

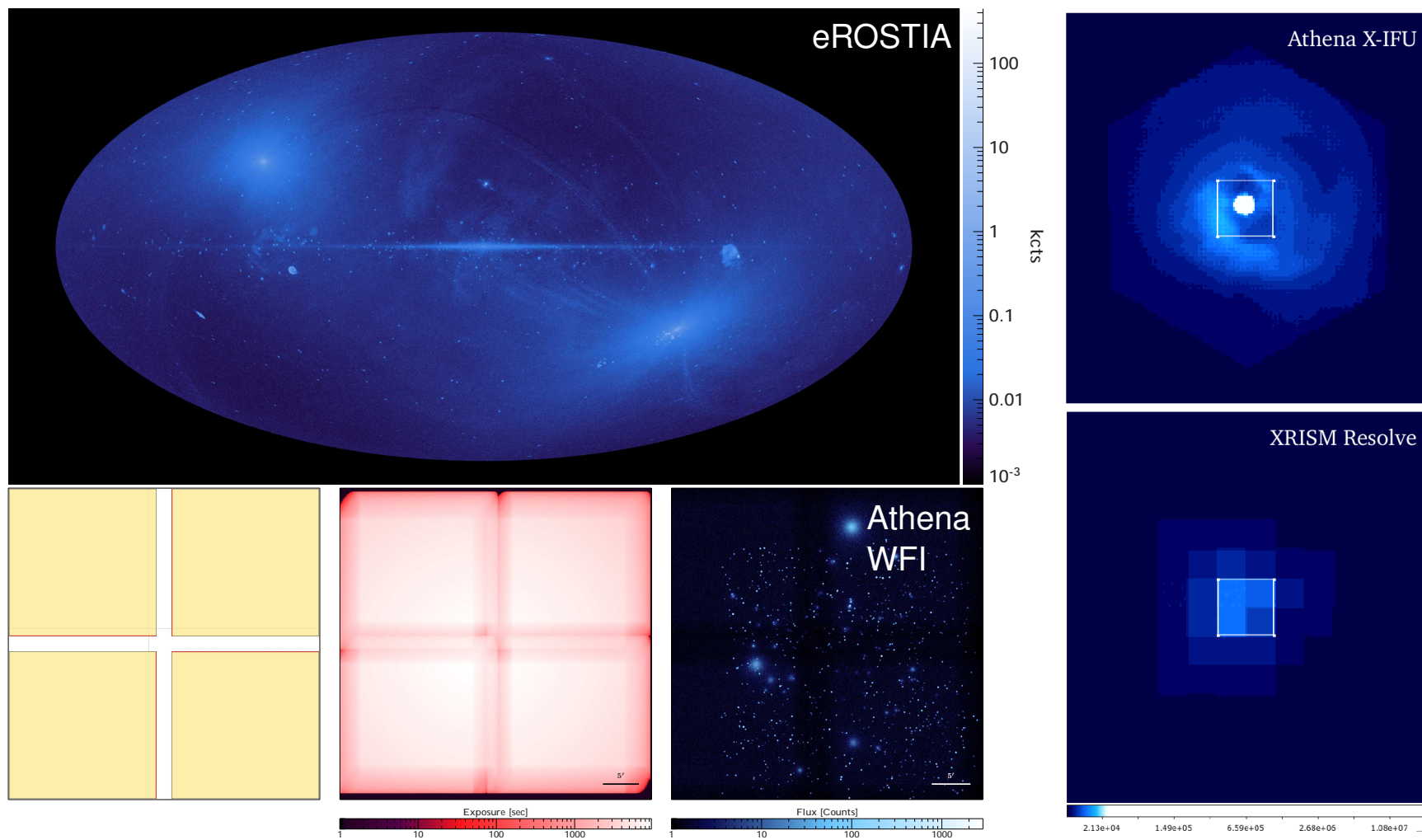
The SIXTE Simulator

The SIXTE Team

Sixte Workshop — November 2024, SRON Leiden

The SIXTE Simulator

Modular **end-to-end simulation software** for X-ray detectors
(tailored to space missions)

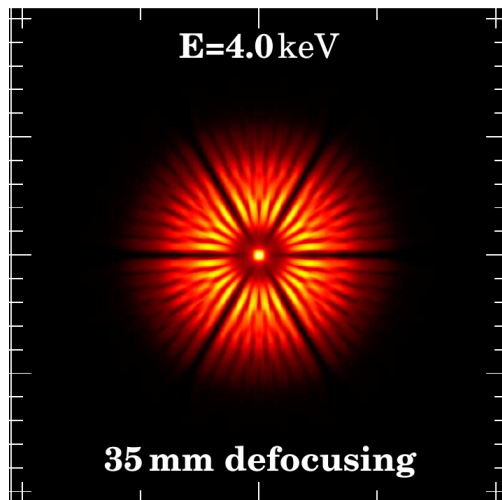


The SIXTE Simulator

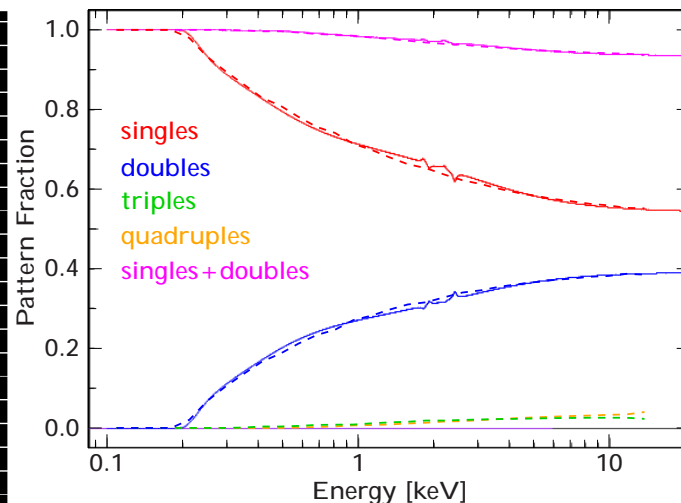
***Philosophy:* simulate typical observations including important detector characteristics on a standard computer**

- compromise between exactness of the simulation and speed
- modular approach / easy to add new detectors/physics
- one simulator for all X-ray missions (code re-usage)

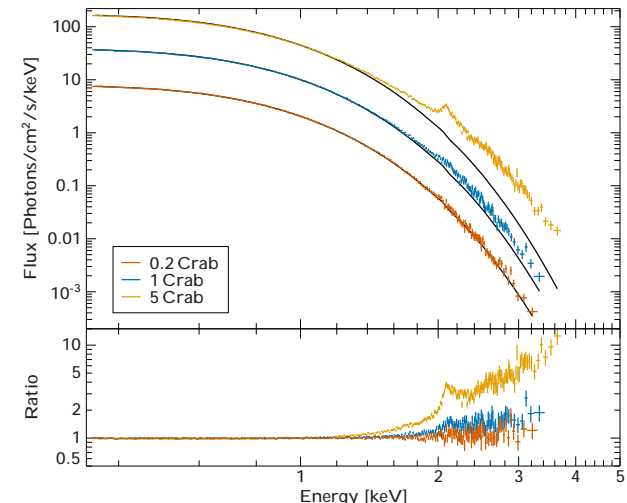
PSF



Pattern Fractions

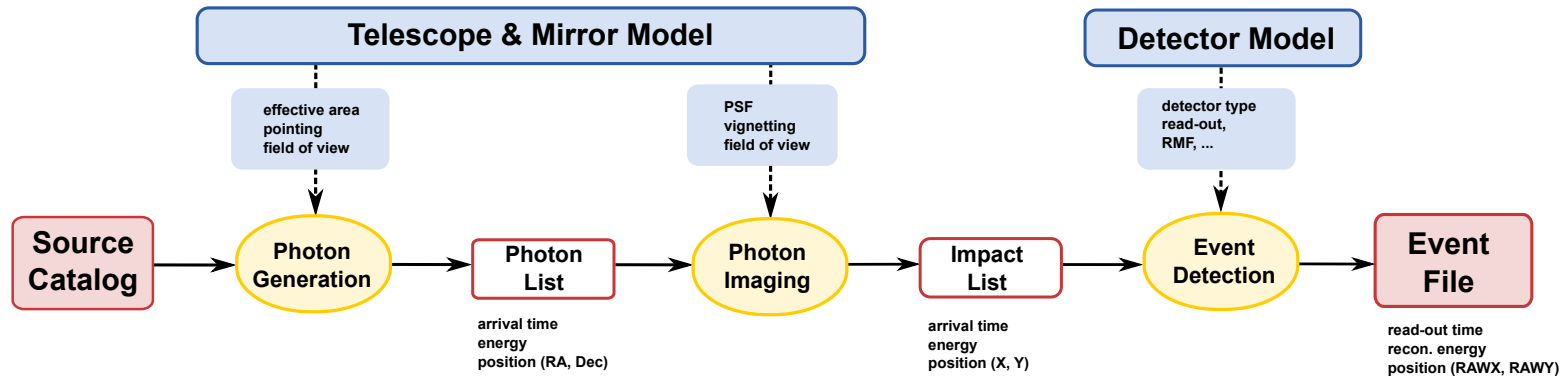


Pileup



The SIXTE Simulator

Generic Monte Carlo simulation environment **SIXTE**



- **Input:** Source Catalog (position, spectral shape, flux, variability, :::)
- **Output:** FITS Event File (time, energy, pixel)
- Allows to **study and optimize** instrument **performance and scientific capabilities**.
- Good description of **instrument physics** and **processing** based on
 - **calibration data** (PSF, vignetting, ARF, RMF)
 - **mathematical models** (e.g., DEPFET readout, charge cloud splitting, pile-up, background, etc.)

Simulation Input — Source Description

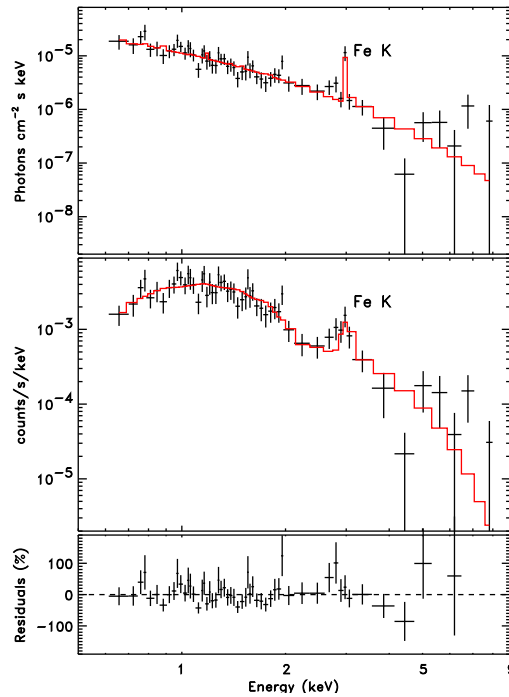
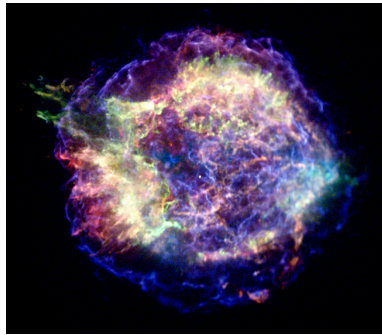
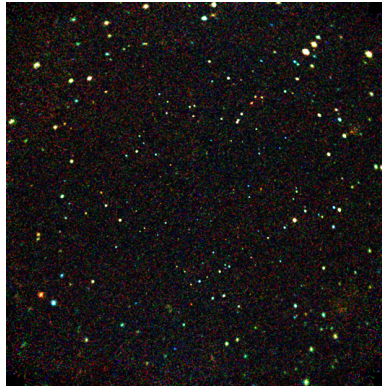
Aim for Input Format:

- be as close as possible to reality; **no artificial limitations on source spectral shape, images, etc.**
- be compatible w/other simulators (simx, MARX)
-) **define general SIMPUT format** (SIMulation inPUT)

“define your favorite source once and simulate it with any detector”

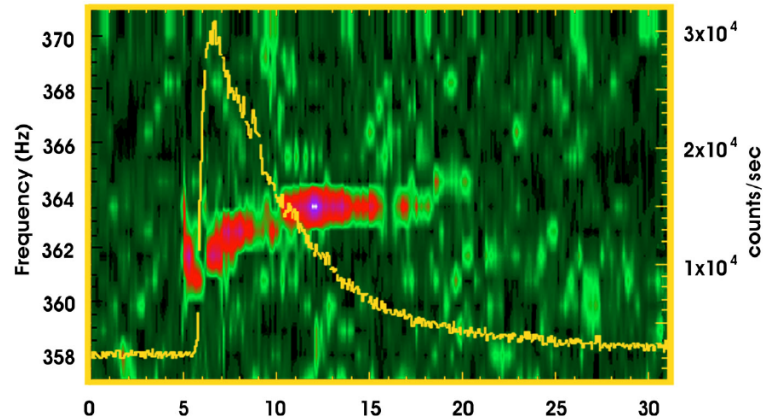
SIMPUP format description: <http://hea-www.harvard.edu/heasarc/formats/simput-1.1.0.pdf>

Simulation Input — Source Description



Sources are characterized by:

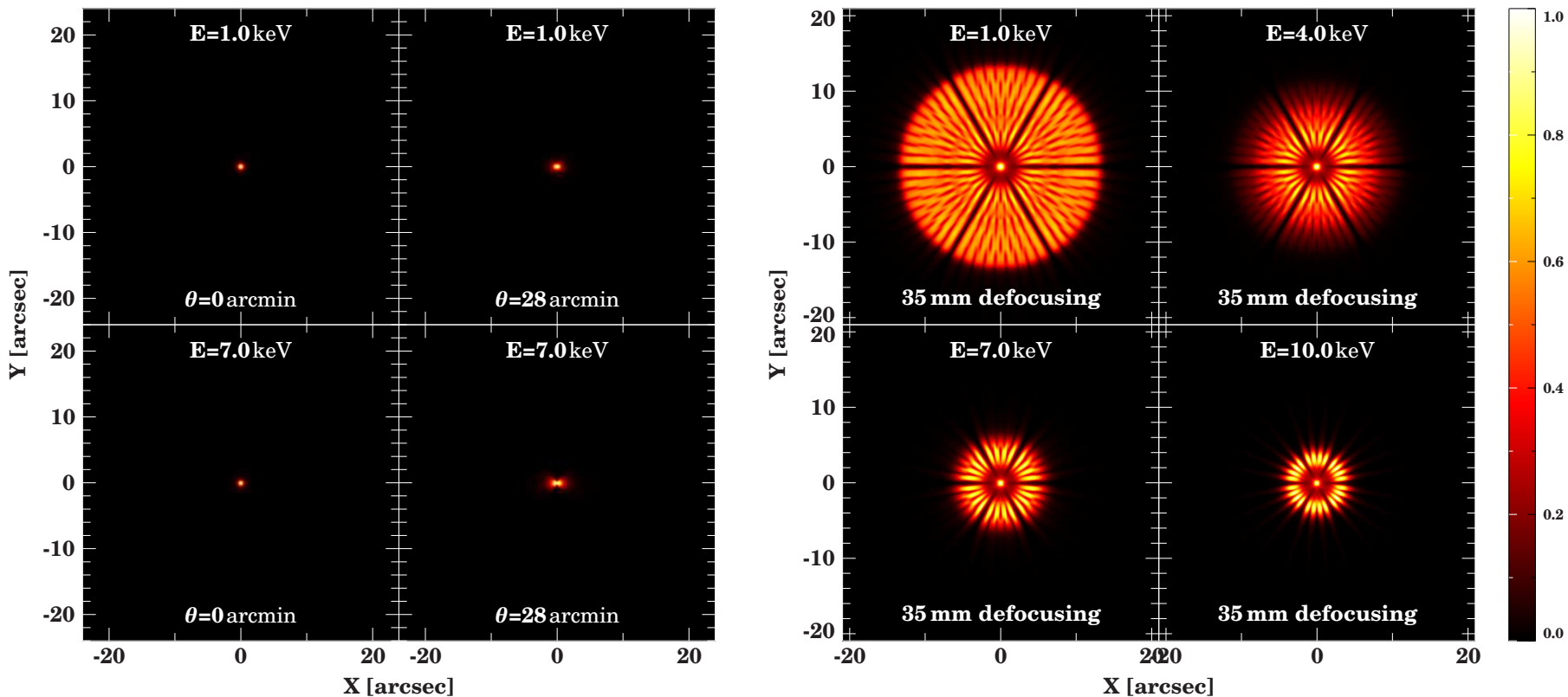
- position: (;)
- spectral shape: $F(E)$
- flux distribution: $F(; ; E)$
- variability: $F(; ; t; E)$
- **photon lists** from simulations



Photon Imaging

Imaging described by the PSF files of the mirrors:

depends on photon energy and offaxis angle (and rotation angle)

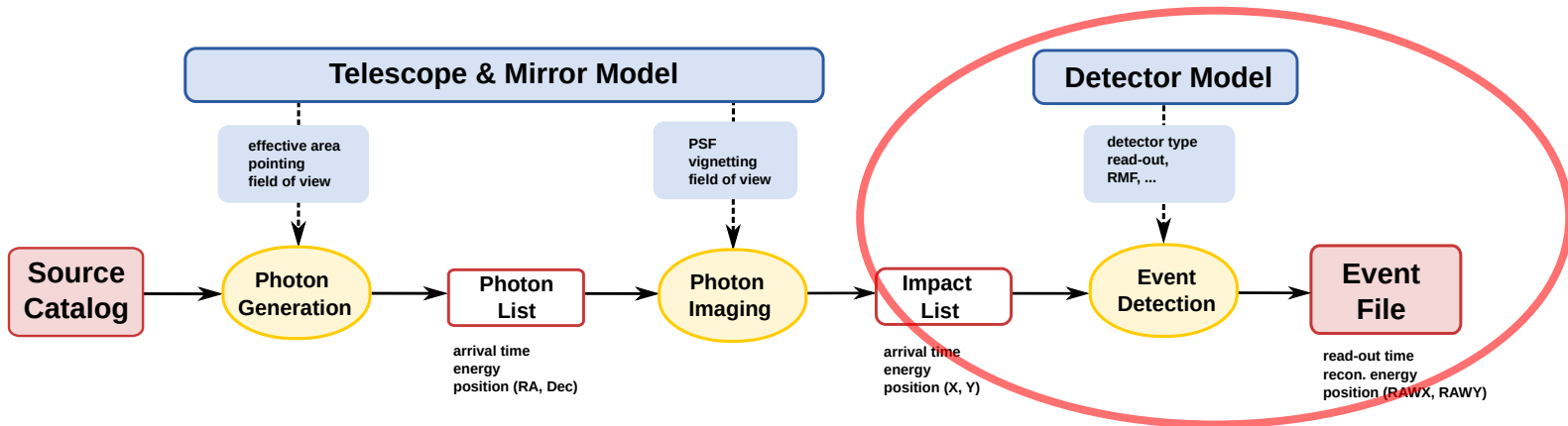


ray-traced Athena PSF

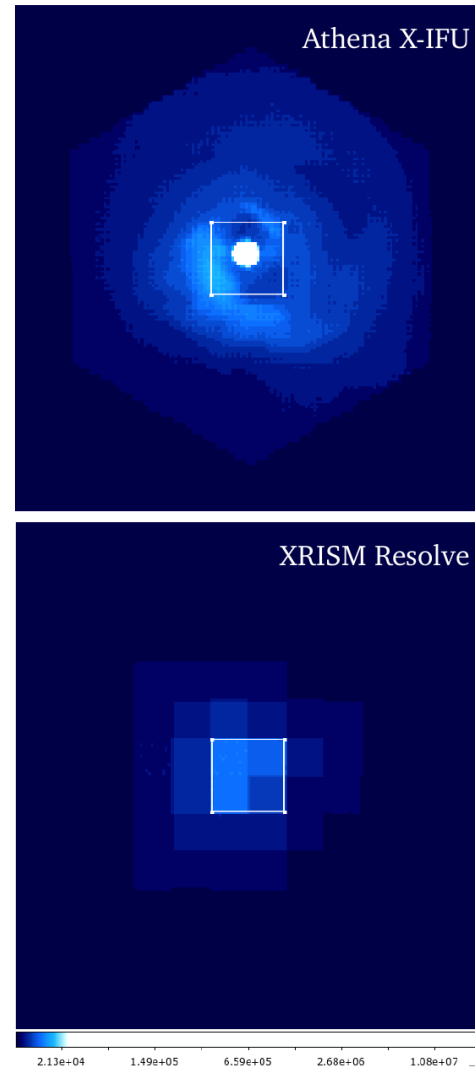
Detection Process

... depends on the type of detector simulated

- DEPFET / CCD-type detectors
(*NewAthena* WFI, *XMM*, *eROSITA*, ...)
- Calorimeter (e.g., *NewAthena* X-IFU, *XRISM* Resolve)
- Polarization (*eXTP*, work in progress, only basic functionality)

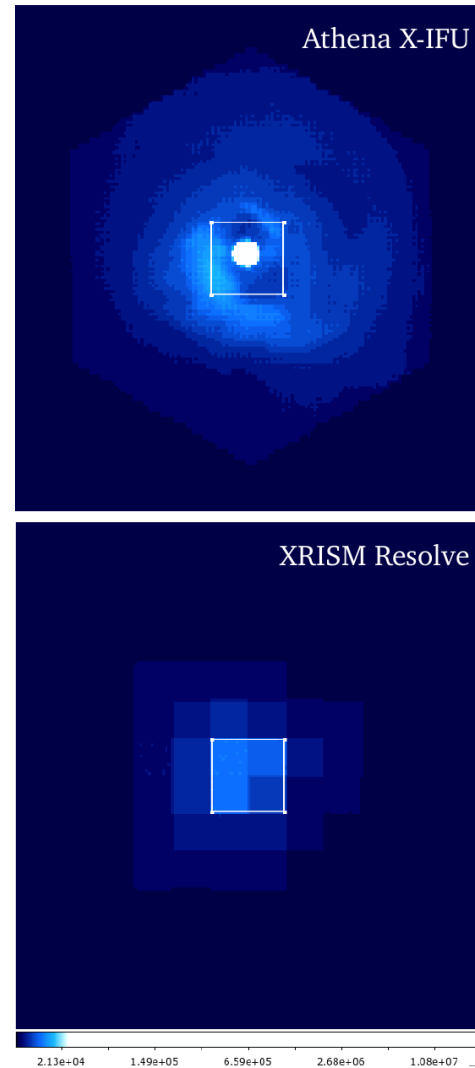


Example: *Athena* and XRISM simulation of Perseus



50 ks simulation of Perseus

Example: *Athena* and XRISM simulation of Perseus



50 ks simulation of Perseus

Simput & Sixte → Workflow

(1) Preparation of the input of the simulation: `simputfile`

- Source definition
 - Point or extended sources
 - Time variability
 - Large catalogs of astronomical sources

(2) Running the simulation: `sixtesim`

- Simulation for most detector setups and exposure
- Output: one or multiple standard FITS event files

(3) Analyzing the simulation: `imggev`, `makespec`, `make1c`

- Creating spectra and images from event files
- Data analysis depends on the simulation
- SIXTE data products are compatible with common X-ray data analysis software -> use your favorite!

SIXTE Simulator

- Installation, manual, configuration files on <https://www.sternwarte.uni-erlangen.de/research/sixte/> and the **SciServer**
- **Helpdesk and support:** sixte-support@lists.fau.de
- Regular (yearly) workshops
- **Mailing list** for news and updates: sixte-users@lists.fau.de
- **Detailed information:** Dauser et al. (2019, A&A 630, A66) and the simulator manual



Thank
you!