

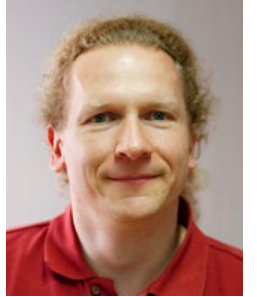
IceCube Upgrade Rebaseline Review
April 26-28, 2022

Timo Karg
WBS 1.3 Deep Ice Sensor Modules

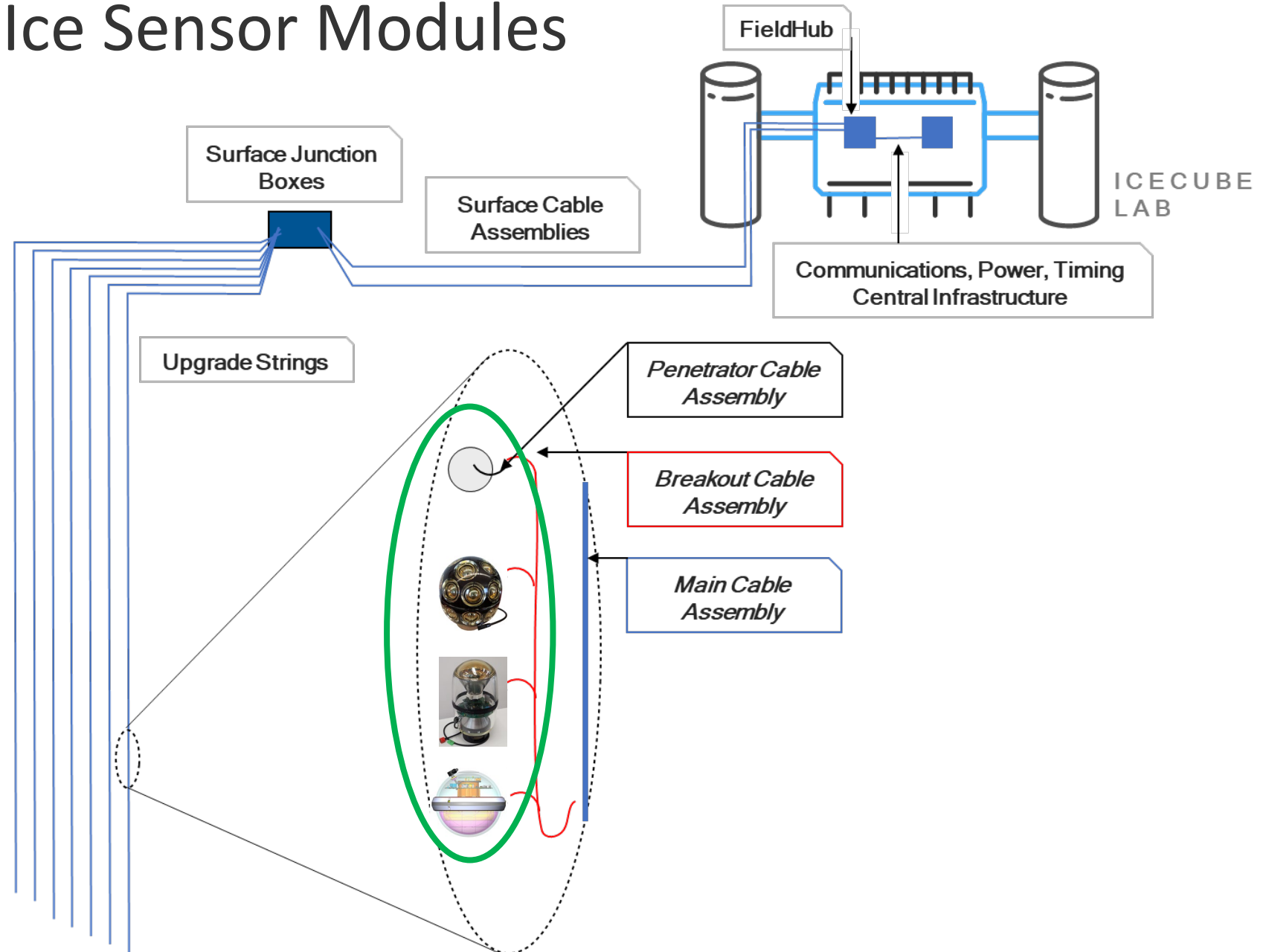


Brief Bio – Timo Karg

- DESY staff scientist
- L2 Mgr. for Deep Ice Sensor Modules
- Project Mgr. for DESY in-kind contributions to IceCube Upgrade
- IceCube member since 2006
- Former cosmic-ray WG lead, acoustic WG lead
- Experience in different roles in detector development and implementation (ANTARES, South Pole Acoustic Test Setup, radio air shower detection, IceCube Surface Extension)



1.3 Deep Ice Sensor Modules



Deliverables and L3 Team

- WBS 1.3.1: mDOM, L3: Alexander Kappes, faculty (U Münster, Germany)
 - Deliverable: 430 deployment-ready mDOM sensors
- WBS 1.3.2: D-Egg, L3: Aya Ishihara, faculty (U Chiba, Japan)
 - Deliverable: 310 deployment-ready D-Egg sensors
- WBS 1.3.3: PDOMs, L3: Perry Sandstrom, senior engineer (WIPAC)
 - Deliverable: 20 refurbished and deployment-ready IceCube DOMs
- WBS 1.3.4: Ice Comms Module (ICM), L3: Karl-Heinz Sulanke, senior engineer (DESY)
 - Deliverable: 900 Ice Communication Modules, incl. firmware, for all in-ice devices
- WBS 1.3.5: Special Devices, L3: Sebastian Böser, faculty (U Mainz, Germany)
 - Coordination and organization of reviews of all in-kind contributed Special Devices

1.3 Deep Ice Sensor Modules

1.3.1. Multi-PMT
Digital Optical
Module (mDOM)

1.3.2. D-Egg

1.3.3. PDOM

1.3.4. Ice Comms
Module

1.3.5. Special
Devices

Current Technical Status and Work to Go

- mDOM design verification complete.
Final Design Review April 2022.
- mDOM integration labs and Final Acceptance Testing (FAT) facilities at DESY and MSU ready
- All 310 D-Egg modules integrated; preparing for FAT
- PDOM Mainboard prototypes produced and tested; other to-be-refurbished subsystems on track
- All Ice Comms Modules (ICM) produced and delivered to sensor developers; ICM firmware has passed Final Design Review
- Preliminary Design Reviews scheduled for all Special Devices and successfully conducted for the LOM, WOM, and Radio Pulser

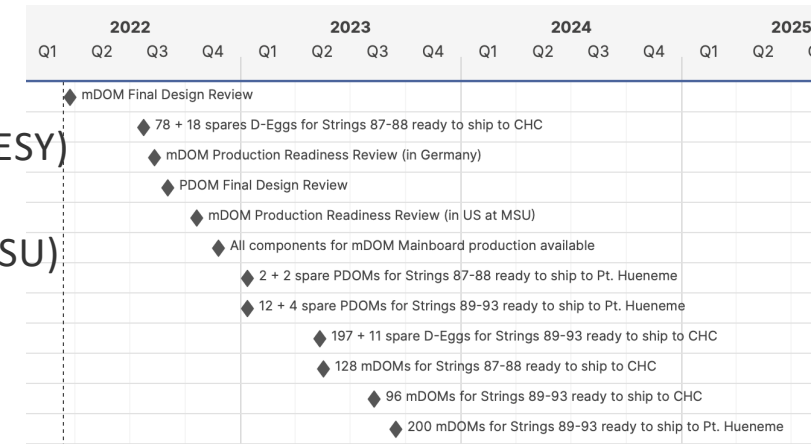


Interfaces

- Mechanical and electrical interfaces to in-module calibration devices (LED flashers and cameras) – defined
- Mechanical interface to String (xDOM Harness) – defined
- Electrical interface to Main Cable Assembly (Penetrator Cable Assembly) – defined and produced
- xDOM Mainboard interface to Mainboard-FPGA firmware – defined
- Software interfaces to central DAQ – defined

L2 Milestones

- mDOM
 - April 2022 mDOM Final Design Review
 - Aug. 2022 mDOM Production Readiness Review (DESY site; after integration and testing of first 20 modules at DESY)
 - Oct. 2022 mDOM Production Readiness Review (MSU site; after integration and testing of first 20 modules at MSU)
 - Nov. 2022 All components for mDOM Mainboard full production available
 - May 2023 128 mDOMs for Strings 87-88 ready to ship from DESY to CHC
 - Aug. 2023 96 mDOMs for Strings 89-93 ready to ship from DESY to CHC
 - Sept. 2023 200 mDOMs for Strings 89-93 ready to ship from MSU to Pt. Hueneme
- D-Egg
 - July 2022 78 + 18 spares D-Eggs for Strings 87-88 ready to ship from Chiba to CHC
 - May 2023 197 + 11 spare D-Eggs for Strings 89-93 ready to ship from Chiba to CHC
- PDOM
 - Sept. 2022 PDOM Final Design Review
 - Jan. 2023 14 + 6 spare PDOMs ready to ship from PSL to Pt. Hueneme



Cost and Main Cost Drivers

- \$218,668 on-award to go in PY5-PY8
- On-award cost are
 - Materials and labor for refurbishing IceCube DOMs to PDOMs \$151k
 - Labor for ICM firmware development and support \$68k
- Majority of WBS 1.3 are in-kind contributions
 - mDOM ~\$5.6M from German collaborators, not including production facilities at DESY and MSU and labor for development, integration, and testing
 - D-Egg ~\$2.7M from Japanese collaborators, not including production facilities and labor for development and testing
 - ICM \$130k from DESY, not including labor development, production, and testing
 - Special Devices contributed in-kind from various collaborators

Risks

- Since the majority of instrumentation is provided in-kind, the largest risks to the project are delays in the various sensor areas
- The current electronics supply chain problems pose a major risk to the timely production of mDOM Mainboards [EXT9]
 - Parts for 40 mainboards are (mostly) available, enabling a pre-production run of 20 mDOMs at DESY and MSU each in spring 2022. This allows us to exercise and optimize integration and testing procedures
 - The mainboard is the last component installed before mDOM sealing. Plan to start production of half-mDOMs in summer 2022 and fill in mainboards as they become available
 - Float between ready-to-ship and shipping of mDOMs for first two strings in Aug. 2024: 63 wks
- If mDOM planned main board electronics parts remain unavailable, a mainboard redesign will be required [EXT18]
 - Includes hardware design effort (off-award) and software & firmware effort (on-award)
 - Latest possible start date for a re-design is January 2023
- If during D-Egg FAT a high failure rate is found, reworking D-Eggs will lead to significant schedule slippage [TECH34]
 - Due to travel restrictions only limited support from the project is possible to get the FAT facilities and procedures production ready
 - We are establishing a project-wide effort to support the D-Egg team to start final acceptance testing as quickly as possible
 - Float between ready-to-ship and shipping of D-Eggs in Aug. 2024: 64 wks

Conclusion

- All Deep Ice Sensor Modules in advanced state
- All 310 D-Egg sensors are integrated and are awaiting testing
- mDOM Final Design Review in April 2022
 - Series production delayed by electronics supply chain issues
 - Mitigation strategies have been developed
- PDOM is on track for Final Design Review in September 2022
- Ice Comms Modules completely produced and delivered
 - ICM Firmware being used in sensor development and testing