Comparison of Galactic Plane Analyses

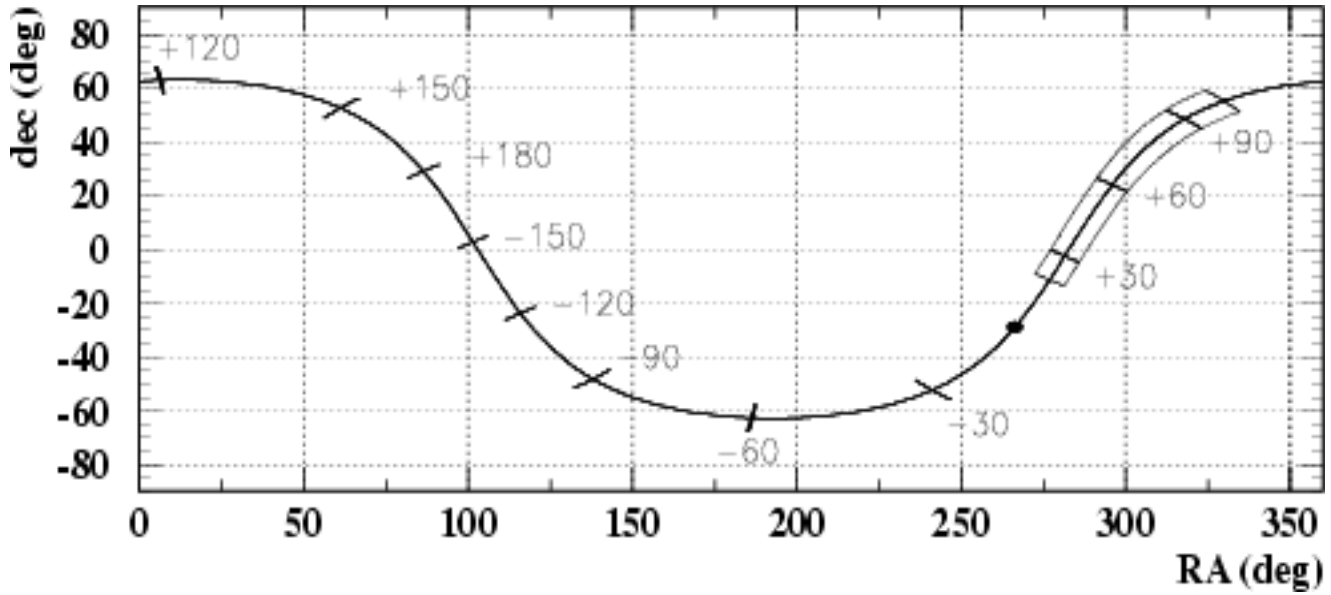
Peter Nemethy (NYU) and
Erik Blaufuss (UMD)

Goal:

To understand the differences between our galactic plane analyses on a common set of data.

A few reminders

- Galactic plane has been broken into two regions that span our area of maximum sensitivity in DEC
  - IG spans Gal Longitude 20-100 degrees
  - OG spans Gal Longitude 140-220 degrees
  - Consider widths of +/- 2 and +/- 5 degrees

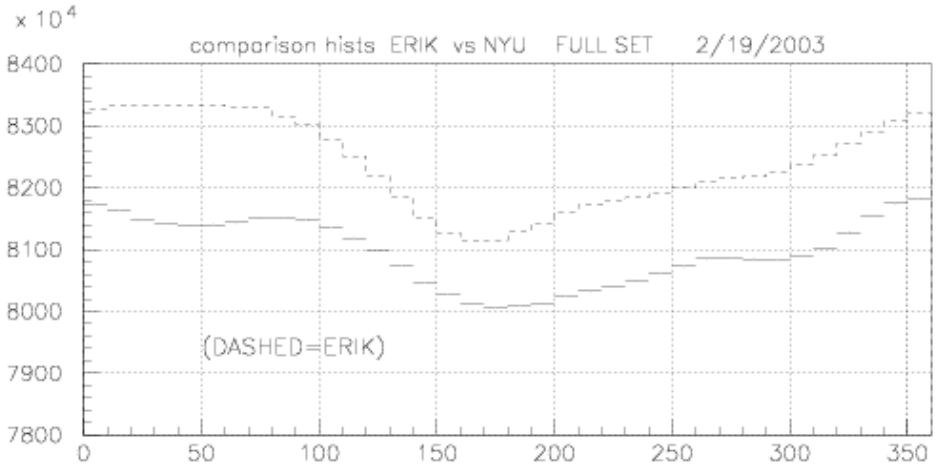


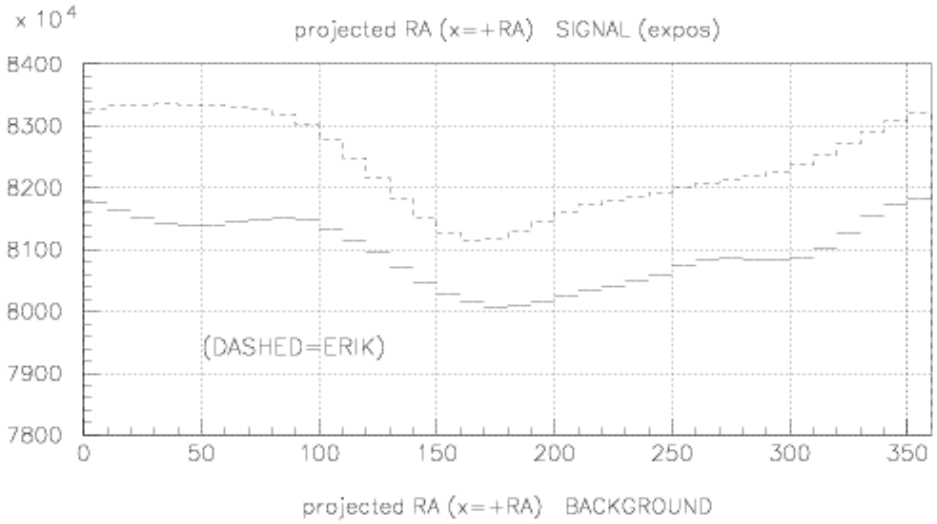
Our strategy at the start...

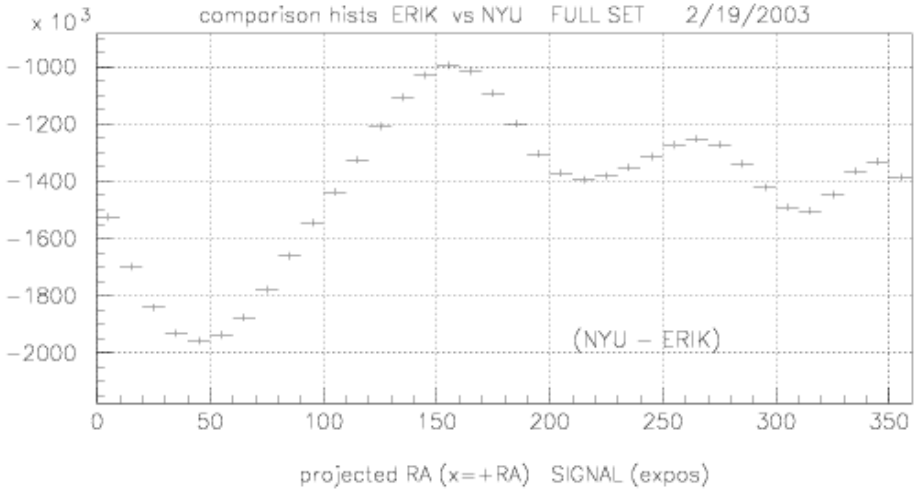
- Our assumption was differences would be in background estimations.
  - Background methods are fundamentally different
  - Found other diffferences “signal” bins
- Define a common set of data files to use
  - Used Data set from Roman's thesis time period (14 mo.)
  - Exclusion and zenith angle corrections turned off.
- Define a common set of cuts to select data to map
  - Again, used set of cuts from NYU analysis
- Identify remaining differences in signal bin
  - Galactic coordinate transformations
  - RA/DEC bin boundary definitions
  - Galactic coordinate mapping methods

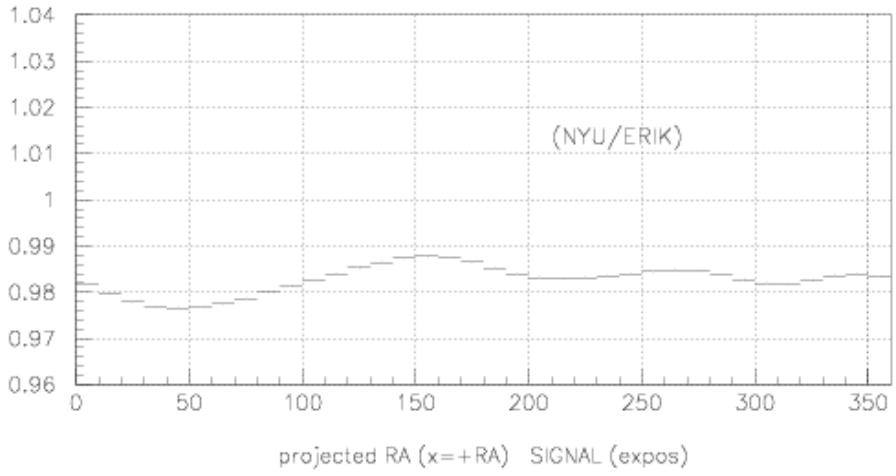
When we started...

RA distribution comparisons





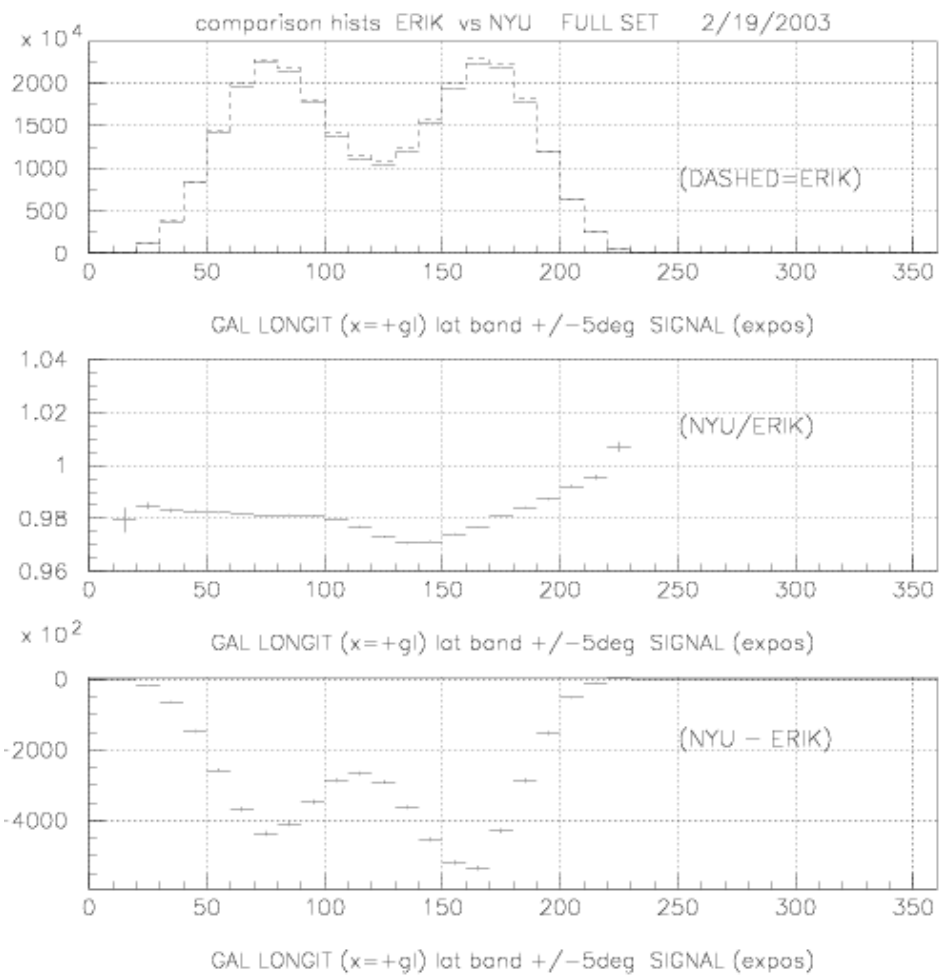


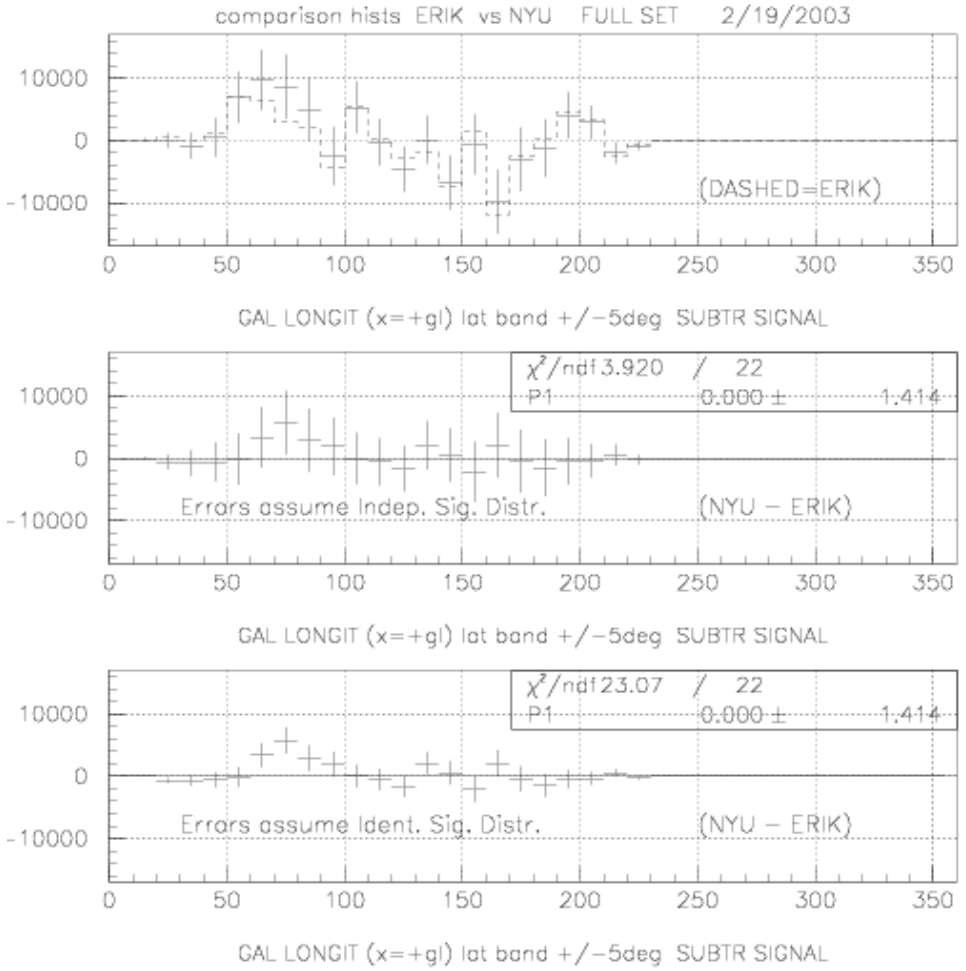


Differences in number of events, exposure seen

When we started (2)...

Galactic longitude profiles +/- 5 deg lat.





Observed systematic differences in subtracted signal

When we started (3)...

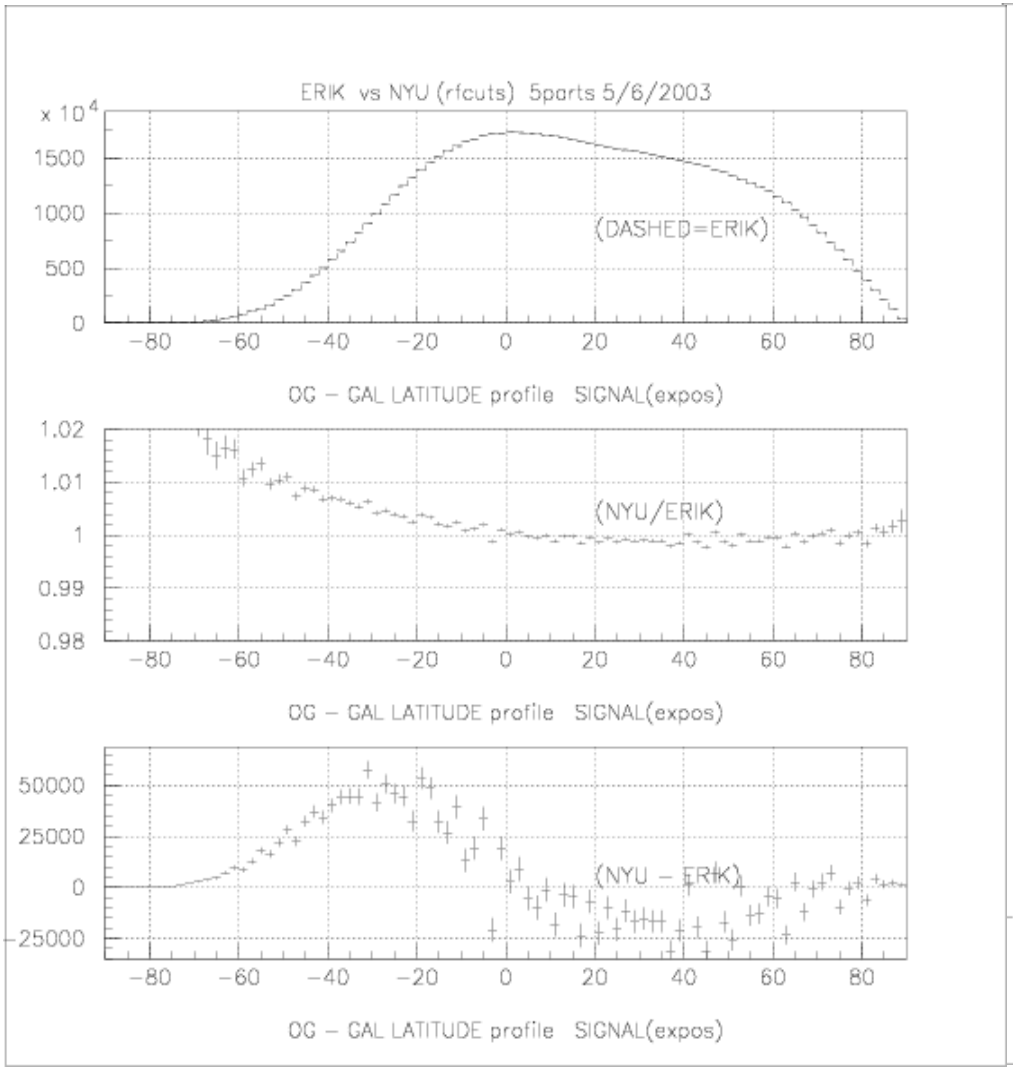
Signal (Exposure)			
Region	NYU	UMD	NYU – UMD
			-829983
IG +/-2	43523896	44353879	
IG +/-5	108527968	110578038	-2050070
OG +/- 2	47097456	48055182	-957726
OG +/- 5	117444016	119882772	-2438756
Subtracted Signal (excess)			
IG +/-2	12,730 +/- 7,093	8528	4202
IG +/-5	27,115 +/-11,540	15570	11545
OG +/- 2	-3,875 +/- 7,392	-2847	-1028
OG +/- 5	-16,696 +/- 12,050	-14607	-2089

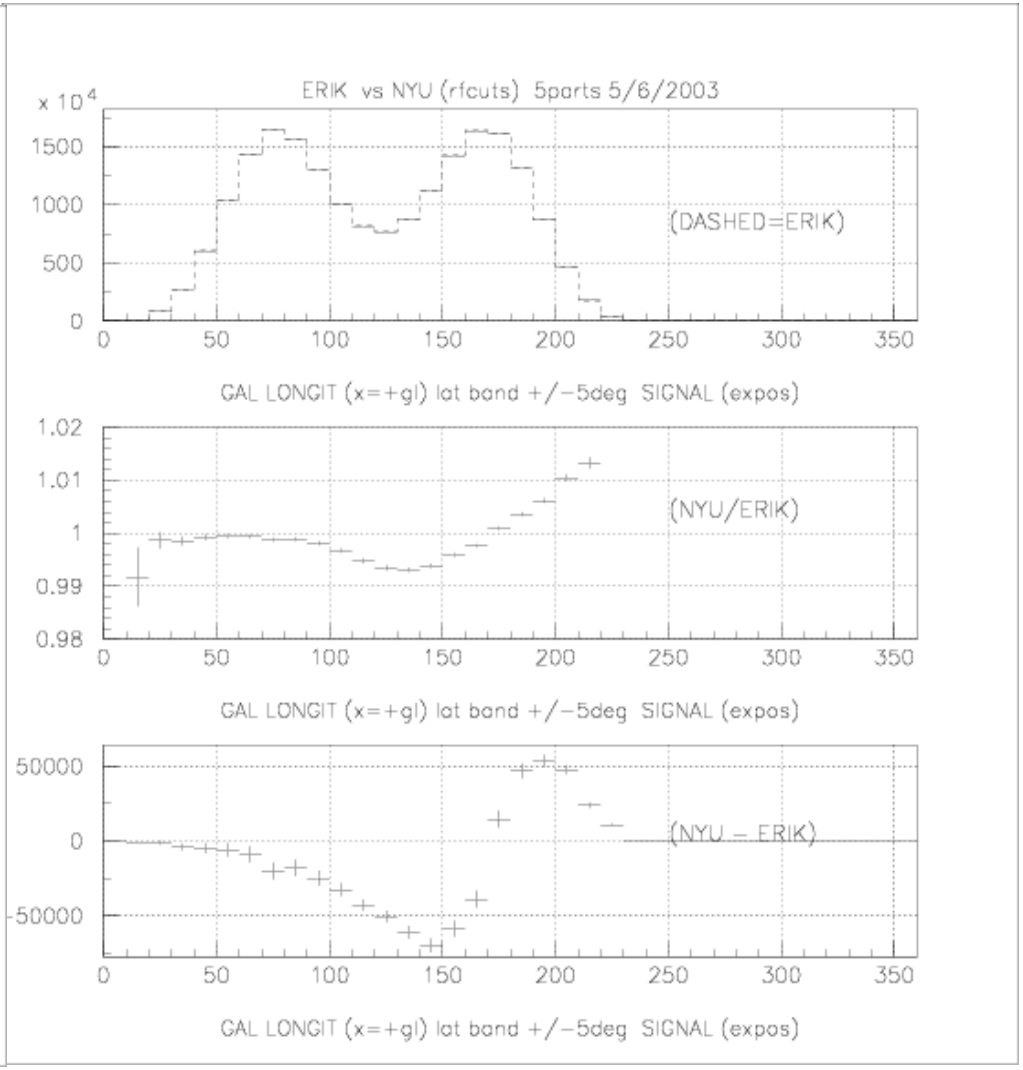
Are these differences in excess due to real differences, or just differences in background estimations?

Next step

- Found a ~10 month data set where we could find exactly the same total number of events passing a defined set of cuts.
  - Other 4 months have differences that are understood.
- Yet differences in RA/DEC and Gal. Lat/Long distributions remained
- Began investigation of these differences of the apparent “shape” of the exposure (signal).
  - These should be the same events!

Examples of shape differences





Differences are small and do not show up in the background subtracted distributions, but need to be understood,

3 Differences Identified

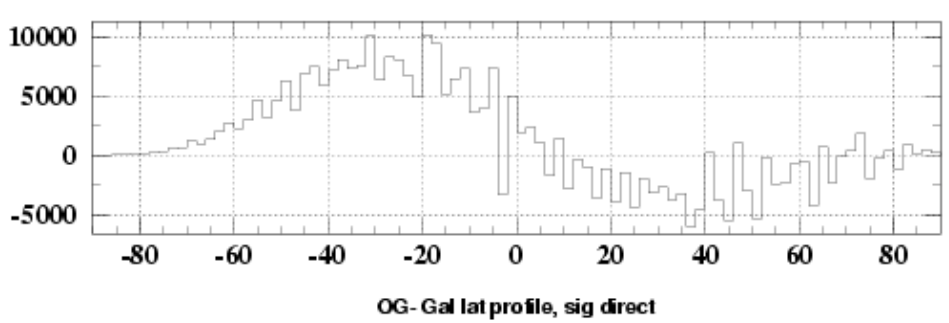
- (1) Small shift in RA/DEC bin centers in my code
  - 0.05 degree shift between map creation and reading introduced when changed from (int) to rintf().
  - Fixed
- (2) Small difference in galactic coord functions
  - Slight difference in location of galactic pole
  - For this comparison, I'm using the same one as NYU.
- (3) Map method differences. (unchanged)
  - NYU – make maps directly in GC
  - UMD - map in 0.1x0.1 degree RA/DEC and do a bin by bin transformation

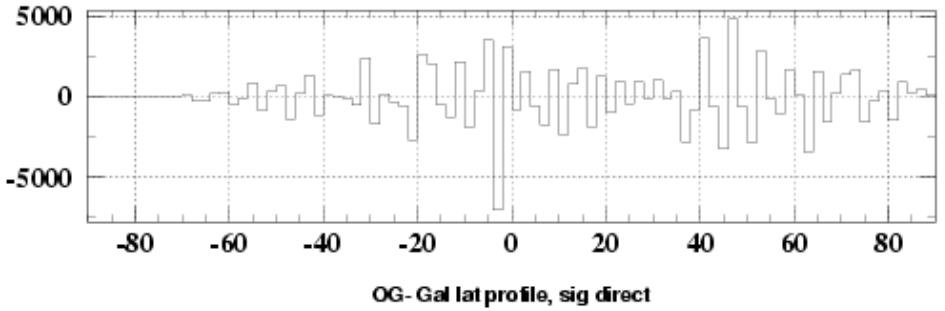
Simulation of map methods

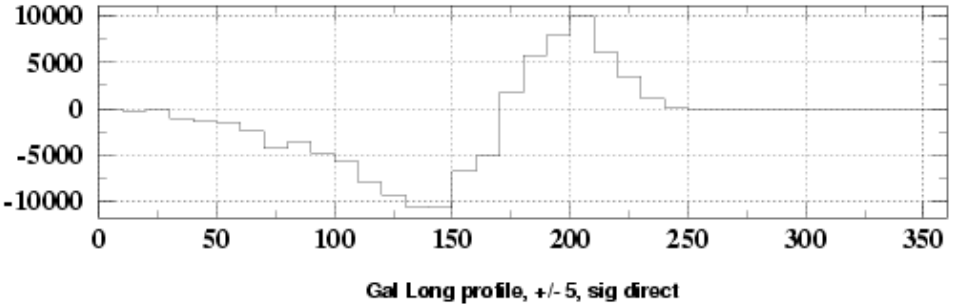
- Generate fake events and times that look like data and make both types of maps at the same time
  - Look at difference between maps
- Systematic shape differences caused by (1) and(2)
- (3) causes no shape differences, just bin to bin fluctuations in number of events in galactic coordinates.

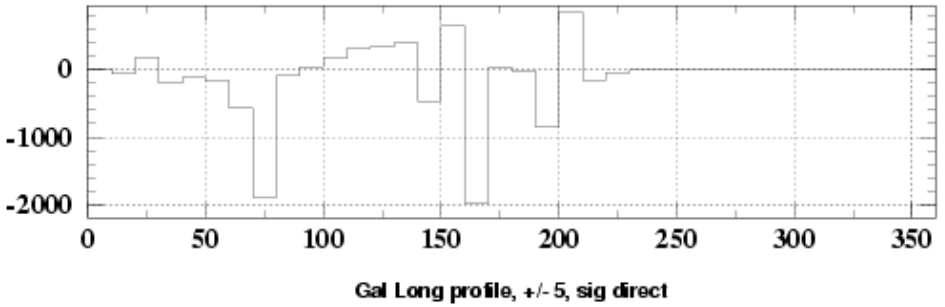
Fixing (1) and (2)

Simulated data.







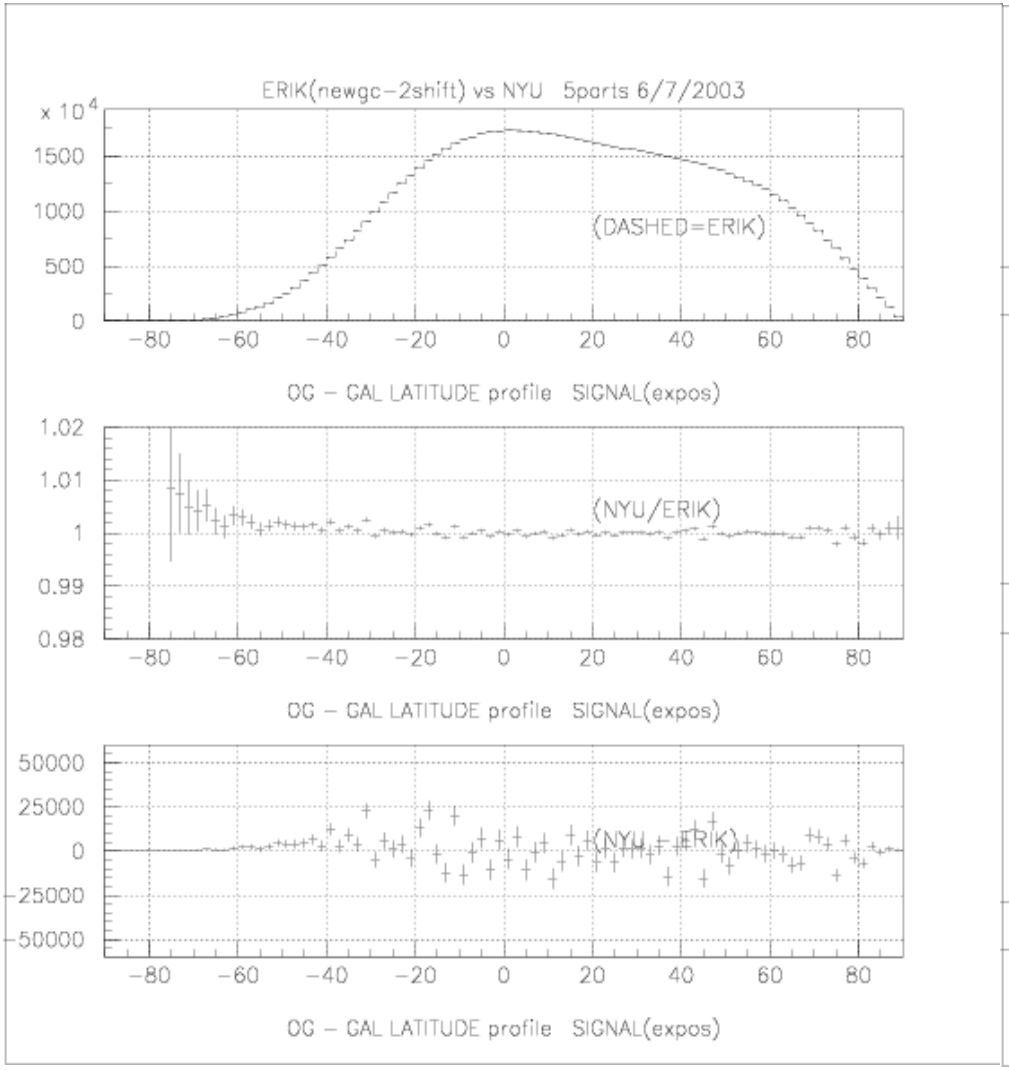


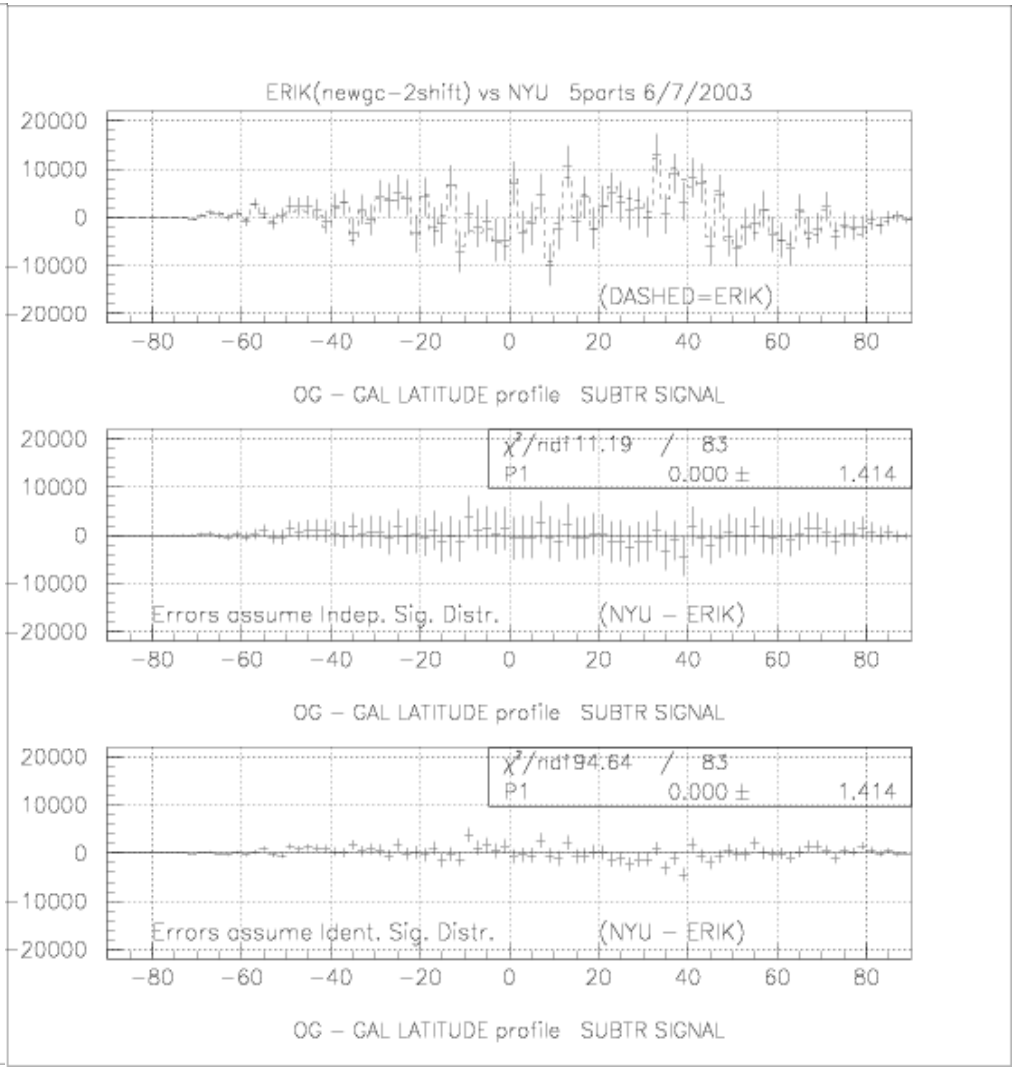
Before

After

(3) remains as an unremovable difference, but similar variations are seen in data when (1) and (2) are corrected.

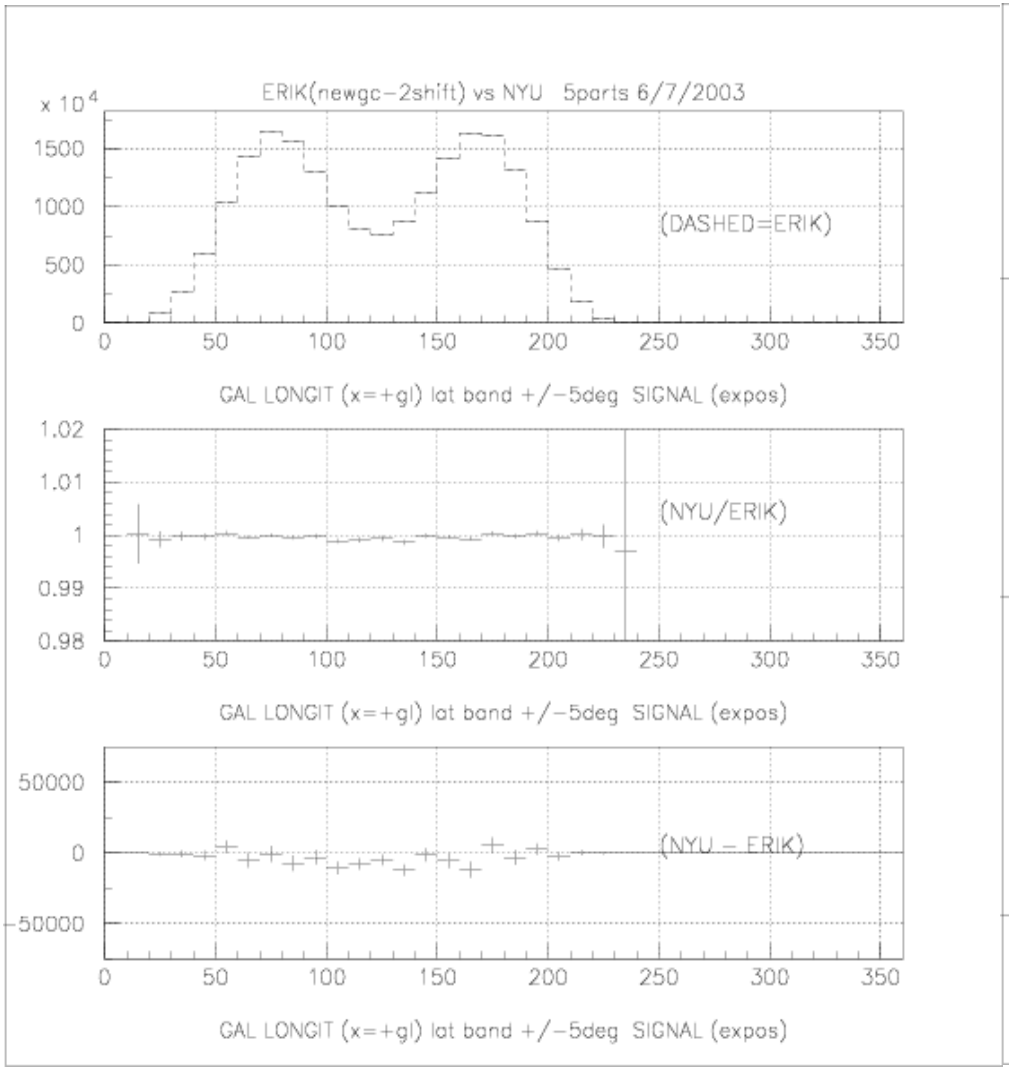
10 months of data corrections

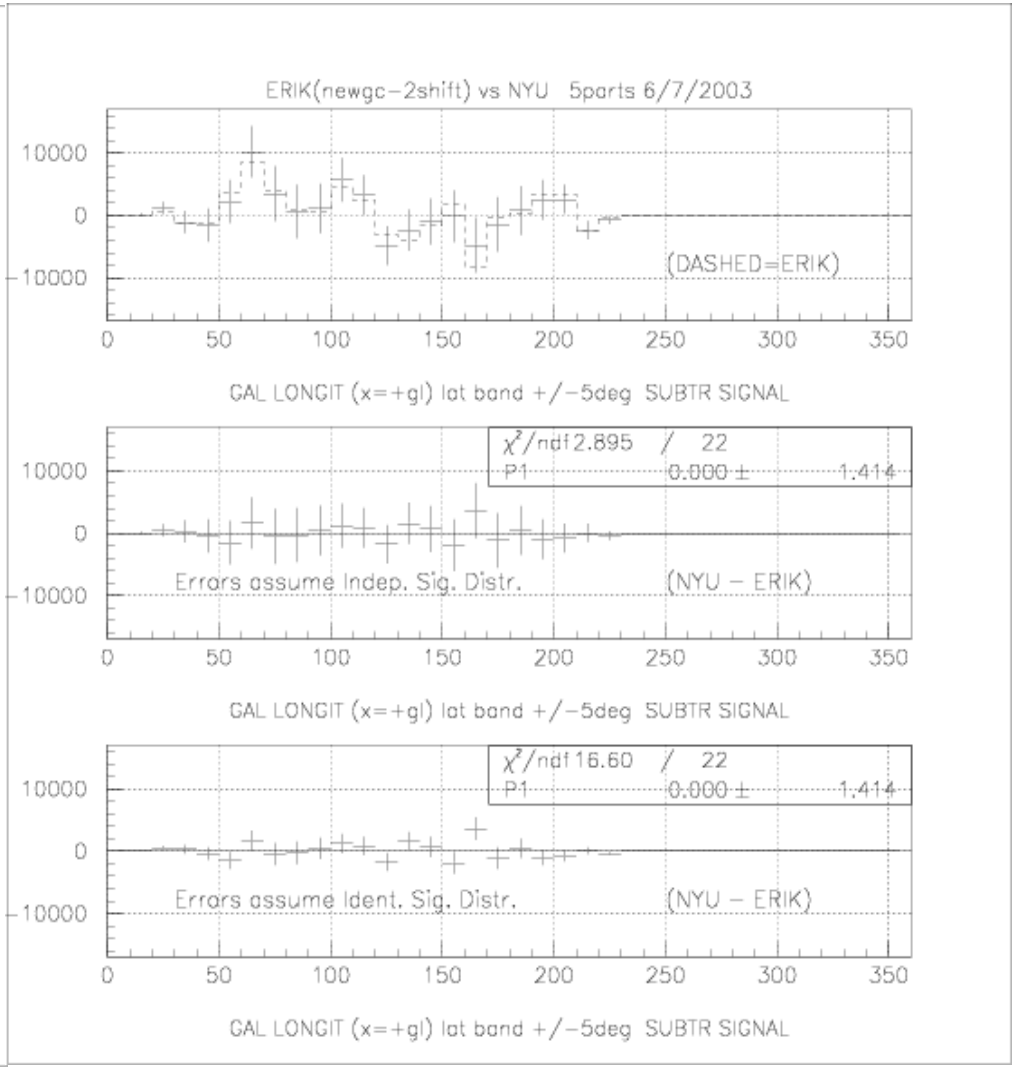




RA and DEC distributions are nearly identical, not shown for brevity

10 months of data corrections(2)





Effects of (3) in both signal and background, subtracted signal is OK

10 months results tabulated

(after corrections...)

Events all sky	Erik	NYU	Difference		
	2143706614	2143706690	76		
	On	Off(bkg)	Excess	Frac Excess	Sigma
+/- 5 IG					
Erik	79320775	79304736	16039	2.02E-004	1.8
NYU	79305616	79286082	19534	2.46E-004	2
Difference	-15159	-18654	3495		
Bkg error		+/-3150	+/-3150		
+/-5 OG					
Erik	86221651	86225485	-3834	-4.40E-005	-0.41
NYU	86205568	86211056	-5448	-6.30E-005	-0.53
Difference	-16083	-14429	-1614		
Bkg error		+/-3200	+/-3200		

14 months results tabulated

(after corrections...)

Events all sky	Erik	NYU	Difference		
	2940507104	2940198443	-308661	1.50E-004	
	On	Off(bkg)	Excess	Frac Excess	Sigma
+/- 5 IG					
Erik	109421994	109403747	18247	1.67E-004	1.74
NYU	109403712	109381656	22053	2.02E-004	1.9
Difference	-18282	-22091	3806		
Bkg error		+/-4988	+/-4988		
+/-5 OG					
Erik	118551419	118562963	-11544	-9.70E-005	-1.06
NYU	118496320	118506264	-9947	-8.40E-005	-0.82
Difference	-55099	-56699	1597		
Bkg error		+/-5290	+/-5290		

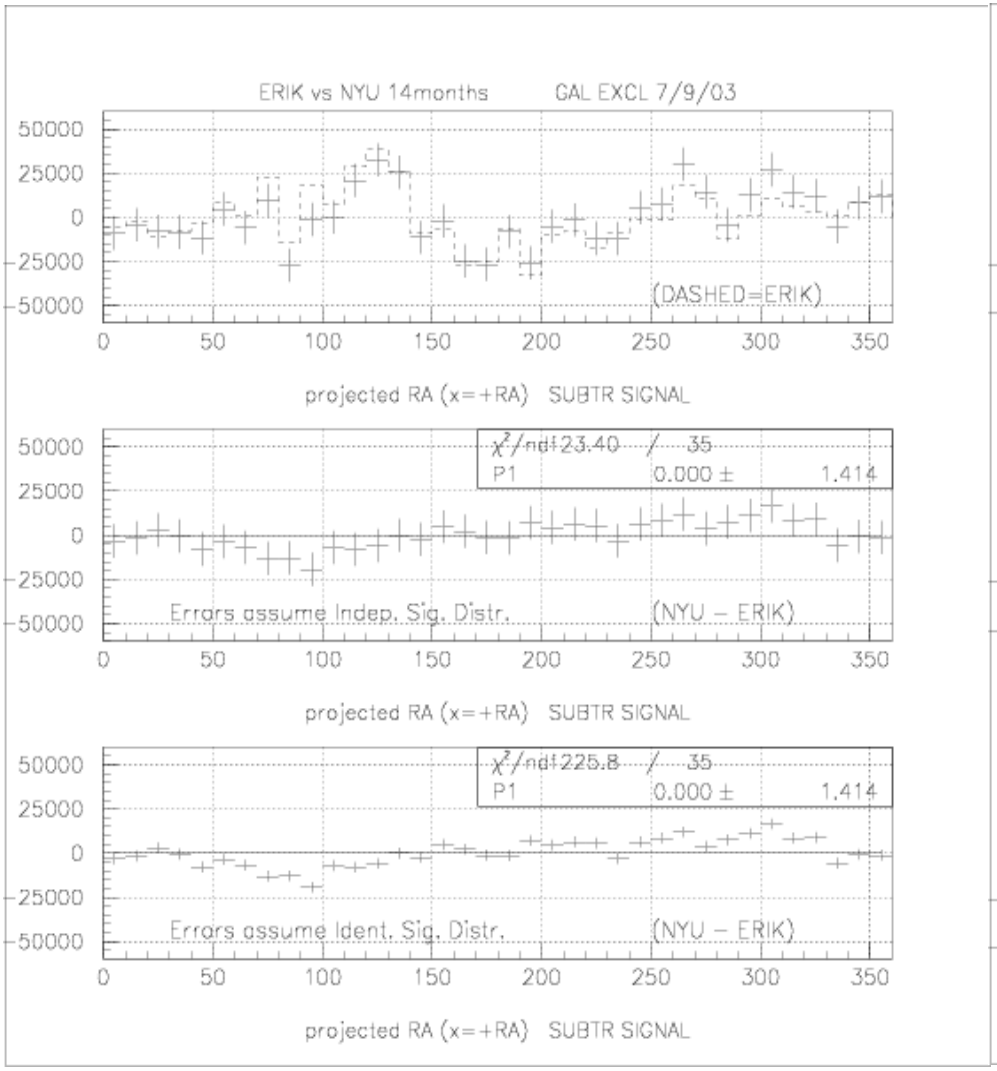
Conclusions so far...

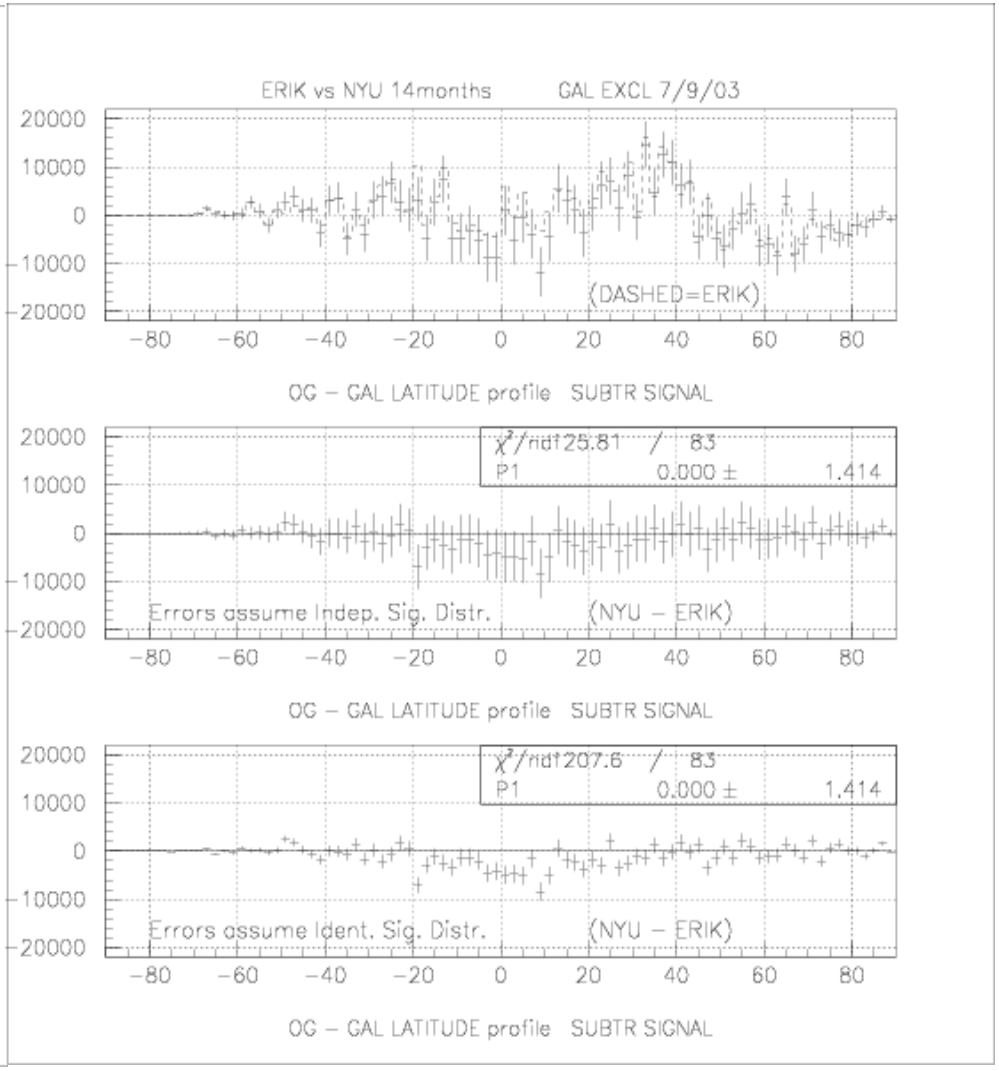
- A useful exercise. Found and fixed a few minor bugs. Better understanding of importance of various remaining differences
- Without exclusion of GP, remaining systematic differences appear to change signal and bkg bins in the same manner
- Differences observed in subtracted signal are the same size as the statistical errors from the background estimations
- We stopped at this point looking into no exclusion analyses.

How about excluding the GP?

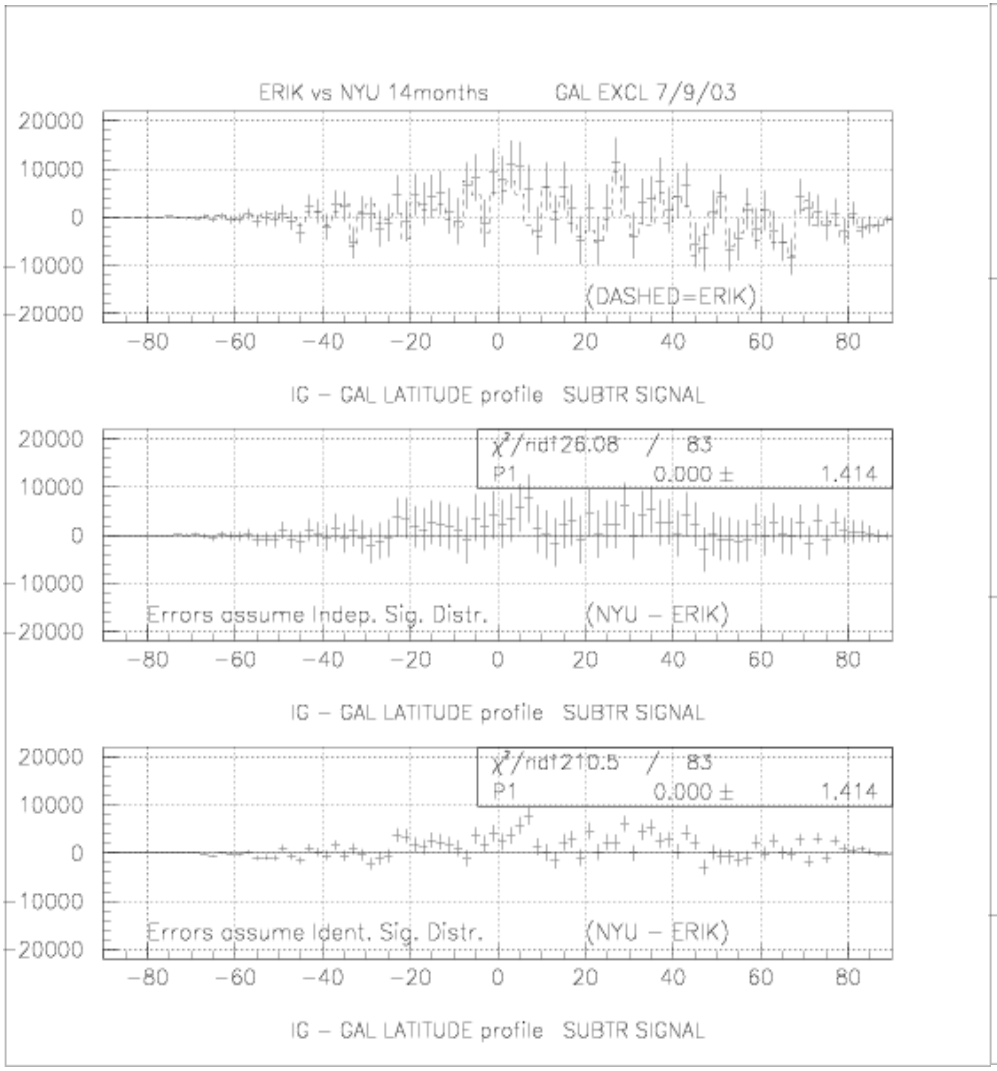
- I've recently developed an extension to direct integration to exclude the GP when calculating background (see next talk)
- We no longer try to keep equality in number of signal events used
  - My method requires long maps, and looses ~5% of maps
- Comparisons of backgrounds with exclusion are just starting.

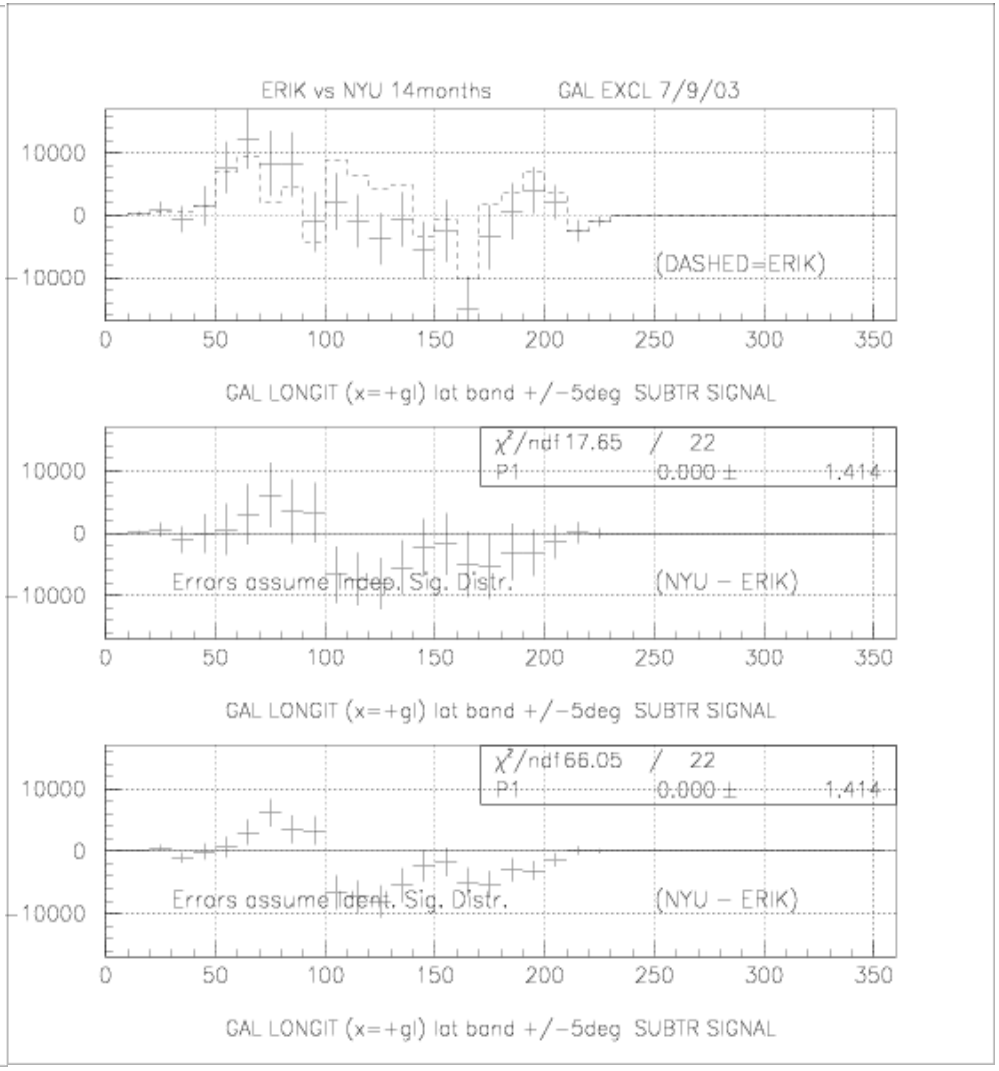
Subtracted signal shapes, exclusion





Subtracted signal shapes, exclusion(2)





Perhaps some systematic differences in signal shapes, needs to be studied

Numerical comparison – GP Exclusion

Events all sky	Erik	NYU	Difference		
	2777675881	2898590000	120914119		
	On	Off(bkg)	Excess	Frac Excess	Sigma
+/- 5 IG					
Erik	104762173	104740871	21302	2.03E-004	2.08
NYU	108238056	108200848	37210	3.40E-004	3.18
Difference			15908		
Bkg error			+/-5345(1)	+/-16491(2)	
+/-5 OG					
Erik	109955988	109956605	-617	-5.00E-006	-0.06
NYU	115885808	115908352	-22546	-1.95E-004	-1.84
Difference			-21929		
Bkg error			+/-5870(1)	+/-17288(2)	

(1) Underestimate- Assumes background only from NYU time sloshing

(2) Overestimate- Assumes signals independent

Real differences in background estimation are starting to appear

Conclusions, What's next...

- We think we understand differences without GP exclusion. Agreement is as good as to be expected given different background methods.
- Our first look at comparing GP exclusion results shows some significant differences in excesses.
  - Most likely differences in background estimation.
- Will be focus of more work
  - Additional data will help with comparison.