## Vita

Candidate's name: Basile Augustin Barnabe Fayol

Universities Attended:

University Claude Bernard Lyon 1 (2020)
Bachelors of Physics

Strathclyde University (2022)
Bachelors & Masters of Physics

University of New Brunswick (2025)
Masters of Science
Physics

**Conferences Presentations:**

Fayol et al., "Birefringent Doppler Wind Imaging Interferometer (BIDWIN), CSA FAST Project Presentation", DASP meeting 2024.

Fayol et al., "Birefringent Doppler Wind Imaging Interferometer (BIDWIN) Instrument Design, CSA FAST Project Presentation", IAGA/ICMA/SCOSTEP 2024.

# Design of the Birefringent Doppler Wind Imaging Interferometer Instrument for the Measurement of Upper Atmospheric Winds

UNIVERSITY OF NEW BRUNSWICK

THESIS DEFENCE AND EXAMINATION

in Partial Fulfillment

of the Requirement for the Degree of
Master of Science

by

**Basile A. B. Fayol**

in the Department of Physics

U.N.B., Fredericton, N.B.

**Friday, April 11th, 2025**
**11:00 a.m.**

Physics Building, Room 302

Examining Committee

| | |
|---|---|
| Dr. P.T. Jayachandran | co-Supervisor |
| Dr. Jeff Langille | co-Supervisor |
| Dr. Ben Newling | Internal Examiner |
| Dr. Kynan Hughson | External Examiner |
| Dr. Abdelhaq Hamza | Chair of Oral Examination |

## Abstract

This thesis presents the design of a ground-based instrument capable of measuring atmospheric motions in Earth's upper atmosphere using a spectrally isolated airglow emission. The work builds on the previous development of a prototype version of the instrument at UNB. Several improvements to the BIDWIN prototype are made that enhance its performance for field applications. The primary focus is on optimizing the optical design to increase throughput while maintaining precision and stability.

A Jones matrix approach, developed in Python, is used to simulate the signal and interference patterns, aiding in the design process. Zemax Optic Studio plays a key role in selecting and refining the optical system, ensuring that the proper lenses and configurations are chosen. Additionally, thermal sensitivity issues are addressed by exploring the feasibility of thermally compensating the interferometer using birefringent materials with inversely proportional thermal coefficients. Experimental results demonstrate the viability of using αBBO and $YVO_4$ crystals to build a thermally compensated, field-widening interferometer. Several designs using different lenses were explored, as well as the use of a four-quadrant prism to increase the FOV while maintaining high precision.