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# Novel Integrated Photonics and Plasmonic Photocathodes

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Next-generation electron sources, including novel plasmonic and photonics-integrated cathodes, are poised to revolutionize applications ranging from low bunch charge stroboscopic ultrafast electron diffraction and microscopy to beam-driven wakefield accelerators requiring transversely shaped electron bunches. In this study, we report the generation of a record low root mean square (RMS) normalized transverse electron emittance of less than 40 pm-rad from a plasmonic photocathode—a reduction of at least an order of magnitude from previous benchmarks. This was achieved through plasmonic light focusing using Archimedean spiral structures, resulting in an RMS electron emission spot size of approximately 50 nm. Additionally, we demonstrate the feasibility of photonics-integrated photocathodes by utilizing nanofabricated waveguides and thin alkali antimonide photoemissive films to produce transversely shaped electron beams. These findings underscore the potential of these advanced cathodes in developing next-generation high-brightness electron sources for a wide range of accelerator applications.

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