LOFT Simulation Toolkit

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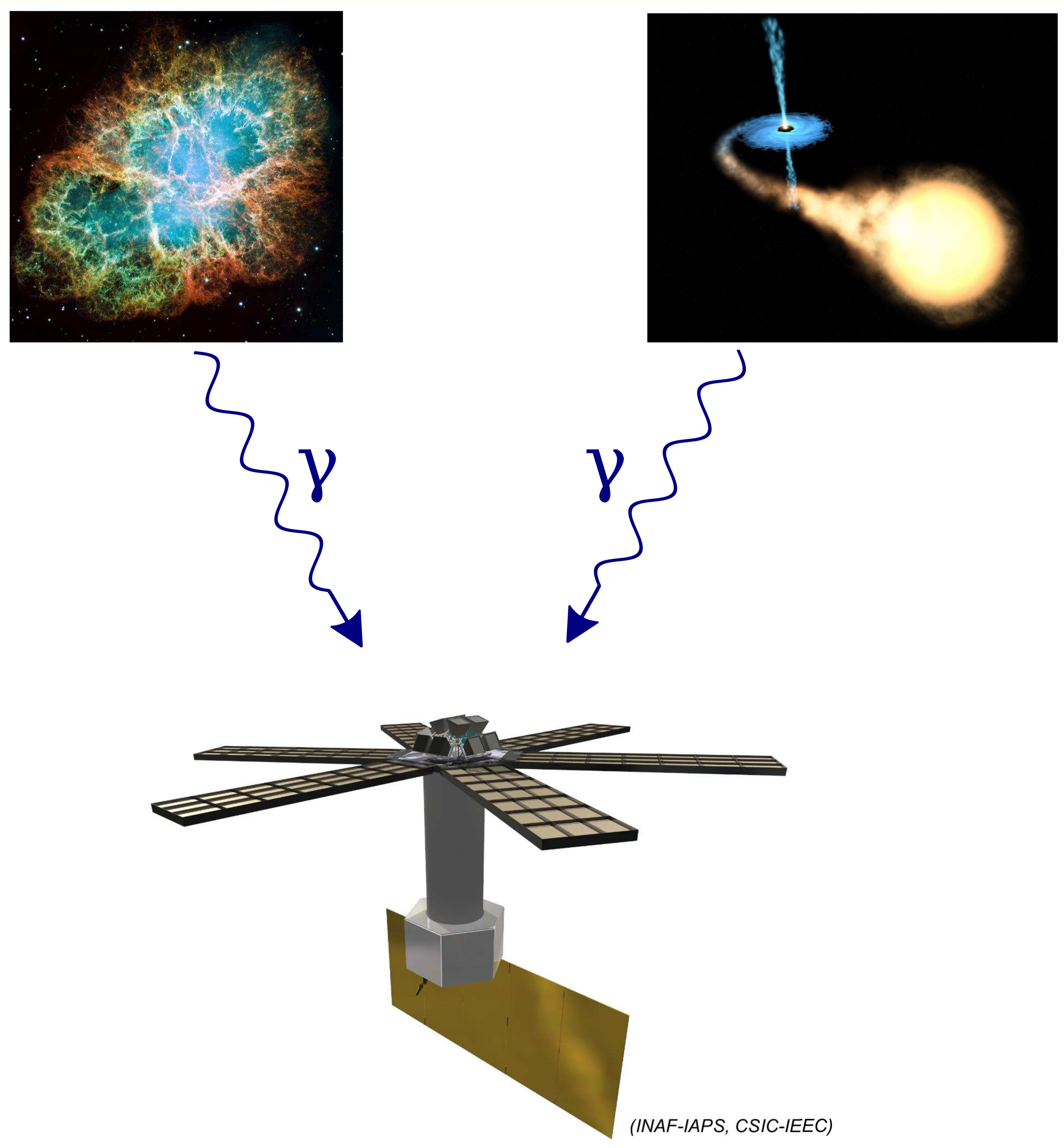
Abstract

The *Large Observatory For X-ray Timing* (*LOFT*) has been selected by ESA as a candidate for the Cosmic Vision M3 mission. The mission concept comprises a Large Area Detector (LAD), which is a collimated instrument with an assembly of Silicon Drift Detectors providing an effective area of $\sim 10\,\mathrm{m}^2$ at 8 keV and excellent timing capabilities. The second instrument aboard *LOFT*, the Wide Field Monitor (WFM), consists of several coded mask cameras monitoring a large fraction of the sky and therefore providing the capability to detect transient events.

We have developed a simulation software in order to investigate the performance of *LOFT* during the current assessment phase. It comprises a model of the LAD and allows to generate a sample of virtual photons that can be further processed with an instrument simulation of the WFM developed at INAF/IAPS Roma. We provide access via a web interface to simulate observations with the LAD. The definition of the X-ray sources required as input for the simulations is done via the SIMPUT format.
On this poster we present the general setup of the simulation software and show an analysis of the timing performance of the LAD as an example illustrating its capabilites.

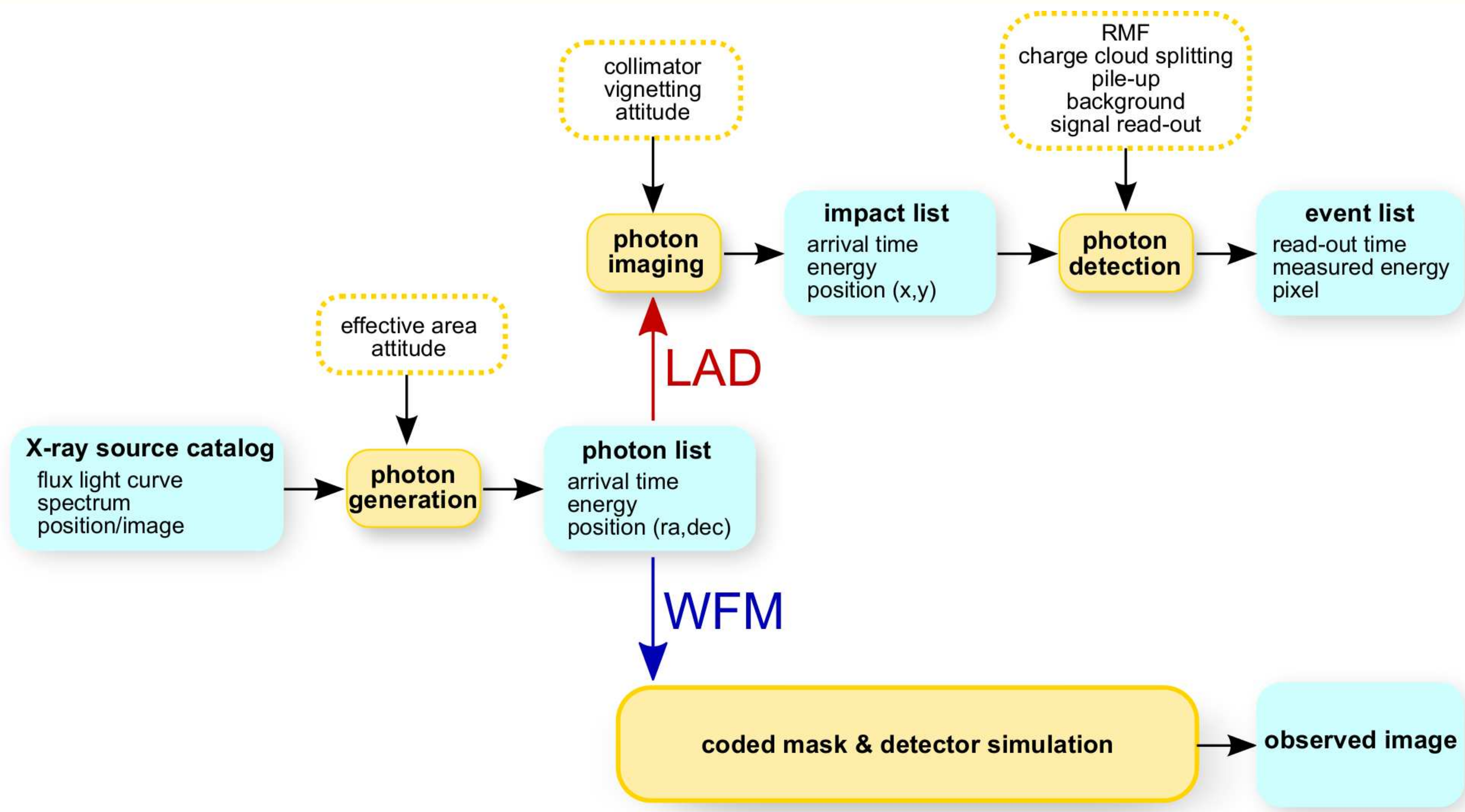
Simulation Software

We have developed a Monte Carlo simulation toolkit for the performance analysis of astronomical X-ray instruments, which is based on the handling of individual photons. It has originally been established for eROSITA on *SRG* and *IXO*/*Athena*. The software 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. The package contains pre-defined models for a variety of different instruments with easily adjustable parameters based on XML description files.
This simulation software package can be used for investigations of the technical and scientific performance of *LOFT* (for a description of the mission see the poster by E. Bozzo).



(INAF-IAPS, CSIC-IEEC)

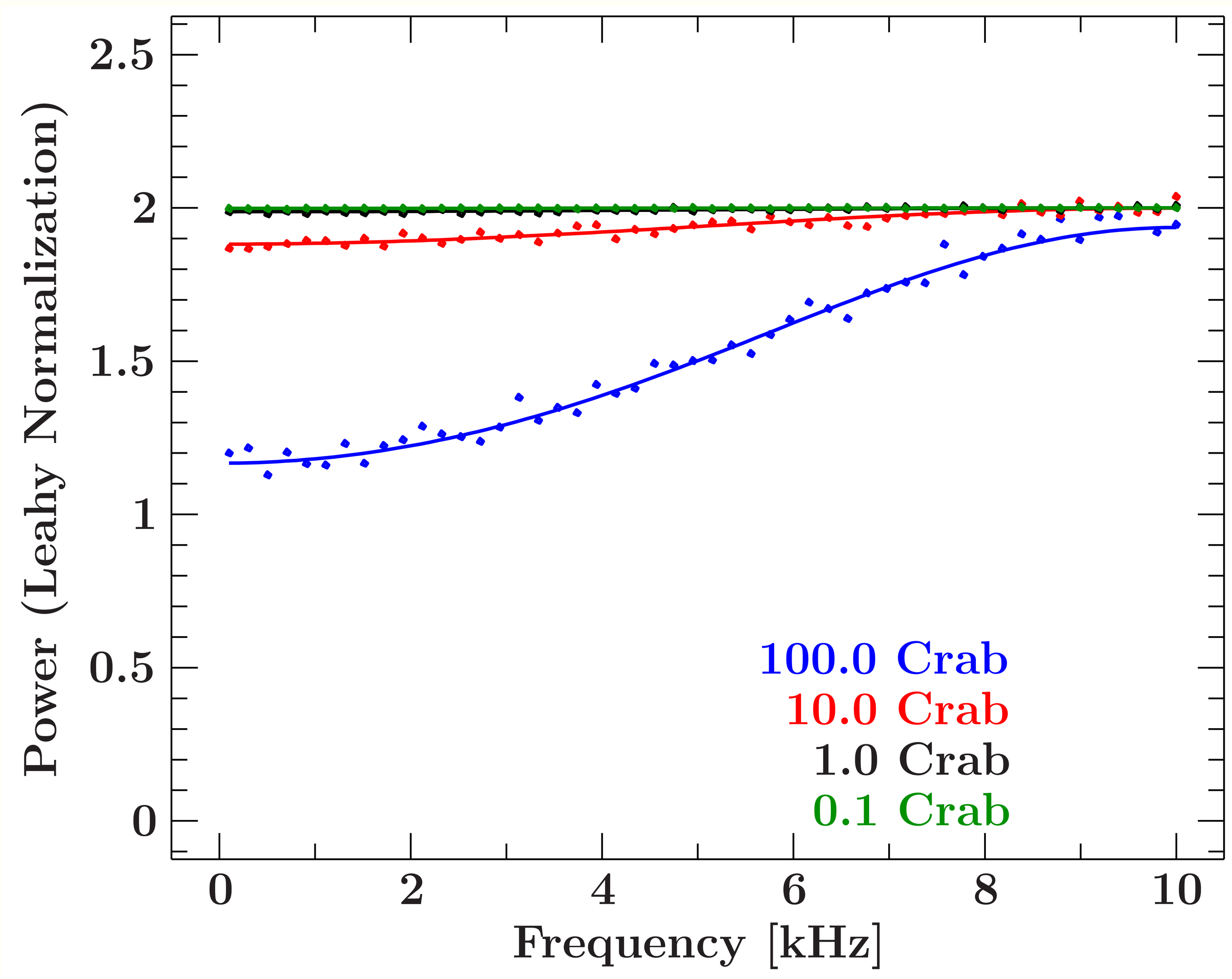
A particular simulation is set up as a pipeline of the relevant tasks such as the generation of a sample of X-ray photons, the absorption of photons by a collimator, and the photon detection by the respective detector.
Due to its modularity the first part of the pipeline, which is responsible for the photon generation, can be used for the LAD as well as for the WFM. For the definition of the observed X-ray sources as the input data for the simulation, we use the SIMPUT file format (`http://hea-www.harvard.edu/HEASARC/formats/simput-1.0.0.pdf`), which provides a powerful approach to describe astronomical sources.



Our model of the LAD consists of the 6 instrument panels. The illumination of the Silicon Drift Detectors (SDDs) is determined by the collimator in front of the LAD panels.
In the simulation the instrument characteristics such as the collimator and detector properties are defined by standard calibration files such as an ARF and an RMF. The pointing direction is specified in a particular attitude file. Depending on the impact position of an individual photon, the spread of the charge cloud produced in the corresponding SDD and the signal measured at the respective anodes is calculated according to the model presented by Campana et al. (2011). The signal processing is implemented in a simplified but appropriate way in order to analyse phenomena such as dead time effects or pile-up.
For the WFM we use the same algorithm as for the LAD to produce a sample of individual X-ray photons for a particular observation scenario. These photons are then processed in a model that is developed at INAF-IAPS Roma and resembles the absorption process by the coded mask and the underneath SDD (Donnarumma et al., 2012, Evangelista et al., 2012).

LAD Dead Time Analysis

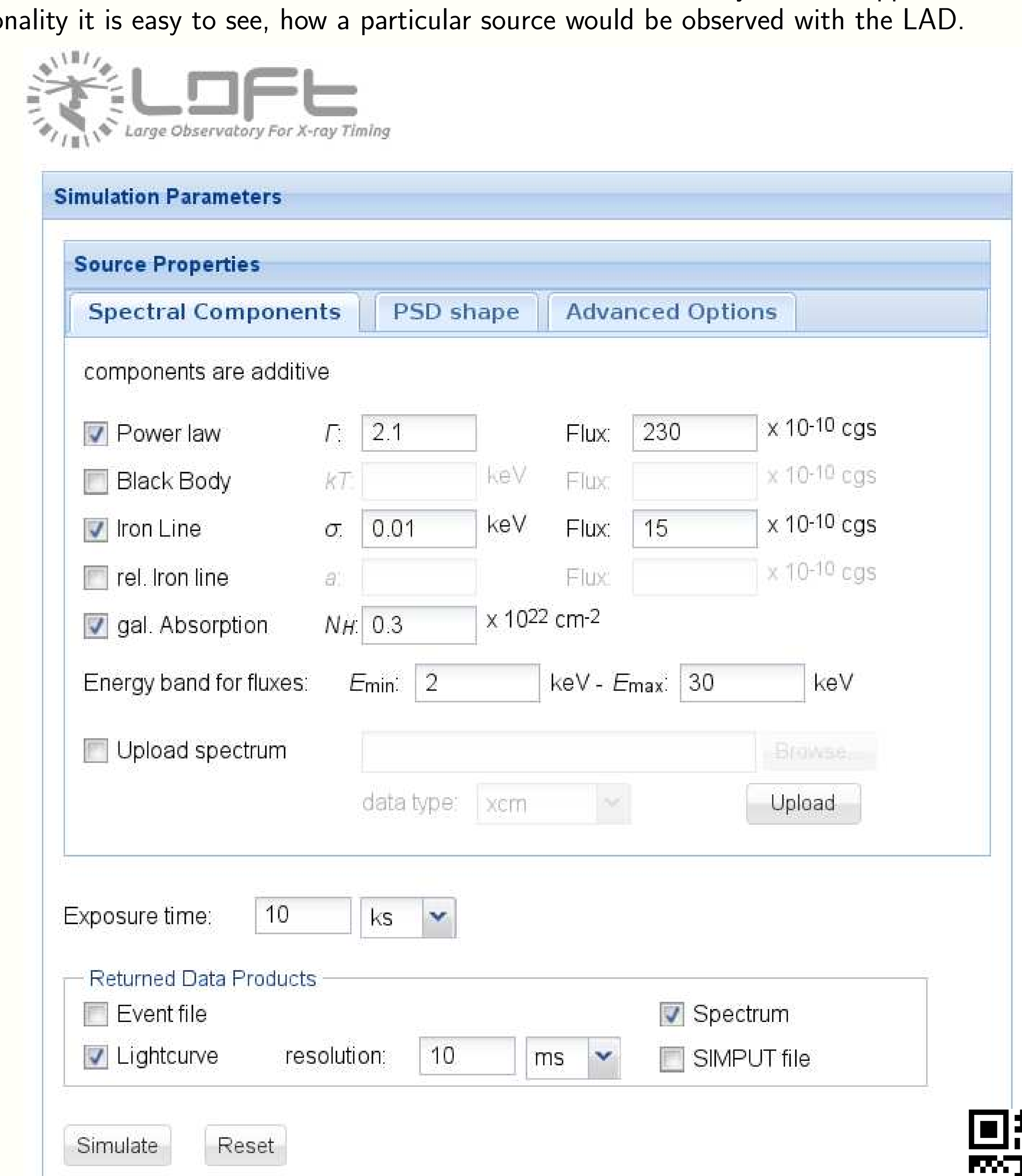
Due to the implemented approach, the simulation software allows the investigation of detector-specific features such as dead time effects. The plot below displays a power spectrum in comparison between an analytical dead time model (according to Zhang et al., 1995) and the corresponding simulations. The LAD is well suitable for observations up to several Crab without being affected by any significant dead time effects. For even brighter sources the observed power spectrum exhibits particular features, as shown by both data sets. These effects have to be taken into account for data analysis.



For a more advanced analysis additional complicated effects have to be included in the analysis, which lie beyond the scope of an analytical model.

Web Interface for LAD Simulations

For quick access to simulations we provide a web interface for our model of the LAD. It allows to define a model of a point-like source with an energy spectrum assembled from different components and an optional time-variability. Alternatively, the user can also 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. With this functionality it is easy to see, how a particular source would be observed with the LAD.



`http://cetus.sternwarte.uni-erlangen.de/~loftsim/`

References & Acknowledgements

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