The SIXTE Simulator

The SIXTE Team

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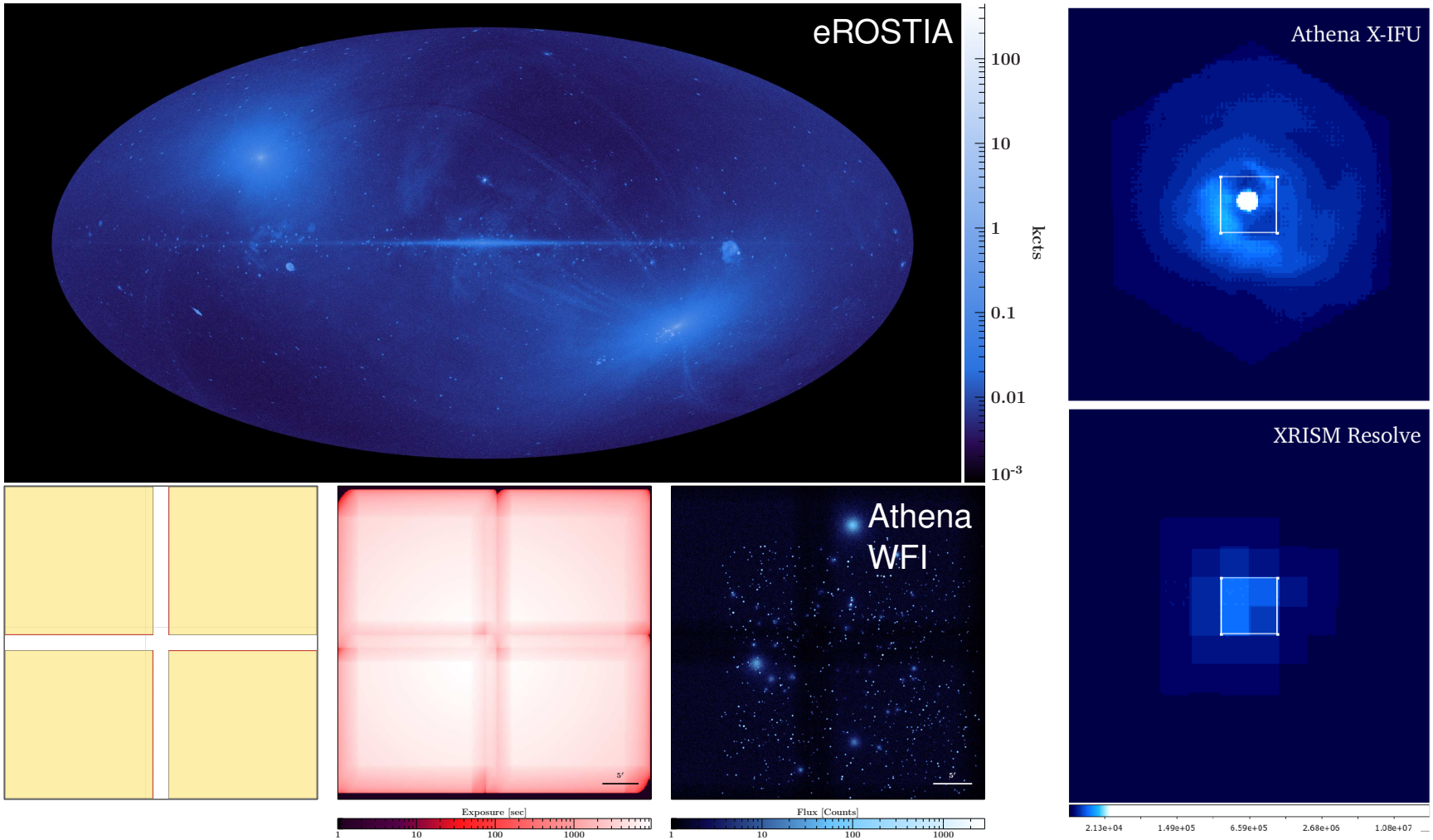
SIXTE

The SIXTE Simulator

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

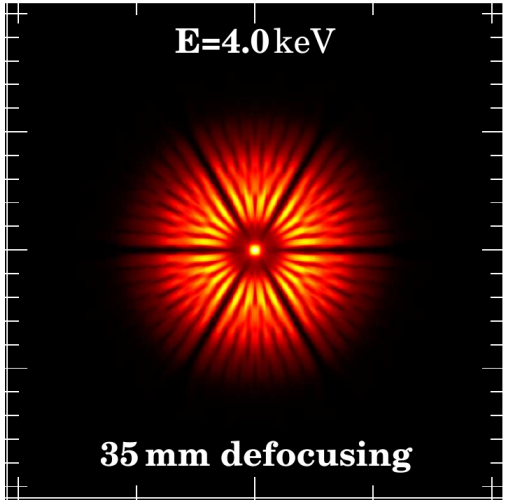


The SIXTE Simulator

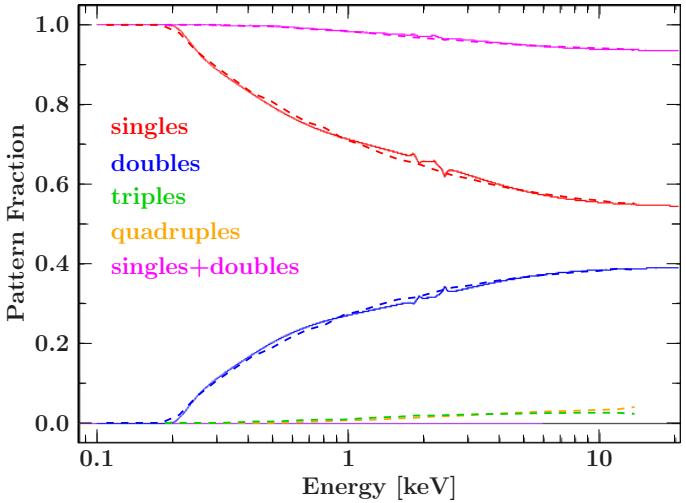
***Philosophy:* simulate typical observations including important detector characteristics on a standard computer**

- 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)

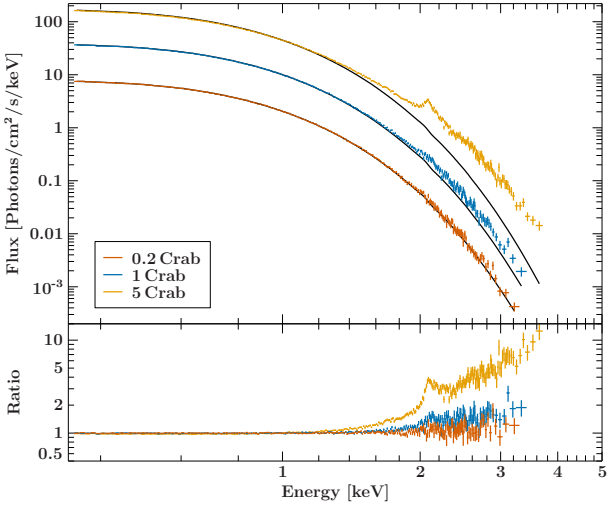
PSF



Pattern Fractions

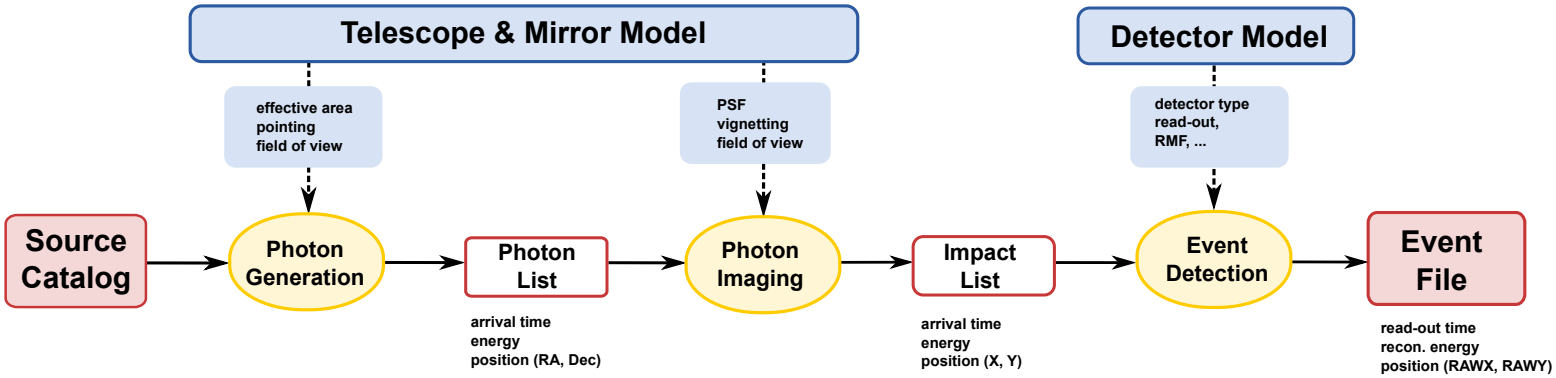


Pileup



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:

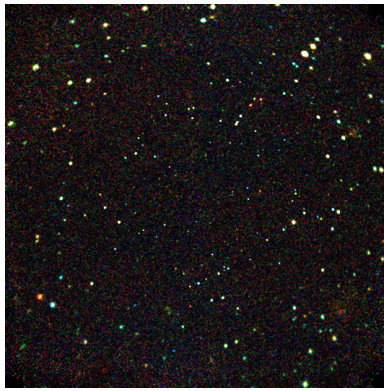
- be as close as possible to reality; no artificial limitations on source spectral shape, images, etc.
- be compatible w/other simulators (`simx`, `MARX`)

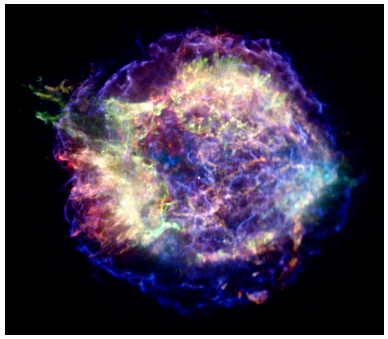
$\Rightarrow$ **define general SIMPUT format** (SIMulation inPUT)

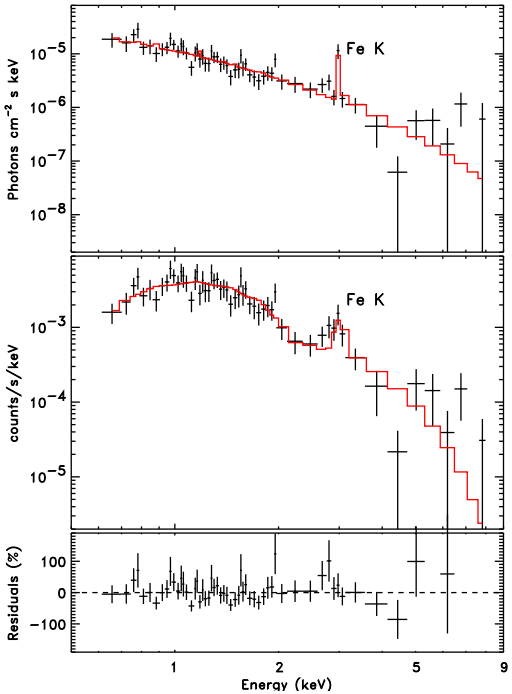
"define your favorite source once and simulate it with any detector"

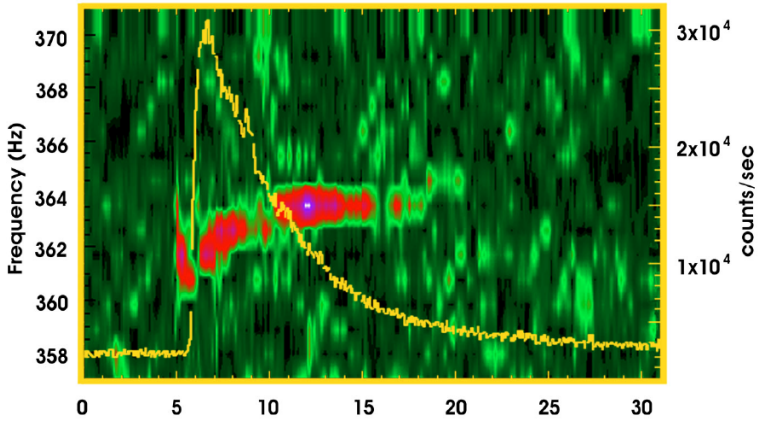
SIMPUT format description: `http://hea-www.harvard.edu/heasarc/formats/simput-1.1.0.pdf`

Simulation Input — Source Description









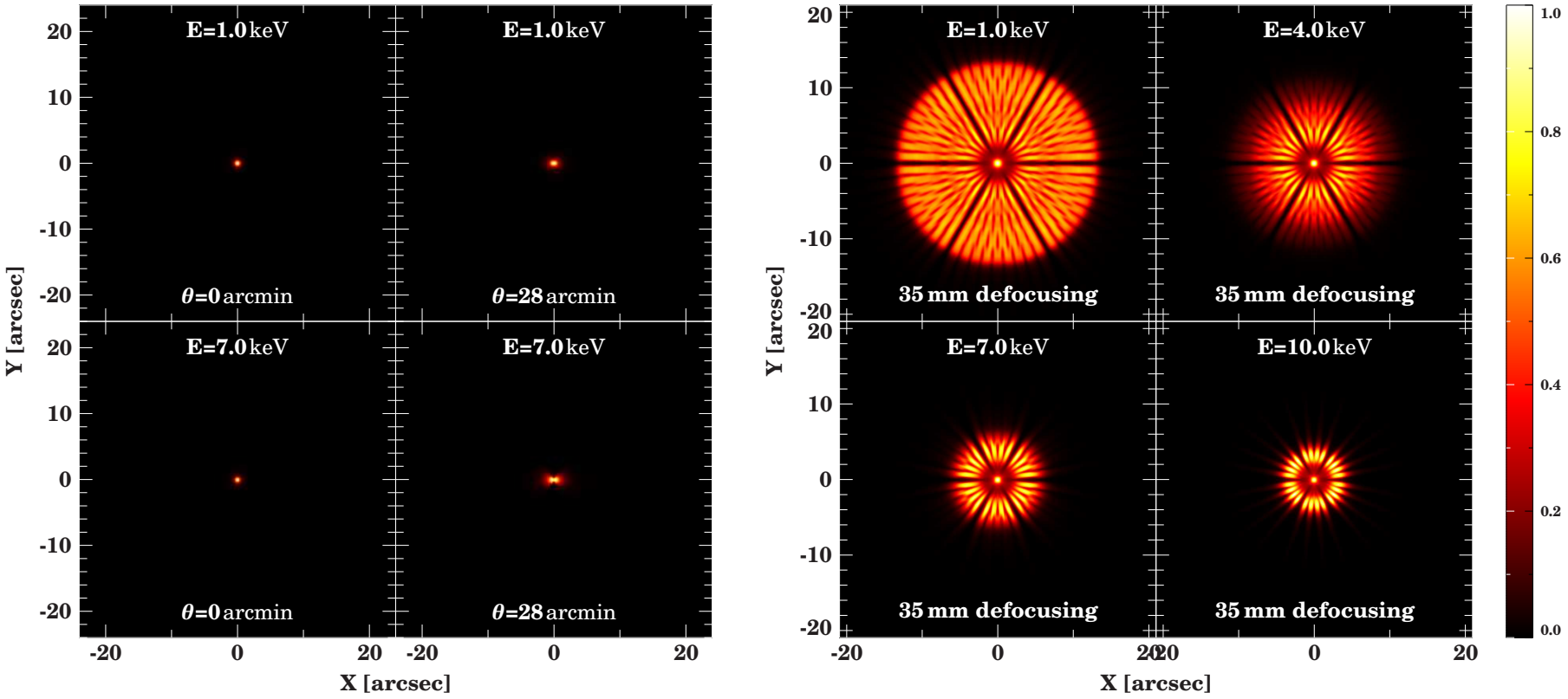
Sources are characterized by:

- position: (α, δ)
- spectral shape: $F(E)$
- flux distribution: $F(\alpha, \delta, E)$
- variability: $F(\alpha, \delta, t, E)$
- **photon lists** from simulations

Photon Imaging

Imaging described by the PSF files of the mirrors:

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

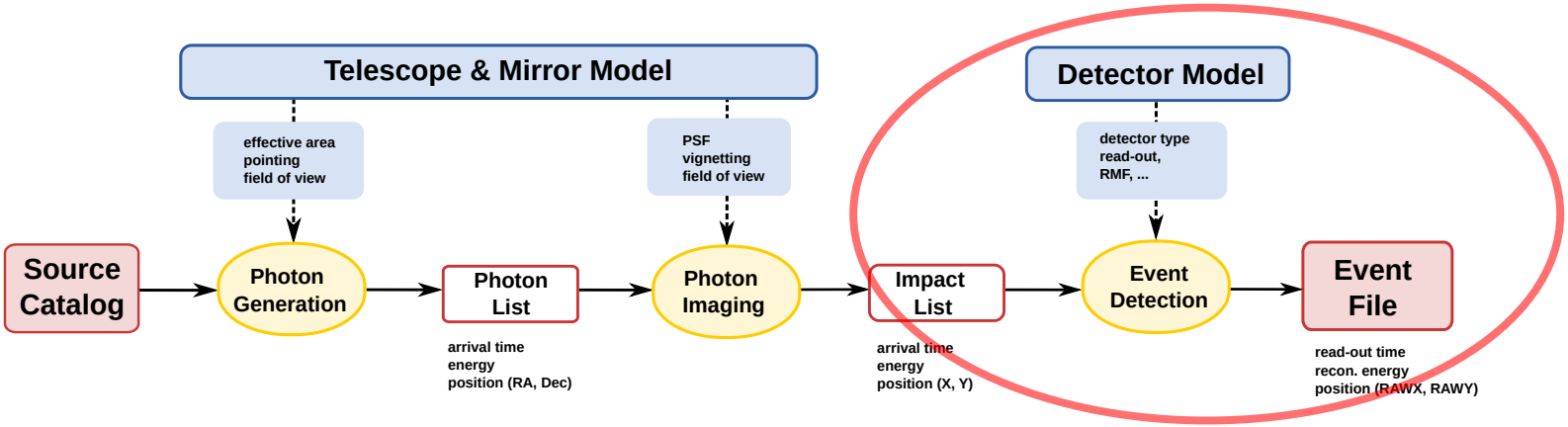


ray-traced Athena PSF

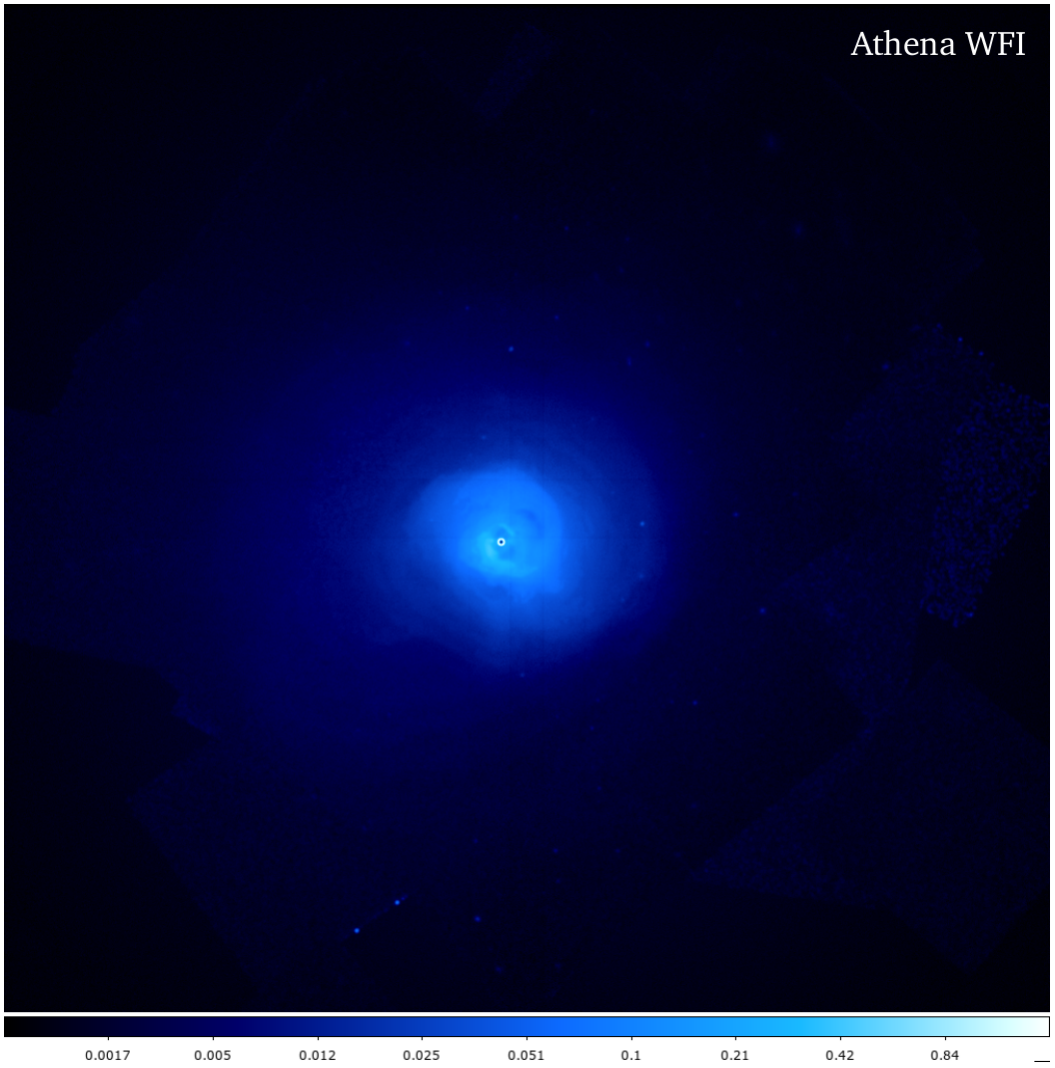
Detection Process

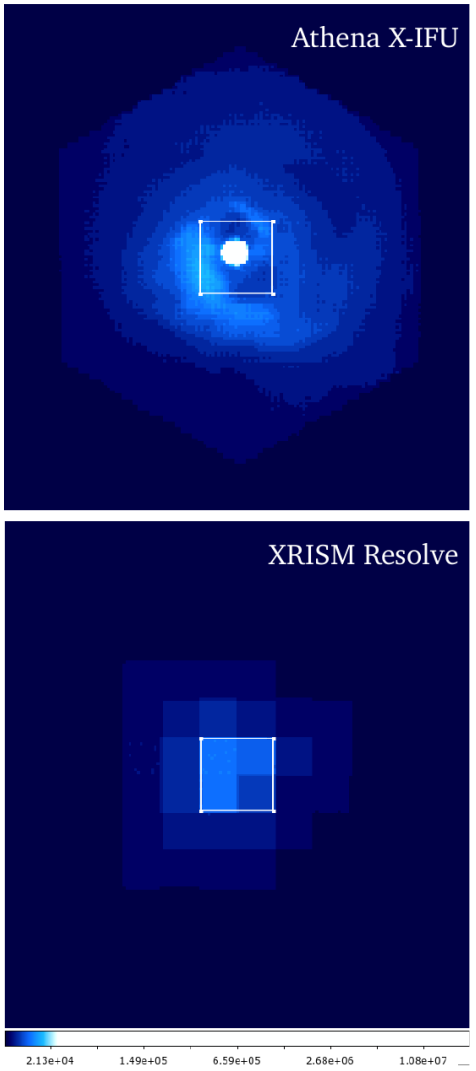
... depends on the type of detector simulated

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



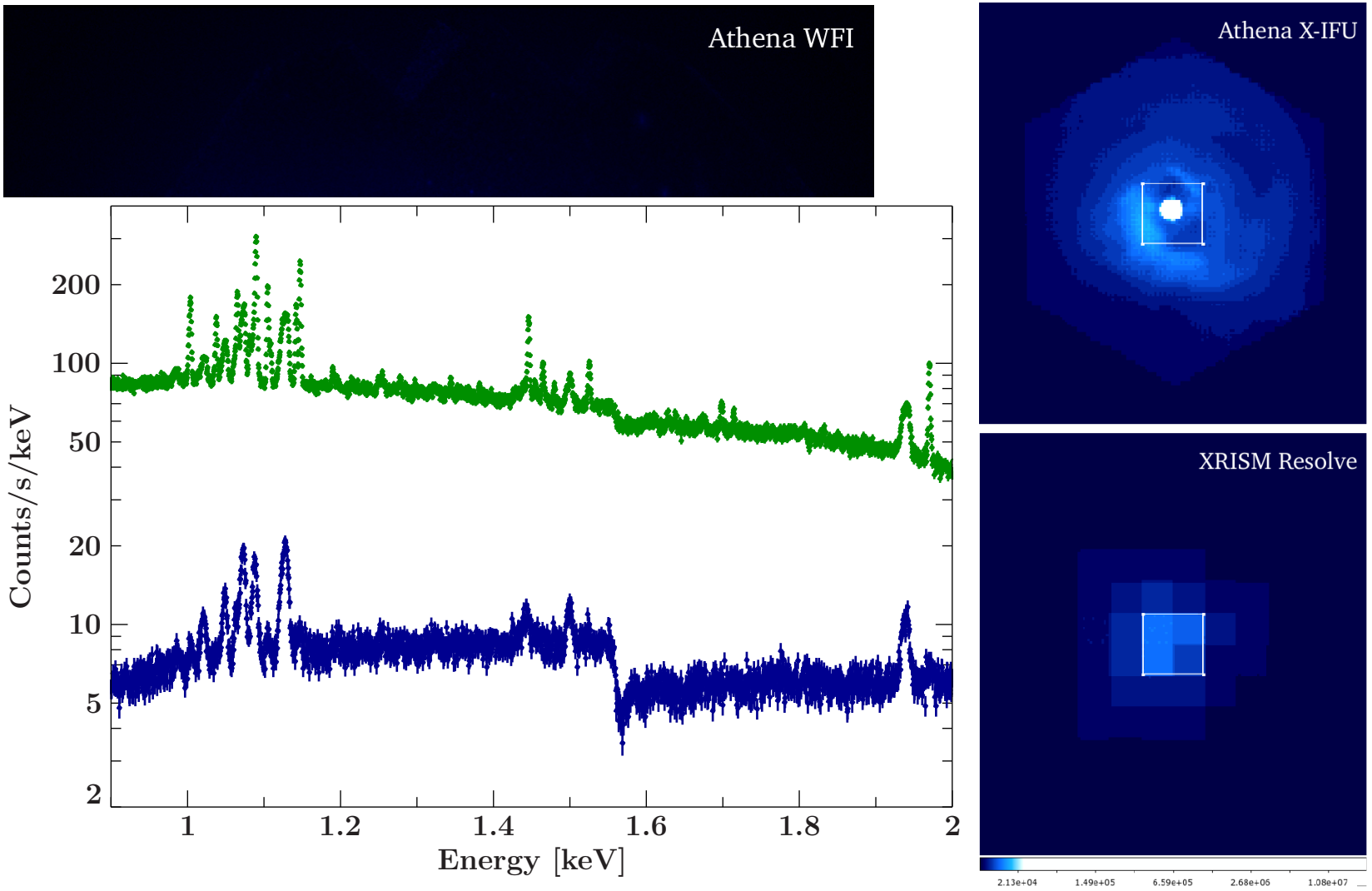
Example: *Athena* and XRISM simulation of Perseus





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: `imgev, makespec, makelc`

- 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!