共同研究報告書

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研究代表者:

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所属・職　Subaru Telescope

研究題目：

１．成果報告

(1)研究の実施日程

研究項目	実施日程											
	4月	5月	6月	7月	8月	9月	10月	11月	12月	1月	2月	3月
Spectrograph design	●	●	●	●	●	●						
Prism Delivery									●			
Lab test							●	●	●	●	●	●
Deployment at Telescope												●

(2)研究成果

The goal of this effort is to deploy a low resolution near-IR spectrograph for photonic lanterns (PL) on the Subaru Telescope. This will enable research of the potential of PL for wavefront sensing and ultra-high resolution imaging for TMT. The FY22 grant funded hardware for the spectrograph: the dispersion prism, a linear stage for remote actuation of the prism, and two reflective mirrors for in-lab testing of the spectrograph.

We **completed the spectrograph design** (prism + optics + mechanics) and **assembled it in the laboratory**. The prism was delivered on Jan 4, 2023, at which point we tested the full spectrograph in the laboratory. After successful testing, **we deployed the spectrograph on the Subaru Telescope in March 2023**. From March 2023 to May 2023 **we have used the spectrograph to demonstrate successful wavefront control with a PL.** The spectrograph is already supporting research experiments and projects, both with the SCExAO internal source and on-sky. These experiments are done in collaboration with partners in the US (UCLA, Caltech) and Australia (Univ. of Sydney, Macquarie Univ.).

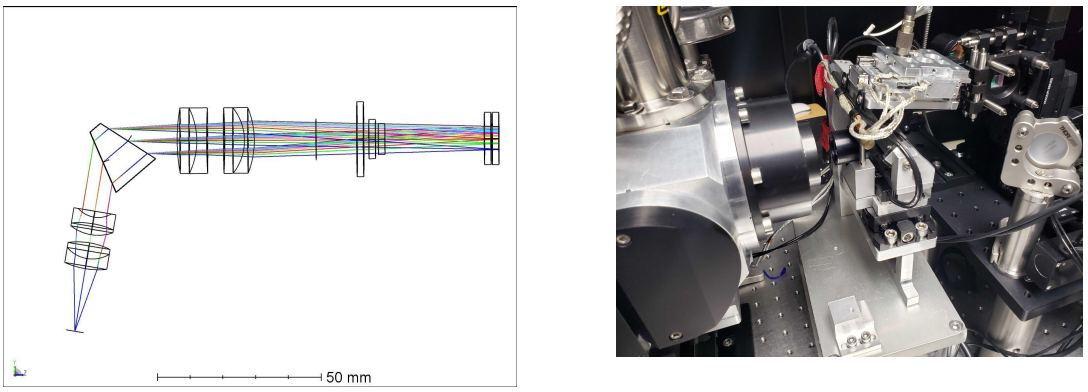

Figure 1: Left: Spectrograph optical design. The source (photonic lantern output) is placed at the spectrograph input at the lower left. Dispersion is achieved with the NIR prism. Right: Picture of the spectrograph deployed at the Subaru Telescope. The camera is shown on the left. The spectrograph is in the center of the image. The PL output fibers are mounted on the top of the spectrograph. The design is very compact.

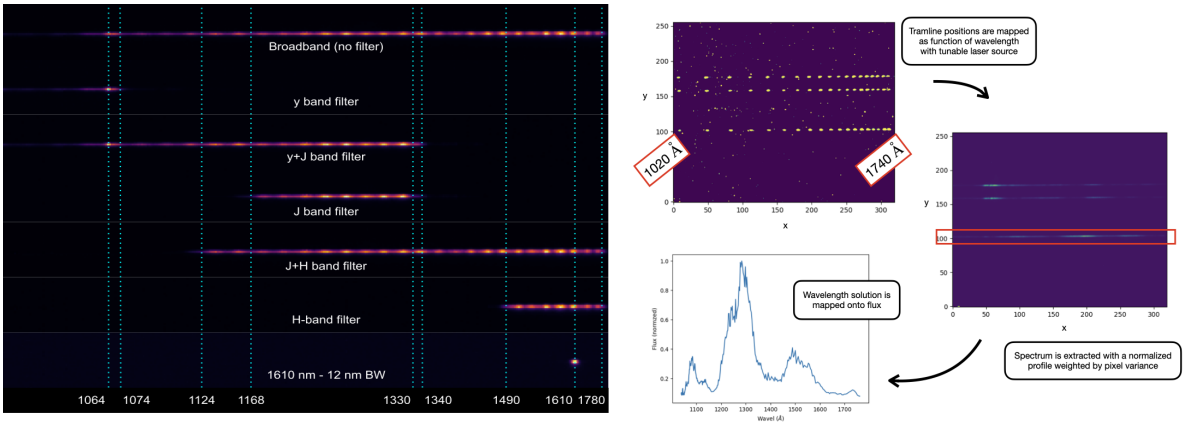

Figure 2: Left: Spectrograph images in the laboratory, using a supercontinuum broadband laser + filters to change the source spectrum. The single mode fiber is moved from top to bottom to acquire multiple spectra. The image shows all spectra are diffraction-limited. With the PL, multiple spectra are acquired simultaneously (one for each PL output). Right: Spectral extraction process.

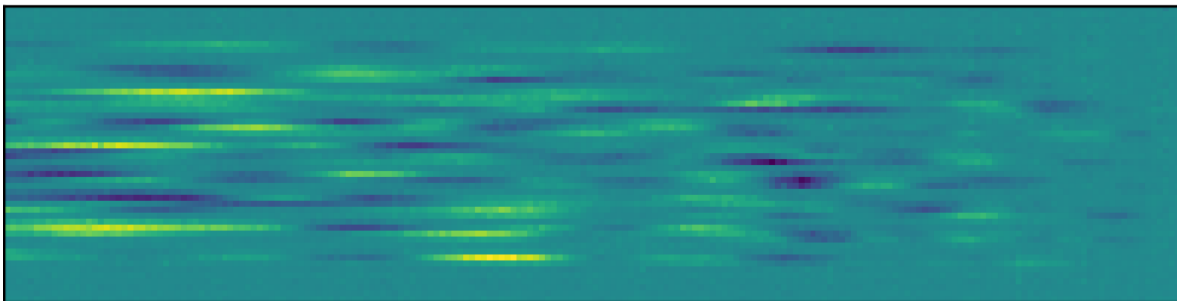

Figure 3: Demonstration of wavefront control with the spectrograph and a 19-port PL. This image has wavelength on the horizontal axis. The 19 output ports of the PL are imaged by the spectrograph, arranged vertically from top to bottom. The figure shows here the difference (derivative) image when a wavefront aberration is added. Using such modal responses, we have demonstrated in the laboratory close loop wavefront control. Credit: Lin et al. 2023 - to be published.