Outline of meeting

The first joint LID-QMS/LIBS meeting for fusion diagnostics took place at ENEA in Frascati from December 9 to 12, 2025. The event brought together nearly 20 leading researchers in the fields of Laser-Induced Desorption Mass Spectrometry (LID-QMS) and Laser-Induced Breakdown Spectroscopy (LIBS) to discuss recent advancements in data analysis and quantification of LID-QMS and LIBS data collected during the experiments following the DTE3 campaign at JET in 2023-2024.

A key focus of the meeting was to advance fuel retention and surface composition analysis for inner divertor tiles using LIBS and LID-QMS diagnostics. This was achieved by comparing results and reviewing calibration approaches to produce quantified results. The agenda also addressed significant topics, such as the principles of both diagnostic techniques, analysis of large-scale datasets using AI and ML, and a new ex-situ LIBS experiment planned for execution in 2026.

Hydrogen retention comparison between LIBS and LIDQMS - Actions

LIBS look into "second order" hydrogen band Littrow

LIBS shorter delay shots could give number of particle in ground state using calibration free method

- Provide total number of atoms in plasma
- Salvatore evaluate number atoms per laser shot

LIDQMS plot DT/HDT as an intermediate comparison (Anna) but ultimate aim is quantified data

LIBS total DT/HDT ratio (Rongxing)

Further efforts to focus on particular pulses (LIDQMS 855/856)/shots (LIBS 63)

Jari – send out atomic areal density data from IBA for HFGC tile for comparison. Although this is from JET D campaigns it will give a starting point for comparison. **Complete**

LIBS quantification

Consider calibration sample for VTT experiment

- There are "IAP samples" available
- Other samples that have IBA?
- Delay times with Littrow and Arielle will be investigated (as per JET experiment and shorter)

LIBS establish set of lines for analysis (currently not unified)

Include Avantes line for carbon at "900nm and something"

Calibration free analysis

Hydrogen concentration calculation – point 63

- 16 January LIBS meeting online
- Salvatore to show how data was treated

Profilometery will be needed for ablation rate

LIDQMS quantification

Gennady

- Analysis of gas puffs shown at meeting
- Pumping fraction of RGAs (except RGA11) - 94% of injected gas goes to main chamber

- RGA11 vs other RGAs? What pumping fraction is needed for RGA11?
- penning gauge analysis continued....
    - H or D calibration for pennings in towers – some ambiguity of hydrogen isotope calibration

Gas injection comparison of calibration methods

- Gennady and Gabriele to work on calibration methods as an alternative to "jump" in signal
- 25/9/2023 start with data on this day (others to consider later 4/10/2023 and 28/10/2023)
- Check pulses and data on those data (Anna/Ionut to circulate pulse numbers)
- Need to treat the data in same way as calibration
- Comparison with jump method (Laura/Anna)

Conference and publications

PSI-2025 with publication

- Likonen – VTT LIBS experiment
- Jepu – RE damage on inner limiters – LIBS pulses required
- Indrek – LIBS IWGL (Poloidal 2X3 and 2X9, 2X17) pulse supporting information on exposure – potentially TDS results
- Gennady – Calibration procedure for LIBS
- Lidia/Salvatore – depth profiling of HFGC & Tile1 using LIBS
- Pavel – Inner divertor calibration free analysis using LIBS
- Miro – ex-situ LID-QMS on W-lamellae (PWIE contribution)

Hydrogen workshop 2025 with separate publication

- Anna – comparison of LID-QMS fuel retention with predictions
- Laura – quantification of LID-QMS using ump method - Include 94% with Gennady

EMSLIBS

- Pavel – Averaging and selection on spectroscopic lines for LIBS analysis (Methodology)

Successes

- Analysis of pumping from Gennady brings LIDQMS closer to a quantified value
- Similar trends in fuel retention across tiles
- Quantification of LIBS using calibration free method
- First absolute HI value in similar order of magnitude to LIDQMS
- Machine learning algorithm progressed for HI
- LIBS depth profiling of each group is converging