The Advanced Modular Incoherent Scatter Radar (AMISR)

Historical Perspectives

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Earth’s Atmosphere
Space Weather Effects

- Energetic Electrons
- Solar Flare Protons
- Damage to spacecraft electronics
- Ionospheric currents
- Geomagnetically induced currents in power systems
- Telluric currents in pipelines
- Induced effects in submarine cables
- Magnetic interference in exploration surveys
- HF Radio wave disturbance
- Radiation effects on avionics
- GPS Signal Scintillation
- Induced effects in exploration surveys
Incoherent Scatter Radars: The most direct technique for routinely observing fundamental properties of the ionosphere and upper atmosphere.

The weak return signals from high-power radio transmitters are used to deduce properties of the ionosphere:

- Ionospheric Composition
- Electron and Ion Temps.
- Electron Density
- Ion Drift Velocity
- Collision Frequencies
The History of Incoherent Scatter in a Nutshell

The Era of Construction for U. S. Incoherent Scatter Radars

The National Science Foundation takes over

The Era of Construction for European Incoherent Scatter Radars

The Age of AMISR
1958-1959

Bill Gordon conceives of the idea of incoherent scatter and construction begins at Arecibo, Puerto Rico, with funding from the Defense Advanced Research Project Office (DARPA)
1961
The Jicamarca Observatory is constructed near Lima, Peru, by the National Bureau of Standards.
1962
Construction of Arecibo is completed.
1963
The Millstone Hill zenith antenna is constructed by MIT Lincoln Laboratories at a site near Boston, MA
1971
The Chatanika Radar is moved from Stanford University to a new site near Fairbanks, Alaska.

1982
The Chatanika Radar is moved to a new location near Sondrestrom, Greenland,
1970 – 1980
The U. S. National Science Foundation takes over operation of four incoherent scatter radars
1981
The European conquest begins with the construction of the EISCAT UHF system at Tromso, Norway.
1985
The EISCAT VHF system begins operation at Tromso.
The EISCAT Svalbard Radar is constructed near Longyearbyen, Norway.
2007
The Global Array of Incoherent Scatter Radars
Earth’s Magnetosphere
The Sun-Earth System
Theta Aurora
The Plight of the Polar Cap Observatory

- 1987 workshop to develop technical requirements for an ISR in the Polar Cap
- Three design studies funded by NSF
- Funding provided for the Early Polar Cap Observatory
- Polar Cap Observatory proposal submitted by SRI
- Proposal reviewed with excellent ratings and strong recommendation for funding
- PCO project put forward for funding under NSF Major Research Equipment program
- Removed from NSF budget by Congress in August 1997
AMISR: The Polar Cap Observatory Resurrected

• To avoid conflicts originating from radar location, NSF recommends a portable facility
• Workshop convened in 1998 to determine the most favorable locations for early deployment of a portable system
• NSF/ATM sets aside $44M for construction of a relocatable ISR
• SRI submits a proposal to build the Relocatable Atmospheric Observatory
• NSF approves funding of the proposal, but the name is changed to the Advance Modular Incoherent Scatter Radar
The Advanced Modular Incoherent Scatter Radar (AMISR)

**Parts List**

- Antenna Element Unit (12288 pieces)
- Solid-State Power Amplifier (12288 pieces)
- AMISR panel (384 pieces)
- AMISR Support Structures (3 pieces)
- AMISR Faces (3 pieces)

= 384 Panel Control Boards
AMISR Prototyping and Risk Reduction Activities

- Antenna element design and development
- 64 test units constructed and two antenna panels assembled
- Design testing conducted in collaborations with USAF at Air Force test facility in Massachusetts
- Funding provided for “Design for Manufacturing” activities in collaboration with electronics firm Sanmina-Sci
- Another award made for manufacture and assembly of 512 AEUs used to assemble 16 panels; two 8-panel systems to deployed for testing in Alaska and Peru
- Numerous technical reviews by external experts
- Reasonable and sound contingency plan developed
- Early Polar Cap Observatory provided experiences in Arctic environment
AMISR Management Structure

- DGA Grants Officer
- NSF Program Officer
- NSF Internal Project Advisory Team
- SRI PI
- External Technical Advisory Committee
- SRI Finance Officer
- Subawards
- SRI Technical Staff
AMISR Management Challenges

- Oversight of subawards
- Funding allocations not matched with construction schedule
- Discontinuation of critical components; changes in manufacturing processes
- Establishing and maintaining agreements with industrial and international partners
- Trade-offs between schedule, cost, and project scope
- Overlap between construction and operations
- Incorporating ancillary instrumentation
The NSF Incoherent Scatter Radar Chain-2006

- Sondrestrom (SRF)
- Millstone Hill (MH)
- Arecibo (AO)
- Jicamarca (JRO)

The NSF Incoherent Scatter Radar Chain-2007

- AMISR-Poker Flat (PFISR)

U. S. incoherent scatter radars--2009

- AMISR-Resolute Bay (RISR)
- Sondrestrom
- Millstone Hill
- Arecibo
- Jicamarca
- AMISR-Resolute Bay (RISR)
- Sondrestrom
- Millstone Hill
- Arecibo
- Jicamarca
What’s new about the Advanced Modular Incoherent Scatter Radar (AMISR)?

- First incoherent scatter radar built by NSF
- First U. S incoherent scatter radar built for basic research
- First phased-array, solid-state incoherent scatter radar; allows for remote access without the need for on-site staff
- First incoherent scatter that allows for continuous, low duty cycle observations
- First modular incoherent scatter radar designed for easy dismantling and relocation
- First reconfigurable incoherent scatter radar