

# Gen2 Project: Current Status and Focus

Vivian

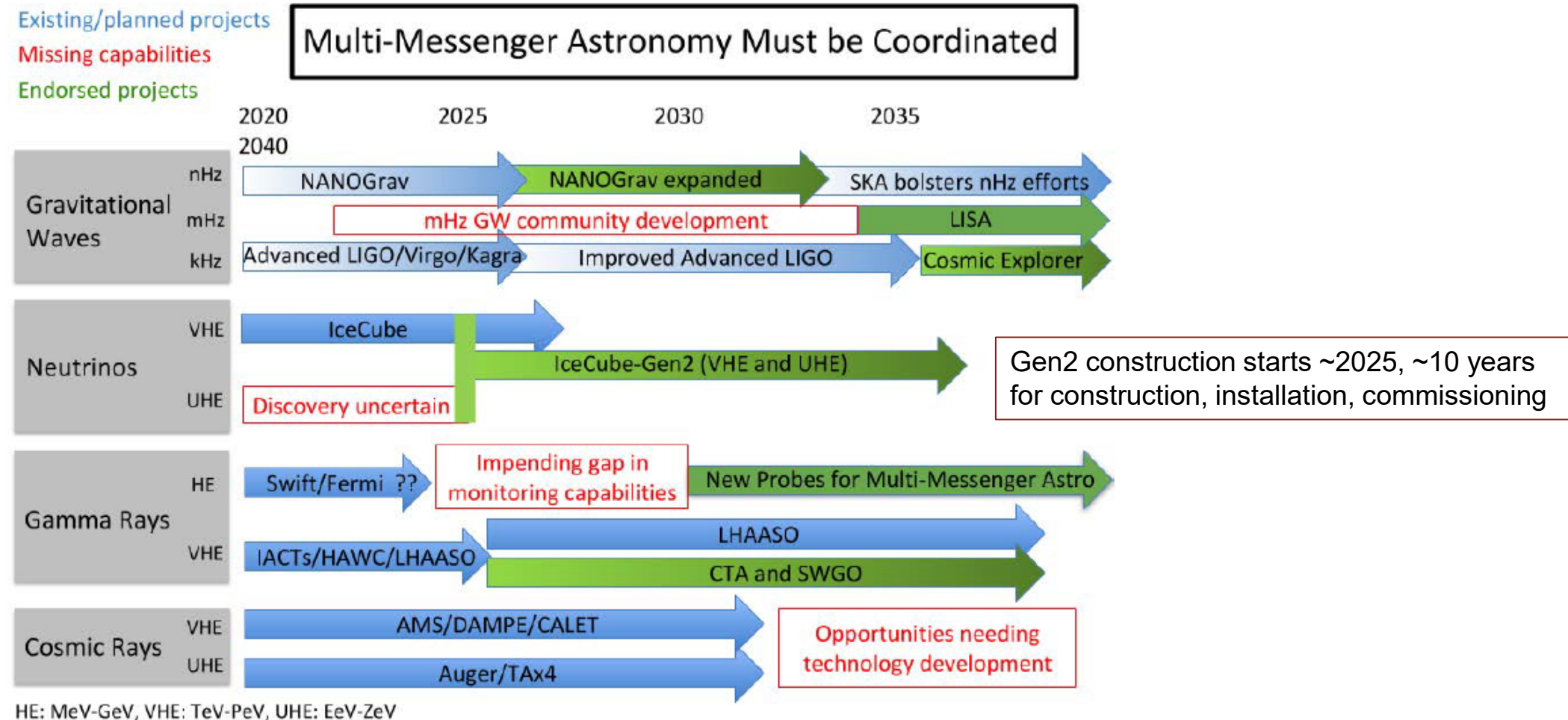
11/10/2021



ICECUBE  
GEN2

# Project Schedule (big picture)

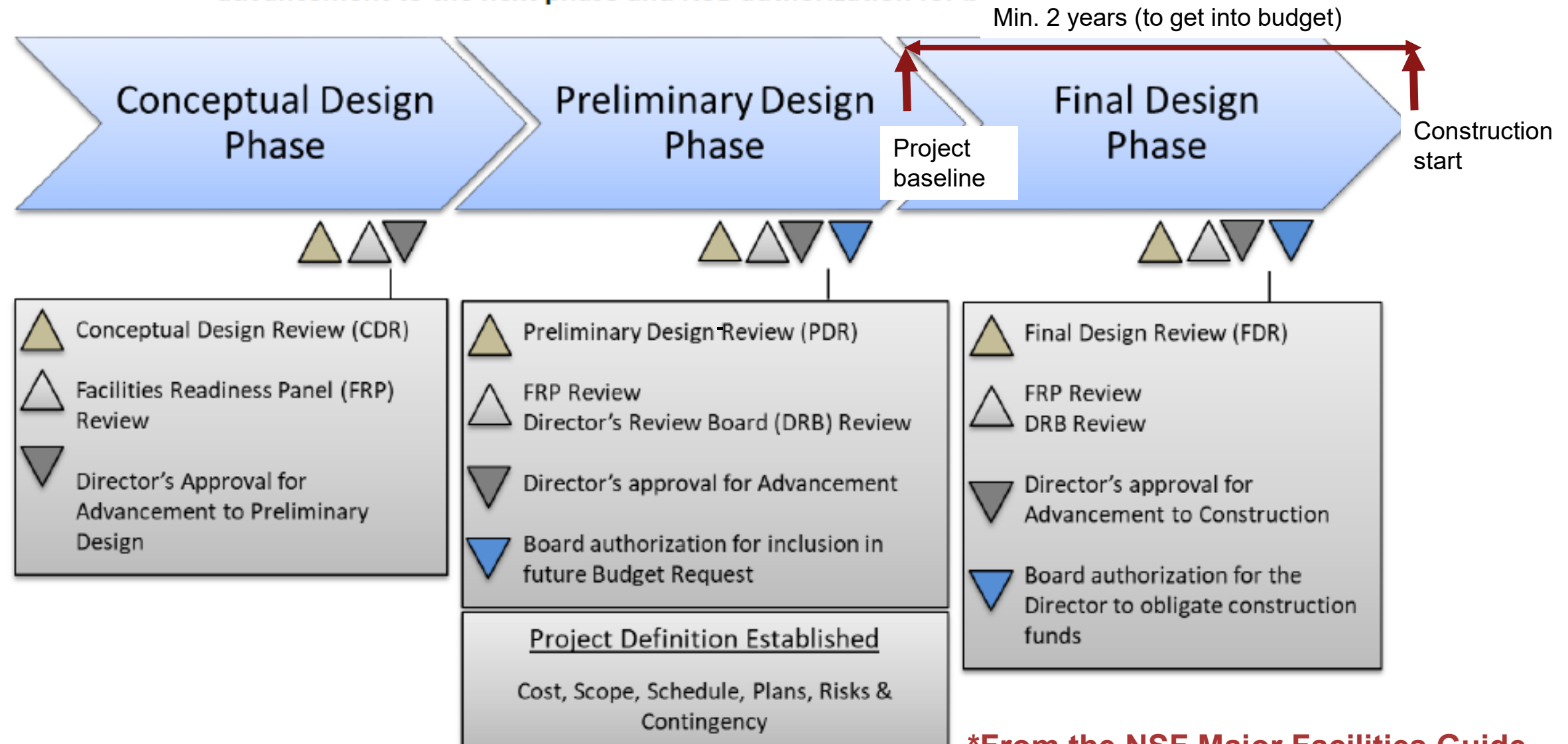
# Construction Schedule from Astro2020 (PAG)



**FIGURE L.4** Schematic high-level view of capabilities in different messengers over decades (blue: existing or planned, red: missing capabilities, green: endorsed new projects, dated by construction starts). Gradient shading indicates projects that can start taking data as construction proceeds. Not shown are many promising potential projects for which technology development is needed. With each messenger, the discovery prospects are outstanding; with multi-messenger observations, they could be transformative.

# Schedule and MREFC process\*

Figure 2.1.3-2 Progressive Phases within the Design Stage, showing review and decision points for advancement to the next phase and NSB authorization for budgeting and award.



# From the NSF Major Facilities Guide

Figure 2.1.4-1 Summary Timeline for Major Facility Projects (Development and Design)

Try to get planning/development  
\$\$ after CDR

	Development	Conceptual Design Phase	Preliminary Design Phase	Final Design Phase
	Preconstruction Planning Funded via R&RA and FHR funds			
Budget evolution		Develop construction budget based on conceptual design Develop budget requirements for advanced planning Estimate operations costs	Expend ~5-25% of construction cost on planning & design activities Construction estimate based on preliminary design Update operations cost estimate	Final design over approximately 2 years Construction-ready budget & contingency estimates Update operations cost estimate
Project evolution	Initial ideas emerge	Formulate science goals: define requirements, prioritize, review	Proponents development strategy defined in Project Development Plan	
	Broad science community consensus built for potential long-term needs, priorities, and general requirements High level concept developed	Develop conceptual design identify critical technologies, high risk items Formulate initial risk assessment Develop top-down parametric cost and contingency estimates Initial proposal submission to NSF Initial Project Execution Plan (PEP)	Develop site-specific preliminary design, environmental assessments/ impacts (NEPA) Develop enabling technologies Bottom-up cost and contingency estimates, updated risk analysis Develop Project Management Control System Develop preliminary operations cost estimate Update PEP	Develop final construction-ready design & PEP Verify key technologies are ready for production or detailed production design Refine bottom-up cost and contingency estimates Finalize Risk Assessment & Mitigation, Management Plans Complete key staff recruitment
		Areas to be addressed in Technical Design Report	Revised Project Execution Plan, Detailed Schedule, Budget	Revised Project Execution Plan, Revised detailed schedule, budget

Astro2020



# So putting together these dates...

- Technical Design Report (early-mid 2022).
  - Should precede CDR and will be used as input to Project Execution Plan.
- NSF Conceptual Design Review (mid-late 2022)
  - All documentation should be there. The cost/schedule would be less precise than the project baseline, but should give confidence that we know a reasonable envelope for both
- NSF Preliminary Design Review (and project baseline) (mid-late 2023)
  - This is really the tough review. We have to have all documentation, excellent cost/schedule documentation. This is a baselining review, meaning we set the baseline cost/schedule that will measure the success of the project.
  - We may have to have an “Independent Cost Estimate (ICE)” type review at this point
- NSF Final Design Review (mid-late 2025)
  - There is a lot of work to go on between PDR / FDR in terms of project management, EVMS, etc. to show we know what we are doing
  - However, typically projects fail this review if either the ICE is very different from our estimates (which is unlikely) or NSF loses its appetite for the project (either because of internal or external considerations)

# Project Current Focus



# Gen2 Workshop (October 18-22)

- Focused on:
  - Science case / simulations; Detector design status and schedules; TDR writing
- Goals for the workshop:
  - Deliverables: TDR outline, list of science plots / simulations, reference detector + additional areas of study, names for editors / authors for the TDR
    - Ongoing work, but we have a TDR outline and a path forward on reference detector/additional areas of study.
    - Goal is to have a first full draft of the TDR in early January.
    - Good participation – talks and recordings can be found here: <https://events.icecube.wisc.edu/event/149/>
- TDR outline as currently proposed, and names (where I know them) are in the following document:  
[https://docs.google.com/spreadsheets/d/1IGB4auUEw\\_bxW5bGmcF9PO\\_o835dlb94cdpuBCdDWWY/edit#gid=0](https://docs.google.com/spreadsheets/d/1IGB4auUEw_bxW5bGmcF9PO_o835dlb94cdpuBCdDWWY/edit#gid=0)
  - (Will be transcribed into overleaf)
- Also see the news here:  
<https://icecube.wisc.edu/news/detector/2021/11/icecube-gen2-convenes-to-kick-off-technical-design-report/>



# TDR Outline

## Part 1: Science and Detector Overview

- Introduction
- Gen2 Science
- Design Overview

## Part 2: IceCube Gen2 Detector

- Optical detector
- Radio detector
- Surface array
- DAQ
- Data Systems and Infrastructure
- Calibration and Commissioning

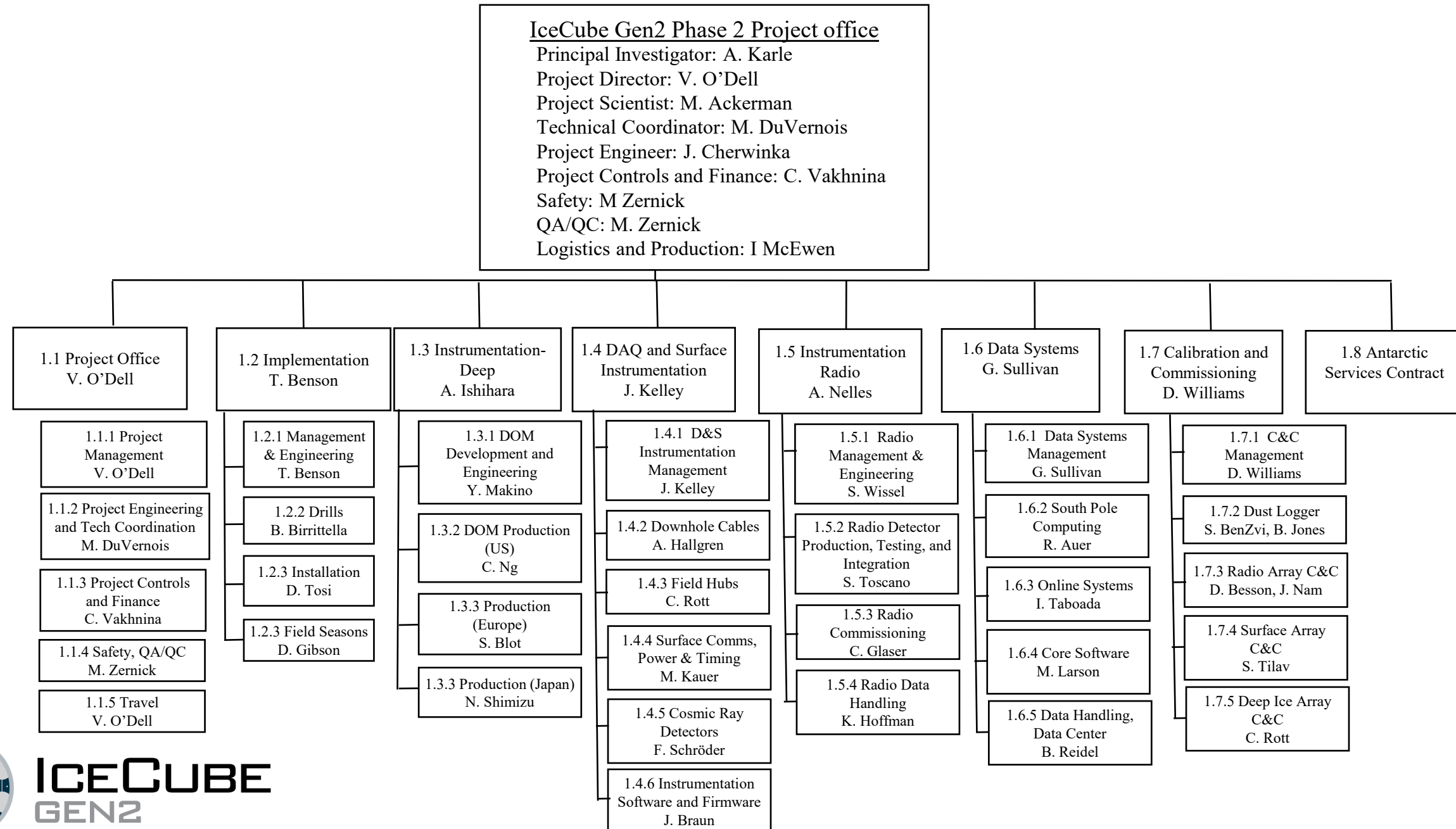
## Part 3: Drilling and Installation, Logistics, General Infrastructure, Project Details

- Drilling and Installation
- Logistics and General Infrastructure
- Ecological Impact and Decommissioning
- Cost and Schedule Overview
- Quality Assurance and Reliability
- Summary of Major Risks
- Project Organization and Management
- Summary and Conclusions
- Glossary

[https://docs.google.com/spreadsheets/d/1IGB4auUEw\\_bxW5bGmcF9PO\\_o835dlb94cdpuBCdDWWY/edit#gid=0](https://docs.google.com/spreadsheets/d/1IGB4auUEw_bxW5bGmcF9PO_o835dlb94cdpuBCdDWWY/edit#gid=0)



# Current Organization



# Current Status (from L2's)

# WBS 1.2 IceCube-Gen2 Deep Drilling

- Time since Workshop primarily focused on IceCube Upgrade
  - Equipment completion and shipping – last shipment this year is next week
  - Finalizing logistics plan and documenting it
  - Upgrade Logistics Review – The review went well. Expanded beyond logistics. Not a lot of feedback at the closeout. Expect draft report in 2 weeks.
- No real work on TDR. Expect to start next week.
- Microturbine and heat exchanger testing ongoing
  - Test results for heat recovery reasonable agreement with capstone performance prediction
  - Expect to run testing through the winter to see impact of cold weather
  - Communication with Artic Energy ongoing. Will likely need a second visit to install fix for 24V power.
  - Plan to explore possibility of grid connection for MT
- Control system
  - Equipment BOM by Sled advancing
  - Cost estimate in progress



# WBS 1.2 IceCube-Gen2 Deep Drilling

- Fuel system
  - Conceptual model of sled day tank
  - Beginning equipment specification
- Water Handling system
  - Budgetary quotation from two Pitot pump vendors for full system
  - Exploring what equipment to purchase for test site
  - Budgetary quotation for two insulated pipe vendors for surface water connection
  - Will revisit possibility for surface hose from IVG
  - Analyzing surface water heat loss
- TOS/TOWER
  - Working on concepts for large sheave to replace crescent
  - Multiple cable reel options
  - Exploring combined hose and cable bundle for return water pump



# WBS 1.2 IceCube-Gen2 Deep Drilling

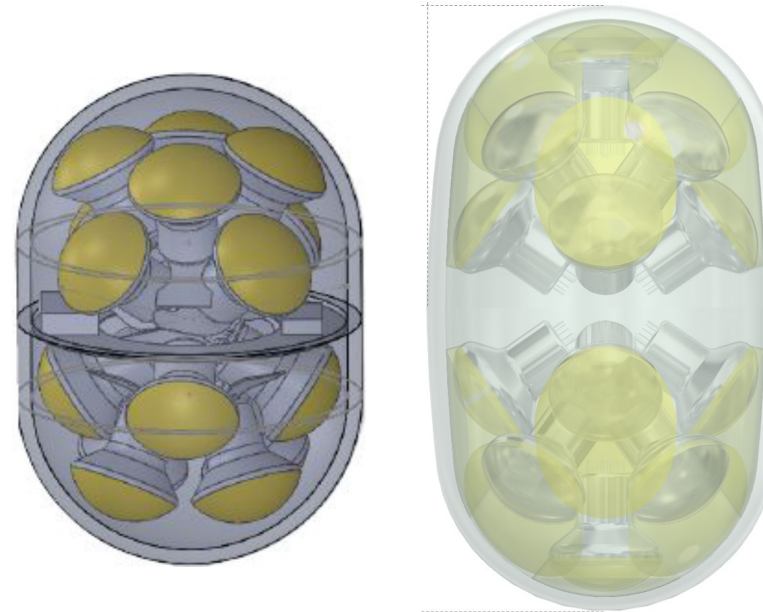
- Drill Head
  - Preliminary specifications
  - Need input from calibration team on inclination and rotation accuracy requirements and possible calibration device inclusion
- Sleds
  - Conceptual models of all sleds
  - Working on alternatives for sled support from snow
    - Air Bladders with PE sheet
    - Foam with P sheet
    - Large low pressure wheels
- Heavy Equipment
  - Getting budgetary prices
- Gen2 Installation & Radio & Surface
  - Need to start addressing installation in a more formal way
  - Need to start communication between PSL implementation folks and Radio Team and Surface Team



# WBS 1.3 Instrumentation-Deep

Many on-going works on

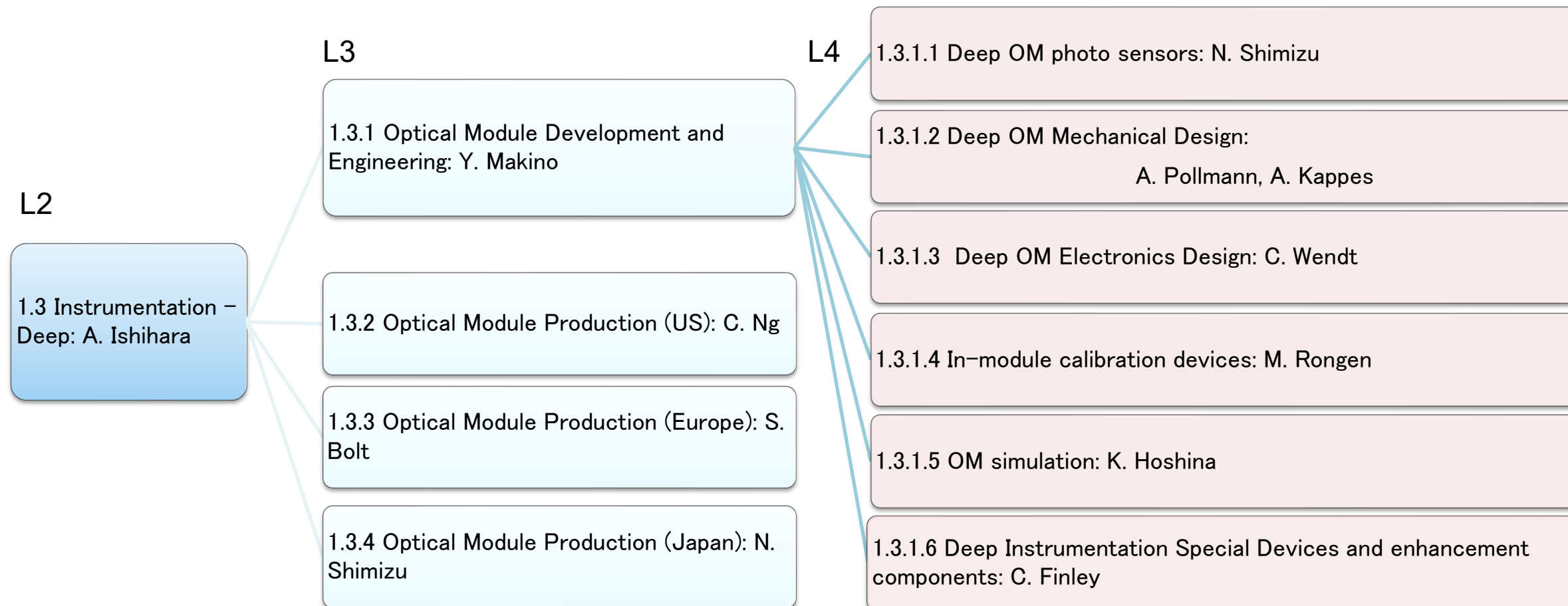
- PMTs
- Pressure vessel
- Gel Pad
- Internal structure
- Integration strategy
- Readout + HV board
- Communication and fanout board
- Calibration devices
- Optimization based on simulation
- New ideas to add more photon collections



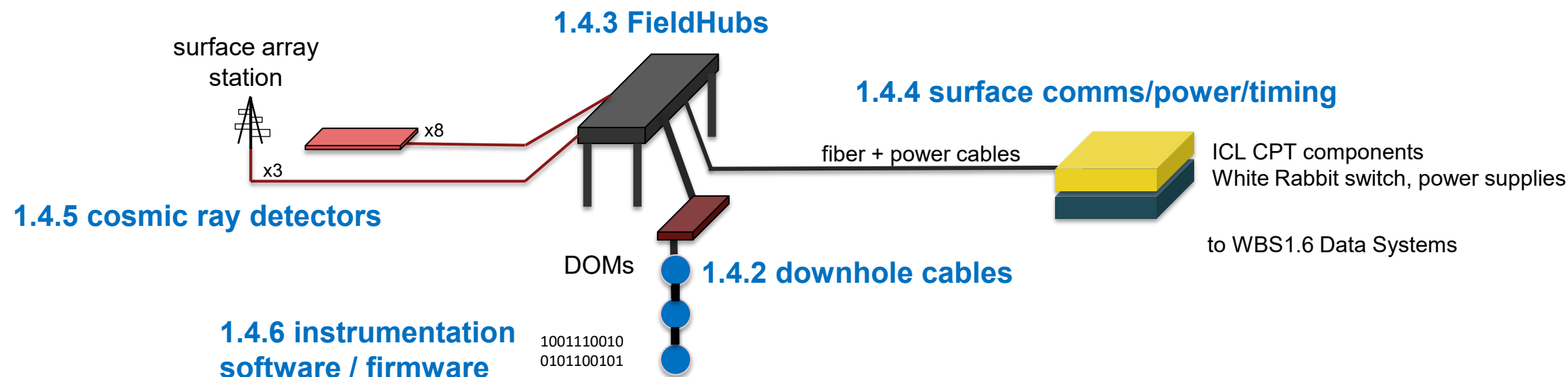
very tight schedule for  
more complex module  
but we have  
experiences!

Target Date	Milestones
December 2021	Conceptual design review
August 2022	Preliminary design review
April 2023	First review on integrated module
August 2023	Workshop on integrated module
Feb 2024	Final design review
August 2024	Production readiness review
Sept 2024	Production rehearsal
Oct 2024-Jan 2025	Batch #1 Production
Nov 2024 – July 2025	Batch #1 FAT
Sept 2025	Batch #1 shipping

# WBS 1.3 Instrumentation-Deep



# WBS 1.4: DAQ and Surface Instrumentation



1.4.1 Management: L2 John Kelley (UW)

1.4.2 Downhole cables: Allan Hallgren (Uppsala)

1.4.3 FieldHubs: Carsten Rott (Utah)

- FieldHub string interface electronics by DESY

1.4.4 Surface CPT: Matt Kauer (UW)

- timing systems by Harvard (Carlos Argüelles-Delgado)

1.4.5 Cosmic ray stations: Frank Schroeder (Delaware + KIT)

- scintillator panels and central station electronics by KIT (Andreas Haungs)

1.4.6 Instrumentation software / firmware: Jim Braun (UW)

- software and firmware running on in-ice optical + surface instrumentation + FieldHubs (does not include radio)



**ICECUBE**  
GEN2

# WBS 1.4 Brief Status

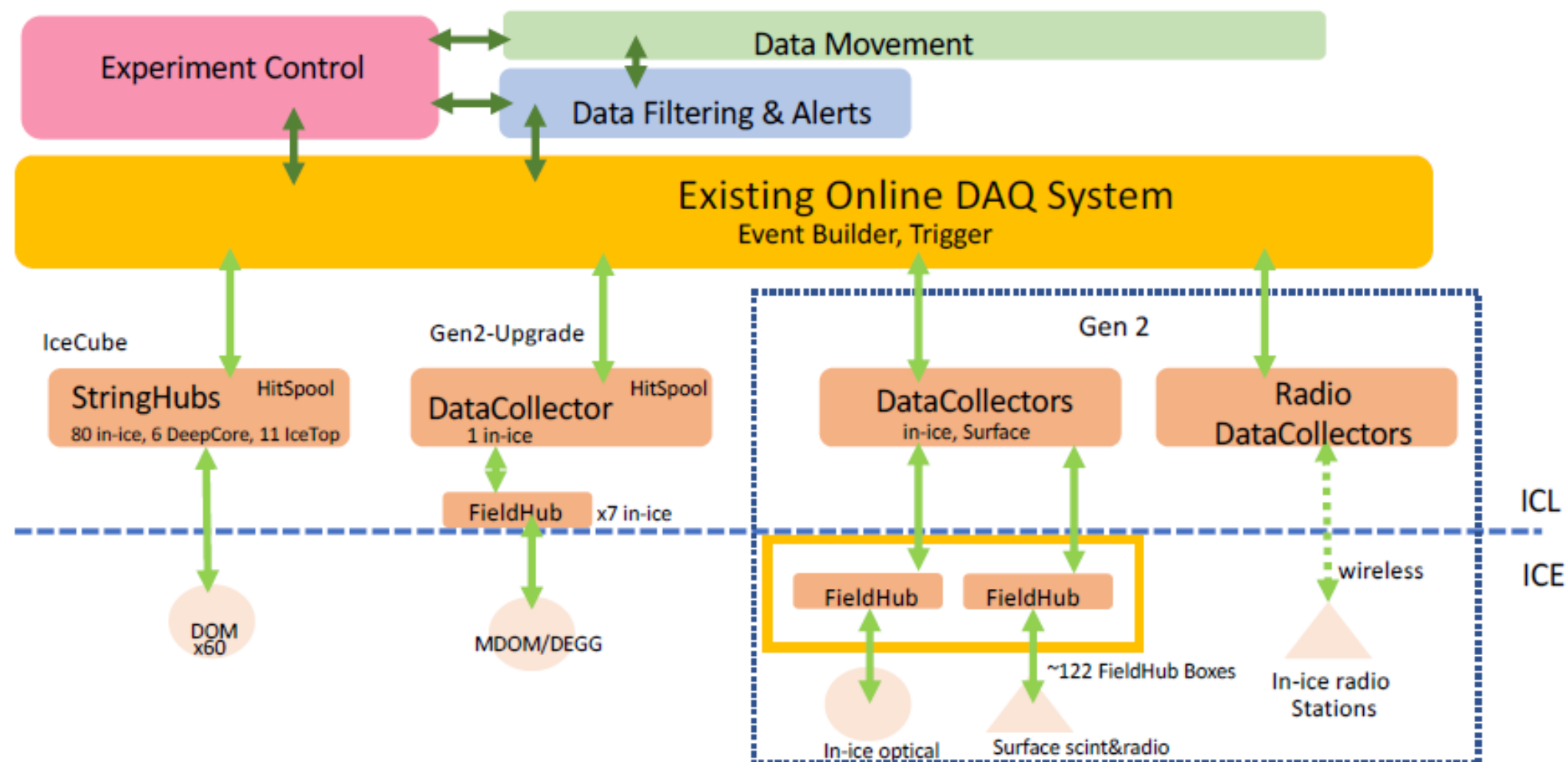
- [Downhole cable reference design](#) of 7 quads
  - enabled via [lower power DOM](#) (4W target) and [DAQ architecture changes](#) (in-DOM hitspooling)
  - can be manufactured by Hexatronic
- Working on prototype [FieldHub enclosure](#)
  - details around cable slack management, thermal requirements
- Cold testing of candidate optical fibers; candidate [power distribution scheme](#)
- New version of TAXI [surface array DAQ electronics](#) to be deployed this season at pole
- Development of [Upgrade LOM firmware / software](#) as proof-of-concept for DAQ scheme
- [Simulation trigger studies](#) to validate data rates and design baseline trigger algorithms
  - in-DOM PMT coincidences are a new pre-trigger requirement
- Interfacing with other L2 areas to understand power, ICL, and communications requirements



# WBS 1.5 Radio Detector

- Simulations for 4 benchmark arrays have started
  - We will use these arrays to flesh out costs and logistics  
<https://docs.google.com/presentation/d/1XL5mlOXDxcTok6OodJDWTeQT8bjRAwrBOjFADou1UIQ/edit?usp=sharing>
- on-going effort with Markus (Project Scientist) to include radio on equal footing in all sensitivity plots
- conversation with CMB-S4 has started about LTE
- discussion about power solution on-going, will depend also on comms solution
- upgraded drill for RNO-G has been ordered from BAS with additional automation and robustness.
  - Will be tested at RNO-G in the summer.
  - RNO-G field season currently under negotiation, tentative dates May - August 2022.

# WBS 1.6 Data Systems



# WBS 1.7 Calibration: Overview

- Goal of Gen2 calibration and commissioning is to deliver detector properties measurements that are sufficient to deliver the science goals of Gen2
- Unlike the Upgrade, calibration is not a primary science goal of Gen2 optical
  - We expect that we will gain substantial new information on bulk ice properties, scattering function, and deep ice below Gen1 instrumented volume from the upgrade
  - We will need to measure “tilt” measurements (local depth of given dust layers) in the Gen2 optical footprint
- Surface array calibration is well understood
- In my view the biggest outstanding questions and issues are in radio calibration
  - Radio will cover a huge footprint
  - Radio neutrinos are yet to be discovered!
  - Radio does not have a natural calibration signal in the form of steady muon flux
  - Radio detector is operating in a more complex environment: firn, surface temperature variations, exposure to anthropogenic noise
  - We have less precise information about all the properties of radio propagation in ice than we have about optical

# WBS 1.7 Calibration: Ongoing Activities

- Several WBS managers are working on the US IceCube Analysis proposal (due Dec. 2) and will have limited cycles until then
- We still need to hammer out the placement of commissioning activities in the WBS for the various subarrays
- Discussions for calibration needs and LOM integration is ongoing (LOM call)
- Discussions for calibration data analysis and plans in RNO-G are in progress (RNO-G call)
- Joint discussion of radar echogram measurements for radio and optical is ongoing (Gen2 tech board)

# WBS 1.8 Logistics (I. McEwen)

- No specific Gen2 progress, **but**
  - Ian / Delia are logistics leads for the Upgrade
  - Just had a 2.5 day review of the Upgrade logistics plan
  - This involved writing documents on methodology; overall cargo and personnel needs; risk analyses; etc.
- This work is directly applicable to Gen2
  - Once NSF signs off on the methodology, Gen2 will adopt the same ideas
  - This should make reviewing logistics go smoother for Gen2...
- I hope we will learn soon about plans to restart the logistics chain to South Pole



# Backups