Tracking studies for the MICE TPG

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Goals

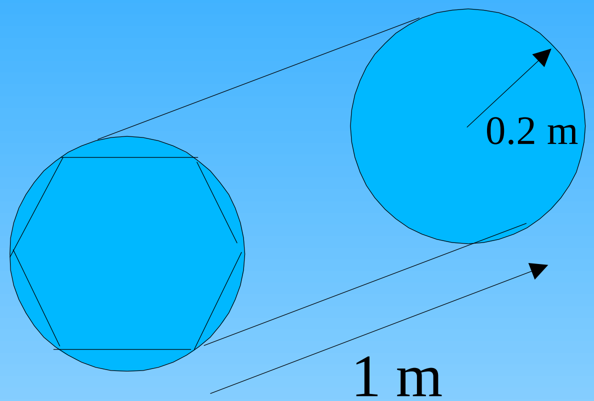
Understanding tracking in the TPG in terms of occupancy, point and momentum resolution, and 3D tracking capabilities

This is not a proper GEANT4 simulation, but uses a stand-alone code to simulate timing, tracking, diffusion and strip readout.

The results of this simulation are later analysed to produce event displays, perform fits and 3D reconstruction

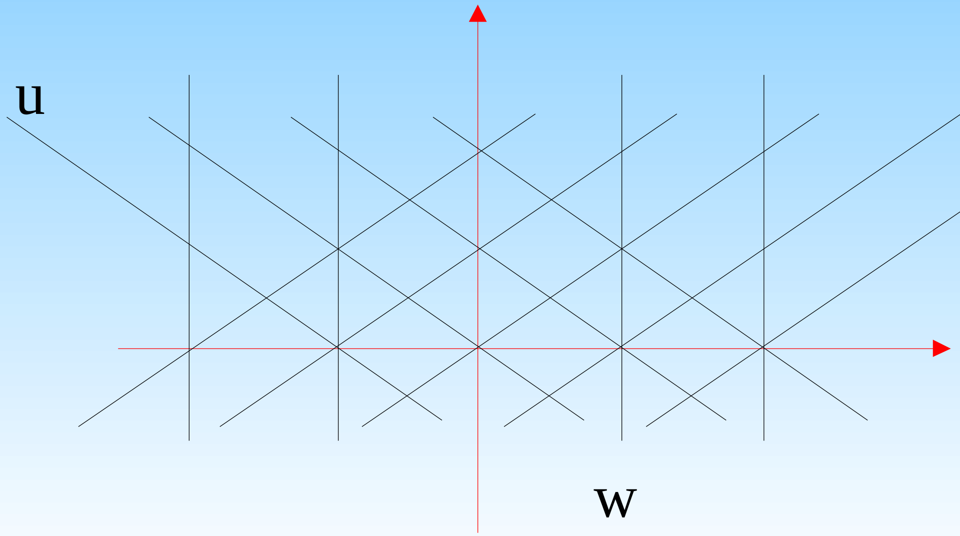
No noise has been included yet, but having the frame ready, its implementation is quite straightforward

(my) Detector description



$B = 4$ T

$v_{drift} = 2$ cm/μs



600 strips in each family 500 μm pich

Data structure

1024 timeslots of 500 ns
total acquisition time: 512 μs

from the accelerator, every 330 ns muons are sent with Poisson probability with μ=0.1

On average, 160 muons enter TPG per acquisition session

For a 2 cm/μs drift time, the most distant ionization takes

50 μs to reach the hexaboard

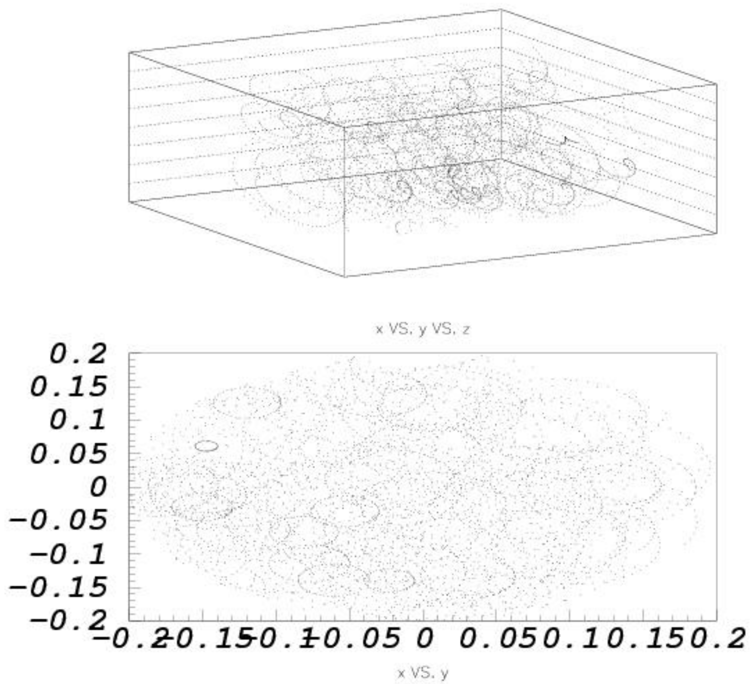
→100 time slots

a muon track traversing the whole detector will only occupy 1/10 of a total acquisition

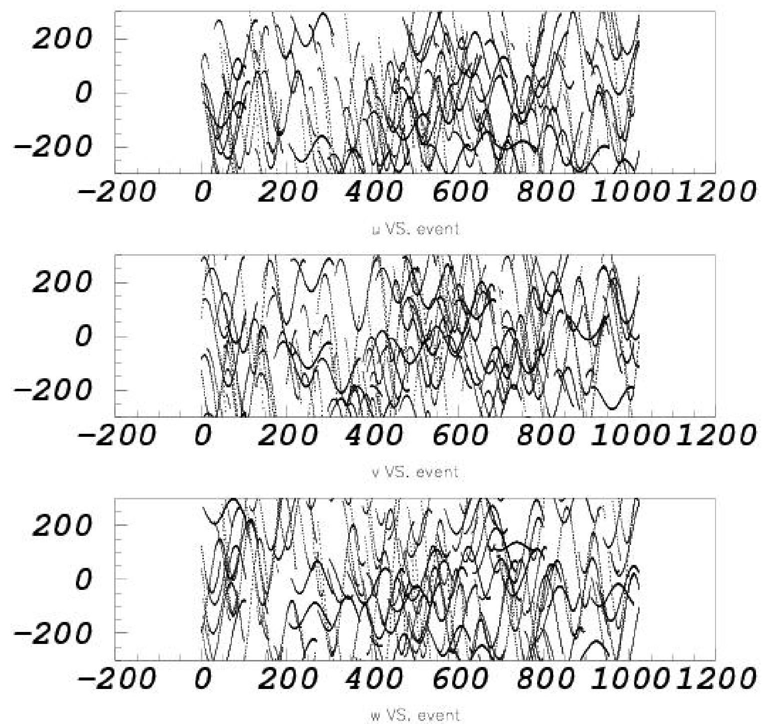
Event views

A typical event, with 165 tracks.

Track coordinates

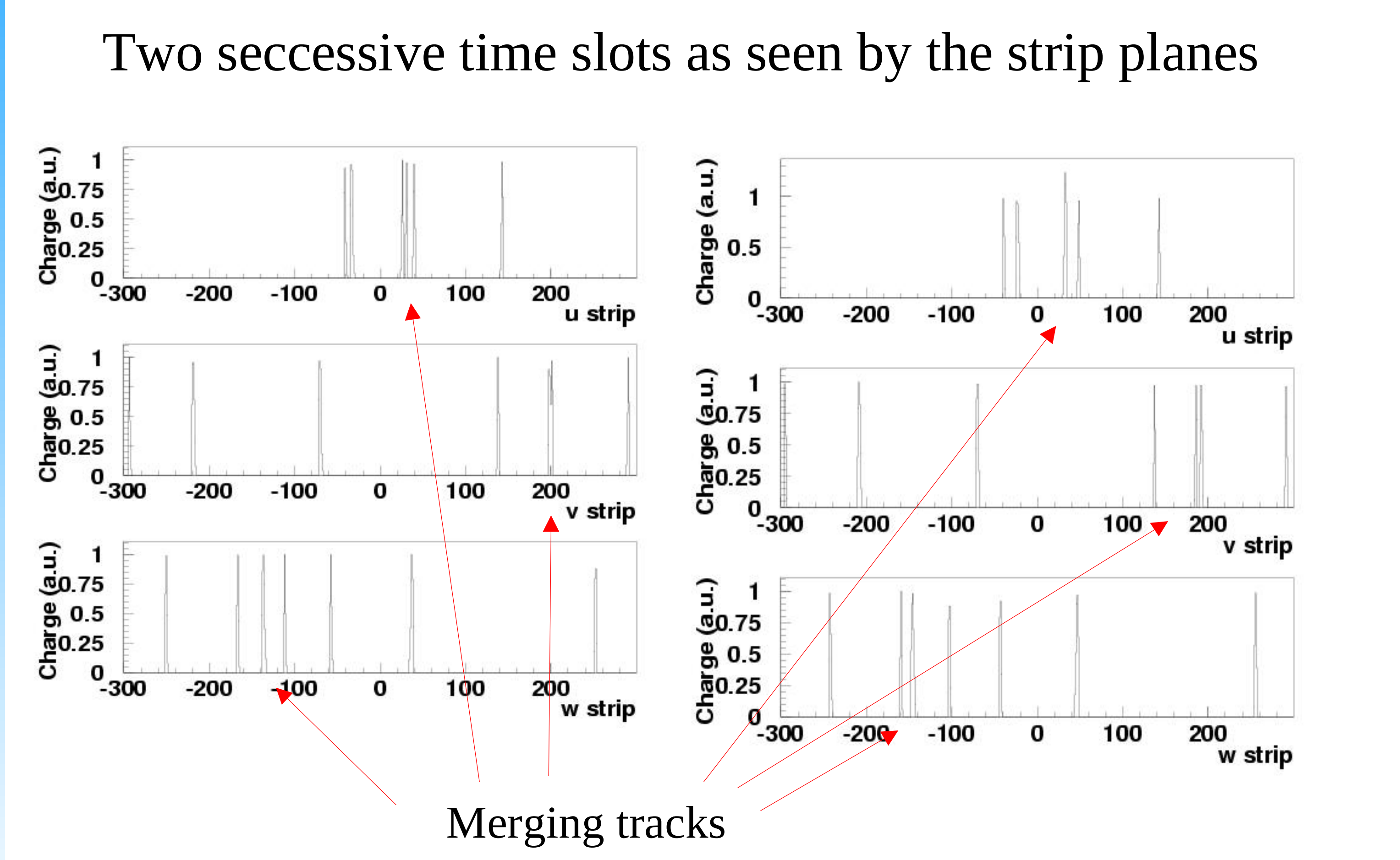


Strip views



Diffusion

In a 90% He 10% C4H10 mixture, the transverse diffusion is 150 µm * √l (cm). Additional 500 µm have been added in quadrature to account for the spray in the GEM



Track fitting

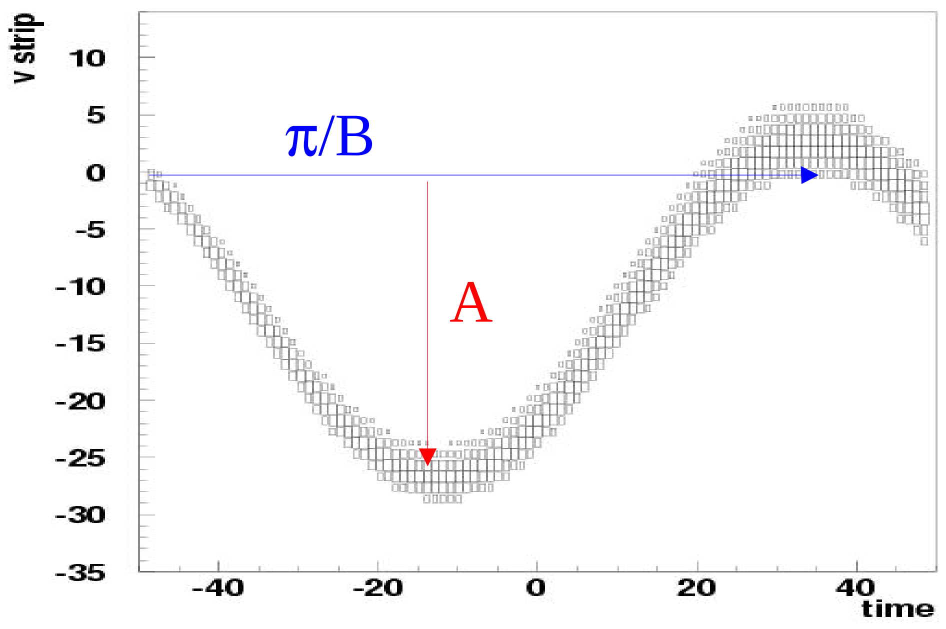
Resolution studies have been performed generating sets of tracks in the TPG with Pt=10 MeV and Pl=200 MeV, fitting the strip views with sinusoidals:

$$f = A \sin(Bx + C) + D$$

where the following relations hold:

$Pt = 0.3\ B\ A$ (A is the projected radius of curvature)

$Pl = 0.3\ B / C$



On average, 3−4 strips are touched (depending on z) due to diffusion. A fit considering only which strips are touched is far from optimal

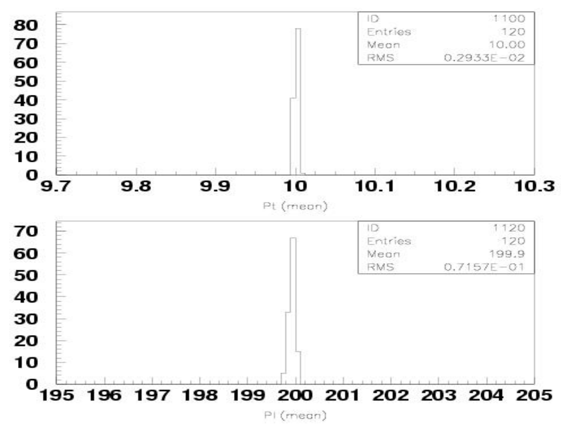
Weighted vs unweighted fits

Unweighted averages are as expected quite unstable, while much better results are obtained by weighted fits.

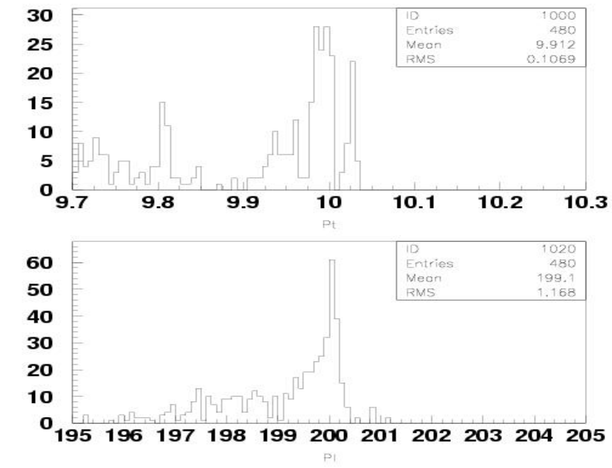
Pt resolution is 15 KeV/10 MeV
Pl resolution 150 KeV/200 MeV

A further factor ~2 can be gained taking the average value of the three strip planes

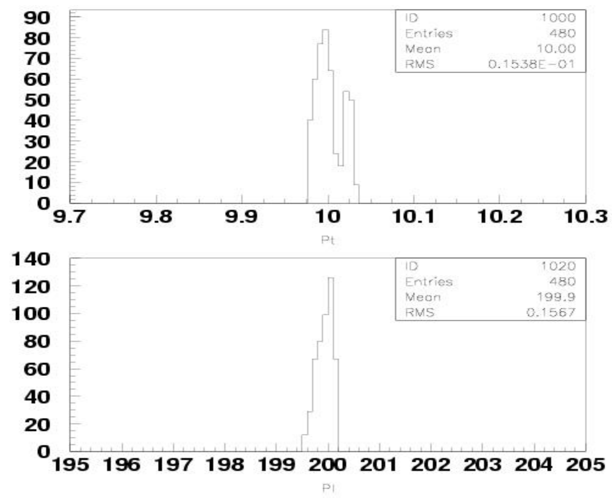
Averaged



Unweighted



Weighted



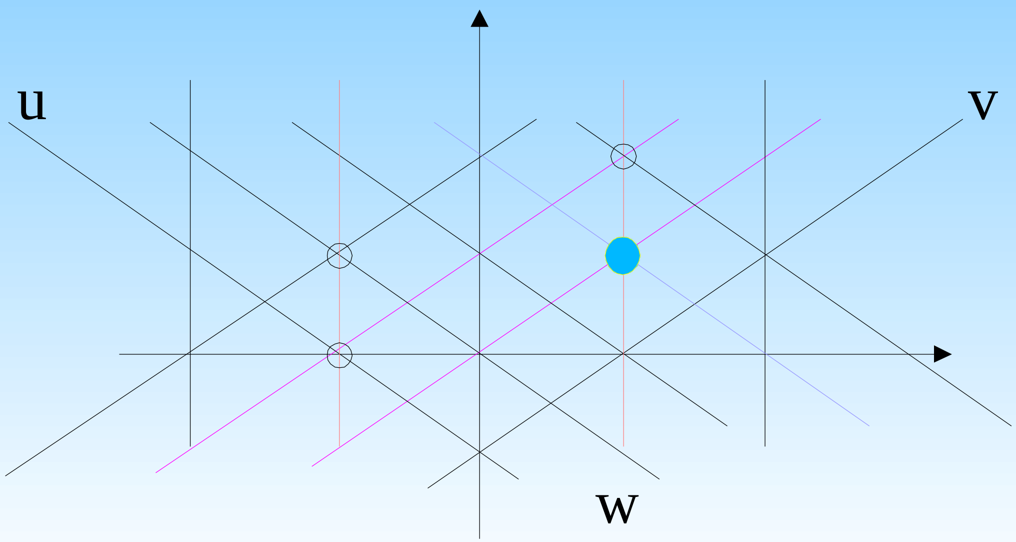
3D reconstruction

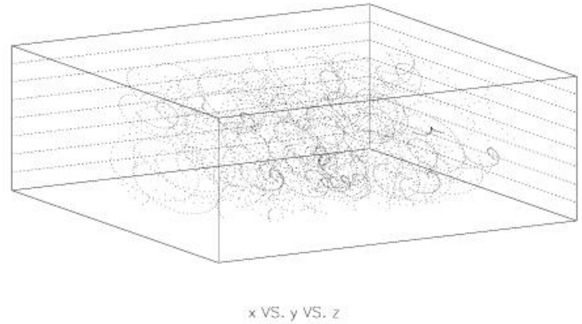
The strip information can be used in an extemely effective way to retrieve the 3−D image of the track.

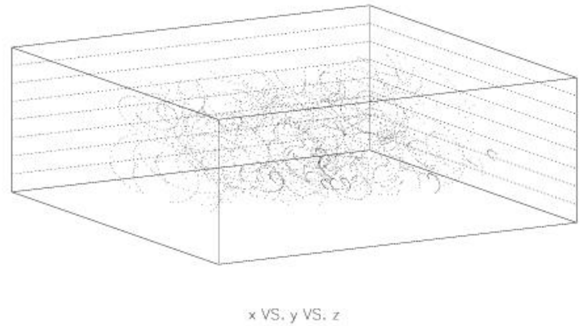
A simple clustering algorithm has been inplemented, to reduce the touched strip distribution to a single central value.

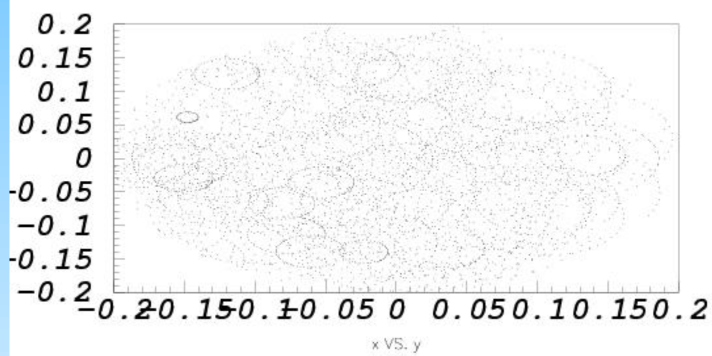
All possible hit combinations in the (w,v) plane are made, but only those compatible with the u plane are retained.

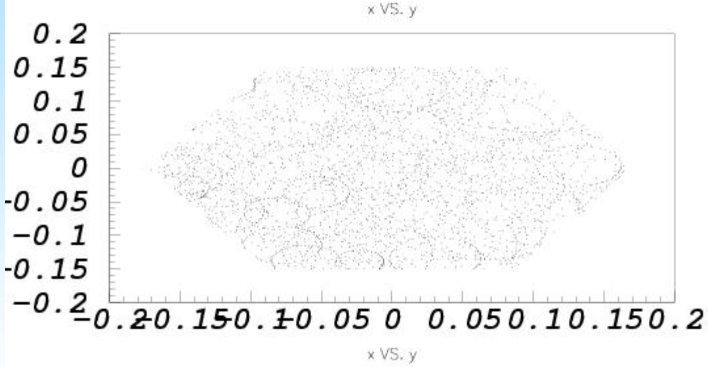
fake rate is very small











Conclusions

This first simulation of the TPG is far from being complete; however it allows the study of the detector performances on a quantitative base, with respect to occupancy, resolution, to study the effect of the diffusion and do some pattern recognition.

In ideal conditions, the TPG is as expected a superb device, with sub−permille momentum resolution, and ability to perform a point−by point 3D reconstruction in a multi−track environment despite the loss of information due to the strip readout.

To do list:
inclusion of simulated GEANT points
better clustering and pattern recognition
noise and development of noise−filtering algorithms