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Type: Masters

Project Title: Development of 2nd version of Slit Mask Integral Field Unit for Southern African Large telescope

1. Background

The first version of the Slit Mask Integral Field Unit (SMI-200) has recently gone through a successful engineering commissioning run on the Southern African Large Telescope. The SMI-200 is a front end module for the visible arm or Robert Stobie Spectrograph (RSS) on board SALT. The module reformats an 18"x23" sky patch sampled at 0.9" onto the spectrograph slit input using optical fibers. Based on the success of SMI-200, the astrophotonics lab at SAAO is planning to develop SMI-300 with a larger footprint and spatial resolution that would match the NIRWALS instrument on SALT. With the upcoming red arm of RSS, the SMI-300 would aim to enable wavelength panorama from blue optical to NIR wavelengths.

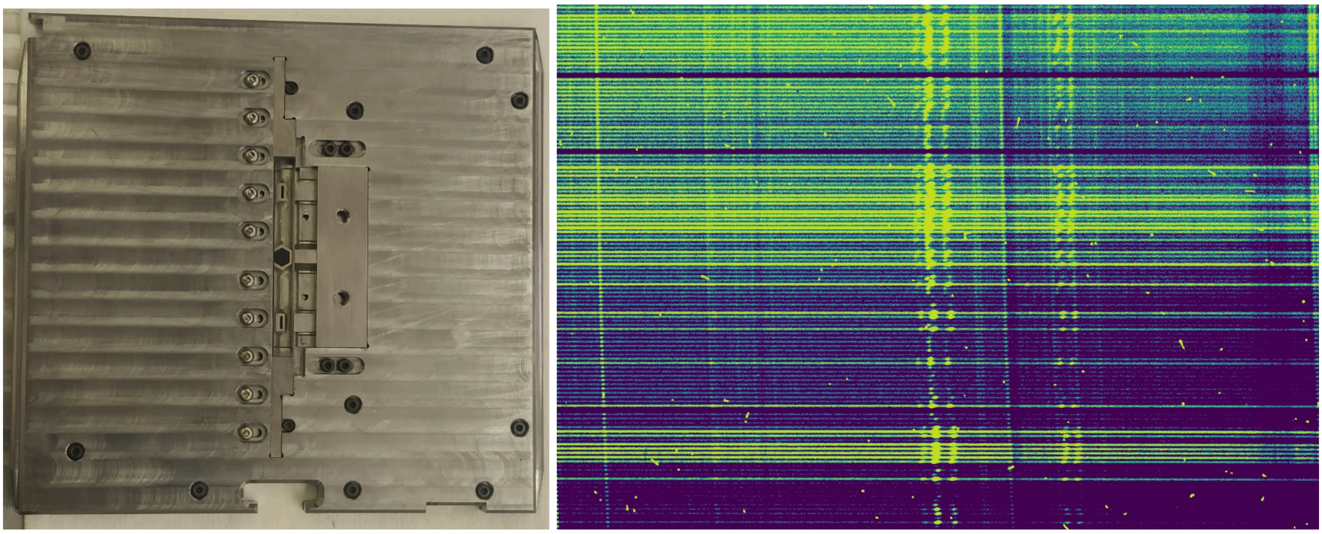

Figure: Left: The fully assembled SMI-200 instrument. Right: Spectra of a star-forming galaxy through several fibers of SMI (each individual horizontal trace is spectra from a fiber). The vertically misaligned zig zag blobs are Hydrogen-alpha (brightest), doubly ionized Nitrogen and Sulphur emission lines.

2. Aims and objectives of the project

The astrophotonics research laboratory at SAAO is one of the few facilities across the globe dedicated towards developing state of the art astronomical fiber based instrumentation. SAAO astrophotonics group is currently involved in developing multiple instruments for telescopes hosted by SAAO/SALT and UCT. The group consists of professor, astronomer, post-doctoral fellows, students and engineer members from SAAO/SALT and University of Wisconsin, Madison.

The SMI-300 will have a total of 246 fibers each with a physical diameter of 300 micron core and 370 with jacket. On one end, the 212 object fibers will be distributed in a rectangular 18"x29" array while on the other end, the fibers would form a 8' 1D long pseudo slit. The remaining 34 fibers would form two sky modules separated from the object bundle by 50". The detailed objectives are following:

a. Develop and perform opto-mechanical assembly of fibers at the telescope end as an integral field unit. This involves fiber cleaving/polishing, fiber packing and glueing.
b. Develop and perform opto-mechanical assembly of fibers at the spectrograph end as a slit assembly. This involves fiber cleaving/polishing, fiber packing and glueing.
c. Design and assembly of fiber routing within Slit Mask cassette. This involves fiber sorting and fabricating minor tools using the existing 3D printer.
d. Characterization of fiber performance after assembly. This involves mapping of fibers and analysis of fiber optical properties via simple python or similar scripting language.
e. Understand focal-ratio-degradation in multi-mode fibers. Using the understanding develop fiber sorting mechanism in order to stress relieve fiber. This involves study of fiber properties and

defining the requirements towards design of such mechanisms.

3. **Potential impacts of the project**

Several astronomical research bodies including ESO, NASA are encouraging large dedicated surveys to use niche capabilities of instrumentation development to bridge the gap in our understanding of the universe. Along this line of exploration, development of SMI-300 would enable multi-wavelength channel observation which is a key capability in the domain of observational astrophysics. Some of the scientific impacts would include:

   a. Strengthening the foothold in development of cost-efficient, scalable and inter-changeable compact front end modules for large telescopes.
   b. Development of multi-wavelength channel IFU spectroscopic capability.
   c. Human capital development for South Africa in the field of Astronomical Instrumentation

4. **Requirements**

The student would require a basic grasp of any software language. Understanding of photonics or optical fiber is not necessary and will be built over the duration of the project. However, a keen interest and willingness to learn and apply the knowledge for solving practical problems would be important.