How far does a particle travel at a particular energy?

Case 1: After the ion source i.e. at 60 keV

To calculate the distance travelled we need to know the velocity and time.

Time is the easier one so:

One RF period takes $\frac{1}{324x10^6} = 3.09x10^{-9}\ seconds$

Calculating the **velocity** of a particle at 60keV:

Kinetic energy = ½ mv^2

Therefore, $v = \sqrt{2 \times (K.E.)}$

$$\text{K.E.} = \frac{\text{Beam energy x (1 x electron charge)}}{Mass\ of\ particle}$$

Where, mass of particle = mass of proton + mass of 2 electrons

(we can ignore electron mass because it is 1/2000th of proton mass)

So,

Beam energy = 60 x 10^3 eV

Electron charge = 1.602 x 10^{-19} Coulomb

Mass of particle = 1.67 x 10^{-27} kg

Therefore, $v = \sqrt{\frac{2\times(60\times10^3)\times(1.602\times10^{-19})}{1.67\times10^{-27}}}$

$v = 3.39 \times 10^6\ m/s$ (or 7 million miles per hour) (for comparison c = 300 x 10^6 m/s)

Distance = velocity x time

= (3.39 x 10^6) x (3.09 x 10^{-9})

= 0.0105m

Answer: The distance travelled in one RF period by a H- particle at 60keV is **10.5mm**

Case 2: After the RFQ i.e. at 3 MeV

Particle velocity = 24 x 10^6 m/s

Distance travelled during 3.09 x 10^{-9} seconds at 3 MeV = 0.074m or **74mm**

Refer to P.84, log book June 2010 to June 2011