

Background Embedding: Implementation Plans

- Single software stack for EIC: DD4hep, podio, EDM4hep, but no decision on reconstruction framework yet → keep focus on Gaudi/juggler for expediency
 - [Example code](#) exists as part of iLCSoft based on LCIO data model (= EDM4hep at MC level)
 - [Example code](#) also exists as part of HEP-FCC based on key4HEP ([PileUp tools](#) in v0.16)
- Chosen approach
 - Run backgrounds through current geometry (to be done automatically by CI)
 - Run physics events through current geometry (as part of CI and/or regular sim jobs)
 - Merge simulated hits (tracker, calorimeter) immediately before reconstruction
 - Apply time shifts, taking into account appropriate overall cross section weights
- Alternative approach (not chosen)
 - Merge events at event generator stage, no pre-existing code available, but this requires new functionality in DD4hep or as a hepmc3 merger, and time/position shifts are more difficult to apply since they require changing the hepmc3 events
- Challenges from the outset: event-by-event different weights

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- Inputs = physics event generators, equal weighting for all events in each file
 - In particular: synchrotron radiation, electron beam gas, proton beam gas (from [indico](#) June 17)
 - S3/eic/test/ATHENA/EVGEN/SR/SR.10GeV_5kVthreshold_hepmc/25098.hepmc (σ ?)
 - /gpfs02/eic/jadam/GETaLM_data/beam_gas/beam_gas_ep_10GeV_foam_emin10keV_10Mevt.hepmc ($\sigma = 699.392 \pm 0.041$ mb)
 - /gpfs/mnt/gpfs02/eic/zhangzq/pythia8/beameffect/BeamGas/test.hepmc ($\sigma = 39.27\text{mb}^2$)
 - STATUS: Prepared for extending background benchmarks for additional data sets
https://eicweb.phy.anl.gov/EIC/benchmarks/physics_benchmarks/-/merge_requests/161
- PileUp code into Gaudi/juggler:
 - PileUp algorithms for gaudi v30r5, we are at v36r5 (diffs include major build system rewrite)
 - Working with original FCC author on locating most recent version and updating to work
 - STATUS: Potentially have a lot of tools nearly ready ([here](#)): PileUpOverlay (with external background files); ConstPileUp, RangePileUp, PoissonPileUp (internal to data signal stream)

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- Lots of progress in understanding what's there and what isn't in last few days
 - This is one of the areas where we benefit from our connections with the key4HEP group, directly by using their existing code and indirectly by being able to get help on future algs too
- Integrated in Gaudi/juggler, up to diffs in old FCC data model and EDM4hep
- STATUS: https://eicweb.phy.anl.gov/EIC/juggler/-/merge_requests/429
 - Pileup internal to data signal stream should already work

Background Noise (no actual tracks)

DD4hep provides noise functionality during digitization, with [large number of models](#) but has not been enabled yet. This could be addressed by new contributors to the DD4hep description of the detector.

DigiActionSequence.h

DigiAttenuator.h

DigiContext.h

DigiDDG4Input.h

DigiData.h

DigiEventAction.h

DigiExponentialNoise.h

DigiFactories.h

DigiGaussianNoise.h

DigiHandle.h

DigiInputAction.h

DigiKernel.h

DigiLandauNoise.h

DigiLockedAction.h

DigiPoissonNoise.h

DigiRandomEngine.h

DigiRandomGenerator.h

DigiRandomNoise.h

DigiSegmentation.h

DigiSignalProcessor.h

DigiSignalProcessorSequence.h

DigiStore.h

DigiSubdetectorSequence.h

DigiSynchronize.h

DigiUniformNoise.h

FalphaNoise.h