Autonomous Real Time Remote Observatory

- System description and review of design, integration and field deployment results
- Lessons learned and new developments
- Improvement for the future

Concept - Requirements

- Observatory to provide continuous power of 50 watts to up to 16 instruments for operation in Antarctica
- Real time transmission of data
- Support for optical instrumentation (domes)
- Twin Otter transportable

ARRO 1 – Development - Enclosure

- Combined development effort between CRREL and Foamtech
- 9’X9’X9’ enclosure with 18” closed cell polyurethane foam sandwiched between OSB
- Front entrance, dome support and cable penatrations support
- Initial enclosure built and tested at CRREL

ARRO 1 Development - Enclosure

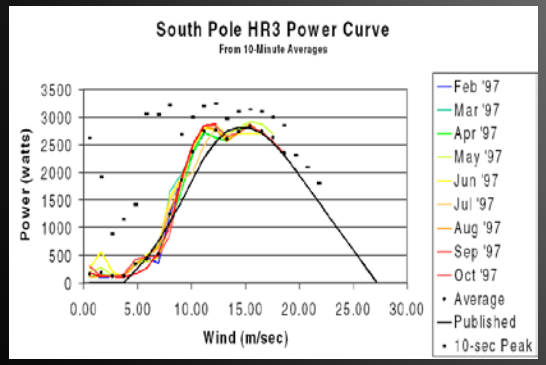
Initial modeling revealed that although R value of wall pieces important, loss through other areas most significant

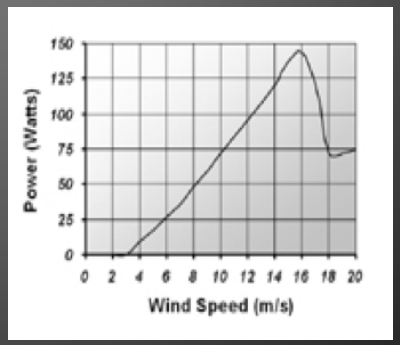
- Overlapping panels with flexible gaskets
- Double dome for optics
- Innovative cable penetration concept developed at CRREL

Power System -Wind Generator Selection

- HR3 – Proven South Pole operation
- Robust design
- Ample power with low cut in (3kW)
- Challenging installation
- Significant shipping volume and weight

- Marlec/Rutland 910 Furlamatic
- Lower power (appx 140 watt maximum) wth low cut in (3m/s)
- Small shipping volume and weight
- Configurable sizing

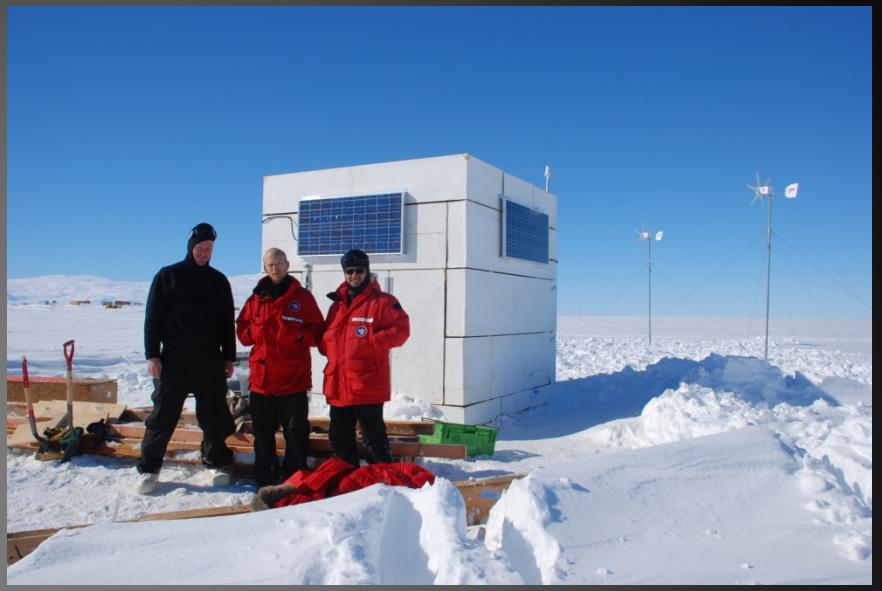




ARRO – Additional Design Components

- 4, Kyocera KC120 120 watt solar panels
- ARRO Data Acquisition Unit
- ARRO DAW
- ARRO System Controller Unit
- NAL Research Iridium Modem
- 370 Ah Nicad Battery Bank
- 12, 5 Gallon Jugs of water

ARRO 1 – Deployed 2007/2008



- Initial Installation of ARRO at Willy Field
- 3 Marlec-Rutland 910-3 wind turbines
- 4 Kyocera, 120 watt solar panels
- 50 watts of resistive dummy loads

2007/2008 Performance Summary

- Continuous operation during light months
- Intermittent operation during dark months
- Consistent “cold soak” recovery
- Lost contact towards end of season due to faulty low voltage cutoff.
- Some infiltration of enclosure noted at gaskets due to expansion/contraction during shipping

ARRO2 – Improved Version

- Fabrication improvements – tolerances on longer cuts
  - Potential existed for direct inflitration when tolerance of long cuts exceeded tolerance of gaskets
  - Solution – greater number of pieces with shorter cuts. Improved machinery for cuts
- Smaller pieces allow for flexible design approach

ARRO 2 Development - Transport

- Assembled transport to Port Hueneme through to McMurdo
- Assembled transport with LC130
  - Disassembled transport with Twin Otter

ARRO 2 Deployment 2008/2009

Power System

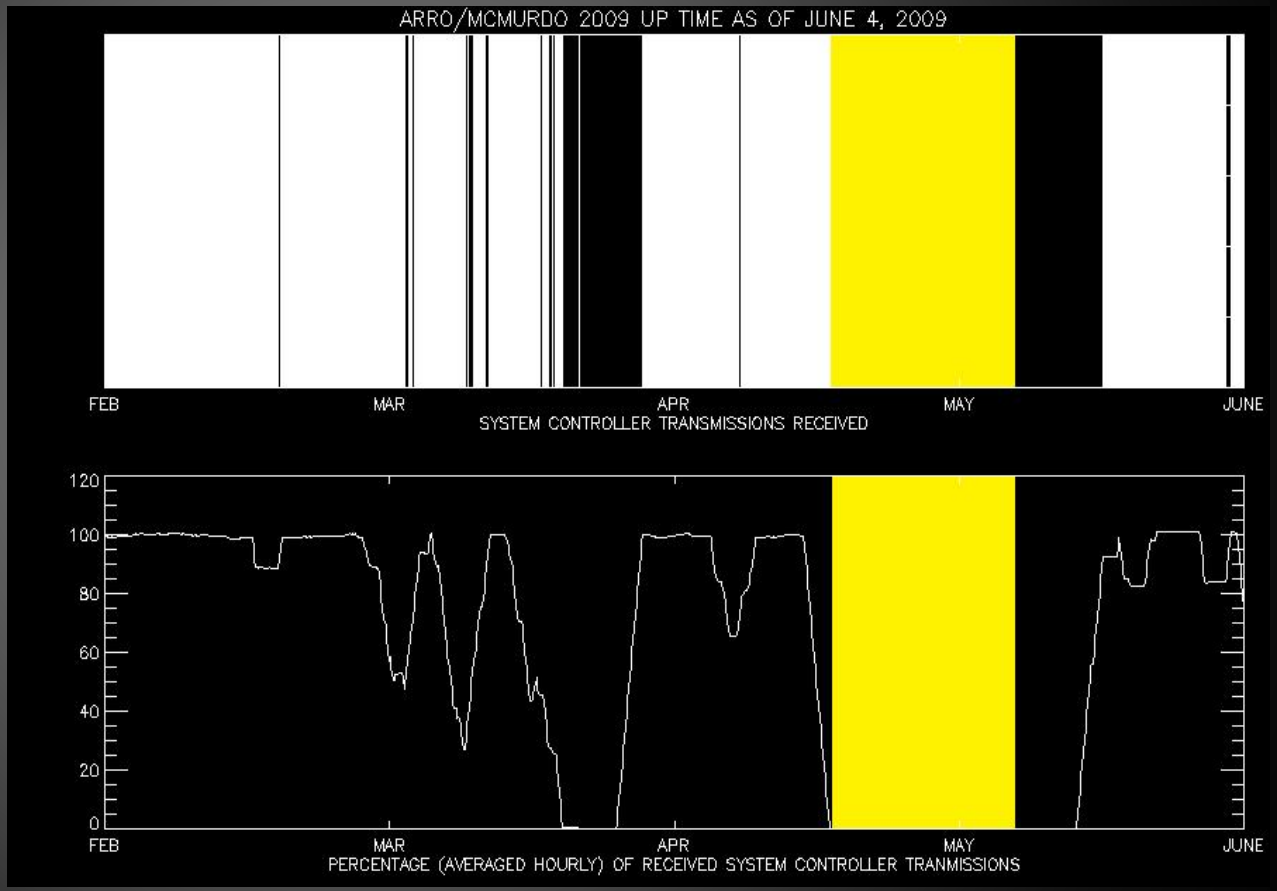
- 4 Kyocera 120 watt solar panels
- 3 Rutland 910 wind turbines

Instrument Installed

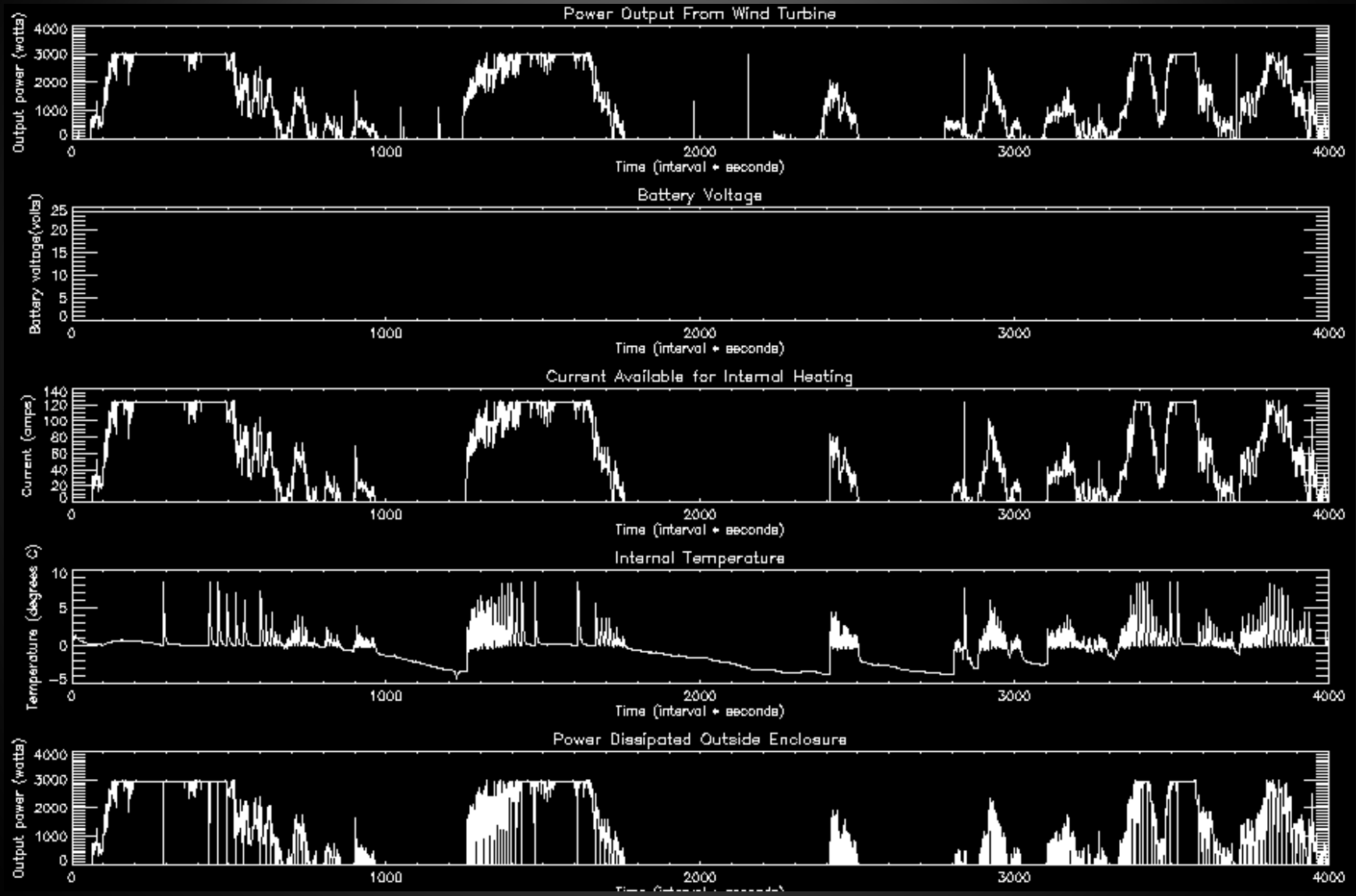
- Berkeley Allsky Camera
- UNH ULF Coils
- Dartmouth HF
- Maryland/Siena Riometer
- NJIT Magnetometer

2009 Performance

- Operational through testing period
- Infiltration greatly reduced in enclosure
- Lost real time data in winter – modem frozen capacitor
- Brief period of data acquisition loss
- All 3 turbines operational through period



System Modelling



Looking Towards the Future for Instrument Support – Bridging the Gap?

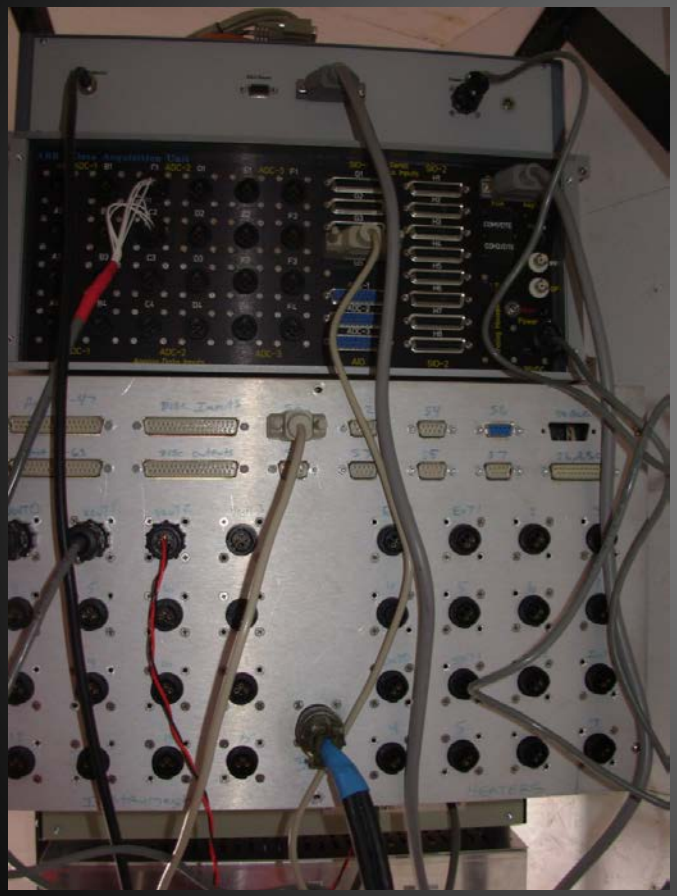
- Moving from an observatory to dedicated instrument support
  - Design optimization for known instrument set versus capability for additions/changes on yearly basis
  - Jackable structure versus buried unit

- Wind/Solar versus Solar only
  - Where is the threshold for the optimal implementation?
    - Autonomy requirements and power
    - Installation/transport requirements
- Instrumentation and Overall Science Requirements

Instrumentation

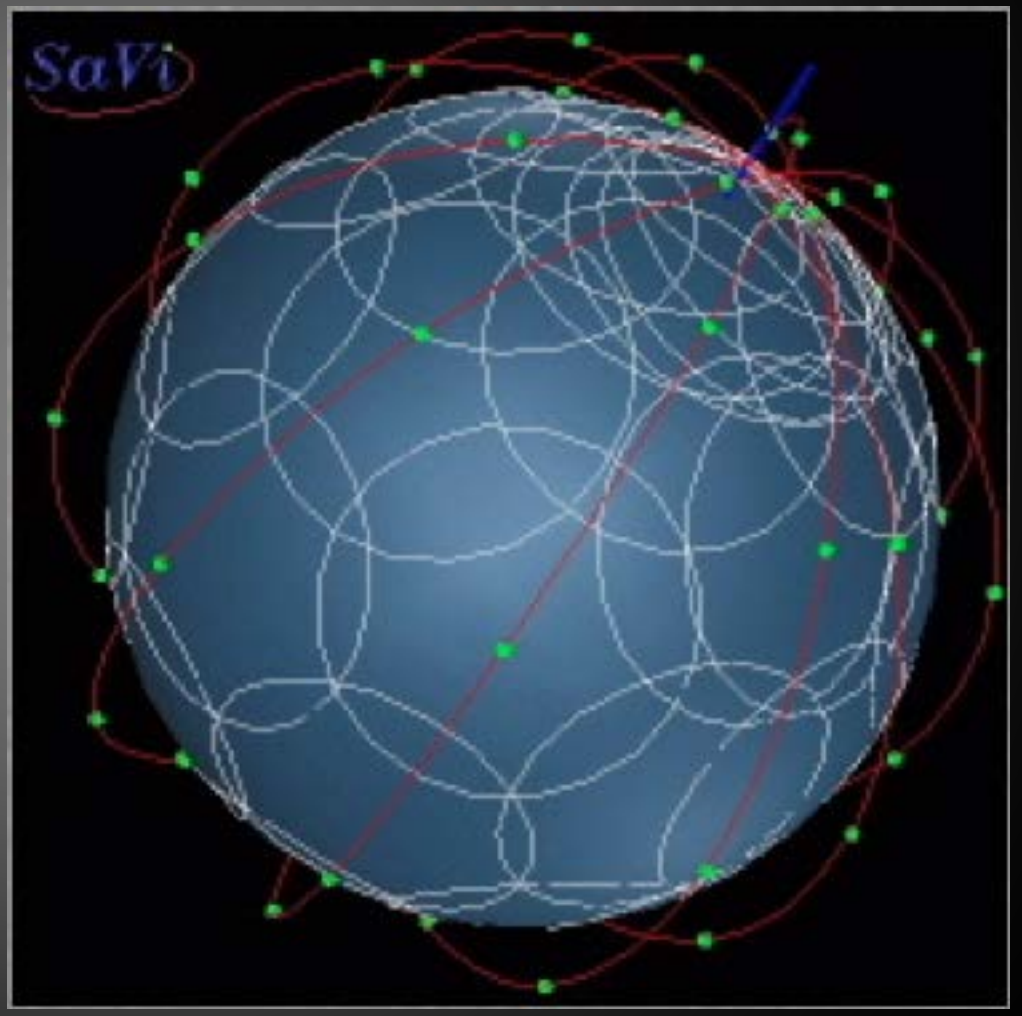
- Technology migration changes power consumption and drives requirements
  - Magnetometer
    - Sub watt operation
  - Allsky cameras
    - TEC Cooled EMCCD – multiple watts
    - Dome requirement

Looking towards improvements Modular System components



- Modular instrument support
  - Number and types of acquisition channels
  - I/O support
- Combining functionality
  - Iridium interface and control
  - Data acquisition
  - System Control
  - Data compression

Looking towards possible improvements
Improvements with Iridium?



Questions?

Further documentation/reports available at

http://mirl.sr.unh.edu/projects_arro/projects_arro.html