

# AMISR Experiment Design

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# Experiment Design

Science objectives and radar operations are a coupled system. Designing a radar experiment is an optimization problem.

## Many parameters need to be determined:

- pulse length  $\longleftrightarrow$  range resolution
- pulse type/code  $\longleftrightarrow$  range resolution
- Rx sampling rate  $\longleftrightarrow$  range resolution
- interpulse period  $\longleftrightarrow$  maximum range
- Tx/Rx frequencies  $\longleftrightarrow$  increasing duty cycle/sampling statistics
- antenna pointing, “look directions” or “line-of-sight”  $\longleftrightarrow$  capturing dynamics, time resolution
- measurement uncertainty  $\longleftrightarrow$  duty cycle, total number of pulses, time resolution
- etc.

Parameters are radar dependent. Each ISR is different.

# Example: Different ISR Antennas

## Dish antenna:

- Single pointing direction
- Moving the dish requires time, usually minutes
- Spatial-temporal ambiguities: is the plasma moving or evolving in time?

## Phased array antenna:

- Multiple pointing directions, change on a “pulse-to-pulse” basis
- Volumetric determination of scalar parameters: density and temperature
- Measurements can be post-integrated; flexible integration time

# AMISR: Advanced Modular Incoherent Scatter Radar

# PFISR: Poker Flat Incoherent Scatter Radar



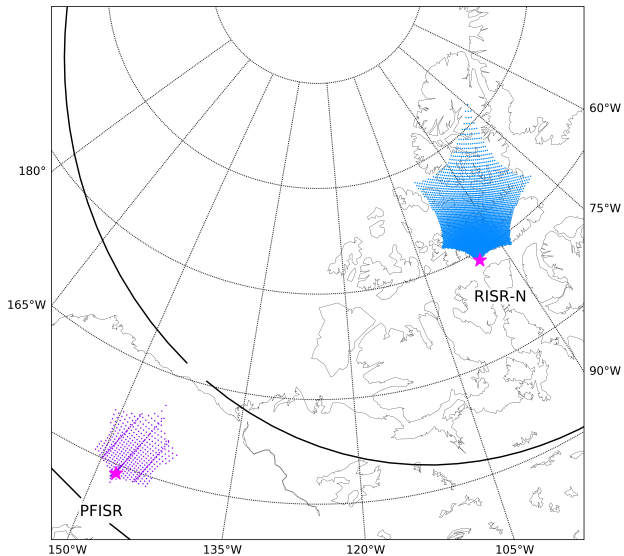
(November 2014)

# RISR-N: Resolute Bay Incoherent Scatter Radar North



(October 2018)

# AMISR Locations





# Pulse Types

## AMISR pulse types, a qualitative summary:

- Uncoded Long Pulse
  - Low range resolution, high sensitivity
  - Best suited for F-region measurements above peak
- Alternating Code
  - High range resolution, medium sensitivity
  - Best suited for E- and lower F-region measurements
- Barker Code
  - Highest range resolution, high sensitivity
  - Best suited for D- and lower E-region measurements

Note: There are many other radar pulse types, including: psuedo-random phase codes, poly-phase codes, amplitude modulated, frequency modulated, etc.

# 3 Flavors

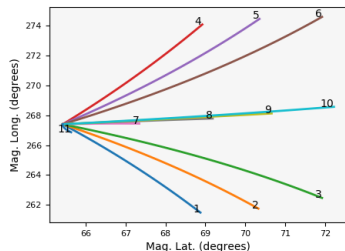
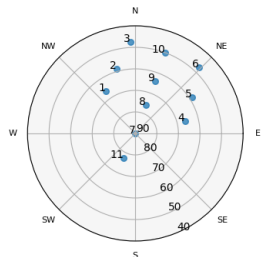
Can propose one of 3 “flavors” of experiments:

- **E- and F-region:**
  - alternating code
  - long pulse
- **D-region focus, E- and F-region context:**
  - barker code
  - alternating code
  - long pulse
- **F-region only:**
  - long pulse only

# E- and F-region

## Example Mode, WorldDay35:

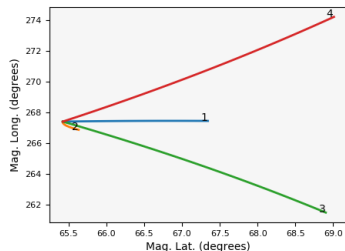
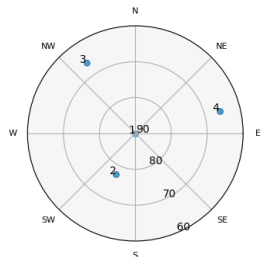
- 480 us pulse, alternating code, 30 us bauds, 10 us samples
- 330 us uncoded long pulse, 20 us samples
- Both upshifted and downshifted plasma line channels
- 11 Beams
- 1/1 pulses split between long pulse/alternating code
- F-region ion velocity field reconstruction and E-region neutral winds



# D-region focus, E- and F-region context

## Example Mode, MSWinds26.v03:

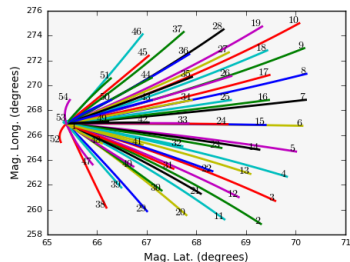
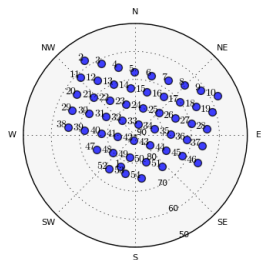
- 130 us, 13 baud barker code, 10 us bauds, 5 us samples
- 480 us pulse, alternating code, 30 us bauds, 10 us samples
- 480 us uncoded long pulse, 30 us samples
- 4 Beams
- 8/1/1 pulse split between barker code/long pulse/alternating code
- F-region ion velocity field reconstruction and both D- and E-region neutral winds



# F-region only

## Example Mode, ZenithImaging:

- Tri-frequency uncoded long pulse
- 330 us uncoded long pulse, 20 us samples
- 54 Beams
- F-region ion velocity field reconstruction



# Experiment Design Choices

## Limited Design Choices

- Propose an experiment for PFISR
- Pick a flavor: D-, E- and F-region, E- and F-region, or F-region only
- Specify a beam pattern (elevation/azimuth pairs)
- Specify a beam revisit pattern (e.g. evenly spread pulses? revisit 1 beam?)

## PFISR Beams:

- PFISR beamcodes:  
[https://amisr.com/amisr/about/about\\_pfisr/pfisr-specs/](https://amisr.com/amisr/about/about_pfisr/pfisr-specs/)

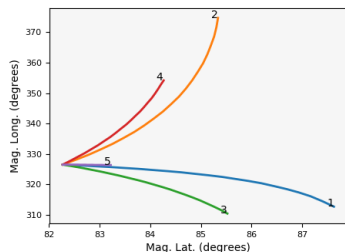
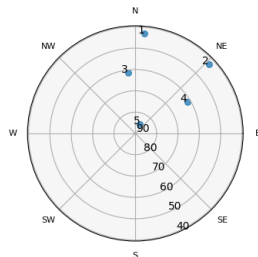
## PFISR Schedule:

- <https://amisr.com/database/61/sched/2019/08>

# RISR-N LowDuty2.v01

## RISR-N will be running LowDuty2.v01 for polar cap context:

- 480 us pulse, alternating code, 30 us bauds, 10 us samples
- Dual-frequency uncoded long pulse
- 330 us uncoded long pulse, 20 us samples
- 5 beams for long pulse, 3 beams for alternating code
- 77/23 duty cycle split between long pulse/alternating code



# Operations

## ISR Realtime Displays:

- PFISR: <https://amisr.com/realtime/viewer>
- RISR-N: Ashton Reimer will make available
- EISCAT: <https://www.eiscat.se/rtg/rtg.cgi>
- Millstone Hill: Bill Rideout will make available

## Global Context:

- Realtime SuperDARN data: <https://superdarn.ca/real-time>
- Realtime ACE (IMF) data:

<https://www.swpc.noaa.gov/products/ace-real-time-solar-wind>



# AMISR Questions

If you have any questions or would like feedback on experiment proposals, please speak to Roger Varney or Ashton Reimer.

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