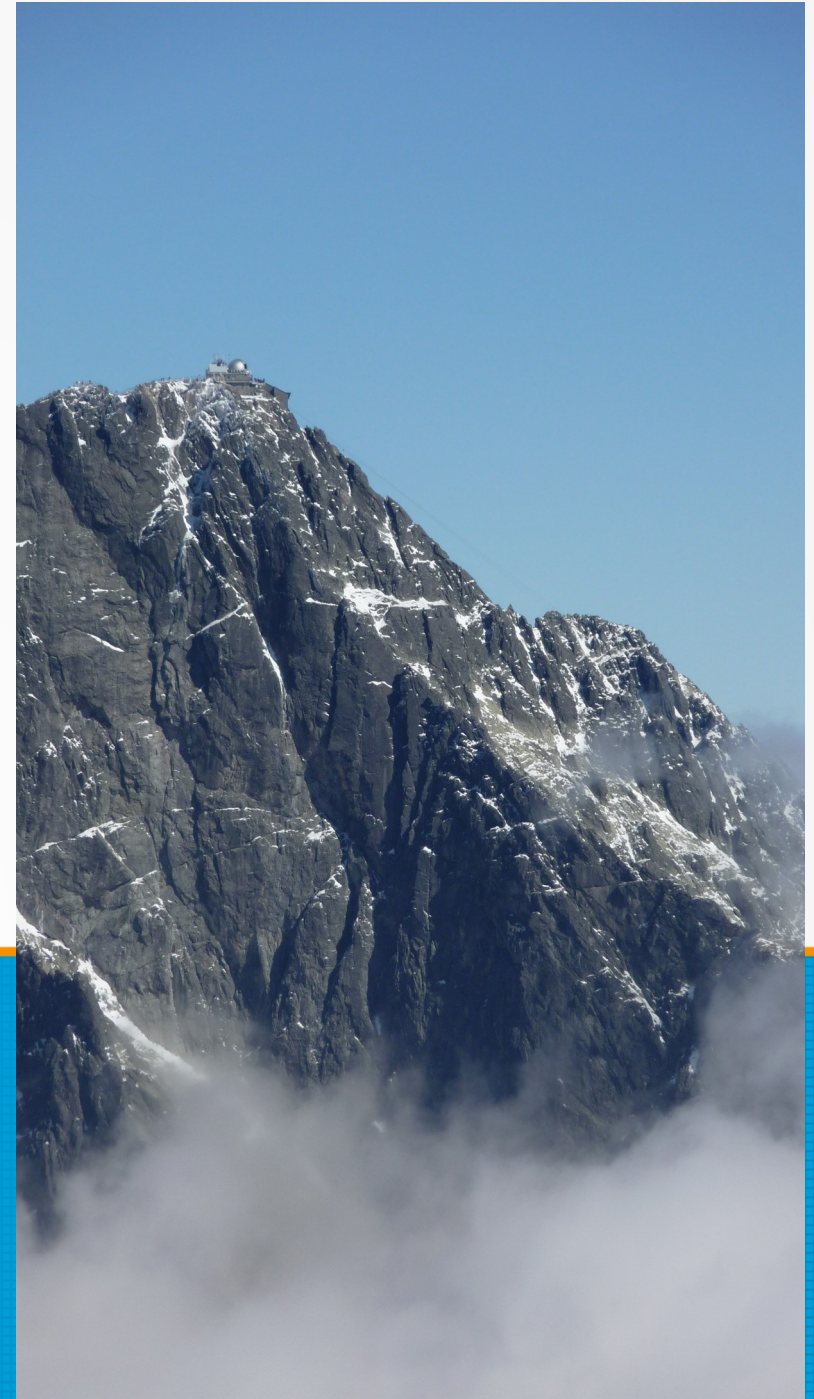


LSO summer internship program: our projects

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2024



Content:

- The only main topic: LSO projects

LSO projects:

- Projects:
 - previous
 - actual
 - in preparation
 - future
- Projects:
 - scientific
 - instrumental
- Mutual relation and consequent evolution of projects:
 - Scientific ~ Instrumental
 - Derived results + new possibilities and ideas => new instruments

Previous projects:

- Instrumental projects:
 - Diffraction grating spectrograph: home made
 - Šolc narrow-band filter: purchased
 - Photoelectric pointing: home made
 - Photographic emulsion → photosensitive el. detectors
 - Mutual pointing system for 2 LSO coronagraphs: purchased
 - CorMag instrument for ESA PROBA-3 mission / South pole: in operation
 - WAMIS: proposal to NASA stratospheric balloon program in Antarctica
- Scientific projects:
 - H alpha prominences
 - Green coronal emission line

Actual projects:

- Instrumental projects:
 - An advanced pointing system UJ2P: tuning of actions
 - The CoMP-S spectro-polarimeter: update
 - Dome: rotation (v.2) + painting
- Scientific projects:
 - Coronal rain
 - He ionization

Projects in preparation:

- Instrumental projects:
 - SLED
 - Testing diffraction grating spectrometer
 - SCD spectro-polarimeter
- Scientific projects:
 - Coronal and prominence lines together
 - Red and green line together
 - Seismology

Future projects:

- Instruments:
 - larger coronagraph objective lens
 - variable artificial moon diameter
 - better location & altitude
 - a significant regular patrol

Previous scientific projects

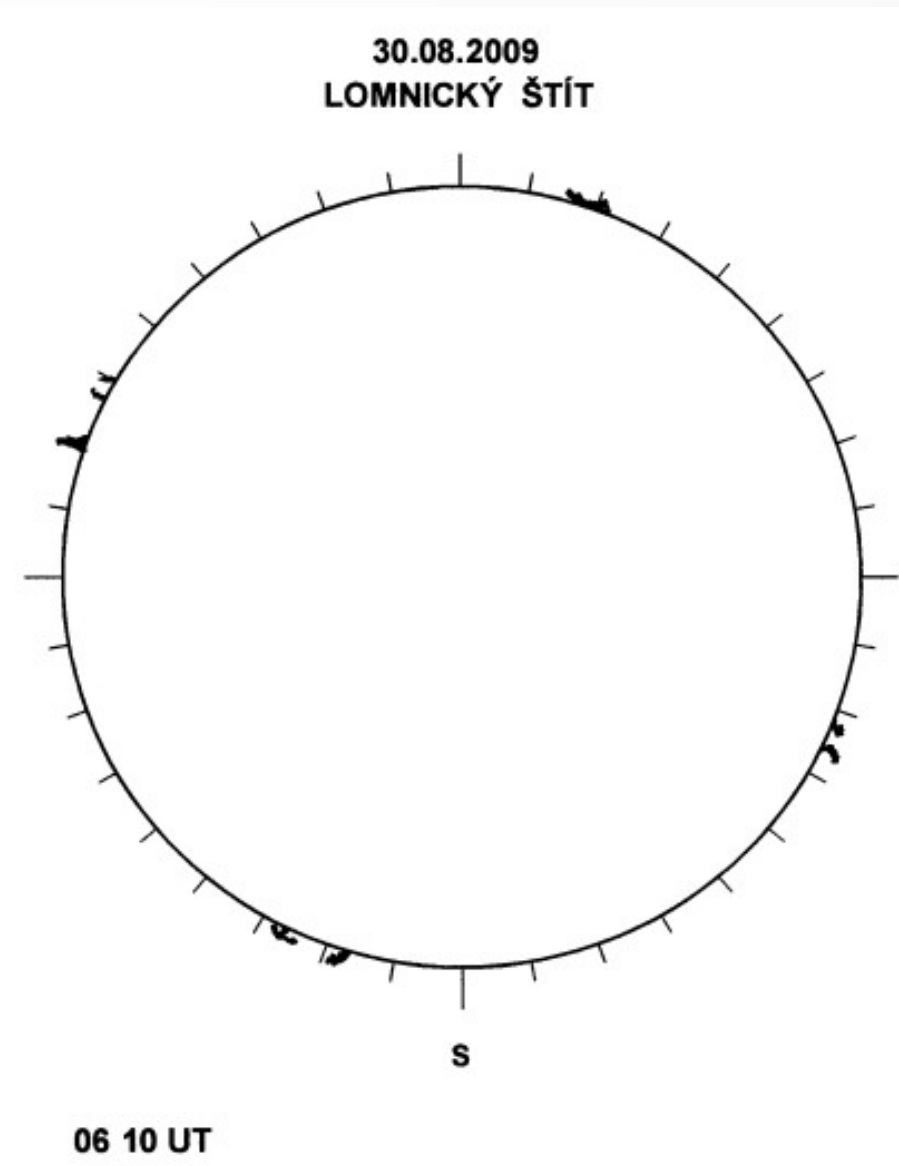
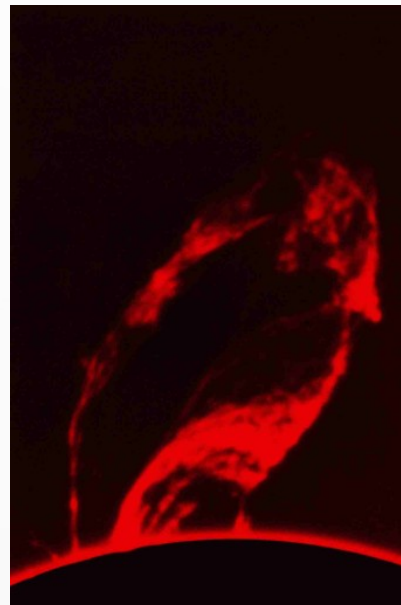
- H alpha prominences
- Green coronal emission line

Previous scientific projects

- Why?
 - 1/ we do not know...
 - 2/ there can be expected...
 - 3/ some interesting results for previous cycles
- Let's do this for a long time!

H alpha prominences

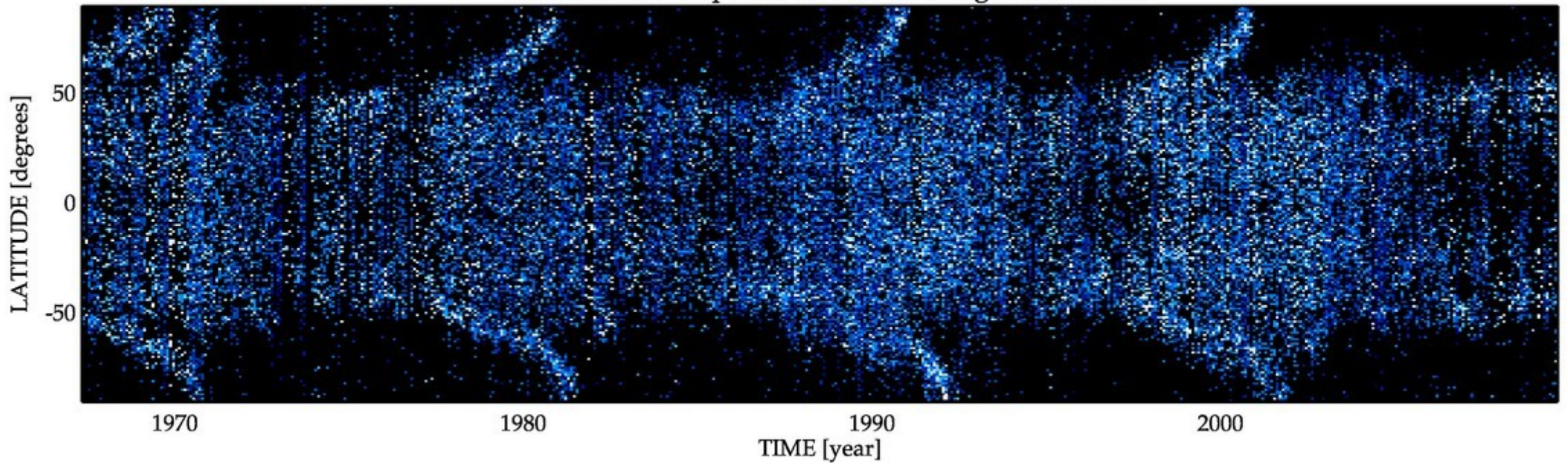
- Right LSO coronagraph + Šolc narrow-band filter
- Daily patrol: several images around the limb
- Data handling: negative, projection, mm-paper
- Data: date/time, position angle, longitude, latitude, area, height, width, brightness
- Program period: 05/1967-08/2009, 41795 records
- KSO continuation



H alpha prominences

- LSO data

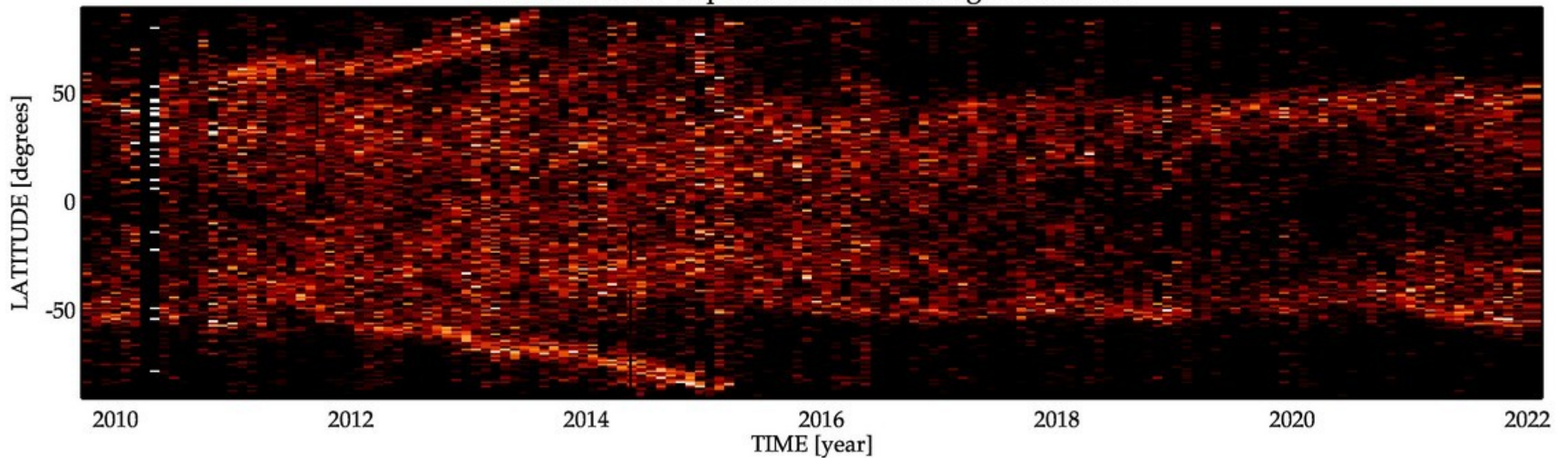
LSO: number of prominences - homogenized data



H alpha prominences

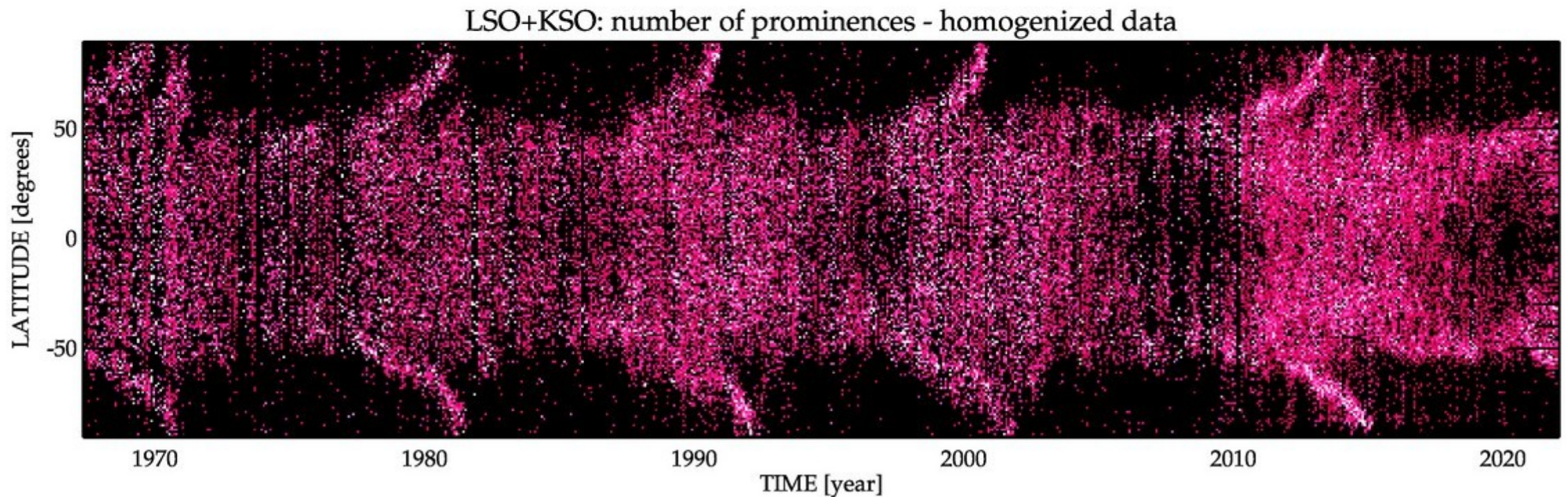
- KSO data

KSO: number of prominences - homogenized data



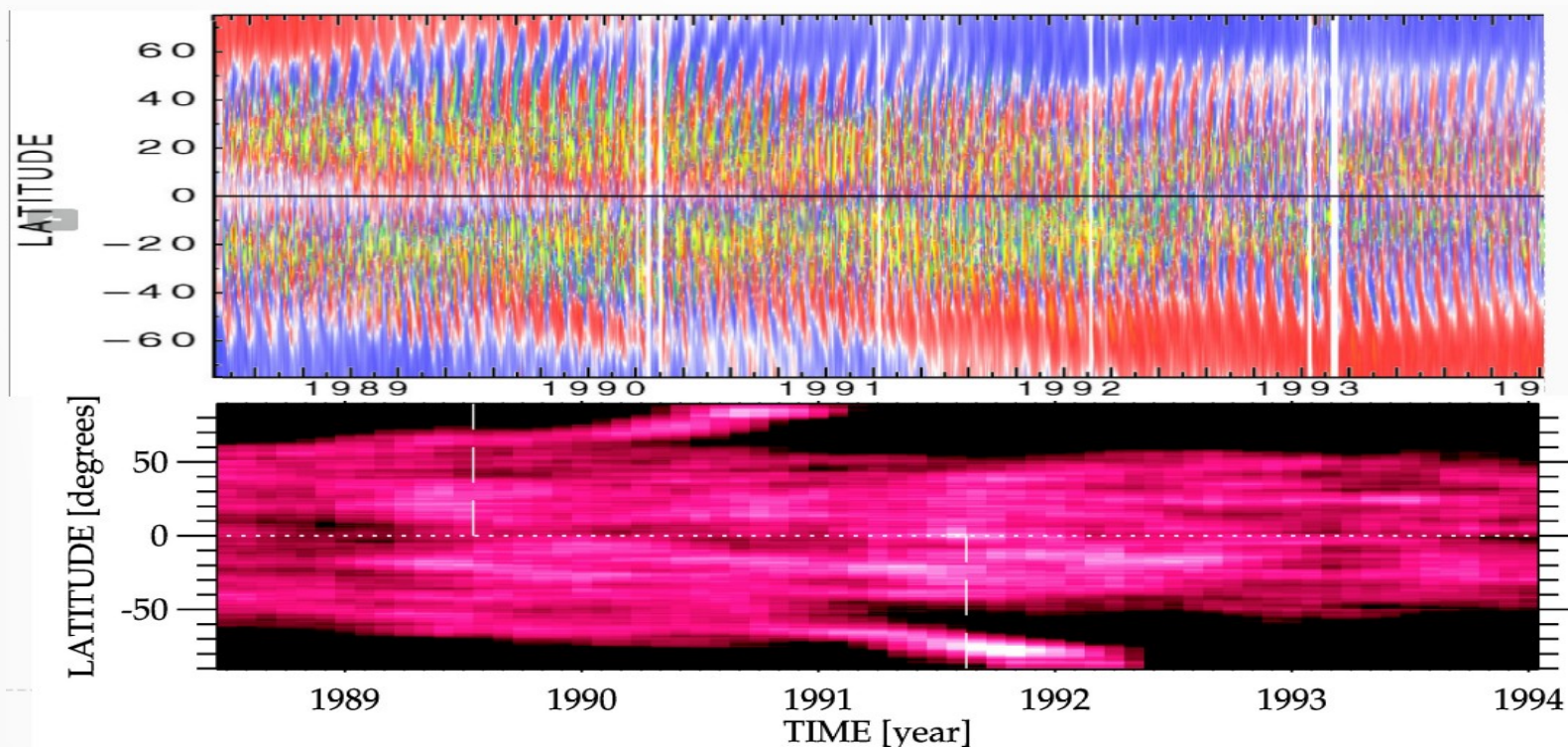
H alpha prominences

- LSO+KSO data



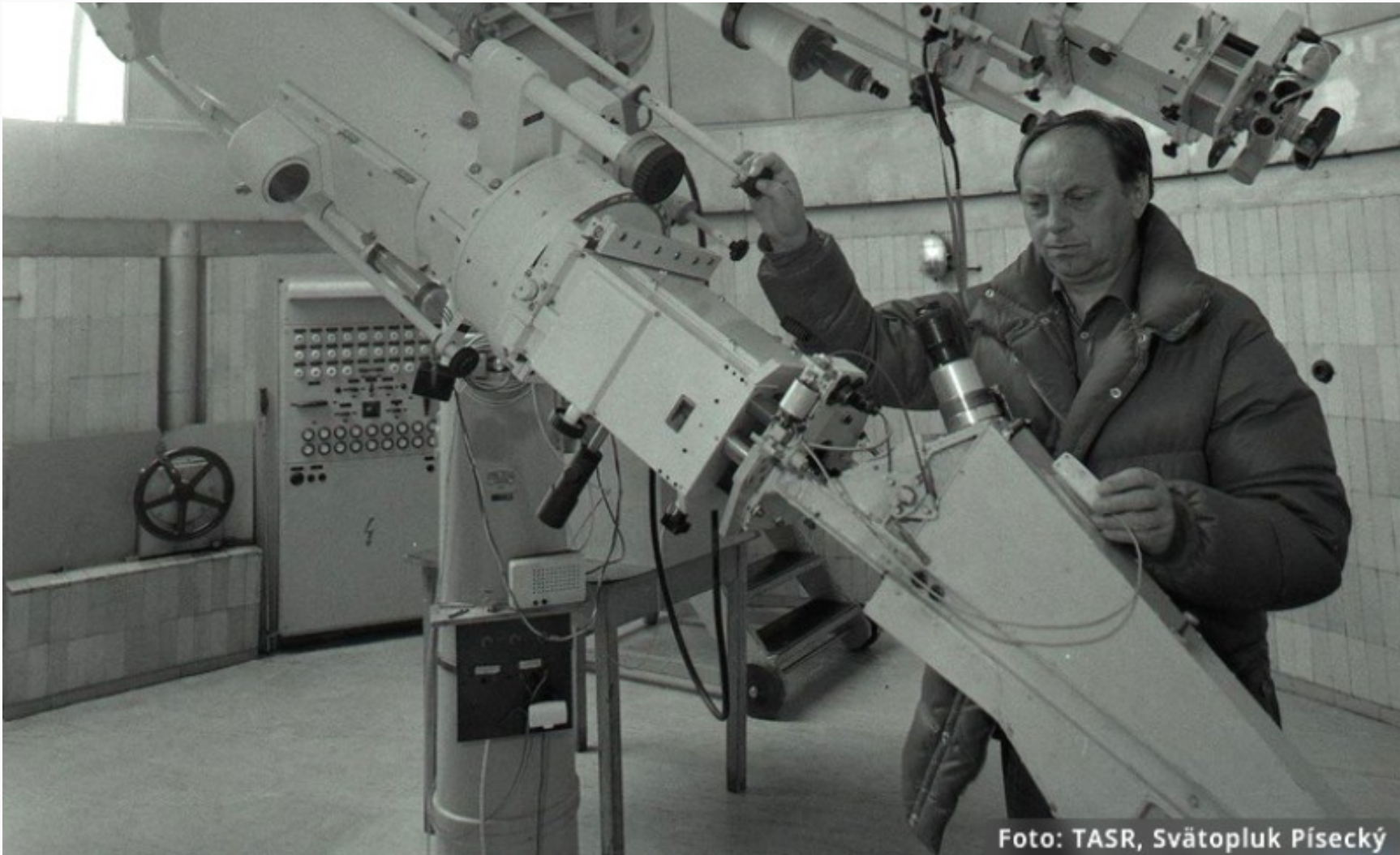
H alpha prominences

- Magnetic Supersynoptic Chart for 1974 to 2012, R. Ulrich, http://obs.astro.ucla.edu/images/supersynoptic_18-cr1617_2124.jpg
- **Our hypothesis** (from the qualitative analysis): the arrival speeds and the arrival speed change are caused by multiple surges of the dispersed magnetic flux → very probably the original concept of the primary and possible secondary branches is not adequate



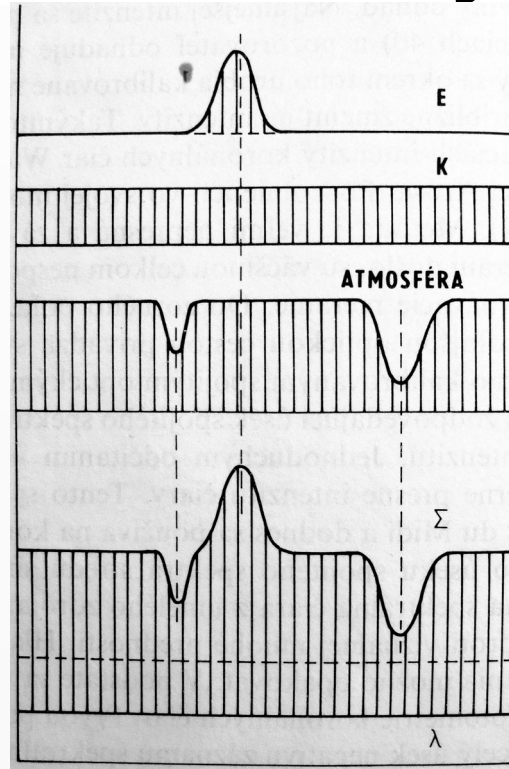
Coronal green line

- Left LSO coronagraph + diffraction grating spectrometer



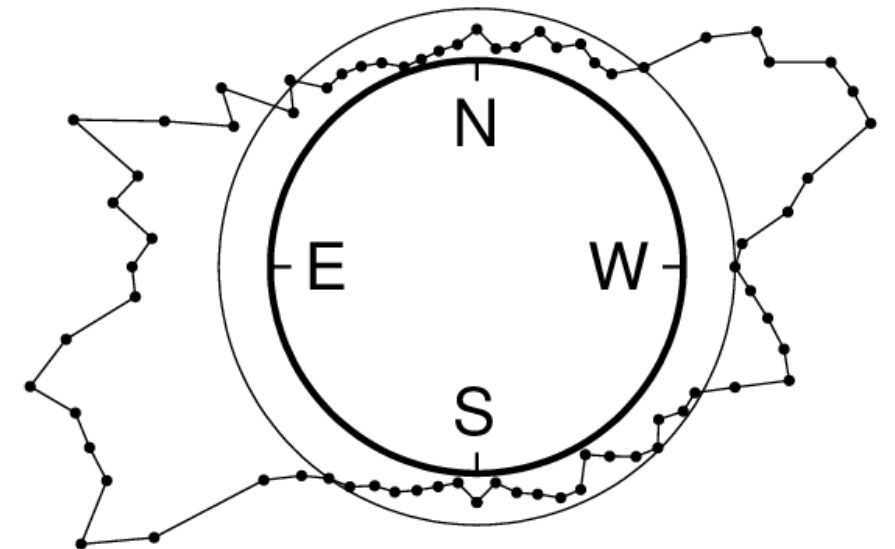
Coronal green line

- Left LSO coronagraph + diffraction grating spectrometer
- Daily patrol: 72 positions of the radially oriented slit → film/CCD
- Data handling: photometric calibration (negative, microphotometer, intensity~transparency correction or bias/dark/flat removal), subtraction of the background, calibration to absolute energetic units



January 4, 1968

10:40 UT



Coronal green line

- Program period: 1964-2009

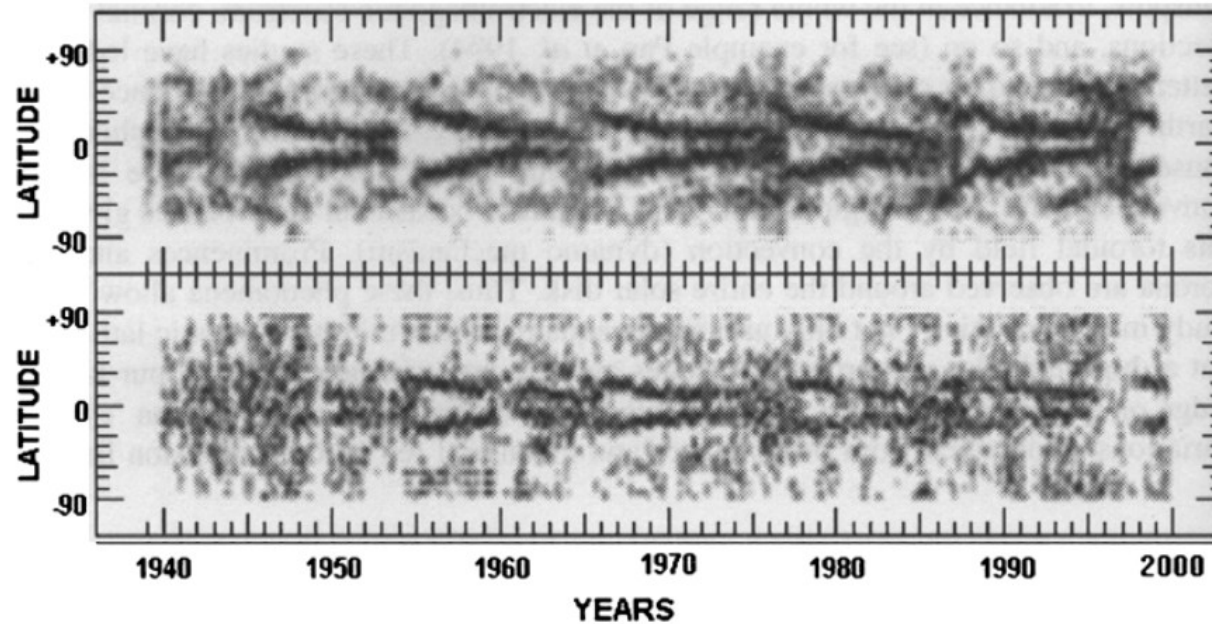
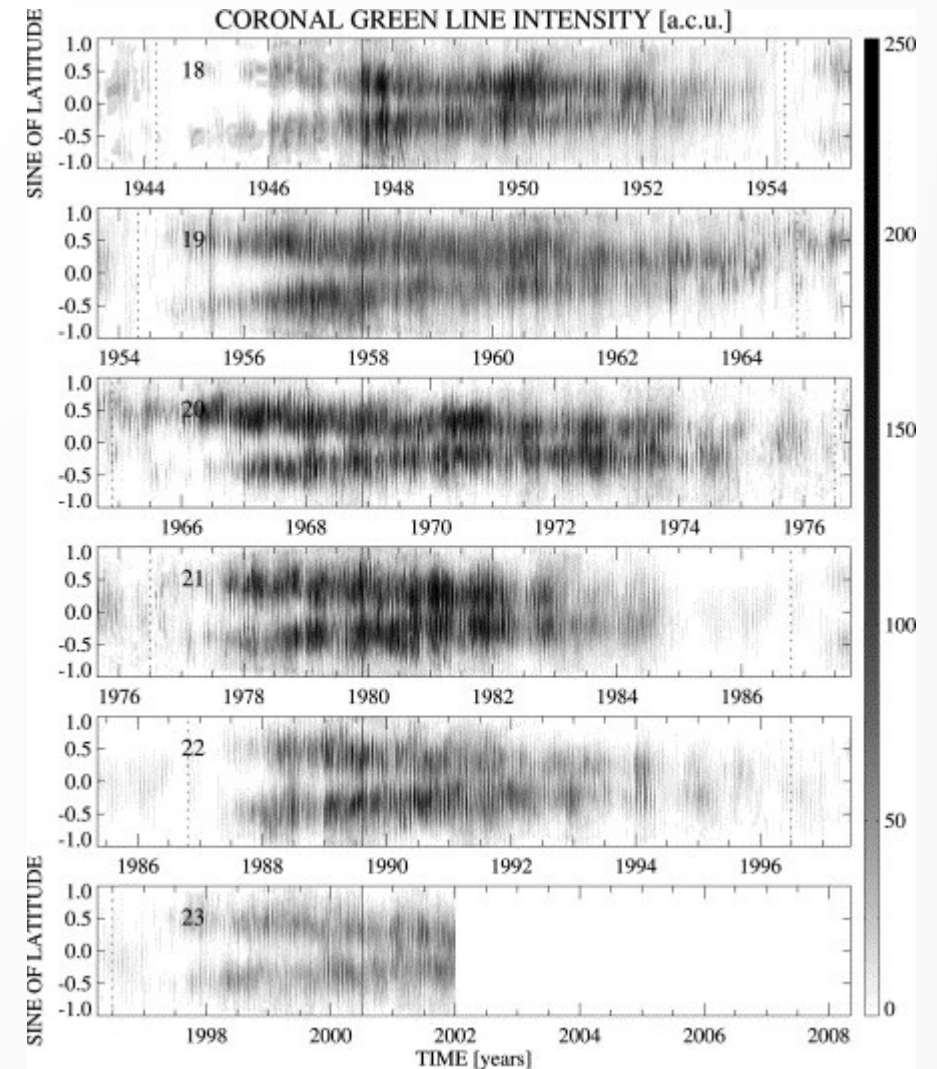


Figure 1. Time-latitude diagrams of local maxima of the green- (top) and red- (bottom) line intensities, respectively, indicating how solar cycles overlap for several years.



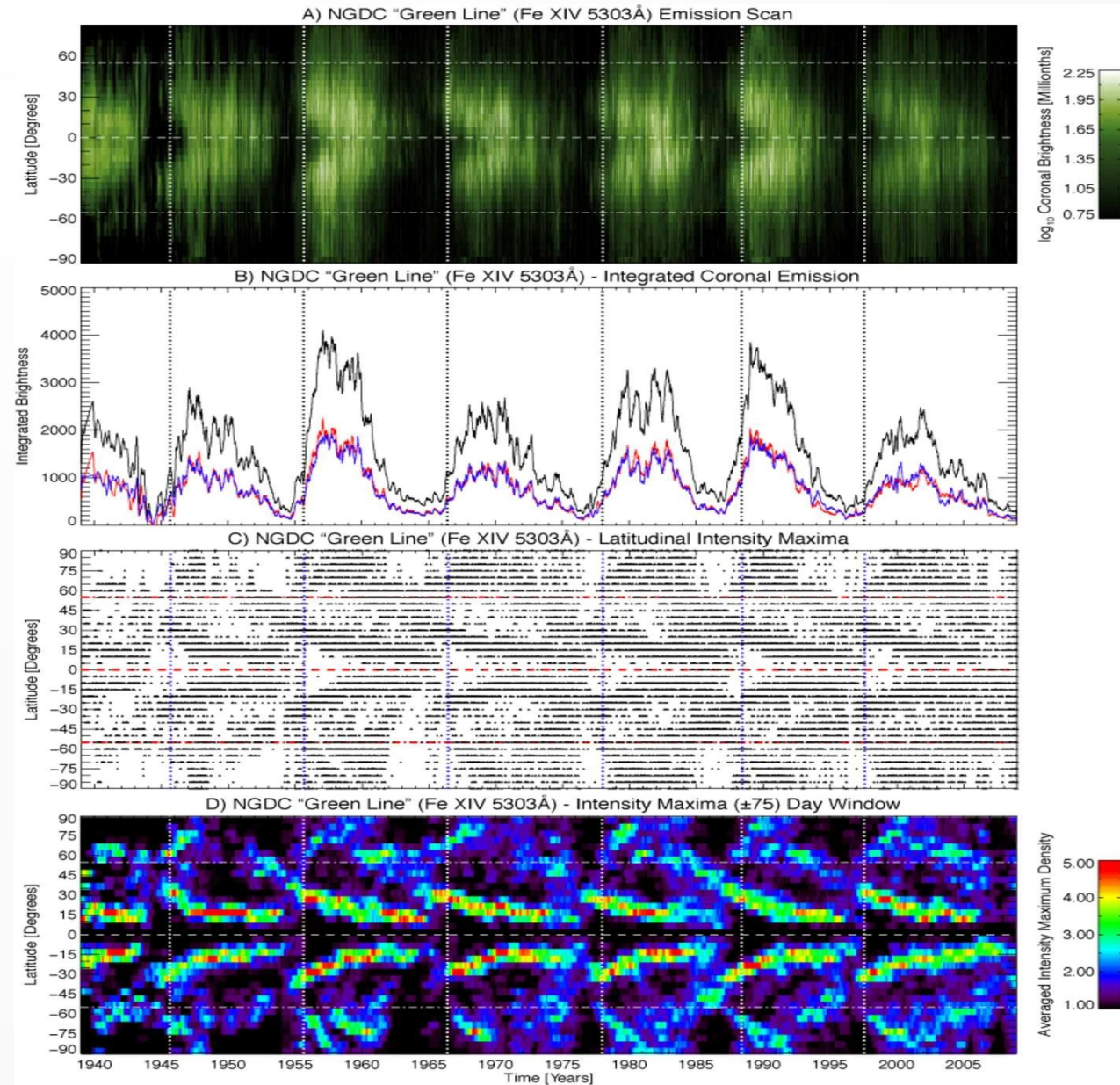
Coronal green line

- What for?
- For example:

“Deciphering Solar Magnetic Activity: 140 Years of the ‘Extended Solar Cycle’ – Mapping the Hale Cycle”, McIntosh, S.W., Leamon, R.J., Egeland, R. et al., Sol Phys 296, 189 (2021).

<https://doi.org/10.1007/s11207-021-01938-7>

- Extended solar cycle
- Solar cycle prediction

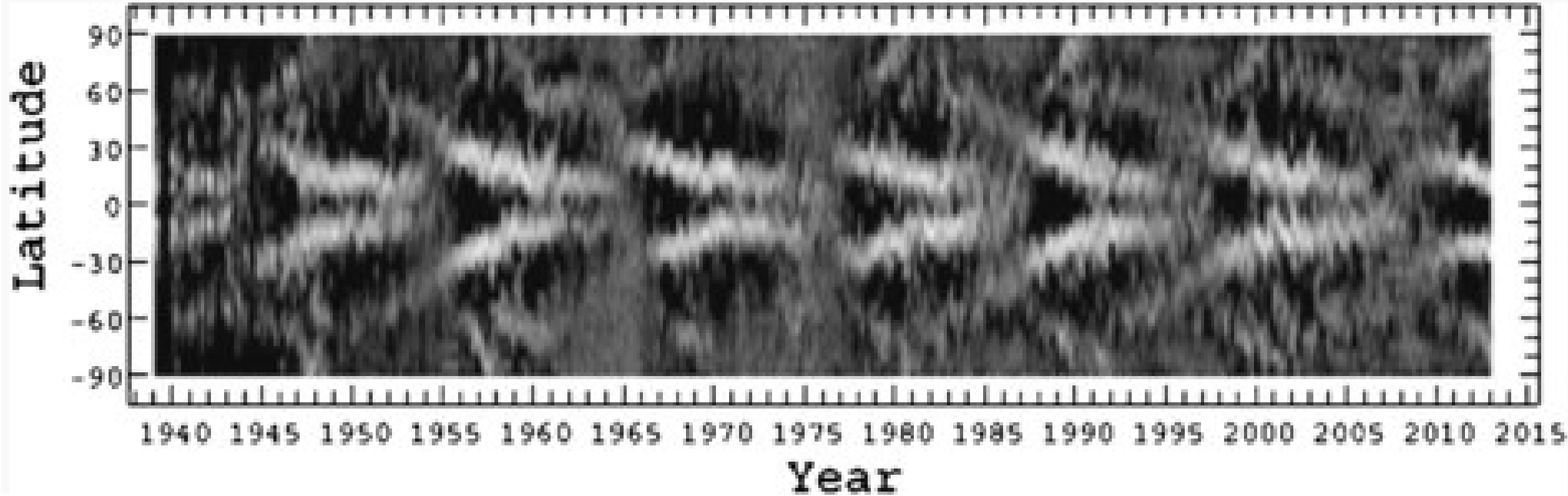


Coronal green line

- SoHO/EIT (28.4 nm Fe XV) + CELIAS continuation:

“Modified Homogeneous Data Set of Coronal Intensities”, Dorotovič, I. ; Minarovjech, M. ; Lorenc, M. ; Rybanský, M. , 2014, Solar Physics, Volume 289, 2697, <https://link.springer.com/article/10.1007/s11207-014-0501-2>

<https://www.kozmos-online.sk/slnko/modifikovany-homogenny-rad-modified-homogeneous-data-set/>



Coronal green line

- Next?

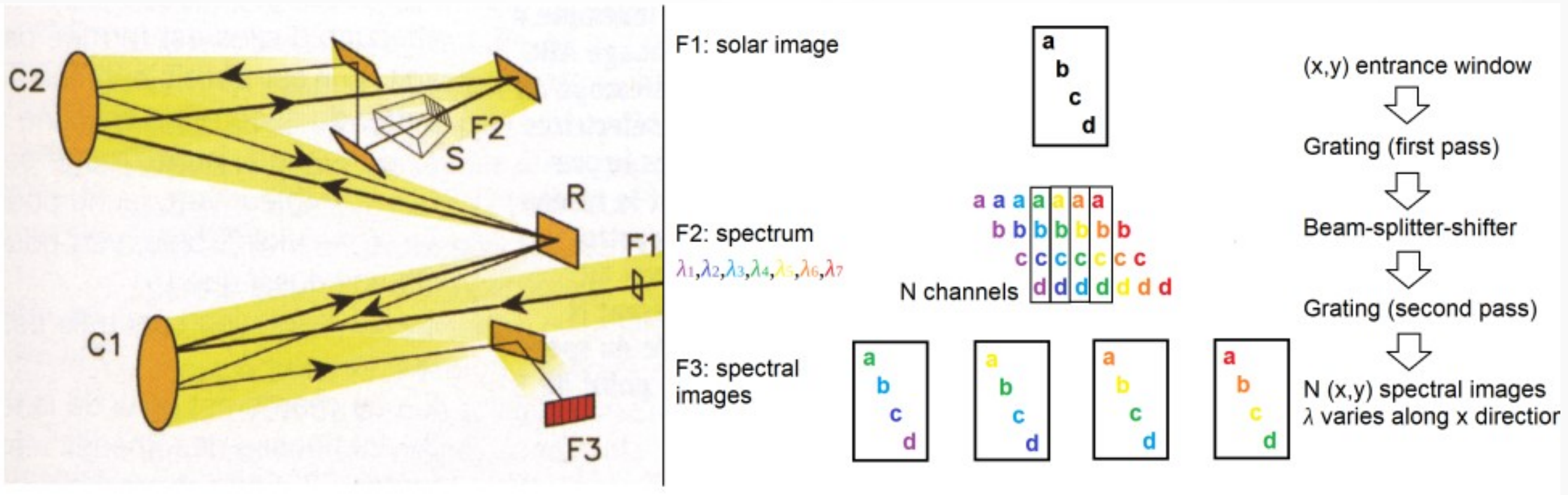
SLED instrument

- SLED – Solar Line Emission Dopplermeter: request to join, development, tests, hosting (consortium of institutions from I, F, GB, PL + SK):
 - 3D measurements simultaneously (X,Y,wavelength): the unique MSDP optical design (P. Mein) + micro (mechanics + optics)
 - Ground-based coronagraph for 2 spectral lines at the same time
 - High cadence: $\sim 1s$
 - The addressed open astrophysics question: do they exist in the solar corona the high frequency waves causing motion (an heating) of the magnetic field loops?
 - Malherbe, J.M., Mein, P., Sayède, F. et al. The Solar Line Emission Dopplerometer project. *Exp Astron* 53, 83–101 (2022), <https://doi.org/10.1007/s10686-021-09804-x>

Jean-Marie Malherbe, Pierre Mein, Frédéric Sayède, Pawel Rudawy, et al., The SLED project and the dynamics of coronal flux ropes. *Advances in Space Research*, Volume 70, 2022, Pages 1562-1569, <https://doi.org/10.1016/j.asr.2021.08.024>

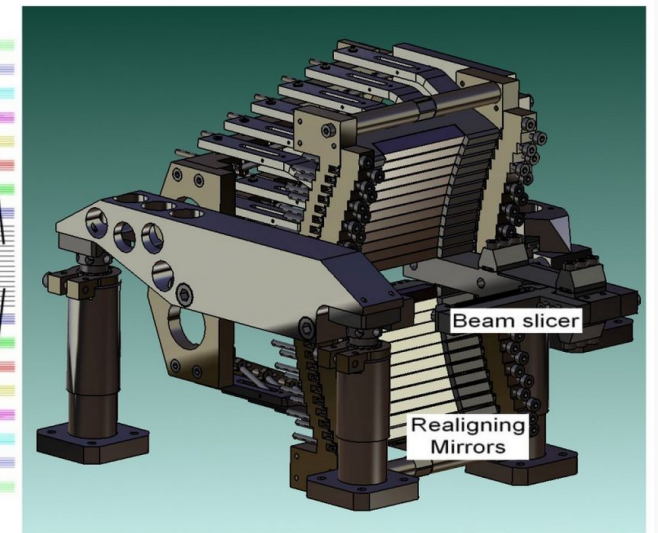
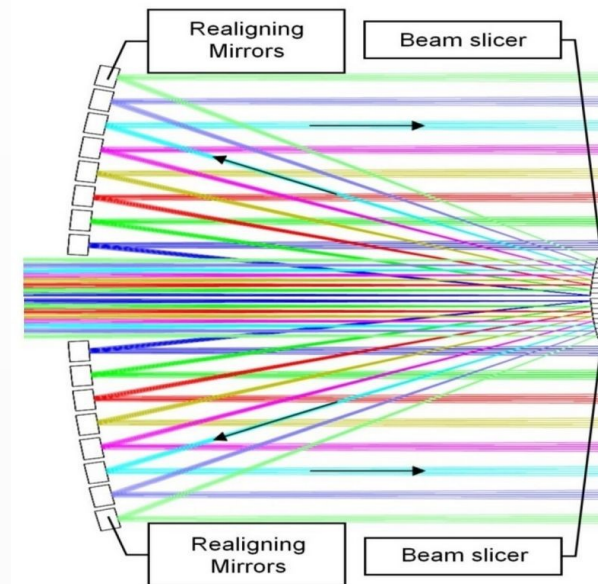
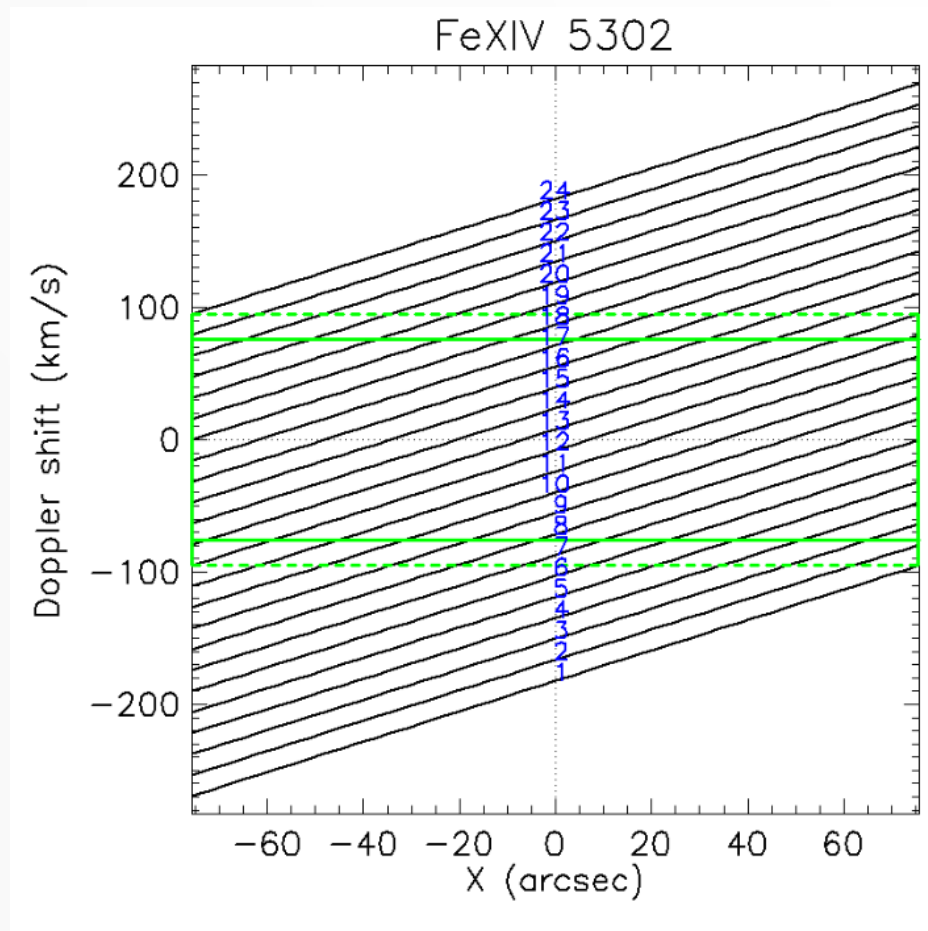
SLED instrument

- 3D measurements simultaneously (X,Y,wavelength): the unique MSDP optical design (P. Mein) + micro (mechanics + optics)



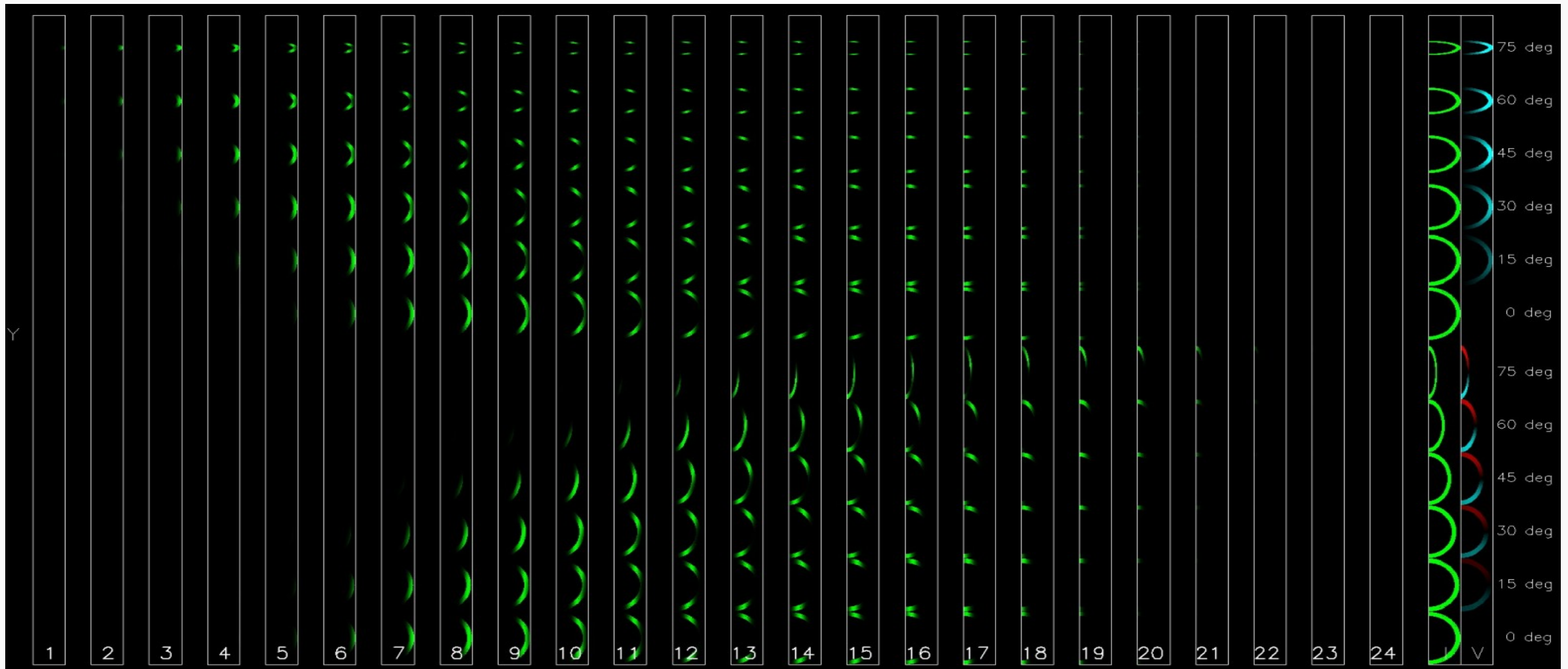
SLED instrument

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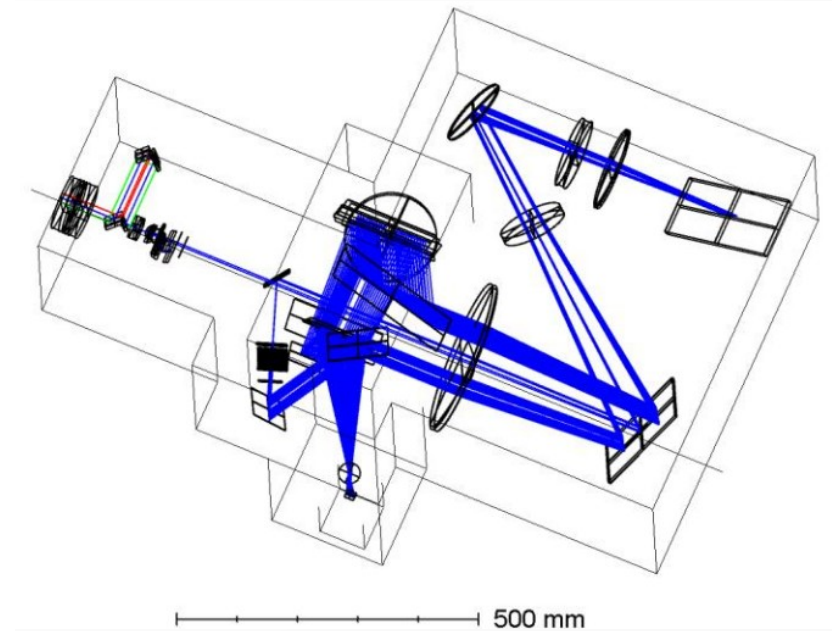
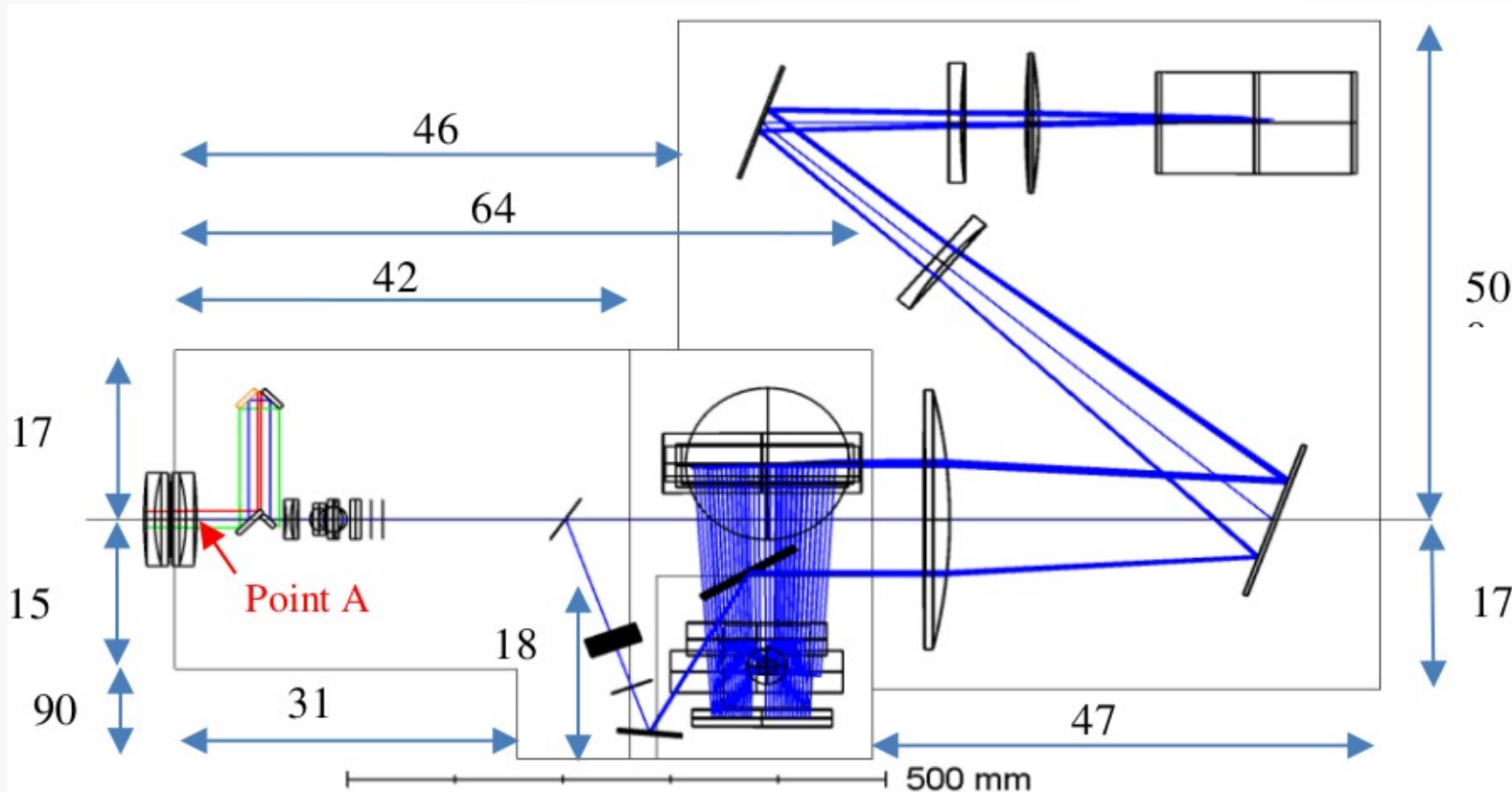
SLED instrument

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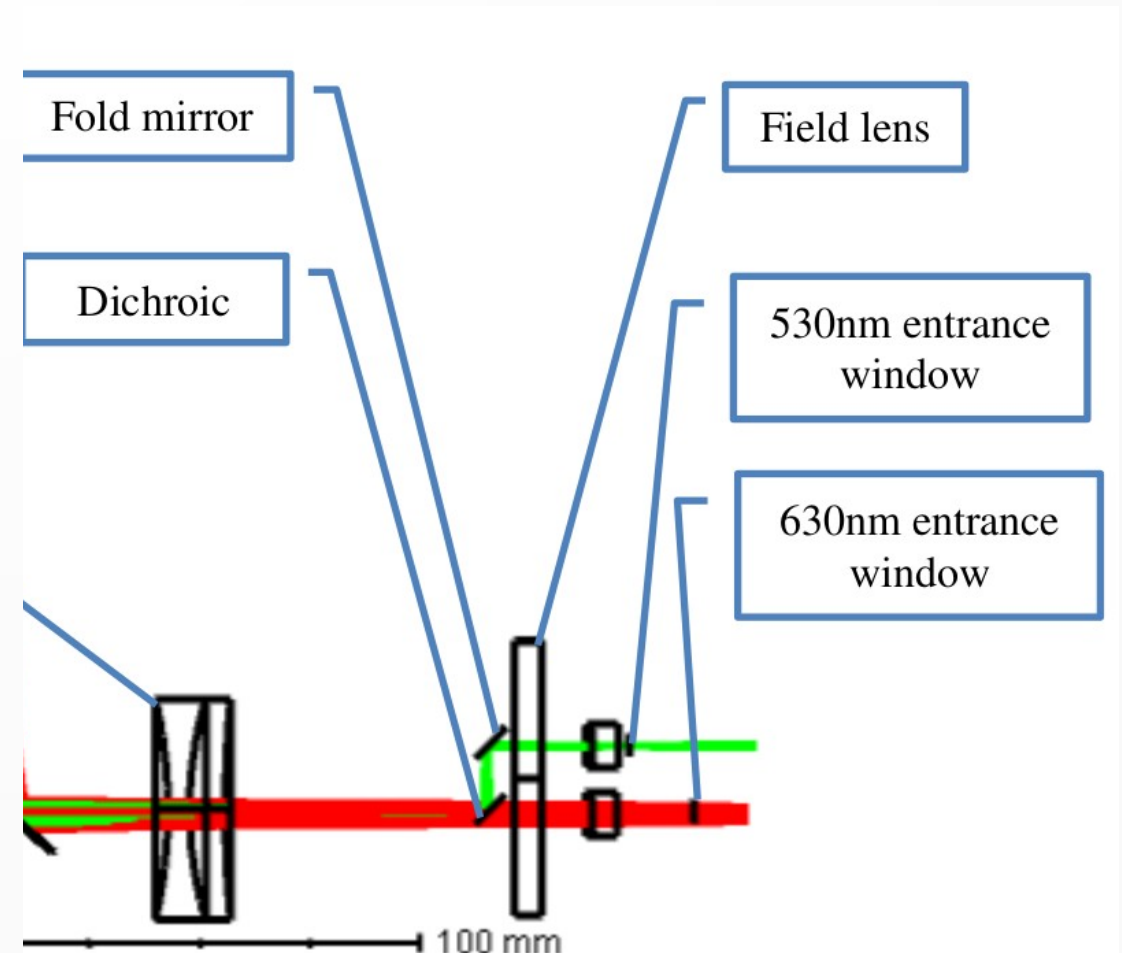
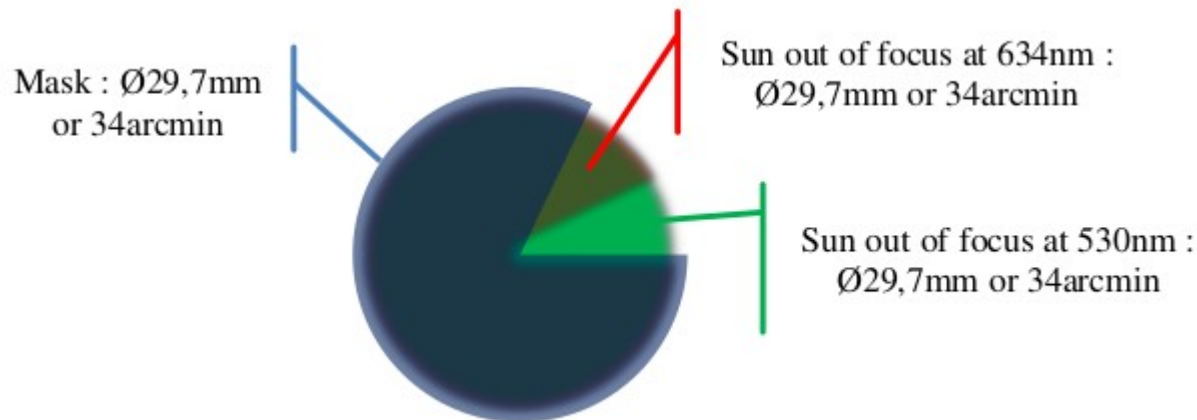
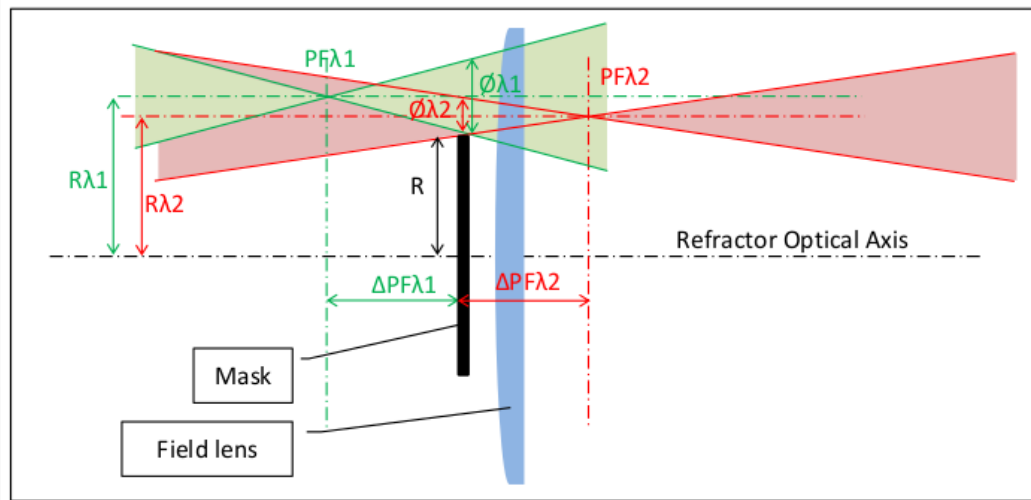
SLED instrument

- 3D measurements simultaneously (X,Y,wavelength): the unique MSDP optical design (P. Mein) + micro (mechanics + optics)



SLED instrument

- Ground-based coronagraph for 2 spectral lines at the same time



SLED instrument

- Actual status:
 - Optics fixed
 - Mechanics plan finished → check in dome → adaptations in progress
- Future prospects:
 - optical_mechanical plans → purchase + production lists → proposal to Polish grant agency
 - Building of instruments – Wroclaw university
 - Alignment and testing of instrument – Bialkow observatory
 - Hosting at the left coronagraph at the LSO
 - Simultaneous observations with the CoMP-S instrument (using UJ2P + mutual pointing systems)



Projects in preparation:

- Testing diffraction grating spectrometer
- SCD spectro-polarimeter