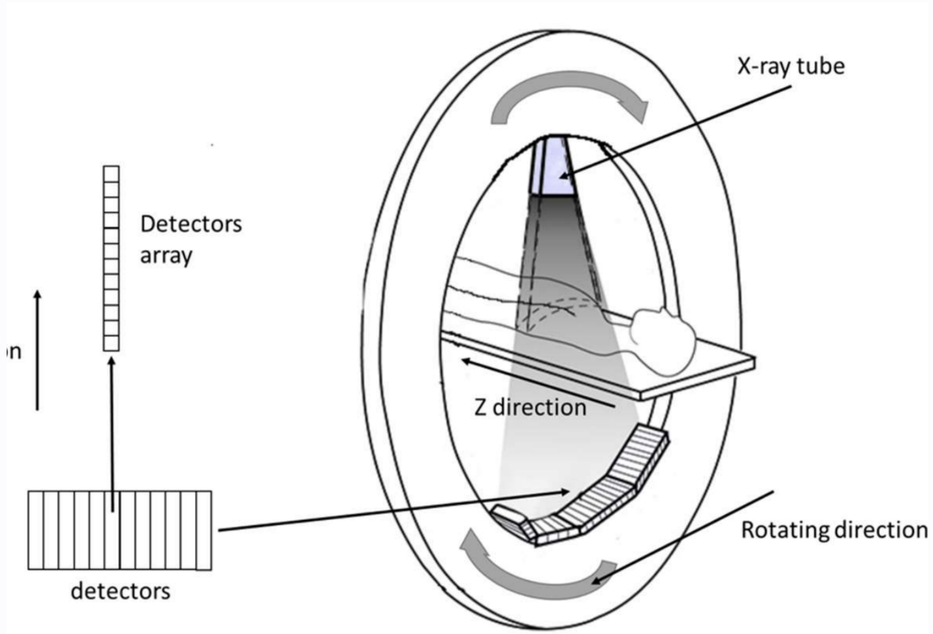
Tofprad: *Time Of Flight Proton RADiography with plastic scintillators*

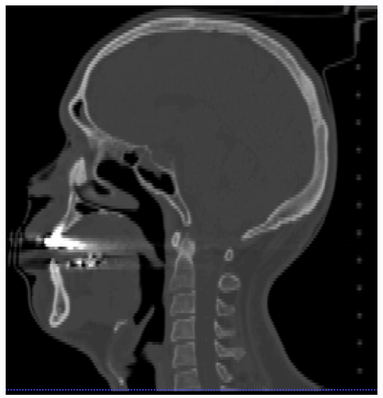
Giacomo Traini

Rationale of proton-CT



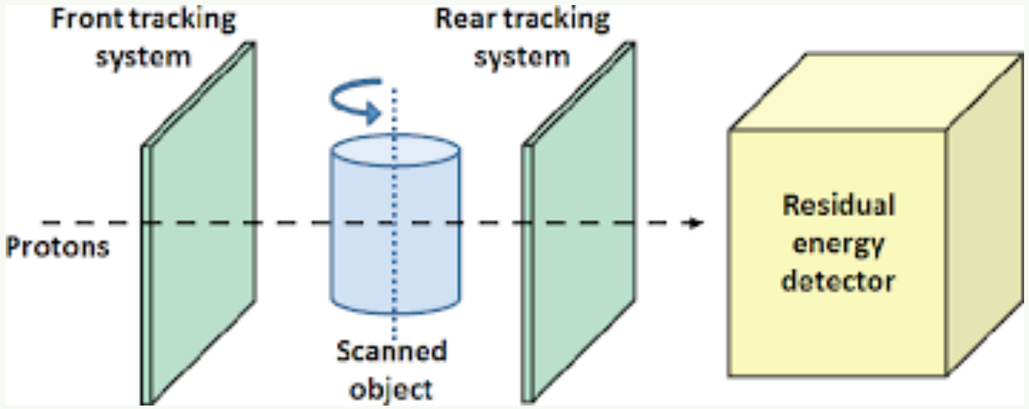
$$I = I_0 e^{-\int \mu(z)dz}$$

reconstruction



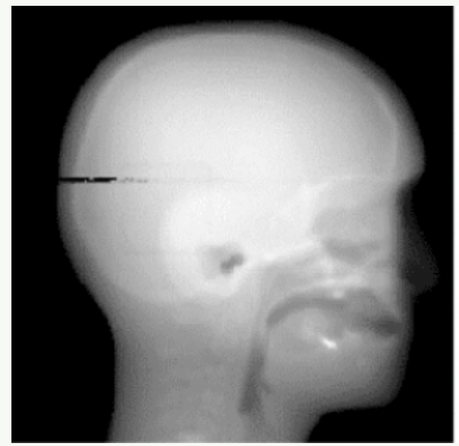
Measurement of photons attenuation

μ(x,y,z) <-> HU



$$\Delta E = \int \frac{dE}{dz}(z,\rho)dz$$

reconstruction

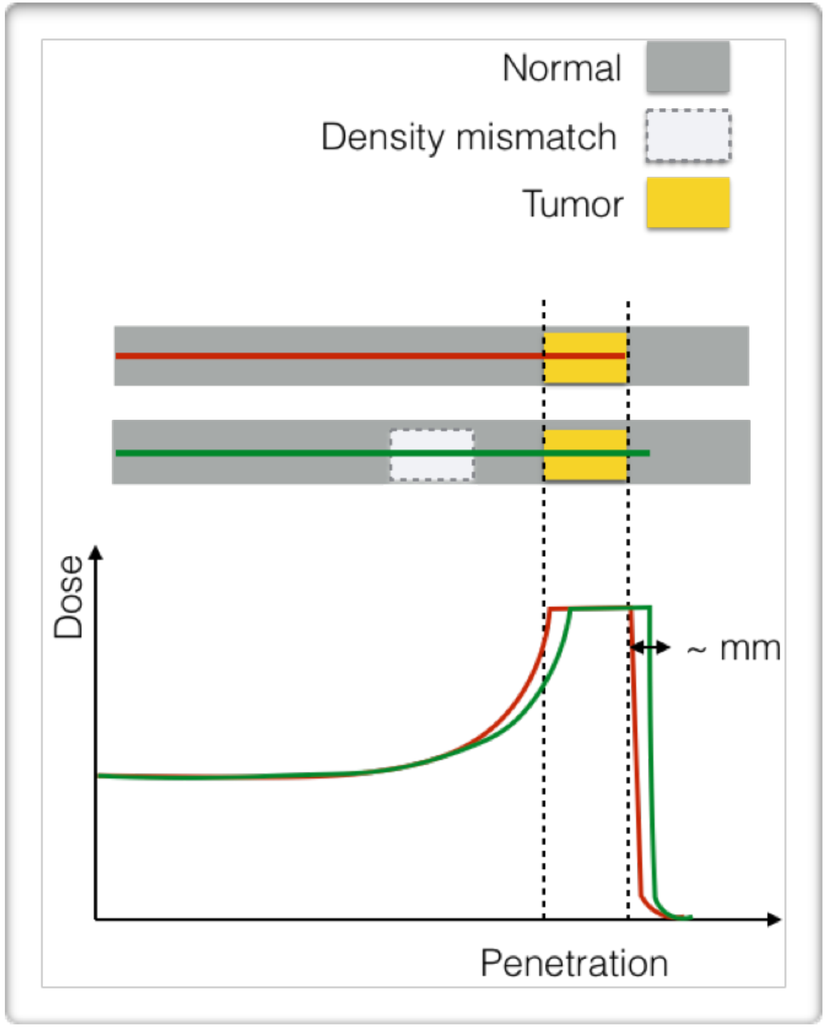


Measurement of proton beam energy loss

RSP(x,y,z)

Motivation: range uncertainties reduction in PT

- **HU -> de/dx conversion errors**. At present, tabulated values in literature are used (Schneider,Parodi 2005)
- Daily variation in the patient setup and morphological variations
- A common practice has been to add an additional margin of **3.5% plus 1 mm** to the nominal range of a proton beam

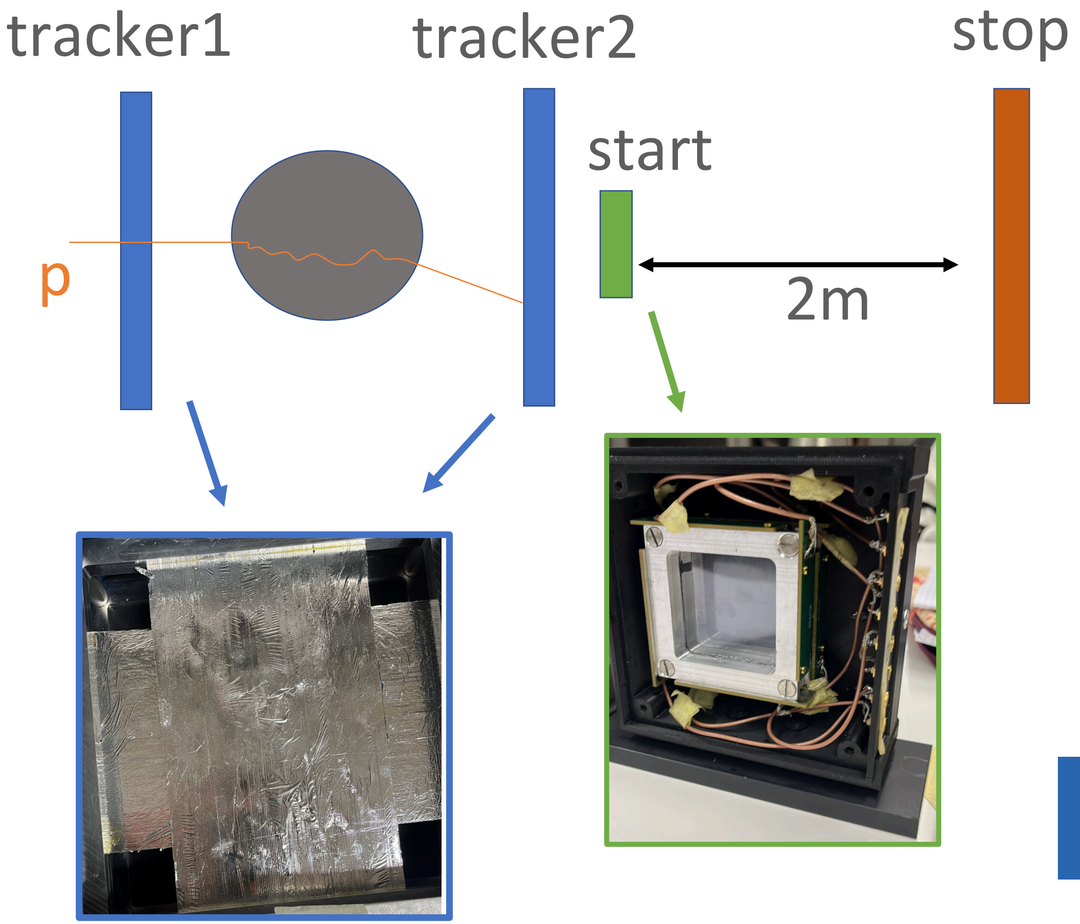


pCT goal:

- **reduce the uncertainty margins** in proton therapy because **uncertainties in the conversion of x-ray CT HU to proton RSP** are avoided
- **detecting changes in anatomy** and RSP distribution before treatment on a weekly or even daily basis for adaptive proton therapy

The Tofprad project

Goal: proton-radiography with time of flight detection exploiting plastic scintillator



- Ekin measured from ToF
- Time resolution < 50ps/m
- Ideal rate capability ~MHz (beam intensity to 10^{10} Hz)

scintillating fibers

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Expected performance

- Faster than standard calorimeter
- Easy and cheap tracking device

First test beam @ CNAO

Krah et al, 10.1088/1361-6560/ac7191