**Preparing the session**
- off-patient
  - Registration
  - stimulation target
- on-patient
  - Positioning the patient
  - Attaching the EMG / Quality check
  - matching MRI to anatomy
  - advanced registration
  - digitization points

**Performing stimulation**
- Navigating the coil
  - Holding the coil
- Setting intensity
- Finding hotspot
- Mapping functional areas

**Post processing**
- EMG/MEP analysis
- Reviewing mapping results

**Creating DICOM export**
DICOM export results to neuronavigator
Some essentials

• Powering up the system
  – Allow camera approx. 20 minutes to settle
  – *First* start up eXimia NBS computer
  – Once *start up completed*, power the eXimia TMS
  – Then start up eXimia NBS 3.2.x software

• Loading MRI data to relevant directory
  – `C:\Nexstim\eXimia NBS 3.2\MRI_DATA`
  – User manual: further details on MRI requirements
  – Hospital’s MRI data need to be checked before installation
Preparing the session (off-patient)

• Select **[Open Session]**
  – To re-use an existing session
  – Skip to next slide, or

• Select **[New Session]**
  – Fill out details and select MRI data stack

• Select **[Perform Registration]**
Creating a new session

General information on the session

Information on the patient

Browse for the patient’s MRI data stack

OK to load the patient’s MRI / load head model
Screen build up

- Tabs
- Registration
- Stimulation target
- Slice scan
- 3D peeling
- Navigation / Display control
- Session tree
- MRI
- Cutting views
- Head model
- Aiming tool
- Controls
- E-field hotspot value (V/m)
Session tree

- General
- Patient / Subject
- MRI landmarks
- Scalp landmarks
- Stimulation targets
- Analysis Exams
- Digitization exams
Setting MRI landmarks

- Select [Crosshair]
- [Set MRI landmark] for
  - Preauricular points (2*)
  - Nasion
Preauricular point

Crux helicis
Nasion

Sagittal

Coronal
Setting stimulation target

- [Add Stimulation target]
- [Select coordinate system]
- Put in X,Y,Z coordinates or use crosshair to point
- Give description
- Stimulation target needs to be set ‘active’ before it can be used with the grid
Attaching the EMG – Quality check

- Connecting EMG electrodes
  - Prep the skin to take off any grease
  - Place ground electrode (not on muscle)
  - Place active (red) electrode on muscle belly
  - Place reference (black) electrode on nearby bony/tendinous part
- Under [Stimulation] and [EMG]
  - Start EMG
  - Check quality of EMG
    - Noise level should be well below 50 microV
    - Let electrodes settle for a while to obtain good skin/electrode contact
    - Check electrode quality / Check cabling
    - Check ground connection
Matching up head to MRI

- Fit the head tracker ‘stably’ on the patient’s head
- Check for tracker ‘visibility’ – moving conditions
- Make sure [Footpedal] is within reach
- Digitize exactly same points as MRI landmarks (yellow crosses)-
  - First nasion (most at risk to move the glasses)
  - then both ear-points
Advanced registration
Checking registration

- Move the digitizing pen over the scalp
- Check whether pen moves correspondingly over 3D head view
- Pen should not penetrate 3D head model, nor float above it while the pen is touching the patient’s scalp
- Rotate the head model and repeat check from different viewing angles
- Select [Close] to exit the dialog and save the registration.
Registration integrity test

• Choose [Digitization] tab
• [New exam]
• [Start Digitization]
• Left pedal to [Digitize point]
• Check session tree for digitized points
• [Stop digitization]
Check registration integrity
Targeting and "dosing" extracranial stimulation to show the intracranial electric field in V/m

"Tapping the functional area non-invasively."
Performing the stimulation/mapping

- Preliminary motor mapping
- Motor Threshold (MT) measurement
- Motor mapping (e.g. With 110% MT)

... but let’s start with the navigation of the coil.
Holding the coil

Hold the coil handle like a pen and ...

... supporting the coil with the other hand
Getting a view on the cortex

- Highlight stimulation target point in the session tree
- **[Set as active stimulation target]**
- Check **[Show target grid]** option in **[Settings]** tab
- Rotate, zoom 3D head to get target point clearly visible
Stimulation

- Select [Stimulation] > [New exam]
- [New sequence]
- Check for proper coil / e-field representation on the screen
- Adjust stimulation intensity
- Place coil on stimulation target point
- Check that the coil is placed optimally (tilting)
- Check for correct stimulation orientation (typically perpendicular to the sulcus)
- Deliver a stimulus (let pedal on the foot switch)
- Check that the result is added in the session tree
- Check whether EMG responses are correctly identified
- [Stop sequence] to stop the stimulation sequence
- Enter sequence description
- [Close exam] closes and saves the results
Preliminary motor mapping

- Giving stimuli along motor cortex
- Around ‘presumed’ APB location
- “Voltage scale” map type
- Minimize intensity
- Maximum responses 100-500 µV
- Optimize rotation
- White stimuli indicates hot spot
Confirming the *hot spot*

- Map around preliminary hot spot
- Keeping (optimal) rotation constant
- Check for *optimal tilting*
On stimulation intensity

• Large variation
  – Between individuals
  – Between days
  – Can be influenced by drugs, ...

• Stimulator output intensity is one thing,
  – Hotspot (V/m) is a better measure,
  – Which depends largely on tilting of the coil

• Aim for 70-80 V/m while exploring
• Adjust progressively to get responses between 100-500 µV
Optimal placing of the coil

• Hotspot in stimulation target
• Red arrow pointing to the M1 gyrus, and
• Oriented perpendicular to the gyrus
• Directional arrows are bright
  – When tilting is optimal (maximum V/m)
• And dim
  – When tilting is suboptimal
Optimal tilting of the coil

Optimal and suboptimal tilting in *biphasic* coil

Optimal and suboptimal tilting in *monophasic* coil
Rotation of the coil (optimal)

Optimised response using E-field navigation for Abductor Pollicis Brevis
Stimulator intensity: 32%, E-field max value = 62 V/m
Rotation of the coil

(suboptimal)
EMG response

Typical MEP response
- Red indicator: start of MEP
- Yellow indicator: Amplitude

Noise can be mistaken for a response
- Note: latency is too long
- Noise exceeds 50 µV level!
Repeating the stimulus

• Select desired stimulus in the session tree
• Set corresponding intensity
• Right click stimulus and [Repeat stimulus]
• Use Aiming tool
  – To either freely stimulate at different directions
  – Or use [Location Controlled Stimulation]
• [Finish repeating stimulus]
Workflow

1. MR image loading
2. Guided registration
   Alignment between MRI’s and head
3. Targeted stimulation
   3D Mapping of the brain
4. Result
   Areas eliciting responses
5. Diagnosis
   Areas that should be avoided
6. MR export to OR navigator

RESULT OUT

MRI’s IN
Analysis exams

• Responses from different sequences
  – E.g. Motor maps and speech mapping, sensory responses, ...

• Combination of these responses in one analysis table

• DICOM export of the combined result in one file
Creating Analysis exams (I)

In [Analysis exams]
Right click and choose
[Create new Analysis exam]
Right click new exam and
Choose [Set as active Analysis exam]
Create Analysis exams (II)

From the Session tree make selection of responses (hold CTRL down and select)
[Add to active Analysis exam]
Add additional responses from other sessions (if required)
From Analysis exam / Analysis Stimuli [Open Analysis Table]
Analysis exam can now be treated through the Analysis table
Further processing can include:
  – different visualisation of the maps
  – DICOM export
DICOM export / Interface to OR navigator

- See detailed description included