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The Ion Channel Laser: Physics Advances and Experimental Plans

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The ion channel laser (ICL) is an alternative to the free electron laser (FEL) that uses the electric fields in an ion channel rather than the magnetic fields in an undulator to transversely oscillate a relativistic electron beam and produce coherent radiation. The strong focusing force of the ion channel leads to a Pierce parameter more than an order of magnitude larger than the typical values associated with FELs. This allows the ICL to lase in an extremely short distance while using electron beams with an energy spread of up to a few percent. The ICL may thus be able to accommodate beams that can be produced by laser wakefield accelerators today. ICLs have several practical challenges, however, including stringent constraints on the beam's transverse phase space and the creation of a wakeless ion channel of sufficient length. We discuss recent advances in the physics of the ion channel laser as well as experimental plans for the first demonstration of an optical wavelength ICL at SLAC's FACET-II facility and to potential future x-ray laser devices.

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