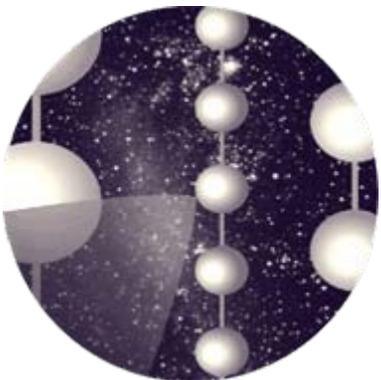


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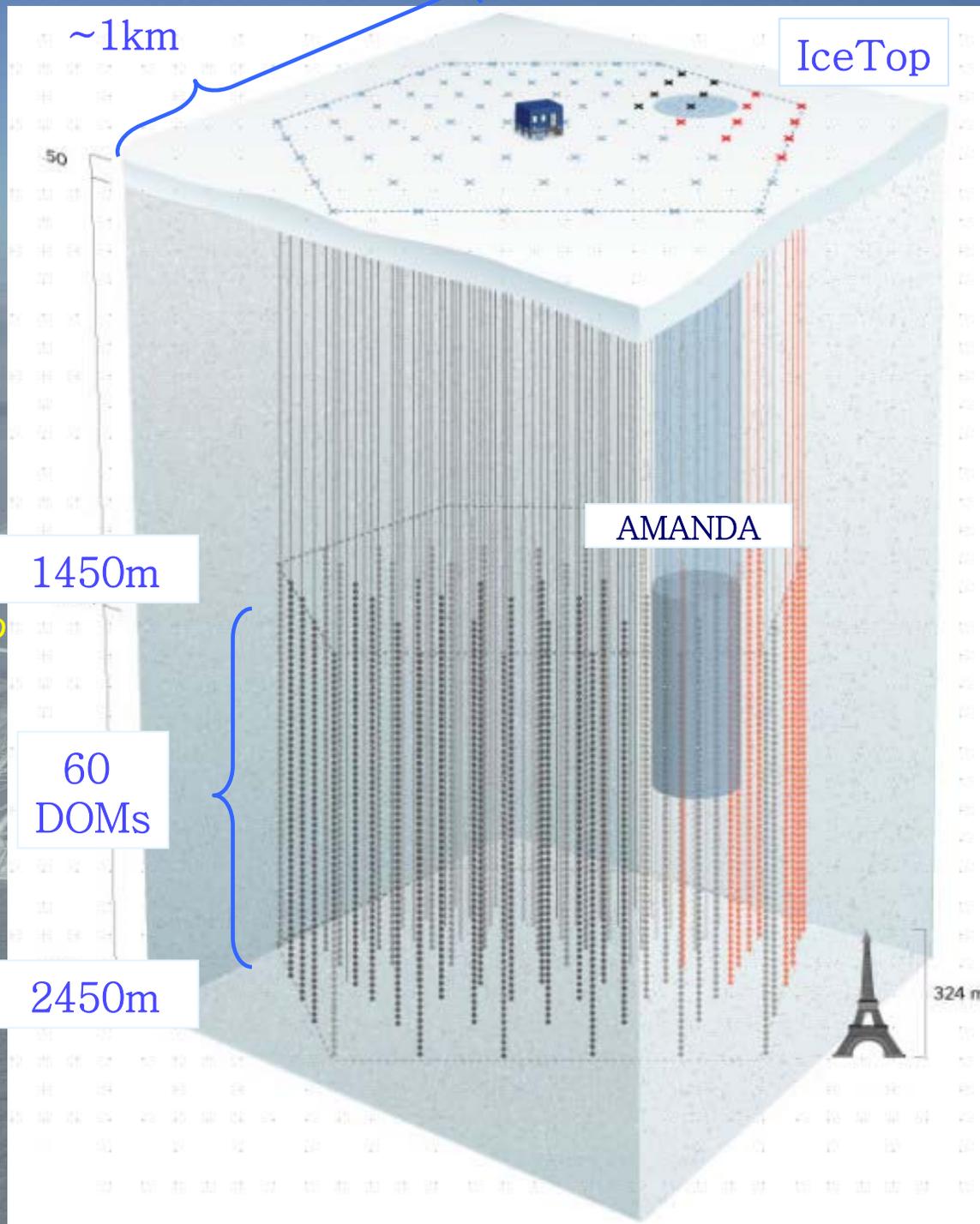
# The IceCube experiment

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**Aya Ishihara**  
(石原安野)  
千葉大学

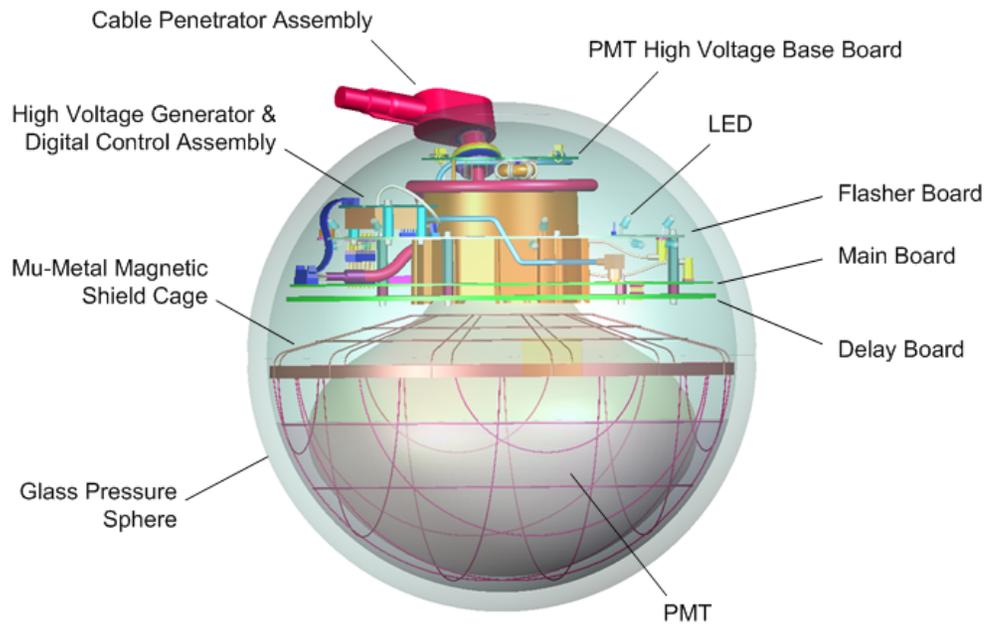
# The IceCube



# Digital Optical Module

## IceCube Digital Optical Module

**Waveforms, times digitized in each DOM**



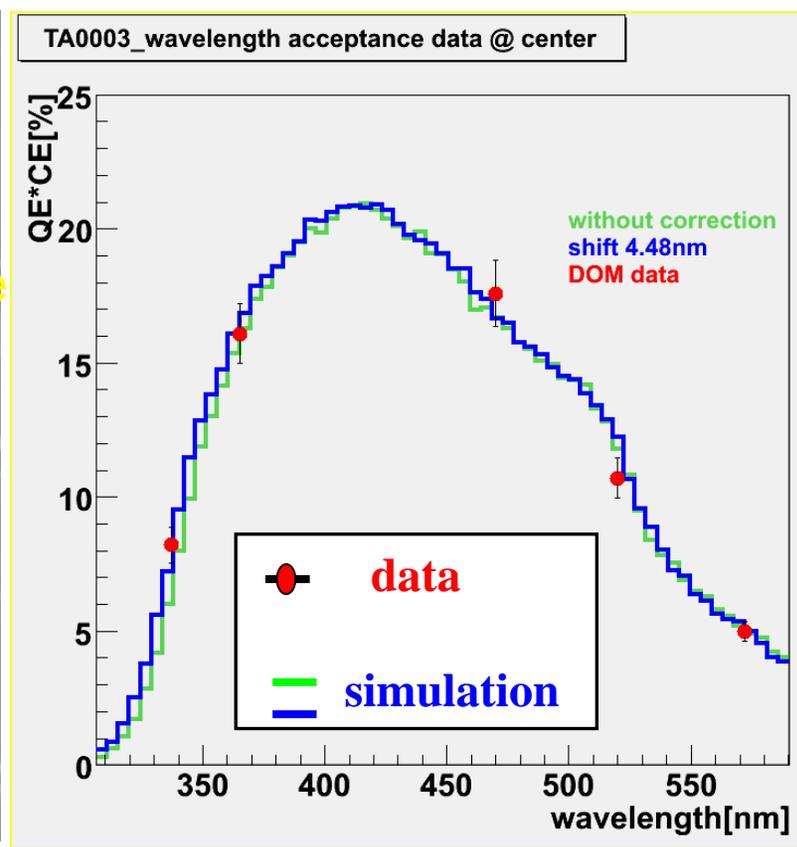
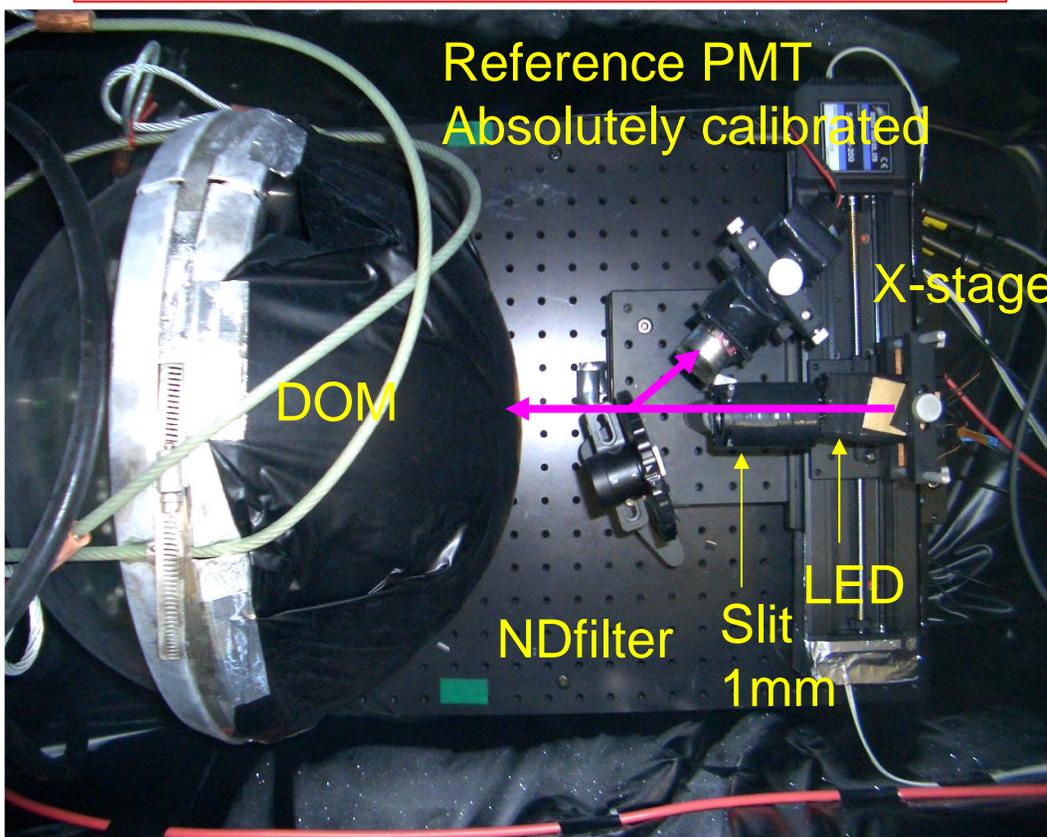
- 400 photoelectron/15ns
- 400ns/6.4 $\mu$ s time range

*25 cm PMT*  
*33 cm Benthosphere*

# In-lab Absolute Calibration

QE × CE Absolute calibration

By Mina Inaba



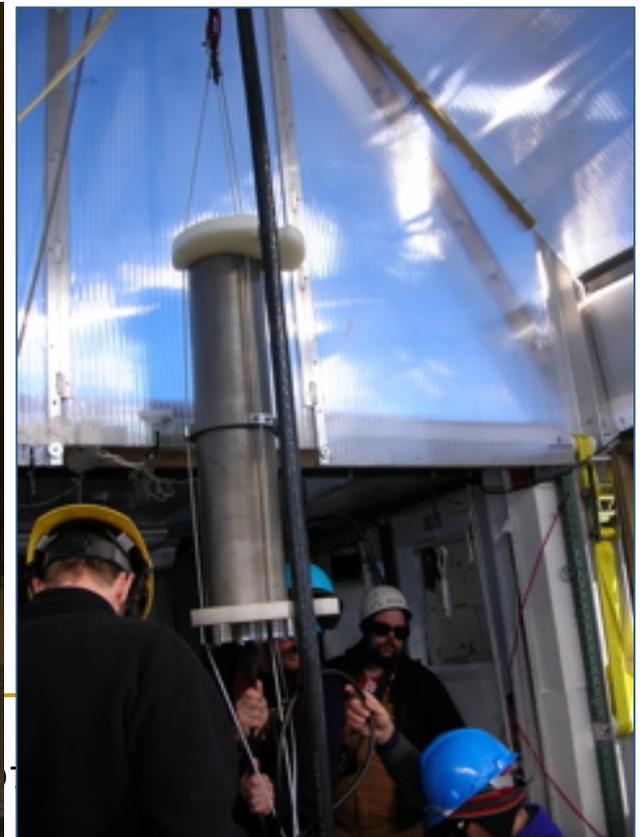
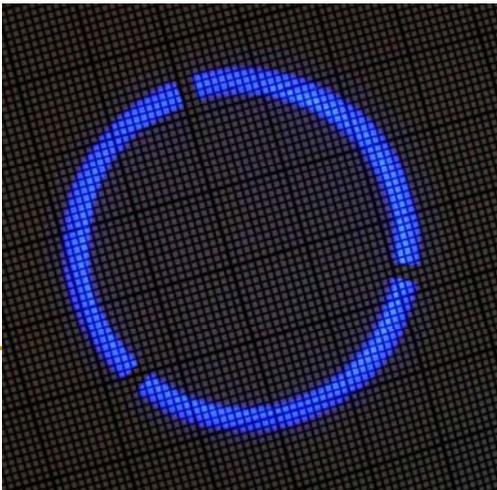
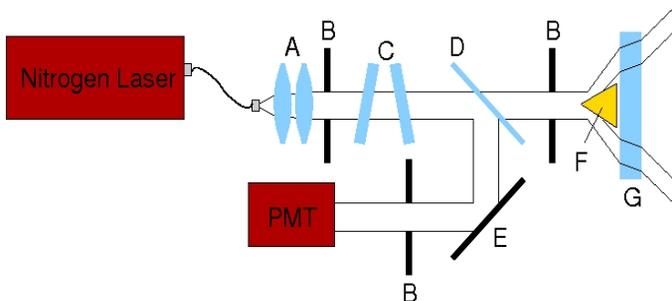
Reflectivity :  $14.5\% \pm 0.73$

Transmission :  $50.7\% \pm 2.54$

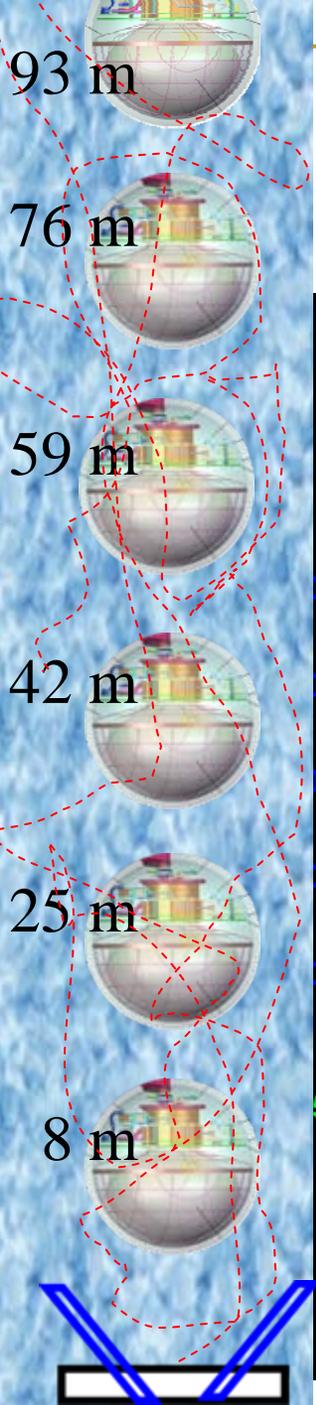
# In-situ Absolute Calibration

## Calibrated light source: Standard Candle (UCB)

- in-situ calibrated N<sub>2</sub> pulsed laser
  - light wavelength 337 nm
- at 100% intensity generates  $4 \times 10^{12}$  photons per pulse emitted at 41°
  - output adjustable between 0.5% ~ 100%

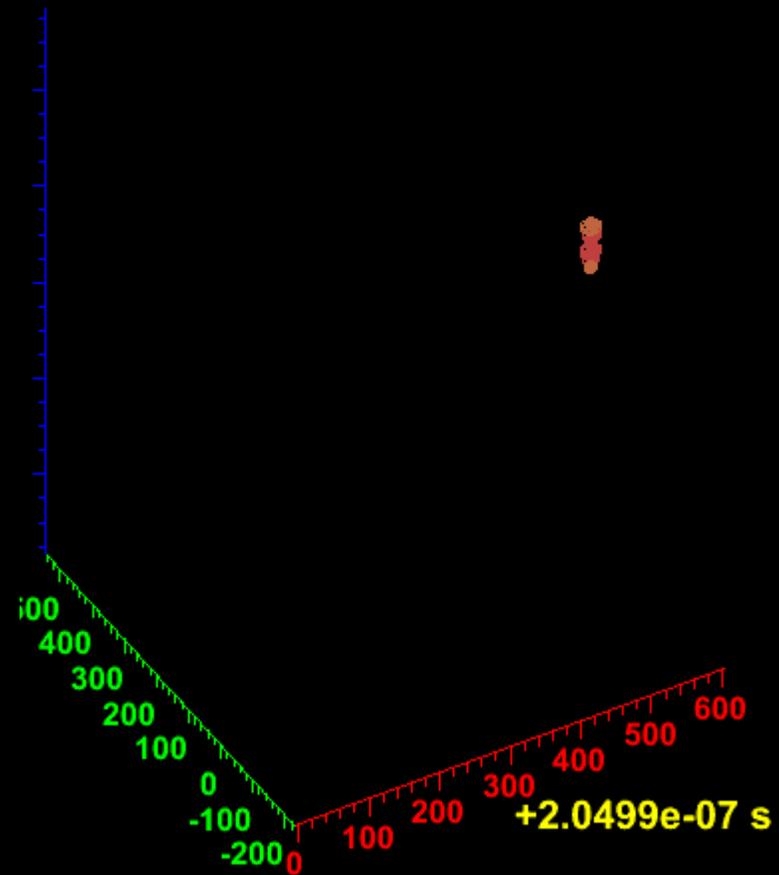
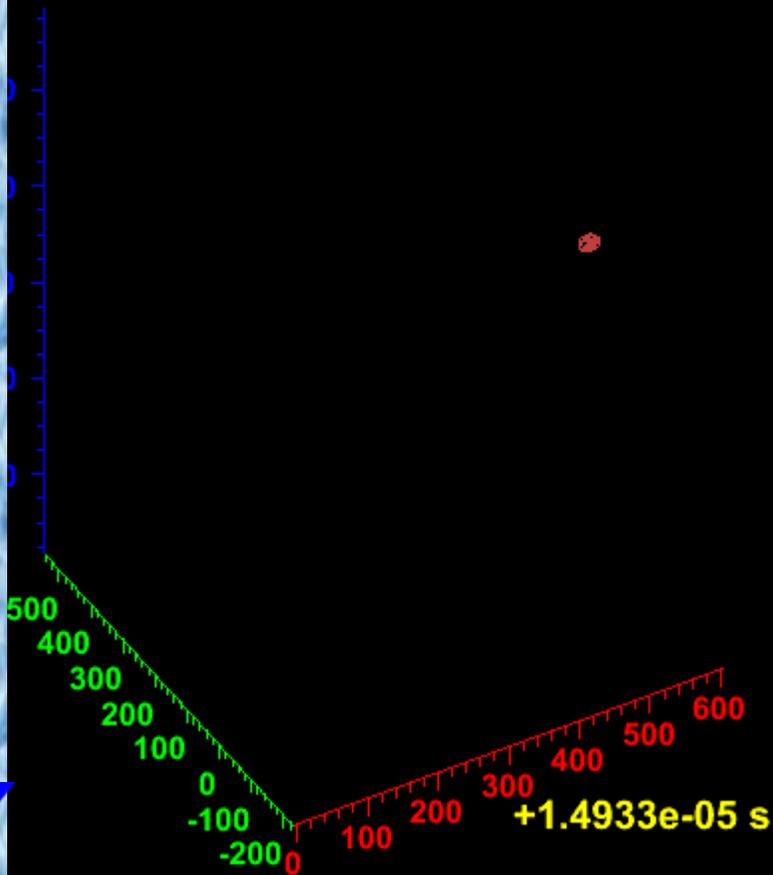


# Photon propagation in glacier ice

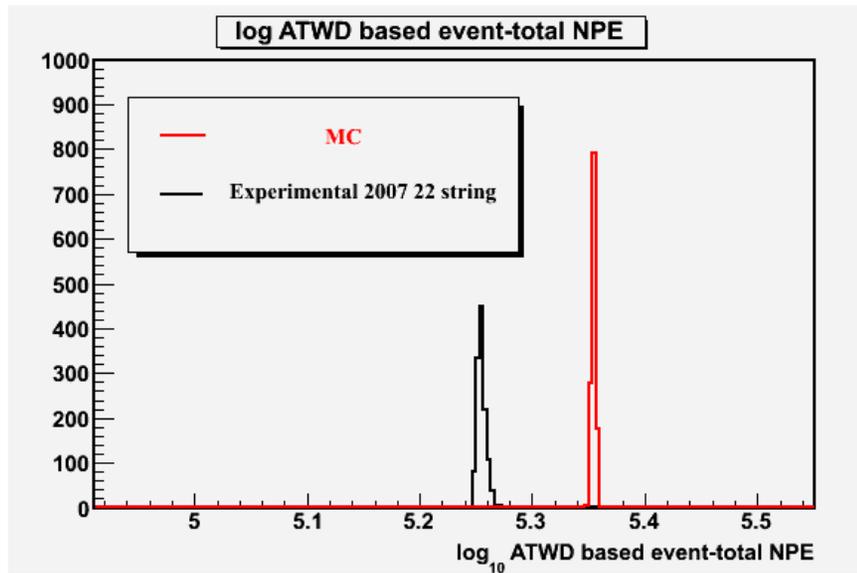


Experimental

MC



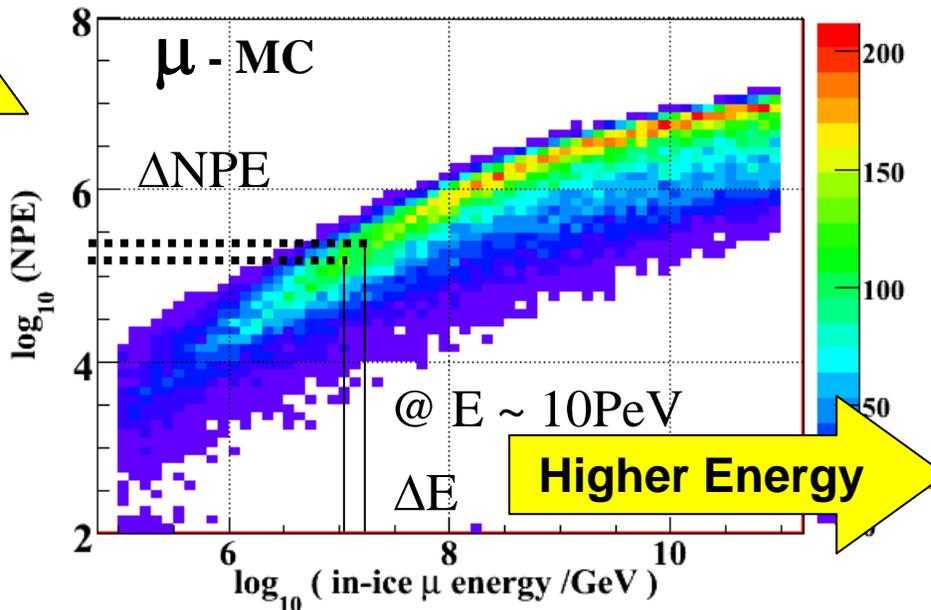
# Total NPE and Energy Scale



$$\Delta NPE/NPE \sim 25\%$$

muon Energy-NPE relation

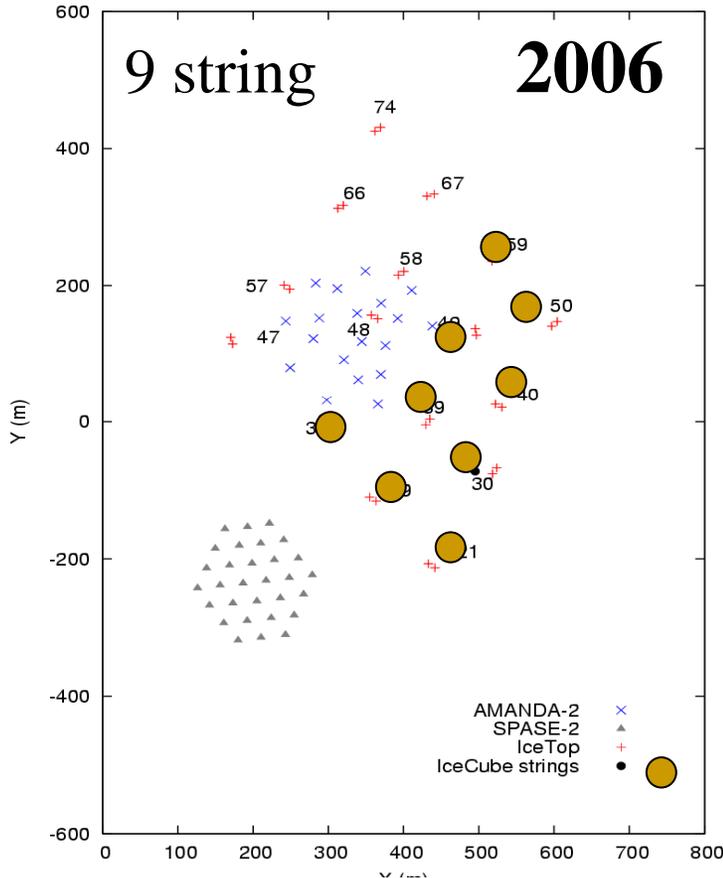
$$E \propto \Delta E \propto \Delta NPE$$



# Top Views: 2006 and 2007

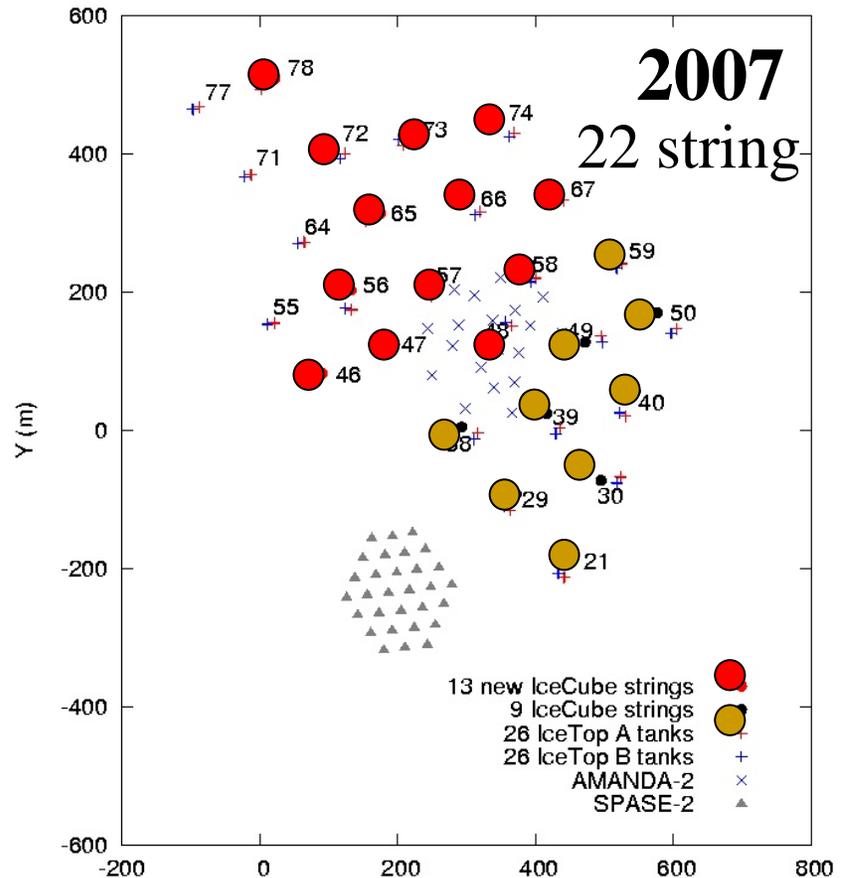
**IC9 ~10%**

Surface map of IceCube in 2006 (as built)



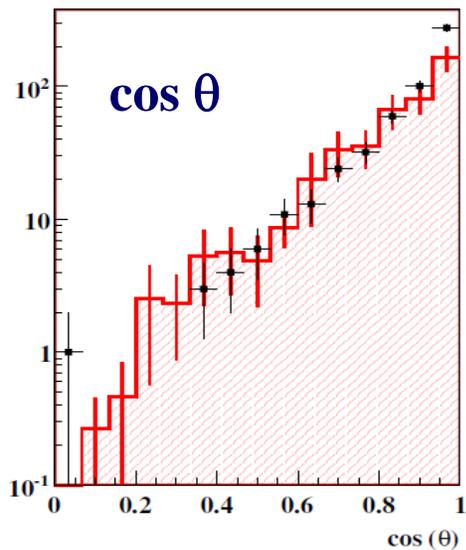
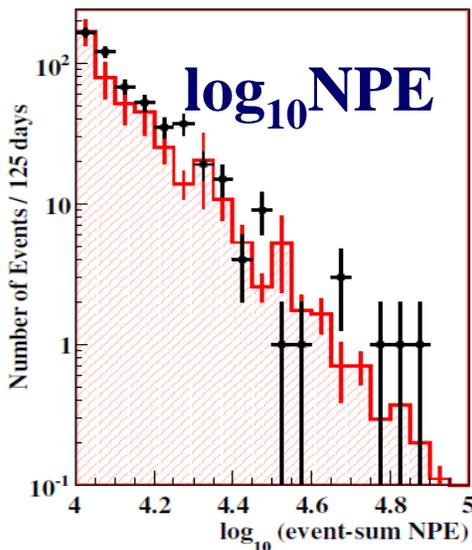
**IC22 ~25%**

Surface map of IceCube 2007 (as built)



**Y2008: 40 string  $\Rightarrow$  Y2009: 60 string  $\Rightarrow$  Y2010: 80 string**

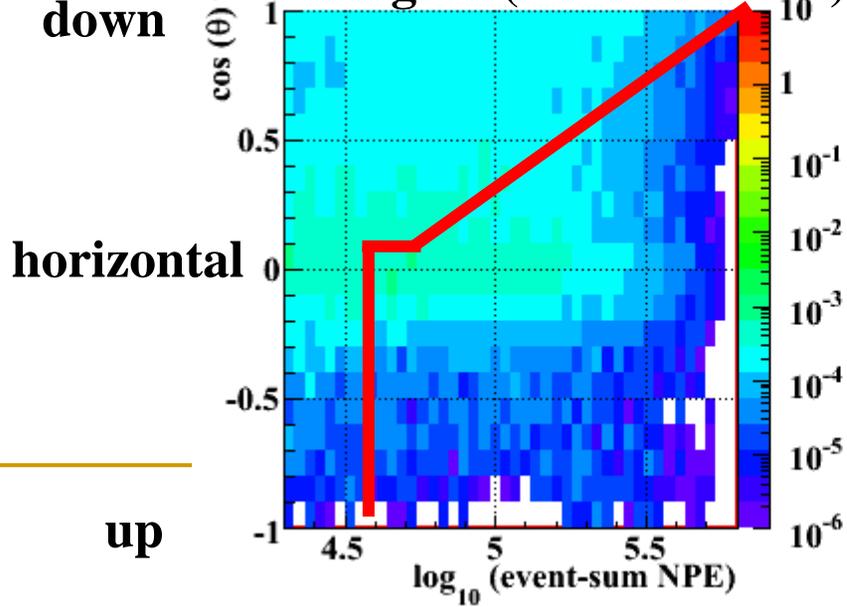
# 2006 – 9 string analysis



—■— experimental data  
— atmospheric  $\mu$  simulation model

Effective live time: 125 days

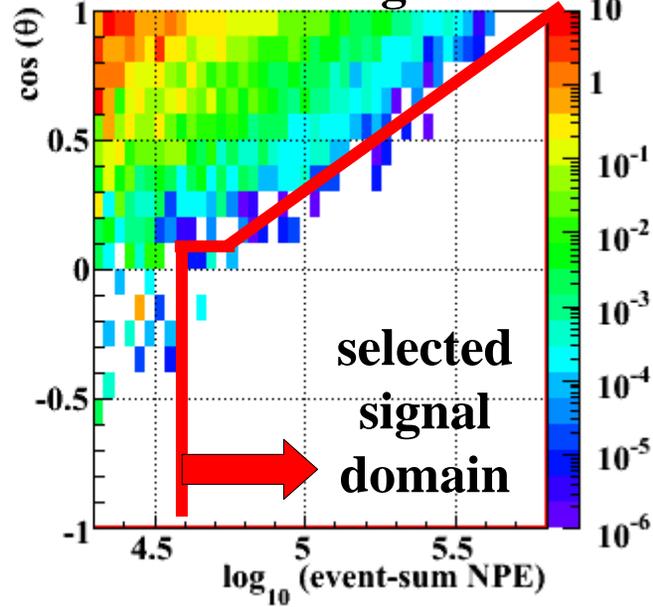
down **GZK : signal (all flavor sum)**



horizontal

up

**muon background**

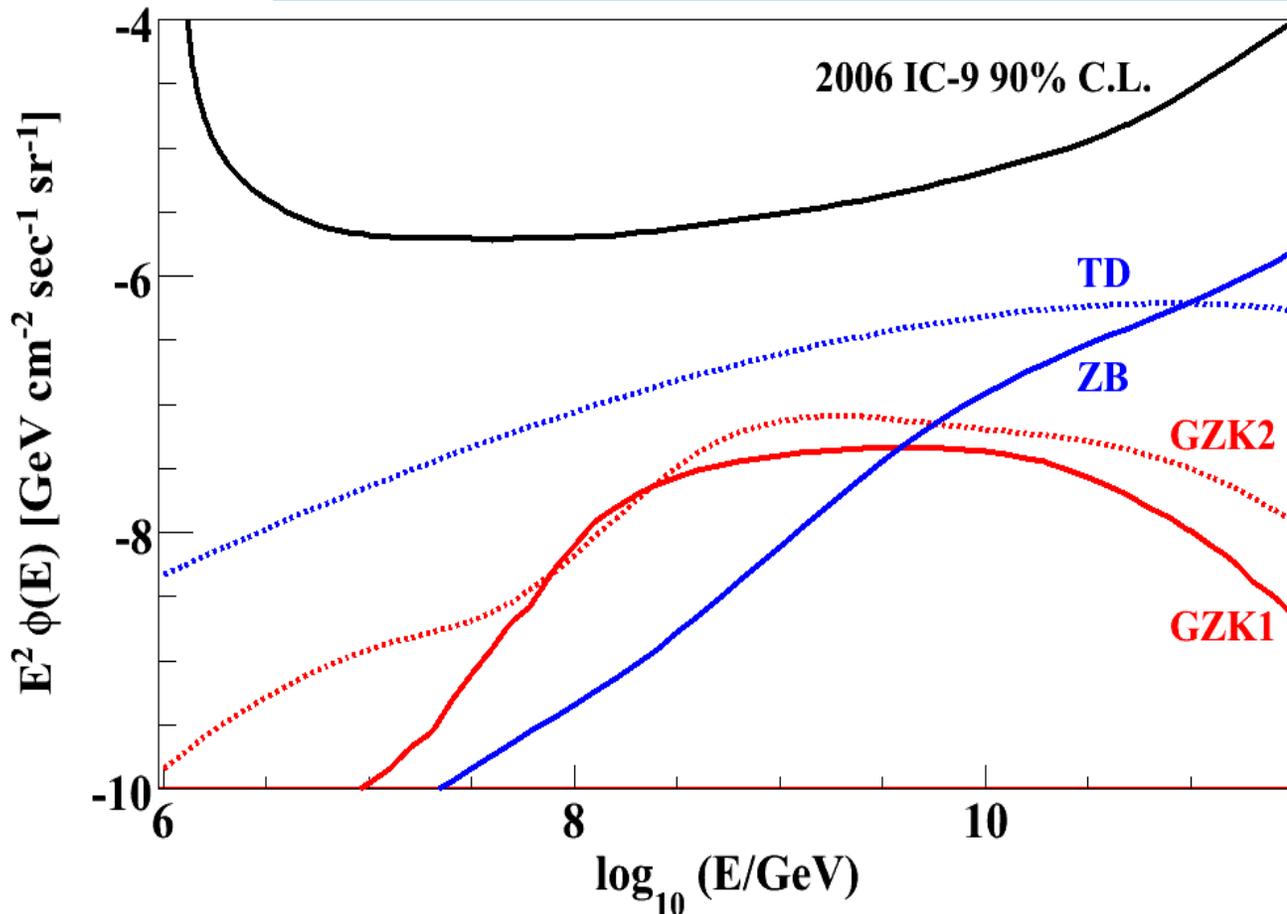


selected  
signal  
domain

# Neutrino flux Upper limit from 2006

Unblinded 2006 data  $\Rightarrow$  No signal candidate found !

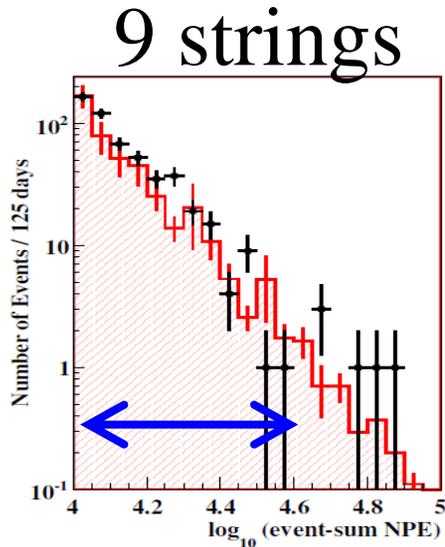
$$E^2 \phi (10^{6.5} < E < 10^{9.5}) \sim 1.6 \times 10^{-6} [\text{GeV cm}^{-2} \text{sr}^{-1} \text{sec}^{-1}]$$



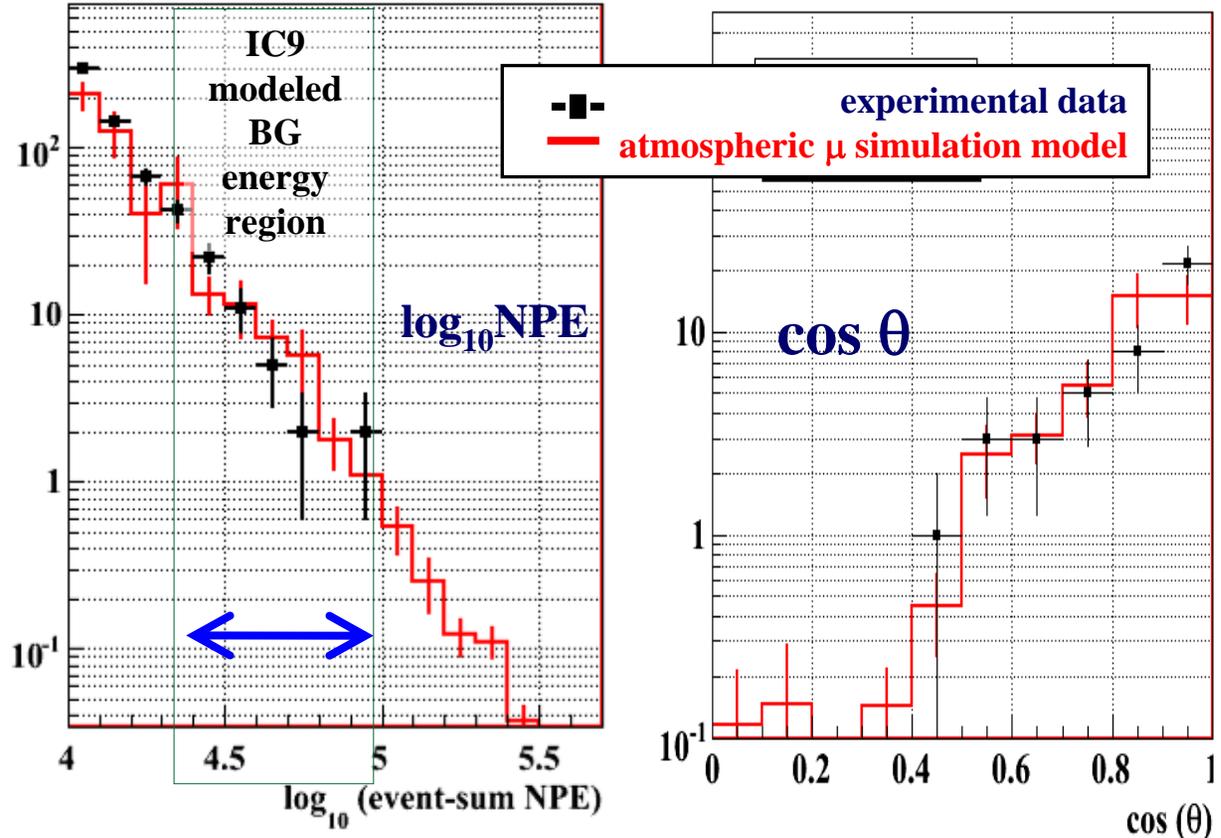
**all  $\nu$  flavor  
added  
assuming  
1:1:1**

# IC9 empirical model and IC22 data

➔ **IC22 dataset: 7/7/07 ~ 8/17/07 livetime 28.9 days**



**No** tuning applied



— The model is consistent with 22 string data! —

So far, ...to be confirmed with more data by K. Mase

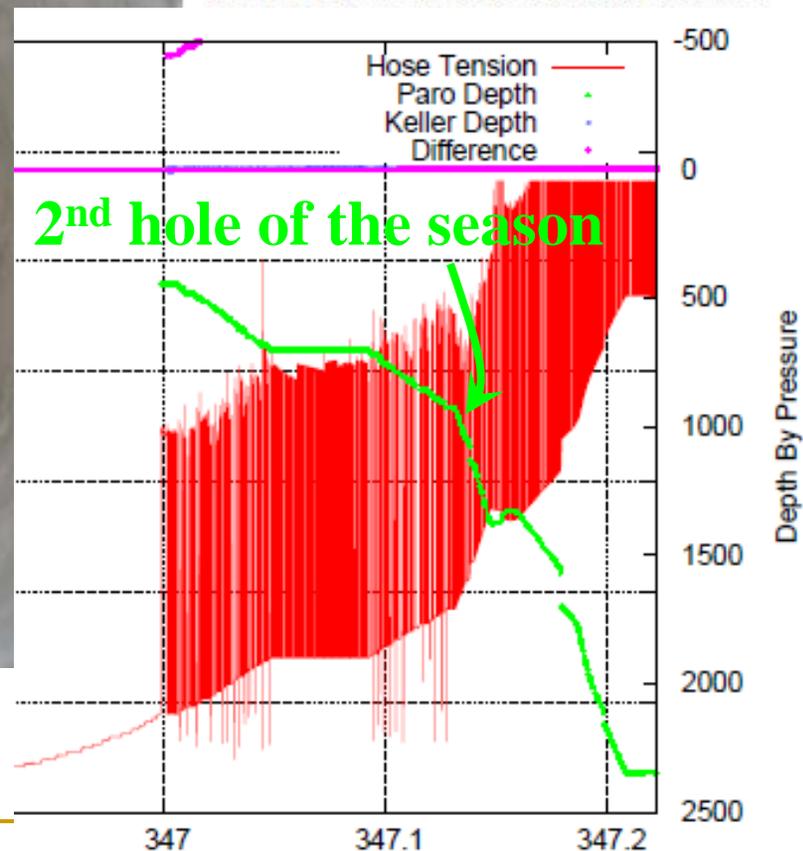
# IC40(?) construction 2007/2008

1<sup>st</sup> string of the season

The installation for Hole 63 was completed at 9:07am on Saturday when we removed the load from the load cell by securing the Surface to DOM cable to a deadman anchor.

2<sup>nd</sup> hole of the season

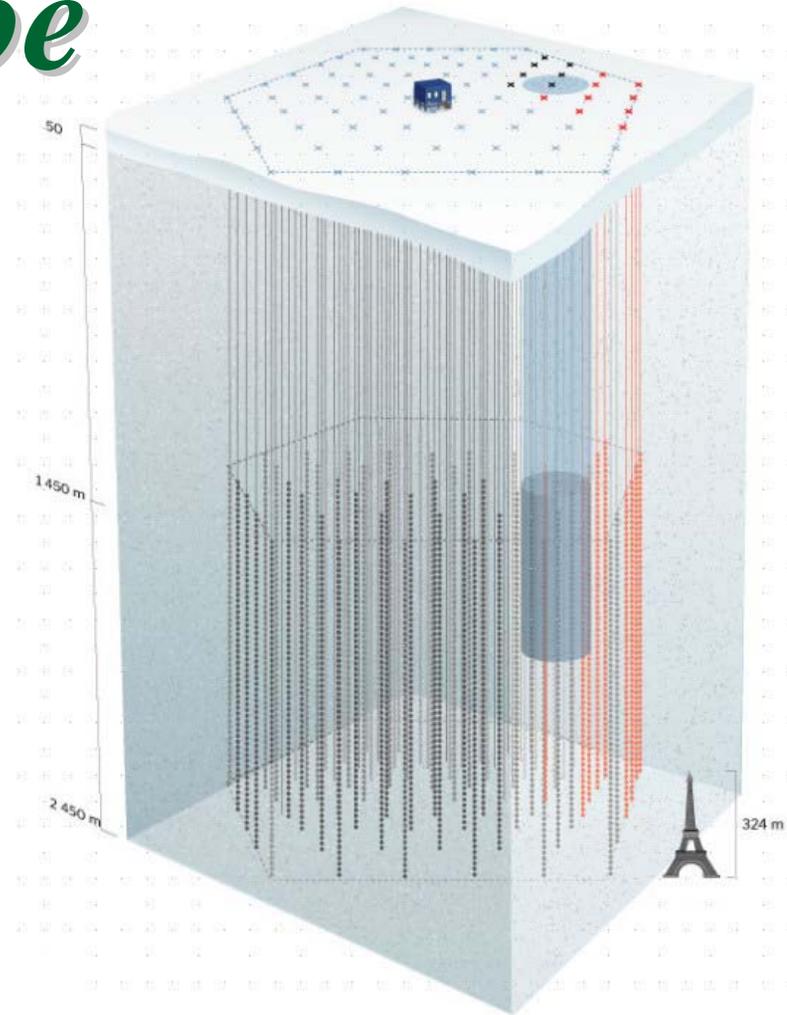
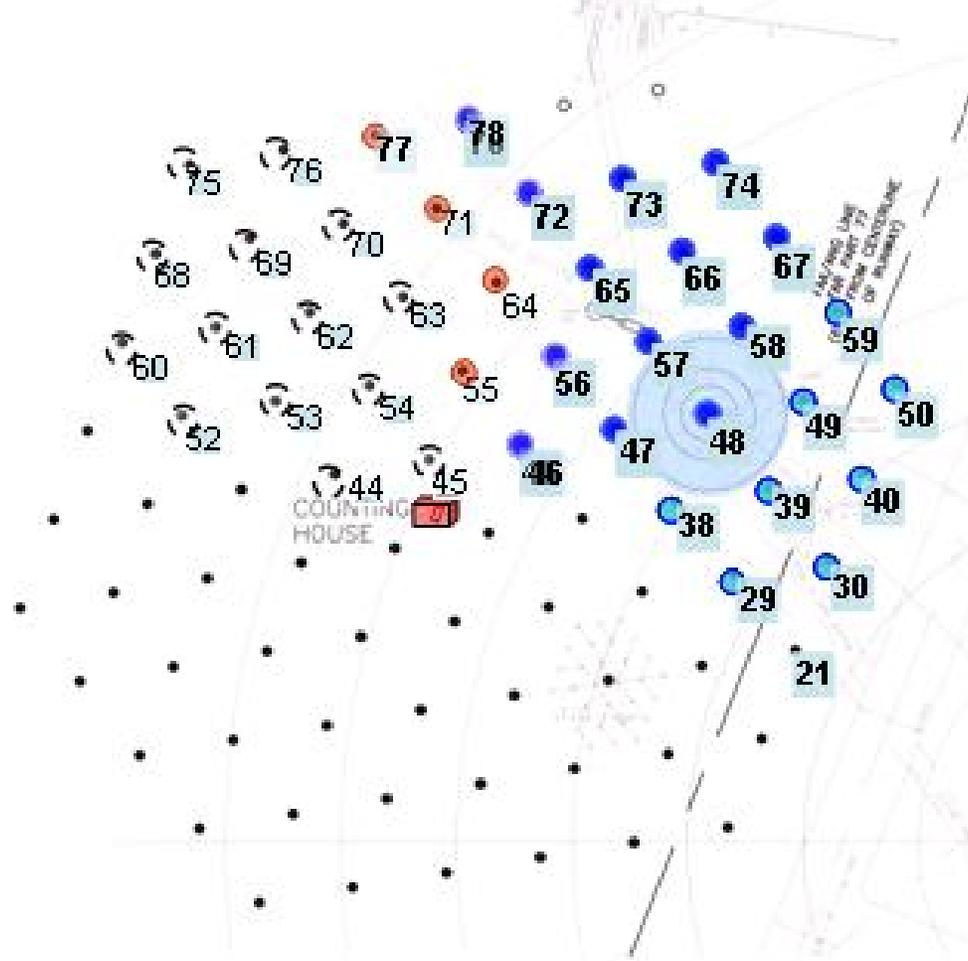
**IC40 Data taking starts in March!**



**Day since new year**

# The Full IceCube

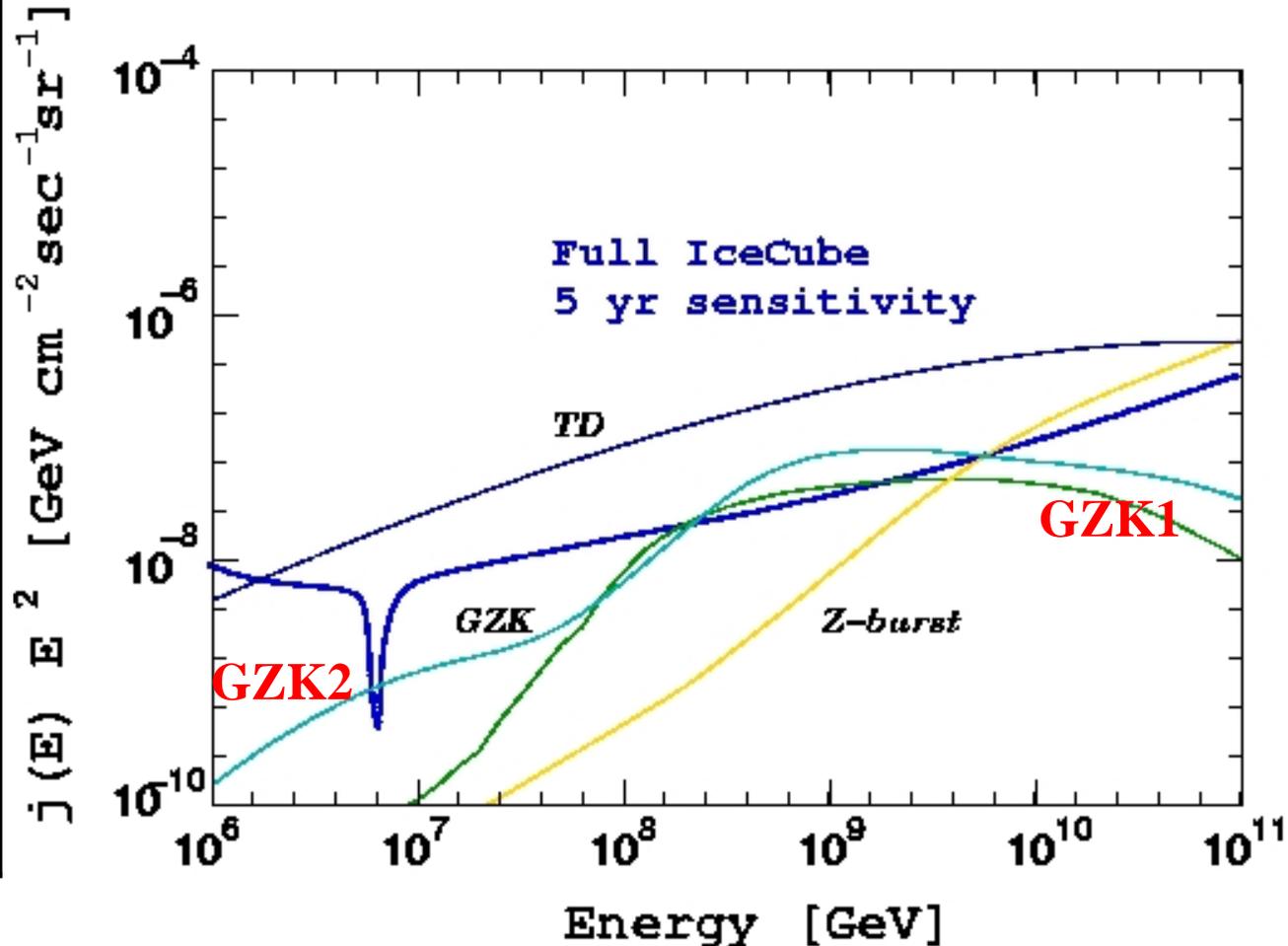
2010 稼働予定



# Sensitivity and Event Rates

Models	N events per year
GZK1	1.03
GZK2	1.62
TD	10.56
Z-Burst	1.70
BG without cutoff	$2.5 \times 10^{-4}$
BG with Cutoff	$2.4 \times 10^{-4}$

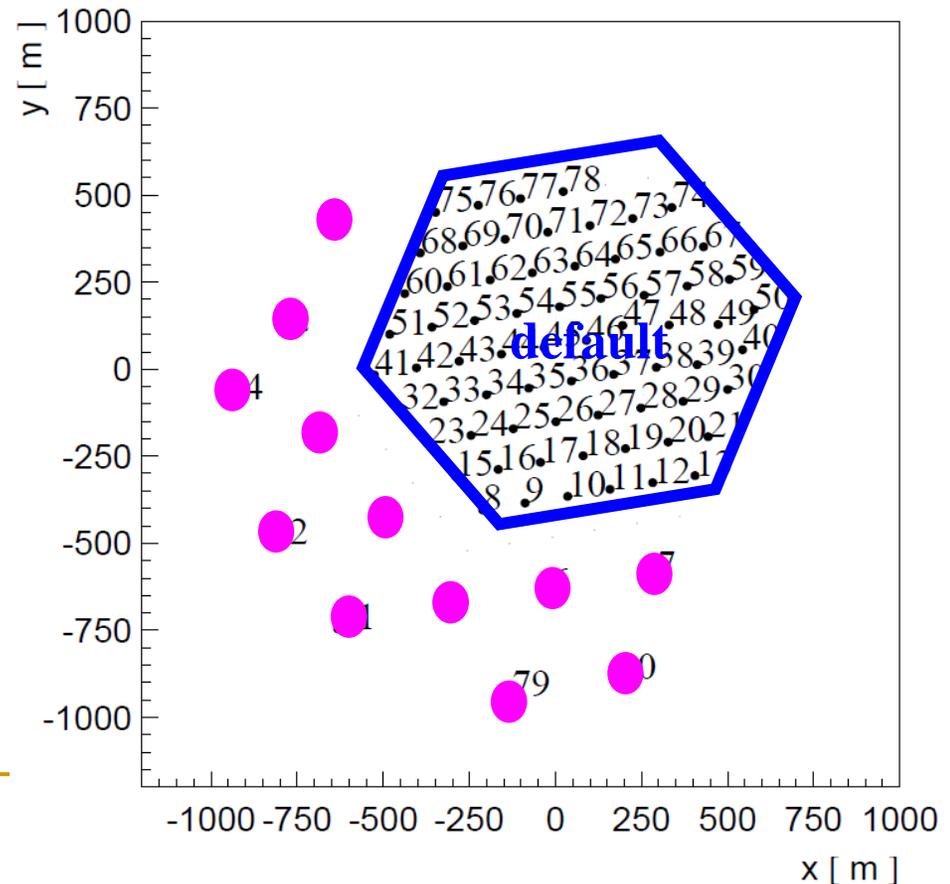
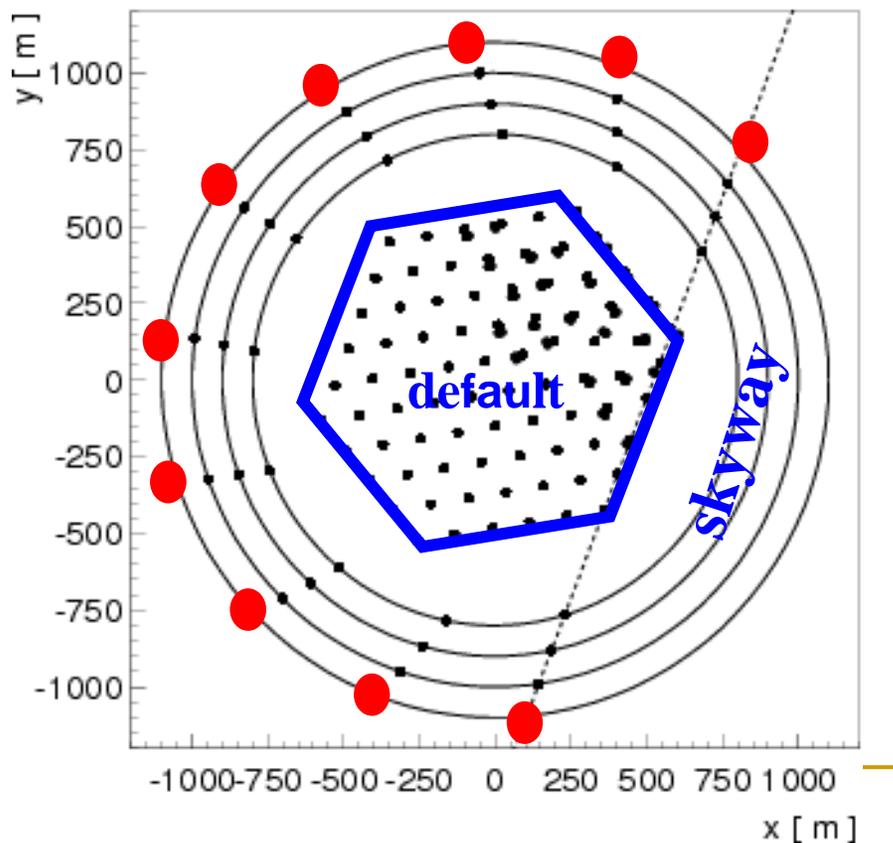
With 9 string data based background / NPE based cuts



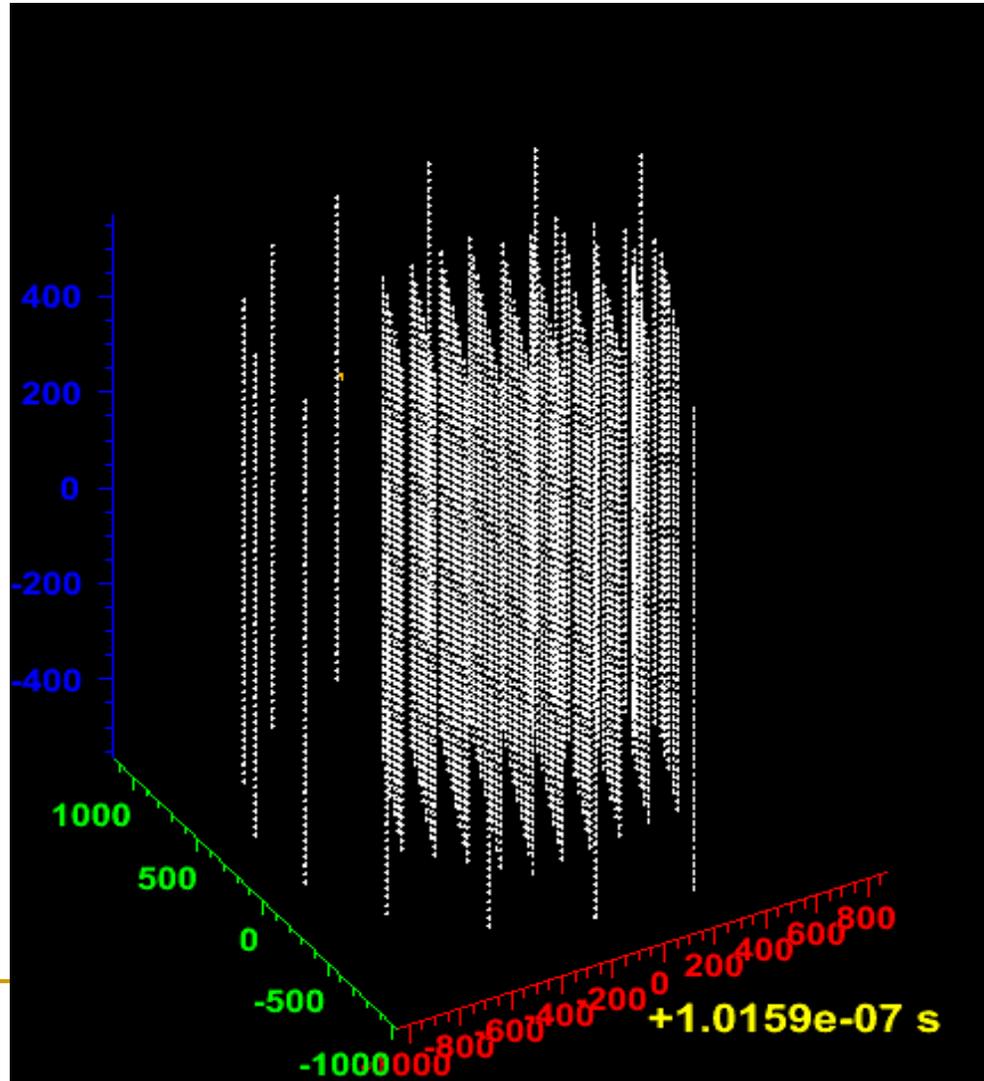
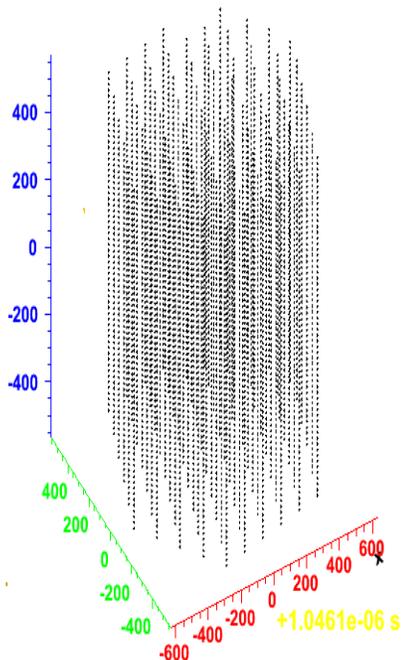
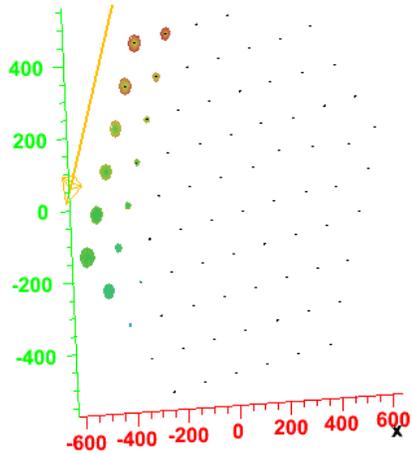
# The IceCube Outer String Extension

We are so close!

Let's rescue the EHE events passing near the IceCube to **double** the events rates to do GZK  $\nu$  physics



# The Extension literary *Extends* the Fiducial Volume for EHE



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# We are the light seekers! High QE DOM Calibration for the Outer Extension

Our IceCube PMT



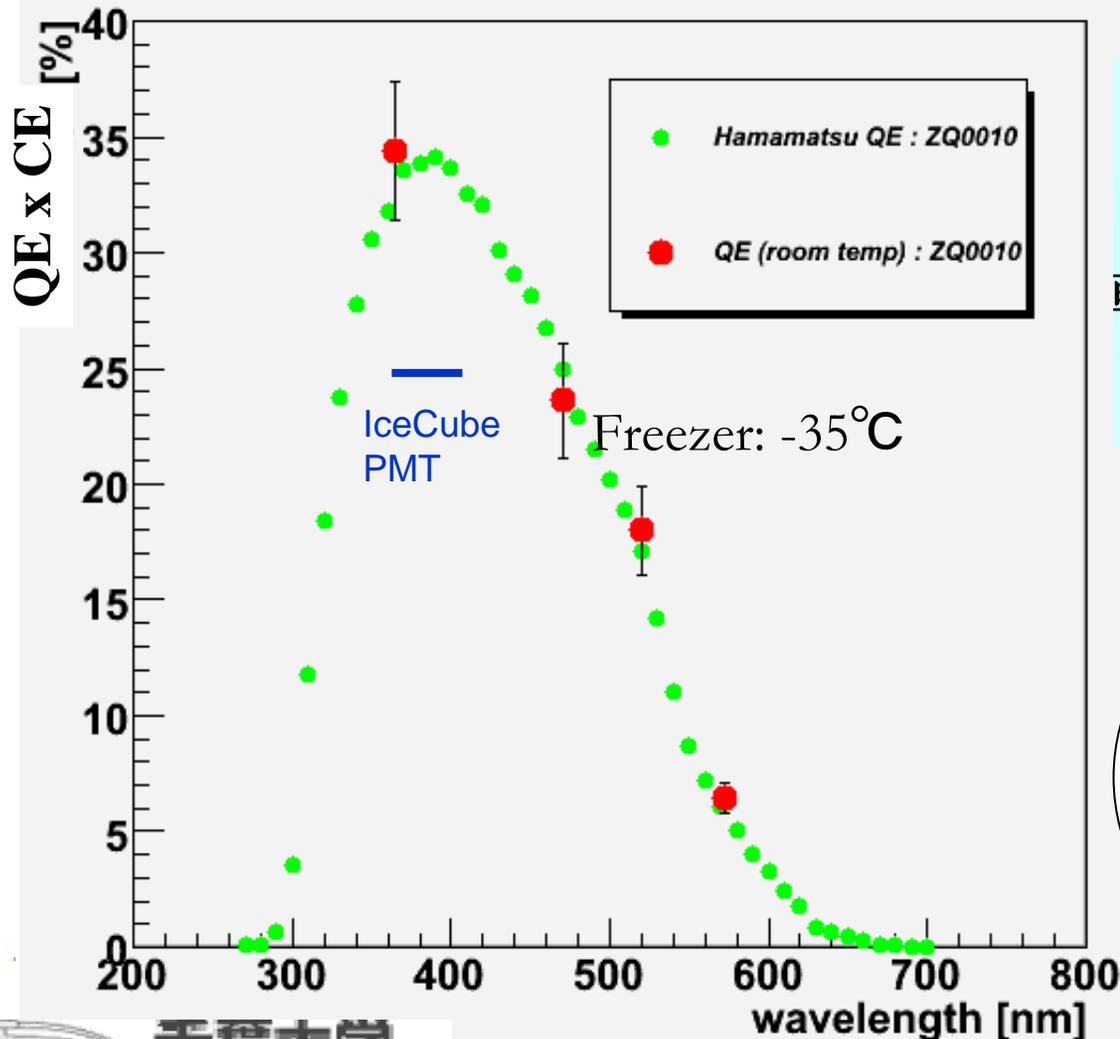
Super Bialkali PMT



# The super QE measurement at Chiba

Quantum Efficiency : ZQ0010

By Yusuke Hasegawa



2008 / 9  
南極夏シーズンに  
校正されたスーパーPMT  
6つを埋設!

宇宙線研にて  
2008年1月中旬  
キャリブレーション  
の予定  
(旅費20万円)

# Summary



- 千葉で較正されたDOMは南極にて順調稼働中
- IceCubeは25%の検出器の建設が終わり、データ取得中・解析進行中
- 今年は50%を目指し建設始動
- **2010年完成にむけたGZKニュートリノ検出(>1 イベント/年)**
- 更なるGZK感度倍増のためのIceCubeアウターエクステンション計画進行中(>2 イベント/年)
- 科研費申請中 (By Yoshida)