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Picosecond Timing Layers for Future Calorimeters: Updates from the Askaryan Calorimeter Experiment (ACE)

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We report on new results and simulations from the Askaryan Calorimeter Experiment (ACE) which uses the coherent microwave Cherenkov emission from high energy particle showers in dielectric-loaded waveguides as calorimetric timing layers with ˜1 ps resolution. Above ACE's energy threshold, a single 5 cm thick (1.4 X_0) layer of ACE waveguides would provide ˜1 ps timing resolution, 3D spatial constraints on the scale of ˜300 µm - 5 mm, and an additional energy measurement, making ACE a true 5D detector. When embedded inside another calorimeter technology, ACE timing layers could provide a powerful additional measurement for particle-flow reconstruction algorithms as well as unique vertexing capabilities to significantly reduce pileup. Due to thermal noise limits, ACE elements have a relatively high energy threshold so they are currently limited to ion colliders like the EIC or future high CoM colliders like the proposed FCC-hh. ACE elements are also exceptionally radiation-hard and can provide exquisite timing precision even when deployed in the damaging far-forward region of these future experiments. We report on new simulation results from deploying ACE timing layers in the barrel and forward calorimeters at these future colliders and discuss ongoing research to further develop and improve the ACE detector concept.

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