37th International Cosmic Ray Conference

Deployment of the IceCube Upgrade Camera System in the SPICEcore hole

Danim Kim[1], Carsten Rott[1,2], Anna Pollmann[3], Christoph Toennis[1,4] on behalf of the *IceCube Collaboration*†

[1]Department of Physics, Sungkyunkwan University, Suwon, 16419, South Korea; [2]Department of Physics and Astronomy, University of Utah, Salt Lake City, UT 84112, USA; [3]Dept. of Physics, University of Wuppertal, D-42119 Wuppertal, Germany;, [4]Institute of Basic Science, Sungkyunkwan University, Suwon 16419, Korea

† http://icecube.wisc.edu/collaboration/authors/

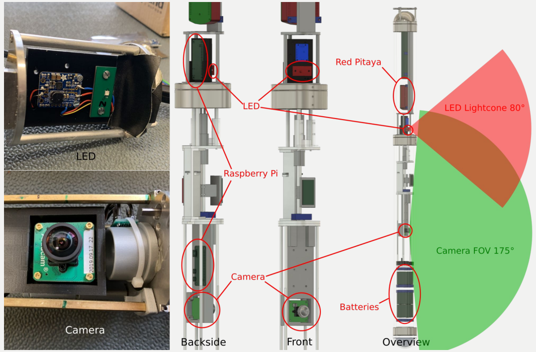
Abstract

IceCube is a cubic-kilometer scale neutrino telescope located at the geographic South Pole. The detector utilizes the extremely transparent Antarctic ice as a medium for detecting Cherenkov radiation from neutrino interactions. While the optical properties of the glacial ice are generally well modeled and understood, the uncertainties which remain are still the dominant source of systematic uncertainties for many IceCube analyses. A camera and LED system is being built for the IceCube Upgrade that will enable the observation of optical properties throughout the Upgrade array. The SPICEcore hole, a 1.7 km deep ice-core hole located near the IceCube detector, has given the opportunity to test the performance of the camera system ahead of the Upgrade construction. In this contribution, we present the results of the camera and LED system deployment during the 2019/2020 austral summer season as part of a SPICEcore luminescence logger system.

SPICEcore hole

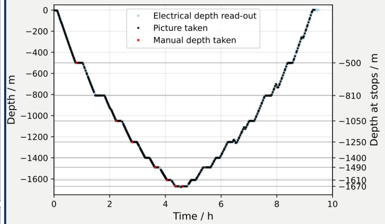
- Filled with ESTISOL to prevent re-freeze
- Drilled in 2014/2015 and 2015/2016 austral summers [1]
- 1,751 m deep and 1 km away from IceCube site
- Overlaps at 1380 m with the depths instrumented by IceCube (1450m and below) due to due to ice layer tilt

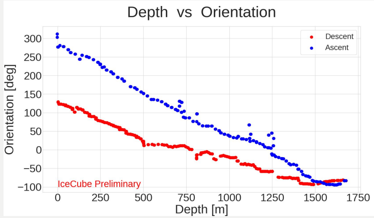
Hardware



- ICU Camera [2] was integrated into the luminescence logger [3]
- IMX225 image sensor from SONY with a 175 degree FOV wide angle lens
- Illumination board used to generate light for camera
- Emitting 43 lm of 470 nm light with a full width at half maximum of 80 degrees
- Camera system is identical to the one being deployed for the IceCube Upgrade
- Each IceCube Upgrade module will have three cameras to carry out ice property measurements

Deployment

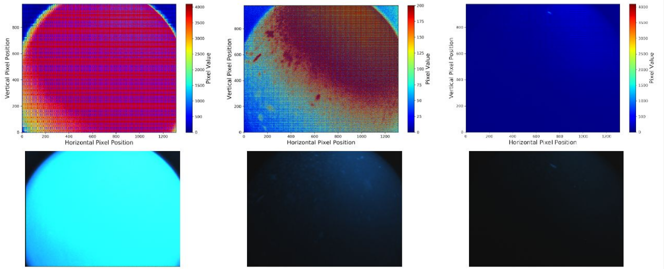


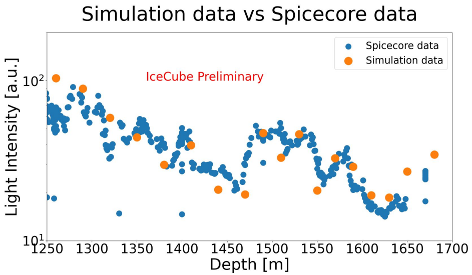


- Deployed on 21.12.2019 for 10 hours
- Stops made at 500 m, 810 m, 1050 m, 1400 m, 1490 m, 1610 m and 1670 m
- 30 images per stop with 3 s exposure and 24 dB gain below 1.5 km, 0 dB above that
- LED enabled at stops and during ascent

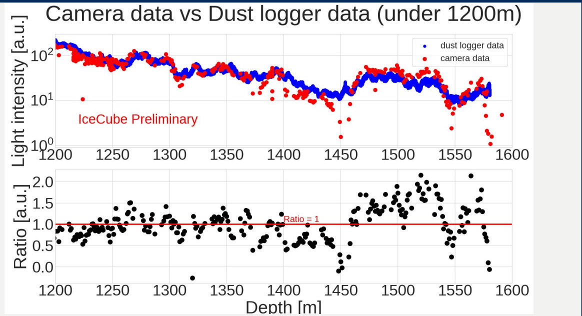
Analysis

- Images shown at different depth showing dependence of brightness on depth
- simulations run using PPC [5] with scattering length taken from IceCube ice model [6]
- Depth values between IceCube and SPICEcore related using ice layer tilt measured by dust logger





Results



- Image brightness compared to laser-based dust logger [4] to evaluate performance
- Demonstrated camera's capability to evaluate Antarctic ice properties
- Strong correlation between camera logger and dust logger data show sensitivity of the camera based method
- Successful field test of the IceCube Upgrade camera system under the extreme Antartic conditions
- Further analyses will be performed to attempt to extract quantitative information about scattering, absorption length or anisotropies in the light propagation in the Antarctic ice

Proceeding

Link

References

1 K. A. C. et al.Annals of Glaciology 55(2014) 137–146.
2 IceCube Collaboration, PoSICRC2021(these proceedings) 730.
3 IceCube Collaboration, PoSICRC2019(2019) 983.
4 N . E. B. et al.Geophys. Res. Lett.32(2005) L21815.
5 IceCube Collaboration, D. ChirkinNucl. Instrum. Meth. A725(2013) 141–143.1258
6 IceCube Collaboration, M. G. Aartsen et al. Nucl. Instrum. Meth. A711(2013) 73–89.116