Secondary Beamlines Operation

P. Batsela, I. Pagonidis,

Supervisor: N. Charitonidis [BE-EA]

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High School Students Internship Program
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Introduction

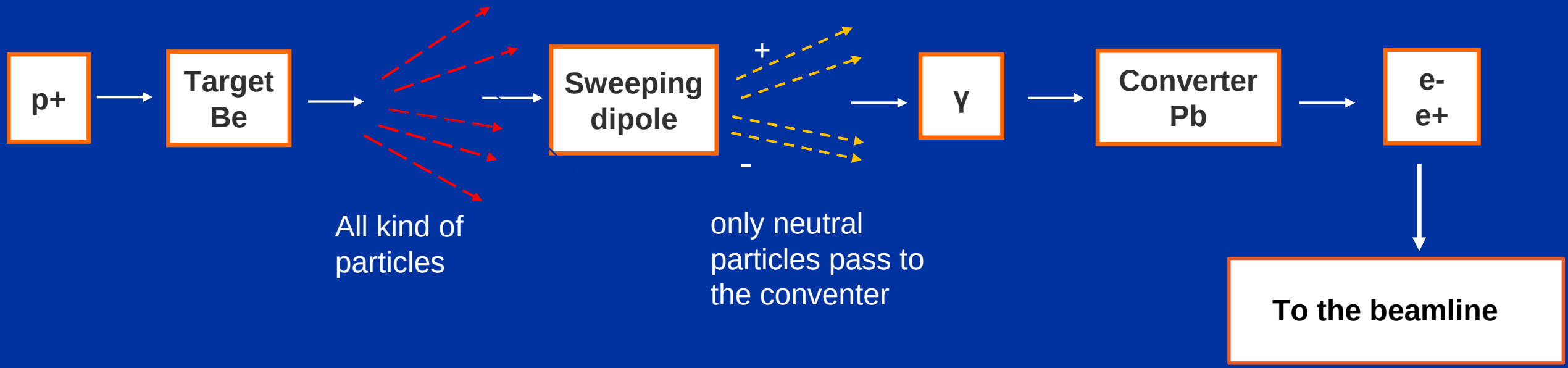
- ***Secondary beams***: **different particles with different energies and intensities.**
- **They are used for smaller experiments and for developing detectors or detector components e.g. for the LHC experiment.**
- **The term secondary refers to the generation of particles; meaning particles that were created by very high energy parents (protons or ions) colliding with targets-converters.**
- **In our project we wanted to design a beamline able to transport 25 GeV/c momentum electrons.**

Introduction

For the construction of a beamline we need to consider two factors:

a) The particles we use and b) the equipment.

Principle of operation of this beamline:



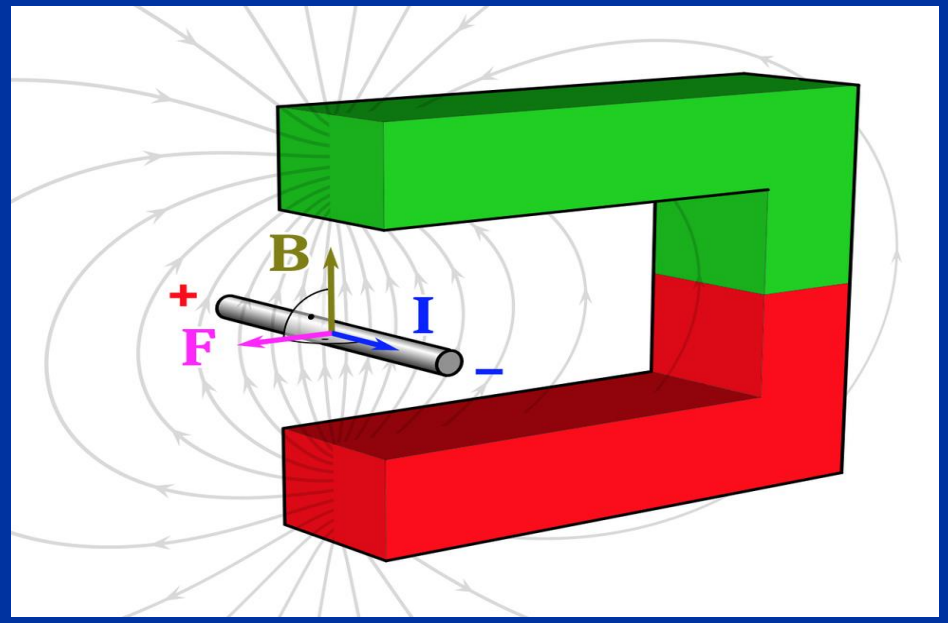
Introduction

Our beamline consists of :

- **Virtual detectors: detect and collect data of the particles.**
- **Target: generate particles through collisions.**
- **Converter: convert particles, e.g. γ ⟶ e- e+**
- **Collimators: absorb the particles with different properties that the one we want.**

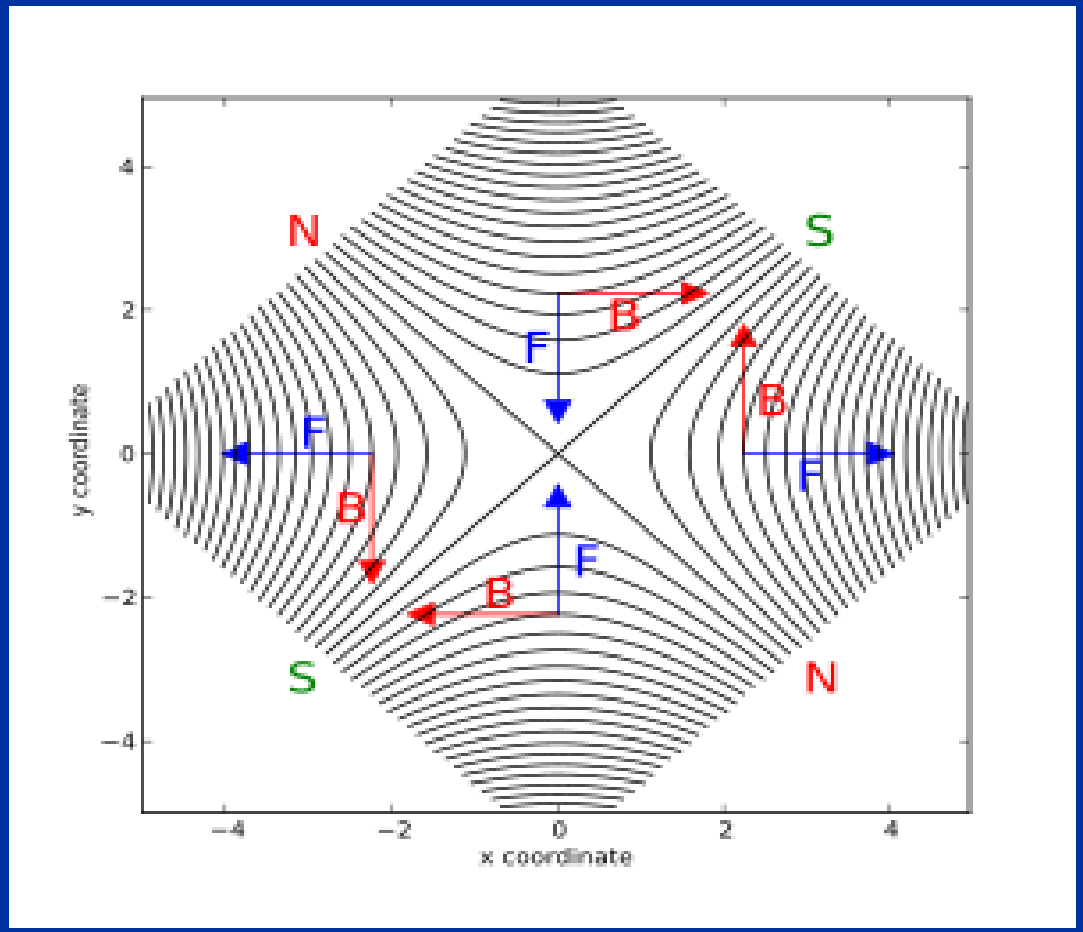
Introduction

- **Dipole**: direct the beam



$$\theta = \frac{B * l * 299,79}{p}$$

- **Quadrupole**: focus the beam



The project

For our project we used the G4 Beamline program. With this program we prepared and executed the input file.

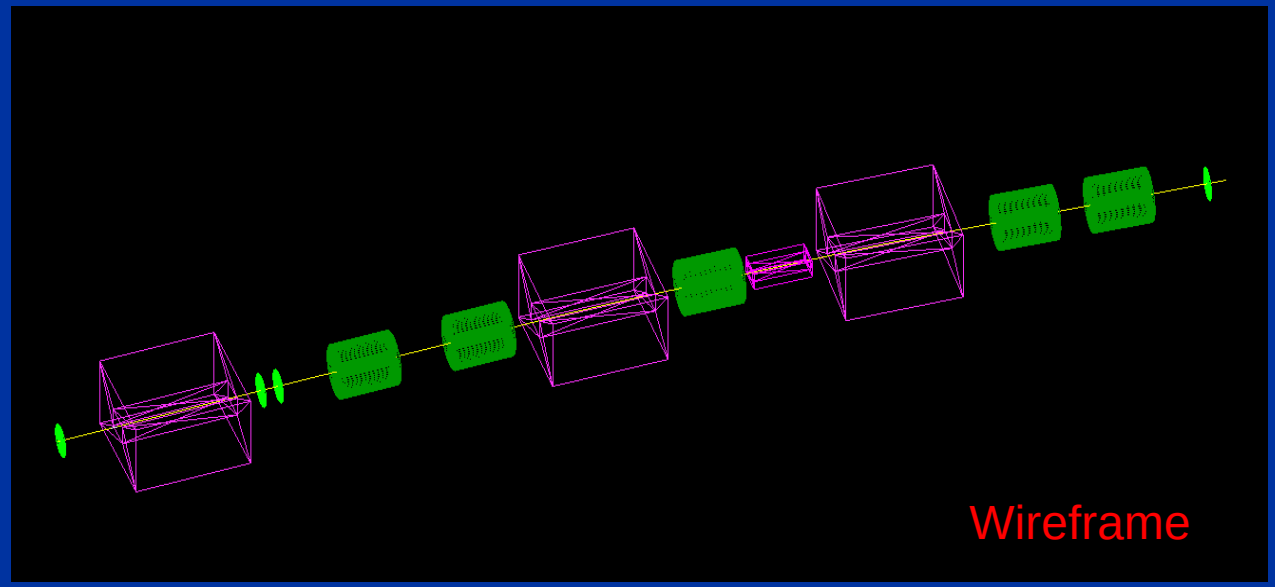
Furthermore, we used the program HistoRoot; with this we analyzed the hypothetical results we should get from our detectors. .

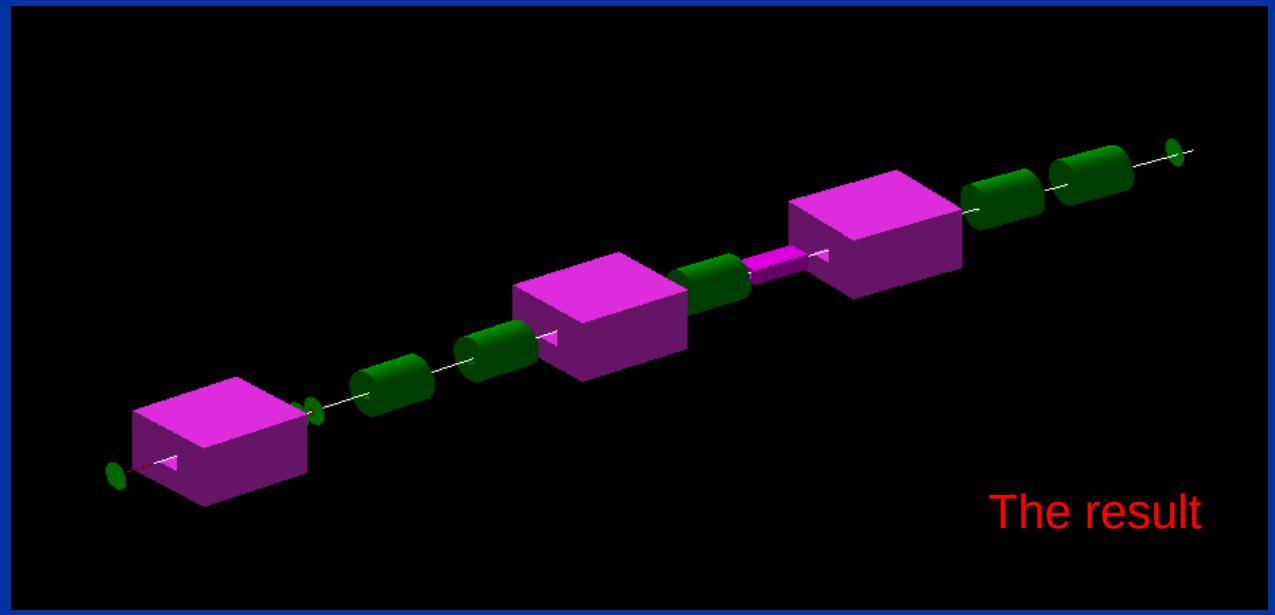
Our beam consists of :

- **4 detectors,**
- **1 Be target,**
- **1 sweeping dipole,**
- **1 Pb converter,**
- **2 dipoles**
- **5 quadrupoles**

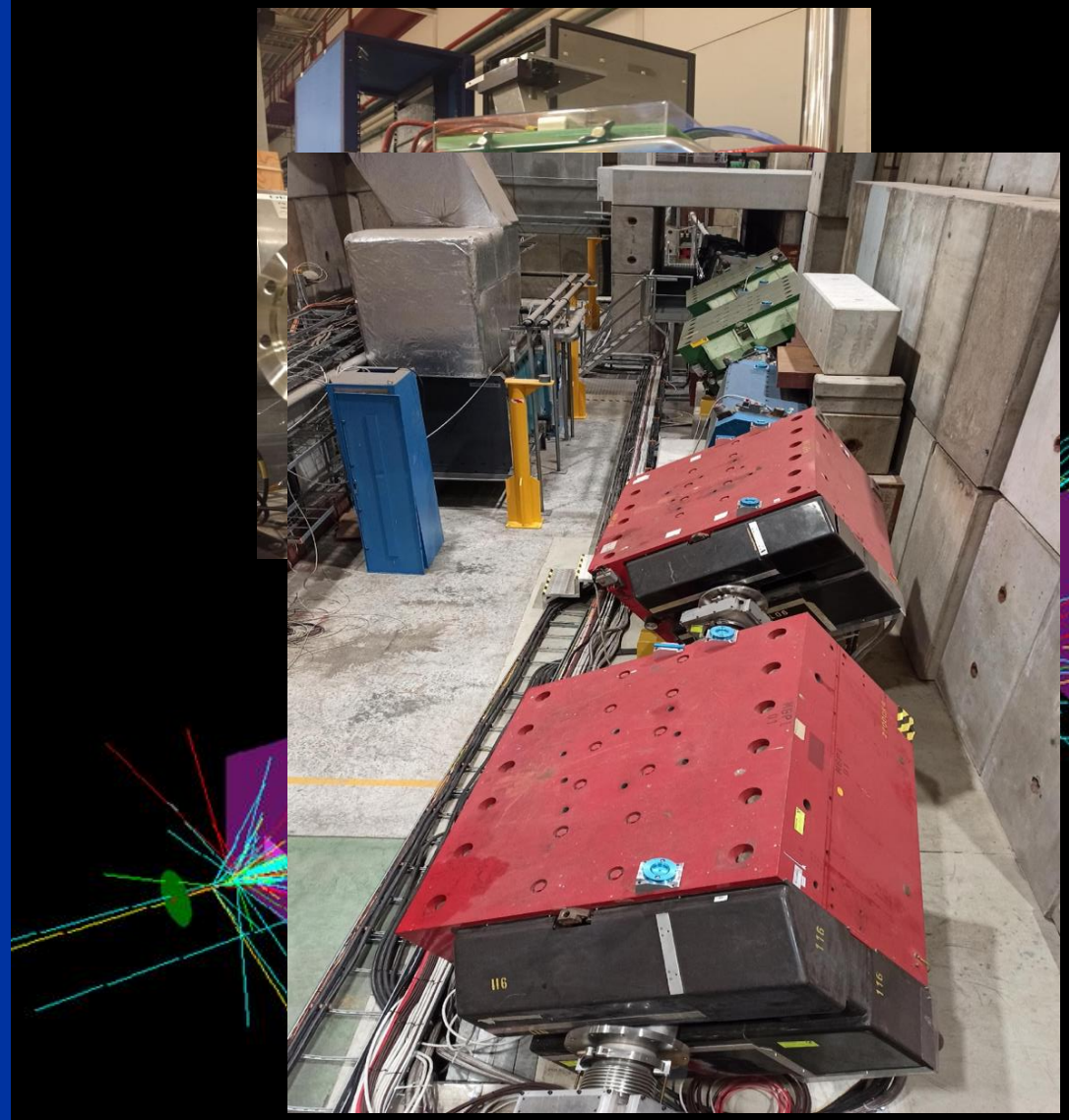
```
genericBend COL fieldWidth=250.0 fieldHeight=150.0 fieldLength=1000.0\
        ironColor=1,0,1 ironWidth=435.0 ironHeight=282.5 ironLength=1000.0 kill=1 fringe=0


tubs TargetBe outerRadius=10.0 innerRadius=0.0 length=500.0 material=Be color=1,0,0

box BPb height=100.0 width=100.0 length=3.5 material=Pb color=1,0,0

virtualdetector Det radius=250.0 length=0.1 material=Vacuum format=ascii color=0,2,0 file=START.txt
virtualdetector Det1 radius=250.0 length=0.1 material=Vacuum format=ascii color=0,2,0 file=SWEEPING.txt
virtualdetector Det2 radius=250.0 length=0.1 material=Vacuum format=ascii color=0,2,0 file=MID.txt
virtualdetector Det3 radius=250.0 length=0.1 material=Vacuum format=ascii color=0,2,0 file=END.txt


beam gaussian particle=proton meanMomentum=400000 beamZ=-350.0 \
     sigmaX=0 sigmaY=0 sigmaXp=0.000 sigmaYp=0.00 \
     firstEvent=0 lastEvent=500 sigmaP=0



## Definitions of strengths


#param -unset Q=0

param -unset Q1=10
param -unset Q2=-10
param -unset Q3=10
param -unset Q4=-10
param -unset Q5=10


#param -unset B=-1.800994029*($pMomentum/$pMomentumRef)


place Det z=-300.0 rename=START referenceParticle=1

place TargetBe z=150.0

reference particle=e- referenceMomentum=25000 beamZ=450.1

place MBP rename=B1 By=0 x=0 z=1700.0 rotation=Y0
corner z=1700.0 rotation=Y0


place Det1 z=3200.0 rename=SWEEPING referenceParticle=1

place BPb z=3450.0

place Det2 z=3500.0 rename=MID referenceParticle=1

place QPS rename=Q1 gradient=$Q1 z=5000.0

place QPS rename=Q2 gradient=$Q2 z=7000.0

place MBP rename=B2 By=-1.6 x=0 z=9000.0 rotation=Y-1.2367
corner z=9000.0 rotation=Y-2.4734

place QPS rename=Q3 gradient=$Q3 z=11000.0

place COL z=12200.0

place MBP rename=B3 By=-1.2 x=0 z=14100.0 rotation=Y-1.2367
corner z=14100.0 rotation=Y-2.4734

place QPS rename=Q4 gradient=$Q4 z=16400.0

place QPS rename=Q3 gradient=$Q5 z=18000.0

place Det3 z=19500.0 rename=FINAL referenceParticle=1

trackcuts killSecondaries=1
```

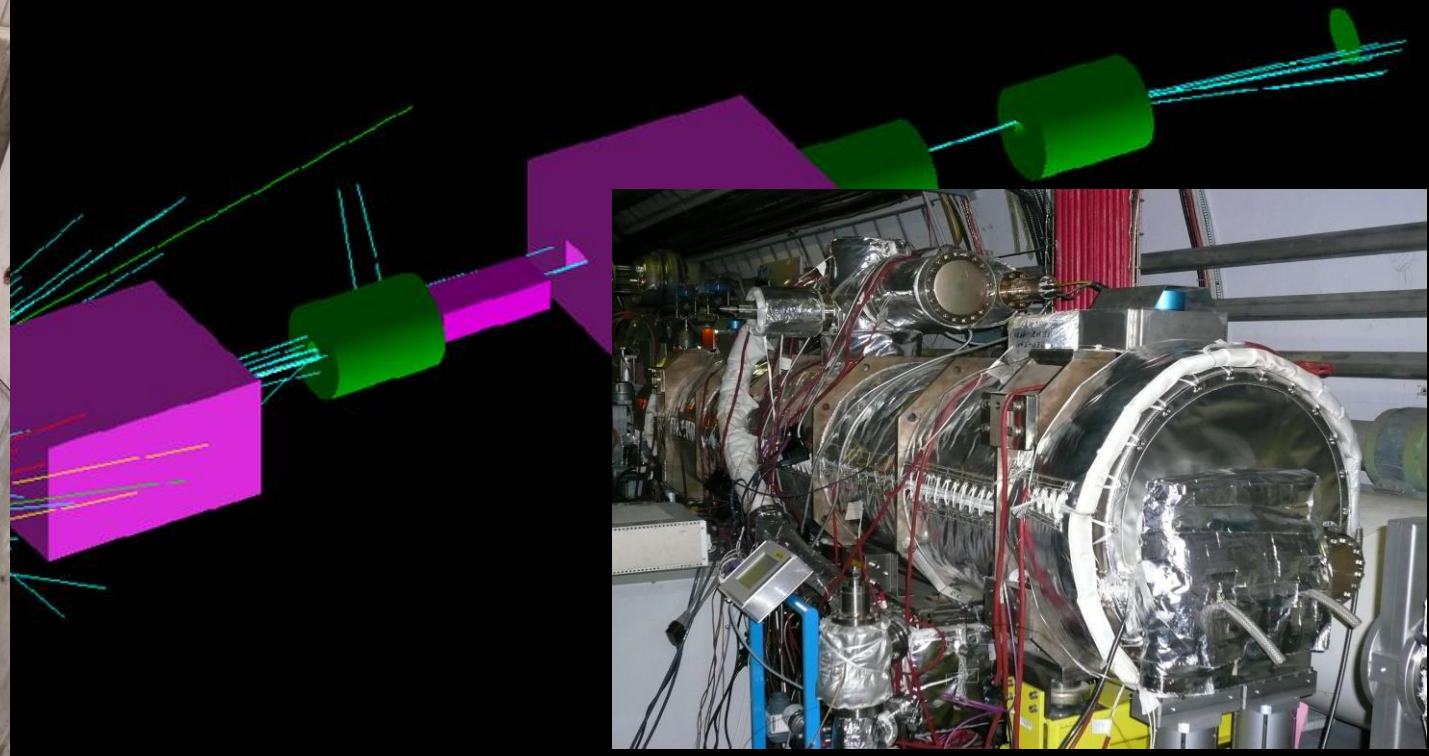
The code



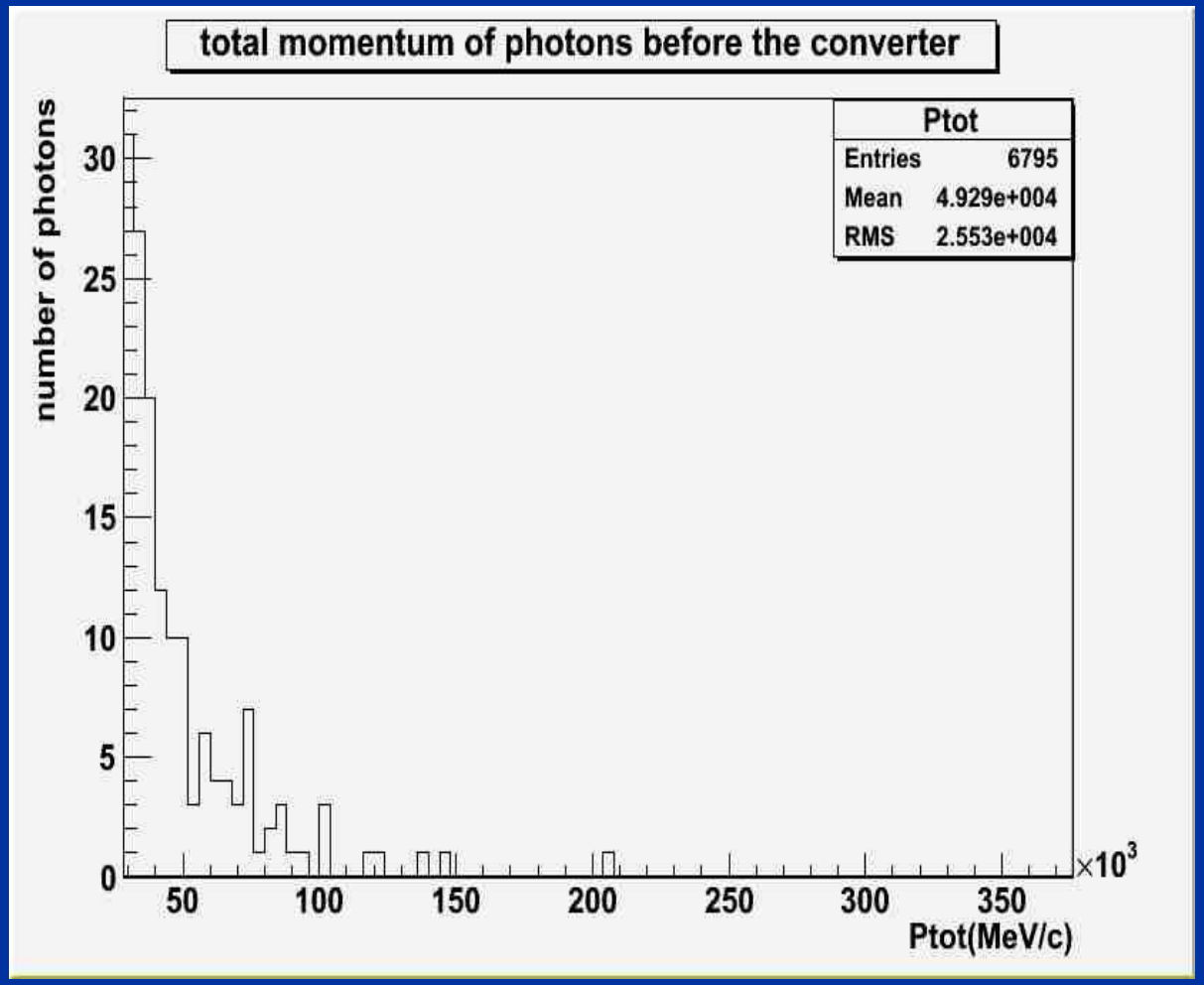


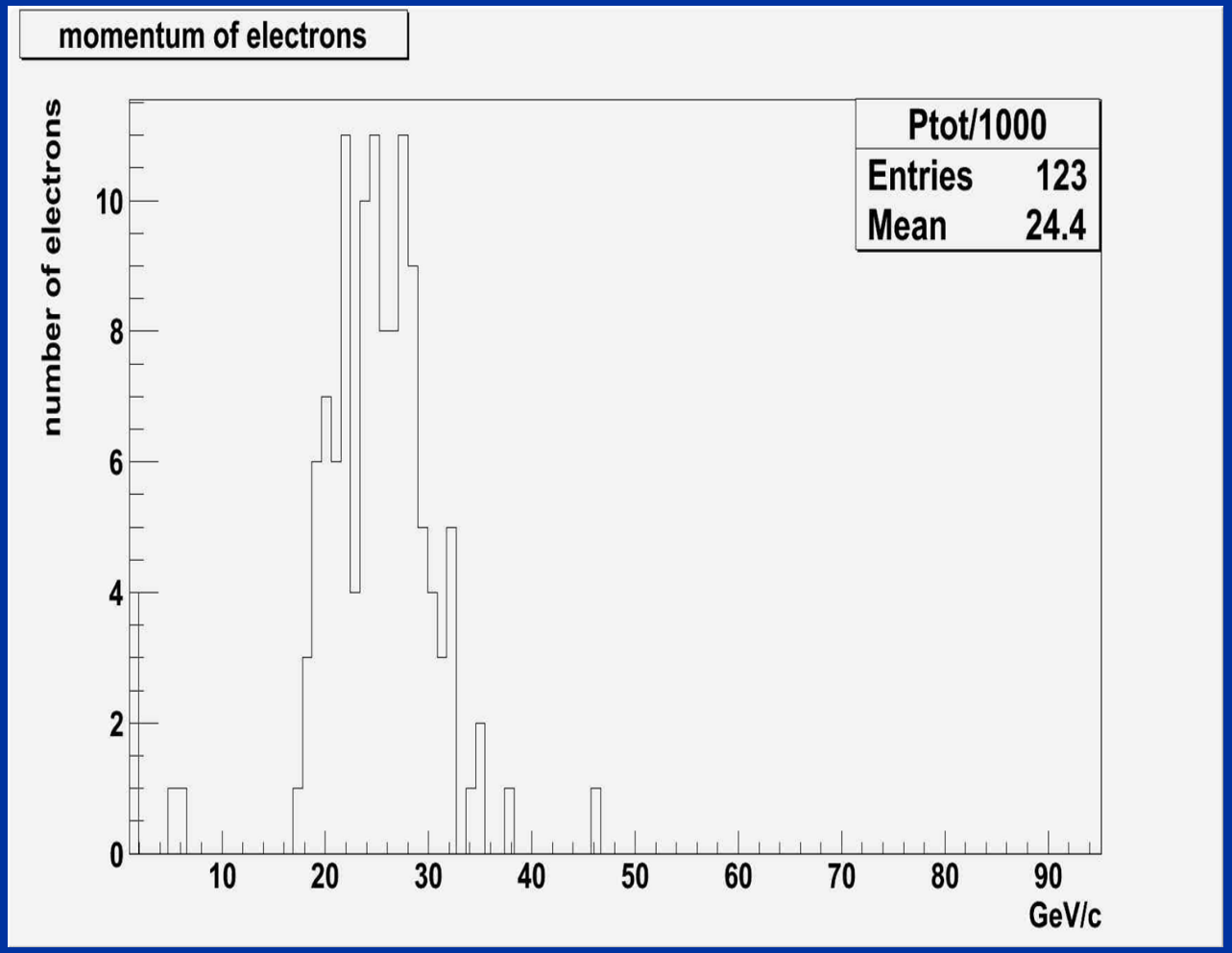
The beamline: simulation vs reality



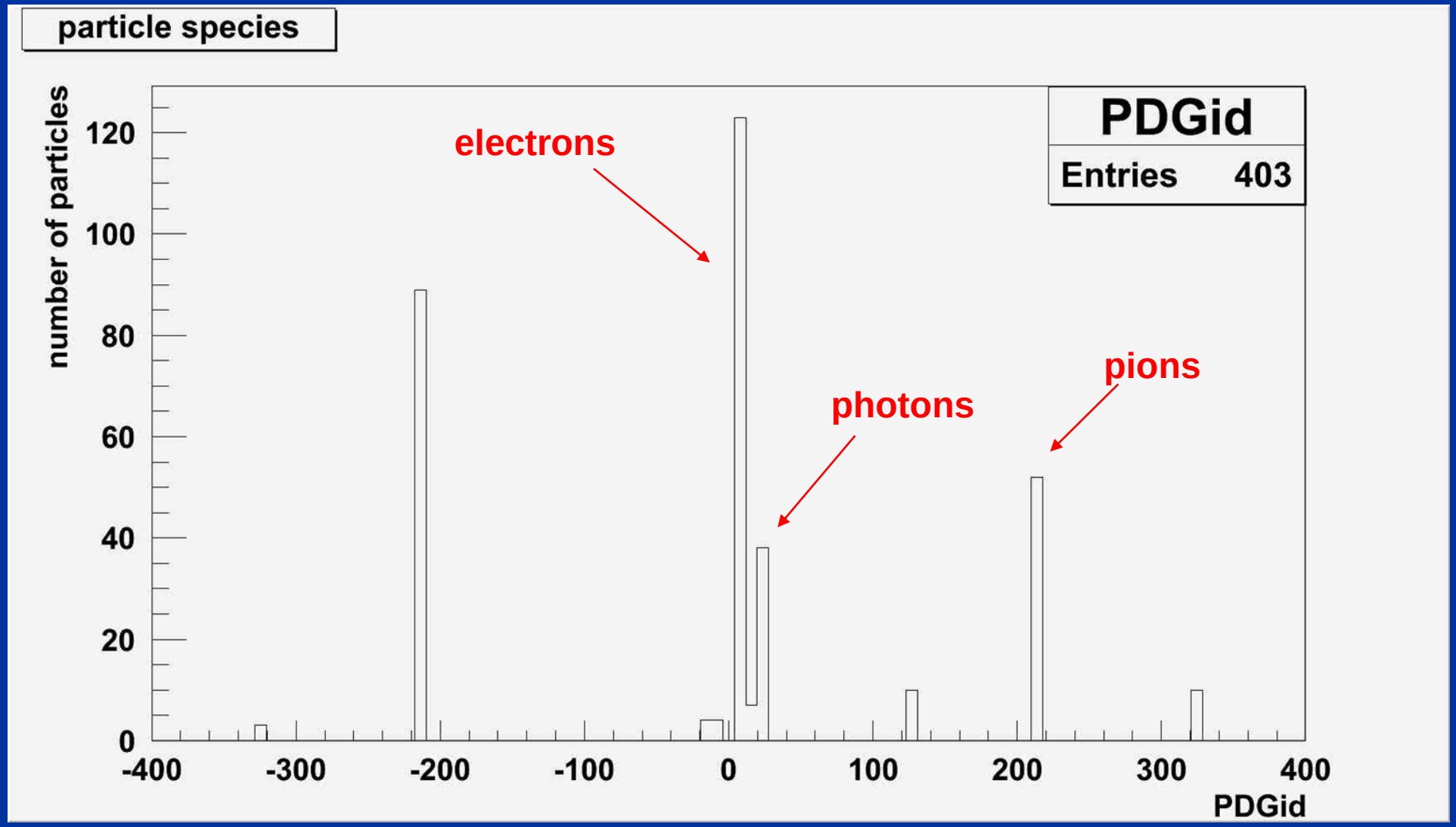


The project


total momentum of photons before the converter
Ptot
Entries 6795
Mean 4.929e+004
RMS 2.553e+004
number of photons
0
5
10
15
20
25
30
50
100
150
200
250
300
350
×10^3
Ptot(MeV/c)


momentum of electrons
Ptot/1000
Entries 123
Mean 24.4
number of electrons
0
2
4
6
8
10
10
20
30
40
50
60
70
80
90
GeV/c

The project


particle species
PDGid
Entries 403
number of particles
120
100
80
60
40
20
0
-400
-300
-200
-100
0
100
200
300
400
PDGid
electrons
photons
pions

North Area

Thank you for your attention

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