SPS Crystal simulation in FLUKA

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Introduction

Role of the simulation :

Assess the fluence of particles in the scintillator and GEM when a crystal is at 6σ in amorphous position

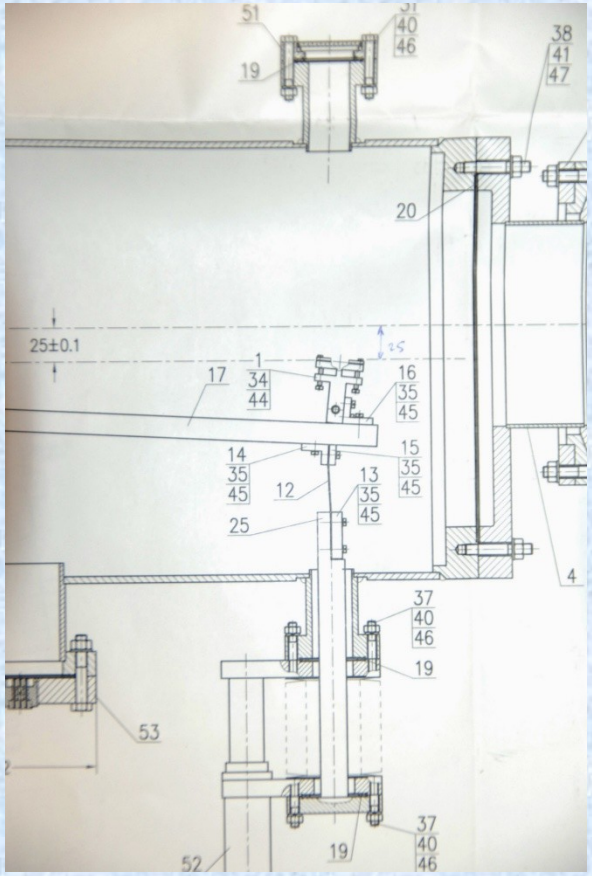
Beam characteristics

- 120 GeV proton beam
- Gaussian distribution in x and y (σ = 0.2mm)

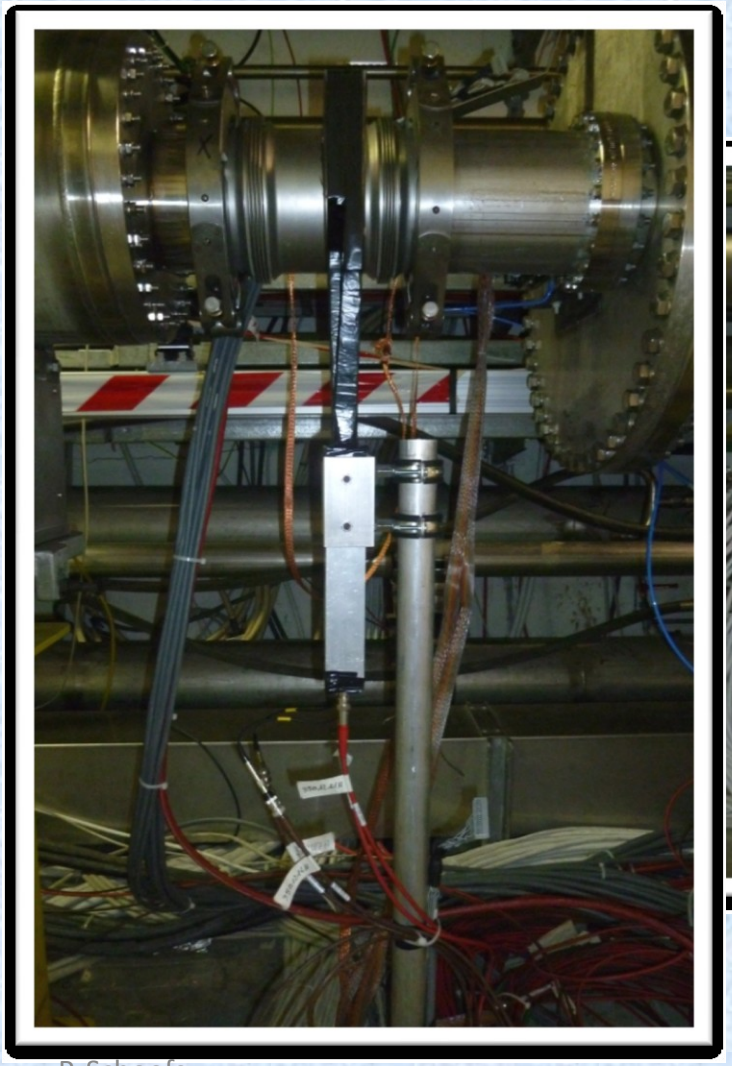
Geometry

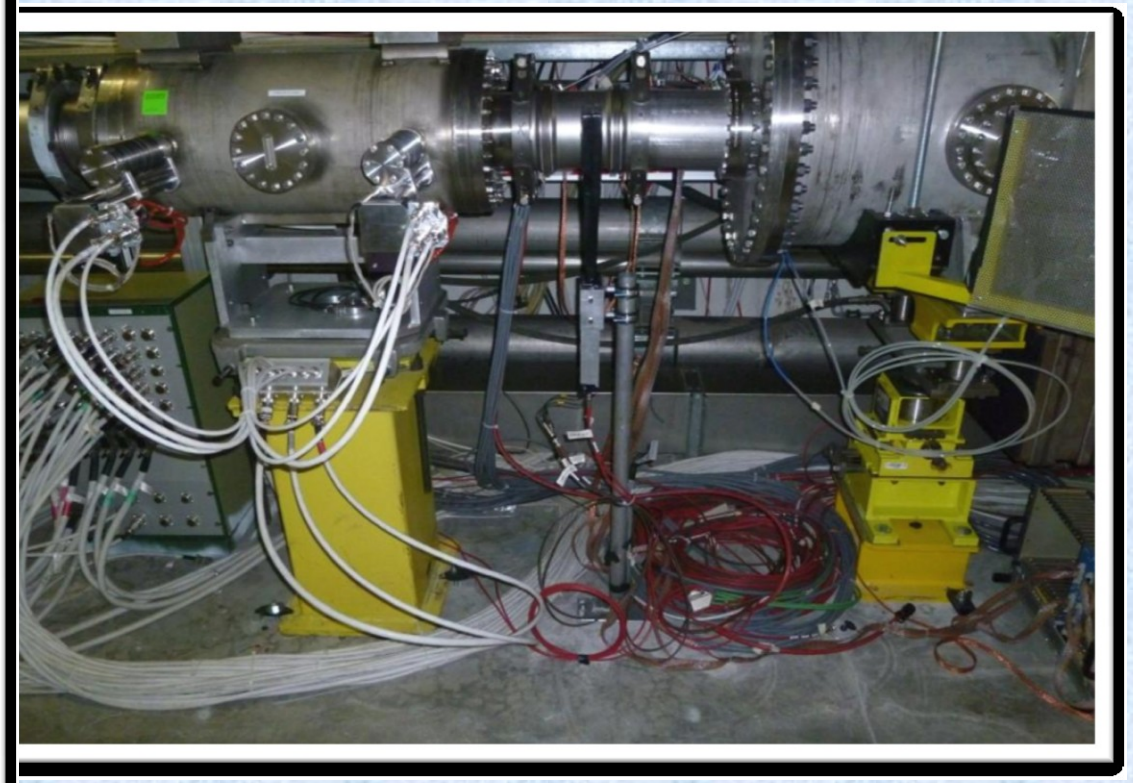
Modelisation of the IHEP tank, the beam pipe, the crystal and both detectors

- Beam pipe (Steel)
  - Inner radius : 78 mm
  - Outer radius : 79.5 mm
- IHEP Tank (Steel)
  - Inner radius : 150 mm
  - Outer radius : 155 mm
  - Offset : 25 mm
- Crystal (Silicon)
  - 2x50x20 mm^3 in the upstream position (80 cm from scintillator)



Geometry

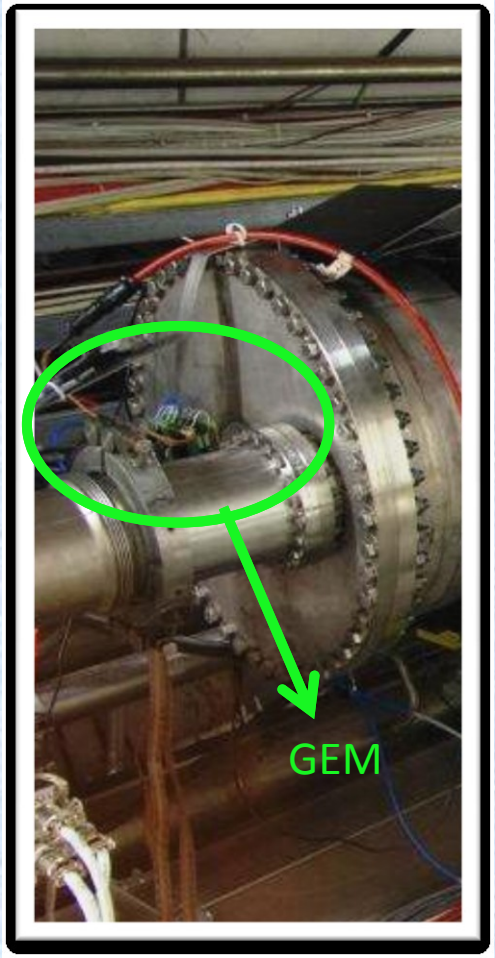




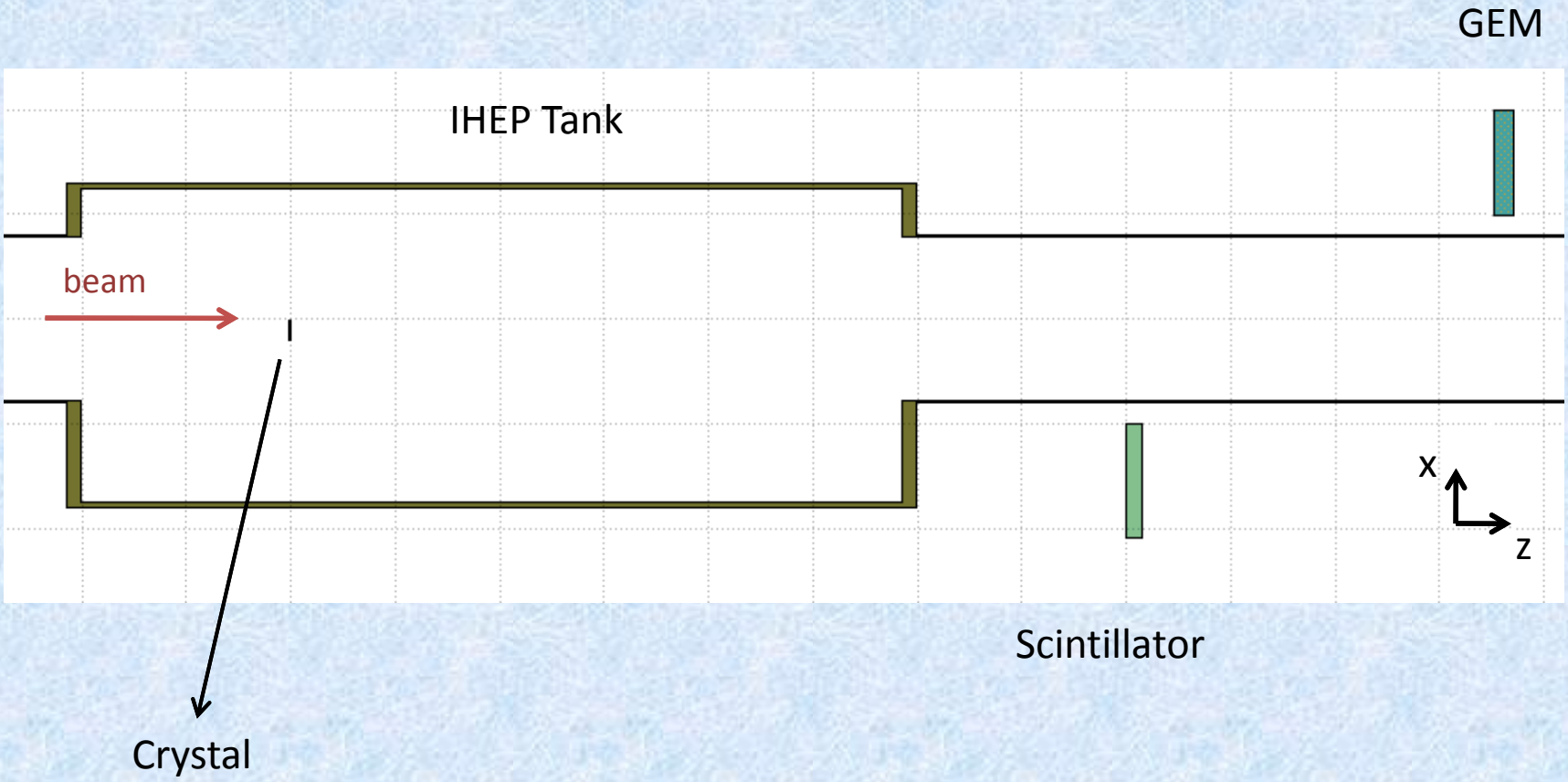
Geometry

2 Detectors :

- Scintillator
  - Downstream the IHEP tank
  - 15x110x110 mm³
- GEM
  - On the front face of CERN tank
  - 20x100x100 mm³



Overall view



Integrated fluence

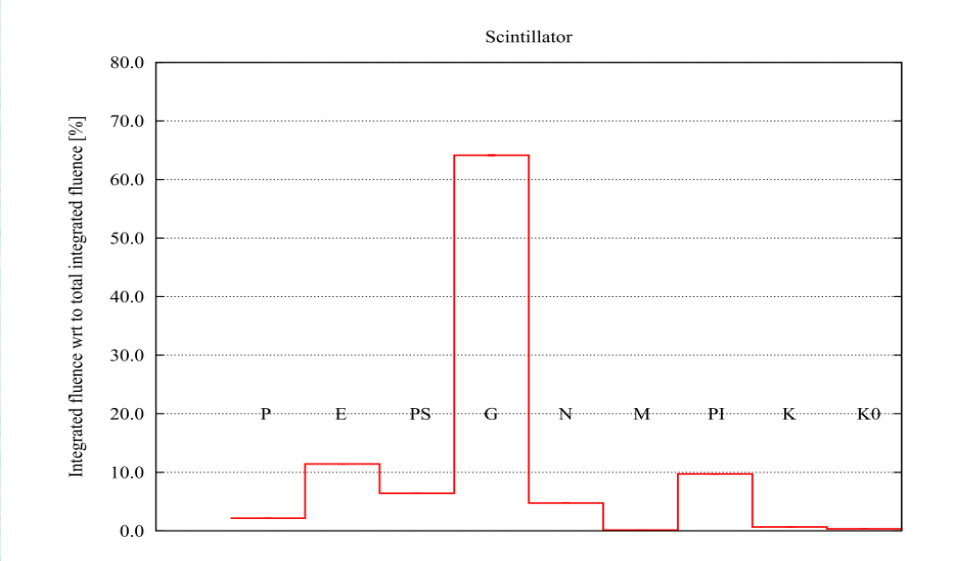
Relative importance of different particles :

– Main contribution : photons

– Substantial contribution: electrons, positrons, neutrons, pions and protons

– ≈ 0 contribution : antineutrons, antiprotons, kaons,...

– **NB** : Error bars not visible here (error ≈ 0.15 % in average)



Fraction of Fluence due to Hadrons :
SCI : 17.86 %
GEM : 17.03 %

Integrated fluence

Total integrated fluence for all particles :

Scintillator	**GEM**
1.4366812 10^-2cm/primary	1.4453325 10^-2 cm/primary
$\Rightarrow$ 7.915599 10^-5 ./cm²/primary	$\Rightarrow$ 7.226663 10^-5 ./cm²/primary
$\Rightarrow$ (Or 0.95779 10^-2./primary)	$\Rightarrow$ (Or 0.72666 10^-2./primary)

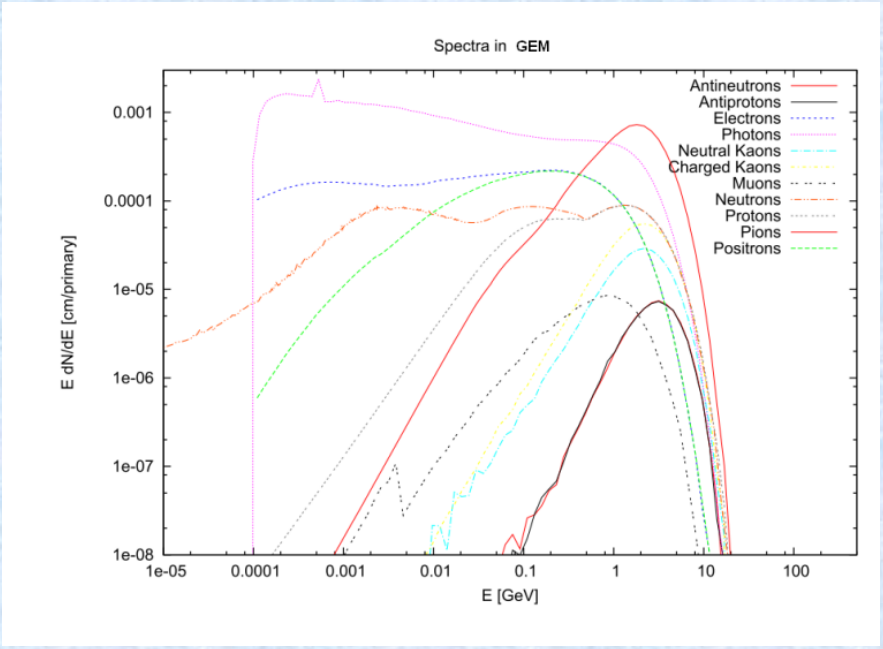
(Here : Per primary incoming on the crystal)

Total fluence per interacting proton : we multiply by 45.17/0.2

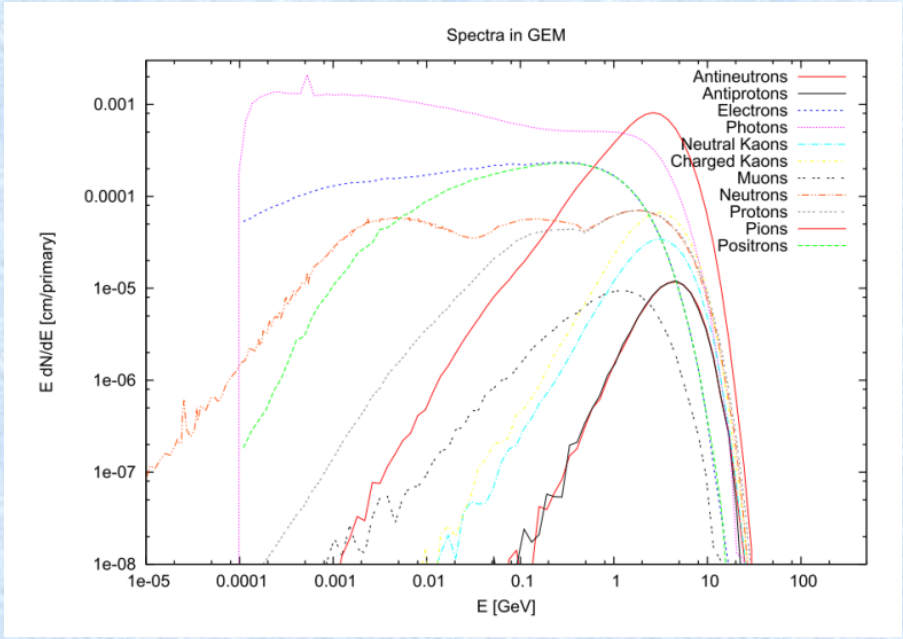
1.787738 10^-2./cm²/interacting p+	**1.632142 10^-2./cm²/interacting p+**

Spectra

SCI



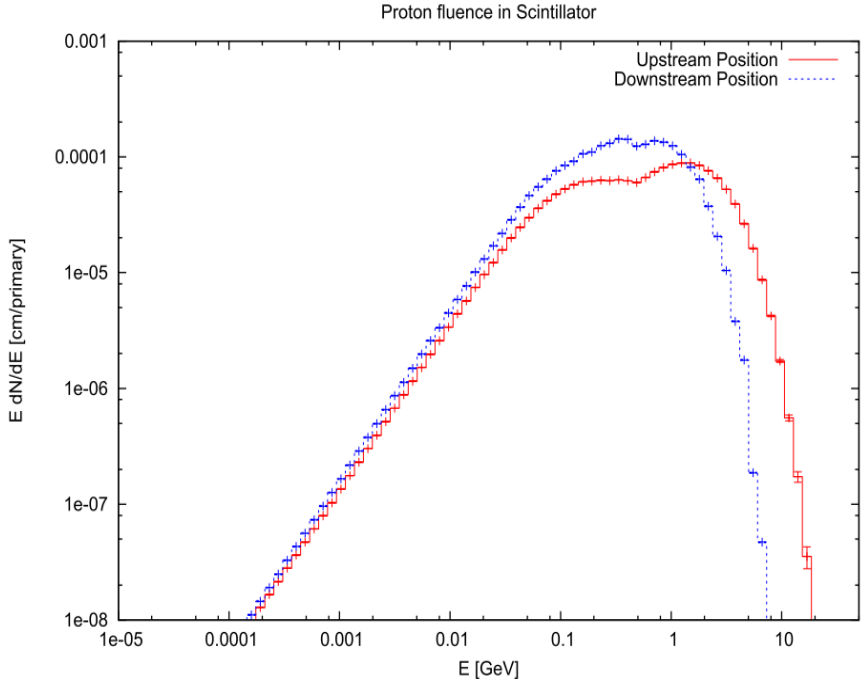
GEM



- Higher energies present in GEM spectra
- Total fluence is comparable but GEM volume is slightly larger
- We see again that photons are the majority of particles entering the detectors

Spectra

Comparison btw 2 Crystal positions

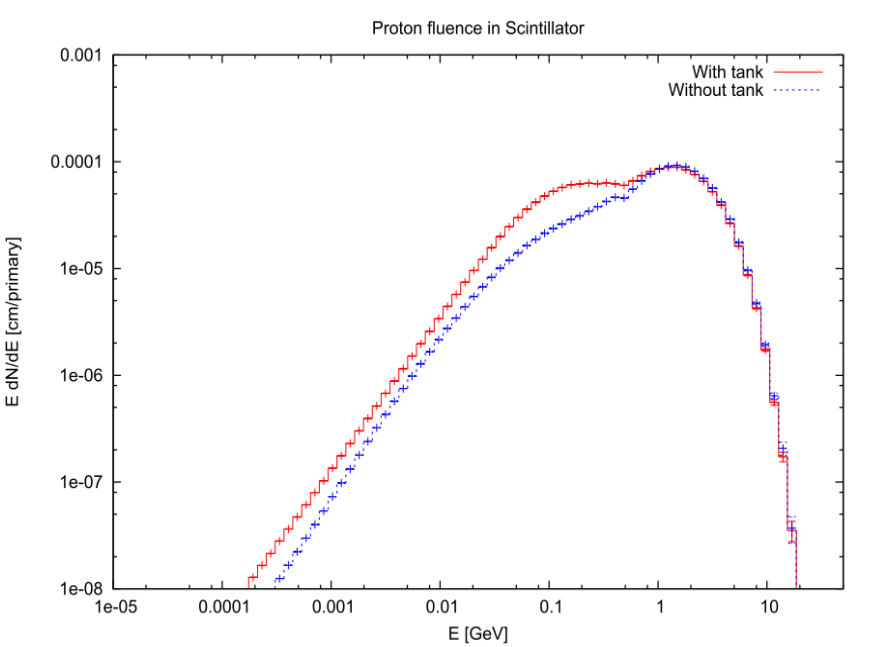


Importance of the angle :

- Higher energies when the angle is smaller -> when the detector is far from the crystal
- Higher total fluence when distance is smaller (solid angle is then larger)

Spectra

Comparison tank-no tank



Importance of the geometry :

- Role of tank is not negligible.
- In general : results are very dependant of the surroundings of the beam pipe.
  - In order to reach more precise results, a deep knowledge of the geometry is required.

Summary

Total fluence per interacting proton in the scintillator (per unit surface) :

- **1.787738 10^-2**./cm²/primary

First estimation of Hadron fluence on a 10cmx10cm detector by Yuri Ivanov using Sullivan formula :

- **0.244** ./primary

Our result for Hadrons :

- 17.86 % x 1.787738 = **0.31929** ./primary

But :

- These results are one-pass only
- Details of the geometry are not described here
- Fluence study does not require detectors details , which is not the case for other measurements e.g. energy deposition