Expérience de trajectoire miniature : reproduire une expérience sur collisionneur en miniature

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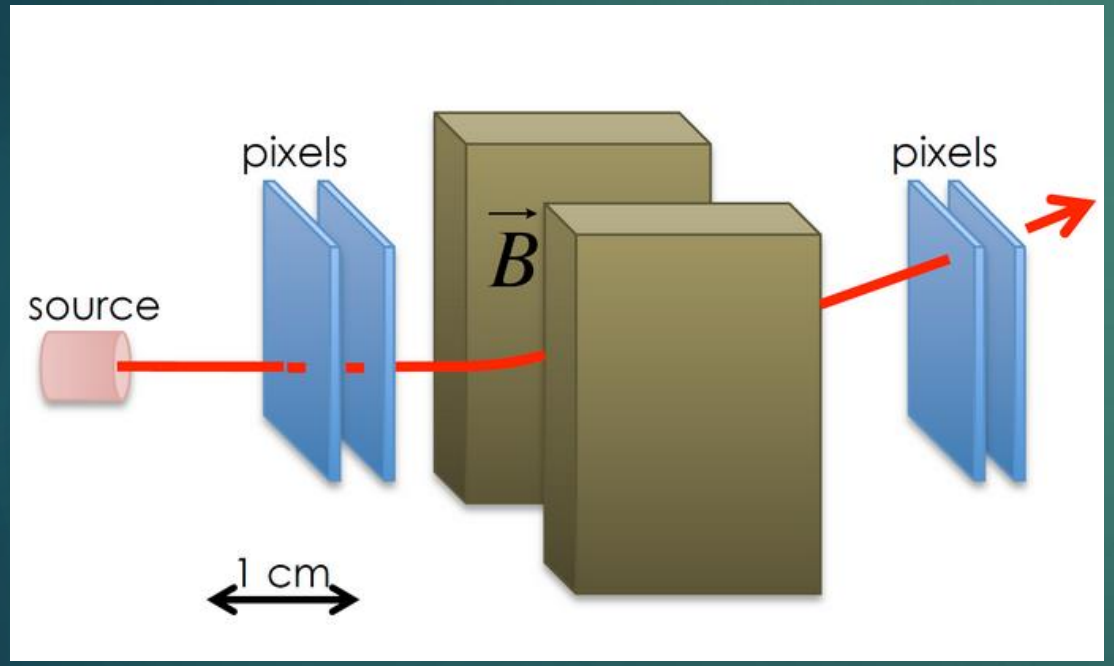
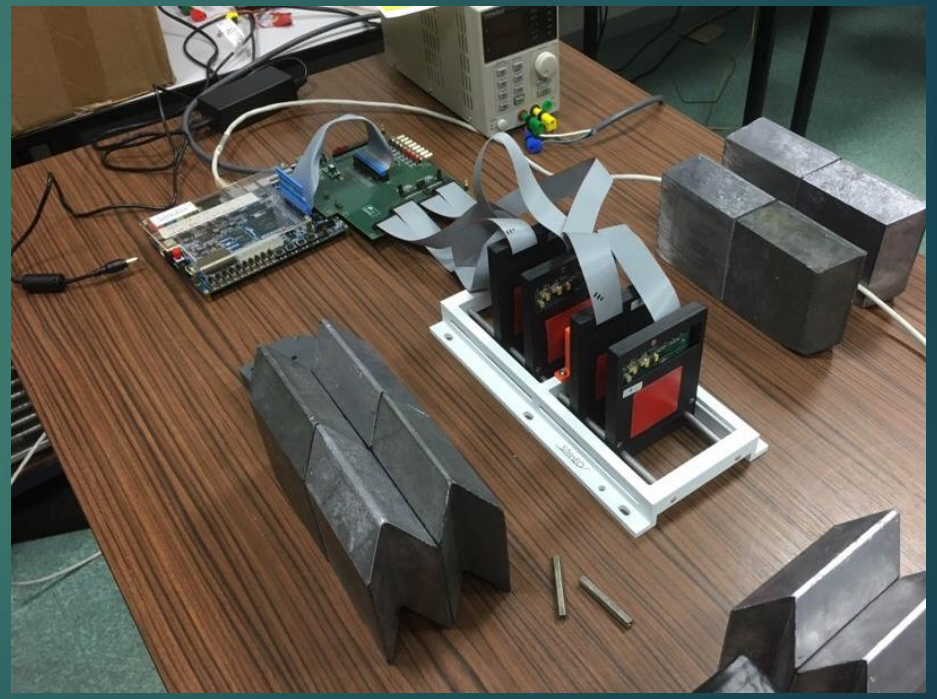
I. Introduction

Presentation of the project

- Source emit a particle wich going through the two first detectors, than is deviating and going though the two other detectors.





My internship :

- Simulation of the trajectory and the momentum with a program, without experiment data use!

- The goal : Get the momentum of the particle deviated by $\vec{B}$, and try to obtain the same p : $p_{before} \approx p_{after}$
- But there are some factors that can change the impulsion after :
  - Height of the particle in different detector
  - Scattering diffusion (angle change after each detector)

- My work : Programmation of the trajectory before the magnetic field (Y_1) , in the magnetic field (Y_2) and after the magnetic field (Y_3).

Caracteristic of the simulation

- Magnetic field : $\mathrm{B} = 0{,}2\ T$,
- Lenght of magnetic field : L= 1cm center in 0 (-0,5 to 0,5 cm)
- Two detectors in left and right of B

  ➔Position of detectors : -2,5cm ; -1,5cm ; 1,5cm ; 2,5cm

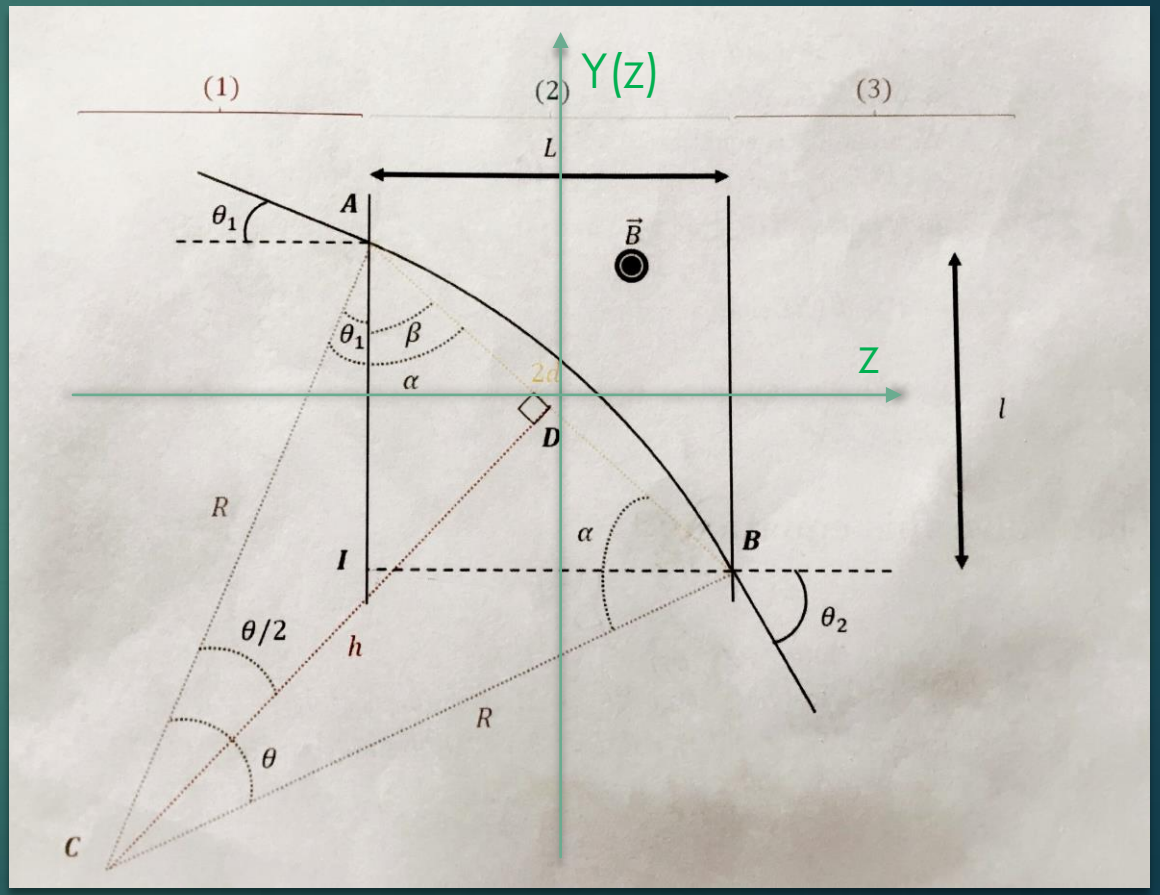
- Charge of particle : q=-1

II. Trajectory construction

Trajectory construction for one trace:

- $\vec{B}$: Magnetic field (Lenght : L)
- R : Curve radius (R increase if B➔0, p➔∞)
- Trajectory for 3 parts :
  - (1) : before $\vec{B}$ ➔ Y_1
  - (2) : in $\vec{B}$ ➔Y_2
  - (3) : after $\vec{B}$ ➔ Y_3

- A : Entries of the particle in $\vec{B}$ (angle θ_1)
- B : Exit of the particle from $\vec{B}$(angle θ_2)



Trajectory part in $\vec{B}$:

- $p = 0{,}3qBR$ ➔ $R = abs\left(\frac{p}{0{,}3qB}\right)$

  p : momentum

  q : charge of particle

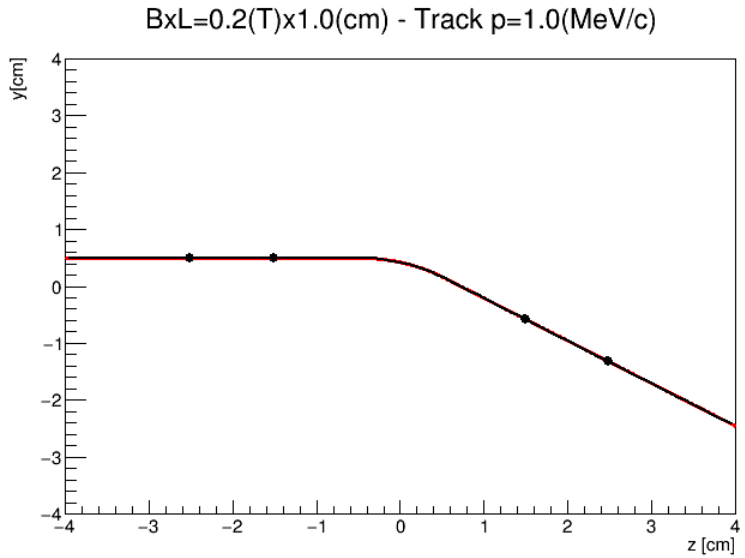
- With trigonometrie : $d(z) = \sqrt{\frac{-Rzsin(\theta_1)+R^2cos^2(\theta_1)+\sqrt{\Delta}}{2}}$
  - With : $\Delta = \left(RLsin(\theta_1) - R^2cos^2(\theta_1)\right)^2 - z^2R^2$

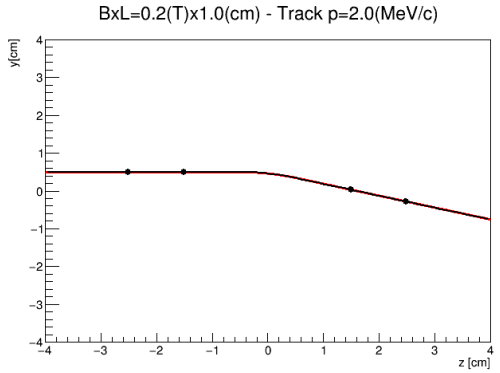
- $\theta_2 = 2\arcsin\left(\frac{d}{R}\right) + \theta_1$

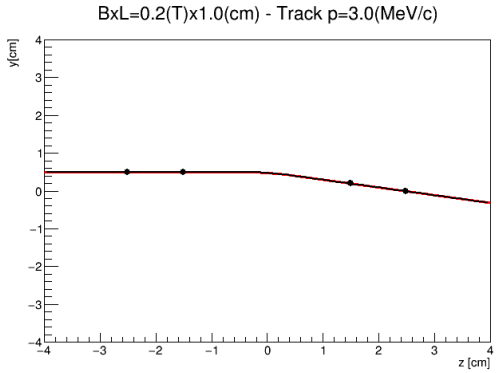
Trajectory equation:

- $y_1(z) = \tan(\theta_1)\,(z - z_0) + y_0$ ➔ parameters : θ_1 & y_0
- $y_2(z) = y_1(z_A) - \sqrt{4d(z)^2 - L^2}$ ➔parameter : p
- $y_3(z) = \tan(\theta_2)\,(z - z_B) + y_2(z_B)$ ➔parameter : θ_2

- We use 4 parameter : $\theta_1, y_0, p, \theta_2$
- With my tutor ➔ application of a fit to the trajectory
- But with multiple scattering, trajectory change !





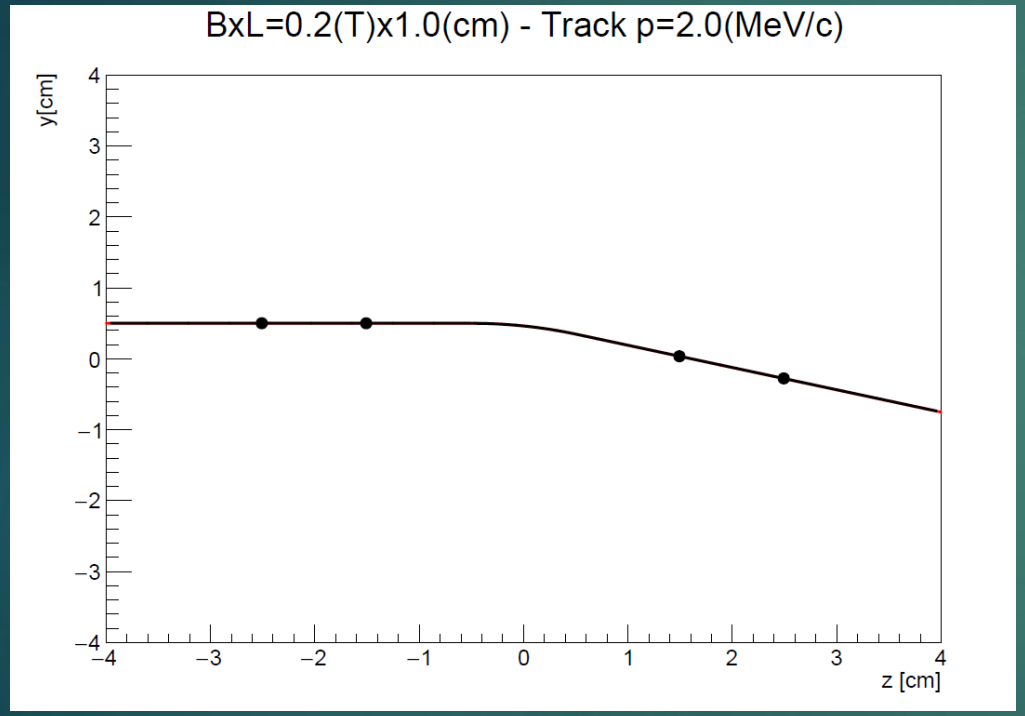


Trajectory example for one track:

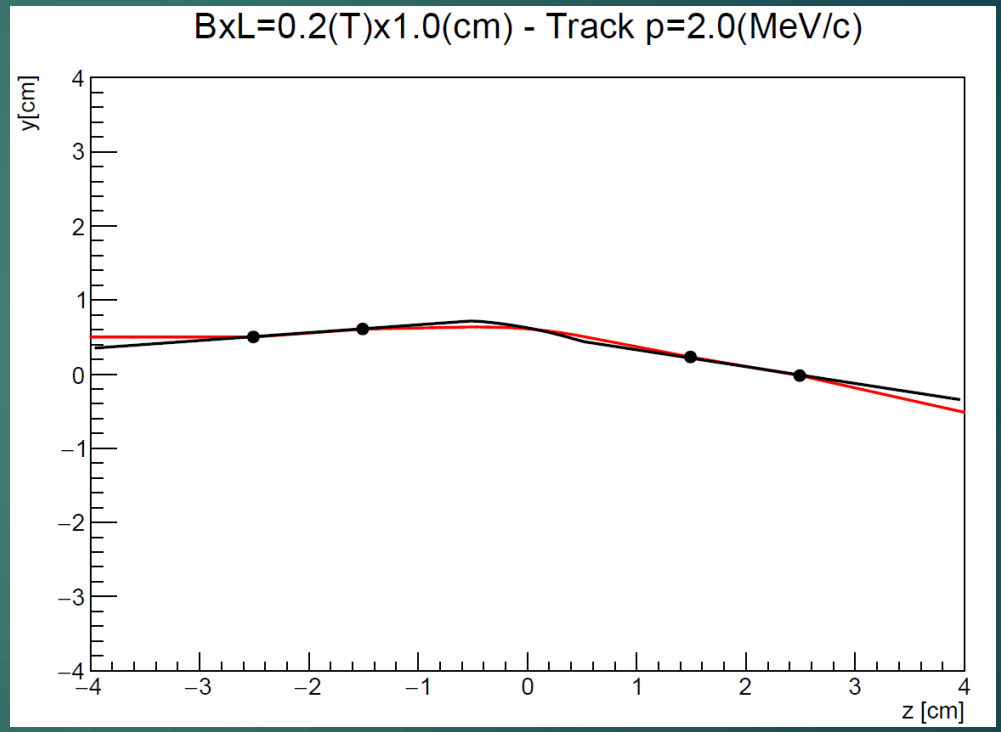
Red : True trace
Black : fit trace (with multiple scatering)

Trajectory comparison with multiple scatering

Without multiple scatering :



With multiple scatering :



- Red : true trace
- Black : fit trace (with multiple scatering)

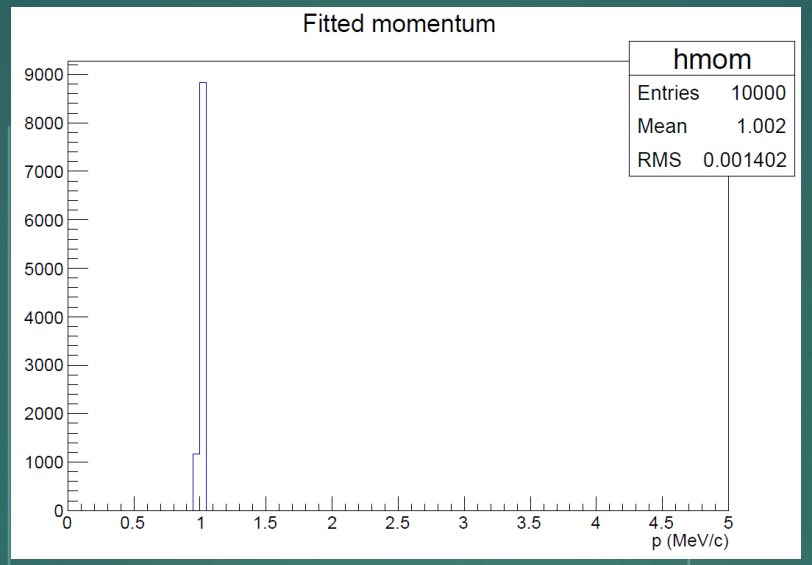
III. Simulation of 10 000 traces

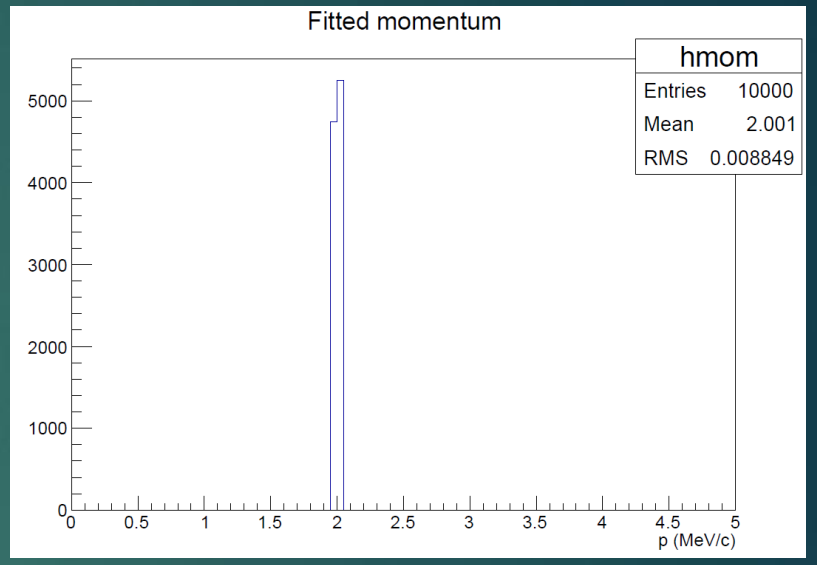
Histogramme of 10 000 points :

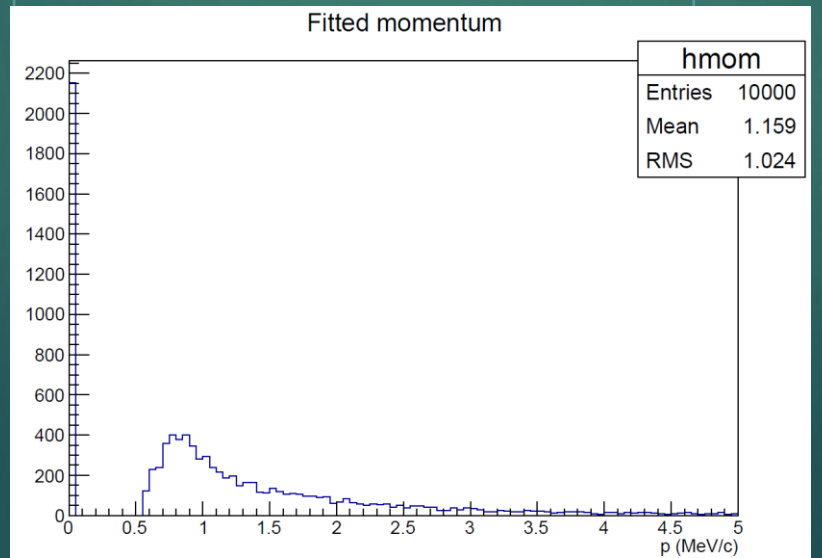
$p = 1MeV/c$ $p = 2MeV/c$

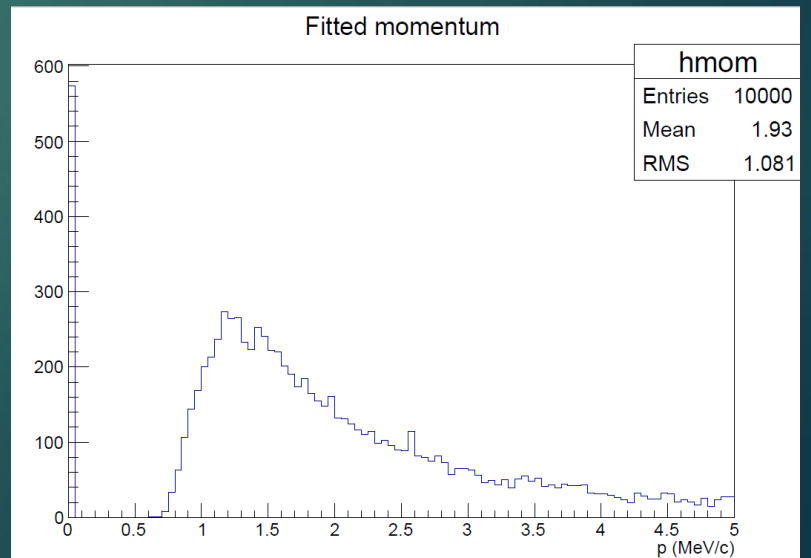
Without Scattering diffusion

With Scattering diffusion









- Without scattering diffusion (both case):
  - ➔$p_{before} \approx \bar{p}_{after}$
- With scattering diffusion :
  - ➔$p_{before} \neq \bar{p}_{after}$
  - ➔More dispersion
  - ➔p=1MeV/c : ≈2 200 points
  - ➔p=2MeV/c : ≈580 points

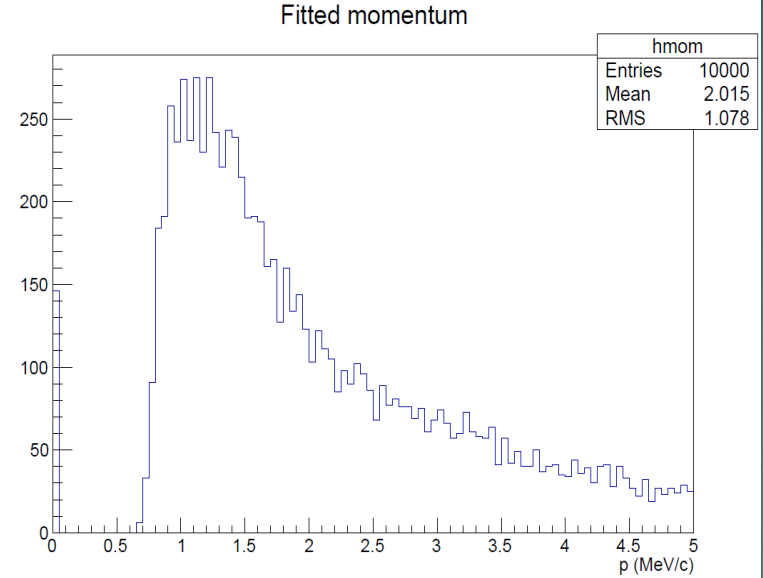
  ⇨ Not fit !

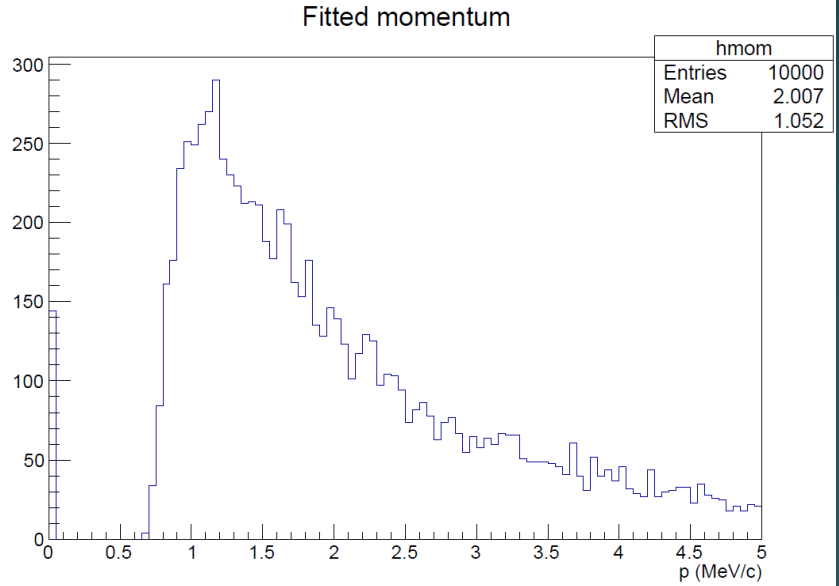
To limits the scattering diffusion effect to the momentum, we can try to change detector location.

2nd and 3nd detectors near $\vec{B}$ (-0,55 ; 0,55)

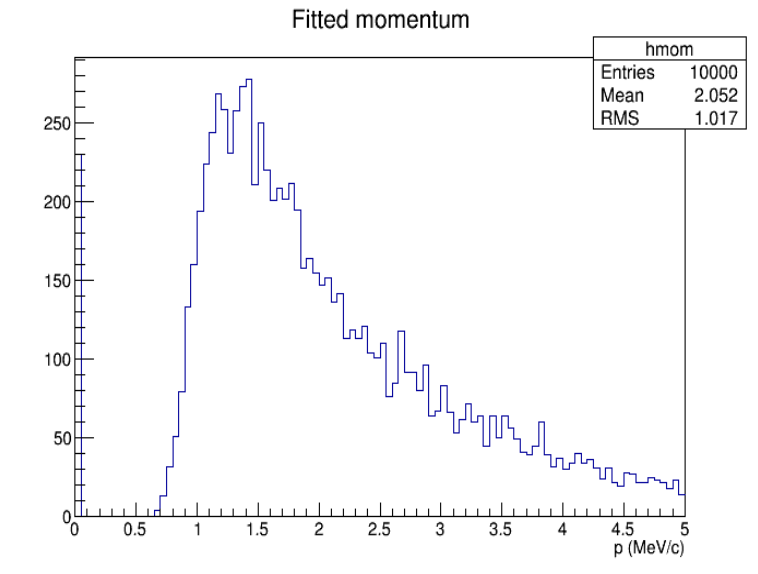
2nd and 3nd detectors exactly in B (-0,5 ; 0,5)

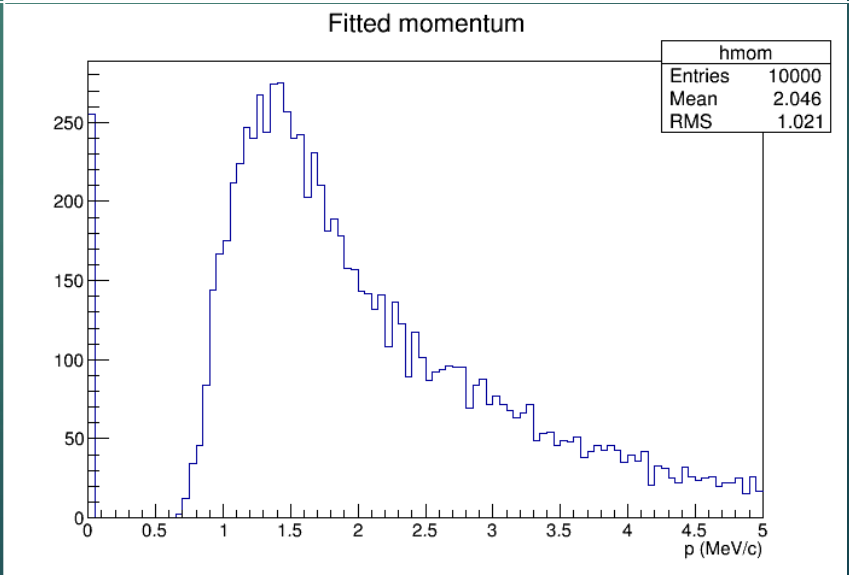
1st & 4nd detector in (-1,5 ; 1,5)





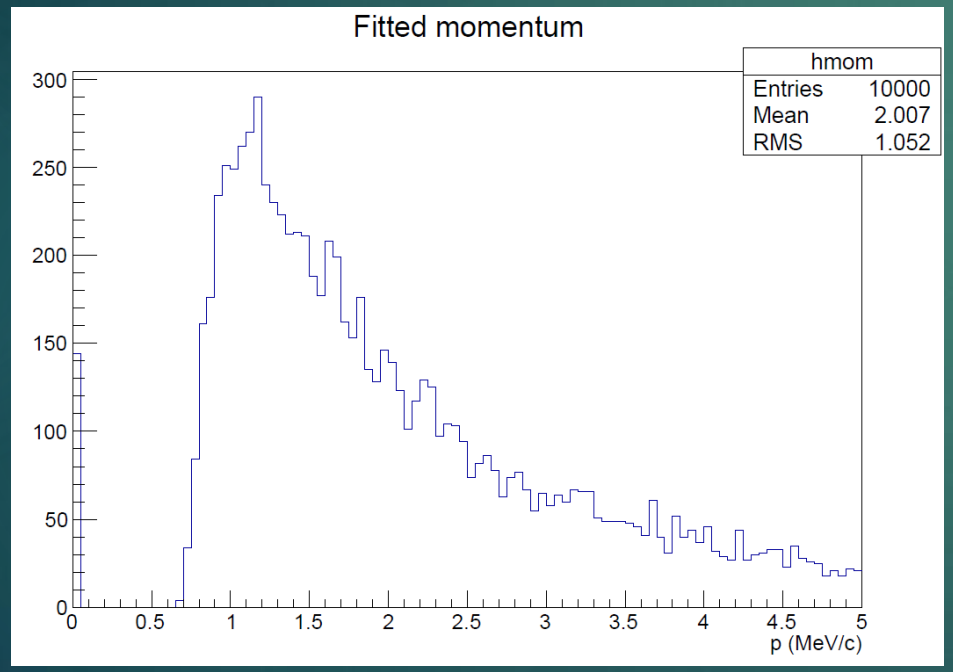
1st & 4nd detector in (-2,5 ; 2,5)



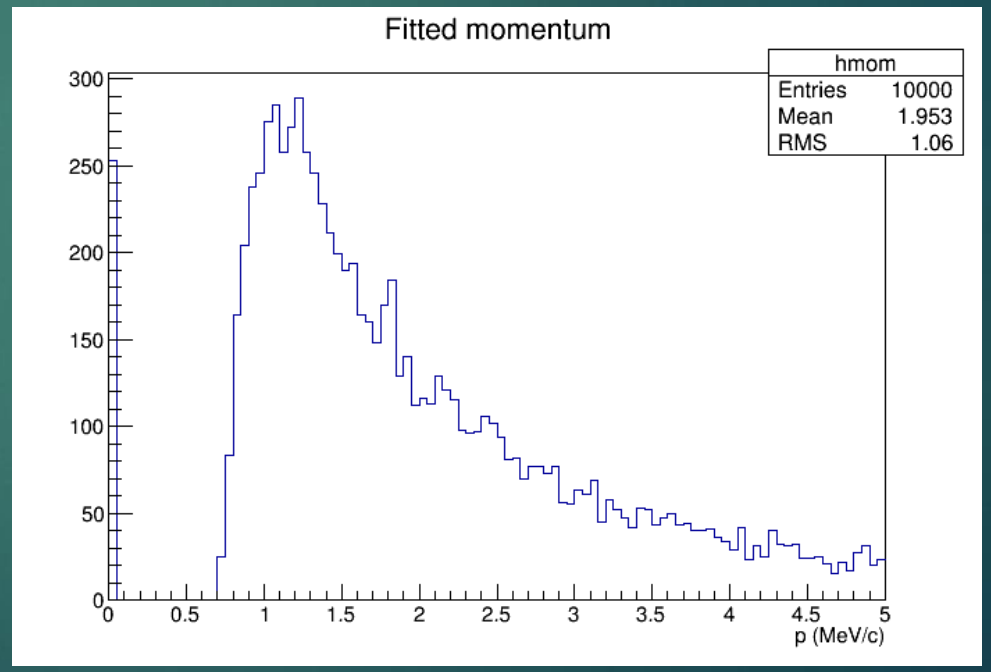


1st and 4rd detectors in ideal position

- Detectors in : -1,5 ; -0,5 ; 0,5 ; 1,5



- 1st and 4rd detectors in -1 ; 1
- ➔-1 ; -0,5 ; 0,5 ; 1



IV. Conclusion

- Representation of 1 track for different momentum
- To obtain a trajectory more realistic, we have include Multiple scatering but it change the trajectory and the impulsion in the simulation !

- It's just a program simulation
- We need data experiments from detectors, to obtain better a better momentum after the magnetic field .