# Hicibas-II: A Balloon Platform To Probe Turbulence at 40km

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UNIVERSITÉ LAVAL · LRIO · COPL Centre d'optique, photonique et laser · CRAQ Comprendre l'Univers Understanding the Universe

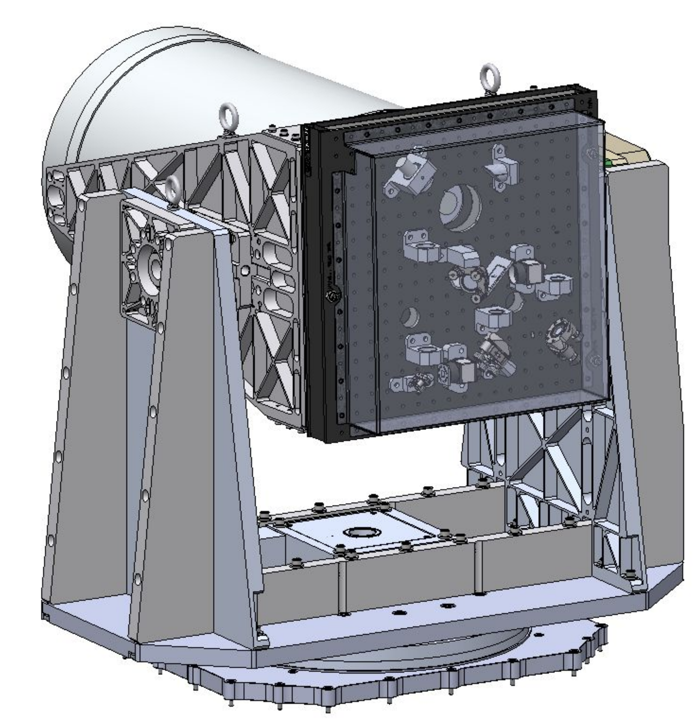

## Abstract

Advances in space-based instruments for planetary observation come at a significant cost. With a previous FAST (CSA) grant, we performed the first HiCIBaS (High-Contrast Imaging Balloon System) mission to study and mitigate two key issues that limit suborbital balloon flight for precision astronomy. Building on gained experience and knowledge, HiCIBaS-II proposes to develop and test instrumentation for experiments aboard sub-orbital balloons at a fraction of the cost of full-fledged orbiting space instruments. Our main technical objectives are to use a wavefront sensor at 36-40 km, to measure and gather data on the high altitude atmospheric dynamic and fly optical systems in a space-like environment. Another key objective is to train HQPs so they are fully ready to integrate the job market in the space industry. We also want to improve the HiCIBaS pointing system to a generic pointing system usable in high-contrast imaging. The proposed project is a great opportunity to position Canada as a world leader for this technology while advancing knowledge in the field on the long term. The impact for Canada is broad, from benefits to industry competitiveness to innovative research in academia, and from new international collaborations to participation in major projects in the future.

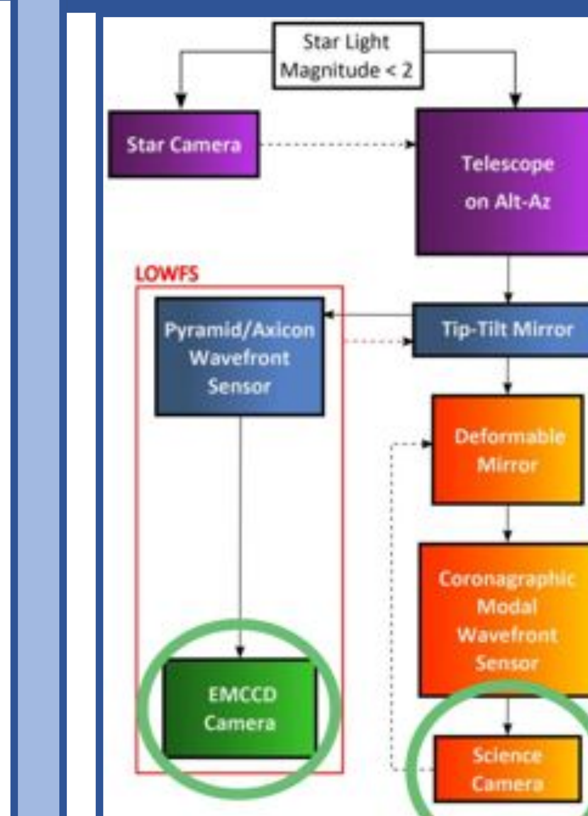

## Improved Mechanical Design

The optical payload is located directly at the rear of the telescope and not on a second floor unlike HiCIBaS-I. This helps to bring the center of mass nearer the telescope's primary mirror.

The mount can also be mechanically balanced once all components are integrated to reduce unwanted forces on the elevation motor.



## Space Situational Awareness




**We will add a SSA experiment using the Nüvu Caméras' EMCCD to the HiCIBaS-II's mission.**

- Reduction of noise by a factor of 10 to 100.
- Cannot be matched in situations requiring fast exposure times or in environments bearing little light.

## Simplified Optical Design

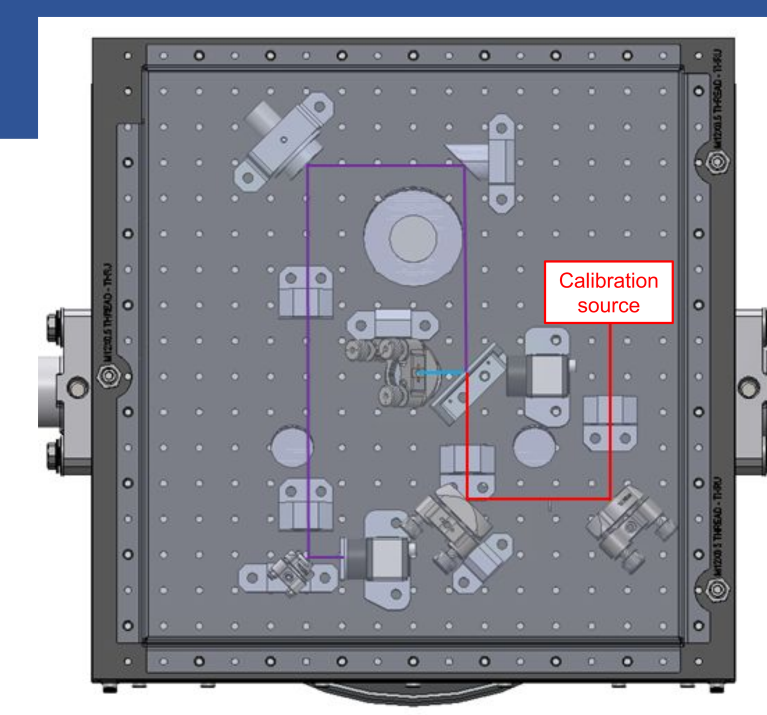
**Coarse guiding camera + Objective F1.3 -** FFOV of 8.65°

**Schmidt-Cassegrain telescope -** Diameter: 14'' (355.5 mm)

**Fine guiding camera -** FFOV of 0.2°

**Fast steering mirror -** Piezo tip/tilt platform

**S-H wavefront sensor**




## Shack-Hartmann Wavefront Sensor

- **Number of lens:** 9 x 9
- **Microlens pitch:** 0.5 mm
- **Sensor pixel size:** 5.86 µm
- **Number of pixels per spot:** Between 2 and 3
- **Resolution:** 0.1 arcsec.
- **Max frequency:** 166 Hz

## Project main goals

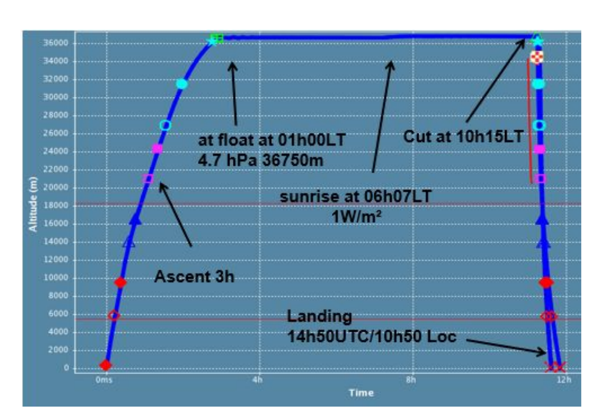
Among the many technical goals of the HiCIBaS project, the main ones are as follow :

→ Test a S-H based fine pointing systemat an altitude of 40 km
→ Measure the atmospheric dynamics at high altitude to gather information for future balloon-borne missions
→ Fly Canadian technologies in a space-like environment

The project also aims at training the next generation of scientists and engineers in the field.

## General Mission Information

**Launch Location**: Timmins
**Launch Date:** Sept. 2023
**Preferred Launch Time:** Late evening
**Temperature:** down to -60°C
**Pressure:** down to 0.5 kPa
**Altitude:** >36 km
**Duration of flight:** > 4h




HiCIBaS-I flight profile

We expect similar atmospheric conditions and flight path as those seen by HiCIBaS-I.

## Project Milestones

**2020**
- **Funding & Recruiting**

**2021**
- **Final design reviews:**
  - Optical design
  - Mechanical design
  - Optomechanics
- **Procurement:**
  - Motors
  - Shack-Hartmann sensor
  - Cameras

**2022**
- **Mechanical and optical assembly**
- **Motor control & Communication in ROS**
- **Integration and functional tests**
- **Performance test outside**

**2023**
- **Complete integration acceptance test**
- **Pre-flight acceptance test at the Mont-Mégantic Observatory**
- **September:** Flight Window

NSERC CRSNG · ABB · nüvü cameras · NTCO · CSA ASC

*Shaping light one ray at a time*