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🌐 Weekly Quality Control V.3

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We use this protocol and it's working

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Abstract

The weekly quality control at the Spinoza Centre REC evaluates the signal quality/performance of the 3T Philips Achieva TX (R5, v3.0).

Troubleshooting

PIQT (spatial stability)

1   **Run PIQT**
Duration: 20 minutes

This scan evaluates several internal parameters of the scanner, including the stability of the gradient coils. This is done by scanning a phantom from which the specs are known.

The protocol is as follows:
- Hook up the PIQT-headcoil (see picture below)

- Check whether the coil contains air (bubbles); shouldn't be larger than about a centimeter in width (in that case: email Lukas)
- Check whether the phantom is inserted correctly; it should be positioned as far back in the coil as possible (i.e. towards the bore) and it shouldn't be able to rotate sideways.
- Outline the phantom/coil in between the vertical and horizontal line.
- On the scan-computer: SPT → Batch Files → perform PIQT

N.B. For efficiency proceed to the QPI test (next Step) while PIQT is running. Also, check step 14 (updates & virus scan) and step 16 (misc.) for things you can do when the PIQT is running!

> **Note**
>
> **What to do if the PIQT indicates problems?**
> If the PIQT shows any values marked in red, it means that some values/parameters are inconsistent with what the scan should contain (i.e. internally, we know what should come out of the PIQT scan). There are a couple of things that you should check before reporting PIQT issues to Lukas/Steven/Tinka.
>
> 1. Check whether the phantom is inserted correctly; it should be perfectly in the middle (no room to 'wiggle').
> 2. Check whether the headcoil ('kap') is closed correctly and check whether the cable from the coil into the table is inserted correctliy.
> 3. Is there too much air, i.e. a bubble, in the PIQT phantom (larger than ± 1 cm)? If so, let Lukas know.
>
> In case of point 1 or 2, fix this. Then, redo the PIQT scan and report back to Lukas if there are still signs of scanner issues (red values). If this is the case, make sure to still perform the AGAR test (temporal stability), because the results from this test give us extra information about what might be wrong with the scanner. Crucially, if the AGAR test gives normal results (i.e. SNR/SFNR >300), then it is likely that something is wrong with the PIQT phantom and, probably, not with the scanner itself.
>
> If the AGAR test also indicates SNR issues, analyze the fourth scan in the Quality control exam cards set (which is called: 'OnlyWhenSnrTooLow') using the StabilityTool as well. This scan is exactly the same as the original EPI-scan in AGAR test, but with a different phase encoding direction: instead of from anterior to posterior (AP foldover direction), it uses phase encoding from right to left (RL foldover direction). This gives us (or actually, Philips) more information about the cause of the SNR problem. Report the SNR scores for both the original (AP) and the extra (RL; 'OnlyWhenSnrTooLow') back to Lukas.

QPI check (spike detection)

2   **QPI test**

The QPI check evaluates whether there have been any abnormal spikes (abnormal measurements of signal) in the past week.
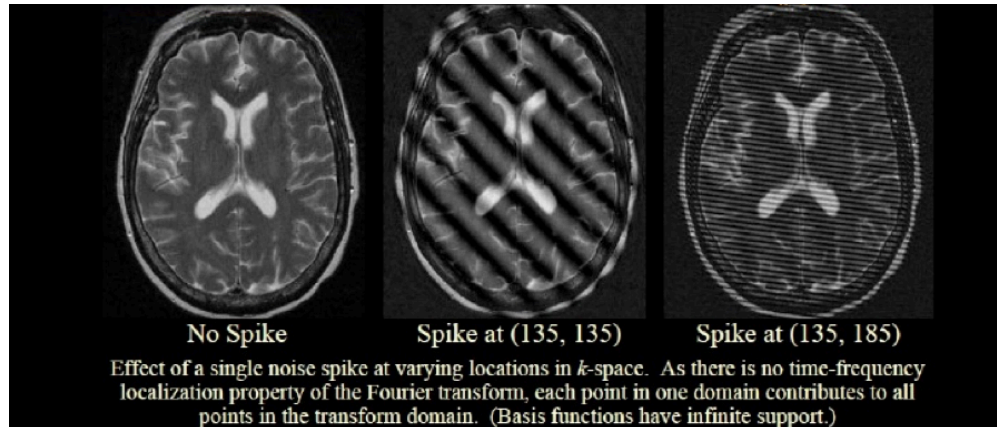A chronological report is generated with Philips' Logging Application (this can be done during the PIQT scan).
Duration: 2 minutes.

- Start → Logging application
- Fill in the following:
- Start date: date of previous weekly QC
- End date: today's date
- Free text: **qpi after correction**
- Press enter; an HTML-file should be generated with 'spike-values' across time.

In the QC excel-document ('QC_specs'), note down the number of spike-values above 1. Values above 1 may indicate artifacts in the scan(s), of which the researcher should be alerted (such that he/she can decide whether to throw away that data or not). In case of values larger than 1, note the date/time of the spike and check in Calpendo who was scanning at that time. Email Lukas the date/time/user during the spike.

For educational purposes, check the image below of what a spike in real MRI may look like (i.e., usually some kind of "striped" pattern).

No Spike   Spike at (135, 135)   Spike at (135, 185)

Effect of a single noise spike at varying locations in *k*-space. As there is no time-frequency localization property of the Fourier transform, each point in one domain contributes to all points in the transform domain. (Basis functions have infinite support.)

3   PIQT Analyses

After the PIQT scan (from step 1) fineshes, a window pops up, ignore this window.

Follow these steps:

- Image view → right click scan name (PIQT) → generate reports
- This generates an HTML-file, with values for the tested parameters. If any values are marked in red, it means that the scanner is out-of-spec.

Note

Sometimes, Image view (or more generally, Patients → Administration) lists an 'old' PIQT scan (with a scan-date before today's date). This happens when there still exists a previous PIQT-scan; in this case, the current PIQT scan is included in the listed ('old') PIQT scan. You can simply run 'Generate reports' and it will, by default, list the results from the latest PIQT (check the date to be sure).

Spurious test (RF detection)

4   **Spurious test (RF detection)**
Duration: ~ 5 minutes

The spurious test evaluates whether the scanner picks up any non-scanner related radiofrequency signals from the scanner room (which shouldn't be present). This can be performed after the PIQT scan.

5   **Preparation**:

- Disconnect and remove the PIQT-phantom/coil from the scanner bore;
- From the storage cabinet in the console-room, get the green/yellow wire;
- Put the wire lengthwise (i.e. along the direction of the bore) inside the bore, from approximately the end of the bore (it may even stick out a little, like 20cm) until the beginning of the table.
  This wire simulates a subject being present in the scanner, which increases the validity/sensitivity of the spurious test by picking up spurious RF signals from *outside* the bore as an antenna (which wouldn't be picked up without the wire).
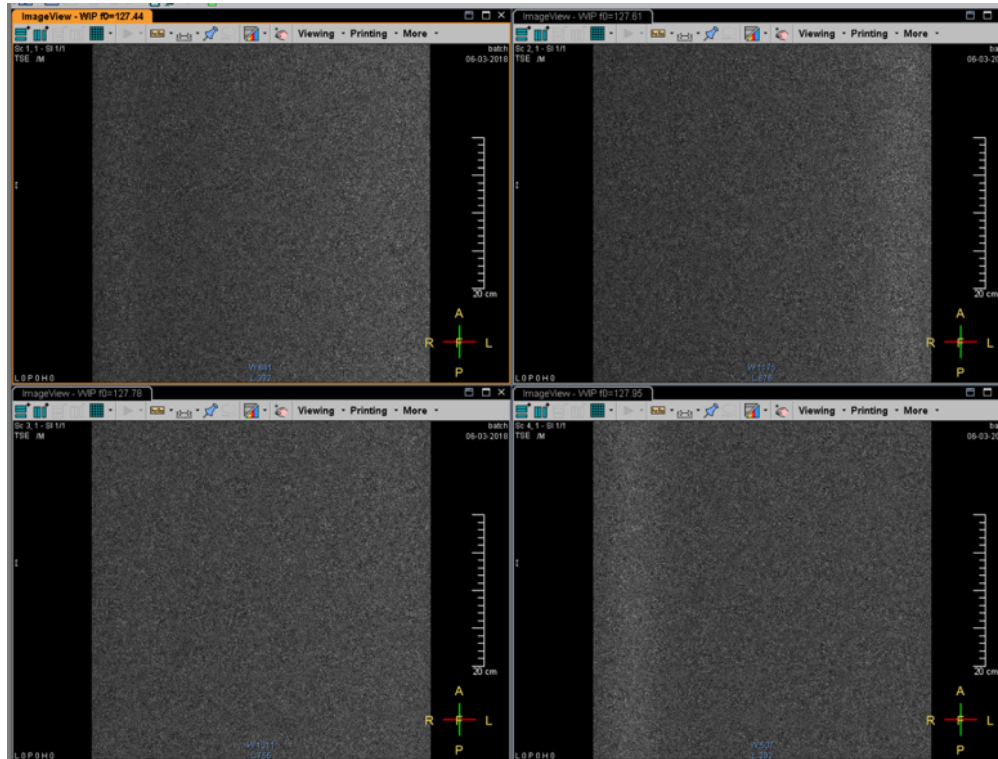
6   **Run spurious test:**

To run the spurious test:
- Start Spurious test
- Windows button
- enter "batch" in the search bar
- click "Batch Interpreter"
- Select scan (open)
- select pbsviq_spurious_t30_180hz_qbc.acq
- press start icon
- After the scan is completed, a new subject should have been created (named 'spur T30 180 Hz/px').

To visualize the spurious scan:
- open this subject in Review mode
- Click: Patients > Open for Review
- select scan, proceed
- Click on the grid-like icon ("Switch to Thumbnail view").
- Drag the scans (each beginning with f0=127...) to the right, resulting in a single panel for each of the four scans. Your view should look something like the image below:

Part of **SPRINGER NATURE**

7   **Odd images from spurious test?**

Seriously problematic spurious RF issues would manifest themselves as very bright bands on the image with almost black backgrounds. The image in the previous step does *not* display this – it's an example of a completely fine test result. The image below, on the other hand, *is* an example of a problematic spurious test:
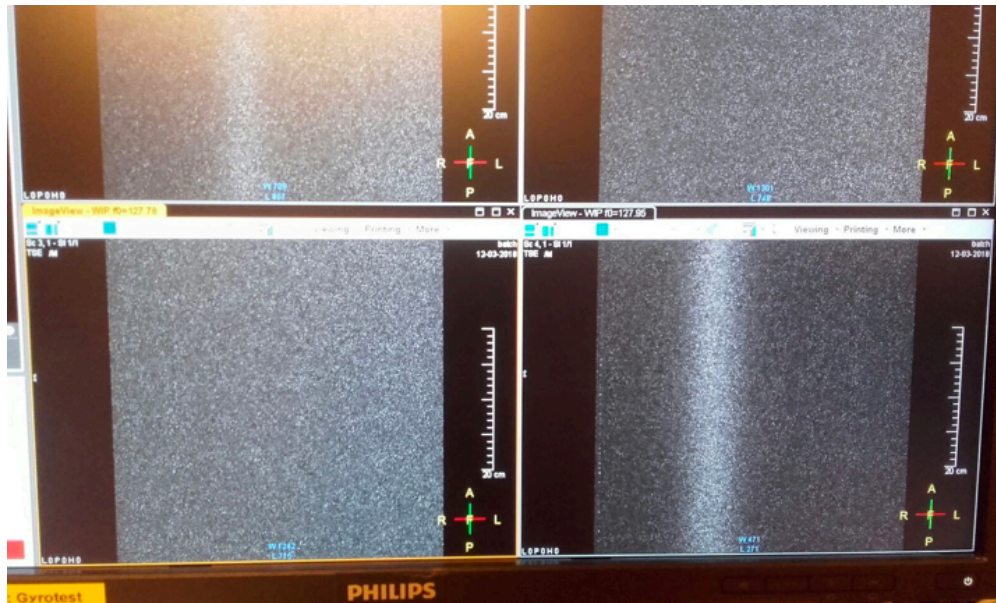
Agar test (temporal stability)

8 **Agar test (temporal stability)**

Duration: ~ 10 minutes

With the Agar test, we assess how stable the measurement of regular fMRI sequences is. To do so, we scan a phantom (the 'Agar' phantom) which signal should remain stable over time. From the variance of the signal measured from the phantom, we can calculate a signal-to-noise metric, next to some other signal/artifact-related metrics using software provided by Philips.

9 **Set-up Agar test**

The procedure is very similar to scanning a real subject. Before creating a new subject, make sure the correct headcoil (32-channel coil) is attached!

Create a new subject with the following info:
- 'Patient name: AgarFantoomyyyymmdd   (use the current date)
- Registration ID: AgarFantoomyyyymmdd
- Date of birth: 01-01-1980
- Sex: Phantom/Other
- Exam name: AgarFantoomyyyymmdd
- Patient weight: 80
- physician: Scholte

- Comments: *your last name*

Run the test:
- Place the spherical Agar phantom (grey orb, with the number 1251 on it) in the regular 32-channel head coil (default for fMRI studies) with the plastic bulb-thingie pointing upwards.
- Outline the laser exactly on the bulb.
- Load in the exam cards from SpinozaCentre (folder: QualityControl)
- Start the SmartBrain.

NB continue with The Trigger test (next step) before proceeding to the next steps of the Agar test

Trigger test

10   **Trigger test during Agar test**

In the meantime, start up Presentation for a trigger test. This "trigger-test" registers whether the pulses from the scanner are transmitted properly to the stimulus computer. As the functional scan we use for the Agar test has 100 dynamics, the counter above the "Go" button should display "100" after the functional scan is done. To start the trigger-test on the stimulus computer, do the following:

- In Presentation, go to Settings
- Click on "Port"
- Click on "Test"
- Click on the *left-most* "Go" button.
- If for some reason you get the following error: "invalid fMRI mode input port channel value", make sure Presentation has loaded an .exp-file which is used during a functional sequence (e.g. any NRX-protocol)

Agar test (temporal stability)

11   **Run Agar test**

- Setup the following functional (TRA_3mm_ISO) and DTI-scans;
- The box should be "straight" throught the phantom (i.e. not angled);
- Start the scans.

Export Agar scans
- Create a new directory on the server:
  \fMRI Projects\fMRI Project

SpinozaCenter\QualityControl\Agar_test\AgarFantoomYYYYMMDD (fill in the year, month, day, in the YYYYMMDD placeholder)

- Export the functional- and DTI-files to this directory

12 Analysis Agar test

Now, we can analyze the SNR and other specs from the Agar test using the Philips Stability Tool, which is located at:
 QualityControl\EPI_Stability_Tool_v2.5\StabilityTool\StabilityTool.exe

EPI

- Open the Stability Tool from the MR-operator PC.
- Press the "Load fMRI dataset" icon and select the functional scan from your AgarFantoomYYYYMMDD directory.
  Do not change the Mask Threshold or any other paramter!
- press Analyze.
- Open the excel-sheet and note down the resulting values for RDC (pixel), drift, ghost, SNR, SFNR, in the excel-sheet

> Note
>
> **If EPI SNR or SFNR <285 ... there might be something wrong!**
>
> There are not minimum/maximum values known for RDC, drift, and ghost, unfortunately. But if the SNR and/or SFNR is below 285, it means that the scanner is probably out of spec. This happens almost always if the PIQT also yields out-of-spec values. In case of an S(F)NR of below 285, do the following:
>
> - Analyze the extra scan ('OnlyWhenSnrTooLow') with the Stability Tool as well (see box **'What to do if the PIQT indicates problems?'** for more information about this extra scan);
> - Report the SNR scores for both the regular EPI-scan and the extra scan ('OnlyWhenSnrTooLow') back to Lukas if one or both of them indicates an SNR below 285

DTI
Do the same thing for the DTI scan (use the DTI Stability tab in the upper left corner).
- Load the corresponding DTI-file from your AgarFantoomYYYYMMDD directory
- press Analyze.
- In excel sheet note down the values for ADC, FA value, and circularity ratio (DWI)

There are no known minimum/maximum values for these parameters.

Helium Level

13 **Measure helium level**

MRI scanners (very) slowly leak helium, causing the helium level to decline over time. This cannot be done during another scan (e.g. PIQT or Agar test).

Measure helium level:
- You can measure the helium level by clicking the Windows buttom,
- searching for "helium" in the search bar,
- click on "Display Helium Level".
- Note down the helium level (%) in the excel document.

Updates, licenses, and virus scan

14 **Update & run virus-scanner / Windows update / Check Presentation license**

Scan computer

On the scan computer, right click the virus-scan icon and press "Update Now …".
You do not have to run a virus-scan on this computer (this is done automatically).

Stimulus computers

Run a virus scan on the following computers:

- On the stimulus computer
- MR-operator computer (right of scan computer)
- *and* the three cubicle computers (one downstairs, two upstairs),

Procedure:

- open Symantec Endpoint protection (rightclick icon in the lower right corner) and
- click LiveUpdate.
- click Scan for Threats and
- perform an Active Scan.

Run a windows update for all 4 stimulus computers and MR Operator computer (**not** scan computer) as follows:

- Go to Control Panel
- Go to Sytems and Security

- Click on 'Windows Update'
- Click on 'Check for Updates'
  N.B.: Do not install "optional updates" (only necessary updates).

On all computers except the scan computer and MR-operator computer, check whether the Presentation license is still valid, as follows:

- Start Presentation
- Click on 'License' (menu bar)
- Click on 'Manage'
- If the license will expire within a month, contact Jasper Wijnen from the TOP (**J.G.Wijnen@uva.nl**).

Check stimulus set-up

15   **Check stimulus set-up (in console- and MRI-room)**

The stimulus set-up should remain the same over time.

Therefore, check the following:
- Clean the eyetracker mirror with the designated cloth (red cloth; located in the storage room left to the MRI-room)
- Is the projection screen in place? Check stickers on the floor next to the screen.
- Is the lens cap (eyetracker camera) still there?
- Do the headphones work properly? Check by playing a movie (check inside bore)
- Clean the headphones (both the padding and the case) with alcohol swabs. Over time, these tend to become "oily", which may give serious artifacts (due to spatial aliasing) in scans! Also, this is also a good things to do in terms of hygiene.
- Check Response Boxes
- Check triggers (b-y-g-r for right hand, e-w-n-d for left hand) using Wordpad/Notepad (mnemonic: b-y-g-r refer to the first letter of the color of each hand (**b**lue, **y**ellow, **g**reen, **r**ed) and e-w-n-d refers to the last letter!)
- Check triggerbox – should have default settings:
  - USB 002
  - HHSC – 2X4 – C
  - HID NAR BYGRT

- Check the GSR/Eyetracker batteries (do they still charge?)
- Check if the sound volume of amplifier is still on its standard value (-12)
- Check if all volume settings on the stimulus computer are set to max; also check windows media player
- Write down in the excel sheet whether all these things were OK. Report to Lukas and Tinka if something is not OK.

Misc.

16   **Other things to check:**

- Check whether the elevator is at the lowest level (i.e. basement), turned Off and the key stored next to the MRI key.
- Check whether there are enough forms (see below). If not, print extra.
- Screeningforms, Dutch and English (~100 each)
- Information brochures (~10 each), Dutch and English
- Informed consents/toestemmingsverklaringen (~50) Dutch and English
- GP / huisarts informed consent (~50) Dutch and English
- Note down the temperature and humidity (from the display left to the quench button inside the console room) in the excel-sheet.
- Go to patient administration and empty **Local Patient Database** according to the schedule. So, remove all scans up to two days ago (except for 'NIET WISSEN' scans).
- Check whether there are enough supplies, such as ear-plugs, hair nets, scan paper, electrodes, etc. If not, go to the TOP (technische ondersteuning psychologie) to order new supplies.

Check whether everything from the QC_specs spreadsheet is filled in!