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:** Imaging the in vivo dynamics of regional lung ventilation and blood perfusion in an experimental model of asthma	**Experiment number**: MD909
Beamline: ID17	**Date of experiment**: from: 11 December 2015 to:16 December 2015	**Date of report**: 31 March 2016
Shifts: 15	**Local contact(s)**: Alberto Bravin	*Received at ESRF: 01 April 2016*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

Rationale and Objectives: A hallmark of asthma is airway inflammation and an exaggerated narrowing in response to environmental stimuli, leading to regional abnormalities in lung ventilation. Defects in regional ventilation are significant because they alter gas exchange and respiratory mechanics, and impact the distribution of inhaled drugs in asthmatic subjects. The importance of understanding the structure and function of very peripheral airways and lung acini (clusters of alveoli) in asthma has been appreciated only recently. Post-mortem examination shows extensive disease in peripheral airways and alveoli in asthma. However, there are currently no data on how regional lung ventilation, blood perfusion and tissue geometry change during the course of a single breath, during an asthma attack. This is due to the lack of quantitative imaging techniques with sufficient temporal and spatial resolution to allow the study the dynamics of regional lung function in vivo. The aim of this experiment was to assess the within-tidal dynamic changes in regional lung gas and blood volume, in an experimental model of asthma in rabbit, using a novel approach.

Methods: The experients were performed in 10 anesthetized New Zealand White rabbits (Wt ~3 kg) at baseline and during acute bronchoconstriction induced by inhalation of methacholine (MCH). The animals were mechanically ventilated in volume control mode with an infant ventilator (vt = 6 ml/kg; I:E =0.5; PEEP=3 cmH_2O). K-edge subtraction imaging was performed on ID17, successively at 34.56 and 33.17 keV, using a liquid nitrogen-cooled Ge detector, allowing for continuous tomographic acquisitions at 350 μm pixel resolution over 2-3 min. True time resolution was 720 projections/s. We used a gaited

imaging sequence (see: *MD679 report*), where projection images were collected continously during ~3 min of breathing, during steady-state inhalation of 70% Xe, or injection of iodine.

Results: Quantitative images of inhaled Xe, injected Iodine and simultaneous tissue-density images included in each data set, were acquired. These data can be post-reconstructed to reproduce a single representative respiratory cycle as 30 consecutive images. These data, currently still under analysis, will allow us to produce for the first time, a video of the within-breath regional changes in blood and gas volumes during a respiratory cycle in rabbit lung. An example of the changes in static distribution of regional blood volume before and after the induction of acute bronchoconstriction (asthma attack) by MCH inhalation is shown in Figure 1, obtained by standard KES imaging for comparison with the gaited images.

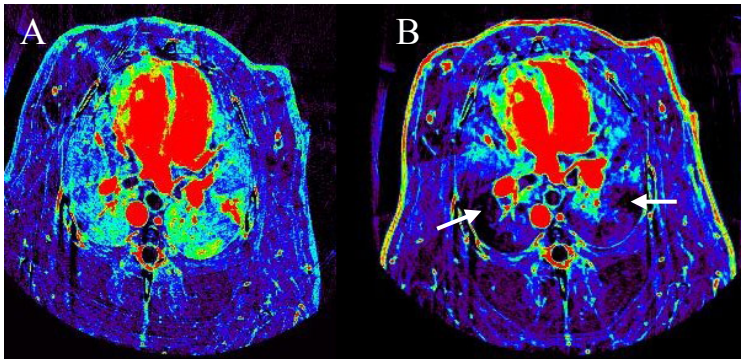

Figure 1. *Sample static KES images showing the regional distribution of iodine in blood within the lung and surrounding tisuues. A: in vivo image at baseline in healthy lung; B: after MCH inhalation (asthma attack). Note the apearance of regional lung perfusion defects (white arrow). Regional blood volume is measured based on regional iodine and corresponding tissue density. Note central blood vessels and cardiac chambers (red). Color scale represents: 0 (black), 1.2 mg/ml (blue), 6.5 mg/ml (red).*

Conclusion: The experiment was successful in acquiring the necessary data that will allow reconstructing dynamic maps of within-breath changes in regional lung gas and blood volume distributions, both in healthy lung and in follwing acute bronchocontriction. Since this is a time-consuming analysis, the present is a preliminary report. However, given the quality and quantity of obtained data, we expect to fulfill the main objectives of the study.