EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal:
https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Deadlines for submission of Experimental Reports

Experimental reports must be submitted within the period of 3 months after the end of the experiment.

Experiment Report supporting a new proposal ("relevant report")

If you are submitting a proposal for a new project, or to continue a project for which you have previously been allocated beam time, you must submit a report on each of your previous measurement(s):

- even on those carried out close to the proposal submission deadline (it can be a *"preliminary report")*,
- even for experiments whose scientific area is different form the scientific area of the new proposal,
- carried out on CRG beamlines.

You must then register the report(s) as "relevant report(s)" in the new application form for beam time.

Deadlines for submitting a report supporting a new proposal

- 1st March Proposal Round - **5th March**
- 10th September Proposal Round - **13th September**

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report in English.
- include the experiment number to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Study of different nozzle geometries on the near-field spray evolution in gasoline direct injection	**Experiment number**: me1516
Beamline: ID19	**Date of experiment**: from: 14/09/2018 to: 14/09/2018	**Date of report**: 02/20
Shifts: 6	**Local contact(s)**: Margie Olbinado and Lukas Helfen	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

***Dr. Lukas Helfen, KIT, ESRF**

***Dr. Alexei Ershov, KIT**

***Tim Russwurm, *Chris Conrad, *Alexander Durst (Institute of Engineering Thermodynamics, Chemical and Biological Engineering, FAU, Erlangen, Germany)**

Report:

In the frame of me1516 we imaged in situ different sprays of gasoline direct injection (GDI) systems using the following set-ups:

1. Multi-exposure radiography using a fast CMOS camera (Vision Research Phantom v2640 with on-head memory) at around 32 kHz and a near-UV-optimized detector optics at a pixel size of around 2.6 µm.
2. Single exposed radiograph series at 5 MHz image acquisition frequency using ID19’s Shimadzu HPV-X2 camera and a pixel size of around 3 µm.
3. Simultaneous shadowgraph using a Photron SA-Z at 5400 Hz image acquisition frequency to depict the general spray expression in the far field (pixel sizes around 100 µm).

For this experiment, a set of glass nozzle tips was fabricated using rapid prototyping methods. Various geometries of the nozzle in- and outlets as well as channel lengths were realized. Figure 1 shows some of the parameters like the length of the spray hole (L) and the offset of the hole from the inlet (H_{off}).

Using shadowgraphy combined with ultra-fast synchrotron radiography allowed us to clearly visualize the different spray behavior and the resulting cavitation (see Fig. 1) and to determine the spray velocity (see plots) near the nozzle exit. This is not possible by other methods like phase Doppler anemometry (PDA) due to the spray opacity. We found that for some nozzle geometries, there is a good agreement between theoretical velocities and X-ray measurements (see Fig. 2). For other geometries, the measurments revealed certain discprepency near the nozzle exit. This makes such types of geometries valuable for further investigations.

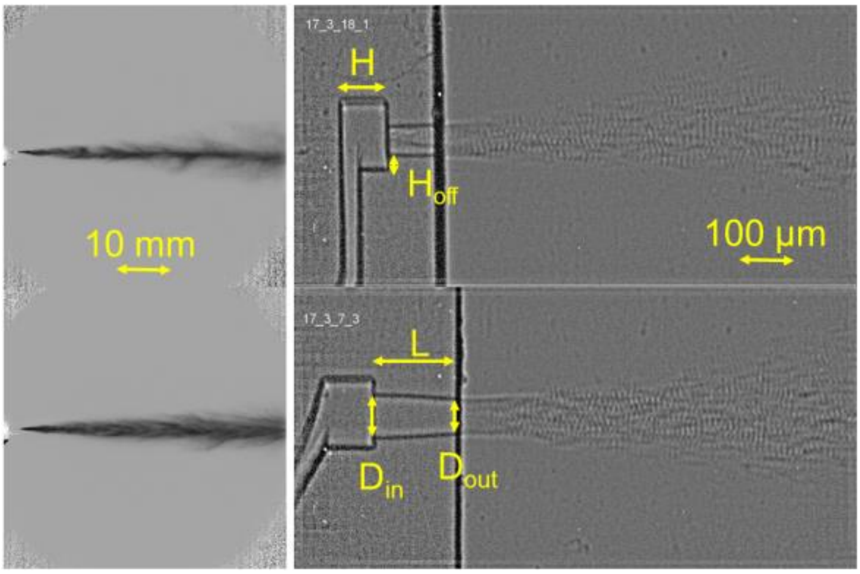

Fig 1: GDI spray for 2 specifically designed glass nozzles investigated by simultaneous shadowgraphy (left images) and x-ray multi-exposures (images right).

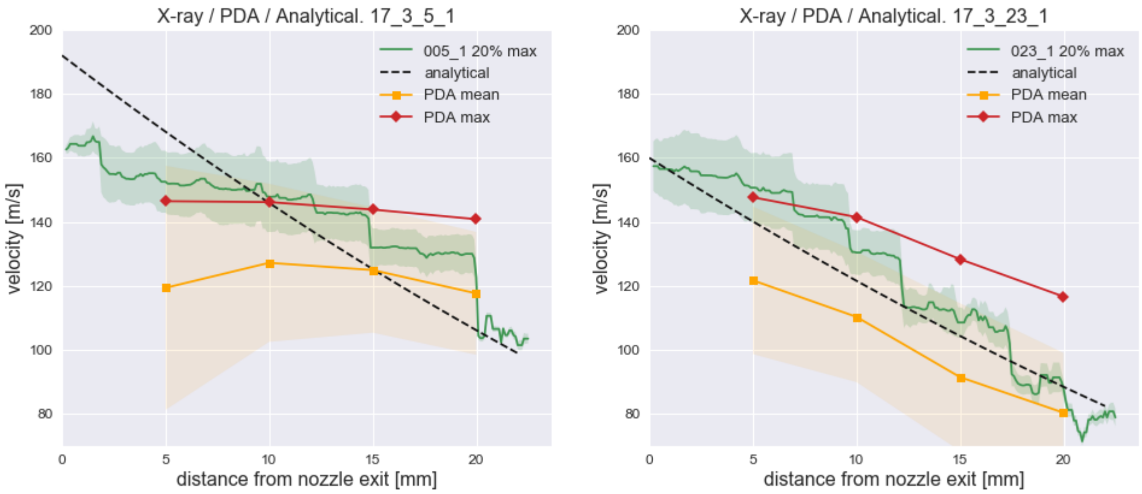

Fig 2: The plots show the mean spray velocities measured by phase Doppler anemometry (PDA) at >5 mm distance to nozzle and x-ray imaging incl. near exit zone, (experiment me1516) compared to analytical predictions.

Part of the data has been published in [1] but we need further data from different geometries to continue our study.

References

[1] S. Bornschlegel *et. al.*, International Journal of Engine Research, 2019