CCBBI Daily QA

Last updated 12-22-2022

How often is QA measurement performed?

The quality assurance (QA) measurement is planned to be performed each working day, including weekend if there is any experiment scheduled.

Typically, the technologist performs the measurement in the early morning. The 32-channel coil is normally used for the test, and the 20-channel coil is used if it is for the first experiment of the day.

If there is potential concern for the system, the measurement will be repeated in the day for verification and diagnose.

Procedure of the QA measurement

1) Set up the sphere phantom (stored in the cabinet closest to the scanner) in the consistent way. Fig. 1a shows the phantom used before 1/1/2023, and Fig. 1b shows the fNIRN phantom used since 1/1/2023.

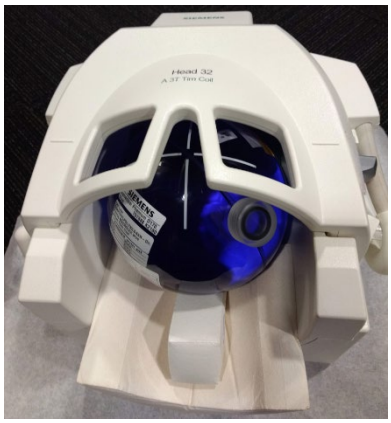


Fig. 1a

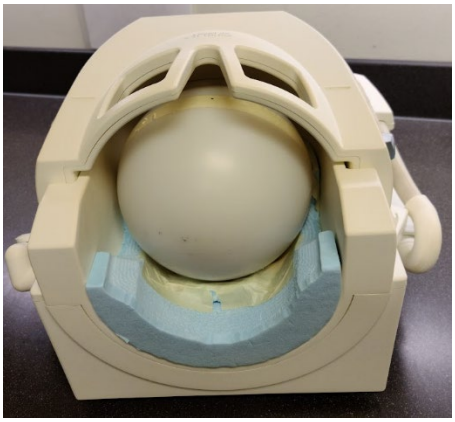


Fig. 1b

2) At the Siemens Console computer, register "Patient" as QA*yymm*, where *yymm* are two digits for year and month, for example QA2212. The typical way is to start the registration from the existing "Patient", so all metrics, like "weight" and "height" etc., will be consistent.

   The Exam cards for QA are stored under SequenceRegion\QA. Choose the one with correct coil name (32 or 20) for the day and start to run sequence under it.

3) For the QA sequence, make sure to **position the slices to the center of the phantom without any rotation.**

   The "stability" sequence is designed to repeat several times, especially if the system is just turned on while it often suffers with larger drift.

Processing the daily QA

The processing of QA data is fully automated at the PACS server. The code will identify the QA data, convert into NIfTI, define ROIs, compute needed scores, save the measurement, plot the data for visualization, and send warning email in case of outbounds of any score.

1) ROI definition
   Fig. 2 shows an example of automated ROI definition based on the center of gravity of the image: signal (red), ghost (green) and background (cyan).

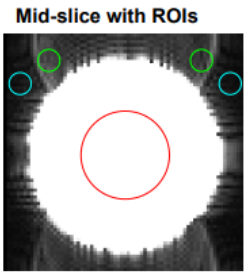


Fig. 2

2) **SNR** is computed as the ratio between mean signal and the standard deviation of the background noise (Eq. 1):

$$SNR = \frac{mean(ROI_S)}{std(ROI_N)} \quad \text{Eq. 1}$$

3) **Ghost** score is measured as the ratio between the ghost and the mean signal, where ghost is computed as the difference between ghost image and background noise:

$$ghost = \frac{mean(ROI_G) - mean(ROI_N)}{mean(ROI_S)} \quad \text{Eq. 2}$$

4) **Drift** score measures how stable the signal is over time. It is the mean signal change in certain period of time. For visualization, the drift score here is computed as the fitted slope in 10 minutes, which is the typical length of a functional run.

5) Two other scores, transmit coil reference amplitude (in volts) and imaging frequency (in Hertz), are also extracted from the DICOM data.

Daily QA plot and interpretation

Next page shows an example of QA plot.

Among these QA scores, the most important ones are SNR and ghost.

The SNR may fluctuate with a large range, due to the small number in the denominator (mean noise), while it is typically above 300.

The ghost score should be stable over time (2 to 3%), and it mainly depends on the sequence parameters and field of view. Here we use the FoV similar to our real experiment, and we define the ghost ROI at the worst ghost image (Fig. 2), so we can catch the worst scenario.

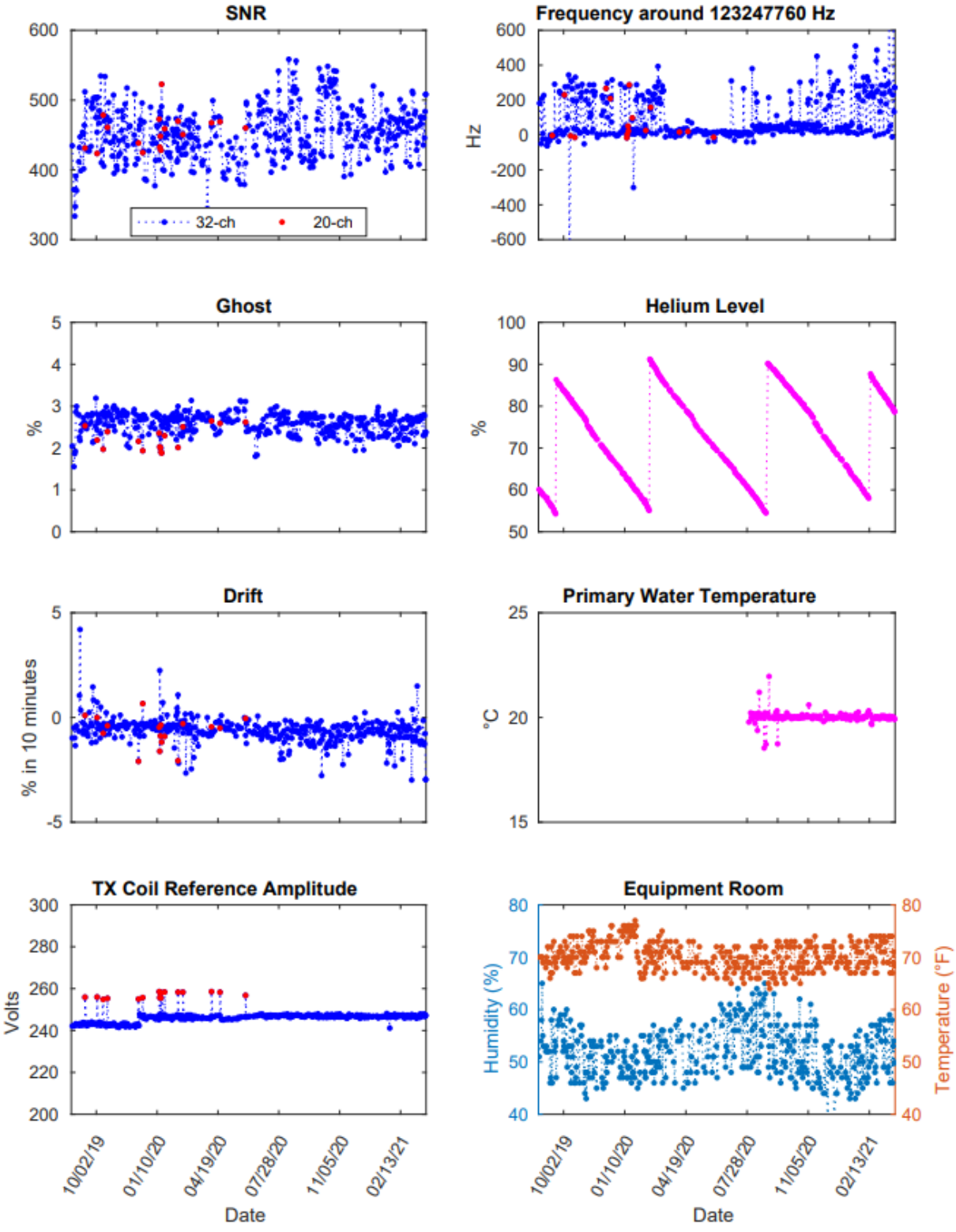
The drift score can change from run to run, or day to day, in large range, but should be lower than 5% in 10 minutes. This is why high-pass filter in fMRI preprocessing is normally necessary.

The imaging frequency is about 123 MHz for 3T scanner. Depending on the regions of phantom or subjects, it fluctuates in hundreds of hertz. The scanner will adjust the frequency for each run, and it will

Updated on Friday March 26, 2021

https://ccbbiinfo.asc.ohio-state.edu/CCBBI_QA.csv

https://ccbbiinfo.asc.ohio-state.edu/DailyQA_procedure.pdf



give warning or error if the frequency does not converge. It is included here for major malfunction detection, so it is not critical to users.

The coil reference amplitude is not critical to users too. We can see it mainly changes due to the different coils or phantom.

The helium level is monitored by Siemens remotely. We monitor it daily just in case the level drops unexpectedly. The refilling happens once every 4~5 months typically.

The primary water temperature (around 20 °C) is also monitored by Siemens remotely. We check it daily (since August 2020) to detect potential cooling issue.

The equipment room temperature (around 70 °F) and humidity (around 50%) are maintained by the special HVAC. We monitor them daily to detect potential issues.

Daily QA data available to users

The PDF plot is available to users at https://ccbbiinfo.asc.ohio-state.edu/CCBBI_QA.pdf . On the top of the PDF page, there is a link to a CSV file. In case users want to get QA scores, they can download the CSV file. Users may use some scores as high level regressor if applicable.

This is part of the CSV file. Note that the time is in format of yymmddHHMM.

time	coil	SNR	ghost	drift	freq	refAmp	helium	temperatur	humidity	water_temp
2007290832	32	445.23	2.573	-0.866	123247774	247.3	60.6	69	59	NaN
2007300833	32	481.25	2.809	-2.004	123247760	247.3	60.4	67	49	NaN
2007310832	32	471.18	2.779	-1.712	123247774	247.3	60.2	67	54	19.78
2008030854	32	427.51	2.587	-0.759	123247762	247.4	59.8	66	49	20.22
2008040806	32	470.95	2.774	-1.98	123247767	247.5	59.5	69	60	19.98
2008050823	32	403.27	2.875	-0.642	123248140	247.1	59.3	69	56	20.06
2008060851	32	449.62	2.859	-1.164	123247814	247.5	59.1	72	63	19.92