International X-ray Observatory (IXO)

The International X-ray Observatory (IXO) Mission Configuration

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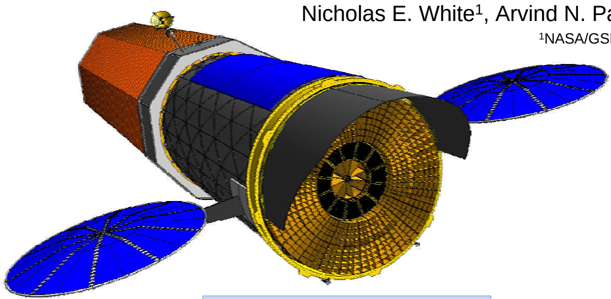


NASA Project Manager: Jean Grady
ESA Study Manager: Philipe Gondoin
JAXA Study Manager: Tadayasu Dotani

The IXO is an inter-agency project with participation from ESA, JAXA, and NASA. The IXO will be a major new astronomical space based facility in the 2020 timeframe to address three timely, high priority science topics:

1) Black Holes and Matter under Extreme Conditions
2) Galaxy Formation, Galaxy Clusters, and Cosmic Feedback
3) Life Cycles of Matter and Energy

To address these topics the mission will provide a factor of 10 gain in telescope aperture with an effective area of 3 sq m at 1 keV and 5 arc sec angular resolution. The next generation instruments are a X-ray Micro-calorimeter Spectrometer (XMS), Wide Field Imager (WFI) and Hard X-ray Imager (HXI), a X-ray Grating Spectrometer (XGS), a High Time Resolution Spectrometer (HTRS) and an X-ray Polarimeter (XPOL). This presentation summarizes the mission implementation based on NASA, ESA, and JAXA design studies.

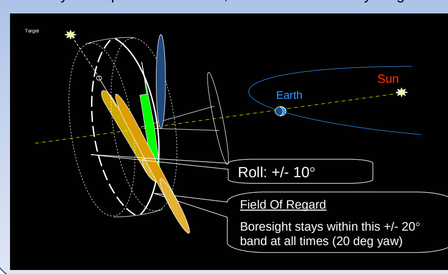
IXO will bring a factor of 10 gain in telescope aperture combined with next generation instrument technology to realize a quantum leap in capability

Key IXO Performance Requirements

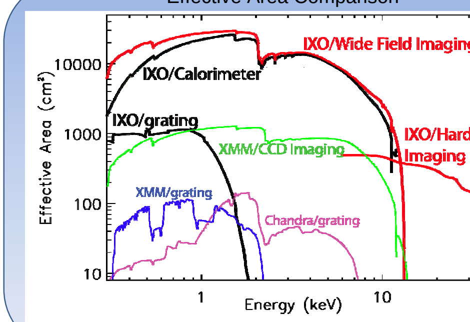
Mirror Effective Area	3 m² @1.25 keV 0.65 m² @ 6 keV with a goal of 1 m² 150 cm² @ 30 keV with a goal of 350 cm²	Black hole evolution, large scale structure, cosmic feedback, EOS Strong gravity, EOS Cosmic acceleration, strong gravity
Spectral Resolution	ΔE = 2.5 eV within 2 x 2 arc min (0.3 – 7 keV) . ΔE = 10 eV within 5 x 5 arc min (0.3 - 7 keV) ΔE < 150 eV @ 6 keV within 18 arc min diameter (0.1 - 15 keV) E/ΔE = 3000 from 0.3–1 keV with an area of 1,000 cm² for point sources ΔE = 1 keV within 8 x 8 arc min (10 – 40 keV)	Black Hole evolution, Large scale structure Missing baryons using tens of background AGN
Mirror Angular Resolution	≤5 arc sec HPD (0.1 – 7 keV) ≤30 arc sec HPD (7 - 40 keV) with a goal of 5 arc sec	Large scale structure, cosmic feedback, black hole evolution, missing baryons Black hole evolution
Count Rate	1 Crab with >90% throughput. ΔE < 200 eV (0.1 – 15 keV)	Strong gravity, EOS
Polarimetry	1% MDP at 3σ confidence on 1 mCrab in 100 ksec (2 - 6 keV)	AGN geometry, strong gravity
Astrometry	1 arcsec at 3σ confidence	Black hole evolution
Absolute Timing	50 μsec	Neutron star studies

IXO Launch, Orbit, and Mission Life

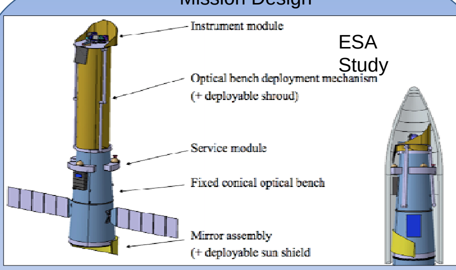
Launch on an Atlas V 551 or Ariane V in 2020
Direct launch into an 800,000 km semi-major axis L2 orbit
5 year required mission life, consumables for 10 year goal



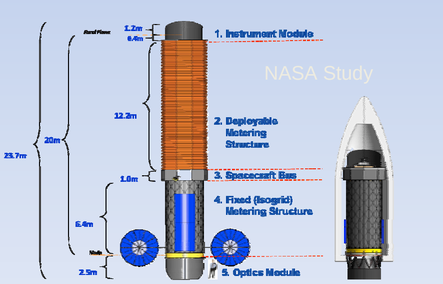
Effective Area Comparison



Mission Design

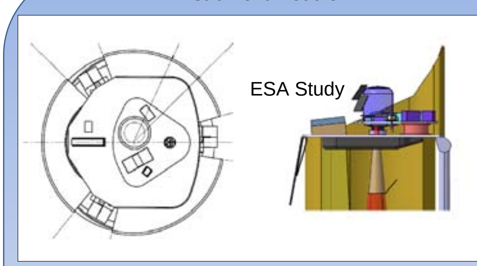


NASA and ESA mission studies demonstrate that the mission is feasible with no technical challenges
The two separate and independent studies result in very similar approaches



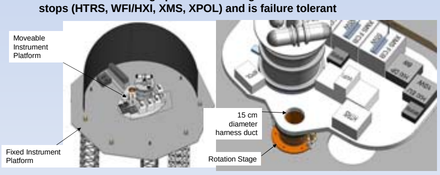
Deployed IXO Configuration   Stowed IXO Configuration

Instrument Module



NASA Study

- **On-Axis Instruments with pre-amp electronics mount on Moveable Instrument Platform**
  - **Focus adjust mechanisms on each instrument for initial adjustment on-orbit**
- **XGS CCD mounts to X-Y Translation Stage on the Fixed Instrument Platform**
  - **Provides adjustable interface to Focus, Rowland circle, and baffle**
- **Main instrument electronics mount to under side of Fixed Platform**
- **Heat Pipes transfer heat between electronics and radiators, both on Moveable Instrument Platform and on Fixed Instrument Platform**
- **The MIP Rotation Stage provides ~90 degrees of rotation with four instrument stops (HTRS, WFI/HXI, XMS, XPOL) and is failure tolerant**



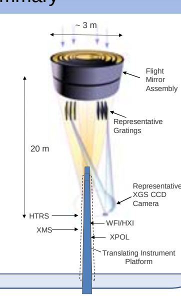
Four instrument are accommodated
On moveable instrument platform, with grating CCD fixed on fixed instrument platform

Payload Summary

Flight Mirror Assembly (FMA)
- 5 arc sec grazing incidence, highly nested mirrors

Instruments on translating platform
- X-ray Micro-calorimeter Spectrometer (XMS)
  - 0.3 to 7 keV with 2.5 eV & 5 arc min FOV
- Wide Field Imager (WFI)
  - 0.1 to 15 keV with < 150 eV & 18 arc min FOV
- Hard X-ray Imager (HXI)
  - Extends band pass to 40 keV
- High Time Resolution Spectrometer (HTRS)
  - Bright source capability
- X-ray Polarimeter (XPOL)

Fixed Instrument (always observing)
- X-ray Grating Spectrometer (XGS)
  - Dispersive from 0.3 to 1 keV with R ~ 3000
  - CCD camera for readout



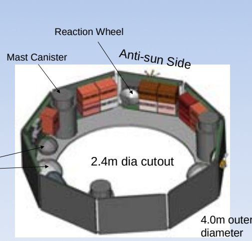
Observatory Level Mass Rack up NASA Study

Mirrors	Estimate	Cont.	Allocation
Flight Mirror Assembly	1748	30%	2273
Mirrors Total	1748		2273
Payload	**Estimate**	**Cont.**	**Allocation**
X-ray Microcalorimeter Spectrometer	257	30%	334
Wide Field Imager	75	30%	97
X-ray Grating Spectrometer	82	30%	106
HXI	24	30%	31
XPOL	11	30%	14
HTRS	25	30%	33
Payload Accommodations	135	30%	176
Payload Total	608		790
Subsystems	**Estimate**	**Cont.**	**Allocation**
Avionics	122	30%	159
Communications	29	30%	[illegible]
Attitude Control	103	30%	134
Structure and Mechanisms	1201	30%	1561
Power	99	30%	129
Propulsion (dry)	79	30%	102
Thermal	258	30%	335
Harness	283	30%	368
Subsystems Total	2174		2826
Observatory	**Estimate**	**Cont.**	**Allocation**
Science Payload Total	2356	30%	3063
Bus Total	2174	30%	2826
Observatory On Orbit Dry Mass	4530	30%	5889
Separation System LV Side	272	9%	300
Observatory Launched Dry Mass	4802		6189
Propellant Mass (10 yrs)			228
Observatory Wet Launch Mass			6417
Margin			
Atlas V 551 Throw Mass (C3= 0.5)			6425
Margin (kg)			8
Margin (%)			0.1%

30% Contingency

Spacecraft Bus Module – NASA Study

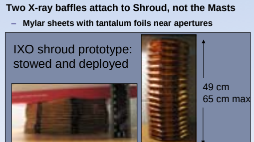
- **3 mast canisters fit inside the Bus Module**
- **9 equipment panels provide plenty of room for avionics & harness**
- **Large hole in bottom and top decks necessary for the X-ray beam from the FMA and gratings**
- **Interface between metering structures and the bus frame is titanium fittings**
- **Spacecraft Bus houses most of the Spacecraft Subsystem components**
- **Propulsion tanks on sun-side**
- **Avionics are mounted to equipment panels on the anti-sun side of spacecraft. Heat conducts through to exterior of panels to zones of white NS43G thermal paint. Heat is radiated away**

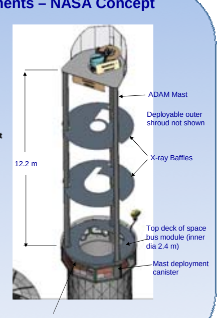


Note: Propulsion tank diameter and free path for x-rays through the middle determine the size of the spacecraft bus

Deployable Structure Components – NASA Concept

- **Deployable Metering Structure consists of masts, shroud, harness, and baffles.**
- **Concept utilizes three 12.2m ADAM masts for extensible structure.**
  - **Similar to NuStar mast**
- **Deployable Telescope Shroud provides thermal protection, light-tight environment**
  - **Pleated shade type construction**
  - **Multilayer dual Whipple-shield type micrometeoroid resistant Shroud with Kapton outer skin**
  - **Harness from S/C Bus to IM deploys within mast system.**
- **Two X-ray baffles attach to Shroud, not the Masts**
  - **Mylar sheets with tantalum foils near apertures**





Stowage Channel (20 x 30 cm) for Shroud

IXO Schedule – For Launch in 2021