R&D Program for IceCube High Energy Extensions

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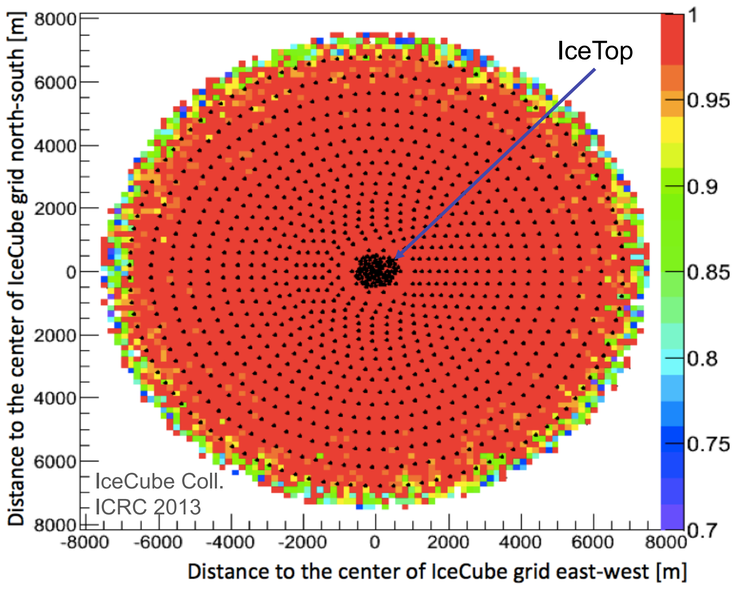
How to explore the high-energy neutrino sky?

Large Area Surface Veto

Veto atmospheric muons in a large zenith range by detecting the associated air shower.



Veto efficiency for extensive air showers which deposit a total signal of > 1000 p.e. in IceCube.

Possible configuration:

- About 1000 simple particle detectors
- Radius of 7 km
  covers zenith range 0 to 75° wrt. IceCube

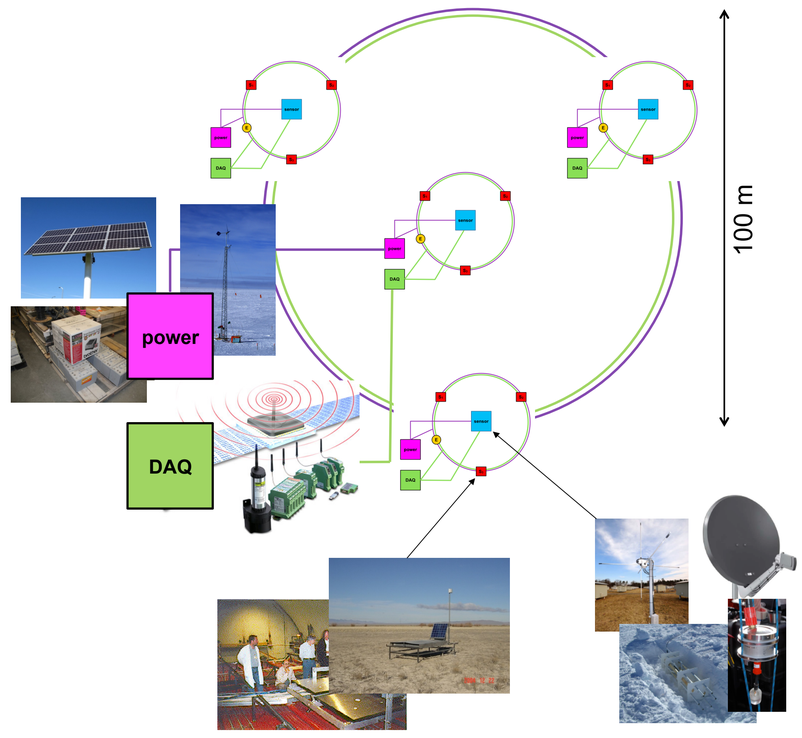
Challenges:

- Autonomous detector stations
- Self-sustained power supply
  (wind, solar, …)
- Wireless communication and
  synchronization

R&D Activities:

TAXI – Transportable Array for eXtremely large area Instrumentation studies

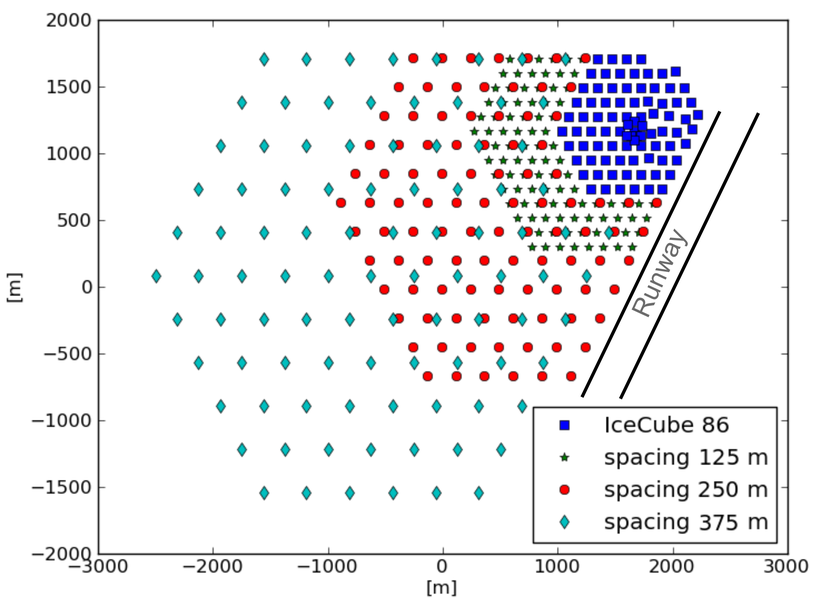
- Platform for in-situ tests of sensors,
  communication, power supply, …



Schematic overview of TAXI.

Increase Volume with Additional Strings

Increase instrumented volume to ~10 km^3 by additional strings with larger horizontal spacing.



Three different detector geometries that have been studied.

Possible configuration:

- About 100 additional strings
- Spacing and geometry to be optimized

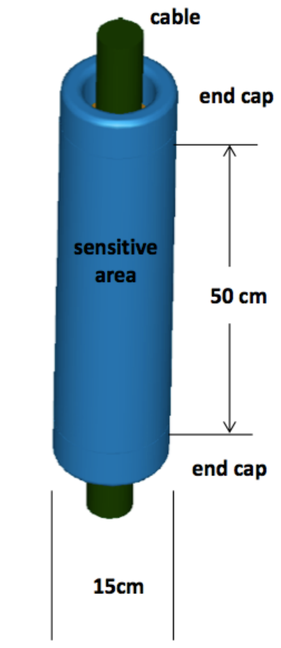
Challenges:

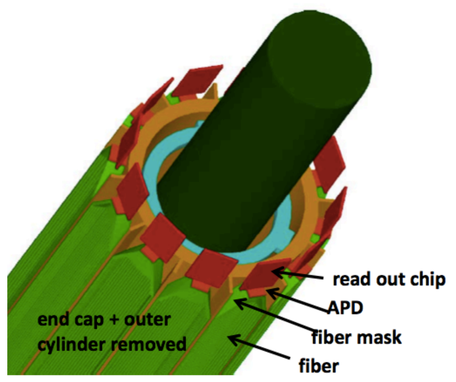
- New drilling and deployment procedures
  for large inter-hole spacing
- New, slender optical modules will allow
  drilling narrower holes
  (cost scales with hole cross section)

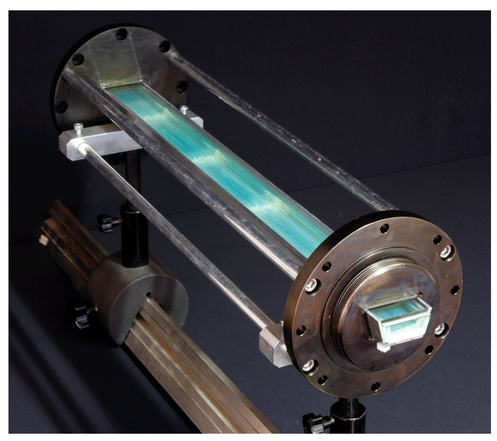
R&D Activities:

ZOMBI – Zeuthen Optical Module for Boreholes in Ice

- Cylindrical, segmented optical module
  filled with liquid wavelength shifter



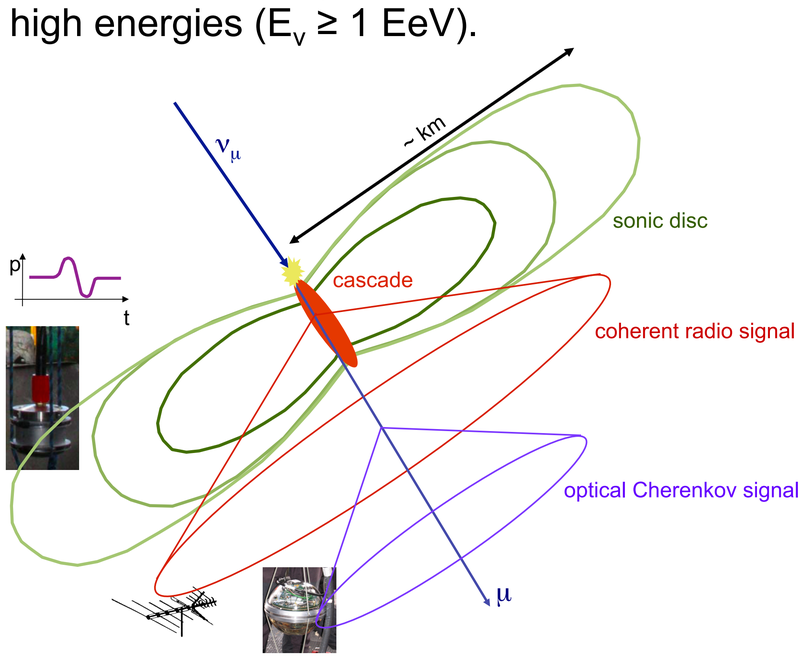




Schematic overview of ZOMBI (top).
ZOMBI test cell without PMTs (right).

New Drilling and Deployment Techniques

Radio and acoustic techniques can be used to detect cosmogenic neutrinos at ultra-high energies ($E_\nu \geq 1$ EeV).



Possible configuration:

- ~1000 shallow strings on 100 km^2
- Radio and acoustic sensors on same string

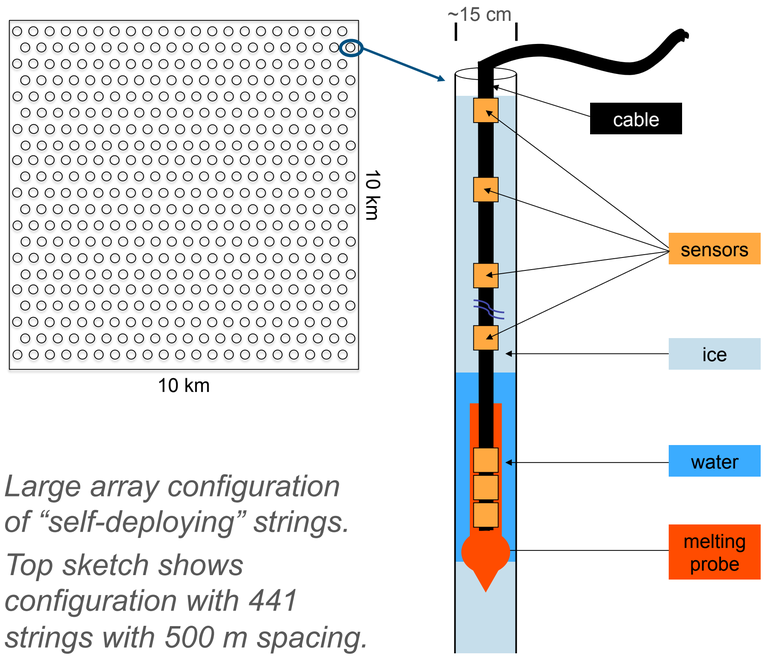
Challenges:

- Robotic drilling and deployment techniques
- Autonomous detector stations at the
  surface of each string

R&D Activities:

Drilling and Deployment

- Deploy sensors from payload of
  single-use melting probe



Large array configuration of "self-deploying" strings.
Top sketch shows configuration with 441 strings with 500 m spacing.

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