Detector Performance and On-site Maintenance

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Detector Operations Manager

NSF Mid-Term Review
29 April 2024

Presenter Background

- PhD 2010 UCL, London

- Joined IceCube 2013

- Assistant Scientist 2021 – present

- IceCube Detector Operations Manager 2023 – present
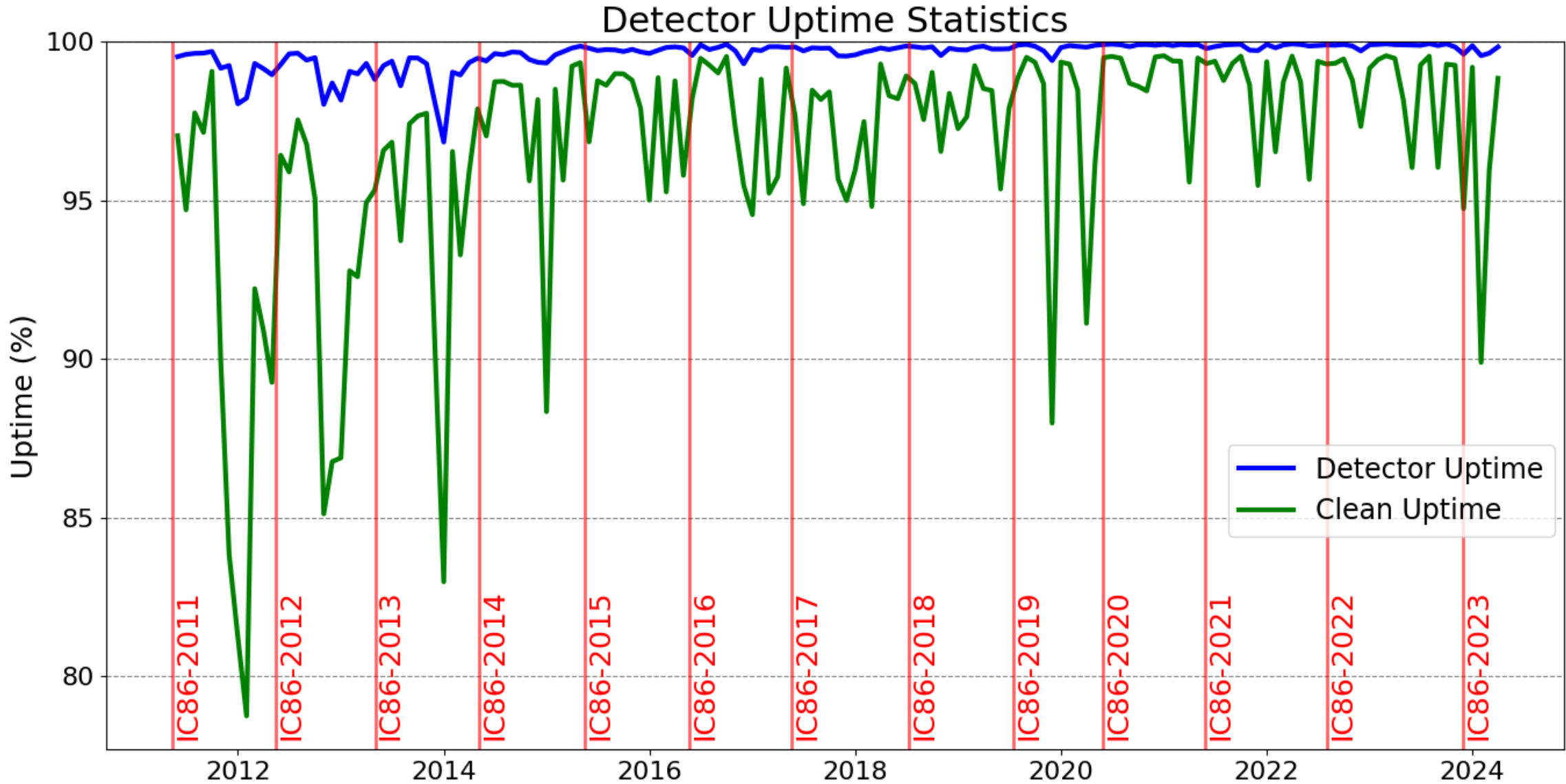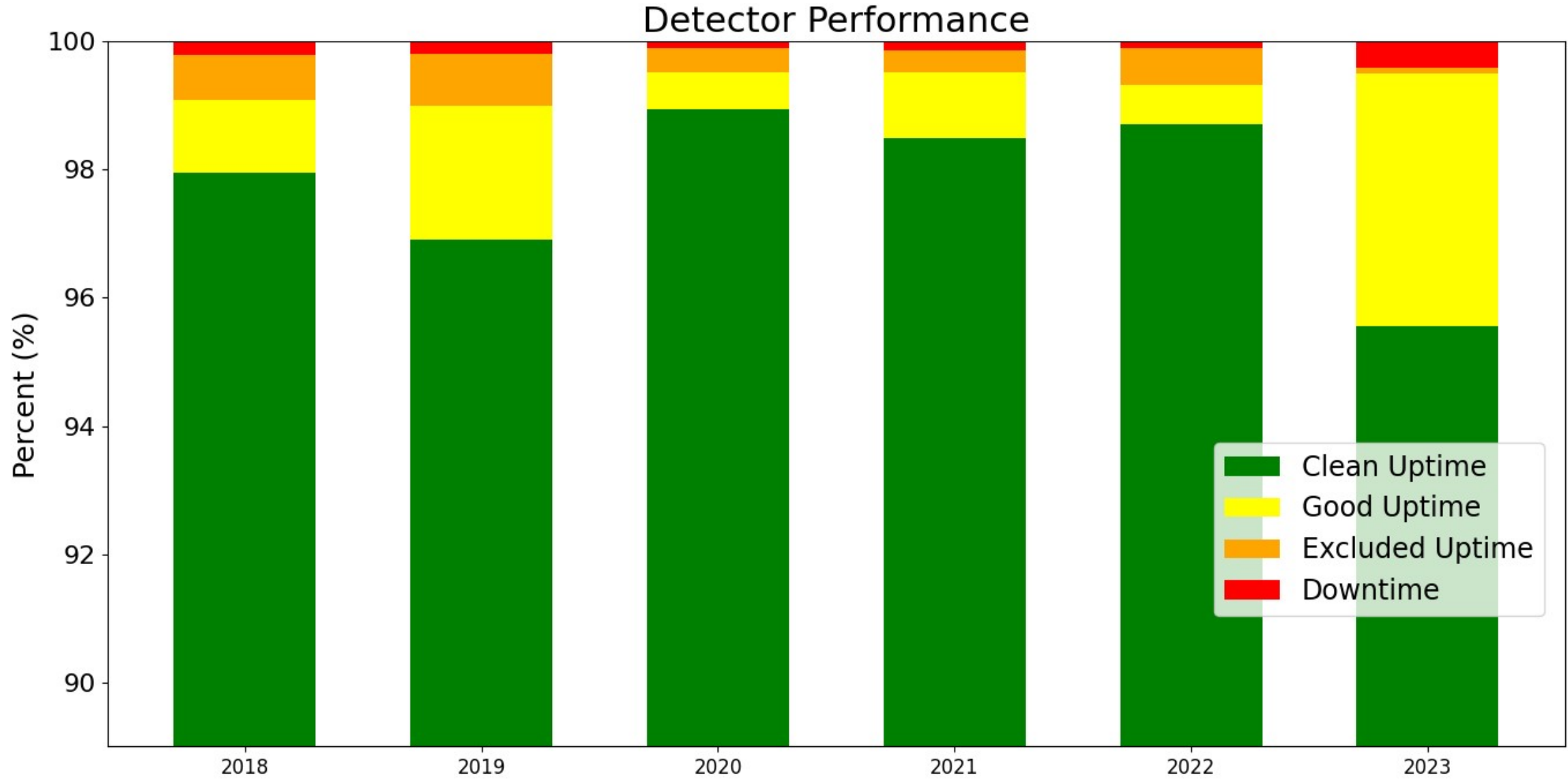
- 5 summer seasons at South Pole

Outline

- Detector Uptime

- Sub-system software updates

- Field season review
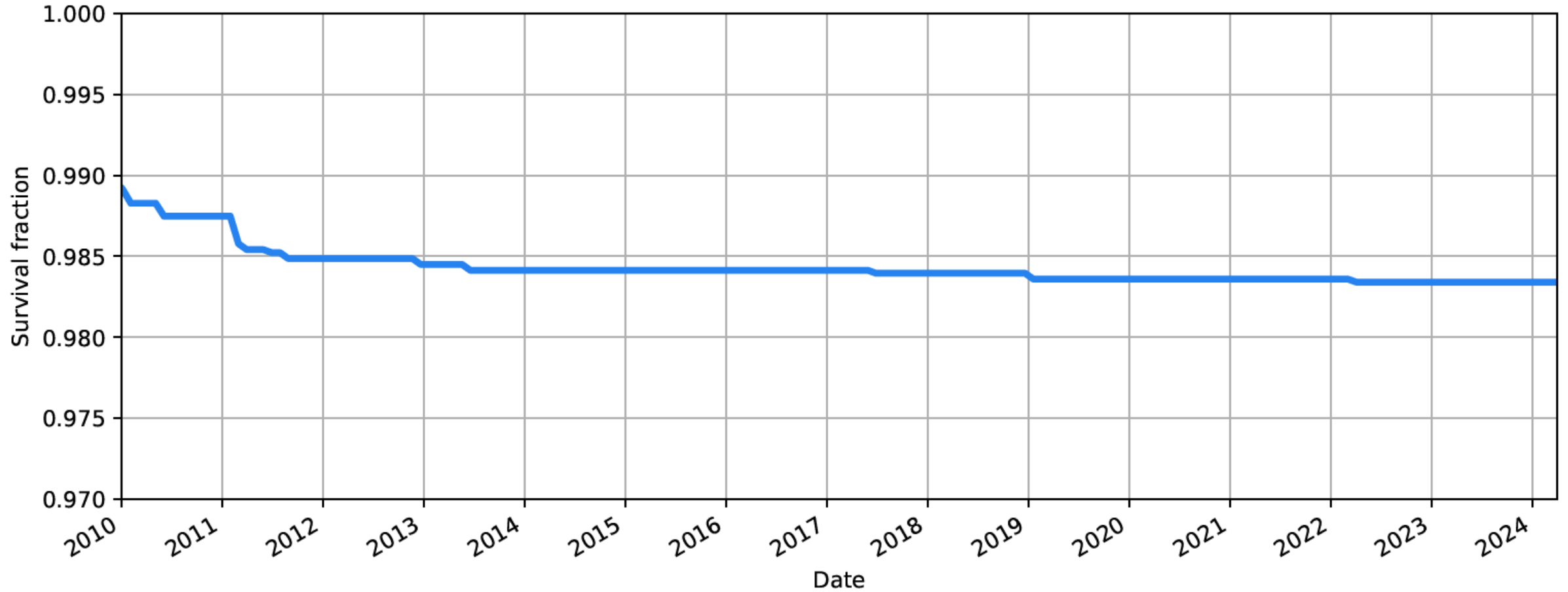
- Surface Array Enhancement

Detector Uptime

Detector Uptime Statistics

Detector Performance

DOM Survival Rate

Data Acquisition

- Python 3 support

- AlmaLinux 8 support

- HitSpool buffer increased

- DM-Ice trigger integration

- Extended DOM operating modes

  - Delayed light emission

  - DOM mainboard software updated

- Non-local-coincidence trigger (Upgrade like)

Releases
2021-07-13   Akupara2
2021-11-17   Akupara3
2022-02-10   Akupara4
2022-07-11   Akupara5
2022-12-14   Basilisk
2023-01-25   Basilisk2
2023-02-23   Basilisk3
2023-08-01   Cyclops

Supernova DAQ

- AlmaLinux 8 support

- Cern ROOT 6.x support

- Fast Response System implemented

  - External alerts forwarded for IceCube follow-up (star mergers, etc.)

- Continued progress toward PySNDAQ

Releases
2021-06-29   BT-19.1
2021-11-24   BT-20.0
2021-11-25   BT-20.1
2023-04-19   BT-20.2

I3Live

- Python 3 support

- AlmaLinux 8 support

- Updated JavaScript support

- Integrated calendar for coordinating operations

- Improved user control interface

- Support for the Supernova Fast Response System

Releases
2021-06-29   v4.4.0 (Enterprise)
2021-09-21   v4.4.1 (Enterprise2)
2021-10-13   v4.4.2 (Enterprise3)
2022-02-08   v4.5.0 (Falcon)
2022-03-15   v4.5.1 (Falcon2)
2022-07-21   v4.6.0 (Galactica)
2023-01-05   v4.6.1 (Galactica2)
2023-02-15   v4.6.2 (Galactica3)
2023-04-19   v4.7.0 (Hyperion)
2023-08-31   v4.7.1 (Hyperion2)
2023-11-28   v4.7.2 (Hyperion3)
2024-02-20   v4.8.0 (Icarus)

Processing and Filtering

- IceTop hit information added to the realtime analysis

- Memory leak identified and resolved

- Improved user control interface

- Additional monitoring of IceTop DOMs

- Updated for Python 3 and AlmaLinux 8

- New filtering concept for IC86-2023

Releases
|	
2021-05-27	V21-04-00
2021-11-18	V21-10-00
2022-01-17	V21-10-01
2022-03-01	V21-10-02
2022-04-14	V21-10-03
2022-07-12	V21-10-05
2022-08-03	V22-08-00
2023-02-15	V23-01-00
2023-07-18	V23-06-00
2023-11-28	V23-11-00
2023-12-01	V23-11-02
2023-12-07	V23-11-03
2023-12-21	V23-11-04

IC86-2023 Physics Run Start

- Run start on Nov 28, 2023
- Two new triggers
- Generalized filtering concept
- Online software SMT-12
- Less computationally expensive at pole
- Working groups have more flexibility

previous

```
   ┌─────────────────────────┐
   │   Trigger (~2.7 kHz)     │
   └─────────────────────────┘
              │
South Pole    ▼
   ┌─────────────────────────┐
   │   Online Filter (L1)     │
   │     (~4-500 Hz)          │
   └─────────────────────────┘
   ········································
   ┌─────────────────────────┐
   │   Offline Filter (L2)    │
   │      (~300 Hz)           │
   └─────────────────────────┘
WIPAC         │
Computing     ▼
   ┌─────────────────────────┐
   │    Level3 Filters        │
   │      (< few Hz)          │
   └─────────────────────────┘
```

IC86-2023

```
   ┌─────────────────────────┐
   │   Trigger (~2.7 kHz)     │
   └─────────────────────────┘
              │
              ▼
   ┌─────────────────────────┐
   │   Generate SuperDST      │
   │      (~2.7 kHz)          │
   └─────────────────────────┘
              │
              ▼
   ┌─────────────────────────┐
   │  Event trigger selection │
   │       (~1.4 kHz)         │
   └─────────────────────────┘
   ········································
   ┌─────────────────────────┐
   │  New/cleaned WG Filters  │
   │       (< few Hz)         │
   └─────────────────────────┘
```

IC86-2022

Name
CascadeFilter_13
DeepCoreFilter_13
DMIceTrigFilter_22
EHEAlertFilter_15
EHEAlertFilterHB_15
EstresAlertFilter_18
FilterMinBias_13
FixedRateFilter_13
FSSCandidate_13
FSSFilter_13
GFUFilter_17
GRECOOnlineFilter_19
HESEFilter_15
HighQFilter_17
I3DAQDecodeException
IceActTrigFilter_18
IceTop_InFill_STA2_17
IceTop_InFill_STA3_13
IceTop_SouthwestNHLCTank1_22
IceTopSTA3_13
IceTopSTA5_13
InIceSMT_IceTopCoincidence_13
LID
LowUp_13
MESEFilter_15
MonopoleFilter_16
MoonFilter_13
MuonFilter_13
OnlineL2Filter_17
ScintMinBias_16
SDST_IceTop_InFill_STA3_13
SDST_IceTopSTA3_13
SDST_InIceSMT_IceTopCoincidence_13
SlopFilter_13
SunFilter_13
VEF_13

IC86-2023

Name
FixedRateTriggerFilter
GFUFilter_23
HESEFilter_23
HighQFilter_23
I3DAQDecodeException
Keep_SuperDST_23
MinBiasFilter
MuonFilter_23
OnlineL2Filter_23
SoftwareSMT12Filt_23
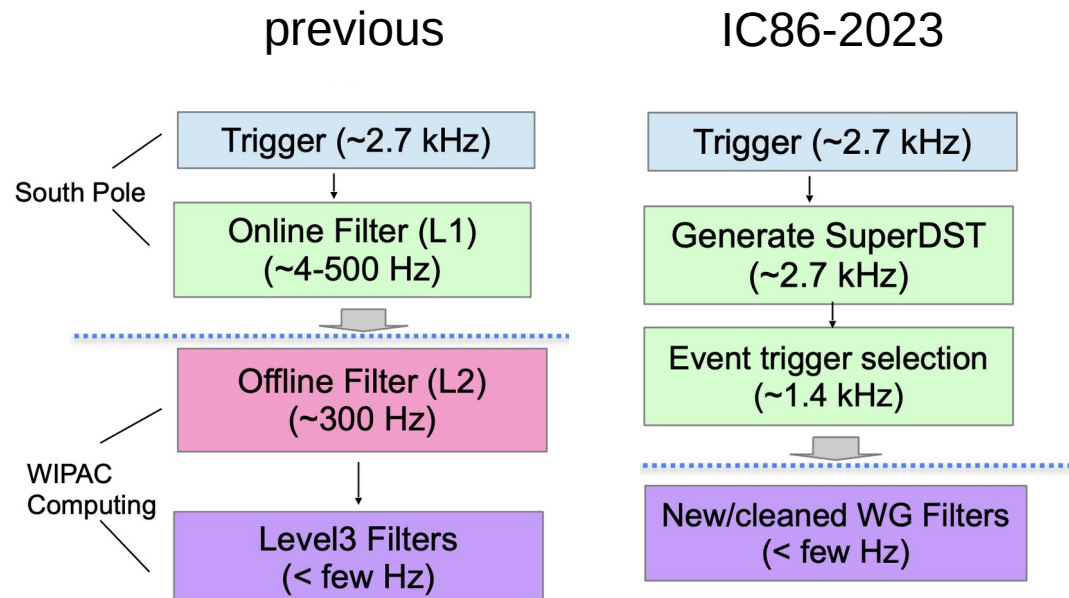
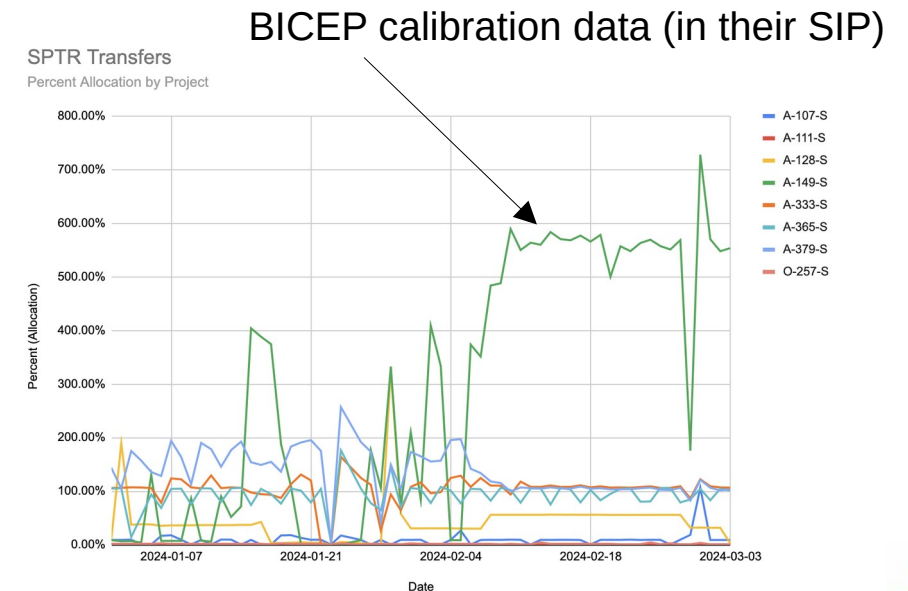# Data Transfer Bandwidth

90 GB/day in July 2023 (low event rate)

110 GB/day in Jan. 2024 (high event rate)
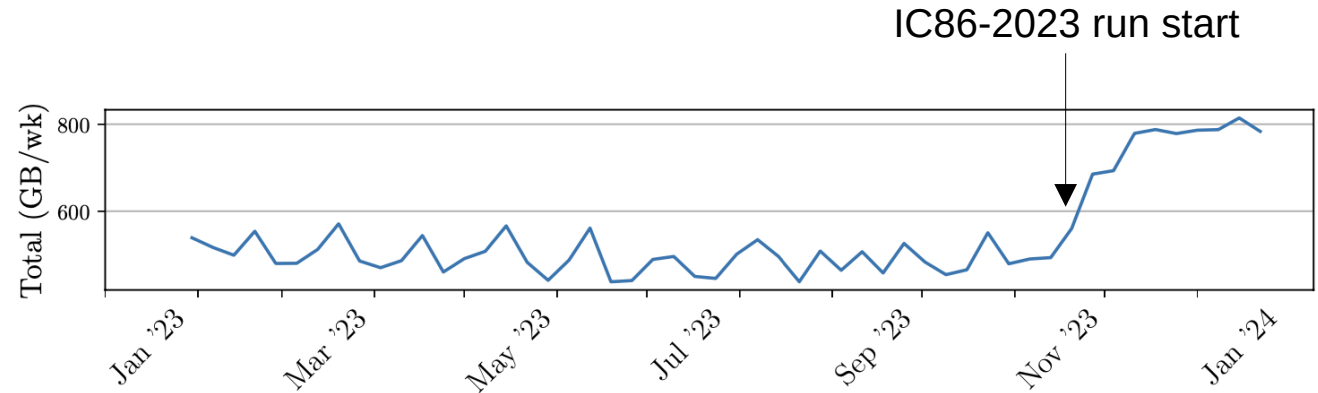
IC86-2023 run start

- A little more data since IC86-2023 run start

- Coordinating with SPT and BICEP

- Plan to request 5-10% increase

BICEP calibration data (in their SIP)

Logistics Challenges

- Population limited since COVID

- Keeping up with critical tasks so far, but it's not sustainable long-term

- Limited personnel rotations is challenging
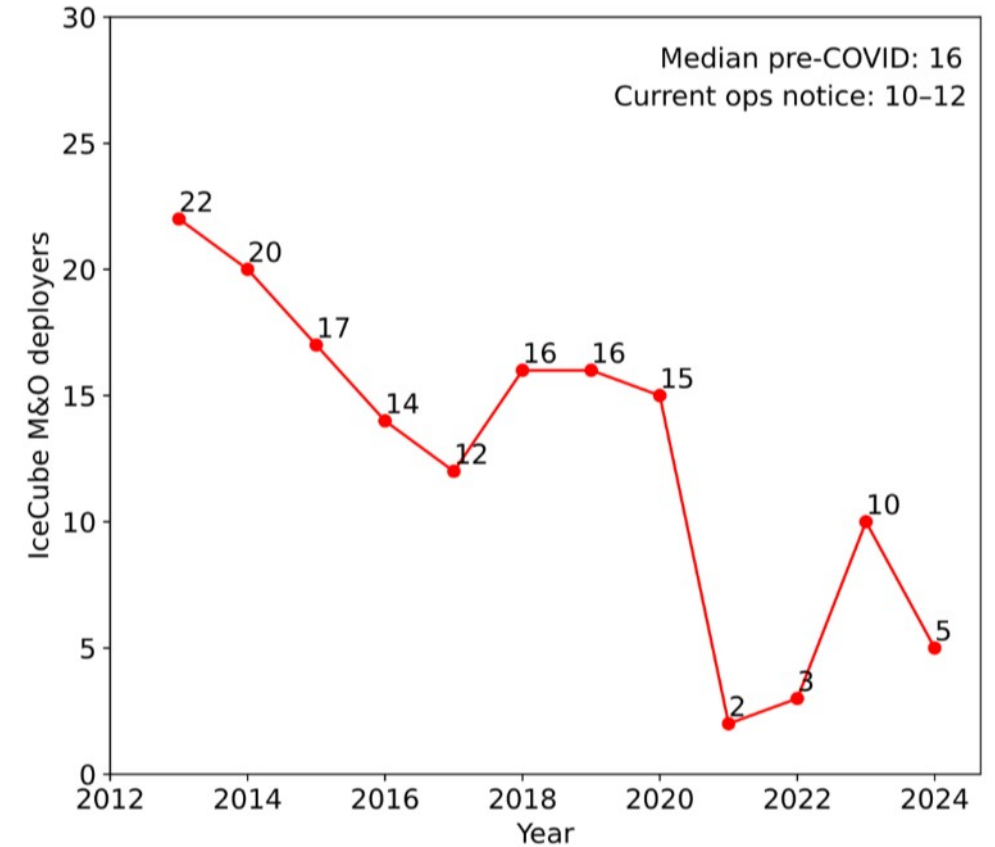
2021-22 Field Season

- OS upgrade to AlmaLinux 8.4
  - New hard drives
- Surface array maintenance
  - Updated FieldHub electronics
  - Repair scint light leaks
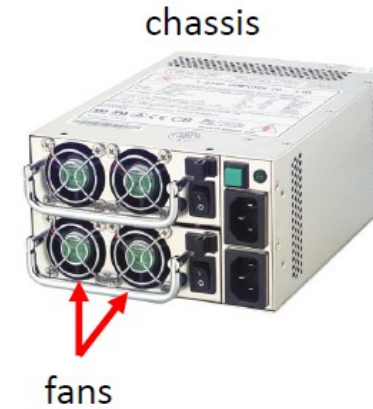- Wind turbine installation
 - Data logging

TAXI DAQ inside of the Fieldhub

VINDKRAFTVERK™

2022-23 Field Season

- ATX power supply maintenance
  - Failed fans and chassis replaced
- Surface array maintenance
  - All instruments raised
  - New scint with improved dynamic range
- ARA-4 DAQ electronics retro
- Starlink beta test
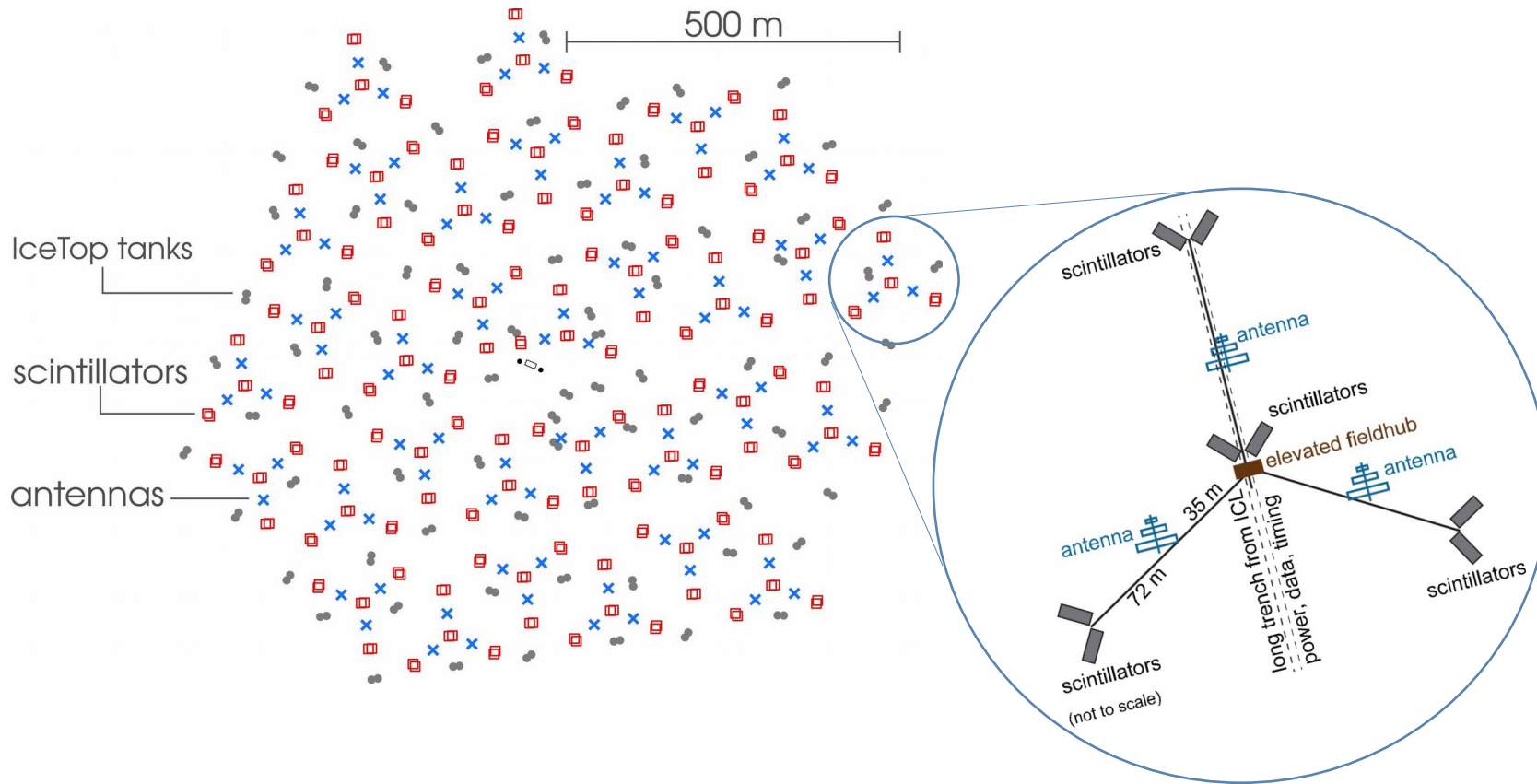- Prep for Upgrade electronics

chassis

fans
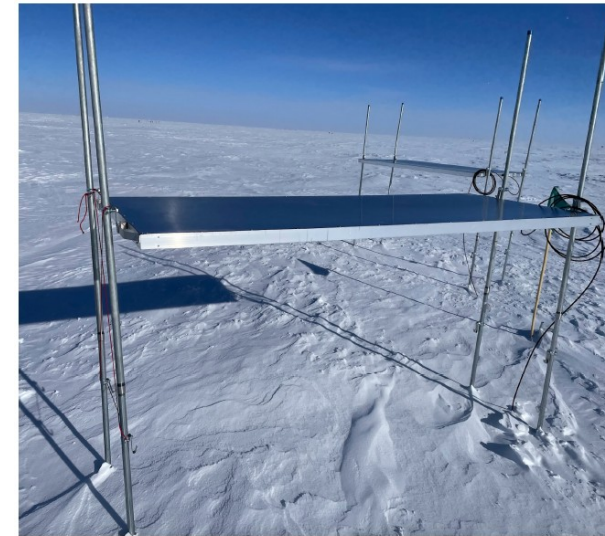
upgraded scintillator panels, after raise

2023-24 Field Season

- Network switch lifecycle replacement

- UPS lifecycle replacement

- Wind turbine upgrade

- IceACT maintenance

- ARA-4 vault extension

- Upgrade cable prep
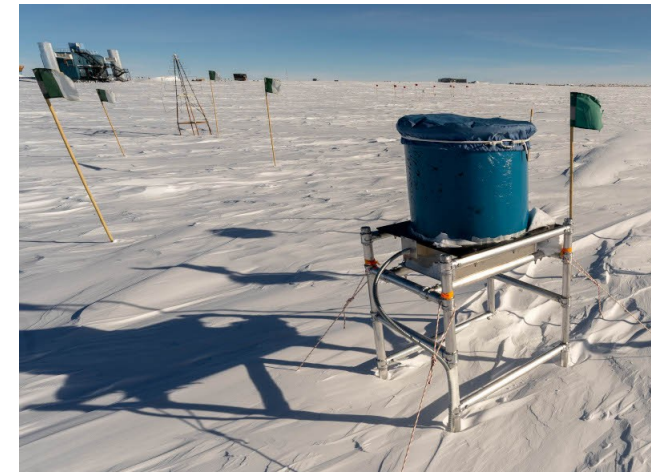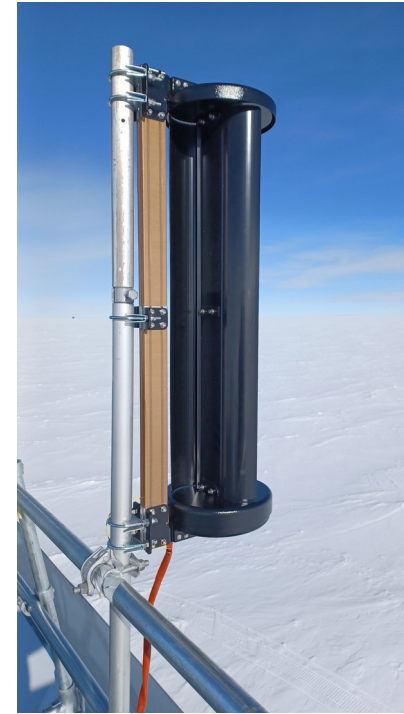
IceTop Surface Array Enhancement

Science and Calibration goals
- better estimation of atmospheric backgrounds
- calibrate IceTop snow attenuation
- testbed for Upgrade and Gen2

A Path Forward

- Successful prototype station

- Construction previously limited by COVID, available logistics support, population limitations, etc.

- Detectors produced for 12 stations.

- 2023-24 deployments deferred. Propose resuming deployments for 2024-25.

- Goal: compact sub-array deployed before Upgrade drilling season.
  - can partially achieve most goals of the full surface array.
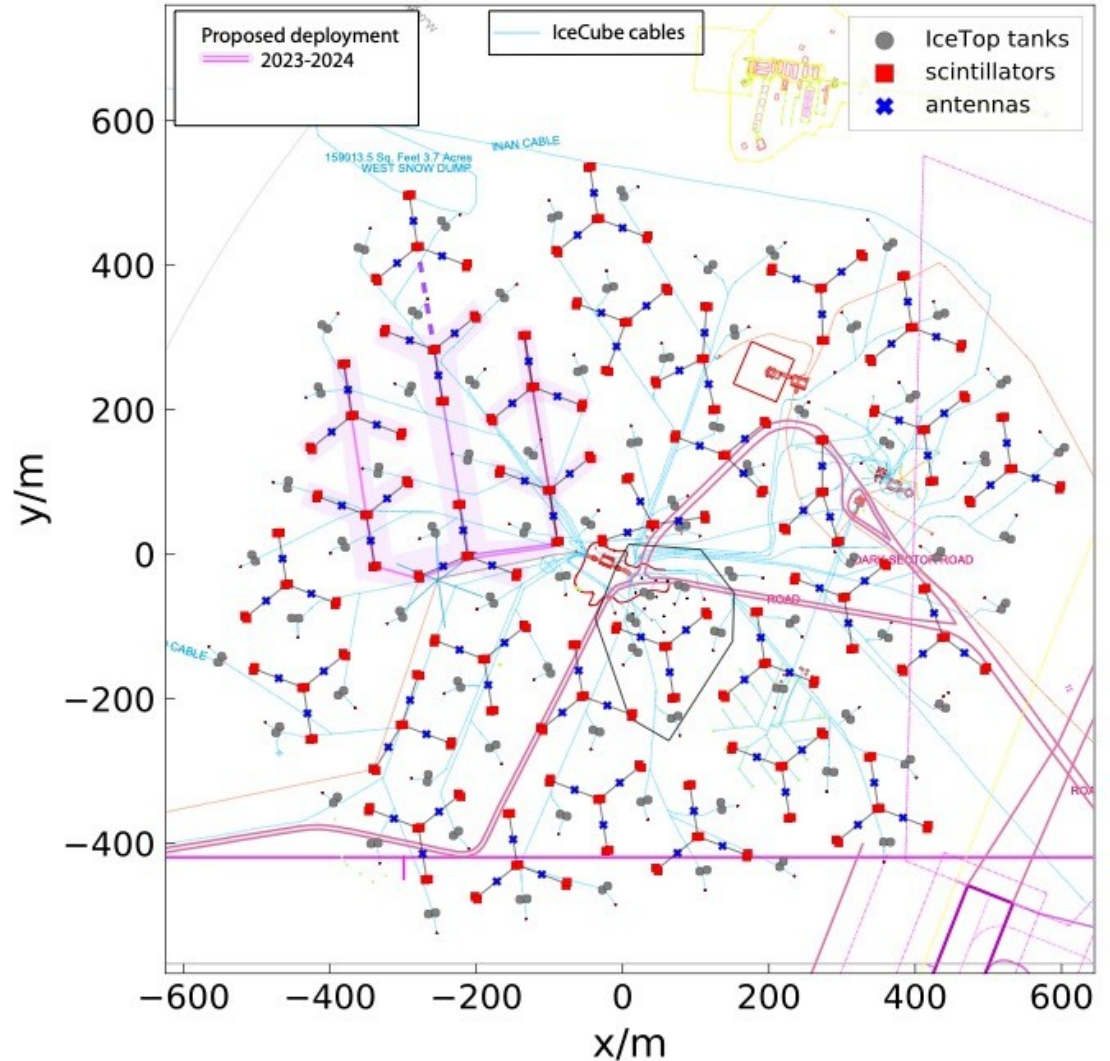
Summary

- Critical hardware and software maintenance prioritized

    – Not sustainable long-term

- Supporting new science is increasingly difficult due to constraints on cargo, field support and personnel.

    – ARA, Surface Array, IceACT