

ABSTRACT

CRISTAL (Copernicus polaR Ice and Snow Topography Altimeter) will be the first mission to carry a dual-frequency synthetic-aperture radar altimeter as its primary payload. The altimeter will have interferometric capabilities at Ku-band to improve the across-track resolution and a second Ka-band frequency to provide information on snow layer properties. The development of a novel mission like CRISTAL is crucially dependent on dedicated campaigns that provide the essential data for the L1 and L2 algorithm development and validation.

CRISTALair succeeds ASIRAS (Airborne SAR/Interferometric Radar System), which operated in both the Arctic and Antarctic from 2004 to 2019. The main advancement in CRISTALair lies in its ability to acquire data simultaneously in Ku- and Ka-band, with interferometric capabilities on both, elevating the Science Readiness Level (SRL) of dual-band algorithms/processing. Beyond the dual-band radar, CRISTALair will integrate an airborne laser scanner, a color-infrared camera, and ancillary equipment to ensure precise positioning and attitude of the interferometer. Additionally, man-made external reflectors will facilitate the performance evaluation of the instrument.

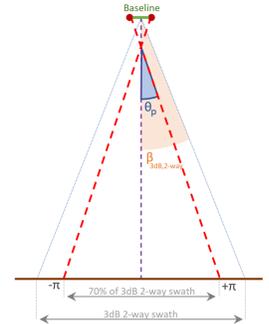
The Development of CRISTALair started in March 2023 and it is currently in the Implementation phase. The first testing flight campaign is planned for Spring 2025 where the full capabilities of the measurements will be evaluated.



INSTRUMENT REQUIREMENTS

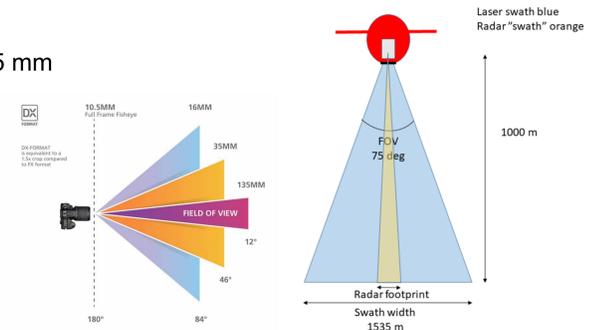
RADAR

- 1-4 km ground altitude
 - PRF, Pulse duration, duty cycle
- Interferometry in both Ku and Ka
- PRF > 10 kHz
- Automatic tracking (range and gain) system
- Swath > 200 m
- $d_{al} > 0.5$ m



LASER

- Accuracy and precision < 25 mm
- Collocated measurements
- Laser Snowfield

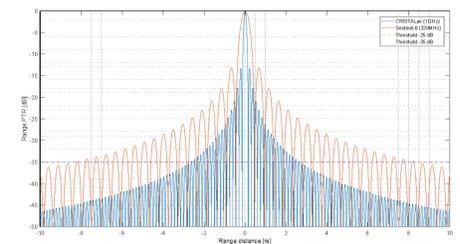
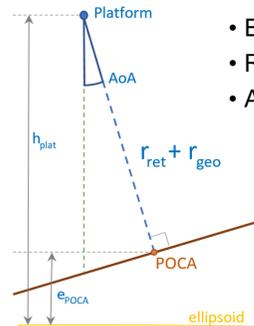


CAMERA

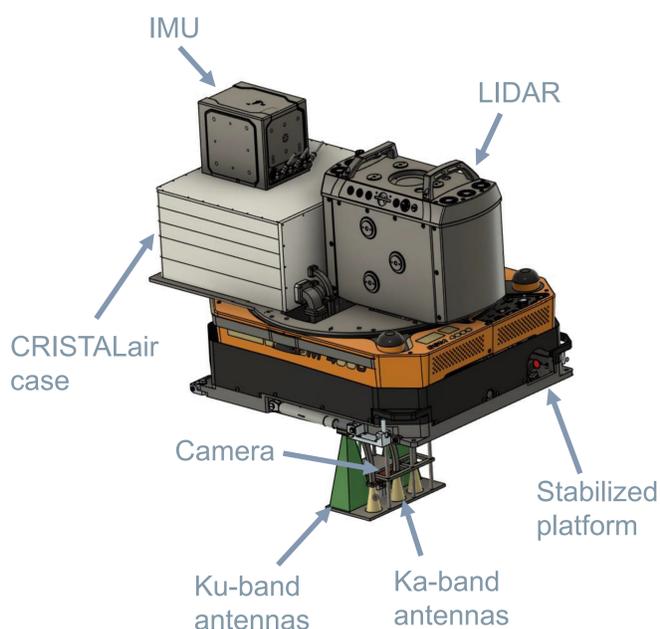
- Colour InfraRed
- Collocated measurements
- Pixel resolution < 1m

PERFORMANCE REQUIREMENTS

- Elevation uncertainty < 10 cm
- Range noise < 0.8 cm
- Altitude accuracy < 5 cm
- s_0 accuracy < 0.7 dB
- PTR shape



PRELIMINARY DESIGN



PROCESSOR REQUIREMENTS

- Open source
- Alignment between CRISTALair and CRISTAL products
- L1B LR, L1B HR, L1B FFSL and FFML
- Quick analysis Tool
- Performance analysis Tool



```

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

fig, ax = plt.subplots()

# Plot the data
ax.plot(x, y)

# Add a title and labels
ax.set_title('CRISTALair Data')
ax.set_xlabel('Range (m)')
ax.set_ylabel('Range (m)')

# Show the plot
plt.show()
    
```

TEST MISSION PLAN: Spring 2025

Functional Flight Campaign:

- 1 week in March 2025 in Iceland and Greenland on Twin Otter
- Validation of performance requirements with all instruments (altimeter, LIDAR, camera)
- Processing of all acquired data to L1B
- Acquisitions over: airport runways, land ice, sea ice, ocean
- Deployment of 2 corner reflectors

