GRBs and other transients with DeepCore

Ignacio Taboada

IceCube

GeorgiaInstitute
of**Tech**nology
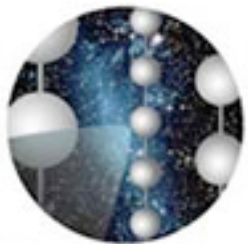
Signals in the 1-100 GeV range

- Decoupled neutrons in GRB Jets
  - Time of GRB known with <1s precision.
  - Typical ν energy: 1-100 GeV
  - Requires 1 km^3 for detection! <u>Look for this anyway</u>

- Choked GRBs / jets inside core-collapse SNe
  - Time of event known within 24 h (for optical SNe);
  - High event rates for nearby SNe

What I assume IC/DC can do

- Trigger/separate events E > 10 GeV with Deep Core
- Reconstruction:
  - E > 30 GeV: 30°
  - E >100 GeV: 5°
- Fiducial mass (2100 -2450 m):
  - 13 Mtons for DC
  - 15 – 26 Mtons for 3-layer veto (wo/w HEE)
 - 64 – 83 Mtons for 2-layer veto (wo/w HEE)

DC background rates

- 4×10^{-3} Hz atmospheric ν_μ (120000 events per year)
- Comparable down-going muon rate?
- In my calculations I'll assume 10^{-2} Hz trigger rate.

Analysis ideas: Rolling search

- From the trigger rate before we need:
  - 5 triggers within 100 s for 3 σ
  - 7 triggers within 100 s for 4 σ
  - 10 triggers within 100 s for 5 σ
- Set up an online filter for O(4) Deep Core triggers within 100 s (and a similar trigger for 1 s).
- Trigger LIGO, trigger HAWC, other panoptic instruments.

Analysis ideas: GCN from satties

γ incoming gamma ray

electron-positron pair
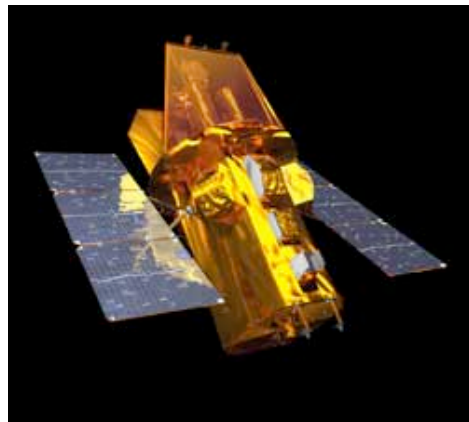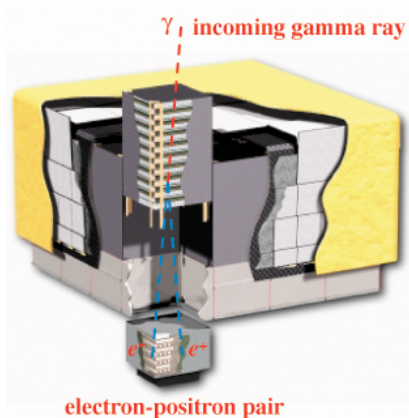
300 GCNs/year

- For a single GRB with T90 ~ 100 s you still need O(10) events for 5 sigma.

- Neutrinos from neutron diffusion arrive before the γ-ray burst, so the window should be expanded/.
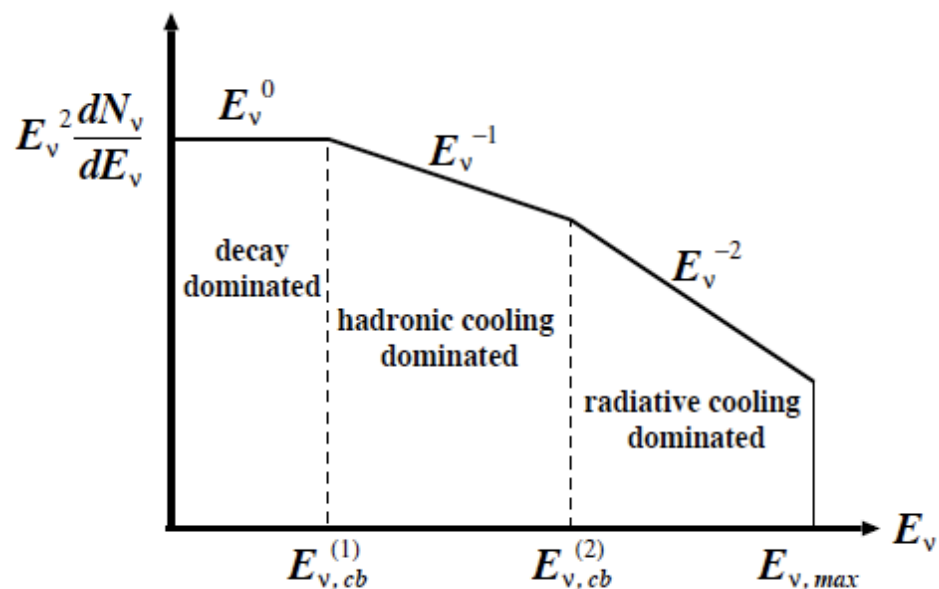
- Can we identify the more interesting GRBs?

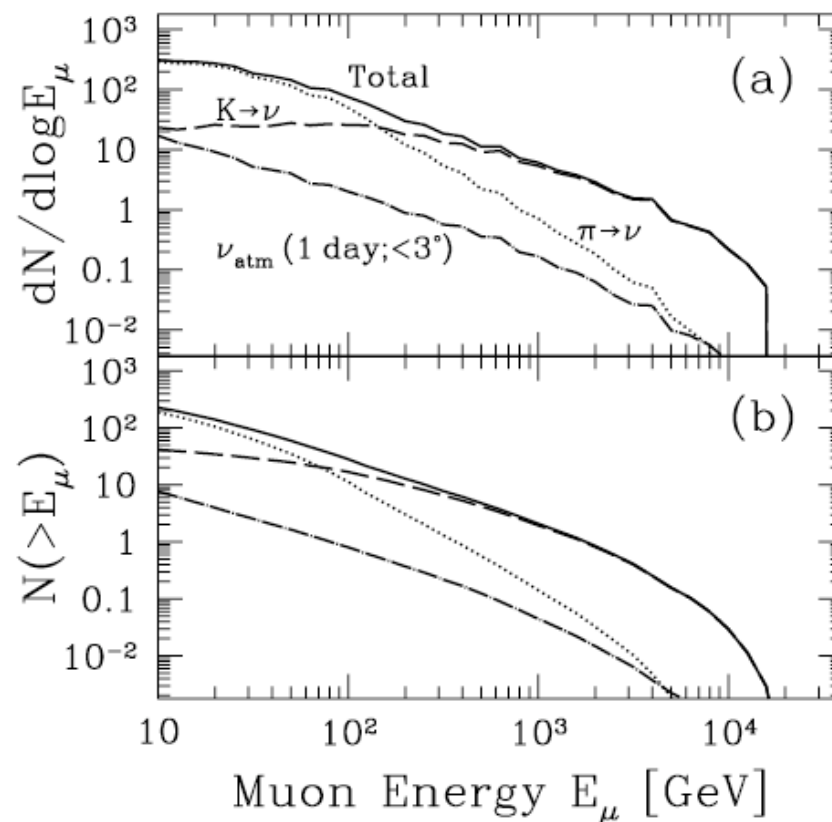# Analysis ideas: 2-layer veto Transition from DC to IC

- 2-layer fiducial volume is 5-6 times that of Deep Core.

- Use reconstruction for E>30 GeV to reduce background.

- Need to develop triggers and filters

Analysis ideas: 2-layer veto
Neutrinos from Choked GRBs / Jets in SNe

K   200 GeV   20 TeV

π   30 GeV   100 GeV

Razzaque, Mészáros and Waxman, Phys. Rev. Lett. 93, 181101 (2004); 94, 109903(E) (2005).

Ando & Beacom. Phys.Rev.Lett. 95 (2005) 061103

Analysis ideas: 2-layer veto
Neutrinos from Choked GRBs / Jets in SNe

- Choked Jet SNe back of the envelope calculation:
  - Signal for E>10 GeV @ 10 Mpc: 5 ν_μ (DC)
  - Signal for E>30 GeV @ 10 Mpc: 6-8 ν_μ (2-layer w/wo HEE)
  - Signal for E>TeV @ 10 Mpc: 3 ν_μ (IC-80)
  - Problem: SNe are known to within ~1day

Sources of Core collapse SNe: Targeted searches LSST

Analysis ideas:
ν-multiplet self-trigger / Choked GRBs

- Atm ν_μ E>30 GeV background (with 30° resolution): 1
- (For now) I ignore the down-going muon bckg
- 2/3 or 3/3 way coincidence enhances significance.

The optical follow-up (TeV multiplets) is already operational
The online 10 GeV online multiplet filter is trivial
Optimize 30 GeV multiplet filter for energy/angle

Conclusion & Outlook

✓ Rolling Search

✓ GCN coincident search

✓ Self triggered neutrino search

Better calculations needed

<u>Online</u> 2-layer and DC filters needed

Multi-Messenger Relativistic Astrophysics 2009
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The School of Physics at the Georgia Institute of Technology is pleased to announce the inaugural conference of the Center for Relativistic Astrophysics (CRA): *Multi-Messenger Relativistic Astrophysics 2009*. The newly established CRA is devoted to interdisciplinary research and education in multi-messenger astrophysics, linking high energy, particle and gravitational astrophysics. This inaugural conference is an opportunity for participants to share their insights and experience on research focusing on extreme astrophysical phenomena such as merger of black holes and neutron stars, central engines of active galactic nuclei, gamma ray bursts, and sources of the high energy cosmic rays and neutrinos.

This conference will be held at Atlanta, Georgia from Tuesday through Thursday, May 19-21, 2009. It will feature invited talks and contributed sessions; posters are also welcome. **April 15** is the deadline to submit abstracts for contributed talks as well as registration and payment of the conference fee ($100 US).

Invited Speakers

Tom Abel, (*Stanford*)

Brenda Dingus, (*LANL*)

Francis Halzen, (*Wisconsin*)

Saul Teukolsky, (*Cornell*)

Jim Buckley, (*Washington U at St Louis*)

Andy Fabian, (*Cambridge*)

Scott Hughes, (*MIT*)

www.cra.gatech.edu/CenterConf