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ICI-1 & ICI-2 A NEW SOUNDING ROCKET CONCEPT TO OBSERVE MICRO-SCALE PHYSICS IN THE CUSP IONOSPHERE

by

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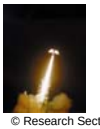

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ICI-1
Investigation of Cusp Irregularities

Abstract:

The scientific aim of the ICI-1 sounding rocket -Investigation of Cusp Irregularities - is to identify the physical mechanism(s) in the cusp ionosphere that generates backscatter irregularities for coherent HF radars. The gradient drift instability is regarded as the dominant mode for producing backscatter targets under IMF Bz south conditions. Moen et al. (2002) made an attempt to test the potential role of gradient drift instability by combining CUTLASS observations with tomographic imaging of the electron density distribution, but concluded that such a test would require experimental observations on much finer scales than can be achieved by ground-based and satellite measurements. Sounding rocket measurements with meter scale spatial resolution is needed to resolve this problem. ICI-1 will be launched into the cusp ionosphere above Svalbard in December 2003.

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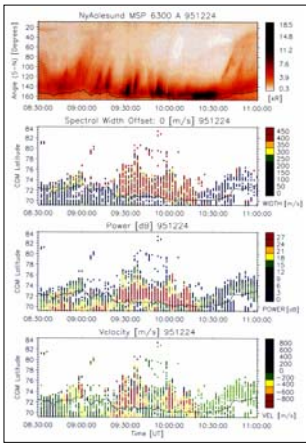
HF-cusp backscatter

- By multi-instrument techniques we have identified a close relationship between daytime auroral cusp over Svalbard, electron density gradients and the onset of HF backscatter echoes
- The generation mechanism(s) of backscatter irregularties are still unknown
- Associated with serious disturbances in HF radio communication

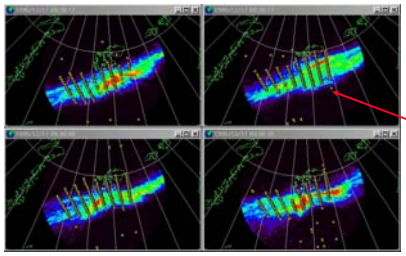


Relationship between cusp aurora and HF-backscatter

- **Cusp auroral activity with poleward moving auroral forms (PMAFs)**
- **Enhanced Doppler spectral widths across the auroral emission boundary**
- **PMAFs are associated with strongly enhanced poleward flows assoiated with the optical events**

Correspondence between the optical cusp and HF radar cusp:

The yellow squares mark the position of CUTLASS HF radar gates with spectral widths ≥220 ms-1(definition of cusp backscatter). Note the close co-location of the equatorward edge of the radar cusp and the equatorward edge of the optical cusp. We don't know why and we even the height of HF-backscatter targets!



Spectral widths ≥220 ms^{-1}

 Moen et al., Ann Geophys. (2000)

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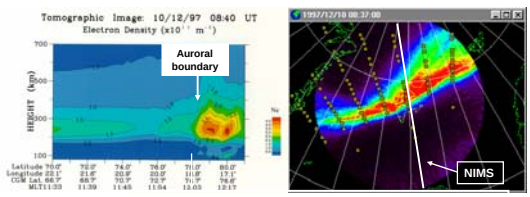
Science Objective:

We want to test the potential role of gradient drift instability to generate decameter scale HF backscatter targits.



Gradient drift instability growth rate $\gamma = -\left(\frac{1}{n_0}\right)\left(\frac{\Delta n}{\Delta y}\right)\left(\frac{E}{B}\right)$ ⇒ **3-10 min**

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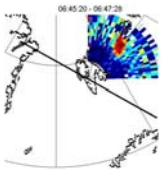
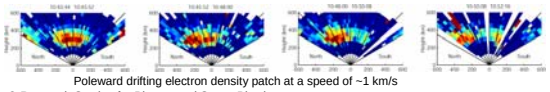
Mapping of electron density patches by EISCAT Svalbard Radar

- Developed fast sweep modes for mapping and tracking of density patches
- For both elevation and azimuth-sweeps the windshield-wiper motion is repeated every 128 seconds, and data is sampled every 3.2 seconds at a range resolution of 50 km.
- Steep density gradients may in a worst case scenario cause serious problems for GPS navigation





Poleward drifting electron density patch at a speed of ~1 km/s

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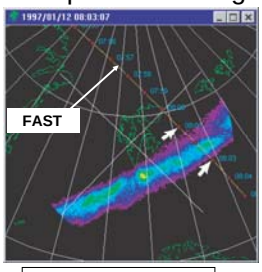
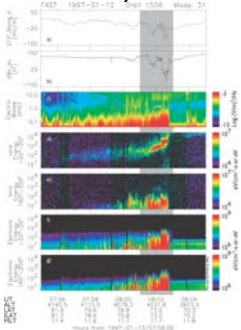
Onset of E-field irrgularities near the equatorward edge observed by FAST





Oksavik et al., submitted to Ann. Geophysicae

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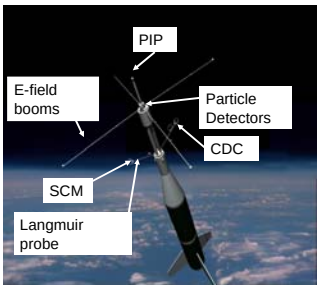
INSTRUMENTATION (i)



- **Ø200 mm Hotel Payload, ARS**
- **Nike/Improved Orion Configuration**
- **55 kg Payload**

Norwegian – French collaboration

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INSTRUMENTATION (ii)

- Positive Ion Probe (PIP) - Norwegian Defence Research Establishment (NDRE).
- AC and DC Electric field - University of Oslo.
- Solid state particle spectrometers for electrons and ions – University of Bergen.
- Search Coil Magnetometer (SCM) - Centre d'etude des Environments Terrestres at Planétaires (CETP).
- Current Density Coil (CDC) - The Laboratoire de Physique et Chimie de l'Environnement (LPCE).
- Langmuir probe – University of Oslo.

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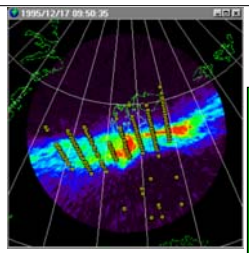
Ground Support:

- Optical instruments at Ny-Ålesund and Longyearbyen
- EISCAT Svalbard Radar
- CUTLASS HF Radar



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Wanted Launch Conditions:

- Launch Window:
  26 Nov – 5 Dec, 2003
  08-14 UT (11-15 MLT)
- Clear sky, cusp aurora with the equatorward edge near apogee.
- HF radar cusp backscatter echoes (>220 ms-1 Doppler spectral width broadening).
- EISCAT Svalbard Radar for identification of the F-region electron density gradient

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Integration

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ICI-1 on the launcher 27 November, 2003

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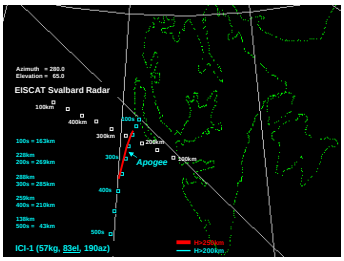
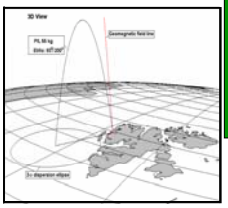
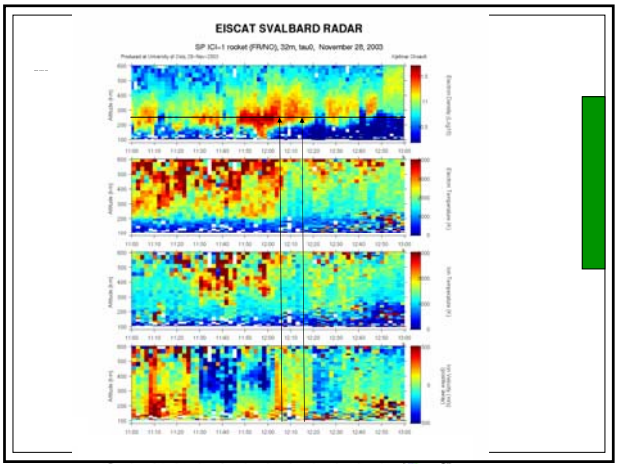
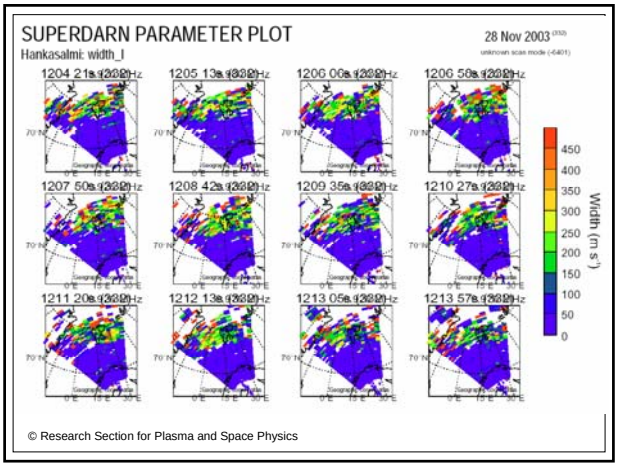
Intended trajectory:

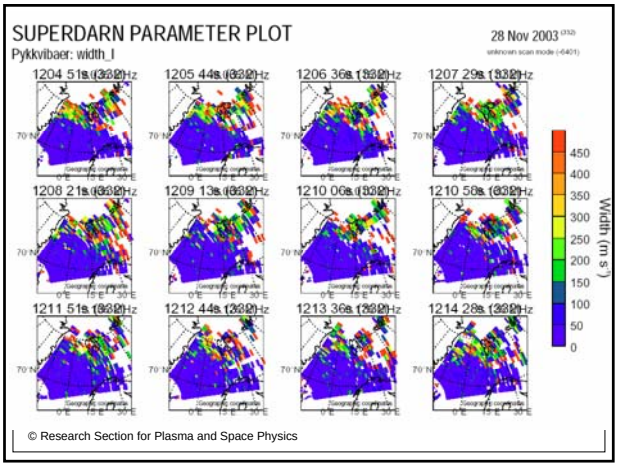




- Nike/Improved Orion configuration
- 58 kg Payload







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Space Research and Technology Development Program

A 5 year research program
NOK 7 mill = EUR 820k

Main objectives:

- Introducing microsystem/MEMS technology in sounding rockets
- Foster inter-disciplinary collaboration between the groups of Space physics and Electronics at UiO and SINTEF (Microsystems).
- ICI-2 sounding rocket – Launch December 2008 or January 2009.

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ICI-2

A likely configuration:

- 2 meter long, 14" diameter payload
- Fore-ward eject-able nose cone.
- 2 stages : Sonda VS-30 + Improved Orion
- Apogee ~430 km
- Encoder: 5-10 Mb/s

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Instrumentation considered:

- Sounding Rocket Attitude Determination System (SRADS)
- Langmuirprobe
- High resolution AC and DC Electric field probe
- Search Coil Magnetometer (SCM)
- Current Density Coil (CDC)
- Suprathermal Electron Imager (SEI) and Suprathermal Ion Imager (SII)
- Solid state particle spectrometers for electrons and ions – University of Bergen