GRB triggered Inspiral Searches in the fifth Science Run of LIGO

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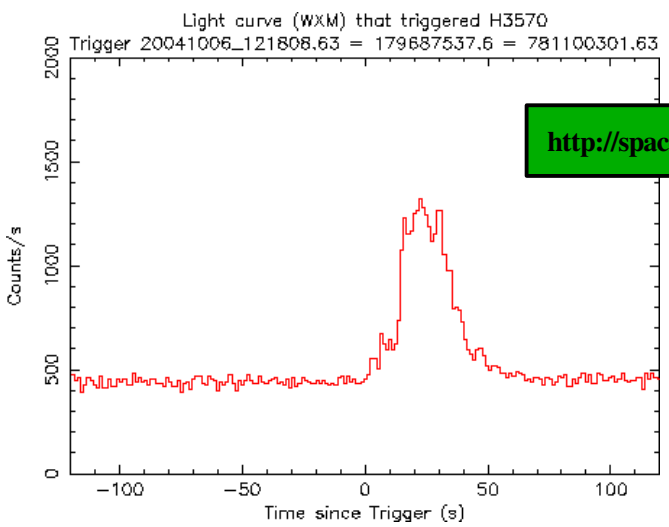
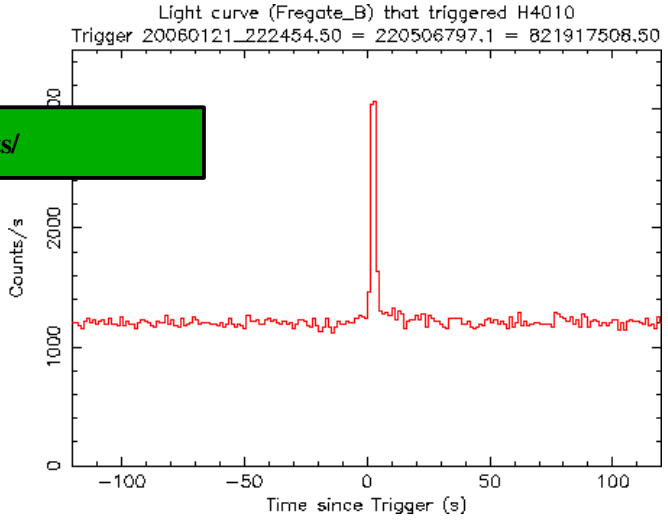
Gamma Ray Bursts

- Long GRB



- Short GRB



http://space.mit.edu/HETE/Bursts/

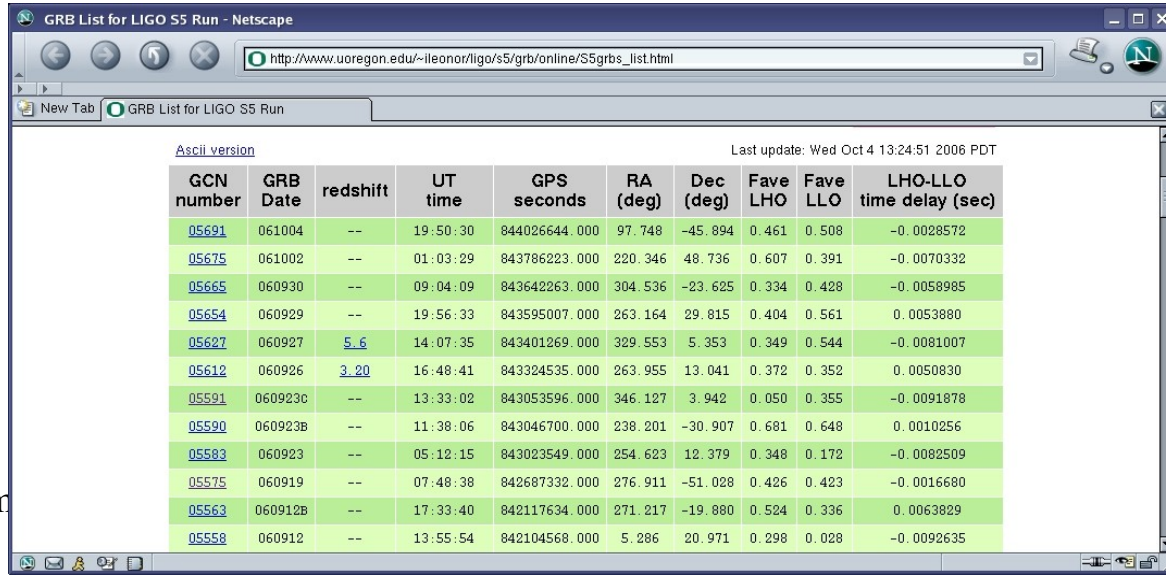
- Associated with Stellar collapse
- 112 found, 33 with redshift

- Evidence for compact binary progenitors
- 14 found, 3 with redshift

GRB triggers

- Triggers obtained from the following places:
  - GCN circulars (http://gcn.gsfc.nasa.gov/gcn3_archive.html)
  - List of GRB derived from GCN alerts (maintained by Isabel Leonor)

HETE2
Swift



GCN number	GRB Date	redshift	UT time	GPS seconds	RA (deg)	Dec (deg)	Fave LHO	Fave LLO	LHO-LLO time delay (sec)
05691	061004	--	19:50:30	844026644.000	97.748	-45.894	0.461	0.508	-0.0028572
05675	061002	--	01:03:29	843786223.000	220.346	48.736	0.607	0.391	-0.0070332
05665	060930	--	09:04:09	843642263.000	304.536	-23.625	0.334	0.428	-0.0058985
05654	060929	--	19:56:33	843595007.000	263.164	29.815	0.404	0.561	0.0053880
05627	060927	5.6	14:07:35	843401269.000	329.553	5.353	0.349	0.544	-0.0081007
05612	060926	3.20	16:48:41	843324535.000	263.955	13.041	0.372	0.352	0.0050830
05591	060923C	--	13:33:02	843053596.000	346.127	3.942	0.050	0.355	-0.0091878
05590	060923B	--	11:38:06	843046700.000	238.201	-30.907	0.681	0.648	0.0010256
05583	060923	--	05:12:15	843023549.000	254.623	12.379	0.348	0.172	-0.0082509
05575	060919	--	07:48:38	842687332.000	276.911	-51.028	0.426	0.423	-0.0016680
05563	060912B	--	17:33:40	842117634.000	271.217	-19.880	0.524	0.336	0.0063829
05558	060912	--	13:55:54	842104568.000	5.286	20.971	0.298	0.028	-0.0092635

Benefits from a triggered Inspiral search

- Other inspiral searches are blind
  - Location and time of binary inspiral & merger are unknown
- GRB triggered search:
  - **Sky location gives time-delay between sites**
  - Relative amplitude correlated for each instrument
  - Quite rare events (one short GRB per month)
  - Possible to decrease SNR threshold to increase the range of this search

Benefits from a triggered Inspiral search

- Triggered Burst search done
  - No waveforms available, range limited
  - Results for S2, S3 and S4 near publishing

S D Mohanty et al 2004 Class. Quantum Grav. 21 S1831-S1837

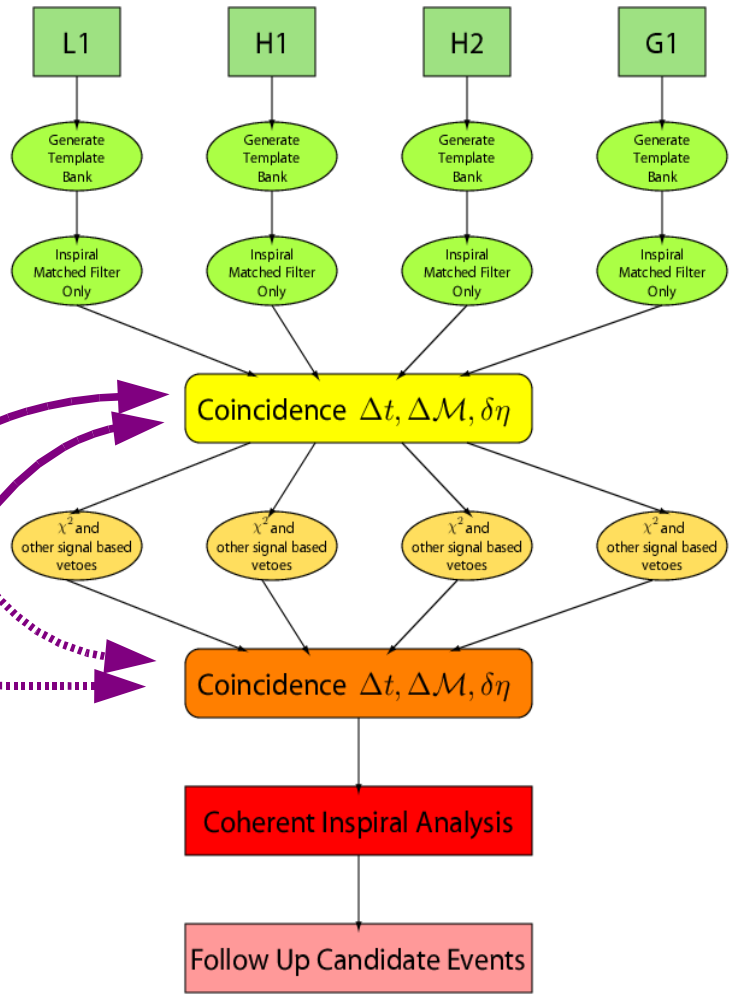
LIGO-P060024-02-Z (To be submitted to Phys. Rev. D)

The GRB triggered inspiral search can probe deeper into the data

Inspiral search pipeline

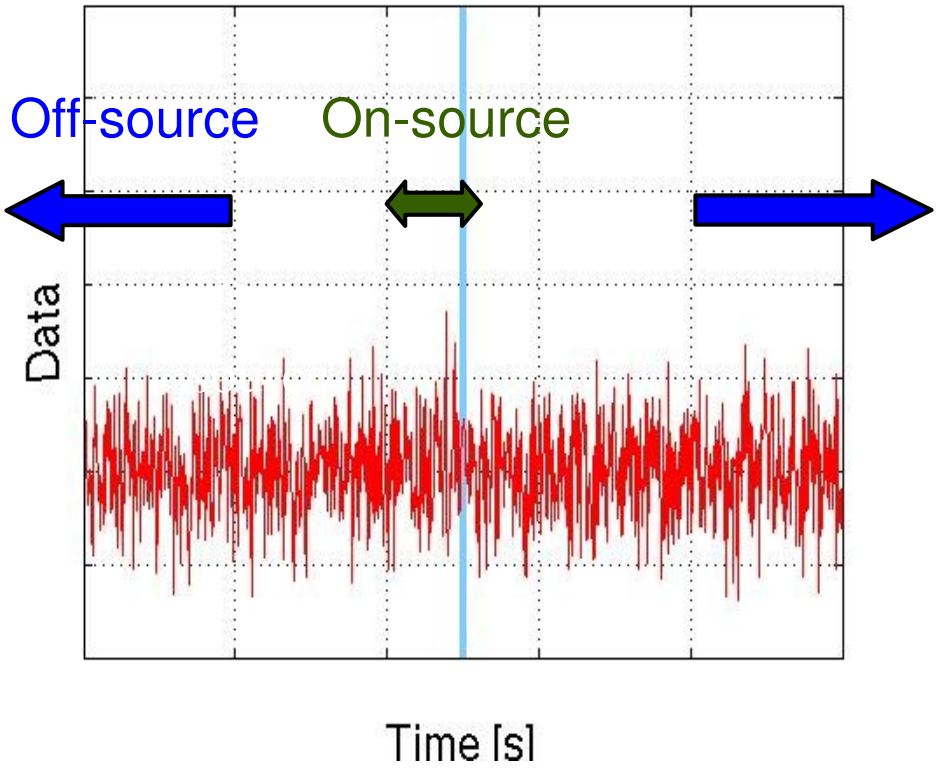
- Same pipeline used as blind search
- Small changes for injection code
- Incorporate known time delay between detector sites
- Use newly developed coincident technique

-> see talk by Craig Robinson



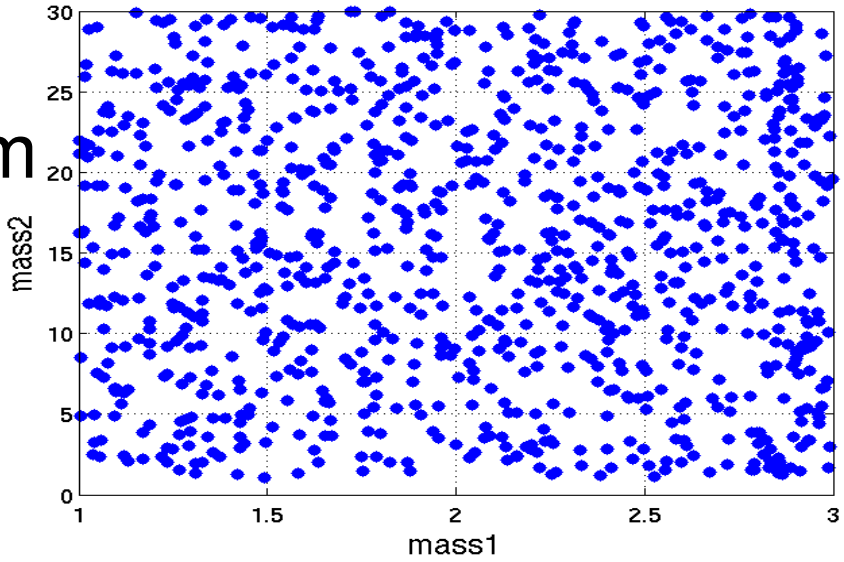
How is the search done?

- GRB trigger gives estimate of binary merger time.
- Assuming GW signal within some time around GRB (on-source)
- Background determined from data enough far away from GRB time (off-source)



Injection Population

- Merger of NS-NS or NS-BH
  - Used range mass1=[1-3 $M_\odot$] (NS)
  - Used range mass2=[1-30 $M_\odot$] (NS/BH)
  - Injections & templates: PN waveforms
  - Distances uniform distributed in $\log_{10}$ from 10 Mpc to 500 Mpc



Analysis plan

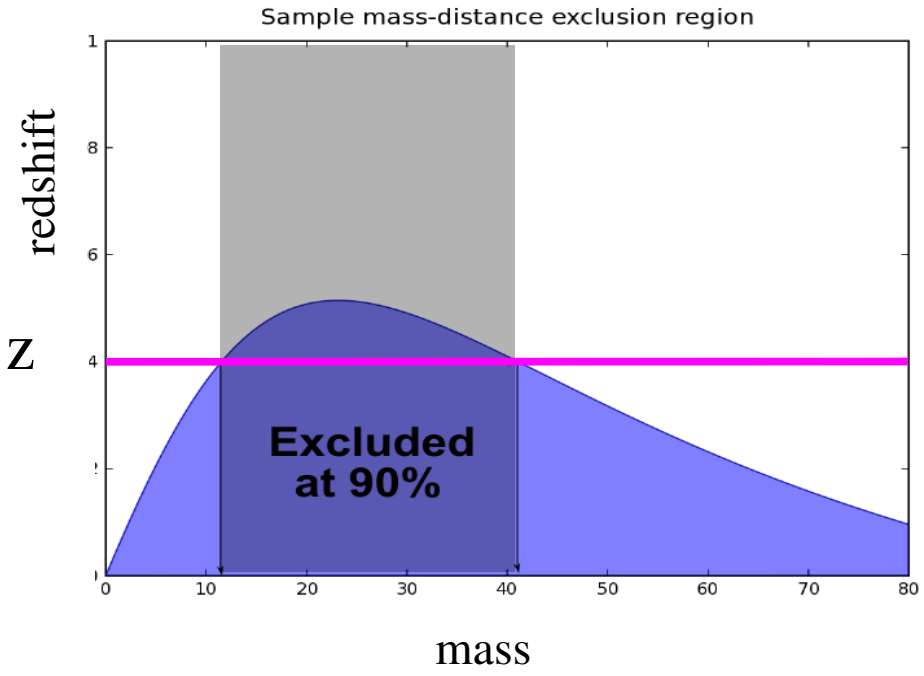
- Short Term:
  - Analyze playground segments in S5 (on- and off source), background studies
  - Perform injections into this playground
    - A fake GRB located optimally
    - A fake GRB mimicking the location of GRB 060427B
- Long term:
  - Analyze all real S5 GRB's

GRB 060427B:

- short GRB (~0.2 sec)
- all LIGO detectors working
- no redshift estimate
- almost optimal located (~92%)

What can we learn?

- In the case of a detection:
  - Confirmation of a binary system as progenitor
  - Gravitational-wave observation can determine the distance to the GRB
- Even in the case of no-detection:
  - Derive exclusion area for masses
  - Example shown for hypothetical GRB detected at some redshift



Summary & Outlook

- GRB triggered search: Location and time known
- Much deeper search possible, tight cuts on out coming triggers
- Uses same pipeline as other inspiral searches
- Much higher detection range possible

❖ To be done:

- Tune some parameters (tight cuts)
- Finish analysis on fake GRB
- Analyze real GRB (e.g. GRB 060427B)
- Extend search to *all* real GRB's with LIGO data available