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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:** Investigating the potential of high resolution K-edge digital subtraction angiography (KEDSA) for the detection of neurovascular pathology.	**Experiment number**: MD 210
Beamline: ID 17	**Date of experiment**: from: April 21 to: April 25, 2006	**Date of report**: May 28, 2006
Shifts: 12	**Local contact(s)**: Dr. Christian Nemoz	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

Previous work of the experimental team, leading up to the MD 210 experiments:

For our previous angiography experiments (MD 156), we had shown in a large animal model (adult pig, 50 kg) that it was possible to acquire angiographic images with K-edeg technique after intravenous injection of iodinated contrast agent (Schültke et al., submitte*d to Phys Med Bio,* presently being revised). Those images had been acquired with the Germanium detector in radiography mode.

Animal model used for the MD 210 experiments:
Six piglets (13 – 15 kg) with a head diameter of less than 14.5cm, to fit the space requirements for CT acquisition.

One day of experimental time was lost due to problems at the hardware – software interface.

Objective of the MD 210 experiments:
1. Further develop the image acquisition protocol used for the pig model in the previous experiments,
2. Attempt to acquire angiographic images in CT mode and
3. Use two animals to create a model of neurovascular electrocoiling, which will closely simulate the pathological setting encountered in human patients after obliteration of a cerebral aneurysm.

The FreLoN camera was used for all experiments of MD 210, with the animal under general anaesthesia.
1a) Images were acquired in radiography mode in posterior-anterior projection. The vertical speed of the goniometer during image acquisition was varied between 50 mm / sec and 200 mm / sec. This was done to test how far radiation exposure could be reduced and the information yielded from the acquired images / image quality was still acceptable. Iodinated contrast agent (XENETIX®) was injected at a velocity of 5 ml / sec to a total of 15 ml.

Vertical goniometer speed (mm / sec)	50	100	200
Radiation exposure (Gy)	80	40	20
Iodine concentration measured in CCA (mg / ml)	30	28	27

Table 1: Correlation of vertical goniometer speed, radiation exposure of experimental subject and iodine concentration measured in the common carotid artery (CCA).

For simple visual evaluation (without actually calculating the signal-to-noise ratio), the image quality seemed to be comparable for 50 and 100 mm / sec gonimeter spped. Despite almost equal contrast agent concentrations in the cerebral arteries, the image contrast appeared visually weaker when acquired at a gonimeter speed of 200 mm / sec. Considering the fact that the animals' brains were only about 5.5 cm in the lateral (L-R) diameter and the diameter of the cerebral blood vessels is considerably smaller than that expected in an adult human patient, it has to be stated that the results obtained are superior to whatever image quality could be obtained with hopsital-based angiography equipment.

1b) Measurements were acquired in an attempt to distinguish whether the brain moved / pulsed perceptibly during the period of image acquisition. The aim of these measurements was to determine, if movements were perceptible, whether these movements were caused by external sources (i. e. breathing of the animal) or internal sources (heart beat prportional frequency). For these experiments, the electrocardiographic signal of the animal was acquired and fed into the same computer that recorded the original images.

2. CT images were acquired with total contrast volumes between 15 and 20 ml per image (1 - 1.25 ml / kg). This reulted in measured contrast concentrations in the cerebral arteries between 5 and 10 mg / ml.

3. Two animals were used as planned to create an aneurysm model. Although in both cases the surgical procedure was successful, arterial spasms due to the manipulation and thrombosis of the anueurysms resulted in our inability to demonstrate the aneurysm with the imaging procedure. We have planned to develop a modification of the surgical procedure in our home laboratory to overcome these obstacles.

Comparing the results of our previous experiments in rabbits and the more recent experiments with pig and piglet models, we feel that many of the future studie can be conducted in the rabbit model. The advantage of a somewhat larger brain in piglets and pigs, compared to the rabbit model, is very much offset by the extreme thickness of the skull bone, especially in adult pigs. Thus, the likeness to human patients is not as good as we anticipated. Also, the rabbits are much easier to handle as experimental subjects.

Future directions:

1. Improvement of the aneurysm model, to be able to acquire images of the aneurysm before and after obliteration by coils.

2. Using the rabbit model of subarachnoid hemorrhage for studies that aim at relieving cerebral vasospasm. This is a study with significant clinical implications, because persisting vasospasms in human patients are known to result in neurological functional deficits.

One presentation of the results from the previous experiments (MD 156) was made at the Annual Canadian Congress of Neurololigal Sciences Meeting in Montreal, in June 2006, with an abstract published in the Canadian Journal for Neurological Science:
Ogieglo L, Schültke E, Fiedler S, Nemoz C, Kelly M, Crawford P, Esteve F, Brochard T, Renier M, Requard H, LeDuc G, Juurlink B, Meguro K (2006): A feasibility study in synchrotron based K-edge digital subtraction angiography in a pig model: a potentially new diagnostic tool for human neurovascular pathology**.** CJNS 33 (Suppl 1): S 24

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