High Energy Solar Physics Data in Europe
(HESPE)

Grant Agreement no.: 263086

Beneficiaries

- **Università di Genova (UNIGE)***
- **Fachhochschule Nortwestschweiz (FHNW)**
- **University of Glasgow (UNIGLA)**
- **Universitaet Graz (UNIGRA)**
- **Centre National de la Recherche Scientifique (CNRS)**
- **University of California at Berkeley (UCB)**

*** NASA Goddard Space Flight Center (GSFC) and CNR - SPIN, Genova (CNR) are 'Third Party' in UNIGE**

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Deliverable D6.1: Publication of database: Publication of database of synthetic instrument-independent visibilities (Month 36)

High-energy visibilities are spatial Fourier components of the count distribution recorded by the satellite detectors at a given energy channel and for a given time interval. The dependences of these observations on the hardware characteristics are at two levels:

1. Each hard X-ray satellite samples the two-dimensional space of spatial frequencies (the so-called (u,v) plane) according to a specific sampling rule, which depends on factors like the mutual orientation of the grids, the dimension of the slits and slats and the possible rotation speed (see Figure 1, containing some examples).
2. The process that transforms the incoming photon flux into count visibilities is modeled by a Detector Response Matrix (DRM) whose entries mimic effects like the geometric area of the detectors, the grid-pair transmission, the blanket transmission or the detector resolution.

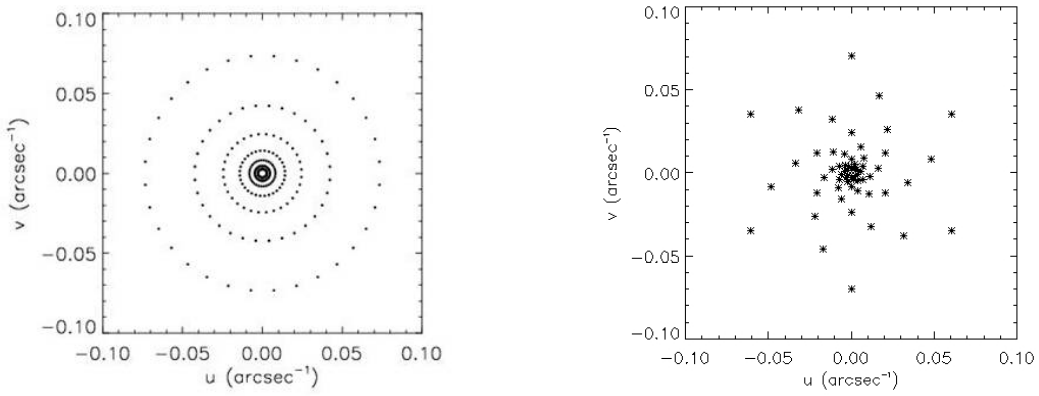

Figure 1. Sampling of the spatial frequency plane. Left: RHESSI. Right: STIX

It follows that hardware-independent visibilities correspond to a mathematical idealization represented by the Fourier transform of the photon flux distribution, possibly sampled everywhere in the spatial frequency plane. The realization of a simulated visibility bag associated to a specific instrument is obtained by picking up, from the complete set of visibilities, just the components selected by the sampling rule of that instrument, by introducing the hardware-dependent recording effects by multiplication with its DRM and by affecting the resulting count visibilities with random noise mimicking the recording procedure.

In order to maintain a high level of independency from the hardware, this database provides sets of noise-free photon visibilities (i.e., count visibilities when the DRM is the identity matrix and the recording process ideally does not introduce noise components) associated to synthetic but

physically relevant source configurations. The (u,v) points are picked up in the frequency plane according to the sampling provided by RHESSI in a specific time interval and energy channel.

We observe that, from the perspective of a data analyst, the ideal goal of hard X-ray data exploitation would be to infer all information on the source contained in the observations just looking at the visibilities in the frequency domain, without any need to reconstruct the image in the photon domain. This database of synthetic visibilities, showing how the visibility surfaces change as a function of geometrical and physical modifications in the spatial domain, aims to allow a first step in this direction

Content of the database

For each configuration, the database provides:

- Four quick-look images representing the synthetic source configuration and the idealized Fourier transform (real part, imaginary part and amplitude).
- A .sav file of the map representing the synthetic source configuration. The map is provided as a structure containing the following 12 tags:

```
DATA            FLOAT     matrix of the intensity values
XC              FLOAT     map center (x-coordinate, arcsec)
YC              FLOAT     map center (y-coordinate, arcsec)
DX              FLOAT     pixel spacing (x-direction, arcsec)
DY              FLOAT     pixel spacing (y-direction, arcsec)
TIME            STRING    image time (UT format)
ID              STRING    unique string identifier
DUR             FLOAT     0.00000
XUNITS          STRING    units (x-axis)
YUNITS          STRING    units (y-axis)
ROLL_ANGLE      FLOAT     image roll
ROLL_CENTER     FLOAT     roll center
```

  We note that the last two tags are very 'RHESSI specific'; they have been left blank in our simulation to preserve the data generation instrument independent.
- A .sav file containing the visibility bag corresponding to the configuration. The bag is provided as a structure containing the following 15 tags:

ISC	INT	detector identification
HARM	INT	number of harmonics
ERANGE	FLOAT	energy range (keV)
TRANGE	DOUBLE	time range (UT)
U	FLOAT	spatial frequency (u, arcsec-1)
V	FLOAT	spatial frequency (v, arcsec-1)
OBSVIS	COMPLEX	visibility value
TOTFLUX	FLOAT	DC component
SIGAMP	FLOAT	error on the visibility
CHI2	FLOAT	X2 value
XYOFFSET	FLOAT	phase center
TYPE	STRING	visibility type
UNITS	STRING	units
ATTEN_STATE	INT	attenuator state
COUNT	FLOAT	stacked counts number

We note that some of these tags are meaningful just in an experimental framework. In particular, in our idealization, we set: SIGAMP = 10% of the DC component; CHI2=1; ATTEN_STATE=0; COUNT=0.

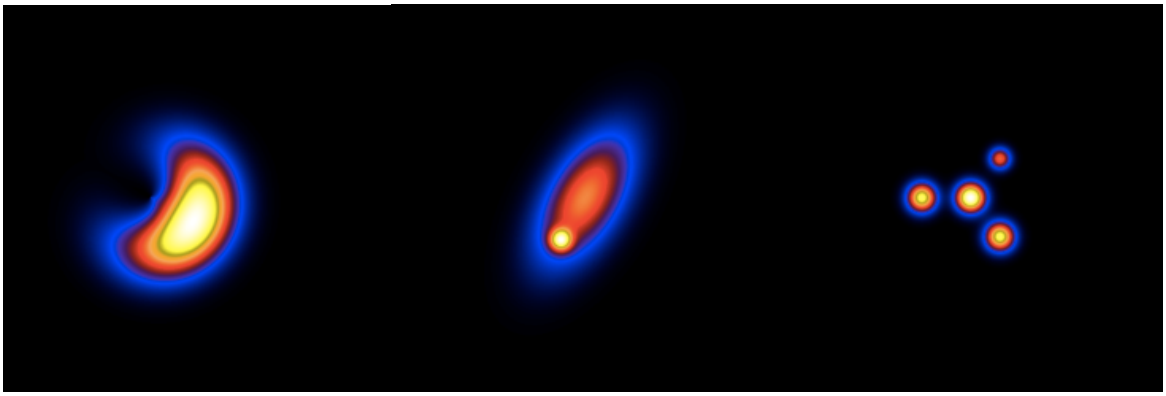

Figure 2. Realistic configurations utilized in the database

The configurations considered in the simulations are:

- A single Gaussian source with fixed width moving along either the x- or the diagonal direction.
- A single Gaussian source with increasing width and fixed position.
- Two Gaussian sources with width ratio equal to 1 and flux ratio equal to 1, moving along the y direction.

- Two Gaussian sources with width ratio equal to 2 and flux ratio equal to 1, moving along the y direction.
- Two Gaussian sources with width ratio equal to 1 and flux ratio equal to 2, moving along the y direction.
- Two Gaussian sources with width ratio equal to 2 and flux ratio equal to 2, moving along the y direction.
- Three realistic configurations mimicking three specific events occurred on: July 23 2002; August 23 2005; December 2 2003 (see Figure 2).

In order to sample the (u,v) plane, we have utilized the configuration assumed by RHESSI during the observation of the November 3 2003 event in the time interval 09:48:20 - 09:48:36 UT and in the energy channel 15-18 keV. Therefore all maps are centered in the corresponding map center, which is (922,130) arcsec.

The database is available at: http://www.hespe.eu/data/synthetic-visibilities/.