Understanding the Contribution of Optical Signals from the New Photodetector LOM18 for the IceCube-Gen2

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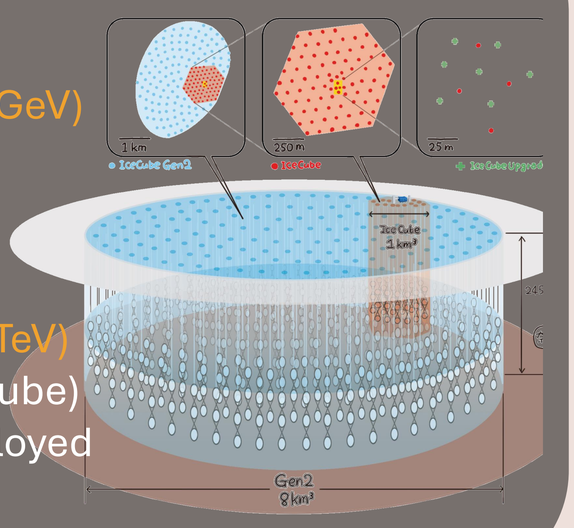
【IceCube Future Extension】

IceCube-Upgrade

- Target : low energy Neutrinos (～GeV)
- Main Detector : D-Egg ＆ mDOM

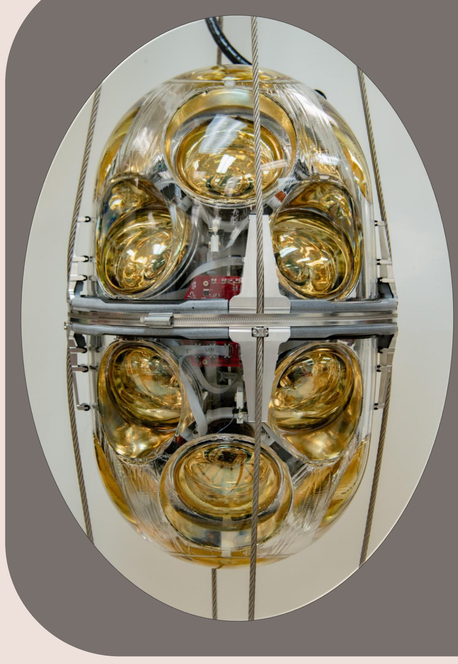
IceCube-Gen2

- Target : High Energy Neutrinos (>TeV)
- 8 km^3 Volume (8 times than IceCube)
- New 10000 Detector will be deployed



https://icecube-gen2.wisc.edu/science/publications/tdr/

【LOM18】

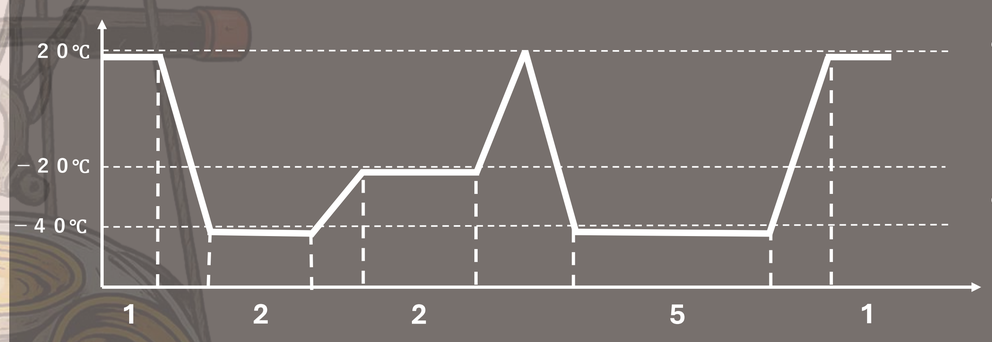


- 18 × 4-inch PMT
- Covered by pressure-resident glass
- Diameter is 96% of IceCube-DOM
- Power consumption : <4W
- Gel pad attached to PMT face
  ➢ Improved sensitivity
- Designed to operate down to -40 ℃ in 70 MPa environment

【Motivation】

In IceCube, rigorous discrimination of optical signals is essential
This study identifies and quantifies the origins and levels of optical backgrounds through experiments and simulations, and quantitatively demonstrates the noise reduction and detection performance of LOM18

【Final Acceptance Test】



- **Stability of Single Photo-Electron (SPE) gain and Darkrate**
- **Measurement at high light intensity**

➢ Each FAT run lasts about two weeks
➢ We completed FAT of 8 LOMs and shipped to South Pole

【Background Signals of LOM18】

LOM signal have mainly 3 components

- Scintillation and Cherenkov light from RI decays
- Scintillation and Cherenkov light from $\mu_{\pm}$ cosmic ray

Depends on LOM glass

- Dark current and thermionic electrons in PMTs

Reproduce detected signals in Genat4

【Glass properties】

Birk formula： Scintillation light emission intensity

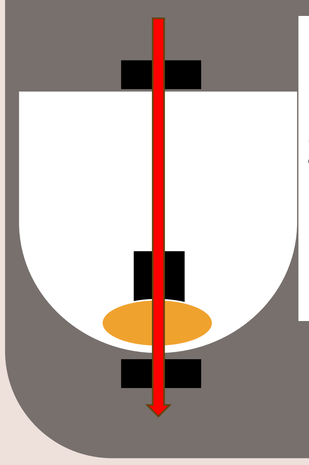
$$\frac{dL}{dx} = S\frac{dE/dx}{1 + k_B\, dE/dx}$$

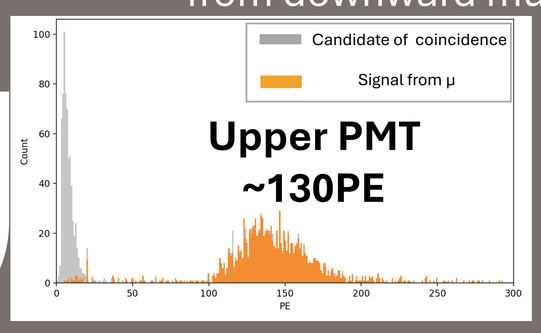
S ： Scintillation Light Yield [Photons /MeV]
k_B ： Birk constant , quenching strength

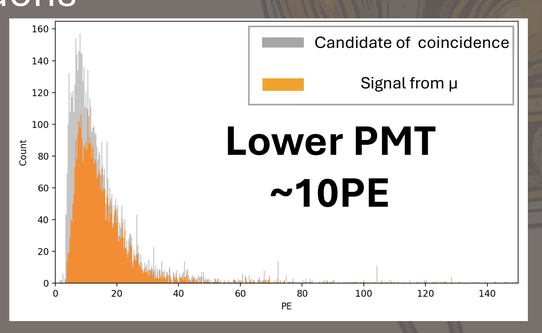
We determine these parameters in LOM glass using simulation and FAT data

【μ tracking to measure glass properties】

Using PMT with glass and 2 plastic scintillator , we measure the light from downward muons





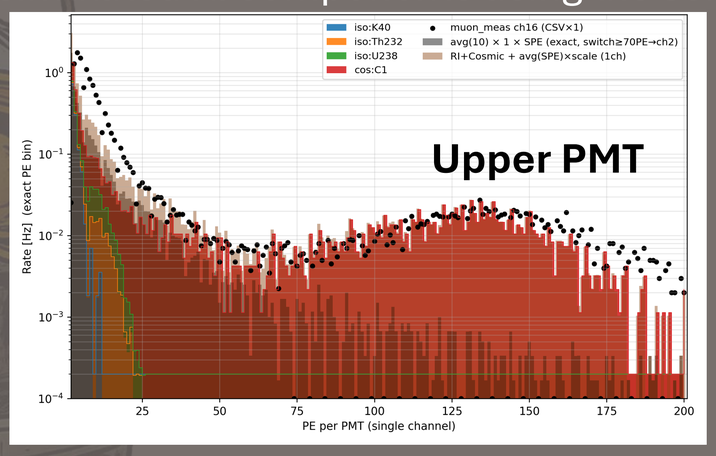


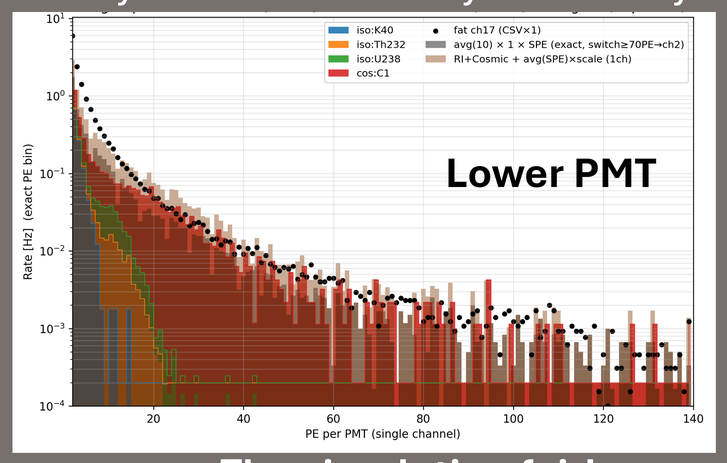
Determine the scintillation yield and Birk constant from the peak light caused by μ

【Result 】

Scintillation Yield ~ 60 [PE/MeV]

I simulated RI components using the scintillation yield determined by cosmic rays





Cosmic rays dominate at large photon region, while RI decay contributes to only small charge region

➡ **The simulation fairly supports the experimental result**

【Conclusion】

- Studied the contributions of the backgrounds of the optical detector
- I compared simulation and FAT data to investigate the glass properties
- The scintillation yield is determined to be ~ **60 PE/MeV**