

# Characterizing Partially-Occulted X-ray Sources

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# A Useful Property of Visibilities

$$\int V(u)e^{iux} dx = I(x)$$

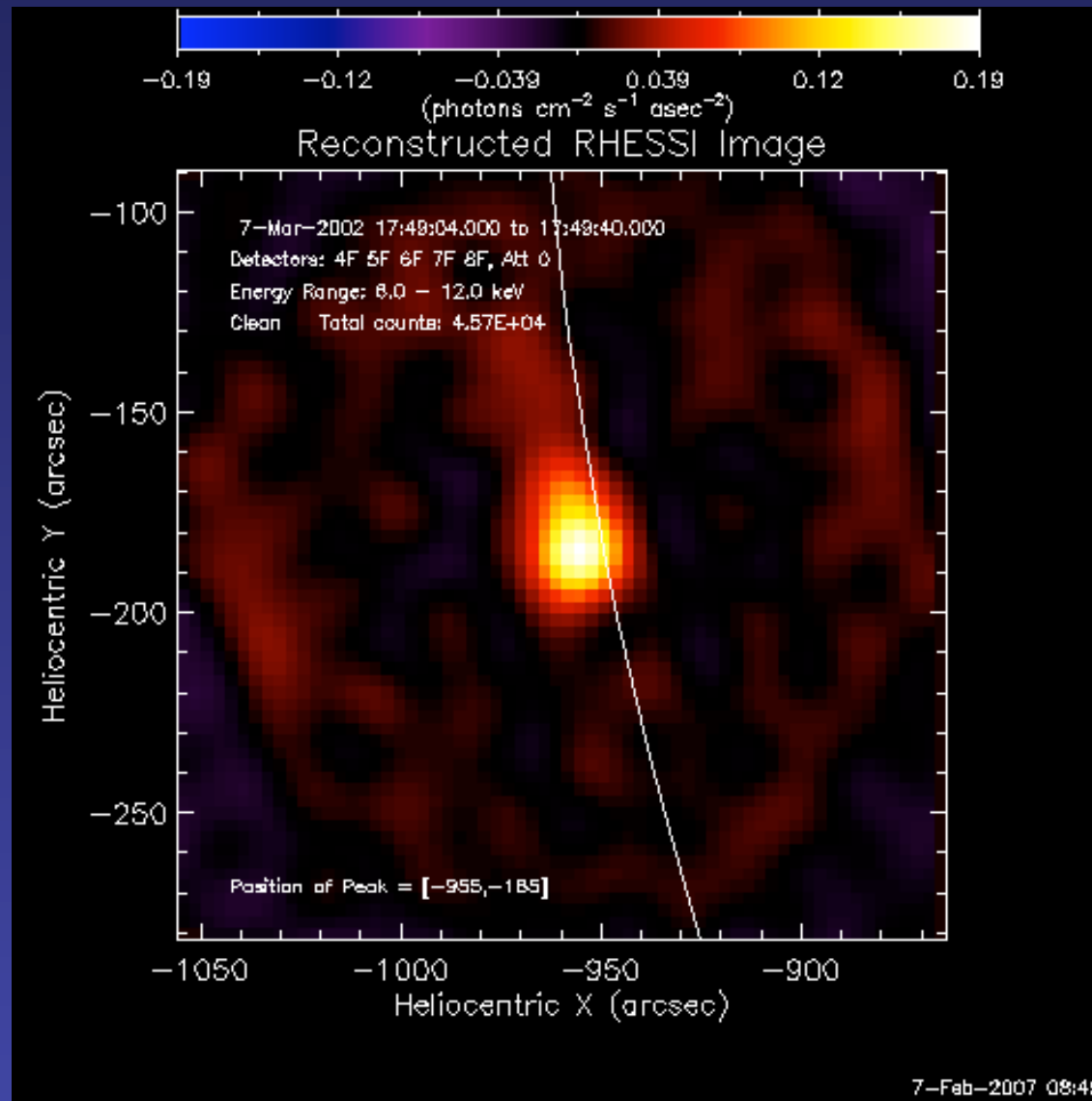
Fourier transform of  $\{V(u)\} \rightarrow$  Map of  $I(x)$

$$\int iuV(u)e^{iux} dx = dI(x) / dx$$

Fourier Transform of  $\{iuV(u)\} \rightarrow$  Map of  $dI(x)/dx$   
(noise-free transformation)

- Can use visibilities to map spatial derivative of source
- Provides basis for mapping sharp edges since  $dI(x) / dx$  of a step function = delta function

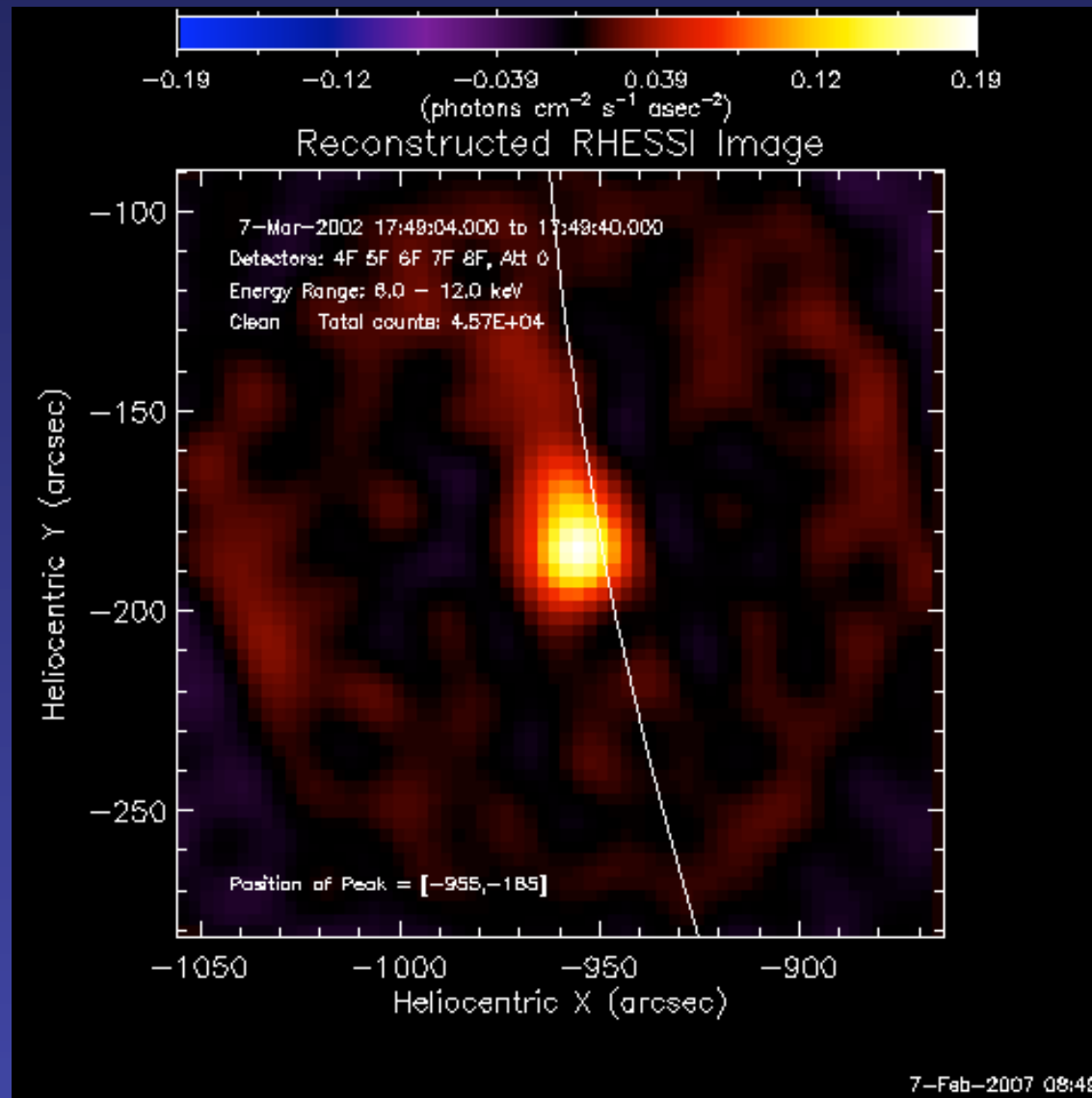
# Typical image of a Limb Flare



What is the altitude and size of the x-ray source ?

7 March 2002 17:47 6-12 keV

# Typical image of a Limb Flare

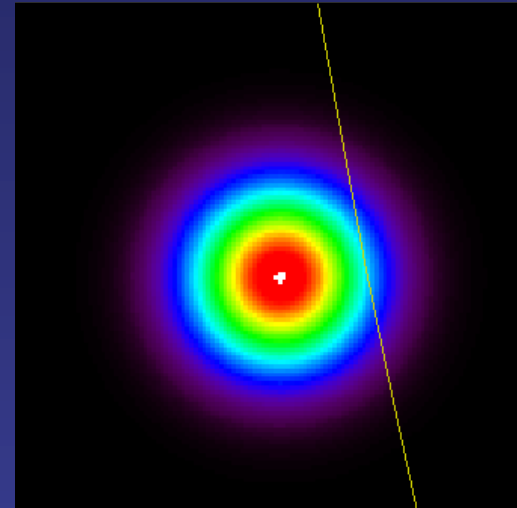
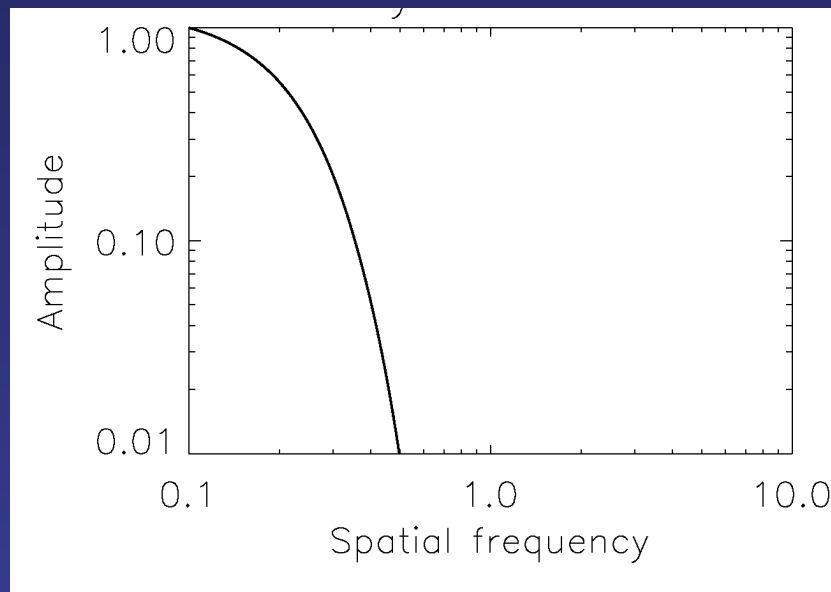


What is the altitude  
and size of the x-ray  
source ?

**Is the source  
partially occulted?**

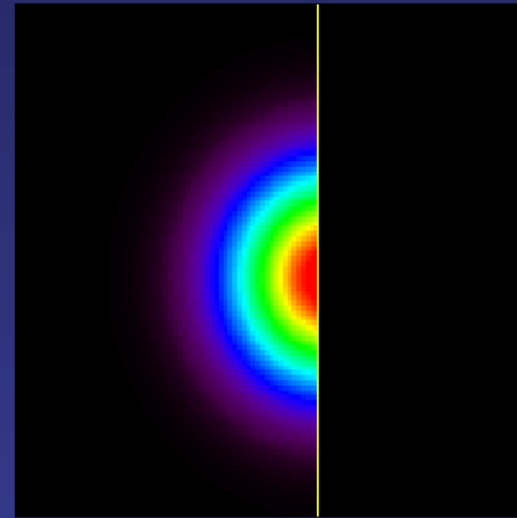
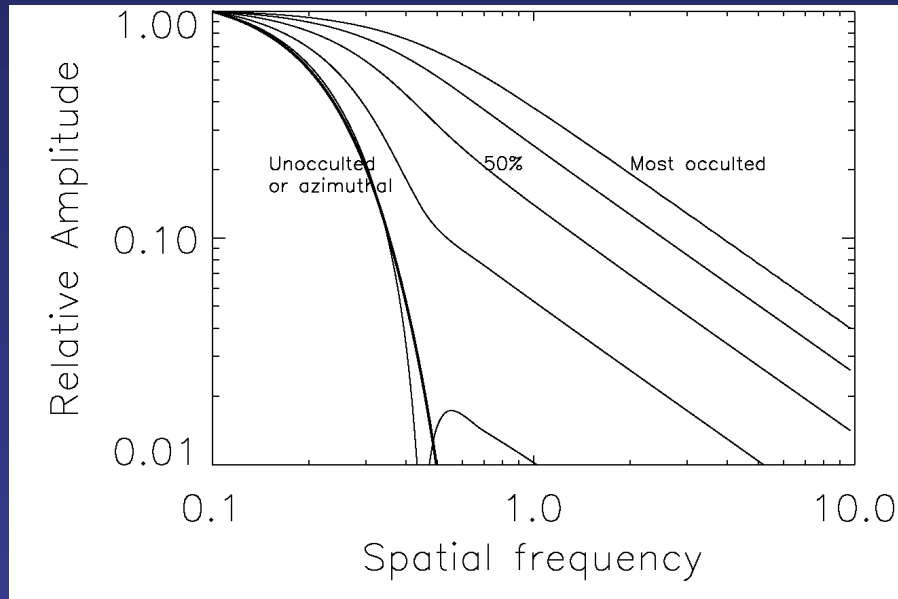
7 March 2002 17:47 6-12 keV

# Relative visibility of a Gaussian



Decrease in relative amplitude with increasing spatial frequency is the basis for measurement of source sizes

# Relative visibility of an Occulted Gaussian

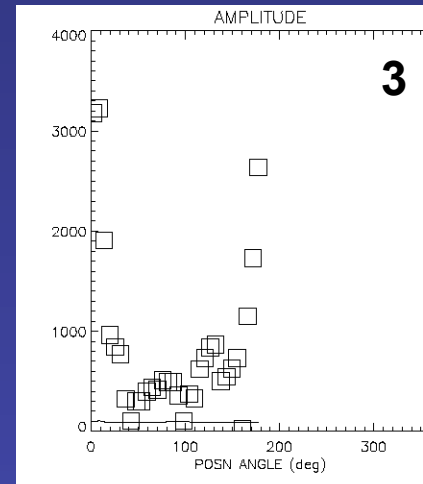
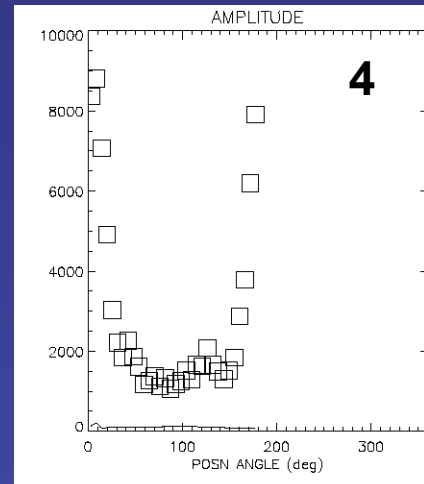
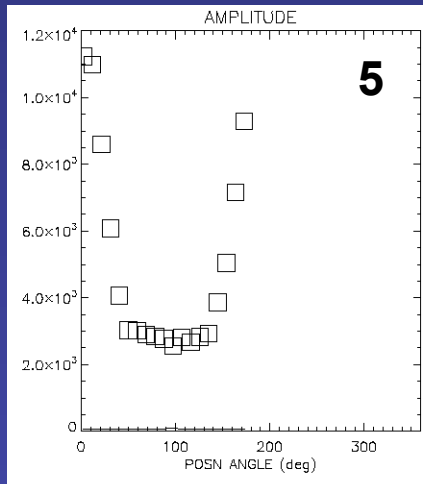
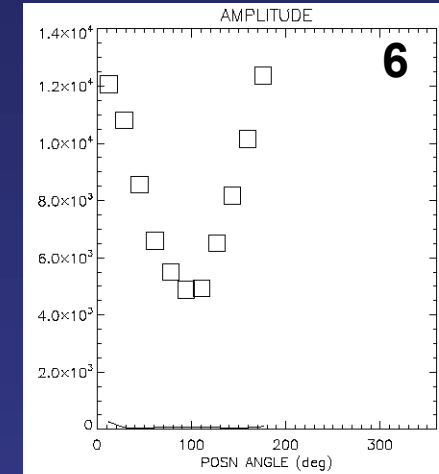
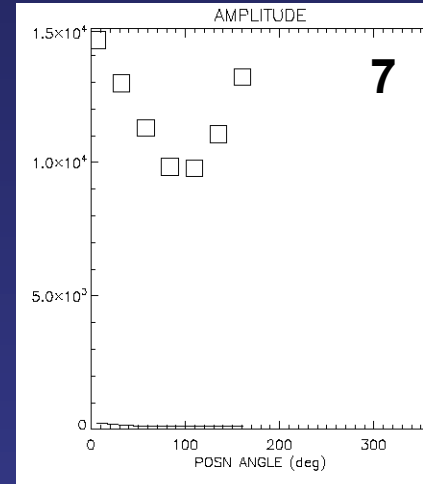
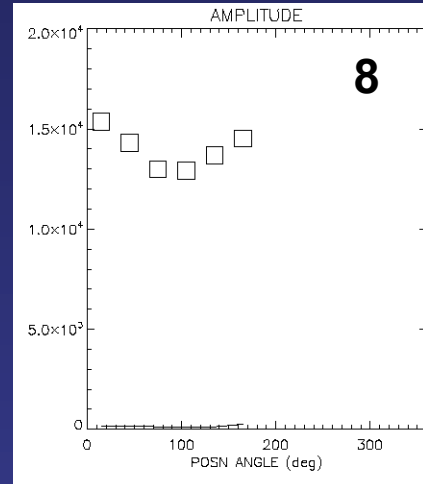
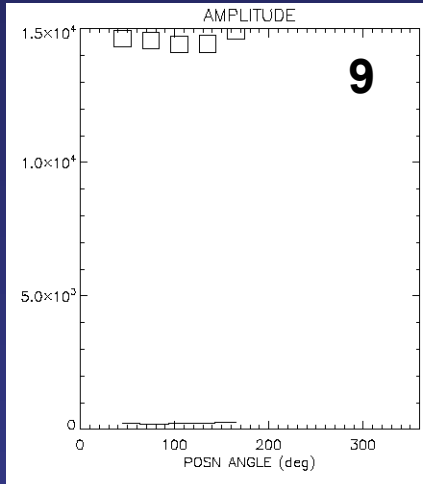


Note the exceptionally high amplitudes when fine grids are oriented parallel to limb

→ **Signature for partially occulted sources**

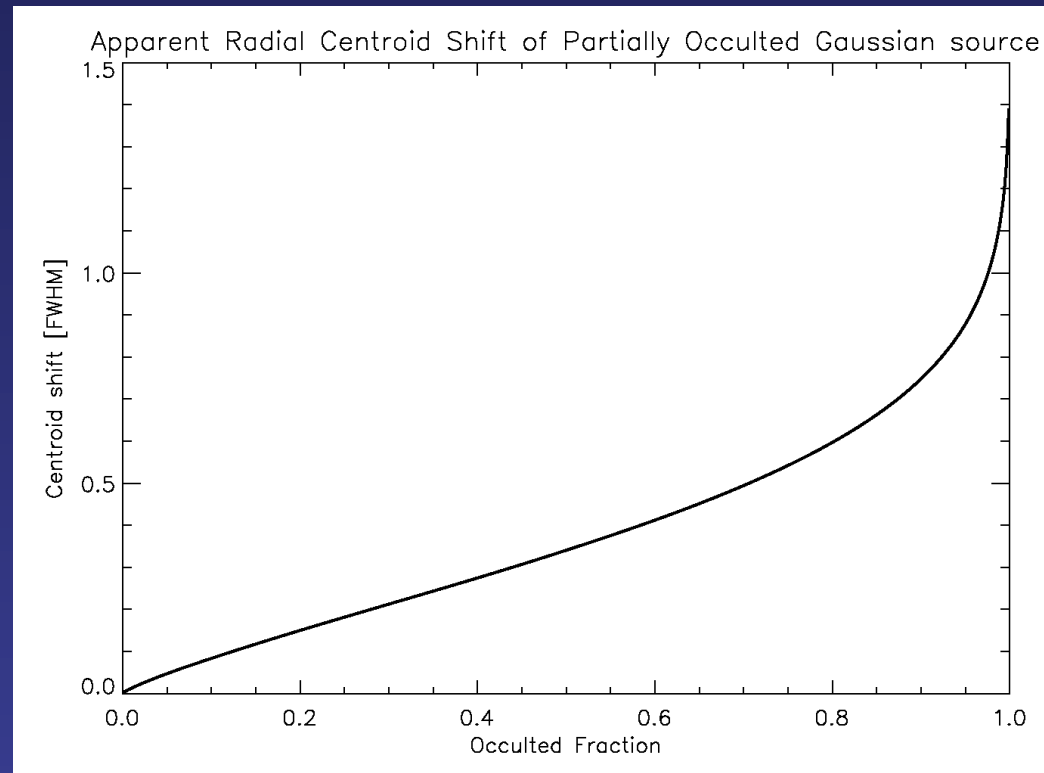
In some cases might be able to infer occultation fraction

# Visibilities Amplitudes for 7 March 2002 Event



Fine grids show large amplitudes when grids are parallel to limb

# Effects of Occultation on Perception of Source



- Intrinsic source flux is underestimated
- Apparent source centroid is radially displaced from intrinsic centroid
- Apparent radial FWHM of source is less than intrinsic radial FWHM

➔ Must be sure source is not partially occulted or make appropriate corrections



# Potential Applications

- Occultation corrections to measurements of limb source sizes and positions.
- Can be exploited to provide new insight into source *shapes*
  - (next logical step after flux, location, size)
  - Hybrid algorithm to simultaneously map  $I(x)$  and  $dI(x) / dx$  ?
- RHESSI could give VERY accurate limb positions and profiles as a function of energy and time
  - (evaporation, chromospheric structure, etc)
- May provide basis of a technique for absolute aspect calibration of STIX

# Next steps

- Exploit phase information
  - Can distinguish intrinsically flat from occulted sources.
- Write module to make 1-D radial profiles maps
  - in progress
- Make in hsi\_vis\_fwdfit provision for occulted gaussian profile.
  - in progress
- Investigate and exploit harmonic enhancement
- Put modules online for general use
- Apply to a set of occulted events to gain insight into x-ray limb profiles.
- See if any disk sources have sharp edges