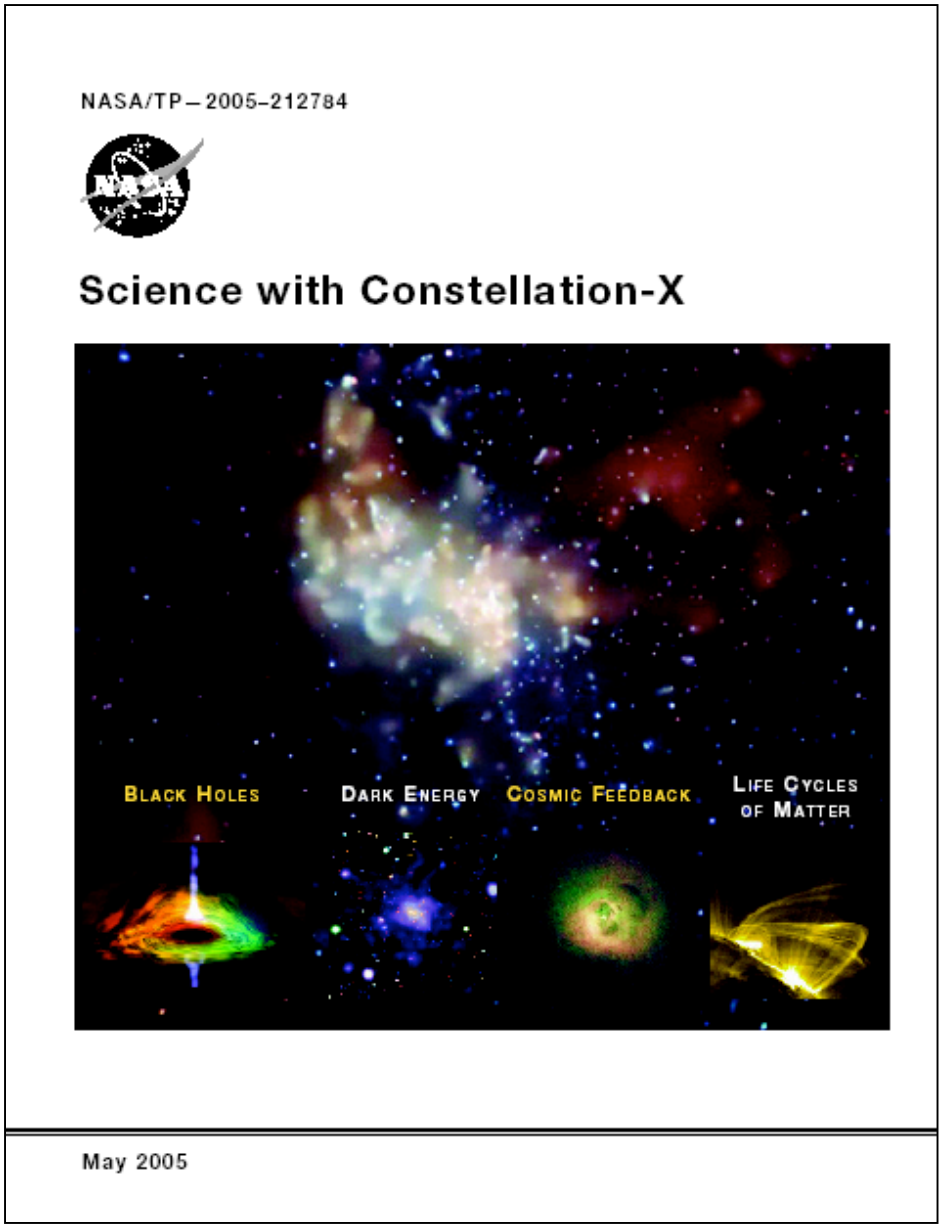


Constellation-X
NASA GSFC

Neutron Stars at X-ray Wavelengths: NASA's Constellation-X Mission

Divas Sanwal
(JHU/GSFC)

Project Scientist: Nick White (GSFC)
FST Chair: Harvey Tananbaum (SAO)
Project Manager: Jean Grady (GSFC)

http://constellation.gsfc.nasa.gov

Outline

- **Why Study NSs at X-ray wavelengths?**
- **Constellation-X Parameters**

NSs and X-ray Astronomy
(statistics)

$$\frac{41}{49} = 0.8367$$

Constellation-X Mission Overview

Use X-ray spectroscopy to observe

- Black holes: strong gravity & evolution
- Dark Matter throughout the Universe
- Dark Energy parameters
- Production and recycling of the elements

Mission parameters

– **Telescope area:** 3 m^2 at 1 keV

25-100 times XMM/Chandra for high resolution spectroscopy

– **Spectral resolving power:** 300-1,500

2-3 times better than Astro-E2 at 6 keV

– **Band pass:** 0.25 to 40 keV

100 times RXTE sensitivity at 40 keV

Enable high resolution spectroscopy of faint X-ray source populations

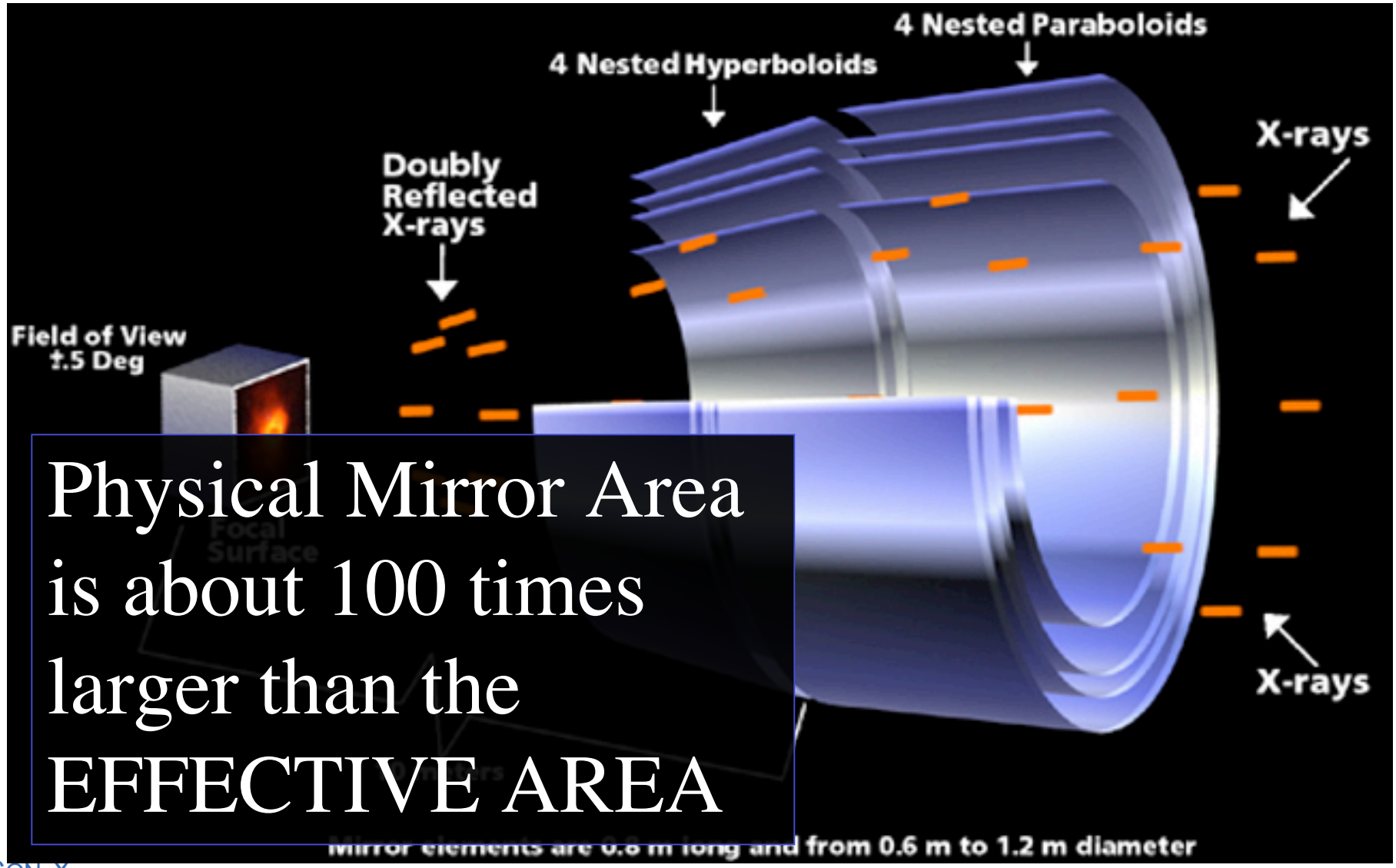
Constellation-X Performance Parameters

- ✓ Effective Area
- ✓ Spectral Resolution
- ✓ Time Resolution
- ✓ …

Constellation-X Mission

- **Band pass 0.25 to 40 keV**
- **Minimum effective area:**
  - **1000 cm^2 (0.25-10 keV)**
  - **15,000 cm^2 (at 1.25 keV)**
  - **6,000 cm^2 (at 6.0 keV)**
  - **1,500 cm^2 (10-40 keV)**
- **Minimum/goal telescope angular resolution**
  - **15"/5" HPD (0.25-10 keV)**
  - **1'/30" HPD (10-40 keV)**
- **Spectral resolving power**
  - **> 300 (0.25-6 keV)**
  - **>1500 (6.0-10 keV)**
  - **>10 (10-40 keV)**
- **Field of view**
  - **> 2.5' x 2.5' (< 10 keV)**
  - **> 8' x 8' (> 10 keV)**
- **Timing**
  - **XRS : absolute 100 μs; relative 10 μs**

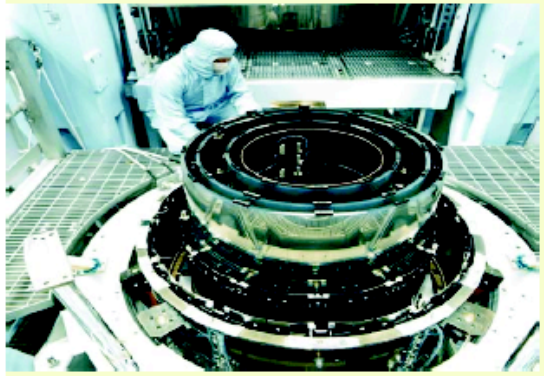
Schematic of Grazing Incidence, X-ray Mirrors

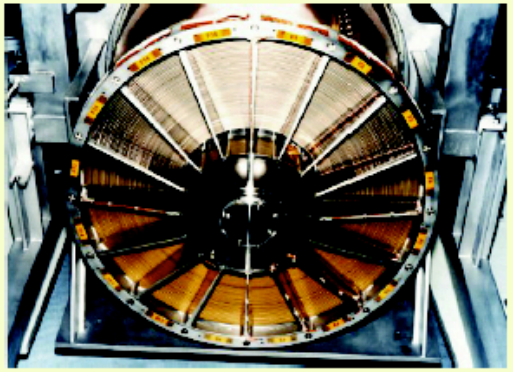


Physical Mirror Area is about 100 times larger than the EFFECTIVE AREA

A Quick Primer on X-ray Optics:

They are extremely heavy.



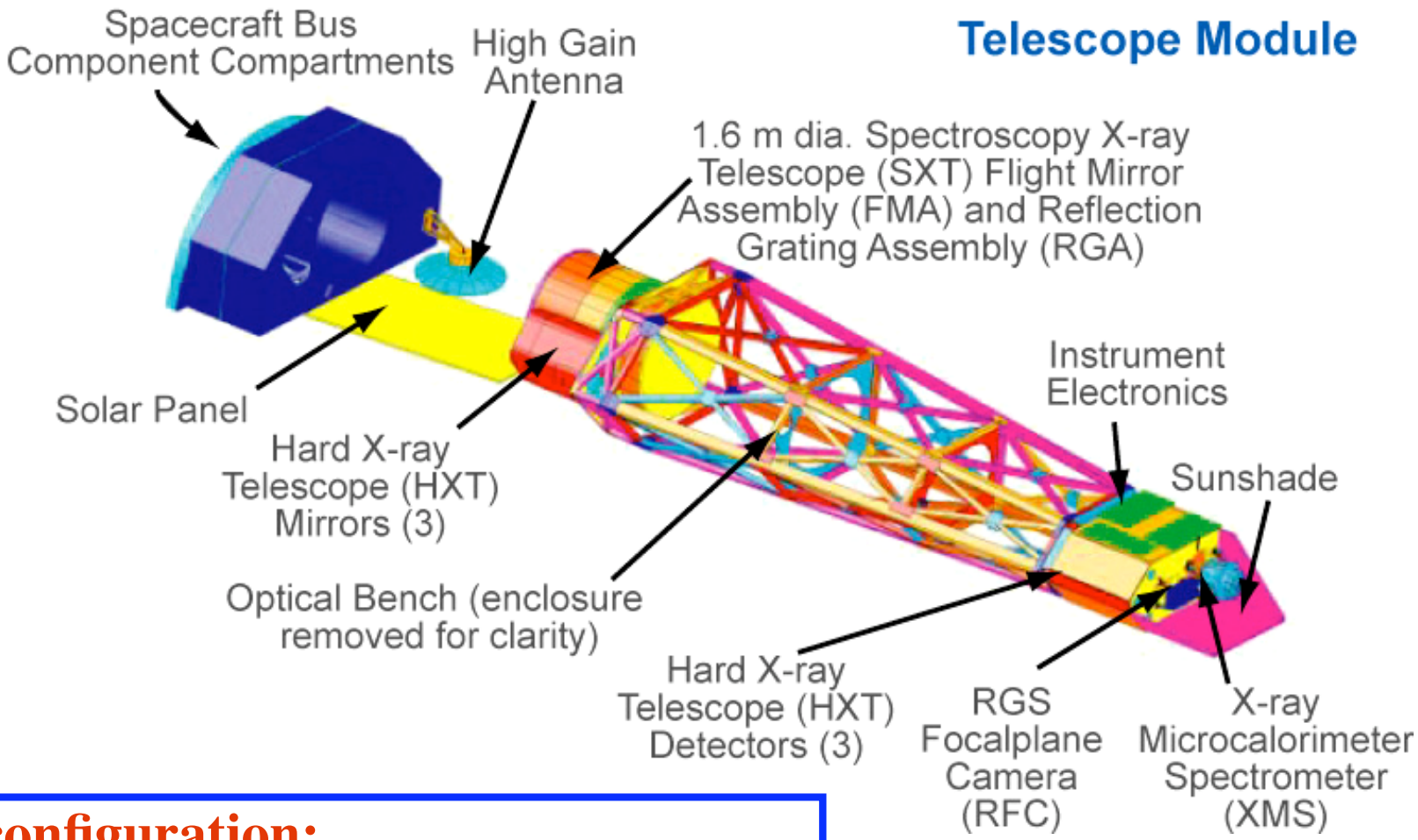


CHANDRA	XMM-NEWTON
0.5”	14”
18500 kg/m^2	2300 kg/m^2
A_{eff} @ 1 keV	A_{eff} @ 1 keV

credit: Marcos Bavdaz, ESA-XEUS team

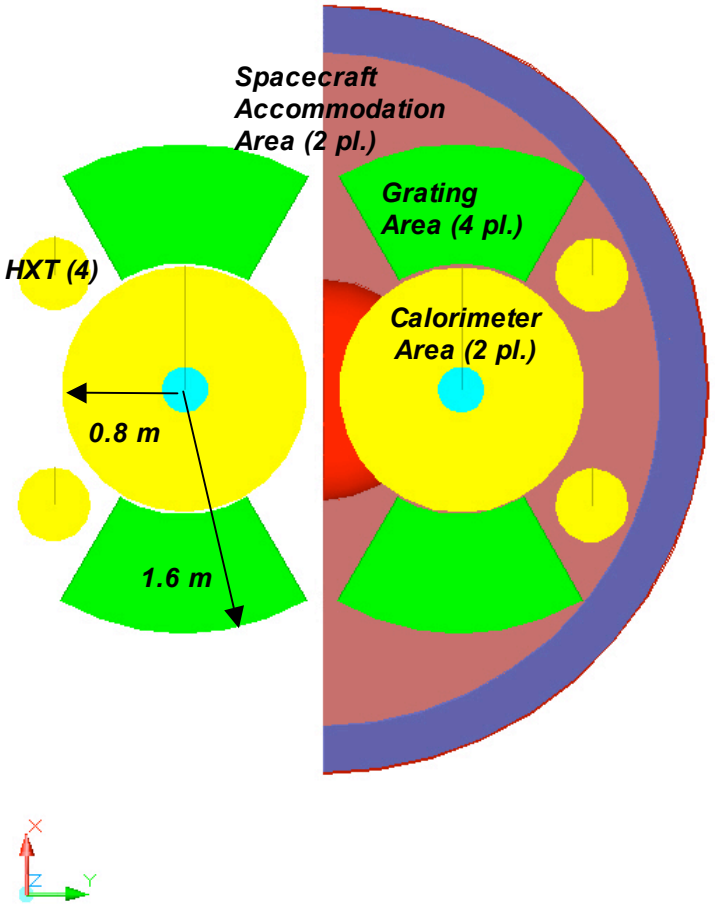
Constellation-X mirrors:
<450 kg/m^2 A_{eff} @ 1 keV

Spacecraft Bus



- **Baseline configuration:**
  10 m focal length, 4 spacecraft
- **Single launch configurations under study:**
  10-50 m FL, EOB and/or formation flying

3.2m/1.6m x12m FL Configuration



2 Complete SXTs per launch

- **2 sets of detectors req'd.**

3.2m OD x (4) 60º wedges for gratings

(2) 1.6m Full Diameter Inner Tel.

- **0.3m ID**

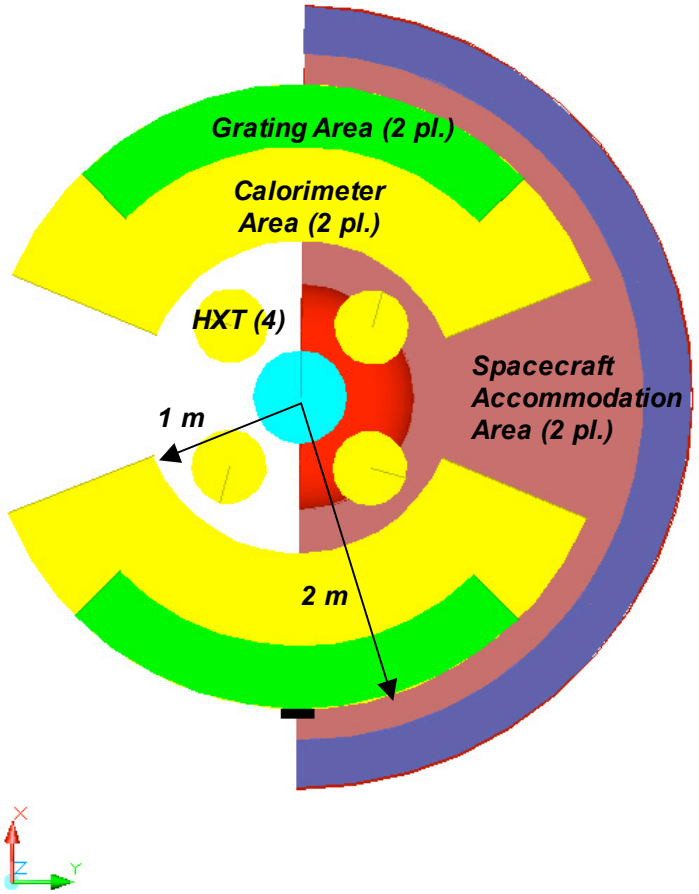
12m Focal Length

- **Can be accommodated in 19.1m fairing with *fixed* optical bench**

SXT raw glass weight ~850 kg

- **Should be OK for Delta-4H launch**

4m/2m 135° Wedge with 50m FL Configuration



4m OD x (2) 135º wedges

2m ID

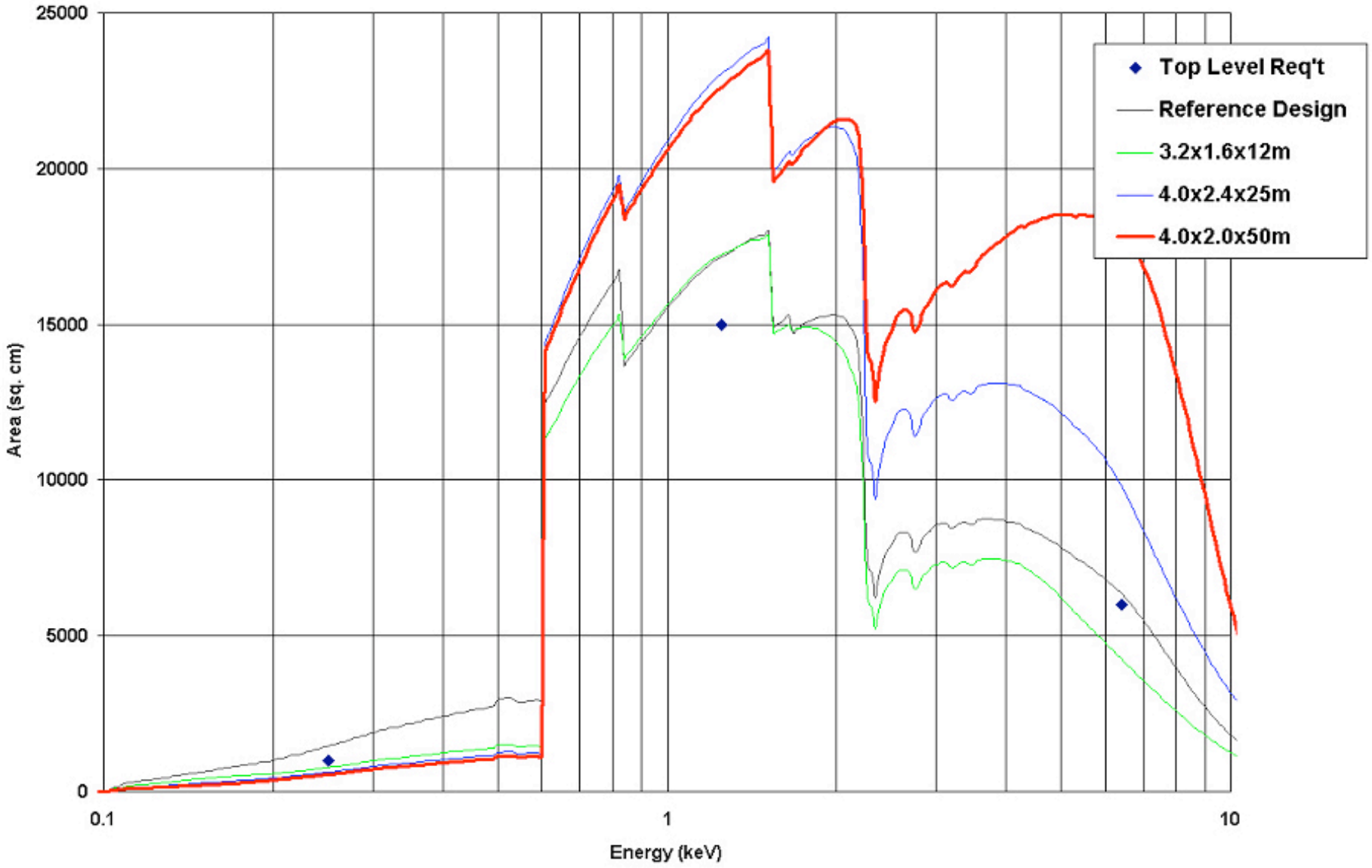
Gratings cover (2) 90º arcs

50m Focal Length

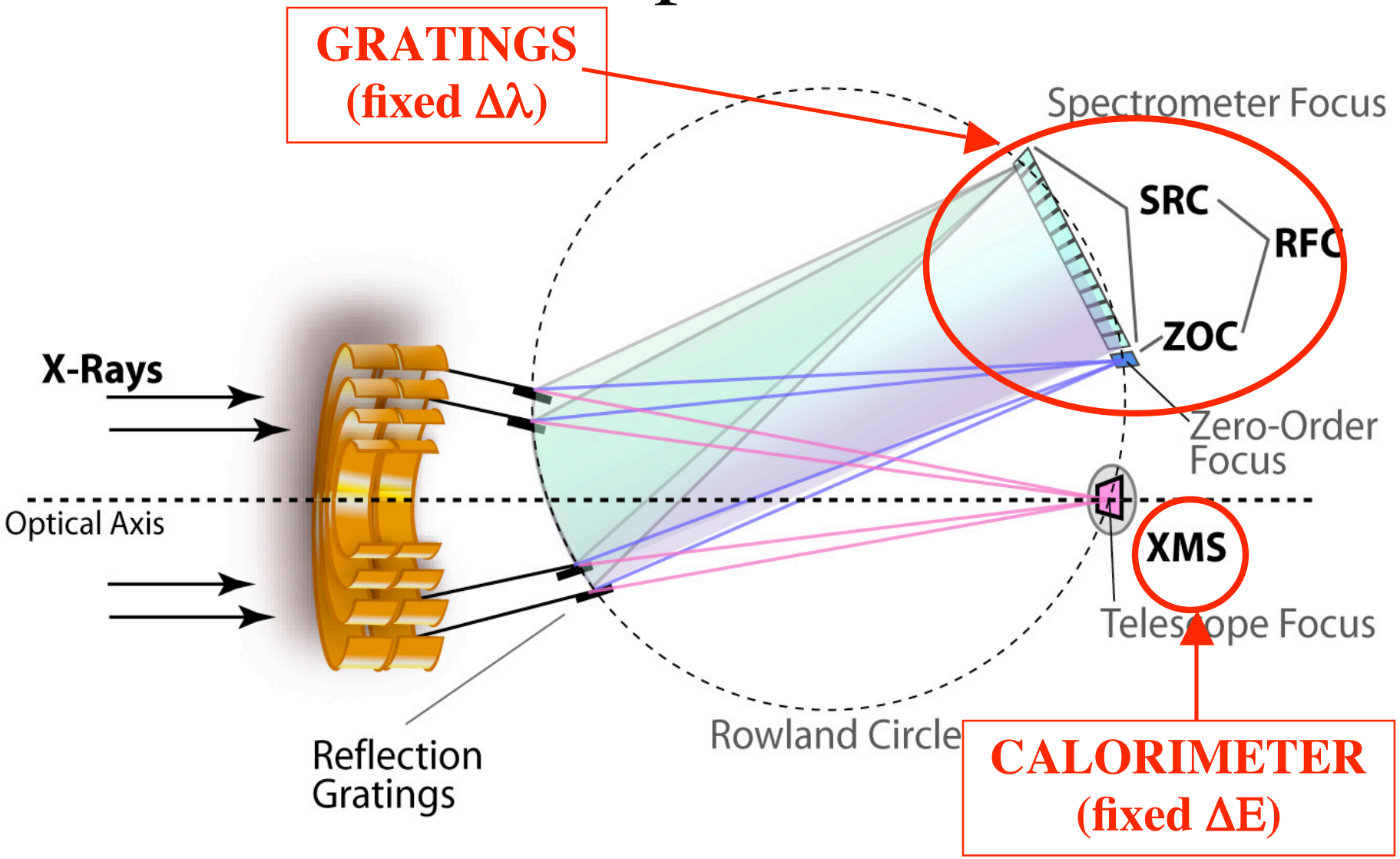
- **Requires 2 spacecrafts**
  - **Formation Flying**
  - **Extendible Optical Bench**

Launch using Delta 4H

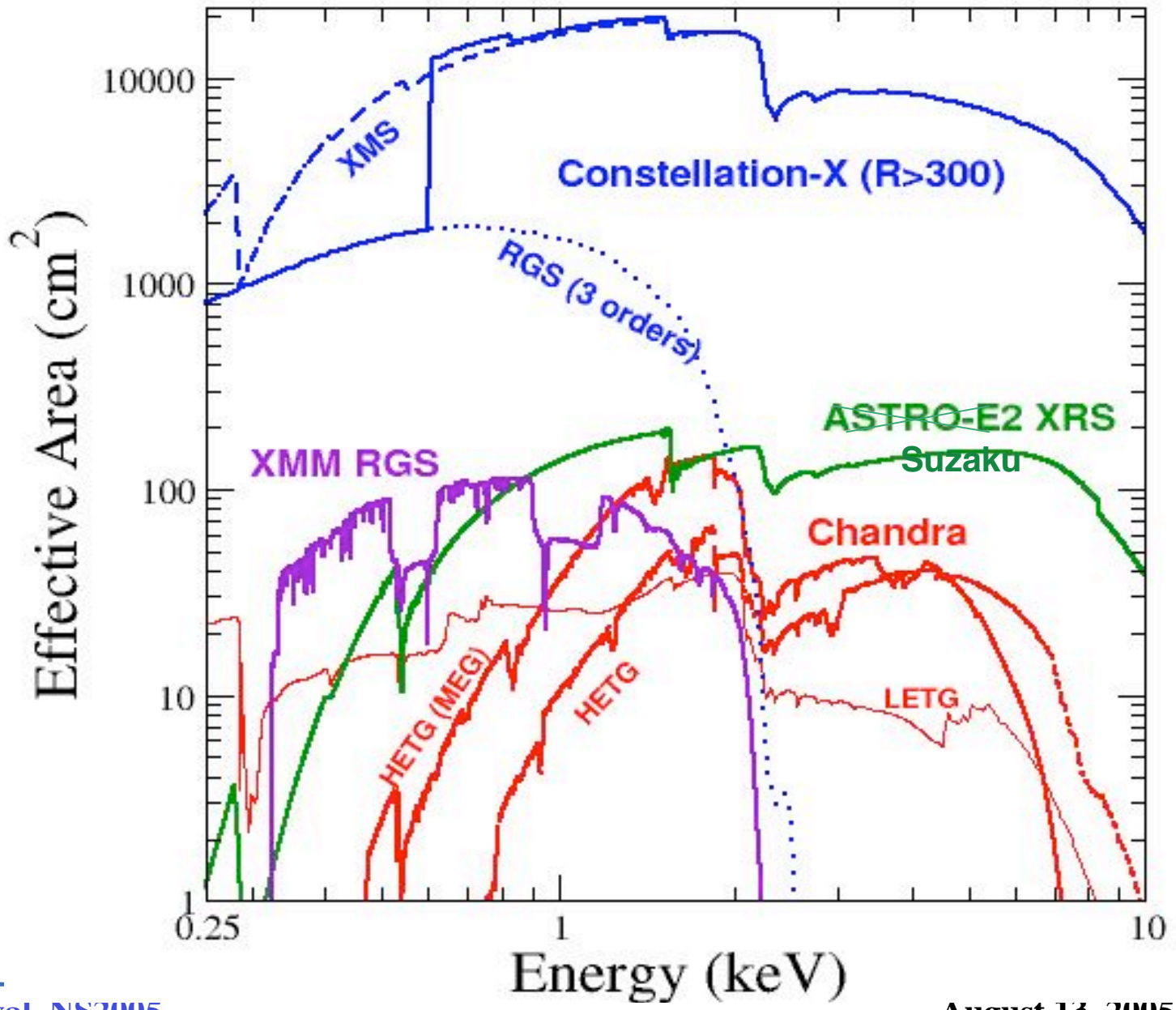
SXT Effective Area



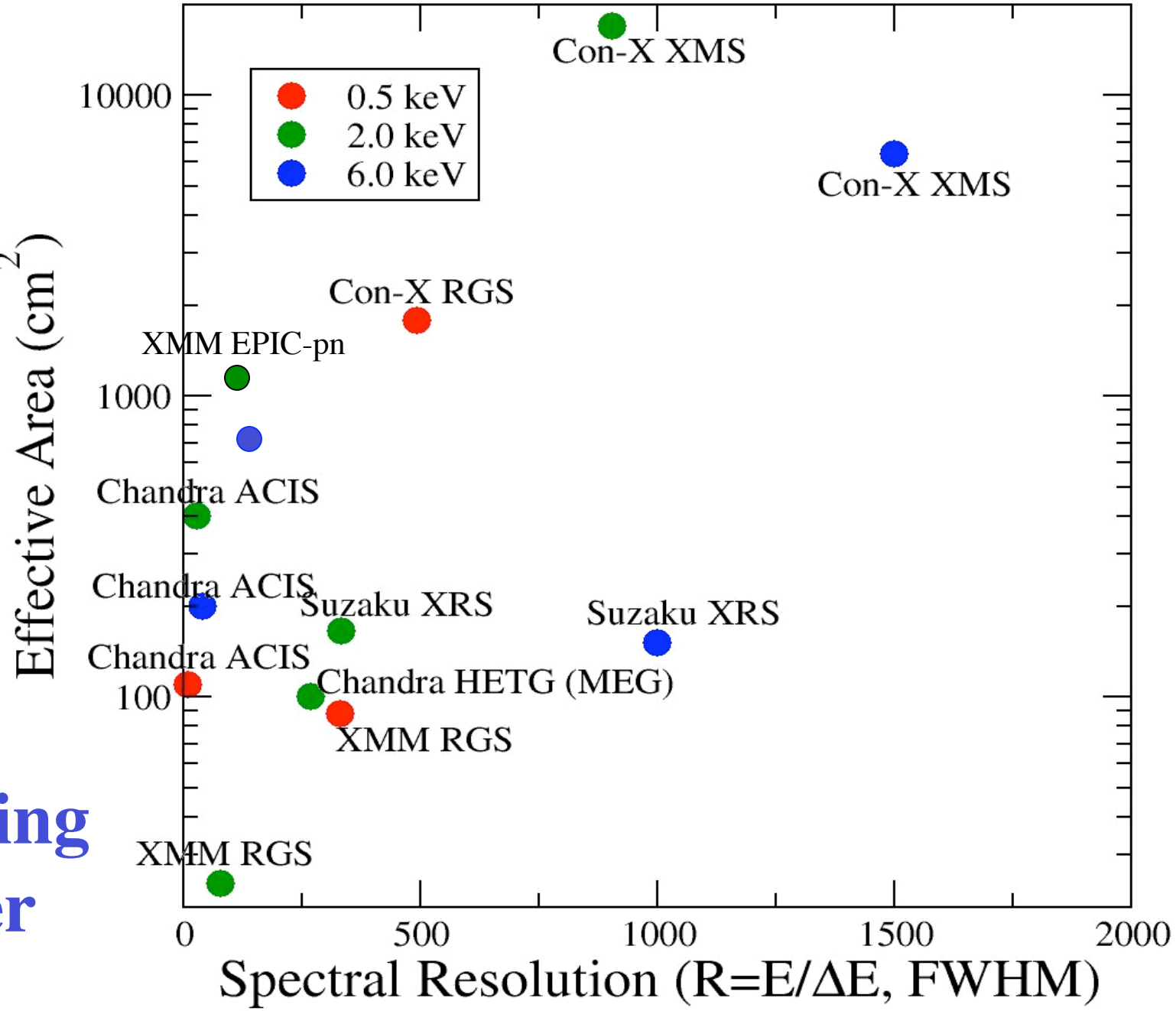
SXT Optical Path



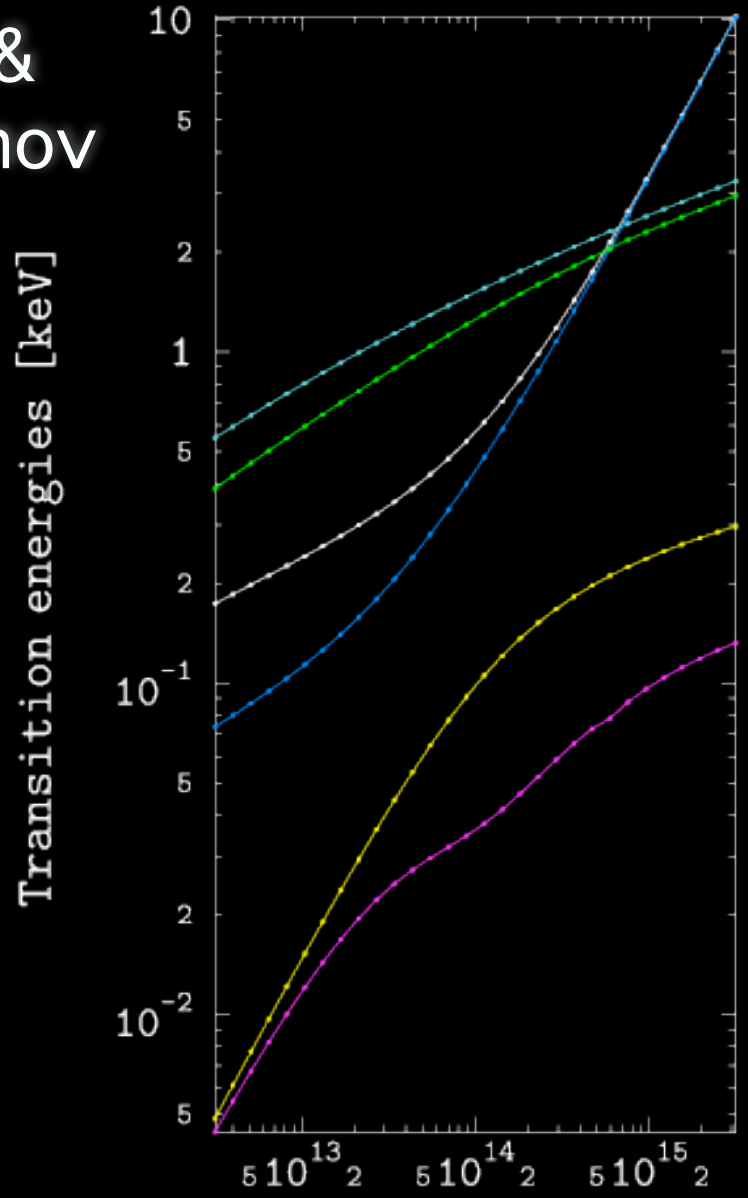
X-ray Mission Collecting Areas

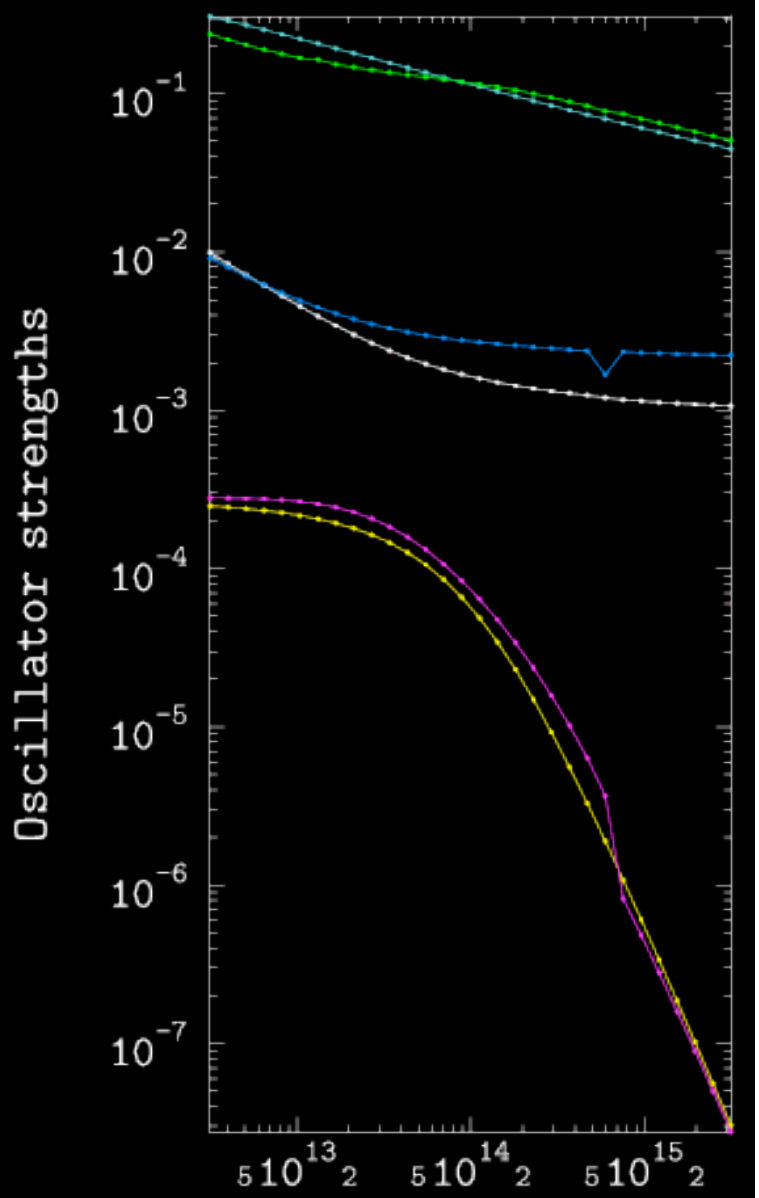


Resolving Power

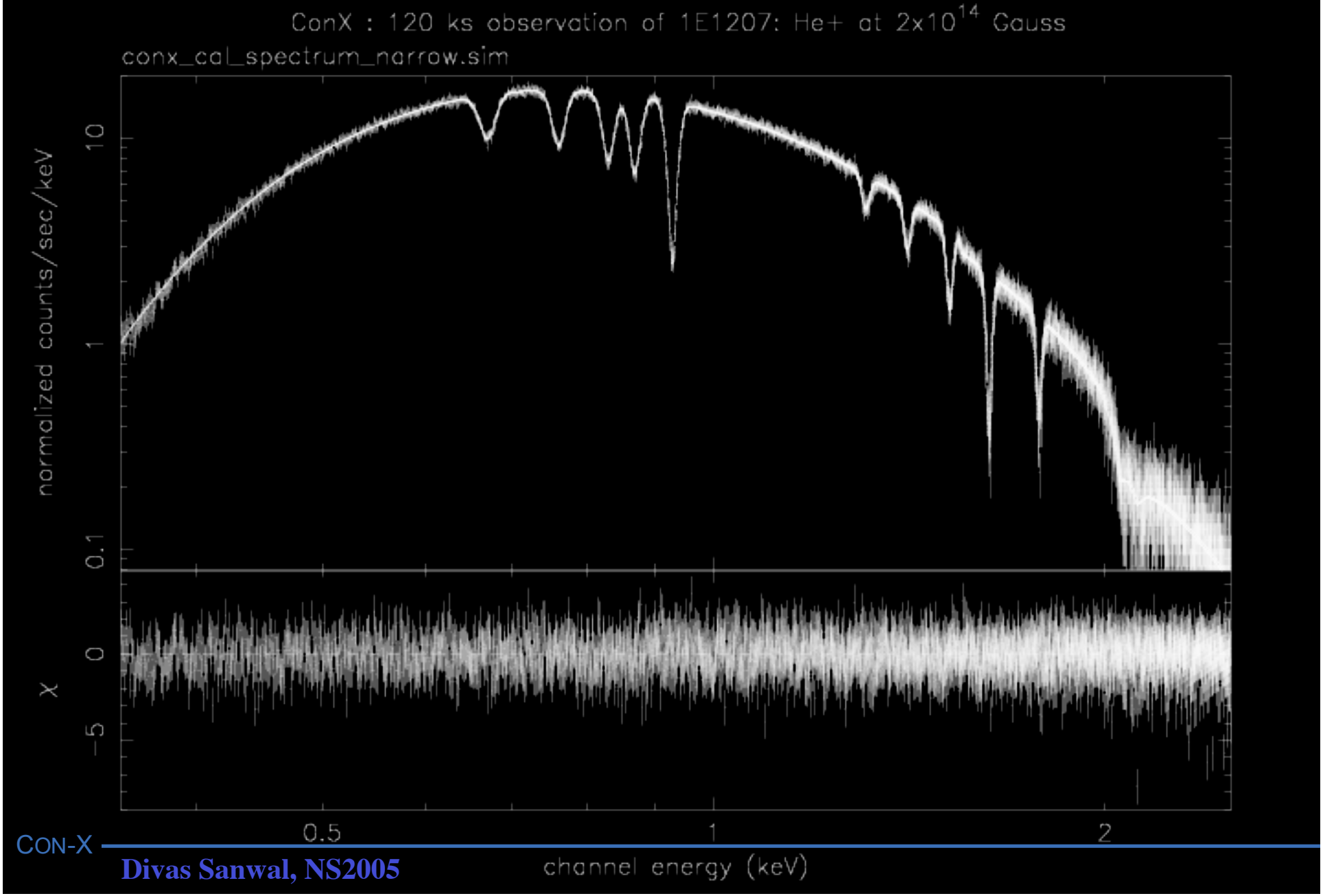


Pavlov & Bezchastnov 2005





AstroEII : 120 ks observation of 1E1207: He+ at 2x10^14 Gauss
aeII_spectrum.grp.sim
normalized counts/sec/keV
0.1
0.05
0.02
0.01
5x10^-3
0.5
1
2
channel energy (keV)


ConX : 120 ks observation of 1E1207: He+ at 2x10^14 Gauss
conx_cal_spectrum_narrow.sim
normalized counts/sec/keV
10
1
0.1
χ
0
-5
0.5
1
2
channel energy (keV)

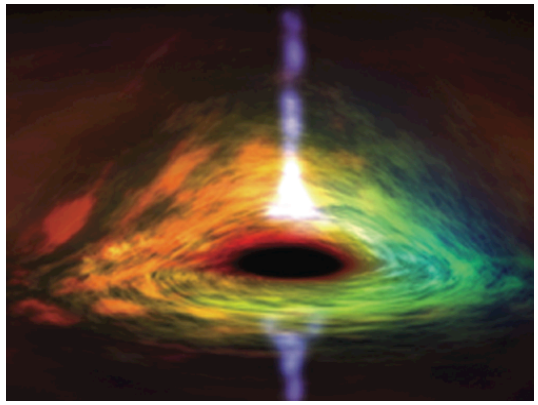
What you don't get?

- Great Spatial Resolution (0.1")
- 100 square meter effective area

Talk to Jeremy Heyl, he will give you Generation-X in/around 2030

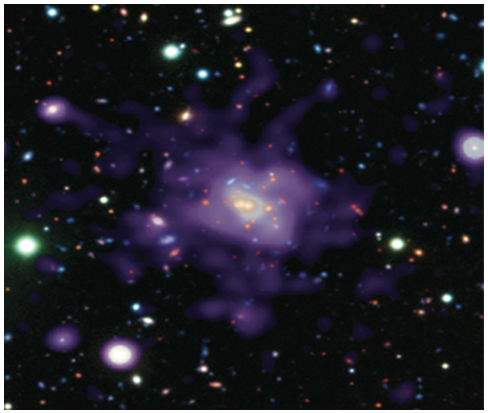
Constellation-X Science

Black Holes



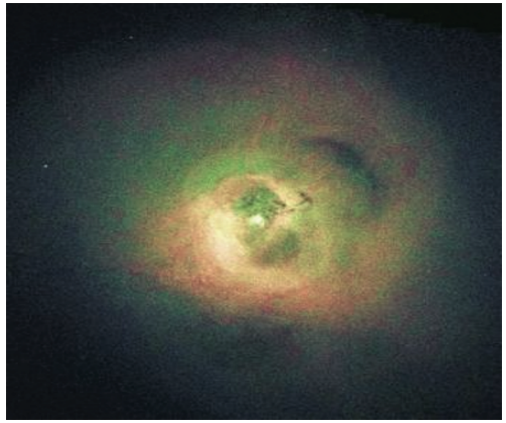
What is the detailed structure of the inner accretion disk?
How prevalent are intermediate-mass black holes?

Dark Energy/Clusters



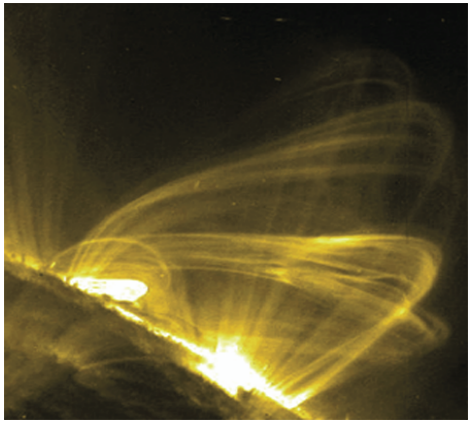
Does the dark energy evolve with redshift?
Can AGN outflows slow cooling flows in clusters?

Cosmic Feedback



How have accretion disks in AGN affected galaxy evolution?
How do starburst galaxies enrich the IGM?

Life Cycles of Matter

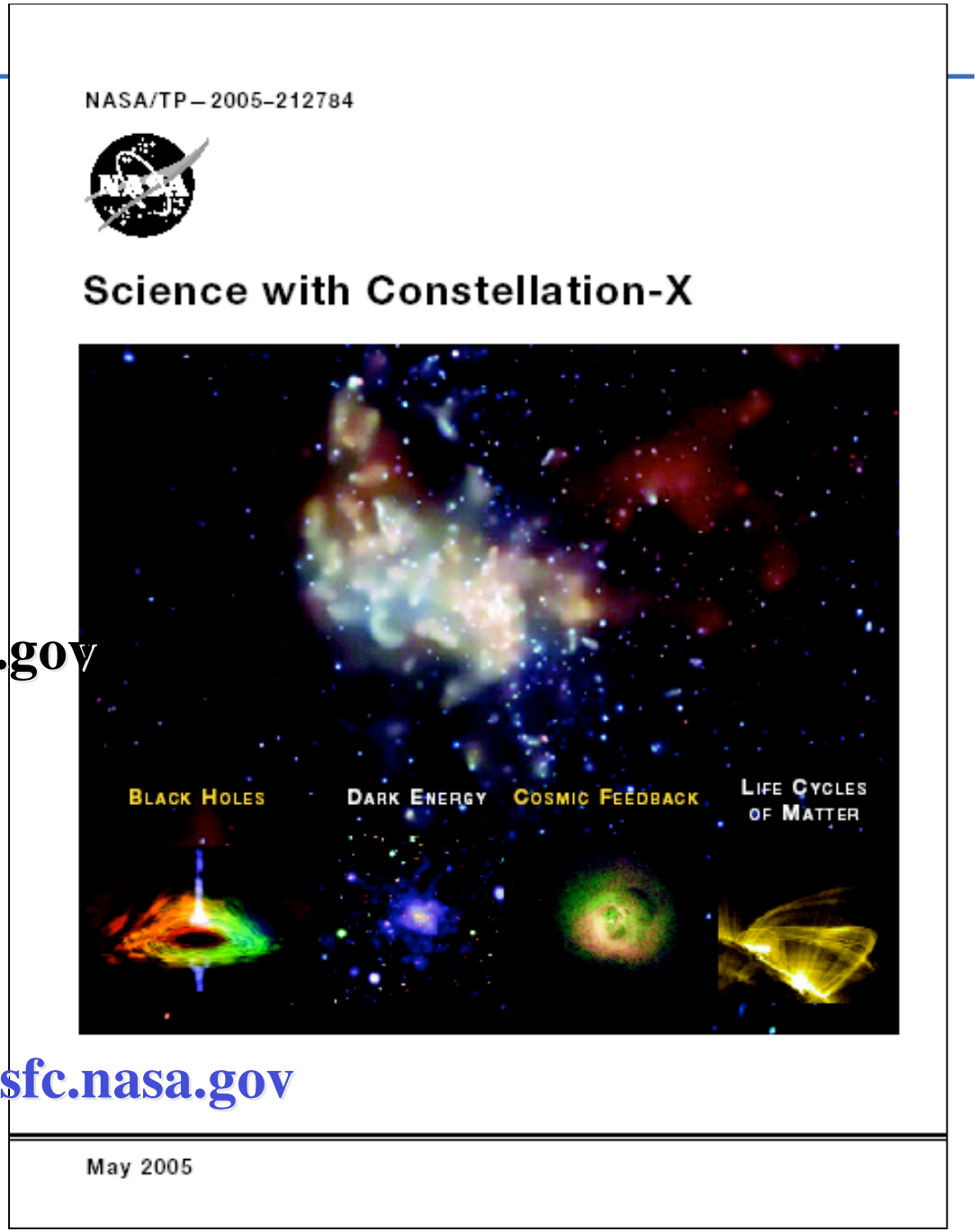


What is the nature of matter that makes stars?
How do stellar outflows affect planet formation?

Few copies available
here in the room

PDF on the website

http://constellation.gsfc.nasa.gov



Questions? Comments?

Email me: divas@milkyway.gsfc.nasa.gov