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AVHANDLINGENS TITTEL:	*Emittance growth and preservation in a plasma-based linear collider*

Plasma-based accelerators promise to drastically shrink the size of the next generation of high energy particle colliders. This work investigates the main challenge of this novel technique: whether it can provide the necessary collision rate.

Particle physics is addressing grand questions, armed with big science machines: high energy particle colliders. These machines have, however, ballooned in size and new technologies for accelerating particles are required. Plasma-based acceleration is a promising new concept which enables higher-than-ever accelerating fields by surfing particles on plasma waves—or wakefields—promising smaller and cheaper particle accelerators. Nevertheless, many challenges remain before plasma wakefield accelerators (PWFAs) can be used for the next linear electron–positron collider.

One particularly important question is whether PWFAs can preserve the required beam quality—or emittance—to produce a sufficient collision rate. This work addresses questions about emittance growth in a plasma-based linear collider, specifically for three aspects of such a machine.

Firstly, staging of multiple plasma accelerators is a method suggested to reach high energies using several moderate-energy drive beams, but this is made difficult by emittance growth induced during capture and refocusing of highly diverging beams. A method known as apochromatic corrective optics is proposed to partially solve this problem.

Secondly, acceleration of positrons is not trivial in a plasma, due to its inherent charge asymmetry. Hollow channel plasma acceleration has been proposed as an acceleration method that symmetrizes the electron/positron plasma response. However, strong transverse wakefields in these hollow channels lead to rapid breakup of the beam—an effect measured for the first time in an experiment performed at SLAC.

Lastly, compact accelerators must be matched by similarly compact beam focusing devices. Active plasma lensing is a promising technique in this regard, but can suffer from plasma-related aberrations that consequently degrades the beam quality. This was studied and mitigated experimentally at CERN, where emittance preservation was demonstrated in an active plasma lens for the first time.