Performance Evaluation of the New Commercial Exradin A30 Ion Chamber for UHDR Reference Dosimetry

Luke Connell, MS[1], Shannon M. Holmes, PhD[2], Sam Beddar, PhD[1] and Emil Schueler[3], [1]Department of Radiation Physics, The University of Texas MD Anderson Cancer Center, Houston, TX, [2]Standard Imaging, Inc., Middleton, WI, [3]MDACC, Houston

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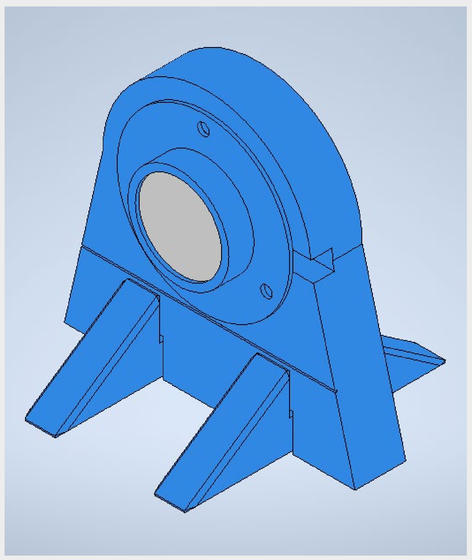
INTRODUCTION

Ionization Chamber represent the gold standard for clinical dosimetry; however, they suffer from severe ion recombination losses at the Ultra-High Dose Rates (UHDR) characteristic of FLASH radiotherapy. This study evaluates the commercial Extradin A30 plane parallel ion chamber, optimized for UHDR reference dosimetry, paired with a modified electrometer capable of temporally resolved charge readouts.

METHODS AND MATERIALS

The commercial A30 plane parallel ion chamber was utilized in this study, alongside a novel Max Elite with the ability to measure at high sampling frequency. This work utilized a Oriatron eRT7 (PMB, Peynier, France) electron LINAC, and simultaneous acquisition of ion chamber, and Beam Current Transformer (BCT) signals will enable direct comparison of temporal response characteristics of the LINAC. Relationship between the ion chamber signal, the BCT integral was established for each of four configurations of the electron gun, including “Conventional”, “Flash Low”, “Flash Medium”, and “Flash High”, which manipulates the instantaneous dose rate. BCT response was initially characterized using EBT4 Gafrchromic film to measure the response between 0.1 and 11.67 Gy per pulse. A holder for the ion chamber and build-up cap were designed and 3D printed to allow the use of the Oriatron’s horizontal beam. **Pulse Width (PW) Linearity** was characterized by delivering 5 pulses at 200 Hz pulse frequency at pulse widths between 0.5 µs and 4 µs. **Pulse Repetition Frequency** was characterized in FLASH High and FLASH Low Configurations by delivering 5 pulses at 2 µs PW at PRF values between 10 Hz and 240 Hz.

Figure 1: 3D CAD Model of the holder (blue) for the A30 ion chamber and its build-up cap (grey)



CONTACT

Luke Connell
MD Anderson
LConnell@mdanderson.org
Schüler Lab

RESULTS

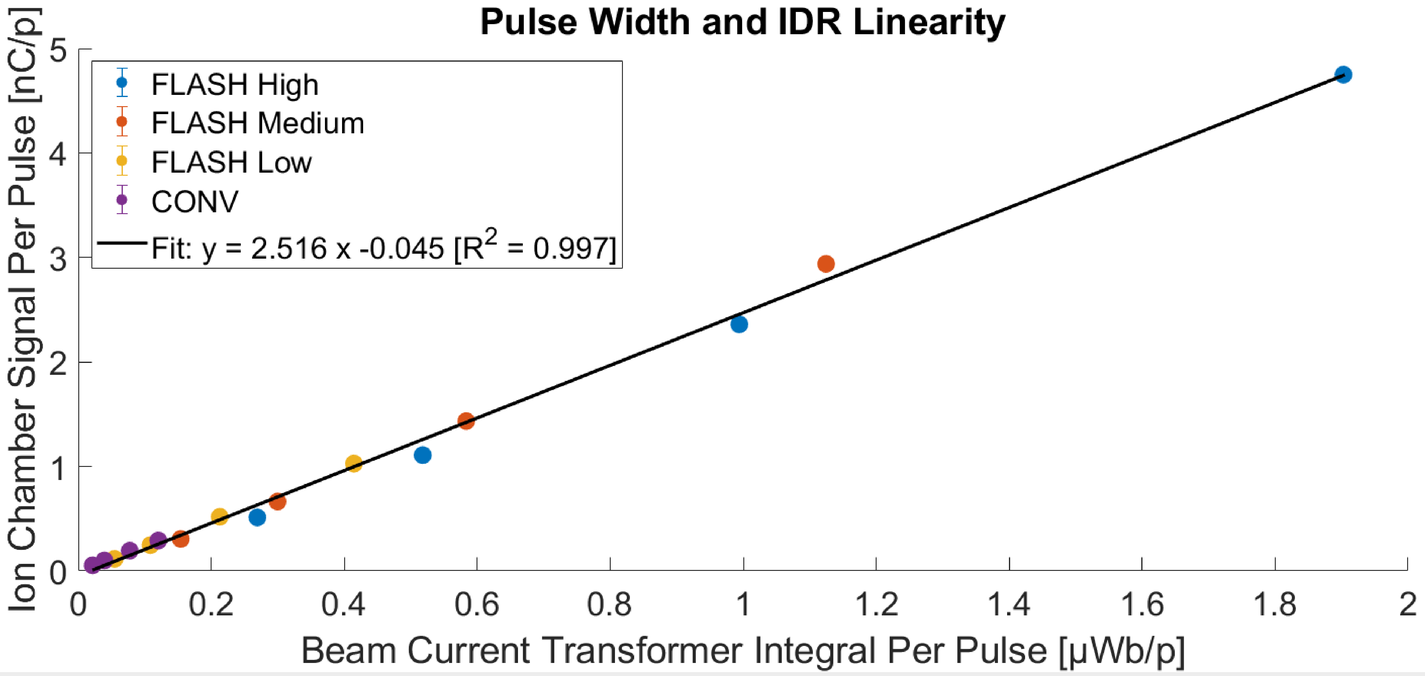


Figure 2: Relationship between configuration, pulse width, and output measured with both ion chamber and beam current transformer. Each configuration consists of a set of four PW values, 0.5 µs, 1 µs, 2 µs, and 4 µs

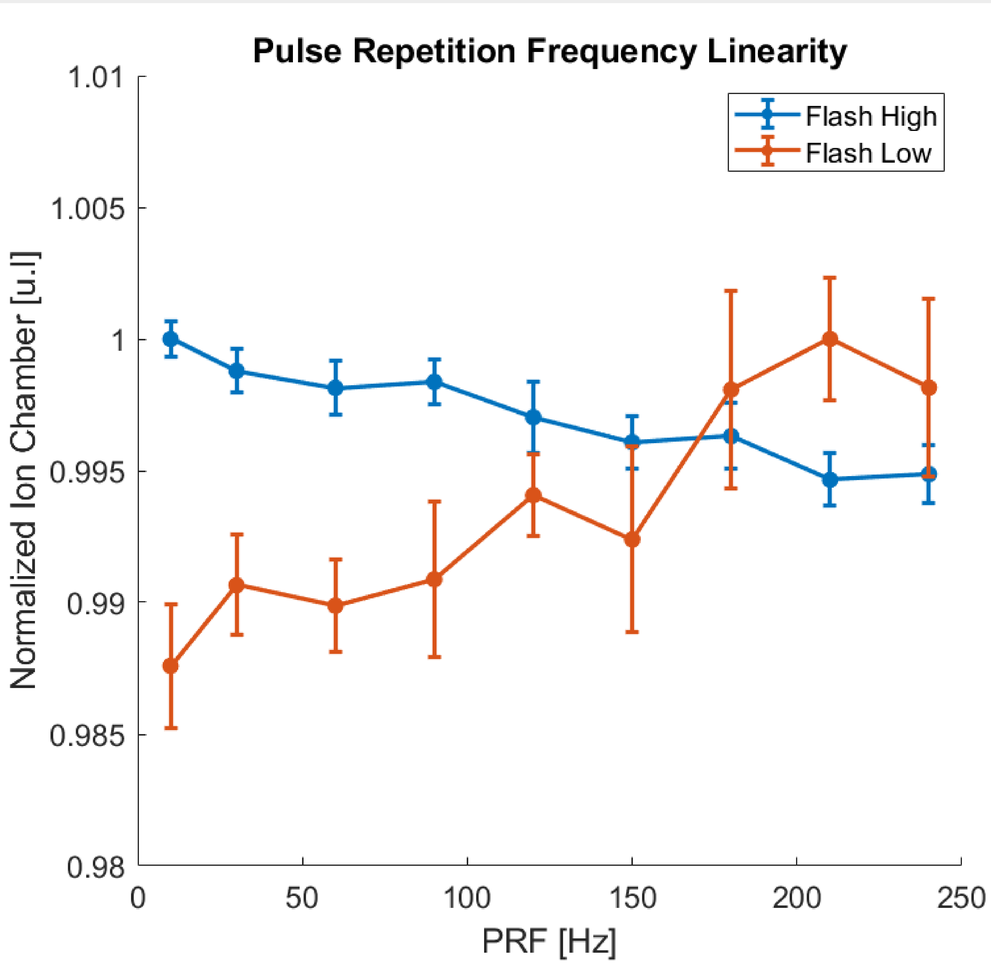


Figure 3: Ion Chamber output in configurations FLASH High and FLASH Low at frequencies between 10 Hz and 240 Hz. Each configuration is normalized with respect to the mean of the set.

CONCLUSIONS

The A30 ion chamber along with novel Max Elite electrometer response to high DPP radiation was characterized utilizing beam current transformers. The response of the ion chamber was linear with response to DPP, which was varied using both pulse width and pulse intensity in the form of varying electron gun configurations. The A30 was also able to characterize the small change in output with respect to pulse repetition frequency. Overall the response was linear between 0.1 Gy/pulse and 11.67 Gy/pulse and was used up to 240 Hz

REFERENCES

1. Liu K, Holmes S, Khan AU, et al. Development of novel ionization chambers for reference dosimetry in electron flash radiotherapy. *Med Phys*. Dec 2024;51(12):9275-9289. doi:10.1002/mp.17425