Optimal high voltages for the Neolith-s gas counter (V2)

Y. Satou

June 30, 2025

Abstract

From a consideration of the stopping power of protons and tritons in an Ar gas environment, optimal high voltage settings of Neolith-s are examined.

1 Proton and triton stopping powers in Ar

Figure 1 shows the proton and triton stopping powers in Ar. The two stopping powers are identical when given as a function of the incident energy in unit of (energy/nucleon). Numerical values at specific proton and triton energies are shown in Table 1.

It has been observed for Neolith-s that to double the pulse height one needs to add around 100 V more high voltages [1]. Multiplication factor F of the cathode/potential pulse height can thus be related to the high voltage variation ΔV as

$$F = 2^{-\frac{\Delta V}{100}}. \tag{1}$$

Here ΔV is practically taken as the deviation from the plateau voltage for the minimum ionizing cosmic rays. It takes negative values.

If the pulse height of the signal from the cathode pads and potential wires is proportional to the deposited charge, one can calculate the optimal voltage deviation ΔV from the reference value, by substituting the left side of Eq.(1) by the ratio of the deposited charge for the proton (or triton) at an interested energy, $Q(E)$, to that of the reference energy (i.e., at the MIP energy), $Q(\mathrm{MIP})$,

$$\frac{Q(E)}{Q(\mathrm{MIP})} = 2^{-\frac{\Delta V}{100}}. \tag{2}$$

By solving this equation one obtains

$$-\Delta V = 100 \cdot \frac{\ln\{Q(E)/Q(\mathrm{MIP})\}}{\ln 2}. \tag{3}$$

On the other hand, if the pulse height is proportional to the square root of the deposited charge, then we obtain the following.

$$-\Delta V = \frac{1}{2} \cdot 100 \cdot \frac{\ln\{Q(E)/Q(\mathrm{MIP})\}}{\ln 2}. \tag{4}$$

The $-\Delta V$ values estimated using the above two assumptions for the 246, 200, 100 and 20 MeV protons are summarized in Table 2.

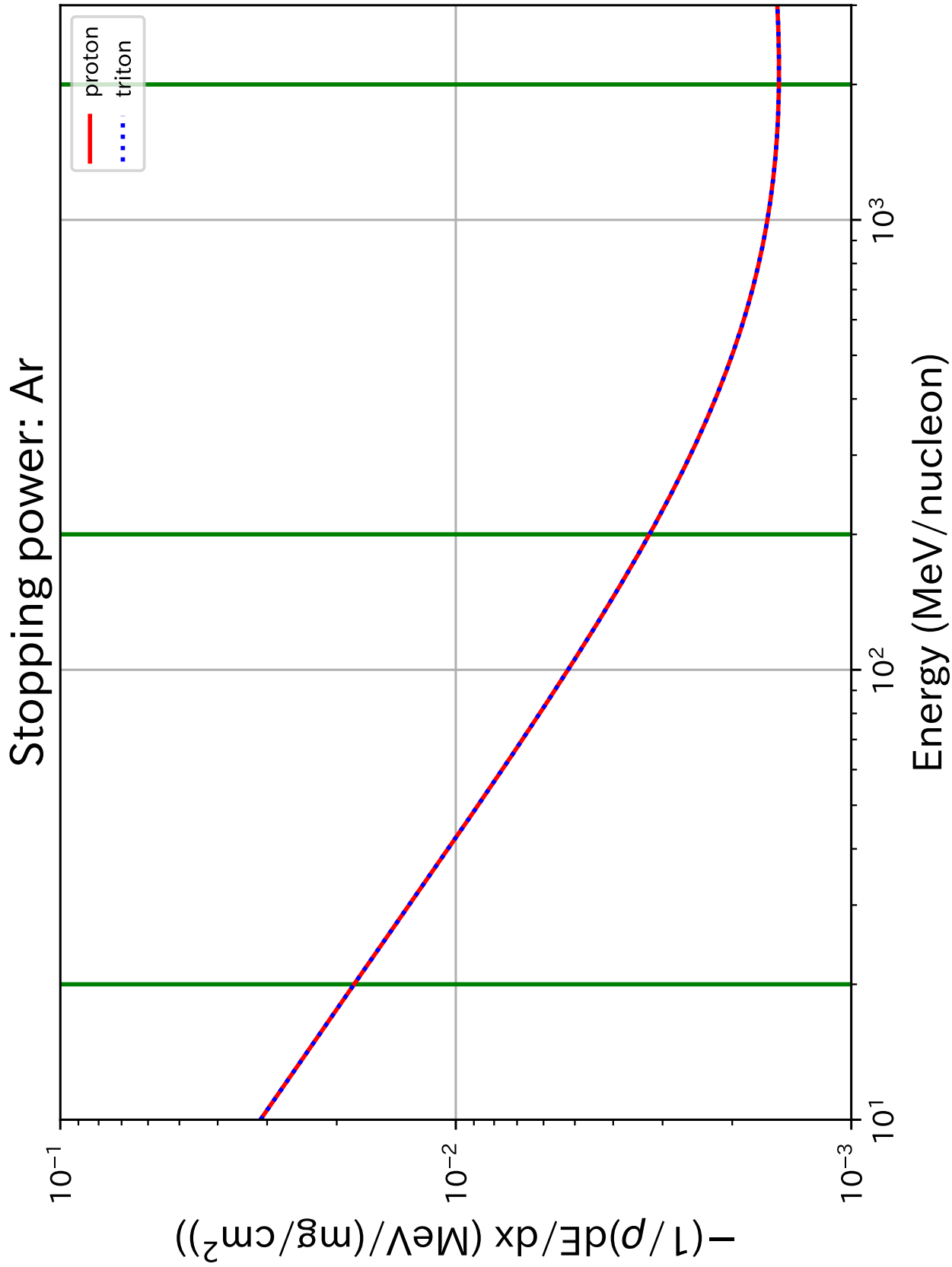

Figure 1: Stopping powers of protons and tritons in an Ar environment.

Table 1: Proton and triton stopping powers at specific energies.

Energy (MeV/u)	Q (proton) (MeV/(mg/cm^2))	Q (triton) (MeV/(mg/cm^2))
2000.0	0.001524	0.001524
246.0	0.002855	0.002855
200.0	0.003238	0.003238
100.0	0.005202	0.005202
20.0	0.018071	0.018071

Table 2: Variation in optimal high voltage from the reference value which is associated with the MIP particles.

Energy (MeV/u)	$-\Delta V$ (P.H.$\propto$Q) (V)	$-\Delta V$ (P.H.$\propto\sqrt{\text{Q}}$) (V)
246.0	91	45
200.0	109	54
100.0	177	89
20.0	357	178

References

[1] Neolith first prototype efficiency curves (Neolith-ss@ISCT).