Automated Analysis for MR Coil QA

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Introduction

MRI coil QA is essential for maintaining image quality, but manual slice selection, ROI placement, and result recording can introduce operator-dependent variability. We developed a unified Python-based desktop application that automates DICOM-based coil QA and MRI raw signal-based magnetic field homogeneity analysis with standardized reporting.

Automated MR Coil QA Workflow

Objective

Develop a unified desktop application to automate MRI coil QA and reduce operator-dependent variability.

Methods

A Python-based application was developed to process DICOM image sets and raw signal files from MR coil QA workflows. The tool automatically performs slice selection, phantom detection using Otsu thresholding and morphological refinement, fixed-geometry ROI placement, and metric calculation. Image-based QA outputs include Signal-to-Noise Ratio (SNR) and Percent Image Uniformity (PIU) for weekly, body, torso, and head-and-neck coil tests. Frequency-domain analysis extracts center frequency (CF), Full width at half maximum (FWHM), and magnetic field homogeneity in ppm from raw signal data. Results are exported as structured Excel reports and plots.

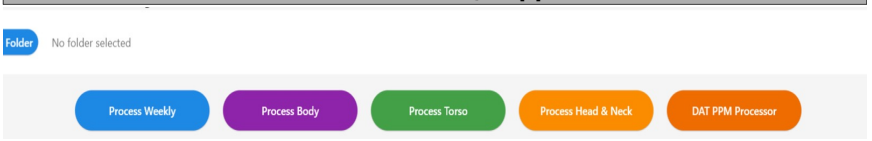
Results

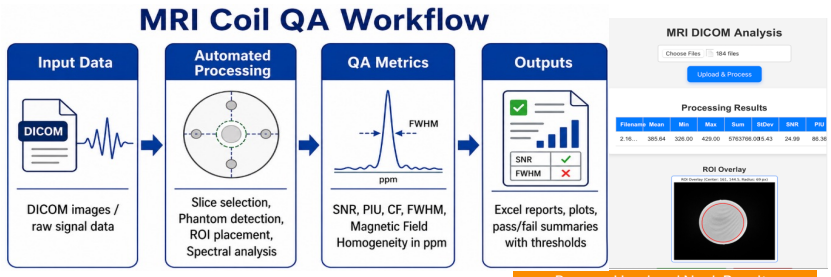
The workflow automatically generated standardized QA metrics across implemented coil configurations without manual ROI placement. Combined-view and individual element analyses enabled assessment of coil and channel performance, while frequency-domain outputs supported gantry-angle-based homogeneity evaluation. An example of head and neck process data is shown in the figure.

Conclusion

The unified workflow standardizes MRI coil QA analysis and reporting, reducing manual effort and improving consistency for routine clinical QA.

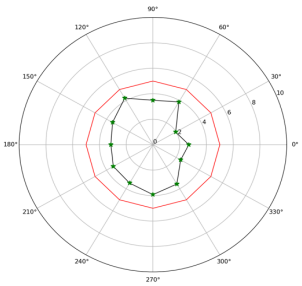
Automated MR Coil QA Application

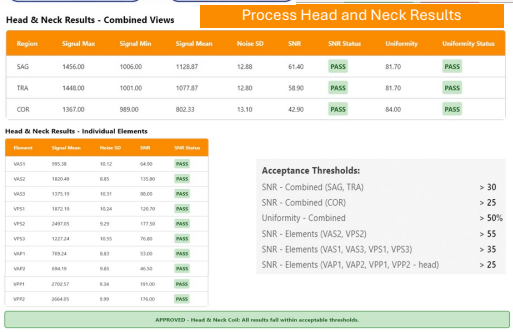


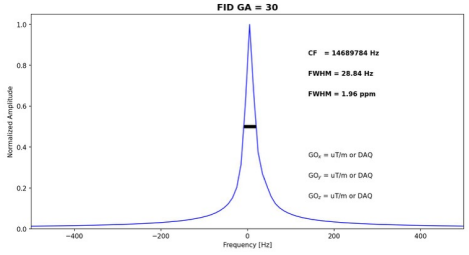


Gantry Angle Variation Of FWHM

GA_Label	CF	FWHM Hz	FWHM ppm
30	14689784	28.83856845	1.963171715
60	14689768	56.93376497	3.875742964
90	14689791	51.2913241	3.491630623
120	14689779	61.94499367	4.216877168
150	14689784	51.2641432	3.48978196
180	14689766	46.21216346	3.145874717
210	14689776	50.21090916	3.418085419
240	14689760	51.2513582	3.488917328
270	14689773	57.68964672	3.927197971
300	14689773	52.46588244	3.571592457
330	14689781	35.15272788	2.393005579
0	14689775	39.41381546	2.683078227







Conclusion and Future Work

Key Outcomes

- Automated DICOM-based coil QA and magnetic field homogeneity analysis in a unified workflow.
- Reduced manual slice selection, ROI placement, and result transcription.
- Generated standardized outputs for SNR, PIU, center frequency, FWHM, and homogeneity in ppm.
- Enabled combined-view, individual coil element, and gantry-angle-based QA assessment.
- Exported structured reports and plots for consistent clinical QA tracking.

Future Work

- Validate the workflow across additional scanners, coil configurations, and institutions.
- Expand compatibility with other vendor formats and acquisition protocols.
- Add longitudinal trend analysis for early detection of coil or field performance changes.