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

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: High Speed 2D X-Ray Imaging of Inhaler Canisters**	**Experiment number**: IN-854
Beamline: ID19	**Date of experiment**: from: 08 July 2016 to: 08 July 2016	**Date of report**: 10/02/2017
Shifts: 1	**Local contact(s)**: Alexander Rack	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Alan McKiernan*, Prior PLM Medical

Report:

The material was presented orally at the Drug Delivery to the Lungs Conference (DDL27, Edinburgh, December 7th – 9th, 2016) organised by The Aerosol Society.
This work has given rise to a 4 page conference proceedings paper, the summary of which will be published in the Journal of Aerosol Medicine and Pulmonary Drug Delivery which is the official journal of the International Society for Aerosols in Medicine (published by Mary Ann Liebert, Inc). Additionally, ESRF have (on 14/02/17) published an online story on it: https://t.co/4mKfjf0P3H

Page 69 of DDL27 proceedings book

Novel techniques for characterising inhalers
A.P. McKiernan[1]

[1]Prior PLM Medical, IDA Business & Technology Park, Carrick-on-Shannon, N41 WK46, Ireland

Summary
Background: While the initial plume formation and expansion during pressurised metered dose inhaler (pMDI) dose release is considered important to drug transport to the lungs, it is not well understood, in part due to the transient nature of the event and the difficulties in accessing the metering chamber. Plume velocity is an important measure of inhaler device

performance as large or very fast drug particles tend to deposit in the oropharyngeal region due to the sharp directional flow change.
Methods: Schlieren imaging is an optical technique that is sensitive to refractive index gradients which are often present in pMDI plumes due to gas density variations. We have developed a Schlieren setup and have observed plume expansion up to 400 mm from commercial pMDIs for various actuator/canister/formulation combinations. We have also used phase contrast X-ray imaging at a synchrotron to investigate the stem/sump/orifice of the same pMDIs and a dry powder inhaler (DPI) during dose release.
Results: The plume leading edge dynamics are well described by a high-speed drag model. It was observed that HFA 134a drives faster plumes than HFA 227ea, particularly as the orifice diameter increases. Propellant cavitation behaviour appears dependent on the canister/formulation while the dose duration appears additionally dependent on the actuator design. Individual carrier particles were observed to travel counter to the general airflow inside a DPI.
Conclusions: High speed Schlieren imaging and phase contrast X-ray imaging are suitable techniques to evaluate formulation or actuator modifications, metering chamber behaviour or tooling modifications during inhaler device development.