Transverse profiles exercise

The SEM grid described in table 2 is used to measure the horizontal profile of the beam described in table 1.

1. Assuming that the readout electronics has a bandwidth of 1MHz, calculate the signal of the central wire and of a wire placed at 3 mm from the center of the beam (the wire can be assumed as square for the calculation of the SEM emission).
2. If the grid and the readout electronics have a very broad bandwidth (>> RF), what are the differences in the signal structure and amplitude?
3. Calculate the maximum temperature in the central wire assuming that the repetition rate is so small that the initial conditions are restored between pulses.
4. An operator decides to verify that the transverse profiles do not depend on the pulse length and starts increasing the pulse durations. With pulse lengths over 25 μs he starts obtaining much smaller beam sizes with very high signals, going back to shorter pulses the beam sizes return normal, and at around 45 μs some channels become dead and do not come back by reducing the pulse duration. Explain what is happening.

Table 1: Beam parameters

Particle	Protons
Energy	3 MeV
Current	40 mA (average)
Pulse length	10 μs
Width (σ_x, σ_y)	1.5 mm
Bunch length (σ_s)	100 ps
RF	352 MHz

Table 2: Grid parameters

Number of wires	24
Material	Titanium
Diameter	40 μm
Spacing	0.75 mm
Amplifier input load	50 Ω
Amplifier gain	100

Table 3: Properties of titanium

Density	4.5 g/cm^3
Specific heat	540 J / (Kg K)
Melting point	1933 K

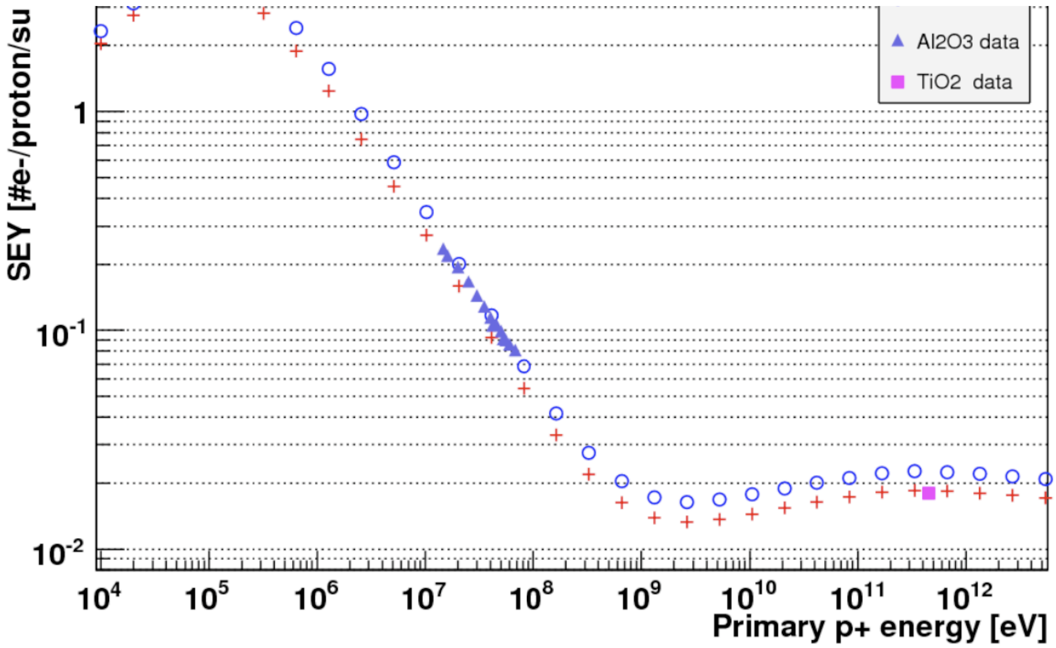

Figure 1: Secondary emission yield for protons in aluminum oxide and titanium oxide

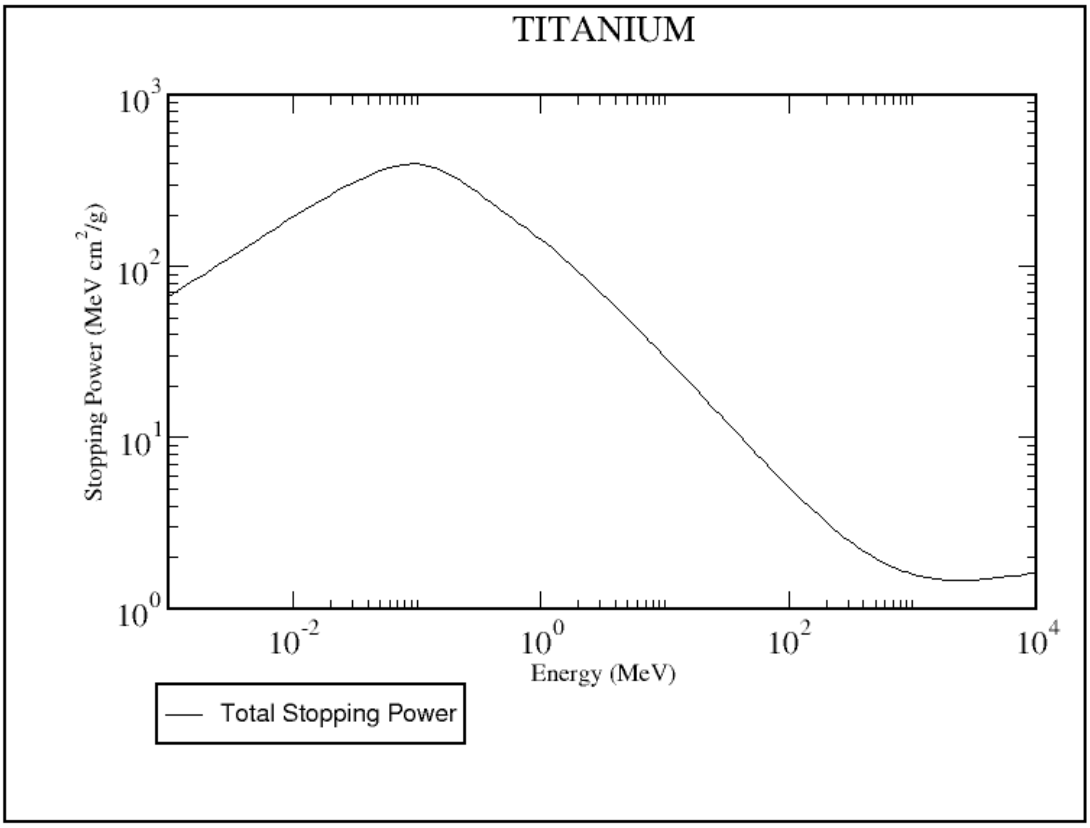

Figure 2: dE/dx for protons in titanium