ICEPOD

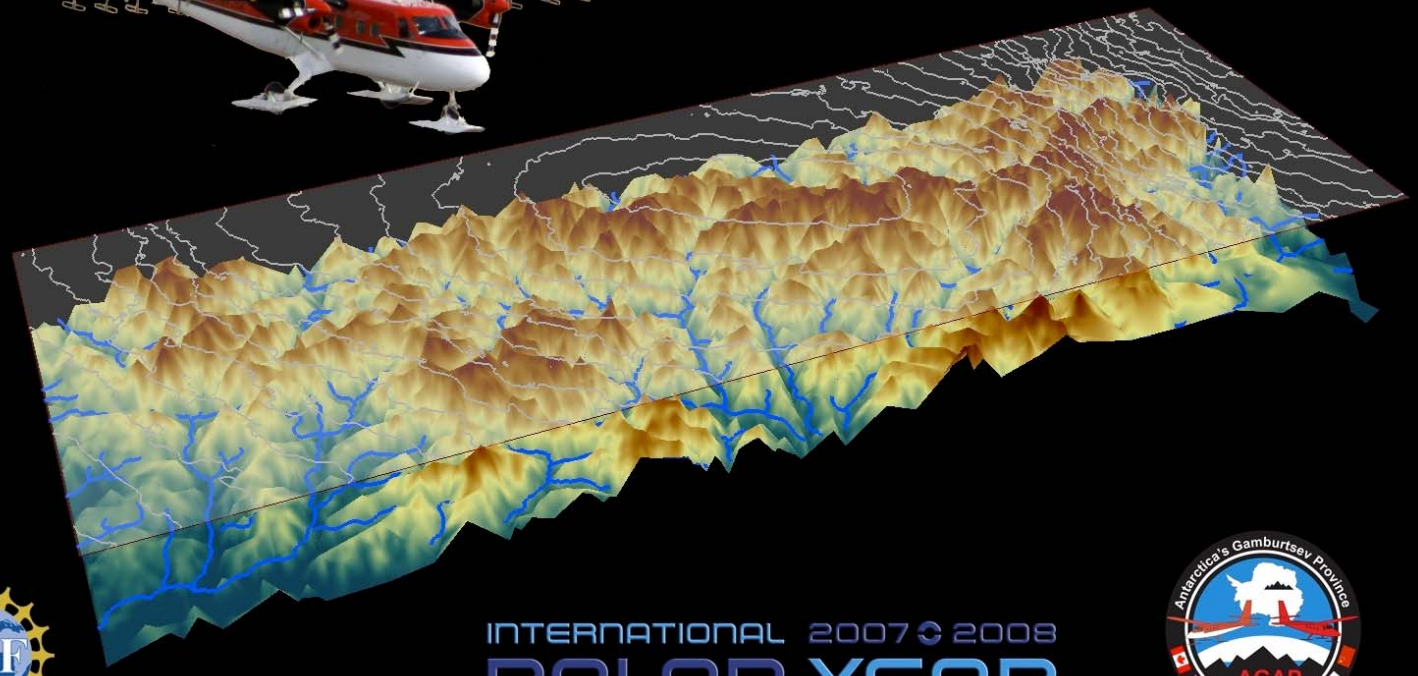
TEAM ICEPOD: Robin Bell, Nick Frearson, Kirsty Tinto, Chris Zappa, Chris Bertinato, Tej Dhakal, Scott Brown, Ling Ling Dong, Indrani Das, Mike Wolovick, Margie Turrin, Jim DeTemple

With Tremendous Support From NYANG
especially Major Josh Hicks, Senior Master Sargent Joe Deamer

Lamont Doherty Earth Observatory
Columbia University

Lamont-Doherty Earth Observatory

COLUMBIA UNIVERSITY | EARTH INSTITUTE



INTERNATIONAL 2007 2008

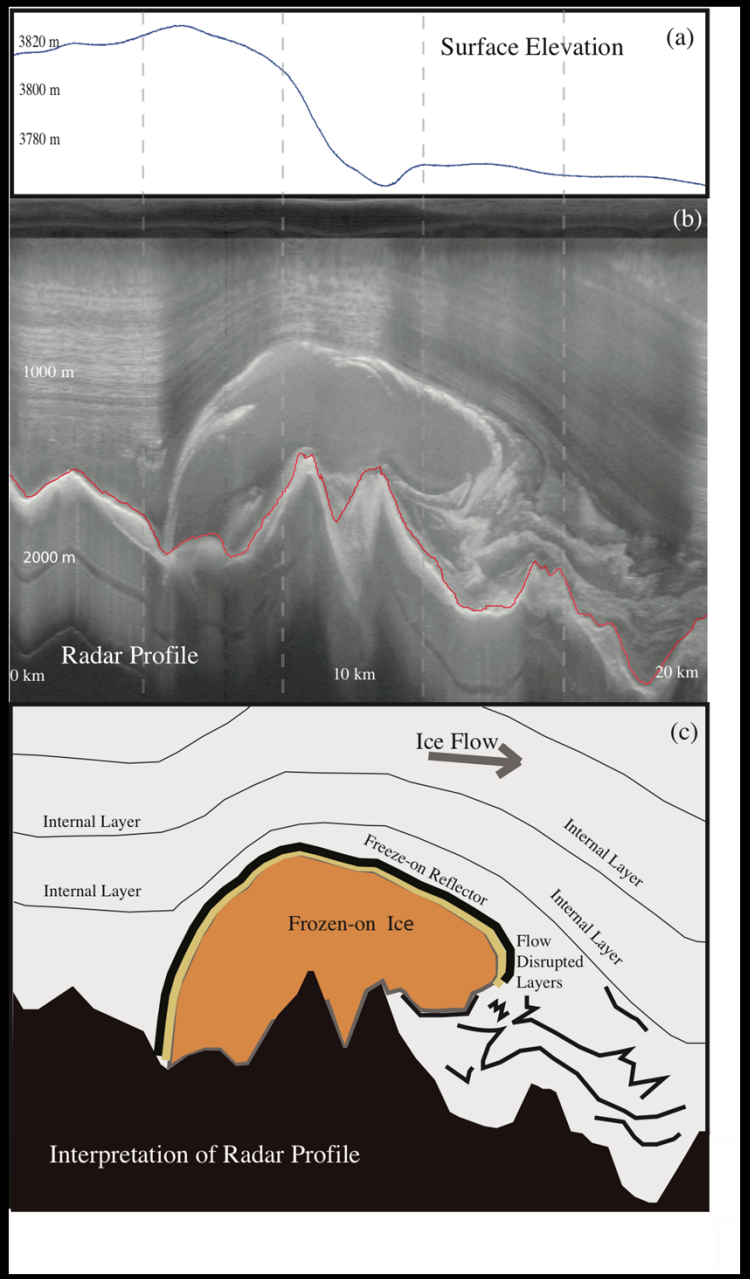
POLAR YEAR

NSF

Antarctica's Gamburtsev Province

AGAP

Up to 1000m Thick----50% of the Ice Sheet

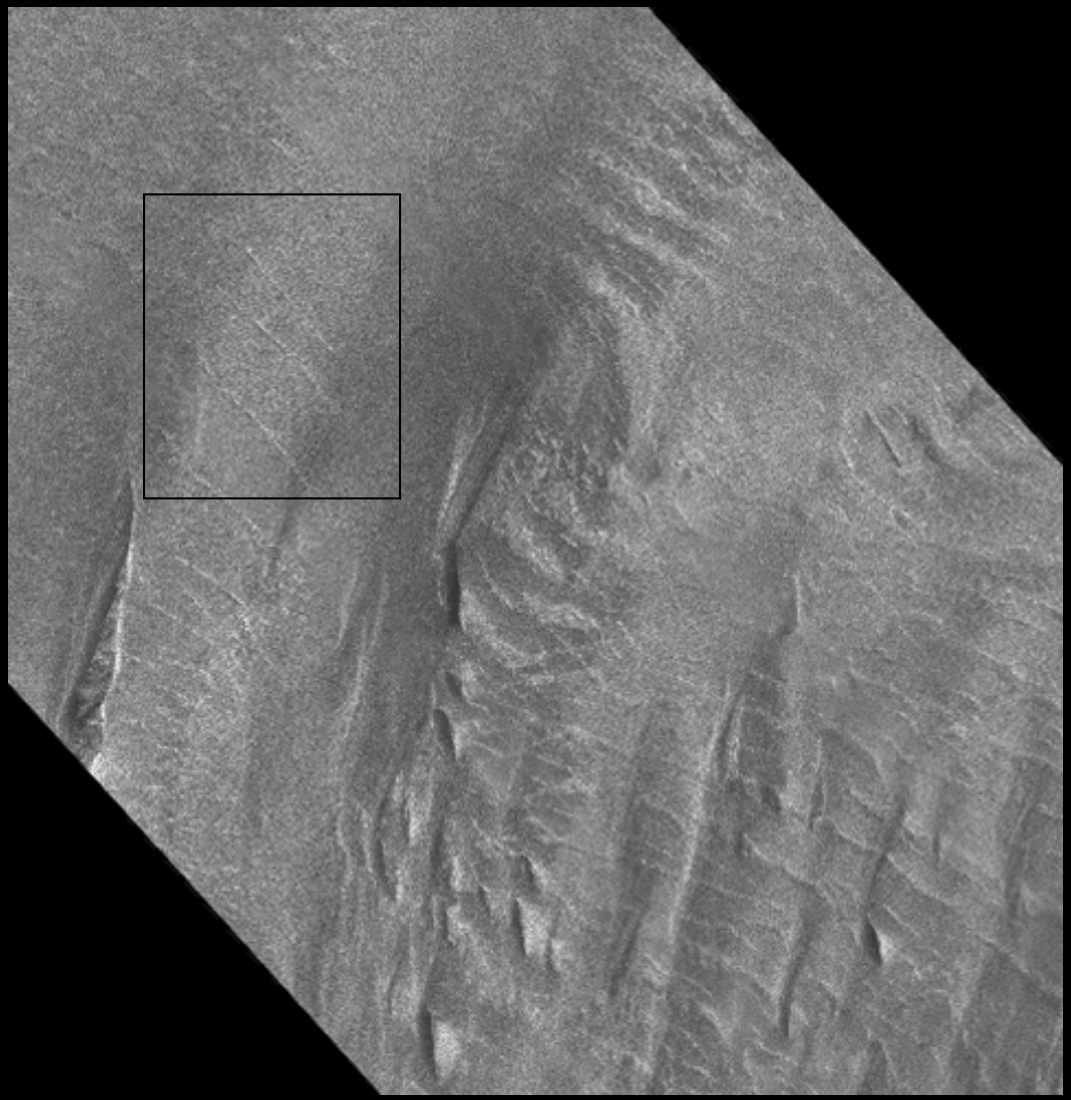


Remote Field Camps

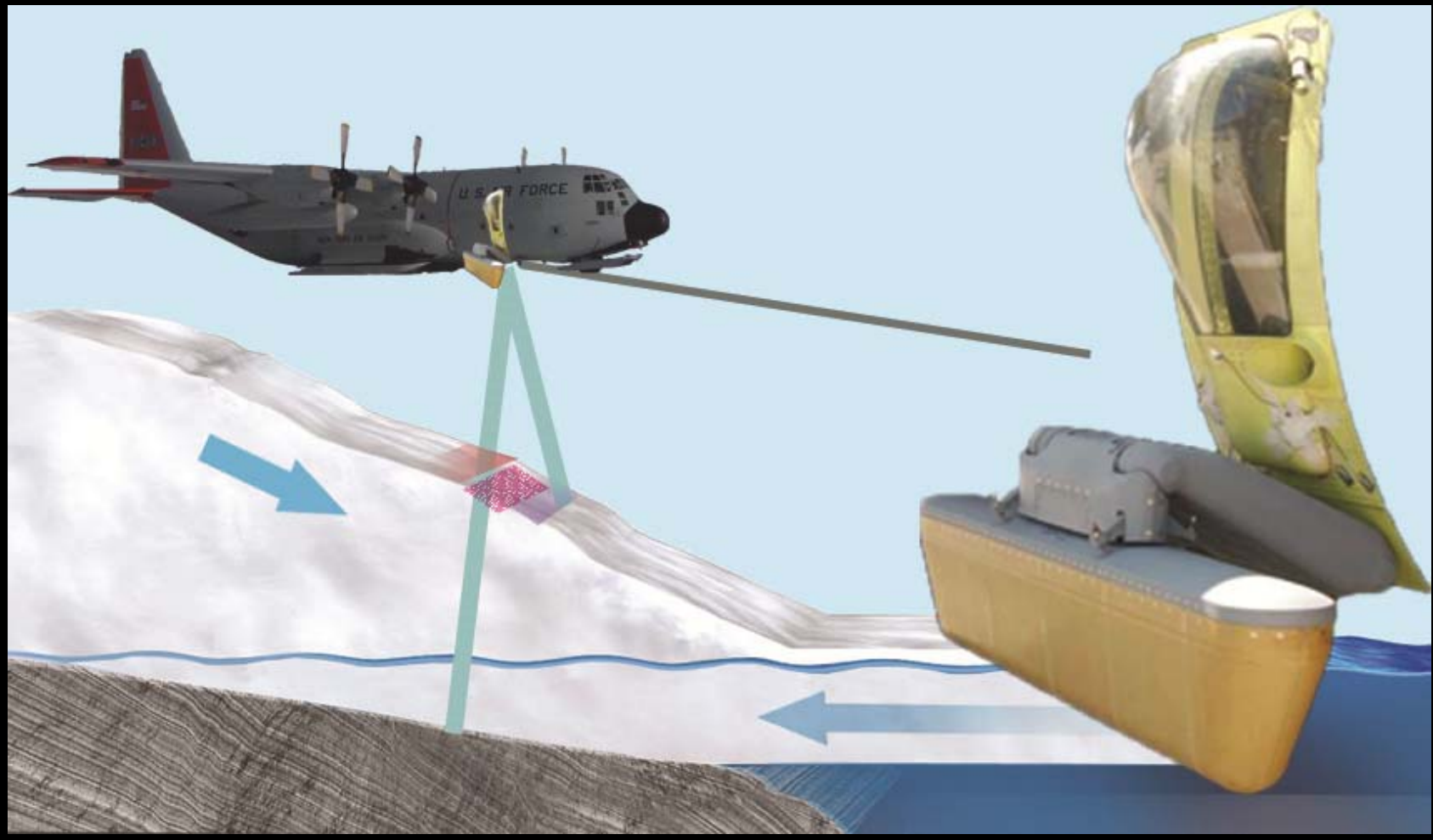

OXYGEN, COMPRESSED
OXYGEN
2
UN1072
OXYGEN, COMPRESSED
OXYGEN
2
UN1072

Crevasse Detection Radar (CDR)

CDR Image of Tres Hermanas (3 Sisters) Crevasses



Recovery Act Funding
Early Pod Design



IcePod

Recovery Act Funding

Goal Instruments, Data and Platform for Community Use through Piggyback Missions and Dedicated Flights

Icepod

- Pod Delivered January 7, 2013
- Flight Certified January 29, 2013
- Field Operation Test April 2013 - Greenland
- Instrument Test July/August 2013 – Greenland
- Commission Antarctica 2014

Icepod

- Operational Modes
  - Piggyback Missions
    - 10% regular missions Antarctica & Greenland
  - Dedicated Investigator Lead Missions
    - Recovery Catchment, Ross Ice Shelf
  - Instrument Development Platform
    - Air sampling, lave tube imaging

A Troop Door

An Arm

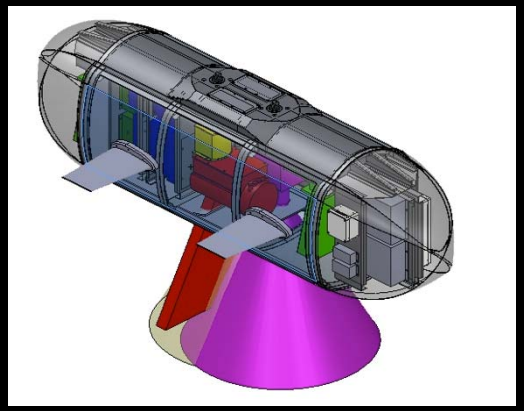
A Data Acquisition Rack

A Sensor Pod

A Skilled Team Including the Guard

IcePod Instrumentation

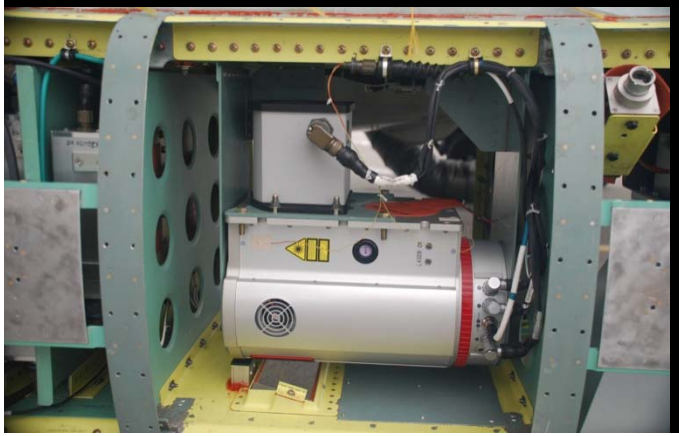
- Optical Instruments
  - IR Camera
  - Pyrometer
  - High Res Vis Wave Camera
  - Scanning Laser
- Radar
  - Deep Ice
  - Shallow Ice [100m]
- Georeference
  - GPS
  - IMU

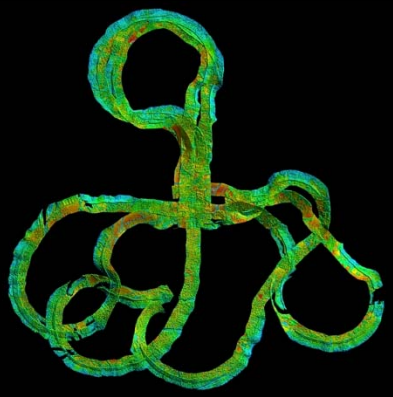


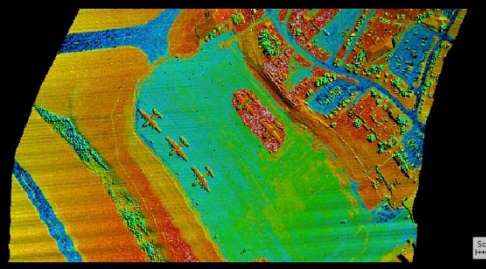
IcePod Instrumentation

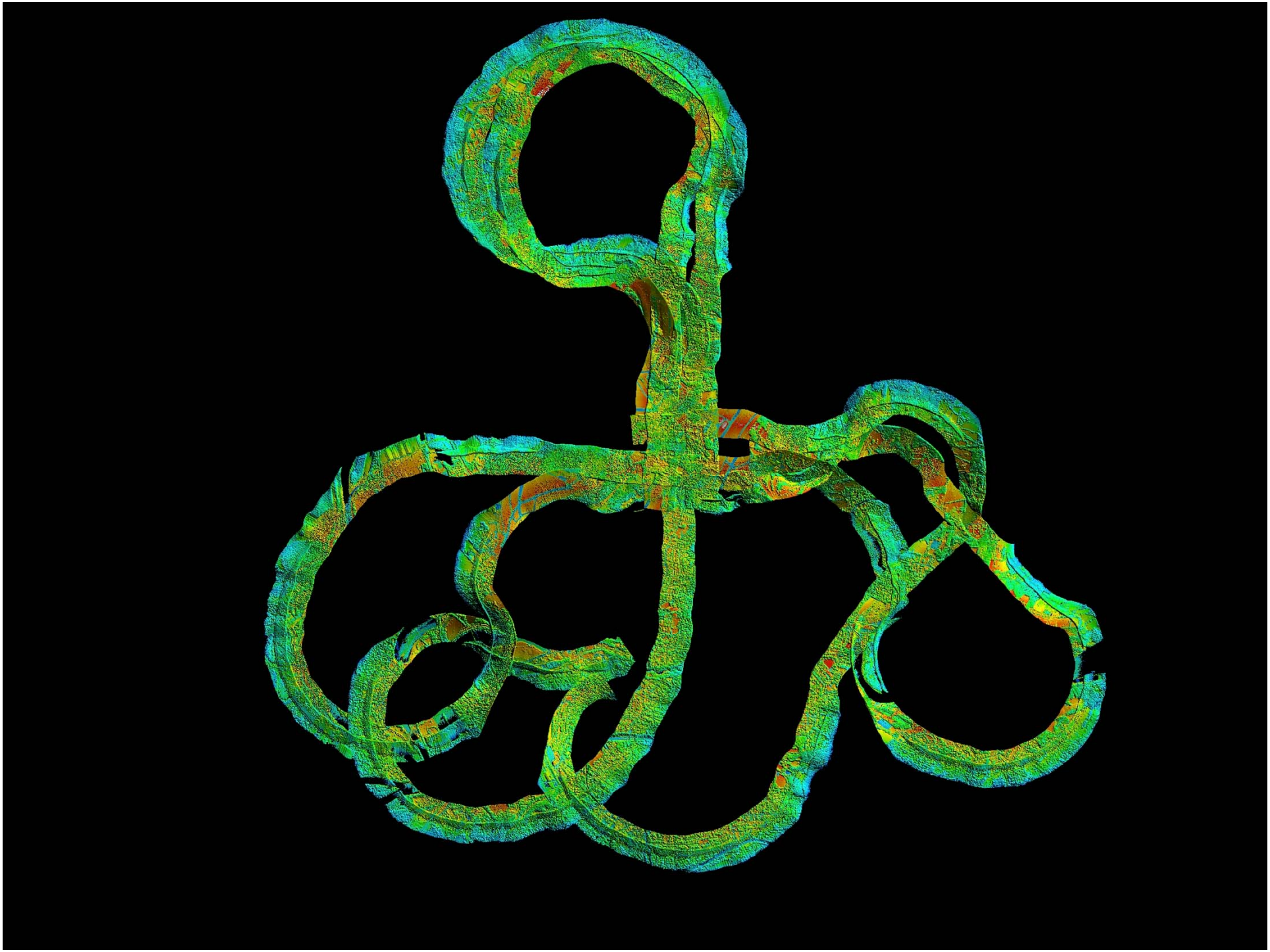
Laser:

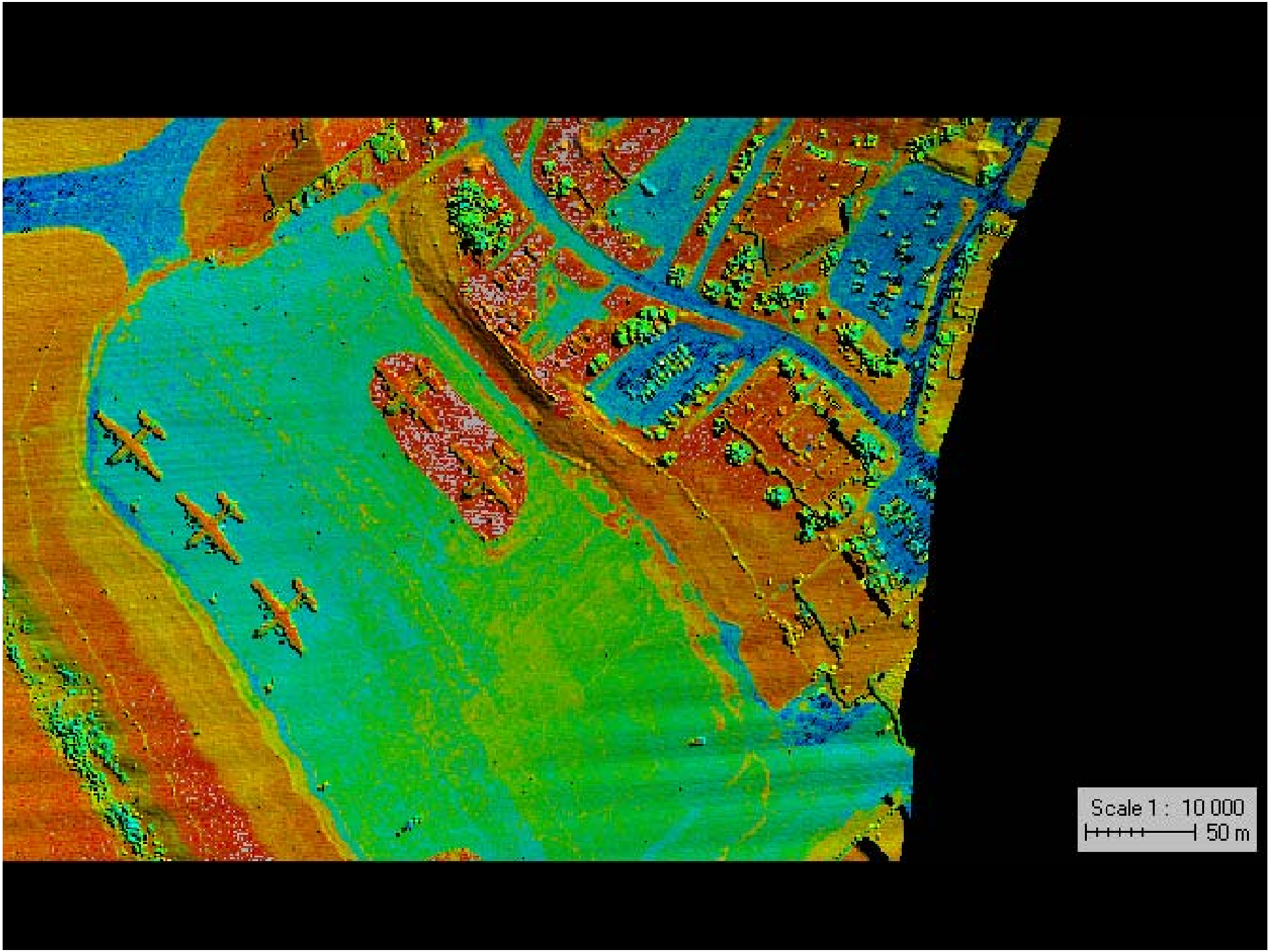
- Type: RIEGL VQ-580 Swath scanning laser
- Range Resolution: 2mm Lidar + ~10cm GPS
- Swath width: ~3,000 ft at 3,000 ft altitude
- Applications: Surface Profiling/Glacier Mapping
- Max scanning altitude: 3,950 AGL feet









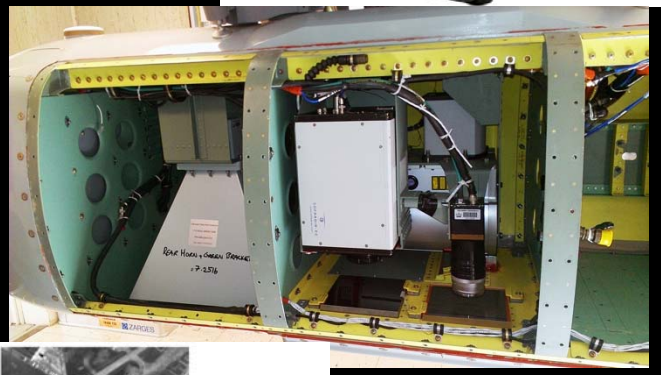

Scale 1 : 10 000
50 m

IcePod Instrumentation

Infrared Camera

Type: Sofradir IRE640L LWIR: 7-9.5um
Accuracy: < 20 mK NEDT
640 x 512 pixels 100 frames/second
Rotary Sterling Cooler [i.e does not need external cooling]
Applications: Thermography
Swath width: 350 m at 1,000m
Resolution: 50 cm
Specifications:

- Temp: −40˚ C to +55˚
- Altitude: 30,000 ft
- Supply: +24Vdc
- Weight: 12lb



IcePod Instrumentation

Sky Pyrometer

Type: Heitronics KT-15

Response: 0.6 ° C

Applications: Surface Reflection Correction

FOV: 3° upward-looking

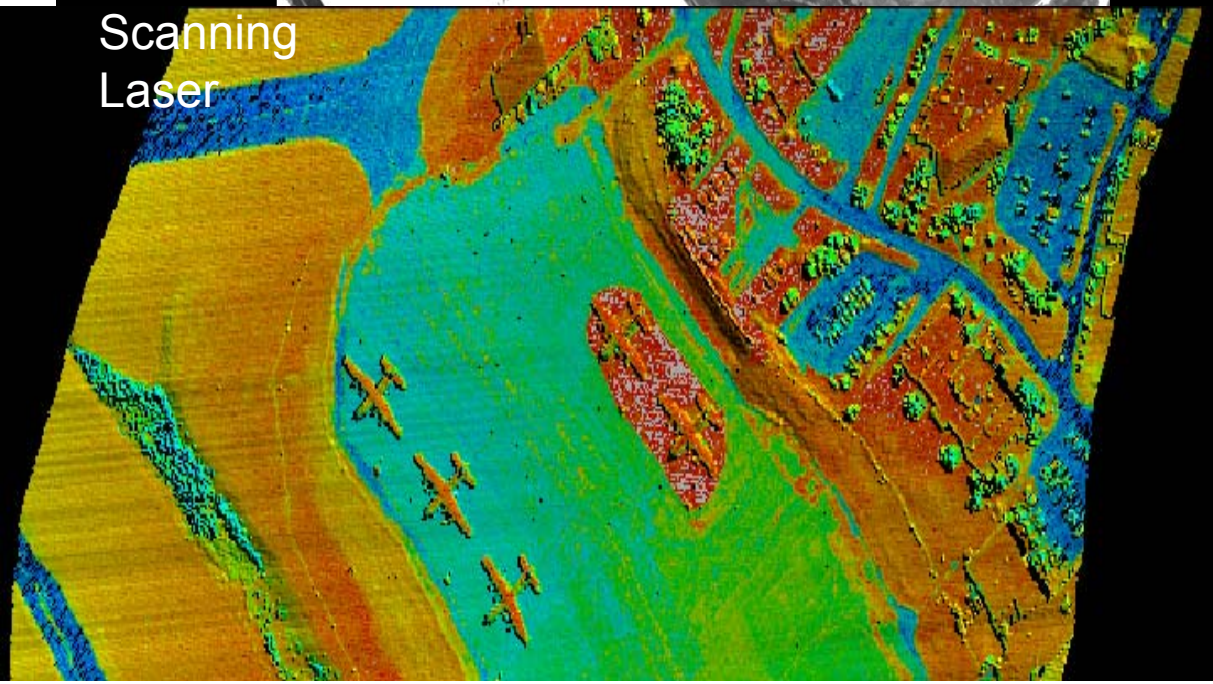
Specifications:

- −40° C to 60° C
- 30,000 feet MSL
- Supply: +28Vdc
- Weight: 2.5lb
- Dimensions: 6” x 2” x 2”

Visible wave

Infra-Red

Scanning
Laser

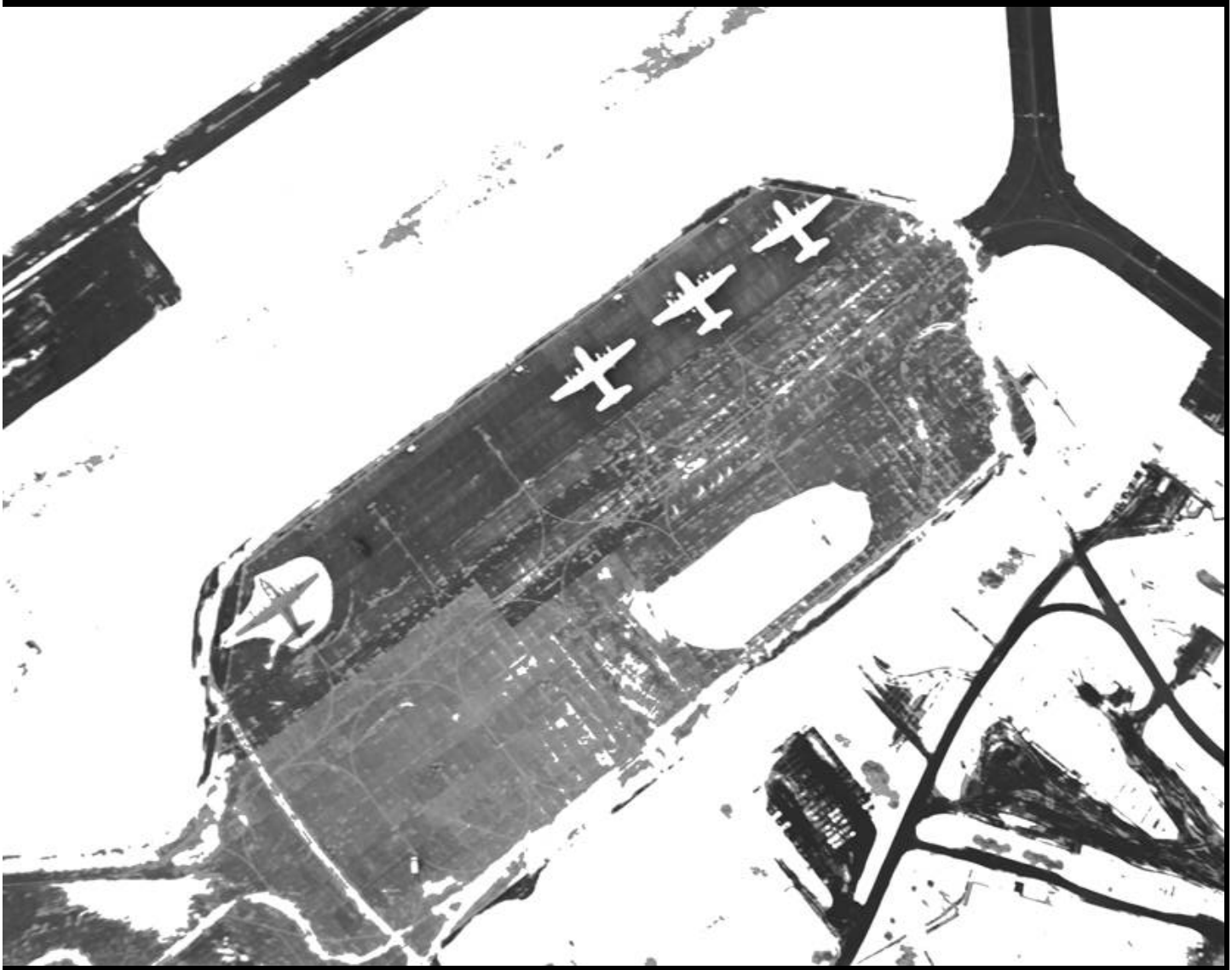


IcePod Instrumentation

Visual Camera

Type: Imperx Bobcat 6620
29Mpixel; 6600 x 4400; 12-bit
Accuracy: 20cm at 1,000m altitude
Swath width: 1,200 m at 1,000m
Applications: Photogrammetry
Specifications:

- −40° C to +80° C
- 30,000 feet MSL
- 2.5lb
- +12Vdc



IcePod Instrumentation

Deep Ice Radar

Type:

- High-Power Coherent Pulsed Radar
- Transmitter: 800W per channel; 2 channels
- Center Frequency = 188MHz
  Bandwidth = 60MHz
- 1us and 10us interleaved chirp signals

Depth Resolution:

- 2.8m

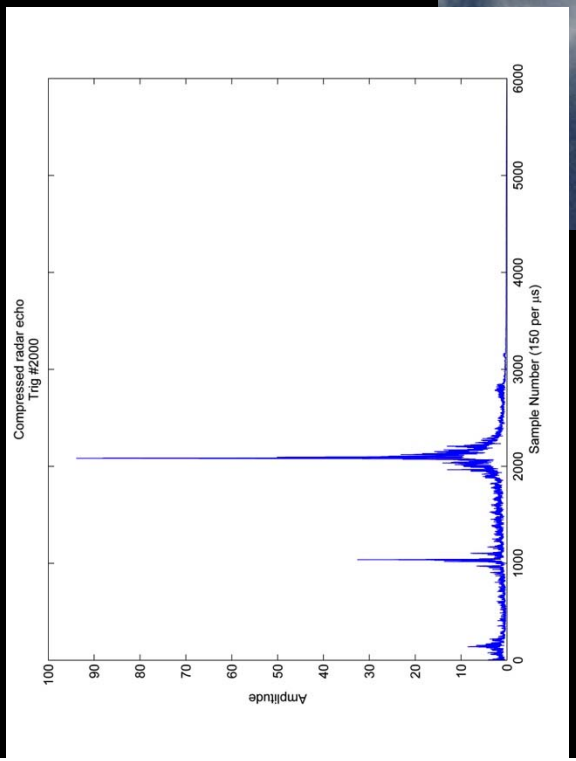
Applications:

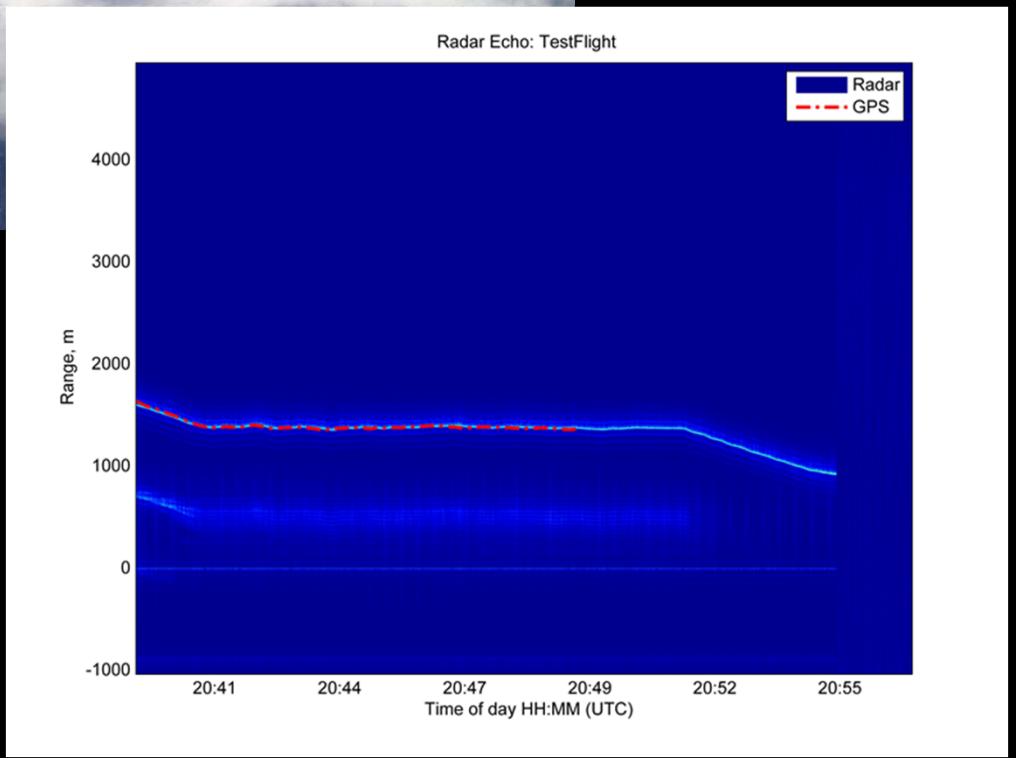
- ice thickness, internal structure, bedrock mapping

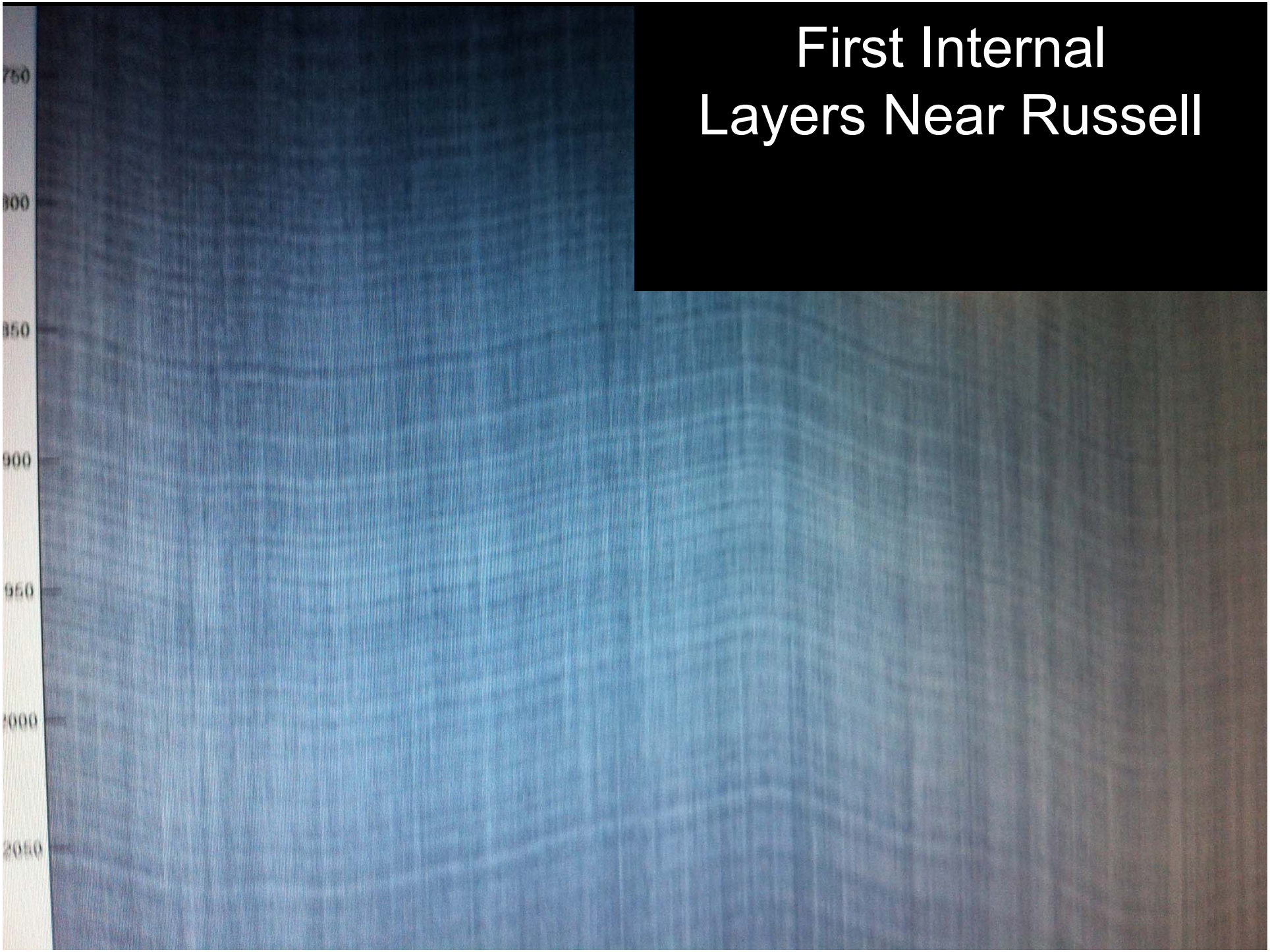
Specifications:

- Dimensions: 18” x 18” x 18” Weight: 83lb


ESSP
ICEPOD


Compressed radar echo
Trig #2000
Amplitude
Sample Number (150 per μs)
100
90
80
70
60
50
40
30
20
10
0
1000
2000
3000
4000
5000
6000


Radar Echo: TestFlight
Radar
GPS
Range, m
4000
3000
2000
1000
0
-1000
20:41
20:44
20:47
20:49
20:52
20:55
Time of day HH:MM (UTC)


First Internal
Layers Near Russell

IcePod Instrumentation

Positioning IMU and GPS

Type: L1/L2 GPS GLONASS

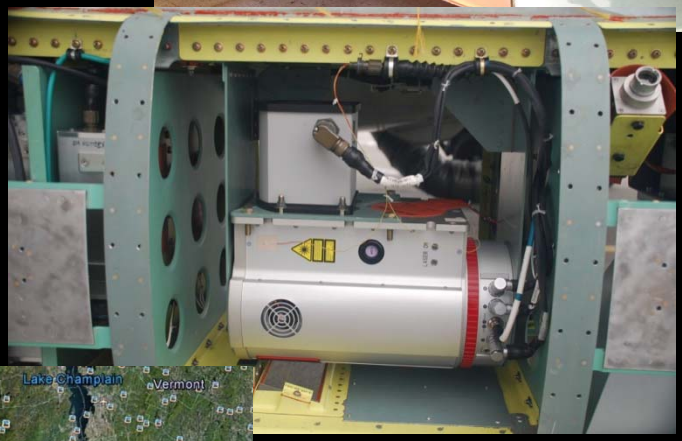
IMU: LN-200, Fiber-Optic Gyros

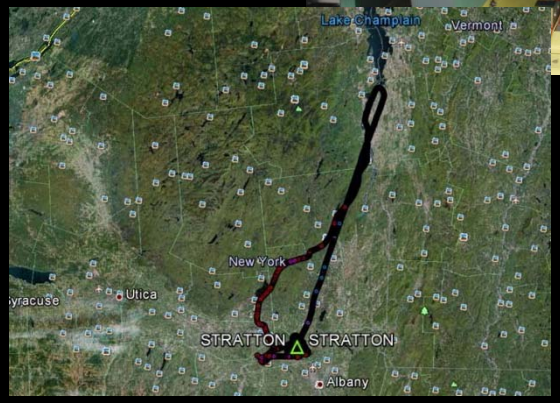
Accuracy: 10 cm

Applications: Position and attitude

Specifications:

- GPS:
  - 10lb
  - +28Vdc
  - 10” x 8” x 3”
- IMU
  - 8lb
  - +28Vdc
  - 7” x 5” x 5”





IcePod Instrumentation

Shallow Ice Radar [SIR]

Type:

- FMCW
- Transmitter Power = ~10W for Firn Ice and <1W for sea-ice
- Center Frequency = 2GHz
- Bandwidth = 600MHz

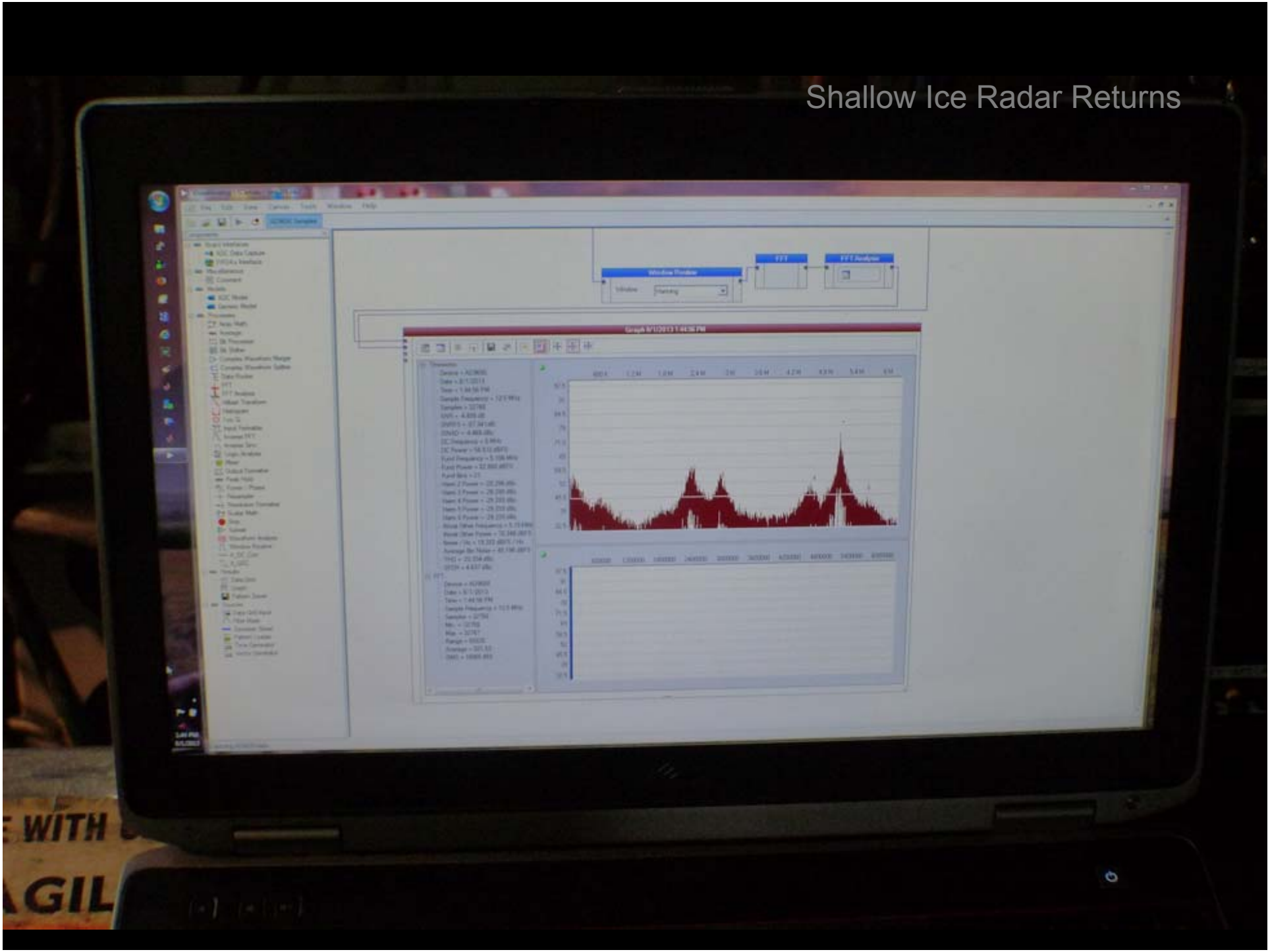
Range Resolution:

- 25 cm

Applications:

- Sea-Ice: Snow Pack, Ice Depth
- Firn internal structure to 100m

Shallow Ice Radar Returns

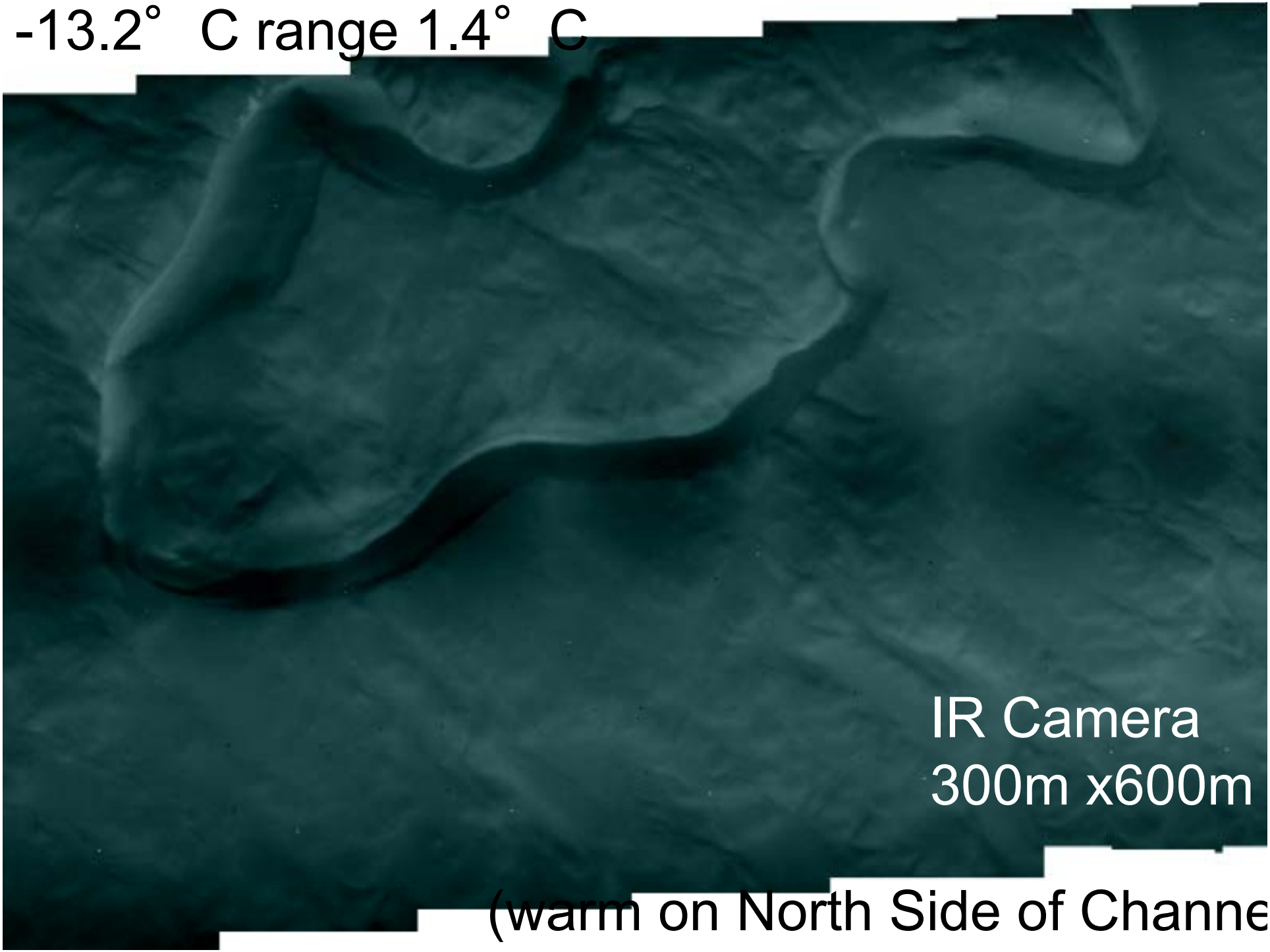


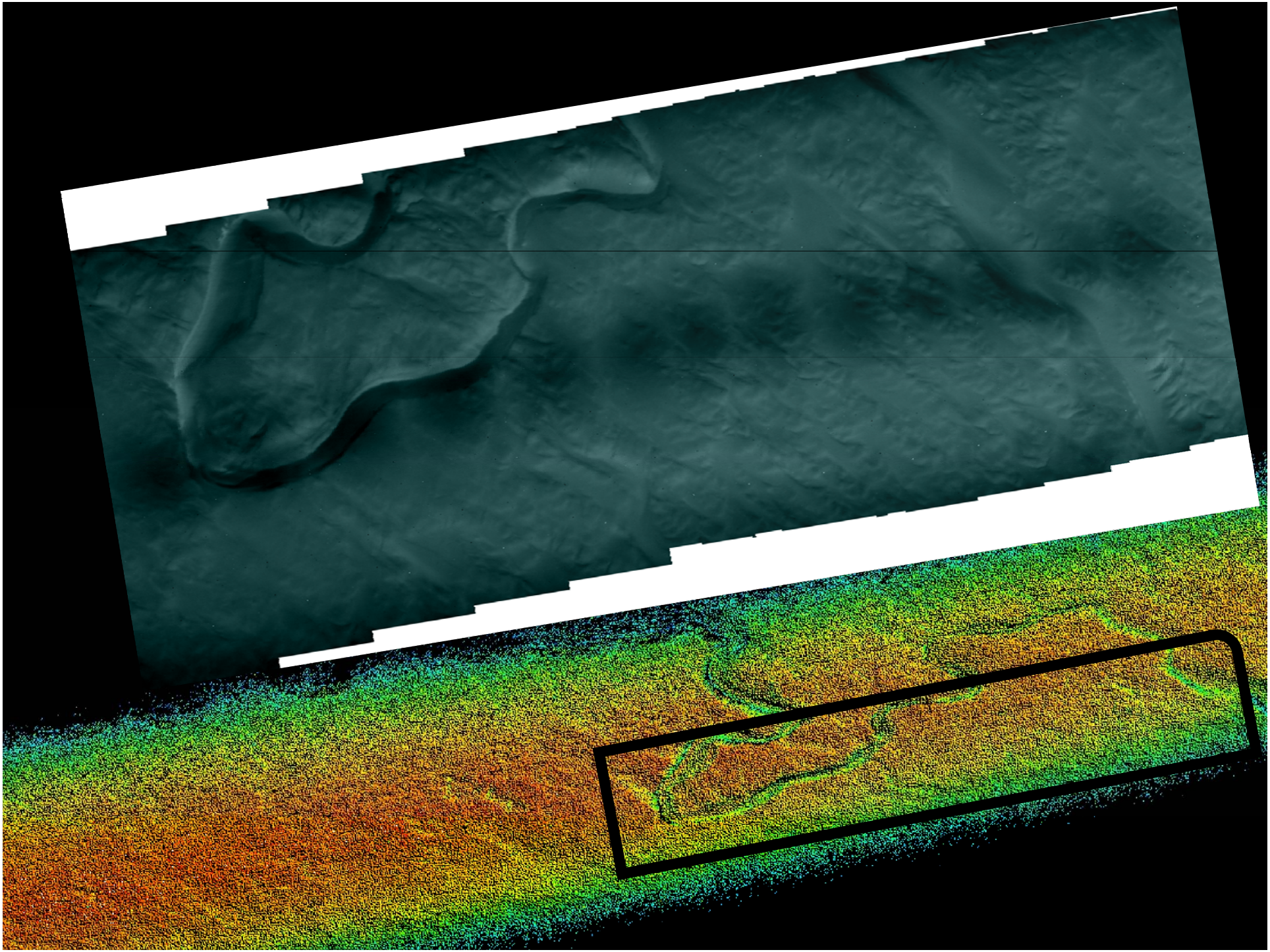
Lab Installation to Flight Ready in 2 days

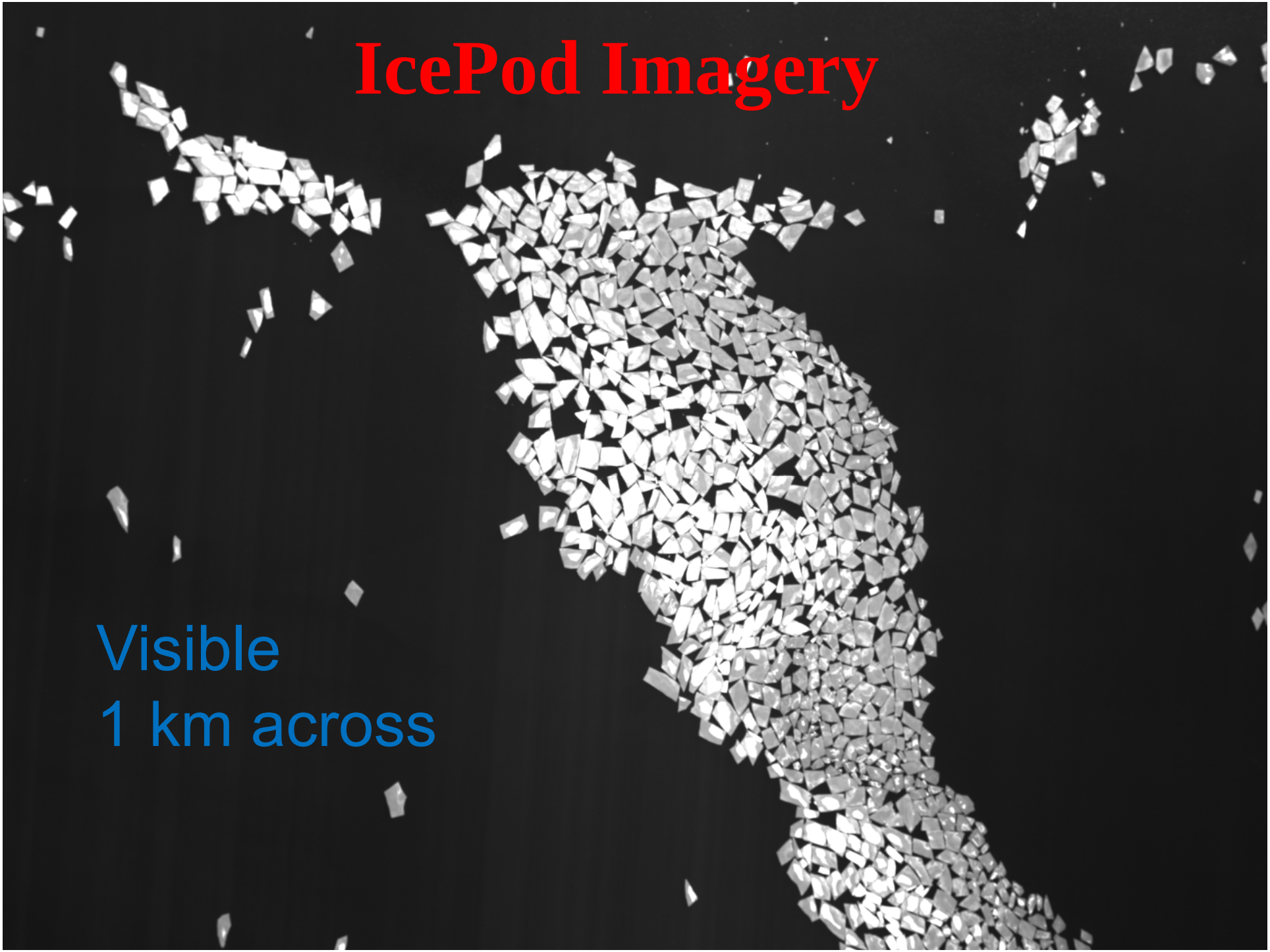
1. Disassemble and pack system: ~3h
2. Unpack and install system: ~4h
3. Test System: ~2h


no signal
channel 3

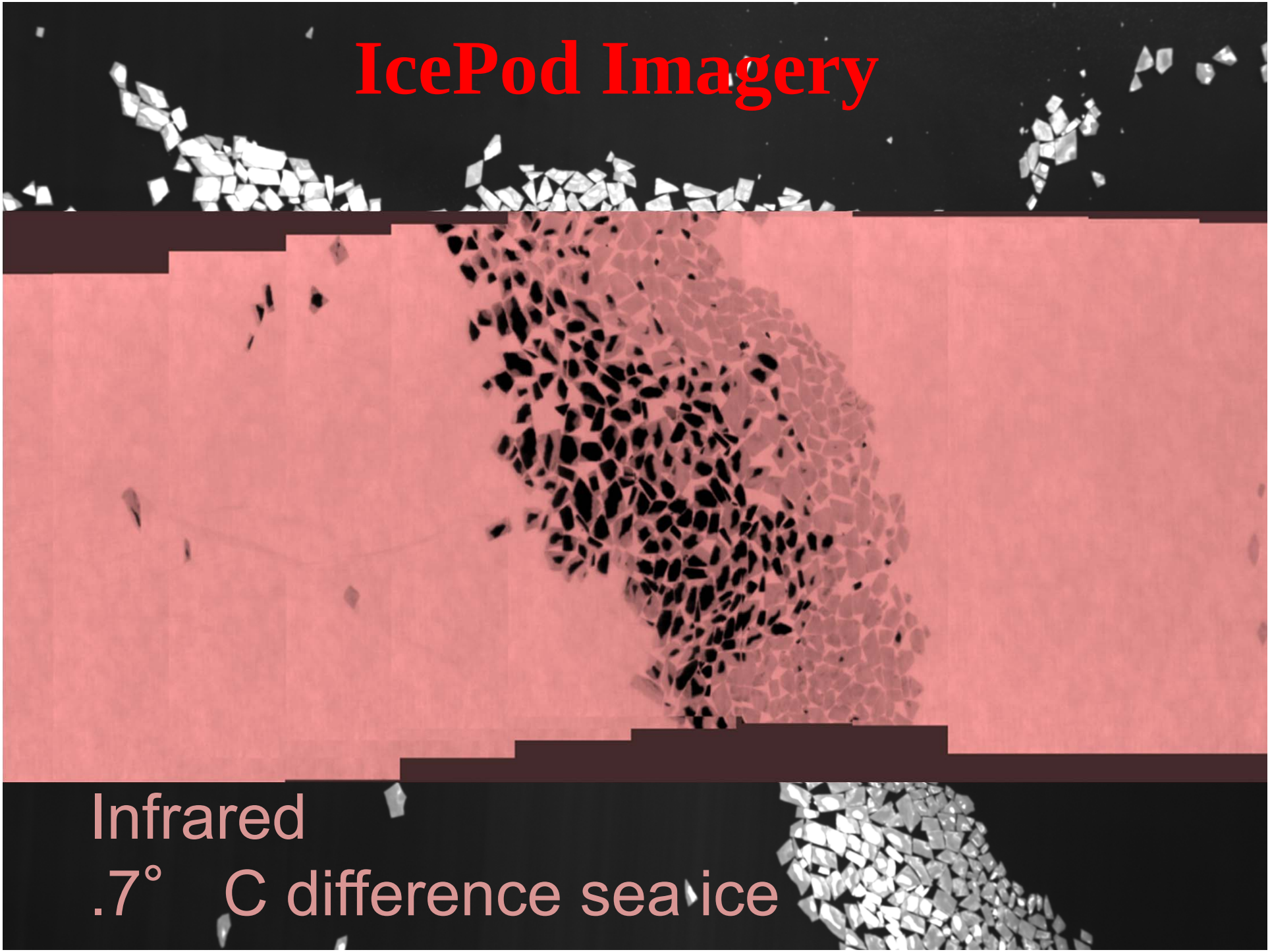
Team Icepod @ Raven August 2013


-13.2° C range 1.4° C
IR Camera
300m x600m
(warm on North Side of Channe

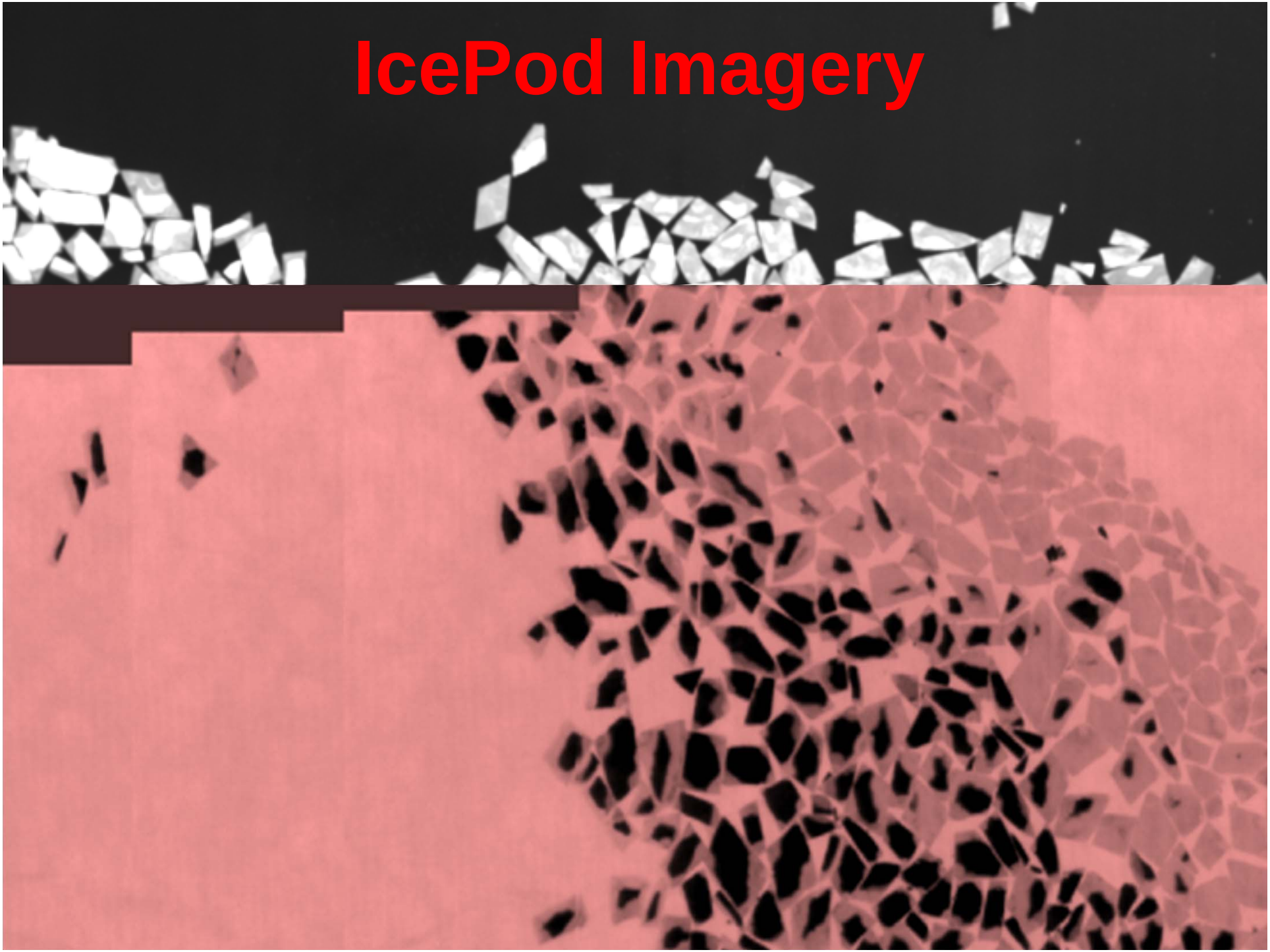



IcePod Imagery
Visible
1 km across

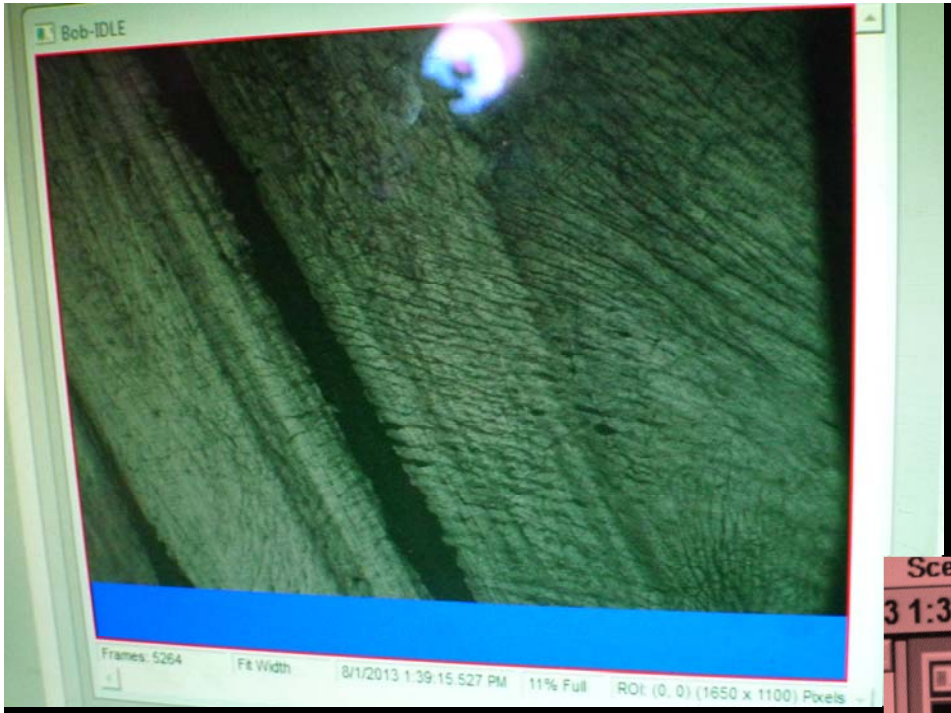
IcePod Imagery



IcePod Imagery

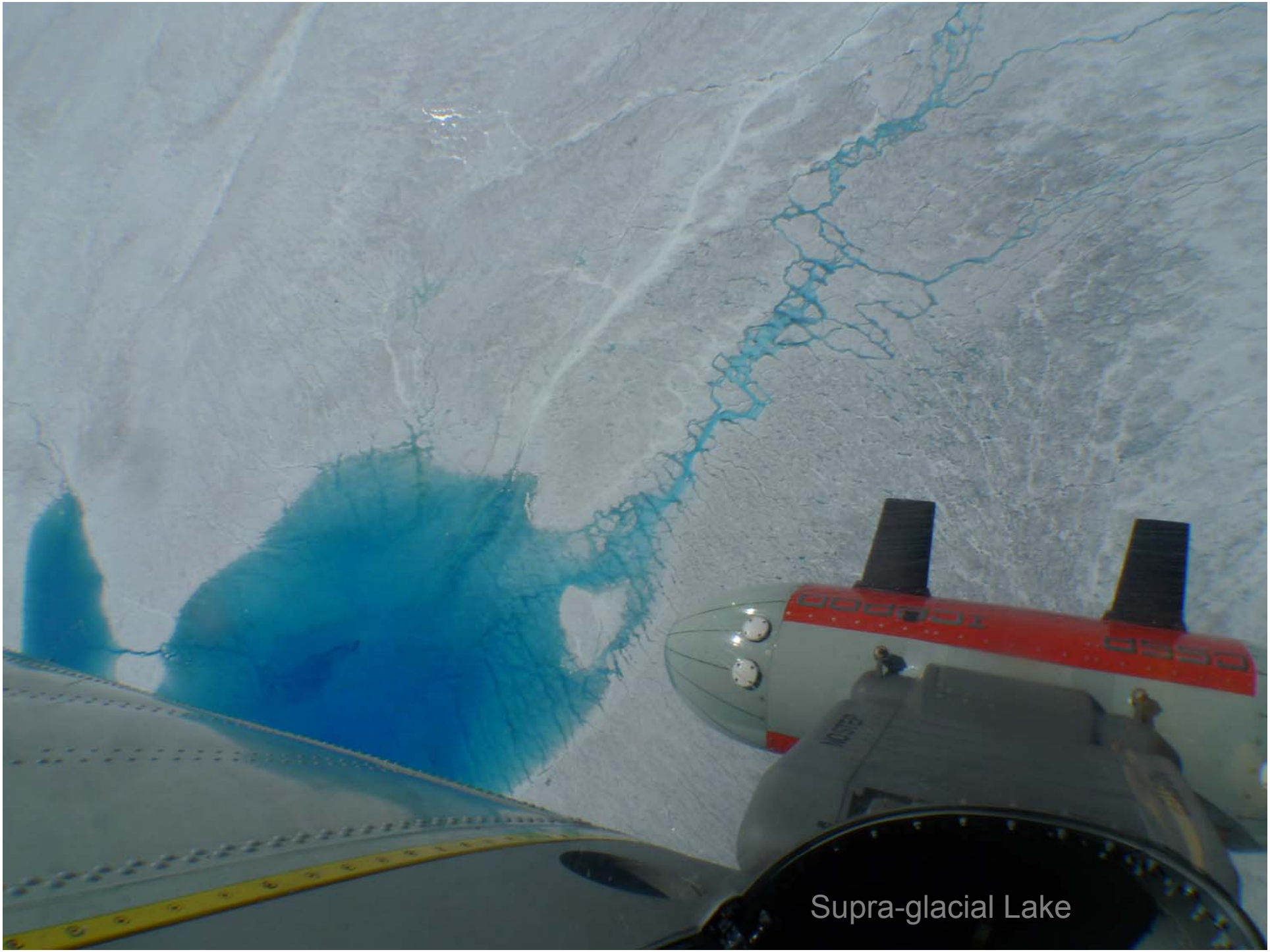


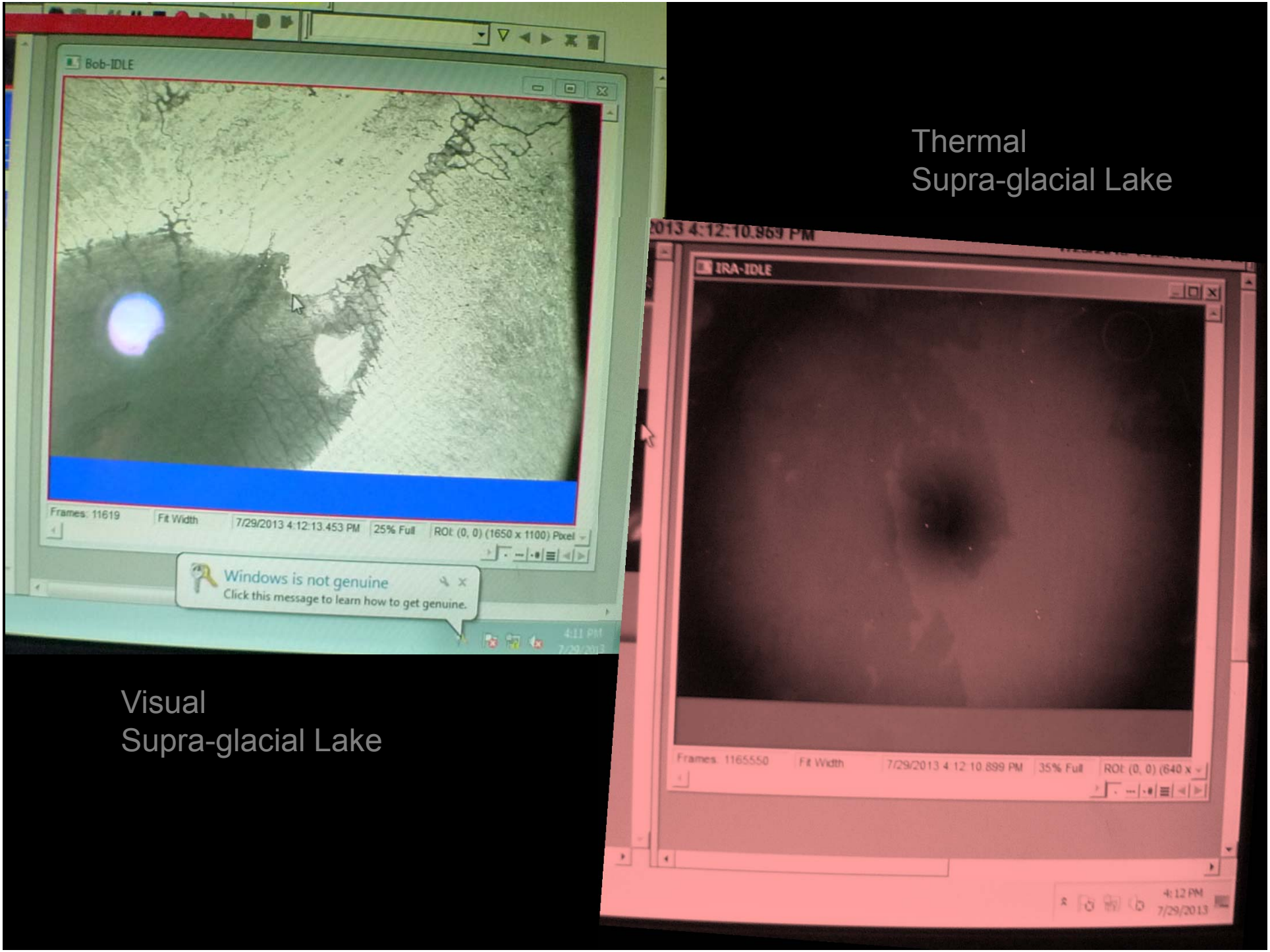

Moraine Structure



Visual
Moraine Structure

Thermal
Moraine Structure

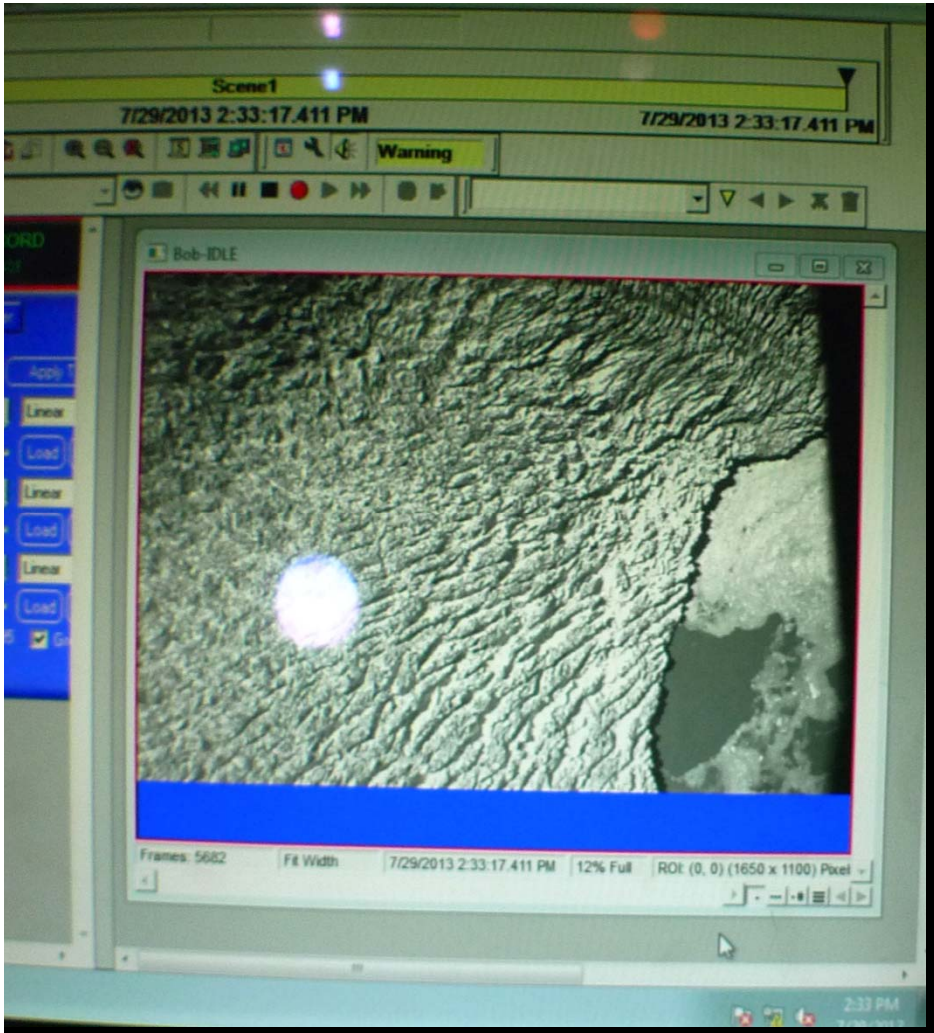

Supra-glacial Lake



Thermal
Supra-glacial Lake

Visual
Supra-glacial Lake


Meltwater Plume



Visual
Meltwater Plume

Thermal
Meltwater Plume

Capturing The Seasonal Melt Cycle

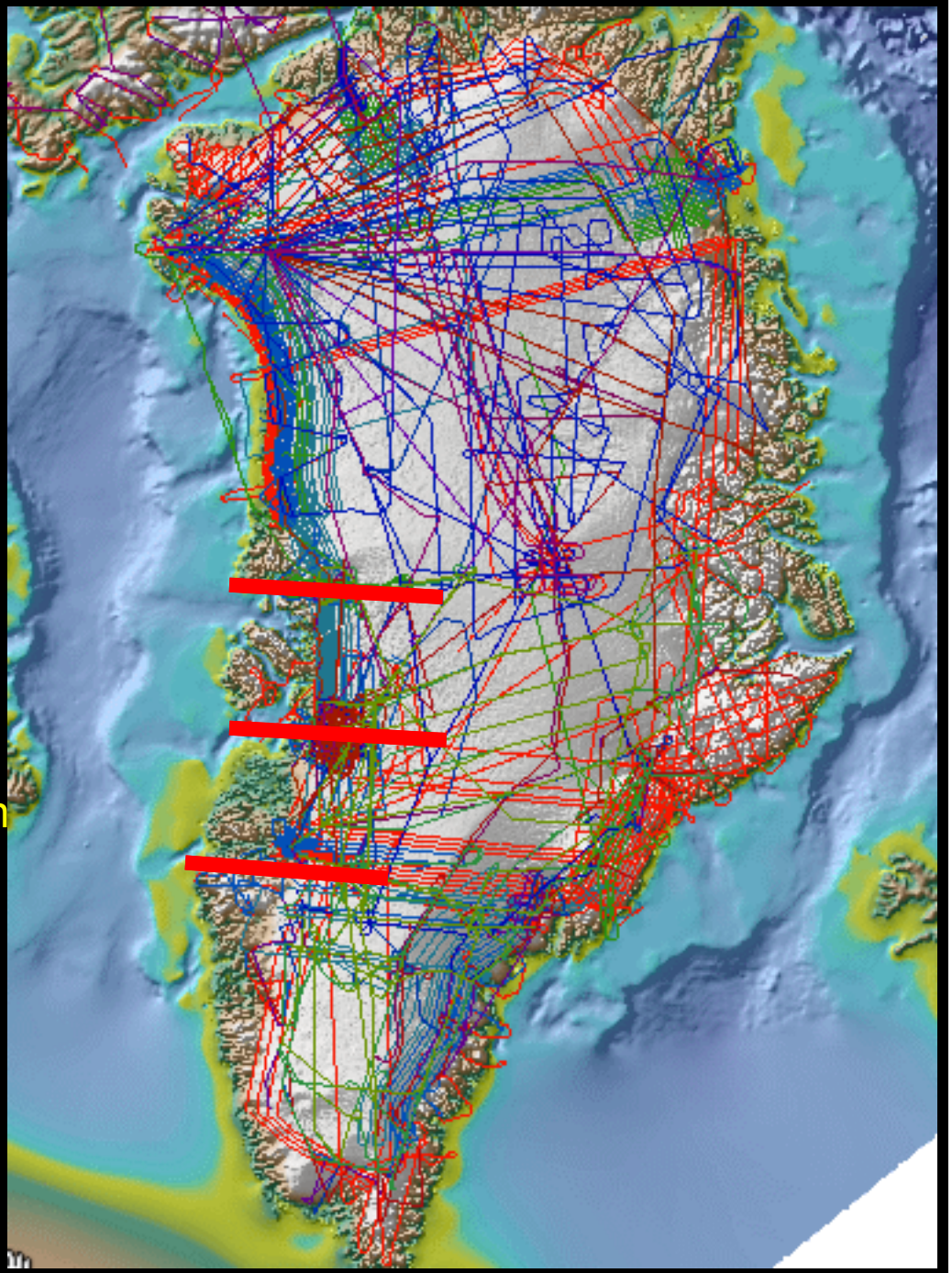
Piggyback Missions on NYANG Missions

April-August

Benchmark Lines

- Summit to the Coast (Rink??)
- Jakobshavn
- Russell Glacier – Return from Raven

Ice Surface Elevation
Surface Temperature
Surface Imagery
Shallow & Deep Radar
Plume Structure
Flow in Fjords
Deploy XCTD



Expanding Instrument Suite
Magnetometer
Gravity meter

Next Steps

Resolve Technical Issues

Demonstrate Data Products

Commission System in Antarctica (Suggestions)

Commission in Greenland

Develop Community Plan for Piggy Back Missions – Greenland and Antarctica

Open Process for Dedicated Use Individual Investigators

Develop Process New Instrumentation