

Simulation Software Package for X-ray Telescopes

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Abstract

We present a generic Monte Carlo simulation software package for X-ray telescopes. It provides different models for imaging and collimating instruments in combination with different detector technologies. The simulation software can be used to study technical and scientific instrument performance.

Catalogs with various source types are provided as input using the SIMPUT format. We are developing a web interface for quick and easy access to simulations.

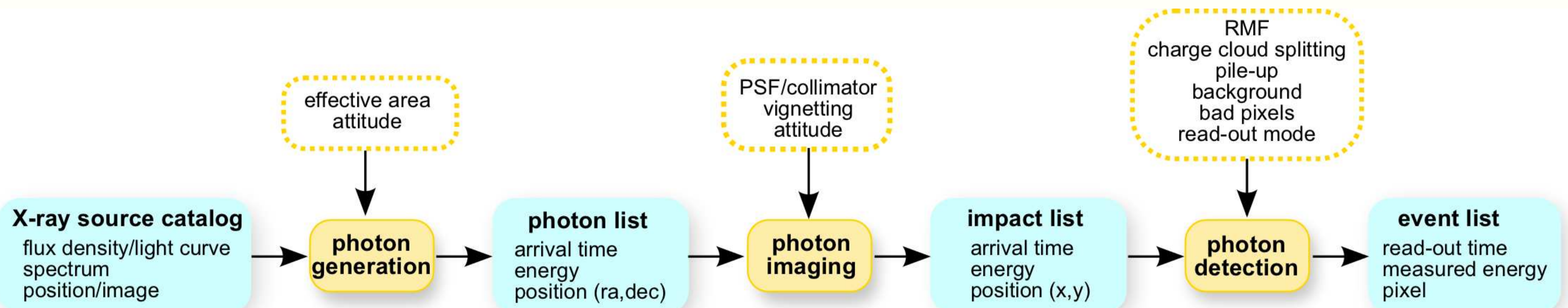
Simulation Software

We are doing **Monte Carlo simulations of the LAD and the WFM on LOFT**. For that purpose we use a generic simulation software package, which has originally been developed for eROSITA on *SRG* and *IXO/Athena*. The software has actually been designed for imaging instruments with pixelized detectors, however we have extended it to be suitable for *LOFT*.

The software package is written in C and implements a common interface by using the APE/PIL library for parameter input and standard FITS files for data access. It contains models for different instruments, such as the Wide Field Imager (WFI) and the X-ray Microcalorimeter Spectrometer (XMS) on *Athena*, the framestore pn-CCDs on eROSITA, or the EPIC-pn camera on *XMM-Newton*. The currently implemented models for the LAD and the WFM on *LOFT* are presented in separate boxes below.

The simulation is set up as a **pipeline** of the relevant tasks such as the generation of a sample of X-ray photons, the imaging process in a Wolter telescope or the absorption of photons by a collimator, and the photon detection by the respective detector. Individual tools in this pipeline can be replaced easily to adjust the simulation to different missions. The instrument characteristics like the optics and detector properties are defined by standard calibration files, such as the **PSF** (for imaging instruments) or a **RSP**. The pointing direction of the telescope is specified in a particular attitude file.

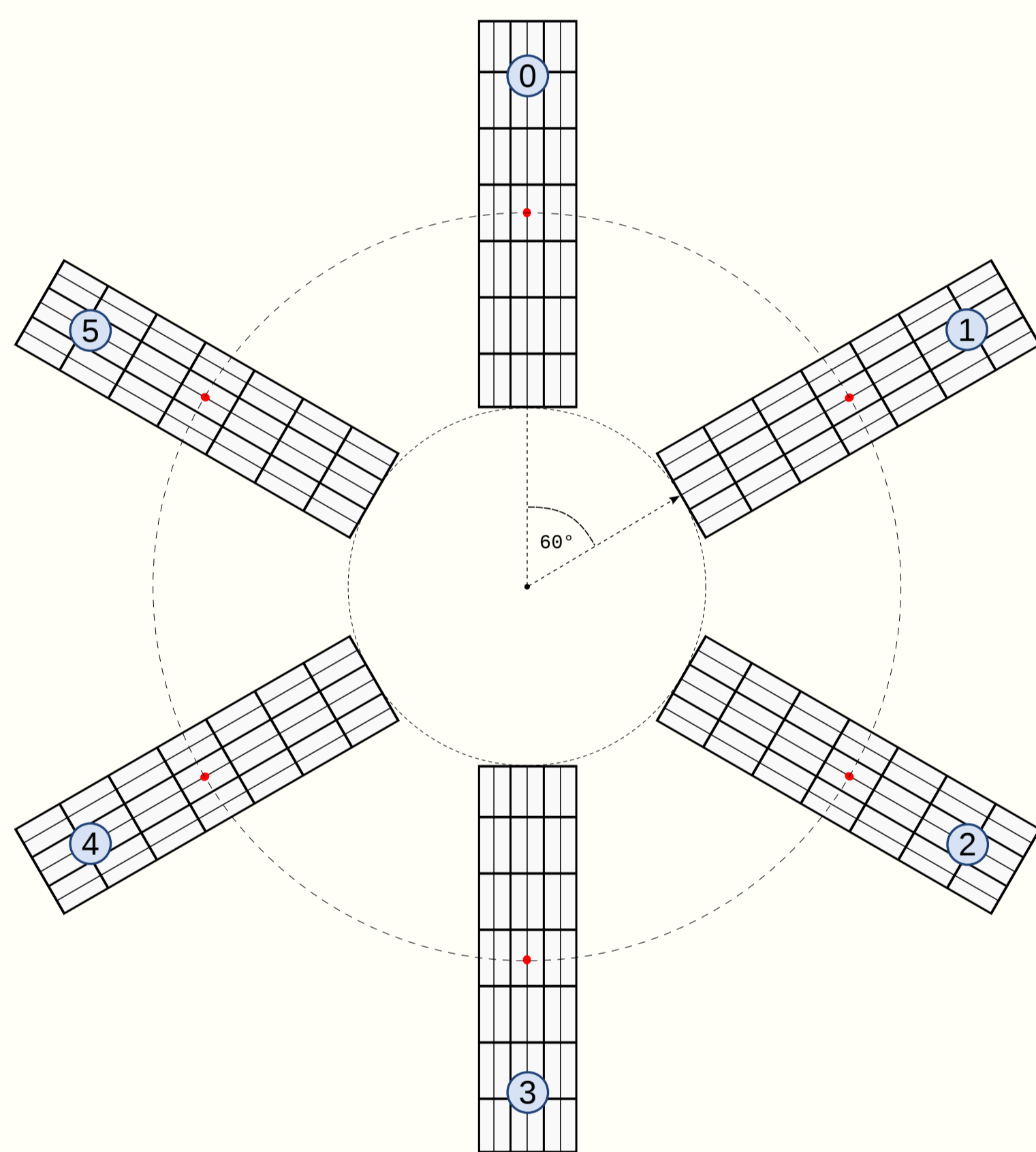
As input data for the simulation appropriate models of astronomical X-ray sources have to be provided. For that purpose we use the **SIMPUT** file format described on the [poster by M. Wille et al.](#)



LAD Simulations

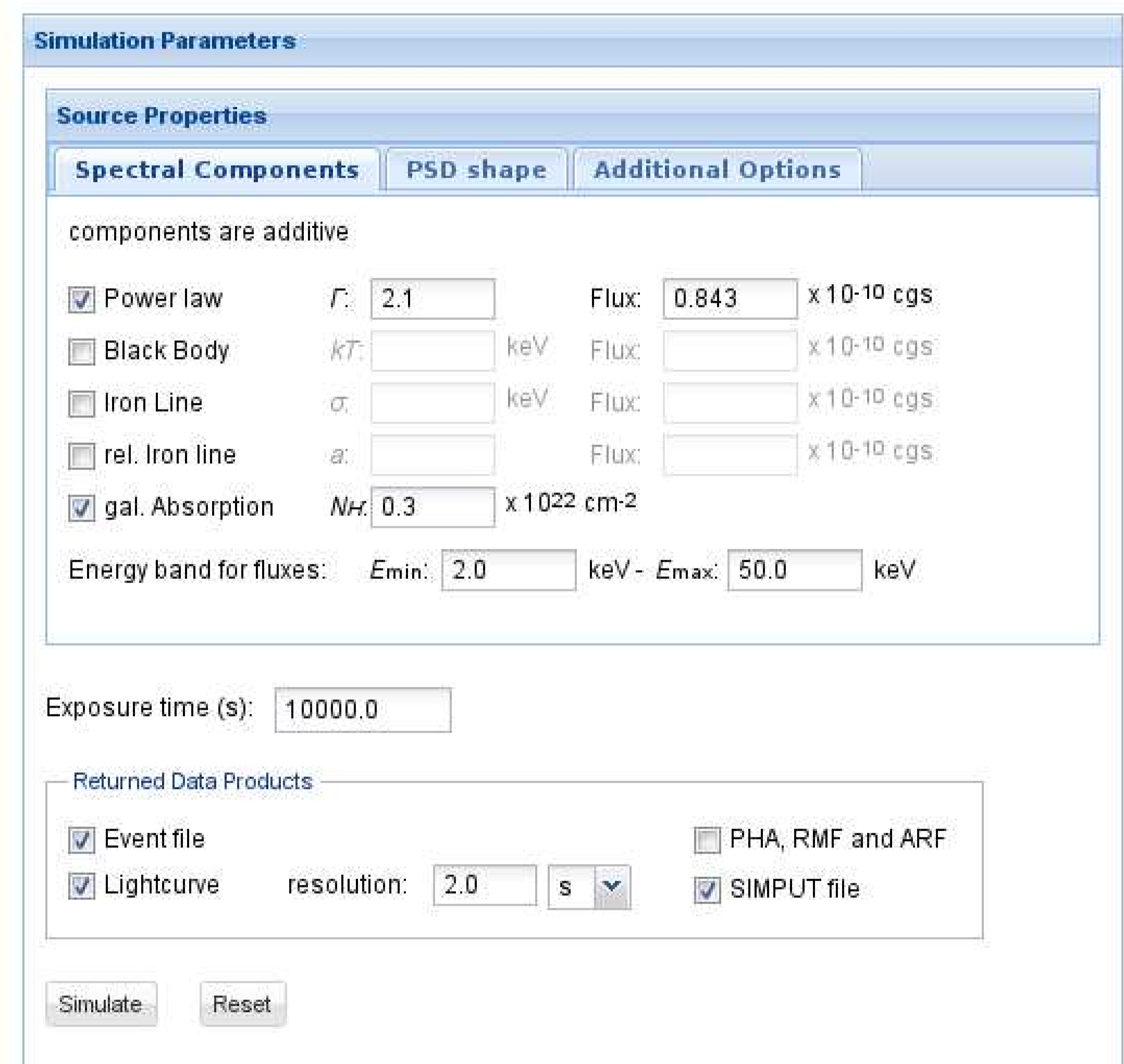
We have developed a computer model for the LAD on *LOFT*. Each of the 6 instrument panels is made up by 21 modules, which consist of 16 elements. Each element has 256 anodes. These numbers and the geometry can be modified easily in order to investigate different instrument configurations.

The impact positions of individual photons on the detector are determined according to the collimator. Depending on the impact position the spread of the charge cloud in the silicon drift detector and the corresponding signal on the individual anodes is calculated according to the model presented by Campana et al. (2011).



Web Interface

For quick access to simulations we provide a web interface for our model of the LAD. It allows to define a model of a simple point-like source with an energy spectrum composed of different components and an optional time-variability. As alternative option the user can upload a SIMPUT file with a more sophisticated source definition.

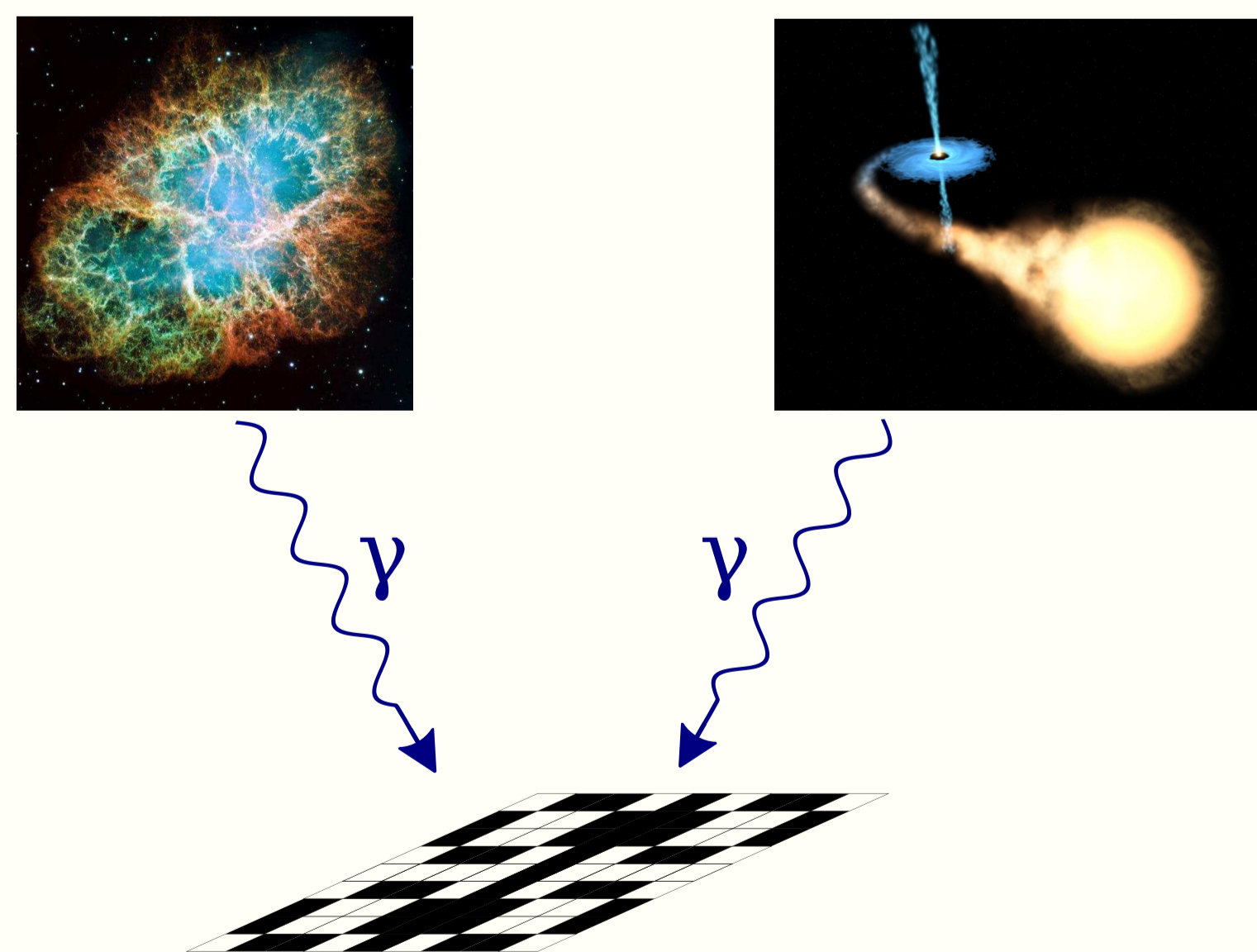


It is possible to select among various data products, such as an event file, a spectrum, a light curve, or the SIMPUT file with the source definition, which are delivered by the web application.

WFM Simulations

In order to study the source detection capabilities of the WFM on *LOFT* we produce **photons lists** for wide sections of the sky based on the **source catalogs** presented on the right-hand side. This corresponds to the first step in the simulation pipeline presented above. In addition to the observable sources we include a catalog with a large number of randomly distributed sources making up the Cosmic X-ray Background.

In the generated photon lists the arrival time, the energy, and the direction of origin in terms of RA and Dec of individual photons are specified. These lists can be further processed with models for the coded mask and the detector of the instrument. The performance of the instrument and the applied image-reconstruction algorithms can be investigated by comparing the simulated data with the input catalogs.



Source Catalogs

As input data for simulations we have assembled various source catalogs stored in different SIMPUT files. The sources in the catalogs are partly taken from real observations, partly they are generated according to common models for source distributions.

- ROSAT All-Sky Survey (BSC & FSC)
- catalog with ASM (*RXTE*) sources (time variability → WFM)
- pulsars
- AGN (modelling the Cosmic X-ray Background according to Gilli et al. 2007)
- galaxy clusters (according to Tinker et al. 2008 and Vikhlinin et al. 2009)
- local fields such as galactic center region and *Chandra* Deep Field South

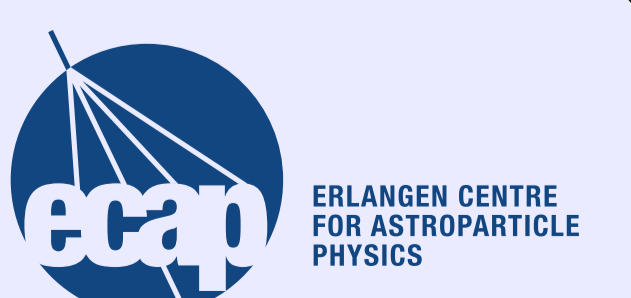
As far as available the catalogs contain realistic source spectra and time-variability (if applicable). The spatial extension of the galaxy clusters is defined via a sample of observed images.

References & Acknowledgments



Campana R. et al., 2011, NIMPA 633, 22
 Feroci M. et al., 2011, ExA, Online First, 100
 Gilli R. et al., 2007, A&A 463, 79

Schmid C. et al., 2011, "SIMPUT"
 Tinker et al. 2008, ApJ 688, 709
 Vikhlinin et al. 2009, ApJ 692, 1033



This research was funded by the German BMWi under DLR grant number 50 QR 0903.