EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

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:** High-resolution time-resolved in-vivo lung CT using the new pink-beam imaging setup	**Experiment number**: MD-1184
Beamline: ID17	**Date of experiment**: from: 28/11/2018 to: 01/12/2018	**Date of report**: 28/02/2020
Shifts: 9	**Local contact(s)**: Alberto Bravin	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Fardin Luca* (University Grenoble Alpes, ESRF)

Sam Bayat* (Department of Clinical Physiology, Grenoble University Hospital Center, France)

Report:

Introduction:

The aim of the proposal was to test the pink beam imaging setup installed at the biomedical beamline ID17, to verify whether this image modality was suitable in terms in-vivo dynamic lung 3D microscopy in a rat model. The ultimate goal of the experiment was to improve the spatial resolution of the in-vivo lung dynamic 3D microscopy techniques available at ID17, moving to a pixel size of 3 μm: the highest spatial resolution, obtained before the experiment, was 22 μm.

Inhouse time preceding the experiment proved that the pink beam imaging setup was causing radiation damages to the lungs, in the form of edema accumulating in the alveolar space during the acquisition of a single tomographic scan. Together with the beamline staff, it was decided to perform the experiment with monochromatic radiation. Since the monochromatic flux was found to be insufficient for in-vivo imaging at a pixel size of 3 μm, it was decided to test optics providing a pixel size of 11 μm and 6 μm, pursuing the main goal of the experiment: increasing the spatial resolution of in-vivo lung dynamic 3D microscopy.

Experimental Method:

The experiment was performed on 9 anesthetized, muscle-relaxed and mechanically ventilated adult rats. Following the dynamic 3D microscopy acquisition protocol, projection images were acquired at a constant frame rate at time resolution down to 2 ms using a PCO edge 5.5 camera, coupled with two different optics determining a final pixel size of ~6 μm and 11 μm, respectively. Six rats were imaged using a pixel size of 11 μm and 3 rats using a pixel size of 6 μm. During imaging, animals were under controlled ventilation using a custom-made mechanical ventilator. To synchronize the image reconstruction with the parenchymal motion, the ECG and respiratory pressure signals were also registered. Images were post-reconstructed by sorting image projections based on the respiratory and cardiac activity phases.

Preliminary Results:

Volumetric images were reconstructed at different phases of the cardiac and respiratory activity, while keeping motion artefacts low at both resolutions: 6 µm (Figure 1) and 11 µm. A pixel size of 6 µm allowed to visualize for the first time the micromechanics of the lung parenchyma during mechanical ventilation at the alveolar scale.

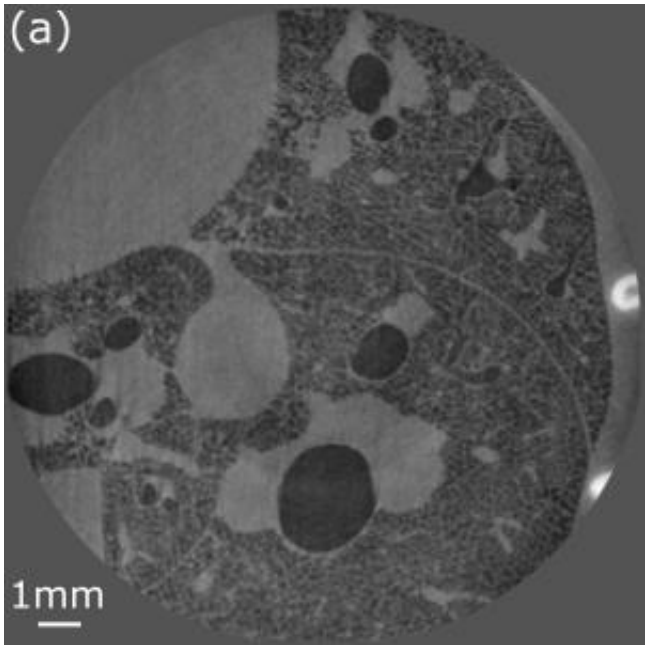

Figure 1 In-vivo lung dynamic 3D microscopy acquired under mechanical ventilation with the acquisition protocol developed at ID17. The time frame shown corresponds to the beginning of the inspiratory cycle at diastolic cardiac phase. The acinar structure can be resolved and its deformation under mechanical ventilation visualized.