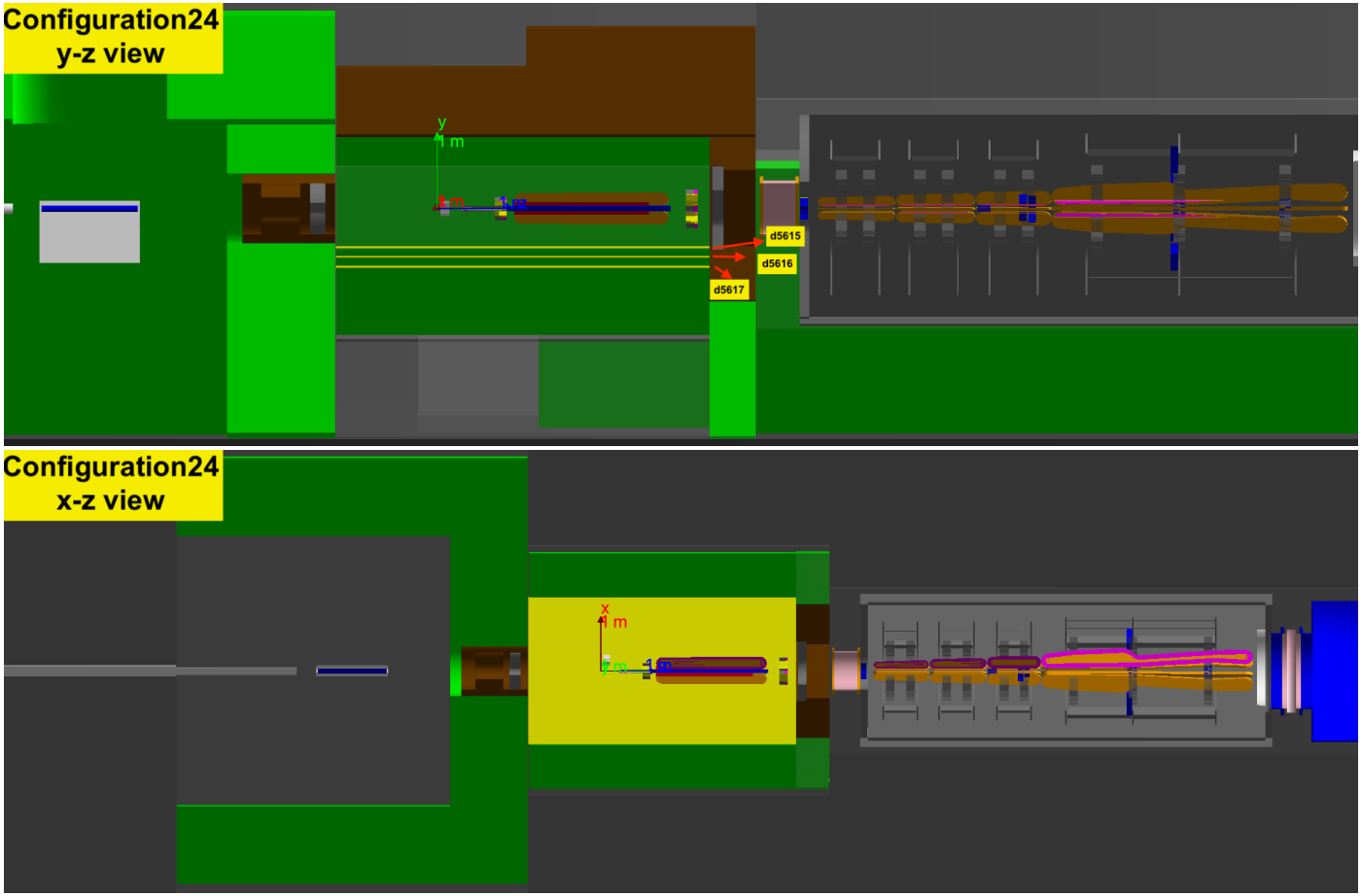
TID calculations for the 1cm thick Viton & EPDM

Ciprian Gal, Vassu Doomra, Zuhal Seyma Demiroglu

11 Mar, 2022

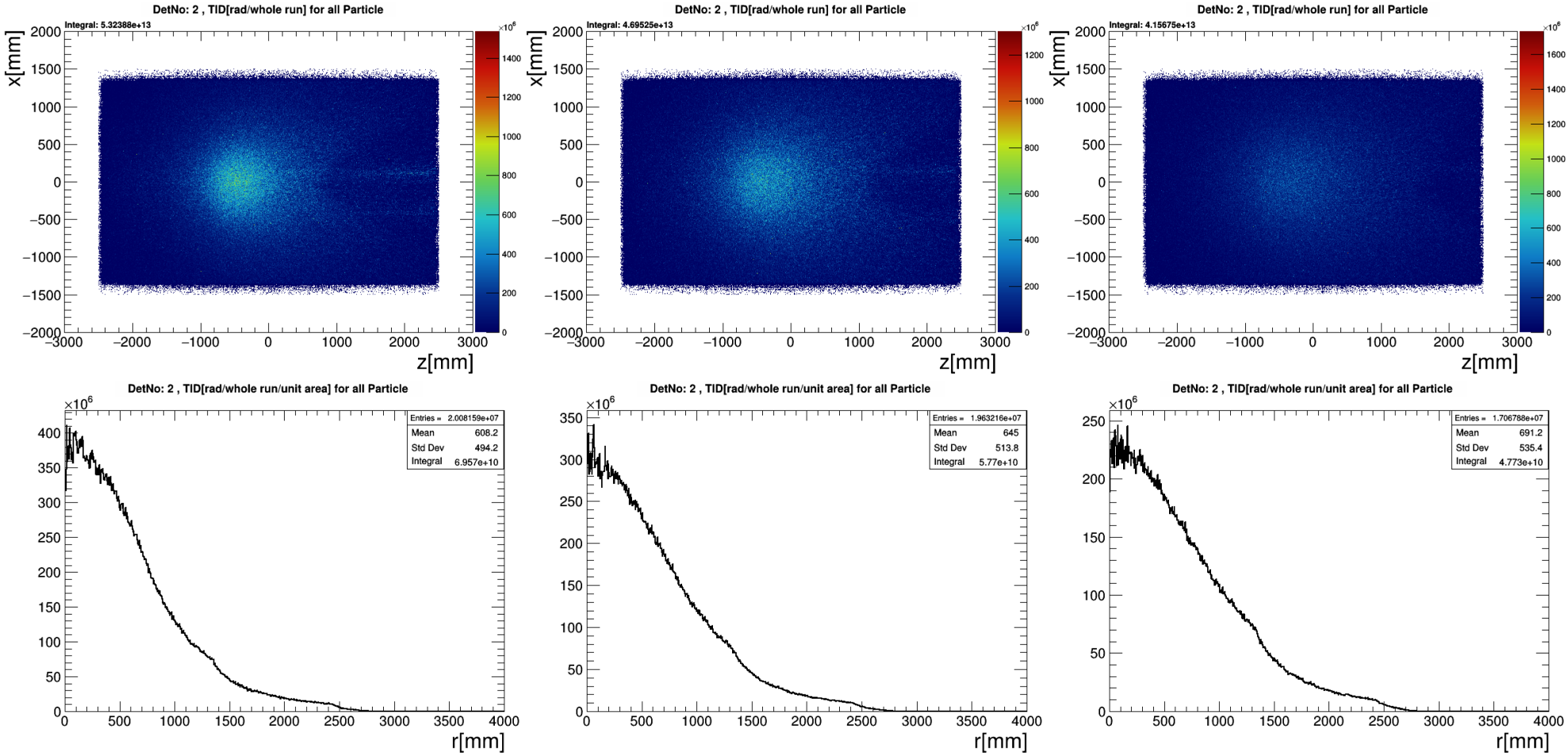
Updated shielding geometry: Configuration24



- New PS bunker design is implemented.
- We evaluated separately the TID for 1cm thick Viton and EPDM materials by using the flux of particles in the following detector planes which are placed underneath the US torus box.
- y_{d5615}= -510.54mm, y_{d5616}= -635mm, y_{d5617}= -762mm

TID calculations for US Torus Bottom det. planes (Viton)

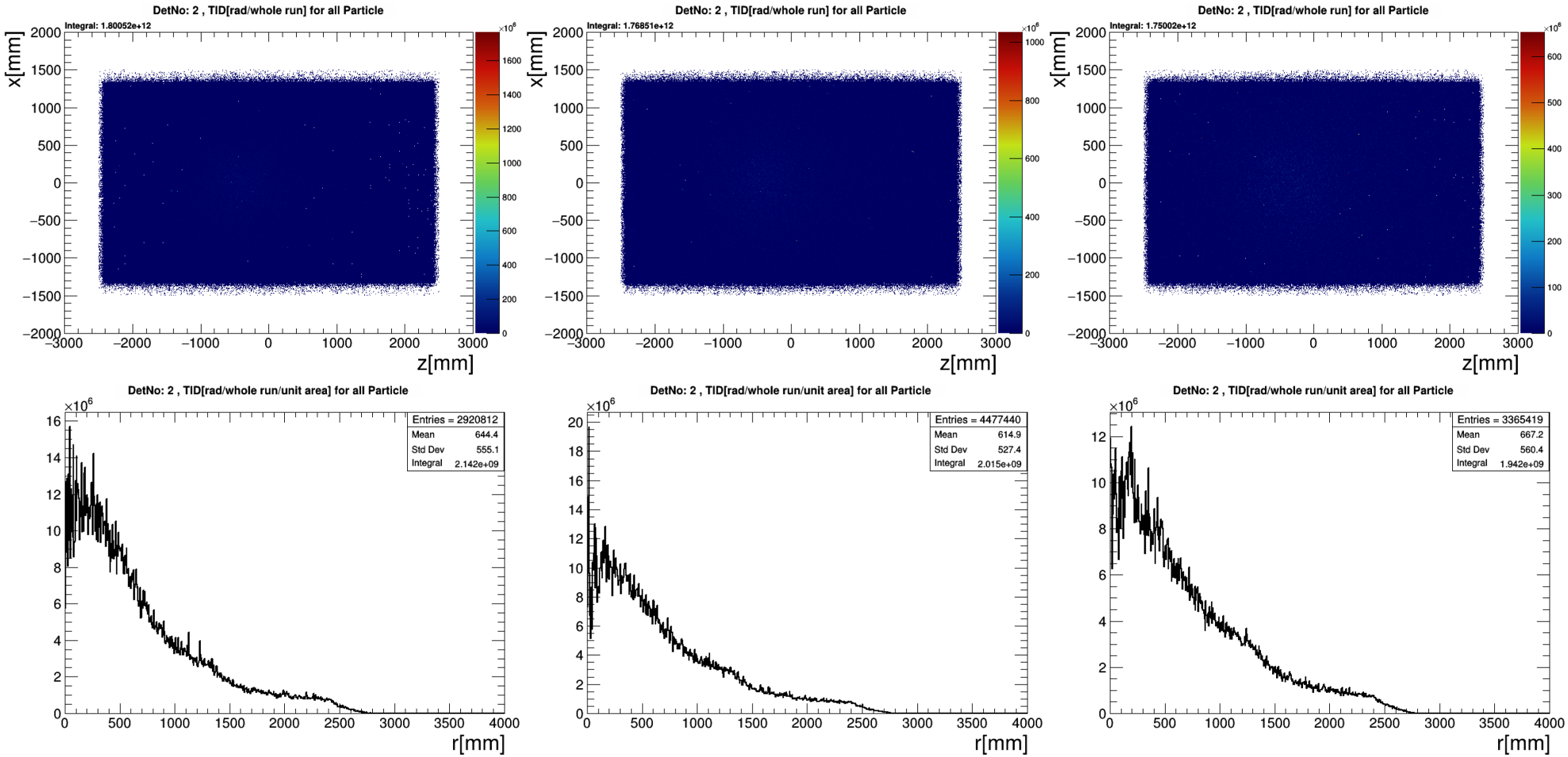
- Simulation ran with shielding config24 (100M beam generator events).
- The particles are passed through 1cm thick of *G4_Viton* plane and deposited energy is evaluated per 5x5mm^2 block (please see page 11 for the simulation geometry).
- TID is computed by dividing the energy deposition in that block by the mass and the results are integrated over the whole MOLLER run.



Top: The 2D distributions of all the particle hits which is weighted by radiation dose for the d5615 (left), d5616 (middle), d5617 (right). Bottom: The average radiation dose as a function of radius for the d5615 (left), d5616 (middle), d5617 (right).

TID calculations for US Torus Bottom det. planes (Viton), with 5cm Pb Shielding

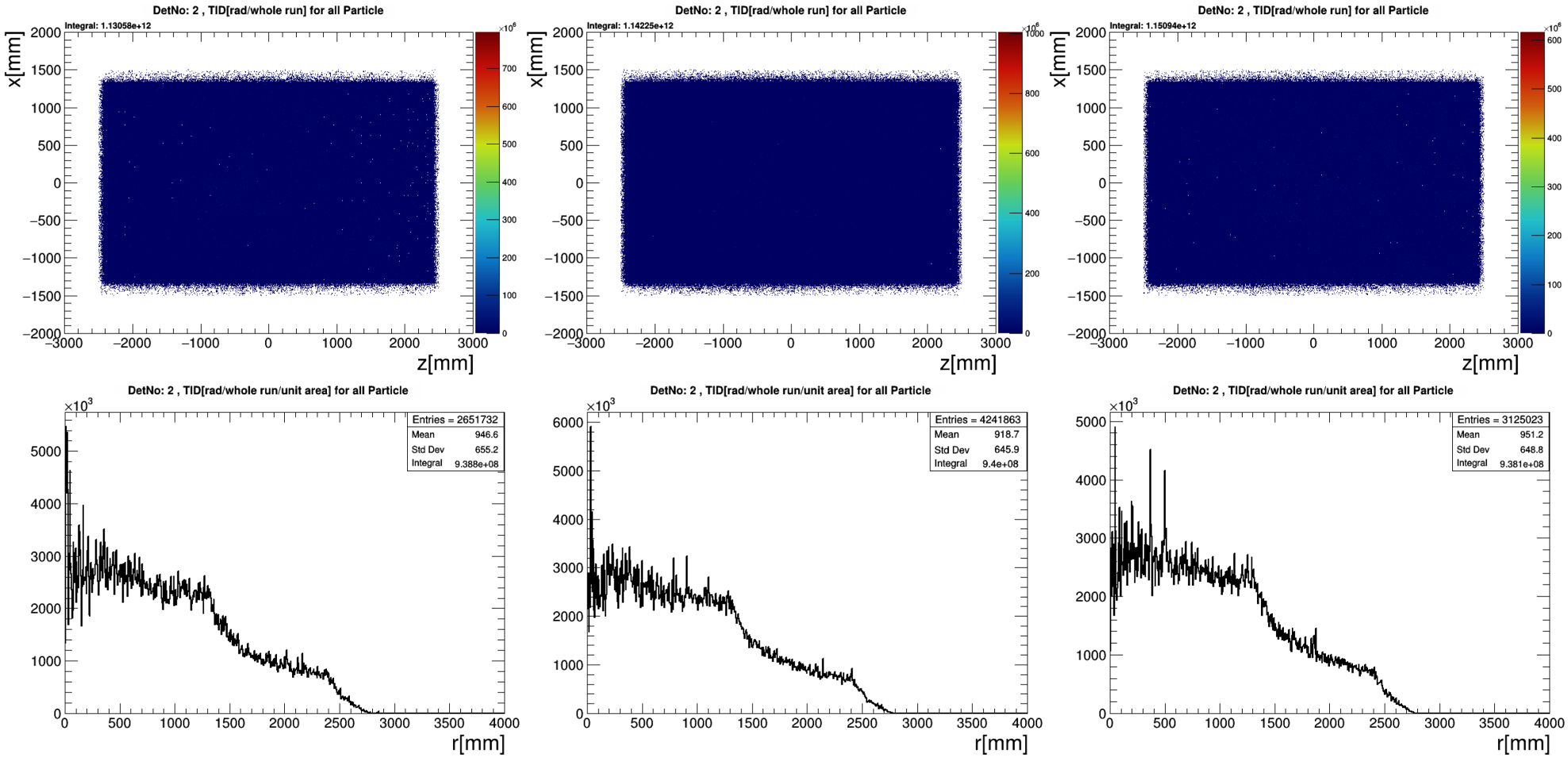
- The similar study is performed by adding 5cm thick Pb in front of the Viton planes (Please see page 12 for the simulation geometry).



Top: The 2D distributions of all the particle hits which is weighted by radiation dose for the d5615 (left), d5616 (middle), d5617 (right).
Bottom: The average radiation dose as a function of radius for the d5615 (left), d5616 (middle), d5617 (right).

TID calc. for US Torus Bottom det. planes (Viton), with 10cm Pb Shielding

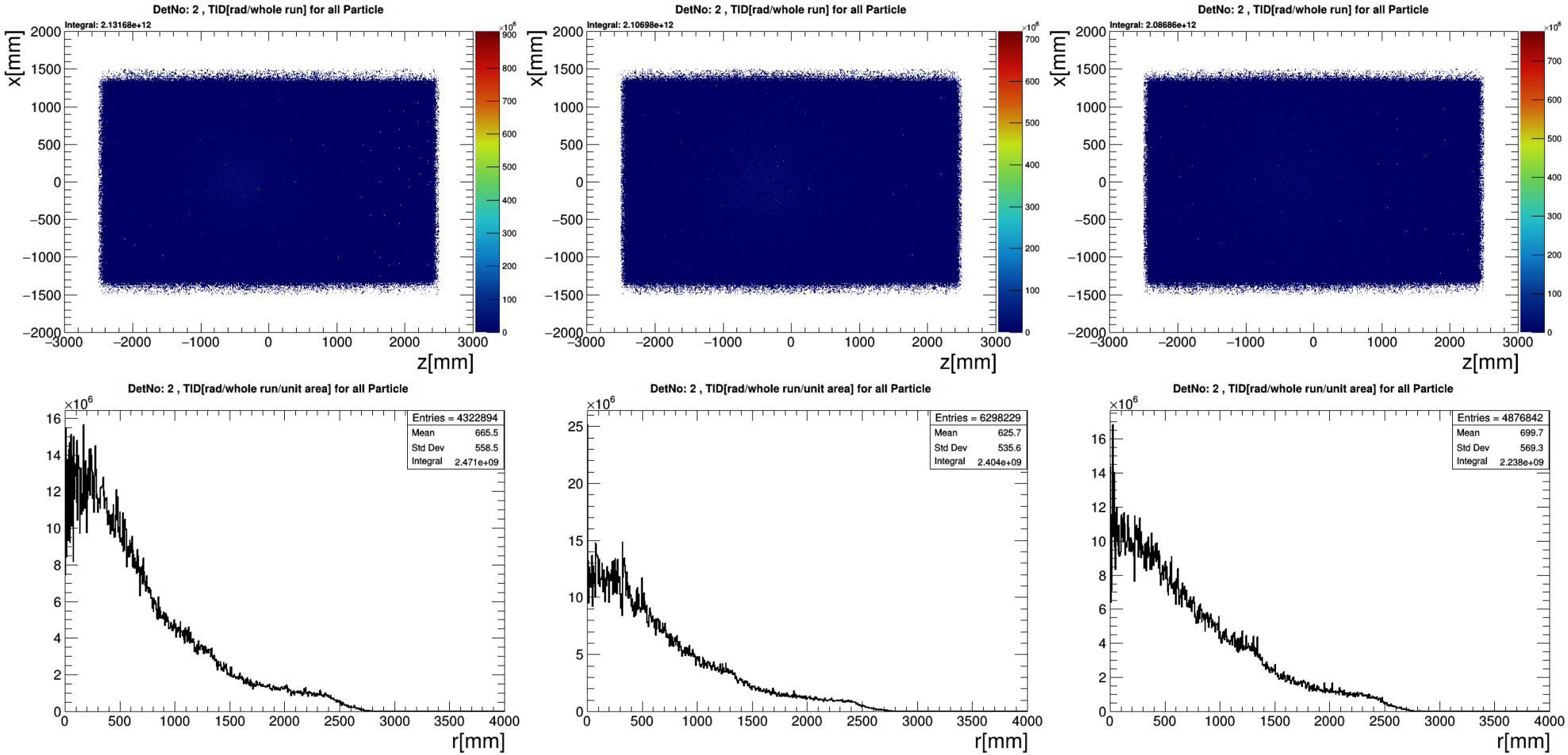
- The similar study is performed by adding 10cm thick Pb in front of the Viton planes (Please see page 13 for the simulation geometry).



Top: The 2D distributions of all the particle hits which is weighted by radiation dose for the d5615 (left), d5616 (middle), d5617 (right).
Bottom: The average radiation dose as a function of radius for the d5615 (left), d5616 (middle), d5617 (right).

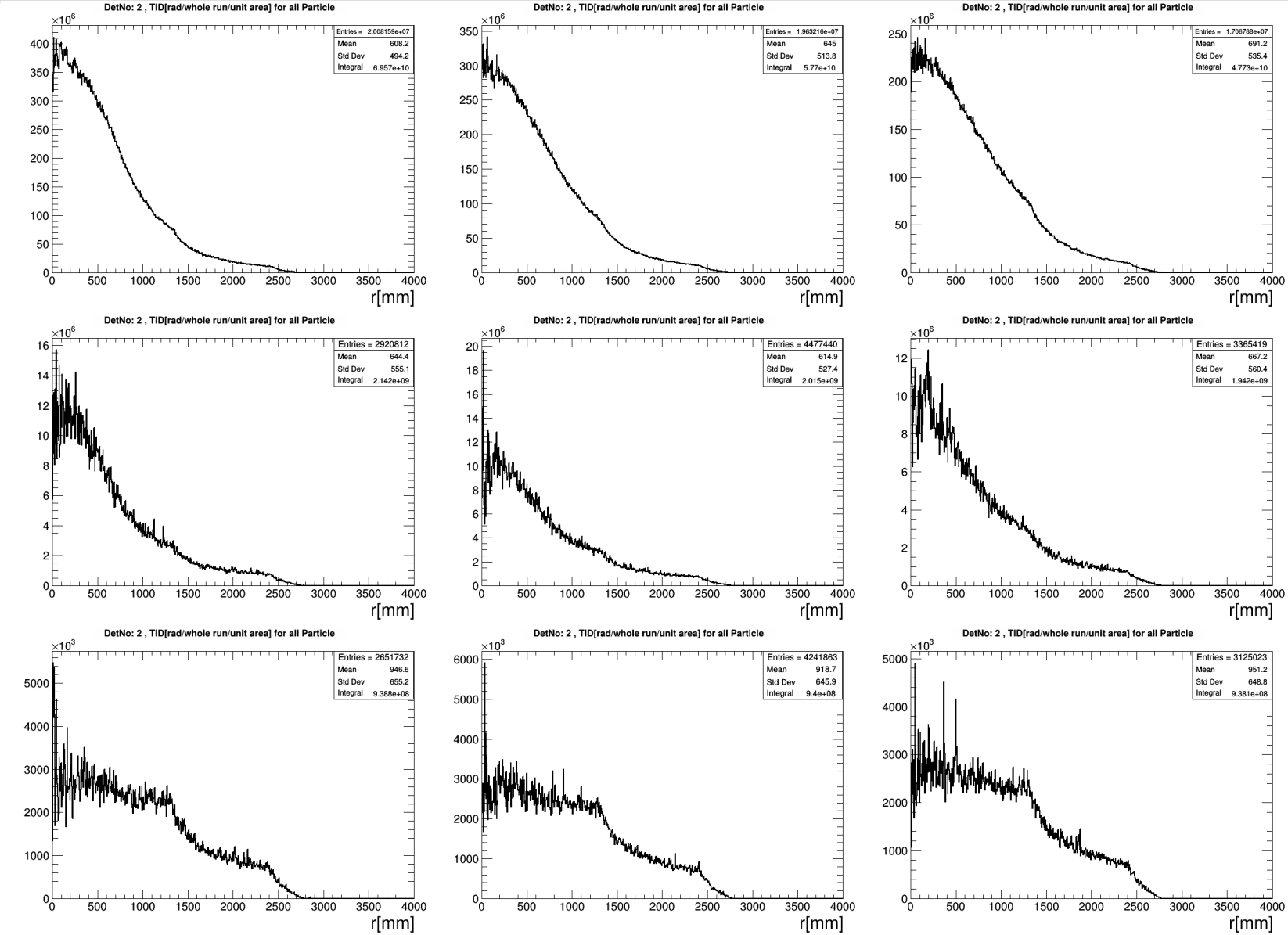
TID calculations for US Torus Bottom det. planes (EPDM) with 5cm Pb shielding

- Simulation ran with shielding config24 (100M beam generator events).
- The particles are passed through 1cm thick of *EPDM* plane and deposited energy is evaluated per 5x5mm^2 block (please see page 9 for the simulation geometry).
- TID is computed by dividing the energy deposition in that block by the mass and the results are integrated over the whole MOLLER run.



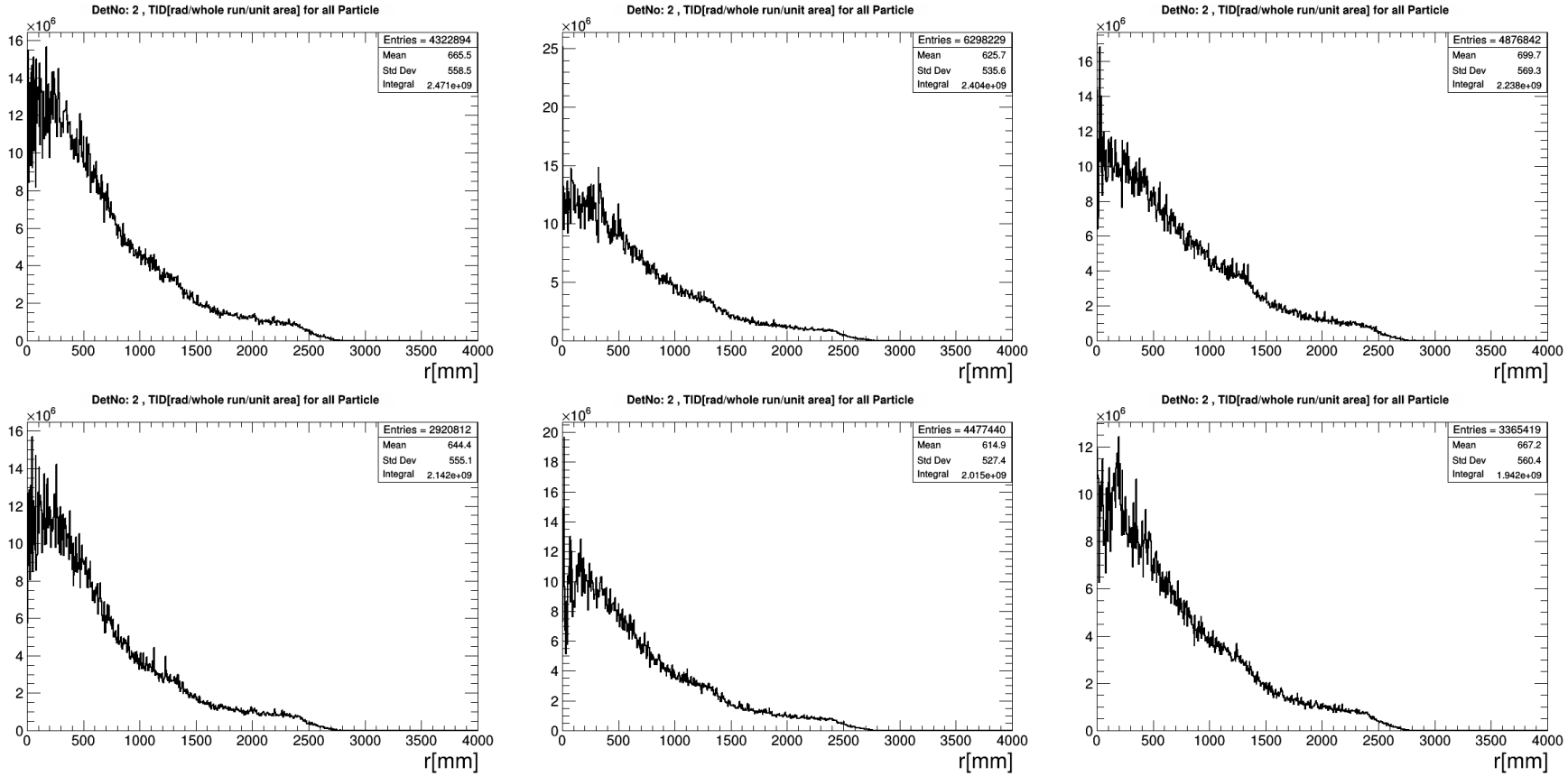
Top: The 2D distributions of all the particle hits which is weighted by radiation dose for the d5615 (left), d5616 (middle), d5617 (right). Bottom: The average radiation dose as a function of radius for the d5615 (left), d5616 (middle), d5617 (right).

TID calculations for US Torus Bottom det. planes (Viton) w-w/o Pb shielding



The average radiation dose as a function of r without any Pb shielding (top row), with 5cm Pb shielding (middle row) and with 10cm Pb shielding (bottom row).

The comparison between the EPDM and Viton materials



The average radiation dose as a function of r with 5cm Pb shielding by using EPDM material (top row) and Viton material (bottom row).

- The average radiation dose is increased ≈15% when we use EPDM material instead of Viton.

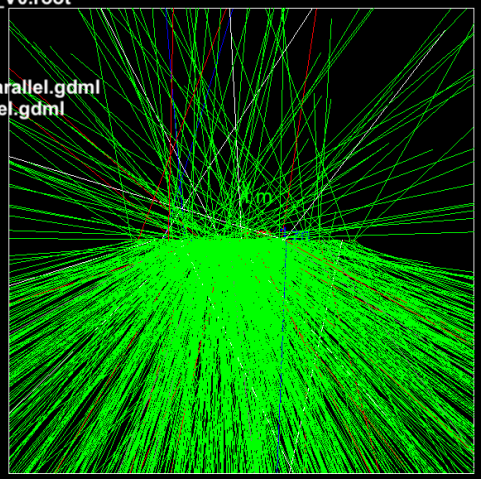
Backup

TID calculations for US Torus bottom detector planes

- Skimmed the remoll output files for d5615/d5616/d5617 by using skimTree.C. While doing the analysis, the skimmed root output is produced separately for the p_y states($p_y > 0/p_y < 0$).
  - det5615: 100M beam generator events.
    - $p_y > 0$: 3231070 (646214) Events; $p_y < 0$: 4958886 (826481) Events
  - det5616: 100M beam generator events.
    - $p_y > 0$: 3183087 (1061029) Events; $p_y < 0$: 4862112 (810352) Events
  - det5617: 100M beam generator events.
    - $p_y > 0$: 3142508 (785627) Events; $p_y < 0$: 4796826 (799471) Events
  - Then, ran the tid.mac by using the external generator
    - file: Skimmed root file
    - copyRate 1
    - startEvent 0
    - detid: 5615/5616/5617
    - yOffset:−(±10 the value of y-position as in mollerParallel.gdml)
    - zOffset:−(the value of z-position as in mollerParallel.gdml)
    - run # skimmed events
  - tidAna.C macro is used to analyse this ext. generator root file.
- 1mm/10mm/1mm thick *G4_Viton* (density= 1.8 g/cm^3) planes are used in the tid.gdml
- 1mm/10mm/1mm thick *EPDM* (density= 1.5 g/cm^3, with a 1:2 C:H elements) planes are used in the tid.gdml

TID calculations for US Torus bottom detector planes

```
/remoll/evgen/external/file o_USTorus_pyL0_remollSkimTree_V0.root
/remoll/evgen/external/detid 5615
/remoll/evgen/copyRate 1
/remoll/evgen/external/startEvent 0
/remoll/evgen/external/yOffset 520.54 #-510.54mm in mollerparallel.gdml
/remoll/evgen/external/zOffset -1107 #1107mm in mollerparallel.gdml
/remoll/filename tid_config24_d5615_pzL0.root
/run/beamOn 50
```



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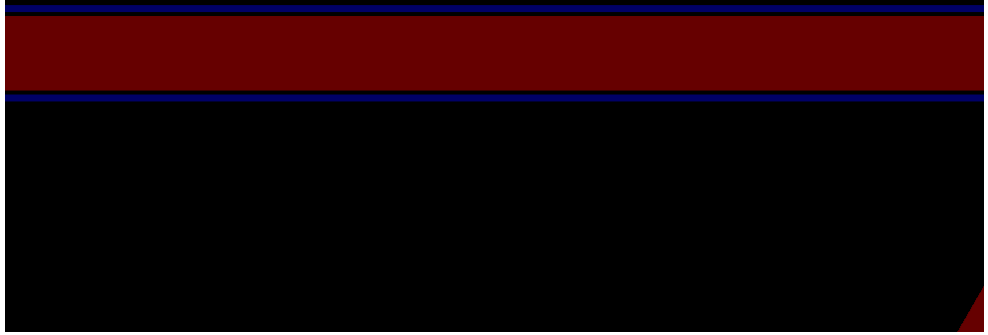
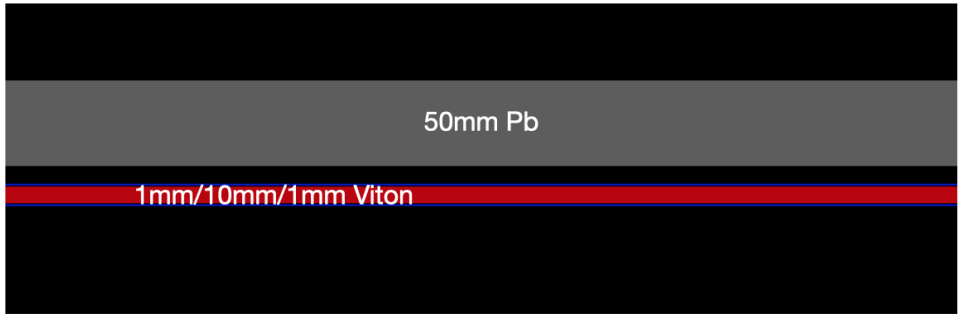
 <position name="front_pos" unit="mm" y="-6"/>
</physvol>

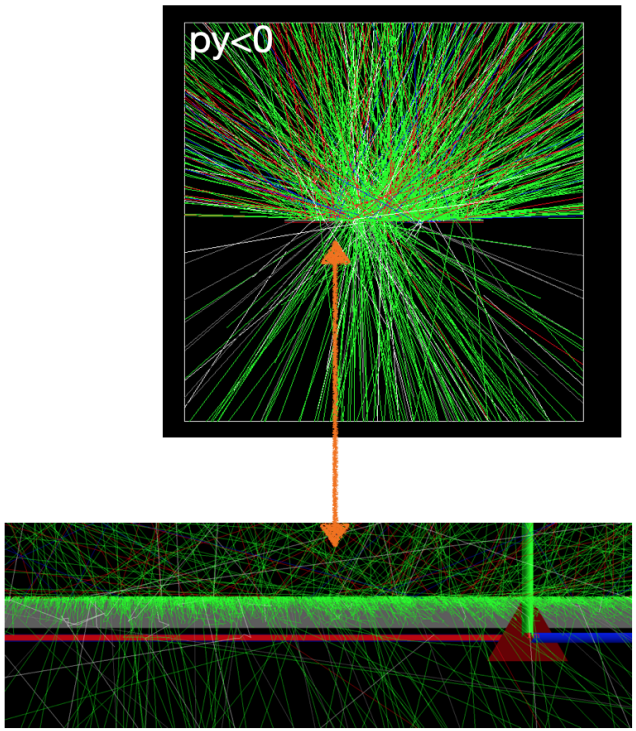
<physvol name="back">
 <volumeref ref="back_logic"/>
 <position name="back_pos" unit="mm" y="6"/>
</physvol>

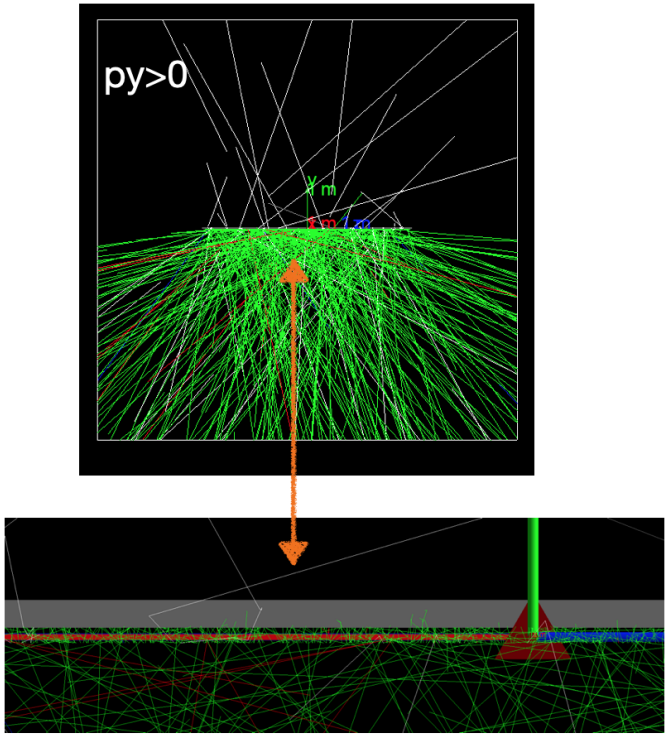
 <physvol name="middle">
  <volumeref ref="middle_logic"/>
</physvol>
```



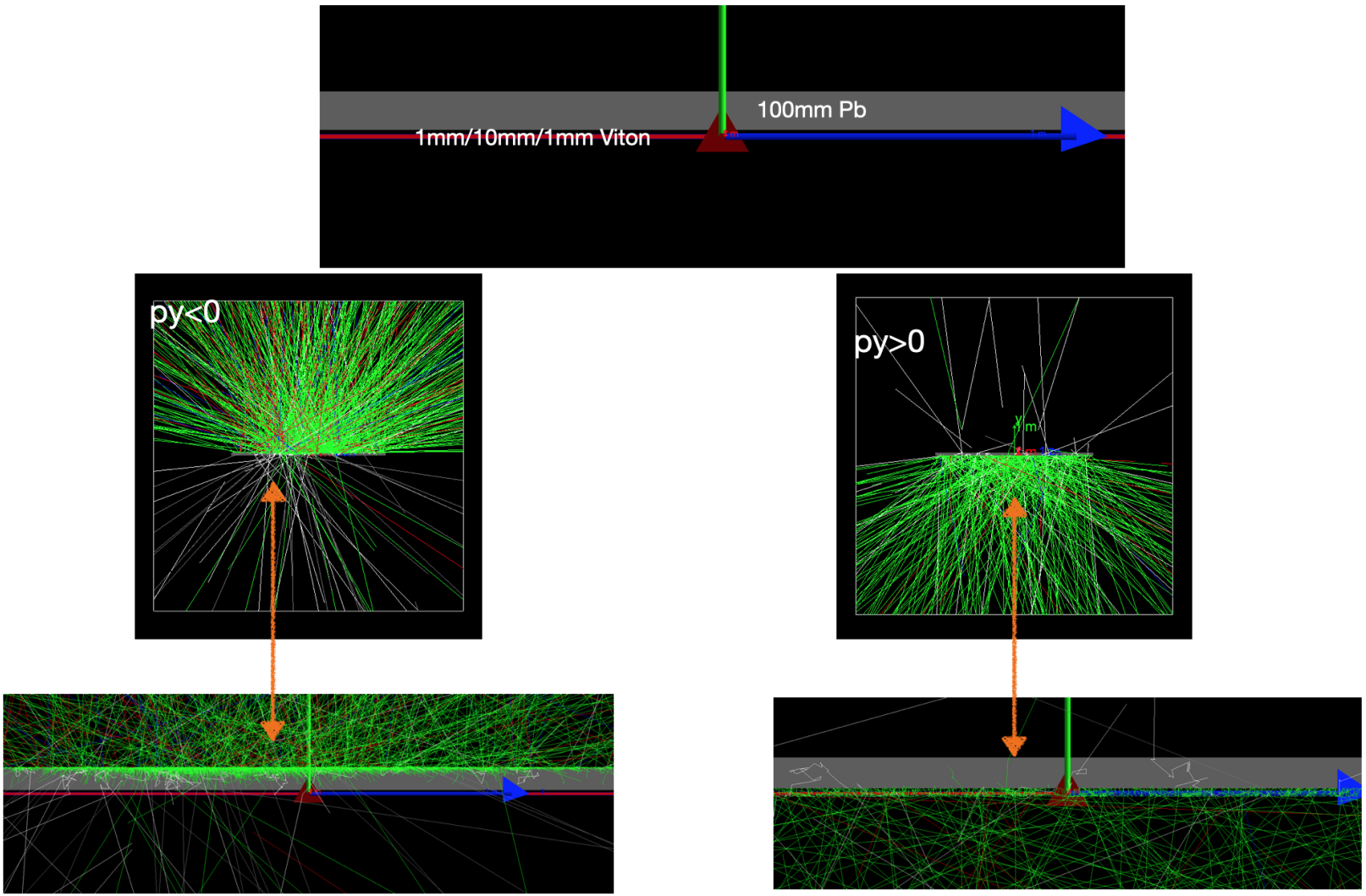
TID calculations for US Torus bottom detector planes, with 5cm Pb Shielding



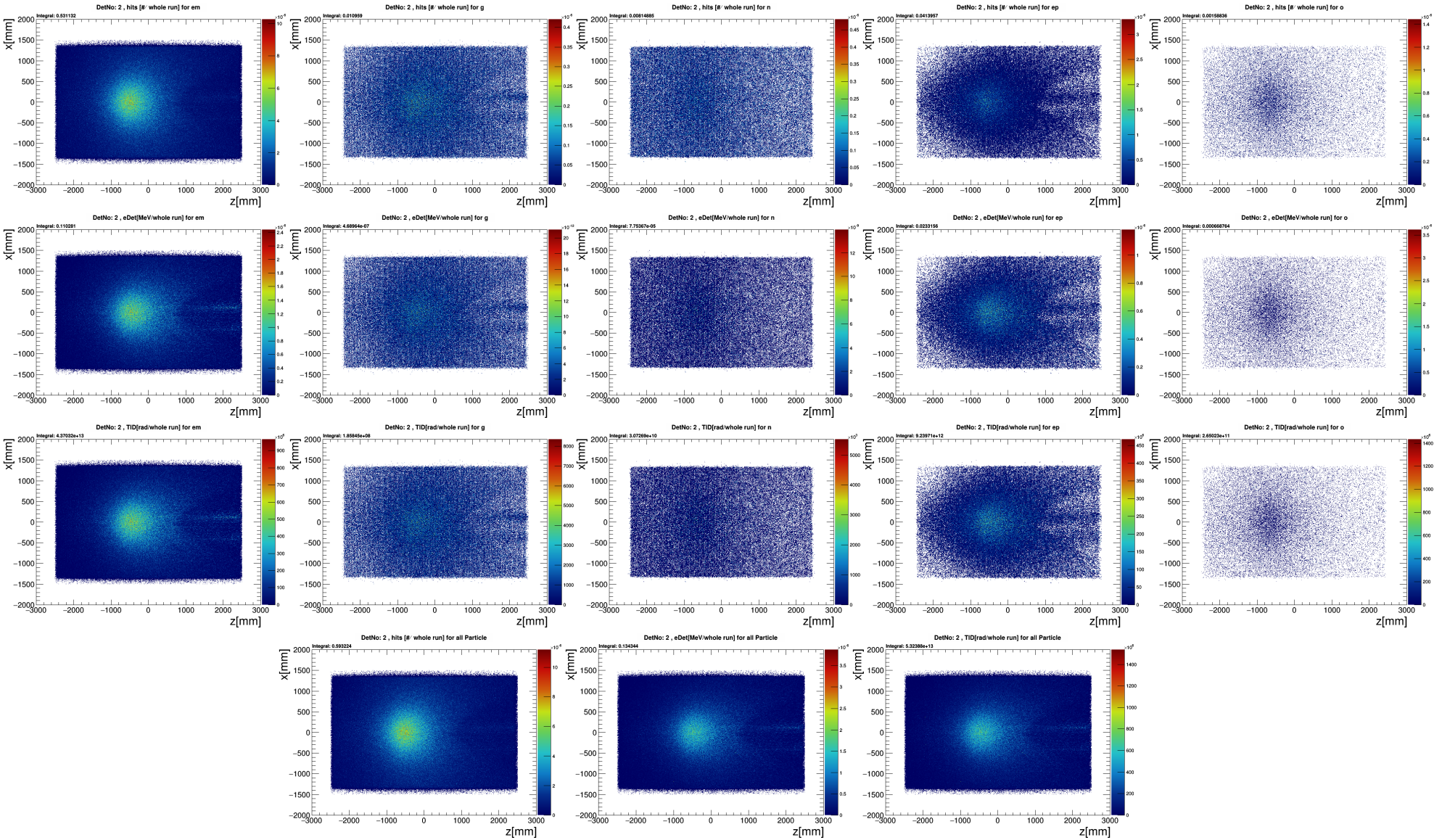




TID calculations for US Torus bottom detector planes, with 10cm Pb Shielding

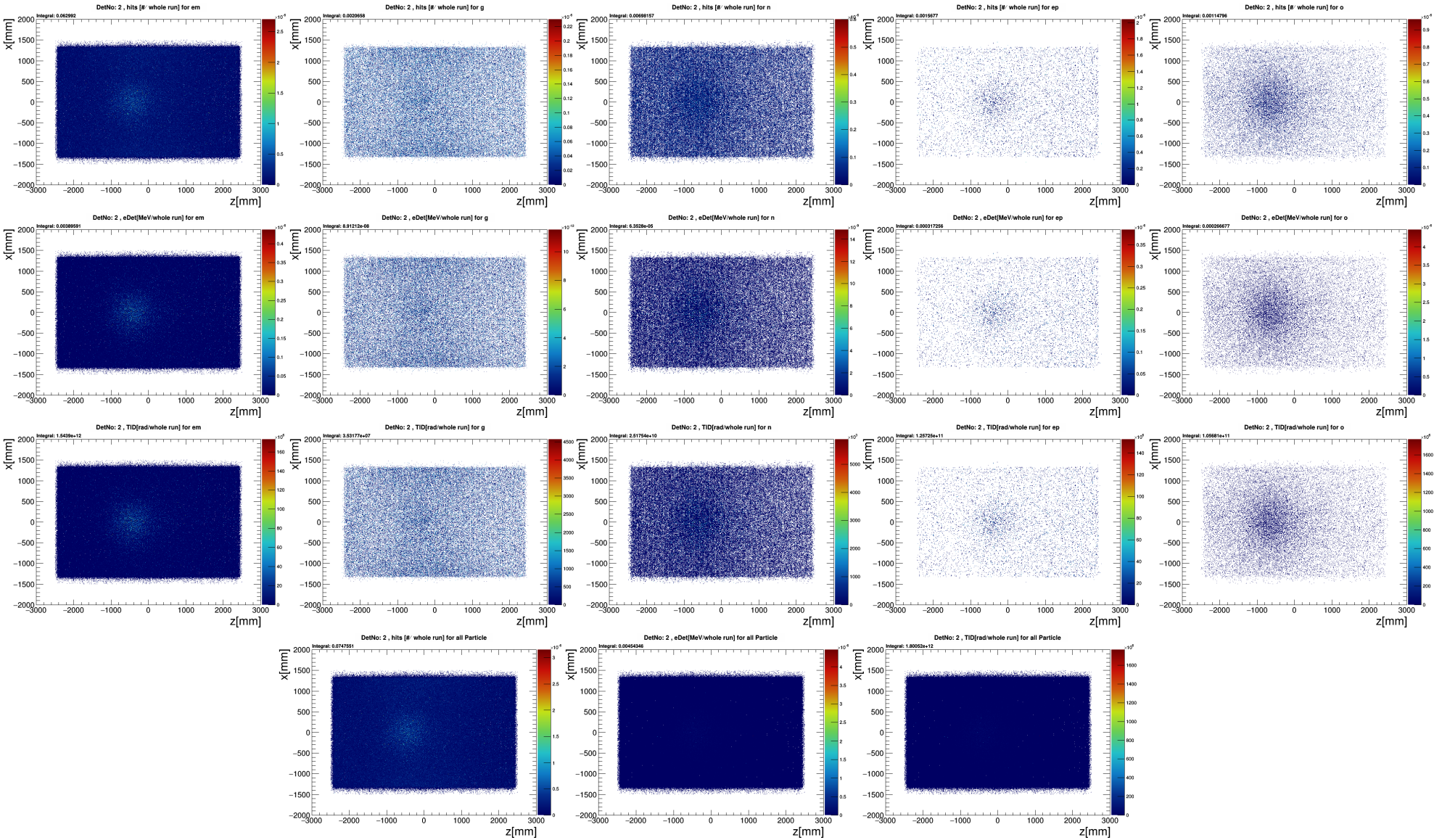


TID calculations for d5615 plane (Viton)



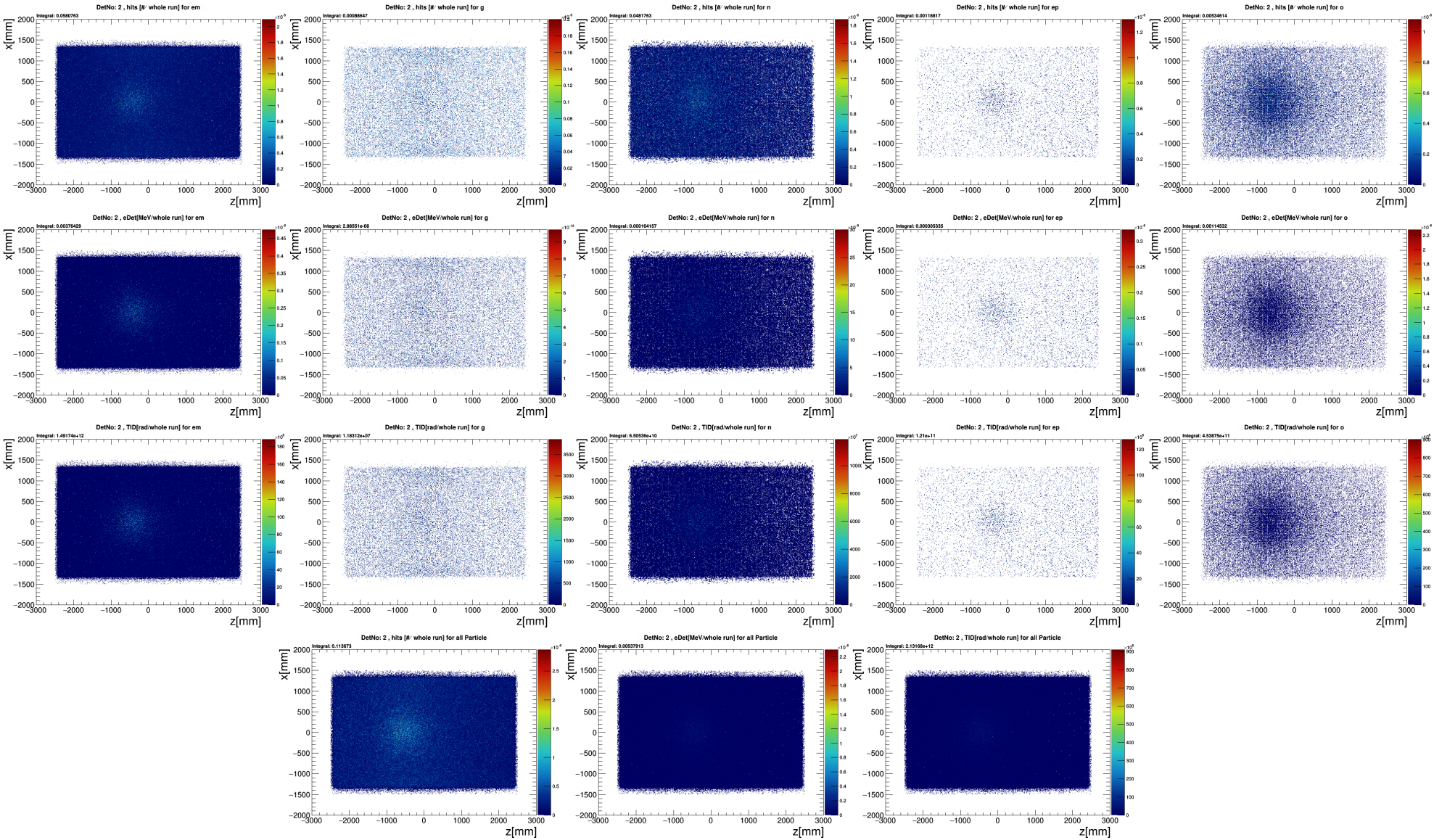
The 2D distributions of the different particle hits in the d5615 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5615 plane (Viton), with 5cm Pb Shielding



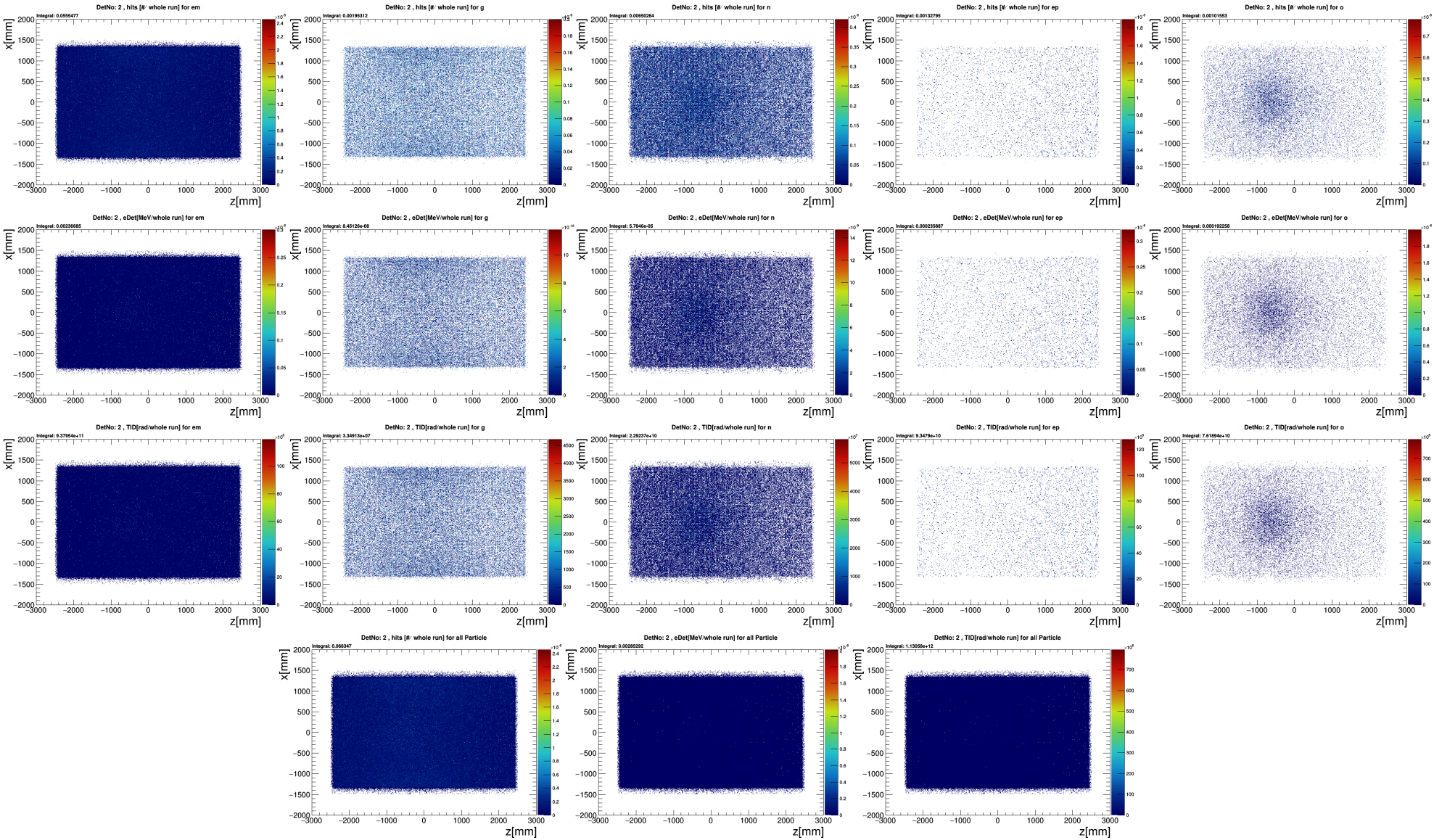
The 2D distributions of the different particle hits in the d5615 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5615 plane (EPDM), with 5cm Pb Shielding



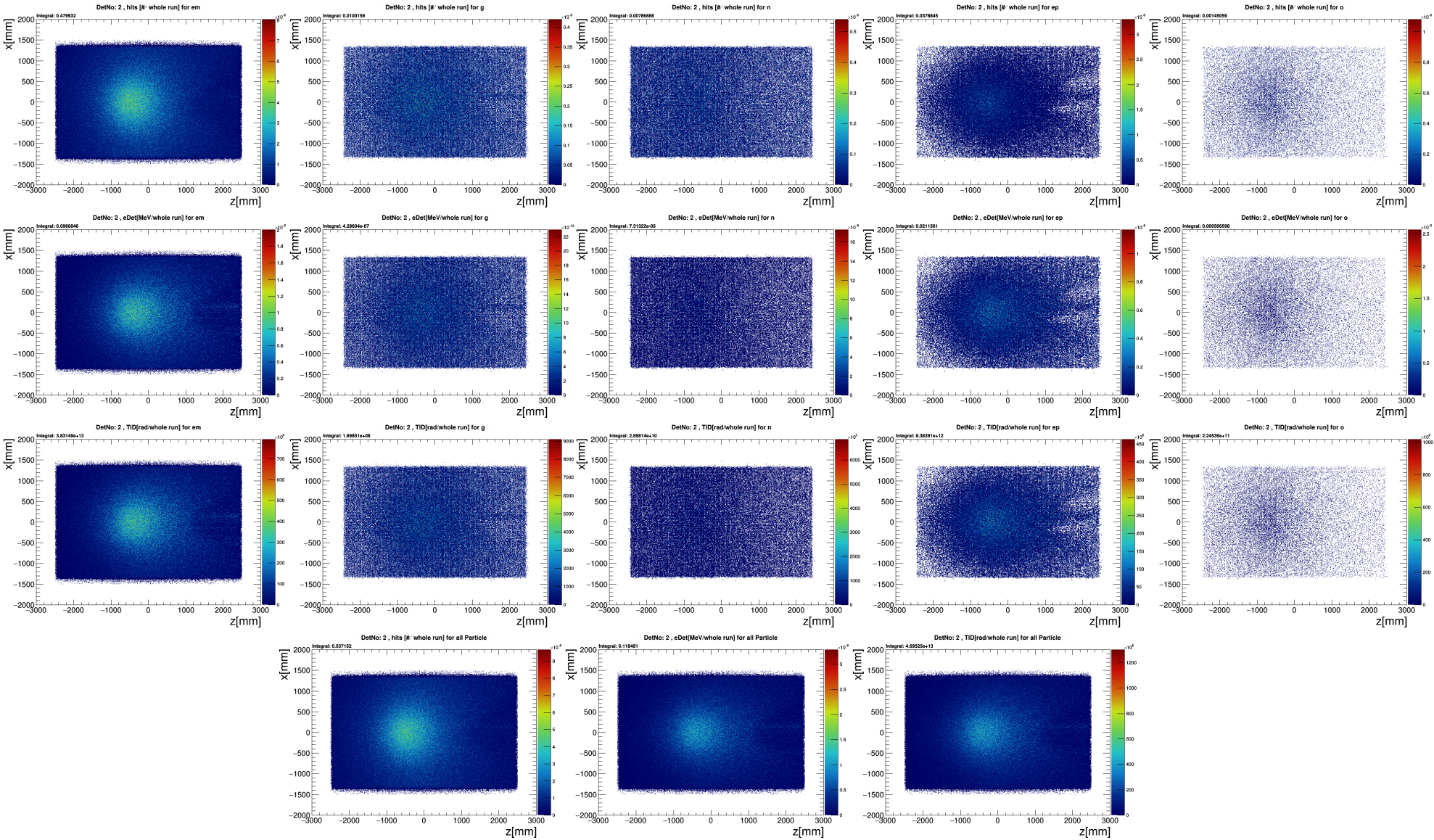
The 2D distributions of the different particle hits in the d5615 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5615 plane (Viton), with 10cm Pb Shielding



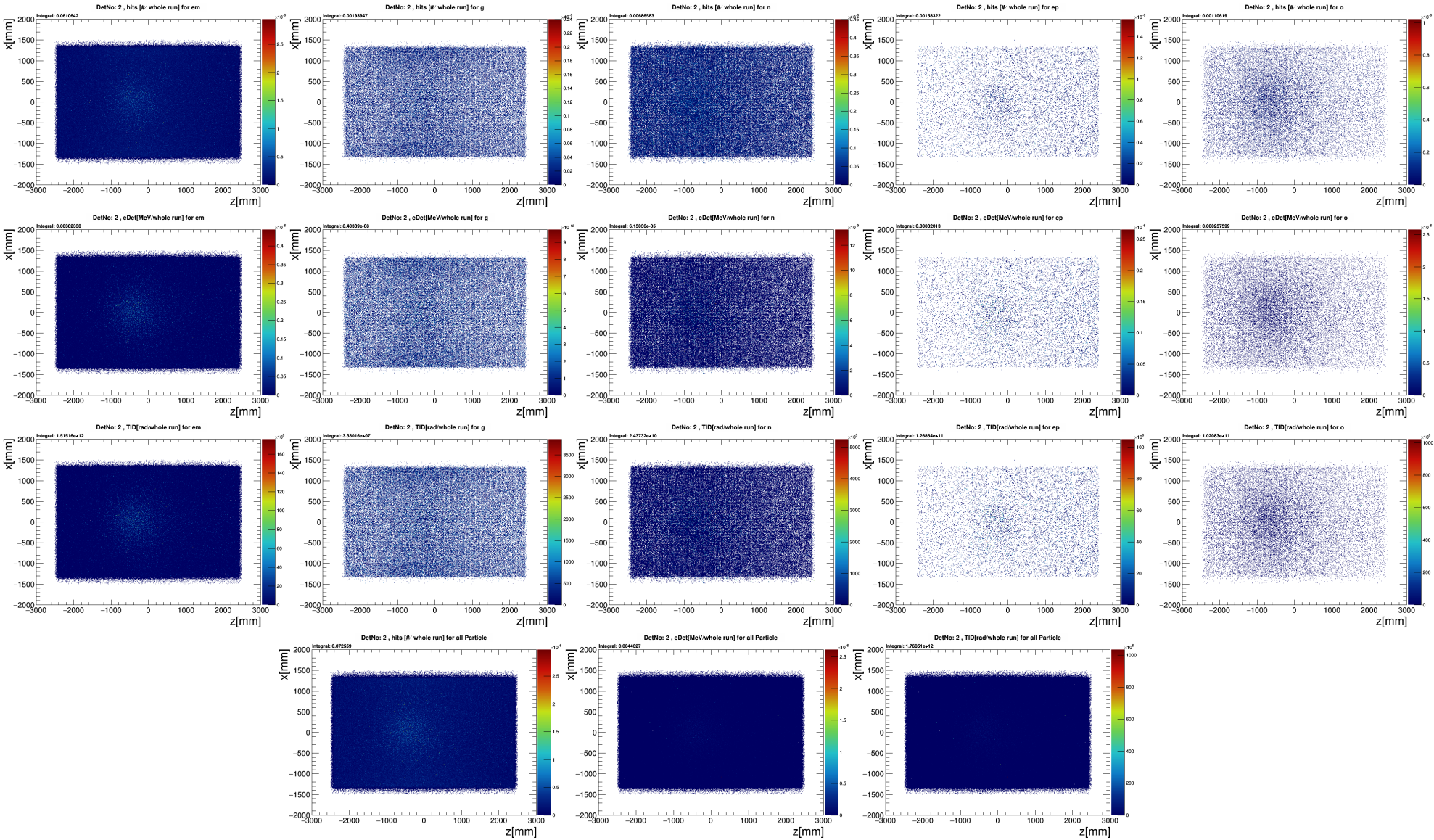
The 2D distributions of the different particle hits in the d5615 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5616 plane (Viton)



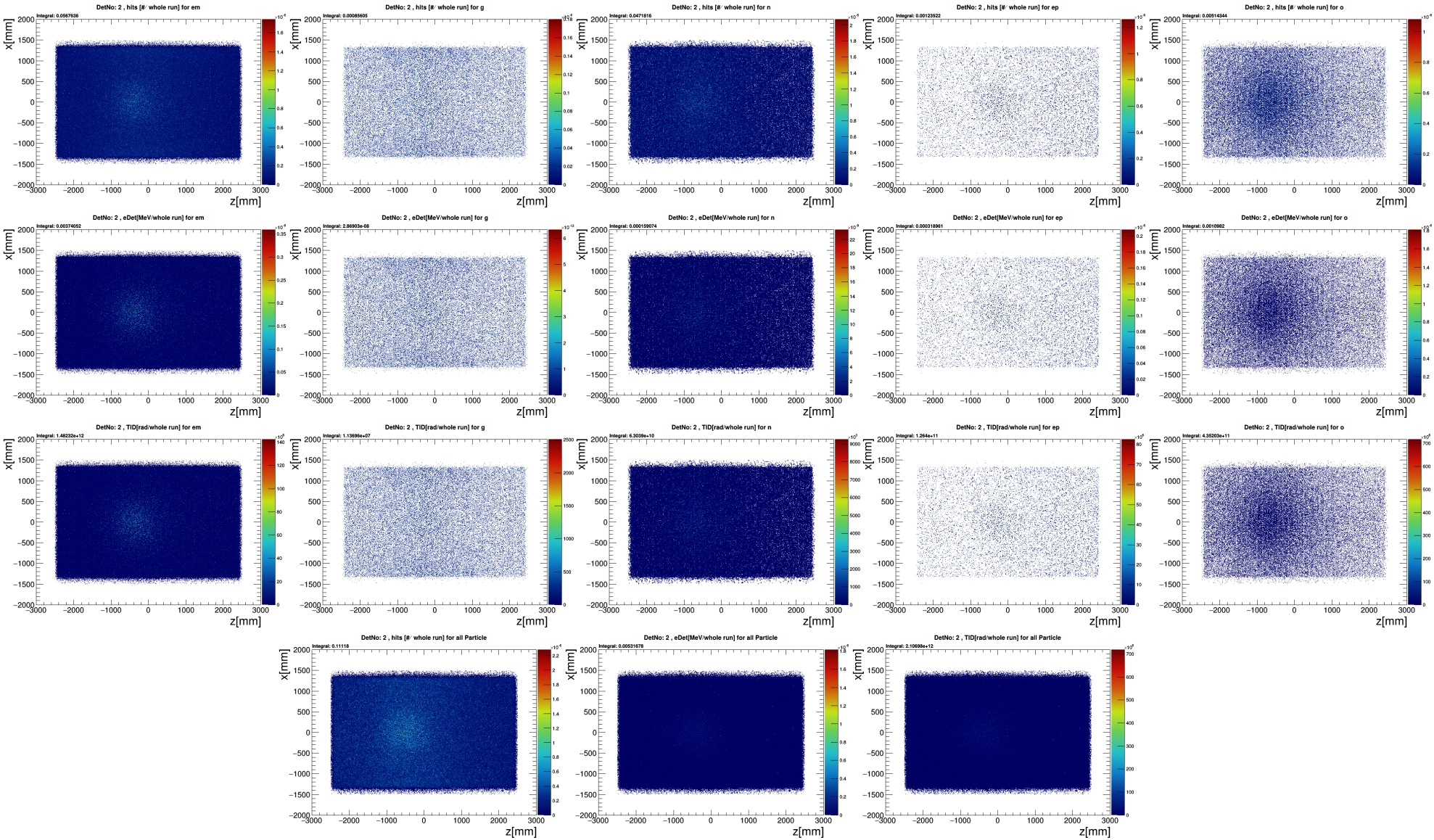
The 2D distributions of the different particle hits in the d5616 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5616 plane (Viton), with 5cm Pb Shielding



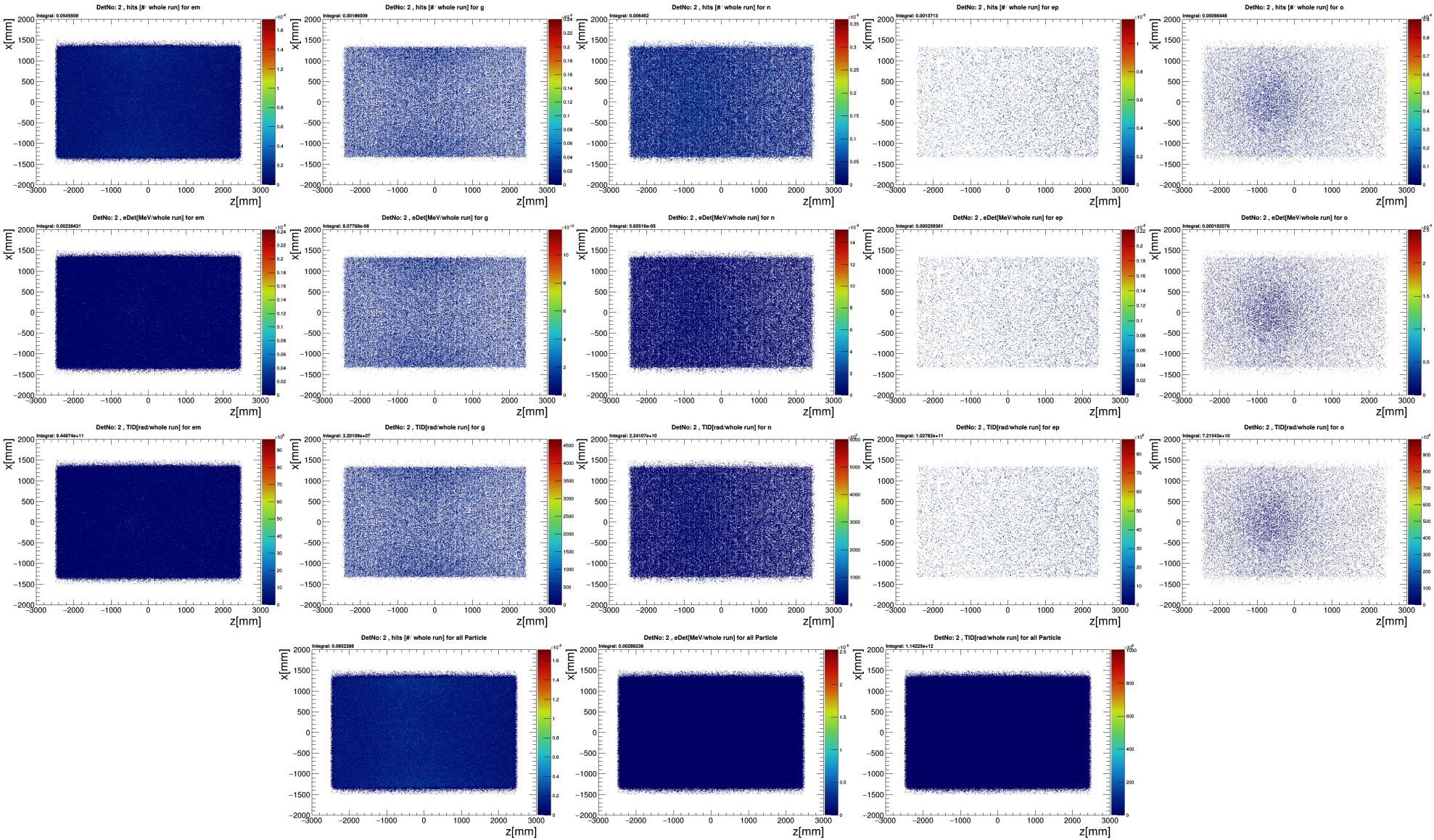
The 2D distributions of the different particle hits in the d5616 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5616 plane (EPDM), with 5cm Pb Shielding



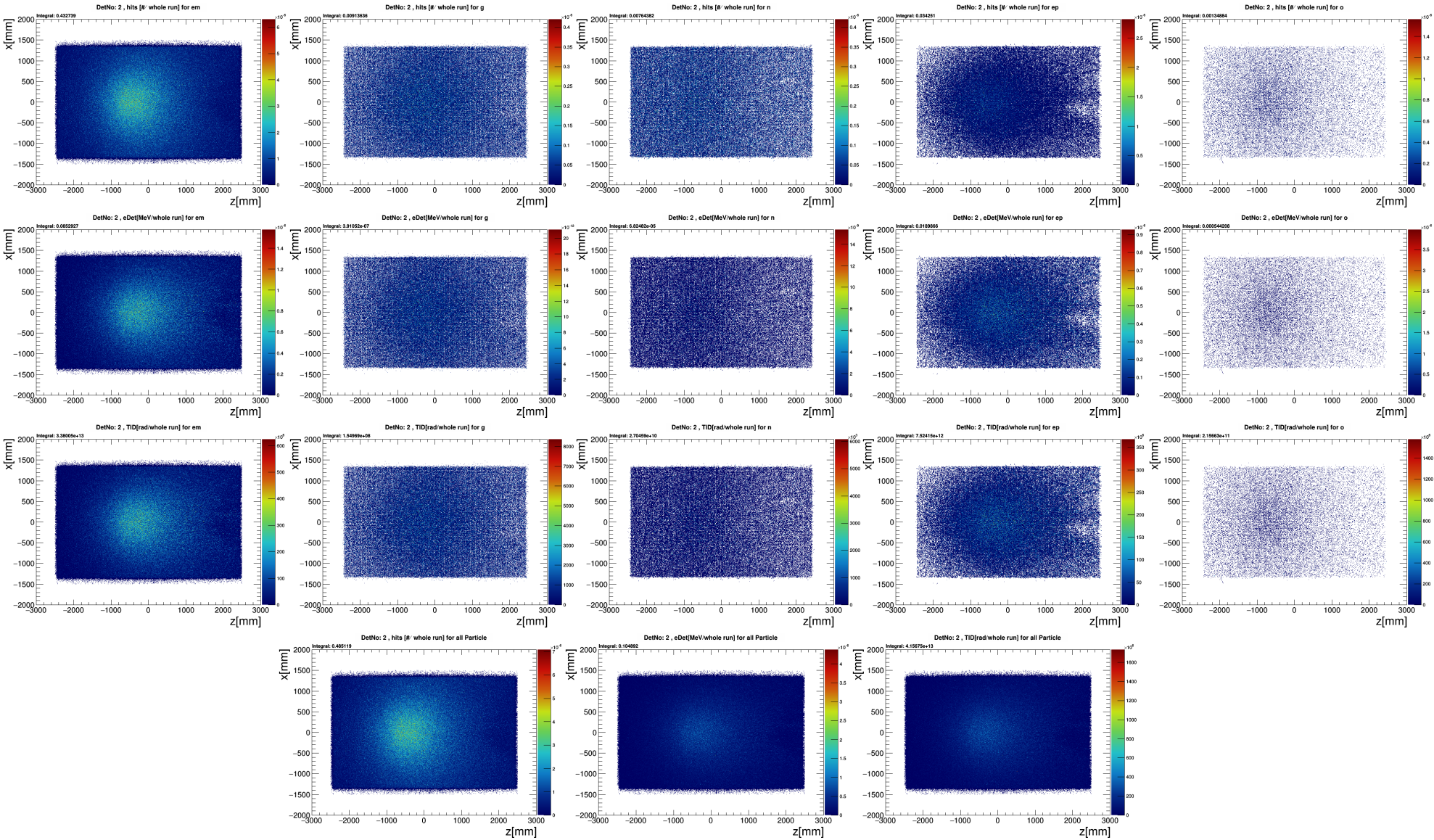
The 2D distributions of the different particle hits in the d5616 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5616 plane (Viton), with 10cm Pb Shielding



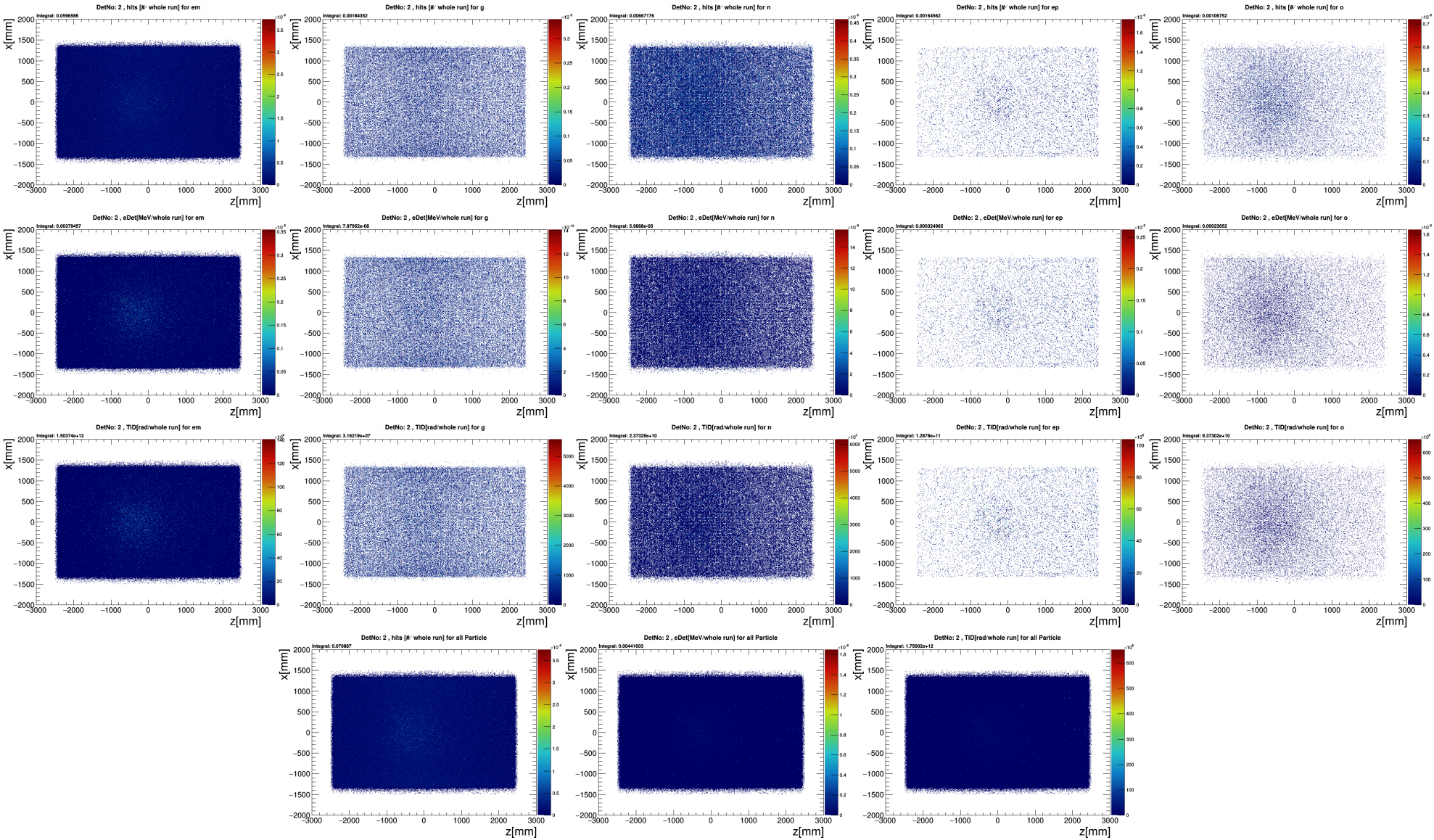
The 2D distributions of the different particle hits in the d5616 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5617 plane (Viton)



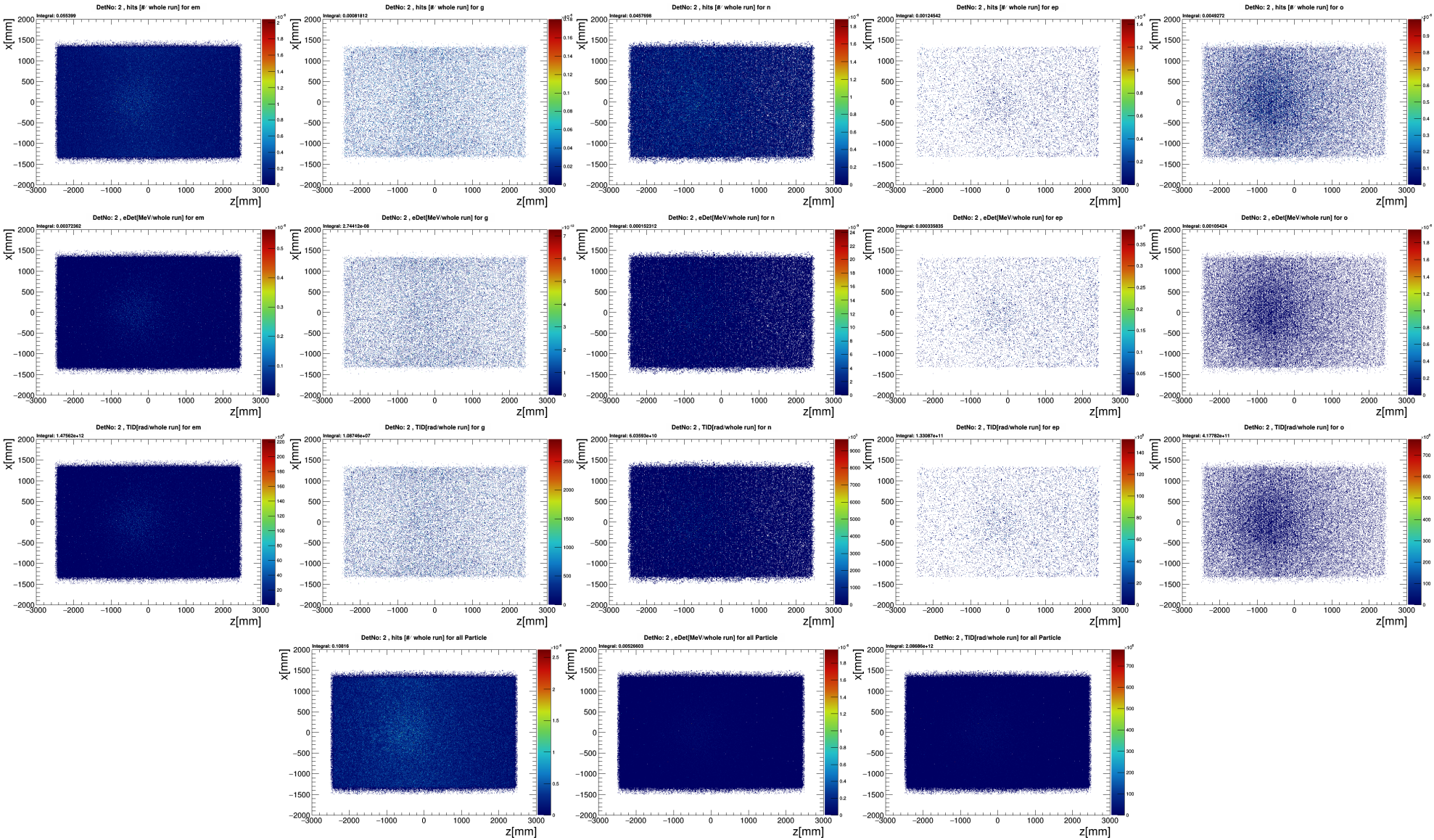
The 2D distributions of the different particle hits in the d5617 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5617 plane (Viton), with 5cm Pb Shielding



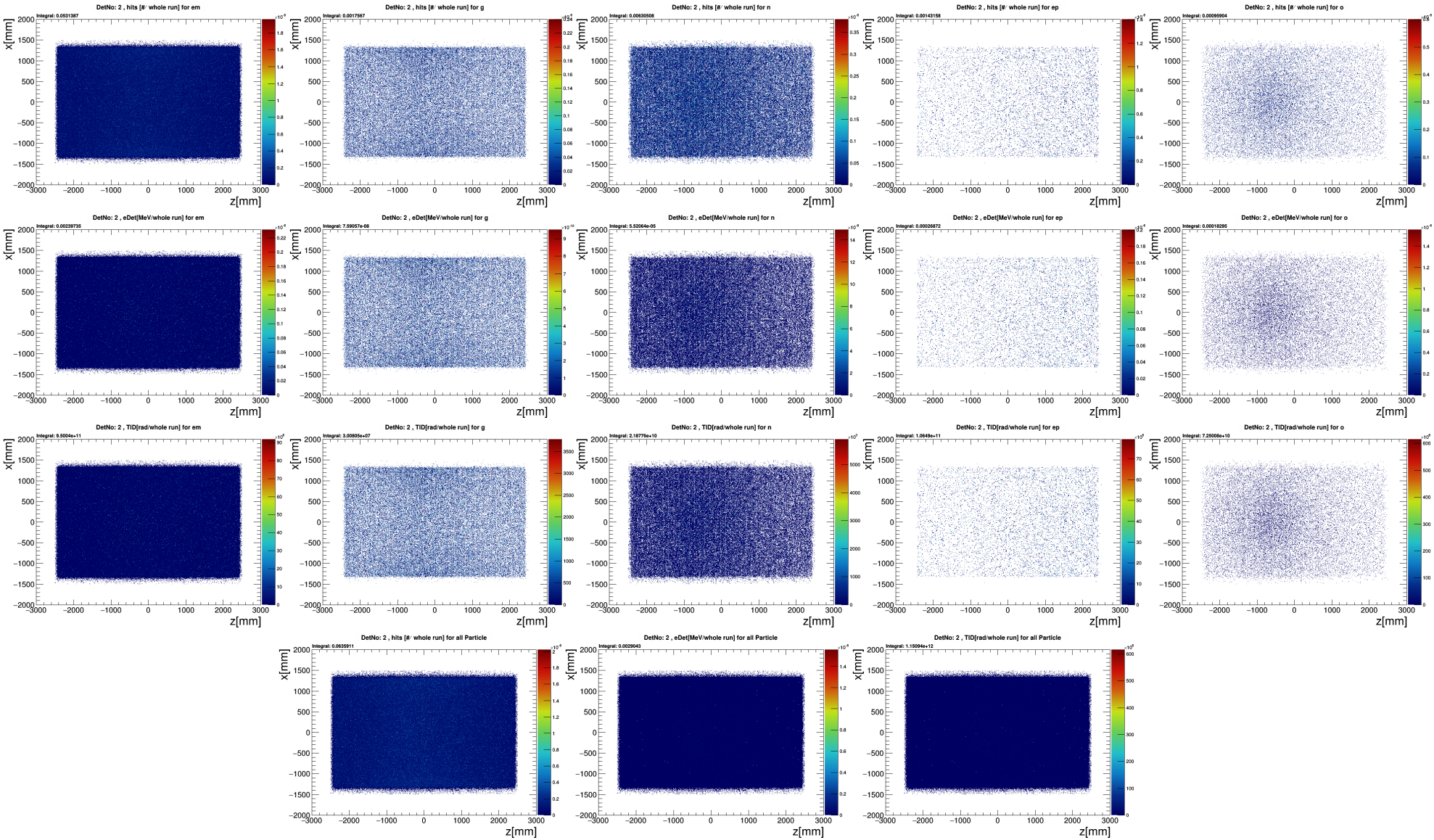
The 2D distributions of the different particle hits in the d5617 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5617 plane, with 5cm Pb Shielding



The 2D distributions of the different particle hits in the d5617 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.

TID calculations for d5617 plane (Viton), with 10cm Pb Shielding



The 2D distributions of the different particle hits in the d5617 for without any weight (1^{st} row), with deposited energy-weighted (2^{nd} row), with radiation-weighted (3^{rd} row). The bottom plots are for the sums of the particle species with three different weighting.