Workshop on Suborbital Platforms and Nanosatellites
Canadian Space Agency

WATER, AEROSOLS AND TEMPERATURE EXPERIMENT ON HIGH ALTITUDE BALLOON

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Discussions - Balloon Platforms

YORK UNIVERSITÉ UNIVERSITY redefine THE POSSIBLE.

Mission Objectives

- Study the region of the **upper troposphere/lower stratosphere** in relation to its role in the coupling of the troposphere/stratosphere/meso-sphere and the effect of key atmospheric parameters as *water*, *temperature* and *aerosol* on the radiative budget of the region as indicators of climate change in the middle atmosphere.

Scientific Objectives

- Accurate, simultaneous and collocated high-resolution measurements of ***H_2O***, ***temperature*** ***and*** ***aerosol*** scattering at 10 - 40 km height and at wavelengths of ***355 nm, 532 nm, 1064 nm and 1500 nm*** for the aerosols and ***1360 nm*** for water.
- Examine the input of H_2O into the stratosphere
- Observe and study thin aerosol layers, polarization properties, spatial and temporal variability.
- Study the dynamics of the UTLS and the troposphere/stratosphere coupling through gravity wave perturbations in the temperature field
- Provide information on the aerosol interference for the retrieval of H_2O and temperature from the SHOW and GPS measurements, respectively.

Science Requirements

- High latitudes (>50°N), summer daylight conditions
- Altitude range 10 - 40 km
- Measurements of
  - Volume scattering rate of sunlight
  - Absorption
  - Radio-occultation
- Vertical resolution – better than 0.5 km
- Horizontal resolution – < 20 km
- H_2O – rms error (by mass) 0.5E3 g/kg or better
- T – rms 0.5 K or better
- Aerosol optical path (integrated over vertical profile range)

  rms < 0.004, bias error < 0.006
- Aerosol extinction coefficient – precision of 1.E-4
- Size distribution - <30% rms precision

SHOW (Spectral Heterodyne Observations of Water)

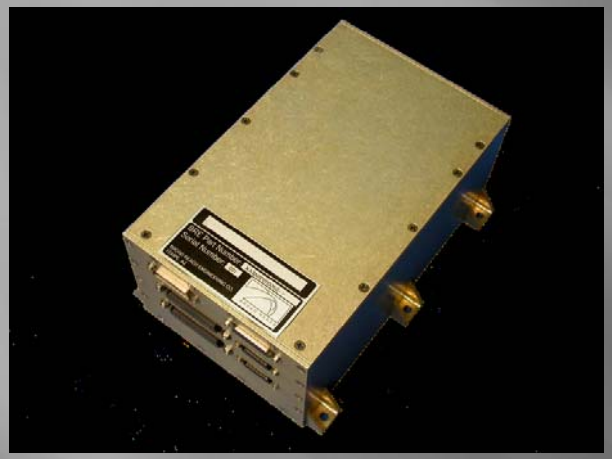
- SHS (Spatial Heterodyne Spectrometer)
- Observations of water vapour absorption in the near IR, at 1.36 μm
- InGaAs detector, wavelength 0.9-1.7 μm
- Focal plane array – 320 x 256 pixels
- No moving parts

SHOW Prototype Model

Design Parameters

Design wavelength:	1364.5 nm
Lines per mm of Gratings:	700
Grating width and height:	50 x 50 mm
Littrow angle:	28.5°@ Order: 1
Prism APEX angles:	12°
Field of View (H.A.):	4° (Half Angle)
Beam-splitter window:	70 x 90 mm
Beam-splitter angle:	-45°
Arm length:	150 mm
Bandwidth (minimum):	1363.5 nm - 1366.2 nm
Spectral Resolution:	0.017 nm

GPS RO – Instrument List



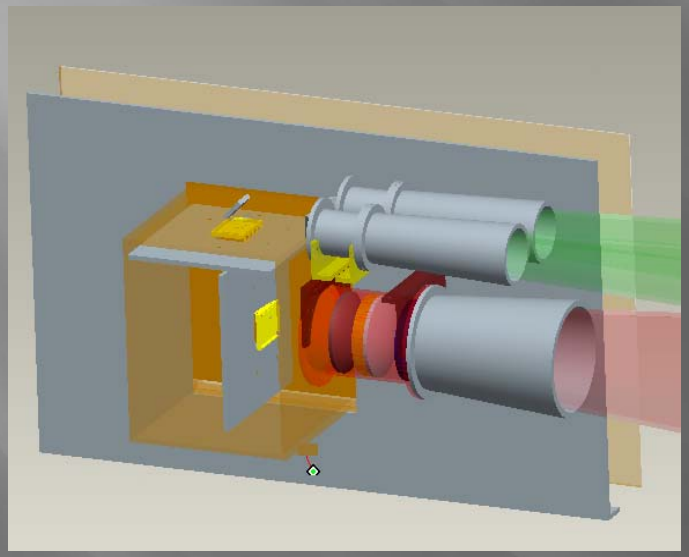
Baseline GPS Occultation Receiver

- Baseline GPS RO package – Pyxis receiver (BroadReach Engineering) < 2.0 kg, 12 to 18W, 12 x 8 x 20 cm
- GPS Reflectometry and Scatterometry
- 2-4 GPS & RO antennas
- Coaxial cabling to interface the antennas & the receiver
- Serial cabling to interface receiver & other platform systems

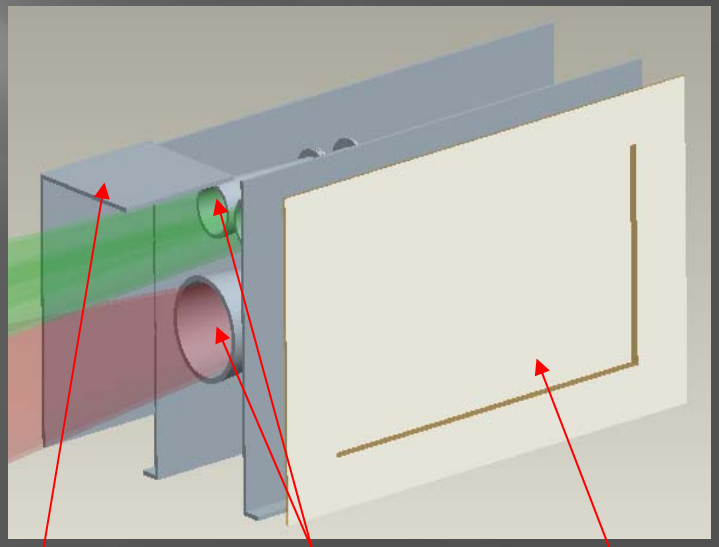
- Analog to digital converter
- GPS code and carrier wave tracking loops & ≥48 tracking channels
- Must be able to withstand the balloon environment at ~ 35 km height
- Weight - ~ 5 kg
- Max power usage – at ~ 35 W

LIMA (Limb Imaging of Aerosols)

- Four-channel imager – solar scattered radiances at 355 nm, 532 nm, 1064 nm, and 1500 nm.
- Preferred look limb direction ≤ 60° of azimuth away from the sun
- Correlative observations with SHOW



Preliminary layout



LIMA Technical Description

- CCD detector (512 x 512 pixels) for 355 nm & 532 nm
- InGaAs detector (320 x 256 pixels) for NIR (1064 nm & 1500 nm)
- Images divided in two
- CCD image vertical binning to match InGaAs : 256 x 512 pixels (width x height) vs 160 x 256 pixels
- High vertical resolution, ~120 m → imaging thin layers and other irregularities within the 30 km height range (10 - 40 km height)
- Channels 355 & 532 nm – exposure time 1 sec, filter width of 10 nm
- Channels 1064 & 1500 nm – horizontally binned into 5x1 pixels, 5 sec exposure time, filter width of 30 nm and 100 nm, respectively.

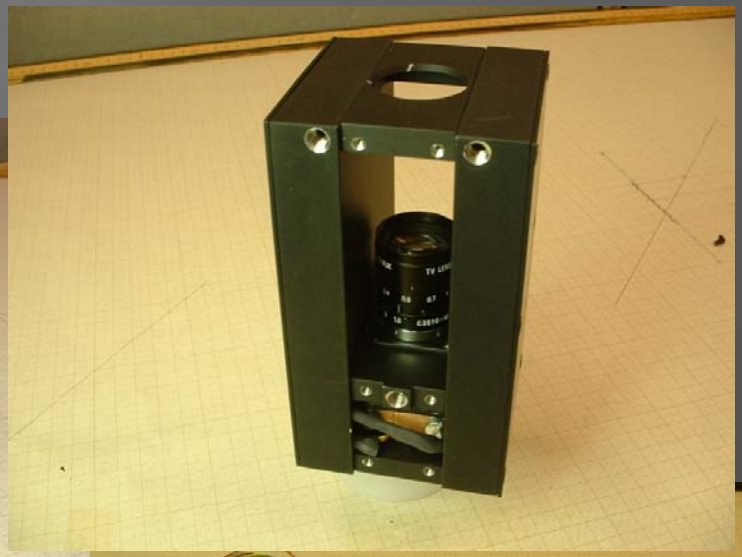
Payload – High-altitude Balloon

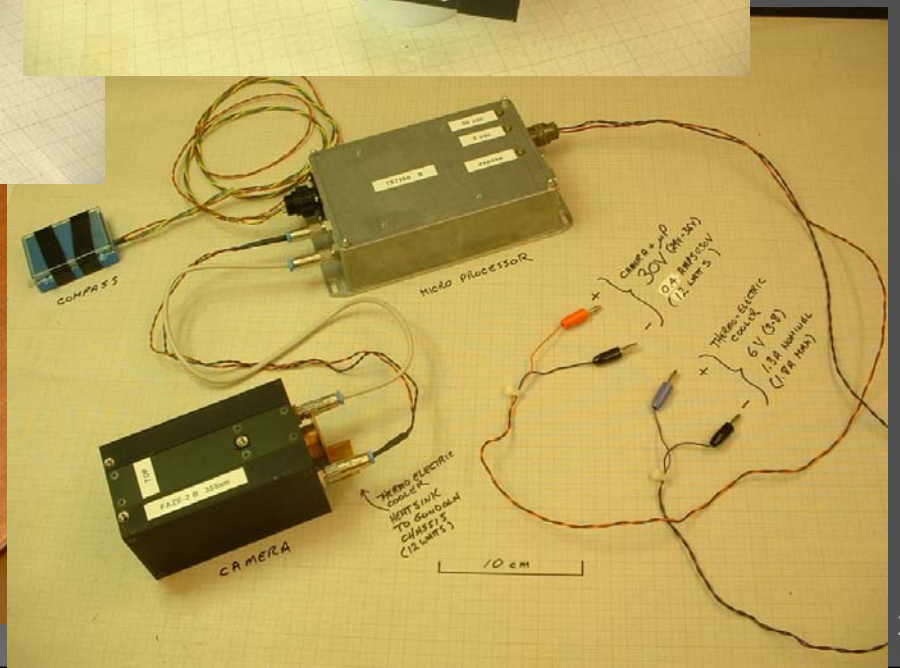
- Standard gondola by CRESS SIL, using existing telemetry and ground link
- Full payload mass, including the gondola – 30 kg → advantages for launch and recovery → multiple flights in a given mission
- Ideal for observations of UTLS region
- State of art instruments but still under development → test what science could be conducted for a spacecraft mission

LIMA Prototype on BIRD Payload

- The BIRD (Balloon borne Investigations of Regional atmospheric Dynamics) experiment (335 kg payload) of Physics Research Laboratory (Ahmadabad) & Boston University - launched on March 8, 2010 at National Balloon Facility, Hyderabad, India
- A nano - payload weighing 6.5 kg – CRESS, York University - measurement of aerosol constituents at sunset.
- Launched on a 109,755 m^3, 25 μm Antrix single shell balloon at 10:52 hrs - the first time in the past 40 years when a balloon was launched around noon.
- The balloon reached a float altitude of 34.8 km. at 12:45 hrs. and was allowed to float till 18:25 hrs.
- After about 5 1/2 hours of float, the flight was terminated by telecommand at 18:25 hrs.
- The recovery was performed 380 km west of Hyderabad.

LIMA Prototype – Single Channel Configuration





National Balloon Facility – Hyderabad – March 8, 2010

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