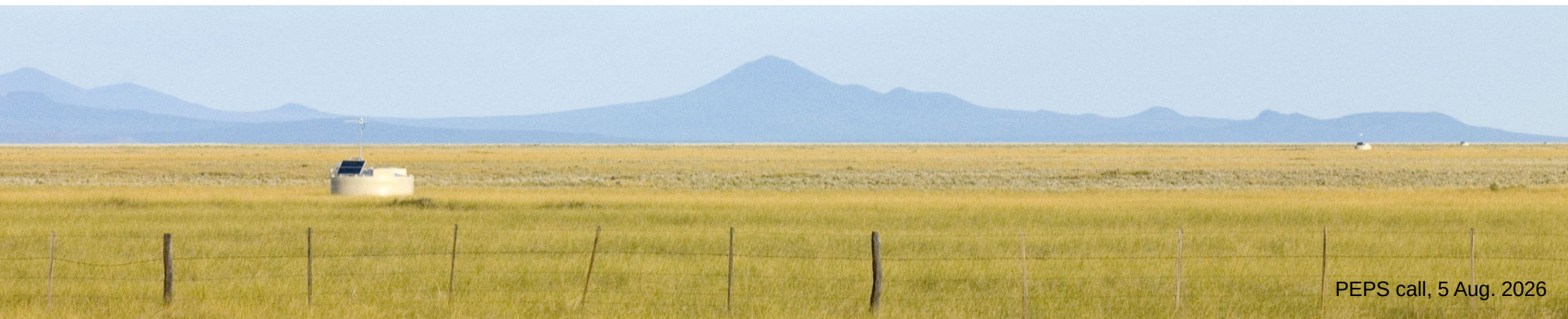


On the PEPS simulation pipeline in AugerOffline

N. González¹ and I. Maris²

¹ Instituto de Tecnologías en Detección y Astropartículas (ITeDA)

² Université Libre de Bruxelles (ULB)



Overview

- ▶ [origin/peps branch](#) has been updated with two `ExampleApplications`

- `SegmentedTank_v2r8`: application copied from the old (~ 10 years) `v2r8-blacktank-experimental` offline branch. Should only be used for reference.

- `SegmentedTank`: port of the old application to current version of Offline

- ▶ Offline compiled with Ubuntu 26.04 using externals from [ape-augerdev-20260514](#)

- ▶ The application is executed following this command sequence (adapt the path accordingly)

1. `eval `/srv/workspace_favalli/ngonzalez/peps_install/bin/auger-offline-config --env-sh``
2. `cd /srv/workspace_favalli/ngonzalez/peps_install/share/auger-offline/doc/ExampleApplications/SegmentedTank`
3. `make run`

Basic configuration files

► EventFileReader.xml.in

- The [input simulated air shower](#)* must be inserted in the tag InputFileNames. By default, we include a 10 PeV proton shower in the same directory

► EventGenerator.xml.in

- The [shower core is randomized](#) around the central station (<stationAtCenter>) of the array in a rectangular area with a configurable size (<deltaNorthing> and <deltaEasting>)

► RecDataWriter.xml.in

- The simulated event is saved in a [ROOT-based format called ADST](#). Here you can configure what variables are saved. Default configuration should be sufficient for most purposes. More info in /offline/Modules/General/RecDataWriterNG

► Miscellaneous

- fix-ci-seeds.sh: controls the CI checks done in GitLab. No user action required
- 'old': bookkeeping old config. files
- 'resources': example scripts for batch event production in clusters
- 'spacing_95m': example config. files for a denser array

* The default configuration supports Corsika showers. For Aires, change the tags <CORSIKA> to <AIRES>

ModuleSequence

```
<loop numTimes="unbounded" pushEventToStack="yes">

  <module> EventFileReaderOG </module>

  <!-- increase numTimes if you want to throw the shower into the array more than once -->
  <loop numTimes="1" pushEventToStack="yes">

    <module> EventGeneratorOG </module>

    <!-- simulation of muon background -->
    <module> SdAccidentalInjectorKG </module>

    <!-- Event simulation -->

    <loop numTimes="unbounded" pushEventToStack="no">
      <module> CachedShowerRegeneratorOG </module>
      <module> G4StationSimulatorOG </module>
      <!--<module> G4SimulatorSegmentedTank </module>-->
    </loop>

    <module> SdSimulationCalibrationFillerOG </module>
    <module> SdPMTSimulatorOG </module>
    <module> SdFilterFADCSimulatorMTU </module>
    <module> SdBaselineSimulatorOG </module>
    <module> TankTriggerSimulatorOG </module>
    <module> TankGPSSimulatorOG </module>

    <module> ClearParticleLists </module>

    <module> CentralTriggerSimulatorXb </module>
    <module> CentralTriggerEventBuilderOG </module>
    <module> EventBuilderOG </module>

    <!-- Event reconstruction (to be developed) -->

    <module> EventCheckerOG </module>
    <module> SdGainRatioCorrectorKG </module>
    <module> SdStationCheckerOG </module>
    <module> SdHistogramFitterKG </module>
    <module> SdBaselineFinderKG </module>
    <module> SdTraceCalibratorOG </module>
    <!--<module> SdCalibratorSegmentedTank </module>-->

    <try>
      <module> SdSignalRecoveryKLT </module>
      <module> SdMonteCarloEventSelectorOG </module>
      <module> SdEventSelectorOG </module>
      <module> SdPlaneFitOG </module>
      <module> LDFFinderKG </module>
      <module> Risetime1000LLL </module>
      <module> SdEventPosteriorSelectorOG </module>
    </try>

    <!-- Writing output -->
    <module> RecDataWriterNG </module>

  </loop>
</loop>
```



For now, we are simulating Auger stations. The [G4SimulatorSegmentedTank](#) module from the 'old' Offline branch must be merged with the current [G4StationSimulatorOG](#).

The PEPS stations are designed in [SModelConfigSegmented.xml](#) (that calls [SModelsSegmented.xml](#)).

The calibration settings are defined in [SdSimCalibConstSegmentedTank.xml](#).

ModuleSequence

```
<loop numTimes="unbounded" pushEventToStack="yes">

  <module> EventFileReaderOG </module>

  <!-- increase numTimes if you want to throw the shower into the array more than once -->
  <loop numTimes="1" pushEventToStack="yes">

    <module> EventGeneratorOG </module>

    <!-- simulation of muon background -->
    <module> SdAccidentalInjectorKG </module>

    <!-- Event simulation -->

    <loop numTimes="unbounded" pushEventToStack="no">
      <module> CachedShowerRegeneratorOG </module>
      <module> G4StationSimulatorOG </module>
      <!--<module> G4SimulatorSegmentedTank </module>-->
    </loop>

    <module> SdSimulationCalibrationFillerOG </module>
    <module> SdPMTSimulatorOG </module>
    <module> SdFilterFADCSimulatorMTU </module>
    <module> SdBaselineSimulatorOG </module>
    <module> TankTriggerSimulatorOG </module>
    <module> TankGPSSimulatorOG </module>

    <module> ClearParticleLists </module>

    <module> CentralTriggerSimulatorXb </module>
    <module> CentralTriggerEventBuilderOG </module>
    <module> EventBuilderOG </module>

    <!-- Event reconstruction (to be developed) -->

    <module> EventCheckerOG </module>
    <module> SdGainRatioCorrectorKG </module>
    <module> SdStationCheckerOG </module>
    <module> SdHistogramFitterKG </module>
    <module> SdBaselineFinderKG </module>
    <module> SdTraceCalibratorOG </module>
    <!--<module> SdCalibratorSegmentedTank </module>-->

    <try>
      <module> SdSignalRecoveryKLT </module>
      <module> SdMonteCarloEventSelectorOG </module>
      <module> SdEventSelectorOG </module>
      <module> SdPlaneFitOG </module>
      <module> LDFFinderKG </module>
      <module> Risetime1000LLL </module>
      <module> SdEventPosteriorSelectorOG </module>
    </try>

    <!-- Writing output -->
    <module> RecDataWriterNG </module>

  </loop>
</loop>
```



These are the standard modules for the SD simulation. For PEPS, the `TankTriggerSimulator` module will receive dedicated configuration from `TankTriggerSimulatorSegmented.xml`, which should be reviewed

Similarly, the `SdBaselineSimulator` and `TankGPSSimulator` received, in the 'old' Offline, special configuration through the `bootstrap.xml`. These choices have to be reviewed

ModuleSequence

```
<loop numTimes="unbounded" pushEventToStack="yes">

  <module> EventFileReaderOG </module>

  <!-- increase numTimes if you want to throw the shower into the array more than once -->
  <loop numTimes="1" pushEventToStack="yes">

    <module> EventGeneratorOG </module>

    <!-- simulation of muon background -->
    <module> SdAccidentalInjectorKG </module>

    <!-- Event simulation -->

    <loop numTimes="unbounded" pushEventToStack="no">
      <module> CachedShowerRegeneratorOG </module>
      <module> G4StationSimulatorOG </module>
      <!--<module> G4SimulatorSegmentedTank </module>-->
    </loop>

    <module> SdSimulationCalibrationFillerOG </module>
    <module> SdPMTSimulatorOG </module>
    <module> SdFilterFADCsSimulatorMTU </module>
    <module> SdBaselineSimulatorOG </module>
    <module> TankTriggerSimulatorOG </module>
    <module> TankGPSSimulatorOG </module>

    <module> ClearParticleLists </module>

    <module> CentralTriggerSimulatorXb </module>
    <module> CentralTriggerEventBuilderOG </module>
    <module> EventBuilderOG </module>

    <!-- Event reconstruction (to be developed) -->

    <module> EventCheckerOG </module>
    <module> SdGainRatioCorrectorKG </module>
    <module> SdStationCheckerOG </module>
    <module> SdHistogramFitterKG </module>
    <module> SdBaselineFinderKG </module>
    <module> SdTraceCalibratorOG </module>
    <!--<module> SdCalibratorSegmentedTank </module>-->

    <try>
      <module> SdSignalRecoveryKLT </module>
      <module> SdMonteCarloEventSelectorOG </module>
      <module> SdEventSelectorOG </module>
      <module> SdPlaneFitOG </module>
      <module> LDFFinderKG </module>
      <module> Risetime1000LLL </module>
      <module> SdEventPosteriorSelectorOG </module>
    </try>

    <!-- Writing output -->
    <module> RecDataWriterNG </module>

  </loop>
</loop>
```



Modules used to **build array triggers**. Should be reviewed considering the different trigger timing and spacing for PEPS, specially in CentralTriggerSimulator

ModuleSequence

```
<loop numTimes="unbounded" pushEventToStack="yes">

  <module> EventFileReaderOG </module>

  <!-- increase numTimes if you want to throw the shower into the array more than once -->
  <loop numTimes="1" pushEventToStack="yes">

    <module> EventGeneratorOG </module>

    <!-- simulation of muon background -->
    <module> SdAccidentalInjectorKG </module>

    <!-- Event simulation -->

    <loop numTimes="unbounded" pushEventToStack="no">
      <module> CachedShowerRegeneratorOG </module>
      <module> G4StationSimulatorOG </module>
      <!--<module> G4SimulatorSegmentedTank </module>-->
    </loop>

    <module> SdSimulationCalibrationFillerOG </module>
    <module> SdPMTSimulatorOG </module>
    <module> SdFilterFADCsSimulatorMTU </module>
    <module> SdBaselineSimulatorOG </module>
    <module> TankTriggerSimulatorOG </module>
    <module> TankGPSSimulatorOG </module>

    <module> ClearParticleLists </module>

    <module> CentralTriggerSimulatorXb </module>
    <module> CentralTriggerEventBuilderOG </module>
    <module> EventBuilderOG </module>

    <!-- Event reconstruction (to be developed) -->

    <module> EventCheckerOG </module>
    <module> SdGainRatioCorrectorKG </module>
    <module> SdStationCheckerOG </module>
    <module> SdHistogramFitterKG </module>
    <module> SdBaselineFinderKG </module>
    <module> SdTraceCalibratorOG </module>
    <!--<module> SdCalibratorSegmentedTank </module>-->

    <try>
      <module> SdSignalRecoveryKLT </module>
      <module> SdMonteCarloEventSelectorOG </module>
      <module> SdEventSelectorOG </module>
      <module> SdPlaneFitOG </module>
      <module> LDFFinderKG </module>
      <module> Risetime1000LLL </module>
      <module> SdEventPosteriorSelectorOG </module>
    </try>

    <!-- Writing output -->
    <module> RecDataWriterNG </module>

  </loop>
</loop>
```



First reconstruction modules. Should be optimized for PEPS detectors.

The module [SdCalibratorSegmentedTank](#) is a dedicated module present in the 'old' Offline. Must be ported and adapted to current Offline

ModuleSequence

```
<loop numTimes="unbounded" pushEventToStack="yes">

  <module> EventFileReaderOG </module>

  <!-- increase numTimes if you want to throw the shower into the array more than once -->
  <loop numTimes="1" pushEventToStack="yes">

    <module> EventGeneratorOG </module>

    <!-- simulation of muon background -->
    <module> SdAccidentalInjectorKG </module>

    <!-- Event simulation -->

    <loop numTimes="unbounded" pushEventToStack="no">
      <module> CachedShowerRegeneratorOG </module>
      <module> G4StationSimulatorOG </module>
      <!--<module> G4SimulatorSegmentedTank </module>-->
    </loop>

    <module> SdSimulationCalibrationFillerOG </module>
    <module> SdPMTSimulatorOG </module>
    <module> SdFilterFADCsSimulatorMTU </module>
    <module> SdBaselineSimulatorOG </module>
    <module> TankTriggerSimulatorOG </module>
    <module> TankGPSSimulatorOG </module>

    <module> ClearParticleLists </module>

    <module> CentralTriggerSimulatorXb </module>
    <module> CentralTriggerEventBuilderOG </module>
    <module> EventBuilderOG </module>

    <!-- Event reconstruction (to be developed) -->

    <module> EventCheckerOG </module>
    <module> SdGainRatioCorrectorKG </module>
    <module> SdStationCheckerOG </module>
    <module> SdHistogramFitterKG </module>
    <module> SdBaselineFinderKG </module>
    <module> SdTraceCalibratorOG </module>
    <!--<module> SdCalibratorSegmentedTank </module>-->

    <try>
      <module> SdSignalRecoveryKLT </module>
      <module> SdMonteCarloEventSelectorOG </module>
      <module> SdEventSelectorOG </module>
      <module> SdPlaneFitOG </module>
      <module> LDFFinderKG </module>
      <module> Risetime1000LLL </module>
      <module> SdEventPosteriorSelectorOG </module>
    </try>

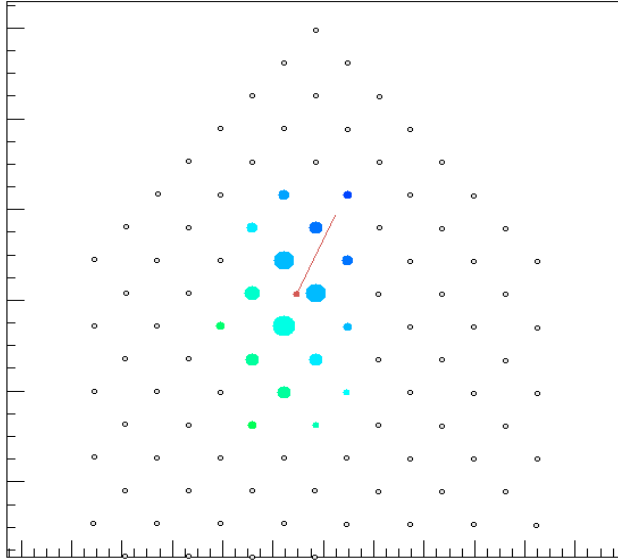
    <!-- Writing output -->
    <module> RecDataWriterNG </module>

  </loop>
</loop>
```

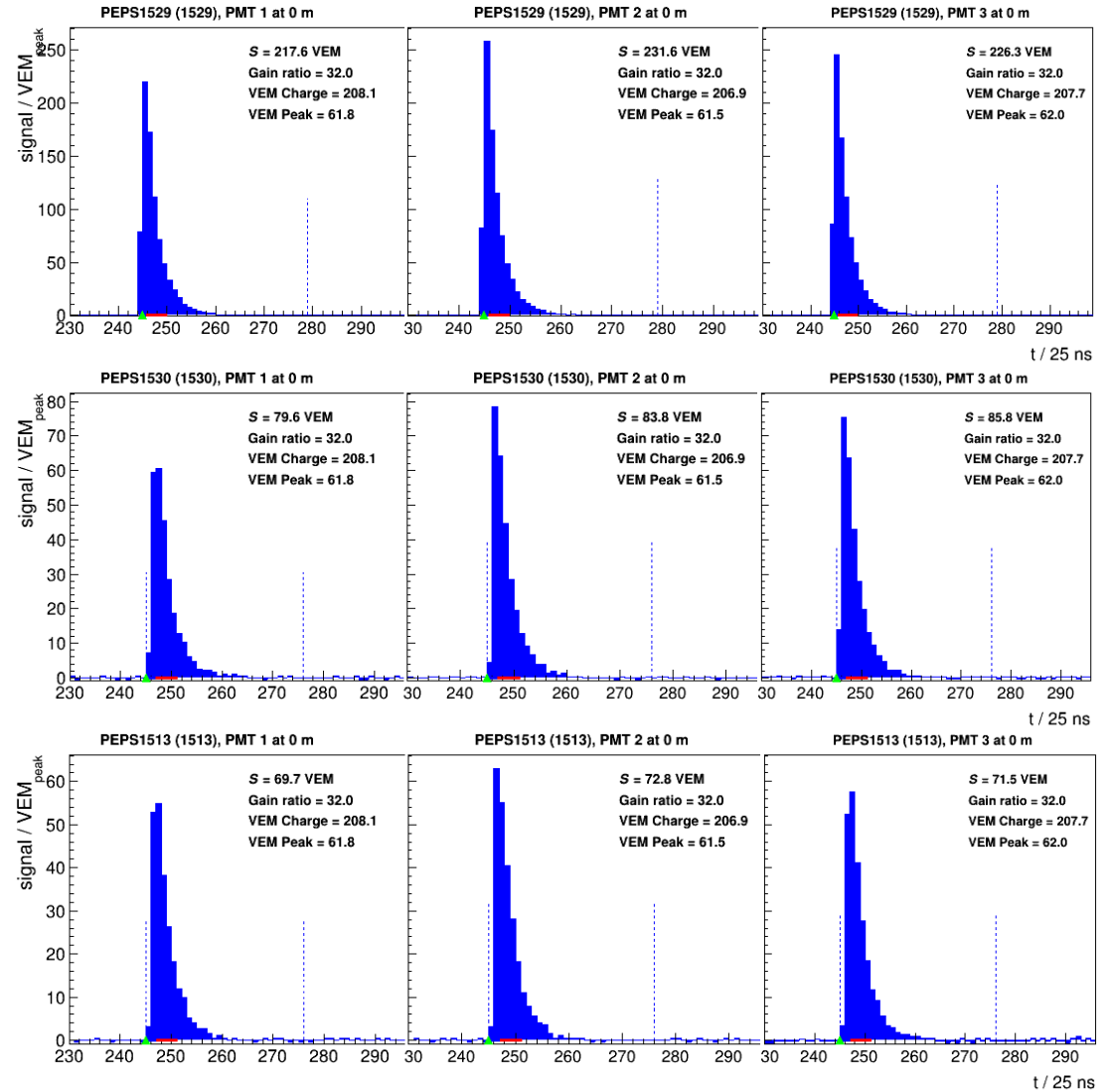


High-level reconstruction modules. Should be optimized for PEPS detectors.

A first simulated event



- 19° 10 PeV proton shower landing in a 145-m spacing with Auger SD stations
- Traces recovered for the three LPMTs in each station



Summary

- ▶ A working application to simulate and reconstruct SD events in a 145-m array has been committed to 'peps' Offline branch
- ▶ Several XML configurations that require review and/or optimization have been identified
- ▶ Two dedicated Offline modules have to be ported from the old v2r8 Offline branch

Backup