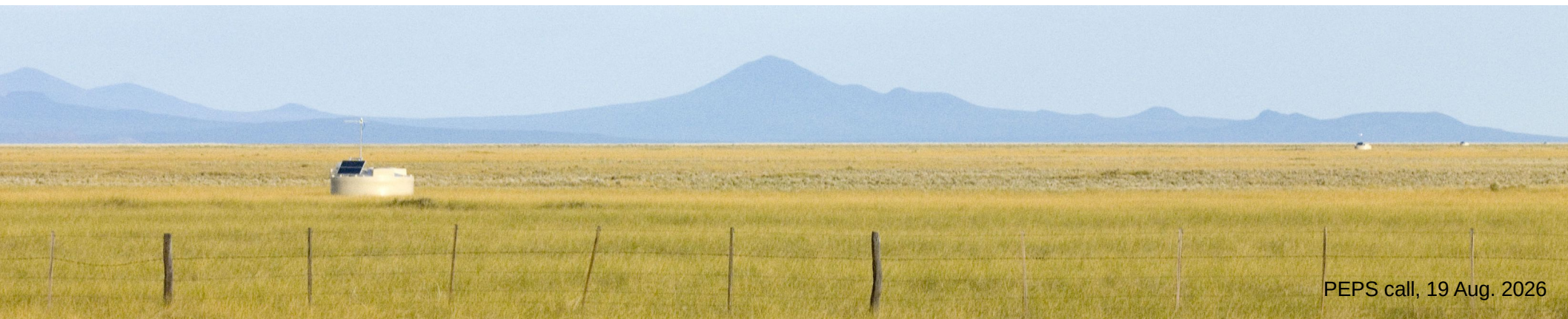


Setup of the PEPS stations in Offline

N. González¹ and I. Maris²

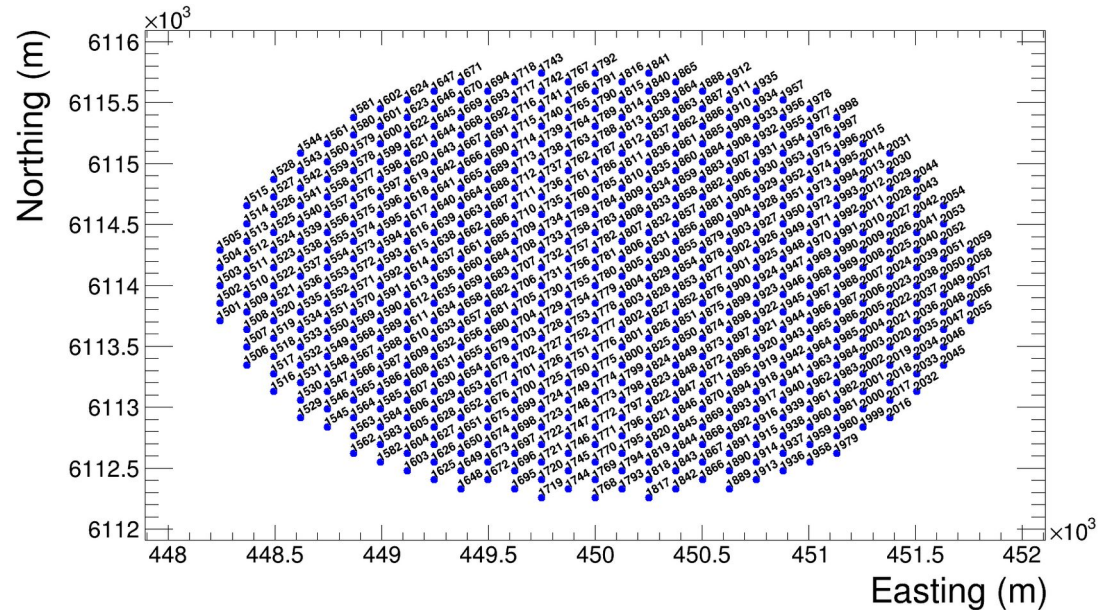
¹ Instituto de Tecnologías en Detección y Astropartículas (ITeDA)

² Université Libre de Bruxelles (ULB)



Circular outer ring

- ▶ 558 stations compose a 10 km² array
- ▶ External shape of the array is now a circle instead of a hexagon
- ▶ Included a ROOT script in the application source to write station lists



SModelConfig

- ▶ Detector geometry and characteristics are defined in four XML files
- ▶ The main one is called **SModelConfig**
- ▶ Sets the tank casing, water, liner, PMTs and electronics

```
<tankCasing id="rotoplas"/>
<tankPMTConfig id="standard"/>
<water id="standard"/>
<liner id="1073B-tyvek"/>
<electronics id="40MHz"/>

<!-- Top three large PMTs -->
<PMT PMTId="1" id="photonis-XP1805"/>
<PMT PMTId="2" id="photonis-XP1805"/>
<PMT PMTId="3" id="photonis-XP1805"/>
<!-- Bottom large PMT -->
<PMT PMTId="4" id="photonis-XP1805"/>

<!-- PMT-specific electronics properties -->
<pmtElectronics PMTId="1" id="wcdLarge40MHz"/>
<pmtElectronics PMTId="2" id="wcdLarge40MHz"/>
<pmtElectronics PMTId="3" id="wcdLarge40MHz"/>
<pmtElectronics PMTId="4" id="wcdLarge40MHz"/>
```

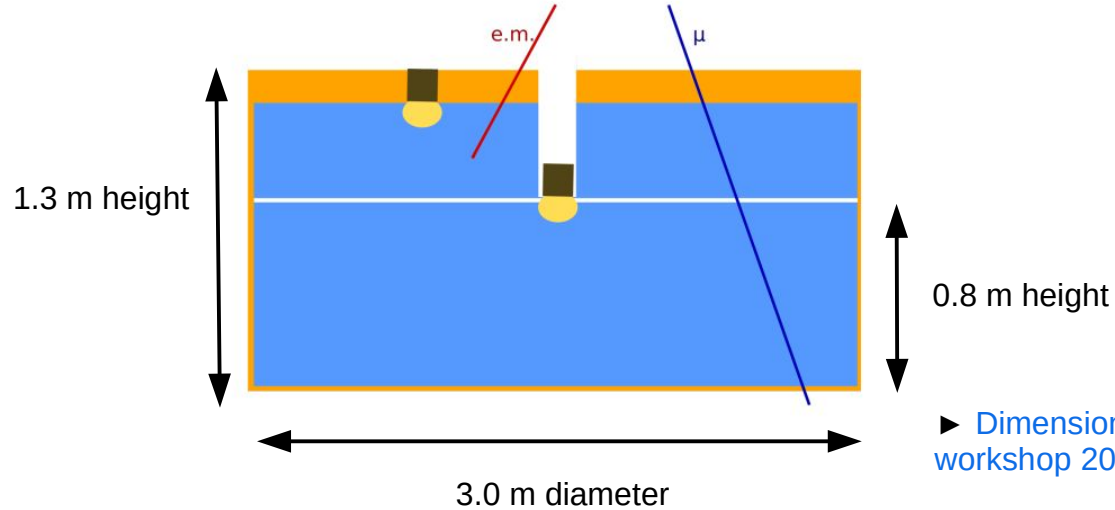
SModelConfigSegmented.xml

- ▶ The definition of each tag (e.g., parameters of “40 MHz electronics”) are defined in three auxiliary files that are discussed later

```
<!-- station models are loaded from separate files -->
<stationModels>
  &pmtModels;
  &electronicsModels;
  &stationModels; <!-- PEPS double-layered geometry -->
</stationModels>
```

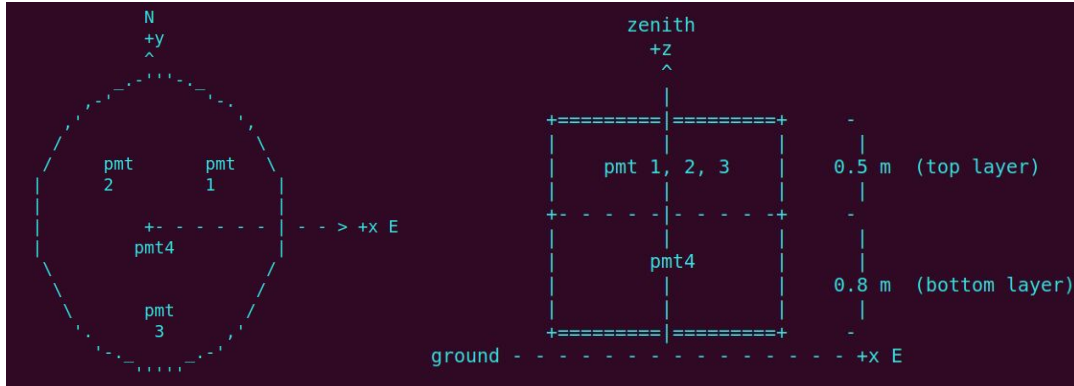
- ▶ For PEPS, we inherit elements from the base design of Auger WCDs:
 - casing, water and liner
 - Photonis large PMTs
 - pre-upgrade 40 MHz electronics

Dimensions of PEPS stations



- ▶ Dimensions taken from Andrea & Ioana's presentation at PEPS workshop 2025
- ▶ Reduction from the 3.6 m diameter used in Auger to allow for easier transport (Ioana @ ICRC 2025)
- ▶ Three PMTs facing the top layer and one facing the bottom layer
- ▶ Setting $(x,y) = (0,0)$ as the center of the tank, the PMT positions are:
 - PMT1 = (1.039 , 0.6) m
 - PMT2 = (-1.039 , 0.6) m
 - PMT3 = (0 , -1.2) m
 - PMT4 = (0,0) m

SModels: ready for review/test



```
<tankCasing id="rotoplas">
  <insideRadius unit="m"> 1.5 </insideRadius>
  <insideHeight unit="m"> 1.3 </insideHeight>
  <casingThickness unit="mm"> 12.7 </casingThickness>
</tankCasing>
```

```
<tankPMTConfig id="standard">
  <!-- Top three large PMTs -->
  <PMTPosition PMTId="1" unit="m"> 1.039 0.600 1.300 </PMTPosition>
  <PMTPosition PMTId="2" unit="m"> -1.039 0.600 1.300 </PMTPosition>
  <PMTPosition PMTId="3" unit="m"> 0.000 -1.200 1.300 </PMTPosition>
  <!-- Bottom large PMT -->
  <PMTPosition PMTId="4" unit="m"> 0.000 0.000 0.800 </PMTPosition>
</tankPMTConfig>
```

SModelsSegmented.xml

```
<water id="standard">
  <waterAbsorptionLength> <!-- tabulated function -->
    <x unit="eV"> <!-- photon energy bins -->
      2.08 2.16 2.19 2.23 2.27 2.32
      2.36 2.41 2.46 2.50 2.56 2.61
      2.67 2.72 2.79 2.85 2.92 2.99
      3.06 3.14 3.22 3.31 3.40 3.49
      3.59 3.70 3.81 3.94 4.07 4.20
    </x>
    <y> <!-- absorption length in relative units -->
      0.092 0.133 0.180 0.203 0.226 0.258
    </y>
  </waterAbsorptionLength>
</water>
```

```
<liner id="1073B-tyvek">
  <reflectivity_shape>
    <x unit="eV">
      2.08 2.16 2.19 2.23 2.27 2.32
      2.36 2.41 2.46 2.50 2.56 2.61
      2.67 2.72 2.79 2.85 2.92 2.99
      3.06 3.14 3.22 3.31 3.40 3.49
      3.59 3.70 3.81 3.94 4.07 4.20
    </x>
    <y>
      0.9957 0.9953 0.9948 0.9942 0.9939 0.9937
    </y>
  </reflectivity_shape>
</liner>
```

SPMTModels and SElectronicsModels

- ▶ The first describes the **Photonis PMT**, like the quantum efficiency, gain, anode pulse shape, etc
- ▶ The second describes the **40 MHz electronics**, like the number of trace bins, latch bin, high- and low-gain channel
- ▶ **Many prototypes** already loaded in the Auger versions of these files. We simply point to the proper prototype in the SModelsConfig.xml:

`<electronics id="40MHz"/>`

`<PMT PMTId="1" id="photonis-XP1805"/>` (the same for the other three PMTs)

`<pmtElectronics PMTId="1" id="wcdLarge40MHz"/>` (the same for the other three PMTs)

- ▶ Both XMLs can be found in `<offline_source>/Framework/SDetector/`

SdSimCalibrationConstants: ready for review/test

- ▶ Sets peak and charge parameters of each PMT. Used in the simulation of the detector's response
- ▶ For the top three PMTs, the values are taken from the Auger version of this file
- ▶ For the bottom PMT, the values are chosen as the average between the other three PMTs
- ▶ Is this correct? Must be checked!

SdSimCalibConstSegmentedTank.xml

```
<!-- G4StationSimulatorOG, 5000 runs, energy = 1 GeV -->
<!-- Taken from the Auger SD calibration constants -->
<!-- The PMT4 values are the average of the other three -->
<simModule name="G4StationSimulatorSegmented">
  <electronics isUUB="0">
    <PMT id='1'>
      <peak> 61.7694 </peak>
      <charge> 203.91 </charge>
    </PMT>
    <PMT id='2'>
      <peak> 61.512 </peak>
      <charge> 202.777 </charge>
    </PMT>
    <PMT id='3'>
      <peak> 61.988 </peak>
      <charge> 203.548 </charge>
    </PMT>
    <PMT id='4'>
      <peak> 61.756 </peak>
      <charge> 203.412 </charge>
    </PMT>
  </electronics>
</simModule>
```

ToDo

- ▶ G4StationSimulator module designed for segmented tanks, named [G4StationSimulatorPEPS](#)
 - merge the 'old' G4SimulatorSegmentedTank and current G4StationSimulator → quite a lot of work :(
 - add simulation of buried scintillators (UMD) → should be significantly easier :)
- ▶ Arrange a first reconstruction sequence for simulated events
 - include the SD-433 reconstruction parametrizations

Backup