



The IceCube Upgrade

and the Sweden Camera

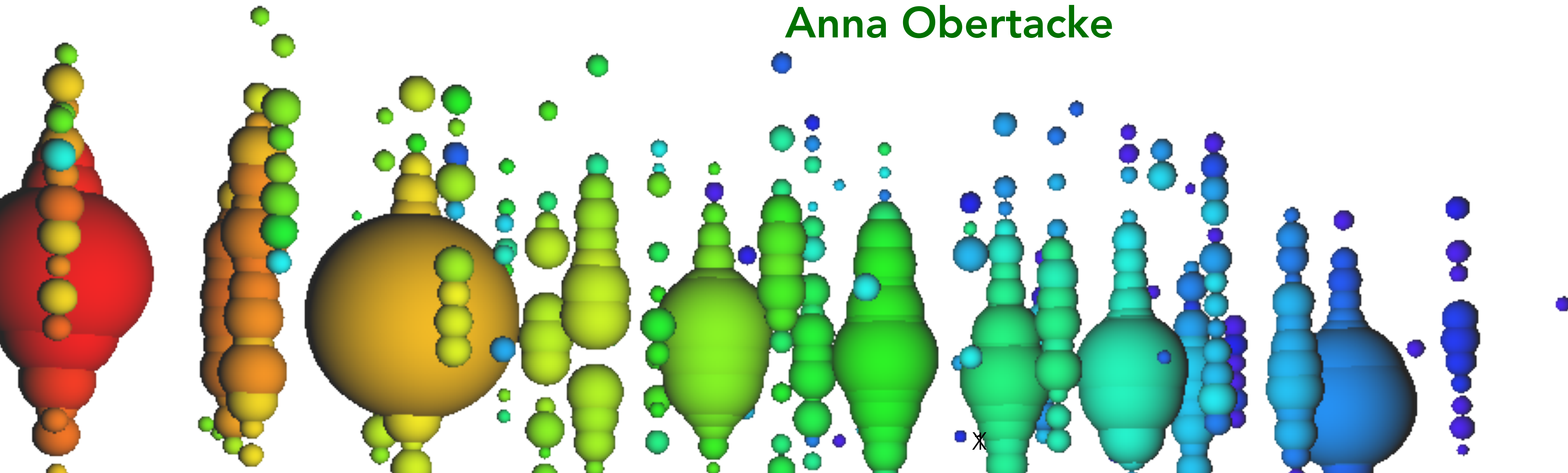
Anna Obertacke



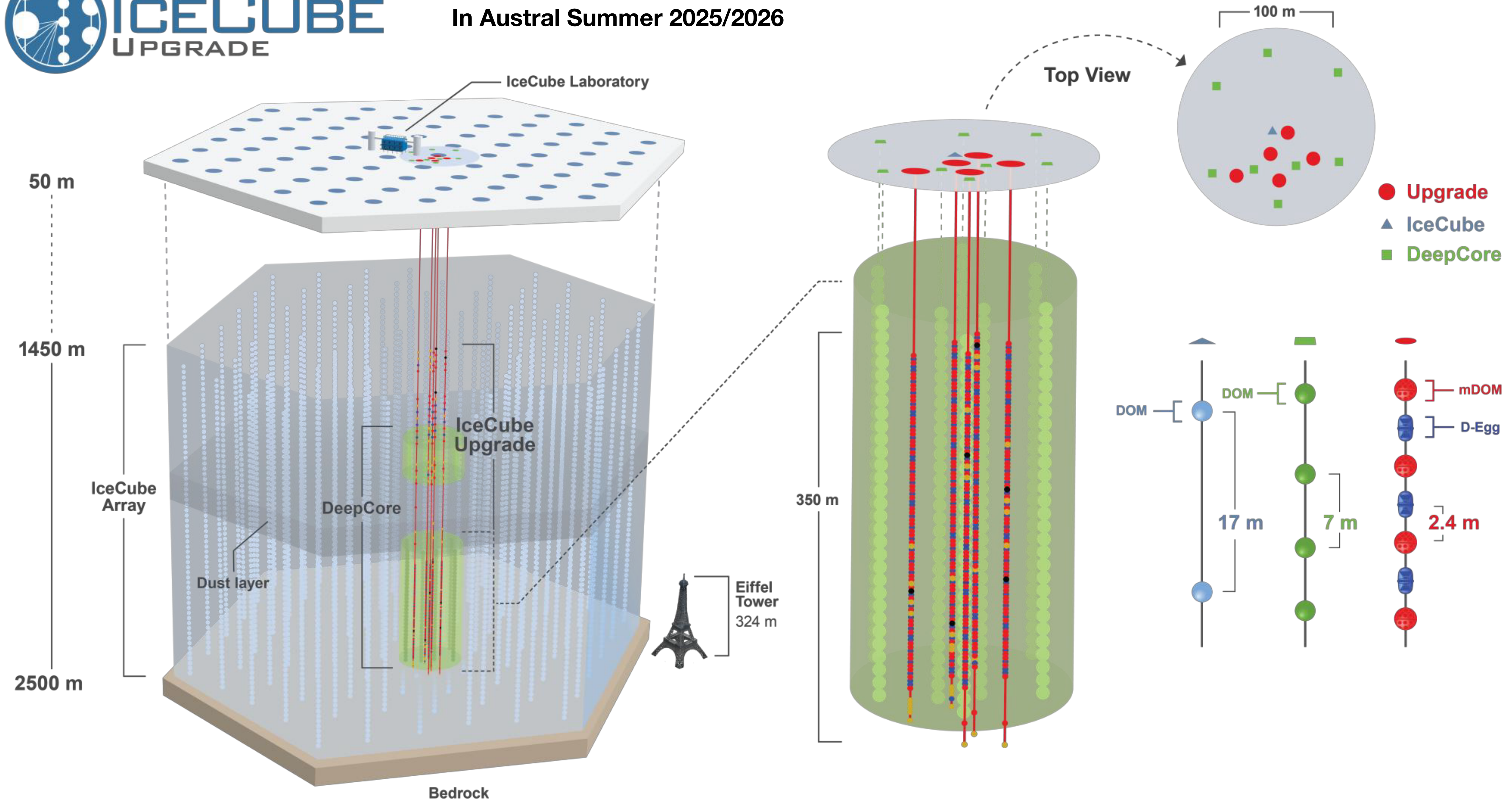
UPPSALA
UNIVERSITET



Stockholm
University



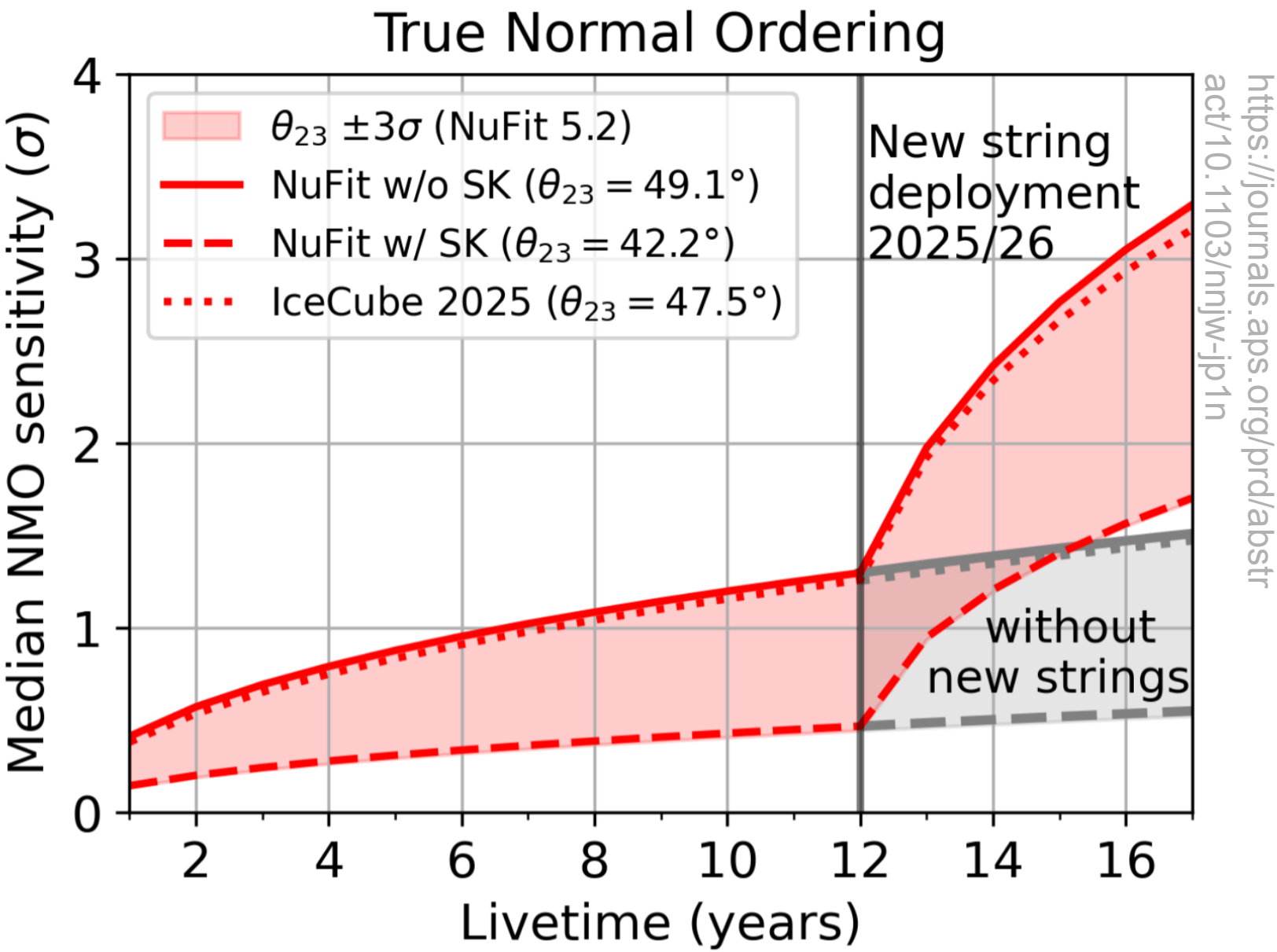
In Austral Summer 2025/2026



Motivation

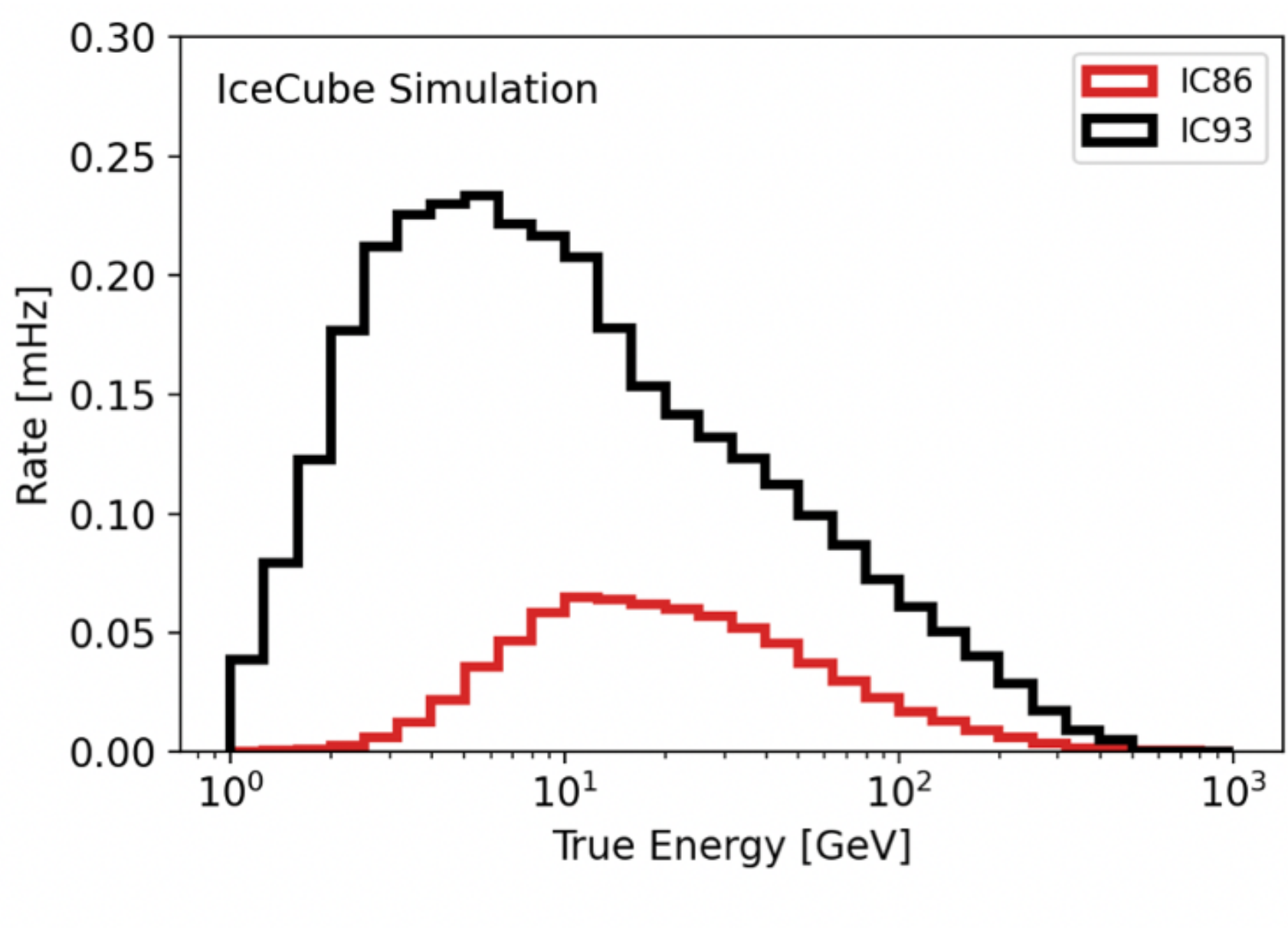
Neutrino oscillation

- neutrino oscillation property measurements best around a few GeV
- current IceCube starts sensitivity around 5 GeV
- infill array can use standard IceCube as veto



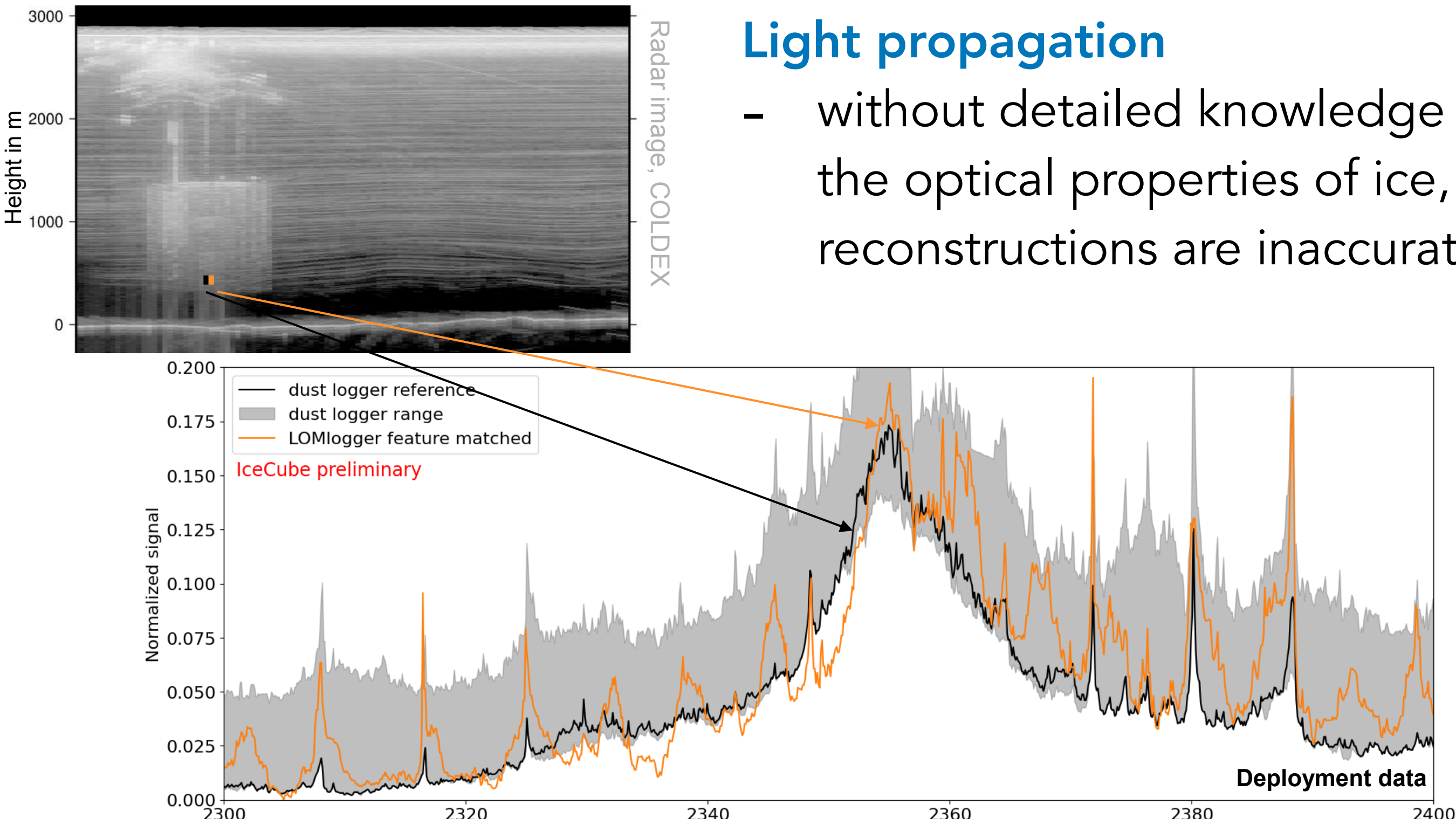
GeV astrophysics

- (Super) Novae
- low energy astrophysical sources



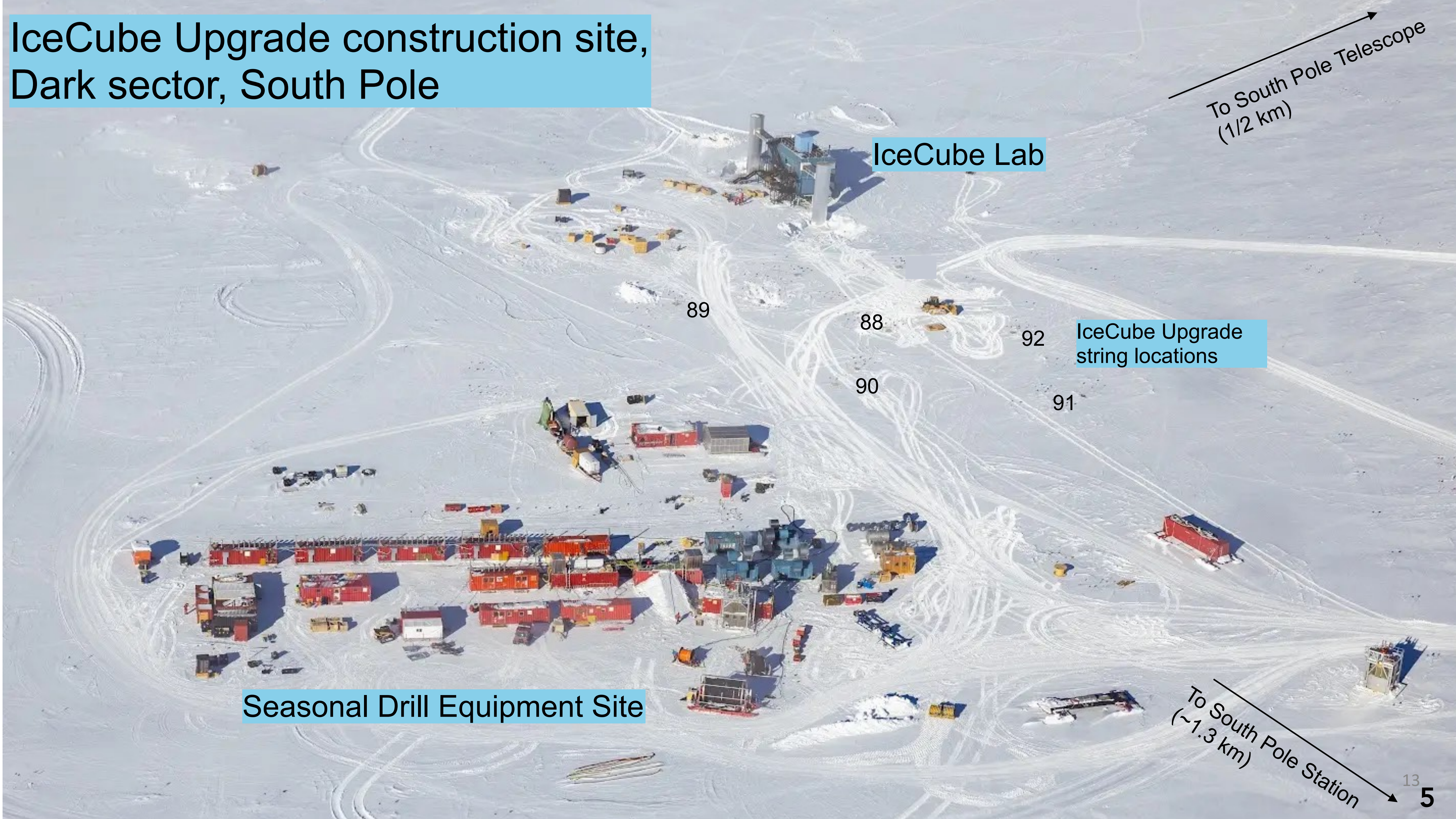
Light propagation

- without detailed knowledge of the optical properties of ice, reconstructions are inaccurate





IceCube Upgrade construction site, Dark sector, South Pole



IceCube Lab

To South Pole Telescope
(1/2 km)

IceCube Upgrade
string locations

Seasonal Drill Equipment Site

To South Pole Station
(~1.3 km)

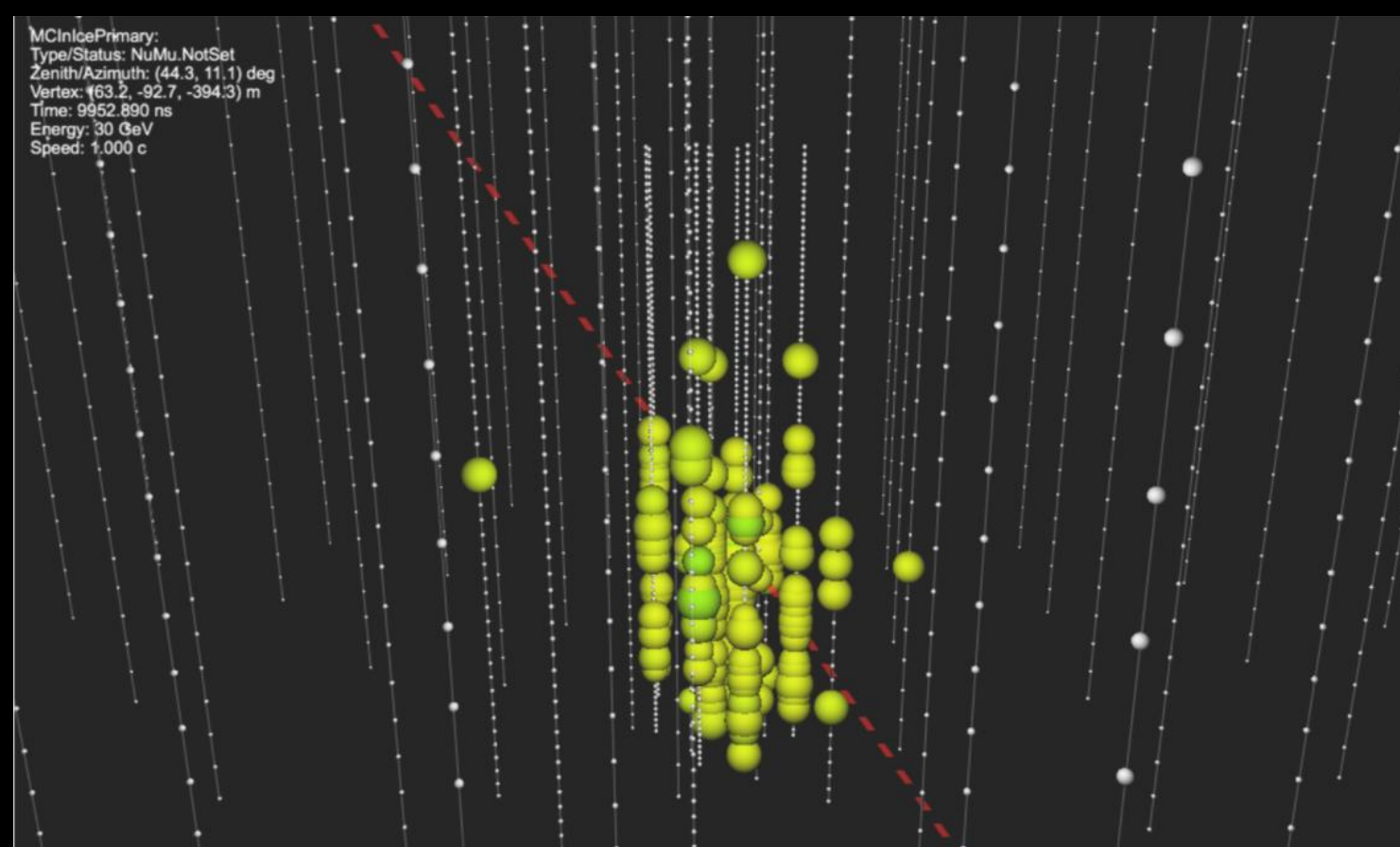
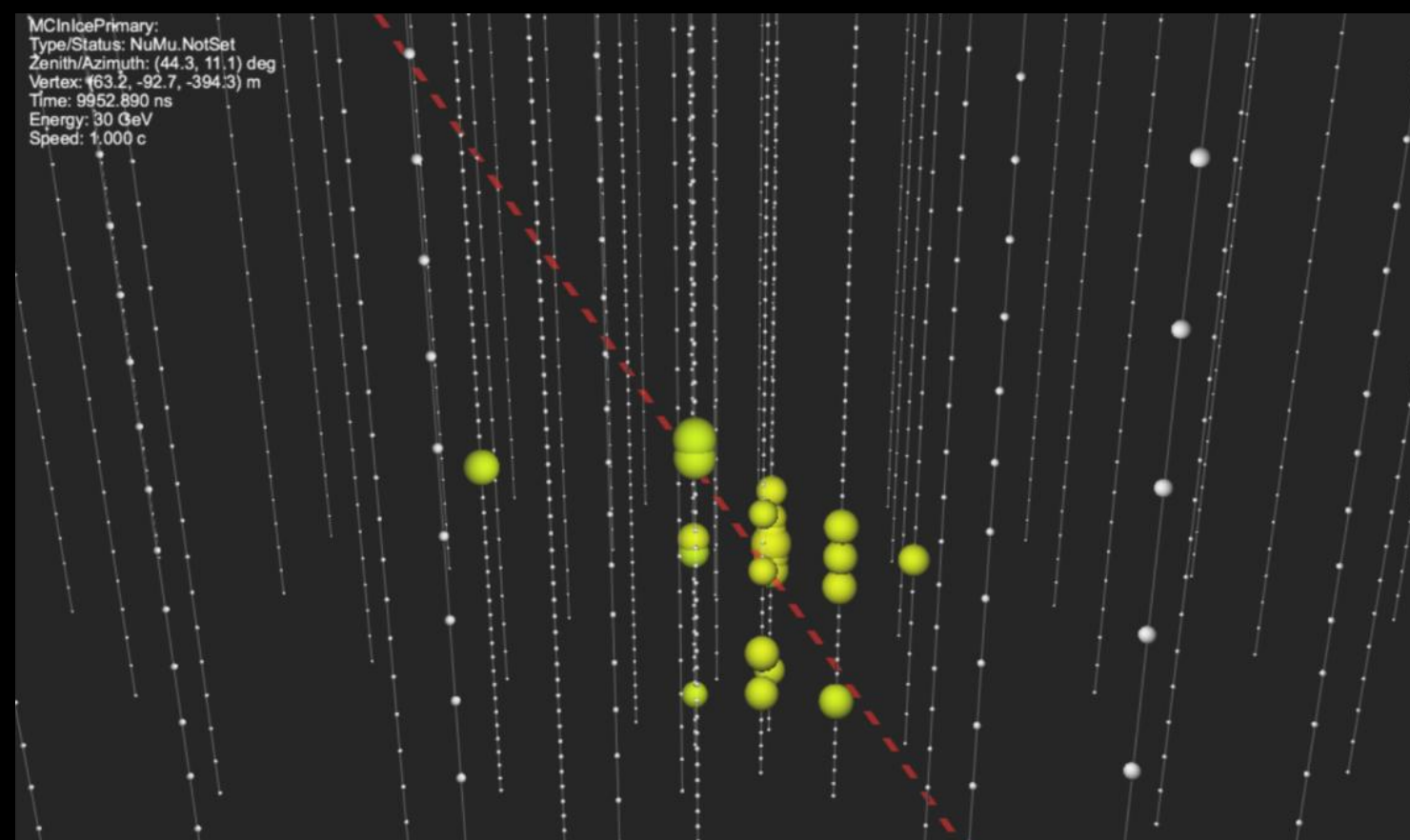




450 mDOM
one of the 2 baseline designs



30 GeV Muon



3x more photo-sensor area

New sensor generation

- large, isotropic sensitivity
- directional information / noise suppression
- integrated calibration systems



450 mDOM
one of the 2 baseline designs

10 WOM 
exploratory design

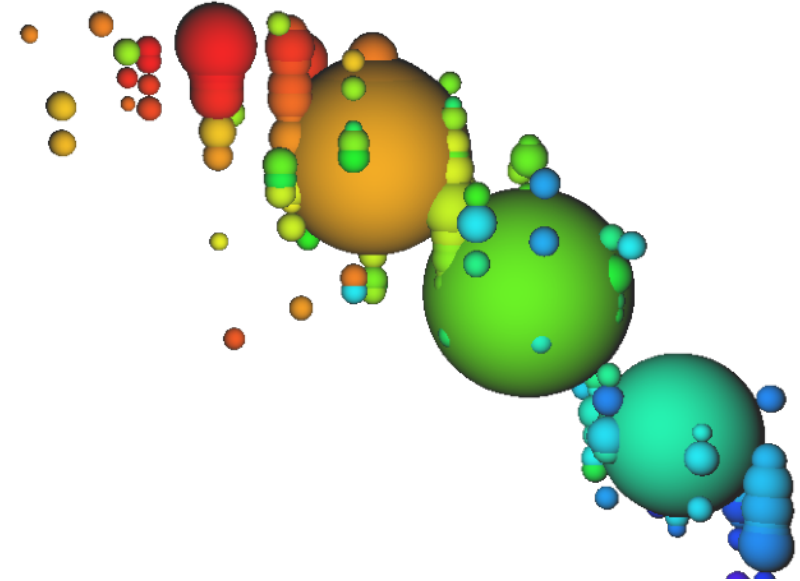
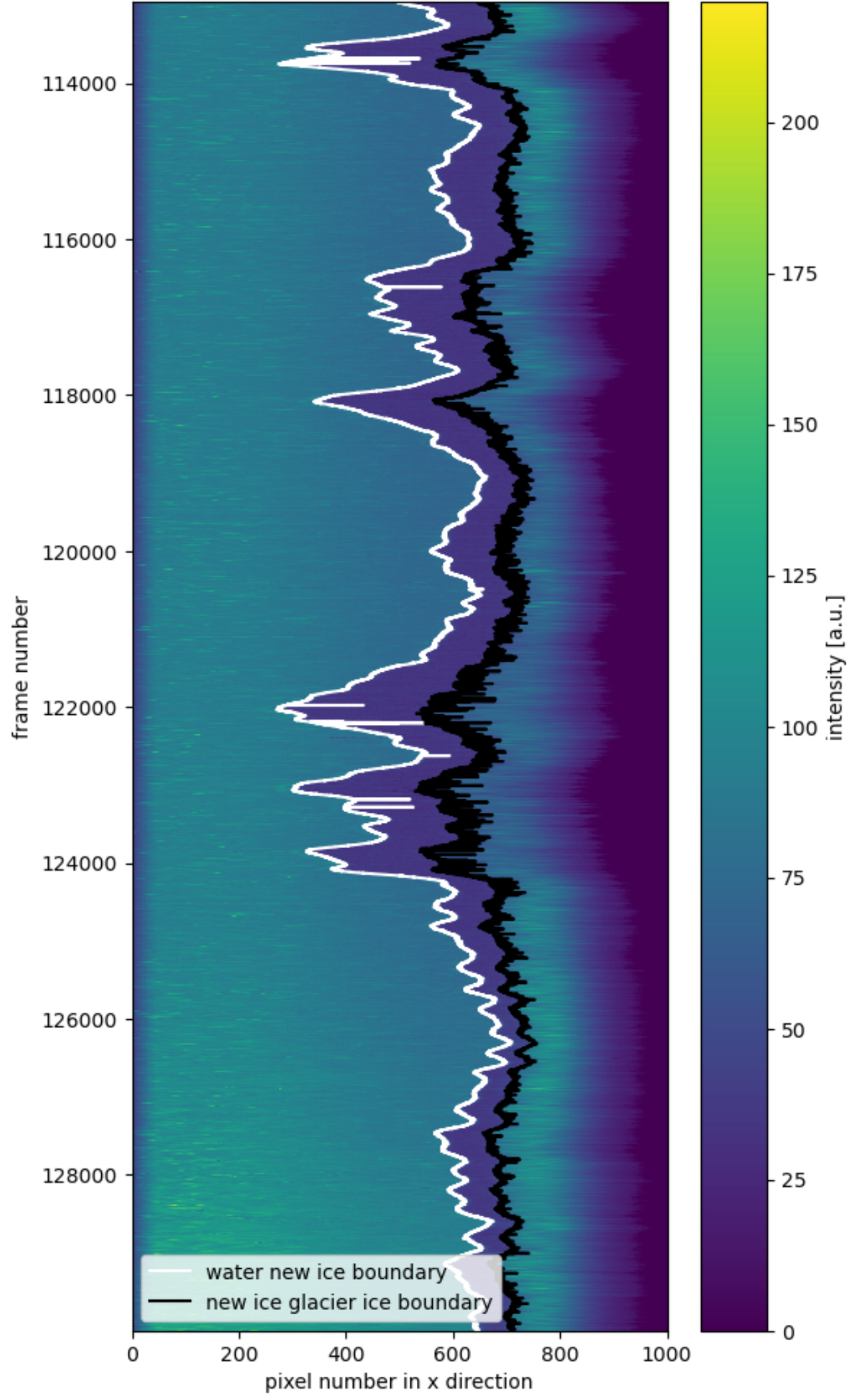
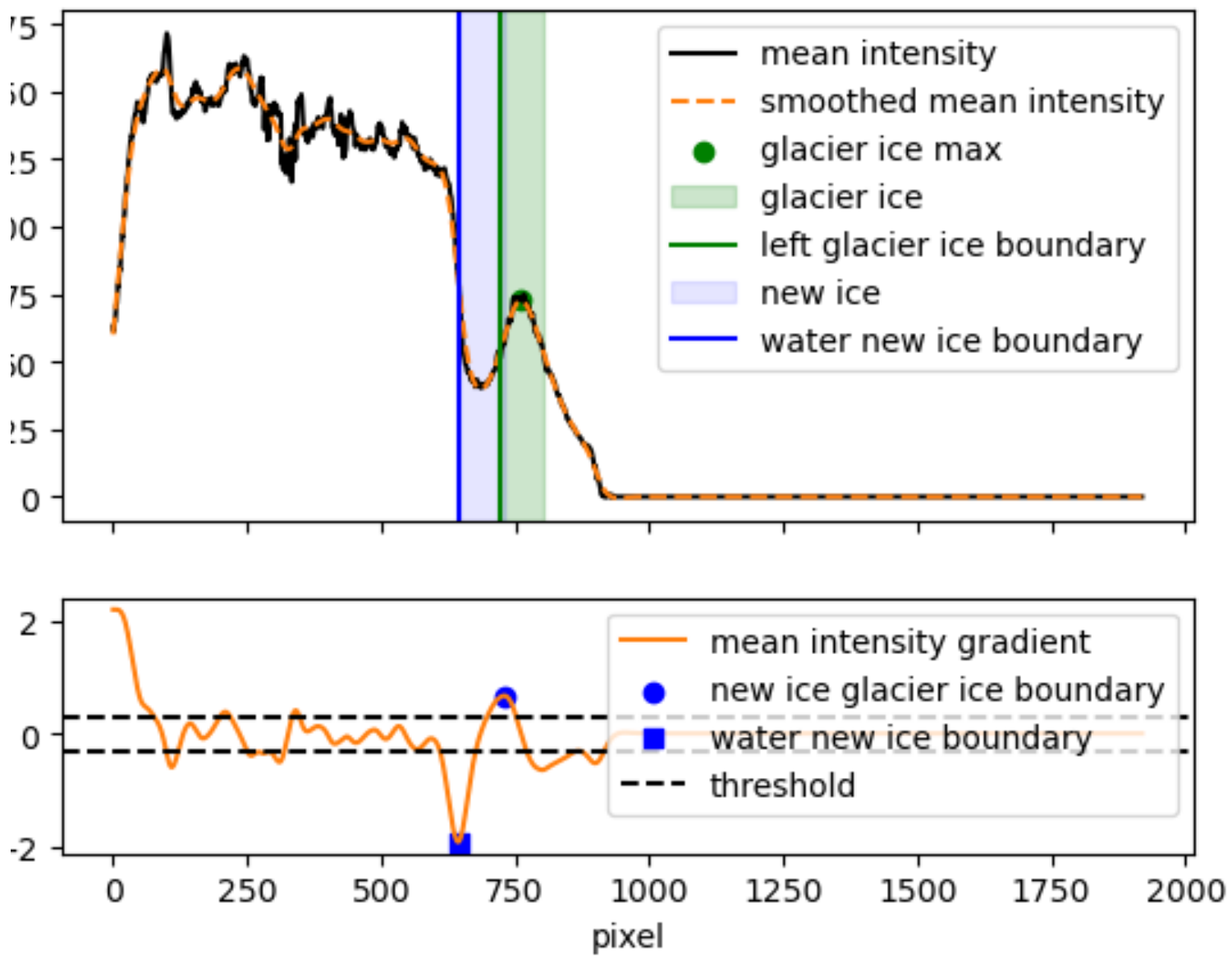
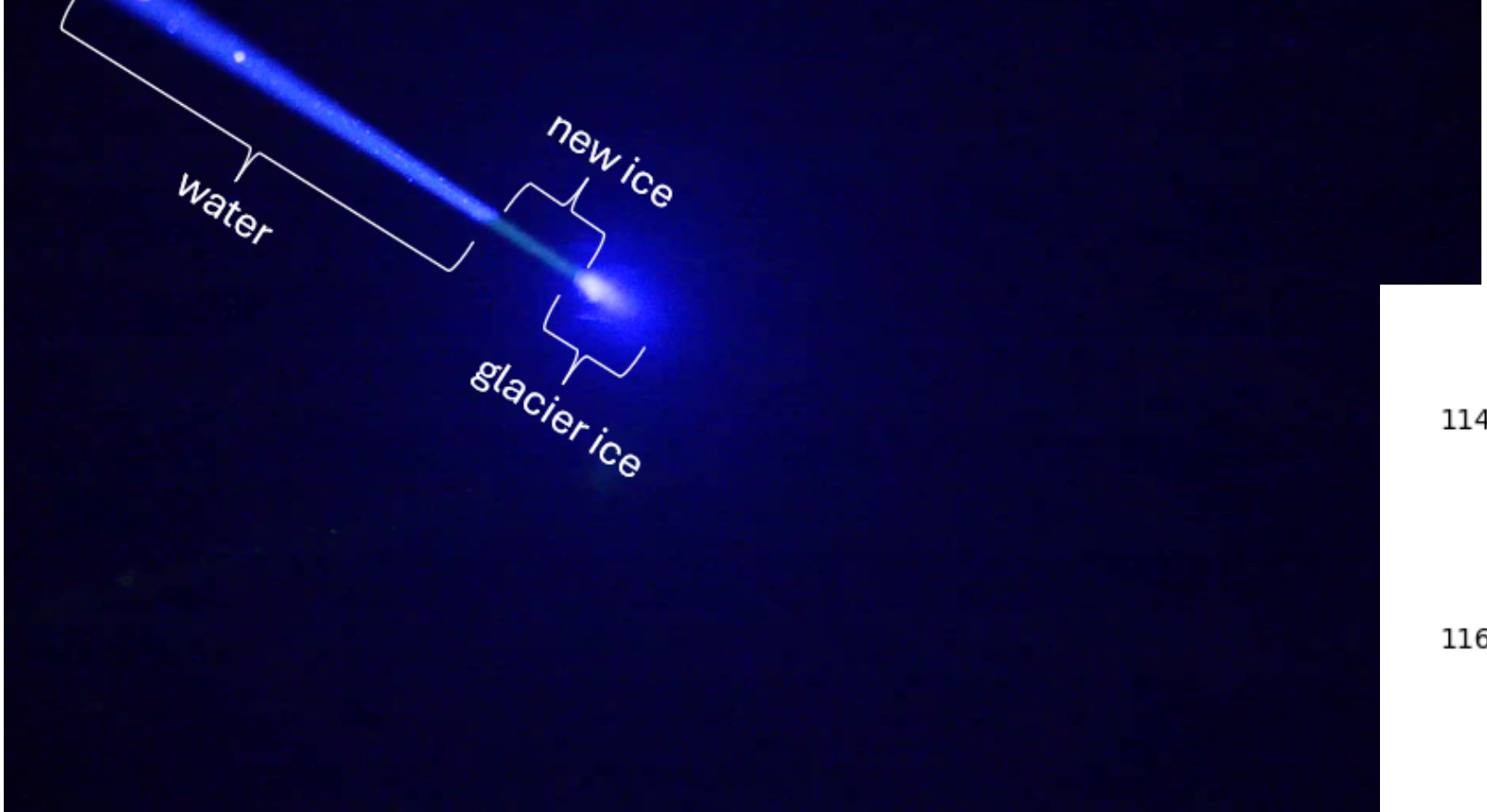
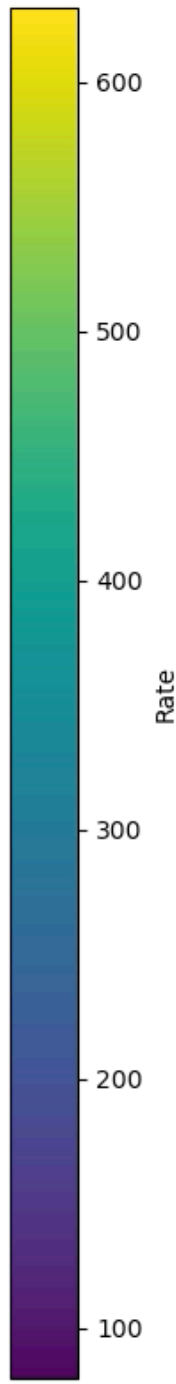
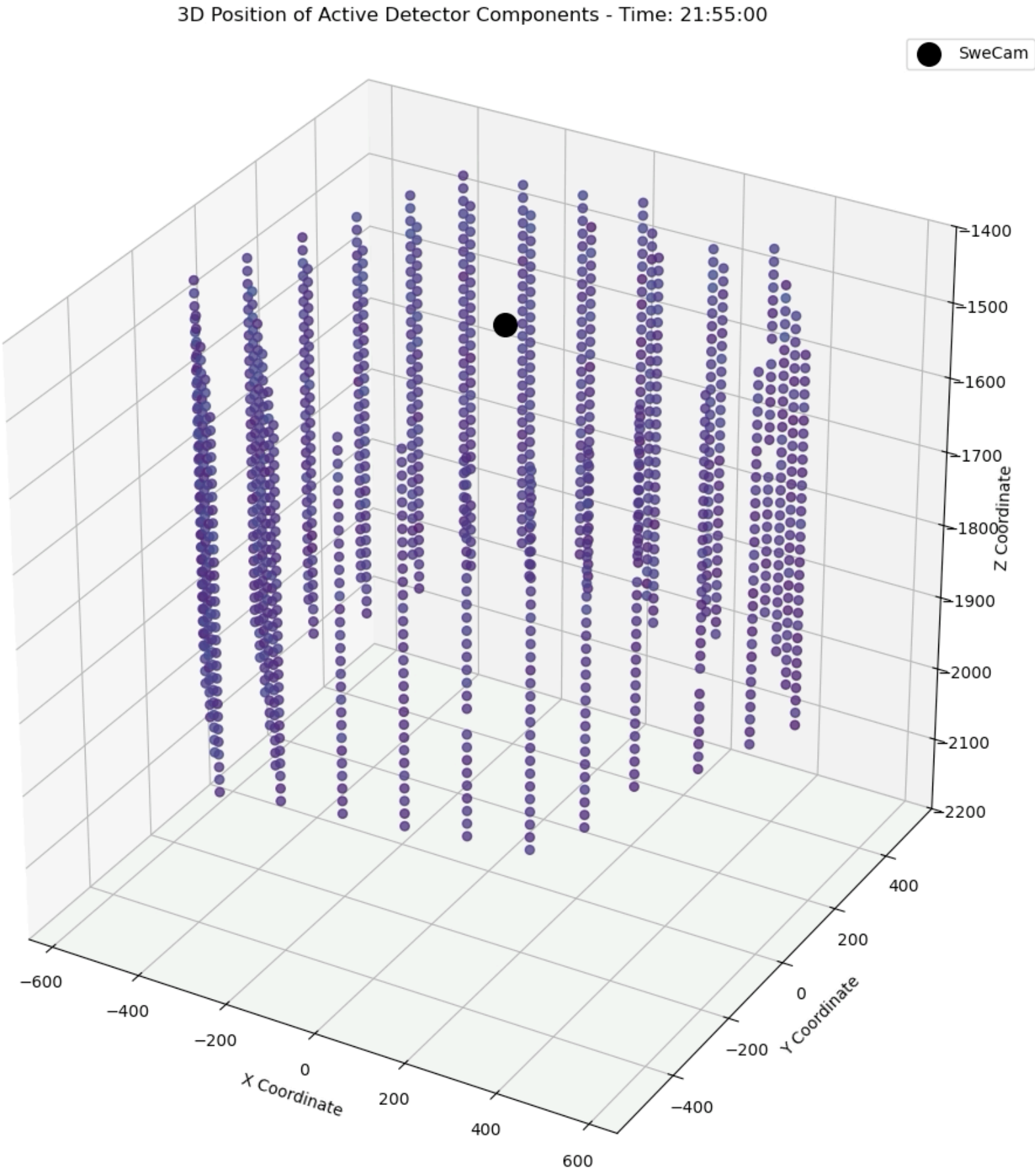


6 Sweden Cameras
calibration devices



Drop operation

- measure stratigraphy

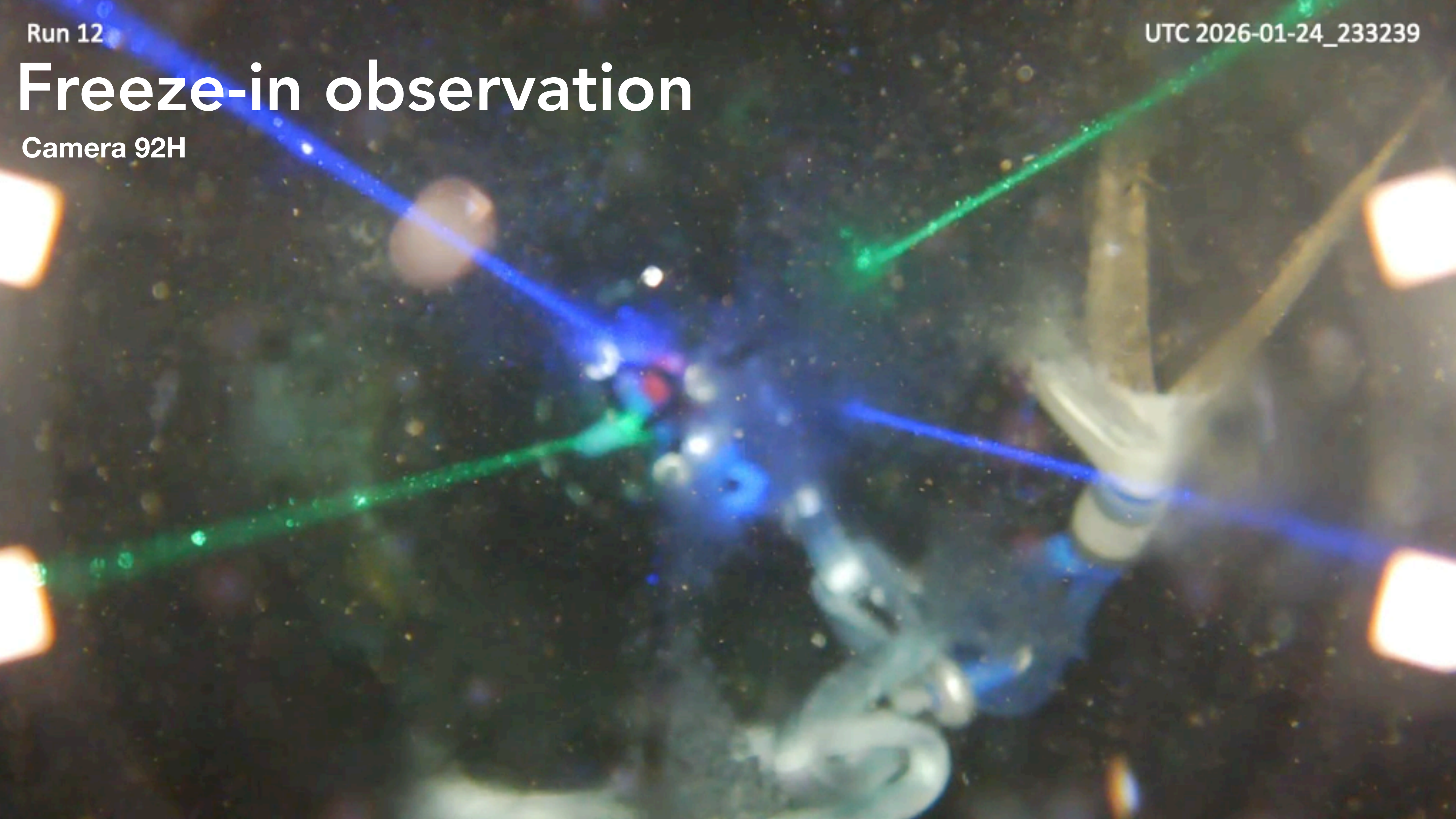


Run 12

UTC 2026-01-24_233239

Freeze-in observation

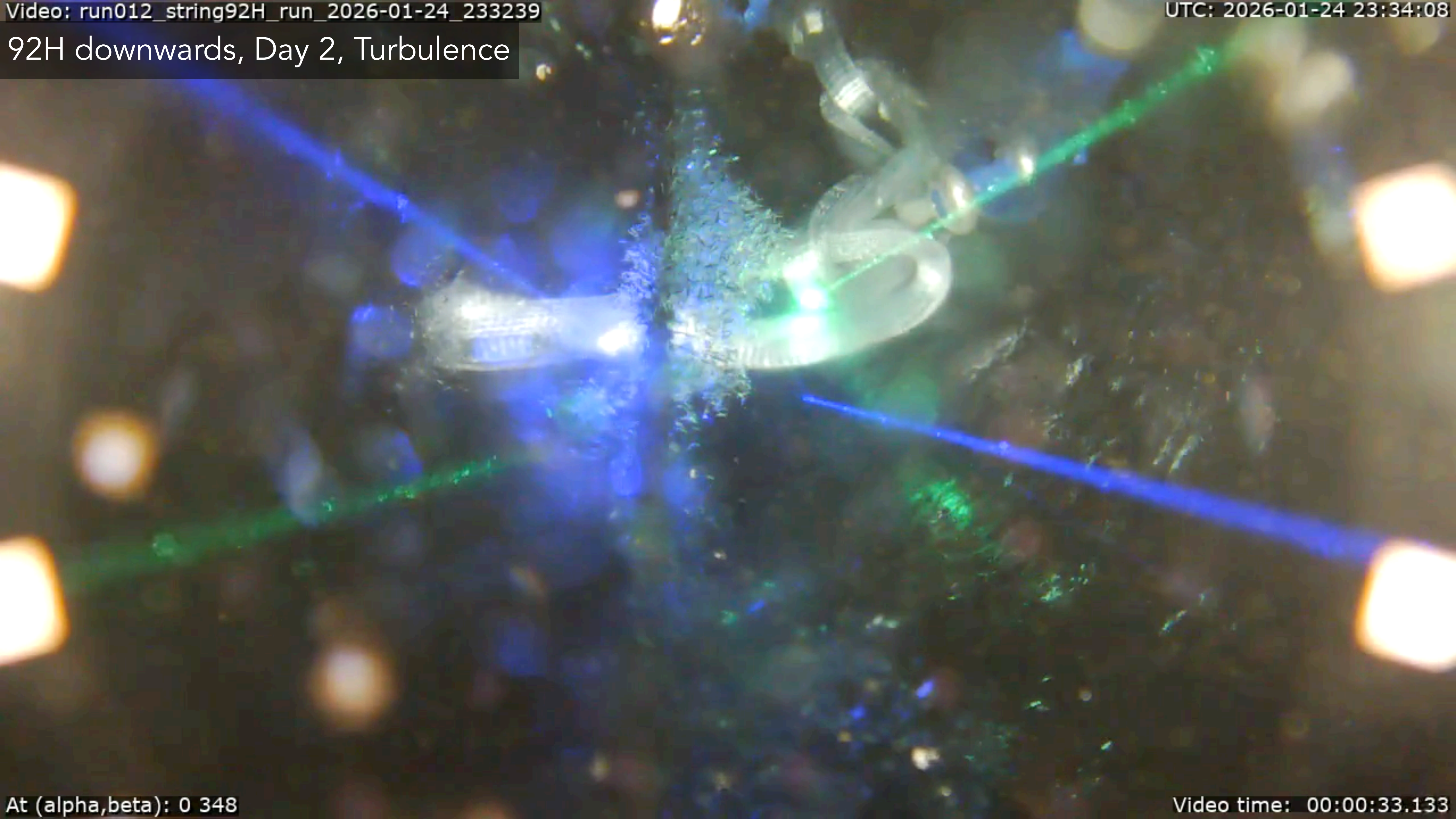
Camera 92H



Video: run012_string92H_run_2026-01-24_233239

UTC: 2026-01-24 23:34:08

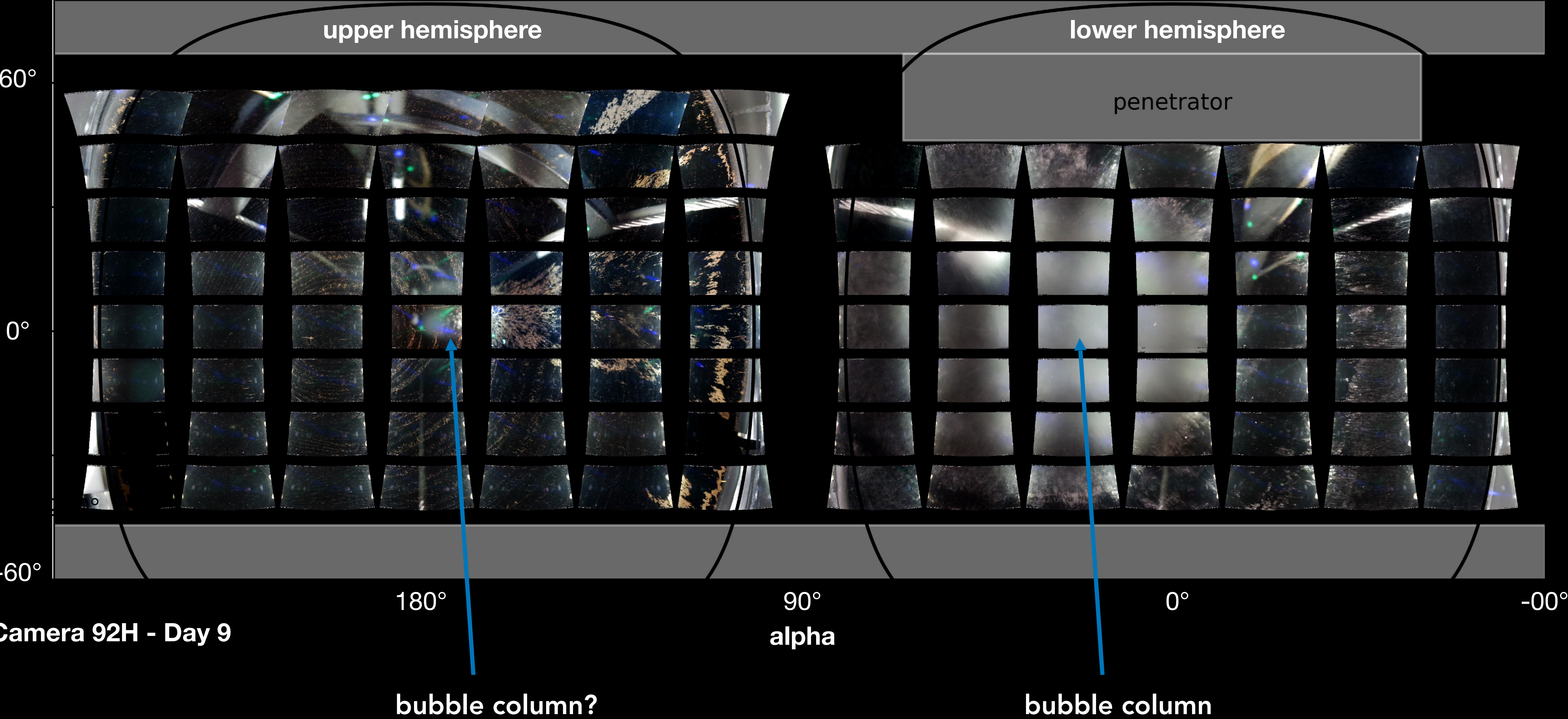
92H downwards, Day 2, Turbulence



At (alpha,beta): 0 348

Video time: 00:00:33.133

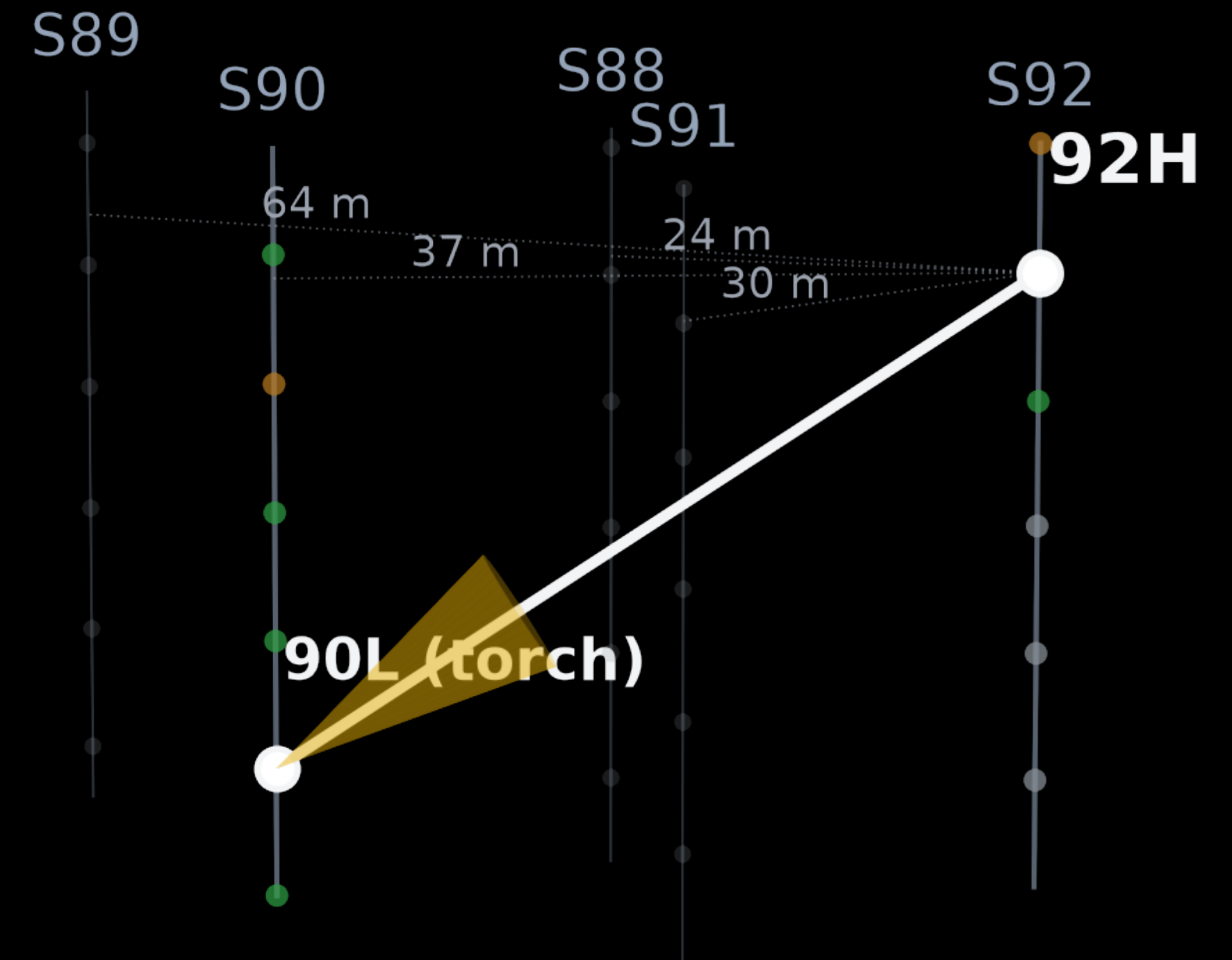
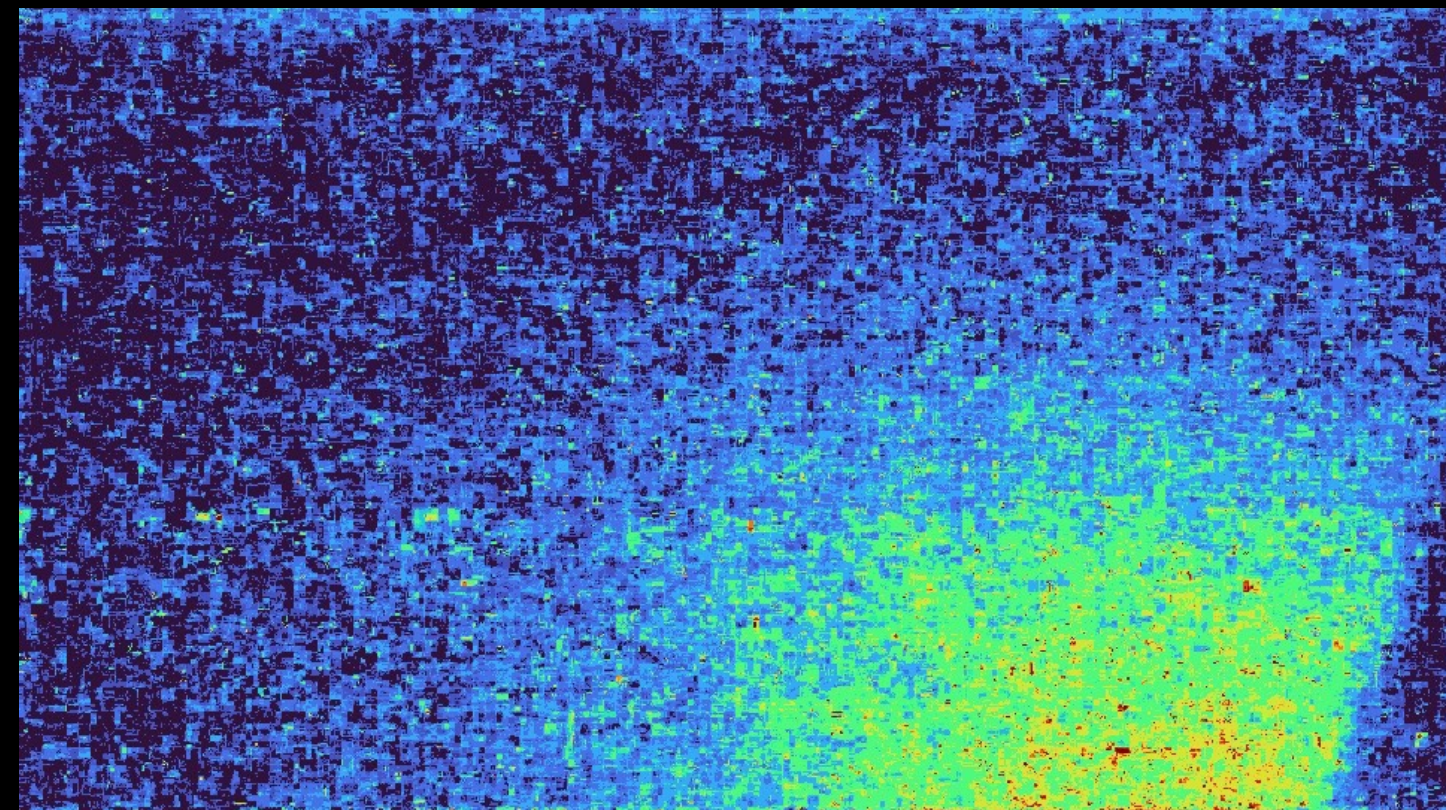
Re-frozen ice's bubble column measurement



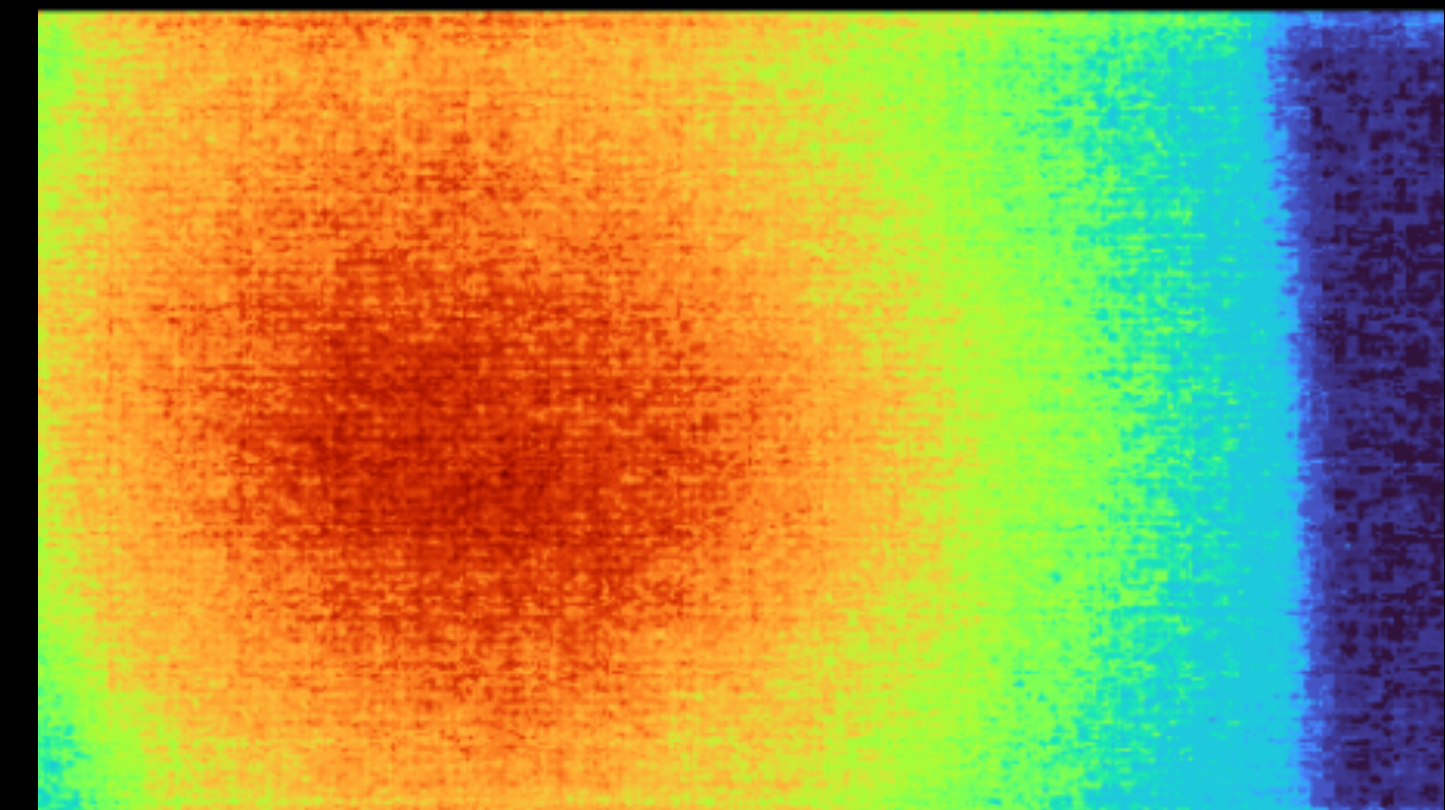
Ongoing: geometry measurement



Camera 90L watching string 88
blue LED of ~10 mW in 20 m distance



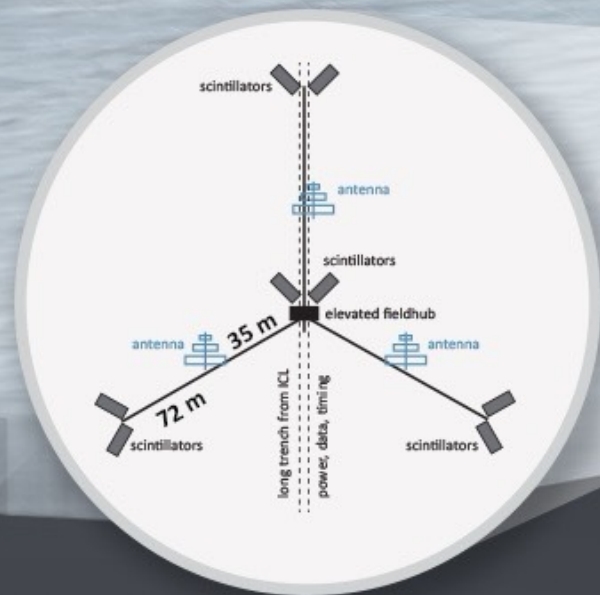
Camera 92H watching string 90L
white light of ~ 5 W in 40 m distance





ICECUBE GEN2

DETECTORS SURFACE • RADIO • OPTICAL



Cosmic Ray Surface Array

An air shower array that sits on top of the optical array

One surface station installed above each optical string



IceCube-Gen2 Optical Module

4x the sensitivity of IceCube's modules

9,600 new optical modules in total to be deployed in the ice



80 modules on each string, spaced 17 meters apart

50 m

1370 m

2780 m

IceCube-Gen2:
120 new strings of optical modules

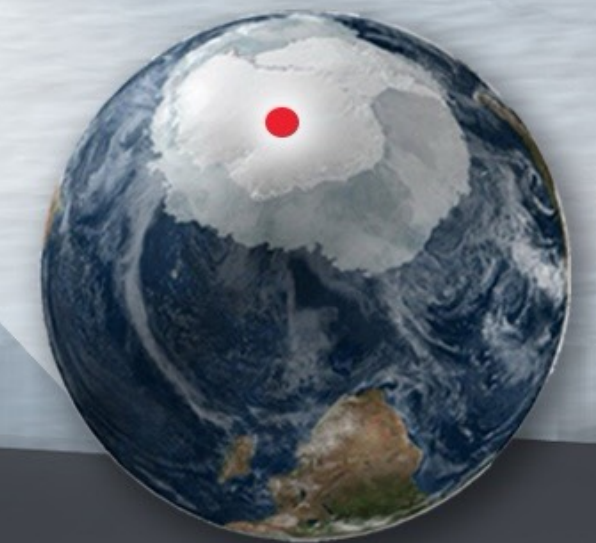
IceCube:
86 strings of optical modules

DeepCore

Antarctic bedrock

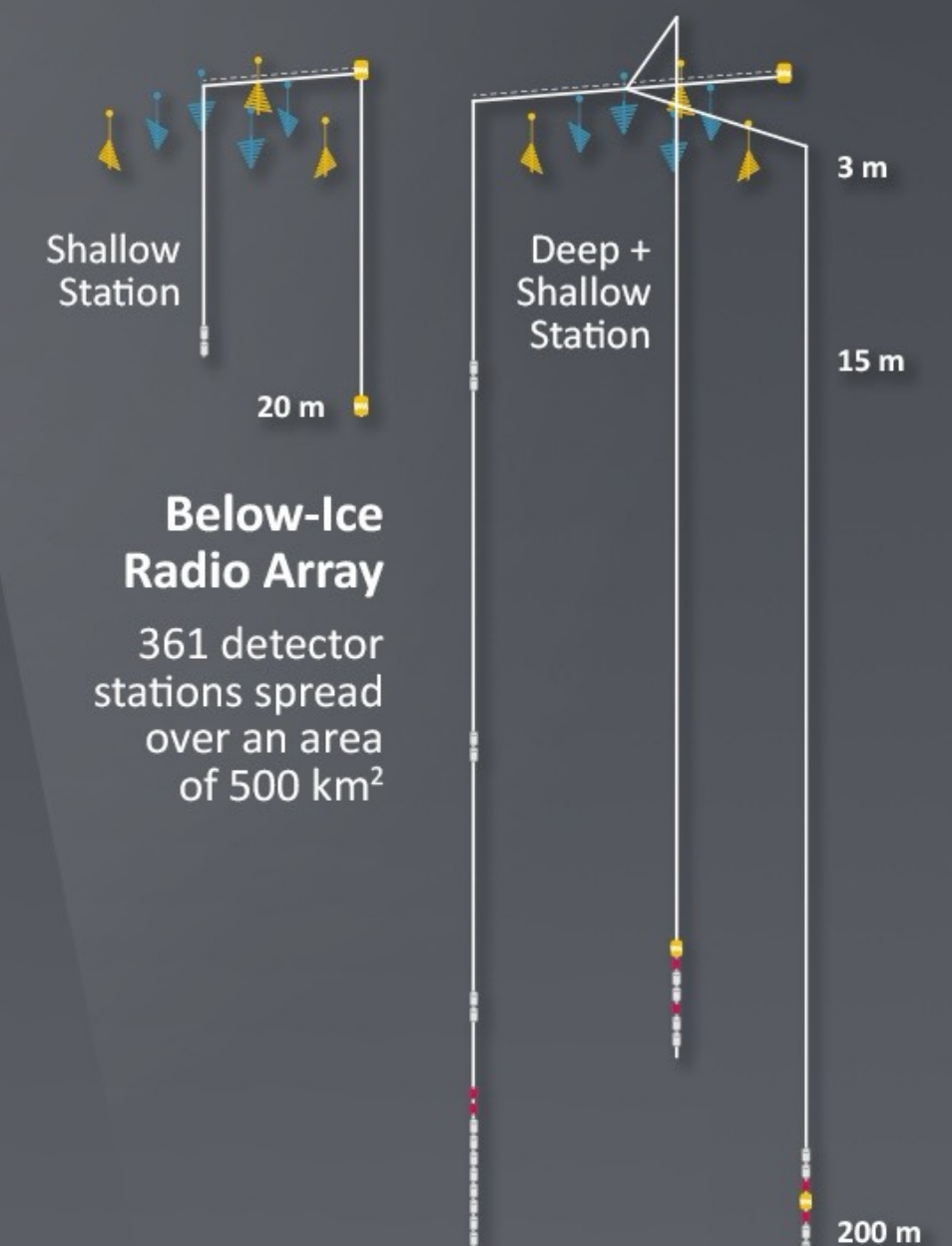
IceCube
(1 km)

IceCube-Gen2
(5 km)



Amundsen-Scott South Pole Station, Antarctica

A National Science Foundation-managed research facility

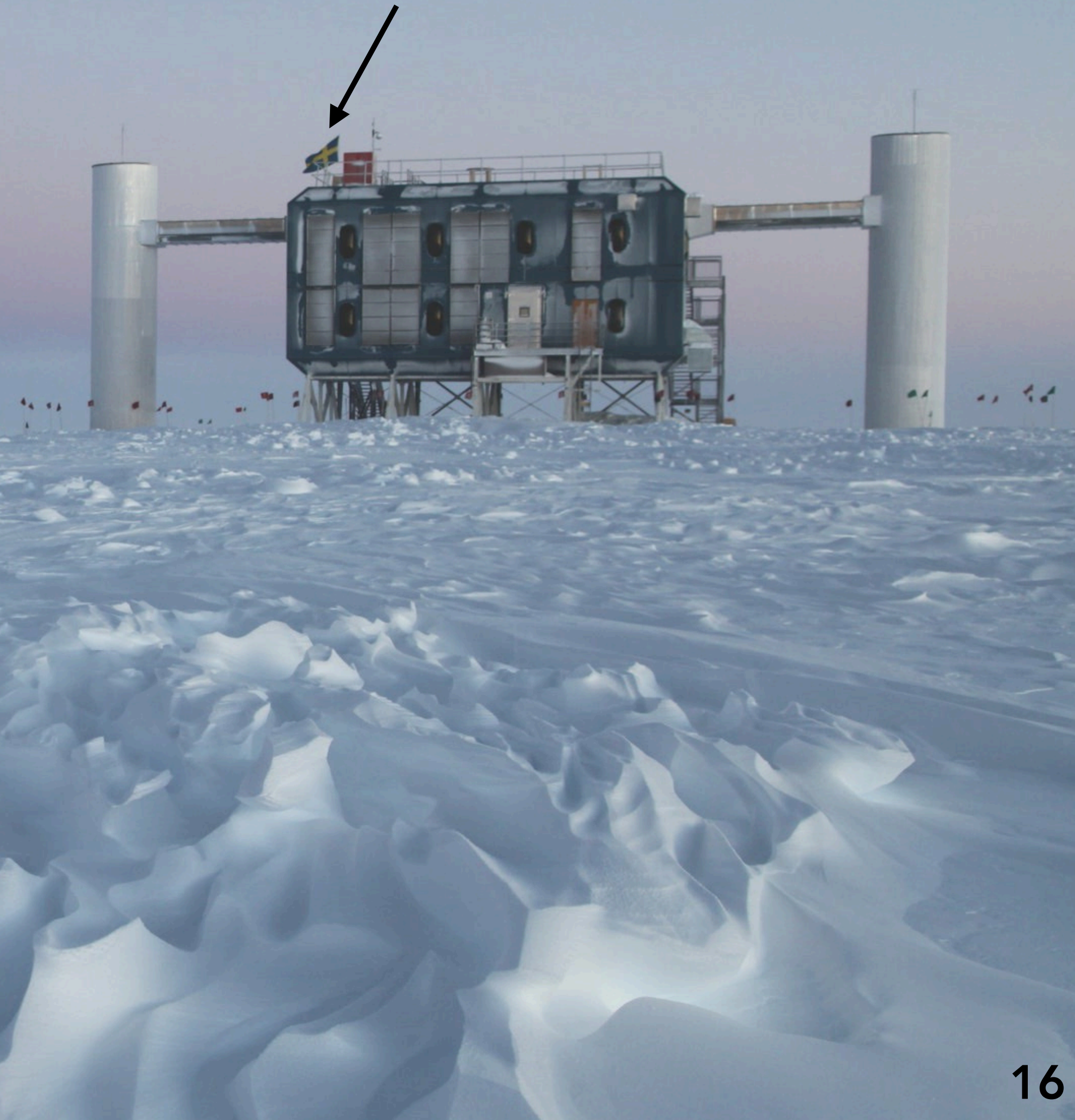


Below-Ice Radio Array

361 detector stations spread over an area of 500 km²

Summary

- successful low-energy extension of IceCube in winter 2025/2026
- first extension of IceCube after 15 years of stable operation
- significant extension of the scope of IceCube
- a lot of new data incoming from the IceCube Upgrade
 - right now: calibration
 - end of year: science
- work on IceCube-Gen2 to push the frontiers of neutrino astrophysics and particle physics



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THE ICECUBE COLLABORATION

FUNDING AGENCIES

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icecube.wisc.edu