DTI QA Considerations

To perform a useful QA, most parameters (e.g., number of gradient directions, gradient orientations, in-plane resolution) should be matched to the protocol being used in the study. However, a few options must be modified to assess scanner performance. In particular, there are 2 options: 'dual SE' (for GE scanners) and 'ASSET' (SENSE-type parallel imaging) which should be considered. Here I describe the considerations and make suggestions in **bold**.

All QA measurements can be obtained from a subset of central slices. **The reduction of # slices should be made (10 central slices) so that TR can be reduced (TR is directly a consequence of # slices for DTI) and scan time can be minimized.**

1) Eddy current measurements: In DTI, dual gradients are used to produce the diffusion sensitization in order to reduce geometric distortions associated with eddy currents. For GE, this is called “dual SE” and we have the option to turn it on or off (not sure about other vendors). For any brain scan it is ON but for the phantom QA you can choose to turn it OFF if you are interested in the performance of the scanner, not specifically the DTI. This is what we do for our daily QA.

   For this study, I recommend dual SE=ON (may be a default/hardcoded for other vendors) and we measure the eddy current distortions produced by the scanning parameters used on the human scans.

2) Nyquist ghosting artifacts: To measure Nyquist ghosting, we make use of the signal that appears in the noise regions, above and below the phantom and compare it to what is present on either side, away from possible Nyquist ghost. Although brain scans use ASSET, we turn ASSET OFF when we run our QA phantom scans for 2 reasons. ASSET, a parallel imaging reconstruction that is implemented by GE, results in an image with background noise regions to be essentially "cut out" (i.e., set to 0). Any parallel imaging method may introduce many structured artifacts into the image that will interfere with proper noise measurements.

   For this study, I recommend ASSET (or other parallel imaging)=OFF for the phantom scans only so that we can measure the Nyquist ghosting

3) SNR: In a phantom, the noise can be measured either from background pixels of the images (with Rician signal distribution) or from a small central circular ROI placed on the difference image computed by subtracting the image signal from two adjacent central slices (Gaussian signal distribution). I have implemented the latter for the DTI analysis so it will not fail if ASSET is ON (i.e., noise is cut out) but ASSET will introduce many artifacts itself.

   For this study, I recommend scanning the QA phantom with ASSET(or other parallel imaging) =OFF and then again for ASSET=ON. SNR can then be measured in both cases. Differences in std(noise) and/or ave(Signal) due to parallel imaging ON/OFF will be a useful measure of level of artifact introduced by the parallel imaging reconstruction. The reduction in TR and scan time will permit this.

Conclusion: match all protocol parameters (keep dual SE=ON) but reduce #slices and reduce TR to the minimum to reduce scan time. Scan 2X (once with and once without parallel imaging).