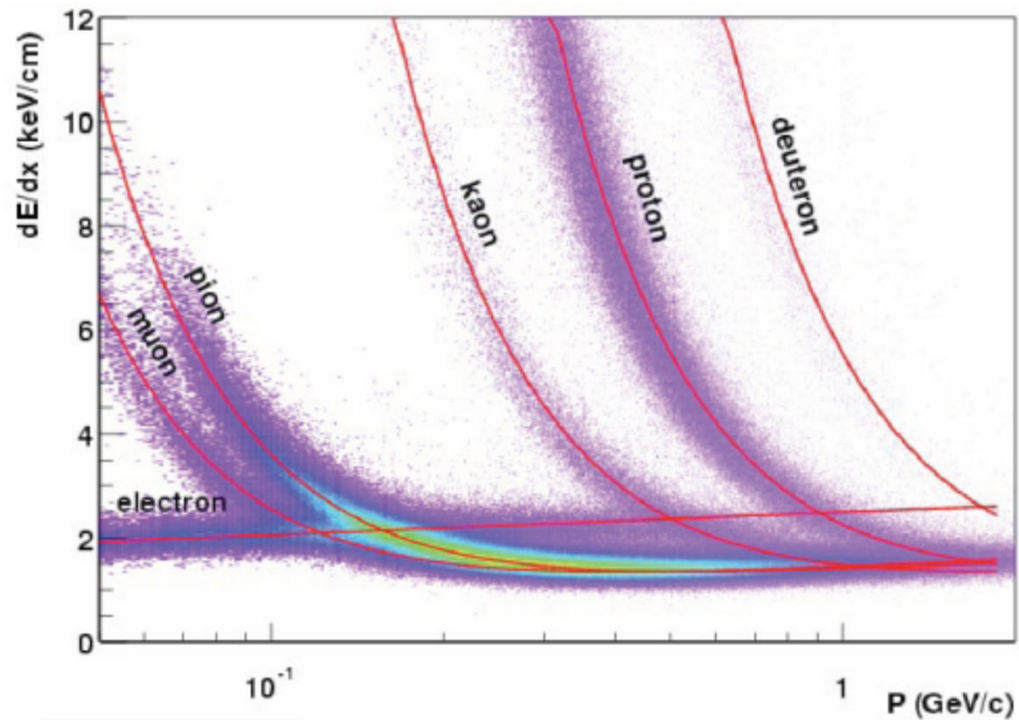
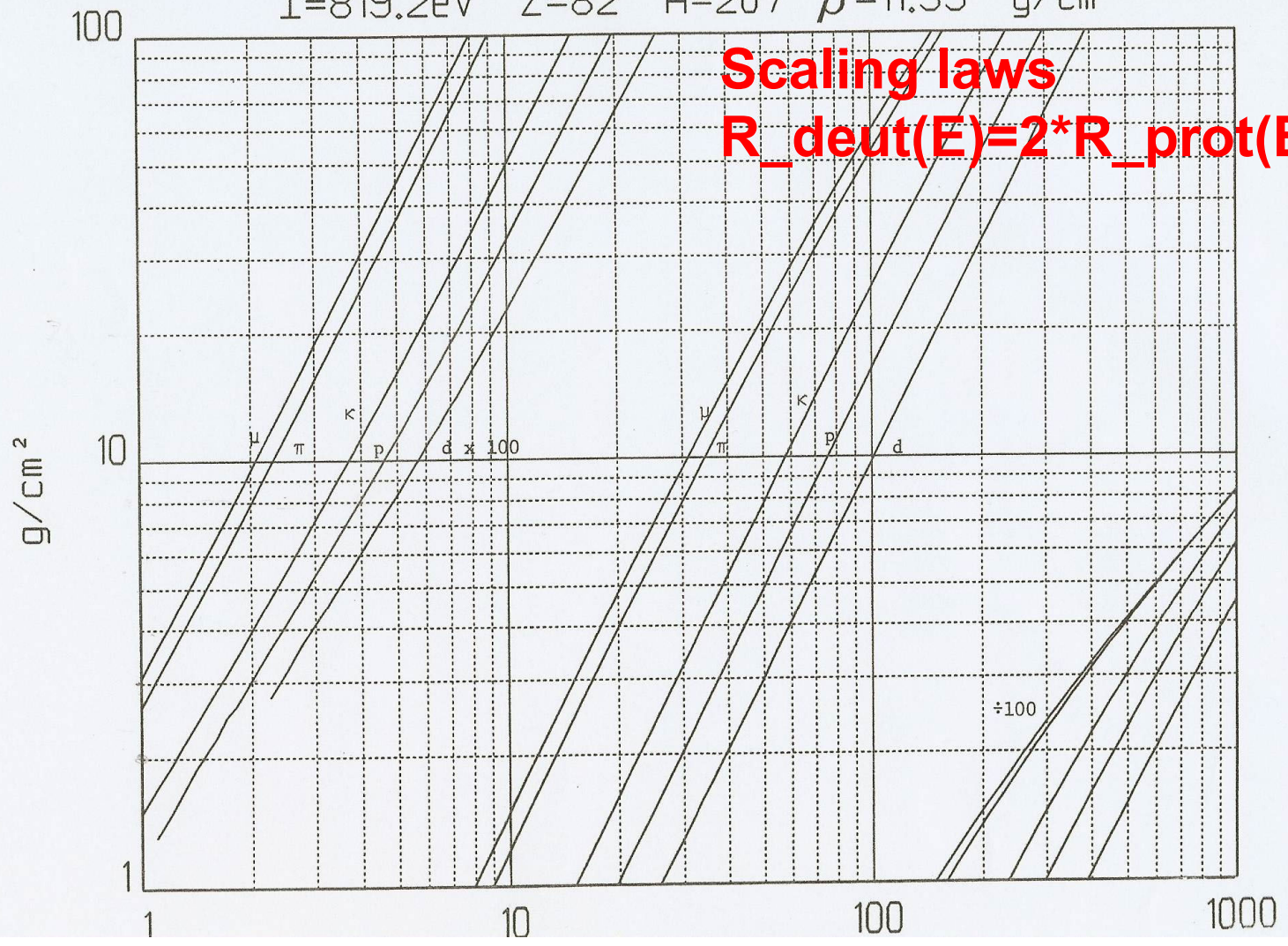


ELECTRON ENERGY LOSS

- STAR Time-Projection Chamber (TPC):
10% Methan / 90% Argon (2mbar above atm. pressure)



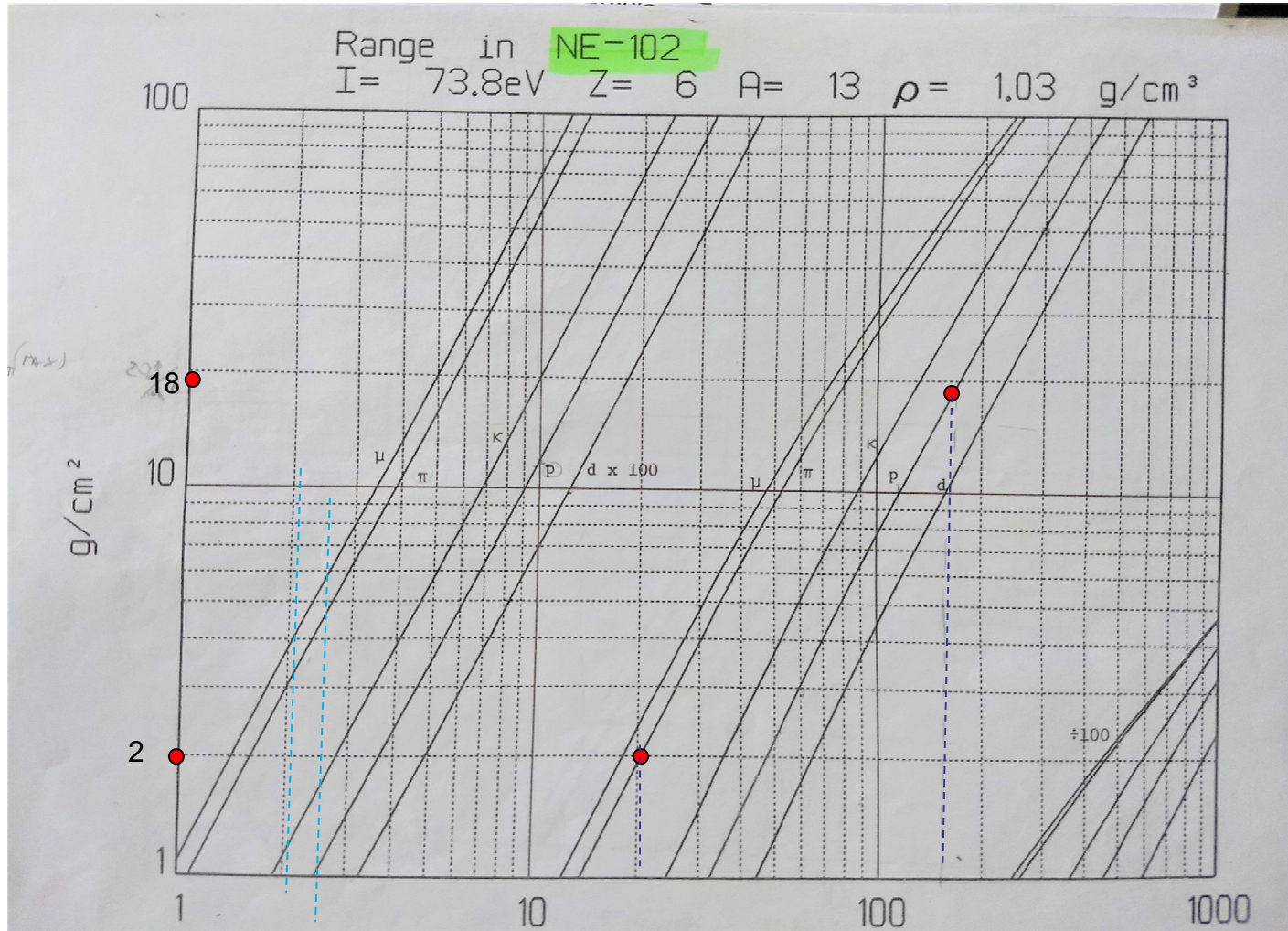
Range in Lead (Pb)
I=819.2eV Z=82 A=207 $\rho=11.35 \text{ g/cm}^3$



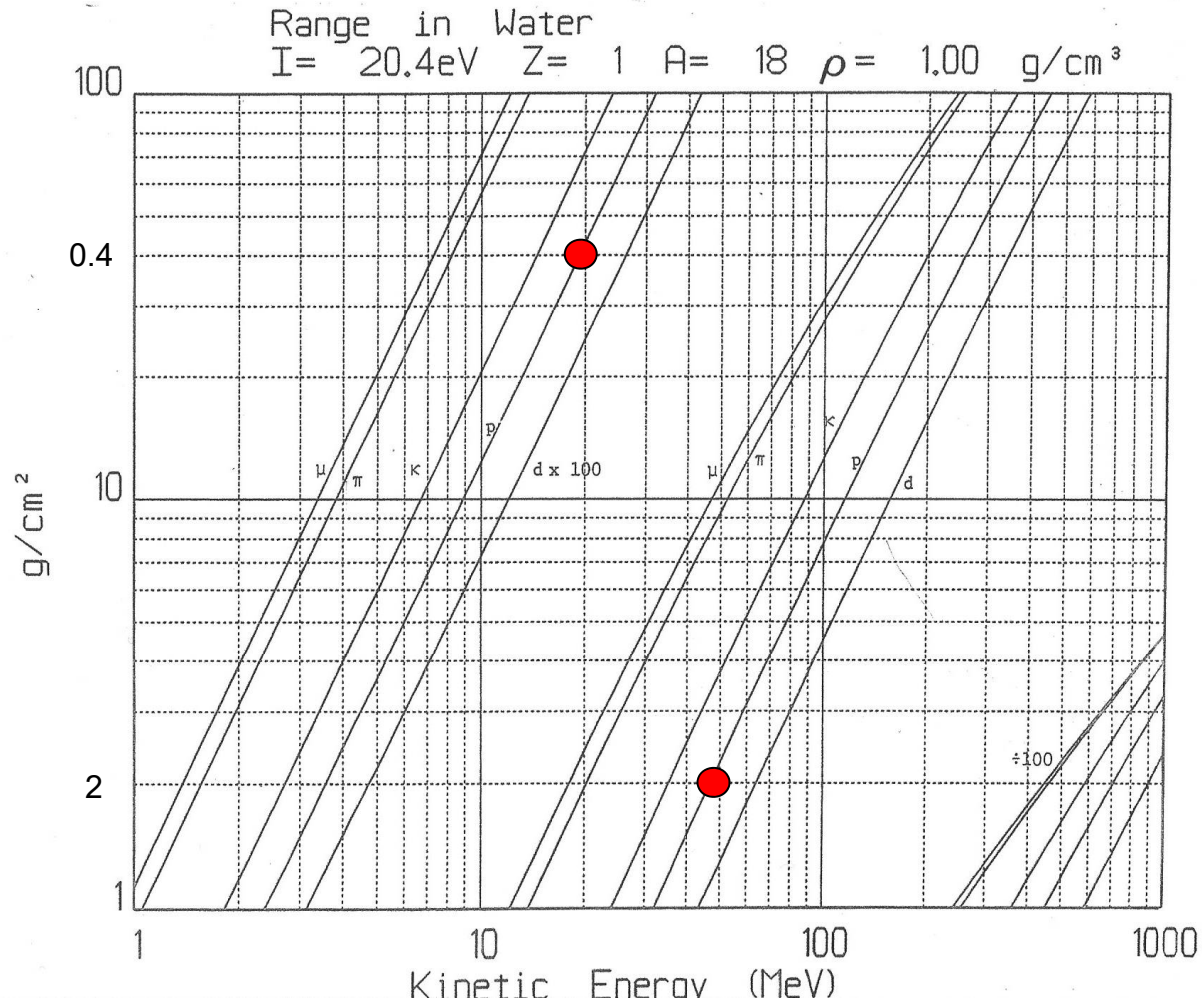
Scaling laws
 $R_{\text{deut}}(E) = 2 * R_{\text{prot}}(E/2)$

Mass discrimination also possible by making RANGE measurements

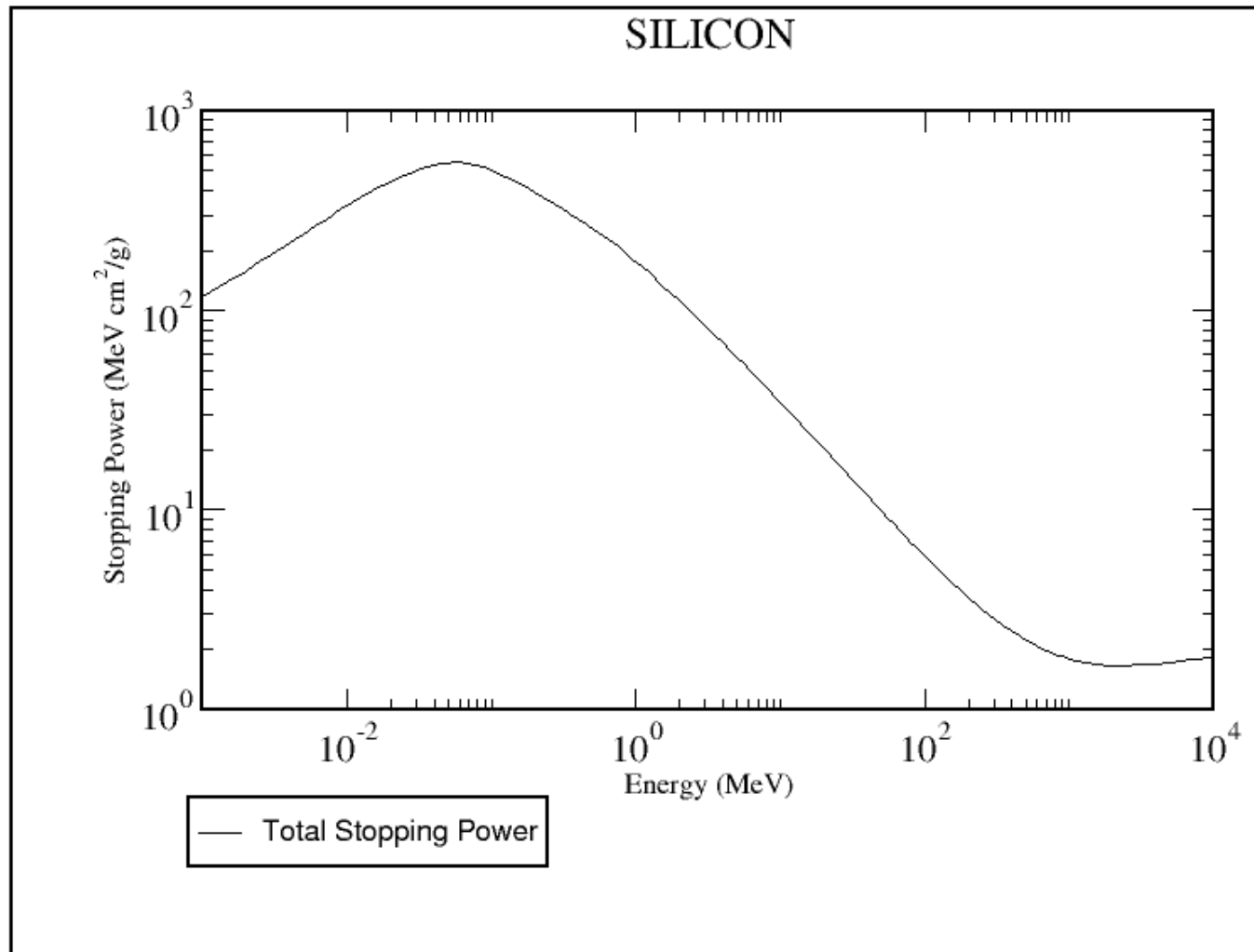
See exercise n. 7 on range discrimination



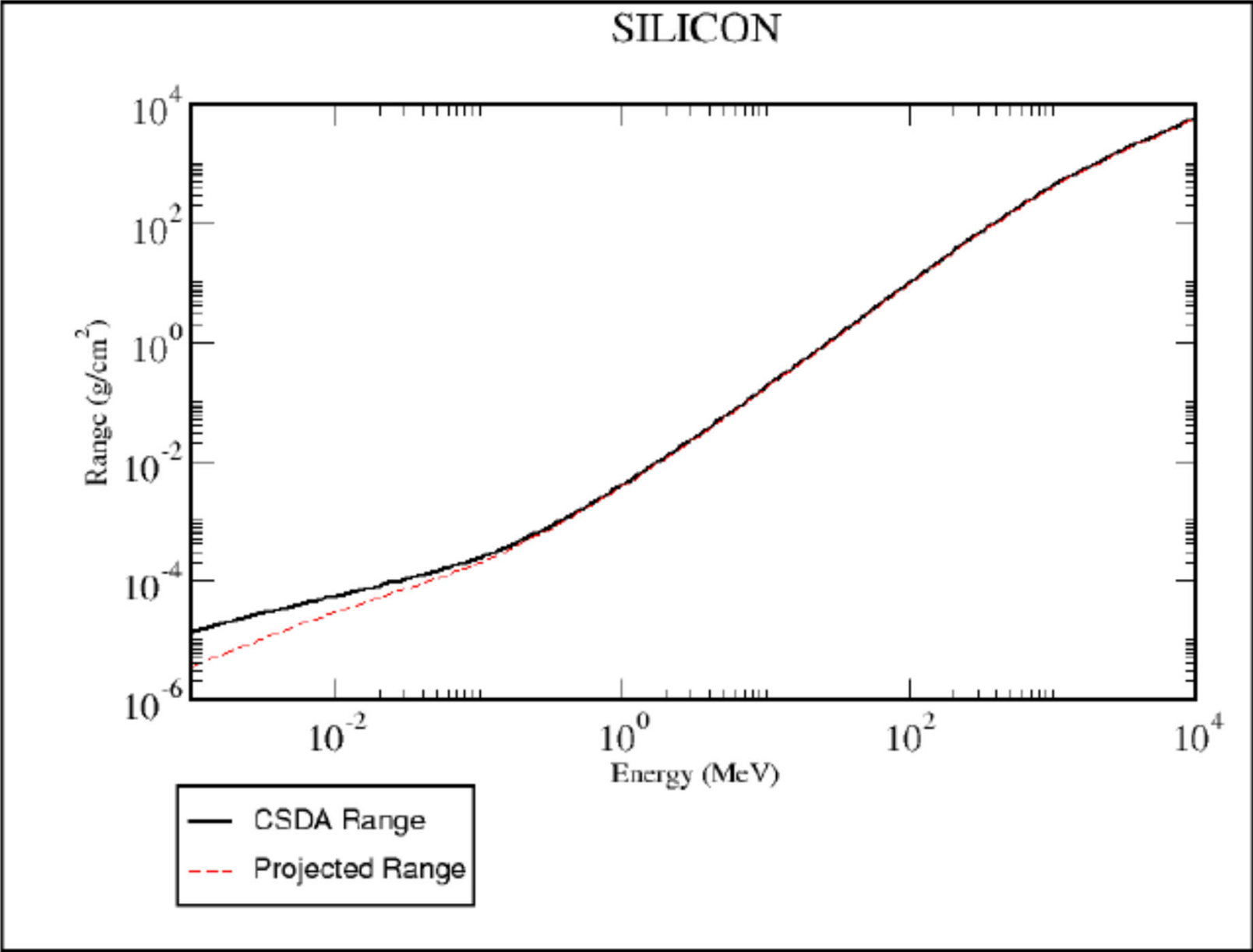
Mass discrimination also possible by making RANGE measurements



Stopping power for protons in silicon

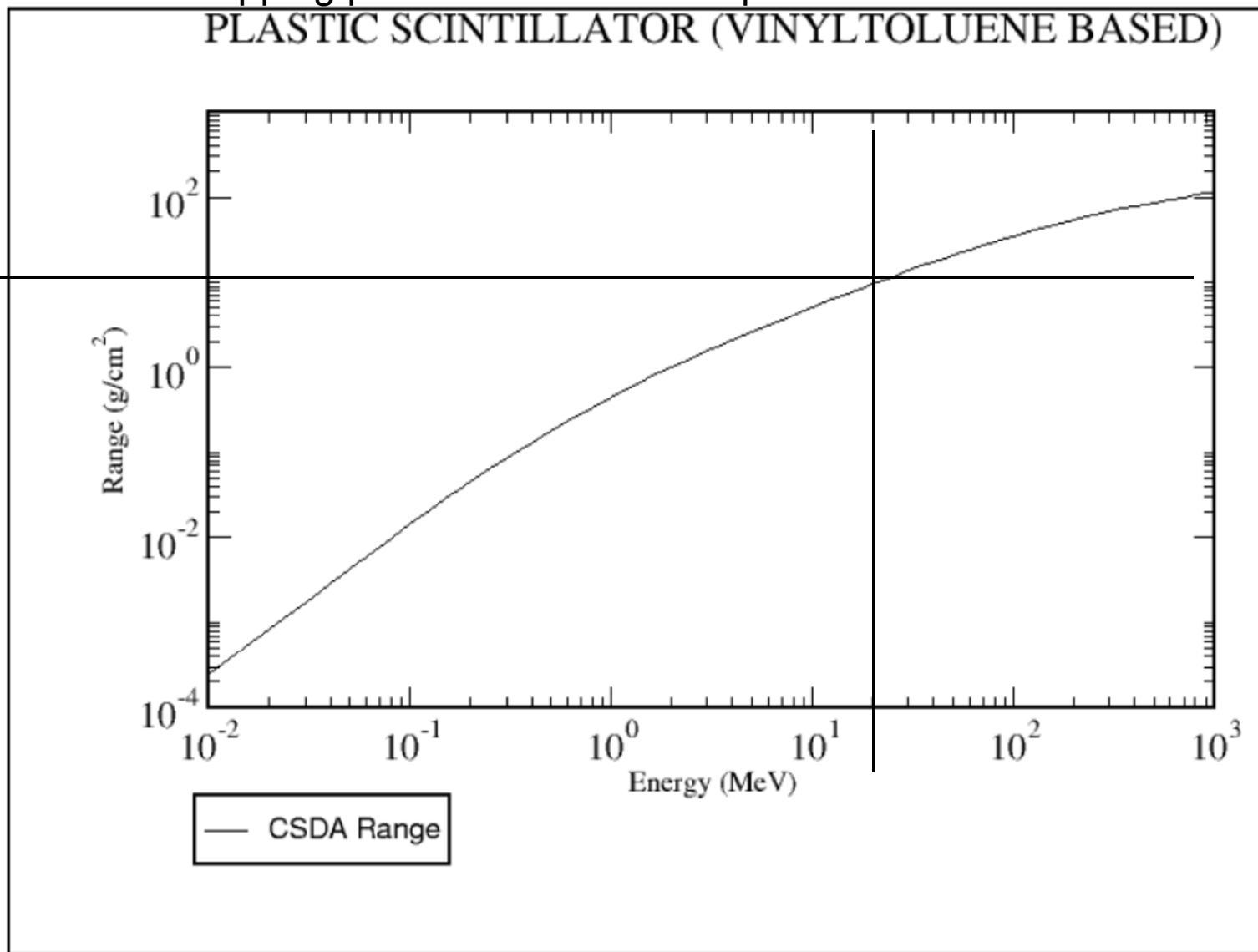


Range for protons in silicon



Stopping power for electrons in pl. scint

PLASTIC SCINTILLATOR (VINYL TOLUENE BASED)



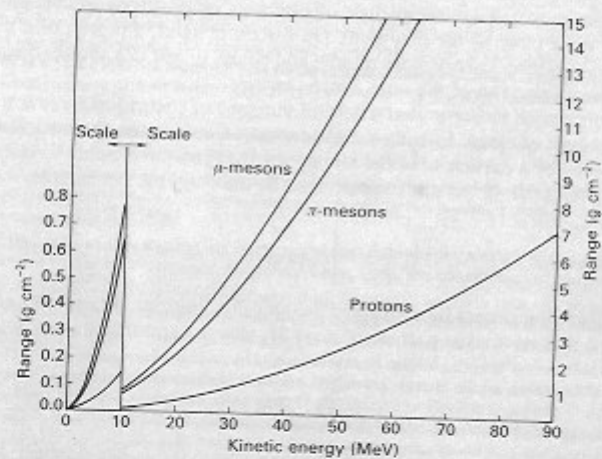


Fig. 11.3 The range-kinetic energy curves for protons, π -mesons and μ -mesons in carbon. Equation (11.1) tells us that at low energies the rate of energy loss is varying inversely as the velocity squared and therefore every increment in incident energy requires a disproportionate increase in range to remove that increase in energy; thus for all particles the range increases faster than linearly with the incident kinetic energy. In addition, Figure 11.2 shows that for the same kinetic energy lighter particles suffer less energy loss and therefore have greater ranges. Thus the features of this figure can be predicted from the properties of the stopping power.

the two particles. Light electrons of a given velocity have low momentum and are easily scattered or badly suffer the effect of multiple scattering, both of which cause an increasing deviation from a straight track, and that means that the track length has a projection on the original electron direction which is shorter or much shorter than the track length (see Fig. 11.5). For α -particles of the same velocity, the momentum is much greater and the track suffers much less deviation and the projected track length is in most cases only slightly less

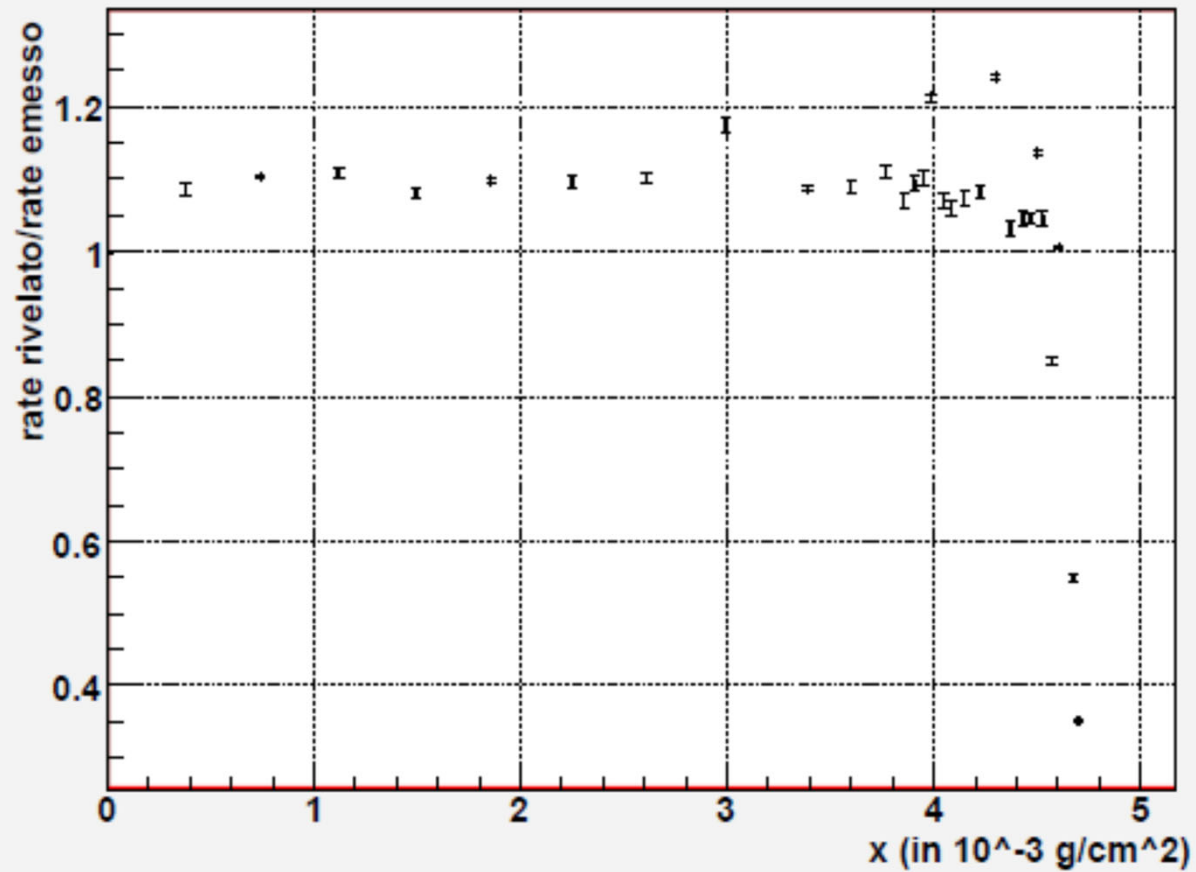
Scintillations per minute
70
60
50
40
30
20
10

Thickness:

Fig. 11.4 The trans hydrogen gas at 15°C other curves by visu from a source react scintillations per min energy the chance of the loss of energy fluctuation on the α -particles travel the until a thickness of definition of range is and the fact that the length (Fig. 11.5). If range could be cut scintillations become point where the curv Fig. 6.6 is a cloud unique range and sr

angle deviation is ap deviation, θ_0 ; it is th

CURVA DI RANGE



Curva di range sperimentale.

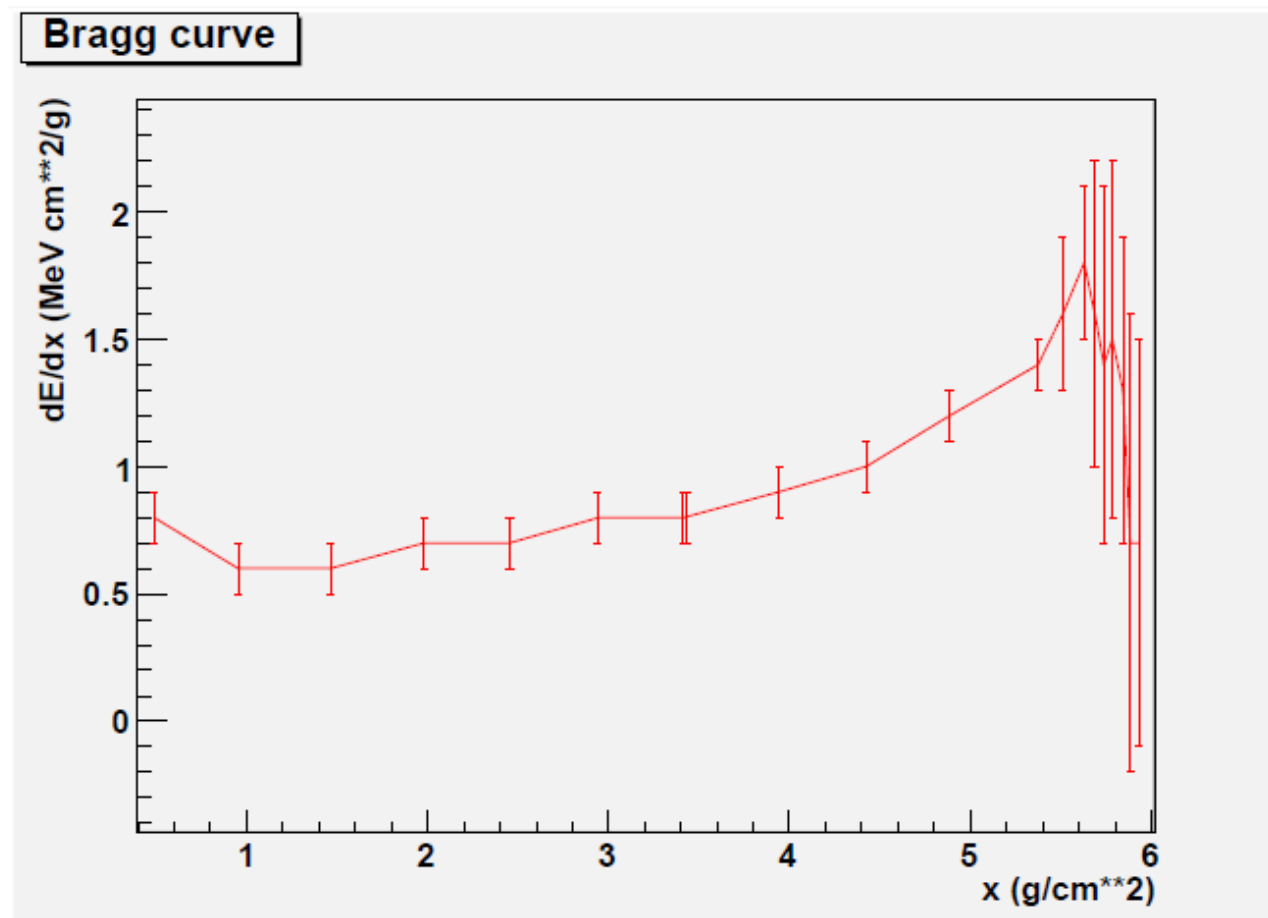
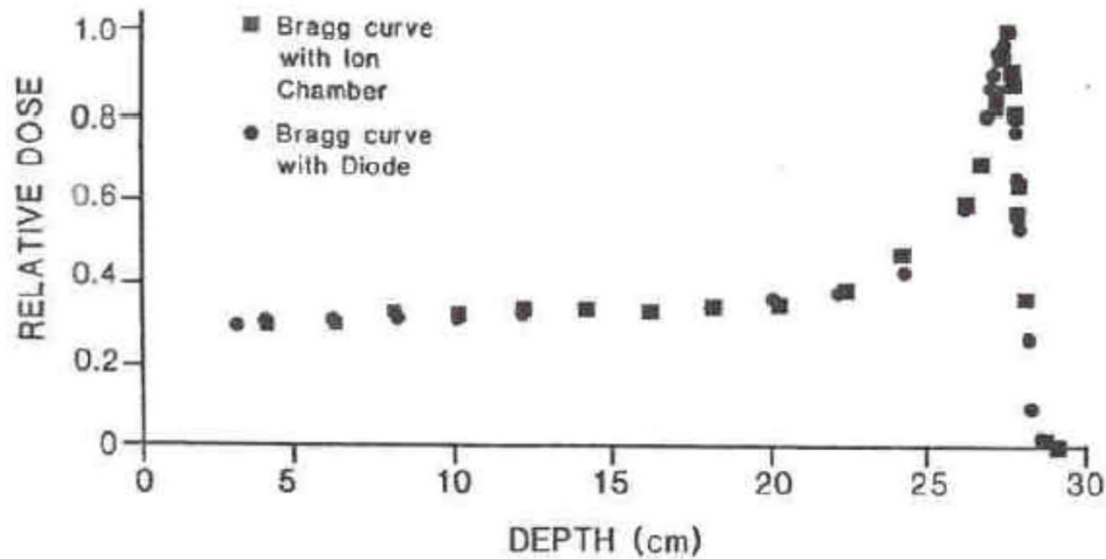


Figura 8: Grafico della curva di Bragg.

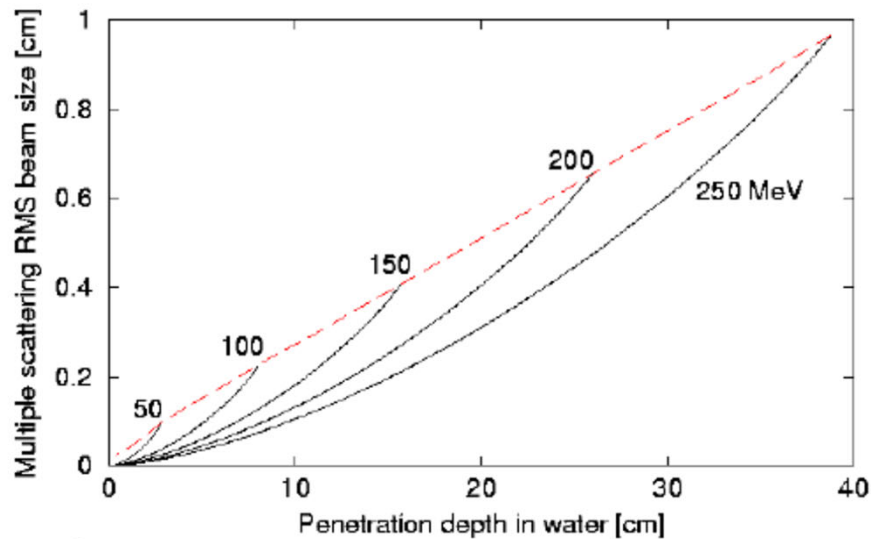
235 MeV Proton Bragg Curve

Loma Linda University Medical Center



- Suitable for 1.5 cm diameter tumor.
- Skin dose ~30% of maximum dose.

Coutrakon *et al*, Med. Phys. 1991. 18:1093-1099.

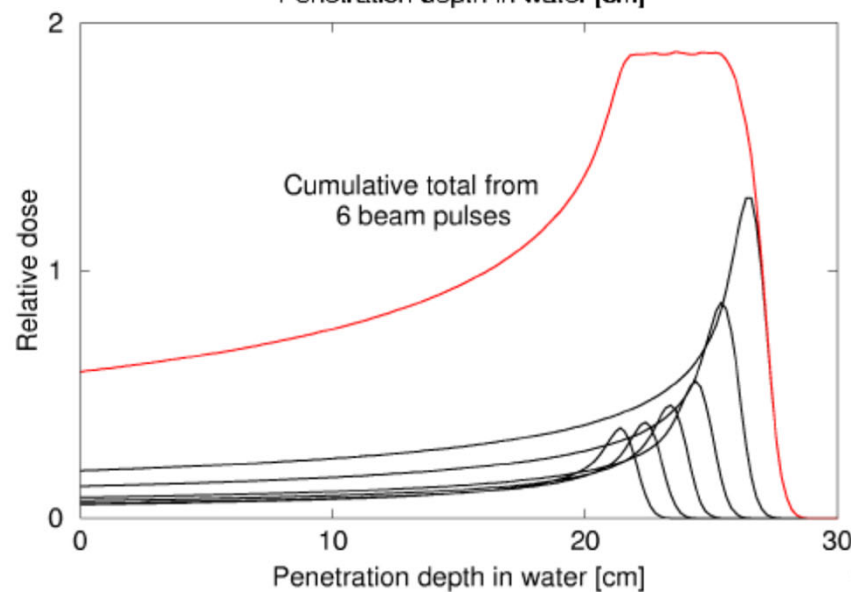


A perfect
monochromatic
proton beam, with
zero initial emittance:

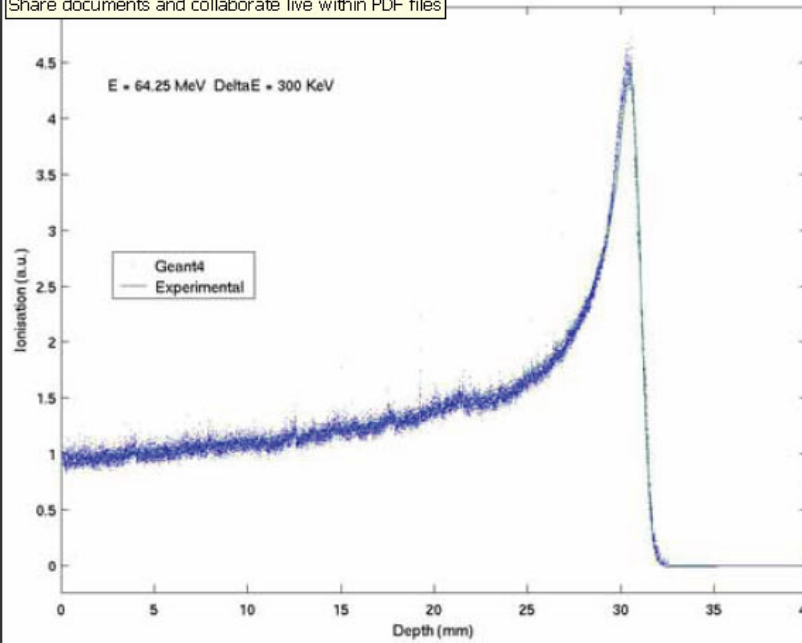
TOP spreads out
transversely

BOTTOM acquires
an energy spread that
blurs the Bragg peak

Steer the beam and
modulate its energy
to “paint” the tumor!



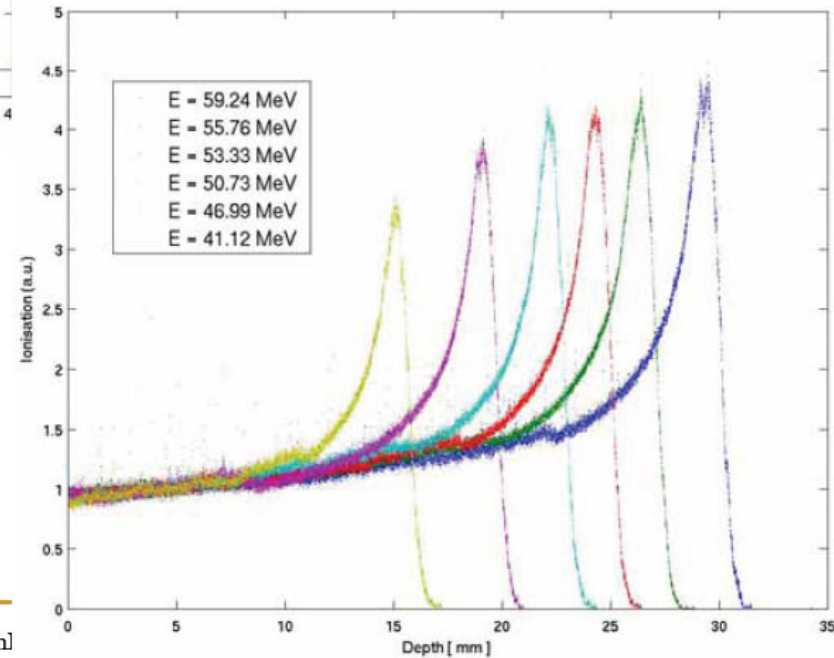
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Physic models: comparison vs experimental data

Low energy libraries and hadronic physics

Bragg peaks at different energies



giovedì 24 maggio 2007

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