

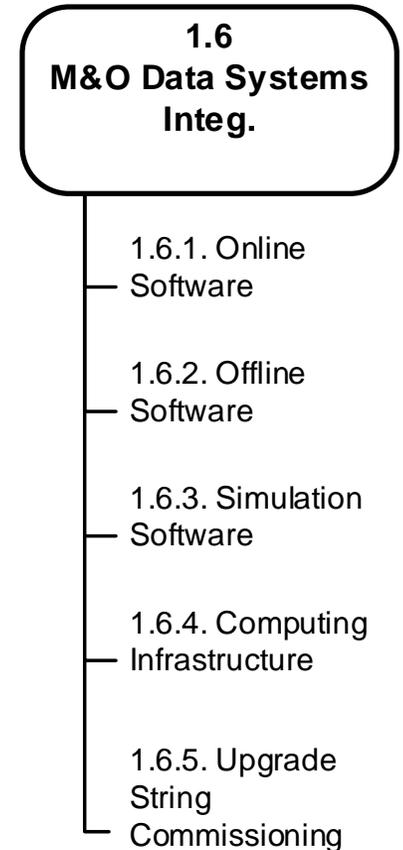
IceCube Upgrade NSF Rebaseline Review
April 26-28, 2022

Erik Blaufuss
1.6 – Data Systems and IceCube Integration

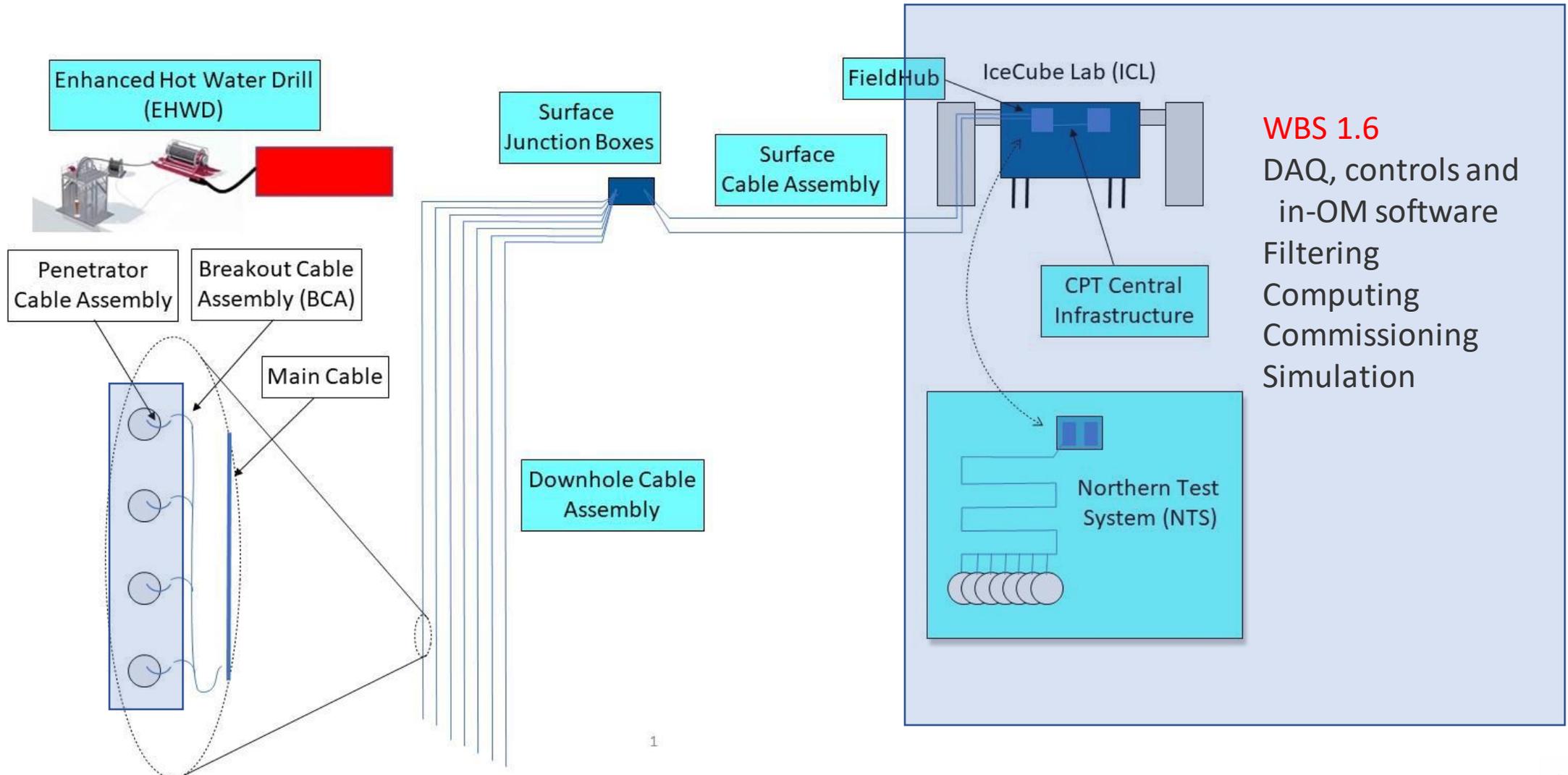


Brief Bios – 1.6 leads

- Erik Blaufuss – University of Maryland Research Scientist
 - IceCube Gen1 MREFC L3 lead for Data Filtering and Software
 - M&O operations lead for online filtering and realtime alerts
 - Former WG lead, collaboration analysis coordinator
- Supported by an experience team from across IceCube collaboration and M&O team
 - 1.6.1 Jim Braun – UW Scientist - L3 lead for Upgrade Online Software
 - 1.6.2 Alex Olivas – UMD Scientist* – L3 for offline software and tools
 - 1.6.3 Tom Stuttard – NBI Postdoc – Expert in IceCube simulation and oscillation analyses.
 - 1.6.4 Ralf Auer – UW Engineer – Pole computing and Winter-over manager



1.6 critical areas



1.6 Overall Deliverables

- Seamless integration of Upgrade hardware into the existing IceCube detector maintenance and operations systems. Including:
 - Online DAQ, Experiment Control, and Online Filter software systems
 - In OM and special device software and firmware
 - FieldHub command and control software
 - Computing systems at Pole and in the north for testing
 - String commissioning – Final checkout of hardware before handover to IceCube M&O
 - Offline software systems
 - Simulation software
- Upgrade provided strings, OMs and special devices become a part of the larger IceCube detector.
 - Equal treatment in triggered events, calibration data, detector simulation and physics analysis to Gen1 hardware.

Current Technical Status and Work to Go

- Delivered: Full testing control and readout system available and in wide use for module testing and development
 - High-level scripted control of modules
 - Mini-FieldHub control of multiple OM devices per wire-pair via ICM-enabled string communication
 - GPS-corrected time stamping of data
 - On-board OM software and firmware with the ability to readout waveforms, perform self-tests, self-calibrated devices.
- Work to go: Integration into existing IceCube data systems:
 - OM-software data acquisition app under control of IceCube DAQ
 - Experiment control of all Upgrade OMs and Special devices
 - Integration into full IceCube data stream for analyses
 - Simulation and reconstruction
 - String commissioning after deployment and refreezing



*PCTS setup at UW
mDOM and DEgg MBs*

*NTS setup – integrated
w/ SPTS test system*



1.6 Interfaces

WBS 1.6 is the area where data interfaces all come together

- **WBS 1.3 Sensors** – *DVT and FAT testing of mDOM and DEgg devices well underway*
 - Provide on-board OM software to support testing and operation of in-ice devices
 - OM Software/Hardware level interfaces
 - Calibration/configuration items needed in operation
 - IceCube Communications Module - On-OM software and DAQ interfaces
 - OM hardware details and performance for detailed system simulation
- **WBS 1.4 CPT** – *Software controlling mDOM/DEgg in use for mini-FieldHub*
 - DAQ interface to Field Hub, timing infrastructure and cable systems
 - Shared responsibility to build-out test systems
- **WBS 1.5 Calibration devices** – *Control and readout of common Mini-Mainboard in place*
 - Provide on-board OM software to support testing and operation of calibration device
 - DAQ/Experiment control of all calibration devices
 - Calibration/configuration items needed in operation
 - Calibration hardware details and performance for detailed system simulation

1.6 Major Milestones

- WBS 1.6 milestones are focused on system readiness reviews and deliverables ahead of needs
- Major milestones in the project schedule for 1.6

Task Name	2023				2024				2025				2026			
	Q1	Q2	Q3	Q4												
Review DAQ Operation plans for new modules		◆														
DAQ software ready for deployment including support for all new OMs													◆			
DAQ software ready for deployment including support for all new Calibration devices													◆			
Review ExpControl/Special devices operations plan for new calibration devices						◆										
ExpControl ready for deployment including support for all new Calibration devices																◆
Review SPAT testing plans for Pole							◆									
SPS computing system for Upgrade complete at pole																◆
Deliver commissioned OMs to detector operations team for integration																◆
Deliver commissioned calibration devices to detector operations team for integration																◆

1.6: Cost and Main Cost Drivers

- WBS 1.6 effort largely an in-kind effort
 - IceCube M&O team experts in DAQ, Experiment control, online and offline software
 - IceCube science collaboration provides simulation and reconstruction software efforts.
- Upgrade project funded efforts focused in a few key areas
 - Project management (\$450K total, \$250K to go)
 - Fractional L2/L3 manager support
 - Travel for reviews and development workshops
 - In-OM software and testing software development. (\$1,150K total, \$800k to go)
 - Computing hardware to expand DAQ systems (testing/pole). (\$50K total, \$15k to go)
 - Deployments for SPAT (1.6.1) and commissioning (1.6.5) on-ice efforts. (\$180K total/to go)

1.6 Risks

- Primary risks related to scaling table-top/lab readout of modules to full-string readouts via the full Field-Hub systems. Important with higher mDOM PMT noise rates.
 - In-OM processing needs sufficient processing power to format, transmit and perform in-device noise mitigations
 - IceCube surface DAQ must be able to handle additional rate of DEgg and mDOM hits into trigger system
 - FieldHub data throughput and processing capacity must be able to handle total data rate from all devices on an Upgrade string.
- Active mitigations being pursued for these in the next 6-9 months
 - Retire: Data rate scaling tests using prototype systems and/or simulated data volumes to ensure full string readouts are working
 - Mitigations: Software mitigations available to further reduce noise-like events to reduce data volumes with small impact on physics.

Conclusion

- WBS 1.6 activities well underway
 - Delivered testing software for optical module design verification and production testing
 - Experts from across M&O team and wider IceCube Collaboration are ready to bring the IceCube Upgrade online as part of IceCube.
- Replan schedule has been developed that delivers needed software and integration efforts ahead of deployment activities at Pole in all scenarios
 - Effort largely provided as an in-kind effort by the IceCube M&O team and collaboration
 - Schedule tracks effort across all sources