Committee on Earth Observation Satellites
Working Group on Calibration and Validation

Microwave Sensors Subgroup

9 November 2005

Christopher Buck

- Payload Engineer
- Working at ESA/ESTEC since 12/87
- Main area of competence: Microwave Instruments for Earth Observation
- Succeeded Manuel Martín-Neira as MW Sensors chair

- CryoSat Status
- SMOS Status
- Sentinels 1 & 3
- P-band Ice Sounder Demonstrator
- PARIS Airborne Demonstrator
- ASAR Receiver Gain Droop Experiment
- SurfSat

Launched 8 October 2005

- Rockot from Plesetsk Cosmodrome

Failed during separation of 2^{nd} and 3^{rd} stages

Failure attributed to software error

- Reproduced on-ground
- Go-ahead for future launches given

Motivation for CryoSat 2 is high

- Programme will take 2-3 years

Experimental Campaigns with ASIRAS set to continue

Soil
Moisture
Ocean
Salinity

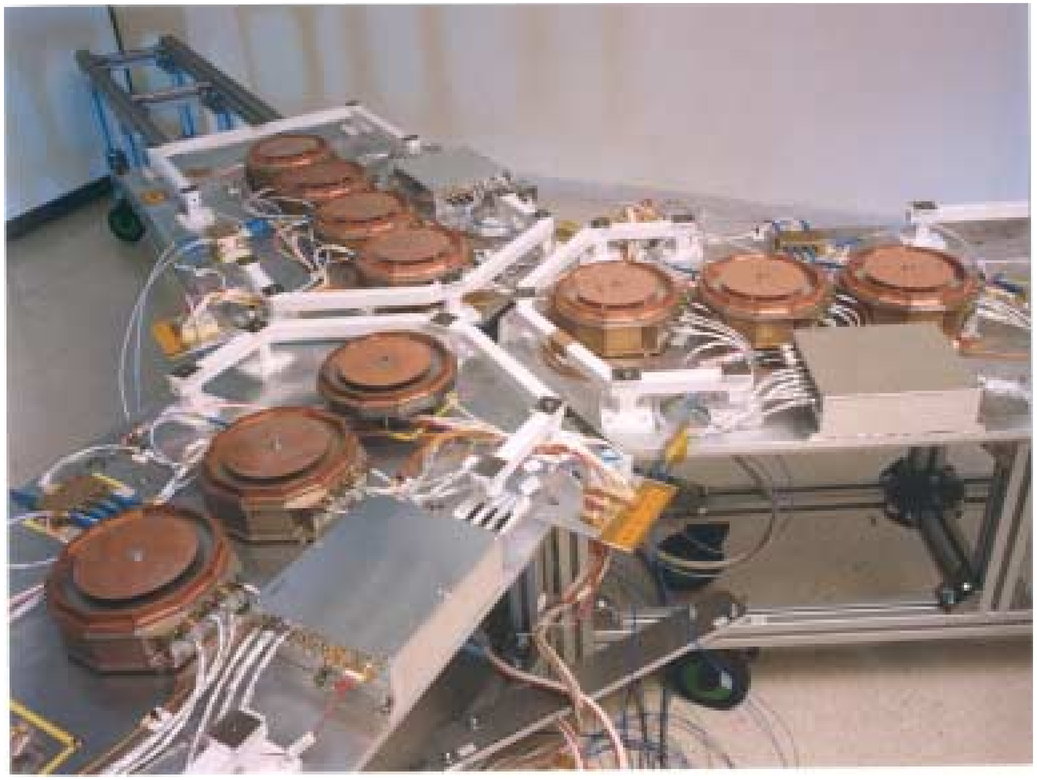
EADS CASA ESPACIO

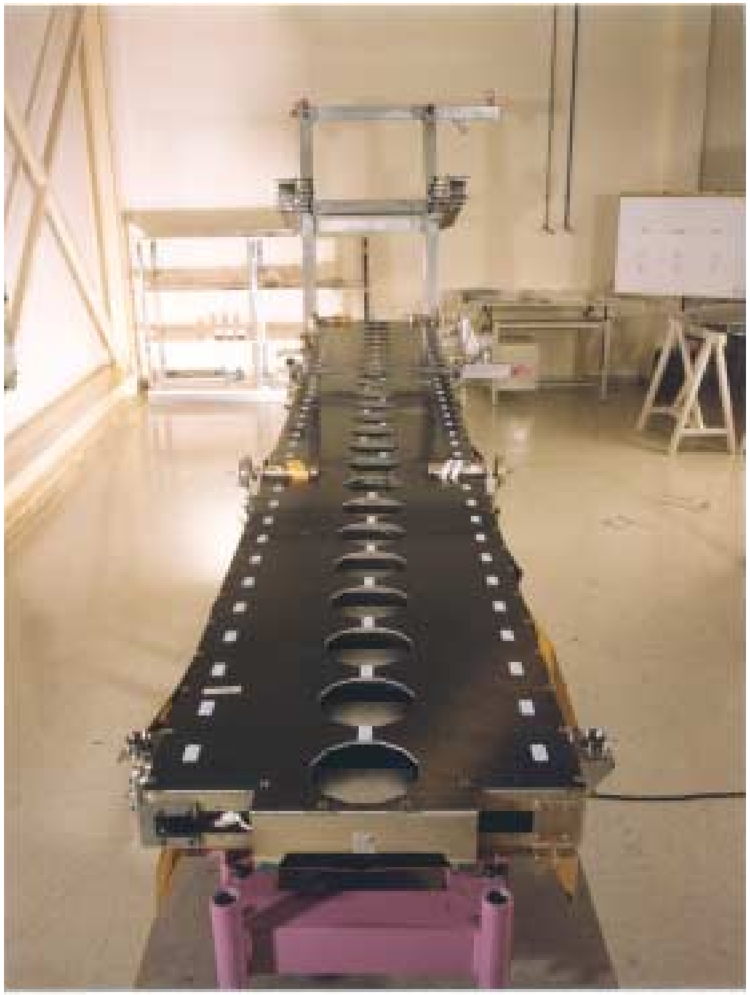
ESTEC

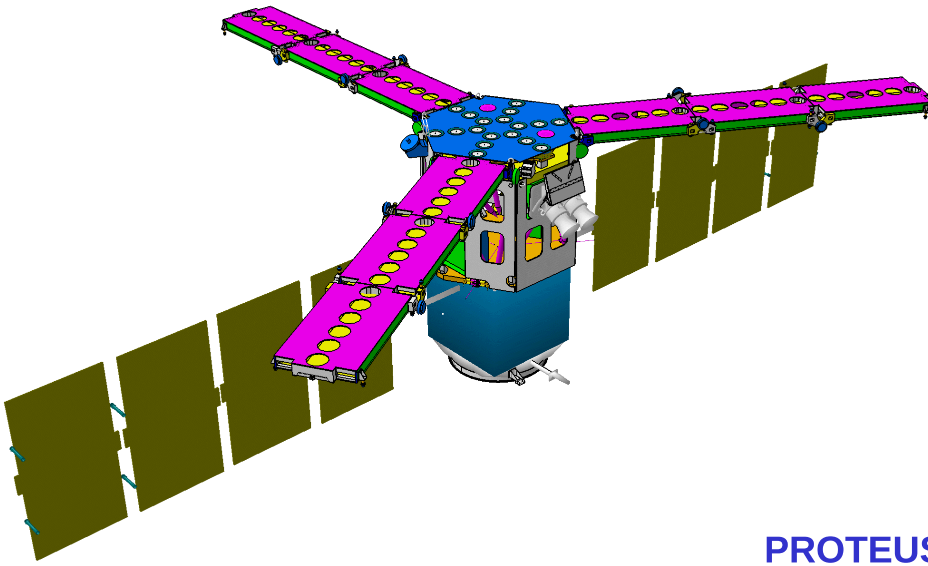
- 2nd mission within ESA's "Opportunity Missions in Earth Observation" programme
- Mission objectives to retrieve maps of:
  - **Soil Moisture**
  - **Ocean Salinity**
- SMOS is a collaboration between CDTI (Spain), CNES (France) and ESA
- Main mission elements:
  - **Platform = PROTEUS (CNES)**
  - **PLM, developed by ESA, EADS CASA Espacio as main contractor**
  - **VILLAFRANCA (Madrid), PLM operational centre**
  - **Eurockot, launcher**

Deployment mechanism test
(October - November 2002)

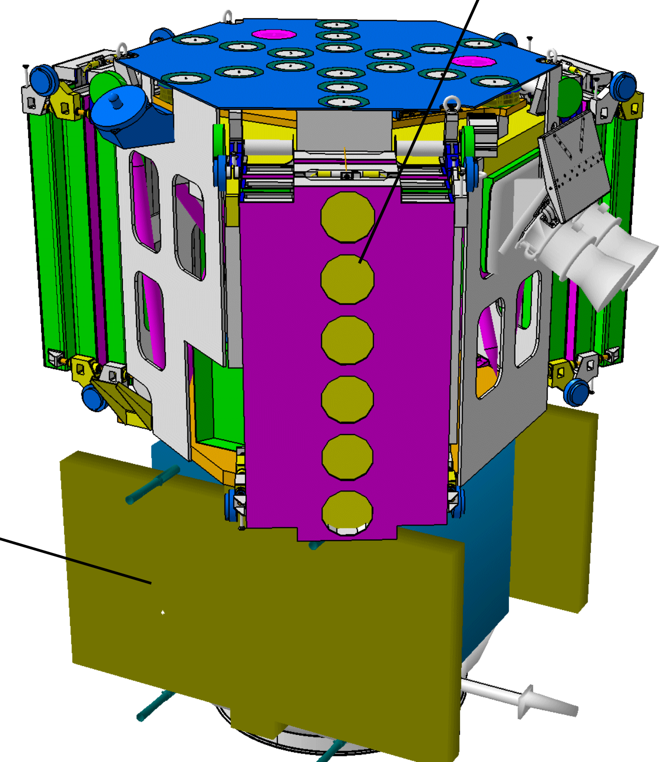
Flight hardware
LICEF assemblies







SMOS PLM
MASS: 360kg
POWER: 400W (average)



SMOS = L-band RADIOMETER (MIRAS)

MIRAS = Microwave Imaging Radiometer with Aperture Synthesis

MIRAS PAYLOAD:

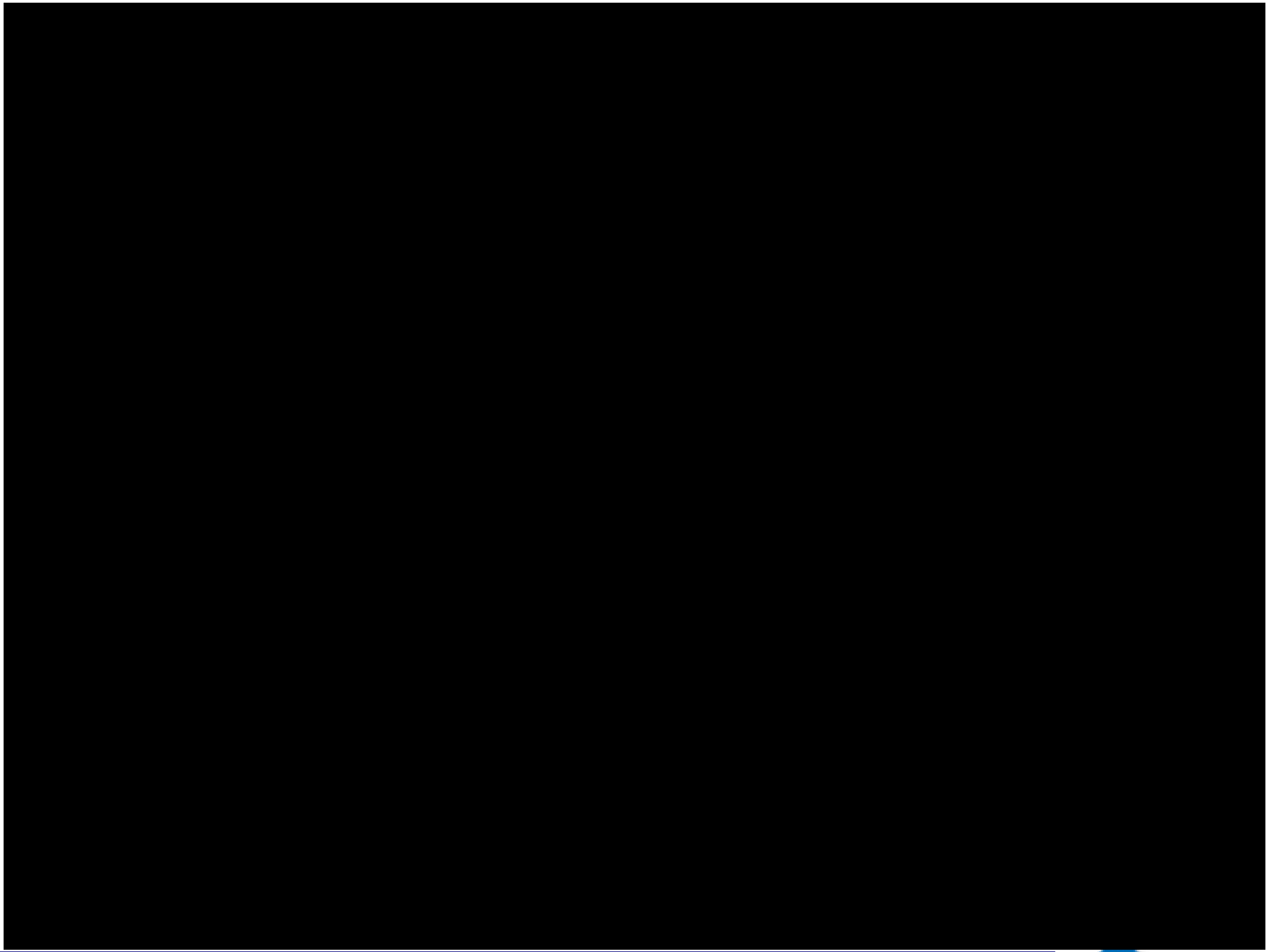
- MIRAS STM is at ESTEC for environmental tests
- MIRAS EM is undergoing end-to-end electrical tests at INTA
- MIRAS PAYLOAD CDR held in October 2005

PROTEUS PLATFORM

- PROTEUS Platform - MIRAS Payload Interface Verification
- Platform Flight Model will be integrated in September/December 2005
- SMOS Satellite Flight Model (Platform + PLM) will be integrated in November 2006 / July 2007

Launch – September 2007

SMOS Deployment



- **Sentinel-1 "Red"**
  - C-band SAR, 100MHz BW, Quad-Pol
  - Trade-off on platform
    - PRIMA or Snapdragon
  - Phase A KO April 2005
  - Prime: EADS Astrium
- **Sentinel-2 "Blue"**
  - Ocean mission
  - Radar Altimeter + Imaging Spectrometer + Radiometer
  - Trade-offs on:
    - No of satellites
    - Type of altimeter (SIRAL, SRAL, RA-2)
    - No of radiometer channels (up to 3)
  - KO September 2005
  - Prime: Alcatel-Alenia Space

P Sounder Demonstrator (TRP/EOEP)

- Development of a P-band (435MHz) radar for ice sounding
- Capable of penetrating up to 4km of ice
- Radar will be installed in a Twin Otter aircraft

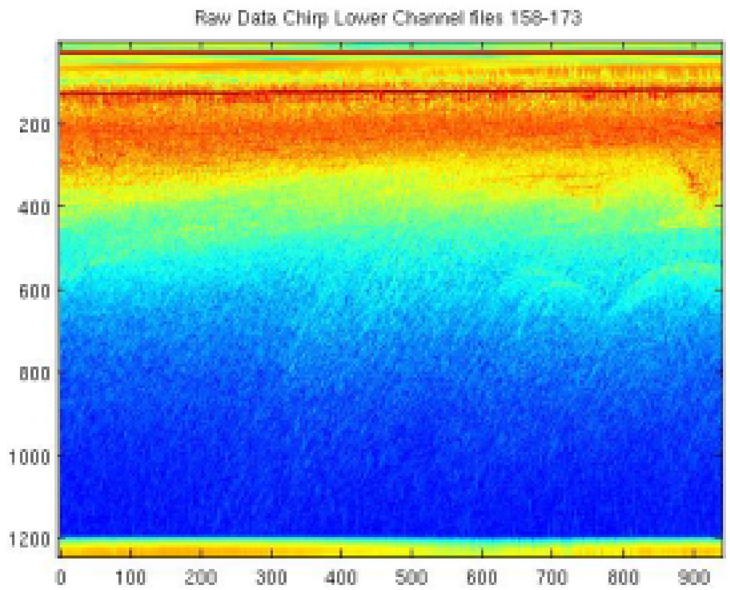
- Proof-of-concept flight to be conducted over Greenland
- Contract won by Oersted.DTU and DNSC but start delayed until 2/1/06

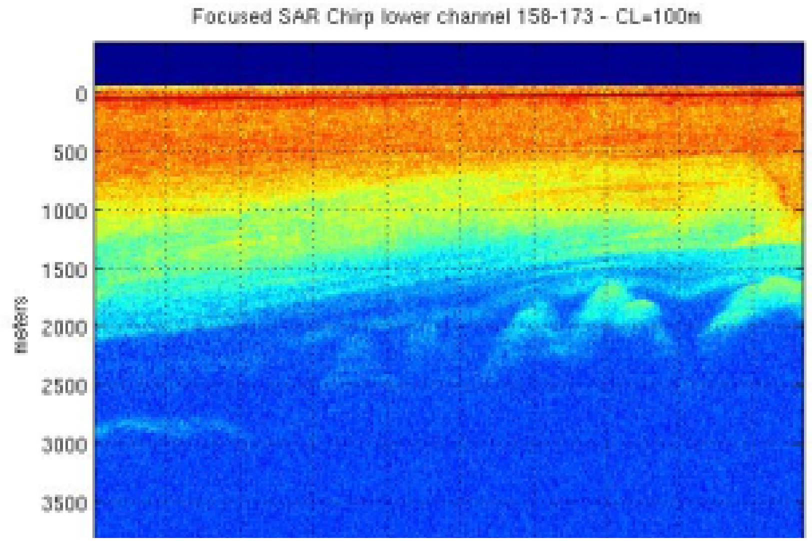
De-Havilland Twin Otter aircraft

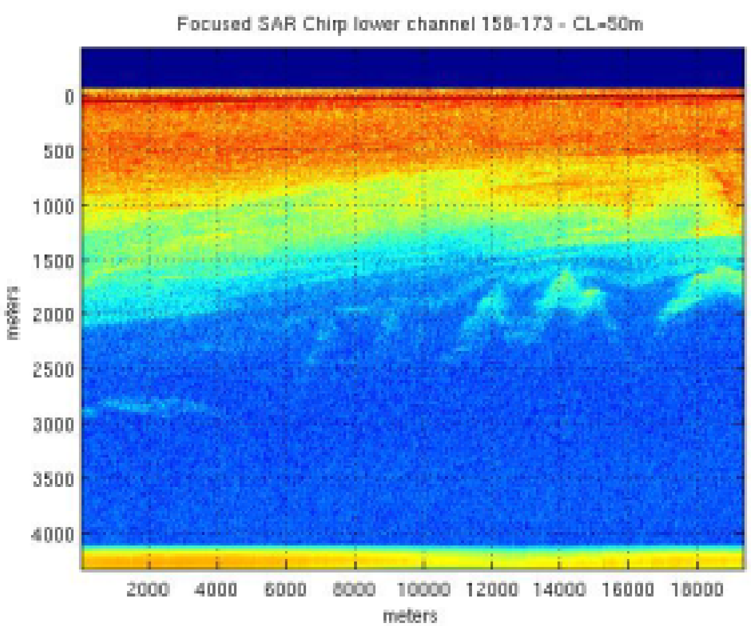
- **Bi-static Radar:**
  - 4 element transmit antenna array on port side
  - Identical receive array on starboard side

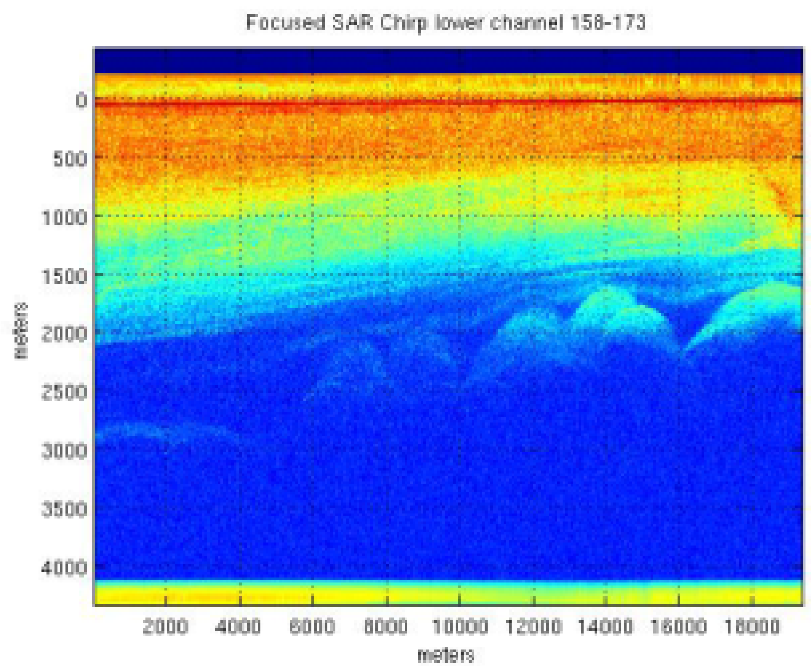
Description of Radar parameter	Characteristics/Value
RF carrier frequency	150 MHz
Chirp Bandwidth	10 MHz – 15 MHz
Transmitted pulse Width	Selectable (250ns-4µs)
PRF	Selectable (kHz)
Peak Transmit Power	1 kW into each of the four antennas
Antenna (bi- static)	8 folded dipole elements orientated across track : - 4 emitters - 4 receivers
Polarimetric mode	2 antennas on each side orientated along track

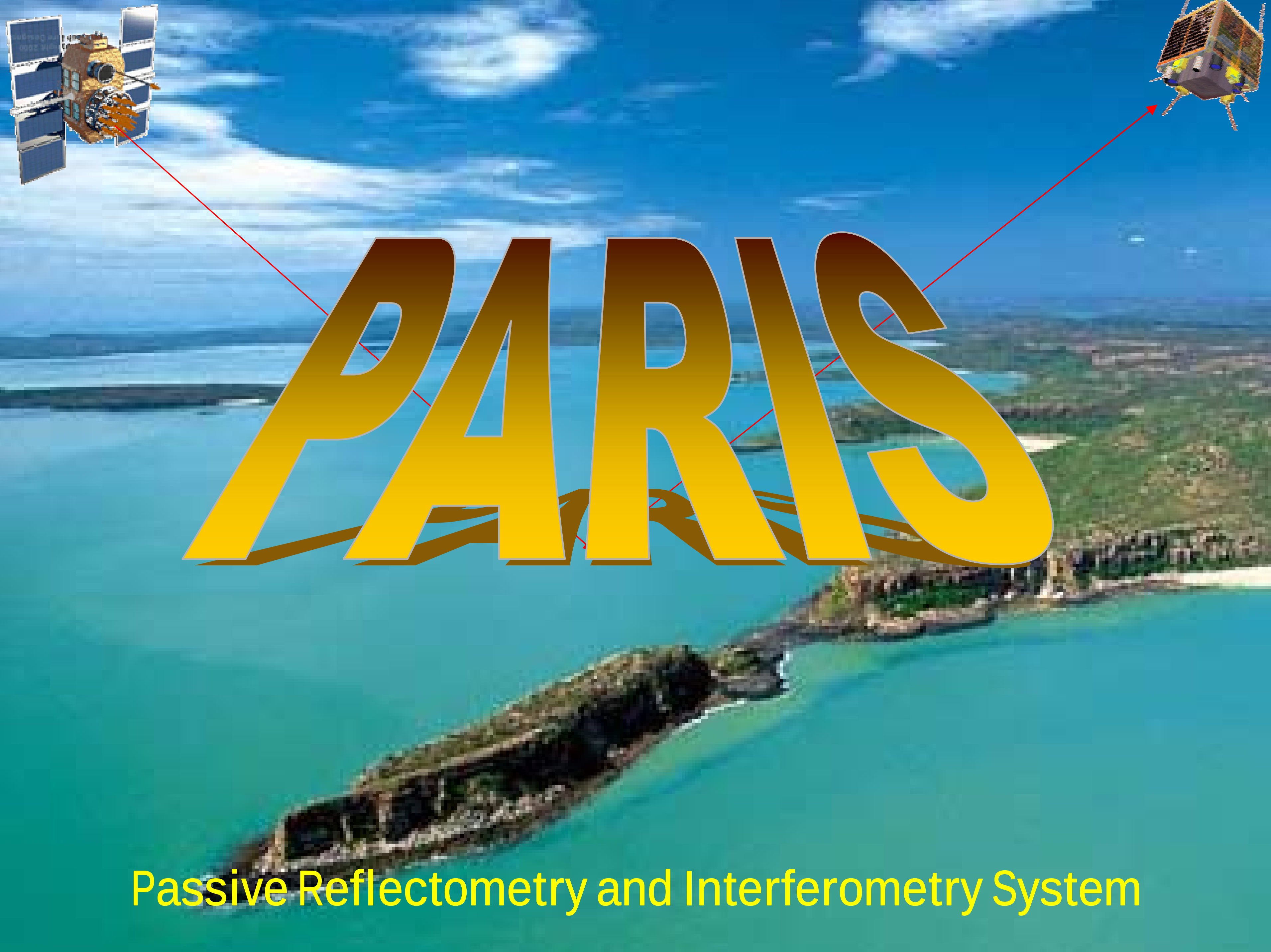
Ice Sounding Results









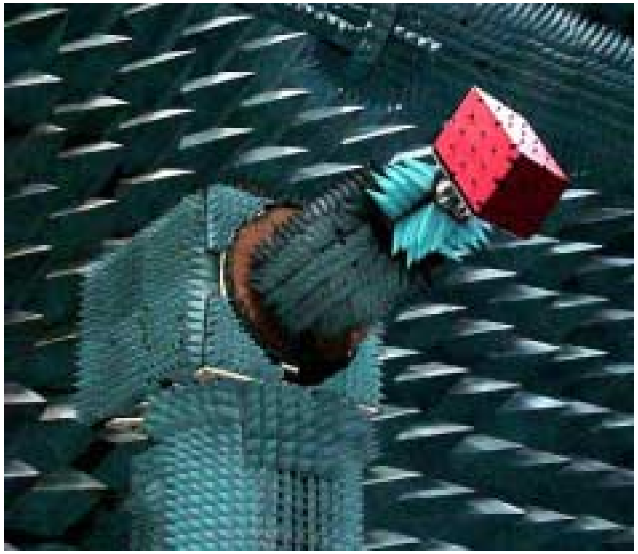

PARIS
Passive Reflectometry and Interferometry System

- **PARIS Airborne Demonstrator (TRP – 1.75M)**
  - Development of a four-beam PARIS instrument for performing ocean altimetry using reflected GPS signals
  - Split into four main parts:
    - A – The overall project including Instrument Control Unit (Starlab) mounting into the aircraft (Do228) and flight – Astrium Portsmouth
    - B – Mutli-beam array – Q-Par Angus
    - C – Signal Processor – Austrian Aerospace, IEEC, D+T CNM
    - D – Digital Beamforming Network and Receiver – Astrium Stevenage

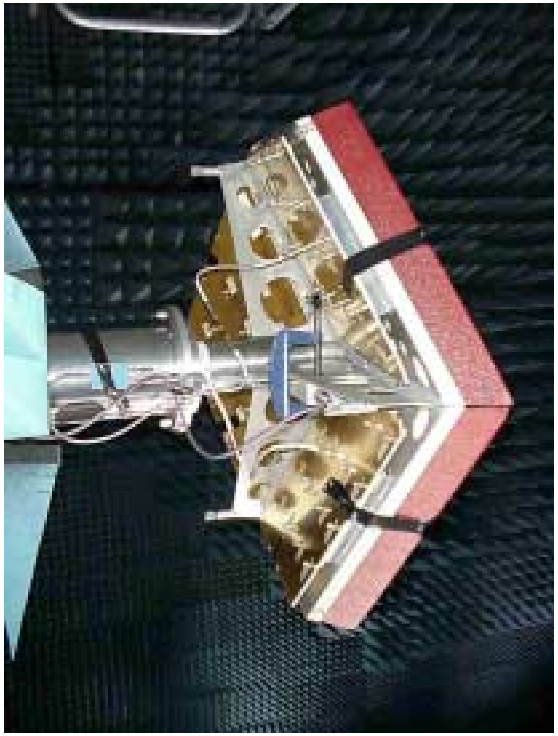
  - Data processing will be done by Starlab including analysis of UK-DMC data for altimetric purposes provided by SSTL

PARIS Antenna Breadboard (BNSC NEWTON)

- **Antenna equipped with three 16x16 Butler Matrix BFNs. OA diameter ~0.9m**
- **9 COTS helix array elements used per facet**
- **16 beam ports per facet (48 beam total capability)**
- **Partial overlap of beam sets from separate array facets allows selective gain enhancement**
- **Intended coverage zone is 100° diameter circle**



TRIO antenna mounted on the Portsmouth NFFF range positioner tower for radiation pattern measurements

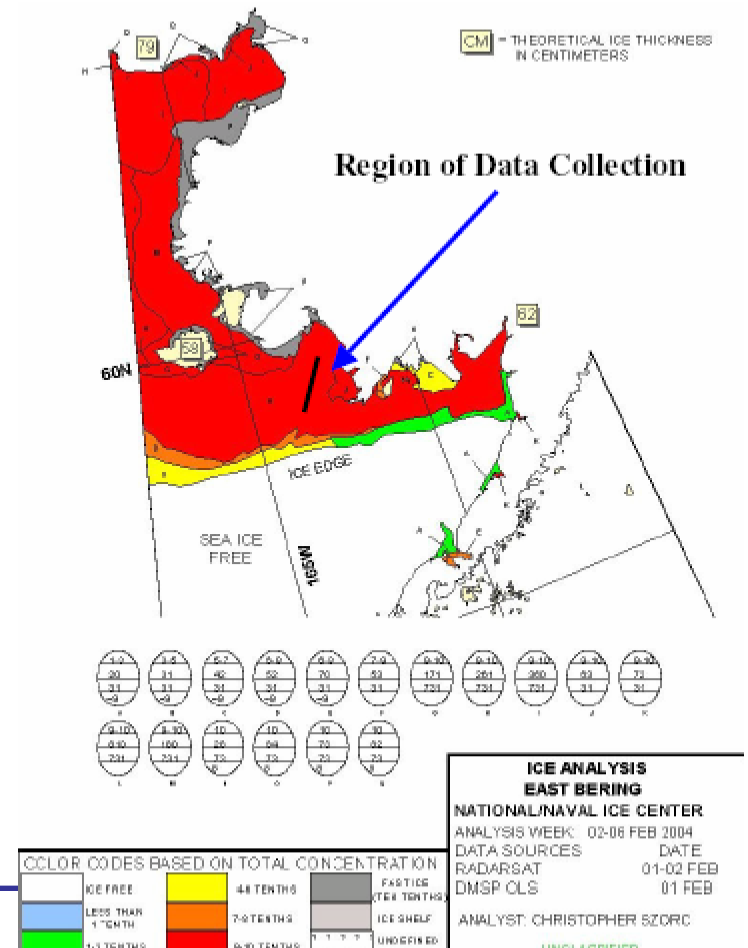


Further PARIS activities:

- Support to SMOS MDPP-3 campaign
  - Provide ocean roughness measurements (MSS)
  - Coast of Norway
  - March/April 2006
- Passenger Instrument on CryoSat ASIRAS Campaign
  - Flights over sea-ice
  - Svalbard
  - Attempt to recover ice reflected GPS signals
  - April/May 2006

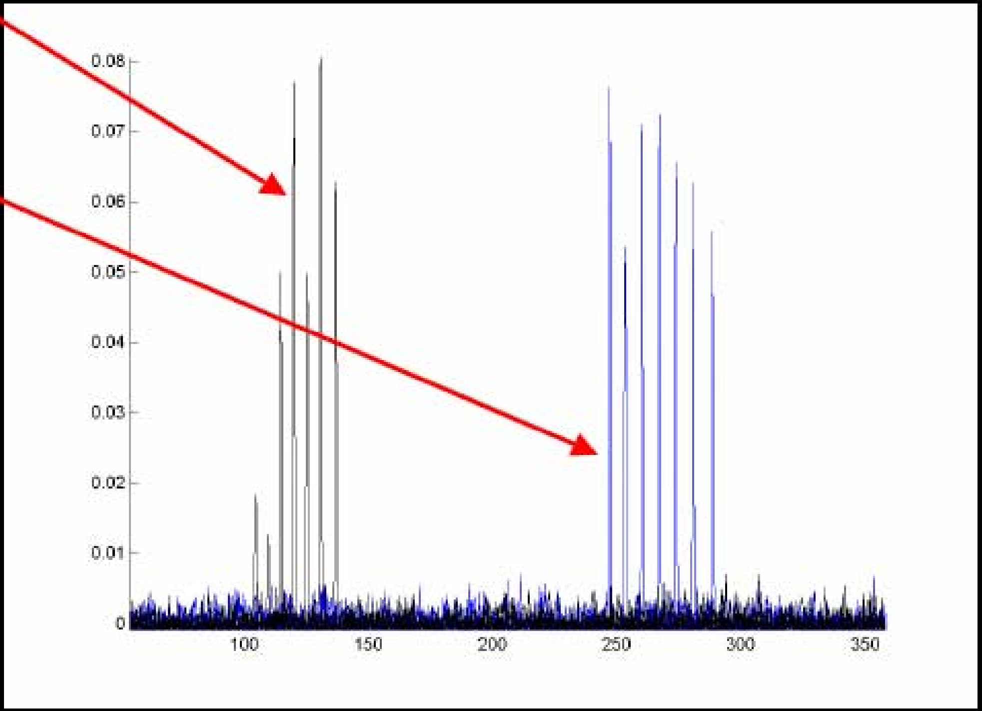
UK-DMC Data Collection over Ice

- **4 February 2005**
- **Data obtained from US National/Naval Ice Centre**
  - Point of specular reflection 90-100% covered by ice
  - Total concentration of first year thin ice, 30-70cm thickness
- **Unofficially confirmed by phone call to Goodnews Bay**



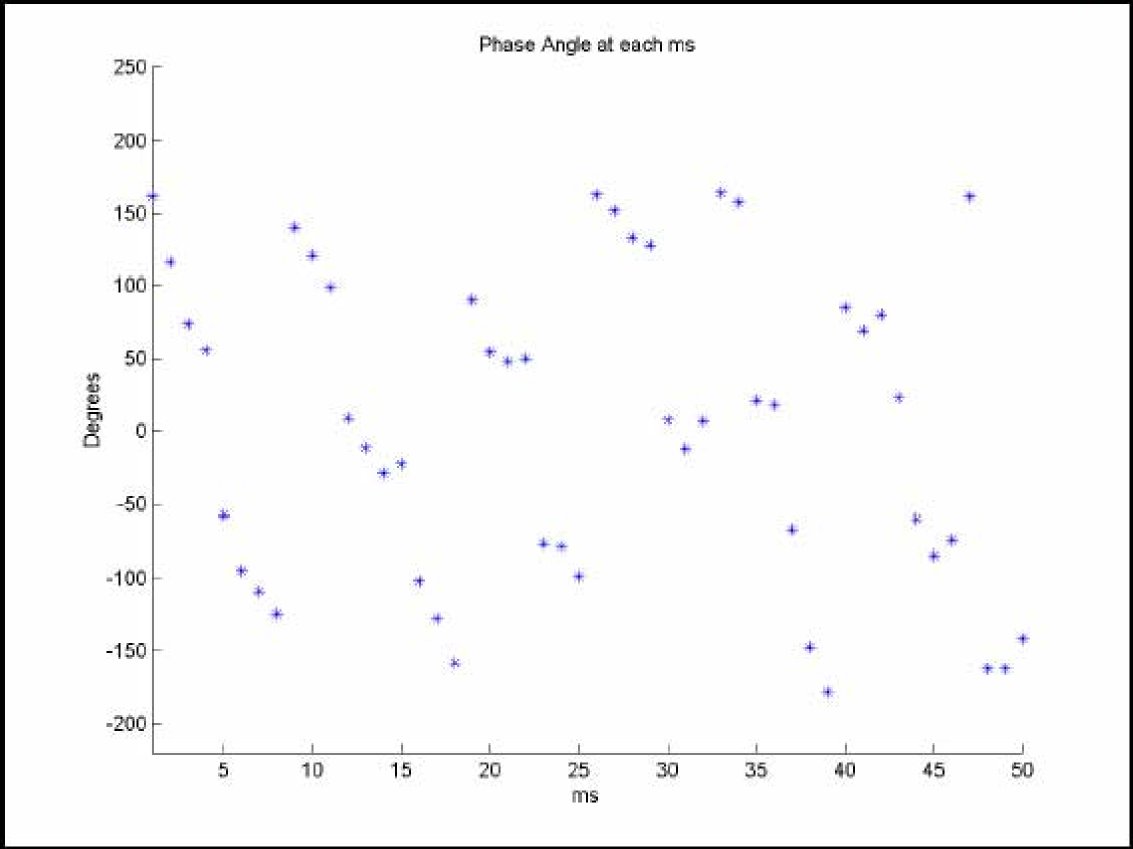
Direct and Reflected Signals C/A Code Phases

- 7 Seconds of data
- Possible Ice Reflections
- Direct Signals at the same time
- Distinctly different
  - Different Doppler's (>2000 Hz)
  - Different C/A phase
  - Different rates of change
- Very Sharp with strong coherent component



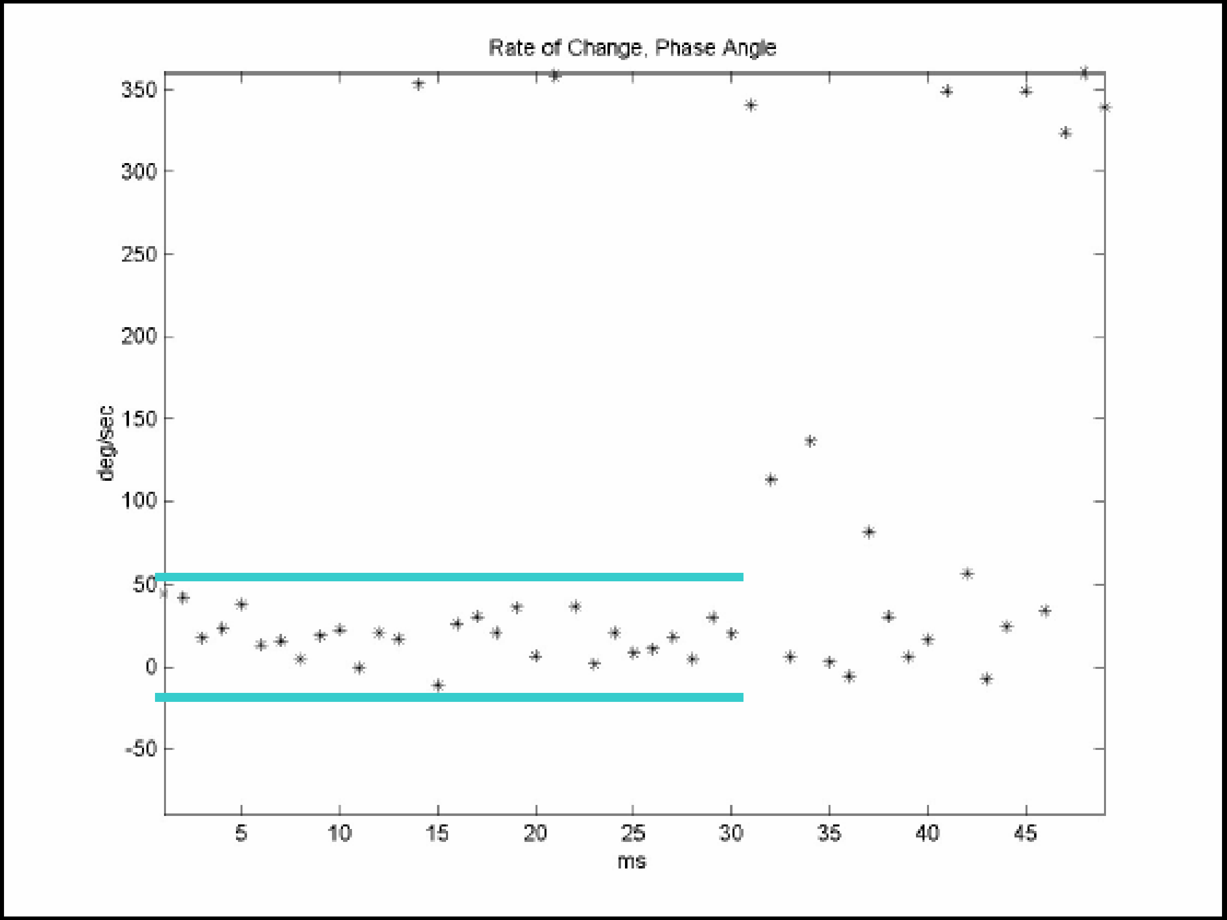
Ice Reflected Raw Signal Phase

- Raw I and Q Phase Angle Measurements at Consecutive Milliseconds



milliseconds

- Open Loop
- Recoverable Phase Observed up to 30th millisecond
- Consistency Deteriorates Near the End of the 50ms

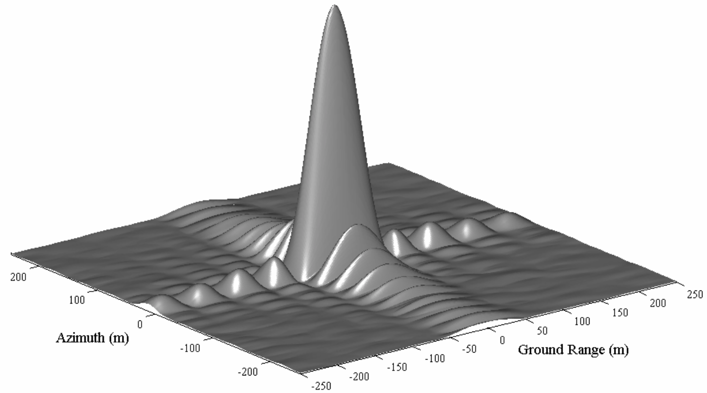


milliseconds

- **7 seconds of UK-DMC data collected over an ice-sheet near Alaska**
- **Both direct and reflected signals detected across entire data set**
- **Magnitude and phase of the reflected signal could be used to sense the ice surface**

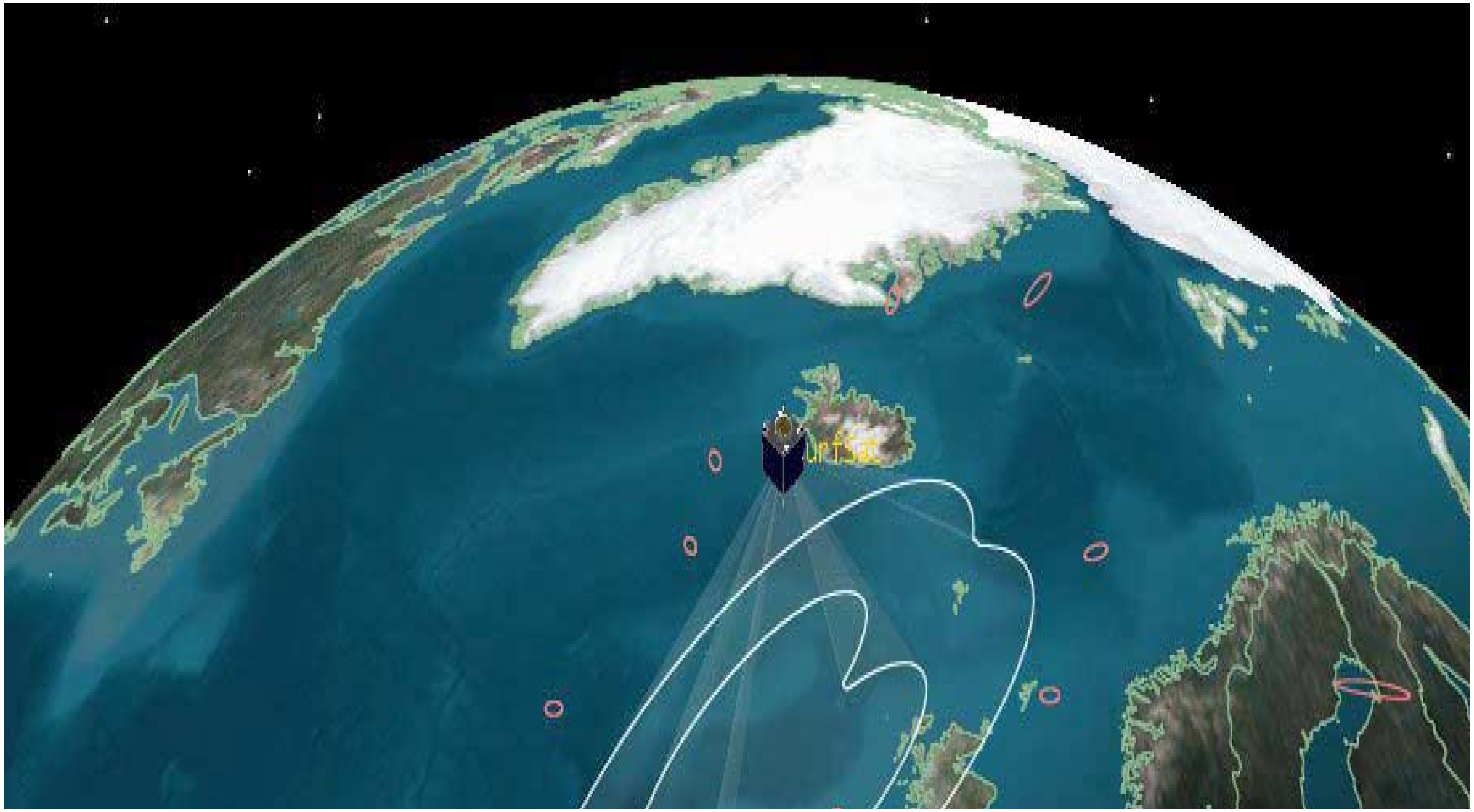
ASAR Receiver Gain Droop

– Use digital coded transponder developed by SEA/Qinetiq under ESA contract to repeat ASAR pulses across swath and so measure directly the receiver gain droop of the instrument
– Paper to be presented at EUSAR'06



- Based on modified version of SSTL's UK-DMC micro satellite
- Idea to trail or lead SMOS
- Collect GPS ocean reflections from within SMOS swath
- Determine ocean roughness (MSS) for those patches
- Feed results into ocean roughness models
- Improve accuracy of ocean salinity measurements

Indication of coverage



- **Workshop on RF Sensors for Earth Observation**
  - Date: TBD/06
  - Location: ESTEC, The Netherlands

- **Workshop on GNSS Reflections (applications and techniques)**
  - Date: TBD/06, probably June
  - Location: ESTEC, The Netherlands