

ISU RACE target summary

The current ISU RACE target is a 2.75 inch diameter, 3.5 inch long cylinder made from 75% of W and 25% Cu. A series of calculations show that the neutron yield of the bare target is not really sensitive to the target geometry as long as it is big than certain size that practical designs normally do. This can be explained by the flux profiles of electrons, photons, and neutrons in the target. As can be seen in Fig. 1 – Fig.3, most of the electrons are distributed very close to where the electron beam impinged, while the bremsstrahlung photons can travel further into the target, and photon-neutrons can apparently penetrate even deeper into the target. However, the high flux regions are mostly populated in the adjacent area of the target end connecting to the accelerator beam port since majority of the photon-nuclear reactions are taking place there. Also, the energy deposited by the neutron and photon interaction are tallied in target, the total energy deposition from neutron and photon interactions inside target is plot in Fig.4. As can be seen, most of the energy deposited are from photon interactions, thus the energy deposition profile is very similar to photon flux profile. For the incident electron at 25 MeV, each source electron will deposit about 11.40 MeV energy in the target through bremsstrahlung photon and neutron scattering interactions, hence, about 45.6% of beam power is dissipated by the target. In order to tally the particle flux profile in the target, the target is divided into 10 equal length sections in beam axial direction and 5 equal thickness sections from center line to the edge of target in radial directions. *Each intersection point of the grids represents the cell flux at the center of the corresponding cell.* The target is positioned from 0 cm – 8.89 cm in X direction, and electron beam is incident from right end of the target to the negative X-direction.

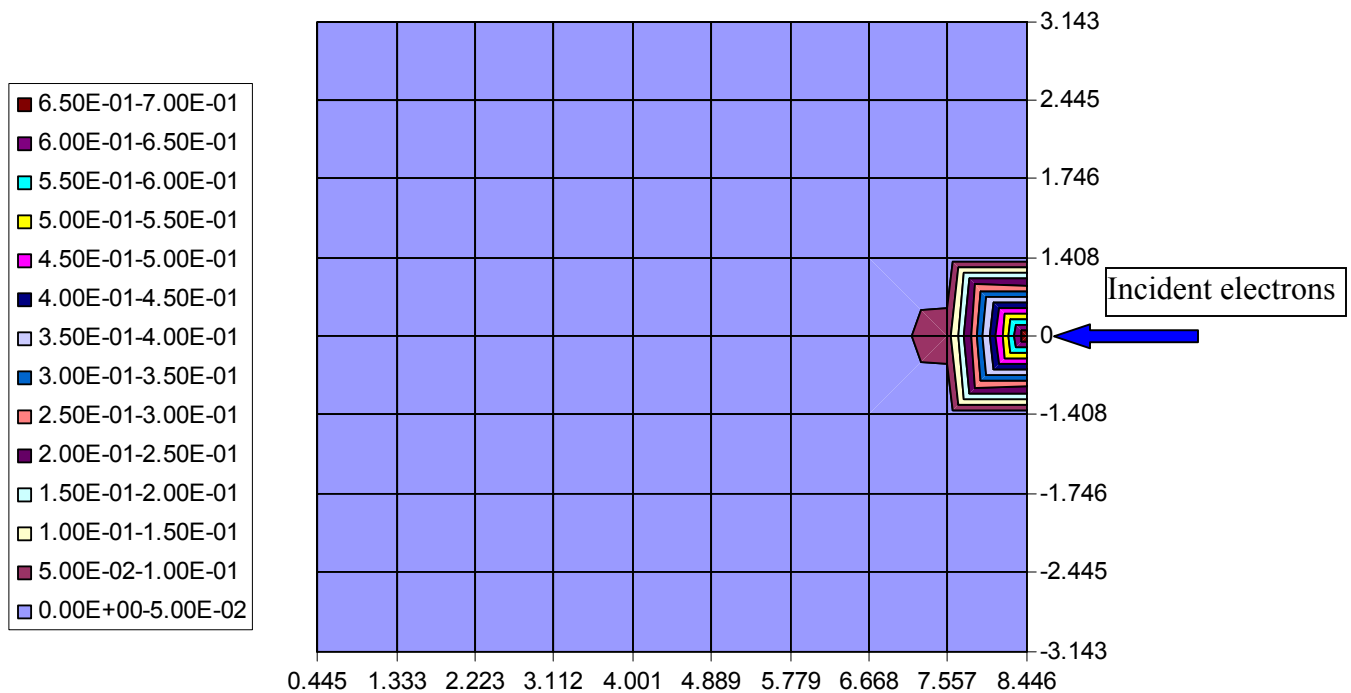


Figure.1 Electron flux distribution inside the target (electron/cm²/incident electron)

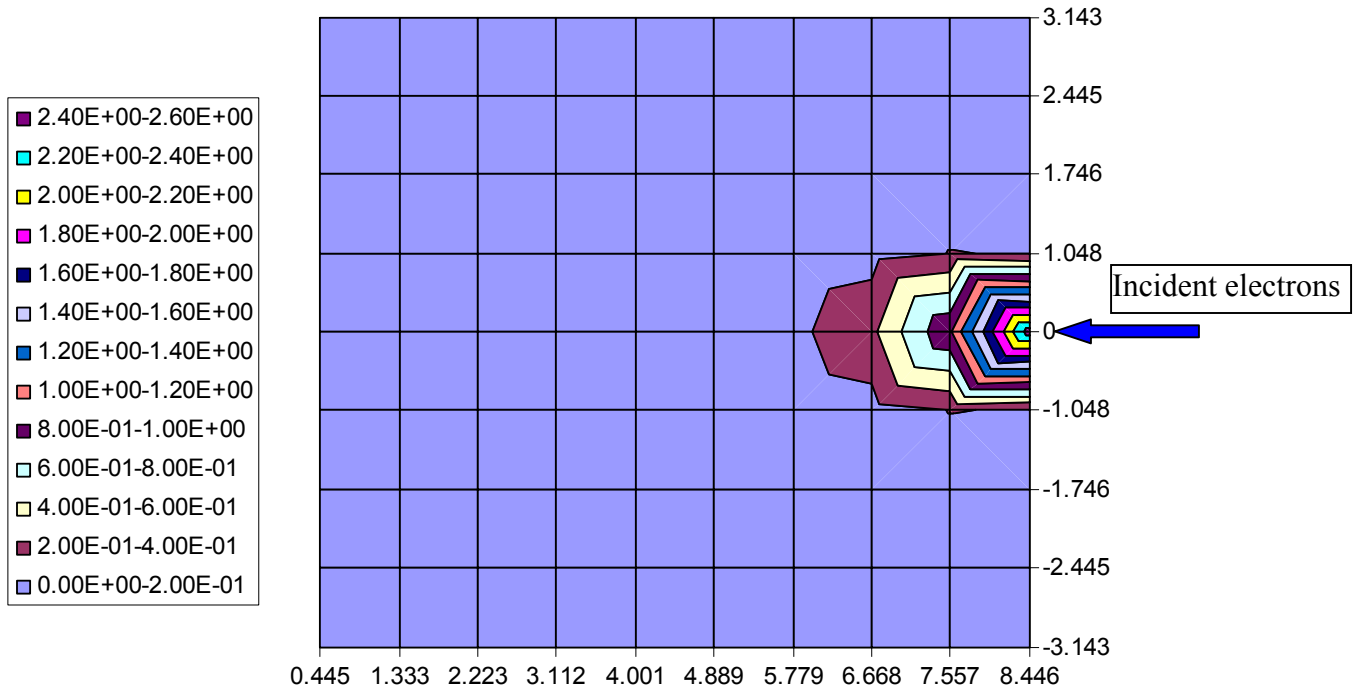


Figure.2 Photon flux distribution inside the target (photon/cm²/incident electron)

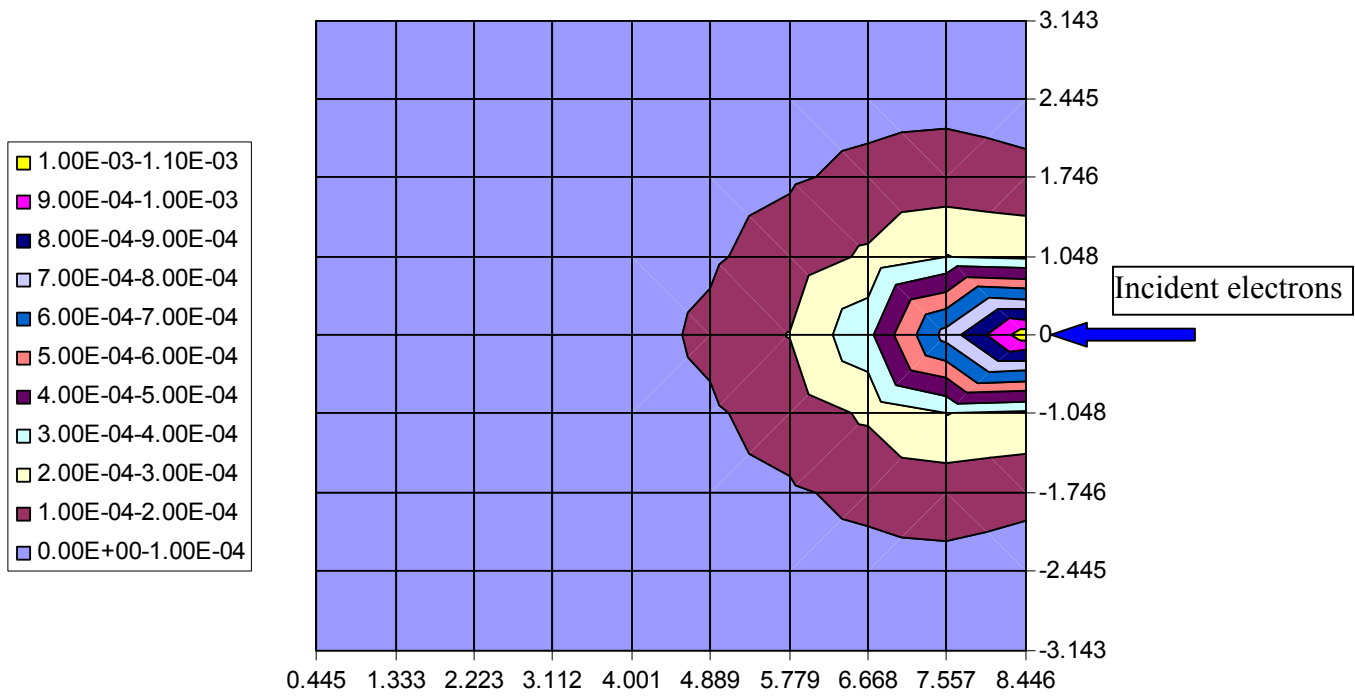


Figure.3 Neutron flux distribution inside the target (neutron/cm²/incident electron)

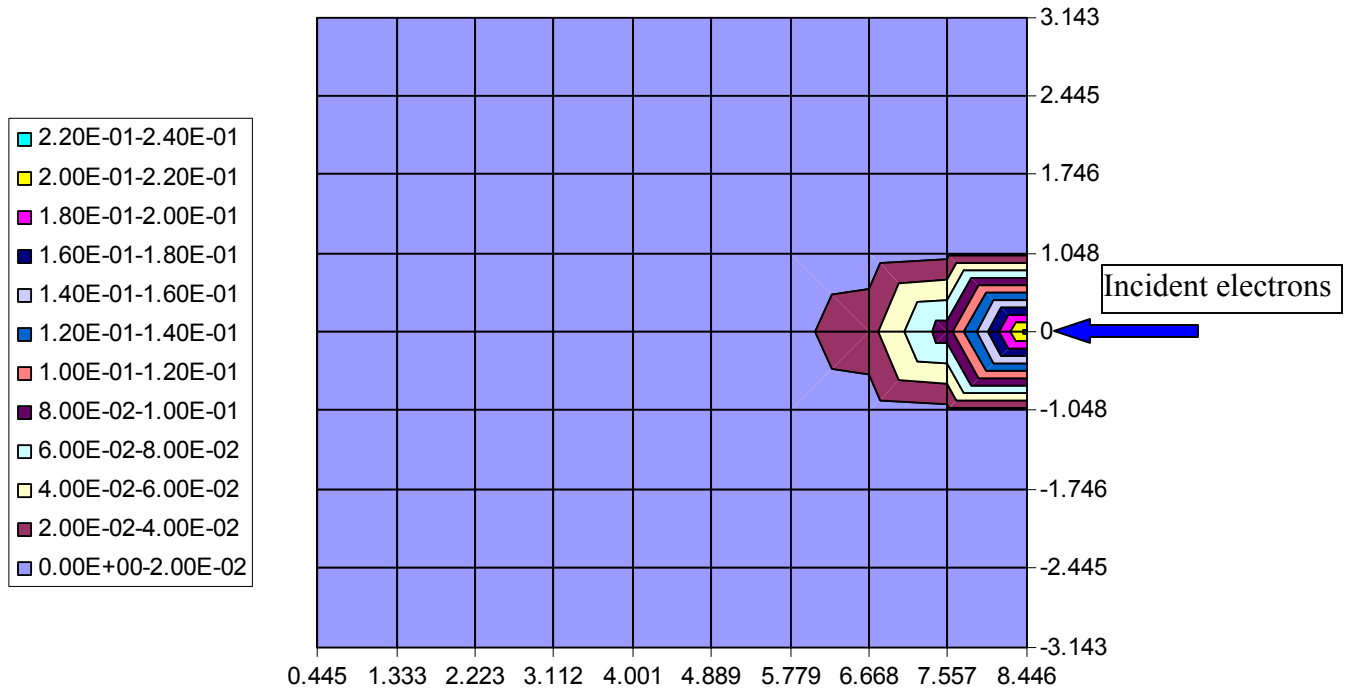


Figure.4 Energy deposition distribution by photon and neutron inside the target (MeV/gram/incident electron)

Due to the availability of the target materials, two materials are investigated: W(75%)-Cu(25%) and depleted uranium. The MCNPX simulation shows that depleted uranium target can produce about 2.6 times of photon-neutrons than that produced from current W-Cu target. The target mechanical and thermal characteristic parameters are listed in Table.1

Table.1 Target material specifications

	W(75%)-Cu(25%)	Deleted Uranium
Density	14.7 g/cm ³	19.05 g/cm ³
Young's modulus	411GPa(W), 130GPa(Cu)	208 GPa
Poission's ratio	0.28(W), 0.34(Cu)	0.23
Thermal conductivity	189 W/m/K	27 W/m/K
Linear thermal expansion Coefficient	10.22 x 10 ⁻⁶ /K	13.9 x 10 ⁻⁶ /K
Yield stress	N/A	N/A

Since the accelerator at IAC could provide beam power up to 30 KW, the neutron yield vs. beam power is plot in Fig.5 for different target materials and incident electron energies. As can be seen, IAC accelerator can provide more than 5×10^{13} neutrons/second source strength.

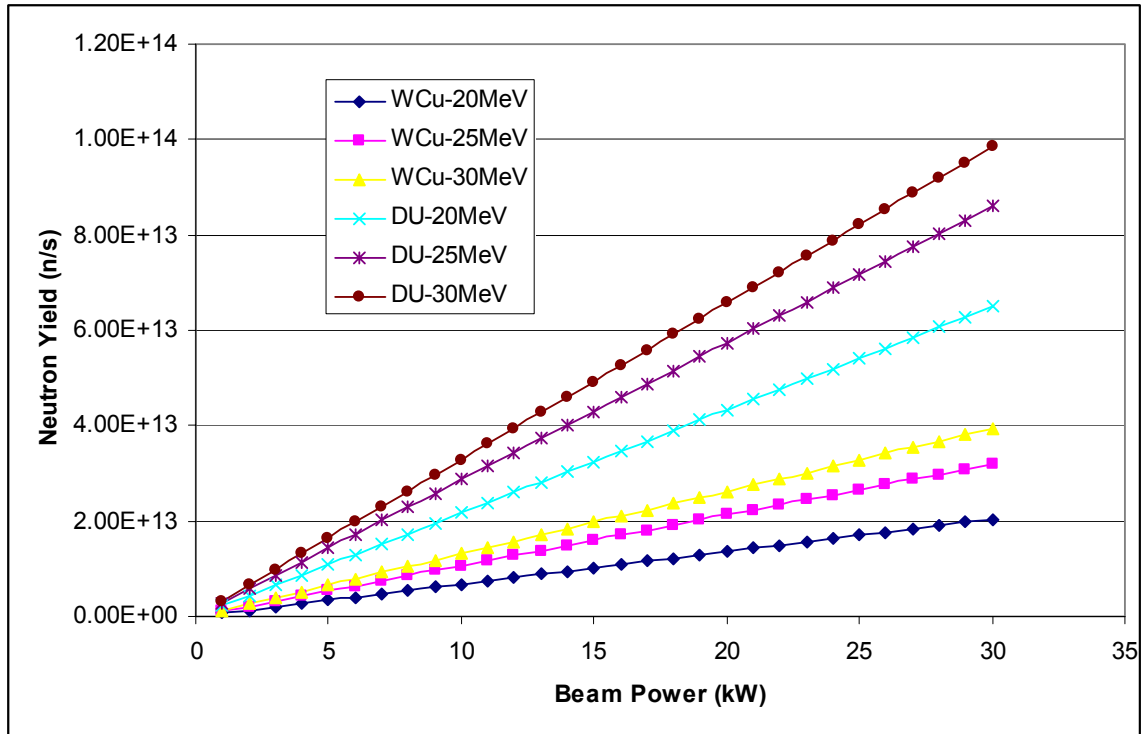


Figure.5 Neutron Yield for different target materials at various incident electron energy.