COMPTEL Telescope Mode Flux Values for Solar Flare 15 June 1991

8 August 1996, UNH G. Rank

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Introduction

We give a description of the deconvolution of the spectrum for the solar flare on 15 June 1991. The intention of this work is to enable a comparison with the SRCLIX method as used by Hans Bloemen.

Observation of the Solar Flare on 15 June 1991

The X-class flare on 15 June starts at 08:10 UT and peaks at 08:21 UT (GOES-7 data). The impulsive phase happens during the SAA for CGRO, but emission can still be seen after the SAA exit.

In figure 1 the observed emission for the first observation interval following the impulsive phase is shown for the energy interval 0.75 ot 30 MeV. The time interval lasts from 32300 s to 34800 s. We use the data sets MPE-EVP-15537 for the flare period and MPE-EVP-13248 for the background on 14 June. For the selections which are indicated in figure 1, 1472 flare counts and 682 background counts (average of two background periods) are accepted. The live time for the flare signal, averaged over the whole time period is about 92%, a minimum live time of about 87% occures at the beginning of the interval. The corrected signal is 923.0 ± 45.8 counts (20.1σ event).

A spectrum (also corrected for live time and background) for the same time interval is shown in figure 2. The used selection windows are the same than indicated in figure 1. A logarithmic binning with 100 bins for the whole energy range 0.75 to 30 MeV was used here.

Spectral deconvolution

To generate the response matrix for the flare event, SIMENE was used (run number SIMEN4-222). The flare occurs under an angle of 12° off-axis, which yields a very clean response. In figure 3 cuts through the response matrix are displayed. The cuts were done at the energies of four prominent flare emission lines. While an escape peak manifests for larger energies, the curves at 1.37 MeV and 2.22 MeV show a well defined Gaussian response.

In principle, it is possible to deconvolve a spectrum of 100 logarithmic bins, as shown in figure 2. But in order to get reasonable error bars on the single bins, the spectrum was binned into 31 energy intervals. At the position of expected emission lines, we use a bin-width of about

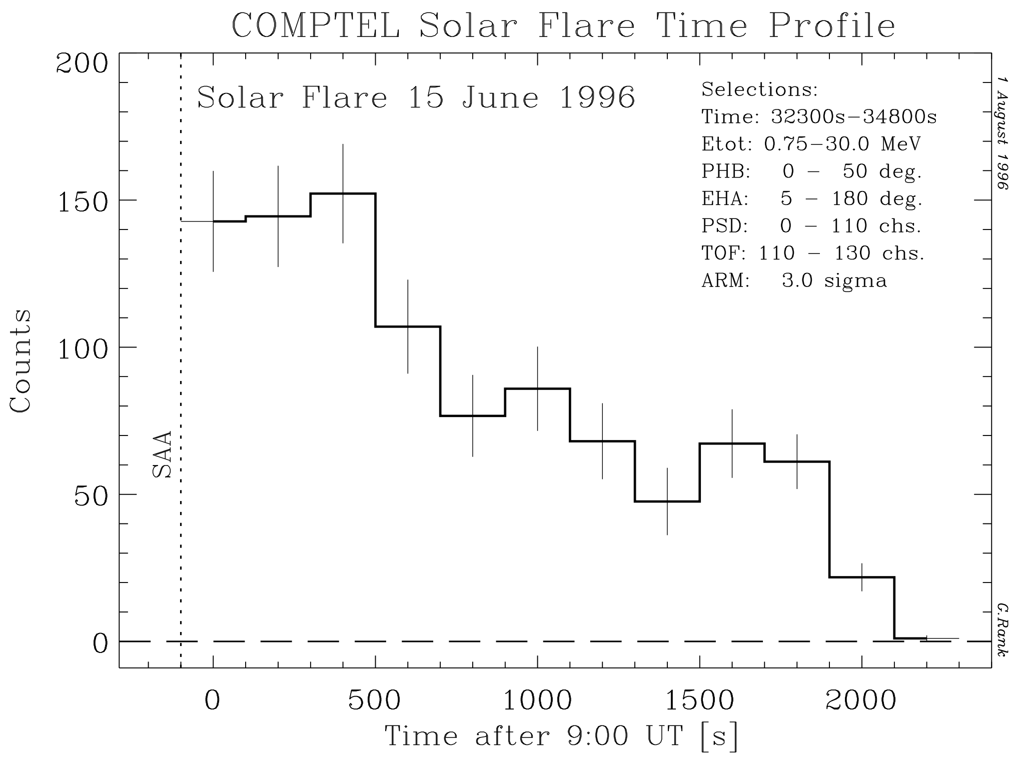


Figure 1: *Live time and background corrected time profile.*

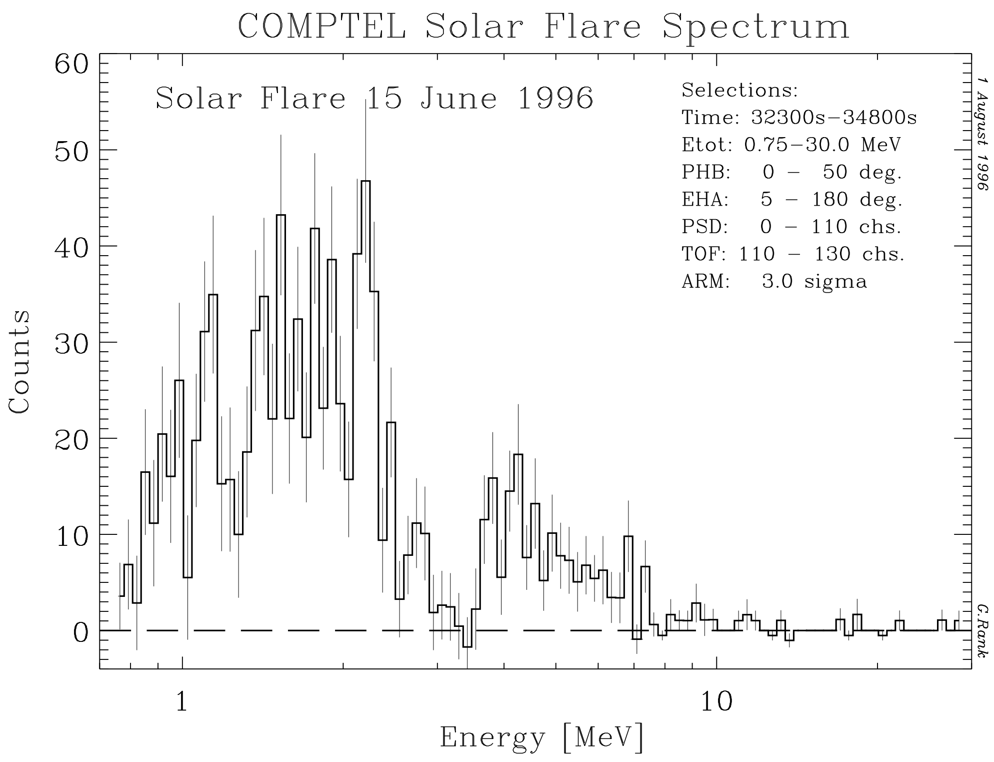


Figure 2: *Count rate spectrum for the time interval shown in figure 1.*

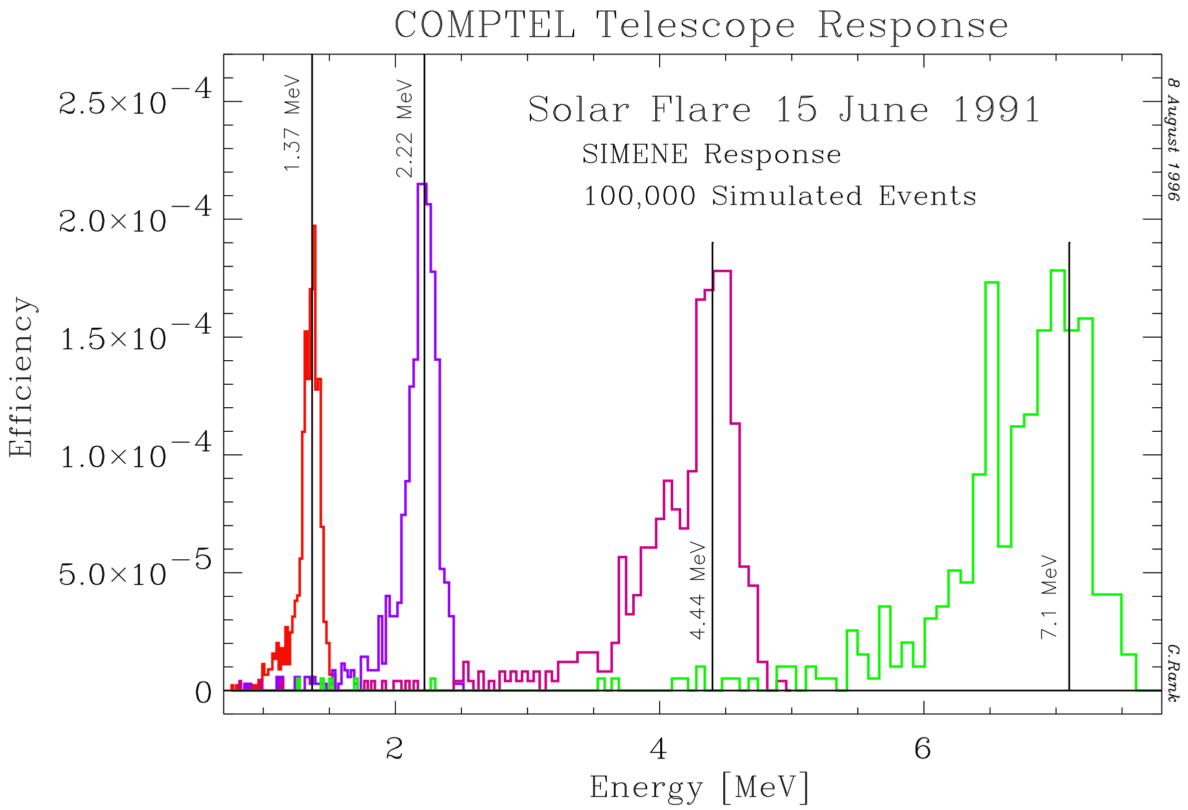
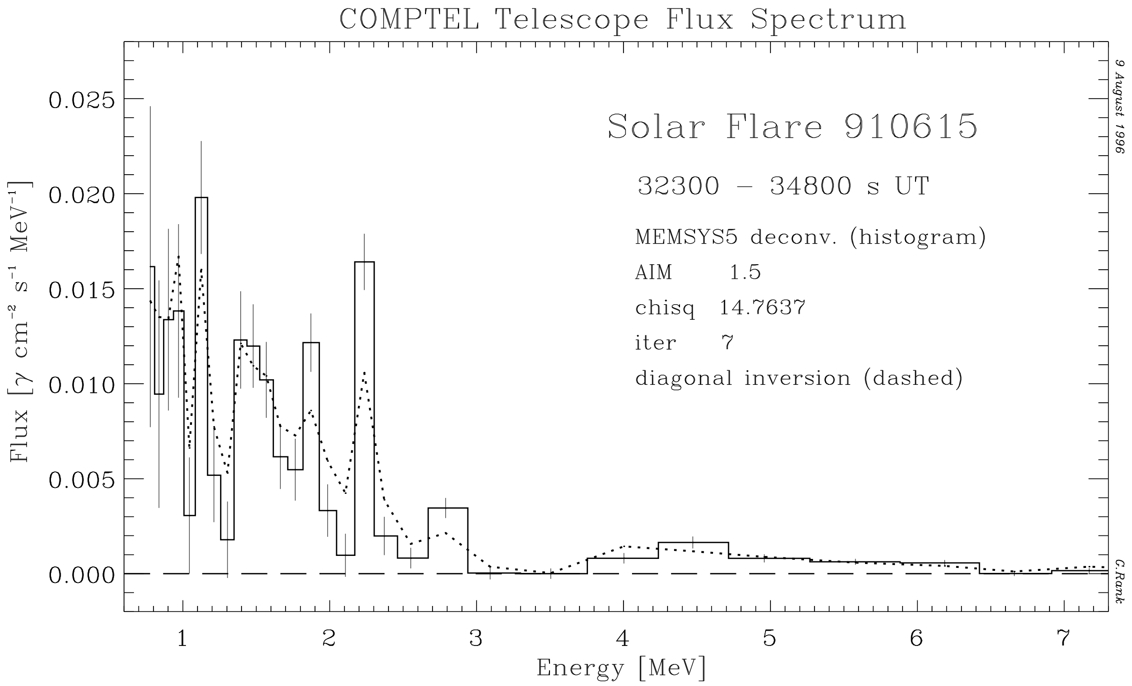


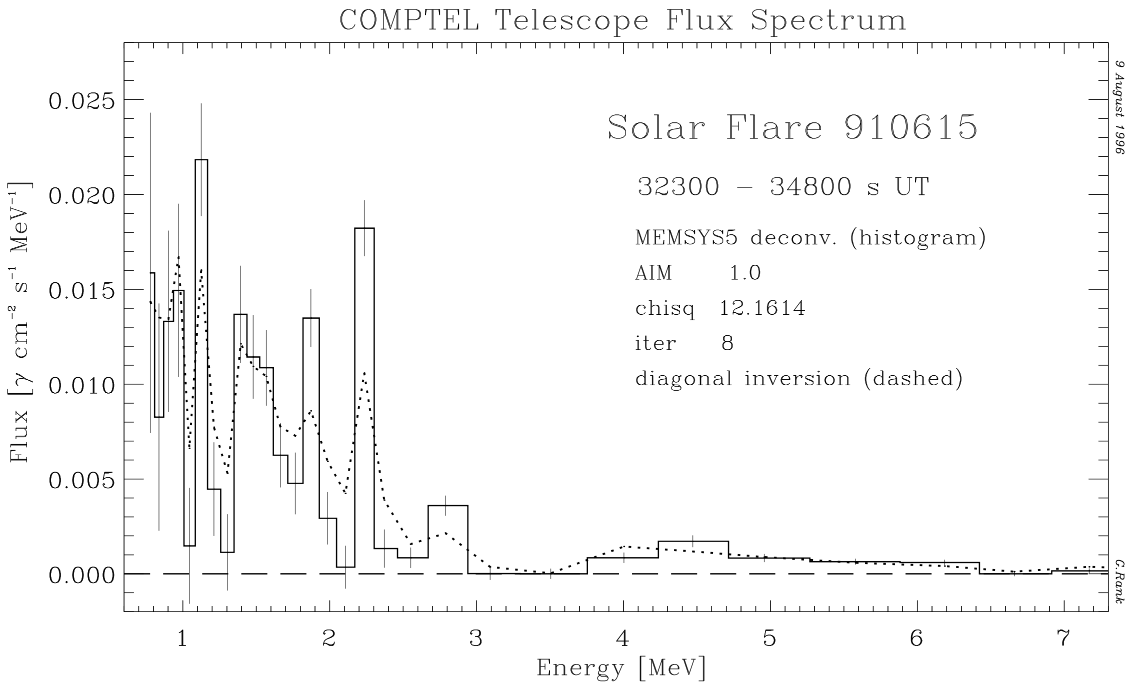
Figure 3: *Cuts through the response matrix at the energy of four flare emission lines.*

2σ the energy resolution as determined in the calibration. At the continuum between the lines the intervals are wider. All energies above 8 MeV are combined.

For the deconvolution of the count rate spectrum, the MEMSYS5 code was used. We use the classical MEM with standard entropy and Gaussian statistics (the input spectrum is already background subtracted, therefore the counts are no longer Poisson distributed). We tried different values for the parameter AIM to test the stopping of the iterations. Generally, a smaller AIM forces the algorithm to fit the data more closely, with less regard of the entropy criterion. For values of 1.5, 1.0 and 0.5, the resulting flux in the 2.2 MeV line varies by a little less than 10% (a value of AIM = 1.0 is suggested by the MEMSYS manual). Also the tolerance parameter UTOL was varied from 1.0 to 0.1 and 0.01, but the changes in the resulting spectra were below 1% (the MEMSYS manual suggests UTOL = 0.1).

The result for the three values of AIM = 1.5, 1.0 and 0.5 (UTOL = 0.1) are shown in figure 4. The histogram denotes the MEM spectrum. As the response for the wide binning is quite diagonal, a simple inversion with the diagonalized response matrix already gives a resonable first order approximation. It is included as the dashed line. From top to bottom, the value of AIM decreases and it can be seen that more flux is concentrated in the line features. The number of iterations and the obtained χ^2 value are included in each plot.


COMPTEL Telescope Flux Spectrum
Solar Flare 910615
32300 – 34800 s UT
MEMSYS5 deconv. (histogram)
AIM 1.5
chisq 14.7637
iter 7
diagonal inversion (dashed)
Flux [γ cm⁻² s⁻¹ MeV⁻¹]
Energy [MeV]
0.000
0.005
0.010
0.015
0.020
0.025
1
2
3
4
5
6
7
9 August 1996
C.Rank


COMPTEL Telescope Flux Spectrum
Solar Flare 910615
32300 – 34800 s UT
MEMSYS5 deconv. (histogram)
AIM 1.0
chisq 12.1614
iter 8
diagonal inversion (dashed)
Flux [γ cm⁻² s⁻¹ MeV⁻¹]
Energy [MeV]
0.000
0.005
0.010
0.015
0.020
0.025
1
2
3
4
5
6
7
9 August 1996
C.Rank

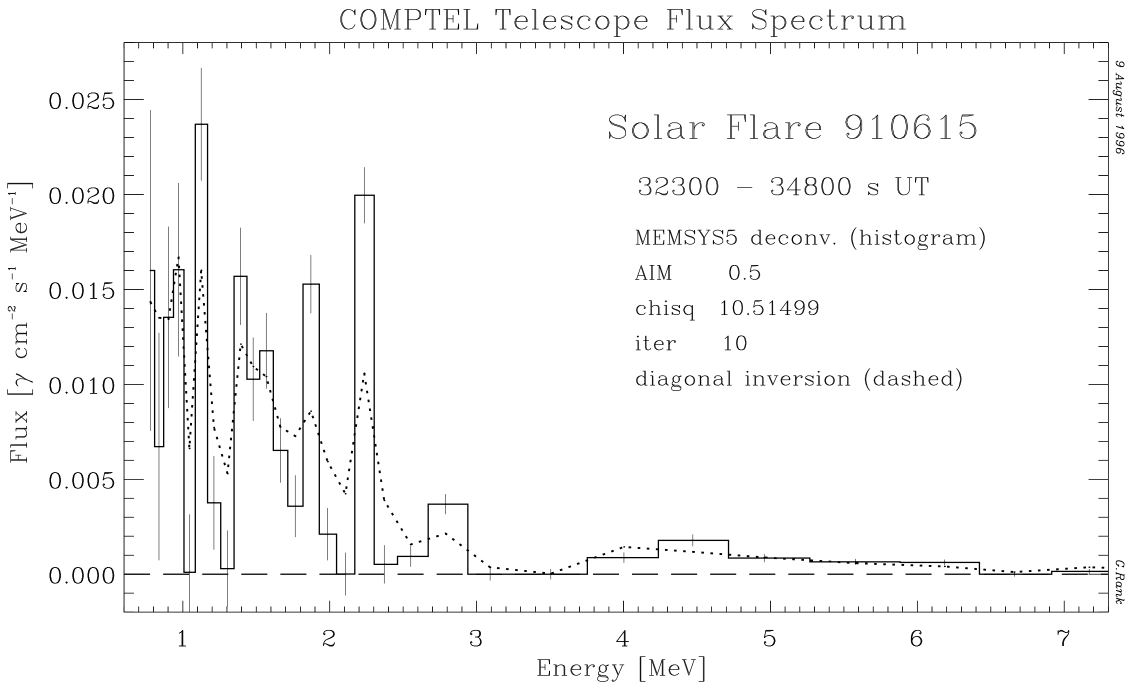


Figure 4: *Flux spectrum for different settings of the MEM parameter AIM.*