Cyg X-1 Status Report

Work Since Last Team Meeting :

- **Finalized an approach to modeling of the image data, based on the use of BGDLCF/SRCLH0.**
- **Incorporated restricted PSD cuts (60-90) on high energy data points (> 10 MeV).**
- **Updated spectra for the following:**
  - ⇒ **Composite Phase 1-3 spectrum**
  - ⇒ **Composite spectrum for contemporaneous Phase 1-3 OSSE data**
  - ⇒ **Composite Phase 1-6 spectrum.**
  - ⇒ **750 keV - 3 MeV time history**
- **Further comparisons with OSSE and BATSE data for contemporaneous phase 1-3 observations.**

Modeling the Image Data

•Analysis is complicated by apparent structure along the plane (unlike most other point sources studied so far).

•BGDLCF/SRCLH0 scheme was used to fit the image data.

•Source models defined by known sources and/or features visible in the images.

•In each energy band, various model combinations (sometimes as many as 20) were used to fit the image data.

•Specific criteria were defined for acceptance/rejection of each model fit. An accepted fit must :

- ☞ **provide a significant improvement to the fit beyond that of using Cyg X-1 alone ($P_\nu(\chi^2) > 0.90$).**
- ☞ **not have any negative scale factors for source models (other than Cyg X-1).**

•Accepted fits (as many as 10-15, in some cases) all considered to be equally valid.

•Average flux from all of the accepted fits was used as the final flux estimate for Cyg X-1.

•Variation of flux values amongst the accepted fits used as an estimate of the systematic error (reflecting uncertainties in the modeling process)

Cygnus Analysis - Source Models

- **The following sources were used (in various combinations) as background components in the spatial modeling:**

  - **Galactic Diffuse Emissions**
    Two separate models to account for gas (HI+CO, with fixed ratio) and inverse Compton distributions. If diffuse emission was included in the analysis, *both* models were used.

  - **Point Source A, located at (l,b) = (71.34°, +3.07°)**
    Corresponds to Cygnus X-1

  - **Point Source B, located at (l,b) = (68.80°, +2.80°)**
    Corresponds to PSR 1951+32

  - **Point Source C, located at (l,b) = (75.50°, -1.50°)**
    Feature seen in the 1-2 MeV image data.

  - **Point Source D, located at (l,b) = (79.50°, +2.50°)**
    Feature seen in the 1.4-2.0 MeV image data.

  - **Point Source E, located at (l,b) = (79.85°, +0.70°)**
    Corresponds to Cygnus X-3

  - **Point Source F, located at (l,b) = (75.46°, +0.60°)**
    Corresponds to 2EG J2019+3719 (defined but never used)

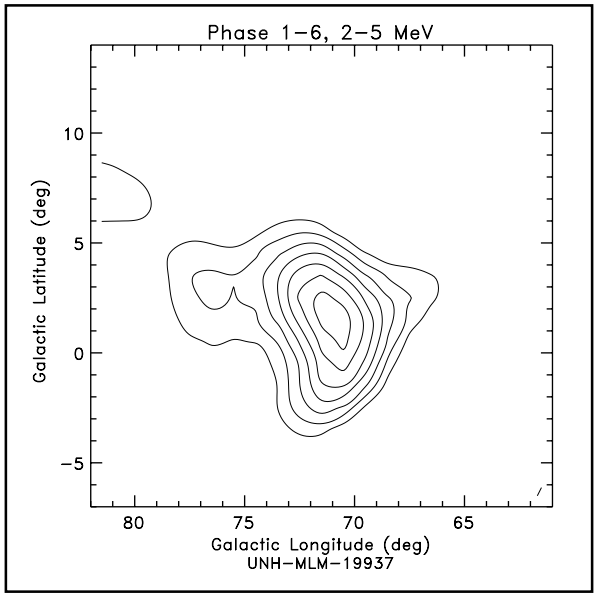
  - **Point Source G, located at (l,b) = (78.12°, +2.23°)**
    Corresponds to 2EG J2020+4026 (defined but never used)

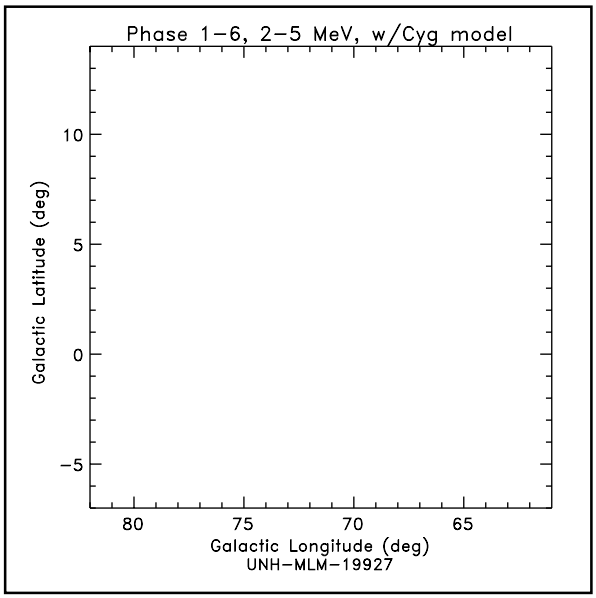
  - **Point Source H, located at (l,b) = (75.31°, -1.18°)**
    Corresponds to 2EG J2026+3610 (defined but never used)

  - **Point Source I, located at (l,b) = (67.00°, +9.00°)**
    Feature seen in the 0.85-1.0 MeV image data.

Evidence for 2-5 MeV Emission

Phase 1-6 (<30°)

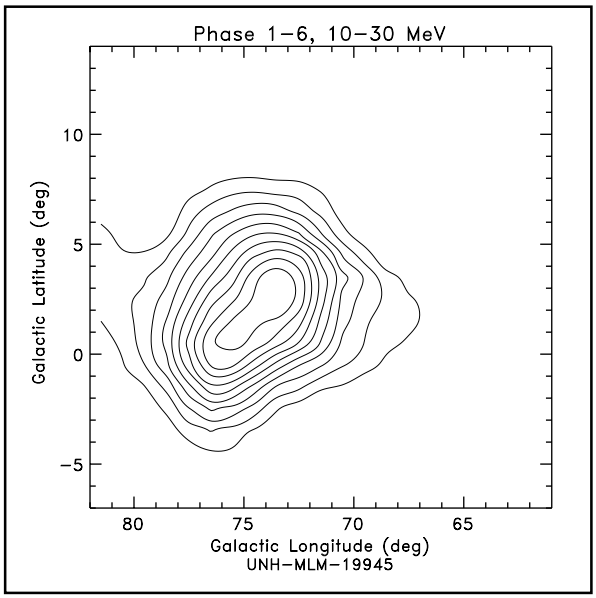


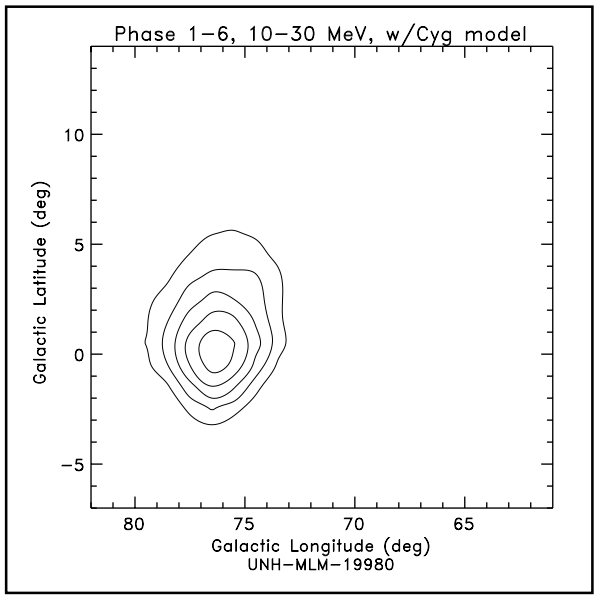


- Figure on the left shows the SRCLIK image generated with BGDLCF background only.
- Figure on the right shows the SRCLIK image generated with a background that also includes Cyg X-1.
- In both cases, contours start at a likelihood value of 9 with a step size of 3.
- Strong evidence for Cyg X-1 (3.1σ).
- Weak evidence for PSR 1951+32. Cyg X-1 alone provides a better fit to these data than PSR alone. Joint fit is not statistically justified by the data.

Evidence for 10-30 MeV Emission?

Phase 1-6 (<30°), PSD = 60-90





- Figure on the left shows the SRCLIK image generated with BGDLCF background only.
- Figure on the right shows the SRCLIK image generated with a background that also includes Cyg X-1.
- In both cases, contours start at a likelihood value of 9 with a step size of 3.
- Some evidence for Cyg X-1 (2.9σ).
- Residual feature is the source discussed at the team meeting last November. Maximum likelihood of 23.6 at (l,b) = (76.4°, 0.1°). Visible in Phase 4 and 5 only.

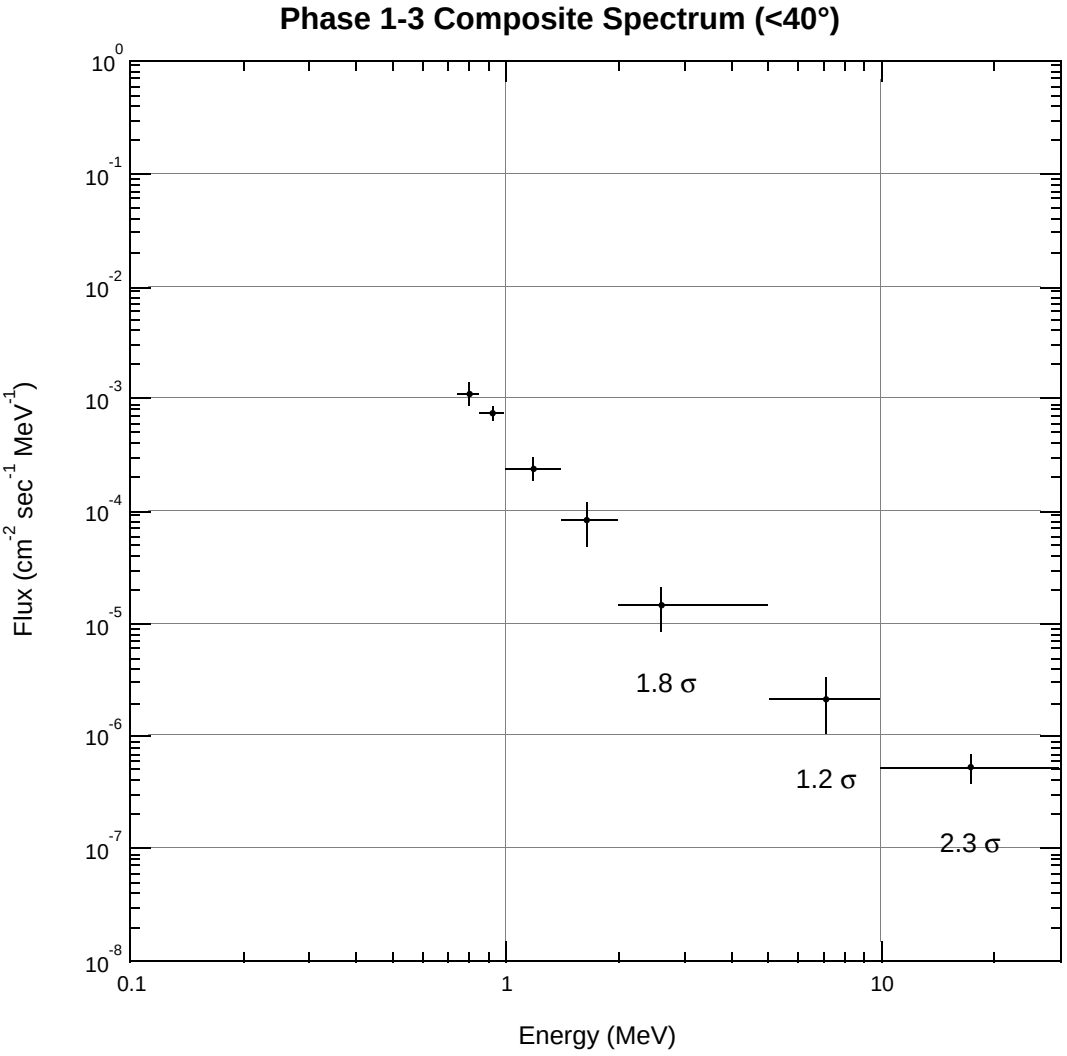
High Energy Data Points

- **Limited visual evidence for Cyg X-1 energies above 5 MeV.**
- **Previous discussions about how to plot high energy datapoints when there is no evidence of a source in the images.**
- **Published spectra in the Compton Symposium reflect this approach.**
- **The spectra shown here do not reflect this approach. These spectra show the data values which come from a complete anlaysis of the data.**
- **Is it truly necessary that we actually 'see' something in the data for it to be considered a valid result?**
  - **Do we impose our subjective judgement on the data by replacing potentially positive results with upper limits? Are we improperly censoring our data?**
  - **Any publication should discuss clearly that the images show no visible evidence of emission, but we should be extremely careful about messaging our results on the basis of personal bias...**
  - **Whatever ground rules are used here should be imposed uniformly throughout all COMPTEL publications.**

The Phase 1-3 Composite COMPTEL Spectrum

The composite spectrum from all phase 1-3 COMPTEL data where Cyg X-1 was within 40° of z-axis.

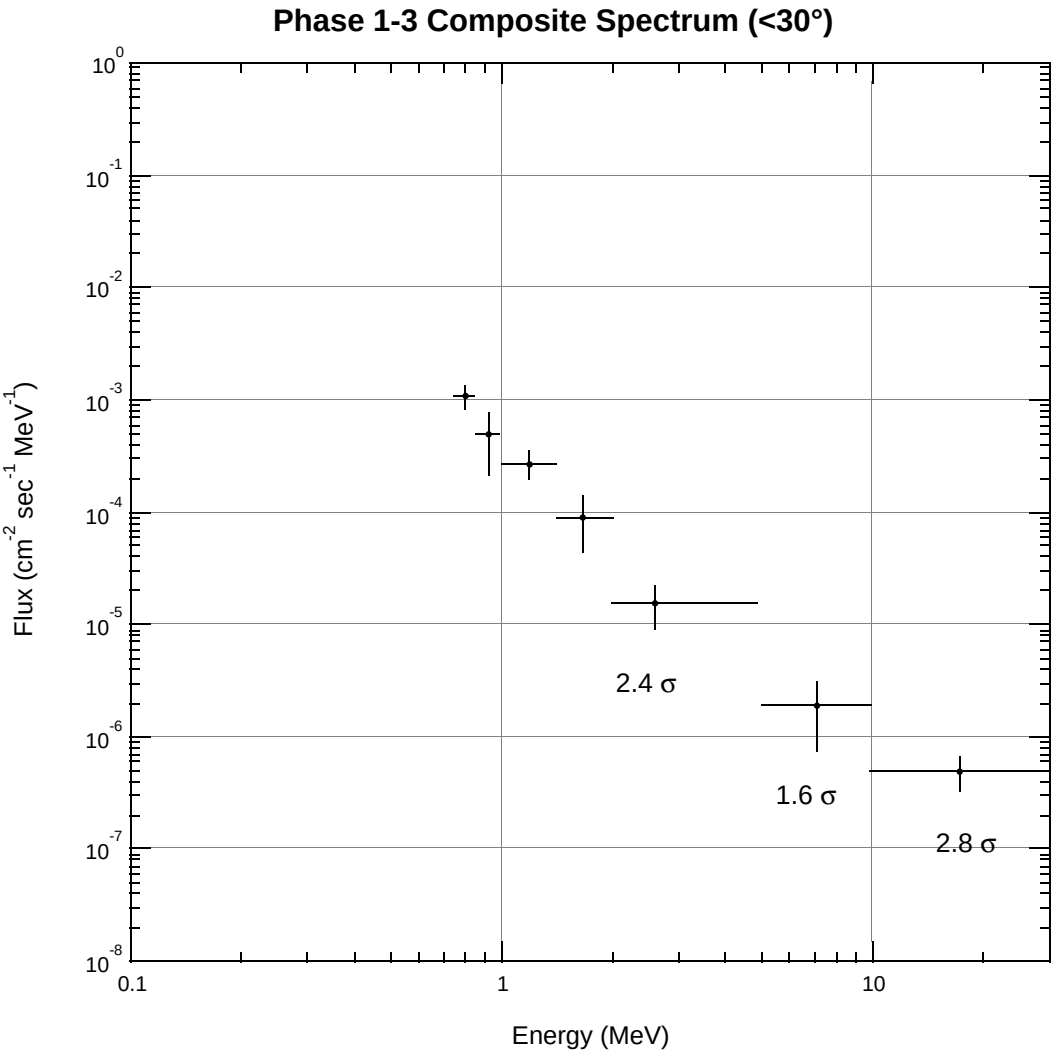
Phibar = 4° - 36°
ToF = 115-130
Zeta > 5°



The Phase 1-3 Composite COMPTEL Spectrum

The composite spectrum from all phase 1-3 COMPTEL data where Cyg X-1 was within 30° of z-axis.

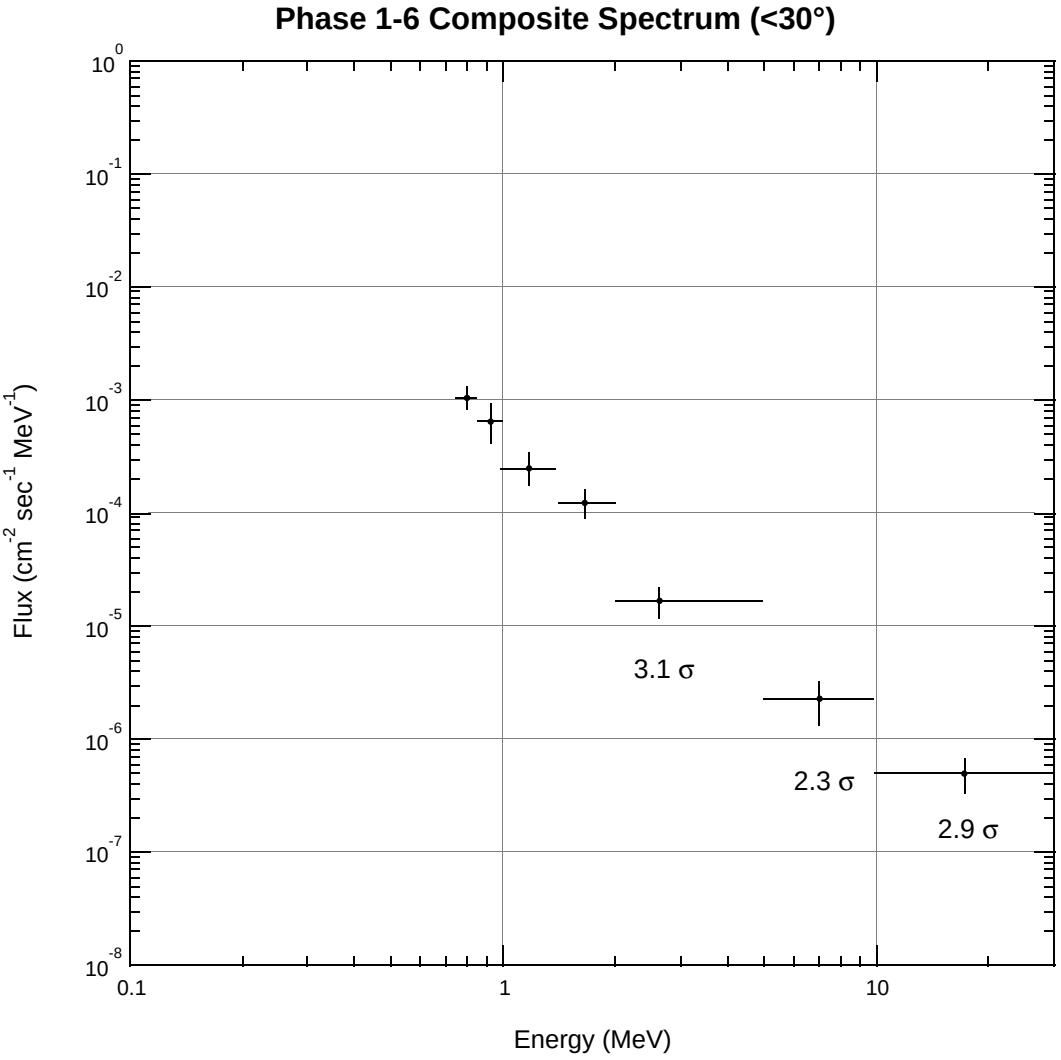
Phibar = 4° - 36°
ToF = 115-130
Zeta > 5°



The Phase 1-6 Composite COMPTEL Spectrum

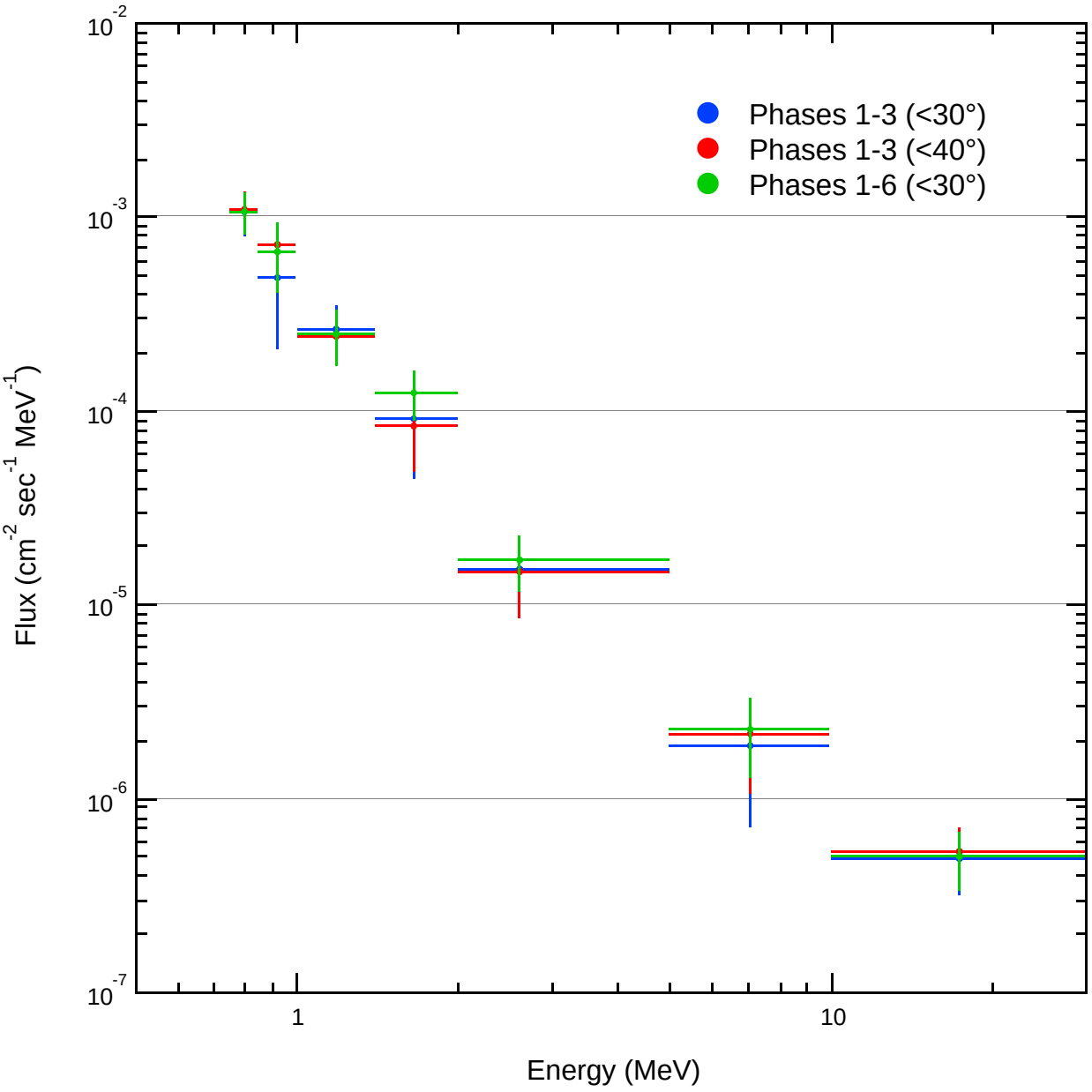
The composite spectrum from all phase 1-6 COMPTEL data where Cyg X-1 was within 30° of z-axis.

Phibar = 4° - 36°
ToF = 115-130
Zeta > 5°



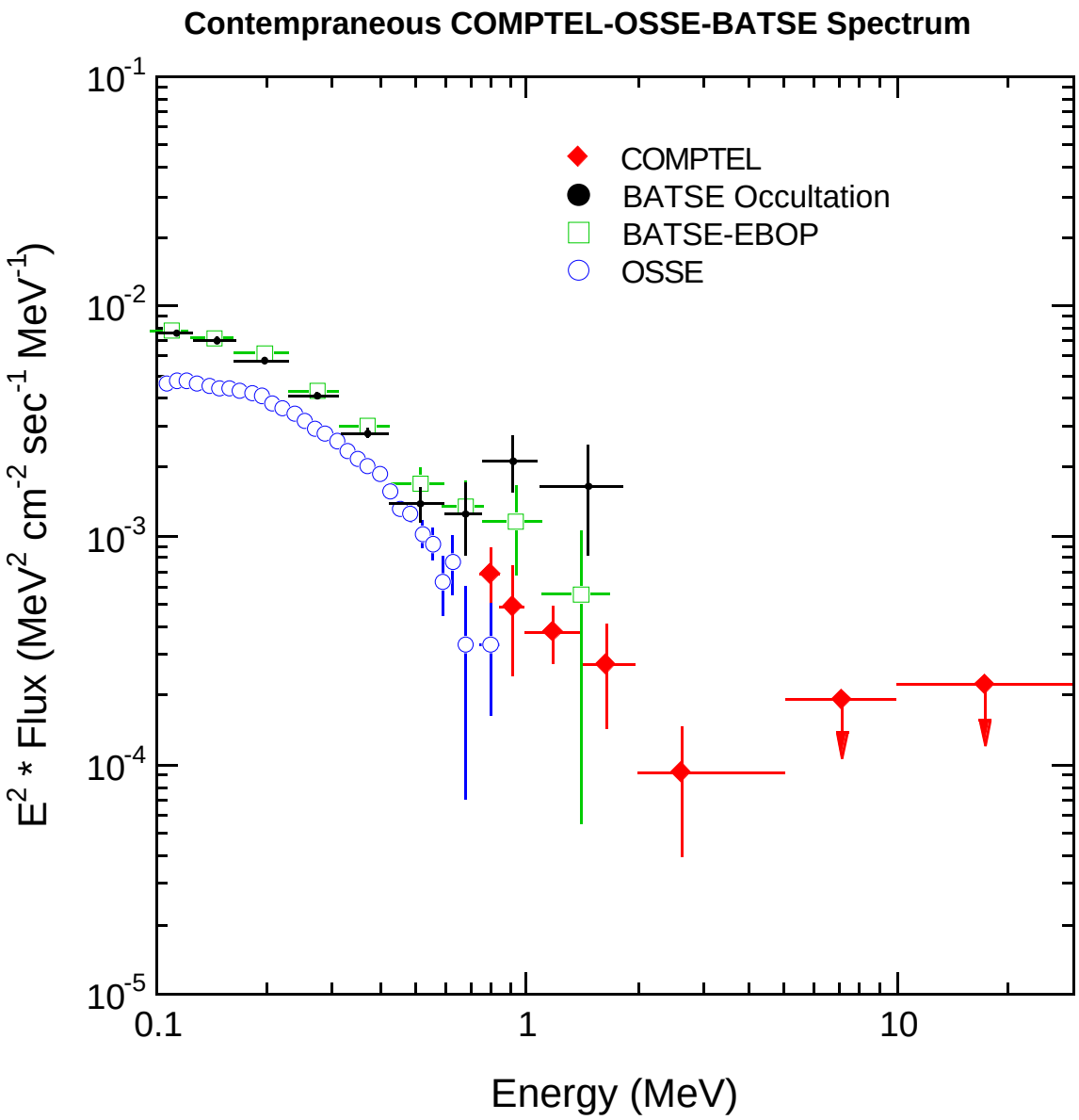
COMPTEL Spectra Comparison

A comparison of various COMPTEL spectra shows consistent results with no significant spectral variation.



BATSE-OSSE-COMPTEL P123 Spectrum

This figure (without the BATSE occultation data) was included in Compton Symposium paper.



BATSE-COMPTEL-OSSE Comparison

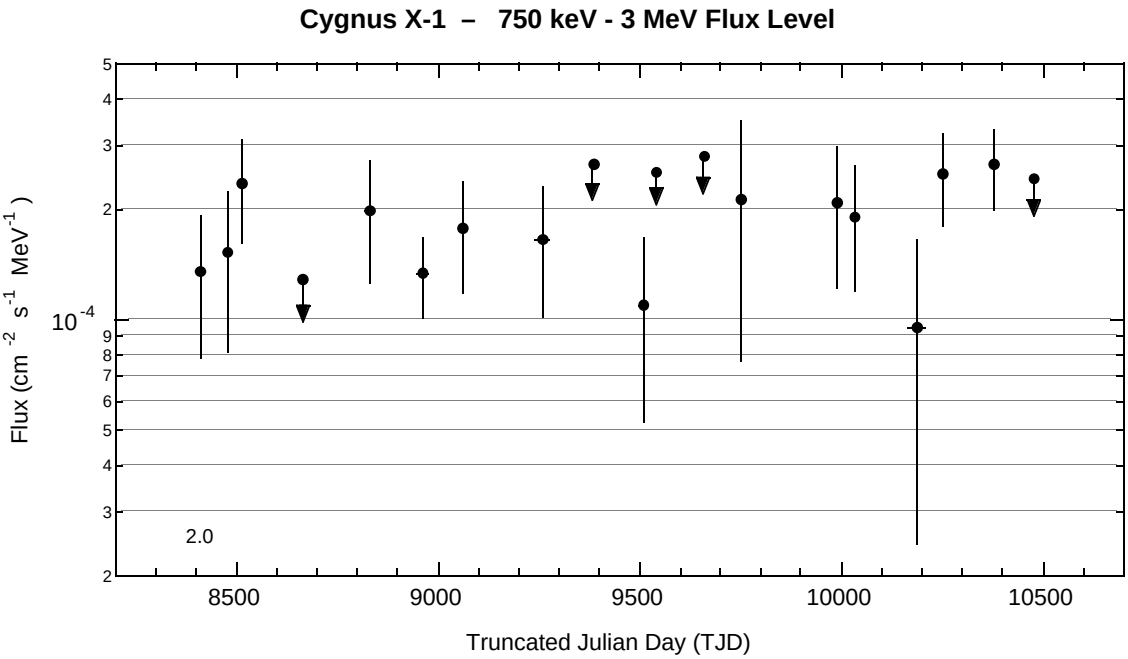
- **Clear differences between OSSE and BATSE. BATSE is a factor of ~1.3 - 1.5 higher than OSSE at all energies.**

- **BATSE occultation analysis (MSFC - Paciesas et al.) agrees well with the BATSE-EBOP analysis (JPL - Ling et al.). This alleviates some earlier concerns about the reliability of the EBOP analysis.**

- **Difficult to make any judgement regarding COMPTEL. Although the extrapolation 'looks better' with BATSE, this should not be used to draw any scientific conclusions.**

- **Scientific implications of the COMPTEL data depend, to a great extent, on how the spectrum extrapolates to lower energies.**

Flux Time History : 750 keV - 3 MeV



The analysis of each individual viewing period indicates no significant variability in the high energy flux.

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OUTSTANDING ISSUES

- **Attempting to resolve (or at least clarify) the discepancy between BATSE and OSSE.**

- **Publication is actively being prepared (really!).**