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

Reports supporting requests for additional beam time

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

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.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal 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:** Real-time radiography of the primary spray break-up using single- and multi-bunch exposures	**Experiment number**: MA 3479
Beamline: ID 19	**Date of experiment**: from: 16/07/2017 to: 18/07/2017	**Date of report**: 08/09/2017
Shifts: 6	**Local contact(s)**: Margie Olbinado	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report (Proposal Ref No: 53754):

The second measurement campaign took place during the storage ring was run in uniform filling mode. Hence, a quasi-continuous beam is achieved. The aim of this campaign was mainly to figure out different propagation distances between sample and detector and the suitability of the uniform filling mode for velocity distribution spray measurements. As the multiple exposure approach, described in the report from the May session, is not possible with a quasi-continuous beam, we focussed on measurements with the Shimadzu HPV-X ultra-high speed camera in this measurement campaign.

To be able to capture stochastic spray processes with another measurement technique simultaneously, we used shadowgraphy. Therefore, a first prototype of a spray chamber was designed. The constant volume chamber has two capton windows for the x-ray beam and orthogonal to the beam two glass windows to enable the shadowgraphy measurements. To avoid an explosive atmosphere within the chamber, it is continuously scavenged by nitrogen. A vacuum pump together with valves at the in- and outlet of the chamber, allows a control of the chamber pressure from 20 mbar to 1 bar. Figure 1 shows the used constant volume chamber.

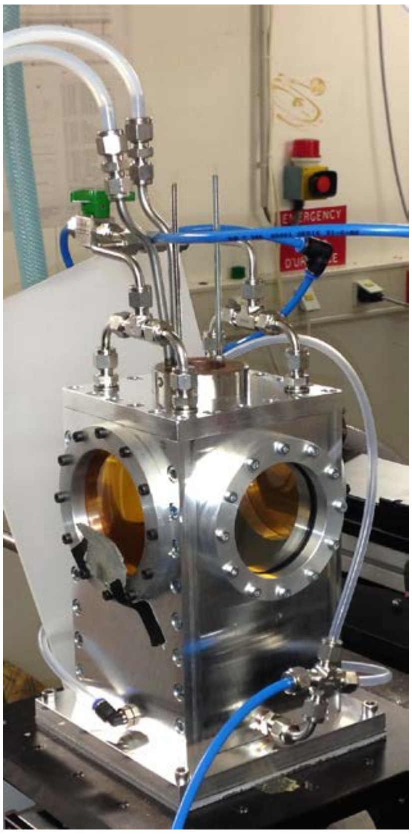

Figure 1: Constant volume chamber used for the spray measurements

Also for the uniform filling mode, a comparison of different scintillator materials was carried out. Figure 2 shows a variation of fuel pressure from 50 bar to 250 bar with a multi hole injector for both scintillators. All images were captured with the Shimadzu HPV-X. As the nozzle outlet velocity is directly linked to the injection pressure, also the spray velocity increases with pressure. In the images the higher decay time of the LuAG:Ce scintillator becomes obvious. During the LYSO:Ce scintillator gives clear images, also for 250 bar injection pressure, the LuAG:Ce scintillator shows relatively sharp pictures for 50 bar, but for 250 bar motion blurring becomes very strong. Therefore, for following investigations with, the LYSO scintillator will be used due to its better dynamic behaviour.

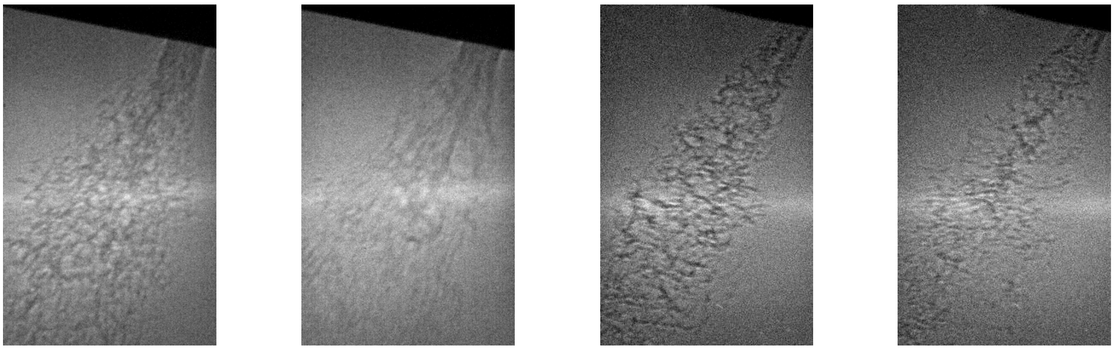

Figure 2: Comparison of the different scintillator materials at two different injection pressures (from left to right): LuAG:Ce, 50 bar; LuAG:Ce, 250 bar; LYSO:Ce, 50 bar, LYSO:Ce, 250 bar

Another important approach was the estimation of the ideal propagation distance for phase contrast measurements. Finding the ideal propagation distance always is a compromise between more contrast through more distance and losing signal by absorption of the x-rays in the air. Figure 3 shows two different images with 5.3 m and 4.5 m propagation distance. A distance of 4.5 m turns out to be the best compromise, delivering good phase contrast and an acceptable signal to noise ratio. Reducing the distance, results in lower phase contrast, during a higher distance leads to a signal loss. The signal was found to decrease 25 % by 1 m additional propagation through air after the constant volume chamber. To reduce beam extinction through air, helium flight tubes were installed before the chamber and between chamber and detector. Figure 4 shows a shadowgraphy image of the whole spray next to a x-ray image of the near nozzle region from the same spray event.

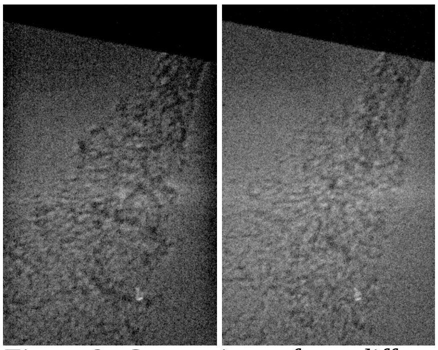

Figure 3: Comparison of two different propagation distances:5.3 m (left) and 4.5 m (right) (150 bar injection pressure)

Figure 4: Shadowgraphy image of the whole spray (left) and x-ray image of the near nozzle region (right) (150 bar injection pressure)

The experimental session during the uniform filling mode showed that velocity measurements principally are possible with a quasi-continuous beam, using the Shimadzu HPV-X ultra-high speed camera. Nonetheless the desired multiple exposure images with the Photron Fastcam SA-Z can only be done in 16-bunch filling mode. Moreover, also the Shimadzu HPV-X camera is delivering clearer images with more contrast in the 16-bunch mode.