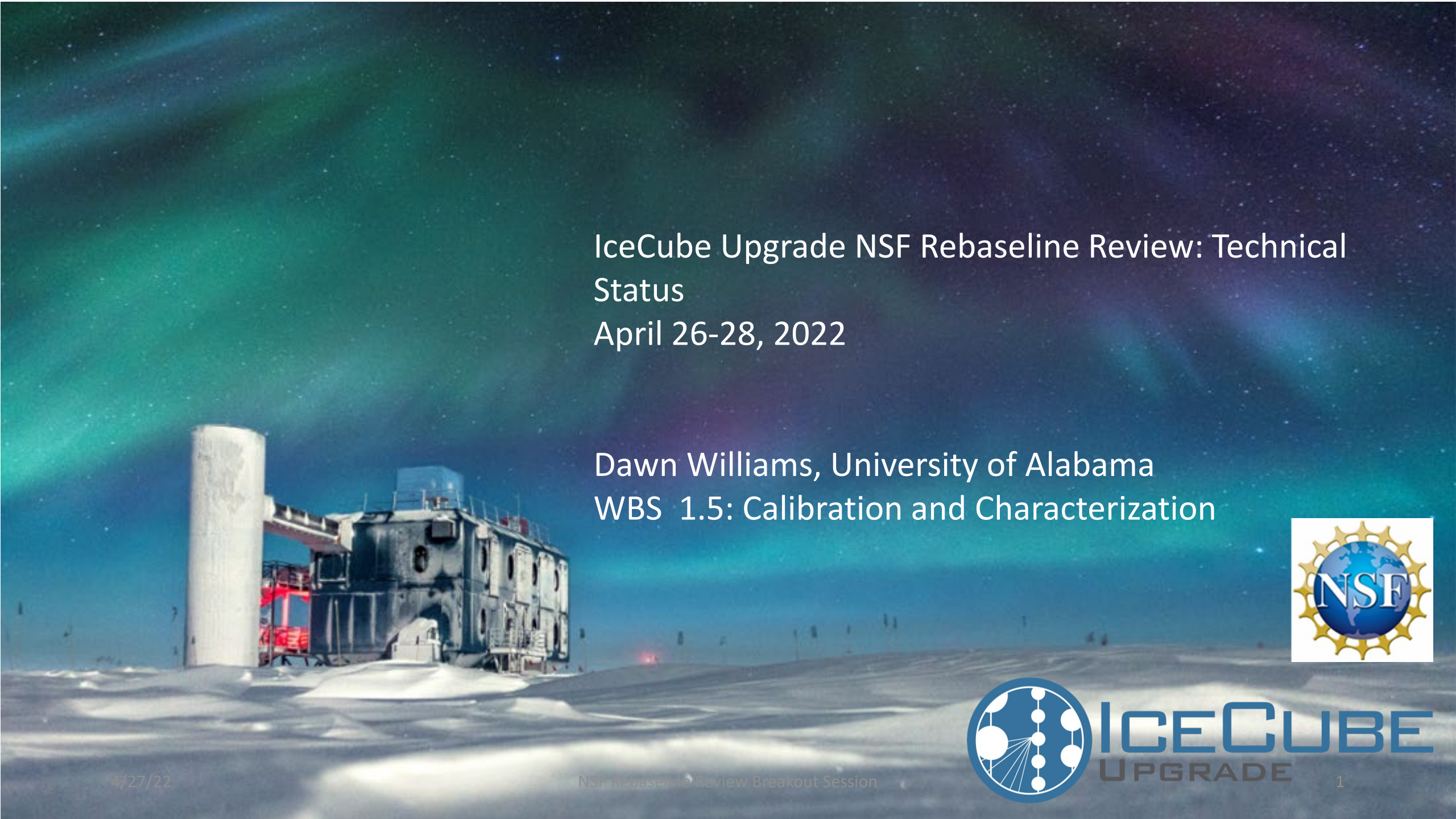


IceCube Upgrade NSF Rebaseline Review: Technical Status

April 26-28, 2022

Dawn Williams, University of Alabama
WBS 1.5: Calibration and Characterization

Charge Question ST1, M1

WBS 1.5.2 Deliverables

1. Upgrade timing and geometry measurements
2. DOM optical efficiency determination *in situ* to better than 3%
3. 2x reduction in uncertainty due to refrozen hole ice
4. Determine the source and depth dependence of anisotropy in optical scattering in bulk ice
5. Measure acoustic properties of bulk ice for Gen2
6. Measure properties of ice below IceCube instrumented volume
7. Calibration devices which are fully integrated into DAQ and experiment control

Device	Goal	Number + spares
Cameras (SKKU/Utah)	3	All mDOMs/Deggs/pDOMs
Flashers (Mainz/Chiba)	1, 6	All mDOMs/Deggs/pDOMs
POCAM (TUM)	2, 3, 6	21 + 4
PencilBeam (UW)	4, 6	11 + 2
Acoustic Modules (Aachen)	1, 5, 6	10 + 2
Sweden Camera 2.0 (Stockholm U.)	3	5 + 2
Mini-mainboard (RWTH Aachen)	7	116 + 14

Nearly all hardware and design effort is contributed/in-kind

Completed milestones

Milestone	Completed
Preliminary design review and downselect for onboard calibration devices	April 2019
Final design review for onboard calibration devices	September 2019
POCAM preliminary design review	October 2019
Acoustic Module preliminary design review	July 2020
PencilBeam Preliminary design review	December 2020
Sweden Camera 2.0 preliminary design review	June 2021

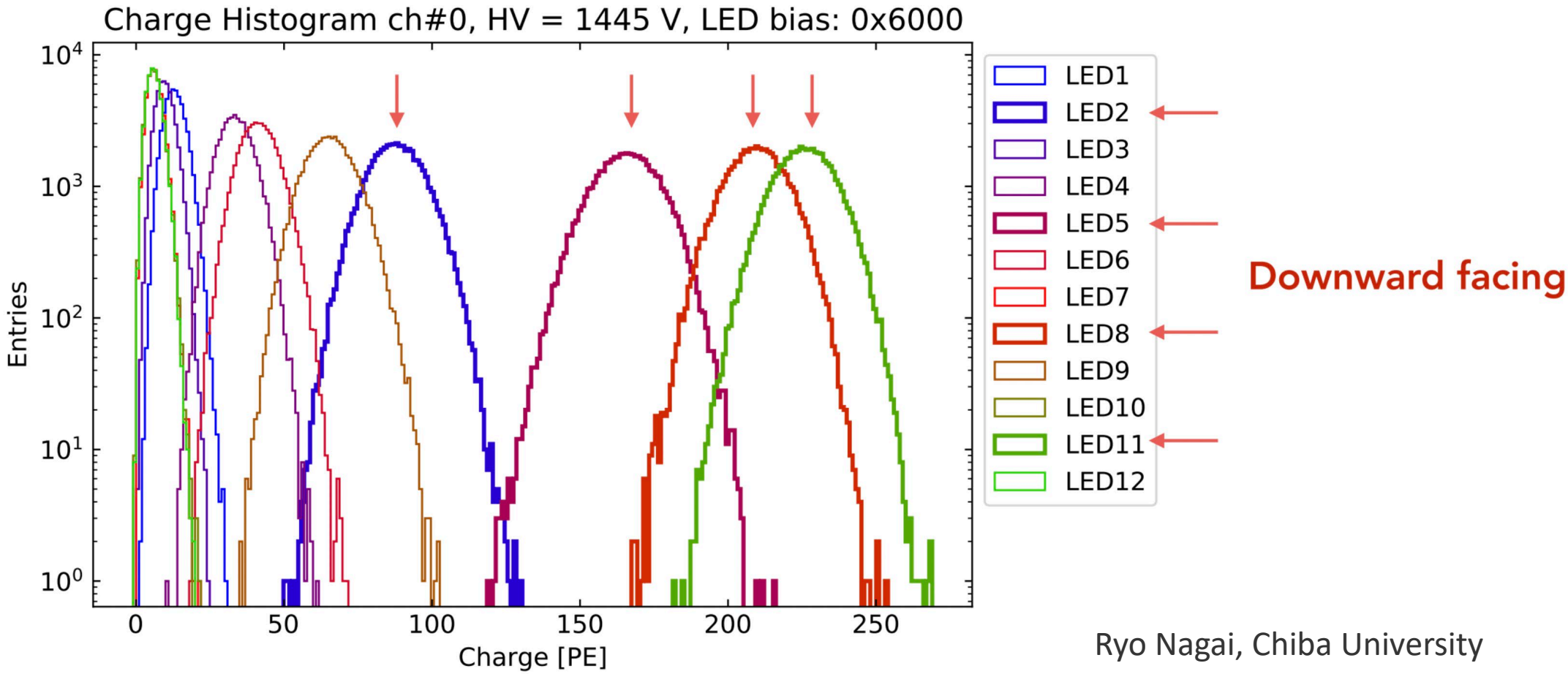
Upcoming Milestones

- July 2022 – Mini-mainboard Rev3 first articles delivered
- September 2022 – POCAM Final Design Review
- October 2022 – Sweden Camera 2.0 Final Design Review
- November 2022 – Acoustic Module Final Design Review
- March 2023 – PencilBeam Final Design Review
- Fall 2024: Delivery of string 87-88 modules
- Fall 2025: Delivery of string 89-93 modules

Current Technical Status and Work to Go

- Flasher and camera production for D-eggs complete, underway for mDOMs, testing is underway with good results so far
- Standalone calibration modules (POCAM, PencilBeam, Acoustic Module, Sweden Camera) have all passed preliminary design review
- All standalone calibration devices are controlled through a Mini-mainboard with a common design, which will also be used by special devices in WBS 1.3
- Mini-mainboard Rev2 first articles are in the hands of all standalone module design teams, Rev3 design is underway, with Rev3 first articles expected by July 2022
- We still need to procure the winch for the dustlogger (to be borrowed from IceDrill Project)

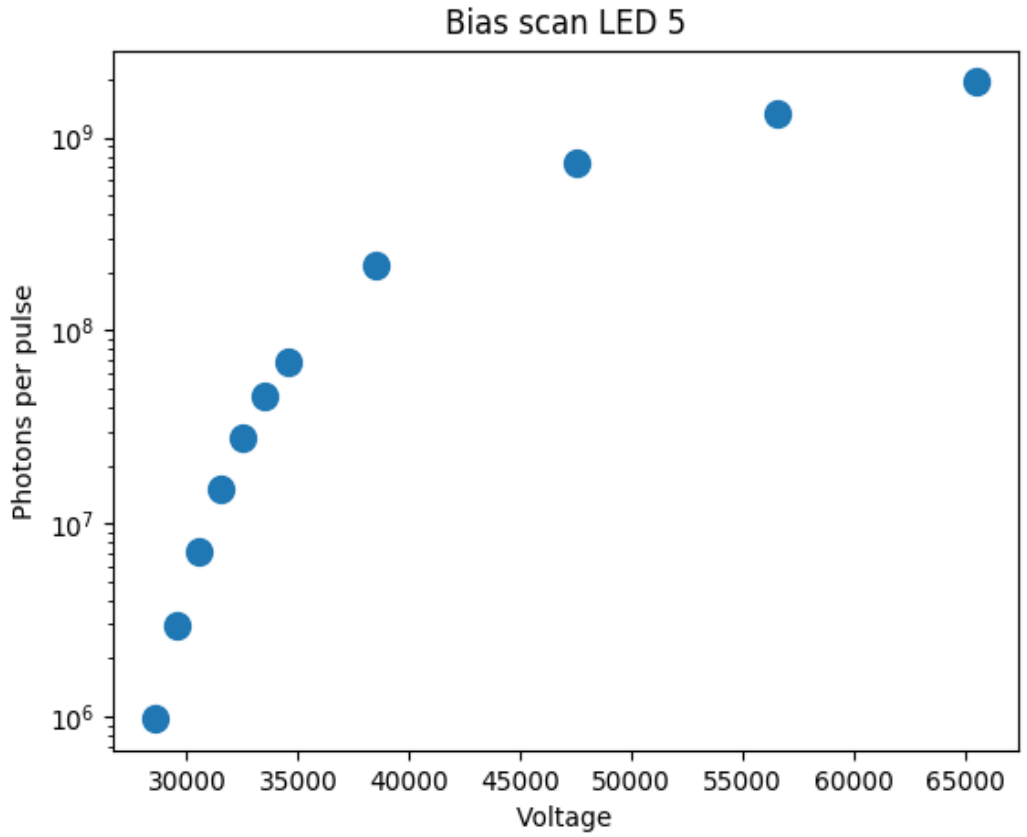
D-egg flashers

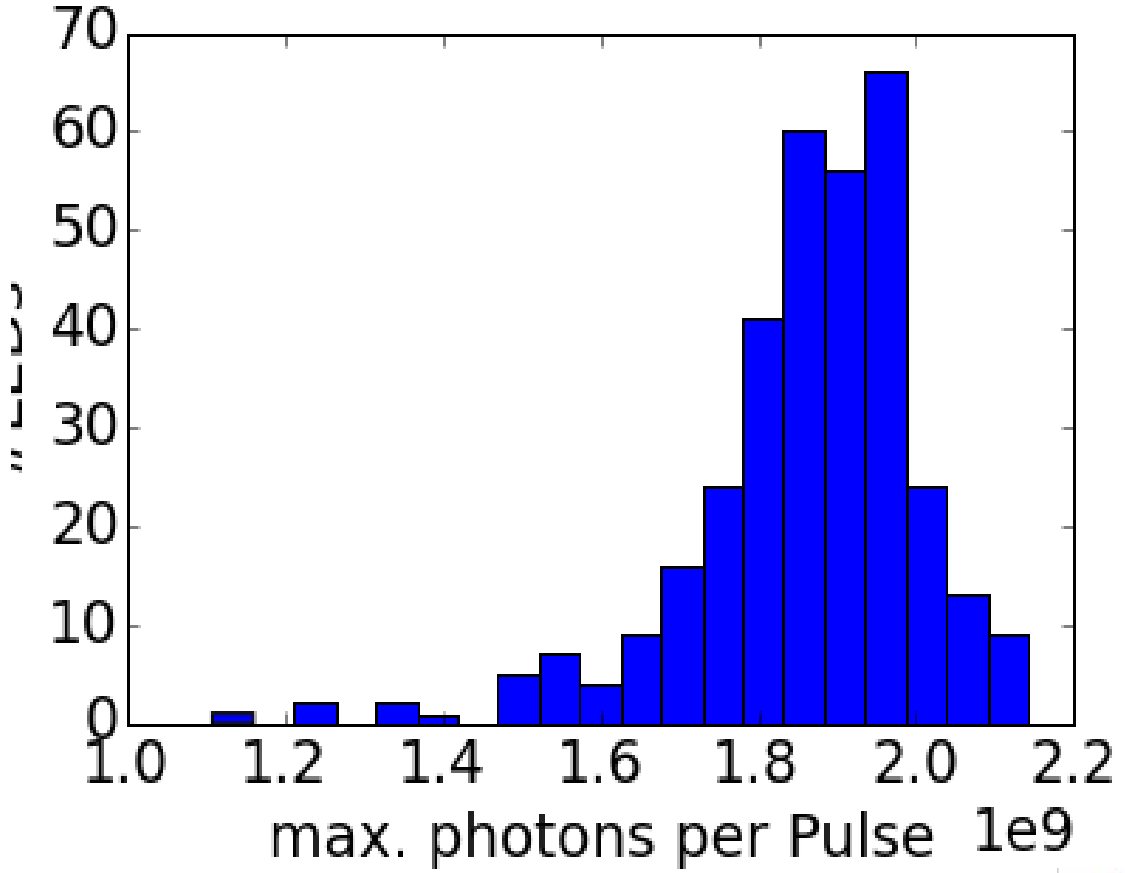


Ryo Nagai, Chiba University

Flashers have been successfully tested on the D-egg

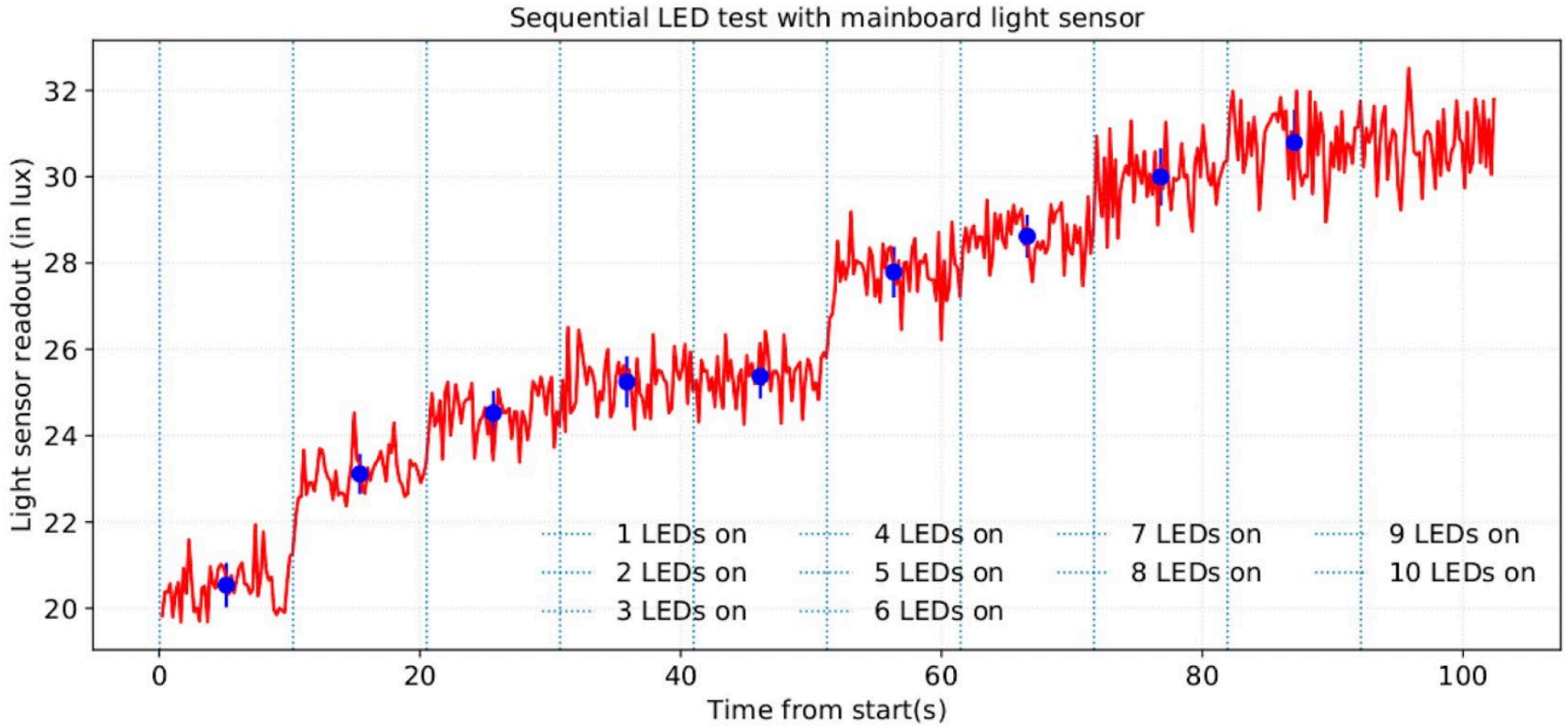
mDOM flashers: production testing (FLAT)





Martin Rongen, Mainz University

mDOM flashers: integrated mDOM DVT testing

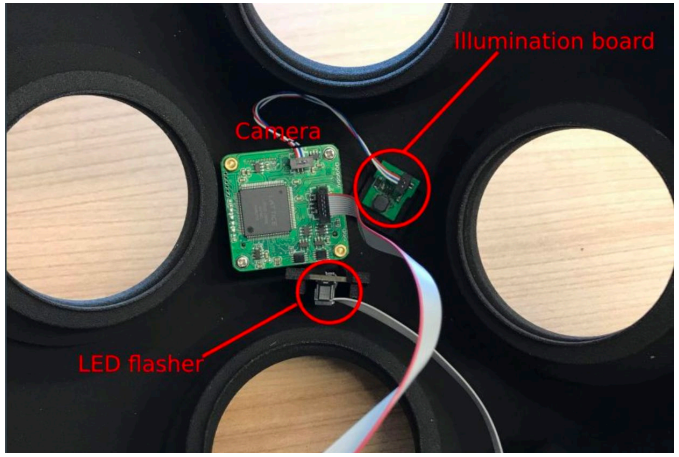


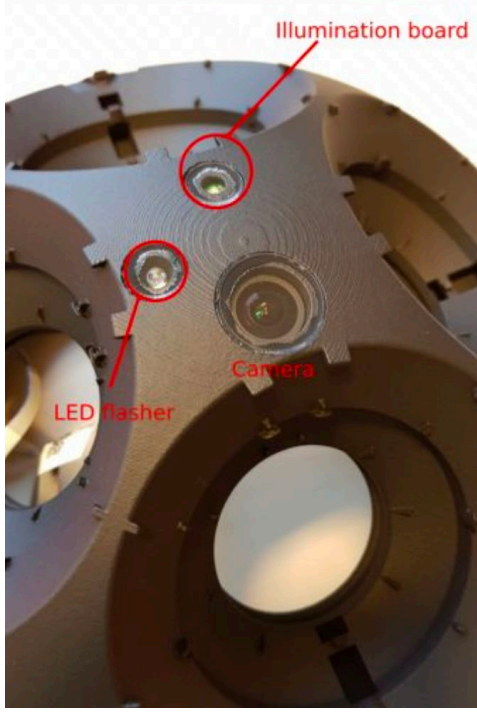
Sarah Mechbal, DESY Zeuthen

Flashers have been successfully tested on the mDOM

mDOM camera status (mDOM FDR, April 2022)

- Since Aug ‘21:
- 600 finished, 430+ sent to DESY collaborators for mDOM assembly
- All materials for camera production are at SKKU including cameras, cables and illumination systems
- 586 packed mDOM cameras
- Remaining cameras (to be packed/sent): 1206-586 = 620





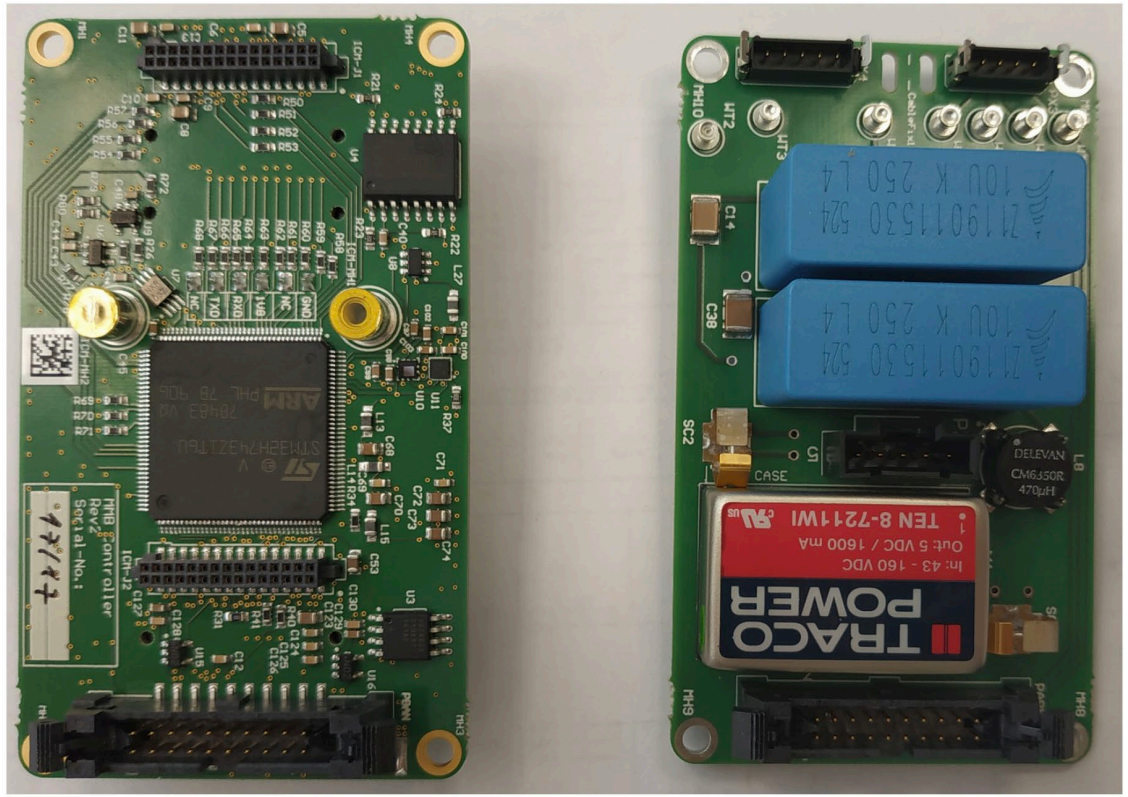
Cameras are tested during production at SKKU and then given basic tests during Final Acceptance Testing of the integrated mDOM

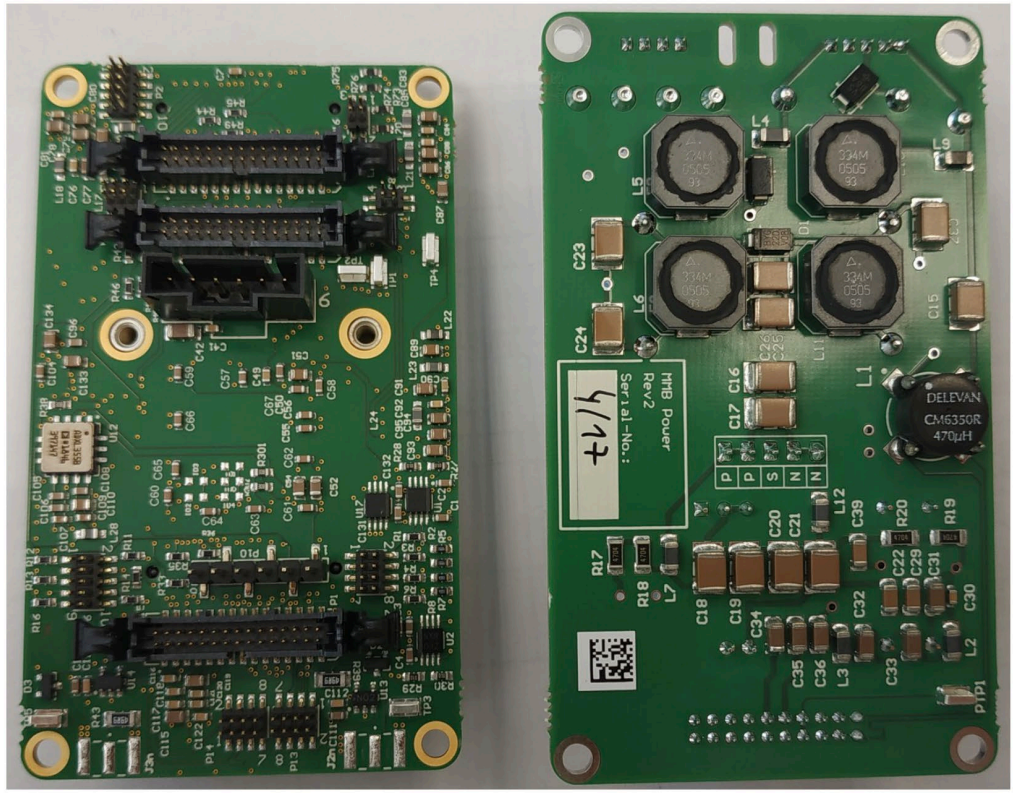
Christoph Toennis, SKKU/Utah

mDOM camera

Camera firmware and software has been updated to correct issues with mDOM camera readout.

Current Technical Status and Work to Go





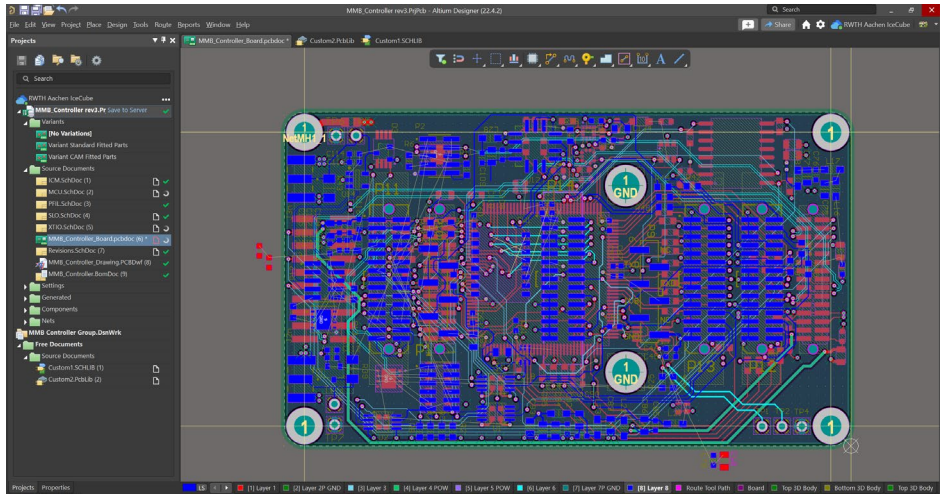
Top

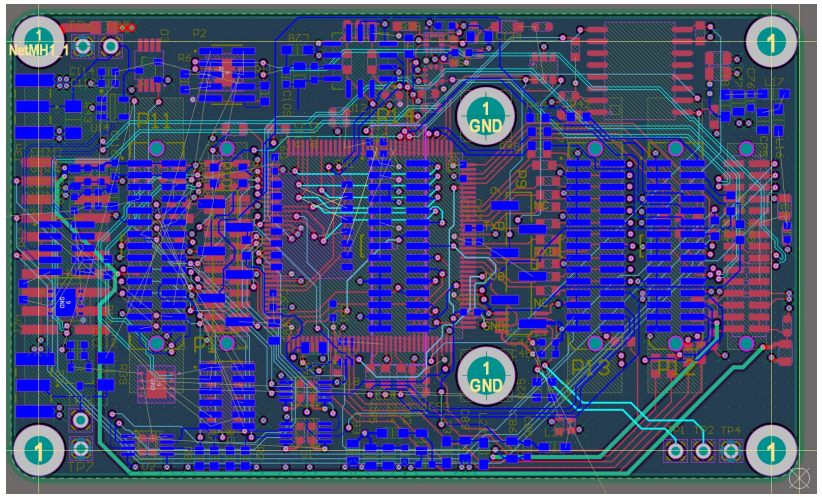
Bottom

Mini-mainboard Rev2 (Christoph Guenther, RWTH Aachen)

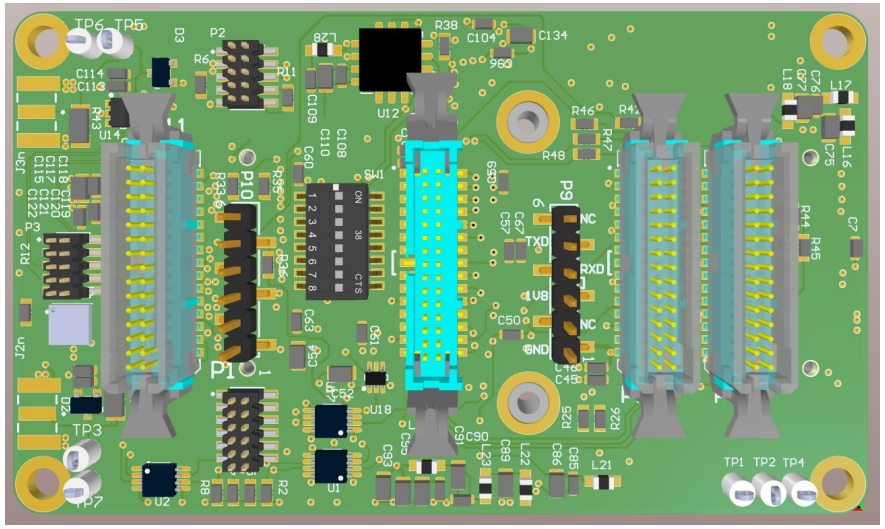
Mini-mainboard Rev2 first articles are being tested and a change list for the Rev3 is being developed, components are being purchased ahead of order

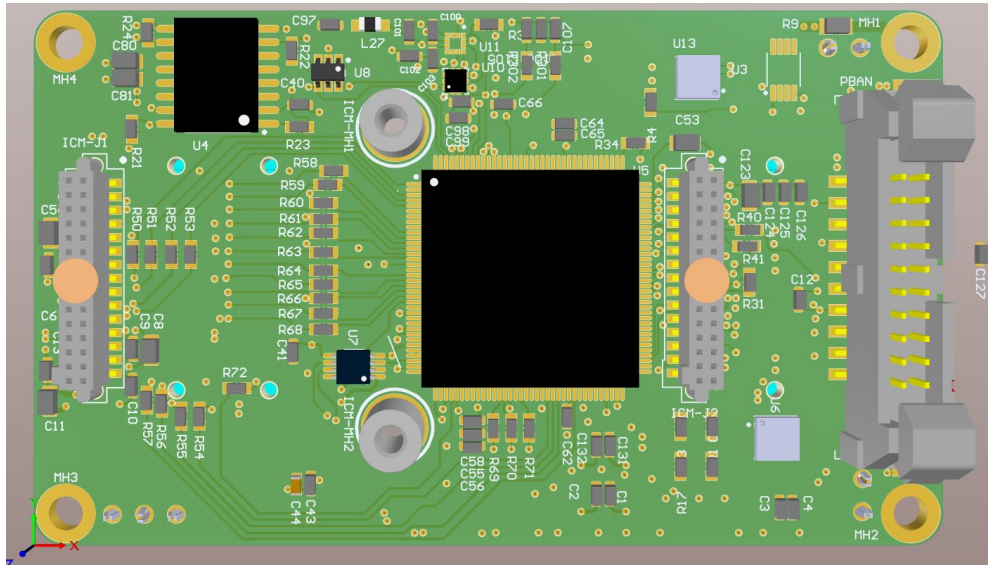
Shared development of Mini-Mainboard





Perry Sandstrom,
UW Madison





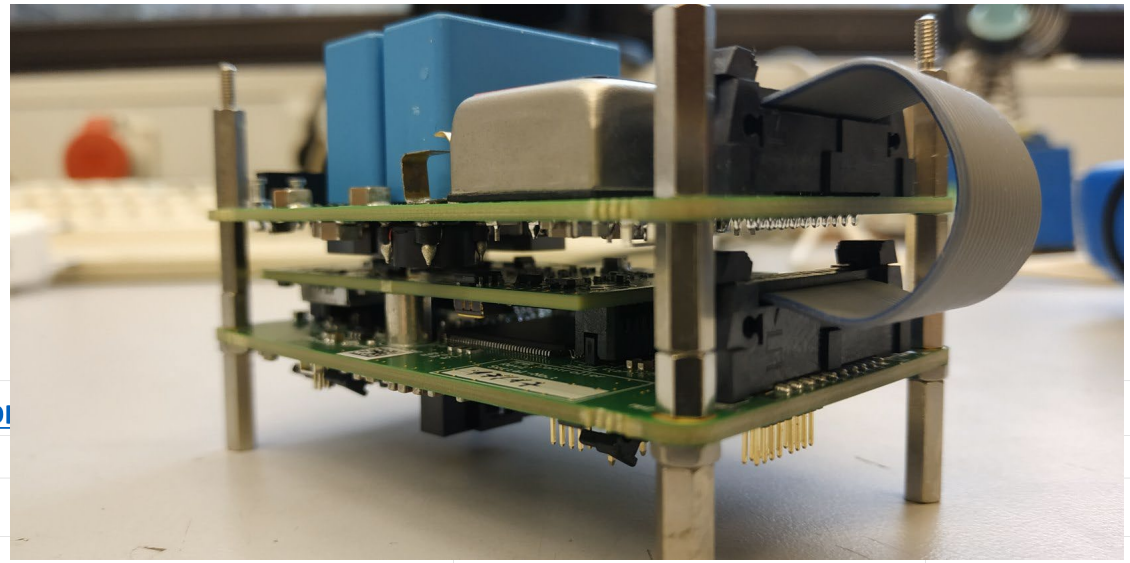
The hardware group uses Altium 365 to share development of the MMB

Parts substitutions for mini-mainboard

Part Number	Description	Used Where	QTY Needed for MMB	QTY Needed for PDOM	QTY Needed for mDOM	Lead Time and order Notes
45230-220230	MMB XTIO shrouded header	MMB, LOM Fanout(x7), PB Control (x3)	90 x 3 + 20 x 7 + 13 x 3			2022-01-20: In stock (Allied, TTI, ...)
45130-010030	MMB XTIO connector	MMB, LOM Fanout A-B (x4)	90 x 6 + 20 x 4			2022-01-20: In stock (DigiKey, Avnet,...)
TFM-115-32-S-D-A	MMB XTIO shrouded header for POCAM and sweden cam		42 x 3			2022-01-20: Total about 100 in stock at DigiKey+Mouser.
TCSD-10-01-N (Seems like incorrect part # here, this # is a 20 pin connector)	MMB XTIO connector for POCAM		42 x 6			
EHT-110-01-S-D-SM	MMB Controller to Power shrouded header		132 x 2			2022-01-20: In stock (DigiKey, Avnet,...)
TCSD-10-01-N	MMB Controller to Power connector		132 x 4			2022-01-20: In stock (DigiKey, Avnet,...)
ADXL355BEZ-RL7						
ADXL355BEZ-RL7	MMB accelerometer		132	40		2022-01-28: In stock, placing order from Mouser for 150 units
LIS3MDLTR	PDOM Magnetormeter			40		
LIS3MDLTR	MMB magnetometer		132			
~~LPS22HDTR~~	~~MMB pressure sensor~~		~~132~~			~~2022-03-08: Unavailable. Part is listed as end-of-life, discontinued production~~
LPS22DF	mDOM pressure sensor				500	New version, In stock at Mouser quantity 528
LPS22DF	PDOM, MMB pressure sensor		150	40		See special-purpose spreadsheet here: https://uwprod.sharepoint.com/:x:/r/sites/icecubeupgrade/_layouts/15/Doc.aspx?sourcedoc=%7B0663C633-F0ED-4063-ACF6-1A5F2E842922%7D&file=Pressure%20Sensor%20Multi-Order.xlsx&action=default&mobileredirect=true
- ~~ILPS22QSTR~~	~~PDOM, MMB pressure sensor alternate~~		~~150~~	~~40~~		
STM32H743ZIT6	MMB Microcontroller		132	40		2022-01-24: Newark order placed (150), delivery Jan 2023

Parts substitutions are discussed weekly on the Upgrade hardware call and in between on the #upgrade-hw-dev slack channel

Mini-mainboard testing



TDT Mini-Mainboard

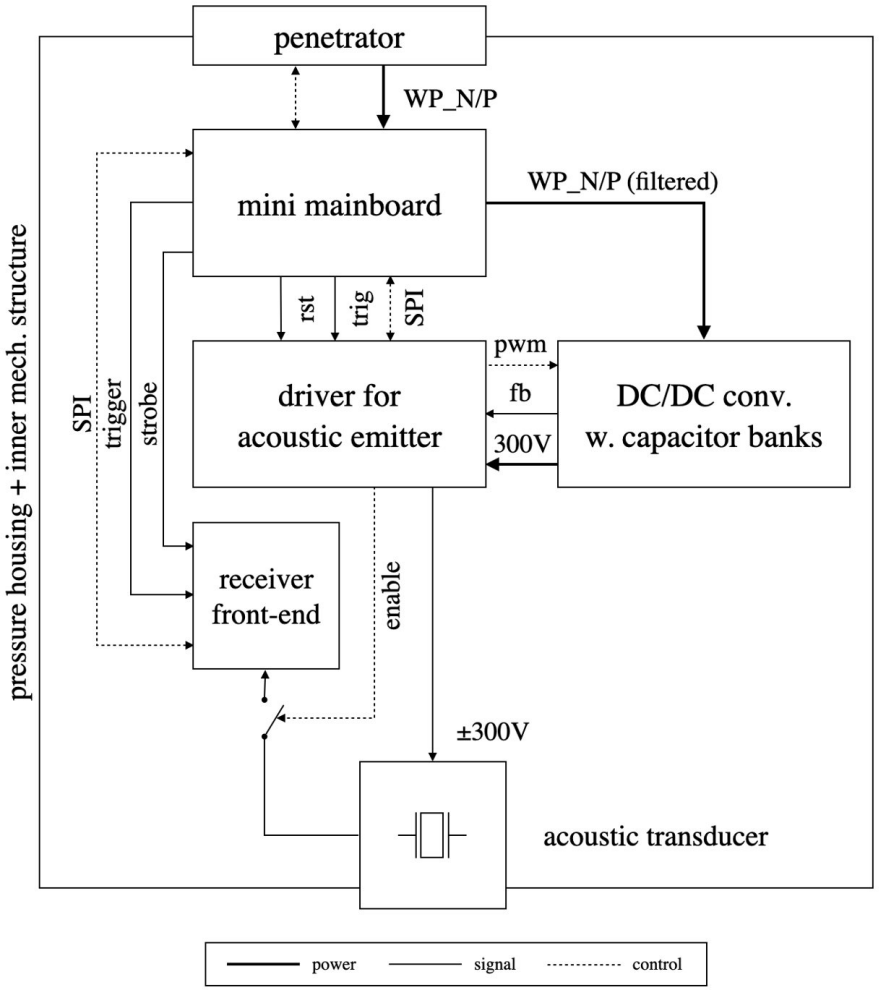
Test Definition Table

Details o

Test ID	Test Name	Boards Affected	Test Description	Rationale	ERD ID
T0	GPIO Waveform	MMB Controller	Test if GPIO signals look okay. Toggle GPIOs and look at them on oscilloscope.	GPIO signals should have an appropriate rise/fall time and return to a defined state.	IR3
T1	GPIO State	MMB Controller	GPIO states of XTIO MCU 1 are set to low and high and are read out by XTIO MCU 2.	Test if GPIOs can be correctly controlled by MCU.	IR3
T2	SPI 2 / 4	MMB Controller	Send test data from SPI2 to SPI4 of XTIO MCU 1 and vice versa and check if data are correct (XTIO MCU 1).	Check if this serial interface works correctly.	IR19
T3	I2C 2 / 4	MMB Controller	Send test data from I2C2 (XTIO MCU 1) to I2C4 (XTIO MCU 2) of XTIO MCU 1 and vice versa and check if data are correct.	Check if this serial interface works correctly.	IR19
			Send test data from UART4 (XTIO MCU 1) to	Check if this serial interface works	

Mini-mainboard test definitions and procedures are stored in Sharepoint

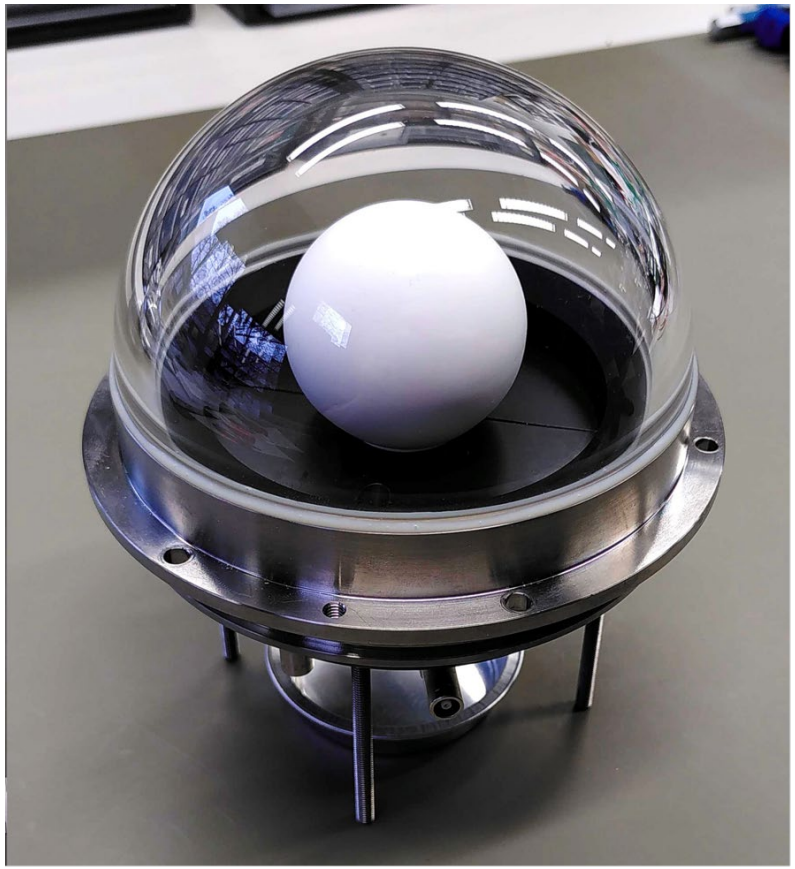
Acoustic Module (RWTH Aachen)

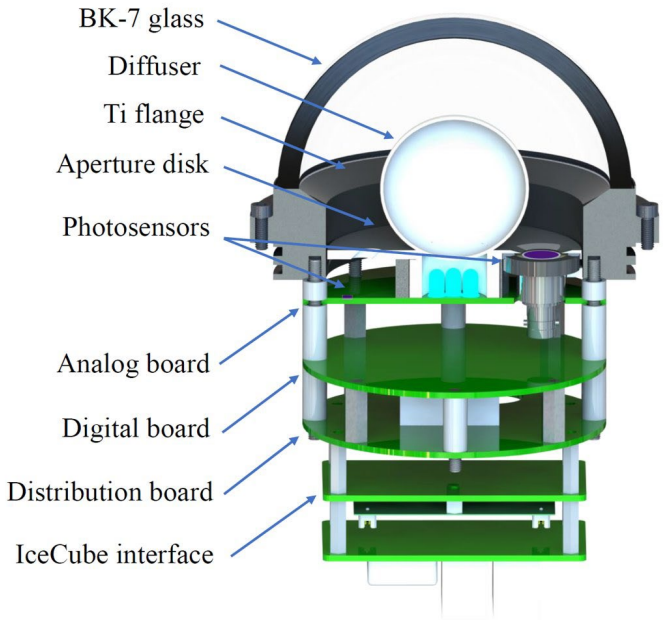


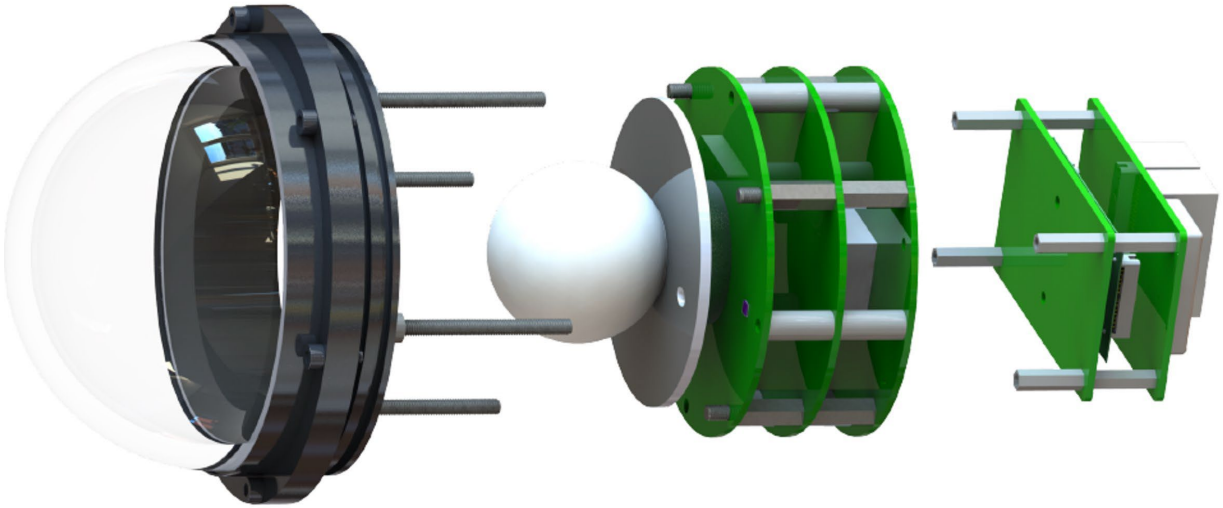
Prototype pressure testing September 2021
Christoph Gunether, RWTH Aachen

Acoustic module inherits from design study for autonomous ice probe for the *Enceladus Explorer*

POCAM (TU Munich)

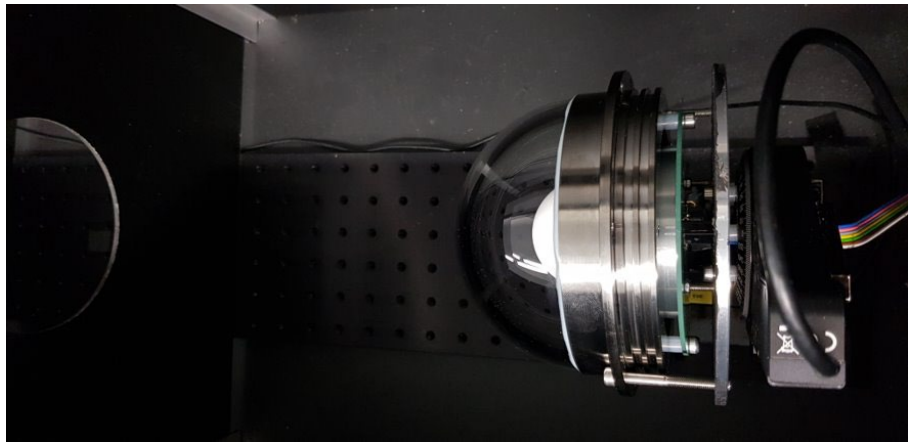


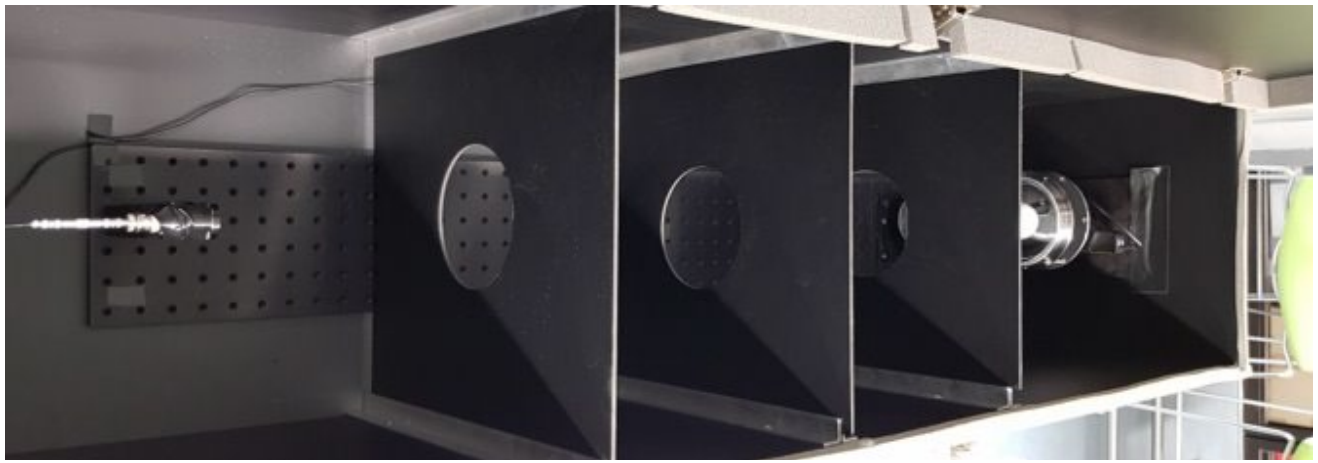


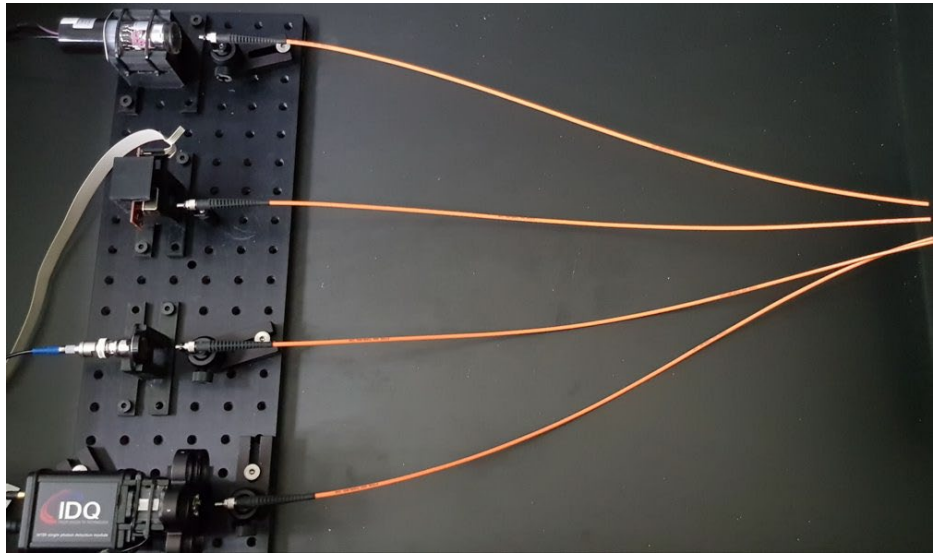


The POCAM has already been tested in the field in Baikal and in P-ONE

POCAM testing (temperature, vibration, shock)



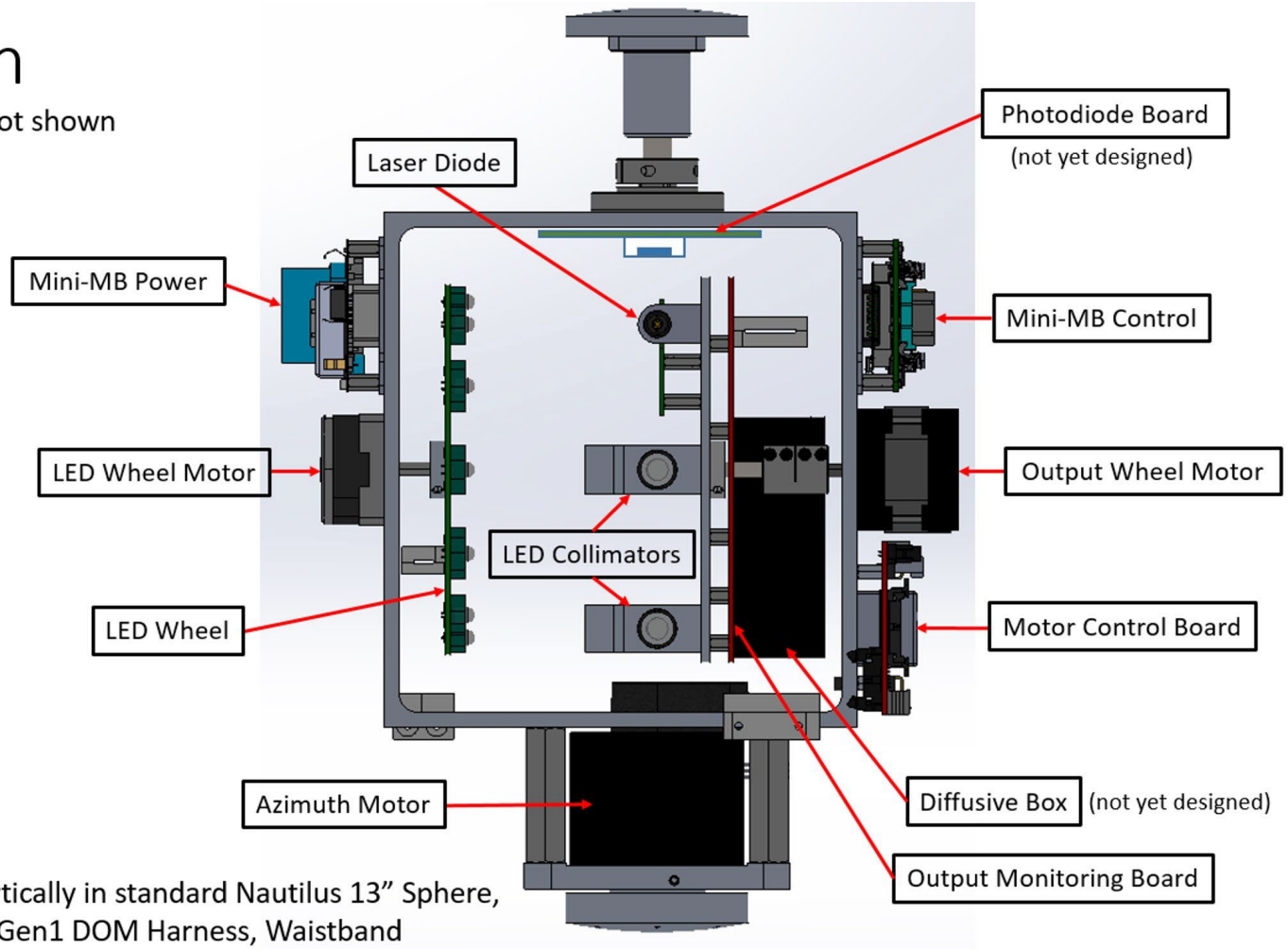




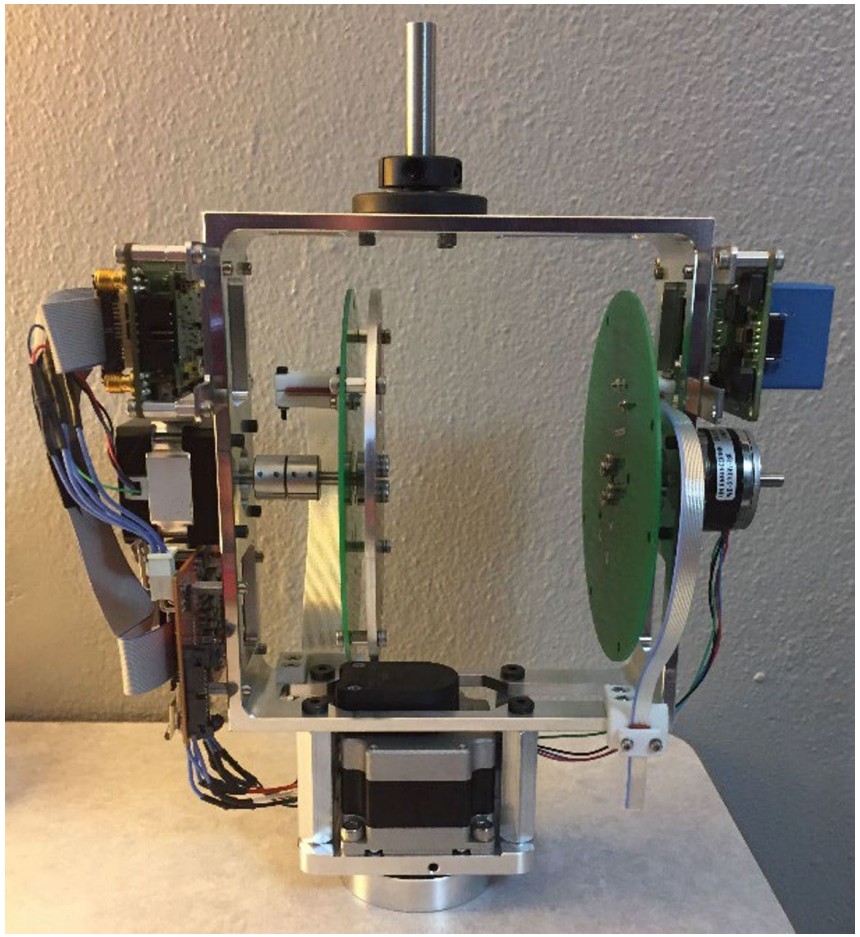
PencilBeam (UW Madison)

Design

*some parts not shown



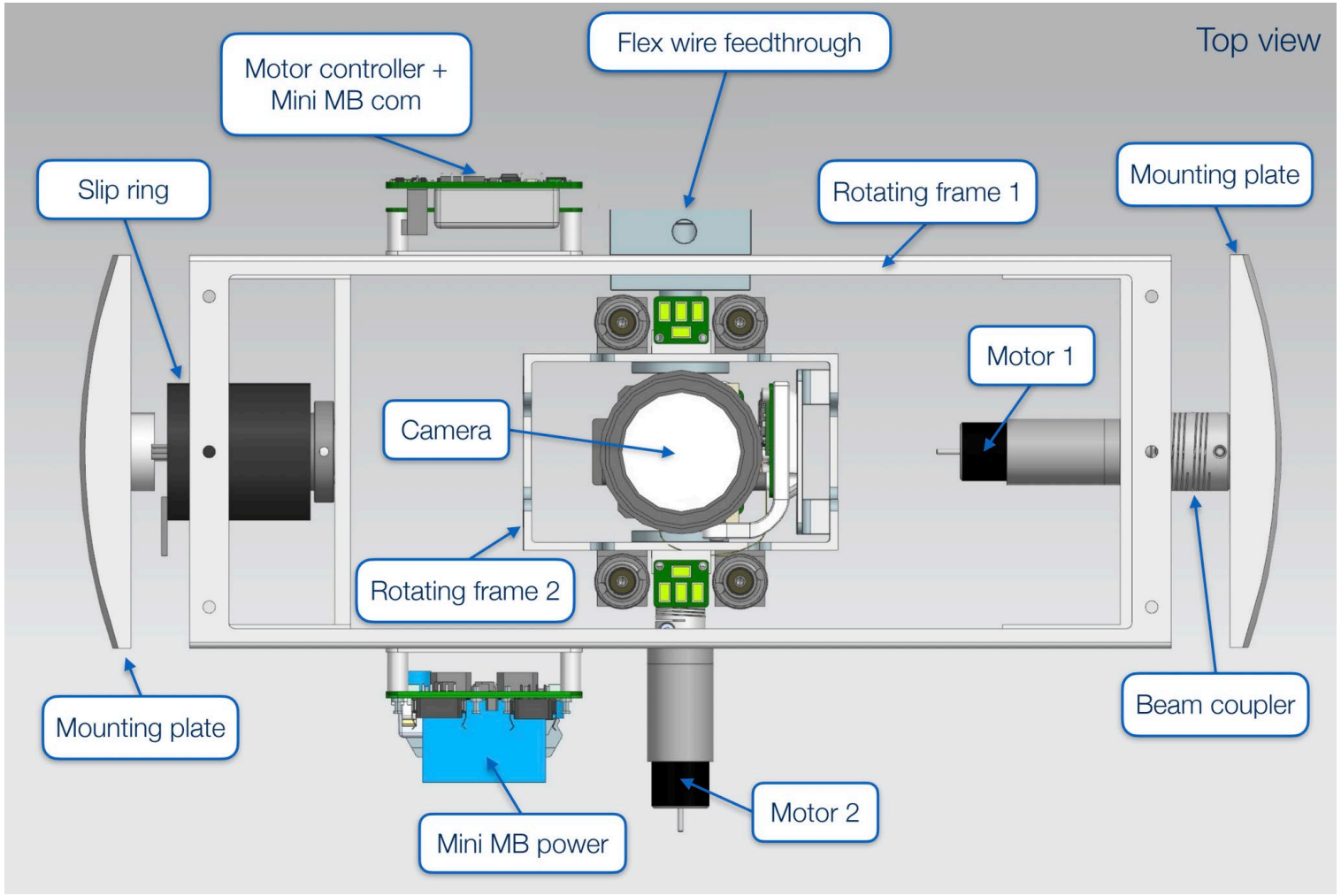
*Mounted vertically in standard Nautilus 13” Sphere, uses adapted Gen1 DOM Harness, Waistband



Jack Nuckles, Chris Wendt

Sweden Camera 2.0 (Stockholm University)

The camera design is based on the highly successful camera which was deployed in IceCube Gen1

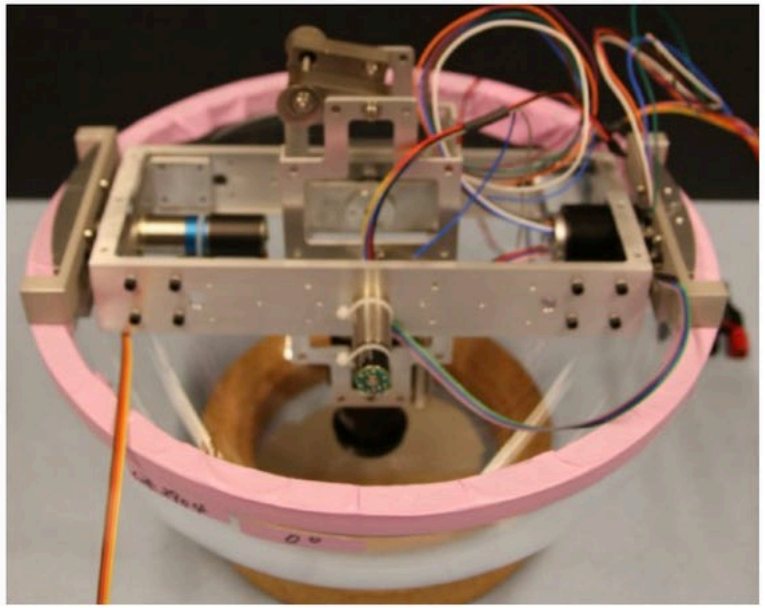


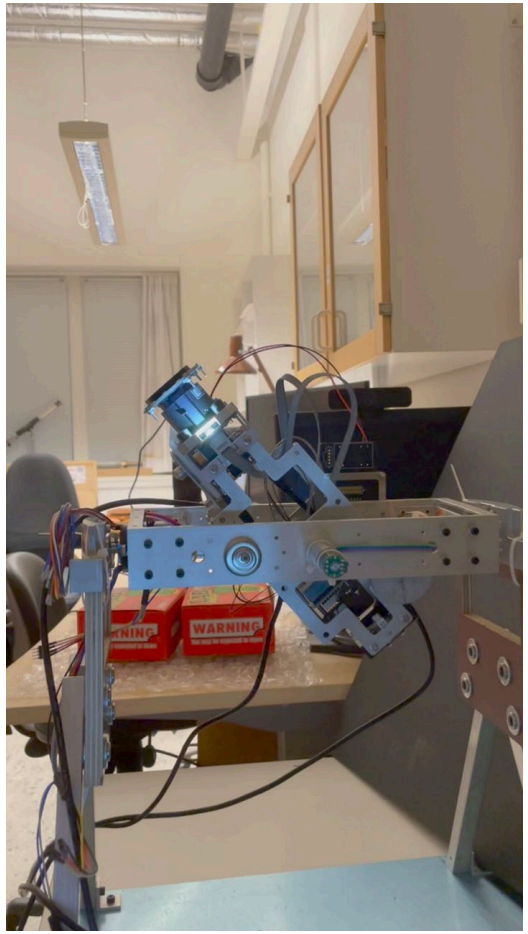
Matthias Hudl, Stockholm U.

Sweden Camera

Internal electronics and firmware review May 12

Prototype mounted in 13 inch hemisphere





In-kind costs: PencilBeam (UW Madison)

	2018 (optional)	2019 (optional)	2020 (optional)	2021 (optional)	2022	2023	2024	2025
Equipment costs	0	0	3000	3000	12000	12000	45000	0
Engineer FTE	0	0.25	1.5	1.3	1.5	1.3	1.3	0
postdoc FTE	0	0	0	0	0	0	0	0
grad student FTE	0	0	0	0	0	0	0	0

In-kind costs: POCAM (TU Munich)

POCAM	2018 (optional)	2019 (optional)	2020 (optional)	2021 (optional)	2022	2023	2024	2025
Equipment costs	?	€65,000.00	€305,000.00	€16,000.00	€25,000.00	€10,000.00	€0.00	€0.00
Engineer FTE	€359.00	€914.00	€4,109.00	€7,000.00	€1,000.00	€1,000.00	€0.00	€0.00
postdoc FTE	€19,200.00	€19,200.00	€19,200.00	€22,560.00	€21,600.00	€9,600.00	€9,600.00	€9,600.00
grad student FTE	€31,200.00	€31,200.00	€43,200.00	€36,000.00	€12,000.00	€31,200.00	€31,200.00	€31,200.00
working student FTE	€4,000.00	€6,000.00	€16,800.00	€1,000.00	€18,400.00	€4,000.00	€4,000.00	€4,000.00

In-kind: Acoustic Module (RWTH Aachen)

	2018 (optional)	2019 (optional)	2020 (optional)	2021 (optional)	2022	2023	2024	2025
Equipment costs	500€	4,000€	1,000€	5,000€	8,500€	30,000€	5,000€	0€
Engineer FTE			0.75	0.75	0.75	0.5	0.5	0
postdoc FTE	0.1	1	0.5	0	0.1	0.1	0	
grad student FTE			0.5	1	1	1	1.5	1.5

In-kind: Sweden Camera 2.0 (Stockholm University)

Sweden Camera	2018	2019	2020	2021	2022	2023	2024	2025
Equipment costs ($)	0	0	20000	24000	25000	10000		79000
Engineer FTE	0	0	0.75	1.6	1.7	0.9		
postdoc FTE								
grad student FTE								