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Particle Flow Algorithm (PFA) development for forward jet reconstruction with the ATLAS ITk detector setup at the HL-LHC

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The ATLAS experiment at the High-Luminosity Large Hadron Collider (HL-LHC) will require advanced reconstruction techniques, particularly in the forward region, to cope with increased pile-up. This work presents a Particle Flow Algorithm (PFA) development for the ITk detector, focusing on tower clusters rather than traditional topological clusters in the $\eta = \langle 0 - 1.5 \rangle$ region. The forward region indicates $\eta = \langle 2 - 4 \rangle$. The strategy integrates tracker momentum measurements with calorimeter energy deposits through cell-based subtraction, prioritising energy density layers to resolve overlaps between tracking and calorimetric data. By employing tower clusters, which aggregate calorimeter cells into fixed $\eta \times \phi$ grids, we aim to improve computational efficiency while maintaining spatial granularity critical for forward jet reconstruction. The framework processes Event Summary Data (ESD), containing raw detector-level information (tracker hits, calorimeter clusters), and it is processed into Analysis Object Data (AOD), a condensed format storing high-level physics objects (jets, leptons) optimised for analysis. The algorithm refines energy subtraction and calibration by implementing Gaussian fitting of $\langle E/p \rangle$ distributions across calorimeter layers, mitigating pile-up effects in the forward region. This approach addresses the high-pileup HL-LHC environment, balancing precision in jet energy resolution with computational scalability for the ITk detector's upgraded granularity.

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