Ice drilling for physics & astrophysics

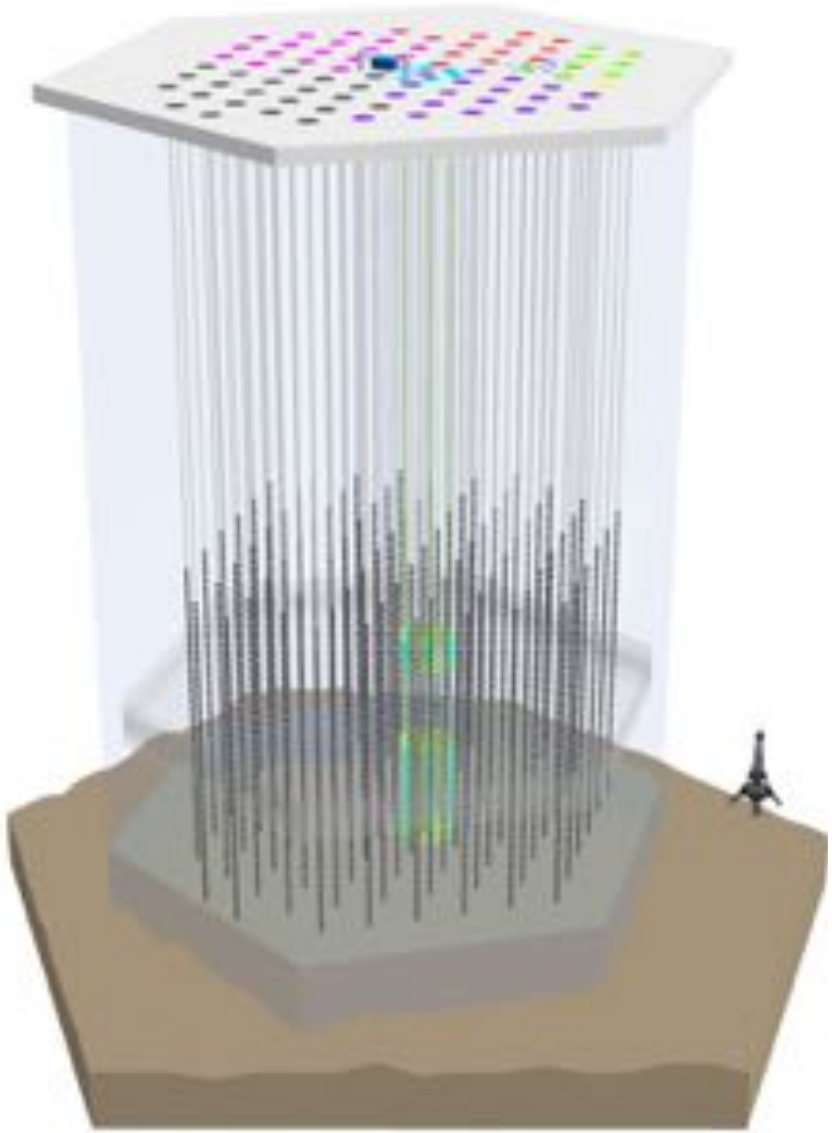
Ice as an observatory

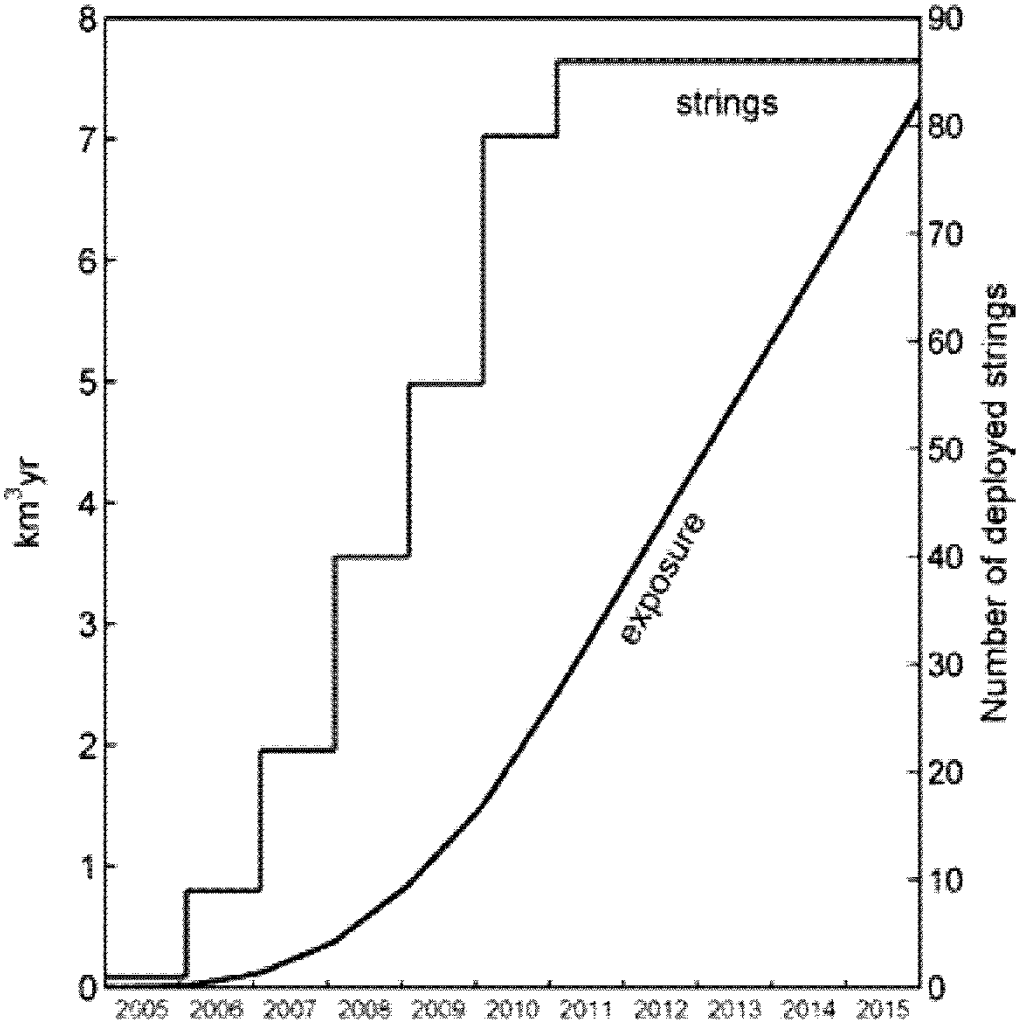
- Physics in ice drives ice drilling technology and expertise

Status Updates:

- IceCube EHWD disposition
- Low energy physics (PINGU, MICA, DM-Ice)
- Ultra-high energy neutrino astronomy (ARA)

IceCube



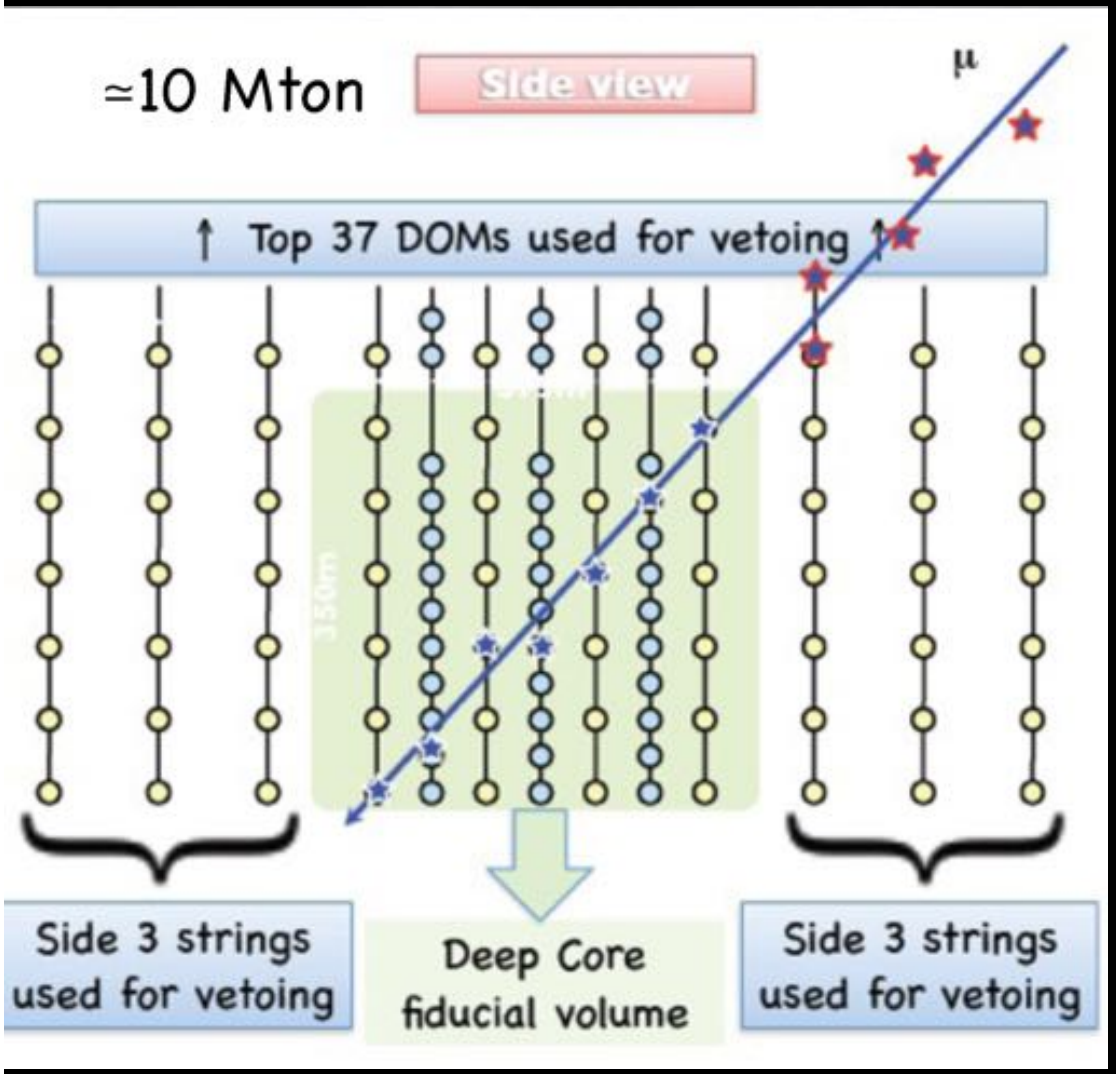

strings
exposure
km^{3}yr
Number of deployed strings
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
90
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

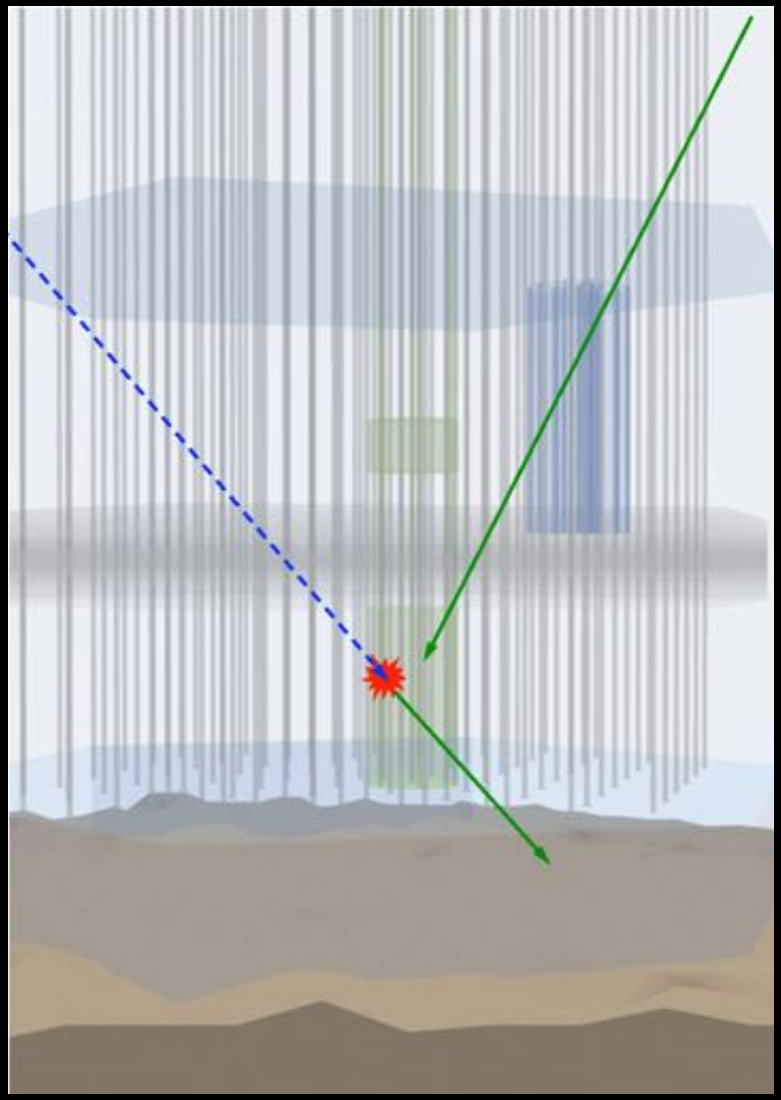
IceCube

EHWD Disposition Status

- EHWD has been broken up between 4 groups
  - IceCube/NSF (long-term storage at South Pole)
  - WISSARD (Univ. of Nebraska, tied up for at least 4 years, field work based out of McMurdo)
  - ARA (UW-Madison, equipment at South Pole, tied up indefinitely)
  - Support Contractor
- Critical equipment that is no longer under IceCube/NSF custodianship
  - Generators, Power Distribution Module, and Cabling - WISSARD
  - RWS (Rodwell System) - WISSARD
  - Main Drill Cable Reel - WISSARD
  - Return Water Cable Reel - WISSARD
  - Independent Firn Drill – WISSARD
  - Fuel Tower – WISSARD
  - Rolling Stock – Support Contractor
  - MECC - ARA
  - SHOP - ARA

Low-energy physics in IceCube: PINGU, MICA, DM-Ice





PINGU

"Precision IceCube Next Generation Upgrade"

- ~20 strings
- Achieve ~1 GeV energy threshold
- WIMPs, atmospheric ν oscillations
- R & D new photon detection technology
  - Very high density photocathode coverage
  - Multi-PMT module
  - Wavelength shifting
  - Multi-channel plate PMTs
  - Large area photodetectors
- Advanced ice calibration
  - Short-distance optical properties
  - Refrozen hole ice properties
- Possible proposal late 2012
- Earliest deployment 2014-15

MICA and DM-Ice

"Multi-megaton Ice Cherenkov Array"

- ~250 strings
- 5 MT fiducial volume w/ 10 MeV threshold
- Supernova ν and proton decay
- Part of revamped S4 NSF funding
- 8 m triangular grid

"Dark Matter in Ice"

- 250 - 500 kg of NaI
- Direct detection of dark matter
- Complements NH experiments
- Two test modules deployed in 2010
- Currently applying for funding
- Hope to deploy 2014-15

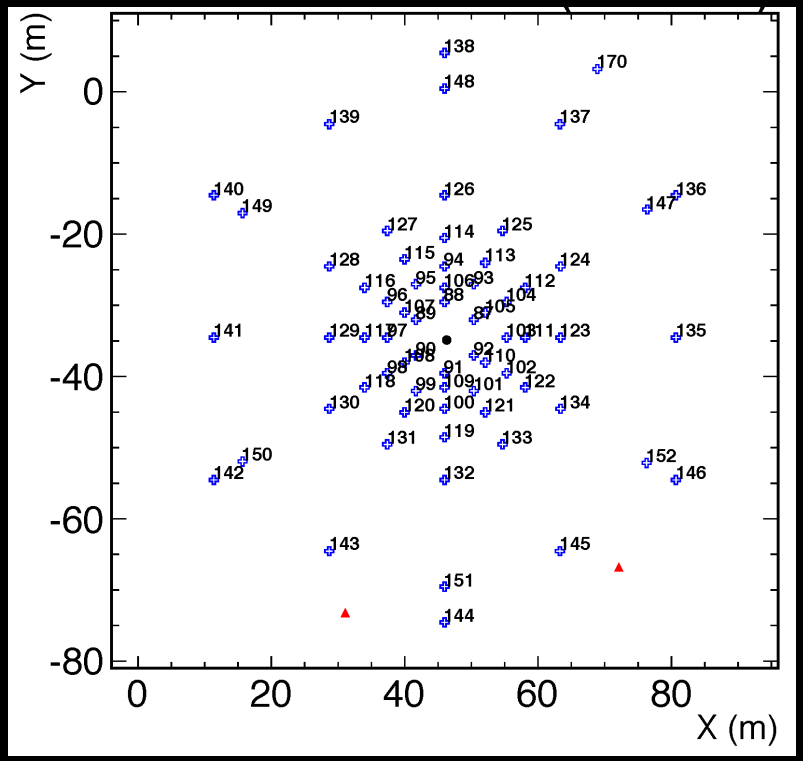
HWD considerations for low energy physics

Close packing with HWDs

- 5 m = no go
- 7 m = marginal
- 10 m probably OK
- drilling straighter may help

HWD upgrades

- Stop condensate recycling
- Better filtration
- Add degassing capability



IceCube EHWD

Starting Estimate of Cost and Schedule

Replace Equipment	$2.3M
Upgrades	$0.7M
Field Seasons	$7.9M
	$10.9M

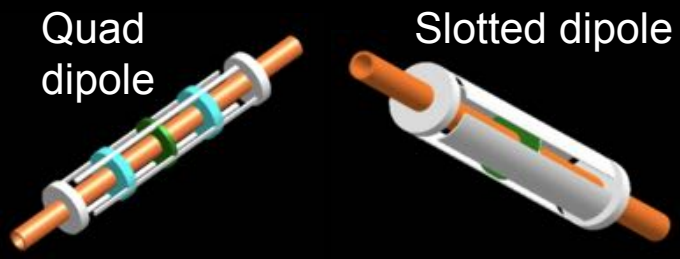
- $11M for 2-season, 18 holes total
  - Half of this needed upfront to begin replacing and upgrading
- 2-yr lead time
  - Would need to get started Sept 2012 to possibly drill in 14-15 season

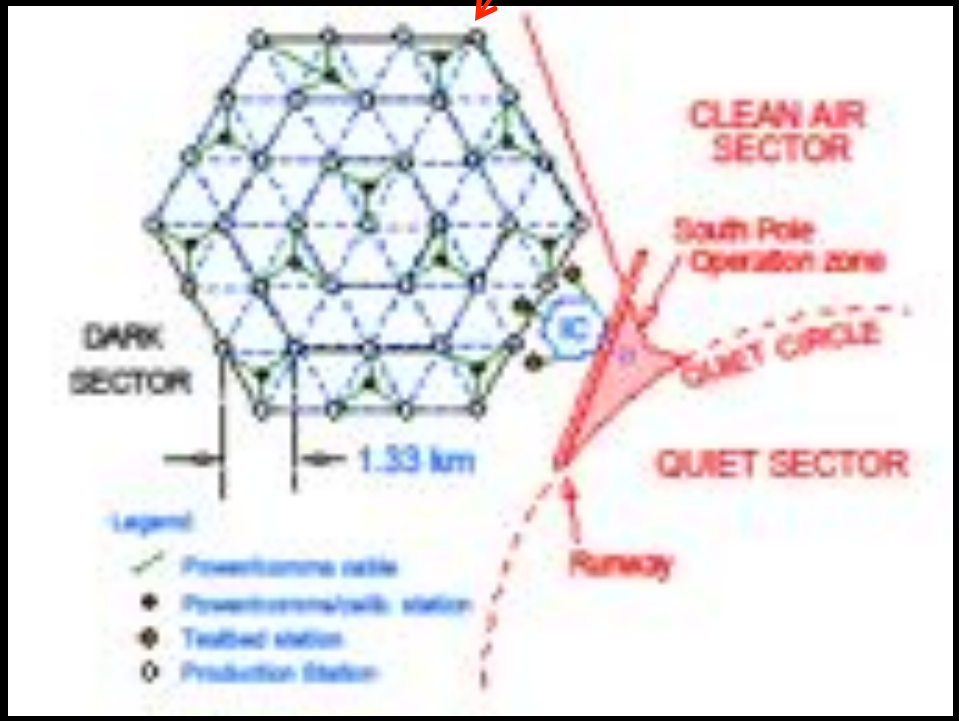
UHE Askaryan Radio Array (ARA)

Ultra-high-energy ν detection via radio Cherenkov (Askaryan) radiation

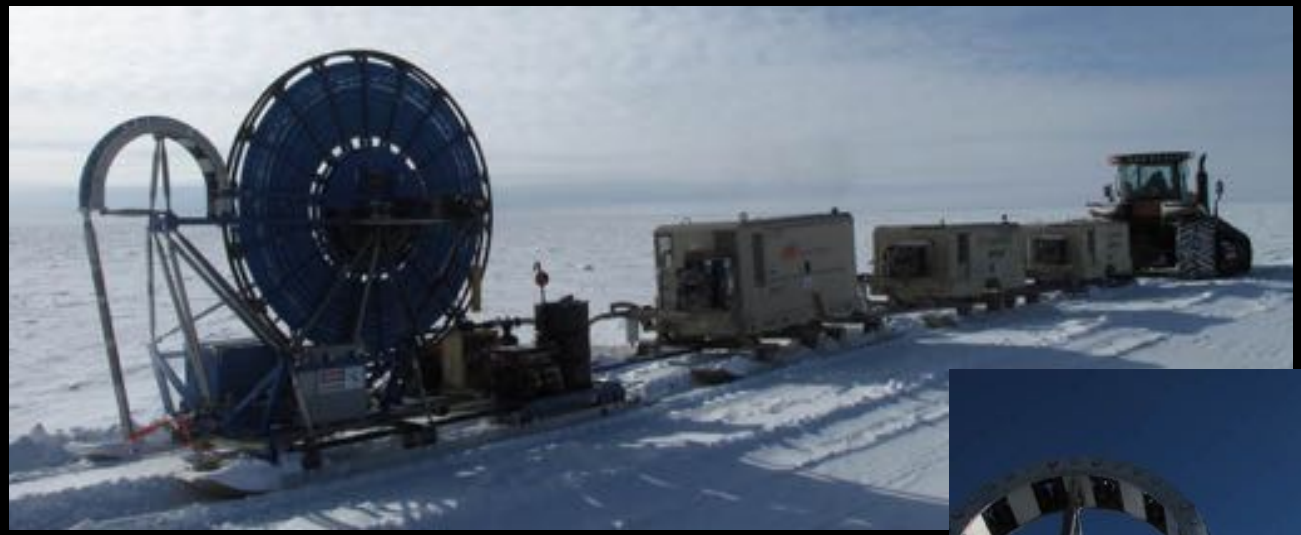
- 10^{16}-10^{17} eV threshold
- **80** km^2 area
- Strings spaced ~ few 100s m

$\Rightarrow$ Hundreds of holes 200 m deep





RAM drilling South Pole 2010-11



As expected, firn air loss is a serious problem

RAM probably not suitable for ARA

ARA drilling season 2011-12

- First season attempting 200 m hole, pumped dry
- One drill stuck, one pump stuck
- 200 m × ∅6” was not attained
- Power delivered not sufficient because of lost water
- Freeze-back faster than expected
- Future:
  - Recirculate water
  - Pump hole dry and drill simultaneously

ARA hole assessment