

IceCube Upgrade Rebaseline Review  
April 26-28, 2022

Timo Karg  
WBS 1.3 Deep Ice Sensor Modules

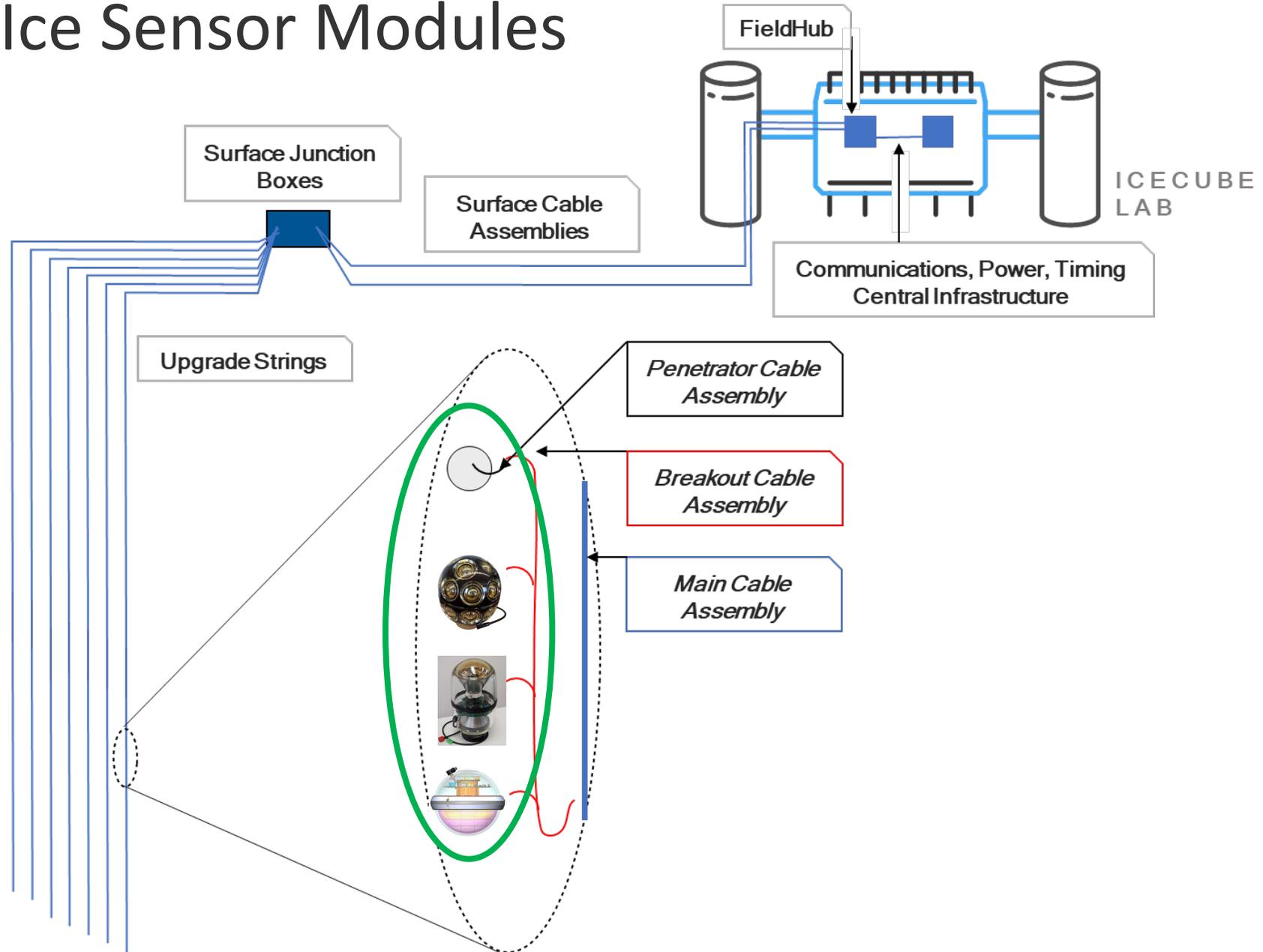


# Brief Bio – Timo Karg

- 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)

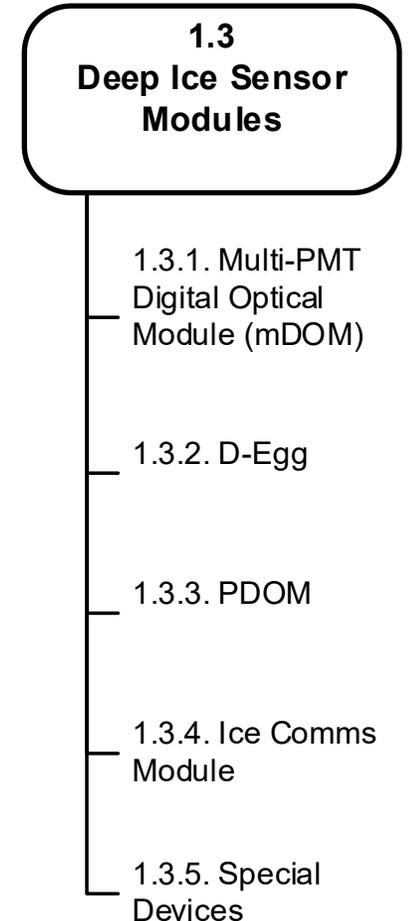


# 1.3 Deep Ice Sensor Modules



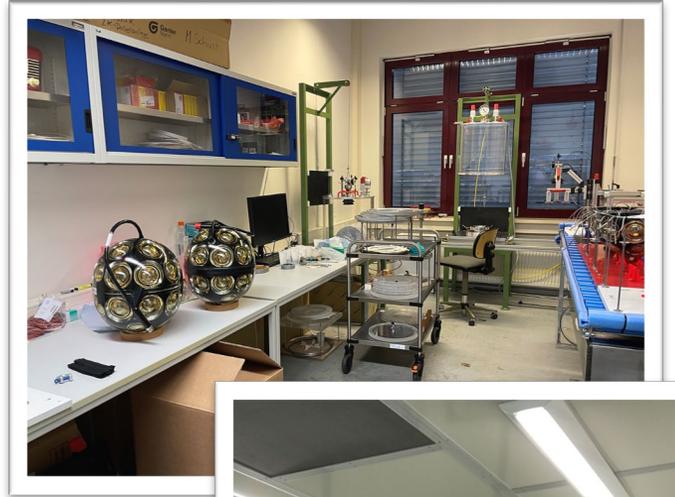
# Deliverables and L3 Team

- 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



# 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