ePIC far forward electron beam gas simulation

Jaroslav Adam
Jakub Češka

FNSPE CTU

7.3.2023

Overview

- Simulation performed using **epic-23.03.0** (latest stable) with included far forward electron beamline
- `/star/u/ceskajak/pwg/eic/simulation/23.03.0_npsim.edm4hep.root`
- Simulation rerun with `npsim`
- New thresholds implemented
  - Cherenkov - uncertain about implementation
  - TOF - LGAD?
- Calorimeters not yet implemented
  - on SDCC cluster, when loading TFile module from ROOT library in python, module *libcppyy3_11* not found
- Forward electron beamline merging in process

Implemented detectors

Detector	Threshold
VertexBarrelHits	0.4 keV (not in table)
SiBarrelHits	0.4 keV (not in table)
MPGDBarrelHits	0.25 keV
MPGDDIRCHits	0.25 keV
TOFBarrelHits	none (not in table)
TrackerEndcapHits	0.5 keV
TOFEndcapHits	none (not in table)
DIRCBarHits	none (0.2 p.e.)
MRICHHits	none (0.5 p.e.)
DRICHHits	none (0.5 p.e.)

Table 1: Detectors and their threshold currently used in readout. Threshold based on athena, will be revisited.

Hit energy distributions

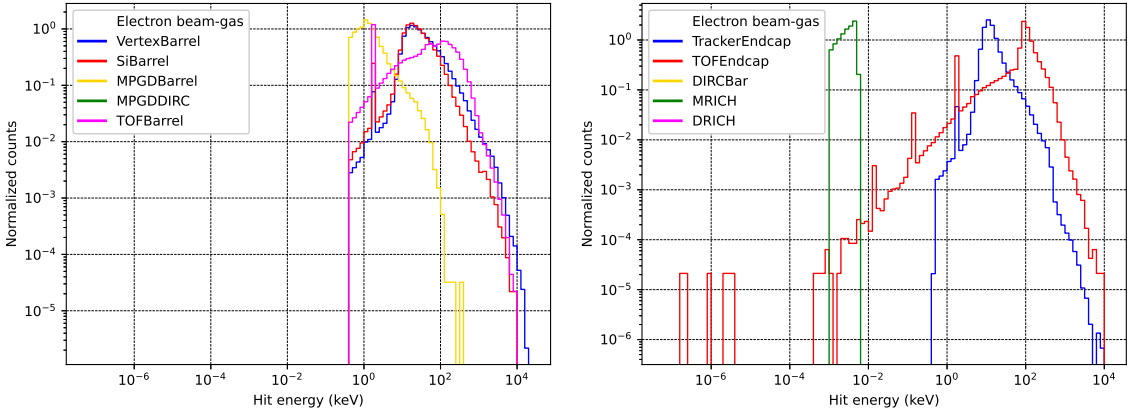

Figure 1: Hit energy distributions for individual detectors. There appears to be a 1 keV threshold applied somewhere, not sure about the location.

Hit *xy* position

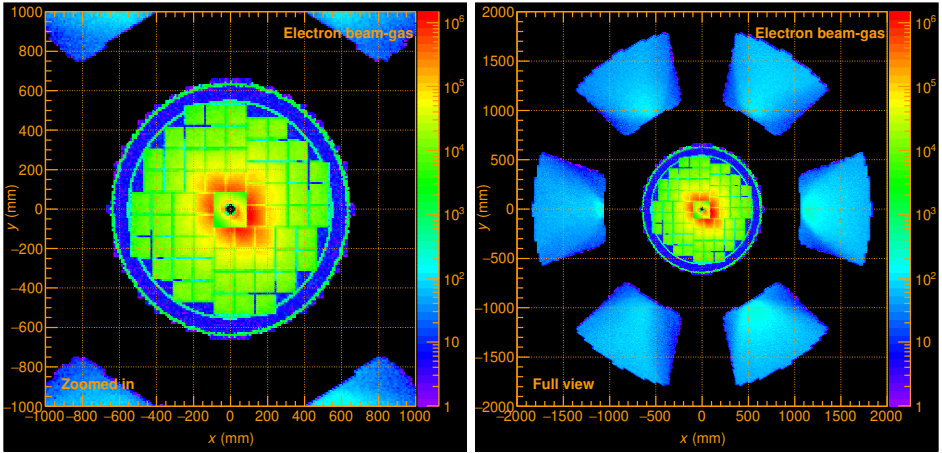

Figure 2: Hit x and y position from this simulation for aforementioned detector setup.

Hit *rz* position

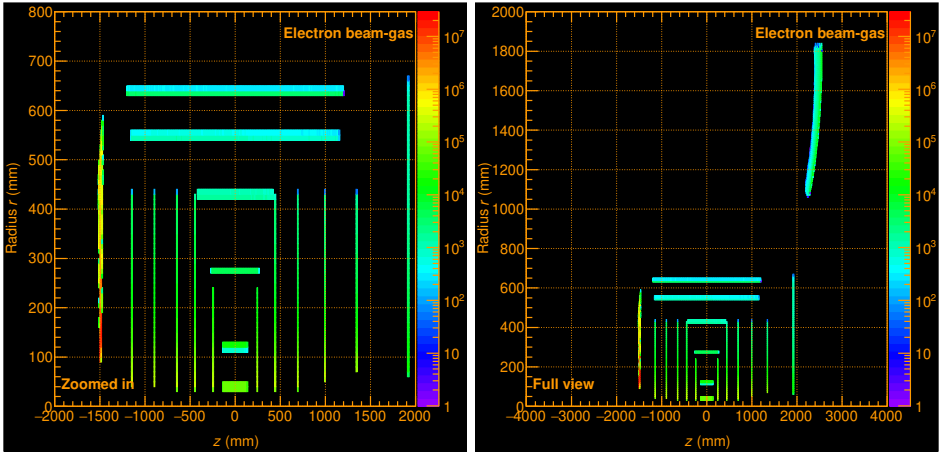

Figure 3: Hit r and z position from this simulation for aforementioned detector setup.

Hit $v_z t$

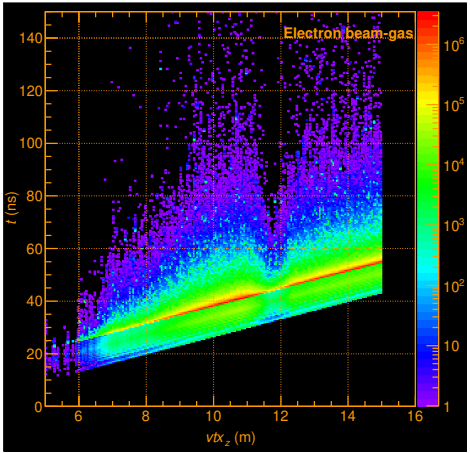

Figure 4: Hit vertex z position and time from this simulation for aforementioned detector setup.

Hit rates

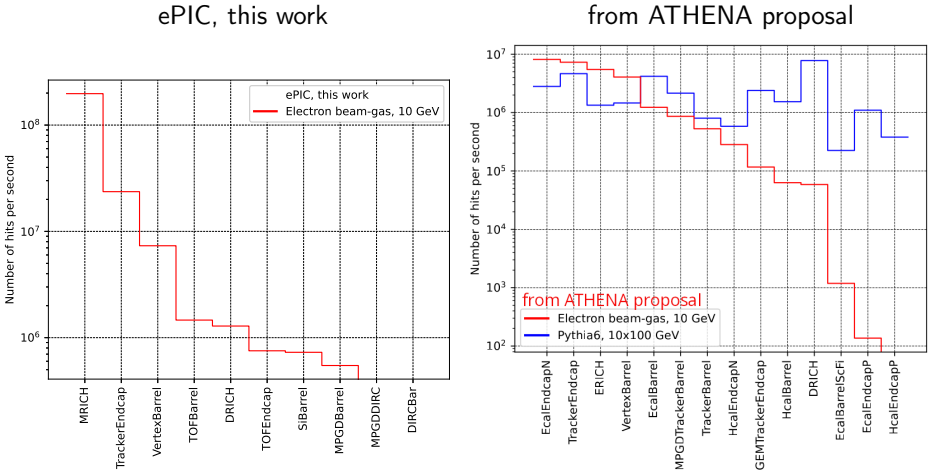

Figure 5: Detector hit rate for this simulation (left) and previous athena simulation (right).

Outlook

- Resolve outstanding issues with calorimeters and include them to the detector setup
- Finish detector thresholds
- Work on completing the full simulation
- Complete forward electron beamline integration

Hit rate

Detector and besm parameters

- Total production rate for electron-beam gas due to bremsstrahlung for $E_\gamma > 10$ keV calculated as 3.177 MHz
- Integration time for detector readout (information from Elke) - 2 μs
  - 3.177 Mhz * 2 μs $\doteq$ 6.35 bremsstrahlung interactions per integration time

Simulation paramteres

- $\sim$2M events (bremsstrahlung interactions) simulated
- number of hits in the most populated detector (*Tracker Endcap*) $\sim$15M
  - 15 M hits / 2M events $\doteq$ 7.5 hits per simulated event/interaction

Conclusion

- 7.5 (hits/interaction) * 6.35 (interactions/integration time) $\doteq$ 47 hits in the entire detector per readout time

Issue with pyROOT on SDCC

```
[rcas6009] ~/pwg/eic/> ./eic-shell
jug_xl> ceskajak@rcas6009:/gpfs01/star/pwg/ceskajak/eic$ source epic-23.01.0/install/setup.sh
jug_xl> ceskajak@rcas6009:/gpfs01/star/pwg/ceskajak/eic$ cd athena_particle_counter/macro/ddhits/
jug_xl> ceskajak@rcas6009:/gpfs01/star/pwg/ceskajak/eic/athena_particle_counter/macro/ddhits$ ./run_ddhits.py
Traceback (most recent call last):
  File "/usr/local/lib/root/cppyy/__init__.py", line 60, in <module>
    importlib.import_module(libcppyy_mod_name)
  File "/usr/lib/python3.11/importlib/__init__.py", line 126, in import_module
    return _bootstrap._gcd_import(name[level:], package, level)
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "<frozen importlib._bootstrap>", line 1206, in _gcd_import
  File "<frozen importlib._bootstrap>", line 1178, in _find_and_load
  File "<frozen importlib._bootstrap>", line 1142, in _find_and_load_unlocked
ModuleNotFoundError: No module named 'libcppyy3_11'

During handling of the above exception, another exception occurred:

Traceback (most recent call last):
  File "/gpfs01/star/pwg/ceskajak/eic/athena_particle_counter/macro/ddhits/./run_ddhits.py", line 8, in <module>
    from analysis import analysis
  File "/gpfs01/star/pwg/ceskajak/eic/athena_particle_counter/macro/ddhits/analysis.py", line 3, in <module>
    import ROOT
  File "/usr/local/lib/root/ROOT/__init__.py", line 22, in <module>
    import cppyy
  File "/usr/local/lib/root/cppyy/__init__.py", line 62, in <module>
    raise ImportError(
ImportError: Failed to import libcppyy3_11. Please check that ROOT has been built for Python 3.11
jug_xl> ceskajak@rcas6009:/gpfs01/star/pwg/ceskajak/eic/athena_particle_counter/macro/ddhits$
```

Issue present on CVMFS release of eic-shell on SDCC. Not present on same eic-shell version run localy.