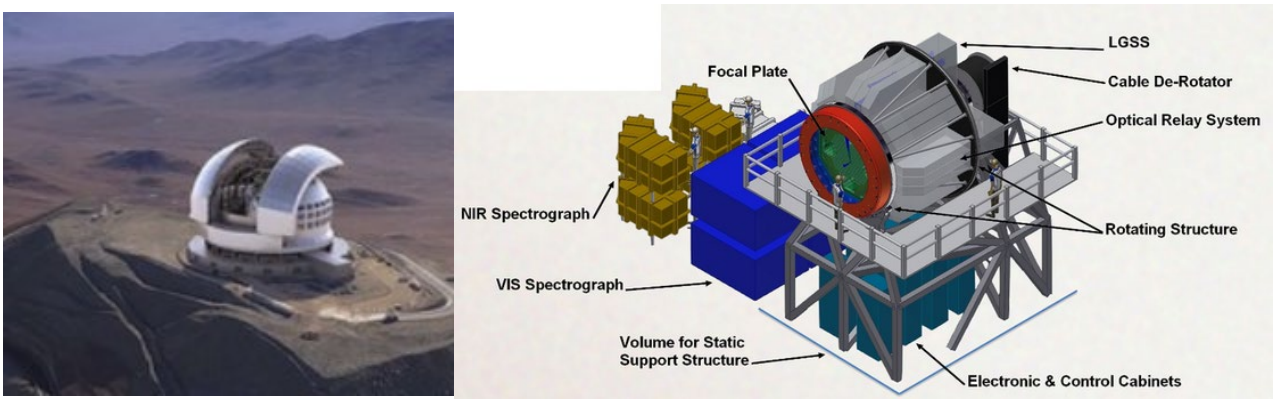
Master thesis project: Alignment, verification and automatization of a test bench for the validation of a complex analogue multi-fiber link for astronomy

Context:

Europe is building a 40m aperture telescope, the E-ELT: European Extremely Large Telescope (https://elt.eso.org/) and a suite of instruments to go with it for the next wave of discoveries. The Observatory of Geneva is a significant contributor to an instrument called MOSAIC. This instrument is a multi-object spectrograph. It can measure the light from many different extra-galactical objects at the same time in the visible and in the infrared (http://www.mosaic-elt.eu/).



ELT and MOSAIC instrument artist view

The Observatory of Geneva is in charge of the Near InfraRed (NIR) *fiber link.* This is a large complex system made of about 1400 30-meter-optical-fibers transporting the light from roughly 200 point-like objects in the focal plane of the telescope to the input slits of two NIR spectrographs. This includes the injection optics in the focal plane of the telescope, a highly reliable vacuum feedthrough to pass the fibers from atmospheric pressure into the vacuum of the spectrographs and a complex structure to form an accurate slit in the input focal plane of the telescope.

(a) (b) (c) (d) (e)

MOSAIC NIR fiber link conceptual parts: (a) Selection of targets on the ELT focal plane; (b) micro-lens array at the ELT focal plane coupled to fibers; (c) light transport in fibers; (d) vacuum feedthrough; (e) fibers coming from cables rearranged to form a slit.

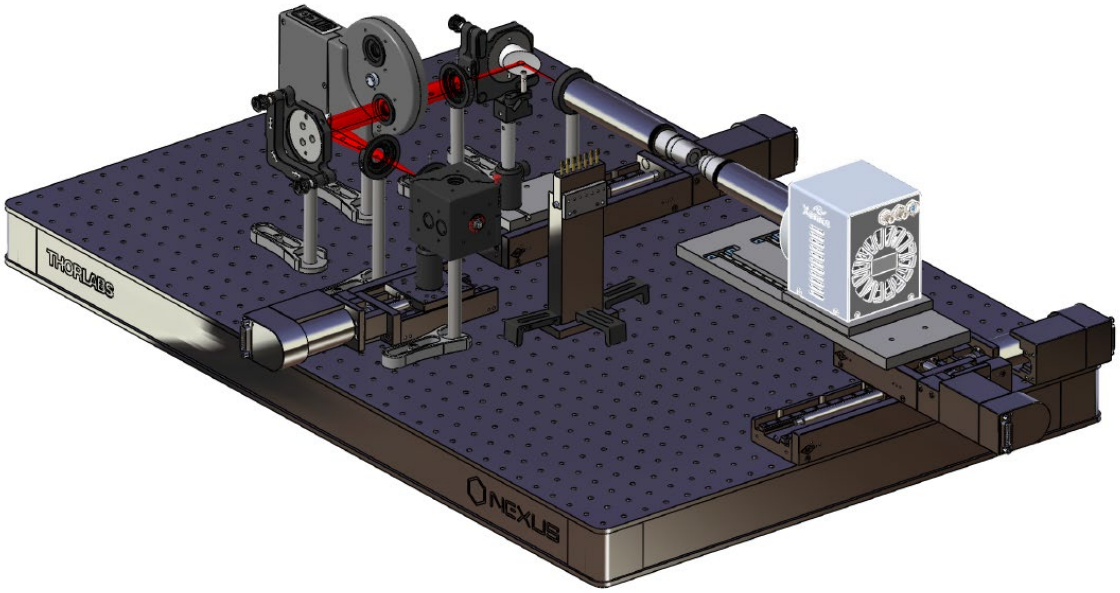
The project:

Last year, an optical bench was designed to characterize the MOSAIC fiber link after manufacturing. The procurement of the optics, opto-mechanics, motorized stages, PLC required to build the bench is almost complete.

The master thesis project will consist in the alignment, verification, and automatization of this bench, which aims at studying and validating the MOSAIC NIR fiber link. Then we will focus on characterizing the fibers themselves. We can divide the work in sub-tasks:

- Optical test bench:
  - Review of the test bench design, evolution of the design if necessary
  - Integration, alignment, and verification.
  - Calibration and error budgeting.
  - Automatization for testing a large number of fiber channels with high repeatability and high efficiency.

- Optical fibers (possibly different types):
  - Characterization of the transmission at various wavelengths
  - Characterization Focal ratio degradation and modal noise
  - Sensitivity analysis and measurement



3D view of the bench to assemble, align, integrate, automatize and validate.

Who we are:

The Observatory of Geneva is the department of Astronomy of the University of Geneva. Its engineering team has participated in several cutting-edge instruments, like the one that discovered the world's first exo-planet (M. Mayor, D. Queloz, Nobel Prize 2019). We have designed and we operate the world's most powerful exo-planet discovery and characterization instruments: HARPS[1] and its successor ESPRESSO[2], and we participate in the design of numerous other ground and space instruments for astronomy. The instrumentation group includes high-level engineers in optics, mechanics (structures, cryogeny, precision assemblies), control systems, and automation.

We offer a very supportive environment and we have already successfully coached several EPFL master theses in optics, opto-mechanics, and control.

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[1] HARPS : http://www.eso.org/sci/facilities/lasilla/instruments/harps.html
[2] ESPRESSO : https://www.eso.org/sci/facilities/paranal/instruments/espresso.html