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:** Study of Articular Cartilage using Diffraction-Enhanced Imaging on whole joints, in CT mode and Multiple Image Radiography	**Experiment number**: MD-248
Beamline: ID 17	**Date of experiment**: from: 4 OCT 2006 to: 10 OCT 2006	**Date of report**: 10 JULY 2007
Shifts: 18	**Local contact(s)**: Dr Herwig REQUARDT	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Dr Chris HALL	CLRC Daresbury Laboratory
*Dr Sarah RIGBY	University of Liverpool
*Dr Majid FAHRAMAND	University of Liverpool
*Ms Suzanne CRITTELL	University of Liverpool
*Dr Steven WILKINSON	Cranfield University
*Dr Kan-Cheung CHEUNG	CLRC Daresbury Laboratory
*Mr Mark IBISON	University of Liverpool

Report:

Objectives.

To demonstrate Diffraction-Enhanced Imaging (DEI) of joint cartilage in CT mode, for comparison with MRI results using the same samples.

To performance test specially-designed phantoms for DEI.

To investigate usefulness of information obtainable from cartilage samples, using the Multiple-Image Radiography (MIR) technique.

Notes on Method.

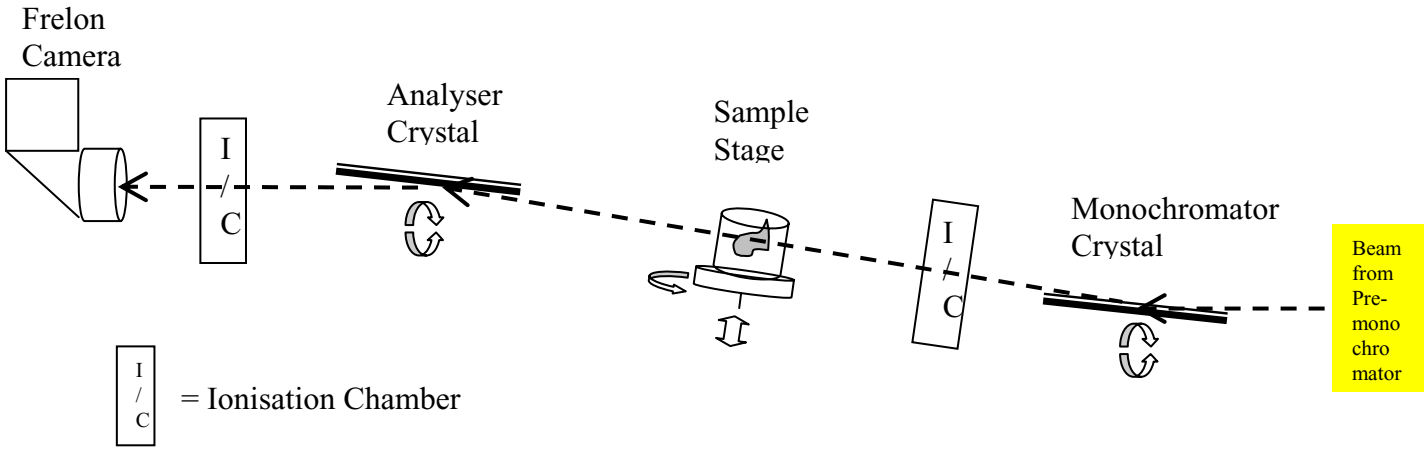
Samples. (i) Phantoms x 3: 2 fabricated from Perspex, to show primarily (a) refraction; (b) absorption properties.
1 Scattering phantom (colloidal silica, tradename LUDOX).

(ii) Animal Cartilage (canine):
(a) core through leg joint surface, into bone;
(b) disarticulated head of knee joint;
(c) whole (intact) knee joint

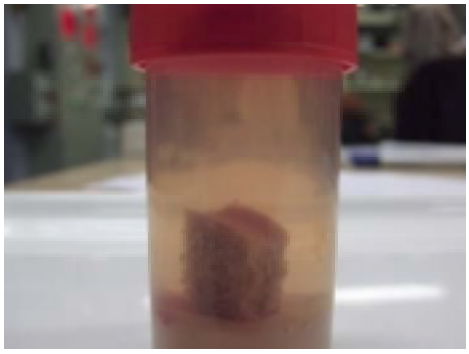
Imaging Parameters.

An early decision was made to operate with the monochromator set at 40keV using the Si 1,1,1 reflection (giving a reasonable compromise between optics stability/rocking-curve width, contrast, and penetration) and an X-ray camera resolution of 30σm (giving acceptable image quality vs. field of view). The upstream Laue monochomator was tuned to this energy, being retuned at every beam refill, when the beam profile was also checked to select the optimum flat intensity region.

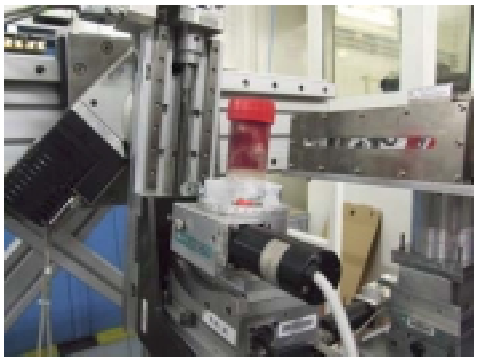
Experimental Beamline Configuration (ID 17).



Sample



Sample Stage



Beamline

Energy calibration was confirmed using the K-fluorescence lines of Xe gas contained in a rubber balloon, detected by a Si PIN diode with spectroscopy-amplifier and MCA.

Automated scripts were run to coordinate image acquisition with motor movements, as well as dark and flat (white) fields. Integration times were adjusted to improve statistics for images away from peak intensity, while avoiding detector 'saturation' in the white fields.

Images were taken at 7 or more positions on the Analyser rocking-curve:-

Peak, ±80%, ±50%, ±30%; and where possible, ±15%.

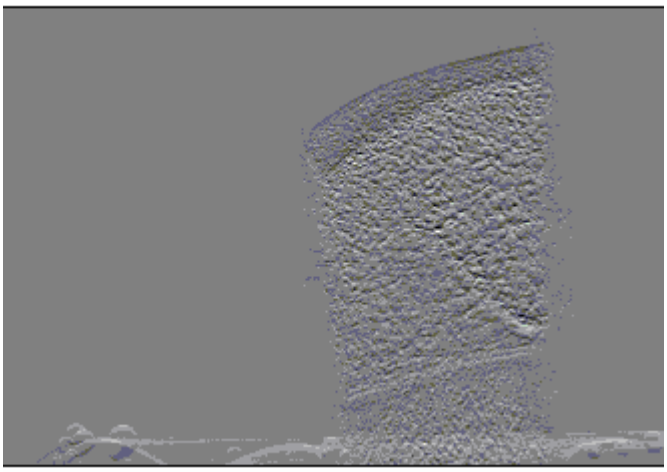
Image sets were collected for all 3 phantoms and 3 tissue samples to support the MIR technique. This uses an algorithm to extract not only a 'refraction' image (as in DEI) but also an 'ultra-small-angle scatter' image from the data set. In addition, a full CT scan set was obtained, for one of the samples; time did not permit CT of all samples.

Analysis of Results.

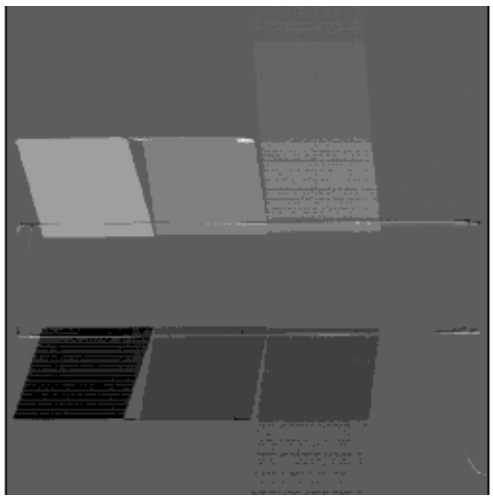
Some initial test processing of image data was carried out at ESRF to check for useability; however, all images were subsequently fully analysed at Liverpool, where special 'MIR' algorithms have been developed.

Problems were encountered in registering flat field with image data files for correction/normalisation, due mainly to the lack of general availability of the specialised ESRF software; however, these were overcome to produce useful results.

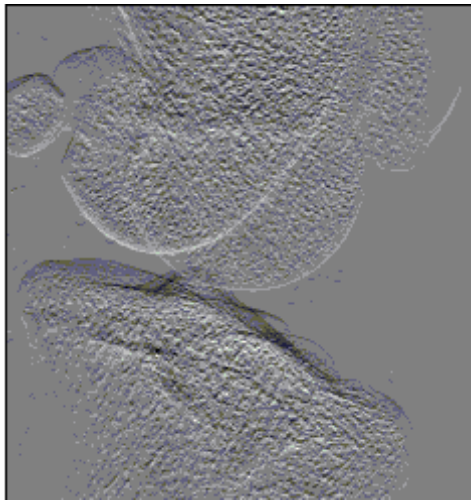
Core sample, Refraction Image- DEI, 50% Rel. Intensity



Refraction Phantom, DEI Refraction Image



Whole Joint Sample, DEI Refraction Image using ±50% points on Rocking-Curve



Refraction Phantom, in Imaging orientation

Conclusions.

It has been shown that acceptable DEI imaging can be performed successfully on the ESRF in 16-bunch operating mode.

Data when fully analysed is expected to be incorporated into the PhD thesis for student Ms S Crittell (Liverpool).

It will also be valuable to compare results with similar images from the newly-commissioned DEI imaging station (9.4) at the SRS, Daresbury Laboratory, UK, which will be used to continue the cartilage study of which Experiment MD-248 forms a part.