

# Comparison of beam output drift for Varian Clinacs and Truebeams: Do Truebeams require more frequent calibration?

Matthew Bolt<sup>1,2,3</sup>, Andy Nisbet<sup>1,3</sup>, Catharine Clark<sup>1,2</sup>, Tao Chen<sup>3</sup>

(1) St Luke's Cancer Centre, Royal Surrey County Hospital, Guildford, UK.

(2) National Physical Laboratory, Teddington, UK.

(3) University of Surrey, Guildford, UK.

Contact: matthew.bolt@nhs.net

## Background

A recent discussion on the MEDICAL-PHYSICS-ENGINEERING JISCMail mailing list debated whether Varian Truebeams, officially released in April 2010, required more frequent calibration than the previous version of Varian Clinac linear accelerators.

This prompted a closer examination of a large dataset of beam output measurements to investigate if the beam output on Truebeams drifted at a greater rate than on Varian Clinacs.

## Methods

A dataset containing local beam output measurements from 23 Clinacs and 27 Truebeams spanning 6 months was analysed to determine the variation in the drift of beam output for each machine. In total this consisted of 5967 measurements of 6MV beam output.

The data was systematically corrected for known recalibrations prior to analysis. A least squares linear regression was performed on the dataset for each machine and extrapolated to determine the annual drift in beam output.

The Truebeam and Clinac datasets were then statistically compared using the Welch's t-test. The potential impact on the number of recalibrations required was assessed.

## Results

A large variation in output drift was found for each linac model and the spread of results is shown in *Figure 1* and *Figure 2*.

A summary of the results for each linac model is given in *Table 1*.

- Mean drift for Truebeams was 1.2% greater than for Clinacs.
  - This was found to be statistically significant ( $p=0.03$ ).

The standard deviation of the drifts was similar at 1.8-2.0%. Of the 50 linacs, 39 (78%) had a positive drift.

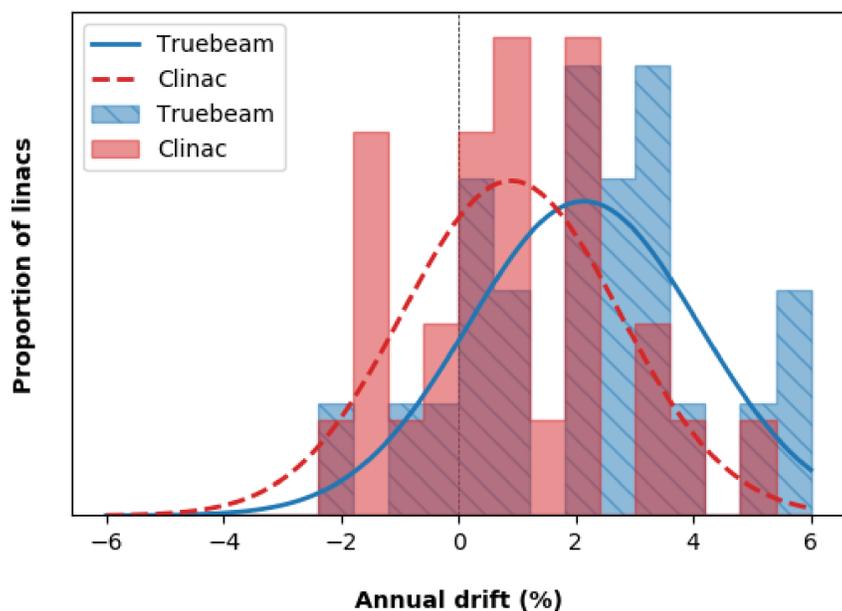
- Based on a tolerance of +/- 2% the mean calibration frequency is:

- Clinacs : 11.4 months per calibration
- Truebeams: 26.7 months per calibration

Measured drift (%/year)	Linac Model		Difference (Truebeam - Clinac)
	Clinac	Truebeam	
Mean	+0.9	+2.1	+1.2
Median	+0.7	+2.1	+1.4
Std. Dev.	2.0	1.8	-0.2
Minimum	-2.0	-2.3	-0.3
Maximum	+5.1	+5.6	+0.5
Mean Age (yrs)	7.8	2.0	-5.8

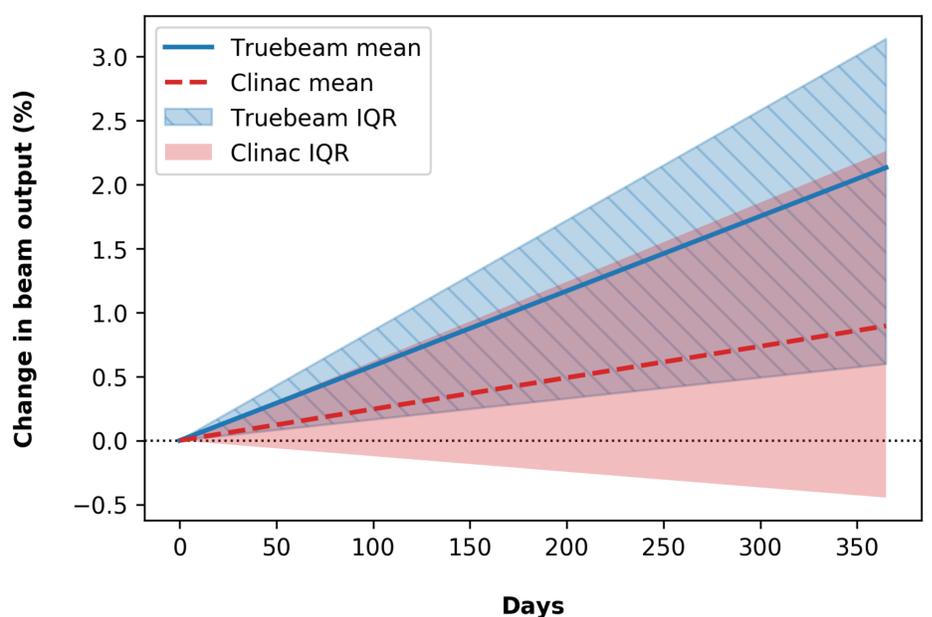
**Table 1:** Summary of Clinac and Truebeam annual output drifts.

Spread of beam output drifts for Truebeams and Clinacs



**Figure 1:** Histogram for the annual output drifts. Clinacs and Truebeams were found to have a mean annual drift of +0.9% and +2.1% respectively. The difference was statistically significant ( $p=0.03$ ).

Annual beam output drift of Clinac and Truebeams



**Figure 2:** Plot showing the mean (dashed line) and IQR (shaded region) of the beam annual beam output drift for Clinacs and Truebeams depicted as a linear annual drift over 1 year.

## Conclusions

A statistically significant difference in the rate of beam output drift was identified between Varian Truebeam and Clinacs, with Truebeams having a mean annual drift +1.2% greater than Clinacs. This supports the clinical experience expressed on the mailbase by users within a number of different centres. Varian attribute the rate of drift to a 'bedding in' period, and in this case all the Truebeams were installed more recently than the Clinacs. Longer term data is required to determine how this changes with machine age.

These results indicate that Truebeams require recalibration more than twice as frequently as Clinacs. This could have a significant impact on resource requirements, particularly for newer machines which may have a faster drift while 'bedding in', however it may be machine specific.

**Acknowledgements:** Funding was provided by the National measurement System (NMS) as part of the larger NPL QUASAR project (Quantifying the impact of dosimetry quality assurance on clinical outcomes of radiotherapy). Thanks to those in each centre who collated and provided data for this work.