Status of the IceCube Upgrade

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IceCube Upgrade Project Director

NSF Mid-Term Review
29 April 2024

IceCube
South Pole Neutrino Observatory

NSF

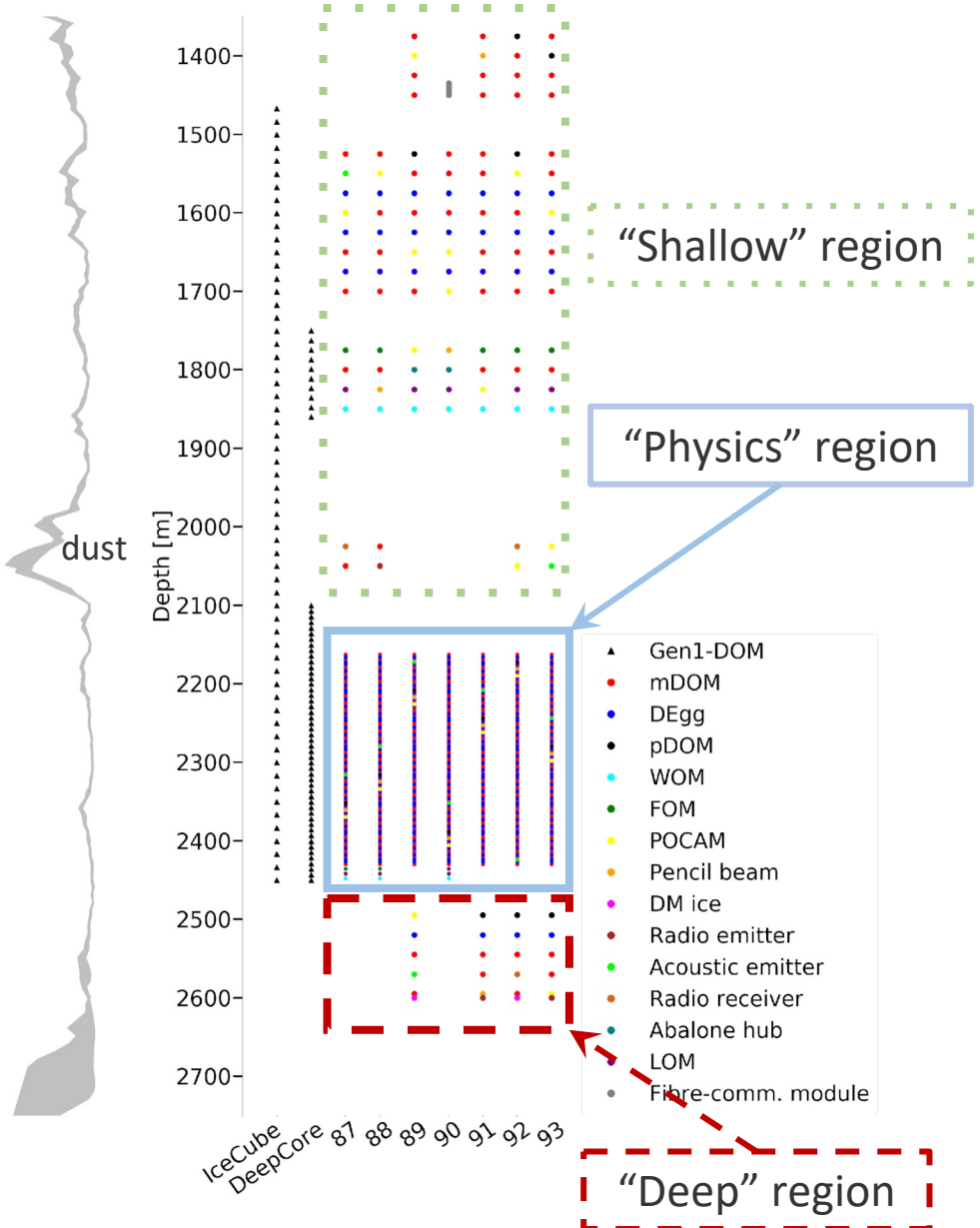
Presenter Background

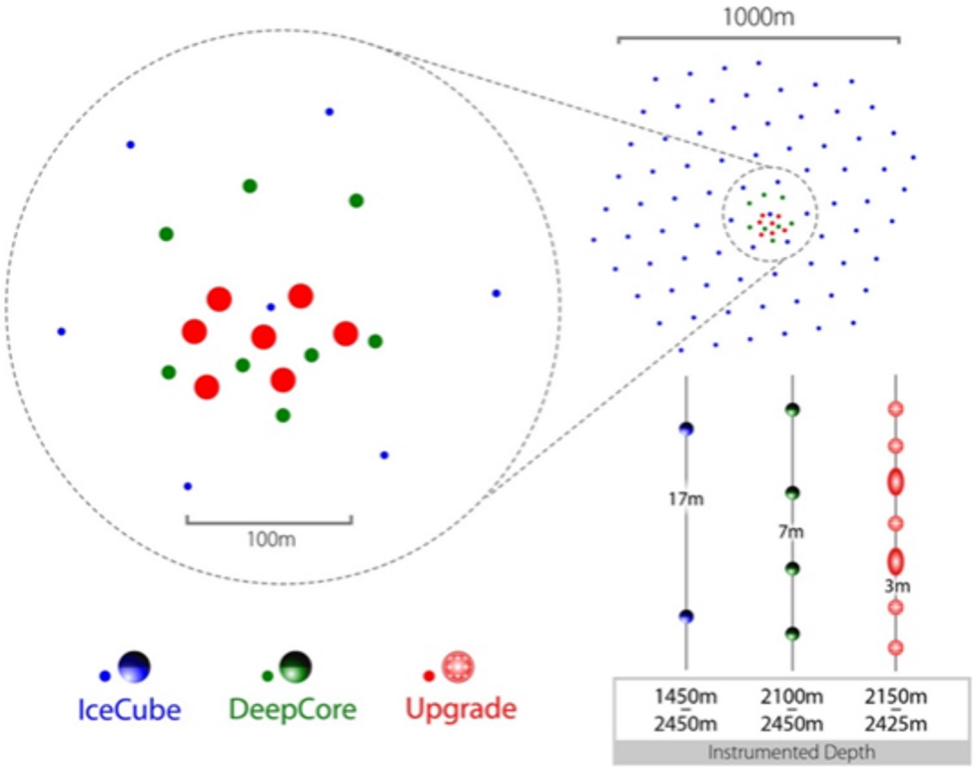
- Vivian O'Dell, Ph.D. in Particle Physics
  - Fermilab Scientist (1993 – present [on LOA])
  - Previous experiments: KTeV, Dzero, CMS, Mu2e; HERA-ZEUS, UA1
  - Mainly focused on calorimetry, data acquisition, management
- Project Director IceCube Upgrade / IceCube-Gen2 (WIPAC)
  - Joined UW / IceCube, January 2021
- Considerable Project Management Experience
  - U.S. CMS HL-LHC Upgrade Project Manager (2015-2019)
    - Combined DOE 413.3b ($250M) / NSF MREFC project ($75M)
  - U.S. CMS Detector Operations Manager (2014) and Deputy Operations Manager (2011-2013); U.S. CMS Level 2 Project Manager for the Data Acquisition system (2022-completion of construction project).
  - Project Manager for the Dzero Run Iib Upgrade (DOE 413.3b project)
- Certified PMP (PMI)

Outline

- Brief reminder of scope / science
- Status of Detector Elements
  - Optical Modules
  - Cables
- On-Ice status / plans
  - Field Season 1 status
  - Field Season 2 plans

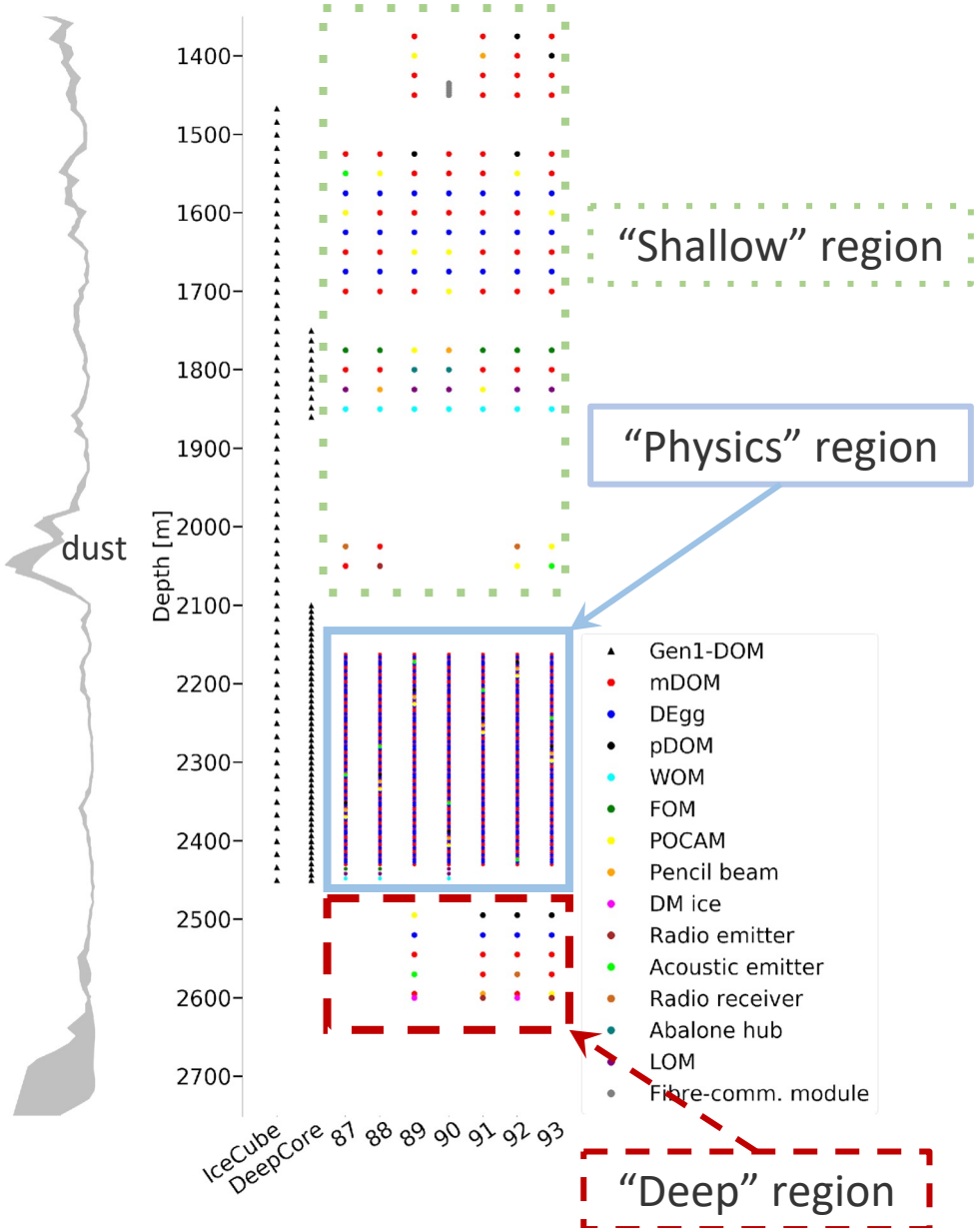
IceCube Upgrade in Brief

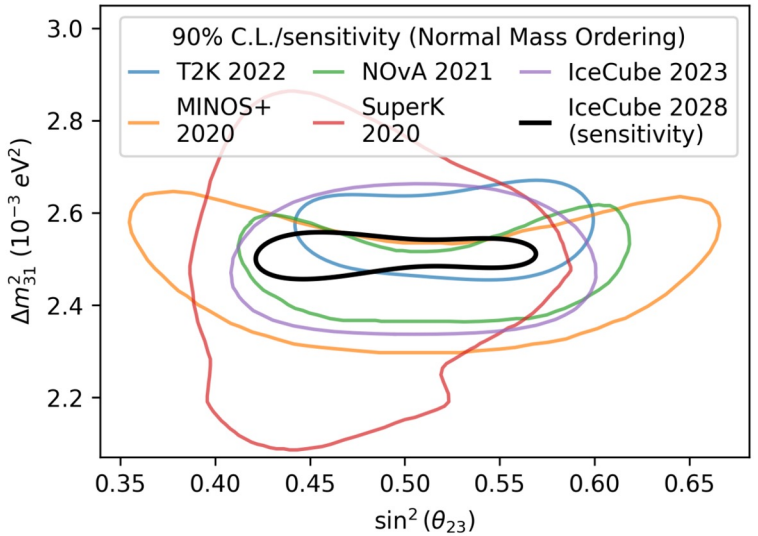




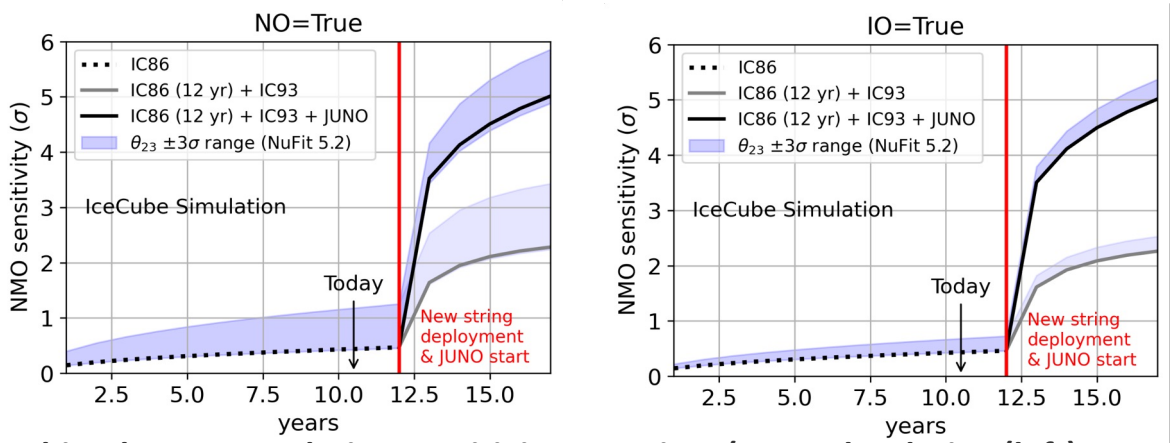
- High precision atmospheric neutrino oscillation measurements
- Better calibration of new and existing detector modules and ice, including previously unexplored depths

IceCube Upgrade in Brief …



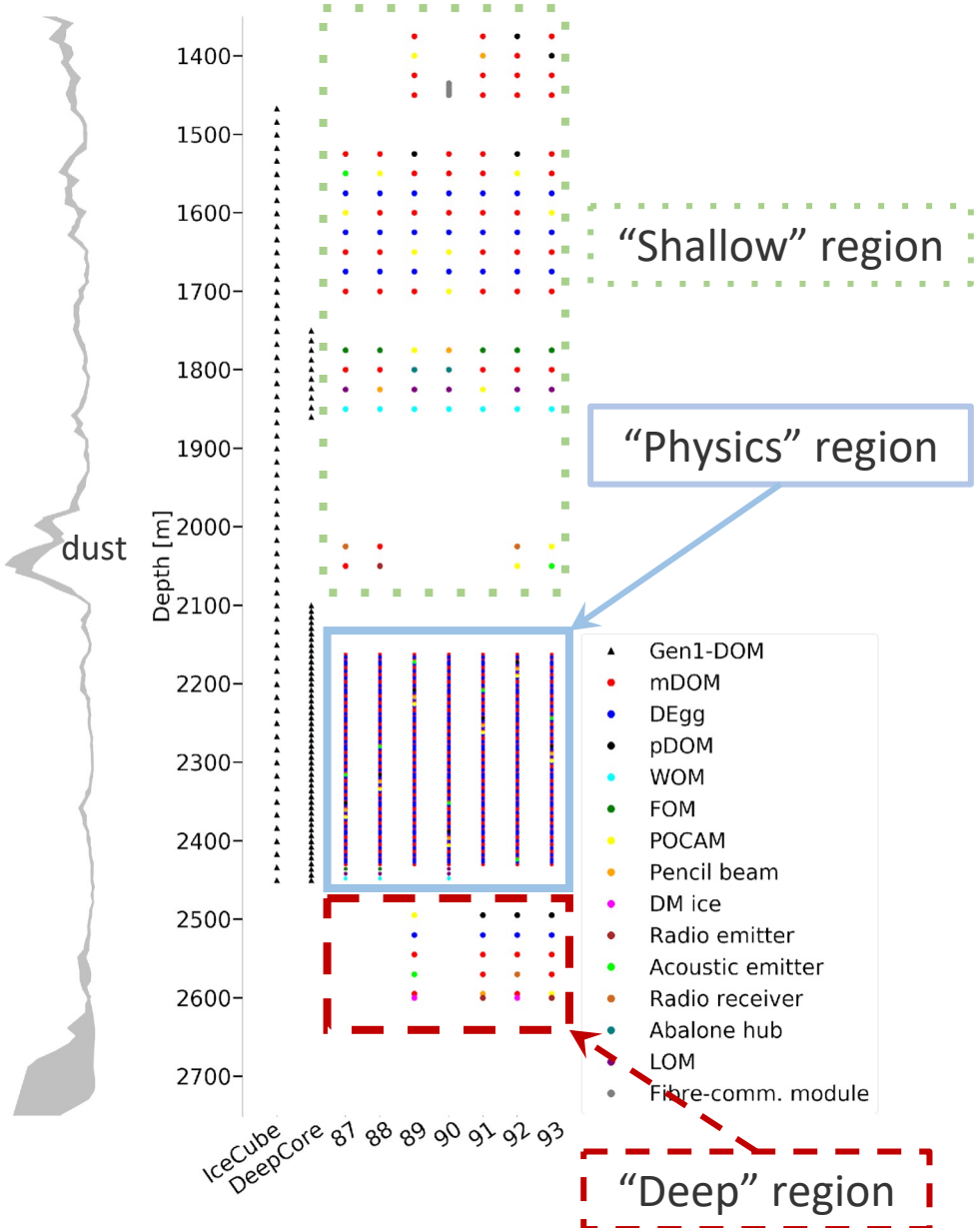


NuMu Disappearance 90% contour compared to other experiments



Combined ν Mass Ordering sensitivity over time (Normal ordering (left), Inverted ordering (right)) (IceCube with Upgrade; IceCube with Upgrade combined with JUNO)

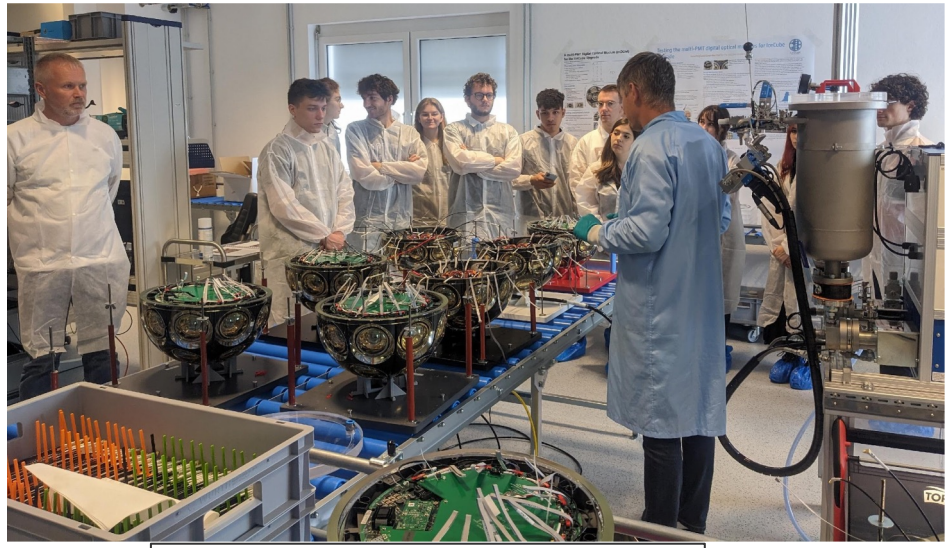
IceCube Upgrade in Brief …



Upgrade Scope (10 km view)

- Major Parts of Detector Instrumentation Instrumentation (***largely in-kind contributions***)
  - 277 D-Eggs (+ spares) (***Chiba University***)
  - 402 mDoms (+ spares) (***Germany; 50% built at DESY-Zeuthen, 50% built at Michigan State University***)
  - 7 Main Cable assemblies (***Michigan State University***) / Surface cables (***Sweden***)
  - In optical module camera systems (***SKKU***)
  - Calibraton Devices / Special Devices (***Various in-kind contributors***)
- Drill and deploy 7 strings of detector elements
  - Drill (University of Wisconsin, Physical Sciences Laboratory)
  - Logistics (NSF Office of Polar Programs)

Deep-ice Sensor Modules



mDOM production at DESY

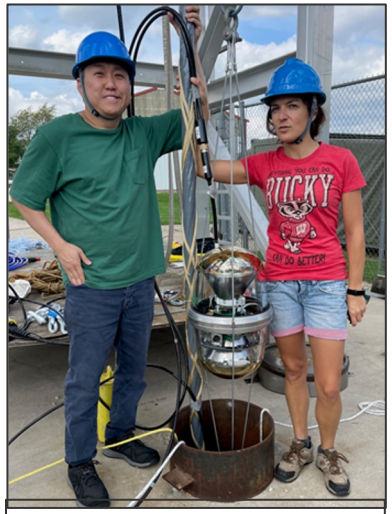
mDOM production at MSU

mDOMs: (DESY/MSU) 6th batch (of 24) Final Acceptance Testing at DESY in progress. Plan to ship 128 this year. MSU module integration in progress, production readiness review held at MSU in April 17.
DEggs:(Chiba) Final Acceptance Testing near completion: reworking some modules. All modules on track to ship this year.

dEgg Production at Chiba

Cable Assemblies

Surface Cable Assemblies in McMurdo. Installation in FS2



Installation tests

Hexatronic Main Cable (left): One full length Septet for Northern Test Stand (right).

Main Cables en route to JDR in Texas to be connectorized into Main Cable Assemblies. MCAs ship ~~November 2024.~~

Main Cable Assemblies (MCA)

- Prototype MCA in progress at JDR. Will ship end of April – testing at PSL 1st week of May.

Breakout Cable Assemblies (BCA)

- Tested prototypes at the UW-Physical Sciences Laboratory testbed
- Bid awarded to Hydrogroup in Scotland
- BCAs ship in 2024 (direct to CHC)

Upgrade Schedule in Brief

Each field season builds upon the previous, while also ***REBUILDING CRITICAL EXPERIENCE***

- Just completed first South Pole Field Season for the rebaselined project (FS1)
- Major goal was refitting / upgrading all subsystems and set up the Seasonal Equipment Site (“drill camp”)

IceCube Field Season 1 – weekly status reports

11/19/2023					
Personnel Status	55%	% of planned personnel at work at South Pole			0.5

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	11%	N/A	33%	24%	0.00
Fuel Tower	0%	N/A	0%	0%	0.50
Independent Firn Drill (IFD)	N/A	0%	0%	0%	0.00
Pre Heat System (PHS)	0%	0%	0%	0%	0.00
Tower Operations Site (TOS)	0%	0%	0%	0%	0.00
Mobile Heating Plant (MHP)	0%	0%	0%	0%	0.00
Generators	N/A	0%	0%	0%	0.00
Advanced Rodwell Apparatus (ARA)	0%	0%	0%	0%	0.00
Water Tanks	0%	0%	0%	0%	1.00
High Pressure Pumps (HPP)	0%	0%	0%	0%	1.00
Reels/Winches	0%	0%	0%	0%	1.00
Seasonal Equipment Site (SES) Setup	0%	0%	0%	0%	1.00
Outfall Drilling (IFD)	N/A	0%	0%	0%	1.00
Outfall Drilling (ARA)	N/A	0%	0%	0%	1.00
Drill Control Center (DCC)	0%	N/A	N/A	0%	1.00
Heat Pump Unit (HPU)	0%	0%	0%	0%	1.00
Closeout	0%	0%	0%	0%	1.00

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Legends

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

11/26/2023					
Personnel Status	82%	% of planned personnel at work at South Pole			0.5

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	11%	N/A	11%	11%	0.50
Power Generation	N/A	3%	2%	3%	0.00
Independent Firn Drill (IFD)	N/A	0%	0%	0%	0.50
Pre Heat System (PHS)	0%	0%	0%	0%	0.00
Tower Operations Site (TOS)	0%	0%	0%	0%	0.00
Main Heating Plant (MHP)	0%	0%	7%	0%	0.00
Advanced Rodwell Apparatus (ARA)	0%	0%	0%	0%	0.00
Water Tanks	0%	0%	0%	0%	1.00
High Pressure Pumps (HPP)	0%	0%	0%	0%	1.00
Reels/Winches	0%	0%	0%	0%	1.00
Seasonal Equipment Site (SES) Setup	0%	0%	0%	0%	1.00
Outfall Drilling (IFD)	N/A	0%	0%	0%	1.00
Outfall Drilling (ARA)	N/A	0%	0%	0%	1.00
Drill Control Center (DCC)	0%	N/A	N/A	0%	1.00
Heat Pump Unit (HPU)	0%	0%	0%	0%	1.00
Closeout	0%	0%	0%	0%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

12/3/2023					
Personnel Status	91%	% of planned personnel at work at South Pole			0.5

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	50%	31%	38%	0.00
Independent Firn Drill (IFD)	N/A	64%	72%	67%	0.50
Pre Heat System (PHS)	0%	0%	4%	1%	0.00
Tower Operations Site (TOS)	0%	0%	0%	0%	0.00
Main Heating Plant (MHP)	8%	5%	16%	10%	0.00
Advanced Rodwell Apparatus (ARA)	0%	0%	0%	0%	0.00
Water Tanks	0%	0%	0%	0%	1.00
High Pressure Pumps (HPP)	0%	0%	0%	0%	1.00
Reels/Winches	0%	0%	0%	0%	1.00
Seasonal Equipment Site (SES) Setup	0%	0%	0%	0%	1.00
Outfall Drilling (IFD)	N/A	0%	0%	0%	1.00
Outfall Drilling (ARA)	N/A	0%	0%	0%	1.00
Drill Control Center (DCC)	0%	N/A	N/A	0%	1.00
Heat Pump Unit (HPU)	0%	0%	0%	0%	1.00
Closeout	0%	0%	0%	0%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

12/10/2023					
Personnel Status	91%	% of planned personnel at work at South Pole			0.5

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	66%	36%	48%	0.00
Independent Firn Drill (IFD)	N/A	90%	86%	88%	0.50
Pre Heat System (PHS)	15%	0%	6%	7%	0.50
Tower Operations Site (TOS)	0%	0%	0%	0%	0.25
Main Heating Plant (MHP)	8%	5%	16%	10%	0.50
Advanced Rodwell Apparatus (ARA)	0%	5%	5%	4%	0.00
Water Tanks	0%	0%	0%	0%	0.50
High Pressure Pumps (HPP)	0%	0%	0%	0%	1.00
Reels/Winches	0%	0%	0%	0%	1.00
Seasonal Equipment Site (SES) Setup	0%	0%	0%	0%	1.00
Outfall Drilling (IFD)	N/A	0%	0%	0%	1.00
Outfall Drilling (ARA)	N/A	0%	0%	0%	1.00
Drill Control Center (DCC)	0%	N/A	N/A	0%	1.00
Heat Pump Unit (HPU)	0%	0%	0%	0%	1.00
Closeout	0%	0%	0%	0%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

12/17/2023					
Personnel Status	123%	% of planned personnel at work at South Pole			1.00

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	80%	45%	59%	0.50
Independent Firn Drill (IFD)	N/A	100%	100%	100%	1.00
Pre Heat System (PHS)	15%	1%	7%	7%	0.50
Tower Operations Site (TOS)	0%	0%	0%	0%	0.25
Main Heating Plant (MHP)	38%	12%	13%	25%	0.50
Advanced Rodwell Apparatus (ARA)	21%	5%	13%	11%	0.50
Water Tanks	0%	0%	20%	10%	0.50
High Pressure Pumps (HPP)	27%	28%	14%	26%	1.00
Reels/Winches	0%	0%	0%	0%	1.00
Seasonal Equipment Site (SES) Setup	0%	0%	0%	0%	1.00
Outfall Drilling (IFD)	N/A	0%	0%	0%	1.00
Outfall Drilling (ARA)	N/A	0%	0%	0%	1.00
Drill Control Center (DCC)	0%	N/A	N/A	0%	1.00
Heat Pump Unit (HPU)	0%	0%	0%	0%	1.00
Closeout	0%	0%	0%	0%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

12/24/2023					
Personnel Status	123%	% of planned personnel at work at South Pole			1.00

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	99%	72%	82%	1.00
Independent Firn Drill (IFD)	N/A	100%	100%	100%	1.00
Pre Heat System (PHS)	44%	49%	61%	51%	0.50
Tower Operations Site (TOS)	3%	2%	3%	3%	0.25
Main Heating Plant (MHP)	47%	33%	44%	46%	0.50
Advanced Rodwell Apparatus (ARA)	21%	5%	13%	11%	0.50
Water Tanks	0%	0%	30%	16%	0.50
High Pressure Pumps (HPP)	39%	33%	20%	35%	1.00
Reels/Winches	0%	0%	0%	0%	1.00
Seasonal Equipment Site (SES) Setup	0%	0%	0%	0%	1.00
Outfall Drilling (IFD)	N/A	100%	100%	100%	1.00
Outfall Drilling (ARA)	N/A	0%	0%	0%	1.00
Drill Control Center (DCC)	0%	N/A	N/A	0%	1.00
Heat Pump Unit (HPU)	0%	0%	0%	0%	1.00
Closeout	0%	0%	0%	0%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

12/31/2023					
Personnel Status	123%	% of planned personnel at work at South Pole			1.00

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	100%	100%	100%	1.00
Independent Firn Drill (IFD)	N/A	100%	100%	100%	1.00
Pre Heat System (PHS)	46%	65%	81%	63%	0.50
Tower Operations Site (TOS)	13%	4%	6%	10%	0.25
Main Heating Plant (MHP)	51%	39%	53%	53%	0.50
Advanced Rodwell Apparatus (ARA)	22%	20%	22%	21%	0.50
Water Tanks	0%	0%	30%	16%	0.50
High Pressure Pumps (HPP)	56%	45%	20%	48%	1.00
Reels/Winches	0%	0%	0%	0%	1.00
Seasonal Equipment Site (SES) Setup	0%	0%	11%	4%	1.00
Outfall Drilling (IFD)	N/A	100%	100%	100%	1.00
Outfall Drilling (ARA)	N/A	0%	0%	0%	1.00
Drill Control Center (DCC)	0%	N/A	N/A	0%	1.00
Heat Pump Unit (HPU)	0%	0%	0%	0%	1.00
Closeout	11%	0%	6%	6%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

1/7/2024					
Personnel Status	115%	% of planned personnel at work at South Pole			1.00

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	100%	100%	100%	1.00
Independent Firn Drill (IFD)	N/A	100%	100%	100%	1.00
Pre Heat System (PHS)	53%	74%	86%	71%	0.50
Tower Operations Site (TOS)	29%	13%	22%	24%	0.25
Main Heating Plant (MHP)	90%	55%	65%	71%	1.00
Advanced Rodwell Apparatus (ARA)	29%	21%	25%	24%	0.50
Water Tanks	0%	0%	60%	32%	0.50
High Pressure Pumps (HPP)	56%	45%	20%	48%	0.50
Reels/Winches	0%	0%	0%	0%	0.50
Seasonal Equipment Site (SES) Setup	N/A	N/A	N/A	29%	1.00
Outfall Drilling (IFD)	N/A	100%	100%	100%	1.00
Outfall Drilling (ARA)	N/A	0%	0%	0%	1.00
Drill Control Center (DCC)	19%	N/A	N/A	19%	1.00
Heat Pump Unit (HPU)	N/A	N/A	N/A	10%	1.00
Closeout	11%	0%	6%	6%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

1/14/2024					
Personnel Status	115%	% of planned personnel at work at South Pole			1.00

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	100%	100%	100%	1.00
Independent Firn Drill (IFD)	N/A	100%	100%	100%	1.00
Pre Heat System (PHS)	81%	88%	93%	87%	0.50
Tower Operations Site (TOS)	31%	13%	22%	25%	0.25
Main Heating Plant (MHP)	100%	100%	100%	100%	1.00
Advanced Rodwell Apparatus (ARA)	38%	33%	39%	36%	0.50
Water Tanks	0%	11%	68%	40%	0.50
High Pressure Pumps (HPP)	82%	57%	20%	66%	0.50
Reels/Winches	12%	10%	0%	8%	0.50
Seasonal Equipment Site (SES) Setup	N/A	N/A	N/A	50%	1.00
Outfall Drilling (IFD)	N/A	100%	100%	100%	1.00
Outfall Drilling (ARA)	N/A	0%	0%	0%	0.50
Drill Control Center (DCC)	22%	N/A	N/A	22%	1.00
Heat Pump Unit (HPU)	N/A	N/A	N/A	90%	1.00
Closeout	11%	0%	6%	6%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

1/21/2024					
Personnel Status	100%	% of planned personnel at work at South Pole			1.00

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	100%	100%	100%	1.00
Independent Firn Drill (IFD)	N/A	100%	100%	100%	1.00
Pre Heat System (PHS)	90%	99%	98%	96%	1.00
Tower Operations Site (TOS)	43%	47%	30%	41%	0.50
Main Heating Plant (MHP)	100%	100%	100%	100%	1.00
Advanced Rodwell Apparatus (ARA)	83%	62%	65%	67%	0.50
Water Tanks	0%	100%	100%	89%	1.00
High Pressure Pumps (HPP)	100%	100%	100%	100%	1.00
Reels/Winches	51%	24%	23%	36%	0.50
Seasonal Equipment Site (SES) Setup	N/A	N/A	N/A	58%	1.00
Outfall Drilling (IFD)	N/A	100%	100%	100%	1.00
Outfall Drilling (ARA)	N/A	0%	0%	0%	0.50
Drill Control Center (DCC)	100%	N/A	N/A	100%	1.00
Heat Pump Unit (HPU)	N/A	N/A	N/A	100%	1.00
Closeout	66%	60%	61%	62%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

1/28/2024					
Personnel Status	92%	% of planned personnel at work at South Pole			1.00

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	100%	100%	100%	1.00
Independent Firn Drill (IFD)	N/A	100%	100%	100%	1.00
Pre Heat System (PHS)	90%	99%	98%	96%	1.00
Tower Operations Site (TOS)	59%	74%	59%	62%	0.50
Main Heating Plant (MHP)	100%	100%	100%	100%	1.00
Advanced Rodwell Apparatus (ARA)	86%	79%	80%	80%	0.50
Water Tanks	0%	100%	100%	89%	1.00
High Pressure Pumps (HPP)	100%	100%	100%	100%	1.00
Reels/Winches	63%	76%	46%	64%	0.50
Seasonal Equipment Site (SES) Setup	N/A	N/A	N/A	84%	1.00
Outfall Drilling (IFD)	N/A	100%	100%	100%	1.00
Outfall Drilling (ARA)	N/A	100%	100%	100%	1.00
Drill Control Center (DCC)	100%	N/A	N/A	100%	1.00
Heat Pump Unit (HPU)	N/A	N/A	N/A	100%	1.00
Closeout	69%	65%	66%	67%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

2/3/2024					
Personnel Status	92%	% of planned personnel at work at South Pole			1.00

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	100%	100%	100%	1.00
Independent Firn Drill (IFD)	N/A	100%	100%	100%	1.00
Pre Heat System (PHS)	90%	99%	98%	96%	1.00
Tower Operations Site (TOS)	74%	80%	69%	74%	1.00
Main Heating Plant (MHP)	100%	100%	100%	100%	1.00
Advanced Rodwell Apparatus (ARA)	86%	95%	95%	93%	1.00
Water Tanks	0%	100%	100%	89%	1.00
High Pressure Pumps (HPP)	100%	100%	100%	100%	1.00
Reels/Winches	79%	88%	95%	87%	1.00
Seasonal Equipment Site (SES) Setup	N/A	N/A	N/A	89%	1.00
Outfall Drilling (IFD)	N/A	100%	100%	100%	1.00
Outfall Drilling (ARA)	N/A	100%	100%	100%	1.00
Drill Control Center (DCC)	100%	N/A	N/A	100%	1.00
Heat Pump Unit (HPU)	N/A	N/A	N/A	100%	1.00
Closeout	79%	70%	100%	87%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

IceCube Field Season 1 – weekly status reports

2/11/2024					
Personnel Status	92%	% of planned personnel at work at South Pole			1.00

System	Electrical	Mechanical	Tech	Overall Progress	Status
Setup	100%	N/A	100%	100%	1.00
Fuel Tower	100%	N/A	100%	100%	1.00
Power Generation	N/A	100%	100%	100%	1.00
Independent Firn Drill (IFD)	N/A	100%	100%	100%	1.00
Pre Heat System (PHS)	90%	99%	98%	96%	1.00
Tower Operations Site (TOS)	74%	80%	69%	74%	1.00
Main Heating Plant (MHP)	100%	100%	100%	100%	1.00
Advanced Rodwell Apparatus (ARA)	86%	95%	95%	93%	1.00
Water Tanks	0%	100%	100%	89%	1.00
High Pressure Pumps (HPP)	100%	100%	100%	100%	1.00
Reels/Winches	83%	88%	100%	90%	1.00
Seasonal Equipment Site (SES) Setup	N/A	N/A	N/A	95%	1.00
Outfall Drilling (IFD)	N/A	100%	100%	100%	1.00
Outfall Drilling (ARA)	N/A	100%	100%	100%	1.00
Drill Control Center (DCC)	100%	N/A	N/A	100%	1.00
Heat Pump Unit (HPU)	N/A	N/A	N/A	100%	1.00
Closeout	100%	100%	100%	100%	1.00

Legends

Bar Chart (% complete)
100%
40%
30%
20%
10%
0%

Status	
As planned	1.00
slightly delayed, no worries	0.50
significantly delayed, worries	0.25
Waiting for Cargo	0.00

Drill camp after Field Season 1

In addition, Upgrade drilled temporary outfall for station

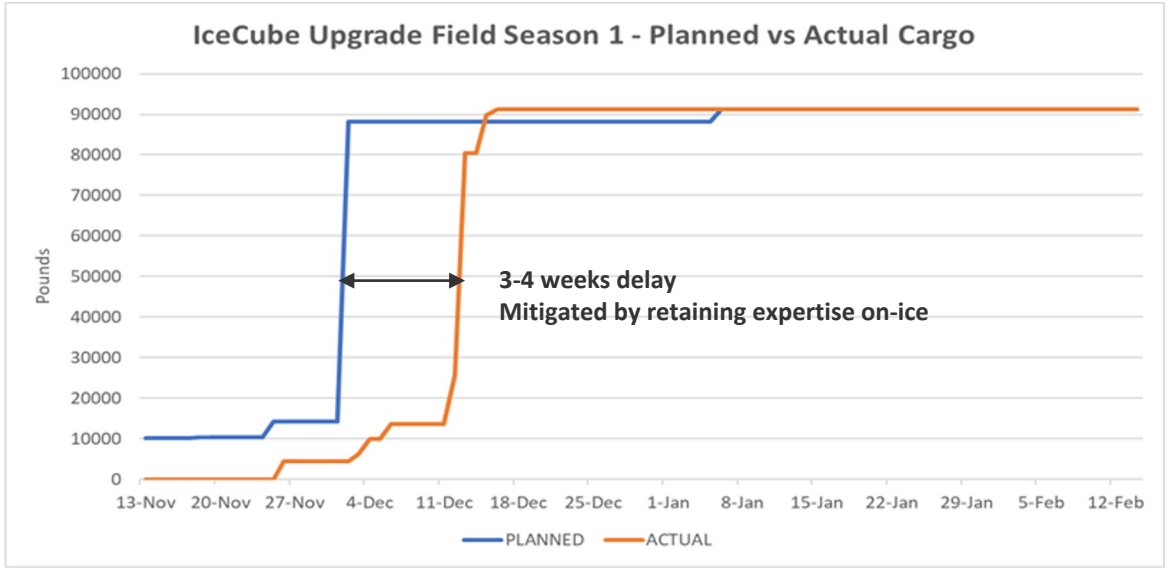
Firn Drill

ARA Hot Water Drill

Drilled hole ~ 280ft deep for station emergency outfall

Upgrade Cargo (Field Season 1)

- Delays in cargo impacted the Field Season. Worked with the Antarctic Service Contractor and NSF to:
  - Prioritize cargo in addition to “Required On-Site” dates
  - Rearrange work to mitigate missing cargo
  - Lengthen deployments to retain expertise on ice
  - Borrow equipment (e.g. batteries) to keep work moving
- This added flexibility led to a successful Upgrade Field Season



Overall very successful Field Season

- The IceCube Upgrade Team completed 98.8% of planned work
  - 90.7% of the plan as captured in our schedule at the time of rebaselining – the rest of the tasks will move to Field Season 2
  - Additionally, completed temporary outfall for the South Pole station
- We had some surprises and challenges, but were able to overcome them
  - ASC coordination and support critical to success
- Building the “next generation” of hot water drillers

Field Season 2 – drill activities

- Major focus – connect and integrate all the drill subsystems
- Drill 9 firn holes with the Independent Firn Drill
- **Commission, troubleshoot, and do full system wet test of the hot water drill**
- Winterize and store all equipment

	Start	End	Week of:	Nov 3	10	17	24	Dec 1	8	15	22	29	Jan 5	12	19	26	Feb 2	9
ICU Season start (NPX)	11/7/2024																	
Opening Activities and SES setup/maintenance	11/9/2024	1/27/2025																
Generators and PDM	11/1/2024	1/20/2025																
Firn Drilling	11/15/2024	1/4/2025																
Final Upgrades and Replacements	11/15/2024	1/15/2025																
Shops, MECC	11/15/2024	11/21/2024																
HPU2	11/15/2024	11/30/2024																
TOS, Tower	11/15/2024	12/9/2024																
DCC	11/15/2024	12/19/2024																
ARA	11/15/2024	1/11/2025																
MHP	11/19/2024	11/29/2024																
PHS	11/19/2024	11/29/2024																
WT	11/19/2024	11/29/2024																
HPP	11/19/2024	11/29/2024																
Fuel Tower	11/30/2024	12/6/2024																
Reels, Winches	11/29/2024	1/15/2025																
Install Hose on Reel	12/3/2024	12/10/2024																
DHF	11/29/2024	12/9/2024																
ARA Ops - Bulbs	12/3/2024	12/24/2024																
Full System Testing	12/5/2024	1/13/2025																
Phase 1: TOS Motion Control	12/19/2024	12/30/2024																
Phase 2: Full System Wet Test	1/1/2025	1/9/2025																
Season Close-Out and Winterize	1/13/2025	1/30/2025																
ICU Season end (NPX)		1/27/2025																

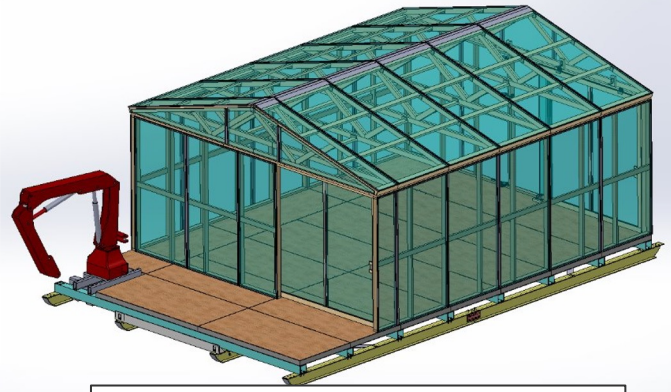
FS2: Installation tasks (with help from M&O team)

- Install and test surface cables and surface junction boxes
- Install / commission timing and power electronics in ICL
- Receive, test, and store all the D-Eggs, 2 strings worth of mDOMs, and 2 strings worth of calibration and special devices.
- DOM handling facility construction (ASC support) and dry run to test procedure

	Start	End	C17 air gap Dec 12 - Feb 4 Week of:	Nov 3	10	17	24	Dec 1	8	15	22	29	Jan 5	12	19	26	Feb 2	9
ICU Season start (NPX)	11/7/24																	
Personnel and Cargo arrival	12/2/24	12/2/24																
Sensor & Electronics Arrival (LC-130)	12/2/24	12/13/24																
SCAs, Container D Arrival (SPOT-1)	12/2/24	12/2/24																
Personnel On Site	12/10/24	1/30/25																
Sensor Testing	11/15/24	1/4/25																
Prepare Tent, Shack, Sleds	12/10/24	12/13/24																
Setup SPAT	12/17/24	12/24/24																
Test String 87	12/26/24	1/2/25																
Test String 88	1/3/25	1/10/25																
Test Special Devices	1/11/25	1/20/25																
Sensor Handling	11/15/24	1/11/25																
Build DHF	12/4/24	12/23/24																
Install Crane & Handling Materials	12/24/24	12/31/24																
Sensor Handling Dry Run	1/1/25	1/6/25																
IME integration	12/15/24	1/20/25																
Surface Cable Assemblies Installation	11/19/24	11/29/24																
Survey, trenching, compact	11/21/24	12/3/24																
Cable Pull & ICL side connection	12/4/24	1/3/24																
SJB installation, connect cables	1/3/24	1/6/24																
Surface Cable & Field Hub Commissioning	1/6/25	1/30/25																
Vault installation, As built survey	12/3/24	12/24/24																
Season Close-Out, Store DNF	1/22/25	1/30/25																
ICU Season end (NPX)		1/27/25																

Pulling Surface Cables in Gen1

Testing area for sensors



DOM Handling Facility

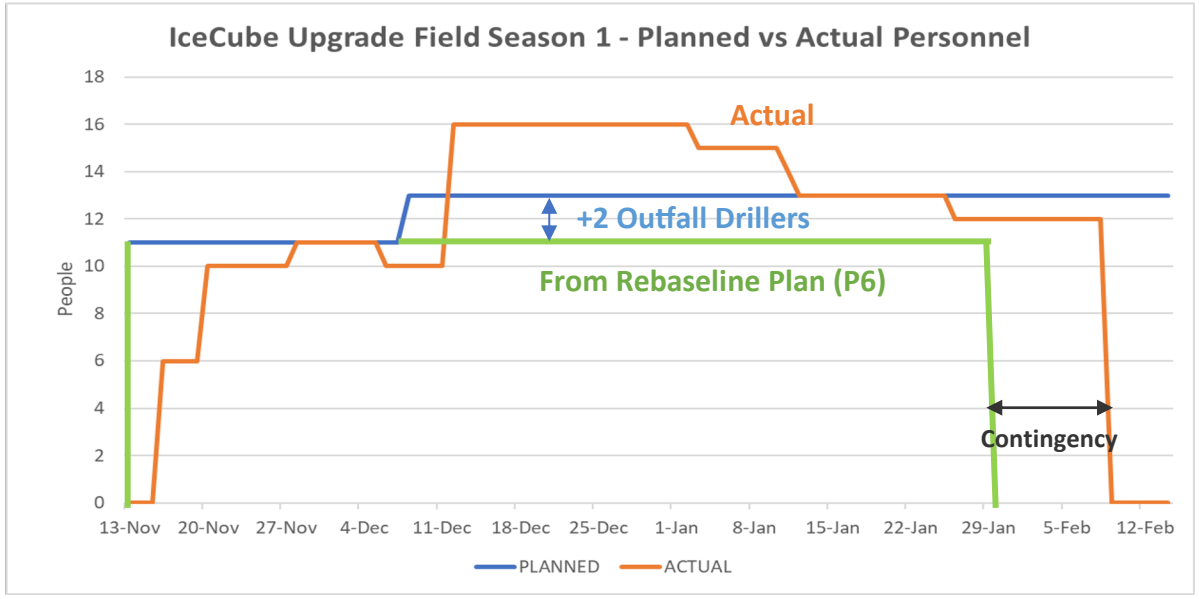
Summary / Conclusions

- The science of the upgrade is compelling, both for measuring neutrino properties, and for improving calibrations.
- The collaboration is engaged, and eagerly awaiting the upgraded detector.
- M&O and Upgrade are working together to ensure we have a detector we can read out, calibrate, and deliver on the science.
- Overall, the project is making remarkable progress
  - Schedule is well understood; schedule risks and variances tracked
  - Costs are higher than budgeted, but we are tracking them and have a healthy contingency.
- Details of integration of Upgrade into ICNO in following talks

Backups

Population (Field Season 1)

- Originally requested 11 personnel on site, with 5 mid-season rotations. Station requested outfall drilling; added two additional drillers to support this.
- Negotiated additional on-ice time to make up for delayed cargo; missing expertise. Flexibility on #beds really helped us succeed this Field Season – **Thank you!**



Additional people had a cost impact on the project; will be dissecting details, updating FS2 plans.