

The Polar Engineering Development Center (PEDC)

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with

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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.



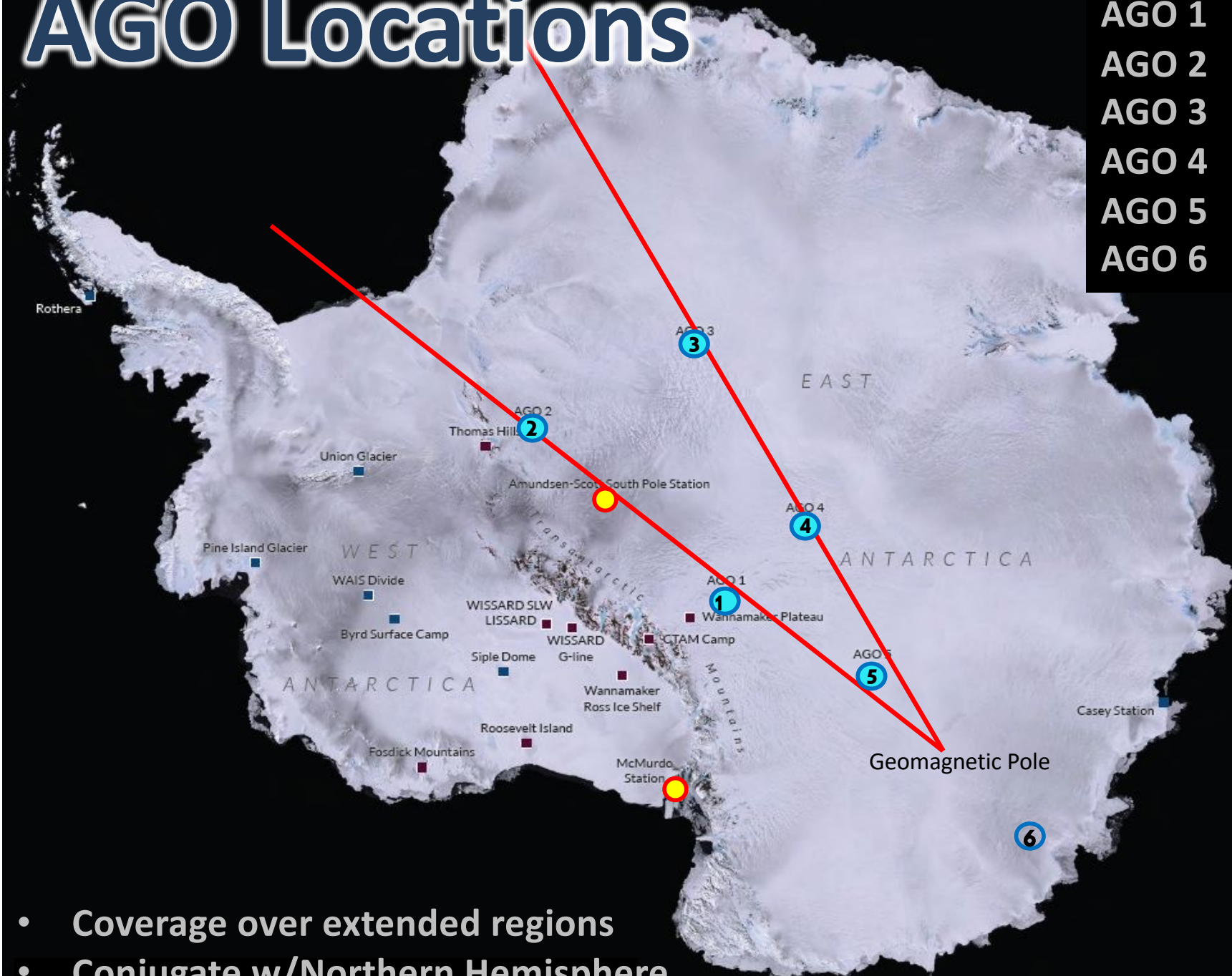
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AGO	Date established
AGO-1	January 1994
AGO-2	December 1992
AGO-3	January 1995
AGO-4	January 1994
AGO-5	January 1996
AGO-6	February 1997

AGO Locations

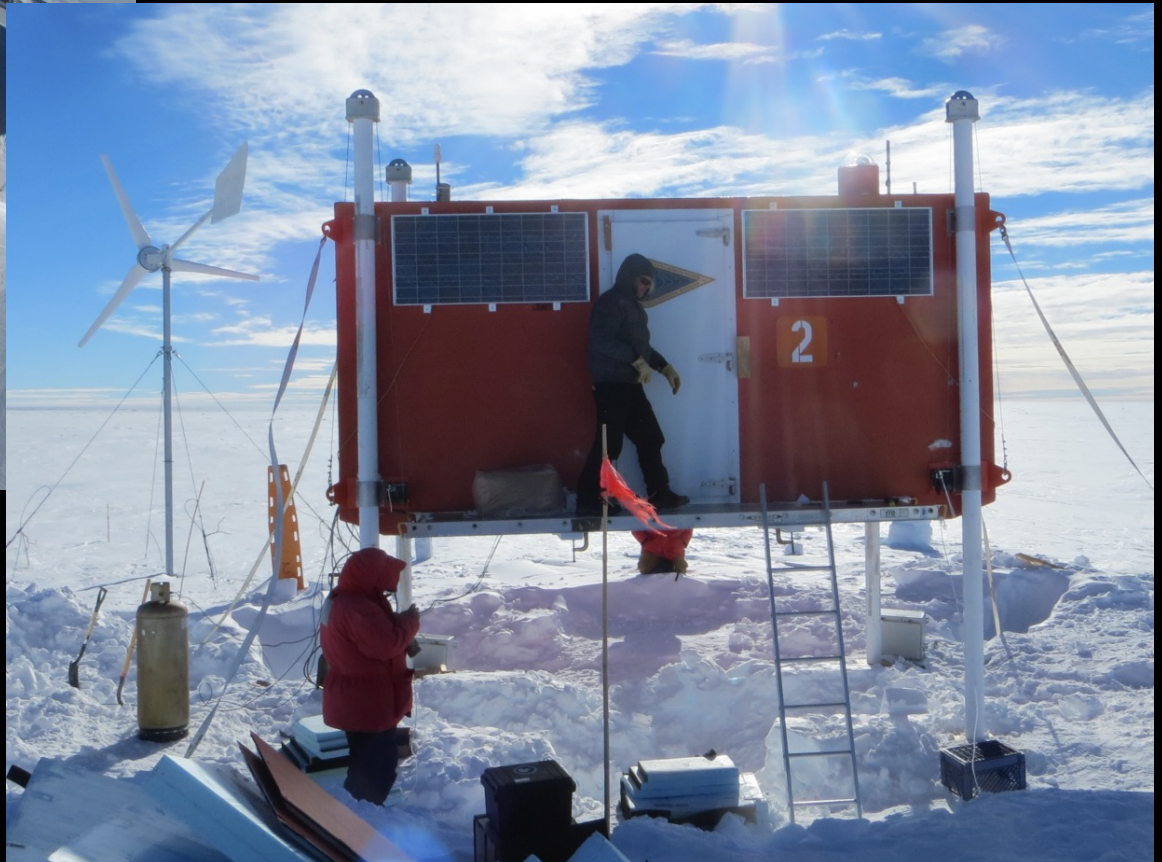
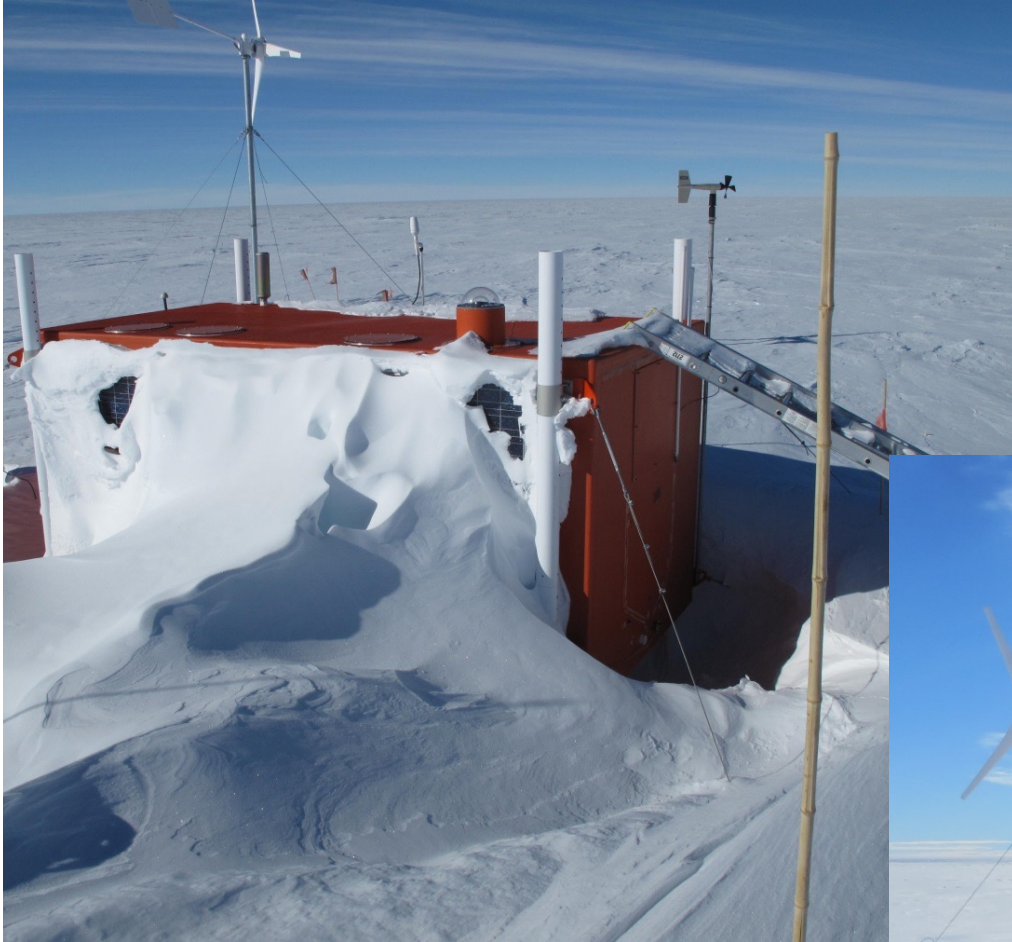
AGO 1	9,400 ft.
AGO 2	6,102 ft.
AGO 3	9,554 ft.
AGO 4	11,696 ft.
AGO 5	10,118 ft.
AGO 6	(8,300 ft.)

Rothera



- 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

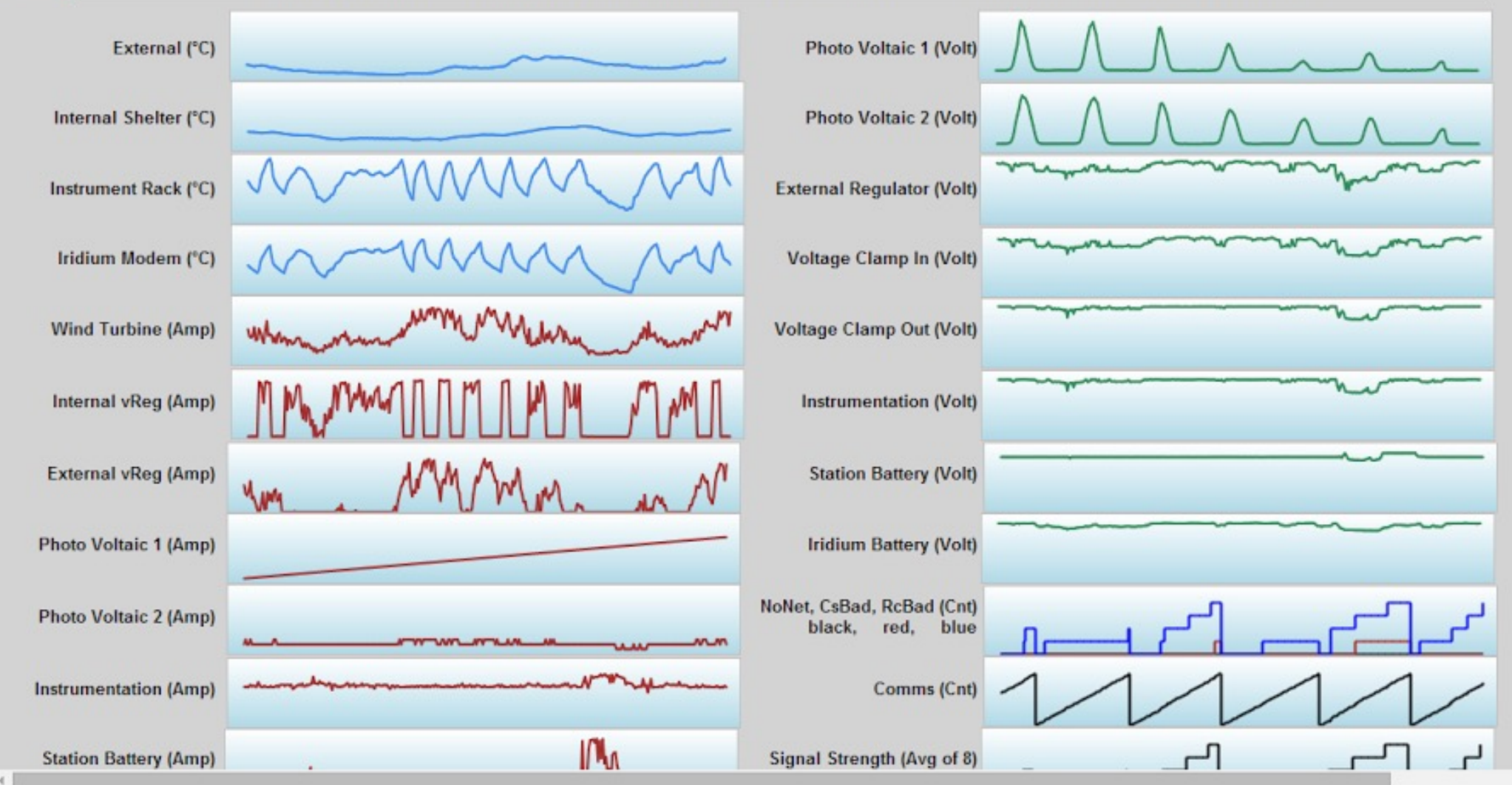


Station Telemetry Reporting

Ago Version
Beginning Date Ending Date

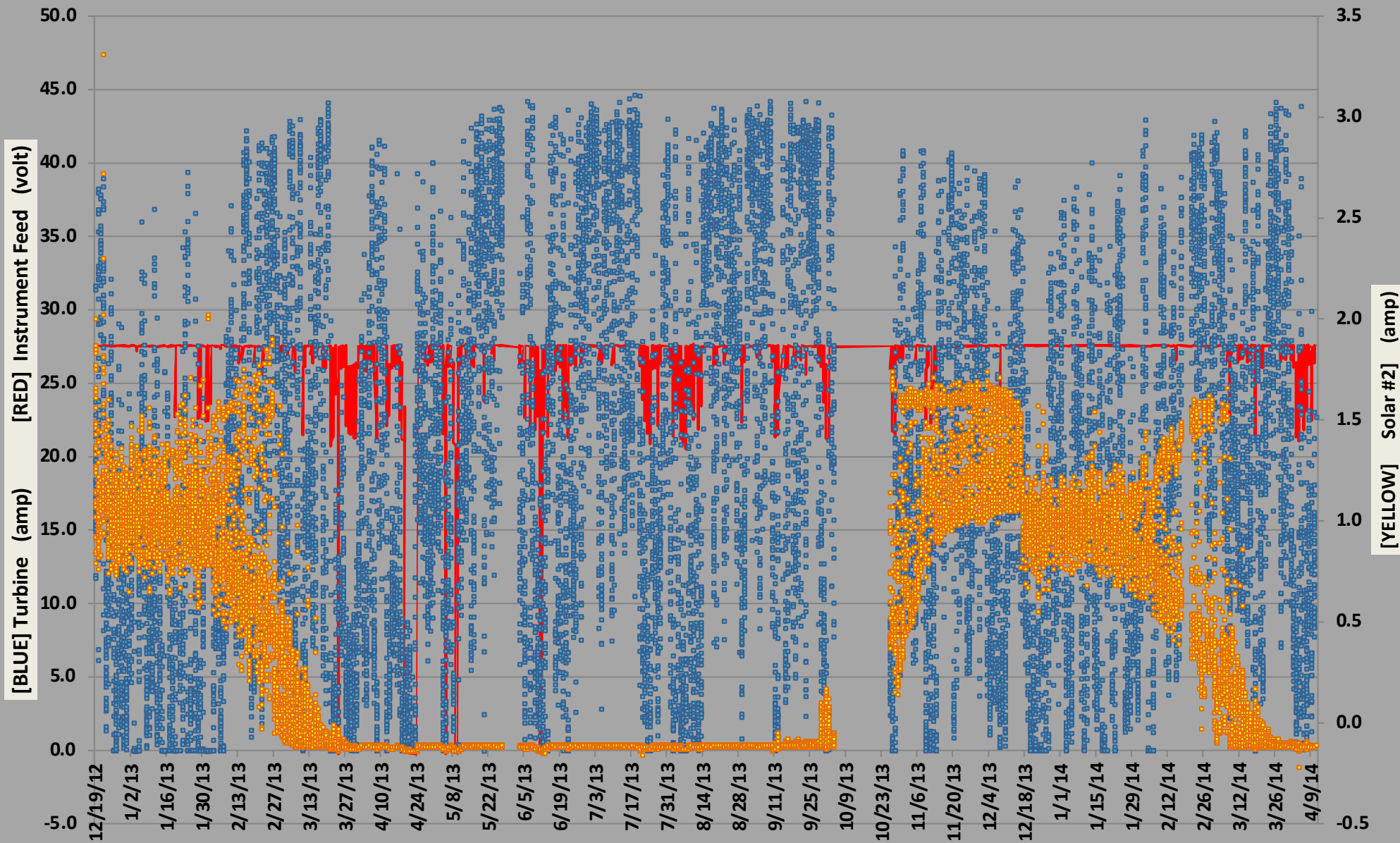
1 of 1 Find | Next

AGO 1 OVERVIEW --- Viewing: 2014-04-08 18:06 to 2014-04-15 17:38 --- Available: 2012-12-19 to 2014-04-15



Investigating Telemetry at AGO1

— Instrument Feed (volt) ■ Wind Turbine (amp) ■ Solar (amp)



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

Set Options and Parameters

ADC Parameters

Board: DT9813A Interval mS: 1000

Status: [List Boards] [Save Config]

SQL Server Parameters

Server: Iodine User ID: []

Database: JJmag Password: []

Table: Test Bypass SQL: [only for development and test]

Status: [Test Connect] [Save Config]

Destination

Sql Server Flat File

[Save Config]

Output Choices and Code to Create Table

Select ADC Channels

ADC Channels	
0 <input type="checkbox"/>	8 <input type="checkbox"/>
1 <input checked="" type="checkbox"/>	9 <input type="checkbox"/>
2 <input checked="" type="checkbox"/>	10 <input type="checkbox"/>
3 <input checked="" type="checkbox"/>	11 <input type="checkbox"/>
4 <input type="checkbox"/>	12 <input type="checkbox"/>
5 <input type="checkbox"/>	13 <input type="checkbox"/>
6 <input type="checkbox"/>	14 <input type="checkbox"/>
7 <input type="checkbox"/>	15 <input type="checkbox"/>

Date [yyyy/mm/dd] and Time Output

None

Local Time Zone:

hh:mm [SmallDateTime]

hh:mm:ss [DateTime2](0)

hh:mm:ss.sss [DateTime2](3)

UTC:

hh:mm [SmallDateTime]

hh:mm:ss [DateTime2](0)

hh:mm:ss.sss [DateTime2](3)

Transact-SQL Code to Create Table [copy to]

```
-- Change field names as desired...
USE [JJmag]
CREATE TABLE [dbo].[Test] (
  [UT] [DateTime2](3) NOT NULL,
  [C1] [real] NOT NULL,
  [C2] [real] NOT NULL,
  [C3] [real] NOT NULL,
  Constraint [PK_Test]
  PRIMARY KEY CLUSTERED ([UT] ASC)
  WITH (
    PAD_INDEX = OFF,
```

Status: 10:04:57 AM: Output parameters saved to registry [To Clipboard] [Save Config]

Misc

Screen Title: AGO P0 - Three-axis Fluxgate Magnetometer at UACNJ

Graph Options

Top X-Axis Sec: 1800 Max Y-Axis Label: +500 nT

Bot X-Axis Sec: 3600 Min Y-Axis Label: -500 nT

Display Graphs

Restart Options

Interval Days: 0 At time (local): 01:00:00

Email Notification of Errors

Send From: CstrNjit@gmail.com

Password: [] [Send a Test]

Server: SMTP.gmail.com Port: 465

Send To: Gil.Jeffer@gmail.com

Use Email [Save Config]

Status: [Save All] [Return]

Mods for Field Deployment

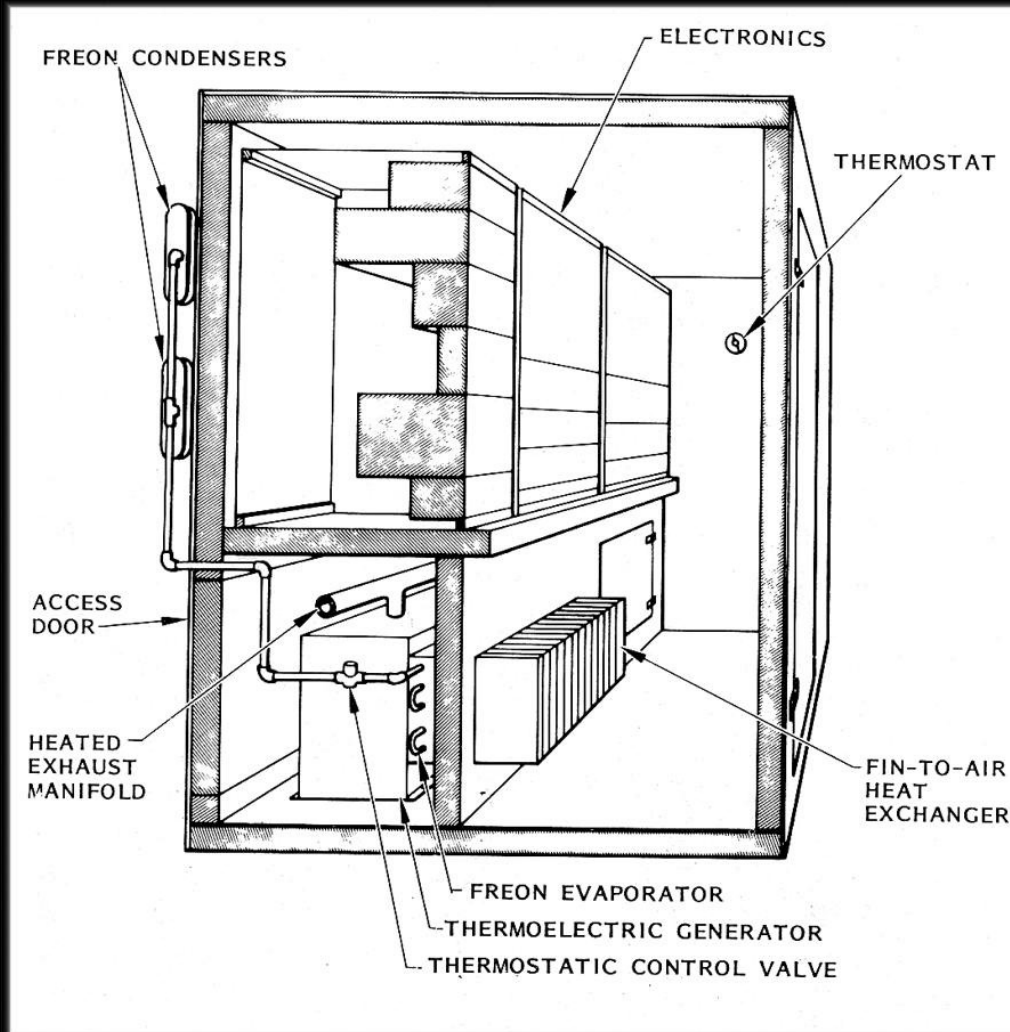
- **Very low-power computer**
- **Fanless design**
- **Solid-State drive**

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

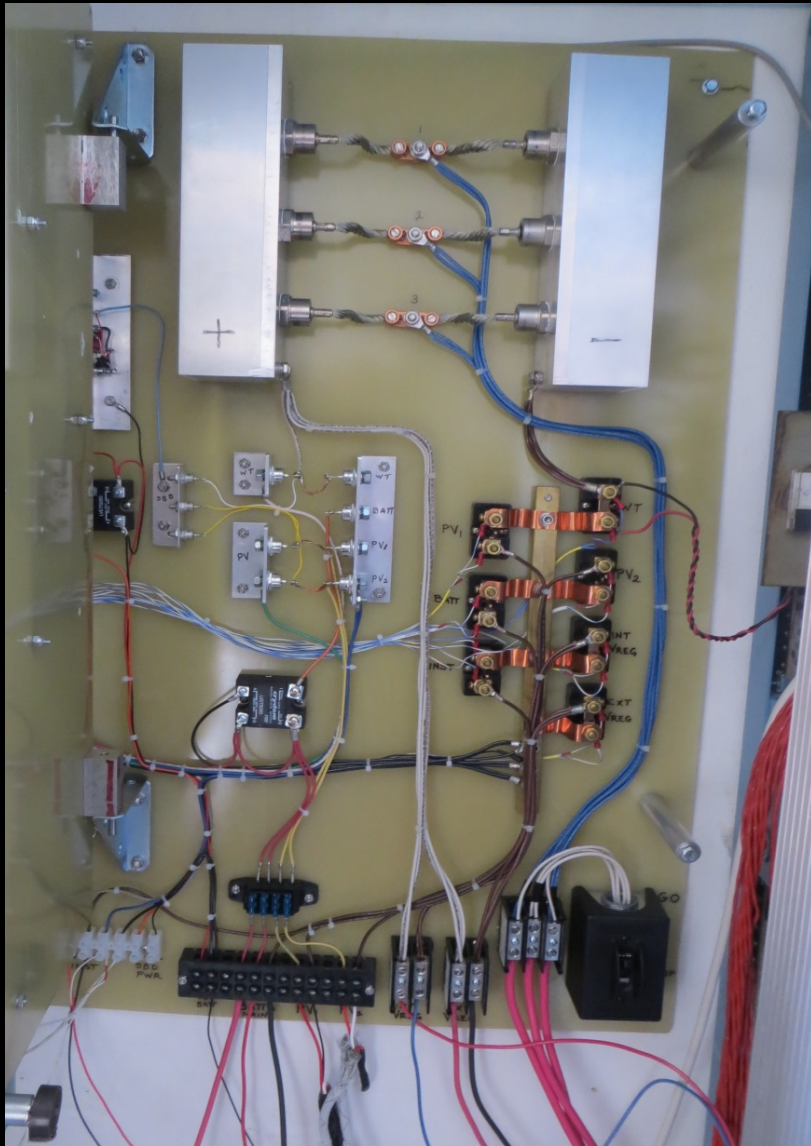
Permanent magnet alternator

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

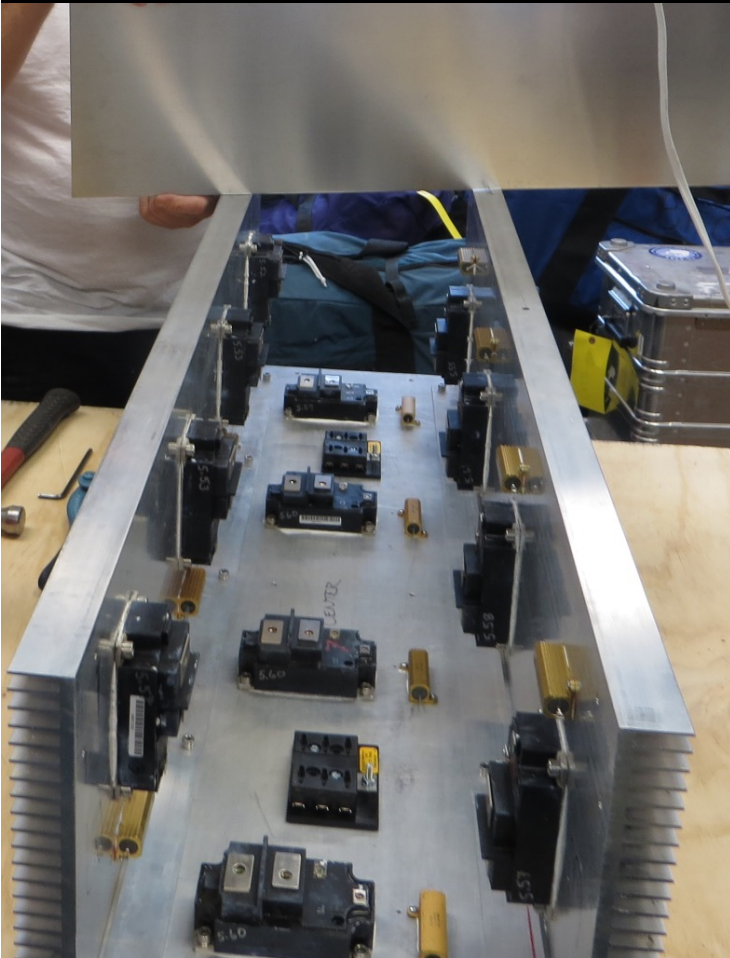
Next Generation Power

External voltage regulator . . .

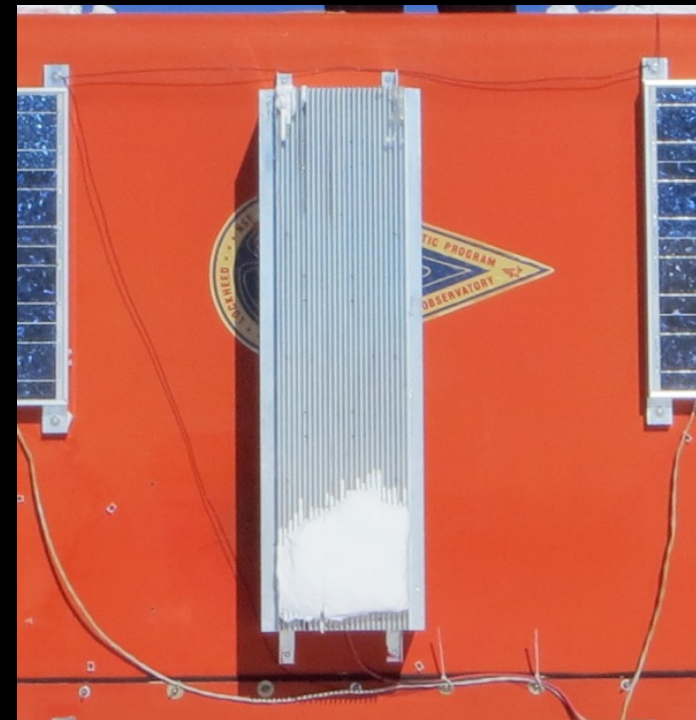
Mounted externally on wall of AGO

**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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