Justin Marquez

- *I am a 4th year graduate student at UW-Madison*
- *Mentors: Matthew Herndon (UW-Madison), Kevin Pedro (FNAL)*

Motivations:

- Accurate detector simulation is necessary for physics measurements and must include in-time (IT) and out-of-time (OOT) minimum bias collisions for pileup simulation.
- Current: n_pu = <65> + 15 OOT * <65> —> 1040 min bias collision per event
- HL-LHC: n+pu = <140-200> — up to 3200 min bias collisions per event
- Currently, we are using a “pre-mixing” process to overlay fully simulated pileup events onto signal samples.
  - 1.8 PB (Run 2) + 10.7 PB (Run 3) to support
- For HL-LHC, we would need approximately two orders of magnitude more storage for the pileup events - likely not feasible.

Potential TAC-HEP R&D projects:

- Reduce number of OOT min-bias events needed to simulate. Needs physics benchmarking.
  - The muon system is the major factor in the current OOT requirements - it likely does not need to be this large.
- Replace pre-mixing with on-the-fly pileup generation using FullSim. Needs CPU benchmarking.
- Pre-mix events at the GEN level with detector simulation on-the-fly. Needs CPU and disk/IO benchmarking.
- Using FastSim instead of FullSim for the two above options
  - This needs development for all subdetectors.
  - The muon system needs more development and studies of pileup background.
- Generative ML (ML4Sim) can be explored to produce the equivalent of fully simulated pre-mixed events using techniques like OmniFold. This would also need development and studies of the muon system.

Accomplishments:

- Read through various resources to understand pre-mixing and its alternatives within CMSSW.
- Reviewed basic CMSSW workflows for reproducing min-bias/pileup samples for pre-mixing.
- Testing HEPScore23 benchmarking utility for measuring CPU performance.

Next steps:

- Meet with mentors and finalize decision on the approach to improve pileup performance - with a focus on muon system studies.