



scannexus

7T training



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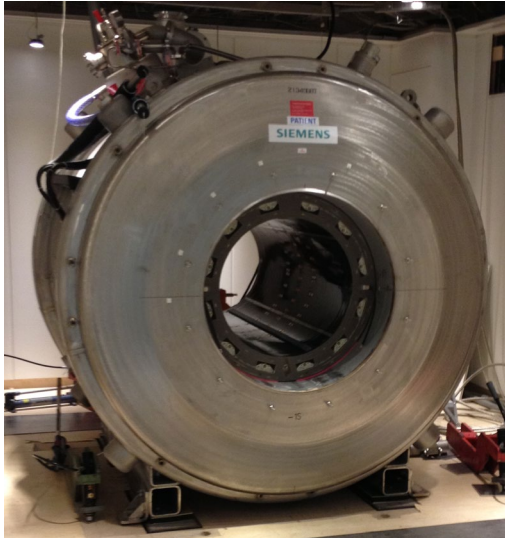
- 3T versus 7T
- Safety rules and screening
- Shimming
- Combined versus pTx



7T Training

3T versus 7T

B_0



B_0 (3T, Prisma fit)

- Active shielding
- Magnet length: 198 cm
- Inner diameter: 60 cm

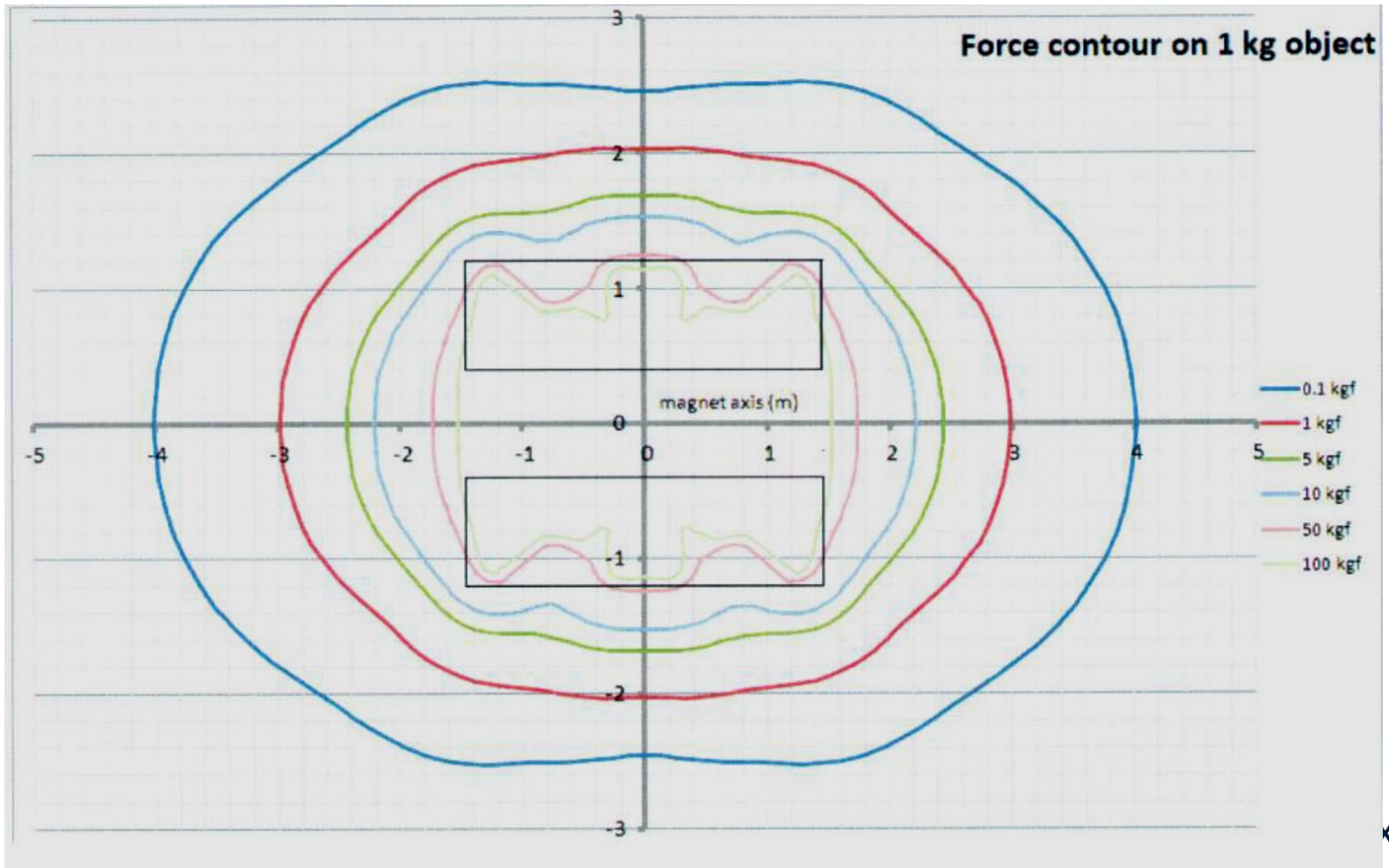


B_0 (7T, Magnetom)

- Active shielding
- Magnet length: 290 cm
- Inner diameter: 59,5 cm
- For investigational use only (not FDA proved or CE-marked)

B_0 (7T)

Force on ferromagnetic objects





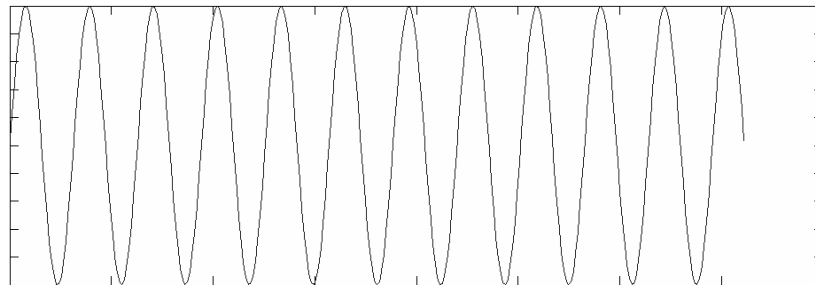
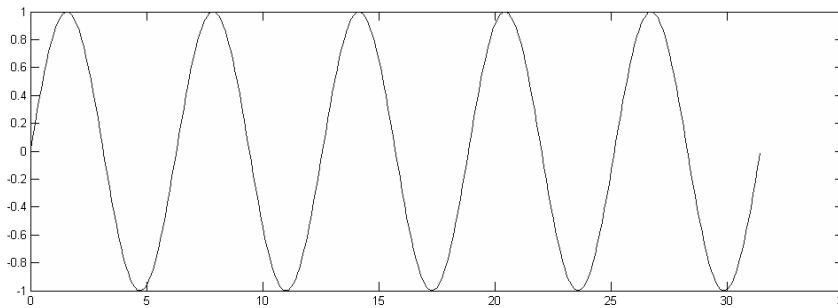
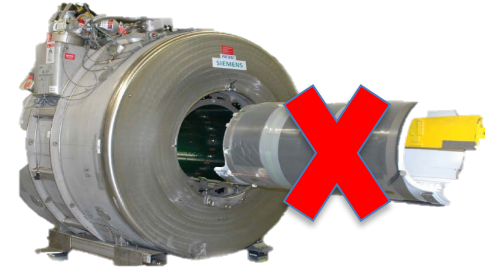
B_0 (7T)

Higher field strength shows increased inhomogeneity. Extra steps in scanning are necessary to optimize B_0 homogeneity.

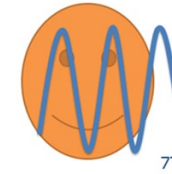
B₁

B₁

- NOT whole body RF coil
- Transmit/receive coils
- 3T: 126 MHz → 7T: 298 MHz



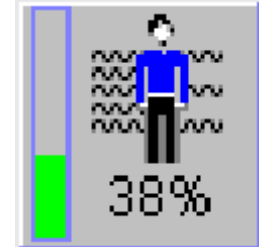
3T 126 MHz



7T 298 MHz
Freq. → 2.3 times
SAR → 5.3 times

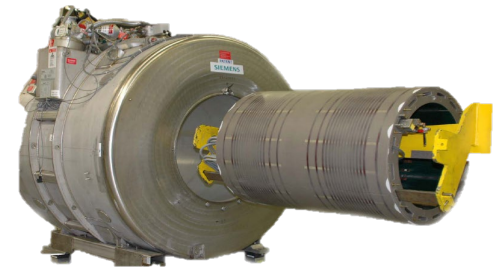
B₁

- Guidelines for B1 limitations and SAR calculation is independent of field strength.
- At 7T SAR limit is reached sooner.
- Scanning in level 1 instead of normal mode might be necessary.
- Case to case situation: SAR depends on subject (protocol might run for one but not for another subject)
- The waves have to “travel” significant distances and become non-uniform which result in
 - inhomogeneous B1 field;
 - inhomogeneous E-field -> Local heating (hotspots)



Click for
info

Gradients dB/dt



3T (Prisma fit):

- max amplitude: 80 mT/m
- max slew rate: 200T/m/s
- FOV: big

7T (Magnetom)

- max amplitude: 70 mT/m
- max slew rate: 200T/m/s
- FOV: relative small

Risk for nerve stimulation is not necessarily higher on 7T compared to 3T. Level of nerve stimulation is also depending on the scan protocol.

Gradients dB/dt

3T (Prisma fit):
Noise measured in
examination room: 84.4 dB

7T (Magnetom):
Noise measured in
examination room: 93.8 dB

Make sure earplugs are used in the correct way!



7T Training

Safety rules and screening



Subjects

Moving in the static field:

- vertigo (Questionnaire Leiden-> reported vertigo: ~35% of subjects)
- vestibular activation results in a sense of moving around a corner and nystagmus

Special speed regulation of the bed at 7T:

DO NOT USE THE SPEED BUTTON when positioning or removing subjects in or out of the bore. Green light means speed button is activated!

Subjects

- Check safety screening explanation form for contra-indications.
- (Small tattoos) **outside** the RF field are allowed
- Retainer wire is allowed at 3T and 7T

- Preferably experienced subject, who has been scanned before at 7T or lower field strength
- Warn subjects about possibility of vertigo
- Advice: max. scan time of 1.5 hours

- The nova coil is small. Large heads might not fit...

- Belt and shoes off!

Implants/ medical devices



MR SAFE

- Non-magnetic
- Non-electrically conductive
- Non-RF reactive



MR Conditional

- Observe the manufactures manual!
- MRI-safety.com
 - Only few items tested for 7T and included in list MRI_safety.com!
 - Problem: B1 field cannot be assumed as homogeneous
 - No agreement about testing methods
- GUFU guidelines



MR UNSAFE

- Induces hazards in all MR environments

Dielectric pads

The pads improve transmit/receive sensitivities in regions of low radiofrequency transmit efficiency, like temporal lobe.

Safety instructions:

- Safe and released for temporal areas (not lying with head on one of the pads!) → because the SAR distribution is influenced by the high-permittivity pads and depends on orientation of the pads
- **Not allowed** in combination with Sensimetric earplugs!
- **Not allowed** in combination with pTx coil!
- Use extra cushioning for fixating in place
- Wrap in paper for hygienic reasons

See also the Scannexus [self service portal](#) about this topic





7T Training

Shimming

Why?

Higher field strength-> increased inhomogeneity and increased operational frequencies

B_0 inhomogeneity:

- produces blurring, distortion and signal loss at tissue interfaces
- will lead to varying flip angles and regional signal variation

B_1 inhomogeneity

- will lead to varying flip angles and regional signal variation

B₀ Shimming

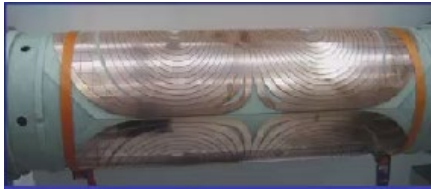
Larmor equation: $\omega = 2\pi\nu = \gamma\underline{B}_0$

 B₀ (homogeneous)

 B₀ (inhomogeneous)

B0 Shimming

The B0 field is 'shimmed' by adjusting currents in the shim coils



First order shim coil

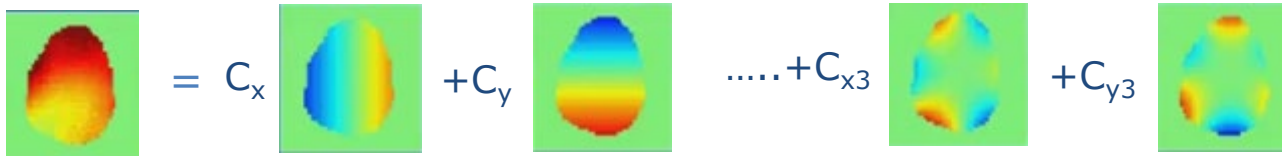


Higher order shim coils

- Second order
- Third order

B₀ Shimming

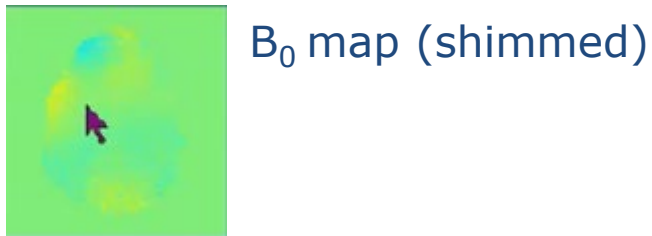




$B_0 \text{ map} = C_x \cdot [shim] + C_y \cdot [shim] + \dots + C_{x3} \cdot [shim] + C_{y3} \cdot [shim]$

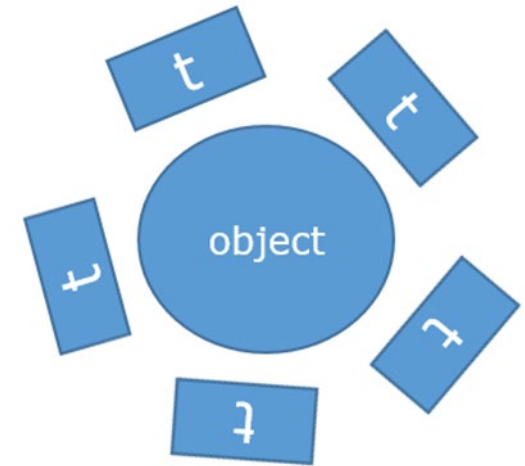


Solve by least-squares optimization



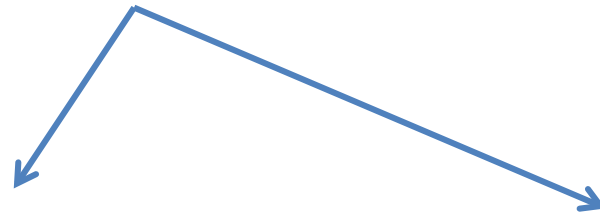
B1 shimming

B1 shimming → pTx = parallel transmission



pTx 7T

- 8 channels transmit
- Optimize individual amplitude and phases in each transmit channel



Static pTx:

B1 shim

Optimized amplitude and phase of transmit channels
For homogeneous B1+ distribution over specific volume

Dynamic pTx:

RF pulse design

Optimization of transmit channels' amplitude and phase
within the time course of an RF pulse



7T Training

Combined versus pTx

Combined and pTx

Combined Nova coil, knee coil, x-nuclei → 1Tx

pTxNova Coil → 8Tx

pTx: CP mode (TrueForm)

SAR to level 1 mode:

combined mode no difference in normal and level 1 mode, both 10W/kg for brain

pTx CP mode, level 1 up to 20W/kg for brain

Level 1 in healthy subjects only!

UP (universal pulses)

B1 shim (B1 volume or patient specific)

Combined and pTx

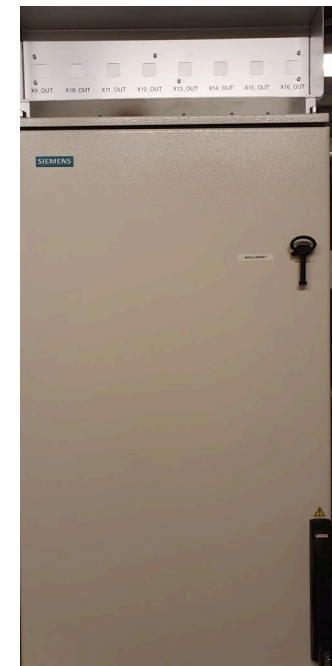
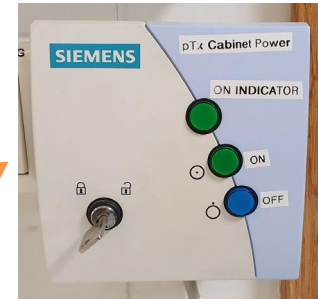
Which mode to choose:

1. Continuation of old studies and good results → stick to combined mode
2. Big risk of high SAR, not interested in temporal lobe or cerebellum → pTx host, CP mode
3. 3D structural imaging with good signal in temporal lobe and cerebellum → pTx host, Universal Pulses
4. Very high resolution → optimizing of RF amplitude or homogenizing RF distribution in small region needed → pTx host, RF shim
(advanced, needs extra training)

Switching modes

pTx to combined:

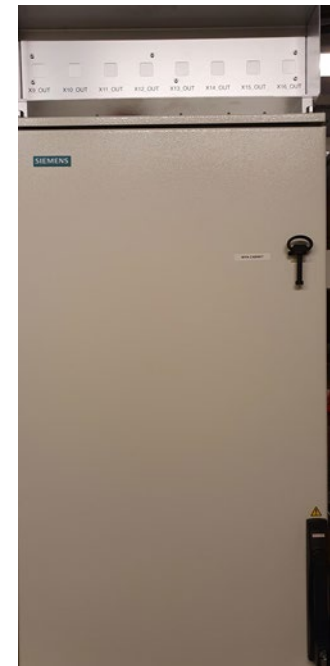
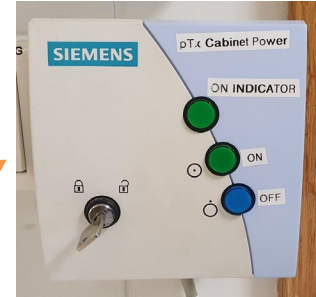
1. Connect Nova 1Tx 32Rx
2. Switch off pTx cabinet power
3. Go to technical room 7T, open RFPA cabinet
 - a. Press button, Select mode
 - b. Combined mode
 - c. Press button
 - d. Switch off power (mains)
 - e. After 10 sec, switch on
 - f. Check if all lights turn from orange to green
 - g. Close door RFPA cabinet
4. Go to console room, wait until booting has finished



Switching modes

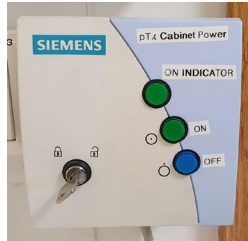
Combined to pTx:

1. No coil connection!
2. Switch on pTx cabinet power
3. Go to technical room 7T, open RFPA cabinet
 - a. Press button, Select mode
 - b. 8 CH mode FBR
 - c. Press button
 - d. Switch off power (mains)
 - e. After 10 sec, switch on
 - f. Check if all lights turn from orange to green
 - g. Close door RFPA cabinet
4. Go to console room, wait until booting has finished
5. Connect the 8Tx32Rx coil



NOTE: ignore message at red line: "scanner installation in progress"

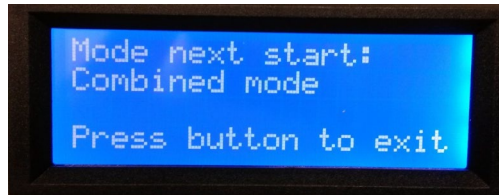
Switching modes



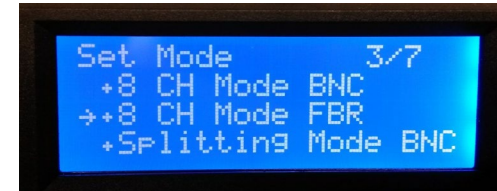
Technical room



Combined mode



pTx mode





Workflow combined mode

Demonstration of possible workflow

1. Localizer
2. B1 Map
3. Data acquisition scans/protocols



Workflow combined mode

1. Localizer:

Run localizer

(Option to perform manual 3D shim in adjustments when localizer is opened, see B1, step 2)

Workflow combined mode

2. B1 Map:

Manual B0 shim:

When B1 map is open:

Position slice box (yellow box)

Position and resize adjustment volume box (green box)

Options → Adjustments

Frequency go, repeat until converged (Y)

3D shim, select GRE Brain

a. Measure, Calculate, Apply

Frequency go, repeat until converged (Y)

Close adjustments window

Apply and run B1 map

Workflow combined mode

3. Actual scan data acquisition protocols:

Step 1:

Manual B0 shim:

When acquisition protocol is open:

Position slice box (yellow box)

Position and resize adjustment volume box (green box)

Options → Adjustments

Frequency go, repeat until converged (Y)

3D shim, select GRE Brain *)

a. Measure, Calculate, Apply

b. Frequency go, repeat until converged (Y)

Close adjustments window

Repeat step a and b until

1. frequency is small and single peaked

2. images in 3D tab show homogeneous blue/green in brain area

*) Or use snxbash (ctrl+esc), option 1 instead, to select the best B0 shim

Close adjustments window

Workflow combined mode

3. Actual scan data acquisition protocols:

Step 2:

Interactive B0 shim, optional in High resolution imaging (below 1 mm iso):

Manual adjustments;

Interactive shim → improve B0 shimming

Measure and adjust linear shims in x,y,z by clicking up/down

Get higher values of T2*, range 16-20

FWHM below 40Hz

Workflow combined mode

3. Actual scan data acquisition protocols:

Step 3:

Optimize B1 power for acquisition

B1 map shows refV calculated to get flipangle of 90°

- use for this refV for whole brain imaging
- smaller region of interest → recalculate power

open acquired B1 in viewing tab

set ROI

mean value of ROI

$(90/\text{mean value})$ times refV shown in B1



Workflow combined mode

3. Actual scan data acquisition protocols:

Apply and run the protocol after the B0 optimization and B1 power optimization steps

Workflow combined mode

3. Actual scan data acquisition protocols:

NOTE: 3D shim values disappear whenever the green box is changed in the following protocol and when the B0 shim mode in the manual adjustments is different as set in the parameter card (system tab):

- Rerun 3D shim in manual adjustments
- **Or** use Snxbash script:
 - Ctrl+esc
 - **Snxbash**
 - Nr. 1
 - Select the shim values you need



Workflow pTx mode

1. In **CP** mode: same workflow as combined mode
 1. Select TrueForm in B1 adjustments
 2. Good B0 shim is important
2. Using **UP**: same workflow as combined mode
 1. Good B0 shim is important
3. Static **B1 shim (no default workflow yet)**:
Patient specific
Volume selective