Investigation of spatial & spectral characteristics of EUV emission from Laser Assisted Vacuum Arc

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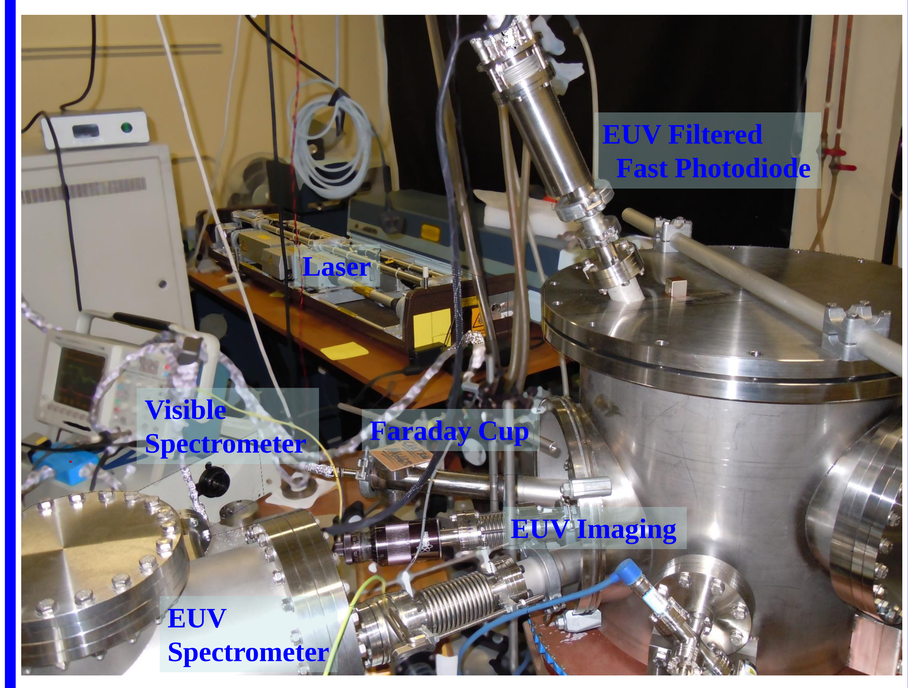
In this we commissioned the ISAN extreme ultraviolet (EUV) laser triggered discharge source, **Laser Assisted Vacuum Arc (LAVA-lamp), at UCD.** Its operation proved similar to earlier studies. In this source the high-current discharge between two rotating electrodes covered with a thin liquid metal film is triggered by local laser ablation of the film material. The results of this investigation will enable better understanding of the physical properties of these kinds of discharge plasmas, such as electron densities, temperatures and characteristic dimensions along with ion species and angular debris characteristics. The knowledge obtained can be used for further optimisation of e.g. conversion efficiency, source brightness, or total in-band EUV output.

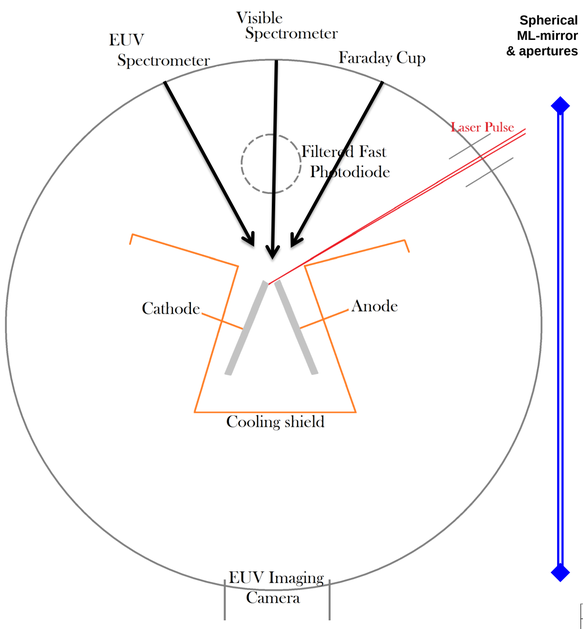
Experimental Setup



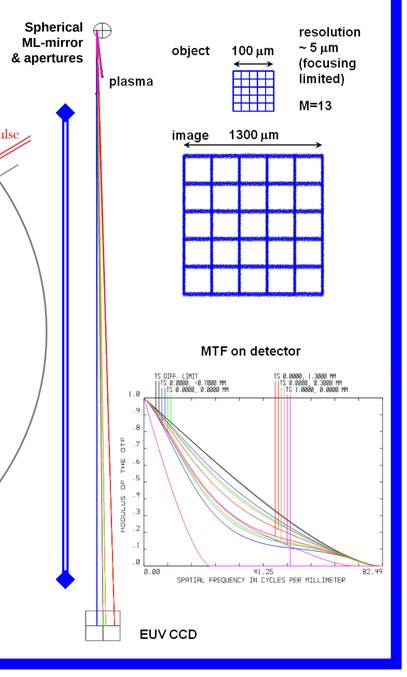
The plasma was studied by the following techniques:

- absolutely calibrated time integrated EUV spectroscopy,
- 2 μm spatially resolved time integrated in-band EUV imaging of the pinch,
- time resolved inband filtered EUV detecting fast photodiode,
- time- and spatially-resolved fast gated visible emission spectroscopy,
- time of flight diagnostic of ions with a Faraday cup
- Rogowski coil characterisation of discharge current

Experimental set-up



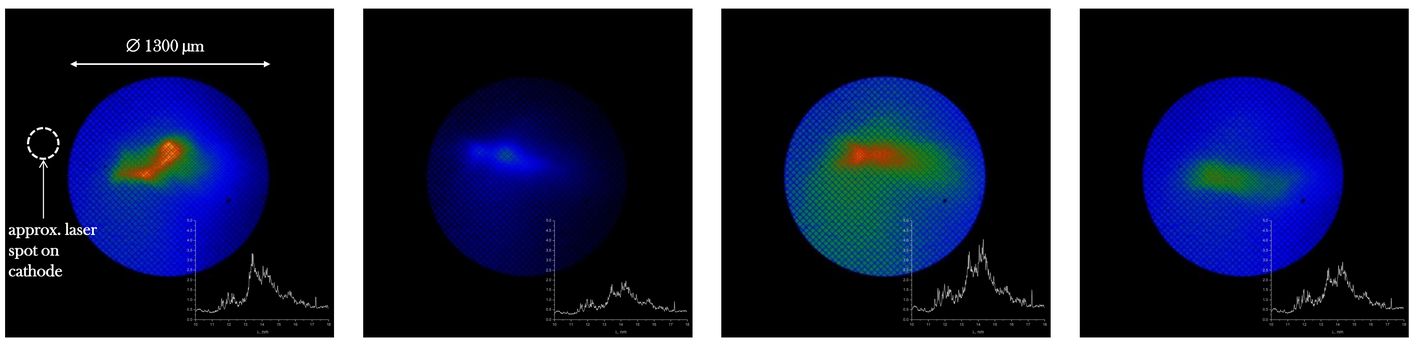
EUV imaging layout



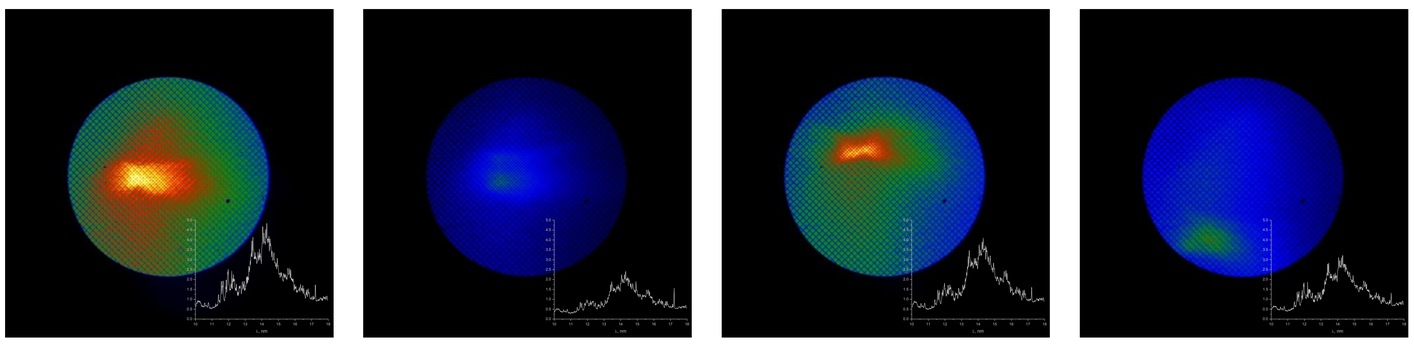
Results for Galinstan

➢ **EUV imaging of plasma pinch** for a range of laser fluencies and discharge voltages:

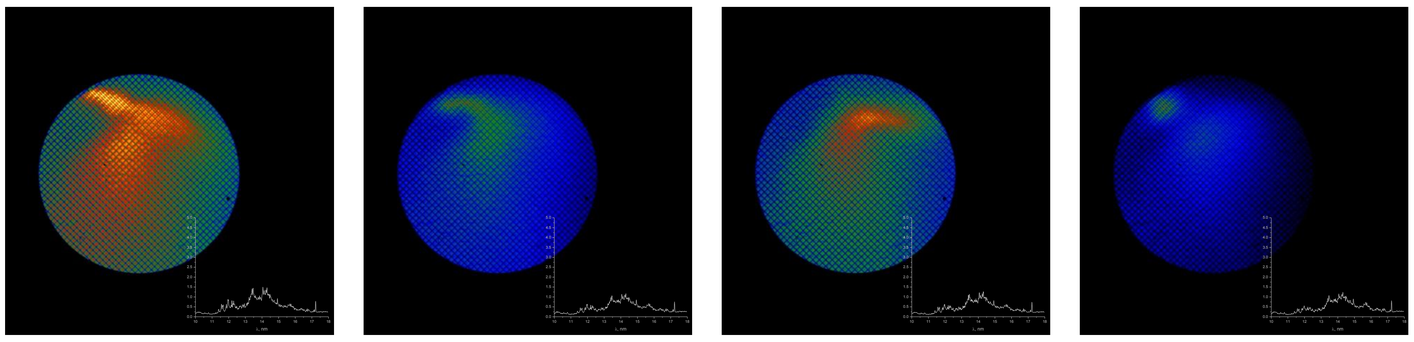
4 J (4.5 kV), 5 mJ, color scale (min – max): 5000 - 35000 counts



4 J (4.5 kV), 40 mJ, color scale (min – max): 5000 - 35000 counts

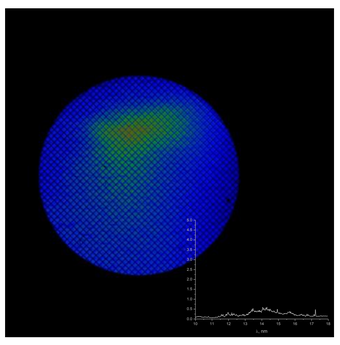


3.2 J (4 kV), 5 mJ, color scale (min – max): 2500 - 10000 counts

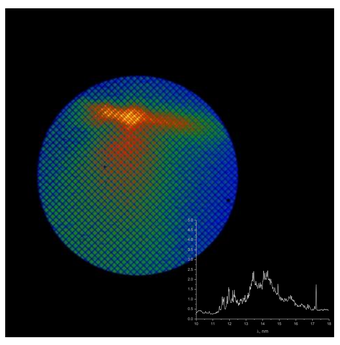


Laser energy = 5 mJ

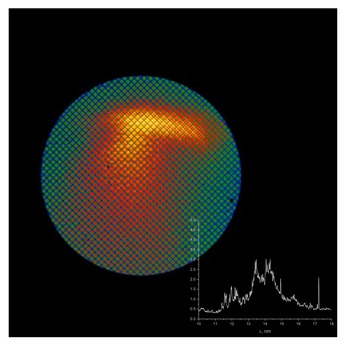
1.8 J (3 kV), 1250 - 5000 cts



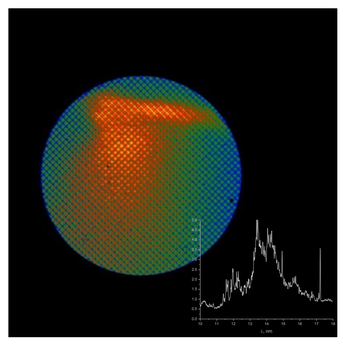
5 J (5 kV), 5000 - 20000 cts



6 J (5.5 kV), 5000 - 20000 cts



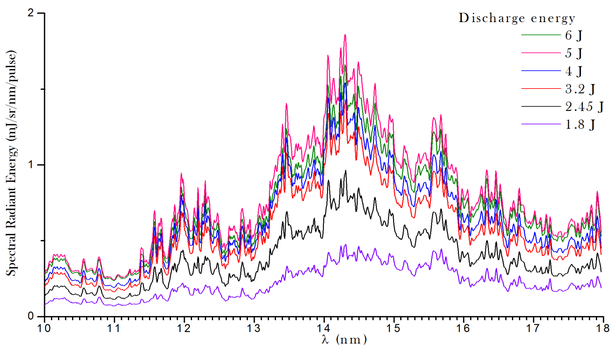
7,2 J (6 kV), 7500 - 30000 cts



Analysis of Galinstan and Comparison With Tin

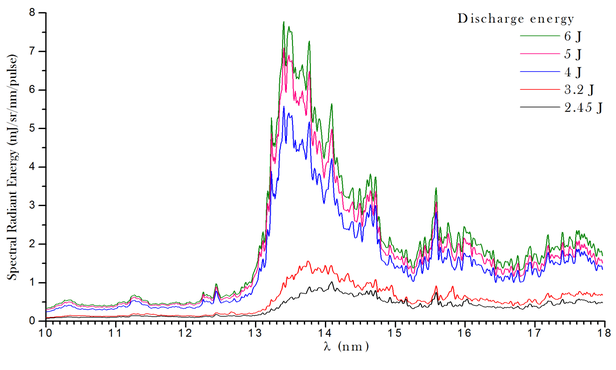
EUV spectra for various discharge energies:

Galinstan:



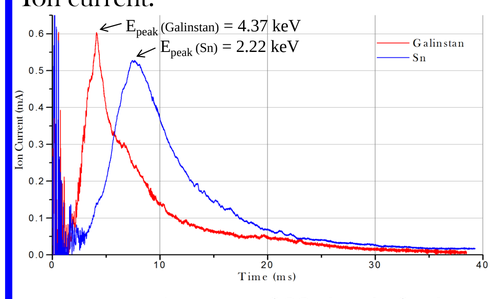
Galinstan is composed of:
68.5% Ga
21.5% In
10.0% Sn

Sn:

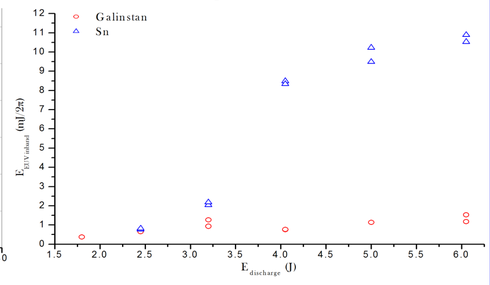


Comparison of analysis tools for 4.5 kV & 5 mJ for Galinstan and 12 mJ for Sn

Ion current:

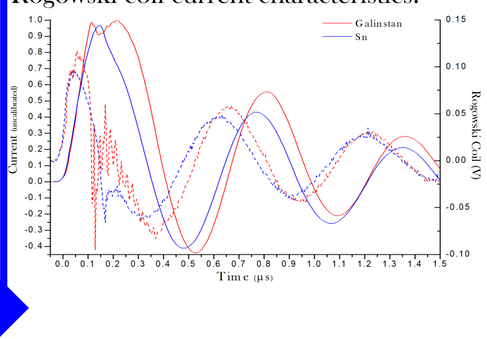


Inband EUV output in 2π sr:

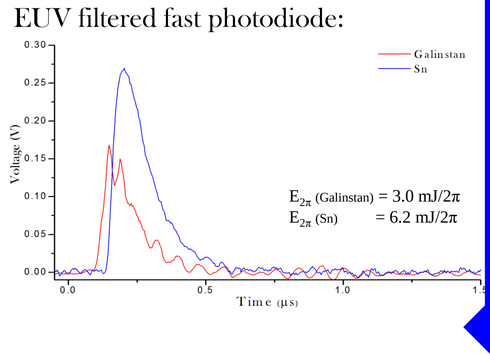


Average of 32 signals for ion currents and inband EUV energy

Rogowski coil current characteristics:



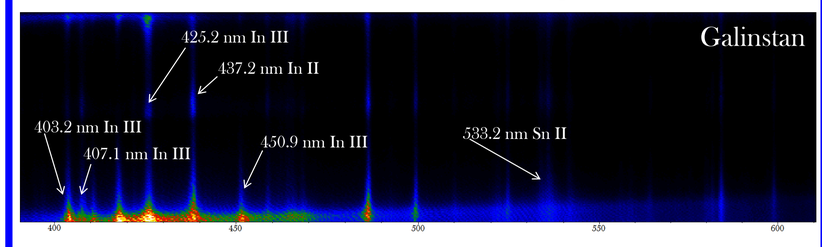
EUV filtered fast photodiode:

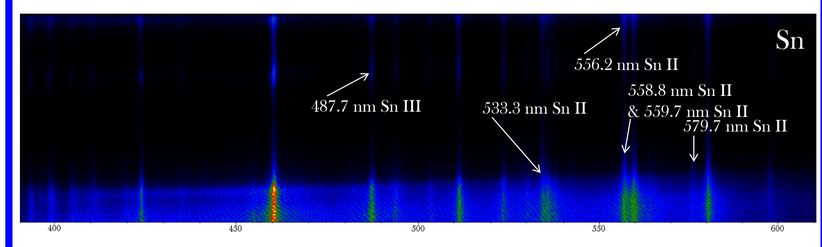


Visible spectroscopy:

- With no discharge only Sn II lines are observed
- With 4.5 kV the Sn plasma has higher ion species

Visible spectra captured 0 ns after laser pulse with 1 μs gate time, 4 J, 5 mJ and 12 mJ & gain 1 and 2 respectively





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