TAMBO:

Searching for astrophysical ν_τ in the Andes

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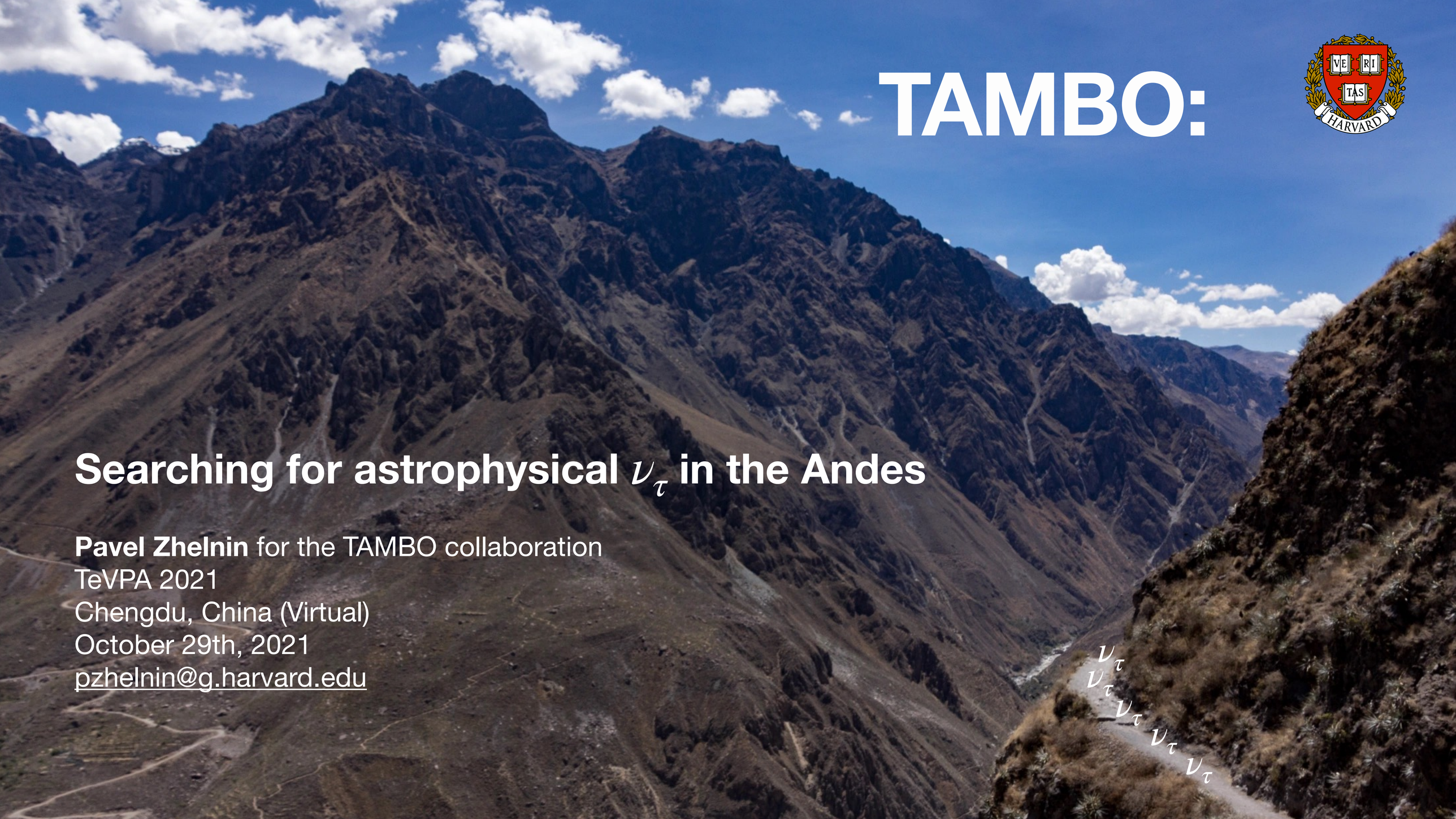
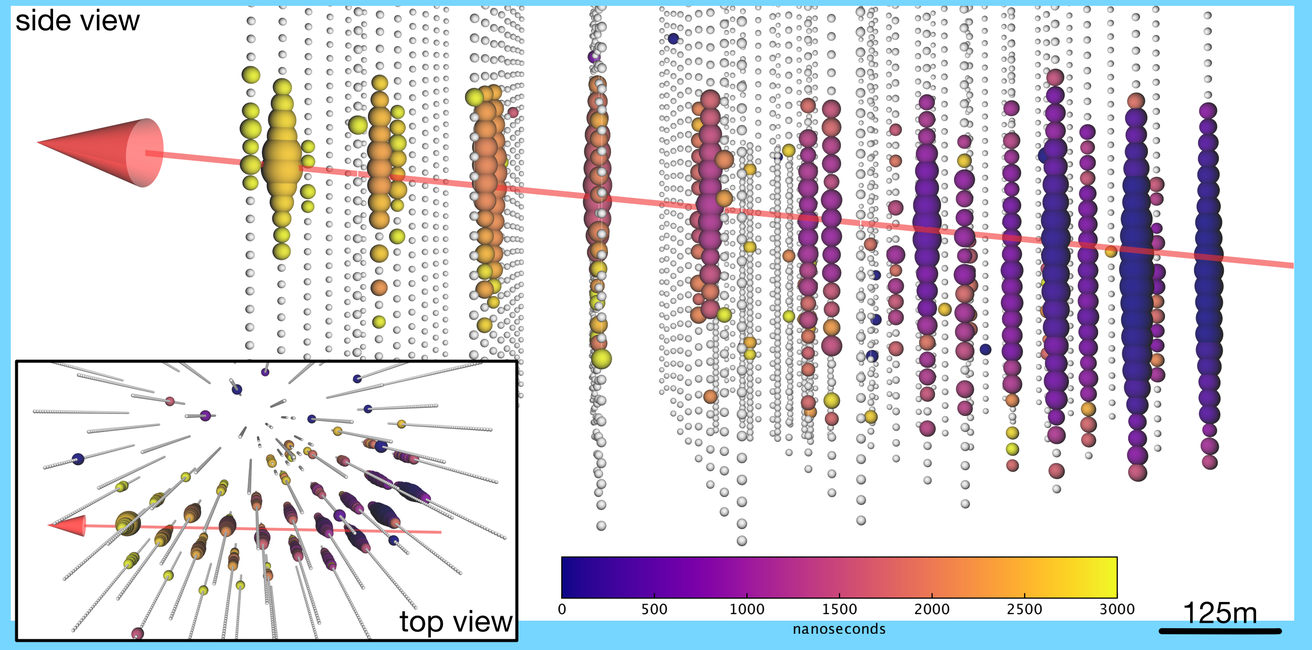


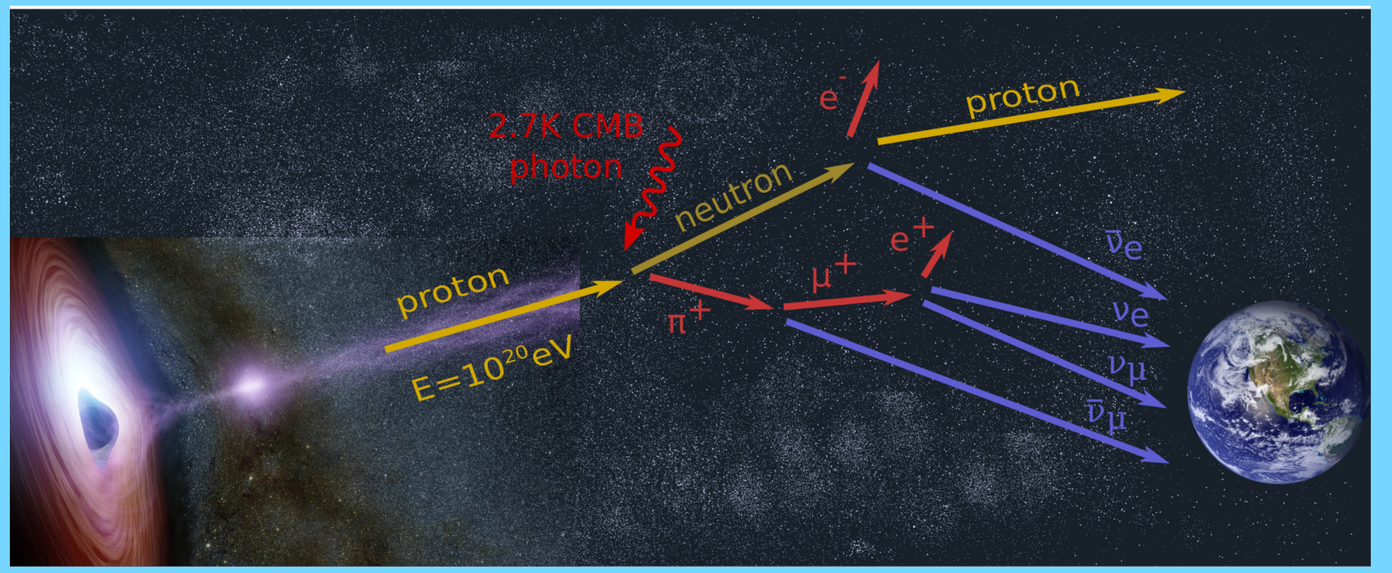
A Decade of Progress:

Astrophysical neutrinos

- Recap:
  - Discovery of diffuse astrophysical neutrino flux
  - Handful of 1-10 PeV neutrinos
  - Extragalactic neutrinos!
  - First hints of neutrino sources.



IceCube, arXiv:1807.08816v1



Otte et al., arXiv:1907.08727

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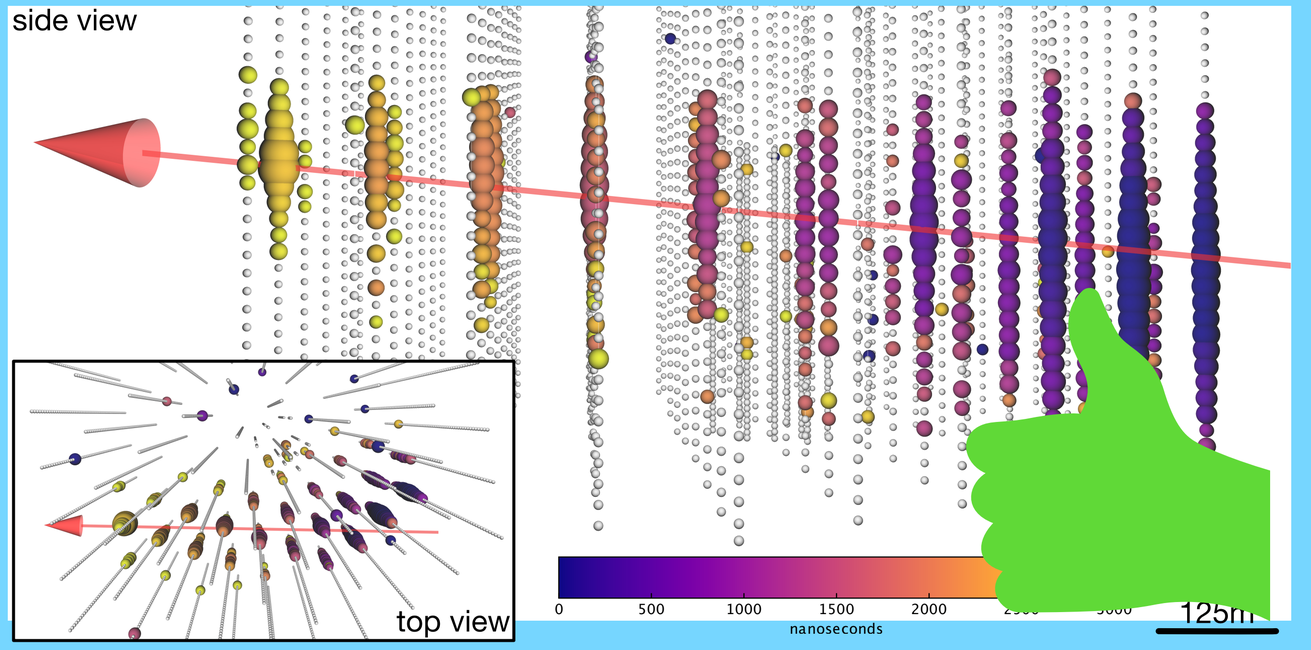

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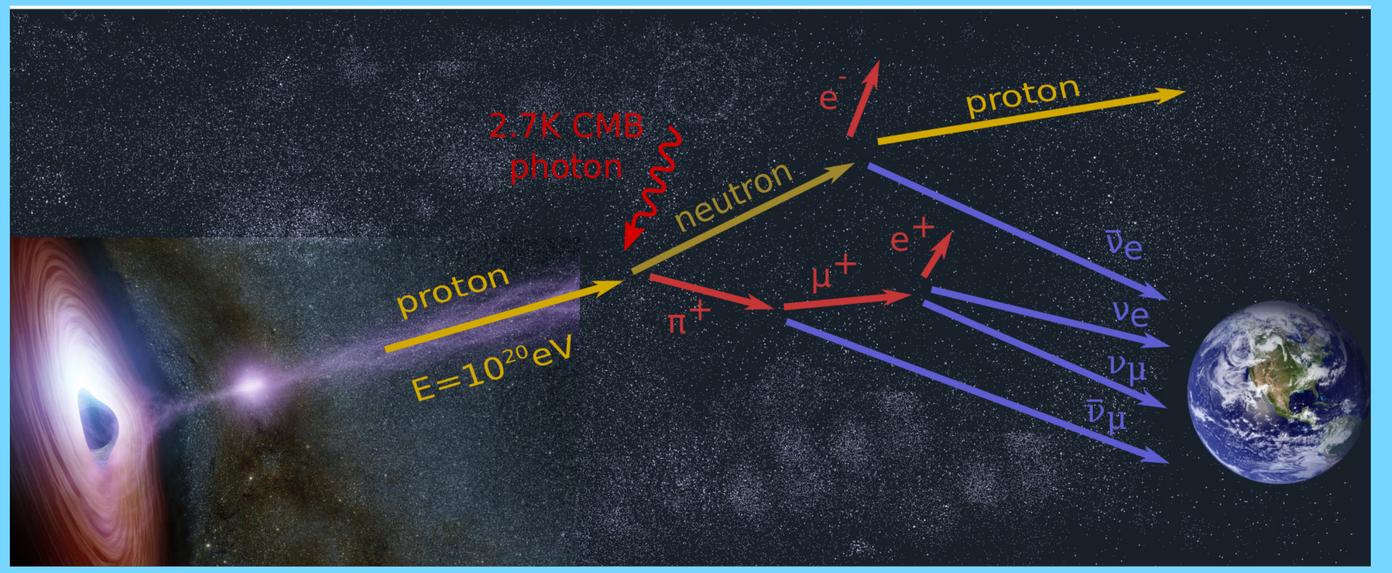

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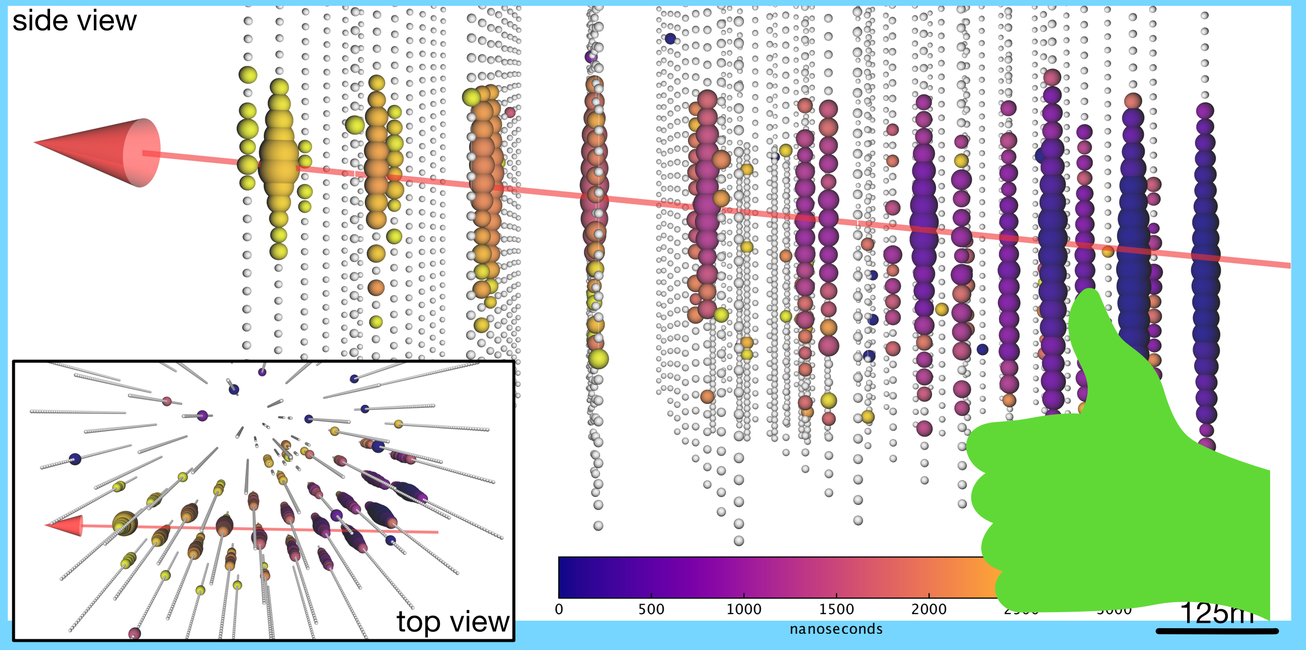
- Great! but…



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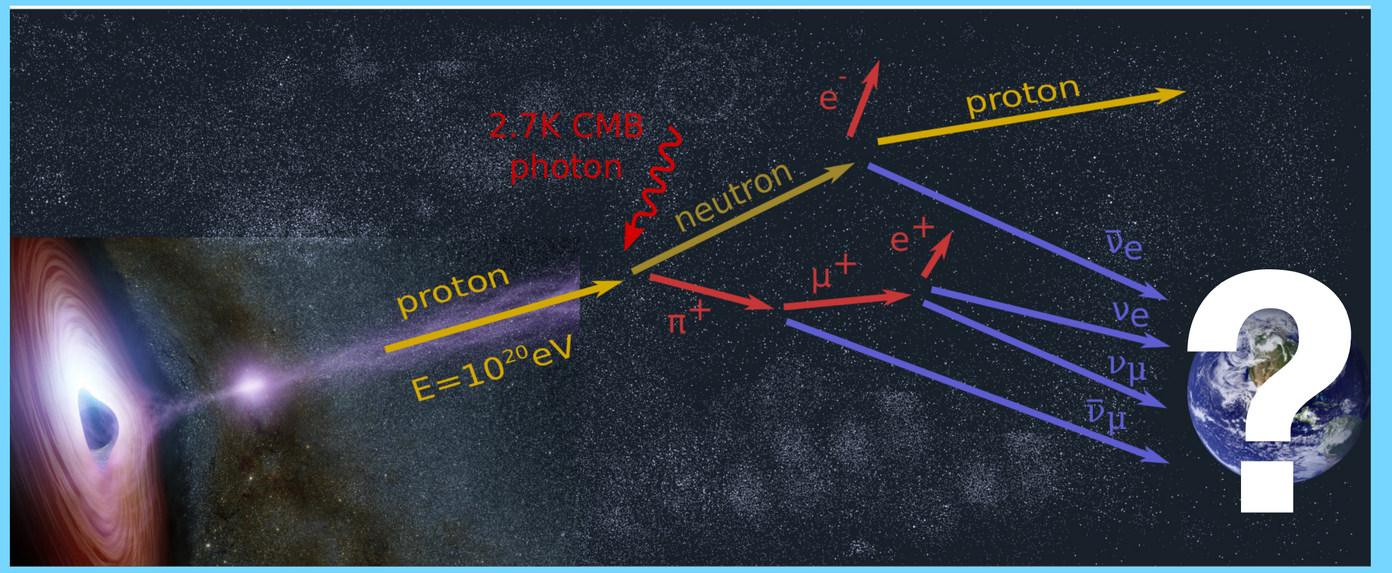

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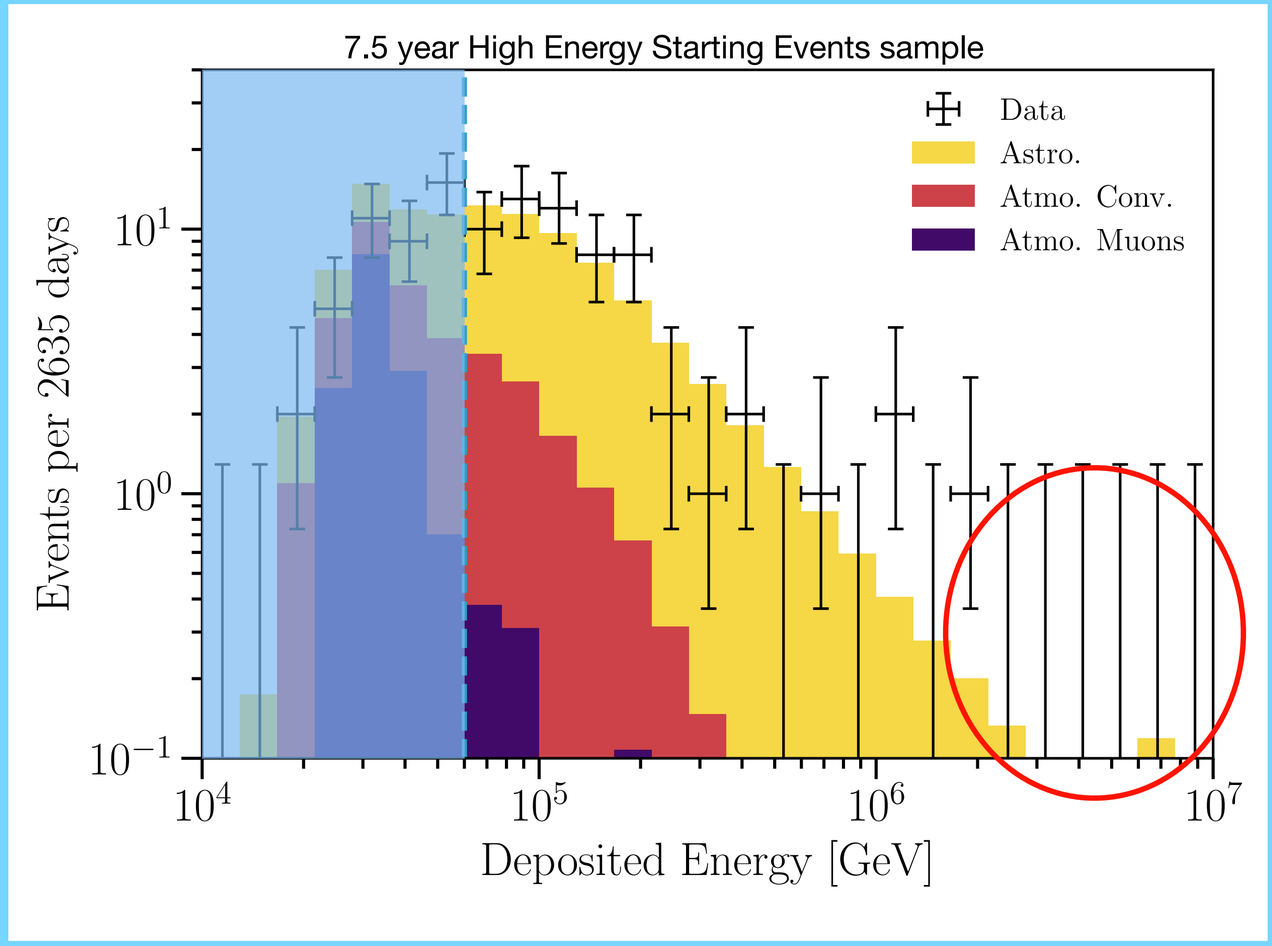
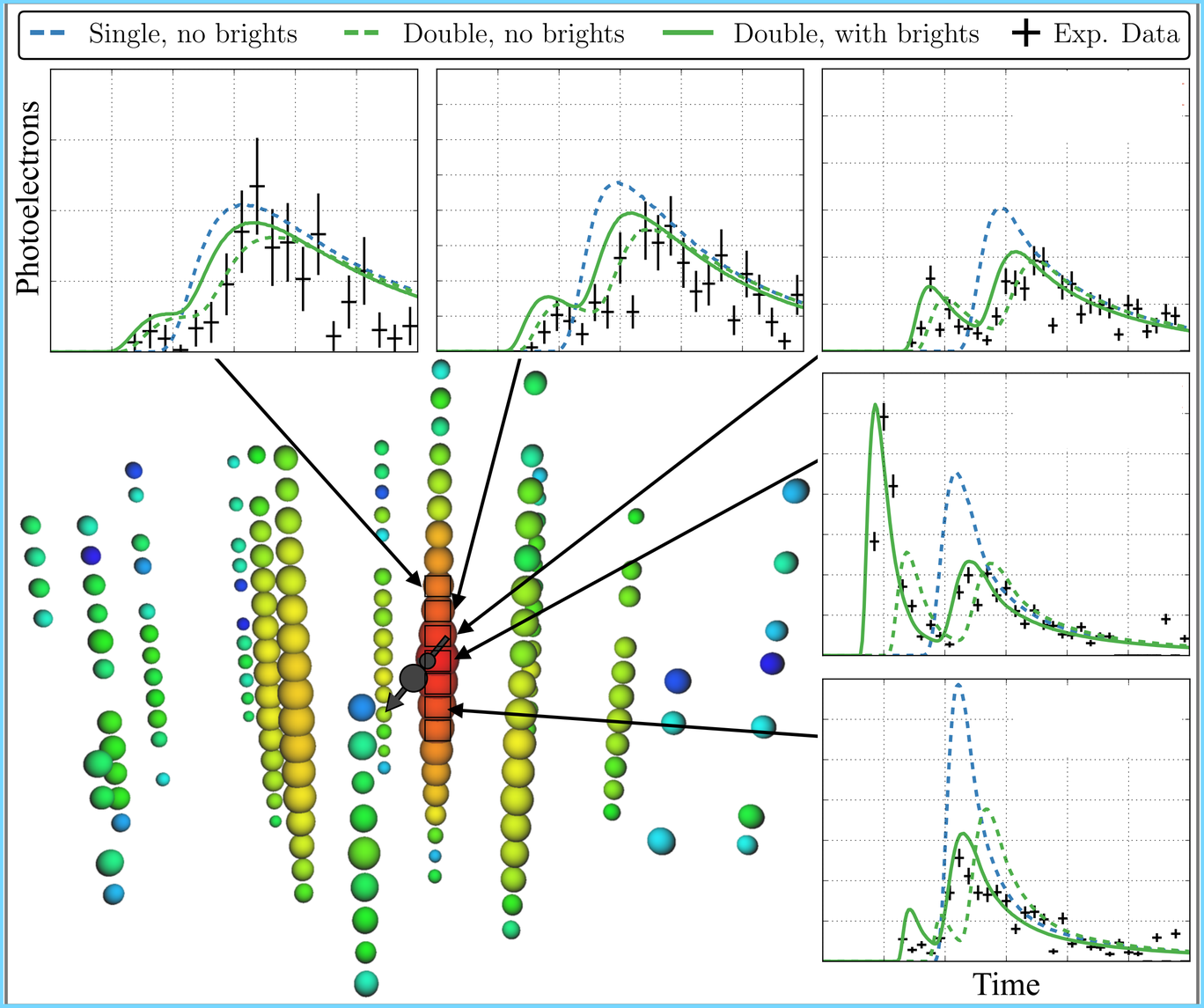
What about HE astro ν_τ?

Shortcomings so far:

- We don't know how the astrophysical flux extends to higher energies
- Low point source sensitivity for ν flux
- Low statistics for HE astro ν_τ
  - Only two candidates in 10 years



IceCube, arXiv:2011.03545v1



IceCube et al., arXiv:2011.03561

Problems with detecting ν_τ

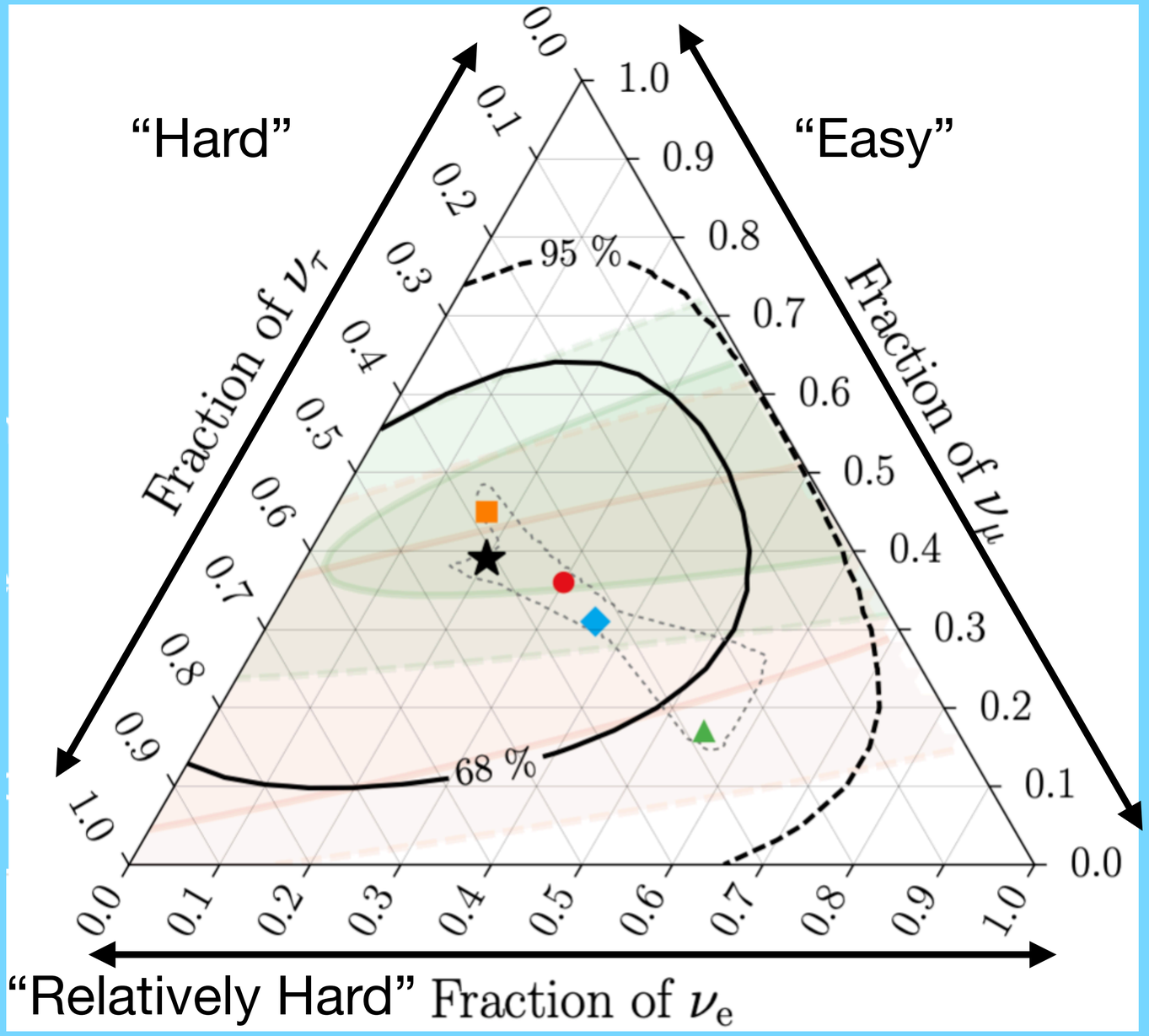
Limits in morphology:

- IceCube can detect muon events well but electrons/taus are troublesome
  - Muon will create a track = identifiable
  - Tau = double bang
  - Electron = shower
  - See talk by Doug Cowen in this session

Why this matters

HESE Flavor measurement

- SM predicts observable flavor ratio within the butterfly ~ (1:1:1)
- Outside this butterfly indicates new physics
- At the moment, flavor measurement is severely limited by tau fraction



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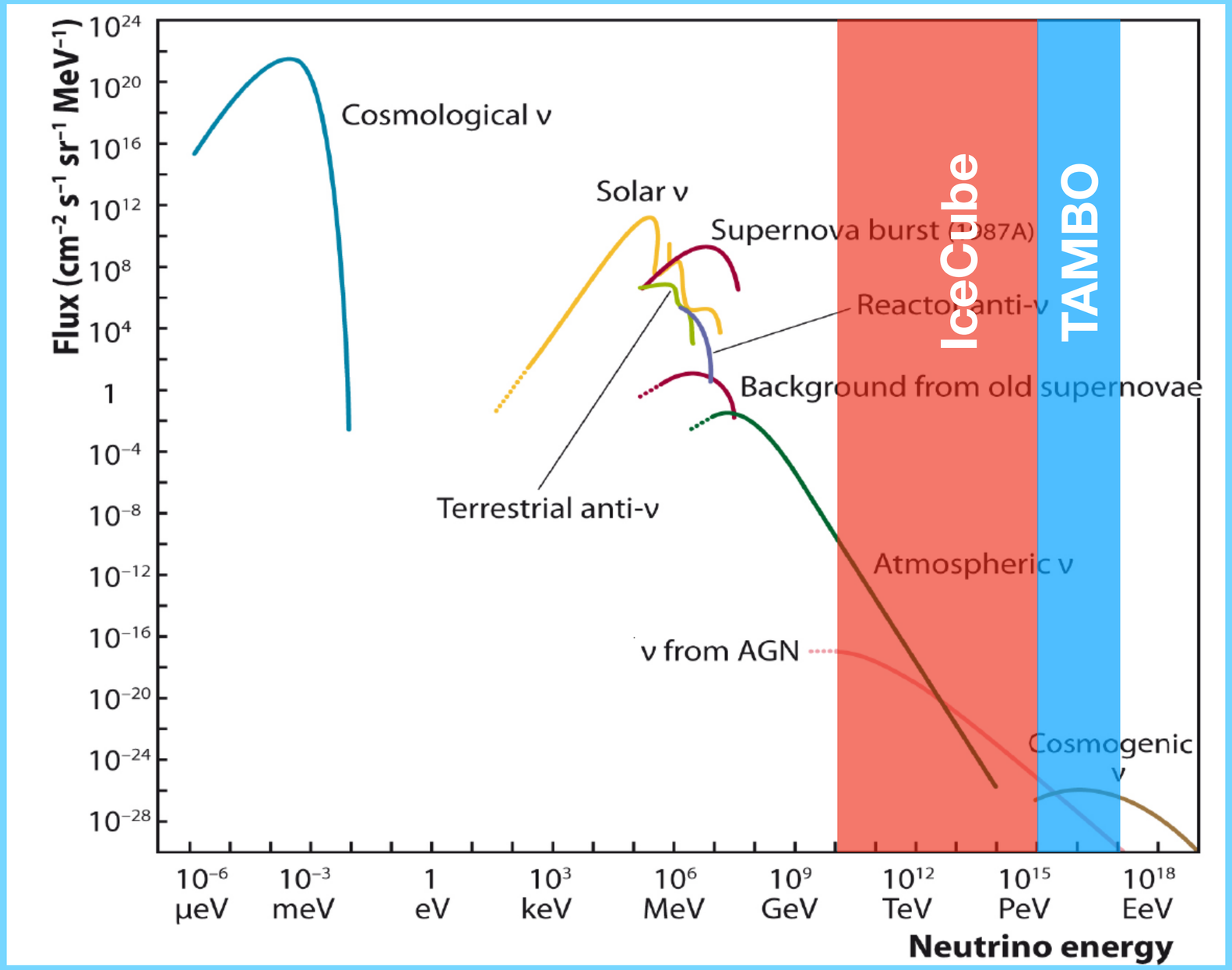
TAMBO!

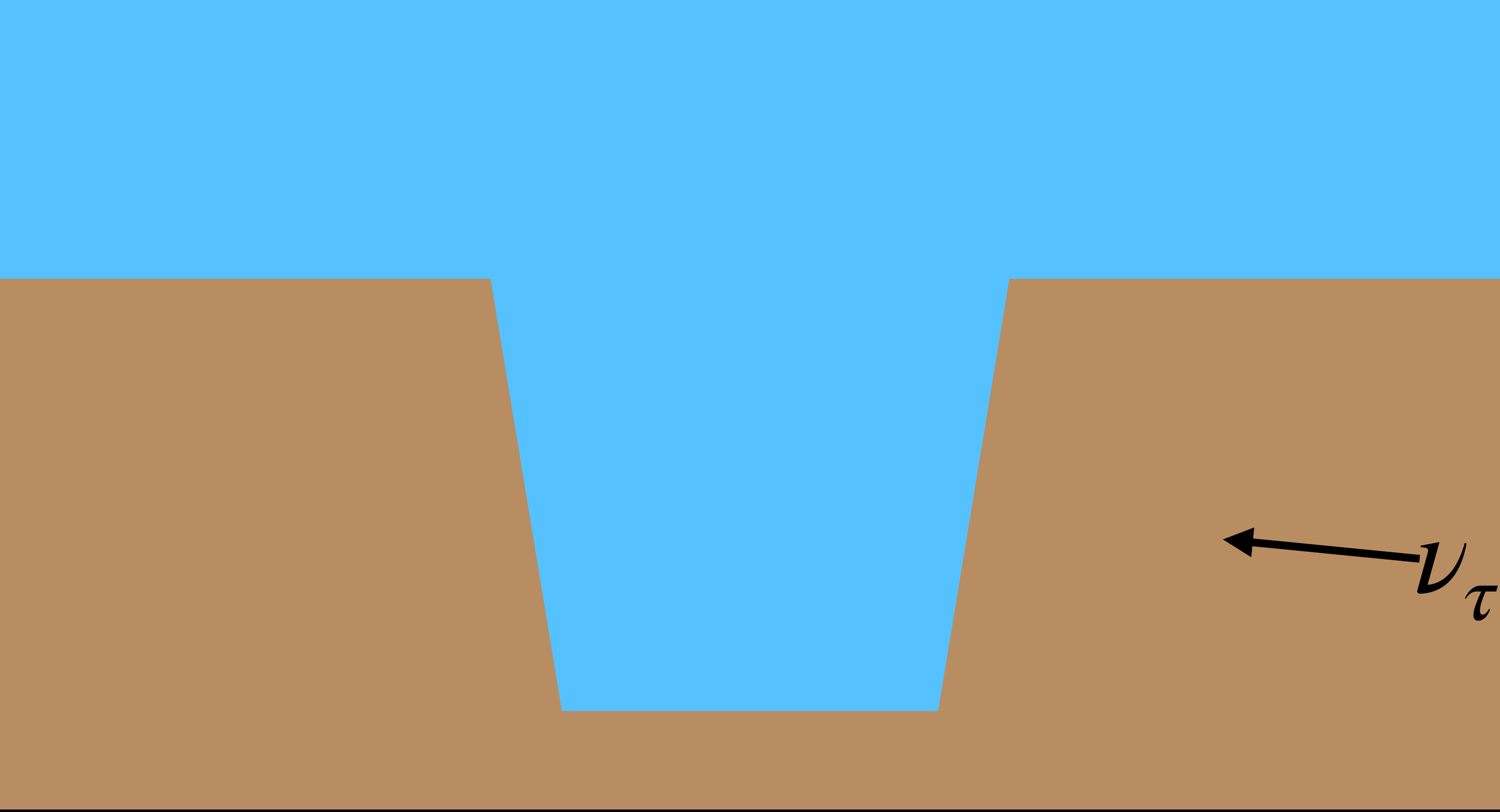
Tau Air Shower Mountain-Based Observatory

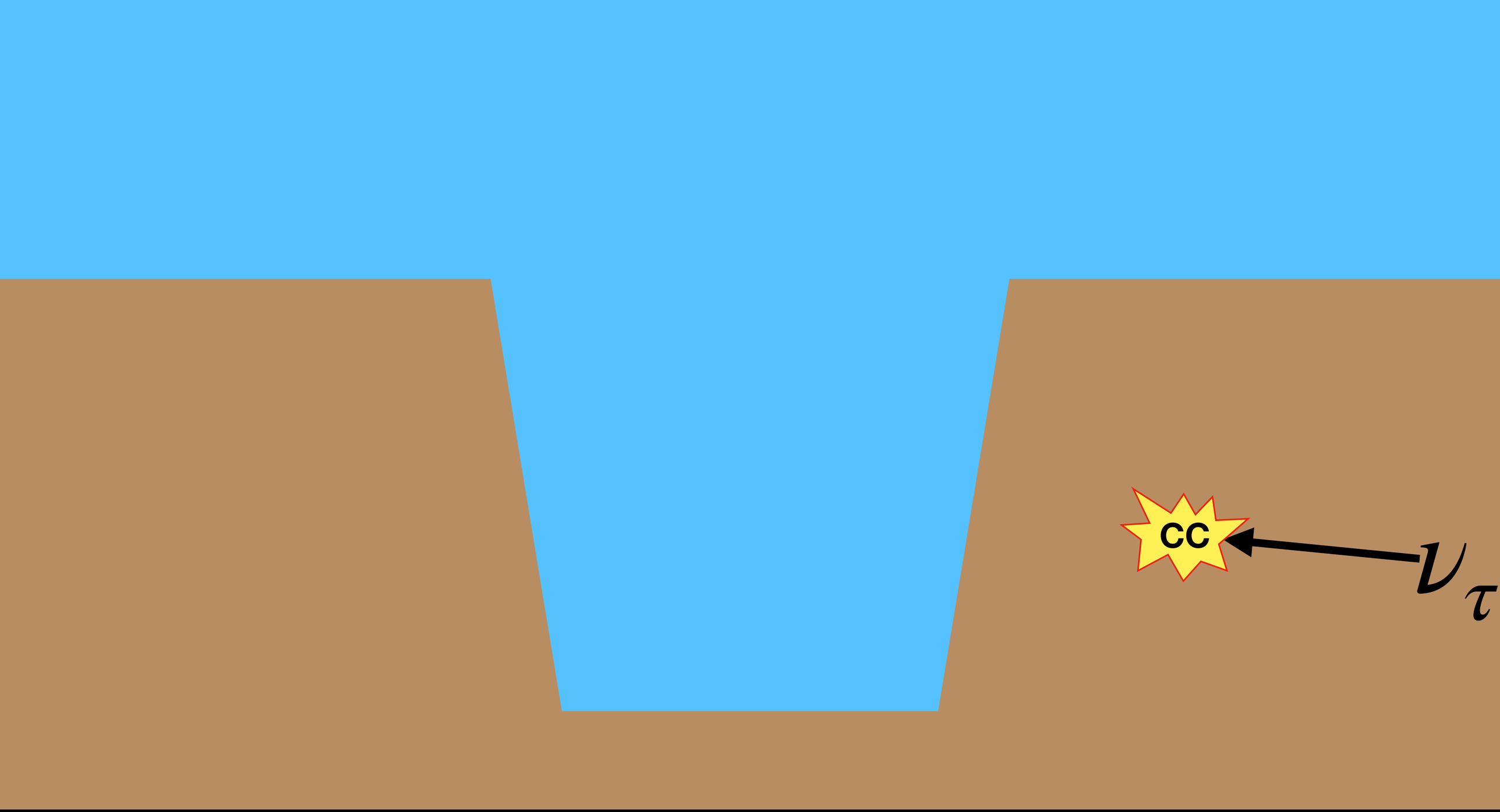
- A deep-valley ν_τ detector to be deployed in the Colca Valley in Peru
- ν_τ detection in the 1-100 PeV band

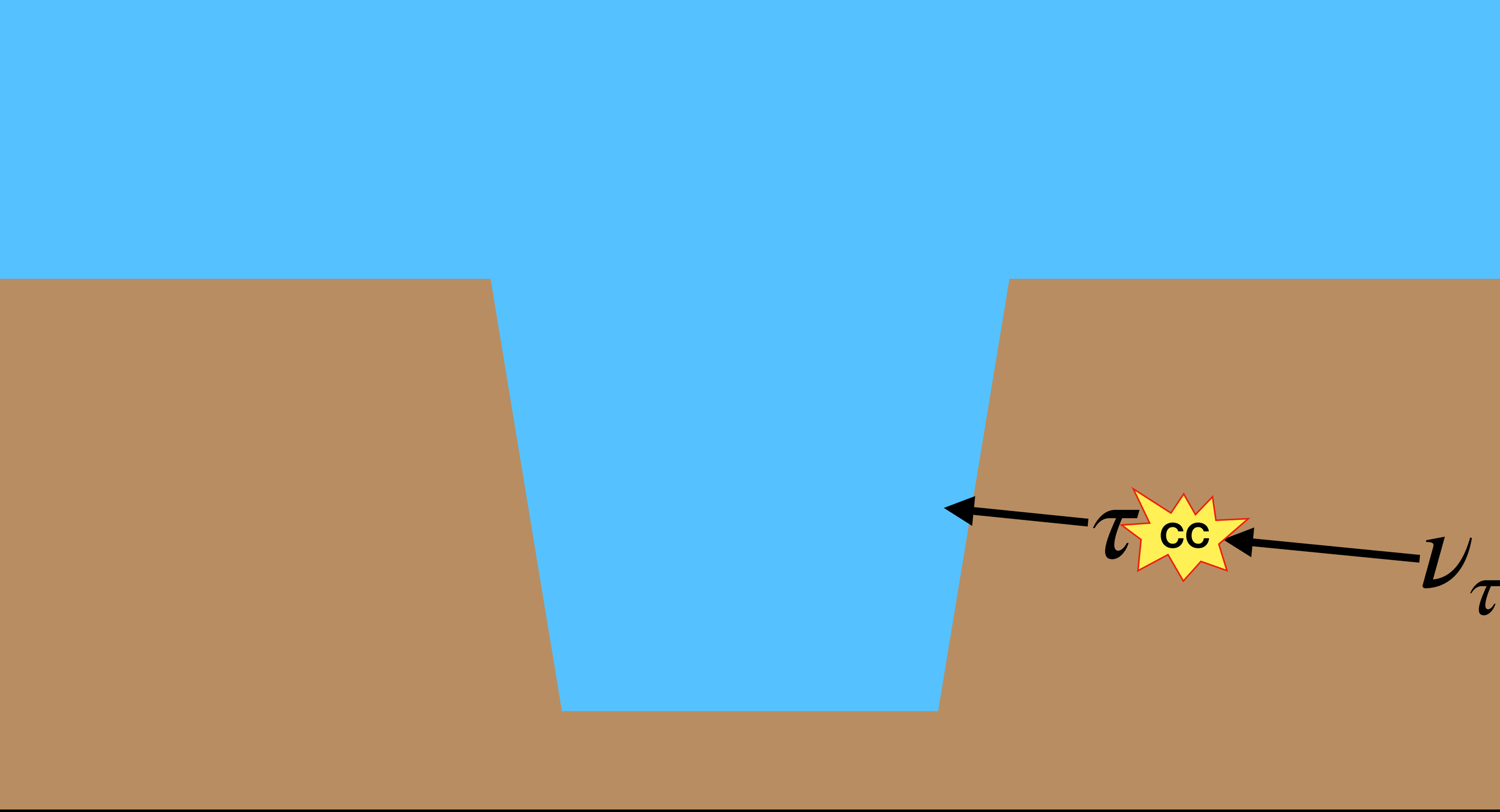


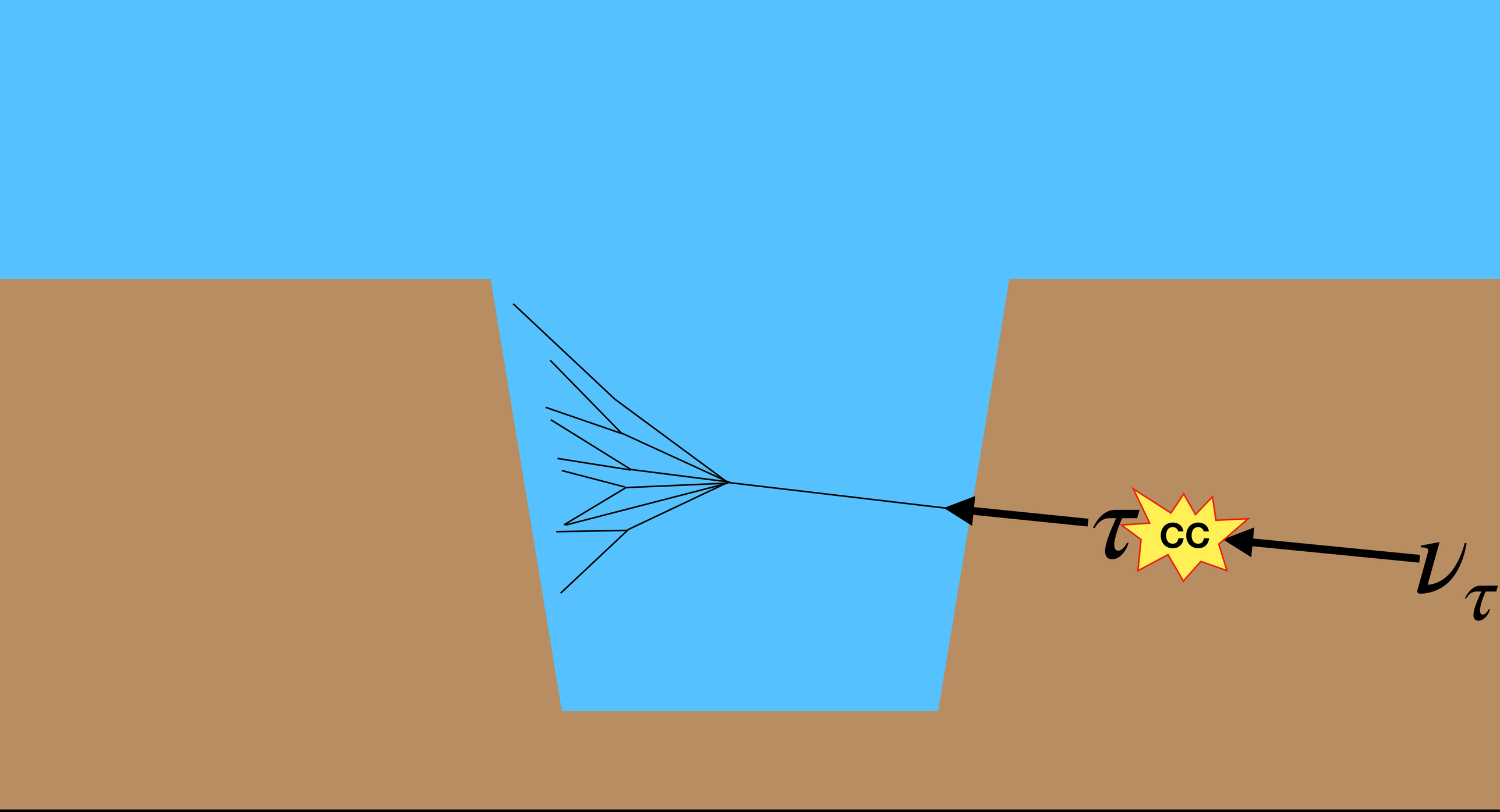
https://masterclass.icecube.wisc.edu/en/learn/detecting-neutrinos

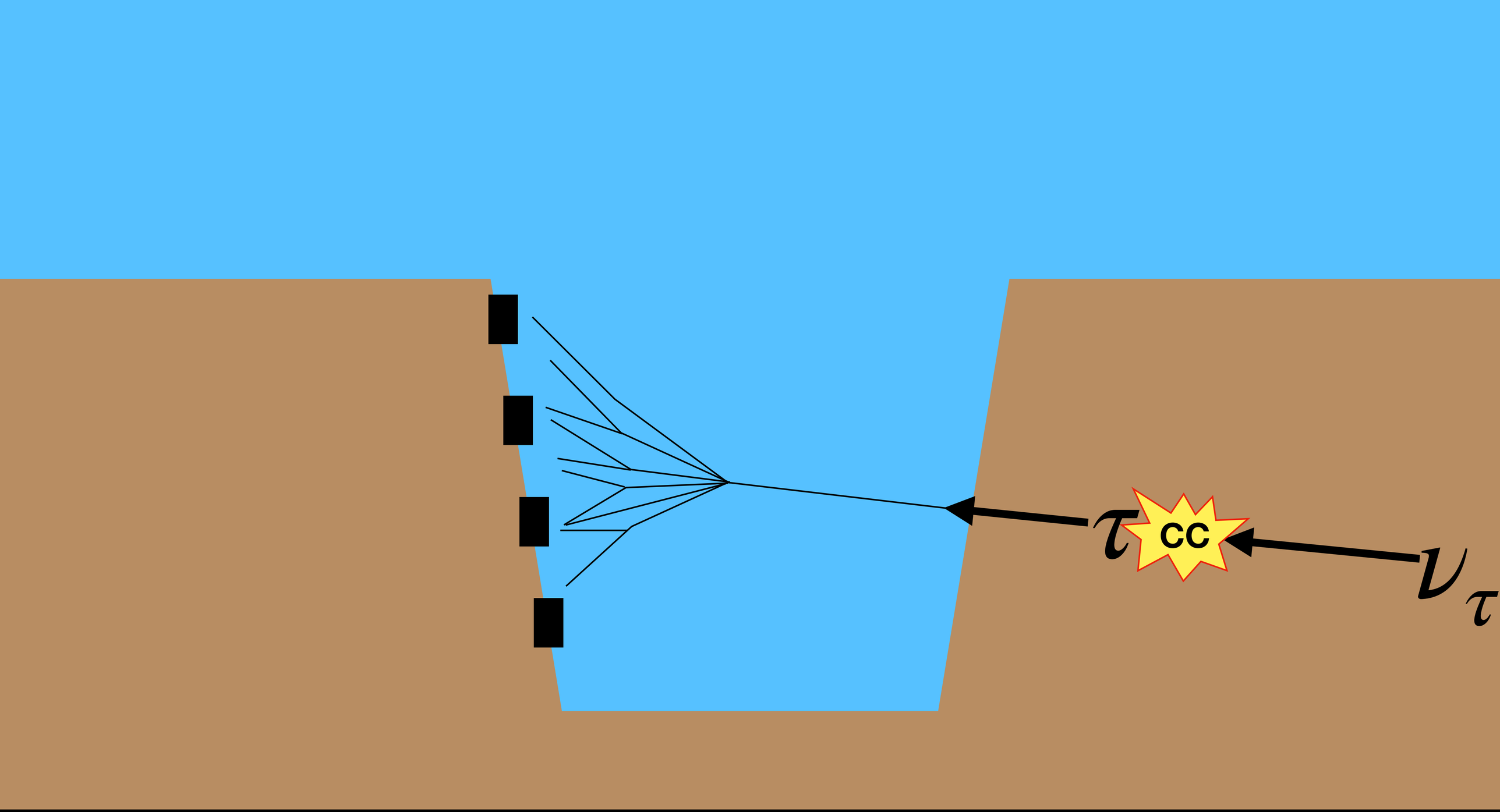
So how does it work?


ν_τ


CC
ν_τ


τ
CC
ν_τ


τ
CC
ν_τ


τ
CC
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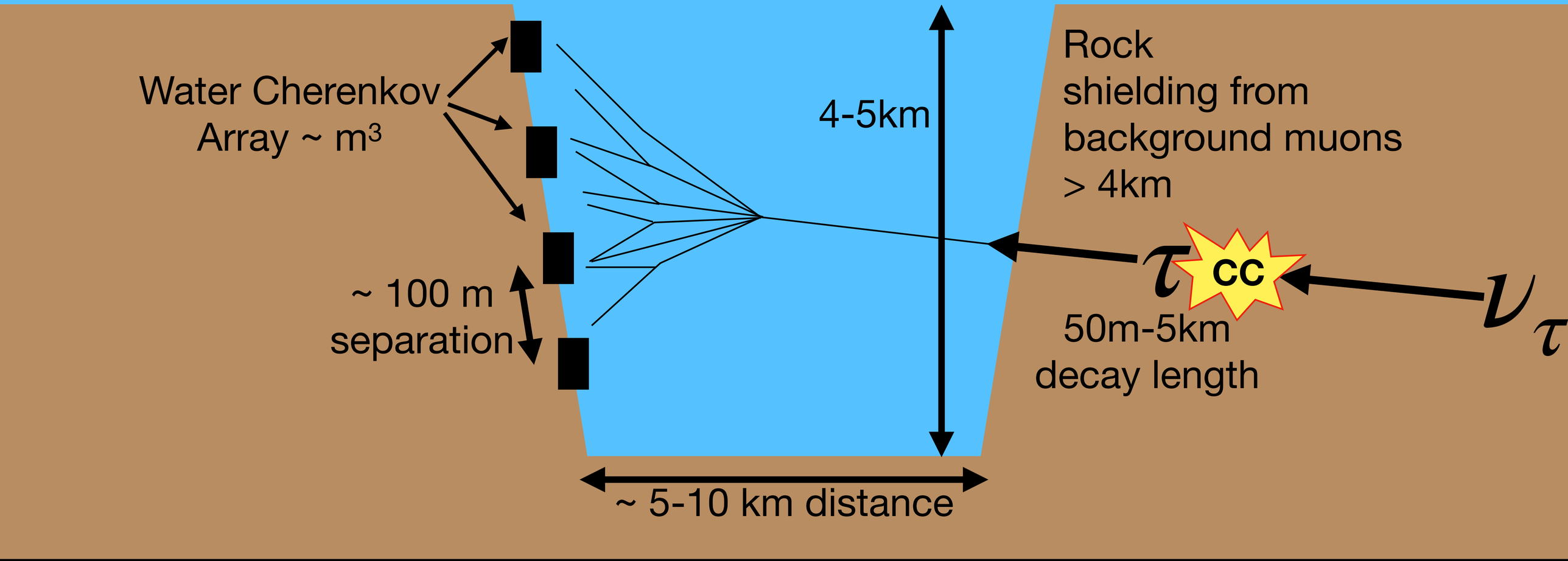
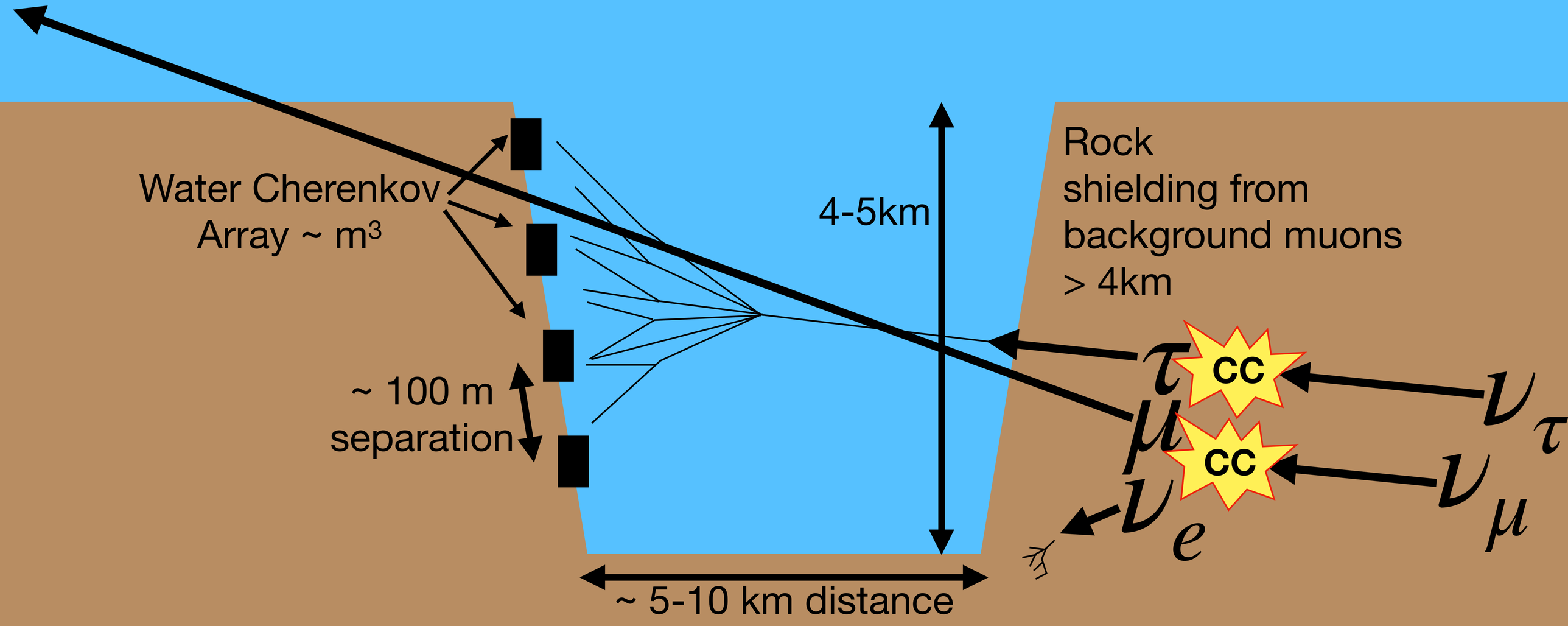
Colca Valley

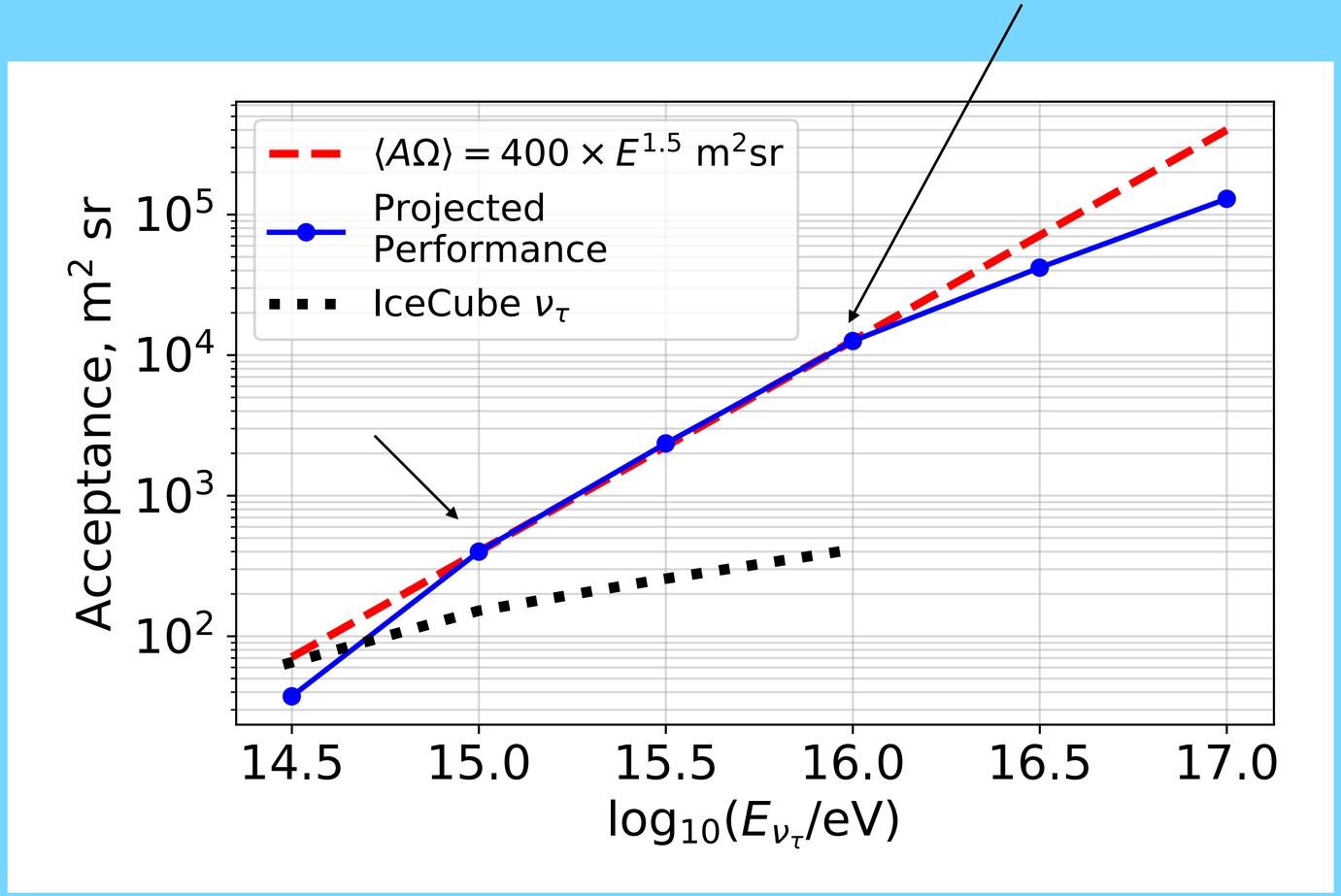


Colca Valley



Effective Areas

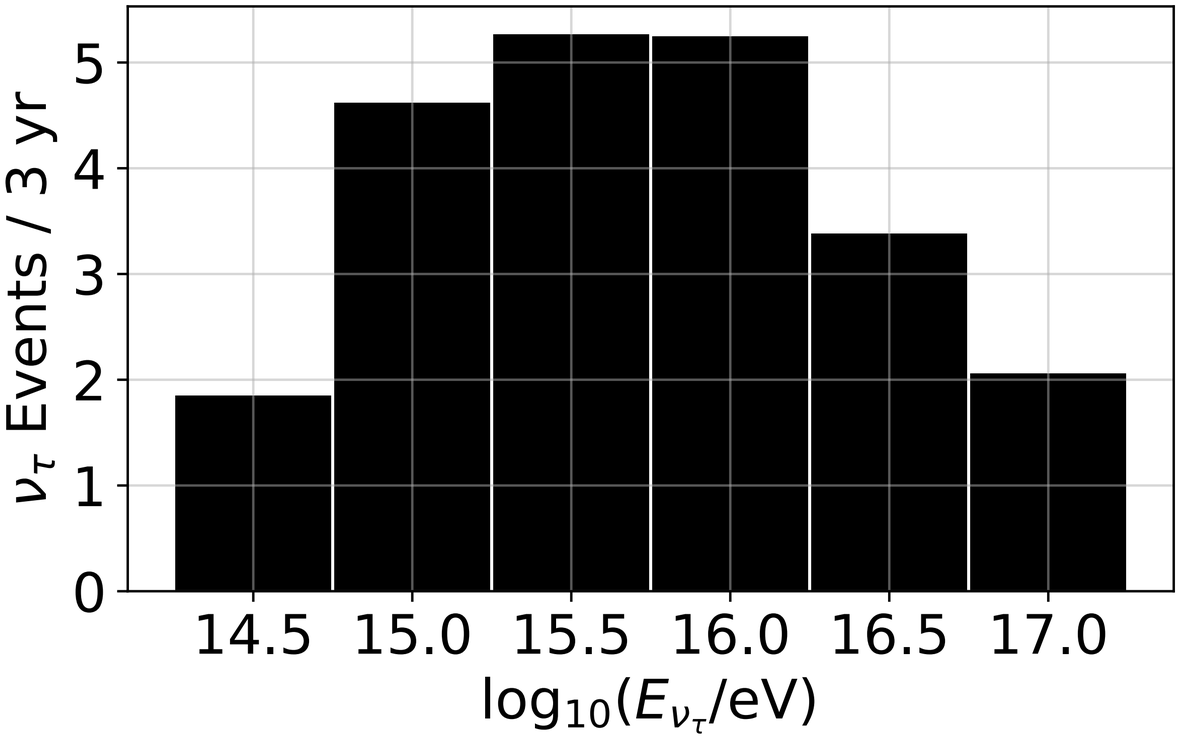
- Calculated using an array of 22,000 detectors spaced 150m apart
- Reduced acceptance at low energies = showers too small
- Reduced acceptance at high energies = tau range exceeds valley dimensions



Romero-Wolf et al., arXiv:2002.06475v1

Expected Performance

$$\phi = \phi_0 E^{-2.5}$$



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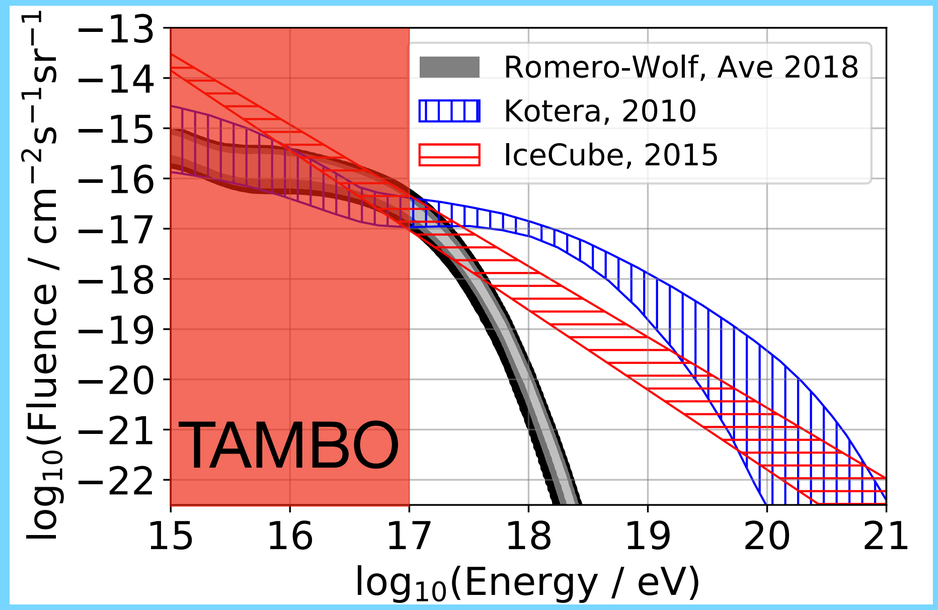
- Optimized for PeV energies to improved measurements of astrophysical flux
- 21 events per 3 years of operation with a peak at 3 PeV



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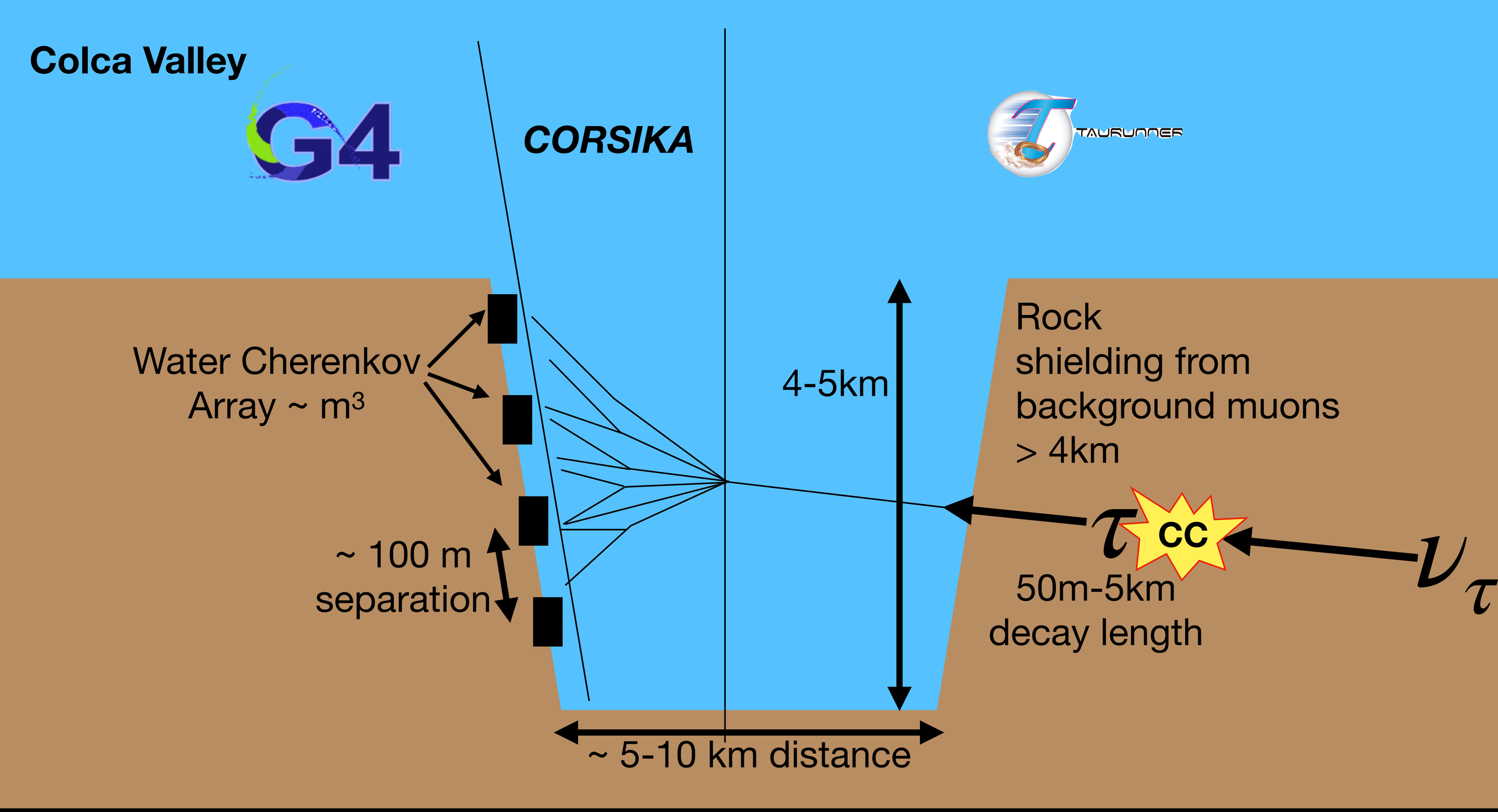
MC Details

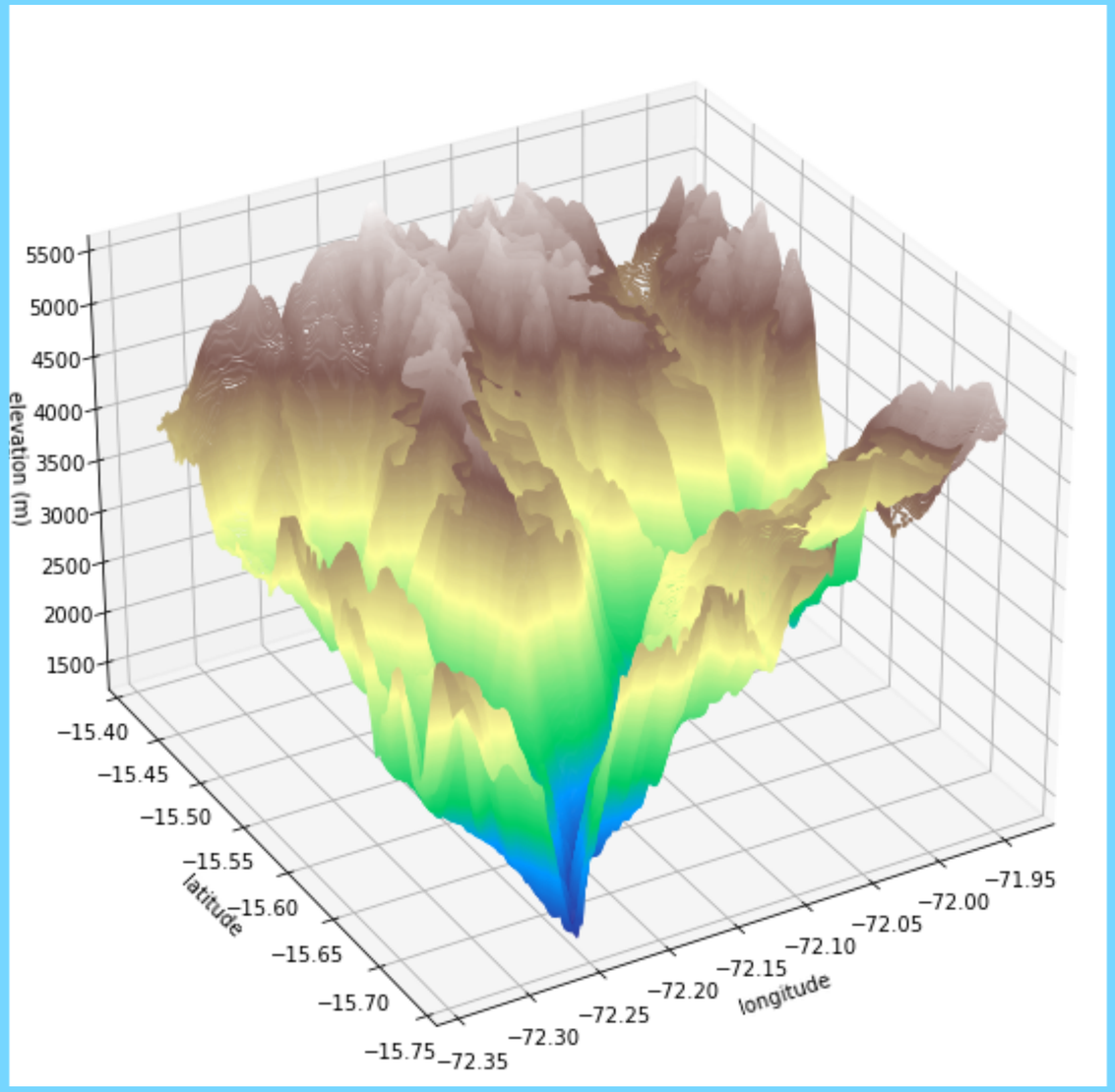
- **TauRunner** -> run ν_τ propagation through Earth, simulate ν_τ interaction, τ propagation in the atmosphere
- **CORSIKA** -> τ decay air showers
- **GEANT4** -> detector effects of measuring showers

https://github.com/icecube/TauRunner

Go check out Ibrahim Safa's talk later

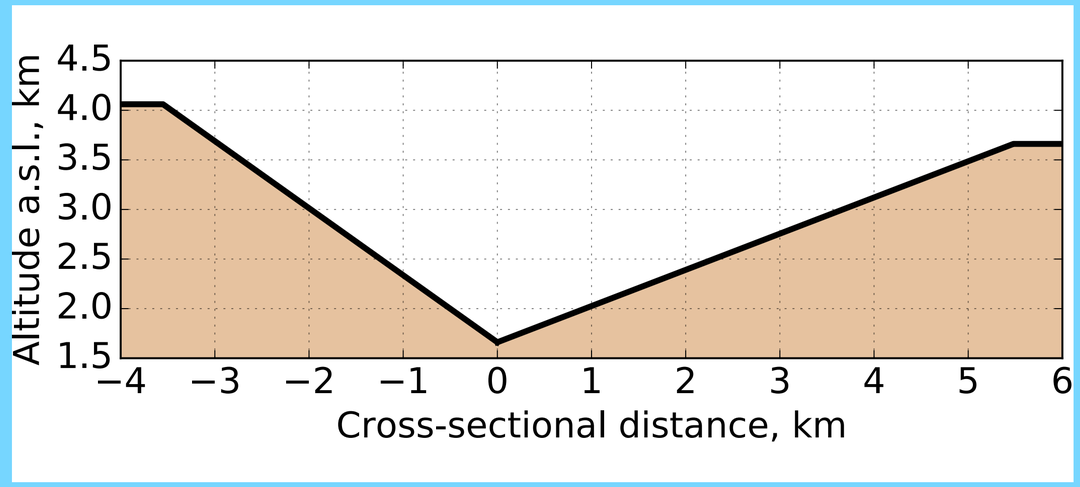

Colca Valley
CORSIKA
TAURUNNER
Water Cherenkov
Array ~ m³
~ 100 m
separation
4-5km
Rock
shielding from
background muons
> 4km
τ
CC
ν_τ
50m-5km
decay length
~ 5-10 km distance

First Stage / Current Work



https://www.gpsvisualizer.com/elevation

- Updating topographical models
- Previous estimations for prelim figures used simple geography
- Update propagation MC to include more complex geometries
- Plastic scintillators vs. Water Cherenkov



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Summary + Outlook

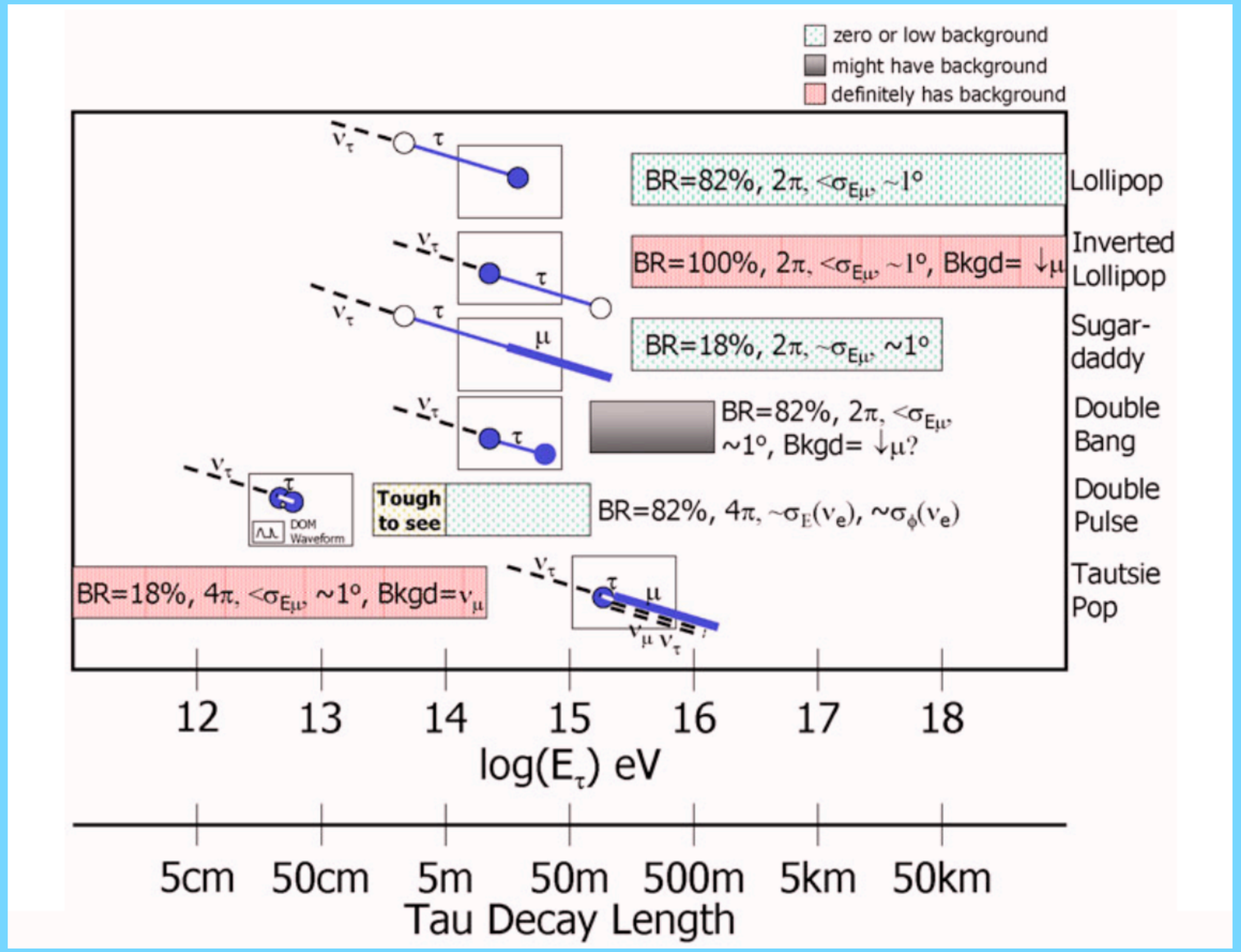
- TAMBO aims to achieve:
  - Increased ν_τ sensitivity at 1-10 PeV
  - Aid point source flux ν_τ constraints
- TAMBO uses already well proven technology
- There is a hole in the tau neutrino spectrum


FLEX
APE
ν_τ spectrum
1 PeV - 100 PeV
TAMBO

Thank you! Questions?

Backup

Different Tau Morphologies



D F Cowen and the IceCube Collaboration 2007 J. Phys.: Conf. Ser. 60 048

Dark Matter too