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:** Bone behavior around a self-tapping dental implant during its insertion	**Experiment number**: LS-3120
Beamline: ID19	**Date of experiment**: from: 15/11/2023 to: 16/11/2023	**Date of report**: 01/02/2023 *Received at ESRF:*
Shifts: 3	**Local contact(s)**: Bratislav Lukic Ludovic Broche	

Names and affiliations of applicants (* indicates experimentalists):

Laura Preiss, INSA de Lyon, MATEIS *
Jérôme Adrien, INSA de Lyon, MATEIS *
Loïc Courtois, 3DMagination *
Rémy Gauthier, INSA de Lyon, MATEIS *
Hervé Richard, Anthogyr *
Eric Maire, INSA de Lyon, MATEIS

Report:

Over the three shifts granted by ESRF, the team was able to carry out all the programmed experiments, all repeated twice. These consisted of three different manipulations:
1) Insertion of a short implant into the bone, with fast scans,
2) Insertion of a long implant, twice, with fast scans 3) Insertion of a long implant, at low implantation speed, with fast scans
Each experiment was preceded and followed by a high resolution acquisition (3µm).
In total, including pre- and post-implantation scans, and decoy scans (an aluminium decoy is inserted into the implant well before the implant is placed, in order to reproduce the same grey level attenuations at the implant sites as the implant once in place), 994 scans were recorded for analysis, and 12 implants were placed (6 of each kind, 2 per experiment).
Two types of implants were studied: the reference implant (REG), which is the standard today, and a new self-tapping implant, which is supposed to create more bone debris, as well as a larger displacement field, in order to achieve better osseointegration.

To date, analysis has begun, particularly with regard to the bone debris around the implant. Indeed, we have found that high resolution images provide real added value, allowing visualisation of osteocyte sites in the mineral bone. We were also able to observe the bone debris in contact with the implant, which we had not been able to do before with the laboratory tomograph.

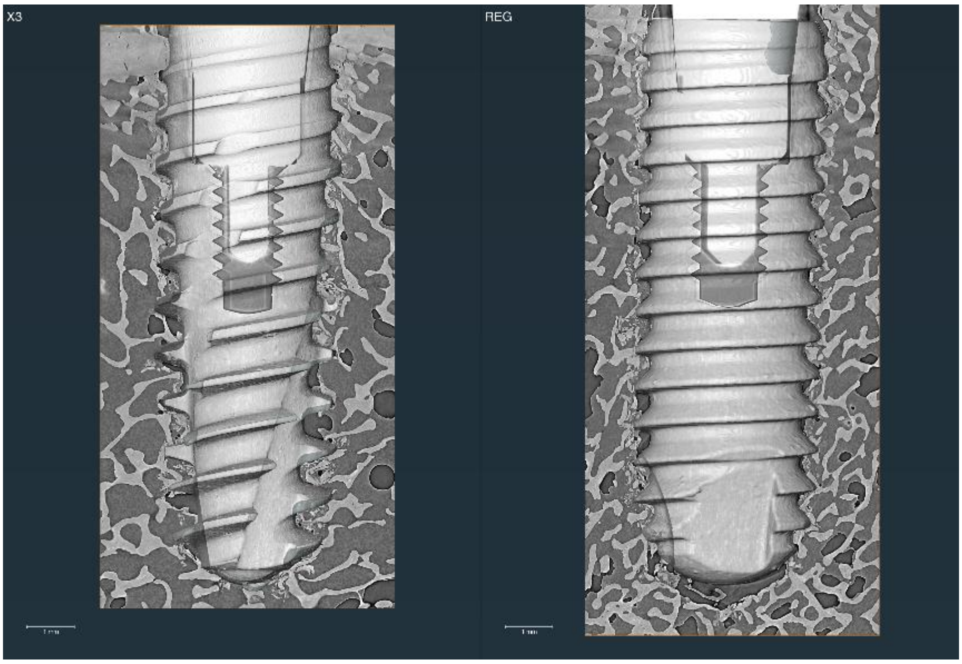

Figure 1: bone debris visualization around the two types of implants: left the autotapping implant, right the reference implant

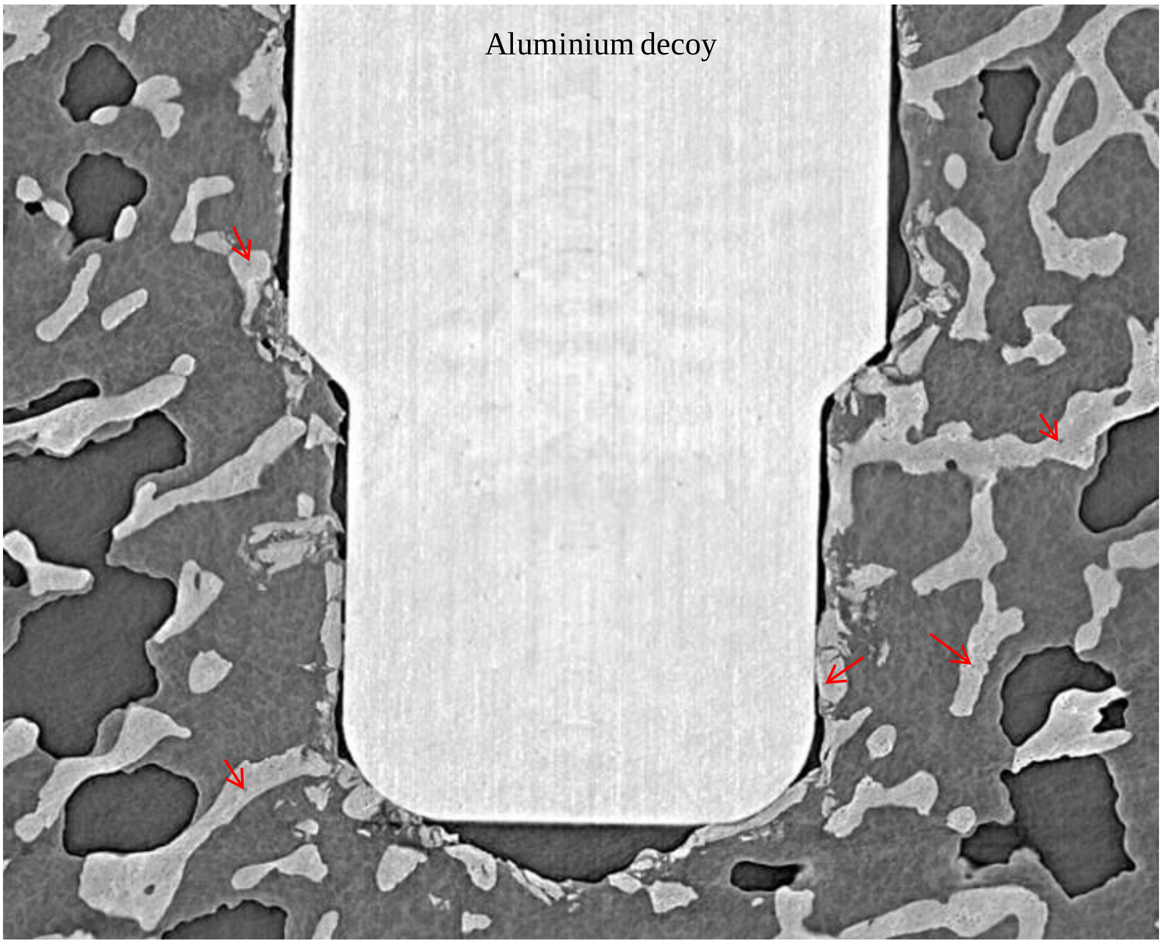

Figure 2: Bone cell (osteocyte) sites (red arrows) around an aluminium decoy

Next, DVC analysis of the bone trabeculae around the implant is underway, and should allow us to differentiate between the two types of implants found and to trace the stresses that they generate in the surrounding mineral bone. As these stress distributions are directly related to the quality of osseointegration, we hope to prove with these results that the new implants that are being developed offer better chances of success.

Finally, thanks to the reconstructed volumes of the low-speed implantations, the creation of debris by fracturing the bone trabeculae could also be demonstrated, which is a first in the field.

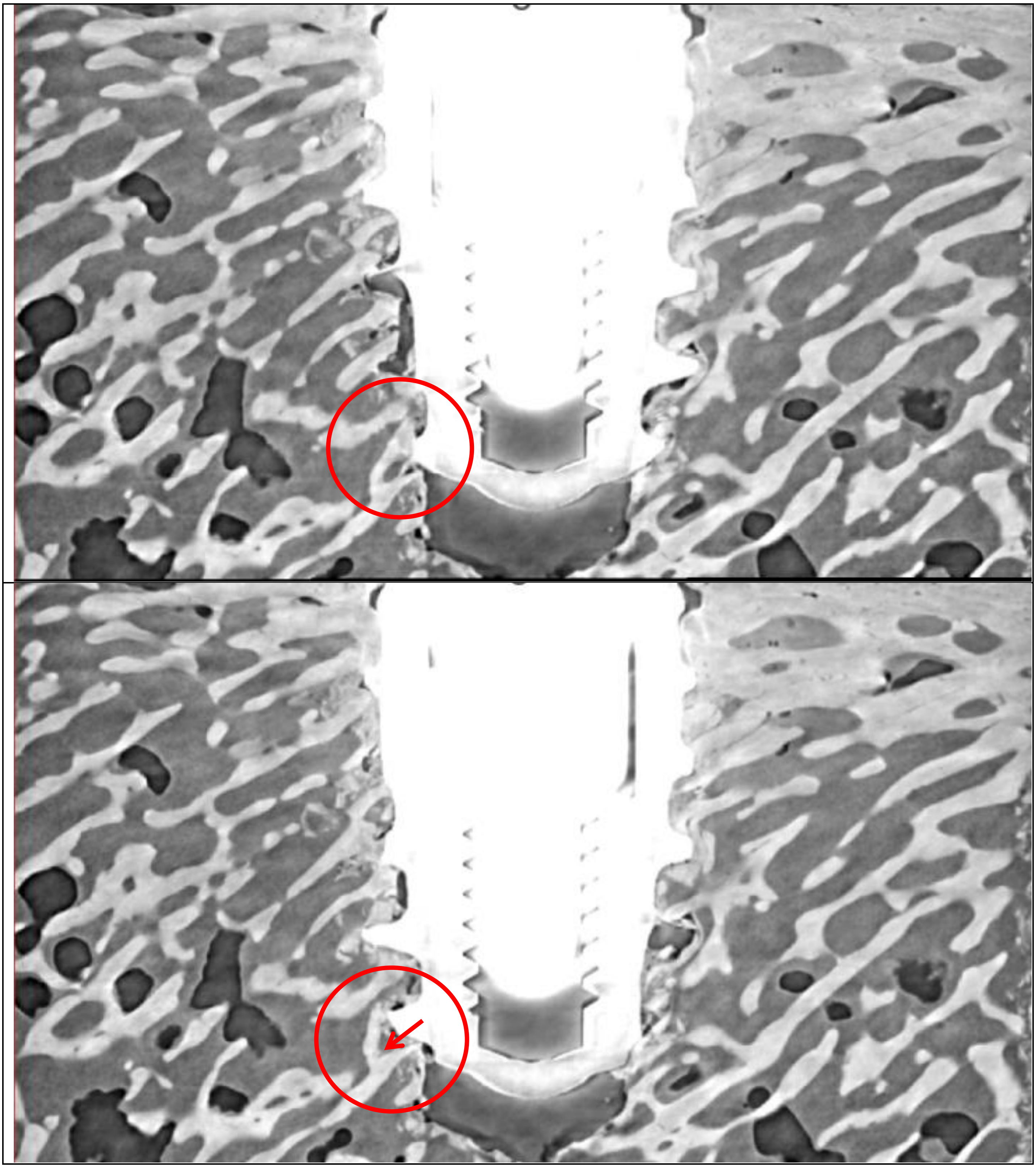

Figure 3: in the red circle: a bone trabecula before (top) and after (bottom) breakage undes the effect of the self-tapping implant insertion

Perspectives

The tests that were carried out highlighted the mechanisms around two types of implants during their insertion into the bone. A second batch of experiments would allow different implant geometries to be tested, and would significantly increase the repeatability of the manipulation (as a reminder, since bone is a biological material, the samples are not identical, so a large number of samples must be tested to make solid conclusions).