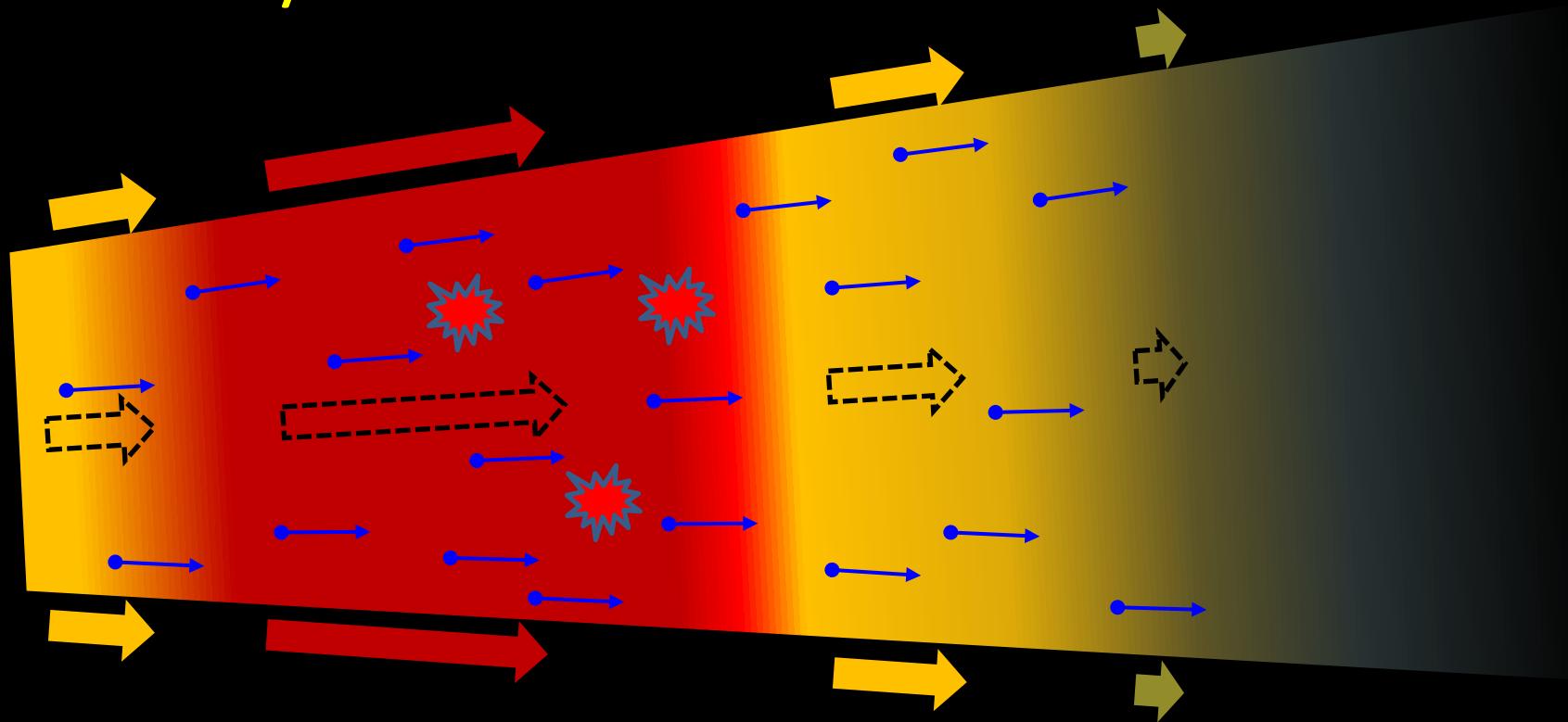


DETECTION PROSPECTS FOR GEV NEUTRINOS FROM COLLISIONALLY HEATED GRBS WITH ICECUBE/DEEPCORE



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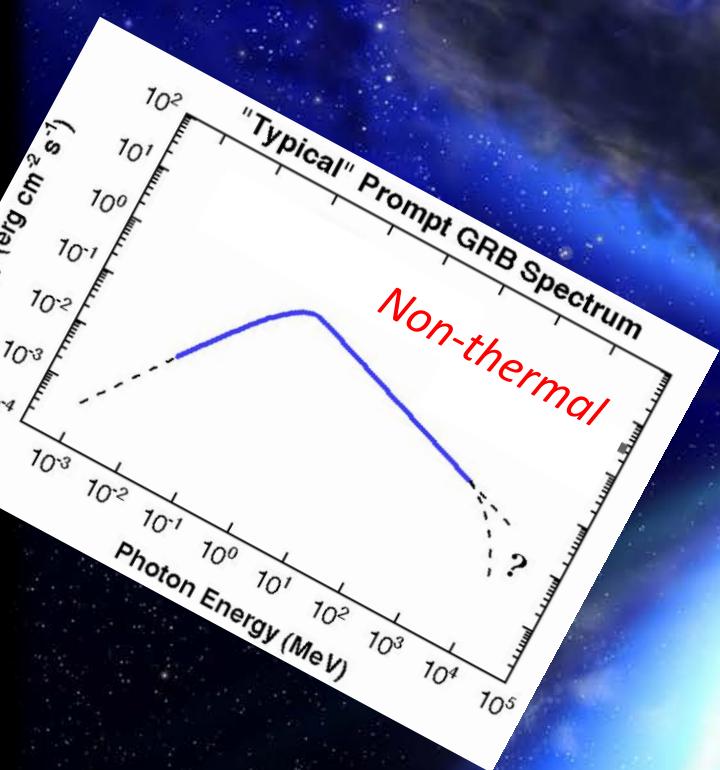
OUTLINE

1. Collisional heating ($n+p$) for GRB emission
 - a. What is it?
 - b. Why is it a promising description of observations?
2. Detection prospects with IceCube+DeepCore
 - a. What can we expect to observe?
 - b. Search strategy?

1.

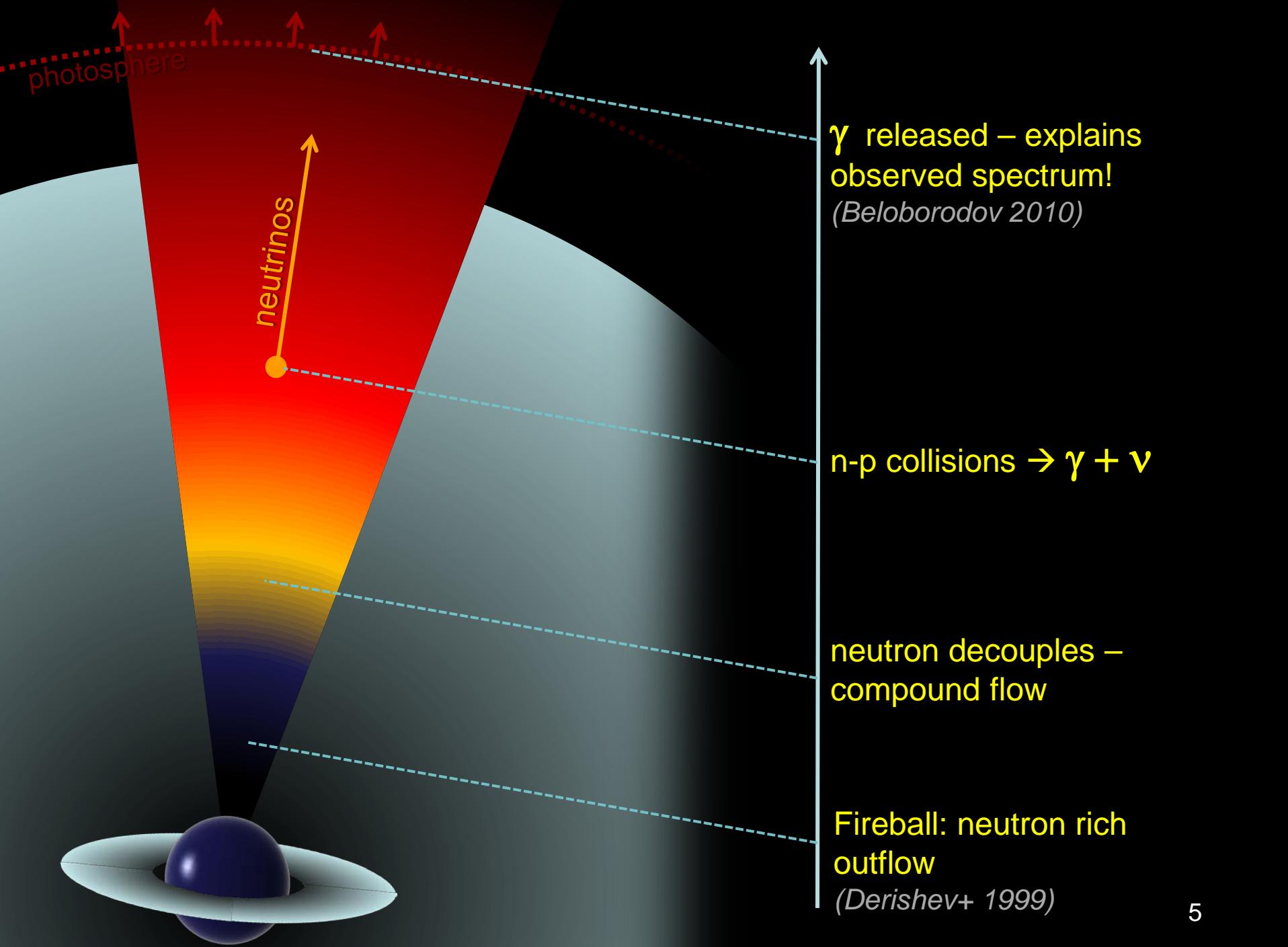
COLLISIONAL HEATING (N-P)
FOR GRB EMISSION

GAMMA-RAY BURST HEATING



Possible explanations of observed spectrum

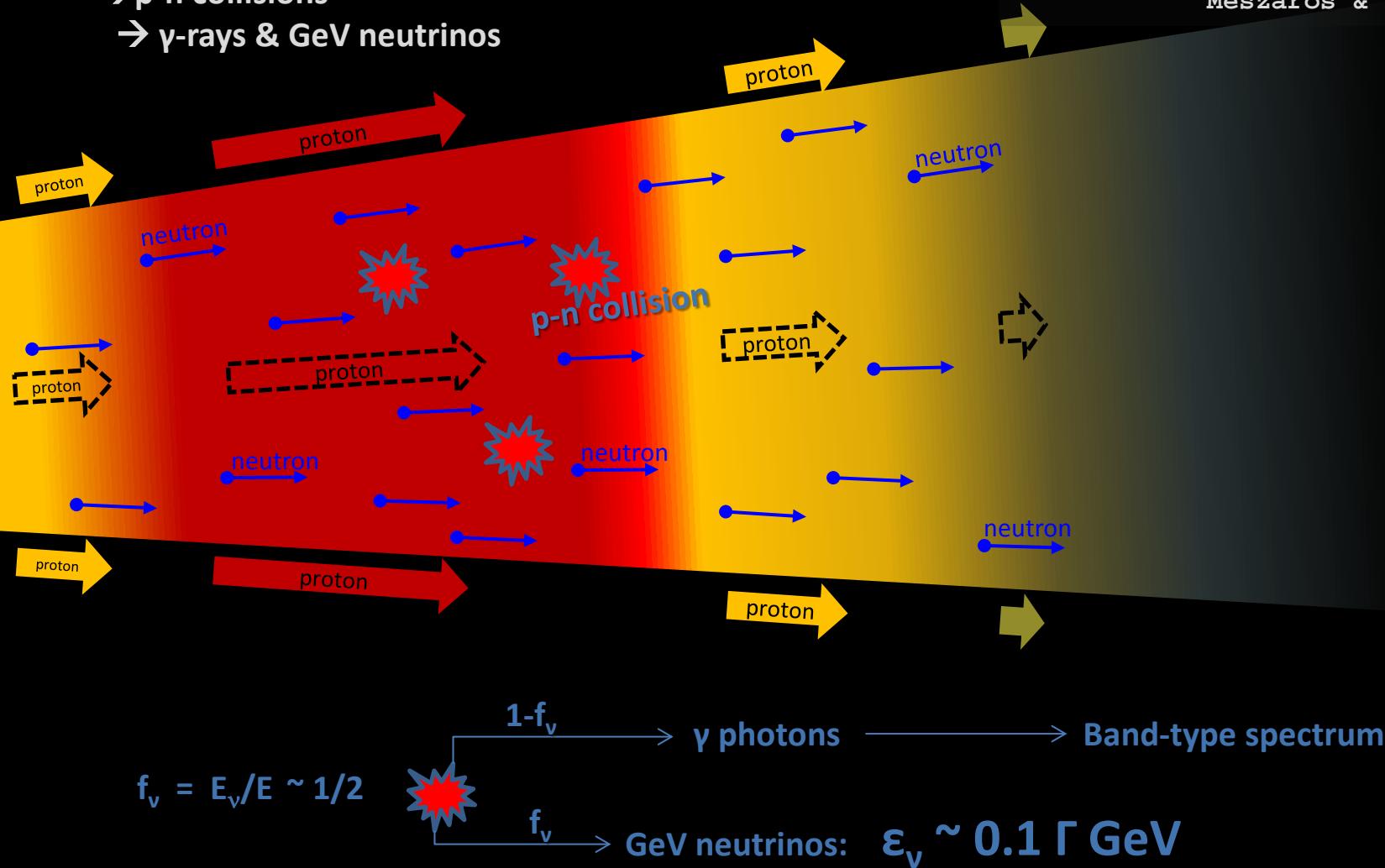
- A. Collisionless internal shocks
 - B. Sub-photospheric dissipation
 - Nuclear (p-n) collisions



COLLISIONAL HEATING

p-n two-fluid compound state
 → p-n collisions
 → γ -rays & GeV neutrinos

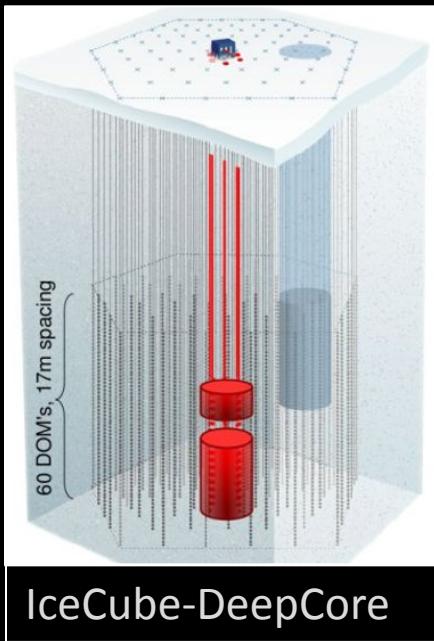
Derishev et al. ApJ 1999
 Bahcall & Mészáros PRL 2000
 Mészáros & Rees ApJ 2000



2.

DETECTION PROSPECTS WITH ICECUBE+DEEPCORE

DETECTION PROSPECTS: ICECUBE+DEEPCORE



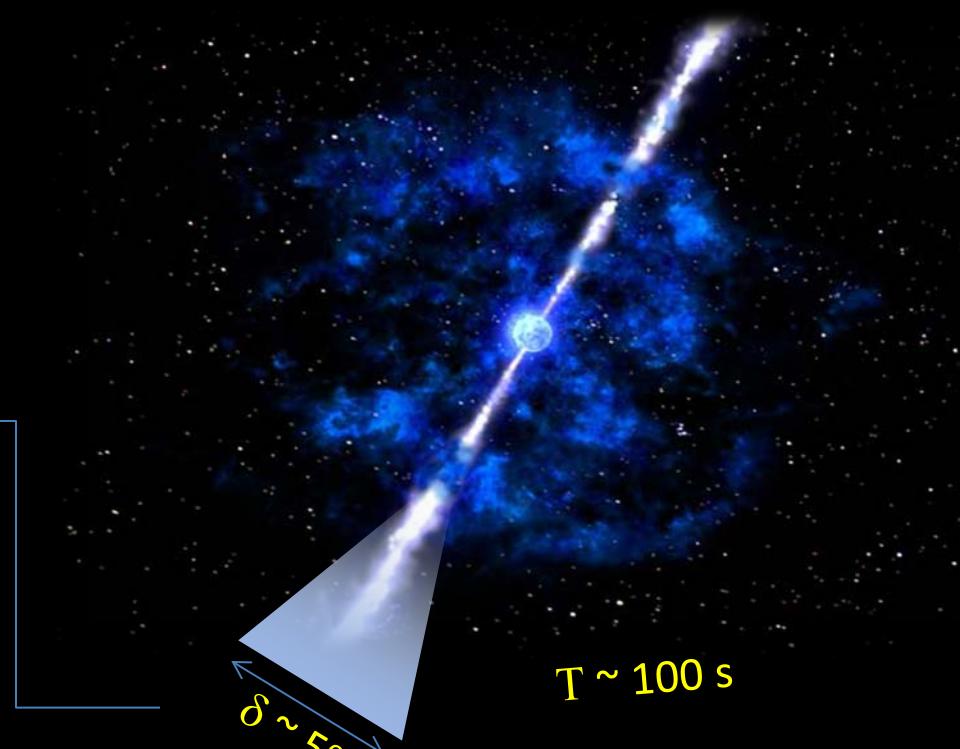
IceCube-DeepCore

Sensitivity: **10-100 GeV**
(+IceCube: >100 GeV)

$(\varepsilon_\nu \sim 0.1 \Gamma \text{ GeV})$

Bartos et al PRL 2013

GRB: $100 < \Gamma < 1000$

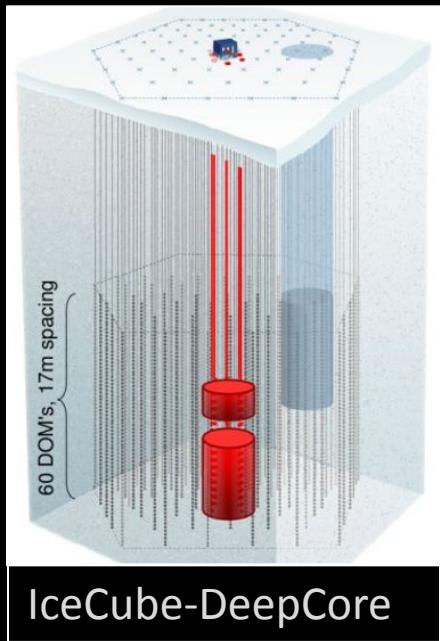


$T \sim 100 \text{ s}$

Low background: $\sim 10^{-4}$ per GRB
→ 1 neutrino is already interesting!

DETECTION PROSPECTS: ICECUBE+DEEPCORE

http://www.physics.wisc.edu/groups/neutrino-experimental/



Sensitivity: 10-100 GeV
(+IceCube: >100 GeV)
($\varepsilon_\nu \sim 0.1 \Gamma \text{ GeV}$)

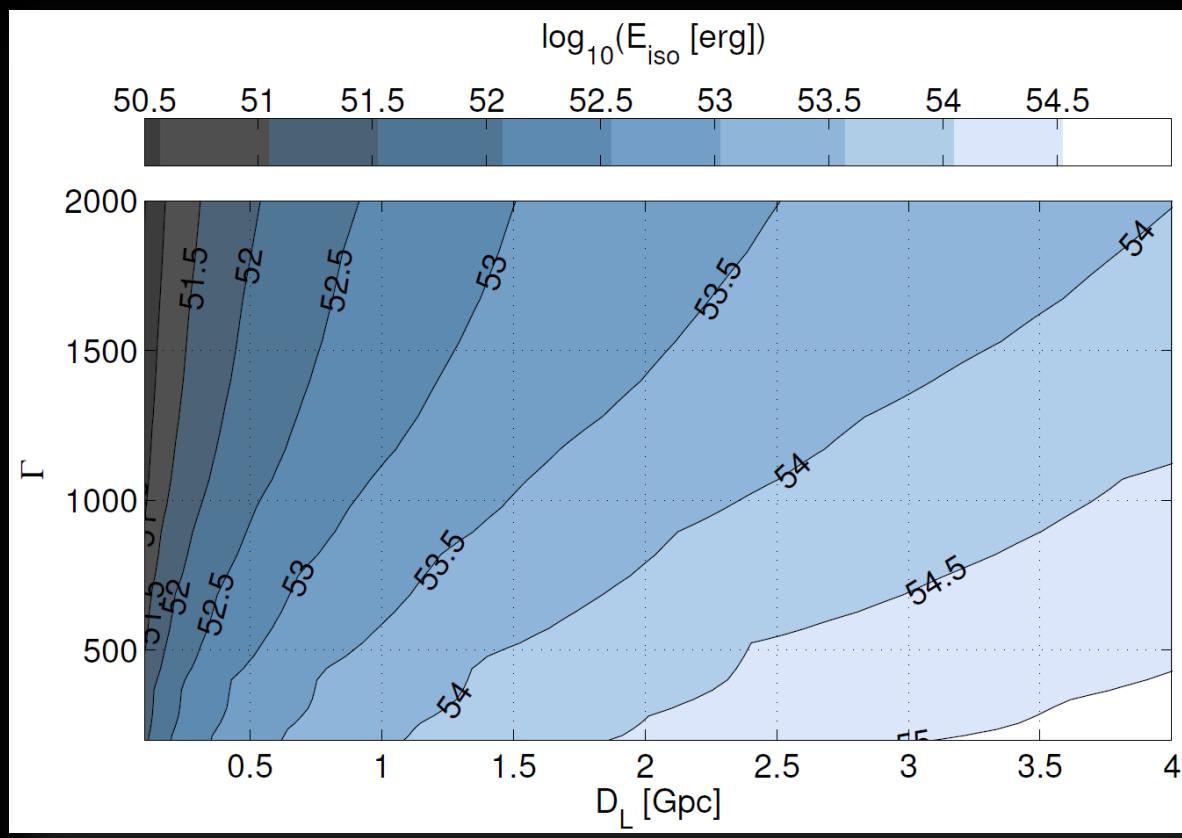
Bartos et al PRL 2013

GRB: $100 < \Gamma < 1000$ ✓

Low background: $\sim 10^{-4}$ per GRB

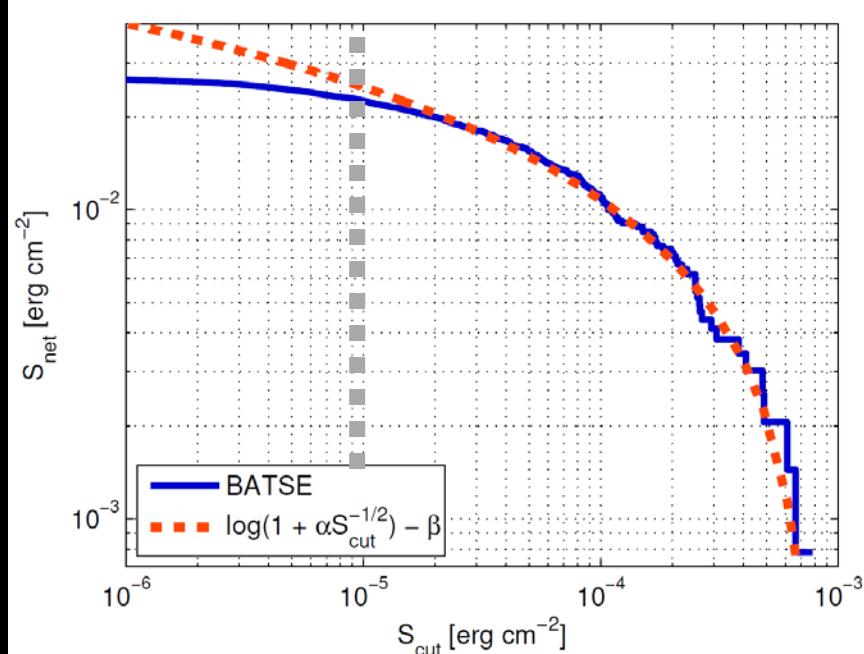
→ 1 neutrino is already interesting!

Most GRBs produce
 $\langle n \rangle \ll 1$ neutrino



E_{iso} that would result in $\langle n \rangle = 1$ detected neutrino

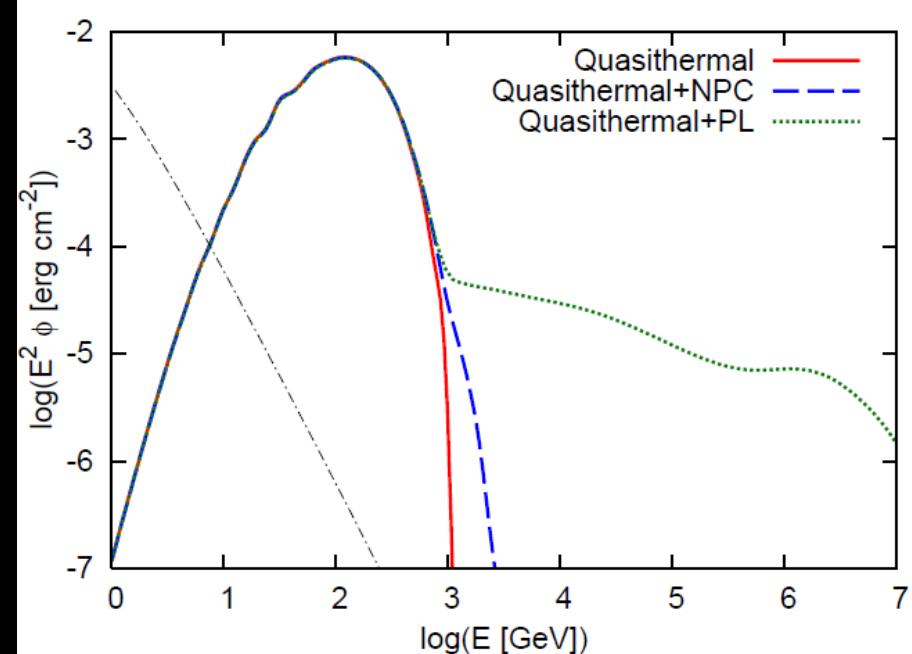
DETECTION PROSPECTS: ICECUBE+DEEPCORE



Bartos et al PRL 2013

Focus on the brightest sources

- ν flux $\sim \gamma$ flux
- don't lose much
- reduced background

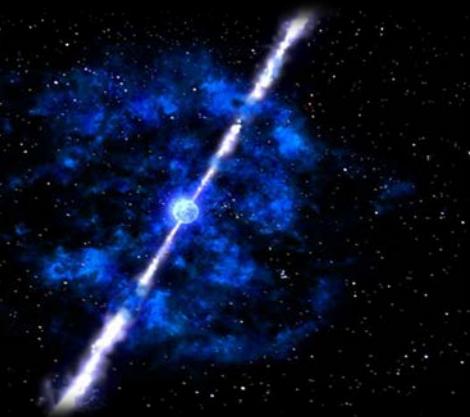


Murase et al 2013

Energy distribution

- background rejection
- probe emission properties
- tune flux estimate

PROPOSED SEARCH



- Select GRBs with fluence $S > 10^{-5}$ erg cm⁻²
(highest-fluence GRBs detectable even without Fermi/Swift)
- Search for > 10 GeV neutrinos
(temporally coincident with prompt emission)
- Existing DeepCore neutrino searches could be applied for GRB searches as well
- (can be optimized w.r.t. angular resolution + energy distribution)

$$\langle n \rangle = A\Psi \approx 8 \times 10^{-4} w S_{-5} \left(\frac{\epsilon}{100 \text{ GeV}} \right)^2$$

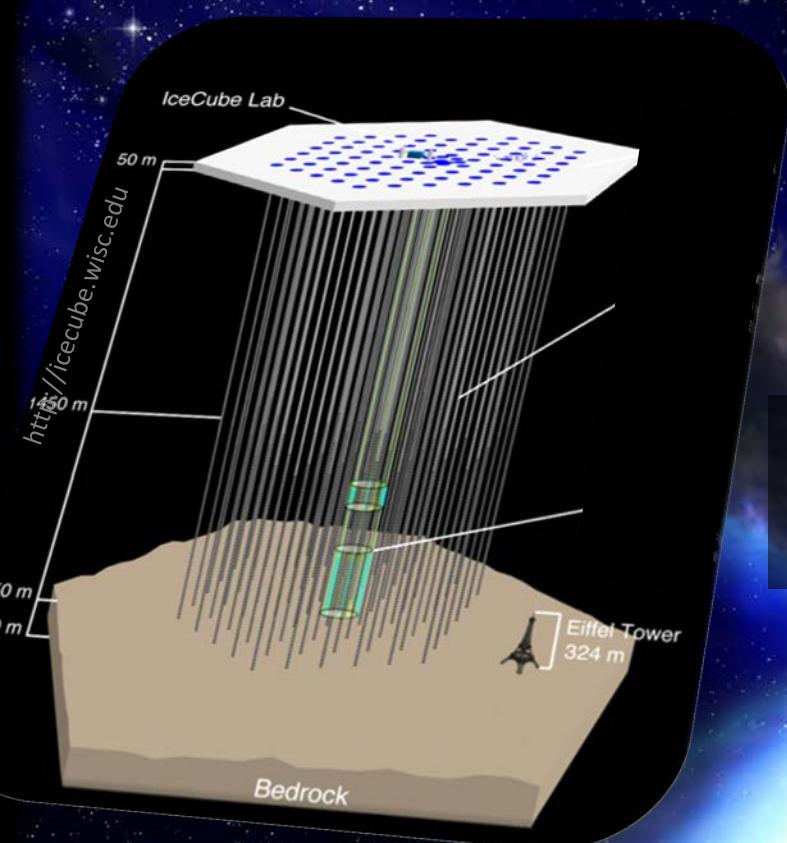
$$\epsilon \approx 30 \left(\frac{\Gamma}{600} \right) \left(\frac{1+z}{2} \right)^{-1} \text{ GeV}$$

$$w = \frac{E_\nu}{E_\gamma} = \frac{f_\nu}{1-f_\nu} \frac{\tau_T^{2/3}}{2} = 3 - 10$$

*~few neutrinos detectable over a 5-10 years measurement period
(DeepCore data could already have such neutrinos)*

DEEP CORE: SCIENCE PROSPECTS

Bartos et al PRL 2013



The detection of GeV neutrinos from GRBs would:

- Confirm collisional heating of GRBs
- Lorentz factor: alternative measurement
- ...

Interesting scientific objective for
IceCube+DeepCore and for
planning future upgrades