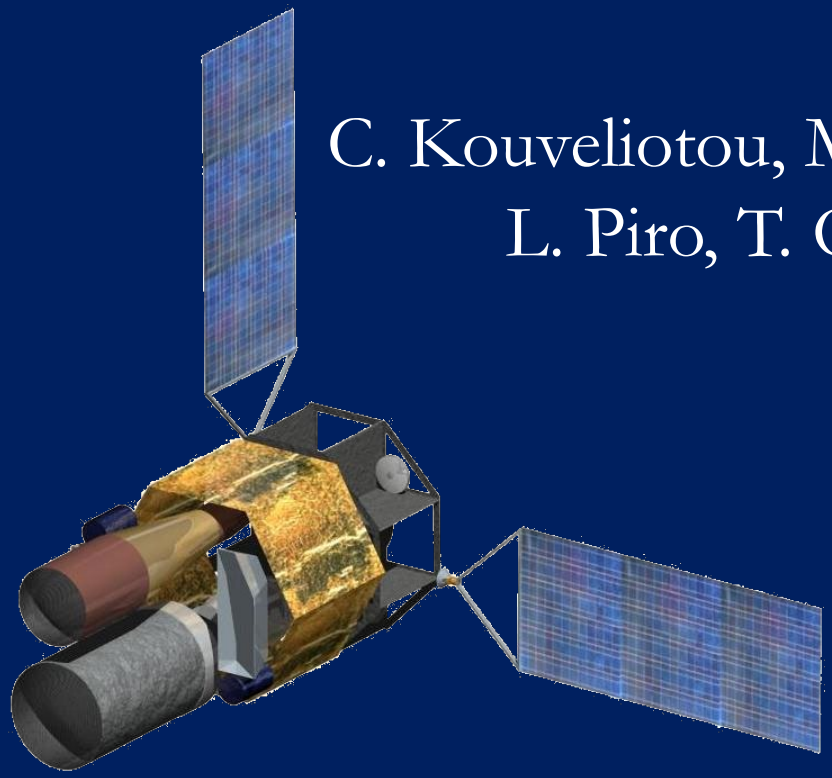
The XENIA mission

Cosmic chemical evolution of baryons

Dieter H. Hartmann

C. Kouveliotou, M. C. Weisskopf, J.W. den Herder,
L. Piro, T. Ohashi, D. Burrows, ……..

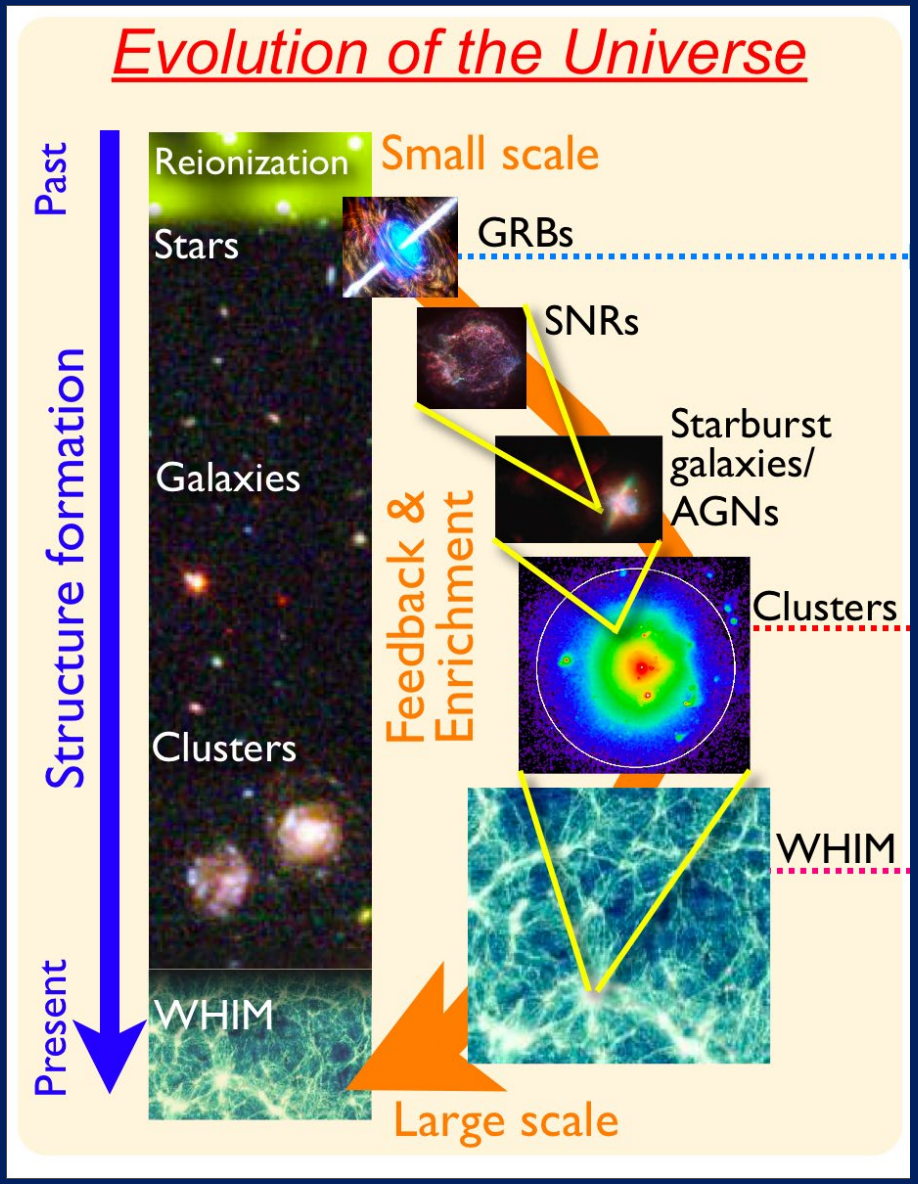


The Xenia team

A large Consortium of groups from the US, Europe, and Japan

Participating Institutions:

Xenia and the



Gamma-Ray Bursts as Probes

- Evolution of massive star formation using GRBs to trace explosions to z > 8)

- Measure metals in their host galaxies and close environment out to z > 8

Clusters of Galaxies

- Trace evolution of clusters out to their formation epoch (z>1)

- Measure the thermal/chemical properties of a fair sample out to the virial radius

Cosmic Web

- Detect large reservoirs of baryons from z~1 to the present time

Xenia instruments

Sky Monitoring &
Fast Response

Fast repointing
< 60 sec for 80% GRB

Ball Aerospace Worldview CMG

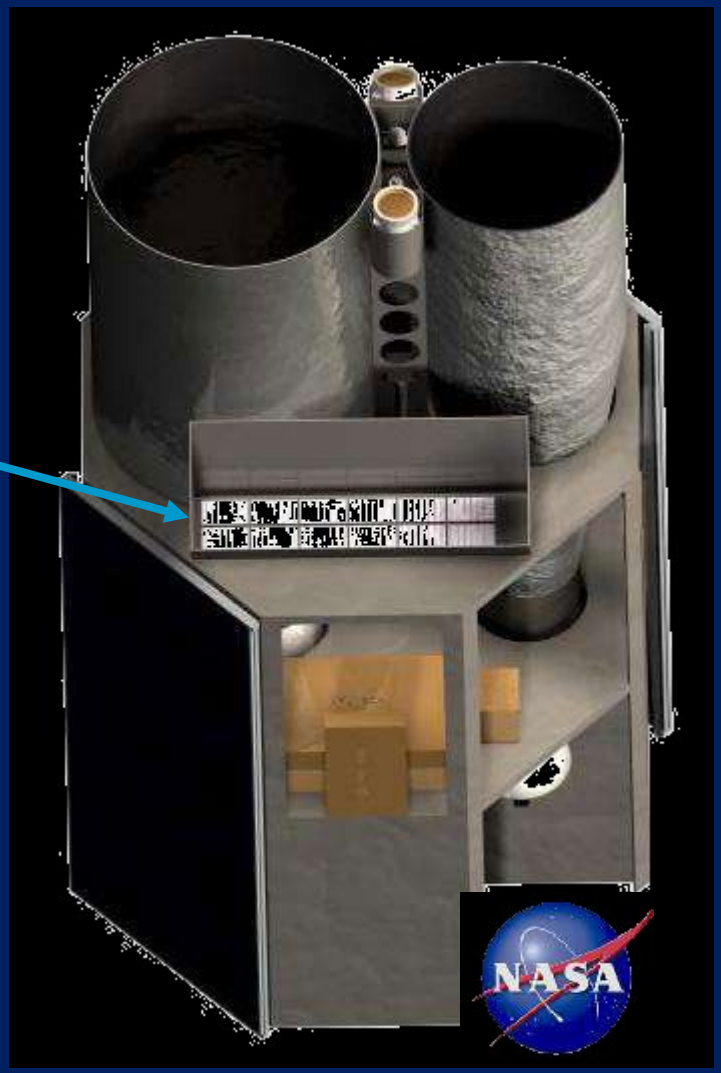
- Suggest using Ball Aerospace M-95 CMG 4 wheel pyramid configuration for all slews, station keeping, and observations.

- Provides up to 6.1 Nm torque (~4.0 Nm required for Xenia)

TED: Transient Event Detector

A_{eff} = 1500 cm^2
8-200 keV (goal <5 keV)
FOV ~ ¼ sky
3' localization

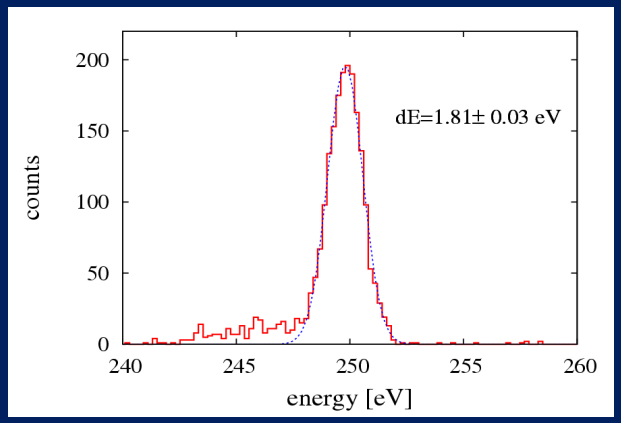
2 CZT based coded mask detectors

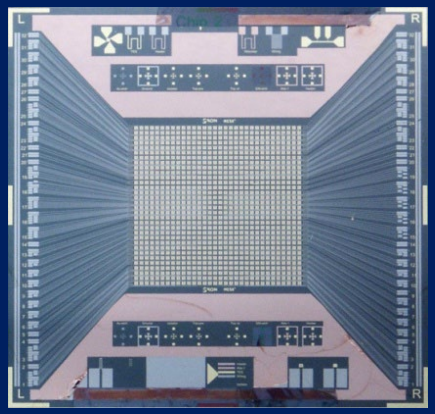


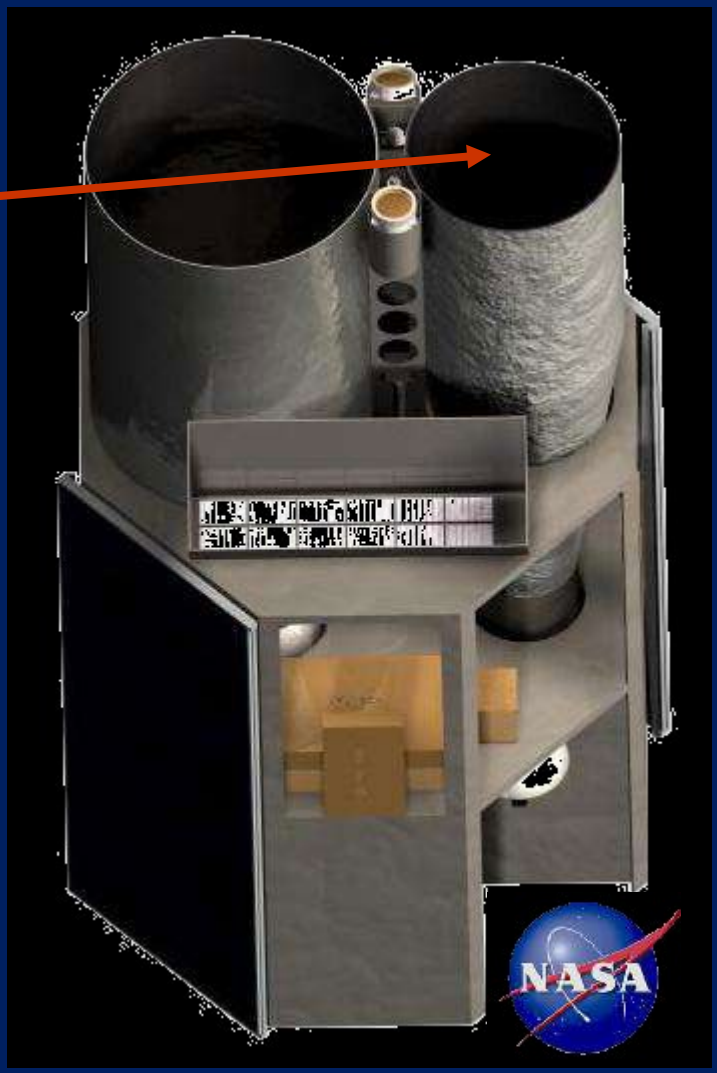
CRIS: Cryogenic Imaging Spectrometer

Area 1000 cm² @ 0.5keV
Energy range: 0.1-3 keV
Resolution: 2.5eV (1eV goal)
Field of view ~1.0°
ang.res. element ~ 3'
GRASP ~ 10³ cm² □°

TES microcalorimeters

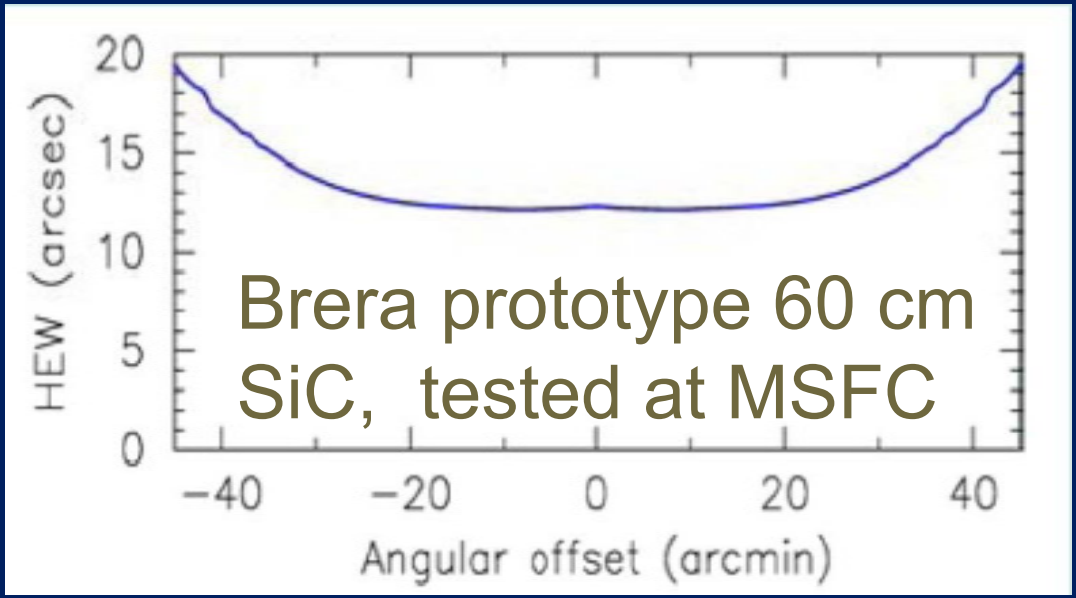


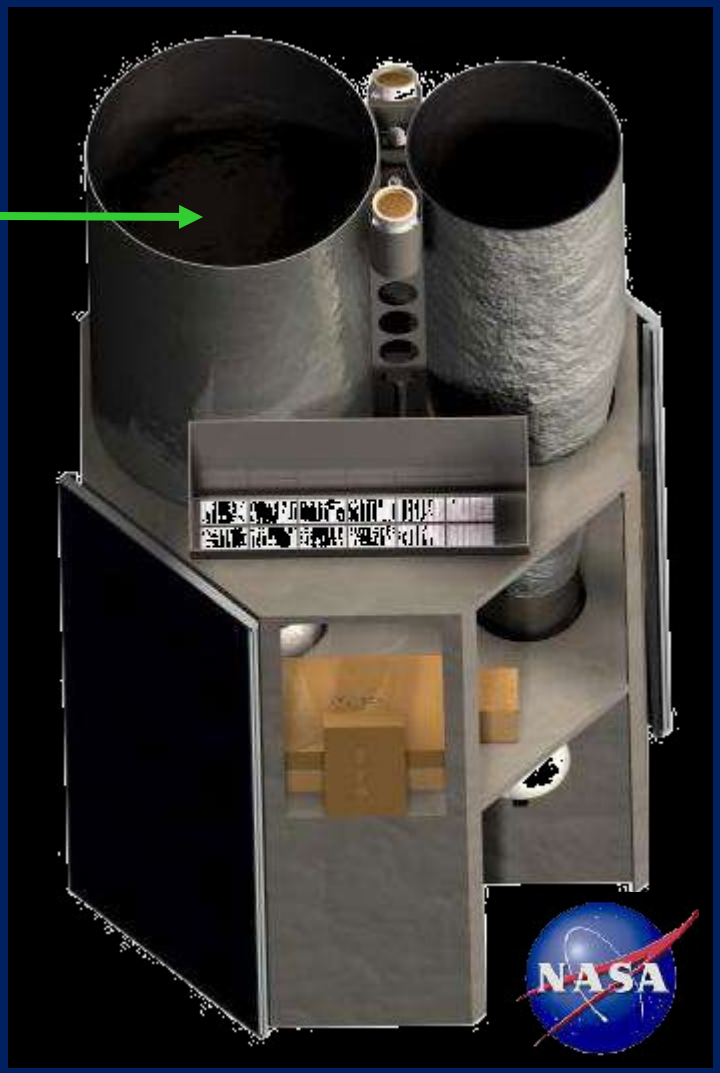




HARI: High Angular Resolution Imager

Area =1000 cm^2 @ 1keV
Range: 0.3-8 keV
Field of view=1.4°
ang.res = 10" constant, CCD

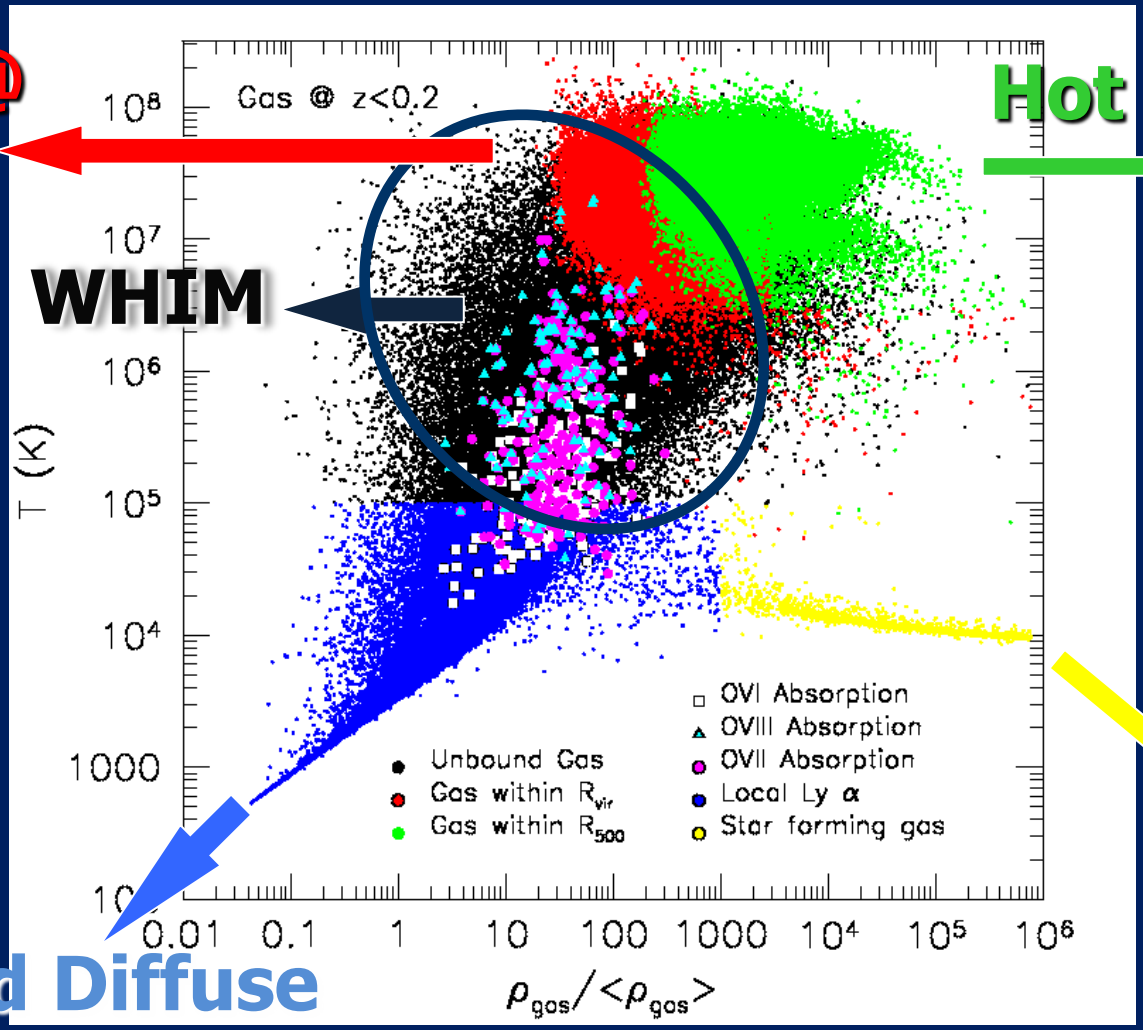




GRBs as cosmological probes

- **TED**: 150 GRB localized per year, 80 GRB with Fluence (15-150 keV) > 10^{-6} erg cm^{-2} s^{-1}
- High-z Universe: GRB @ z > 6 ~ 10 year^{-1}
- Mid-bright GRB afterglow with a **fast (t < 60s) pointing CRIS** yields 10^{5-6} X-ray photons, and 10^{3} cts in 1 eV resolution bin
- **5 year mission:** >250 afterglows with high resolution X-ray spectra: redshift, metals in host-galaxy and GRB environment over wide z range
- 150 afterglows for WHIM studies

Exploring the Cosmic web



Cluster @ Virial r.

Hot (clusters)

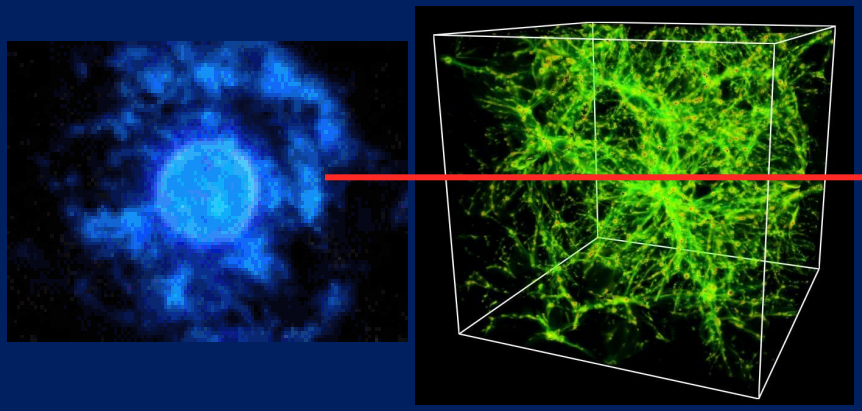
WHIM

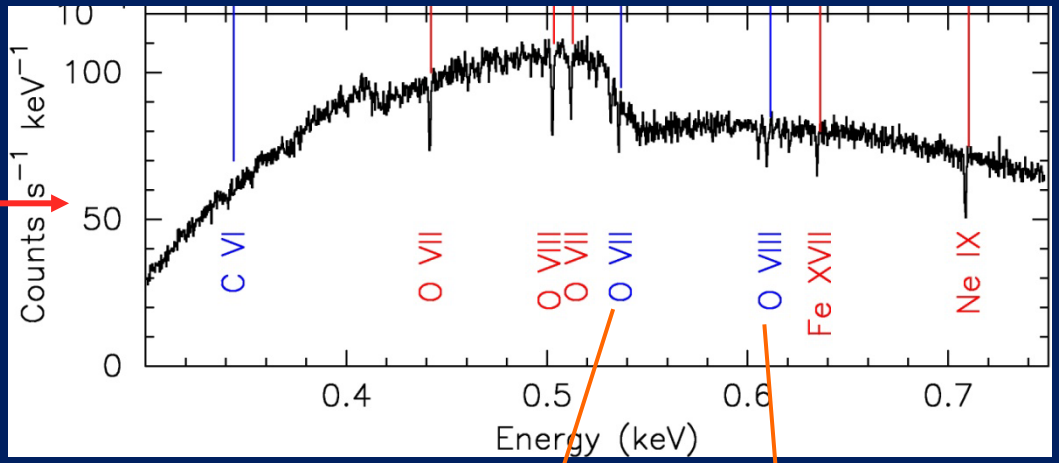
Cold Diffuse

*** forming**

Branchini et al 2009

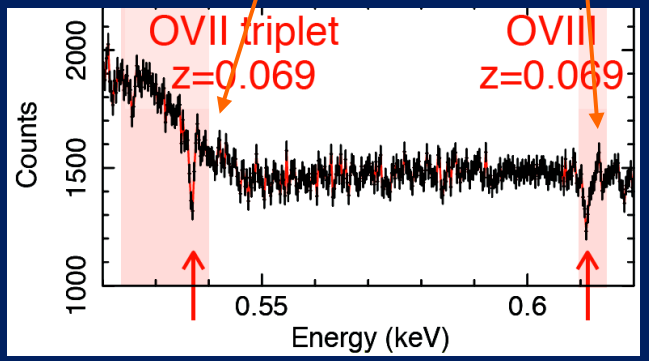
Tomography of the Universe: the X-ray forest from the Cosmic Web with GRBs





Absorption line EW ➔⇧

~200s OVII-OVIII filaments in 5 years



Mapping the Cosmic Web

Emission line strength ➔ ⇧²

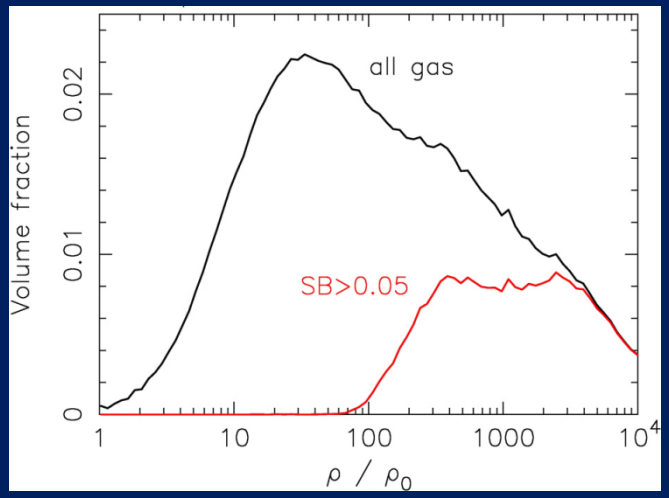
Sim. gas at <z> =0.2

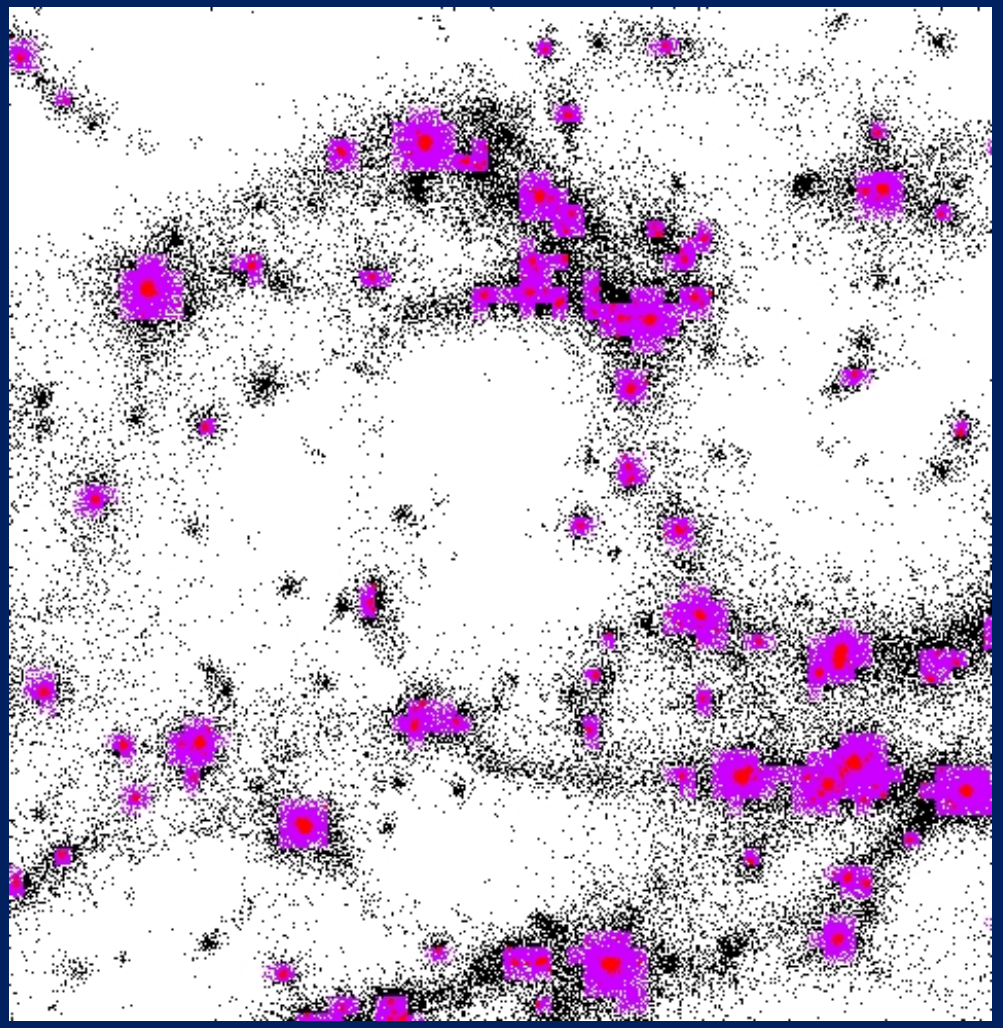
2° × 2° area

Detected OVII

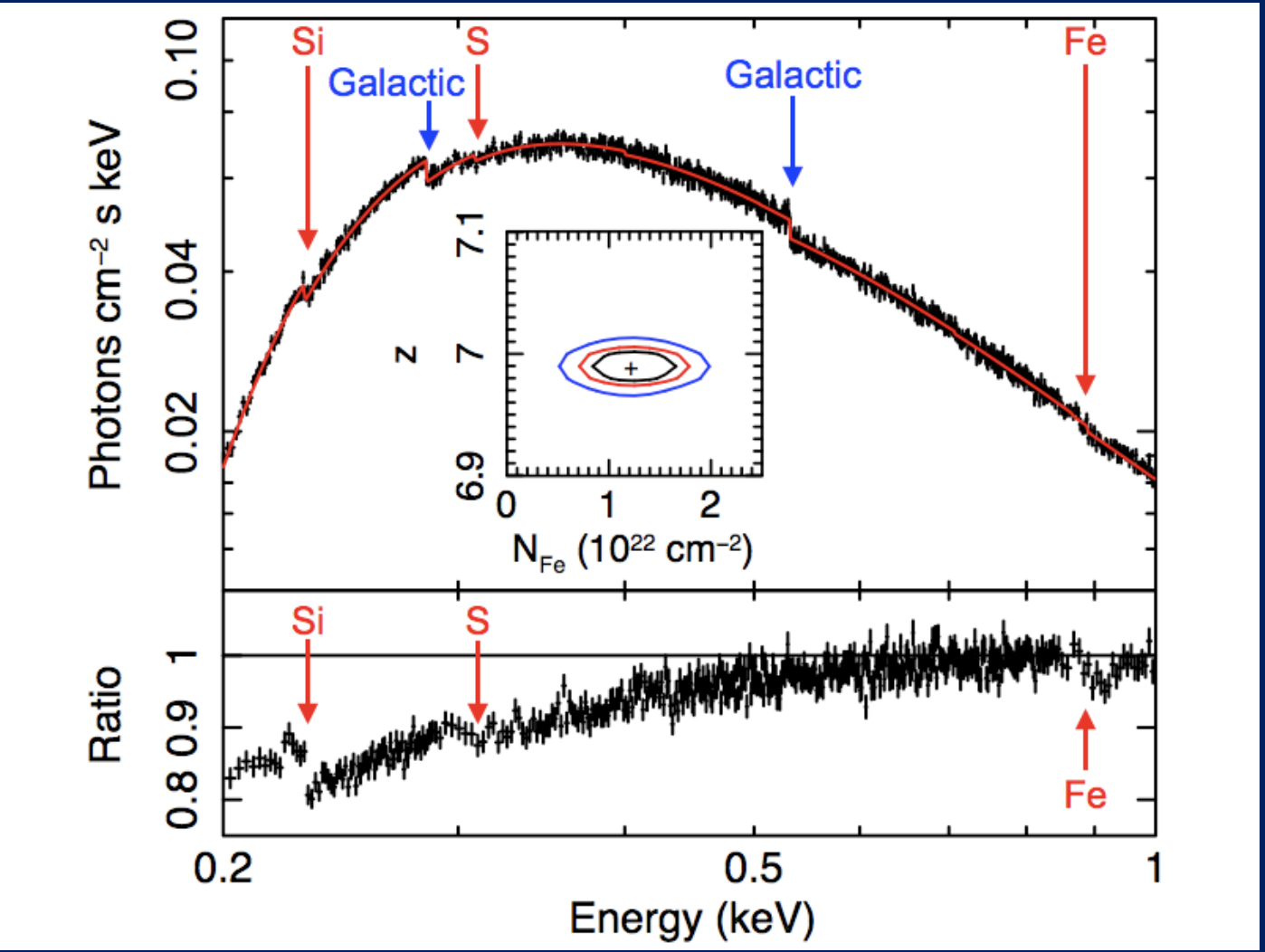
Emission in 1 Ms

5 σ = 0.05 γ/cm² s sr

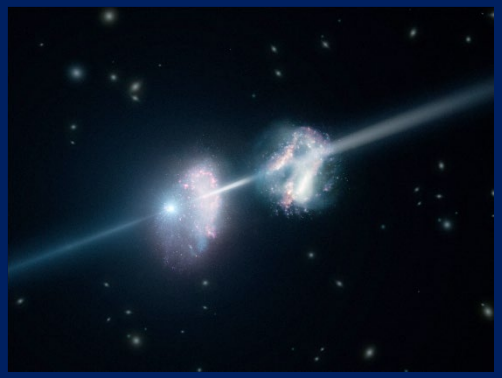




Metals in GRB local surroundings

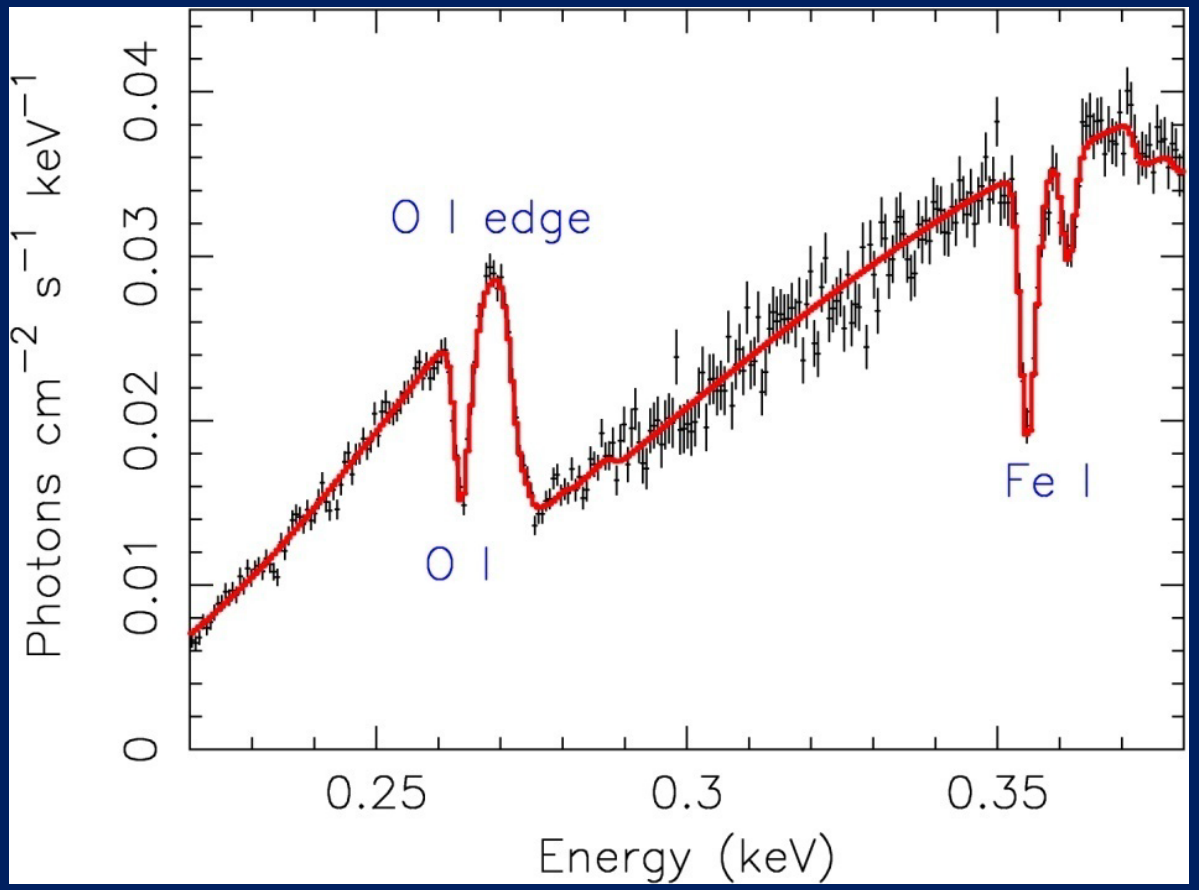


X-ray metal edges from a local GRB environment (z=7)



The ISM of host galaxies

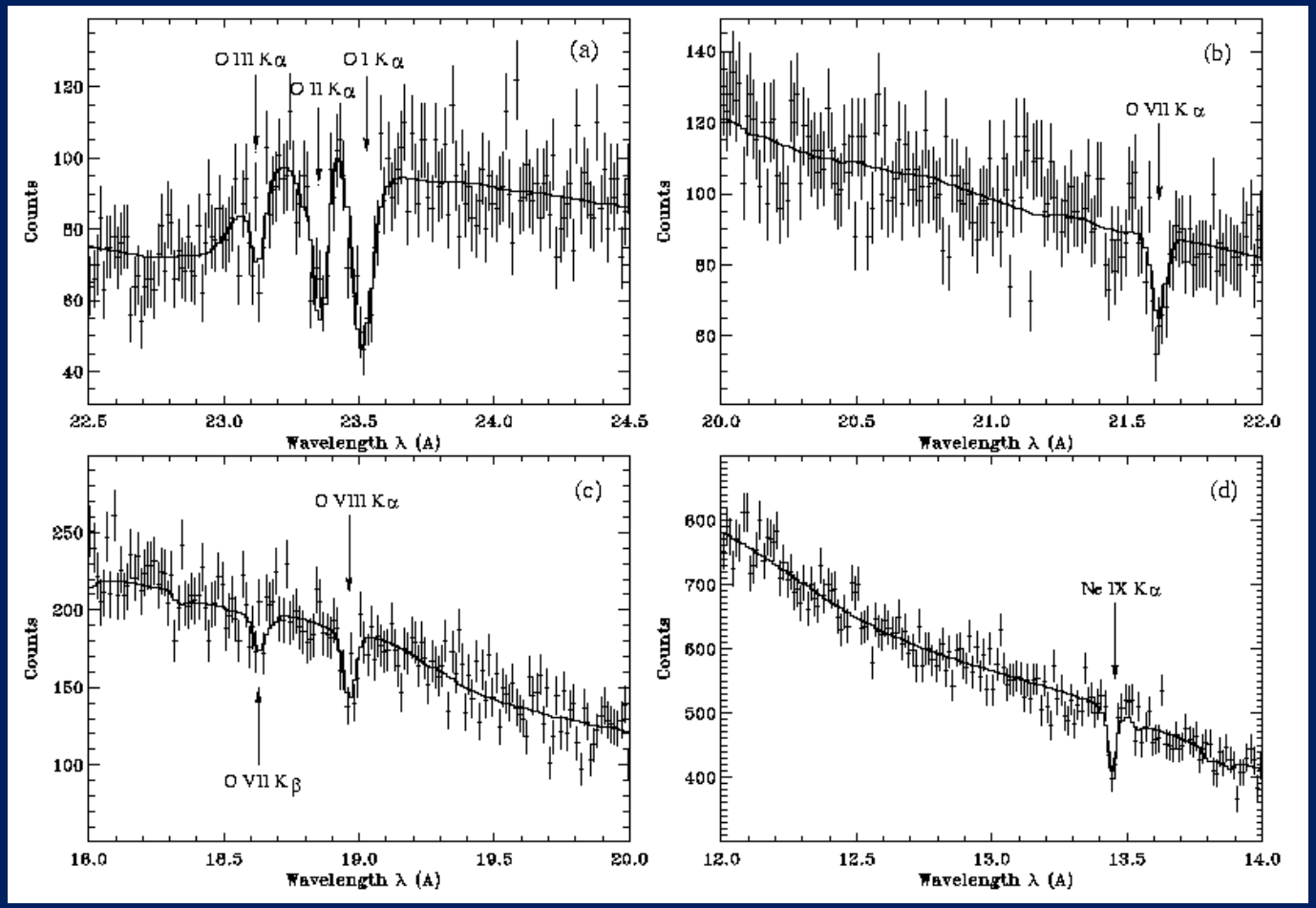
Composition, ionization, kinematics (outflows) in galaxies up to z>7



Resonant absorption lines from hosts at z = 1

Narrow abs lines from ISM in our galaxy

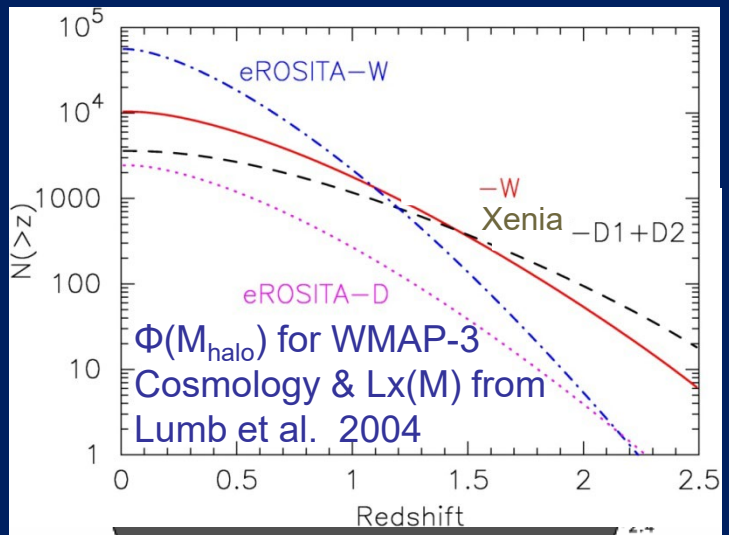
- Galactic binary 1820-303 with Chandra grating

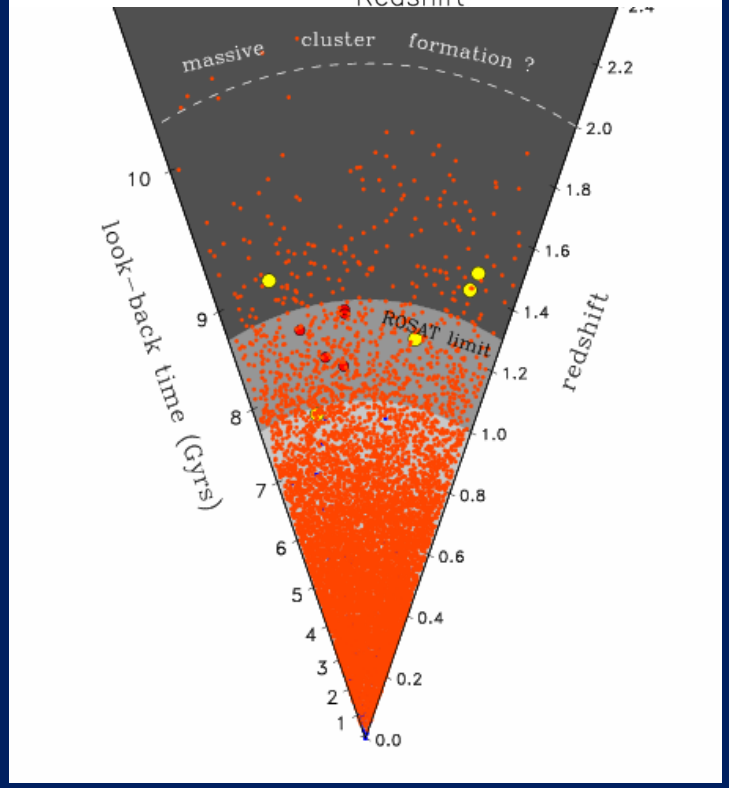


Yao and Wand 2006

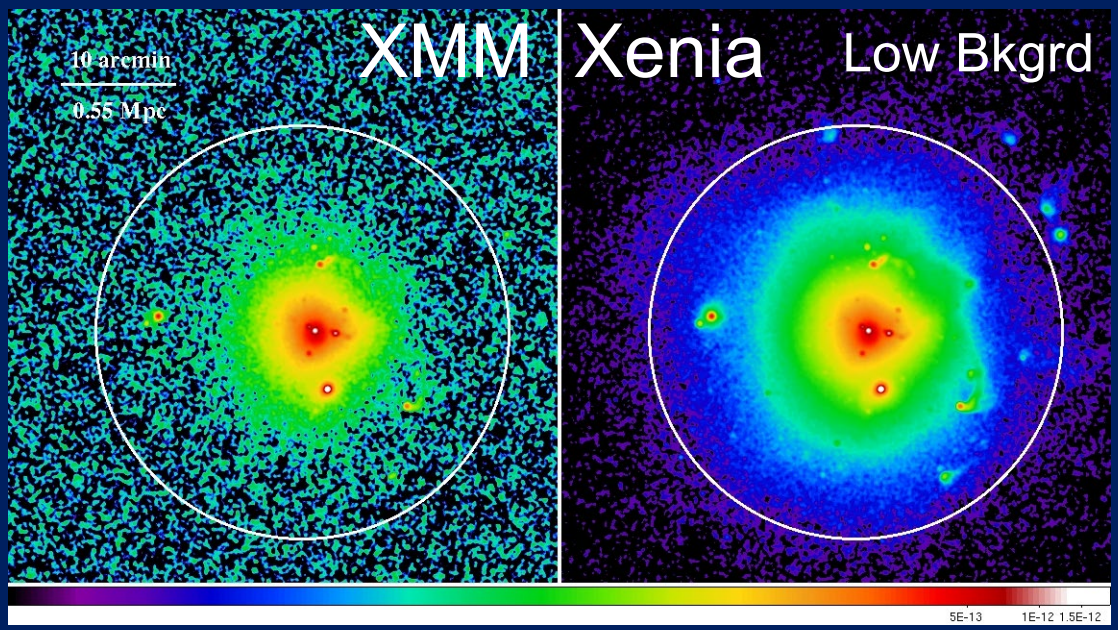
Cluster evolution

- SZ surveys -

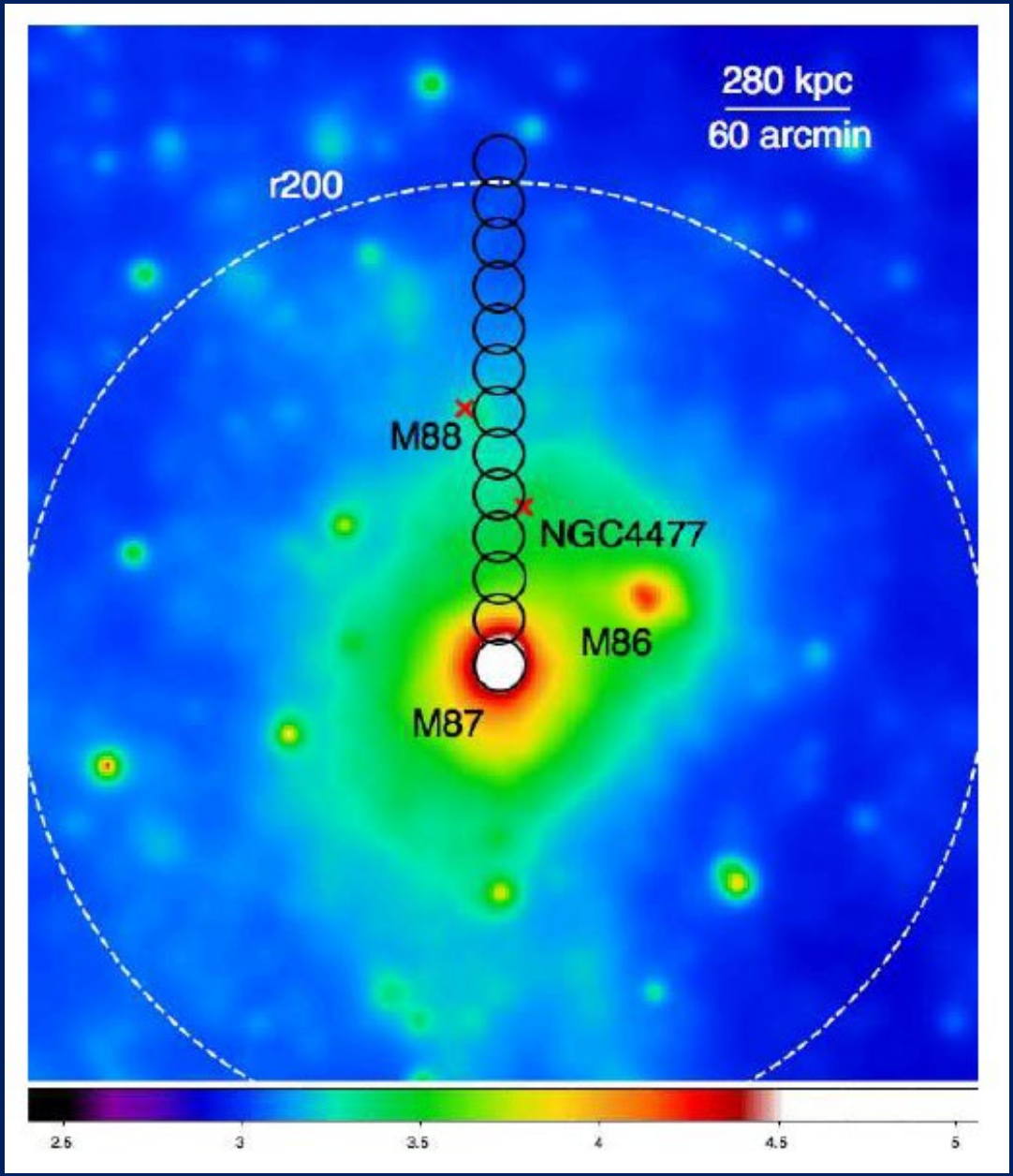




Survey	Wide	Deep-1	Deep-2
Exposure	50 ks	1 Ms	2 Ms
Total area (deg^2)	340	11.5	8
Clusters @ z>1	1800	510	600
Clusters, T_X @ z>1	450	140	170

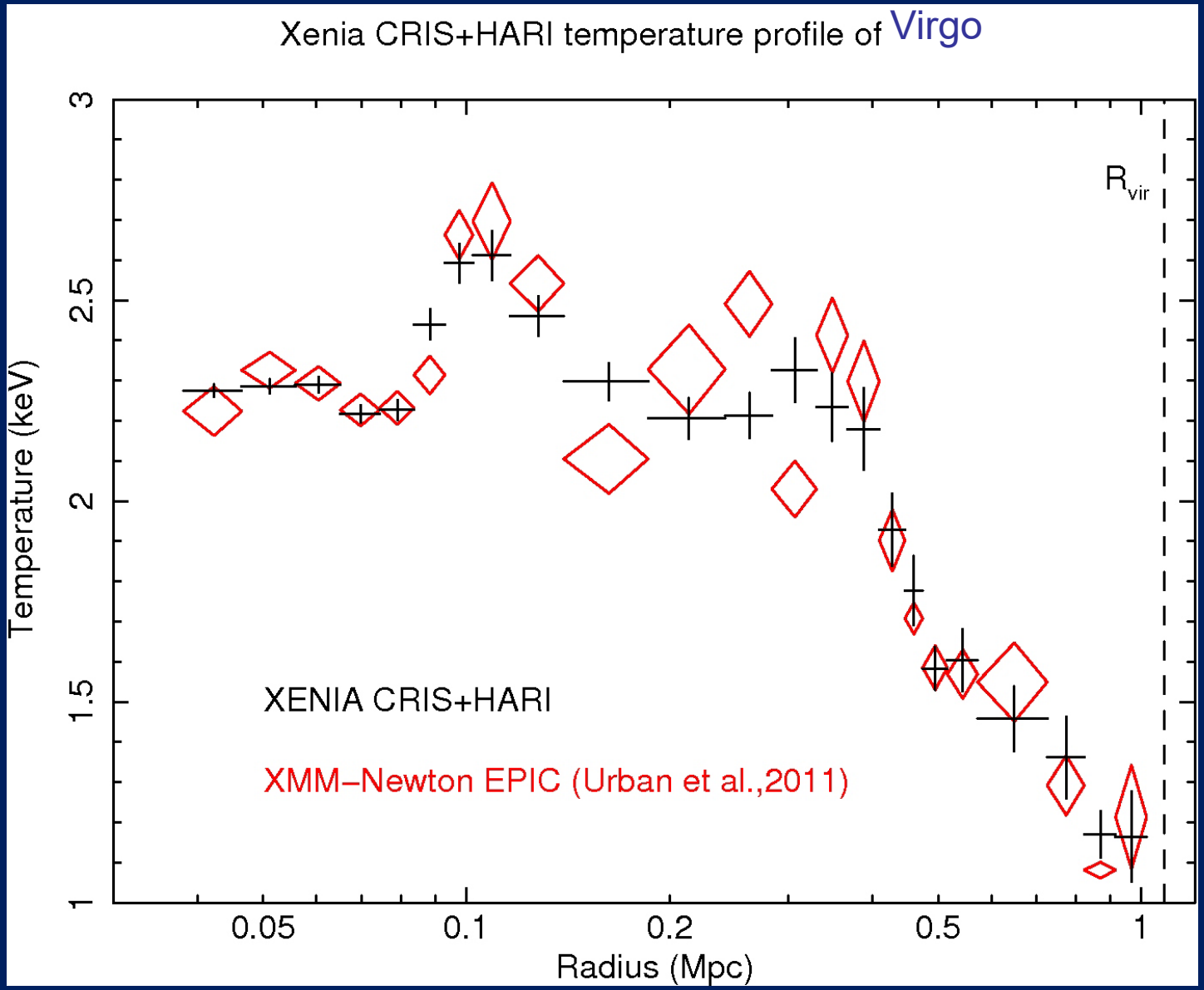


Virgo cluster @ 16 Mpc

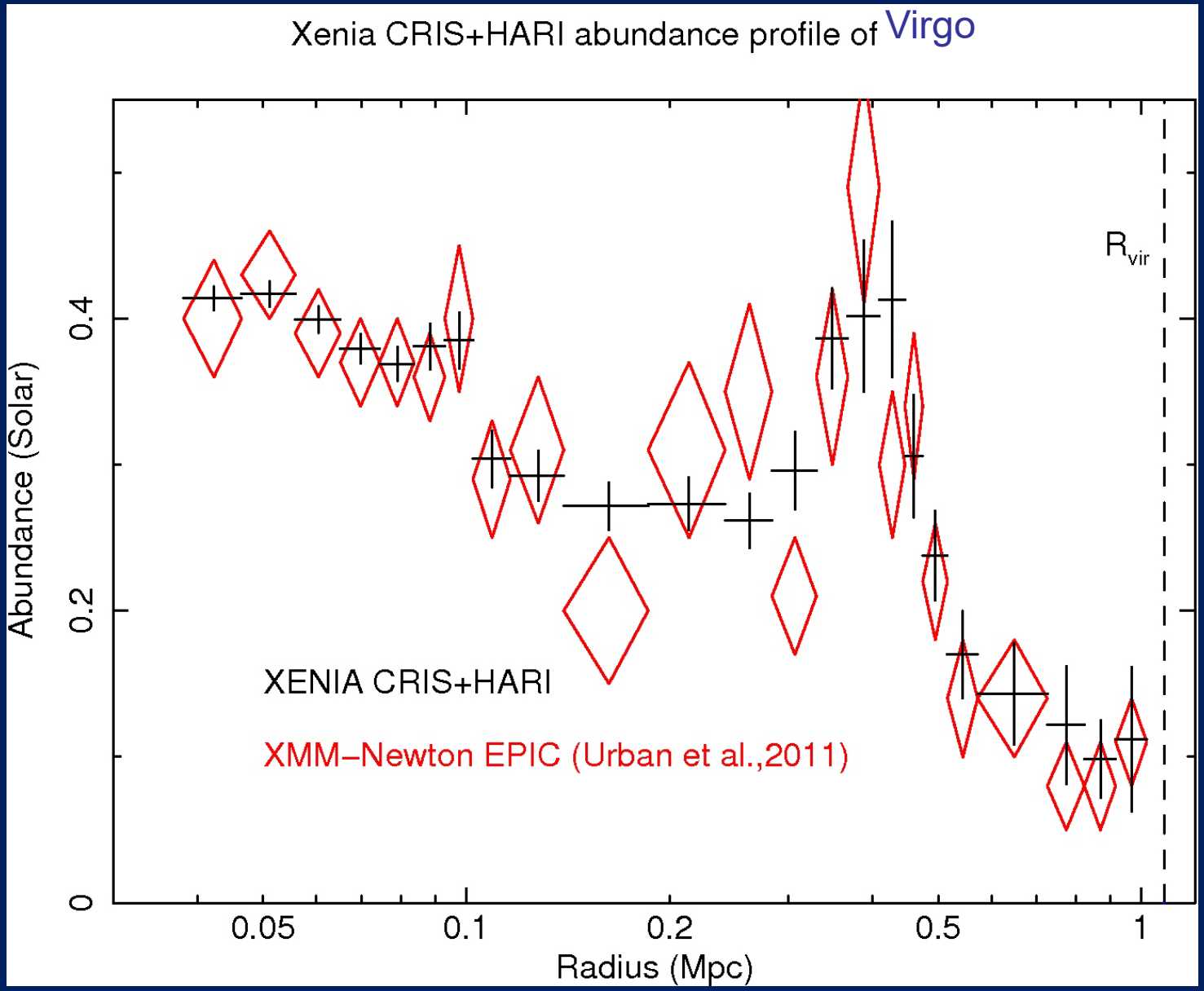


Urban et al. 2011
XMM scan to R_{200}
<kT> ~ 2 keV
Med. M ~ 10^{14} M_o
z/z_o > 0.1
Clumpy

14 XMM pointings
200 ks
6 Xenia pointings

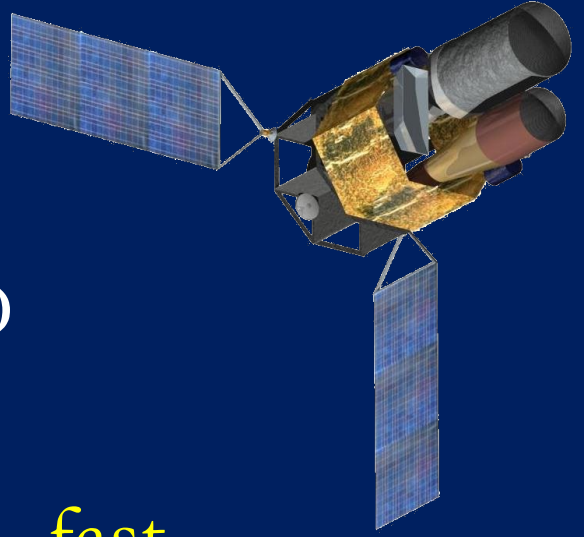


Simulation by Jelle de Plaa

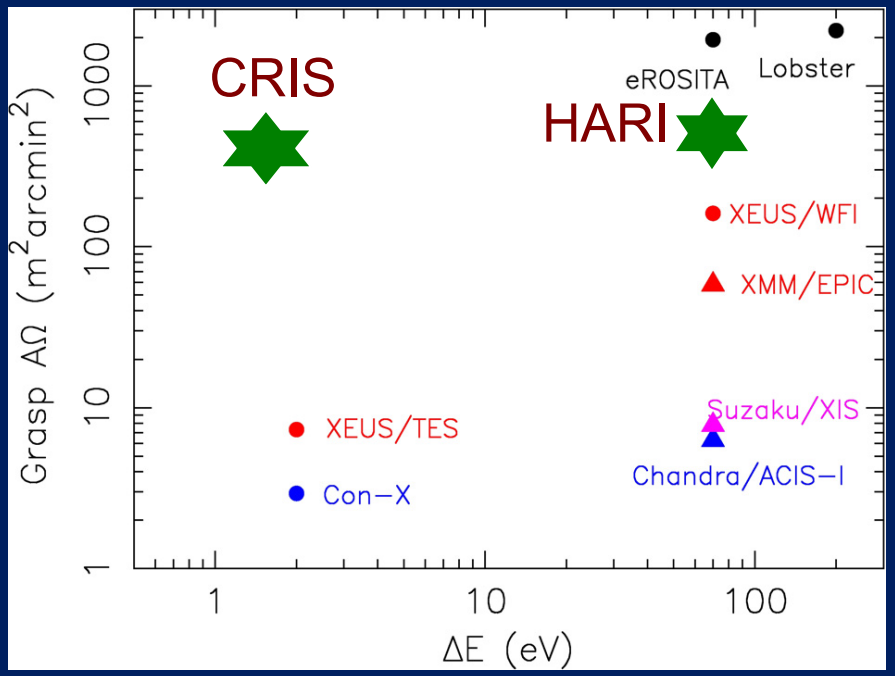


Simulation by Jelle de Plaa

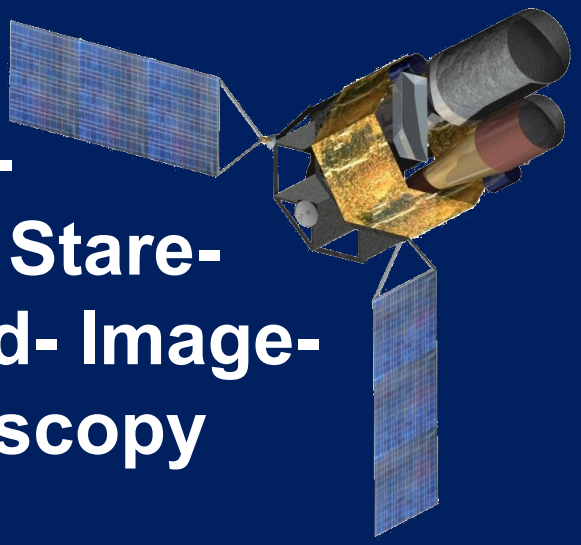
Xenia:



- Medium/large class mission in LEO
- Unique capabilities: large AΩ(grasp), fast reaction, high spectral resolution: eV)
- Core science: GRB as probes, WHIM, clusters
- TED-CRIS-HARI and the IXO Themes:



Xenia:
Monitor- Survey- Stare- Respond- Image- Spectroscopy



✓ GR Physics at 6 keV (…. Origin TED development)

U-compact NS + C/O-WD 4U 0614+091 rel. broad. O VIII Lyα em 0.7 keV

✓ SMBH evolution: AGN survey with HARI 15” (10”)

✓ Missing baryons, CCE

✓ Clusters, AGN feedback, outflow kinematics

✓ NS EOS from XRBs (timing properties TBD)

+ Galactic transients, SNRs, TDEs, ULXs, GRBs…

+ Multi-messenger astrophysics: gw, neutrinos

Evolution of the Universe

XENIA

Past

Structure formation

Present

Reionization

Small scale

Stars

GRBs

SNRs

Galaxies

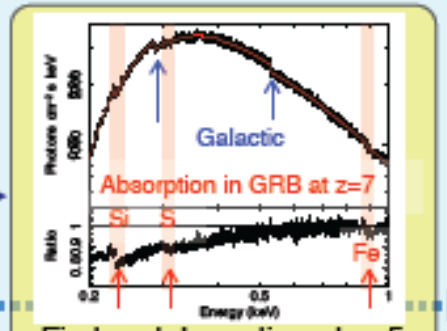
Starburst galaxies/ AGNs

Clusters

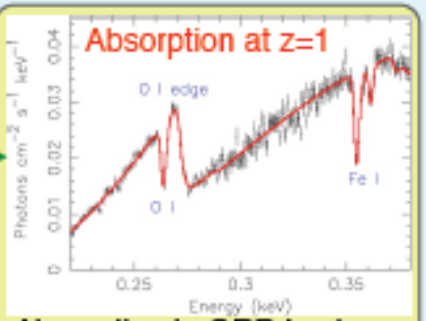
Feedback & Enrichment

WHIM

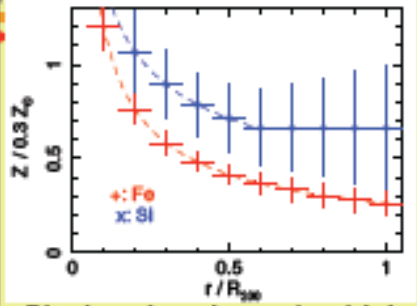
Large scale



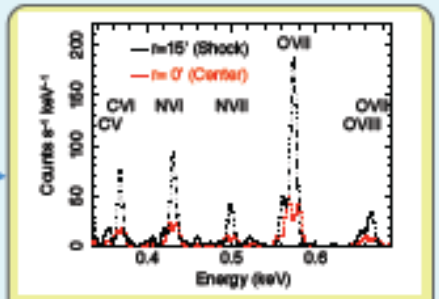
First metal creation at z>5



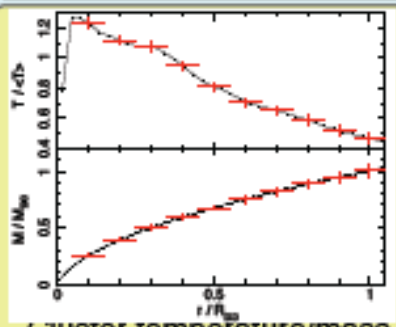
Absorption in GRB host galaxies



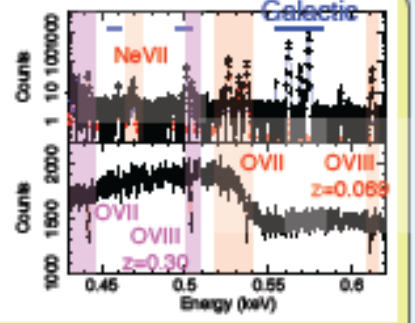
Cluster abundance to virial radius



Metal creation/injection by super novae

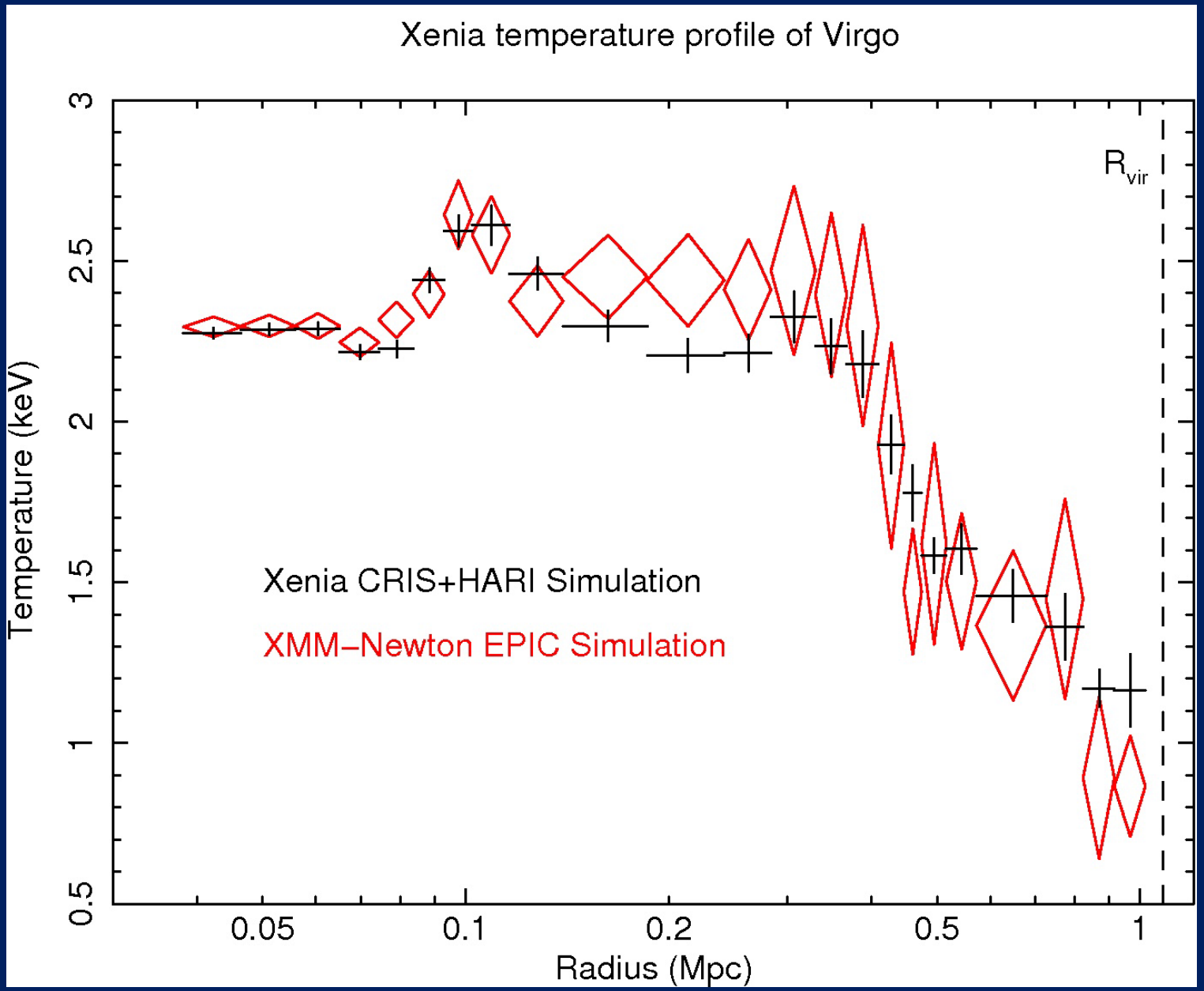


Cluster temperature/mass study to virial radius

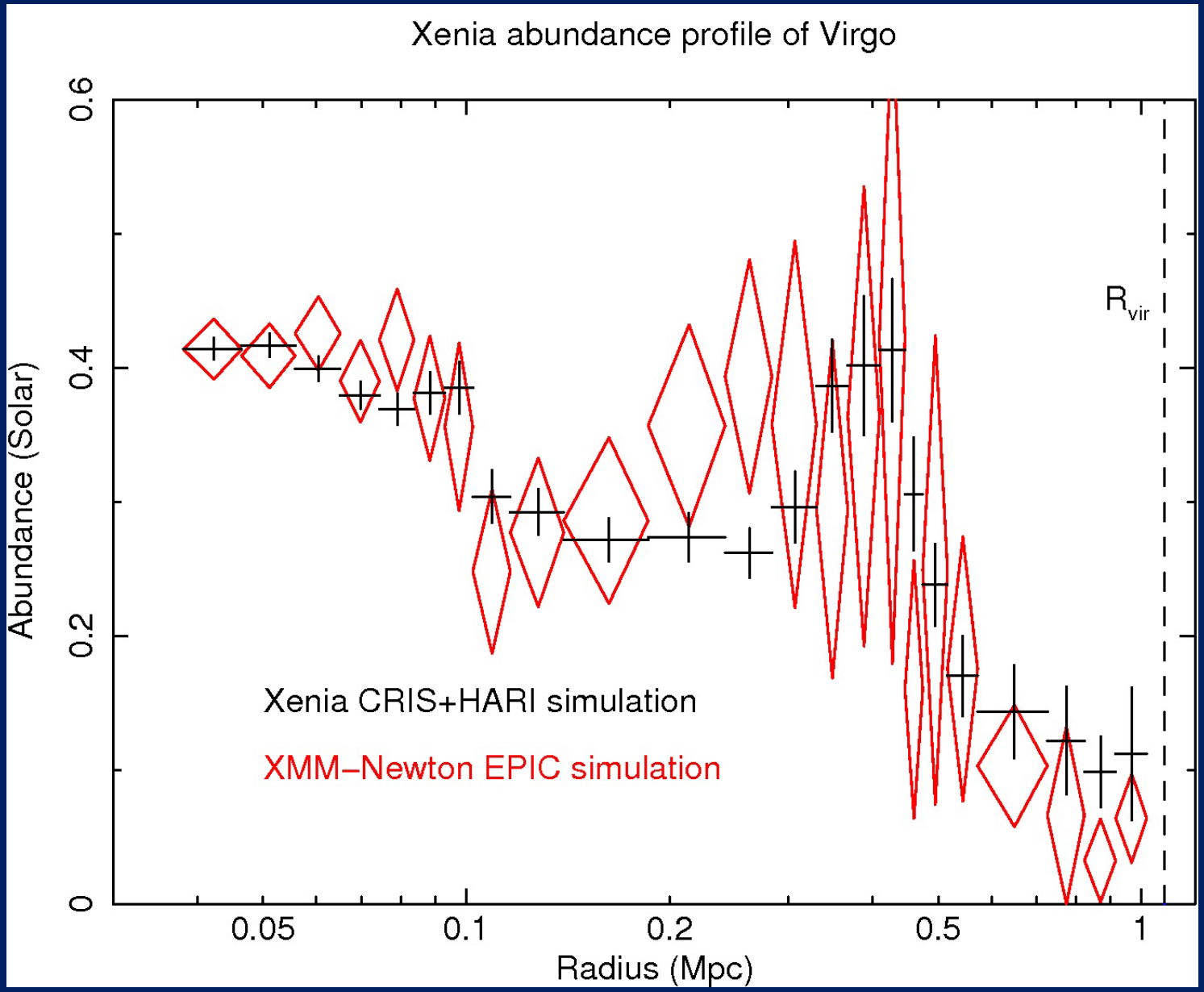


Missing baryons at low redshift

Approved for public release, distribution unlimited



Simulation by Jelle de Plaa



Simulation by Jelle de Plaa

Cosmic Chemical Evolution Workshop
June 2-4, 2010 St. Michael's Maryland

(http://sms.msfc.nasa.gov/xenia/workshop.html)

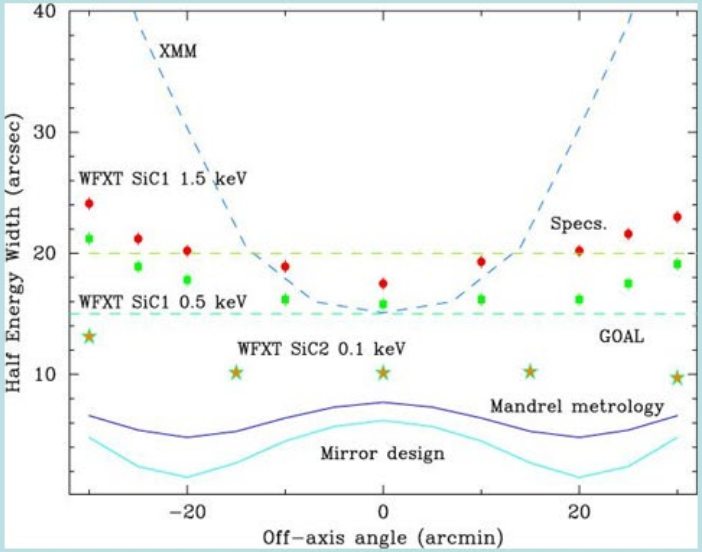
SOC

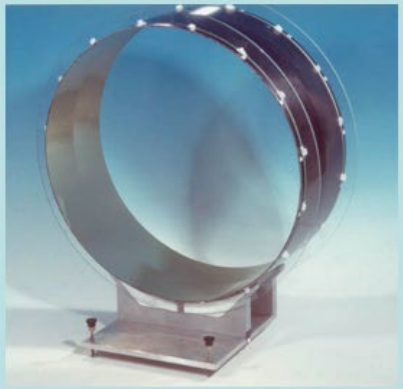
Dieter Hartmann -- Chair
Tom Abel
Stefano Borgani
Joel Bregman
Dave Burrows
Renyue Cen
Martin Elvis
Jan-Willem den Herder
Chryssa Kouveliotou
Tiziana di Matteo
Neil Gehrels
Brad Gibson
Pat Henry
Jack Hughes
Jelle Kaastra
Francesca Matteucci
Takaya Ohashi
Luigi Piro
Xavier Prochaska
Sandra Savaglio
Volker Springel
Yasushi Suto

INVITED SPEAKERS:

Shirley Ho
Alex Heger
Jason Tumlinson
Serena Bertone
Takaya Ohashi
Grant Matthews
Art Champagne
Jelle Kaastra
Kyoko Matsushita
Neil Gehrels
Friedel Thielemann
David Burrows
Renyue Chen
Yoh Takei
Jochen Greiner
Volker Bromm
Andreas Burkert
Anna Frebel
Kazuhisa Mitsuda
Josh Grindlay
Eli Dwek
Thorsten Naab
Nobu Kawai
Christoph Pfrommer
J.-W. den Herder

Polynomial optics

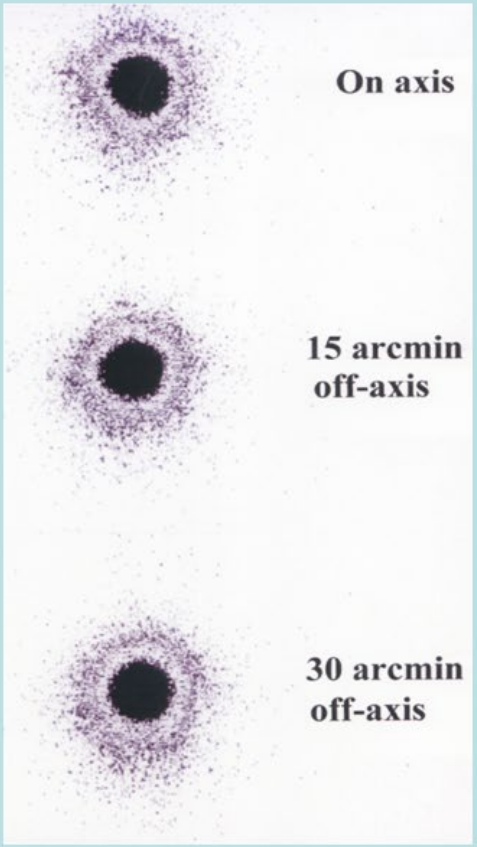




WFXT (epoxy replication su carrier in SiC) – Ø = 60 cm

F. L. = 300 cm

HEW = 10 arcsec



Test @ Panter-MPE