The Solar Line Emission Dopplerometer (**SLED**) and the dynamics of coronal structures

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Session 2, The Solar Atmosphere: Heating, Dynamics and Coupling

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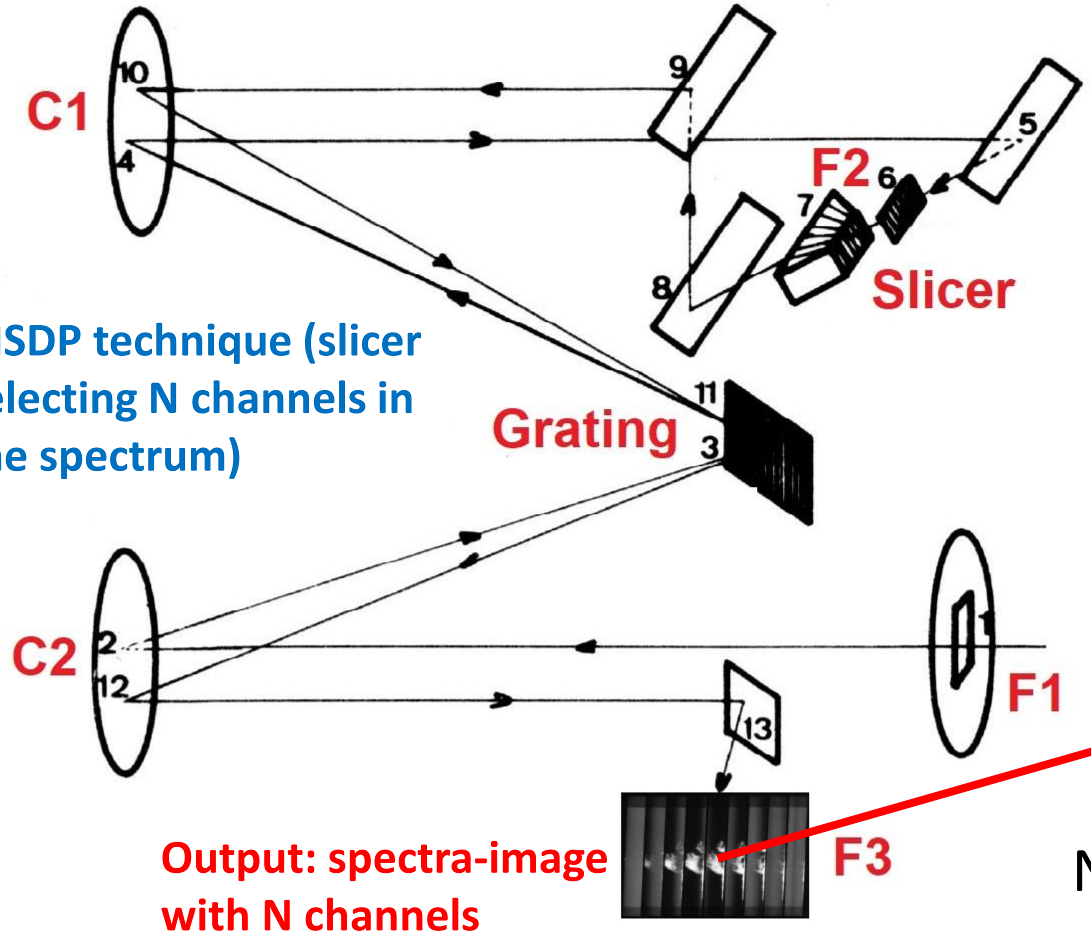
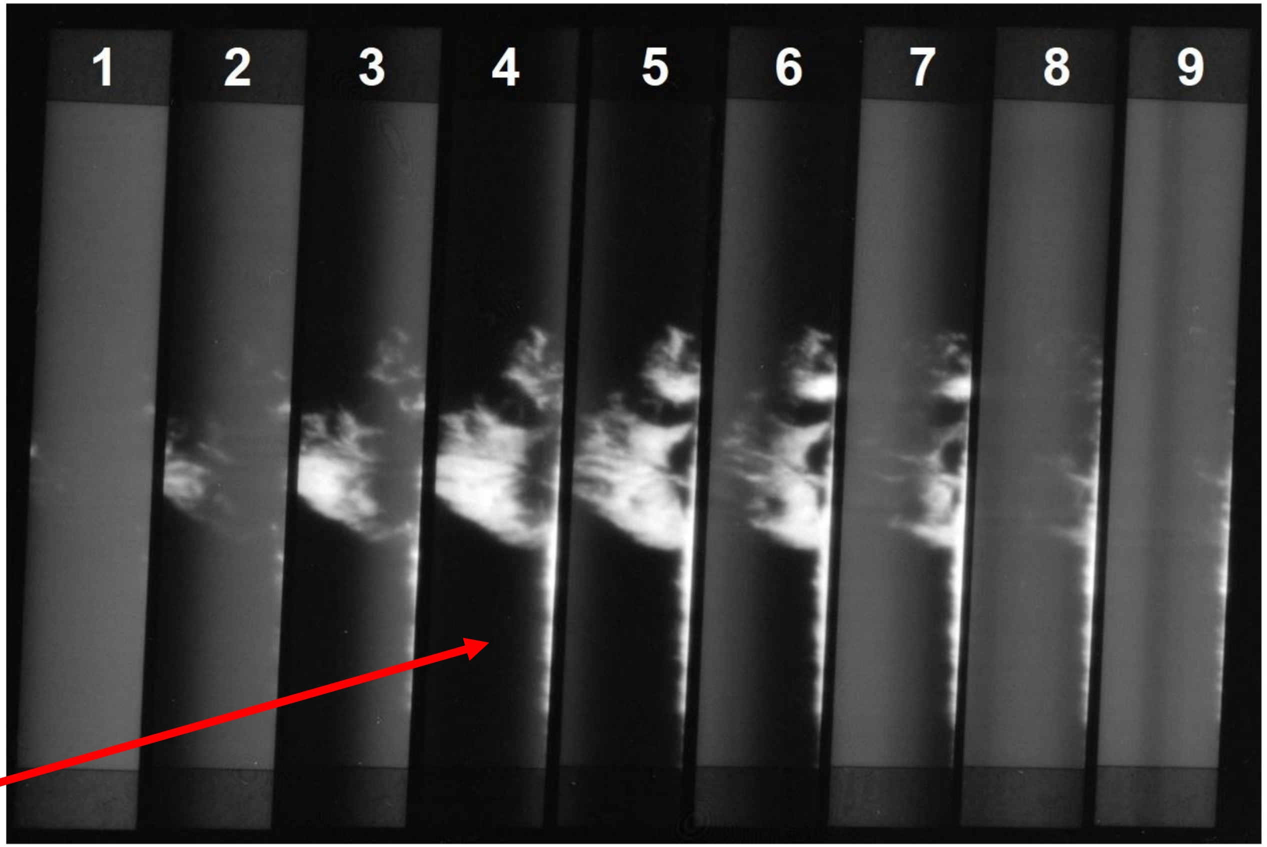
SLED is an imaging spectrometer optimized for the detection of high-frequency waves (> 1 Hz) possibly involved in the coronal heating, and analysis of the dynamics of fast events (flares, CMEs). It is based on the Multi-channel Subtractive Double Pass (**MSDP**) technique, which combines the advantages of filters and slit spectrographs.



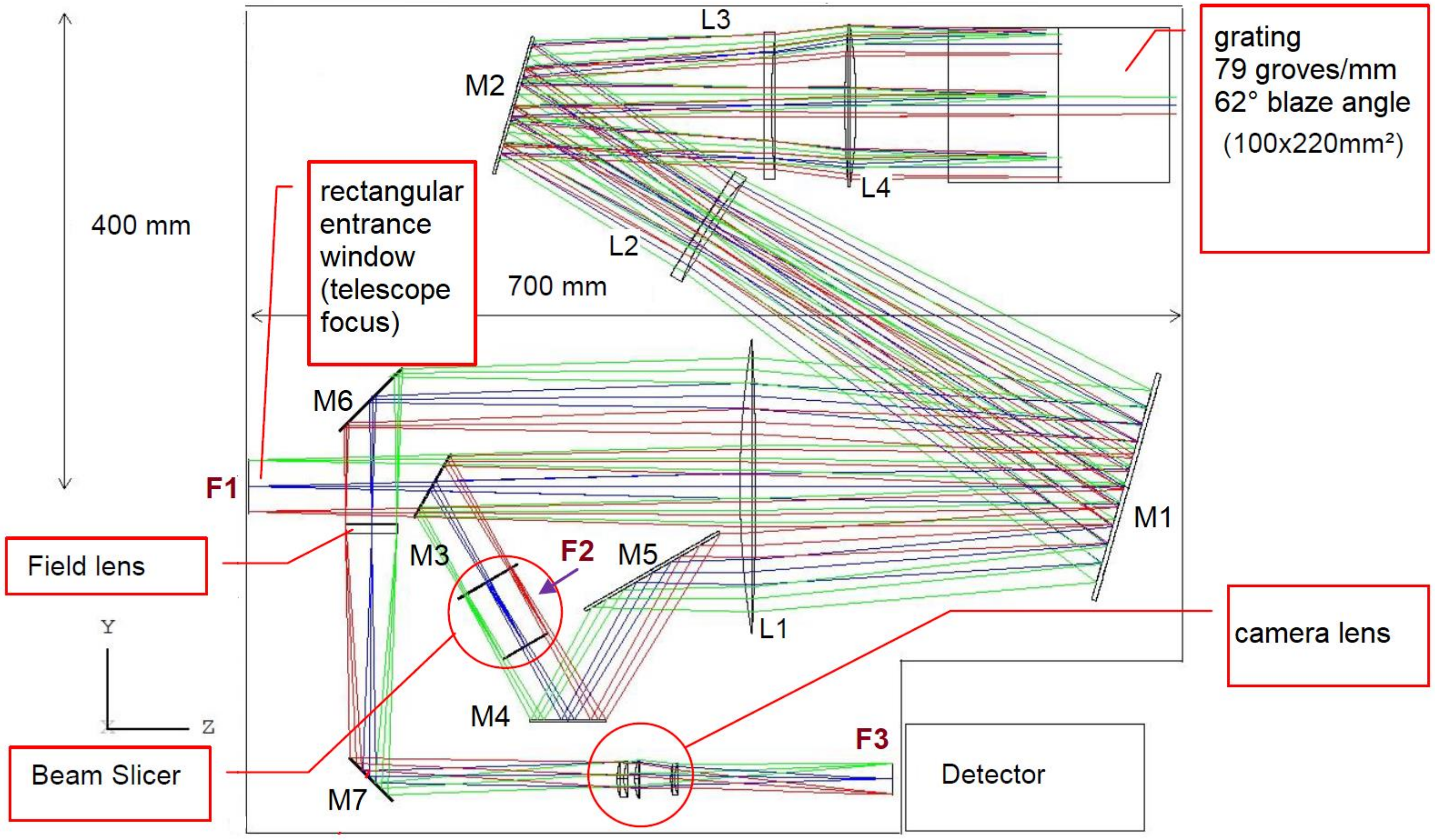
MSDP technique (slicer selecting N channels in the spectrum)

Output: spectra-image with N channels



N <u>simultaneous</u> 2D channels (here N = 9, SLED N = 24)

SLED will record the forbidden lines of FeX (6374 A) and FeXIV (5303 A), range 1 – 2 MK. It will measure Doppler shifts up to 75-150 km/s at high precision (50-200 m/s depending on the photon flux) simultaneously for all pixels of the 2D FOV (150” x 1000”).

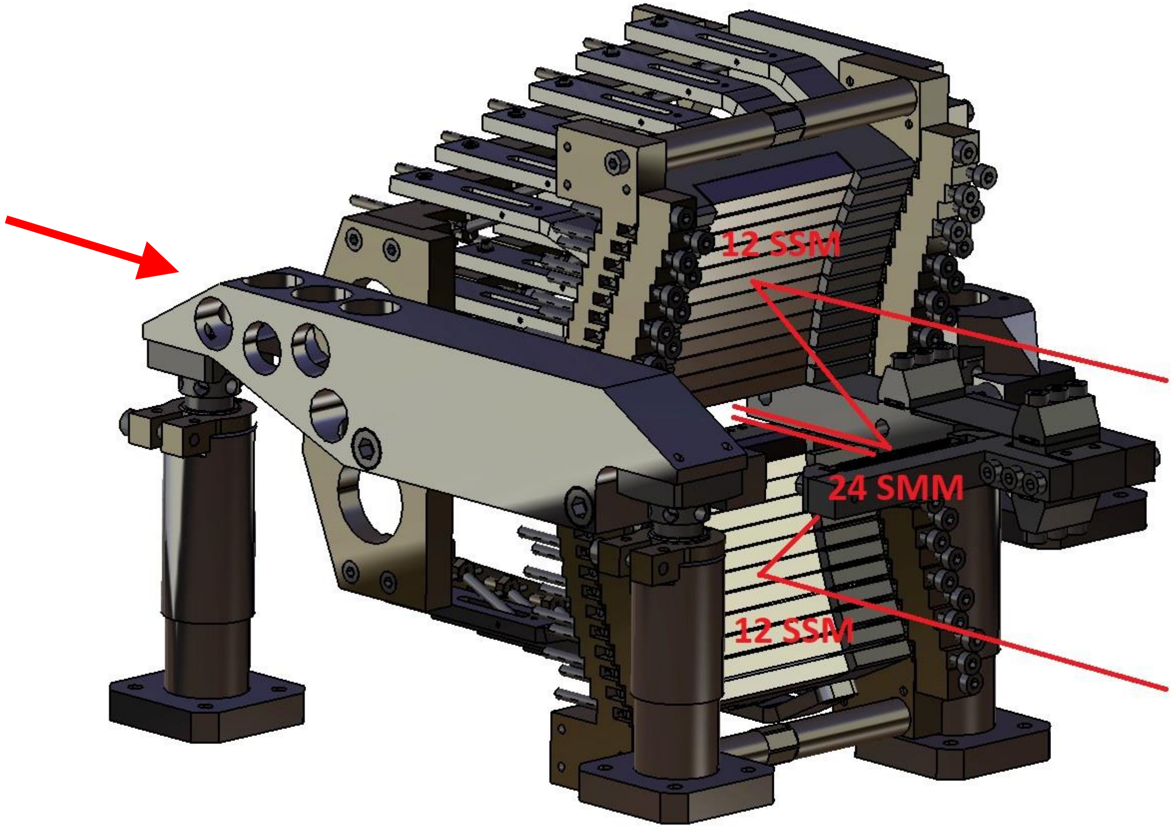


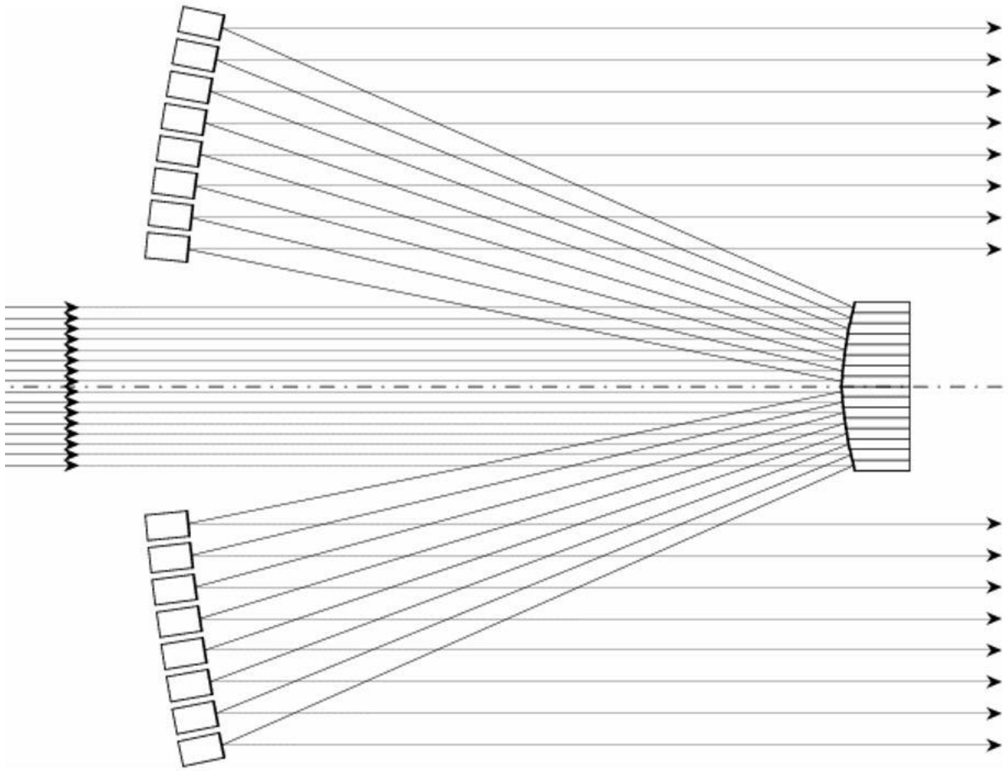
SLED design (top view)

L1, L2, L3, L4 = collimator (2 m focal length)
M1, M1 = folding mirrors

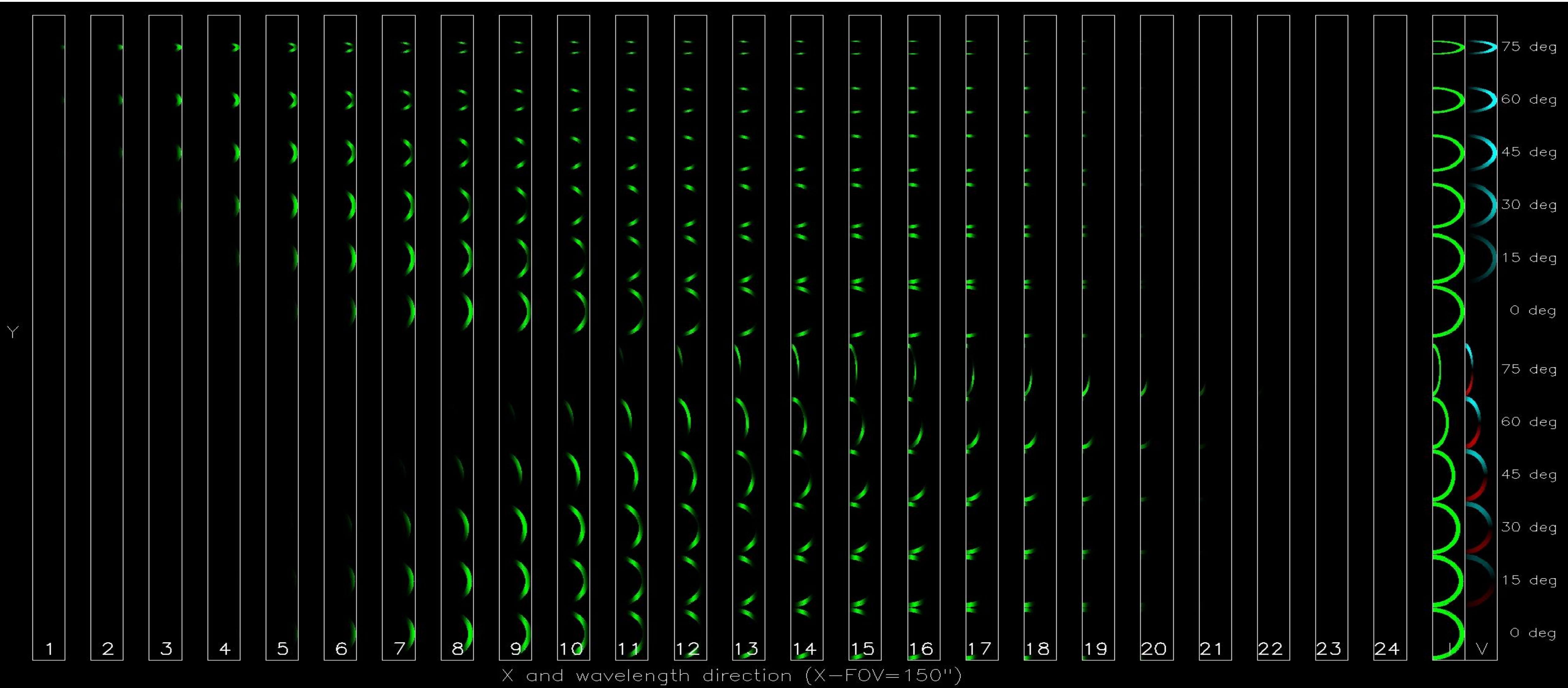
F1 = 2D entrance window
F2 = spectrum and slicer
F3 = sCMOS detector

The beam slicer of the SLED (located in the spectrum): 24 beam splitting micro mirrors + 24 beam shifting mirrors form 24 spectra-images of the 2D entrance window

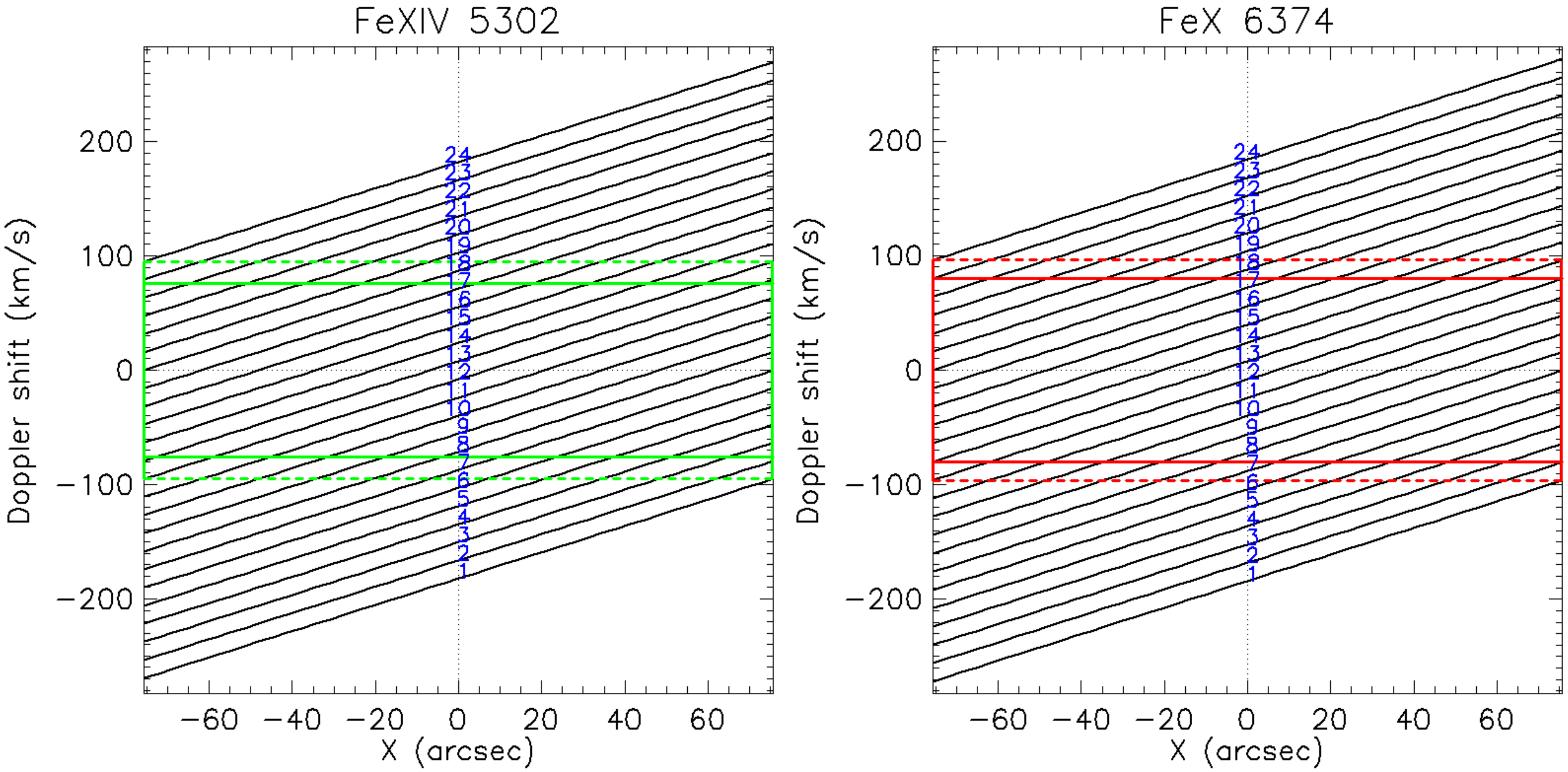




Numerical simulation of a spectra-image recorded by SLED for a siphon flow in a semi circular loop at the limb, under various viewing angles (intensities and dopplershifts at right, profiles assumed gaussian, N = 24 channels)



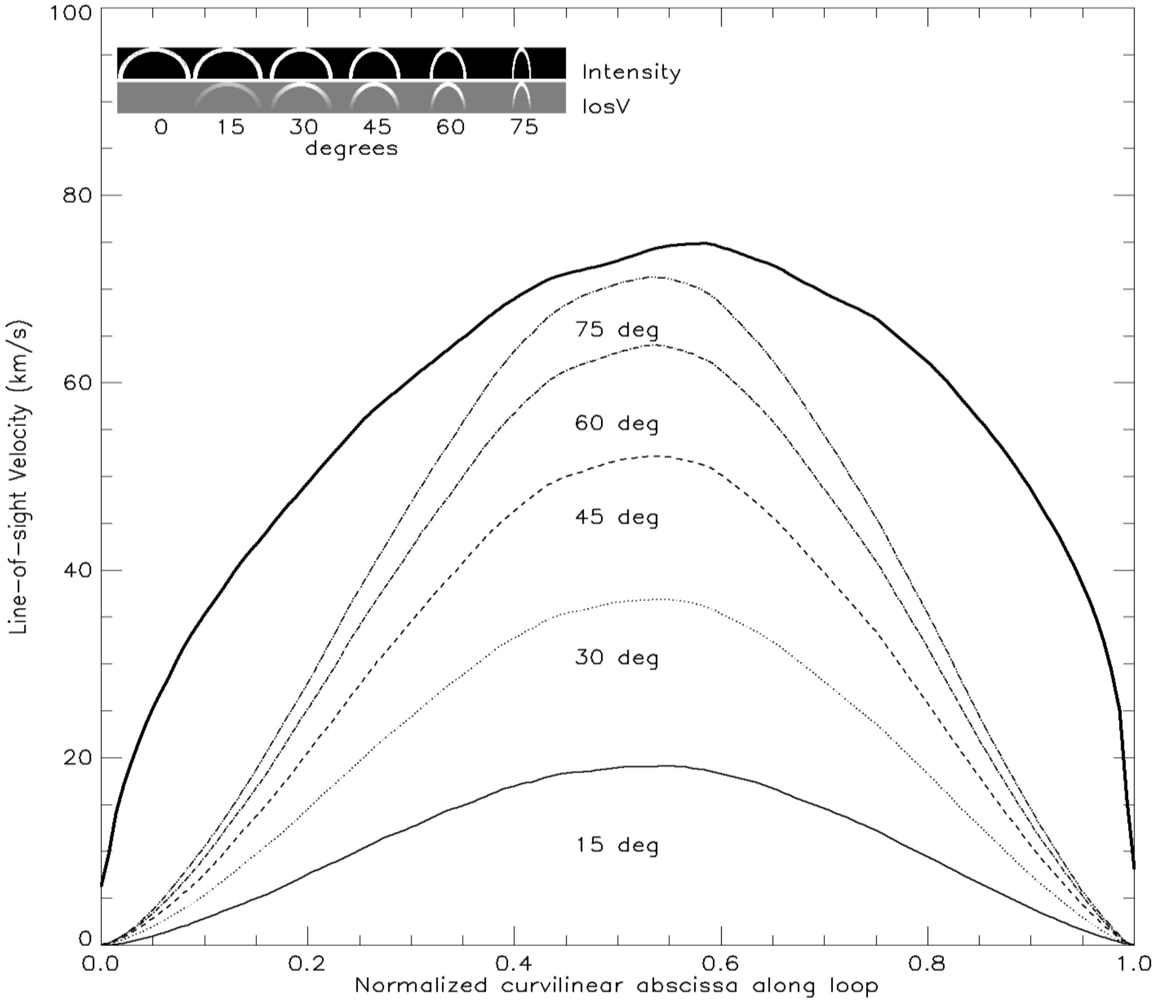
SLED wavelength functions for FeXIV and FeX spectral lines. The 24 channels are not monochromatic, while wavelength varies linearly from the left to the right sides of the 2D FOV (in x-direction). The spectral resolution is 0.28 A. Velocities of ±75 km/s can be measured <u>everywhere</u> in the FOV (green and red boxes) and up to ±150 km/s in the central part of the FOV.

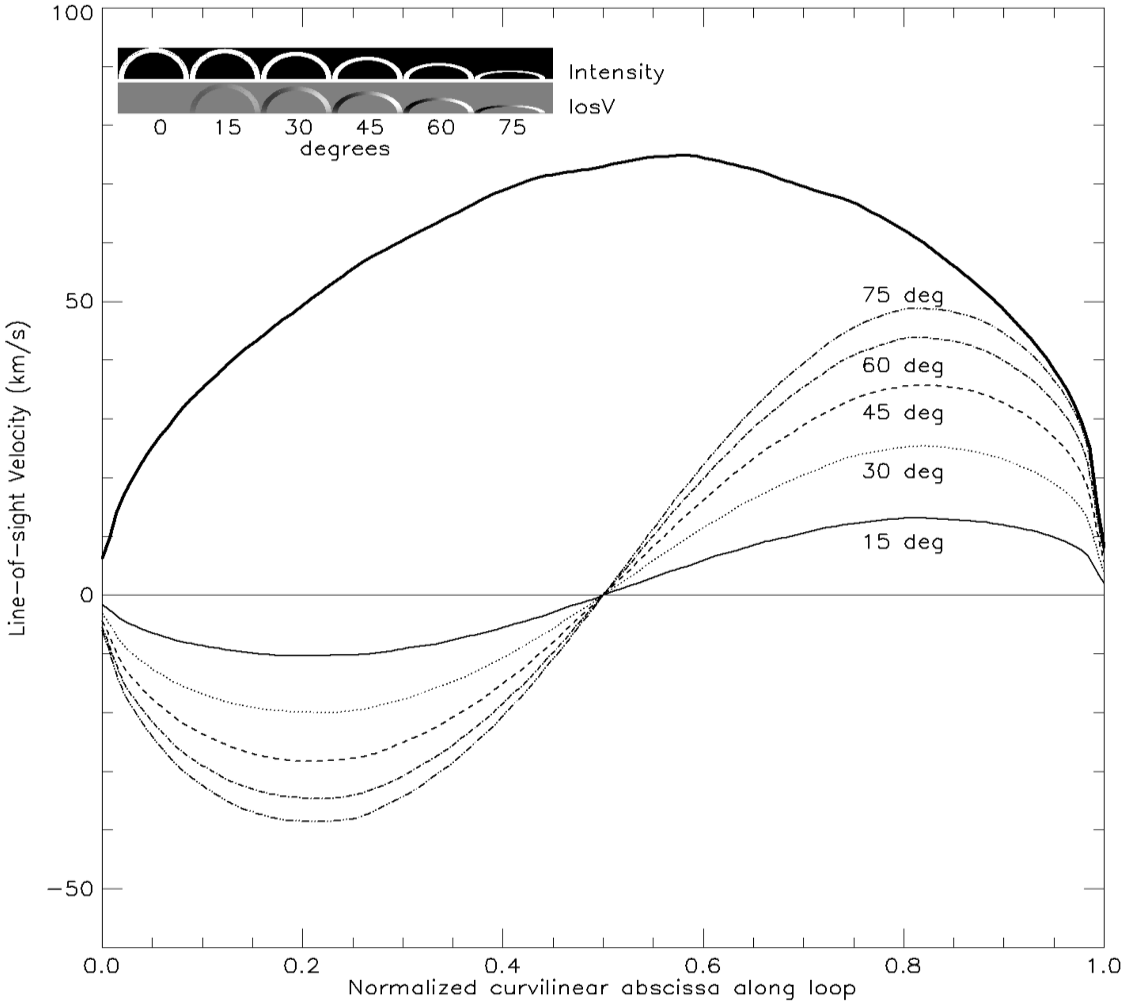


Numerical simulation of the radial velocity restoration by SLED observations of the subsonic siphon flow model of Orlando & Peres (1998).

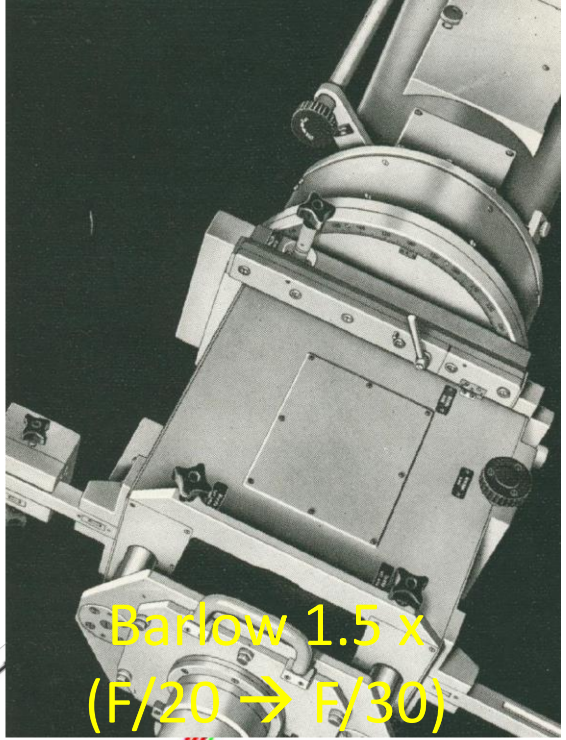
Thick line = velocity along the loop as a function of the curvilinear abscissa s (**model**)

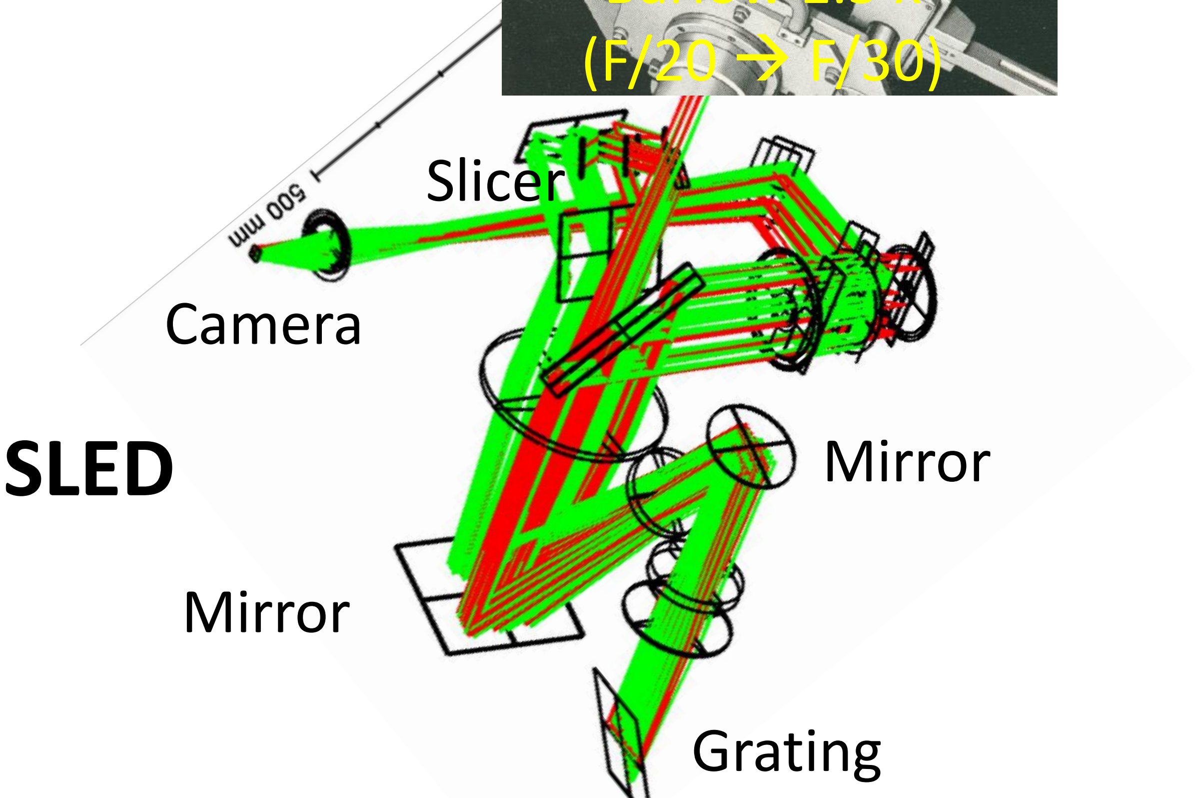
Thin lines = radial velocity restoration by SLED for various viewing angles at the limb; RMS error = 50 m/s at the inflexion points of the spectral line for S/N = ∞





SLED at Lomnicky Stit Observatory (LSO, 2634 m, Slovakia)
Zeiss 200/3000/4000 coronagraph (20 cm diameter)
Barlow 1.5 x (F/20 → F/30)
SLED at F/30 focus, operating in 2023
FeXIV and FeX simultaneously at 1Hz cadence
Spectral resolution R = 19000
150” x 1000” FOV, pixel size 2”

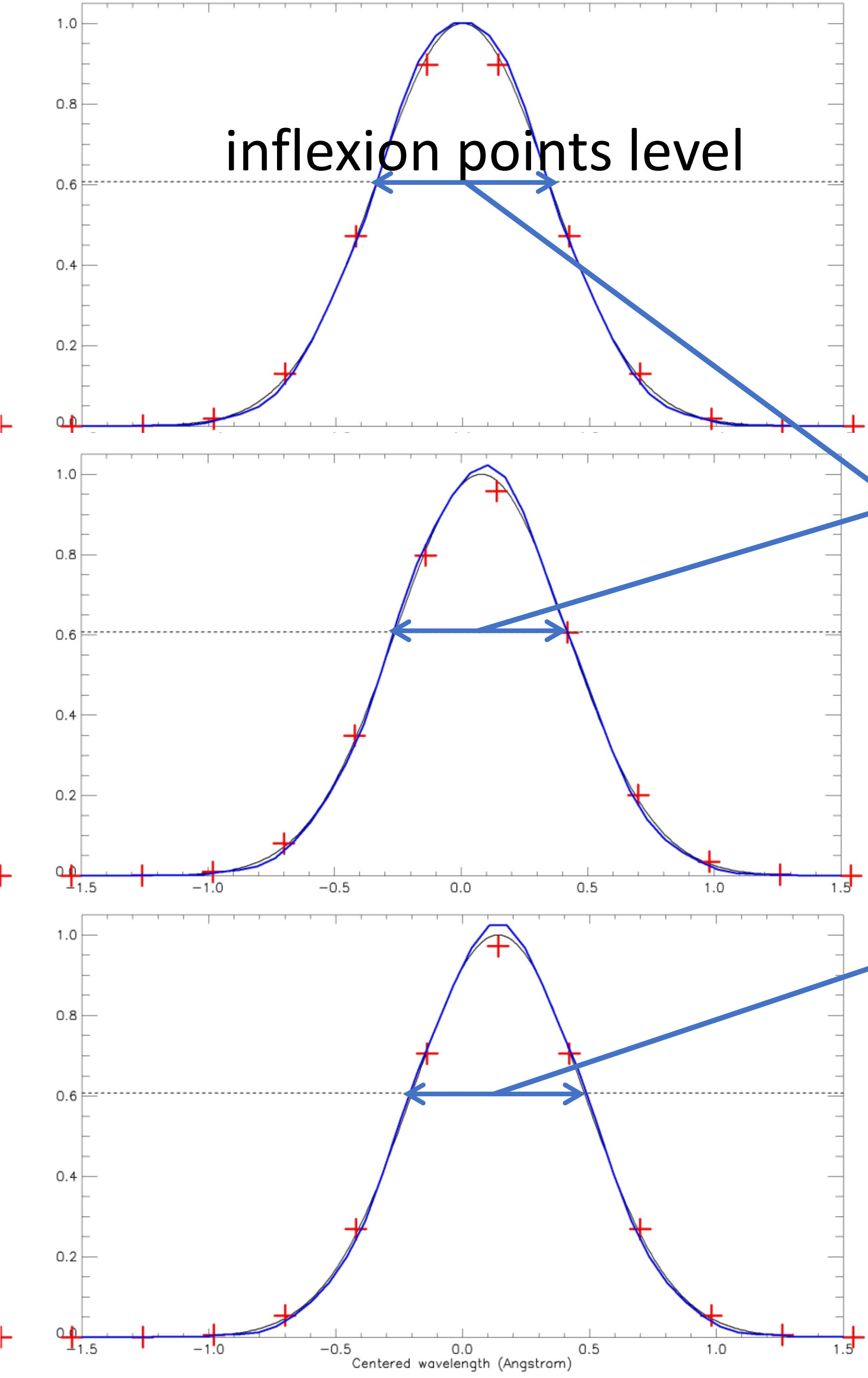


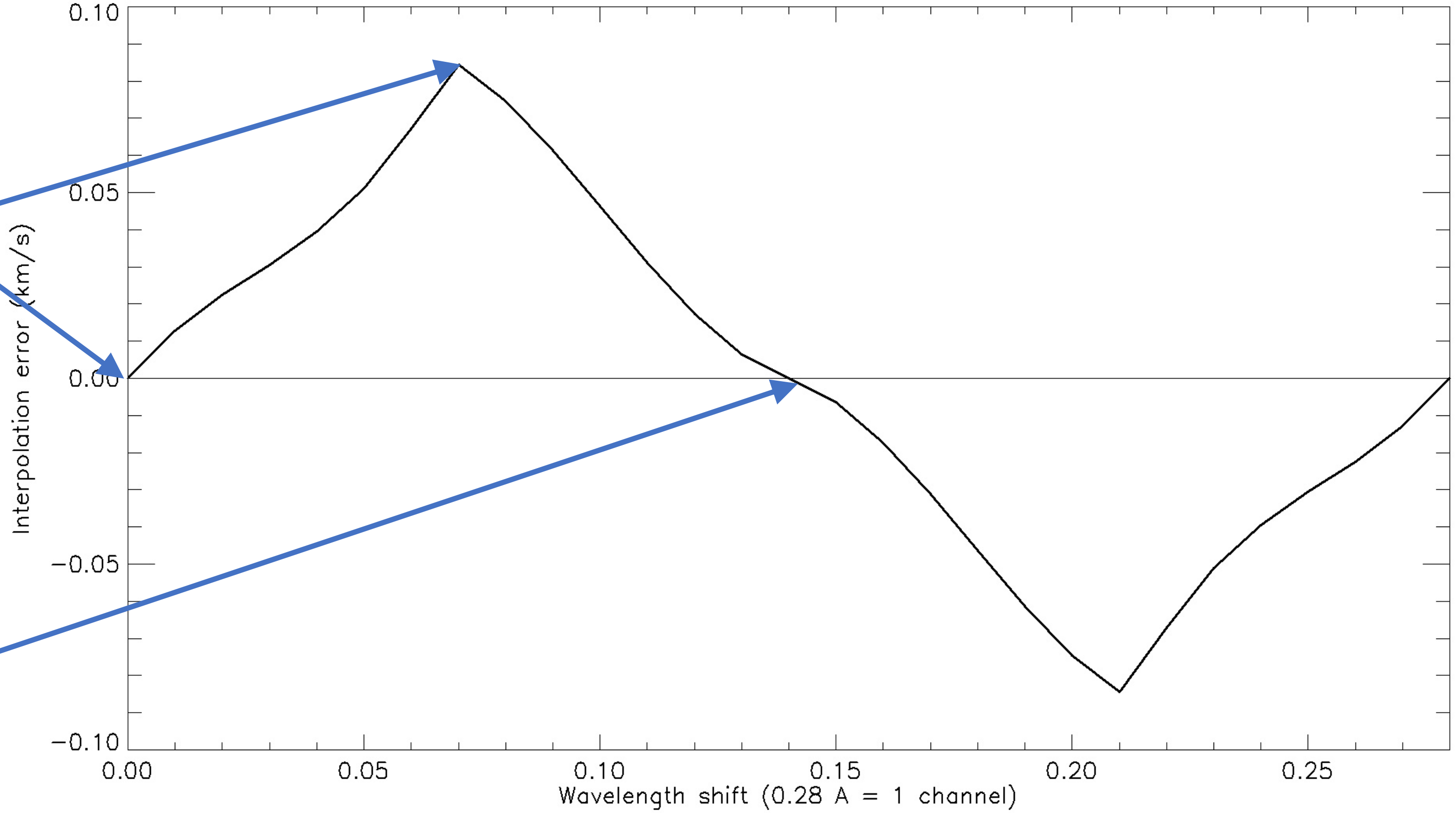


Additional information concerning

- Interpolation errors of line profiles
  (0.28 A step & 0.28 A bandwidth)
- Influence of photon noise

Radial velocity interpolation error of line profiles for chords at inflexion points (0.05 km/s RMS)



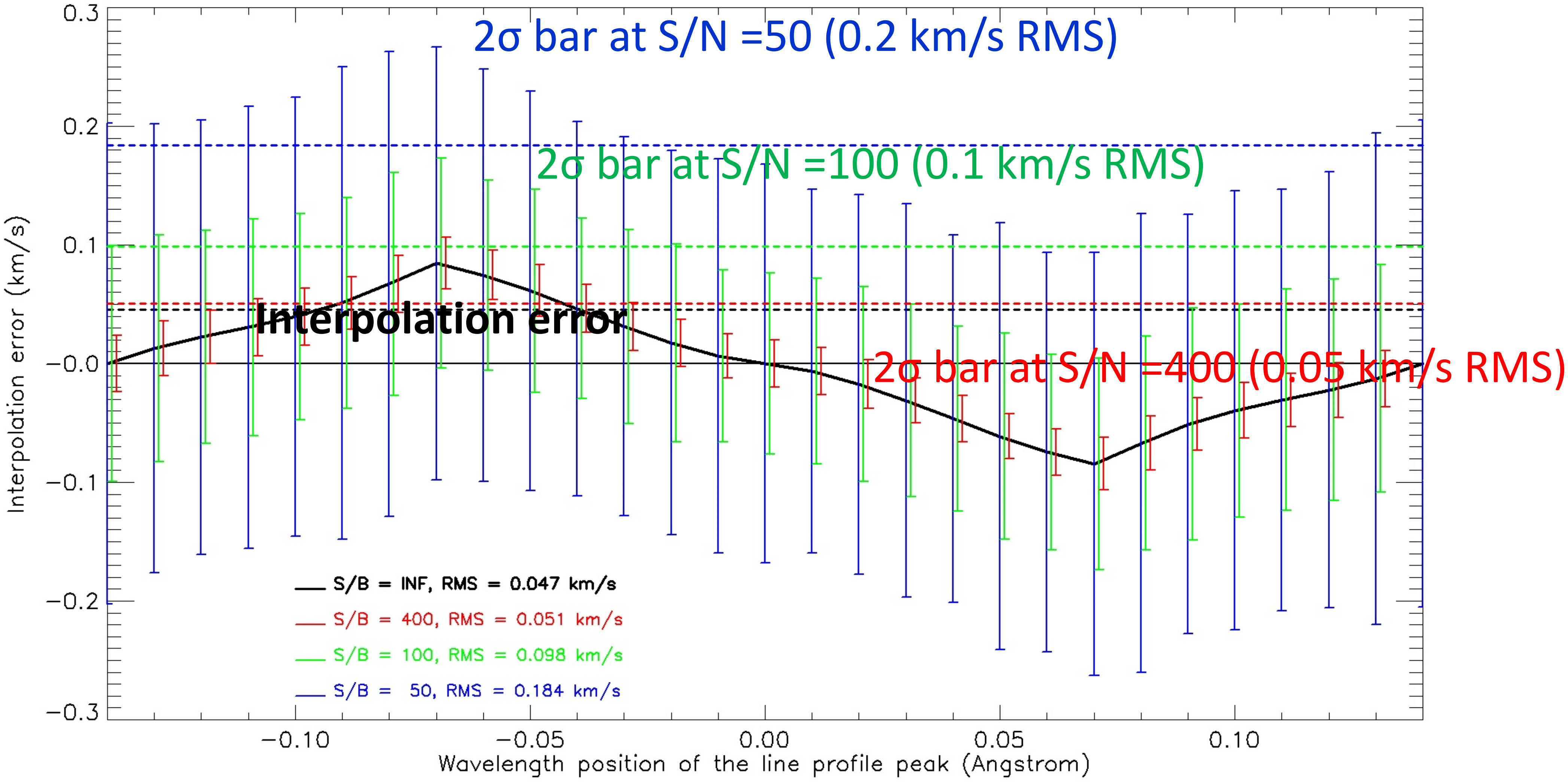


____ theoretical gaussian profile

\+ sampling points by SLED (0.28 A step & bandwidth)

____ restored profile (interpolation using sampling points)

Influence of the S/N ratio (photon shot noise) on the precision of radial velocity measurements. Line profile interpolation errors (0.05 km/s) depend on the peak position in wavelength and exhibit a period of 0.28 A = slicer step, which is degraded by S/N errors (simulation with gaussian profiles, velocity restoration at inflexion points)



Radial velocity interpolation error of line profiles for chords at inflexion points (IP, 0.70 A), just below (0.77 A), and at half maximum (HM, 0.84 A) for the siphon flow model of Orlando & Peres (1998). Abscissa = curvilinear coordinate.