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Development of a novel high granularity crystal electromagnetic calorimeter

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Motivated by the physics programs that aim at precision measurements of the Higgs, W and Z bosons, as well as the top quark, future lepton colliders (e.g. the Circular Electron Positron Collider, or CEPC) require an excellent calorimetry system to achieve the unprecedented jet energy resolution. The CEPC team has proposed a new detector concept named "the 4th detector concept". A major motivation is to significantly improve the Boson Mass Resolution (BMR) of better than 3% compared to 4%, which corresponds to the performance of the baseline detector proposed in the CEPC Conceptual Design Report (CEPC CDR). As a key sub-detector of "the CEPC 4th detector concept", the novel high granularity crystal electromagnetic calorimeter (ECAL) is designed to achieve an excellent jet reconstruction and an optimal EM energy resolution of $2-3\ \%/\sqrt{E(GeV)}$ with the homogeneous structure and excellent three-dimensional spatial and temporal resolutions.

Extensive R&D efforts have been carried out to assess the potential and requirements of the crystal ECAL with dedicated Geant4 full simulation, ranging from the ECAL detector units to the full sub-detector system. Hardware activities, which focus on characterizing crystals and silicon photomultipliers (SiPMs), have been conducted to provide solid inputs for simulation validation. The physics performance evaluation studies are ongoing with particle-flow algorithm "Arbor", which is being optimized for the crystal ECAL as well as the general "4th detector concept". Meanwhile, small-scale crystal modules are currently under development for beam tests to evaluate the performance of electromagnetic showers and to address critical issues at the system-level.

This contribution will introduce the crystal ECAL design and optimizations, the latest progress on the performance evaluation, crystal-SiPM measurements and simulation validation. Preliminary beamtest results could also be expected.

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