EUROPEAN SYNCHROTRON RADIATION FACILITY

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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 Multiple Scattering in phantoms by using the Diffraction Enhanced Imaging technique	**Experiment number**: MD 19
Beamline: ID 17	**Date of experiment**: from: 03 April 2003 to: 08 April 2003 and from: 01 August 2003 to: 04 August 2003	**Date of report**: 30.09.2003
Shifts: 15 and 9	**Local contact(s)**: Alberto BRAVIN	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Gabriele Heike Heitner, University Siegen, Germany, Univeristy Trieste, Italy [1), 2)]

Hans-Juergen Besch, University Siegen, Germany [1)]

Hartmute Plothow-Besch, University Siegen, Germany [1)]

Ralf Menk, ELETTRA Trieste, Italy [1)]

Fulvia Arfelli, University Trieste, Italy [1)]

Luigi Rigon, University Trieste, Italy [1)]

Alessandra Pillon, ELETTRA Trieste, Italy [2)]

Alberto Bravin, ESRF Grenoble, France [1), 2)]

[1)] Present at beamtime in April 2003

[2)] Present at beamtime in August 2003

Report:

One subject we study within our PHASY EU-Project [1] is the effect of Multiple Scattering by using the Diffraction Enhanced Imaging (DEI) technique. For this we proposed an experiment entitled “Study of Multiple Scattering in phantoms by using the Diffraction Enhanced Imaging technique”.

The experiment was supposed to study correlations between scattering and thickness of the penetrated material at different energies by using the DEI method. With our experiments we are intending two things:

One is to prove a new DEI algorithm [2], which was evaluated to overcome some remaining limitations within the current DEI modality.

The other one is to study in general the effect of multiple scattering by using the DEI method. The aim is to implement the knowledge to biological multiple scattering material such as a lung, to prove, if DEI would be an applicable instrument for lung studies and diagnostics.

For the first step of our experiments we prepared phantoms made of pmma spheres of a well-known diameter. We used spheres of three various sizes, arranged in a stair-like phantom to simulate material of

different thickness. In these phantoms the spheres are distributed randomly. Furthermore, we used similar phantoms in material and thickness, but with a definitively well-known substructure of the microelements.

In April 2003 we recorded at the beamline ID17 several DEI series at 25 keV and 60 keV by using the SI- analyser crystal at the (111)-reflectivity. For each DEI series we recorded an image at the so-called "far slopes", "half slopes" and "top" of the analysers reflectivity curve.

The ESRF has accorded exceptionally some supplementary shifts in August 2004 because of some technical problems occurred during the beamtime in April 2003, that prevented a regular end of the experiment.

So, in August 2003 we continued our measurements by recording DEI series acquired at 40 keV using the SI (111) reflectivity to complete the dataset.

Altogether we recorded:

Run	# DEI-series (# Phantoms)	# Pure absorption images (# Phantoms)	Energy (reflectivity)
April 2003	20 (6)	8 (6)	25, 60 keV (SI (1,1,1))
August 2003	20 (7)	9 (7)	40 keV (SI (1,1,1))
In sum	**40 (9)**	**17 (9)**	**25, 40, 60 keV (SI (1,1,1))**

Table 1, Run statistics MD19

Finally, in consideration of our measurements we observed significant signals due to multiple scattering by using the Diffraction Enhanced Imaging technique [Fig. 1, Fig. 2]. The data analysis is still in process and we are convinced to observe similar characteristics within biological material with the property of multiple scattering. So, the next important step would be to prove the feasibility of DEI for lung studies and diagnostics. For this, we proposed at the ID17 a continuative experiment entitled "Study of Multiple Scattering of an in vivo rabbits lung by using the Diffraction Enhanced Imaging technique" [3].

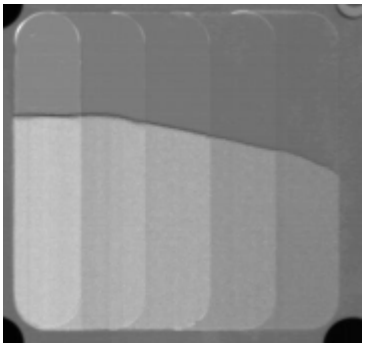

Fig. 1
"Far slope image", post processed

Pmma spheres in an arrangement of different thickness,
largest thickness on the left hand side.

Comment: The larger the layer, the stronger the scattering signal.

recorded at ID17, ESRF, Grenoble, Experiment MD19, 2003/04

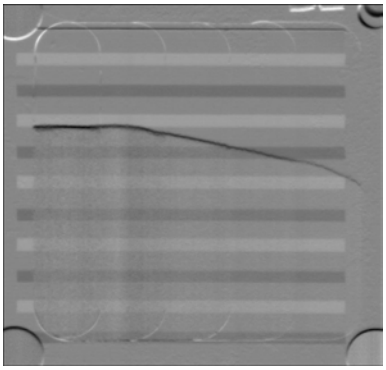

Fig. 2
Calculated refraction image according to the Chapman algorithm [4]

Pmma spheres in an arrangement of different thickness, largest thickness on the left hand side, superimposed by an element of known refraction properties.
Comment: The larger the layer of the scattering material, the weaker the remaining signal of the superimposed structure.

ID17, ESRF, Grenoble, Experiment MD19, 2003/04

[1] Phase Analyzer System for Novel Imaging Modalities (PHASY) –Call identifier IHP-INF-99-1, Proposal N. HPRI-1999 50035

[2] Rigon Luigi, Besch Hans-Juergen, Arfelli Fulvia, Menk Ralf-Hendrick, Heitner Gabriele, Plothow-Besch Hartmute - "A New DEI Algorithm Capable of Investigating Sub-Pixel Structures", J. Phys. D: Appl. Phys. **36** (21 May 2003) A107-A112

[3] Proposal ID, Ref.: 6904

[4] D. Chapman, W. Thomlinson, R.E. Johnson, D. Washburn, E. Pisano, N. Gmür, Z. Zhong, R. Menk, F. Arfelli, D. Sayers, Phys. Med. Biol. 42 (1997) 2015-2025.