AMISR
The Advanced Modular Incoherent Scatter Radar

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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

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<thead>
<tr>
<th></th>
<th>OBuoy</th>
<th>AMISR</th>
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<tbody>
<tr>
<td>Deployment</td>
<td>2 hours</td>
<td>2 months</td>
</tr>
<tr>
<td>Power</td>
<td>15W</td>
<td>700KW (2MW)</td>
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<tr>
<td>Telemetry</td>
<td>2MB/day</td>
<td>17GB/day</td>
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<tr>
<td>Communications</td>
<td>Iridium</td>
<td>Broadband</td>
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<tr>
<td>Control</td>
<td>Data Transport Network</td>
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Sondrestrom, Greenland
Sondrestrom, Greenland

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

- 430–450 MHz
- 2MW peak power
- 10% duty cycle
- 1μsec – 2msec pulse
Poker Flat, Alaska

- 4096 TXRX elements
- 1.1° beam width
- 43 dBi antenna gain
- ±25° beam steering
Example Science Results

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

Latitude / Altitude Cross Section

Altitude / Time Cross Section

Three-Dimensional Visualization

14 March 2007, 05:01—05:14 UT

Ne at 100 km

Latitude / Longitude Cross Section

Ground distance (km)
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 AEUs Per Panel, 128 panels per face
Deployment to Resolute Bay
Preparing The Site
Assembling The Structure
Assembling The Structure
Hoisting Panels
Remote Monitoring

System Health

Received Data
Power Generation at Resolute

1MW Cummins Diesel
400Hz Power On The Array
Environmental Design Considerations

-60°C to 90°C
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

Structure
- 11 miles of cable
- 200 tons of steel

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