

GLAST



Fun with DC1: GRB Triggers, Localizations, Etc.

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Approach: General Procedure, Limitations

- Mostly bright GRBs in DC1 — Most real GRBs will be nearer threshold.
- We used the raw ~ 15 Hz data, decimated only by removal of events with $\{\phi, \theta\} = \{0, 0\} \rightarrow 12$ Hz. This expedient gave us a quasi-realistic background rate against which to search for GRBs.
- We used only one N-event sliding window as the first bootstrap step in searching for significant temporal-spatial clustering. Compute Log {Joint (spatial*temporal) likelihood} for tightest cluster in window:

$$\text{Log}(P) = \sum \text{Log}\{ [1 - \cos(d_i)] / 2 \} + \sum \text{Log}\{ 1 - (1 + X_i) \exp(-X_i) \}$$

- Our work is somewhat at 45° to main DC1 purposes. But DC1 set us up with all the equipment necessary to proceed:
 - Gleam machinery working, and we gained experience on debugging and evolving the trigger & localization algorithms.
 - Future emphasis will move to on-board recon problems: highest accuracy real-time triggers & localizations.

Day 1 Triggers, Panels Top→Bottom:

Log Prob [$\Delta\rho$'s] + Log Prob [Δt 's]

Log Prob [$\Delta\rho$'s]

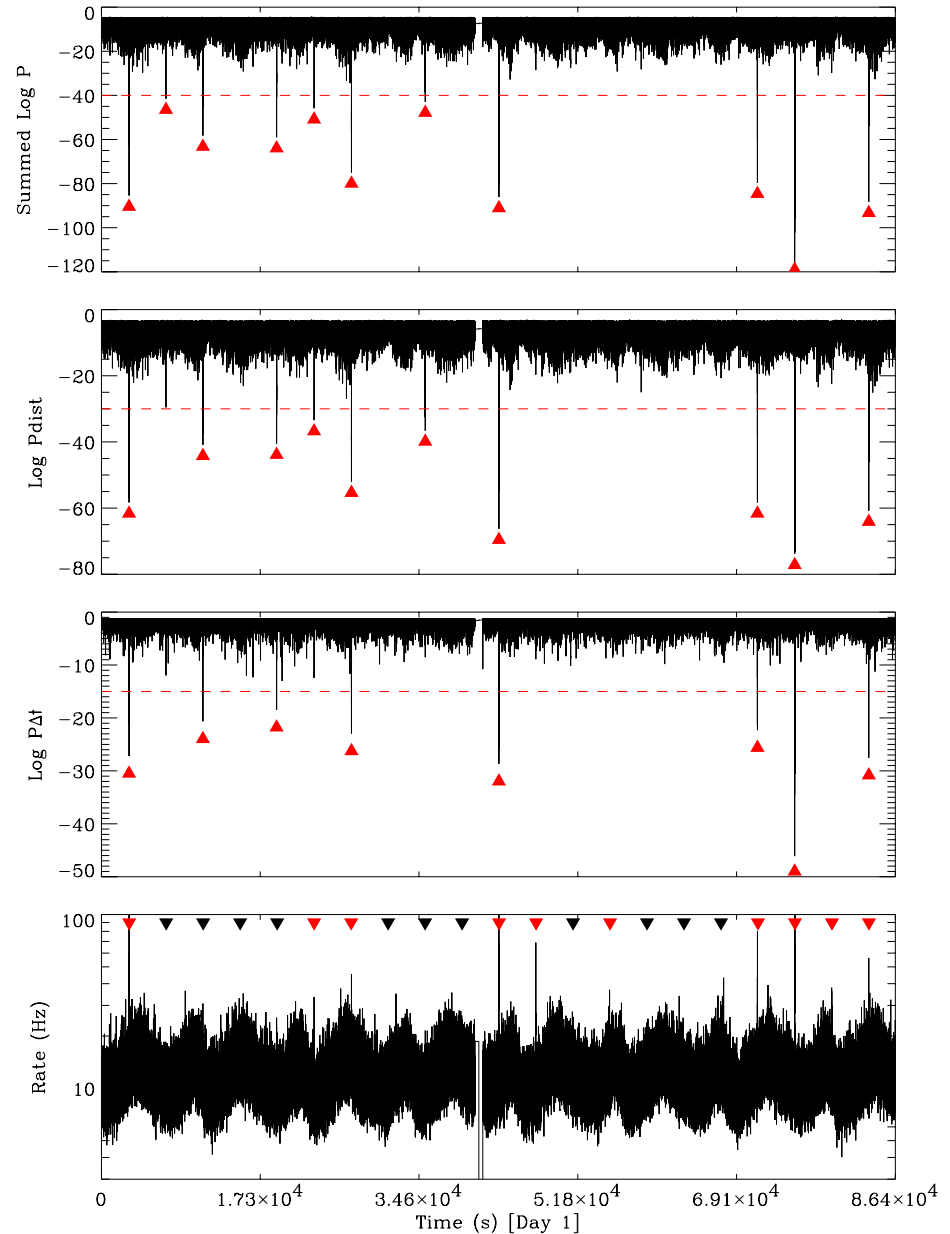
Log Prob [Δt 's]

Raw Rate (includes non-recon'd γ 's
— but we don't use them!)

Similar approach to previous studies:

- (1) Operate sliding 20-event window;
- (2) Find tightest spatial cluster;
- (3) Compute log probs for Δt 's, $\Delta\rho$'s in the selected cluster;
- (4) Exceed threshold value, set to allow < 1 false trigger/6 days?

Real Question is: How many "life-like" GRBs would be detected ?



Day 1 Triggers

Estimates: Times, Positions, Integral Counts

T_{\min}	T_{\max}	{RA, Dec}	ϵ_{est}	ϵ_{act}	" σ "	$N_{>10\text{MeV}}$	$N_{>100\text{MeV}}$	$N_{>1\text{GeV}}$
3000.0	3005.8	200.14,-32.42	0.068			82	57	14
7022.2	7023.0	92.42, -1.17	0.292			8	4	0
11044.2	11047.3	326.88, 27.14	0.109			21	18	6
19063.1	19067.2	138.66,-34.33	0.055			32	27	8
23139.1	23140.5	18.78, 26.98	0.472			13	9	0
27210.5	27214.2	258.56,-15.93	0.095			35	30	7
35236.6	35242.3	97.77,-16.05	0.094			23	21	6
43254.6	43259.6	146.02, 34.73	0.073			107	97	7
71386.4	71398.3	224.96,-33.49	0.056			71	51	2
75437.4	75456.3	91.95, 56.56	0.035			753	556	65
83510.2	83514.8	200.05,-32.49	0.044			50	41	11

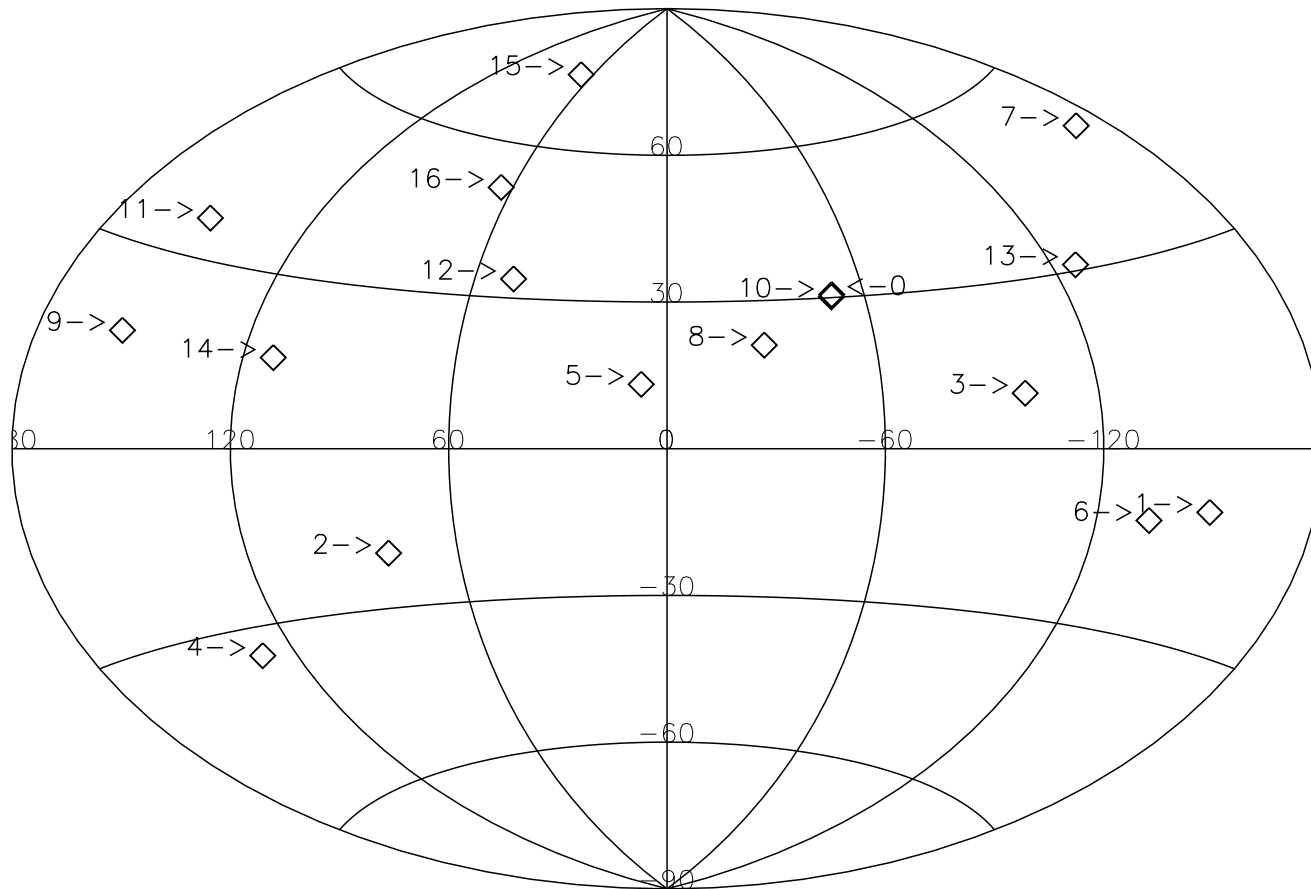
Days 2→6 Triggers

Estimates: Times, Positions, Integral Counts

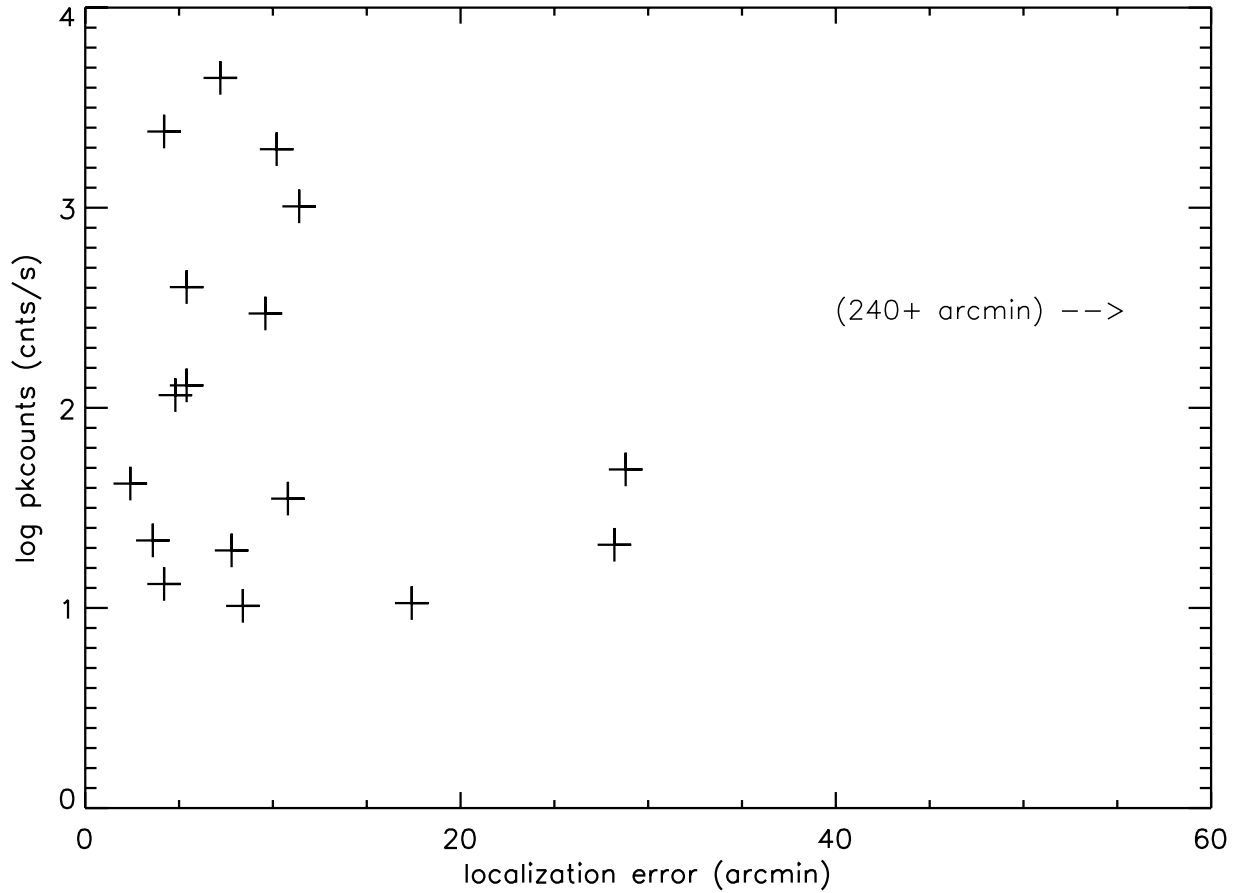
T_{\min}	T_{\max}	{RA, Dec}	ϵ_{est}	ϵ_{act}	"No"	$N_{>10\text{MeV}}$	$N_{>100\text{MeV}}$	$N_{>1\text{GeV}}$
176748.2	176860.1	128.78, 64.31	0.029	0.026	0.90	1633	1521	135
215700.4	215740.7	251.61, 27.82	0.090	0.070	0.77	514	224	24
220440.4	220444.0	134.39, -2.81	0.052	0.131	2.52	329	309	32
327096.0	327096.0	319.80, 73.29	4.418	0.621	0.14	10	5	0
386280.7	386309.7	199.14, 33.45	0.346	0.165	0.48	58	26	1
410280.2	410313.4	236.71, 41.72	0.122	0.122	0.27	372	153	10

- **Very sensitive trigger** — incorporates most of the useful information.
- **17 detections:** 11 on Day 1; 6 on Days 2-6. Some bright, some dim.
- **No false trigger.** Formal expectation any detection is false $\ll 10^{-6}$ /day.
- **Additional aspects we will evaluate for on-board implementation:**
 - Floating threshold; 2-D PSF; spatial clustering (Galactic Plane)

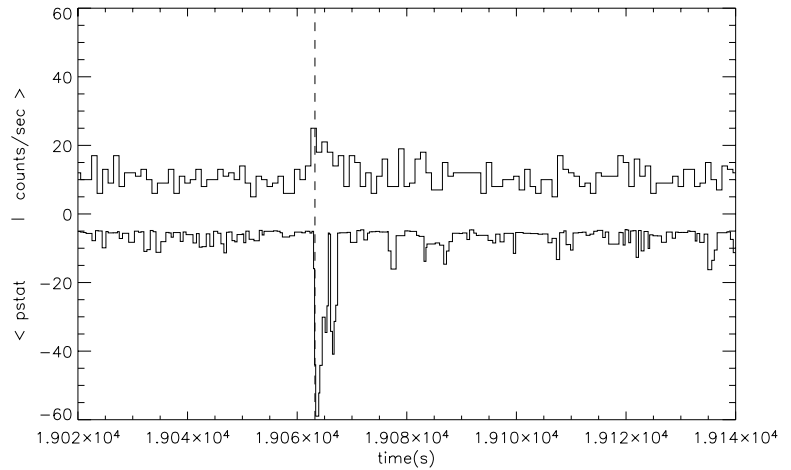
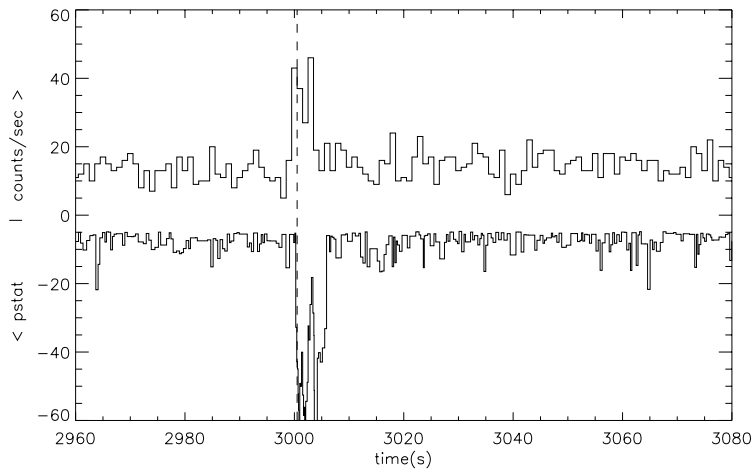
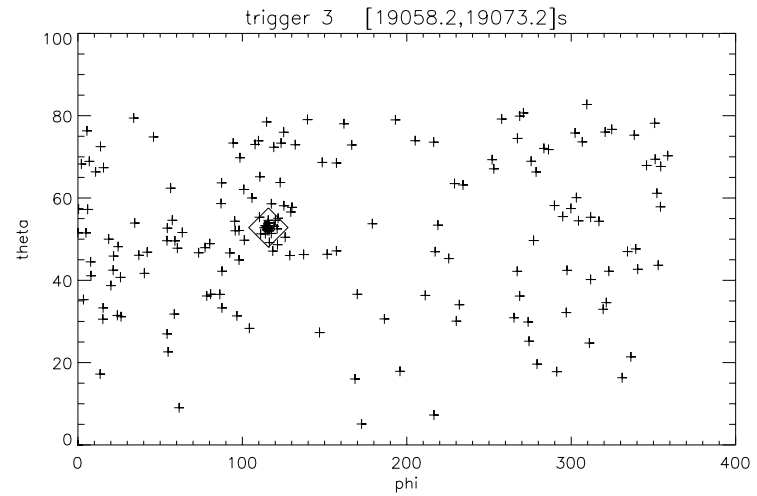
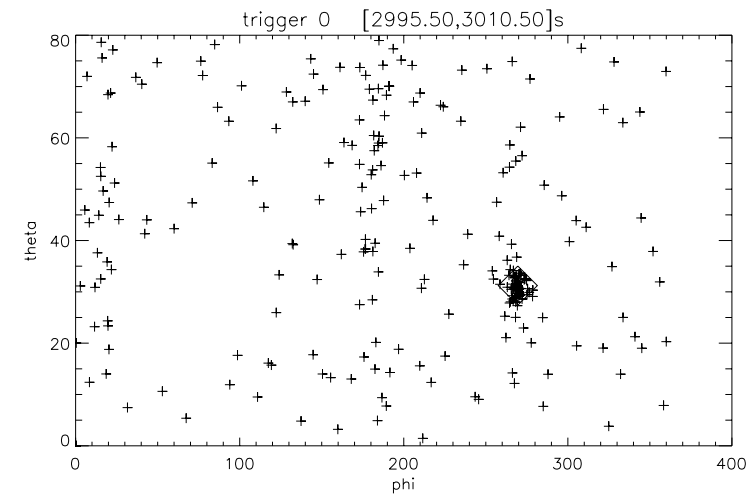
DC1 GRB Sky (Galactic coordinates)



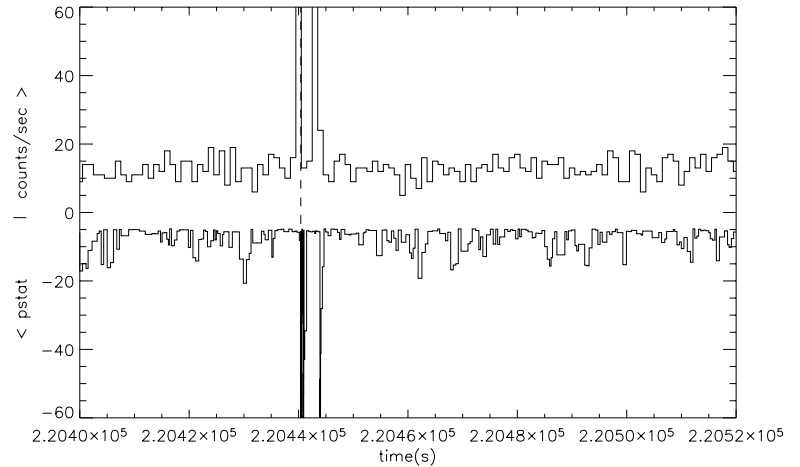
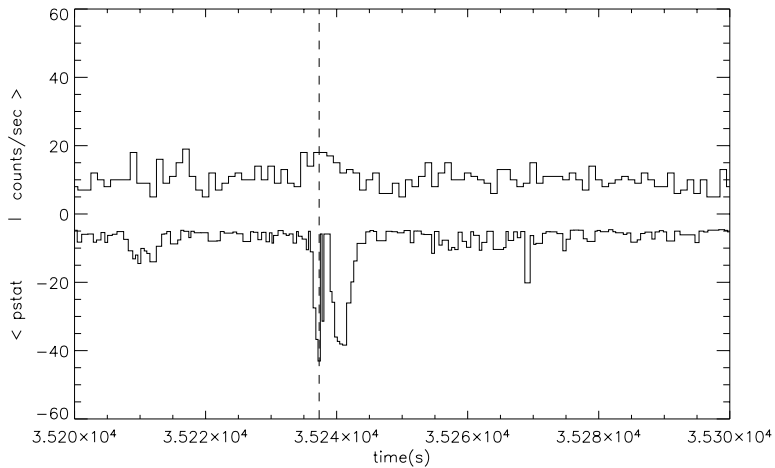
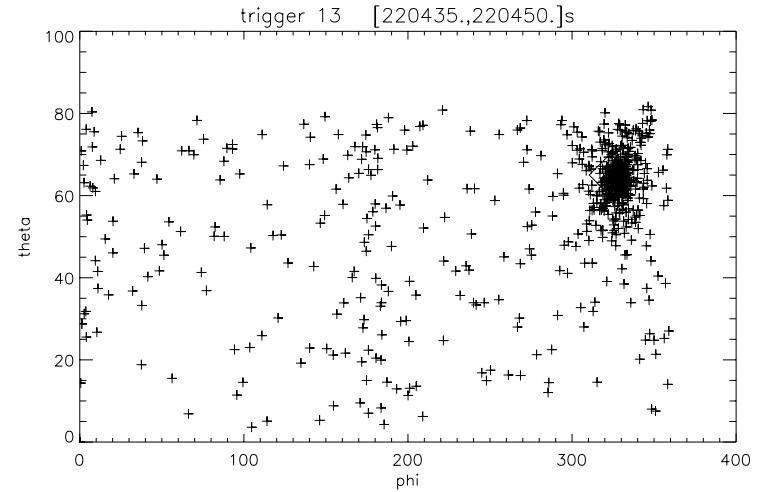
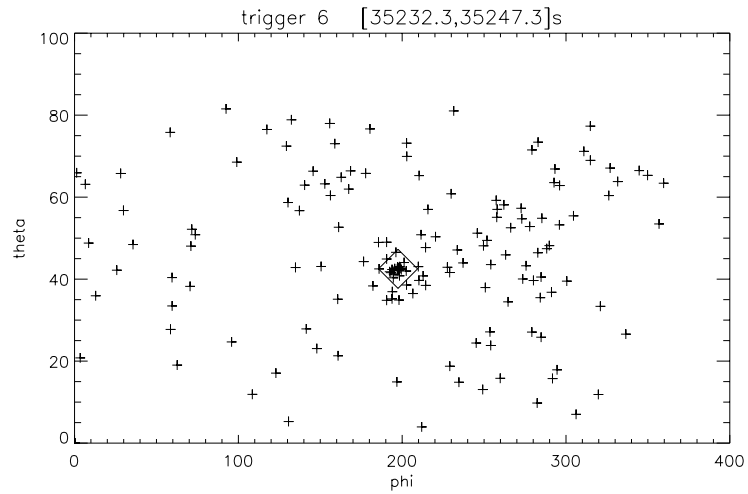
GRB Localizations vs. Peak Counts



GRB Trigger regions, 1



GRB Trigger regions, 2



GRB Trigger States

trigger	time(s)	pstat(sum)	phi(.deg)	theta(.deg)	ra(.deg)	dec(.deg)	size (.deg)
0	3000.50	-42.84	269.51	31.22	199.80	-31.90	4.38
1	7023.02	-41.54	94.84	39.01	92.56	-0.96	4.54
2	11044.47	-58.27	287.49	41.46	326.56	27.29	3.35
3	19063.24	-43.99	115.84	52.82	139.02	-34.58	1.51
4	23140.10	-45.82	278.67	35.33	19.80	27.80	4.10
5	27211.41	-40.58	315.34	37.31	258.60	-15.79	5.51
6	35237.33	-43.06	197.46	42.51	97.95	-16.20	3.82
7	43255.29	-78.64	317.45	60.23	146.05	34.82	4.17
8	71387.34	-47.00	202.09	47.88	226.17	-34.26	4.09
9	75437.51	-49.00	298.02	15.51	92.54	57.96	3.83
10	83510.50	-60.88	305.49	33.20	200.15	-32.32	3.00
11	176748.17	-49.63	240.93	63.31	130.33	64.27	4.81
12	215700.46	-43.83	172.26	21.60	256.54	26.48	6.78
13	220440.40	-69.92	322.38	65.02	139.15	-1.47	7.70
14	327096.00	-82.31	305.89	41.77	327.05	74.52	4.38
15	386281.47	-42.39	246.08	44.79	208.08	35.22	6.43
16	410280.35	-58.61	228.09	18.19	237.14	40.27	3.66

Summary: Observations, Caveats, Lessons

- Mostly bright GRBs in DC1 — Most real GRBs will be nearer threshold.
- We used constant threshold, 1 window. Rate variation will necessitate **floating threshold**, and **multiple N-event sliding windows**.
- The localization and duration estimates are derived from information in the trigger algorithm, post facto — requires “holding” buffer on-board.
- “ T_0, T_{100} ” mostly accurately recovered, Days 2-6 (the GRBobs bursts).
- Localization Errors:
 - Accurate localizations for Days 2-6 (have MC truth) ...
 - ... Error distribution “understood” — verify with Day 1 MC truth.
 - Just one high energy background γ can throw off accuracy ...
 - ... modified algorithm to “deweight” such γ 's far from cluster center.
- Real on-board triggers, localizations will be more intriguing:
 - Work in progress w/ S. Ritz, D. Wren, et al. — usage of track info for higher fidelity on-board recon.
 - DC1 put us in the right gear to proceed. Thanks DC1 team!

Extra Credit: Intervals Between Photons (Day 1)

