Proton beam radiotherapy is a cancer treatment that uses proton beams to irradiate a tumor. A Compton camera that tracks prompt gamma rays emitted along the beam’s path through the patient has the potential to verify treatment delivery in real time, provided it works at clinically relevant high dose rates. We demonstrate that machine learning cleans noisy raw data rapidly and can give more accurate images across all dose rates.

**Contrast-to-Noise Ratio (CNR)**

\[
\text{CNR} = \frac{\mu_{\text{BP Region}} - \mu_{\text{noise}}}{\sigma_{\text{noise}}}
\]

quantifies the improvement in the reconstructed image.

- Body of the beam is the noise free zone.
- A region after the beam is the noisy zone.

**Uncleaned**

- 20kMU/min: CNR: 33
- 100kMU/min: CNR: 30
- 180kMU/min: CNR: 10

**Cleaned**

- 20kMU/min: CNR: 41
- 100kMU/min: CNR: 30
- 180kMU/min: CNR: 22

- Larger CNR is better than smaller CNR.
- All dose rates show CNR improvement after cleaning by the neural network.

**UMBC HPCF**

Interdisciplinary core facility for scientific computing at UMBC:

- taki: CPU cluster with over 100 nodes, 19 GPU nodes, 8 Big Data nodes
- ada GPU cluster: 13 nodes with over 100 GPUs in total
- Tensorflow 2.4.0 and Keras leverage four NVLink-connected NVIDIA Tesla V100 GPUs with 16 GB onboard memory each.

**Team-Based Online Learning**

Synergy in pedagogy and technology from regular classes to research programs:

- All activities are team-based as preparation for the real world.
- Online delivery opens participation to students with special needs and from across the nation.
- UMBC provided tools include Webex, Blackboard, Panopto, and more.
- Students gain demonstrated experience in modern professional skills!