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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 156
Beamline: ID 17	**Date of experiment**: from: September 07 to: September 11, 2005	**Date of report**: October 15, 2005
Shifts: 12	**Local contact(s)**: Dr. Christian Nemoz	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Prof. Kotoo Meguro*, University of Saskatchewan, Saskatoon, Canada

Prof. Dean Chapman, University of Saskatchewan, Saskatoon, Canada

Dr. Paul Crawford*, Royal Veterinary Hospital, London, U.K.

Prof. Francois Esteve, INSERM U647-ESRF, Grenoble, France

Dr. Stefan Fiedler*, European Molecular Laboratory, Hamburg, Germany

Dr. Michael Kelly, Stanford Medical Center, Stanford University, U.S.A.

Dr. Christian Nemoz*, ESRF, Grenoble, France

Dr. Lissa Ogieglo*, University of Saskatchewan, Saskatoon, Canada

Dr. Michel Renier, ESRF, Grenoble, France

Dr. Elisabeth Schultke*, Walton Medical Centre, University of Liverpool, U.K. and University of Saskatchewan, Saskatoon, Canada

Report:

Previous work of the applicants, leading up to the MD 156 experiments:

Using K-edge digital subtraction angiography, we were able to prove that it is possible to acquire angiographic images of the cerebral vasculature after intravenous injection of iodinated contrast agent. These experiments were performed in a small animal model. (Schültke et al., *Nuclear Inst. and Methods in Physics Research, A*, 548 (1-2): 84-87, 2005)

Objective of the MD 156 experiments:
To test whether it would be possible, with the same technique, to acquire angiographic images of the cerebral vasculature also in a large animal model, in size comparable to human patients.

Animal model used:
Adult male pigs (4).

The animals were kept under general anesthesia for the duration of the imaging sessions and were sacrificed at the end of the experiments. All animals yielded useful experimental results.

1. We established what could be seen if the contrast agent was injected directly into the carotid artery (comparable to digital subtraction angiography, a.k.a. DSA, the present 'gold standard' for the diagnostic of neurovascular disease with conventional, hospital-based equipment).

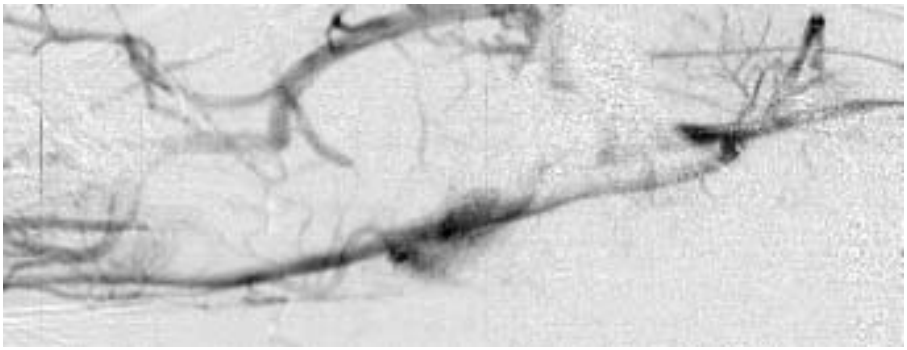

Figure 1: after injection of contrast agent into the aorta
Images of cerebral blood vessels in an adult pig, a.p. projections after injection of 5 ml XENETIX® into the right carotid artery. Injection speed: 5 ml/sec.
Only the right internal carotid artery (after the rete mirabile) is filled.

2. We used a central venous access for contrast administration, reasoning that the risk for neurological deficits is lower with central venous injection than with catheterisation of the arterial system.

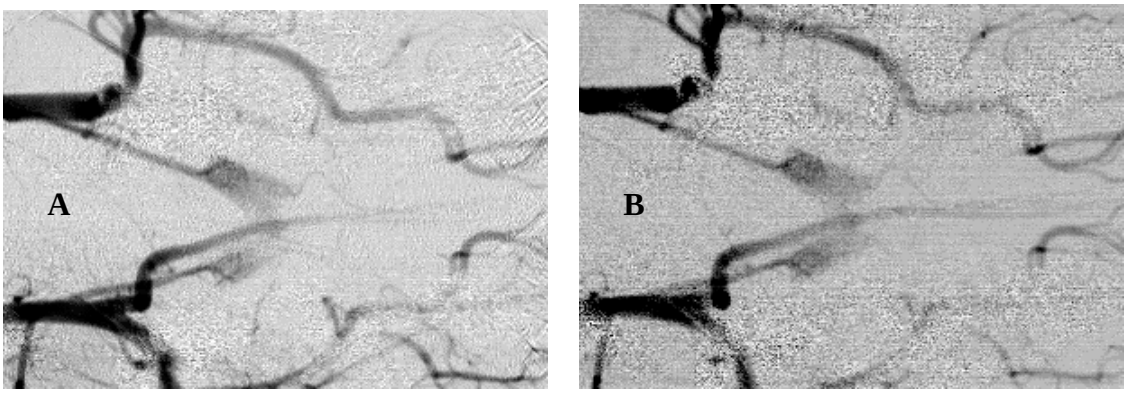

Figure 2: after injection of contrast agent into the jugular vein
Images of cerebral blood vessels in an adult pig; a.p. projections after injection of 45 ml XENETIX® into the right jugular vein. Injection speed: 15 ml / sec.
Speed of vertical movement of the imaging chair through the beam was 40 mm / sec for image A and 180 mm / sec for image B.
The thick skull bone causes more beam attenuation at the higher scanning speed, but the vascular structures can still be well identified.

3. Finally, we were testing whether we could acquire angiographic images of the cerebrum also after injection of contrast agent into a peripheral vein, which would carry the least risk.

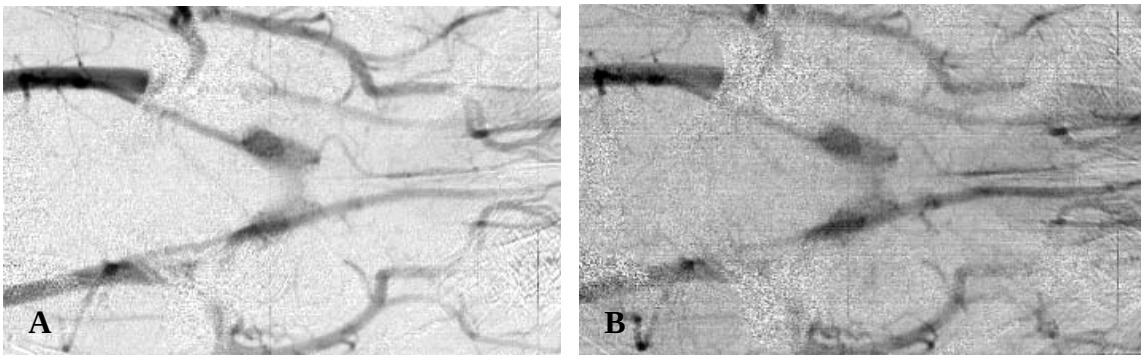

Figure 3: after injection of contrast agent into a peripheral vein (fore limb)
Images of cerebral blood vessels in an adult pig; a.p. projections after injection of 45 ml XENETIX® into a peripheral vein. Injection speed: 15 ml / sec.
Speed of vertical movement of the imaging chair through the beam was 40 mm / sec for image A and 180 mm / sec for image B.
Although the thick skull bone causes more beam attenuation at the higher scanning speed, the vascular structures can still be well identified.

Vertical speed (mm/sec)	**Temporal resolution** (sec)	**Duration of image** (sec)
40	2.11	1.92
180	0.912	0.407

Table 1: Correlation of vertical speed of the imaging stage moving through the beam, the resulting temporal resolution and the required duration to acquire one image.

Thus, we have reached the objective of the MD 156 experiments.
We have demonstrated that it is possible, in a model that is comparable in size to human patients, to acquire images of the cerebral vasculature after injection of contrast agent in a peripheral vein when synchrotron-based digital K-edge subtraction angiography is used. We have also shown that this can be done at radiation dose exposures that are acceptable for imaging in human patients. In fact, we have understood from these experiments that the acquisition of angiographic images is even more challenging in pigs than in human patients, because the ratio between brain size and thickness of the skull is much more favorable in humans than in pigs.

Manuscript in preparation for 'Radiology':
E. Schültke, S. Fiedler, L. Ogieglo, C. Nemoz, M. Kelly, P. Crawford, F. Esteve, T. Brochard, M. Renier, H. Requard, G. LeDuc, B. Juurlink, K. Meguro: Synchrotron-based intra-venous K-edge digital subtraction angiography in a pig model: A feasibility study.

Future directions:
1. Introduction of coils into the cerebrovascular system of two animals, to create an appropriate model of a human-sized patient after endovascular treatment. This will simulate the conditions encountered in our target population.
2. Testing the suitability of CT angiography in an animal model of electrocoiling.