N. Giglietto – Infn Bari
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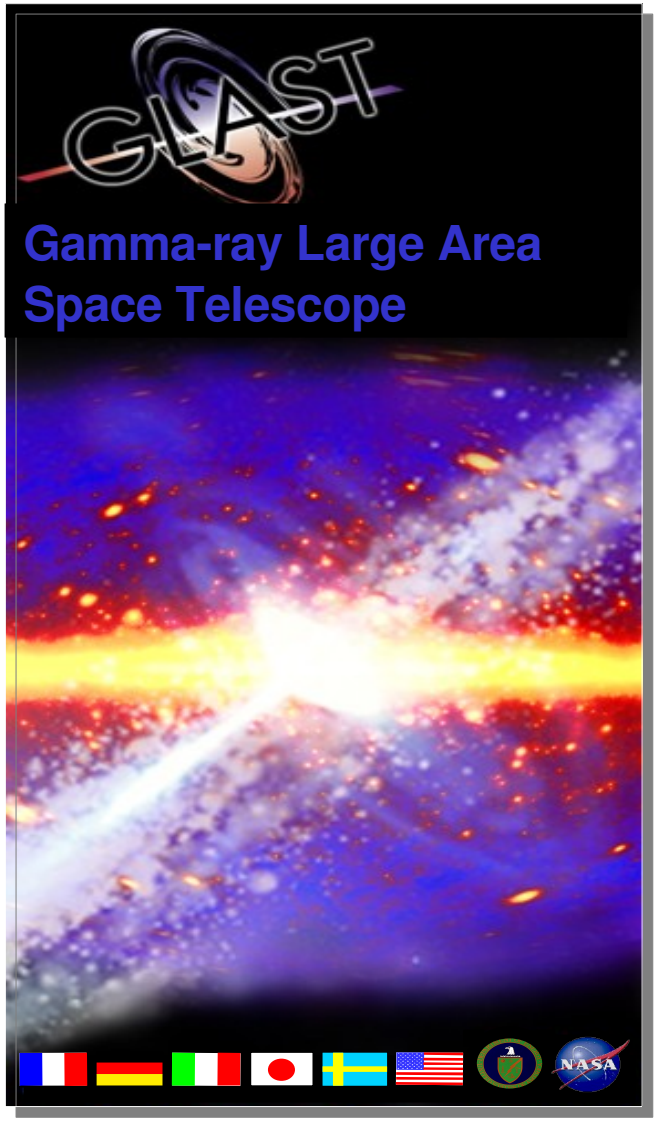


Science Tools WG
status of analysis efforts using ST for moving sources of solar system

Nico Giglietto

Latest activities

Deep usage of ST to use for moving sources:

- **New data selector**
- **Package MoonSel (unofficial package and name to be changed)**
- **Python scripts and other considerations**

Newselector

- Newselector is a package (not yet released) working using tip (to read fits files) and astro (to have Moon&Sun position) and data subselector
- Event by event cone-cut selector centered on the istantaneous Moon/Sun position (user defined the choice between solar system objects) (Standard Cone Cut)

Advantages:

accurate selection of the events

Disadvantages:

using the chain indicated in the likelihood workbook you find:

- Problems in exposure calculations (no circular cone defined)
- Gtlikelihood fails in every case due to “too many DSS keys...” error message (formally a cone cut for each events)

CONCLUSION:

It's not obvious to follow this way – not useful results

MoonSel (temporary name)

- This package works like gtexposure i.e. It reads fit table and adds new columns
- Using the interface to astro package, the celestial coordinates relative to the Sun and to the Moon are added

ADVANTAGES:

- No selection defined to the original data and therefore all the analysis chain is kept untoached
- Easy solution to have a prompt display of events relative to whatever moving frame (see example next page)

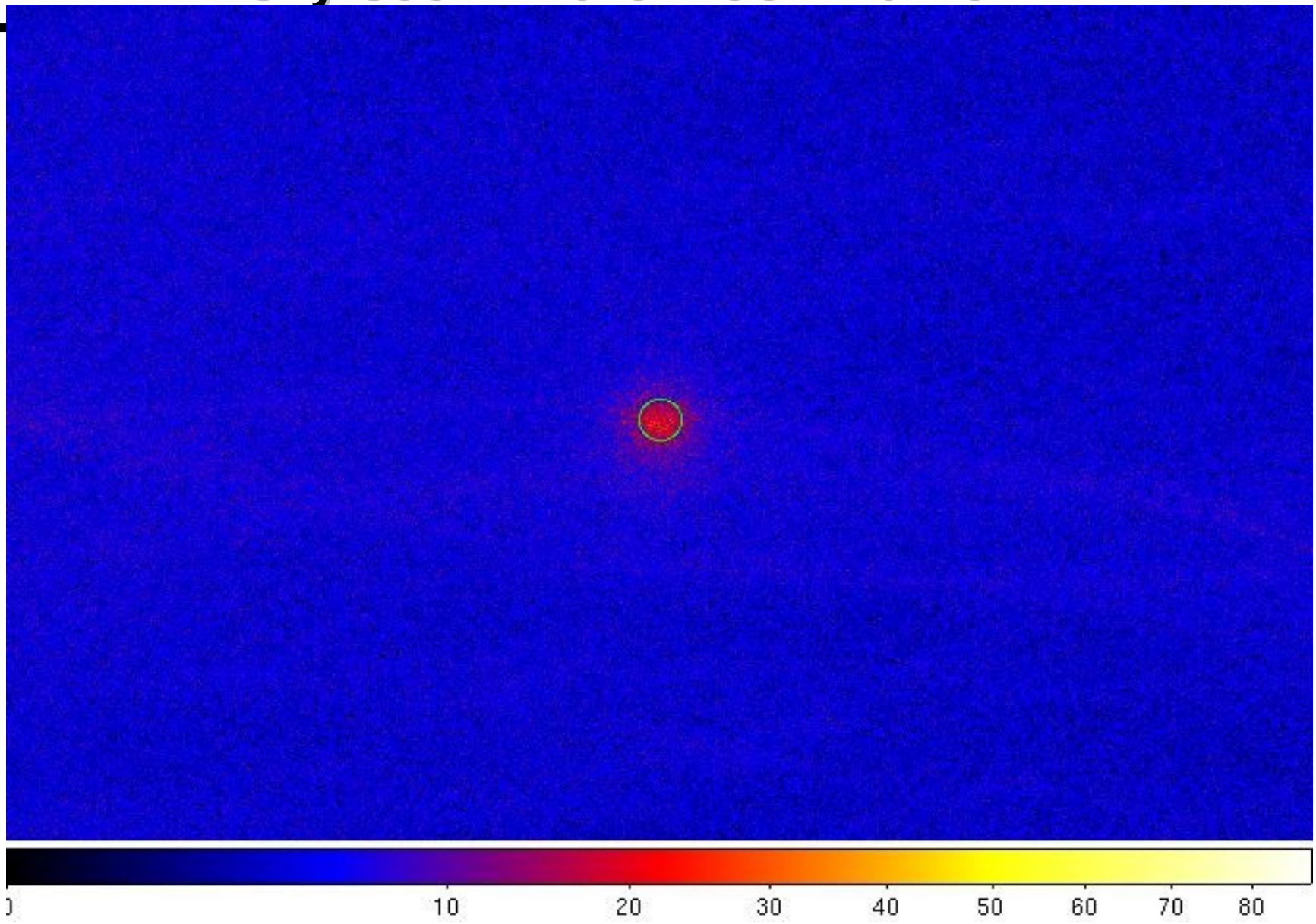
DISADVANTAGES:

- Probably adding the coordinates of both Sun and Moon could be too much expensive (in term of amount of data)

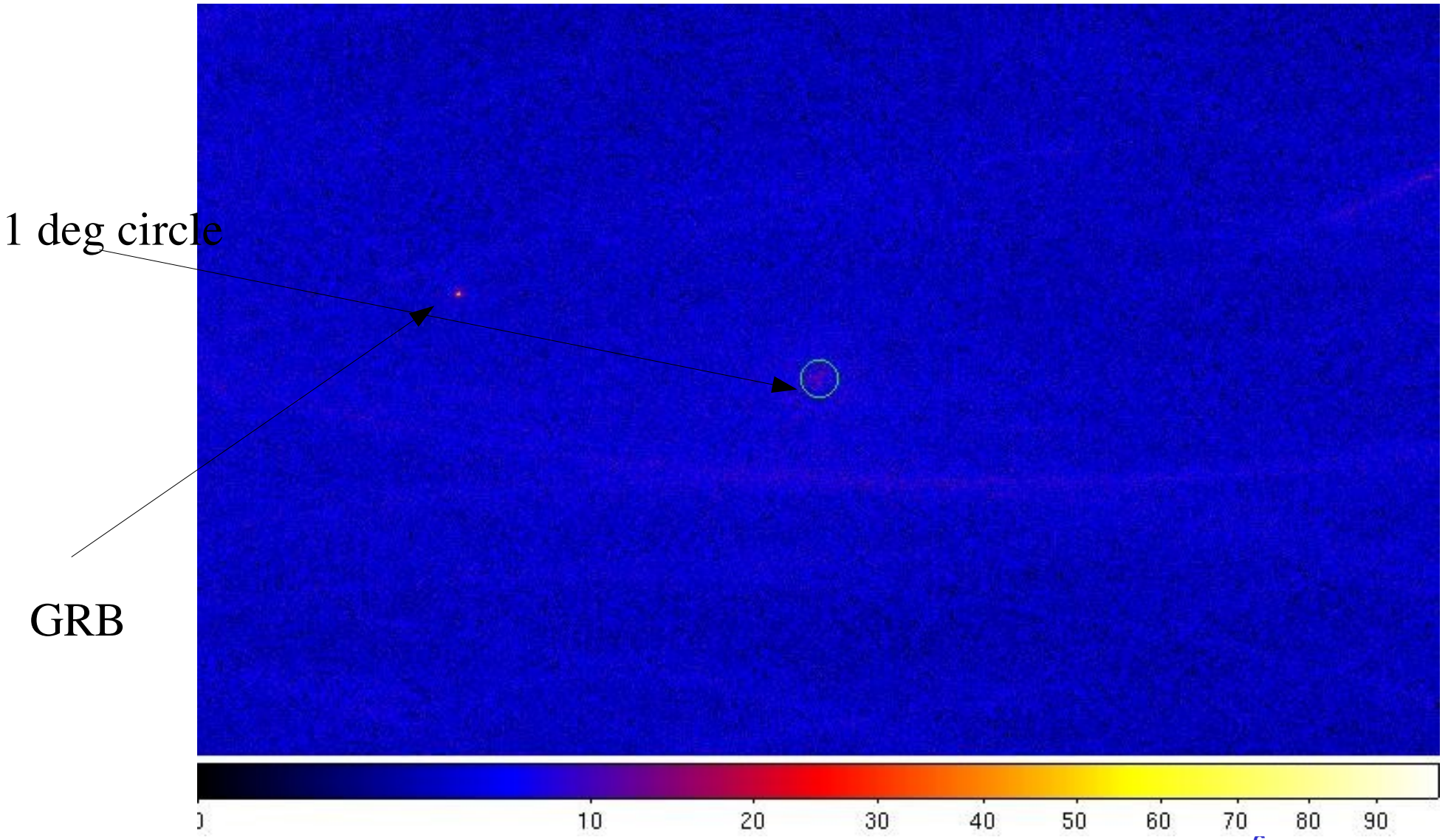
ALTERNATIVES:

- Replace RA,DEC colums with those relative to SUN or MOON

All sky seen in the Moon frame



Allsky seen in the Sun frame



Which kind of analysis can be performed?

A quick look of the images let us to draw the following conclusions:

- **Central region should be modelled as an extended circular region**
- **Background is almost diffuse (but is not really a flat distribution)**

There is some way to have a simple circular region of emission?

- **Using ModelEditor seems not possible (but should be in principle the choice of 2d-gaussian extended source)**
- **When defined a proper model of the source then gtlikelihood should work in principle**

In this latter case how select events and force gtlikelihood to work?

Analysis of moving sources

Alternatively one possible solution is to use GTSELECT:

I have modified GTSELECT (again interfaced with astro library) to define a simple cone cut centered on the average SUN or MOON position (averaged on tmin-tmax cut). Therefore a possible way is the following:

- **Split fits files using a time cut (each file 3hr long) using GTSELECT and at the same time centered on the MOON/SUN (time duration should garantee that Sun don't move in the sky while MOON moves of about 2° in 3 hrs so you need a large cone)**
- **A python script can help to do this job in simple way**

ADVANTAGES

- **On each file, exposure and livetimecan be evaluated, and DSS keys are compatible with gtlikelihood**

PROBLEMS

- **How add/merge each exposure/flux files if the cone-cut is different?**
- **Again source model?**

Part of the code inside gtselect...

```
SolarSystem sun(SolarSystem::SUN);
SolarSystem moon(SolarSystem::MOON);

 if(mytmin<gti.minValue()) mytmin=gti.minValue();
 if(mytmax==0||mytmax>gti.maxValue()) mytmax=gti.maxValue();
 // Now define a SkyConeCut centered on the average Sun/Moon position
 double mytime=(mytmin+mytmax)/2.; //average time
 std::cout<<"Time range selection:"<<mytmin<<" "<<mytmax<<std::endl;
 JulianDate myjdtt(JulianDate::missionStart()+mytime/JulianDate::secondsPerDay);
...
 SkyDir sundir=sun.direction(myjdtt);
 SkyDir moondir=moon.direction(myjdtt);
 # for SUN
   ra=sundir.ra(); // calculated sun's ra
   dec=sundir.dec();

if (radius < max_rad) {
  m_cuts.addSkyConeCut(ra, dec, radius);
}
```

Moon and Sun directions are the same calculated as for the simulation (should contain parallax corrections)

Standard Sky Cone Cut

Analysis for solar system sources

But gtlikelihood is not necessary for some analysis:

for sun/moon analysis what we really need is a spectrum evaluation and eventually the temporal behaviour (like pulsar and GRB analysis)

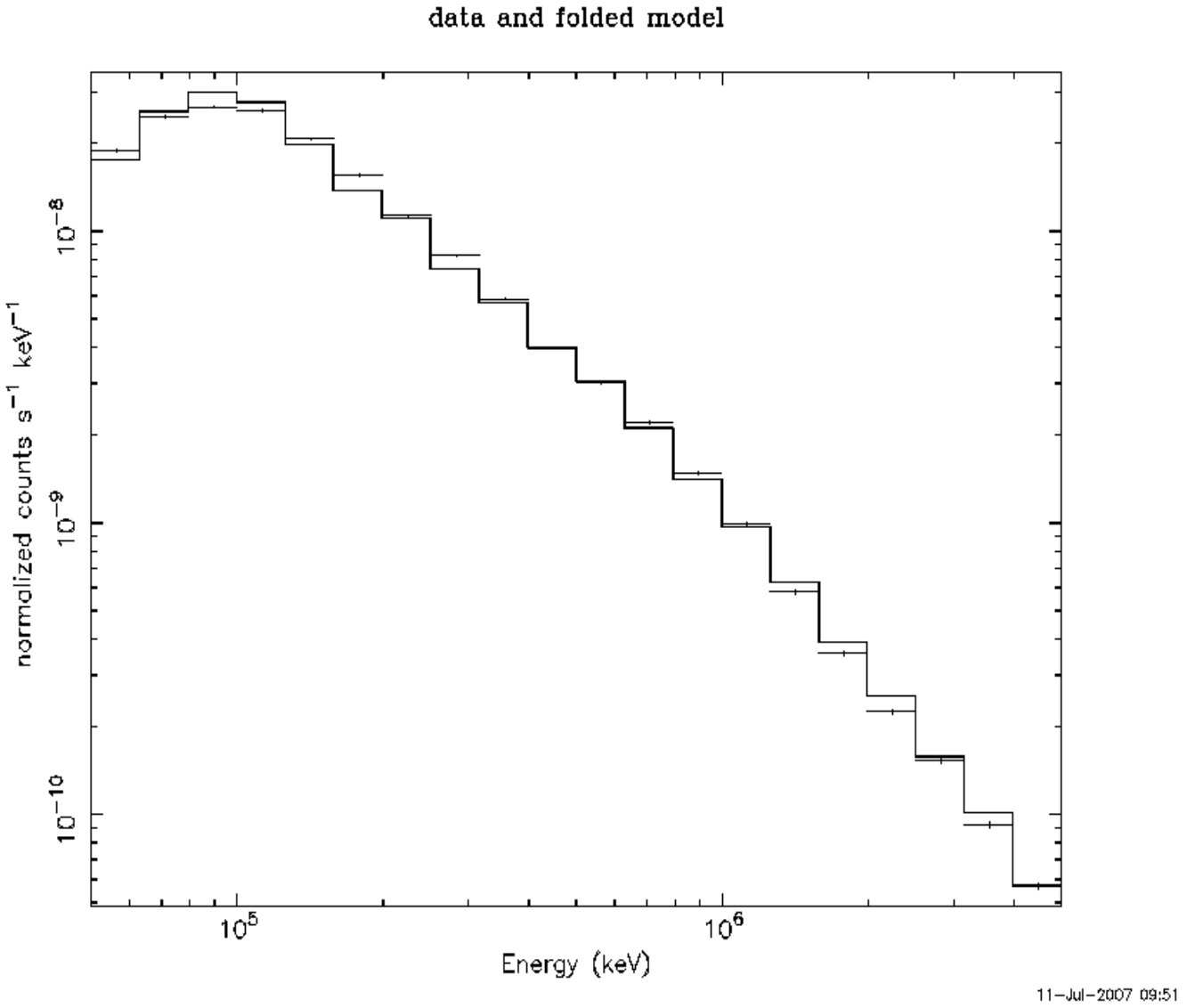
To do this is important that gtbin works!

- **Using splitting+gtselect (modified) the fits file have simple cuts**
- **Gtbin works well with these files producing pha1 output**
- **Gtrspgen also works well**
- **GTBIN works well also passing the list of splitted files**

Some example of application in next slide

MOON Spectrum (example)

Powerlaw model
(fitted power index=2.276)
thresh=50 MeV
events within 5° from the Moon center



CONCLUSIONS

- Few modifications to gtselect are sufficient to have gtbin working also for moving sources
- Spectrum analysis can be done for SUN+MOON using xspec
- Likelihood analysis not easy to do:
  - too many packages to modify
  - Coordinates in moving frame are to be added to likelihood packages (gtexpmap, gtexpcube, gtlivetimecube and gtlikelihood)
  - Extended source model to add (a disk, radius as parameter)
- Simple package to add colums in fits file useful for display purpouses can be released as a general package or a user package in CVS