Diffraction Limited Near Infrared Spectropolarimeter (DL-NIRSP):

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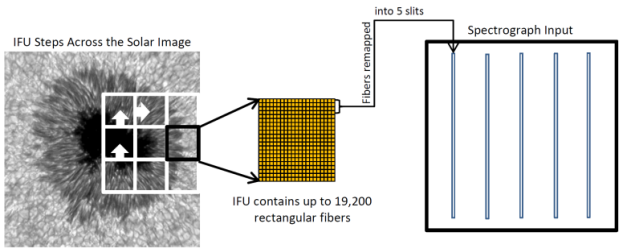

One tile at a time, DL-NIRSP builds spectropolarimetric full data cubes: [X ; Y ; λ ; S [=I,Q,U,V] ; t]

The DL-NIRSP is a flexible, three-channel, diffraction-grating based integral field spectrograph. It prioritizes simultaneity of spatial and spectral coverage while achieving high spatial resolution, spectral resolution, and polarimetric accuracy. On-disk, off-limb, and limb-occulted observations are all available, providing diagnostics for photospheric, chromospheric, and coronal plasmas.

Spatial Field of View and Resolution:

Optical: 2 arcmin square (the full single-pointing, post-AO DKIST field of view)

Physical: Depends upon choice of instrument feed-optics and IFU. Larger maps made by stepping physical FOV.
High res mode: 2.4“ x 1.8“
Mid res mode: 6.2“ x 4.6“
Wide-field mode: 18.6“ x 27.8"

Resolution: High res mode: 0.06 arcsec (0.03 arcsec sampling) – diffraction limited above 900 nm
Mid res mode: 0.15 arcsec (0.077 arcsec sampling)
Wide-field mode: 0.93 arcsec (0.464 arcsec sampling)

Spectral Range and Resolution:

Range: 500 – 1800 nm
Three simultaneous bands covered: 500 – 900 nm, 900 nm – 1350 nm, 1350 – 1800 nm
One spectral channel/line is observed in each of the three spectral bands.

Channel Bandwidth:
Bandpass filters isolate narrow spectral regions for each spectral channel/line.
+/- 125 km/sec Doppler coverage in each channel (0.72 nm wide @ 900 nm)

Currently available channel wavelengths:
Fe XIV 530.3 nm, He I D3 587.6 nm, Fe I 630.2 nm, Fe XI 789.2 nm, Ca II 854.2 nm,
Fe XIII 1074.7 nm, Fe XIII 1079.8 nm, He I 1083.0 nm, Si X 1430.0 nm, Fe I 1565.0 nm

Resolution: High spectral resolution mode: R ~ 125000 @ 900 nm

Temporal Cadence:

Must be calculated using the DL-NIRSP instrument performance calculator. Single field temporal cadence is limited by camera frame time (~33 msec), and is determined by the number of polarization modulation steps and the depth of integration (i.e. target SNR). Stepping the IFU field introduces approximately 250 msec of time between field positions in a map. Minimize the field size to achieve highest cadence. See example modes below.

Polarimetric Capabilities and Accuracy:

Full Stokes vector polarimetry (dual beam), or Stokes-I only

5×10^{-4} P/I_{cont} polarimetric accuracy (using facility-provided calibration methods)

Photometric Capabilities (Precision):

1% photometric precision or better for on-disk intensity observations.

Photon-limited precision for Q/I, U/I, and V/I observations

Instrument Modes Available:

Three different spatial resolution modes (see above).

Full Stokes polarimetry and spectroscopic-only modes supported

Field stepping for larger field of views (lowers cadence)

On-disk, off-limb, and limb-occulted observations

Example Modes of Operation:

It is important to note that the DL-NIRSP instrument is designed for operational flexibility to meet a range of research needs, both those currently known and well understood and many unknown or only poorly understood. The instrument thus aims to serve a wide range of exploratory science, and the use cases below are only examples. Further, it is highly likely that some parameters will change once the instrument is properly tested on the sky.

Example #1:	**High resolution, small field-of-view, photospheric and chromospheric dynamics**		
SPATIAL COVERAGE AND RESOLUTION			
Resolution Mode	High		
Spatial Sampling	0.03″ per pixel		
Spatial resolution limit	0.06″		
Target location	On-disk ; Disk-center intensities assumed		
Num. of IFU x/y positions	2 / 3		
Total Field of View	4.8" x 5.4"		
SPECTRAL INFO:	Band #1	Band #2	Band #3
Wavelength:	Ca II 854.2 nm	He I 1083.0 nm	Fe I 1565 nm
Diffraction limit [arcsec]	0.054″	0.068″	0.098″
Velocity coverage:	+/- 125 km/sec	+/- 125 km/sec	+/- 125 km/sec
Spectral dispersion	0.00243 nm/pixel	0.00427 nm / pixel	0.00629 nm/pixel
Spectral resolution (R)	125000	125000	125000
Stokes I Continuum SNR	1182	2216	2065
TIMING SUMMARY			
Duration of single scan tile	1.05 seconds		
Full field of view map	6.30 seconds		
Time for 100 maps	10.5 minutes		
DATA RATES			
Average raw data rate	365 MB/sec		
Total raw data (100 maps)	230 GB (does not include calibration data)		

Example #2:	**Mid resolution, medium field-of-view, photospheric and chromospheric dynamics**		
SPATIAL COVERAGE AND RESOLUTION			
Resolution Mode	Mid		
Spatial Sampling	0.077″ per pixel		
Spatial resolution limit	0.154″		
Target location	On-disk ; Disk-center intensities assumed		
Num. of IFU x/y positions	5 / 6		
Total Field of View	30.8″ x 27.7″		
SPECTRAL INFO:	Band #1	Band #2	Band #3
Wavelength:	Ca II 854.2 nm	He I 1083.0 nm	Fe I 1565 nm
Diffraction limit [arcsec]	0.054″	0.068″	0.098″
Velocity coverage:	+/- 125 km/sec	+/- 125 km/sec	+/- 125 km/sec

Spectral dispersion	0.00243 nm/pixel	0.00427 nm / pixel	0.00629 nm/pixel
Spectral resolution (R)	125000	125000	125000
Stokes I Continuum SNR	3508	6550	6087
TIMING SUMMARY			
Duration of single scan tile	7.45 seconds		
Full field of view map	3.73 minutes		
Time for 40 maps	2.48 hours		
DATA RATES			
Average raw data rate	51.54 MB/sec		
Total raw data (40 maps)	460 GB (does not include calibration data)		

Example #3:	**Wide field, low resolution, off-limb coronal dynamics and magnetometry**		
SPATIAL COVERAGE AND RESOLUTION			
Resolution Mode	Wide		
Spatial Sampling	0.464″ per pixel		
Spatial resolution limit	0.928″		
Target location	On-limb ; Line and background brightnesses are estimated to be: 100.e-6 and 25e-6 of disk center		
Num. of IFU x/y positions	1 / 1		
Total Field of View	18.6" x 27.8″		
SPECTRAL INFO:	Band #1	Band #2	Band #3
Wavelength:	Fe XI 789.0 nm	Fe XIII 1074.7 nm	Si X 1430 nm
Velocity coverage:	+/- 125 km/sec	+/- 125 km/sec	+/- 125 km/sec
Spectral dispersion	0.00232 nm/pixel	0.00447 nm / pixel	0.00545 nm/pixel
Spectral resolution (R)	125000	125000	125000
Polarimetric SNR	441	642	587
Polarimetric Noise (norm.) after coadding all 120 time steps of sequence	0.00021	0.00014	0.00016
TIMING SUMMARY			
Duration of single scan tile	8.00 seconds (1 co-add)		
Full field of view map	8.00 seconds		
Time for 120 maps	16.00 minutes		
DATA RATES			
Average raw data rate	48 MB/sec		
Total raw data (120 maps)	46 GB (does not include calibration data)		