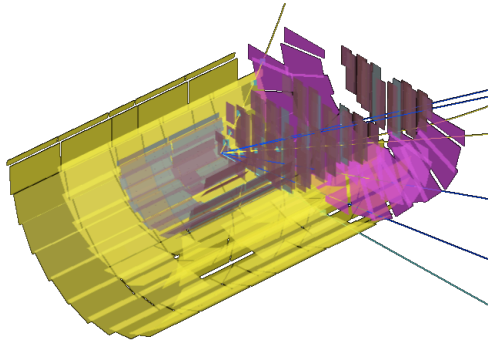
Monte Carlo performance study for the PANDA MVD



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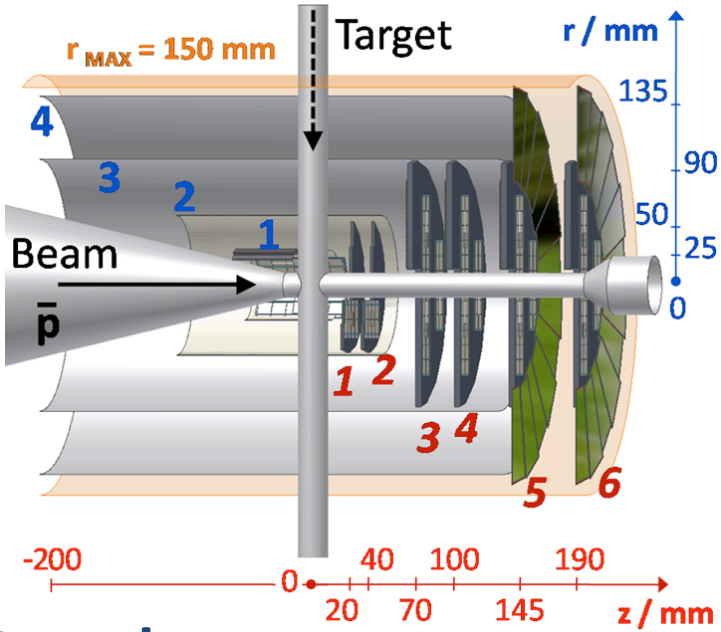
The Micro Vertex Detector

The MVD detector components:

- 2 layers of silicon **pixels** } Barrel
- 2 layers of silicon **strips** }
- 6 disks equipped with **pixels** } Fwd
- 2 wheels of **strips** }

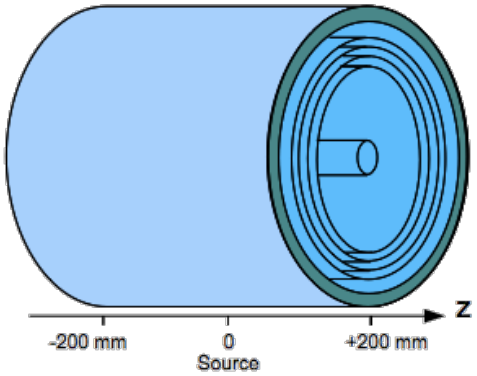


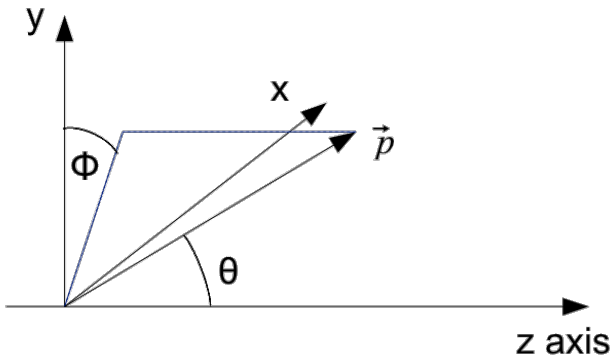
MVD Requirements and Goals

- High geometrical coverage
- Low material budget
- Handling of high rates (about $2*10^7$ annihilations/s)
- **Vertexing for D, K^0_S , ($c*\tau$ = 123µm for D_0)**
- Good momentum resolution
- PID

For information about PANDA: **M. Fritsch HK 13.2**
about the MVD: **T. Wuerschig HK 21.1**

Simplified MVD-Barrel Implementation





- Particles: π^+, μ^-, p, e^-
- Scans on momenta: 50 MeV/c → 3.5 GeV/c
- Simulations with different θ values: 90°, 60° and 45°
- Different material budget setups:

"Only Air"

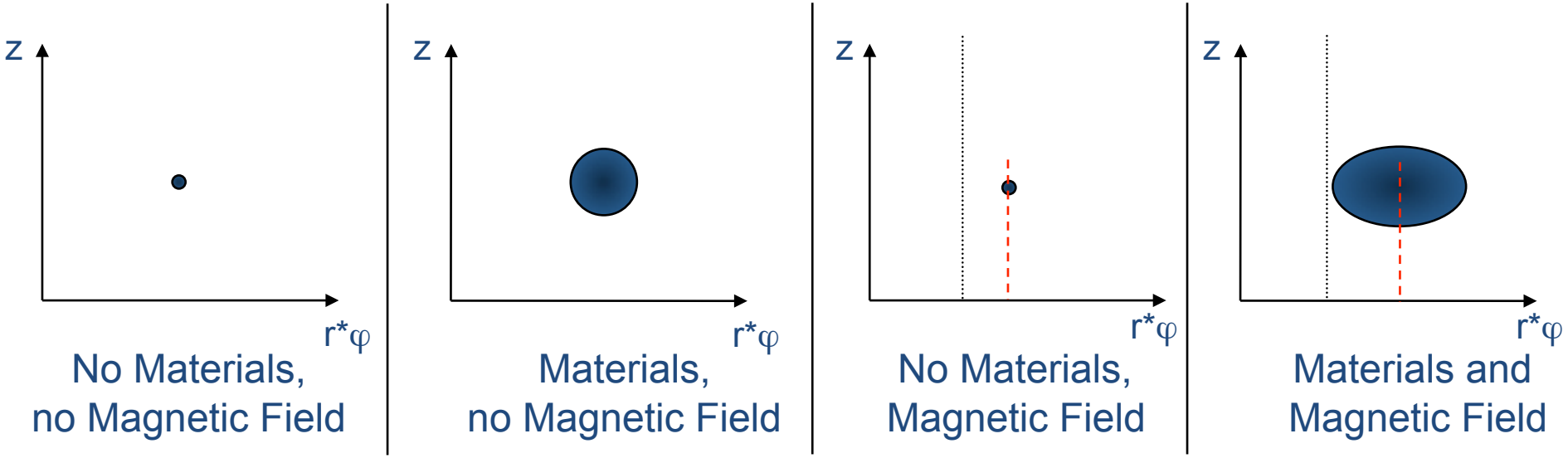
MVD volume filled with air.

One silicon cylindrical detector placed on the outer surface of the volume (r=150 mm)

"Full Material"

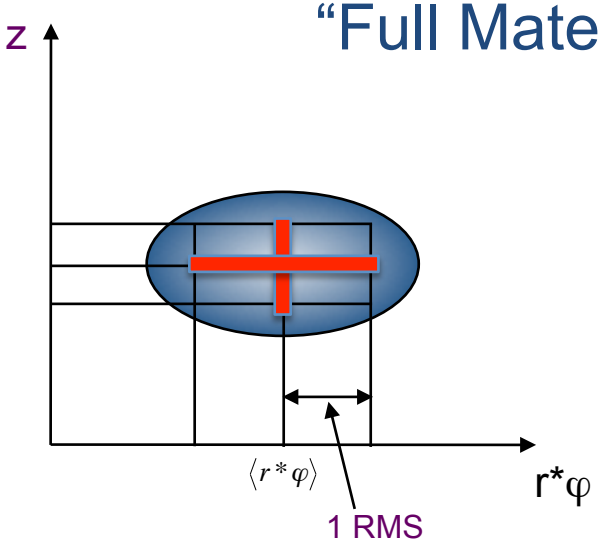
Sensor (Sensors + FFE)
Cooling (H_2O + Pipes)
Cables
Glue

Simplified MVD-Barrel Analysis



"Only air" setup → Ideal reference

"Full Material" → Worst possible scenario

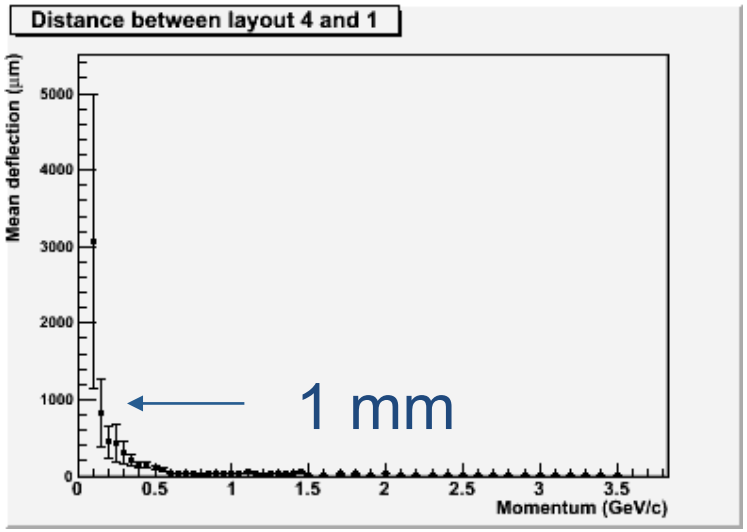


Mean value and RMS of the distributions from both setups:

- Distance between the centers of gravity → Info on energy loss
- RMS → Info about multiple scatterings

Simplified MVD-Barrel Results

Momentum Scans with π^+



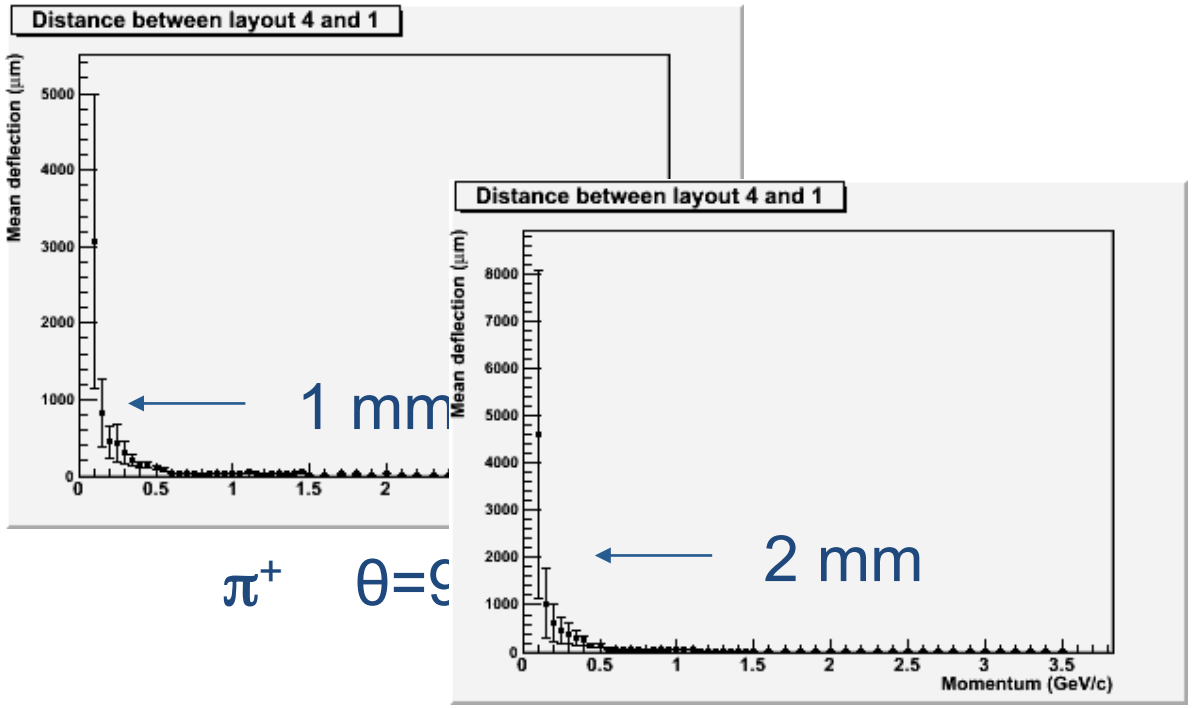
π^+ θ=90°

Error bars show the “radius” of the hits distribution with full material setup.

The effect of multiple scatterings is negligible above 500 MeV/c. Particles with momentum below 200 MeV/c are significantly affected.

Simplified MVD-Barrel Results

Momentum Scans with π^+



π^+ θ=9

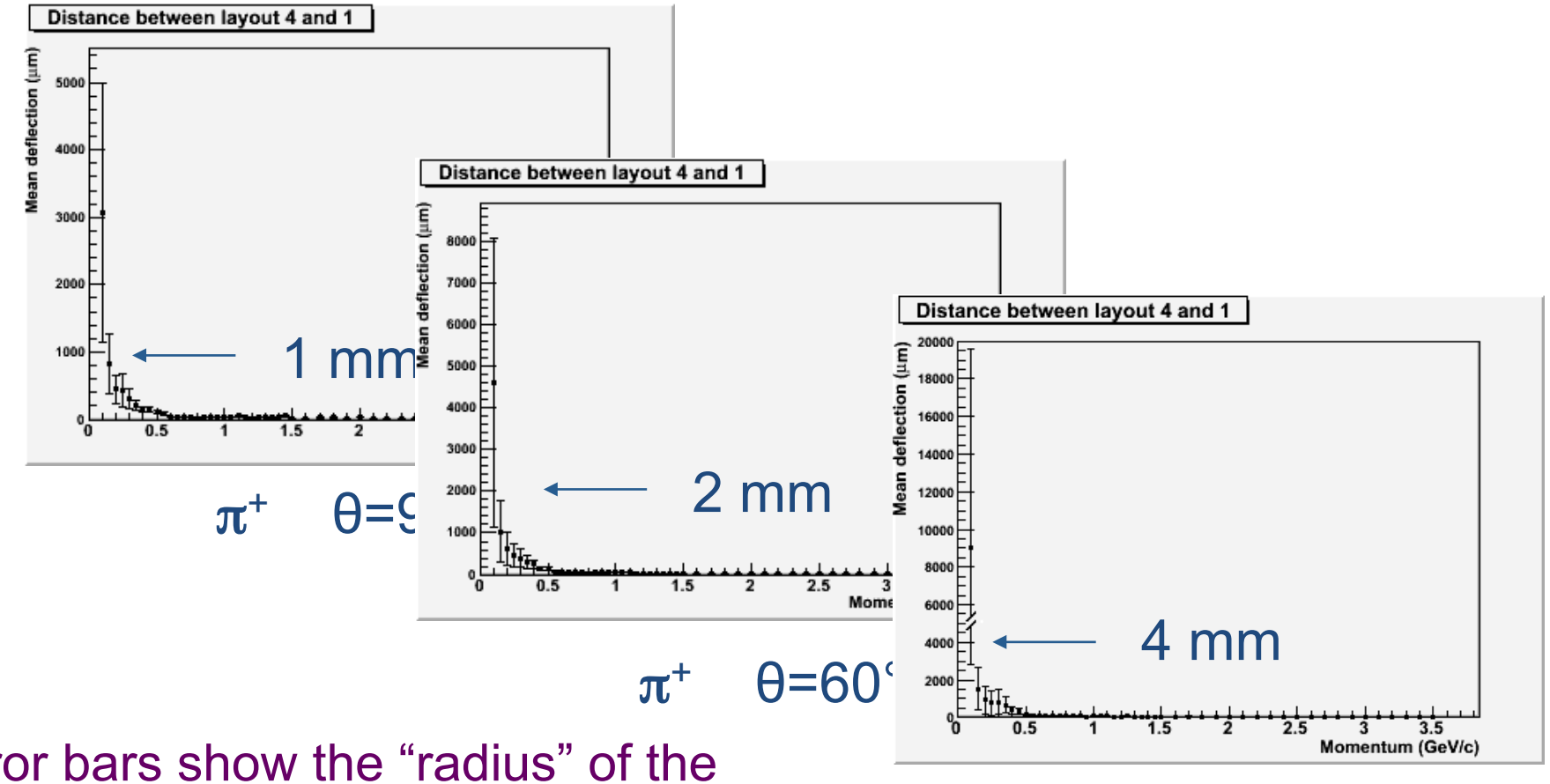
π^+ θ=60°

Error bars show the “radius” of the hits distribution with full material setup.

The effect of multiple scatterings is negligible above 500 MeV/c. Particles with momentum below 200 MeV/c are significantly affected.

Simplified MVD-Barrel Results

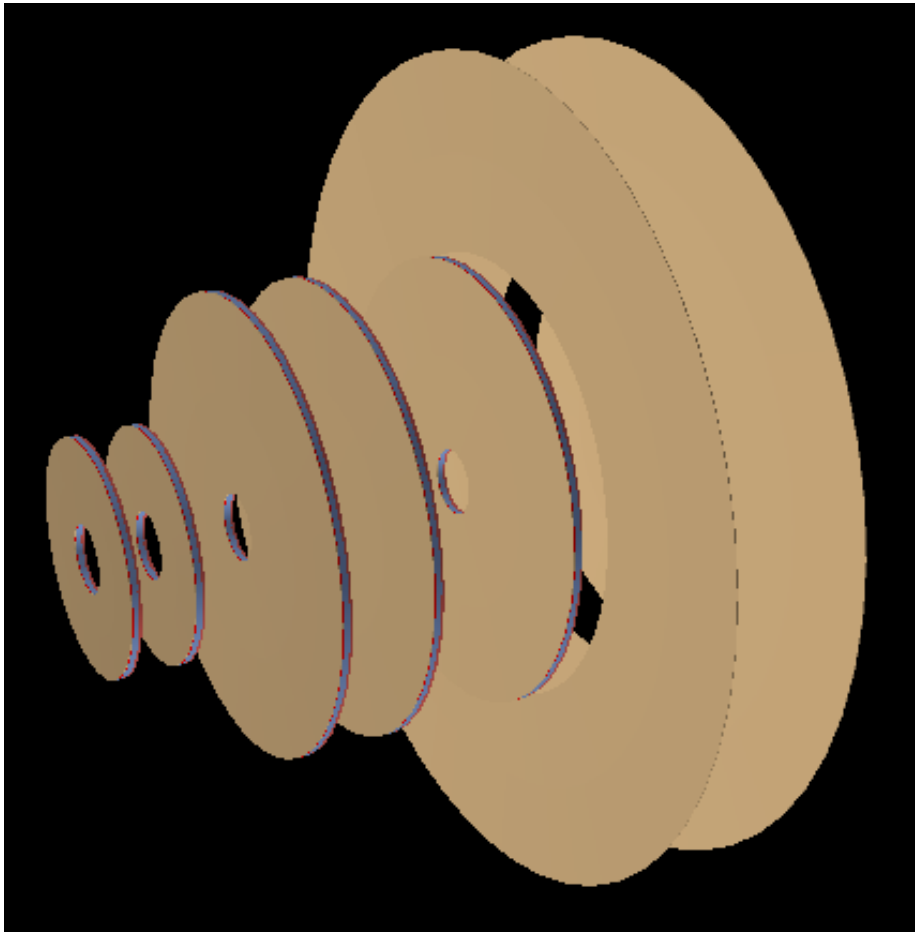
Momentum Scans with π^+



Error bars show the "radius" of the hits distribution with full material setup.

The effect of multiple scatterings is negligible above 500 MeV/c. Particles with momentum below 200 MeV/c are significantly affected.

Simplified MVD-Forward Implementation



Material Budget

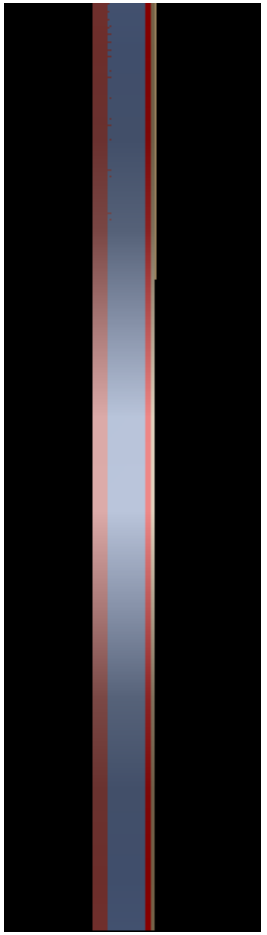
Silicon: Sensor + FEE
Water: Cooling
Carbon: Support

PIXELS

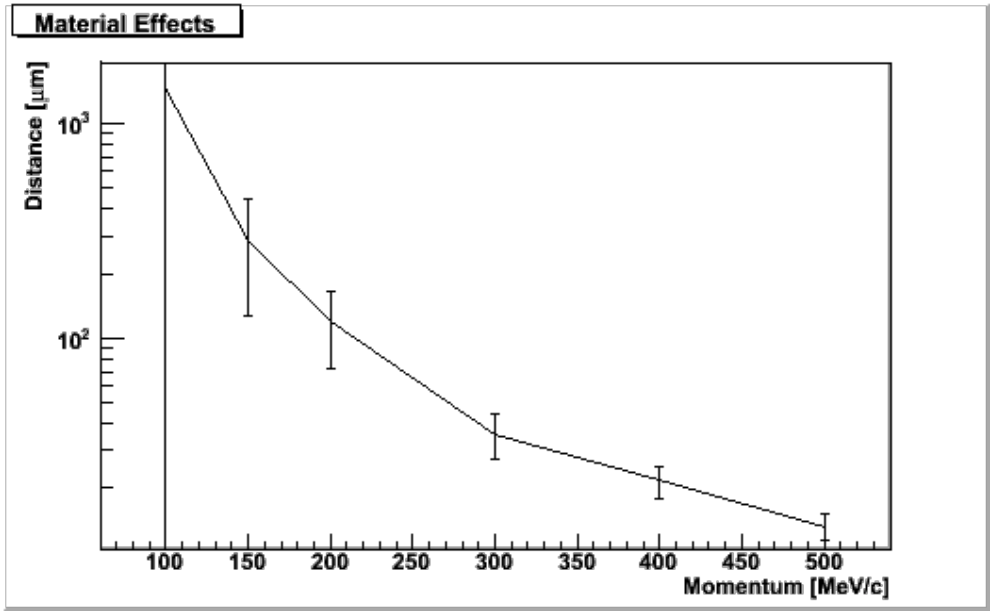
Sensor	200 μm
F.E.E.	300 μm
Water	2 mm
Carbon	1 mm

STRIPS

Sensor	200 μm



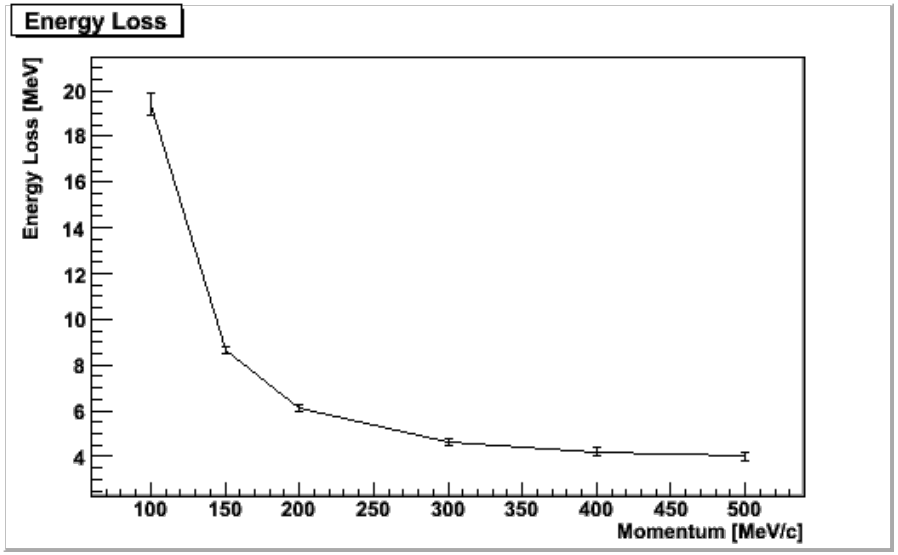
Simplified MVD-Forward Results



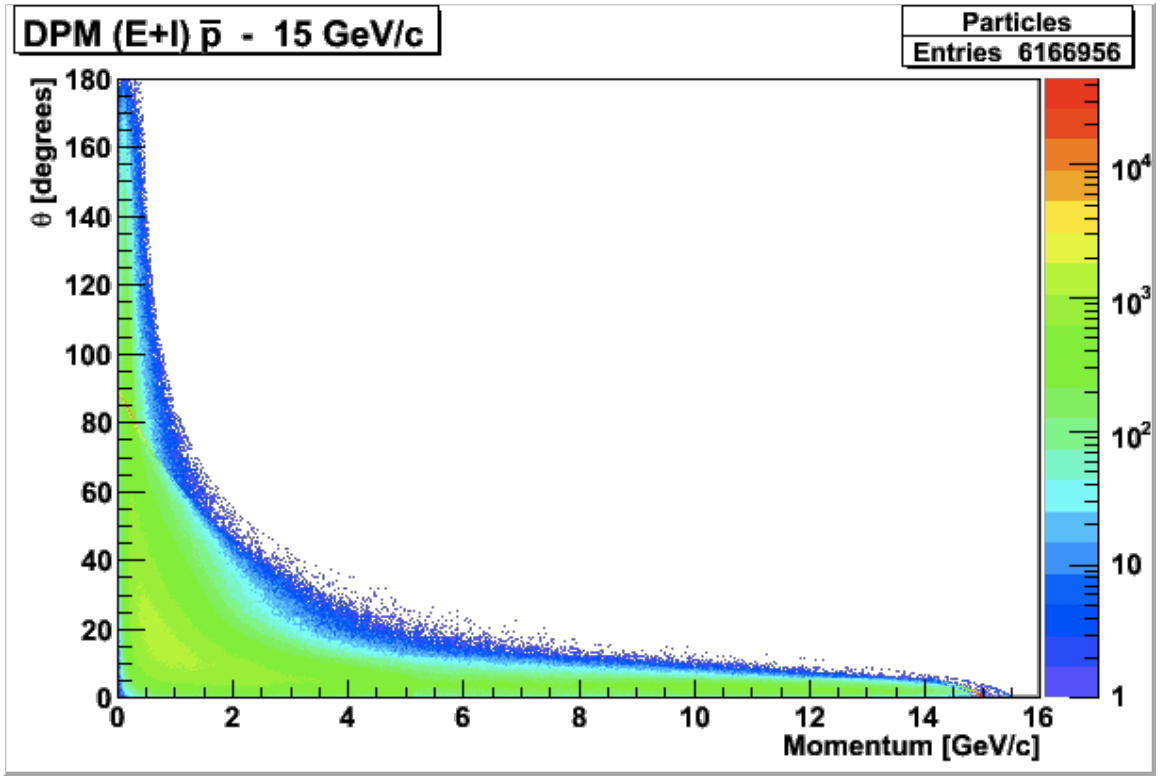
π+ shot with ϑ = 30°
from the Interaction Point

Scattering effects become important at momenta below 200 MeV/c

Energy loss information is important for the momentum measurements in the forward arm



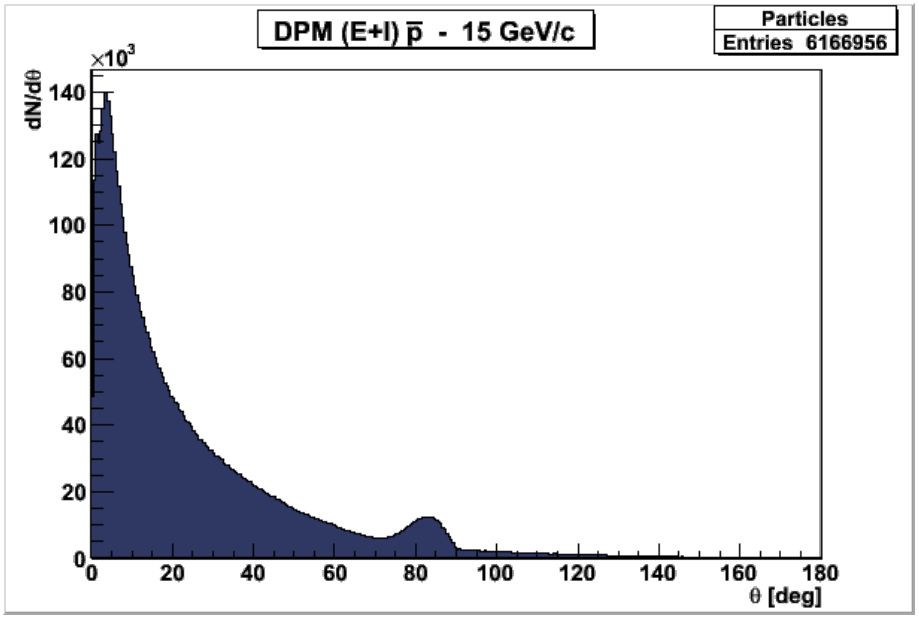
Parameters from the DPM model



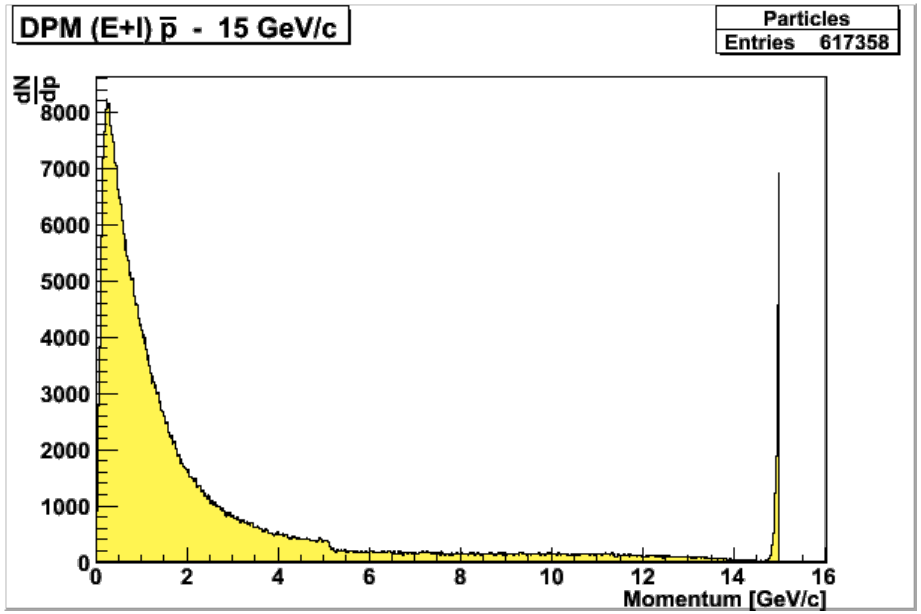
Spectrum of DPM events with elastic and inelastic interactions of antiprotons at 15 GeV/c

Parameters from the DPM model

The angular distribution is not isotropic, a forward and a 90° peak are present

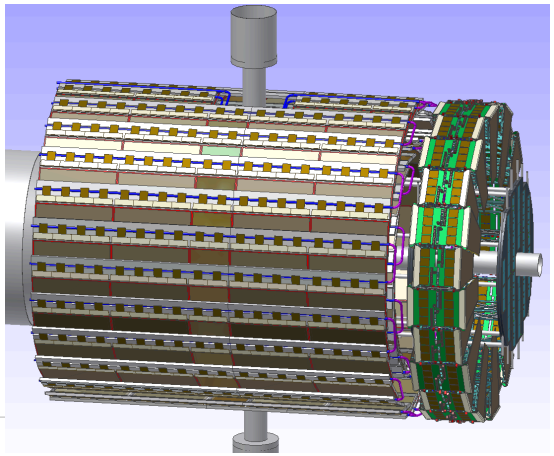


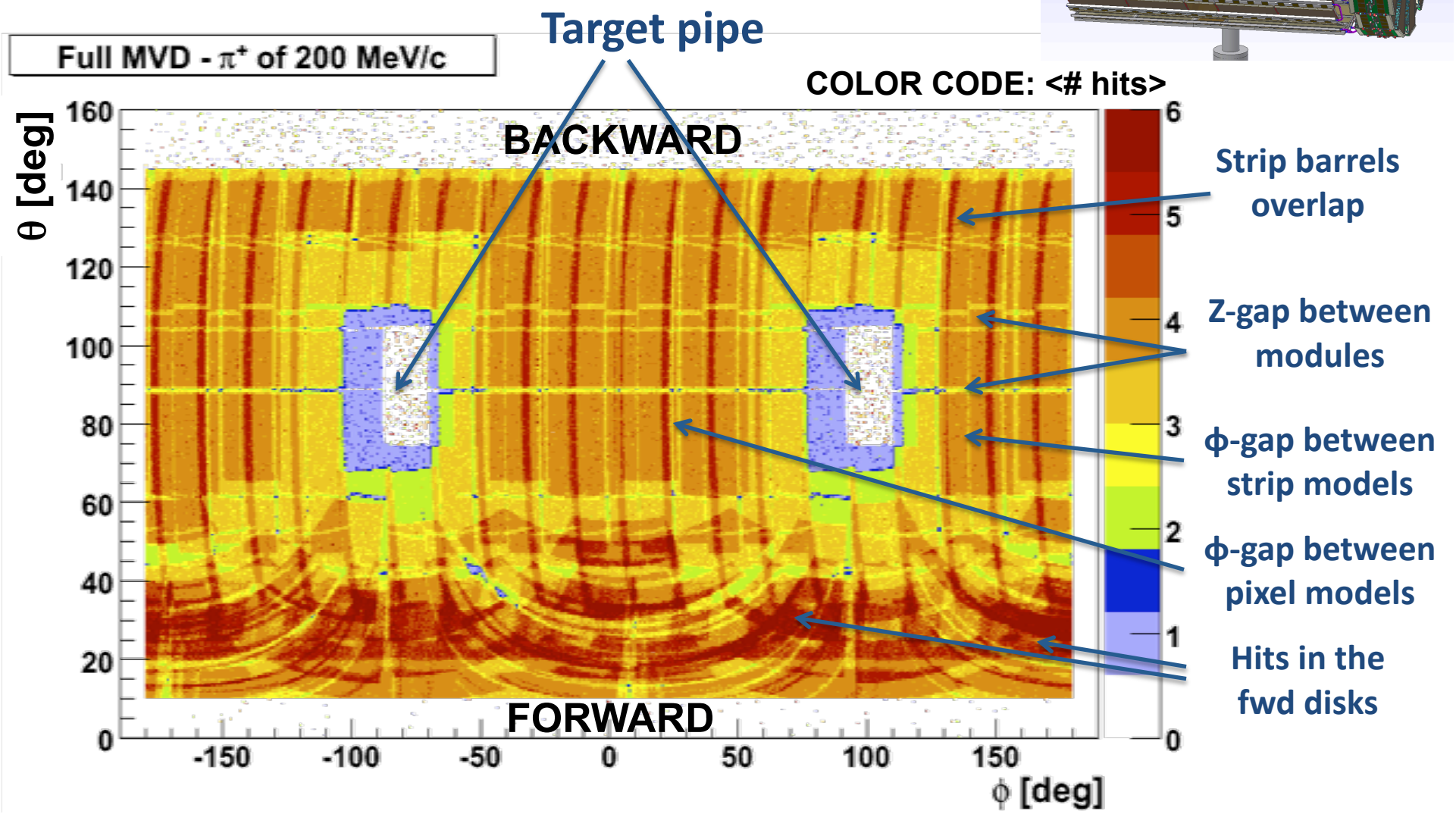
Momentum spectrum shows two peaks which are due to the elastic interaction



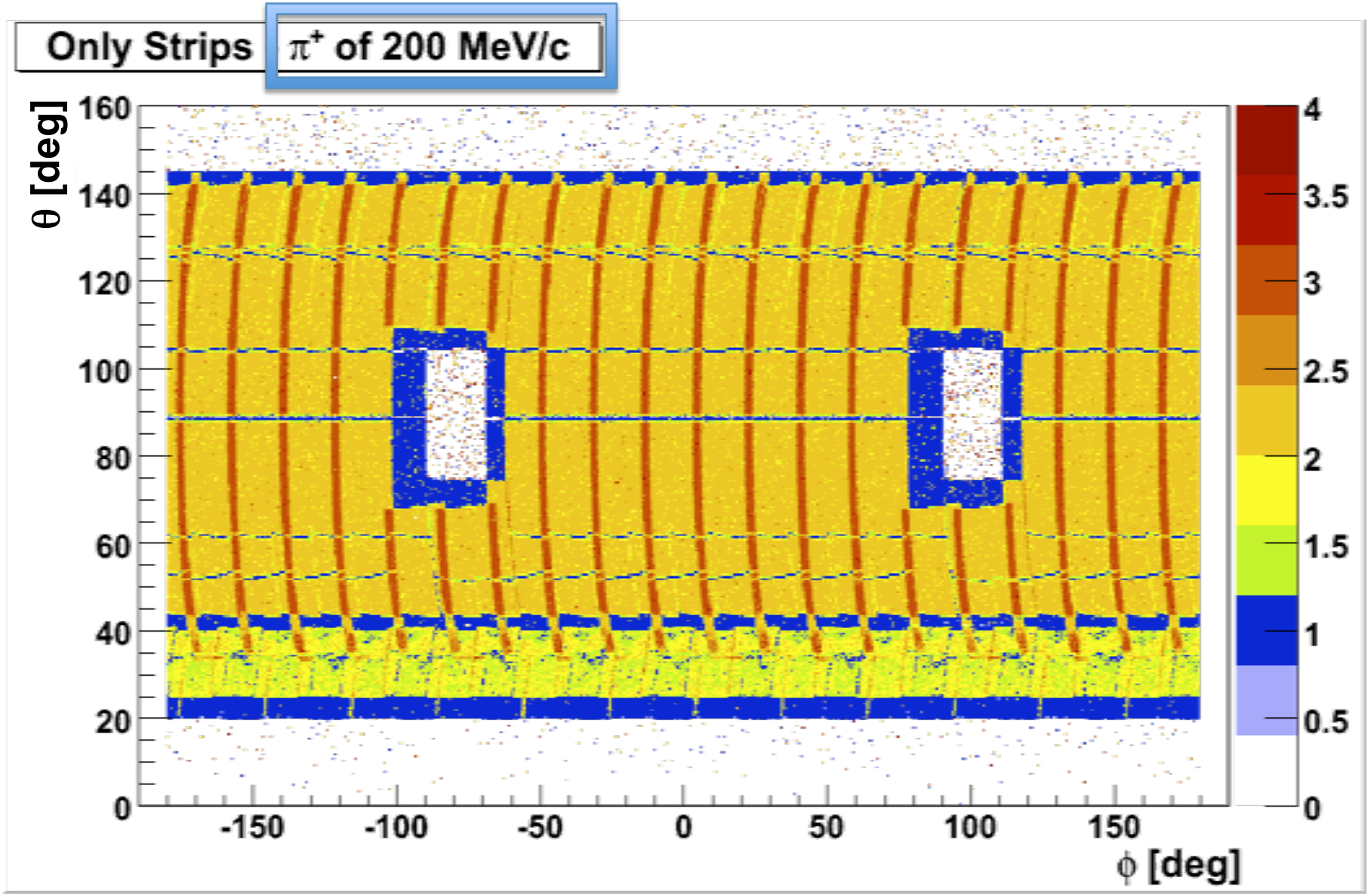
MVD 2.0: Analysis

Geometries created from the mechanical projects via the CAD converter

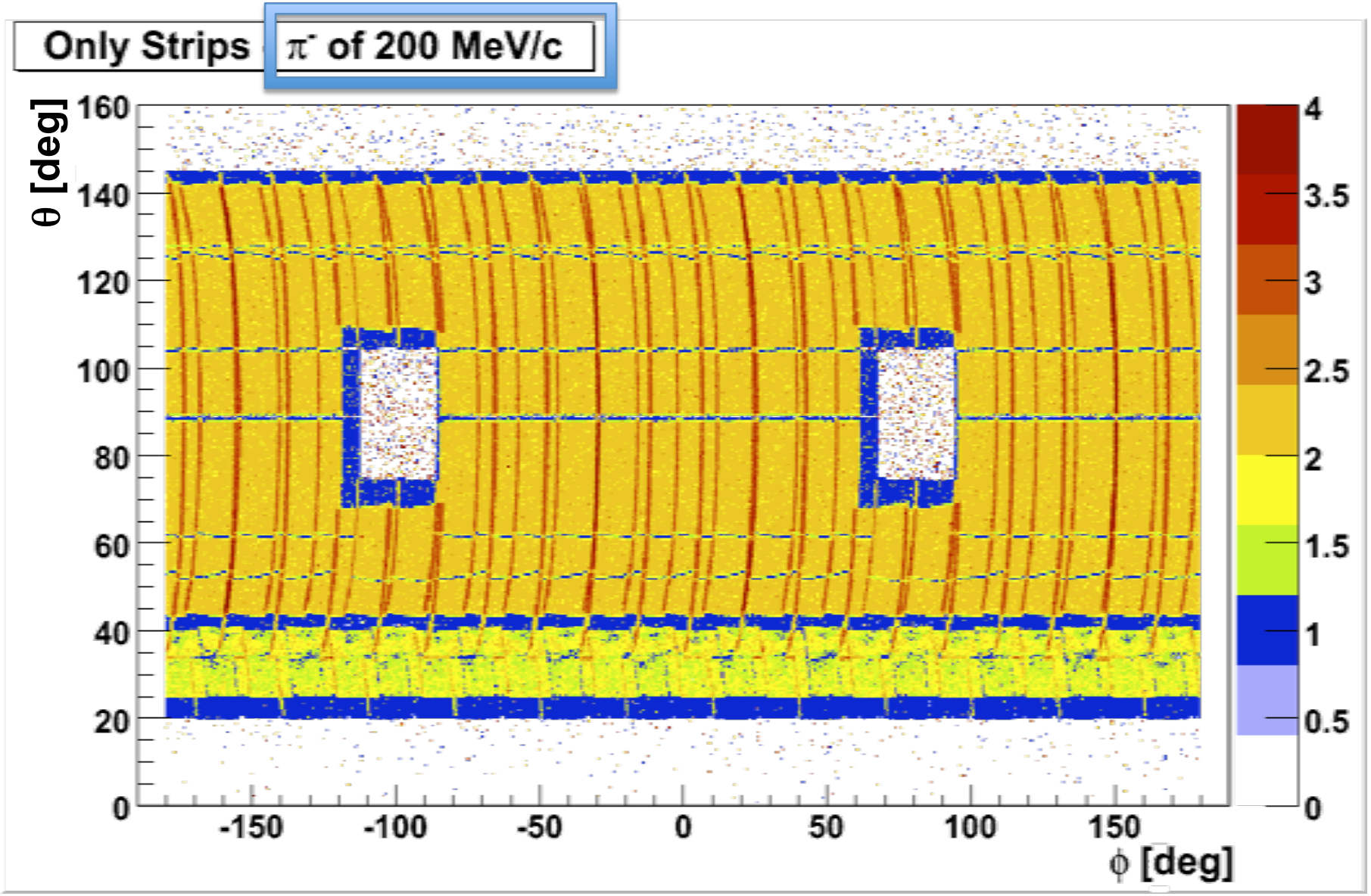




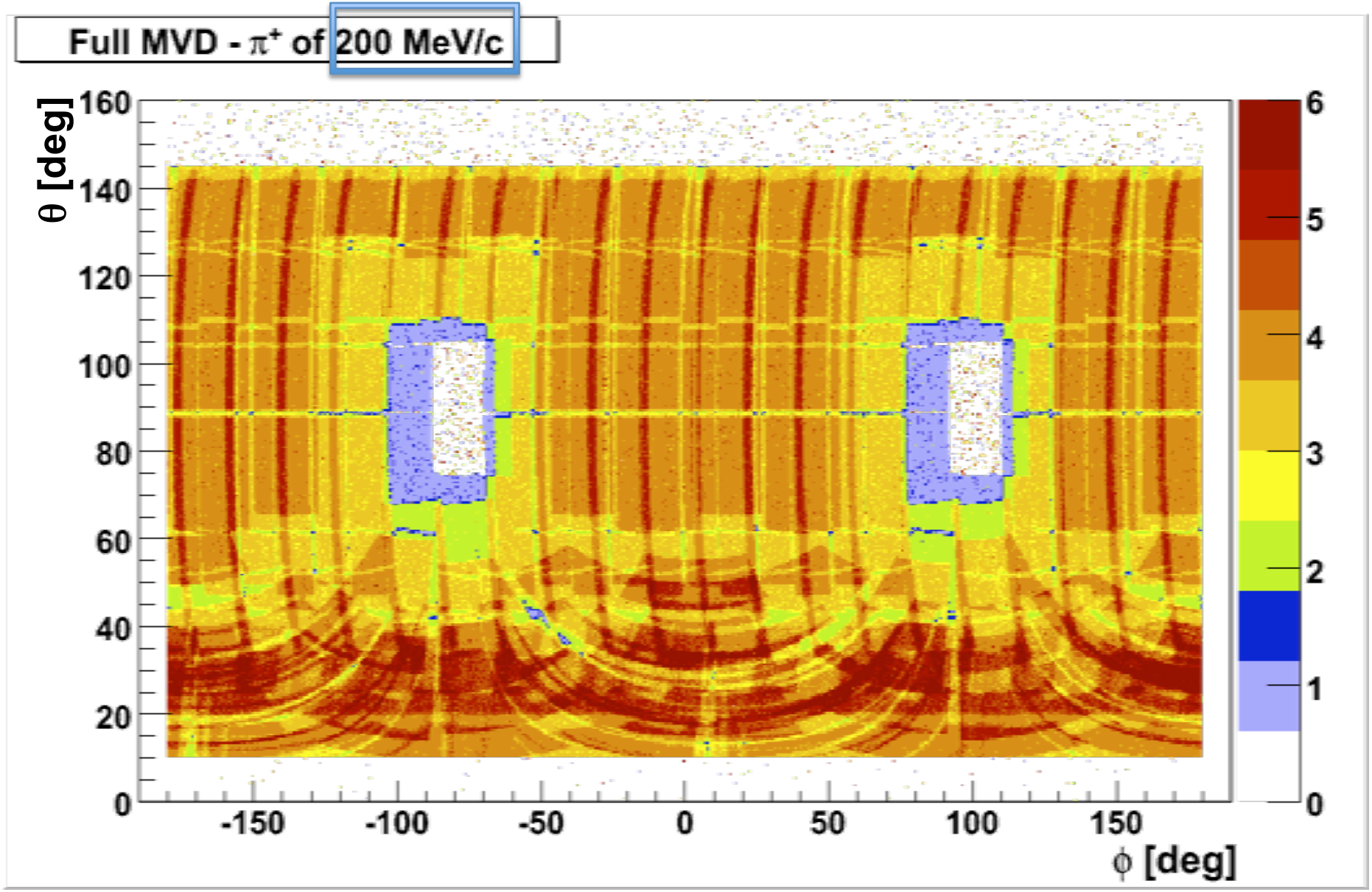
Coverage VS Charge



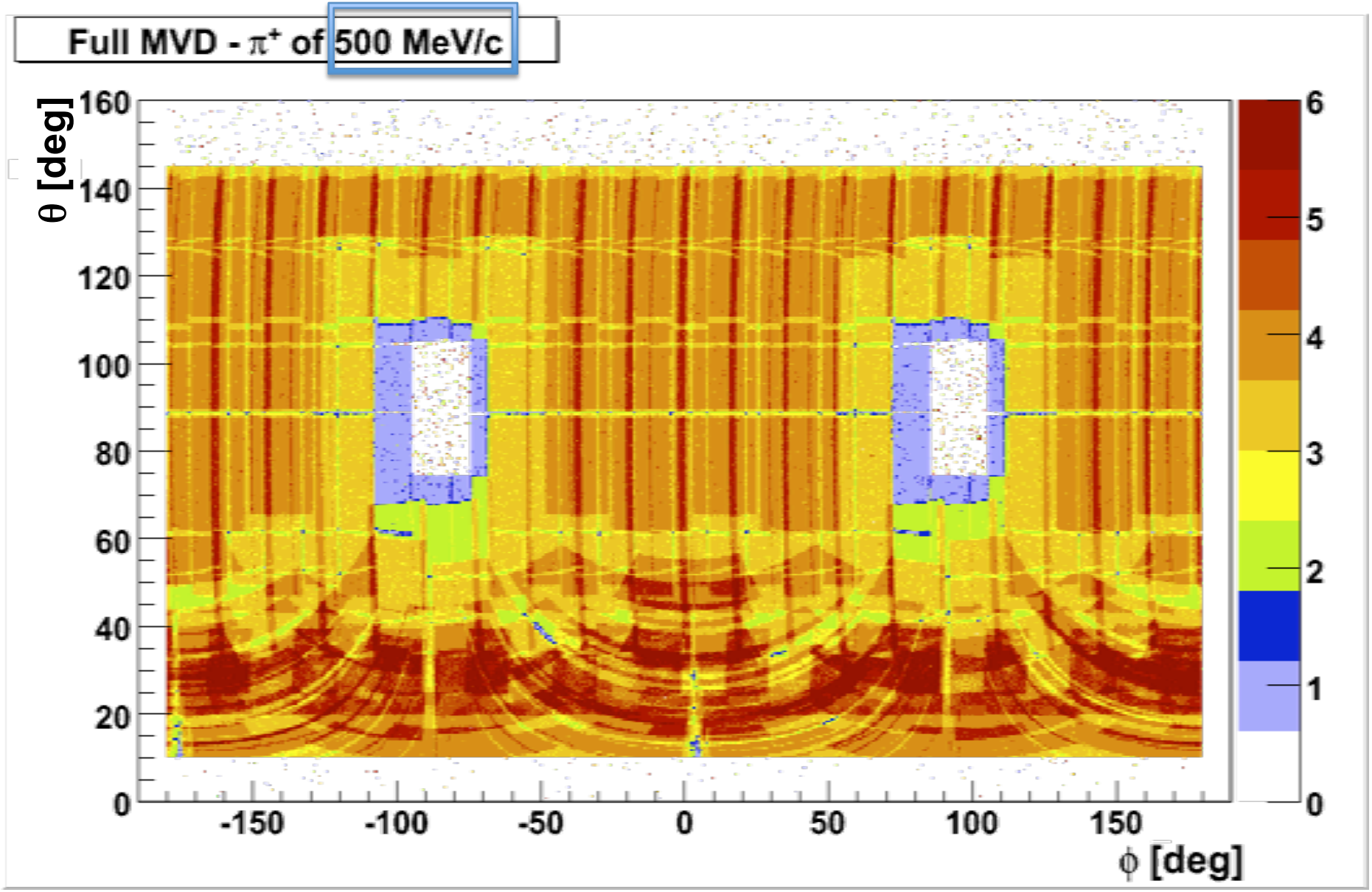
Coverage VS Charge



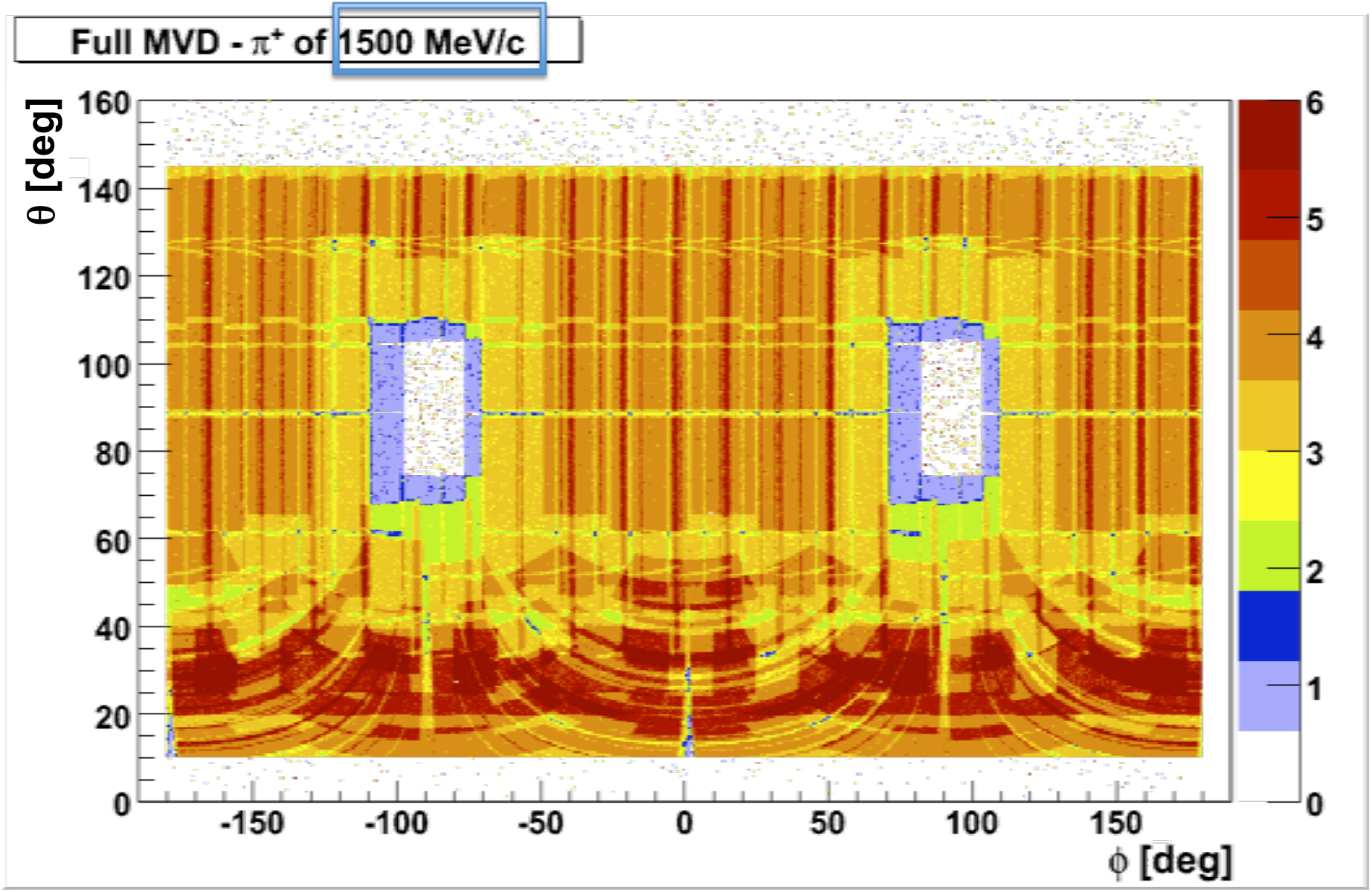
Coverage VS Momentum



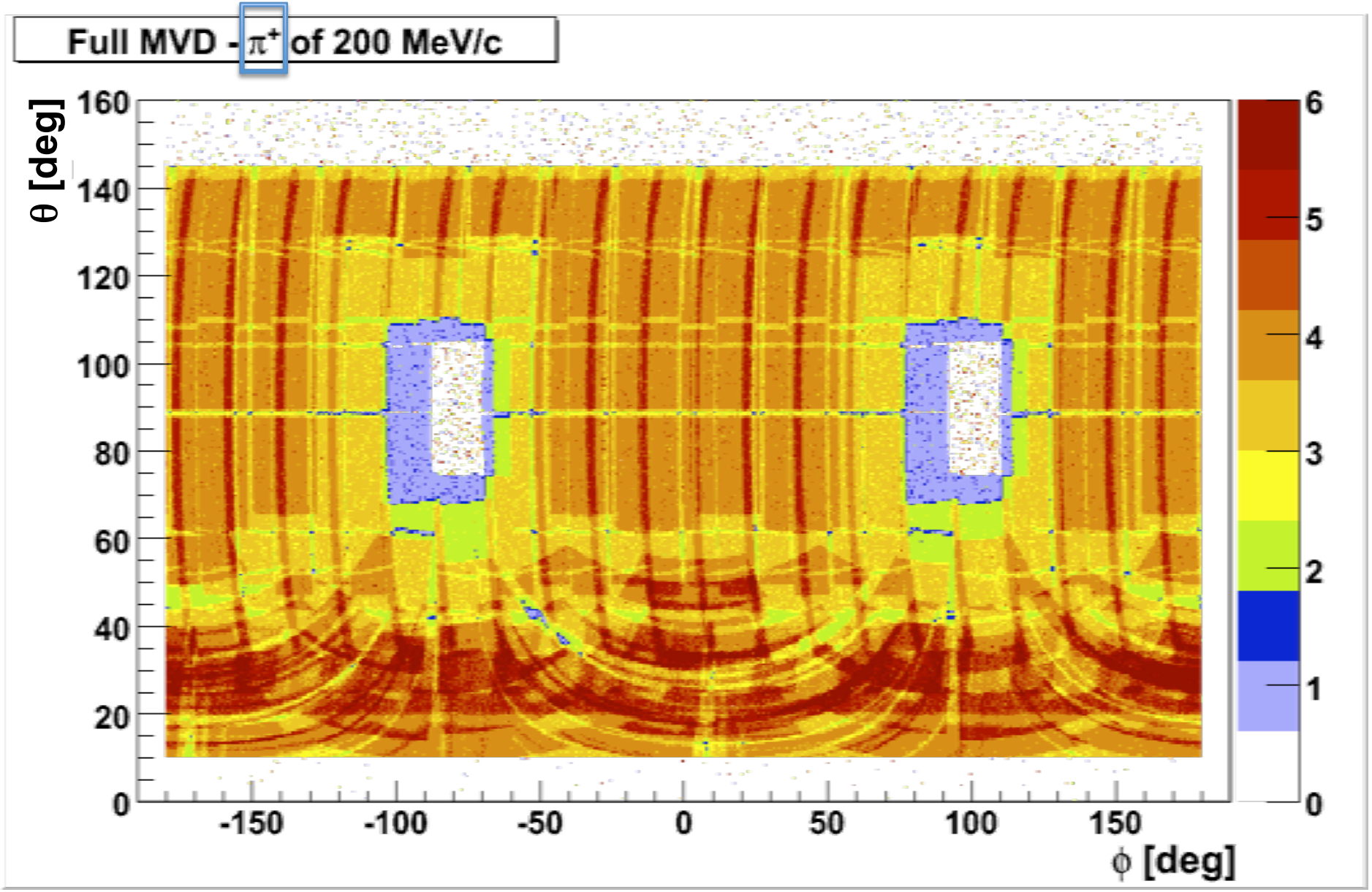
Coverage VS Momentum



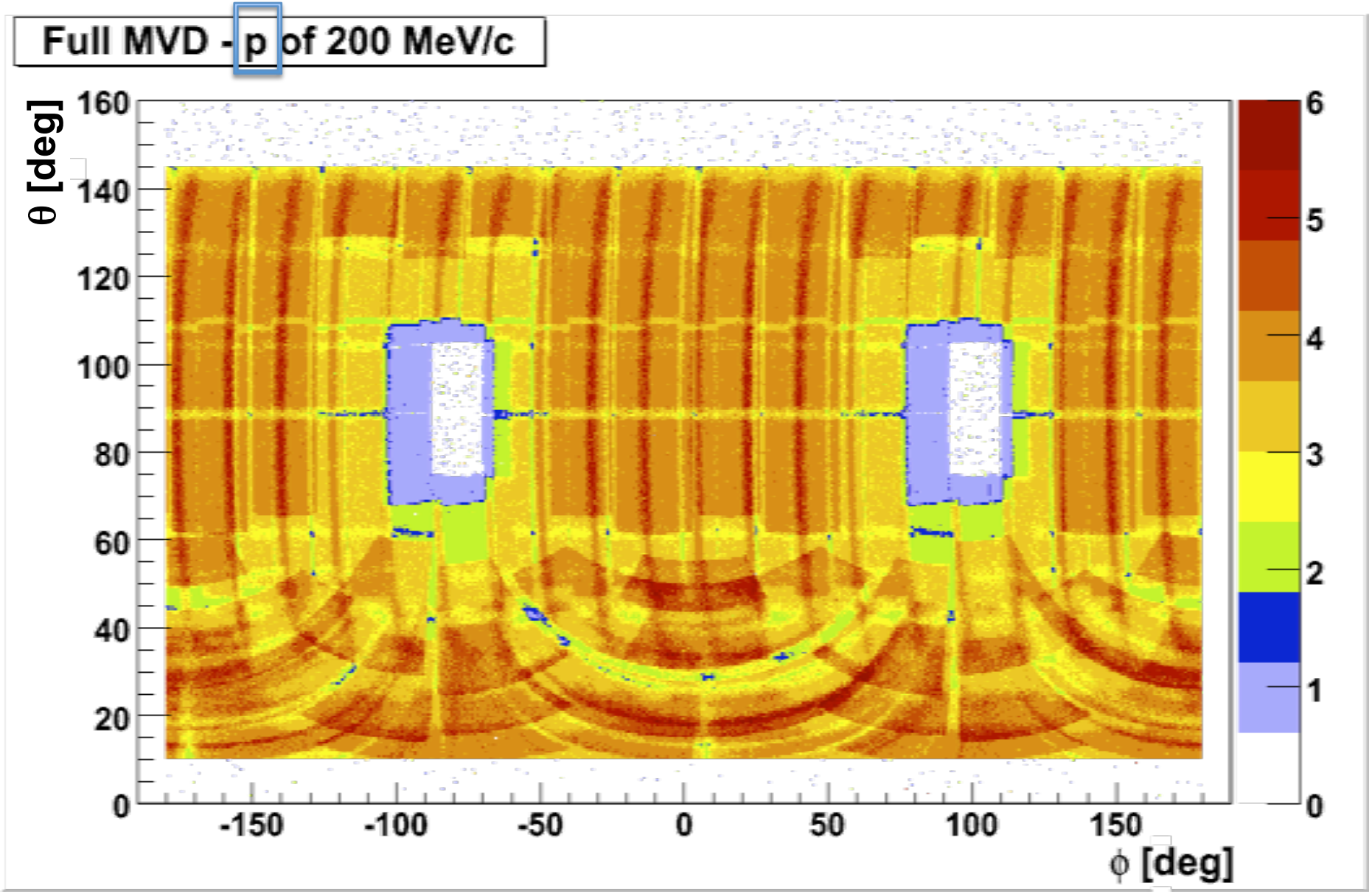
Coverage VS Momentum



Coverage VS Mass



Coverage VS Mass



Conclusions

Dominant multiple scattering effects
for particles with momentum below 200 MeV/c

The simplified "full material" setup represent a worst-case scenario that should be considered an overestimation of the realistic material budget

The tool developed allows quick comparisons between different models

The coverage of the MVD is not deeply influenced by the momentum, the charge and the mass of the particles

Physical requirements must match the mechanical limits

MVD design well optimized!