RHESSI as a Monitor of the Hard X-Ray Sky

Mark McConnell (UNH), David Smith (UCB),
Valerie Connaughton (UAH), Jim Ling (JPL),
Bill Wheaton (JPL), Colleen Wilson-Hodge (MSFC)

The RHESSI Mission

Ramaty High Energy Solar Spectroscopic Imager

600 km orbit, 38° inclination

Launched 5 Feb 2002

Arcsecond imaging of the Sun in the 3 keV – 20 MeV energy range

Imaging achieved using Rotation Modulation Collimators

Array of 9 Ge detectors

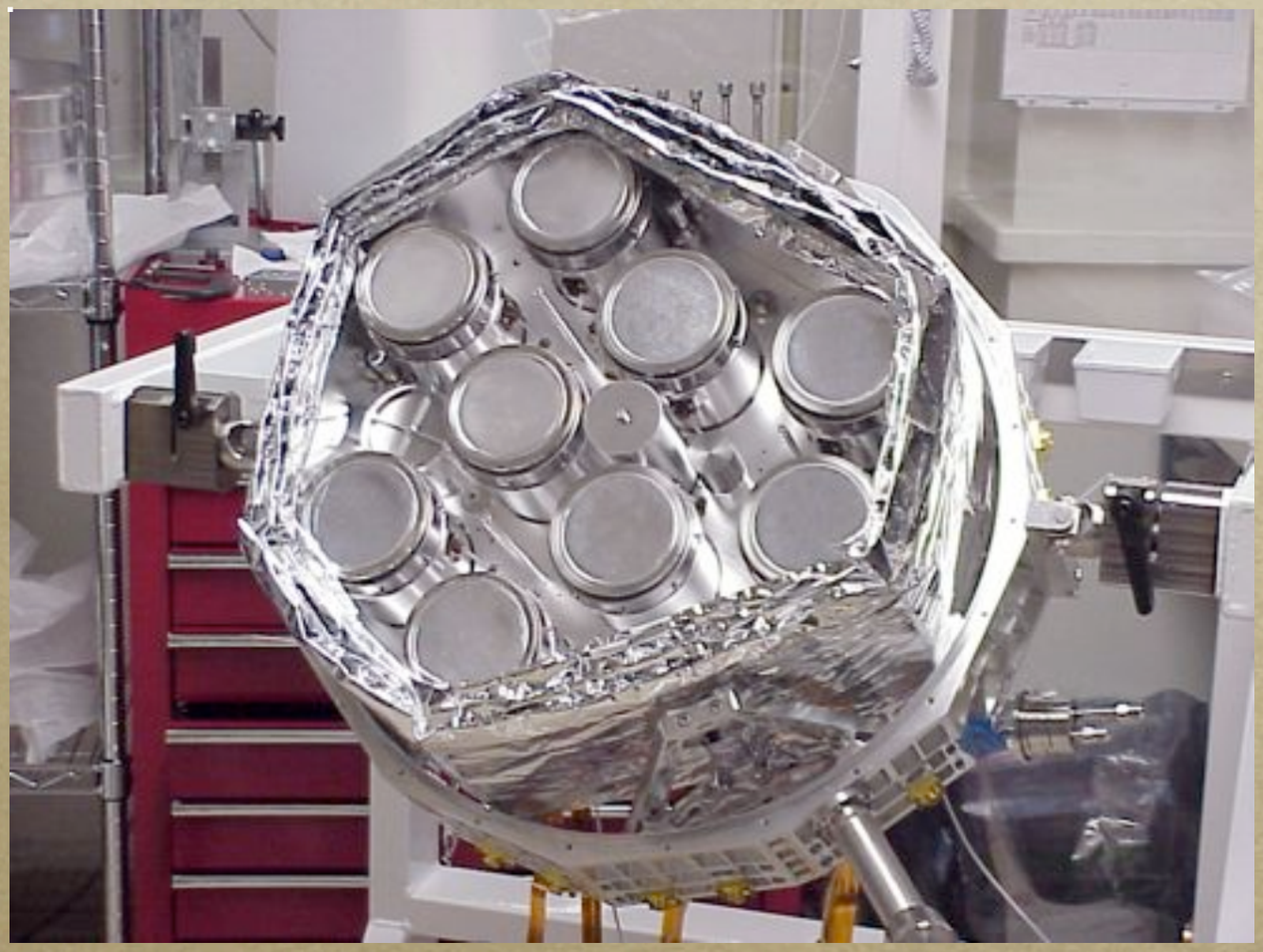
RHESSI Imaging

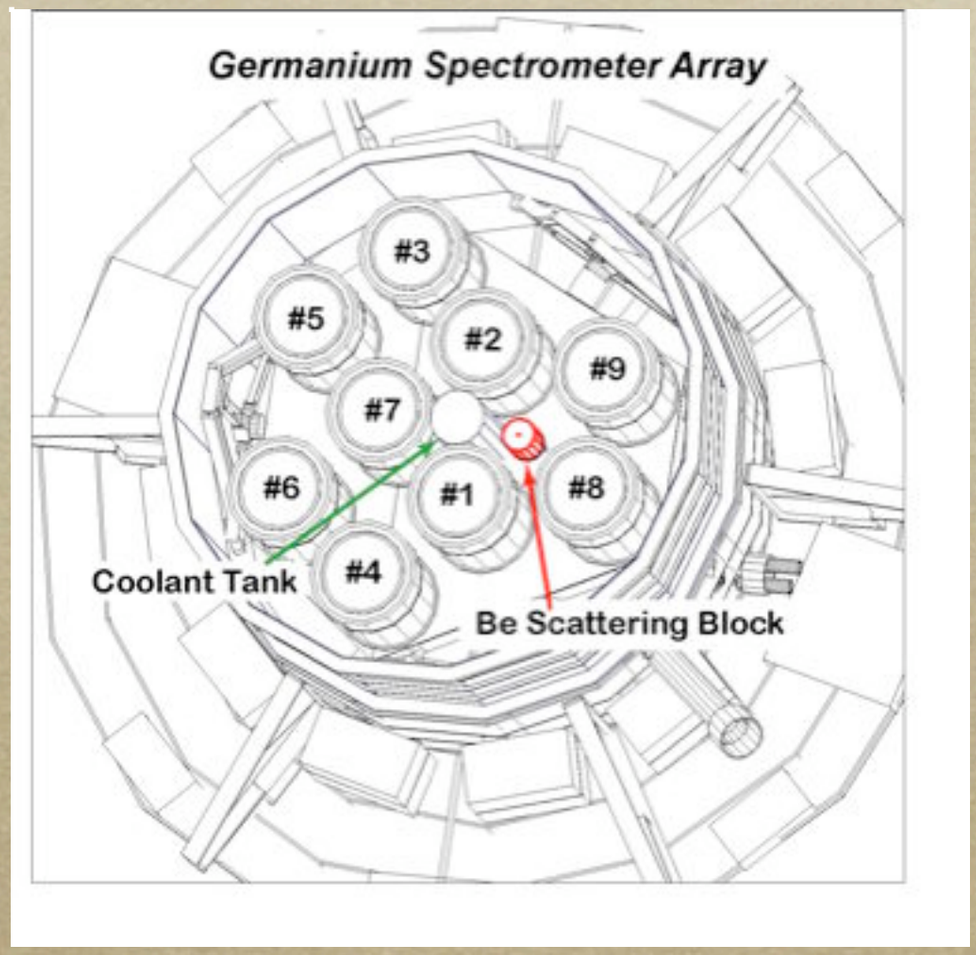
Characteristics :

- *Energy-dependent angular resolution*
  - *2.3" at 30 keV*
  - *36" at 10 MeV*
- *Limited field-of-view ~ 1°*
- *Follows the Sun along the ecliptic*

Non-Solar studies cannot generally rely on imaging mode of RHESSI...

RHESSI Detector Array

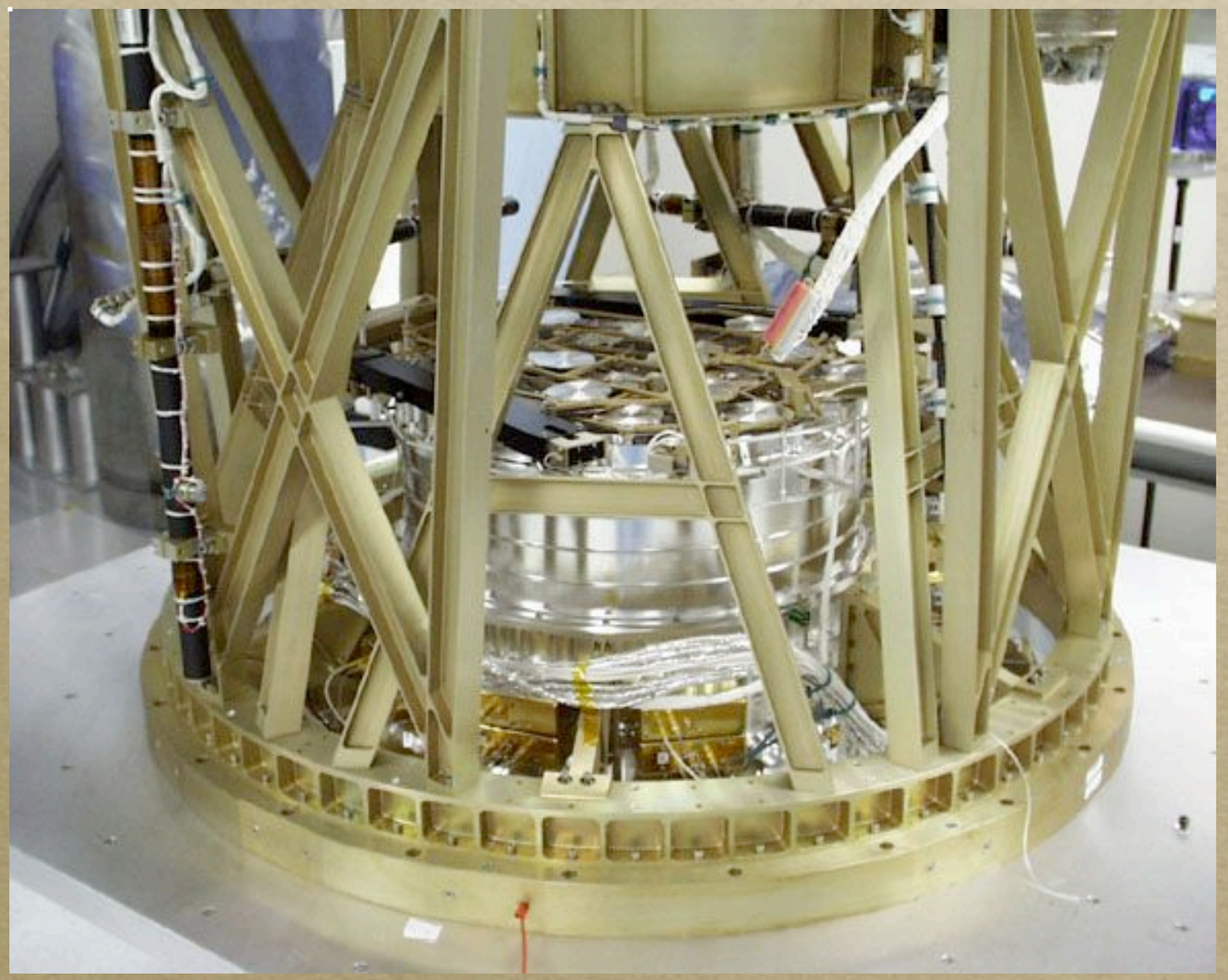




Array of nine coaxial Ge detectors (~7.1 cm diam x 8.5 cm long) cover energy range from 3 keV to 20 MeV.

Spacecraft Structure

The unshielded array of Ge detectors is surrounded by a minimal amount of spacecraft mass. Photons above ~20 keV can readily reach the detector array.



RHESSI Methods for Sky Monitoring

The fact that photons can readily reach the detector array permits the use of these data for all-sky monitoring.

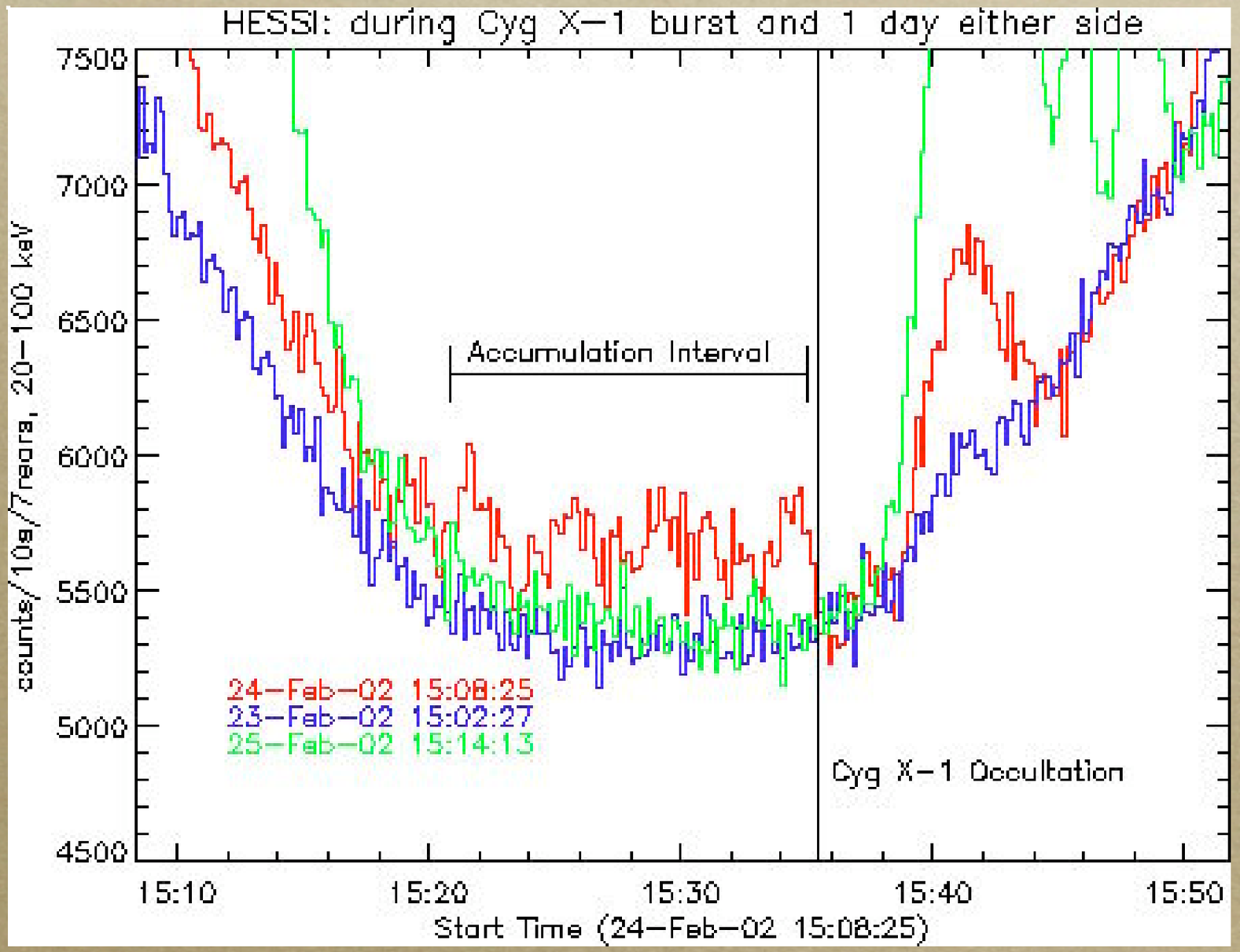
- *Earth Occultation Mode (EOM)*
  Uses source occultation by the Earth. Patterned after techniques developed by CGRO-BATSE.
- *Detector Shadowing Mode (DSM)*
  Relies on the rotation of the spacecraft and the occultation of sources by adjacent Ge detectors.

Why Use RHESSI?

- *RHESSI provides hard X-ray all-sky monitoring capability that is currently unavailable.*
- *Supplements current NASA/ESA misssions.*
- *The RHESSI sensitivity is, in some ways, better than that of CGRO/BATSE*
- *RHESSI provides high energy resolution Ge detectors.*

Earth-Occultation Mode (EOM)

Occultation steps from bright sources can sometimes be seen directly in RHESSI data.

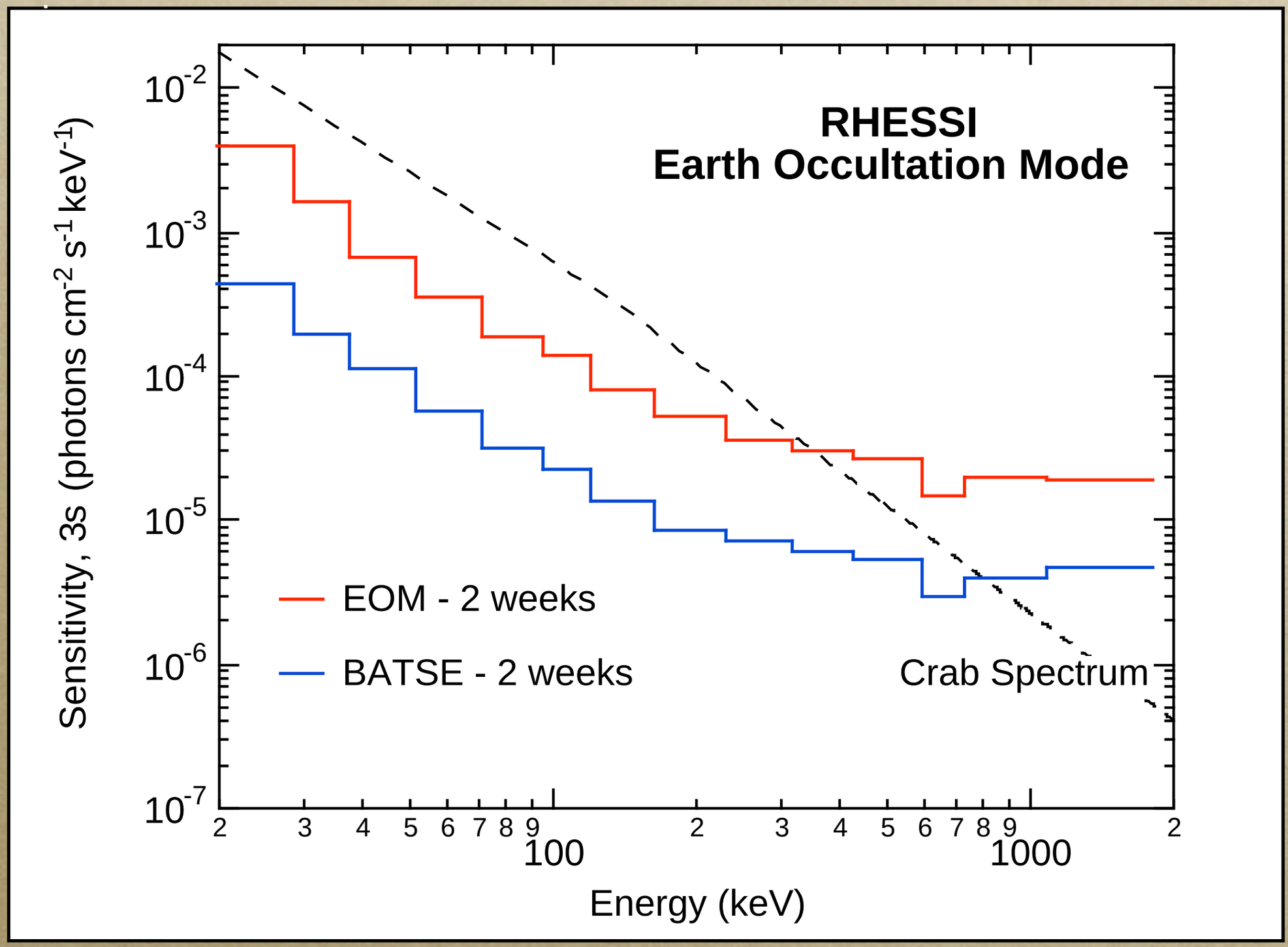


Estimating EOM Sensitivity

An estimate of the EOM sensitivity comes from a scaling of the BATSE sensitivity based on relative background and effective areas.

$$\frac{F_{RHESSI}}{F_{BATSE}} = \frac{\sqrt{B_{RHESSI} / B_{BATSE}}}{A_{RHESSI} / A_{BATSE}}$$

EOM Source Sensitivity



Detector Shadowing Mode (DSM)

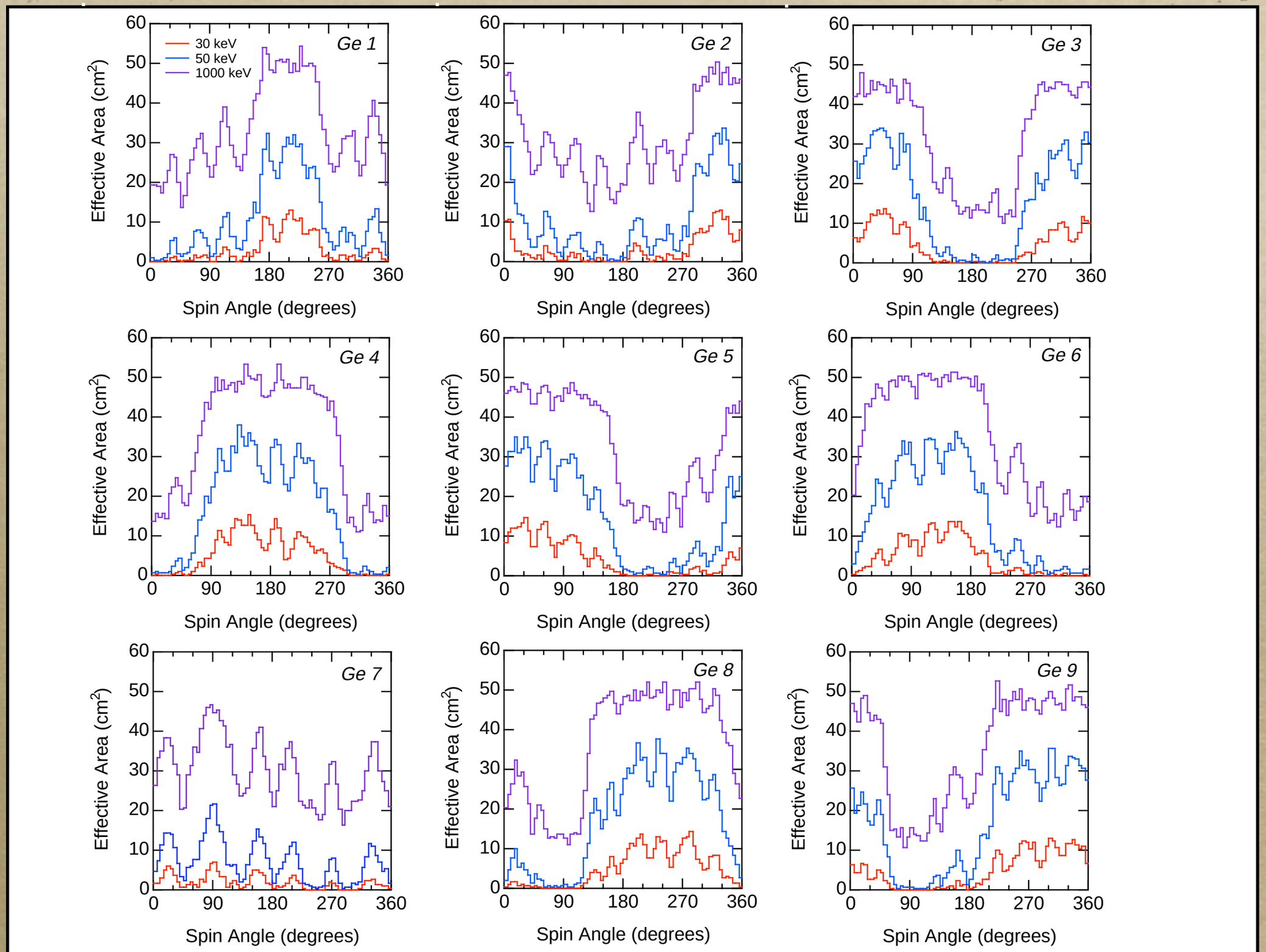
As the spacecraft rotates (~15 rpm), sources that lie in the equatorial plane of the spacecraft rotation (±30°) will be repeatedly blocked (or shadowed) by adjacent Ge detectors.

These modulation patterns vary from detector to detector and depend on the source position in the sky.

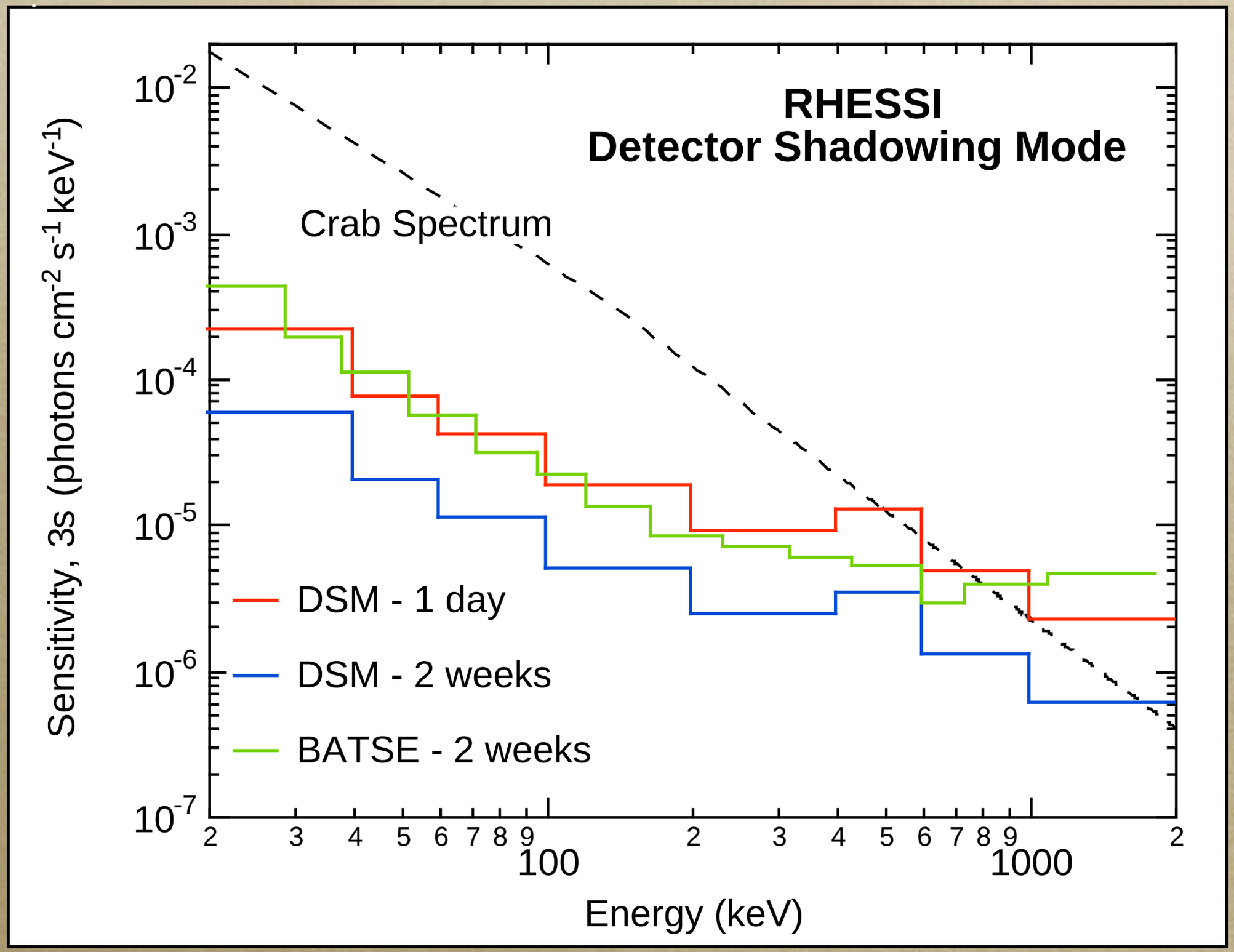
Measured modulation patterns can be used to determine source spectra.

Simulations have been used to determine the expected modulation profiles.

Detector Modulation Profiles



Estimated DSM Source Sensitivity



Summary of the Two Methods

- *<u>Earth Occultation Mode</u> (EOM) provides moderate sensitivity (relative to BATSE) over a large fraction of the sky.*
- *<u>Detector Shadowing Mode</u> (DSM) provides high sensitivity (relative to BATSE) over a more limited region of the sky.*
- *Both methods offer the possibility of high spectral resolution.*