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Robert R. Wilson Prize for Achievement in the Physics of Particle Accelerators Lecture: Frontiers of FEL Physics and Technology

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For much of the past 40 years, efforts to advance the capabilities of FELs have focussed on the frontiers of operation at high average power and short wavelengths with impressive and gratifying results. But a number of potentially important additional frontiers remain to be explored. I will briefly describe several of the new areas in which we have worked relating to the exploitation of boundary conditions to enhance oscillator phase coherence and stability, the exploitation of phase coherence to reduce the quantum fluctuations in amplitude of the coherent harmonics, the elucidation of the classical Wheeler-Feynman coherent radiation reaction force in single pass radiation sources, the development of the precision, robust high peak and average power optical elements needed for the reliable operation of these sources and the application of these advances to the development of optimized inverse-Compton x-ray and gamma ray sources.