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Investigating scintillation performances of ultrafast GAGG and YAG garnets for High-Energy Physics

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The development of advanced scintillating materials for electromagnetic calorimeters is a key challenge for future High-Energy Physics (HEP) experiments, particularly in environments with high collision rates, such as the High-Luminosity LHC and next-generation particle colliders. These experiments require scintillators capable of both fast scintillation performance and precise time resolution to ensure accurate energy measurements, event separation and particle identification. Achieving these goals demands materials that combine high light yield ($\geq 10^3$ photons/MeV), short scintillation decay times ($\tau_{\text{eff}} \leq 10$ ns), and the ability to maintain performance under intense radiation conditions. Garnet-based scintillators, including GAGG:Ce,Mg and YAG:Ce,Mg,Ca, have emerged as strong candidates due to their potential to
fulfill all of the above requirements. In this work, we focus on the ongoing R\&D in the framework of the European Project TWISMA, whose purpose is to develop advanced scintillation materials for calorimeters in HEP. We performed experimental measurements on various YAG and GAGG samples to evaluate both energy and time resolution capabilities. Simulation are performed to complement the experimental results, providing valuable feedback for crystal producers to refine material properties and meet the demands of high-luminosity environments.

Primary experiment

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