Spin-polarized ion beams from laser-plasma interaction

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Spin-polarized particles are of interest for a variety of applications such as fusion, where the use of spin-polarized reactants may increase the nuclear cross section, or further investigation of the nucleon structure by means of deep inelastic scattering. In recent years, the acceleration of such polarized particles via laser-plasma interaction has gained traction in research due to the short acceleration distances needed compared to conventional accelerators [1]. While several schemes for efficient ion acceleration are generally known, many of them are not feasible for polarized beams since the target needs to be pre-polarized.

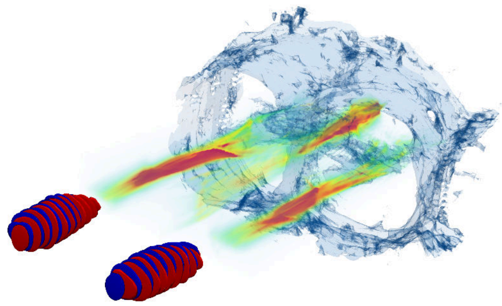

Figure 1: *Schematic of the dual-pulse scheme.*

In our talk, we present an overview over the current state-of-the-art for spin-polarized ion beams and their study by means of particle-in-cell simulations. More specifically, we propose an acceleration scheme based on Magnetic Vortex Acceleration (MVA), where the laser creates a plasma channel of low density in whose center an ion filament is formed. This filament is ejected at the end of the target when the expanding electromagnetic fields lead to the formation of accelerating and focusing electric fields. With conventional MVA, proton beams up to 53 MeV can be obtained from laser pulses with $a_0 = 25$ while maintaining a beam polarization of up to 82%. For stronger fields, a dual-pulse scheme (cf. Fig. 1) is proposed: two co-propagating pulses create a central ion filament that is better shielded for the laser fields, thus delivering higher polarization at comparable pulse energies than single-pulse MVA [2].

References

[1] M. Büscher et al., *High Power Laser Sci. Eng.* **8**, e36 (2020)
[2] L. Reichwein et al., *Phys. Rev. Accel. Beams* **25**, 081001 (2022)