Project Oversight and Processes

IceCube Upgrade Rebaseline Review
April 26-28, 2022

Farshid Feyzi
Project Manager

Outline

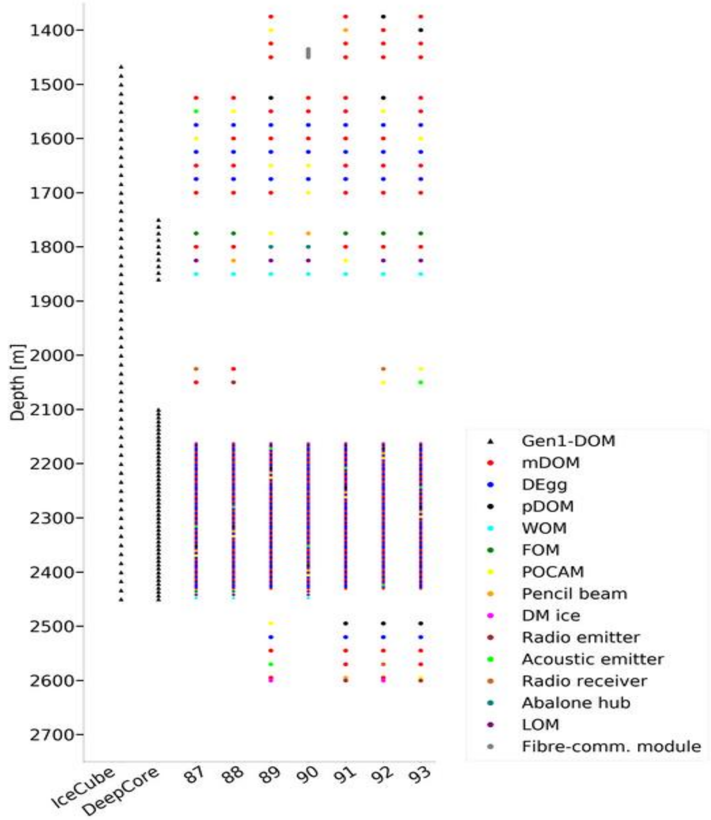
- Project baseline and configuration control
- Project work plan
- Interfaces and processes
- Reviews and oversight

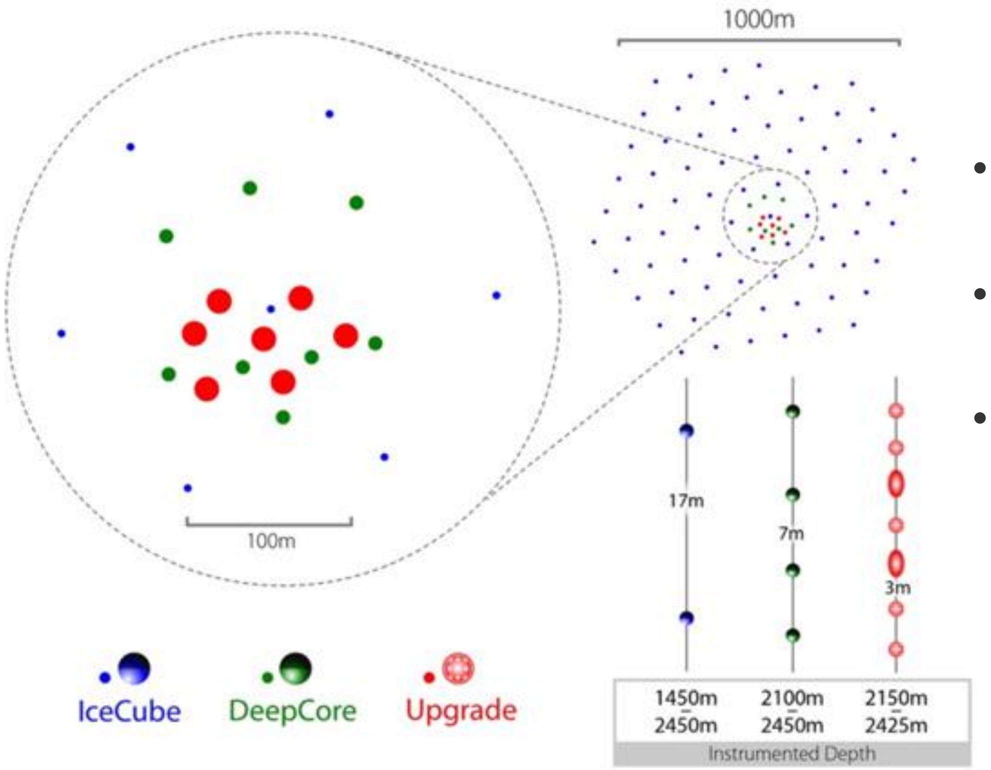
THANK YOU FOR THE REVIEW!

Brief Bio

- Farshid Feyzi, Project Manager for IceCube Upgrade since July 2019
- Previous relevant experience:
  - Project Engineer, DUNE Far Detector, Fermilab, 2018-2019,
  - Project Engineer, Accelerator Division, Facility for Rare Isotope beams, Michigan State University, 2014-2018
  - Director, Physical Sciences Lab, UW-Madison 2008-2014
  - Technical Director, PSL, 1995-2008
  - Lead design and integration engineer for CMS Endcaps 1993-2008
  - Mechanical Engineer, PSL 1983-1995 (CDF, SSC, MST…)
- Direct hands-on involvement in design, construction and installation of IceCube Gen1: modules, drill, implementation

Project Objectives Unchanged





- Location and Depth relative to IceCube Gen1
- Integrated with IceCube Lab
- Surface cables and entry into ICL same as Gen1

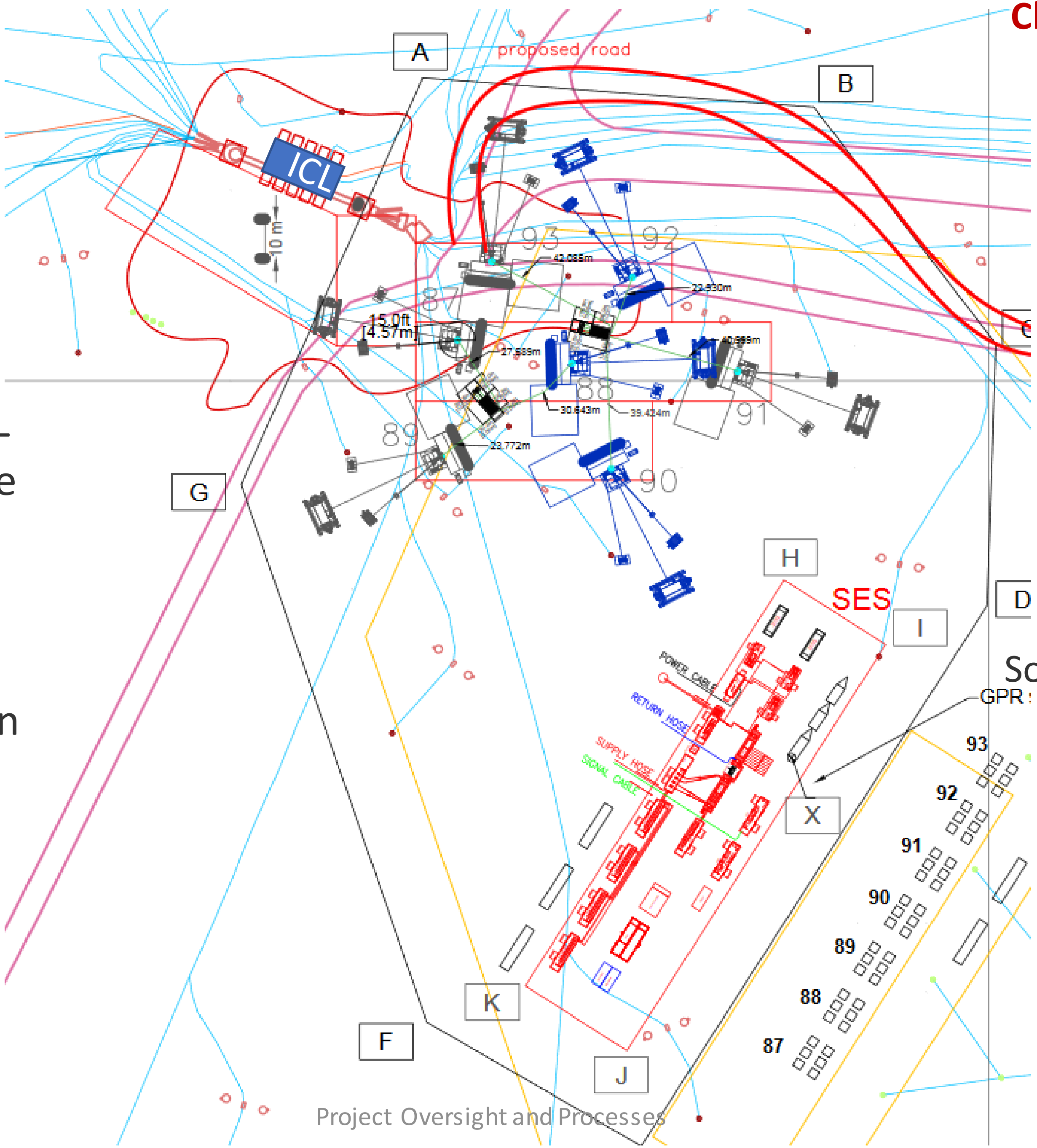
1. Neutrino Properties
2. Recalibration and Reanalysis of IceCube Data
3. IceCube-Gen2 Research and Development

} Drive Design Requirements

Surface Plan Established

Charge Question ST5, O2d

- Hole locations and surface cable paths determined
- Overall survey completed – focused survey will be done
- Drill site and sequence established
- Surface plan and is actively managed interface between project and contractor

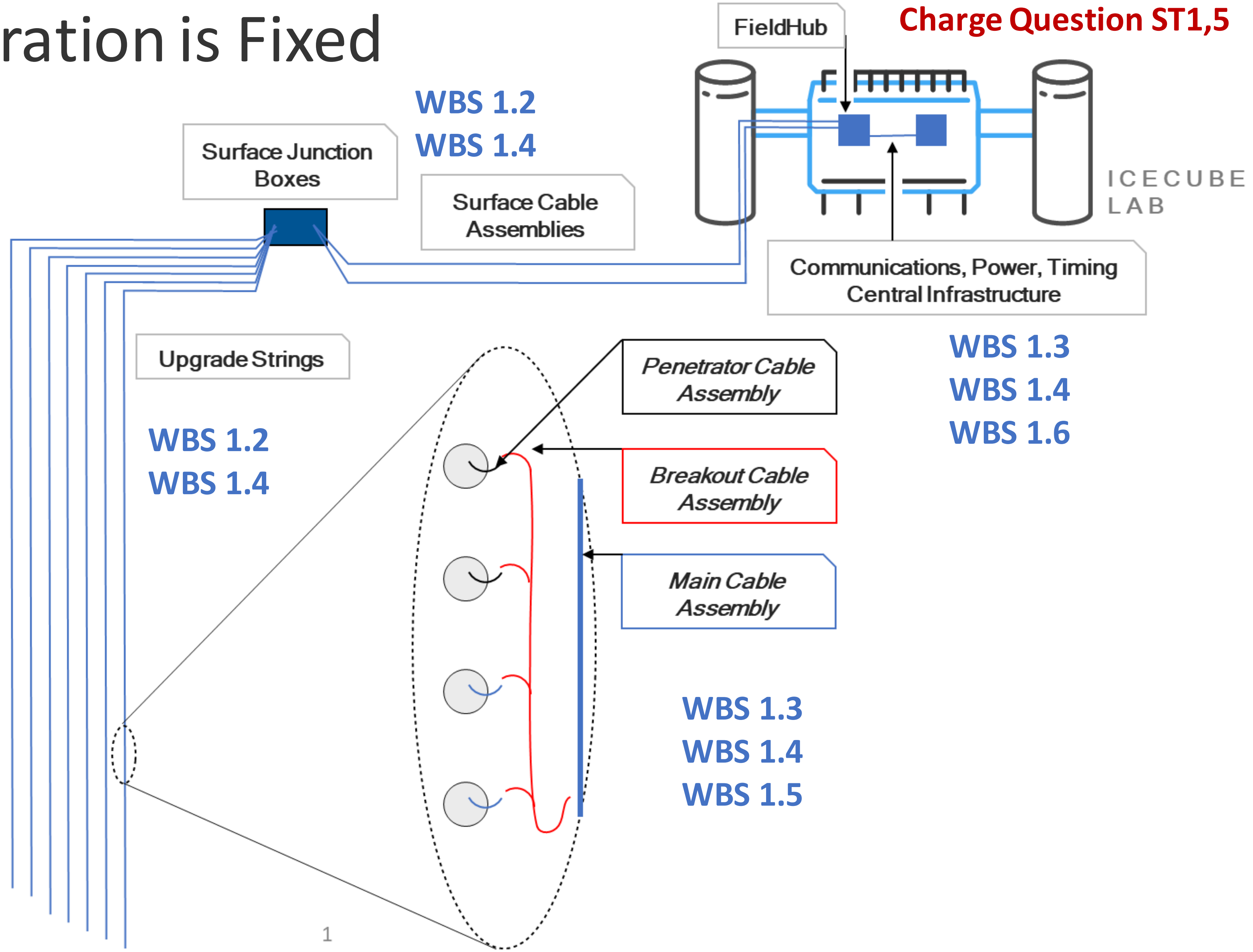


Grid North

South Pole Station

Project Configuration is Fixed

- WBS organized according to project configuration
- Each WBS area has a control account manager who is also the level 2 manager
- Interfaces are well defined and not complex
- Configuration is same as Gen 1, only difference is addition of breakout cable assembly



Overall IceCube Upgrade Work Plan Established

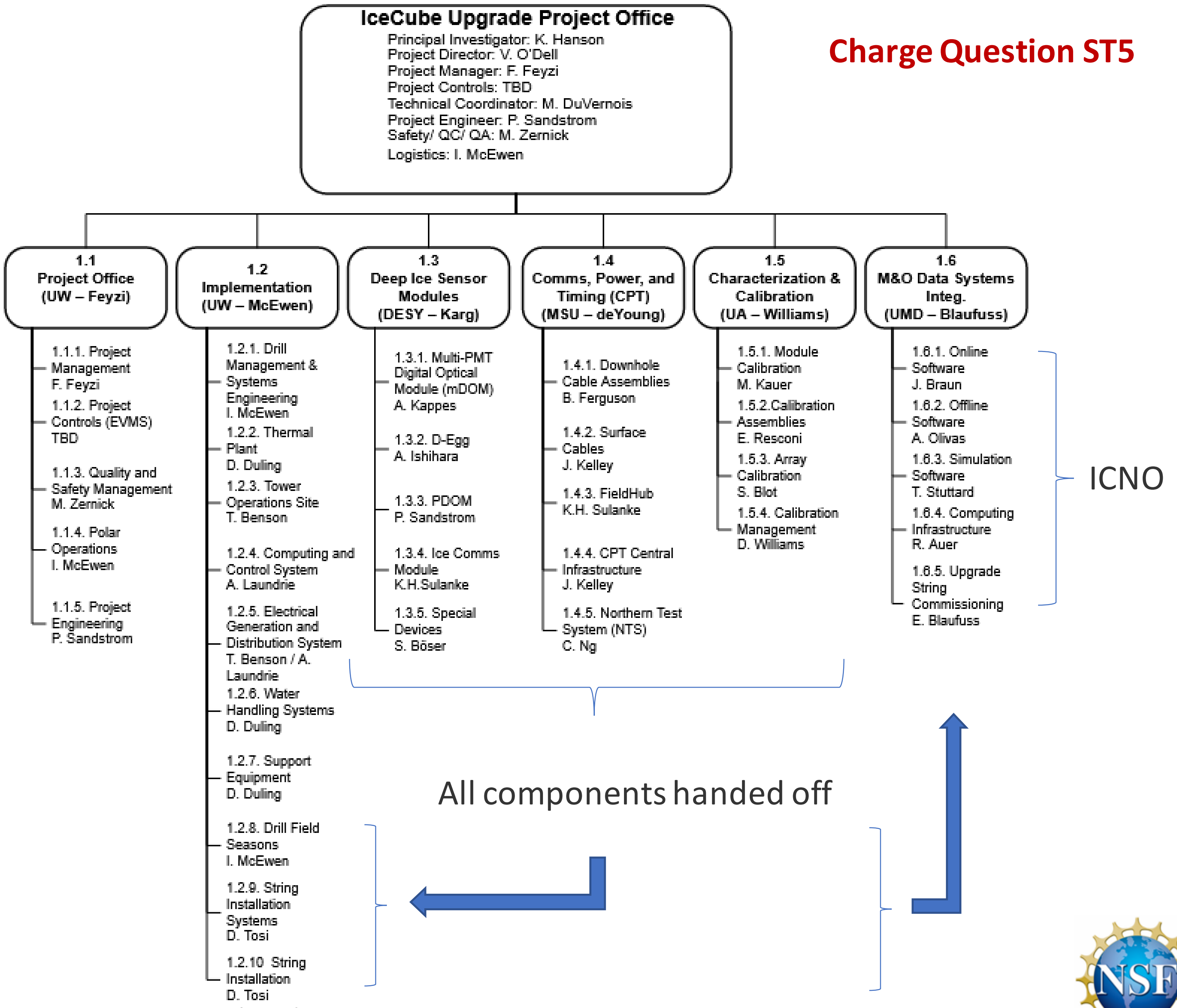
Charge Question ST2, 6

- Off-Ice work
  - Construction and testing of instrumentation and cables – nearly all contributed in kind - benefitting from strong collaboration
  - Reuse nearly all drill components from Gen1 – most are in Antarctica
  - Repair, replace and refurbish drill components – complete here and ship south
- On-ice: Five field seasons planned
  1. **2018-19:** Locate drill components and inventory – ✓**Done**, started long-lead time procurements, e.g. drill hose
  2. **2019-20:** Assessment of drill and retro what needed work off-ice – ✓**Done**, in fairly good condition, retro completed
  3. **2020-21:** Repair drill and initial test – Scheduled for **23-24**
  4. **2021-22:** Drill set up, full hot test, drill 7 firn holes, install surface cables and junction boxes– Scheduled for **24-25**
  5. **2022-23:** Drill 7 deep holes and install all instrumentation - Scheduled for **25-26**

Organization at Level 3 and Interface to Implementation and ICNO

Charge Question ST5

- WBS 1.3, 1.4, 1.5 and 1.6 are responsible for design and production of components
- Components are handed off to WBS 1.2 for installation
- WBS 1.2 is responsible for all on-ice activities including drilling and installation
- WBS 1.6 is responsible for integration in ICNO



Upgrade Project Scope Under Configuration Control

Charge Question ST1

- 7 new strings in the center of IceCube
- Instrumentation defines each string:
  - Optical modules
  - Calibration devices
  - R&D device
- Configuration of strings is determined by project objectives and is managed by Tech Board and Change Control Board

Drilling and installation sequence

Type	String	87	88	89	90	91	92	93	Total
Optical modules	mDOM	59	57	57	53	60	58	58	402
679	D-Egg	39	41	40	38	40	39	40	277
Calibration devices	pDOM	1	1	2	1	2	4	3	14
61	POCAM	2	2	5	3	2	3	4	21
	Pencil Beam (PB)	1	2	1	2	3	1	1	11
	Acoustic Module (AM)	2	1	2	1	1	1	2	10
	Swedish Camera (SWE))	1	1	0	1	0	1	1	5
R&D devices	Long Optical Module (LOM)	0	1	2	1	3	3	2	12
56	DM-ice	0	1	0	1	0	0	0	2
	Radio Pulser (RP)	0	1	1	1	0	0	1	4
	Radio Receiver (RR)	1	0	0	0	0	2	0	3
	Abalone Hub (AH)	0	0	1	1	0	0	0	2
	Wavelength-shifting Optical Module (WOM)	4	4	0	4	0	1	1	14
	Fiber-optic Optical Module (FOM)	2	1	1	0	1	1	1	7
	Fiber Test System (FTS)	0	0	0	6	6	0	0	12
Pressure sensors	Paro (PS)	1	1	1	1	1	1	1	7
ALL	ALL	113	114	113	114	119	115	115	803

Excerpt from string configuration control document

87	88	89	90	91	92	93	Depth [m]
mDOM	mDOM	mDOM	mDOM	mDOM	mDOM	mDOM	2322
mDOM	PB	mDOM	mDOM	mDOM	mDOM	SWE	2325
DEgg	DEgg	DEgg	DEgg	DEgg	DEgg	DEgg	2328
mDOM	mDOM	mDOM	mDOM	mDOM	mDOM	mDOM	2331
mDOM	POCAM	mDOM	mDOM	mDOM	mDOM	mDOM	2334
DEgg	DEgg	DEgg	DEgg	DEgg	DEgg	DEgg	2337
mDOM	mDOM	mDOM	mDOM	mDOM	mDOM	mDOM	2340

Configuration Management

Charge Question ST5, M3

Configuration Management Plan
2019-007.2

Document Control

- Requirements
- Document Content
- Document Management Procedures
- Approval and Release
- Distribution
- Document Control Systems

Hardware Control

- Control of Hardware Documentation
- Assembly Drawings
- Assembly Procedures
- Bill of Materials
- Hardware Configuration Database
- Installation

Software Control

Hardware Documentation:

- Configuration management document (CMD) - links the hierarchy of configuration items and BOMs for bottom level configuration items.
- Engineering requirements document (ERD) - details the engineering requirements, and often how a requirement hooks to science requirements, how a requirement is verified, and how a requirement is set.
- Interface definition document (IDD) - covers the interfaces (electrical, mechanical, optical, etc.) between a given configuration item and any other configuration items affected
- Design status document (DSN) - within a presentation format, contains the status of the design, photos of parts, and links to manufacturers and software repositories as needed, and it generally forms an evolving repository of documentation of the design process of the individual configuration item

Design Process and Flow

- Applies to all Upgrade items identified as key by the Technical Coordinator and Project Engineer in the Upgrade Detector
  - Conceptual Design – A conceptual design is a plausible set of ideas which can reasonably meet the requirements. There are likely sketches, drawings, previous similar pieces of equipment, and/or prototyped subsystems for this design.
  - 4.2 Preliminary Design – A preliminary design is a reasonably well documented prototyped design which either meets the requirements or has a plausible development path to meeting any requirements not yet met. Drawings exist for the prototype and the interfaces between this system, and others are understood and agreed on.
  - 4.3 Final Design – A final design is a well-documented item which is complete, meets requirements, has an agreed interface to other systems, defined testing plans, and a method of mass production. Drawings are in place in the production folder and costs to construct are based on quotations.
- The Upgrade Technical Coordinator is responsible for guiding staff through all of steps needed to exit design stages

IceCube Upgrade Item Design Flow 2020-002.0

Description of Instrumentation Design Deliverable	Work Product	to exit Conceptual Design, you need below	to exit Preliminary Design, you need below	to exit Final Design, you need below	to exit Production Readiness, you need below	Comment
Description	DSN and CMD	Initial	Update	Complete		
Requirements	ERD	Initial	Update	Complete		
Block Diagram	DSN	Initial	Update	Complete		show interfaces
Mechanical Drawings	DSN	Initial	Update	Complete		integrate with Bill of Materials if possible
Schematic Circuit Diagrams	DSN	Initial	Update	Complete		if applicable
Circuit Board Layout	DSN	Initial	Update	Complete		if applicable
Bill of Materials	DSN	Initial	Update	Complete		integrate with Mechanical Drawings if possible
Interfaces Identified	IDD	Initial	Update	Complete		
Verification Plan / Report	VDR	Initial	Update	Complete		
Investigate alternatives, rationale for design	DSN	Initial	Complete			
Risk Assessment	Risk Register	Initial	Update	Update	Update and current	Document changes throughout lifetime of product, apply to project
Conceptual Design Review meeting	**SharePoint Review Meetings folder**	**completed Internal Review**				**Exit to Preliminary Design with CDR 'approval' or Skip review and proceed to Preliminary Design with L2 / CCB OK**
Integration Procedure	Integration PCR		Initial	Complete		must include materials, tools, process, training
Test Plan	Test PCR		Initial	Complete		must include materials, tools, pass/fail criteria, process
Shipping Procedure	Shipping PCR		Initial	Update	Update and complete	must consider all transport modes for delivery
Installation Procedure	Installation PCR		Initial	Complete		if needed
Production Plan	DSN		Initial	Update	Update and complete	include labor, sites, rate, equipment, capacity, bottleneck indentificaiton, shipping plan, metrics identification
Procurement Plan	DSN		Initial	Update	Update and complete	
Prototype - Rev 0	actual unit that can be evaluated		Initial			
Preliminary Design Review meeting	**SharePoint Review Meetings folder**		**completed Internal Review**			**Exit to Final Design with PDR 'approval' or Skip review and proceed to Final Design with L2 / CCB OK**
Prototype Yield	DSN			Initial	Update	if applicable, include failure analysis, pareto chart, actions to fix
Prototype - Rev 1 or more	DSN			Update	Update	if needed
Hazard Analysis	Right now, no template available yet.			Initial	Update and complete	if needed
Final Design Review meeting	**SharePoint Review Meetings folder**			**completed Internal Review**		**Exit to Production Readiness with FDR 'approval'. All key instrumentation MUST have an Internal Final Design Review.**
Production Readiness Review meeting	**PRR template + SharePoint Review Meetings folder**				**completed Internal review**	**Exit to Production / Procurement with PRR 'approval'**

Change Control and Approval Process

ICECUBE UPGRADE

Configuration Management Plan
2019-007.2

- Project Change Request Process
  - Applies to both technical and programmatic changes
  - Level of approval is per change class as shown
- Project Change Control Board (CCB)- Meets weekly as part of L2 meeting
  - The CCB is chaired by the PM and consists of the technical coordinator, the project engineer, the quality and safety manager, the project controls manager, the L2 managers, the IceCube associate director for science and instrumentation, and the PD. The PI is an ex-officio member.
  - The CCB is an executive decision-making body convened when the level of a proposed change to the budget, schedule, or scope of the project demands approval of this body as defined in the Configuration Management Plan.
- Project Tech Board (TB) – Meets weekly
  - The technical board is chaired by the technical coordinator and includes the Level 2 and Level 3 managers and technical support staff. The PI, PD, and IceCube Collaboration spokesperson are ex-officio members.
  - The technical board meets once per week, via conference call, to discuss project progress, problems, interfaces, potential changes, risk and risk mitigation strategies, and technical requirements, and in person as needed.
  - The technical board also provides recommendations to the change control board and maintains the technical issue tracker.

Change Class Table

Class of Change	Class 1	Class 2	Class 3
Types of Change	• Project purpose or goals • Total Project cost (>/= $150K) • NSF milestone	• Project Technical Baseline • Performance Requirements • WBS Level 2 cost • Project Office milestone • Interfaces • Safety • Quality • Contingency Funds • Reliability	• WBS Structure below Level 3 • Does not affect form, fit or function • WBS Level 3 cost • Subsystem milestones • Does not cross interfaces or WBS elements
NSF Approval?	YES	NO	NO
Approval Signatures	Project Manager L2 Originator QA	Project Manager L2 Project Engineer Originator QA	L2 Technical Lead/Engineer Originator QA
CCB Approval?	YES	YES	NO
Tech Board Approval?	YES	YES	YES

Partnerships and Contributions in Kind- Remain Firm and on Track

Charge Question ST7

Non NSF-Funded Institutions			Funding Agency
DESY – Zeuthen, Germany	Level 2 management WBS 1.3	mDOM production, data acquisition electronics, cables, ICMs	Helmholtz Association of German Research Centers
Karlsruhe Institute of Technology		Photomultiplier tubes (PMTs) acquisition	Helmholtz Association of German Research Centers
Universität Münster, Germany	Level 3 management WBS 1.3.1	mDOM mechanical design and integration	Federal Ministry of Education and Research-Germany
Tech. Univ. of Munich, Germany		Precision Optical Calibration Module (POCAM)	Federal Ministry of Education and Research-Germany, TUM
Sungkyunkwan University, South Korea **University of Utah**		In-module camera system	National Research Foundation of Korea University of Utah
Chiba University, Japan	Level 3 management WBS 1.3.2	Optical sensors, D-EGG design, integration, and production	Japan Society for the Promotion of Science (JSPS), Ministry of Education, Culture, Sports, Science and Technology (MEXT)
Michigan State University	Level 2 management WBS 1.4	main cables, mDOM production	Michigan State University
Rheinisch-Westfälische Technische Hochschule Aachen		PMT characterization and acceptance testing, Acoustics Modules, Mini-Mainboard	Federal Ministry of Education and Research-Germany
Technische Universität Dortmund		PMT characterization and acceptance testing,	Federal Ministry of Education and Research-Germany
Friedrich-Alexander-Universität Erlangen-Nürnberg		mDOM optical FAT design and test stand	Federal Ministry of Education and Research-Germany
Uppsala University **Stockholm University**		Surface cables, prototype main cable Sweden Camera 2.0 System (standalone camera module)	Swedish Research Council
University of Mainz		Flasher production for the mDOMs, WOMs are	Federal Ministry of Education and Research-Germany
University of Wuppertal		mDOM mechanical design and integration	Federal Ministry of Education and Research-Germany

Project Plan Outline and NSF Oversight- Baseline and Re-baseline

Charge Question S5

2018CY			2019CY												2020CY												2021CY												2022CY												2023CY								
2019FY												2020FY												2021FY												2022FY												2023FY											
Upgrade PY1												Upgrade PY2												Upgrade PY3												Upgrade PY4												Upgrade PY5											
10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
												1					2								3				4								5				6			7a			7b						8						9
Start	Equip. Invent. Done												Drill Assess Done												Drill Repair cancel												Drill Hot Test, Firn Drill 7 holes												Drill and install 7 strings cancel										Finish

- Review and oversight dates shown as numbers:
  - Reviews 1, 2 ,and 3 were done per plan
  - Review 4 was done in the context of rebaselining last year
  - Review 5 was done as a full logistics review to define support plan
  - Review 6 is being done now as rebaselining review
  - Reviews 7a and 7b are readiness to deploy and will be postponed to 2025
  - Review 8 and 9 were closeout and will be postponed to 2026

NOW

New Plan

FY2022												FY2023												FY2024												FY2025												FY2026											
10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
	5					6							7					8							9					10							11				12				13a		13b							14					
																									Drill Repair Season												Drill Wet Test, Firn Drill 7 holes												Drill and install 7 strings					FINISH					

NOW

ICECUBE UPGRADE

NSF External Panel Upgrade Logistics Review Nov 2021

- A logistics review was held to focus on field support requirements
- Cargo Planning methodology integrated with shipping methods and capabilities was developed and reviewed in detail
- Cargo Master Spreadsheet developed which identifies schedule float and is in synch with deliverables from all institutions
- The logistics planning methods for Upgrade are now more advanced than Gen1 was – good model for other projects
- Review focused on many other aspects of project in addition to logistics, i.e. cost, schedule, project tools, and helped get ready for this review
- Recommendations and findings status in backup
- Contractor support requirements were developed and integrated with AIL plans
- Contractor activities integrated in the project schedule

Support Plan Received in January 2022

ICU Planning Capacities
OPP-AIL, 1/31/2022

Year	FY23	FY24	FY25	FY26	FY27
Vessel South (TEUs)	18*	as needed	as needed	n/a	n/a
Vessel North (TEUs)	n/a	17	50	17	50
LC-130: Hours/Flights^	12/2	114/19	60/10	42/7	36/6
SPoT-1 (Sleds/Weight, lbs)	3/180,000	3/180,000	3/180,000	3/180,000	3/180,000
SPoT-2 (Sleds/Weight, lbs)	3/180,000	3/180,000	3/180,000	3/180,000	3/180,000
SPoT-3 (Sleds/Weight, lbs)	3/180,000	3/180,000	3/180,000	3/180,000	3/180,000
Pole Population (Nov-Jan)	0	11	21	46~	4

*If ICU needs more space to move things ahead, we will find a way to make more TEUs available.

^This does not fully meet the goal to have all fuel required on site prior to the FY26 main drilling season. AIL will continue to look at ways to mitigate that risk as planning moves forward.

~This is a hard maximum and needs to be reviewed again for ways to bring it down if at all possible.

In general:

1. Our supportability is dependent on moving as much cargo to Pole as possible in FY24. This means getting as much cargo on the FY23 vessl or, if needed, getting it to MCM via commercial surface shipment/C17 no later than Nov. 2024.
2. FY27 info is provided in advance of IPT discussion/clarification on retro requirements.
3. Temperature controlled storage (at MCM and Pole) is likely still an issue that needs to be resolved with this capacity.

- Great news for project!!!
- Allowed for planning project schedule and developing rebaseline cost estimate
- Allows for full planning of cargo and population
- Full engagement in place between project and AIL to plan on-ice work and contractor support

Conclusion

- IceCube Upgrade is a construction project and was directly impacted by the pandemic
- All three critical field seasons have been cancelled and parts availability has delayed many aspects of the project apart from field seasons
- A three year delay is necessary for the completion of the project
- Despite the pandemic, project has made excellent progress owing to a strong collaboration, international partners and experienced and dedicated teams
- NSF has given the project field season support plans for three seasons that are consistent with requirements – great news! We are planning accordingly and are energized
- The level of planning for on ice work and is much more advanced now – support contractor activities included
- Logistic plans are much more advanced now and much better than Gen1 – recommended as model
- Prospects for completion are excellent due to the expert team and level of support from NSF!

Backup Slides

Status of critical systems

In-ice modules

- D-Egg: Passed FDR. All modules completed. Final Acceptance Testing starts this month
- mDOM: FDR done this month. Production begins afterwards. Some parts are difficult to procure.
- POCAM: Passed FDR. Awaiting common parts delivery.
- Pencil Beam: Passed PDR. Final review expected in late 2022.
- pDOM: Work to begin late 2022.

Other components

- ICM/FieldHubs: Passed FDR. Common to all in-ice devices.
- Mini-Mainboard: Passed FDR. To support R&D and Calibration modules. Some parts issues.
- Main cables: MSU-Vendor work ongoing. FDR in Summer 2022.
- Cable entry logistics: Evaluated at South Pole in 2019. Full plan for installation. Shipping in 2022.
- Drill control system review done this month

Recommendations from Logistics Review

Charge Question L1

Recommendation	Responsible	Status	Last update 4/7/2022
Project team should perform their own schedule analysis using the 10 Best Practices for a high-quality and reliable schedule discussed in the GAO Schedule Assessment Guide (GAO-16-89G) for guidance and deliver their self-assessment to NSF at their next project review	Vivian O'Dell / Contractor	Closed	Schedule cleanup performed to implement GAO best practice
Produce a graphic that shows all planning tools being used and how they feed and/or link with each other. Additionally, identify who is the single point of contact and/or manager for each planning tool and its roll-up destination.	Vivian O'Dell / Contractor	Closed	Produced document that has all of this information.
Consider mechanization of cable pulling operations up the ICL towers to reduce labor and potential for injury.	John Kelley	open	John will work with ASC for this. Needs to be resolved in time for the year before deep drilling. (in principal year 2 in a 3 FS project
Research potential advantages of heating the cables in the area where they enter the ICL towers to make snaking them from the snow trench into ICL easier.	John Kelley	open	See above. Need a comprehensive plan for cable pulling with ASC.
Give serious consideration to splitting shipments of the two Conex vans of D-eggs into two carriers to reduce potential impacts of an accident with one.	Aya Ishihara, Ian McEwen	open	Will look into shipping separately
Extend tolerance or recommended alternate location for GPR scan of proposed nine firn holes and cable trenches to CRREL and define the level of fidelity needed.	Delia Tosi	open	Will provide a plan to CRREL and survey crew by August 2022 That includes extended tolerance of hole placement and recommendations for alternate sites.
Planning should identity the schedule float that exists between the earliest and latest dates when deliverables must be ready to enter the USAP logistics system. Add a float column with conditional formatting (red, yellow, green; based on number of days) in the cargo spreadsheet.	Vivian O'Dell /J Lowe/Ian McEwen/Delia Tosi	Closed	Float calculations are now included in the Cargo Master as Shipment Float & South Pole Float. Total time between Shipment and need by date at South Pole is calculated additionally.
Include recording accelerometer in sample packaging for first available South Pole Traverse to get a sense of the potential for shock and vibration damage during shipment using the traverse.	Terry Benson	In progress	Developed plans to include data loggers on 2 traverses (SPOT1 & SPOT2). Package shipments are in the FY23 cargo plan. Research into commercially available accelerometer loggers is underway.
Activities planned for the same construction season should be prioritized before the start of the season to ensure resources are applied to the most critical activities should delays begin to be experienced.	Dar Gibson, Ian McEwen	Closed	Field season activities have been prioritized and planned in detail for all three field seasons. They will be reviewed and further optimized prior to each field season.
Drilling activities in the schedule should be broken down into smaller duration activities to allow for better visibility of the entire drilling process and to allow planned efficiency when staff are expected to move from one hole to the next.	Dar Gibson, Terry Benson	Closed	Drilling activities have been broken down. Relocation from hole to hole has also been inserted in the schedule
Drilling activities should include some buffer time to allow for inefficiencies experienced at shift changes and mid-day breaks.	Dar Gibson, Terry Benson	Closed	Buffer time has been built into the schedule by adding time between end of predecessor activity to start of successor activity

Recommendations from Logistics Review

Charge Question L1

Recommendation	Responsible	Status	Last update 4/7/2022
The Excel spreadsheet that was provided as an output from Smartsheet showed that generic resources are applied for tasks occurring in the same time period. EN and TE are the two most common resource types. With multiple activities occurring during the same time frame that use EN and TE resources it is not possible to determine if the planned staffing is over or under allocated. This can be solved by creating unique resource names (SHFT1_ENG, SHFT1_DRL, SHFT1_HOS, SHFT2_ENG, SHFT2_DRL, etc.). This may provide for a better analysis of resource loading and population planning.	Contractor	Closed	Resource tags have been expanded to allow for better visibility and analysis. Electrical Engineer (EN-EE), Mechanical Engineer (EN-ME), and Safety Engineer (EN-S) are now sorted in Smartsheet hours reports.
The risk register should include both technical risks and programmatic risks. An analysis of the risk register should include looking for pairs of risks that are correlated (i.e., if Risk A happens, then the probability of Risk B increases).	Vivian O'Dell/Farshid Feyzi	Closed	Risk Register includes both technical and programmatic risks. Risk workshop conducted with all L2s in January. Correlated risks have been identified and analyzed
Improve documentation overall; and including documentation pertaining to (1) on-site personnel needs and (2) spares especially in the context of risk assessment	Vivian O'Dell/Farshid Feyzi/Ian McEwen/Delia Tosi	In progress	Document updated are in progress. Safety and quality plans and risk mitigation plans are being revised. New documents for project management have been developed.
Consider risk mitigating scenarios within forthcoming logistical support guidance. Shallow drilling with the FS2 team, reducing the number of strings, or reducing the number of DOMs per string have been mentioned.	Mike DuVernois, Farshid Feyzi, Ian McEwen	Closed	Have studied the effects of reducing the number of strings in a scoping document. Have also worked with AIL on the logistics needs and availability.
Develop the software toolset to meet the requirements of an integrated master schedule including linkages and dependencies	Jim Lowe	Closed	Have made a new bottom up estimate of cost and schedule, including dependencies and linkages.
Provide better visualization such as float associated with tasks and cargo	Jim Lowe, Ian McEwen	In progress	Float calculations are now included in the Cargo Master as Shipment Float & South Pole Float. Total time between Shipment and need by date at South Pole is calculated additionally.
Further develop the on-ice safety plan considering a safety lead at each drilling location	Mike Zernick	Closed	The plan has been developed and will be presented during the reviews by MAZ.
Refine quality control / assurance processes for packing/shipping	Ian McEwen, Delia Tosi, Mike Zernick	Closed	Quality assurance processes for packing and shipping are being updated and incorporated in the logistics plans. A Pre-Shipping Quality Checklist has been developed.

NSF External Panel Review March 2021

- External panel review was conducted March 16-18, 2021
- The objective was to evaluate various rebaseline scenarios based on different assumptions of field season support
- Project presented its case for rebaselining and cost estimates for all scenarios
- Project received endorsement for rebaselining at full scope
- None of the rebaseline plans were approved due to continued uncertainty in the level of possible field season support (a separate review to focus on field seasons was ordered by NSF)
- Additionally, continued limitations due to the pandemics caused further delays in procurement and construction in most technical areas
- Despite that, the project has made excellent progress and is poised to finish in the 8-year plan

Key Points from March 2021 Review Report

The science enabled by the IceCube Upgrade is essential for expanding the reach to lower neutrino energies, improve precision, and significantly improves the understanding of the properties of the ice.

The Upgrade project team has shown excellent performance in carrying out the proposed tasks during the first two years of the project and preparing for the third year activities at the South Pole.

The project cannot be completed as planned and must be re-baselined....NSF work with the project to devise a plan that maximizes the opportunity to continue the project in the near term while additional funding is pursued.

The comprehensive and detailed presentations by the project team clearly demonstrated the importance of completing the project in the shortest time frame allowed.

...scenarios defined in the charge were reviewed....well thought out and could be executed given adequate funds.

The panel recommends that a crew of at least four be deployed to the South Pole this coming season...

Project Personnel

- Each WBS area is responsible for recruiting and maintaining expert personnel per work plan
- Personnel supported by contributions in kind are not on the NSF award and not accounted, this constitutes bulk of WBS 1.3,1.5 and1.6
- WBS 1.4 are mostly at MSU and on NSF award
- WBS 1.2 personnel are nearly all from Physical Sciences Lab and are on NSF award, also I. McEwen and most of d. Tosi
- Project Office personnel in WBS 1.1 are as shown and are on award

Person	Title	WBS	Duties	FTE
Kael Hanson	Principal Investigator	1.1.1	Overall responsible for project scientific and technical scope.	0.15
Farshid Feyzi	Project Manager	1.1.1	Manage project scope and budget, award management.	1.00
Greg Sullivan	UMD Inst. Lead	1.1.1	Oversee UMD subaward.	0.04
Doug Cowen	Co-PI / PSU Inst. Lead	1.1.1	Oversee PSU subaward.	0.04
Jim Lowe (interim)	PMCS	1.1.2	Project cost, schedule and controls.	1.00
Laura Mercier	PMCS	1.1.2	EVMS reporting; subaward management; award compliance.	0.4
Mike Zernick	Quality & Safety Manager	1.1.3	On-ice and off-ice safety lead. Quality lead, change control.	0.75
Mike DuVernois	Technical Coordinator	1.1.4	Project scientific and technical management; Technical Board chair.	0.5
Perry Sandstrom	Project Engineer	1.1.4	Project system engineering; owner of engineering configuration management	0.5
Delia Tosi	Installation Manager	1.1.5	Responsible for installation of optical modules and associated instrumentation.	0.25

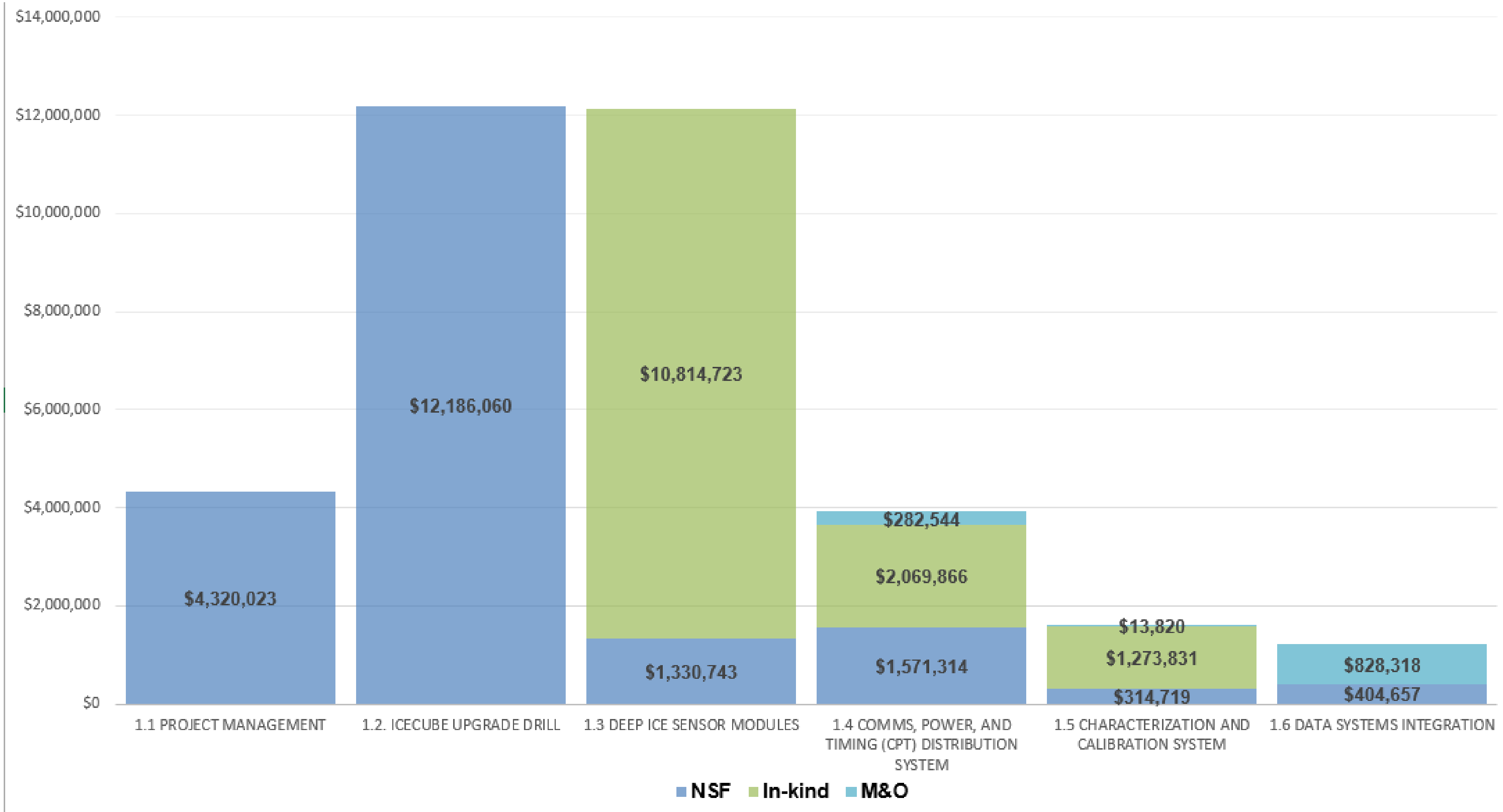
Contributions in Kind Original Estimate

MANAGED BY COLLBORATING INSTITUTIONS

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

Baseline Funding by WBS

Charge Question O4, C4



Project Baseline
NSF Funding Profile in Cooperative Agreement

	Baseline	Contingency	Total	Project Year	
FY19	$4,066,527	$664,979	$4,731,506	1	Funded
FY20	$5,130,419	$575,002	$5,705,421	2	
FY21	$3,641,504	$362,229	$4,003,733	3	
FY22	$3,604,047	$464,748	$4,068,795	4	Funded as stand-alone to allow for continued work while rebaselining
FY23	$3,685,016	$788,853	$4,473,869	5	
Total	$20,127,513	$2,855,811	$22,983,324		

Charge Question C1,5

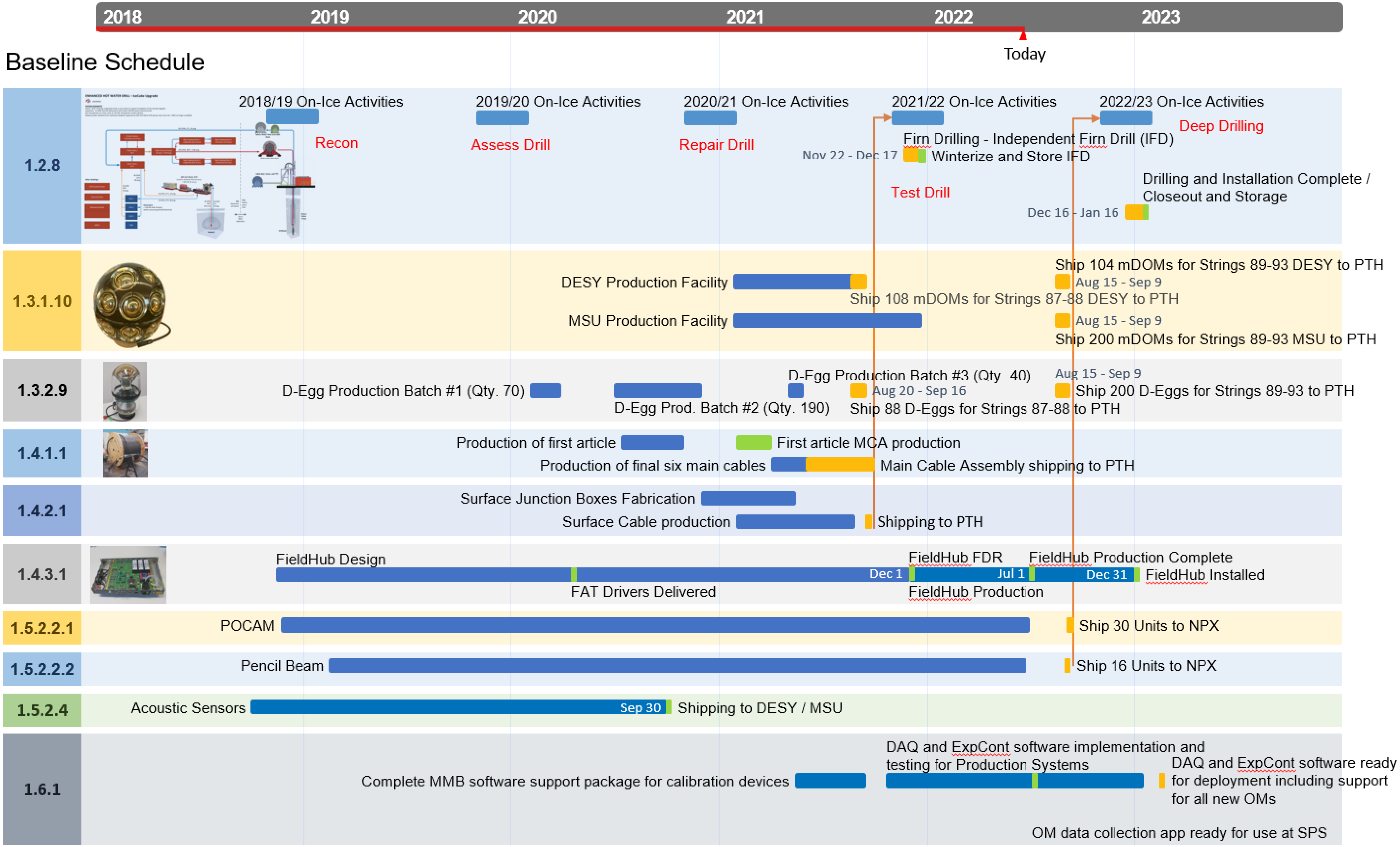
Project Cost

- Total project cost estimated for the baseline and rebaseline are compared below
- Baseline is per cooperative agreement, PY1, 2, 3, 4 funded
- Rebaslined is per bottom-up estimated and included PY1,2,3 actual cost and PY4 estimated cost

	PY1	PY2	PY3	PY4	PY5	Total
Baseline estimate (w/o contingency)	$ 4,066,527	$ 5,130,419	$ 3,641,504	$ 3,604,047	$ 3,685,016	$ 20,127,513
Contingency	$ 664,979	$ 575,002	$ 362,229	$ 464,748	$ 788,853	$ 2,855,811
Total cost with contingency	$ 4,731,506	$ 5,705,421	$ 4,003,733	$ 4,068,795	$ 4,473,869	$ 22,983,324

	PY4	PY5	PY6	PY7	PY8	Total
Rebaseline estimate (w/o contingency)		$ 4,769,325	$ 3,774,471	$ 3,799,270	$ 2,383,917	$ 14,726,983
Anticipated actual cost PY1 thru PY4	$ 17,426,108					$ 17,426,108
Total rebaseline (w/o contingency)						$ 32,153,091
Cost uncertainty		$ 683,102	$ 487,010	$ 419,023	$ 259,733	$ 1,848,869
Risks MC(80%)		$ 620,414	$ 620,414	$ 620,414		$ 1,861,241
Total contingency to go						$ 3,710,110
Total with contingency						$ 35,863,201
Contingency on cost to go						25.2%

Baseline Schedule



Drill - Schematic

ENHANCED HOT WATER DRILL – IceCube Upgrade

PSL v20190301

SYSTEM SCHEMATIC

Intent: Drill 7 IceCube-magnitude holes in one season to support installation of the IceCube Upgrade
Capacities: 4.6 MW thermal delivered to drill nozzle; 250 kW system electrical load
Run two gensets at a time, each at 125 kW, third genset is online backup
Makeup water obtained from stationary Rodwell, supported by ARA Hot Water Drill (pump, heat, hose reel – RWS no longer available)