Final Exam: Parameterized Simulation

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Corso di Programmazione++

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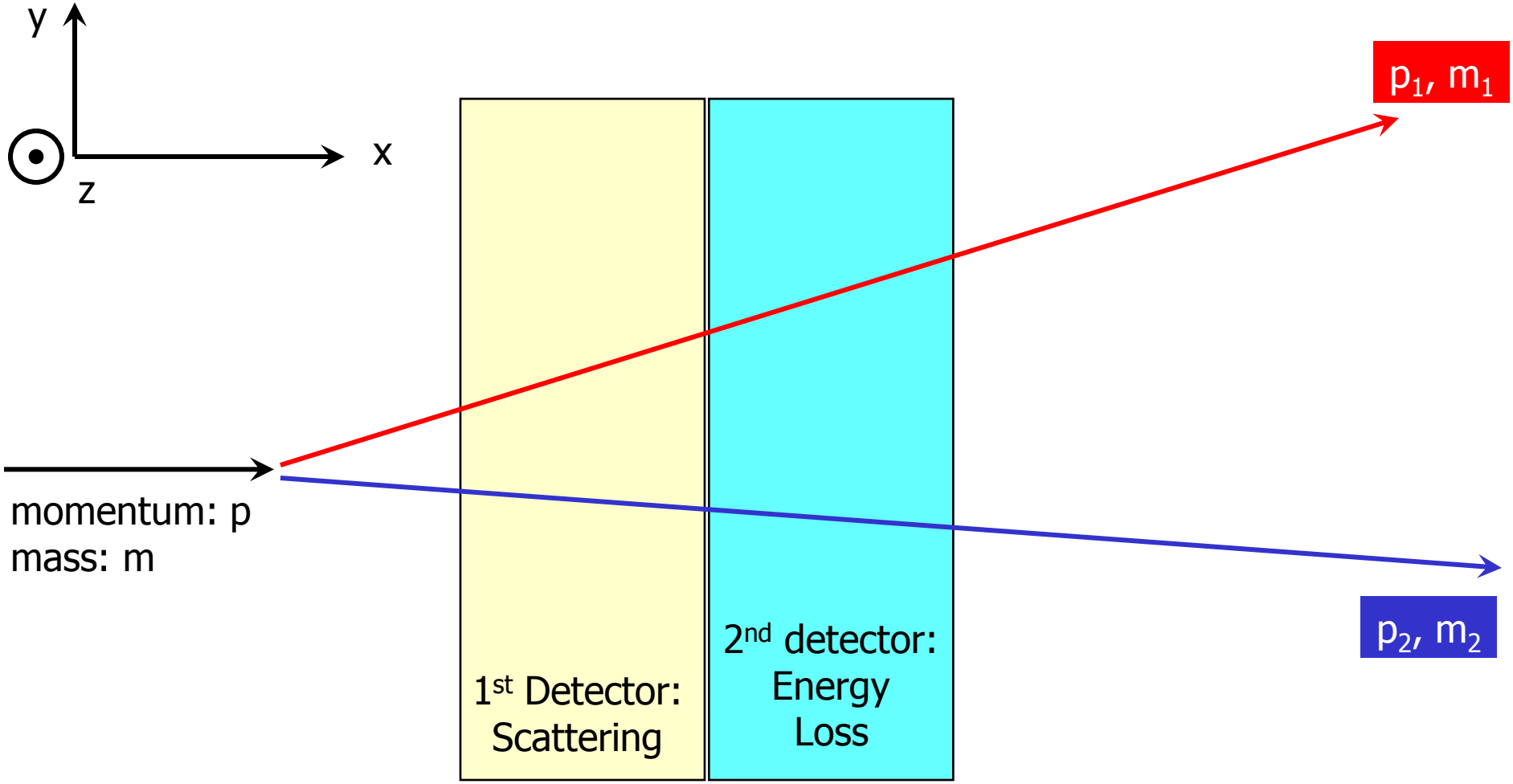
Experimental Setup

- Particle of mass m=2 GeV/c^2 and momentum p=5 GeV/c decaying into two particles of different mass m_1=0.5 GeV/c^2 and m_2=0.150 GeV/c^2 in laboratory

- Particles go through two detectors
  - Passage through each detector modifies the incoming 4-momentum of each particle
  - 1st detector causes only change in direction of particles (scattering)
  - 2nd detector reduces only the energy of the particle

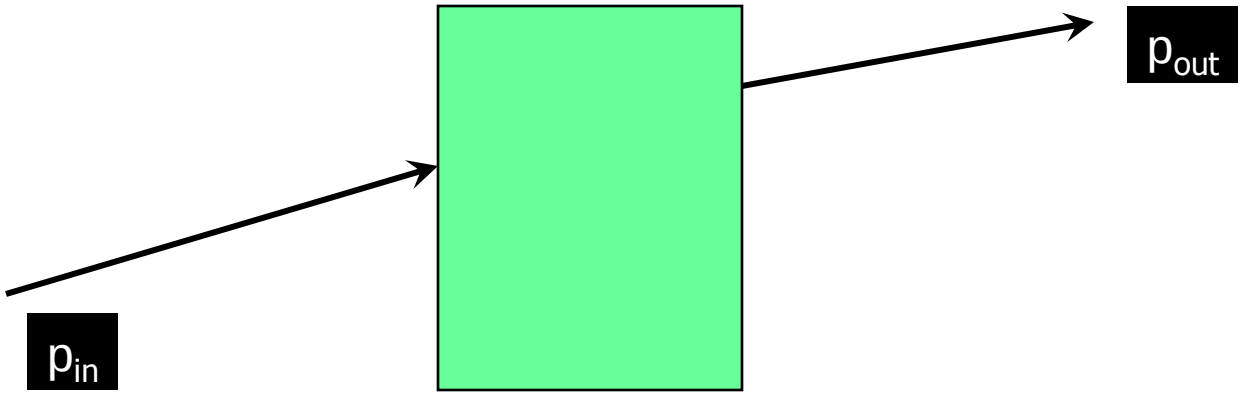
- Particle decays before reaching first detector

Passage of Particle Through Matter



Modeling of Detector Response

- Each detector causes variation in the 4-momentum of incoming particles
  - particle comes into the detector with 4-momentum $\mathbf{p}_{in}$
  - particle leaves detector with 4-momentum $\mathbf{p}_{out}$
- Use Gaussian to model effect of detector
  - direction and/or direction (angles) of particles smeared
  - parameters of smearing (width of Gaussian) are properties of each detector
  - parameters can be configured by user



What You Have to Do?

- Generate sample of 1000 or more decaying particle
  - Decays occurs before first detector
  - Use application from midterm to generate 4-vectors of decay products
- Use polymorphism to define generic and specialized detectors
- For each particle show
  - variation of momentum and energy before and after passing each detector
    - for example E_{out}-E_{in}, p_{out}-p_{in}
  - variation of energy and momentum after passing through all detectors
- Show invariant mass computed from 4-momenta of decay products after each detector
  - $p_{tot} = p_1 + p_2$
  - invariant mass = sqrt($E^2_{tot} - p^2_{tot}$)

What Else You Can Do

- Goal of exercise is to understand impact of experimental apparatus on measurements
  - Compare measured invariant mass of decaying particle after each detector and compare to real mass m of the particle

- You can vary parameters of each detector and observe impact of different amount of scattering and energy loss on distribution of invariant mass

- Optional
  - Allow original particle to decay within the detectors
  - Implement lifetime of decaying particle
    - Use exponential model to determine where the particle decays