

Background Mixing In Production

Jan 16, 2025

Signal Background Merger

[GitHub - eic/HEPMC_Merger: A code used to merge events from provided HEPMC files.](#)

4 backgrounds need to be mixed with every signal sample:

- 1) Minbias
- 2) Electron beamgas
- 3) Hadron beamgas
- 4) Synrad

Need a modification to the interface because currently the script only allows 3 types of backgrounds

```
jug_dev> eicprod@ifarm2402:~$ SignalBackgroundMerger --help
Usage: Merge signal events with up to three background sources. [--help] [--version] [--signalFile
VAR] [--signalFreq VAR] [--signalsSkip VAR] [--bg1File VAR] [--bg1Freq VAR] [--bg1Skip VAR] [--bg2Fi
le VAR] [--bg2Freq VAR] [--bg2Skip VAR] [--bg3File VAR] [--bg3Freq VAR] [--bg3Skip VAR] [--outputFi
le VAR] [--rootFormat] [--intWindow VAR] [--nSlices VAR] [--squashTime] [--rngSeed VAR] [--verbose]

Optional arguments:
-h, --help          shows help message and exits
-v, --version      prints version information and exits
-i, --signalFile   Name of the HEPMC file with the signal events [nargs=0..1] [default: "root://d
tn-eic.jlab.org/work/eic2/EPIC/EVGEN/SIDIS/pythia6-eic/1.0.0/10x100/q2_0to1/pythia_ep_noradcor_10x
100_q2_0.000000001_1.0_run1.ab.hepmc3.tree.root"]
-sf, --signalFreq Signal frequency in kHz. Default is 0 to have exactly one signal event per sli
ce. Set to the estimated DIS rate to randomize. [nargs=0..1] [default: 0]
-S, --signalSkip  Number of signals events to skip. Default is 0. [nargs=0..1] [default: 0]
-bg1, --bg1File   Name of the first HEPMC file with background events [nargs=0..1] [default: "ro
ot://dtn-eic.jlab.org/work/eic2/EPIC/EVGEN/BACKGROUNDS/BEAMGAS/proton/pythia8.306-1.0/100GeV/pythi
a8.306-1.0_ProtonBeamGas_100GeV_run082.hepmc3.tree.root"]
-bf1, --bg1Freq   First background frequency in kHz. Default is the estimated hadron gas rate at
10x100. Set to 0 to use the weights in the corresponding input file. [nargs=0..1] [default: 31.9]
-bg1S, --bg1Skip Number of first background events to skip. Default is 0. [nargs=0..1] [default
: 0]
-bg2, --bg2File   Name of the second HEPMC file with background events [nargs=0..1] [default: "r
oot://dtn-eic.jlab.org/work/eic2/EPIC/EVGEN/BACKGROUNDS/BEAMGAS/electron/beam_gas_ep_10GeV_foam_em
in10keV_30Mevt.hepmc3.tree.root"]
-bf2, --bg2Freq   Second background frequency in kHz. Default is the estimated electron gas rate
at 10x100. Set to 0 to use the weights in the corresponding input file. [nargs=0..1] [default: 317
7.25]
-bg2S, --bg2Skip Number of second background events to skip. Default is 0. [nargs=0..1] [default
: 0]
-bg3, --bg3File   Name of the third HEPMC file with background events [nargs=0..1] [default: ""]
-bf3, --bg3Freq   Third background frequency in kHz. Default is 0 to use the weights in the corr
esponding input file. Set to a value >0 to specify a frequency instead. [nargs=0..1] [default: 0]
-bg3S, --bg3Skip Number of third background events to skip. Default is 0 [nargs=0..1] [default:
0]
-o, --outputFile  Specify the output file name. By default bgmerged.hepmc3.tree.root is used [na
rgs=0..1] [default: "bgmerged.hepmc3.tree.root"]
-r, --rootFormat  Use hepmc.root output format, default is true.
-w, --intWindow  Length of the integration window in nanoseconds. Default is 2000. [nargs=0..1]
[default: 2000]
-N, --nSlices    Number of sampled time slices ('events'). Default is 10000. If set to -1, all
events in the signal file will be used and background files cycled as needed. [nargs=0..1] [default
: 10000]
--squashTime     Integration is performed but no time information is associated to vertices.
--rngSeed        Random seed, default is None [nargs=0..1] [default: 0]
-v, --verbose    Display details for every slice.
jug_dev> eicprod@ifarm2402:~$
```

Summary of Rates

Summary of rates for various sources of particle production in the central detector region (+5.0m to -4.5m from IP). Luminosity values are taken from EIC CDR [Table 3.3](#) (high divergence luminosity configuration - most-conservative numbers with highest rates). Total cross section taken from Pythia6.

cross-section	5x41 GeV	5x100 GeV	10x100 GeV	10x275 GeV	18x275 GeV
Total ep	28.5ub	35ub	41ub	50ub	54ub
hadron beam (p) gas	77.3mb	76.8mb	76.8mb	78.5mb	78.5mb
electron beam gas	622.158 +/- 0.036 mb	622.158 +/- 0.036 mb	699.393 +/- 0.041 mb	699.393 +/- 0.041 mb	768.343 +/- 0.049 mb
DIS eA	ub	ub	ub	/	/
hadron beam (Au) gas	3418mb	3440mb	3440mb	/	/

This table shows the rates for electron+proton beam configurations:

Electron beam-gas rates consider larger region of -5 to +15 meters along the IP, hadron beam-gas rates consider region of -5.5 to +5 meters.

rates in kHz	5x41 GeV	5x100 GeV	10x100 GeV	10x275 GeV	18x275 GeV	Vacuum
Total ep	12.5 kHz	129 kHz	184 kHz	500 kHz	83 kHz	
hadron beam gas	12.2kHz	22.0kHz	31.9kHz	32.6kHz	22.5kHz	10000Ahr
	131.1kHz	236.4kHz	342.8kHz	350.3kHz	241.8kHz	100Ahr
electron beam gas	2181.97 kHz	2826.38 kHz	3177.25 kHz	3177.25 kHz	316.94 kHz	10000Ahr
DIS eA	kHz	kHz	kHz	/	/	
hadron beam (Au) gas	7.36kHz	10.3kHz	10.3kHz	/	/	10000Ahr
	79.1kHz	110.7kHz	110.7kHz	/	/	100Ahr
electron SR					14 MHz	

[Background - Electron-Proton/Ion Collider Experiment](#)

[Talks on rate calculations](#)

Peak Luminosity Config

Rate = Luminosity x Cross-section

These frequencies in kHz are used as inputs parameters to the signal background merger

Method

- 1) Added [frequency table](#) to [datasets repository](#)
- 2) Download and parse table at [submit step](#)

```
#!/bin/bash
set -Euo pipefail
trap 's=$?; echo "$0: Error on line "$LINENO": "$BASH_COMMAND"; exit $s' ERR
IFS=$'\n\t'

# Set url for frequency tables
EGAS_URL=https://raw.githubusercontent.com/eic/simulation_campaign_datasets/${DETECTOR_VERSION}/config_data/egas_freq.csv
HGAS_URL=https://raw.githubusercontent.com/eic/simulation_campaign_datasets/${DETECTOR_VERSION}/config_data/hgas_freq.csv
MINBIAS_URL=https://raw.githubusercontent.com/eic/simulation_campaign_datasets/${DETECTOR_VERSION}/config_data/minbias_freq.csv

# Download tables
EGAS_TABLE=$( curl -L ${EGAS_URL} )
HGAS_TABLE=$( curl -L ${HGAS_URL} )
MINBIAS_TABLE=$( curl -L ${MINBIAS_URL} )

# Initialize associative arrays (maps) for each type of background
declare -A EGAS_MAP
declare -A HGAS_MAP
declare -A MINBIAS_MAP
```

Need to tag datasets repository

The screenshot shows a GitHub pull request for the repository 'feature-add-background-nlx'. The 'Changes' tab is active, showing three files: 'config_data/egas_freq.csv' (+3 -0), 'config_data/hgas_freq.csv' (+12 -0), and 'config_data/minbias_freq.csv' (+3 -0). A commit message by Wouter Deconinck is visible: 'Might be useful to add units to the suffix, _10000hrs.'. The diff view for 'config_data/hgas_freq.csv' shows 11 lines of data with columns for detector version, background type, and a numerical value.

Line	Detector Version	Background Type	Value
1	5x41_10000		12.2
2	5x41_100		131.1
3	10x100_10000		31.9
4	10x100_100		342.8
5	10x275_10000		22.5
6	10x275_100		241.8
7	5x41_Au_10000		7.36
8	5x41_Au_100		79.1
9	10x100_Au_10000		18.3
10	10x100_Au_100		110.7
11	10x110_Au_10000		10.3

Method (continued)

3) [Run](#) and label output location accordingly to distinguish between background mixed and regular outputs

Current directory structure:

```
root://dtm-eic.jlab.org/work/eic2/EPIC/RECO/24.12.0/epic-craterlake/  
<TAG_PREFIX>/DIS/NC/.../<TAG_SUFFIX>_<FileName>
```

Example: TAG_PREFIX= BKG/10000Ahr, TAG_SUFFIX=BKG_10000Ahr

We will use nested directory structure to indicate different configs.

Starting with just background mixed DIS for now