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THE FLORIDA IMAGE SLICER FOR INFRARED ASTROPHYSICS AND COSMOLOGY

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We report on the design, manufacture, and scientific performance of the Florida Image Slicer for Infrared Astrophysics and Cosmology (FISICA), a fully cryogenic all-reflective image slicing integral field unit (IFU) for the FLAMINGOS near-infrared spectrograph (Elston et al. 2003). We find that FISICA is capable of delivering excellent scientific results. It now operates as a turnkey instrument at the KPNO 4-m telescope via collaboration with the instrument team, who can assist with the proposal preparation and observations, as well as provide the data reduction tools for integral field spectroscopy.

FISICA with FLAMINGOS was designed to slice a $16{\times}33$ arcsec^2 field of view (FOV) from a $\sim f/15$ beam into 22 parallel elements; however, slight vignetting for some field positions limits the effective FOV to $15{\times}32$ arcsec^2. This large rectangular FOV allows for traditional infrared A-B nodding, for sources up to ∼15 arcsec in size, and makes FISICA very competive when compared to other IFUs. For example, for sources as large as, or larger than, the FOV of the GNIRS-IFU on Gemini ($3.15{\times}4.8$ arcsec^2; Allington-Smith et al. 2004), FISICA on the KPNO 4-m telescope is about as sensitive, on an equal time basis.

The image quality (IQ) does vary across the field, due to varying amounts of distortion across the field. However, with an effective spatial sampling of 0.70 arcec, FISICA's IQ is limited by seeing, even under the best conditions at the KPNO 4-m. The 0.70 arcsec spatial sampling delivers 960 spatial resolution elements. Combined with the FLAMINGOS spectrograph, $R \sim 1300$ spectroscopy over the 1-2.4 micron wavelength range is possible, in either the $J{+}H$ combined bandpass or the $H + K$ bandpass.

FISICA's design follows a bolt-and-go appproach using diamond-turned monolithic aluminum mirror arrays. All of the mirrors have spherical surfaces; aspheric surfaces are possible, but this was first attempt of such a monolithic slicer mirror array. Our approach was successful due to careful iteration between the optical and mechanical designers (e.g., including the tool path for the diamond turning fabrication was required). In FISICA's optical design, the f/15 beam is re-imaged onto the slicer array by a 3-mirror relay. After the slicer, the beam is sent in turn to a pupil mirror array and to a field mirror array. Fold mirrors then project the resultant f/8 beam as a $1{\times}22$ array of slitlets to the FLAMINGOS spectrograph, which accepts this virtual slit array the same as if a normal long slit were present. The slicer mirror array has 22 parallel mirrors machined into an aluminum block $8.8{\times}19$ mm^2 in size, and each mirror is indepently tilted and powered. The pupil mirrors are arranged in a $2{\times}11$ monolithic array, where each mirror is ∼9 mm in diameter and powered and tilted; the field mirrors are also ∼9 mm in diameter and powered and tilted, but they are arranged in a $1{\times}22$ pattern.

The utility of FISICA's wide FOV was demonstrated to us during an early engineering run where we observed the 3 Super Star Clusters (SSCs) in the dwarf starburst galaxy NGC 1569. Two lines, He I 1.083 μmm and Pa β 1.282 μmm were identified in the spectrum from each image slice. The He I reconstructed line image reveals that the population of young, massive, and windy stars is near the SSCs, but mostly lies outside of them! Non-IFU spectroscopy observations of the SSCs would likely have missed this important result.

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