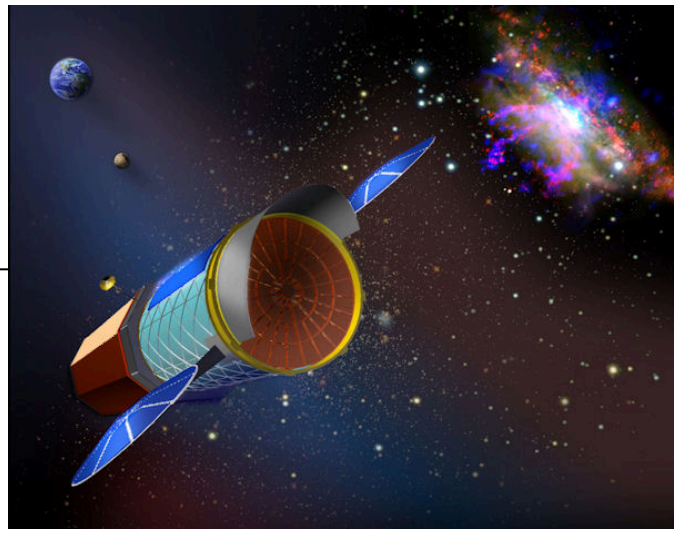
High Energy Astrophysics Division Meeting, 2010, Hawaii

Detecting the WHIM with IXO

Randall Smith

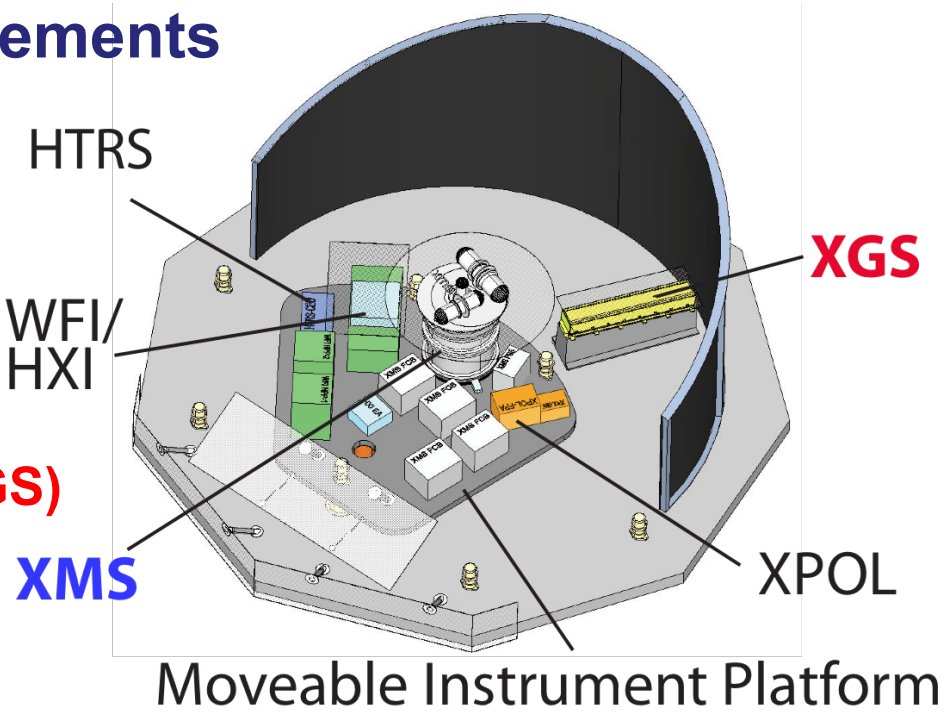
on behalf of the IXO team



Key WHIM Performance Requirements

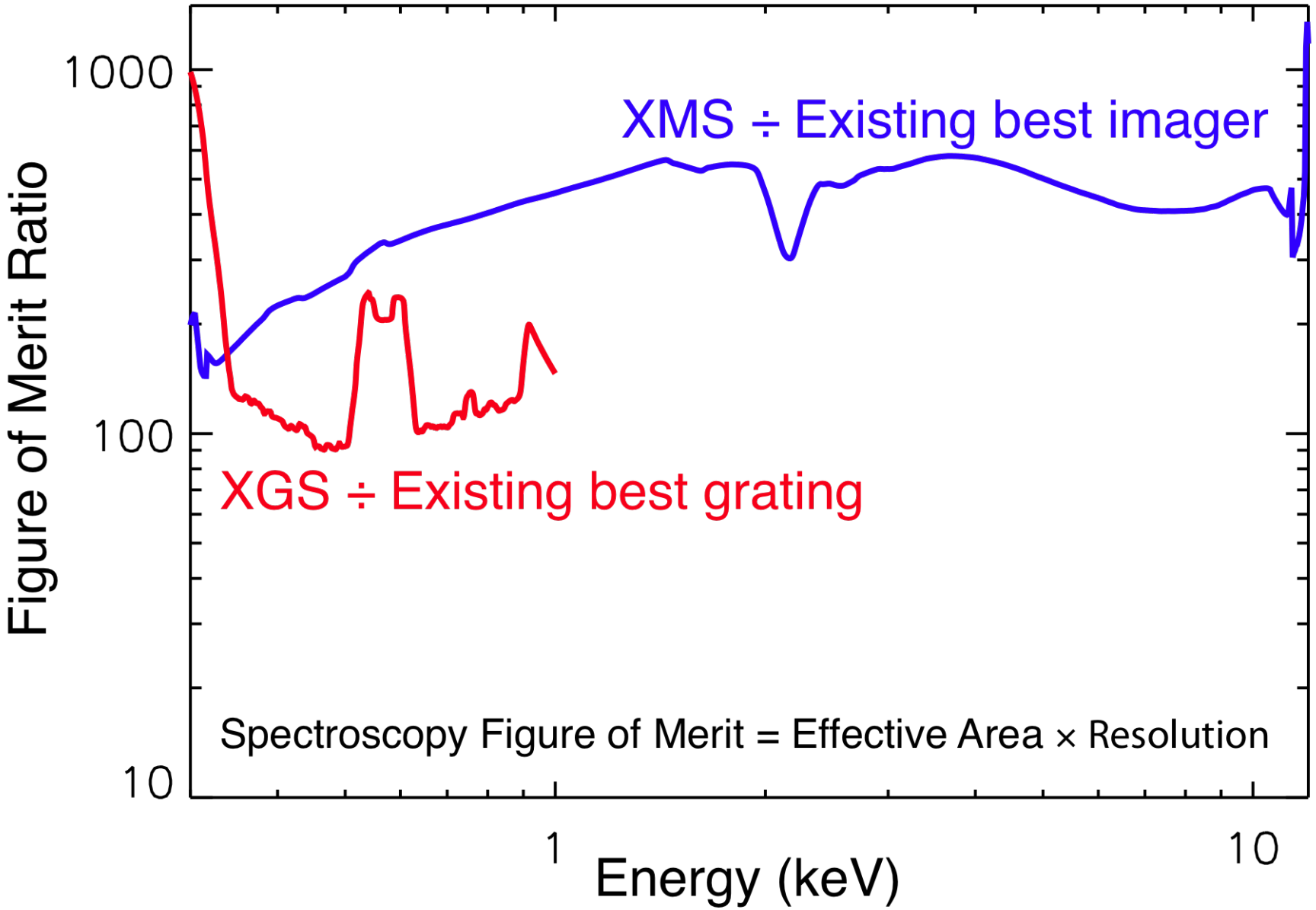
Key WHIM Instruments:

- X-ray Microcalorimeter Spectrometer (XMS)
- X-ray Grating Spectrometer (XGS)



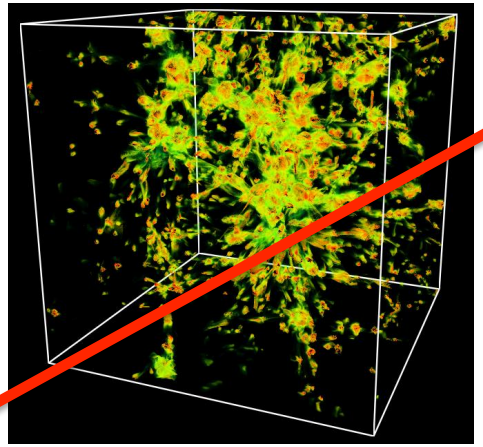
Mirror Effective Area	**3 m^2 @1.25 keV**
Spectral Resolution/FOV **E = 0.3–7 keV** **E = 0.3 –1 keV**	**ΔE = 2.5 eV within 2 arc min** **10 eV within 5 arc min** **E/ΔE = 3000 with an area of 1,000 cm^2**
Mirror Angular Resolution	**≤5 arc sec HPD <7 keV**

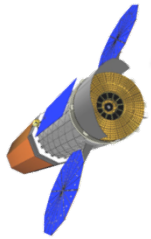
(Effective Area * Resolution) Figure of Merit Ratio



Find and Characterize the Missing Baryons

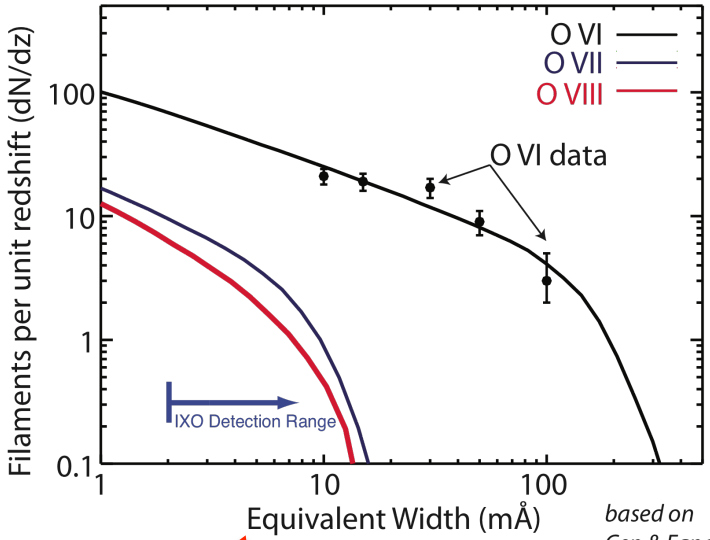
- ***Where is the hot gas relative to the galaxies?***
- ***How do filaments connect to groups and clusters?***





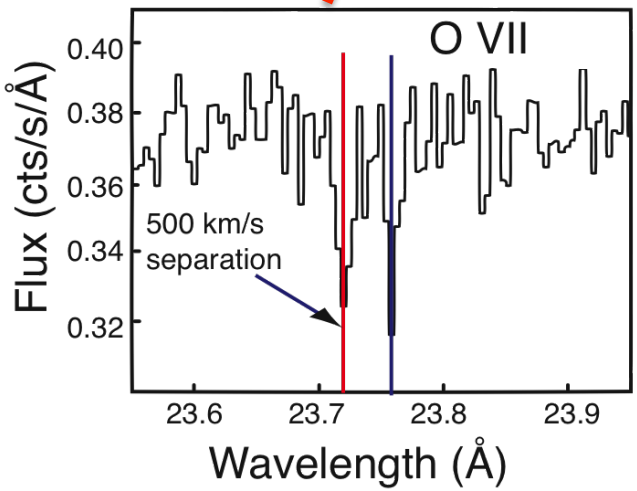
Use background AGN

Expect multiple filaments in each line of sight



based on Cen & Fang (2006)

Compare distribution of filaments to models



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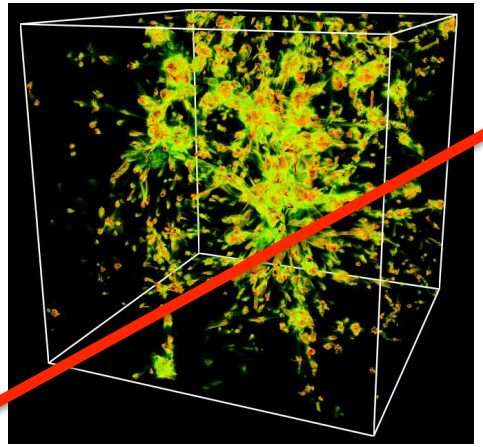

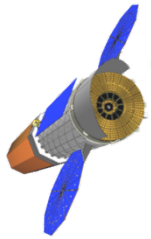

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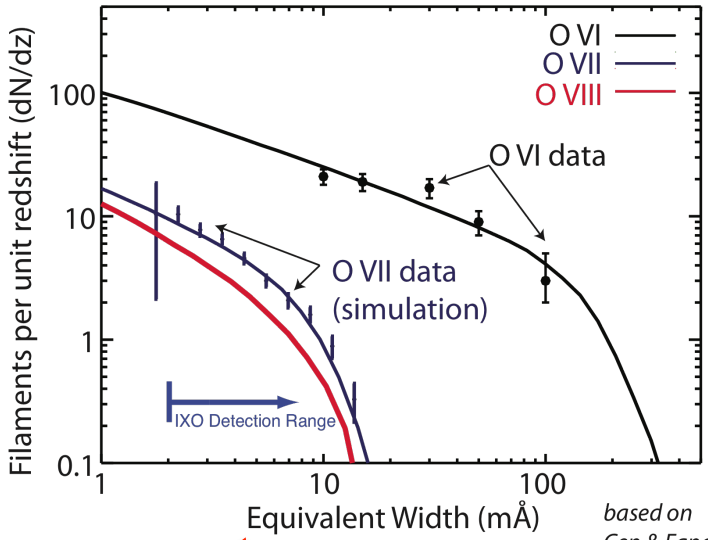

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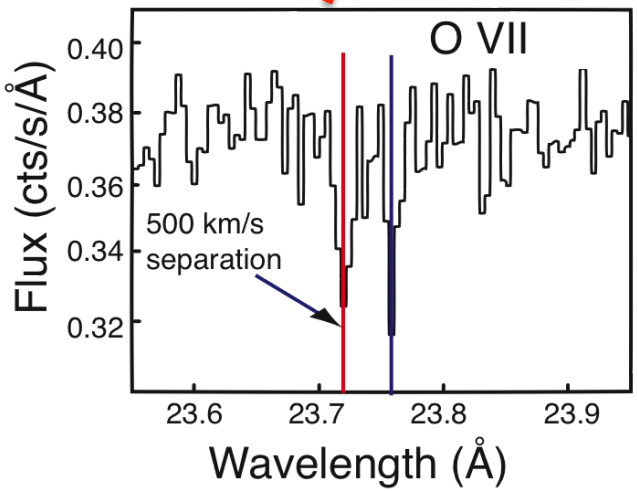
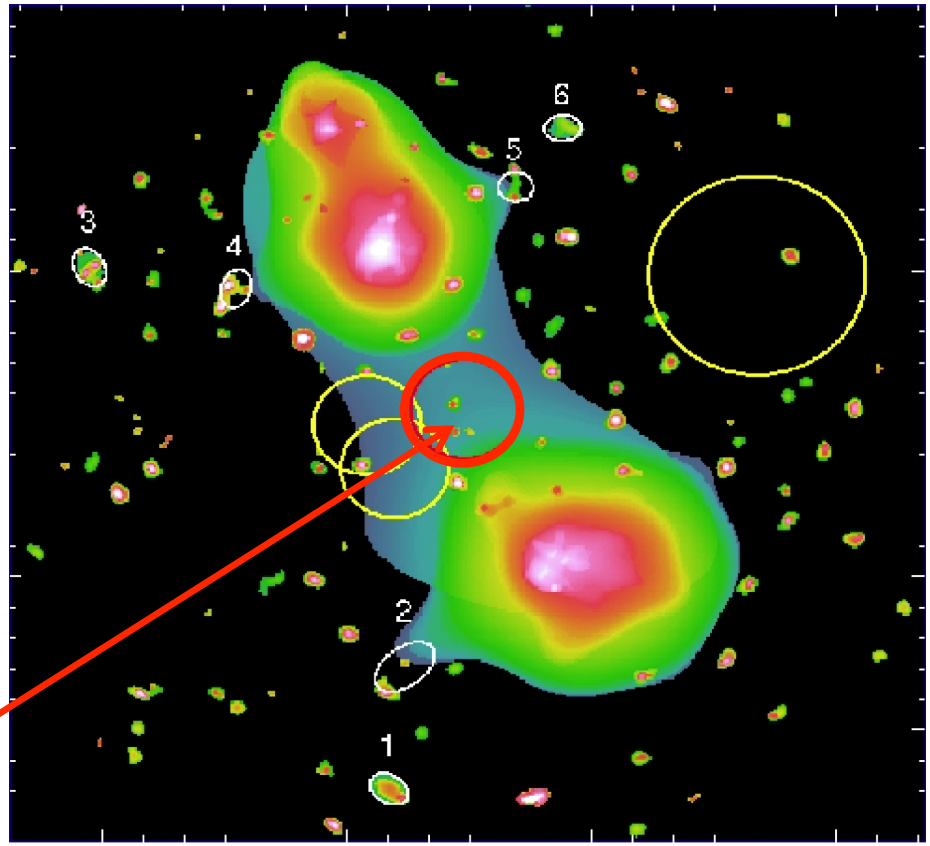
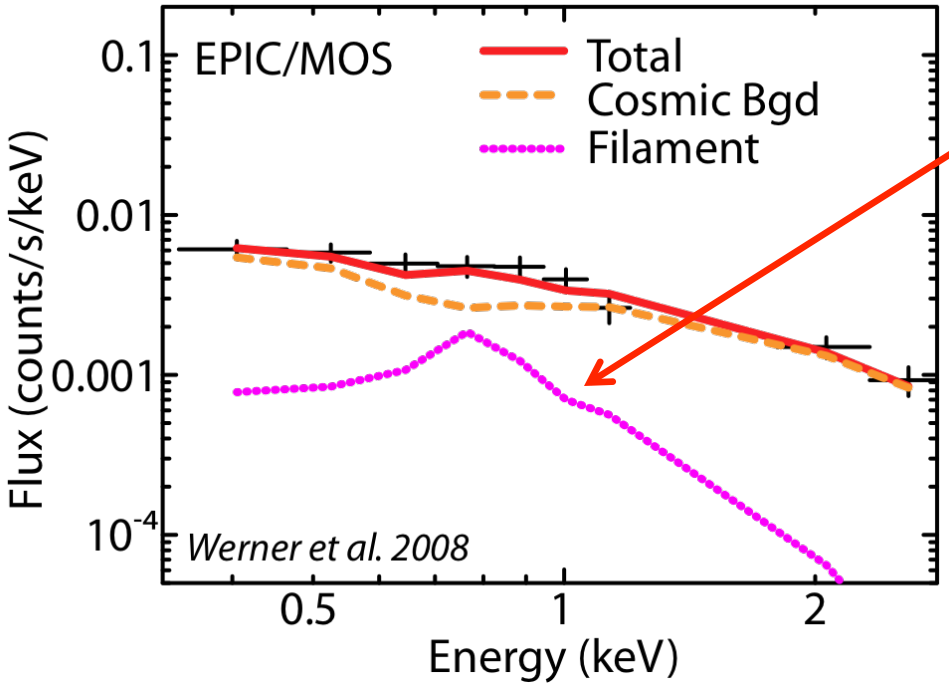


WHIM in Emission

Werner et al (2008) detected a WHIM filament connecting two clusters of galaxies at z=0.21

The emission in the red circle has kT=0.9±0.25 keV with ρ/ρ_c=150±60 for 20% solar abundances and a 15 Mpc line of sight depth.





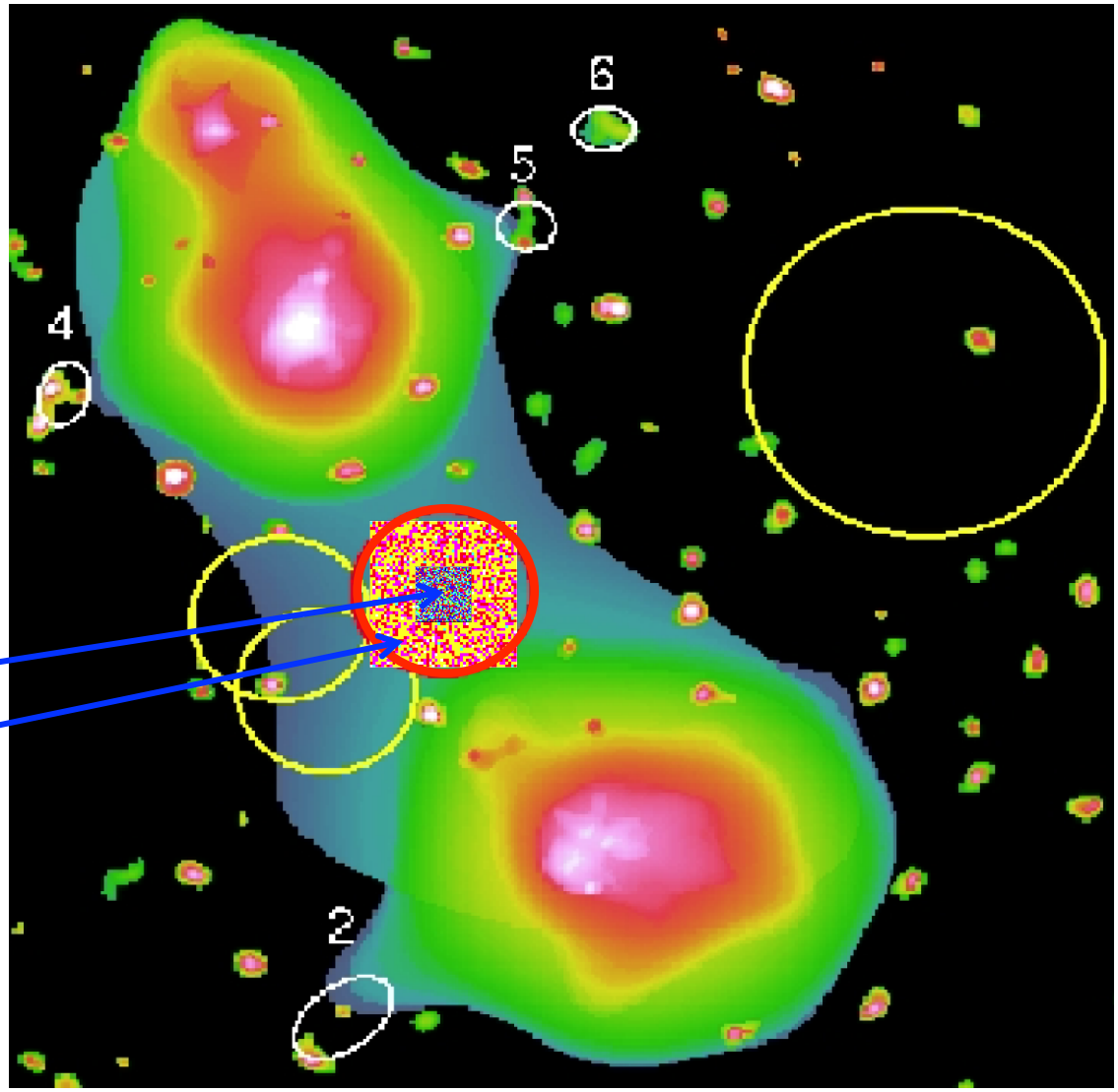
WHIM in Emission

XMS has a core 40x40 pixel array and an outer array of 52x52 pixels.

This simulation is a 100 ksec IXO observation with the XMS.

The core array pixels have a resolution < 2.5 eV.

The outer array pixel resolution is <10 eV.



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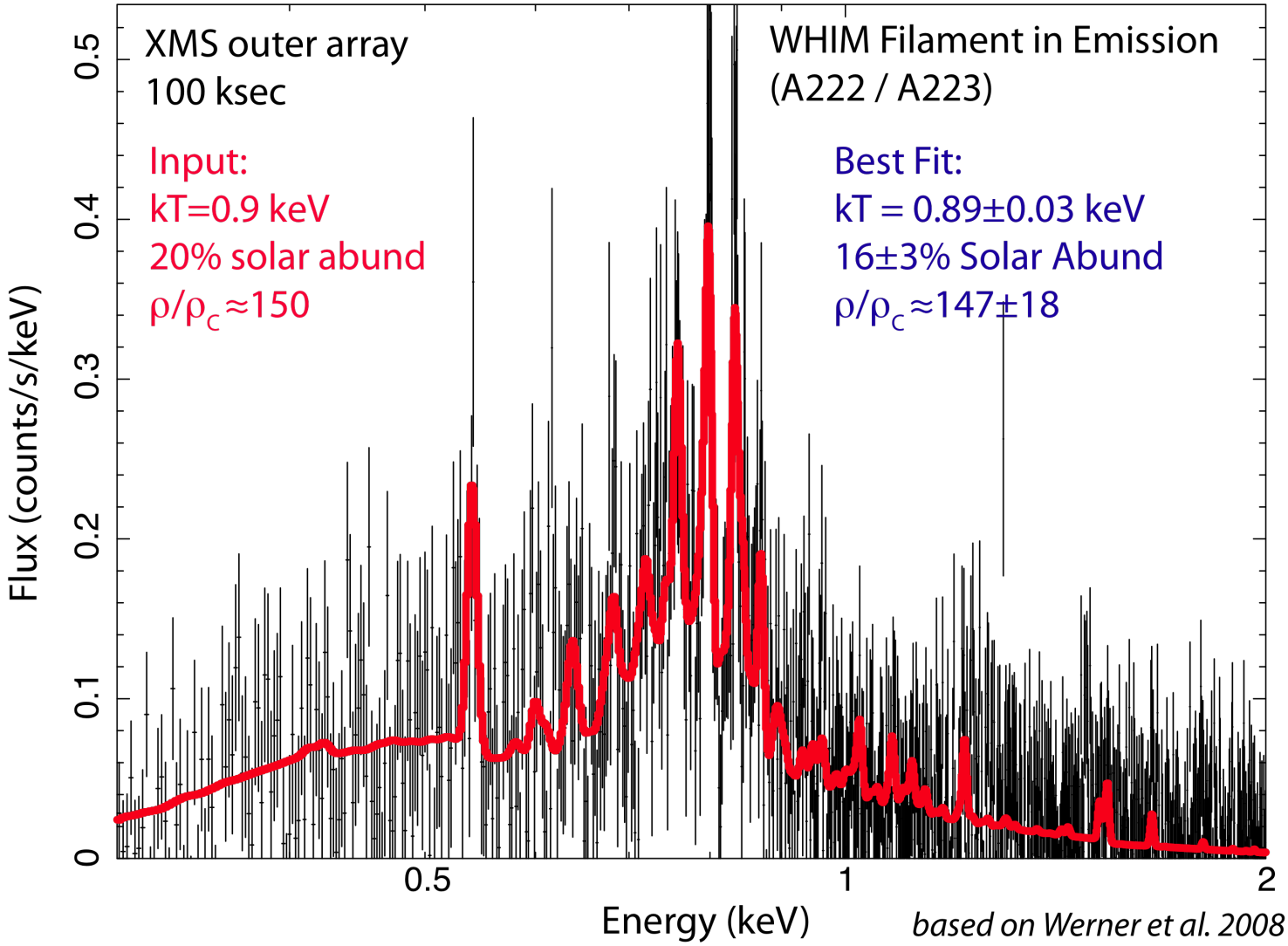

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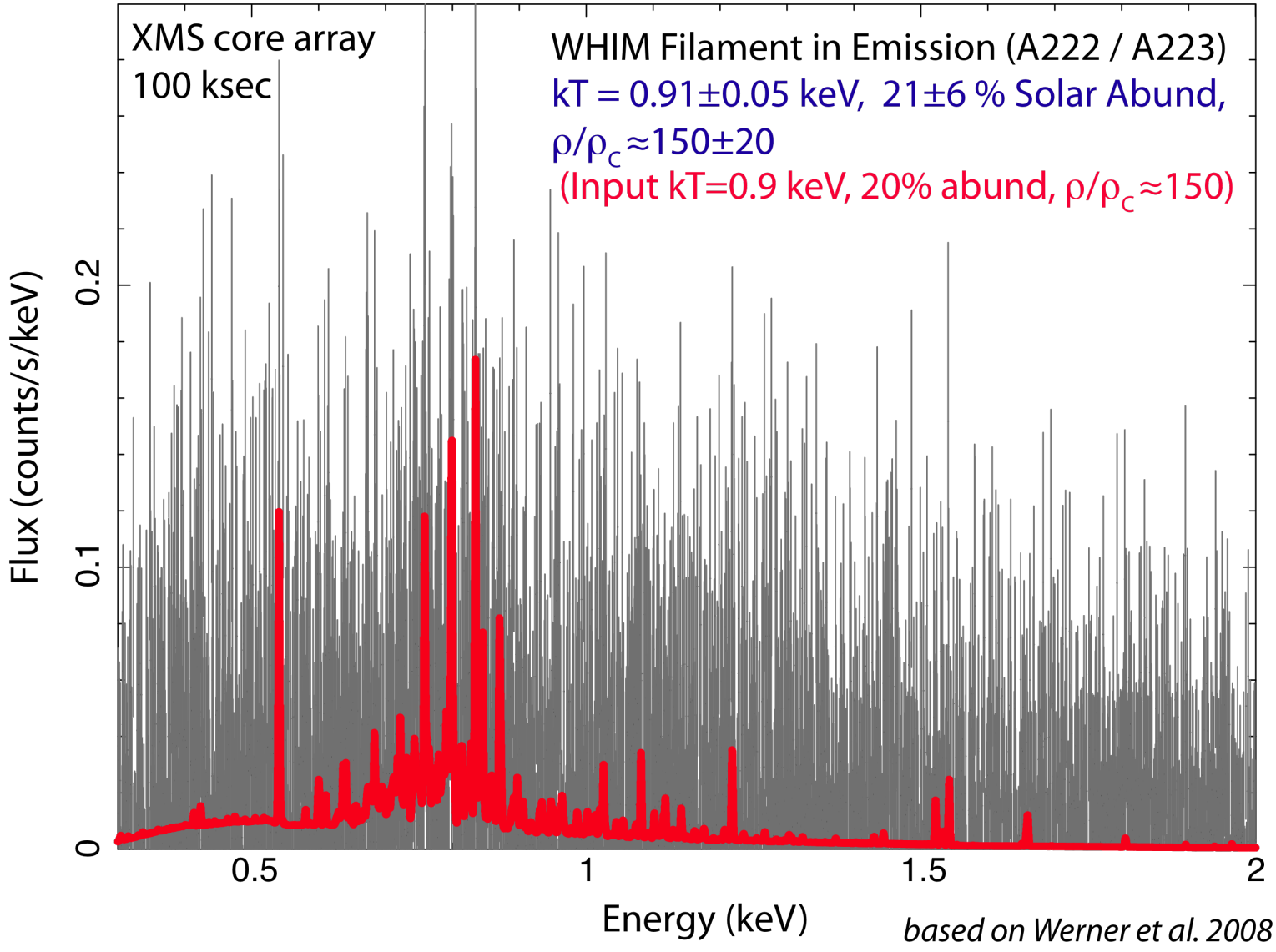
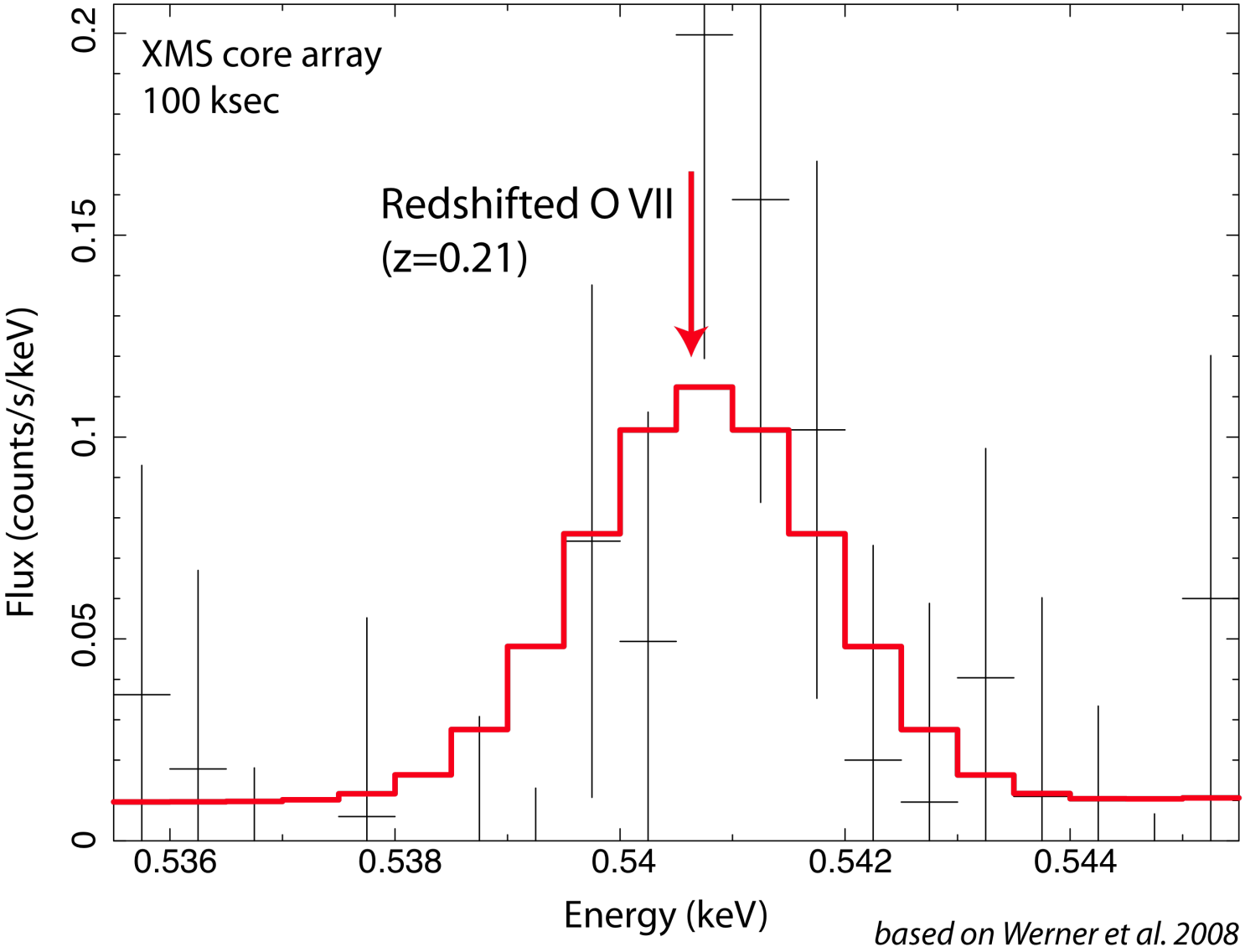


WHIM in emission – zooming in on one line



based on Werner et al. 2008

Conclusions

- **The WHIM in Absorption: O VII is the key.**
  - **Comparison with nearby clusters will show structure.**
  - **Combining with O VIII observations and other atoms/ions determines temperature and abundance.**
  - **Detection is hard, *requiring* high sensitivities**
  - **With a nominal 6 Msec WHIM observing program, IXO gratings will detect ~100 filaments in ~30 sources**

- **The WHIM in Emission: Serendipity.**
  - ***Any* deep XMS field could show unexpected emission lines**
  - **IXO can both detect and characterize temperature and abundances in ρ/ρ_c~100 regions.**