

IceCube Upgrade Rebaseline Review  
April 26-28, 2022

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WBS 1.4 Comms/Power/Timing (CPT) Systems



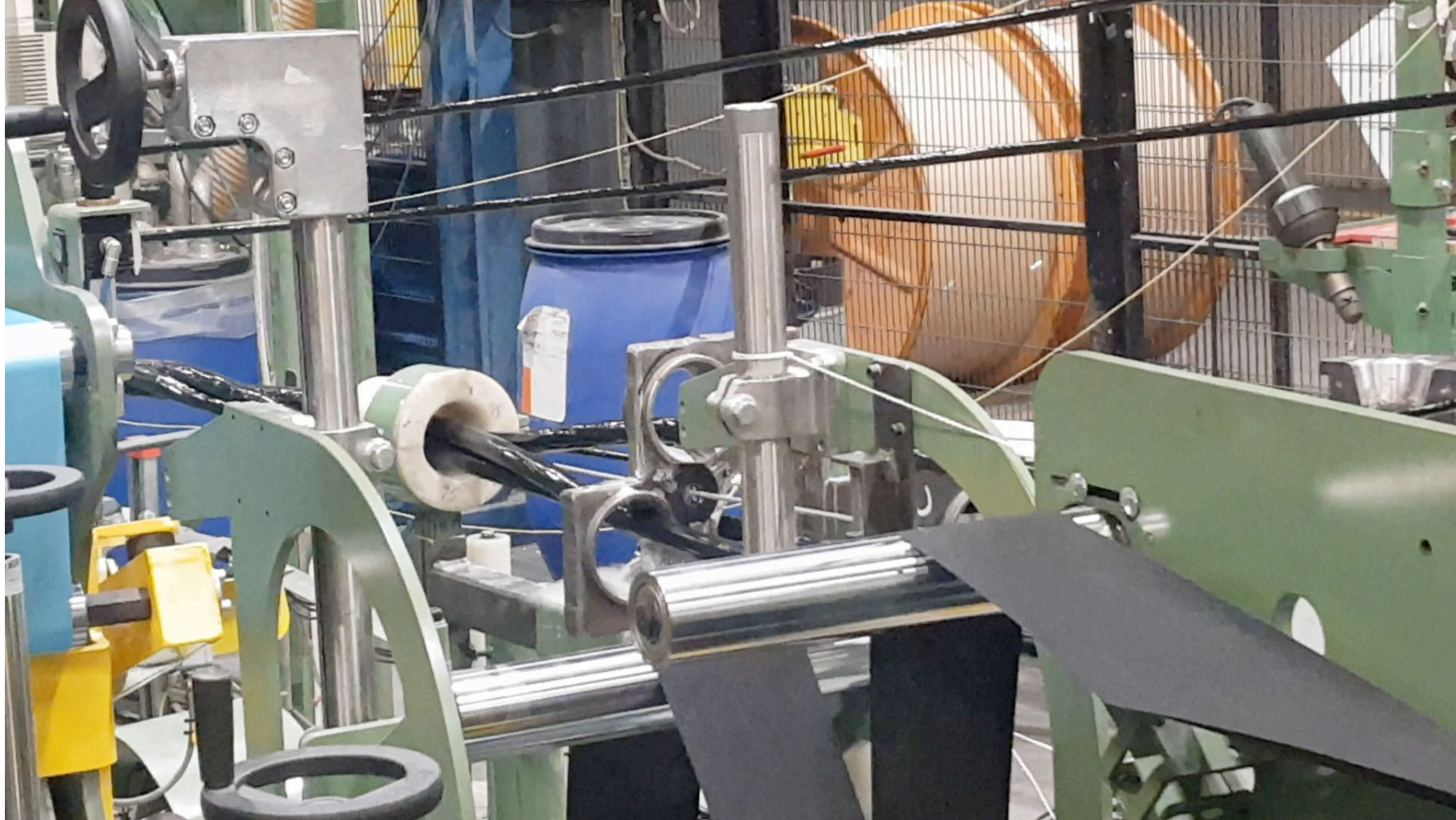
# Overview of Work to Go

- Essentially complete – will be finished in PY4:
  - Penetrators, surface cable assemblies, cable load emulators, NTS
- Mostly complete, awaiting inputs to final design:
  - Surface junction boxes (need main cable design to finalize grounding)
  - ICL patch cabling (need final ICL electronics layout to finalize lengths)
- Design work underway:
  - Main Cable Assemblies
  - Breakout Cable Assemblies
  - FieldHubs
  - Power systems
  - Timing systems

# Main Cable Assemblies (Plan A)

- Prototype cable from Hexatronic (Gen1 supplier) in production
  - Novel composite design assembled in partnership with NKT in Falun, Sweden
  - Working closely with University of Uppsala (in-kind contribution)

# Winding primary sub-components (signal cables)



# Winding primaries with auxiliary quads



# Controlling torsion during winding



# Fully-wound cable ready for outer mantle



# Main Cable Assemblies (Plan A)

- Prototype cable from Hexatronic (Gen1 supplier) in production
  - Novel composite design assembled in partnership with NKT in Falun, Sweden
  - Working closely with University of Uppsala (in-kind contribution)
- Pull test planned in next weeks to qualify raw cable mechanically
  - Confirm that subcomponents do not undergo relative motion under load
  - Load is applied via compressive cable grip, ensuring good frictional coupling between components...but need to test in real life
- Then select company to install breakout connectors
  - Discussions underway with subsea cable suppliers (JDR, Hydro Group, Fibron, South Bay)
  - Need to work on reducing costs
  - Samples of prototype main cable will reduce uncertainties for suppliers and facilitate finalization of design, including cost engineering
  - This work can proceed in parallel to production of raw main cables

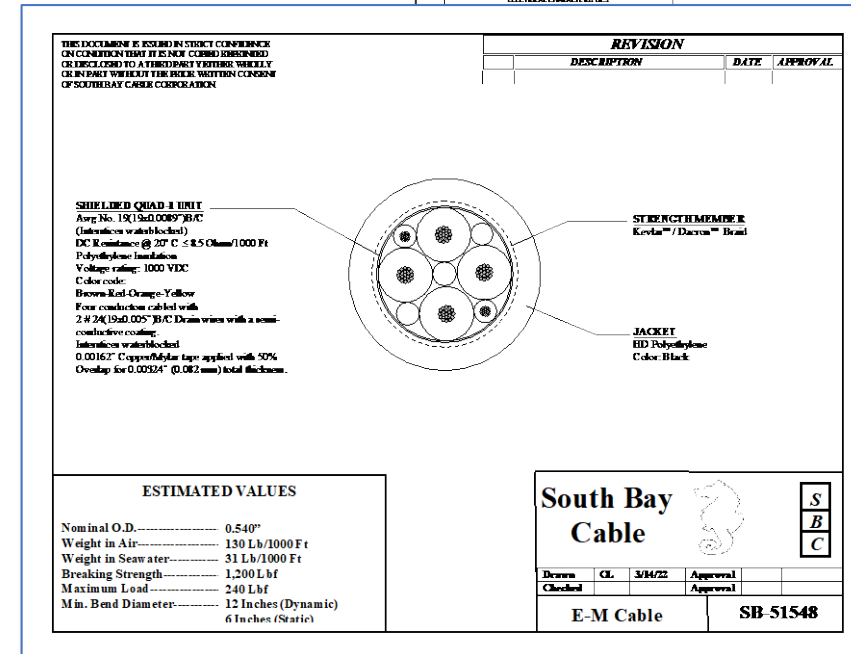
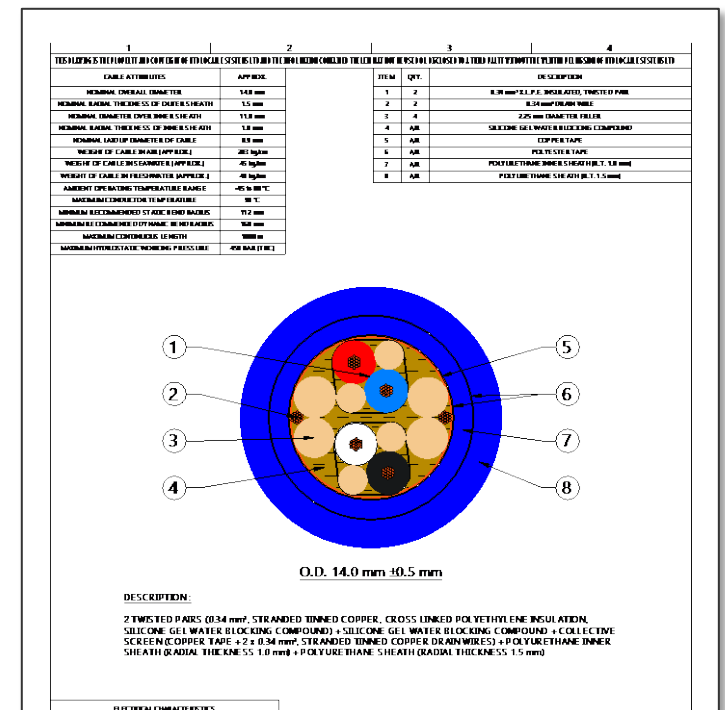


# Main Cable Assemblies (Plans B-D)

- Plan B: test cable from alternate supplier (Fibron) also in production
  - Full-length three-quad cable for evaluation of electrical properties/comms bandwidth
  - Scheduled delivery to MSU in mid-June
  - Would be used in NTS if Fibron is selected as MCA supplier
- Traditional cable design, essentially identical to Gen1 cables from Ericsson
- Fibron would also install breakouts, deliver completed product
- Based on costs of test cable, we expect cable costs to be around twice what Hexatronic is charging us
  - Likely to exceed MSU commitment, require financial support from project
  - Comms bandwidth expected to be lower than Hexatronic cable (TBD)
- Plans C&D: bid recently received from JDR; South Bay is working on another
  - Similar cost/performance concerns as for Fibron, and additional delays to obtain sample cable for qualification (around 6 months)

# Breakout Cable Assemblies

- Shorter auxiliary one-to-several cable running from Main Cable to DOMs and instruments
  - Coupled to Main Cable design
- Preliminary designs received from several companies, others expected soon
- Iterating with cable, installation teams toward a preliminary design review in late spring
- Order and test prototype(s) leading into final design review this winter
  - Production in 2023



ALL DIMENSIONS, DATA AND DIMENSIONS ARE NOT VERIFIED AND CONFORMANCE OF APPLICATION REQUIREMENTS FOR RATING FACTORS SHOULD BE APPLIED.

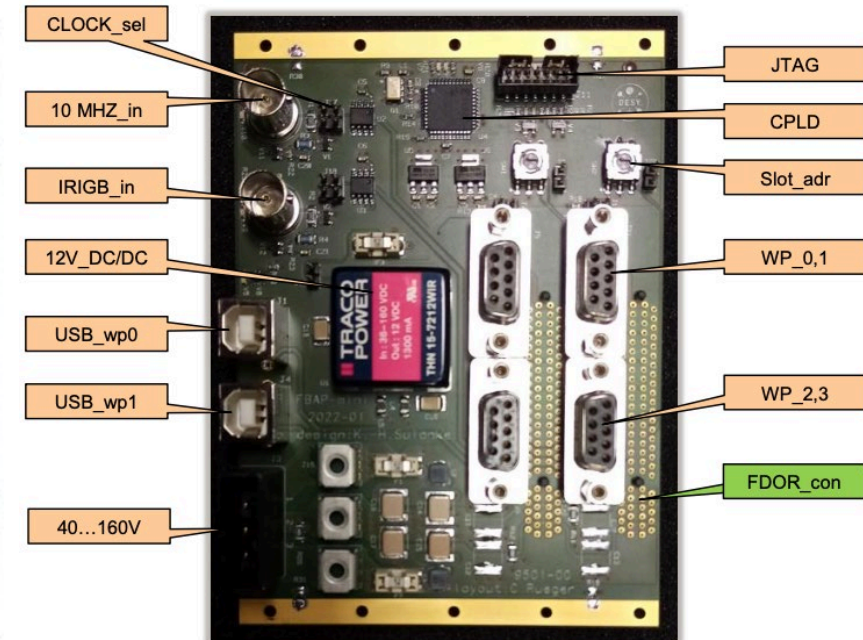
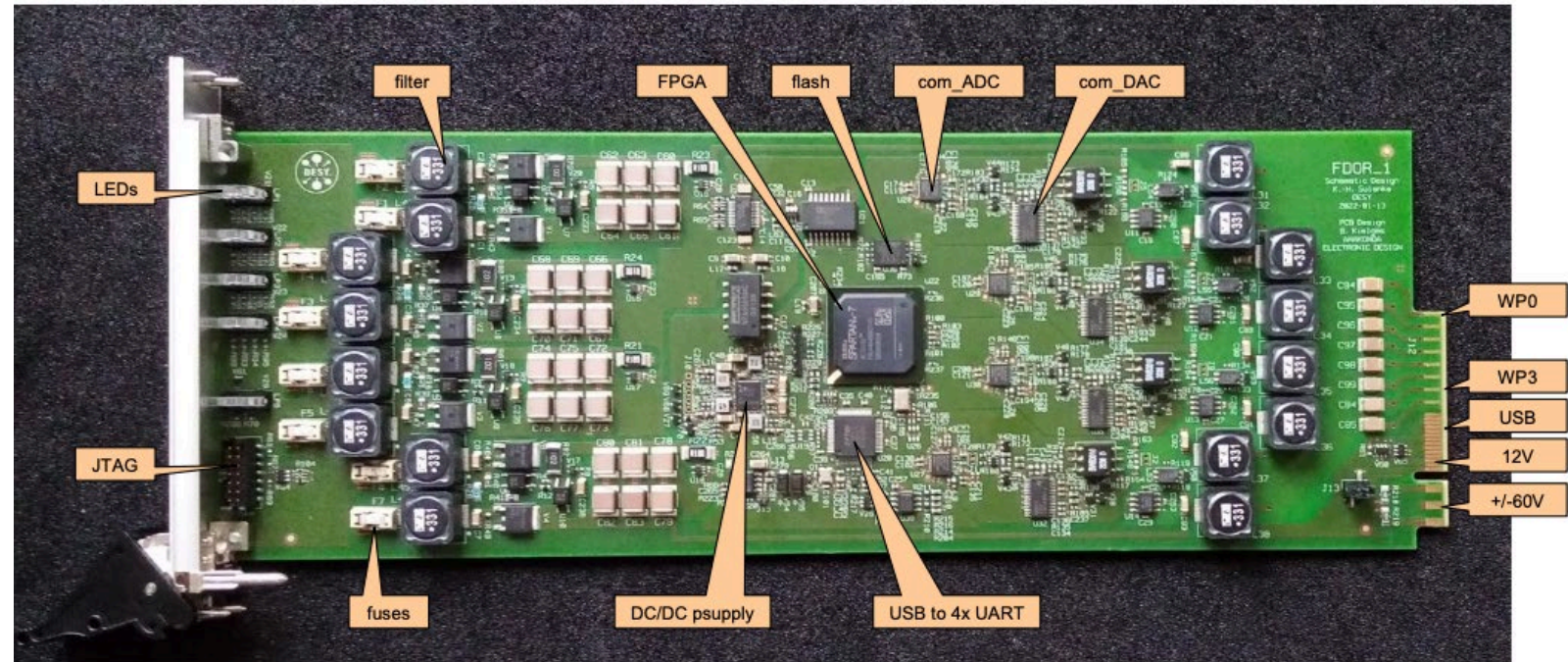
BY DRACABLE SYSTEMS, INC.  
DRACABLE SYSTEMS, INC. is a registered provider of training courses for the cable industry. For more information, visit our website at [www.dracable.com](http://www.dracable.com).

TITLE: 27P - 0.34 mm (13.4 mil) P.E. INSULATED TWISTED PAIR + SILICONE GEL WATER BLOCKING COMPOUND + COLLECTIVE SCREEN + POLYURETHANE INNER SHEATH + POLYURETHANE SHEATH

DRG. NO.: CS 8845      Rev. 15

# FieldHubs

- Evolution from “mini-FieldHubs” used for DOM development, acceptance testing
- Rev1 prototype now assembled, in testing
  - Additional prototype cycles in 2022
- Production in summer/fall 2023



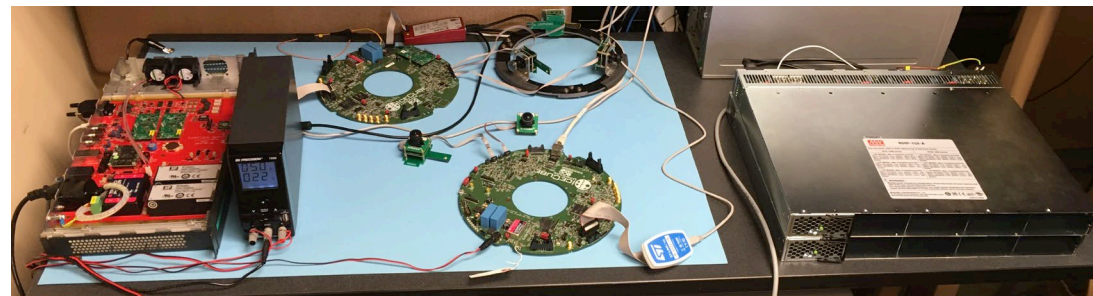
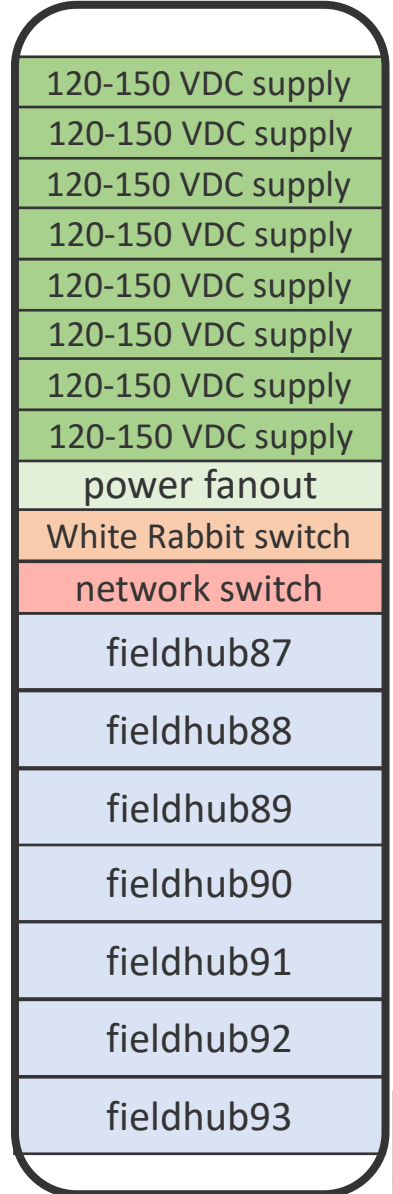
# Power System

- Redundant power supply to DOMs through the FieldHubs
  - Up to 1.3 kW / string, remote monitoring and control
- Preliminary design complete
  - trade study, evaluation of commercial power supplies
  - custom power control board design
- Next steps
  - Complete modifications for increased DOM power requirements
  - Testing at NTS with FieldHub prototype
  - Final design review 11/2022

CPT central power system



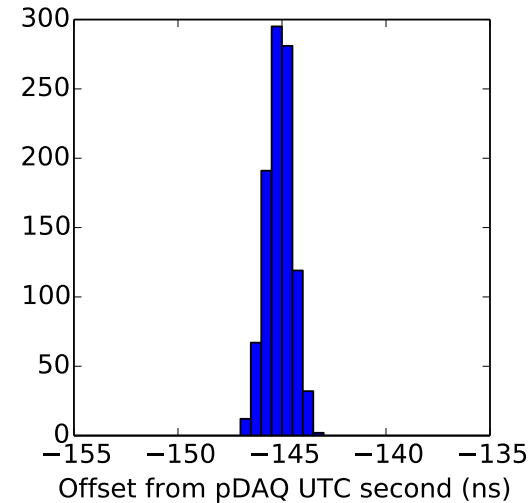
ICL Upgrade Rack



Power supply testing at DRTS

# Central Timing/Comms System

- Timing and communications via CERN White Rabbit protocol
  - Similar system currently running in ICL for IceCube surface array, timing based on existing IceCube master clock
- Preliminary design complete
  - WR switch installed at NTS
  - WR node tested with mini-FieldHub
- Will test WR node in prototype FieldHubs
  - Procure additional WR-LENs for production FHs
- Gen1/Upgrade timing offset monitoring
  - Current cross-domain timing study:  $\sigma < 1$  ns
  - Final timing monitoring system production 2024



CPT central timing system



WR-LEN in FieldHubs

ICL Upgrade Rack

