Light output characteristics of Neolith-s scintillators

Y. Satou, Y. Makimura, S. Malladi

June 23, 2025

Abstract

Light output characteristics of Neolith-s scintillators are examined. Based on this, the coincidence detection efficiency of both of the front converter and rear catcher scintillators is deduced as a function of the incident neutron energy for an assumed threshold settings.

1 Cumulative neutron detection efficiency

The Neolith-s plastic scintillator has a thickness of 6 cm. The cumulative detection efficiency for this scintillator, for neutrons at an energy of 200 MeV is shown in Fig. 1. Calculation was done using the code CECIL [1]. In the figure, decomposition of the efficiency into the constituent channels is also given.

The calculation was repeated for different incident energies of the neutron. Energy dependence of the detection efficiency for a threshold setting of 2 MeVee is shown by the green curve in Fig. 1. The curve exhibits a decreasing trend as increasing the neutron energy.

2 Light output characteristics

Figures 3 through 10 show the light output characteristics of the Neolith-s scintillators for various assumed incident energies of the neutrons. Energy loss characteristics of the protons (emerging from the front scintillator) inside the materials consisting the tracking section of Neolith-s [2] have been taken into account. Left upper panel in each figure shows the distribution of the position where the emerging protons are lastly interactied within the front converter scintillator. Right upper panel shows the energy distribution of the protons emerging from the front scintillator (EEXT). Left bottom panel showns the light output distribution of the front converter scintillator (ELT, in unit of MeVee), while right bottom one the light output distribution of the rear catcher scintillator (ELT2). In these panels, the green histogram has the constraint of ELT$\geq$2.0 MeVee$\otimes$EEXT$>$4.0 MeV, while the orange one has the constraint of ELT$\geq$2.0 MeVee$\otimes$ELT2$\geq$2.0 MeVee.

Energy dependence of the efficiency of detecting neutrons with the former condition is shown as a blue dashed curve in Fig. 2, while that of detecting neutrons with the latter condition is shown as a red curve in Fig. 2.

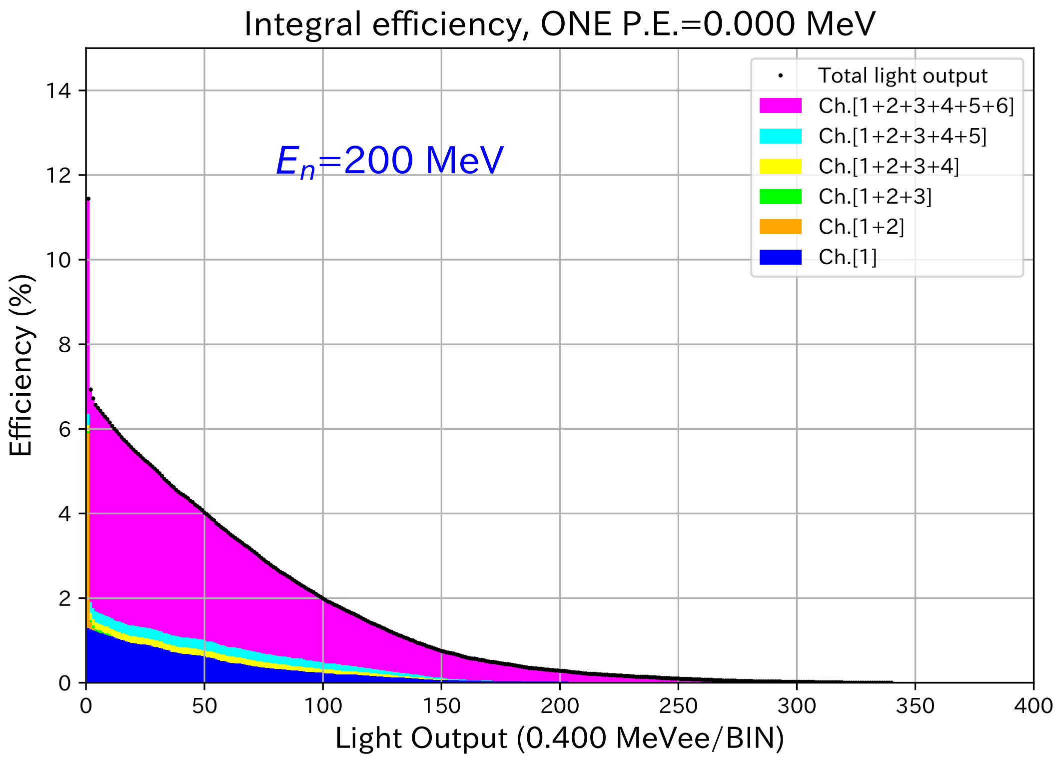

Figure 1: Cumulative neutron detection efficiency (as a function of the threshold value: light output=ELT) for the front plastic scintillator of Neolith-s. The neutron energy assumed is 200 MeV.

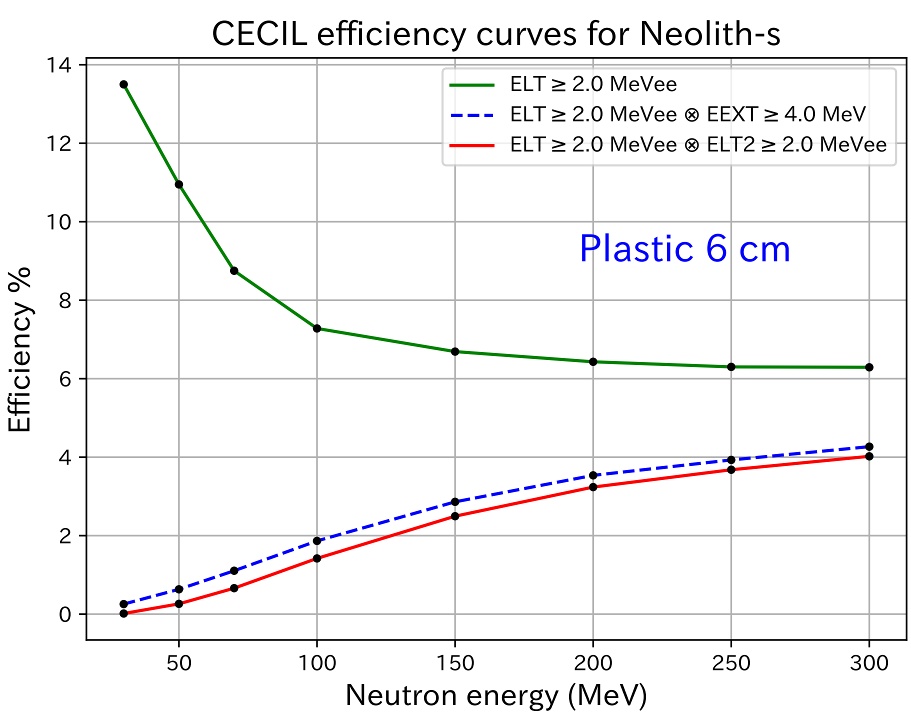

Figure 2: Energy dependence of the neutron detection efficiencies of Neolith-s as calculated by the CECIL code [1].

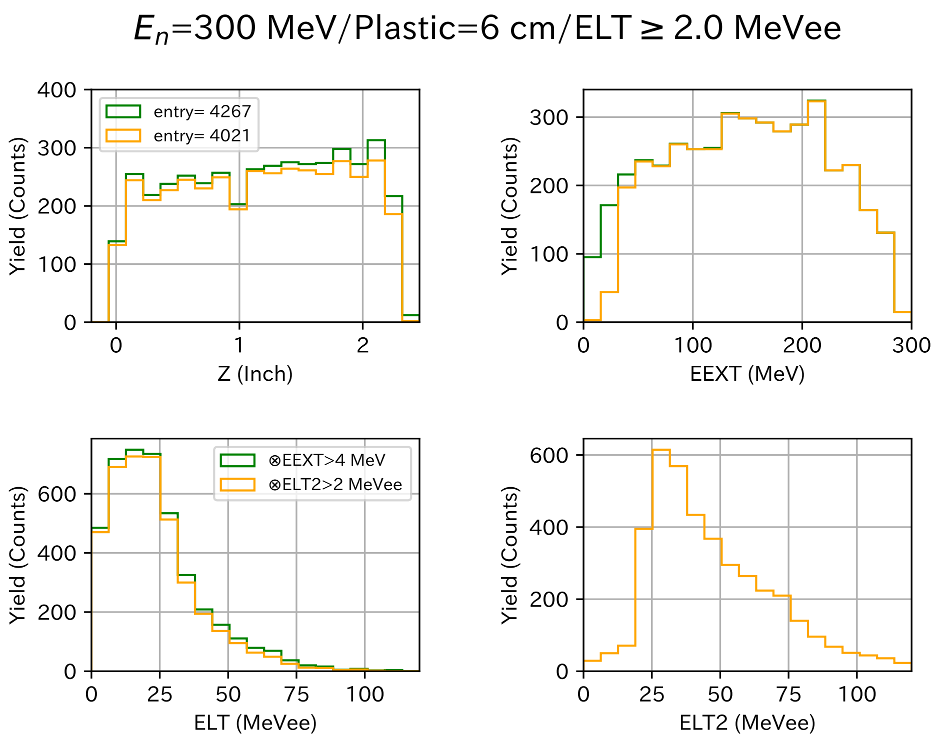

Figure 3: Light output characteristics of Neolith-s. The assumed neutron incident energy is 300 MeV. (Left top) vertex distribution. (Right top) energy distribution of emerging protons escaping the front scintillator, EEXT (in MeV). (Left bottom) light output distribution in the front scintillator (in MeVee). (Right bottom) light output distribution in the rear scintillator (in MeVee).

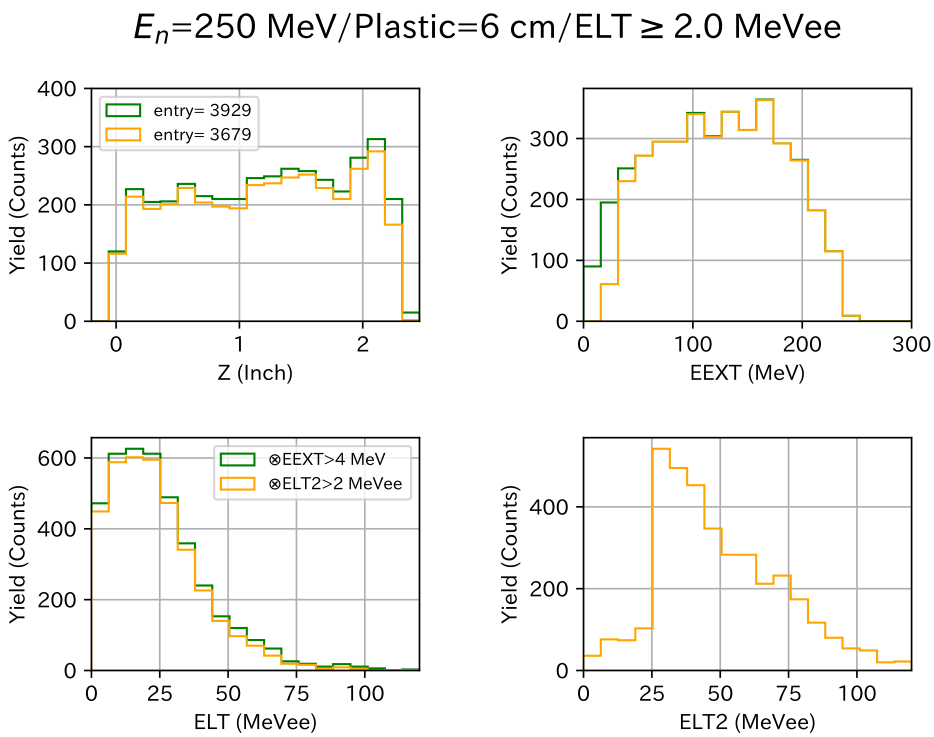

Figure 4: Same as Fig. 3 but for the neutron energy of 250 MeV.

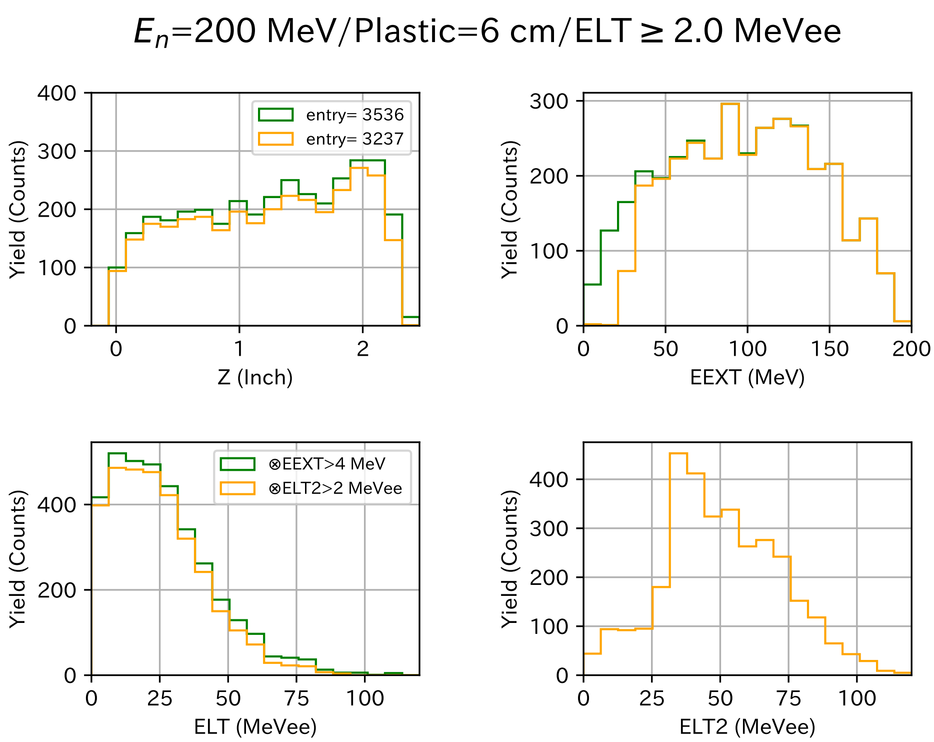

Figure 5: Same as Fig. 3 but for the neutron energy of 200 MeV.

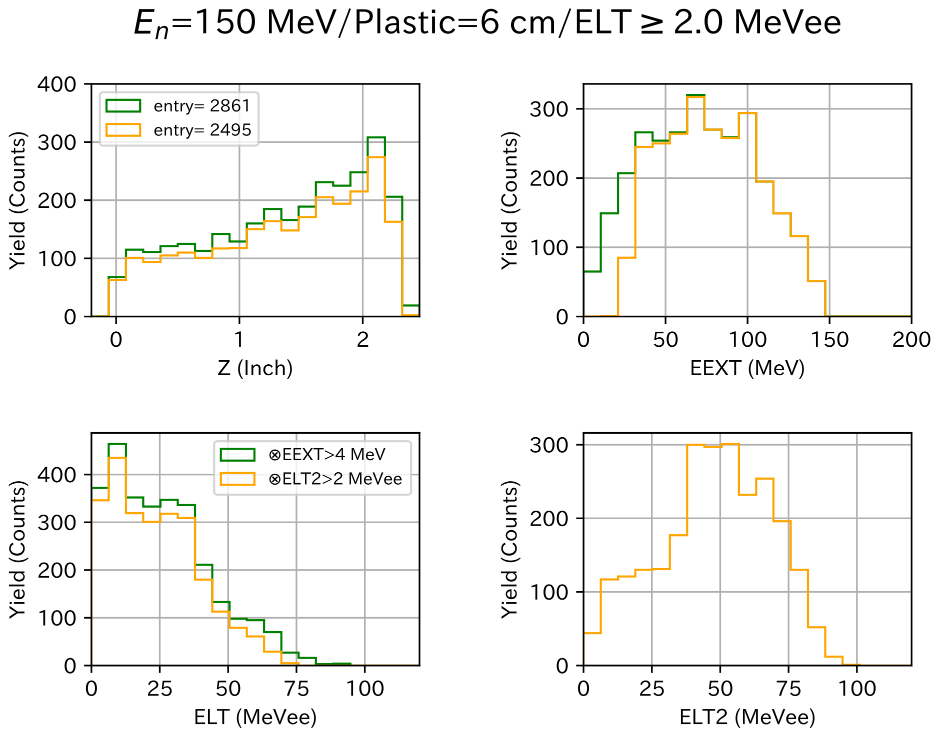

Figure 6: Same as Fig. 3 but for the neutron energy of 150 MeV.

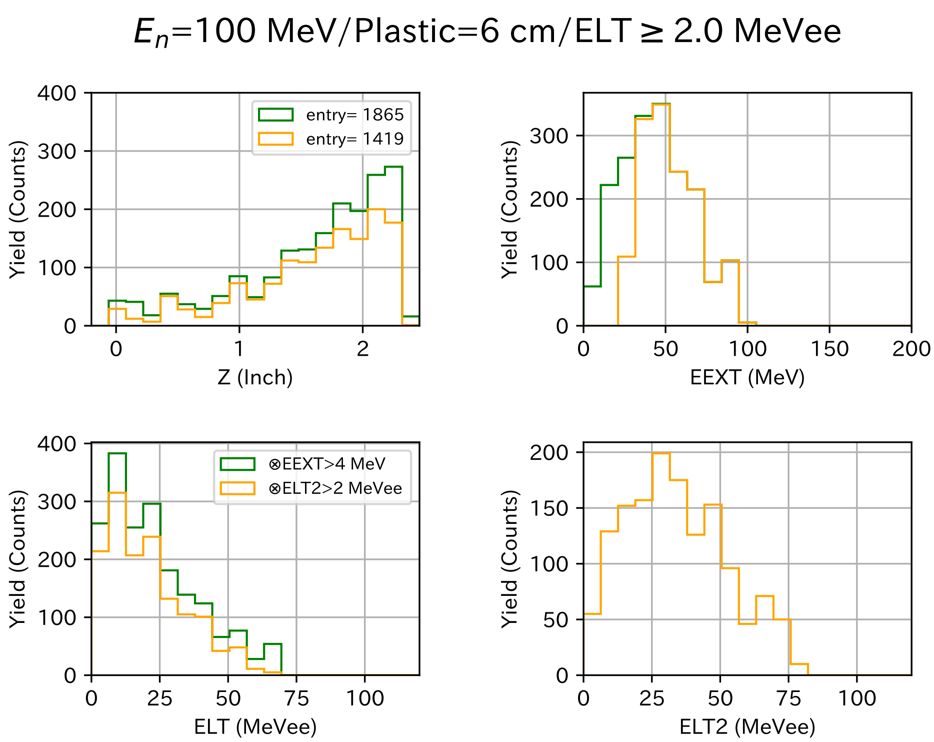

Figure 7: Same as Fig. 3 but for the neutron energy of 100 MeV.

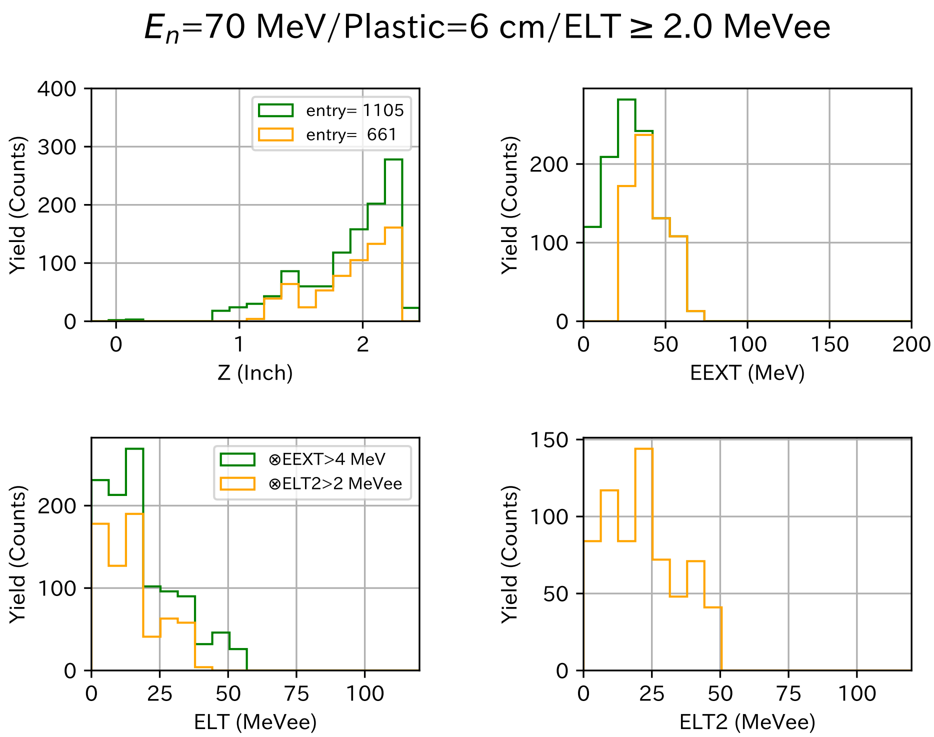

Figure 8: Same as Fig. 3 but for the neutron energy of 70 MeV.

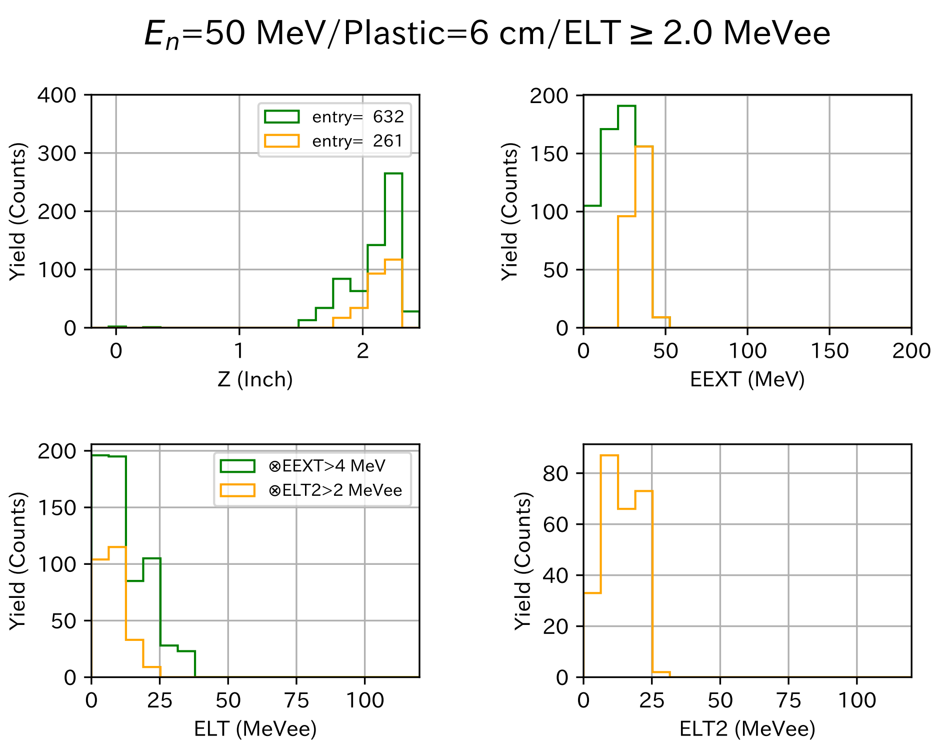

Figure 9: Same as Fig. 3 but for the neutron energy of 50 MeV.

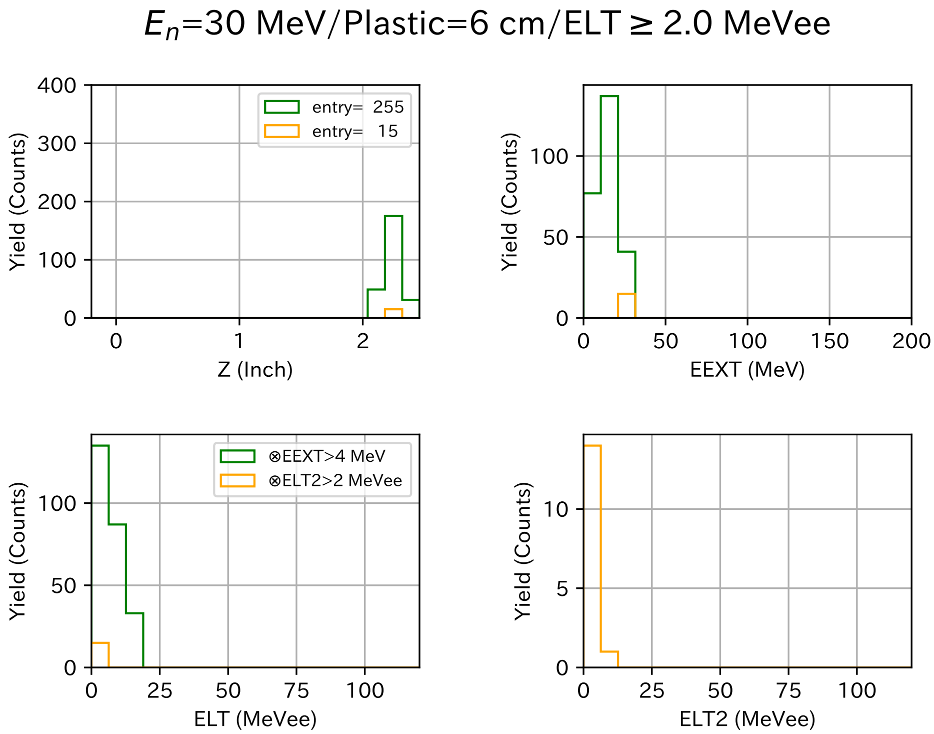

Figure 10: Same as Fig. 3 but for the neutron energy of 30 MeV.

References

[1] R.A. Cecil, B.D. Anderson, and R. Madey, Nuclear Instruments and Methods 161 (1979) 439.

[2] Energy loss characteristics of Neolith-s (Y.Satoui).