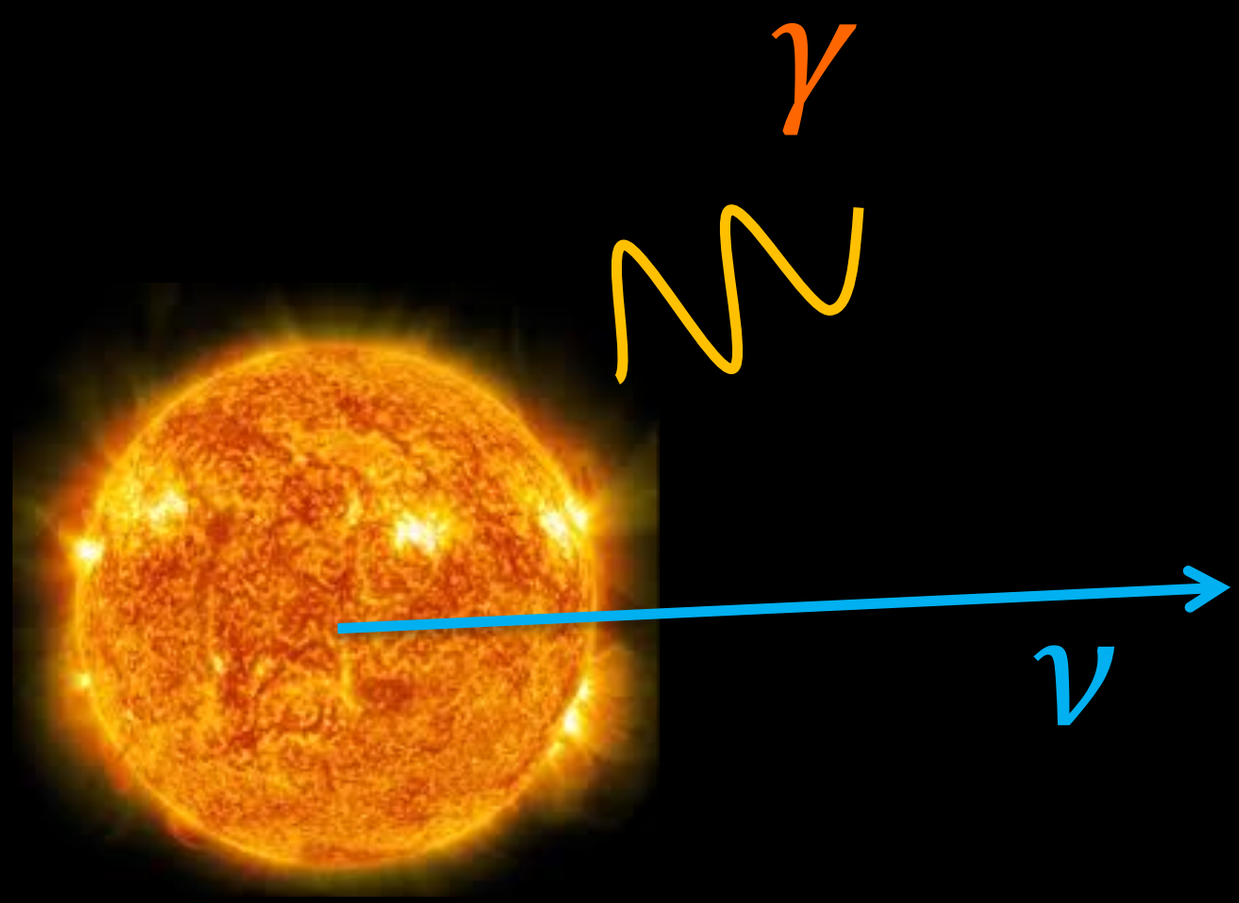
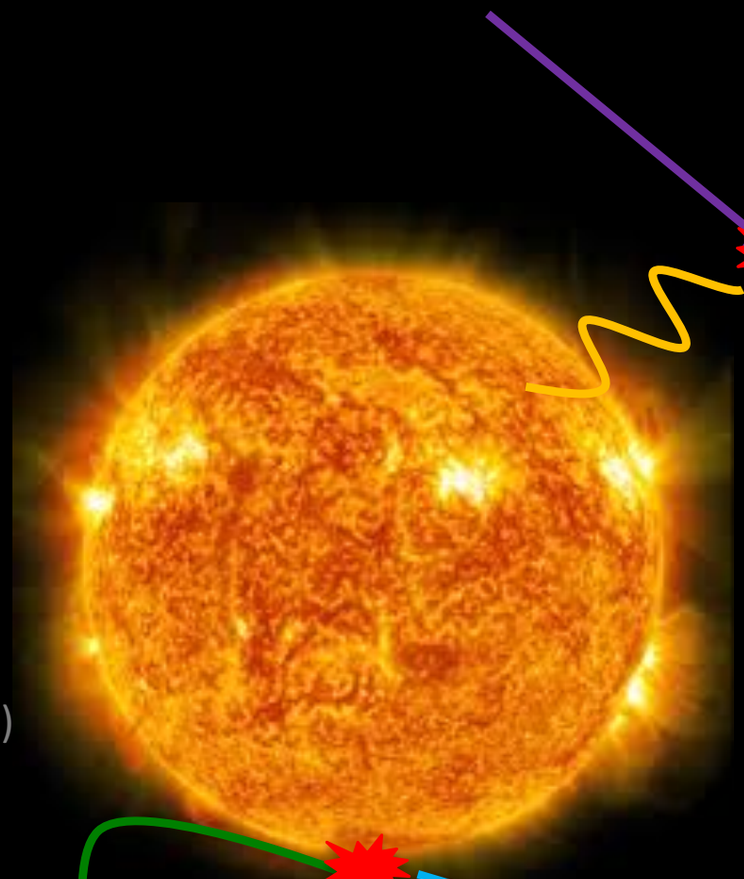
Solar Atmospheric Neutrinos



Kenny CY Ng
Marie Curie Fellow, GRAPPA, UvA

Sun - Cosmic-ray Beam Dump



CR electrons
Inverse-Compton

Moskalenko, Porter, Digel 2006
Orlando, Strong 2007

γ Continuous

Seckel, Stanev, Gaisser (1991)
Zhou, ***KCYN***, Beacom, Peter
PRD 2017

CR protons
Hadronic

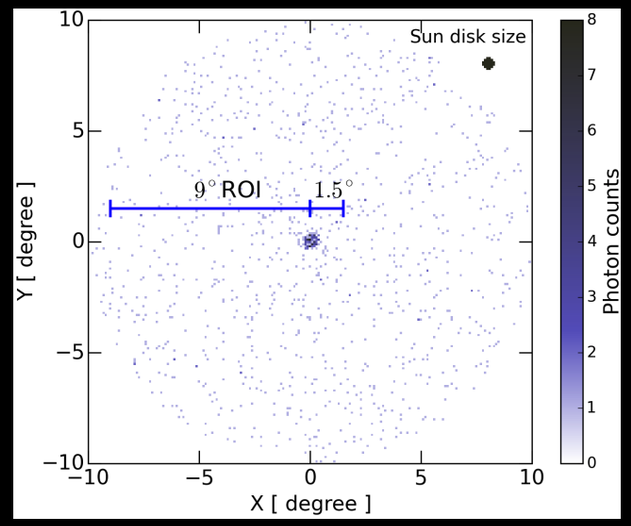
ν

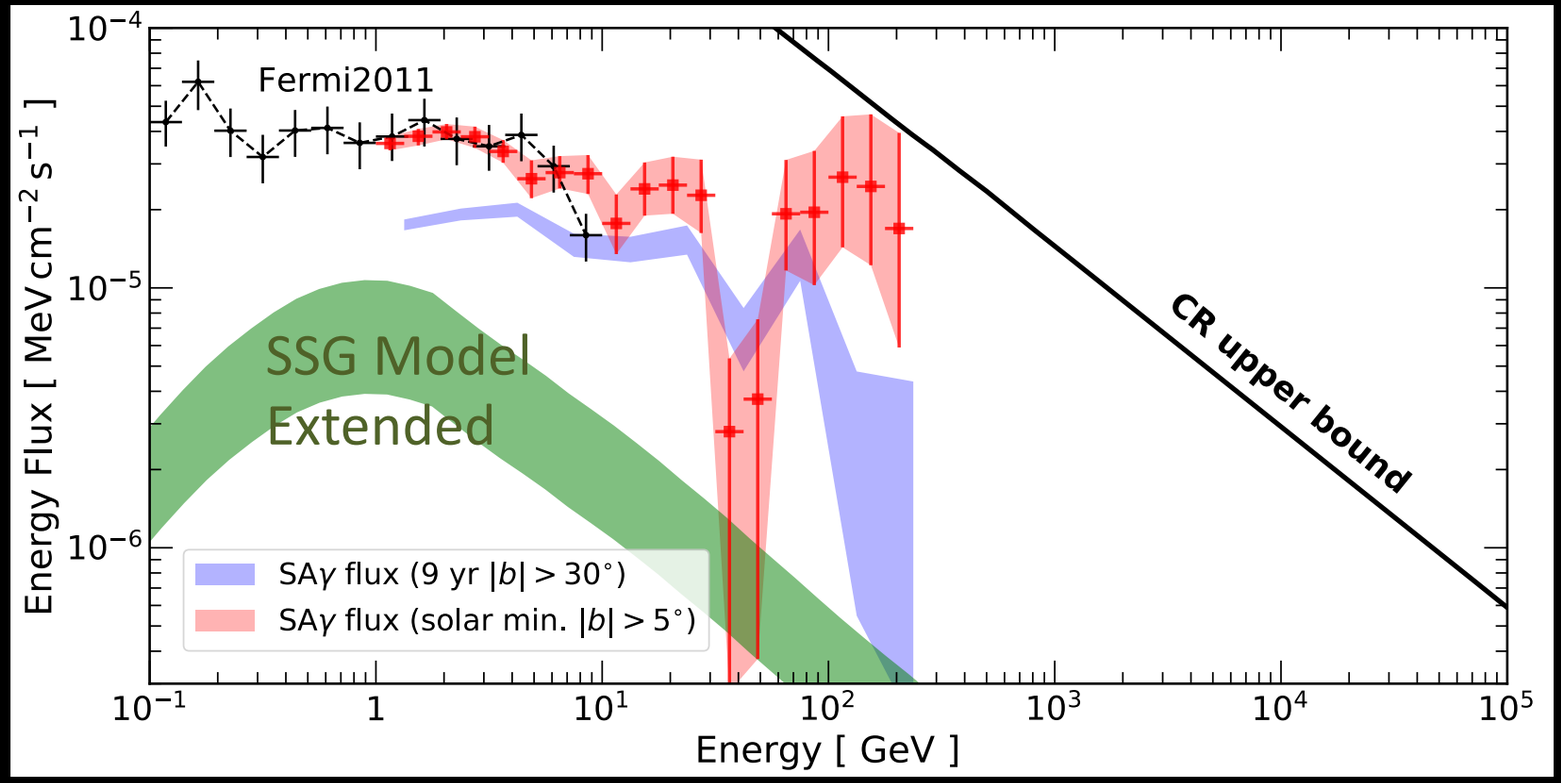
$e^{\pm}, \mu^{\pm}, \mathrm{n}$

γ Continuous

Solar Atmospheric Gamma-ray Puzzle

- High Flux, O(10)% efficiency at 100 GeV
- Time variation solar Min-Max
  - (2x @1 GeV, 10x @ 100 GeV)
- Morphology changes
- Dip at ~ 30 GeV, mostly at solar min.
- Hard Spectrum, $\sim E^{-2.2}$

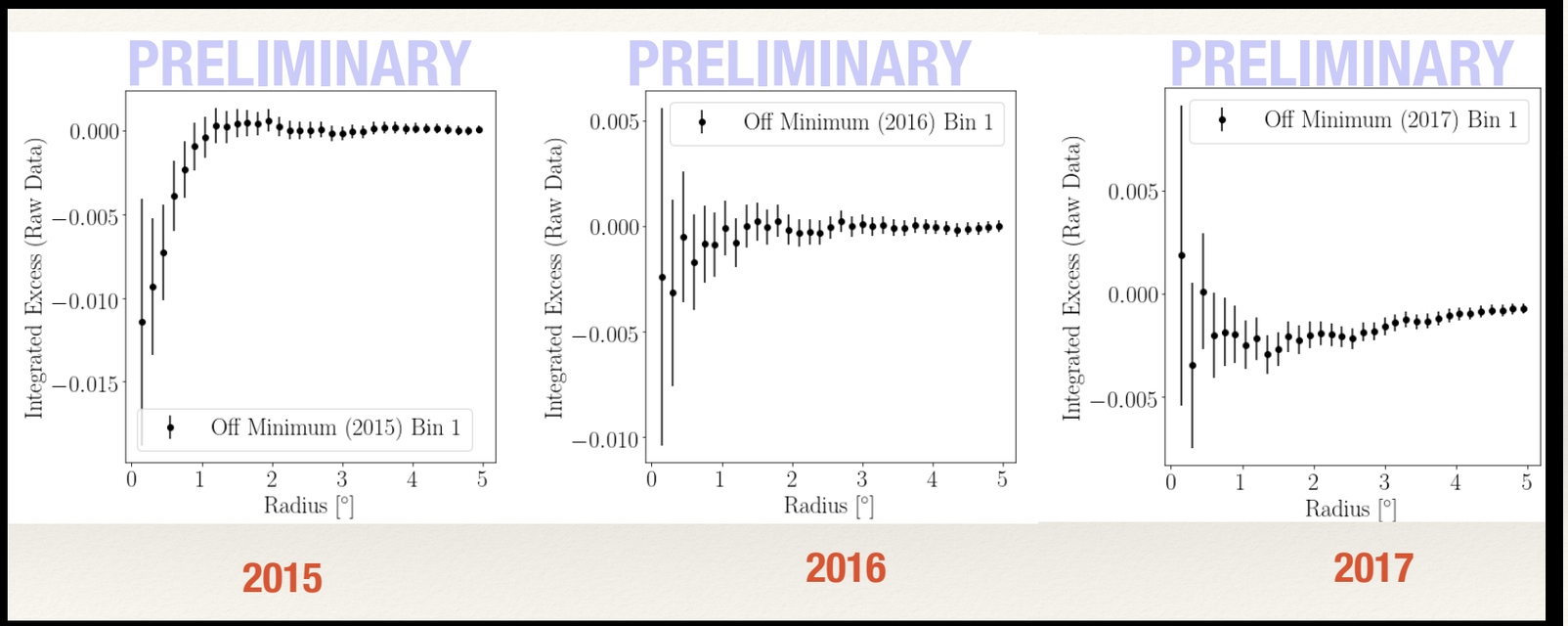


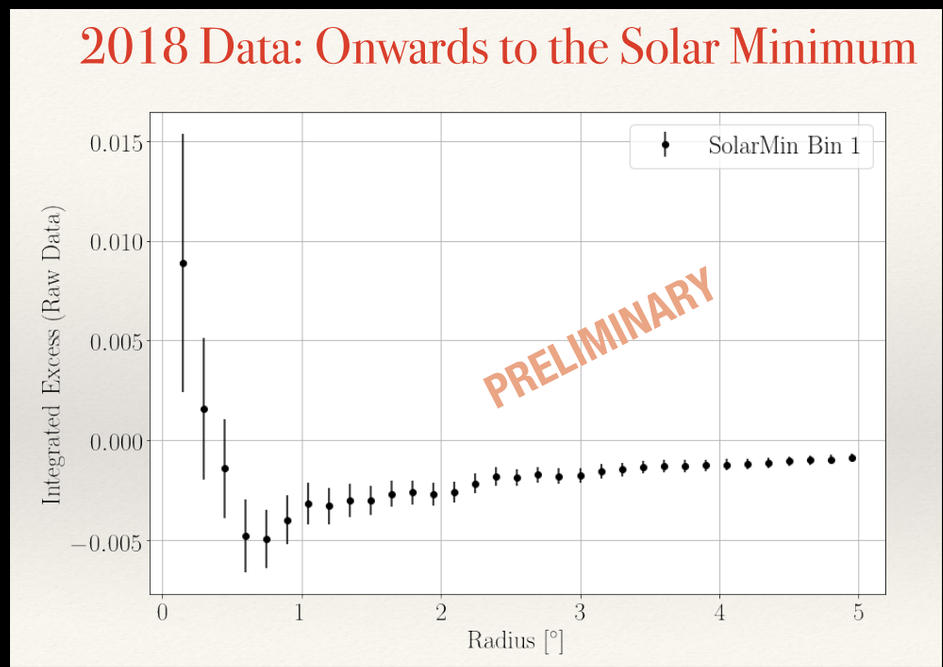


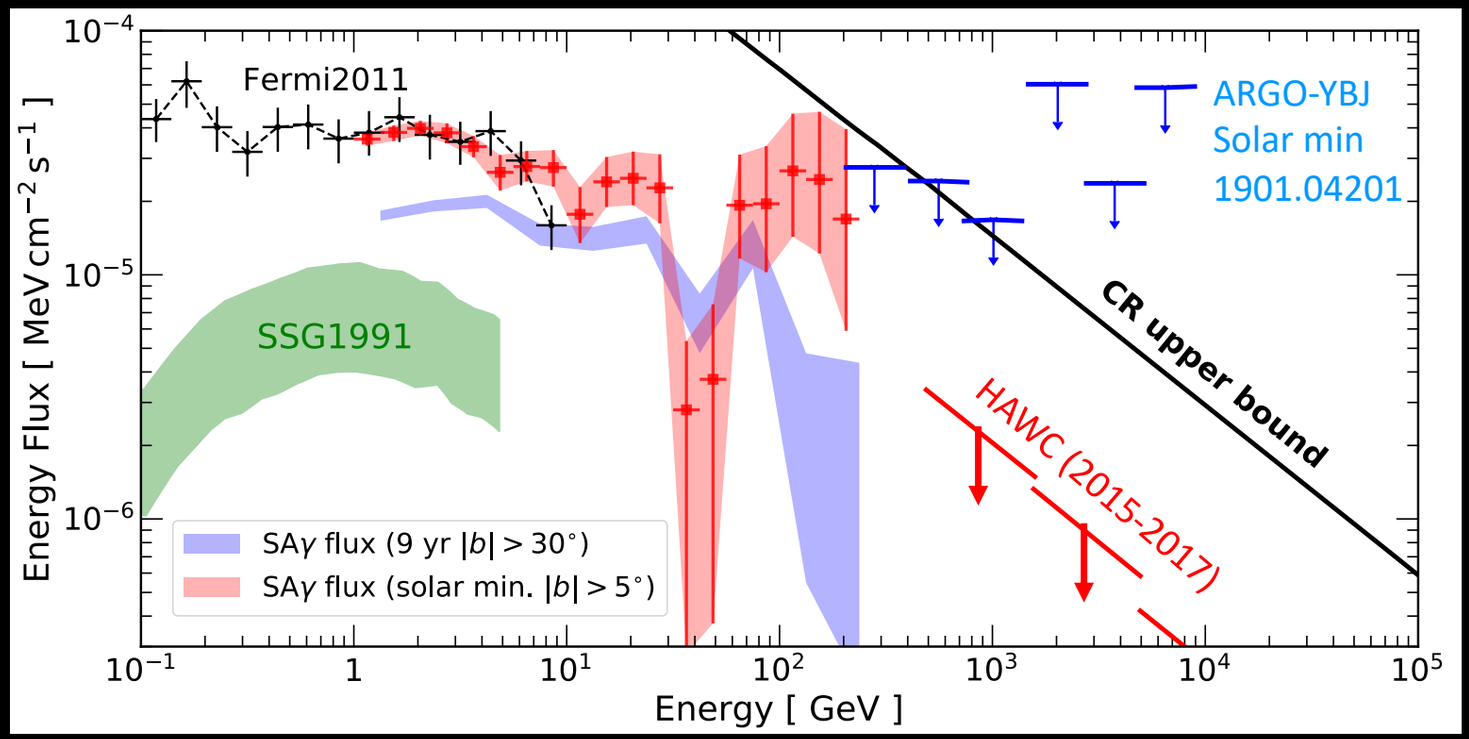
- Abdo+ Apj, 2011
- KCYN+ PRD, 2016
- Linden+ PRL. 2018
- Tang+ PRD, 2018

The Sun as a TeV Source?

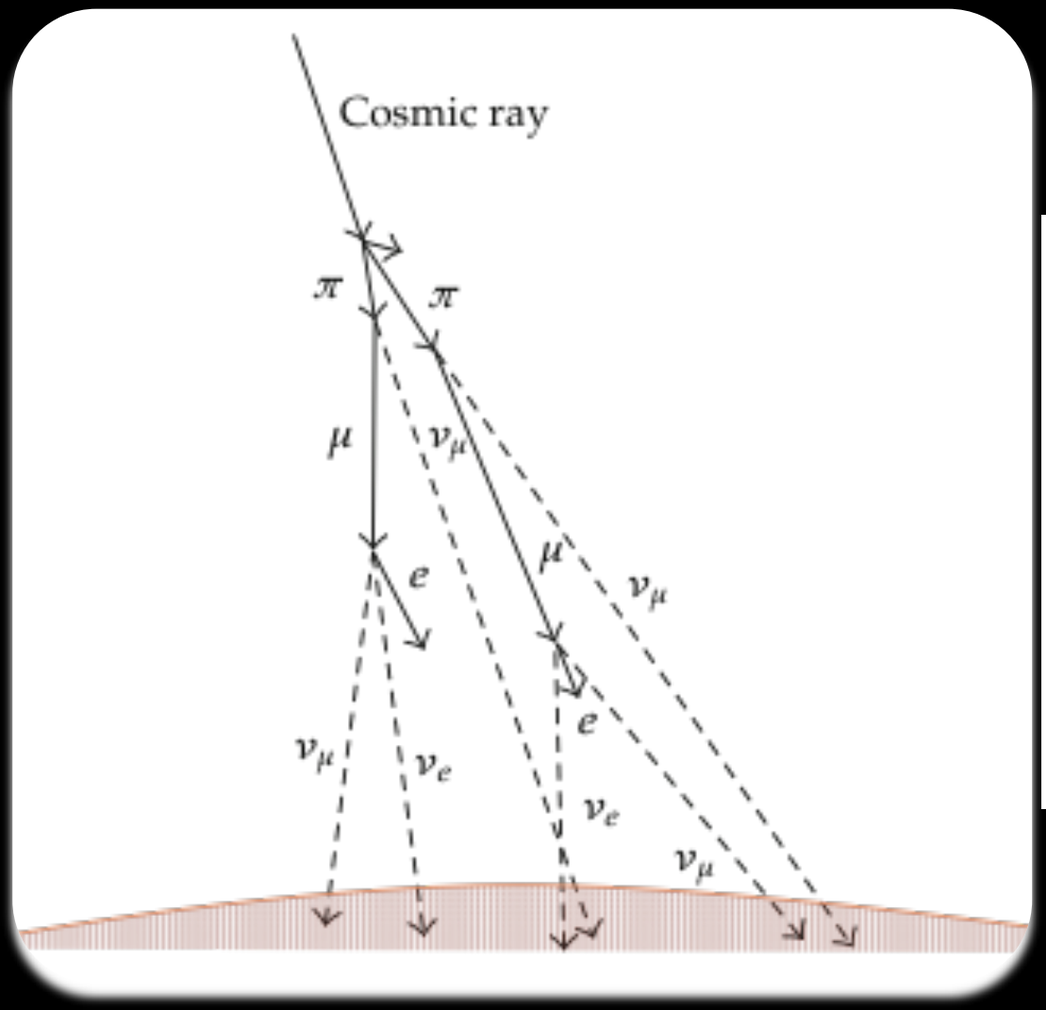
HAWC ICRC2019



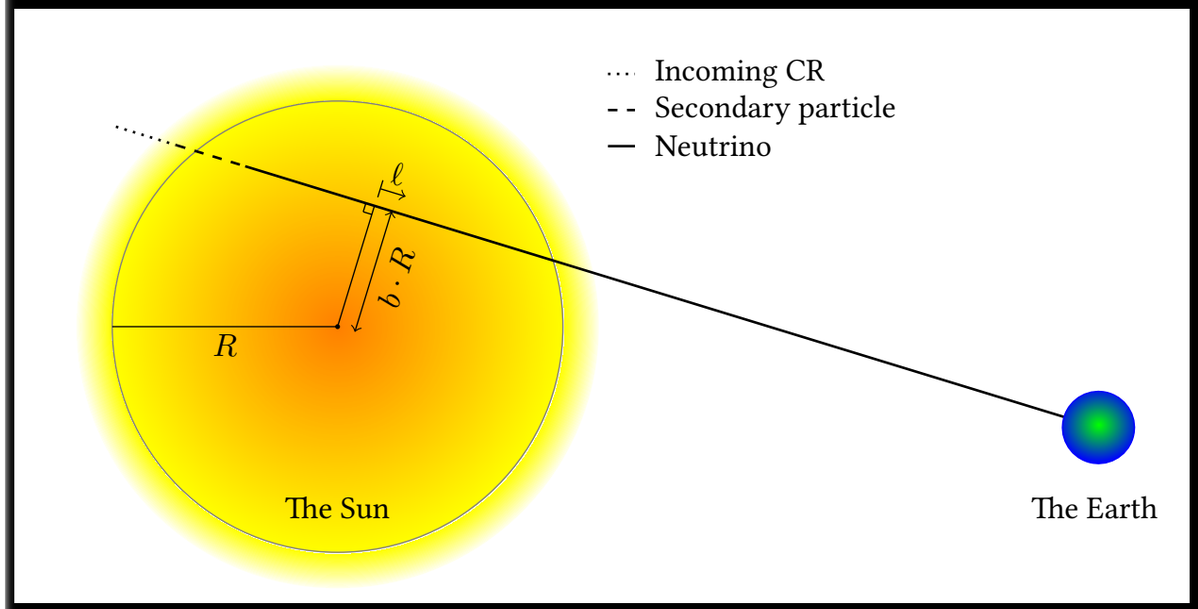




Sun - Astrophysical Neutrino Source



Zero Magnetic Fields!

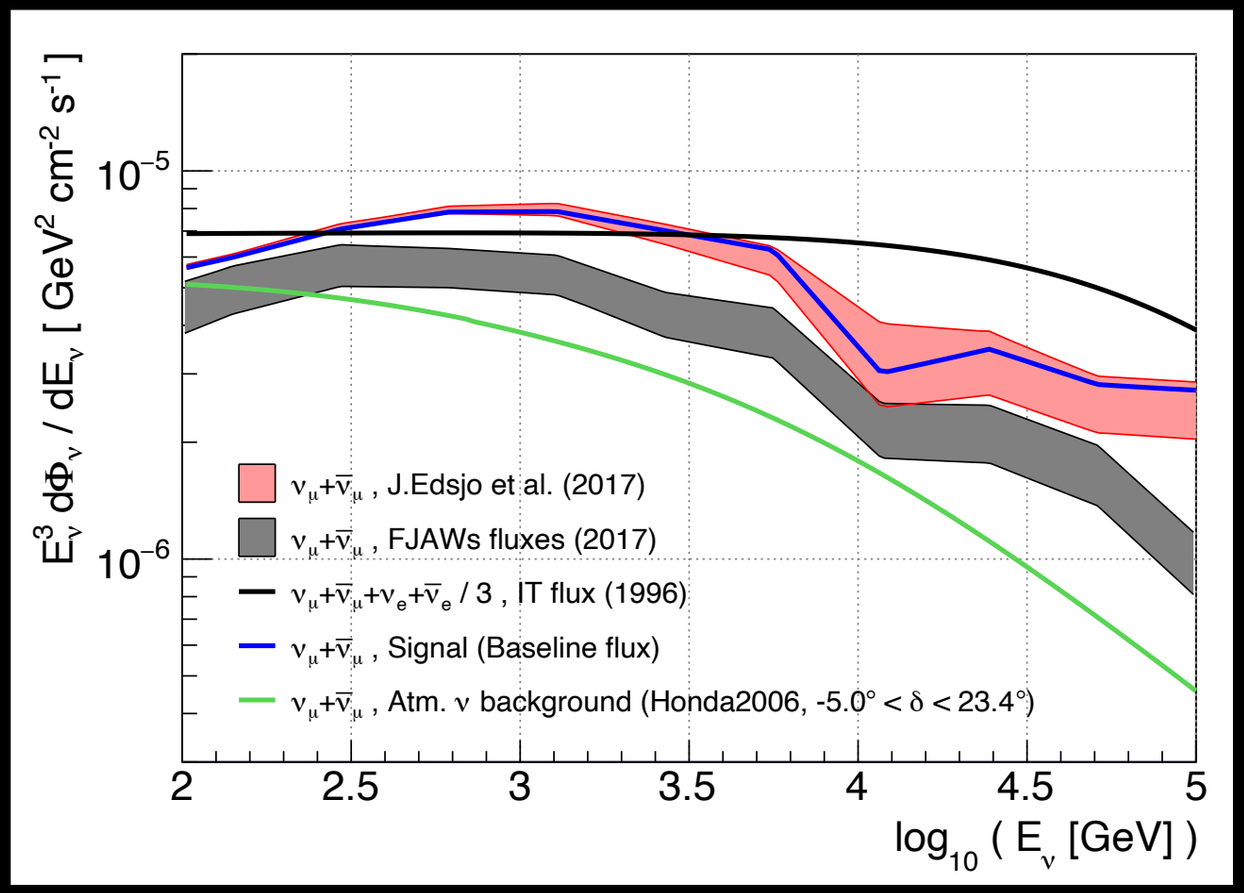


- Dilute atmosphere, larger neutrino flux

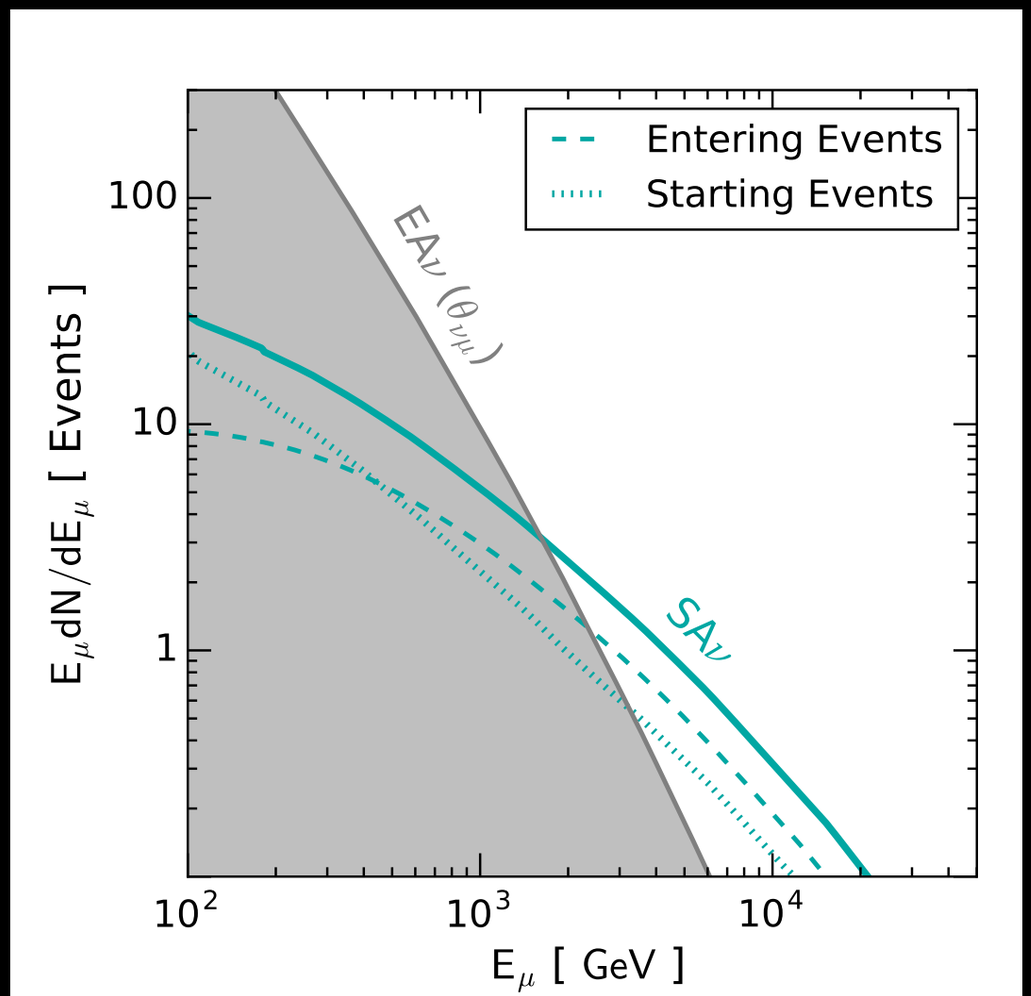
Seckel+ 1991, Moskalenko+, 1993, Ingelman+ 1996, Hettlage+ 2000, Fogli+ 2003

C.A. Argüelles+ 1703.07798
Joakim Edsjo+ 1704.02892

Sun - Astrophysical Neutrino Source

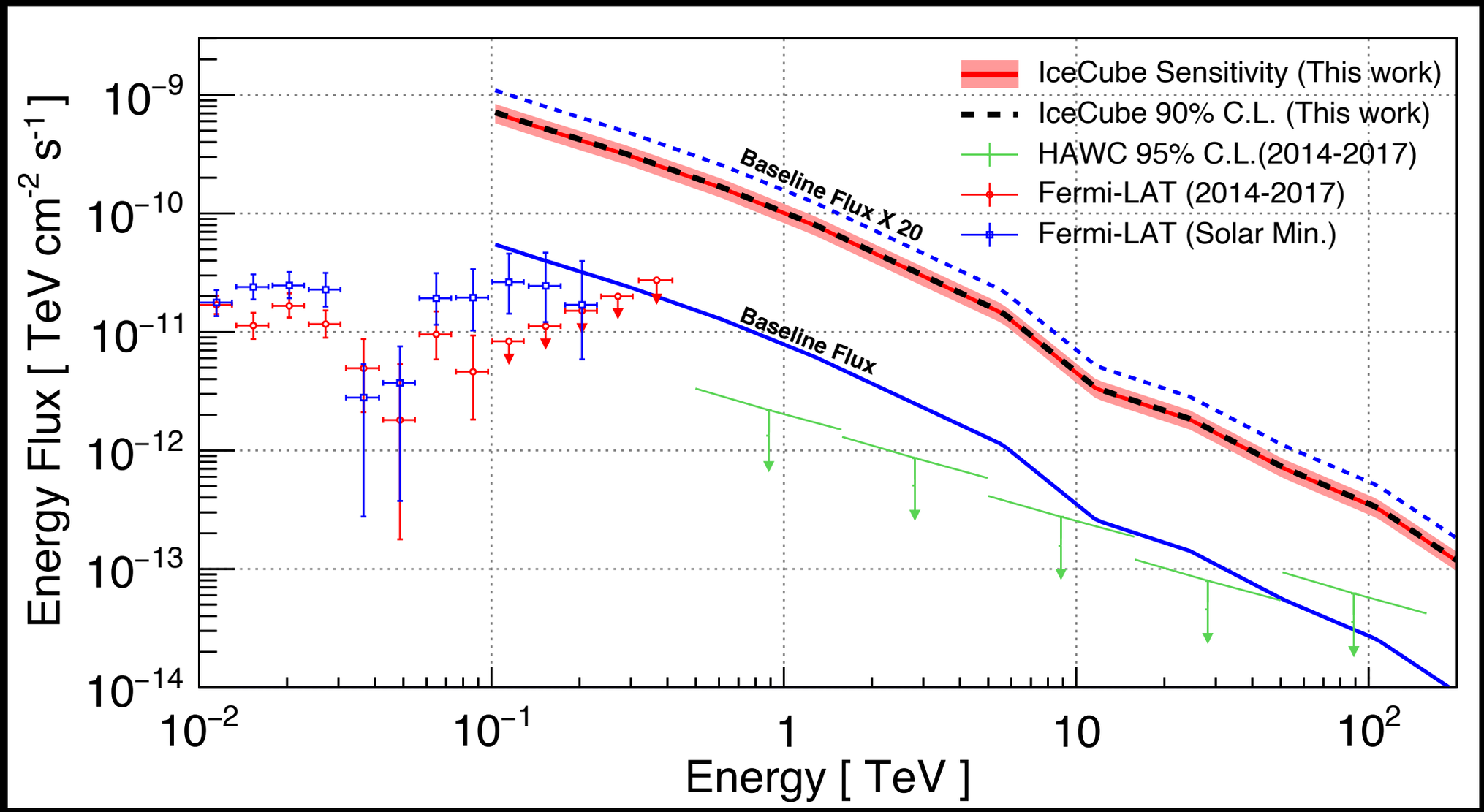


Icecube
1912.13135



KCYN+ 2017

First IceCube search



Not quite sensitive to the benchmark flux yet
- signal too small and too much background

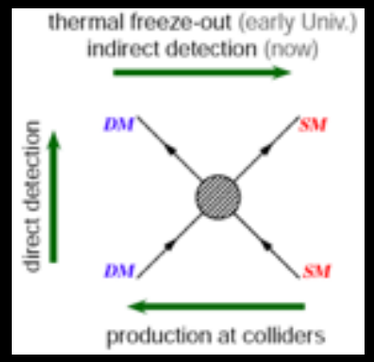
Icecube
1912.13135

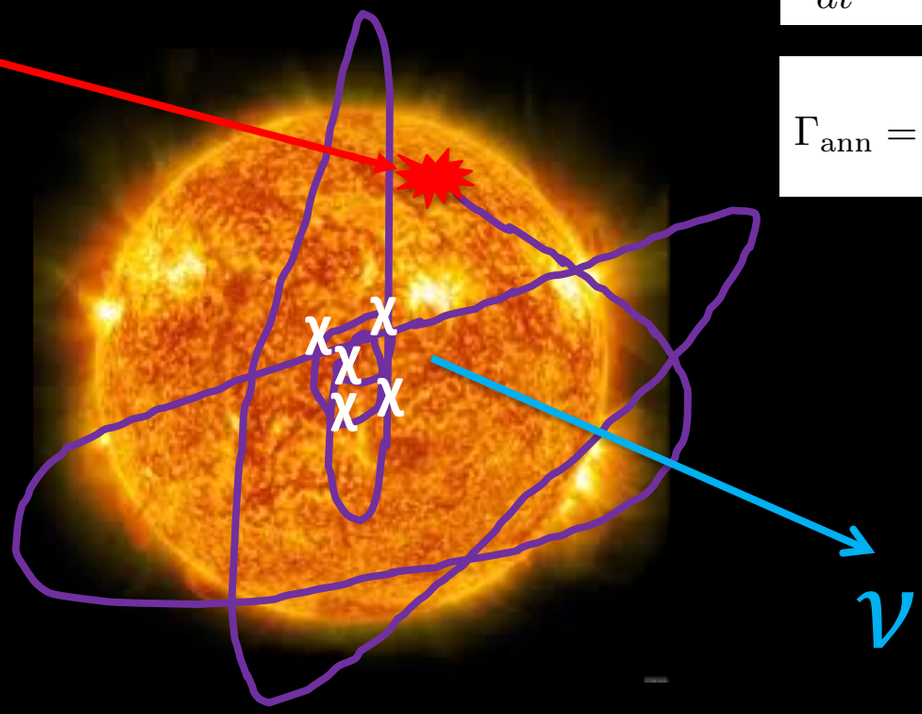
Sun - Dark Matter Detector

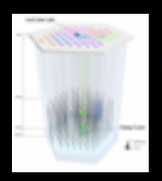
χ

$$\frac{dN}{dt} = \Gamma_{\rm cap} - C_{\rm ann} N^2$$

$$\Gamma_{\rm ann} = \frac{1}{2} C_{\rm ann} N^2 = \frac{1}{2} \Gamma_{\rm cap}$$



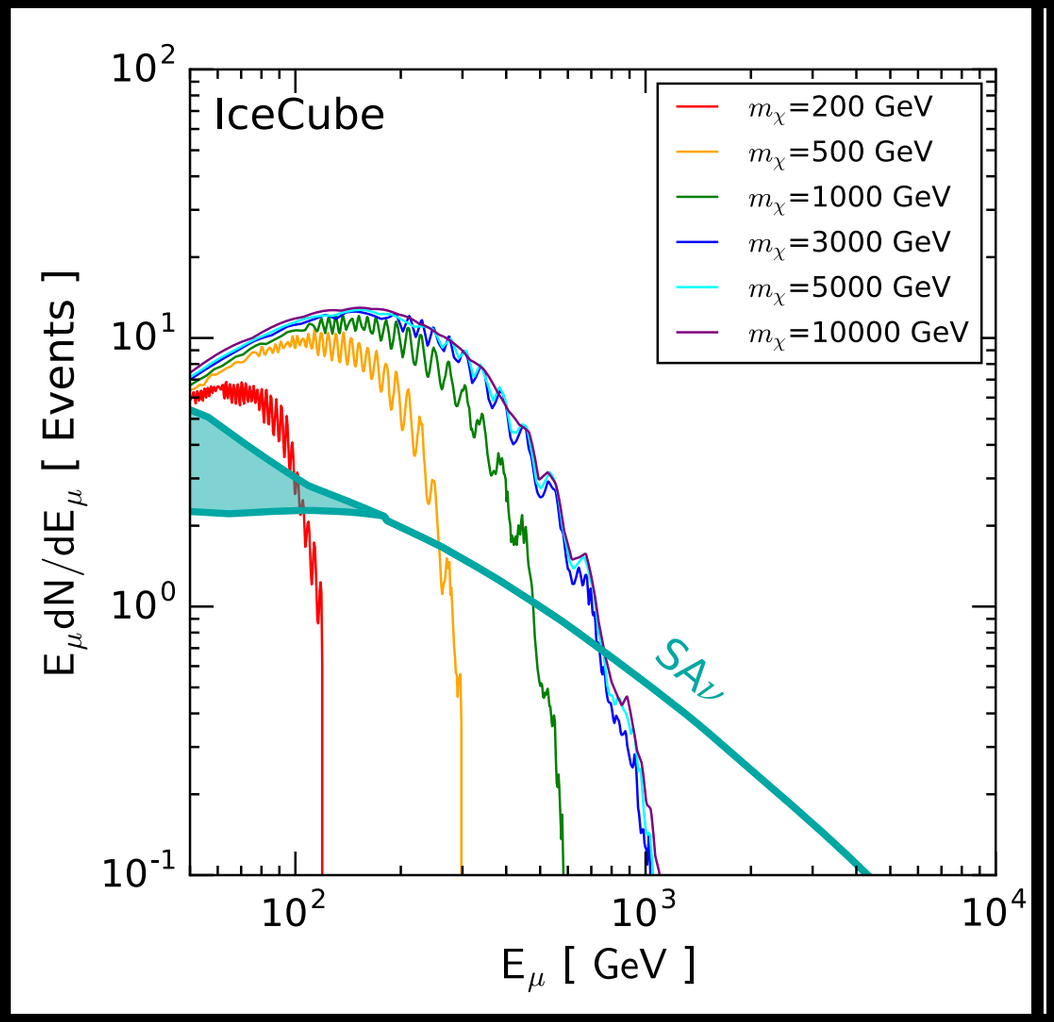


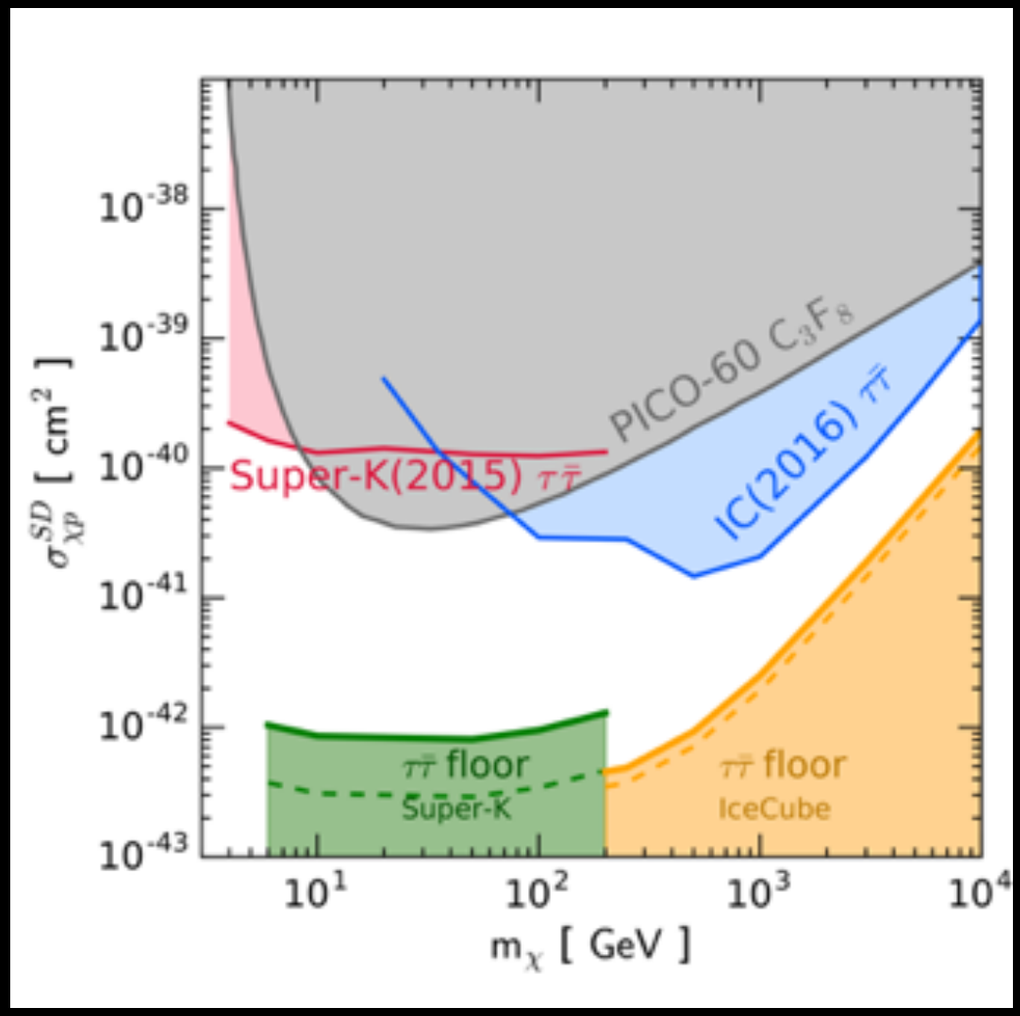


Press, Spergel (1985)
Krauss, Freese, Press, Spergel (1985)
Silk, Olive, Srednicki (1985)

Neutrino telescope the most sensitivity prob for SD cross sections

Sun - Dark Matter Detector





KCYN+ 2017

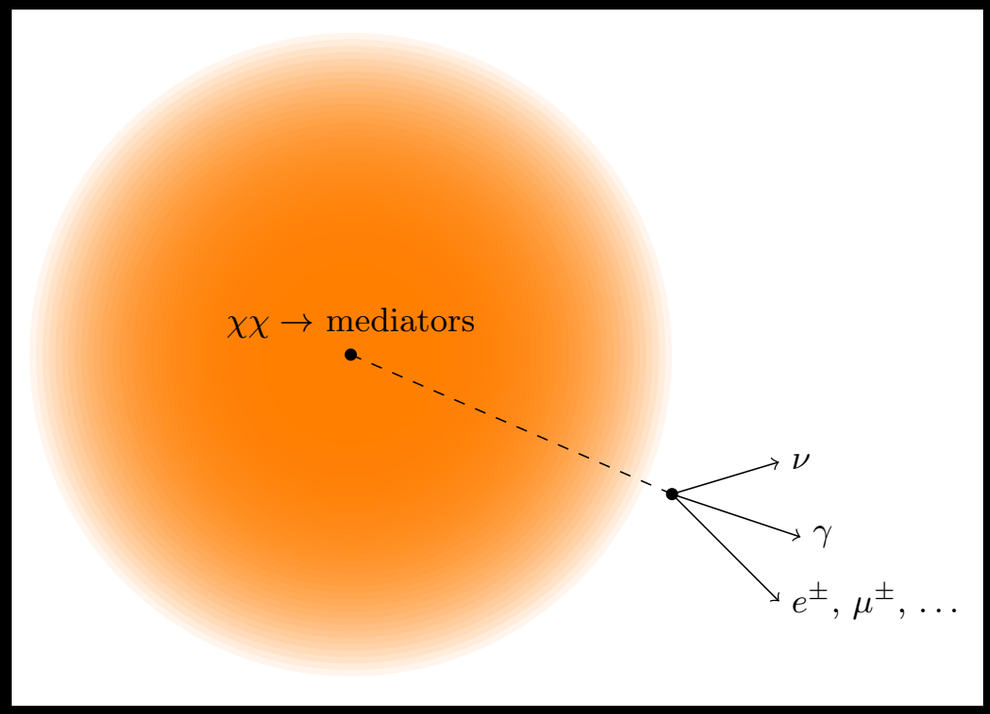
TeV Neutrinos cannot escape the core of the Sun

Sun - Dark Matter Detector

- Unlock
  - Gamma rays
  - Electrons, muon, etc
- Unsuppressed
  - Neutrinos!

- Less absorption (ν)
- Lower density (ν)
- Decay tail (ν, γ)

Leane, KCYN, Beacom 1703.04629

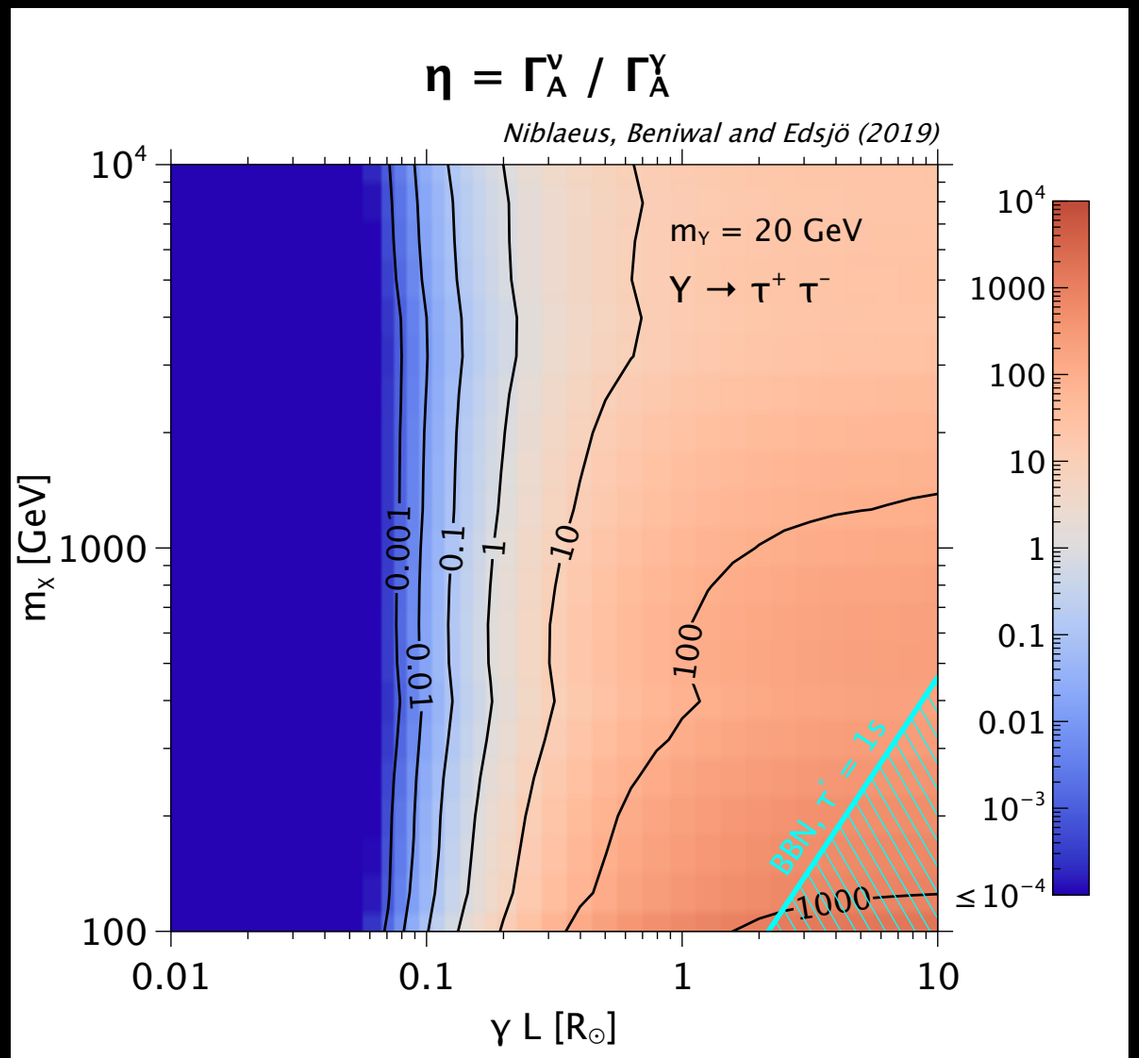


Batell, Pospelov, Ritz, Shang, 0910.1567
Bell, Petraki, 1102.2958
Feng, Smolinsky, Tanedo, 1602.01465
Arina, Backovic, Heisig, Lucente, 1703.08087

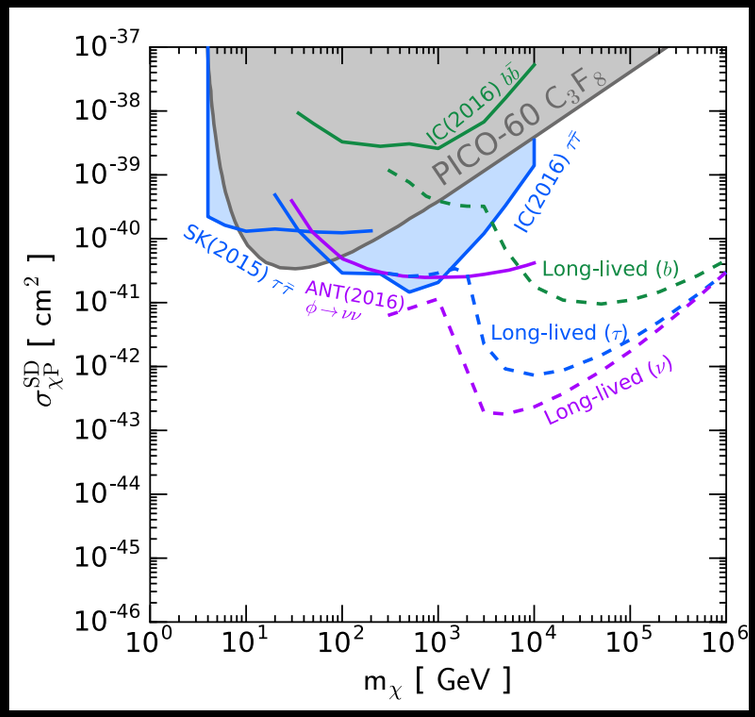
Niblaeus, Beniwal, Edsjo, 1903.11363
etc

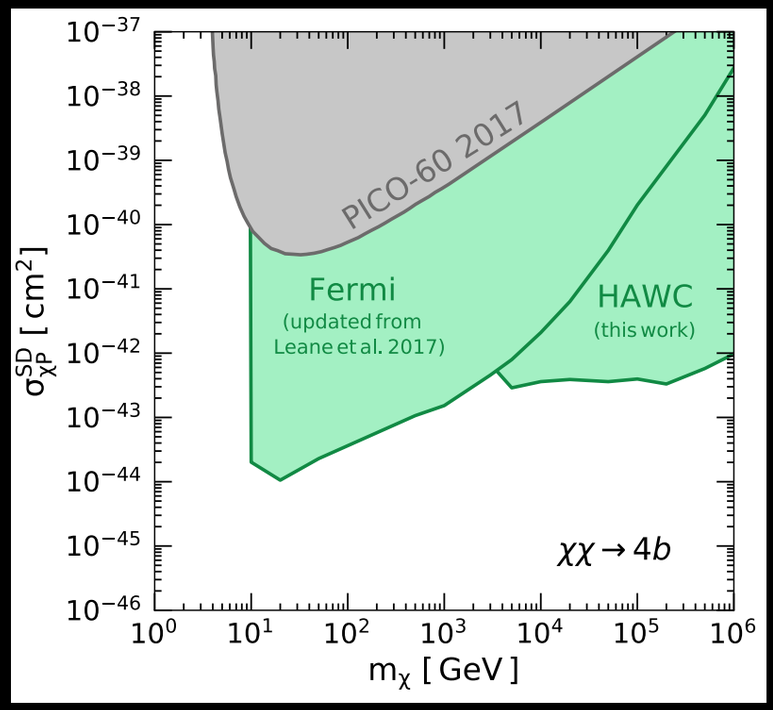
Synergy between gamma rays and Neutrinos

Niblaeus, Beniwal, Edsjo, 1903.11363



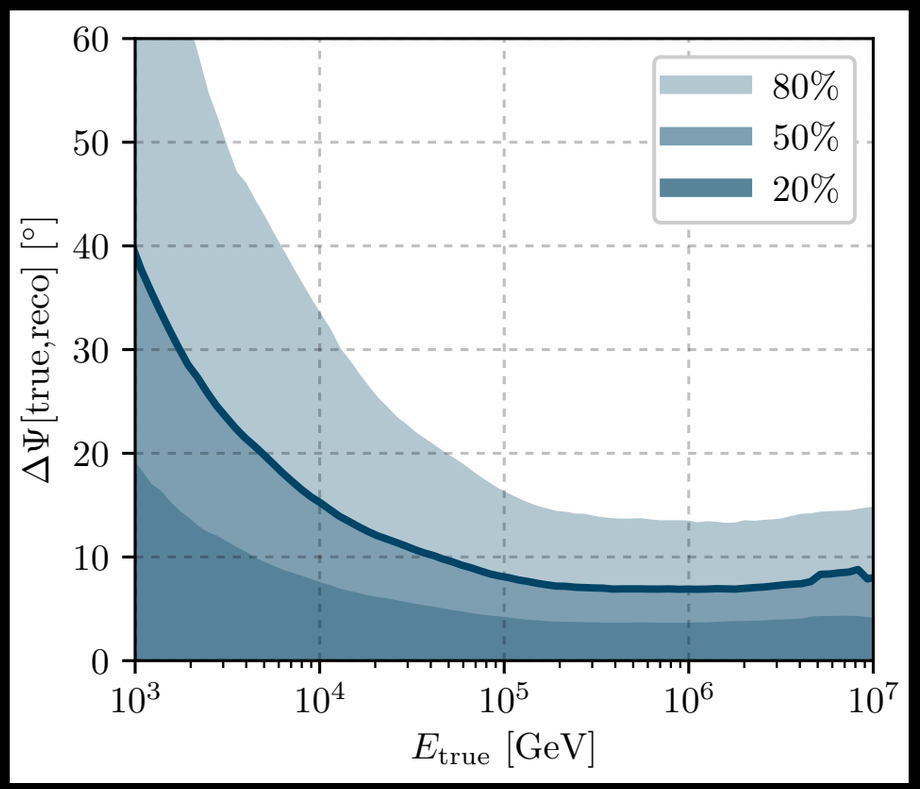
Neutrinos <— — —> gamma rays
mediator decay length

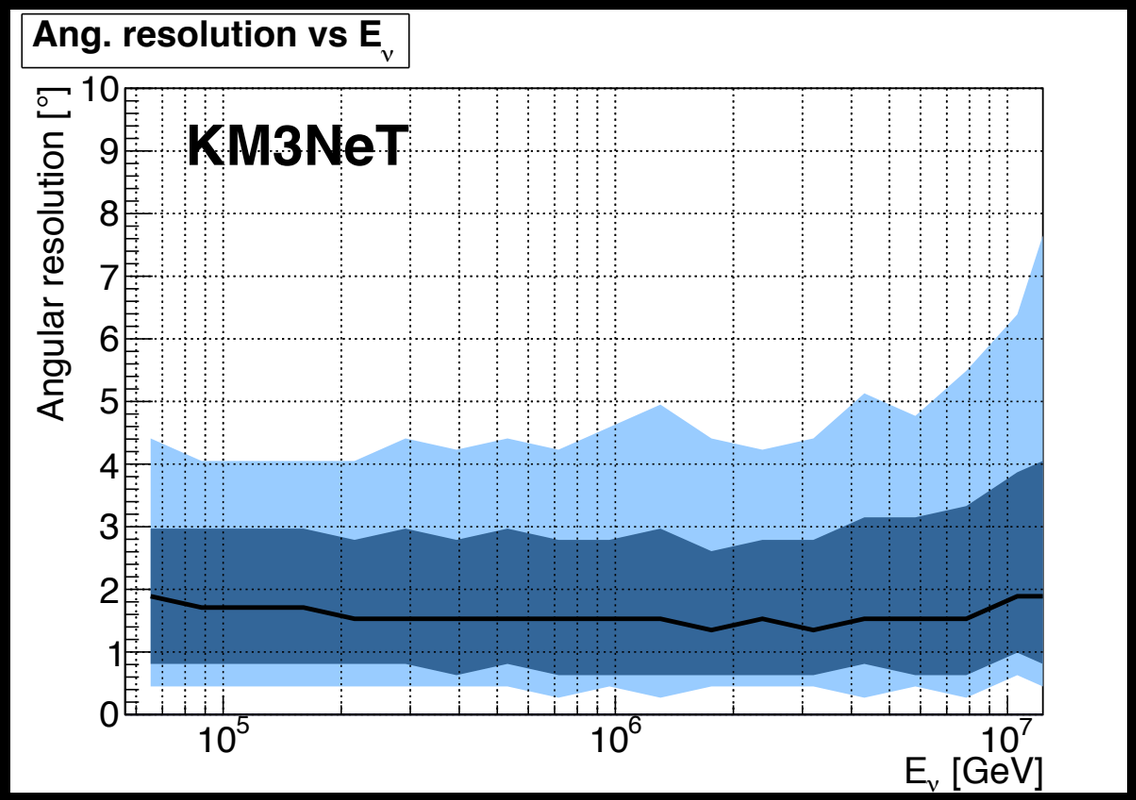




Solar ATM neutrinos- The case for KM3NeT

IceCube
https://arxiv.org/abs/1907.06714





Much better angular resolution!

+ lower atmospheric neutrino background
+ similar signal strength

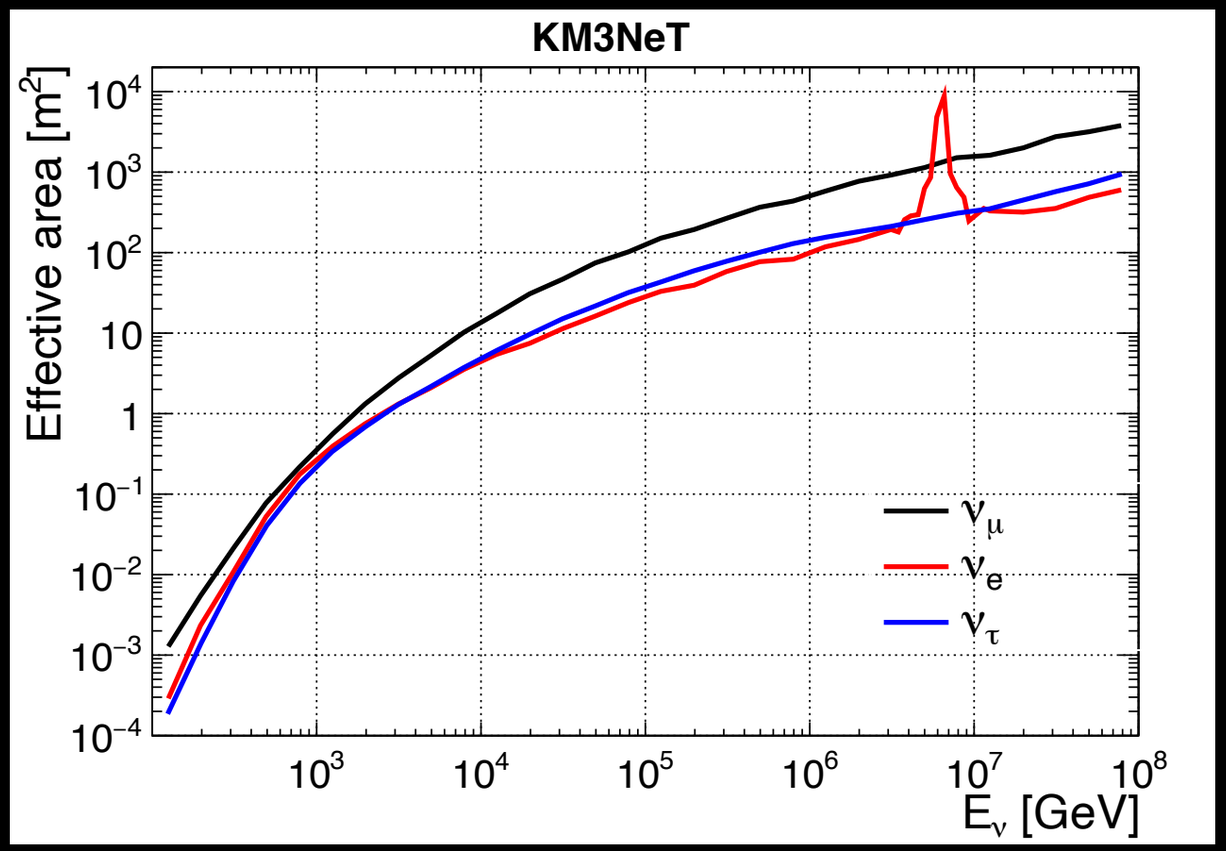
sensitivity comparable to tracks

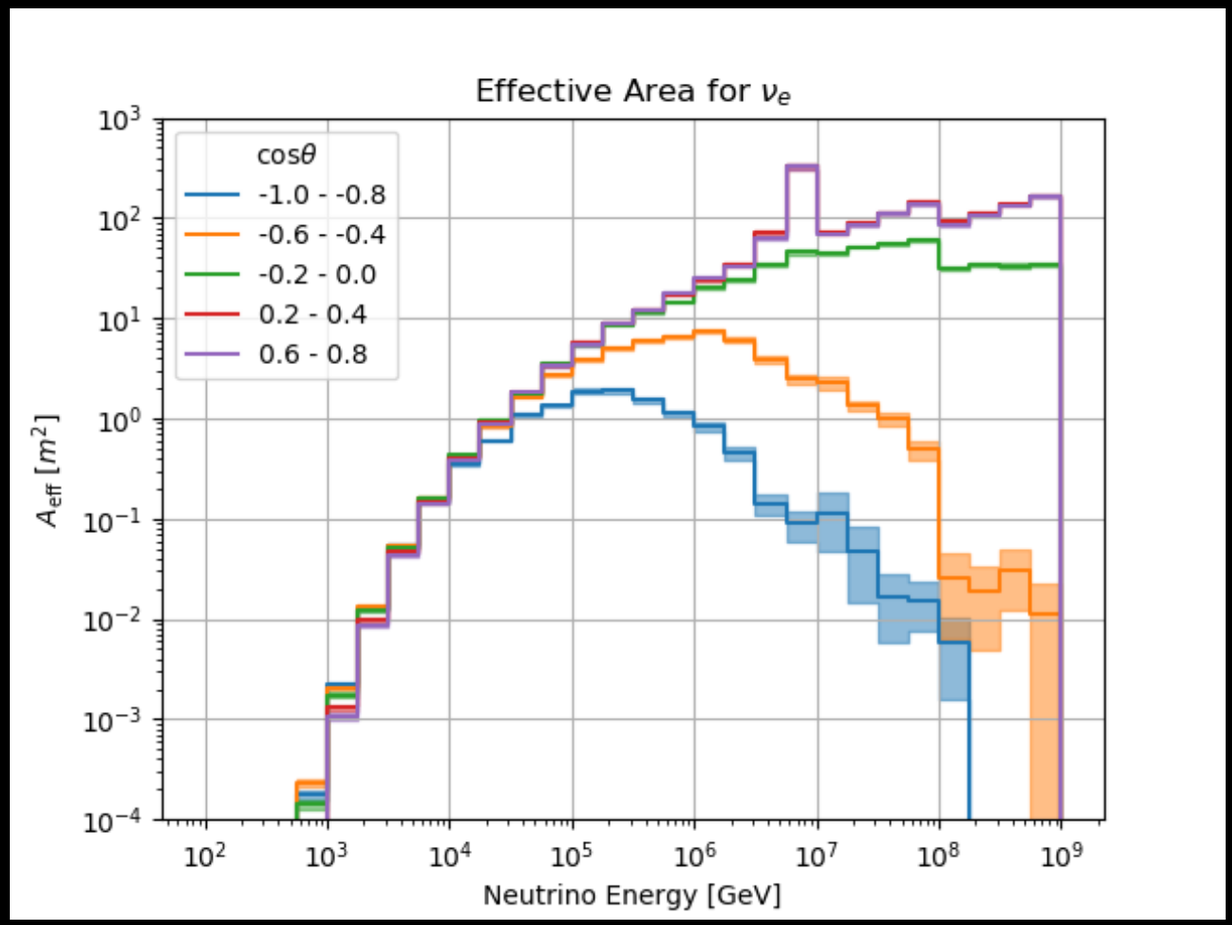
+ intrinsically much better energy resolution

KM3NeT — The power of cascades?

IceCube 2015

letter of intent





10x larger effective area at 100 TeV?

ITFA workshop 2020:
Searching for DM decays with KM3NeT

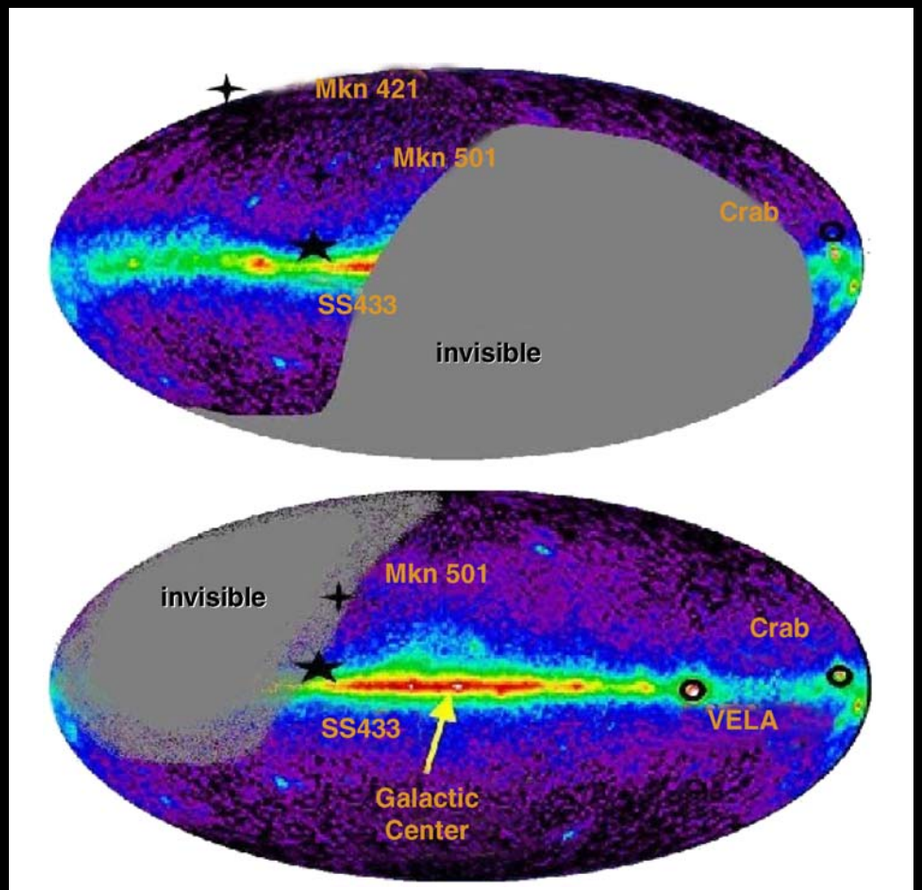


Fig. 1. Field of view of a neutrino telescope at the South Pole (top) and in the Mediterranean (bottom), given in galactic coordinates. A 2π-downward sensitivity is assumed; the grey regions are then invisible. Indicated are the positions of some candidate neutrino sources.