

Intro to Advanced Simulations

Maximilian Lorenz on behalf of the SIXTE team
Remeis Observatory & ECAP

Lea Dauner, Thomas Dauser, Esin G. Gulbahar, Jakob Stierhof, Christian Kirsch
Karan Pal, Philipp Thalhammer, Franziska Haluschka, Jörn Wilms

SIXTE Online Workshop, 2026

SIMPOT defines sources through a catalog that links spectra, variability, and spatial extent

Source Catalog Extension

SRC_ID	SRC_NAME	RA	DEC	IMGROTA	IMGSCAL	FLUX	E_MIN	E_MAX	SPECTRUM	IMAGE	TIMING
1	SPEC01	NULL	LC01
2	SPEC01	IMG01	LC02
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

SPEC01

IMG01

LC01

LC02

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SPEC01

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LC01

LC02

Format description:

<https://hea-www.harvard.edu/heasarc/formats/simput-1.0.0.pdf>

For extended sources, a FITS image defines the spatial distribution of observed flux

Eta Carinae



NASA/CXC/GSFC/K.Hamaguchi, et al.

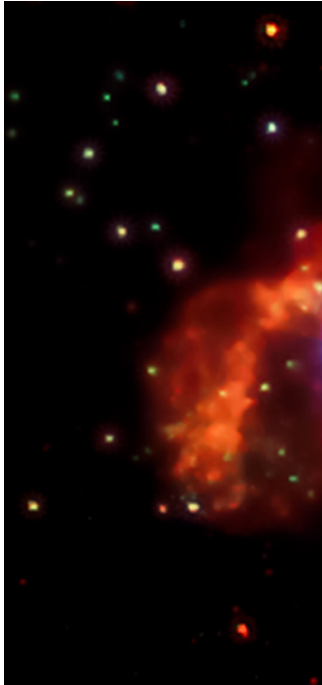
```
simputfile \  
  Simput=output/etaCar.simput \  
  Src_Name=eta_car \  
  RA=161.267156643662 \  
  Dec=-59.684372315062 \  
  srcFlux=1e-11 \  
  Emin=3. \  
  Emax=8. \  
  Elow=2. \  
  Eup=10. \  
  XSPECFile=input/etaCar.xcm \  
  ImageFile=input/etaCar_xray_hi.fits \  
  clobber=yes
```

See [simulation_examples/extended_sources/simple_extsource](#)

For extended sources, a FITS image defines the spatial distribution of observed flux

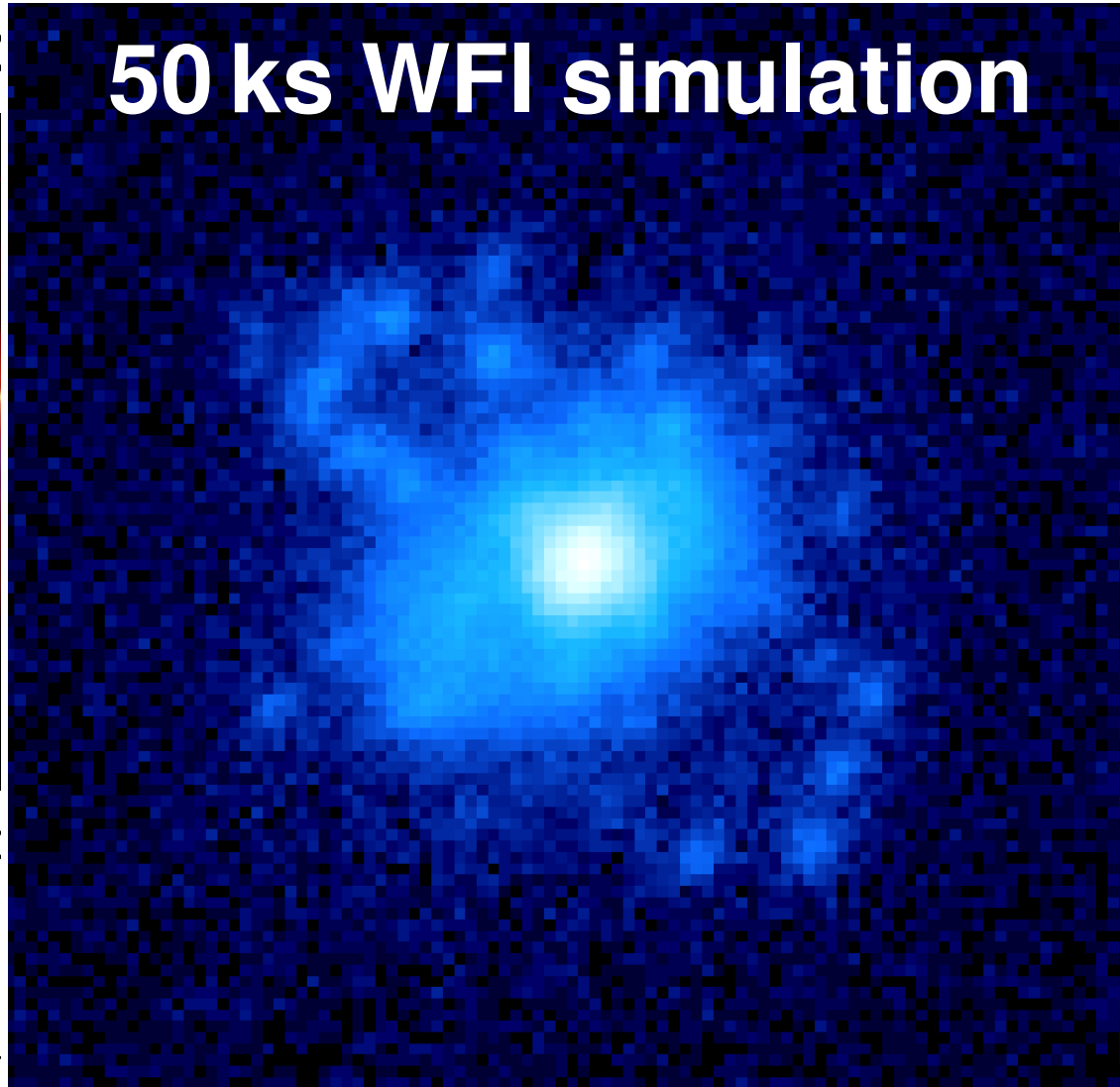
Eta C

50 ks WFI simulation



NASA/CXC/GSFC

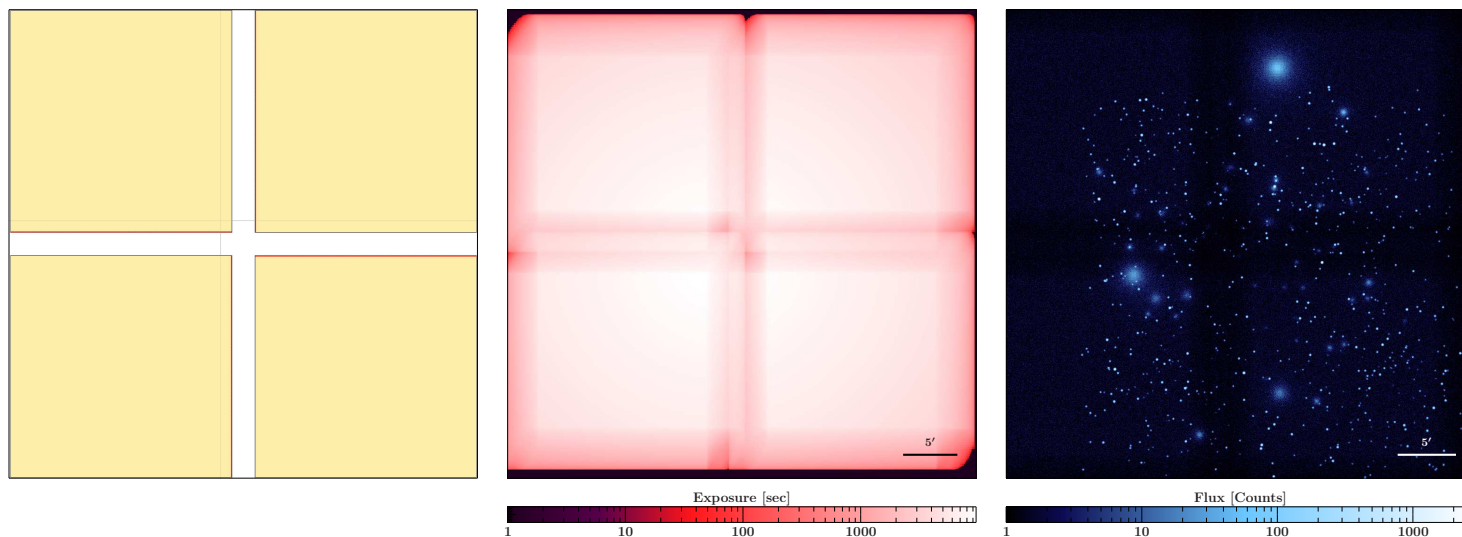
See simulati



_hi.fits \

lrce

SIXTE can simulate deep fields from large source catalogs with dithering and calculate exposure maps



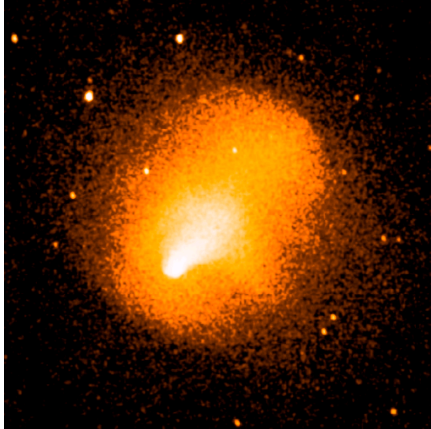
```
attgen_dither \  
  Attitude=output/cdfs_attitude_lissajous.fits \  
  Amplitude=0.035 \  
  SrcRA=53.13 \  
  SrcDec=-27.8 \  
  Exposure=5000 \  
  clobber=yes
```

```
exposure_map \  
  Vignetting=athena_vig_13rows_20231211.fits \  
  Attitude=output/cdfs_attitude_lissajous.fits \  
  Exposuremap=output/cdfs_exposure_map.fits \  
  XMLFile=ld_wfi_ff_all_chips.xml \  
  CoordinateSystem=0 projection_type=TAN \  
  NAXIS1=1063 NAXIS2=1063 \  
  CUNIT1=deg CUNIT2=deg \  
  CRVAL1=53.13 CRVAL2=-27.8 \  
  CRPIX1=532 CRPIX2=532 \  
  CDELTA1=-6.207043e-04 CDELTA2=6.207043e-04 \  
  TSTART=0 timespan=5000 dt=100. \  
  clobber=true
```

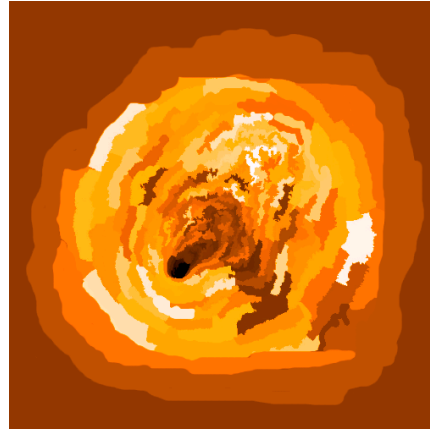
See [simulation_examples/surveys/athena_wfi_cdfs_deep_field](#)

FITS parameter maps can define how spectral models vary across an extended source

Luminosity



Temperature



Abundance

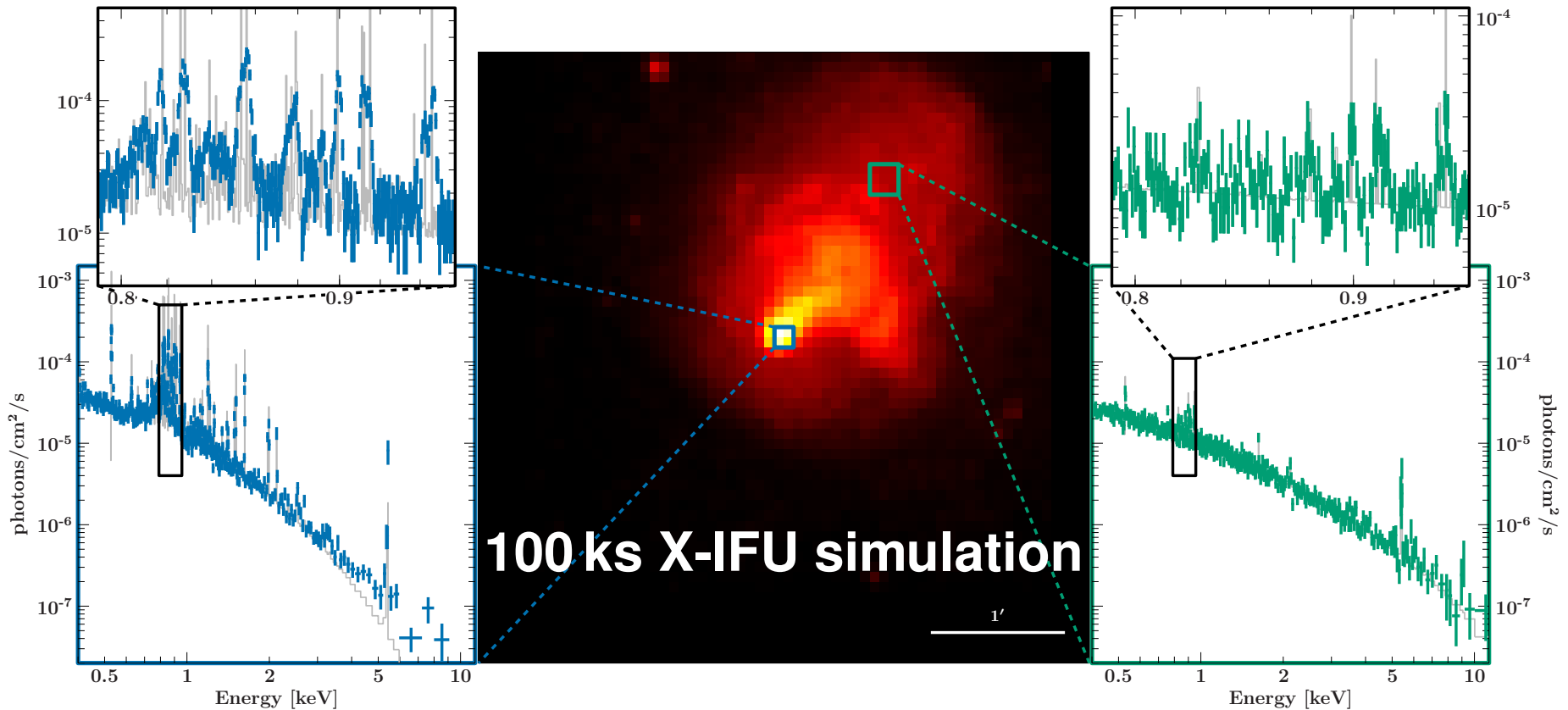


Abell 2146, Russell et al. (2012)

```
simputmultispec \  
  Simput=output/xifu_a2146_multispec.simput \  
  XSPECFile=input/xifu_point_source.xcm \  
  ImageFile=input/A2146_SXB_russel_coord_cal.fits \  
  ParamFiles="input/A2146_kt_russel_coord_cal.fits;input/A2146_ab_russel_coord_cal.fits"  
  ParamNames="2;3"  
  ParamsLogScale="yes;no"  
  ParamsNumValues="8;8"  
  Emin=0.5 Emax=10.0 \  
  srcFlux=7.995076796356145e-12 \  
  RA=239.064583333 Dec=66.3470277776 \  
  Elow=0.2 Eup=12 Estep=0.00025
```

See [simulation_examples/extended_sources/multispec](#)

FITS parameter maps can define how spectral models vary across an extended source

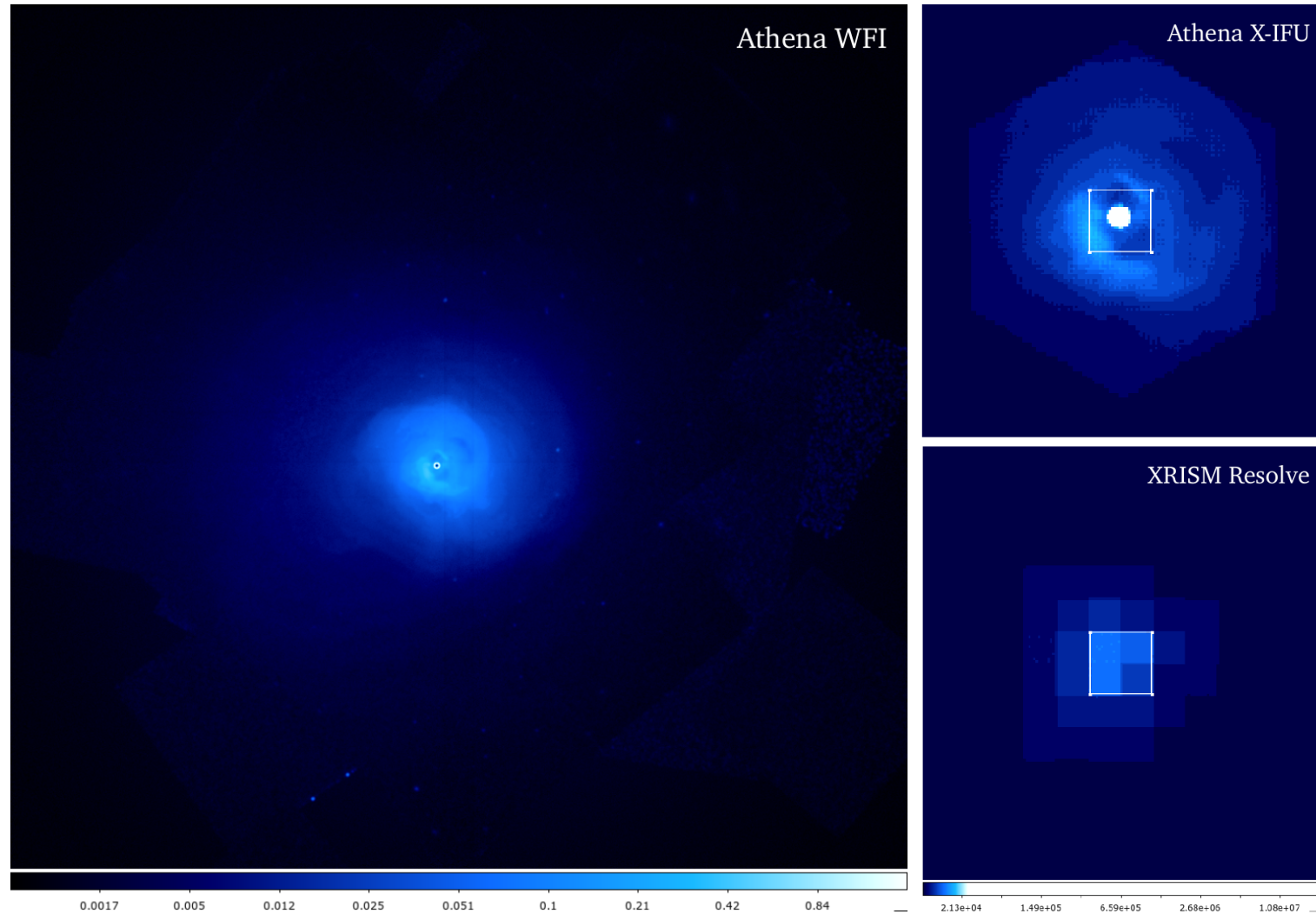


```
Emin=0.5 Emax=10.0 \  
srcFlux=7.995076796356145e-12 \  
RA=239.064583333 Dec=66.347027776 \  
Elow=0.2 Eup=12 Estep=0.00025
```

See [simulation_examples/extended_sources/multispec](#)

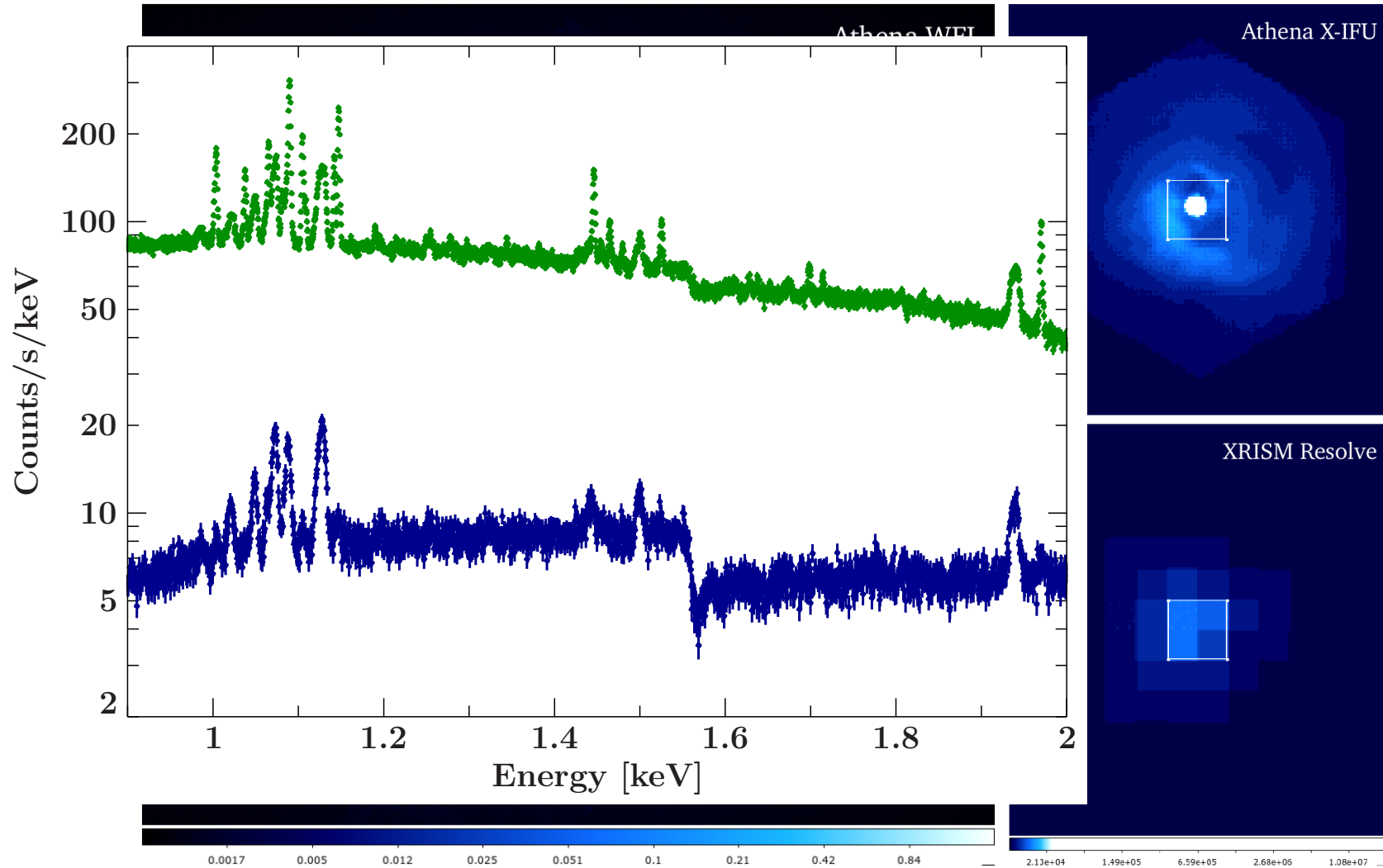
Simulation of the Perseus cluster: reuse the same SIMPUT file for different instruments

50 ksec simulation (Lea Dauner)

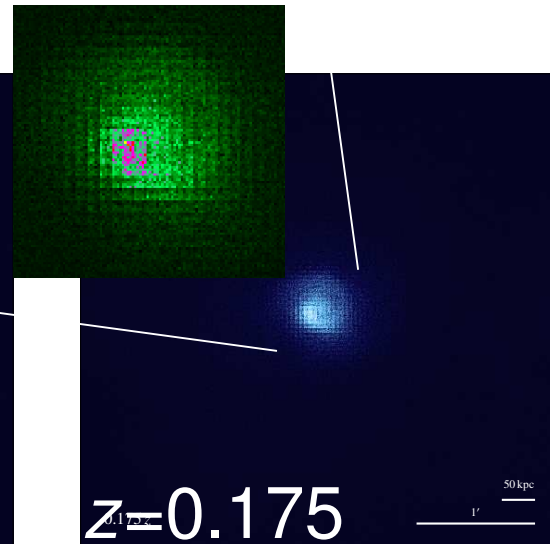
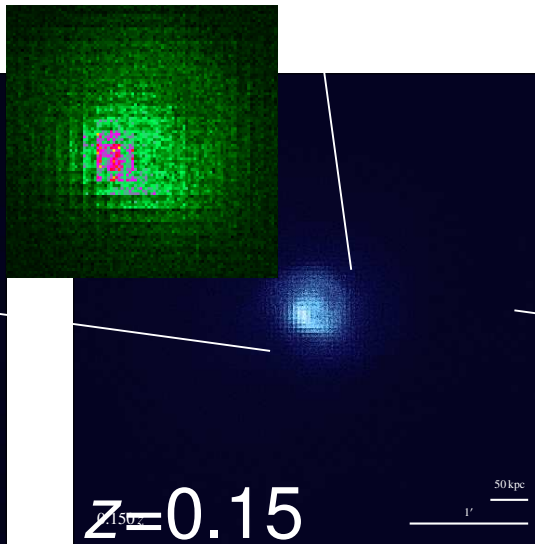
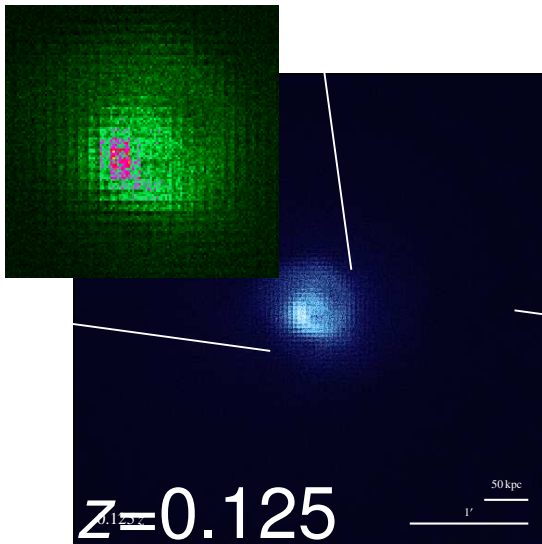
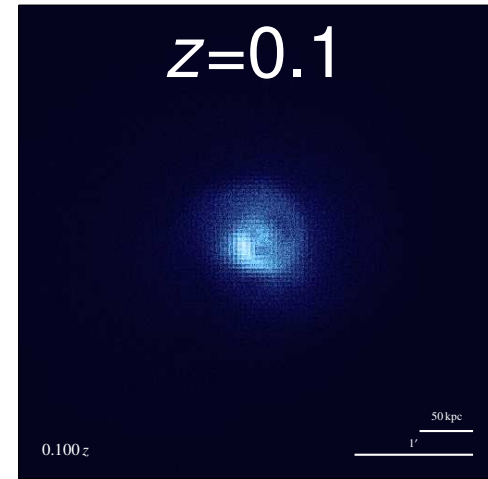
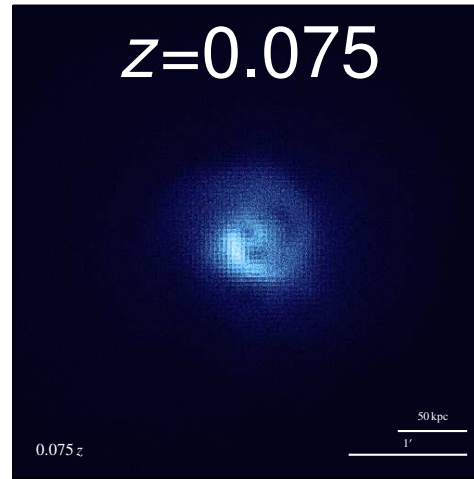
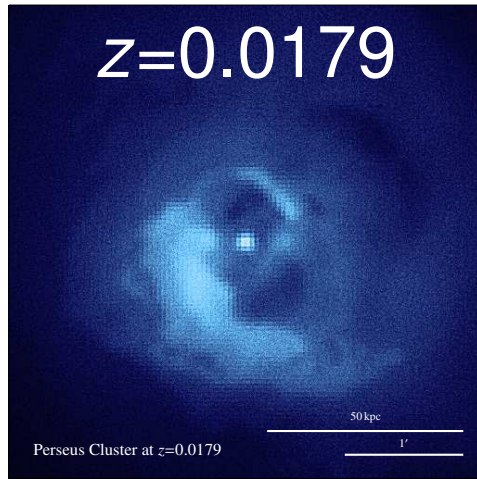


Simulation of the Perseus cluster: reuse the same SIMPUT file for different instruments

50 ksec simulation (Lea Dauner)



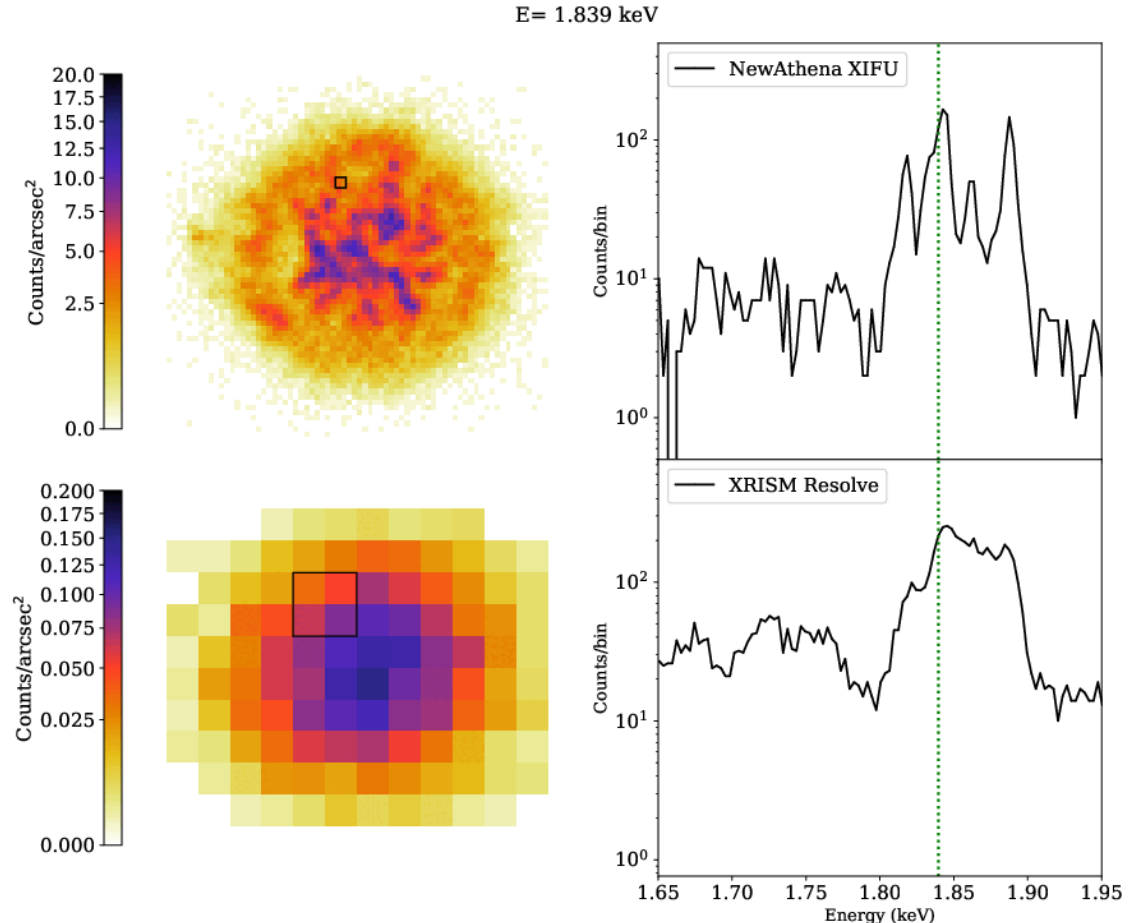
SIXTE simulations show WFI can resolve Perseus-like cluster substructure to about $z=0.1$



Simulation of Cas A based on 3D MHD model encodes spatial and line-of-sight spectral variation

- Parameters vary strongly along line-of-sight, including redshift.

⇒ Full physical potential of eV spectral resolution also needs good spatial resolution.

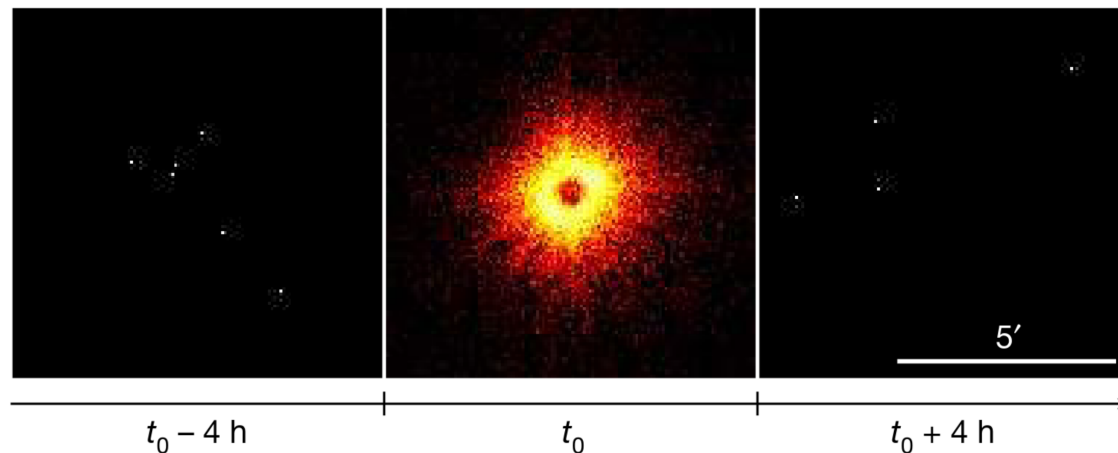


Christian Kirsch & Fabio Acero

See [simulation_examples/extended_sources/data_cube](#)

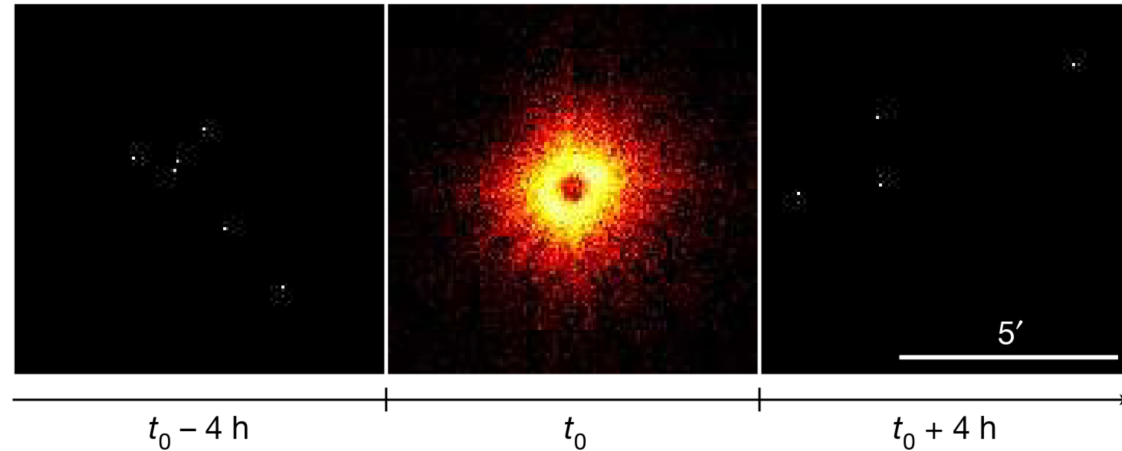
SIXTE simulations recover nova properties from a severely piled-up eROSITA observation

eROSITA
observation:



SIXTE simulations recover nova properties from a severely piled-up eROSITA observation

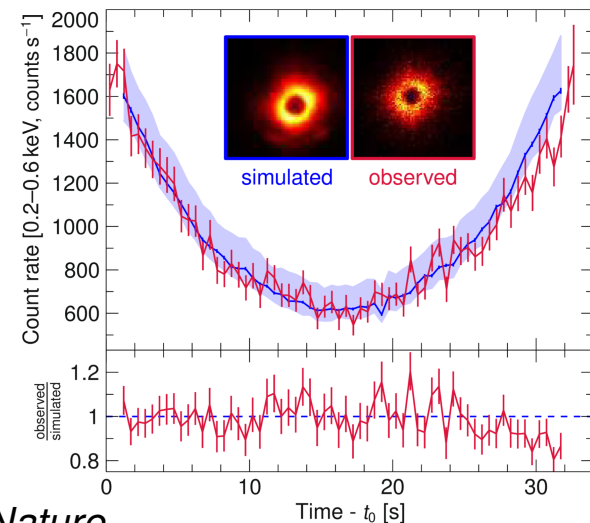
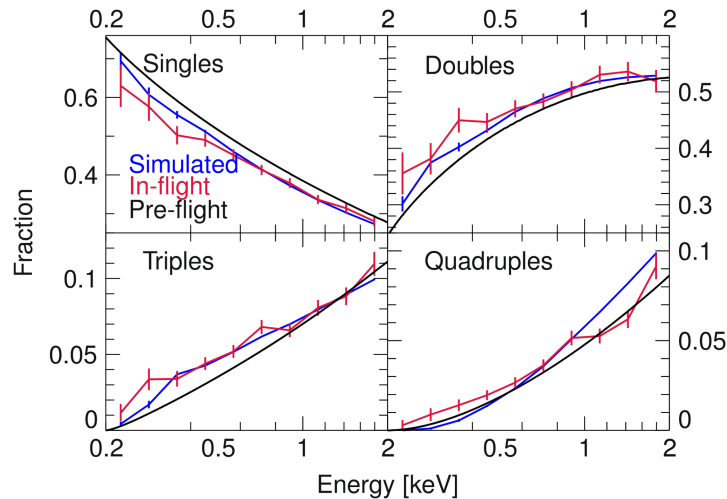
eROSITA
observation:



⇒ Use SIXTE to recover source properties

Simulated and measured pattern fractions

Observed lightcurve and simulation



König et al. (2022), *Nature*

Q&A and Next Steps

- **Now:** Q&A
- **Tomorrow:** Hands-on GatherTown session for working on your own SIXTE simulations, with support from the team.
 - Room opens at **2:00 pm CEST** for chat and questions. Please join before **3:00 pm CEST!**
 - Session starts at **3:00 pm CEST** with short intro via Zoom.
- **Offline work:** Come prepared with a simulation idea, gather the material you need, and ideally start working on it before tomorrow's session.
- **Submit questions here:**

