Segmentation: UV, Strips
MPGD Meeting 12/16/2024

Yann Bedfer

CEA/DPhN Saclay

18 December 2024

Outer Barrel: $XY \rightarrow UV$ segmentation

- So far: XY segmentation, *i.e.* necessarily **along sensitive volume axes**:

  <segmentation type="CartesianGridXY" grid_size_**x**="0.150*mm*sqrt(12)"
  grid_size_**y**="0.150*mm*sqrt(12)" />

  In master ref. frame: Y ($measurement\ axis$) is along z axis.

  $\longrightarrow$ cellID pattern x/y asymmetric

  <**id**>system:8,layer:4,module:12,sensor:2,**x:-14,y:-18**</id>

  "system:8,layer:4,module:12,sensor:2" identifies the sensitive volume.

  ($system$=64, $single\ layer$(=**1**), $modules$ [1,24], $sensor$=0)

  "x:-14,y:-18" describes the segmentation: 14 (*resp.* 18) bits, signed (>0 and <0 integers).

- In order to implement UV, one needs new segmentation class: `CartesianGridUV`

  $\longrightarrow$ Administration delay: PR to `DD4hep`, PR to epic software, wait for an update of `eic-shell`.

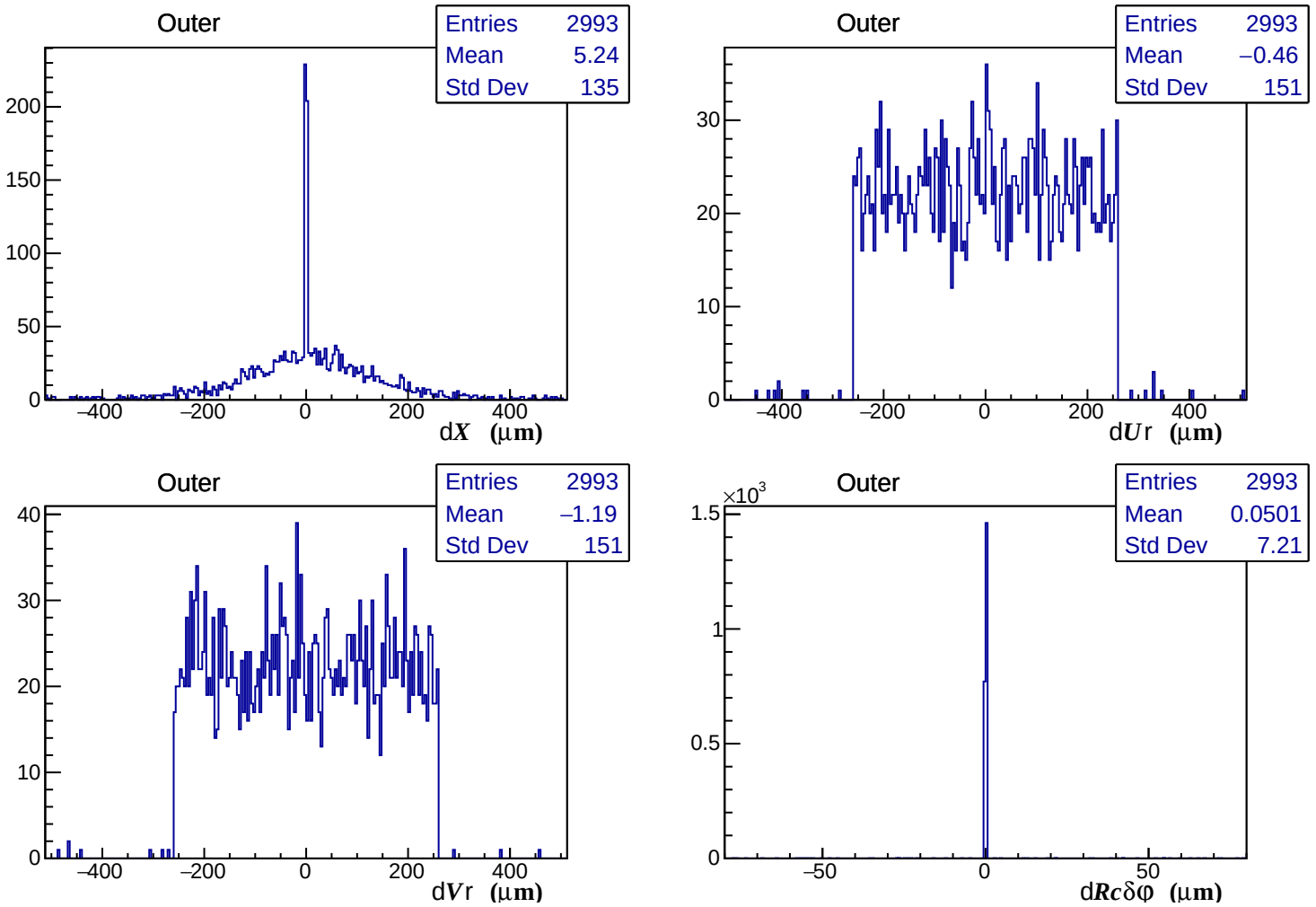
- **What follows is only in `2D-strip-MPGDs` branch, so far.**

  <segmentation type="CartesianGridUV" grid_size_**u**="0.150*mm*sqrt(12)"
  grid_size_**v**="0.150*mm*sqrt(12)" **grid_angle**="**M_PI*rad/4**" />

  <**id**>system:8,layer:4,module:12,sensor:2,**u:-16,v:-16**</id>

Outer Barrel w/ UV Pixel segmentation: Residuals

- `ddsim:` `SIM.gun` μ^- $15 < \theta < 165$ deg. $P = 10$ GeV



Outer Barrel: Strip segmentation

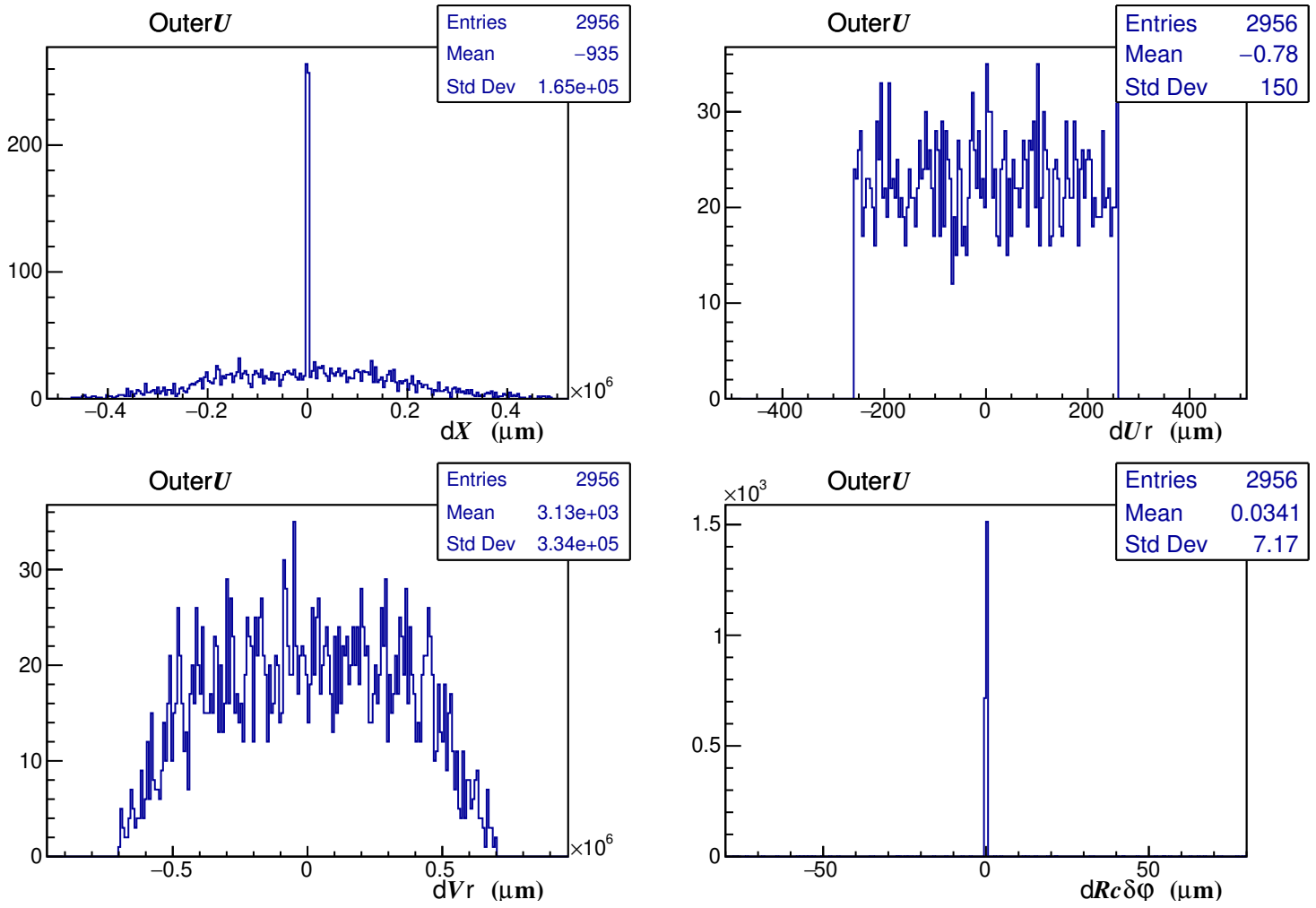
- Strip segmentation = "MultiSegmentation" + `MPGDTrackerDigi` digitization
  - "MultiSegmentation": hinges on a **key** discriminator. Here key="**strip**"

```
<segmentation type="MultiSegmentation" key="strip">
  <segmentation name="Pixels"   type="CartesianGridUV" key_value="0"
    grid_size_u="0.150*mm*sqrt(12)"   grid_size_v="0.150*mm*sqrt(12)"   grid_angle= . . .
  <segmentation name="UStrips"  type="CartesianGridUV" key_value="1"
    grid_size_u="0.150*mm*sqrt(12)"   grid_size_v="μRWellStrip_range"   grid_angle= . . .
  <segmentation name="VStrips"  type="CartesianGridUV" key_value="2"
    grid_size_u="μRWellStrip_range"   grid_size_v="0.150*mm*sqrt(12)"   grid_angle= . . .
</segmentation/>
<id>system:8,layer:4,module:12,sensor:2,strip:30:2,u:-16,v:-16 </id>
```

  - In **simulation** and
    in **reconstruction** w/ **present digitization** (*viz.* `SiliconTrackerDigi`): "**Pixels**" segmentation.
  - `MPGDTrackerDigi` . . .
    . . . takes **true Cartesian coord.s** from input,
    . . . **ignores cellID** from input,
    . . . instantiates **two** `RecHits` *per* input, w/ appropriate strip "**key**".
    (*not yet*) . . . instantiates **two clusters** of `RecHits`.
  - "MultiSegmentation" could be committed to `epic` . . .
    . . . while digitization keeps unchanged (=`SiliconTrackerDigi`).

Outer Barrel: U-strips, singleHit-clusters: Residuals

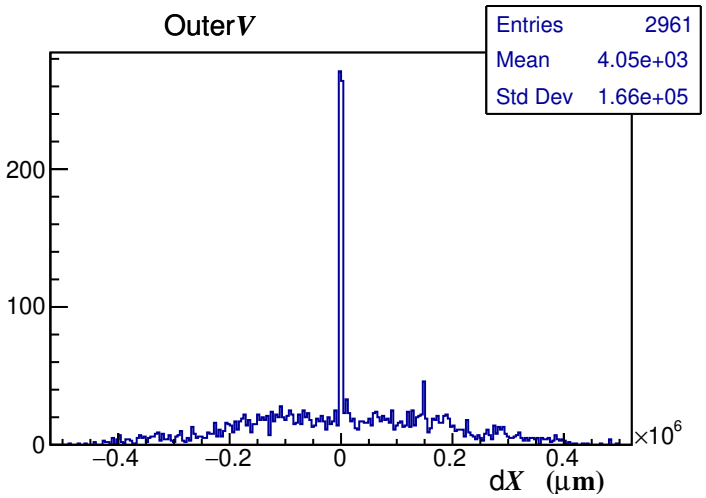
- Same simulation as before.

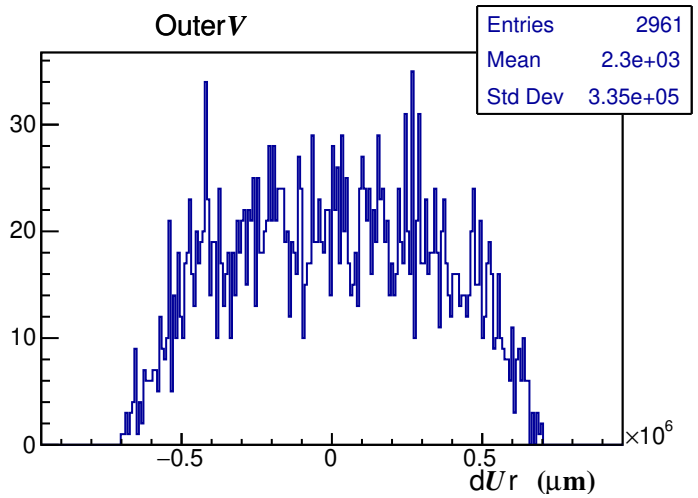


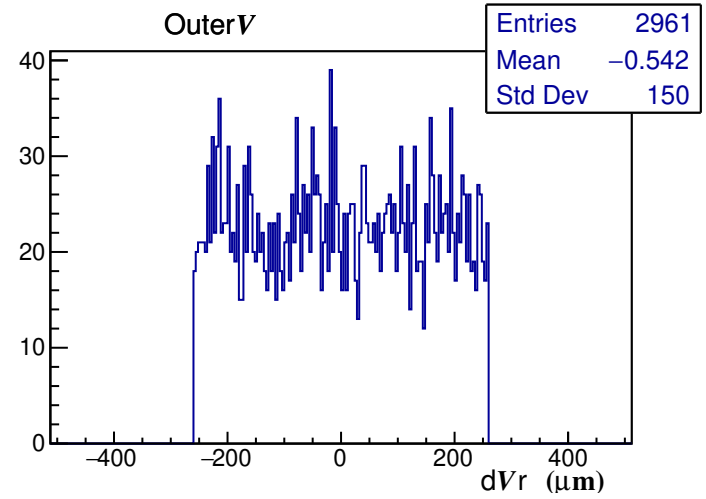
- Slight inefficiency ∼0.5%.

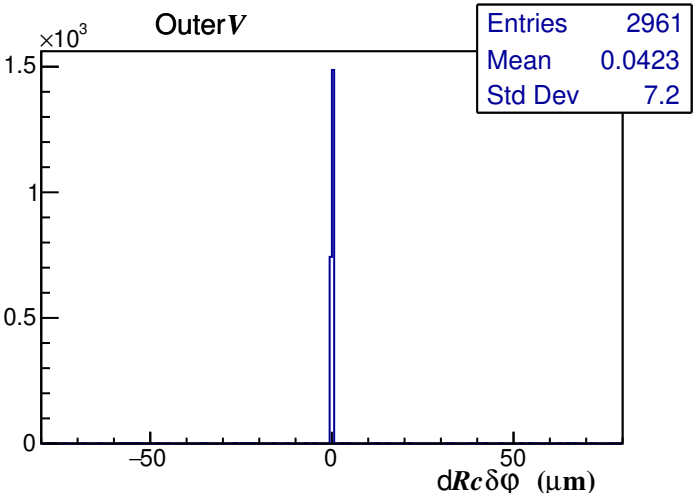
Outer Barrel: V-strips

- Same simulation as before.

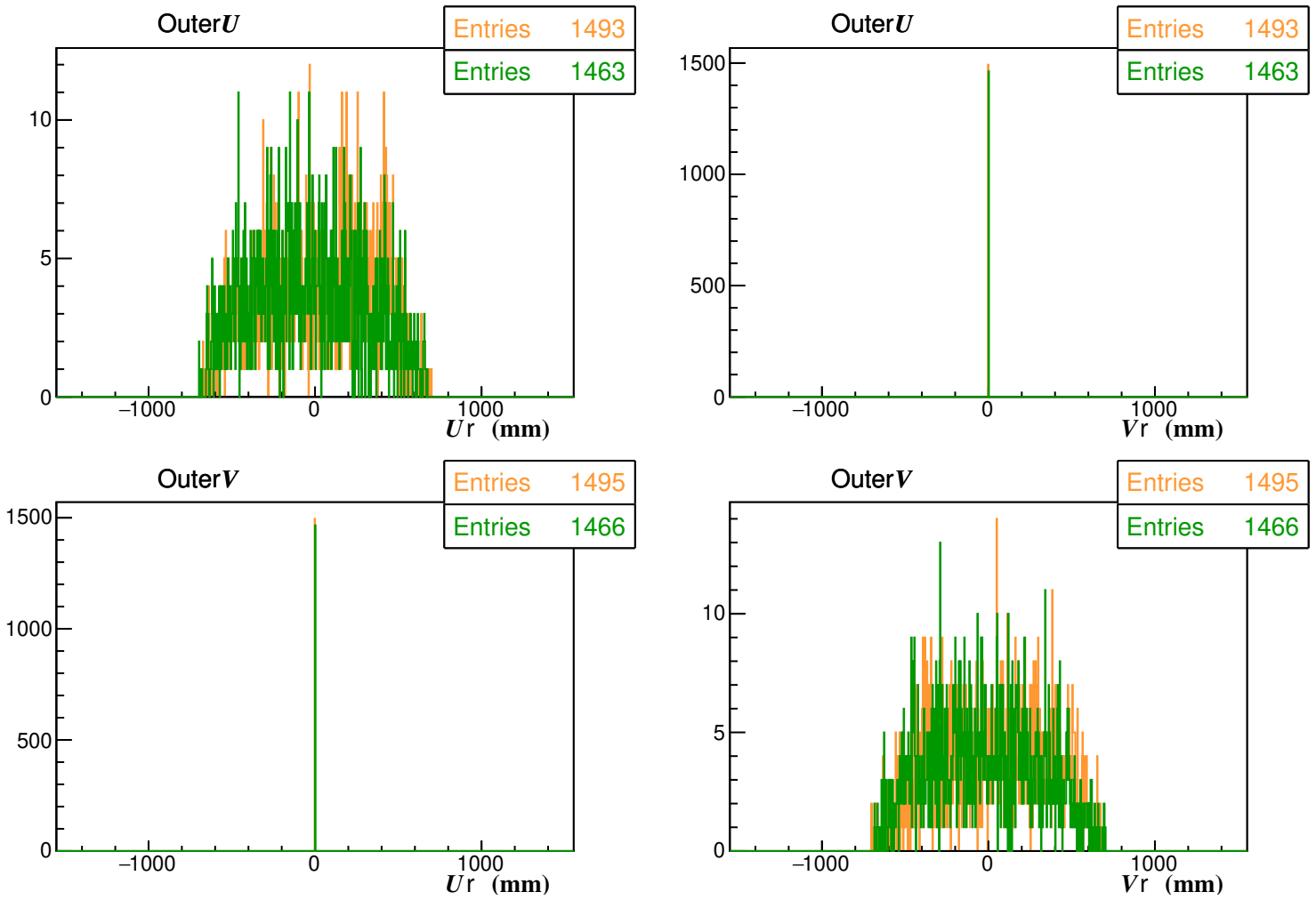








Outer Barrel: RecHits



- Along perpendicular to measurement axis:

  Position could be made more accurate.

  Uncertainty = μRWellStrip_range = $(Length + Width) \times \sqrt{2}/2$ could be made smaller.

Strip segmentation for CyMBaL

- **Nested** "MultiSegmentation"

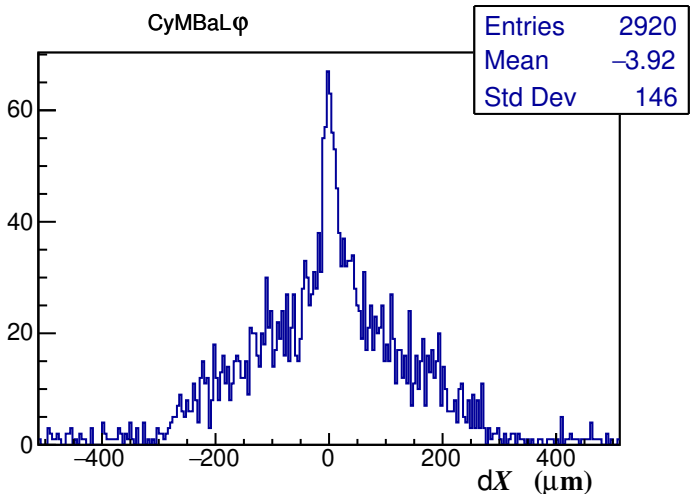
  key="**sensor**" to assign distinct radii to `CylindricalGridPhiZ`,

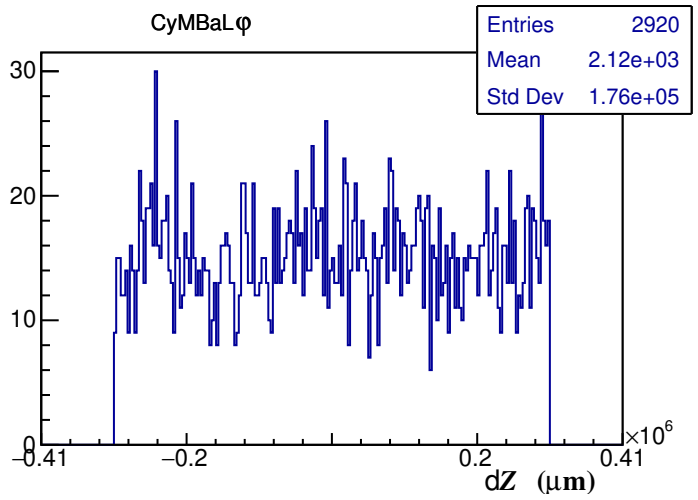
  key="**strip**" for strip segmentation.

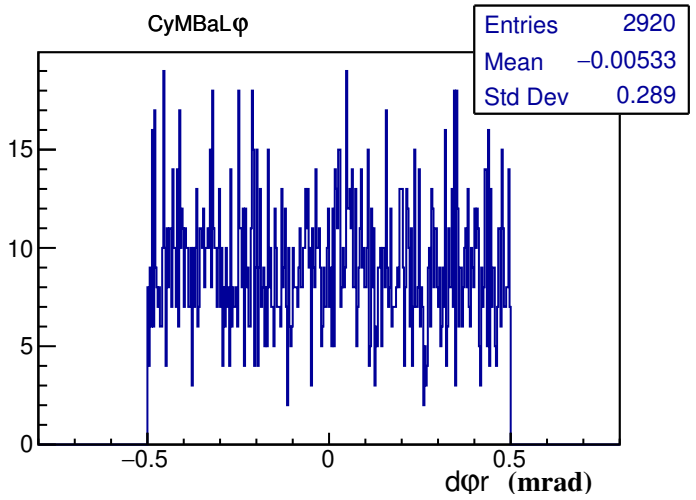
```
<segmentation type="MultiSegmentation" key="sensor">
  <segmentation name="Inner" type="MultiSegmentation" key_value="0" key="strip">
    <segmentation name="InnerPix" type="CylindricalGridPhiZ" key_value="0"
      grid_size_phi="1*mrad" grid_size_z="0.150*mm*sqrt(12)" radius="InnerR" />
    <segmentation name="InnerPhi" type="CylindricalGridPhiZ" key_value="1"
      grid_size_phi="1*mrad" grid_size_z="MMModuleLength" radius="InnerR" />
    <segmentation name="InnerZ" type="CylindricalGridPhiZ" key_value="2"
      grid_size_phi="MMInnerAperture" grid_size_z="0.150*mm*sqrt(12)" radius="InnerR" />
  </segmentation>
  <segmentation name="Outer" type="MultiSegmentation" key_value="1" key="strip">
        ...
</segmentation>

<id>system:8,layer:4,module:12,sensor:2,strip:30:2,phi:-16,z:-16 </id>
```

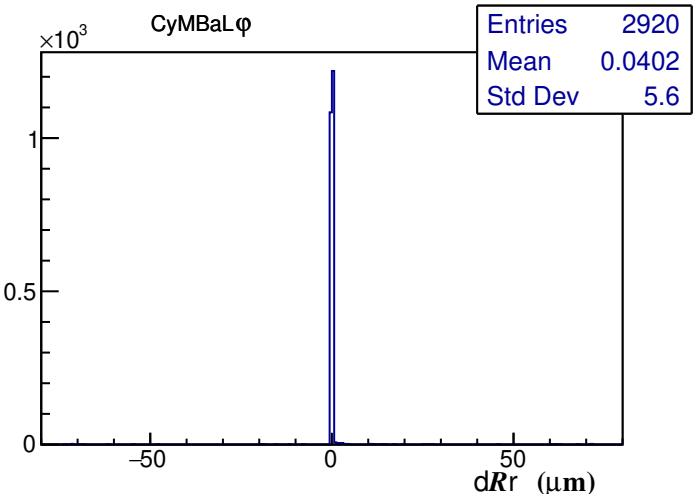
CyMBaL: φ-strips, singleHit-clusters: Residuals

- Same simulation as before.



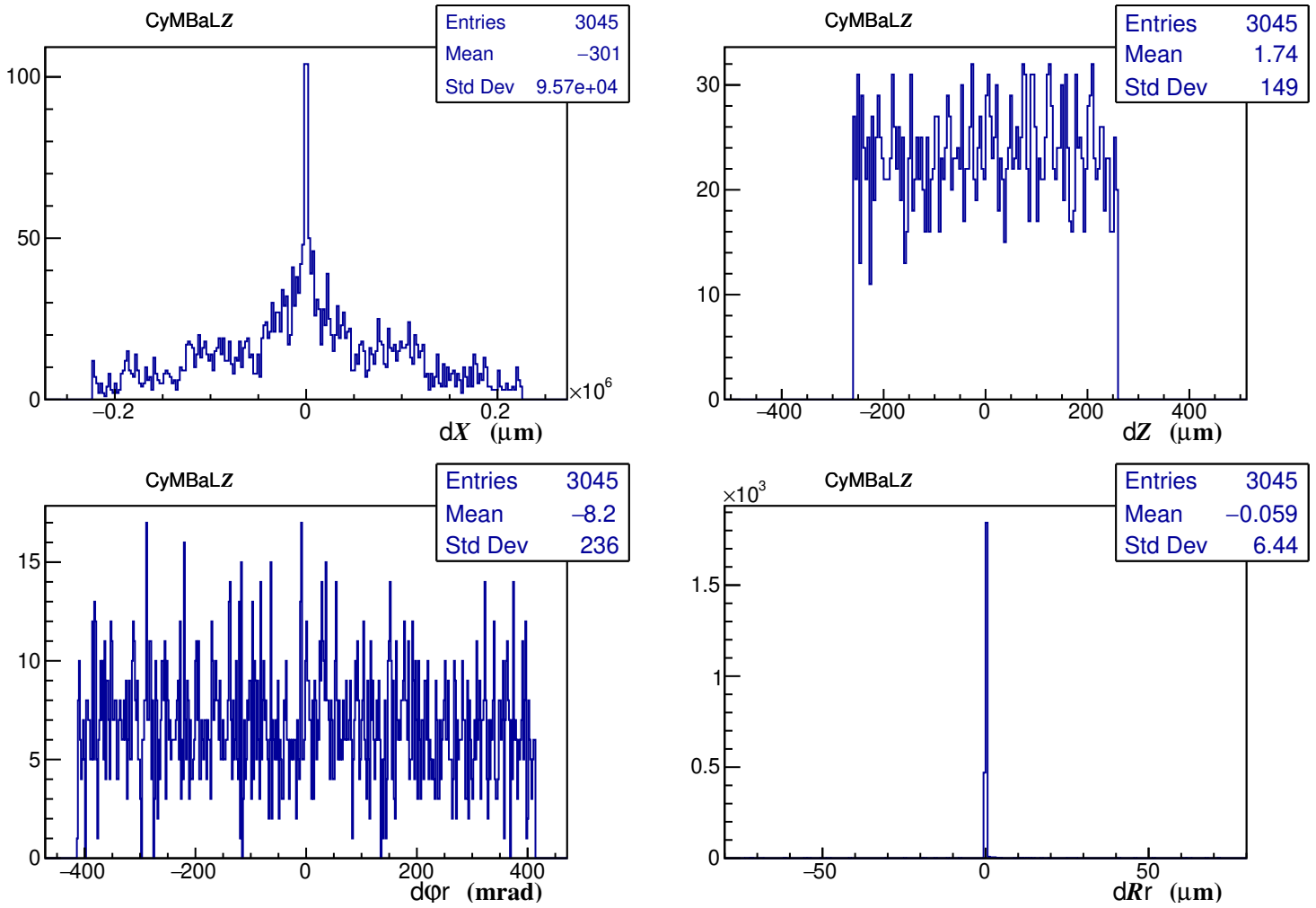






CyMBaL: Z-strips

- Same simulation as before.



- More entries than for φ: $\sim$4% (!?)

Roadmap, TODO

- **Wait** for `CartesianGridUV` availability.
- **PR** to `epic`: UV and (provision for) Strip segmentation.
- **PR** to `eicrecon`: `MPGDTrackerDigi` singleHit digitization.

- **Cluster**: ($Simplistic$) digitization (`MPGDTrackerDigi`) and reconstruction (`MPGDHitReconstruction`)
  . . . and coarser segmentation.
  $\Rightarrow$ Then only ready to determine **accurate hit rates**.

- **Debug** inefficiencies showing up here and there.

- **Endcap** MPGDs: extend strip segmentation.

- Sophisticated **clusterization**: task belongs to each detector sub-group.

- `VolPlane( SurfaceType typ, double thickness_inner, double thickness_outer, ...)`
  What thickness is this? Aren't we double-counting some material?
  `VolCylinder` instead of `VolPlane`?