GRB triggered Inspiral Searches in the fifth Science Run of LIGO

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Gamma Ray Bursts

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

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

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

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