Real-Time Output Gating and Fault handling for a UHDR Mobetron FLASH Linac

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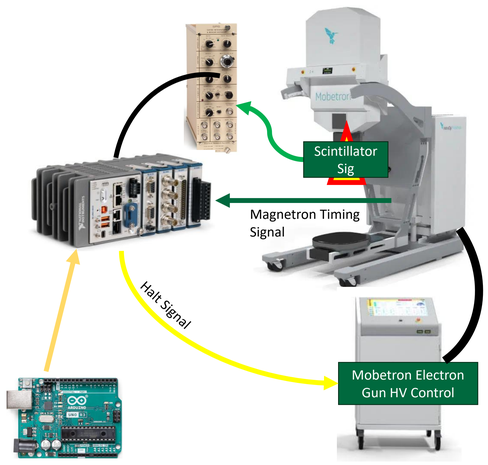
ABSTRACT

The IntraOp UHDR Mobetron is a powerful irradiator for FLASH research due to its wide range of programable pulse parameters. However, because UHDR deliveries are pre-programmed with most monitoring and feedback systems disabled, there is a high level of trust placed in the expected performance of a machine. Real-time monitoring of output and beam spatial information, with the ability to halt a delivery in the event anomalies are detected is an essential capability for safe and effective translation towards clinical trials.

METHODS AND MATERIALS

Interlock latency was simulated with an external signal provided by an Arduino. Output integration was measured on an SRS250 gated integrator.



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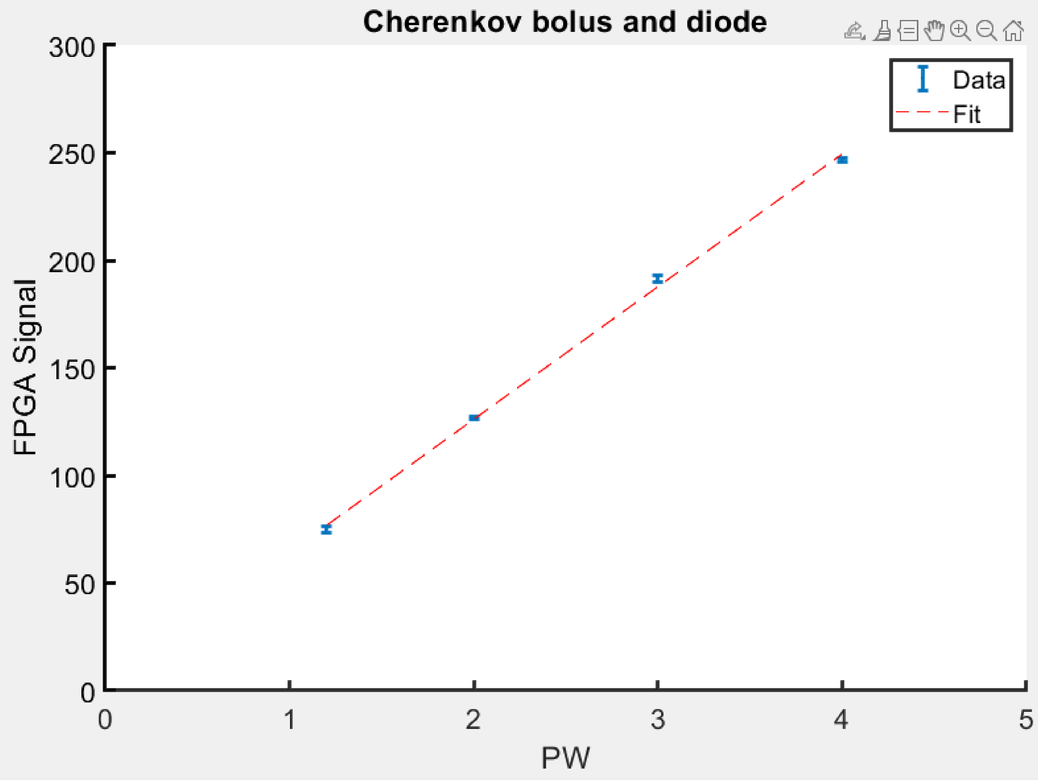
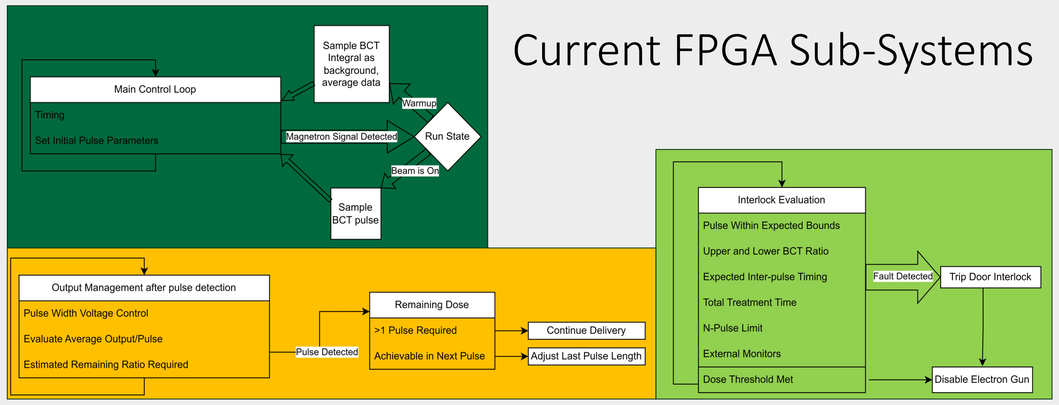
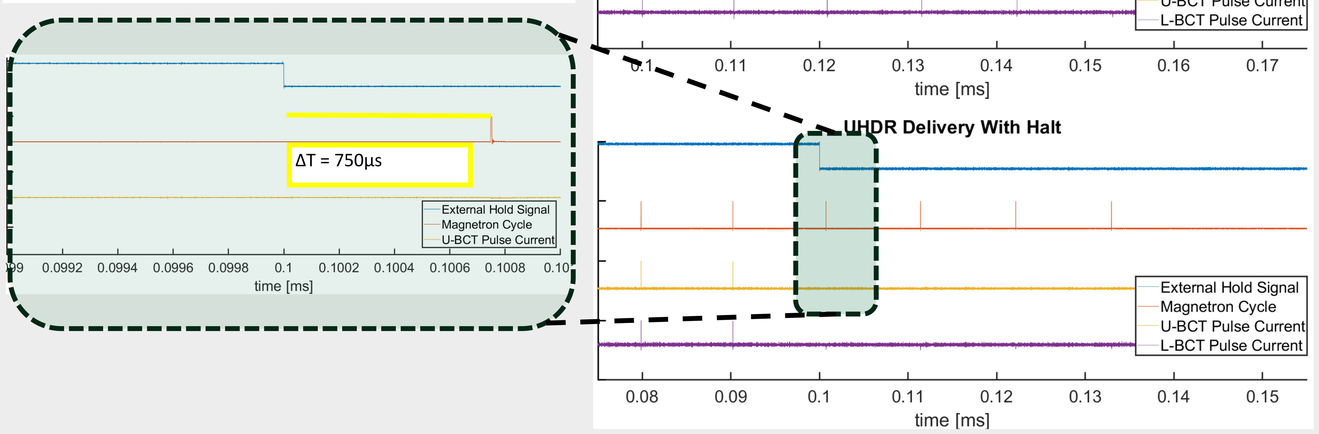


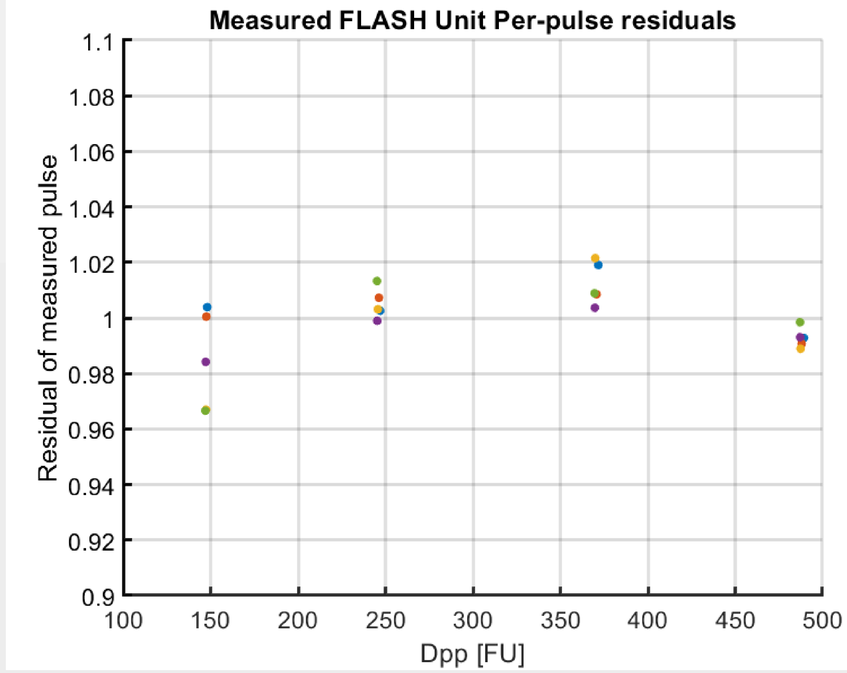
The monitoring system integrates dosimetry signals and evaluates if additional pulses are required. Adjustment of pulse-length on a per-pulse basis to converge on a target dose and fault handling if per-pulse data differs from expected values by a set threshold are under development, but at present there is sufficient time to react to fault situations and halt a delivery.



Interlock signals evaluated / presented at least 750 µs before an imminent pulse can prevent additional dose output



Since Traditional MU chambers saturate under UHDR conditions, alternative dosimetry devices must be developed to meet regulatory demands for eventual human electron FLASH trials. Real-time, per-pulse dosimetry was achieved by measuring scintillation signals on a gated integrator by processing timing and measurements on a cRIO FPGA. Per-pulse residuals were <4%, which is sufficient to meet the regulation demands for integral output.



CONCLUSIONS

This UHDR beam control platform provides the essential monitoring and output gating systems that are traditionally disabled for UHDR operation. Such systems may be sufficient to ensure safe and accurate delivery of doses to experimental sites, with plans towards implementation in a human trial for safety and feasibility of electron UHDR treatments on human subjects.

Acknowledgements

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