Elevated Electronics at South Pole
a.k.a
No More Digging

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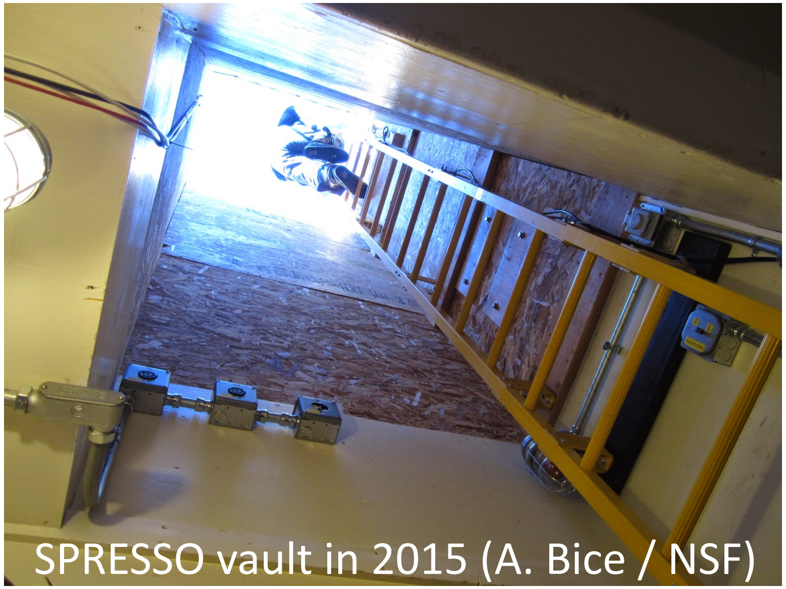
Radio Pre-meeting

28 April 2019

Fundamental Issue

- Average snow accumulation of ~25 cm / year at pole
- Vaults / enclosures with active electronics often need maintenance
  - an ARA station has been dug up every year for 5 years
  - dug up the WT3 junction box and replaced with passive electronics
  - dug up the IceCube surface array junction box twice already (once the same year it was deployed)

Solutions (I)



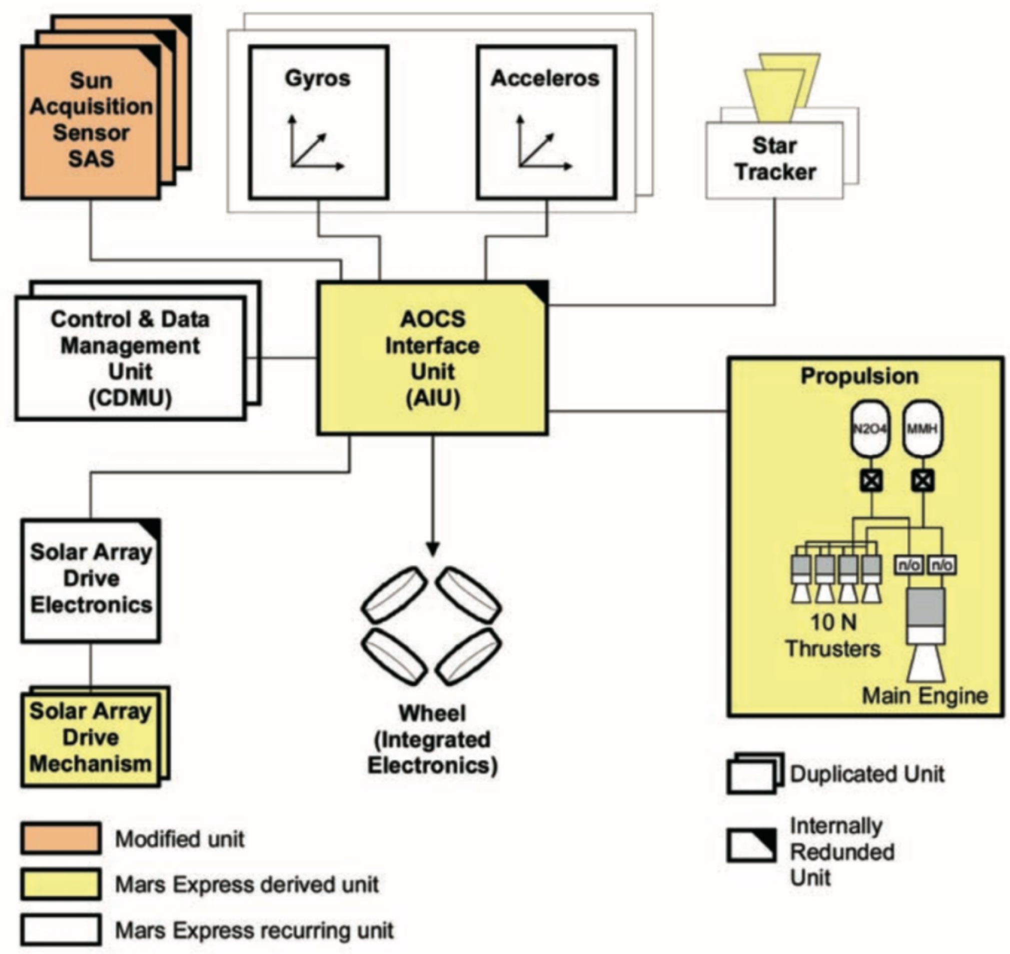
SPRESSO vault in 2015 (A. Bice / NSF)

- Add / maintain surface access to buried vaults
  - has a long history at pole (e.g. SPRESSO)
  - retrofitting existing ARA vaults with extensions
  - discouraged for new installations for safety / maintainability reasons

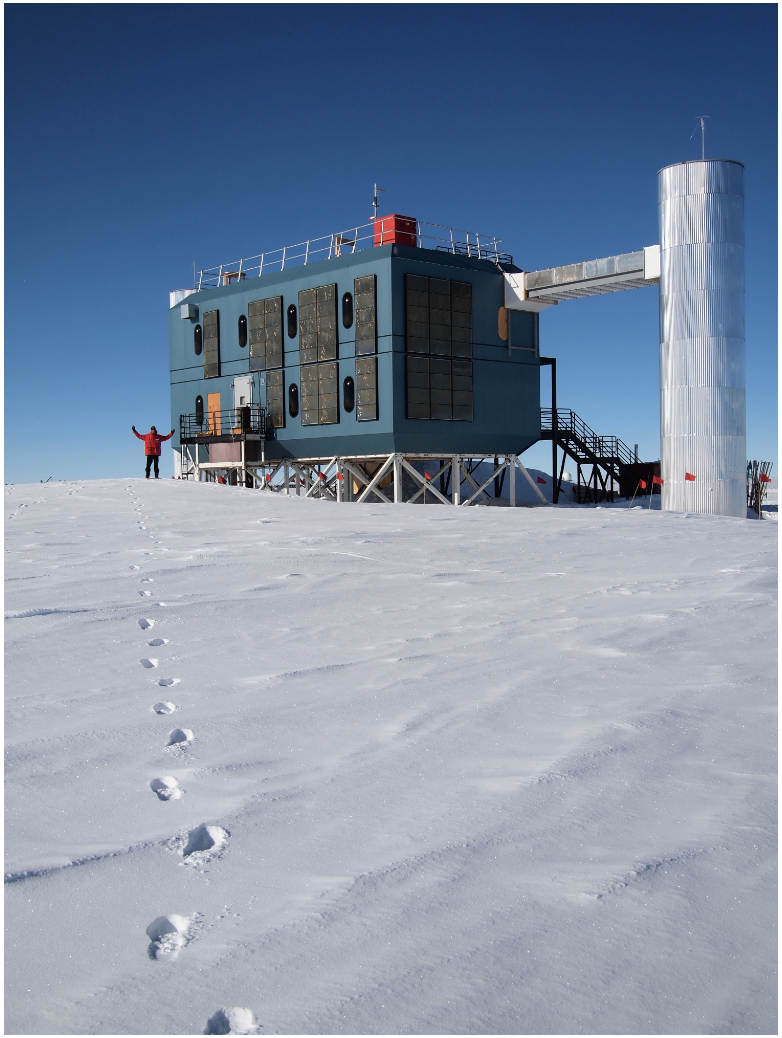
Solutions (II)

- Design for low/zero maintenance
  - many sensors, e.g. IceCube DOMs – each failure impacts at most 0.04% of detector
  - robustness via duplicated systems or internal redundancy, e.g. spacecraft
  - but… expensive and design-intensive

Control system of Venus Express spacecraft



Solutions (III)



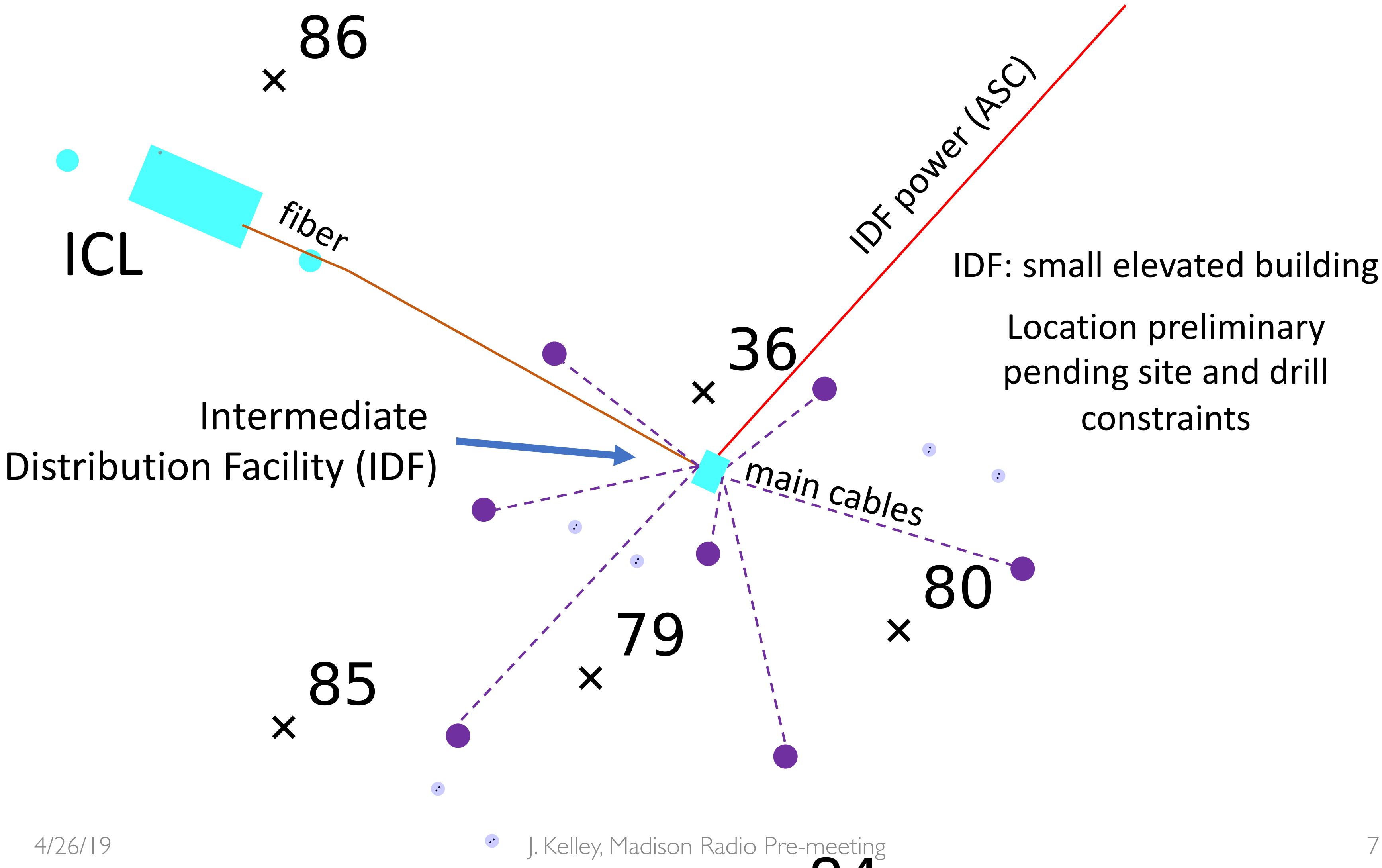
- Elevate electronics above snow
  - in separate building (e.g. ICL) or small enclosure
  - long-term maintainability implies raising regularly
  - other issues: induced snow accumulation, thermal stability, cable slack management

IceCube Upgrade

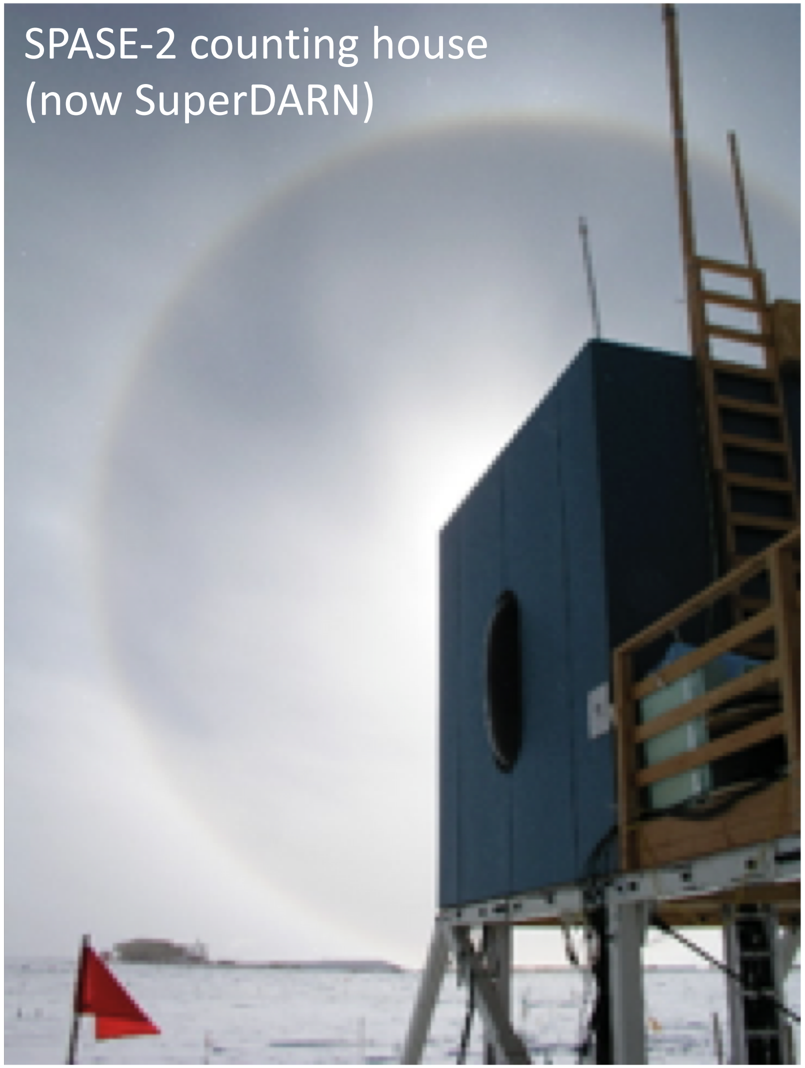
- Seven additional strings in core of detector
- Upgraded optical modules
- Redesigned surface electronics
- Deployment 2022–23

Surface Overview

Example site layout

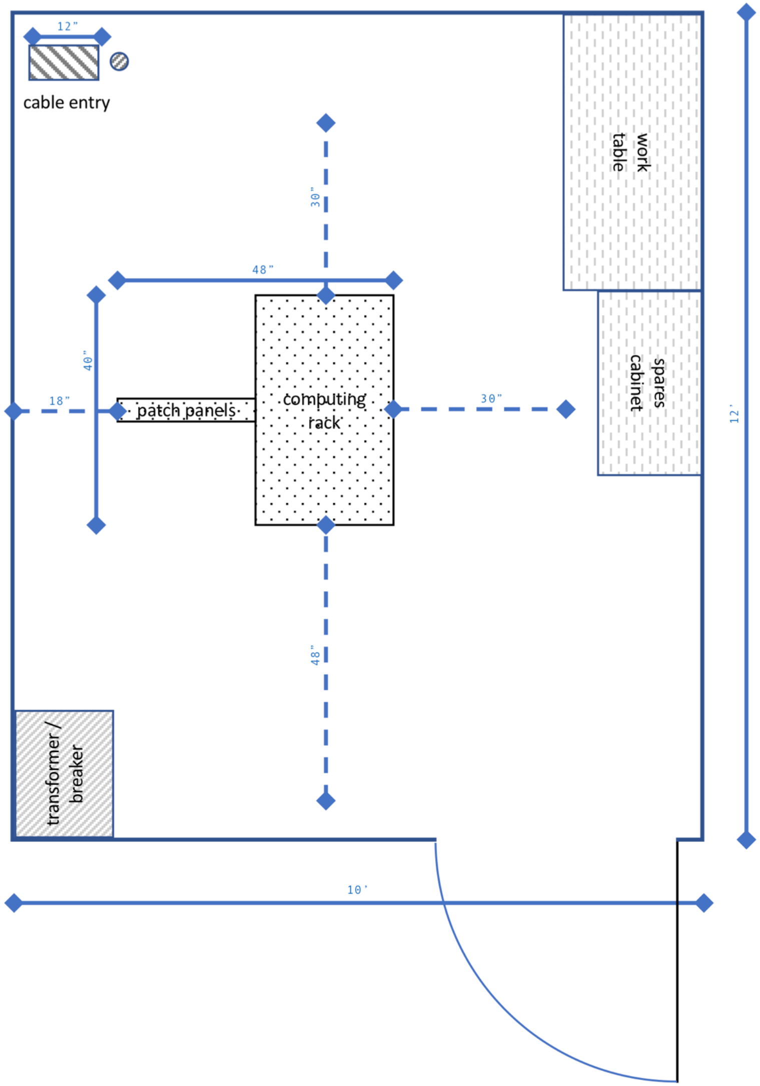


IDF Key Requirements



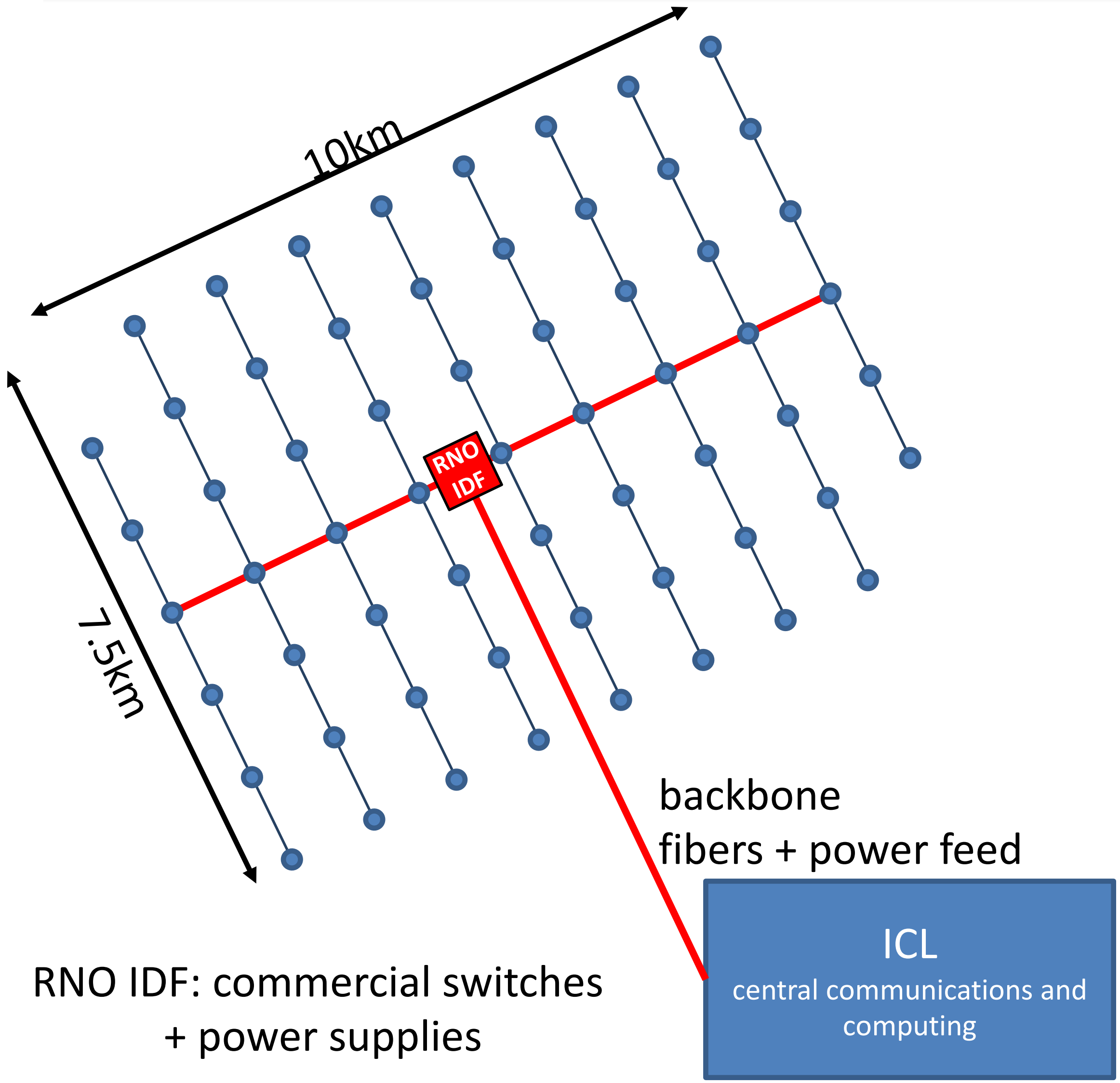
- Elevated, heated building (~4x4m)
- 30-year lifetime
  - raisable
  - cable slack not buried
- Building Faraday cage
- Support standard computing rack (208VAC)
  - custom electronics + OTS power supplies, network switches

IDF Design Status



- Finalizing building requirements with ASC
- Building could be easily copied
- Similar structure could serve as RNO power/comms primary junction

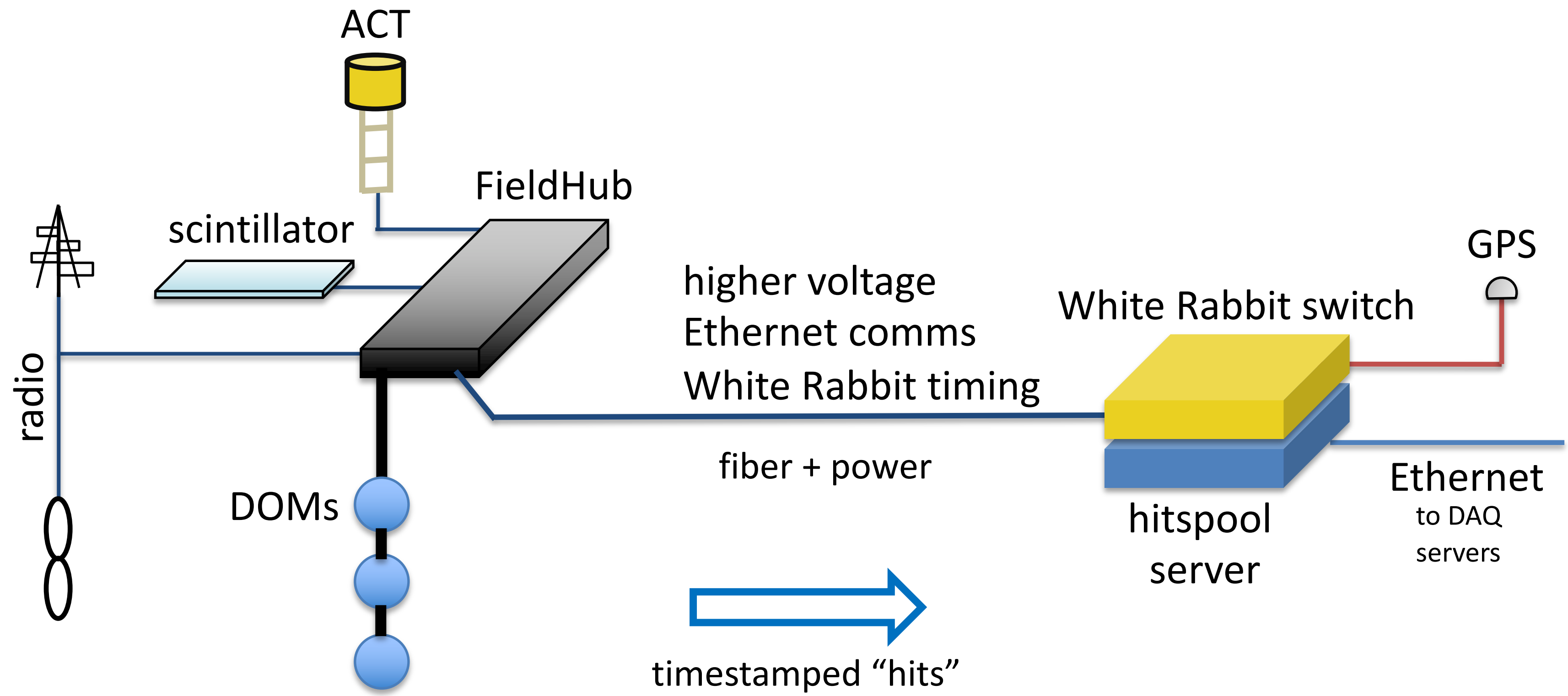
RNO Central Architecture



RNO IDF: commercial switches + power supplies

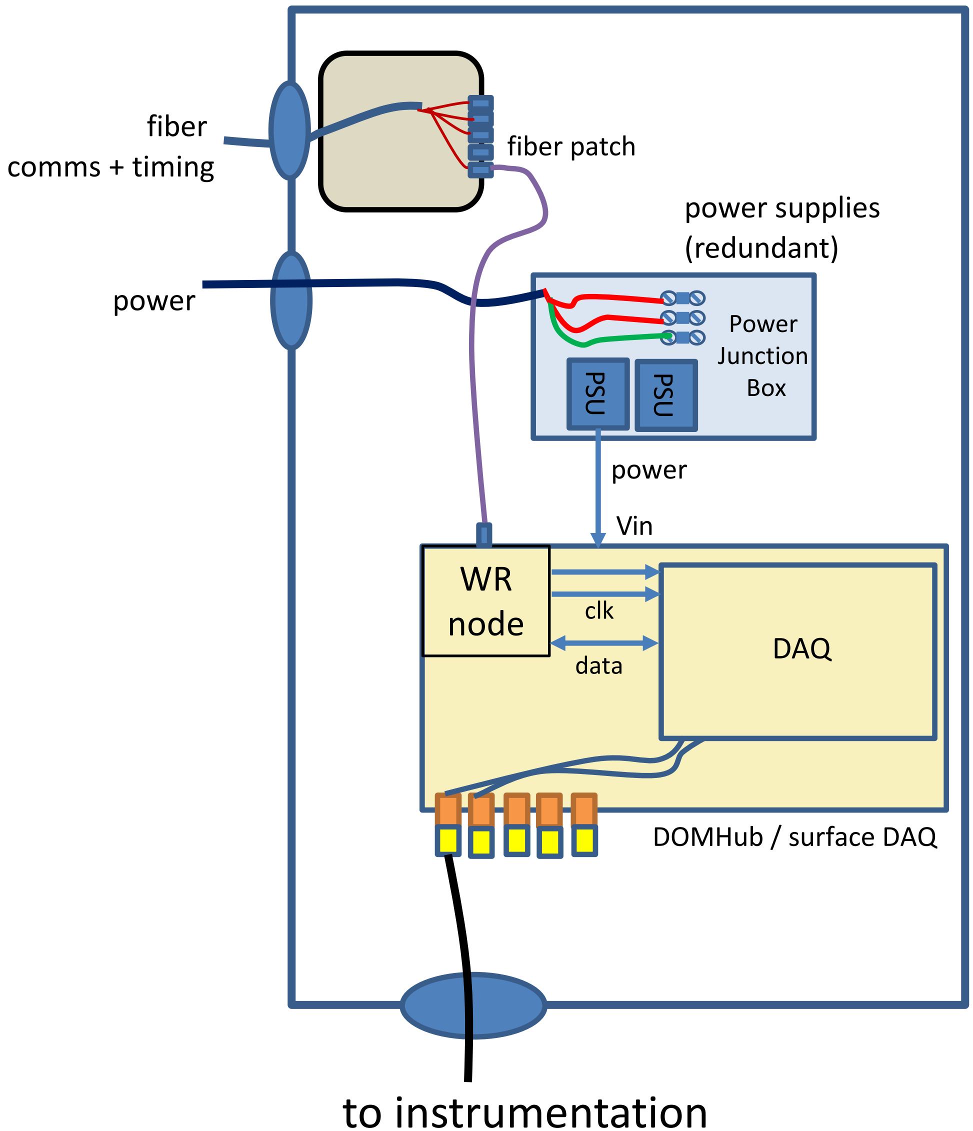
- RNO baseline
  - every fiber back to ICL
  - power supplies in ICL
- Central option
  - a few fibers from ICL to RNO IDF
  - high voltage power feed from ASC

IceCube Next-Gen Comms/Power/Timing



Goal: support a variety of instrumentation by providing standard comms/power/timing

Generic FieldHub



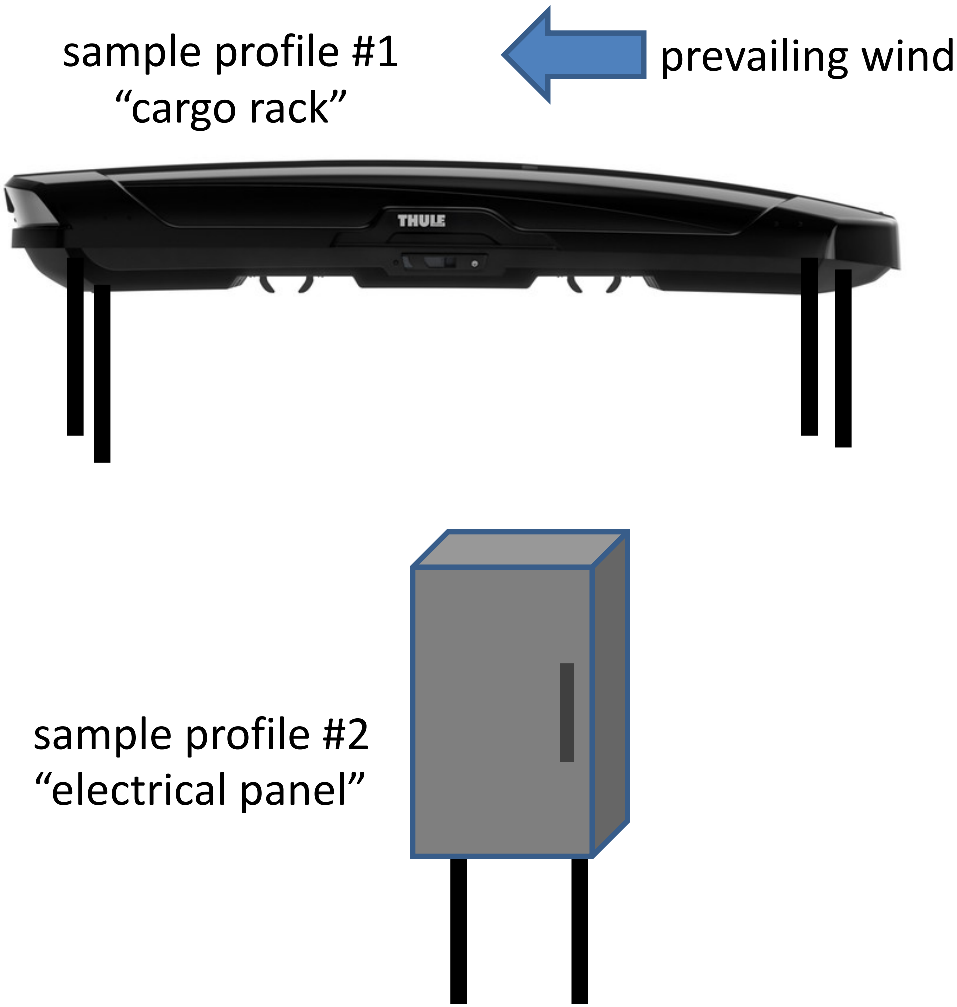
- Benefits
  - synchronize a variety of instrumentation
  - avoid timing, comms problems over long copper cables
  - lower cost and resistive losses
- Challenges
  - reliability and redundancy of field electronics
  - long-term maintainability

Current Status

scintillator FieldHubs

excavation in 2019 for radio upgrade

Elevated FieldHub

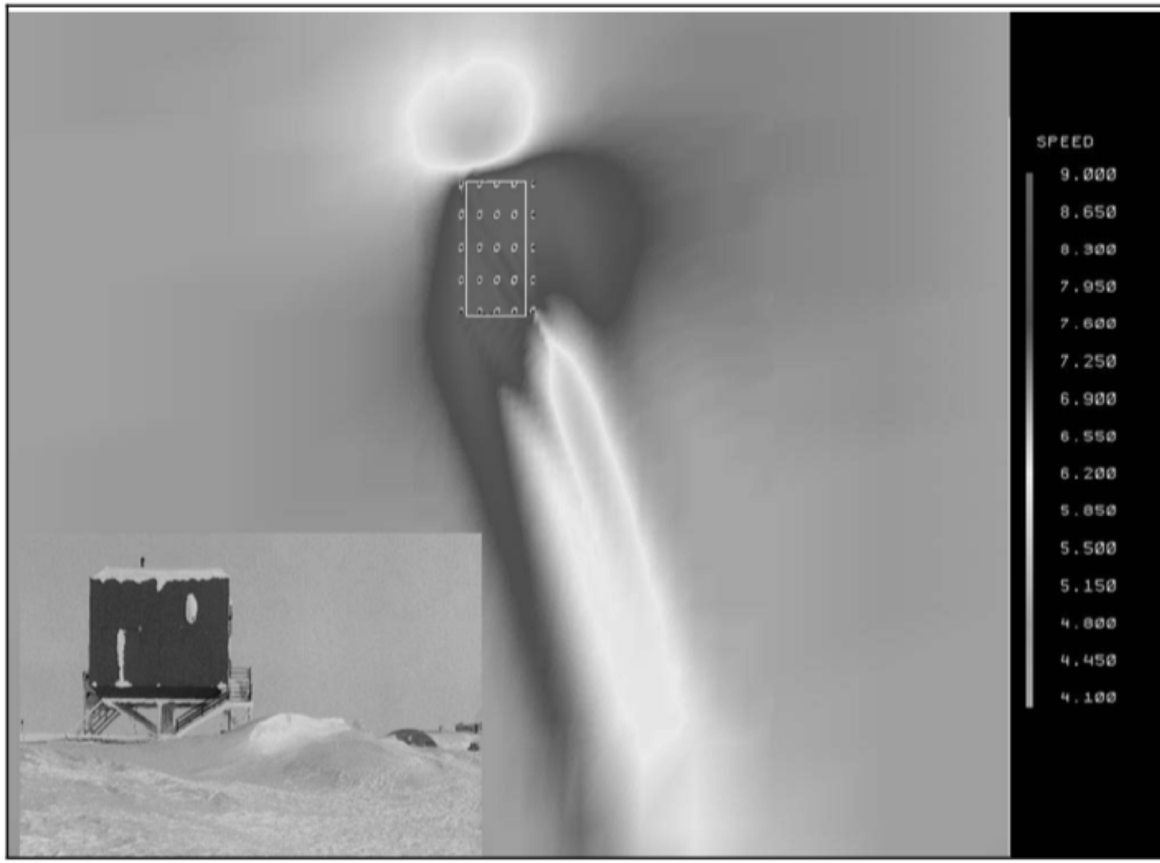


- FieldHub elevated on poles
  - easier maintenance
  - larger temperature swings
- Add UPS to cover power outages
- Improved insulation
  - investigate addition of pre-heater
  - investigate thermal buffering
- Cable management to allow raising
  - spools under box

Next Steps

- Proper mechanical / thermal design
  - minimize wind profile
  - EMI properties
- Planned prototype deployment 2019–20 season
- Investigate application to RNO stations / junction boxes

CFD simulation of wind speed around SP building



B.F.Waechter et al., *Snow engineering* (1997): 511