KM3Net Outing
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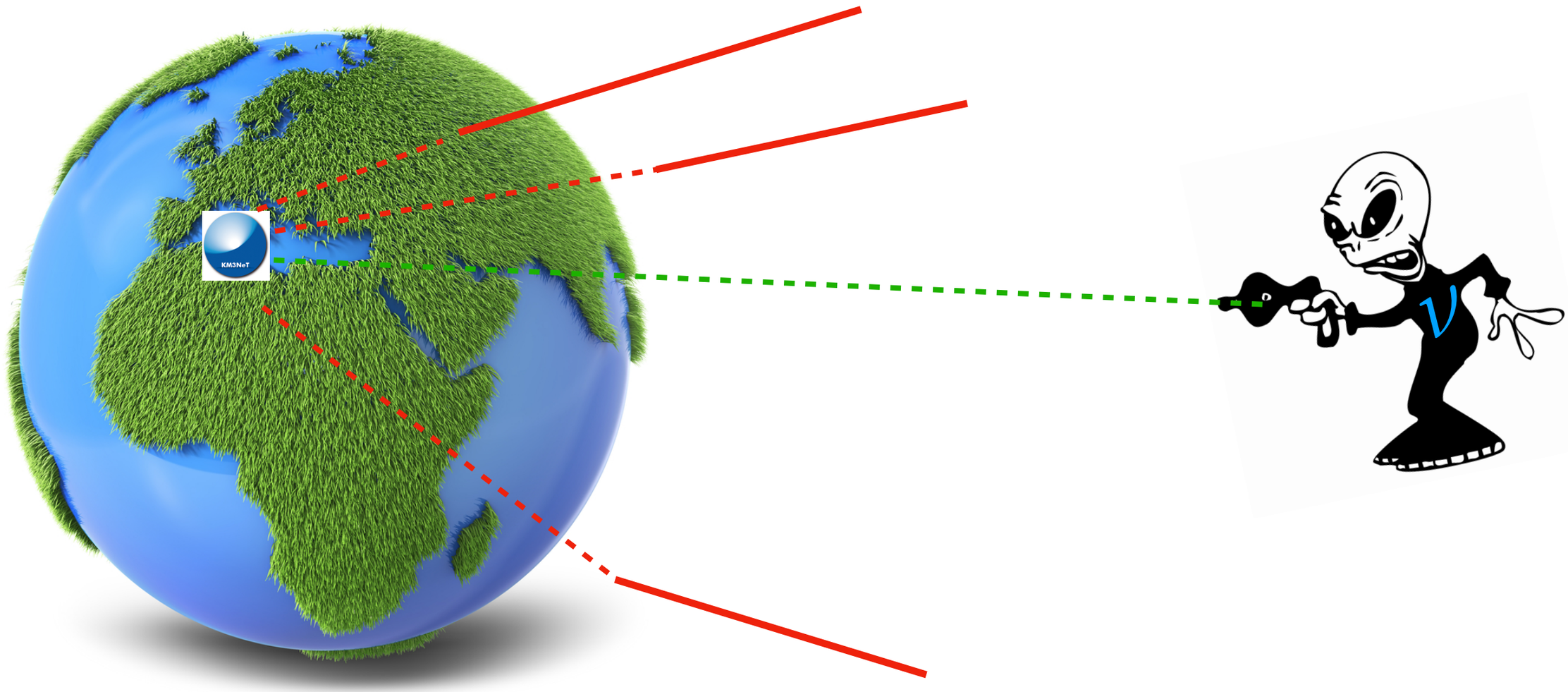
Cross Sections & Telescopes

Alfonso Garcia

How do neutrino telescopes work?

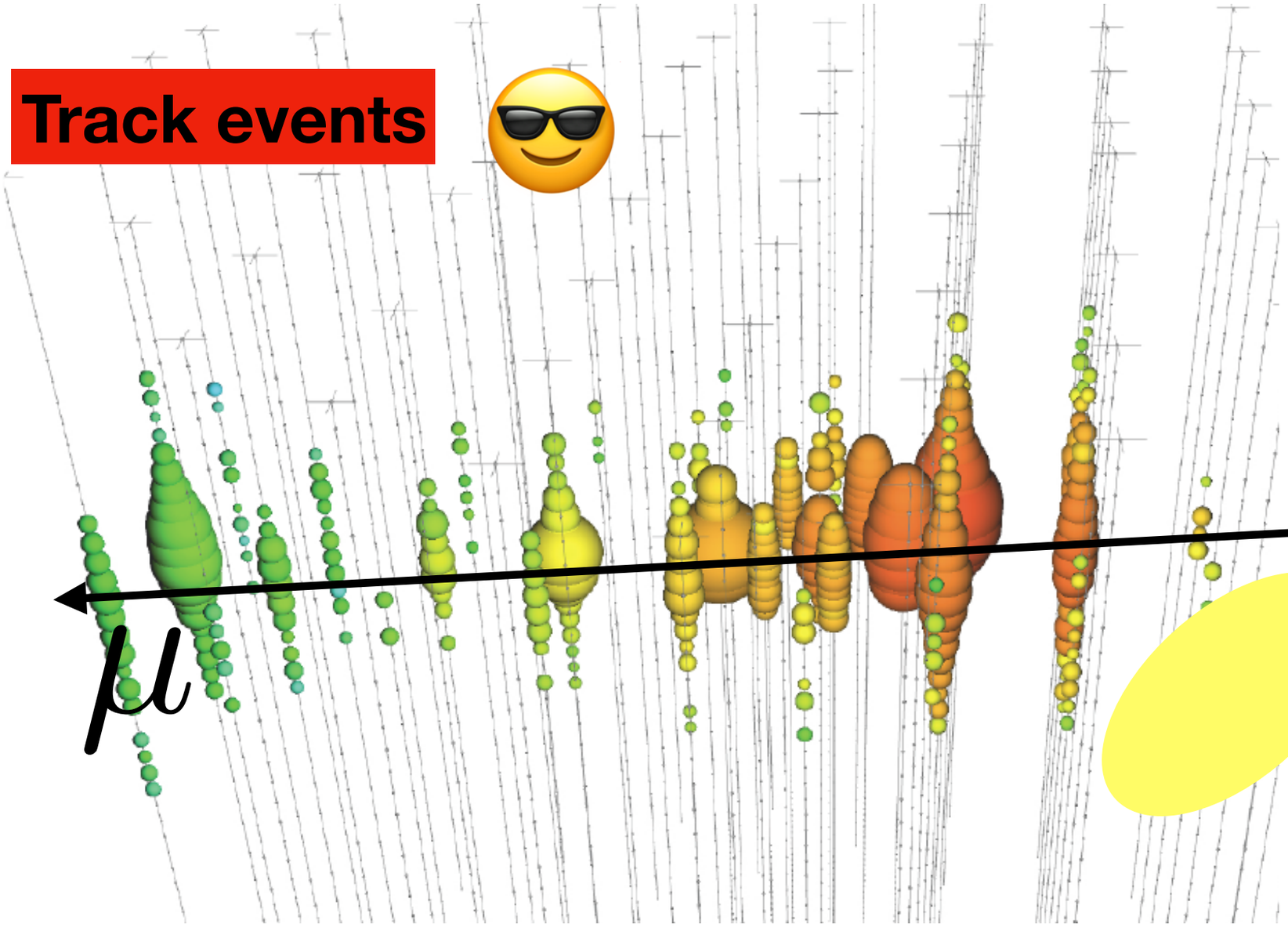
- High energy neutrinos come from two different sources.
  - Cosmic rays interactions in the Earth -> BACKGROUND
  - Extraterrestrial sources -> SIGNAL

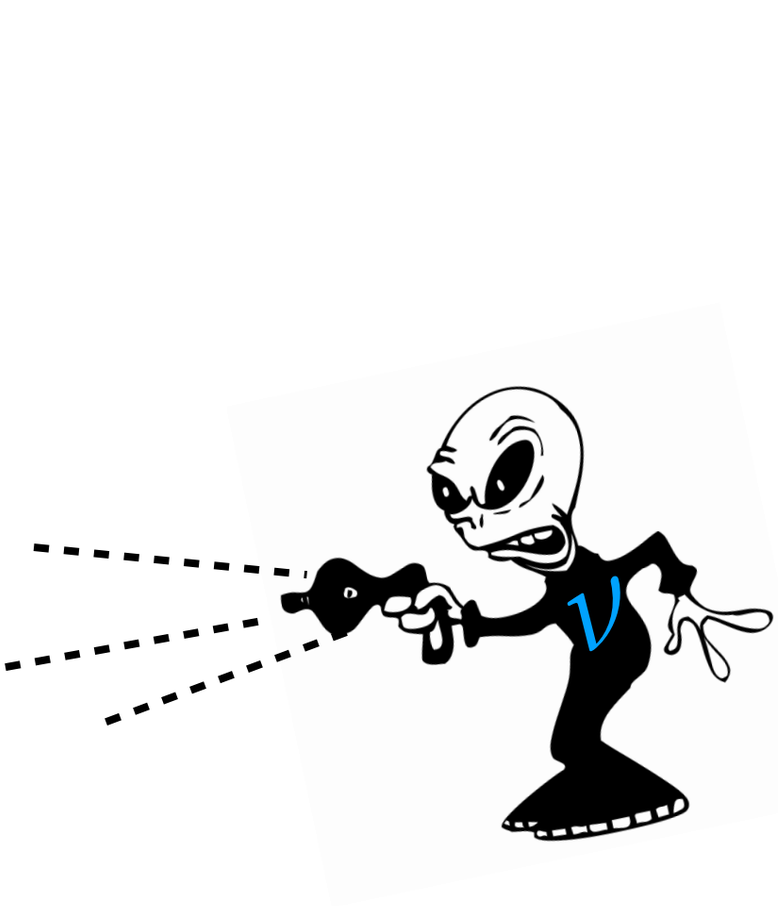


How do neutrino telescopes work?

- Background should be isotropic.
- Signal should cluster in a particular region of the sky.
  - Reconstruct the direction of the incoming neutrino.

Track events 😎





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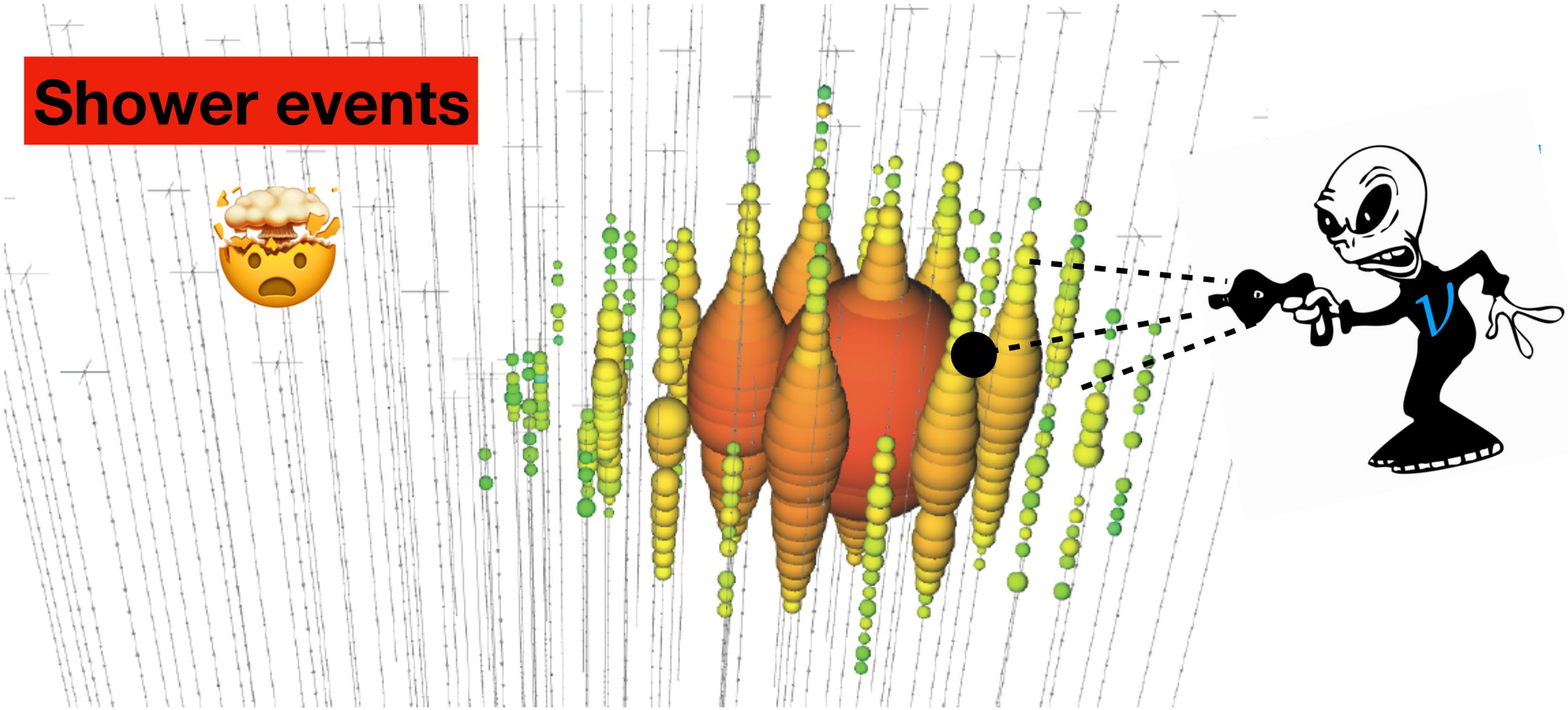
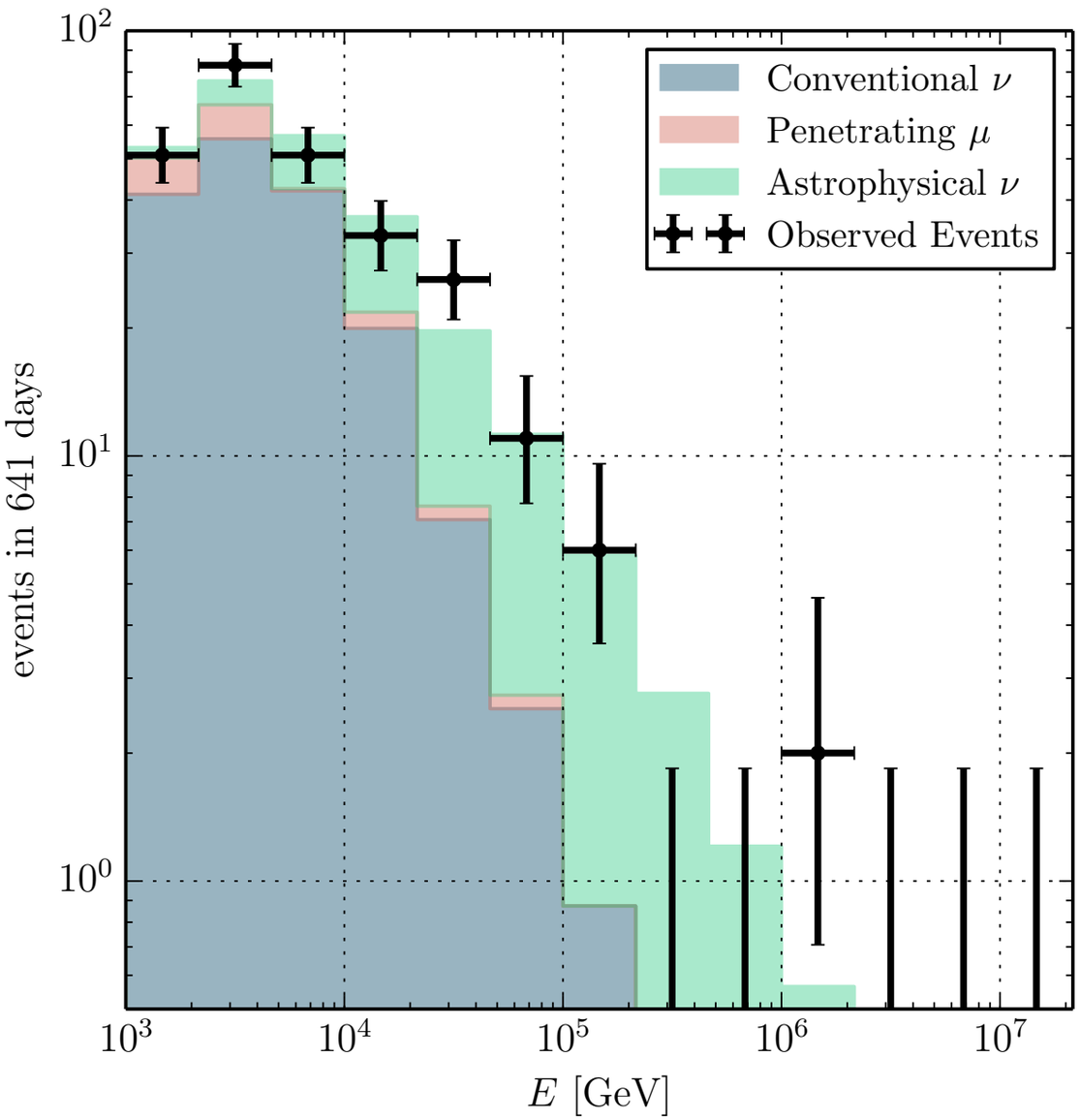


How do neutrino telescopes work?

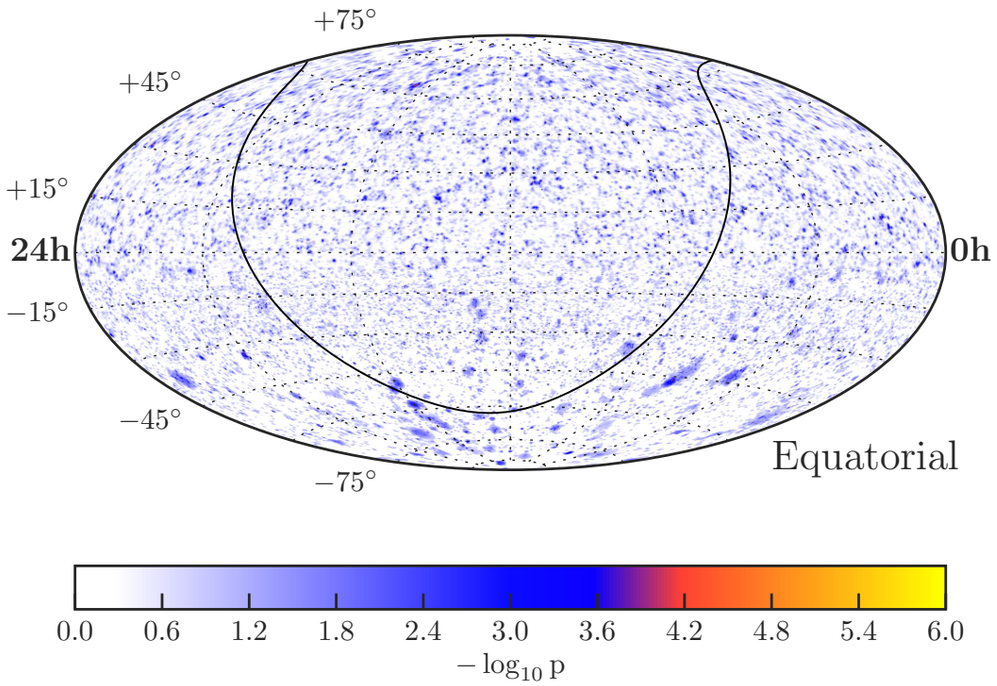
- Need other variables to discriminate between SIGNAL & BACKGROUND.
  - Reconstruct the energy of the incoming neutrino.
  - Very handy for SHOWERS because they are contained in the detector.



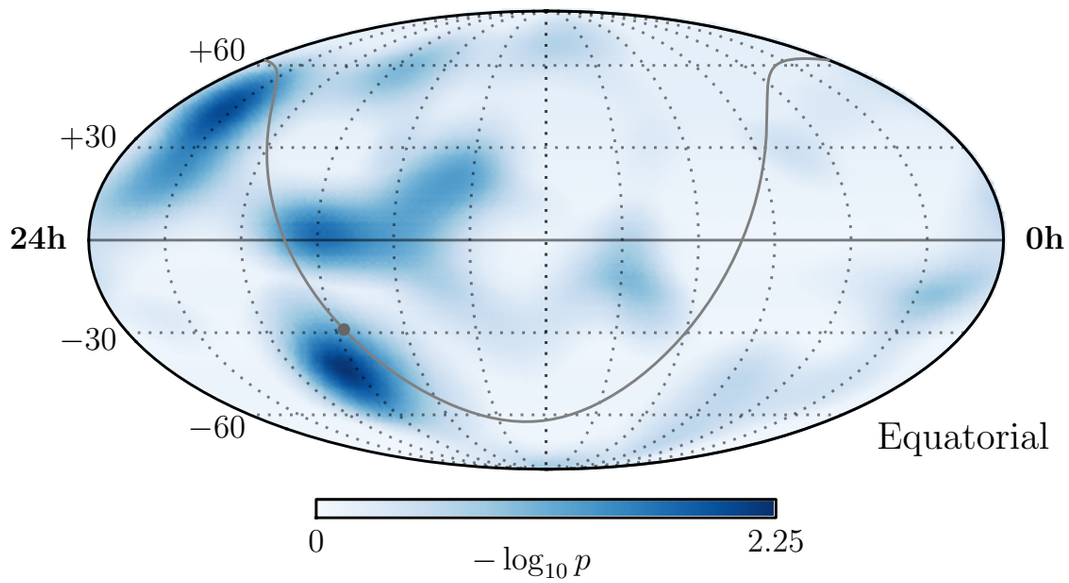
How do neutrino telescopes work?

- Reconstructing energy and direction we obtain some discrimination power.

Track events

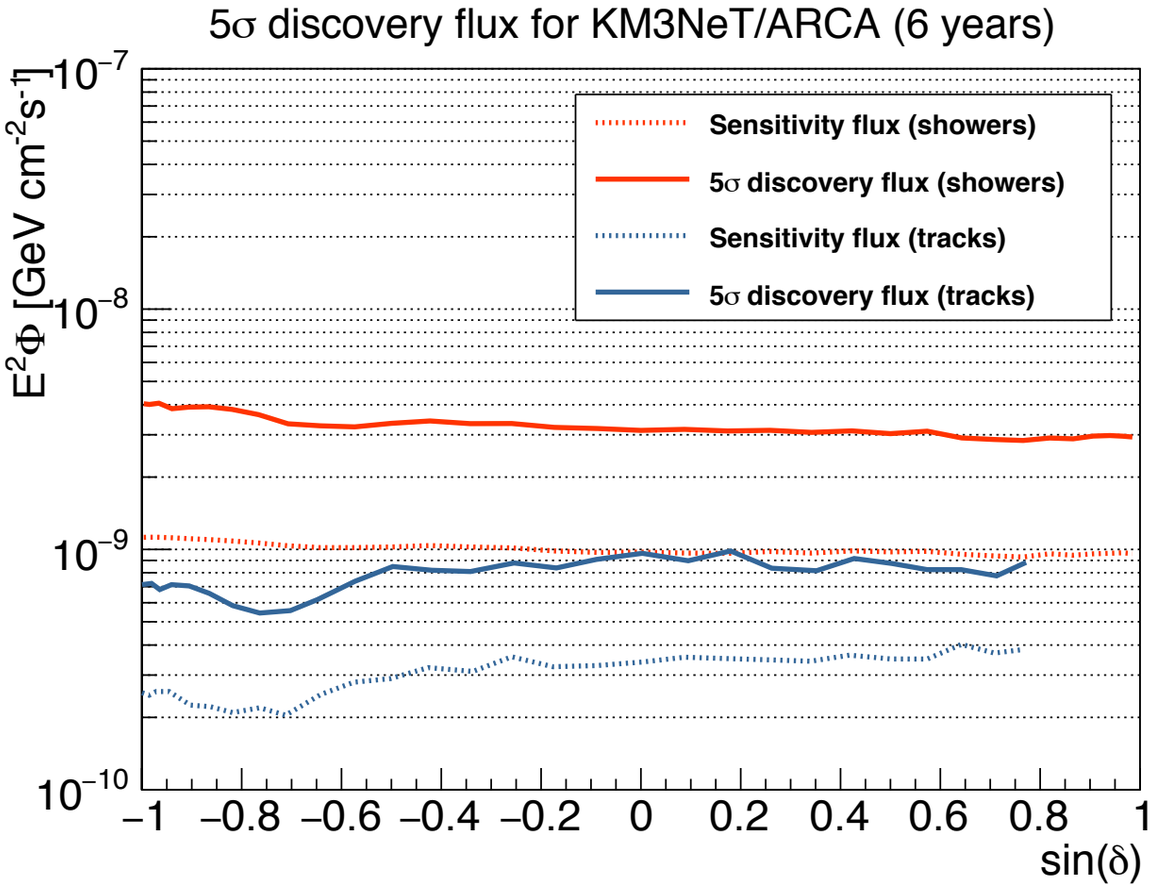


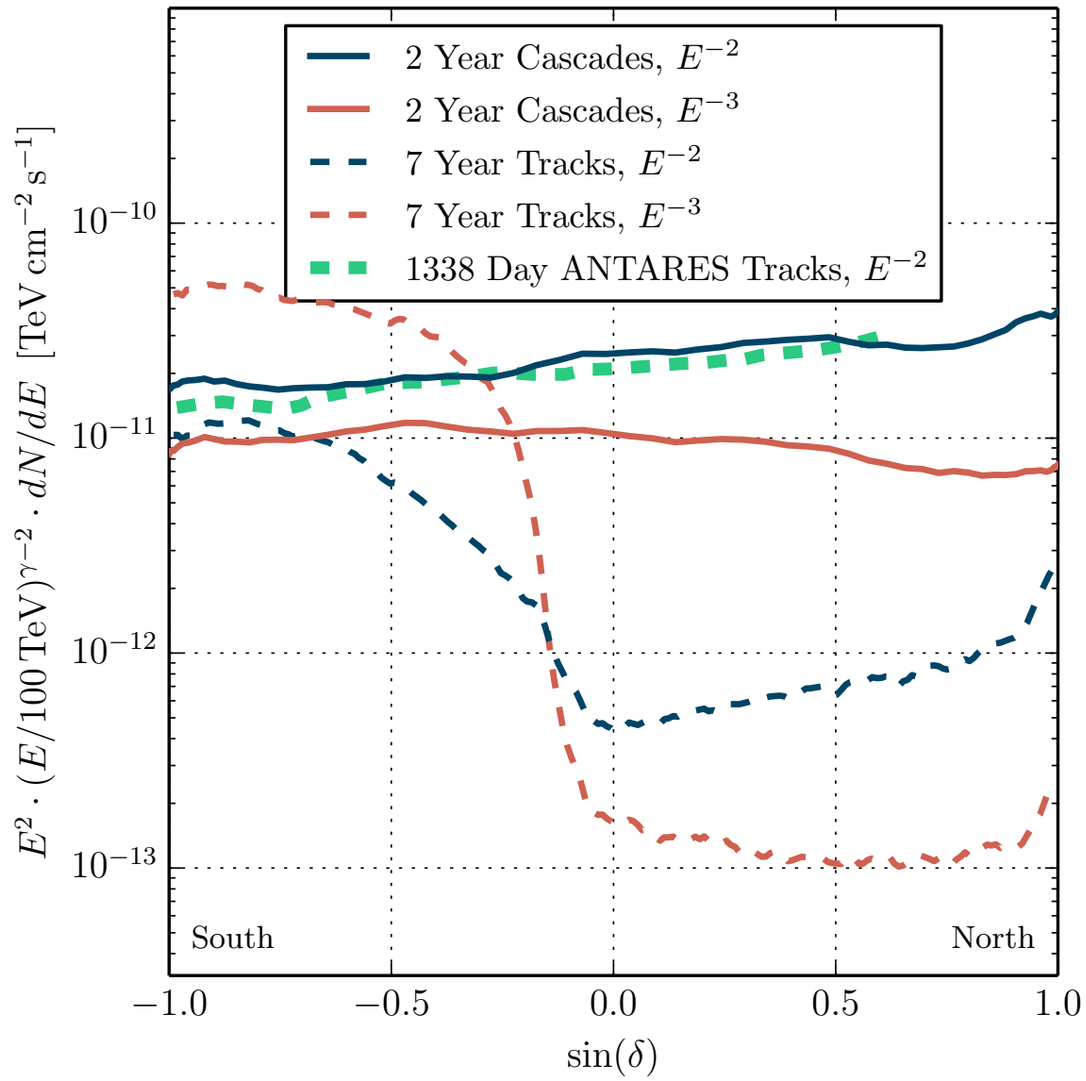
Shower events



How do neutrino telescopes work?

- Both Track & Shower events are used to state how good is our telescope.





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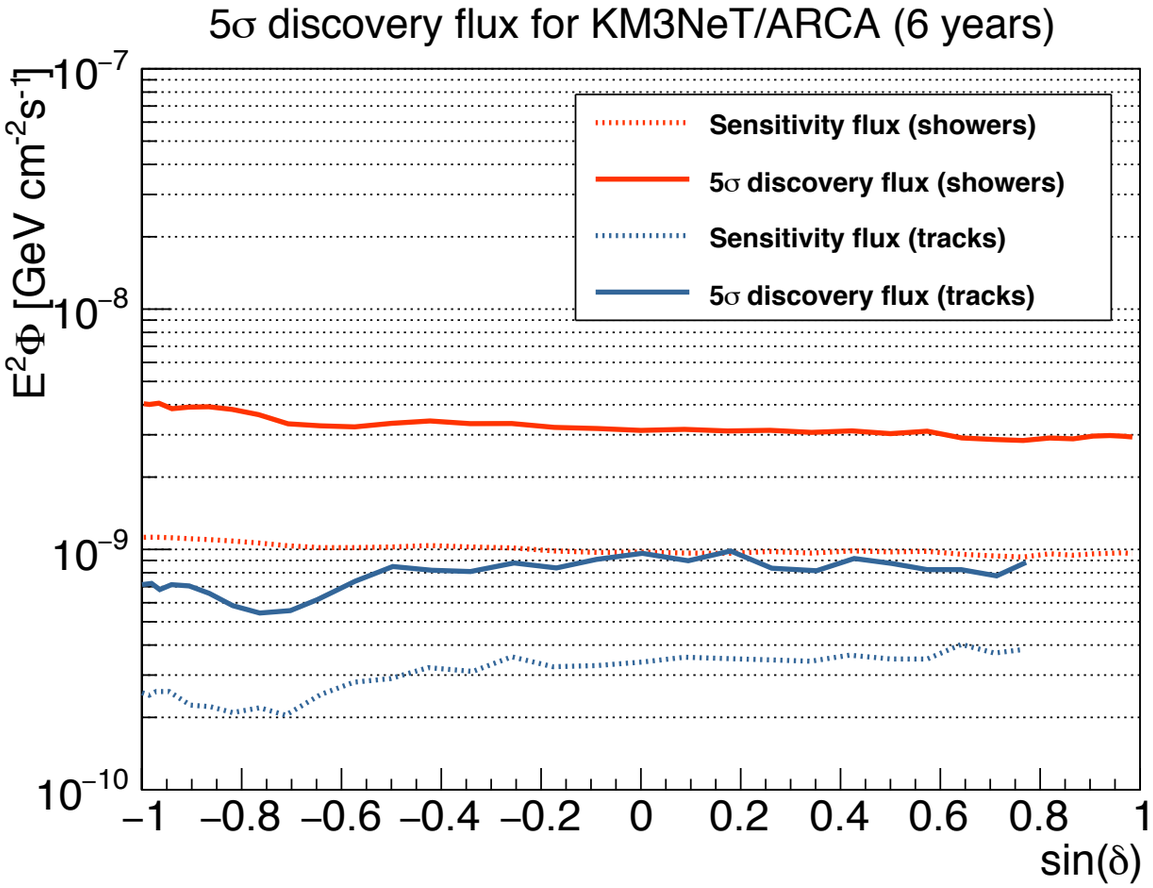
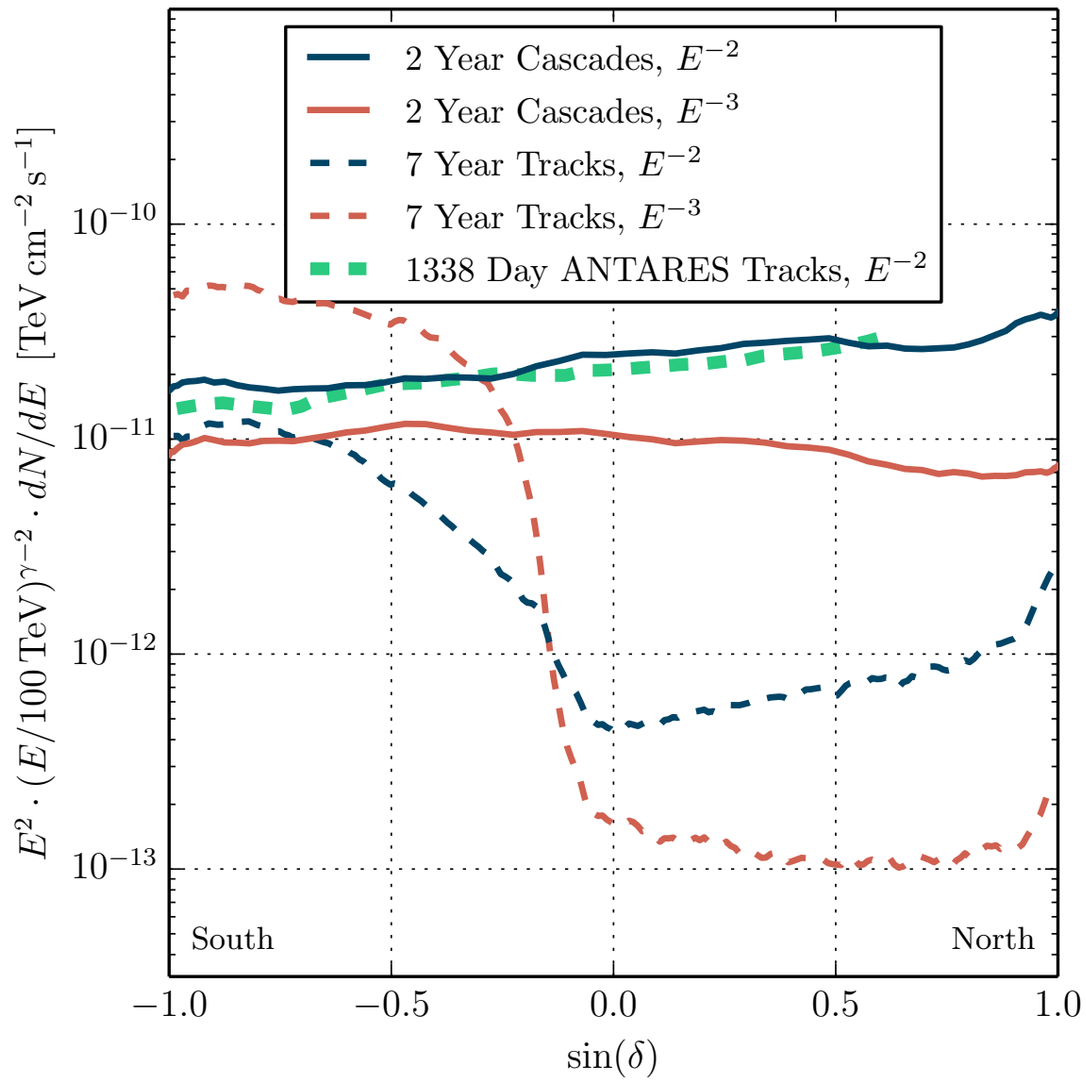


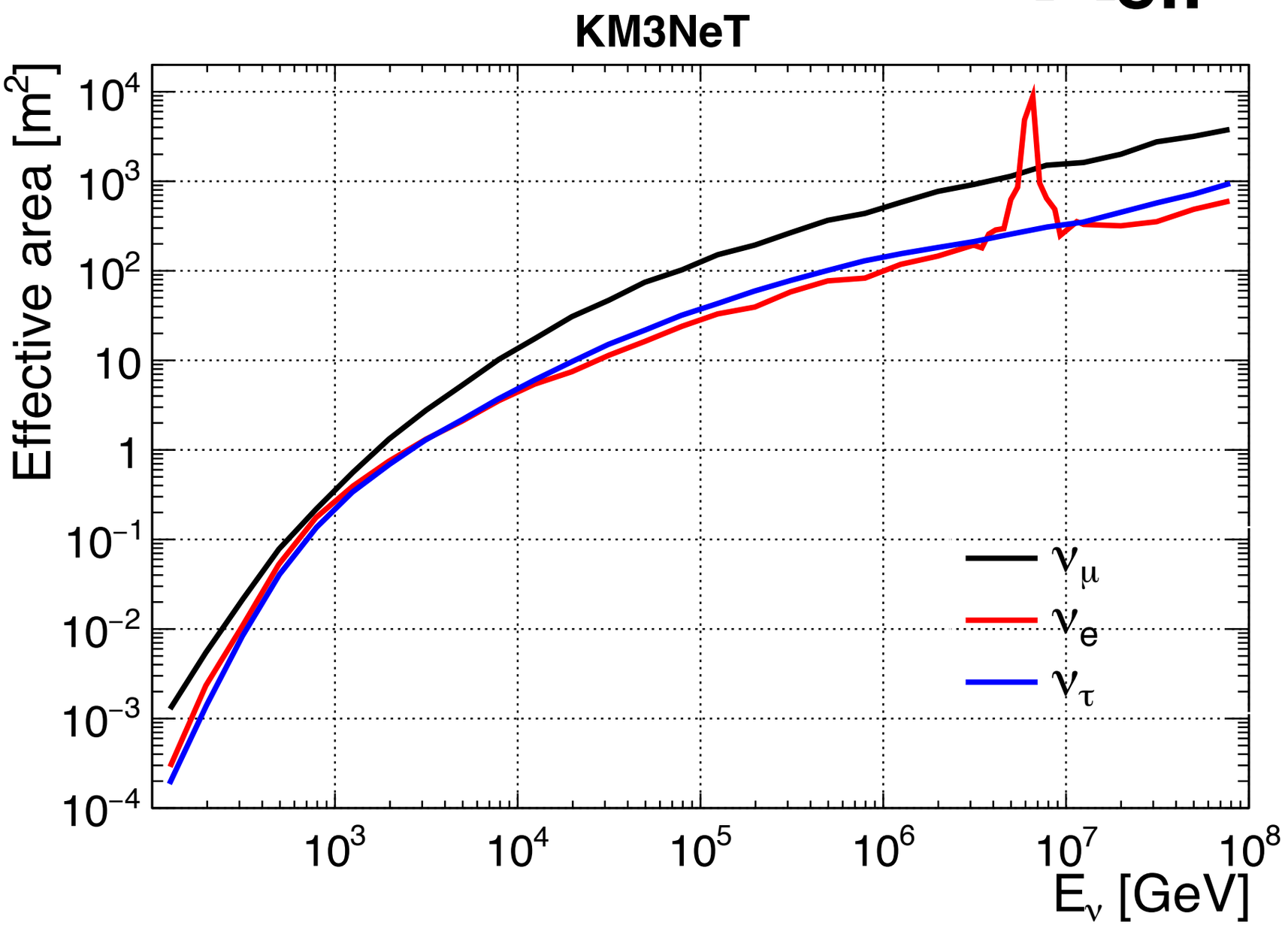


Where is cross section playing a role??

Cross section.

- It tells us how likely an interaction is going to happen at different energies..
- It affects to the rate of events, thus the effective area.

$$A_{eff} \propto \sigma(E)$$



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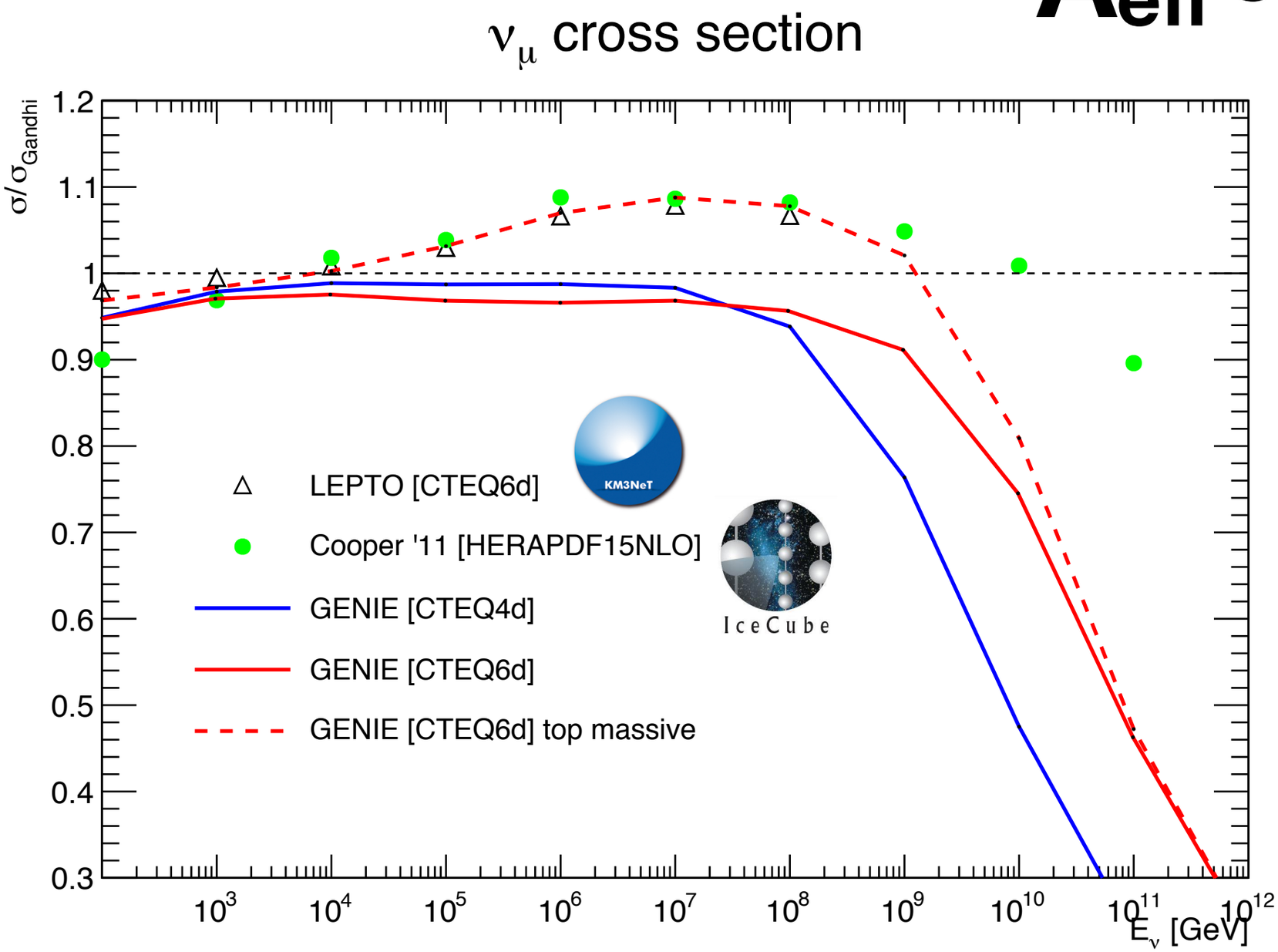
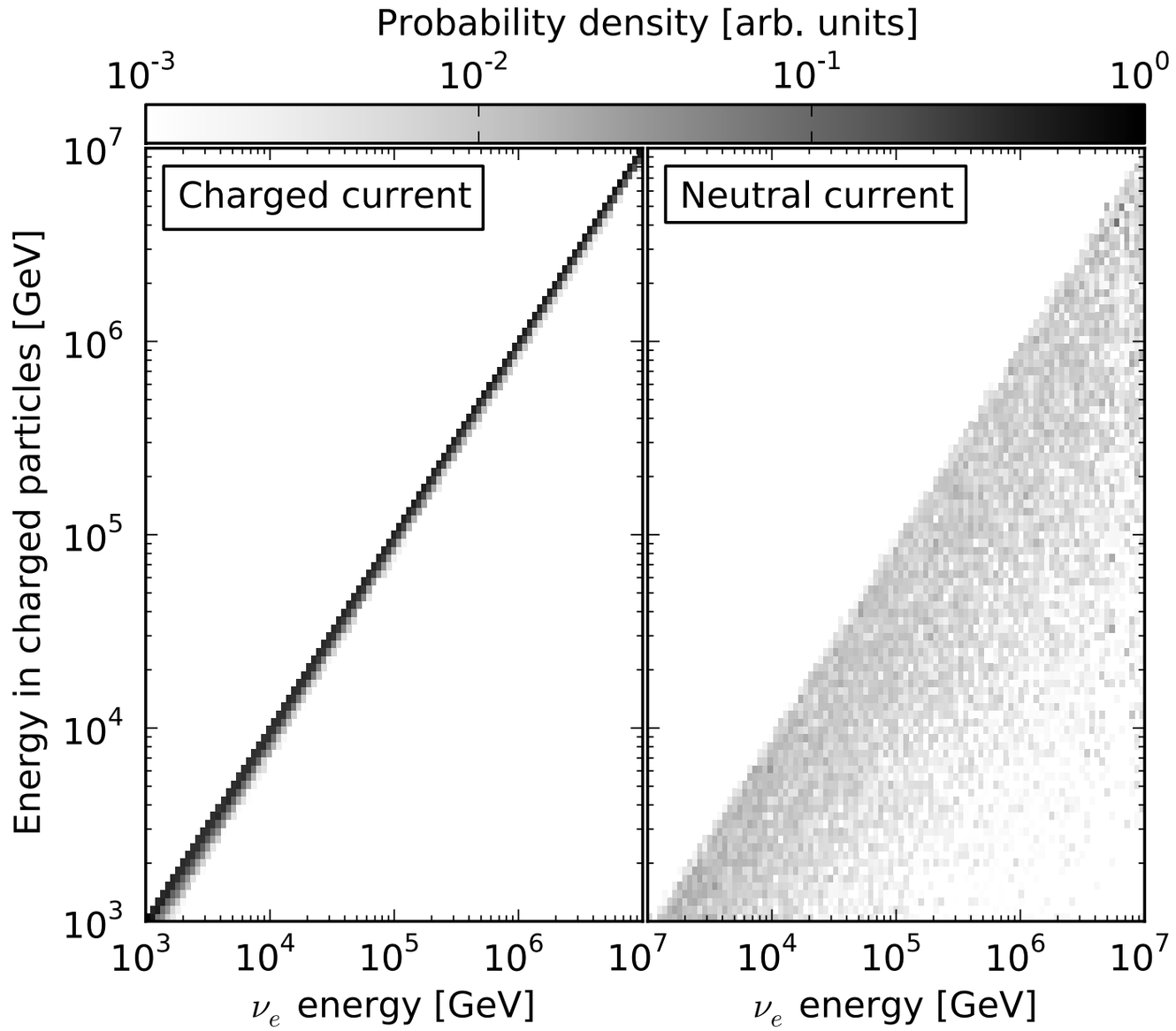


Differential Cross section.

- It tells us the energy of the outgoing lepton and shower.
- It affects to the energy reconstruction.
  - NN trained with simulated neutrino interactions -> very model dependent!!!
    - Tracks -> How much energy is given to the muon?
    - Shower (NC) -> How much energy is given to the neutrino?

$$E_{rec} \propto d\sigma/dy$$



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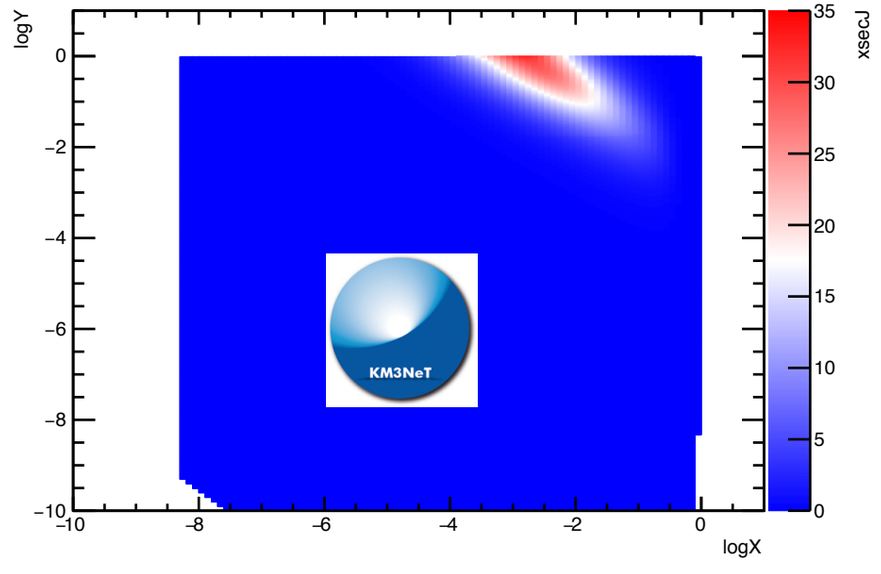
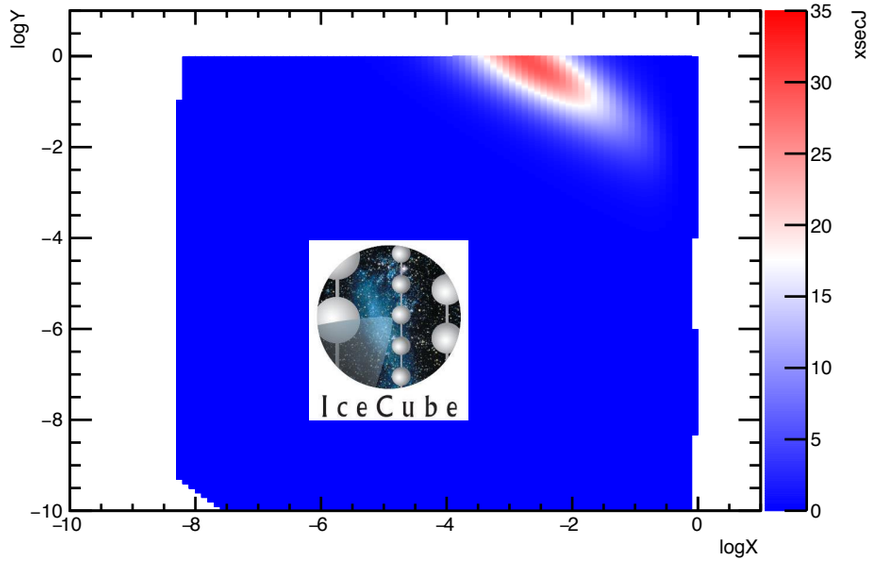
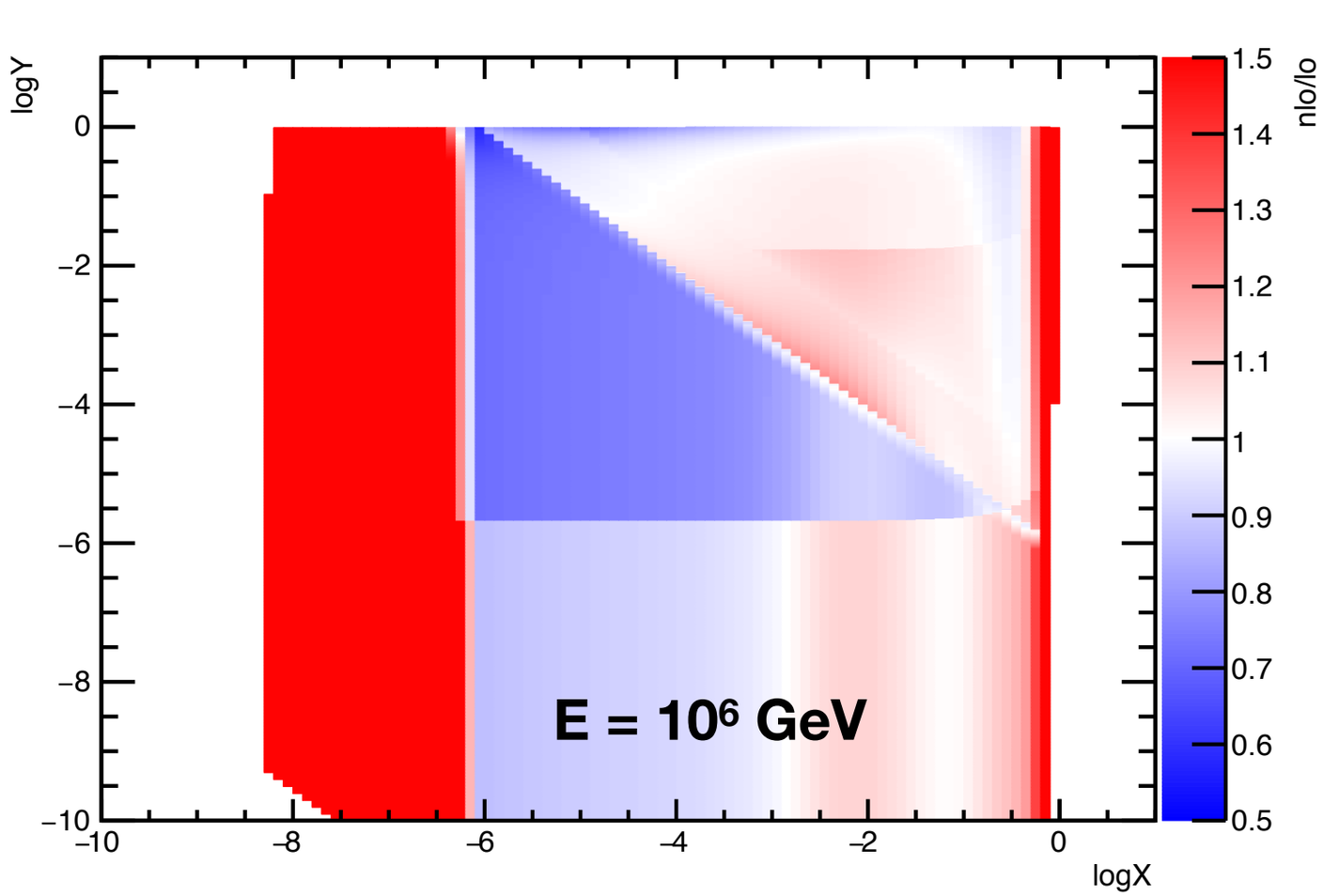




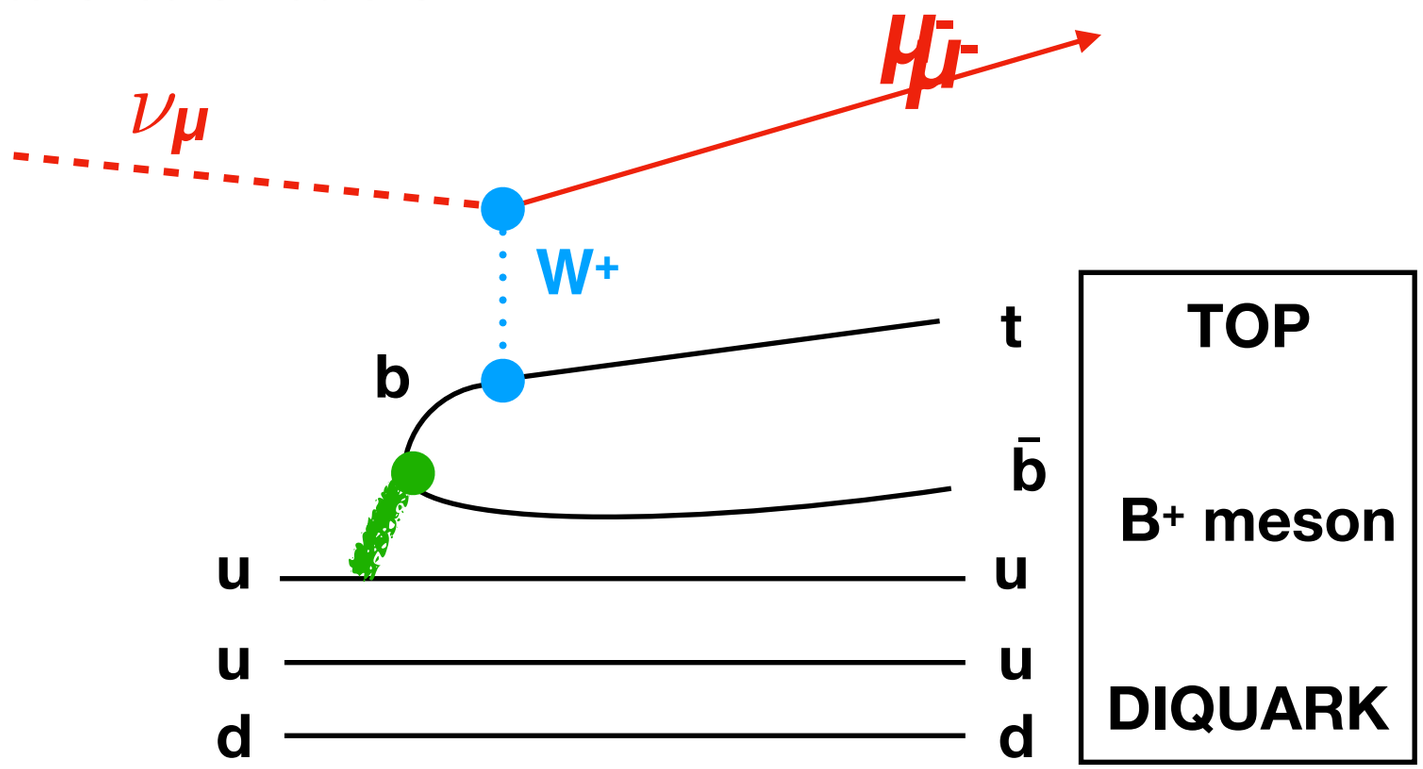


IceCube / KM3NeT

Quark content:

- It affects to the energy reconstruction.
  - Neural network trained with simulated neutrino interactions -> very model dependent!!!
- It tells us the ID of the outgoing hadrons.
  - Current simulations only take into account light quark mesons (K,π) in the final state.
  - At high energies, more exotic mesons (B,D) can contribute.
    - They will immediately decay into leptons? other hadrons?

$$E_{rec} \propto \sigma(q)$$



Quark content:

$$E_{rec} \propto \sigma(q)$$

E = 10^6 GeV

Quark	IceCube	KM3NeT
u	14 %	15 %
d	43 %	48 %
c	8 %	10 %
s	23 %	25 %
b	10 %	1 %