necessary for accomplishing a significant fraction of the highly-ranked *IXO* science
- *See more tomorrow at R. Petre presentation at PCOS Town Hall 12:45pm Room 104B*

# IXO X-ray Science

(as accomplished by missions in the X-ray Study)

Science	IXO	AXSIO	N-CAL	NXGS	NWFI
Strong Gravity	<i>orbiting Fe K<math>\alpha</math></i>				
SMBH Growth	<i>spin survey</i>				
Evolution of LSS	<i>WHIM</i>				
	<i>cluster survey</i>				
Feedback	<i>cluster imaging</i>				
High density matter	<i>NS spectra</i>				
	<i>NS timing</i>				

**Legend:**

IXO Science Goal is

Fulfilled

Partially fulfilled

Not fulfilled

Not Applicable

# Working Group – NWNH Science

**Task:** Develop science case and requirements for X-ray mission

- Based on NWNH (including Astro-H, NuSTAR science results)
- **Short term:** For FY15 “probe-class” mission (initial drop ~3/13)
- **Longer term:** For 2020 decadal (also ~3/13)
- Organize workshops, websites, etc.

**Leads:** Ptak / Smith / Vihklinin

**Status:**

- Blog <http://xraynwnh.blogspot.com>
  - Over 350 relevant papers collected
- Traceability started
  - Black hole accretion
  - Neutron star physics
  - Matter/Energy life cycles (incl. feedback, missing baryons)
  - **Stellar astrophysics (New area for X-ray spectroscopic imaging)**

# Working Group – XRSAG-COPAG common interests

**Task:** Develop working group to identify where x-ray measurements can support COPAG science. Identify common technology needs.

**Leads:** Kouveliotou / Mushotzky

## **Status:**

1. Currently spinning up with additional members:  
Ramsey, Gehrels
2. Deliverable: White paper on what multipurpose missions (ie., SMEX?) combinations can be built in parallel to discipline-specific probes to maximize the science return across the highest number of disciplines

# Working Group – Costing (defunct)

- NRC held a 2-day workshop Nov. 2012
  - **Lessons Learned in Decadal Planning in Space Science**
  - [http://sites.nationalacademies.org/ssb/CurrentProjects/SSB\\_070954#webcast](http://sites.nationalacademies.org/ssb/CurrentProjects/SSB_070954#webcast)
- **Key panels**
  - Panel on Decadal Survey Program Formulation: Lessons Learned and Opportunities for Improvement
  - Panel on Program Formulation: The Role of Cost Estimation, Technical Evaluation, and Budget Projections in Prioritizing Missions
  - Panel on How to Plan for High-Profile Missions
  - Panel on Incorporating International Perspectives into Future Decadal Planning
  - Panel on Decadal Survey Stewardship: The Role of the Mid-decade Reviews and Standing Committees

# Working Group Status – Tech Dev Plan

**Task:** Complete Technology Development Plan (drafts 12/12) based on IXO/AXSIO work, but also including/emphasizing need for early funding for long-lead future technologies. Final draft 3/13.

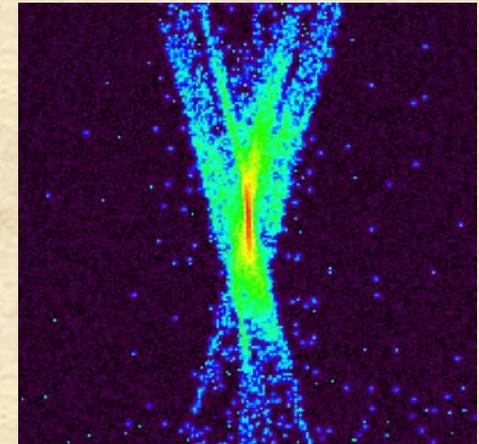
**Leads:** Petre / Reid

## **Status:**

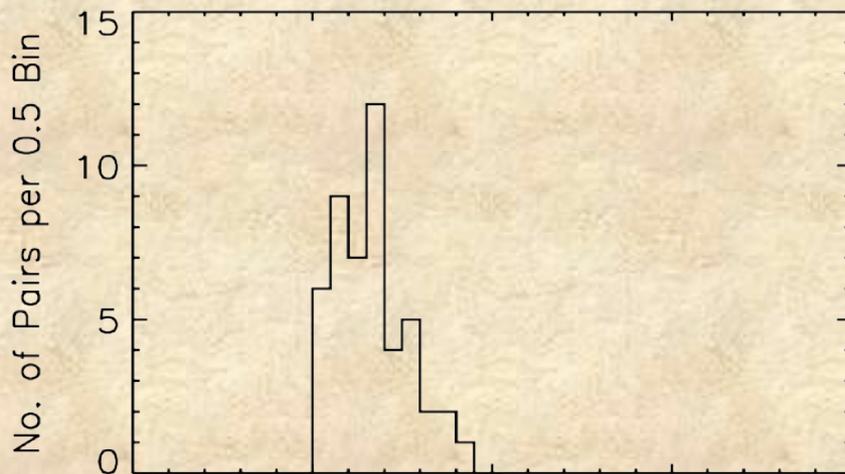
- Heritage of key elements (optics, detectors) of TDP from IXO.
- Inputs from all major elements being coordinated for a final draft release by HEAD meeting
- Inputs for >2020 missions needs to be included in next few months
- The TDP will provide a detailed description of the path (milestones, timescales and cost) to TRL-6
- The TDP will offer costs, timescales for multiple funding scenarios

# Optics Technology Developments

- **Major achievements (~TRL-5)**
  - Consistently fabricate mirror segments at 6" HPD (two reflections)
  - Consistently assemble and construct modules of multiple co-aligned pairs of mirror segments at 12" HPD (two reflections, full illumination)
    - Modules to be subjected to acoustic tests
- **Major Issues being addressed**
  - Laboratory thermal stability causing focal length change and defocusing
  - Coating stress causing image degradation



Full aperture illumination x-ray image of TDM: 11.5" HPD (7.9 keV)



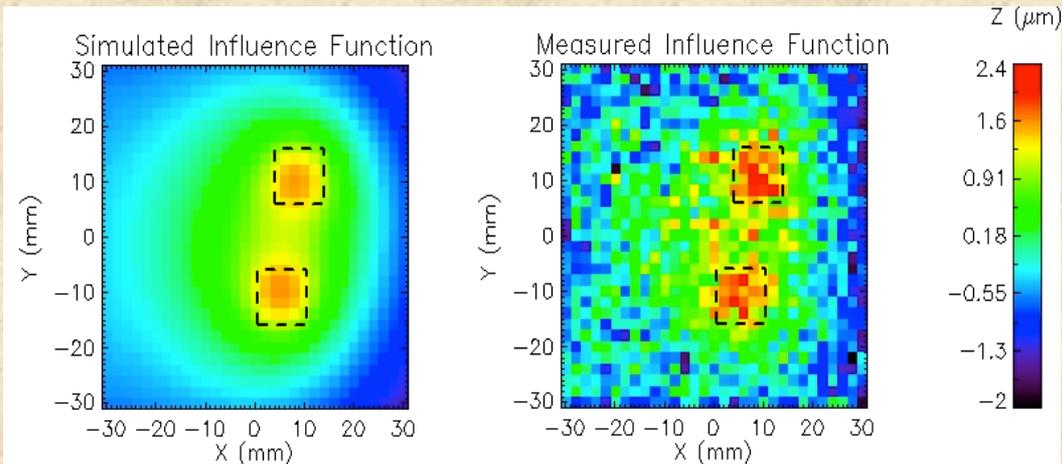
1/5/2013

Mirror Pair Performance (ArcSecond HPD) XR-SAG update to PhysPAG



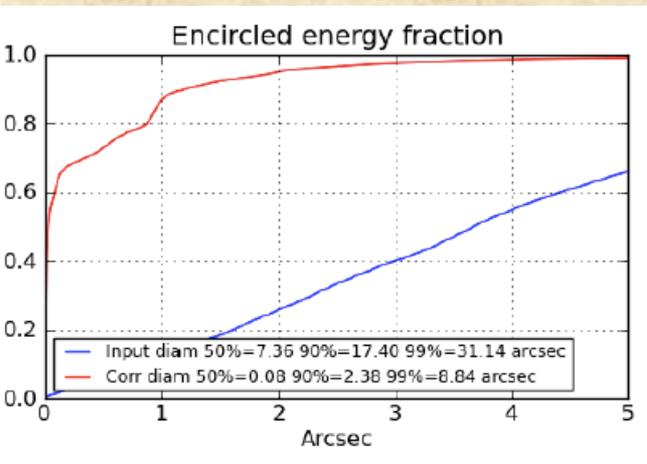
TDM passed vibration & TV tests with bonds and optical alignment intact.

# Adjustable X-ray Optics

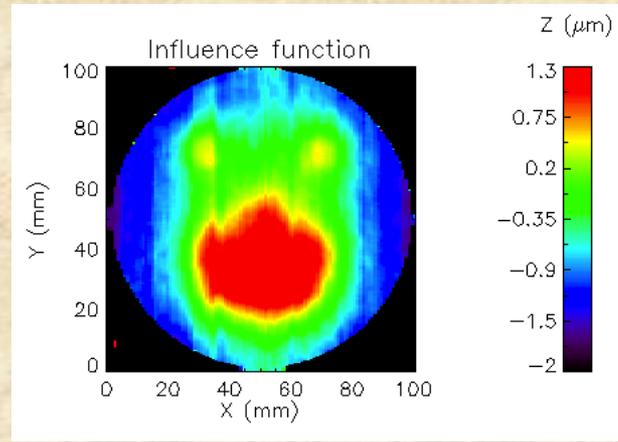


Modeled (left) and measured (right) pair of influence functions on flat test mirror.

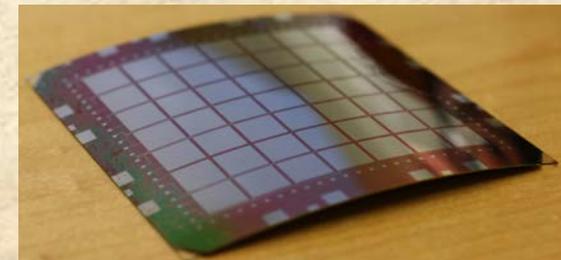
Measured influence functions match modeled predictions well, performance is stable and repeatable to within current metrology noise, and yield on flat test mirrors improved to consistently 97–100 per cent.



Simulations show correction of ~7 arc sec HPD errors (blue) to less than 1 arc sec HPD (red)



Arbitrary figure change can be introduced: "The [Adjustable X-ray Optics] Scream"



Curved segments produced and currently under test. Preliminary results- hysteresis curves - show piezo successfully deposited.

# AXSIO & N-CAL XMS concept

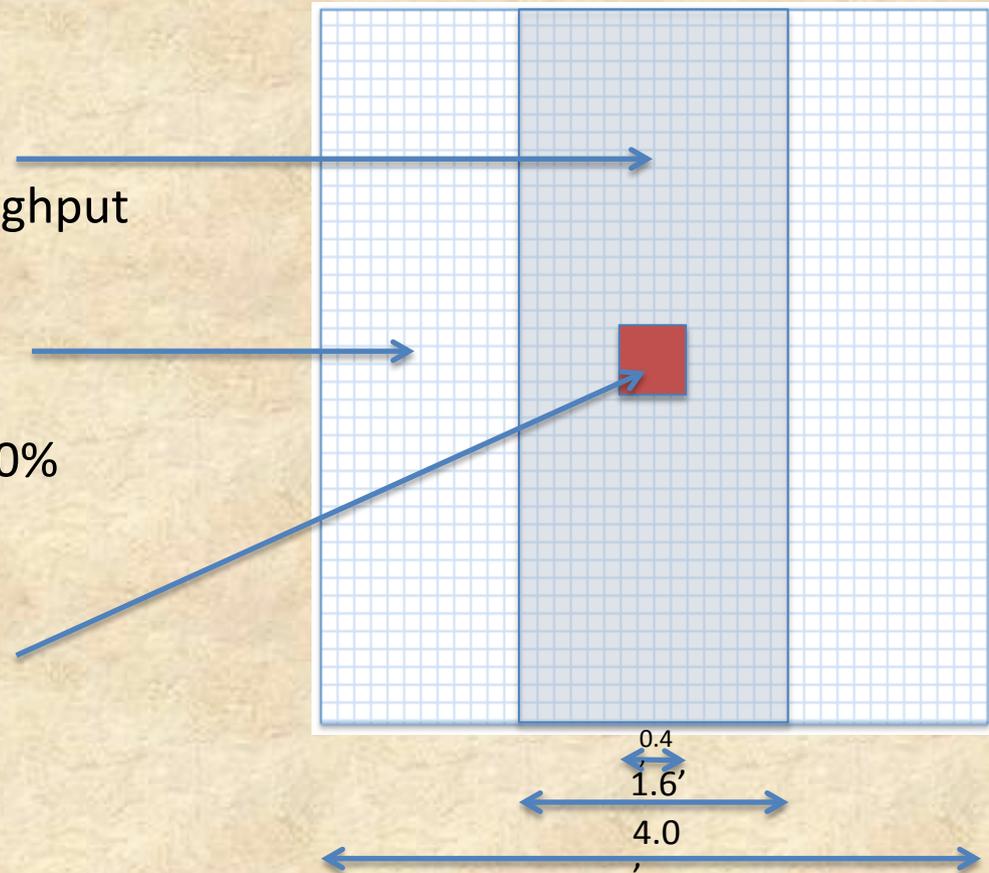
Main array – single silicon carrier chip:

- 40 x 40 pixels, hole in middle: 4 x 4 pixels
- Pixels: 6" each, 300  $\mu\text{m}$
- Inner shaded region:
  - 16x40 – single pixels
  - < 3 eV resolution (FWHM)
  - 50 cps capability, 80% throughput
  - 624 TESs
- Outer envelope – 4x4 Hydra
  - < 6 eV resolution (FWHM)
  - 10 cps per pixel capability 80% throughput
  - 240 TESs (6x40 each side)

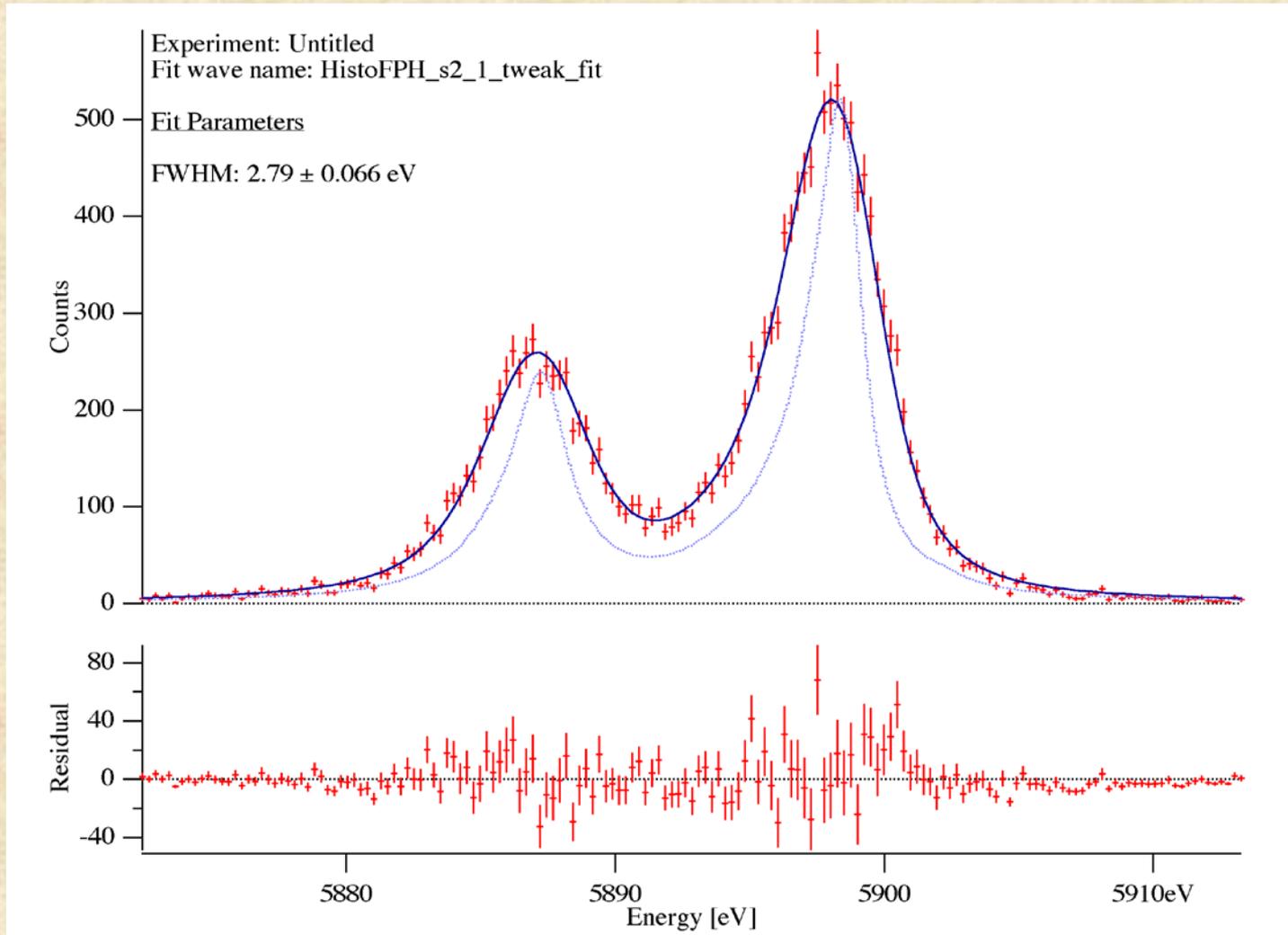
Point source array (PSA):

- 16 x 16 pixels, 1.5" each, 75  $\mu\text{m}$
- 24 arcsec FOV
- 2 eV resolution (FWHM)
- **80% event throughput at 300 cps/pixel**
- 256 TESs

## XMS Array Concept



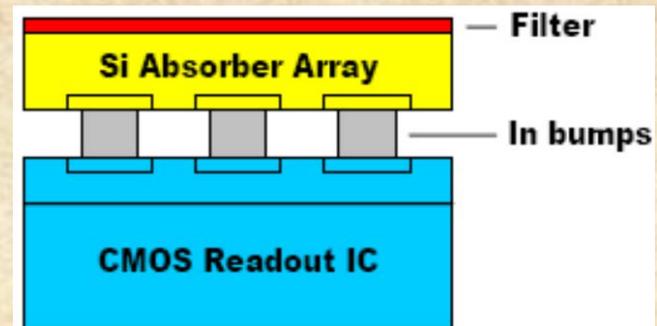
# PSA-Type Pixel



Faster pixel,  $\sim 22$  ms decay time,  $\sim 630$  cps  
data collected above 1000 cps, still to be analyzed.

# PSU/Teledyne Hybrid CMOS Detectors

- Detector array and readout array built separately, bump-bonded together
  - Allows separate optimization of detector and readout
  - Readout electronics for each pixel
  - Optical blocking filter on detector
  - **However, current readnoise ( $\sim 8 e^-$ ) and inter-pixel crosstalk need improvement.**



- Recent work has shown that for an H2RG with 36 micron pixels, interpixel crosstalk becomes nearly unmeasurable ( $1.7 \pm 1.0 \%$ )
- Hybrid CMOS detectors have been measured to have read noise as low as  $\sim 7.1 e^-$  (RMS)

*(see Prieskorn et al. 2013, NIM, submitted this week)*

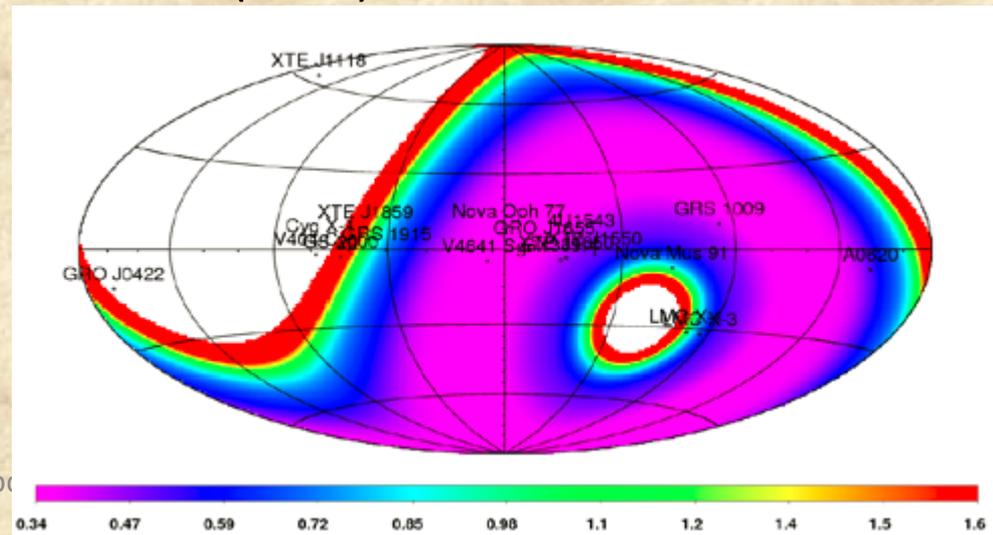


- Teledyne and Penn State are now working on detectors that should have zero inter-pixel capacitive coupling, should achieve low read noise, and should have fast frame rates enabled by the ability to read only the pixels with X-ray signal

# International Flavorings

- ESA selected JUICE, not Athena, as its L1 mission
  - Calorimeter mission is now highest priority in US
- ESA is considering how L2, L3 missions are to be selected. Decision is expected by early this year
  - Earliest launch date for L2 is 2028; L3 is 2035
  - European community undecided about strategy for L2/L3
  - For L2, ESA would require a technology freeze in ~2015; would have to be Athena or equivalent
  - A more ambitious mission requiring technical advances (e.g., higher angular resolution) would have to be proposed as L3 (2035)

- MIRAX: SAO/INPE collaboration
  - MIRAX is a high energy (5 – 200 keV) wide field survey, 5arcmin, 2 keV resolution.
  - Difficult from a contracting perspective
  - ~2018 launch



# XRSAG Near Term Plans

- Complete the analysis of the NWNH X-ray science case.
- Support the Technology Development Plan for the critical technology for the notional missions (mirrors, calorimeters, gratings),....
  - Include tech dev for 2020 mission(s).
- Support follow up mission study in FY 14 to maximize the science return for a ~\$1B class mission concept, consistent with Astrophysics Division guidance (expected January 2013).
- Maintain community involvement through XRSAG to prioritize science objectives (starting from *IXO* and *NWNH*) and align on specific mission for 2017 start

# Future XRSAG meetings

- **Splinter session at the 13<sup>th</sup> HEAD meeting**
  - April 6- 11, 2013 in Monterey, CA
    1. Tech Dev Plan WG
    2. Science WG
    3. XRSAG/COPAG WG
    4. Updates on mission studies
    5. Updates on technology progress
- **Potential splinter session at summer AAS**
  - Indianapolis, IN, June 2-6, 2013
  - Past deadline... but....
- **Quarterly webcons**
  - February 2014
  - May 2014
  - August 2014
  - November 2014

**END**