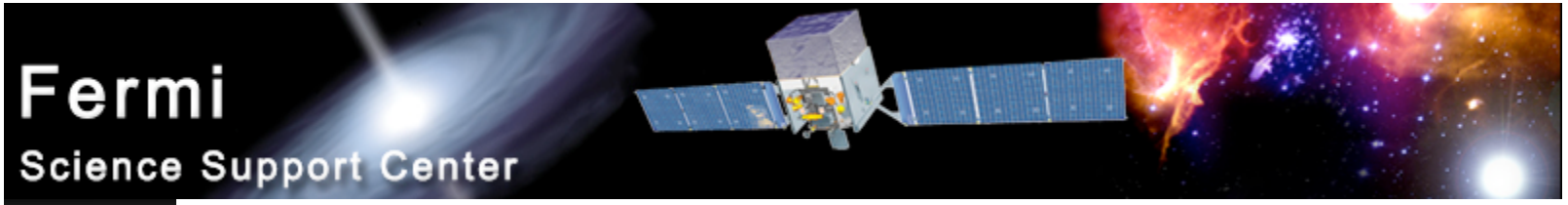
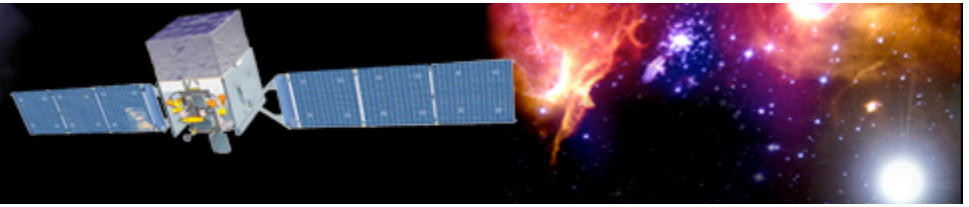
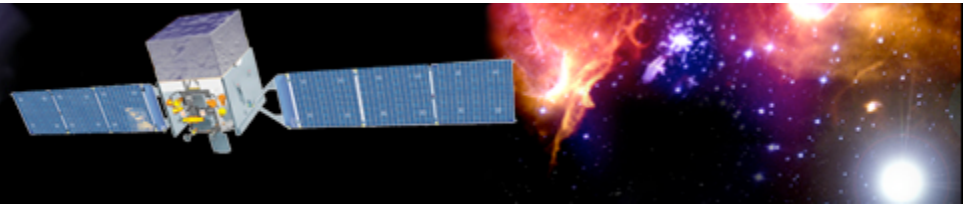


LAT Light Curve Analysis



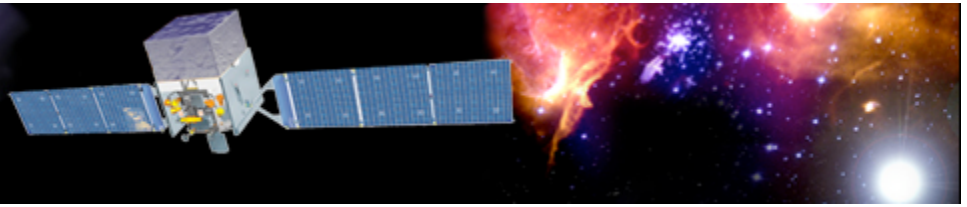
Photometry

- *LAT Light Curves can be obtained in two basic ways:*
  - *Likelihood Analysis*
  - *Aperture Photometry*
- *Likelihood analysis has the potential for greater senstivity. However, aperture photometry is easier, faster, and has the benefit of model independence.*
- *This presentation only deals with aperture photometry*



Aperture Photometry Process

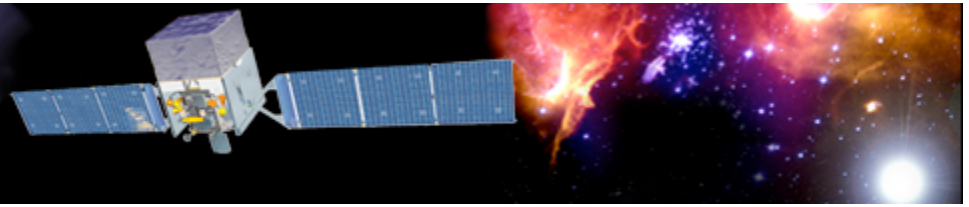
- *It is recommended to use a script to create an analysis chain from the toolset*
  - *fkeypar - extracts start and stop times*
  - *gtselect - performs desired data cuts*
  - *gtmktime - creates good time intervals*
  - *gtbin - makes quasi-light curve (counts rather than rate)*
  - *fdump - exports data*
  - *other tools - convert counts to rates, calculate errors*



Extract Start/Stop Times

- *$ fkeypar "L090923112502E0D2F37E71_PH00.fits[1]" TSTART*
  (photon start time = 266976000.)

- *$ fkeypar "L090923112502E0D2F37E71_PH00.fits[1]" TSTOP*
  (photon stop time = 275369897.)



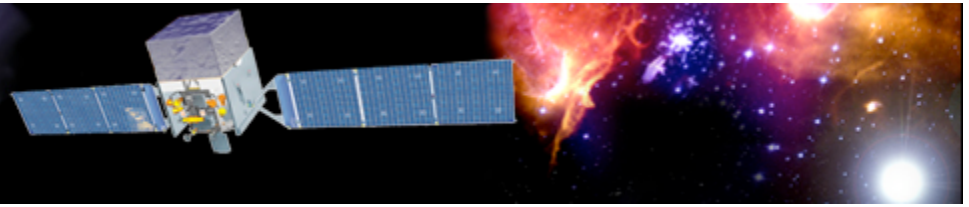
Perform Data Selection

- *$ gtselect zmax=105 emin=100 emax=200000 L090923112502E0D2F37E71_PH00.fits outfile=temp2_1DAY_3C454.3.fits ra=343.490616 dec=16.148211 rad=1 tmin=266976000. tmax=275369897. evclsmin=3 evclsmax=10*

- *Parameters Specify*
  - *Energy Range (100 to 200,000 MeV)*
  - *Source coordinates*
  - *1 degree aperture radius*
  - *Previously determined start and stop times*

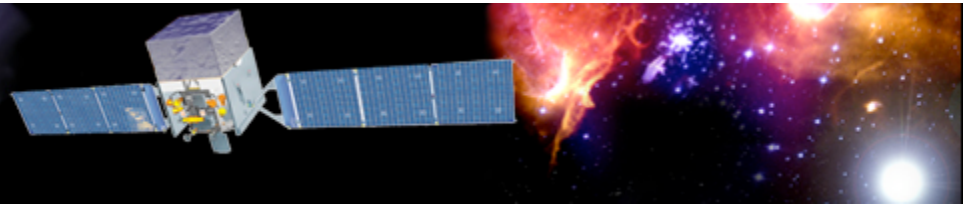
    (Note: if you're going to barycenter then the min and max times should be slightly greater/less than the times in the spacecraft file
  - *Event class min/max (3 for diffuse class, 0 for simulated data)*

- *Writes to file: temp2_1DAY_3C454.3.fits*



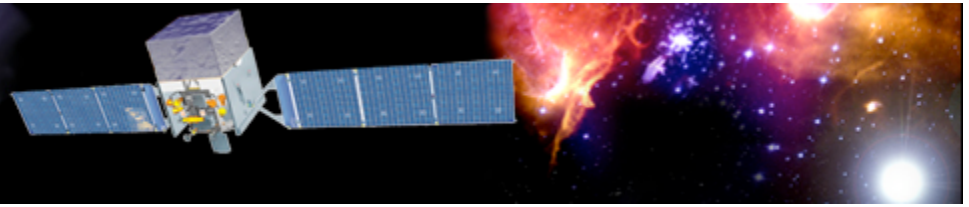
Calculate GTIs

- *$ gtmktime scfile="L090923112502E0D2F37E71_SC00.fits" filter="(DATA_QUAL==1) && (angsep(RA_ZENITH,DEC_ZENITH,343.490616,16.148211)+1<105) && (angsep(343.490616,16.148211,RA_SCZ,DEC_SCZ)<180)" roicut=n evfile="temp2_1DAY_3C454.3" outfile="temp3_1DAY_3C454.3"*
- *Parameters Specify*
  - *Good data quality*
  - *Photons less than 105 degrees from zenith (+1 is for 1 degree aperture)*
  - *Photon locations not in the exact center of the field of view*
  - *Input file is output from gtselect*
- *Writes to file: temp3_1DAY_3C454.3.fits*



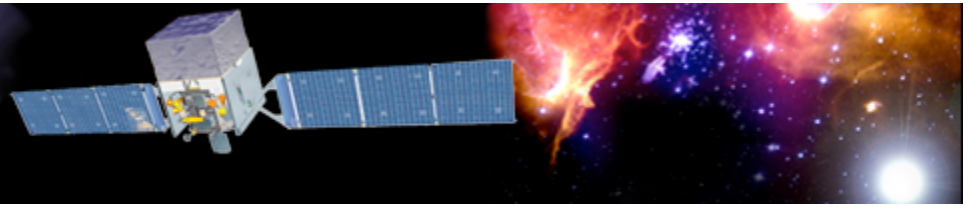
Extract a Light Curve

- *$ gtbin algorithm=LC evfile=temp3_1DAY_3C454.3.fits outfile=lc_1DAY_3C454.3.fits scfile=L090923112502E0D2F37E71_SC00.fits tbinalg=LIN tstart=266976000. tstop=275369897. dtime=86400*
- *Parameters Specify*
  - *Make a light curve (LC)*
  - *Input file is output file from gtselect*
  - *Spacecraft file*
  - *Linear time bins*
  - *Start and stop times*
  - *Size of time bin in seconds (86400 = 1 day bins)*
- *Writes to file: lc_1DAY_3C454.3.fits*



Calculate Exposures

- *$ gtexposure infile="lc_1DAY_3C454.3.fits" scfile="L090923112502E0D2F37E71_SC00.fits" irfs="P6_V3_DIFFUSE" srcmdl="none" specin=-2.1*
- *Parameters Specify*
  - *Spacecraft file*
  - *Instrument Response Function to use*
  - *Source model (for more complex model than power-law)*
  - *Spectral Index for use in power-law spectrum (convention requires minus sign)*
- *EXPOSURE column is added to file: lc_1DAY_3C454.3.fits*

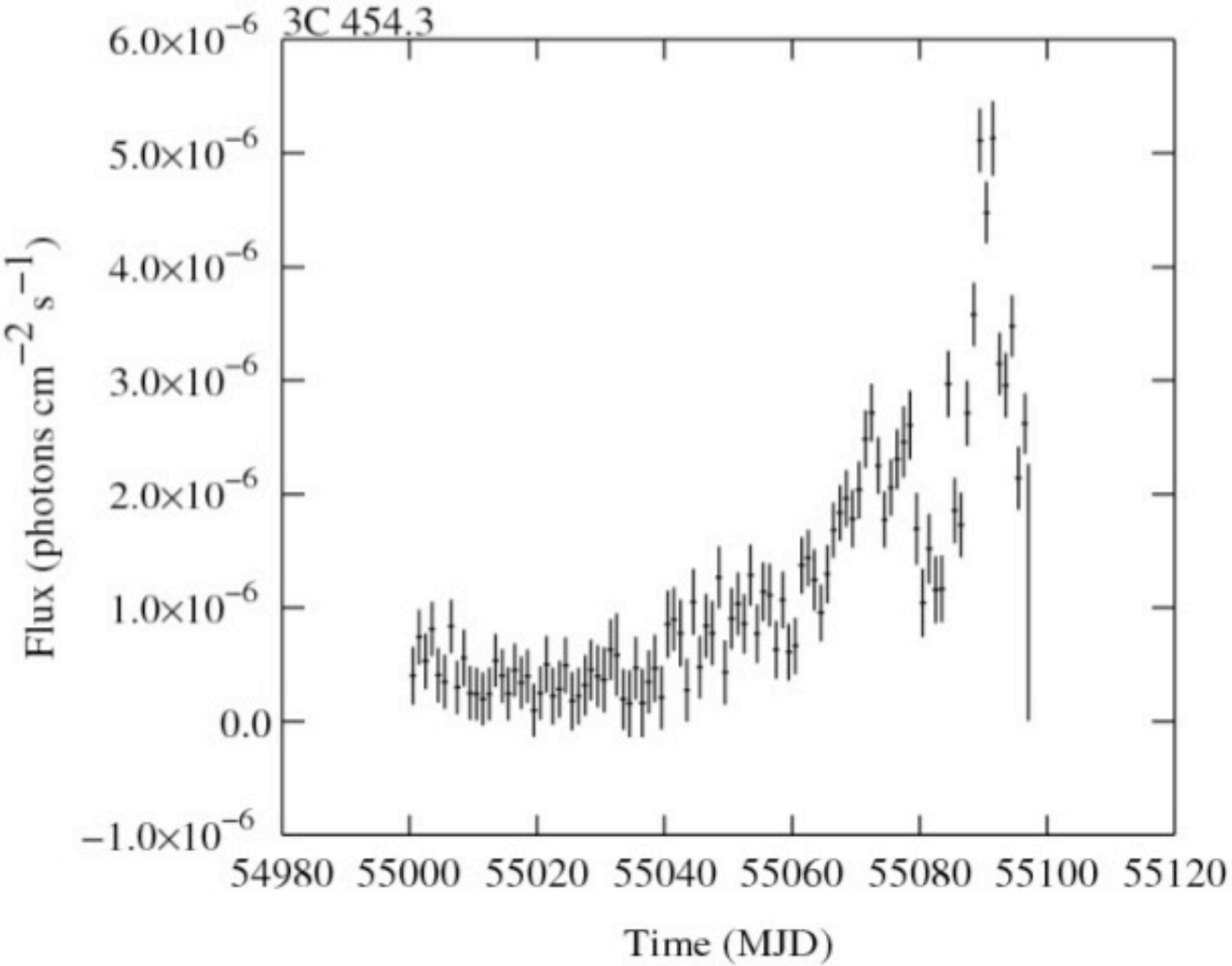


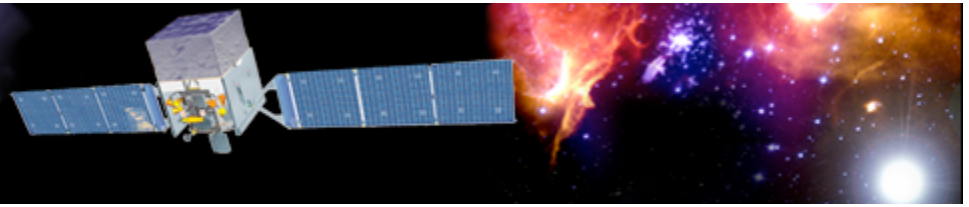
Results

- *Final FITS file contains:*
  - *Time in MET*
  - *Bin Width in seconds*
  - *Number of counts per bin*
  - *Error*
  - *Exposure*

- *To convert to rates, use fv or other tool to divide counts by exposure*
- *Error bars in output are sqrt(counts)*
  - *In some instances (e.g. too few counts) this may be incorrect*
  - *Correcting this may be more complicated*

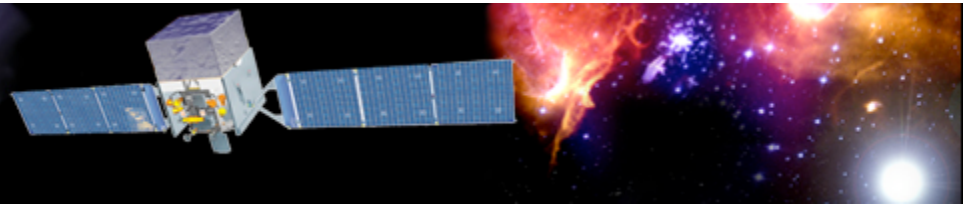
Light Curve


3C 454.3
6.0×10−6
5.0×10−6
4.0×10−6
3.0×10−6
2.0×10−6
1.0×10−6
0.0
−1.0×10−6
Flux (photons cm−2 s−1)
54980
55000
55020
55040
55060
55080
55100
55120
Time (MJD)



Barycentering

- *If your source is sensitive to the motion of the Earth, you may wish to barycenter the events file to remove that effect*
- *gtbary is usually used to barycenter the events file for pulsar timing. But it can also be used for light curves*
  - *gtbary must be the last step of the analysis (after exposure caluclation)*
  - *Spacecraft file must be longer than the events file (remember this when doing the gtselect step)*
  - *gtbary overwrites the time column with the barycentered (corrected) photon arrival times. It's wise to make a copy of your data file before running gtbary.*



Using Exposure Errors

- *For some purposes, errors based on observed counts may not be correct*
- *Alternative is to use errors based on the exposure*
  - *Calculate the mean count rate*
  - *For each time bin, calculate the expected number of counts based on the exposure for that time bin*
  - *Take the square root of that predicted number of counts*
  - *Divide by the exposure to get the rate*
  - *The resulting error value is based only on the "quality" of each time bin*
- *References for error bars treatment:*
  - *Gehrels, 1986, ApJ, 303, 336*
  - *Kraft, Burrows, & Nousek, 1991, ApJ, 374, 344*

Comparing Error types