technische universität
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CERN

Summerstudent project 2017

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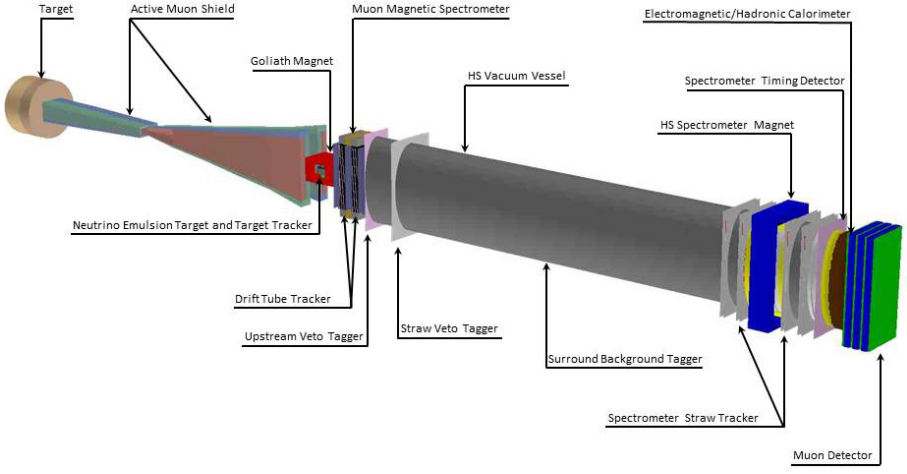
content

1. data sets
2. reconstructed distance to target
3. Monte Carlo truth and particle distribution
4. particle flux in strawtubes

Used data sets

- Constructed via the FairShip framework
  - `run_SimScript.py` with flags `--MuonBack --FollowMuon` and `--Field` customized to change the field of the muon shield.
  - `ShipReco.py` to simulate the reconstruction and detector
  - files with different magnetic fields `muShield.B` of the muon shield
  - And also without any magnetic field in all detector components (`c.tauMS.B`= 1,5 T/`c.EmuMagnet.B`= 1 T)
  - first samples with 100 000 events
  - use of weights for certain events

The detector

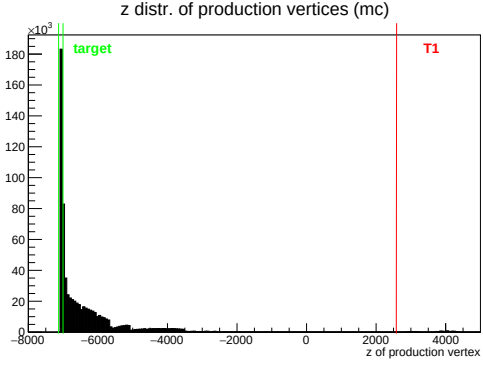


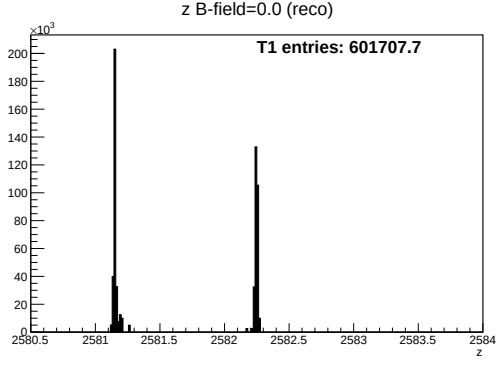
Calculation of impact parameter

The reconstructed tracks (namely the fitted states) are accessed via:

```
523 for event in t00:
524     for track in event.FitTracks:
525         state = track.getFittedState()
526         mom = state.getMom()
527         pos = state.getPos()
528         pdg = state.getPDG()
529
```

They yield a spatial vector $\vec{r}_{\text{track}} = (x, y, z)$ and a momentum vector (p_x, p_y, p_z). The spatial vector is used as a starting point, while the momentum vector defines the direction. The so defined straight line in 3D space can then be extrapolated to the z-component of the target centre.


z distr. of production vertices (mc)
×10³
target
T1
180
160
140
120
100
80
60
40
20
0
−8000
−6000
−4000
−2000
0
2000
4000
z of production vertex


z B-field=0.0 (reco)
×10³
T1 entries: 601707.7
200
180
160
140
120
100
80
60
40
20
0
2580.5
2581
2581.5
2582
2582.5
2583
2583.5
2584
z

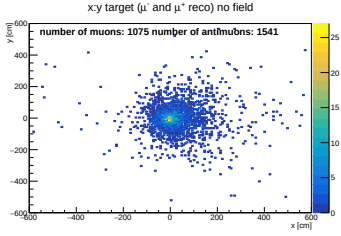
Calculation of impact parameter

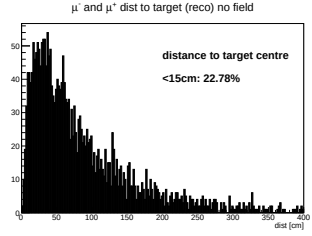
The target centre is located at $z_t = -7067.0$, so that the x and y coordinates of the fitted tracks can be calculated. Of course assuming there is no scattering and no magnetic field altering the direction of the momentum of the particles. So the track is described by

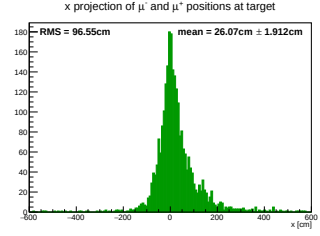
$$\vec{r}(t) = \vec{p} \cdot t + \vec{r}_{\text{track}} \tag{1}$$

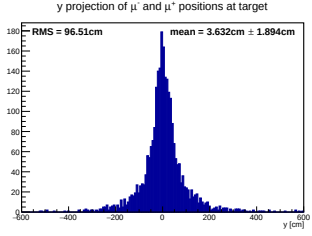
Thus one only needs to calculate the t for the z-component and apply it to x and y.

- $t = \frac{z_{\text{target}} - z}{p_z}$
- $x_{\text{target}} = p_x \cdot t + x$
- $y_{\text{target}} = p_y \cdot t + y$
- this then gives the distance in the x-y-plain: $d = \sqrt{x_{\text{target}}^2 + y_{\text{target}}^2}$

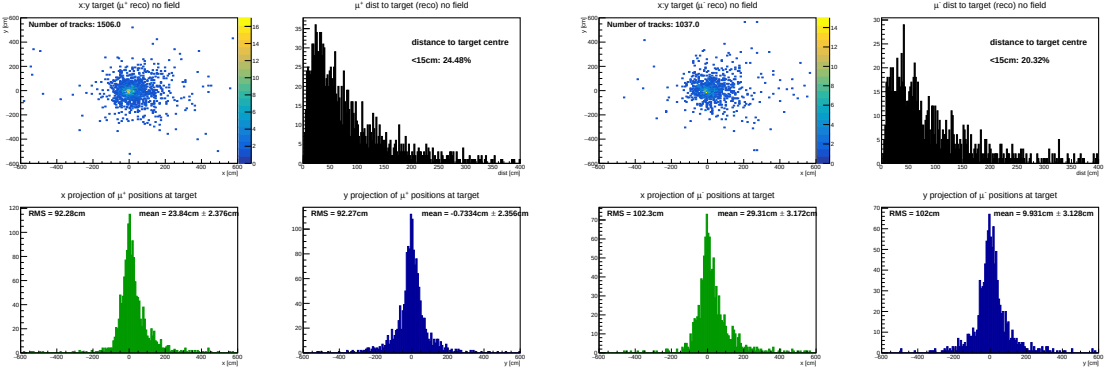

x:y target (μ⁻ and μ⁺ reco) no field
number of muons: 1075 number of antimuons: 1541
y [cm]
x [cm]


μ⁻ and μ⁺ dist to target (reco) no field
distance to target centre
<15cm: 22.78%
dist [cm]

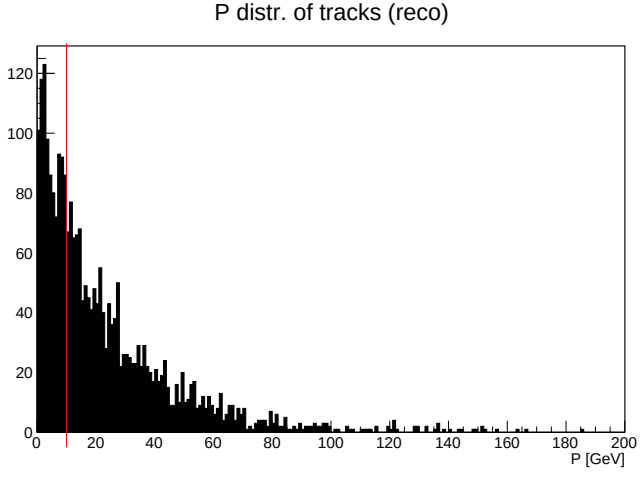

x projection of μ⁻ and μ⁺ positions at target
RMS = 96.55cm
mean = 26.07cm ± 1.912cm
x [cm]


y projection of μ⁻ and μ⁺ positions at target
RMS = 96.51cm
mean = 3.632cm ± 1.894cm
y [cm]

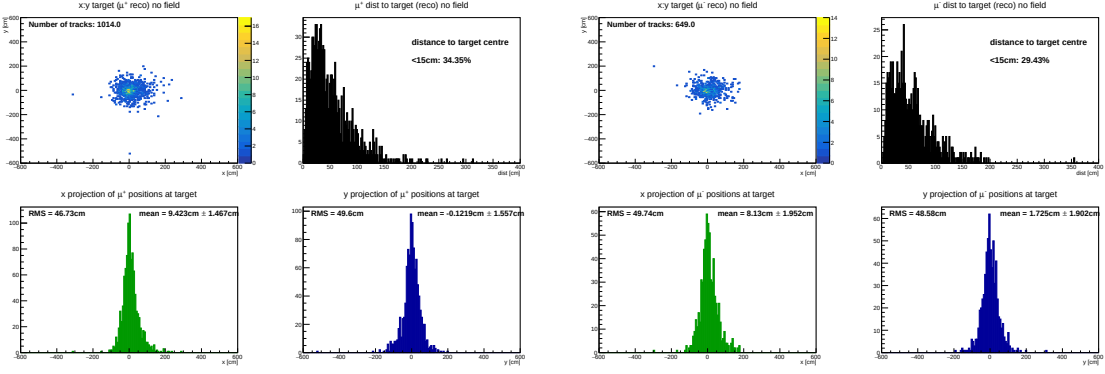
Divided for μ^+ and μ^-



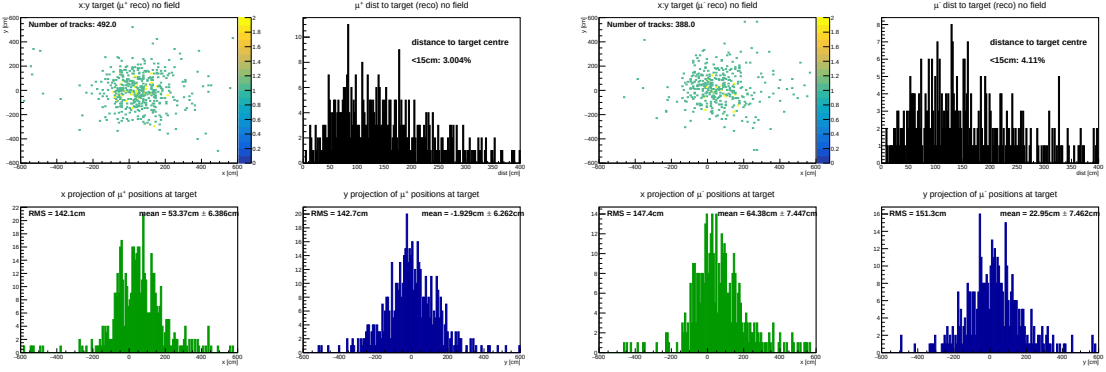
Momentum distribution of the tracks



Divided for μ^+ and μ^- only momenta > 10 GeV



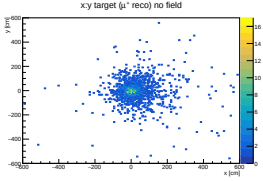
Divided for μ^+ and μ^- only momenta < 10 GeV

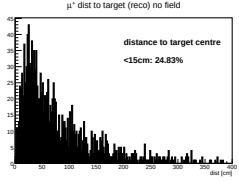


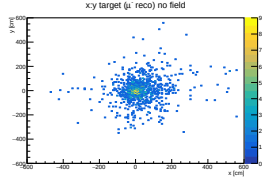
μ^+	all momenta	$p > 10$ GeV	$p < 10$ GeV
mean x /cm	$23{,}84 \pm 2{,}38$	$9{,}4 \pm 1{,}5$	$53{,}37 \pm 6{,}39$
mean y /cm	$-0{,}733 \pm 2{,}356$	$-0{,}12 \pm 1{,}56$	$-1{,}93 \pm 6{,}26$
RMS x /cm	92,28	46,73	142,1
RMS y /cm	92,27	49,6	142,7
μ^-	all momenta	$p > 10$ GeV	$p < 10$ GeV
mean x /cm	$29{,}31 \pm 3{,}17$	$8{,}13 \pm 1{,}95$	$64{,}38 \pm 7{,}45$
mean y /cm	$9{,}931 \pm 3{,}128$	$1{,}725 \pm 1{,}902$	$22{,}95 \pm 7{,}46$
RMS x /cm	102,3	49,74	147,4
RMS y /cm	102	48,58	151,3

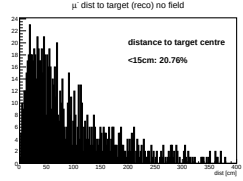
Tabelle: Means and RMS of the x- and y-projections of the reconstructed IP.

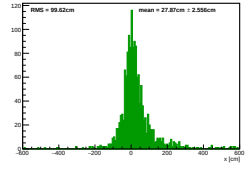
Divided for μ^+ and μ^- all momenta but muon shield 1mT

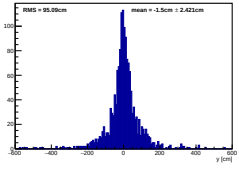


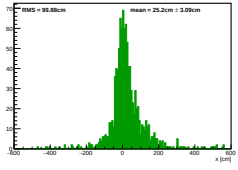


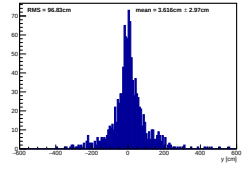






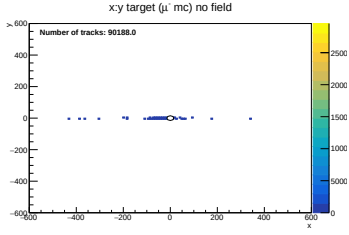


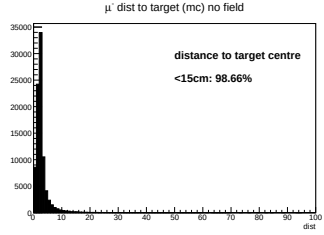


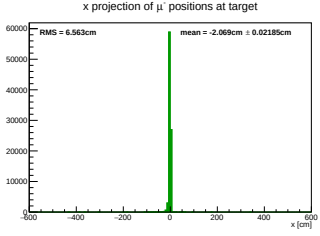


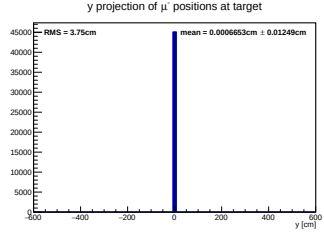
μ^+	$B_{\text{mu shield}} = 1\,\text{mT}$	all momenta
mean x /cm	$27{,}87 \pm 2{,}56$	$23{,}84 \pm 2{,}38$
mean y /cm	$-1{,}5 \pm 2{,}4$	$-0{,}733 \pm 2{,}356$
RMS x /cm	99,62	92,28
RMS y /cm	95,09	92,27
μ^-	$B_{\text{mu shield}} = 1\,\text{mT}$	all momenta
mean x /cm	$25{,}2 \pm 3{,}1$	$29{,}31 \pm 3{,}17$
mean y /cm	$3{,}62 \pm 2{,}97$	$9{,}931 \pm 3{,}128$
RMS x /cm	99,88	102,3
RMS y /cm	96,83	102

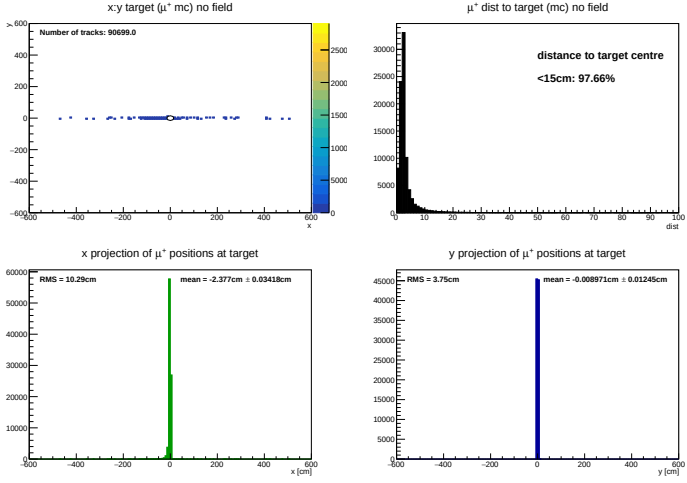
Tabelle: Means and RMS of the reconstructed IP for no magnetic field and a 1 mT field in the muon shield.

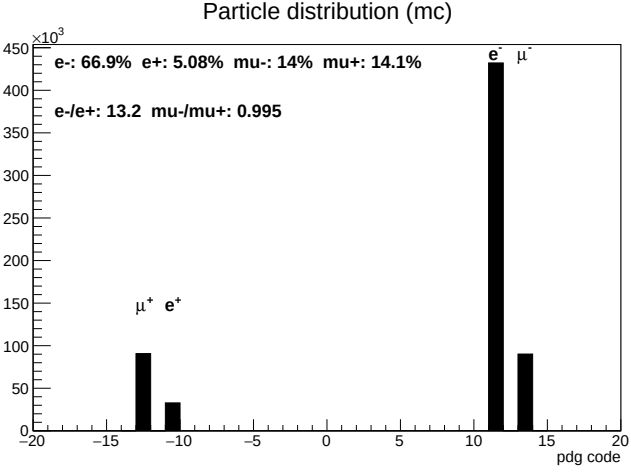

x:y target (μ⁻ mc) no field
Number of tracks: 90188.0
y
x

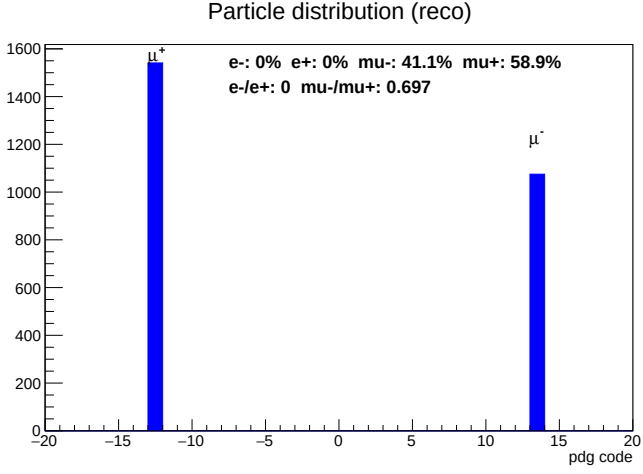

μ⁻ dist to target (mc) no field
distance to target centre
<15cm: 98.66%
dist


x projection of μ⁻ positions at target
RMS = 6.563cm
mean = -2.069cm ± 0.02185cm
x [cm]


y projection of μ⁻ positions at target
RMS = 3.75cm
mean = 0.0006653cm ± 0.01249cm
y [cm]


x:y target (μ⁺ mc) no field
Number of tracks: 90699.0
y
x
μ⁺ dist to target (mc) no field
distance to target centre
<15cm: 97.66%
dist
x projection of μ⁺ positions at target
RMS = 10.29cm
mean = -2.377cm ± 0.03418cm
x [cm]
y projection of μ⁺ positions at target
RMS = 3.75cm
mean = -0.008971cm ± 0.01245cm
y [cm]


Particle distribution (mc)
×10^3
e-: 66.9% e+: 5.08% mu-: 14% mu+: 14.1%
e-/e+: 13.2 mu-/mu+: 0.995
e⁻ μ⁻
μ⁺ e⁺
450
400
350
300
250
200
150
100
50
0
−20 −15 −10 −5 0 5 10 15 20
pdg code


Particle distribution (reco)
e-: 0% e+: 0% mu-: 41.1% mu+: 58.9%
e-/e+: 0 mu-/mu+: 0.697
μ+
μ-
1600
1400
1200
1000
800
600
400
200
0
–20
–15
–10
–5
0
5
10
15
20
pdg code

- When running the reconstruction script:
  ```
  Error in <TDecompChol::Decompose()>: matrix not positive definite
  Error in <TDecompChol::Solve()>: Decomposition failed
  ```
- When trying to loop over fitted tracks in 1 000 000 sample:
  ```
  state = track.getFittedState()
  Exception: const genfit::MeasuredStateOnPlane&
  genfit::Track::getFittedState(int id = 0, const genfit::AbsTrackRep*
  rep = __null, bool biased = true) =>unhandled, unknown C++ exception
  ```
- After reconstruction:
  ```
  shipDigiReco::findVetoHitOnTrack extrapolation did not worked : 18
  ```