IceCube Upgrade Project Status

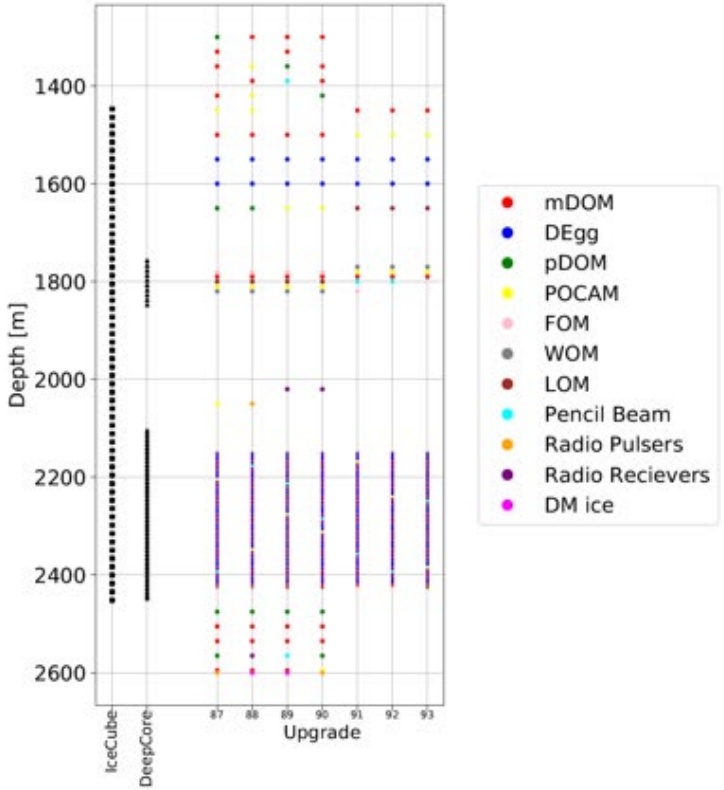
Farshid Feyzi - Project Manager

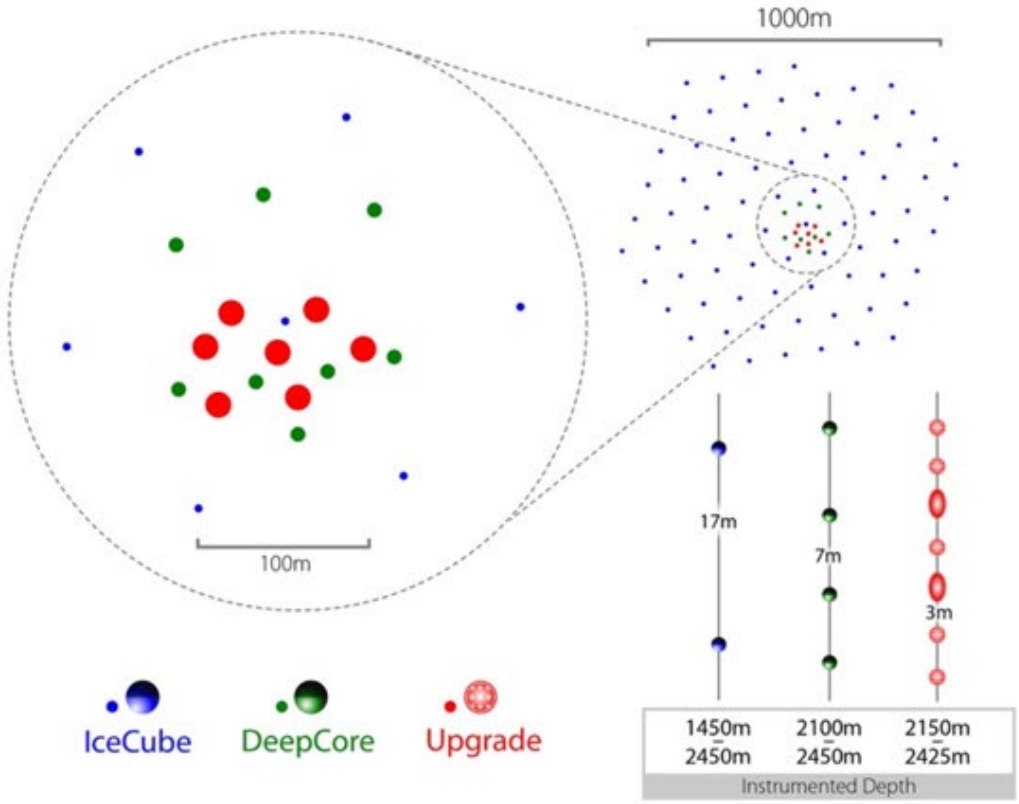
30 September, 2020

Outline

- Progress since last meeting
- Present status and focus
- Project year 3 plan (starts tomorrow)
- Impact of COVID-19 pandemic
- Summary

Upgrade Scope Fixed:





Upgrade Objectives remain the same:

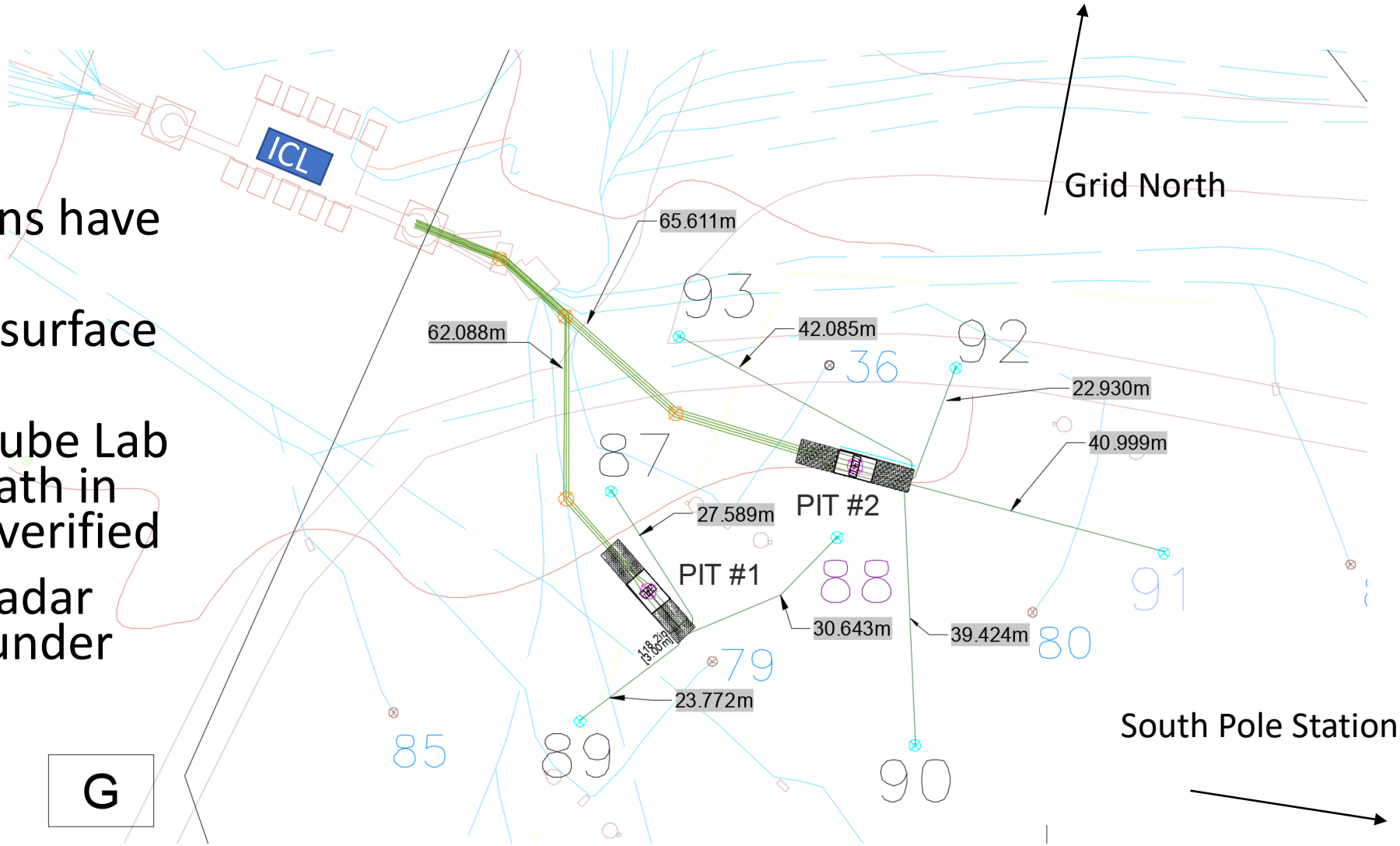
1. Neutrino Properties
2. Recalibration and Reanalysis of IceCube Data
3. IceCube-Gen2 Research and Development

Technical Progress

- Progress since last report continues to be excellent despite the pandemic
- Production and testing of optical modules started
- Development and testing of calibration and special devices is mostly on track
- Drill assessment done in 2019-2020 season, better than expected
- Project year 2 annual report contains the highlights and status of project level 1 and 2 milestones

Surface Plan

- Surface and cable plans have been fixed
- Two pits will house 7 surface junction boxes
- Cables will enter IceCube Lab through one tower, path in tower and cable way verified
- Ground penetrating radar survey done, results under study



From Chiba University

*Cleanroom used in assembly and integration of D-Egg at the **Nippon Marine Enterprises (NME)** facility in Yokohama, Japan where 50 D-Egg modules were completed.*

From Chiba University

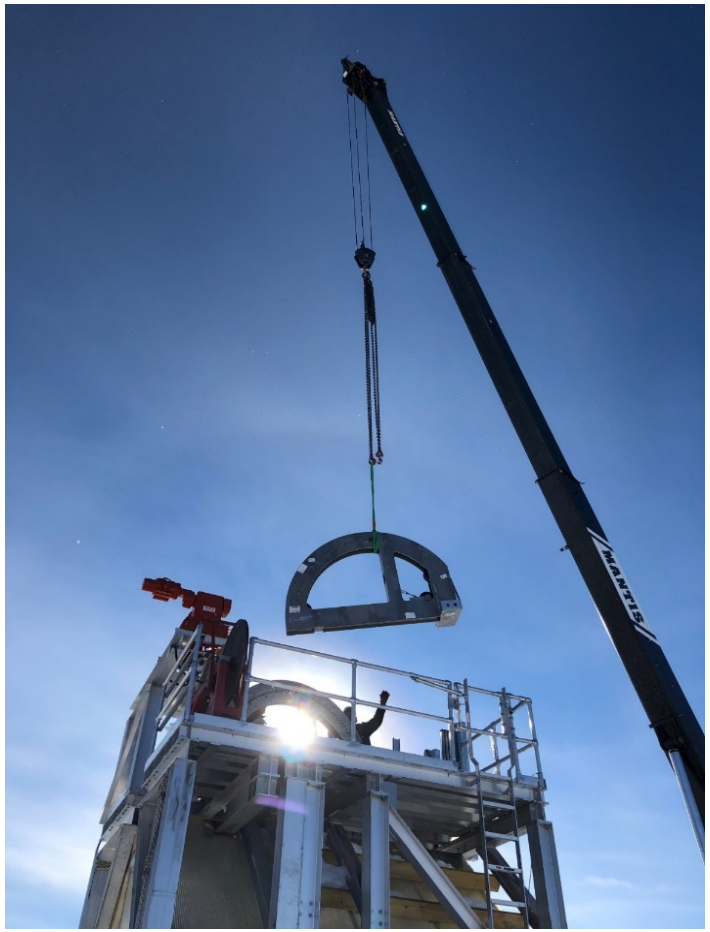
Freezer partially loaded with D-Eggs in their test structures

D-Egg module in its FAT test stand

D-Egg module holders, for the D-Egg FAT, being assembled

From the South Pole 2019-2020 Season

Testing the high pressure pumps

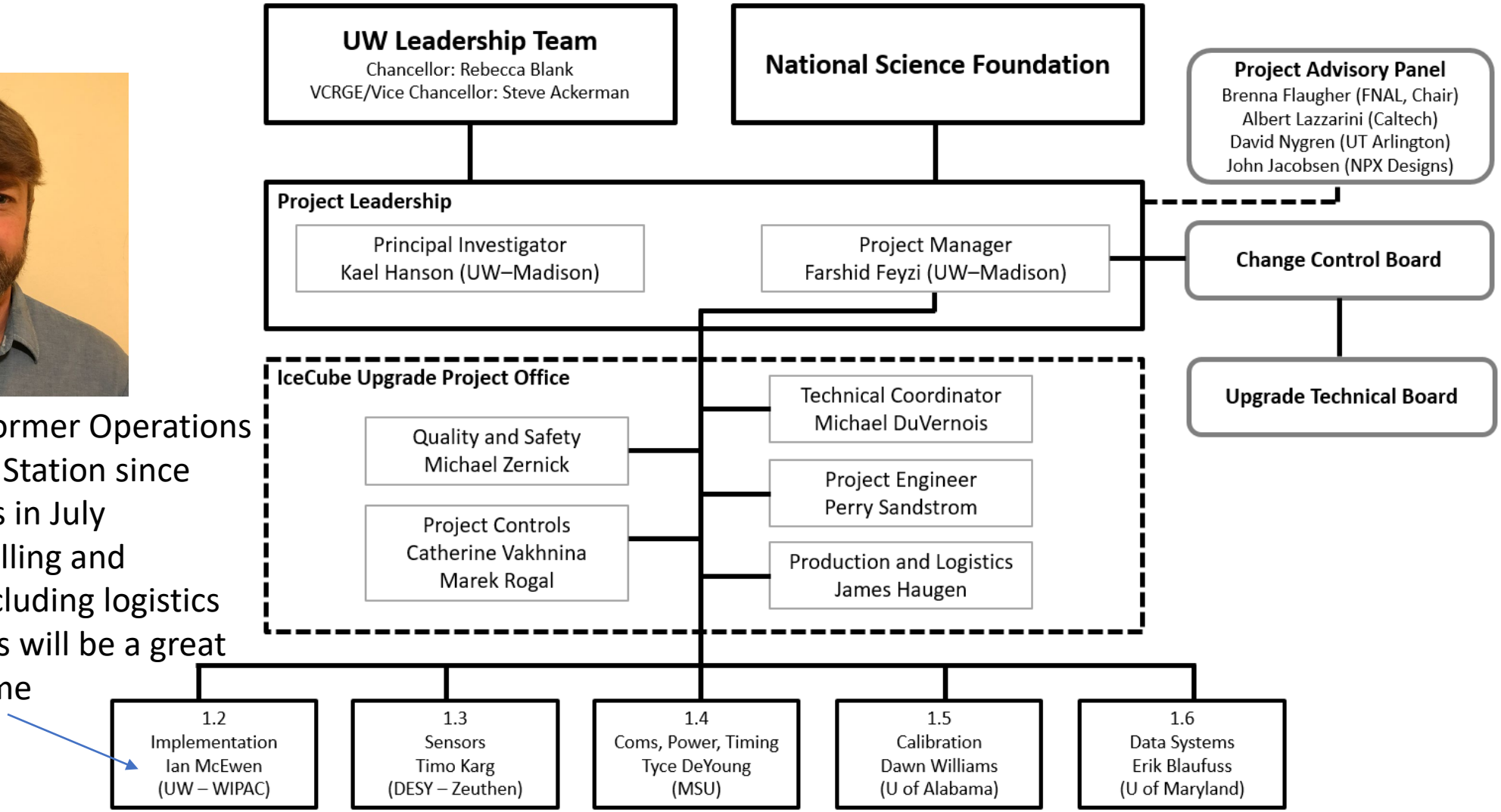


Installing crescent on main drill tower

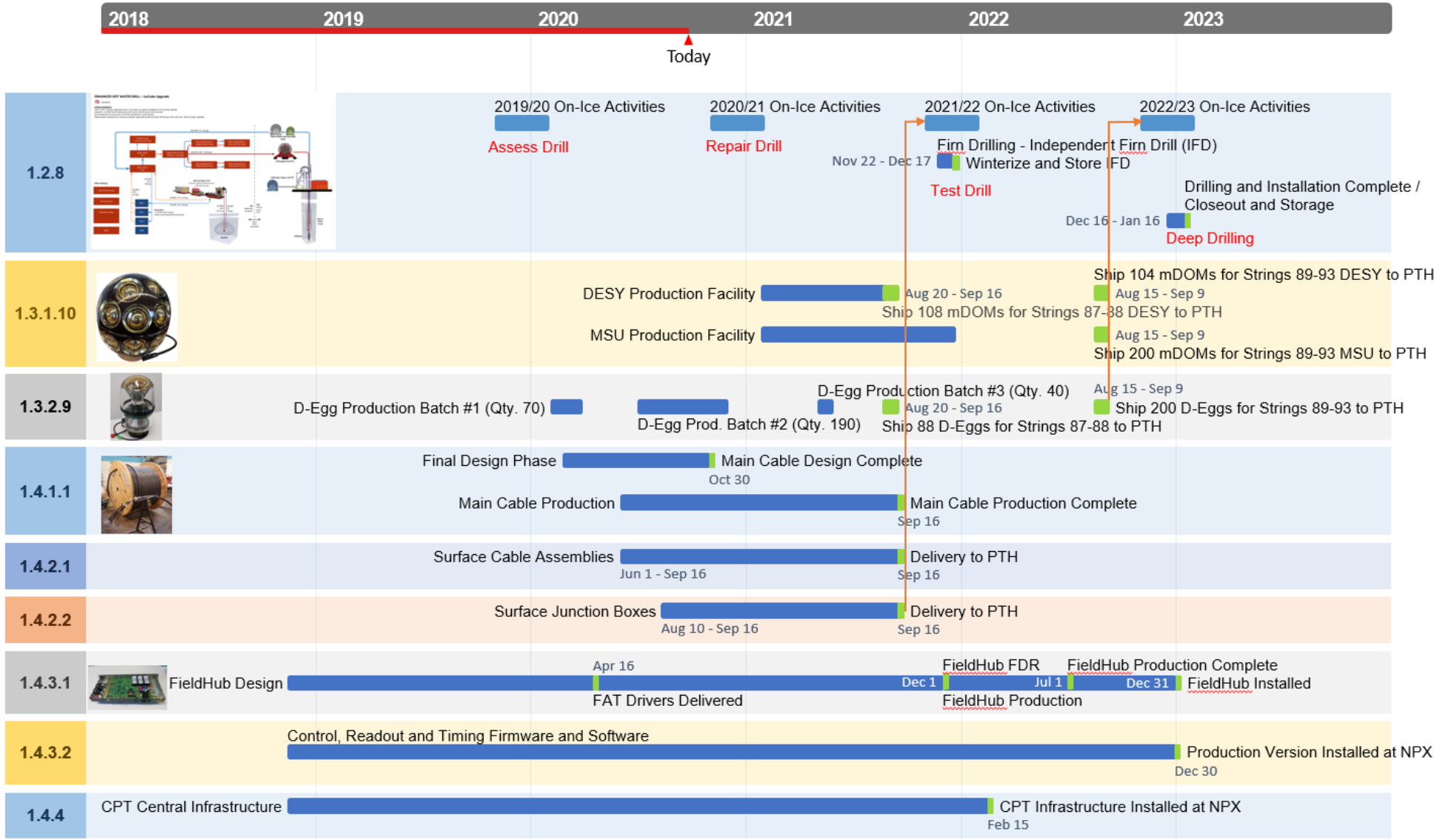
Inspecting heated interconnecting hoses

Project Office Update

- Ian McEwen, former Operations Manager at SP Station since 2014, joined us in July
- He will lead drilling and installation, including logistics
- His experiences will be a great asset at this time



Pre-pandemic Schedule



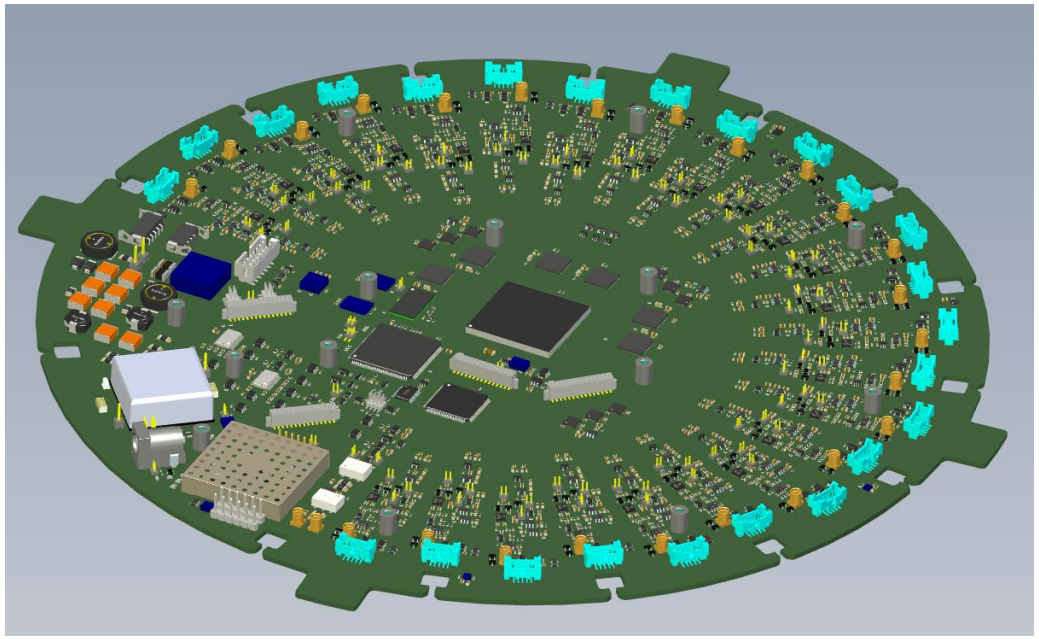
Technical Status and Focus

- Project year 2 progress is behind schedule due to the pandemic
- A plan for project year three as a stand-alone plan has been developed to continue the work and try to catch up:
  - Continue production and testing of D-Eggs and start mDOMs
  - Procure main and surface cables, penetrators
  - Advance drill repairs and control system
  - Move cargo southward – to McMurdo Station and to South Pole
- This plan assumes a compressed7 final season in project year 5
  - Drill testing and commissioning, plus drilling and installation are done in one season
- Compressed7 plan also combines 2020-21 season work with 2021-22 season
- Other plan under consideration is 2+5 in which drill testing and commissioning plus drilling and installation of 2 holes are done in year 5 and remaining 5 holes are drilled and installed in year 6

Present Status with Collaborating Institutions

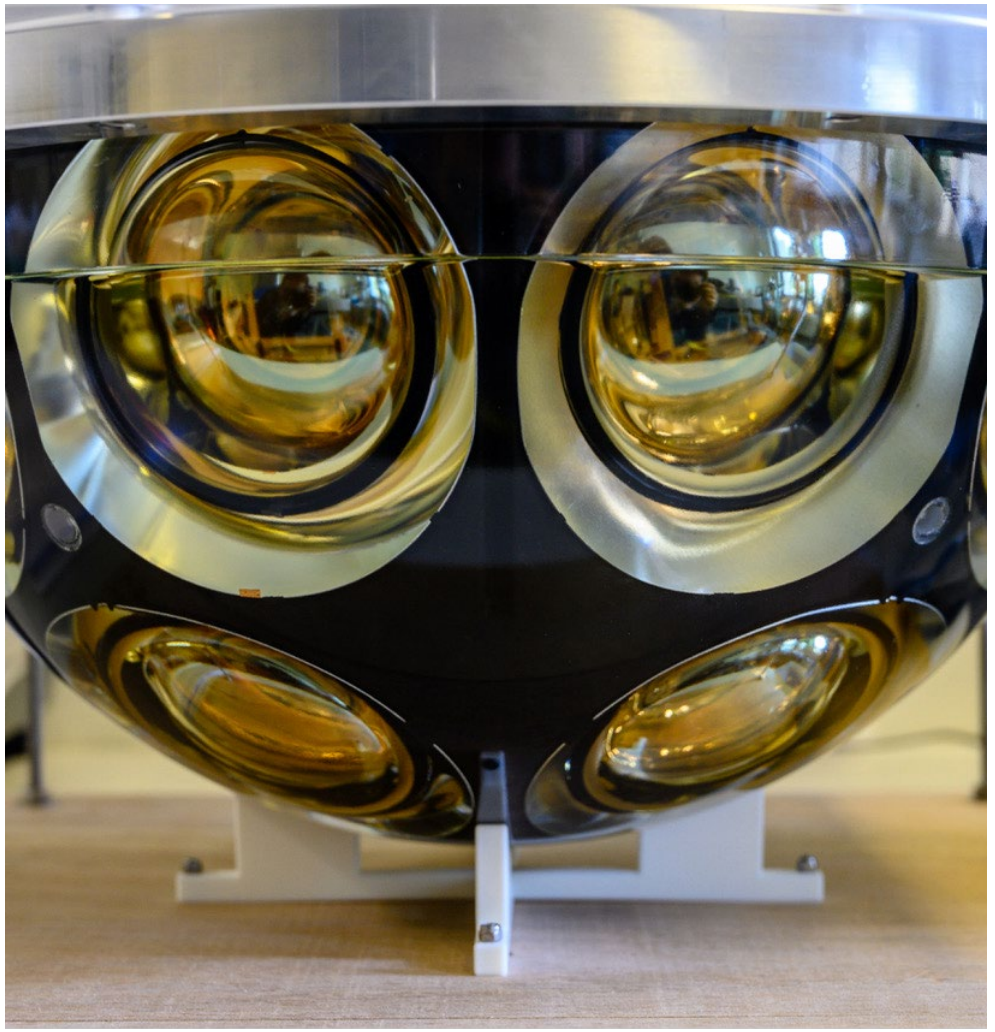
- Work at all collaborating institutions continues based on commitments
- D-Egg production beginning in October - a few months later than plan
- mDOM design and production on track with some delays
  - All PMTs for mDOMs on contract through KIT
- Main and surface cable procurement and penetrator cable assemblies proceeding per plan with some delay
- Calibration and special device development and production making good progress at collaborating institutions
  - Cameras produced at SKKU are being added to modules now

From DESY



mDOM mainboard CAD layout
(actual pictures within a month)

From WWU Münster



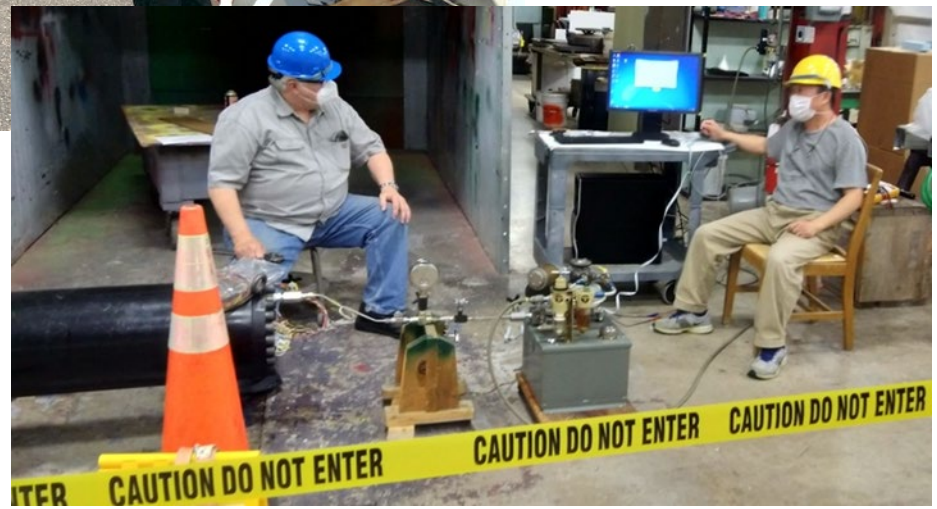
mDOM in the midst of gel pour (partially filled):

From KIT in Karlsruhe

All PMTs for mDOMs have been ordered

From Physical Sciences Laboratory

Offloading old drill cable from the main drill cable reel



Testing a drillhead – all three are done

IVG surface hose just after arrival at PSL Main hose has been delivered to Port Hueneme in California for loading on USAP resupply vessel

Present Status with NSF Project

- Annual report for project year 2 (Oct 2019 – Sep 2020) was completed and submitted
- This allowed for release of project year 3 funding
- At the close of project year 2, expenditures will be on target with budget
- But project year 3 estimate for a compressed7 plan may exceed budget – this is being worked now
- Contingency use is not currently allowed for cost increase due to pandemic
- Cost impact of pandemic on NSF project is being tracked in the earned value management system (EVMS) for possible recovery
- Next project review tentatively scheduled in February 2021

COVID-19 Impact and Future Plans

- Field season for 2020-21 was cancelled – drill repair work at SP is postponed
- Collaborating institutions have been able to continue work and to provide back up for others, this has been absolutely essential
- Drill hot test and firn drilling in 2021-2022 may also be delayed
- Effects of pandemic on shipping are evolving - no cargo or fuel delivery by air this year from McM to SP, all going by overland traverse
- Roughly 50% of cargo staged in McM may ship to SP during the 2020-21 season, remainder will ship in 2021-22 season
- Drill hose scheduled to ship on USAP re-supply vessel, will remain at McM and in containers for shipment to SP in 2021-22 season
- Fuel delivery to SP for season 5 drilling may not be sufficient – this may force us to delay one year

COVID-19 Cost Impact on NSF Project

Delayed Work

Period	Cost Impact (schedule variance per period)	Cumulative Cost Impact (cumulative schedule variance)
April 2020	-$106,284	-$106,284
May 2020	-$183,087	-$289,371
June 2020	-$340,526	-$629,897
July 2020	-$128,810	-$758,707
August 2020	-$442,869	-$1,201,576

Direct Cost

WBS	Cost Incurred	Justification	Notes
1.1.4.1.1	$15,280	Oscilloscope for remote technical work	Need for the oscilloscope to enable remote, in-home work on mainboard integration.
1.2.1	$16,000	Dynamometer for drill testing	Due to delay in access to equipment at the South Pole, this system is needed for testing control system synchronization
Total	$31,280		

Summary

- Progress continues to be great, despite the pandemic
- Strong international collaboration has made this possible, institutes remain very active and provide back up
- Additional costs of delay are being estimated in two ways:
  - Independently in yearly detail plans
  - As variances against original plan
- Doing all possible to expedite work to relieve pressure on future years and stay as close to schedule as possible
- Impact on project schedule unknown at this time, one year delay is likely if ramp up in PY3 not possible or due to fuel delay

Thank you for your attention!

Backup

Funding Profile in Cooperative Agreement

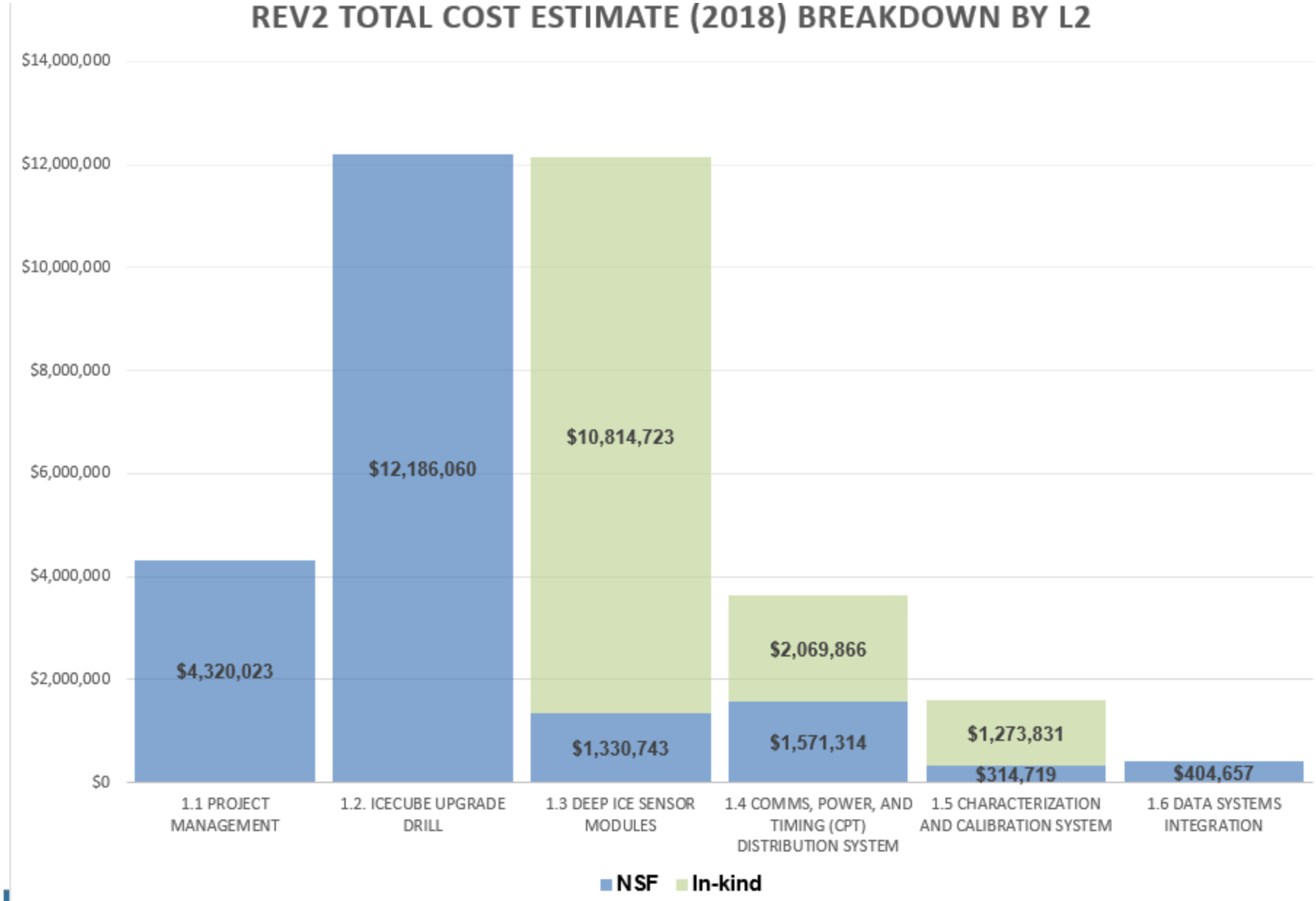
FYI (NSF Appropriation year)	Baseline	Contingency	Total	PY
FY18	$4,066,527	$664,979	$4,731,506	1
FY19	$5,130,419	$575,002	$5,705,421	2
FY20	$3,641,504	$362,229	$4,003,733	3
FY21	$3,604,047	$464,748	$4,068,795	4
FY22	$3,685,016	$788,853	$4,473,869	5
Total	$20,127,513	$2,855,811	$22,983,324	

FUNDED

Performance Measurement Baseline

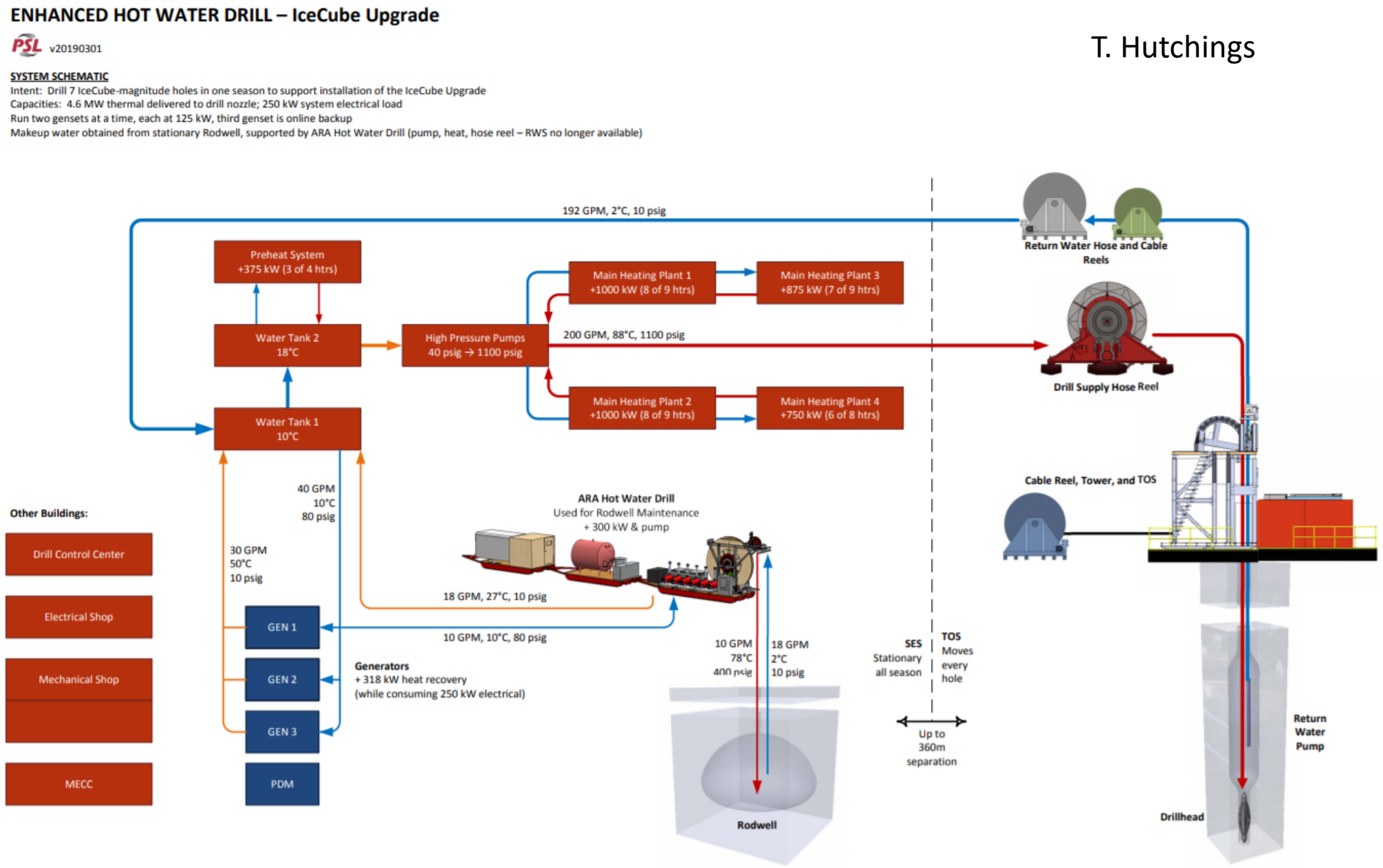
Contributions in Kind

WBS	YEAR1	YEAR2	YEAR3	YEAR4	YEAR5	TOTAL
	Total ($)	Total ($)	Total ($)	Total ($)	Total ($)	GRAND TOTAL
1.1 PROJECT MANAGEMENT	0	0	0	0	0	0
1.2. The ICECUBE UPGRADE DRILL	0	0	0	0	0	0
1.3 DEEP ICE SENSOR MODULES	$2,990,308	$2,942,536	$3,478,825	$713,016	$690,038	$10,814,723
1.4 CPT DISTRIBUTION SYSTEM	$621,185	$679,573	$605,485	$97,394	$66,229	$2,069,866
1.5 CHARACTERIZATION AND CALIBRATION SYSTEM	$187,130	$340,870	$344,690	$198,584	$202,557	$1,273,831
1.6 M&O DATA SYSTEMS INTEGRATION	0	0	0	0	0	0
Total Non-NSF	$3,798,623	$3,962,979	$4,429,000	$1,008,994	$958,824	$14,158,420


REV2 TOTAL COST ESTIMATE (2018) BREAKDOWN BY L2
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
$4,320,023
$12,186,060
$1,330,743
$10,814,723
$1,571,314
$2,069,866
$314,719
$1,273,831
$404,657
1.1 PROJECT MANAGEMENT
1.2. ICECUBE UPGRADE DRILL
1.3 DEEP ICE SENSOR MODULES
1.4 COMMS, POWER, AND TIMING (CPT) DISTRIBUTION SYSTEM
1.5 CHARACTERIZATION AND CALIBRATION SYSTEM
1.6 DATA SYSTEMS INTEGRATION
NSF
In-kind

Drill - Schematic

T. Hutchings



Configuration