

## uv\_smooth: Basic Principles and Usage

### The RHESSI imaging concept according to uv\_smooth

- RHESSI rotating modulation collimators generate Fourier components (real and imaginary parts) in series of circles in the uv-plane;
- making images with uv\_smooth consists of:
  1. interpolating the visibilities in the uv-plane,
  2. reconstructing the image of the source by means of a fast Fourier transform inversion,
  3. reducing the ringing effects by imposing a positivity constraint.

Remark: in uv\_smooth, items 2. and 3. are performed in one shot, by means of an iterative algorithm.

### Interpolation (Figure 1)

- RHESSI samples the uv-plane in circles whose radii are signatures of the collimators;
- a real and an imaginary smooth visibility surfaces are generated by applying a thin-plate spline algorithm

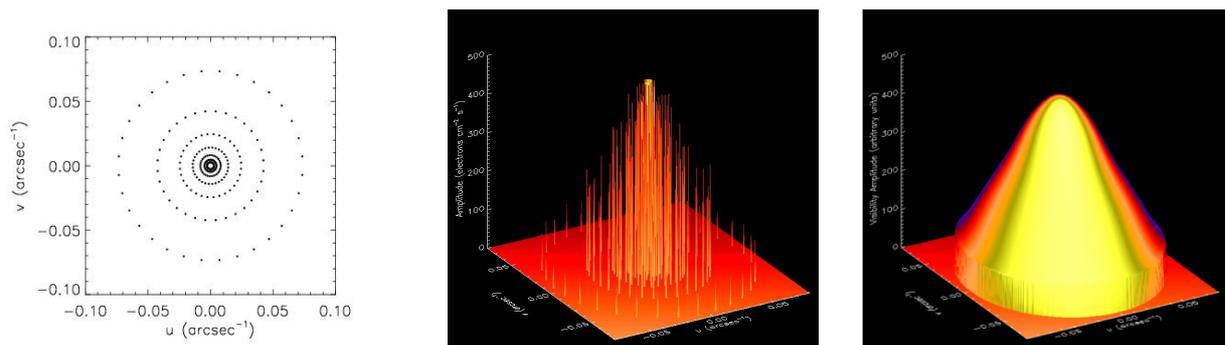


Figure 1. Left: how RHESSI samples the uv-plane; middle: visibility amplitudes; right: visibility amplitude smooth surface provided by spline interpolation

### Image reconstruction and ringing reduction (Figure 2)

- The fast Fourier transform inversion of the visibility surface is performed iteratively, by means of a successive approximation scheme;
- at each iteration all negative pixels are set to zero, thus reducing ringing effects around the source image;
- the iteration is stopped when a  $\chi$ -squared criterion is fulfilled.

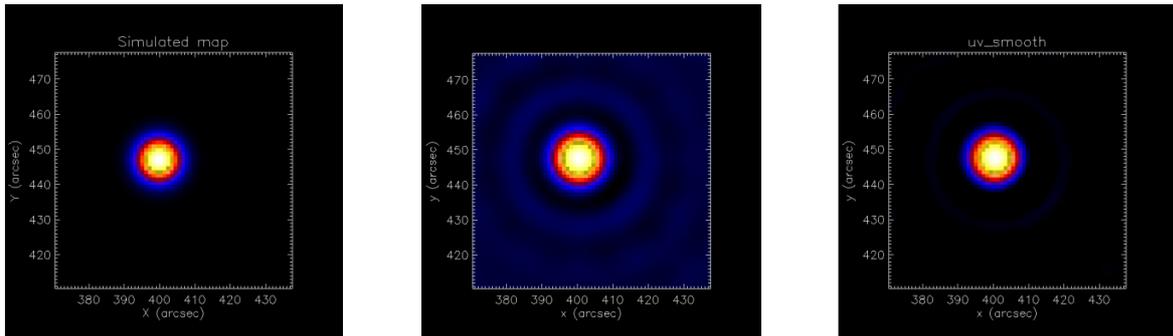


Figure 2. Left: original source; middle: Fourier transform inversion of the visibility smooth surface; right: ringing reduction by means of successive applications of the positivity constraint.

### Example: July 23 2002 (Figure 3)

- time interval: 00:29:10 – 00:30:19 UT
- collimators: 3 to 9

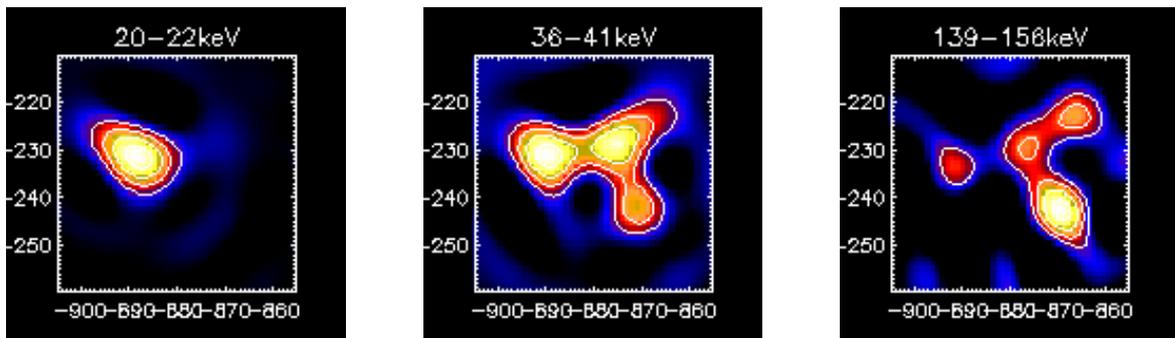


Figure 3. Left: energy channel: 20-22 keV; middle: energy channel: 36-41 keV; right: energy channel: 139-156 keV

## Current release of the software

- The gridding in the uv-plane is performed according to a cartesian sampling;
- Parameters in the GUI (Figure 4):
  - pixelsize: 1 arcsec;
  - image size: 128x128 or 64x64;
  - ‘combine conjugates’: disabled (uv\_smooth needs visibilities in all four quadrants of the uv-plane. If the user enable the ‘combination’ option, the software automatically ignores it);
  - detectors: any combination of detectors from 3 to 9.
- Output in the GUI (Figure 5):
  - reconstructed image (main window)
  - uv sampling (optional, if the flag ‘Plot visibilities’ in the ‘Visibility options’ window is enabled).

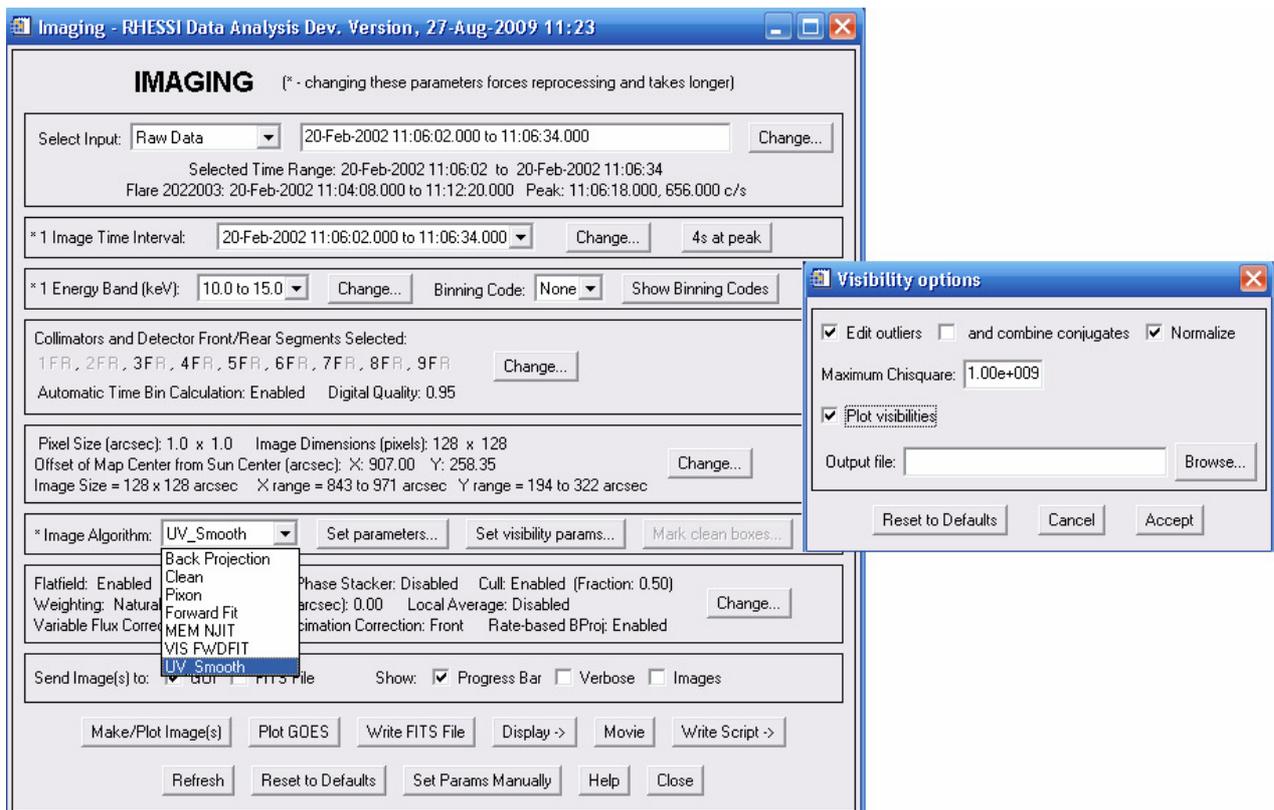


Figure 4. Input parameters in the imaging window.

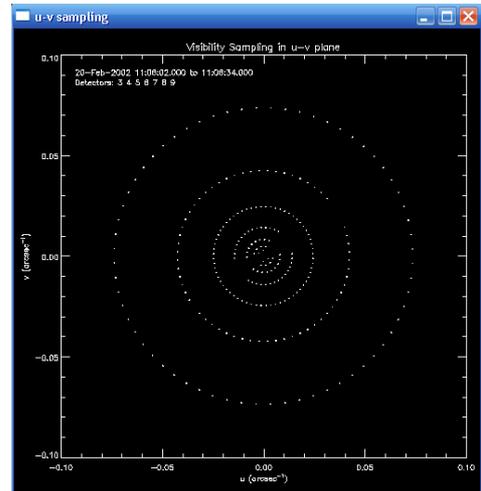
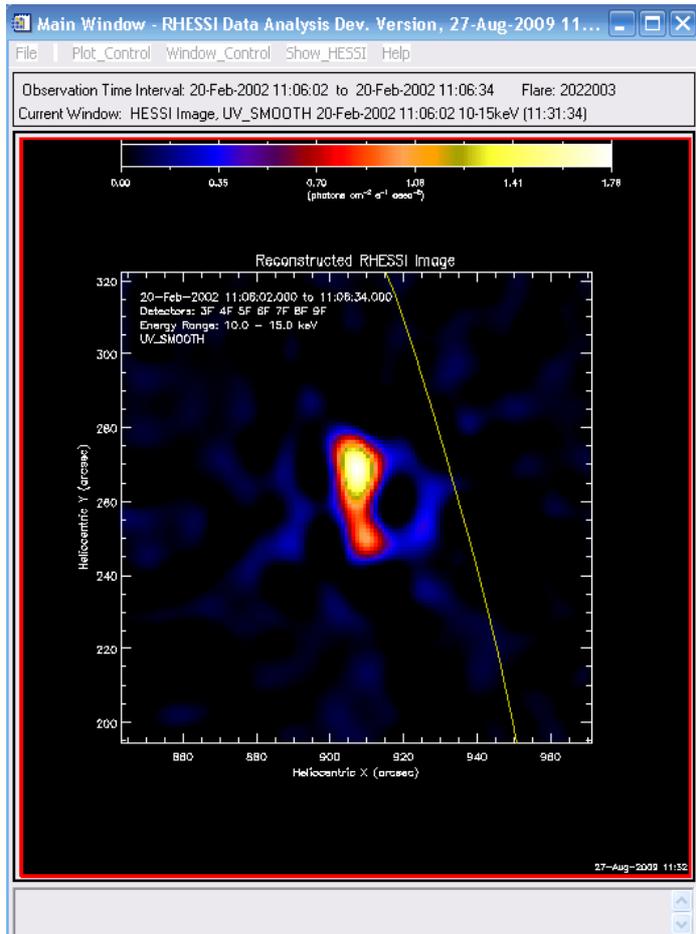


Figure 5. Output windows

## Reference

Massone A M, Emslie A G, Hurford G J, Prato M, Kontar E P and Piana Hard X-ray Imaging of Solar Flares using Interpolated Visibilities *Astrophysical Journal* 703 (2009) 2004-2016.