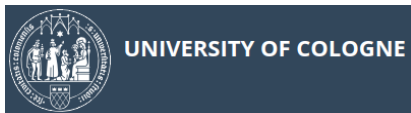




First results of photonic-based interferometry with the CHARA ARray Integrated Optics Testbed (CHARIOT)

Kévin Barjot, Aline N. Dinkelaker, Alyssa V. Mayer, Lucas Labadie, Nicholas J. Scott, Narsireddy Anugu, Gail Schaefer, Aurélien Benoît, Robert R. Thomson, Kalaga Madhav, Theo ten Brummelaar, Karolina Kubiak, Edgar R. Ligon





Plan

1. The CHARIOT project at CHARA
2. On-sky results
3. Conclusion and outlook



CHARIOT at CHARA





1. CHARIOT at CHARA

Objectives of CHARIOT

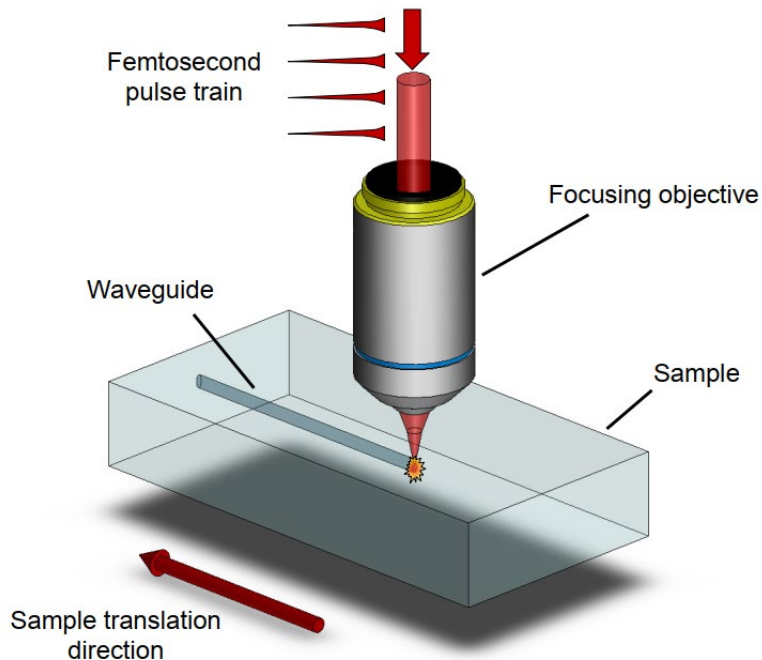
CHara ARray Integrated Optic Testbed (CHARIOT)

1. Assess the performance and potential of laser written K-band IO for long-baseline interferometry
2. Foster high-precision (1% goal) V2 interferometry for high-contrast science (debris disks) following JouFLU decommissioning
3. Offer a community-wide platform to test novel photonic concepts
4. Deployment of a 4-telescope beam combiner for nulling interferometry



1. CHARIOT at CHARA

Ultrafast Laser Inscription (ULI)



- less manufacturing processes
- more degrees of freedom (3D-inscribed waveguides)
- versatile
- targeted and low production

Limitations:

need of iterative characterization to get repeatable results

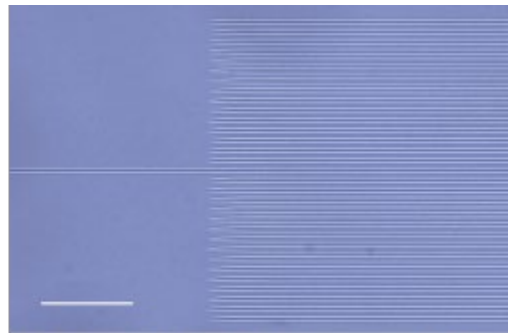


1. CHARIOT at CHARA

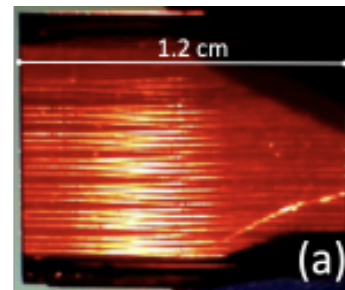
Ultrafast Laser Inscription (ULI)



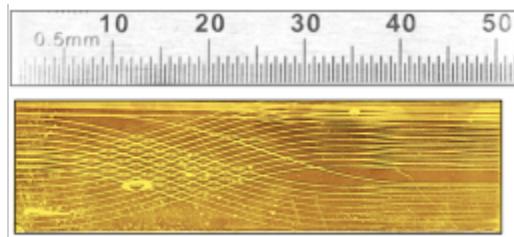
4T H-band DBC chip (Nayak+2021)



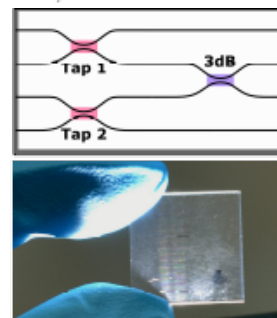
6T J-band DBC chip (Dinkelaker+2023)



3T N-band combiner (Rodenas+2012)



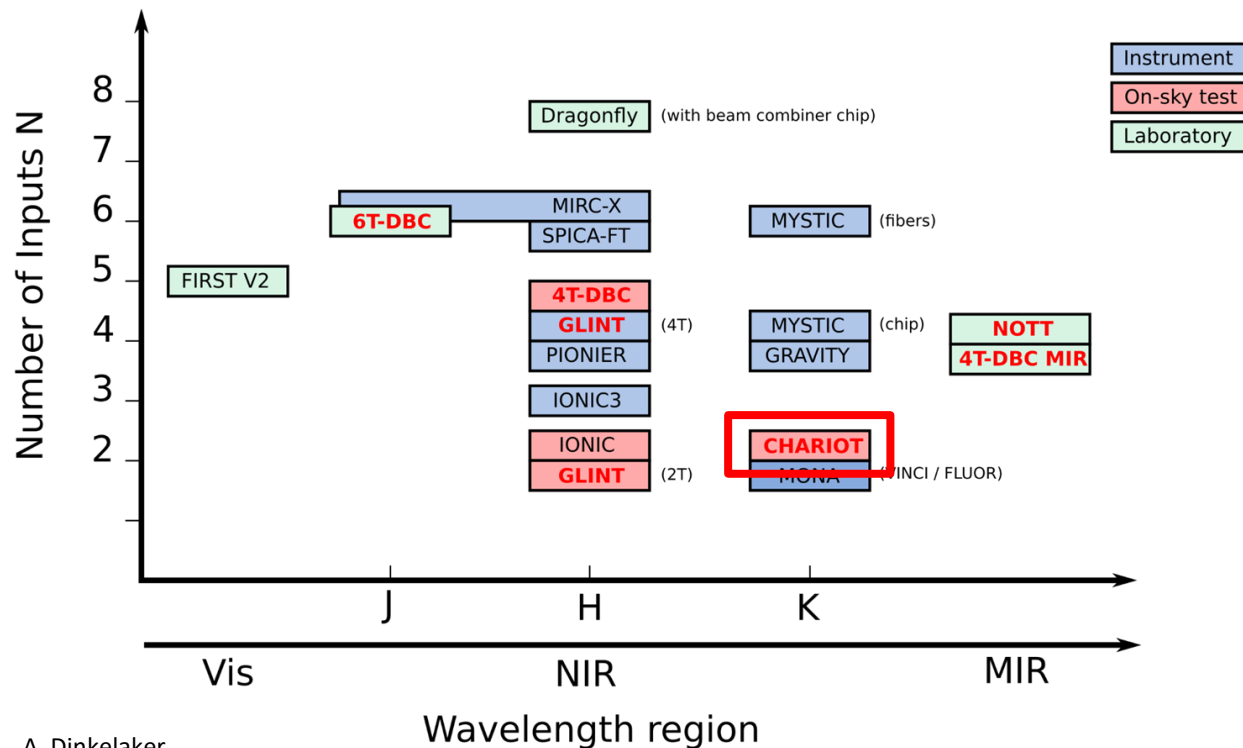
4T L'-band combiner (Ahmed+2025)



2T K-band combiner (Siliprandi+2024)

1. CHARIOT at CHARA

Photonic-based instruments

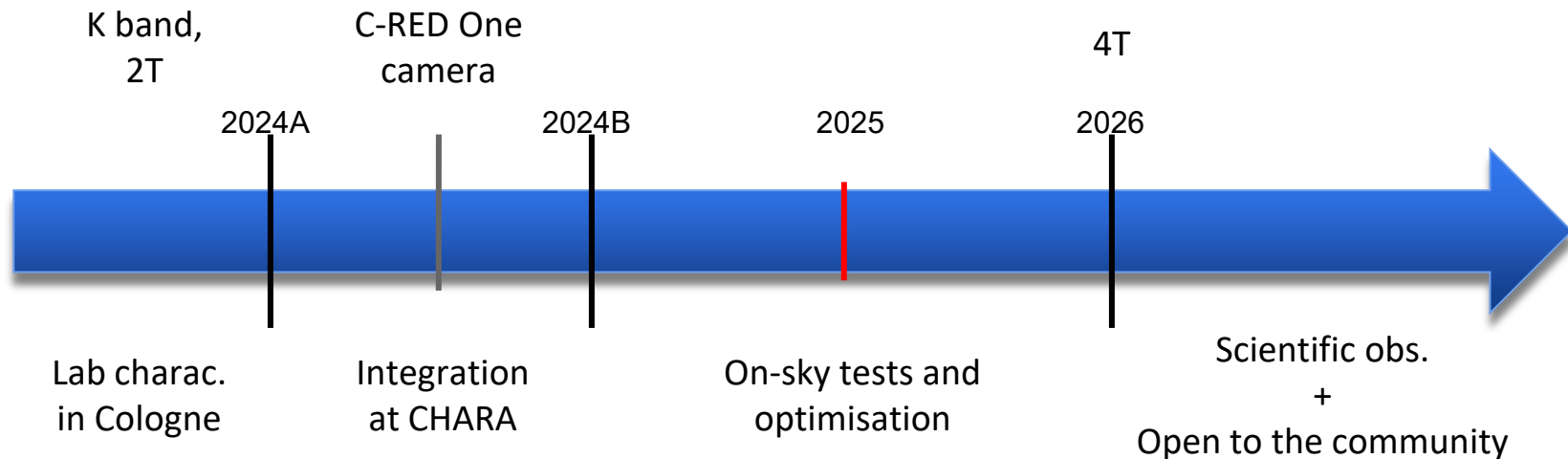


A. Dinkelaker



1. CHARIOT at CHARA

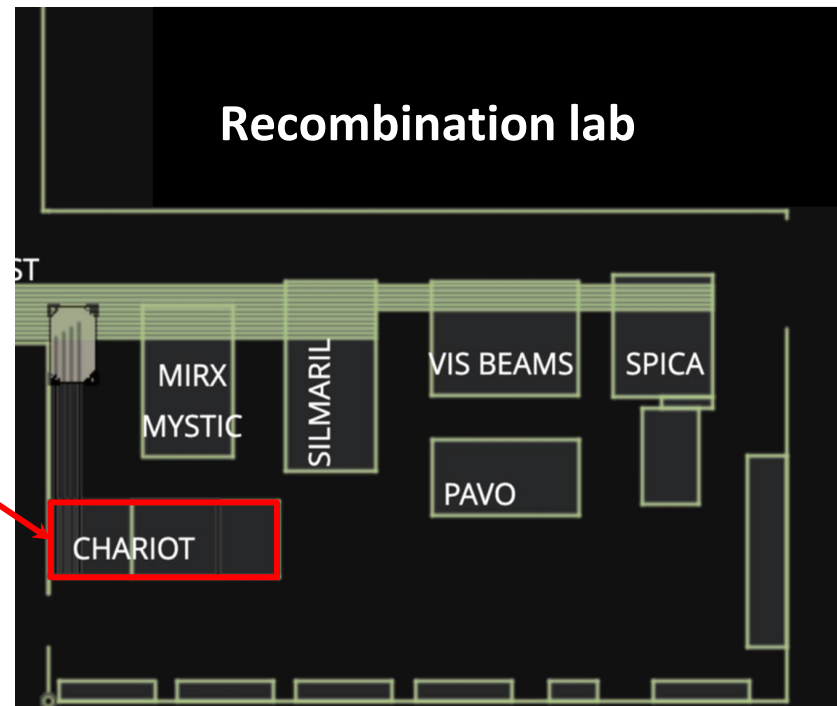
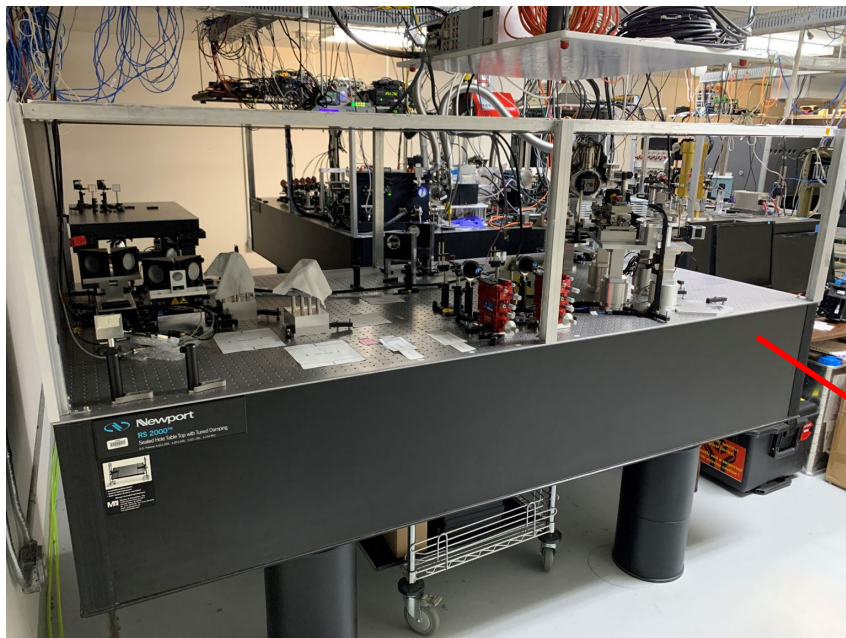
CHARIOT Development phases





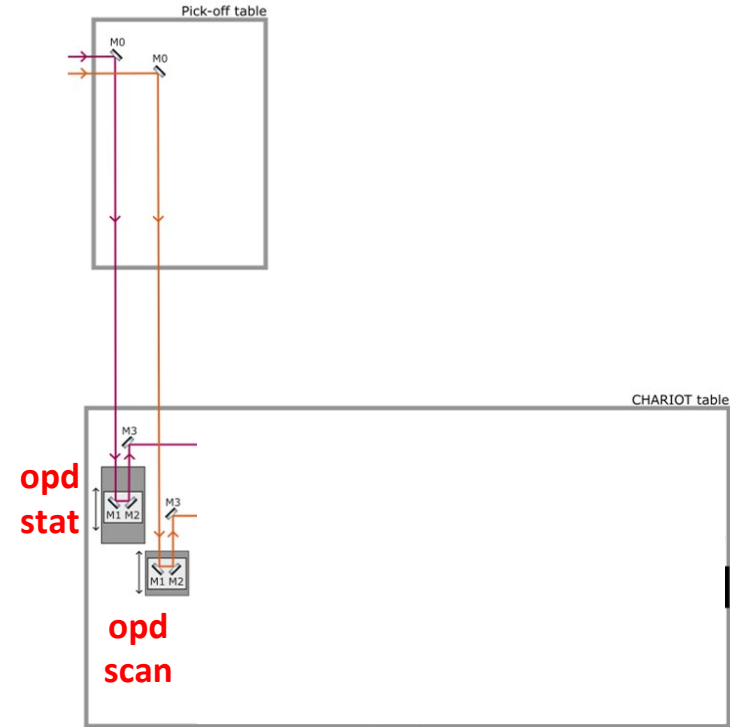
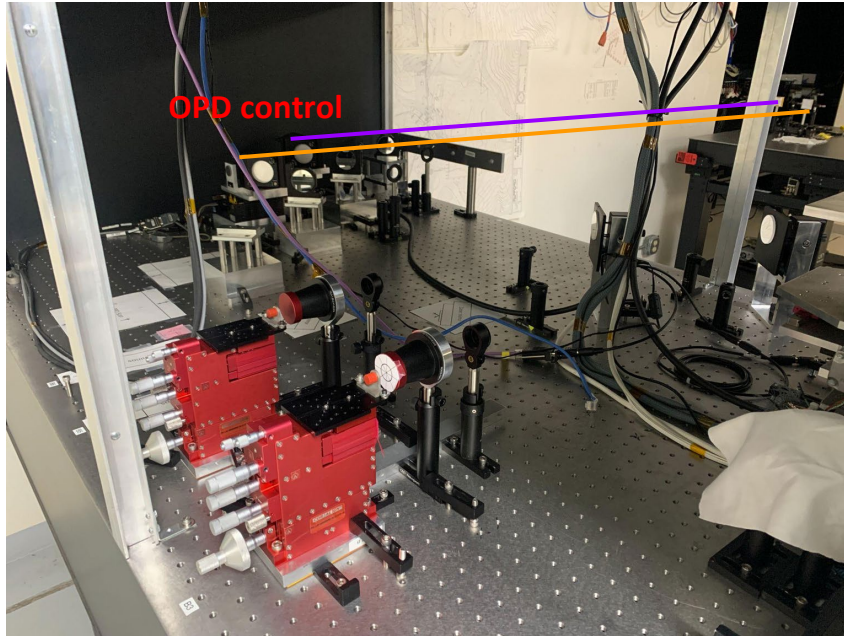
1. CHARIOT at CHARA

CHARIOT at CHARA



1. CHARIOT at CHARA

CHARIOT at CHARA

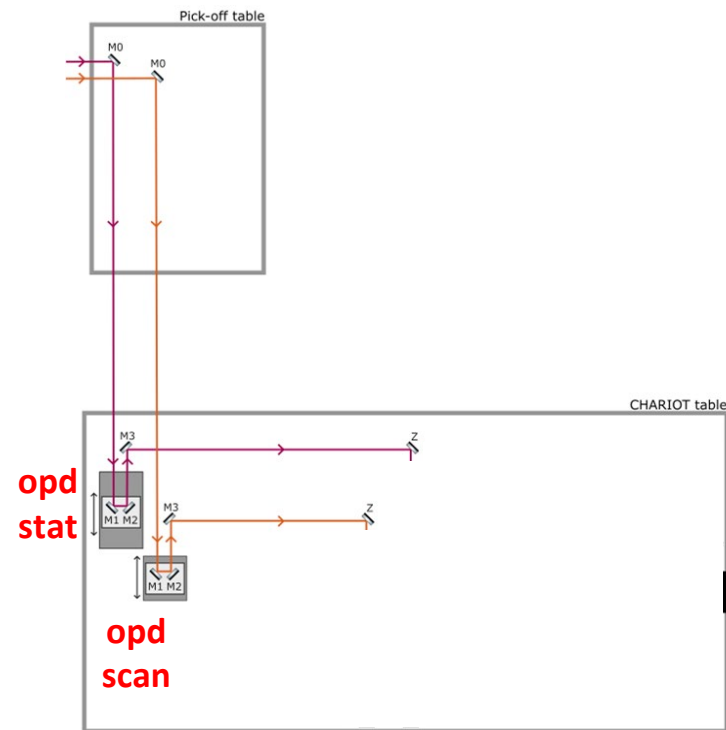
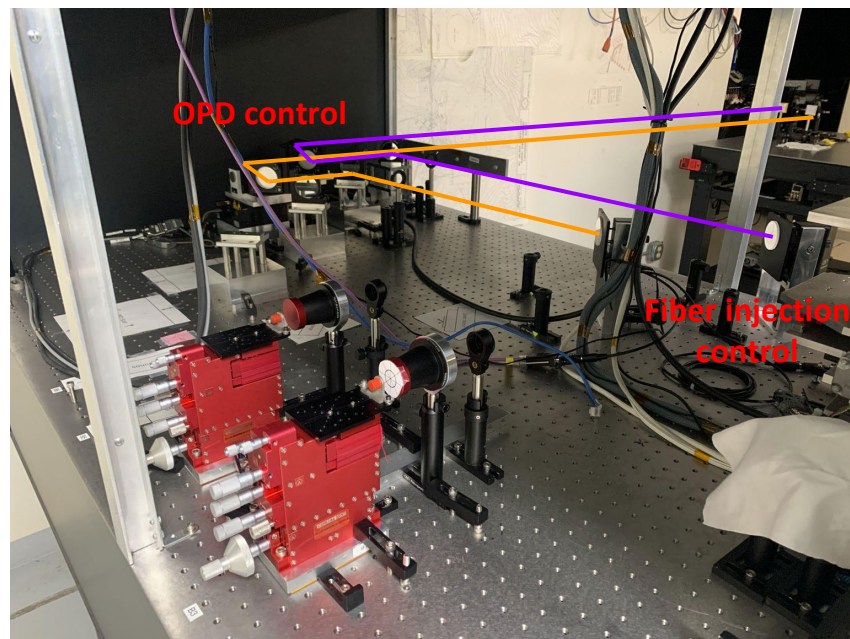


A. Dinkelaker, A. V. Mayer



1. CHARIOT at CHARA

CHARIOT at CHARA

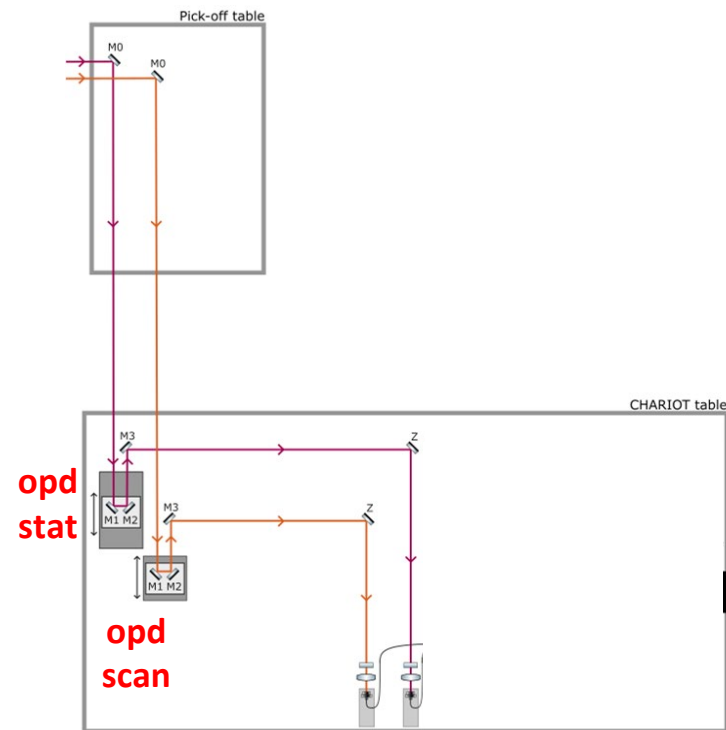
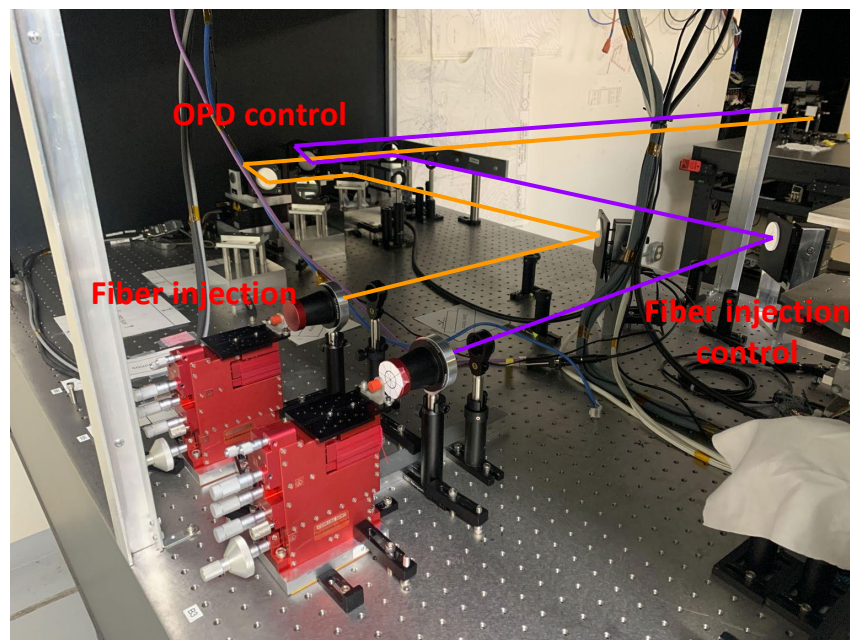


A. Dinkelaker, A. V. Mayer



1. CHARIOT at CHARA

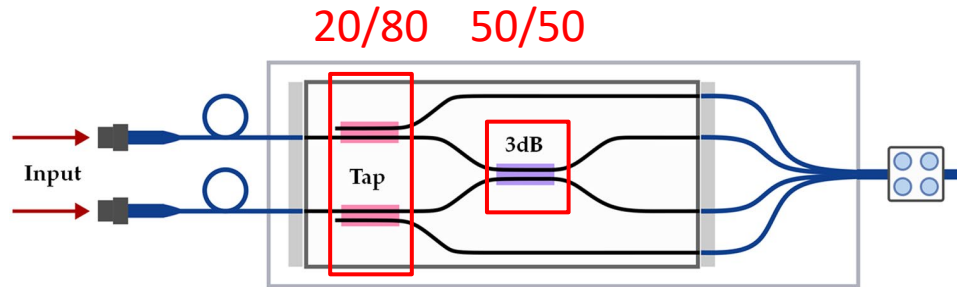
CHARIOT at CHARA



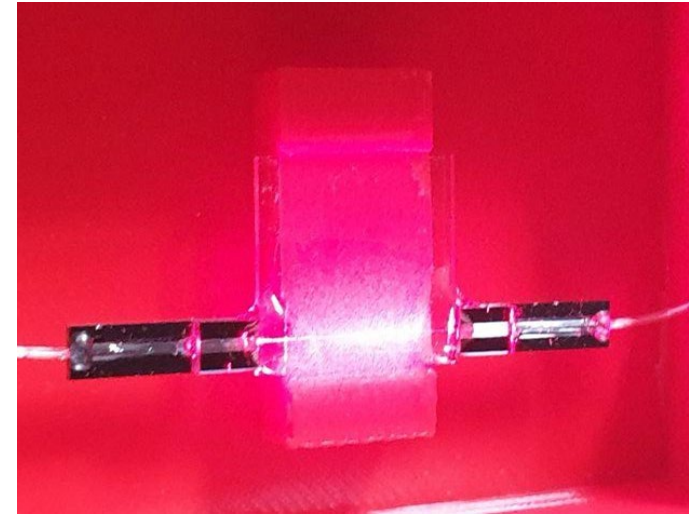
A. Dinkelaker, A. V. Mayer

1. CHARIOT at CHARA

CHARIOT - 2T ULI beam combiner



Benoit et al. 2021



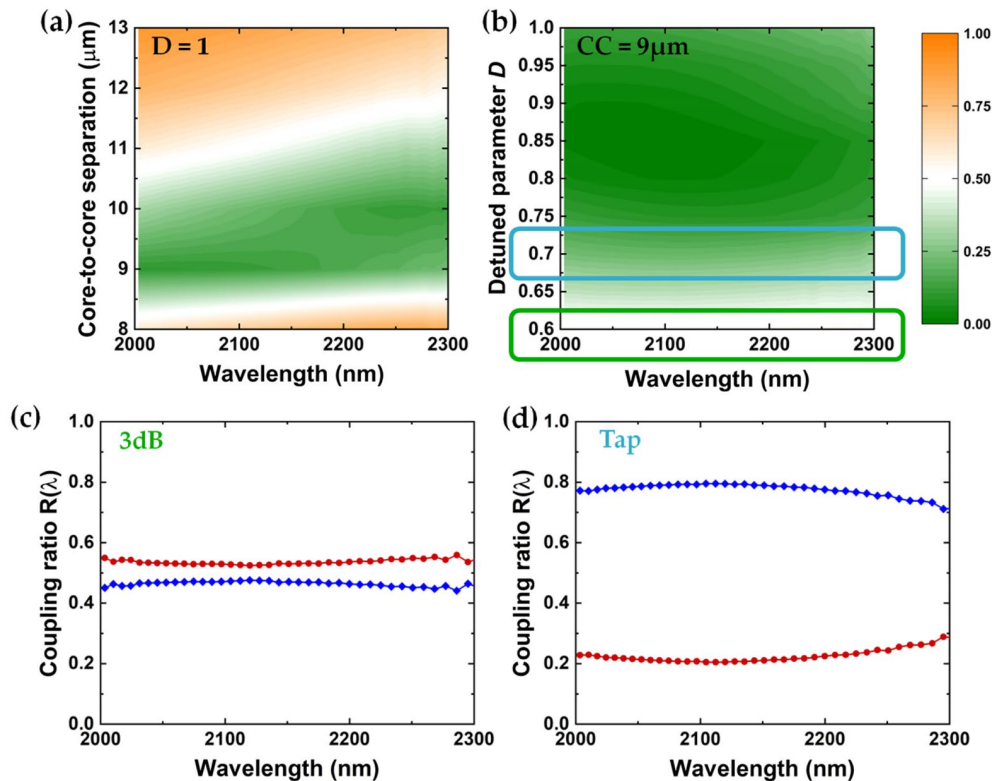
A. Dinkelaker



1. CHARIOT at CHARA

CHARIOT - 2T ULI beam combiner

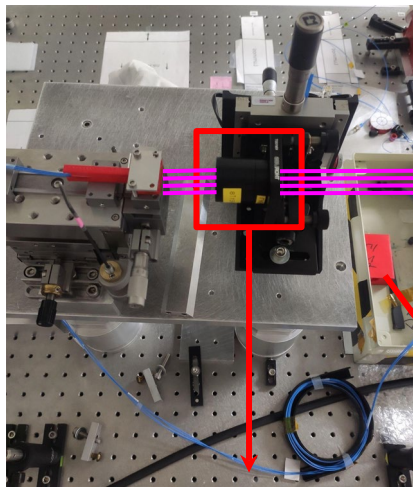
Optimization &
laboratory
characterization
(Siliprandi et al. 2024)



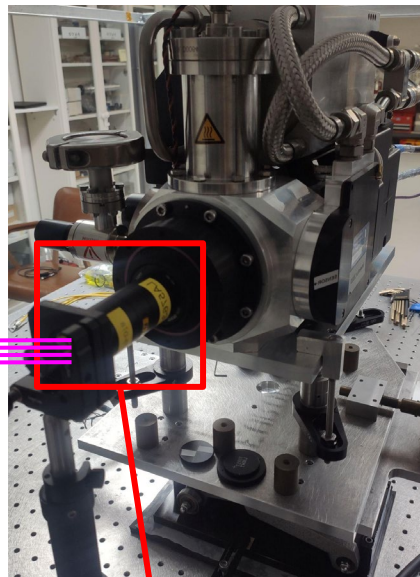


1. CHARIOT at CHARA

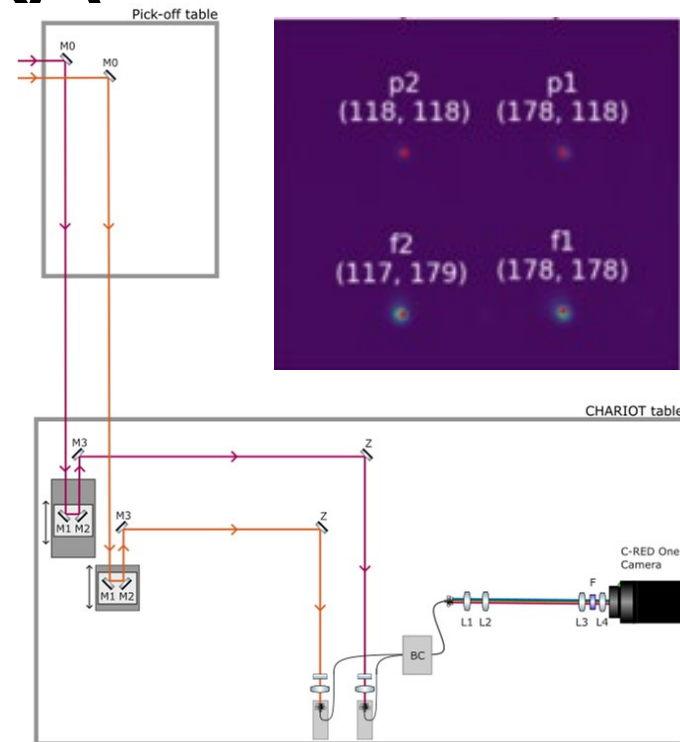
CHARIOT at CHARA



L1 & L2

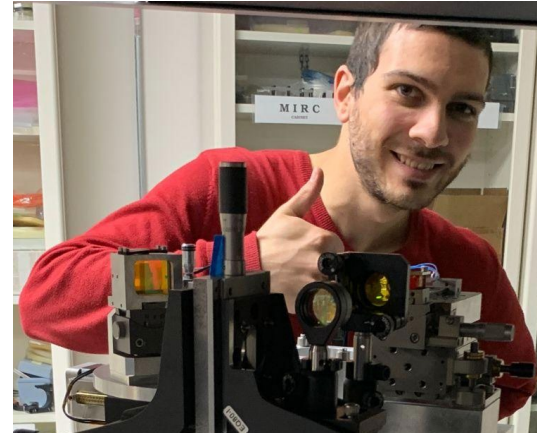


L3, K' filter, L4



A. Dinkelaker, A. V. Mayer

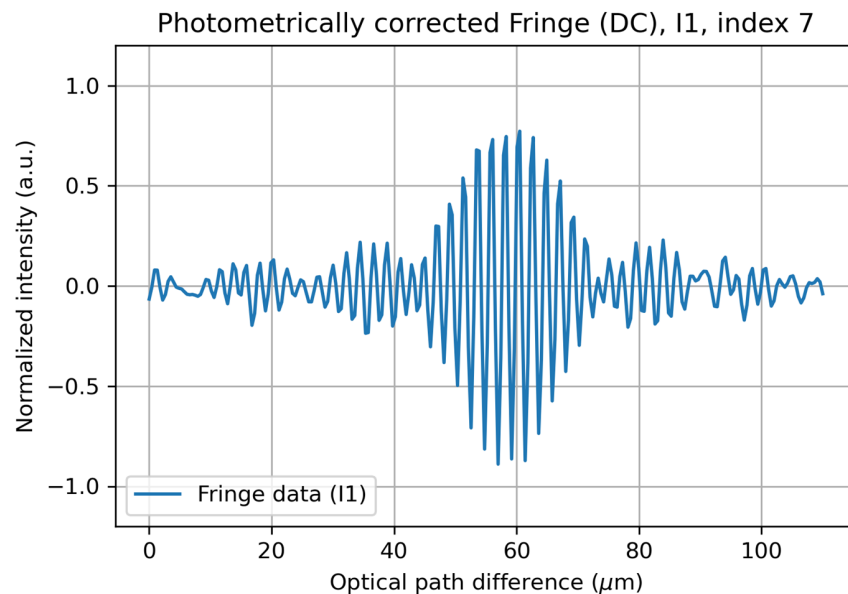
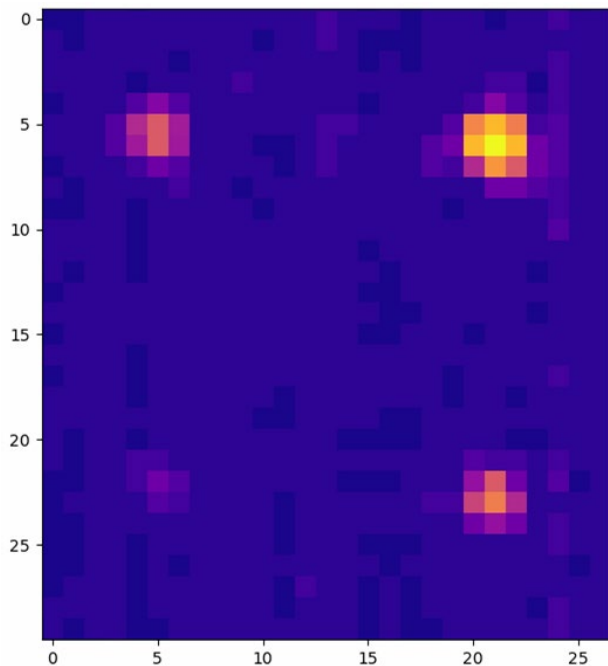
Results





2. Results

Data acquisition (temporal encoding)

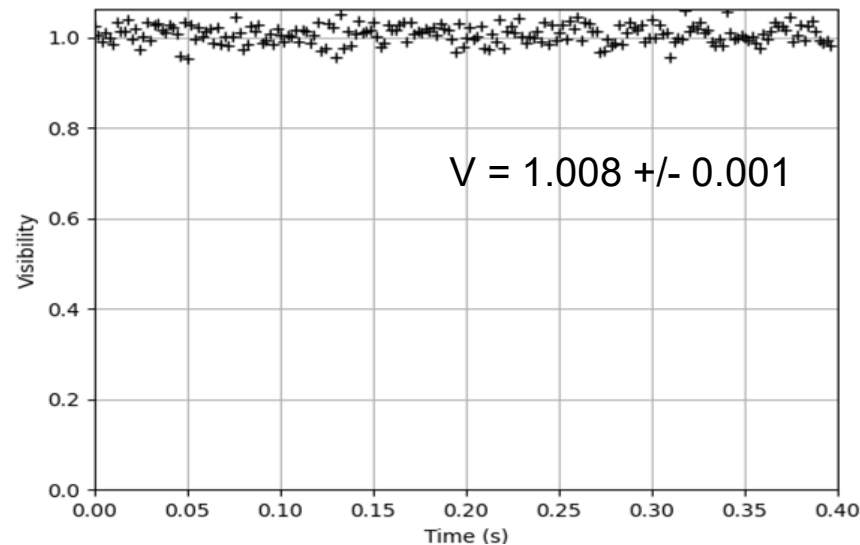
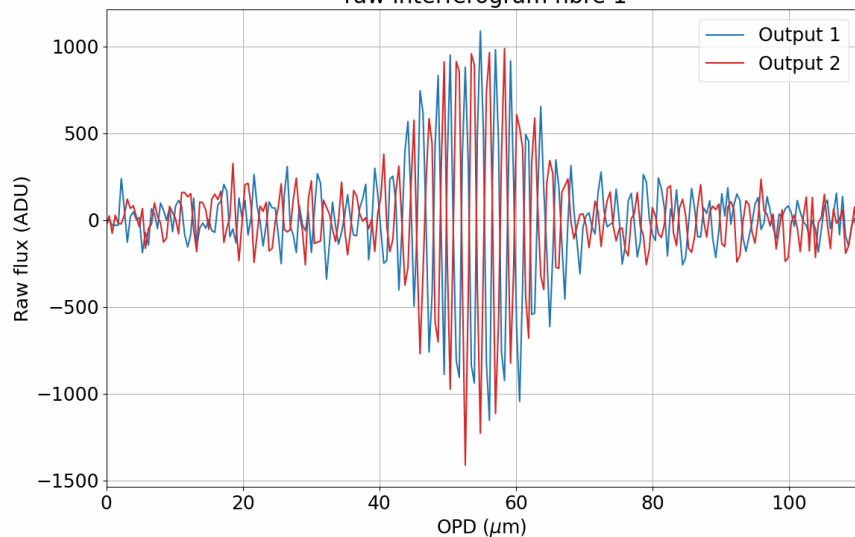


**CLASSIC/JouFLU data
reduction pipeline (cf. TR96,
TR97)**

2. Results

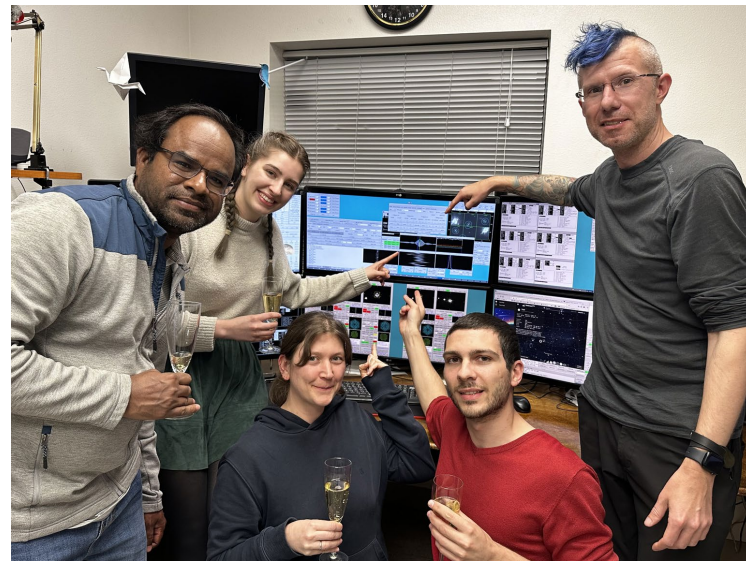
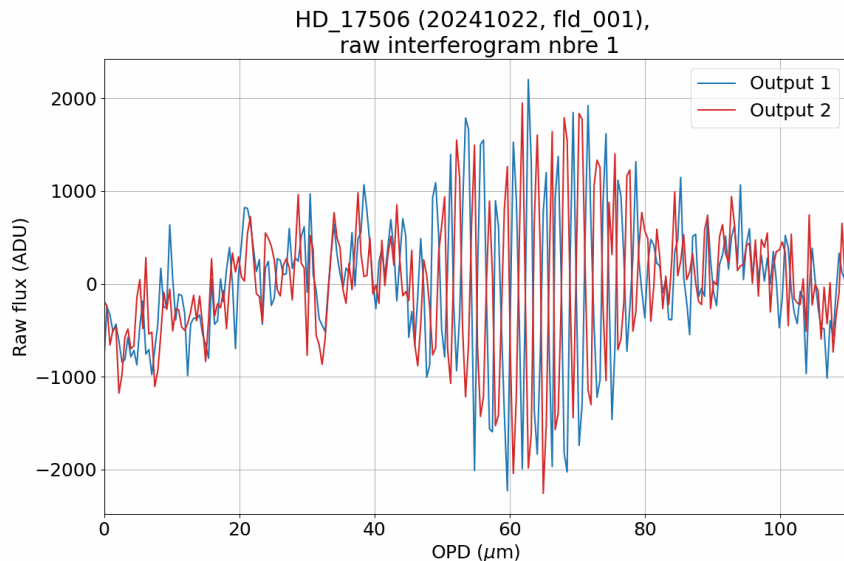
Internal source

STS (20241022, fld_002),
raw interferogram nbre 1



2. Results

First on-sky tests

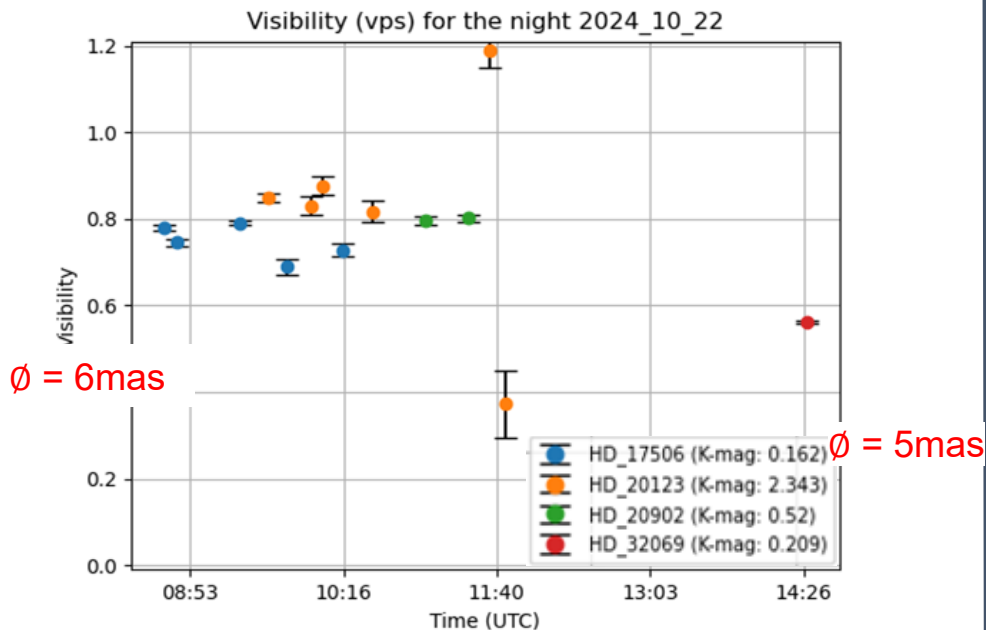
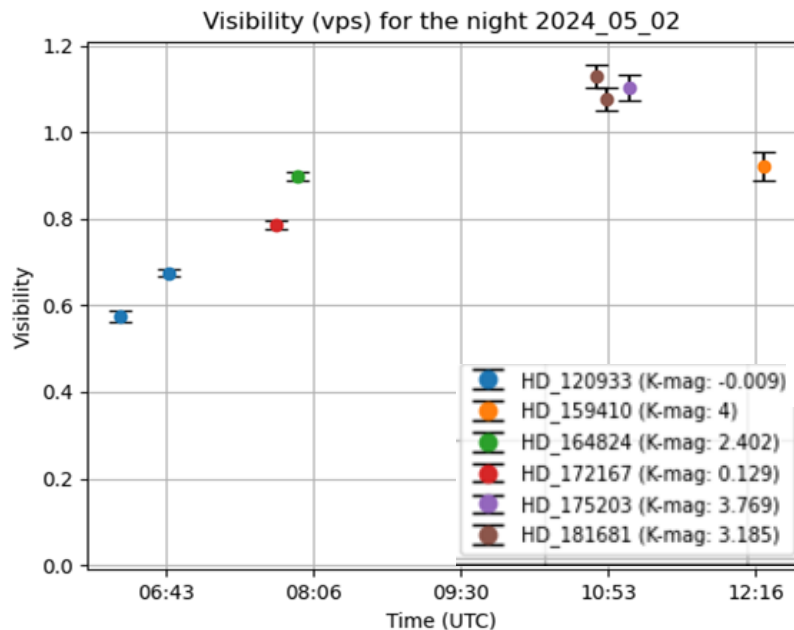


G. Schaefer

2. Results

On-sky visibilities

Baseline: S1-S2 (34m)



Conclusion



Conclusion

Summary

Conclusion:

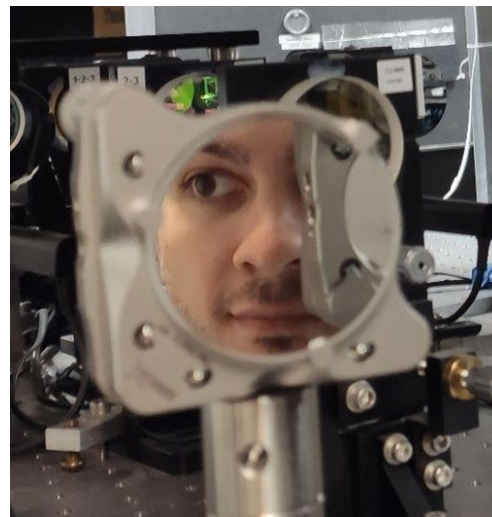
- the optical system was improved
- ULI-BC in K band gave first light on sky
(~10 targets)
- K-mag 4 target observed

Outlook:

- *observing run in July 2025*
- *implement a fringe tracker with MIRC-X*
- *improve the imaging optics alignment*
- *combining 4 CHARA telescopes*
- *optimization of the testbed accessibility*

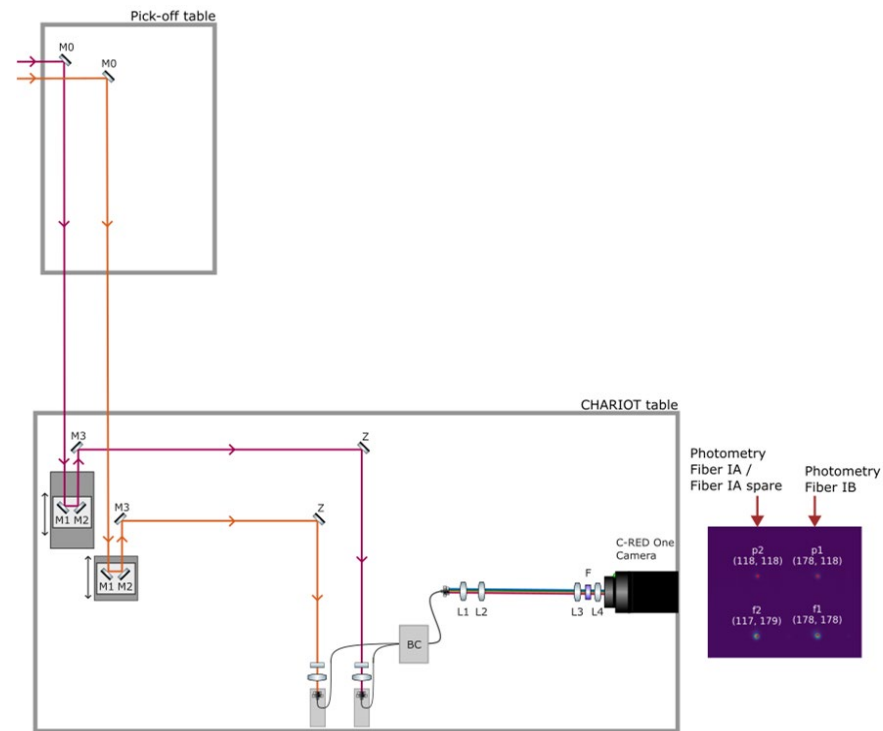
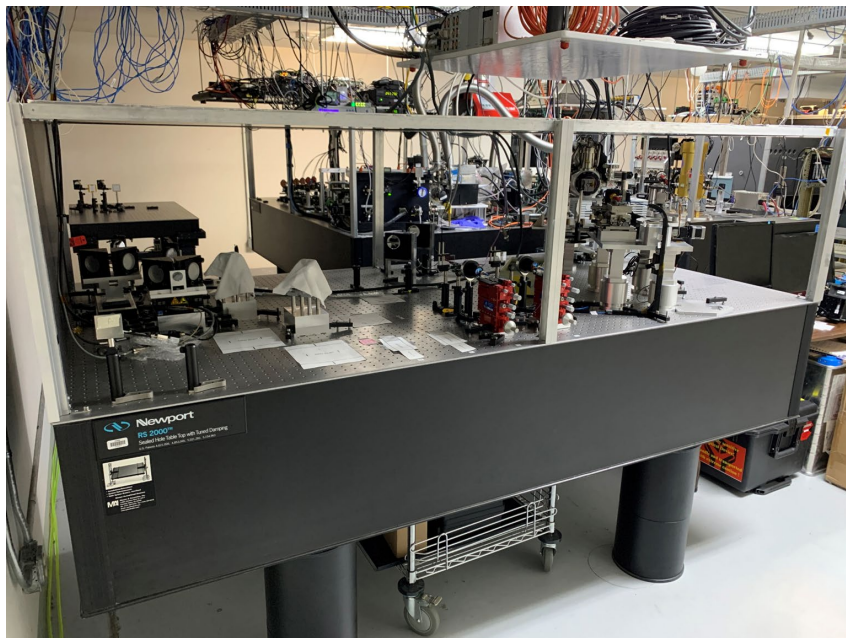


Thank you
Merci





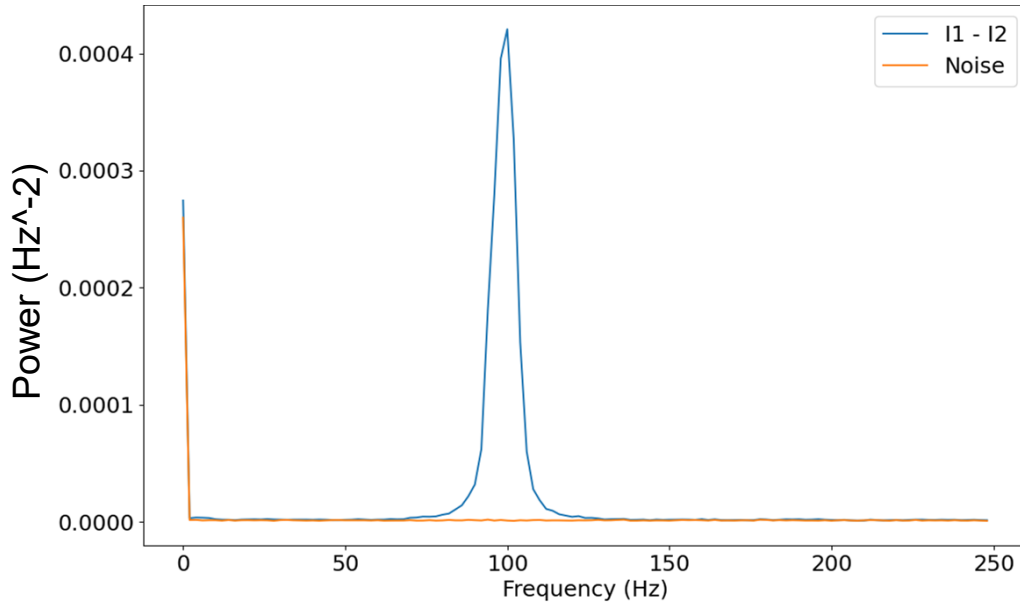
CHARIOT at CHARA



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Data reduction

Power spectrum

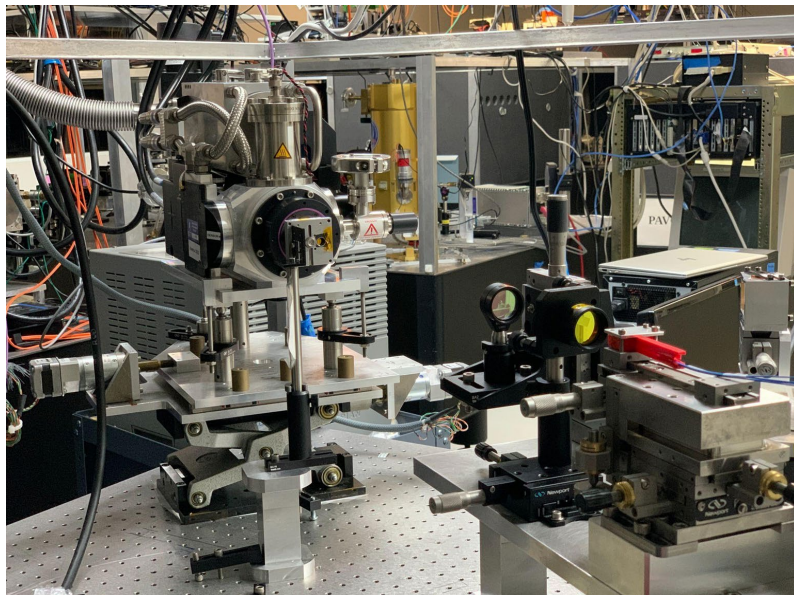


Power spectrum, $PS(f(t)) = |F(f)|^2$

$$\int_0^{\infty} PS(f(t)) df = \frac{V^2}{4\Delta\sigma v}$$



Plug and play



A. V. Mayer

Improve the output interface:

- *V-Groove*
- *FC connector*
- *bare fiber*



Novel Astronomical Instrumentation through photonic Reformatting (NAIR)

- Astronomical Photonic Reformatter EXperiment for Infrared Science (APREXIS)
- Development of ULI technology
- Proposes modular instruments for high contrast imaging (CHARA, VLTI)
- Multi-core Integral Field Unit (MCIFU) spectroscopy
- Multiplexed Discrete Beam Combiner