International X-ray Observatory

ESA Status – managing the transition from XEUS to IXO

Introduction

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- Background - Introduction to the ESA Science Programme
- ESA's Cosmic Vision Selection Process
- XEUS Advisory Structure Organisation
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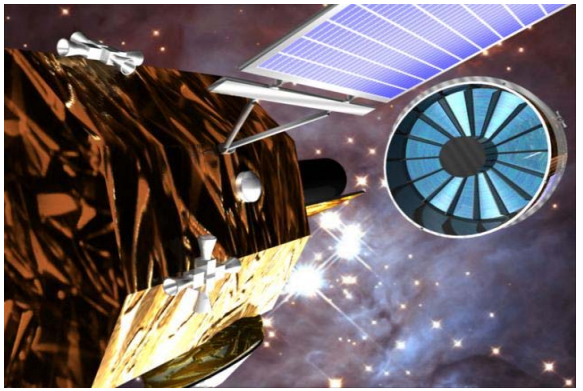
ESA Science Programme

- Science has an annual budget of around 400 M€. Covers, technology development, spacecraft manufacture in industry, launch, overall management and (part of) operations
- Payload and science operations funding comes from interested ESA Member State agencies (CNES, DLR, etc)
- Science missions are selected competitively by 3 levels of external committees (AWG, => SSAC, => SPC)
- Payloads are competitively selected following an AO at the start of Definition
- Mission approval is a step-by-step process. First selected for Assessment, then for Definition, then full approval to end of operations (with a final check when the industrial Phase C/D costs are received)

ESA Science Programme

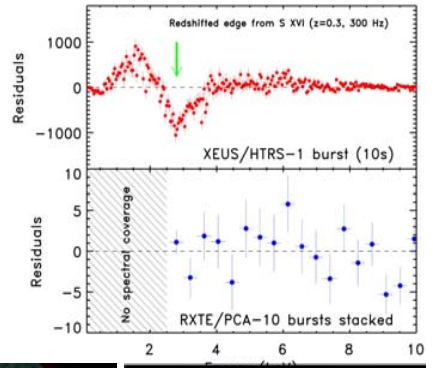
- The Science Programme has a number of approved missions in astronomy, fundamental physics and solar system research.
- The post 2015 missions are not yet chosen, although the process “Cosmic Vision” is underway.
- XEUS proposal submitted in June 2007 (Turner & Hasinger and 39 co-investigators from Europe, Japan, US, Russia and China)
- In November 2007, 4 M-class and 3 L-class mission concepts were selected for assessment (1+1 launch).
- The L-class concepts are LISA, Tandem/Laplace and XEUS
- The L-class ESA cost cap is 650 M€ and the first launch is not before the end of 2018

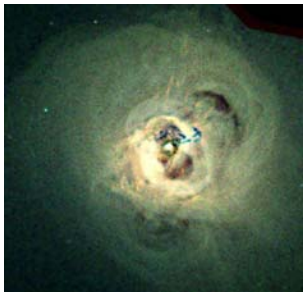
Cosmic Vision Selection



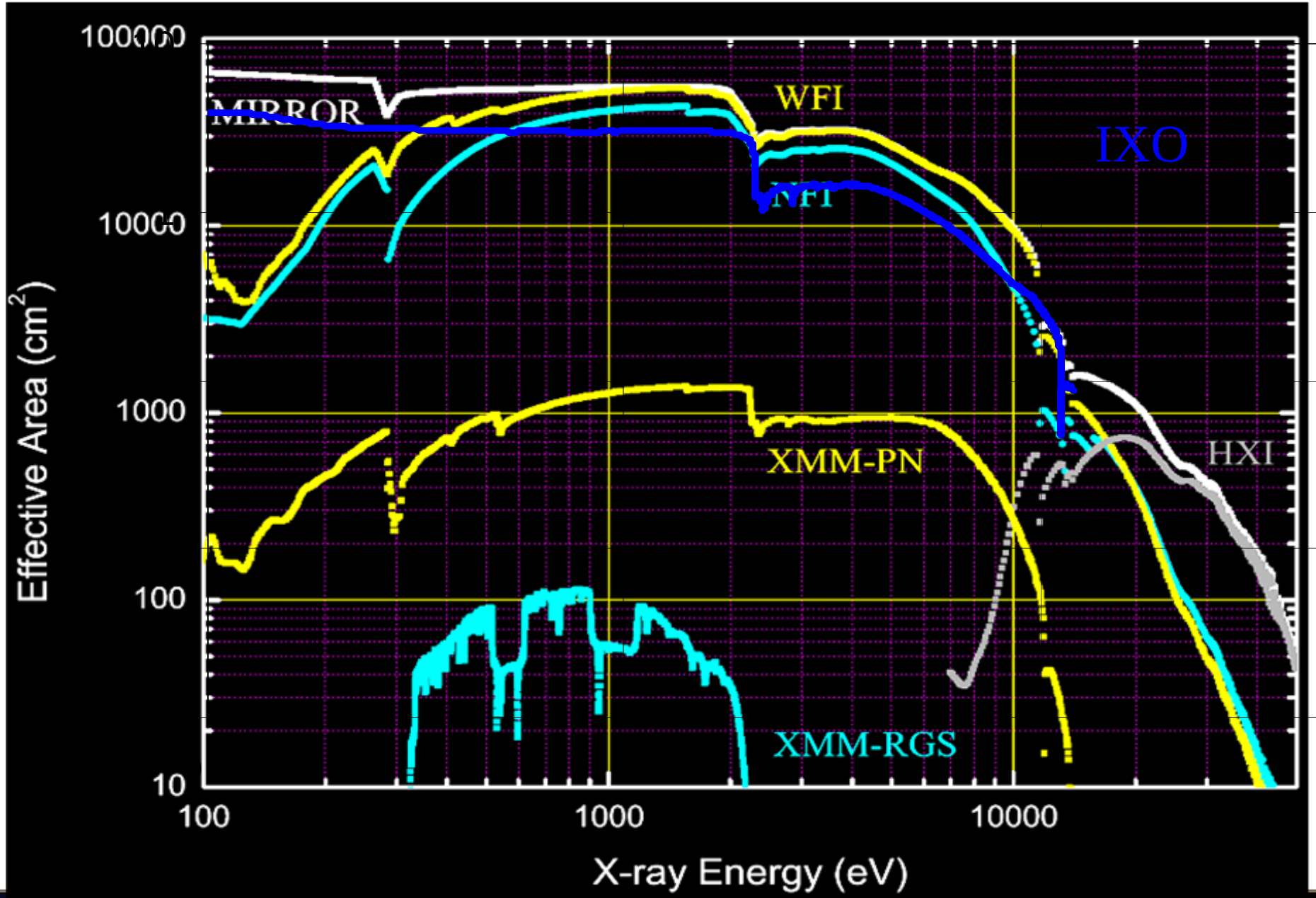
The key characteristics of the XEUS proposal were:

- A spectroscopic collecting area >5 m^2 at 1 keV and >2 m^2 at 7 keV
- An angular resolution <5", targeted at 2" HEW
- Spectral resolution of 2-6 eV between 0.1-8 keV
- A bandpass of 0.1-40 keV with ultra-fast timing and spectroscopic capabilities

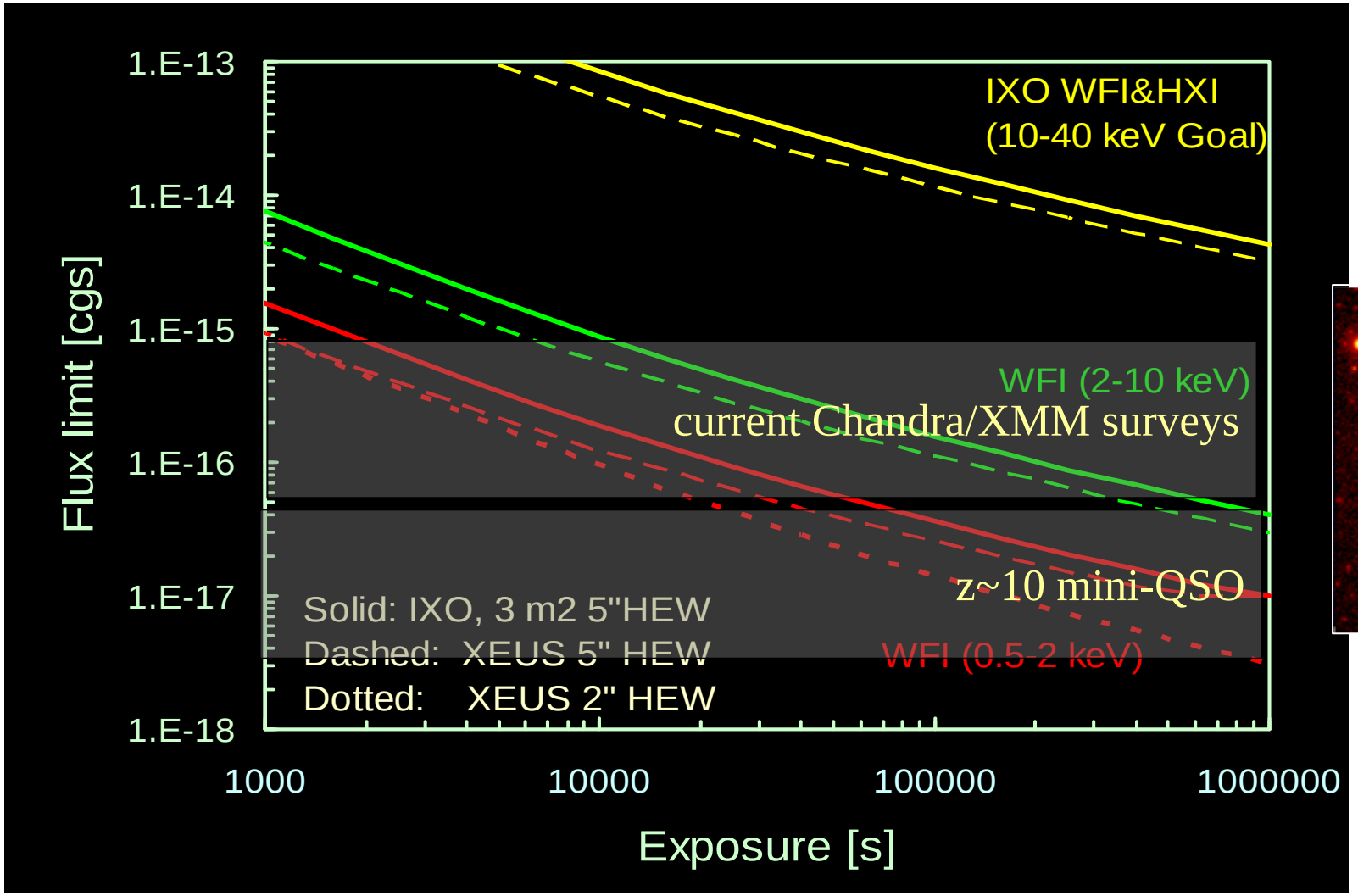


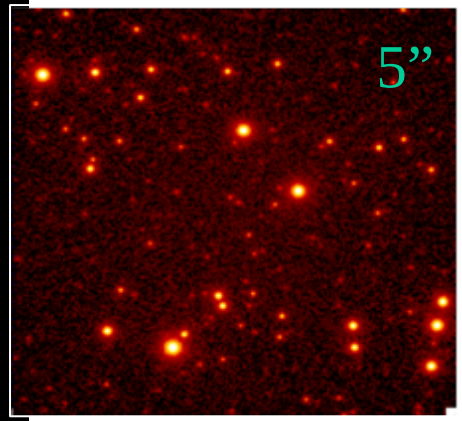


In comparison to IXO, the proposal science goals were more demanding with greater emphasis on the early Universe, hard X-rays, timing studies of bright objects, and polarimetry.


100000
10000
1000
100
10
Effective Area (cm^2)
100
1000
10000
X-ray Energy (eV)
MIRROR
WFI
IXO
XMM-PN
HXI
XMM-RGS

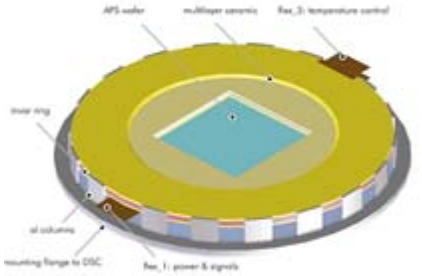
IXO Point Source Sensitivity

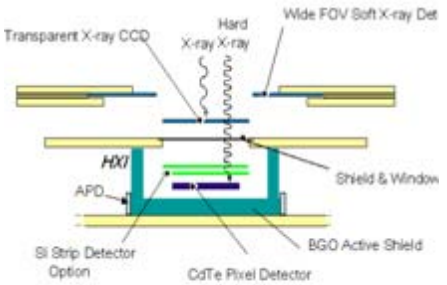


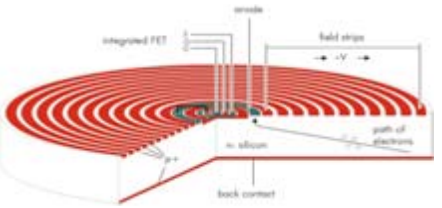


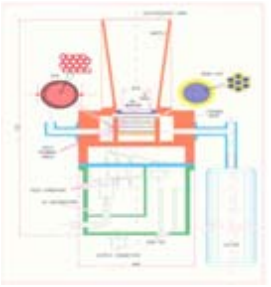
Cosmic Vision Selection

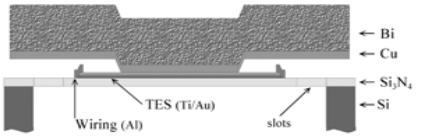
- Cryogenic Imaging Spectrometer: A TES microcalorimeter array with a FOV of 40" diameter and an energy resolution, ΔE, of 2-6 eV. bandpass
- Wide Field Imager: A silicon active pixel sensor with a FOV of 7' diameter ΔE = 150 eV at 6 keV and a limiting sensitivity of 3 10^{-18} erg cm^{-2} s^{-1} (0.2-2 keV)
- Hard X-ray Camera: Confocal CdTe and Si strip detectors to extend the energy range to 40 keV with a FOV of 5' x 5'
- High-Time Resolution Spectrometer: A non-imaging spectrometer that provides 10 μs timing at count rates of 2 10^6 s^{-1} and ΔE 30-140 eV
- X-ray Polarimeter: An imaging gas pixel detector providing 2% MDP at 3σ confidence for 10 mCrab source in 10 ksec











Cosmic Vision Selection

The final evaluation of the XEUS proposal was by the SSAC:

1. They were impressed with the very high science rating of the mission
2. Recommended that the mission should be done in international collaboration (which it always has been, with our Japanese partners)
3. Stated that to maximize the science output the angular resolution must be optimized to reach the goal of 2 arcsec
4. Proposed that a dedicated optics technology study taking into account alternative technologies be performed

Cosmic Vision Selection

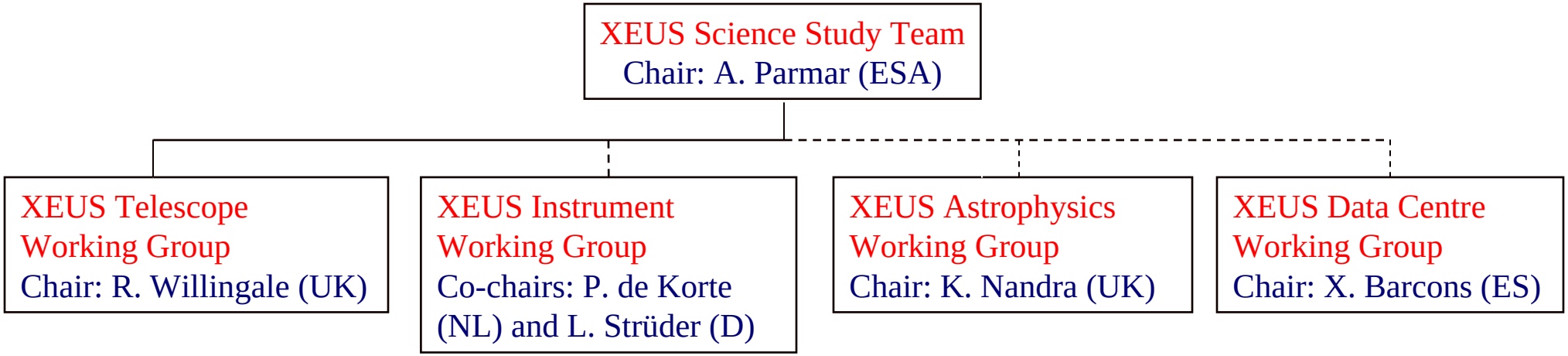
CV selection provides XEUS (IXO) with:

1. Visibility within the ESA Science Programme
2. Access to ESA funding for further technology development
3. Establishment of a science advisory structure
4. Access to funding for an industrial level assessment study following internal evaluation in the CDF (Coordinated Design Facility ≈ NASA's MDL)
5. Chance to compete for a Definition Study (3 => 2 down selection with 2 studies in parallel) sometime in ~2010.

XEUS Advisory Structure

How Things Were Organized…

XEUS Advisory Structure



XEUS Science Study Team

Arvind Parmar	ESA (chair)
Monique Arnaud	CEA Saclay, F
Xavier Barcons	U de Cantabria, ES
Didier Barret	CERS, Toulouse, F
Piet de Korte	SRON, Utrecht, NL
Gunther Hasinger	MPE, Garching, D
Paul Nandra	IC, London, UK
Luigi Piro	INAF, Roma, I
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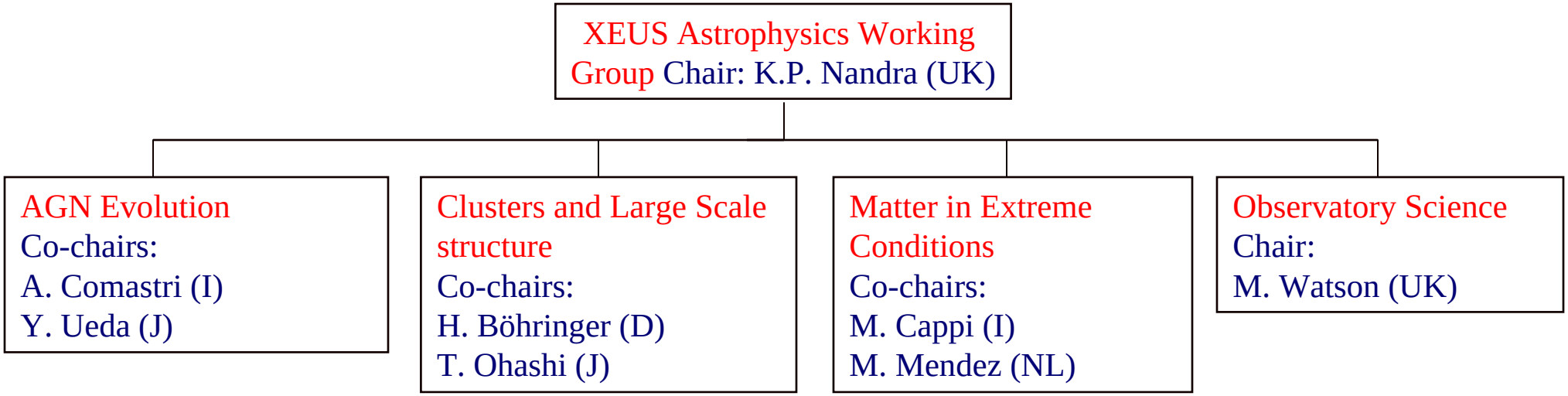
Lothar Strüder	MPE, Garching, D
Jacco Vink	SRON, Utrecht, NL
Richard Willingale	U Leicester, UK

XEUS Astrophysics Working Group



XEUS Telescope Working Group

Richard Willingale	U Leicester, UK (chair)
Ladislav Andricek	MPE, Garching, D
Marcos Bavdaz	ESA
Finn Christensen	DNSC, DK
Peter Friedrich	MPE, Garching, D
Hideyo Kunieda	U Nagoya, J
Giovanni Pareschi	INAF, Brera, I

XEUS Instrument Working Group

Pier de Korte (co-chair, SRON, NL)
Lothar Strüder (co-chair, MPE, D)
Didier Barret (Toulouse, F)
Lionel Duband (Saclay, F)
George Fraser (Leicester, UK)
Didier Martin (ESA)
Ronaldo Bellazzini (INFN, I)
Tadayuki Takahashi (JAXA, J)
Peter Verhoeve (ESA)

Managing the Transition to IXO

- Joining our missions gives IXO a number of advantages:
  - Sends a strong message to our funding agencies that this mission has global support
  - Reduces technological risk – e.g. no longer dependent on a single optics technology – can wait and see whether glass or silicon turns out better.
  - Reduces costs to any one agency (however, total cost probably increased) making it easier to obtain approval – However approval will be needed by all 3 agencies
  - We will have to learn how to combine our scientific, engineering, and management skills to produce a compelling mission that answers important scientific questions at low risk to each of the agencies.

Next Steps – Short Term

- XEUS CDF study has been completed – final report is still awaited. Do not intend further XEUS activities.
- IXO CDF study of EOB concept should start in Oct/Nov 2008. Study output will be used for a 6-9 month industrial system study with NASA and JAXA involvement
- ESA Technology activities (mainly for the optics) will continue at an accelerated pace – Marcos' talk
- Establish an IXO Coordination Group which will replace the former science teams with members from Europe, Japan and the US. Goal is for the IXO-CG to have its first meeting after the Science Workshop, MPE, Garching, September 17-19
- Agree how to reorganize the respective advisory teams in the most effective manner for a global mission.

The Way Forward

- Europe, Japan and the US need to learn how to work together to assemble the first truly global space observatory
- From an ESA perspective, we need to ensure that IXO can fulfill the core of the CV science case – that so impressed the Advisory Structure
- Need to ensure that European industry has a role that it considers worthwhile and so will support the mission
- Need to ensure that the individual ESA Member States continue to support the mission (particularly D, F, I and UK) – even though their participation in our global mission will likely be less

Summary

- ESA/JAXA/NASA agreement to proceed with the study of a single large International X-ray Observatory. Results of this study will be used as input to NASA's Decadal survey and ESA's Cosmic Vision processes.
  - The science case is very powerful and addresses key and topical questions
  - The technology development is proceeding well. Concept probably has lower risk than L-class competitors (LISA and Tandem/Laplace).
  - ESA contribution can be within the L-mission cost cap
- We are on track to submit a very strong proposal to the Cosmic Vision process, Decadal Survey and Japan for eventual approval of IXO and launch sometime after 2018.