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:** Impaired bone material quality due to Marfan syndrome? High resolution SAXS/WAXS studies to reveal correlations between mineral nanostructure and osteocyte network structure	**Experiment number**: SC-5010
Beamline: ID13	**Date of experiment**: from: 09.09.20 to: 13.09.20	**Date of report**: 09.03.2023
Shifts: 9	**Local contact(s)**: Manfred Burghammer	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

We investigated the mineral nanoparticle properties of cortical bone from 12-week-old mice with Marfan syndrome (namely Fbn1$^{mgr/mgr}$) and their healthy littermates. Using small angle X-ray scattering (SAXS) with micrometer resolution we characterized the bone material at ID 13 with the aim to determine the mineral particle size and orientation as a function of the position in relation to the OLCN which was imaged before using confocal microscopy. Generally, the structure of bone is adapted at every hierarchical level to its mechanical needs, i.e. the extra cellular matrix (ECM) is subjected to a lifelong interplay between bone resorption by osteoclasts and bone formation by osteoblasts (Weinkamer and Fratzl, 2011). Osteocytes are embedded in the bone matrix and orchestrate the remodeling process via fluid flow in the lacuno-canalicular network (LCN) and likely contribute directly to mineral homeostasis (Kerschnitzki, 2013). Combining our methods we found that the LCN and collagen orientation are less aligned in the mice with Marfan syndrome than in healthy littermates, showing a clear band of unordered network and collagen fibers surrounded by more ordered lamellar bone. Additionally, mineral particles are thinner and shorter in mgr/mgr mice than in their healthy littermates (see Figure 1).
Moreover, first analyses show evidences reveal micron- and ultrastructural impairment in Marfan syndrome resulting from reduced expression of Fbn1which supports our hypothesis that osteocytes directly influence the mineralization process. The experiments performed in September 2020 were very succesful and we could measure all samples as planned. The results have been partly shown in a PhD thesis (Schemenz, 2022) and we are currently writing up a manuscript which presumably will be submitted to a peer reviewed journal in 2023.

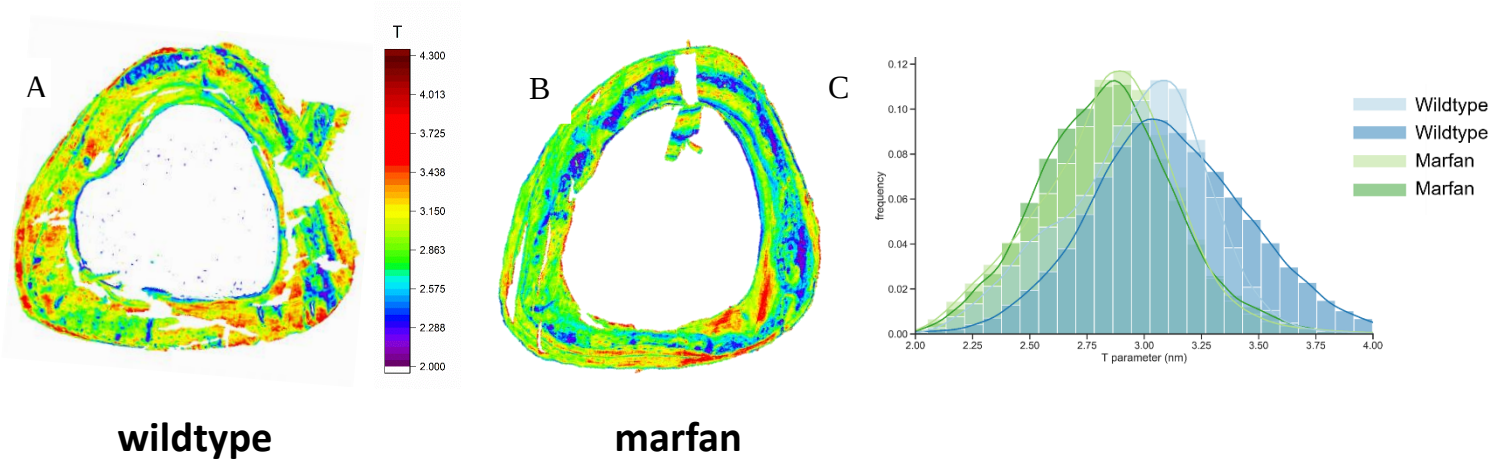

Figure 1: Scanning small angle X-ray scattering results. The color maps of the T parameter (mineral thickness) show in general higher values in the healthy wildtype mouse (A) than in the mgr/mgr mouse (B). Furthermore, the blue band, which might correspond to unremodeled bone from early bone modelling, is more prevalent in the mgr/mgr mouse. This effect could also be shown quantitatively in C.

References:

Kerschnitzki, M., Kollmannsberger, P., Burghammer, M., Duda, G.N., Weinkamer, R., Wagermaier, W., Fratzl, P., 2013. Architecture of the osteocyte network correlates with bone material quality. J. Bone Miner. Res. 28, 1837–1845.

Weinkamer, R., Fratzl, P., 2011. Mechanical adaptation of biological materials — The examples of bone and wood. Mater. Sci. Eng. C 31, 1164–1173.

Schemenz, V., 2022. Correlations between osteocyte lacuno-canalicular network and material characteristics in bone adaptation and regeneration. Universität Potsdam.