Optimising a Radiotherapy Prostate CT Protocol using the Mercury Phantom

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Aims

- Optimise the CT protocol used to image patients having prostate radiotherapy treatment
- Make suggestions for protocol improvement
- Find a generalizable method for optimisation of CT protocols

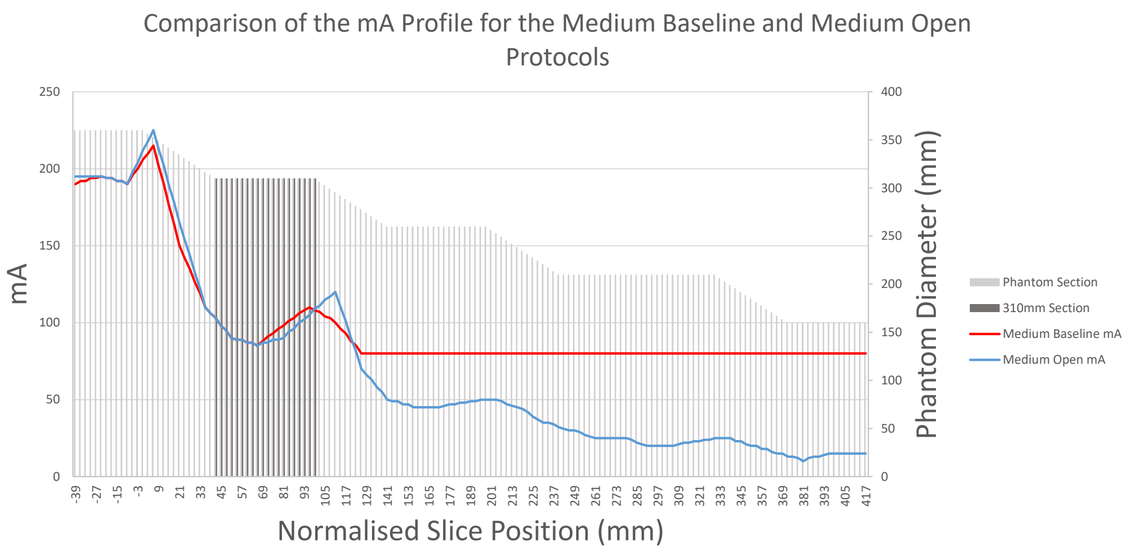
Automatic Tube Current Modulation (ATCM)

ATCM can be used to achieve a balance between image quality and dose in CT scanning.

When using ATCM the mA used will vary throughout the scan length based on a calculation of water equivalent diameter (WED) performed using the scan projection radiograph (SPR).

The mA used is calculated with consideration of an image quality index (SD) entered by the user and the WED. When inappropriate settings, such as restrictive mA limits, are used the required image quality may not be achieved or the dose may not be kept ALARP. An investigation into the SD and mA settings was therefore performed.

Figure 1 – The mA profile calculated by the scanner to image the Mercury phantom before and after protocol optimisation, overlaid on the phantom outline.



Method

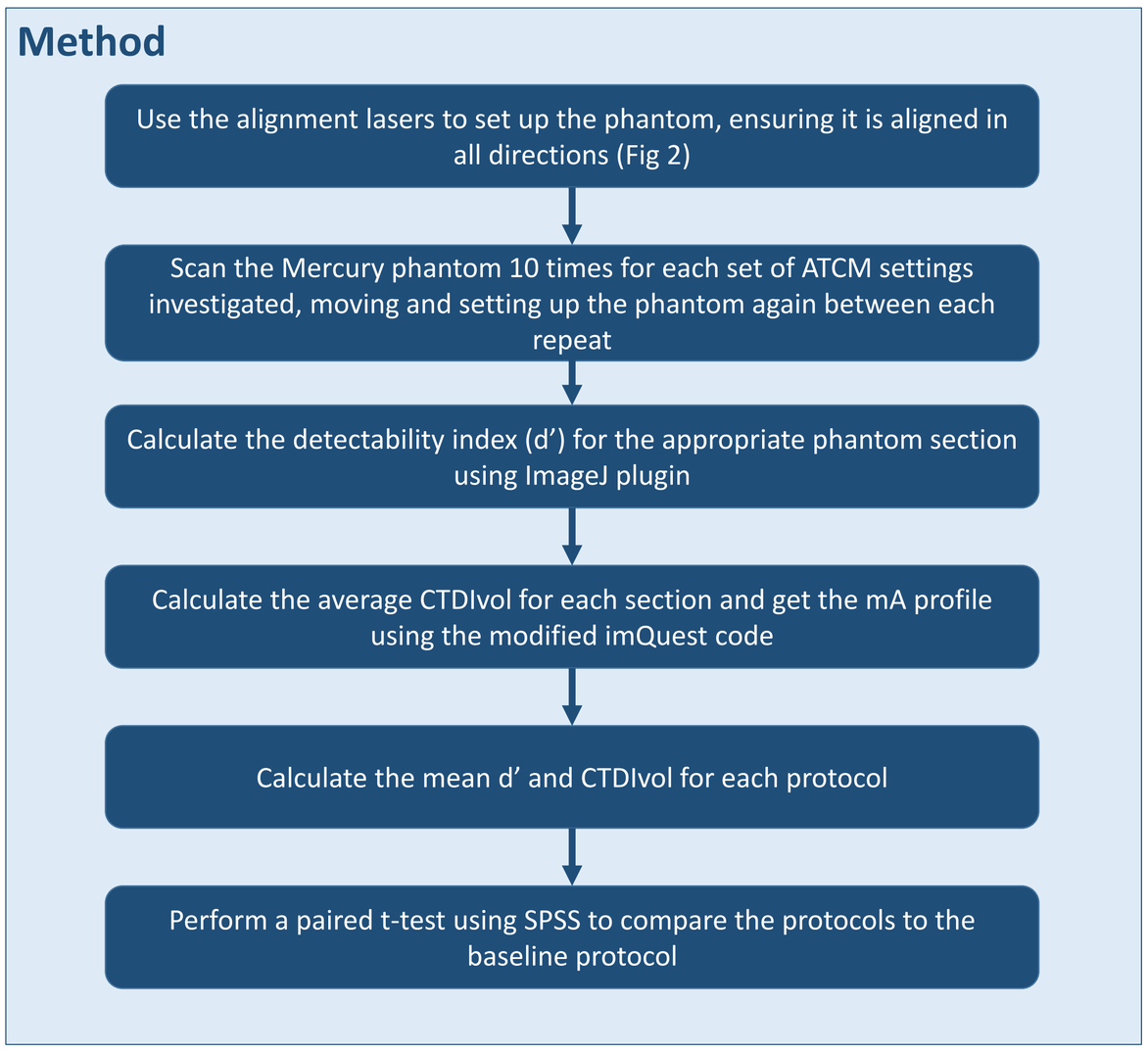
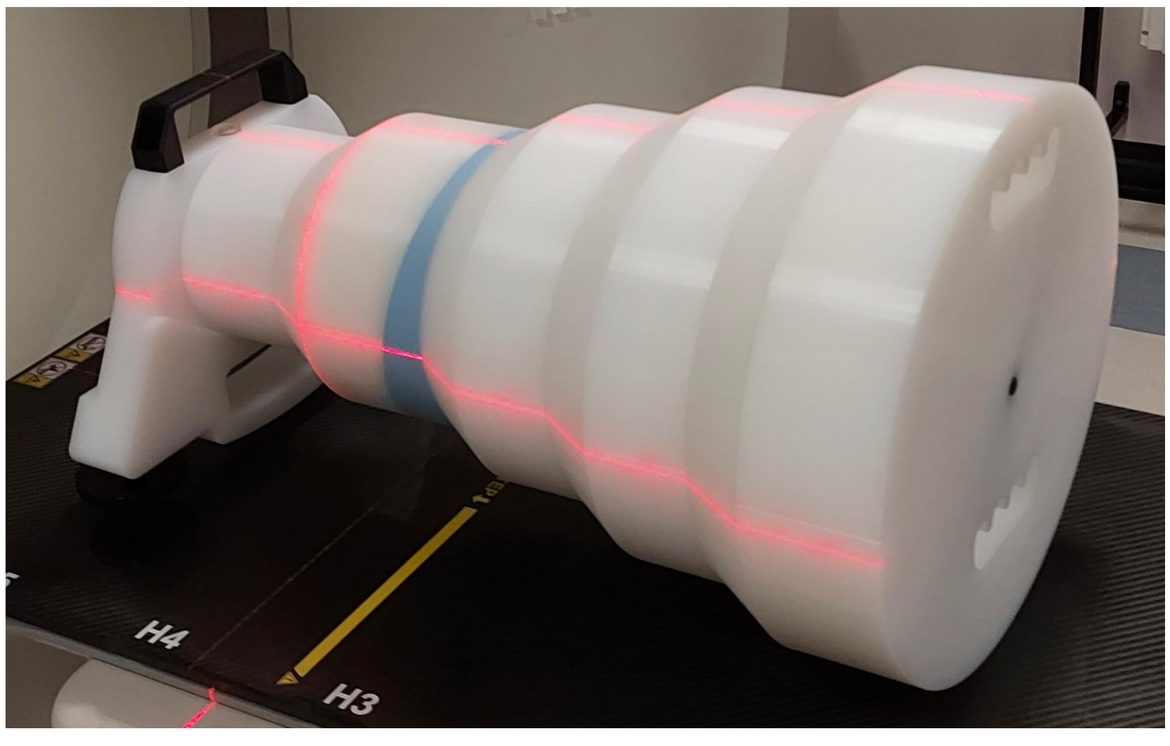


Figure 2 – The Mercury Phantom.



Results

It was found that for the medium and slim baseline protocols, the mA limits set by the user restricted the performance of the ATCM (Fig 1).

d' decreases with increasing SD value for each phantom section. (Fig 3) The average CTDIvol also decreases with increasing SD value for each phantom section.

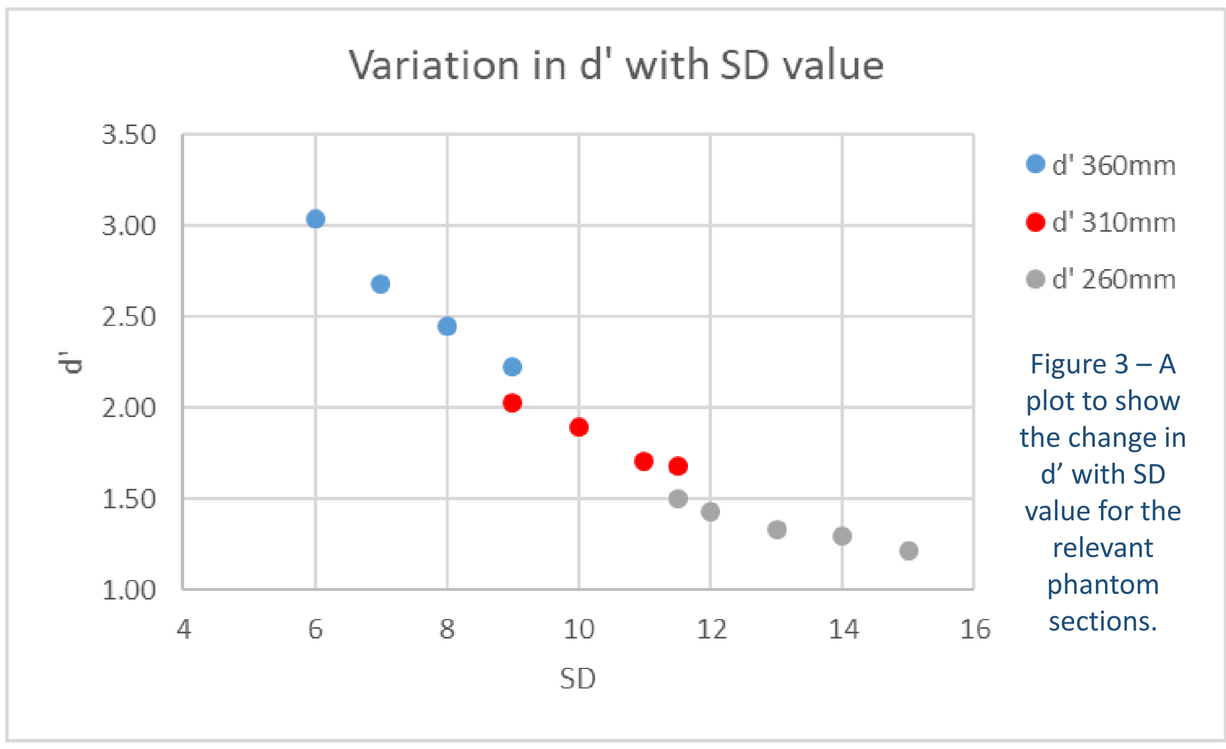


Figure 3 – A plot to show the change in d' with SD value for the relevant phantom sections.

Discussion

To decide which protocols to recommend for use it was important to think about if the change in d' and CTDIvol were clinically relevant.

d' – The change in image quality will be reviewed with clinical staff to ensure the resultant images are fit for clinical purpose.

CTDIvol – A calculation was performed to assess the risk to the patient from the resultant radiation dose. A risk category was used to determine if the optimised protocol results in a change of risk to the patient.

	Baseline			Recommendation		
Patient Size	ATCM Settings	d'	CTDIvol (mGy)	ATCM Settings	d'	CTDIvol (mGy)
Large (360mm)	SD: 15 mA: 80-500	1.24	10.07	SD: 14 mA: 10-600	1.30	11.66
Medium (310mm)	SD: 11.5 mA: 80-500	1.62	7.92	SD: 11.5 mA: 10-600	1.68	7.86
Slim (260mm)	SD: 9 mA: 100-500	2.64	9.27	SD: 9 mA: 100-500	2.64	9.27

Table 1 – A summary of the protocol baselines and recommendations made.

Conclusions

It was possible to use the Mercury phantom to optimise the prostate protocol using a method that could be easily transferred to other protocols.

Large Protocol
For the large protocol it was recommended that the 14 SD open mA limits protocol should be used.

Medium Protocol
For the medium protocol it was recommended that the 11.5 SD open mA protocol should be used.

Slim Protocol
For the slim protocol it was recommended that the baseline protocol should be used.

Future Work

This method will be applied to the optimisation of other CT protocols within the Trust.

In this future, the water equivalent diameter will be calculated for a historic patient cohort so that the phantom sections are specific to the site.

References

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