WP PWIE SP F monitoring meeting for 2026 activities

Commissioning of ps-LIBS on BiGyM and first tests with boron-coated samples

L. Laguardia, S. Cipelli, A. Uccello, A. Cremona, S. Almaviva, F. Cani

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Deliverable 2026

Deliverable ID	Deliverable Title
D007	Complete installation and optical integration of LIBS on BiGyM and perform system calibration with test samples

Human Resources 2026

Deliverable Owner	Beneficiary	PM	Deliverable (Team)
L. Laguardia	ENEA	4	L. Laguardia, S. Almaviva, S. Cipelli, A. Cremona, A.Uccello, H.Wu, F. Cani

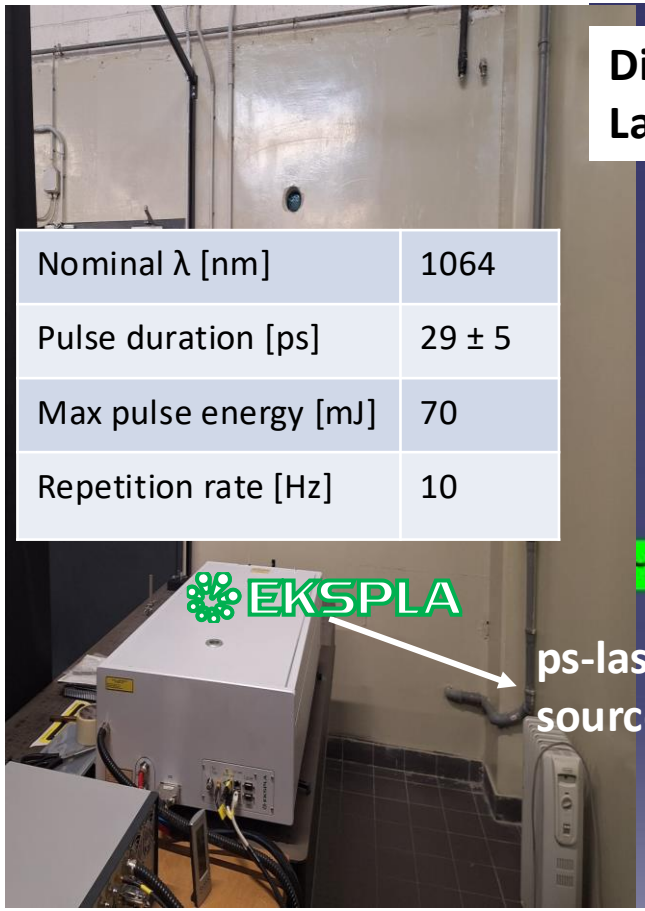
The activities required to complete the deliverable were carried out in collaboration with **Huace Wu (FZJ)**, who visited our institute from 12 to 23 October 2026 through the CNR Short Mobility Programme, and **Salvatore Almaviva (ENEA)**, who is visiting us this week to complete the analysis of the measurements.

Machine Resources 2026

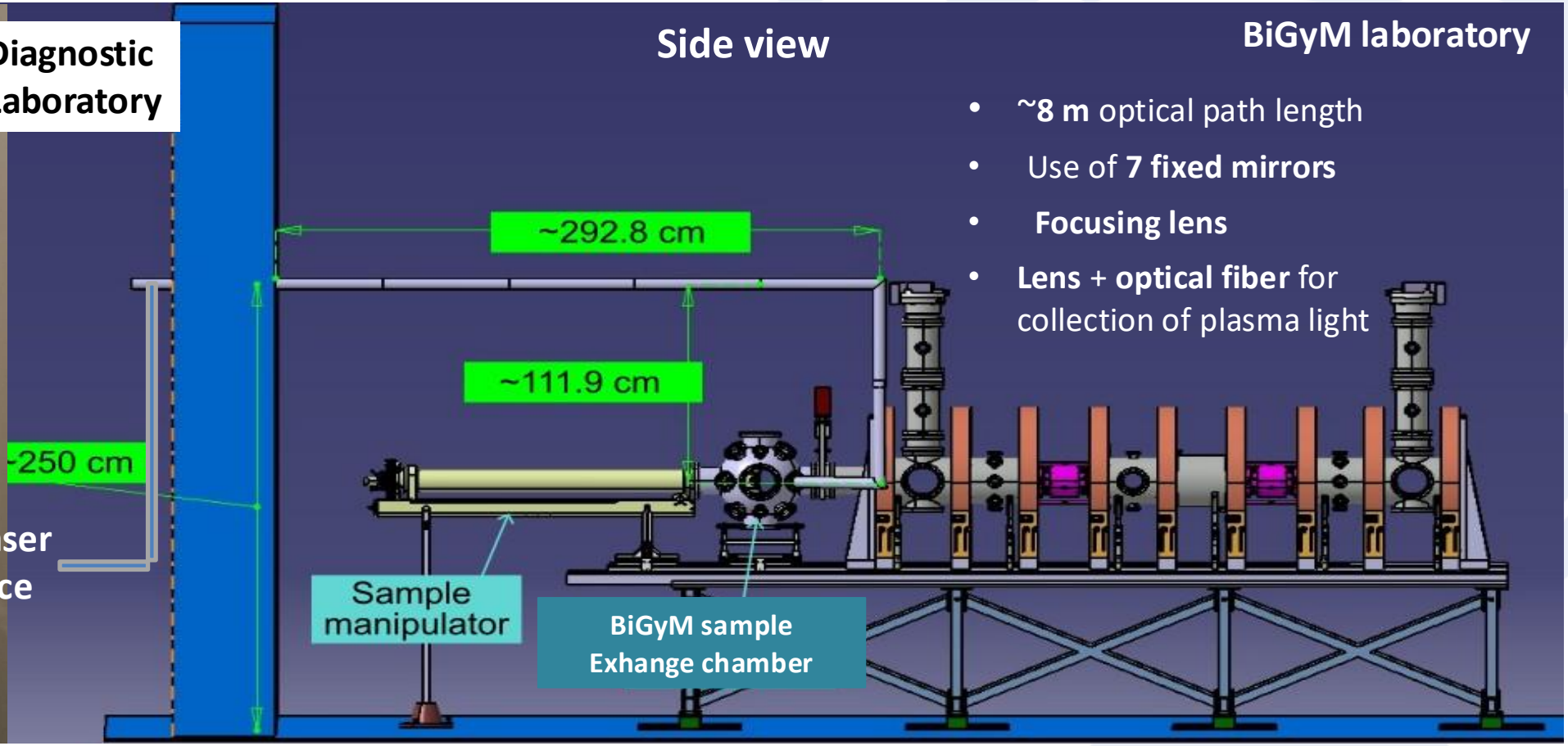
Device	Beneficiary	Days	Related Deliverable
GyM/BiGyM	ENEA	5	D007

Optical path connecting the laser system to the BiGyM sample chamber

Completing the deliverable involved installing all the optical components—rails, mirrors, and lenses—to establish the laser beam path from the source in the Diagnostics Laboratory to the pre-chamber sample holder in BIGYM. The beam path passes through an opening in the wall separating the two laboratories; the work also included aligning the laser beam.

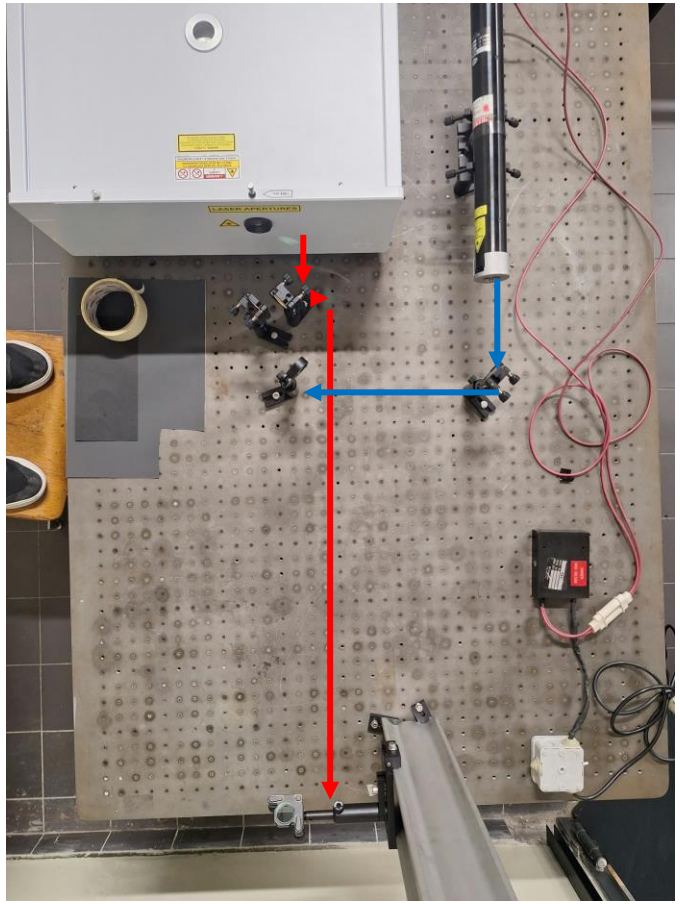


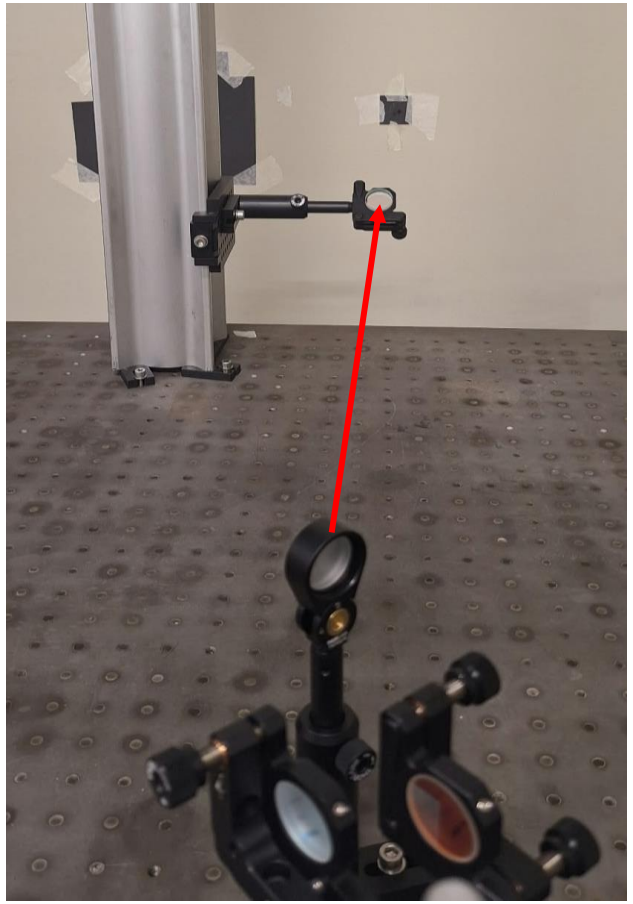
Nominal λ [nm]	1064
Pulse duration [ps]	29 ± 5
Max pulse energy [mJ]	70
Repetition rate [Hz]	10

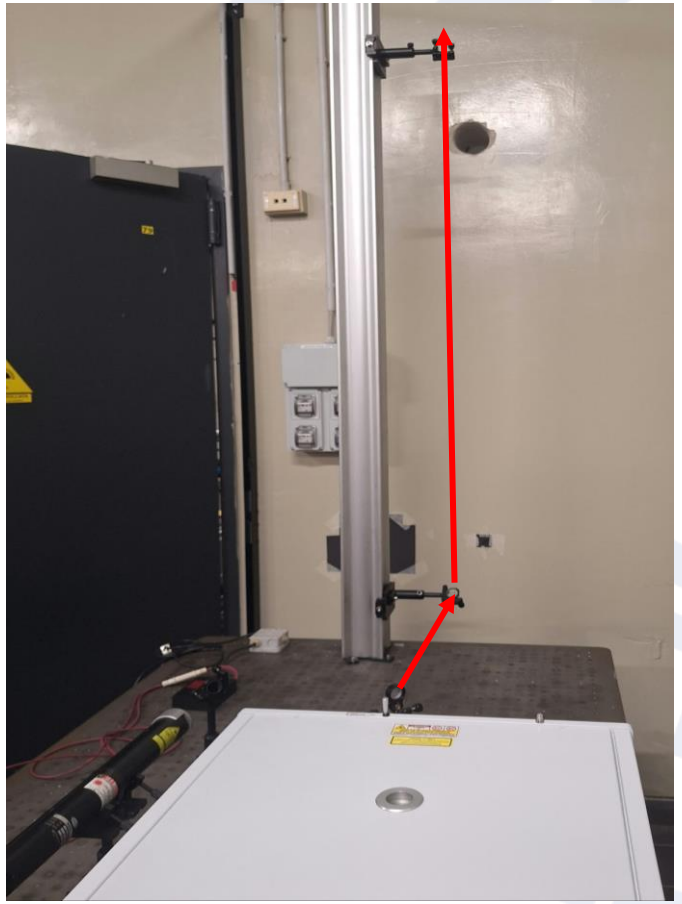


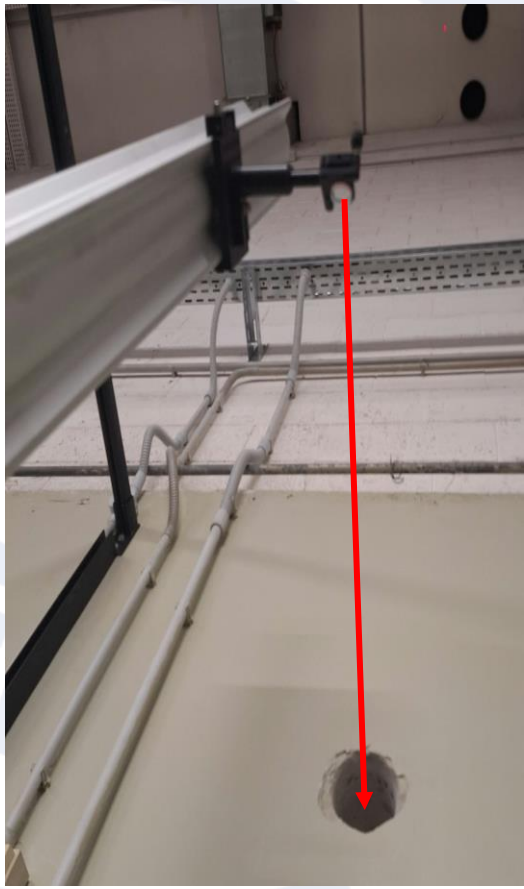
- **~8 m** optical path length
- Use of **7 fixed mirrors**
- **Focusing lens**
- **Lens** + **optical fiber** for collection of plasma light

Optical path in the diagnostic laboratory

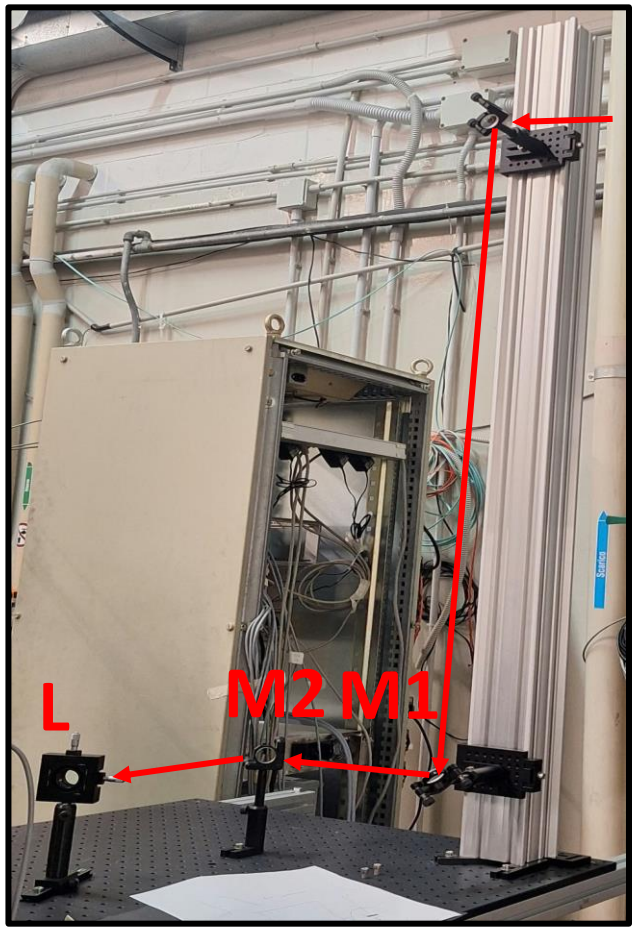


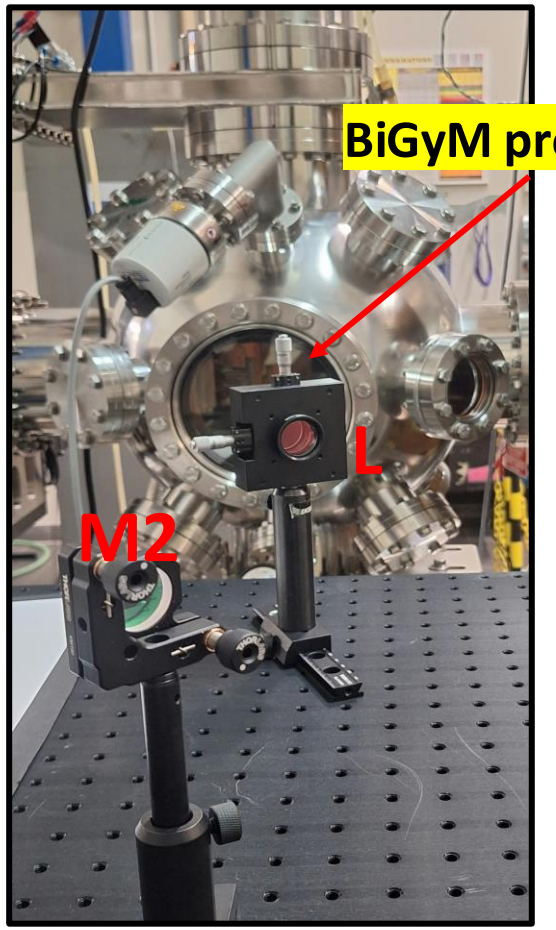


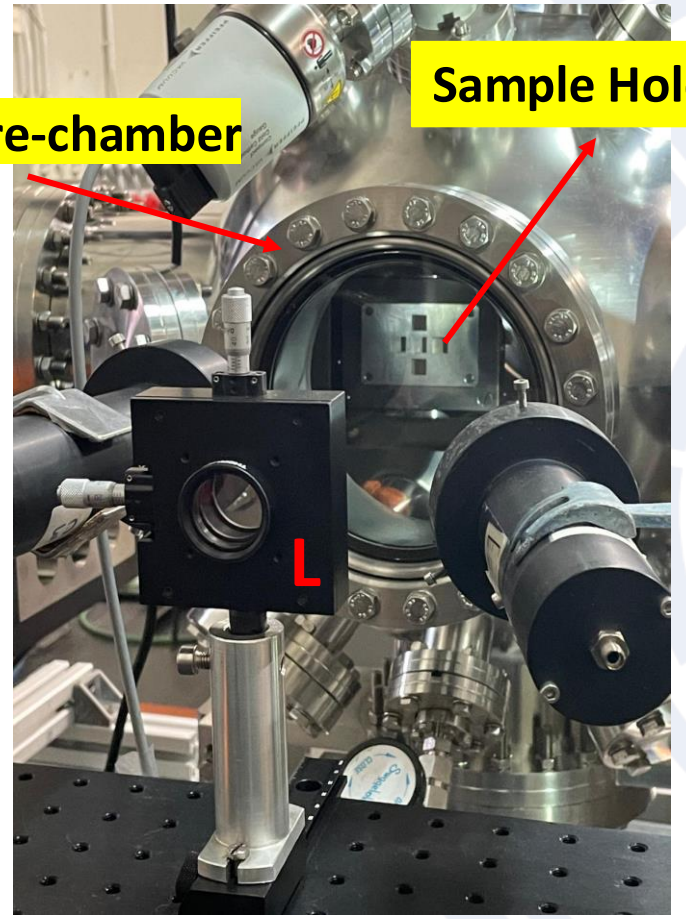


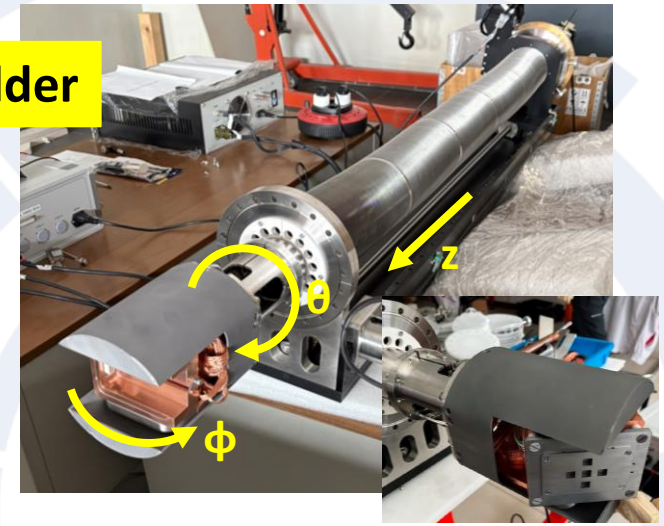


Optical path in the BiGyM Laboratory

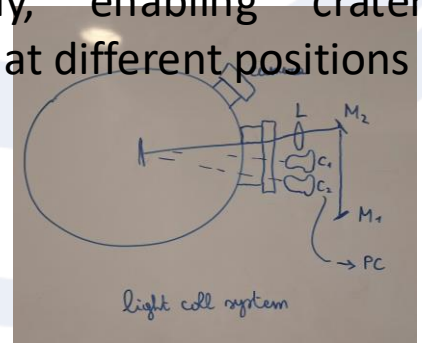








While waiting for the rotating mirror, we used the sample holder's ϕ-axis rotation to tilt the sample and its z-axis translation to move it horizontally, enabling crater formation at different positions



By tilting the sample-holder manipulator, we were able to use the large window both to deliver the laser beam to the sample and to collect the emitted light through the same window, enabling coaxial measurements.

Boron-coated samples provided by IAP and analyses by ps-LIBS in different experimental conditions



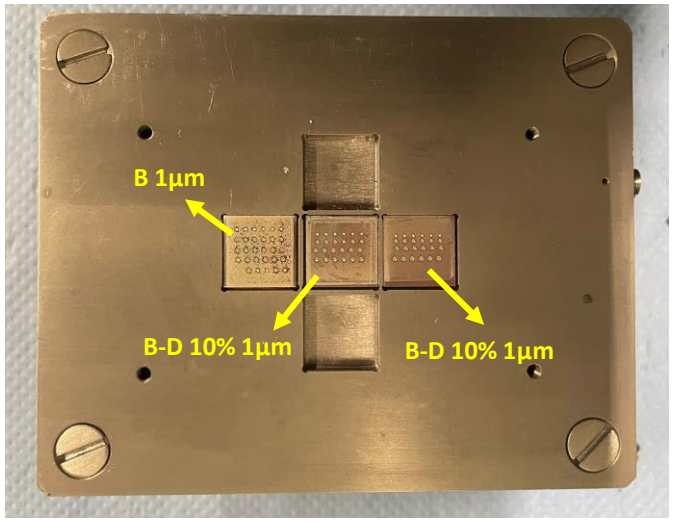
Boron coatings deposited on W substrates by magnetron sputtering

Samples received and analysed

B	B-D 5%	B-D 10%
1000 nm		1000 nm
500 nm	500 nm	500 nm
200 nm	200 nm	200 nm
100 nm	100 nm	100 nm

Measurements were carried out under different experimental conditions, (including laser energy, delay time…), generating a large dataset for analysis.

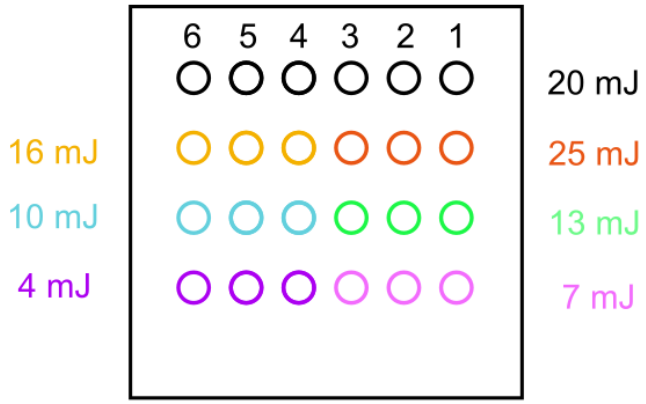
LIBS measurements on 1-µm-thick samples performed at a pressure of 10^{-6} mbar.



Arrangement of the samples mounted on the sample holder

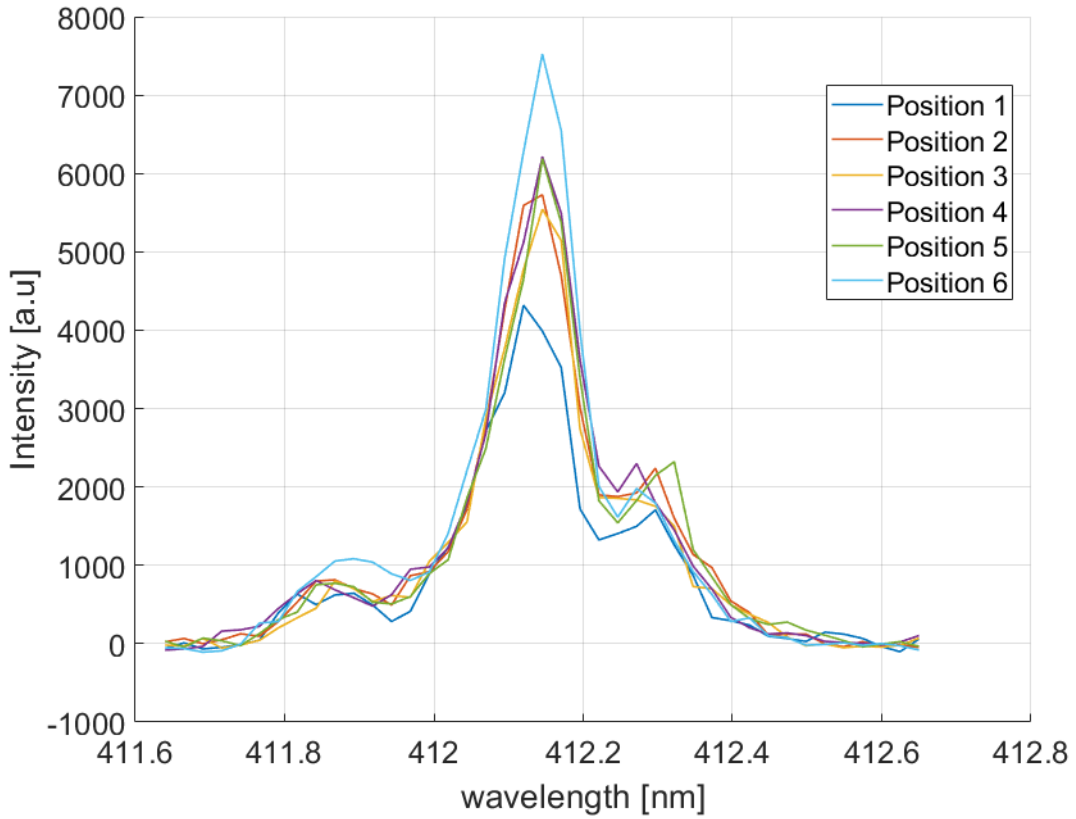
The samples were arranged as shown in the photograph. Under the same experimental conditions, LIBS measurements were performed at 412 nm to record the B II line from both the pure boron sample on the left and the B–D (10%) sample in the center. The equivalent B–D (10%) sample on the right was measured in the Balmer-α region This procedure was adopted because two spectrometers capable of simultaneously recording the two different spectral regions were not available

Laser pulse energy and measurement positions

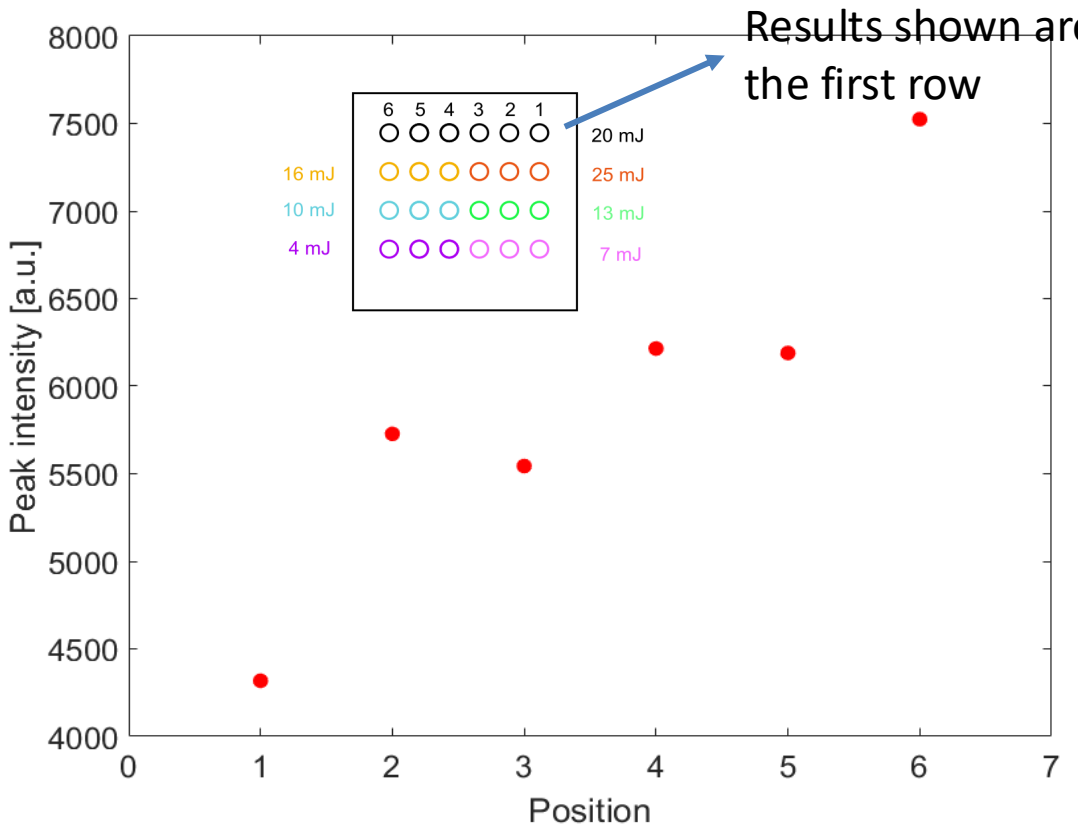


700 µm diameter of the each laser spot
1,5 nm distance between craters
LIBS measurements were performed at positions 1–6 using the laser pulse energies indicated in the figure. The six positions in the first row were measured at the same laser pulse energy to assess the uniformity of the coating.

Preliminary results: assessment of coating uniformity across six positions



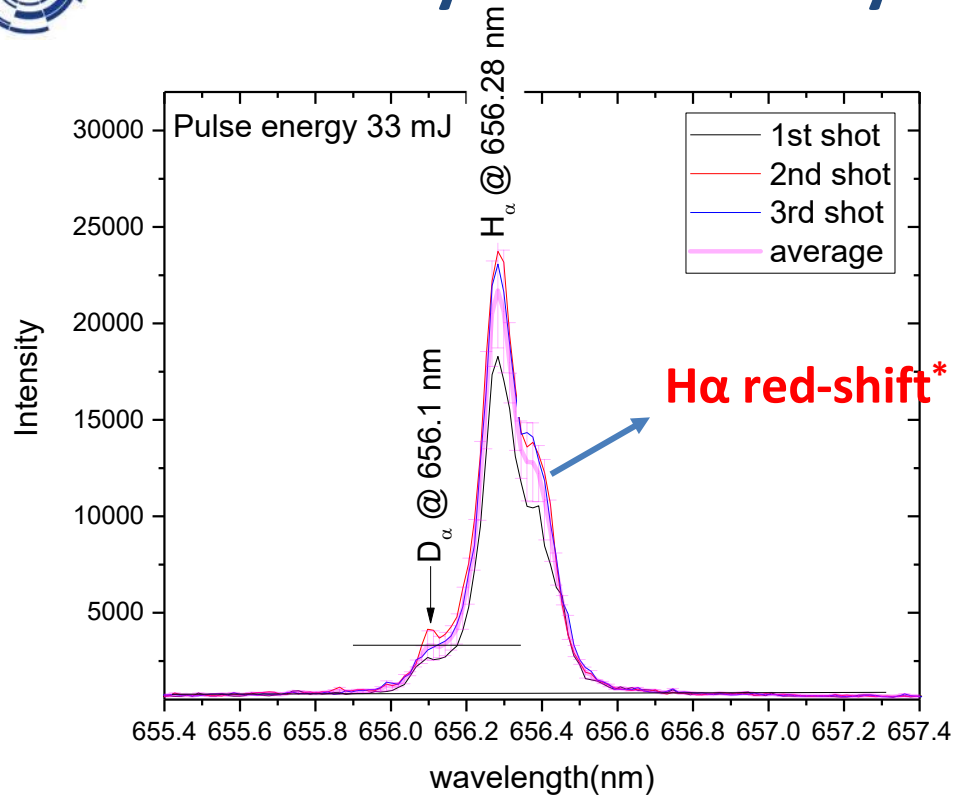
BII peak @ 412,19 nm at different horizontal positions at 26 mJ.

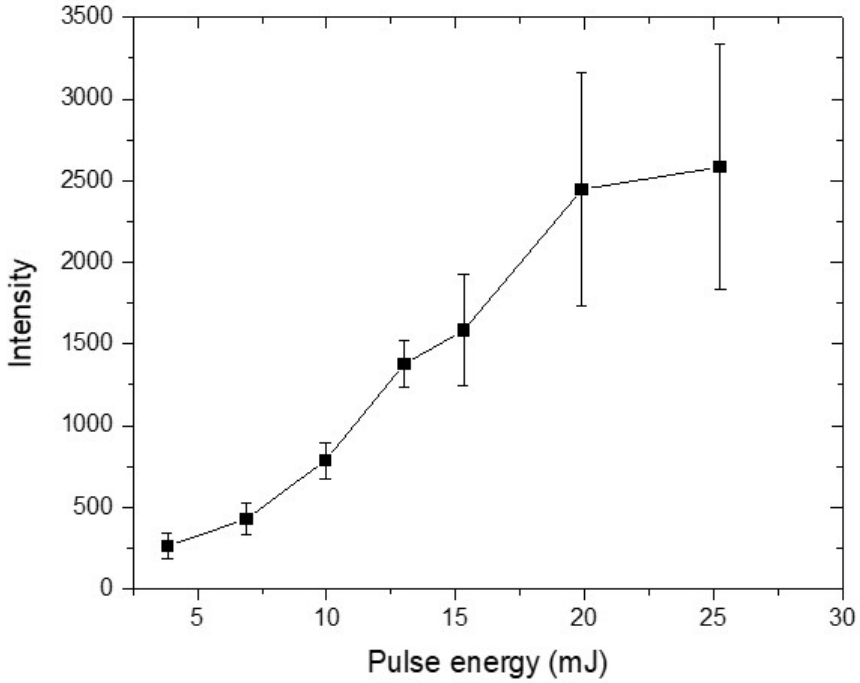


Variation in the B peak intensity across the six positions at constant laser energy

At a constant laser pulse energy, the boron peak intensity varies across the six measurement positions. The spectra show a clear position-dependent variation, with the lowest peak intensity at Position 1 and the highest at Position 6. This indicates that the coating is not fully uniform across the sampled area.

Prelimiray results: analysis of Dα measurements @ 656.1 nm





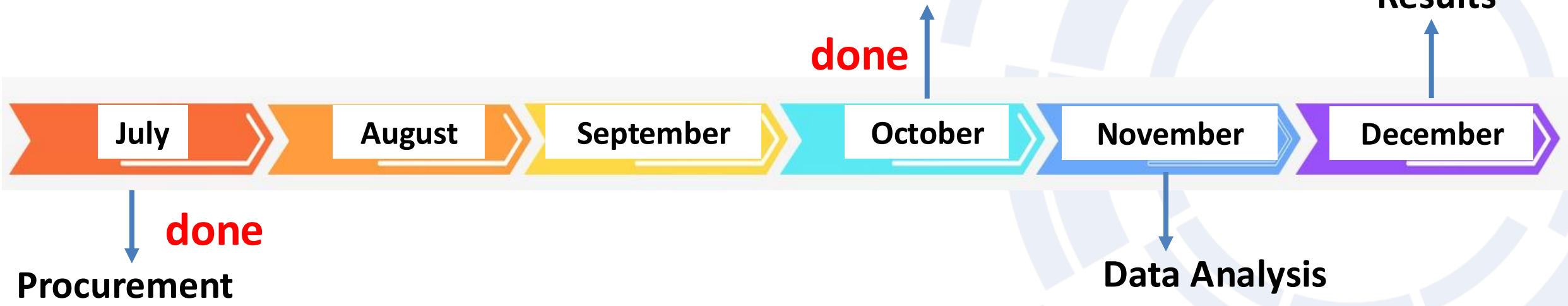
Balmer α emission spectra recorded in the position 1,2,3. The magenta curve represents the average spectrum.

- Variation in the Dα line intensity as the pulse energy
- The error bar represents the standard deviation of three measurements

*Yi, Rongxing, et al. "Source-dependent kinetic separation of H in tungsten by Doppler-shift-tuned LIBS." *Spectrochimica Acta Part B: Atomic Spectroscopy* (2026): 107627.

Conclusions

Installation, testing, measurements and preliminary analysis of boron coatings with H. Wu and S. Almaviva



Next steps

- Characterise the laser-induced craters in detail using SEM to examine their morphology.
- Repeat the measurements using two spectrometers simultaneously: our high-resolution Princeton spectrometer and a full-range spectrometer to be lent to us by Salvatore Almaviva.
- Install the motorised mirror.
- If feasible, analyse Boron coating samples provided by other laboratories.
- Perform LIBS measurements on samples exposed to the BiGyM plasma



Thanks to Huace, Bobi and Salvatore for their valuable collaboration

and

thank you for your attention