

AMISR

The Advanced Modular Incoherent Scatter Radar

Todd Valentic

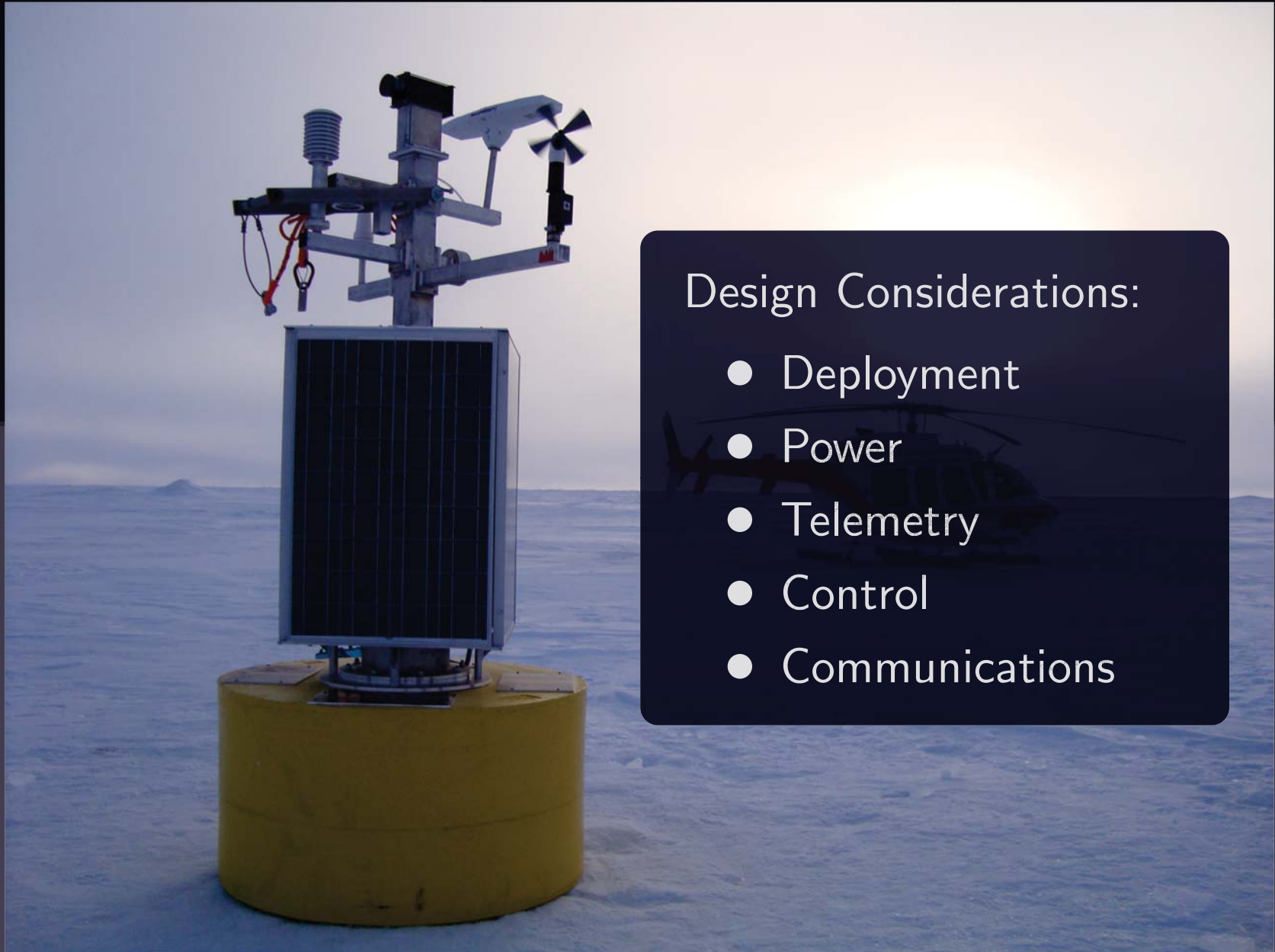
Center for Geospace Studies
SRI International

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Autonomous Systems in the Polar Regions



Autonomous Systems in the Polar Regions



Design Considerations:

- Deployment
- Power
- Telemetry
- Control
- Communications

Autonomous Systems in the Polar Regions



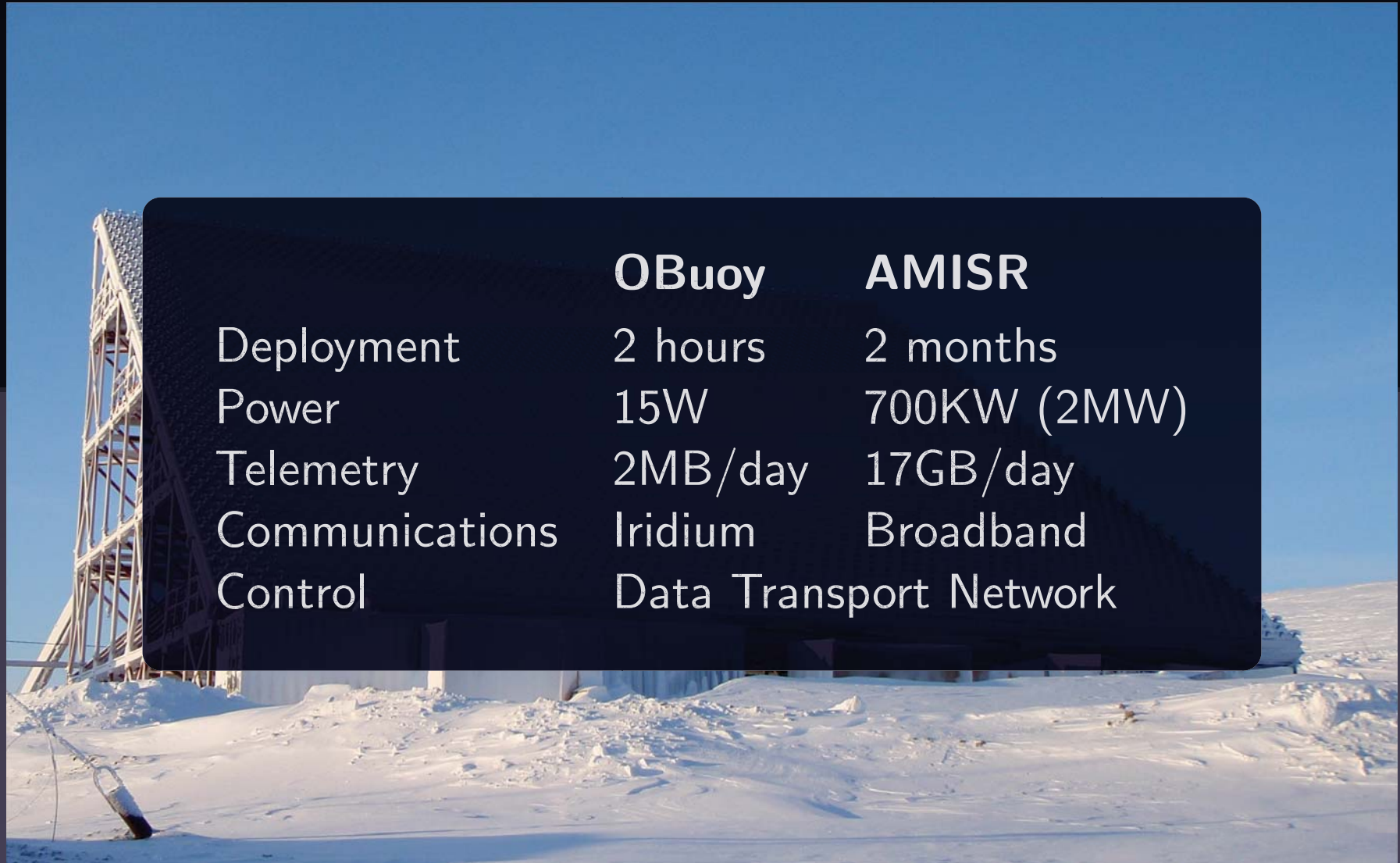
But Are We Assuming?

- Small
- Low-Power
- Cold

Resolute Bay Incoherent Scatter Radar



Resolute Bay Incoherent Scatter Radar



	O Buoy	AMISR
Deployment	2 hours	2 months
Power	15W	700KW (2MW)
Telemetry	2MB/day	17GB/day
Communications	Iridium	Broadband
Control	Data Transport Network	

Sondrestrom, Greenland



Sondrestrom, Greenland

- Large steerable antennas
- Vacuum tube power amplifiers
- High voltage power supplies
- Liquid cooling heat exchangers
- Full-time site crew

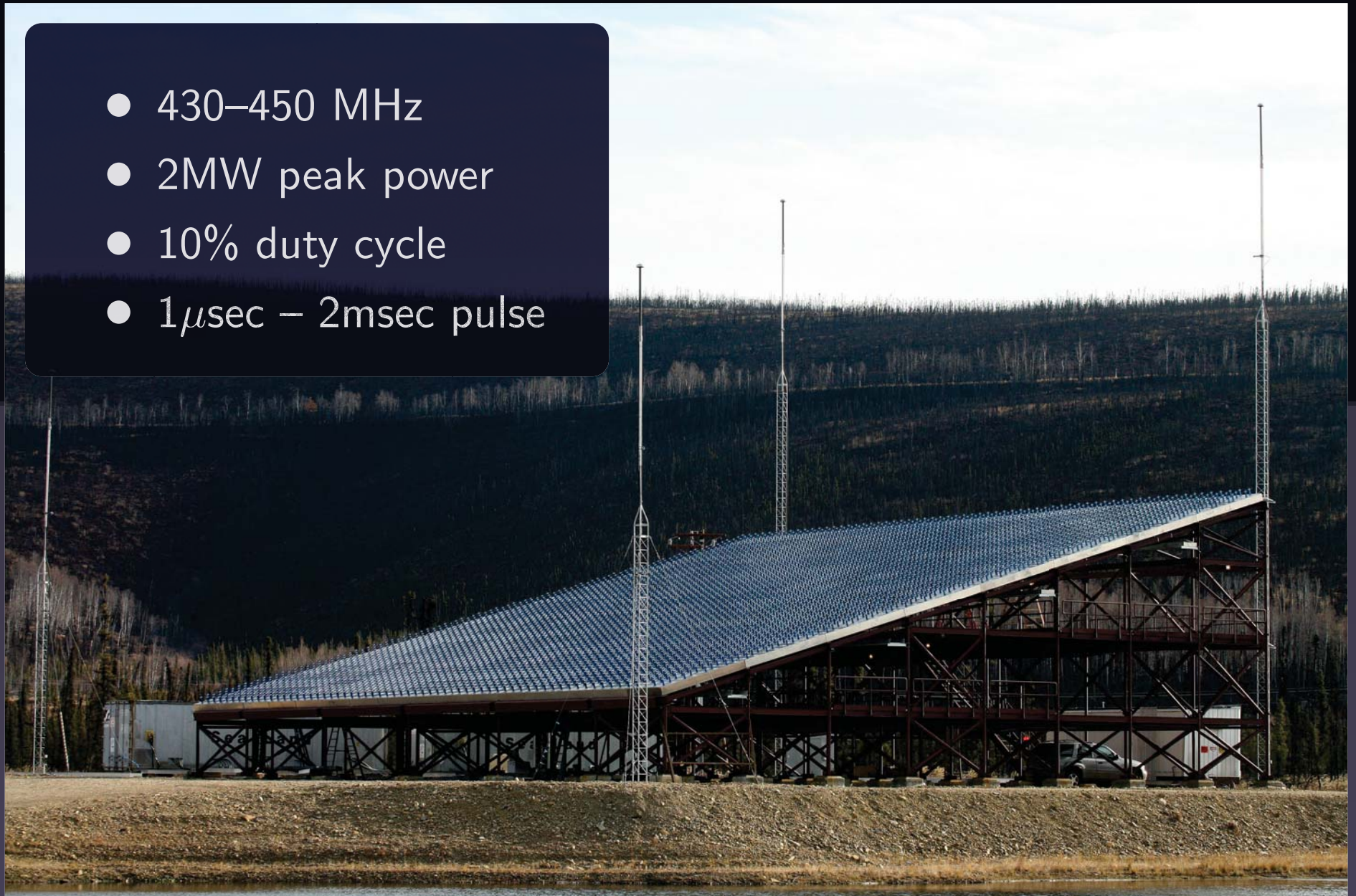


ISR Locations



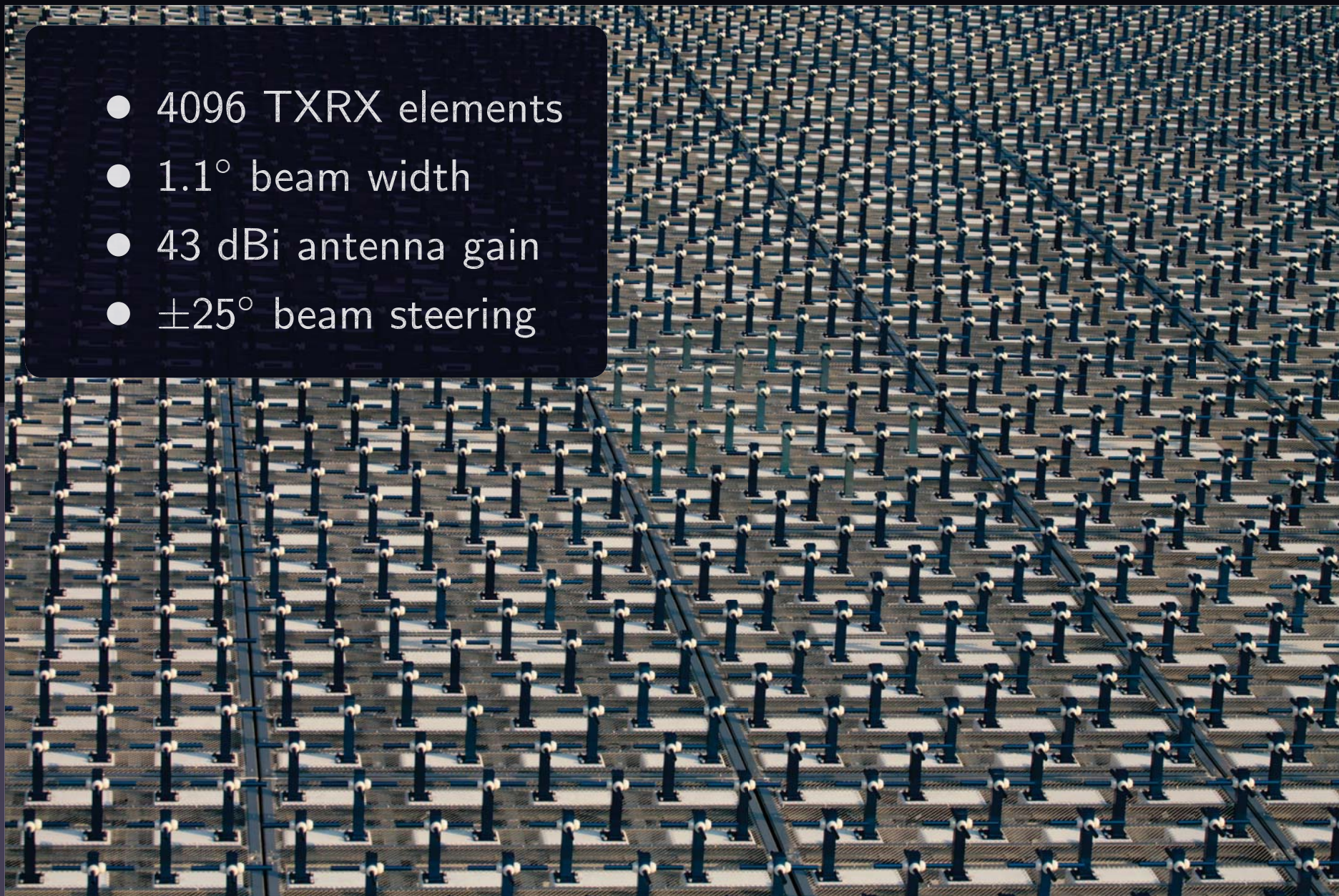
Poker Flat, Alaska

- 430–450 MHz
- 2MW peak power
- 10% duty cycle
- $1\mu\text{sec}$ – 2msec pulse



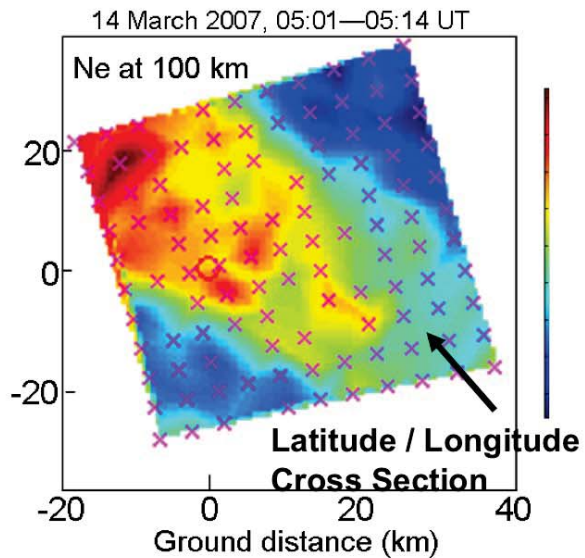
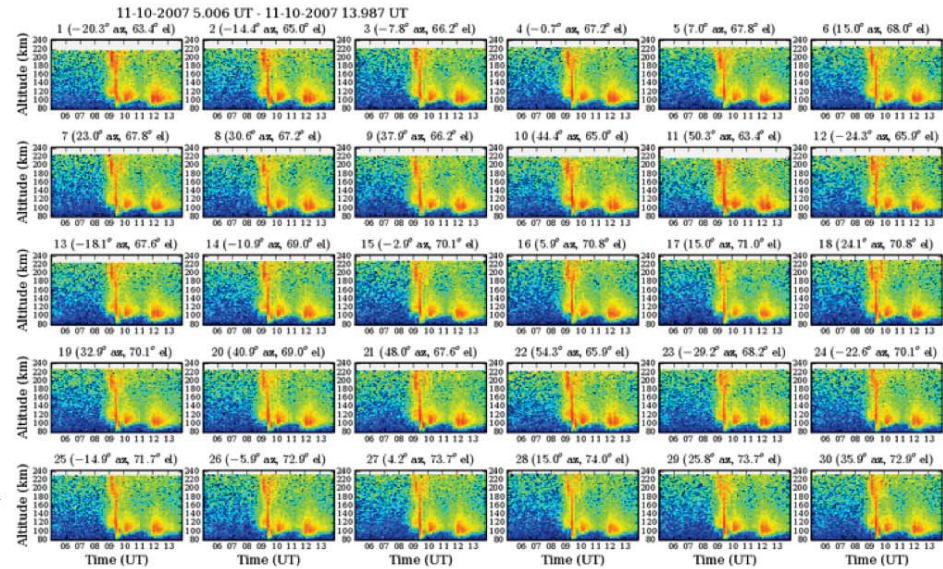
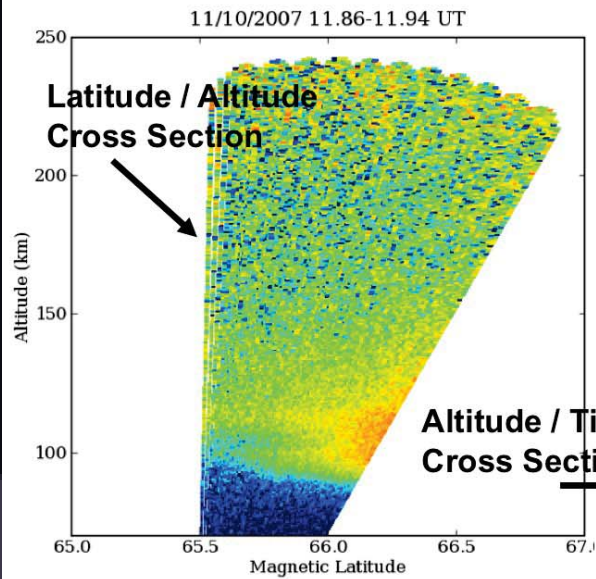
Poker Flat, Alaska

- 4096 TXRX elements
- 1.1° beam width
- 43 dBi antenna gain
- $\pm 25^\circ$ beam steering

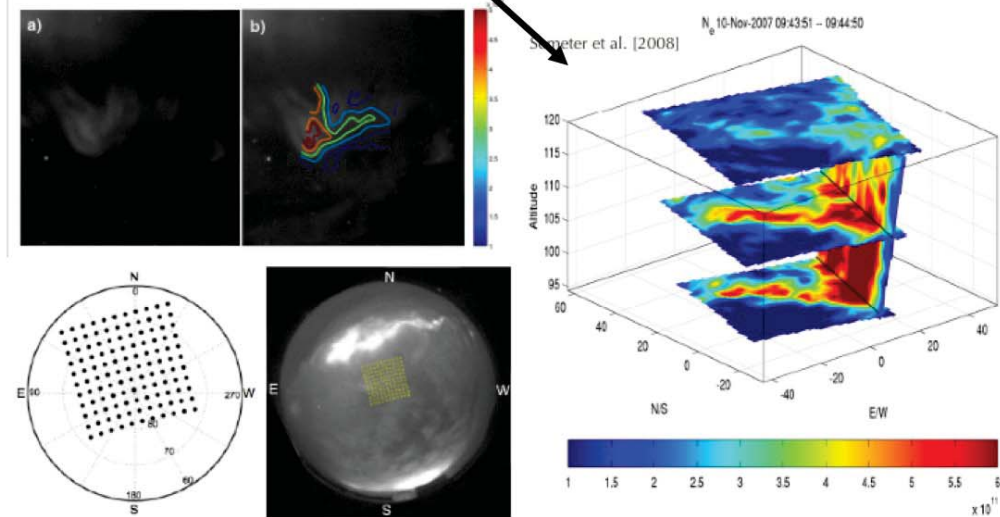


Example Science Results

PFISR: Images of the Aurora in 4-Dimensions (3-D images v. time)

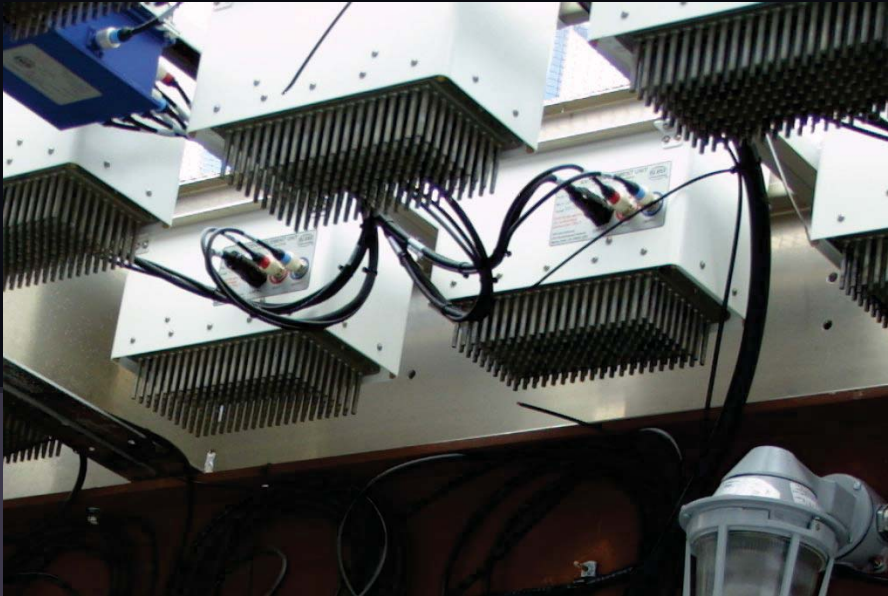


Three-Dimensional Visualization



Antenna Element Unit – AEU

Transmit and Receive

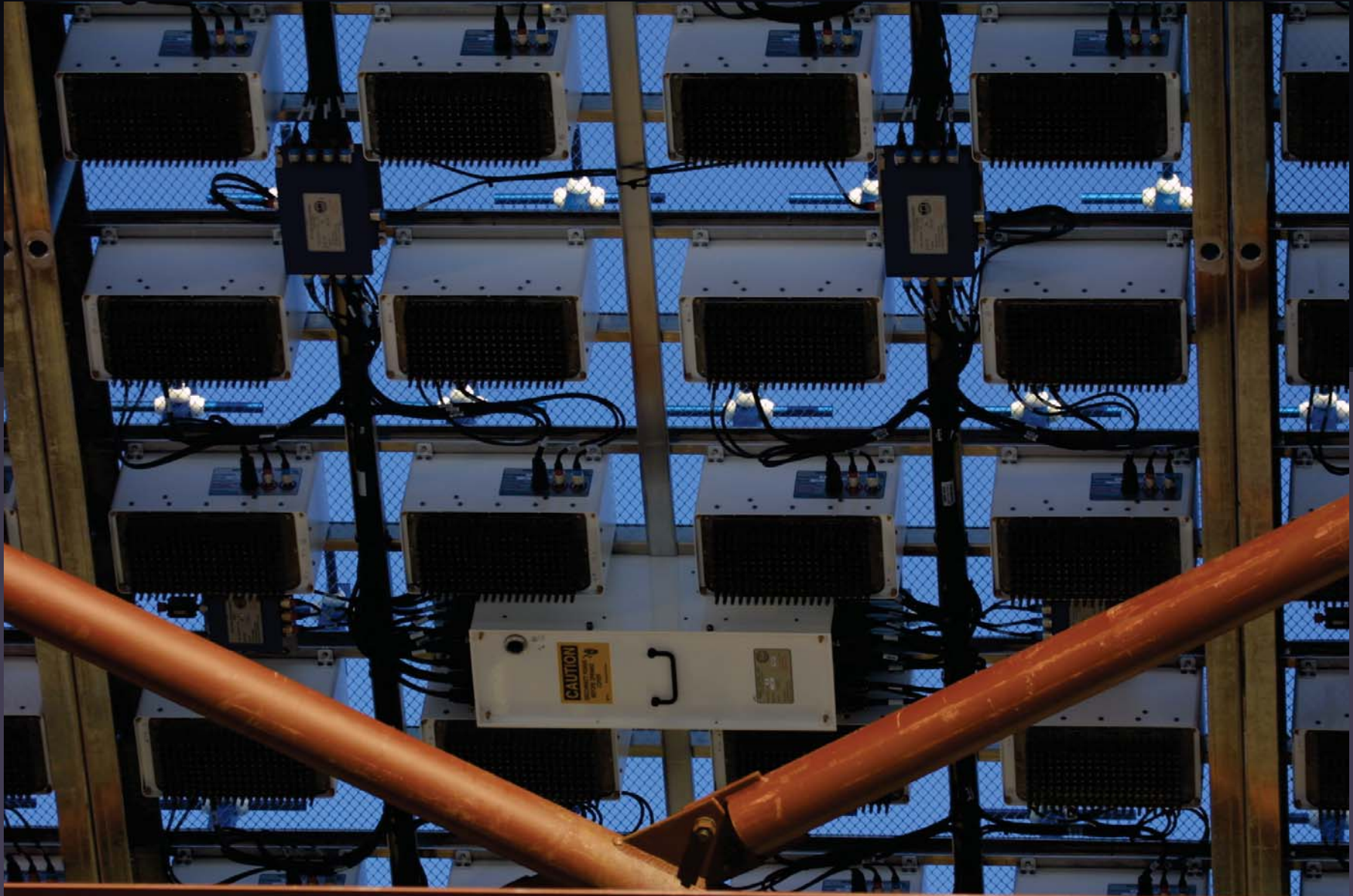


- 500W solid-state transmitter
- Phasing control
- Low noise receive amplifiers
- Status monitoring (PIC)



Panel Control Unit – PCU

32 AEU's Per Panel, 128 panels per face



Deployment to Resolute Bay



Preparing The Site



Assembling The Structure



Assembling The Structure



Hoisting Panels

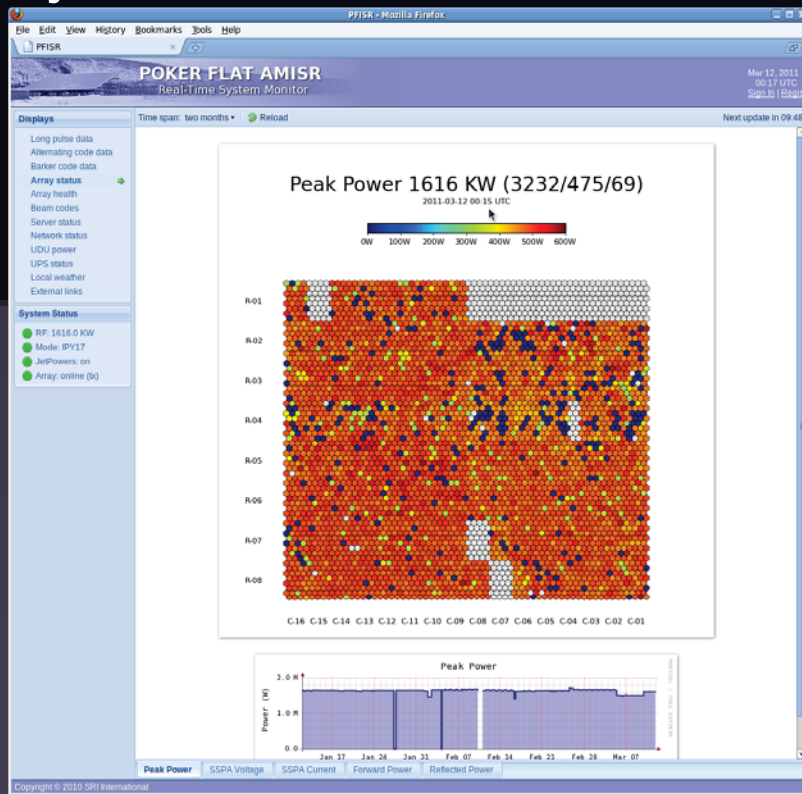


Completed Resolute North Face

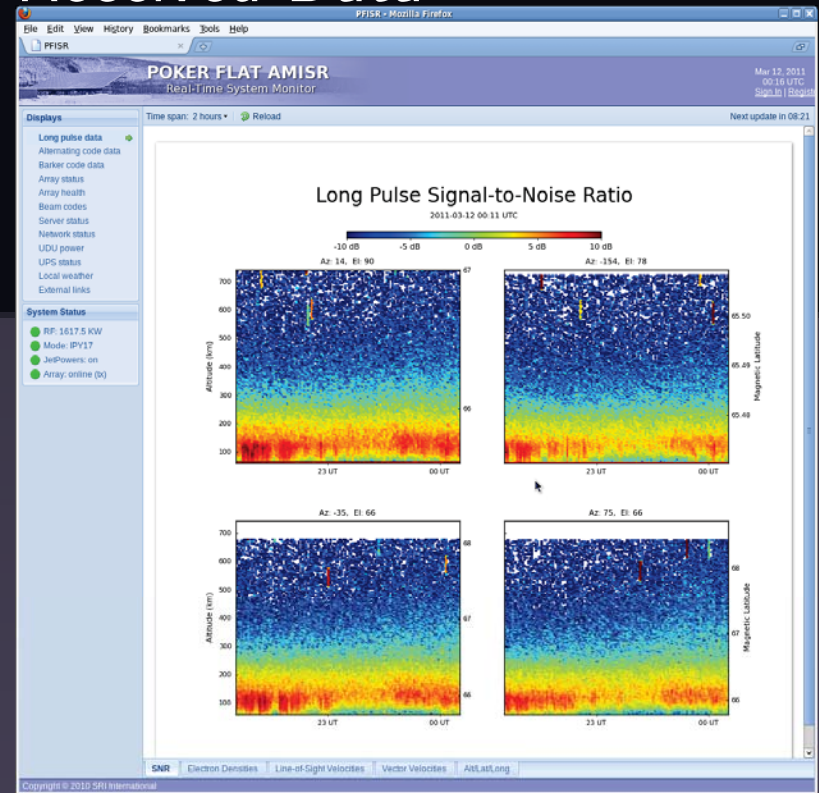


Remote Monitoring

System Health



Received Data



Power Generation at Resolute

1MW Cummins Diesel

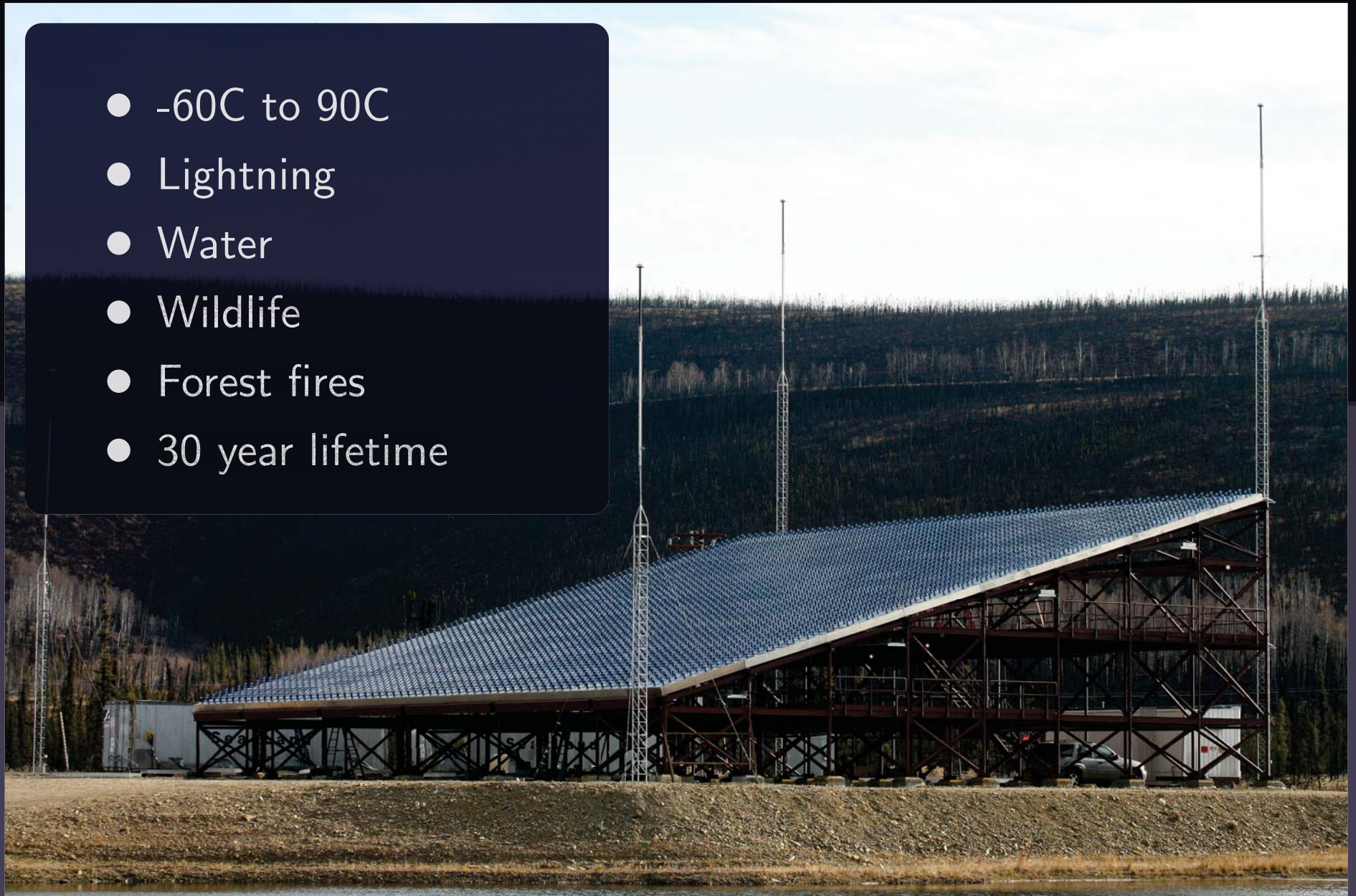


400Hz Power On The Array



Environmental Design Considerations

- -60C to 90C
- Lightning
- Water
- Wildlife
- Forest fires
- 30 year lifetime



Design Philosophies

- Simple over complex
- Minimize single point failure points
- Parts of the system will fail
- Hardware protects itself
- No moving parts
- Manufacturing best practices

Some Lessons Learned

- Generators are hard
- 400Hz power is a pain
- Design for maintainability
- Dealing with obsolete parts
- History and performance tracking

Each AMISR Face

Components

- 235,000 connectors
- 330,000 IC chips
- 425,000 screws
- 740,000 capacitors
- 800,000 resistors

Control

- 4 Windows workstations
- 9 Linux servers
- 128 embedded Linux controllers
- 4096 microcontrollers
- 30,000 lines of code

Structure

- 11 miles of cable
- 200 tons of steel