

Comparison of rates for different Lucite designs with the Lead donut frame turning to Galactic

The MOLLER Project
Measurement Of a Lepton Lepton Electroweak Reaction

Elham Gorgannejad
Dr. Wouter Deconinck

June, 2021

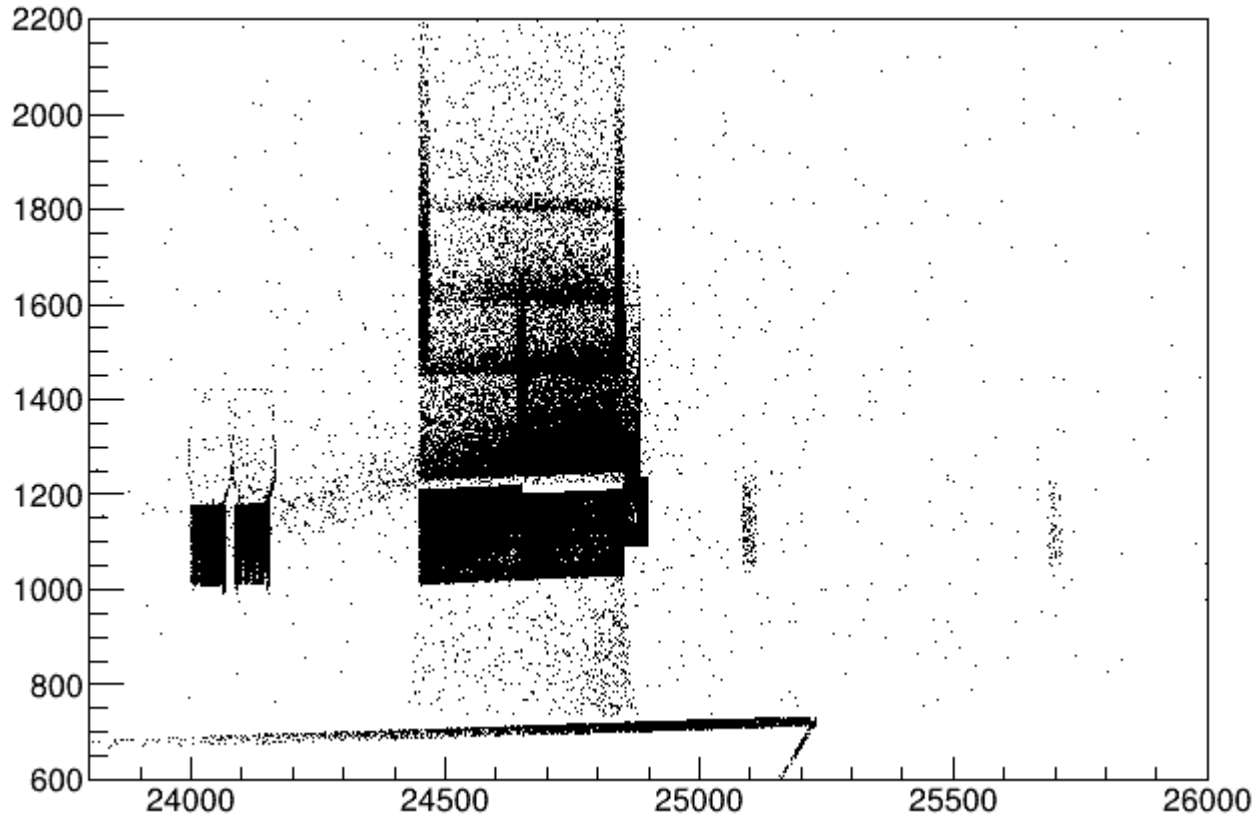


University
of Manitoba

The origin location of all the secondaries anywhere for 5M events- Galactic outer sleeve and top/bot sleeve support

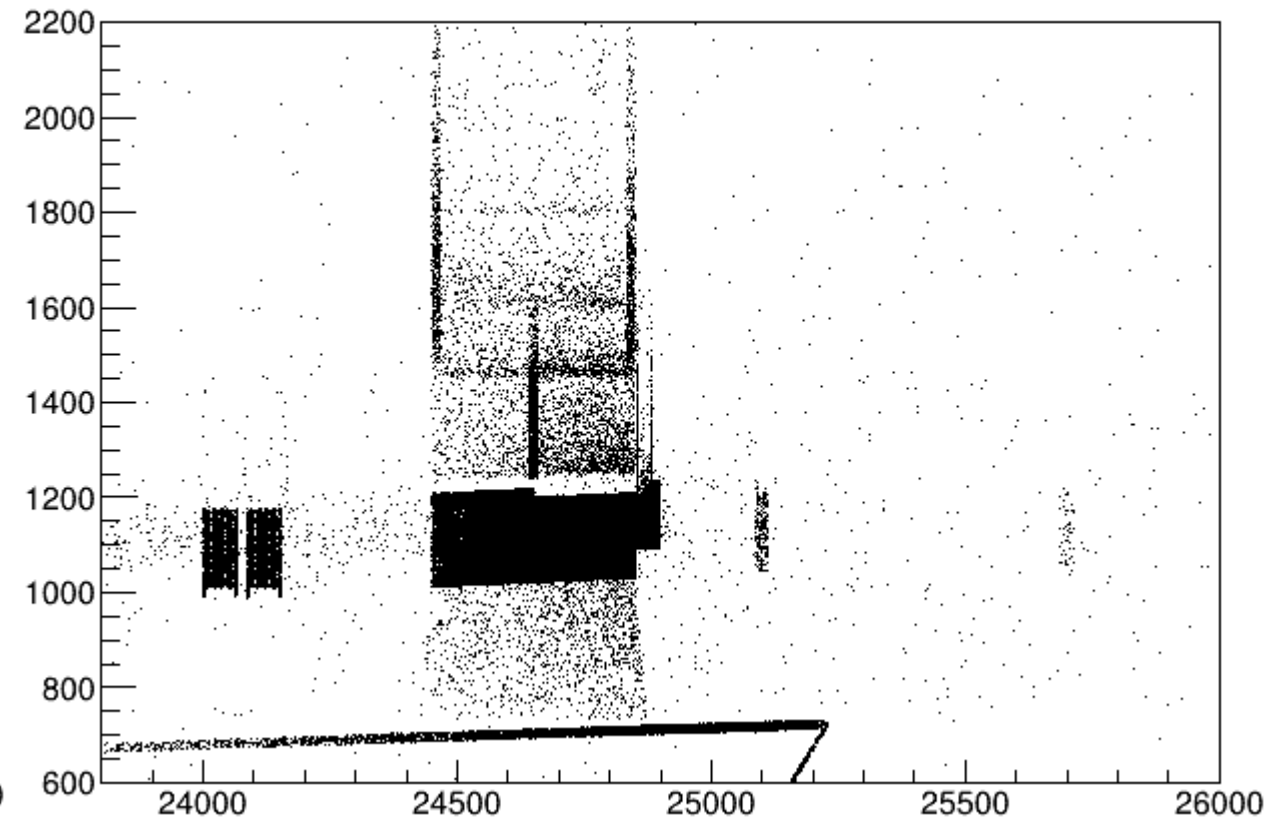
Moller

`sqrt(hit.vx**2+hit.vy**2):hit.vz {rate*(hit.det==8001 && hit.trid>2)}`



Pion

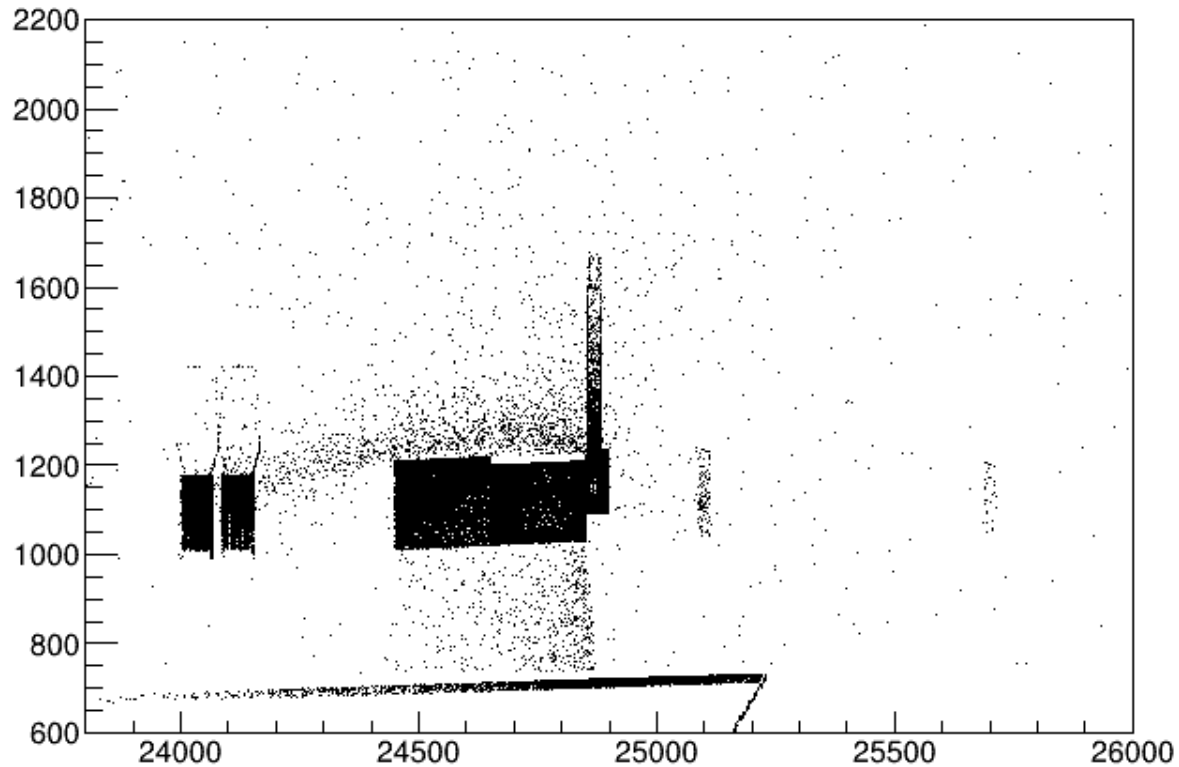
`sqrt(hit.vx**2+hit.vy**2):hit.vz {rate*(hit.det==8001 && hit.trid>2)}`



The origin location of all the secondaries anywhere for 5M events- Galactic frame

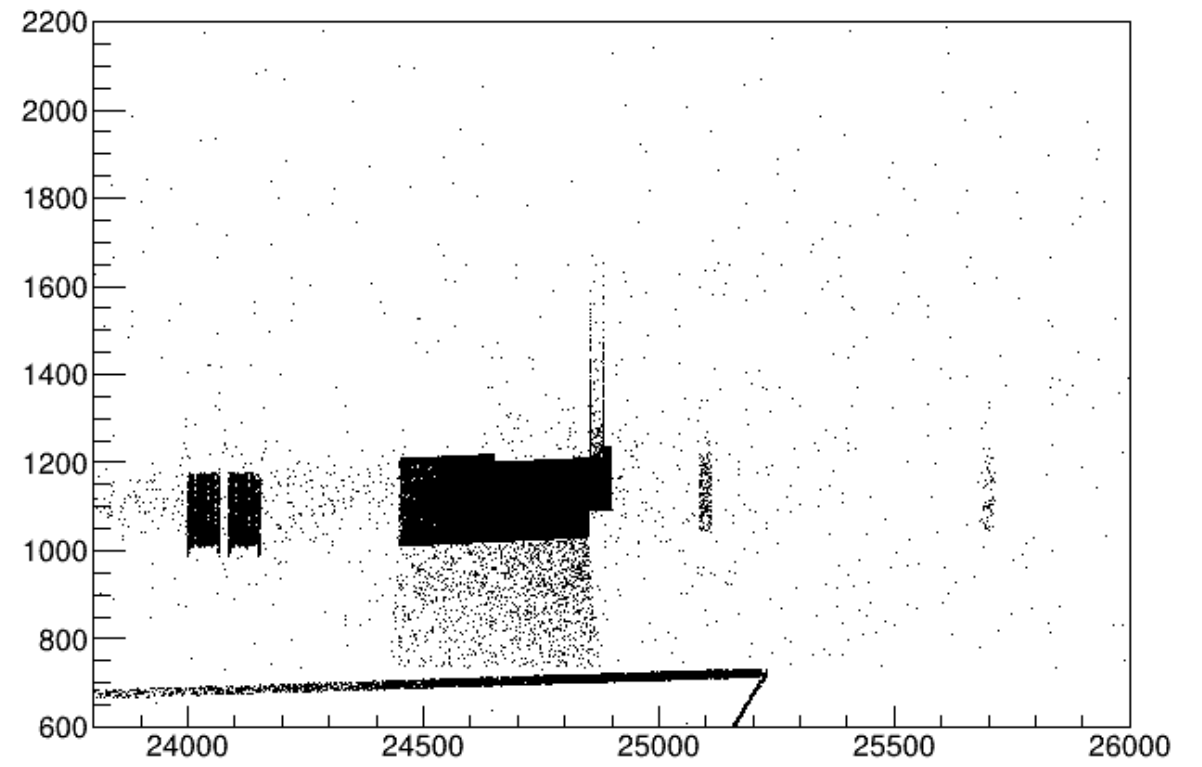
Moller

`sqrt(hit.vx**2+hit.vy**2):hit.vz {rate*(hit.det==8001 && hit.trid>2)}`



Pion

`sqrt(hit.vx**2+hit.vy**2):hit.vz {rate*(hit.det==8001 && hit.trid>2)}`



Comparison of rates for Galactic outer sleeve (Low energy particles)

Rates $GH z/\mu A$ /Detector	Rate of electrons	Rate of pions	Pi/e	Rate of photoelectrons from electrons	Rate of photoelectrons from pions	Pi/e
Aluminium	$(2.47 \pm 0.01) \times 10^{-3}$	$(5.49 \pm 0.08) \times 10^{-6}$	0.22%	$(4.834 \pm 0.006) \times 10^{-2}$	$(5.039 \pm 0.008) \times 10^{-4}$	1.04%
Galactic	$(2.54 \pm 0.01) \times 10^{-3}$	$(5.58 \pm 0.08) \times 10^{-6}$	0.22%	$(4.215 \pm 0.006) \times 10^{-2}$	$(4.945 \pm 0.007) \times 10^{-4}$	1.17%

Comparison of rates for Galactic outer sleeve and Galactic top/bot sleeve support

Galactic	$(1.71 \pm 0.01) \times 10^{-3}$	$(5.41 \pm 0.08) \times 10^{-6}$	0.32%	$(2.216 \pm 0.004) \times 10^{-2}$	$(4.957 \pm 0.008) \times 10^{-4}$	2.24%
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Comparison of rates for Galactic frame

All frame- Galactic	$(1.260 \pm 0.009) \times 10^{-3}$	$(5.29 \pm 0.08) \times 10^{-6}$	0.42%	$(1.822 \pm 0.004) \times 10^{-2}$	$(4.850 \pm 0.007) \times 10^{-4}$	2.66%
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Comparison of rates for Galactic outer sleeve (High energy particles)

Rates $GH z/\mu A$ /Detector	Rate of electrons	Rate of pions	Pi/e	Rate of photoelectrons from electrons	Rate of photoelectrons from pions	Pi/e
Aluminium	$(3.05 \pm 0.02) \times 10^{-3}$	$(2.78 \pm 0.02) \times 10^{-5}$	0.91%	$(4.834 \pm 0.006) \times 10^{-2}$	$(5.039 \pm 0.008) \times 10^{-4}$	1.04%
Galactic	$(2.99 \pm 0.01) \times 10^{-3}$	$(2.73 \pm 0.02) \times 10^{-5}$	0.91%	$(4.215 \pm 0.006) \times 10^{-2}$	$(4.945 \pm 0.007) \times 10^{-4}$	1.17%

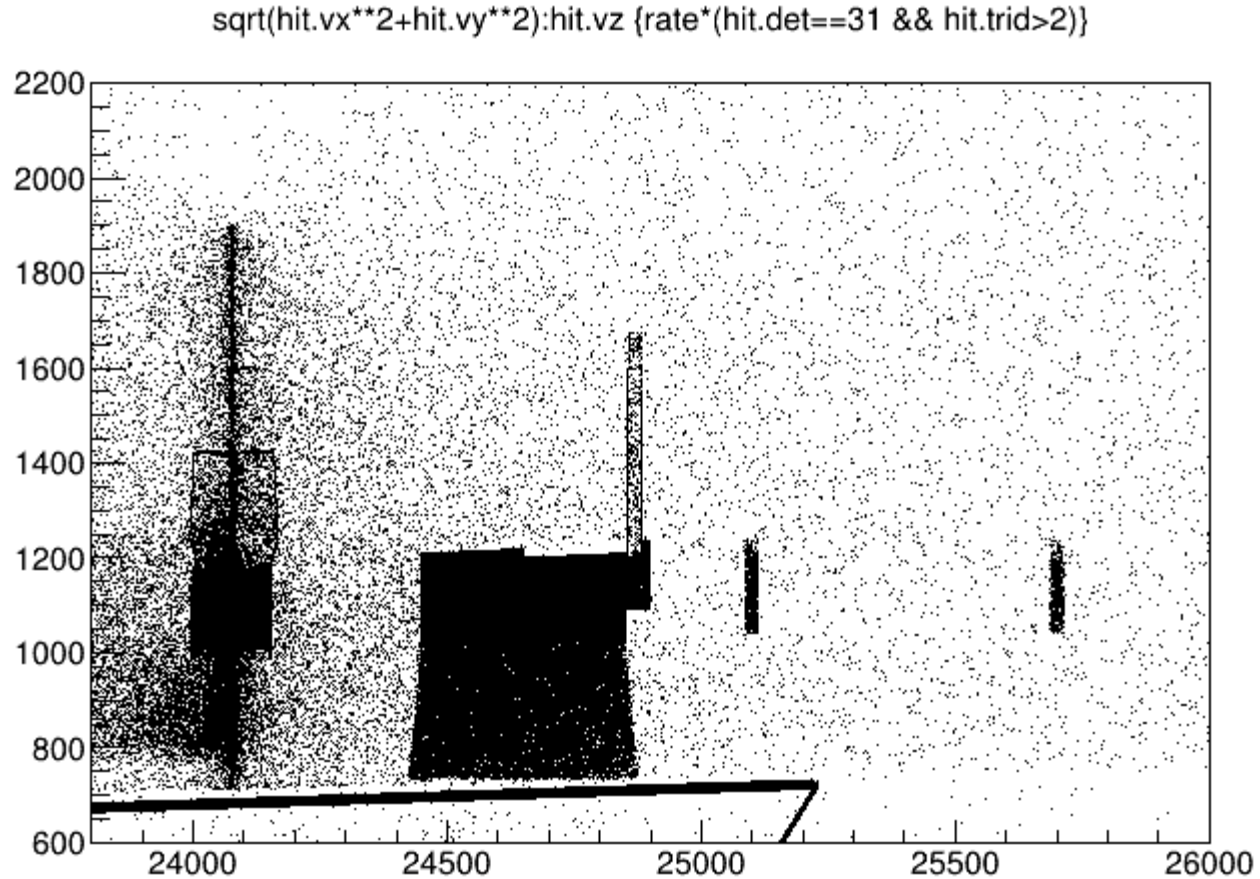
Comparison of rates for Galactic outer sleeve and Galactic top/bot sleeve support

Galactic	$(1.56 \pm 0.01) \times 10^{-3}$	$(2.75 \pm 0.02) \times 10^{-5}$	1.76%	$(2.216 \pm 0.004) \times 10^{-2}$	$(4.957 \pm 0.008) \times 10^{-4}$	2.24%
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Comparison of rates for Galactic frame

All frame- Galactic	$(1.163 \pm 0.009) \times 10^{-3}$	$(2.74 \pm 0.02) \times 10^{-5}$	2.36%	$(1.822 \pm 0.004) \times 10^{-2}$	$(4.850 \pm 0.007) \times 10^{-4}$	2.66%
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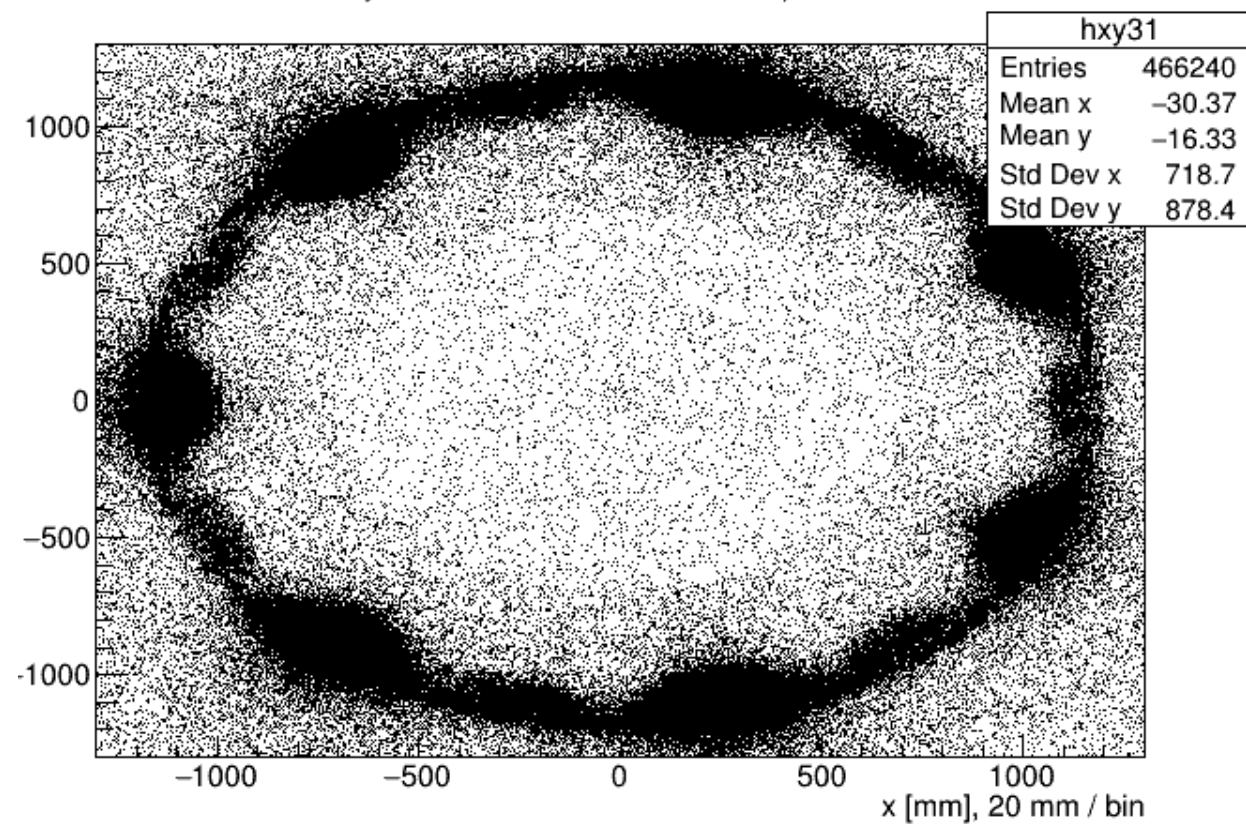
**The location of all the hits on the showermax for 5M events (Galactic frame)
(showermax plane at the center of both showermax detectors)**



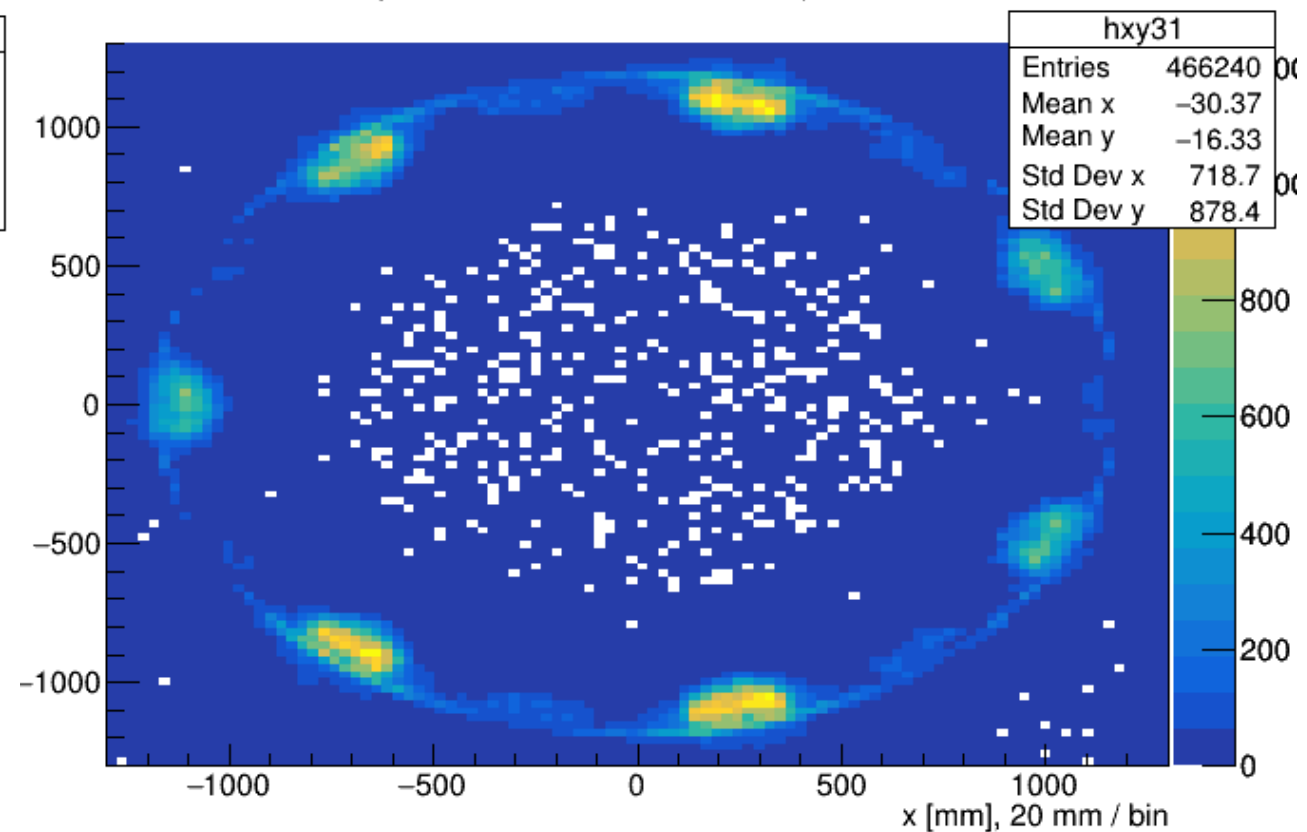
T->Draw("sqrt(hit.vx**2+hit.vy**2):hit.vz>>h1(100,23800,26000,100,600,2200)","rate*(hit.det==31 && hit.trid>2)")

The location of all the hits on the showermax for 5M events in x y - Aluminium frame (Plane at the center)

Hit vertex x y at showermax from events at pion lucite detector

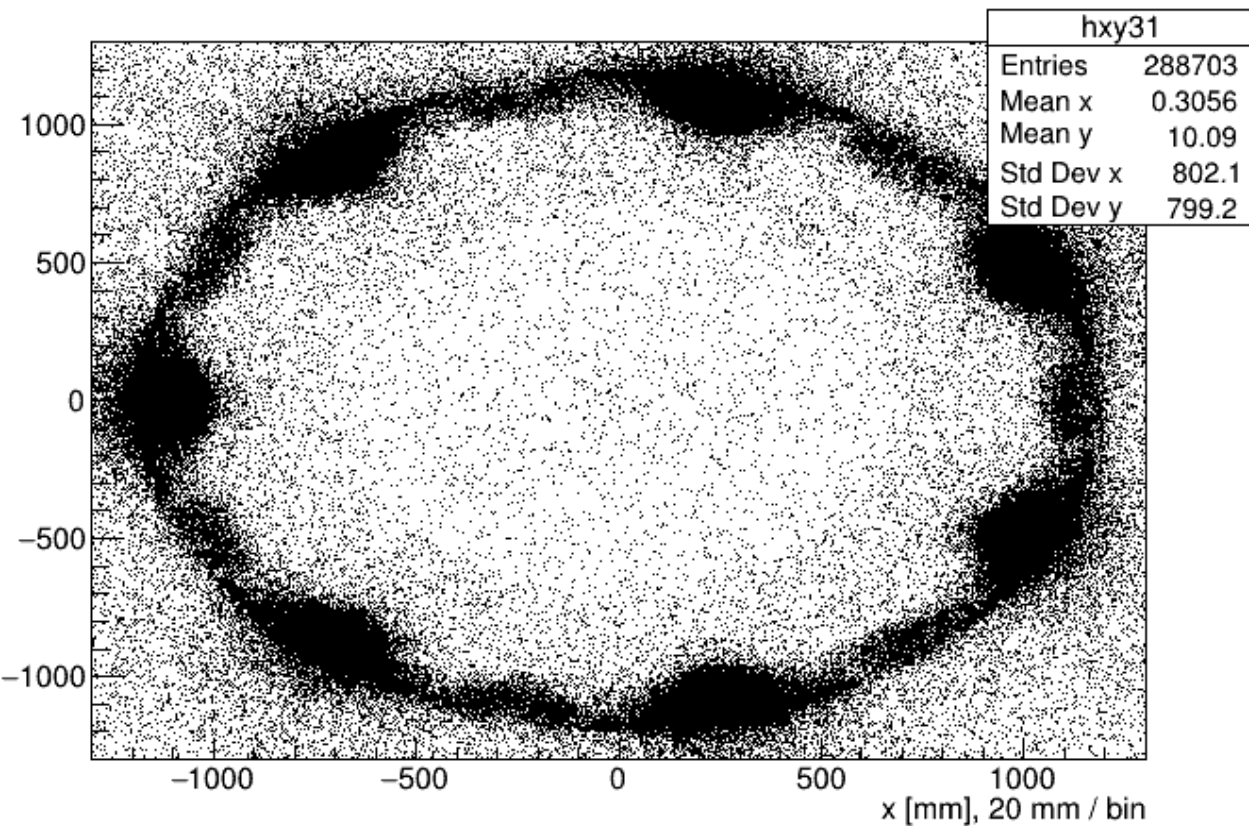


Hit vertex x y at showermax from events at pion lucite detector

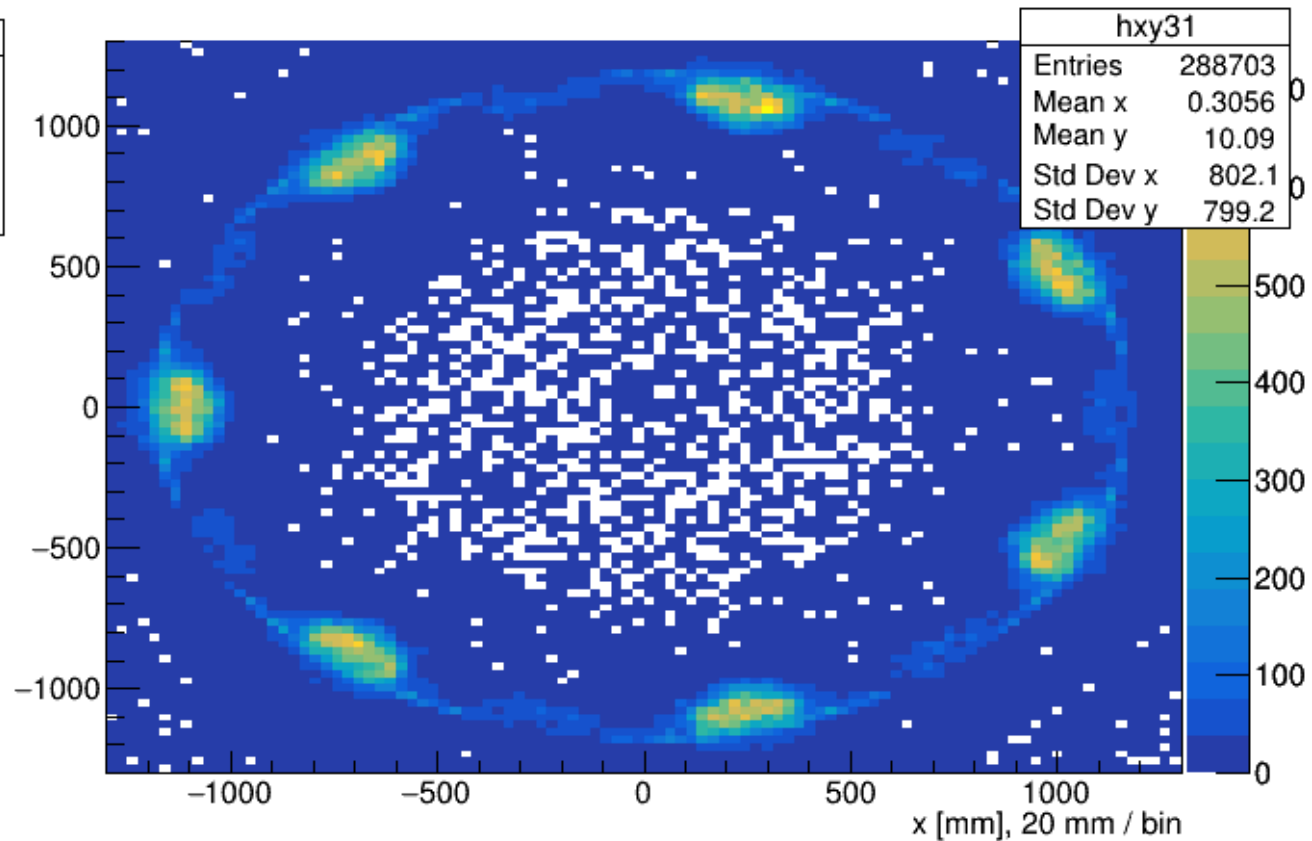


The location of all the hits on the showermax for 5M events in x y - Galactic frame (Plane at the center)

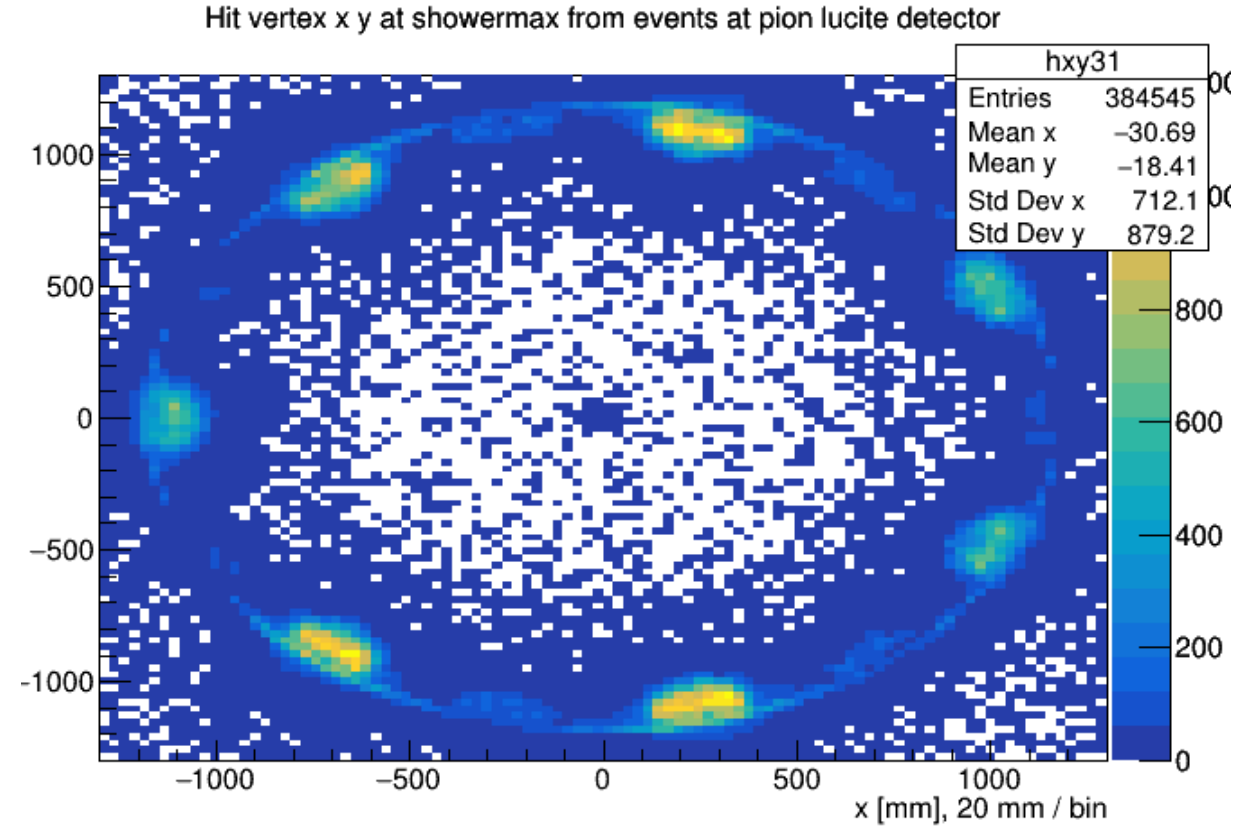
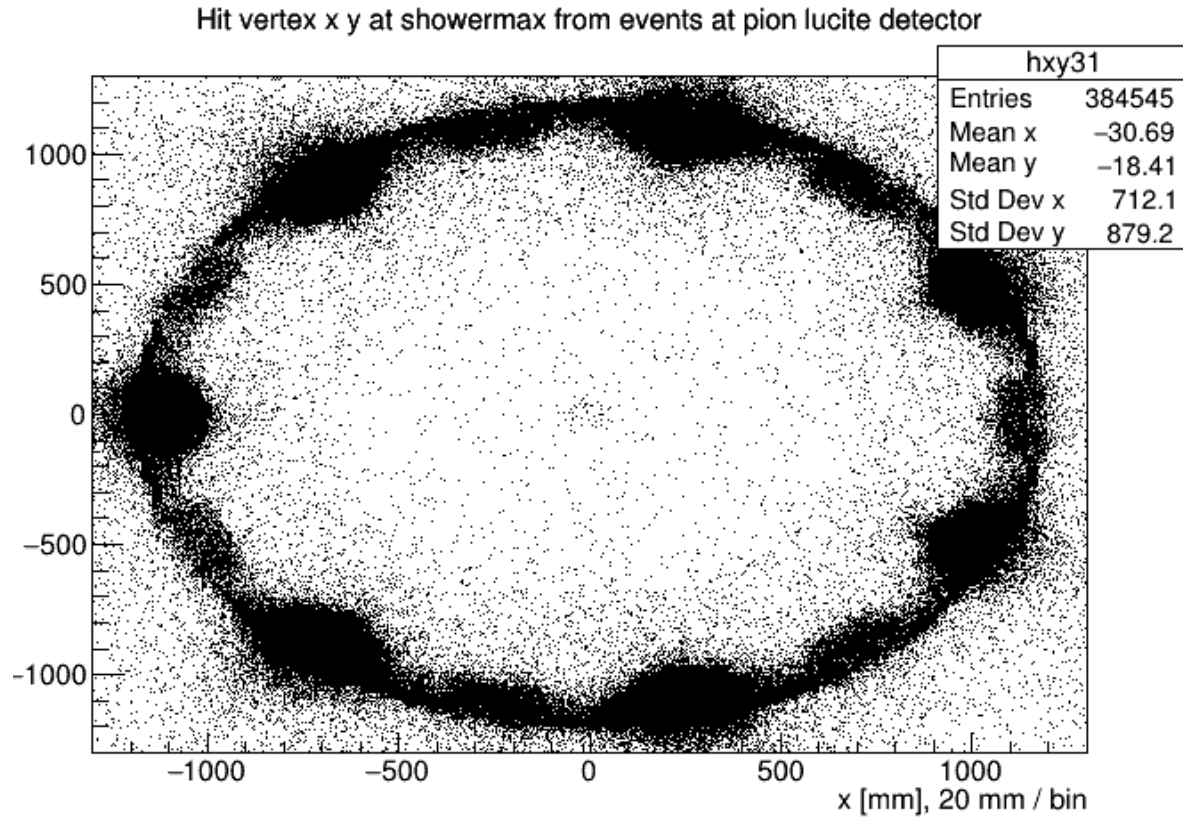
Hit vertex x y at showermax from events at pion lucite detector



Hit vertex x y at showermax from events at pion lucite detector

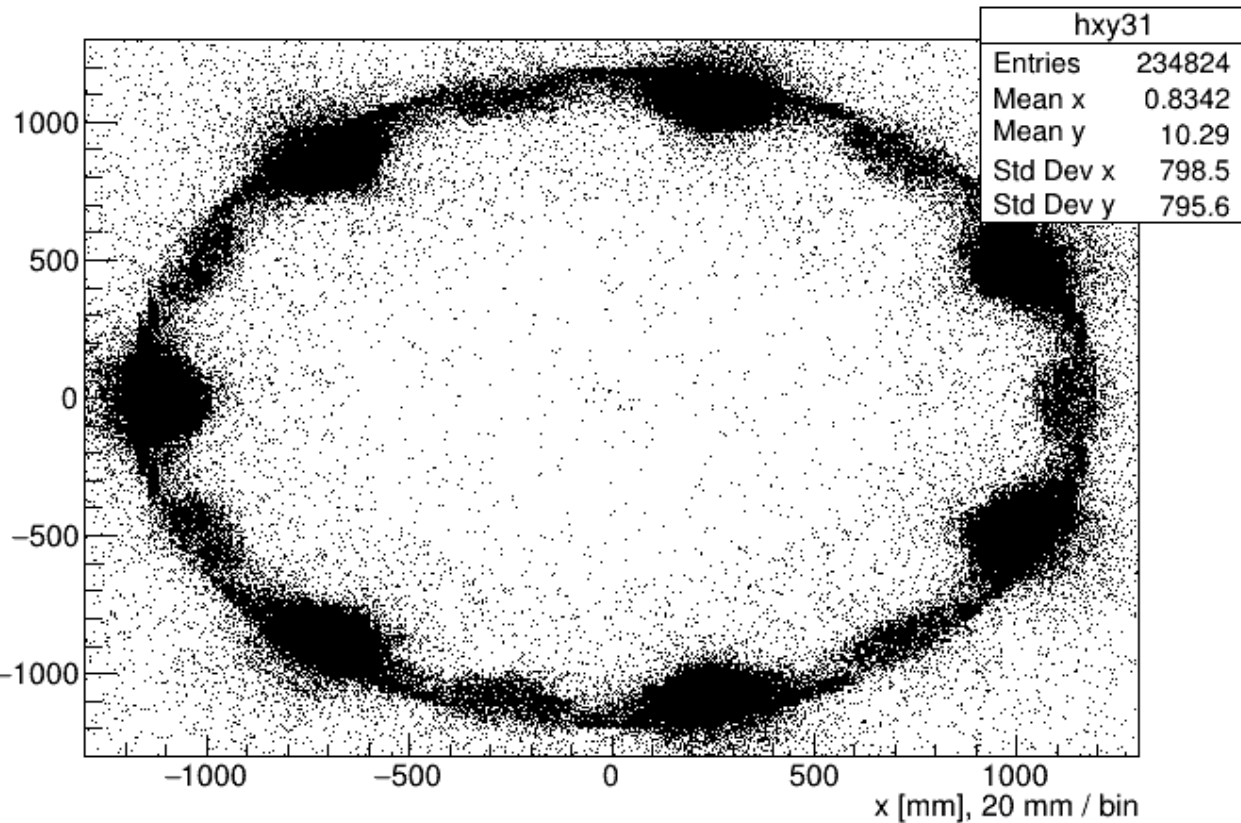


The location of all the hits on the showermax for 5M events in x y - Aluminium frame (Plane at the center-moving forward-hit.pz>0)

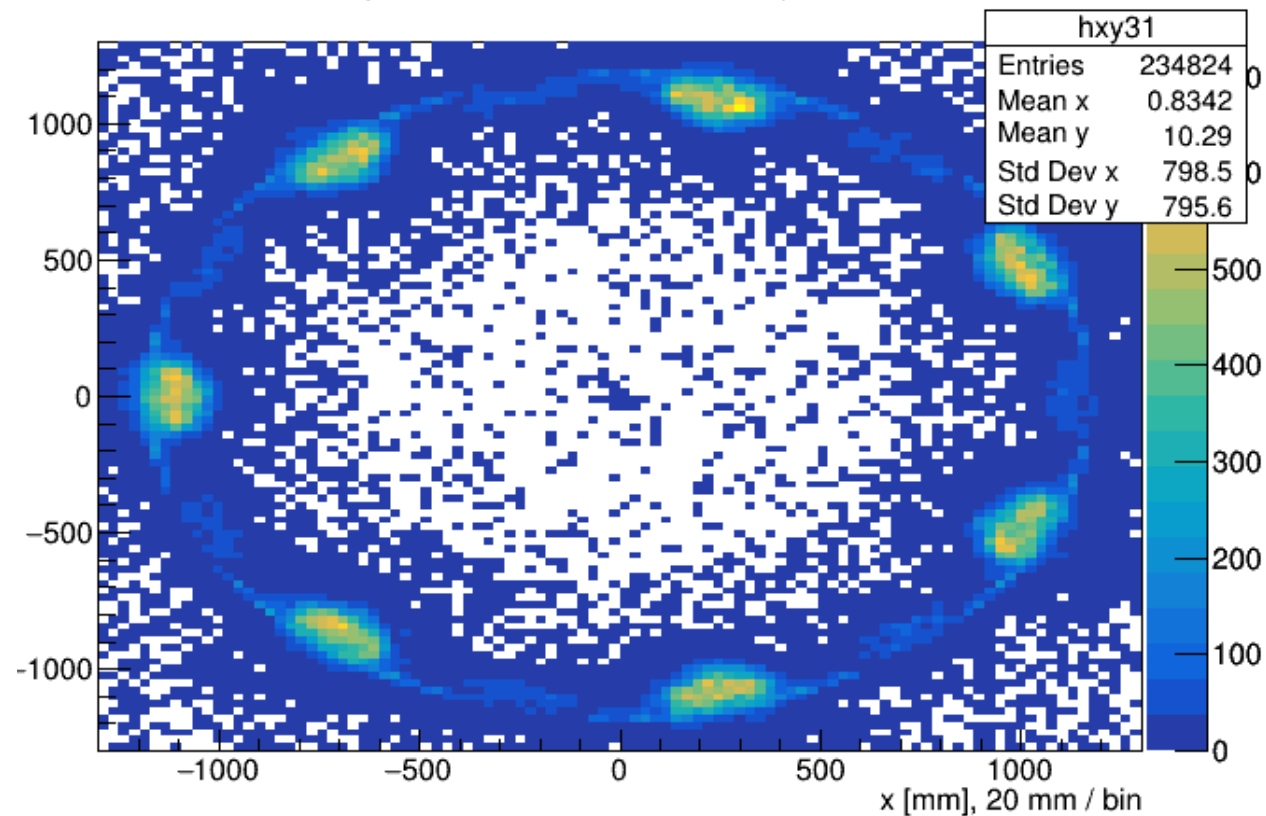


The location of all the hits on the showermax for 5M events in x y - Galactic frame (Plane at the center-moving forward-hit.pz>0)

Hit vertex x y at showermax from events at pion lucite detector

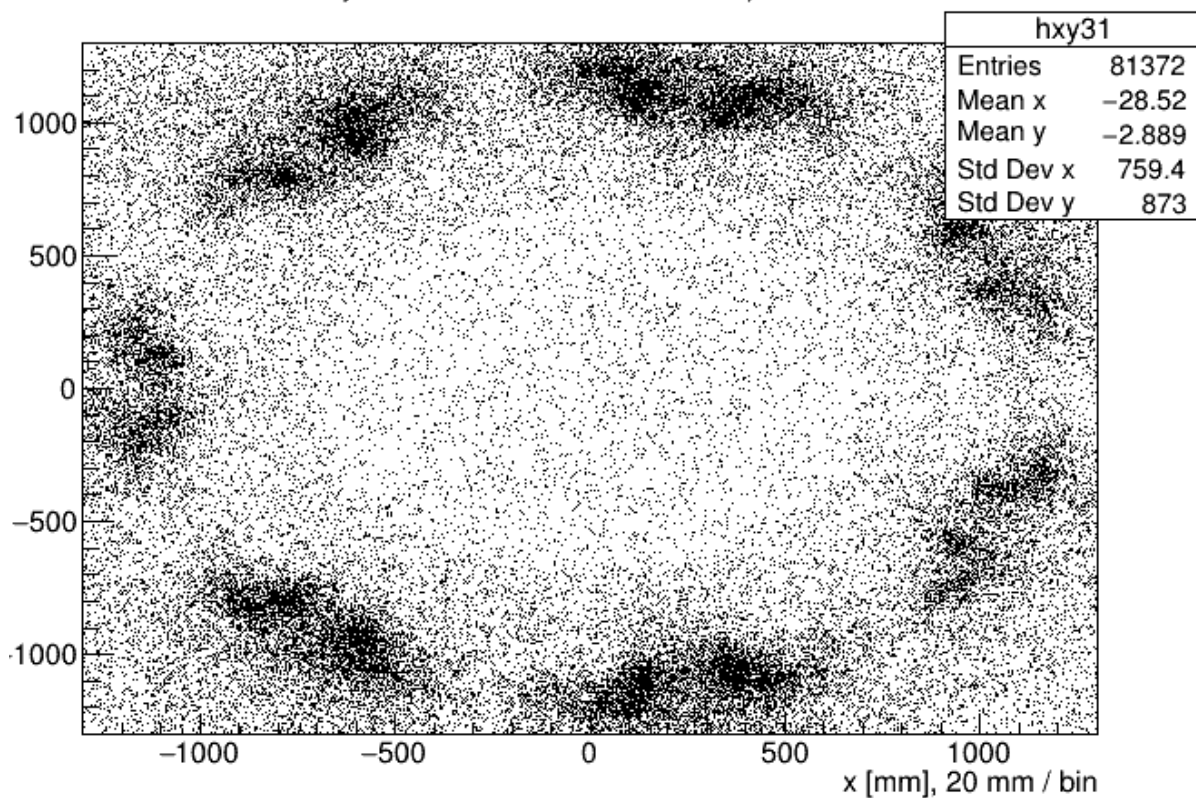


Hit vertex x y at showermax from events at pion lucite detector

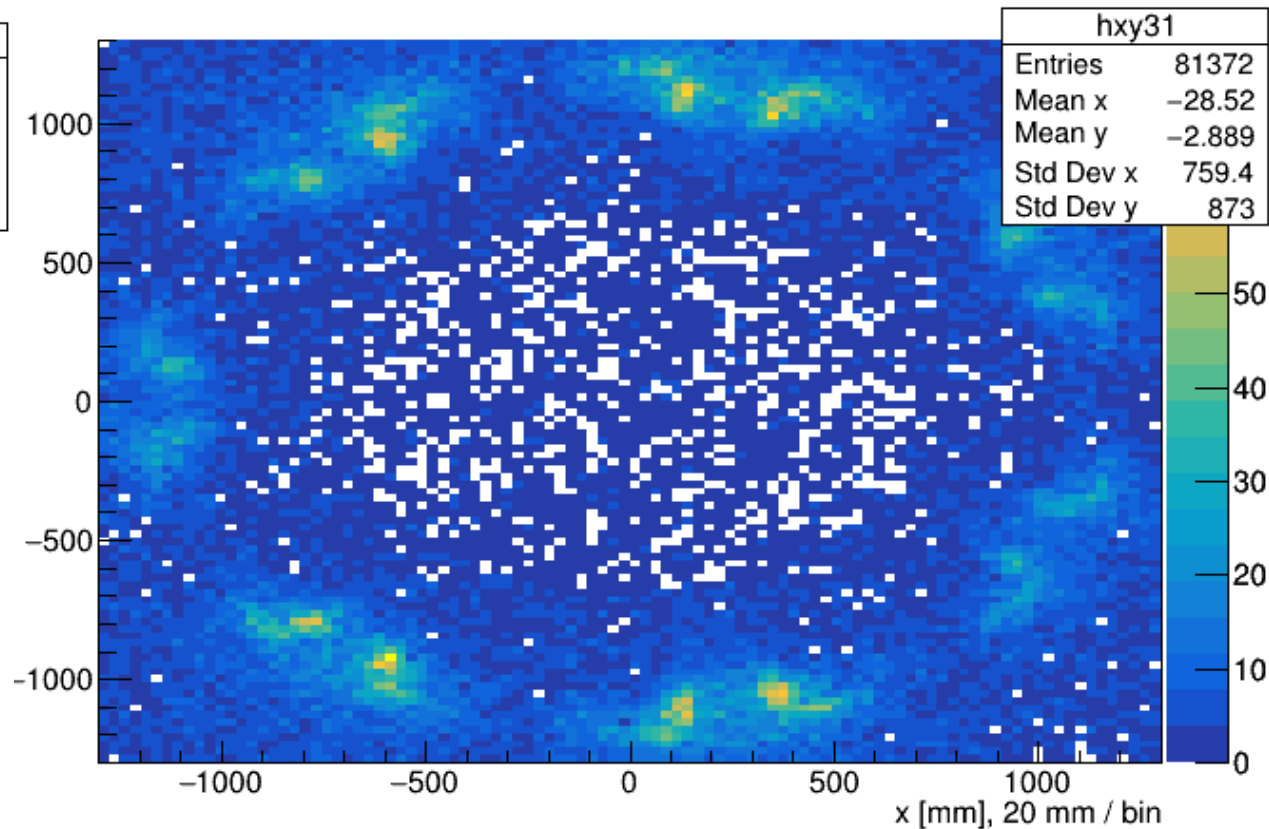


The location of all the hits on the showermax for 5M events in x y - Aluminium frame (Plane at the center-moving backward-hit.pz<0)

Hit vertex x y at showermax from events at pion lucite detector

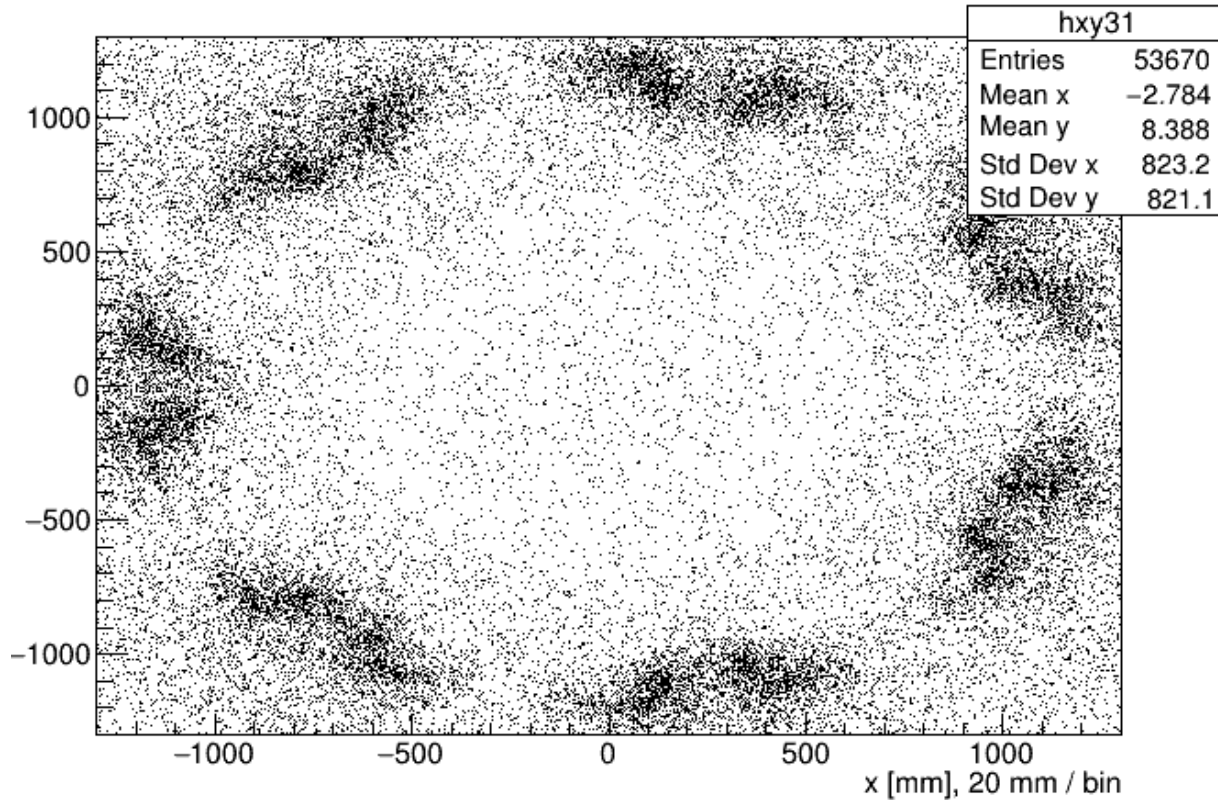


Hit vertex x y at showermax from events at pion lucite detector

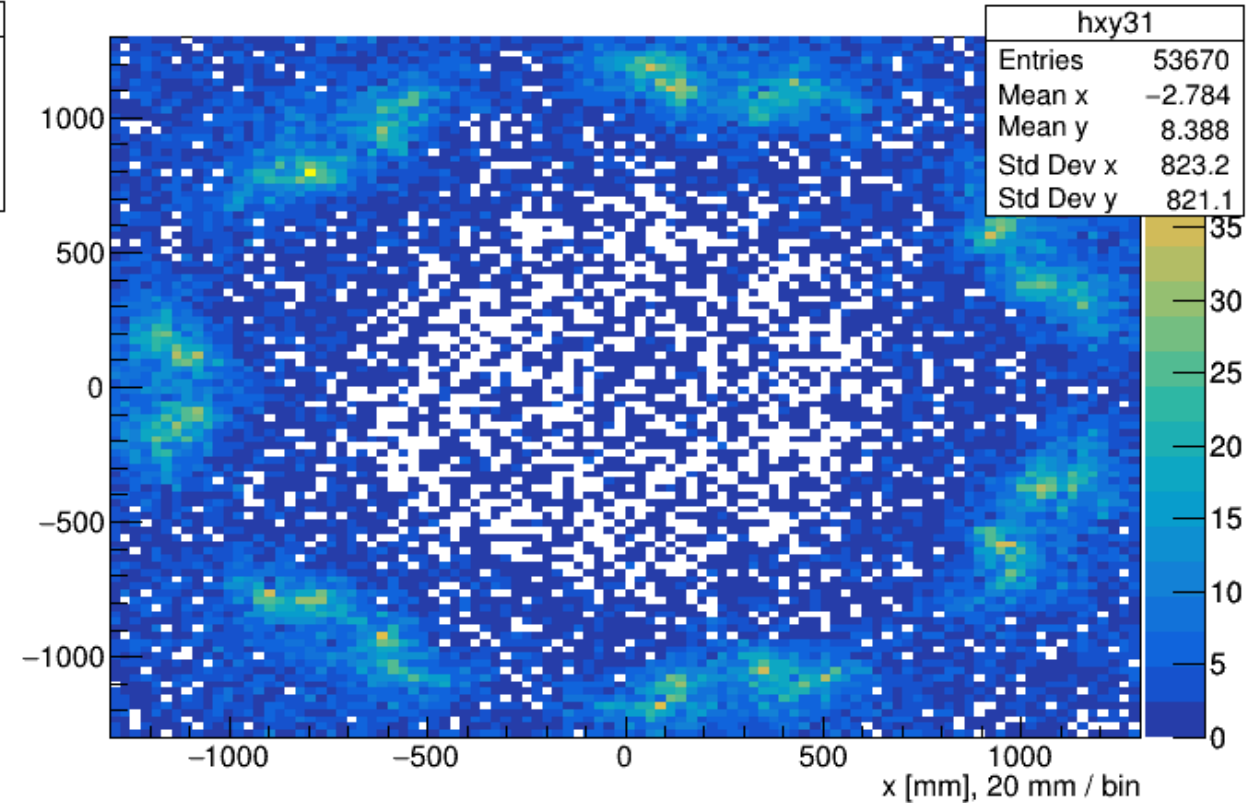


The location of all the hits on the showermax for 5M events in x y - Galactic frame (Plane at the center-moving backward-hit.pz<0)

Hit vertex x y at showermax from events at pion lucite detector

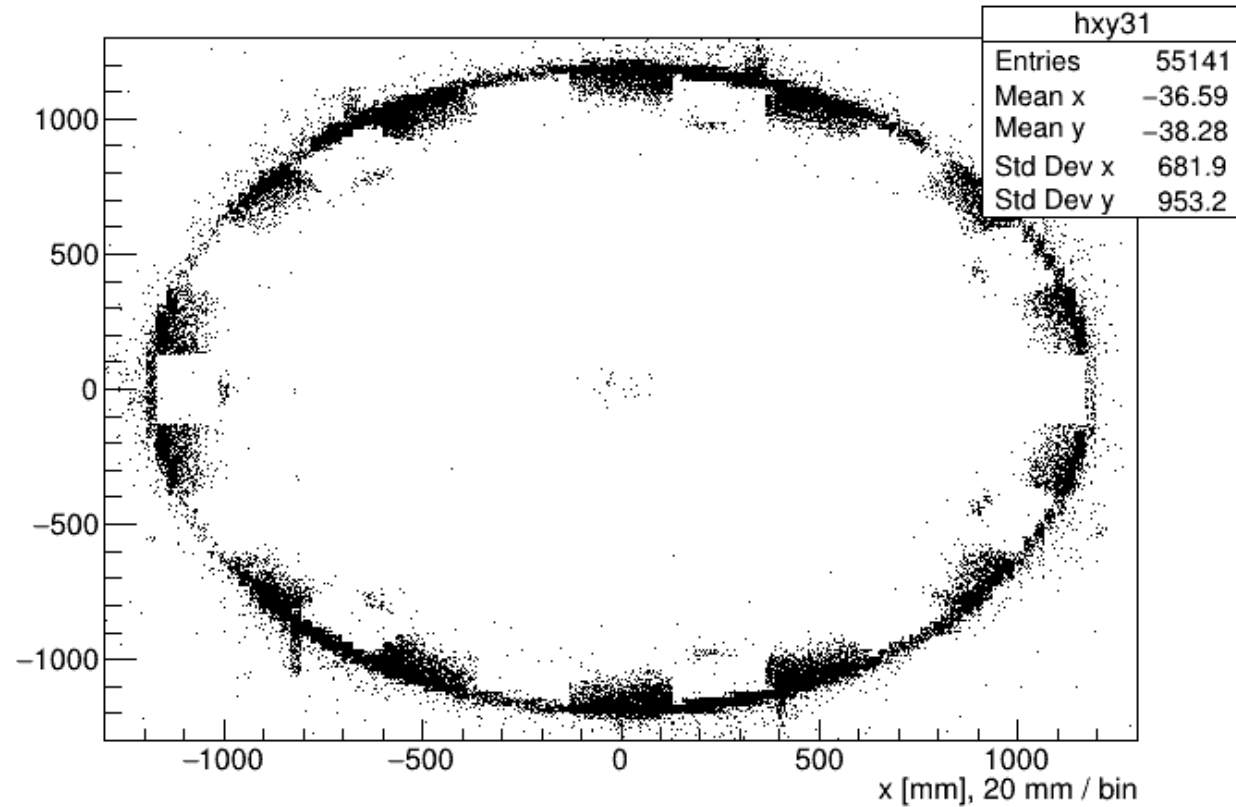


Hit vertex x y at showermax from events at pion lucite detector

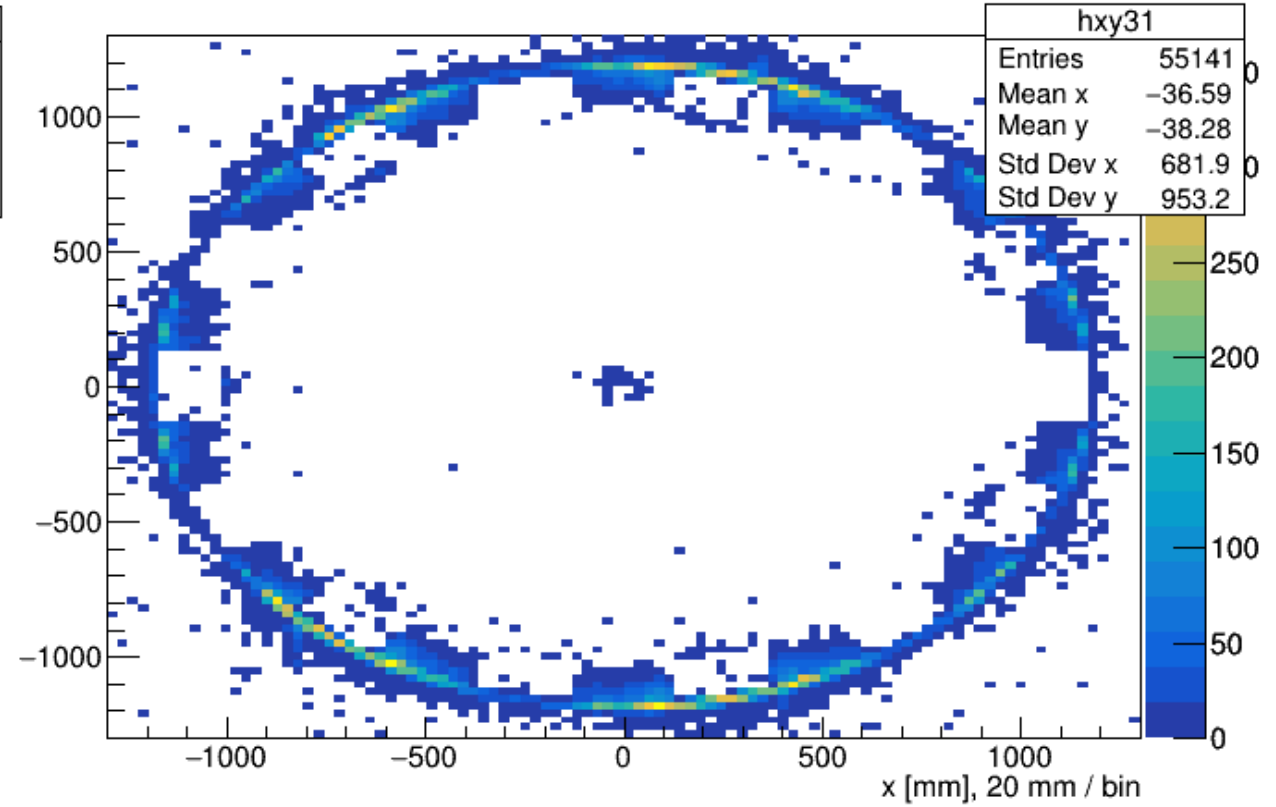


The location of all the hits on the showermax for 5M events in x y- Aluminium frame (primaries - plane at the center)

Hit vertex x y at showermax from events at pion lucite detector

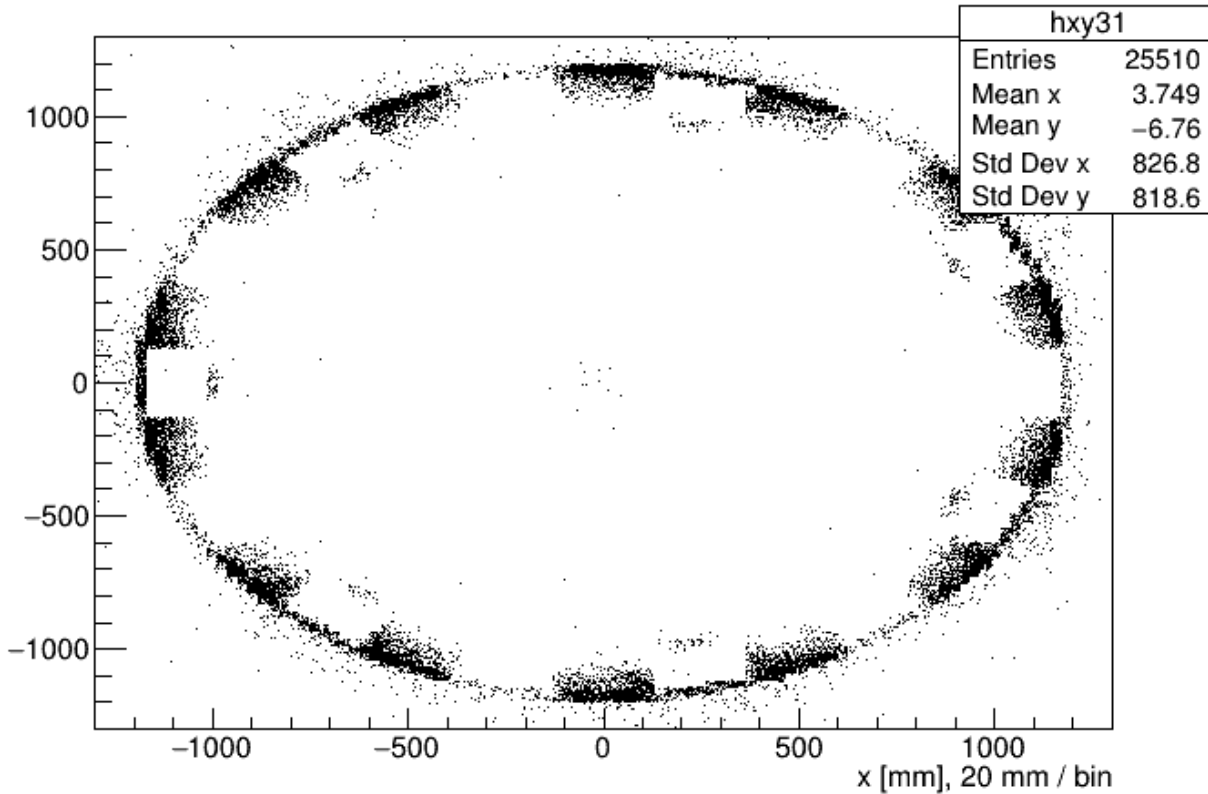


Hit vertex x y at showermax from events at pion lucite detector

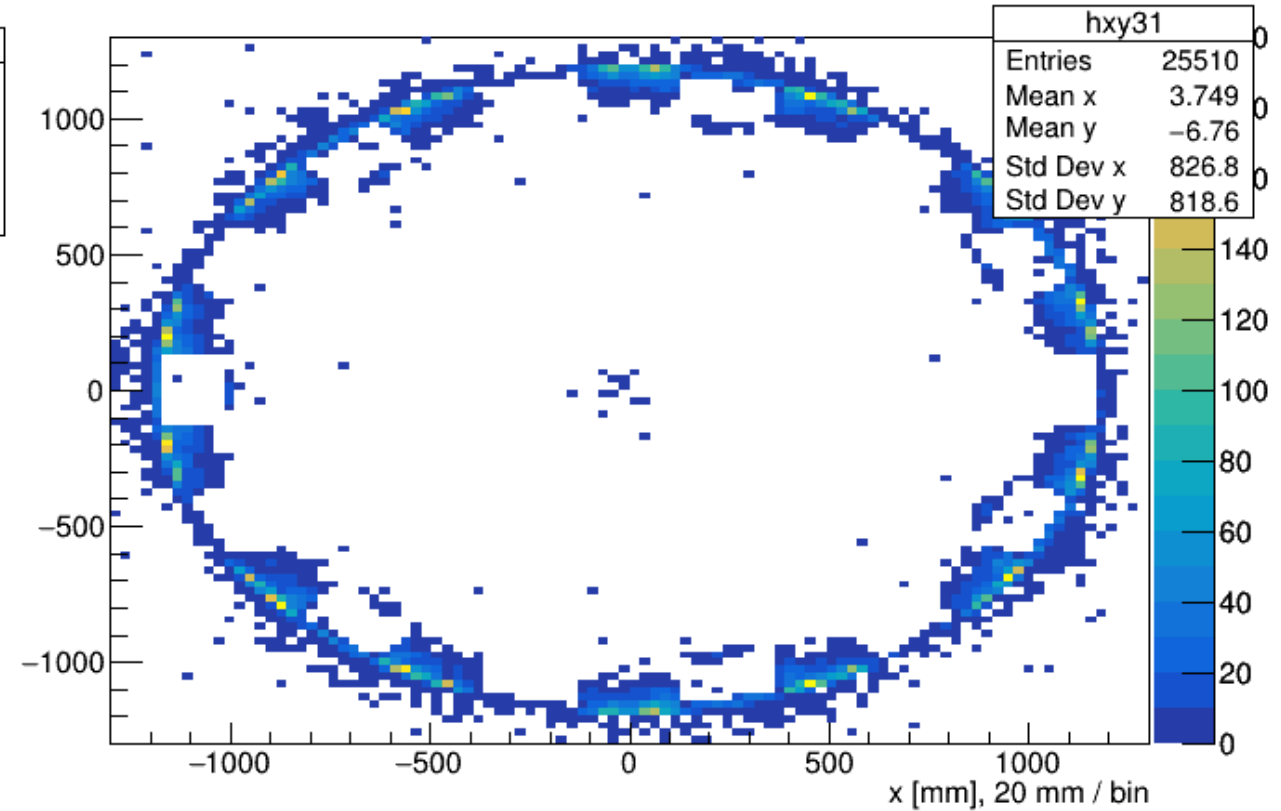


The location of all the hits on the showermax for 5M events in x y – Galactic frame (primaries , plane at the center)

Hit vertex x y at showermax from events at pion lucite detector

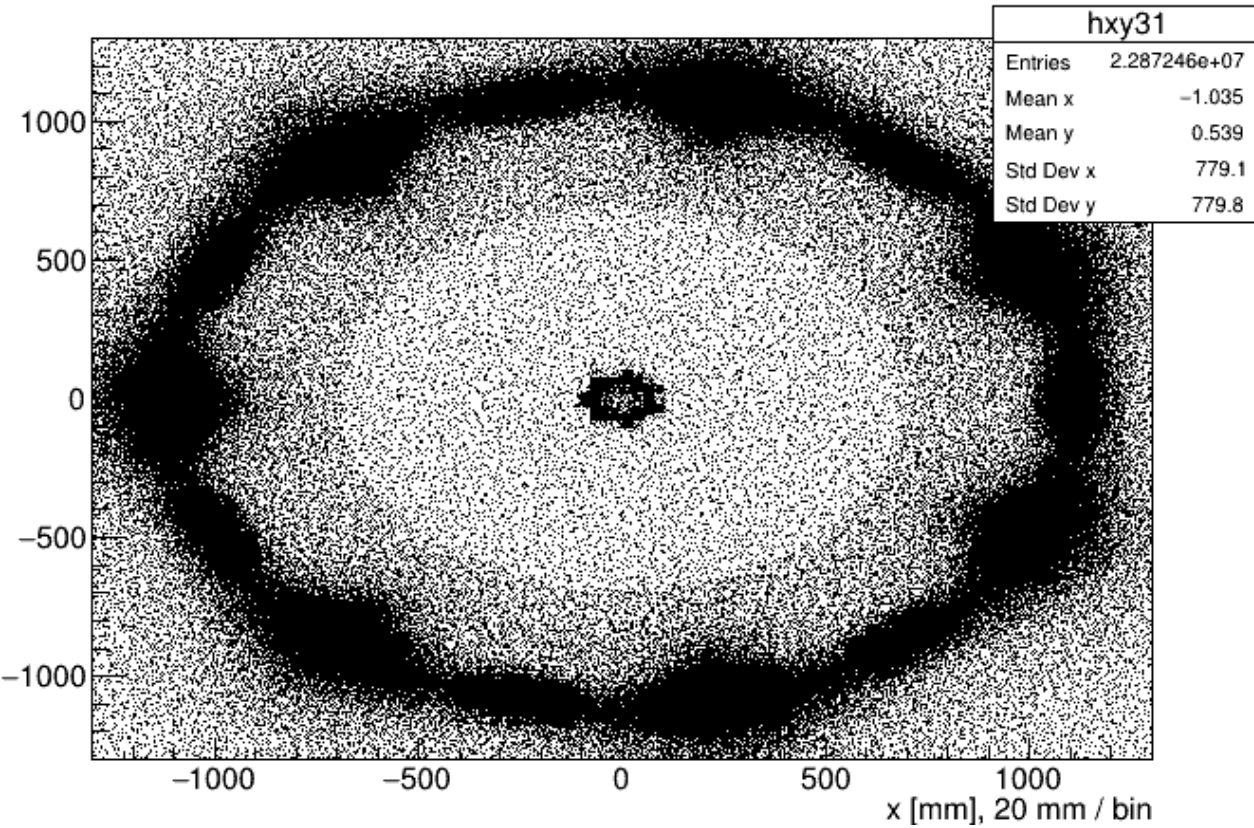


Hit vertex x y at showermax from events at pion lucite detector

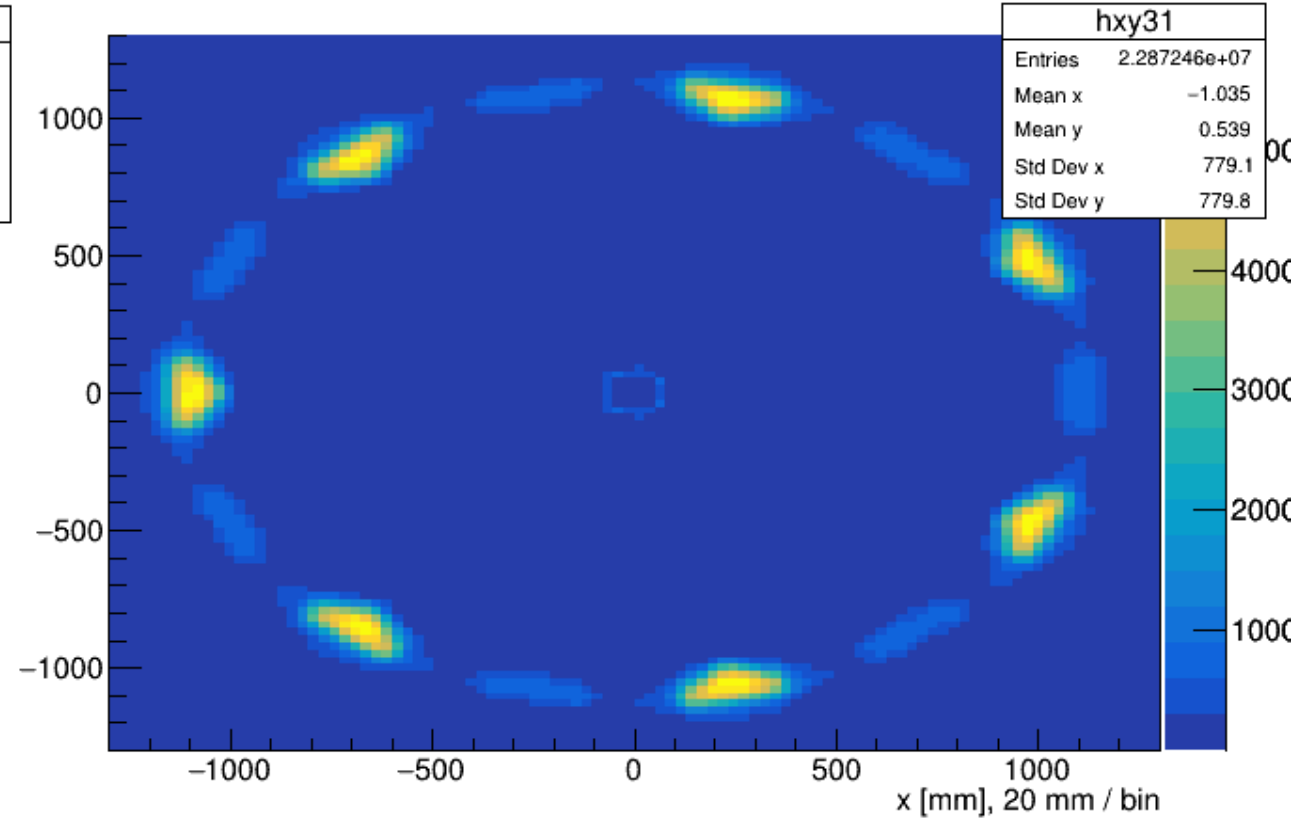


The location of all the hits on the showermax for 5M events in x y - Aluminium frame (without the Lucite, plane at the center)

Hit vertex x y at showermax from events at pion lucite detector

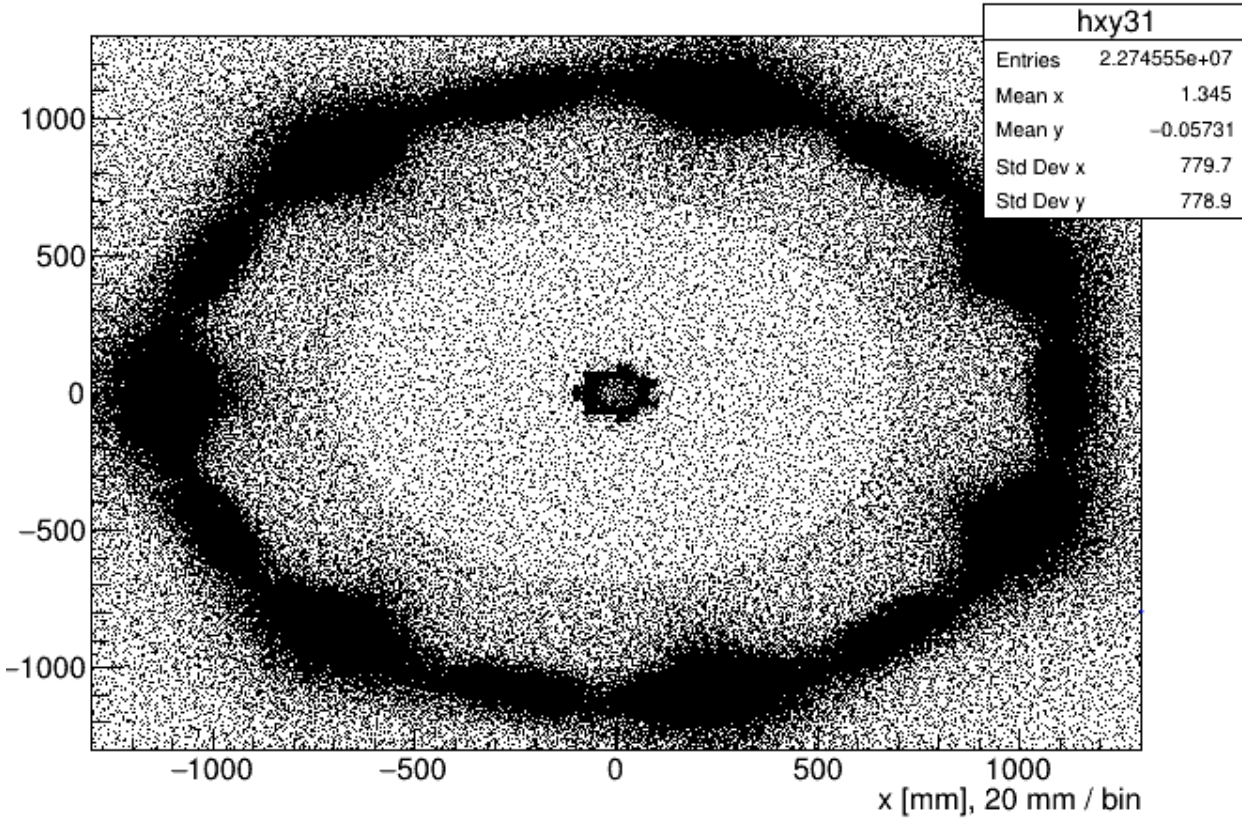


Hit vertex x y at showermax from events at pion lucite detector

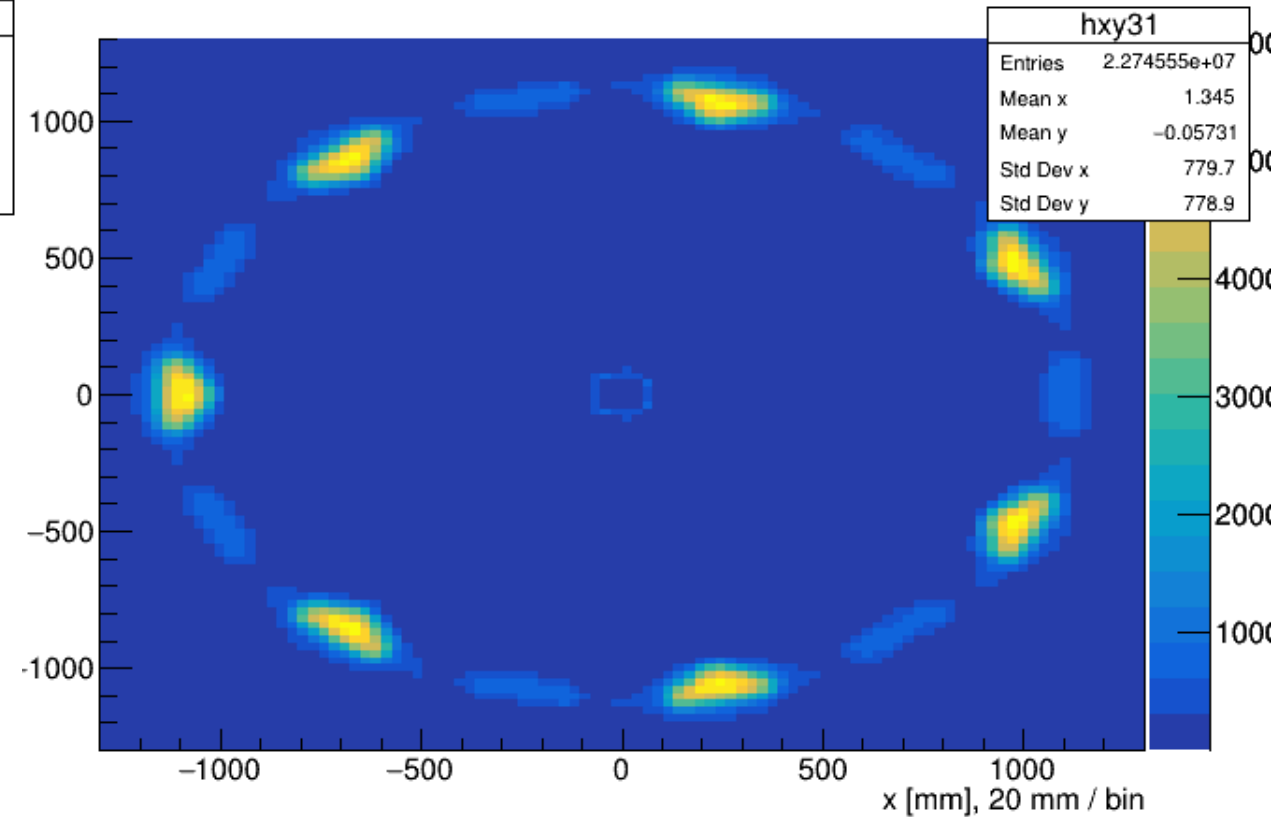


The location of all the hits on the showermax for 5M events in x y - Galactic frame (without the Lucite, plane at the center)

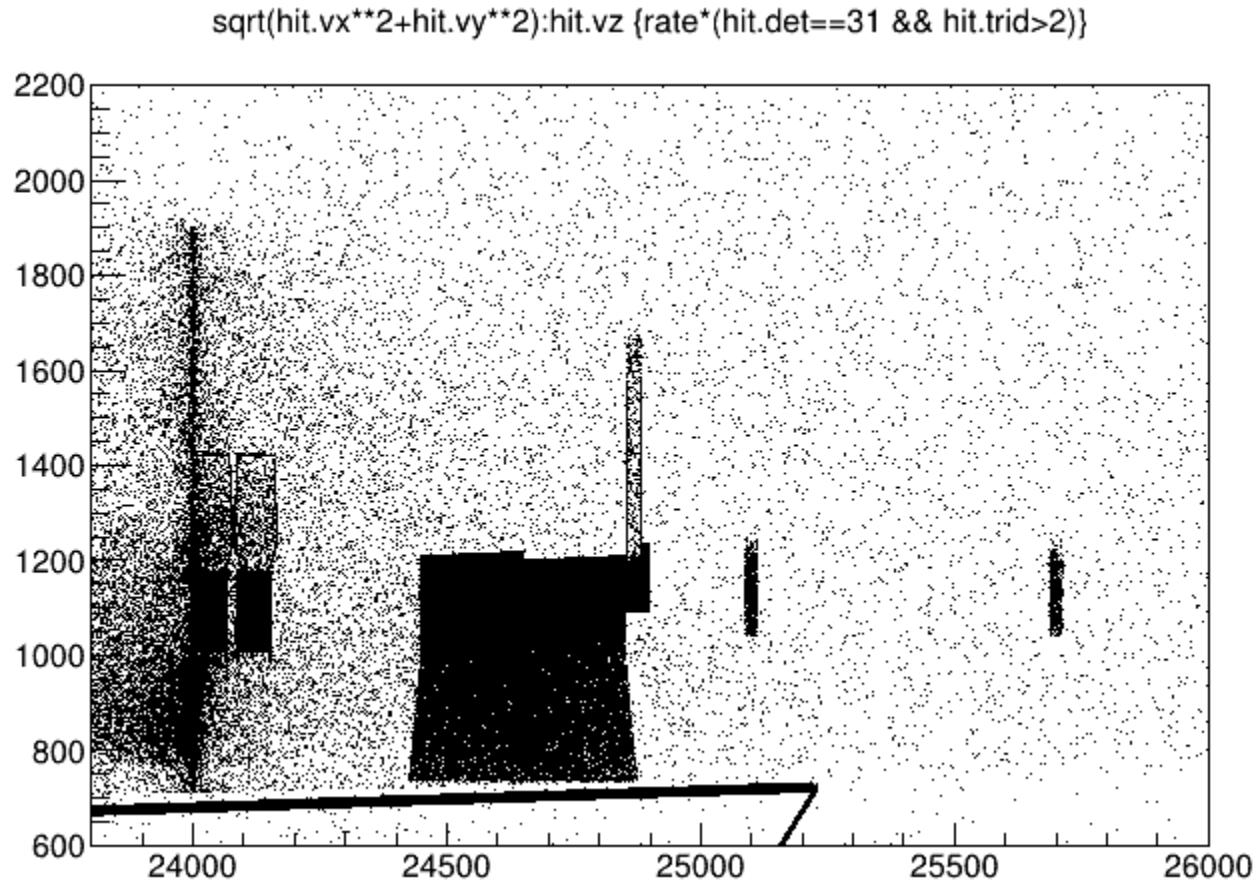
Hit vertex x y at showermax from events at pion lucite detector



Hit vertex x y at showermax from events at pion lucite detector



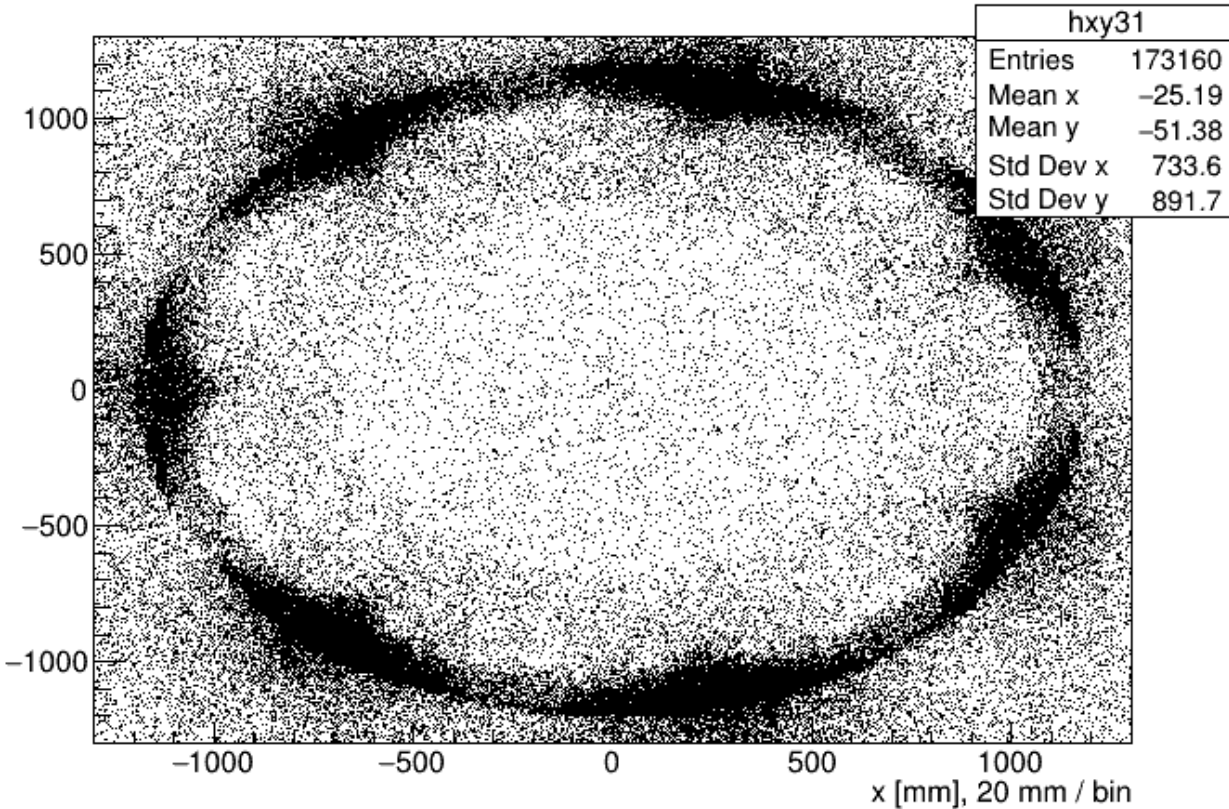
**The location of all the hits on the showermax for 5M events (Galactic frame)
(showermax plane at the upstream of both showermax detectors)**



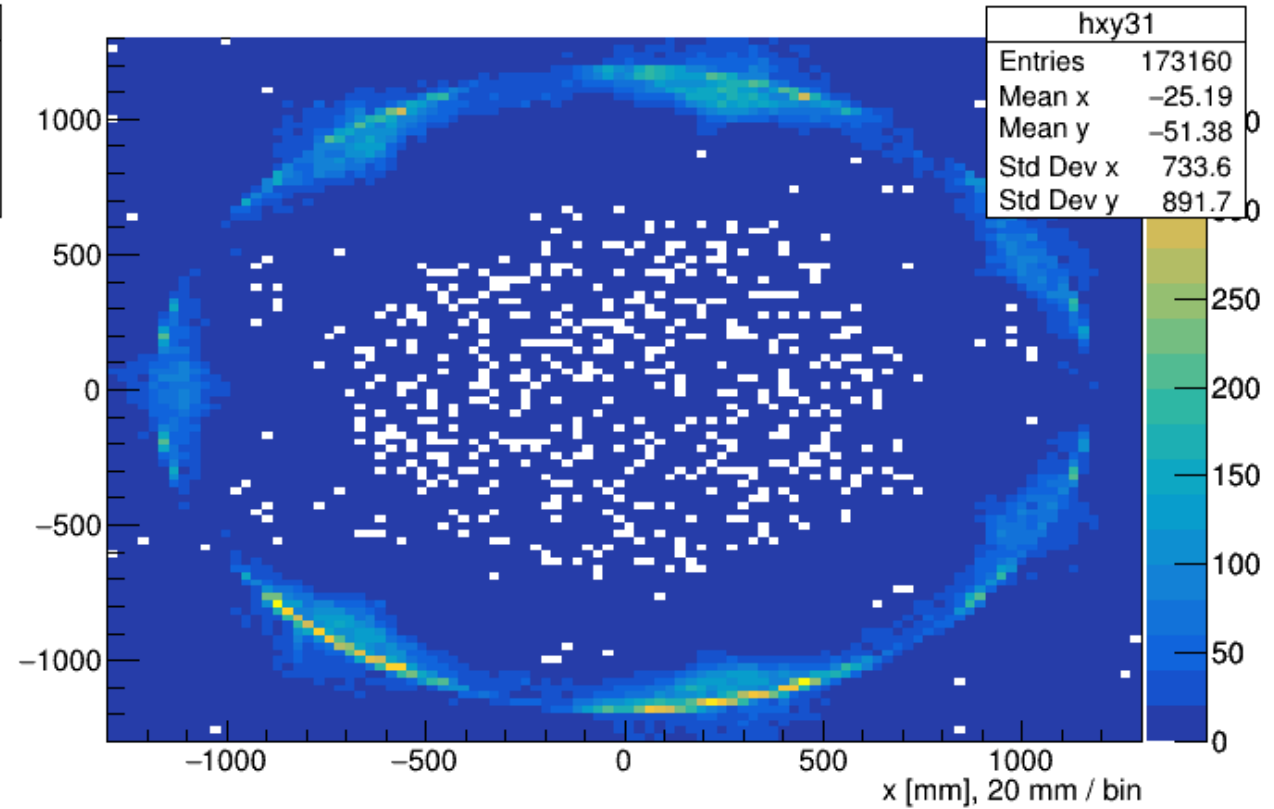
T->Draw("sqrt(hit.vx**2+hit.vy**2):hit.vz>>h1(100,23800,26000,100,600,2200)","rate*(hit.det==31 && hit.trid>2)")

The location of all the hits on the showermax for 5M events in x y - Aluminium frame (Plane at the upstream)

Hit vertex x y at showermax from events at pion lucite detector

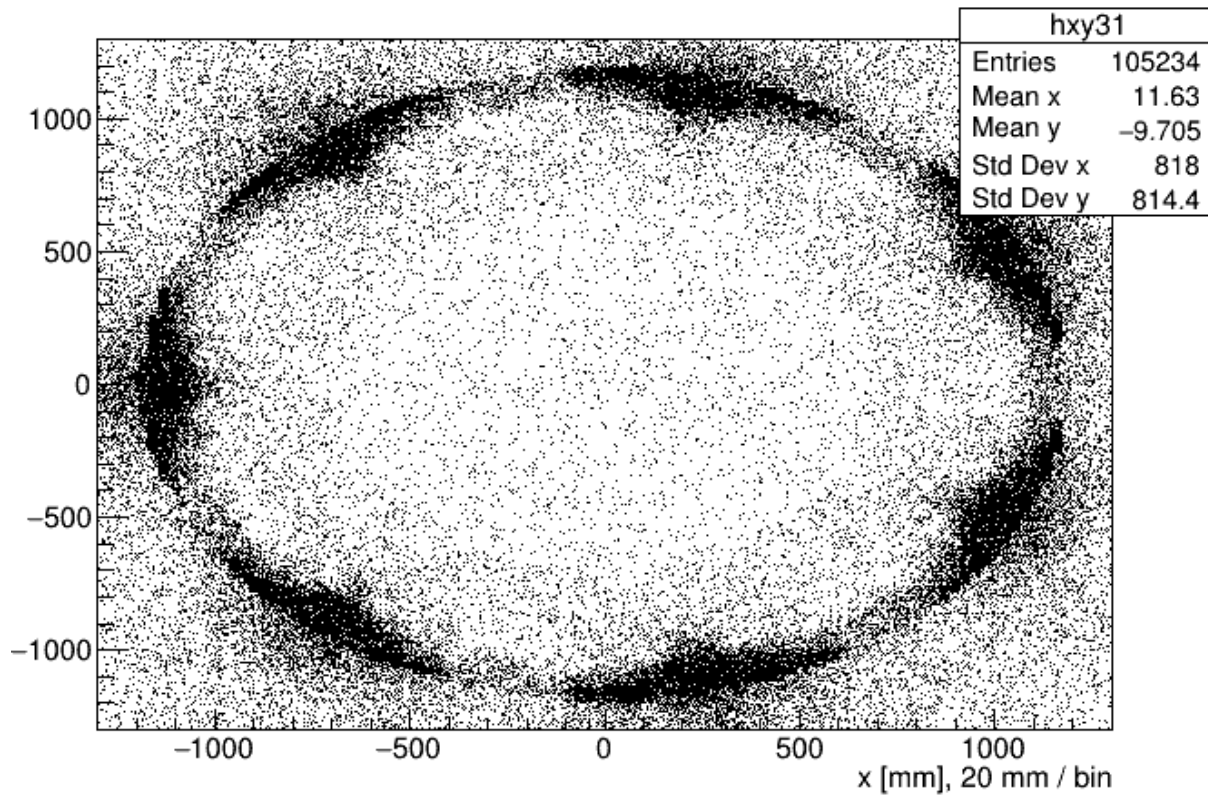


Hit vertex x y at showermax from events at pion lucite detector

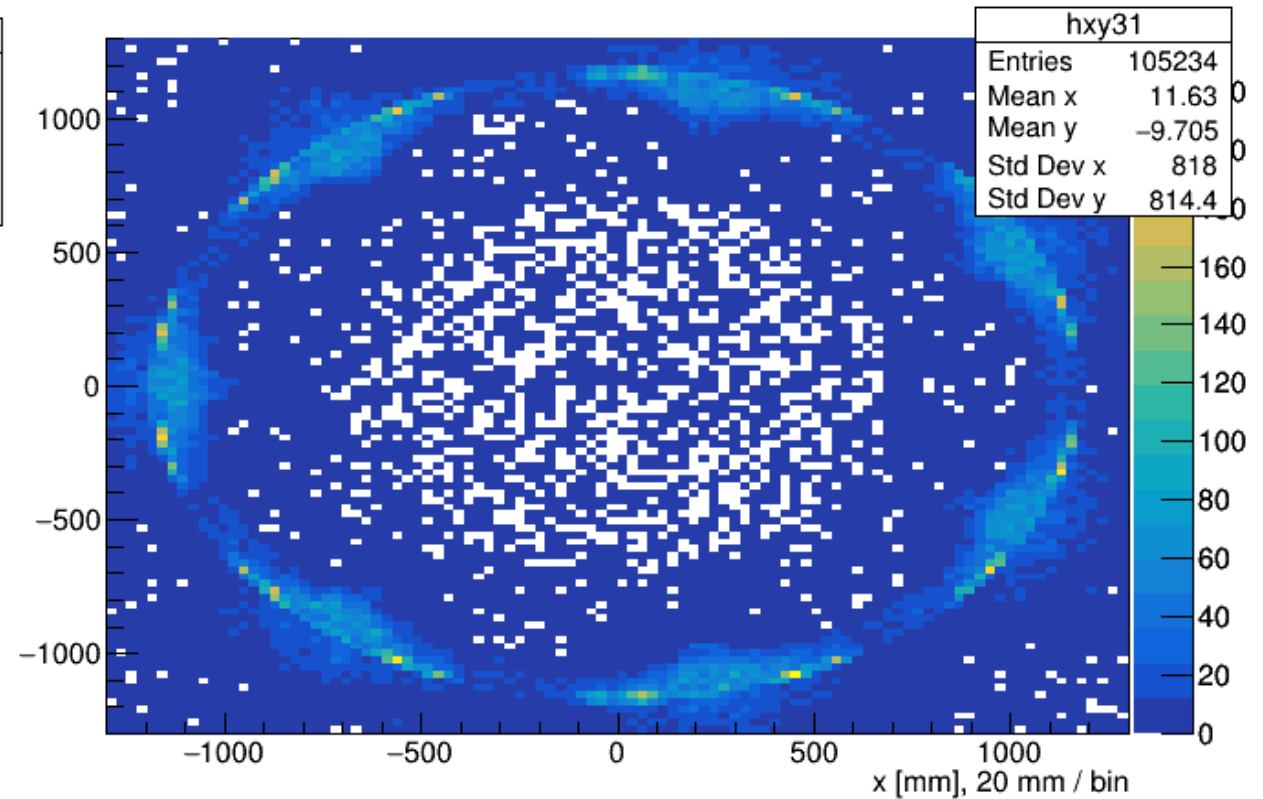


The location of all the hits on the showermax for 5M events in x y - Galactic frame (Plane at the upstream)

Hit vertex x y at showermax from events at pion lucite detector

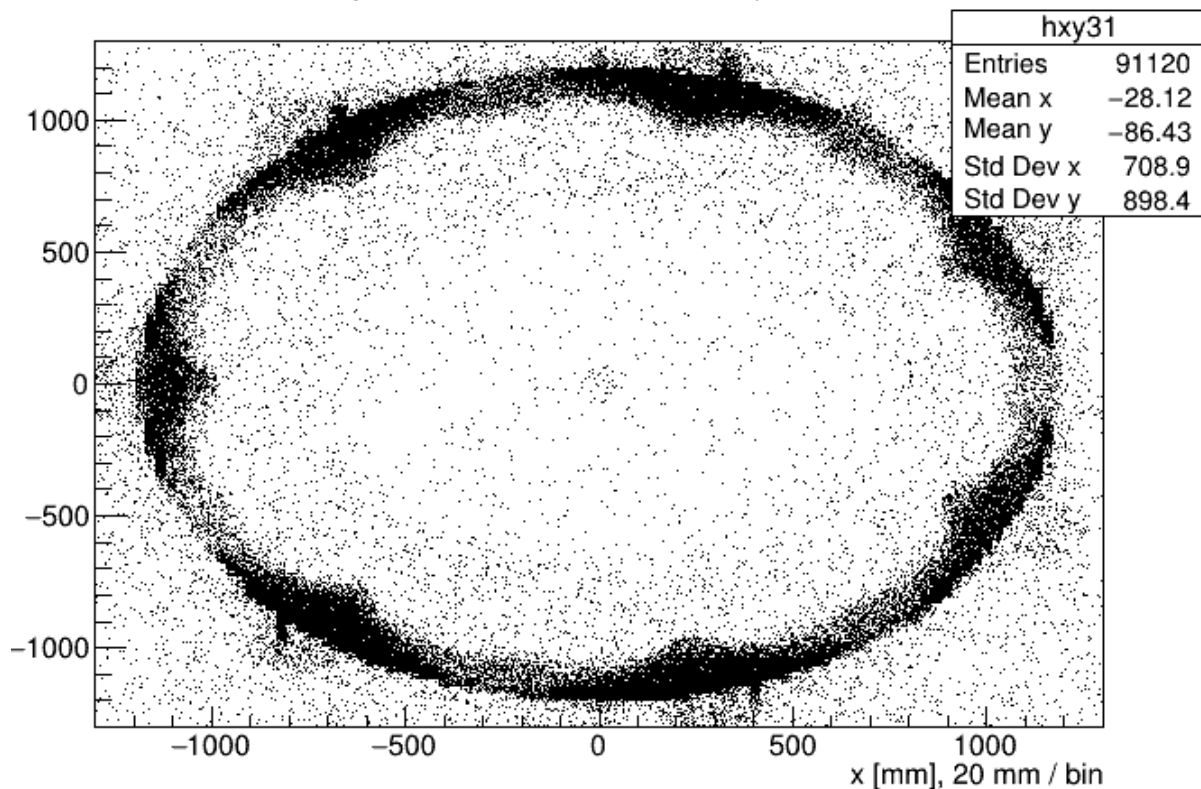


Hit vertex x y at showermax from events at pion lucite detector

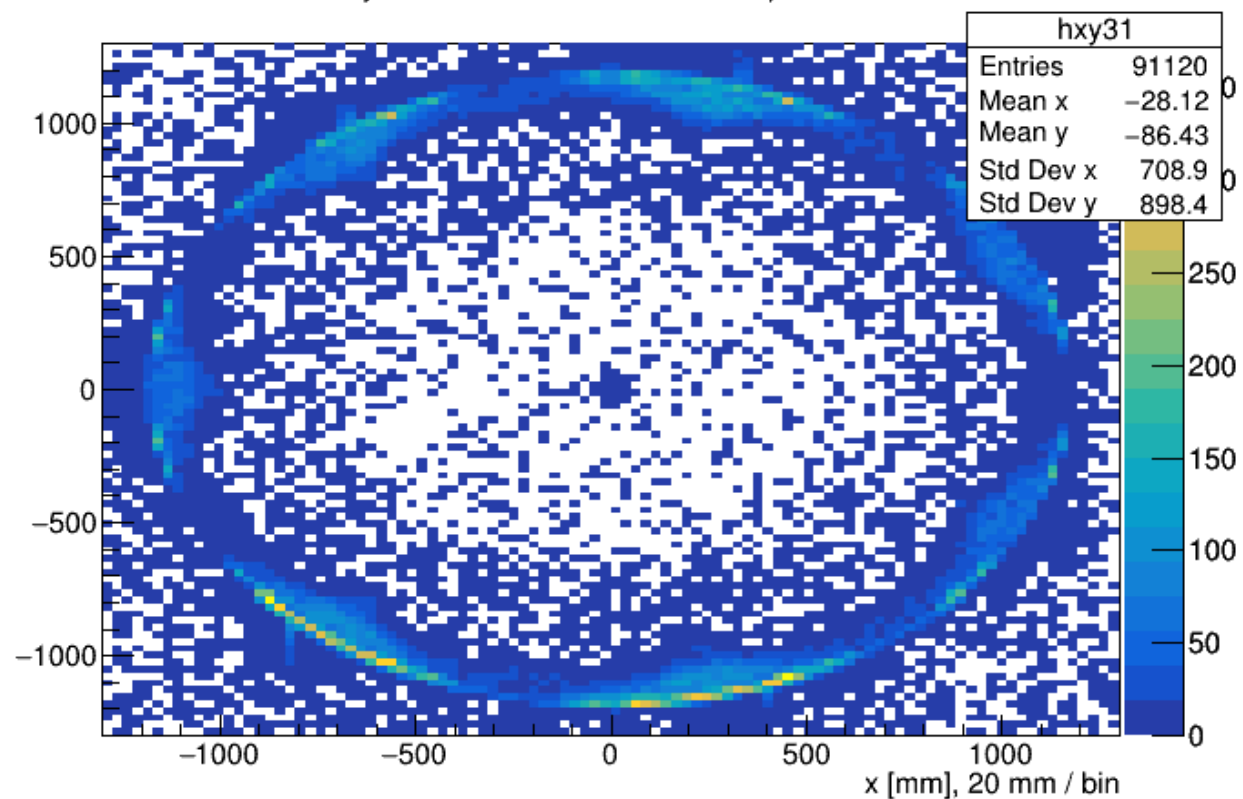


The location of all the hits on the showermax for 5M events in x y - Aluminium frame (Plane at the upstream-moving forward-hit.pz>0)

Hit vertex x y at showermax from events at pion lucite detector

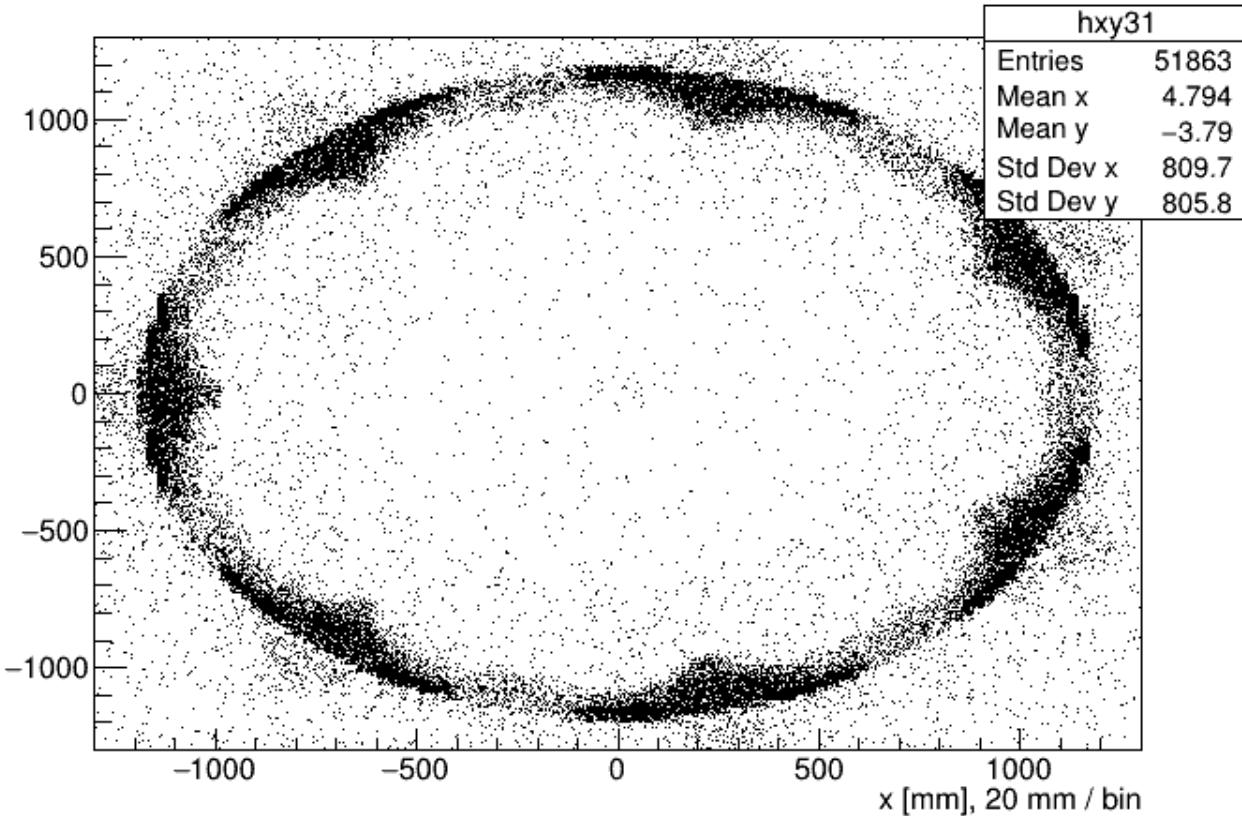


Hit vertex x y at showermax from events at pion lucite detector

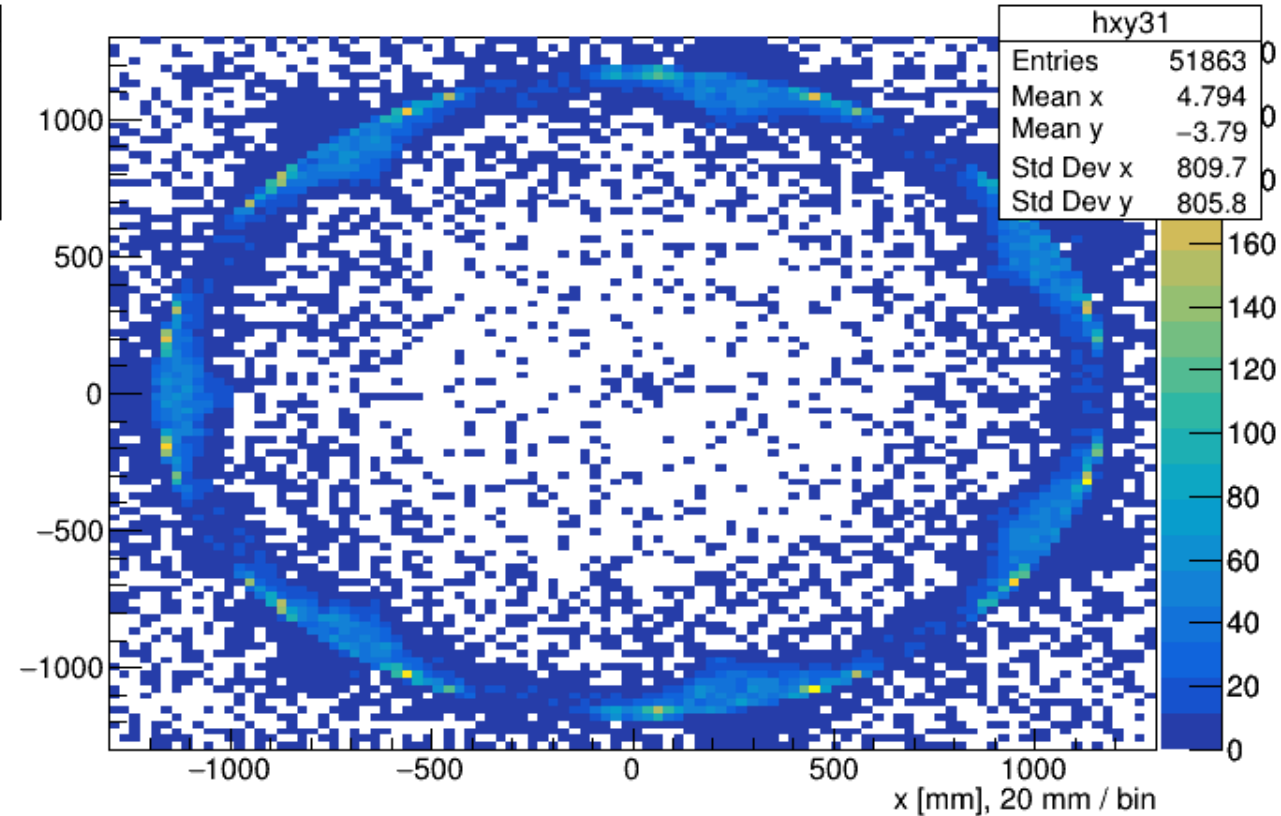


The location of all the hits on the showermax for 5M events in x y - Galactic frame (Plane at the upstream-moving forward-hit.pz>0)

Hit vertex x y at showermax from events at pion lucite detector

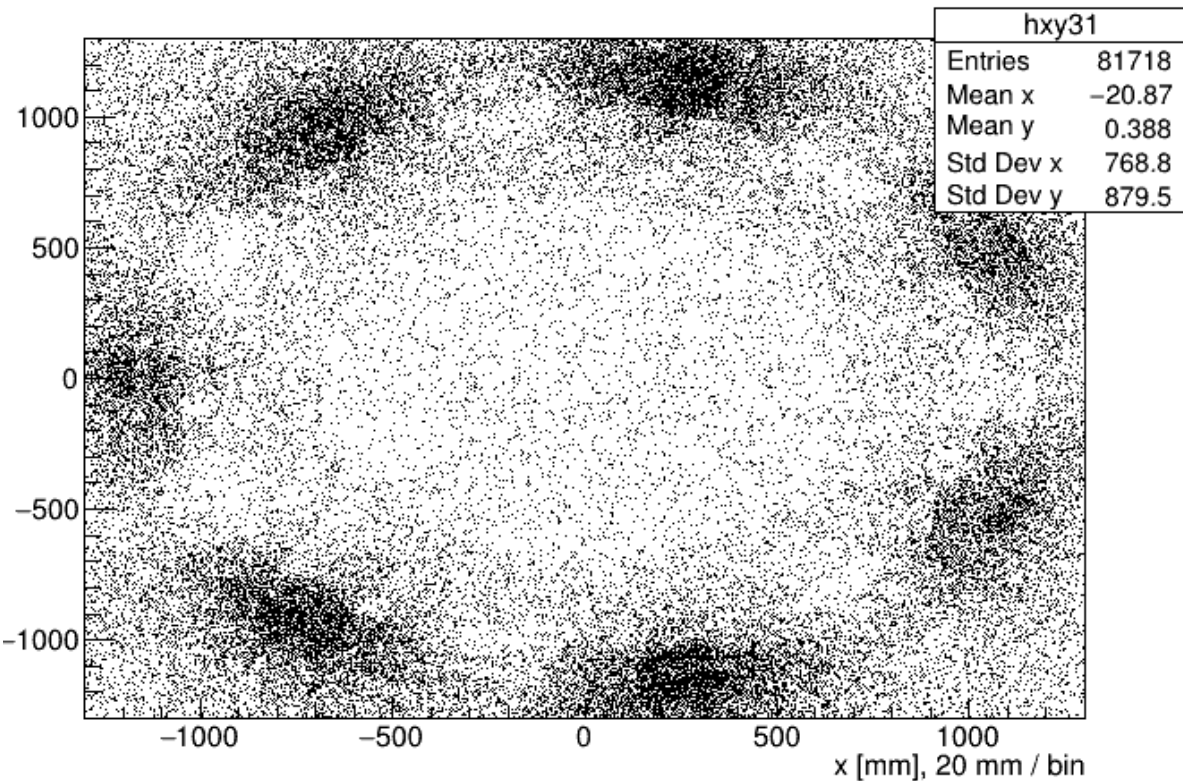


Hit vertex x y at showermax from events at pion lucite detector

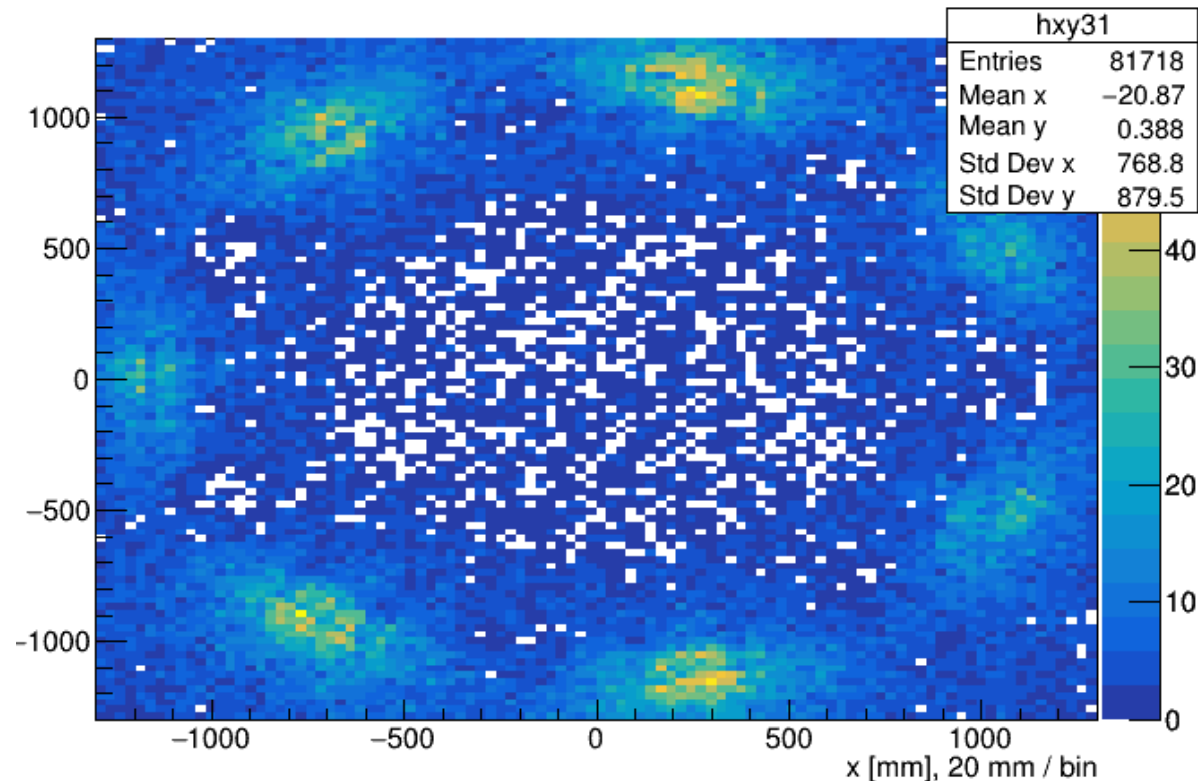


The location of all the hits on the showermax for 5M events in x y - Aluminium frame (Plane at the upstream-moving backward-hit.pz<0)

Hit vertex x y at showermax from events at pion lucite detector

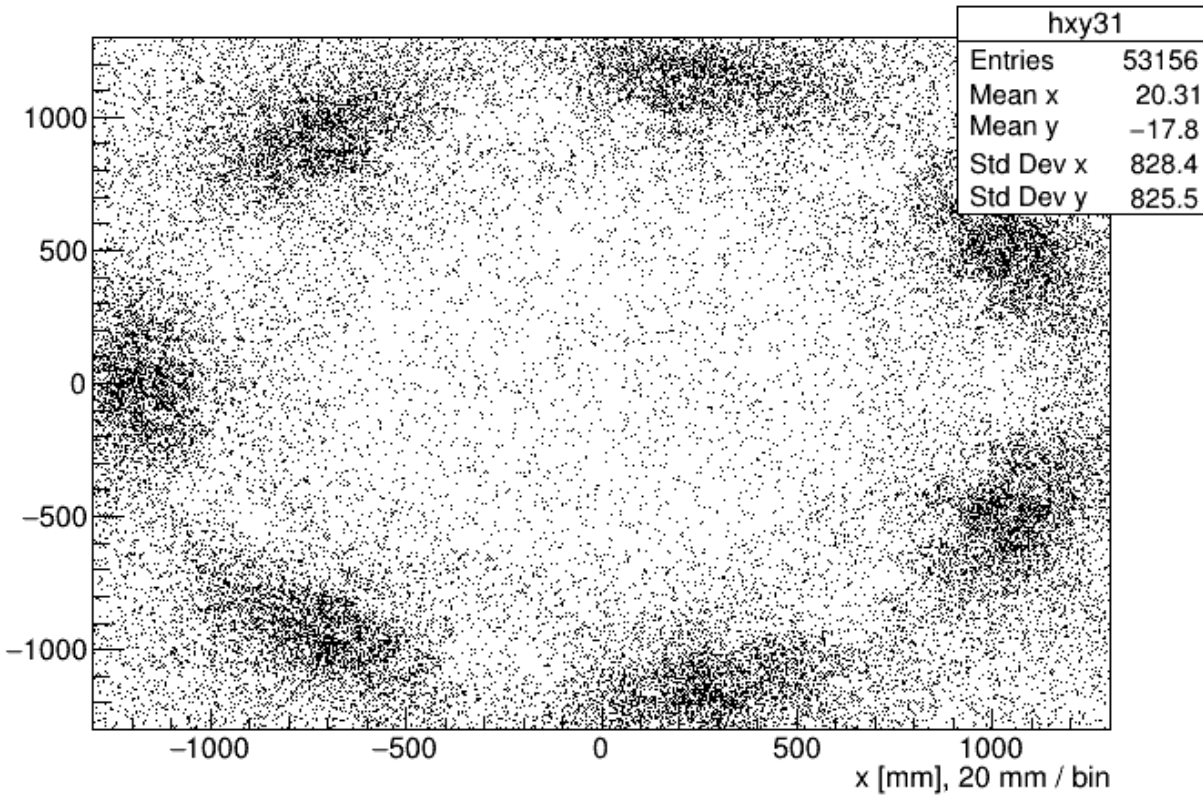


Hit vertex x y at showermax from events at pion lucite detector

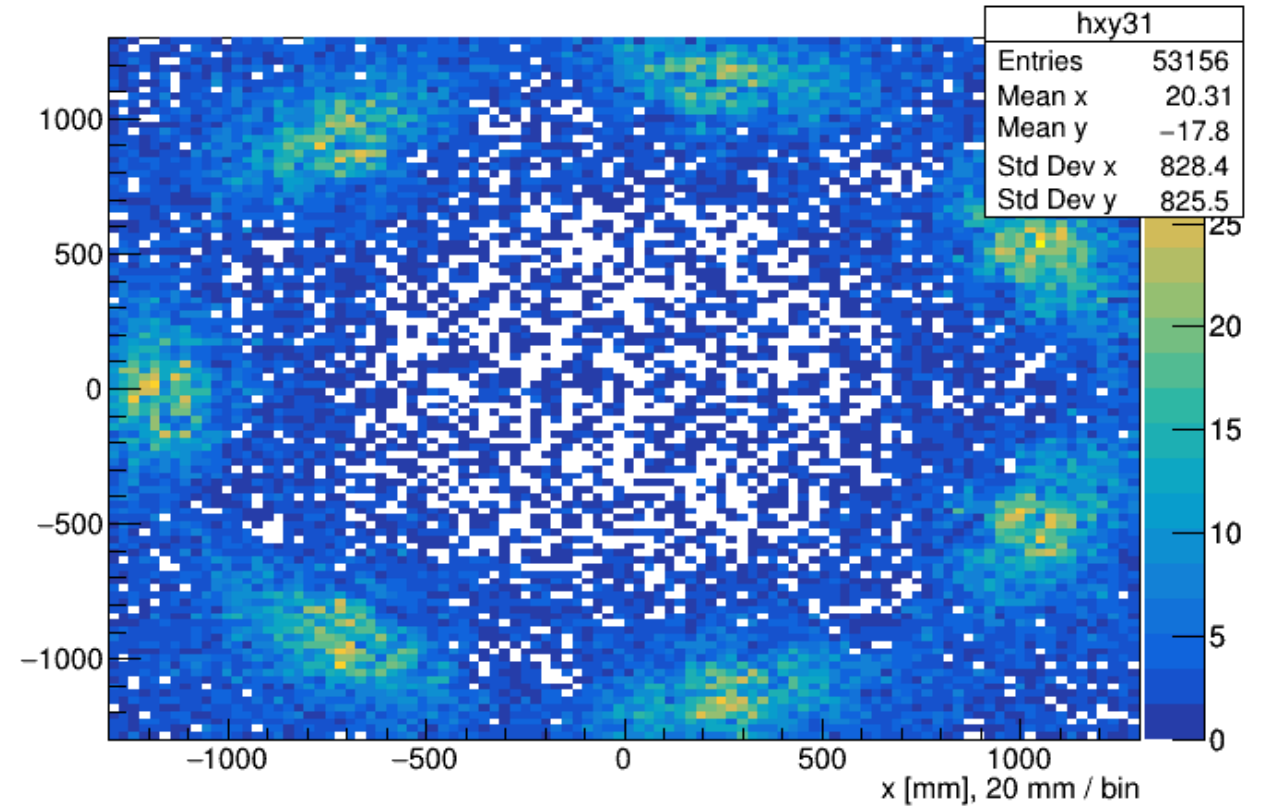


The location of all the hits on the showermax for 5M events in x y - Galactic frame (Plane at the upstream-moving backward-hit.pz<0)

Hit vertex x y at showermax from events at pion lucite detector

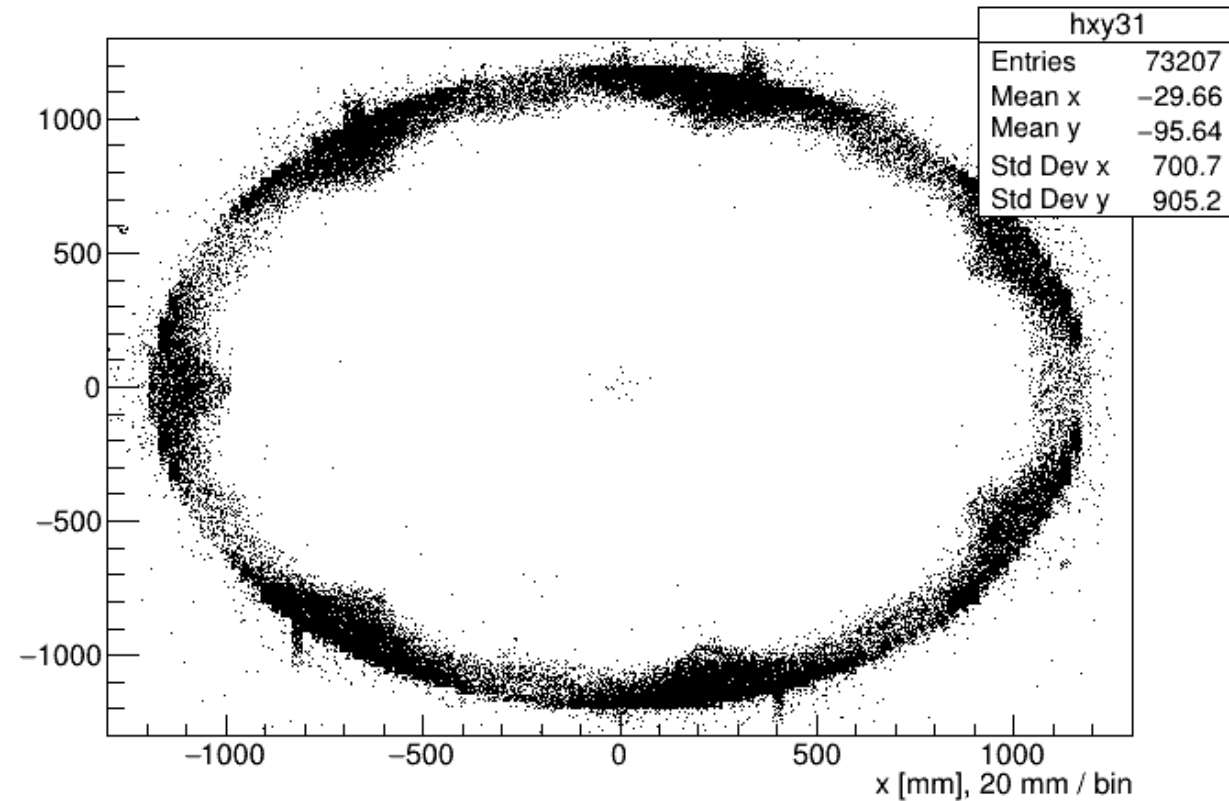


Hit vertex x y at showermax from events at pion lucite detector

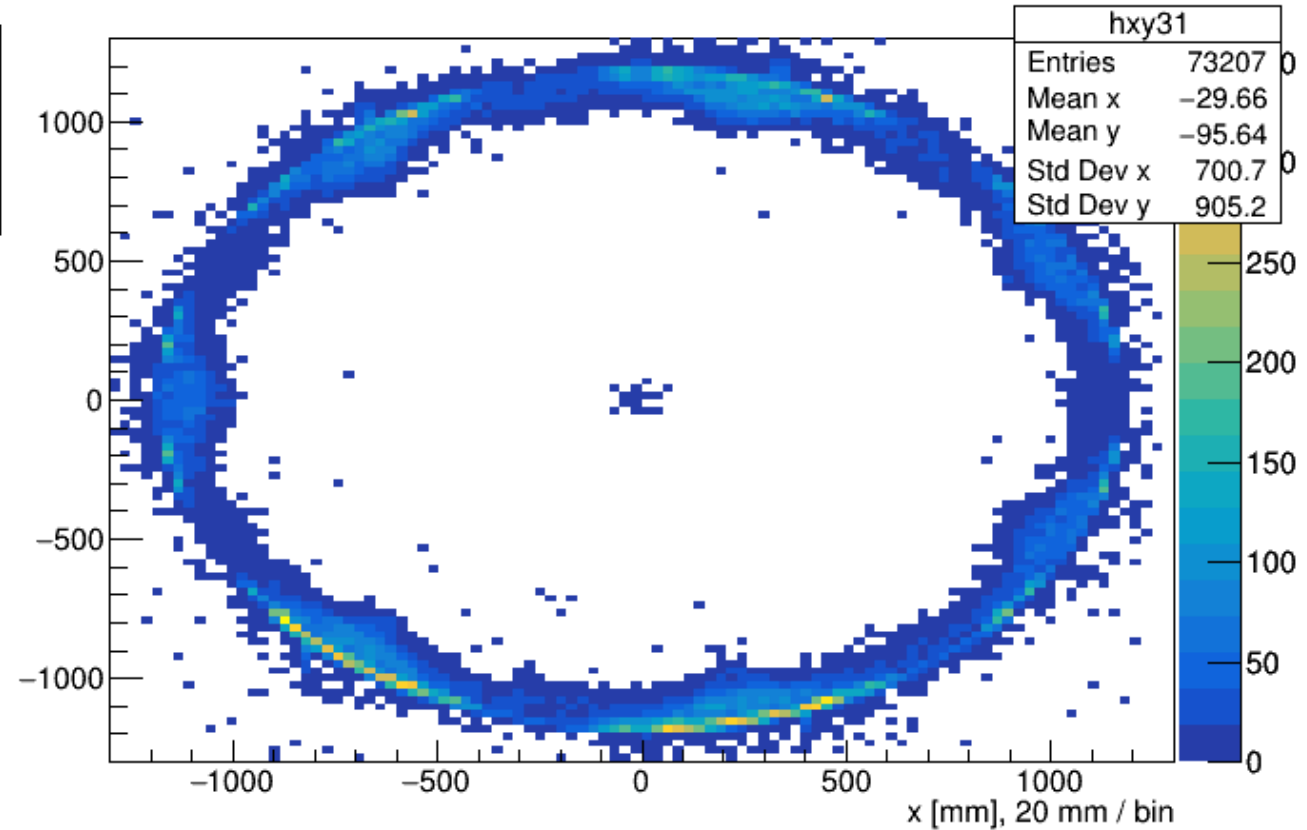


The location of all the hits on the showermax for 5M events in x y - Aluminium frame (primaries, plane at the upstream)

Hit vertex x y at showermax from events at pion lucite detector

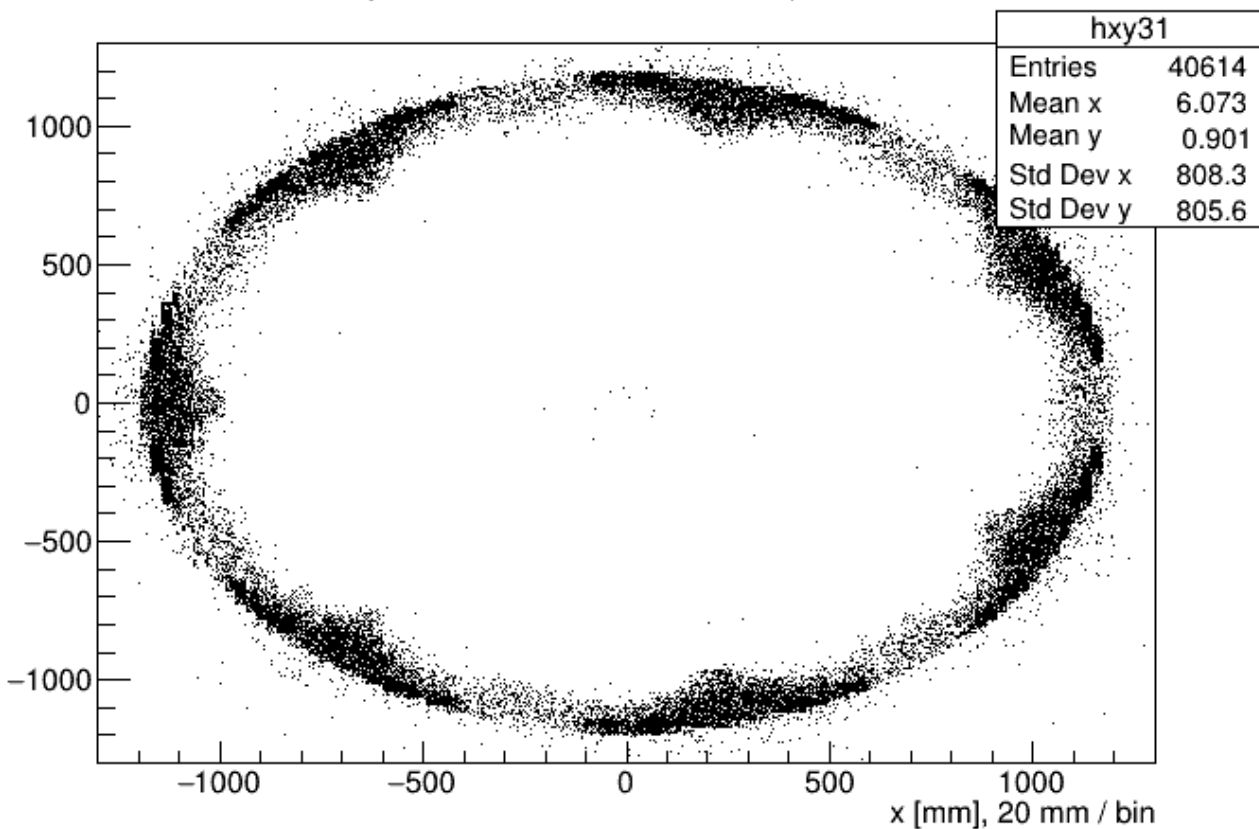


Hit vertex x y at showermax from events at pion lucite detector

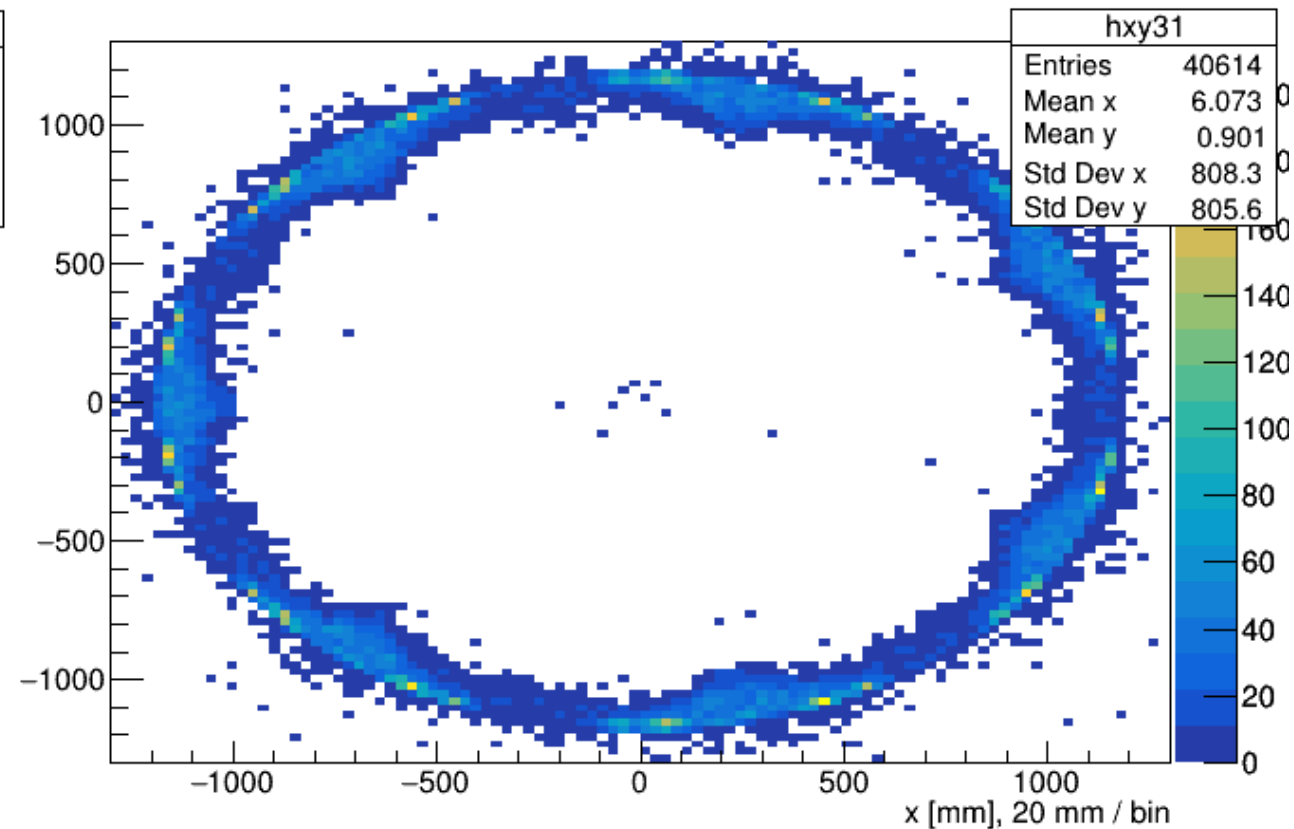


The location of all the hits on the showermax for 5M events in x y - Galactic frame (primaries, plane at the upstream)

Hit vertex x y at showermax from events at pion lucite detector

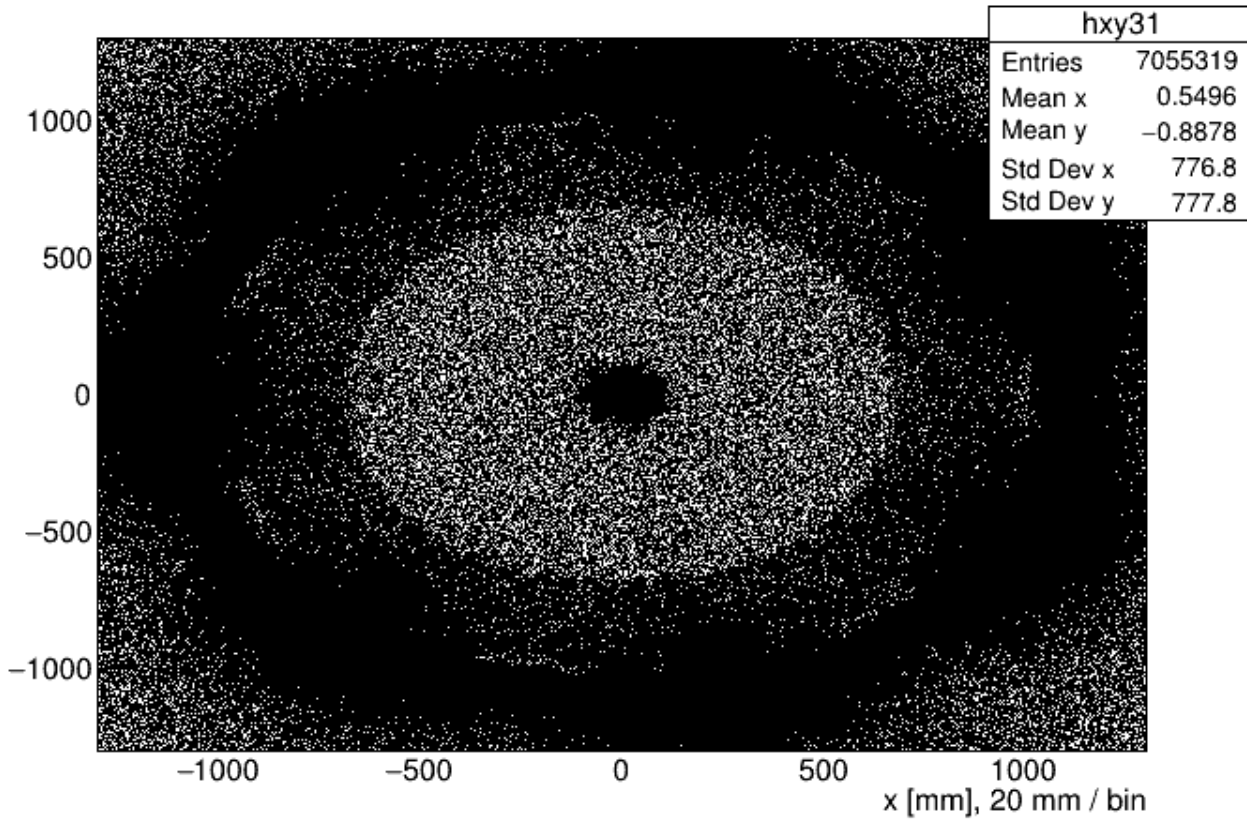


Hit vertex x y at showermax from events at pion lucite detector

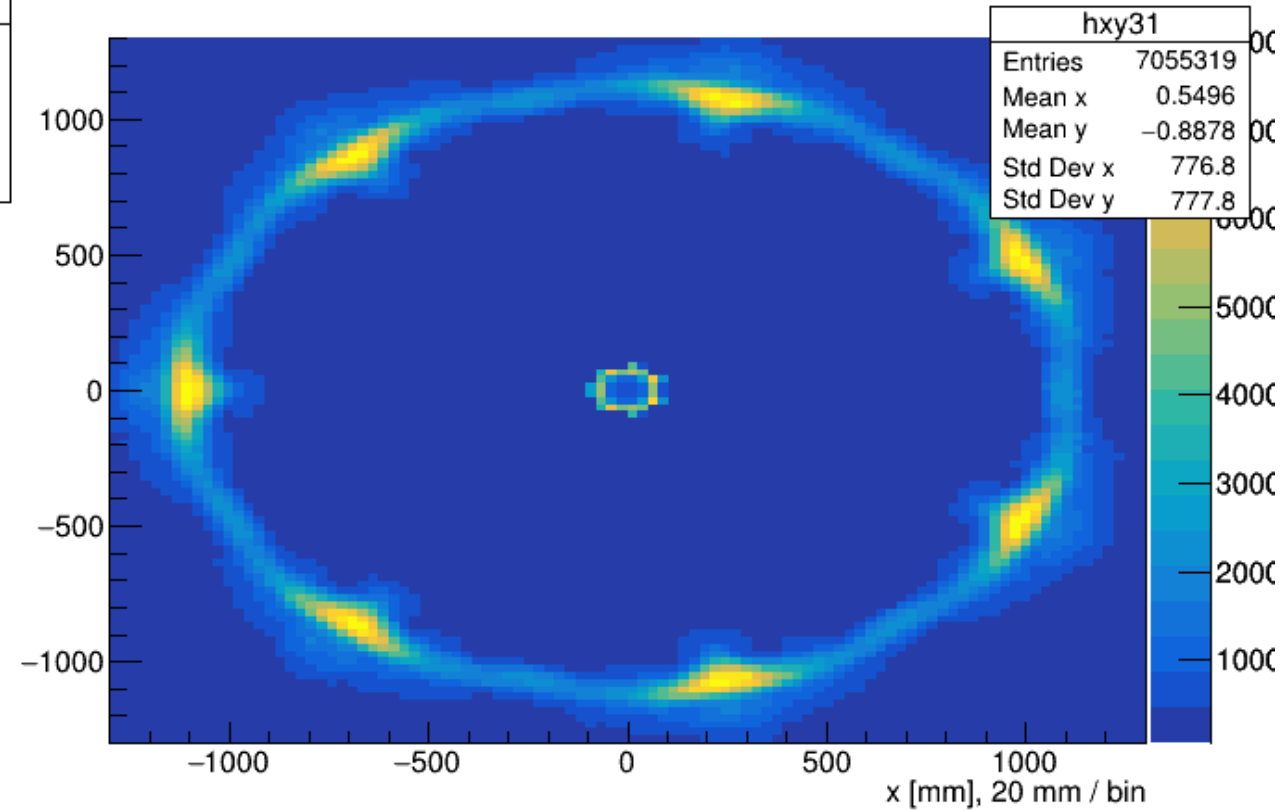


The location of all the hits on the showermax for 5M events in x y - Aluminium frame (without the Lucite, Plane at the upstream)

Hit vertex x y at showermax from events at pion lucite detector

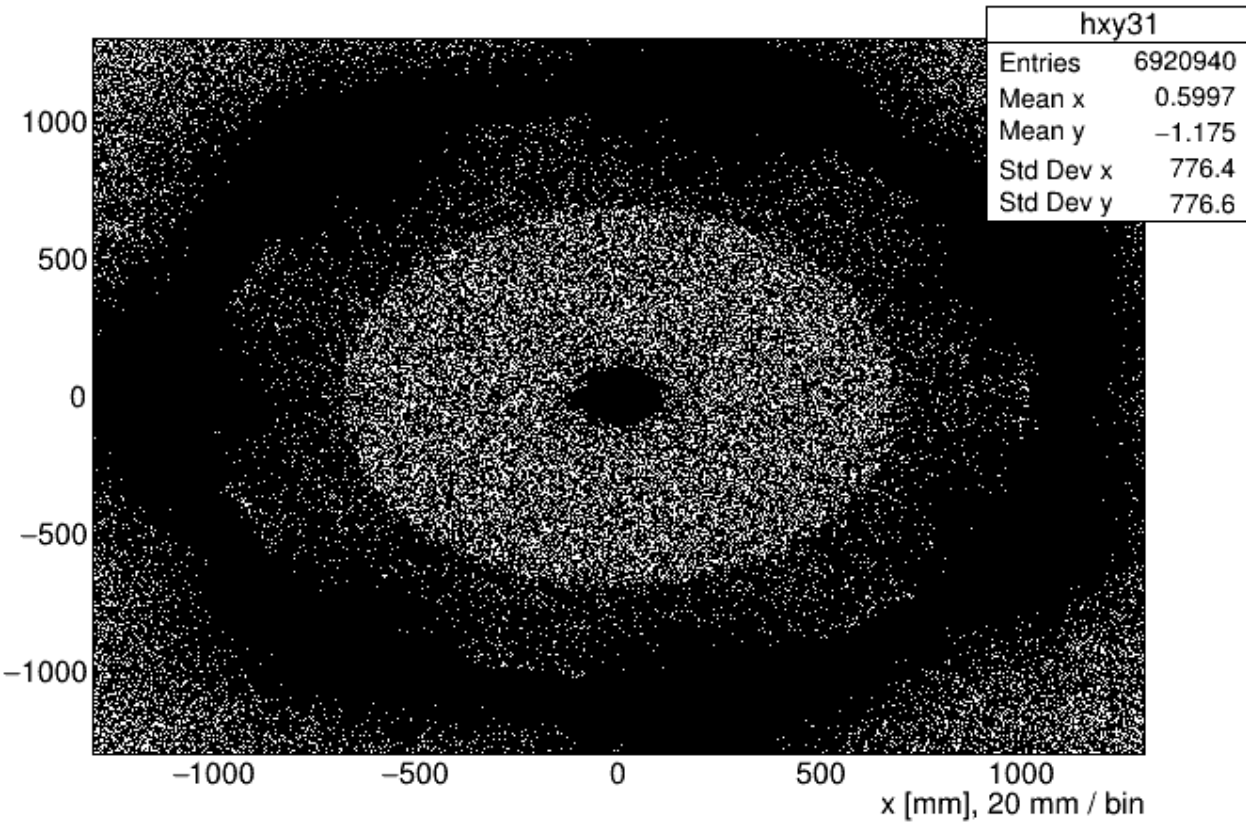


Hit vertex x y at showermax from events at pion lucite detector

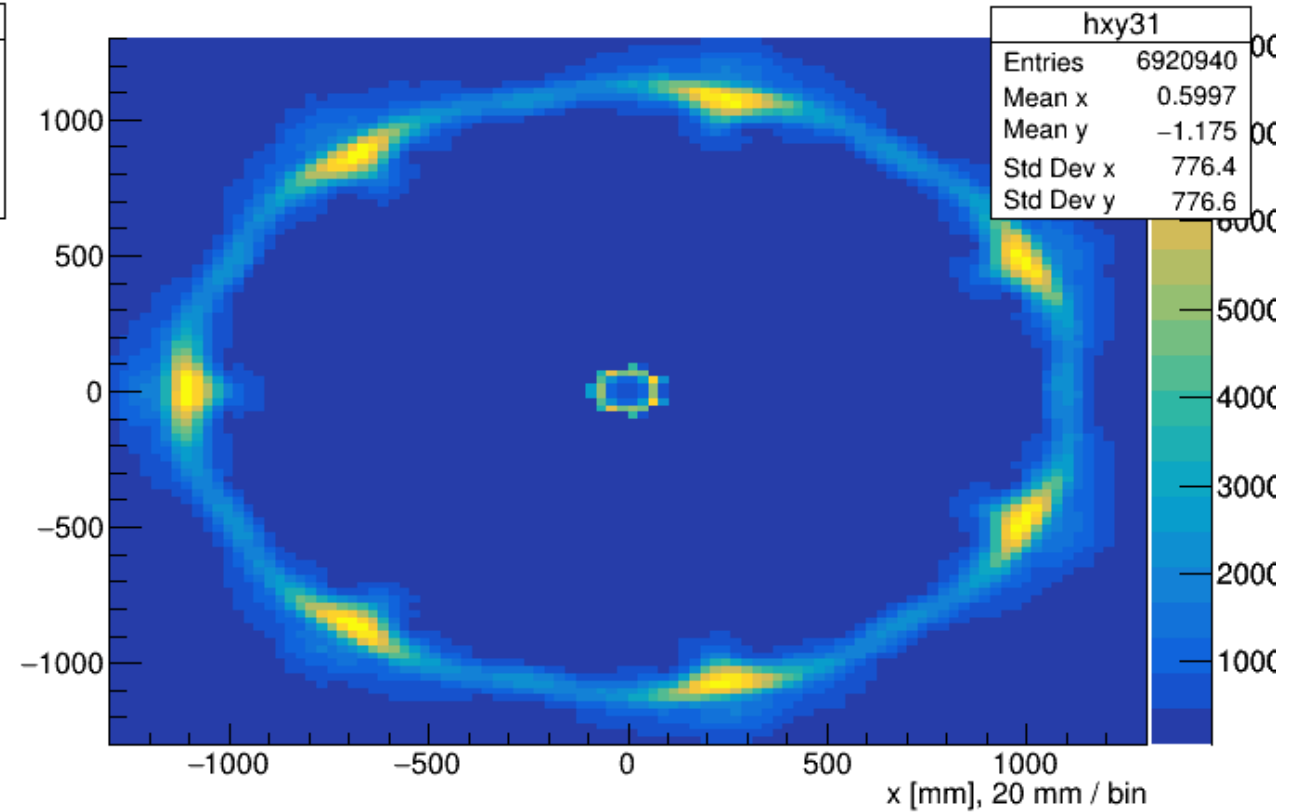


The location of all the hits on the showermax for 5M events in x y - Galactic frame (without the Lucite, Plane at the upstream)

Hit vertex x y at showermax from events at pion lucite detector



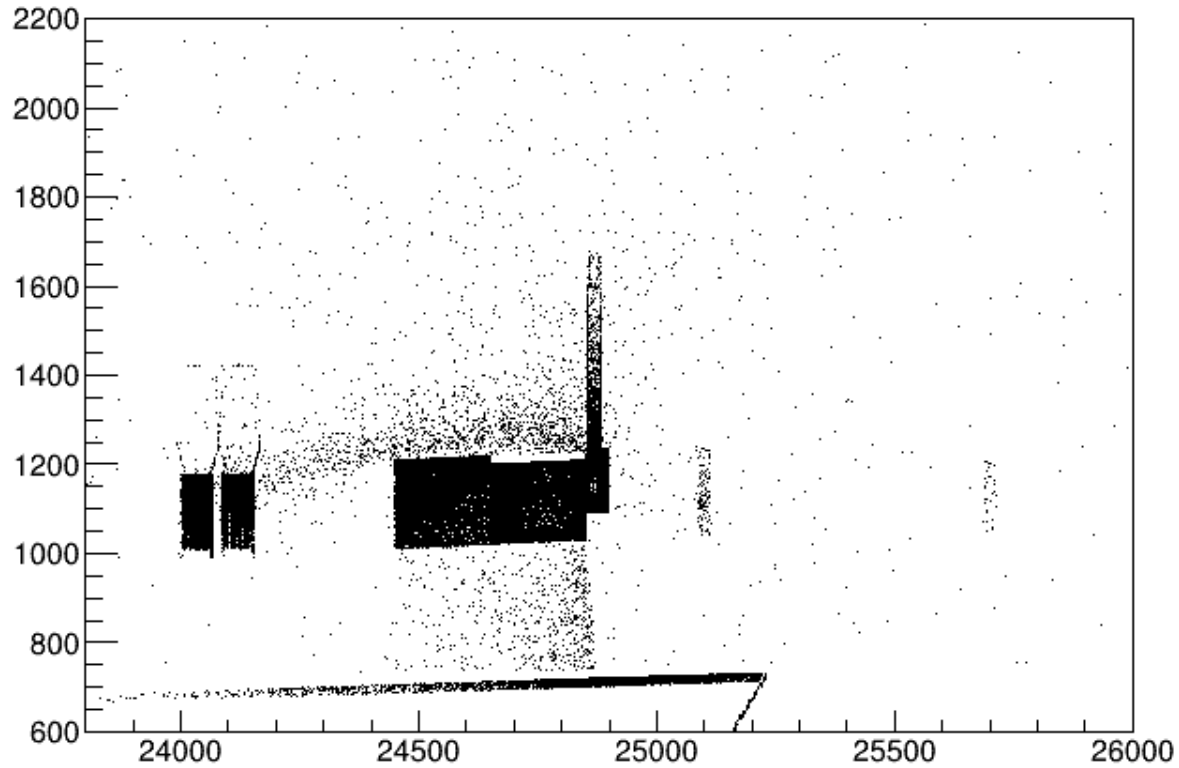
Hit vertex x y at showermax from events at pion lucite detector



The origin location of all the secondaries anywhere for 5M events- Galactic frame

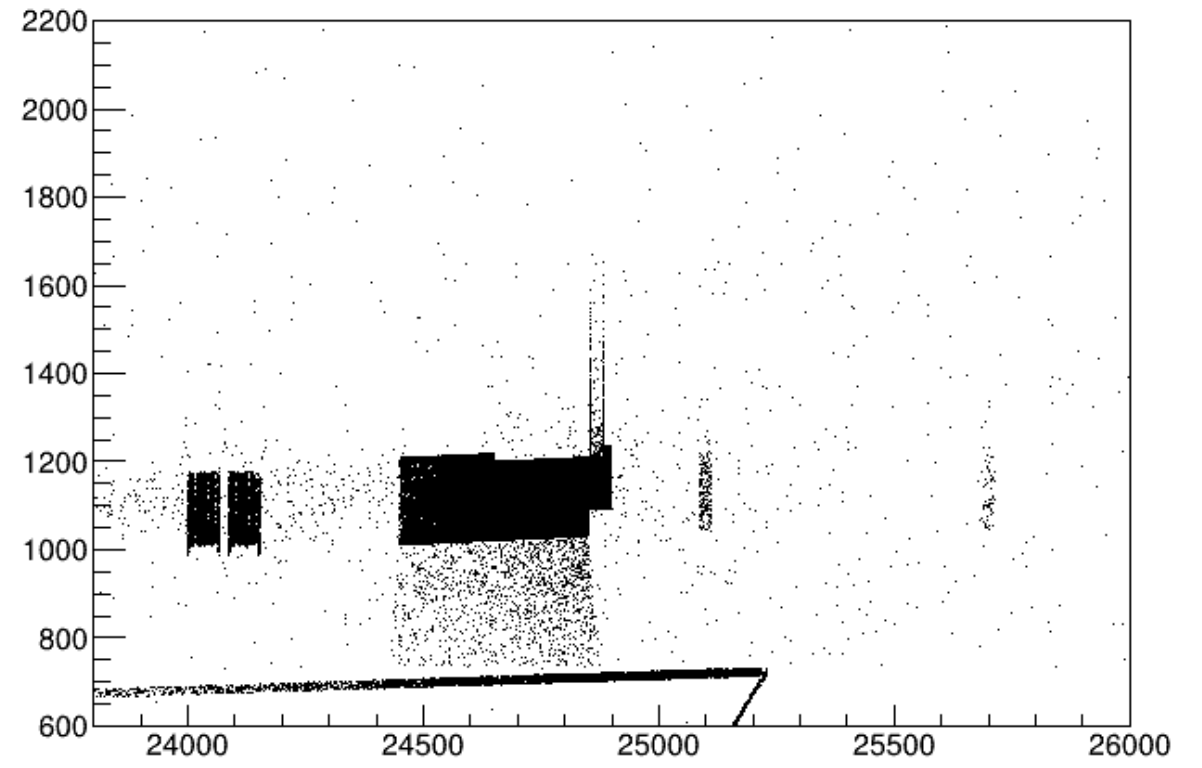
Moller

`sqrt(hit.vx**2+hit.vy**2):hit.vz {rate*(hit.det==8001 && hit.trid>2)}`



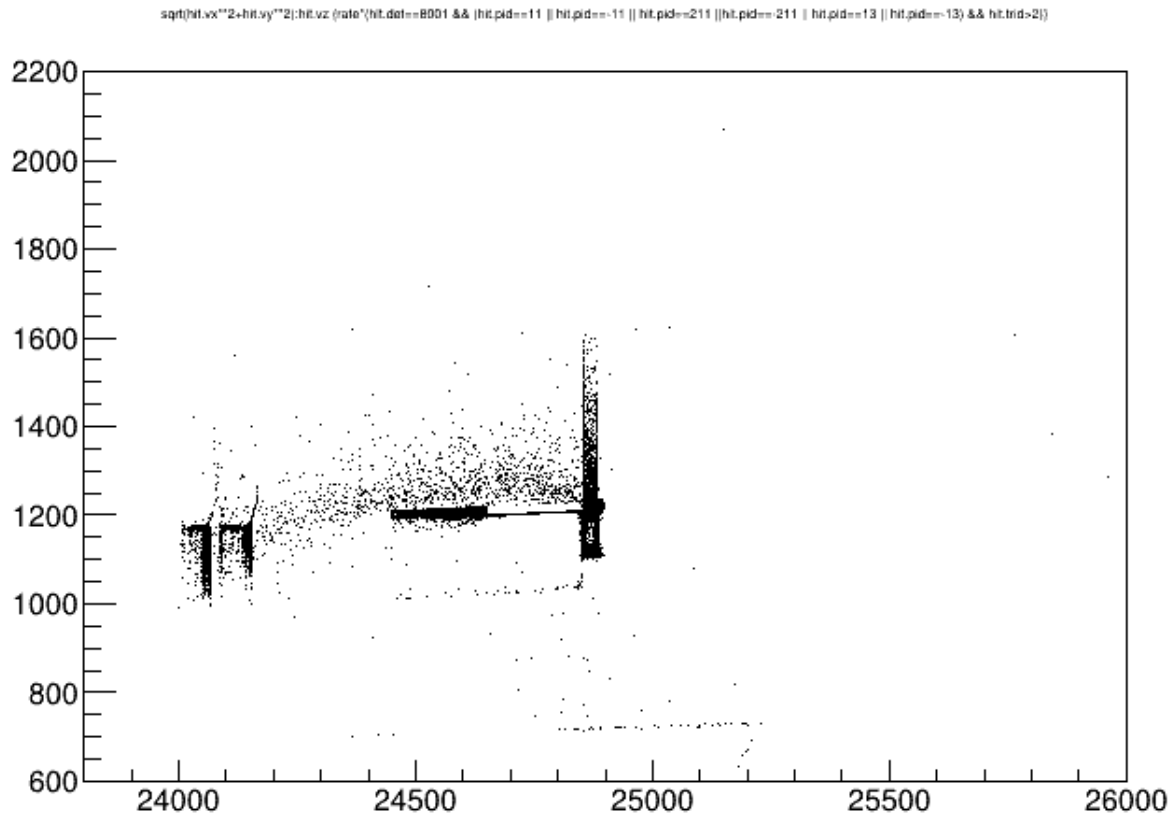
Pion

`sqrt(hit.vx**2+hit.vy**2):hit.vz {rate*(hit.det==8001 && hit.trid>2)}`

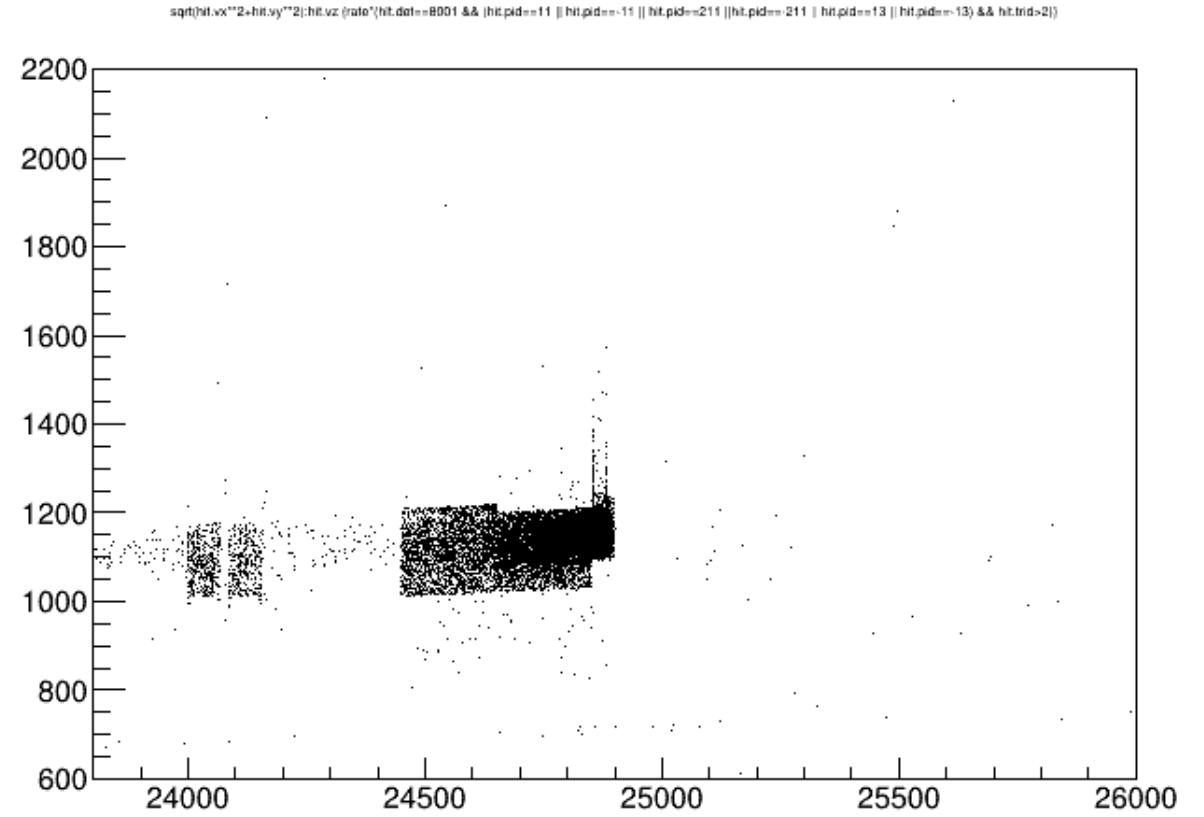


The origin location of all the secondaries anywhere for 5M events- 16 cm Lead - with particles inclusion- Galactic frame

Moller



Pion



`T->Draw("sqrt(hit.vx**2+hit.vy**2):hit.vz>>h1(100,23800,26000,100,600,2200)","rate*(hit.det==8001 && (hit.pid==11 || hit.pid==11 || hit.pid==211 ||hit.pid==211 || hit.pid==13 || hit.pid==13) && hit.trid>2)")`

Shifting the Lucite inward – 1cm – No wedge

In PionDetectorLuciteSector.gdml file:

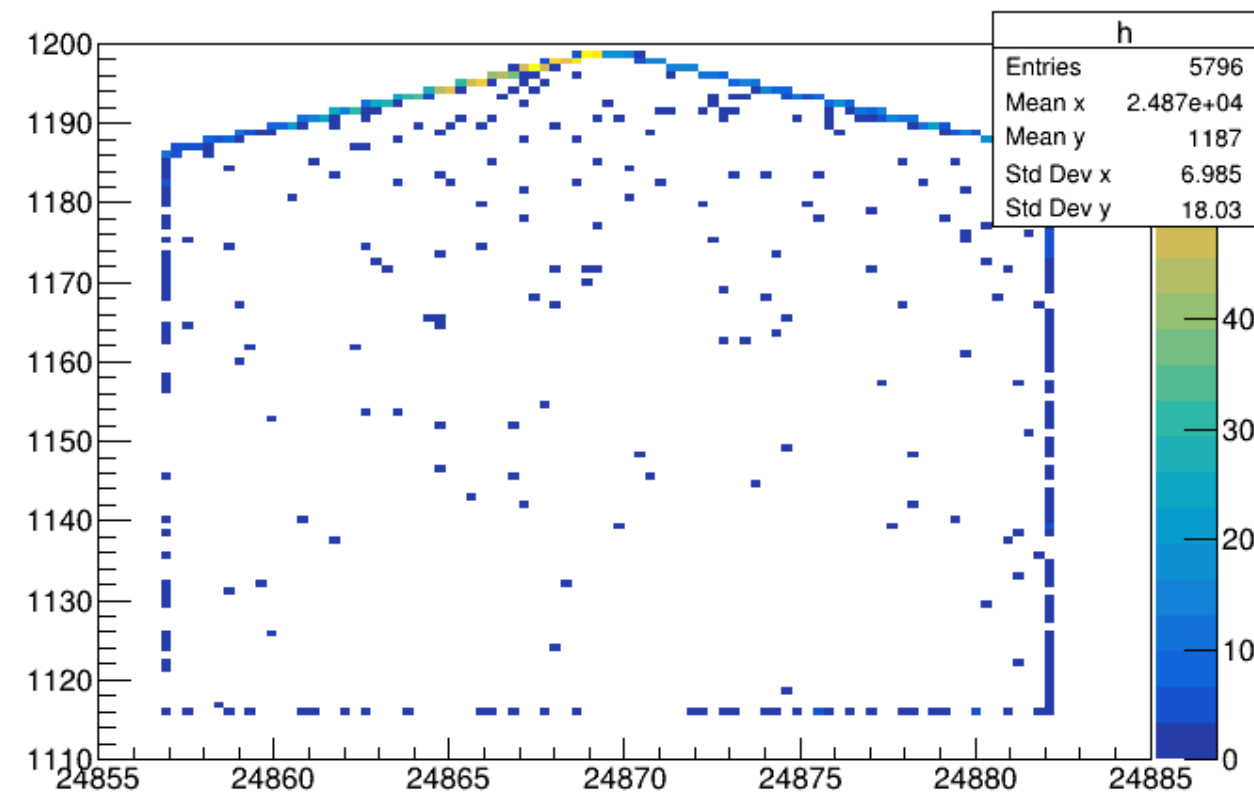
- `<constant name="pionDetectorLuciteWedgeHeightFraction" value="0.5"/> <!-- in]0, inf[-->`
- + `<constant name="pionDetectorLuciteWedgeHeightFraction" value="0.01"/> <!-- in]0, inf[-->`

- `<quantity name="pionDetectorLuciteInnerEdgeRadialPosition" type="length" value="109.5+12.5/2" unit="cm"/>`
- + `<quantity name="pionDetectorLuciteInnerEdgeRadialPosition" type="length" value="109.0+12.5/2" unit="cm"/>`

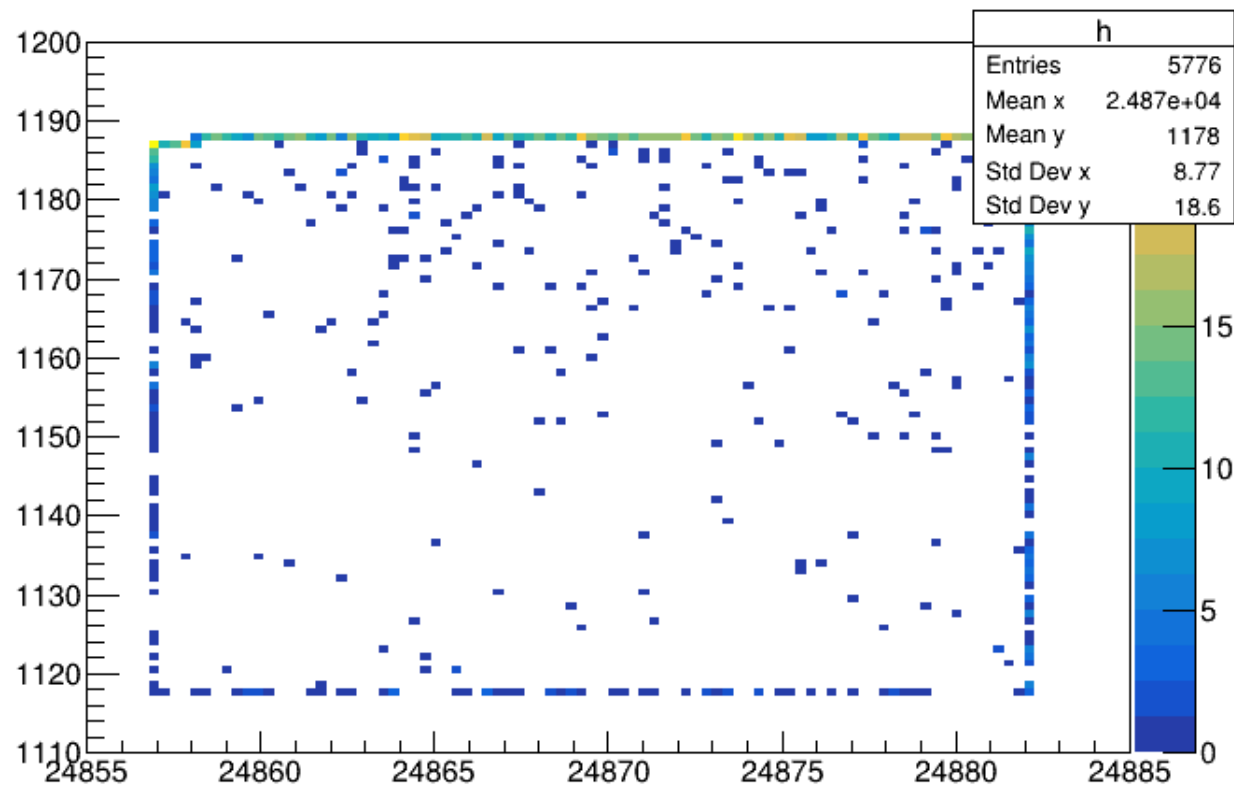
- `<quantity name="pionDetectorLuciteShieldDSInsideWidth" type="length" value="50.0" unit="cm"/>`
- `<quantity name="pionDetectorLuciteShieldDSOutsideWidth" type="length" value="54.5" unit="cm"/>`

- + `<quantity name="pionDetectorLuciteShieldDSInsideWidth" type="length" value="49.5" unit="cm"/>`
- + `<quantity name="pionDetectorLuciteShieldDSOutsideWidth" type="length" value="54.0" unit="cm"/>`

hit.x:hit.z [hit.det==8001 && hit.y>-250 && hit.y<250 && (hit.pid==11 || hit.pid==-11 || hit.pid==13 || hit.pid=-13 || hit.pid==211 && hit.pid=-211)]



hit.x:hit.z [hit.det==8001 && hit.y>-250 && hit.y<250 && (hit.pid==11 || hit.pid==-11 || hit.pid==13 || hit.pid=-13 || hit.pid==211 && hit.pid=-211)]



```
T->Draw("hit.x:hit.z >>h(100,24855,24885,100,1110,1200)","hit.det==8001 && hit.y>-250 && hit.y<250 && (hit.pid==11 || hit.pid==-11 || hit.pid==13 || hit.pid=-13 || hit.pid==211 && hit.pid=-211)","colz")
```

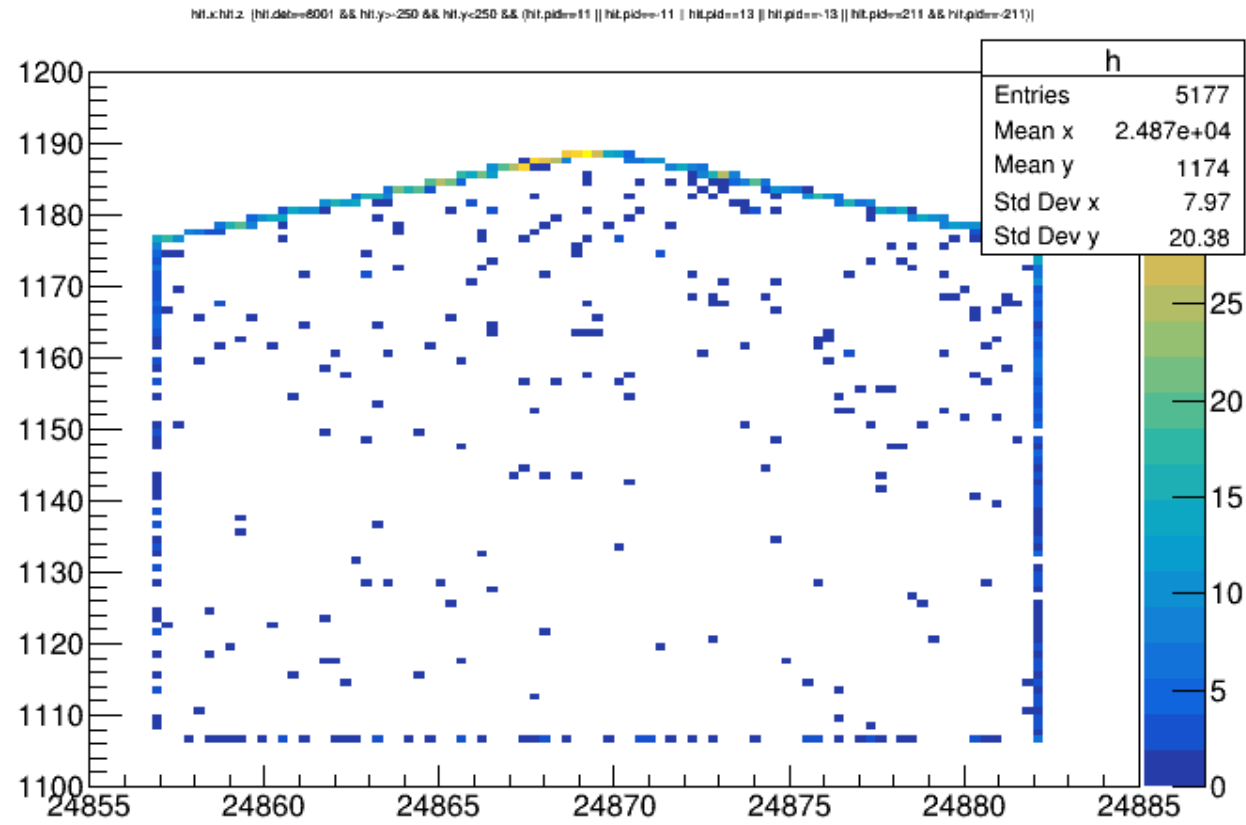
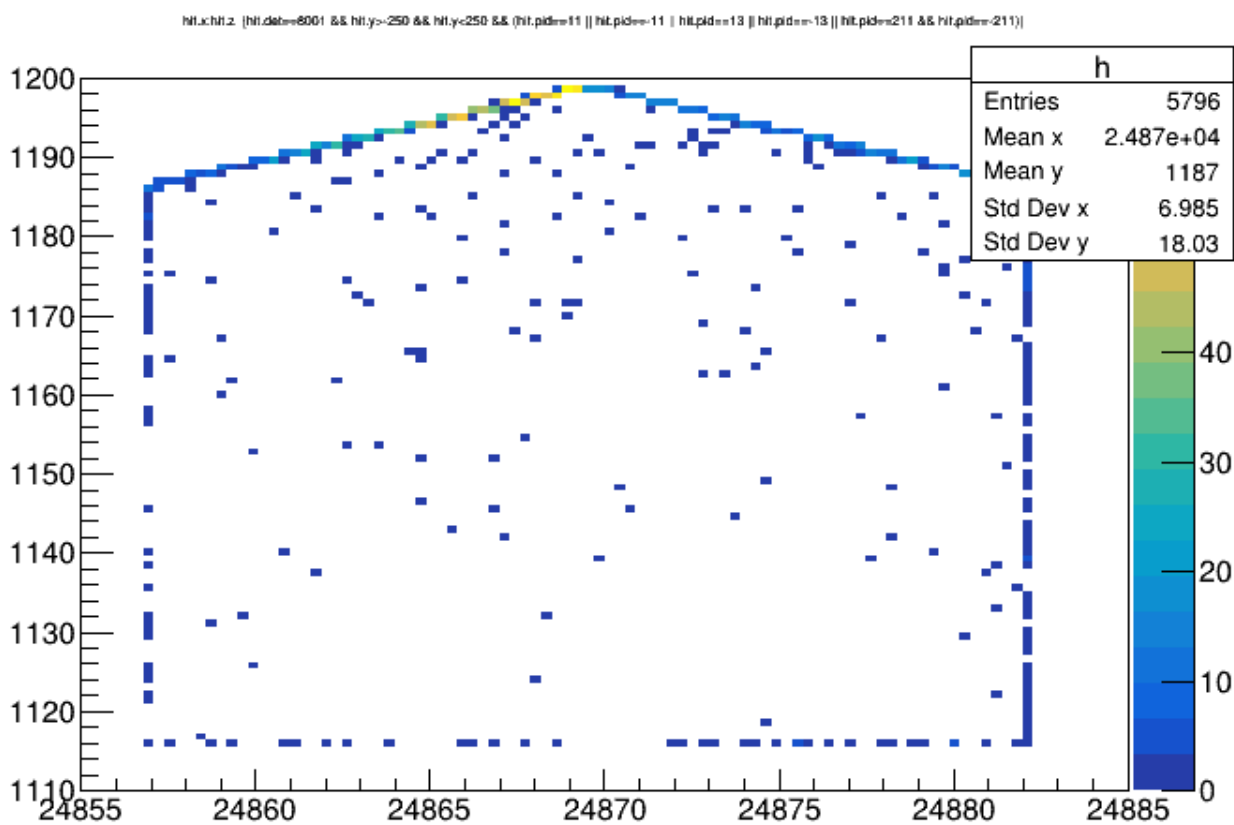
Shifting the Lucite inward – 2cm

In PionDetectorLuciteSector.gdml file:

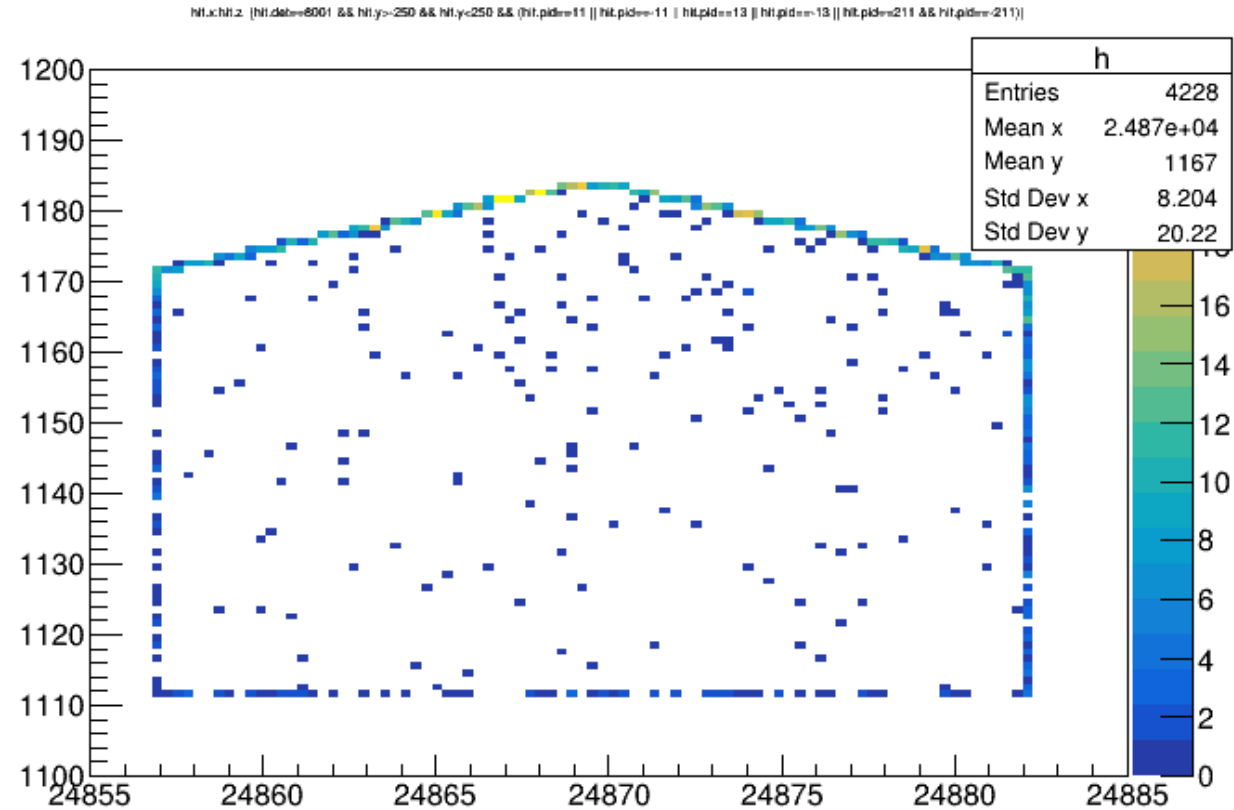
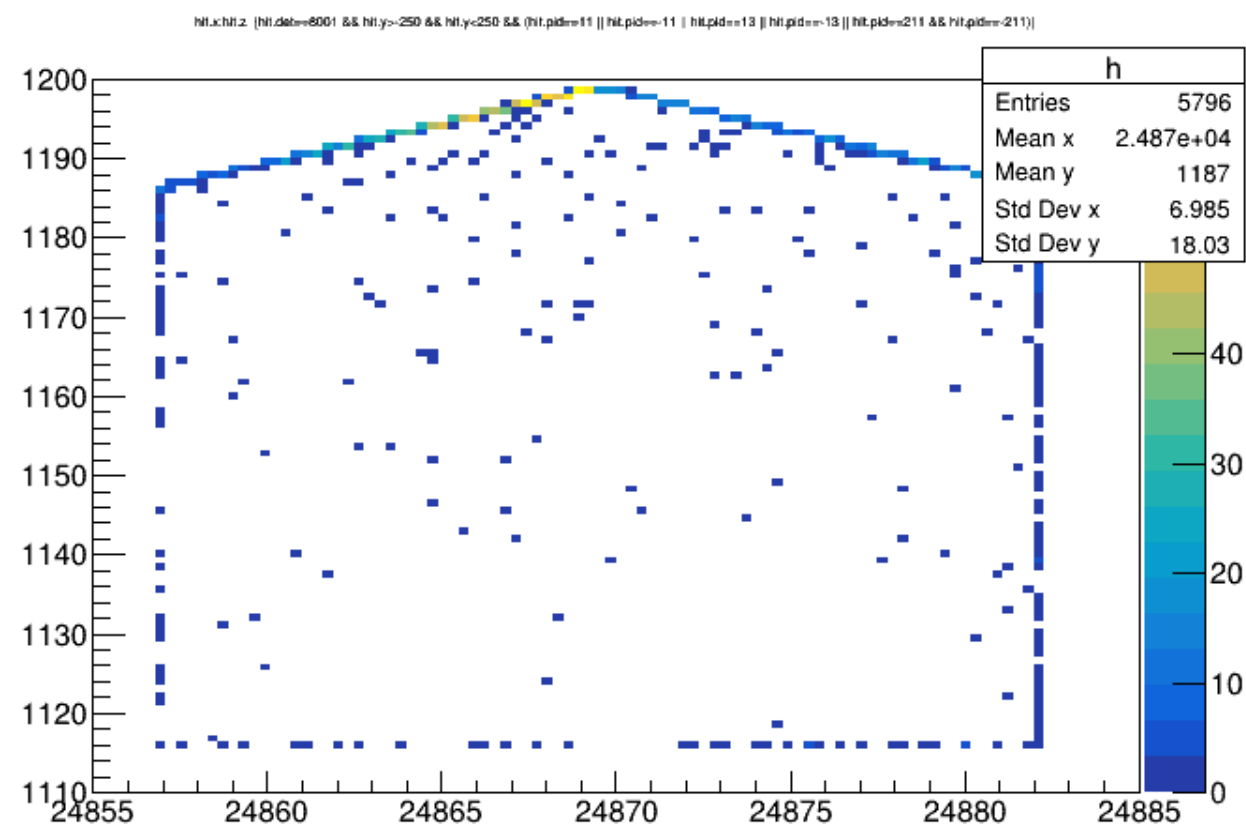
- `<quantity name="pionDetectorLuciteInnerEdgeRadialPosition" type="length" value="109.5+12.5/2" unit="cm"/>`
- + `<quantity name="pionDetectorLuciteInnerEdgeRadialPosition" type="length" value="108.5+12.5/2" unit="cm"/>`

- `<quantity name="pionDetectorLuciteShieldDSInsideWidth" type="length" value="50.0" unit="cm"/>`
- `<quantity name="pionDetectorLuciteShieldDSOutsideWidth" type="length" value="54.5" unit="cm"/>`

- + `<quantity name="pionDetectorLuciteShieldDSInsideWidth" type="length" value="49.0" unit="cm"/>`
- + `<quantity name="pionDetectorLuciteShieldDSOutsideWidth" type="length" value="53.5" unit="cm"/>`



T->Draw("hit.x:hit.z >>h(100,24855,24885,100,1100,1200)","hit.det==8001 && hit.y>-250 && hit.y<250 && (hit.pid==11 || hit.pid==-11 || hit.pid==13 || hit.pid==-13 || hit.pid==211 && hit.pid==-211)","colz")



```
T->Draw("hit.x:hit.z >>h(100,24855,24885,100,1100,1200)","hit.det==8001 && hit.y>-250 && hit.y<250 && (hit.pid==11 || hit.pid==11 || hit.pid==13 || hit.pid==13 || hit.pid==211 && hit.pid==211)","colz")
```

Comparison of rates for different Lucite design with Galactic frame (Low energy particles)

7cm Lucite- with wedge- Not shifted	$(1.260 \pm 0.009) \times 10^{-3}$	$(5.29 \pm 0.08) \times 10^{-6}$	0.42%	$(1.822 \pm 0.004) \times 10^{-2}$	$(4.850 \pm 0.007) \times 10^{-4}$	2.66%
7cm Lucite- without wedge 1 cm shifted	$(1.446 \pm 0.010) \times 10^{-3}$	$(5.19 \pm 0.07) \times 10^{-6}$	0.36%	$(2.286 \pm 0.004) \times 10^{-2}$	$(2.524 \pm 0.005) \times 10^{-4}$	1.10%
7cm Lucite- with wedge 2 cm shifted	$(1.37 \pm 0.01) \times 10^{-3}$	$(5.53 \pm 0.08) \times 10^{-6}$	0.40%	$(2.180 \pm 0.004) \times 10^{-2}$	$(5.200 \pm 0.008) \times 10^{-4}$	2.39%
6cm Lucite- with wedge 2 cm shifted	$(1.120 \pm 0.009) \times 10^{-3}$	$(5.08 \pm 0.07) \times 10^{-6}$	0.45%	$(1.956 \pm 0.004) \times 10^{-2}$	$(5.360 \pm 0.008) \times 10^{-4}$	2.74%

Original geometry: Everything is Aluminum, 7 cm Lucite, not shifted

Original geometry	$(2.47 \pm 0.01) \times 10^{-3}$	$(5.49 \pm 0.08) \times 10^{-6}$	0.22%	$(4.834 \pm 0.006) \times 10^{-2}$	$(5.039 \pm 0.008) \times 10^{-4}$	1.04%
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Comparison of rates for different Lucite design with Galactic frame (High energy particles)

7cm Lucite- with wedge- Not shifted	$(1.163 \pm 0.009) \times 10^{-3}$	$(2.74 \pm 0.02) \times 10^{-5}$	2.36%	$(1.822 \pm 0.004) \times 10^{-2}$	$(4.850 \pm 0.007) \times 10^{-4}$	2.66%
7cm Lucite- without wedge 1 cm shifted	$(1.012 \pm 0.009) \times 10^{-3}$	$(2.46 \pm 0.02) \times 10^{-5}$	2.43%	$(2.286 \pm 0.004) \times 10^{-2}$	$(2.524 \pm 0.005) \times 10^{-4}$	1.10%
7cm Lucite- with wedge 2 cm shifted	$(8.47 \pm 0.08) \times 10^{-4}$	$(2.84 \pm 0.02) \times 10^{-5}$	3.35%	$(2.180 \pm 0.004) \times 10^{-2}$	$(5.200 \pm 0.008) \times 10^{-4}$	2.39%
6cm Lucite- with wedge 2 cm shifted	$(5.91 \pm 0.07) \times 10^{-4}$	$(2.55 \pm 0.02) \times 10^{-5}$	4.31%	$(1.956 \pm 0.004) \times 10^{-2}$	$(5.360 \pm 0.008) \times 10^{-4}$	2.74%

Original geometry: Everything is Aluminum, 7 cm Lucite, not shifted

Original geometry	$(3.05 \pm 0.02) \times 10^{-3}$	$(2.78 \pm 0.02) \times 10^{-5}$	0.91%	$(4.834 \pm 0.006) \times 10^{-2}$	$(5.039 \pm 0.008) \times 10^{-4}$	1.04%
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Thank you