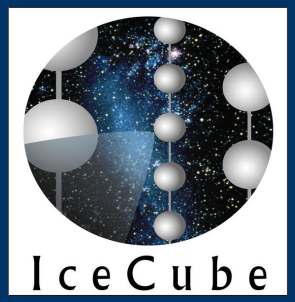
Tau neutrino detection in IceCube via the τ->μ channel



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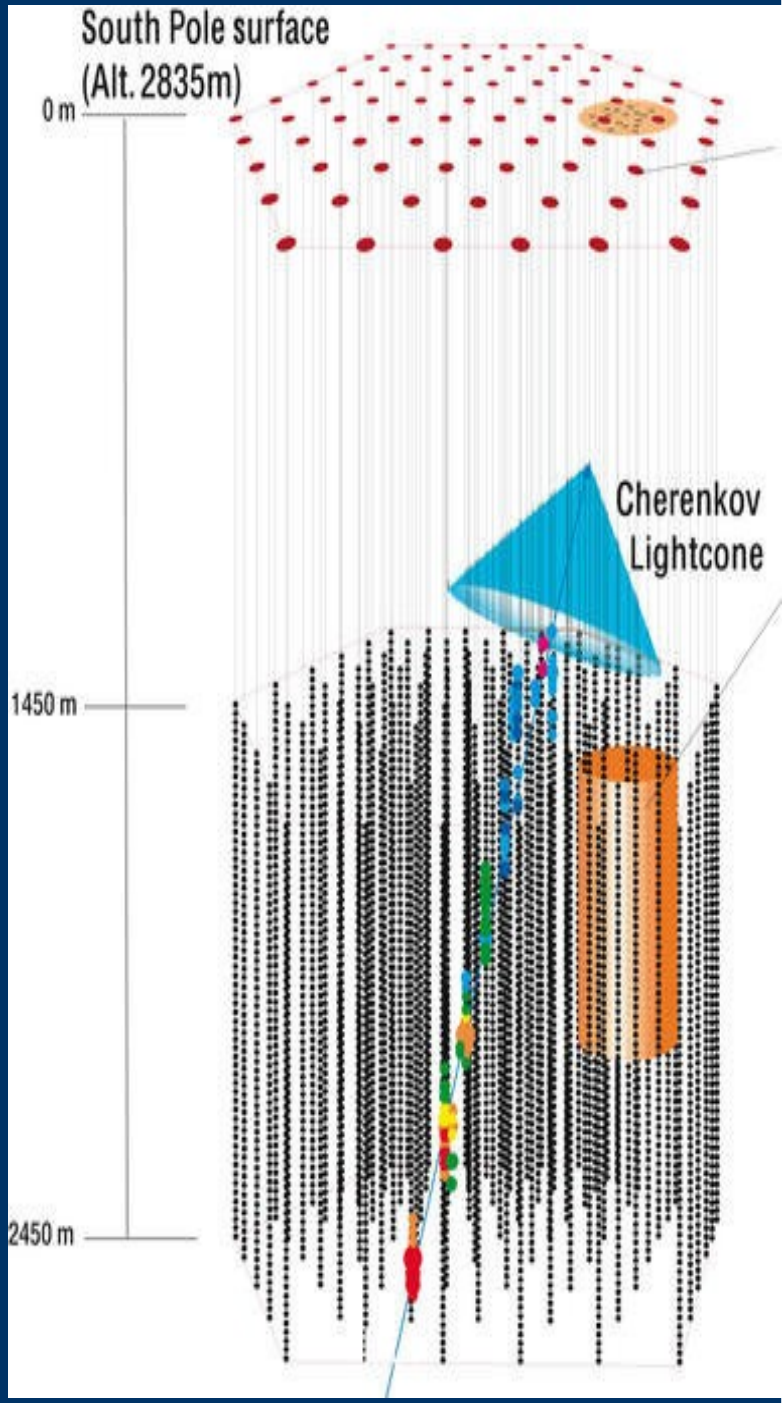
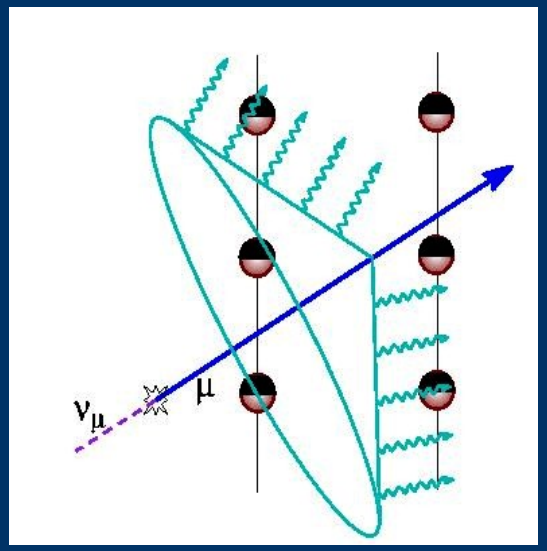
The telescope IceCube

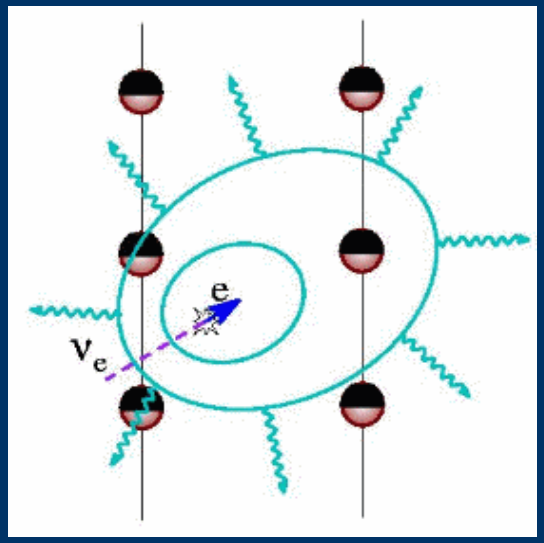
- In Ice between 1500 m and 2500m
  - 80 strings
  - 60 DOM/string
- Search of cosmic neutrinos (supposed to be emitted by violent astrophysical objet)
- Obsvervation of Cerenkov light emitted by secondary particle coming from the C.C interaction of neutrinos



Tau neutrino search in IceCube

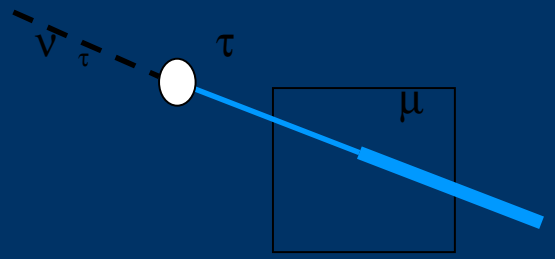
- ν_τ can be observed on earth because of neutrino oscillations in cosmological scale
  - At source: $\nu_\mu:\nu_e:\nu_\tau=2:1:0$
  - On Earth: $\nu_\mu:\nu_e:\nu_\tau=1:1:1$
- IceCube has the capabily to detect all flavor of neutrino due to its large size





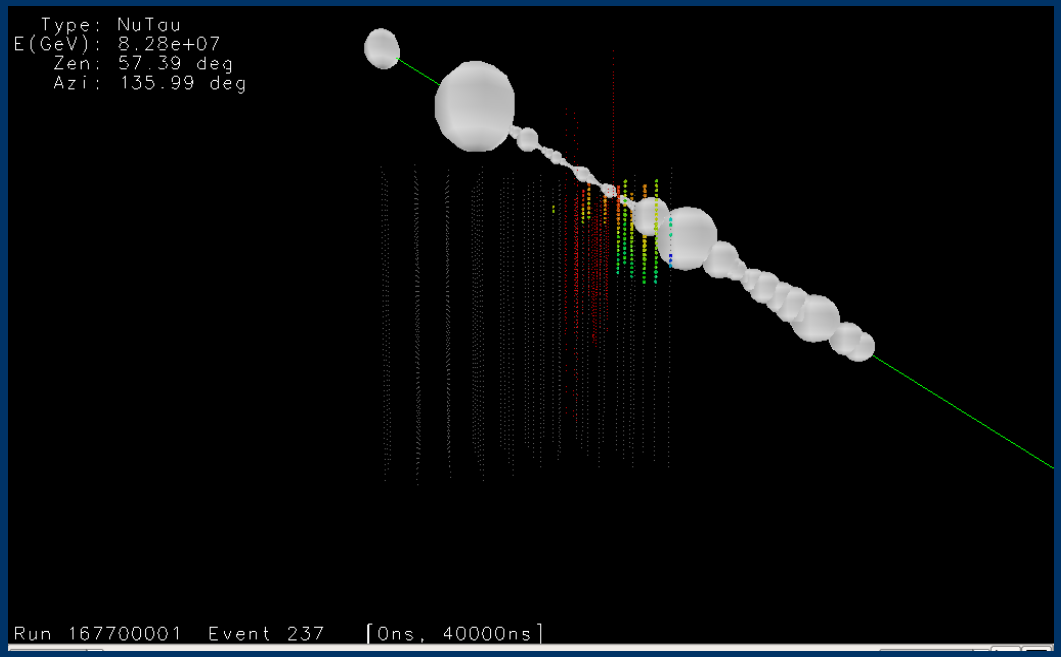
- Tau neutrino are almost background free
- Distinctive signature

Features of the decay τ->μ

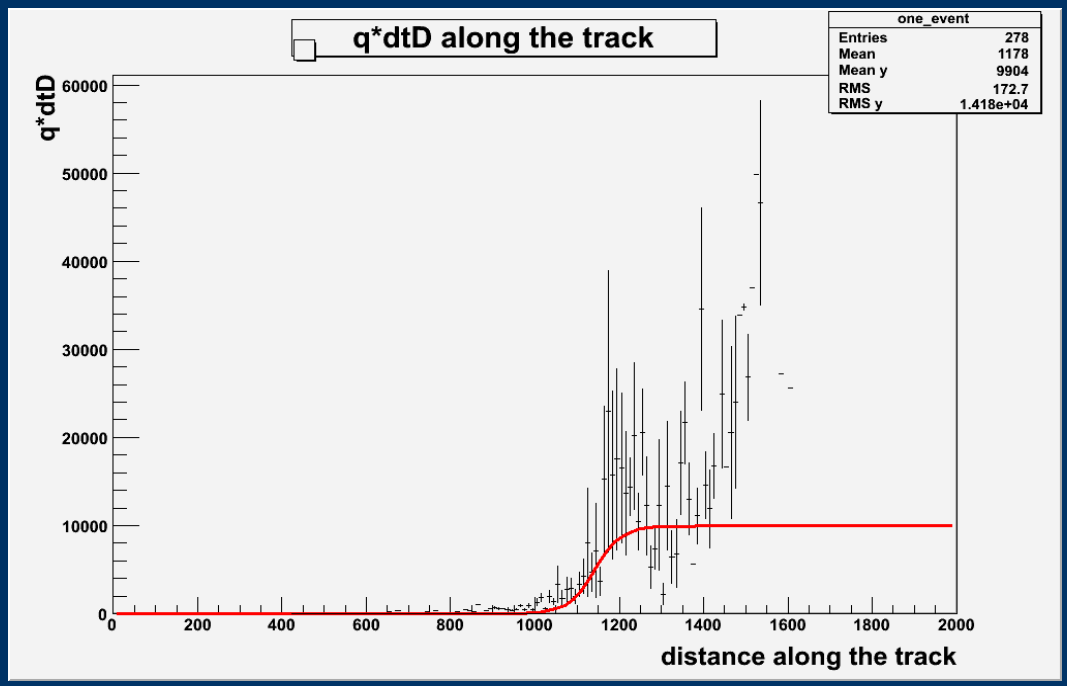


- $\nu_\tau N \rightarrow \tau X$

  $\tau \rightarrow \mu \nu_\tau \nu_\mu$ with $\Gamma_\mu \sim 17\%$
- decay inside the detector volume
- To detect the tracks: energy betwen PeV and EeV
- Muon energy loss->brem, $e^- e^+$
- Tau energy loss->photonuclear process
- ->muon track is brighter than the tau
- Problem: brightness variation due to the ice non-uniformity



- τ->μ MC in the IceCube detector (40 strings)
- μ track brightness = (3-7)* τ track brightness



- Tau2mu characterization :
  - The charge distribution follows a sigmoid function
  - f(x)=a/(1+exp(-b(x+c))) where
    - a=height of the step
    - b=sharpness of the transition
    - c=center of the step along x

Reconstuction of τ->μ event

- The idea is to minimize a likelihood function to find the following parameters:
  - The position of the decay
  - The direction of the particle
  - The energy loss of the particle
- The likelihood represent the probability to observe n_i photons in the ith pulse when the expected charge is μ_i:
- $$\mathcal{L}_{\tau 2\mu} = \prod_{i=1}^{K} \frac{e^{\mu_i}}{n_i!} \mu_i^{n_i}$$
- Tau2mu-llh is based on the following hypothesis:
  - The charge (or energy loss) along the track follows a step function

Reconstuction of τ->μ event

- Deals with ice properties and photons propagation via photons tables
- Use an infinite track of cascade as model for tau->mu track
- Still in progress...