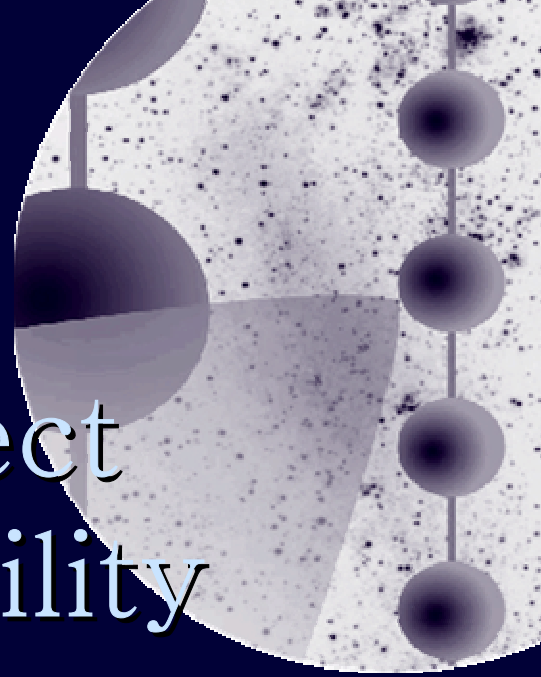
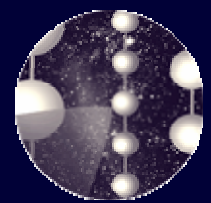


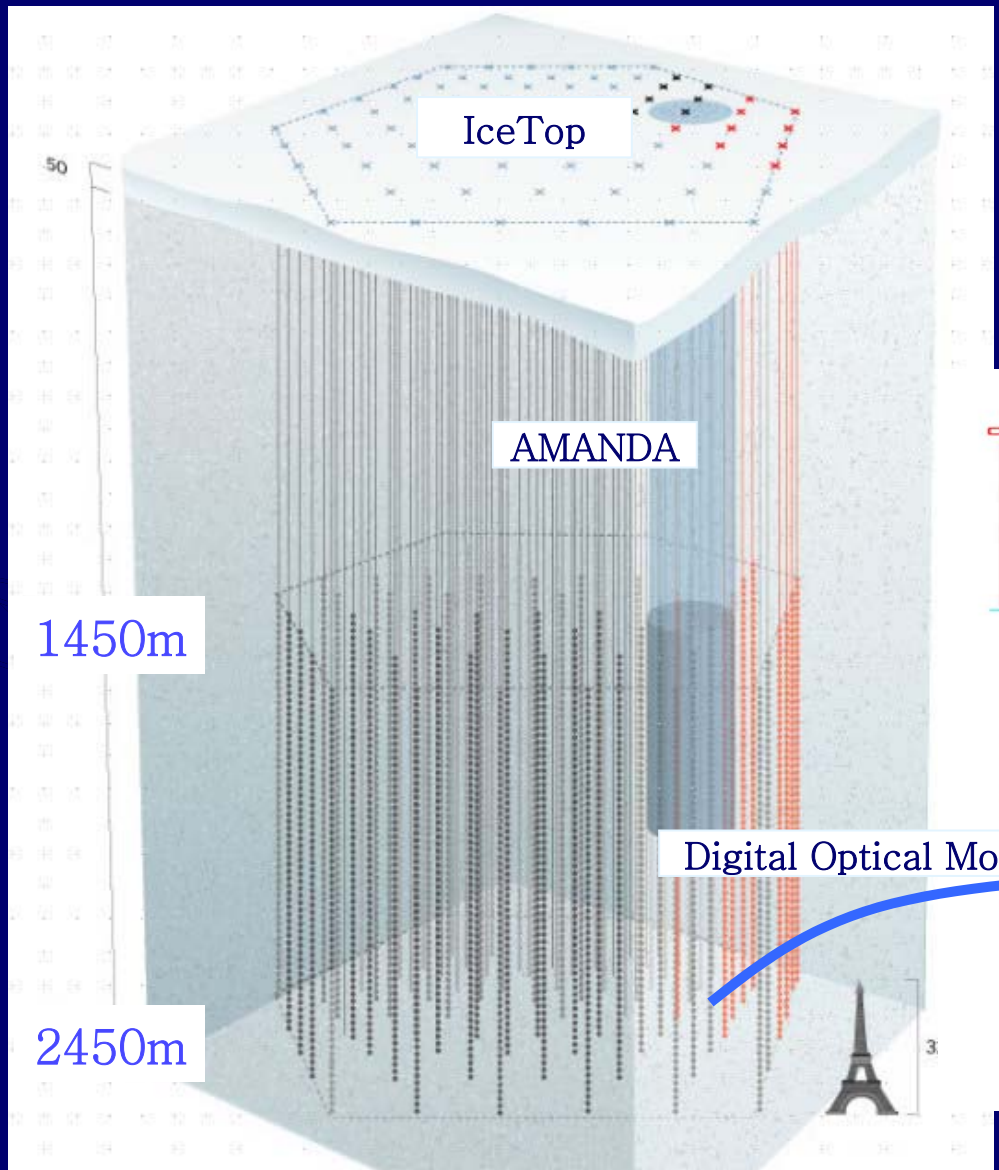
The IceCube project and its EHE capability

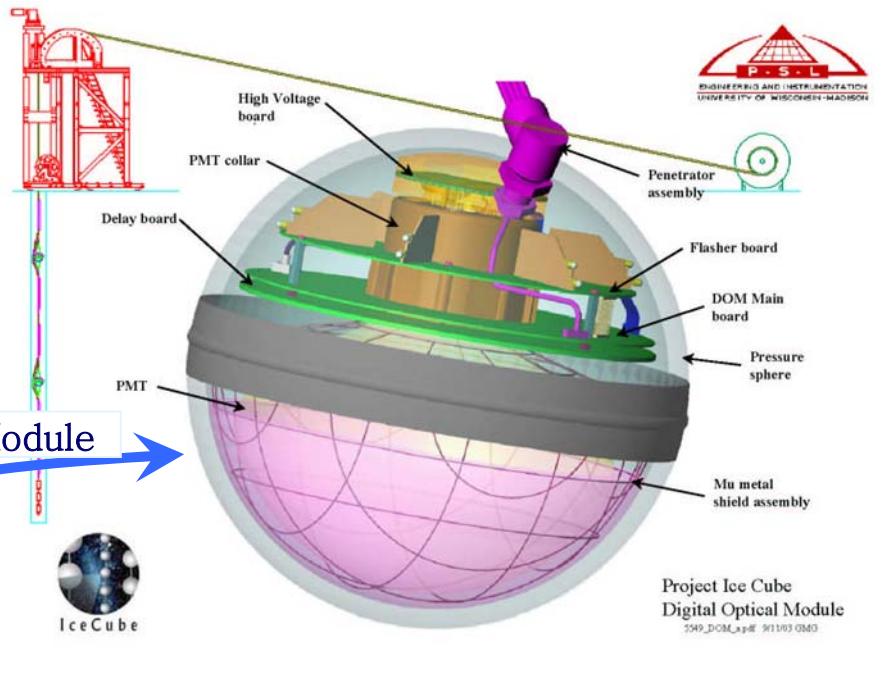
Aya Ishihara
University of Wisconsin – Madison
(for the IceCube collaboration)



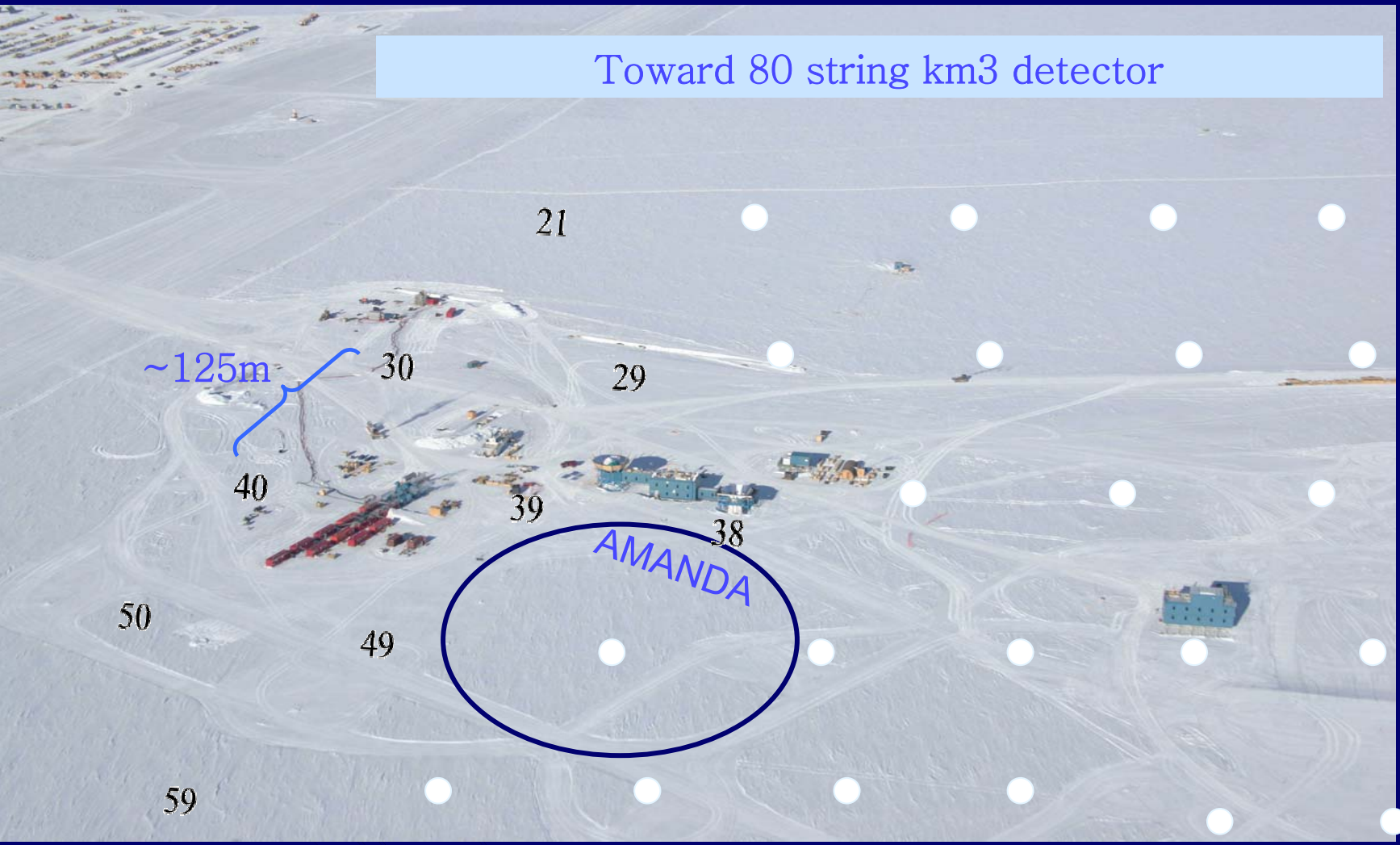
Outline

The IceCube Detector





This year's strings and more

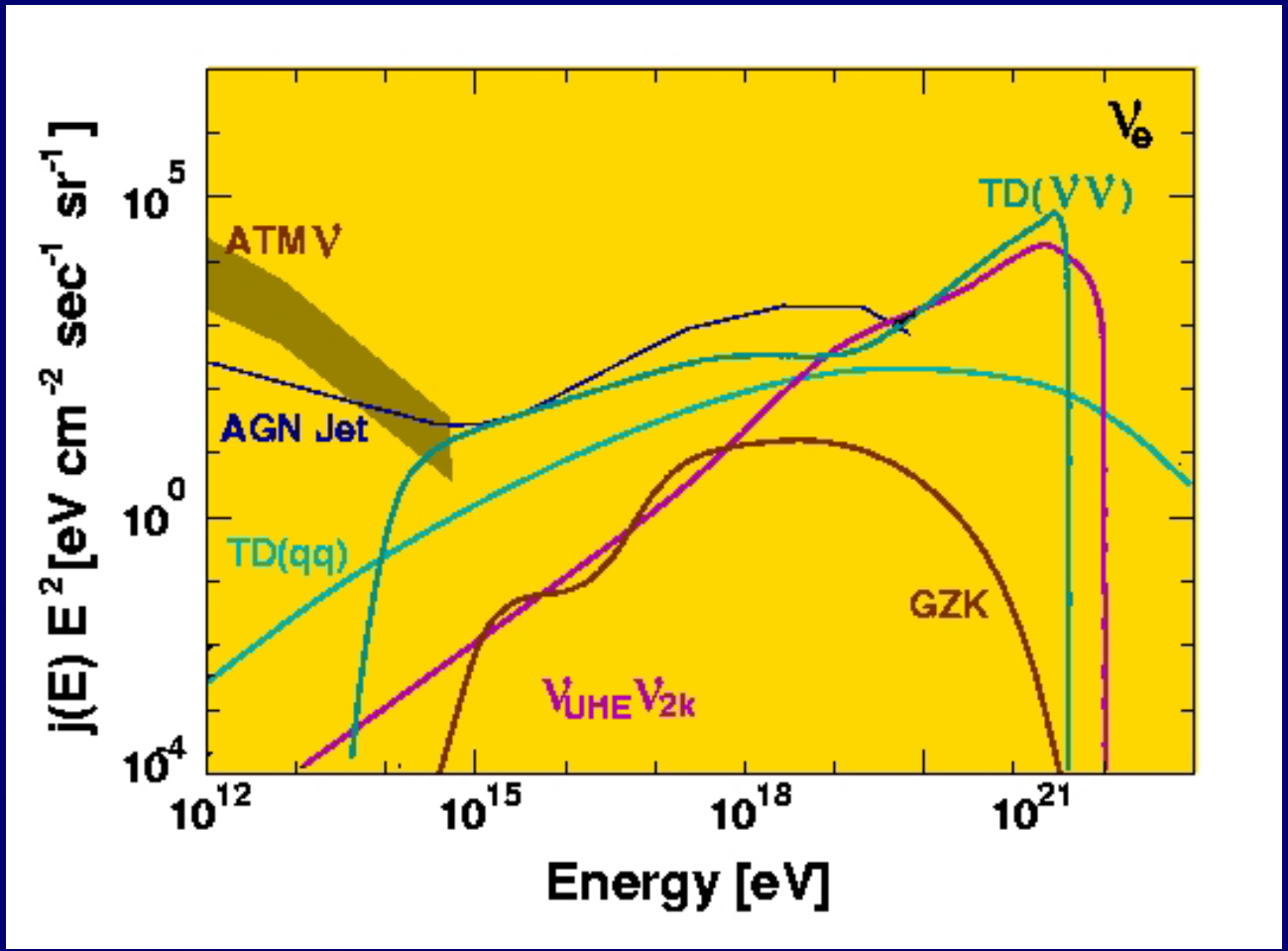


GZK Neutrino and Beyond

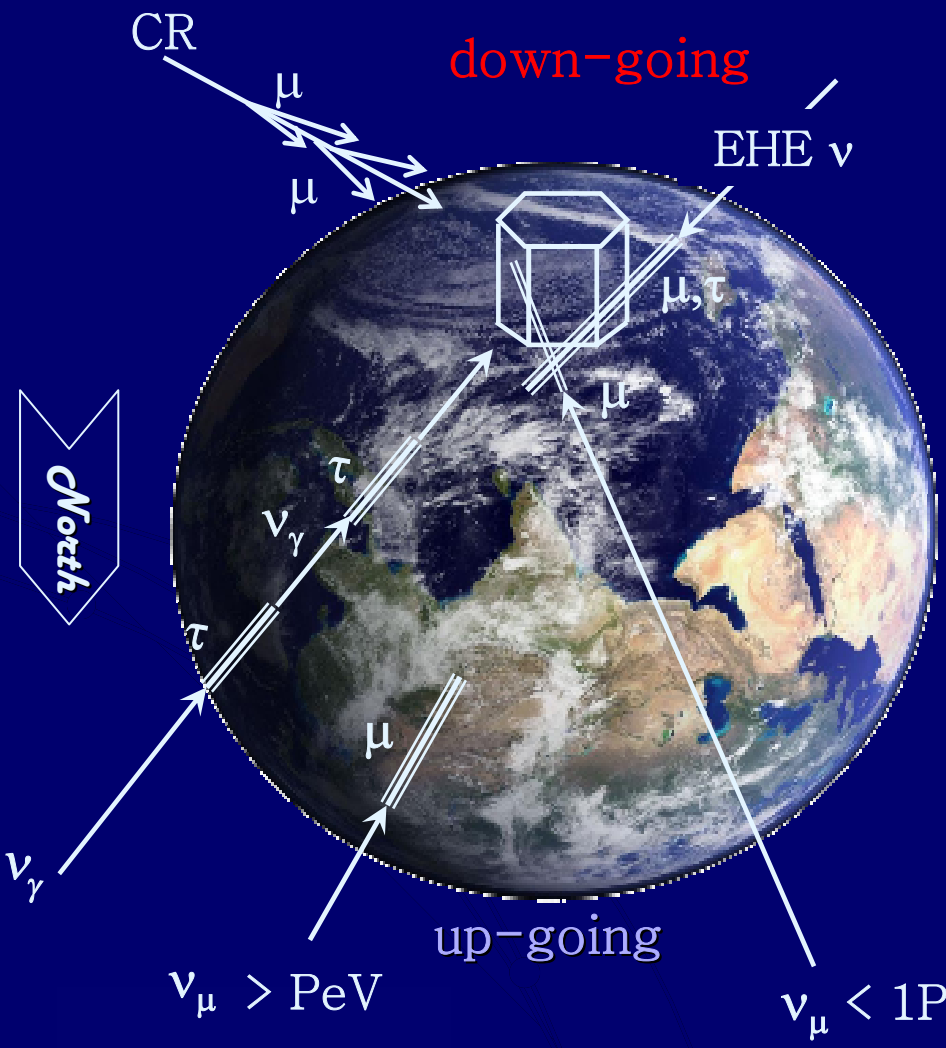
- GZK neutrino

- Beyond the Standard Model

Extremely High Energy Neutrino Targets



EHE Events in the Earth

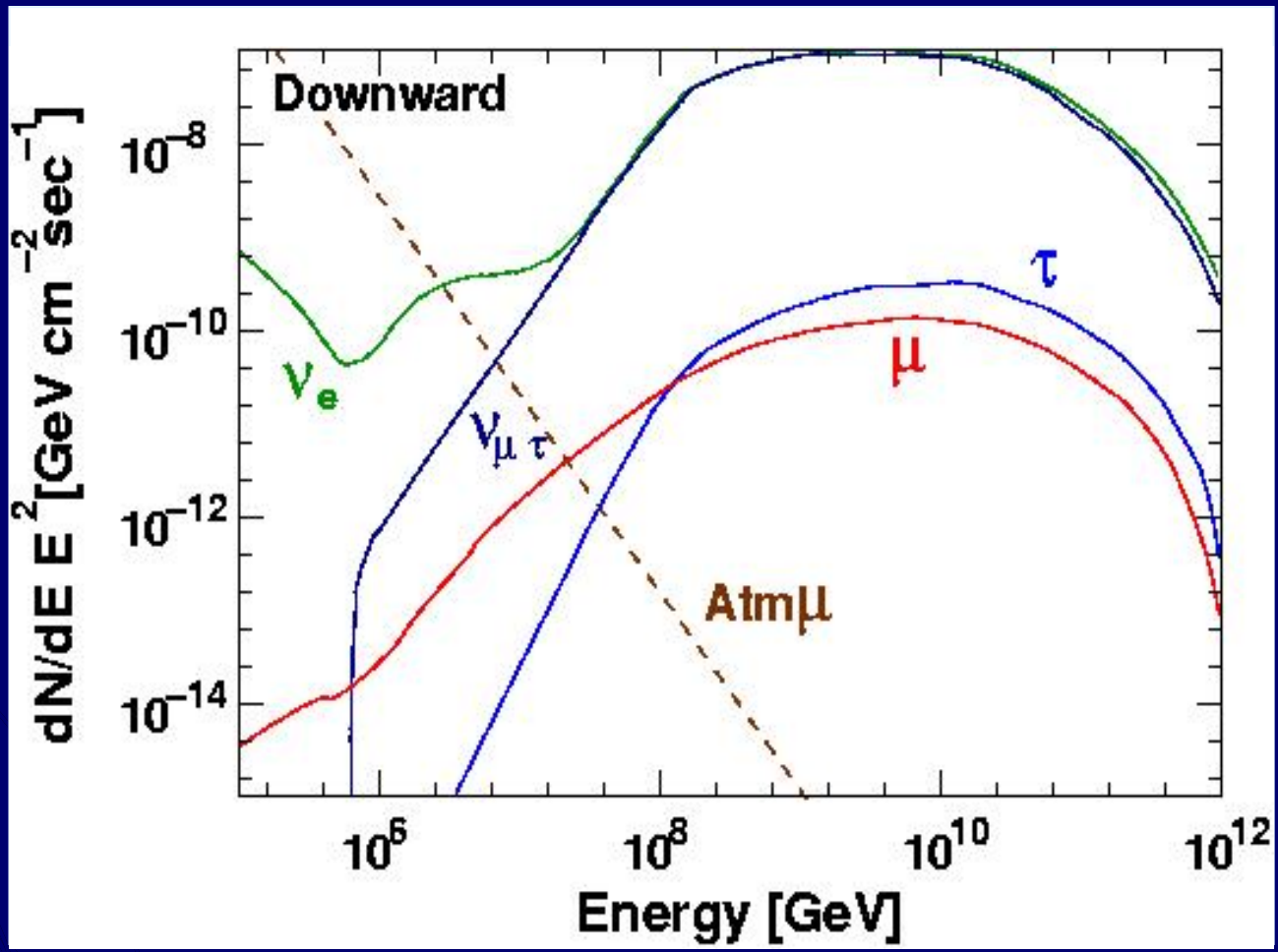


- Generally upgoing events are selected
- Earth is opaque for EHE neutrino
- EHE neutrino events are mostly down-going NOT up-going

EHE Events in Ice

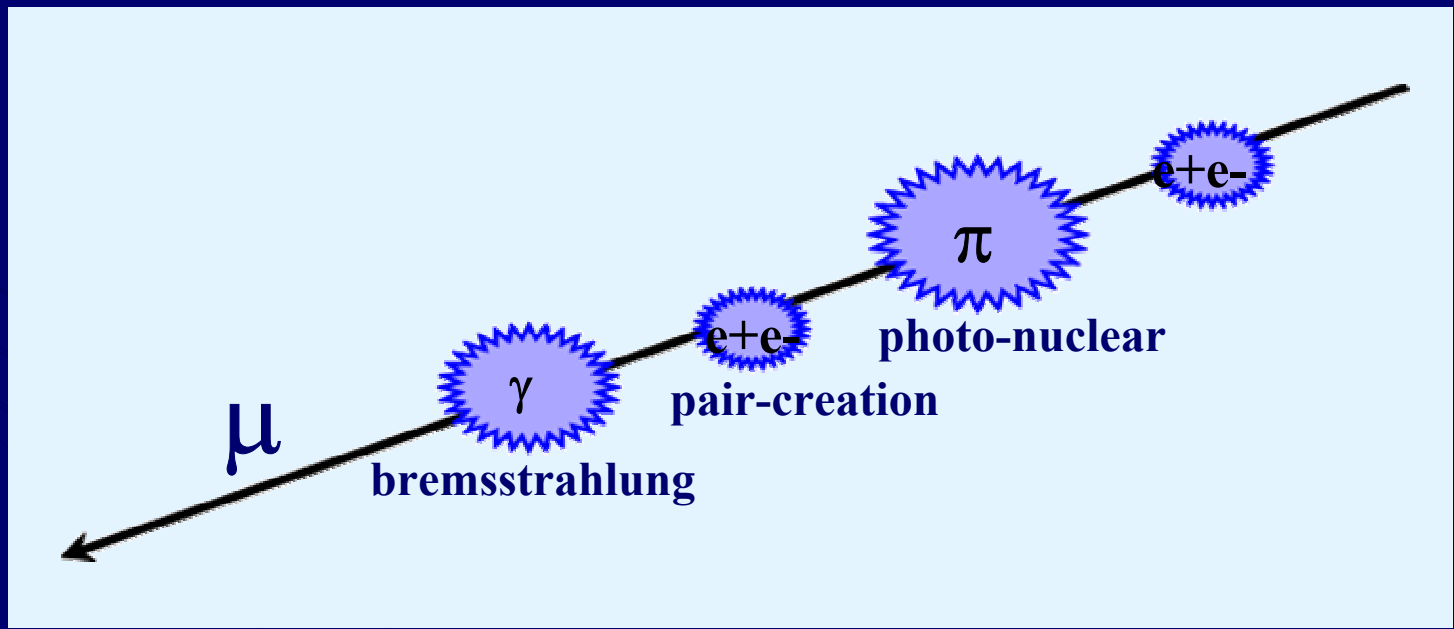
GZK neutrino induced lepton and atmospheric muon fluxes at the IceCube depth

$E_{GZK} >> E_{Atm\mu}$

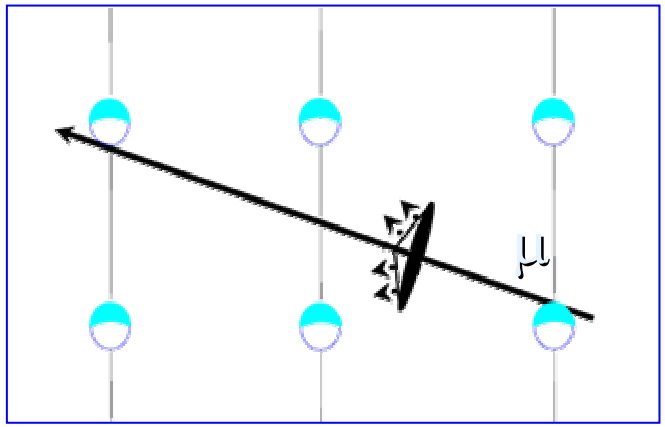


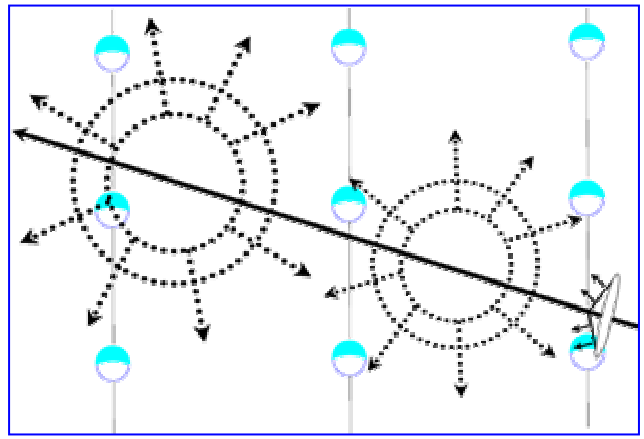
EHE Events with the IceCube

- Muon energy losses by radiation cascading dE/dx propto E

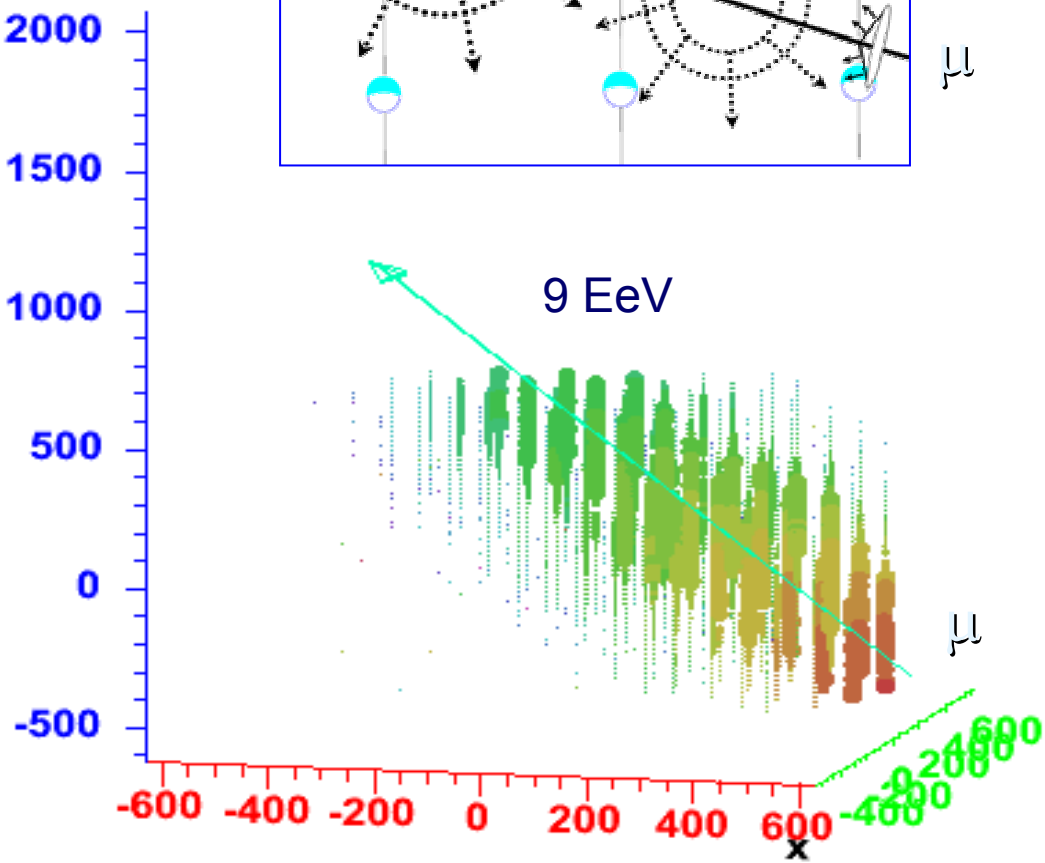


Muon Events





100 TeV
μ
2000
1500
1000
500
0
-500
600
400
200
0
-200
-400
-600 -400 -200 0 200 400 600
x

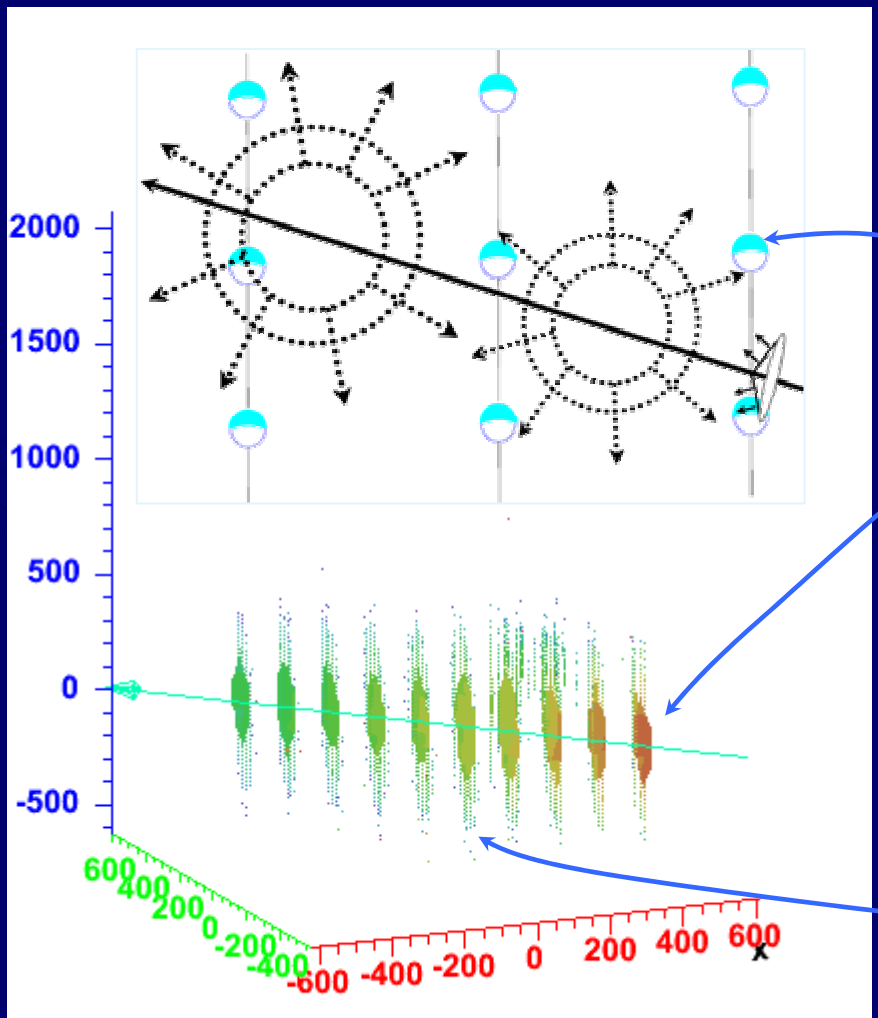

9 EeV
μ
2000
1500
1000
500
0
-500
-600 -400 -200 0 200 400 600
x

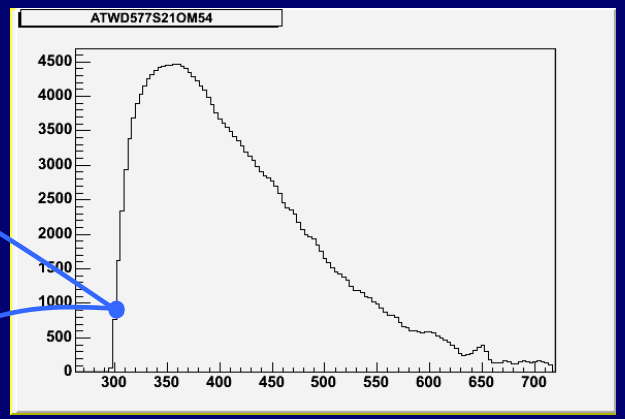
MC Setup

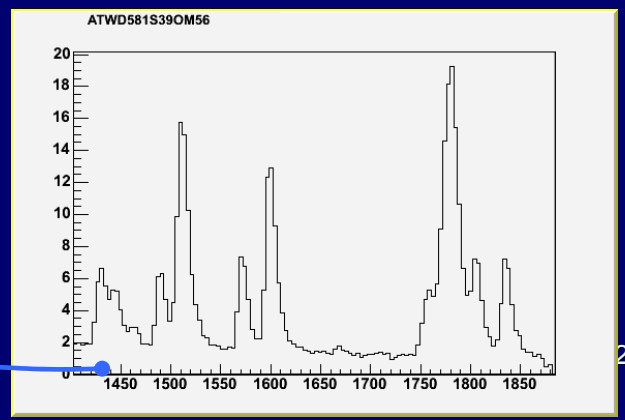
- Benchmarking models
  - GZK muons and tau signals
  - Atmospheric muon background

NPE

- Explain Waveforms and NPE just an integral of all the arrival phot-electron
- In-ice particle energy dependent, No timing/geometrical information

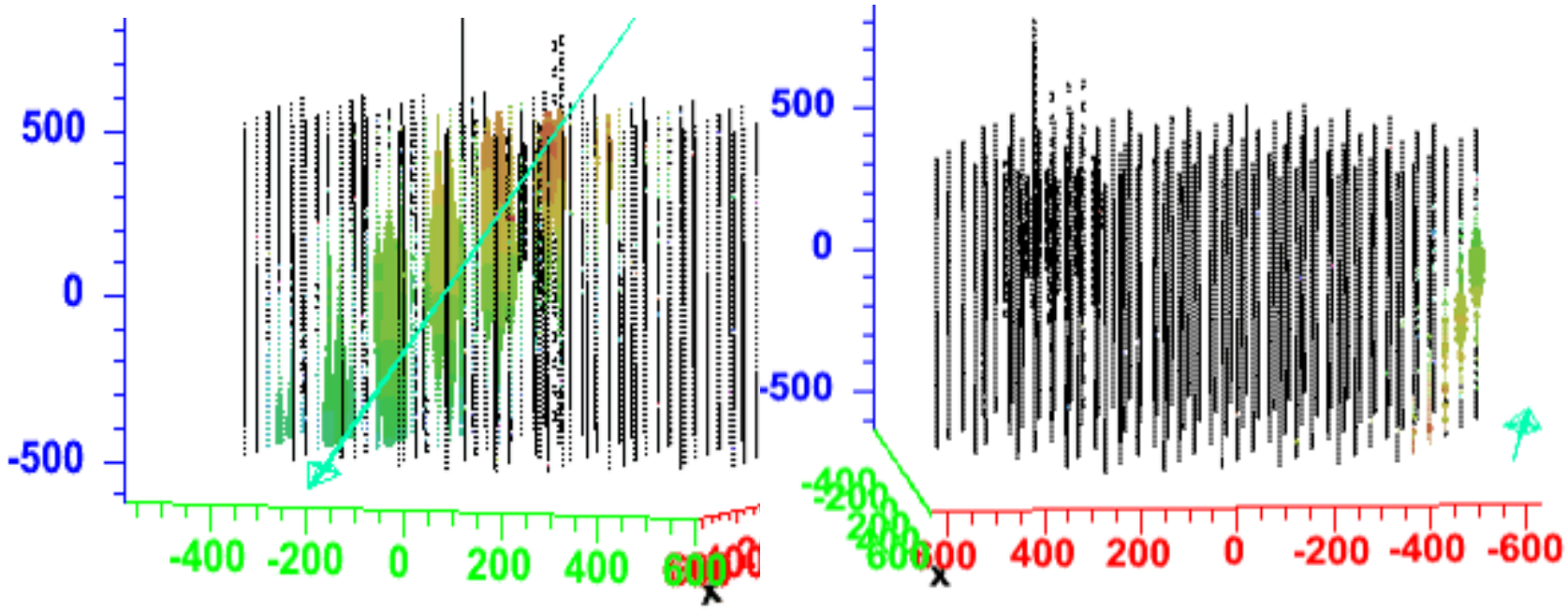






Another factor to NPE

Events with the same energy ~ 30PeV

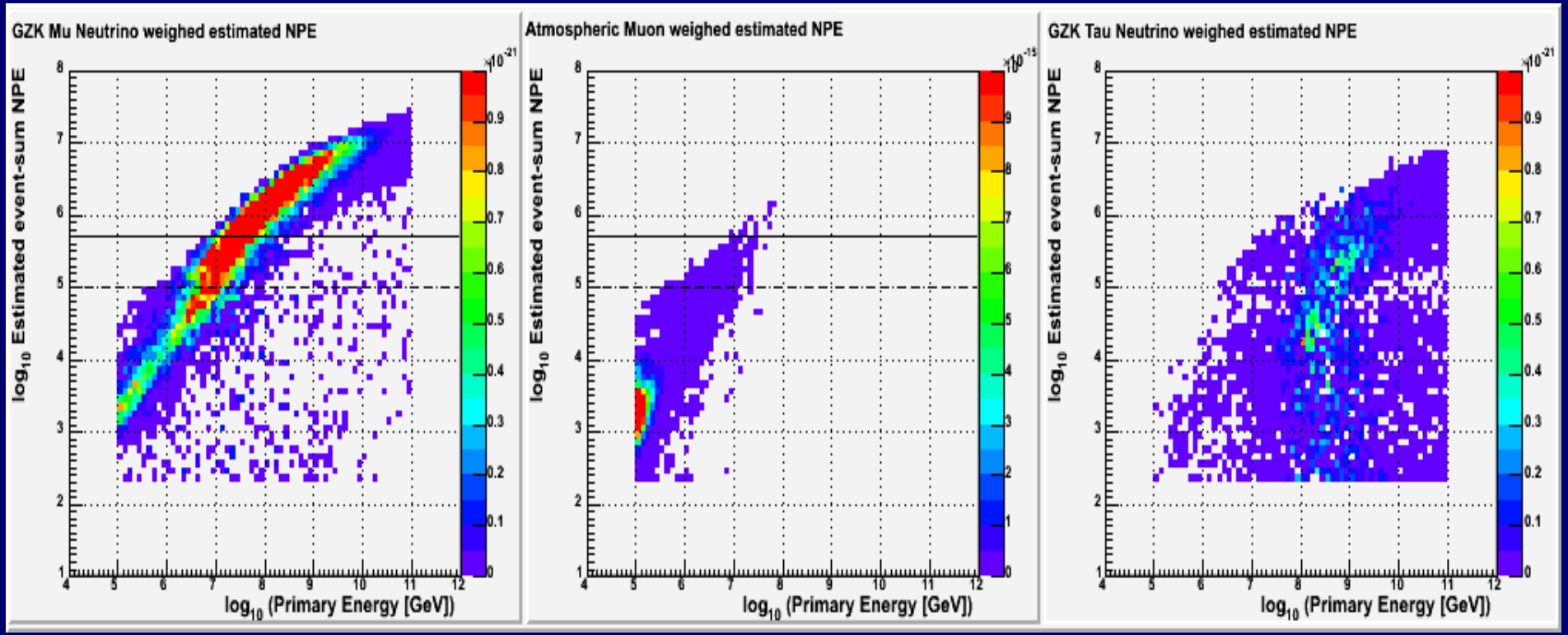


contained
High npe: 10^7 npe

uncontained
Low npe: 1000 npe

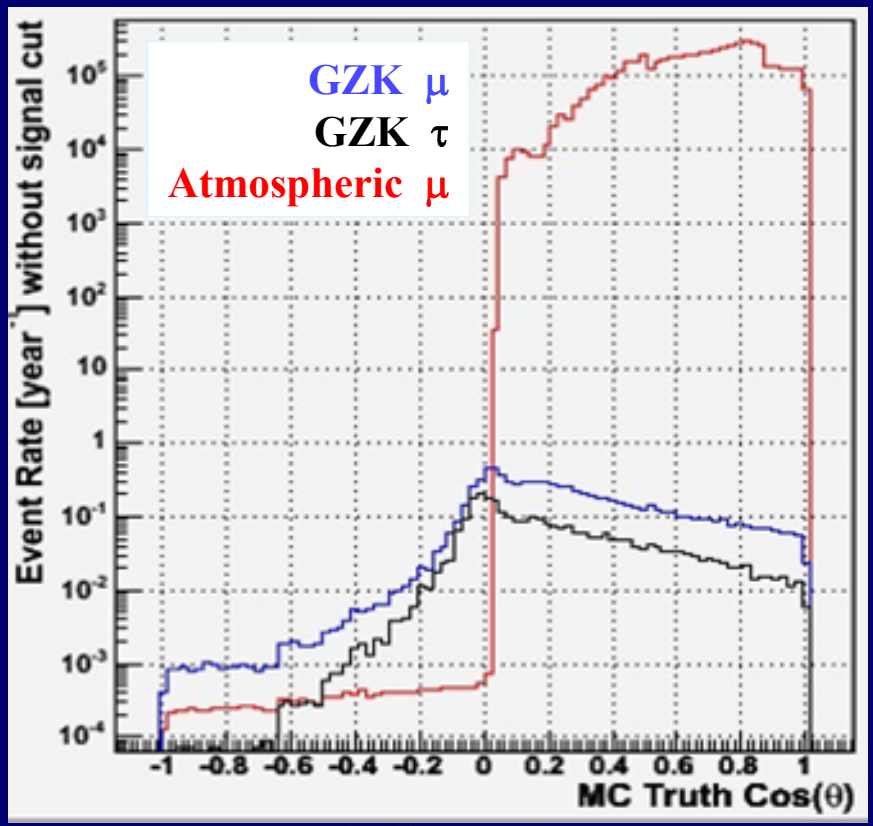
NPE Distributions

GZK μ **Atmospheric μ** **GZK τ**



Zenith Distributions

Zenith angle

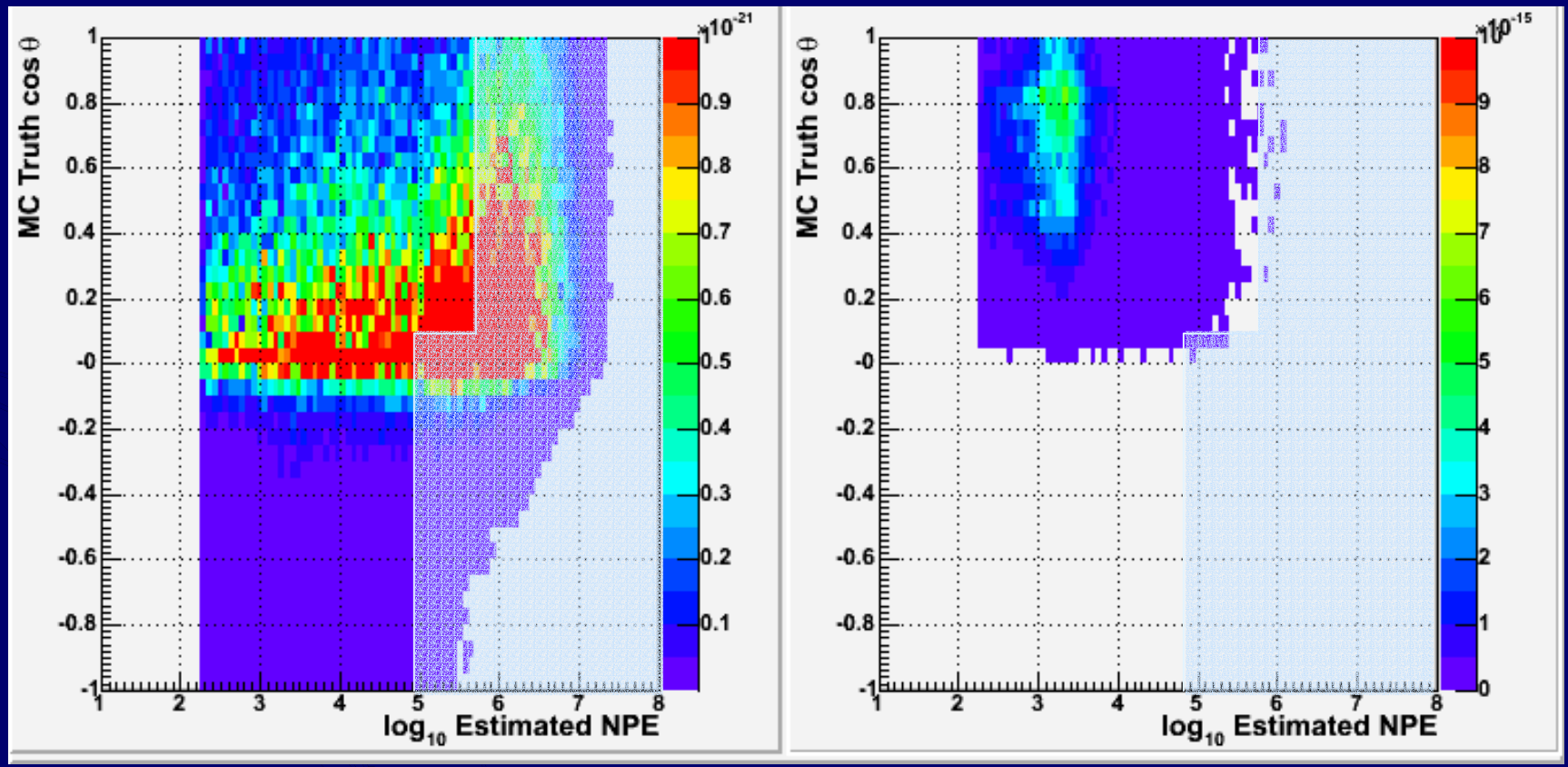


up

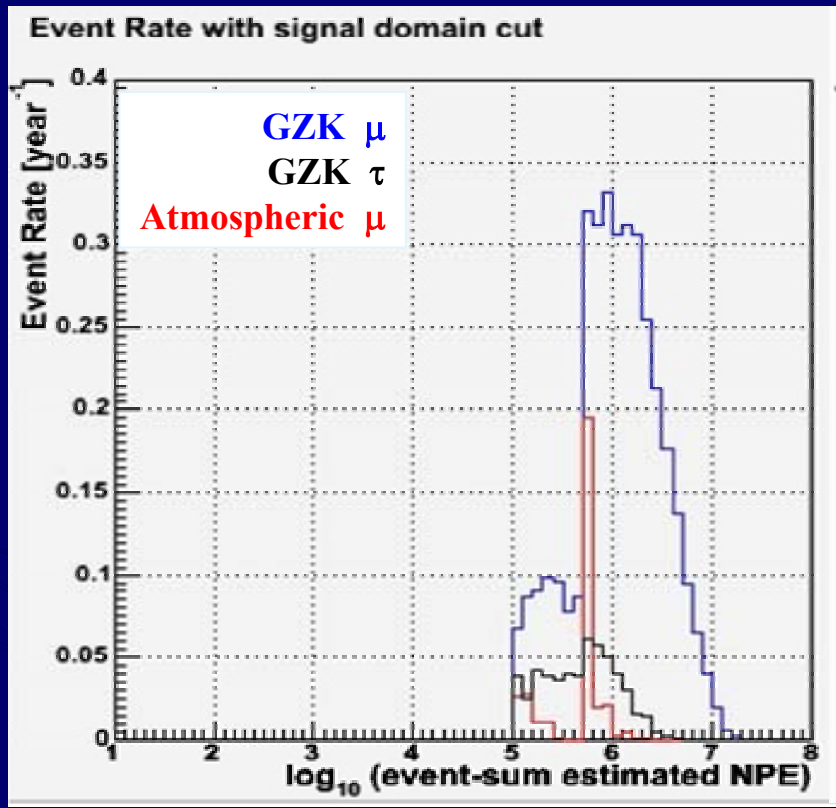
down

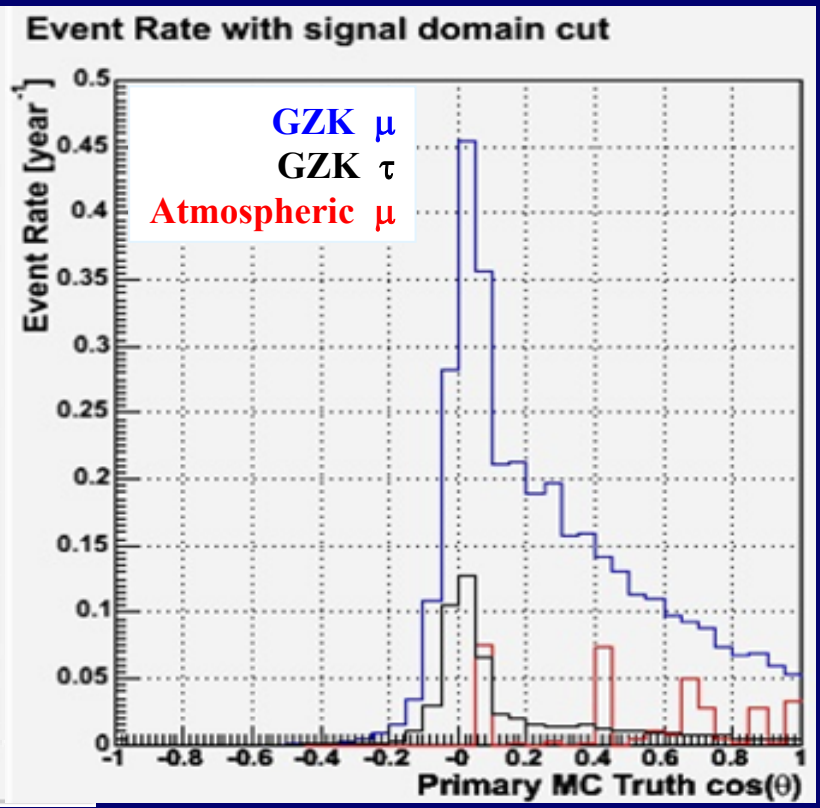
Signal Cuts

GZK μ **Atmospheric μ**



Event Rate 80 strings

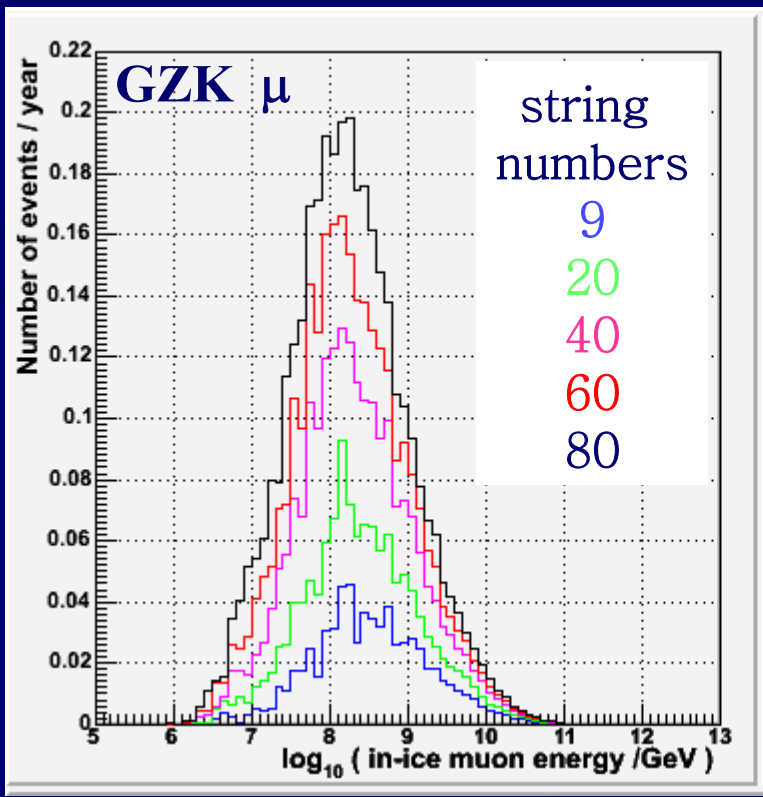


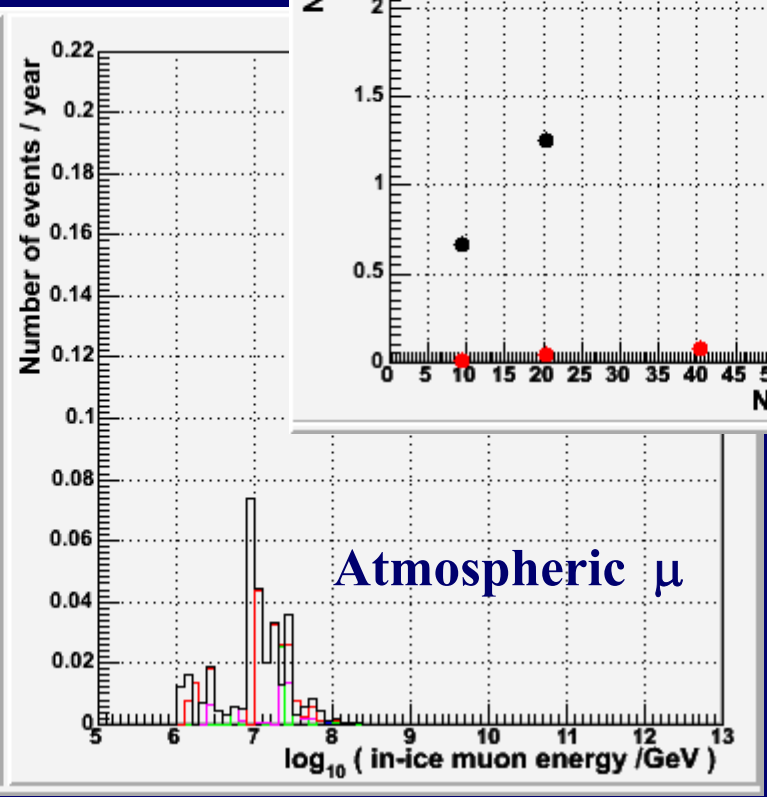


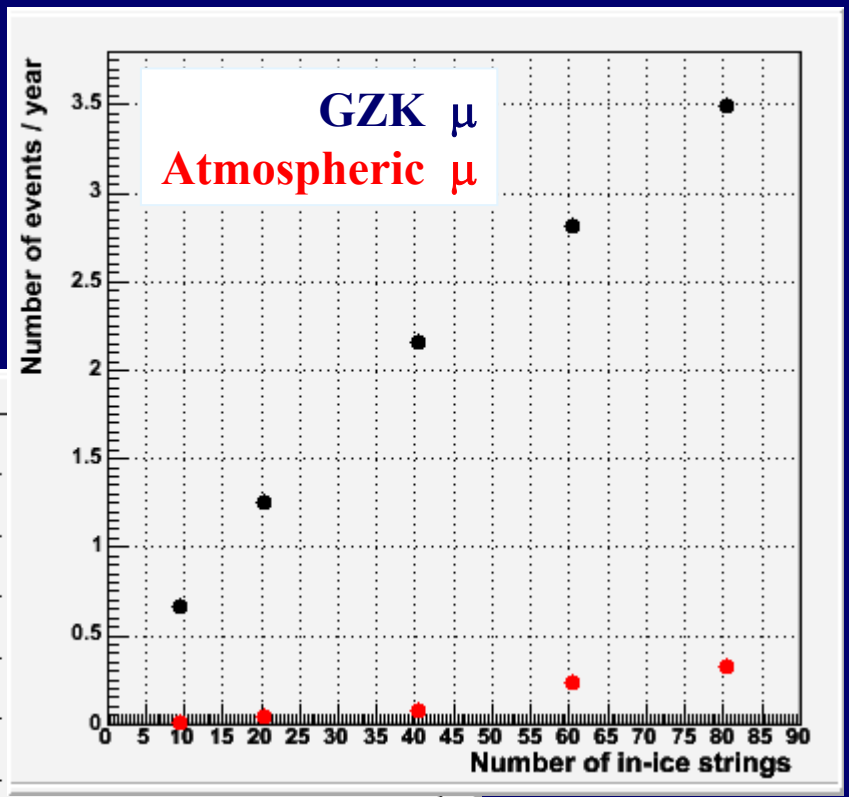
GZK μ	3.5 events/year
GZK τ	0.56 events/year
Atmospheric μ	0.33 events/year

Event Rate 9 strings and more

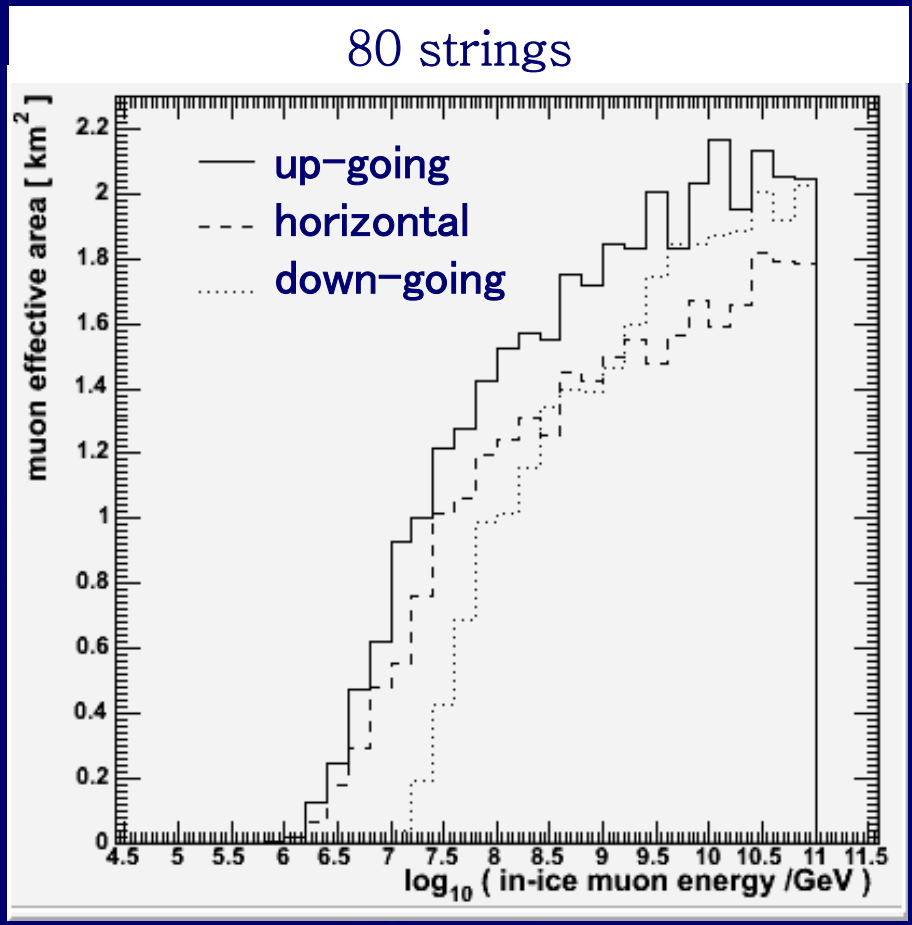
- With the same cut for all the string numbers

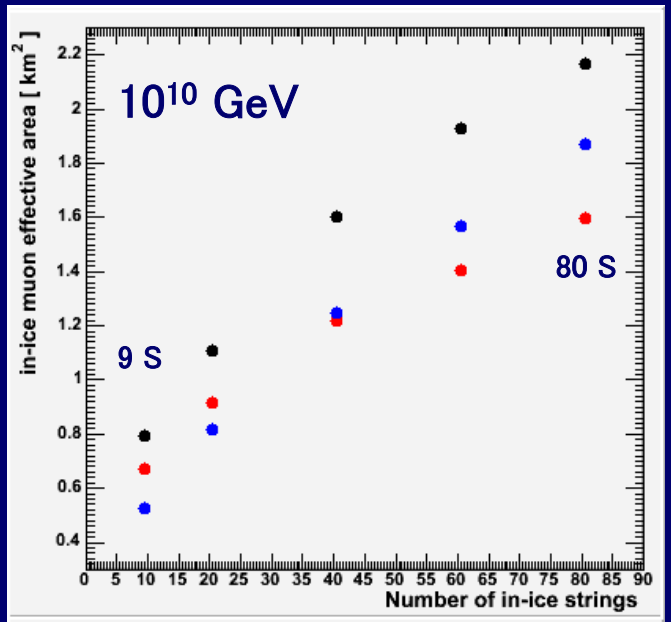


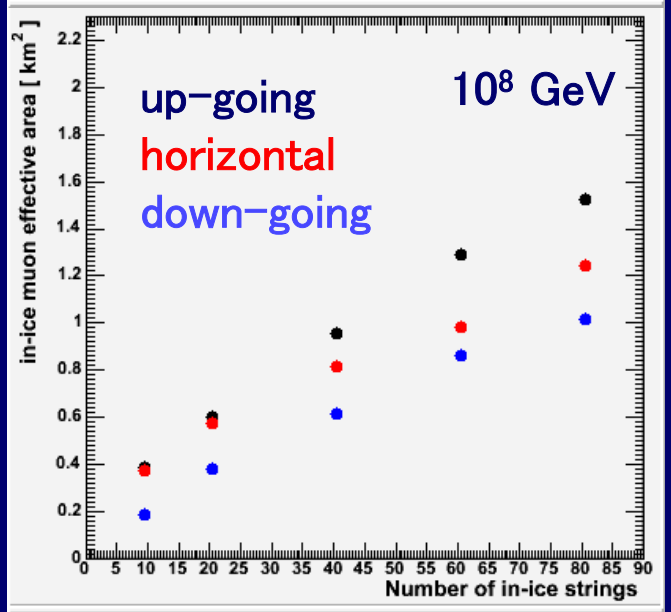




Effective Area

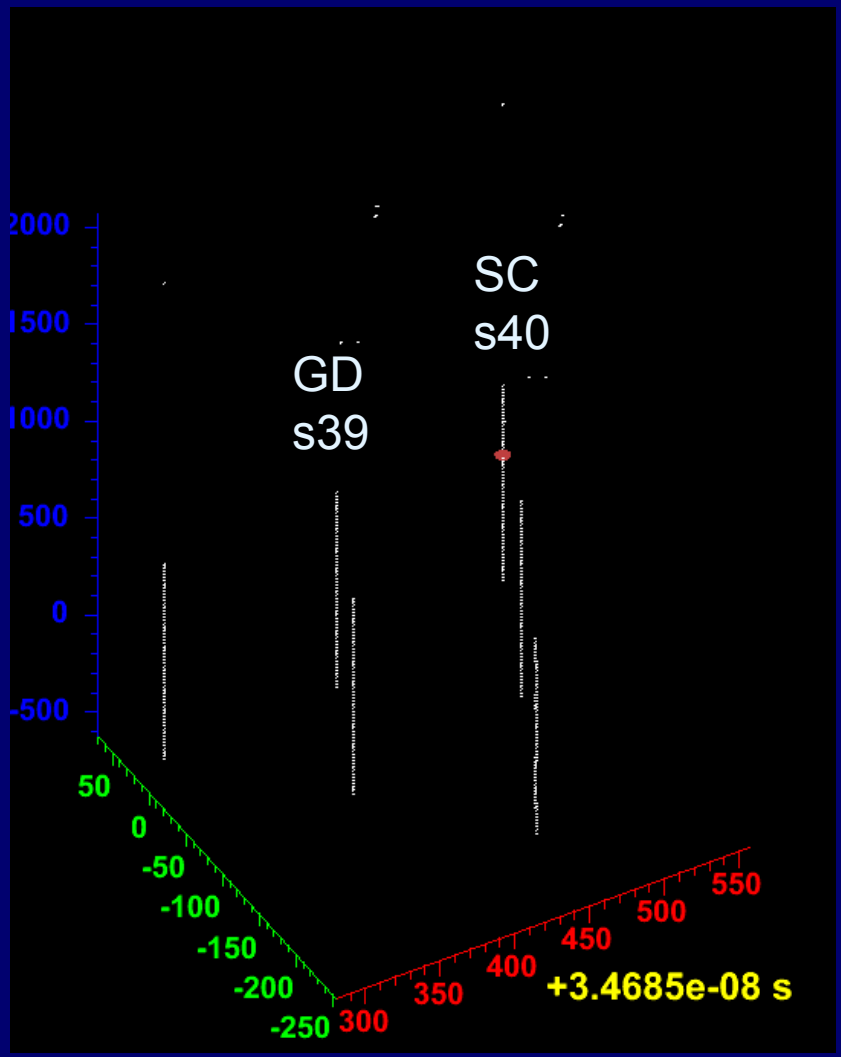






Energy Calibration

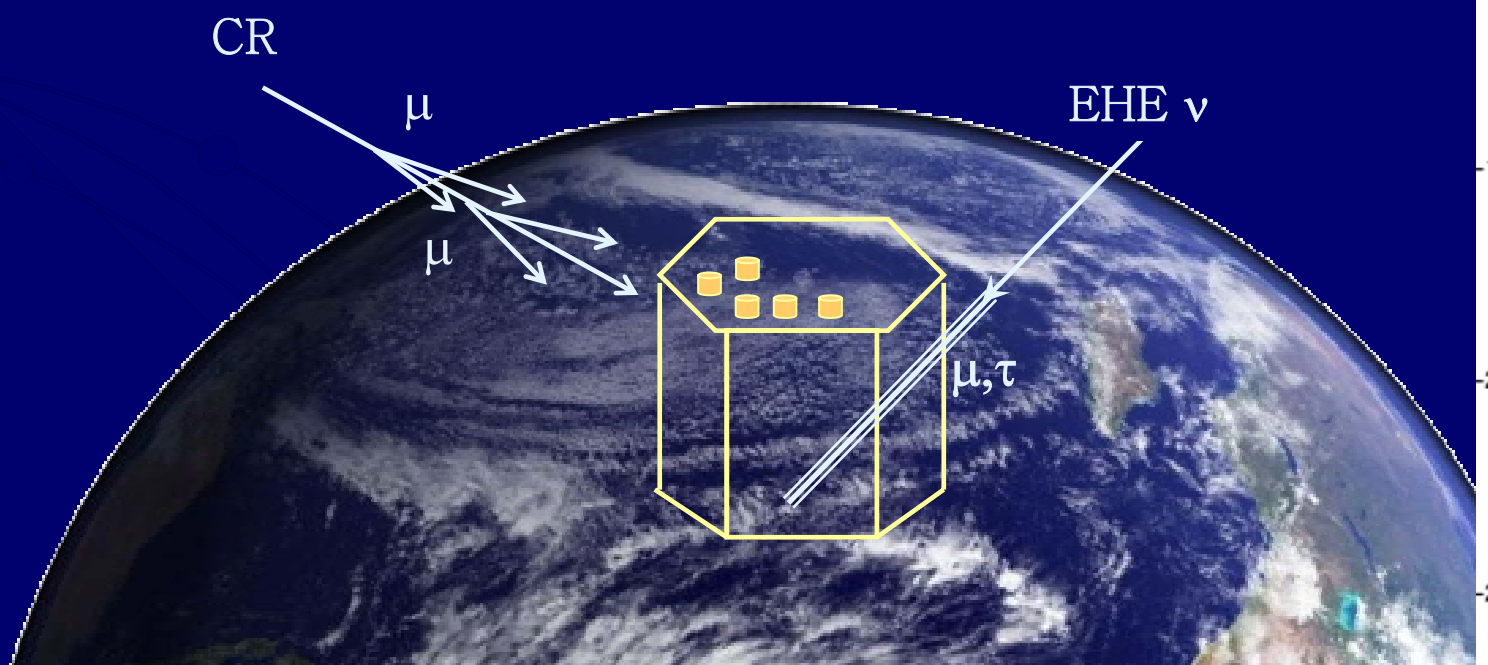
- Absolutely calibrated photon source (standard-candle) and receivers (golden-dom)

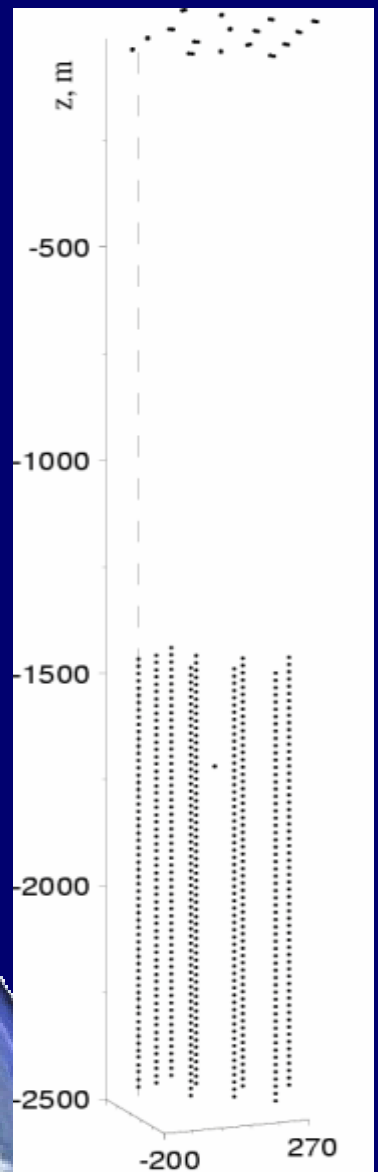


Standard Candle

IceTop: Background Tagging

- Major background is atmospheric muon of which in-ice nature still unknown at this regime
- Tagging on the surface muons with surface array for an additional information





Conclusion -outlook-

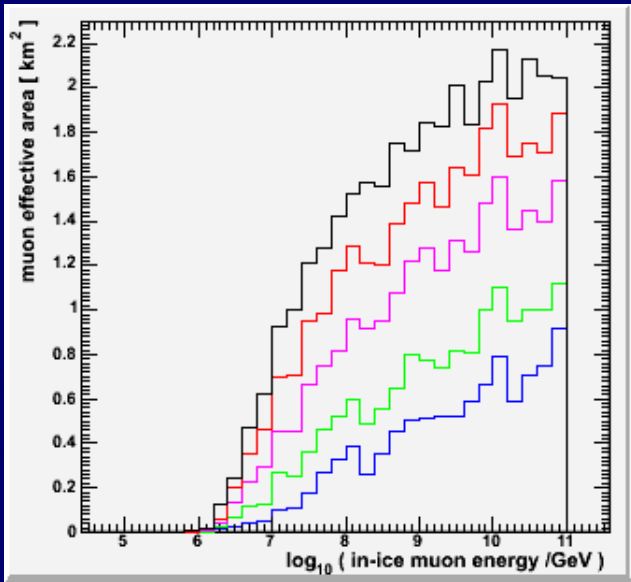
- IceCube is capable of EHE and the capability is glowing year-by-year
- EHE event selection can be done only using amount of photon emitted / received
- For reconstruction of further uncontained events, energy/geo, more sophisticated methods using information of photon propagation in ice, e.g. arrival timings, geometrical distributions reflected in waveforms
- subsystems

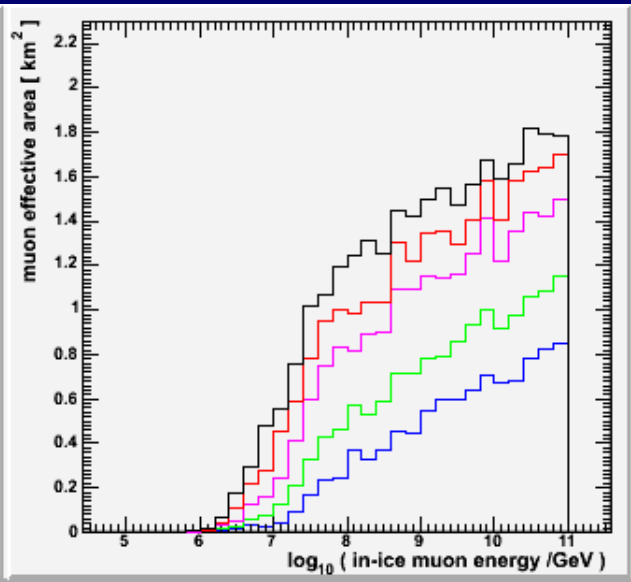
Extra slids

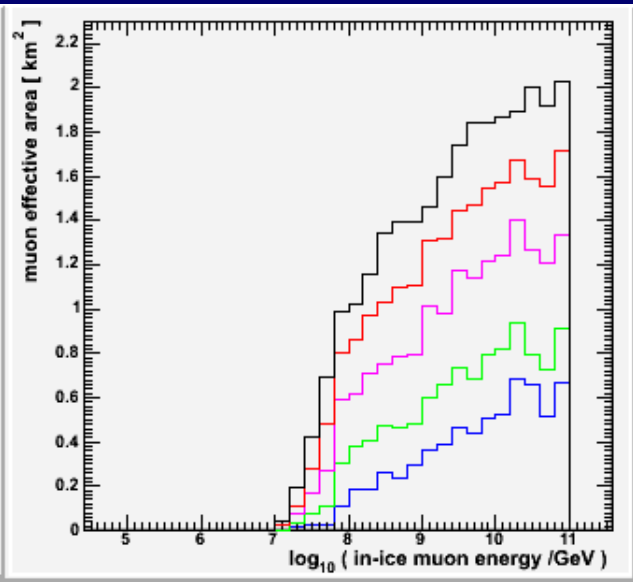
Timing/Geometry

- In-ice in-DOM flasher

Effective Area 9 strings and more

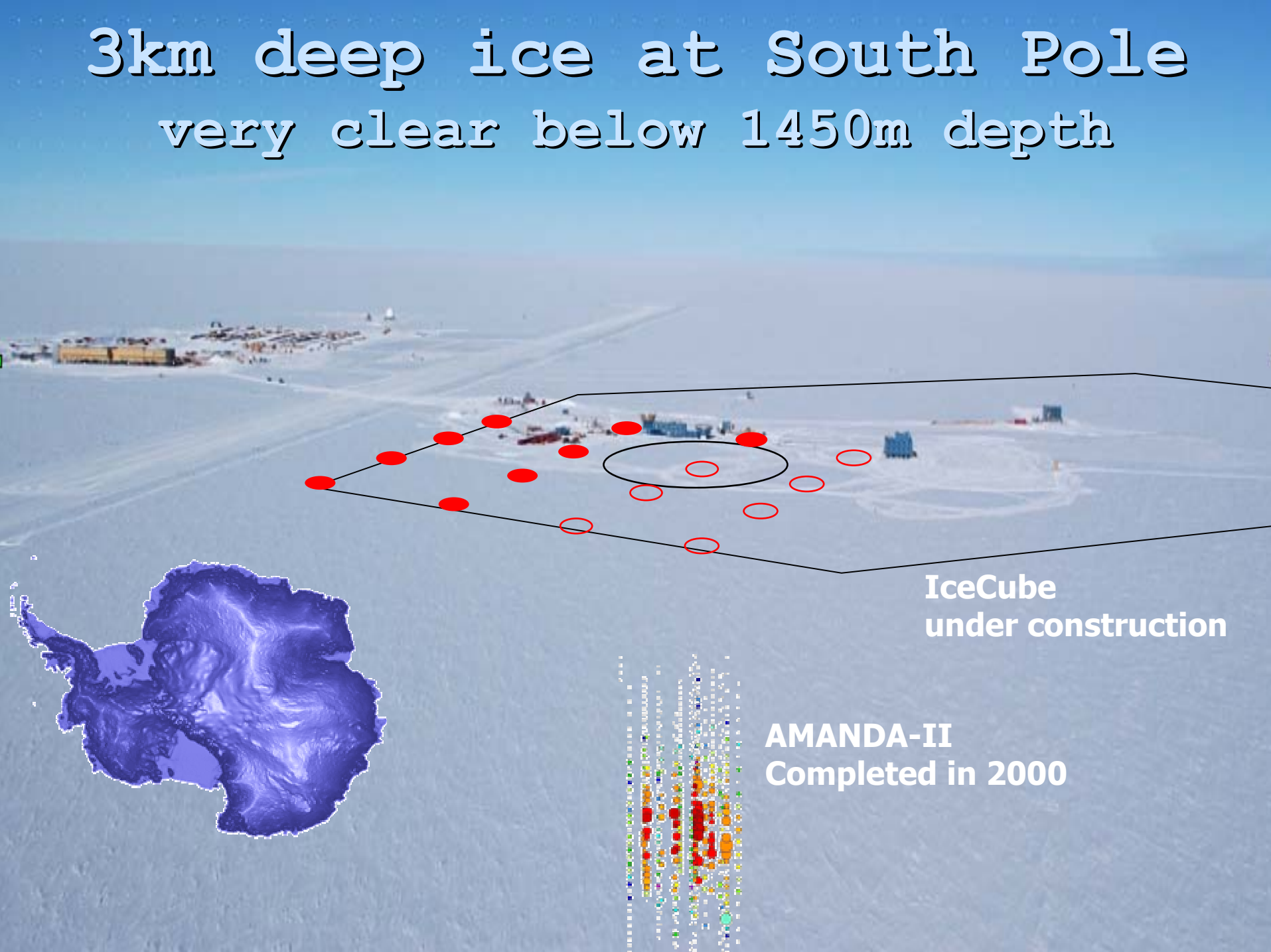






3km deep ice at South Pole

very clear below 1450m depth



IceCube
under construction

AMANDA-II
Completed in 2000

The IceCube collaboration