

In this Issue

- A Word from the CEO p. 1
- Brain Imaging in Scotland p. 1
- 7T Eye Tracking Using Video Oculography p. 2
- NNL HeadTracker for the MR Simulator p. 3
- Introducing NENA p. 4
- Introducing MR Instruments p. 5
- Introducing New NNL Employees p. 6
- 2010 Conference Schedule p. 6



A Word from the CEO



Tormod Thomsen, Ph.D.
CEO

Dear Reader,

After the snowiest winter within living memory, we are finally experiencing warmer weather and spring is arriving in Norway. That also means that the ISMRM in Stockholm and

HBM in Barcelona are coming up and we will, of course, be exhibiting. At the ISMRM we will share a booth with our friends from MR Instruments, and you can read about our collaboration with them in this newsletter.

In this newsletter you will also find information about an exciting new collaboration we have started with Dr. Bas Neggers (Utrecht University Medical Center, NL) related to neuronavigation and TMS, and how we have been involved in the excellent SINAPSE project lead by Dr. Cyril Pernet (University of Edinburgh, UK).

An important part of our work is to continuously develop new products to meet the requirements from both research and clinical users. In this edition, we present the new HeadTracker system for the MR Simulator.

With the clinical market for functional MRI starting to grow, there is also a need for expanding our organization and we are introducing our new colleagues in this newsletter.

Happy reading!

Brain Imaging in Scotland

By Dr. Cyril Pernet, fMRI Lead Researcher SINAPSE, University of Edinburgh

Despite its small size, Scotland is the 3rd most productive (citations per researcher) country in the world. Scotland has four top-flight pre-clinical/clinical medical schools (which include the UK's highest rated medical school and one of the top 20 universities in the world) and one of the largest communities of researchers in the field of neuroscience. Six centres across Scotland now have full fMRI capabilities and all are equipped by NNL. In 2007, NNL equipped the Centre for Cognitive Neuroimaging in Glasgow (www.ccn.gla.ac.uk), a newly founded brain imaging centre in the Department of Psychology. In 2008, NNL won the bid to equip all 4 SINAPSE (Scottish Imaging Network – A Platform for Scientific Excellence) MRI centres located in Aberdeen (Aberdeen Biomedical Imaging Centre, www.abdn.ac.uk/ims/imaging), Dundee (Tayside Clinical Research Centre, www.crctayside.org.uk), Edinburgh (SFC Brain Imaging Research Centre, www.sbirc.ed.ac.uk) and Glasgow (www.gla.ac.uk/departments/clinicalneuroscience). Finally, in 2009, NNL provided equipment to the newly opened Clinical Research Imaging Centre (CRIC) in Edinburgh (www.wtcrf.ed.ac.uk/CRIC).

fMRI research in Scotland

SINAPSE (www.sinapse.ac.uk) is a consortium of six Scottish universities; Aberdeen, Dundee, Edinburgh, Glasgow, St. Andrews and Stirling. It has been established with funding from the Scottish Funding Council, the Chief Scientist's Office and the six Universities. The aim of this world-class consortium is to create a strong dynamic network for a shared environment for strategic research de-

velopment in brain imaging. The focus is primarily on the technologies of magnetic resonance imaging (MRI), positron emission tomography (PET), single photon emission computed tomography (SPECT), and electrophysiology (EEG). The network has increased the number of key research staff and students within Scotland and it allows the sharing of skills and education via e-learning, seminars and other key events. The formation of SINAPSE has increased the imaging capability of participating sites as it has facilitated cutting edge imaging equipment for the Scottish brain research community, which is compatible between imaging centres thus enhancing multi-centre trials and research.

fMRI research in Scotland now goes from cognitive neuroscience to clinical evaluation. Current research covers areas of basic cognitive processes such as human voice perception (vnl.psy.gla.ac.uk), visual illusions and perception (www.psy.gla.ac.uk/~lars), memory (www.psy.ed.ac.uk/research/hcn), and normal ageing (www.abdn.ac.uk/ims/imaging/research/brain), to applications to various diseases such as developmental disorders in infancy (www.dundee.ac.uk/psychology/research/index.htm), cognitive impairments in psychiatric disorders (www.pst.ed.ac.uk/neuro.html) or surgical planning for patients with brain tumours (www.sbirc.ed.ac.uk/neurosurgical.html). All scanners operate to a common quality assurance programme thus facilitating multicentre imaging studies. Work is now going on with people from all over the world and we welcome new collaborations. Don't hesitate, join the Scottish venture!

7T Eye Tracking Using Video Oculography

By Dr. Bas Neggers, Research group leader TMS/fMRI, Utrecht University Medical Center

Over the last decade, 3T MRI scanning has become the workhorse for the clinic and the neuroscientist alike. At present, 7T MRI scanners are moving from highly experimental devices to more mainstream MRI systems for use in clinical practice and imaging research in the neurosciences. In functional MRI, 7T promises a non-invasive insight into brain function of behaving human subjects at an unprecedented spatial scale below 1 mm. At this resolution, a fundamental scale of functional organization and specialization is found: the columns. For the first time, this feature well known from invasive recordings in laboratory animals could be observed in human subjects.

Such a breakthrough is important especially for vision neuroscientists, since columnar functional organization, although expected to be a more general feature of neuronal organization, has been most prominently demonstrated for the visual cortex. As a consequence, vision researchers are keen to move to high resolution fMRI at 7T.

The key to visual stimulation of the occipital lobe is a stationary visual field. Therefore, researchers require eye tracking systems which also function in the 7T environment, in order to be able to ensure that the subject is actively fixating a fixation spot. Additionally, eye movements themselves are more and more becoming the focus of neuroscientists investigating brain and behavior, as they are known to reflect various cognitive processes of interest.

Reliable eye tracking is usually done using infrared cameras and real-time image processing software following the pupil's position. Whereas eye tracking on 1.5 and 3T MR scanners is now feasible and many commercial solutions are available, eye tracking at 7T this is much more problematic. Most 7T head coils, for example, are completely closed cylinders containing 16 receive coils or more. Getting a visual display

inside this coil is already laborious because of the little space left above the eyes, and often achieved through prism or mirror projection. Eye tracking systems suitable for 7T are not easily available commercially.

Recently, the NNL EyeTracking system was successfully adopted in a Philips 7T scanner in the UMC Utrecht, the Netherlands. This system uses standard video oculography at 60Hz, and the works in field strengths up to 7T. The camera hardware is put outside the 20mT line in the scanner room, and converts the signal to an optical signal that leaves the scanner room through a standard waveguide, thus preventing RF noise to enter the scanner room and disturb MRI images. Conversion to common electrical video signals, capturing,

“Such a breakthrough is important especially for vision neuroscientists”



7T EyeTracking Camera setup with patient

and real time processing are done on a PC in the control room using the Arrington Viewpoint software. The main advantage of this system is that the camera and infrared LEDs are sufficiently small to fit into the closed head coil lateral of the mirror used for visual projection. First tracking results are reliable, and the fMRI images seem completely undisturbed.

NNL HeadTracker for the MR Simulator

Adding flexibility & accuracy

By Vegard Vangdal, Head of Hardware Development NNL

Movements during MRI and fMRI acquisitions can be a major contributor to poor quality data. Especially in pediatric or anxious subjects and patients this problem is particularly common, making training sessions in MR-like environments prior to the actual MR session necessary.

A novel system for monitoring the position and rotation of the patient's head can be used to lessen the influence of this motion. NNL has designed a system capable of tracking the position of the head with high spatial and temporal resolution, which is intended to be used for training sessions at the MR Simulator.

Using a camera with infrared illumination fixated to the head coil during scans, a video-feed of the patient's head is captured by a computer. A target device with three reflectors is fixated on the patient's head, giving a set of points visible in the image acquired by the camera.

A tailor-made software solution uses the video feed from the camera and a model of the target device to calculate the position and rotation of the patient's head. This is achieved using lens correction algorithms, image segmentation, back projection and linear algebra to extract

the position information from the captured images. The software presents both the current and historic position and rotation for the user in the control room. Activity can be saved with timestamps and the user can define conditions (e.g. threshold movement) that will trigger events, such as control of media playback, alerts, or pausing of a running paradigm until the patient is once more at rest.

Tests show that the system is able to measure the position with sub-millimeter accuracy.

The system can be used for real-time monitoring of patients, by providing accurate data and

presenting it in an intuitive manner. By enabling logging, the data can also be of later use and provides a much higher temporal resolution than software estimating movement based on volume data from the MRI. The control of media playback particularly relevant in training environments, such as training children in an MR Simulator by



pausing playback of video when they move and reward them when lying still by resuming playback.

The HeadTracker is available as an optional add-on to the NNL MR Simulator, and can also be retrofit to older models of the MR Simulator.

Introducing NENA - Accurate Neuronavigation for TMS

By Dr. Bas Neggers, Research group leader TMS/fMRI, Utrecht University Medical Center

In both the neurosciences and clinical practice, the use of transcranial magnetic stimulation (TMS) is rapidly increasing. With TMS, brain activity in healthy volunteers and patients can be safely and reversibly altered for a short time period. It adopts a focused magnetic field deployed by a coil which is held over the head. The magnetic field penetrates the skull unattenuated. This magnetic field change then causes an electric field in the brain that can affect specific brain functions. It

can, for example, induce finger movement or prevent speech or memory retrieval, depending on the brain area that is stimulated. TMS is a safe and reversible technique, and the brain functions normally again briefly after a stimulation pulse.

TMS has been in use since the 1980s in a neurological setting, where the integrity of the spinal cord can be tested by measuring electromyograms at the hand while stimulating the motor cortex in the brain. Since the 1990s, TMS has been increasingly used in neuroscience research, owing to its ability to safely, specifically, and reversibly affect brain function. Presently, the use of TMS in treating several psychiatric and neurological disorders is investigated in large clinical trials, and promising results have been reported for the treatment of depression. In several countries it is currently being discussed whether such treatments can be covered by standard health insurance.

The use of TMS requires accurate placement of the coil over a brain region of interest, preferably with an accuracy of up to a few millimeters. As no two brains are alike, the placement of the TMS coil based on head shape as visible from the outside is insufficient. An increasing number of researchers, therefore, want to use individual subjects' MRI scans, possibly with added functional imaging maps, to accurately guide the TMS coil to its goal. To do this, accurate spatial registration of the subject's head with the MRI scan is crucial. The solution to this problem is referred to as 'neural navigation', and has proven to be the most accurate method for TMS coil placement to date¹. A neural navigator should display the position of a hand-held pointer or TMS coil with respect to a 3D representation of the participant's head and brain on a computer screen in 3D. This allows interactive TMS coil placement over a brain region of interest in individual participants.

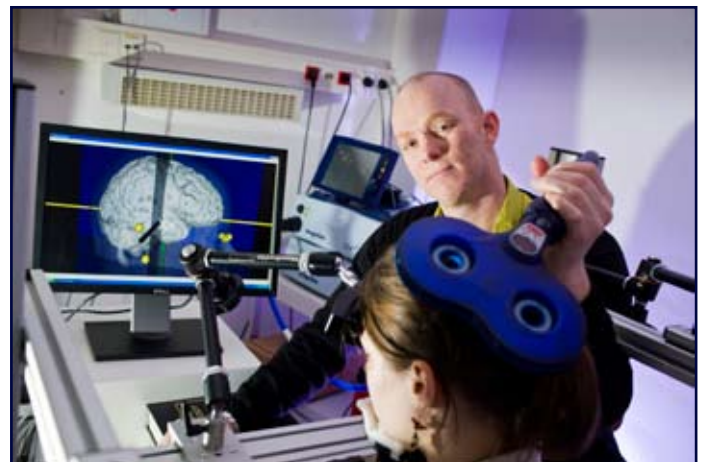
“neural navigation has proven to be the most accurate method for TMS coil placement to date”

The NENA software developed at the University Medical Center and the University of Utrecht is especially tailored to offer the functionality as mentioned above for the use with TMS (www.neuralnavigator.com). It is accurate and easy to use, offers exactly

what a researcher needs and is compatible with MR data formats commonly used in research. NENA adopts a proven registration technology²⁷ and has been rigorously tested on participants and using computer simula-

tions. The NENA software works in combination with magnetic tracking hardware.

NENA has been developed over the past 5 years by neuroscientists who, from first-hand experience, were aware of TMS researchers' requirements and, consequently, developed the software tailored around these. Furthermore, regular user feedback



NeNa Neural Navigator in use

from beta testers at several departments was consistently collected and implemented over the years, which improved NENA considerably and turned it into the easy-to-use tool it is today.

Recently, NNL reached an agreement with the UMC Utrecht Holding to start marketing the NENA neural navigation system to research customers. Together, NNL and the NENA Team now offer a complete neural navigation solution, not only including the NENA system itself, but also on-site installation and training, after-sales support, neural navigational hand-held tools, and options for further training and knowledge exchange.

*References available on page 6.

Introducing MR Instruments

By Tyler Folsom, Sales & Application Engineer, MR Instruments

As a partner of NordicNeuroLab we would like to take the opportunity to introduce ourselves to you. We are MR Instruments Inc., located in Minneapolis, Minnesota, USA. While our primary business is the design, development, and production of clinical and research coils for the MR industry, we are the North American based manufacturer and service center for NordicNeuroLab's fMRI hardware.

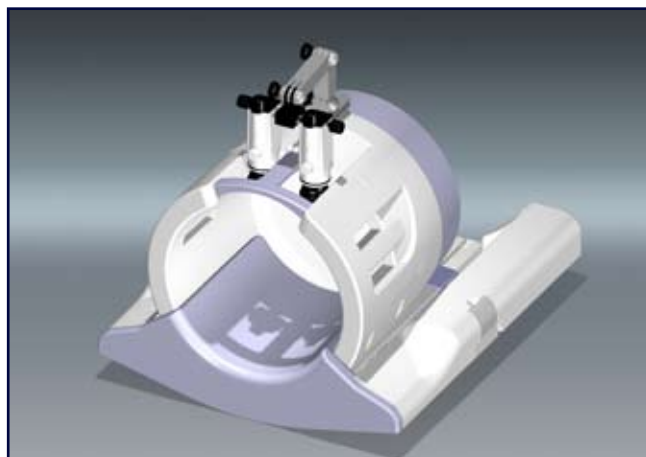
Currently, our flagship product is a 3.0T 32 Channel Head Coil for the global imaging market. While the 32 Channel Head Coil is an excellent routine head imaging coil, providing higher SNR and faster scan times, the primary advantage over existing technologies can be found in its fMRI capabilities. By using unique and proprietary hardware topologies, the 32 Channel Head Coil produces a significant increase in Contrast to Noise. Additionally, by working with NordicNeuroLab during the design phase, we were able to ensure complete compatibility with the entire array of fMRI hardware while preserving maximum patient comfort. The result is a complete fMRI hardware solution that can be delivered in a single order.

Our relationship with General Electric (GE) has culminated into an excellent partnership with our 32 Channel Head Coil having garnered positive attention within the MR industry on the MR750 System. GE's current sales strategy has been to promote the 32CH Head Coil as their fMRI solution in addition to its capabilities within routine brain imaging. With GE's expanding success installing MR750 Systems we are being met with an ever increasing share customers who desire the high end capabilities of the 32CH Head Coil to match with their MR System.

Building on the success of the 32 Channel Head Coil, we will be launching our 16 Channel Head Coil during Q2 of 2010 for both the 3.0T and 1.5T markets. The 16 Channel Head Coil was designed with the same proprietary methods used to develop the 32 Channel Head Coil. The 16CH's lower channel count meets a much broader MR audience than the 32CH and at a more cost effective price point which

fits with users who are not yet ready to migrate to higher channel count systems. However, the most appealing feature of this coil will be its ability to image patients in the 99th percentile of head size while housing the full array of NordicNeuroLab's fMRI equipment, including standard over-ear headphones. There is not another head coil on the market that can make these claims and provide the SNR and image acceleration that is needed on a day-to-day basis in the MR Suite.

As this year unfolds, it is presenting itself as an exciting one for MR Instruments. Our head coil sales are promising, we are expanding our involvement with OEMs, and we are developing a direct sales approach in concert with our strategic partners, such as NordicNeuroLab. The aim is to deliver complete imaging solutions along with training, education, warranties and single point of service for the end-user. This will result in a superior practice, less down time, and no confusion.



MR Instruments 32 channel head coil with NordicNeuroLab VisualSystem

On behalf of MR Instruments we would like to thank NordicNeuroLab for their ongoing support of our Head Coils. We have an interesting partnership as complementary companies in such a unique industry. We wish the best for your company and we have no doubts of your continued success. We believe in your products and consider them to be industry leading.

Introducing New NNL Employees



Thomas Lie Omdahl

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Thomas began working for NordicNeuroLab mid December 2009 and with his MBA and sales experience from various medical companies he is strengthening our European sales team. Thomas is located at the NNL headquarters in Bergen, Norway.



Jed L. Roubique

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As an MRI Technologist and with his extensive experience in sales and applications, we are glad to have Jed aboard. He will be a valuable addition to our US team and will be working out of Louisiana.



Josef P. Debbins , PhD

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With his educational background from biophysical sciences and electrical engineering, Joe will be a valuable resource for our organization. Joe is joining NordicNeuroLab on a consultant basis and will mainly function as application specialist. He will be located in Phoenix, AZ, and work closely with our US team, but will also be involved in application support worldwide.

2010 Conference Schedule

Conference	Location	Dates
ISMRRM	Stockholm, Sweden	May 1 - 7
ASNR	Boston, MA, USA	May 15 - 20
IBMISPS	Washington, DC, USA	May 24 - 27
HBM	Barcelona, Spain	June 7 - 10
ESNR	Bologna, Italy	October 4 - 9
RSNA	Chicago, IL, USA	Nov. 28 - Dec. 3

NeNa Article References (from p. 4)

¹ Sparing R, Buelte D, Meister IG, Paus T, Fink GR. Transcranial magnetic stimulation and the challenge of coil placement: a comparison of conventional and stereotaxic neuronavigational strategies. Hum Brain Mapp 2008;29:82-96.

² Neggess SF, Langerak TR, Schutter DJ, Mandl RC, Ramsey NF, Lemmens PJ, Postma A. A stereotactic method for image-guided transcranial magnetic stimulation validated with fMRI and motor-evoked potentials. Neuroimage 21:1805-1817, 2004.