Measuring Composition Resolution w/IceCube

- Energy Spectrum: $N_{e,}$ Composition: N_{μ} vs N_e
- SPASE/AMANDA (also IceCube) $N_{\mu}(> 500$ GeV) vs N_e

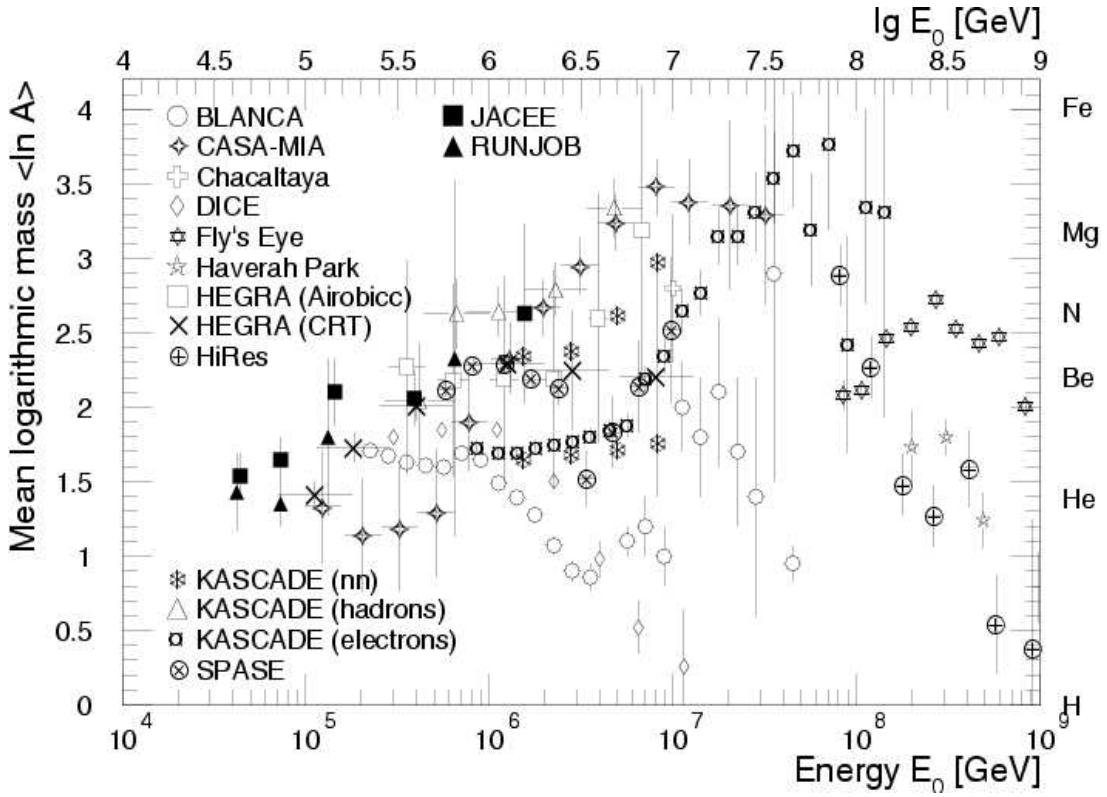
  cf. Sea level + $N_{\mu}(> 1$ GeV)
- Relation to X_{max}
- SP2+/AMII, IceCube

Spectrum and Composition

Hoerandel – ICRC 2001

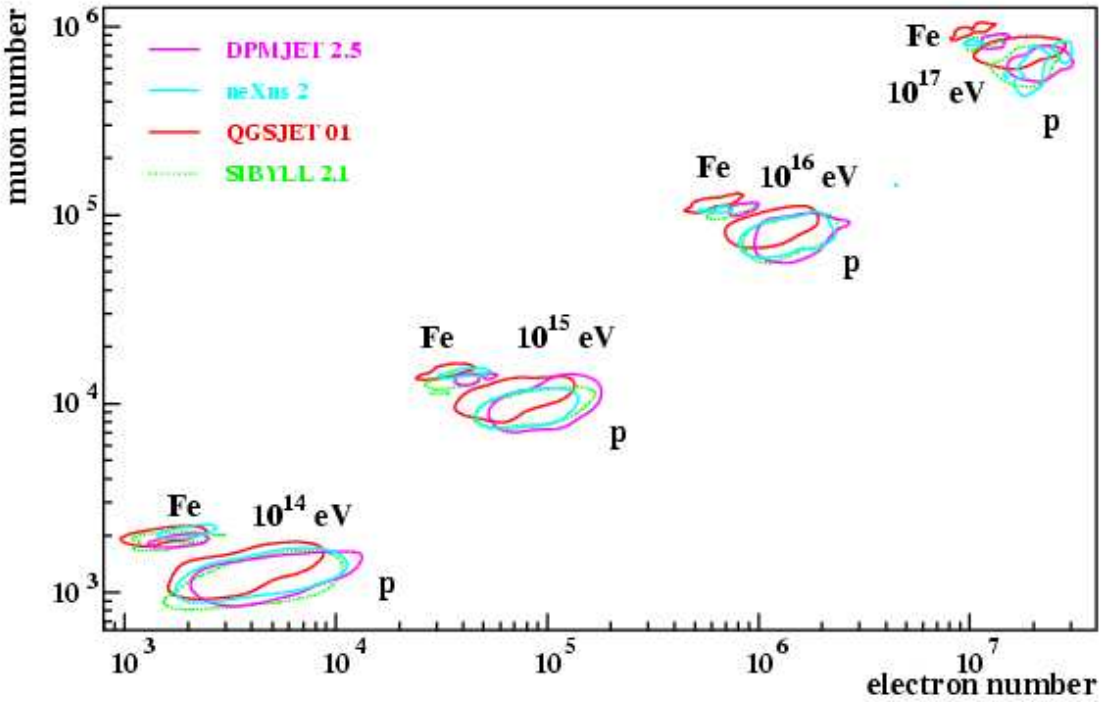
Imagine:

- Cosmic ray spectrum
- Log(E^2 dN/dE) vs Log(E)
- Several experiments
  - agree on slope
  - but not on amplitude
  - or details
- Knee & Ankle



Modeling Composition

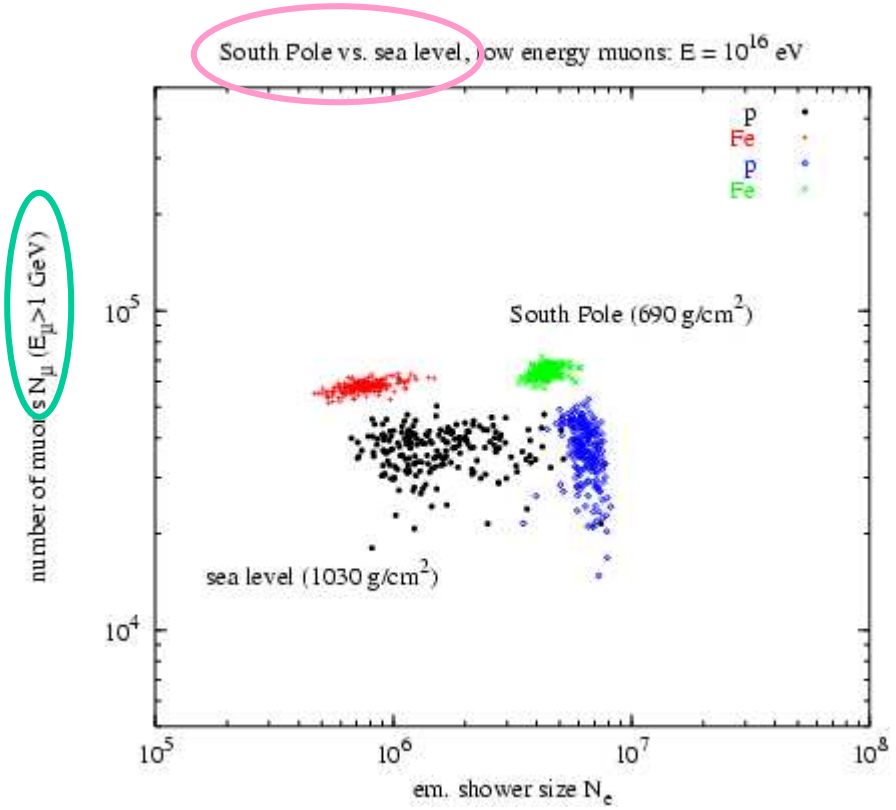
Heck, ICRC 2001

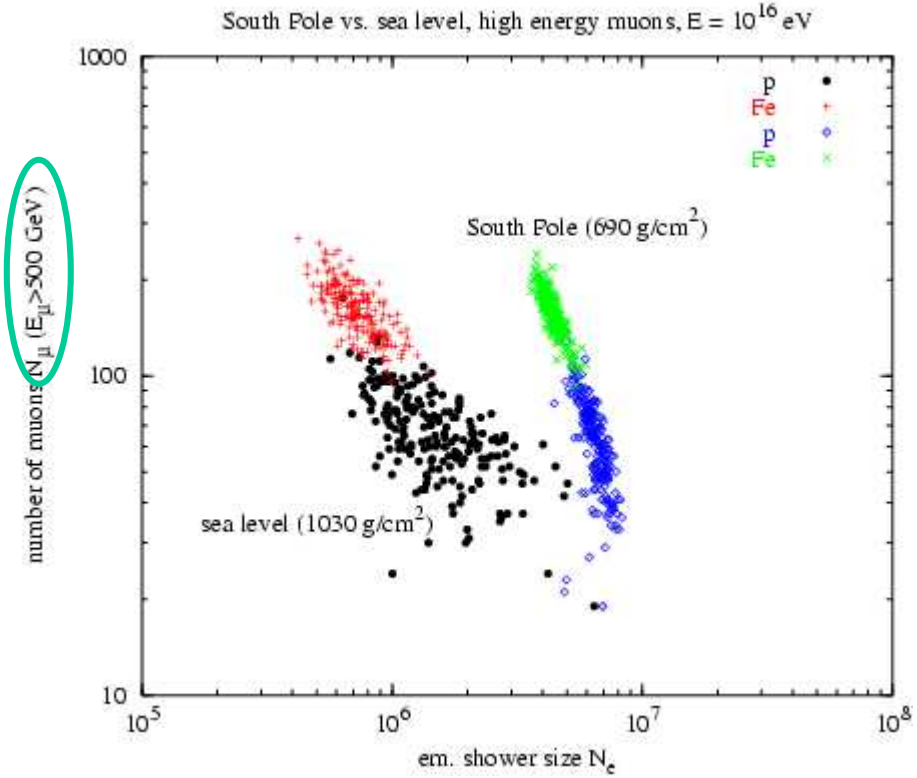


Muon vs. electron numbers as function of energy and primary particle.

(Vertical incidence, $\varepsilon_{\text{thin}} = 10^{-5}$, $E_\mu > 0.1$ GeV, $E_e > 0.1$ MeV, 110 m a.s.l.)

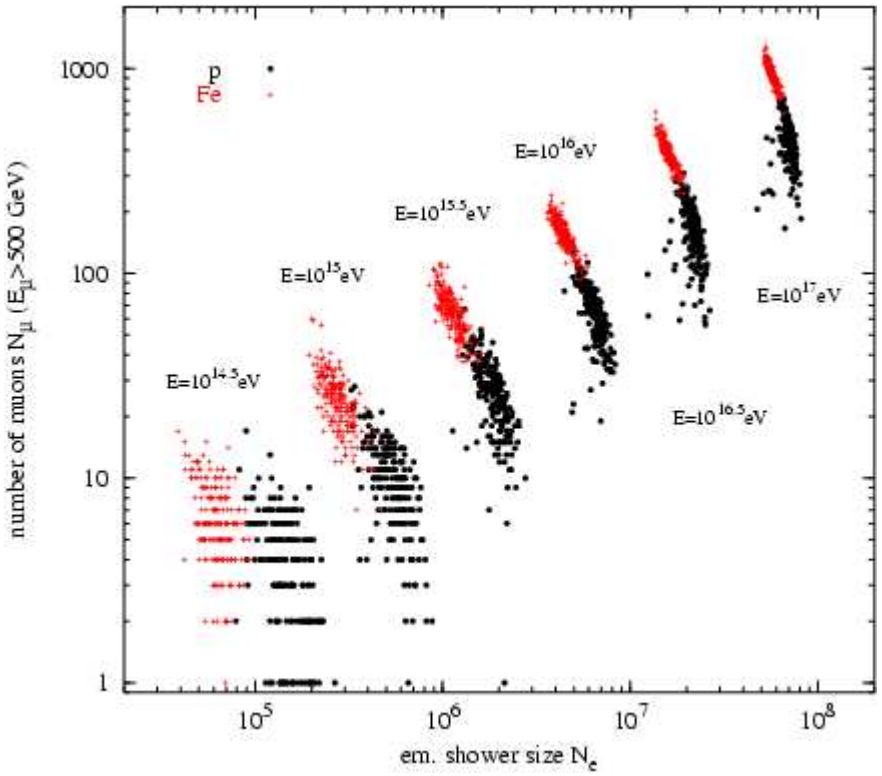
Advantages of IceCube (SPASE/AMANDA)

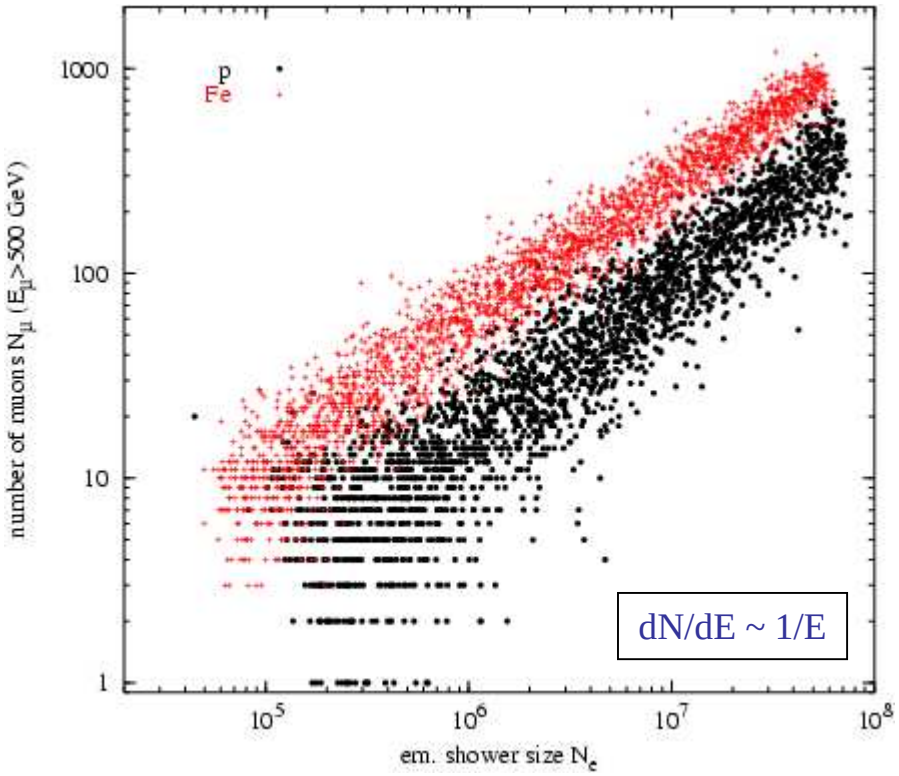




Simulation by Ralph Engel: MOCCA/SYBILL 2.1

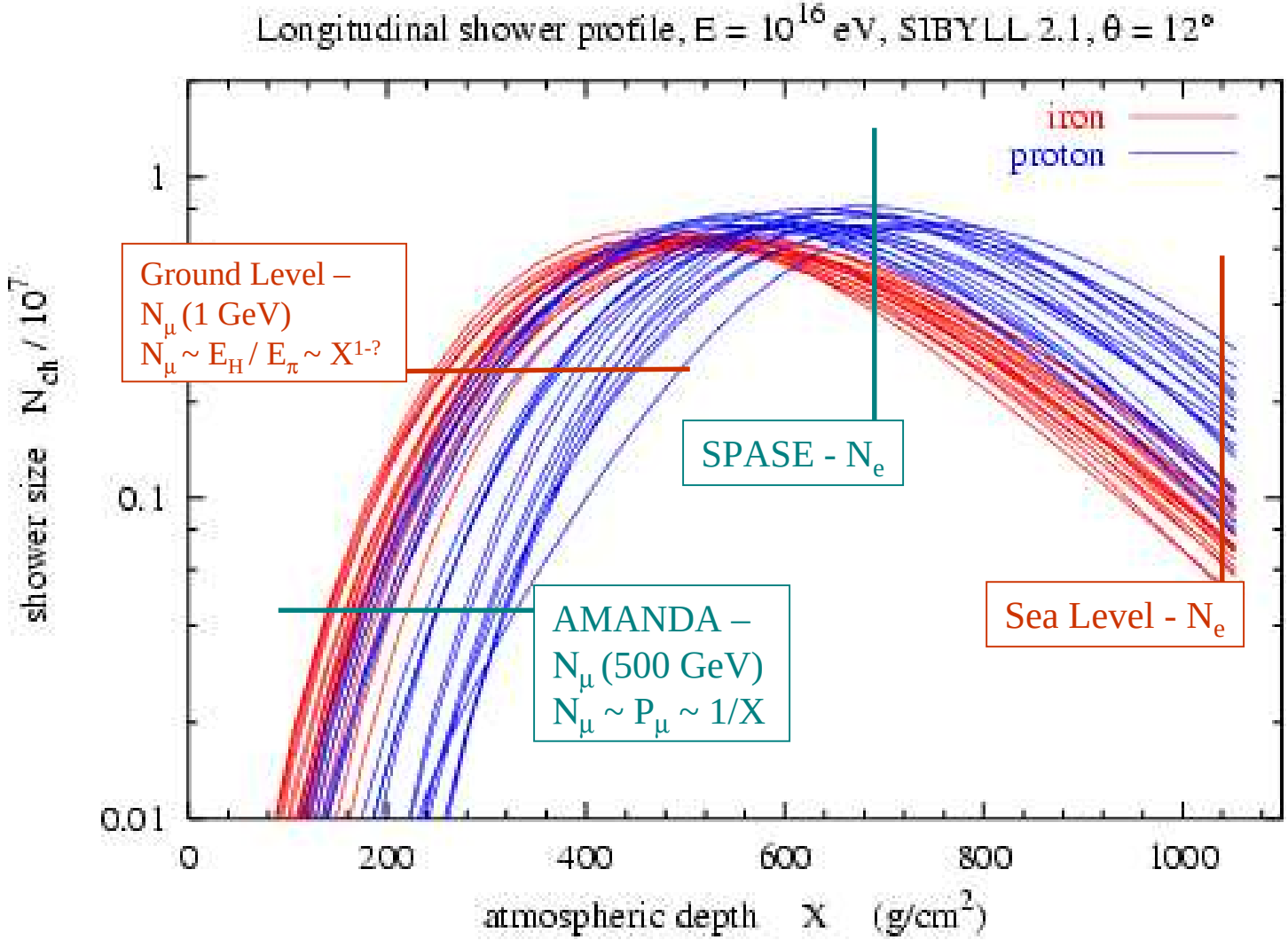
More about SPASE/AMANDA





Simulation by Ralph Engel: MOCCA/SYBILL 2.1

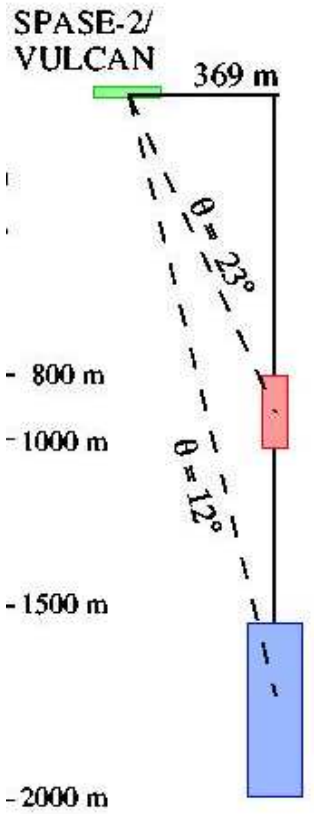
Relationship to X_{max}

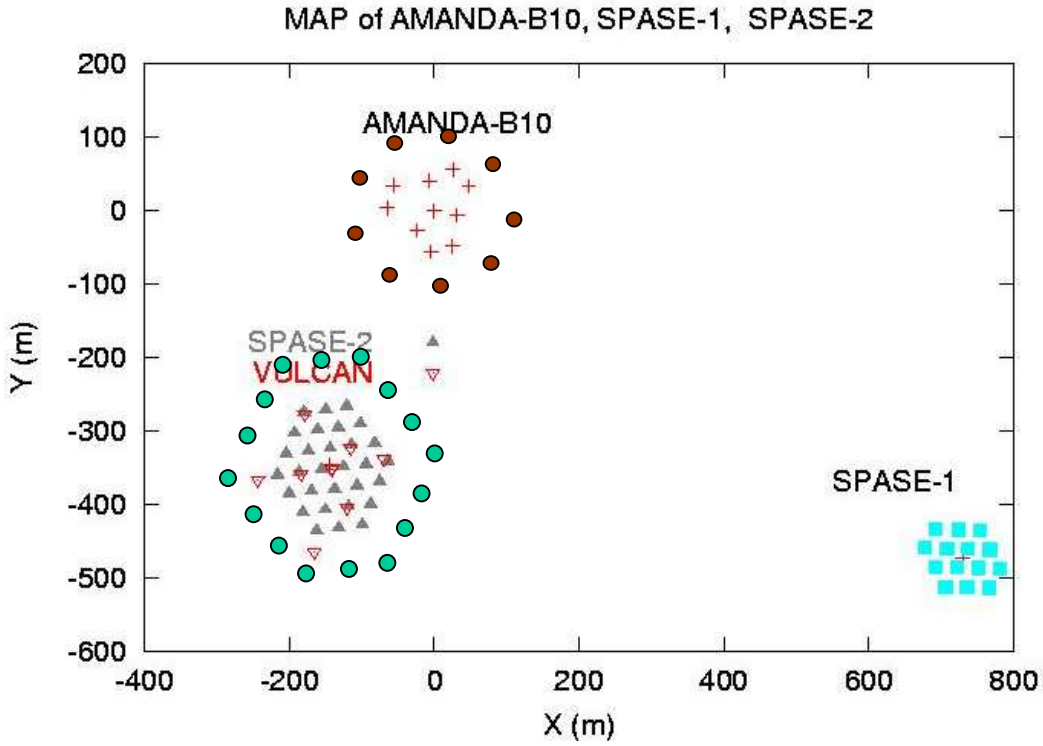


Simulation by Ralph Engel: MOCCA/SYBILL 2.1

SPASE extension

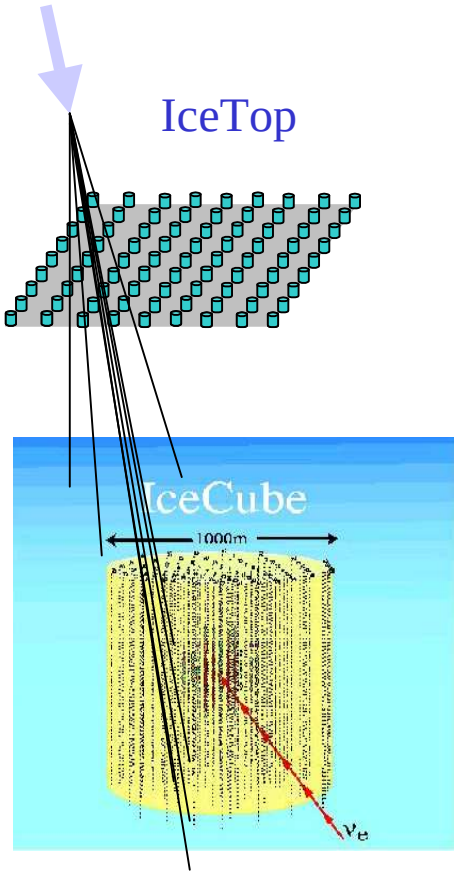
Goal: Improved livetime + Acceptance = E_{max} x 5

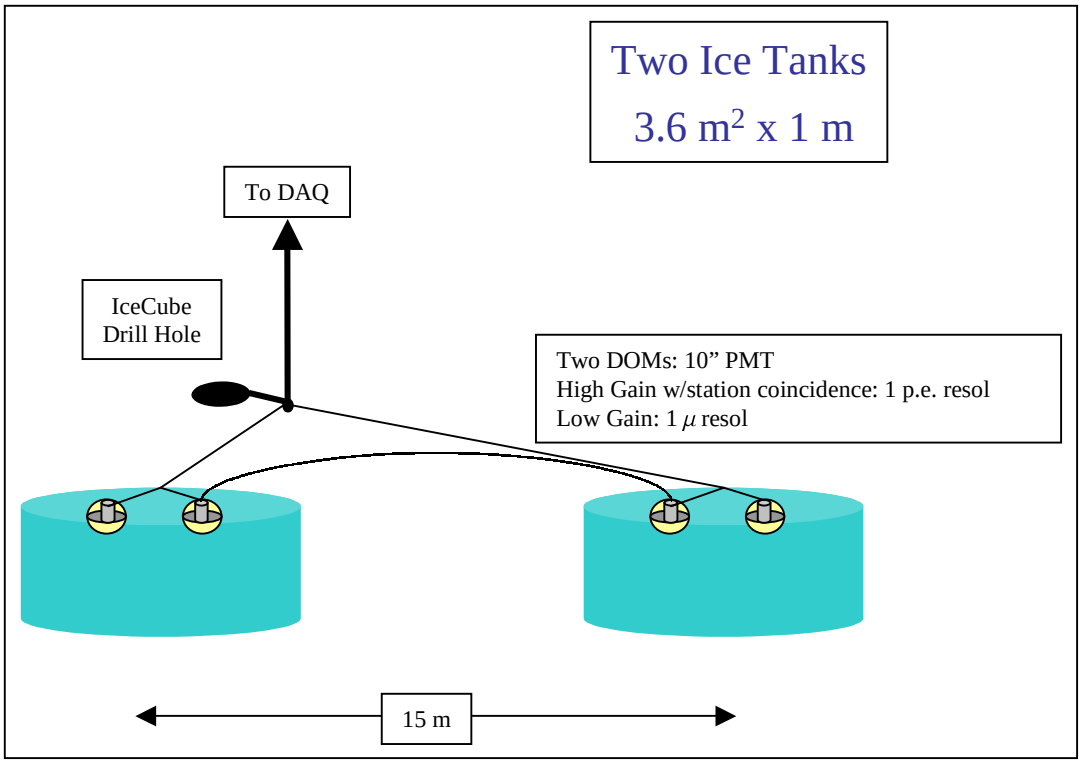




"Guard Ring" @ +60m
+AMANDA II

IceCube: bigger A, bigger Ω, N_e, N_μ(500 GeV), N_μ(1 GeV)?





$\varepsilon_\mu = 7.2\ m^2/12500\ m^2 = 6 \times 10^{-4}$

$N_\mu = \varepsilon_\mu\ 5 \times 10^3\ (E/PeV) = 3\ (E/PeV)$

? – can one identify surface muons
? – root-N fluctuations

Summary

- South Pole uniquely good for Energy Resolution.
- Composition OK, but surface muons would be nice.
- SPASE 2+ /AMANDA II should increase E_{max} by 5.
- IceCube has potential for excellent composition measurement in the range 10^{15}-10^{18} eV.