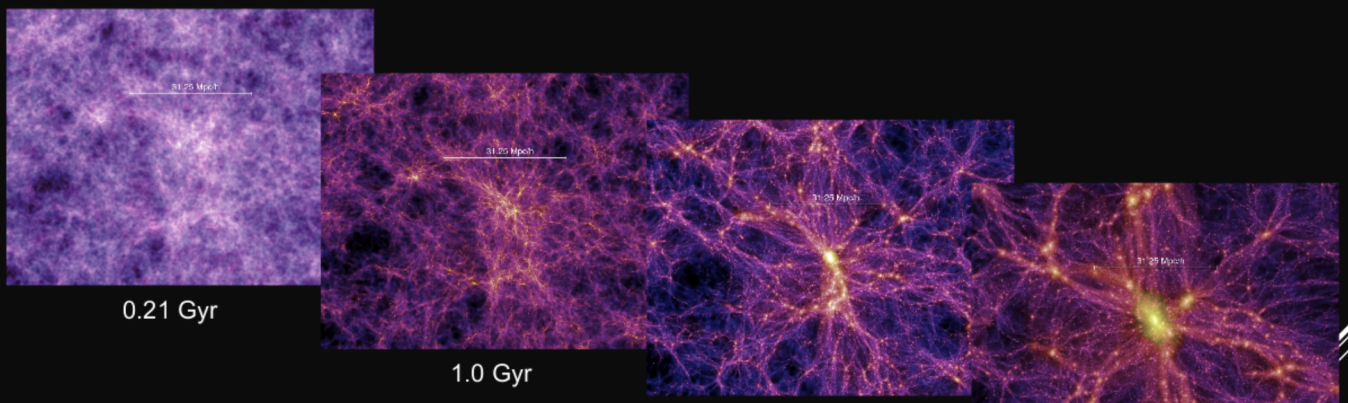
X-RAY SURVEYOR – THE BEGINNING

Jessica A. Gaskin (Study Scientist, NASA MSFC)

On Behalf of the X-Ray Surveyor Community



Credit: The Millennium Simulation Project
Virgo Supercomputing Consortium
Computing Centre Max-Planck Society in Garching

SPIE. 2016 – Edinburgh, UK

X-ray Surveyor Goals

Scientifically Compelling

Frontier science from Solar system to first accretion light in Universe

-Welcome broad Science Community Support – Domestic & International
-Maintain core science requirements over Program lifetime, while being flexible enough to incorporate timely new discoveries

Leaps in Capability

Large area with high angular resolution with orders of magnitude gains in sensitivity, large field of view with subarcsec imaging, high resolution spectroscopy for point-like and extended sources

-Allow for multiple technology paths
-Formulate a strong plan for achieving requirements
-Invest in technology development and proof-of-concept testing

Feasible

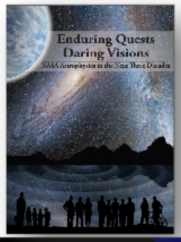
Science and Technology Definition Team (STDT) and community will define a path forward within the astrophysics budget and Decadal mission timeframe.

-Embrace Chandra Heritage and lessons learned
-Utilize previous studies when possible (IXO, Con-X, AXSIO, etc…)

Based on:

NASA Astrophysics Roadmap:

Enduring Quests, Daring Visions

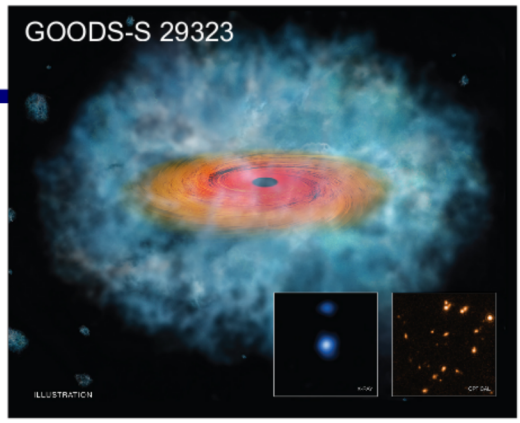


http://science.nasa.gov/media/medialibrary/2013/12/20/secure-Astrophysics_Roadmap_2013.pdf

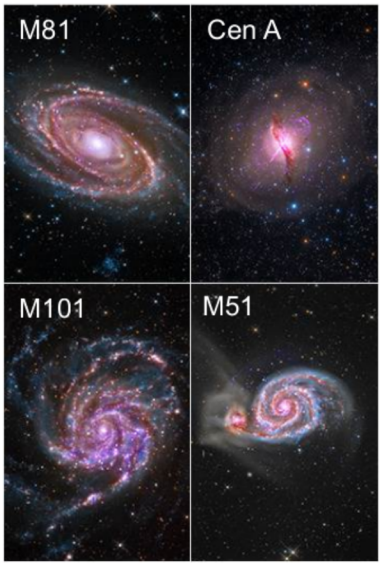
Scientific Commonalities

NASA Big Questions

How does the Universe work?	Probe the origin and destiny of our universe, including the nature of black holes, dark energy, dark matter and gravity.
How did we get here?	Explore the origin and evolution of the galaxies, stars and planets that make up our universe.
Are we alone?	Discover and study planets around other stars, and explore whether they could harbor life.



X-ray: NASA/CXC/Scuola Normale Superiore/ Pacucci, F. et al, Optical: NASA/STScI; Illustration: NASA/CXC/M.Weiss



X-ray: NASA/CXC/SAO; Optical: Detlef Hartmann; Infrared: NASA/JPL-Caltech

Scientifically Compelling - Roadmap

How Did We Get Here?

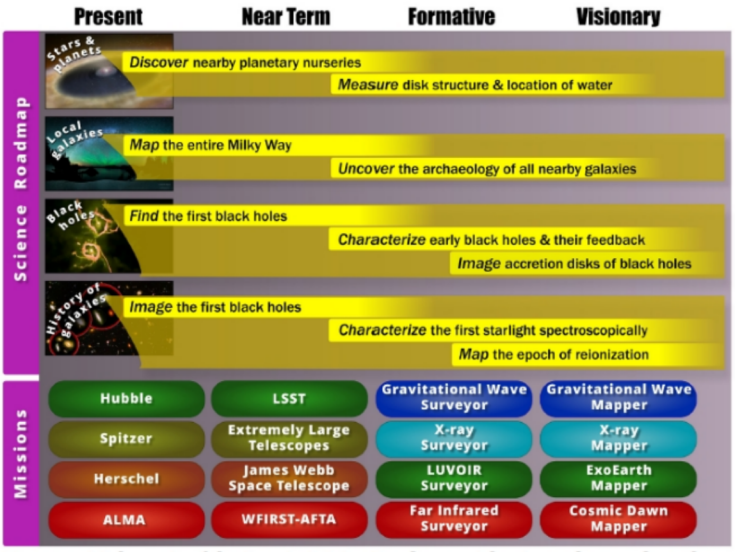


Figure 3.16 Schematic of the Cosmic Origins Roadmap, with science themes along the top and a possible mission sequence across the bottom. Credit: F. Reddy (NASA/GSFC)

How Does The Universe Work?

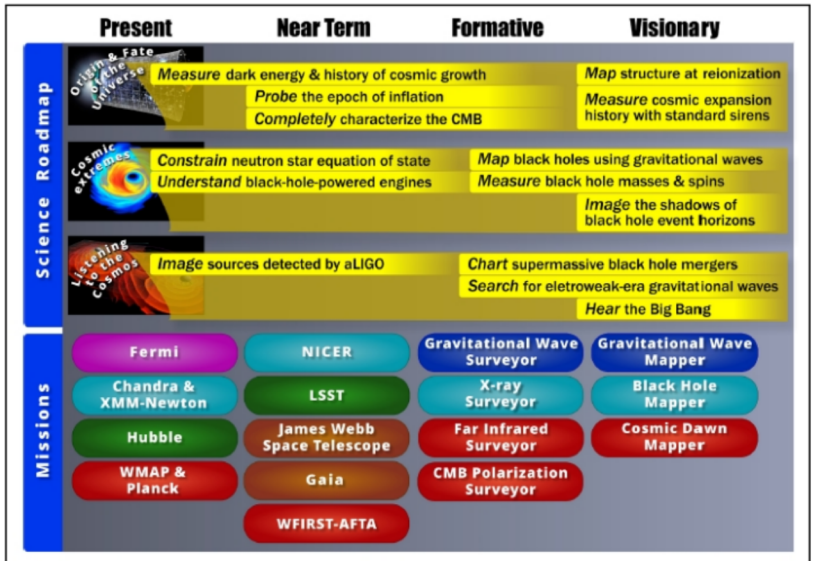


Figure 4.8 Schematic of the Physics of the Cosmos Roadmap, with science themes along the top and a possible mission sequence across the bottom. Credit: F. Reddy (NASA/GSFC)

Key topics that will be addressed include:

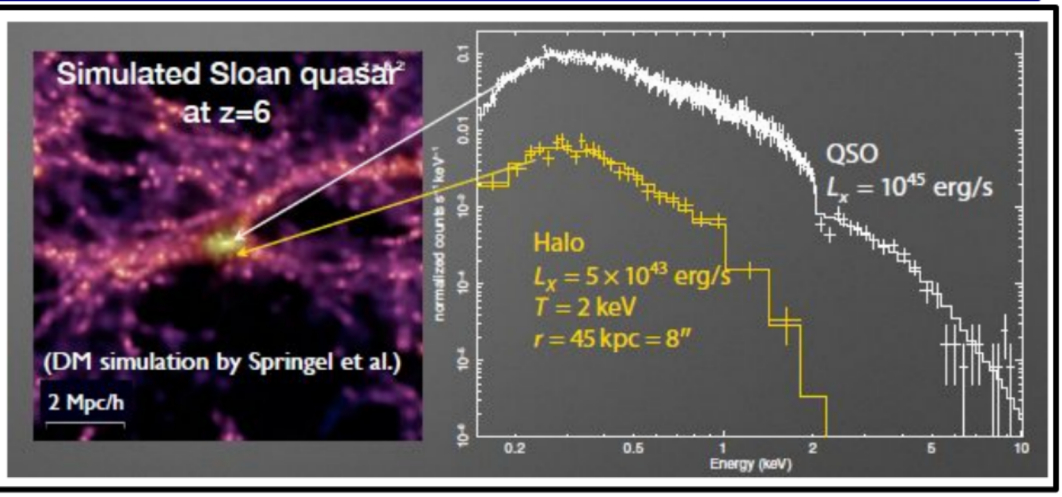
1) *The Origin and Growth of the First Supermassive Black Holes*
2) *Galaxy Evolution and the Growth of Cosmic Structure*
3) *The Physics of Matter in Extreme Environments*
4) *The Physics of Feedback and Accretion in Galaxies and Clusters*
5) *The Origin and Evolution of the Stars that make up our Universe*

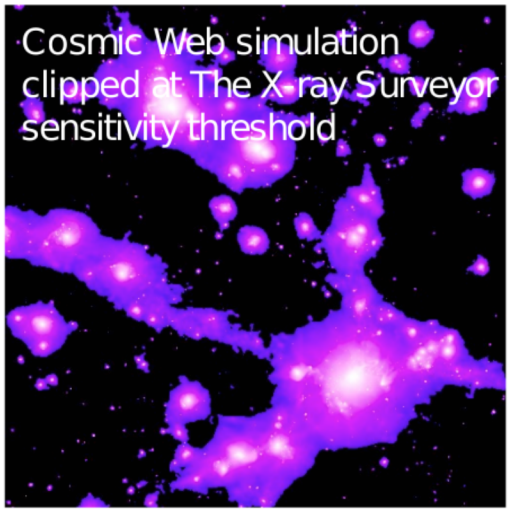
Scientifically Compelling

The Origin and Growth of the First Supermassive Black Holes

What is their origin?

How do they co-evolve with galaxies and affect their environment?





Galaxy Evolution and the Growth of the Cosmic Structure

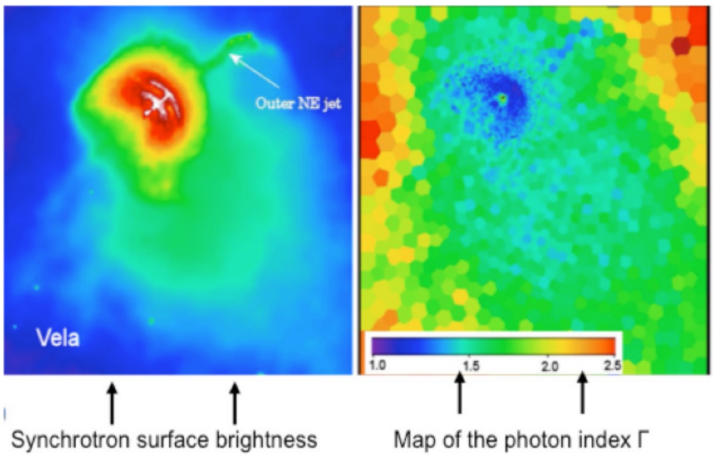
Structure of the Cosmic Web through observations of hot IGM *in emission*

How did the "universe of galaxies" emerge from initial conditions?

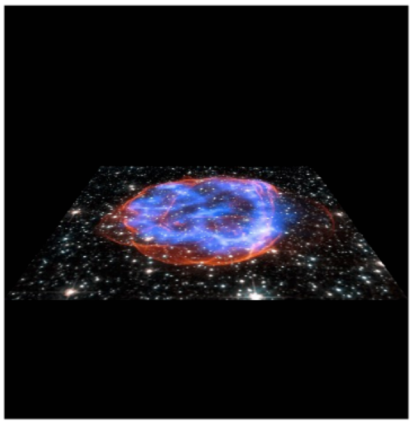
Scientifically Compelling

The Physics of Matter in Extreme Environments

Plasma physics, gas dynamics, relativistic flows in astronomical objects:



- **Supernova remnants**
- **Particle acceleration in pulsar wind nebulae**
- **Jet-IGM interactions**
- **Hot-cold gas interfaces in galaxy clusters and Galactic ISM**
- **Plasma flows in the Solar system, stellar winds & ISM via charge exchange emission**
- **Off-setting radiative cooling in clusters, groups & galaxies**
- **…**

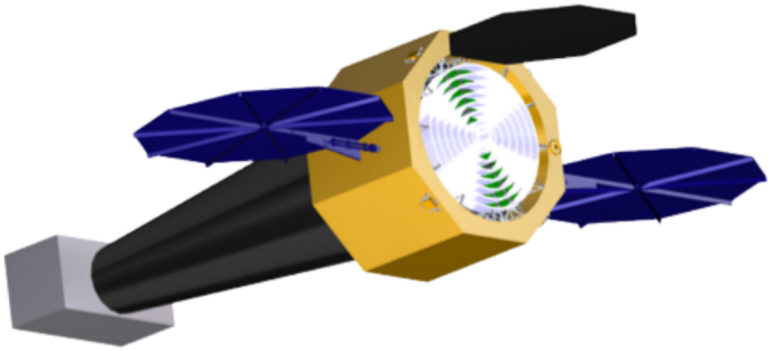


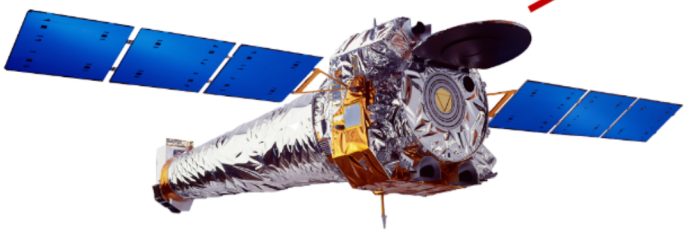
Required capability: **high-resolution spectroscopy *and* resolving relevant physical scales**

Leaps in Capability

We are now in the process of defining the successor to Chandra.

X-ray Surveyor





Chandra

We need your input!

'Notional' Goals:

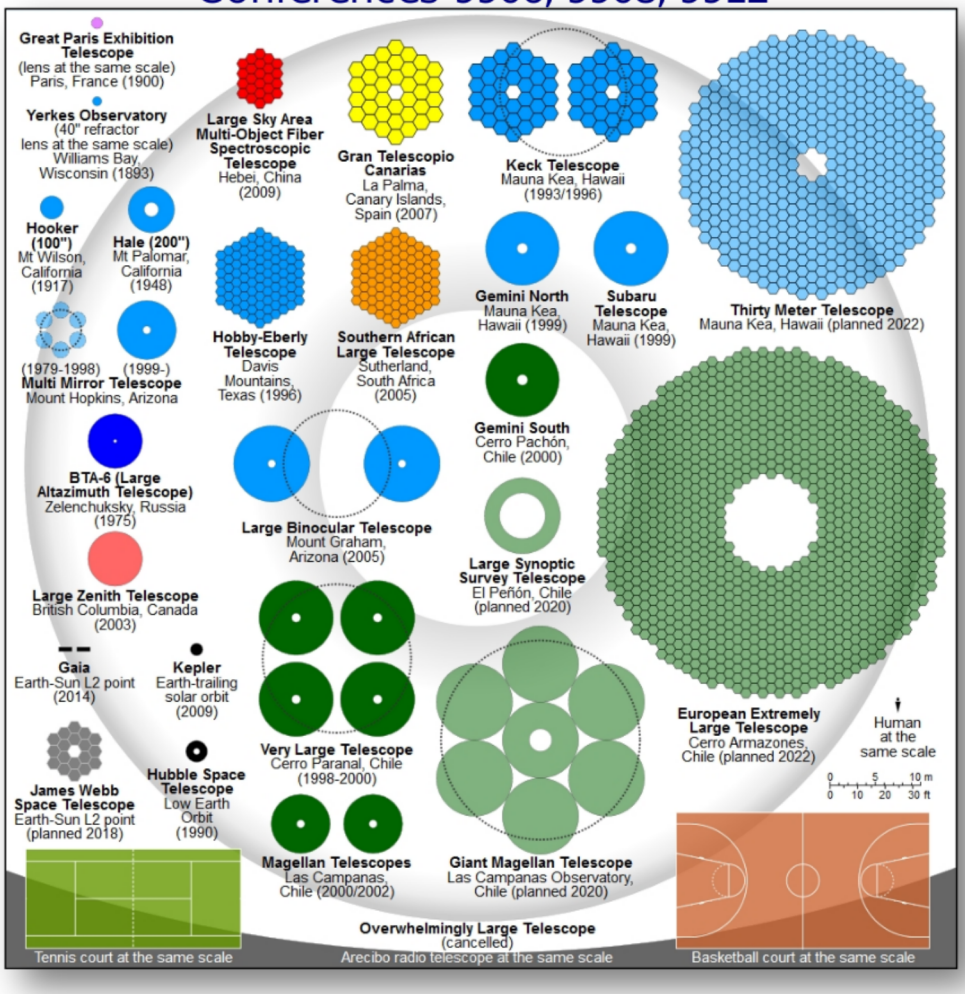
- Sensitivity (50× better than Chandra)
- R≈1000 spectroscopy on 1″ scales, adding 3rd dimension to data
- R≈5000 spectroscopy for point sources

✓ Area is built up while preserving Chandra angular resolution (0.5″)

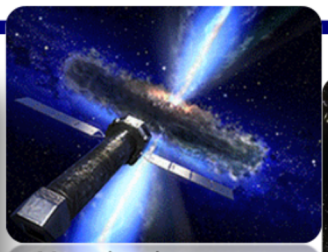
✓ 16× field of view with sub-arcsec imaging

Complementary

Conferences 9906, 9908, 9912



ATHENA



- Mapping hot gas structures & determining their physical properties
- Searching for SMBH

WFIRST

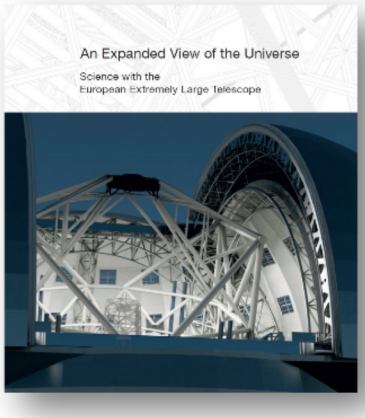
- Dark Energy
- Exoplanets
- Large Area NIR Surveys

What's Next ???

https://xkcd.com/1294/

Complementary – E-ELT (Example)

European Extremely Large Telescope (E-ELT):



- 40-m telescope: largest optical-infrared telescope in the world (2024)
- Diffraction limited performance (16x sharper than Hubble)
- Wide field of view: 10 arcmin
- Mid-latitude site (Armazones in Chile)
- Two first-light instruments have been identified: a diffraction-limited near-infrared imager and a single-field near-infrared wide-band integral field spectrograph

Contemporary science:

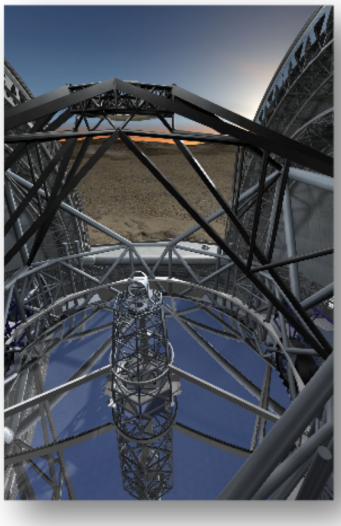
Exoplanets: radial velocity detections, direct imaging, transit spectroscopy, proto-planetary disks

Fundamental physics: GR in the strong field limit, variation of fundamental constants, expansion history of the Universe

Resolved stellar populations: beyond the Local Group

The physics of high-redshift galaxies

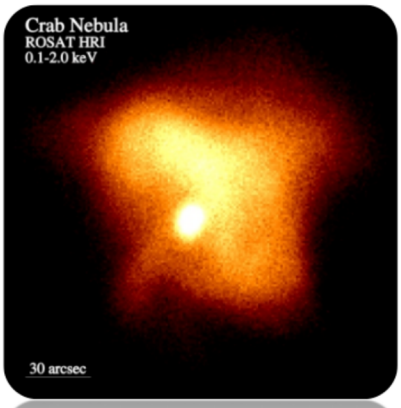
… and much more!

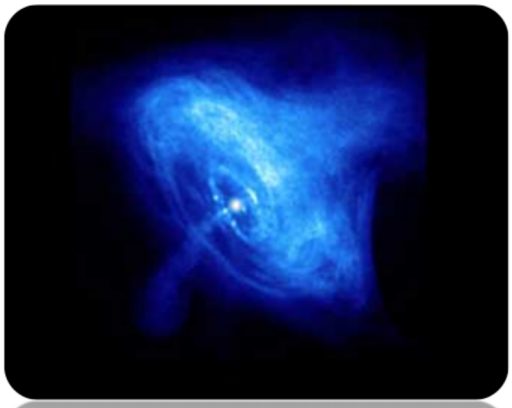


Tim de Zeeuw, ESO's Director General said: "The E-ELT will produce discoveries that we simply cannot imagine today, and it will inspire people around the world to think about science, technology and our place in the Universe."

Complementary – The Crab Nebula

Imagine a Universe without *Chandra-Vision!*



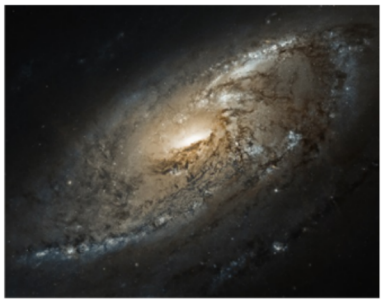


Complementary - NGC 4258 (M106)

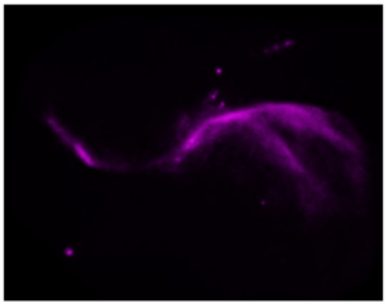
Credit: X-ray: NASA/CXC/Caltech/P.Ogle et al; Optical: NASA/STScI & R.Gendler; IR: NASA/JPL-Caltech; Radio: NSF/NRAO/VLA

X-Ray
Bubbles of hot gas

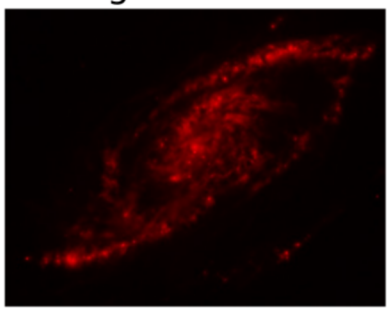
Optical
Stellar and gas distribution



Radio
relativistic jets and shocks



Infrared
Cold molecular gas and dust



STDT Community Members


Steve Allen, Stanford


Megan Donahue, MSU


Laura Lopez, Ohio State


Alexey Vikhlinin, SAO (Co-Chair)


Feryal Özel, Arizona (Co-Chair)


Mark Bautz, MIT


Ryan Hickox, Dartmouth


Piero Madau, UCSC


Mike Pivovaroff, LLNL


Eliot Quataert, Berkeley


Niel Brandt, Penn State


Tesla Jeltema, UCSC


Rachel Osten, STScI


Dave Pooley, Trinity


Chris Reynolds, UMD


Joel Bregman, Michigan


Juna Kollmeier, OCIW


Frits Paerels, Columbia


Andy Ptak, GSFC


Daniel Stern, JPL

Ex-Officio Non-Voting Members Of The STDT

Daniel Evans, NASA HQ
(Program Scientist)

Ann Hornschemeier,
PCOS Program
Office Chief Scientist

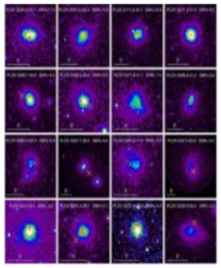
Rob Petre,
GSFC X-ray Lab
Branch Chief

Randall Smith,
Athena liaison

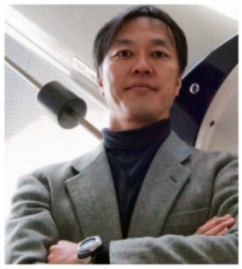
Arvind Parmar
ESA-Appointed
Observer

Kirpal Nandra
DLR-Appointed
Observer

Brian McNamara
CSA-Appointed
Observer



Gabriel Pratt
CNES-Appointed
Observer



Makoto Tashiro
JAXA-Appointed
Observer

MSFC AND SAO STUDY TEAM LEADERSHIP

Smithsonian Astrophysical Observatory

NASA

SRO Science Research Office

Alexey Vikhlinin,
SAO, STDT Co-Chair

Jessica Gaskin,
MSFC, Study Scientist

Mark King
MSFC Study Manager

Harvey Tananbaum
SAO Senior Scientist

Martin Weisskopf
MSFC Senior Scientist

Doug Swartz, USRA/MSFC
Deputy Study Scientist

X-Ray Surveyor Mission Concept Study

Study output will provide the Decadal Survey Committee with:

1. The ***science case*** for the mission
2. A ***notional mission*** and observatory, including a report on any tradeoff analyses
3. A ***design reference mission***, including strawman payload trade studies.
4. A ***technology assessment*** including: current status, roadmap for maturation & resources
5. A ***cost assessment*** and listing of the top technical risks to delivering the science capabilities
6. A ***top level schedule*** including a notional launch date and top schedule risks.

STDT Recent & Near-Term Activities

- STDT Kickoff Meeting was held March 30, 2016
- First Face-to-Face Meeting planned for July 25-26th at CfA, Cambridge, MA
- Possible second Face-to-Face meeting in September, 2016
- Bi-weekly STDT meetings open to the community

Near-Term STDT tasks include:

1. Decide the structure and mechanics for the Working Groups
   - Optics Working Group
   - Instrument Working Group
   - Multiple Science Working Groups
2. Define high-level science prioritizations and a path forward
3. Determine the potential technology gaps for further development
4. Plan workshops and conferences for 2017

OPTICS WORKING GROUP

Chair: Mike Pivovaroff (X-Ray Surveyor STDT Member; LLNL)
Co-Chair: Lester Cohen (Study Team Member; SAO)
Co-Chair: Mark Schattenburg (Community Member; MIT)

- Charter will be developed
- Open to the Community
  - A sign-up will be posted on the X-Ray Surveyor website:

    http://wwwastro.msfc.nasa.gov/xrs/
  - Emails will be sent through the X-Ray Surveyor and PCOS distribution lists
- Responsibilities will include:
  - Formulation of an optics development roadmap
  - Development of a common error budget
  - Development of the technical complexity metric for the mirror
  - Development of a unified set of standards for reporting progress
  - Involving industry and other potential partners

Check out these talks! 9905-57, 9905-60, 9905-61, 9905-62, 9905-63

Community Participation

Don't Wait! Be Proactive!

X-Ray Optics Workshop

- Workshop March 28-29, 2016, University of Maryland
- Participants included a mix of government, university, industry

X-Ray Vision Science Workshop

- Workshop October 6-8, 2015, Washington DC
- Participants included ~100 participants from multiple universities and institutions
- Presentations are available at: http://cxc.harvard.edu/cdo/xray_surveyor/

Technology Needs & Trades

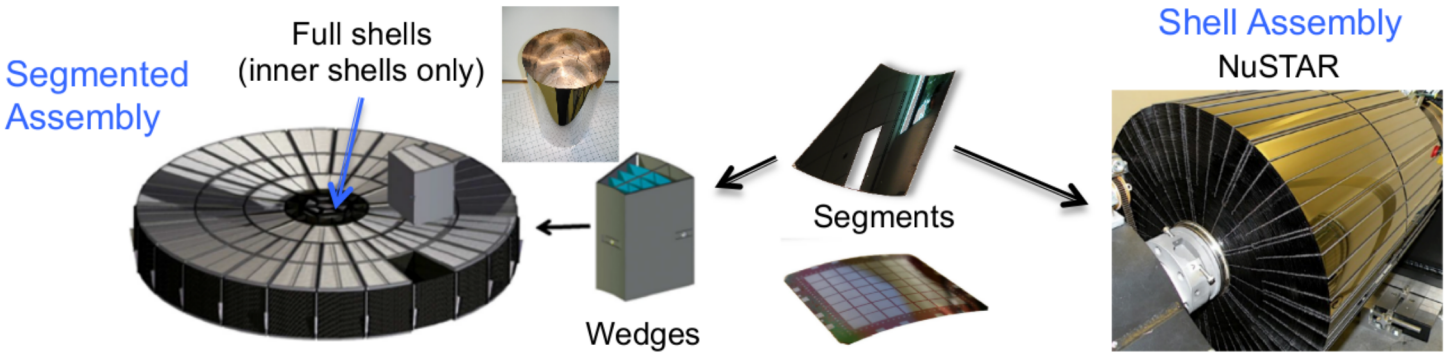
X-Ray Optics

- Segmented/Full-Shell
- Active/Passive
- High-resolution
- Light-weight
- Low-Stress Coatings/Surface Treatments
- Mounting/Assembly
- Metrology/Calibration
- Thermal Control
- Large-scale Fabrication

Focal Plane Instruments & Gratings

- High-definition Imager (CMOS/CCD)
- Microcalorimeter
- Gratings (OPGs/CAT)
- Grating readout (CCD/CMOS)

- Other???



Community Participation

Your participation is fundamental to the X-Ray Surveyor mission top prioritization in the 2020 Decadal Survey.

[Domestic & International Participation is Welcome!]

- Working Groups (science, optics, instruments; formal & informal)
- Public Website (join the X-Ray Surveyor News Group!)
- Requests for Information (RFIs) regarding relevant technologies
- Outreach (web-based Q&A, AAS "Future in Space" series -May 20)
- Workshops and Conferences (science and technology). Suggestions for synergistic and other workshop ideas are encouraged


National Ae
Marshall Spa
http://wwwastro.msfc.nasa.gov/xrs/
X-RAY SURVEYOR
XRS Home
Links
Documents
Presentations
Newsletters
Sign up for XRS News and Announcements
Documents
Mission Concept Study Team Charter
Decadal Studies Management Plan
PhysPAG Report on Flagship Mission Concept Studies for the 2020 Decadal Survey
XRSIG Report on Science with XR
RFI: Technologies for Large-Area Sub-
X-ray Surveyor is one of four large mission concepts to be studied as candidates for prioritization by the 2020 NRC Decadal Survey, anticipating that the Survey Committee will use these studies in formulating their recommendation for the priorities for large strategic missions following JWST and WFIRST. Each study will be led by a Science and Technology Development Team (STDT) and enabled by a NASA Center-based study office. The study STDTs have the responsibility to develop the science case for each candidate concept, flow the science case into mission requirements, vet technology gaps, and direct trades of science vs cost/capability. The STDTs will be chartered and managed by NASA HQ with membership selected from the scientific community. The X-ray Surveyor mission concept was identified in the Astrophysics Visionary Roadmap as contributing through major improvements in sensitivity, spectroscopy, and angular resolution.
X-ray Surveyor Science and Technology Definition Team (STDT)
Community Chairs of the STDT
Feryal Özel University of Arizona fozel@email.arizona.edu
Alexey Vikhlinin Smithsonian Astrophysical Observatory avikhlinin@cfa.harvard.edu
Study Scientist and co-chair of the STDT
Jessica Gaskin NASA/Marshall Space Flight Center jessica.gaskin@nasa.gov
Study News & Meetings
01 Jun 2016
X-ray Surveyor Mission Concept Study Telecon Agenda » Read
25 May 2016
X-ray Surveyor Mission Concept Study Telecon Agenda » Read
11 May 2016
X-ray Surveyor Mission Concept Study Telecon Agenda » Read
27 Apr 2016
X-ray Surveyor Mission Concept Study Telecon Agenda » Read
13 Apr 2016
X-ray Surveyor Mission Concept Study Telecon Agenda » Read
30 Mar 2016
X-ray Surveyor Mission Concept Study Kickoff Telecon Agenda » Read
Call In Info
X-ray Surveyor STDT Meeting » Call In Information

BACKUP SLIDES