Polar Seismic Stations, Issues with Cold Operation and Our Approach to the Solution

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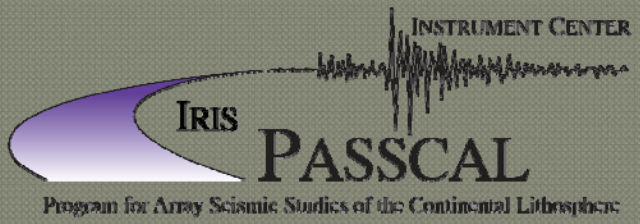
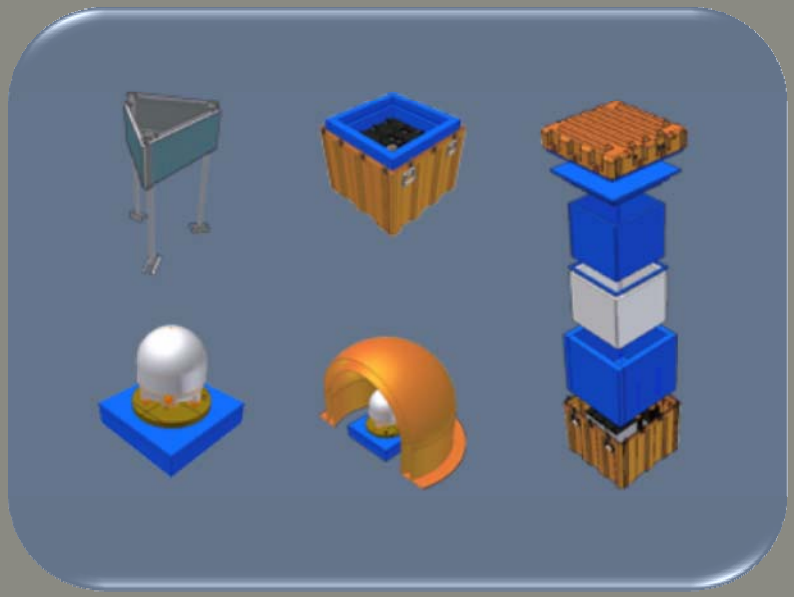


Development & IPY Support

- MRI – Development of a Power and Communications System for Remote Autonomous Polar Observations
  - Second year development deployed this winter
  - Leveraged development to support IPY science
- MRI – Acquisition of Broadband Seismic Stations for Polar Regions
  - Acquisition of 37 cold-hardened stations
  - 20 currently deployed at AGAP & POLENET

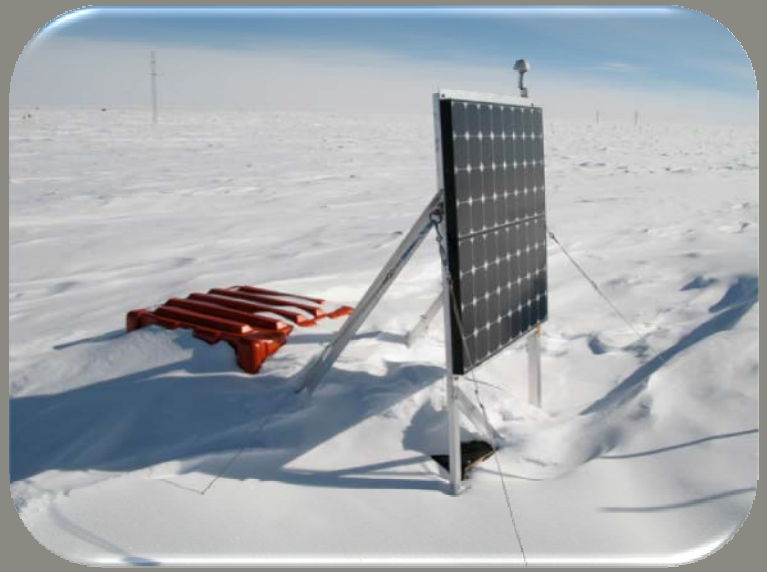
Current Development

- Reduce Power
  - Work with manufacturers
  - Low bandwidth SOH
- Harness DAS heat
  - Increase battery potential
  - Operate within specification
- Simplify deployment
  - Minimize ground time & payload
- Utilize Primary batteries
  - Simple
  - Dependable at extreme cold
  - Highest energy density



PASSCAL Polar Station

- Proven year round operation
- Low power (<1.5W)
- Leverage DAS heat to maintain station temperature ~20-25°C above ambient
- 275 kg total station weight (with Lithium)
- Easily deployed
  - AGAP stations installed on average 2 hours
- 2-way station communications
  - SOH
  - Command & control
- Power management



Station review/perfomance

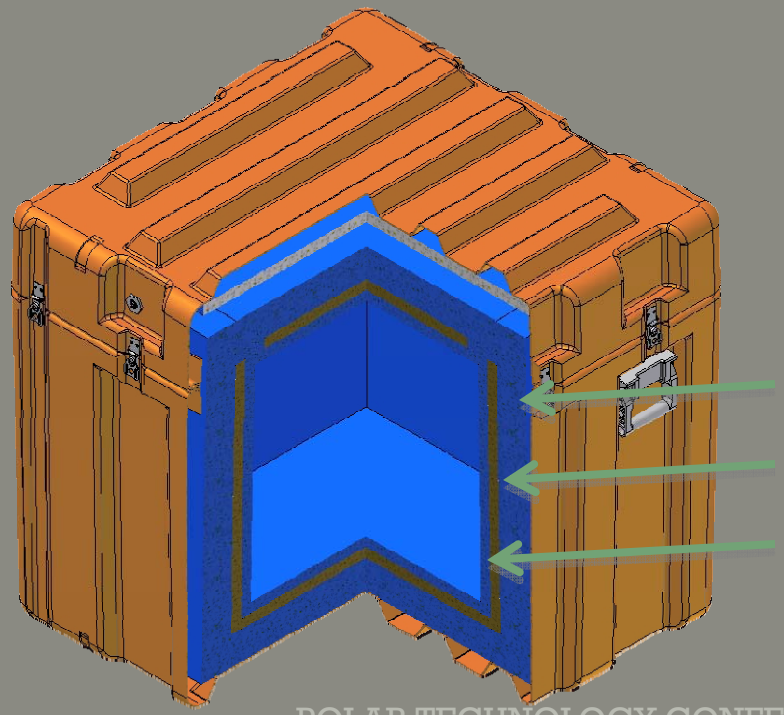
- Three installed last year
- All performed well
- The minimum installable Li pack lasted 85 instead of 90 days, 4 packs@2 watt load
- PSP01 was re-powered after the small pack was used up to continue testing Trillium T240 sensor
- PSP02 lasted full season despite Flexcharge solar controller failing in spring, ran 8.5 months on lithium
- PMC01 ran all season, no problems, 4.5 months on lithium
- All data available at DMC under station code XD

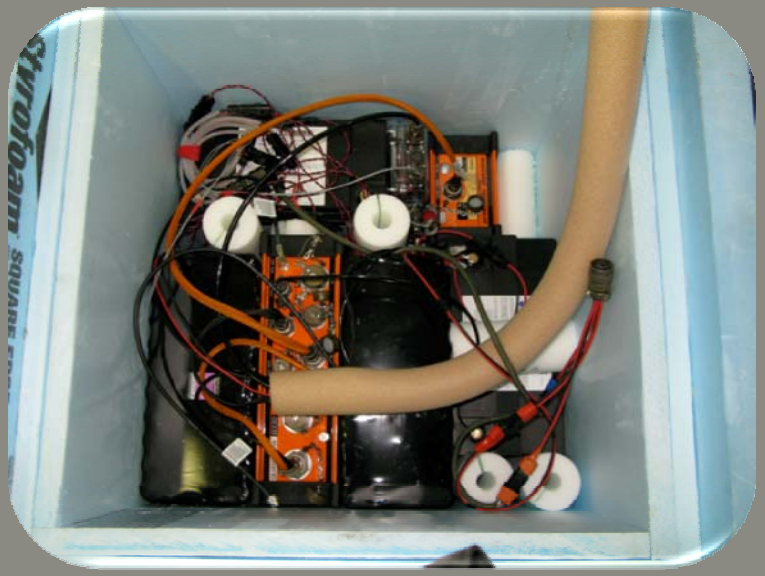
Highlights of Observed Performance

- Buried boxes have stable temp compared to surface boxes
- Phenolic blocks stable on snow for one season
- Redundancy good, power switching module keeps system running between two power sources
- Nanometrics Trillium sensors perform well in cold (Not cold rated -20C)
- Year round seismic station is possible!

Station Box

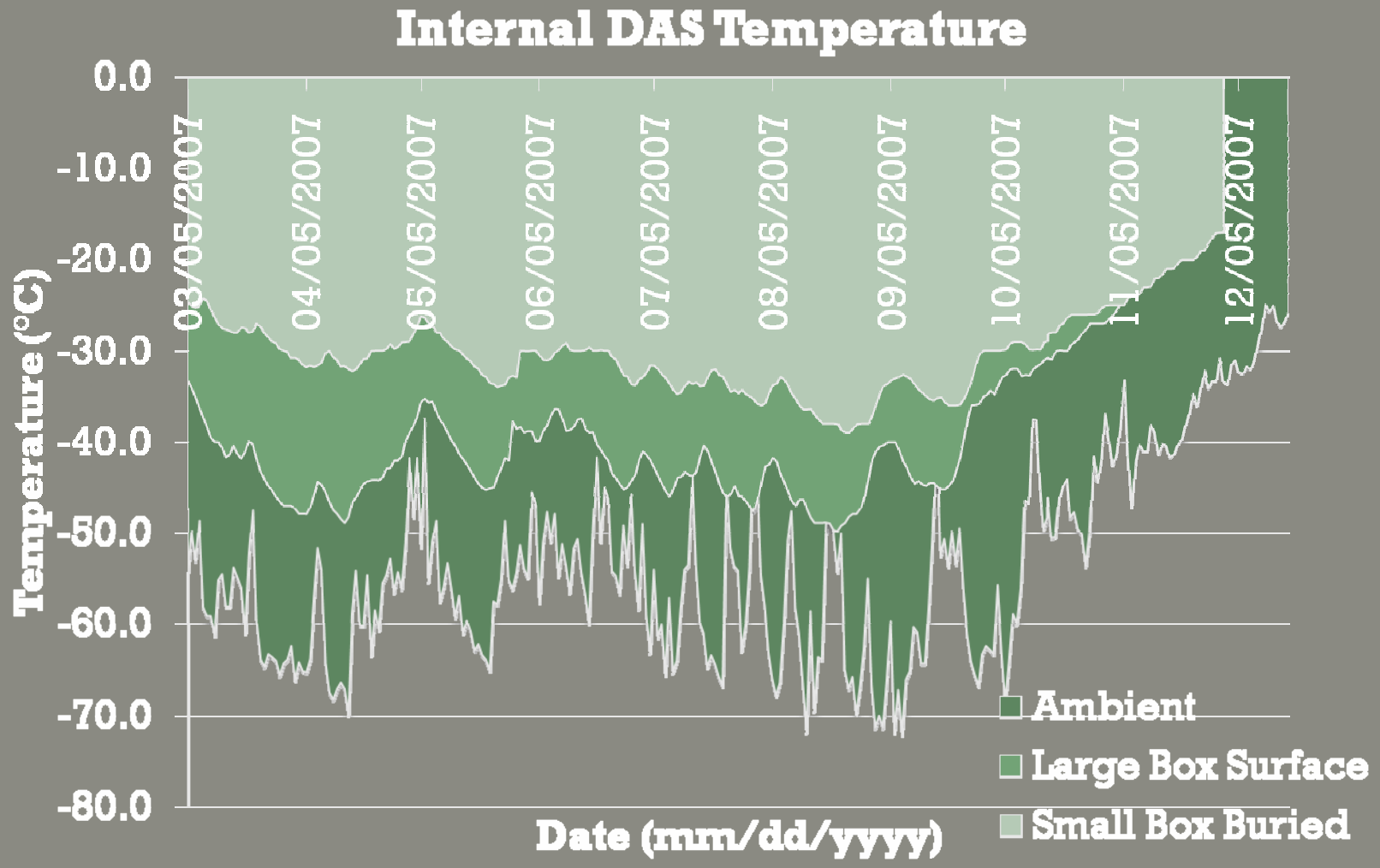
- Design
  - Hardigg Case
  - 94cm x 94cm x 94cm





- 7.6 cm Thick Foam Insulation
- 2.5 cm Thick Vacuum Panel
- 2.5 cm Thick Foam Insulation
- 1.9 cm Wall Cable Insulation

Station Box Performance



Colder rated Digitizer

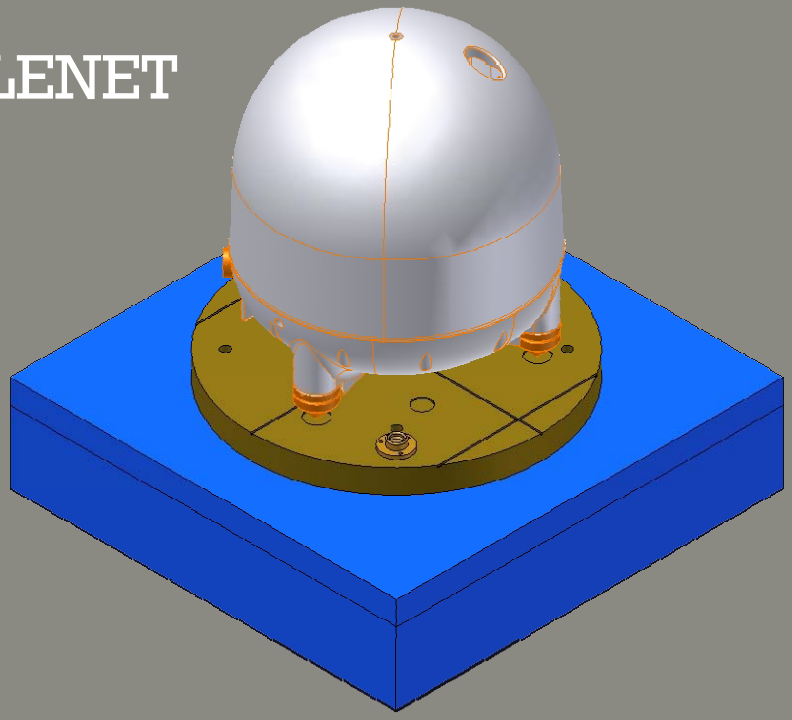
- Quanterra Q330
- Rated to -45°C, was -40°C
- 32MB of buffering allows longer time between baler cycles saving 2/3 of the baler power budget from last year
- 16GB of -45°C rated station storage device (media rated to -55°C)
- Power budget for Q330, 3 channels @ 40sps and continuous GPS is ~0.8 watts

Cold Rated Guralp 3T

- MRI funded development of cold rated seismometer
- Coldest rated and lowest powered broadband sensor
- 0.3 Watts, -55°C rated, tested to -60°C

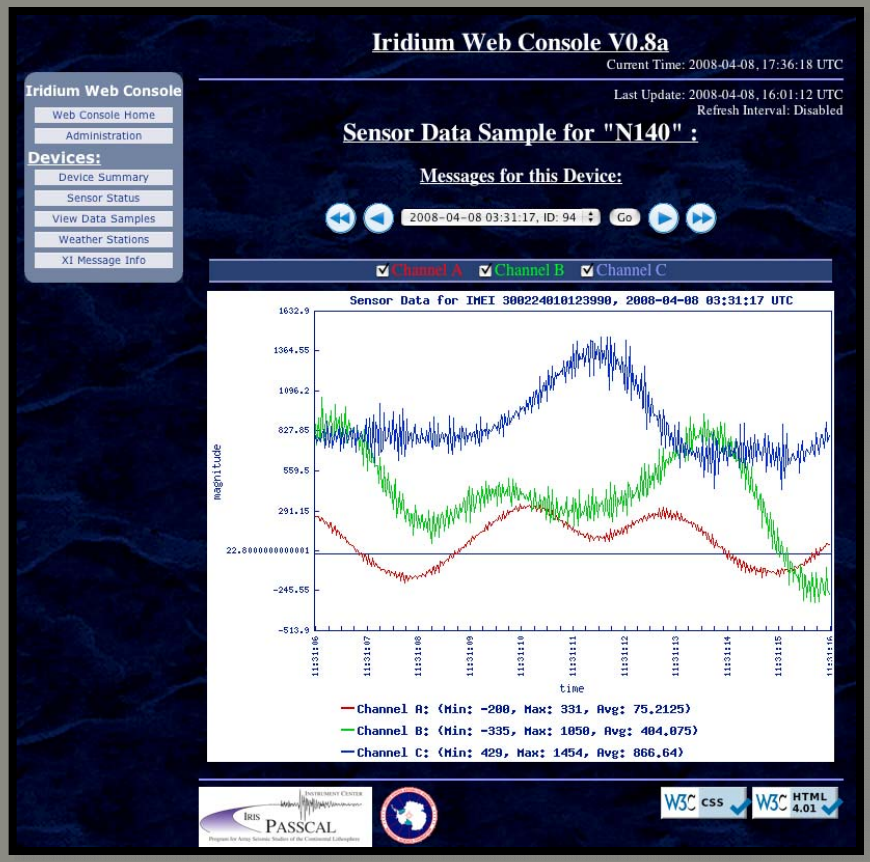
Nanometrics Trillium 240

- Successfully used for one season at South Pole
- 20 currently deployed for POLENET and AGAP
- 0.65 watts, -20°C rated



Development of SOH Iridium Telemetry

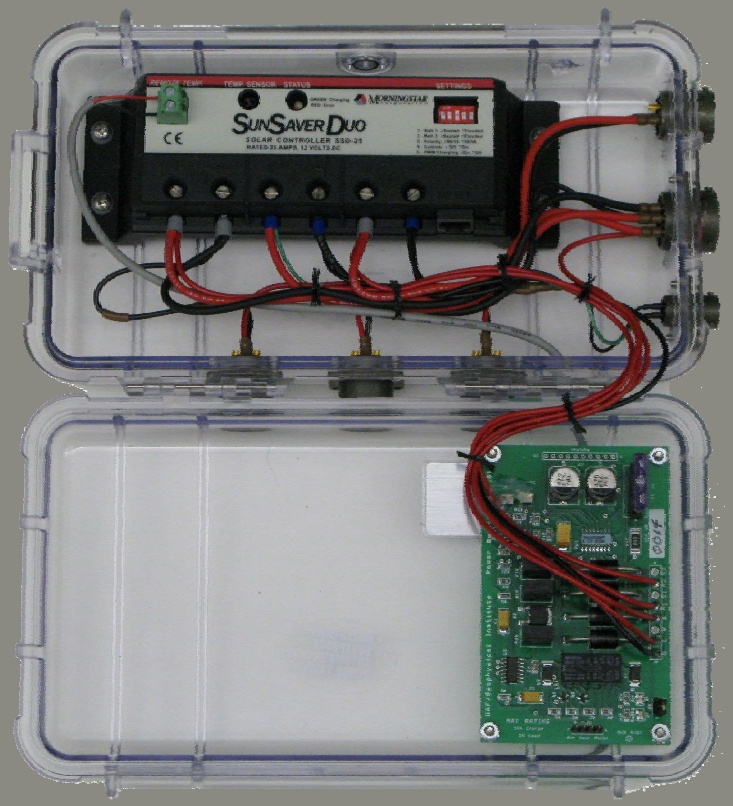
- Deployed but still in alpha testing of phase 1 of a two phase development
- Yearly power budget for once-a-day SOH, 5AH
- Data rate ~2.4 Kb/s
- Status and data snippets
- Command and control of a subset of important station commands and reporting schedules
- Developed in collaboration with XEOS Technologies
- Integration of Vaisala weather station - data averaging, reporting and power control
- Power control of external device



10s data snippet from Antarctica

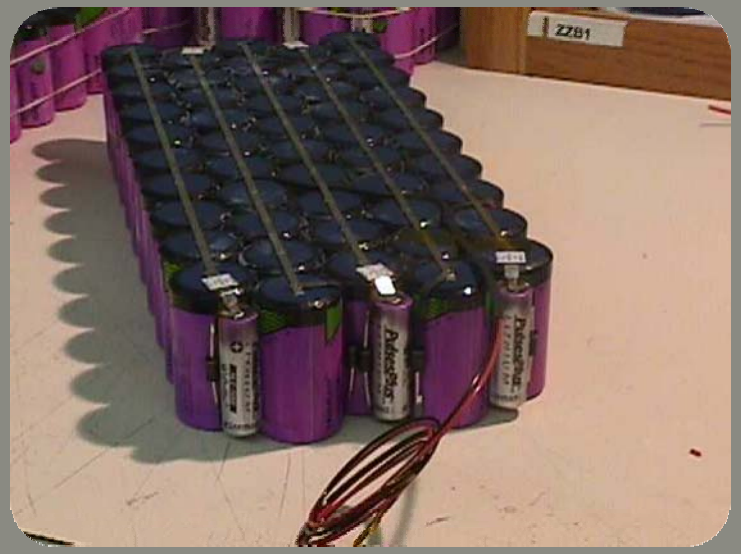
Power Management

- New power switching board, lower parasitic power
  - Switches between chargeable and primary batteries
- Charge controller, can use one charging source for two battery banks e.g. preferential charging
- LVD and HVR settable
- Cold culled to -50°C, 5 out of 30 fail because of charge controllers



Batteries

- Lithium Thionyl Chloride primary battery pack for winter operations
  - 190 A-h/unit between 18.5-15.5V
  - 10 unit pack
    - 30,000 W-h at room temperature
    - 23,000 W-h at -30°C
    - 16,500 W-h at -55°C
- AGM secondary, solar charged
  - 2x100 A-h

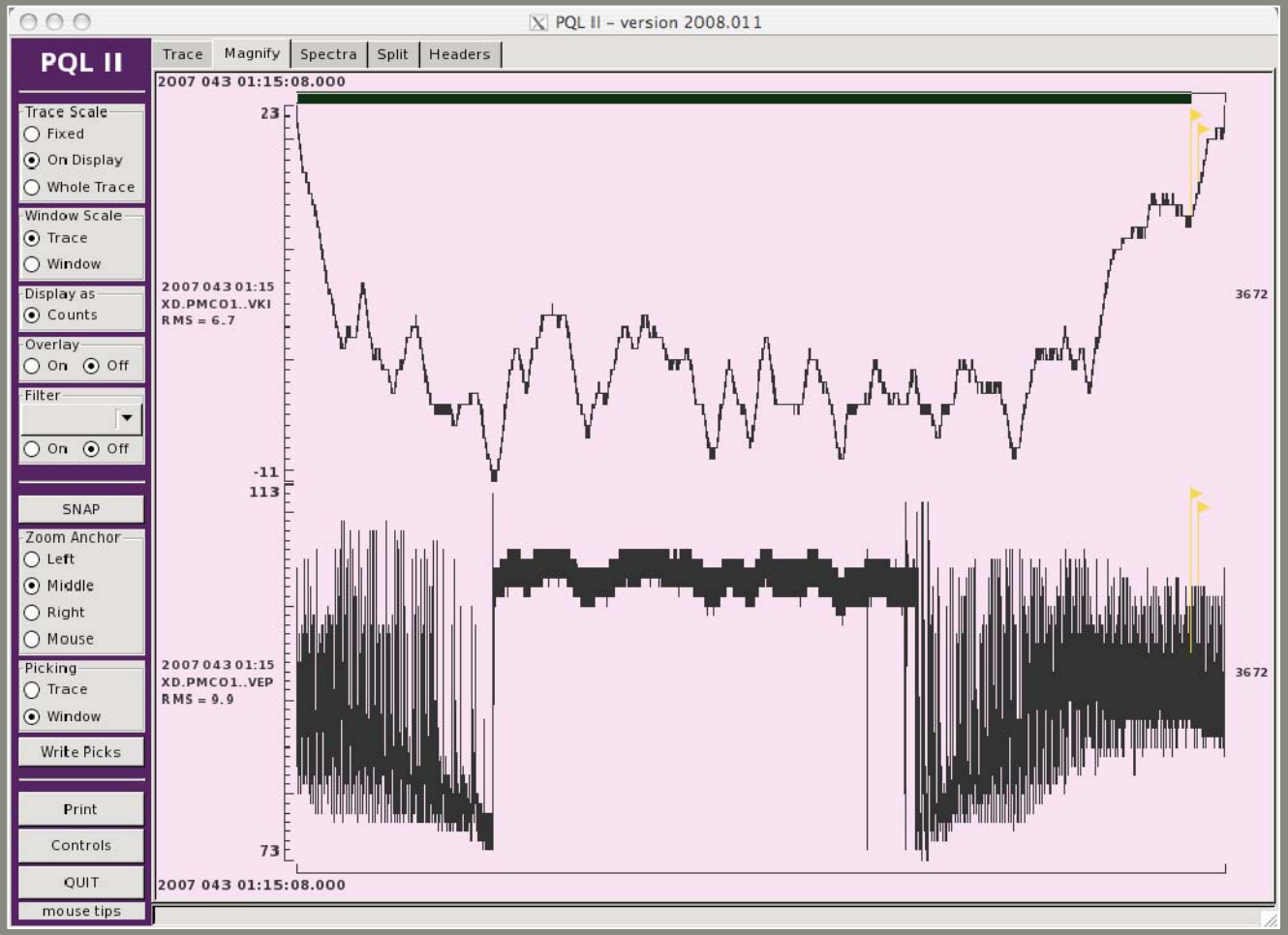


190 A-h unit prior to shrink wrap

Power Switching at PMC01

DAS Temperature

System Voltage



SPRESSO, PSP03

- Plateau seismic system test bed
- Designed to last over 2 years without service
- Uses new .3 watt Guralp cold rated 3T
- 3x 90W Sharp solar panels
- Snow vault, buried insulated dome
- Vacuum insulated enclosure design
- 2x 108AH AGM batteries for summer ops
- 20 Lithium 190AH@18V battery packs
- 1 watt heater powered by solar
- Ethernet coms to SPRESSO vault to DMC
- 1.5 watt load and under 700 pounds to install

Minna Bluff, PMC03

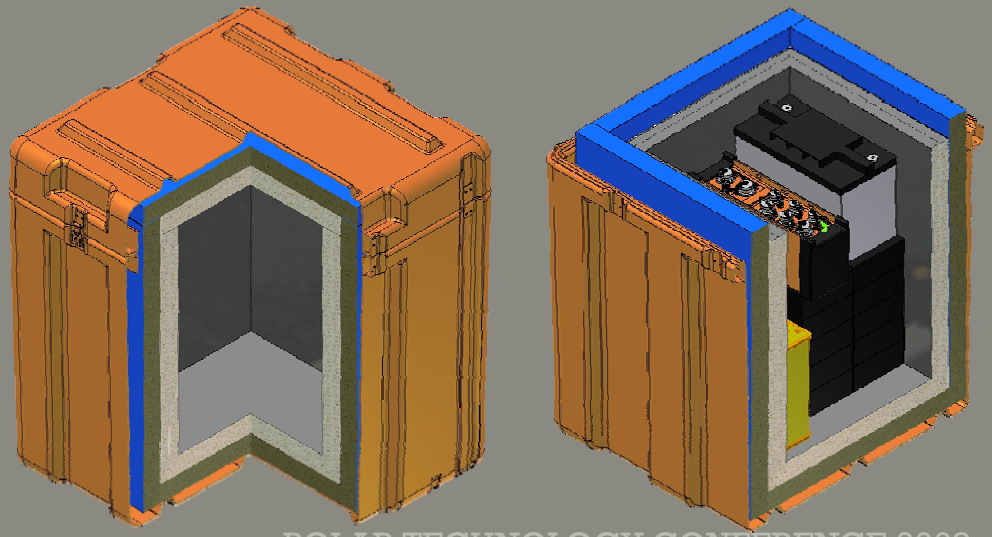
- Margin seismic system prototype
- New enclosure but only extruded polystyrene insulation used, 4 inches all around
- AGM batteries only, 8@108AH plus 2@35AH
- 160 watts of solar charging, 5 watts of wind
- 3 watt heater driven by either wind or solar
- 1.5 watt load
- Xeos SOH transmitter

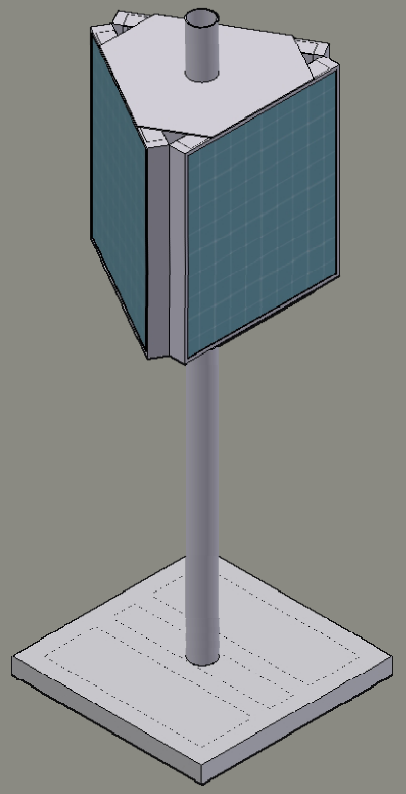
Minna Bluff, PMC03 Continued

- Co-located with GPS MRI station
- Solar panels have backing panel for armoring
- Dead weighted with 4 gabions ~ 3000pounds

New Development

- New station box design
  - Better insulated
    - Double vacuum panel
    - Insulated cable harness
  - More durable
    - Hard liner
  - More easily fabricated
  - Smaller and lighter
    - 76cm x 76cm x 84cm
- New solar mount
  - Low wind, high-latitude environment
  - Single pole
  - 32kg
  - 3x30W panels





New Development

- New cold-rated solar charge controller development
- Iridium phase two
  - Request event data
  - Realtime low sample rate data (<10Hz)
- Parallel iridium development with Quanterra
- Alternate battery technologies
  - Lithium Ion

More Information & Design Docs