Filling Technological Gaps for Planetary Science Missions with Customized SRI Solutions

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SRI International for NASA Planetary Science Technology Showcase

SRI International®

Areas of SRI Expertise

•Incoherent Scatter Radars – For NSF
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•Interferometric Synthetic Aperture Radar – Used on CubeSat SRI-CIRES NASA Earth Science
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•Ground Penetrating Radar – For DoD/DARPA
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•UHF Antenna Design Erin.rivard@sri.com

•Robotic Mobility jesse.wodin@sri.com

•Optics Design and Fabrication
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•Novel diamagnetically levitated optical beam steering technology marcus.bagnell@sri.com

•Highly stable, space rated lasers w/ micro-radians of precision shon.cook@sri.com

•Quantum Sensors and Semiconductors
joseph.christesen@sri.com

Past Mission Involvement

•Parker Solar Probe (**PSP**) – Wide-Field Imager for Solar Probe (WISPR)
Uses SRI's Active CMOS Detectors, Jim Janesick, jim.janesick@sri.com

•SRI CubeSat Imaging Radar for Earth Science (**SRI-CIRES**)
Mike Huff michael.huff@sri.com
Utilizes Interferometric Synthetic Aperture Radar (InSAR)

•Cyclone Global Navigation Satellite System (**CYGNSS**)
Data Analysis, April Warnock, April Warnock april.warnock@sri.com

•Sun Radio Interferometer Space Experiment (**SunRISE**)
Scientific Analysis Pipeline Design, Alex Hegedus alex.hegedus@sri.com *

•Radio Aurora Explorer (**RAX**) CubeSat Scientific Payload
Tony van Eyken anthony.vaneyken@sri.com

•Farside Array for Radio Science Investigations of the Dark ages and Exoplanets (**FARSIDE**)
Scientific Analysis Pipeline Design, Alex Hegedus alex.hegedus@sri.com *

•Advanced Modular Incoherent Scatter Radar (**AMISR**)
Asti Bhatt asti.bhatt@sri.com and Tony van Eyken anthony.vaneyken@sri.com

* Work done while employed at University of Michigan

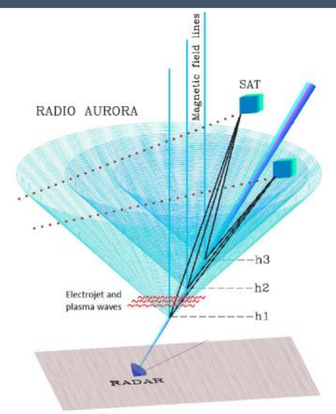
Advanced Modular Incoherent Scatter Radar (AMISR)

- AMISR designed and managed for the NSF
- Studies upper atmosphere and space weather events.
- Investigates the energy and momentum transfer among all layers of the Earth's upper atmosphere
- Provide scientists with the technology necessary to collect critical data and study global climate trends from year to year.
- Remote operation and instant electronic beam steering
- Modular design of AMISR enables relative ease of relocation
- Multiple designs & locations of AMISR: PFISR, RISR-N, RISR-C **[4, 5, 6]**

From [6], layout of PFISR, the AMISR face at Poker Flat, Alaska

Radio Aurora Explorer (RAX) CubeSat

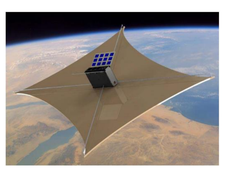
- Funded under the NSF CubeSat-based Space Weather and Atmospheric Research Program **[1, 2]**
- Ground-to-space bi-static radar to measure & understand causes of meter-scale ionospheric irregularities
- Orbits over PFISR to receive refracted radar signals
- Helps understand field-aligned irregularities (FAI), such non-thermal, coherent fluctuations of electron density
- FAI occur in response to strong ionospheric flows or plasma density gradients during geomagnetic disturbances
- FAI are considered a space weather concern due to disruption to communication and navigation signals



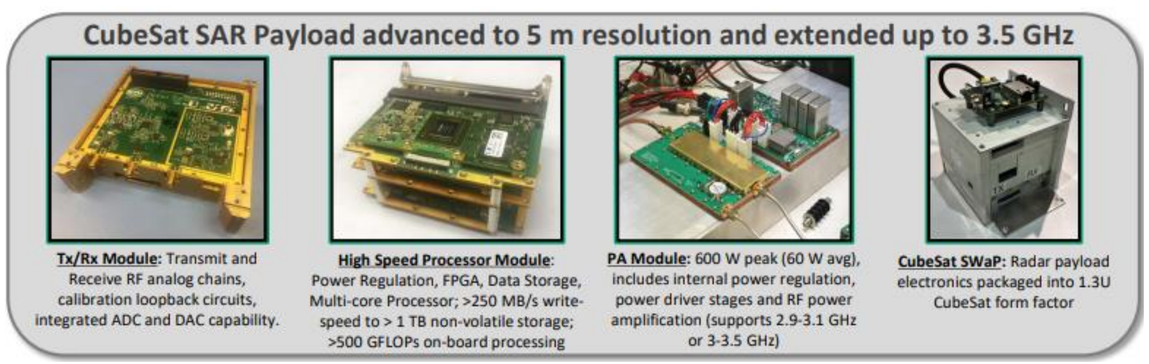
From [1], drawing of how RAX measures radio aurora (cones)

Interferometric Synthetic Aperture Radar (InSAR) in CubeSats

- SRI CubeSat Imaging Radar for Earth Science (SRI-CIRES) funded by Earth Science Technology Office's Instrument Incubator Program (ESTO-IIP) **[7]**
- 5 meter resolution in a CubeSat form factor with deployable ~6.5 m^2 phased array antenna



Figures from [7], showing design of SRI-CIRES

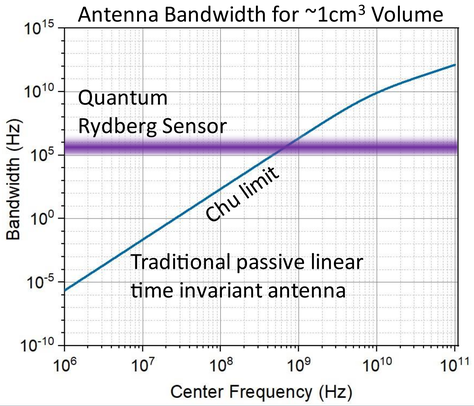


Quantum Receivers

Approach: Use Rydberg atoms to convert RF to optical signals with high sensitivity. Each atom acts like an independent "antenna", imprinting baseband of an incident RF carrier onto an optical signal. **[3]**

Advantages:

1. Resonant access to HF to sub-THz bands: SRI approach allows access to wide range of resonances, in some cases beating the Chu limit
2. All-dielectric construction/optical control and preparation. Minimizes perturbations
3. Dynamic range: Receiver may be "turned off" via preparation lasers
4. Approach uses all-NIR lasers compatible with long fiber lengths and mature photonic integrated circuit (PIC) technology



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