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New designs of helical coil targets for laser-driven proton, carbon and alpha acceleration

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Helical coil targets [1] are commonly used to focus, collimate, bunch, and accelerate protons via the Target Normal Sheath Acceleration (TNSA) process, producing highly focused and collimated beams [2]. However, acceleration and bunching remain limited by current dispersion along the helix. To overcome this, we introduced a tube around the helix, reducing dispersion and enhancing bunching [3]. To increase the post-acceleration, a new electromagnetic model with variable pitch and diameter was then developed to synchronize proton propagation with the current pulse over longer helices [4]. Our recent experiments at the ALLS facility confirmed effects on both protons and carbon ions [5]. Building on this, new helical targets were designed to accelerate alpha particles for scandium radioisotope production. Simulations predict a 10–3000-fold increase in radioisotope yield [6].

References
[1] S. Kar et al., Nature Com. 7, 10792 (2016)
[2] M. Bardon et al., Plasma Phys. Control. Fusion 62, 125019 (2020)
[3] A. Hirsch-Passicos et al., Phys. Rev. E 109, 025211 (2024)
[4] C.L.C. Lacoste et al, Matter Radiat. Extremes 9, 067201 (2024)
[5] C.L.C. Lacoste et al, submitted to Matter Radiat. Extremes (January 2025)
[6] C.L.C. Lacoste et al, submitted to Phys. Rev. Appl. (January 2025)

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