Update on the PLATO project, and its future development

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Image: The Galactic Centre and aurora from the South Pole, Daniel Luong-Van, 2010

AASTO at South Pole
50W power budget
1996

AASTINO at Dome C; 2004
500W power budget

PLATO

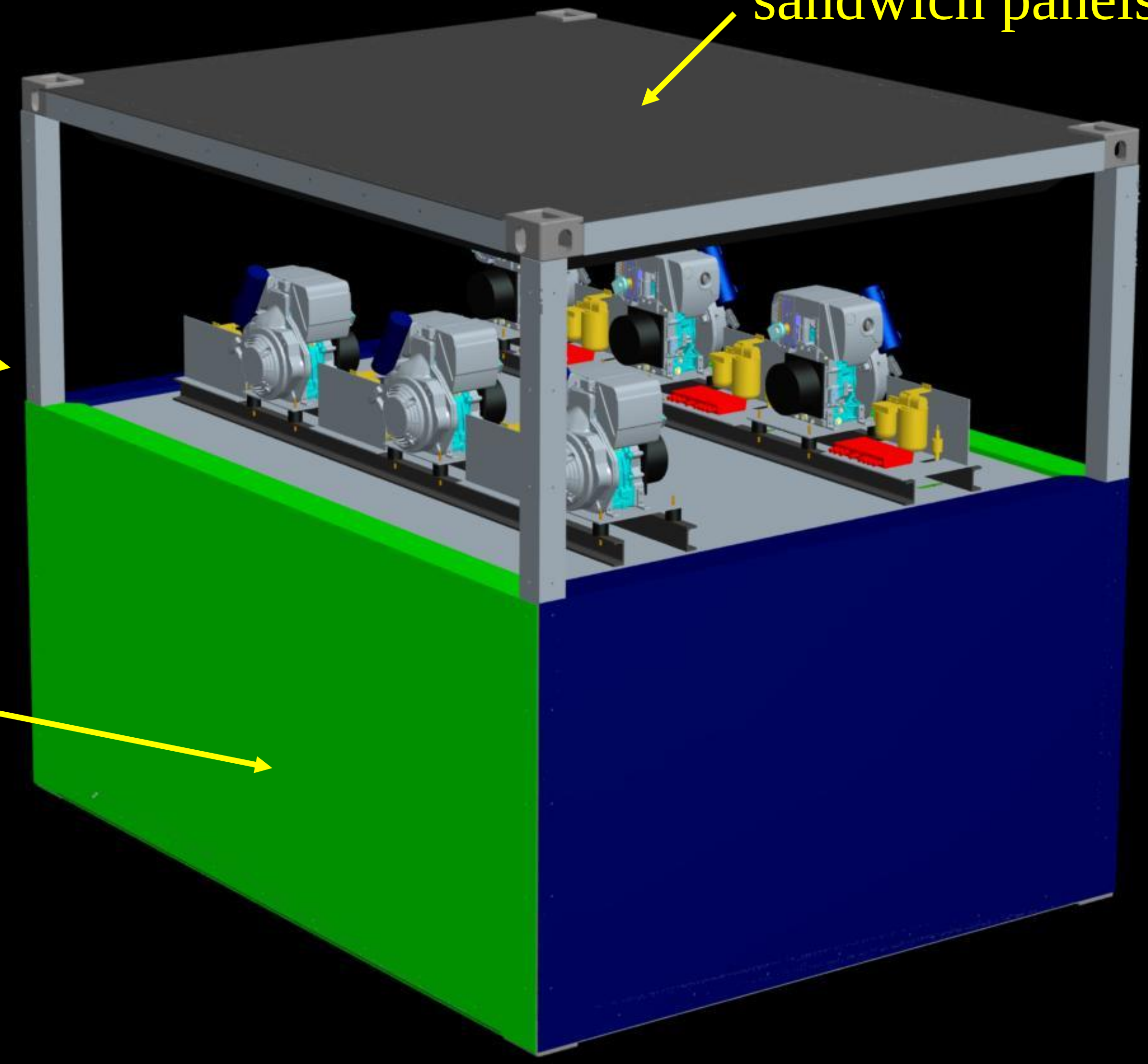


Image: Campbell McLaren


2
3


PLATO
PLATO


Dome F
Ridge A
Dome A
South Pole
Dome C
SOUTHERN OCEAN
KONG HÅKON VII HAV
WEDDELL SEA
BELLINGSHAUSEN SEA
AMUNDSEN SEA
ROSS SEA
EAST ANTARCTICA
WEST ANTARCTICA
ANTARCTIC PENINSULA
DRONNING MAUD LAND
ENDERBY LAND
KEMP LAND
MACROBERTSON LAND
PRINCESS ELIZABETH LAND
WILHELM II LAND
QUEEN MARY LAND
WILKES LAND
TERRE ADÉLIE
GEORGE V LAND
OATES LAND
VICTORIA LAND
MARIE BYRD LAND
ELLSWORTH LAND
COATS LAND
PALMER LAND
RONNE ICE SHELF
FILCHNER ICE SHELF
ROSS ICE SHELF
AMERY ICE SHELF
SHACKLETON ICE SHELF
BRUNT ICE SHELF
LARSEN ICE SHELF
FIMBULISEN
Transantarctic Mountains
Subglacial Lake Vostok
Antarctic Circle 66°34'S
South Orkney Is
Signy (UK)
South Shetland Is
Anvers I.
Palmer (USA)
Adelaide I.
Rothera (UK)
Alexander I.
Halley (UK)
Amundsen-Scott (USA)
McMurdo (USA)
Mt Erebus
Vinson Massif 4892m
Ellsworth Mts
Shackleton Range
Queen Maud Mts
Queen Elizabeth Range
Queen Alexandra Range
Executive Committee Range
Whitmore Mtns
Peter I Øy
Prydz Bay
Davis Sea
Dumont d'Urville Sea
Balleny Is
90°W
90°E
80°S
70°S

PLATO status

- The “original PLATO” went to Dome A in late 2007.
- A new design, PLATO-F sent to Dome Fuji in late 2010, and PLATO-A to Dome A in late 2011.
- A slimmed-down model, PLATO-R has been at Ridge A since Jan 2012.
- We have now accumulated 13 years of combined operation of all the PLATOs.
- PLATO-F ran from Jan 2013 to Apr 2014 (out of fuel).
- PLATO-R ran from Jan 2015 to mid-July, engines wore out.
- PLATO-A still running at Dome A. Has enough fuel to last all year; 2 of 5 engines still work.

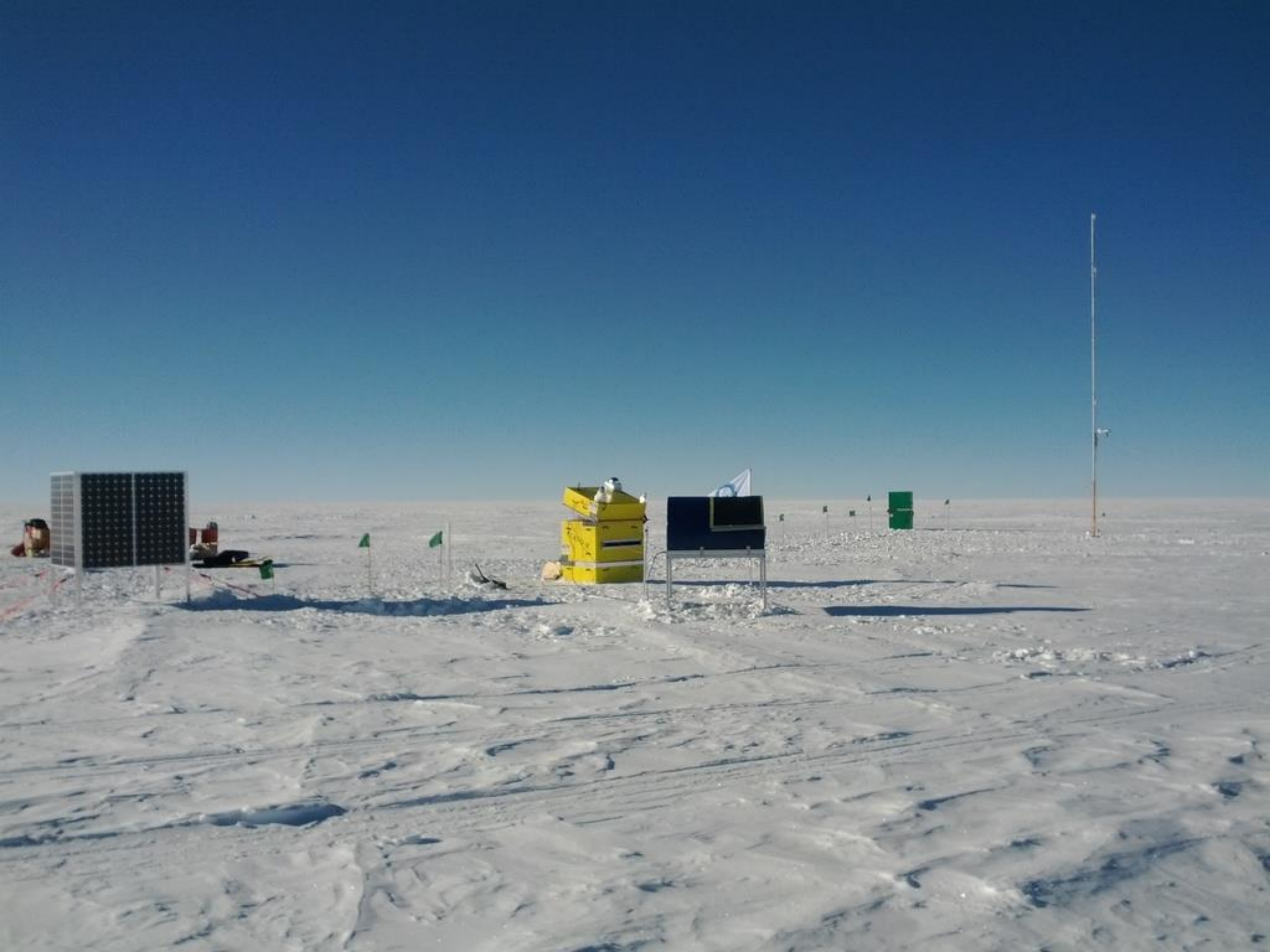
PLATO-A at Dome A, January 2013

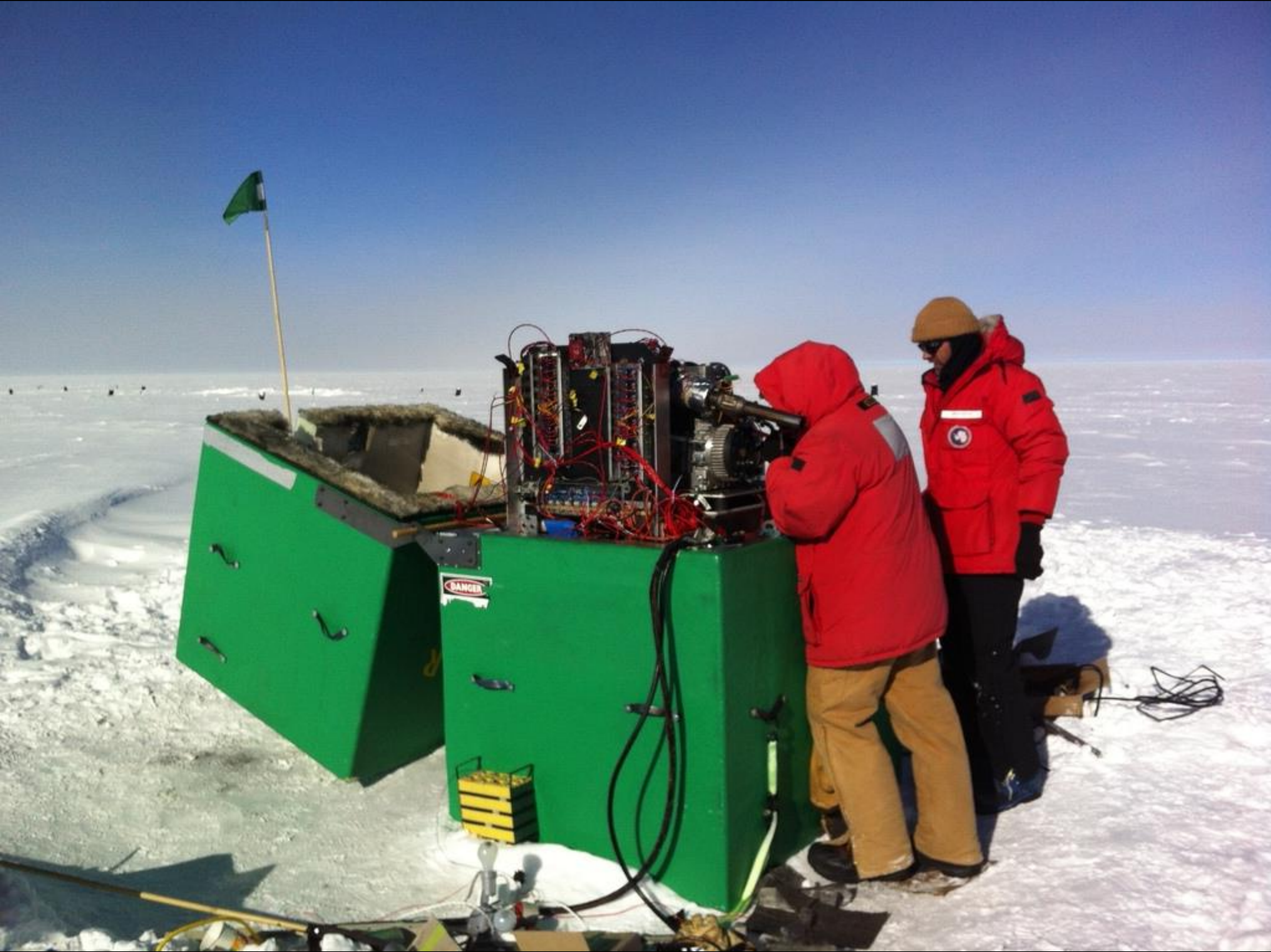
Jan 2012, Giguo Tian

PLATO-F at Dome F, January 2013

Jan 2013, Hirofumi Okita

PLATO-R at Ridge A, January 2013




DANGER

PLATO-A plots for the last week

Welcome to the PLATO-A plots page. Here you can find many of the parameters that we monitor to make sure everything is running smoothly.

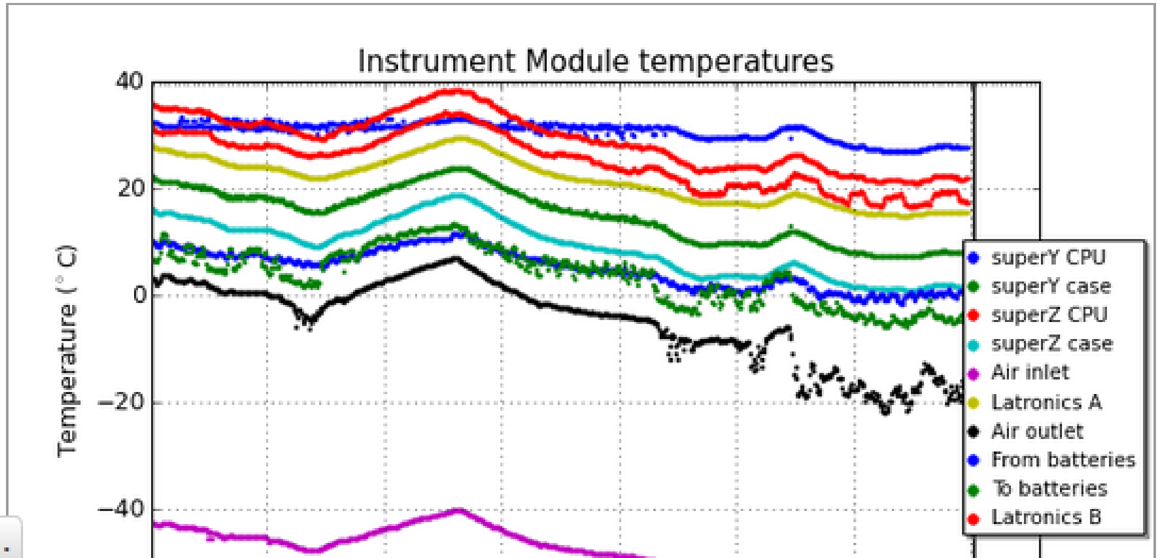
The page is divided into several categories: Instrument Module, Batteries, Solar power, Engine Module, Diesel engines, Current flow, Bus voltages, and Miscellaneous.

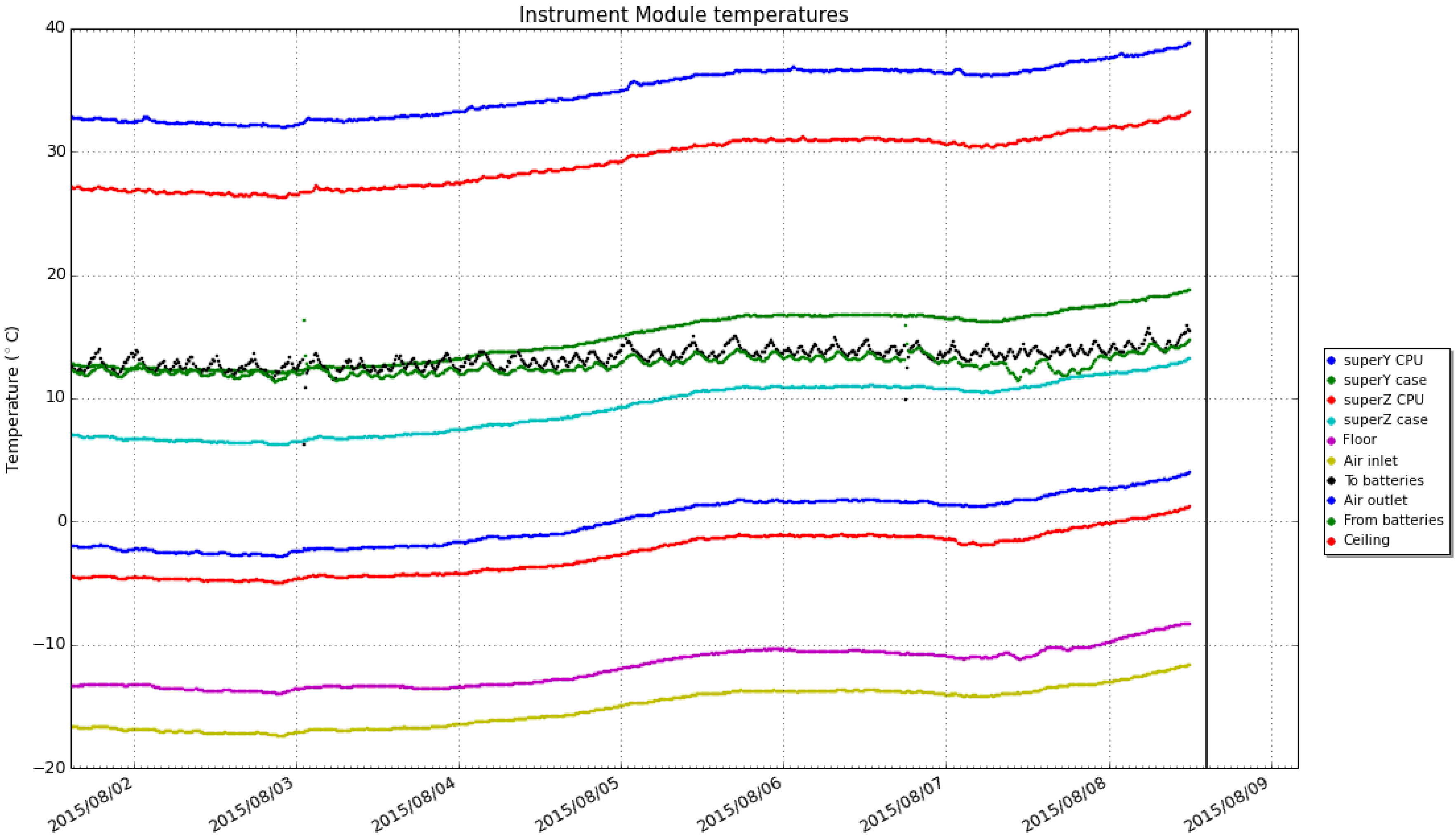
Click on any plot to enlarge it. In the image caption there are links to large versions of the plots in PNG format. Also in the caption you might notice the text (quick-link). If you bookmark or email this link, it provides a direct jump to the graph of interest.

All times are in UTC and the plots have a vertical black bar that indicates the time when the plot was generated. This bar lets you know how old the data are and when the last update occurred. The plots are updated regularly. The side bar has links to plots of different time intervals if you need a closer look at what is happening now, or want to see what happened in the past.

Instrument Module

The Instrument Module contains most of the scientific experiments, the 20kWHr LiFePO4 battery pack, the Iridium communications equipment, the Linux supervisor computers, and the solar panel power supplies. The plots below show some parameters relevant to these systems.




Instrument Module temperatures
Temperature (°C)
40
30
20
10
0
−10
−20
2015/08/02
2015/08/03
2015/08/04
2015/08/05
2015/08/06
2015/08/07
2015/08/08
2015/08/09
superY CPU
superY case
superZ CPU
superZ case
Floor
Air inlet
To batteries
Air outlet
From batteries
Ceiling

HRCAM image from Dome A   6 June 2014

The future for PLATO-like facilities

A PLATO-like facility is essential up until you have a winterover station, which is a massive increase in costs over a fully remote operation.

A winterover station probably requires a minimum of three 100kW diesel engines.

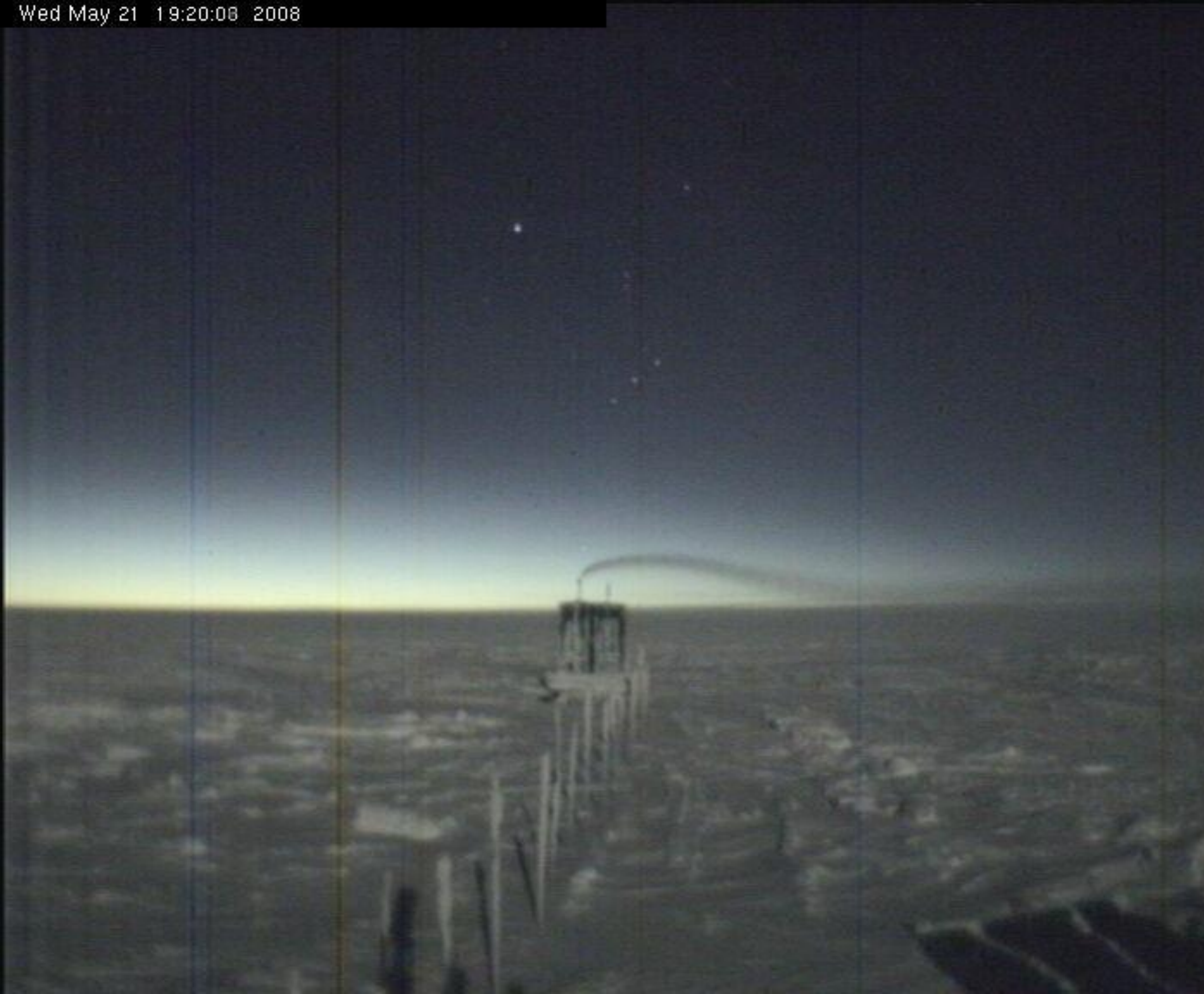
Fully remote telescopes are probably practical up to about KDUST/DATE5 size, with power requirements up around 10-20kW.

Next generation PLATO

- There is an urgent need for more power (> 1kW). Need at least 2kW, ramping to 10kW or more for KDUST, DATE-5.
- Ease of servicing.
- Improved modularity (e.g., single engines in individual modules; battery packs in individual modules).
- External fuel tanks.

Diesel pollution

- Glaciologists at Kunlun are concerned about pollution from our diesel engines.
- The diesel engines produce water vapour, carbon dioxide, carbon monoxide, NOx, particulates. Only the latter is a problem. Water vapour may look like a plume of pollution, but isn't.
- Particulates can be captured with a DPF (diesel particulate filter), but this is only really practical for large multicylinder engines. And it is not clear whether unattended operation is possible.
- The key thing is to avoid running in the "black smoke" regime, where large quantities of particulates are produced. An optical sensor in the exhaust may help, but this is tricky.


Wed May 21 19:20:08 2008

Wind power

- Average surface wind speed of 2.5m/s is below the cut-in speed of commercial wind turbines.
- Several approaches are possible:
  - Drive the turbine in order to overcome stiction
  - Increase the hub height
  - A special blade design optimized for low wind
- UNSW is designing a wind turbine now.
- We have extensive wind data (from 2012 and 2015) at heights up to 15m, and these can be used to model the design performance, and explore trade-offs (e.g., more battery capacity, and generate power only in top 25% of conditions. Note: power is proportional to wind speed cubed.

Strawman wind turbine design

- 15m hub height.
- Three 6m carbon-fibre blades (longest that can fit in a 20’ container).
- No pitch control, for simplicity.
- Yaw control is necessary.
- High-efficiency permanent magnet alternator.
- Gearbox?

Lessons for instrument/telescope designers

- Minimize power! Particularly heating.
- As much as possible of the instrument should be able to cold soak to -80C without damage.
- Run things as cold as possible, e.g., -40C is not a problem for most electronics.
- Be wary of encapsulated DC-DC converters. E.g., with Vicor go for the military grade since it uses different encapsulation (but still fails below about -60C).
- Consider burying electronics 1m below the ice level: constant ~-55C.

Computing power

- Power for on-site computing is becoming a major issue.
- We need to look closely at the most efficient architectures.
- We need to keep up with the state of the art.
- Intel NUC (Next Unit of Computing) is nice.
- Power-down computers when not needed.
- Helium-filled disk drives solve the altitude problem.