The ROYAL MARSDEN
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Bespoke software for rapid compilation and analysis of daily automated CT QA results

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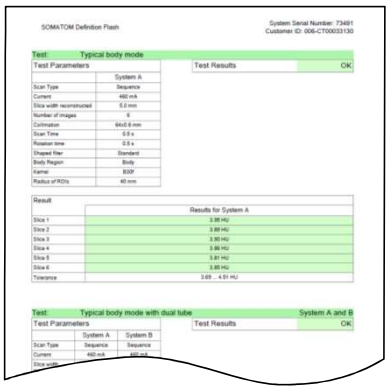
Introduction

Siemens CT scanners have a QC routine that is run daily after the scanner warm up. This measures CT number, noise and homogeneity in a QA water phantom and compares results with nominal and scanner baseline values. Scanners typically make measurements in body and head scan modes, and in dual tube mode where appropriate. The user is presented with a pass/fail result, but detailed results are also saved as pdf files locally on each scanner. This represents a wealth of QA information at daily time intervals, but review and analysis of these results in this format would be an impractically tedious and lengthy process. In-house software has been written at the RMH to enable rapid compilation and analysis of results for long-term trend analysis.

Method

Individual pdf files generated by each daily QA are exported from each CT scanner at routine Physics QA visits either two or three times a year. The in-house software consists of a Linux shell script of just a few lines of code that instigates the creation of a results csv file, conversion of each pdf into a text file, sorting and searching of the text to extract QA measurement results using an AWK program, and appending these values into a new line of the csv file. These lines are copied into a master spreadsheet that updates graphs of performance data against time. A flow chart of this process is shown below in figure 1.

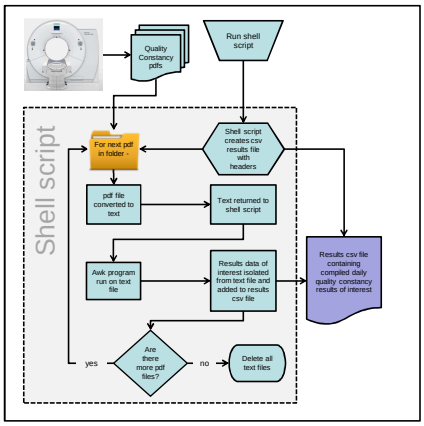


Part of one page of a Siemens Daily Quality Constancy results pdf

Table 1: scanners for which this analysis is routinely done

Site code	Scanner model	Current software
1	Siemens Sensation 64 (now decommissioned)	syngo CT 2007S
1	Siemens Definition Edge	syngo CT 2012B
1	Siemens Definition Flash	syngo CT 2012B
2	Siemens Definition Edge	syngo CT 2012B
2	Siemens Definition Flash	syngo CT 2012B
3	Siemens Definition Flash	syngo CT 2012B
3	Siemens Biograph 64 mCT	syngo MI.PET/CT 2012A
3	Siemens Biograph 128 mCT	syngo MI.PET/CT 2012A
3	Siemens Symbia Intevo 16	syngo CT 2007E - VA70A
3	Siemens Symbia Intevo 16	syngo CT 2013E - VB10A

Figure 1: Flowchart of automated analysis process



Software details

A **shell script** can be run from a Linux command line, or from Windows if software is installed that supports Linux tools, for example Cygwin, which is included if you install the Git version-control software. Alternatively a Windows batch file could be created to perform the same function.

Pdfttotext is a Linux command-line utility included with many Linux distributions that converts pdf files into text. It is available for Windows as part of the Xpdf Windows port.

AWK is a scripting language designed for searching and manipulation of text strings. It treats a text file as a sequence of records, each record being a text string. A version exists for Windows, called Gawk for Windows. All of these tools are **open-source** and **free**.

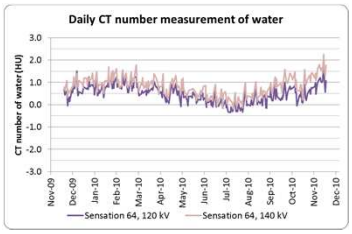
Results and discussion

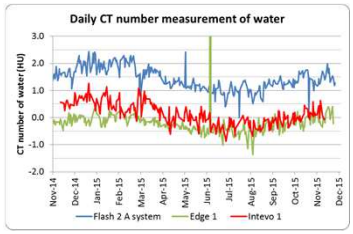
Challenges of implementing this analysis include the fact that different measurement results are performed for different scanners, for example different numbers of water scans done at different kVp and filter combinations, repeated scans for dual energy mode or for a second tube-detector system. Additionally, the layout and format of the results pdf files is different for different software versions on each scanner. This requires separate AWK programs for different scanners, or the inclusion of logical statements in the program to account for these differences.

Analysis of several months of pdf files generated by daily QA typically takes a couple of minutes on a desktop PC. From charts of the results data it is possible to identify step-changes in performance, long-term trends in data, and comparison of performance of similar model scanners to one another. Further examples of observations are given in the bullet-point boxes below.

• *Seasonal variation*

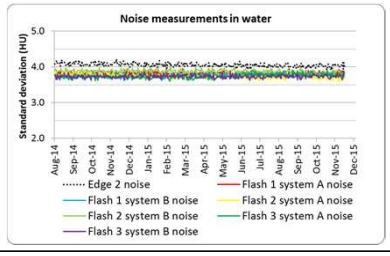
A trend of seasonal variation in measured HU of water is observed for some scanners of all models. This variation has a maximum magnitude of approximately ± 1 HU from the mean, and a period of 1 year. This has been attributed to change in ambient temperature of the Siemens QA water phantom.





• *Long-term stability in measured noise*

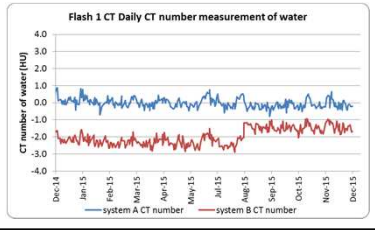
The noise measurements for all the Siemens Flash scanners is remarkably stable with time and is well matched across scanners and between each A and B system. Note that measured noise on the Edge scanner are slightly higher; QA scans are performed at 210 mAs on the Edge and 230 mAs on the Flash.

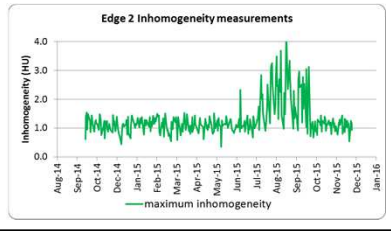


• *Step-changes following corrective action*

The chart below-left shows a step change in measured CT number of water for system B in a dual-source system after a recalibration in August 2015. The two systems are now better matched in measured CT number.

The chart below-right shows a worsened measured inhomogeneity due to an air bubble in the QA phantom: the water phantom was refilled in October 2015 and measured inhomogeneity improved.





Conclusions

Daily QA is important in providing simple performance measurements at frequent time intervals, as more complex tests are performed only between two and three times a year by Physicists for these Siemens CT scanners. In the past, each set of daily QA measurements was assessed purely for pass or fail conformity in isolation from other daily QA data. With this software it is now possible to perform quantitative analysis on a much richer set of data over longer time periods, enabling identification of performance trends and performance changes due to corrective action, and better inter-scanner performance comparison.

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