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:** MHz radiography of the primary spray break-up at different injection pressures and ambient conditions	**Experiment number**: Ma4ß78
Beamline: ID19	**Date of experiment**: from: 10/03/2018 to: 12/03/2018	**Date of report**: 03/20
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 experiment ma4078 we aimed to perform systematic spray velocity investigations under varying spraying conditions (e.g. different nozzle geometries, fuels).

For this purpose we have employed the Shimadzu HPV-X2 camera and an imaging setup achieving a pixel size of around 3 µm. In a course of experiment we performed multiple measurements to acquire a diverse geometrical configurations:

- we performed temporal stitching of different spraying events at various temporal moments to cover larger time scales of injection process
- we performed spatial tiling of different events to cover the spray's region of interest in the near-field zone close to the nozzle exit

In such a way we achieve very high spatio-temporal resolution of the injection process in the most challenging region of nozzle exit and obtained a large number of spraying events, which should facilitate the statistical analysis.

To process the data we have developed a robust variational 2D optical flow method. The method computes a dense displacement field between two successive frames using an iterative optimization procedure. The algorithm is capable of capturing wide range of velocities, including large displacements and is robust to noise and low image contrast.

Using the 16 bunch beam mode resulted that approximately 50% of frames contain severe brightness variations due to the discrete exposure mode and scintillator afterglow.

An example of quantitative comparison of injections with different experimental conditions (P=100 bar and 250 bar) is shown on Figure 1.

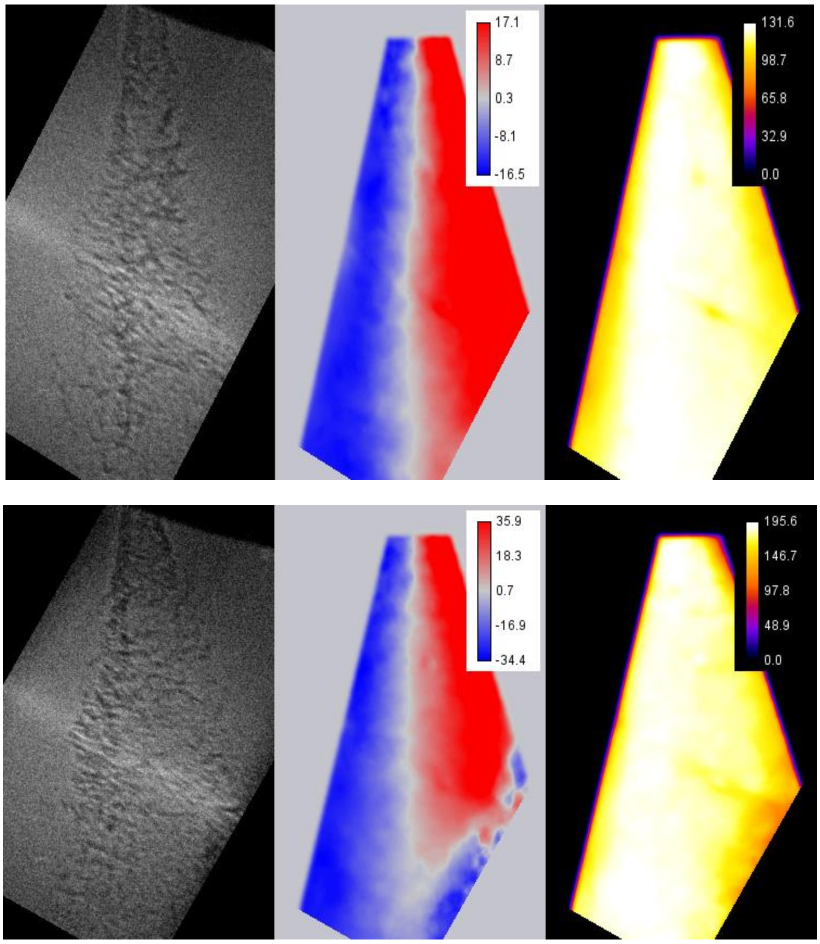

Fig 1: Calculation of spray velocity distribution for n-Heptane fuel. a) input radiograph, b) transformed coordinate system to show flow components across spray direction (x-axis), m/s c) transformed coordinate system to show flow components along spray direction (y-axis), m/s. Top row: P=100 bar, T=30 C. Bottom row: P=250 bar, T=30.

Statistical study of individual spraying events reveals very high stability of the injection process. The results are shown in Figure 2.

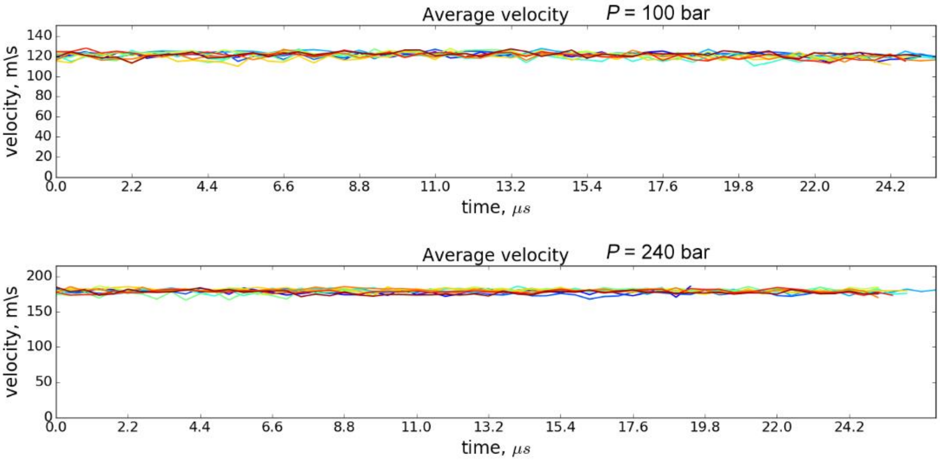

Fig 2: Average velocity over time for P=100 bar and P=250 bar datasets. 10 independent datasets (depicted in different colors) are used for statistical comparison. The experiment show very high stability in average velocity values.