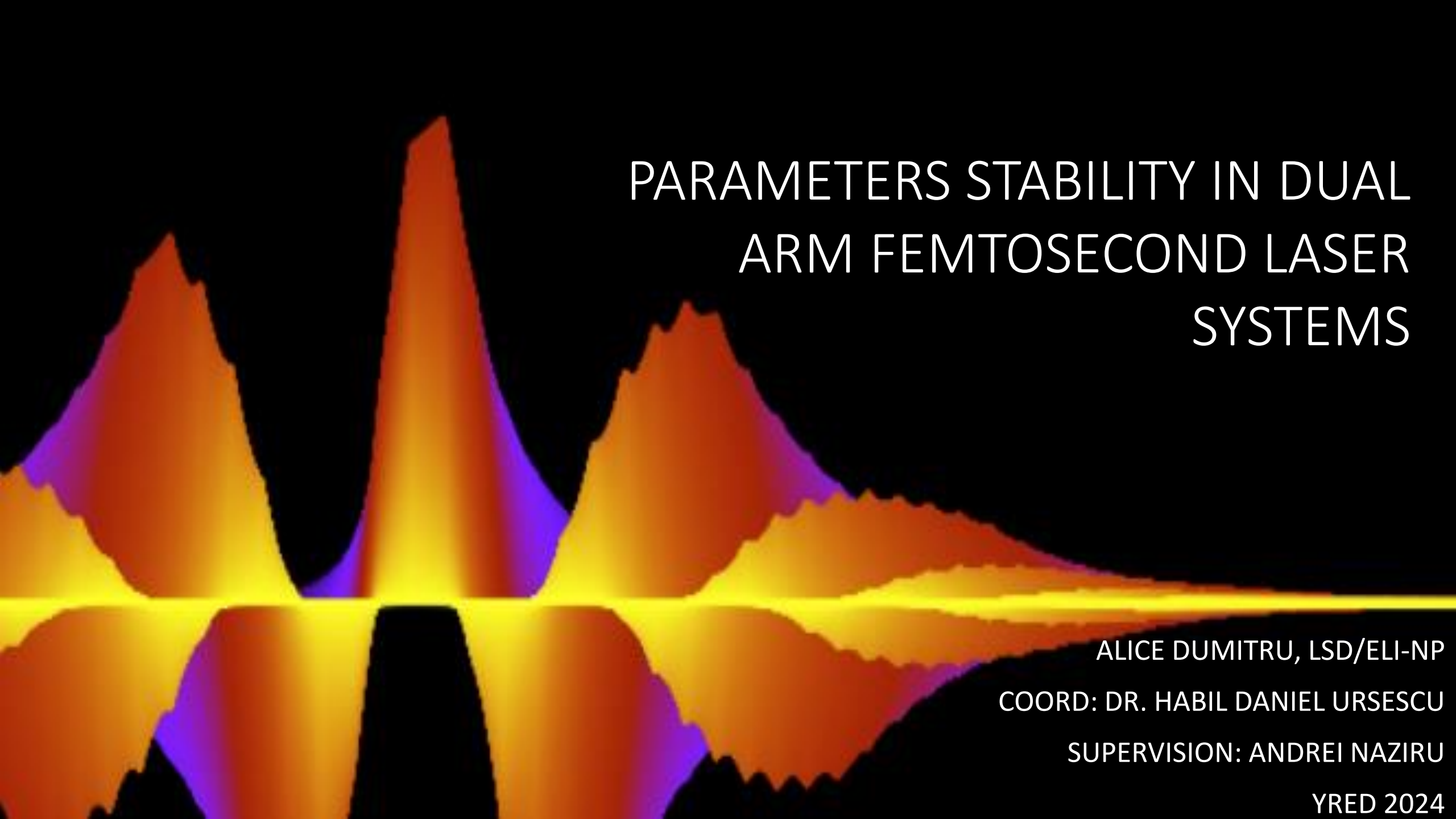

PARAMETERS STABILITY IN DUAL ARM FEMTOSECOND LASER SYSTEMS

ALICE DUMITRU, LSD/ELI-NP

COORD: DR. HABIL DANIEL URSESCU

SUPERVISION: ANDREI NAZIRU

YRED 2024

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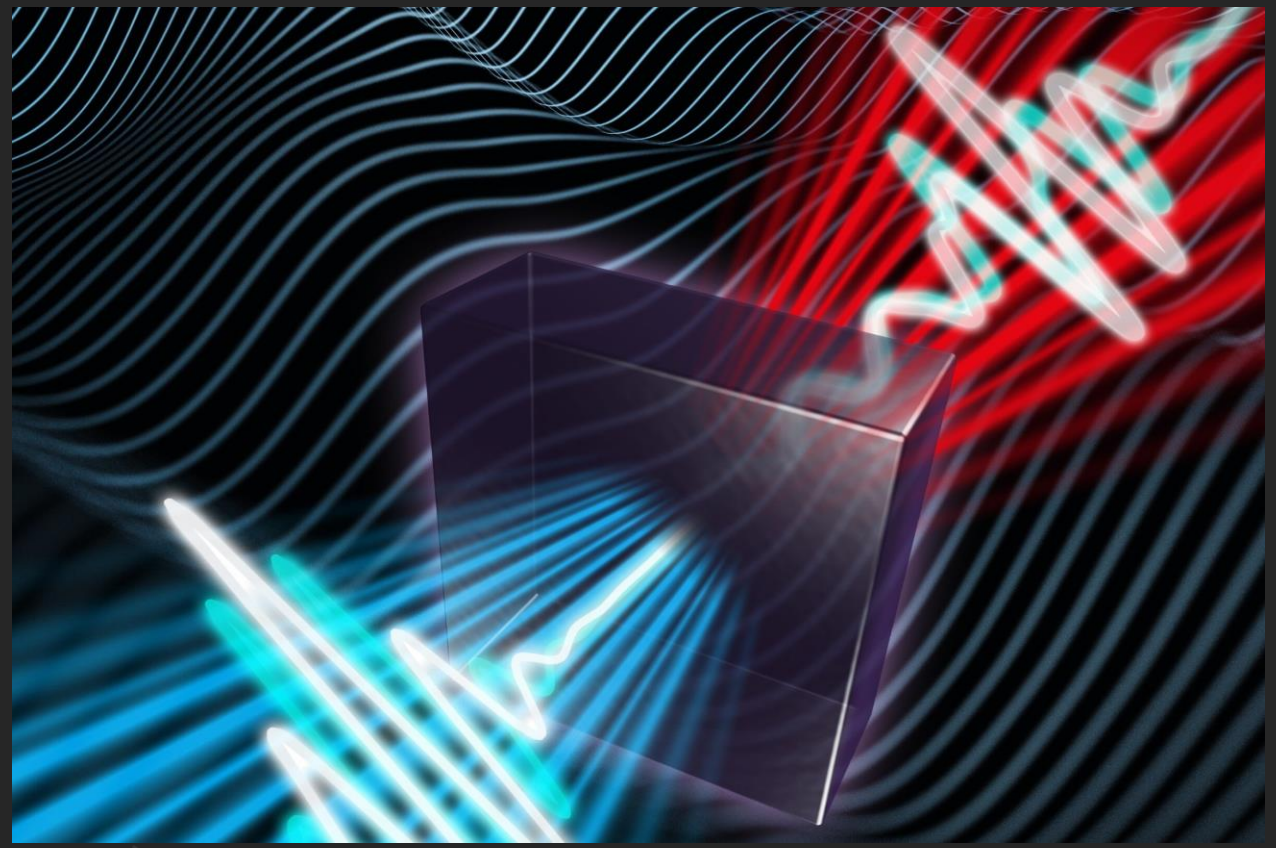
Relevant laser parameters for synchronized experiments



- Unprecedented EM field strengths
- Great focused intensity
- Petawatt level beams allow QED studies

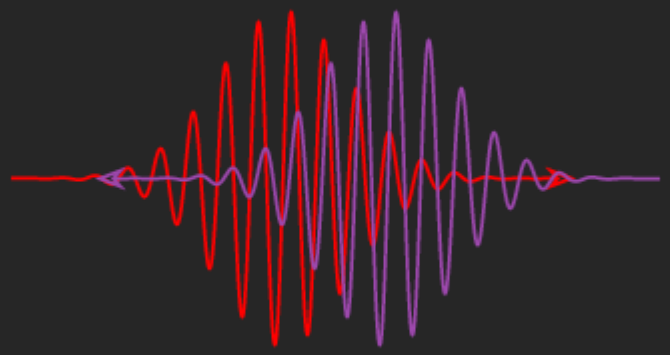
- Great fluence on components
- Manufacturing limit for big diameter optics and crystals

- Increased intensity directly on target
- Coherent combination of two beams
- Synchronisation for secondary particle generation

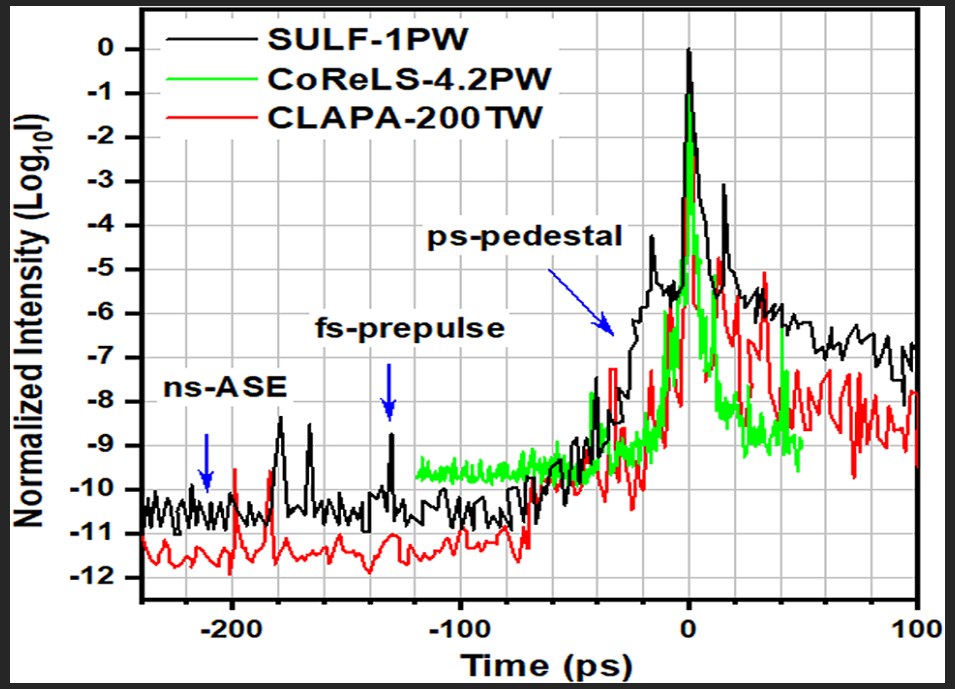
Image source: Steinleitner, P., Nagl, N., Kowalczyk, M. et al. Single-cycle infrared waveform control. Nat. Photon. 16, 512–518 (2022). https://doi.org/10.1038/s41566-022-01001-2

Relevant laser parameters for synchronized experiments

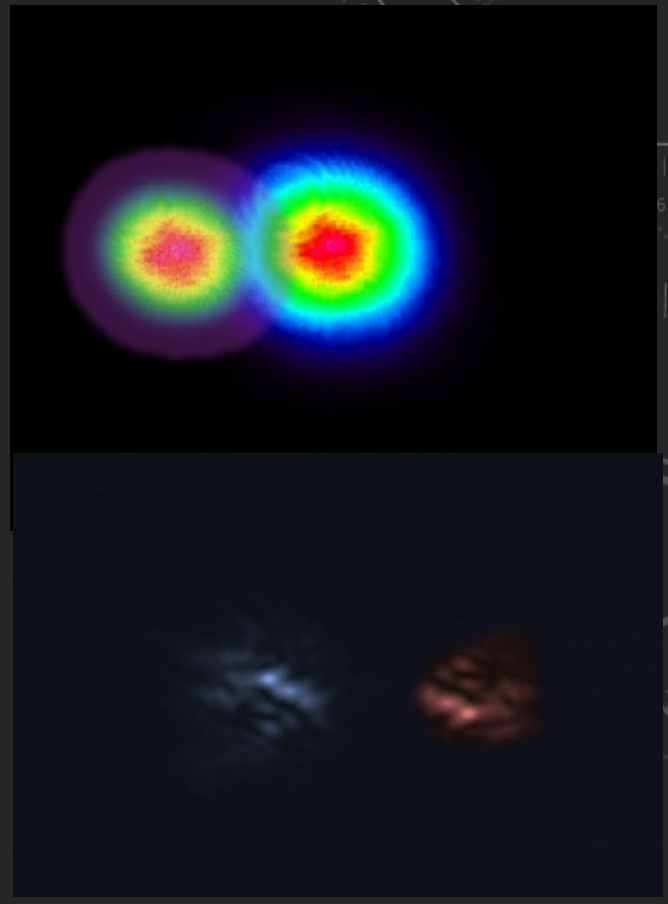
Spectral distribution:
- wave components (Bandwidth, carrier wave envelope, centroid)
- dispersion (GD, GDD, TOD)



Temporal distribution:
- pulse duration
- contrast (ps, ns scale)



Spatial distribution:
- focus profile
- energy distribution stability



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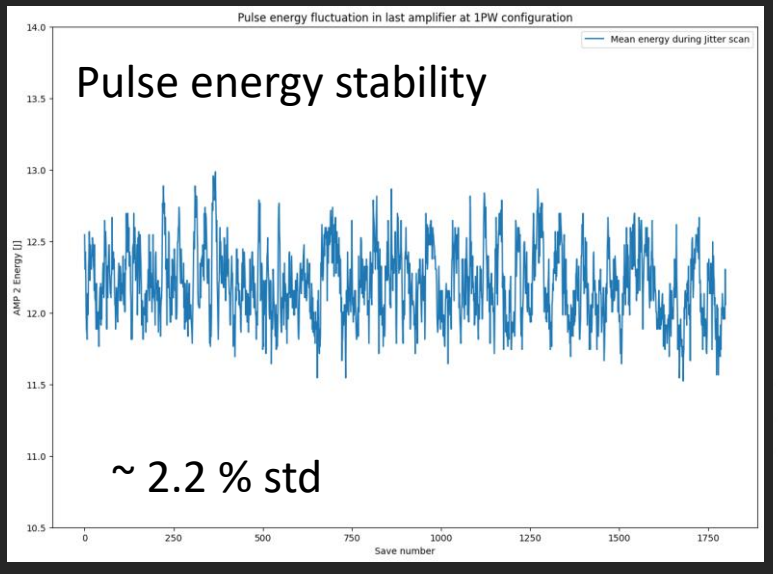
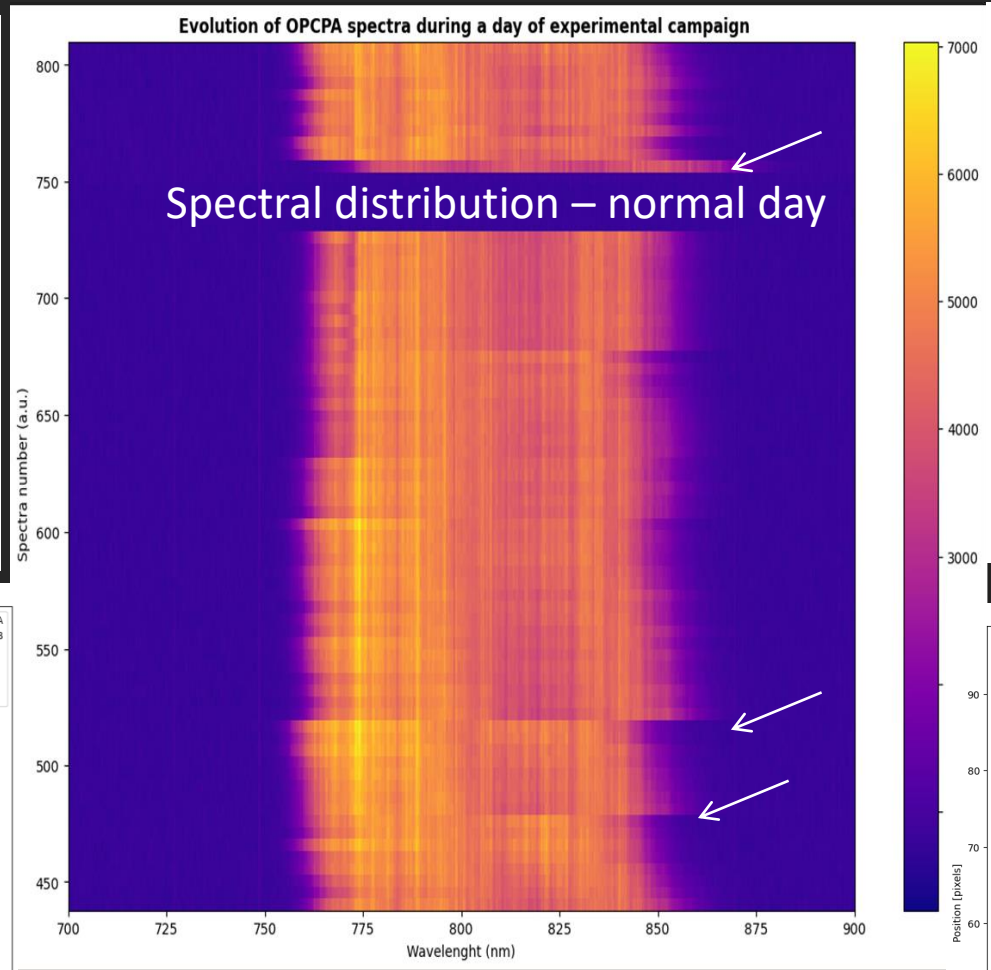
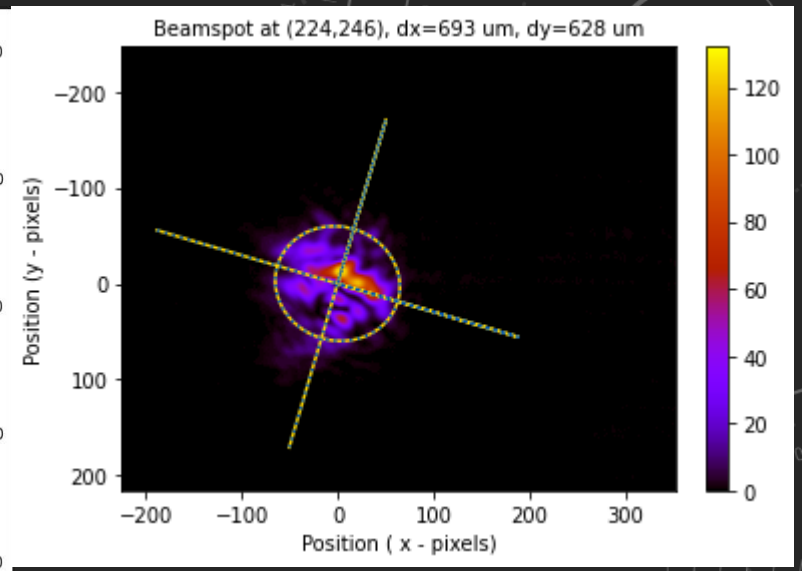
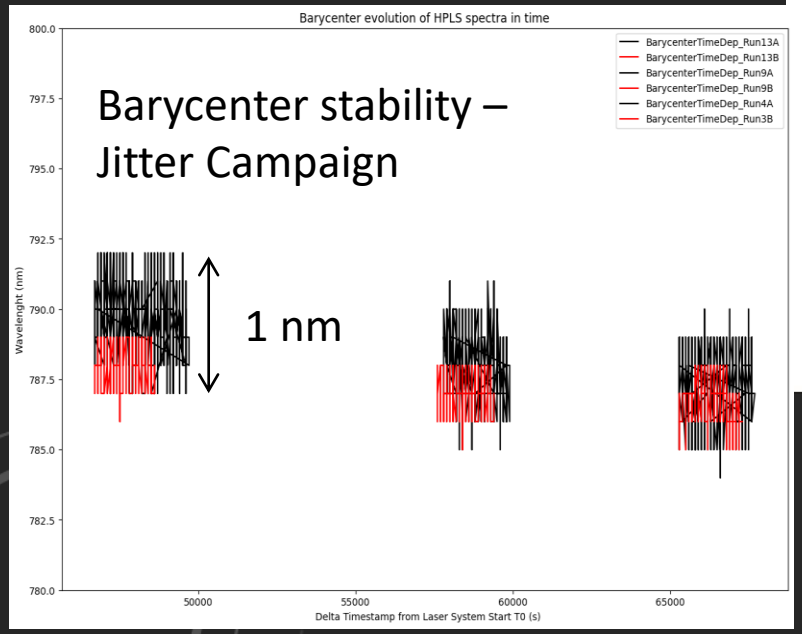
Parameters recorded for HPLS systems and their stability

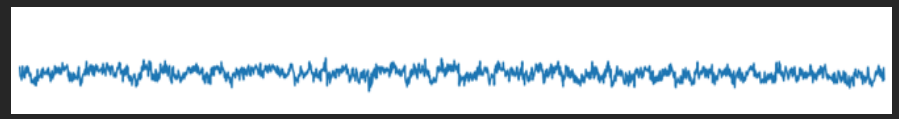


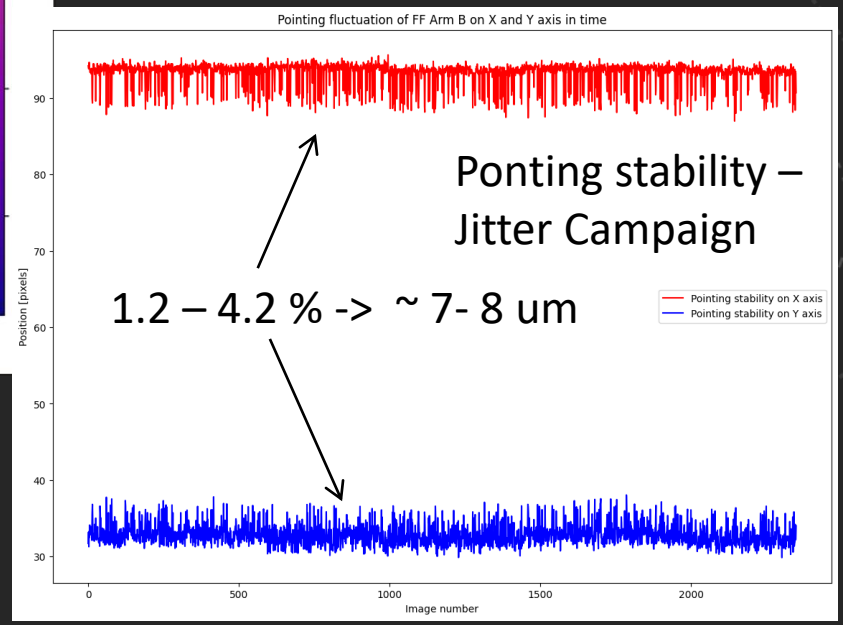






~ 0.09 % average barycentre fluctuation





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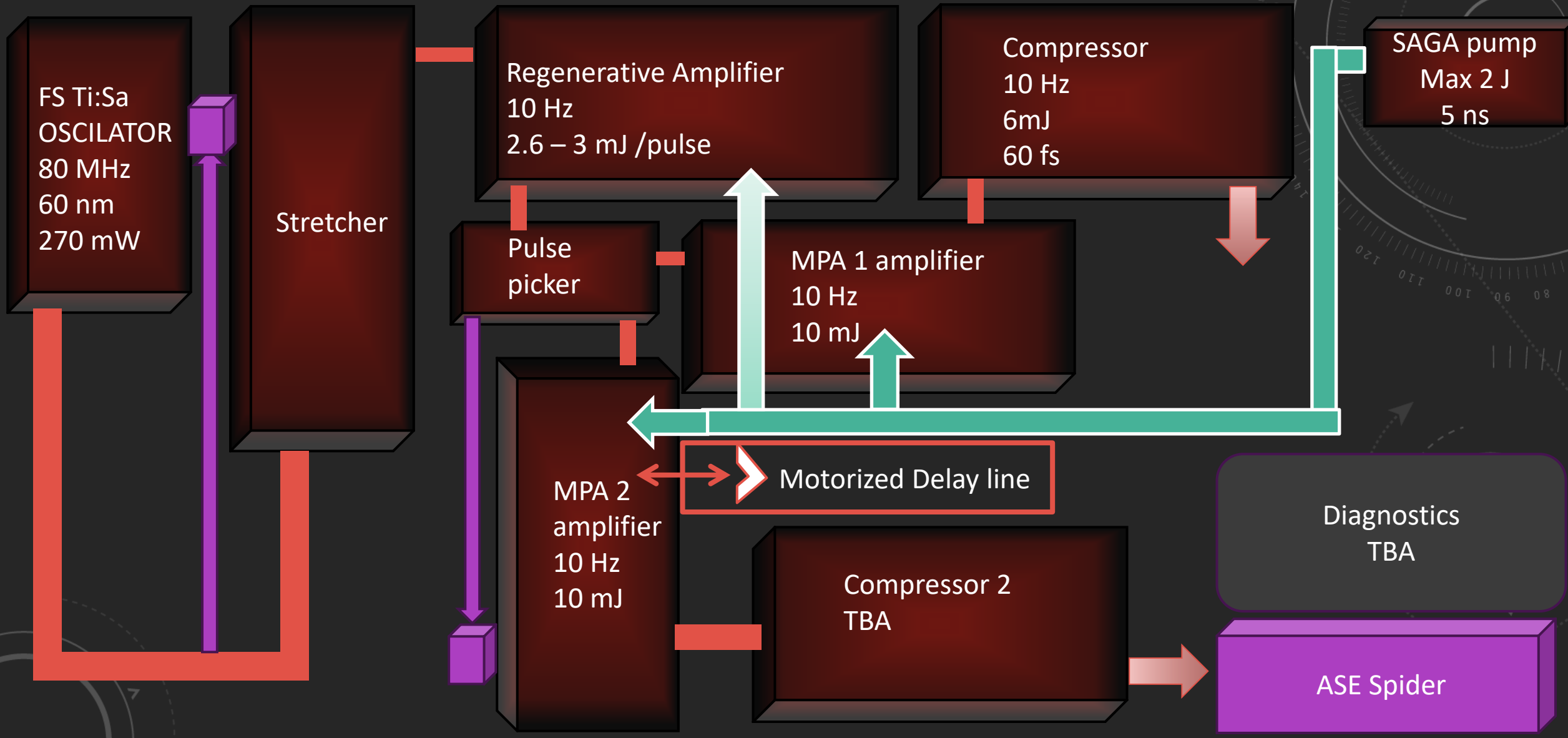
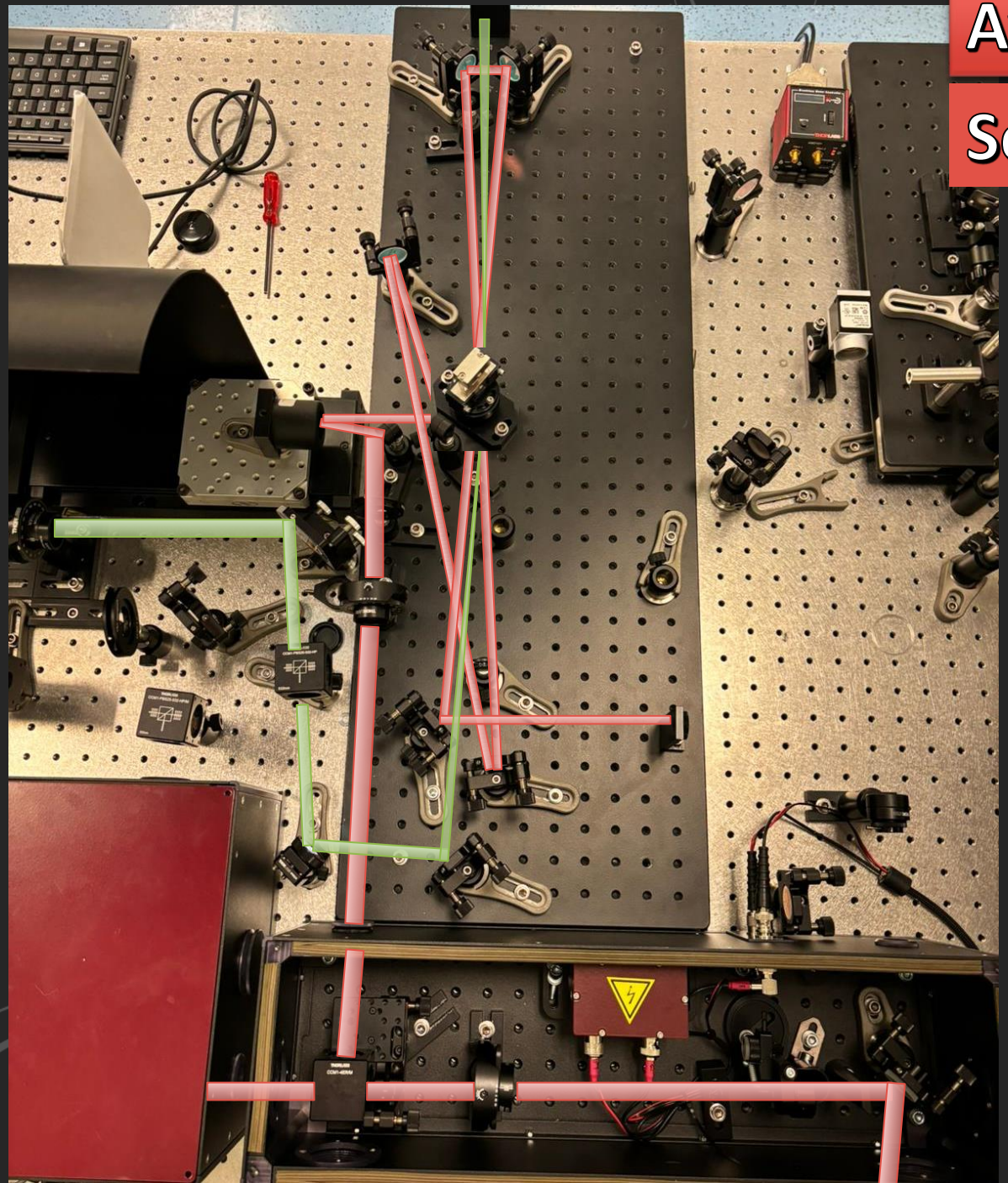
Avesta laser system improvements

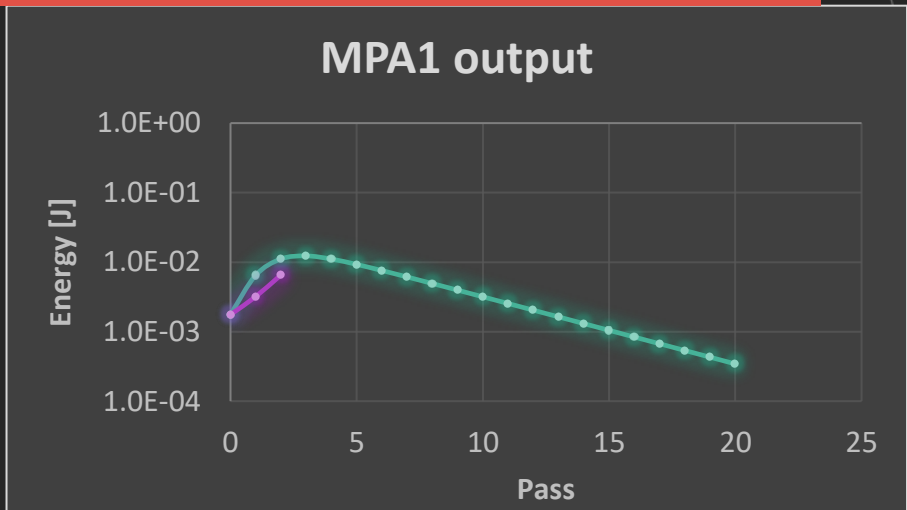


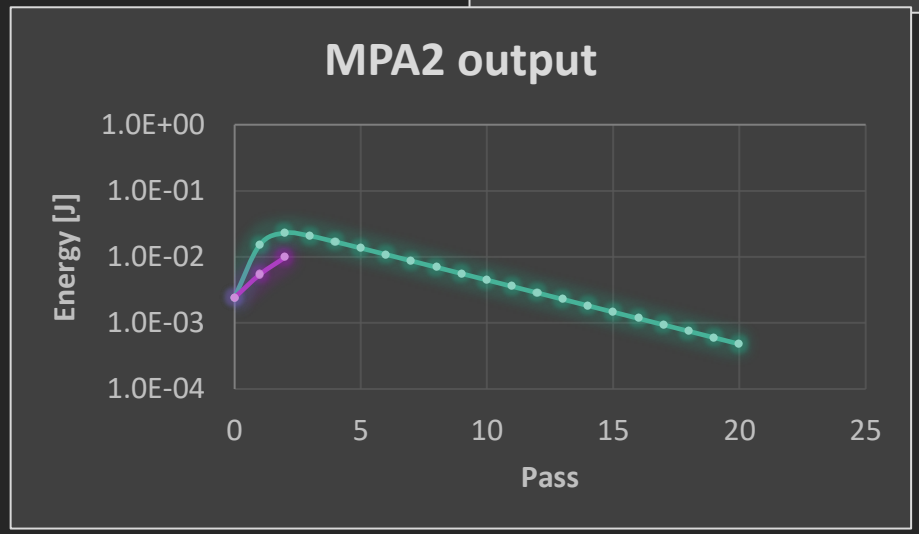
Avesta laser system improvements

Secondary multi-pass capabilities



MPA 1



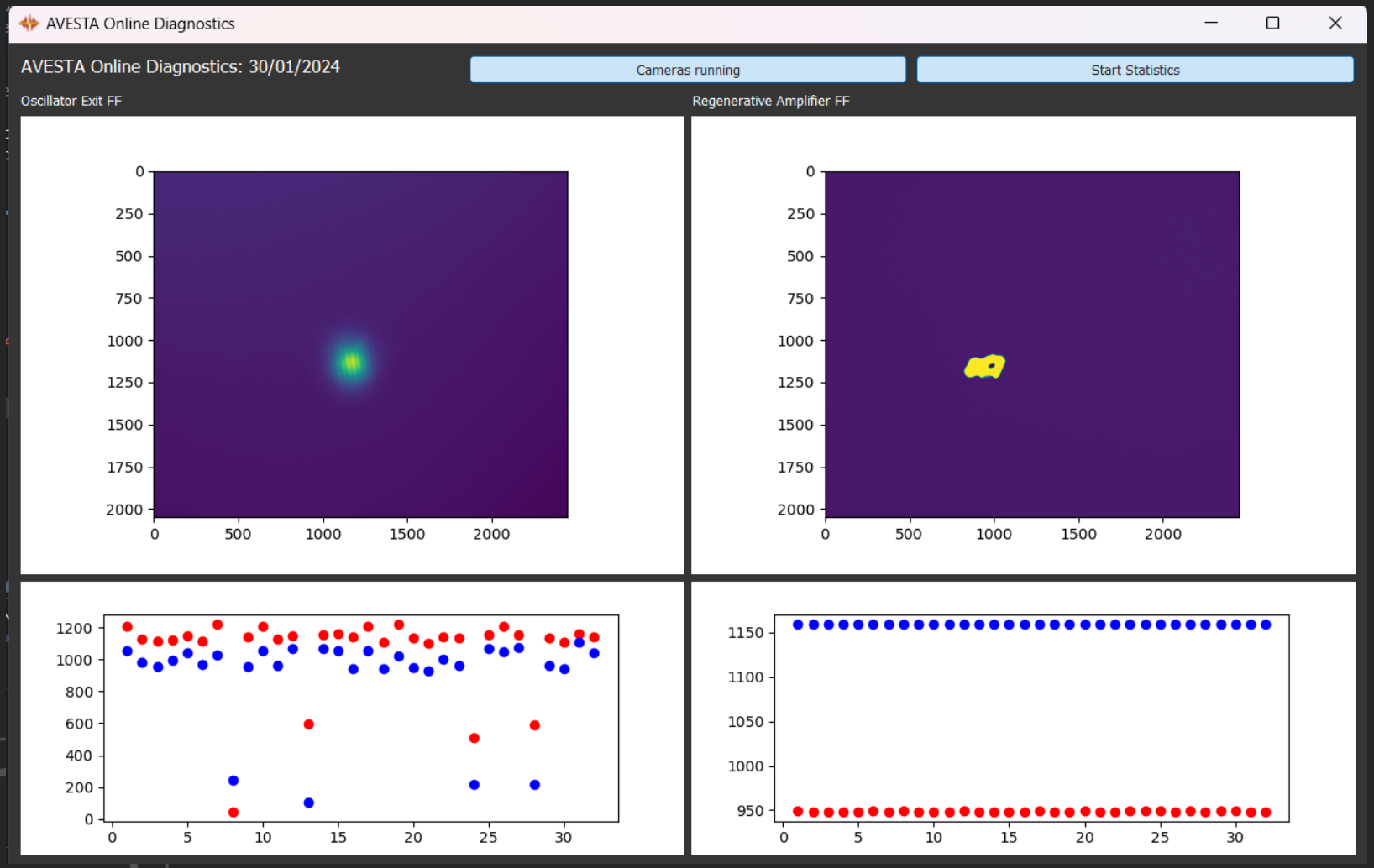


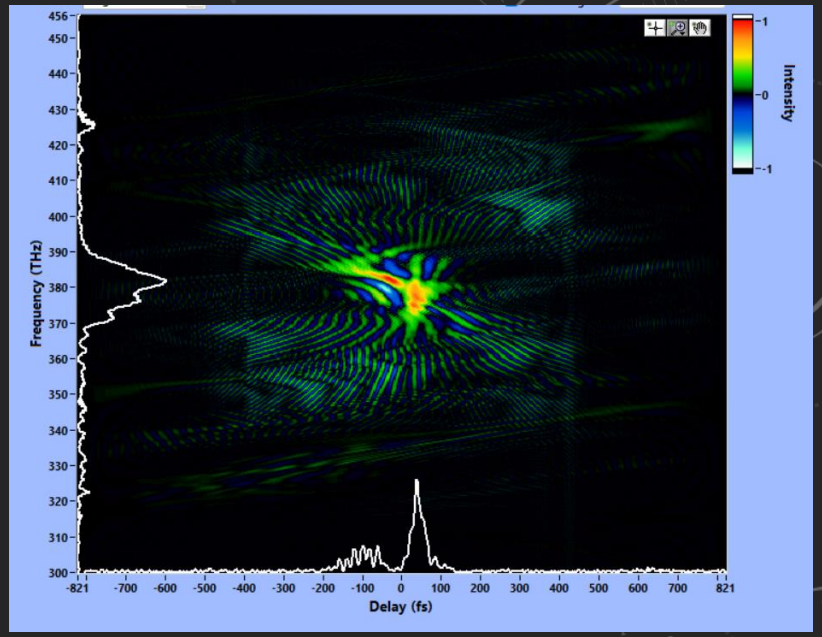
MPA 2

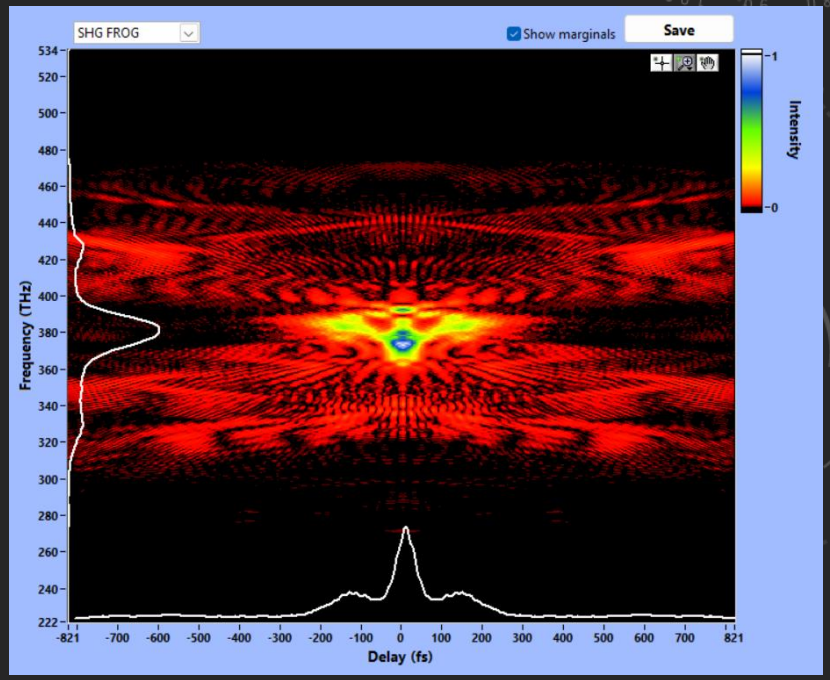
Franz & Nodvik model

Avesta laser system improvements

Implementing online diagnostics







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Conclusions and outlook

- We investigated HPLS parameters in time (already pretty stable with human compensation)
- We started preparing and upgrading AVESTA system (same type of instabilities, but exaggerated)

- We will use the AVESTA laser system to induce and investigate instabilities
- Study more closely correlations between parameters
- Build active compensation mechanisms for corrections

Bibliography

Steinleitner, P., Nagl, N., Kowalczyk, M. et al. Single-cycle infrared waveform control. Nat. Photon. 16, 512–518 (2022). https://doi.org/10.1038/s41566-022-01001-2

Wang D, Shou Y, Wang P, et al. Laser-induced damage thresholds of ultrathin targets and their constraint on laser contrast in laser-driven ion acceleration experiments. High Power Laser Science and Engineering. 2020;8:e41. https://doi.org/10.1017/hpl.2020.40

Andrei Naziru, Stefan Popa, Ana-Maria Lupu, Dan Gh. Matei, Alice Dumitru, Ioan Dancus, Claudiu Stan and Daniel Ursescu 2023. Relative pulse delay stabilization in dual arm PW-class laser system. *- In preparation.*

laserbeamsize:python module, ISO 11146 analysis of laser beams. DOI 10.5281/zenodo.8346799

Frantz&Nodvik Model, Journal of Applied Physics 34, 2346 (1963); https://doi.org/10.1063/1.1702744

THANK YOU FOR YOUR ATTENTION!