S6/VSR2 online GRB search for inspiral signals
- an update -
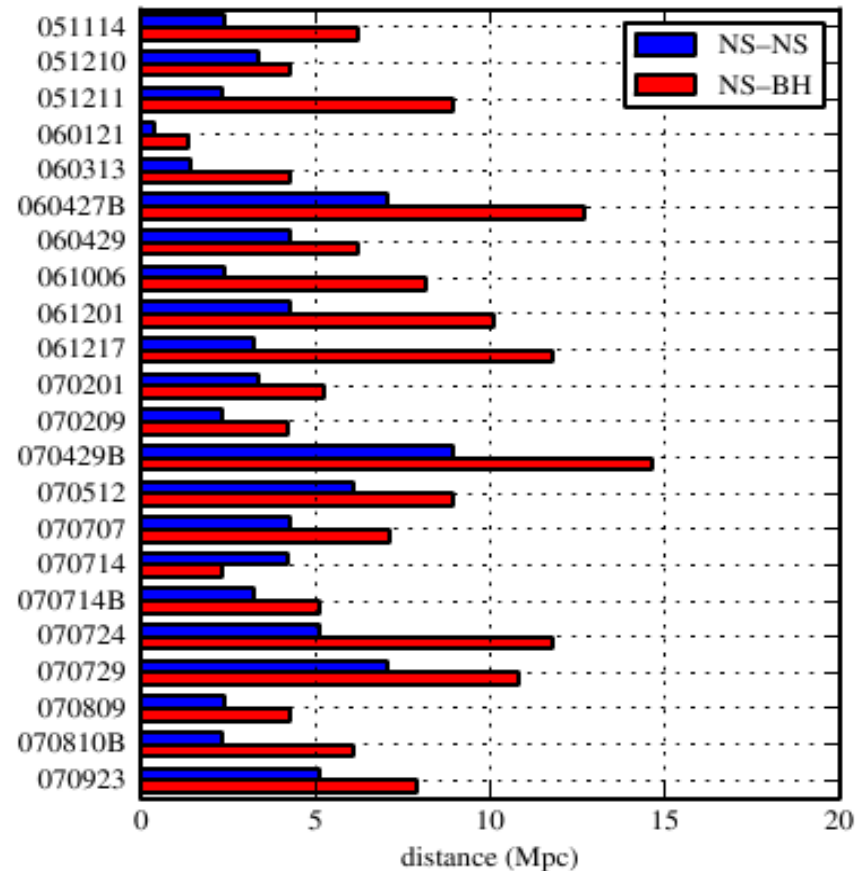
Alexander Dietz

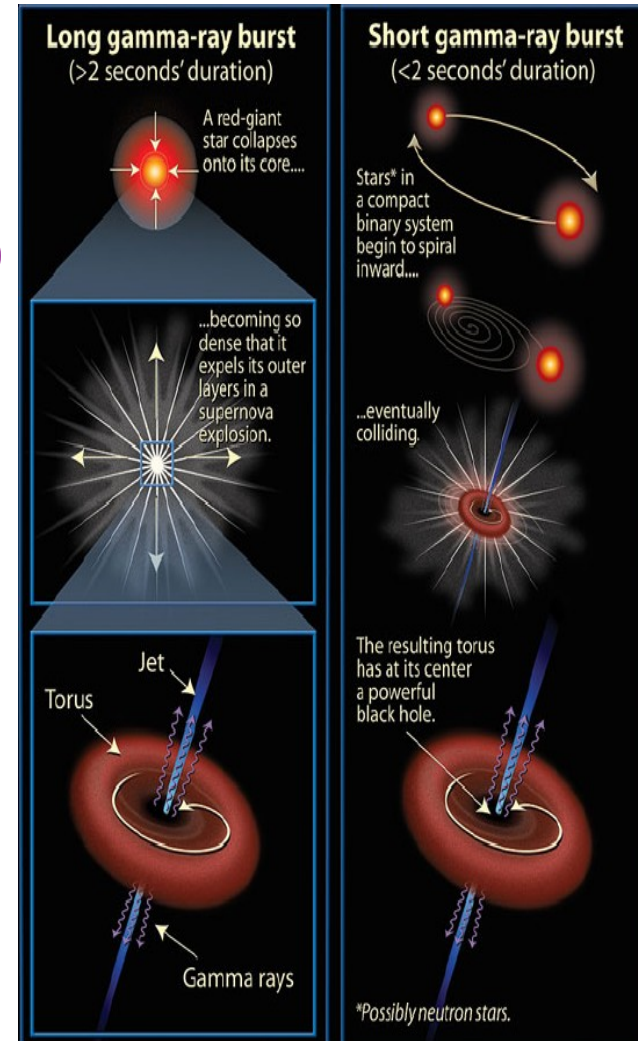**Virgo week May 2010**

- # S5 search:
  - – Search for inspiral signal in data around 22 short GRB
  - – *No signal found*
  - – *Distance exclusions*
  - – Published:

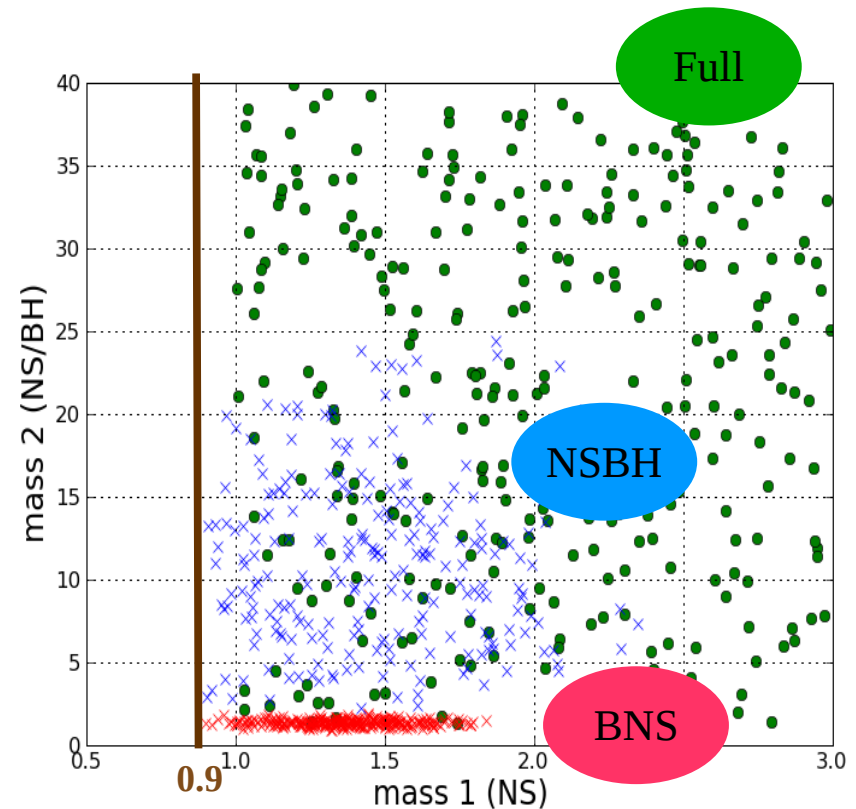 J Abadie *et.al.,* arXiv:1001.0165 (2010), accepted by ApJ.

Summary S6/VSR2,3

- Gamma-Ray bursts:
  - "Long": Core-collapse (burst) *type-II*
  - "Short": Soft Gamma Repeater (burst)
    merger of compact objects (CBC)
    type-I

- Inspiral Search in S6:
  - Using low-latency pipeline
  - Fully automated
  - Analysis starts within 1 hour
    even if duration not yet available

- Open boxes on 'long' GRBs:
  - Analysis is done anyway
  - Models on GRBs not definite, there
    are many issues, unsolved problems...
  - Some could have CBC progenitor (i.e.
    are type-I)

Long gamma-ray burst
(>2 seconds' duration)

A red-giant star collapses onto its core....

...becoming so dense that it expels its outer layers in a supernova explosion.

Jet

Torus

Gamma rays

Short gamma-ray burst
(<2 seconds' duration)

Stars* in a compact binary system begin to spiral inward....

...eventually colliding.

The resulting torus has at its center a powerful black hole.

*Possibly neutron stars.

Search parameters

- Foreground: [-5;+1] second segment

- Background estimation:
  – From offsource segments rather timeslides (~300 trials)

- Injections (short GRB only+ followup):
  – 3 different waveform families (TaylorT1, PPN, 2x SpinTaylor3)
  – 3 mass areas (1-3/1-40 + 1.35/1.35 + 1.35/10)
  – 3000 injections each (36'000 total)

Overview web-pages

https://ldas-jobs.phys.uwm.edu/~dietz/S6_tagged/total_summary.html

Nr	GRB	Status	Tag	GPS	Date	redshift	duration	Coord	H1	L1	V1	Sanity	Result	Box
121	100316D	NoData NoData	None None	952778705	16 Mar 2010 12:44:50	—	100.00	107.61 -56.28	0.89	0.89	0.62	—	—	—
120	100316C	NoData NoData	None None	952765094	16 Mar 2010 08:57:59	—	7.00	32.29 -68.01	**0.91**	**0.81**	0.56	—	—	—
119	100316B	NoData NoData	None None	952761711	16 Mar 2010 08:01:36	—	5.00	163.50 -45.48	**0.05**	**0.10**	0.89	—	—	—
118	100316A	NoData NoData	None None	952741395	16 Mar 2010 02:23:00	—	10.00	252.03 71.83	0.49	0.36	0.86	—	—	—
117	100305A	NoData NoData	None None	951815153	05 Mar 2010 09:05:38	—	20.00	168.37 42.38	0.99	0.83	0.06	—	—	—
116	100302A	NoData NoData	None None	951594801	02 Mar 2010 19:53:06	—	35.00	195.34 74.58	0.59	0.48	0.73	—	—	—
115	100225A	NoData NoData	None None	951101146	25 Feb 2010 02:45:31	—	13.00	312.50 -54.90	0.83	0.86	0.71	—	—	—
114	100224A	NoData NoData	None None	951060025	24 Feb 2010 15:20:10	—	0.50	83.47 -7.99	0.78	0.82	0.52	—	—	—
113	100224B	NoData NoData	None None	951014470	24 Feb 2010 02:40:55	—	77.00	269.56 -17.08	0.86	0.95	0.47	—	—	—
112	100223A	NoData NoData	None None	950927904	23 Feb 2010 02:38:09	—	0.21	104.10 2.80	0.69	0.89	0.47	—	—	—
111	100219A	Complete Not started	s6_exttrig_100202 None	950627761	19 Feb 2010 15:15:46	—	—	154.22 -12.56	**0.35**	**0.70**	0.57	onoff —	box closed	box closed
110	100218A	NoData NoData	None None	950503140	18 Feb 2010 04:38:45	—	30.80	206.60 -11.90	0.41	0.20	0.63	—	—	—
109	100216A	Complete inspiralERROR	s6_exttrig_100202 None	950350035	16 Feb 2010 10:07:00	—	0.30	154.26 35.52	**0.93**	**0.72**	0.15	onoff —	box closed	box closed
108	100213B	Complete Not started	s6_exttrig_100202 None	950137129	13 Feb 2010 22:58:34	—	30.00	124.34 43.45	**0.51**	**0.50**	0.98	onoff —	box closed	box closed

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117	100305A	NoData NoData	None None	951815153	05 Mar 2010 09:05:38	—	20.00				0.06	—	—	—
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115	100225A	NoData NoData	None None	951101146	25 Feb 2010 02:45:31	—	13	-54.		0.86	0.71	—		
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108	100213B	Complete Not started	s6_exttrig_100202 None	950137129	13 Feb 2010 22:58:34	—	30.00	124. 43.45				ff	box closed	box closed

No data

type-II

type-I

Virgoweek, 4 May 2010

6

S6A Boxed opened

- 17 Boxes opened (type-II GRBs in S6A):

  (5 more type-II GRBs found later)

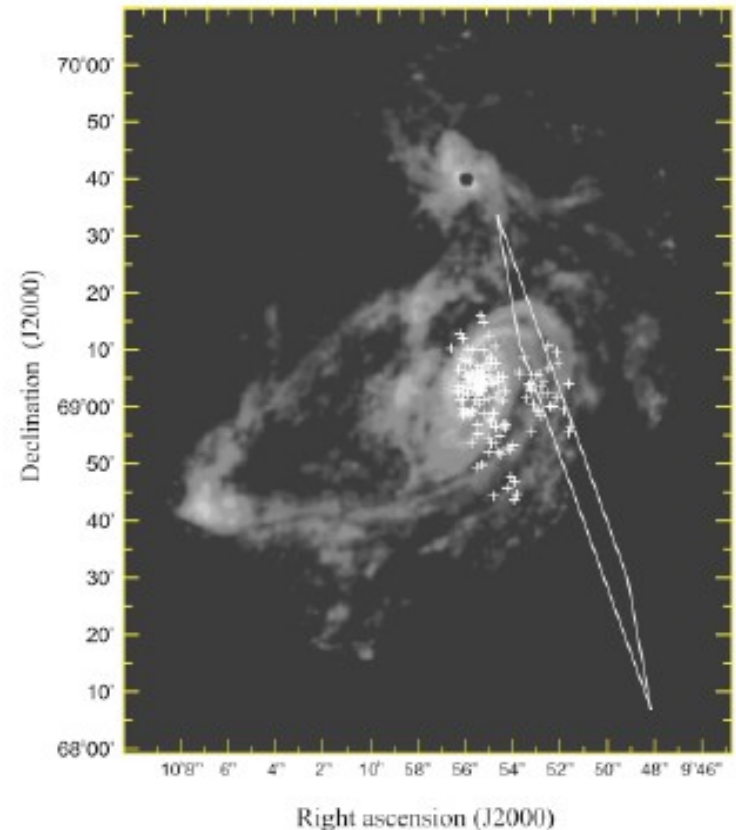| S6A	total	long	short
total	46	40	6
With data	19	*17*	2

  – No outstanding candidate found
  – Followup & injection run for most significant candidates
  ➔ Most significant = candidate with FAP < 2%

- Most significant candidate:

  - GRB 090809B with 1.3% FAP: Fermi GRB, T~15 s
  - Total: 87 trials (over GRB, IFO combos, mchirp bins):
    Loudest candidate consistent with backg. expectations

GRB 051103

- GRB 051103: *(One day before start of S5)*

  – Probable ocurred in M81 (at 3.6 Mpc distance)

  – Uses same code as S5 analyzes

  – No standard data-quality available
    Investigation by Robert Schofield

  – Data-quality investigation finalized
    Need to veto one 6-second segmer
    Postprocessing underway

Right ascension (J2000)

Outlook

Rerun postprocessing

- Implementing short term improvements:
  - Improving background estimation:
    - Implementing segment-slides, improving false-alarm estimation from 0.003 to 10^{-5}
  - Coherent search: GRBs provide test case
  - Followup pipeline: Look at the interesting candidates
- Full likelihood analysis for short GRB
  - Requires full injection run
  - Implementation underway
- Publication: Joint with burst; all S6
- Population statement:
  - Use of type-I GRBs only
- Input from astrophysicists required:
  - Require precise trigger time & location
  - Classification of GRB

Summary

- Inspiral S6 search:
  - Low latency pipeline, fully automated
  - Search for inspiral signal on all GRBs
  - on/off-results ready after ~1 day of trigger notification

- First S6A result:
  - Opened boxes on 17 type-II GRB
  - Most significant candidate consistent with expectation from background
  - Injection runs still underway

- Implement some short term improvements
- Input required from GRB specialists