

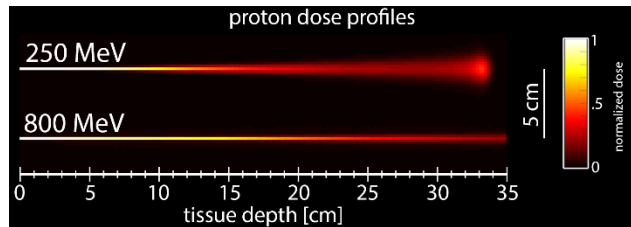
Instantaneous Full-Field Proton Radiography for Image Guidance

Matthew S. Freeman, Ph.D., Los Alamos National Laboratory

Tuesday, July 31, 2018, 11:00 - 11:00 AM, Imaging for Particle Therapy Session, TU-D-KDBRB1-1, Karl Dean Ballroom B1

goals for proton radiography:

- provide **water equivalent thickness** (WET) for treatment planning
- provide high resolution, real-time **anatomical alignment**



a flash of 800-MeV protons provides **200- μm** resolution, due to low scatter

scatter induced by the object:

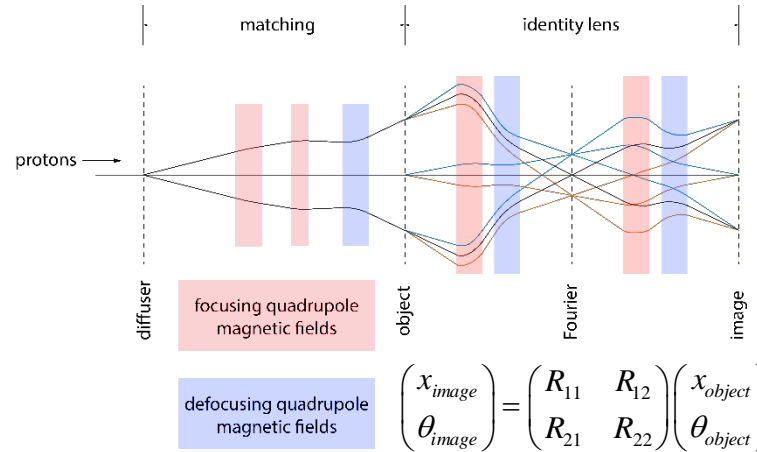
$$\theta_o = \frac{13.6 \text{ MeV}}{\beta p} \sqrt{\frac{x}{X_0}} \left[1 + 0.038 \ln \left(\frac{x}{X_0} \right) \right]$$

directly translates to transmission:

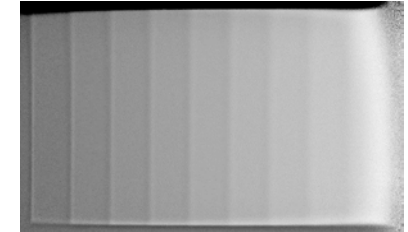
$$T = e^{-x/\lambda_c} \left(1 - e^{-\theta_o^2/2\theta_c^2} \right)$$

as defined by system acceptance angle, θ_c

protons are focused by a **magnetic lens**:



Al stepwedge (3-mm steps)

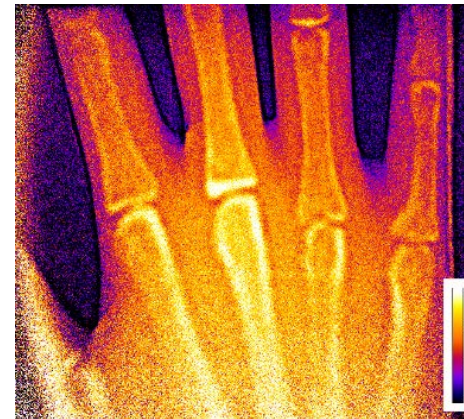


transmission proton radiography provides information about **areal density** and thus **water equivalence**

transmission proton radiograph



→ WET



magnetic focused proton radiography provides:

- **instantaneous, full-field, beam's-eye-view** imaging
 - **water equivalence**
- for the purposes of:
- **anatomical alignment**
 - **treatment planning**
 - **adaptive proton therapy?**