Status and results of the IceCube experiment

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Theoretische Physik IV
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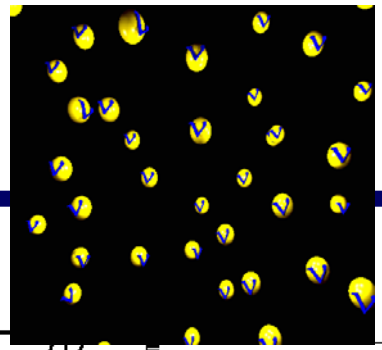
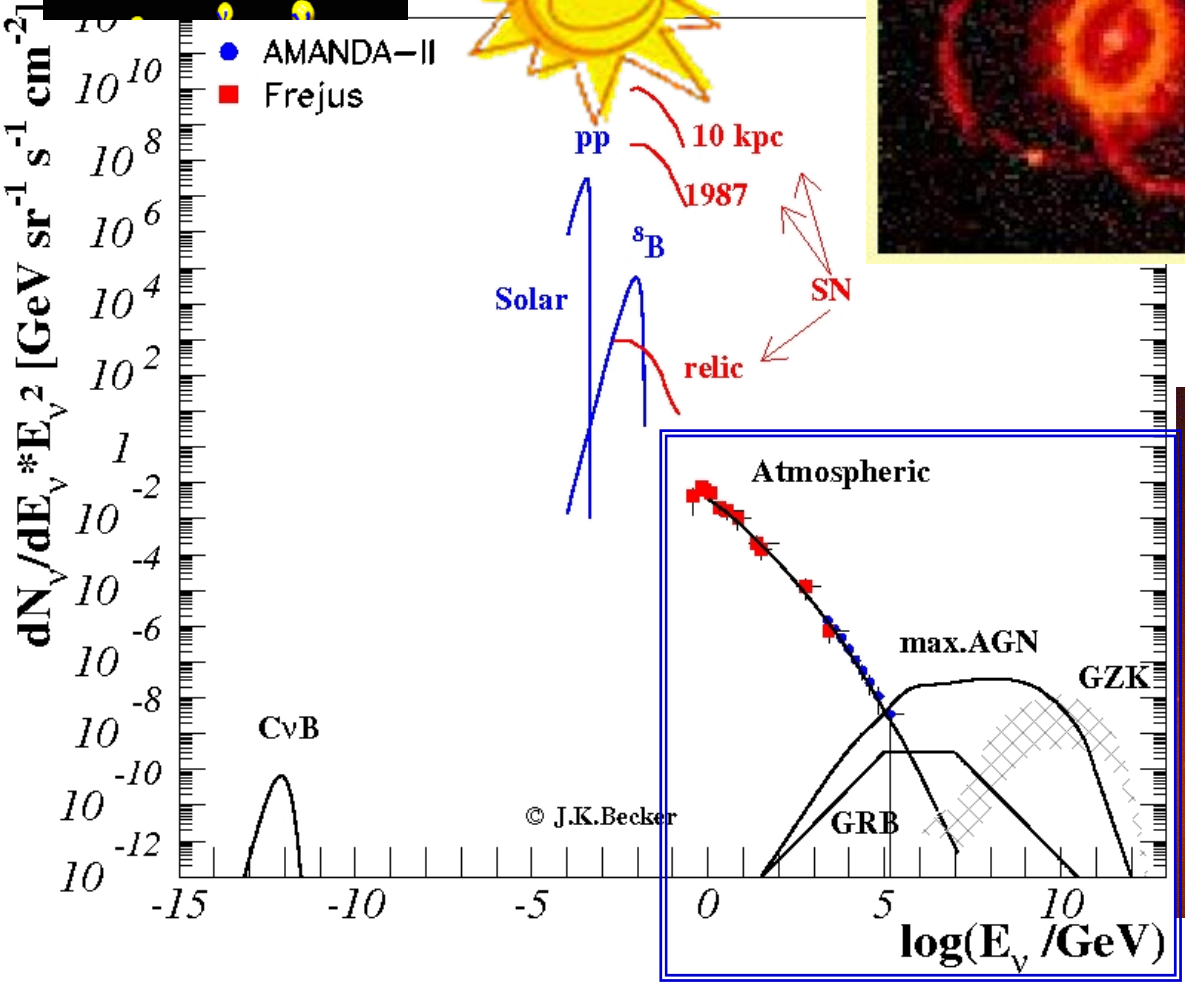
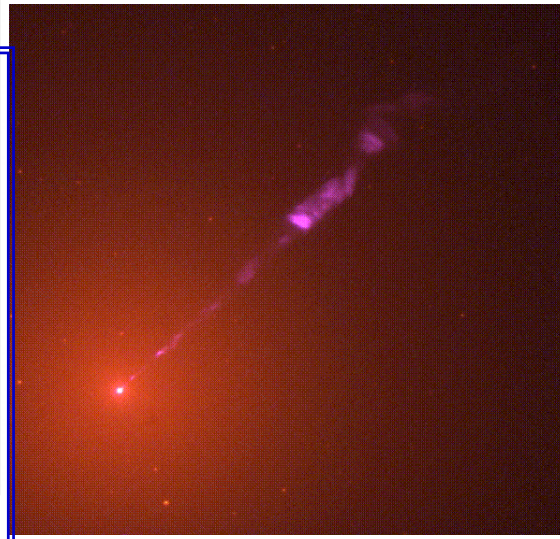
Cosmic Neutrinos



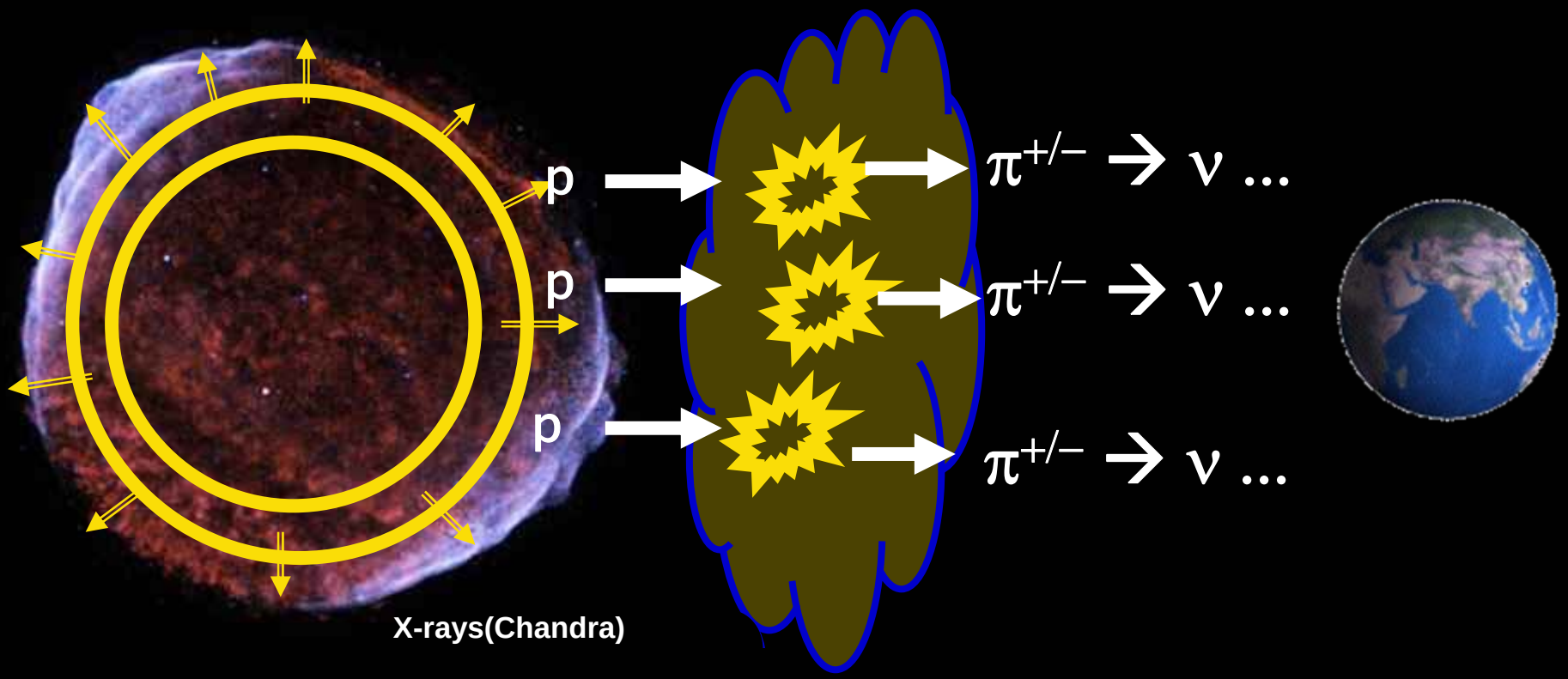




JKB, Phys.Rep. (2008), arXiv:0710.1557

High-energy neutrino production

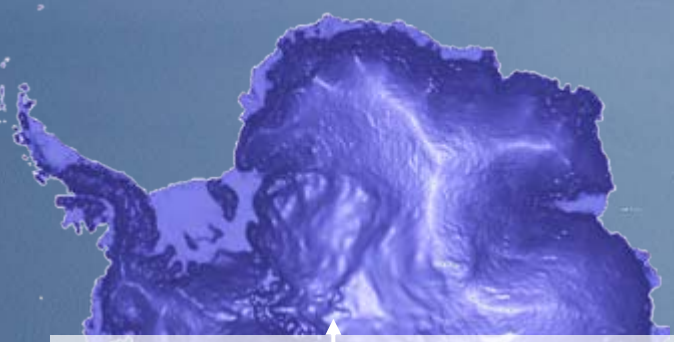
1.) CR acceleration **2.) CR interaction** **3.) ν detection**



$dN_{CR}/dE_{CR} \sim E_{CR}^{-2}$ $dN_{\nu}/dE_{\nu} \sim E_{\nu}^{-2}$ $A_{eff} \sim P_{surv} * P_{det}$

$E_{max} \sim 10^{15}/10^{21}$eV $E_{max} \sim 10^{14}/10^{20}$eV

Amundsen-Scott South Pole Station



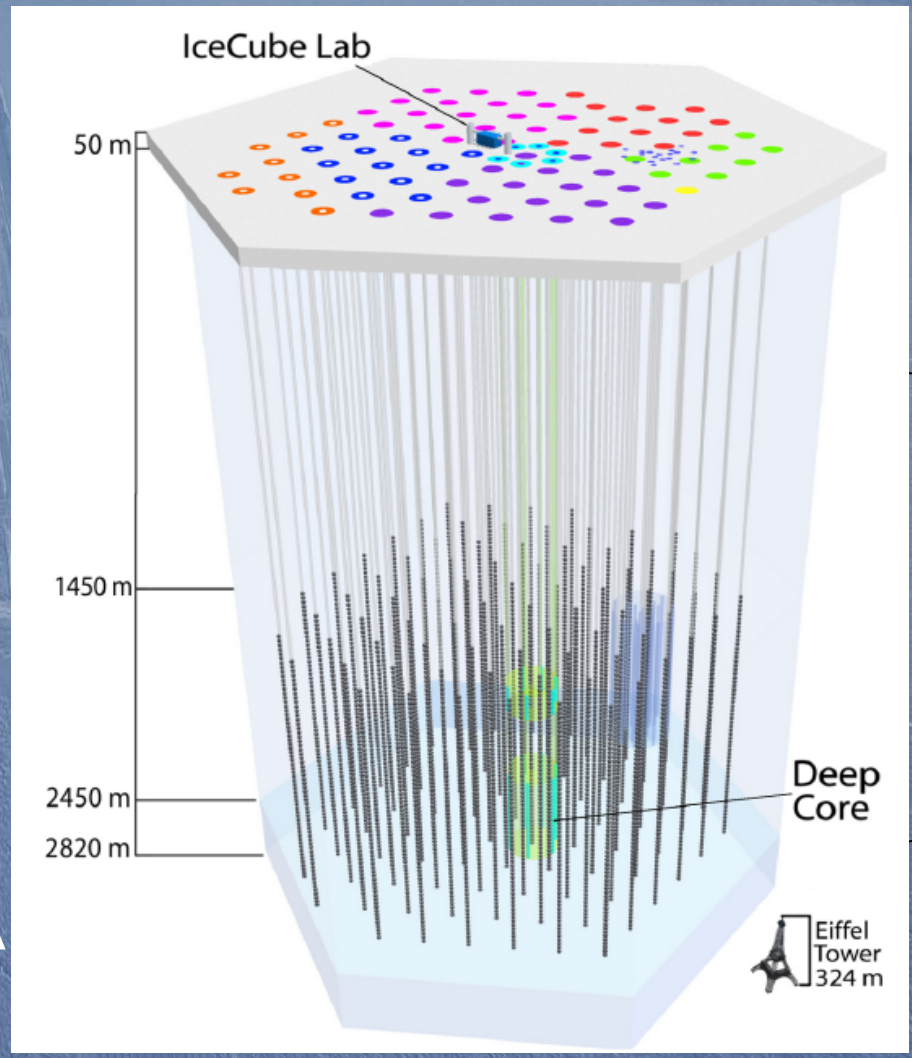
- **Final Configuration (2011):**
- **5160 DOMs/ 86 strings**
- **~100 ν/day**
- **1.7e8 μ/day**
- **energy > 10 GeV**
- **angular res: 0.4° – 1°**

- **Current configuration:**
- **4790 DOMs/ 79 strings**

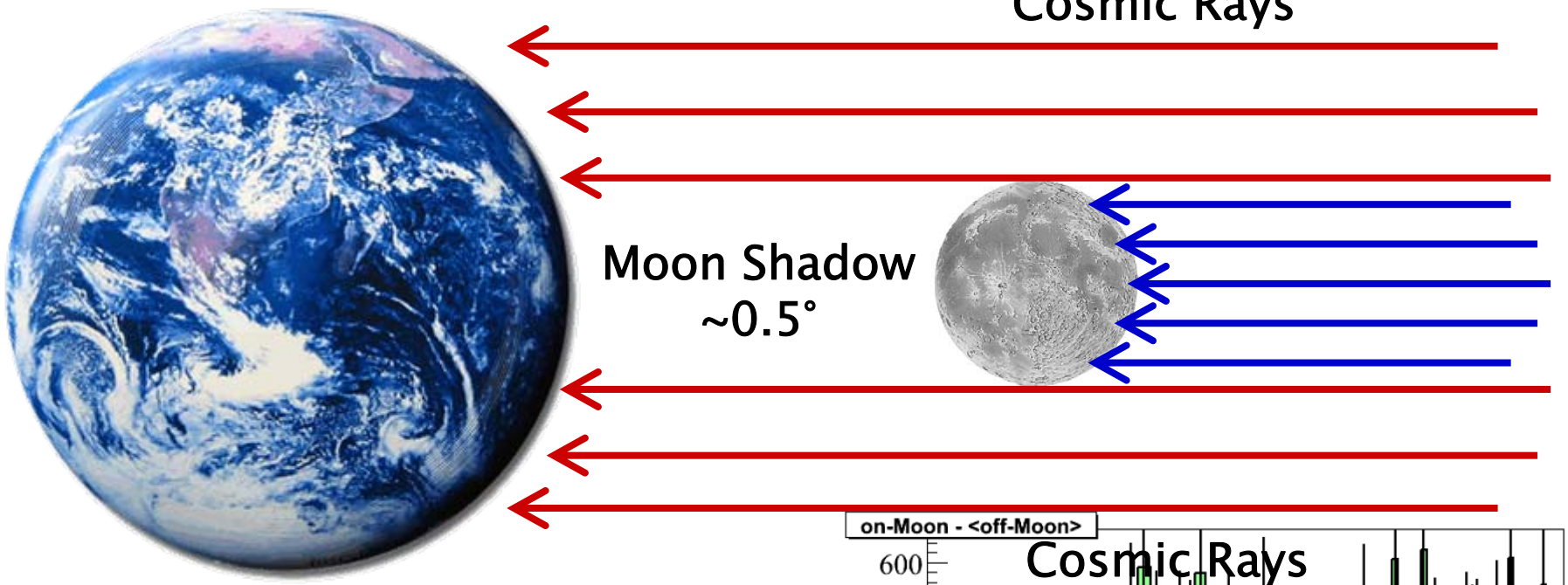
South Pole

A

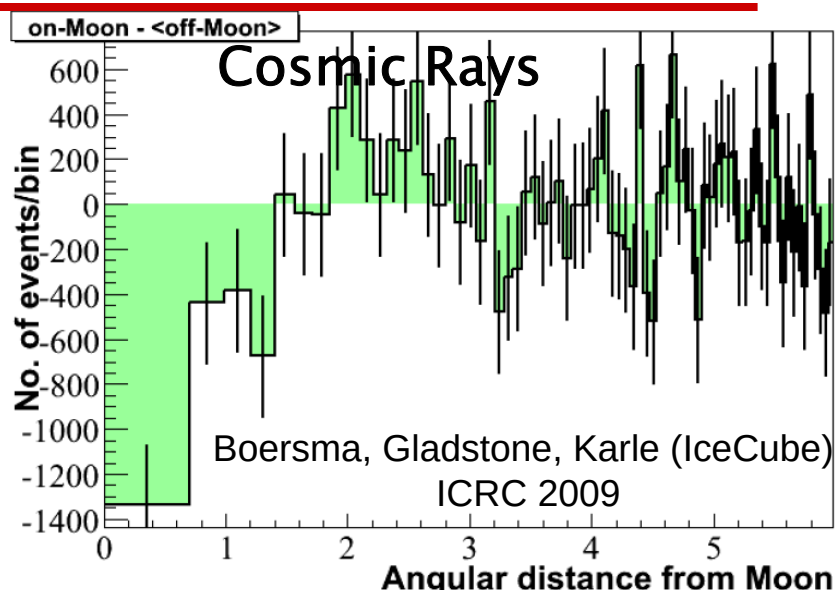
IceCube



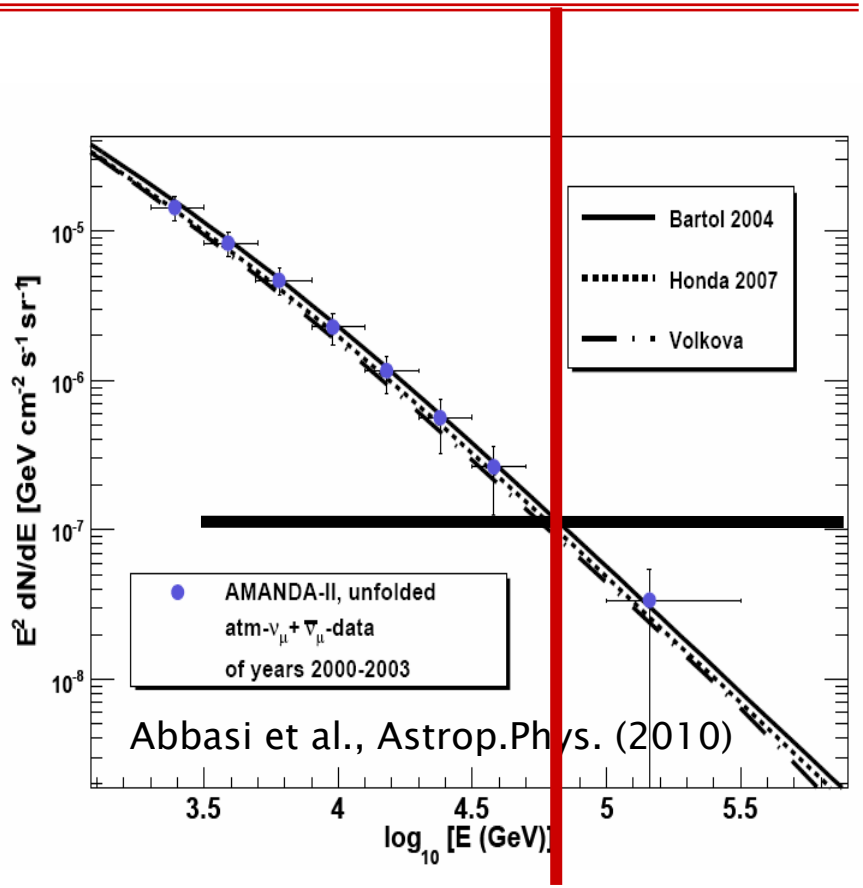
Cross-check for pointing: Moon shadow



- observed events: 88202
  → expected events: 89522
- deficit: 1320; error: 315 events
- significance: > 5 σ



IceCube's Capabilities

Information about ν	Background reduction
Energy (unfolding)	
Direction (<1°)	
Timing (~3ns)	
FoV > 2π	
Duty cycle > 90%	

Abbasi et al., Astrop.Phys. (2010)

IceCube's Capabilities

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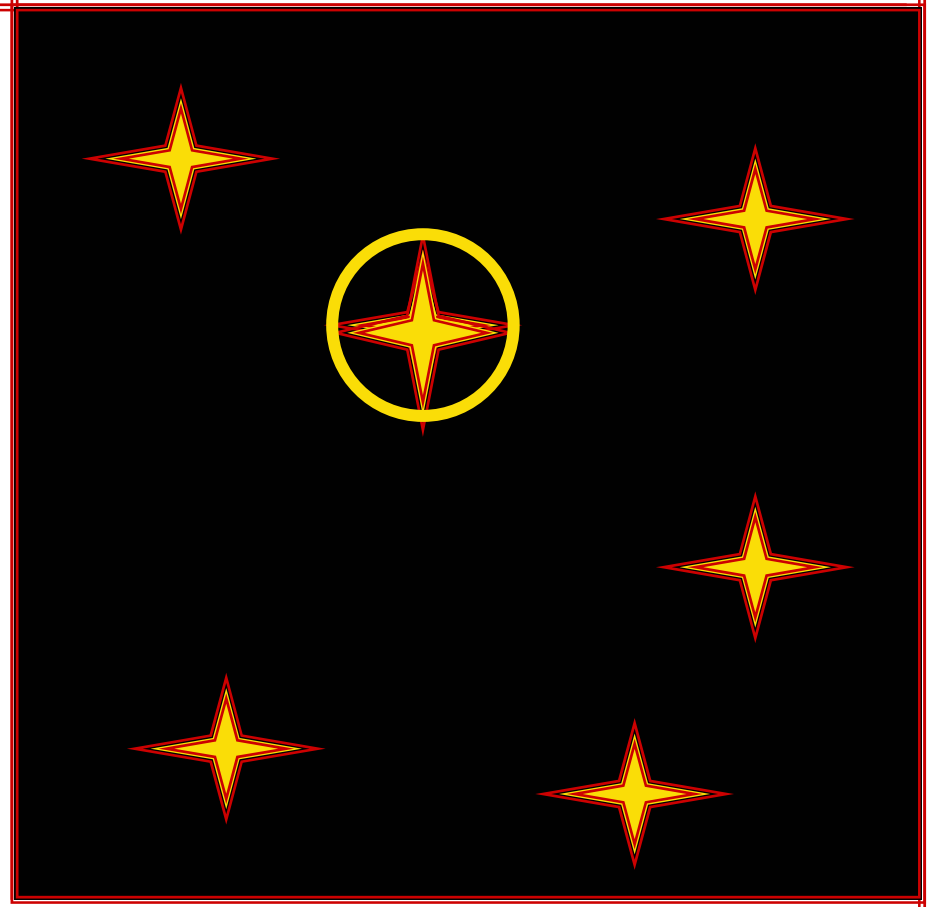
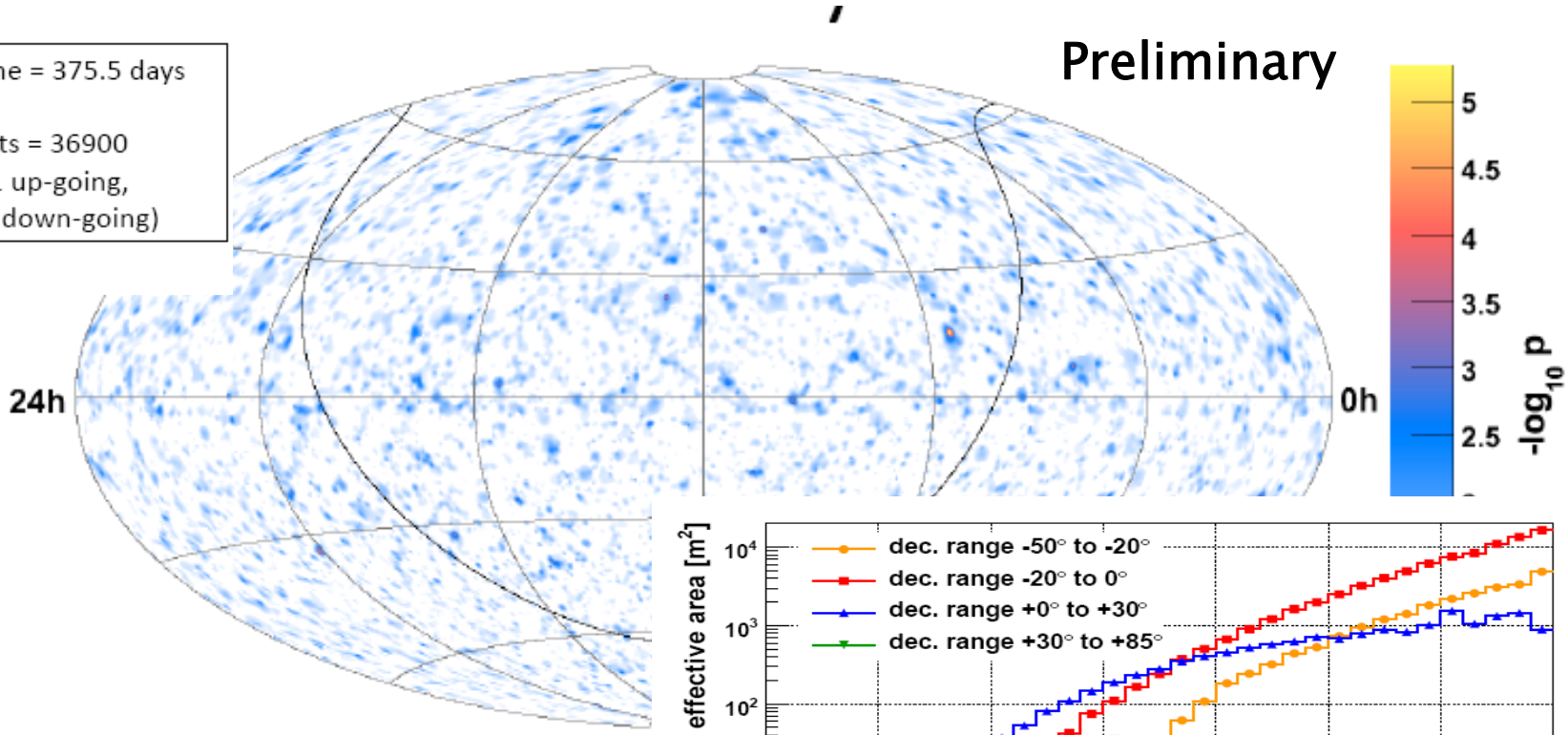
Energy (unfolding)	
Direction (<1°)	
Timing (~3ns)	
FoV > 2π	
Duty cycle > 90%	

Significance sky map (40 strings)

Livetime = 375.5 days

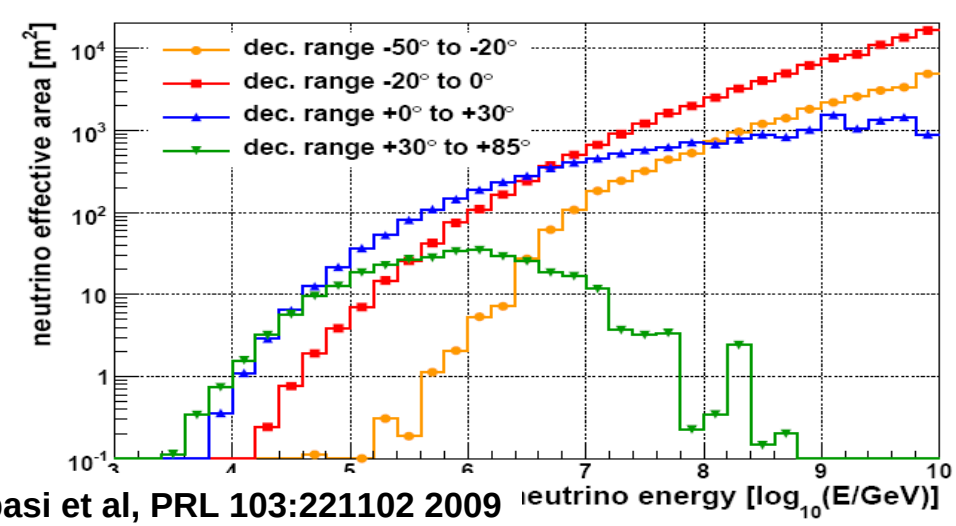
Events = 36900
(14121 up-going,
22779 down-going)

Preliminary



Hottest location in the all-sky search is:
Ra=113.75, Dec=15.15

Pre-trial $-\log_{10}$(p-value) = 5.28
Best-fit # of source events = 11.0
Best-fit spectral index = 2.05



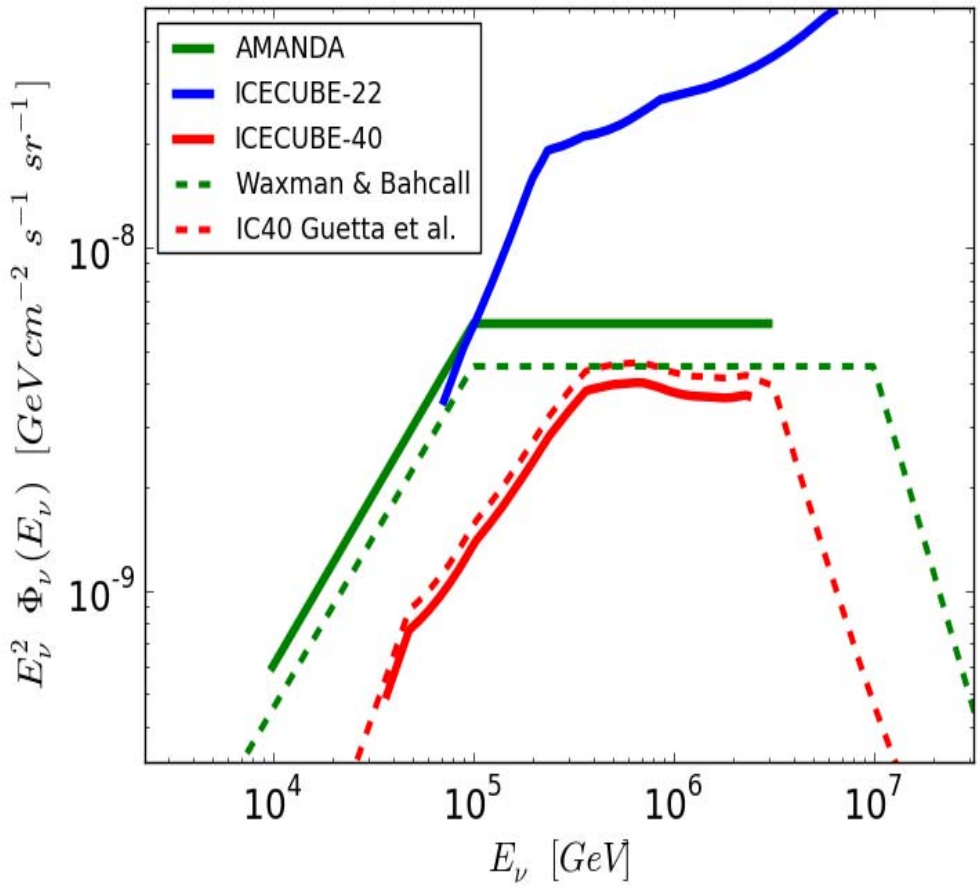
Abbasi et al, PRL 103:221102 2009

Jon Dumm et al (IceCube), ICRC2009

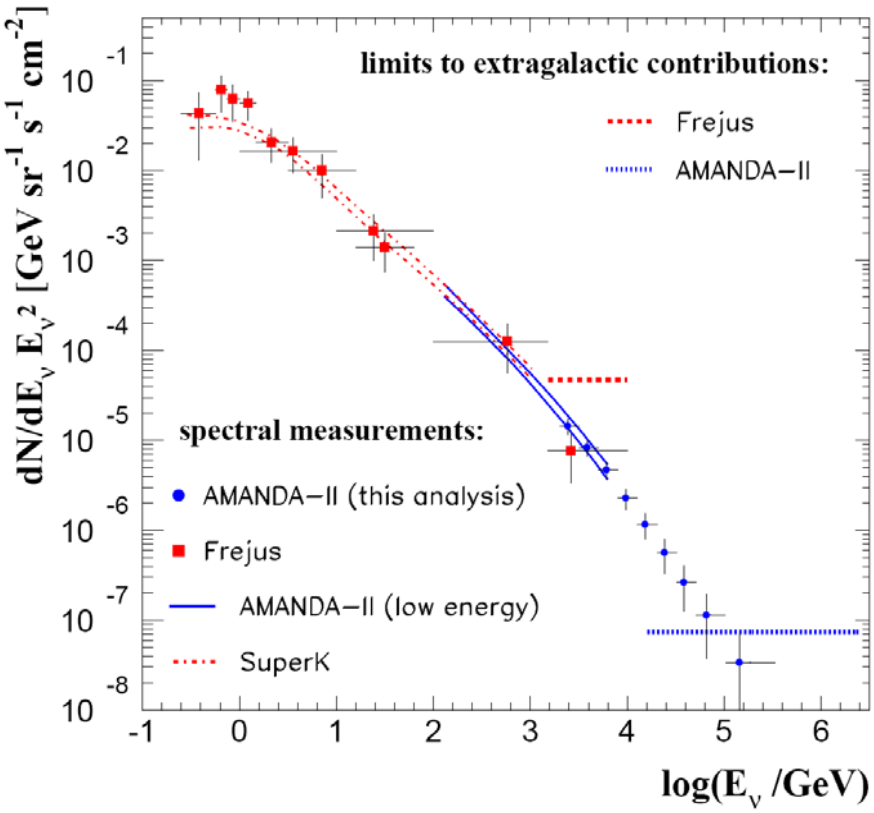
Search for GRBs (40 strings)

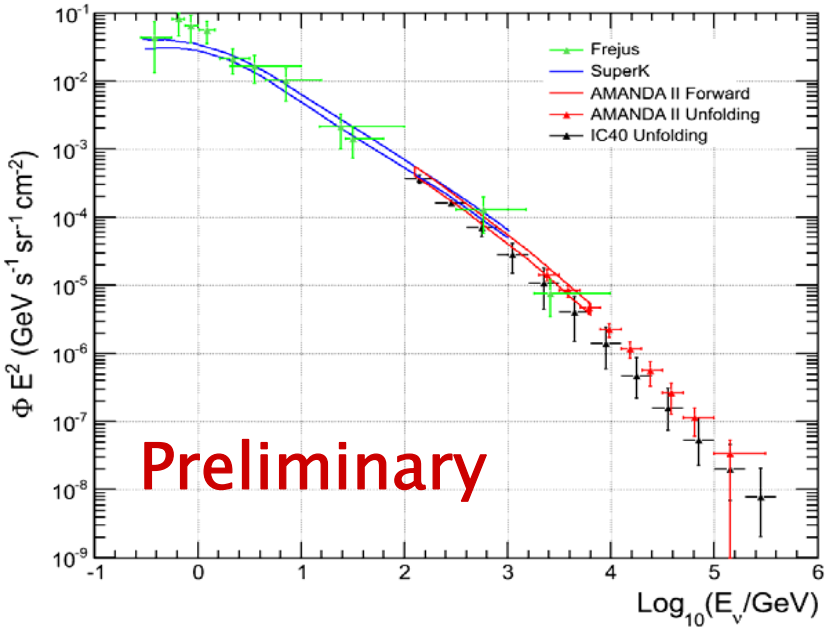
Preliminary

- **Limits for generic GRB spectrum** (Waxman & Bahcall, PRL 1999)
- **Individual GRB spectra** (e.g. Guetta et al; JKB et al) →
- **senstitivity of prediction reached:**
- **MRF = 0.81**



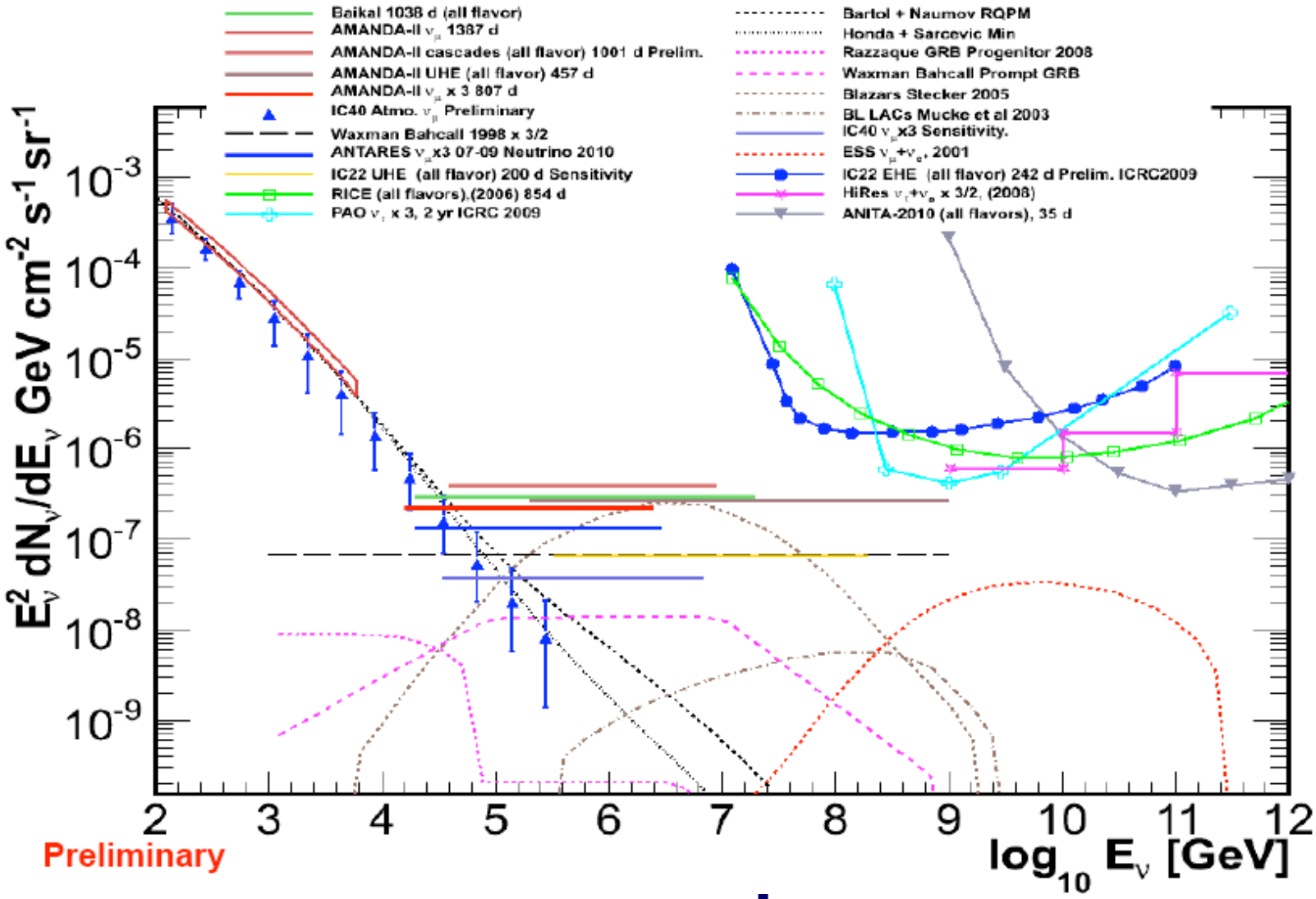
Atmospheric neutrinos up to 400 TeV





Abbasi et al., Astrop.Phys (2010)

Limits & Predictions



Desiati et al (IceCube), Beyond 2010

more being analyzed:

Point sources

source stacking
correlation studies
online analysis
...

Diffuse searches

extremely high energies,
cascades, Lorentz violation, ...

Dark Matter

Sun, Earth core

Cosmic rays

anisotropy
composition
spectrum

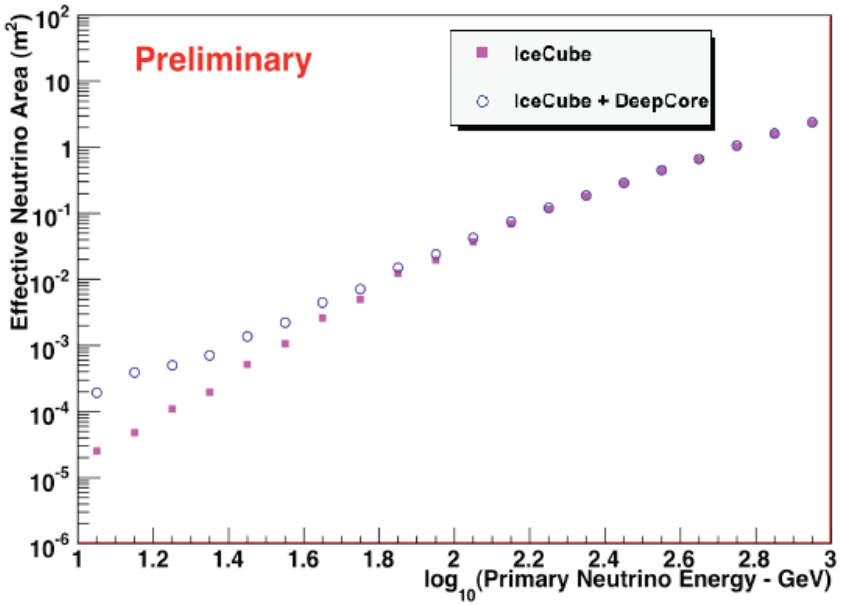
GRBs

single GRBs
model-independent search

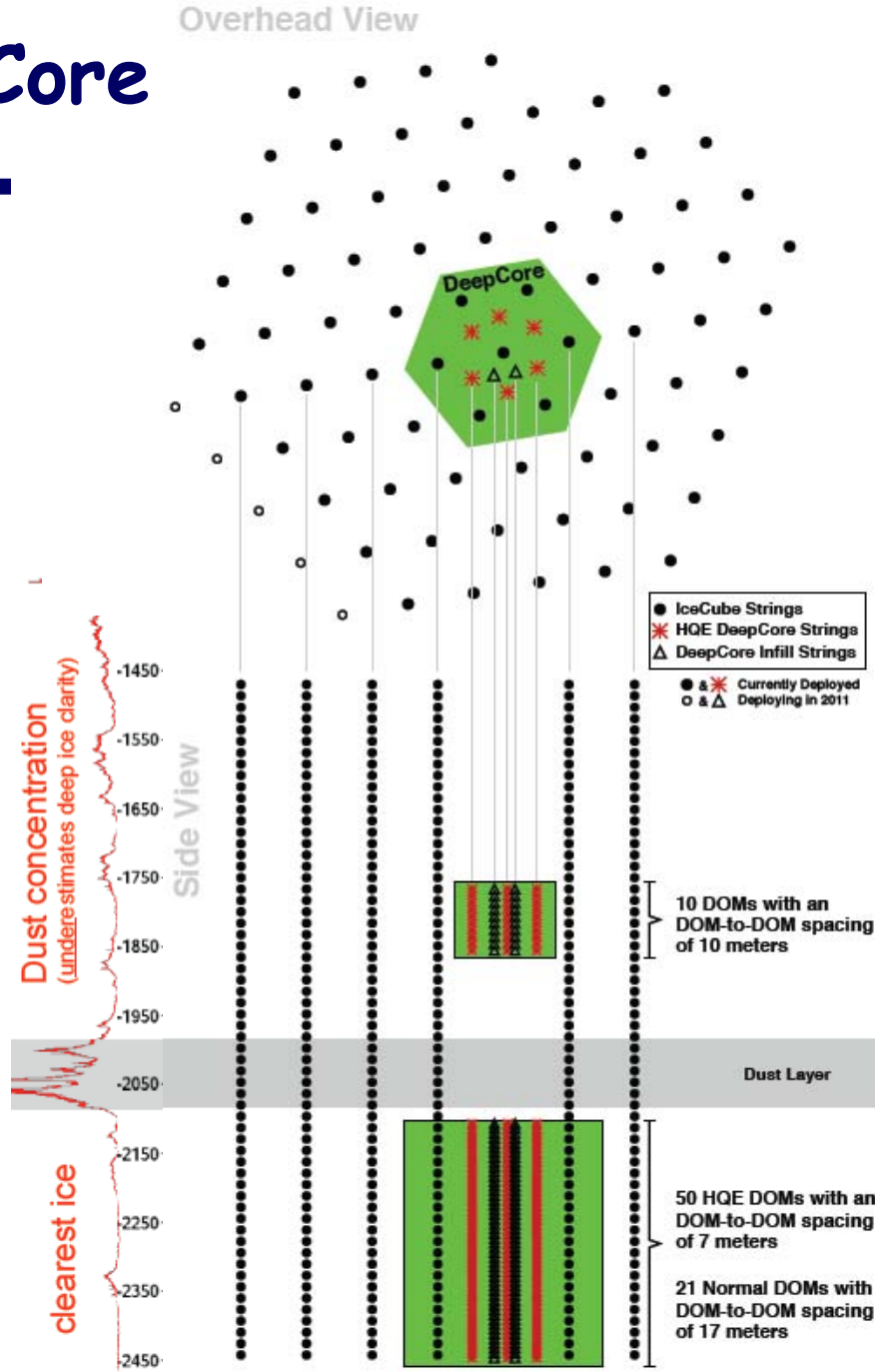
Deep Core

- 7IC strings + 6 densly spaced strings
- → DeepCore helps to reduce IceCube's energy threshold to 10 GeV

Simulated data

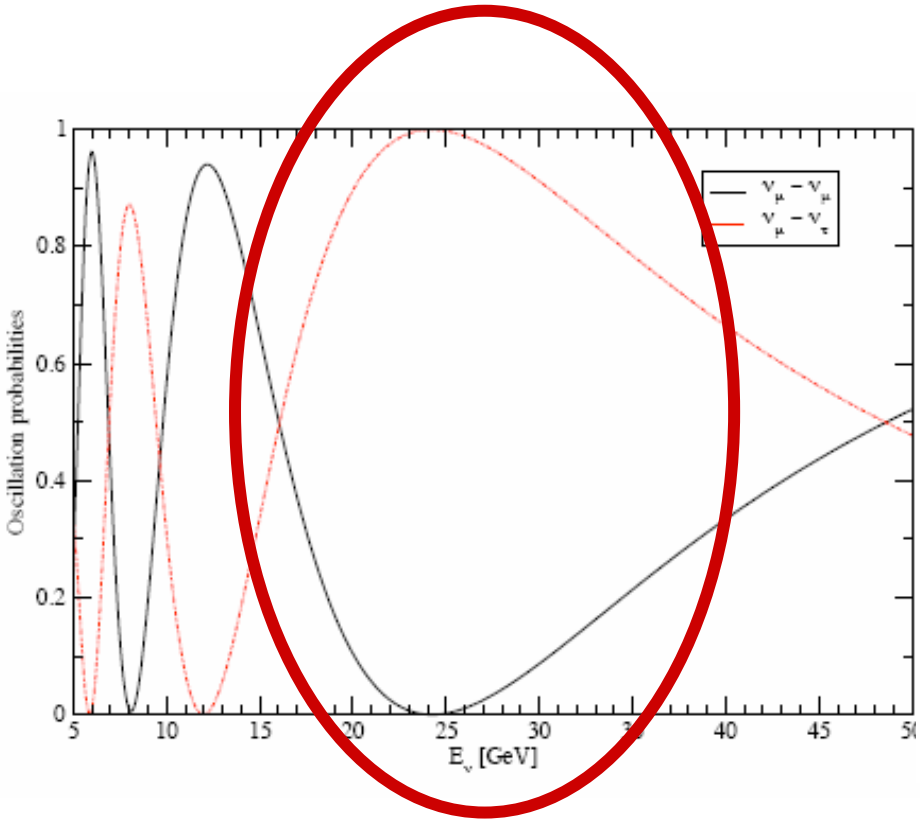


Grant et al (IceCube) ICRC 2009

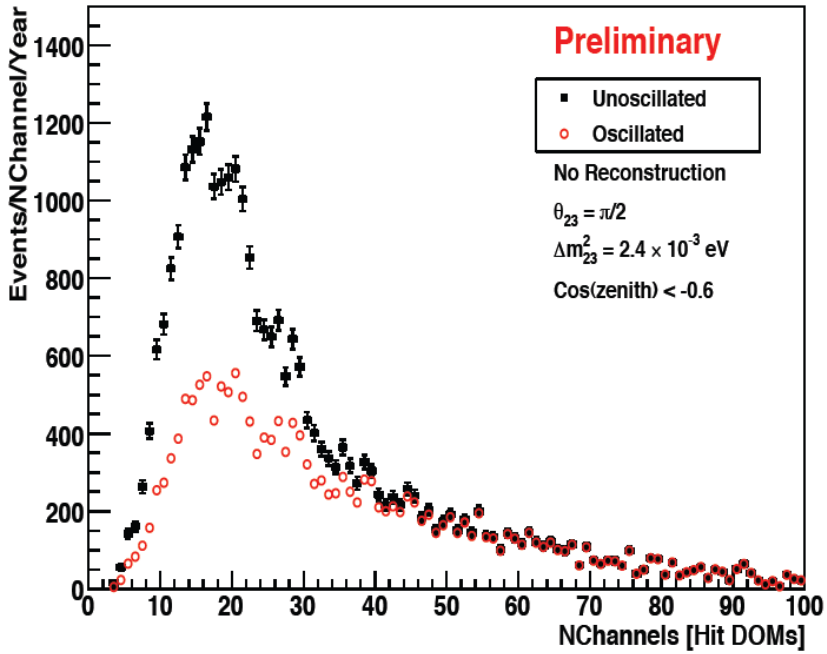


Neutrino Oscillations with IC-DC

Koskinen for IceCube, Neutrino 2010



simulation



Measurement of Δm_{23}^2 and $\sin^2(2\theta_{23})$ @ E >10GeV & confirmation of ν_τ appearance possible

Rott for IceCube, ICRC 2009

Mena et al, Phys.Rev.D78:093003,2008

Conclusions & Outlook

- **IceCube will be fully operating in about 6 months from now**
- **Results for 40-string configuration:**
  - **point source sensitivity dN/dE~10^{-11}–10^{-12}/TeV/s/cm^2 reached (declination-dependent)**
  - **atmospheric neutrino spectrum up to 400 TeV**
- **Analyses of 59/79-string & configurations ongoing**
- **DeepCore: mearurement of ν_μ disappearance and ν_τ appearance possible**