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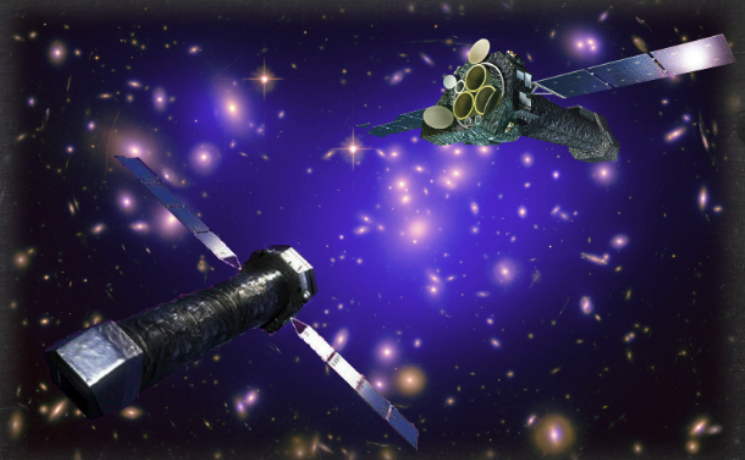
Istituto di Astrofisica e Fisica Cosmica di MILANO

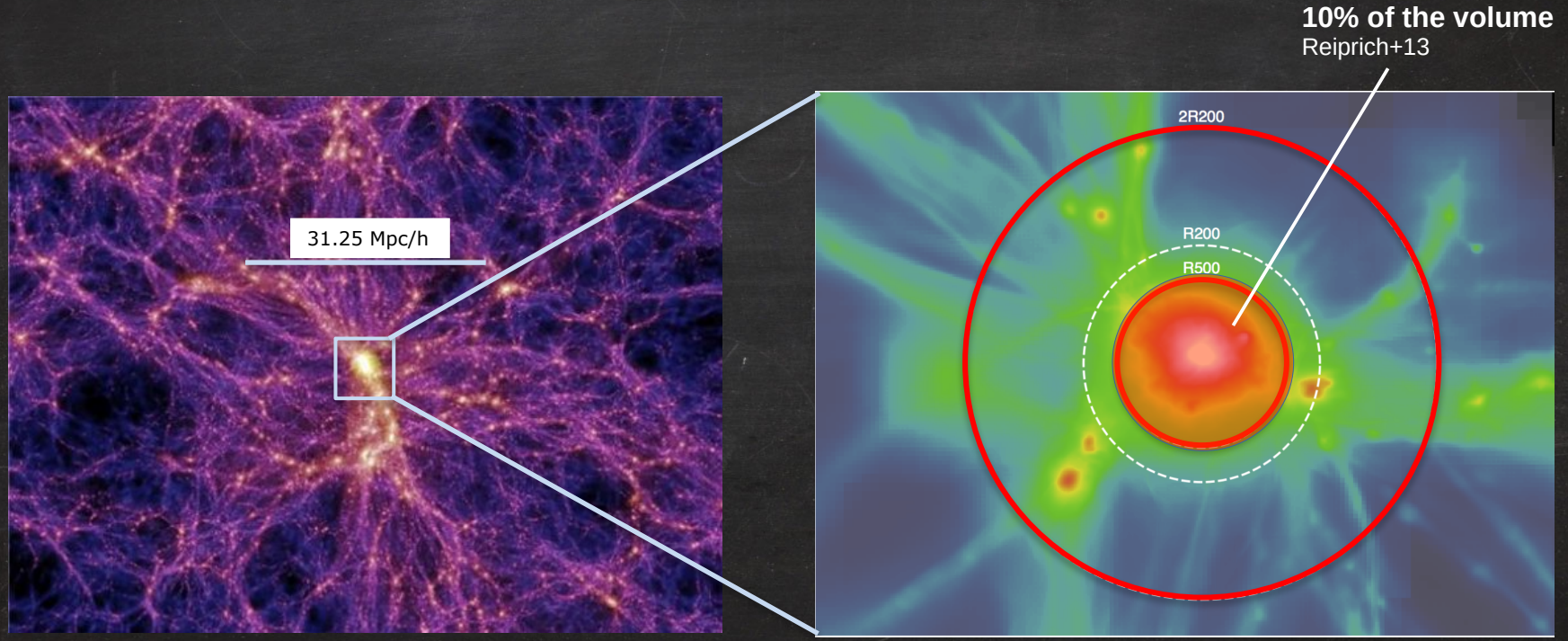
A Simulation Framework for Synthetic X-ray Observations with NewAthena



Iacopo Bartalucci

1. (very breaf) Introduction: scientific value

Context: galaxy cluster outskirts, almost unexplored territory as of today



V.Springel, MPA

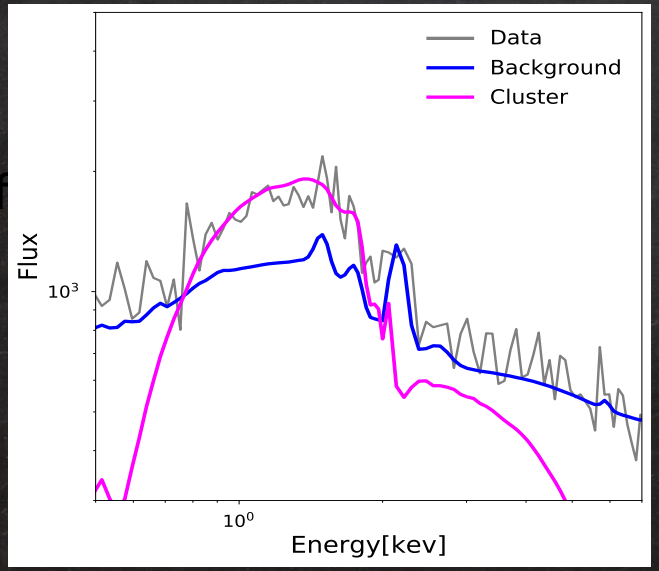
Vazza et al. 2011

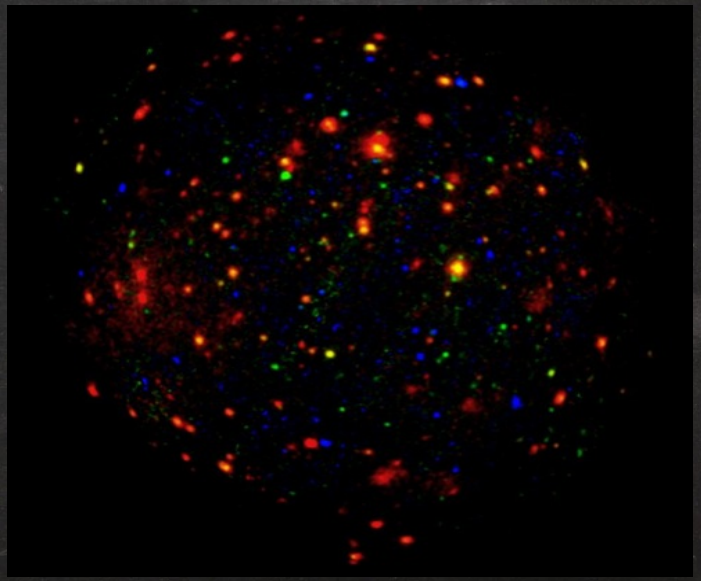
1. (very breaf) Introduction: limiting factors

Why is so hard to study faint and diffuse emission

- high particle background → systematics

- unstable PSF





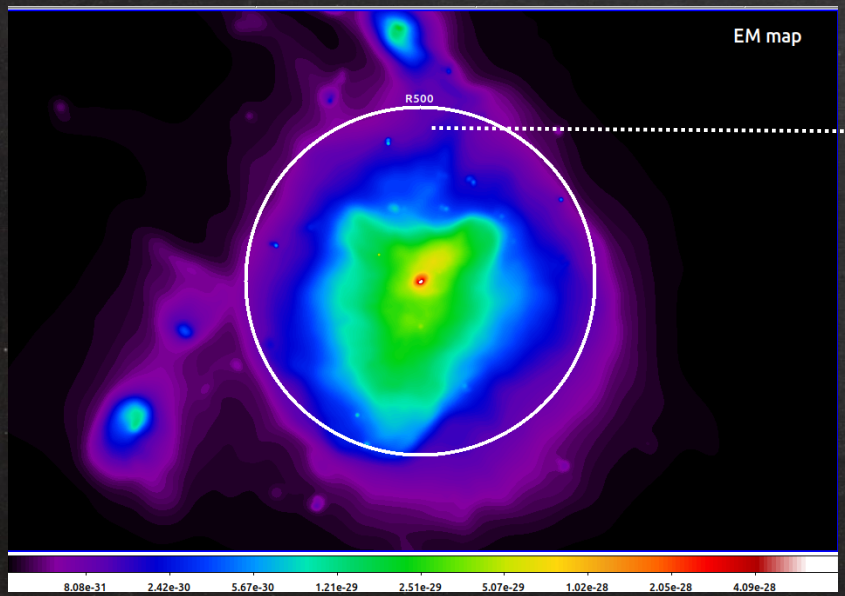
Comastri+17

2. newAthena simulations: cluster related inputs

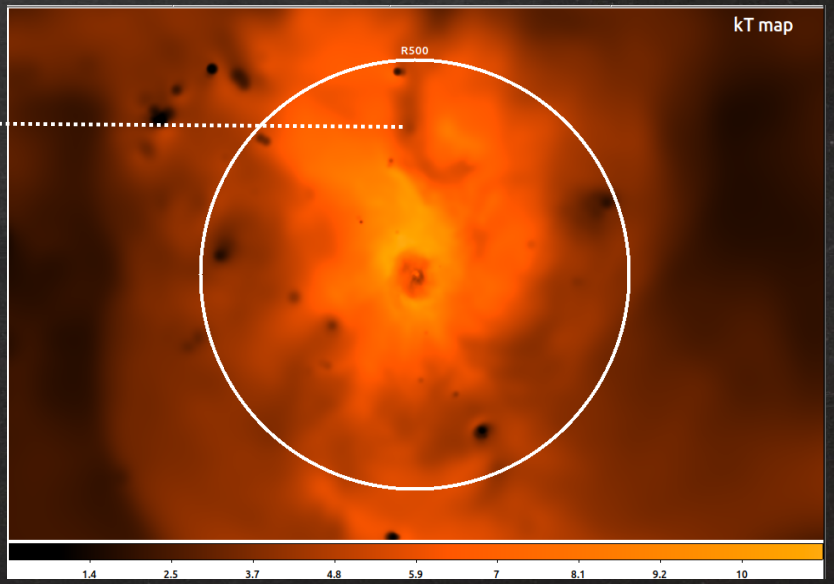
Driving question: is newAthena capable of studying outskirts?

Needs to simulate the complex behaviour → spatial & spectral

For our work we started from simulation drawn from the 300 cosmological suite (Cui+18)



Image



Temperature map

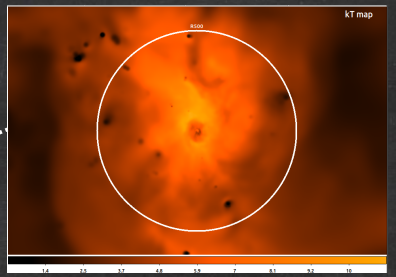
2. newAthena simulations: cluster simput

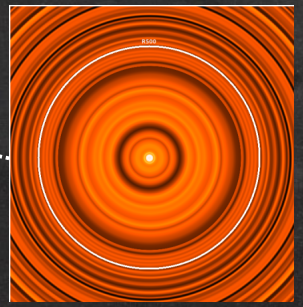
We used SIMPUT to model the cluster complex emission

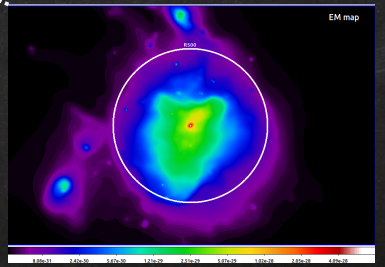
absorbed apec as model for the cluster emission

par	comp		
1	1	apec	kT
2	1	apec	Abundanc
3	1	apec	Redshift
4	1	apec	norm

spatial behaviour of each parameter determined by the input maps







Produced using Ghizzardi+21

2. newAthena simulations: background simput

The particle background is built-in → sky background

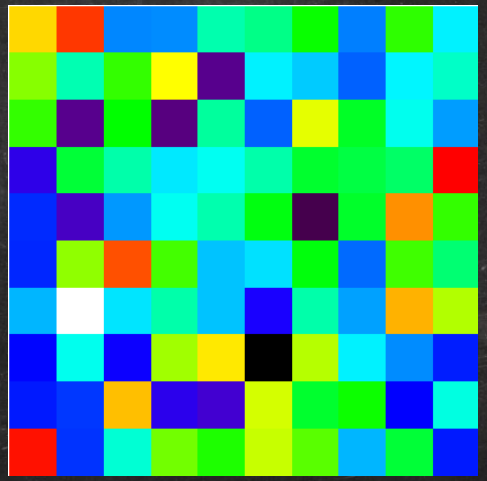
used the model described in WFI-MPE-ANA-10-013

Double thermal emission models

Model	Parameter	Value	Unit
apec	kT	9.9E-2	keV
apec	abundance	1	
apec	redshift	0	
apec	norm	1.7E-6	$(10^{-14}/(4\pi(D_A(1+z))^2))\int n_e n_H dV$ [1]
phabs	N_H	0.018	10^{22} cm^{-2}
apec	kT	0.225	keV
apec	abundance	1	
apec	redshift	0	
apec	norm	7.3E-7	
bknpower	photon index 1	1.728	
bknpower	break energy	1.468	keV
bknpower	photon index 2	1.452	
bknpower	norm	1.96E-7	pho/keV/cm^2/s/amin^2 @ 1 keV

CXB

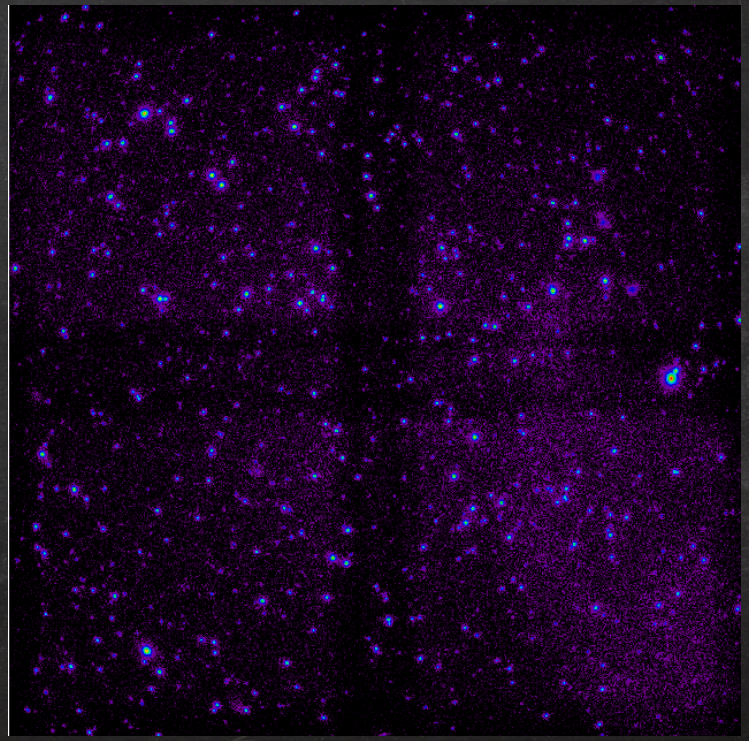
Using SIMPUT to account for a ~3% variation on ~3 arcmin scale



2. newAthena simulations: point sources simput

We used the file provided by Nicolas Clerk and available at the webpage
https://www.sternwarte.uni-erlangen.de/sixte/example-source-files/

- $42 < \log_{10} Lx(0.5\text{-}2) < 48$
- $0 < z < 5$
- Spatially uniform

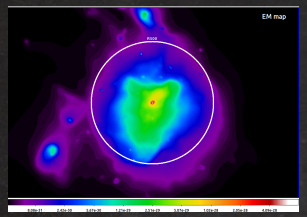


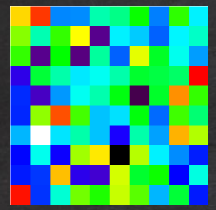
WFI 0.5-2.5 keV

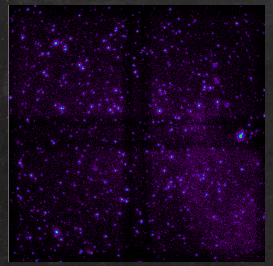
2. newAthena simulations: SIXTE

We combined the 3 simput files and used SIXTE to simulate WFI & X-IFU observations

SIMPUT source files







SIXTE

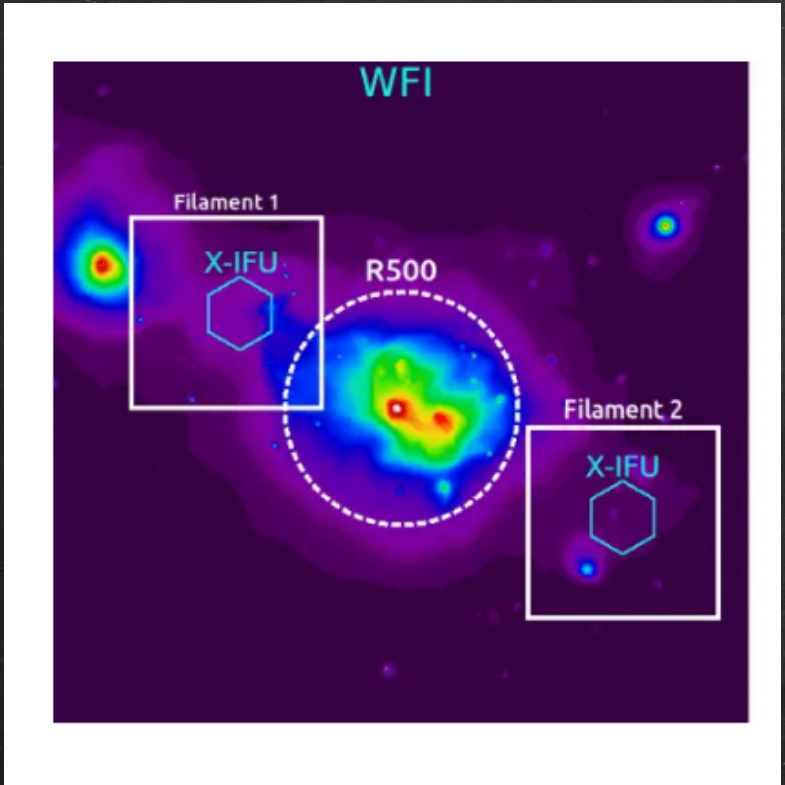
Event files and **spectra**

With latest upgrades we extracted spectra from different shaped regions

WFI and XIFU simulations

Different setups e.g. 13-15 rows

2. newAthena simulations: changing SIXTE paramaters



Why do we use map inputs instead of 3D cubes?

- capabilities & observing strategy → need to know source position!

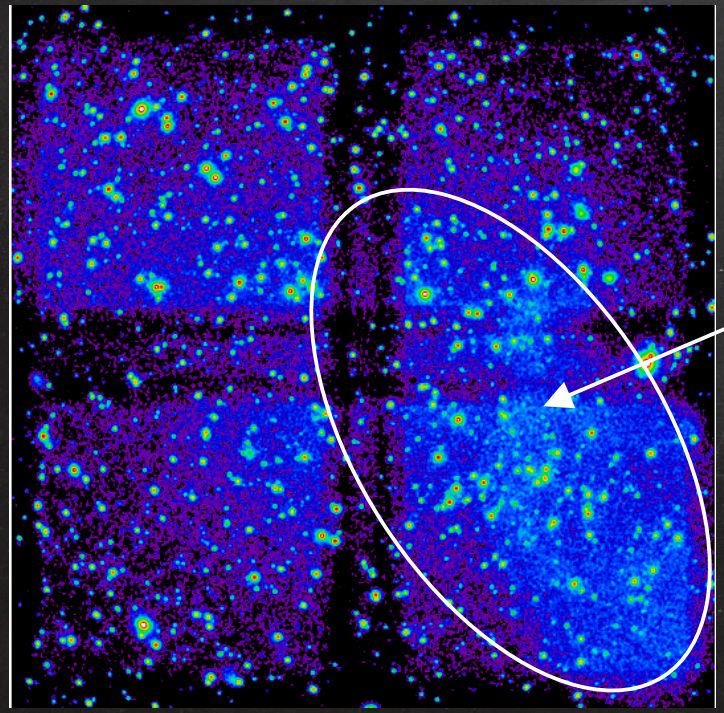
- complex temperature spatial distribution → are we getting the right temperatures?

Ideal simulation setup for our purposes (even though not the best scientific setup)

3. X-ray analysis: point sources

We want to stick as possibile to the real analysis → also to start developping what we need for the future

Firt step → point sources



Extended emission contaminated by **lots** of point sources

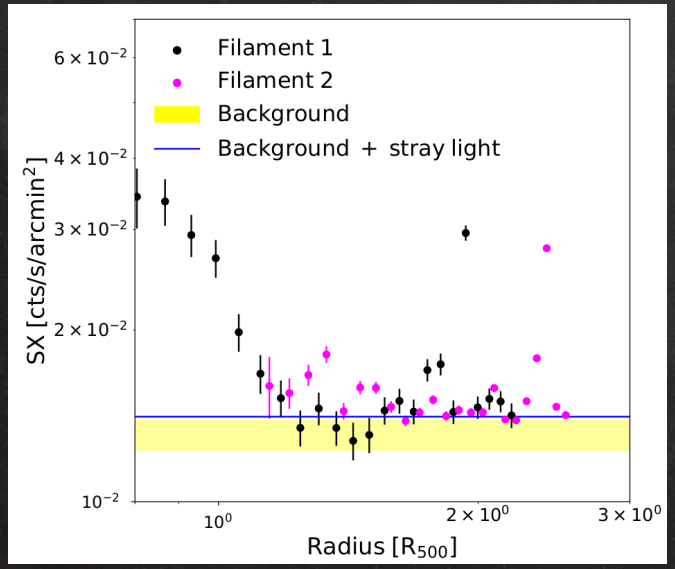
Used the *Chanra* CIAO *wavdetect* and *Sextractor* tools...BUT check by eye is not possible

Crucial point

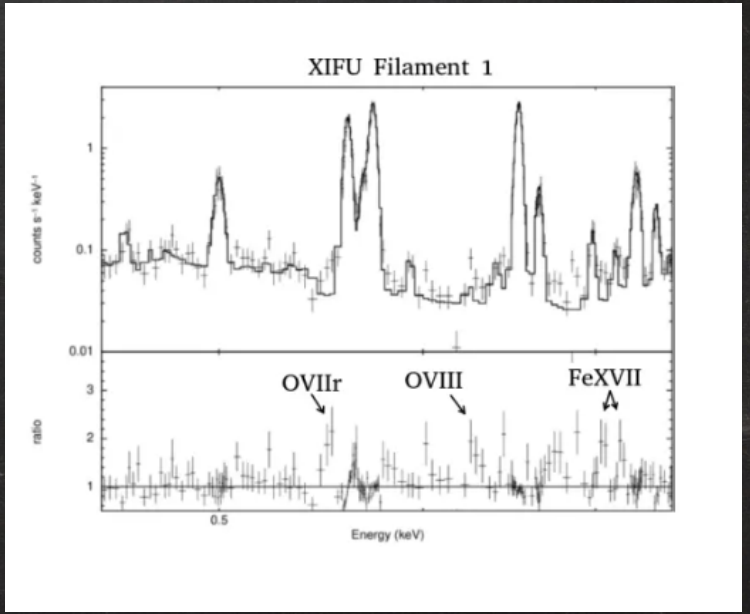
3. X-ray analysis: data production and analysis

We performed the X-ray analysis using standard X-ray tools widely used by the community

SIXTE → image, particle background and exposure map → pyproffit (D. Eckert + collaborators)



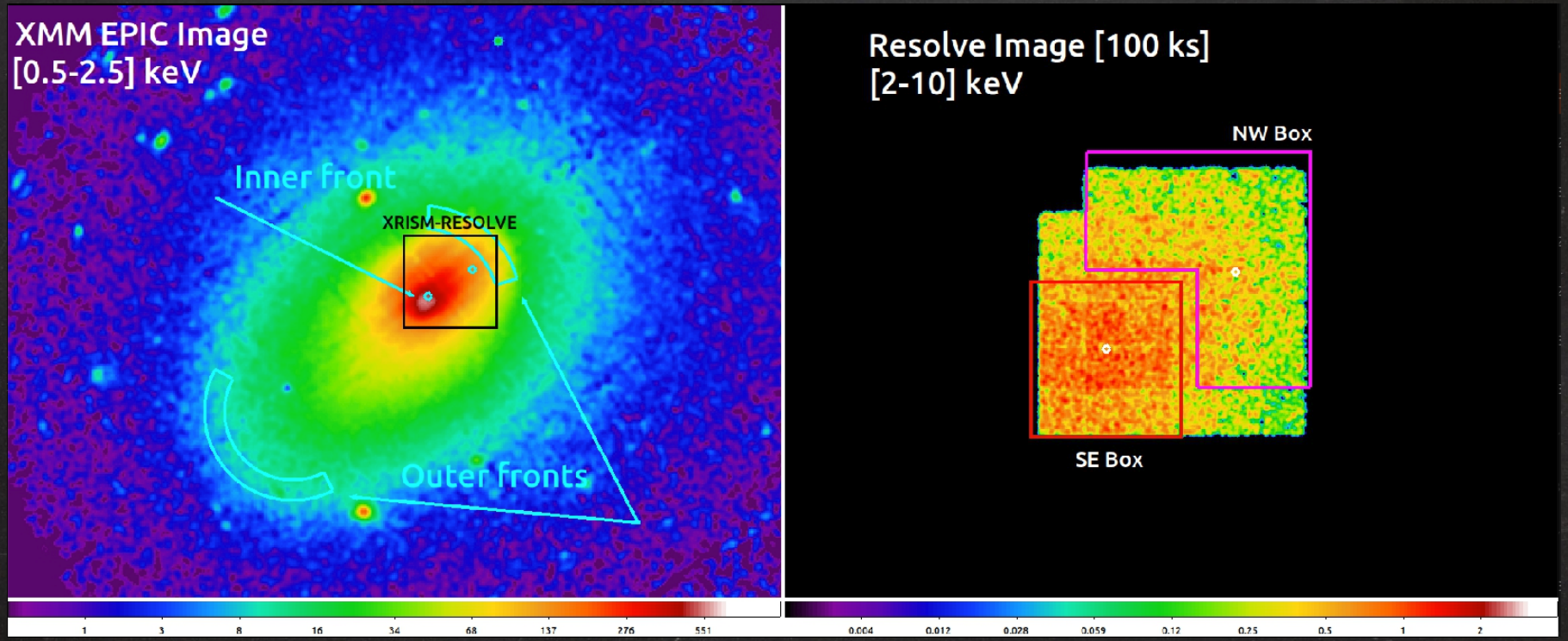
SIXTE → spectrum extracted from tailored regions → XSPEC



(stray light assumed constant, will use latest implementations)

3. X-ray analysis: not only newAthena

Our simulation and analysis framework was easily adapted also for XRISM (proposal)



PI F. Gastaldello

Conclusion

We have presented the work we have done for newAthena (and XRISM) aiming at sharing our codes and foster new possibilities for future X-ray analysis

- Include 3D data cubes as alternative (and more scientifically accurate) input option
- Share codes and know how on how to produce input maps → simulation and kT-image wavelet cleaned map
- Share codes on how to easily change instrument-observation setup, especially for newAthena