IceCube

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What is IceCube

- Neutrino observatory
- Located on the South pole (Antarctica)
- Array of DOM detectors deep in the arctic ice

Detector Design

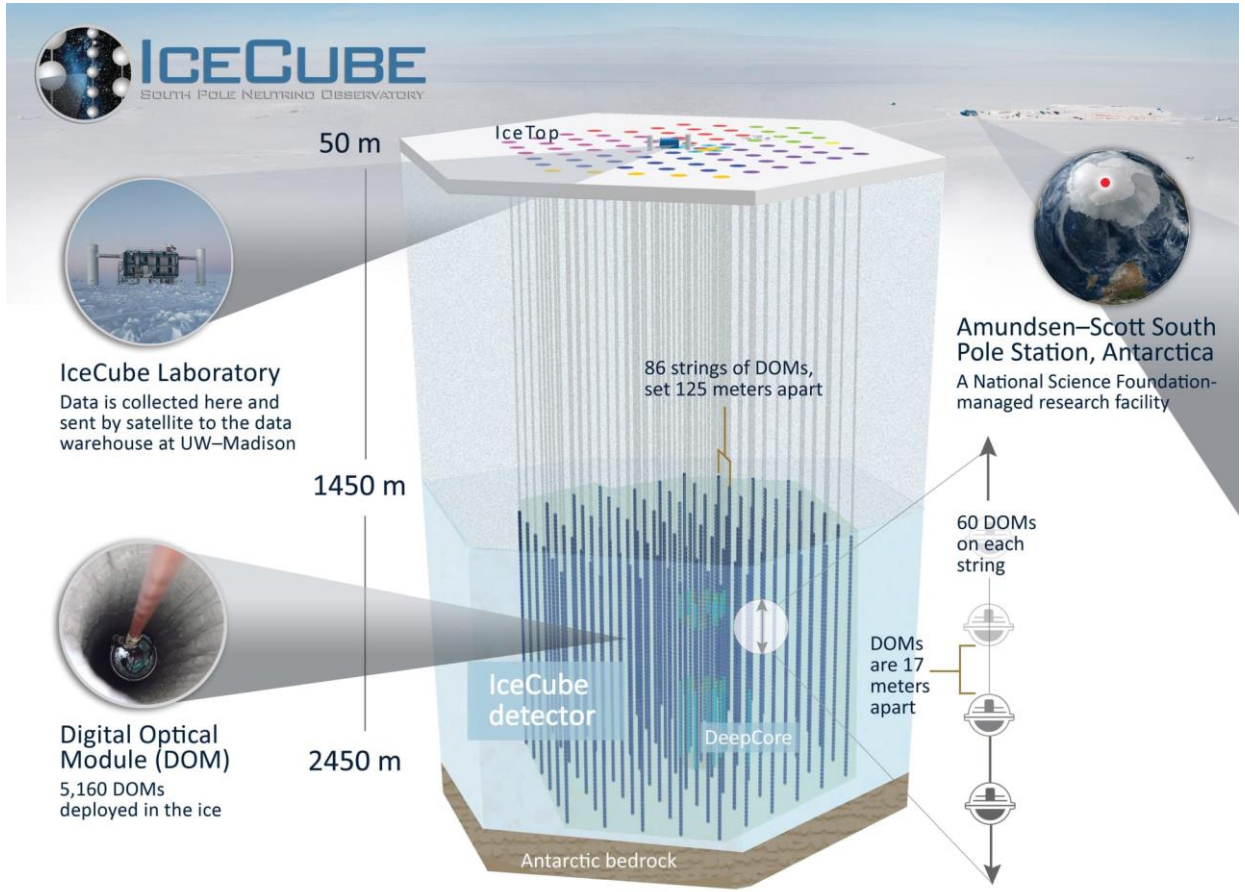
1 gigaton of instrumented ice

5,160 light sensors, or digital optical modules (DOMs), digitize and time-stamp signals

1 square kilometer surface array, IceTop, with 324 DOMs

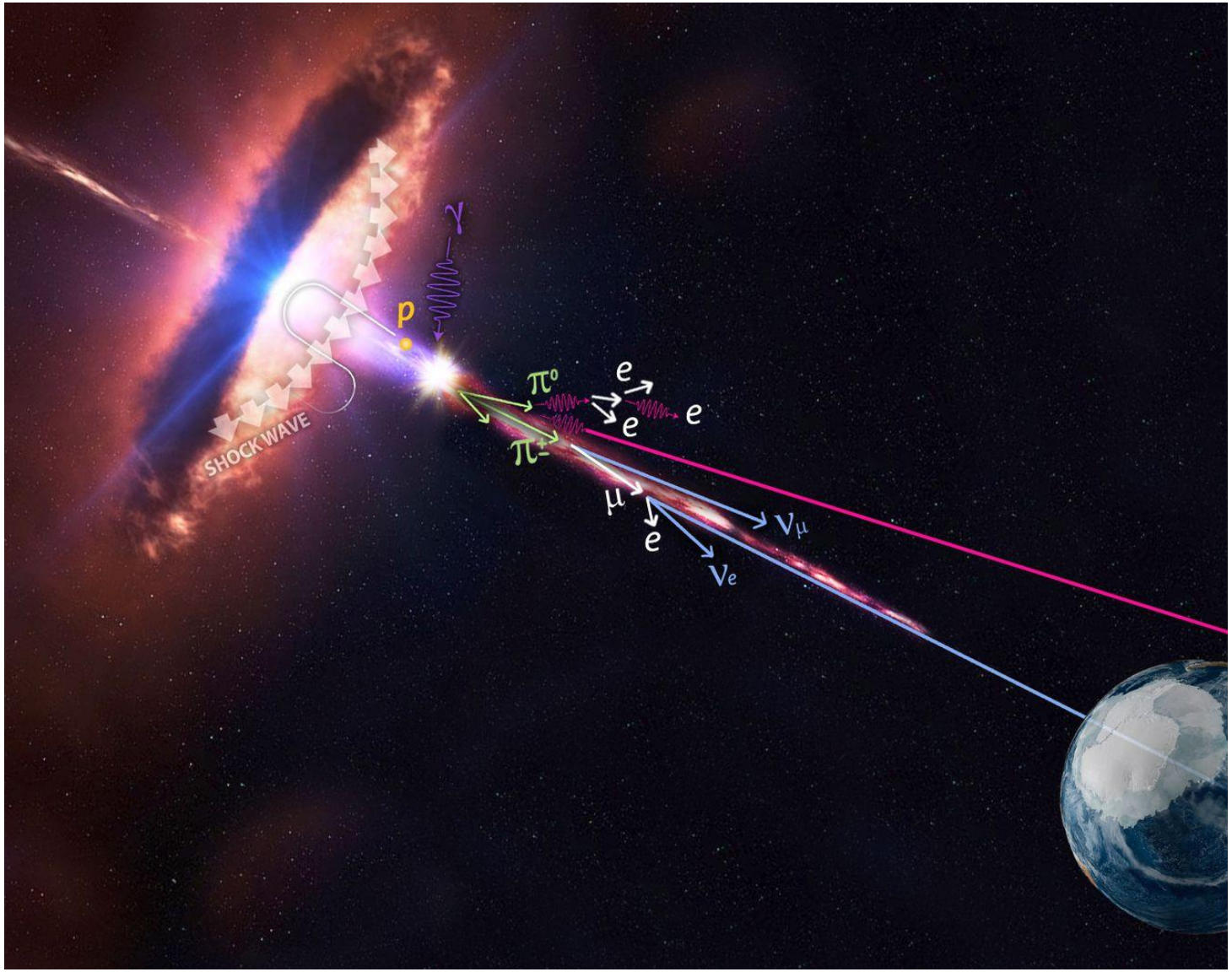
00:00:02^{-9} 2 nanosecond time resolution

IceCube Lab (ICL) houses data processing and storage and sends 100 GB of data north by satellite daily



Why south pole?

- To measure extra-solar neutrinos in the GeV-TeV range
- Location allows for the distinction of solar neutrinos and cosmic rays
- Search for highest energy astrophysical processes



Why measure neutrinos?

Expected energies of up to PeV (10^15 eV)

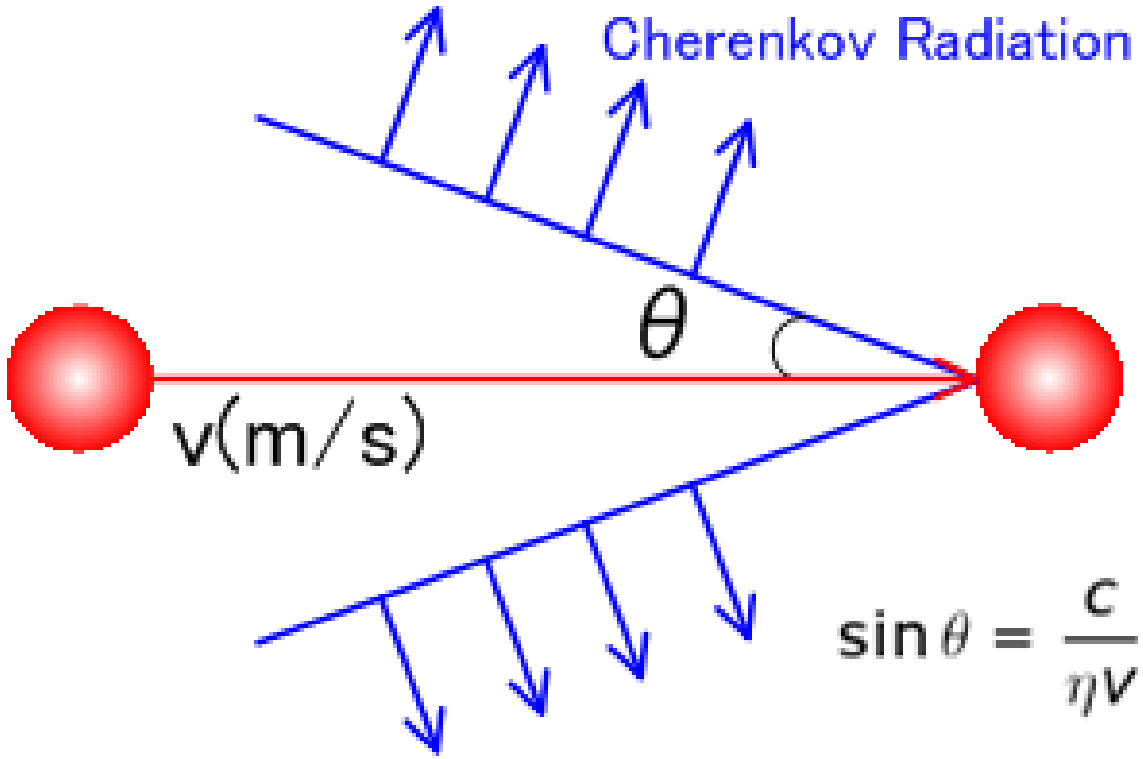
No scattering or deflection -> point directly towards source

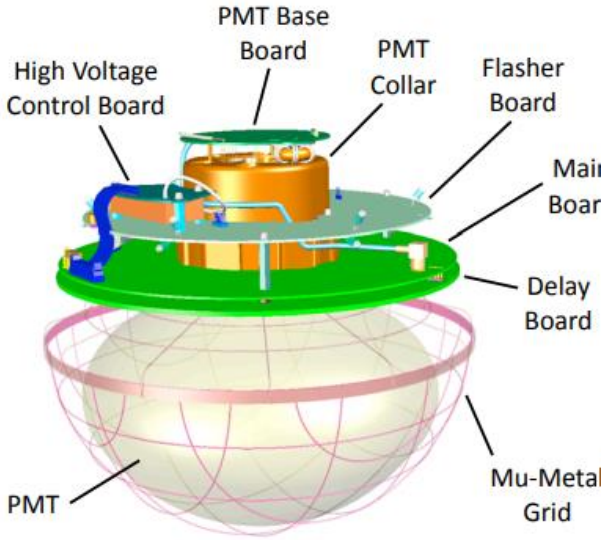
Clearer view of dense and shrouded areas

Great look into super high energy phenomena

Cherenkov radiation

- Charged current interaction
  - Charged particles created
  - High energies
- Cherenkov radiation
  - Speed of light in medium
  - Charged particles move faster than c
  - Angle dependent on speed of particle

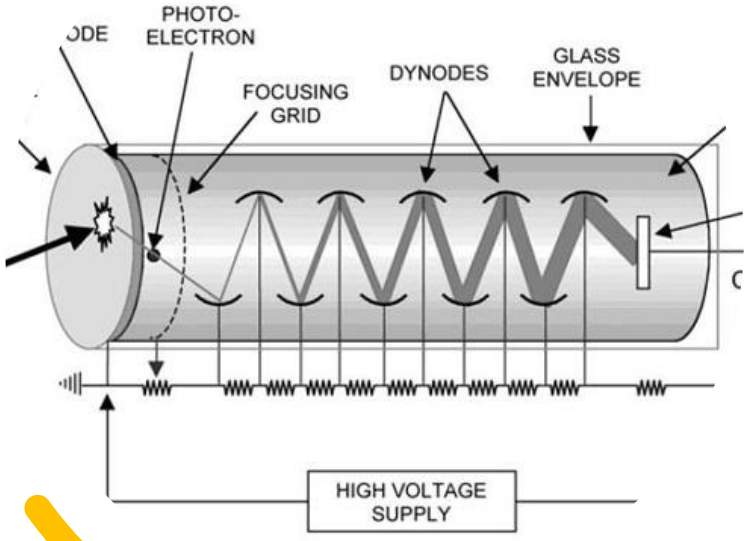




DOMs

- Digital Optical Module
- Electric hardware controlling measurements and data
- Hamamatsu R7081-02 PMT
- IceCube uses 5160 DOM units

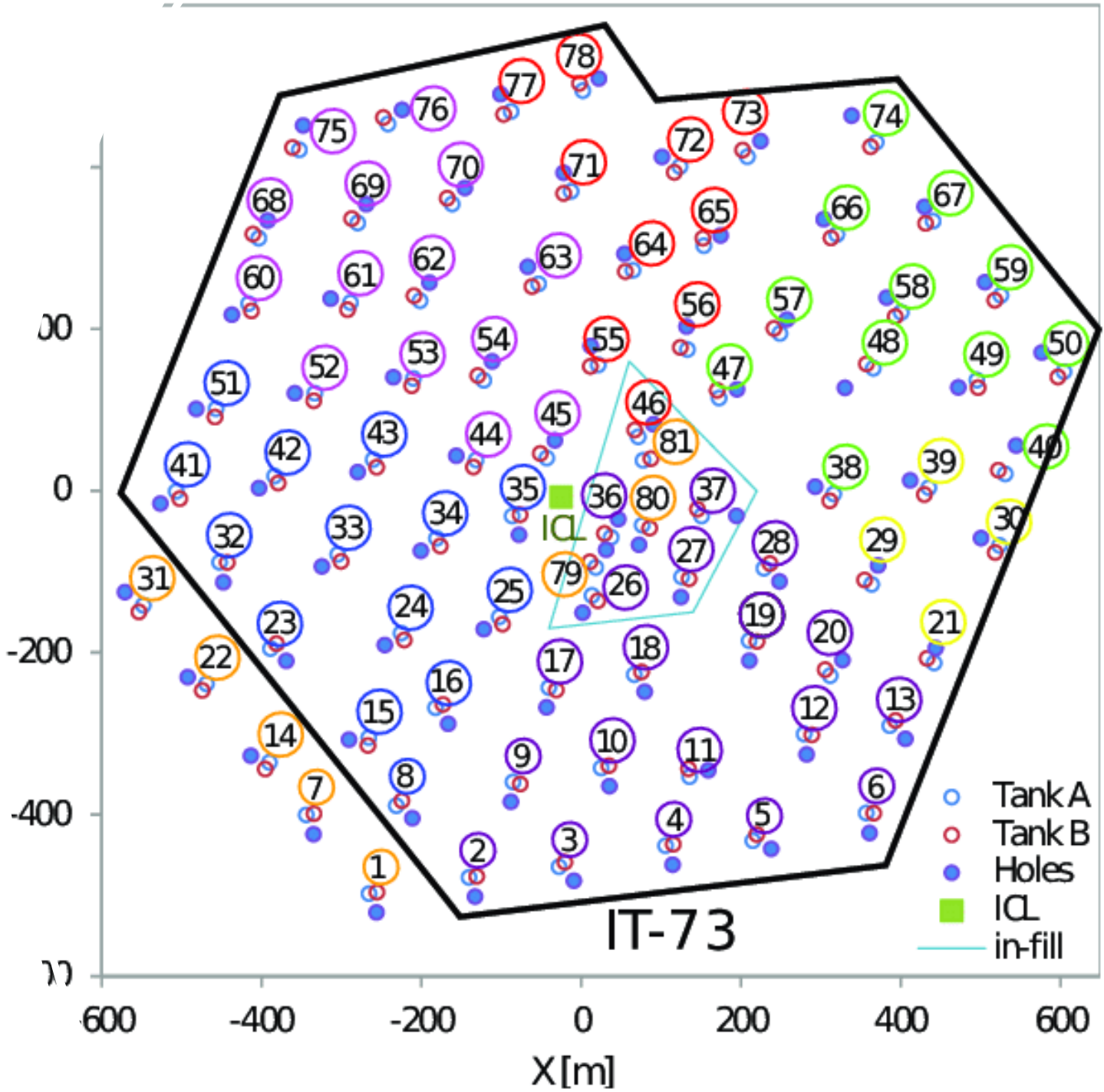
PMTs



- Photo Multiplier Tube
- Hamamatsu R7081-02 PMT
- 300 – 650 nm range

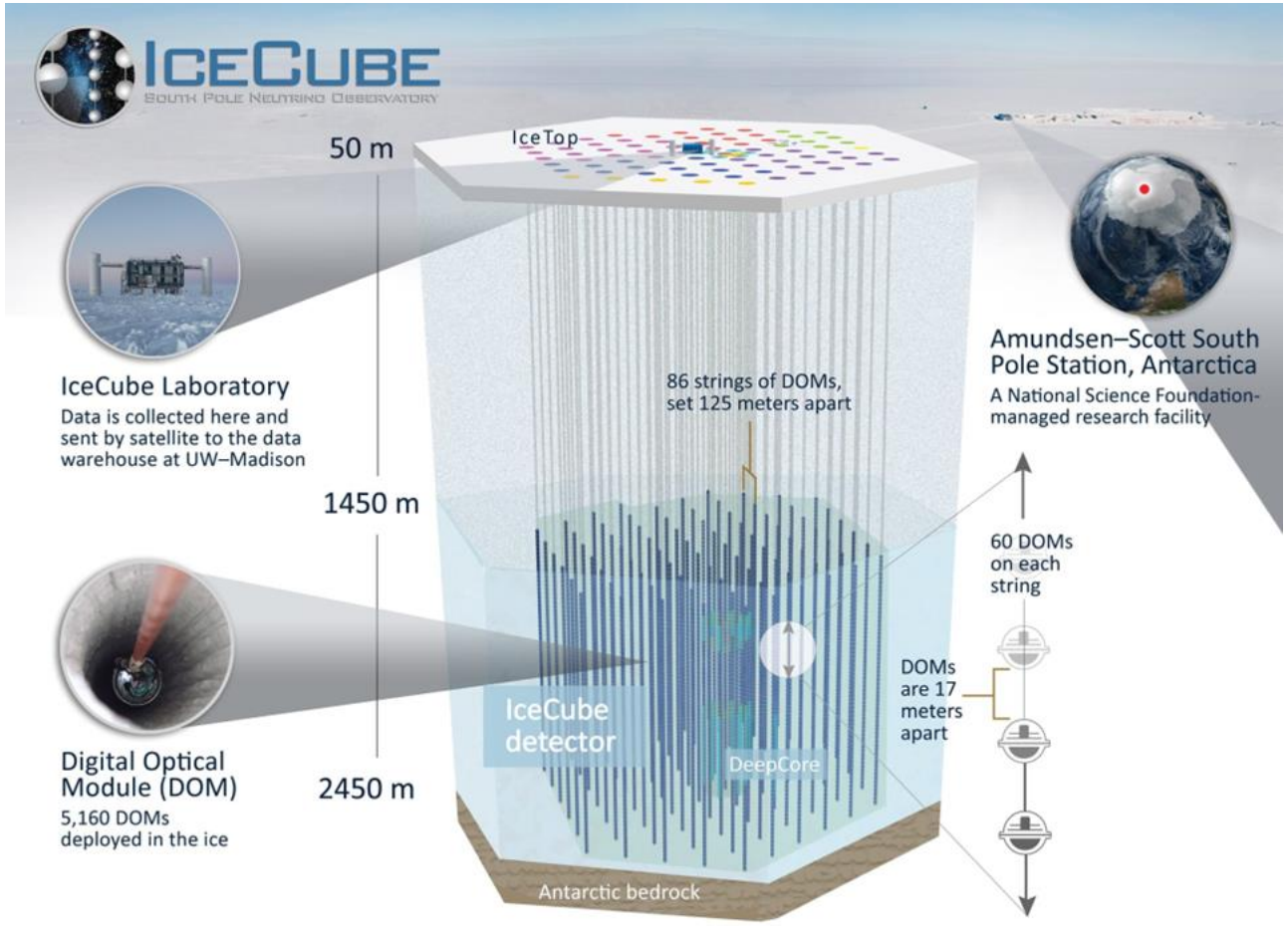
IceTop

- 162 tanks with each 2 DOM detectors
- VETO for IceCube
- Functions as own experiment
- Cosmic rays in energy range of 300 TeV – 1 EeV (10^6 TeV)



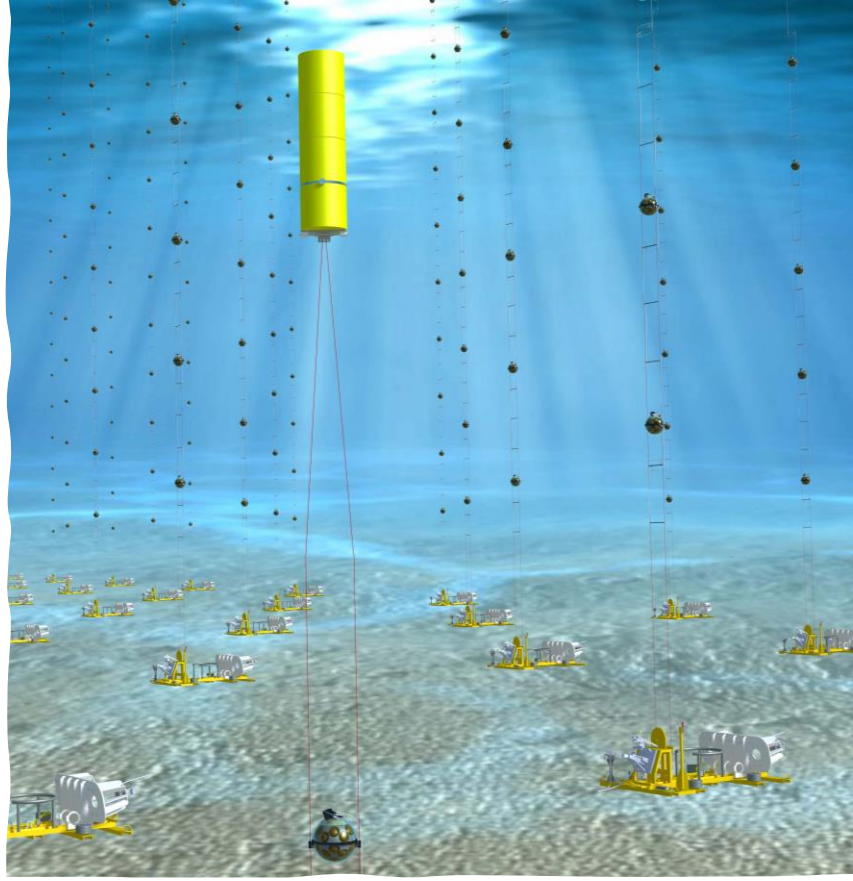
In-ice component of IceCube

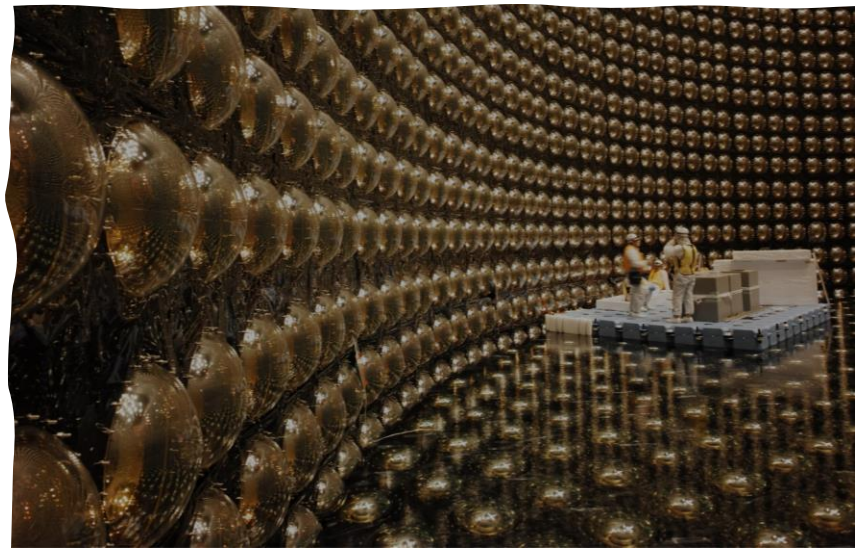
- Main detector array
  - 86 strings with 60 DOMs each
  - Set 125 meters apart
  - Vertical spacing of 17m between DOMs
- DeepCore subdetector
  - Eight strings at center more compact
  - 70 meters apart
  - Vertical spacing of 7m between DOMs
  - Lower energy threshold of 10 GeV
  - Allows for neutrino oscillation



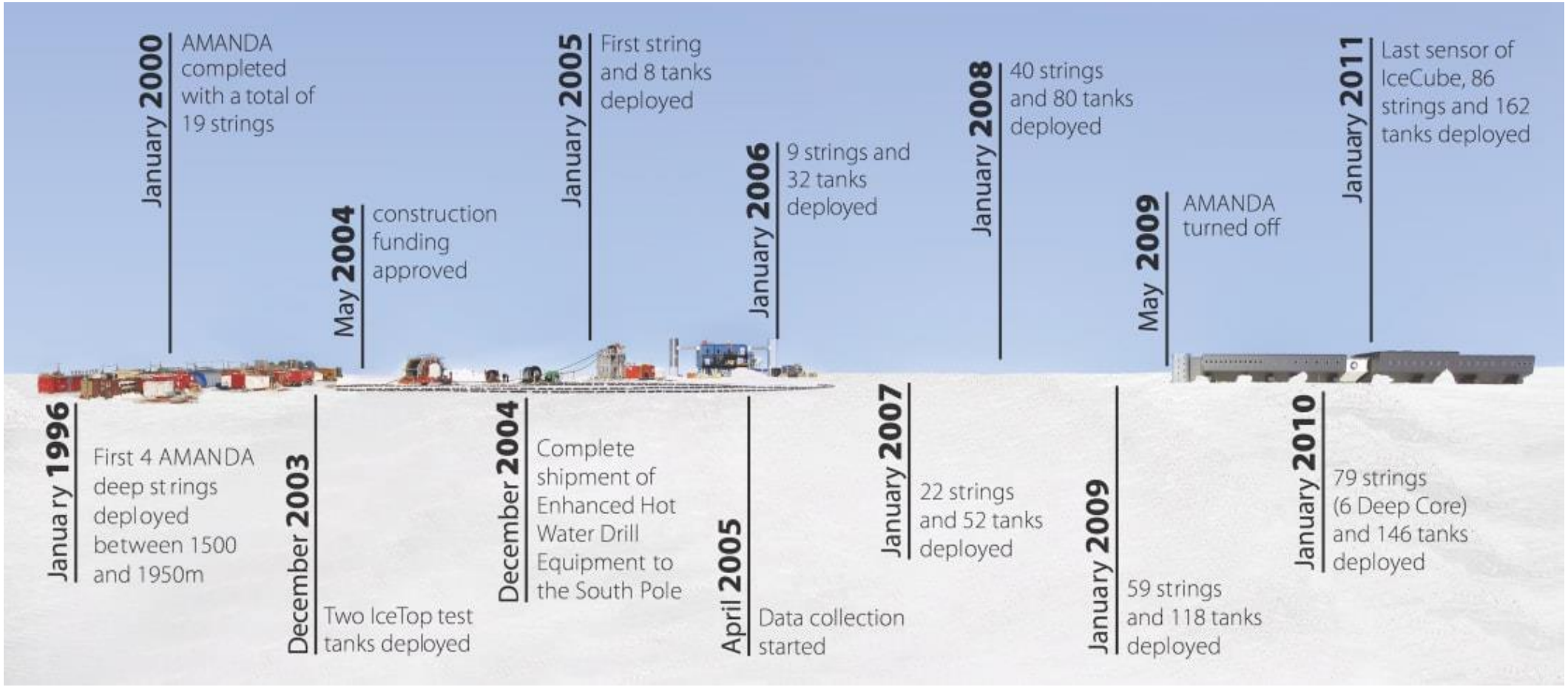
Differences with other detectors

- Super-Kamiokande
  - Solar and Athmospheric neutrinos
  - Lower energy neutrinos
  - Higher resolution
- Km3NeT
  - More stable detector placement
  - Follow up of IceCube
  - Many errors of IceCube we’re corrected



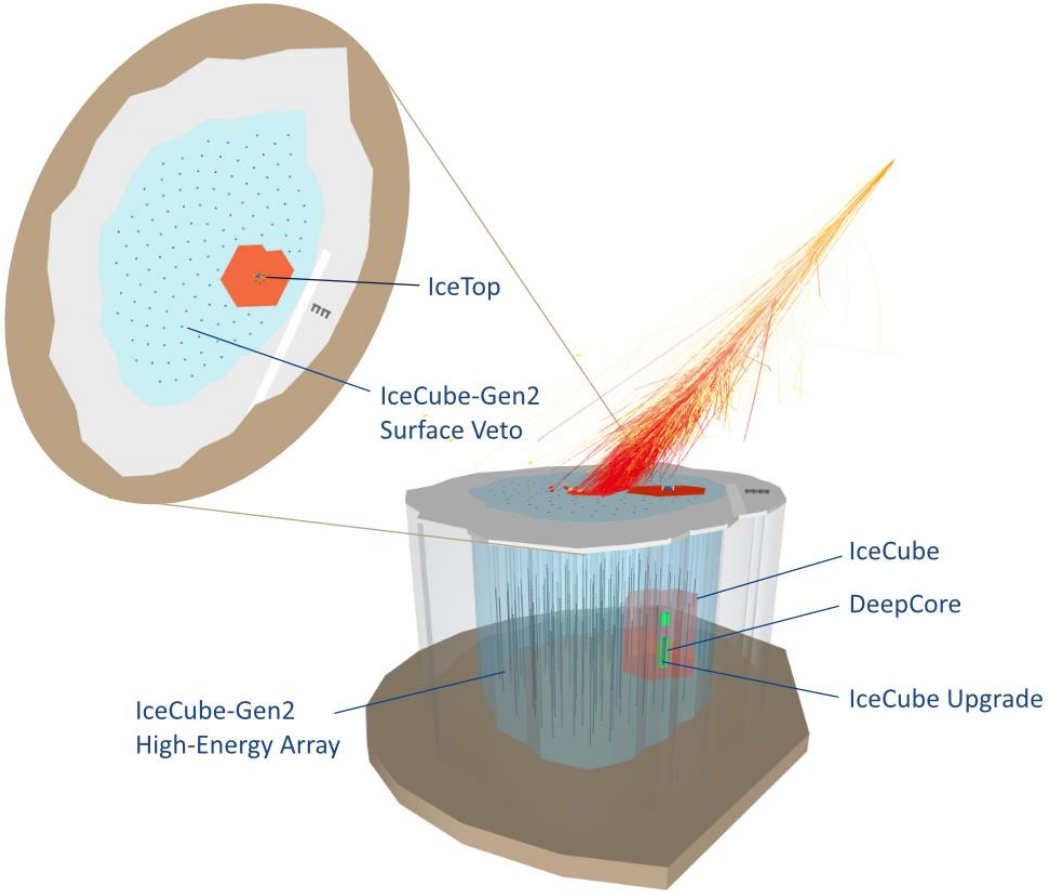


Timeline


January 1996
First 4 AMANDA deep strings deployed between 1500 and 1950m
December 2003
Two IceTop test tanks deployed
January 2000
AMANDA completed with a total of 19 strings
May 2004
construction funding approved
December 2004
Complete shipment of Enhanced Hot Water Drill Equipment to the South Pole
January 2005
First string and 8 tanks deployed
April 2005
Data collection started
January 2006
9 strings and 32 tanks deployed
January 2007
22 strings and 52 tanks deployed
January 2008
40 strings and 80 tanks deployed
January 2009
59 strings and 118 tanks deployed
May 2009
AMANDA turned off
January 2010
79 strings (6 Deep Core) and 146 tanks deployed
January 2011
Last sensor of IceCube, 86 strings and 162 tanks deployed

IceCube gen2

- Based on 2 main discoveries
  - Large cosmic neutrino flux at high energies
  - Exceptional clarity of the ice
- Specifications
  - Volume of around 10 km^3
  - Completed around 2033
  - Costs of $350 million
- PINGU
  - Dense array inside DeepCore
  - Neutrino oscillations down to GeV energy



Questions

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