

# Enhancement of the IceCube Surface Instrumentation by a Hybrid Radio and Scintillation Detector Array

Shefali for the IceCube Collaboration

## Surface Enhancement Array

The IceCube surface array, IceTop, is forseen to be enhanced by a hybrid detector array. Each station will include:

- 8 Scintillation detectors
- 3 Radio antennas
- A central DAQ

Planned to deploy 32 stations by 2026.

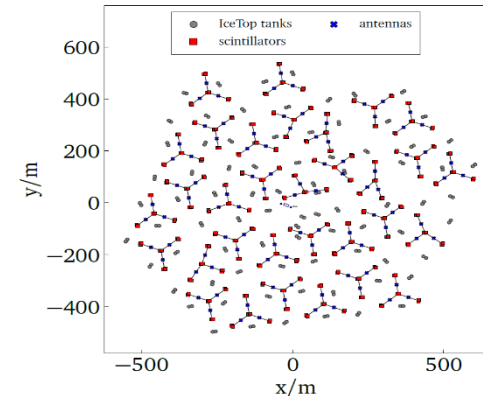
Science Case:

- Veto to atmospheric neutrinos
- energy spectra and composition of cosmic rays in a wide energy range
- validation of hadronic interaction models

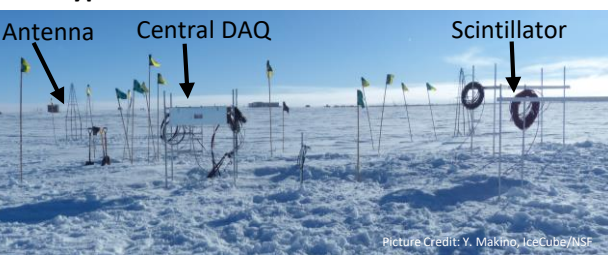
The science case requires:

- Lower energy threshold** for air shower measurements
- Improved veto capabilities** of the in-ice detector
- Mitigate the effect of **snow accumulation** on the IceTop detectors
- Multi-component observation of air showers

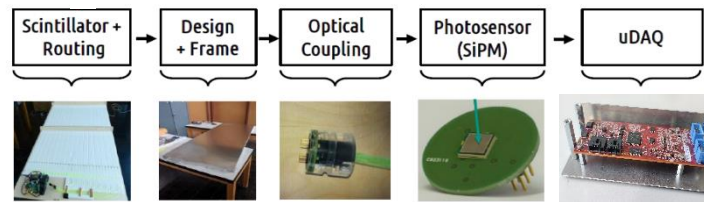
A complete prototype station was deployed in January 2020. The first results have shown proof of feasibility of the design.



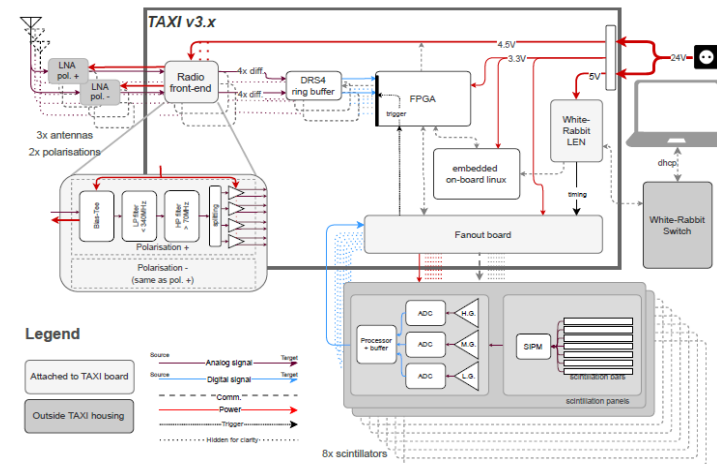
## Prototype Station



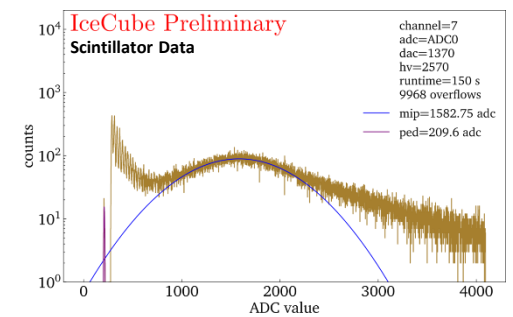
## Scintillation Detectors and Radio Antennas



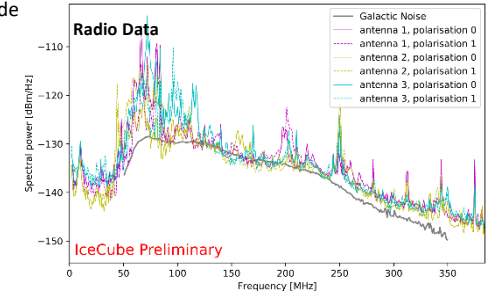
- Scintillators:** 1.5 m<sup>2</sup> sensitive area connected via wavelength shifting optical fibres to an SiPM readout
- Antennas:** SKALA-2 antennas with dual arms used in range: 70 – 350 MHz
- Central DAQ:** TAXI board for processing radio waveforms and digital scintillator signals; consists of 3 DRS4 samplers, a SPARTAN FPGA and an embedded linux system; nanosecond timing by White Rabbit



## Preliminary Results



- Scintillators:** The charge histograms are used for gain calculations and a MIP peak is fit for charge calibration.
- Antennas:** Median spectrum of one day of radio data from the prototype. The black line is the galactic noise based on the Cane mode



- Triple coincidence event with IceTop, radio and scintillation detectors data within 2μs window.**

