ICRC 2021
THE ASTROPARTICLE PHYSICS CONFERENCE
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Detection prospects for low-energy muon neutrinos from collisionally heated GRBs with current and future neutrino telescopes

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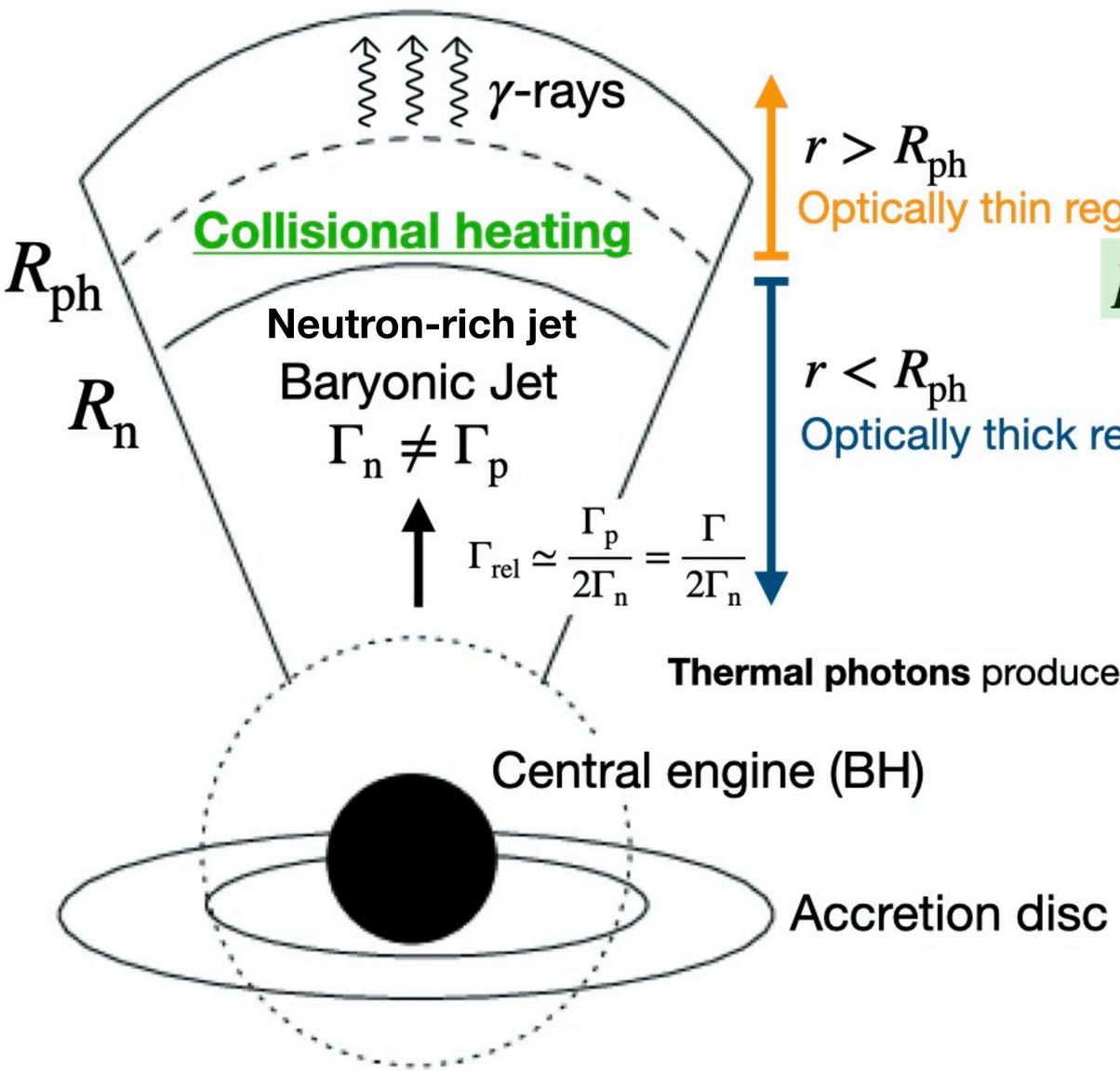
Inelastic collisional model



$r > R_{ph}$
Optically thin region

$r < R_{ph}$
Optically thick region

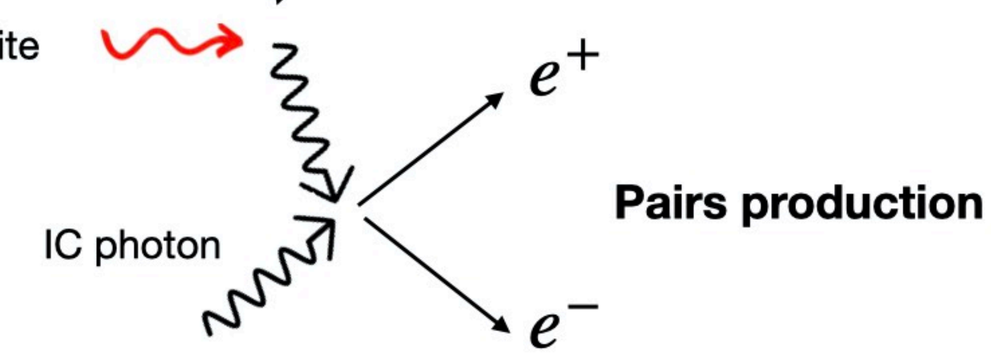
Thermal photons produced at the jet launch site

Multi-GeV neutrino production

$$p + n \longrightarrow \pi^+ + 2n$$

$\pi^+ \xrightarrow{26\ \text{ns}} \nu_\mu + \mu^+ \xrightarrow{2.2\ \mu\text{s}} e^+ + \nu_e + \bar{\nu}_\mu$

positron LF ~ 50 Γ_{rel}

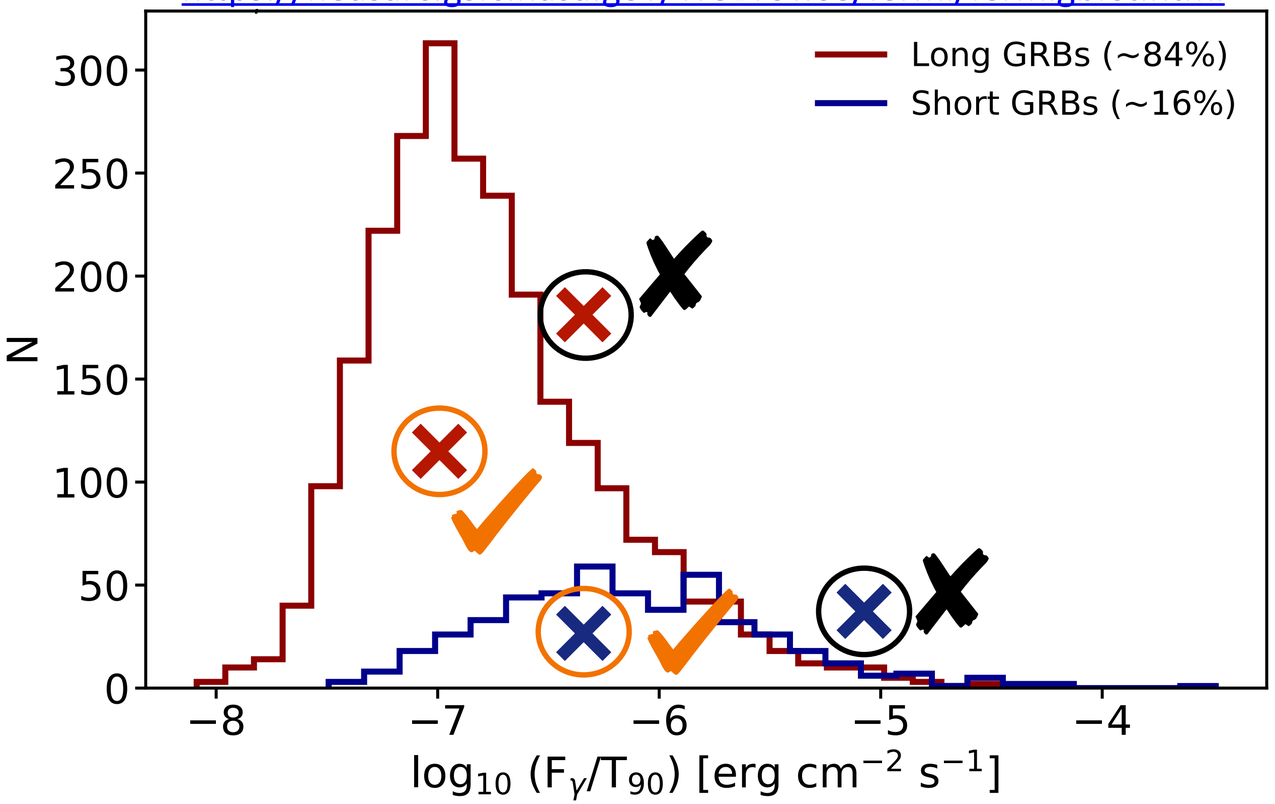


Beloborodov A. M., MNRAS 407 (2010) 1033
Bartos I. et al., Phys. Rev. Lett.. 110 (2013) 241101

GRB selection and neutrino fluence estimation

Extractions of GRB gamma-ray fluence F_γ and prompt duration T_{90} equivalent to ~5 years of observation in the 2π-sky from Fermi GBM distributions

https://heasarc.gsfc.nasa.gov/W3Browse/fermi/fermigbrst.html



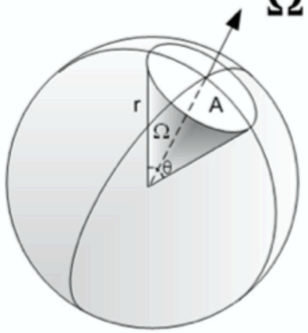
Estimation of the expected **signal neutrino fluence** according to the model

$$E_\gamma^2 \phi_\gamma \sim E_{\nu_\mu}^2 \phi_{\nu_\mu} \xrightarrow{\text{peaking at}} E_\nu \sim 100\ \text{GeV} \left(\frac{\Gamma}{600}\right)\left(\frac{\Gamma_{\text{rel}}}{2}\right)$$

Murase K., Kashiyama K., Mészaros P., Phys. Rev. Lett. 111 (2013) 131102

Estimation of the **background** (atmospheric neutrino flux by Honda model) within $T_{90} \pm 30\% T_{90}$

$$\Omega = 2\pi\left(1 - \cos(\theta/2)\right)$$

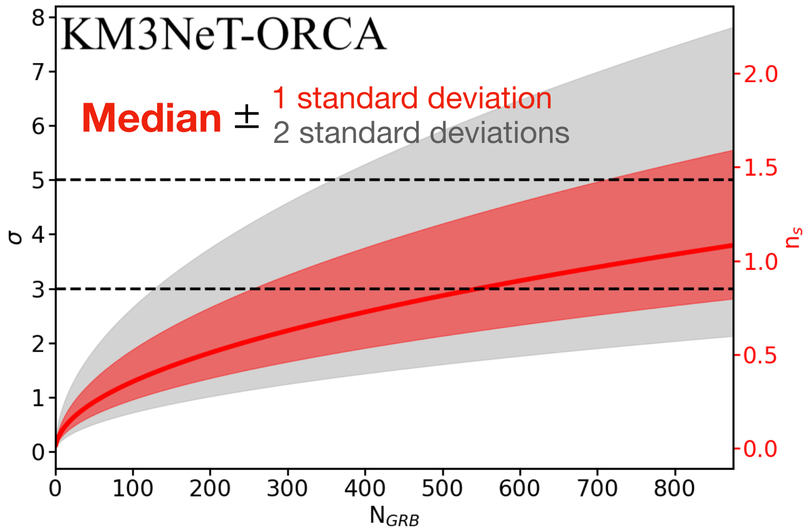


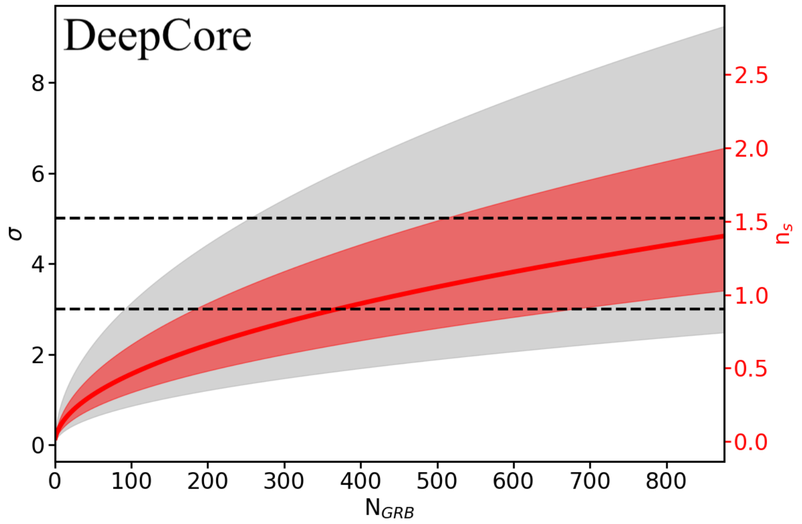
$$\theta_{\text{bkg}} = 3\theta_{\nu\mu}(E_{\nu_\mu})$$

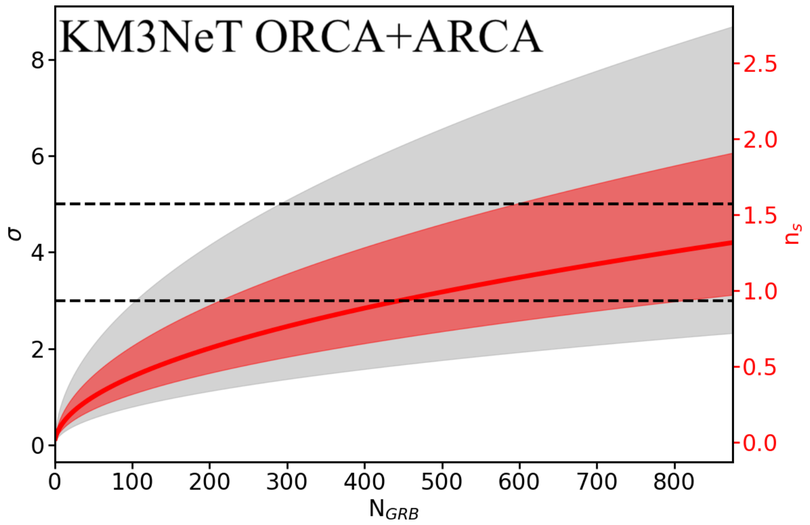
$$\theta_{\nu\mu} \simeq \frac{0.7^\circ}{[E_\nu(\text{TeV})]^{0.7}}$$

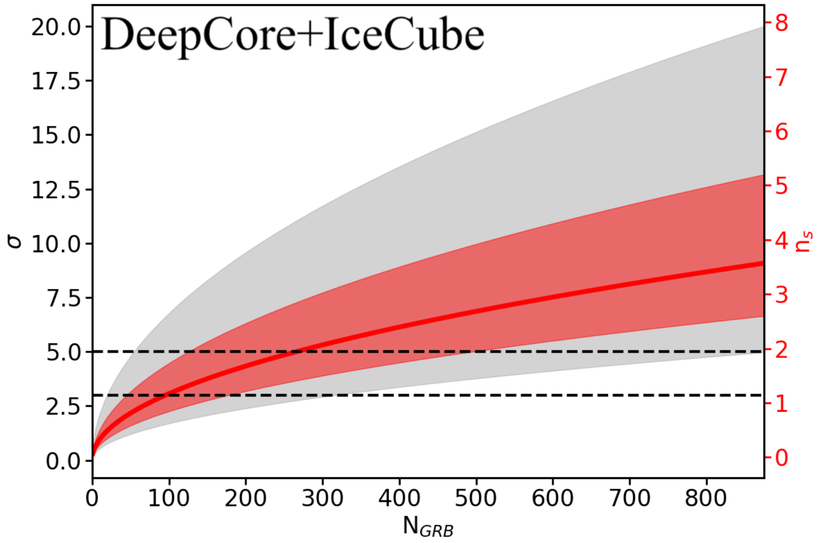
Stacking detection prospects for ν's observatories

Long GRBs with $\Gamma = 300$, effective areas at TRIGGER LEVEL









GRBs added in sequence choosing the one that gives, for each step, the maximum increase of total significance $\sigma = n_s/\sqrt{n_b}$

Detection prospects for low-energy muon neutrinos from collisionally heated GRBs with current and future neutrino telescopes

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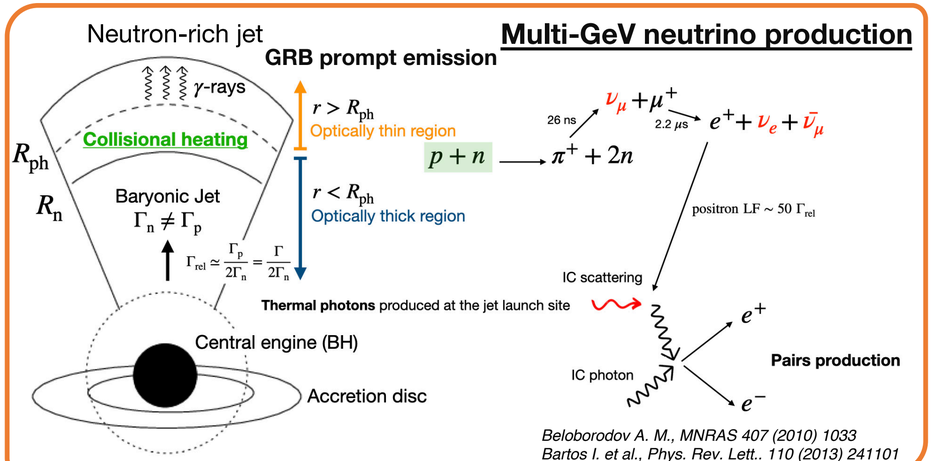

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GRBs added in sequence choosing the one that gives, for each step, the maximum increase of total significance

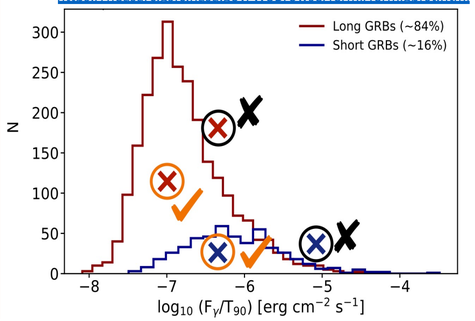
$$\sigma = n_s/\sqrt{n_b}$$

Procedure repeated **1000 times**

GRBs selection and neutrino fluence estimation

1. Extractions of GRB **gamma-ray fluence** F_γ and **prompt duration** T_{90} equivalent to ~**5 years** of observation in the 2π **sky** from Fermi GBM distributions

https://heasarc.gsfc.nasa.gov/W3Browse/fermi/fermigbrst.html



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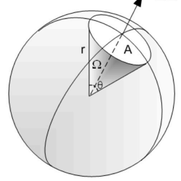
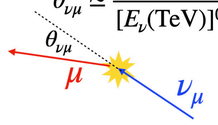
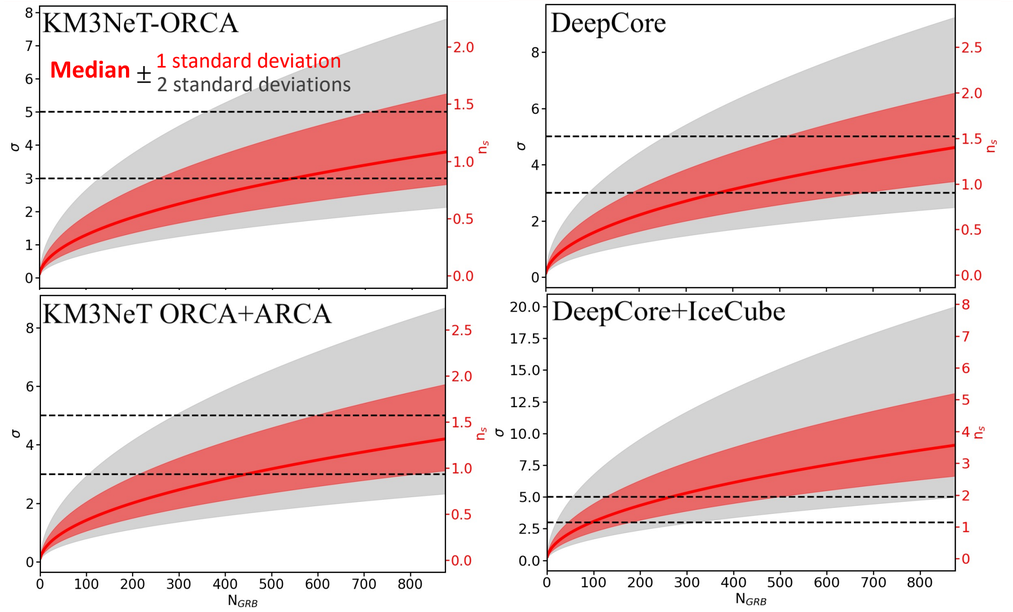


$$\theta_{\nu\mu} \simeq \frac{0.7^\circ}{[E_\nu(\text{TeV})]^{0.7}}$$

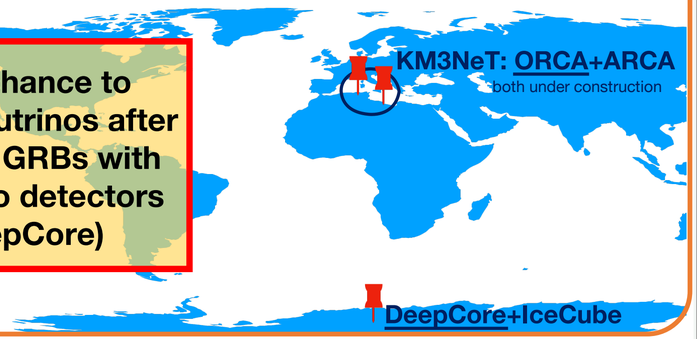


Stacking detection prospects for ν's observatories

Results shown for long GRBs with $\Gamma = 300$ and with effective areas at TRIGGER LEVEL



There is a good chance to detect multi-GeV neutrinos after stacking ~900 long GRBs with low-energy neutrino detectors (ORCA and DeepCore)



Proceeding URL: https://pos.sissa.it/395/1019