SPINER: Testing the feasibility of a spectro-interferometric-échelle beam combiner.

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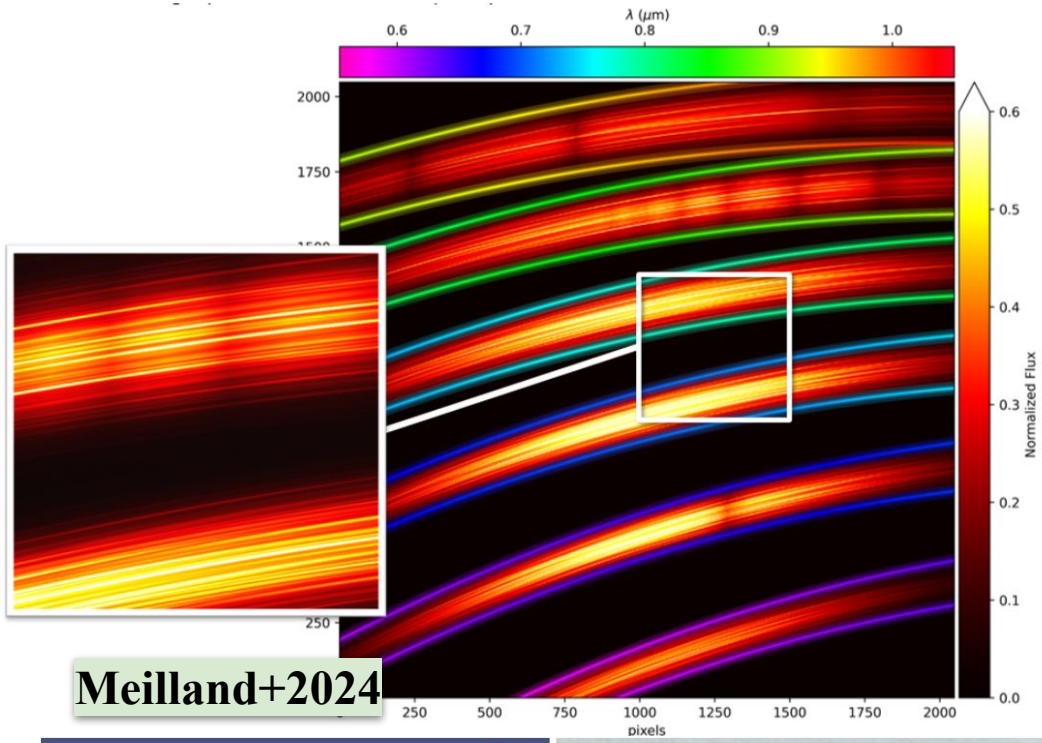
SPINER: SPectro-INterferometry with Échelle grating at high Resolution

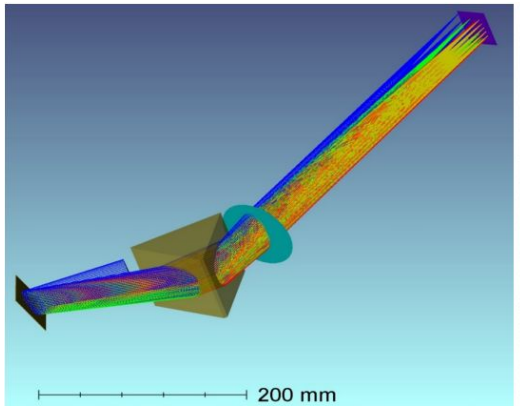
Concept presented by Meilland+(SPIE, 2024)

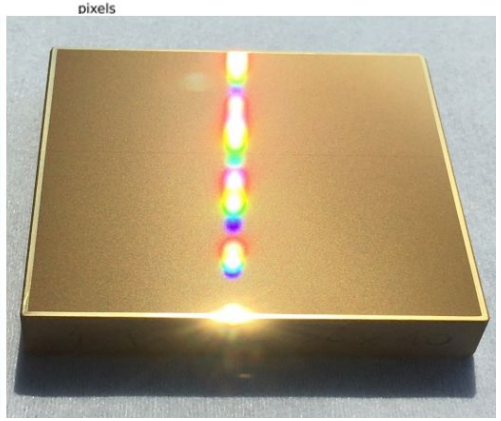
- **R~20000** in the wavelength range **600–900 nm** (R & I).
- First **simulations** of fringed échelle spectra.
- Optical simulations of the system.
- Main optical components acquired (échelle grating, prism).

Setup and lab integration started in Jan/2025:

- Rough **alignment** + detector tests.
- **Interferometric masks** design.
- First **white fringes**.
- Preliminary data acquisition/analysis scripts written.





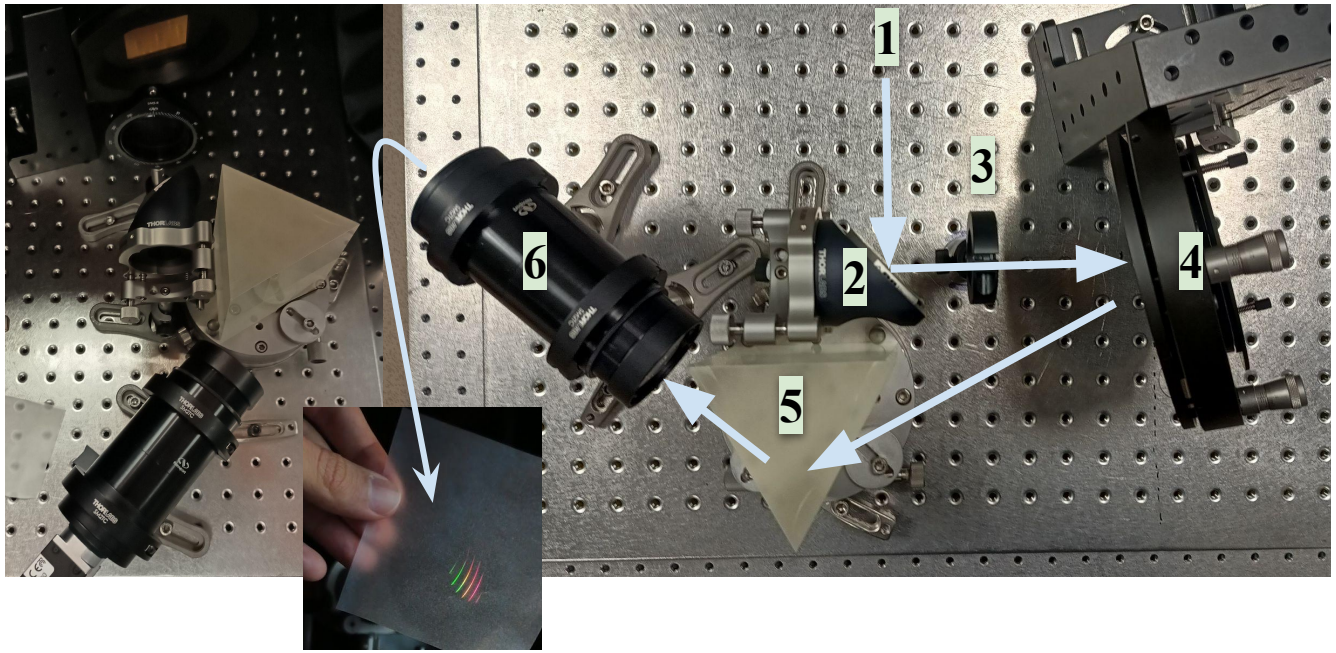


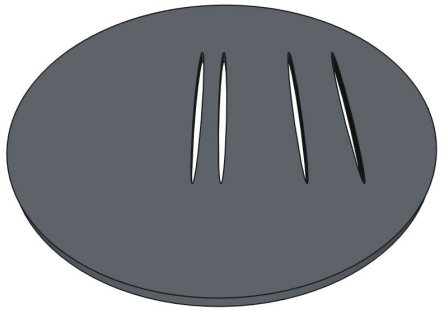
Optical bench setup

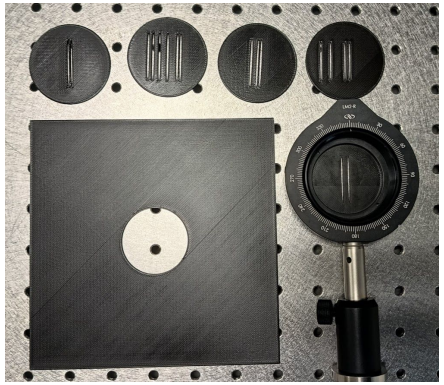
Components:

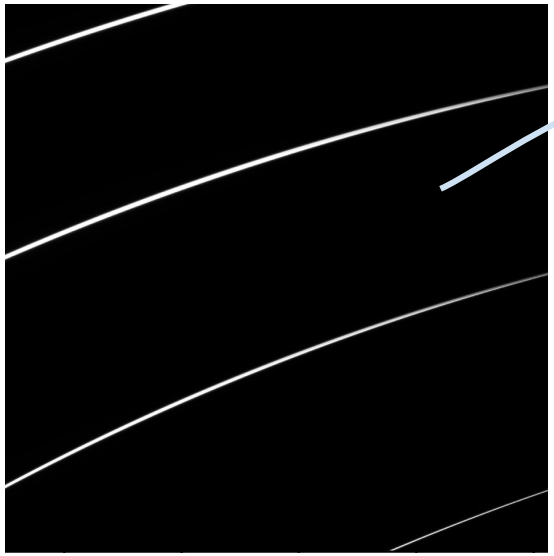
1. Collimated input beam.
2. Flip mirror.
3. Interferometric mask.*
4. Échelle grating (75 grooves/mm).
5. Cross-dispersing (60°) prism.
6. Camera optics + 1920x1200 px detector.

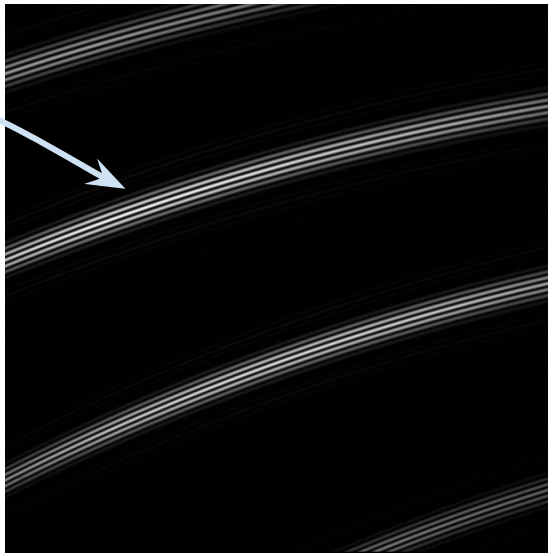
*: 3D printed masks to emulate the anamorphose telescope beams.











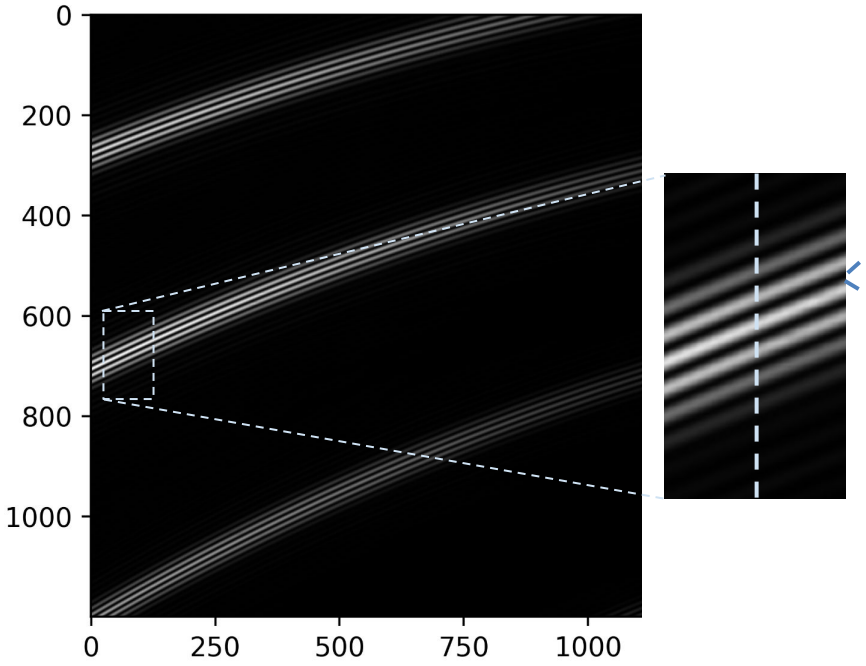
First calibration of SPINER – I

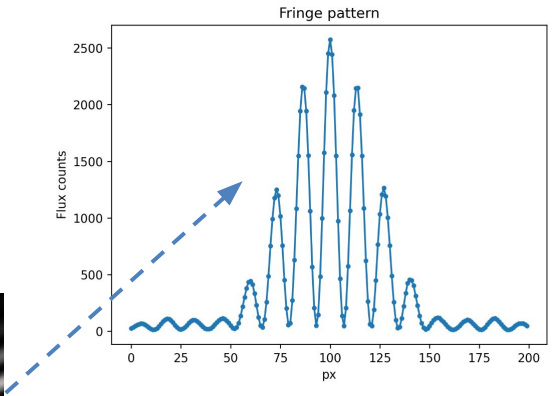
First Échelle-Interferogram (EIG) extraction (2T case):

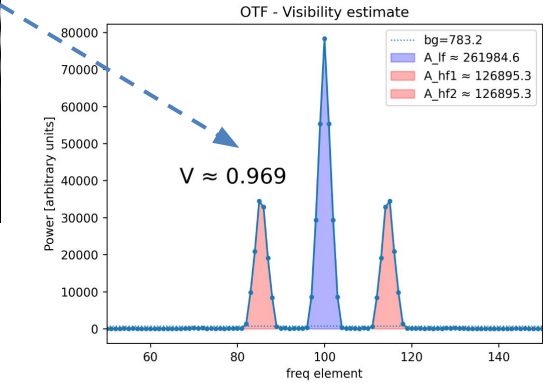
- Order extraction.
- Visibility estimation per spectral channel.
- Interfringe distance estimation.

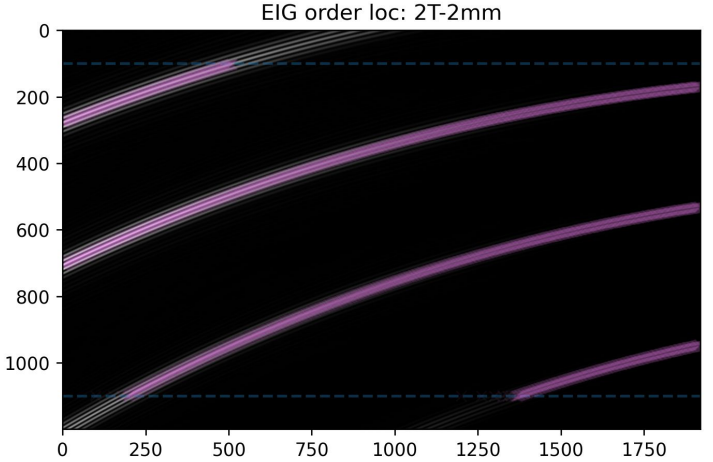
Calibration method:

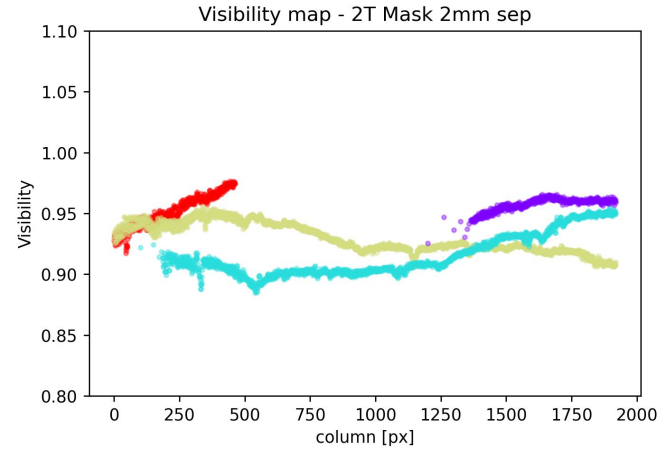
- 2-sources:
  - Leukos supercontinuum source (200–2000 nm).
  - Laser source at 633 nm.
- Interfringe separation for a known wavelength.







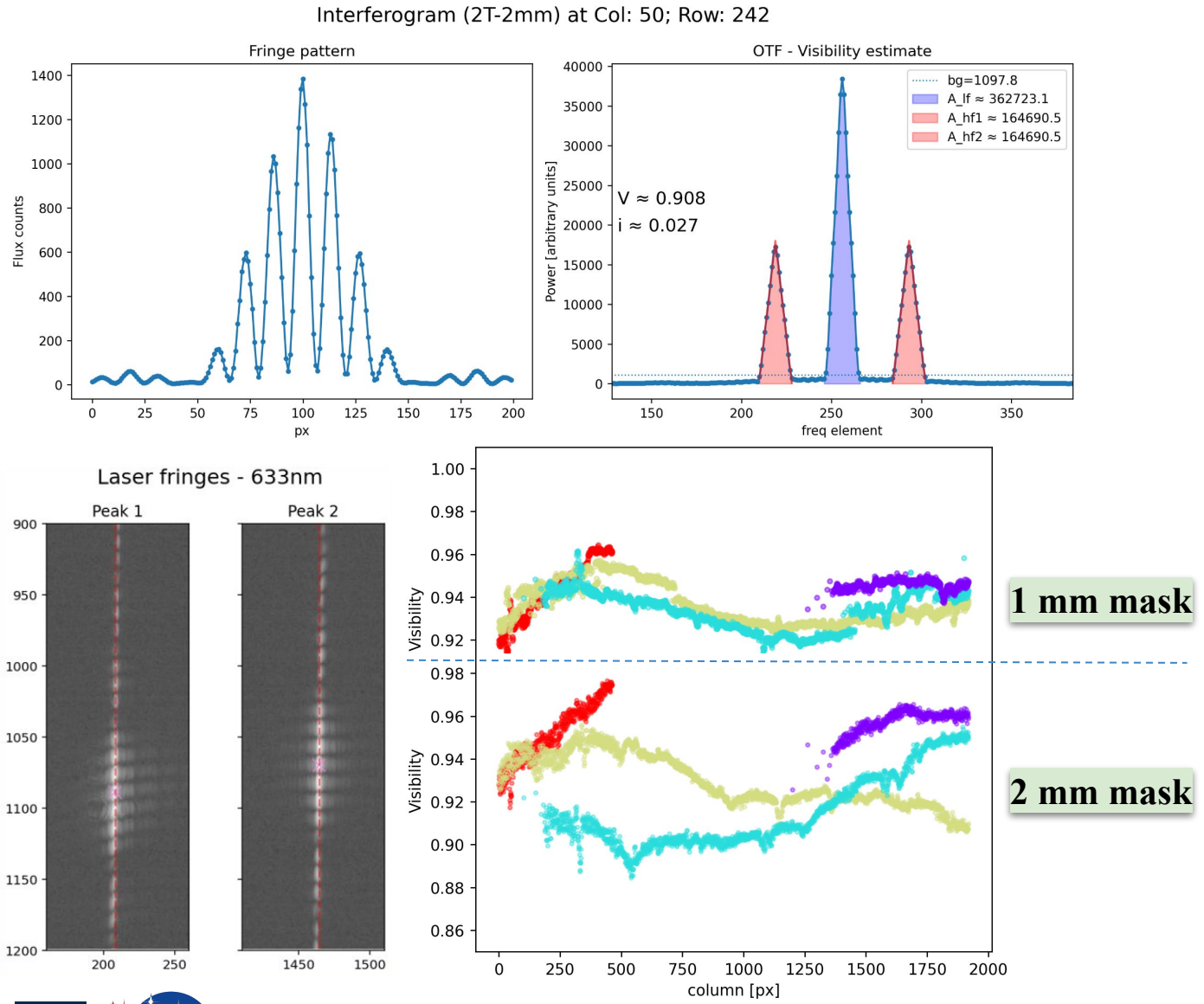




First calibration of SPINER – II

Calibration method:

- Interfringe separation for a known wavelength.
  - Fitting the shape of the OTF peaks.
  - Zero-padded fringe pattern to interpolate OTF peaks.
- Spectral response in white fringes:
  - Tracking contrast losses along orders
  - Testing for different beam separations – i.e. 2T masks with 1, 2, & 4 mm separations. Mask apertures of 0.5 mm.



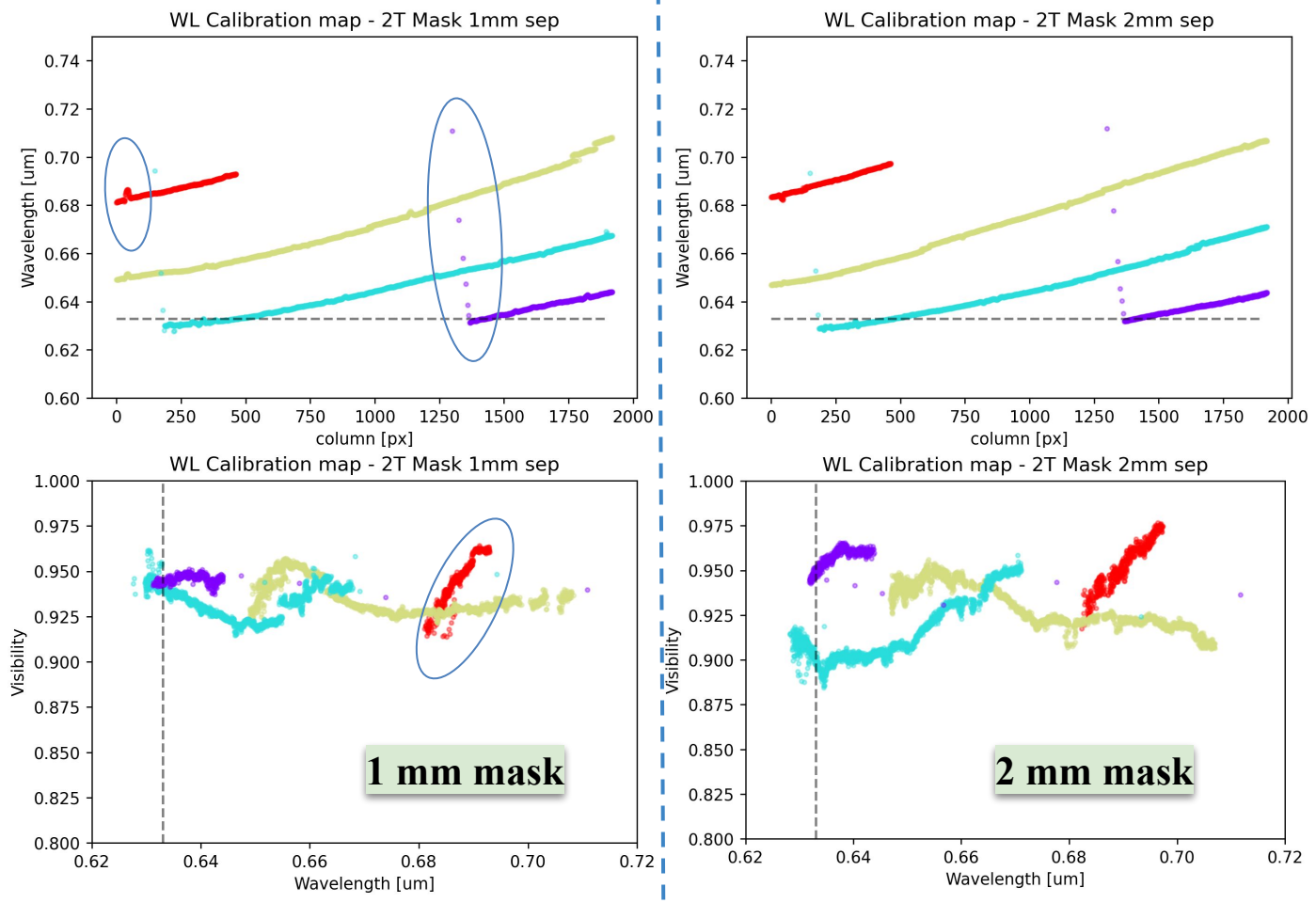
Results and next steps!

Main results:

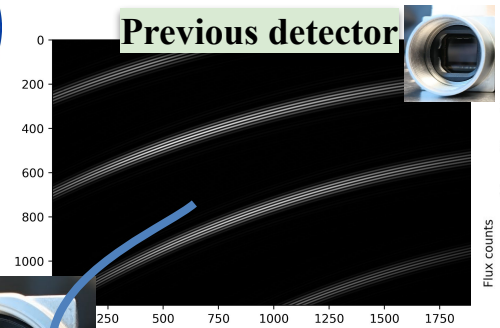
- First **spectral calibration**. Range **~630–710 nm**.
- Pipeline to extract orders, V^2, and interfringe distances for 2T cases.
- White fringe contrast values **>0.87**.

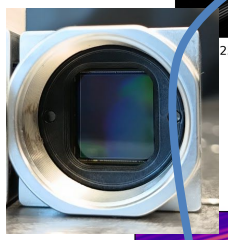
Next steps:

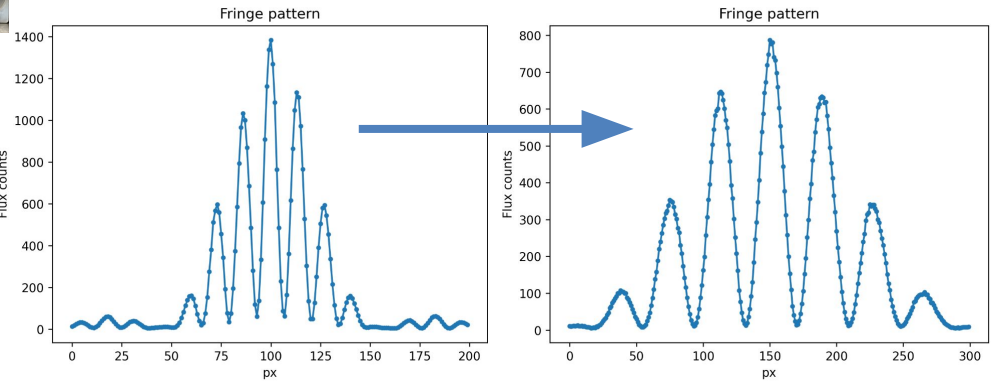
- **Phase** estimations.
- Robust extraction pipeline for EIGs from **3T, 4T, 6T** masks.
- **Throughput**, **R** estimation.
- Refine spectral calibration with **spectral lamps / laser sources**.
- Split the source using fiber inputs (more realistic input beams).
- Parallel with **photonics approach**? Stay tuned…

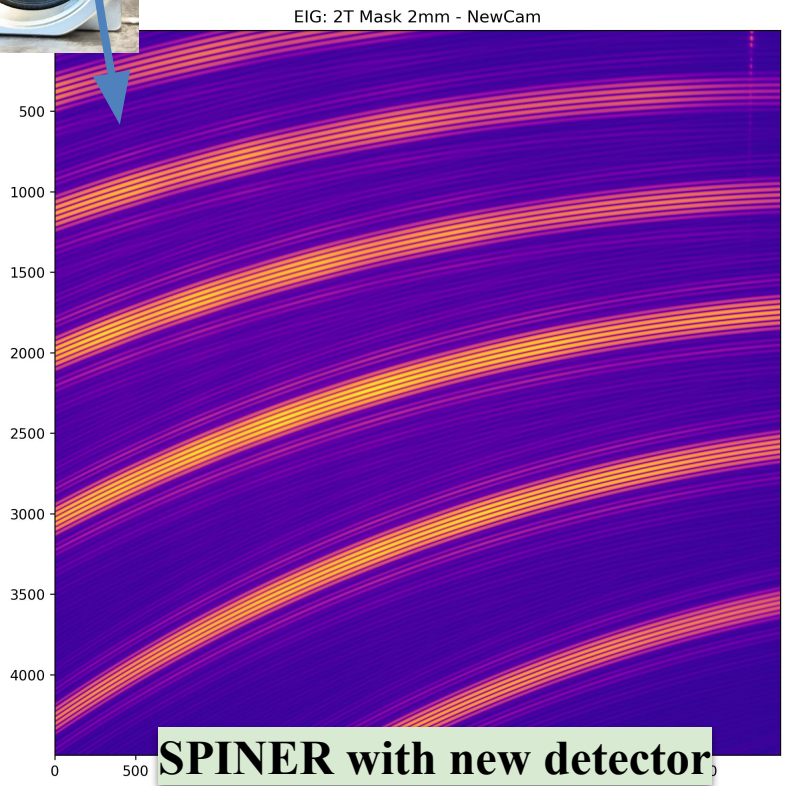


Results and next steps!

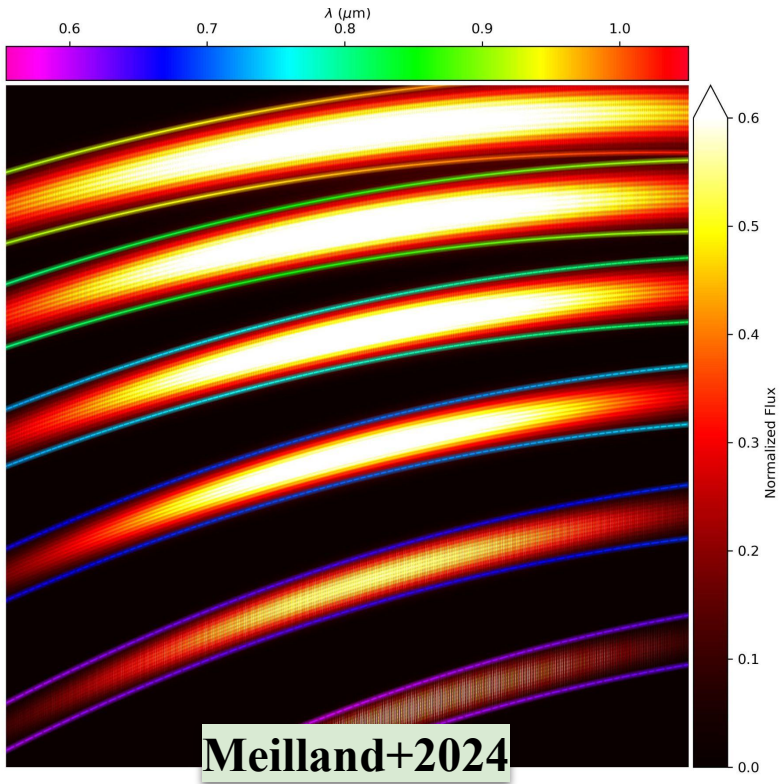








SPINER with new detector



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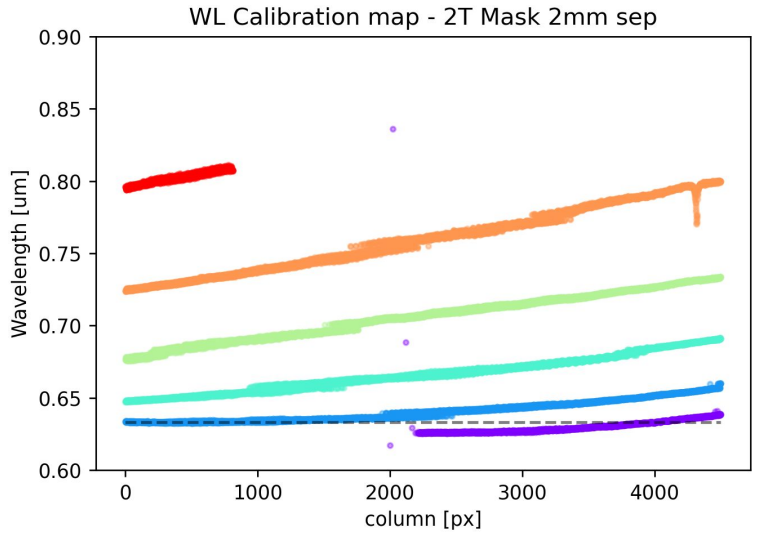
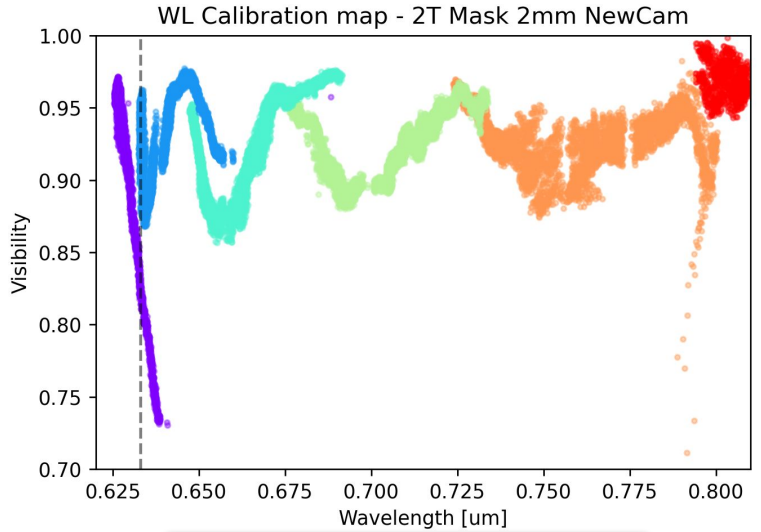




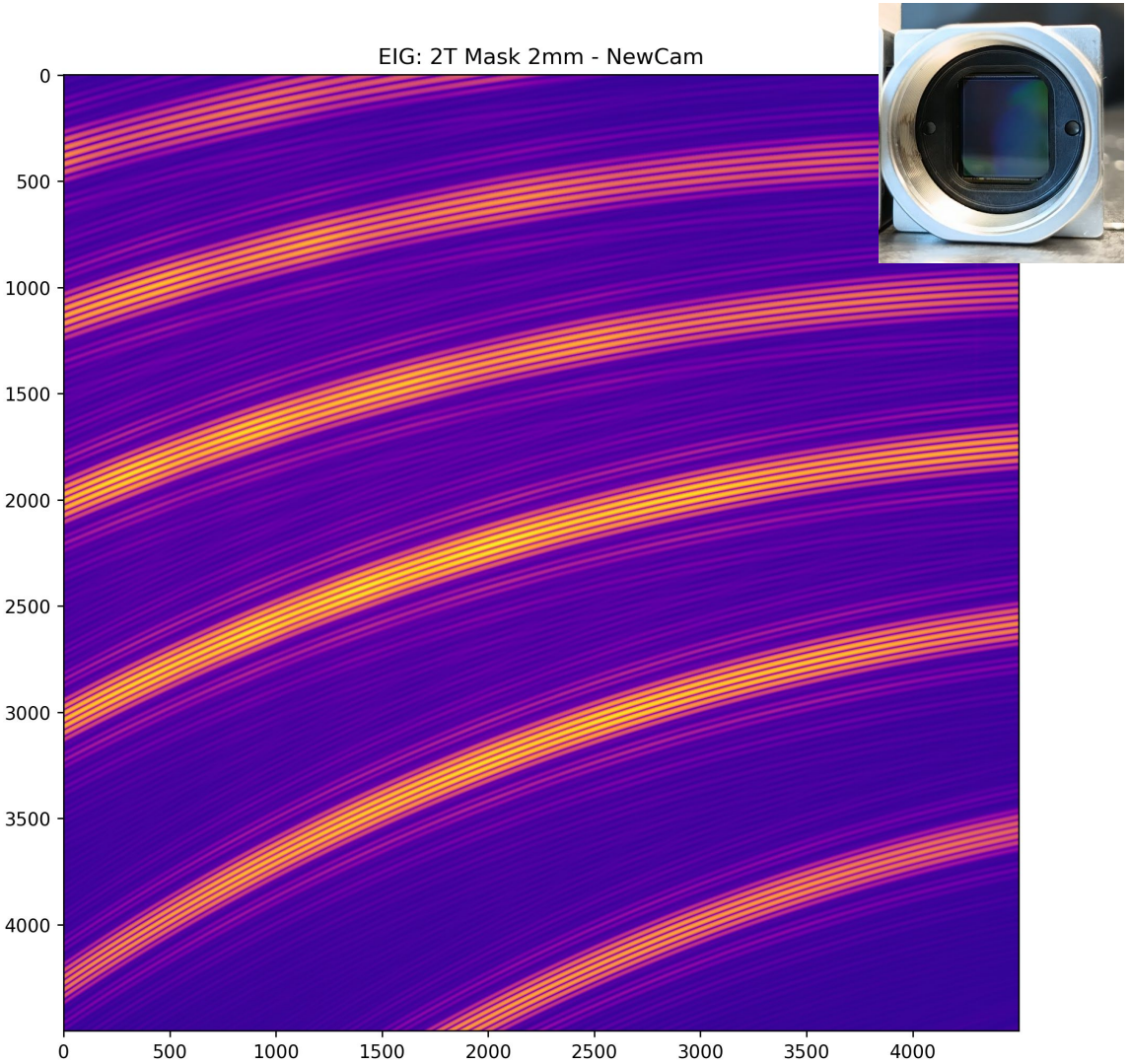
First spectral calibration with new detector (rough)

SPINER: Échelle spectro-interferometer

Summary and conclusions

Current status of the SPINER bench:

1. First results from rough **alignment + lab integration**.
2. EIG acquisition/analysis pipeline in development:
   a. N-Telescope cases.
3. New 4500x4500 px detector just arrived!
   a. More checks required.
   b. Realignment with **optical modeling** + **spectral lamp**.
   c. Refine **spectral calibration**.
4. **Thinner aperture** masks: current limit 0.5 mm. We would like to do tests with 0.1x15 mm apertures – i.e. broader the fringe pattern.
5. Further exploration with **more realistic input beams** and comparison to **photonics** applications!



Acknowledgments to the **SPINER team** and the **Lagrange engineering team** for support in my first approach to an optical lab setup. To F. **Martinache**, M. **Ireland**, S. **Robbe-Dubois** for very interesting and useful discussions on the intricacies of optical interferometry. The SPINER project is funded by **Observatoire de la Côte d'Azur**, the **Laboratoire Lagrange**, and the **ANR** project MASSIF. J. Calderon's MSc degree is funded by the **Erasmus Mundus Joint Master** scholarship as part of the **MASS program**.

¡Gracias!

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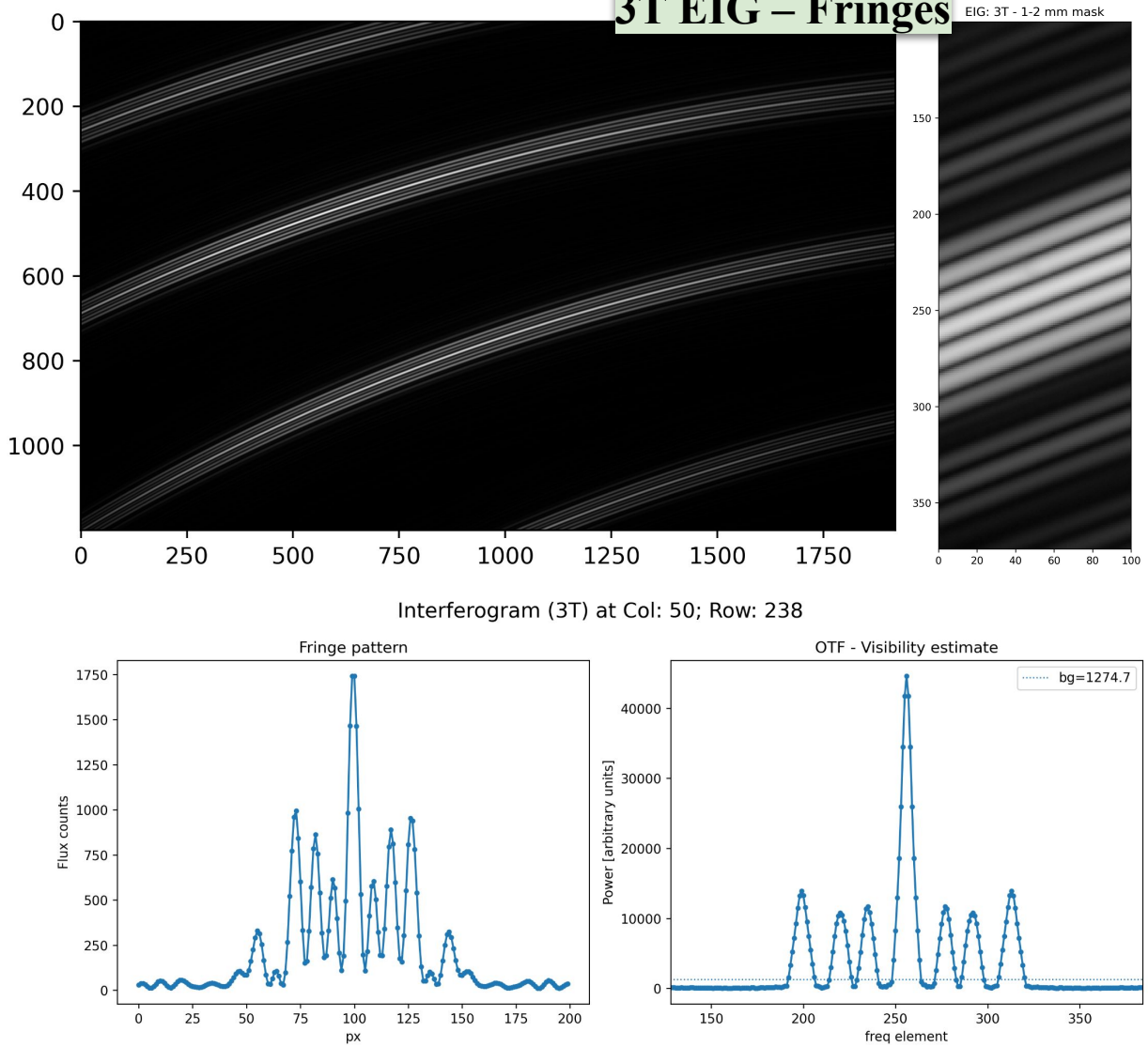
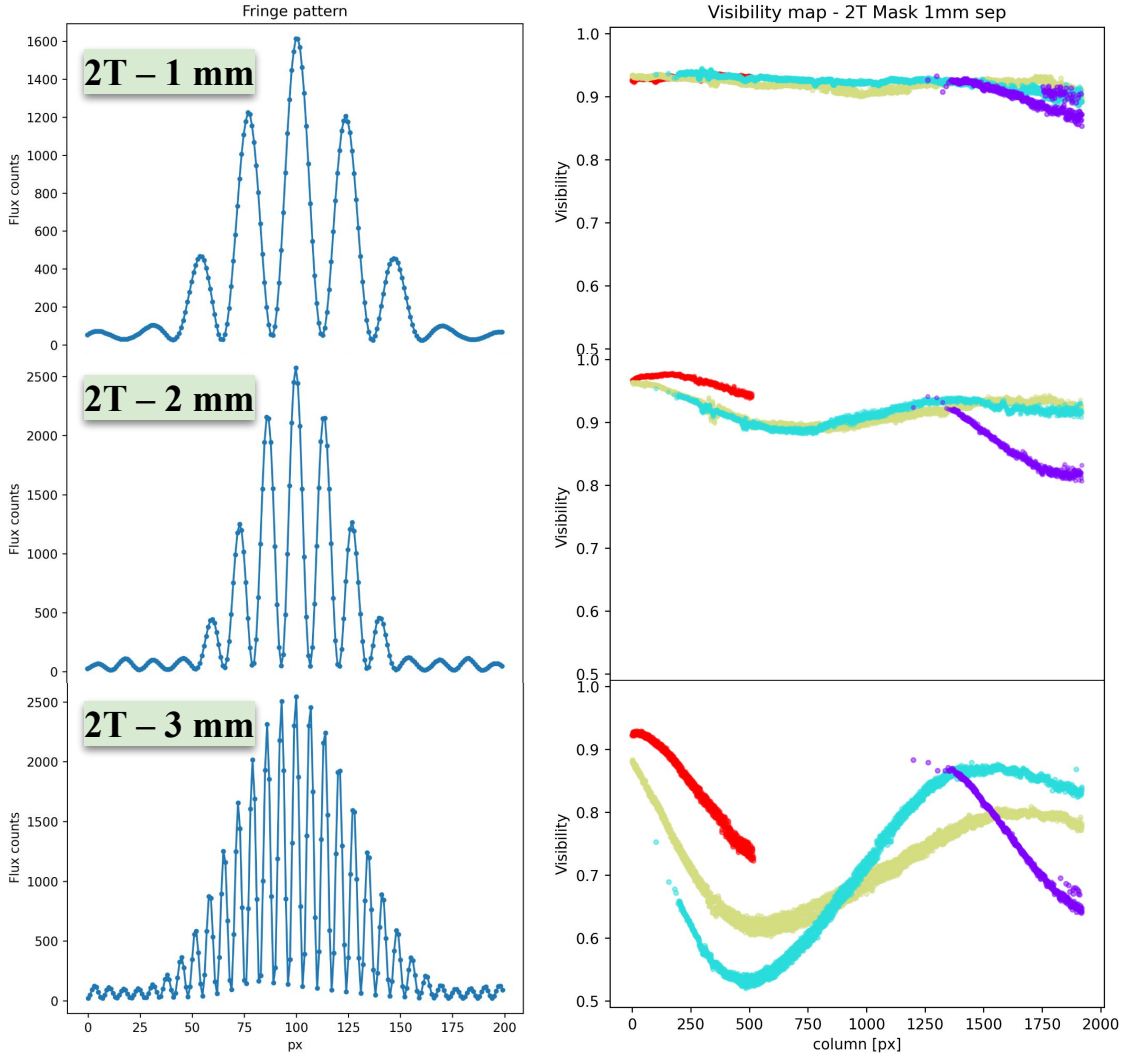
Bonus slide

3T EIG – Fringes



Sampling issues in larger baselines



(Older datasets)