**PURPOSE**

Phase II SBIR project in progress:
- Construct a fully functional prototype of a clinical proton radiography system
- 40 x 40 cm^2 field size
- Mounted on a C-arm to accommodate a wide variety of patient and beam orientations
- CPU-GPU workstation for prompt (< 60 seconds) delivery of a reconstructed image
- Perform a series of tests culminating in the production of images of phantoms.

**METHODS**

Principle of Proton Imaging (CT or radiography):
- Tracking detectors measure the position of protons before and after the patient.
- A residual range detector measures the proton energy absorbed within the patient.
- With one direction:  Form image showing proton range across the field.
- With all directions:  3D image from tomography.

Proton Imaging before treatment:
- Use protons with enough energy to traverse patient.
- Use ultra-low intensity beam:
  - Lower dose than equivalent x-ray image.
- Subsequent treatment beam uses:
  - Lower energy, protons stop in tumor
  - Higher intensity, delivers prescribed dose

**RESULTS**

Scanning pencil beams at Northwestern Medicine (Thanks to Nick Detrich for operational setup):
- Pencil beam scan pattern provides uniform coverage over 20 x 20 cm^2 in 0.3 sec
- Scanning pencil beam at ultra-low intensity

**CONCLUSIONS**

From joint DOE-NCI workshop on ion beam therapy:
"A better method of determining the stopping power, be it through proton CT or other means, would greatly increase the accuracy of the treatment, particularly when 1 mm range precision is desired. This is an important area for further R&D."

Construction of a fully functional prototype is in progress

Beam tests of prototype components combined with simulations:
- Sharp images directly showing WET
- Compared to X-rays:
  - Less interference from bone
  - Greater sensitivity to soft tissue structures such as carina
  - No artifacts from metallic objects
- Lower dose for equivalent images
- Benchmarking tests of image reconstruction software on CPU-GPU computers:
  - < 60 seconds for image from ~10^7 protons