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# Optimization and application of helical coil target with varying geometry and screen tube

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The concept of the Travelling Wave Tube (TWT) was proposed in 1947 [1], followed by analytical models in the 1950s [2, 3, 4]. This system found applications in high power and high frequency microwave electronics such as gyrotrons, relativistic travelling wave tubes and free-electron lasers. The TWT uses an electron beam to amplify an electromagnetic field propagating in a helically shaped wire.

Laser-driven ion acceleration is currently one of the most dynamic research domains due to its conpactness and numerous applications such as isochoric heating, isotope or neutron production, plasma radiography, and nuclear fusion in a fast ignition scheme. In the scheme of target normal sheath acceleration (TNSA), the laser pre-pulse creates a plasma on the target, and the main pulse accelerates electrons, generating charge separation and a static electric field of several TV/m. This field accelerates protons to energies of MeV to tens of MeV. However, the angular divergence of the accelerated protons is still too high, and energy distribution is poorly controlled, limiting application possibilities.

The idea to couple TNSA and helical coil to post-accelerate and focus the proton beam, was proposed in Ref. [5]. The discharge current, created in the laser-plasma interaction, is used to feed the helix. The physics of current propagation in this helix is analogous to coupled transmission systems [3, 2]. However, the current dispersion prevents continuous post-acceleration and focusing of ions along the helix length [6]. Similar issues have been observed in coupled transmission systems, leading to the idea of adding a tube around the helix [4]. This new setup helps reducing current dispersion in the helix. We implemented a tube around the helical coil (HCT) [7] and demonstrated that the HCT bunches the proton beam in energy and increases the energy cut-off. To optimize the HCT, we also vary the geometry of the HCT as a function of the proton propagation axis, which permit to change the synchronization of the electromagnetic field with the protons. We refer it as the varying helical coil with tube (VHCT) [8]. In this presentation, we will present our analytical theoretical work, the results of an experiment showing for the first time the effect of helical coil on heavy-ions, and the simulations for the application of helical coil on radioisotope production. We show, that the radioisotope production is increase by a factor 10 to 3000 on the effect of helical coil, dependently of the wanted radioisotopes.

**Références**

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