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Testing electroweak phase transition at muon colliders

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We study the complementarity of the proposed multi-TeV muon colliders and the near-future gravitational wave (GW) detectors to the first order electroweak phase transition (FOEWPT), taking the real scalar extended Standard Model as the representative model. A detailed collider simulation shows the FOEWPT parameter space can be greatly probed via the vector boson fusion production of the singlet, and its subsequent decay to the di-Higgs or di-boson channels. Especially, almost all the parameter space yielding detectable GW signals can be probed by the muon colliders. Therefore, if we could detect stochastic GWs in the future, a muon collider could provide a hopeful crosscheck to identify their origin. On the other hand, there is considerable parameter space that escapes GW detections but is within the reach of the muon colliders. The precision measurements of Higgs couplings could also probe the FOEWPT parameter space efficiently.

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