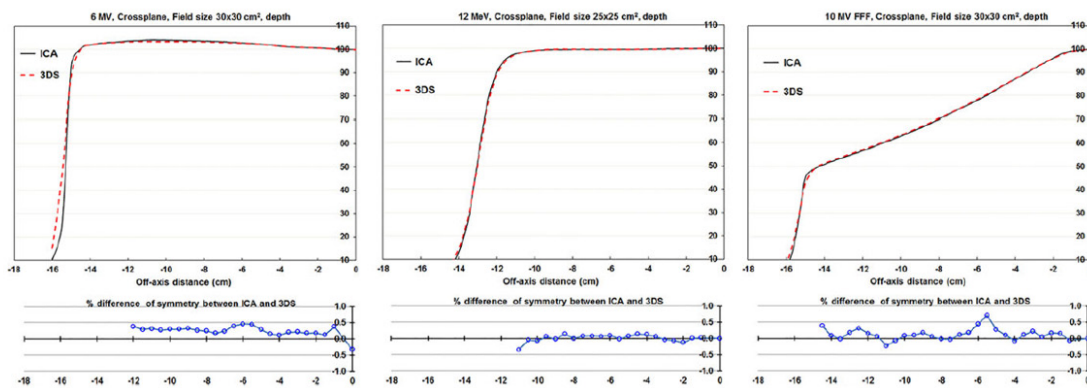


## IC PROFILER™ Accuracy Studies Water Equivalent Studies

### Quantification of beam steering with an ionization chamber Array

S. Gao, et al., J Appl Clin Med Phys 2018 May; 19(3):168-176

- “We have demonstrated that with the correct equipment and procedures, a 2D detector array can be used to steer linear accelerator photon and electron beams and achieve a resultant beam symmetry that matches that of a 3D water scanning system.”
- “Use of the ICA (IC Profiler) greatly speeds up the steering process because of its real-time feedback and reduces effort by eliminating the need to setup a 3D water scanning tank.”
- “No significant differences were found among the various array calibrations even though they spanned 4 yrs suggesting that the device has good short-term reproducibility and long-term stability with respect to the array calibrations.”



**Fig. 5.** Samples of profiles measured with a 2D ionization chamber array (ICA) and 3D Scanner (3DS) (upper chart) and differences in point-by-point symmetry (lower chart).

### Quality Assurance of Beam Energy and Output for Gated Treatment Delivery Using IC Profiler and Quad Wedges

L. Hu, et al., SU-K-SAN1-5, 2019 AAPM Talk/Abstract

- Study using IC Profiler and Quad Wedges to test Gating beam stability at very low doses
- “IC Profiler provided stable energy and output measurement for very low MU delivery, validating its use for gating QA.”
- “Mean IC Profiler deviations for MU bursts <3MU and all IC Profiler standard deviations were an order of magnitude smaller than ion chamber”

### Measuring Beam Energy and Symmetry Constancy with an Ion Chamber Array

Varian Reference Bulletin 100052071-01, December 2010, Varian Medical Systems, Inc., Palo Alto, CA

- Uses Dual Wedges for energy checks on Varian Linac beams (6-20 MV and 4-22 MeV)
- “The investigation has yielded the following results: This device can measure beam energy and symmetry changes with a sensitivity comparable to a Wellhofer water phantom
- This device can measure beam profiles with a repeatability comparable to a Wellhofer water phantom”

## Measurement of changes in linear accelerator photon energy through flatness variation using an ion chamber array

S. Gao, et al., Med. Phys. 40 (4), April 2013

- Uses Diagonal Flatness for energy checks on Varian Linac flattened beams
- *“Our measurements indicate that there is a strong correlation between changes in photon energy and changes in the diagonal normalized flatness, FDN. In contrast, we found that PDD changes were not as sensitive to changes in photon energy particularly when the beam energy was reduced below the nominal energy.”*

## Beam Quality Verification Using IC Profiler with Quad Wedge Accessories

L. Tirpak, et al., Sun Nuclear and Varian Medical Systems Co-Authored 2016 Technical Bulletin P1018976

- *“Conclusion: Energy verification using IC Profiler with Quad Wedge accessories can yield results with accuracy comparable to water tank measurements.*
- *For Varian TrueBeam accelerators, the accuracy (3 standard deviations) of calculated D10 and R50 metrics was shown to be 0.45% and 0.05 cm, respectively.*
- *The reproducibility of results (3 standard deviations) is 0.1% for D10 and 0.03 cm for R50.*
- *The setup of an IC Profiler and accessories is much simpler than the setup of a water scanning system. This means that the IC Profiler is less prone to errors and uncertainties, which provides more consistent reproducible results.”*

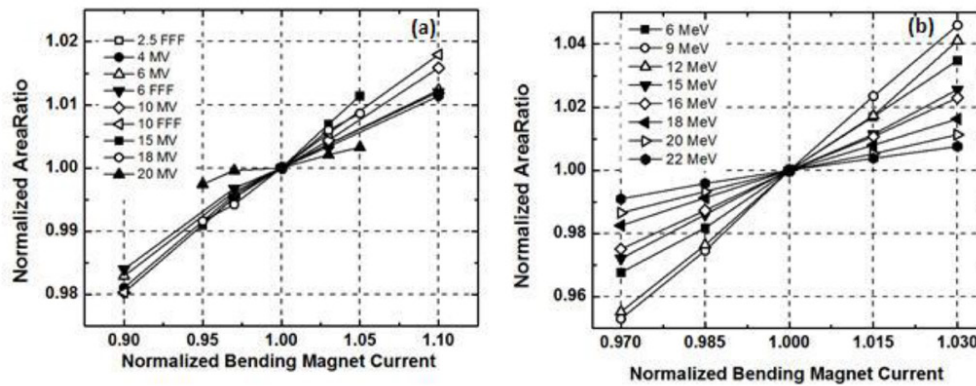


Figure 4: Relative change in AreaRatio as a function of bending magnet current for photon (a) and electron beams (b). The lines are drawn as a guide for the eye and do not represent a linear fit.

## Use of AutoTest BeamPro™ for rapid set-up of Photon and Electron Beams

Elekta White Paper, 2016

- Uses Dual Wedge Tray for energy checks on Elekta Linac beams (6MV and 4-22 MeV)
- *“Conclusion: AutoTest BeamPro™ makes use of widely available ion chamber array technology as an alternative to traditional water phantoms for preliminary system set-up.*
- *The system has the advantage of eliminating some of the user-dependent sources of inconsistency and provides beam profiles and analysis in real time thereby enabling very efficient tuning and set-up of the beams.*
- *AutoTest BeamPro™ therefore represents a major step forward in the ability to prepare systems for customer acceptance quickly and consistently.”*

## Clinical implementation of photon beam flatness measurements to verify beam quality

S. Goodall, et al., J Appl Clin Med Phys, 2015, Vol 16:6

- Uses Diagonal Flatness for energy checks on Elekta Linac flattened beams
- *“Conclusion: A strong linear correlation was shown between...TPR15/5 and FDN (Diagonal Flatness) values for 6 and 10 MV photon beams across multiple Elekta linacs.”*

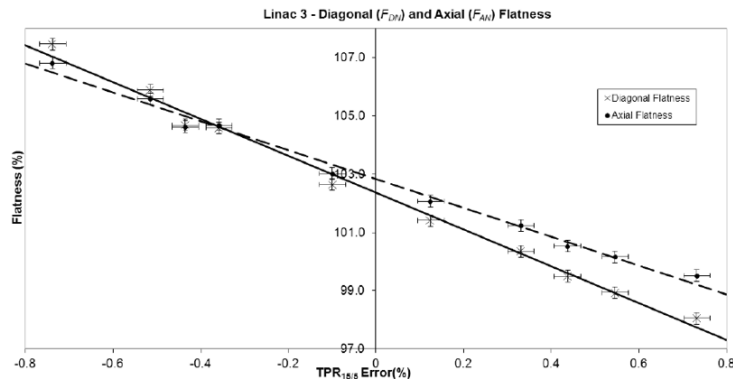


FIG. 1. The variation of diagonal normalized flatness (solid line  $R^2 = 0.9924$ ) and axial normalized flatness (dashed line  $R^2 = 0.9908$ ) with  $TPR_{15/5}$  error (%) for linac 3 at a nominal energy of 6 MV.

## IC PROFILER and 1D SCANNER™ for Varian’s Halcyon™ System

### Acceptance and verification of a Halcyon-Eclipse linear accelerator-treatment planning system without 3D water scanning

S. Gao, et al., J Appl Clin Med Phys, Aug 2019;1-7

- Study successfully compares IC PROFILER with 1D SCANNER vs. a 3D scanner to accept and commission the Halcyon/Eclipse system.

## IC PROFILER for TBI Validation

### Extended SSD VMAT treatment for total body irradiation

G. Pierce, J Appl Clin Med Phys, 2019; 20:1:200-211.

- Provides a method using an IC PROFILER at three inline positions to validate VMAT-based TBI treatments.

## Daily QA™ 3

### CyberKnife Output Constancy Utilizing Daily QA3 Device

T. Reynolds, et al., AAPM 2019 Abstract, PO-GePV-T-269

- Four year constancy and suitability study comparing Daily QA 3 to Ion Chamber measurements
- *“The DQA3 device showed a good agreement with ion chamber measurements making it a suitable device for detection of output variations during routine measurements.”*

## When a Good Monitor Chamber Goes Bad: Diagnosing Atmospheric Communication of a Sealed Monitor Chamber

T McCaw, et al., AAPM 2018 Abstract, SU-I-GPD-T-323

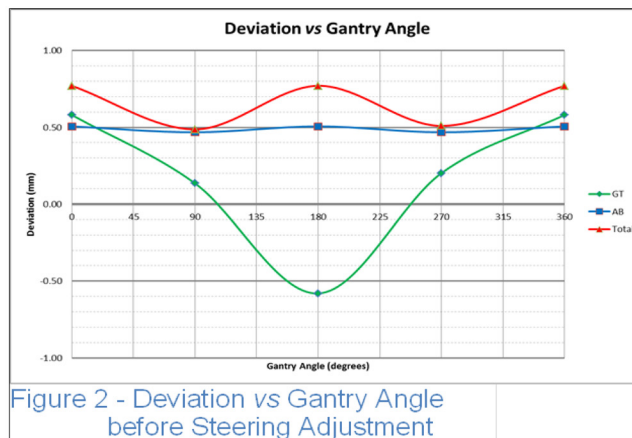
- *Conclusion: "Daily output variations measured with two independent systems on a TrueBeam STx were found to highly correlate with atmospheric conditions during a period in which the monitor chamber was suspected to be communicating with the atmosphere. Additional measurements acquired during controlled temperature variation of the monitor chamber confirmed atmospheric communication of an originally sealed chamber."*

## SunCHECK™ - SNC Machine™

### A new method for optimizing radiation isocenter for linac-based SRS

S. Hancock, et al., AAPM 2015 Abstract

- "Sub-millimeter accuracy is increasingly important in radiation therapy as the field trends towards highly conformal and high dose-per-fraction therapy. We developed a new method to minimize deviation of linear accelerator x-ray beams from the centroid of the volumetric radiation isocenter for all combinations of gantry, collimator and table angle."
- *"Conclusion: The process presented in this work can be used to effectively minimize the isocentric volume... Separation of gantry and table variables is the key element of this method that facilitates the reduction of isocentric deviations."*



## Which One Is More Reliable in Determining Leaf Position Uncertainties: SNC Machine™ Hancock MLC Test Or AutoCAL™ MLC Test

K. Jacobs, et al., AAPM 2019 Abstract, PO-GePV-T-256

- *"Conclusion: It can be concluded both statically and for best clinical use that the SNC Machine™ Hancock test is a more reliable and robust test than AutoCAL™ for absolute MLC position tests."*