Status report on Perugia group software activities

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- Observation simulator
- Independent Component Analysis (ICA)
- Wavelets Analysis –

Roma, sept 16 2003

Perugia Observation Simulator:

Light_Sim package of Science Tools: standalone generation of sky maps , tables for photons and SC parameters (FITS files) using :

- parameterization of instrument response functions (SA, PSF, ED) (from S. Ritz and S. Digel)
- orbit model (astro package)
- source emission modeled as a power law with parameters from 3EGC or from user file.
- diffuse emission (>100 MeV) from EGRET model

First attempt of data production to compare with other simulators and to test analysis tools

Simulation of 1 week GLAST sky survey

- **Energy range (0.03 , 30) GeV**
- **30 degrees radius around [b,l]=[0,75]**
- **sources list from S. Digel**

  134 sources from:

  3EG, faint blazars, local galaxies, galactic halo, low latitude

  sources with flux (>100 MeV) > 10^{-8} cm^{-2} s^{-1}

OUTPUT:

Maps + FITS binary tables available on web

http://www.slac.stanford.edu/~lubrano/skymap_tot.fits

/source_map_tot.fits

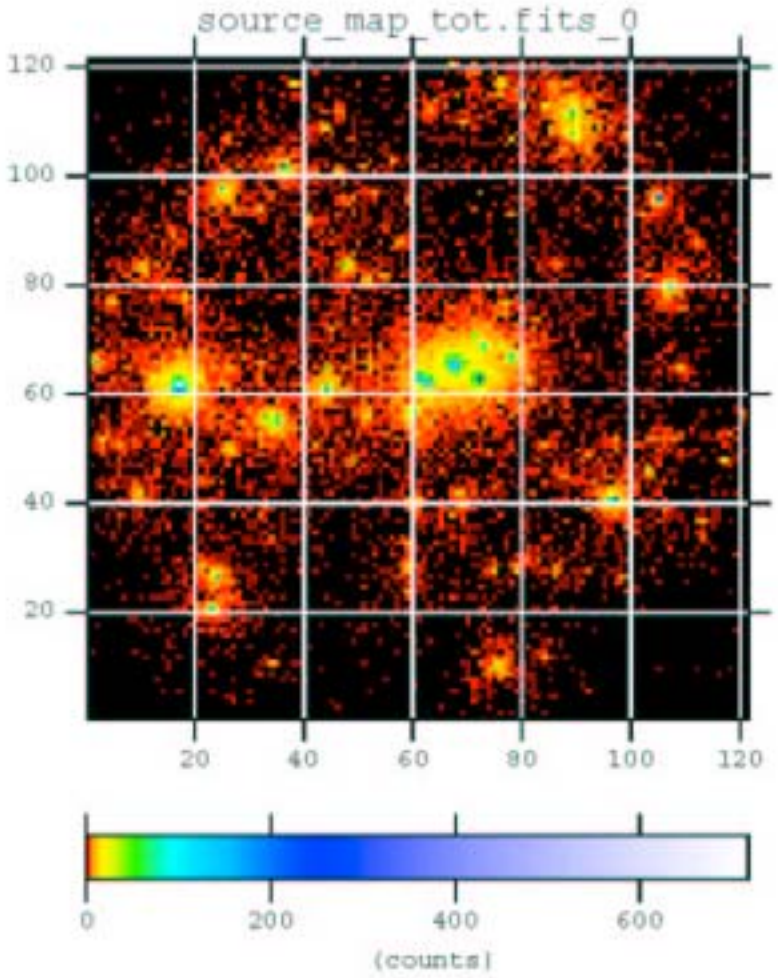
/tables/xxx.fits

Details on the simulation can be found in:

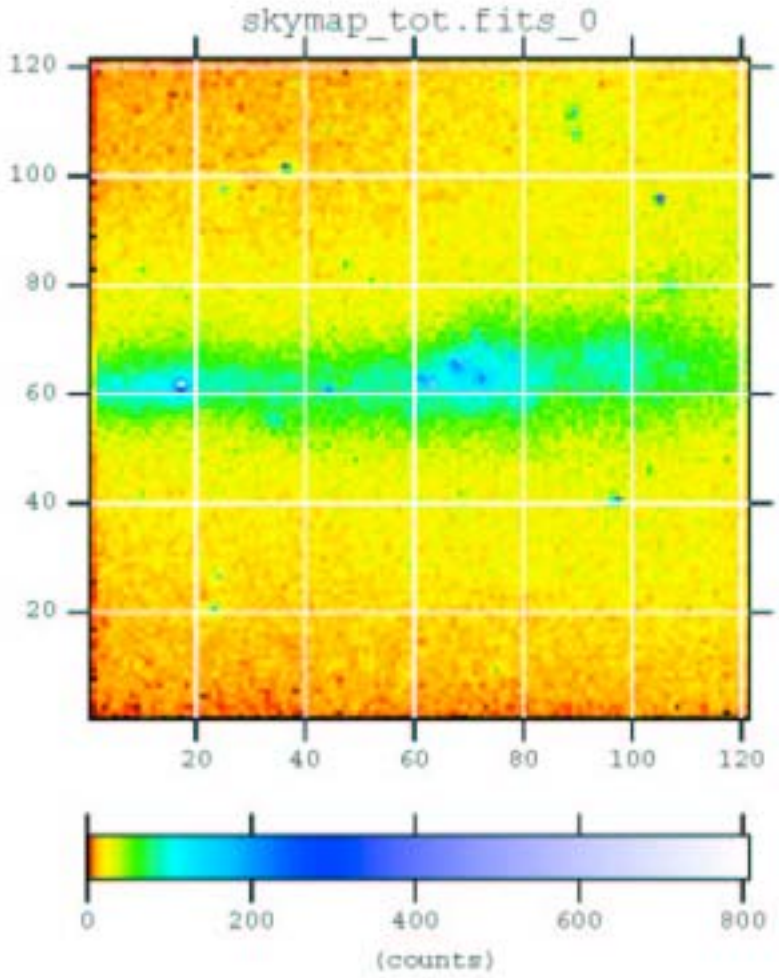
http://www.slac.stanford.edu/~lubrano/light_simulator_new.doc

http://glast.gsfc.nasa.gov/science/lat/oct02/CCecchi_wg3.pdf

Work in progress to compare results from observationSim from J. Chiang



source_map_tot.fits_0 Colorbar



skymap_tot.fits_0 Colorbar

Variables as defined in: http://www-glast.stanford.edu/protected/mail/scisoft/0155.html

ENERGY_meas	ENERGY_UNC	SUBSYSTEM_FLAG	DIRECTION	RA_meas	DEC_meas	TIME	ZENIT_ANGLE	EARTH_AZIMUT_ANGLE
E	E	1J	E	E	E	E	E	E
GeV	GeV		deg	deg	deg	s	deg	deg
4.97E-01	6.77E-02	1	8.00E+01	2.76E+02	3.42E+01	1.89E+03	1.16E+02	1.52E+02
1.00E-03	8.47E-02	1	8.00E+01	2.75E+02	2.90E+01	5.54E+02	1.03E+02	7.10E+01
3.90E-01	7.02E-02	0	8.00E+01	2.76E+02	2.89E+01	4.62E+02	9.97E+01	7.74E+01
1.08E-01	9.89E-02	0	8.00E+01	2.76E+02	2.92E+01	5.15E+02	1.02E+02	7.31E+01
1.04E-01	8.84E-02	0	8.00E+01	2.77E+02	2.89E+01	7.05E+02	1.07E+02	6.16E+01
8.78E-02	9.06E-02	1	8.00E+01	2.78E+02	5.92E+01	7.60E+02	8.83E+01	1.02E+02
1.12E+00	6.52E-02	0	8.00E+01	2.79E+02	5.94E+01	1.26E+03	9.10E+01	9.24E+01
1.20E-01	9.83E-02	1	8.00E+01	2.78E+02	5.91E+01	1.44E+03	9.19E+01	9.24E+01
1.11E-01	9.62E-02	0	8.00E+01	2.82E+02	5.94E+01	1.57E+03	9.27E+01	9.12E+01
2.48E-01	7.44E-02	0	8.00E+01	2.83E+02	5.98E+01	6.51E+02	8.64E+01	1.04E+02
4.72E-01	6.72E-02	0	8.00E+01	2.83E+02	5.92E+01	6.74E+01	8.37E+01	1.29E+02
2.42E-01	8.17E-02	0	8.00E+01	2.92E+02	1.82E+01	9.88E+02	1.13E+02	3.11E+01
1.77E-01	7.41E-02	0	8.00E+01	2.90E+02	1.66E+01	7.81E+02	1.04E+02	4.73E+01
1.98E-01	7.87E-02	0	8.00E+01	2.92E+02	1.84E+01	3.43E+02	8.36E+01	8.74E+01
1.49E-01	8.45E-02	1	8.00E+01	2.94E+02	1.78E+01	1.28E+03	1.25E+02	3.10E+01
3.01E+00	7.02E-02	1	8.00E+01	2.92E+02	1.76E+01	1.62E+03	1.34E+02	8.61E+01
3.74E+00	7.15E-02	0	8.00E+01	2.92E+02	1.76E+01	2.04E+03	1.36E+02	1.36E+02
6.74E-03	9.80E-02	1	8.00E+01	2.92E+02	1.77E+01	1.95E+03	1.37E+02	1.37E+02
1.48E-01	8.89E-02	0	8.00E+01	2.92E+02	1.76E+01	7.35E+02	1.03E+02	4.98E+01
9.59E-01	6.52E-02	1	8.00E+01	2.95E+02	1.47E+01	1.03E+03	1.14E+02	2.93E+01

LatRaZ	LatDecZ	LatRaX	LatDecX	ins SAA	SClon	SClat
E	E	E	E	E	E	E
deg	deg	deg	deg		deg	deg
5.16E+01	1.33E+01	1.14E+02	-9.32E+00	0.00E+00	1.39E+01	2.48E+01
2.55E+02	-4.44E+01	4.48E+01	-1.66E+01	0.00E+00	-7.19E+01	1.56E+01
2.41E+02	-4.46E+01	4.04E+01	-1.86E+01	0.00E+00	-7.68E+01	1.32E+01
2.50E+02	-4.46E+01	4.33E+01	-1.72E+01	0.00E+00	-7.36E+01	1.48E+01
2.77E+02	-4.19E+01	5.22E+01	-1.36E+01	0.00E+00	-6.34E+01	1.93E+01
2.86E+02	-4.02E+01	5.52E+01	-1.26E+01	0.00E+00	-5.99E+01	2.06E+01
3.46E+02	-1.54E+01	8.11E+01	-6.89E+00	0.00E+00	-2.78E+01	2.81E+01

INDEPENDENT COMPONENT ANALYSIS (ICA)

ICA is a statistical method to determine the independent sub-parts of a complex dataset.
It is useful to solve a typical Blind Source Separation (BSS) problem

The assumed model is a linear convolution of the "source" signal s by a mixing matrix A producing observed data x

$x = A\,s$ If the mixing matrix A is unknown, using the central limit theorem the method is able to find the latent variables s, without any assumption on the components except for their statistic independence

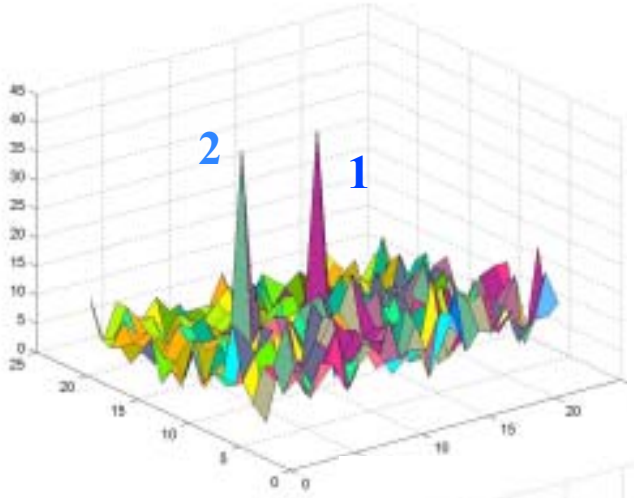
Algorithm (FastICA) tested on simulated (light_sim package) and real (EGRET) data in an energy range between 100 MeV and 30 GeV

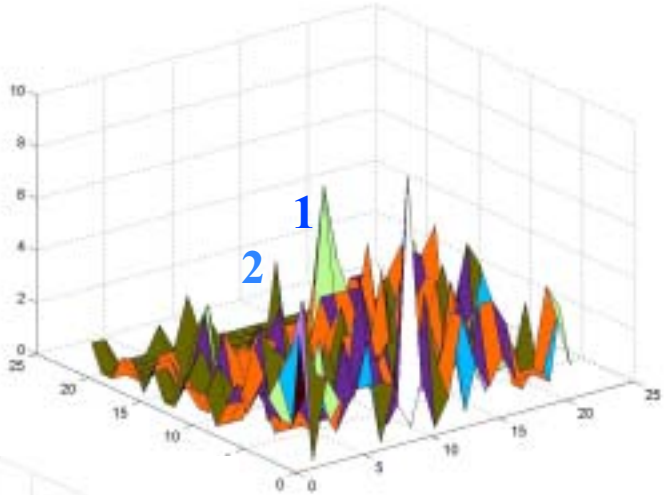
Simulated images: 21x21 pixels around 3C279, 827 orbits

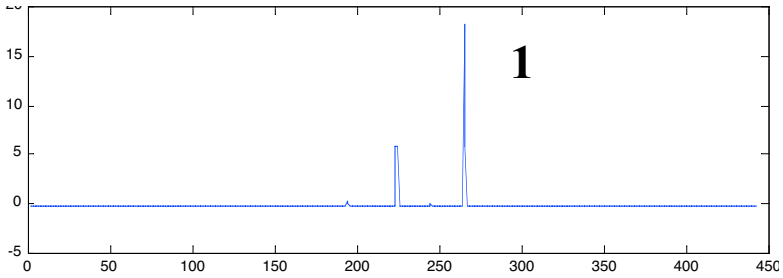
Number of photons from sources is reduced of a factor 150

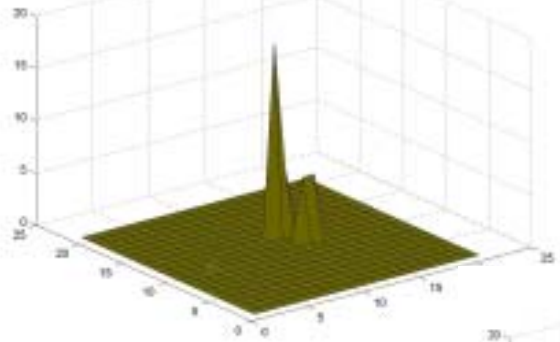
INPUT images:

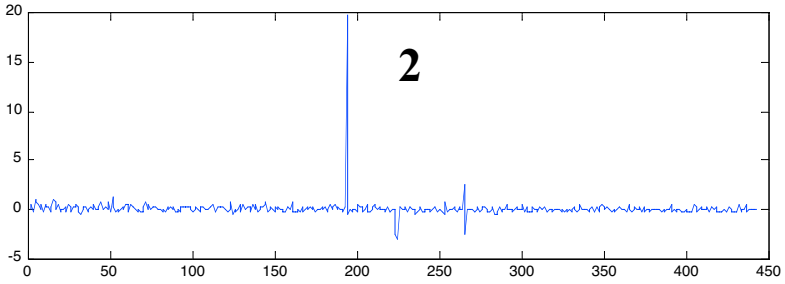
OUTPUT:

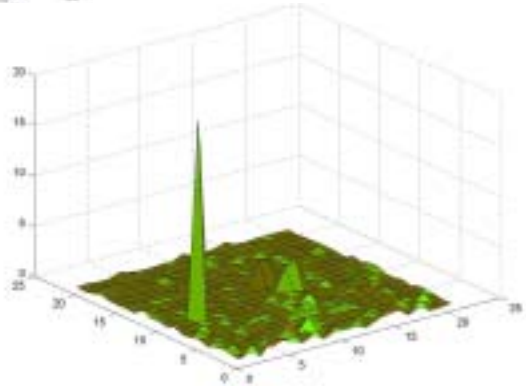












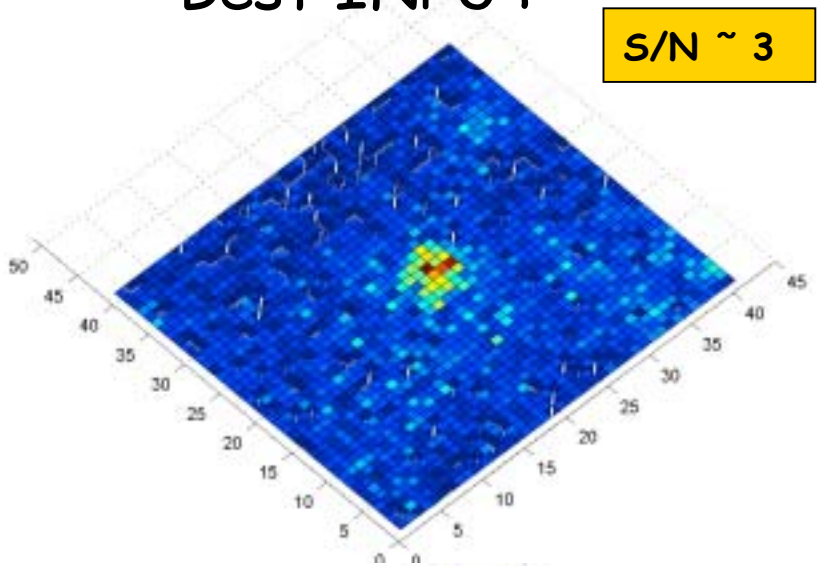
Real and Simulated images: CRAB region, 300 orbits

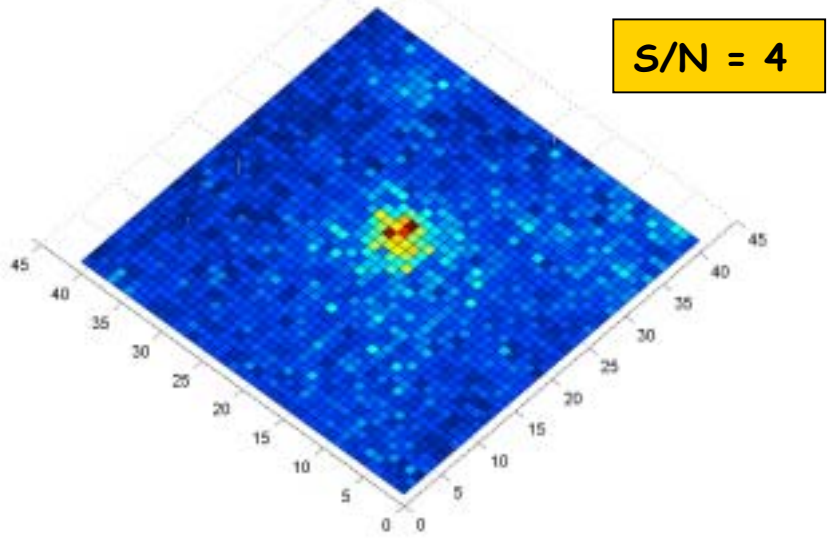
ENERGY RANGE 40 MeV-150 MeV

Best INPUT

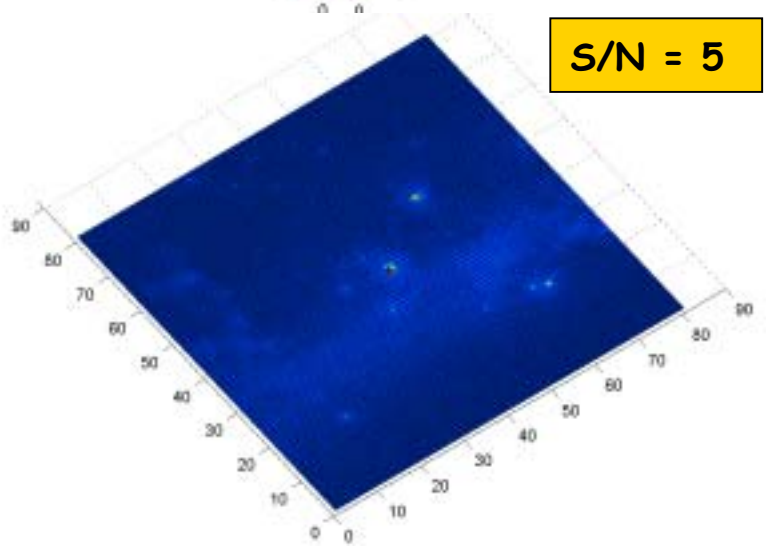
Best OUTPUT

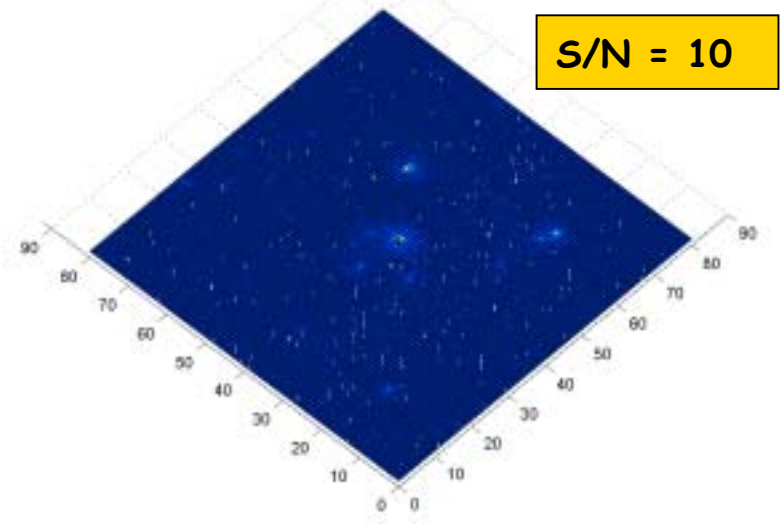
REAL



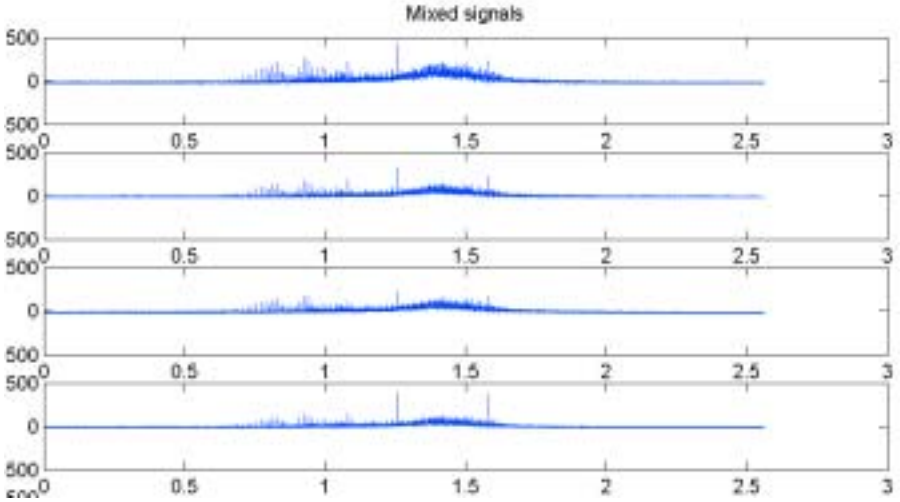


SIMUL

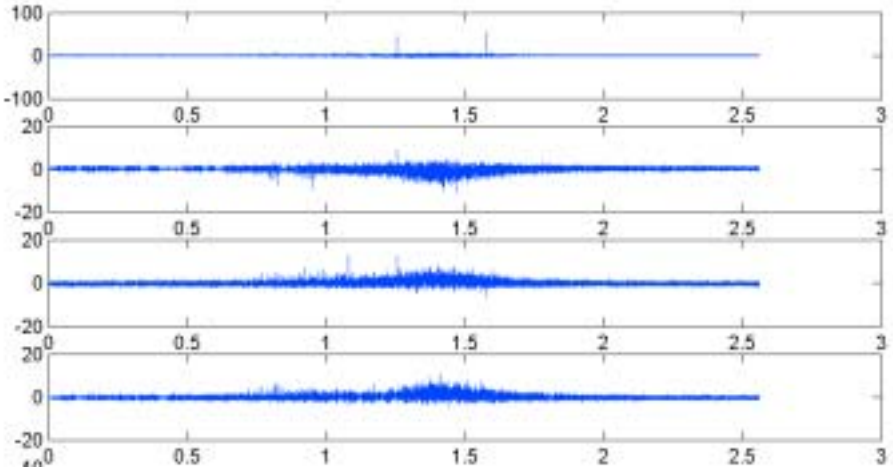




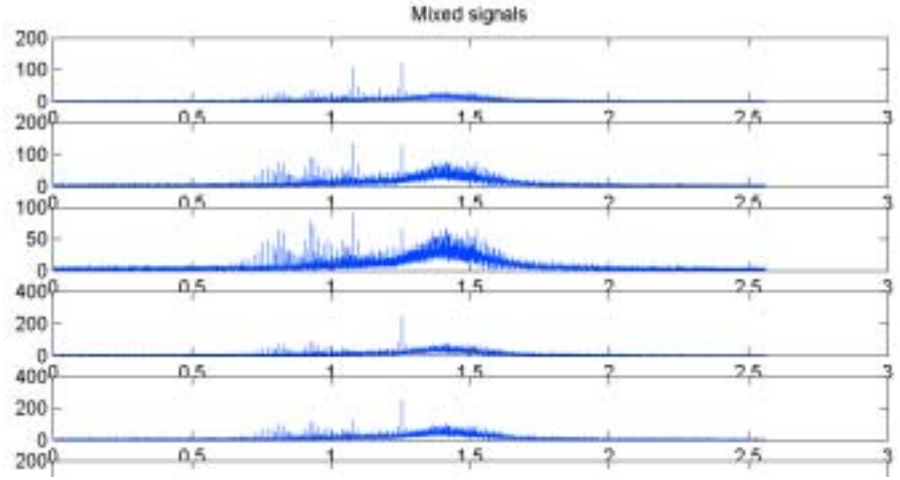
TEST: HOW THE ALGORITHM DEPENDS ON MODEL LINEARITY



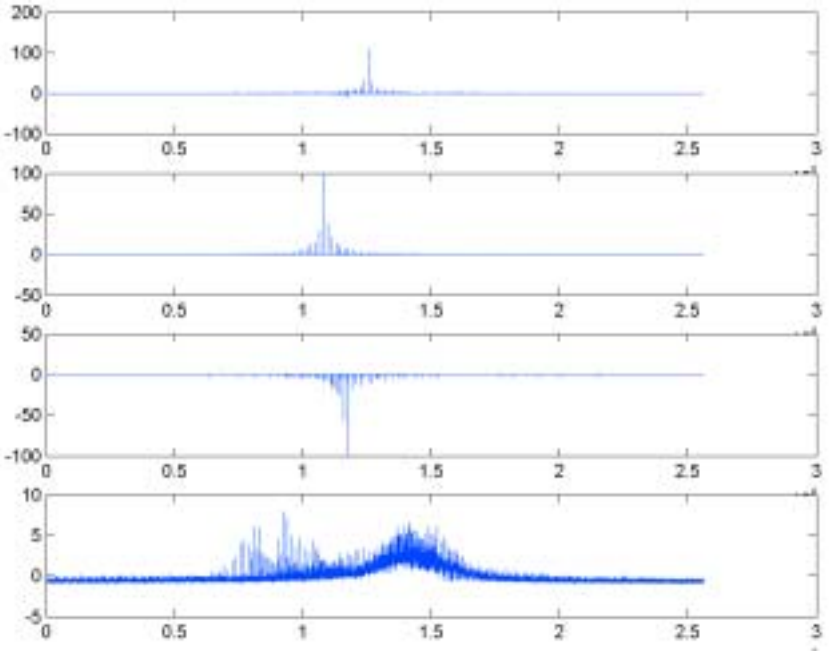
INPUT Mixing: PSF convolution



OUTPUT



INPUT Mixing: random matrix (perfectly linear model)

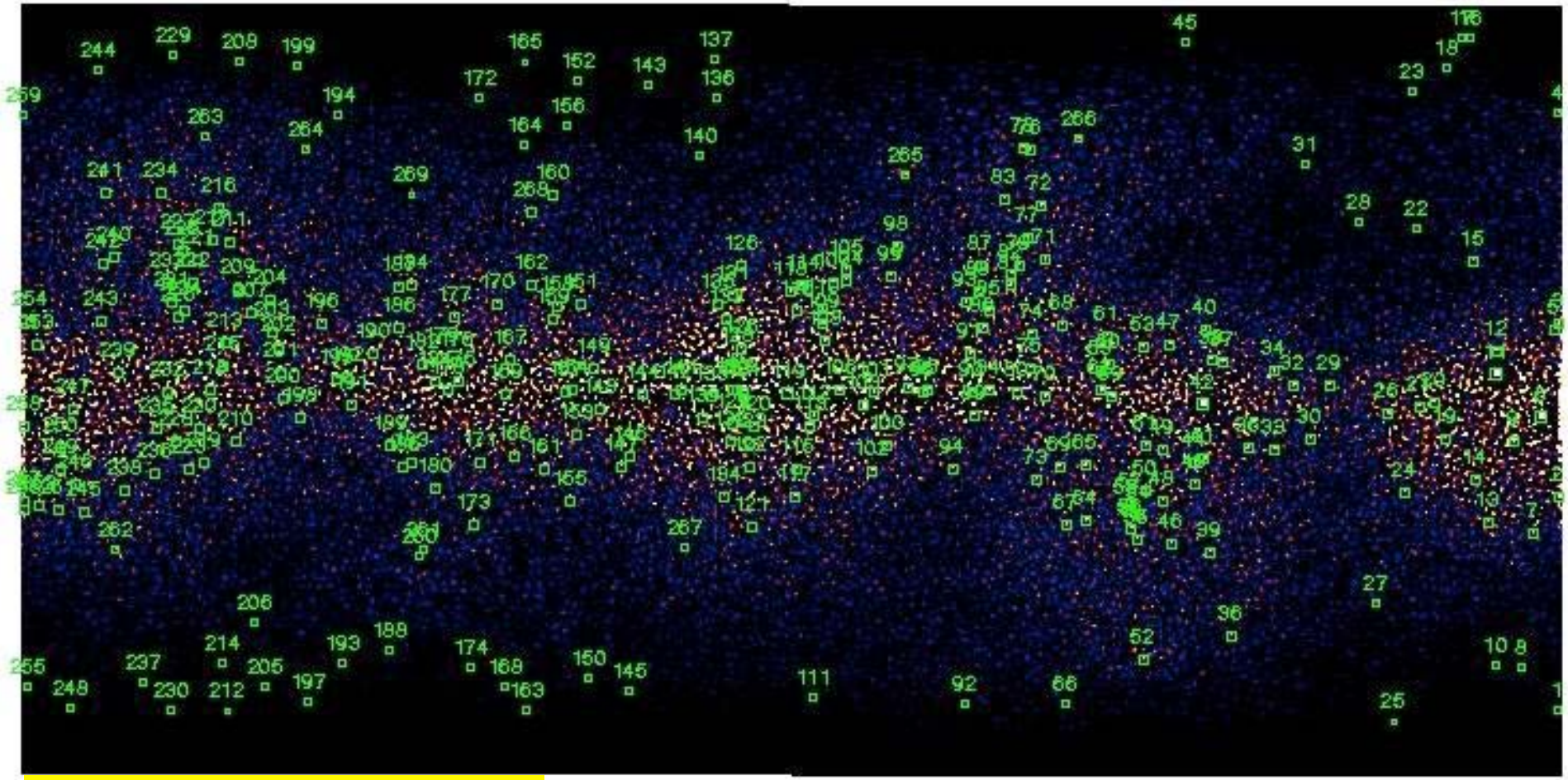


WAVELETS ANALYSIS

- A model independent method of source detection is critical for the discovery of un-modeled and unknown objects
- One project is addressing the viability of the wavelet transform for source detection. EGRET data are being reanalyzed with the above procedure and compared with the acclaimed 3EG catalog.

- Currently there are 269 sources detected at 5σ by the detection algorithm. These are results of a yet unfinished algorithm, of which 203 sources match other catalogs.
- This study of the wavelet transform provides a glimpse at the possibilities yielded in gamma-ray astronomical use of the wavelet transform.

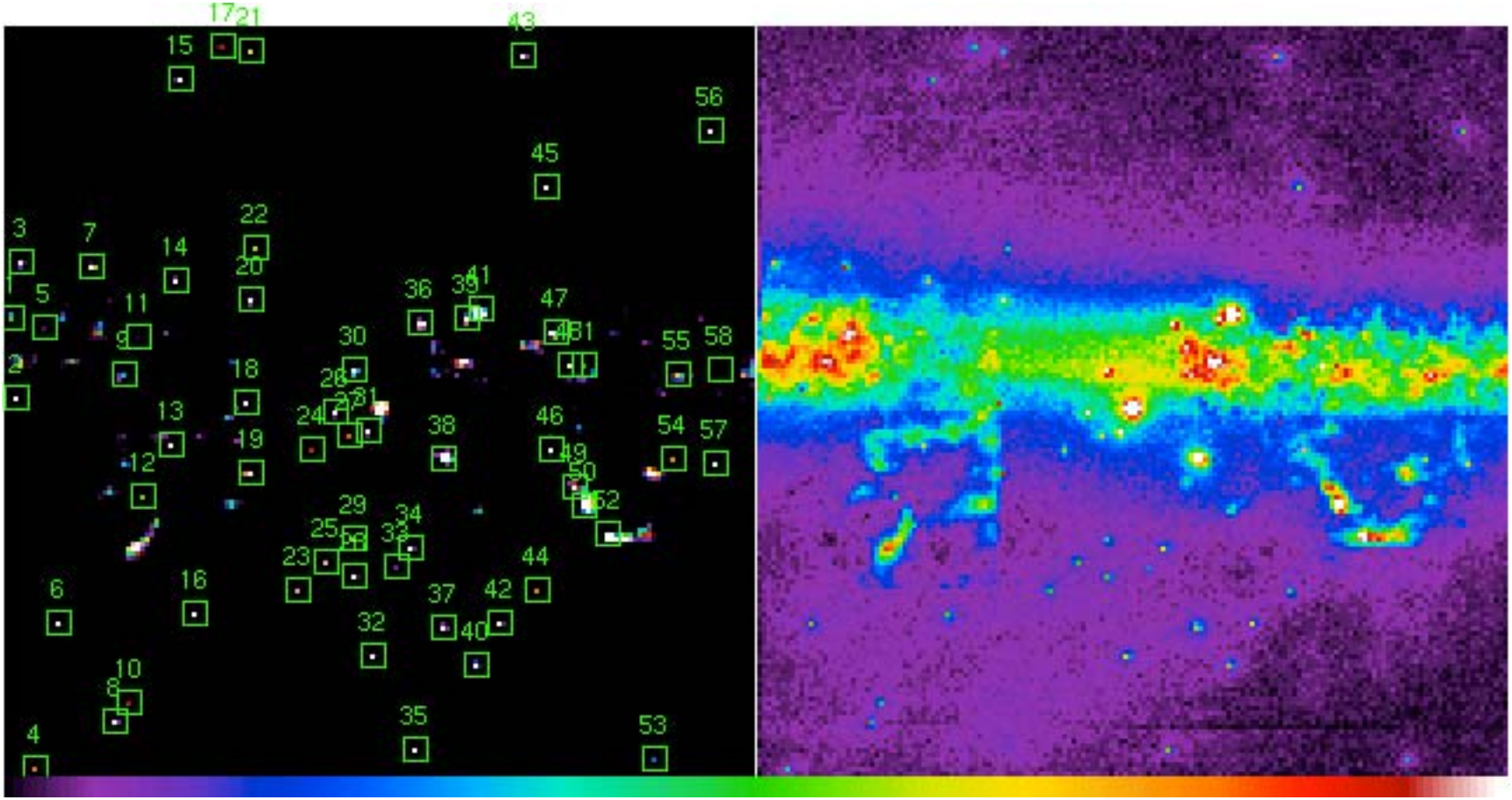
WT analyzed EGRET all-sky map



Analyzed by Kyle Augustson

269 point sources detected (preliminary results), background map subtracted

WT Analysis of light_sim GLAST Simulated Data



WT analysis **Raw simulated data**

300 orbit exposure of Crab region

Analyzed by Kyle Augustson

EGRET Crab Region WT Per Energy

1) 30-50 MeV
2) 50-70
3) 70-100

4) 100-150 MeV
5) 150-300
6) 300-500

7) 500-1000 MeV
8) 1000-2000
9) 2000-4000

Analyzed by Kyle Augustson

Energy bins 1-9 energy range 30 - 4000 MeV

FUTURE PLANS

Simulator:

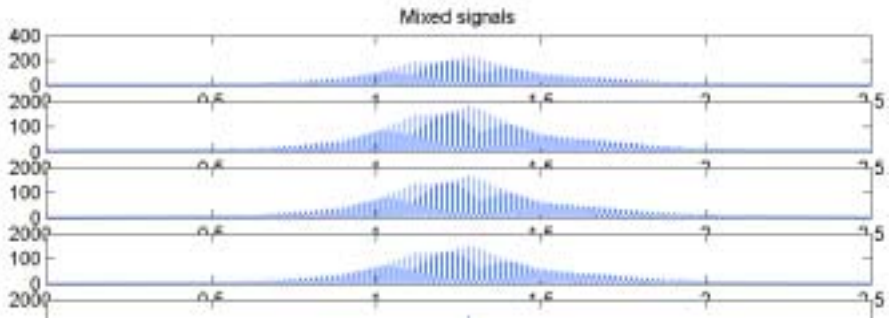
- Understand differences between two simulator packages
- Implement time variability

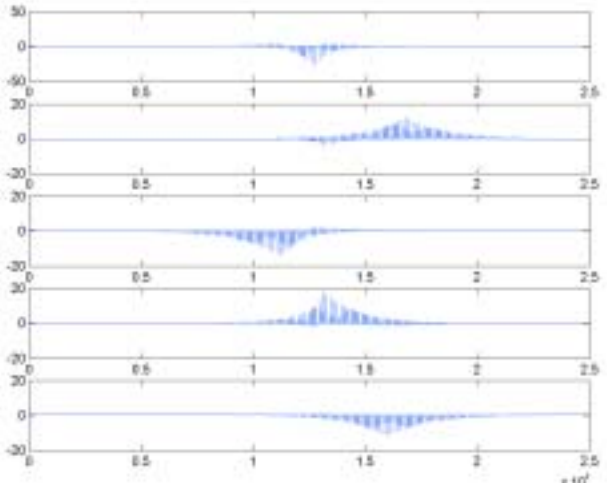
ICA:

- Study non linear method and verify its feasibility on data

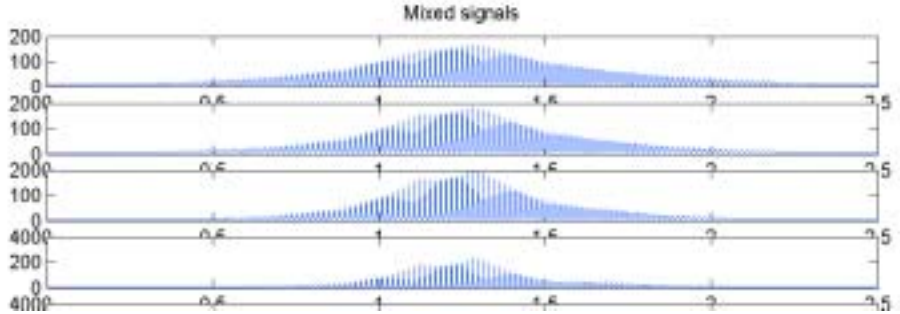
Wavelets:

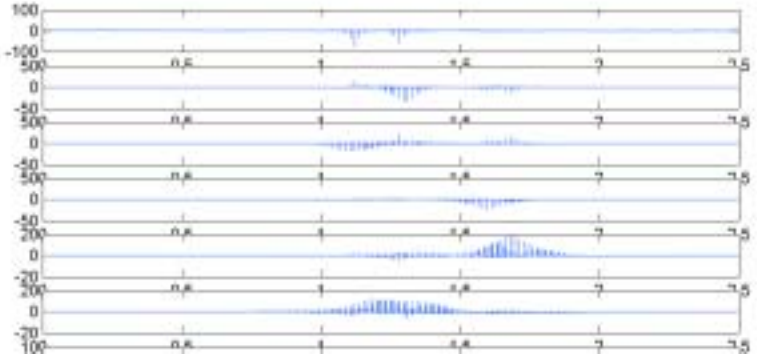
- Complete EGRET data analysis producing source catalogue (point and extended)
- Improve the algorithm for the GLAST data analysis, using simulated images
- Include time series analysis



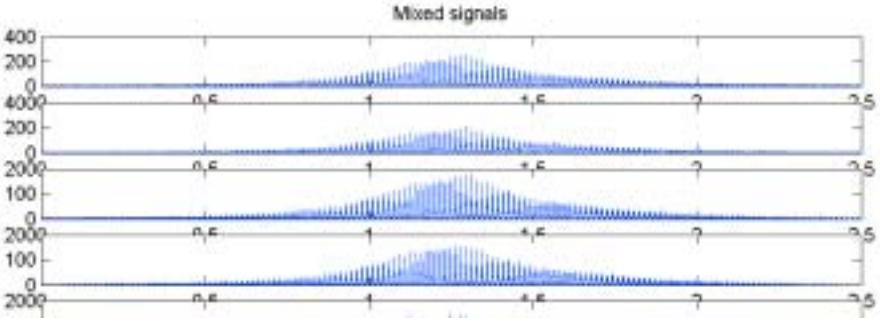


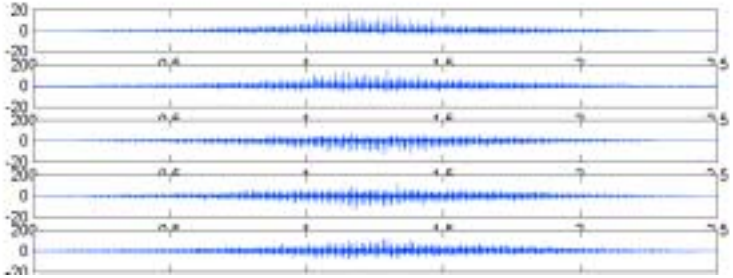
2 gauss $\sigma \neq \sigma(E)$ without Poidev





2 gauss $\sigma = \sigma(E)$





2 gauss $\sigma \neq \sigma(E)$ with Poidev