Final Design and Technologies for the Interferometric BIdimensional Spectrometer IBIS 2.0

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Introduction

The IBIS 2.0 Interferometric BIdimensional Spectrometer 2.0 instrument combines two tunable Fabry-Pérot (FP) interferometers in classical mount, narrowband interference filters, a polarimetric unit, fast cameras, and a proper Instrument Control System to perform high-resolution solar spectro-polarimetric observations. A previous version of the instrument, named IBIS (Cavallini 2006), operated at the Dunn Solar Telescope of the National Solar Observatory from 2003 to 2019. IBIS 2.0 (Ermolli et al. 2020) is planned to enter operation over the spectral range 580-860 nm at the Vacuum Tower Telescope at Teide Observatory in 2023.

We present the final optical layout adopted for IBIS 2.0 along with its polarimetric unit, which is realized with Liquid Crystals Variable Retarders and a Wollaston prism acting as a Polarizing Beam Splitter. We also present the expected performances of the IBIS 2.0 instrument, and the Instrument Control Software based on PLC Beckhoff and ESO VLT Control System.

Final Optical Layout

- 1:1 relay optical system between the adaptive optics KAOS of VTT and IBIS 2.0 (Figure 1).
- Diffraction limited and aberration free optical design (Figures 2 and 3) with Zemax OpticStudio software for high spatial resolution from 0.17 to 0.23 arcsec over the spectral range from 580 to 860 nm.
- Large Field of View of 80 arcsec in both spectroscopic and in spectro-polarimetric observing modes.
- Narrowband prefilters placed in a filter wheel (FW2) between the two FPs to suppress reflections and ghosts.
- Two sCMOS Andor Zyla 4.2+ (CAM1 and CAM2) for correct Nyquist spatial supersampling.
- Broadband channel (BB, 620 nm and FWHM of 10 nm) for application of post-facto image reconstruction techniques.
- Beam Splitters (BS) and TV cameras used to check the proper alignment of the various optical components.
- He-Ne Laser and beam steering (BST) used to verify the parallelism of the FPs' plates.
- Continuous lamp (CL) with relay lenses (RL) used for the spectral calibration of the FPs.

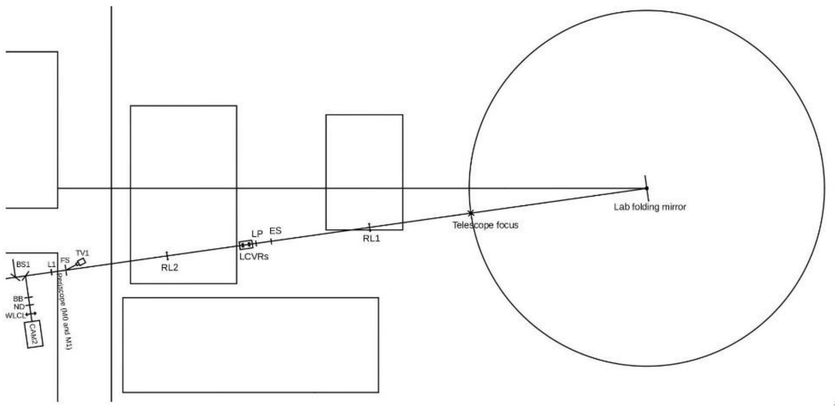

Figure 1: Optical relay system between the telescope focus and IBIS 2.0. The entrance shutter (ES), the calibration linear polarizer (LP) and the polarimetric modulator (LCVRs), are placed between the two relay lenses (RL1 and RL2).

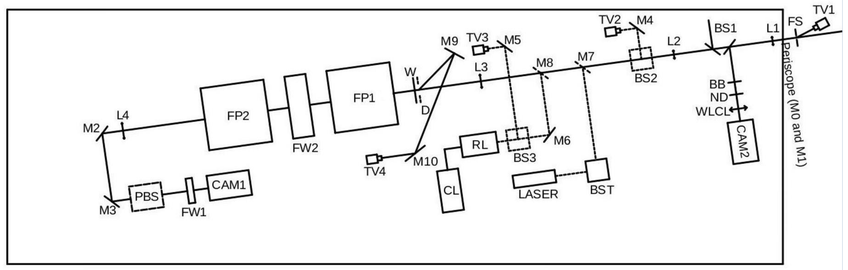

Figure 2: Final Optical Layout of IBIS 2.0 at VTT. The instrument will be placed diagonally on the available optical table (rectangle). See text for acronyms.

Polarimetric Unit

- Polarimetric modulator based on two Liquid Crystal Variable Retarders (LCVRs) modulated in 6 polarimetric states (Viavattene et al. 2022).
- Polarimetric analyzer (Polarizing Beam Splitter, PBS) based on a optimized Wollaston prism (calcite) and a corrective lens system to minimize the optical aberrations.
- Recorded polarimetric states on the scientific detector: I+Q, I+V, I-Q, I-V, I-U and I+U.
- Diffraction limited optical design for the polarimetric unit (Figure 3).
- LCVRs calibration procedure with a calibration linear polarizer (LP).
- Instrument polarimetric calibration using the telescope Instrument Calibration Unit (ICU).
- Telescope polarimetric calibration using a geometrical model optimized with in situ measurements.

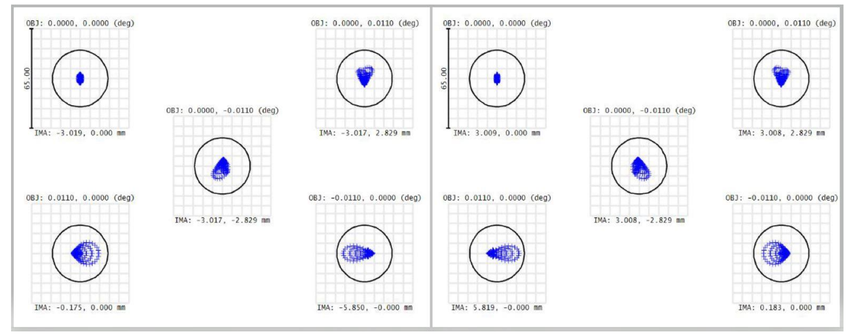

Figure 3: Diffraction limited spot diagrams of the split beams on the scientific detector for double channel spectro-polarimetry.

Instrument Control

- Innovative Instrument Control for a full automation of the calibration and observation procedures.
- Beckhoff PLC (CX2030 CPU series) running with TwinCAT3 software environment.
- Dedicated motors, actuators and stages to control and set the position and inclination of the optical components.
- CS100 controllers for the FPs.
- Control architecture developed with ESO VLT Control Software divided in standard packages (Figure 4): Instrument Control Software (ICS), Detector Control Software (DCS), Observation Software (OS), and Maintenance Software (MS).

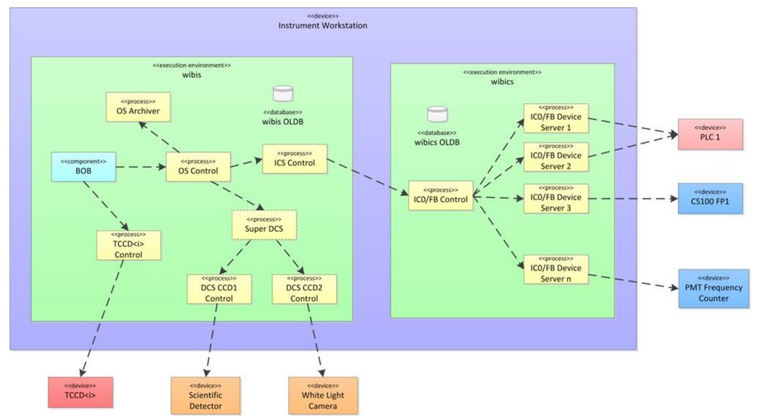

Figure 4: IBIS 2.0 software architecture.

References

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Find updated information about IBIS 2.0 at www.ibis20.inaf.it

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