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 using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now 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: **Comparison of micro-structural trabecular bone features obtained by ultrasound and 3D SR µCT. Development of virtual osteoporosis on reconstructed 3D images".**	**Experiment number**: MD-24
Beamline:	**Date of experiment**: from: 11/04/2003 to: 14/04/2003	**Date of report**: 01/09/2003
Shifts:	**Local contact(s)**: P. Cloetens	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

Osteoporosis is a bone fragility disease characterized by a loss of bone mass and alteration in trabecular bone micro-architecture. Although lesss considered, cortical bone is also affected. Ultrasonic measurements are attracting the attention of a number of researchers, but the exact nature of measured architectural features is not clear. The LIP which has a long experience in ultrasound techniques recently proposed 1) a model to predict ultrasound backscatter coefficient using 3D images of micro-architecture of trabecular bone, 2) a method for assessing cortical shells of long bones using axial transmission.

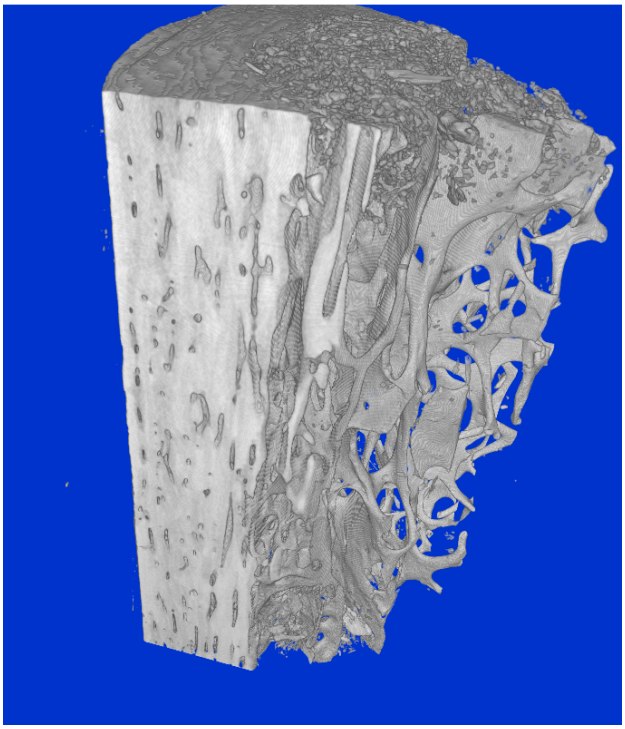
In view to validate and optimize ultrasound measurements, the aim of this proposal was to acquire 3D images of a large number of trabecular and cortical samples to assess accurately the properties of bone samples in terms of architecture and degree of mineralization.

Fifty specimens of human femoral neck were extracted from cadavers, ("Banque du Don d'Organe", Université Paris 5) and defatted leaving only the inorganic network. Both cylindrical cores (diameter : 1 cm, thickness : 1 cm) from cortical and trabecular bone were prepared. All samples were placed in a plexiglas sample holder allowing a very fast manipulation of the samples during the experiment. Ultrasound measurements (by backscattering and axial transmission) were performed on the bone samples befor imaging.

The samples were imaged using SR µCT on beamline ID19 at ESRF in the following conditions : voxel size : 10µm, detector FRELON camera 1024x1024, exposure time : 0.5

sec. To optimize image contrast, the energy was adapted to each series of samples, and was set to 24 Kev for trabecular sample, and 26 Kev for cortical samples. A total of 81 samples were acquired. Volumes of interest of 800 x 800 x 1024 voxels were selected and reconstructed using the filtered back projection algorithm.

Typical 3D displays are presented in figure 1 (a: cortical bone and b : trabecular bone).



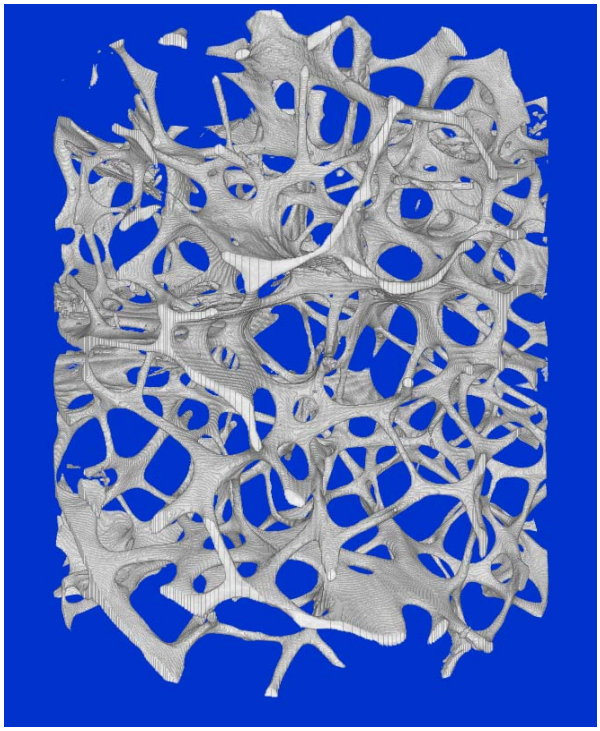


Figure 1 : a) cortical bone b) trabecular bone

The 3D-images are currently under image analysis for extracting both parameters of bone micro-architecture and bone mineralization. Note that the analysis has to be adapted to the type of bone (trabecular or cortical).

Future works are the following :
1) concerning trabecular bone : the micro-architecture parameters obtained from SR µCT will be compared to those estimated from ultrasonic measurements using the specific model developed at the LIP. This should allow to validate and improve the ultrasound backscatter model.
2) concerning cortical bone : the morphometric parameters obrained from the SR µCT images, and more precisely the cortical thickness, the true bone mineral density and the porosity will be correlated to the ultrasound measurements. It will therefore allows to clarify the nature of the properties being measured by axial transmission technique.
3) To 3-D images will be used to simulate virtual osteoporosis in order to assess the sensitivity and potential of the different ultrasound methods to monitor osteoporosis and anti-osteoporosis drugs.