Outline for planning….

5 min – WILT – on NASA – ESA discussion, status, ??? – 1 or 2 slides
merger & status

10 min on science - 4 Slides

5 min on current configuration - 2 slides

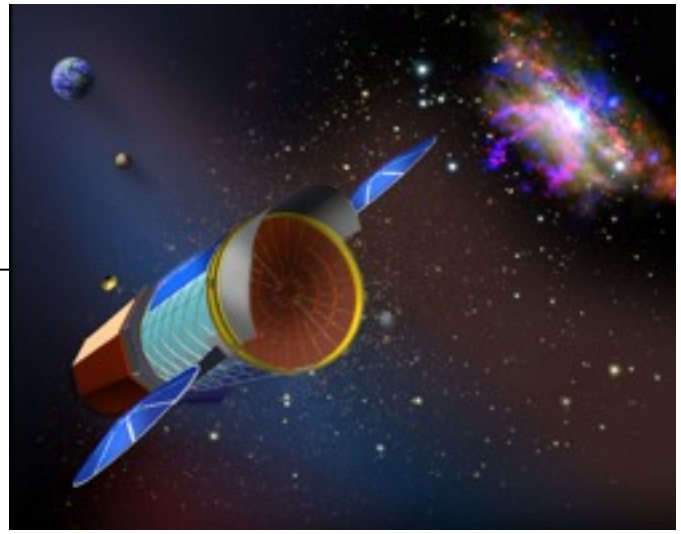
6 min on the CV process and ESA industry studies 2 slides

3 min on update of XMS progress – not so sure this is worthwhile – 1 slide

5 min in update of mirror progress - 2 slides

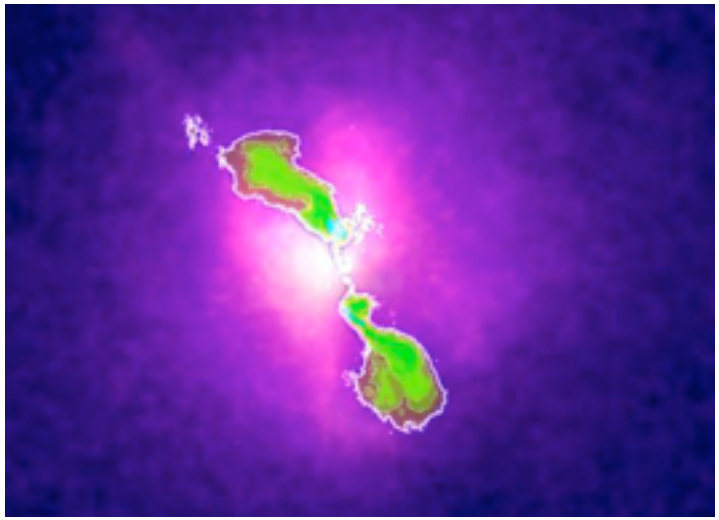
The IXO Mission and Status

Randall Smith
on behalf of the IXO team

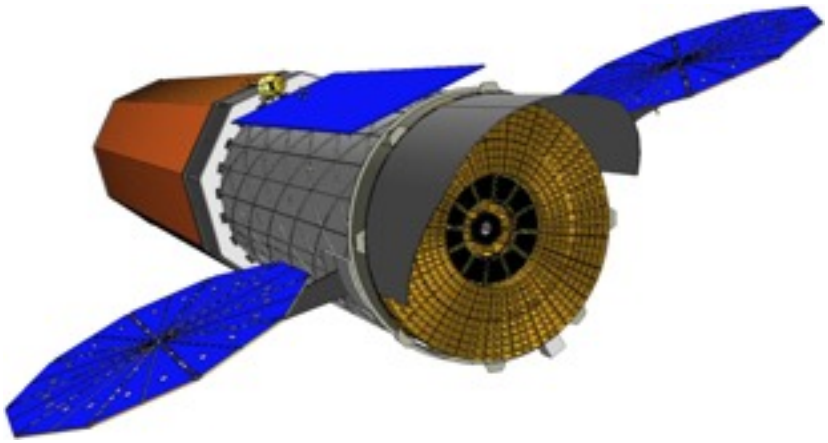


The International X-Ray Observatory

- What happens close to a black hole?
- When and how did super-massive black holes grow?
- How does large scale structure evolve?
- What is the connection between these processes?



Hydra A Galaxy Cluster

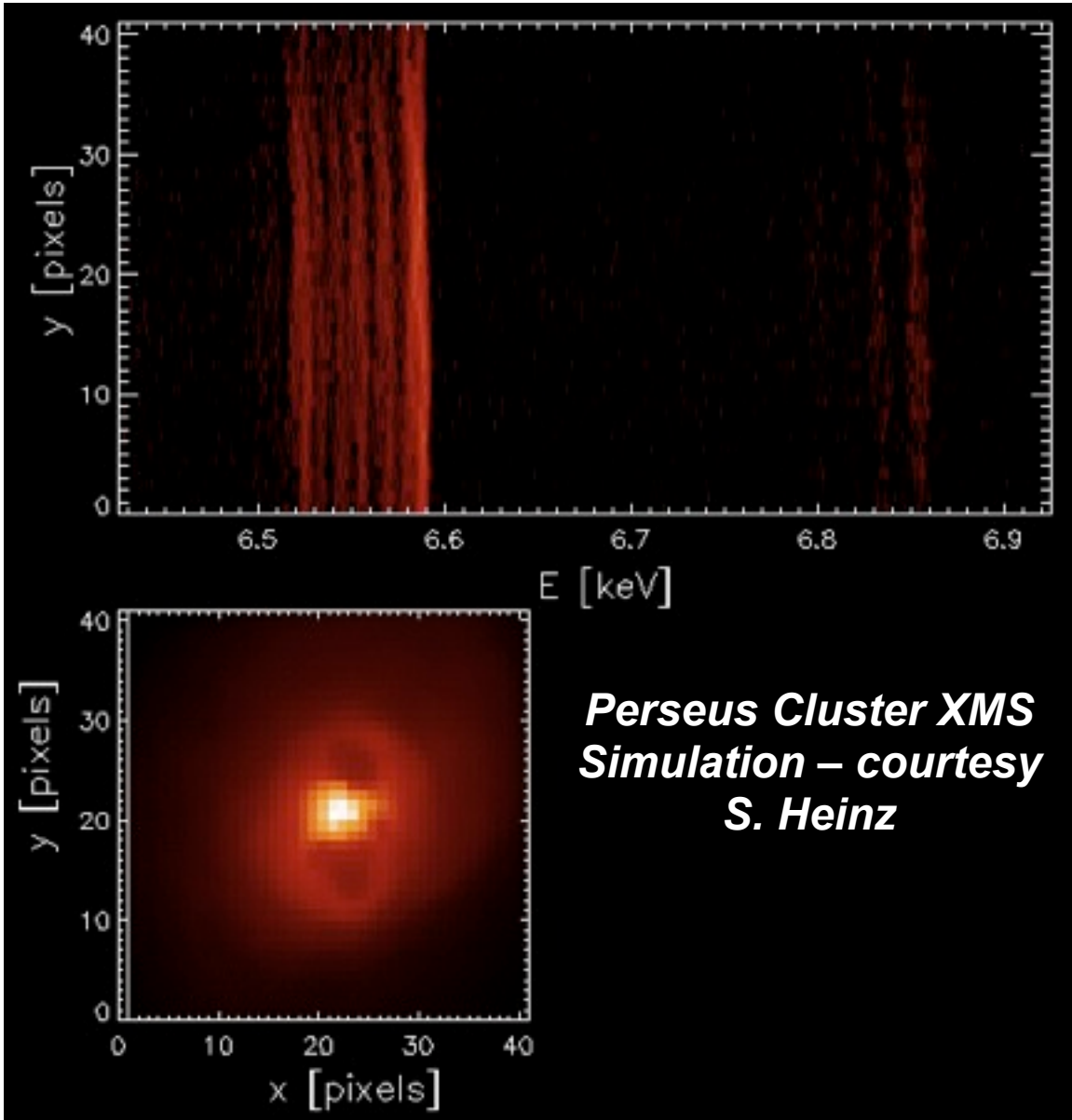


- 20m focal length
- Mass 5894 kg (incl. ~40% margin)
- NASA EELV or ESA Ariane V
- L2 orbit
- 5 year lifetime; 10 year goal

Cosmic Feedback

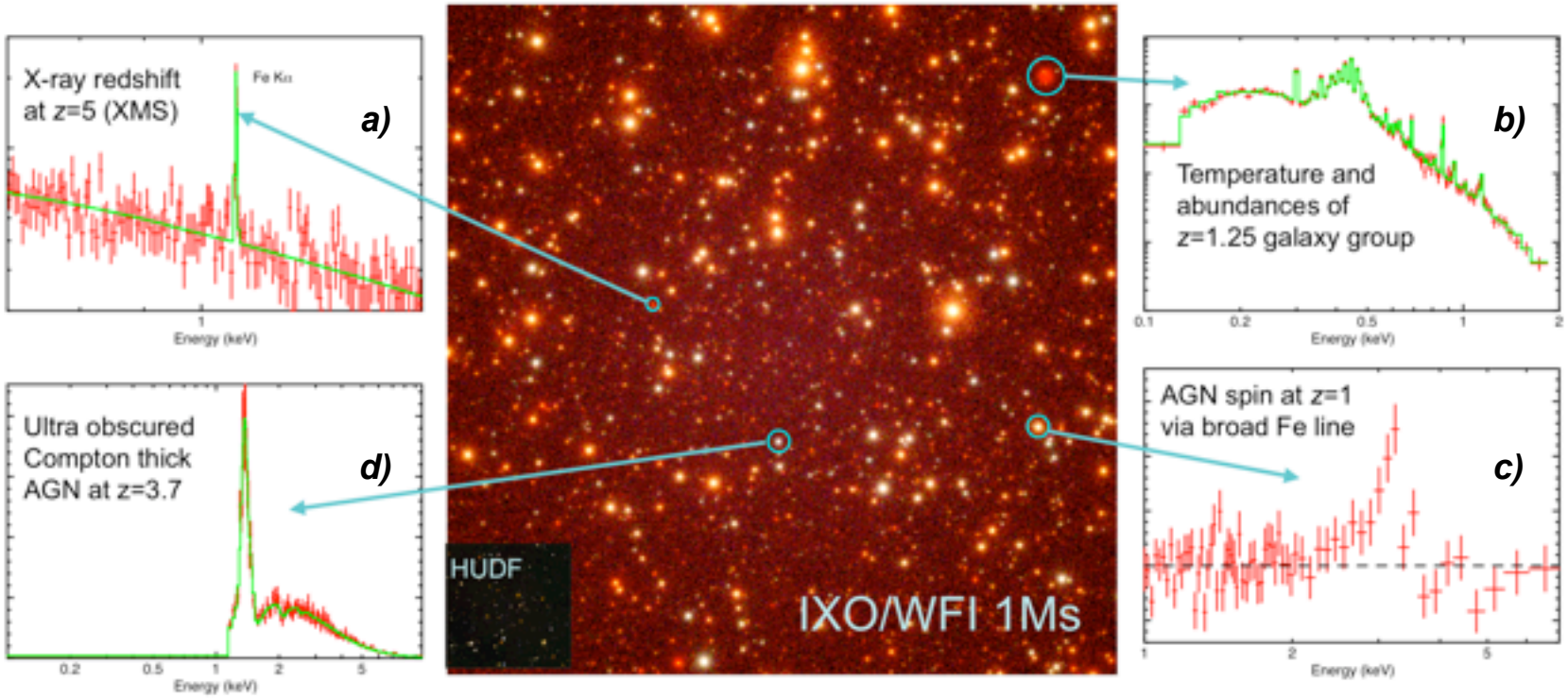
- *AGN jets create bubbles of hot gas in clusters in feedback process that regulates the growth of galaxies and clusters of galaxies*

- *Velocity measurements of the bubble walls are crucial to determine the heating and state of hot gas found within clusters of galaxies*



Perseus Cluster XMS Simulation – courtesy S. Heinz

Black Hole & Large Scale Structure Evolution



IXO has the ability to characterize the extragalactic Universe:

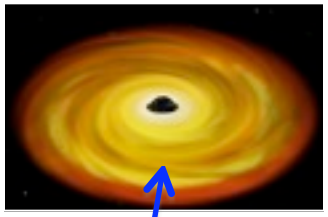
a) determine redshift autonomously in the X-ray band

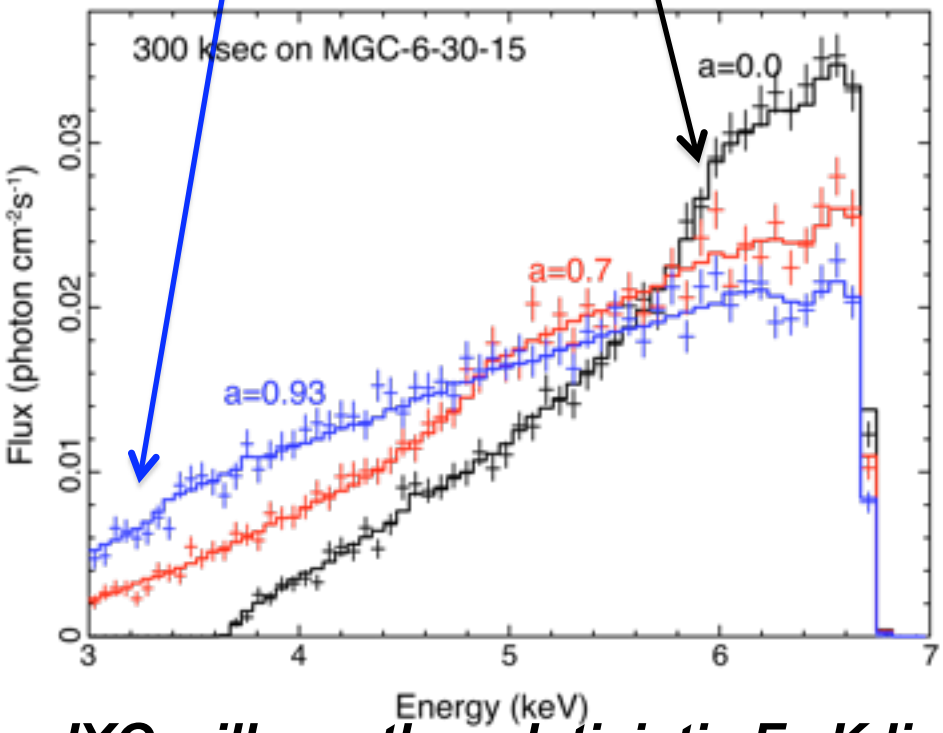
b) determine temperatures and abundances even for low luminosity galaxy groups

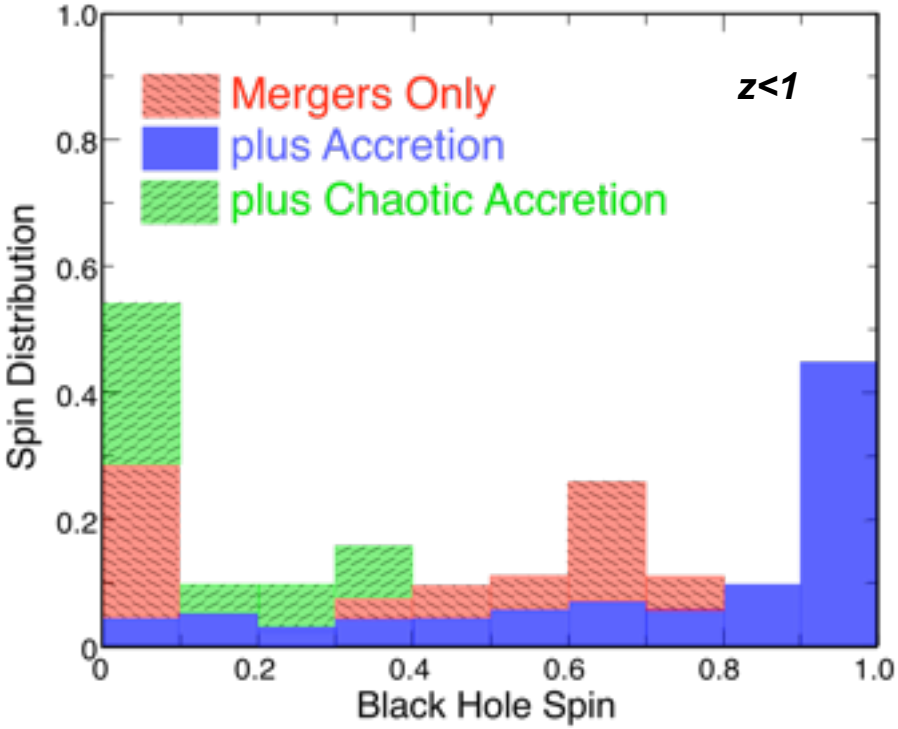
c) make spin measurements of AGN to a similar redshift

d) uncover the most heavily obscured, Compton-thick AGN

Super-massive Black Hole Spin & Growth





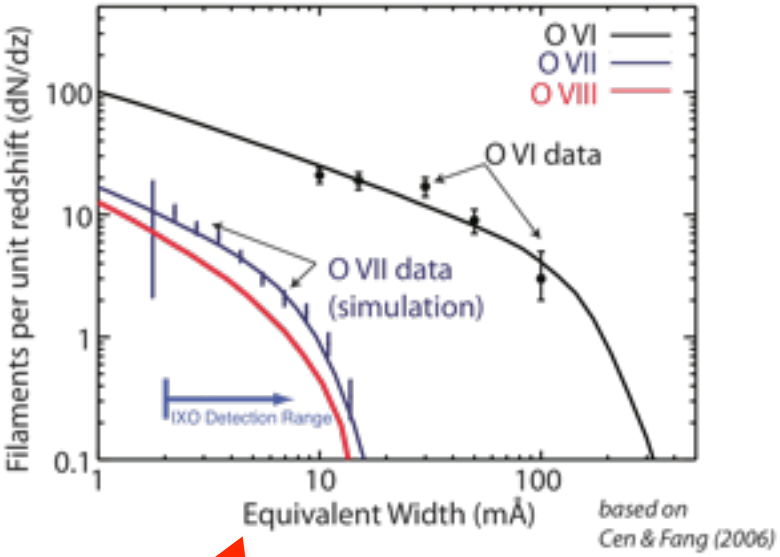


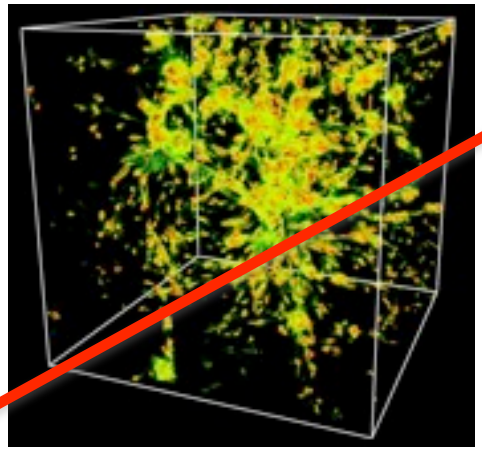
Based on Berti & Volonteri (2008)

IXO will use the relativistic Fe K line to determine the black hole spin for 300 AGN within z < 0.2 to constrain the SMBH merger history

Find and Characterize the Missing Baryons

- Where is the hot gas relative to the galaxies?
- How do filaments connect to groups and clusters?

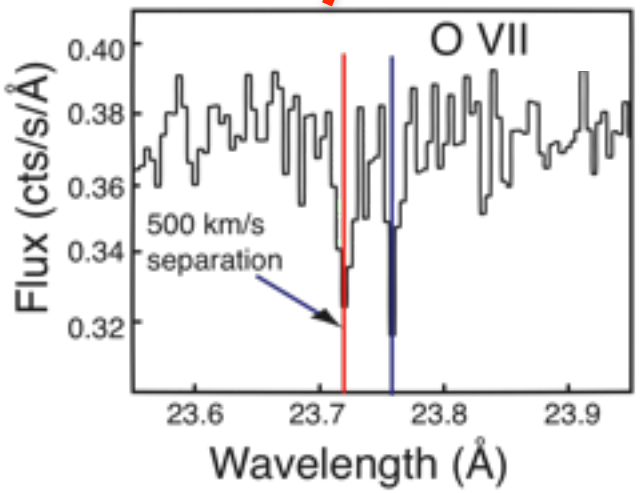




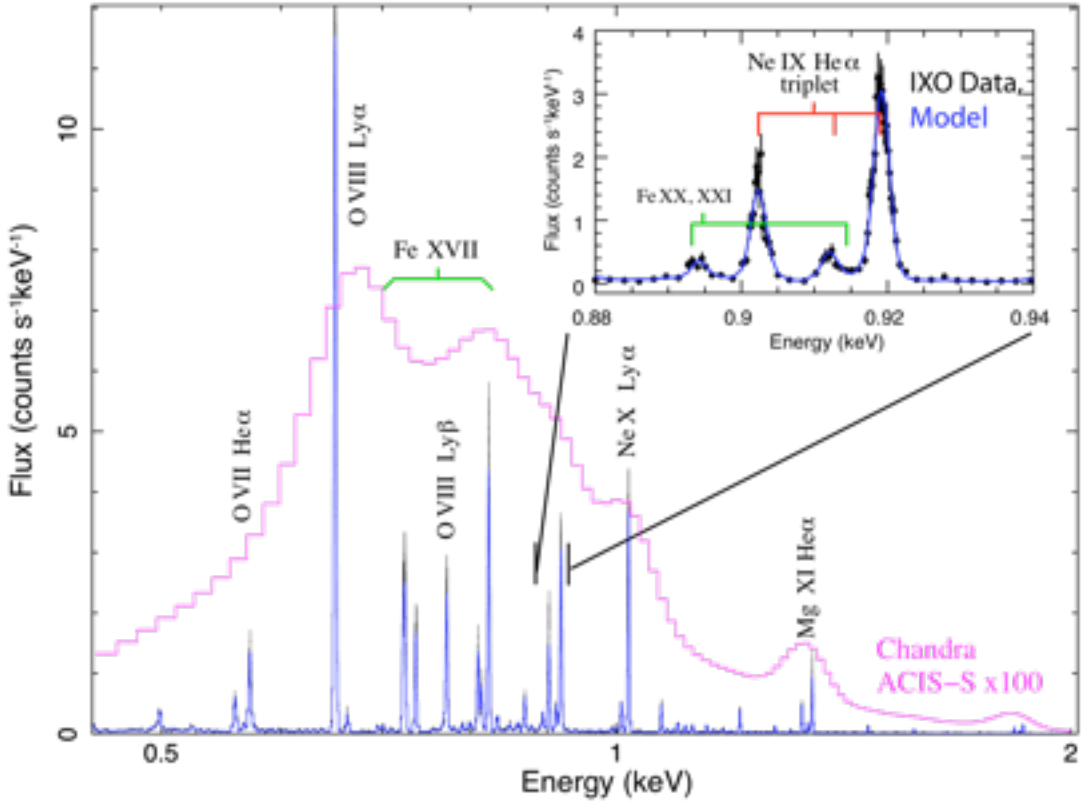
Use background AGN

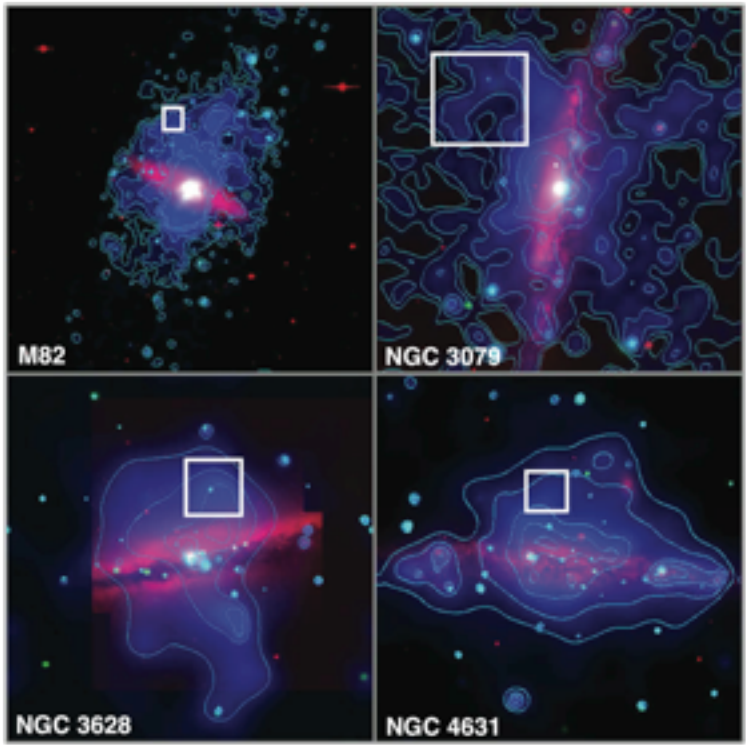
Compare distribution of filaments to model

Expect multiple filaments in each line of sight



Starburst Superwinds





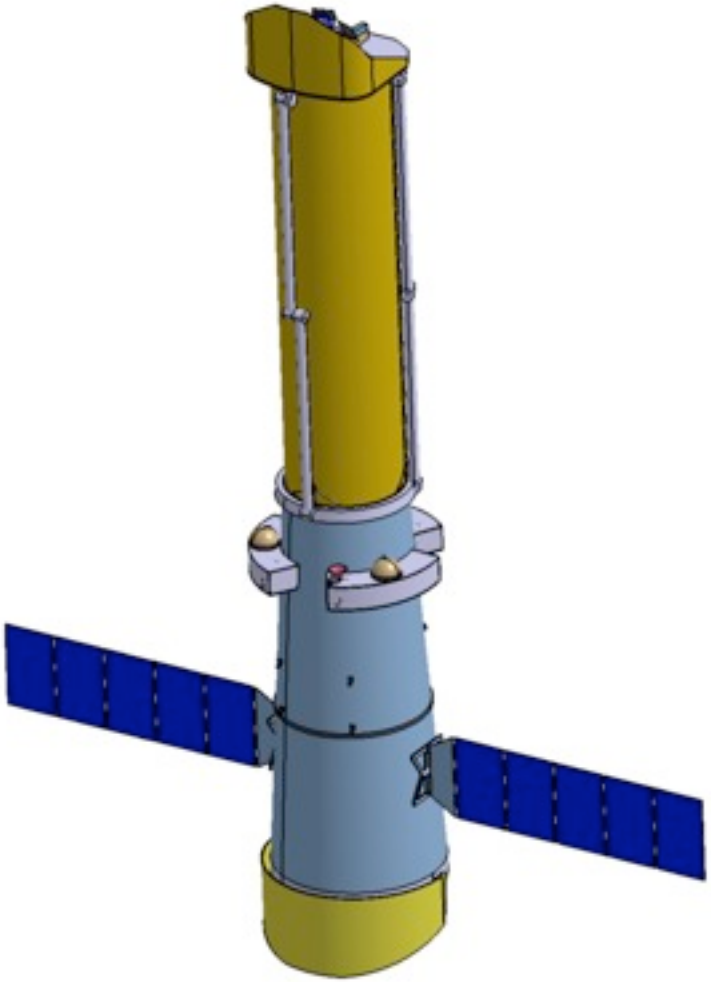
The starburst phase is thought to be a major contributor to both the intra-cluster and intergalactic metals .

IXO spectra will measure the velocity, abundances, and ionization state of the wind, determining mass, metal and energy ejection rates.

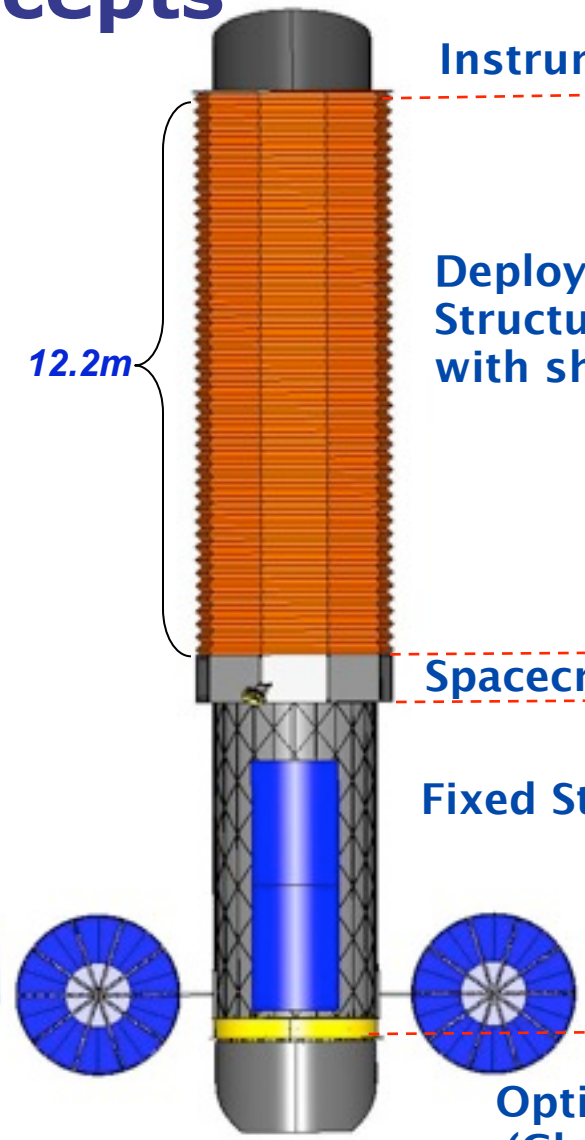
Key Performance Requirements

Mirror Effective Area	3 m^2 @1.25 keV 0.65 m^2 @ 6 keV 150 cm^2 @ 30 keV	Black hole evolution, large scale structure, cosmic feedback, EOS Strong gravity, EOS Cosmic acceleration, strong
Spectral Resolution/ FOV E = 0.3 – 7 keV	ΔE = 2.5 eV within 2 arc min 10 eV within 5 arc min < 150 eV within 18 arc min E/ΔE = 3000 with an area of 1,000 cm^2	Black Hole evolution, Large scale structure Missing baryons using tens of
Mirror Angular Resolution	≤5 arc sec HPD <7 keV ≤30 arc sec HPD > 7 keV	Large scale structure, cosmic feedback, black hole evolution, missing baryons Black hole evolution
Count Rate	1 Crab with >90% throughput	Strong gravity, EOS
Polarimetry	1% MDP on 1 mCrab in 100 ksec (2 - 6 keV)	AGN geometry, strong gravity
Astrometry	1 arcsec at 3σ confidence	Black hole evolution
Absolute Timing	100 μsec	Neutron star studies

IXO Mission Concepts



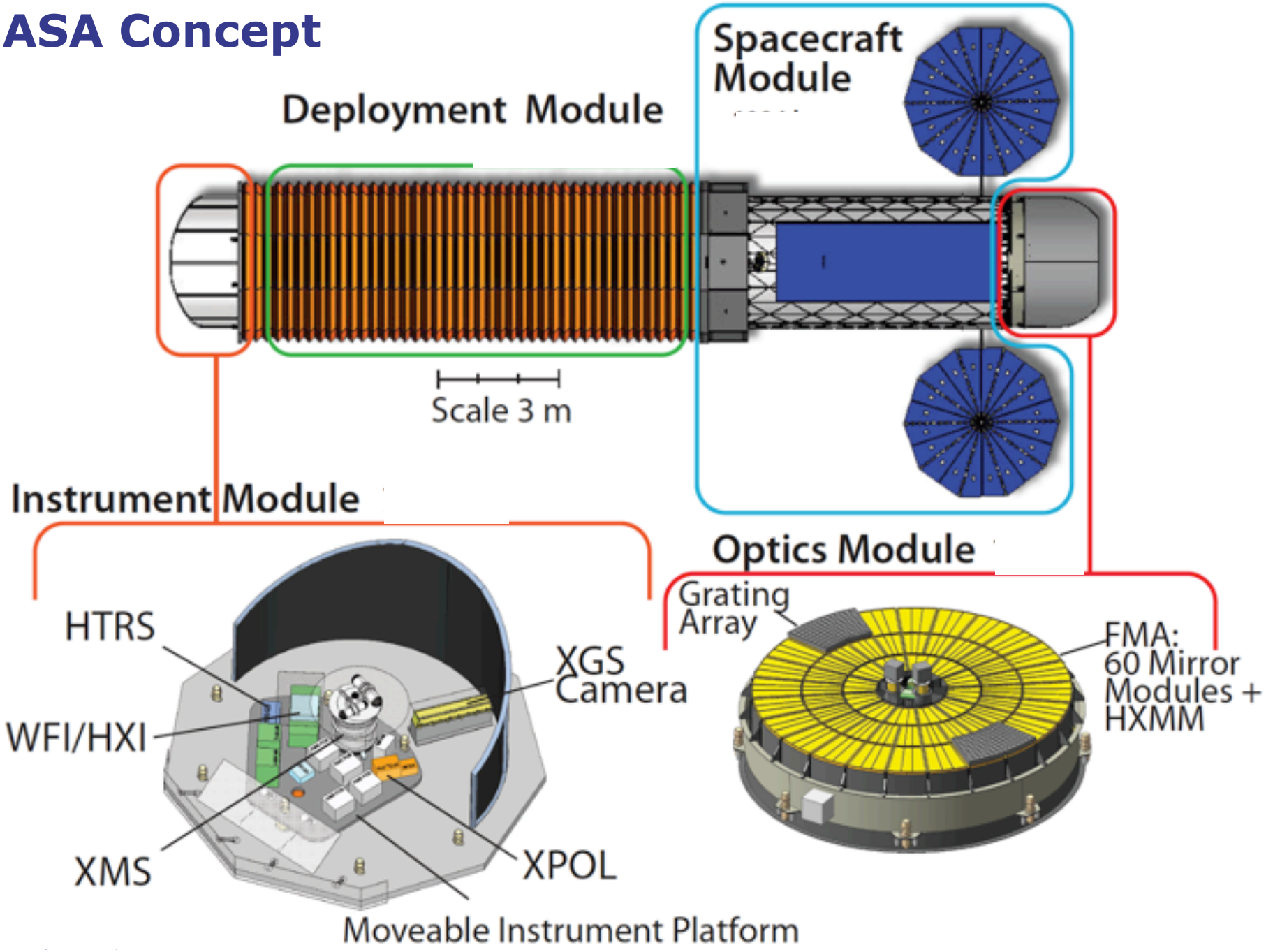
Deployed ESA Configuration



Deployed NASA Configuration

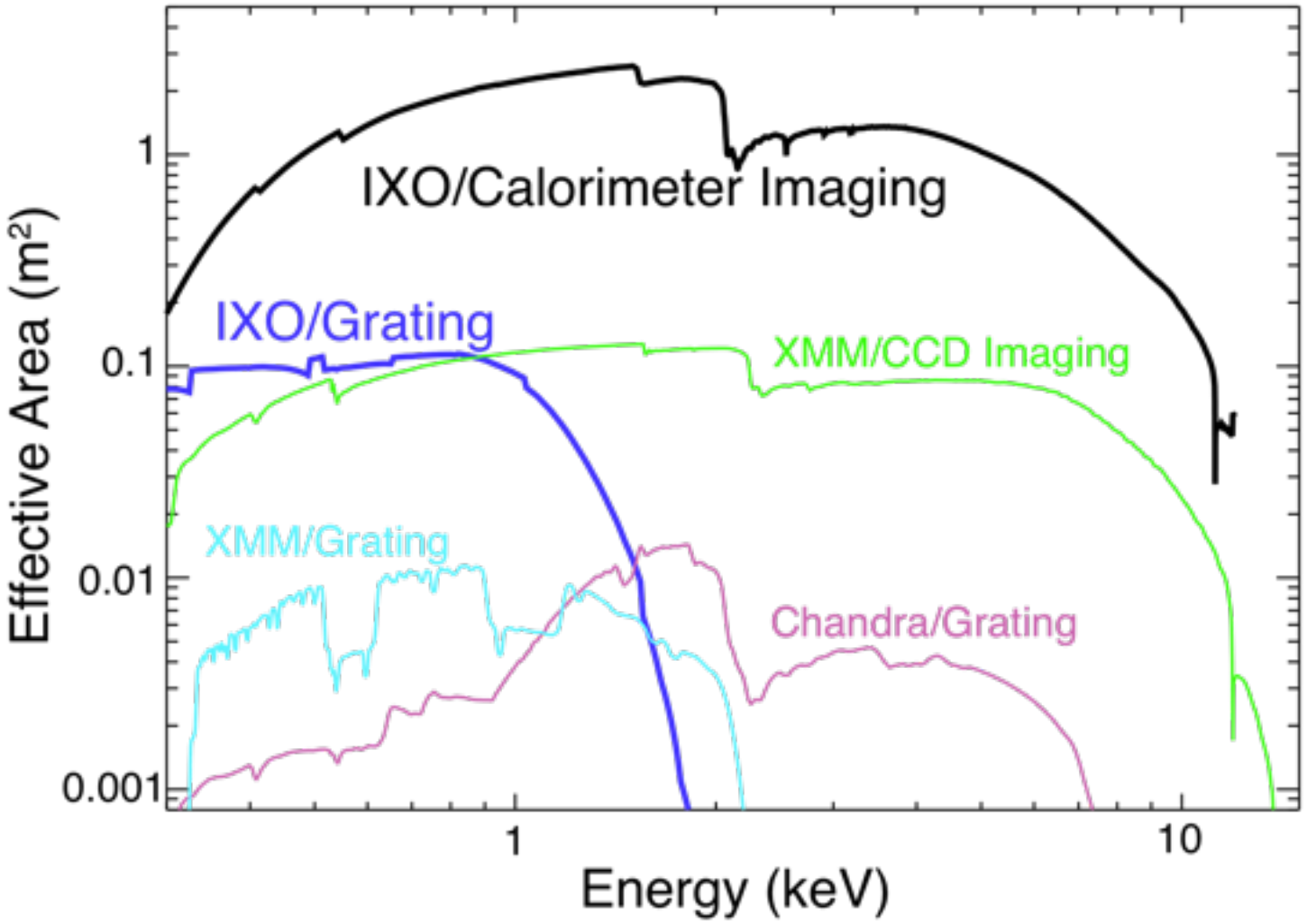
Stowed NASA Configuration

NASA Concept

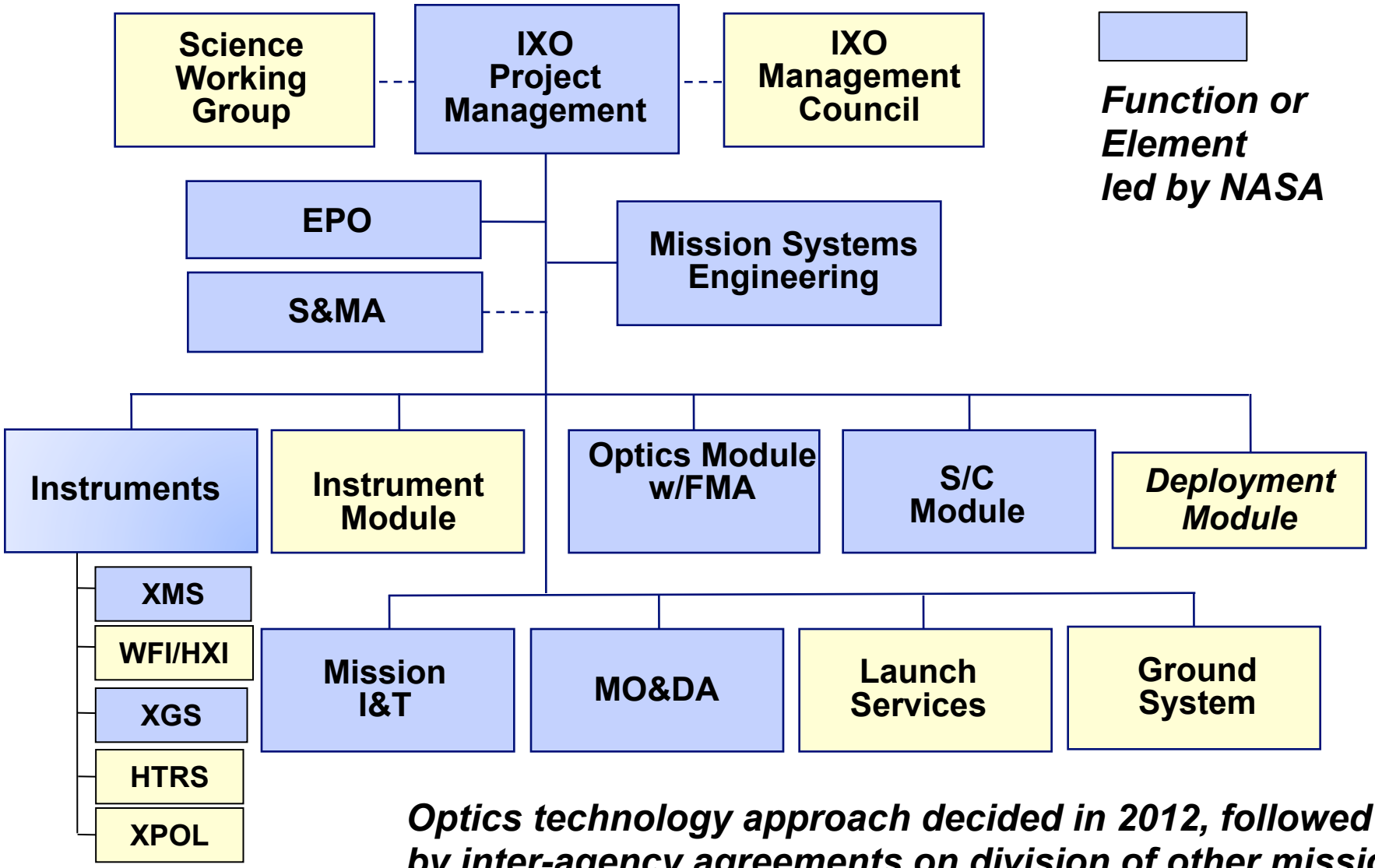


Existing X-ray Missions ➔ IXO

Palomar 200 inch ➔ *20 meter telescope*
Spectral band imaging ➔ *Integral field spectrograph*



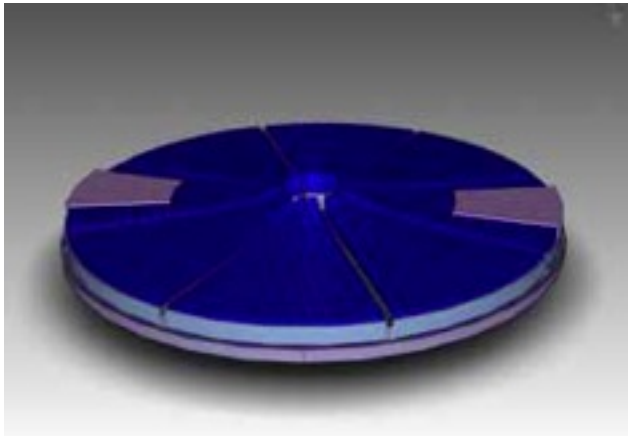
Notional Implementation Responsibilities

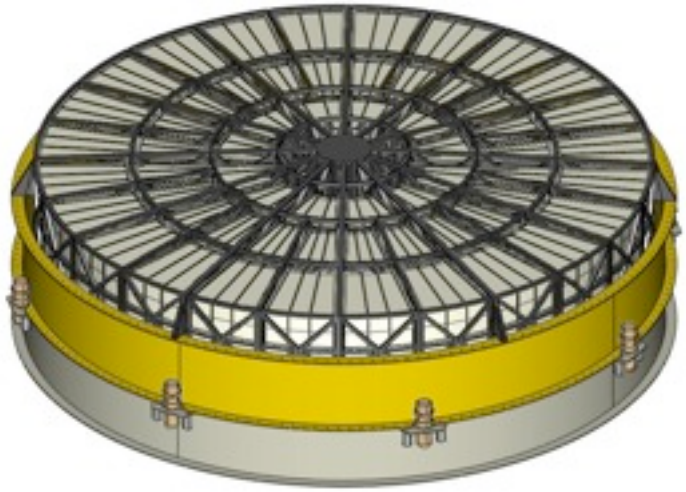


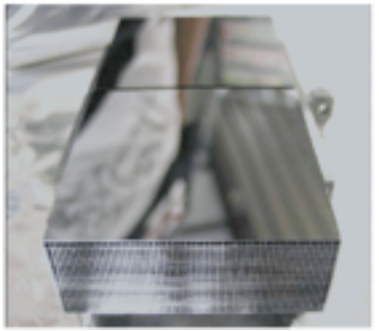
Optics technology approach decided in 2012, followed by inter-agency agreements on division of other mission efforts. E.g., could swap Optics Module and LV.

IXO Flight Mirror Assembly

- **Key requirements:**
  - **Effective area ~3 m^2 @ 1.25 keV**
  - **Angular Resolution <= 5 arc sec**
- **Two parallel technology approaches being pursued:**
  - **NASA: Segmented glass**
  - **ESA: Silicon micro-pore**
- **Both making progress**
  - **Segmented glass used for NuSTAR**

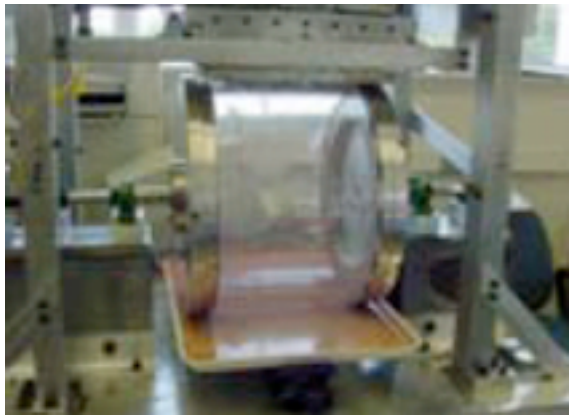




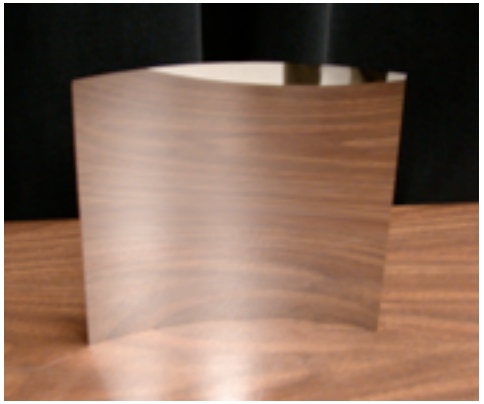


Glass Segment Progress

Date	HPD (two reflections	Comment
November 2007	~16”	Progress in reducing mid-frequency errors - using normal incidence metrology Metrology validated by X-ray testing
April 2009	~14.7”	
August 2009	~12”	
October 2009	~10”	
December 2009	~8.5”	
January 2010	~7.5”	
Transitioning from existing mandrels (~6.5”) to new mandrels (~2.4”)		

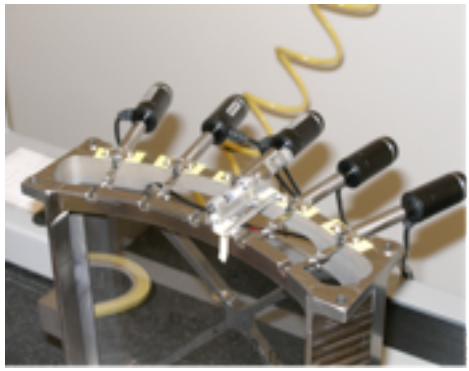


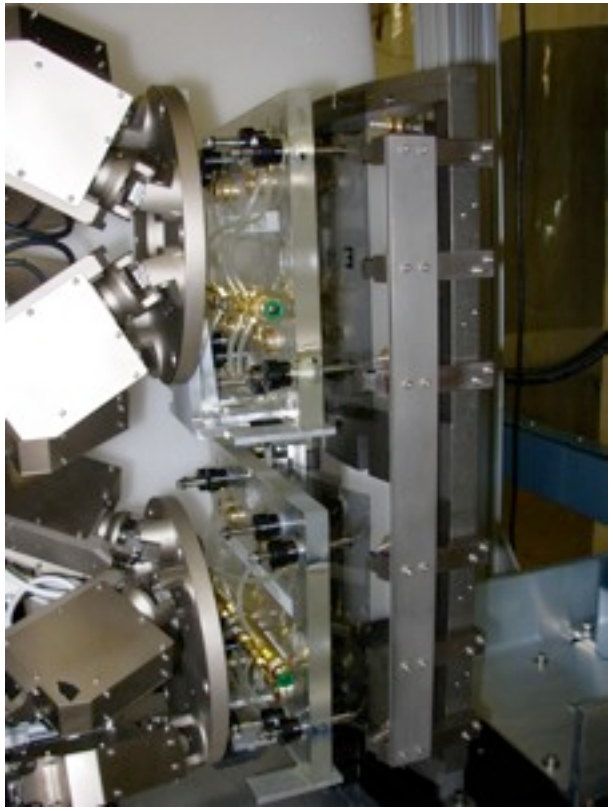
IXO Requirement: 3.3 arcsec HPD

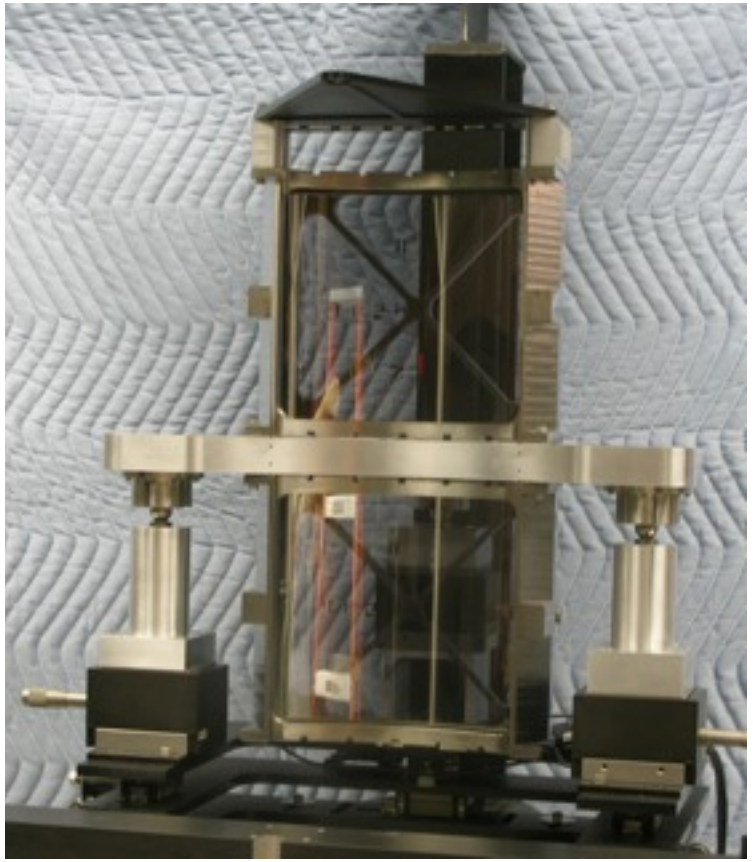


Glass Mounting & Alignment Improvements

- Two types of mounting approaches being investigated
  - Passive approach
  - Active approach
- TRL 4 for alignment and bonding planned for this spring

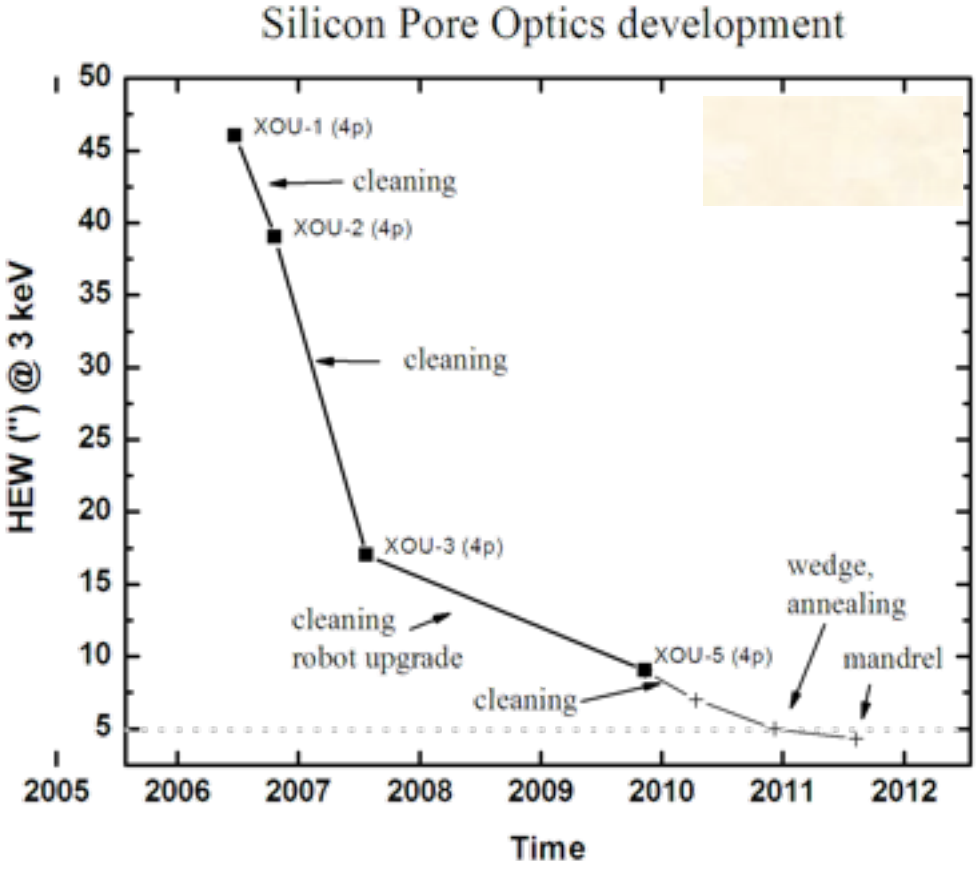


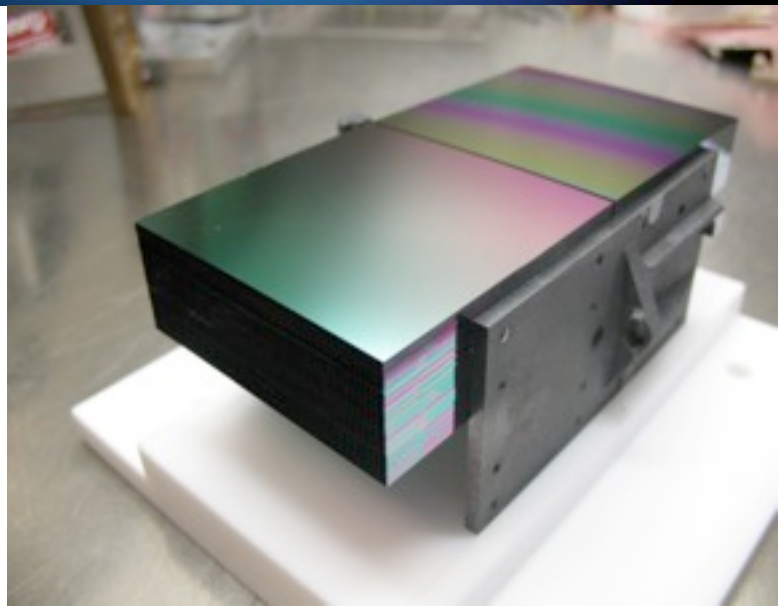


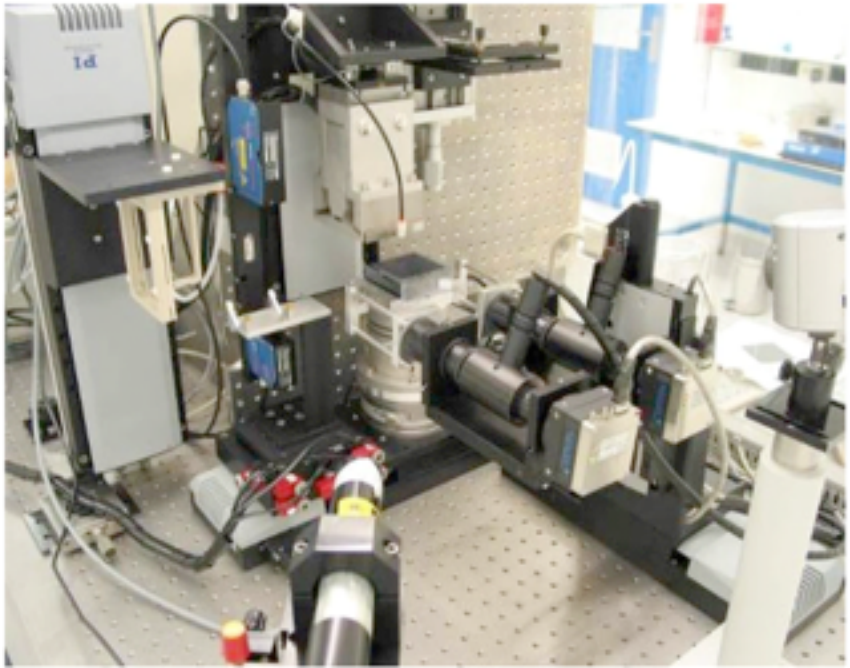


SPO Development status

- Silicon pore optics - Phase A

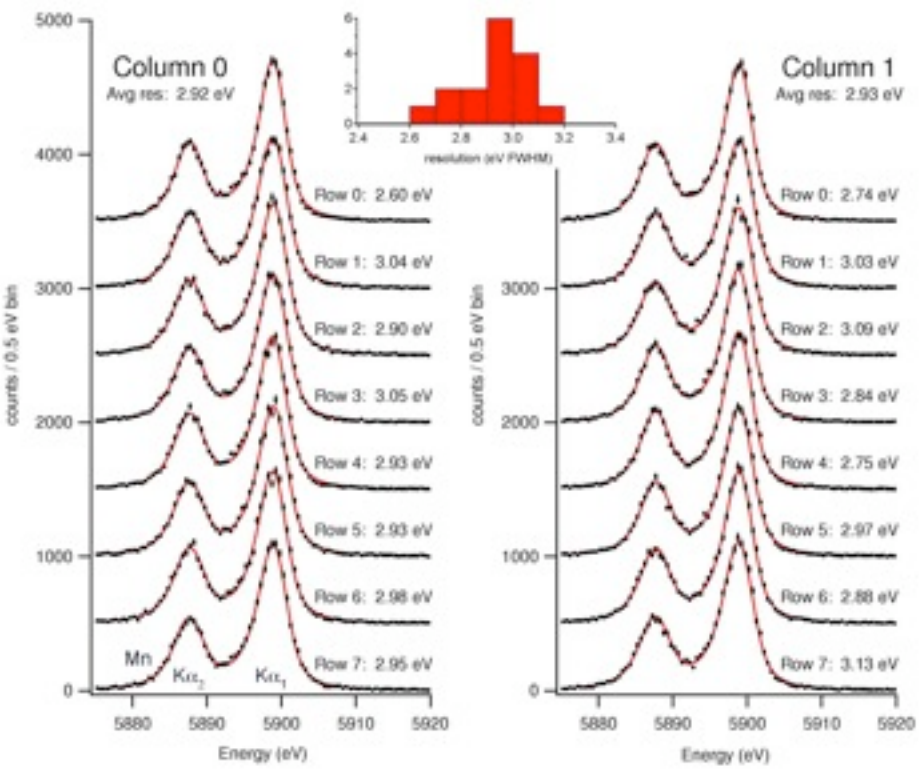






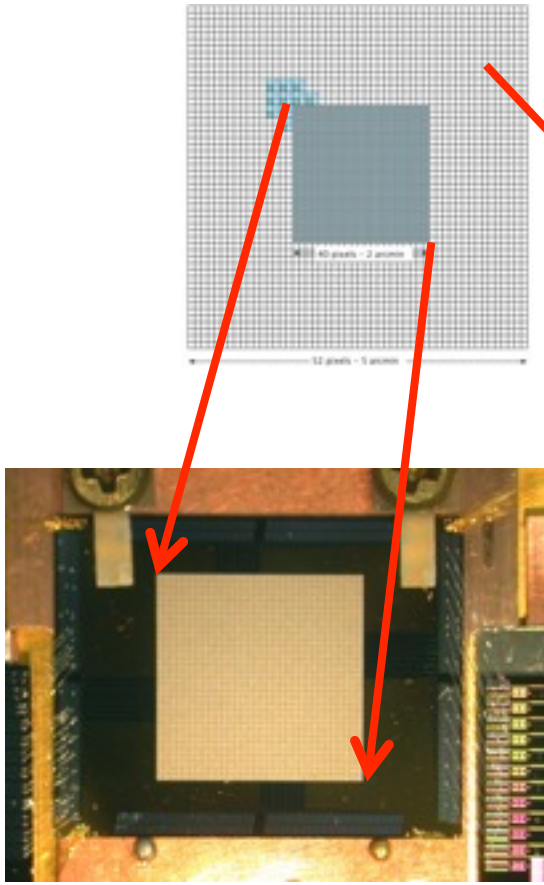
X-ray Microcalorimeter Progress

- 2x8 array built with average resolution < 3 eV



- Progressing towards TRL 5 this spring

- 32x32 flight-like core array built
- FOV-extending larger pixel designs being developed and tested



ESA Studies for Cosmic Vision

- ESA Industrial Mission "Phase A" Studies
  - Kicked off studies with Thales and Astrium in September 2009
  - Mission Definition Reviews held in October/December 2009
  - Mission Final Reviews/Reports planned for July 2010
- Instrument "Phase A" Studies
  - Kicked off instrument studies in June 2009
  - Instrument Definition Reviews held in December 2009
  - Instrument Mid-term Reviews planned for March - April 2010
  - Plan Instrument Final Reviews/Reports planned for July 2010
- Cosmic Vision Milestones (best guess from M-Class schedule)
  - Submit "Yellow Book" to ESA: ~September 2010
  - Cosmic Visions Presentations: ~November 2010
  - Cosmic Visions Selection: ~ January 2011
- IXO Science Meeting – April 27-29

Mission Timeline