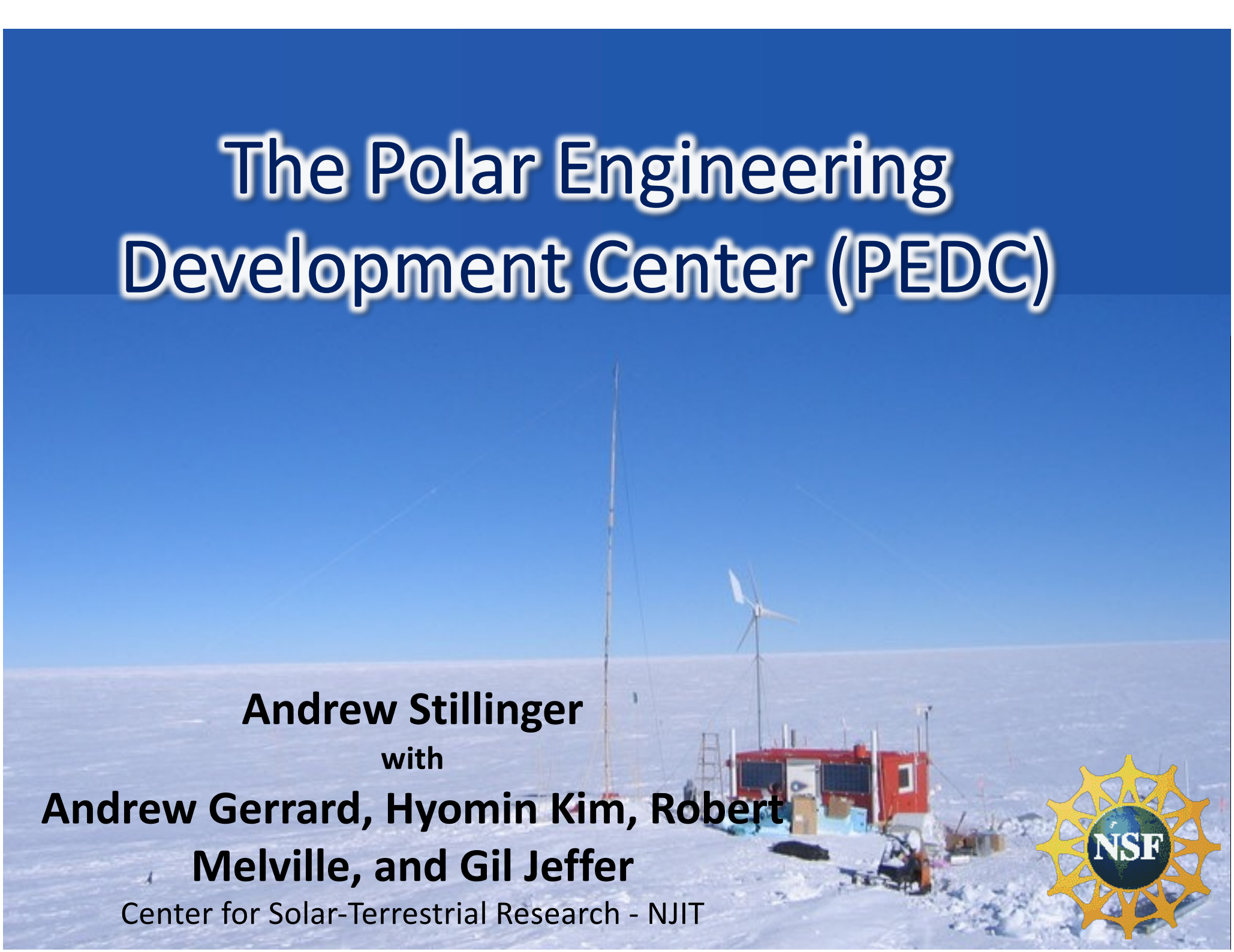
The Polar Engineering Development Center (PEDC)



Andrew Stillinger

with

Andrew Gerrard, Hyomin Kim, Robert Melville, and Gil Jeffer

Center for Solar-Terrestrial Research - NJIT

What is the PEDC?

The PEDC, housed at the New Jersey Institute, consists of a highly skilled group of collegiate professors, research scientists, electrical and mechanical engineers, and technicians that have decades of experience in instrument and hardware design for deployment at high latitude/polar regions.

Now supported by NSF and reaching out to serve the broader astrophysical and geospace scientific communities conducting research in polar environments by providing support in the areas of:

(a) sustainable “green” power generation in the 10-W to 500-W range,
(b) power conditioning and control,
(c) robust engineering for polar climates,
(d) data acquisition techniques, units, and transmission services, and
(e) general polar field support.

The original group was formed in the 1980’s as part of the NSF-supported Automatic Geophysical Observatory (AGO) program which operates to this day on projects active across the Antarctic ice shelf. ***And which we are most known for…***

US AGO Program

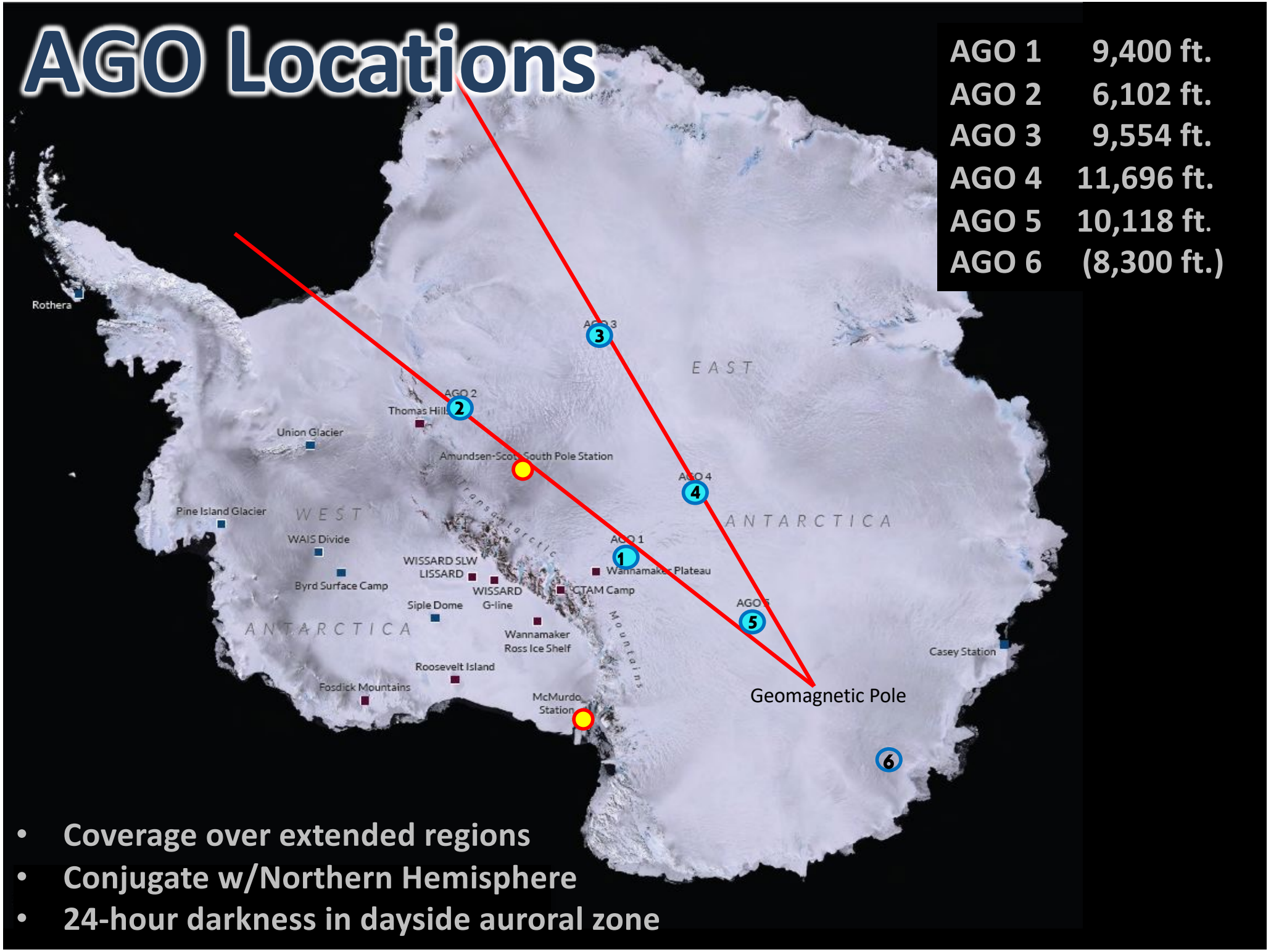
AGO at SPA in 1983.

AGO at McMurdo in 1991.

AGO	Date established
AGO-1	January 1994
AGO-2	December 1992
AGO-3	January 1995
AGO-4	January 1994
AGO-5	January 1996
AGO-6	February 1997

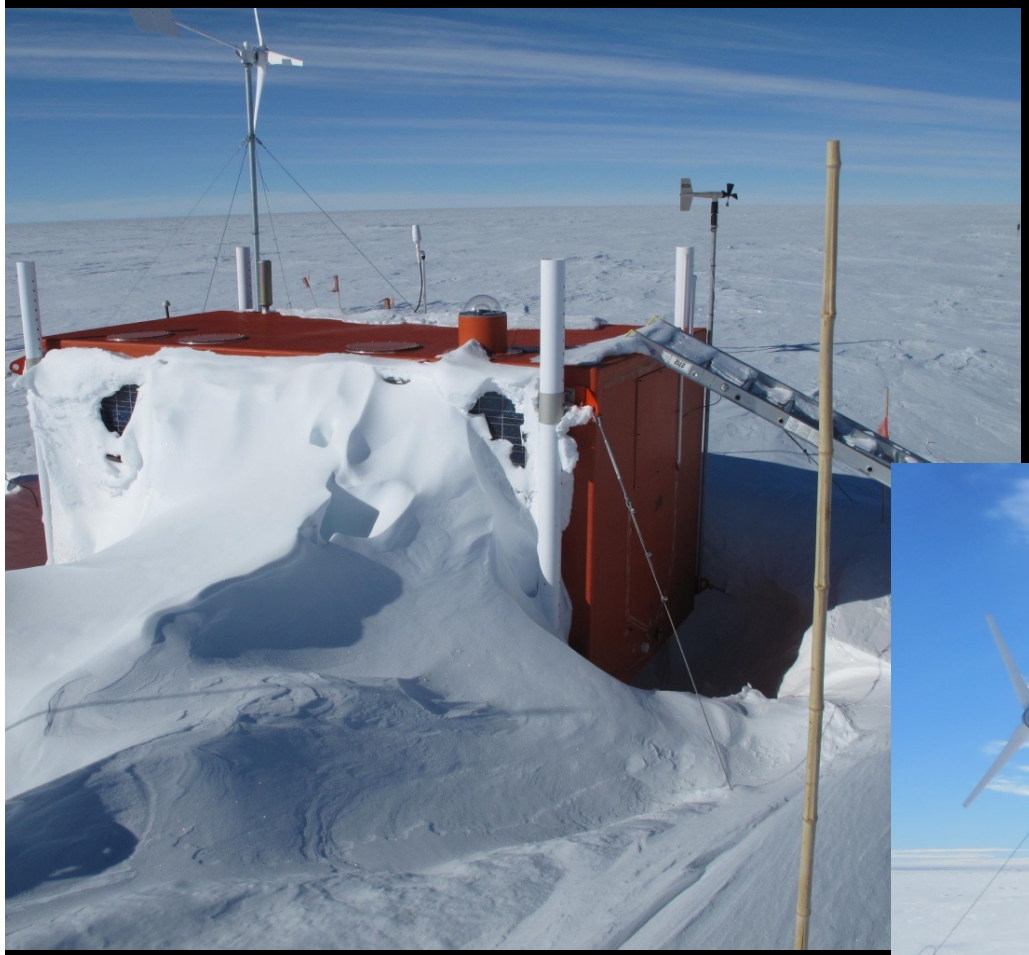
AGO Locations

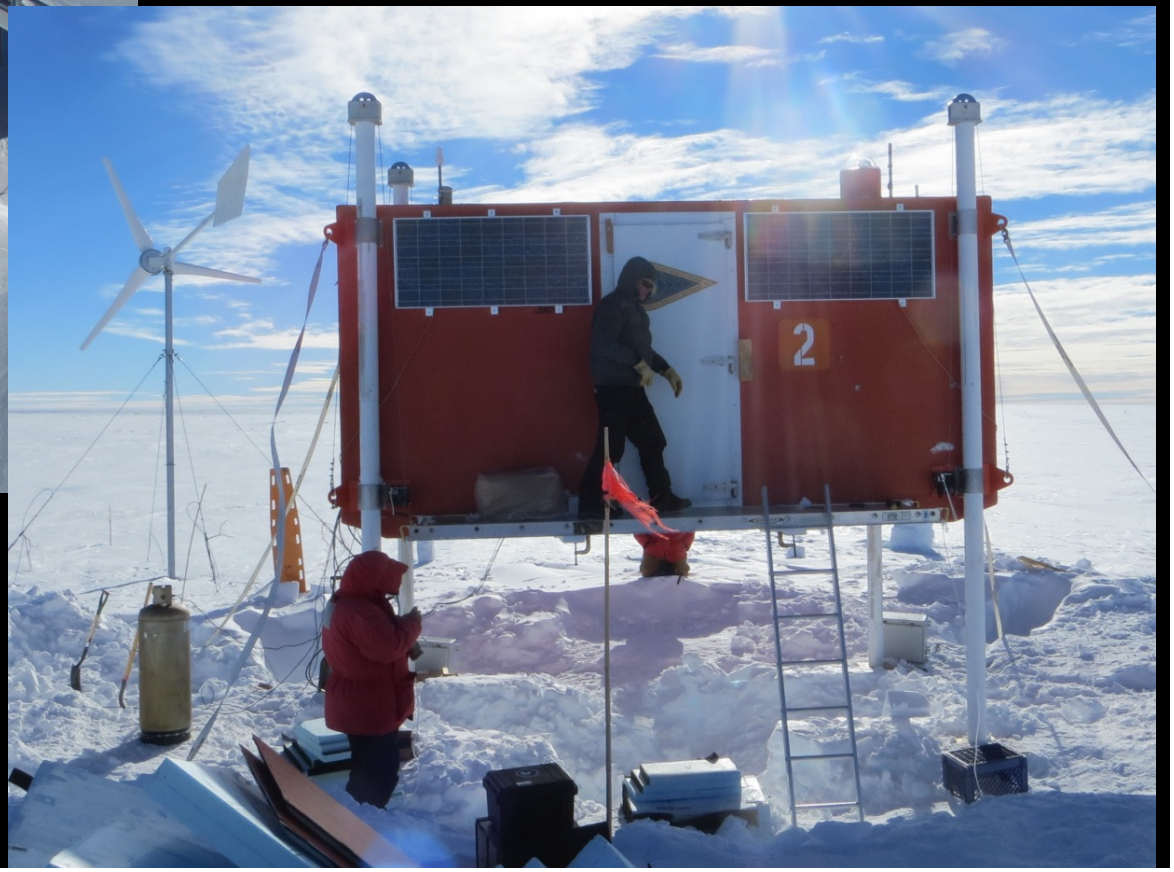
AGO 1	9,400 ft.
AGO 2	6,102 ft.
AGO 3	9,554 ft.
AGO 4	11,696 ft.
AGO 5	10,118 ft.
AGO 6	(8,300 ft.)



- Coverage over extended regions
- Conjugate w/Northern Hemisphere
- 24-hour darkness in dayside auroral zone

1. AGO Servicing





2. SBD Telemetry Module

Designed by Bob Melville

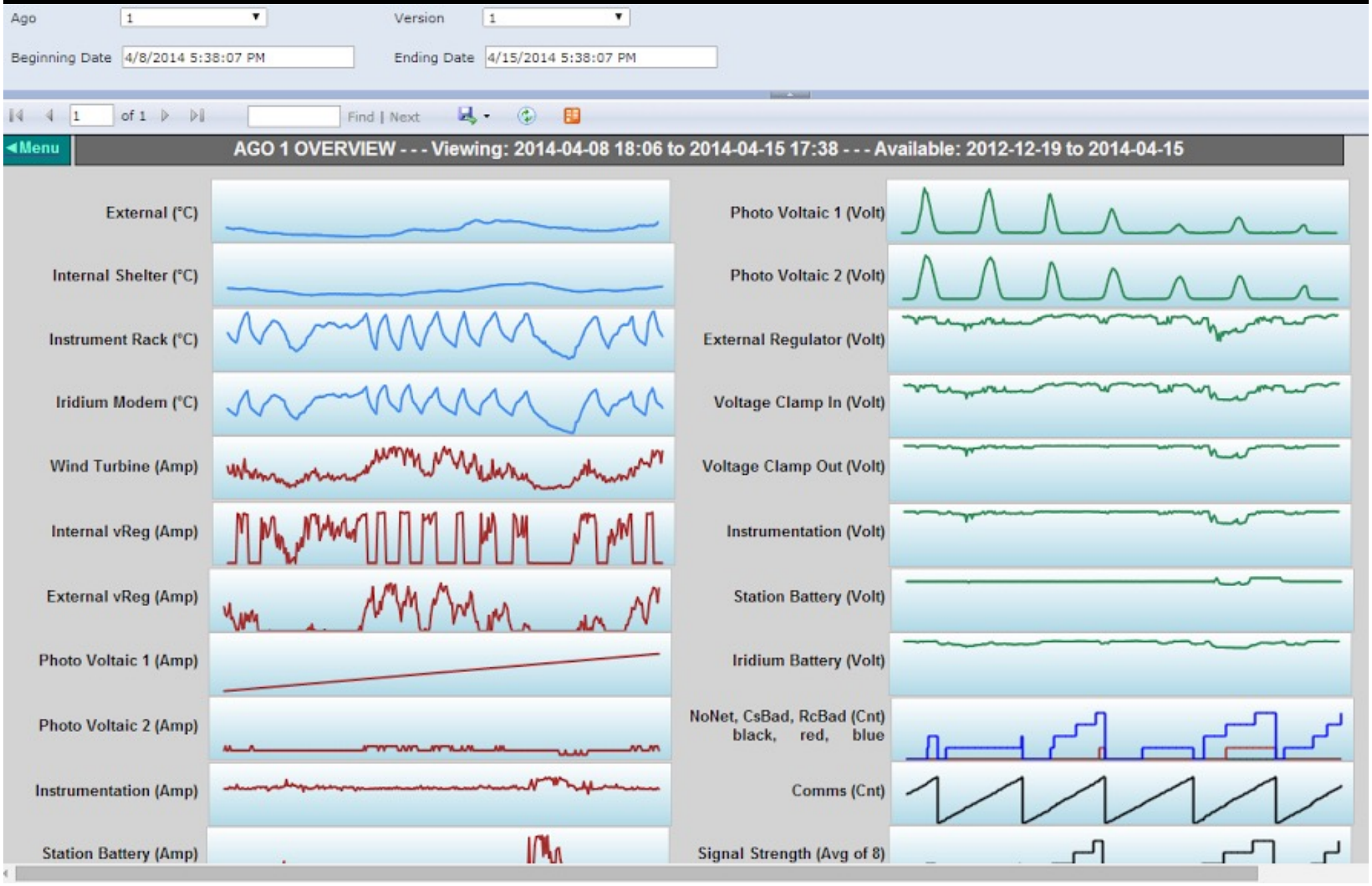
Telemetry components housed within heavily insulated case with small self-heater inside

Powered by separate batteries dedicated to communications

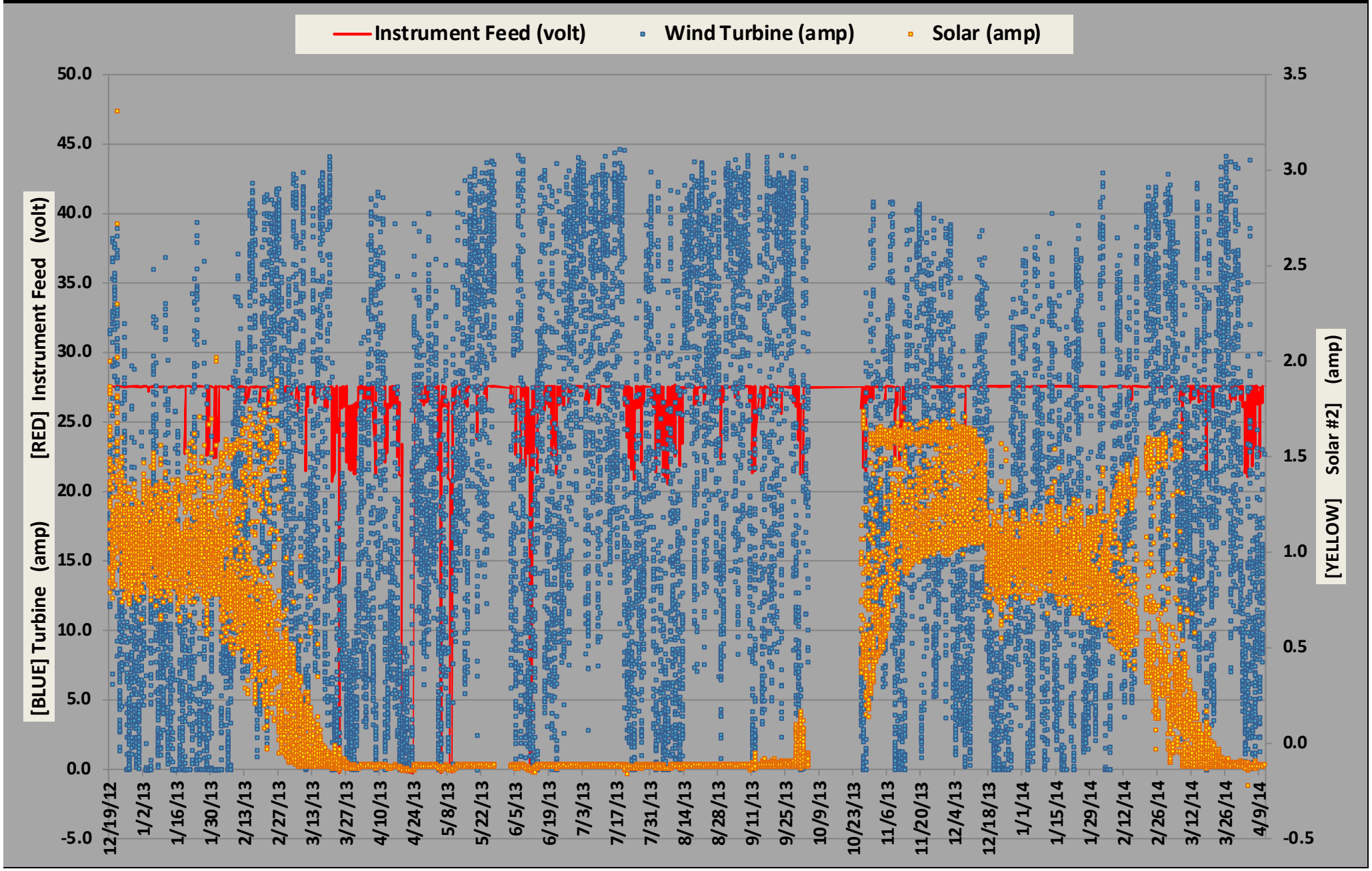
Insulated case resides within the larger insulated & heated instrument rack enclosure

Goal: Telemetry continues even when instruments powered down

Station Telemetry Reporting

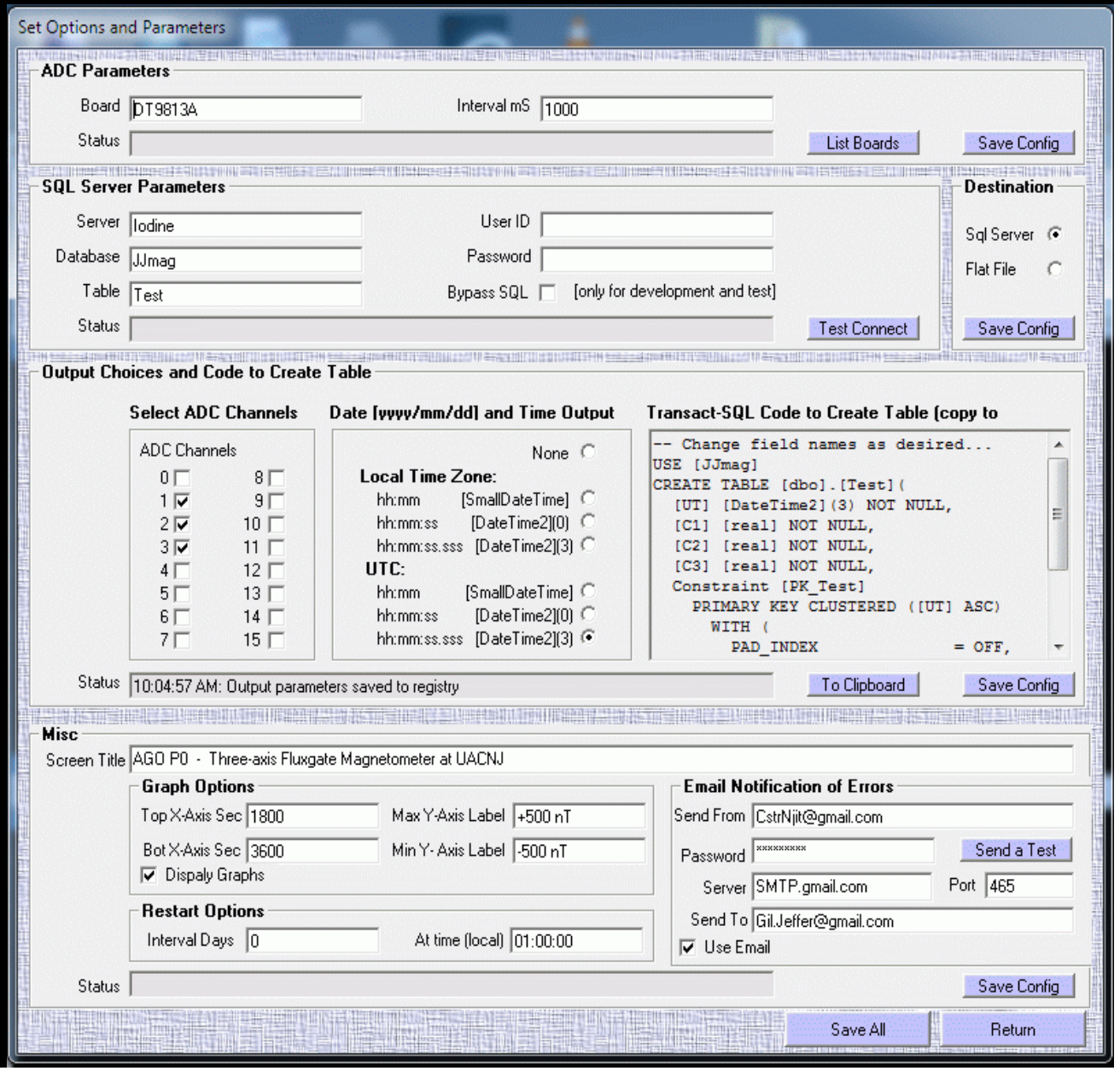


Investigating Telemetry at AGO1



3. New Data Acquisition System

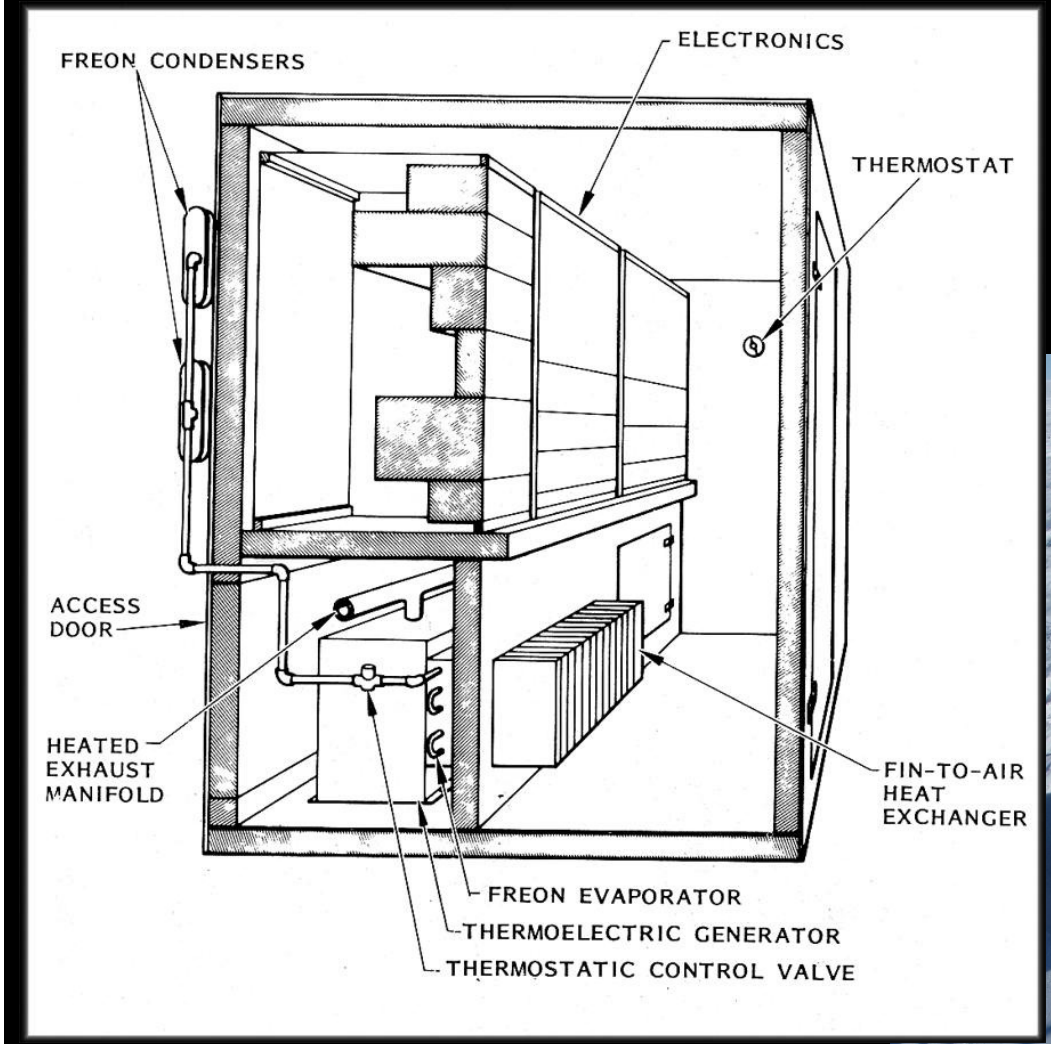
- Replace aging system with off-the-shelf parts
- Interface to various Data-Translation ADC devices
- Writes to daily files or direct to SQL database
- Can run multiple ADC units on one computer
- Parallel deployment at both MCM & SPA
- Enhancements for serial and cadence by channel



Mods for Field Deployment

- Very low-power computer
- Fanless design
- Solid-State drive

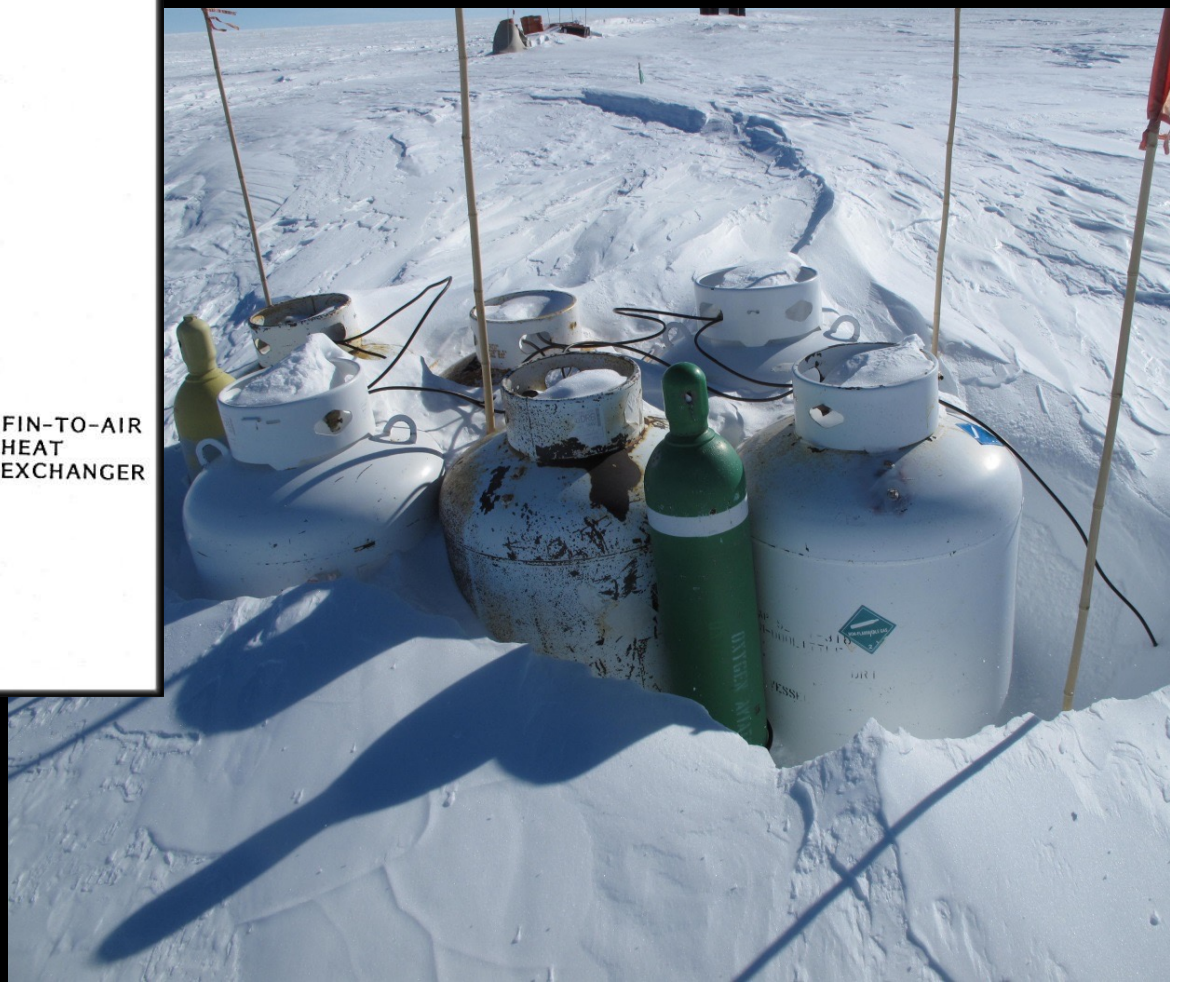
4. Power System



Complex, inefficient system

Over 2,500 lbs propane per year

Expensive C-130 supply flights



2,500 lbs propane
= 2,500 lbs water
= 2,500 lb lump of ice

Last-Generation Power

Solar Panels

Four total (2 x 2)

Each rated 240-W

50-W shaded side

African Windpower 3.6 Turbine

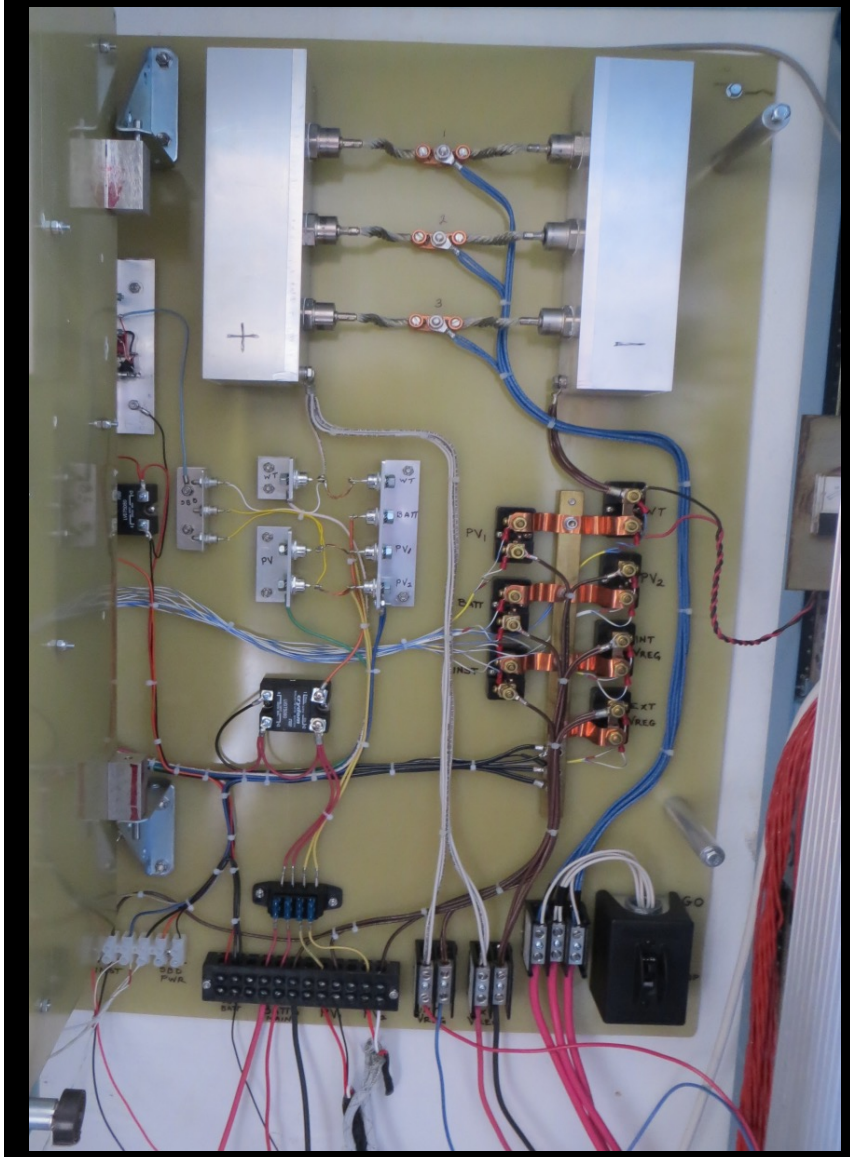
Permanent magnet alternator

Can supply over 1,000 watts

Ice-fog infiltration of grease
New shield fixed this problem

Next Generation Power

Simplified design utilizing robust components



Control circuitry . . .

Designed by Andy Stillinger

Open design for ease of maintenance

Outfitted to monitor key voltages and currents – feeds into telemetry system

Next Generation Power

Internal voltage regulators . . .

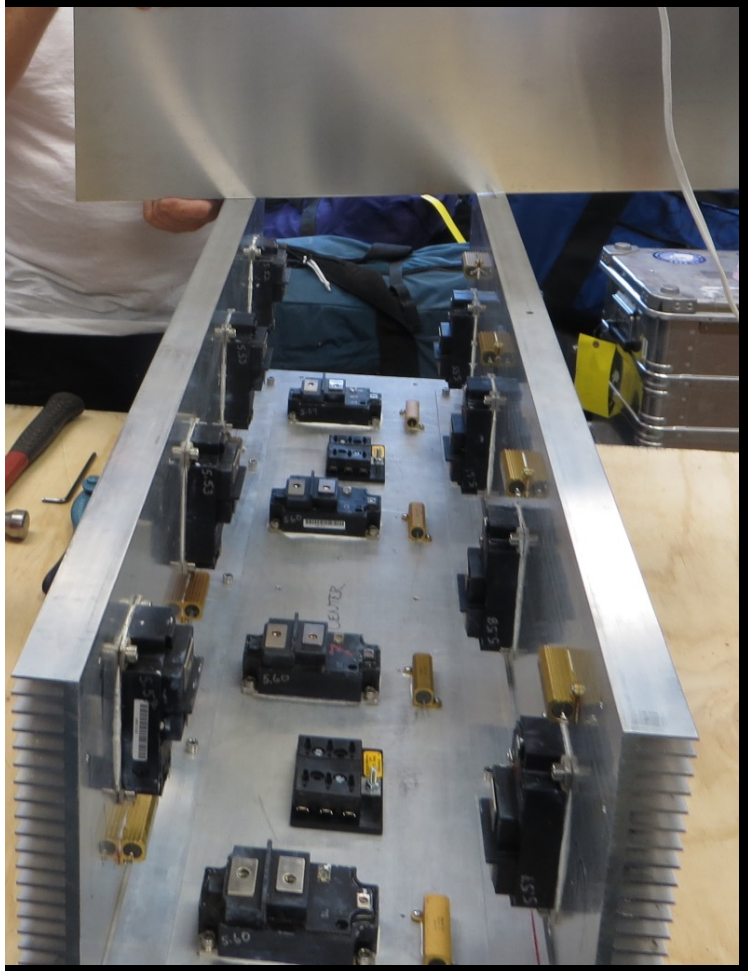
Situated within blue board enclosure

Heavy finned aluminum heatsinks

Dissipate 200 watts each

Heat instruments within the enclosure

Next Generation Power

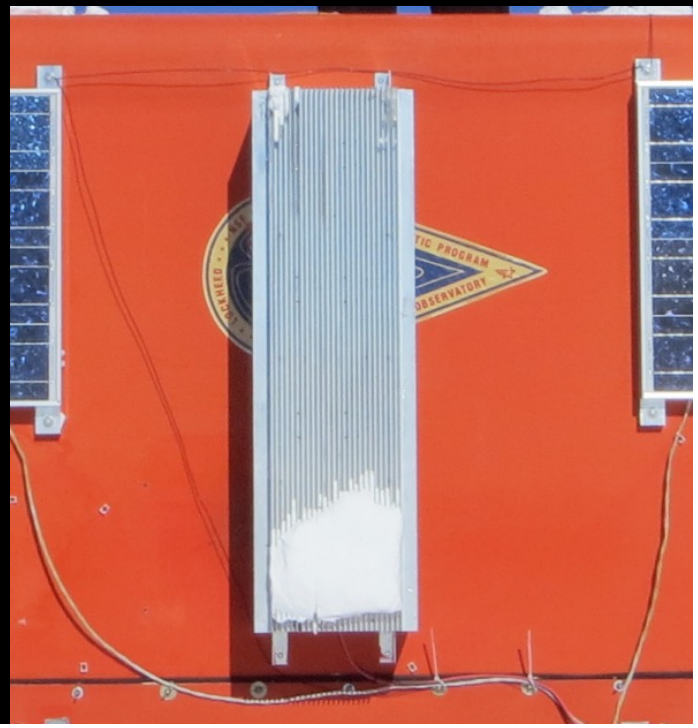


External voltage regulator . . .

Mounted externally on wall of AGO

Contains 12 x 800 watt IGBT transistors
(Used in MRIs, electric cars, welders, etc)

Capable of dissipating ~10 Kw



After installation at an AGO,

Wet finger stuck to heat sink while it was dissipating 1 Kw

Next Generation AGOs

- Wind turbines at AGOs 1, 3, 4, and 5 have been operating continuously for 3 ½ years without maintenance or problems
- Turbine at AGO 2 has been operating for 2 ½ years due to the inability of getting there due to bad weather the year the others were serviced
- Telemetry systems have been operating since they were installed at AGO 1, 2, 3, and 4 during the 2012-2013 season
- As previously mentioned, we have experienced periods without communication but each time they have come back online showing that the station is operating.

5. Instrument Siting at AGOs

- Five installations
  East Ant. Plateau
- Two 19-inch racks
  With open space
- Insulated & heated
  Electronics > -40°C (typical)
- Reliable power
  ~200 watts @ 28v
- Iridium connectivity
  Modem and SBD
- Service missions

The infrastructure is already there . . .

BUT…

The PEDC is more than just the AGOs

More Information At:

- **antarcticgeospace.org**

- ***Future Science Opportunities in Antarctica and the Southern Ocean***
  National Academies of Science [2011]

- ***Solar-Terrestrial Research in Polar Regions: Past, Present, and Future***
  NSF Workshop Report [2014]

- Mende, S., W. Rachelson, R. Sterling, H. U. Frey, S. E. Harris, S. McBride, T. J. Rosenberg, D. Detrick, J. L. Doolittle, M. Engebretson, U. Inan, J. W. Labelle, L. J. Lanzerotti, and A. T. Weatherwax (2009), Observations of Earth space by self-powered stations in Antarctica, Review of Scientific Instruments 80, 124501; doi: 10.1063/1.3262506.

- Melville, R., A. Stillinger, A. Gerrard, A. Weatherwax (2014), Sustainable energy at the 100-W level for scientific sites on the Antarctic Plateau: Lessons learned from the PENGUIn-AGO project, Review of Scientific Instruments, 85, 4, id.045117.

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