Updates to the X-Pinch Platform and Faraday Rotation Imaging Diagnostic on the MAIZE Facility

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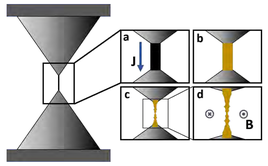
Motivation

X-pinches:

- Formed by driving intense current through the crossing of 2 or more wires
- Generate a single micro-pinch both spatially and temporally localized
- Compress to very small radius (~1 μm) "Hot Spot" of x-ray emission



- **Gbar pressures from modest university-scale drivers!**

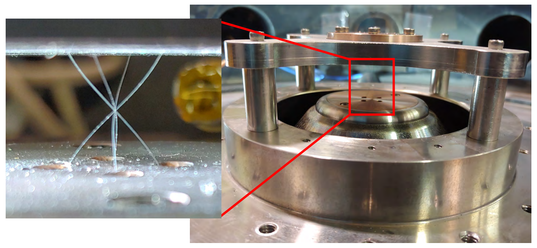
$$p_{\mathrm{mag}} = \frac{B^2}{2\mu_0} = \frac{\mu_0 I^2}{8\pi^2 r^2} \propto \frac{I^2}{r^2}.$$

Current Delivery:

- 100 kA to ~1 μm is ~1 Gbar
- Fraction of current delivered to small radii in and X-pinch is not well known
- Faraday rotation imaging is a non-perturbative way to probe the magnetic field around the X-pinch neck

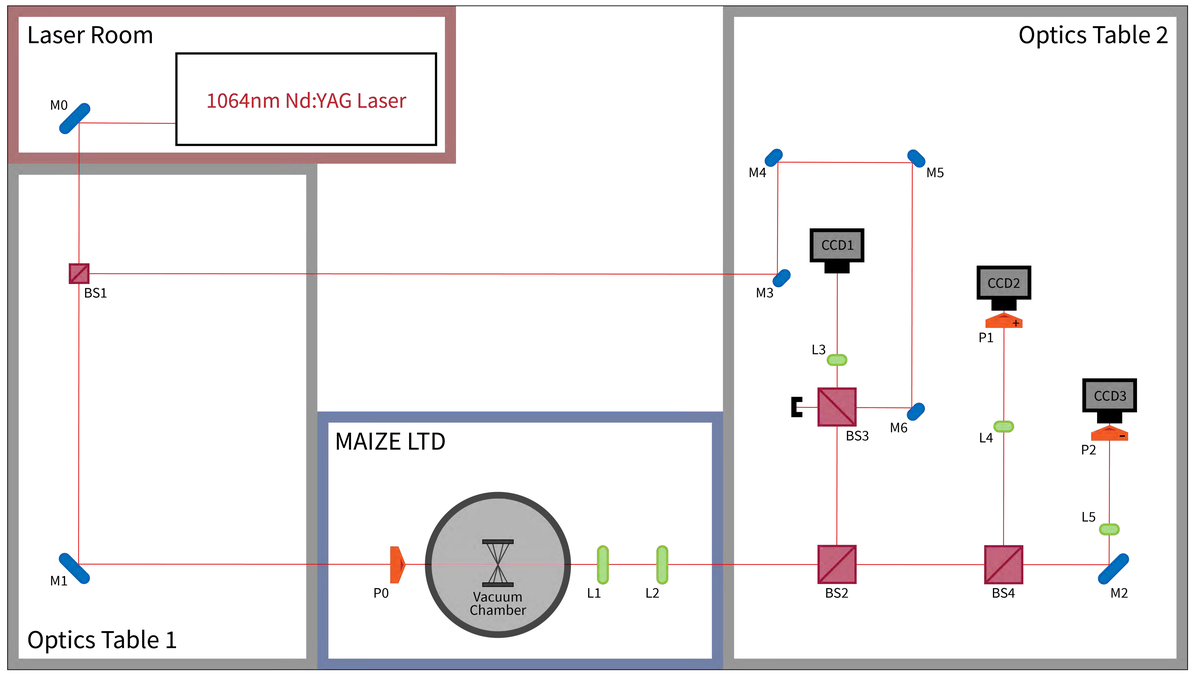
Main Load Hardware

Main load hardware with interchangeable x-pinch mounts was developed and fielded on the MAIZE LTD, and was the platform on which the presented data was collected.



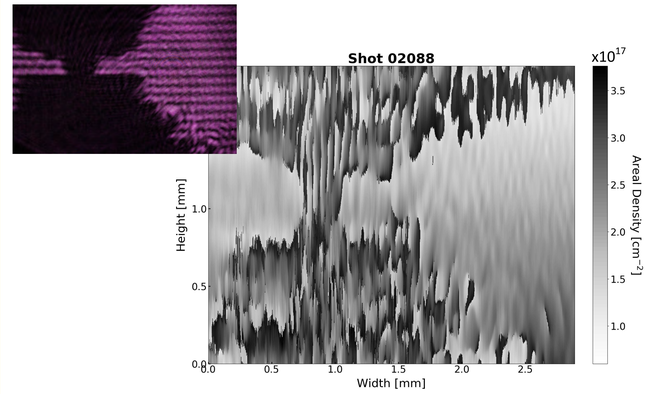
Faraday Rotation Diagnostic

A Faraday rotation diagnostic has been designed for use with the MAIZE LTD to examine x-pinch current distributions. The design, shown in the figure below, consists of a p-polarized probe beam of ~180 mJ at 1064 nm from an Nd:YAG laser which is split into an interferometric reference beam and combined interferometry and polarimetry probe beam. The probe beam is then split further to recombine on the interferometry leg, while the polarimetry line is equally split between two counter-rotated polarization analyzers to better improve noise reduction.



Data Processing

Python code is being written and tested to process the interferograms and polarograms. Below is an example semi-processed interferogram indicating low areal density around the x-pinch and persisting into the neck region.



Future Work

Near Future:

- Implement Abel inversion for better radial B-field and I-enclosed profiles
- Calibrate Diamond Radiation Detectors (DRDs) for x-ray measurements
- Integration of Ross filter pairs to collect time-resolved x-ray emission data

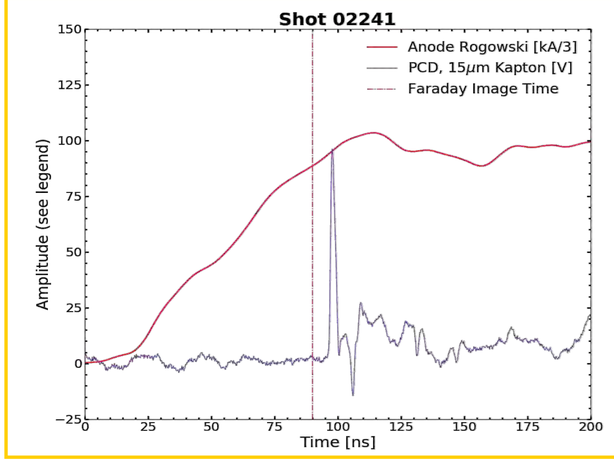
Further Goals:

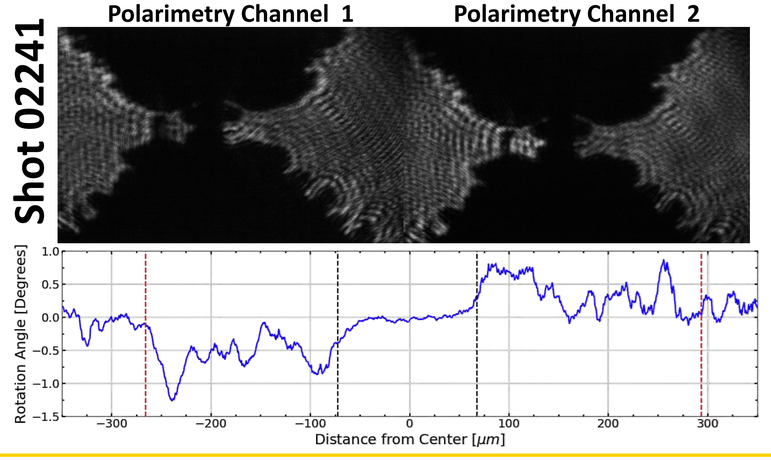
- Investigate current distribution variations in time and possibly from both hybrid x-pinches and varying materials

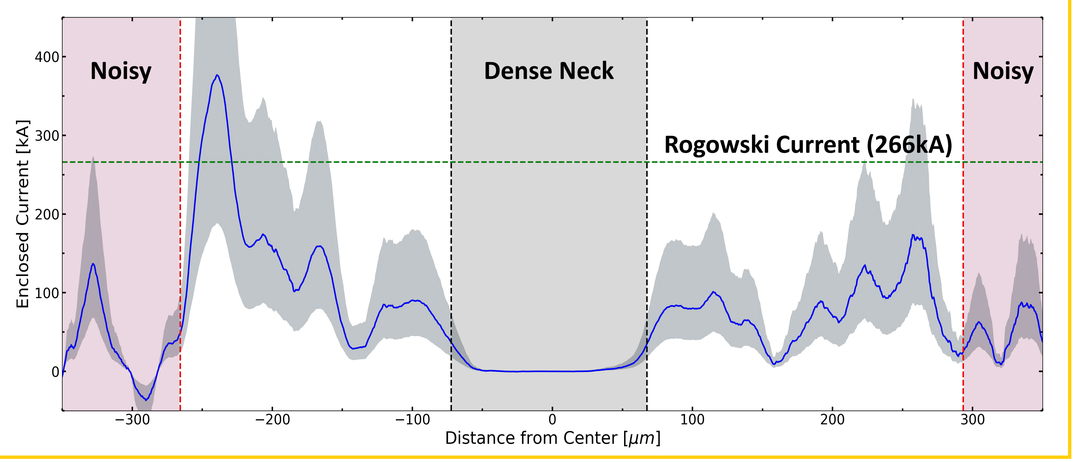
References

[1]G. F. Swadling et al., "Diagnosing collisions of magnetized, high energy density plasma flows using a combination of collective Thomson scattering, Faraday rotation, and interferometry (invited)," Review of Science Instruments, vol. 85, no. 11, p. 11E502, Nov. 2014.
[2]S. A. Pikuz, T. A. Shelkovenko, and D. A. Hammer, "X-pinch. Part I," Plasma Physics Reports, vol. 41, no. 4, pp. 291–342, Apr. 2015.
[3]S. A. Pikuz, T. A. Shelkovenko, and D. A. Hammer, "X-pinch. Part II," Plasma Physics Reports, vol. 41, no. 6, pp. 445–491, Jun. 2015.

Data Collection: Each shot has a combination of Rogowski coils and diamond radiation detectors (DRDs) to determine the MAIZE current and pinch time relative to the polaro-interferometry image time.







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