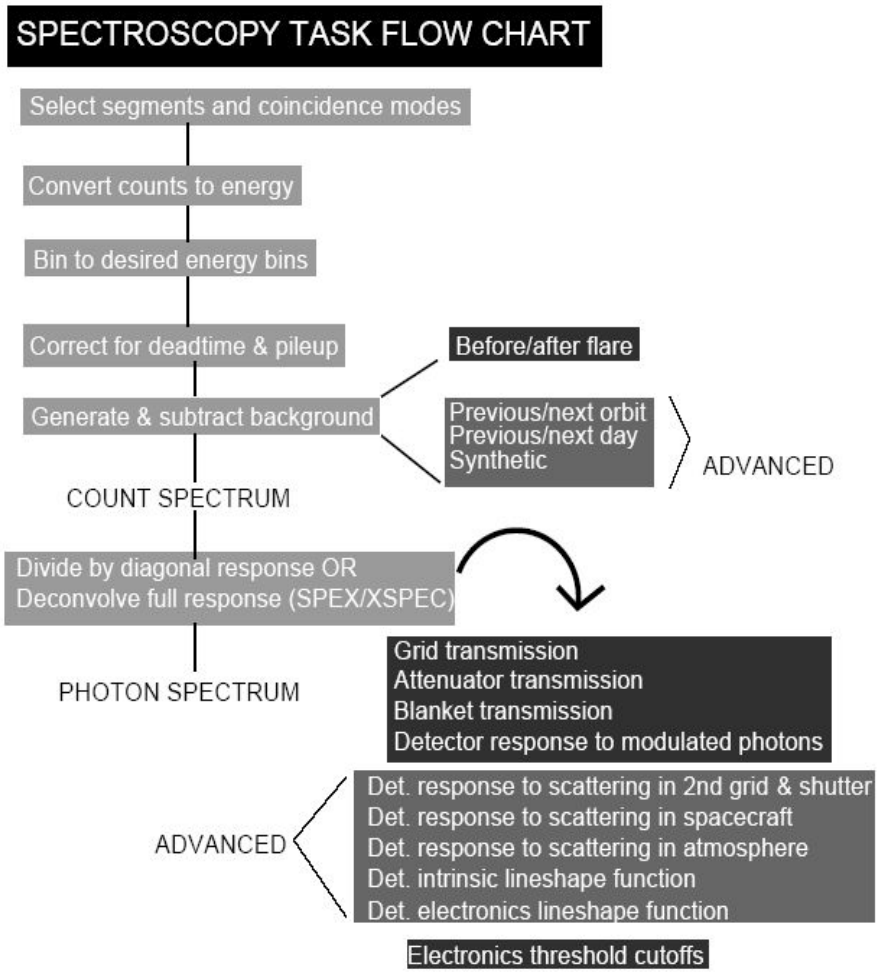
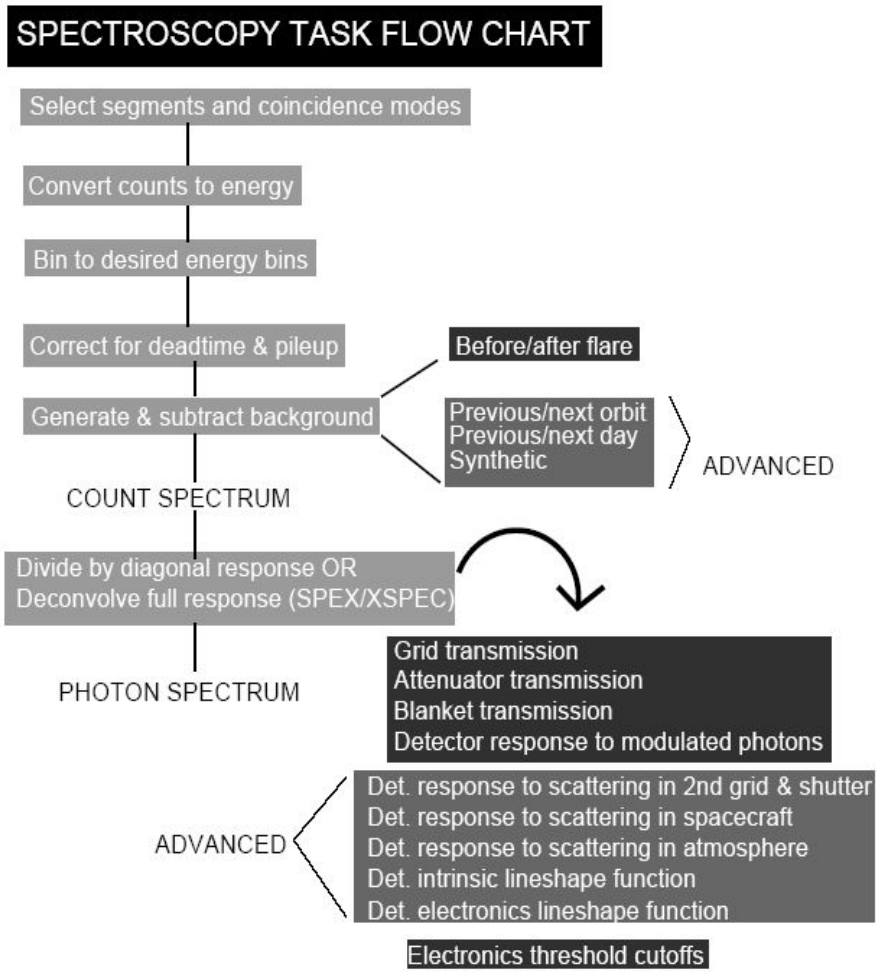
RHESSI X and Gamma Ray Spectroscopy

- Basic Equation of X-ray Astronomy
- From Photons to Counts – detector physics in the response matrix
- Background
- Determining the photon flux from the observations.



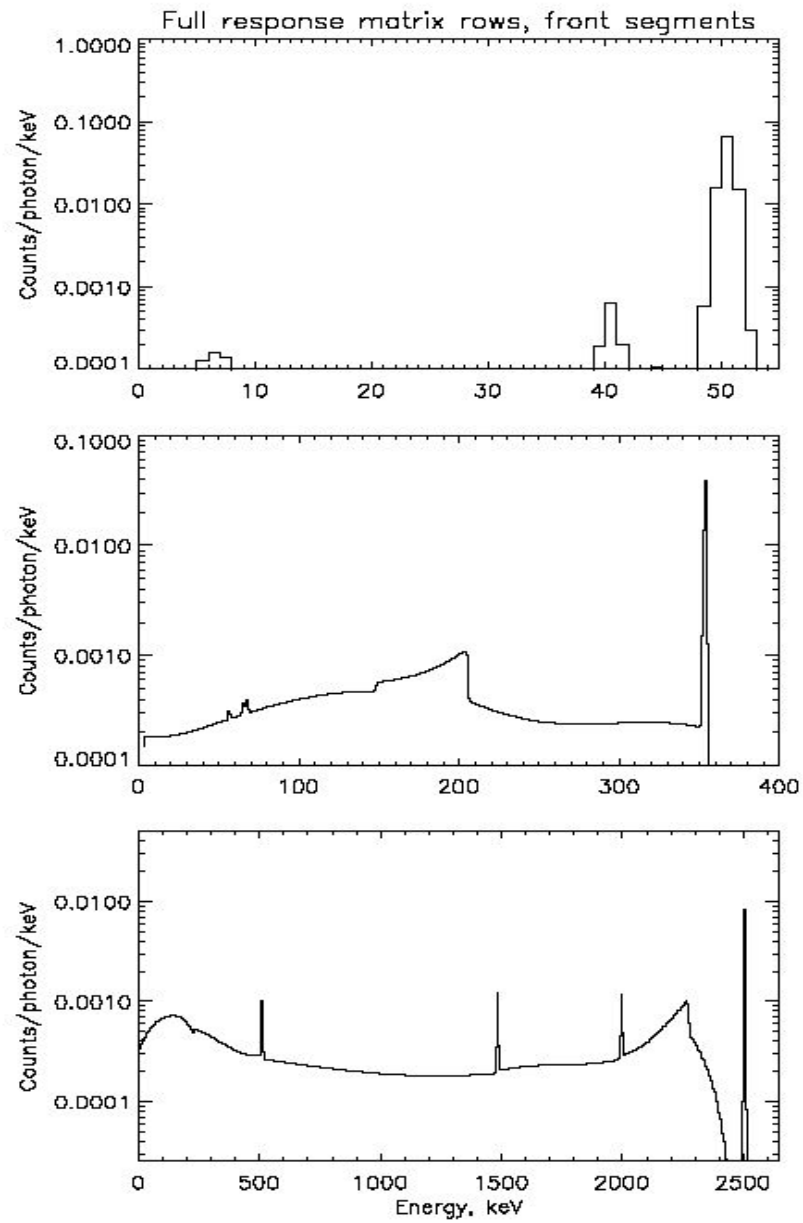
RHESSI X and Gamma Ray Spectroscopy

- Basic Equation of X-ray Astronomy
  C = B + R#J
- J – the incident rate of photons on the detector
- C – the observed rate of counts (events) binned in energy and time. Must normalize for detector deadtime.
- B – the rate of background events. Can be and most often is varying in time.
- R- the response matrix giving the probability of a count at E1 for a photon at E2



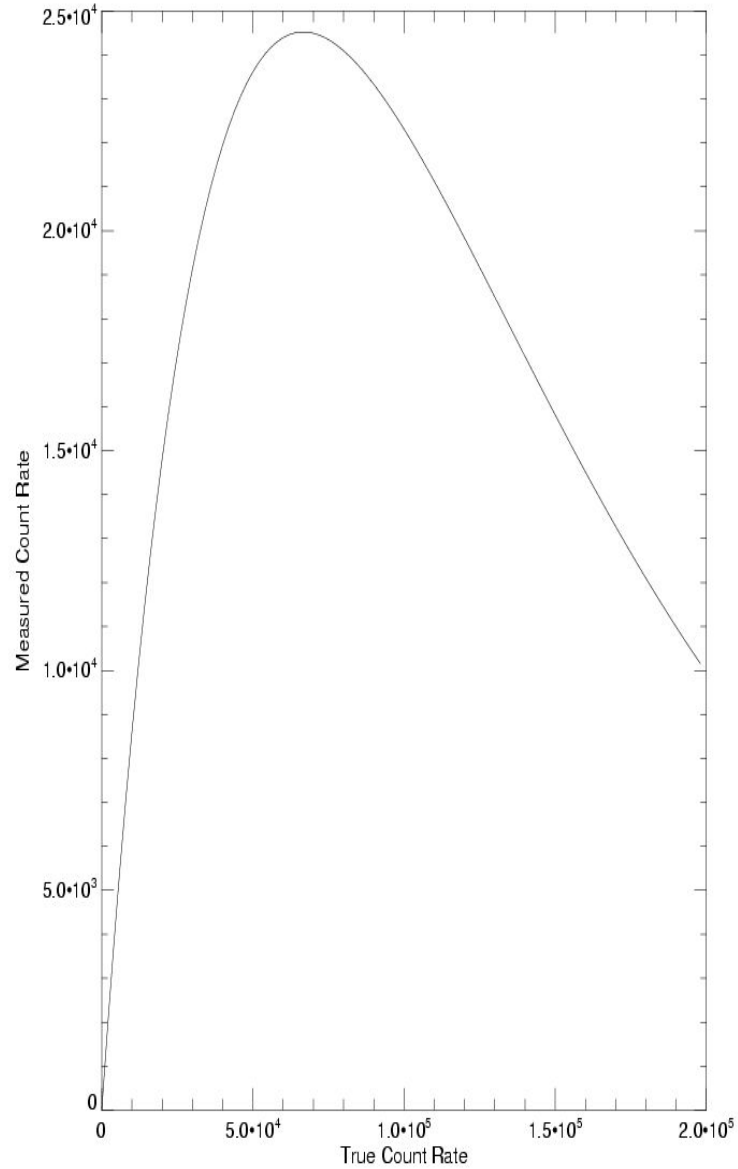
RHESSI X and Gamma Ray Spectroscopy

- Processes that are described by the Response Matrix R
- Grid, blanket, attenuator transmission.
- Photoelectric Effect – full energy loss dominates 3-200 keV with fluorescent escape
- Compton Scattering, partial and multiple energy loss important from 100 keV – 20 MeV
- Pair Production – above 1.022 MeV, single and pair escape at 511 keV



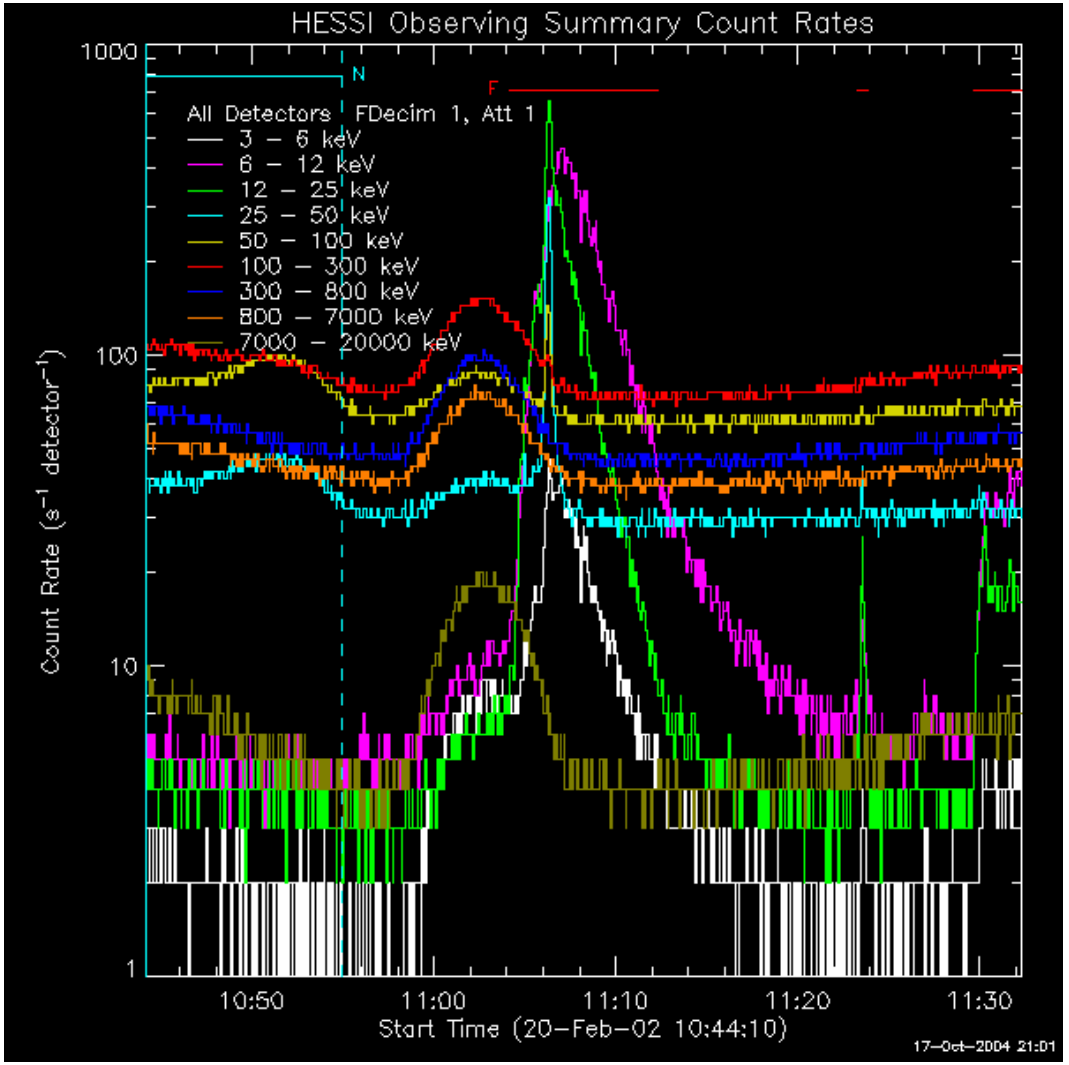
RHESSI X and Gamma Ray Spectroscopy

- Detector Livetime
- For a random process the best estimate of the true count rate is given by the observed counts divided by the livetime of the detector during the interval.
- Livetime = 1-Deadtime
- For RHESSI the peak detector rate will not exceed 25,000 counts/second while the true rate may exceed >10X that value.

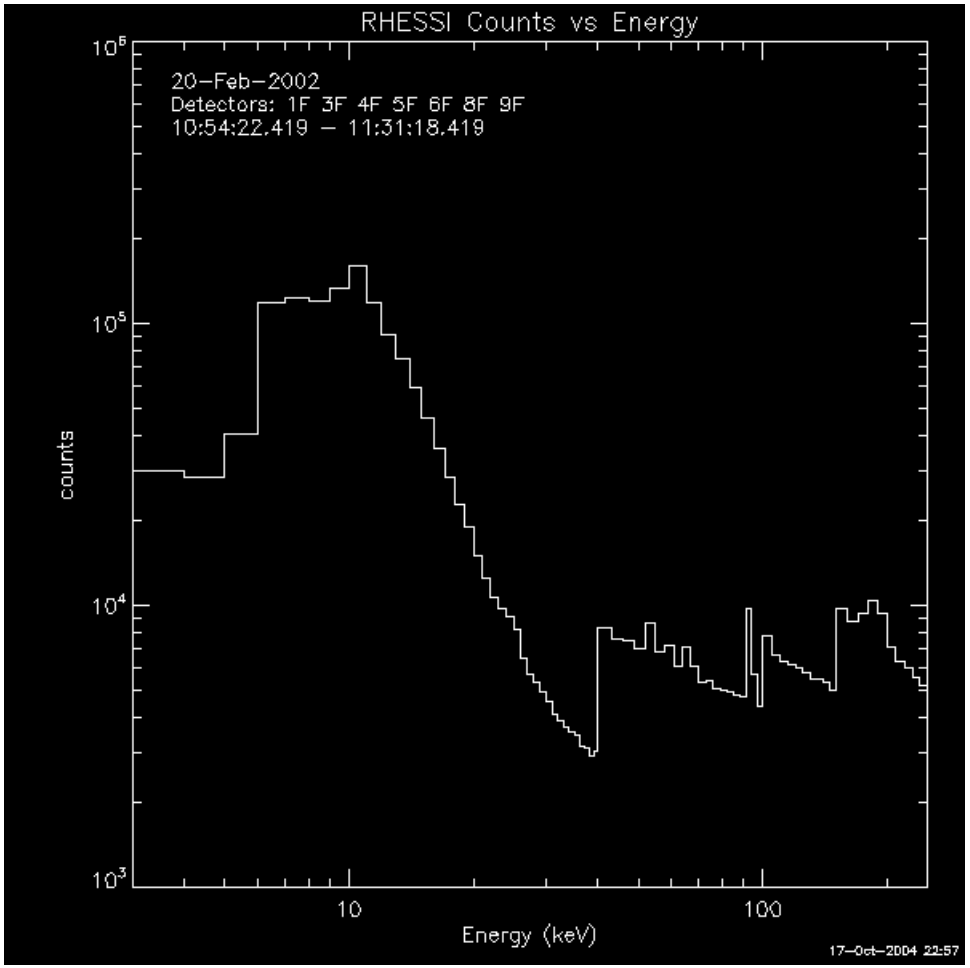


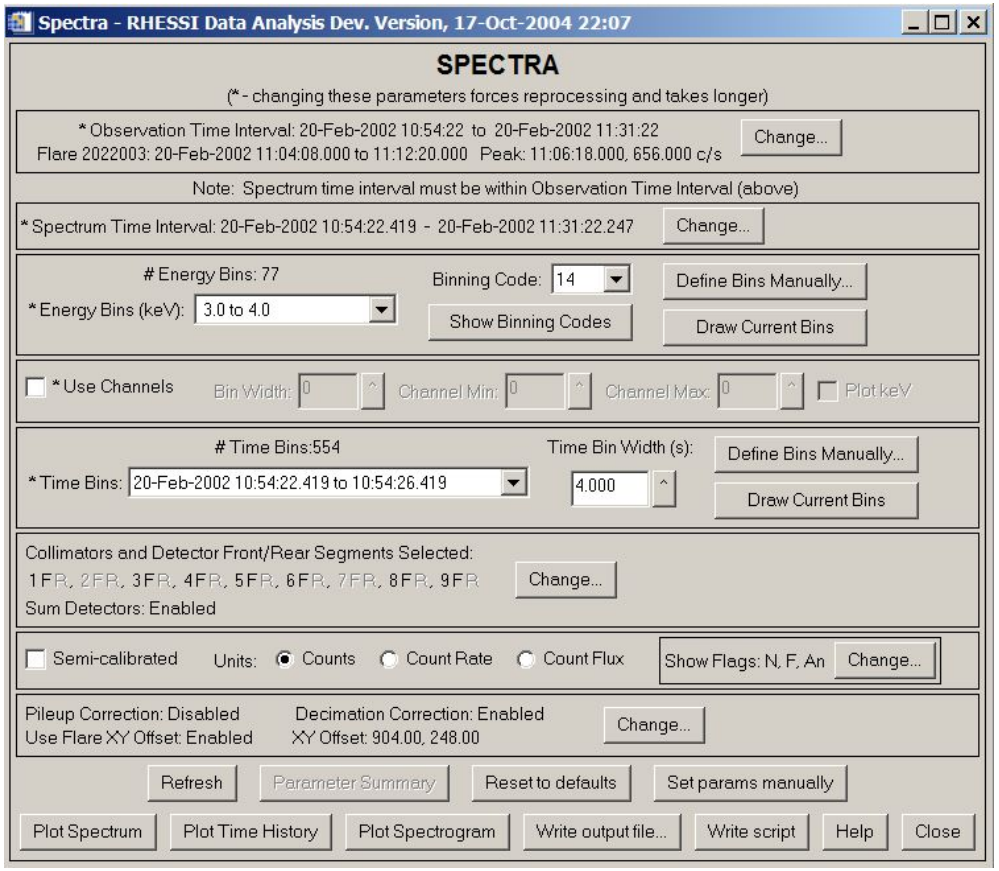
RHESSI X and Gamma Ray Spectroscopy

- Orbital Background Sources
- Diffuse Cosmic X-ray Background – Varies by geometry
- Cosmic Rays – High energy particles interact with spacecraft and Earth
- Trapped radiation – energetic particles that interact directly and indirectly with the detectors.
- Time variability is energy dependent. Only high signal to background saves us.

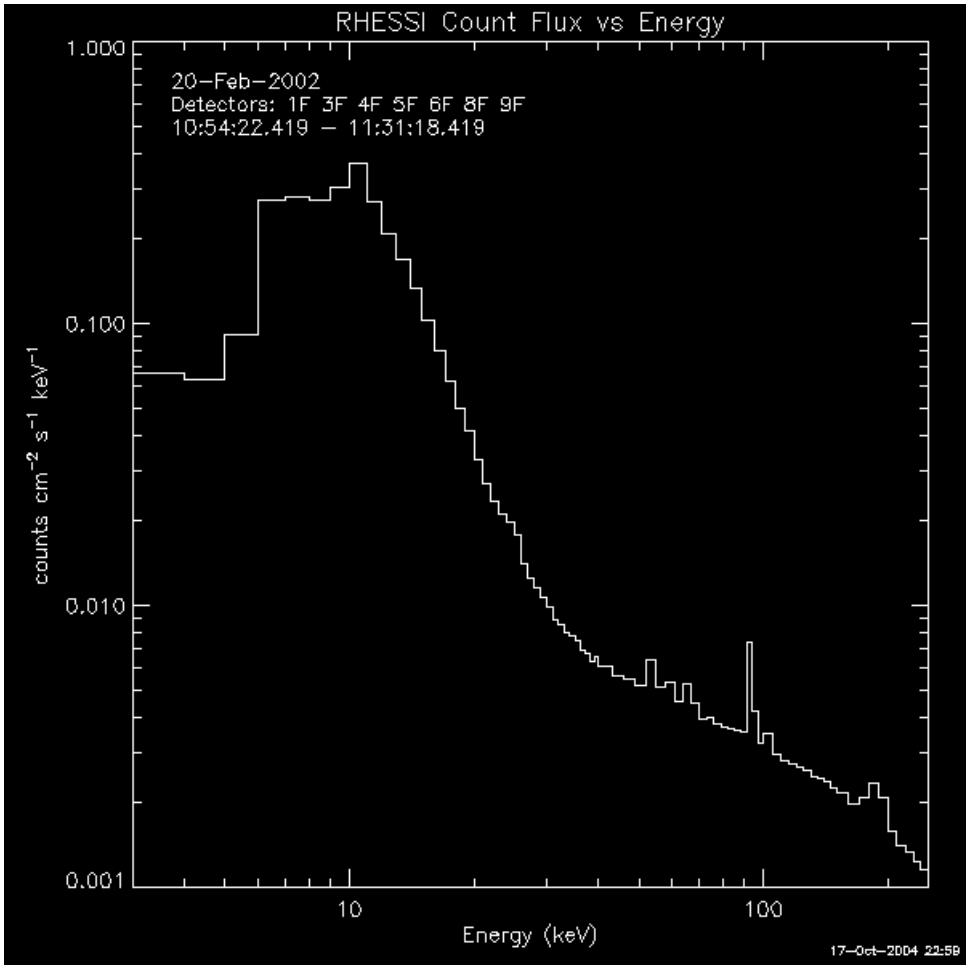


RHESSI X and Gamma Ray Spectroscopy

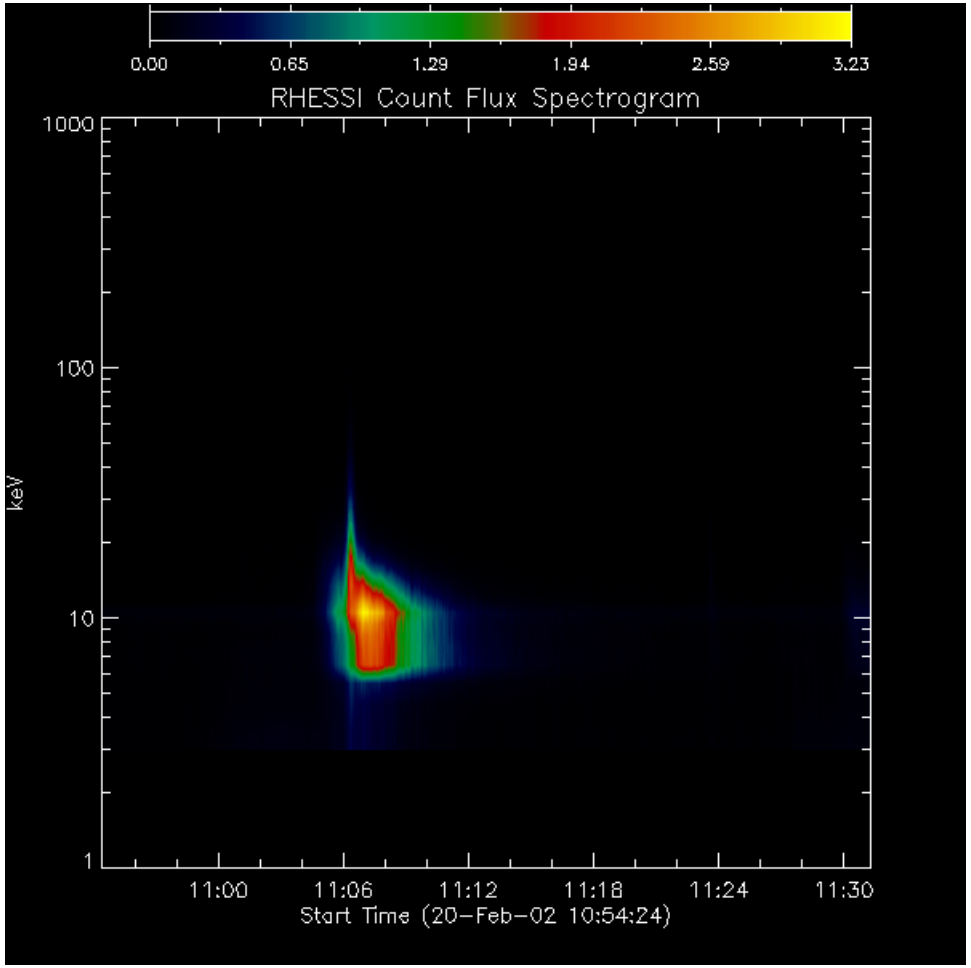




RHESSI X and Gamma Ray Spectroscopy

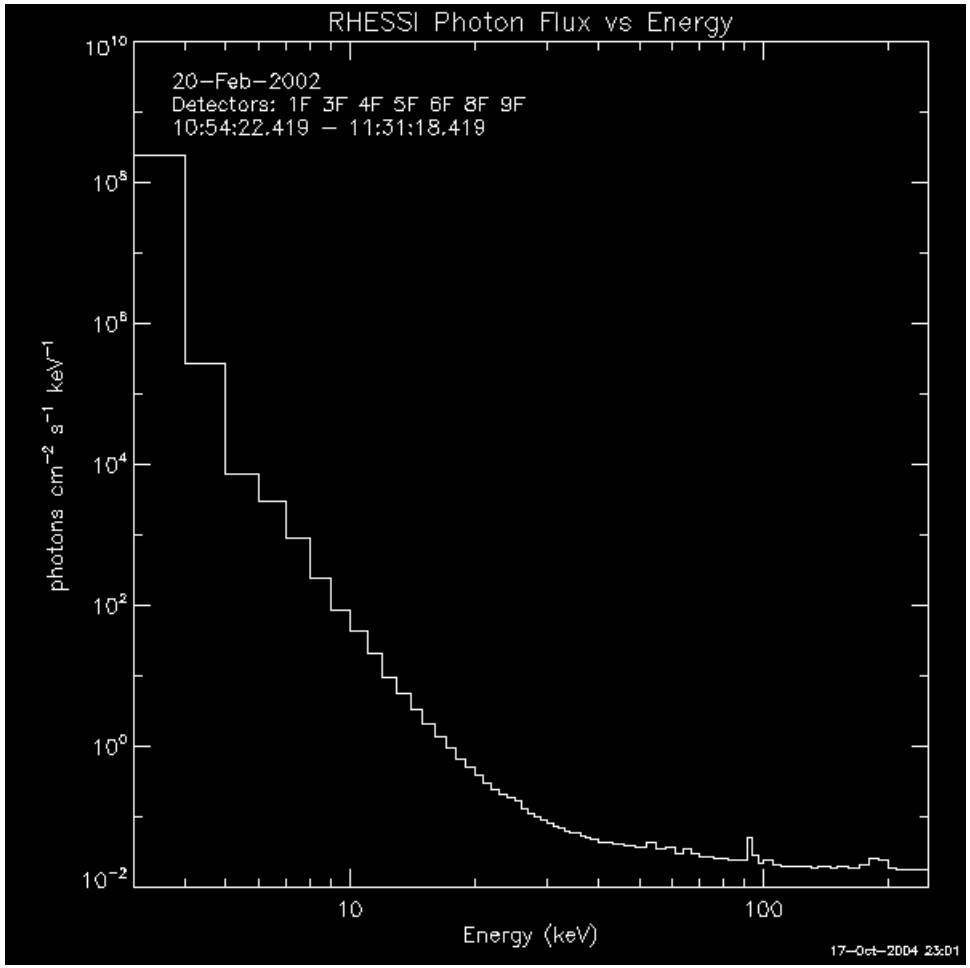


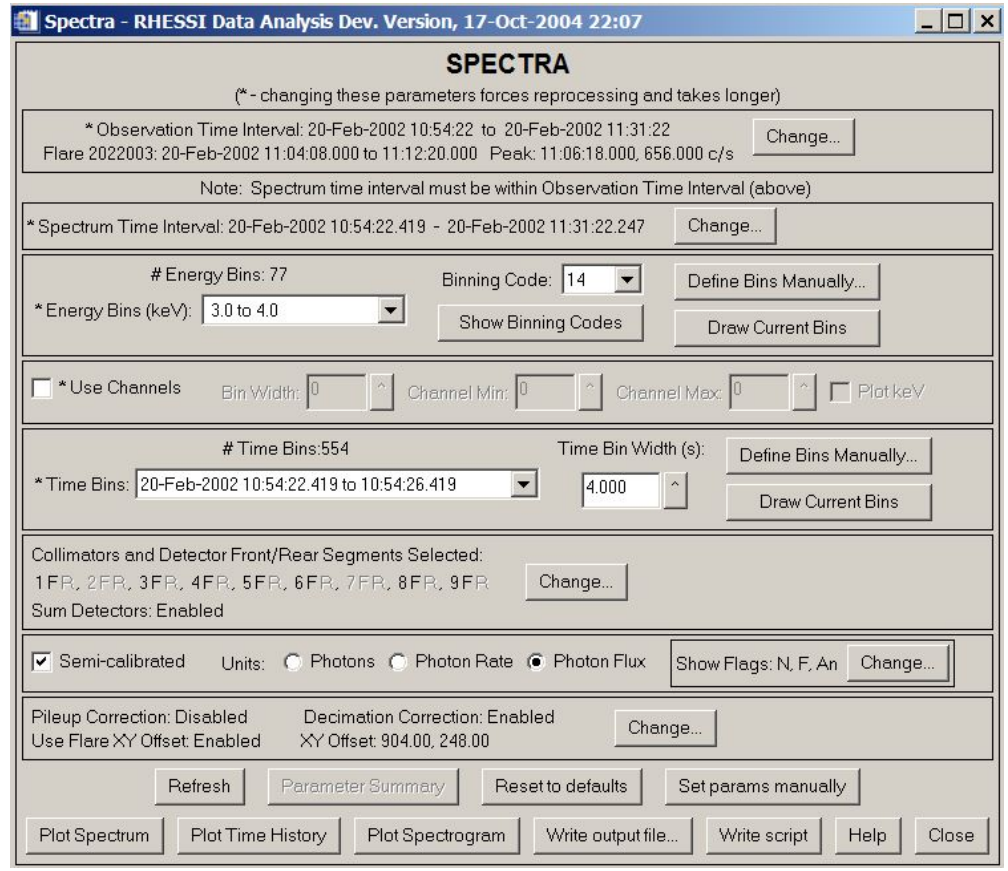
Count Spectrum in Flux



Count Spectrogram in Flux

RHESSI X and Gamma Ray Spectroscopy





Photon Spectrum in Flux

RHESSI X and Gamma Ray Spectroscopy

```
; Create the Script from the Write Script Button on the GUI
; hsi_spectrum script created Sun Oct 17 23:20:51 2004
; Includes only parameters changed from default settings.
;
obj = hsi_spectrum()
obj-> set, obs_time_interval= ['20-Feb-2002 10:54:22.419', '20-Feb-2002
11:31:22.247']
obj-> set, seg_index_mask= [1B, 0B, 1B, 1B, 1B, 1B, 0B, 1B, 1B, 0B, 0B, 0B,
0B, 0B, 0B, 0B, $
 0B, 0B]
obj-> set, sp_data_unit= 'Flux'
obj-> set, sp_energy_binning= 14L
obj-> set, sp_semi_calibrated= 1B
obj-> set, sp_time_interval= 4.00000
;To create the spectrum output

sp = obj->getdata()
```

RHESSI X and Gamma Ray Spectroscopy

Exercises

Observing summary for flare 20-Feb-2002 09:57 UT

Look at the observing summary starting for this flare.
Extend it by one orbit (96 minutes) on each side.

Set observing time interval for the flare.
In Spectrum GUI make short accumulations, less than 5 minutes
using multiple time bin sizes, energy binnings. Look at spectrum and spectrogram
using counts, rate, and flux choices. How do they change?
Do the same using SEMI-CALIBRATED. Look at the spectrum at the peak and
away from the peak. How does it change?

Pick time binning, energy binning, and detectors suitable for analysis and write
the FITS files for the spectrum and the detector response using full response
and the diagonal response (That's two cases, so two spectrum and two srm files).