Muon Identification without Iron

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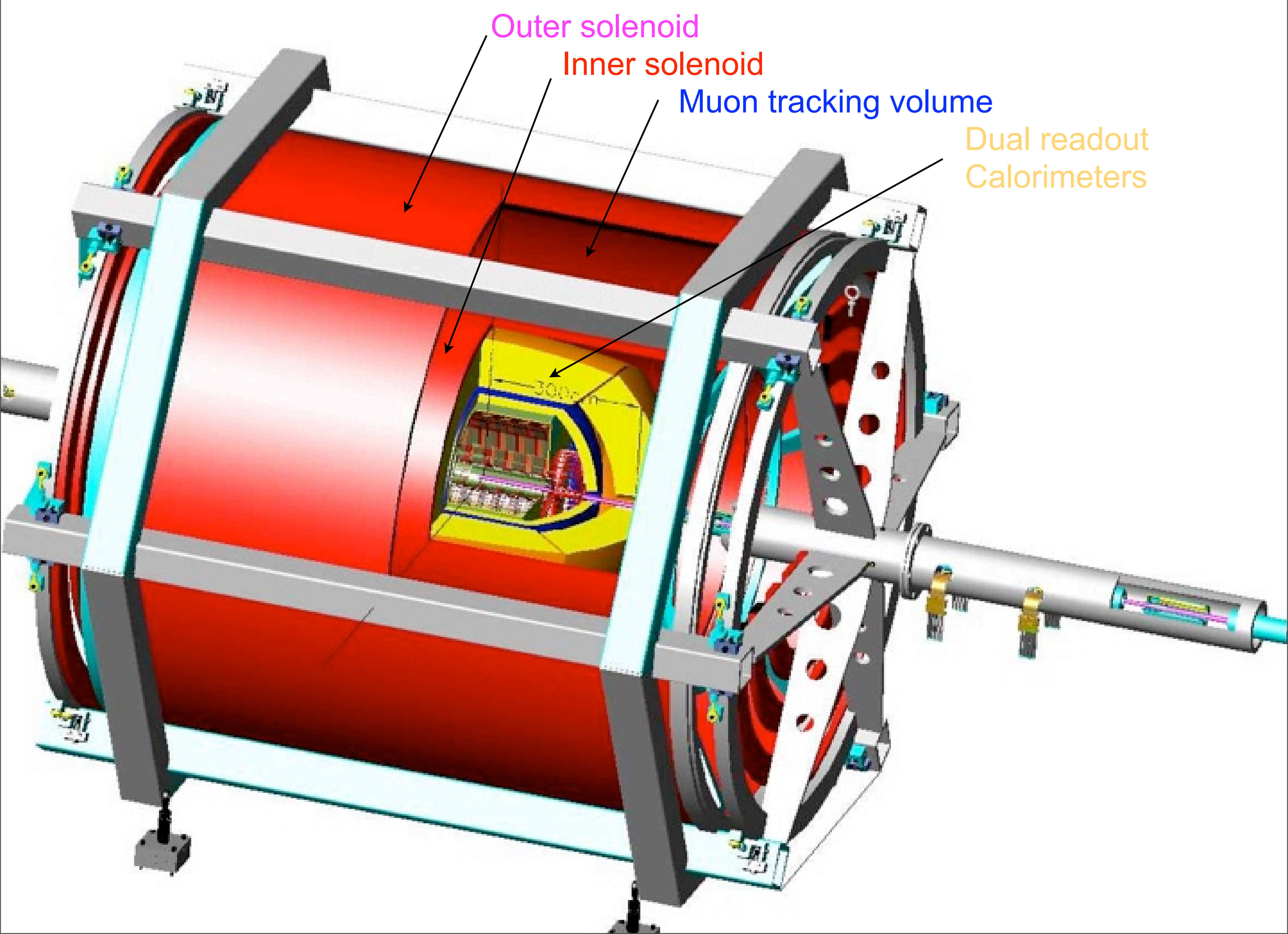
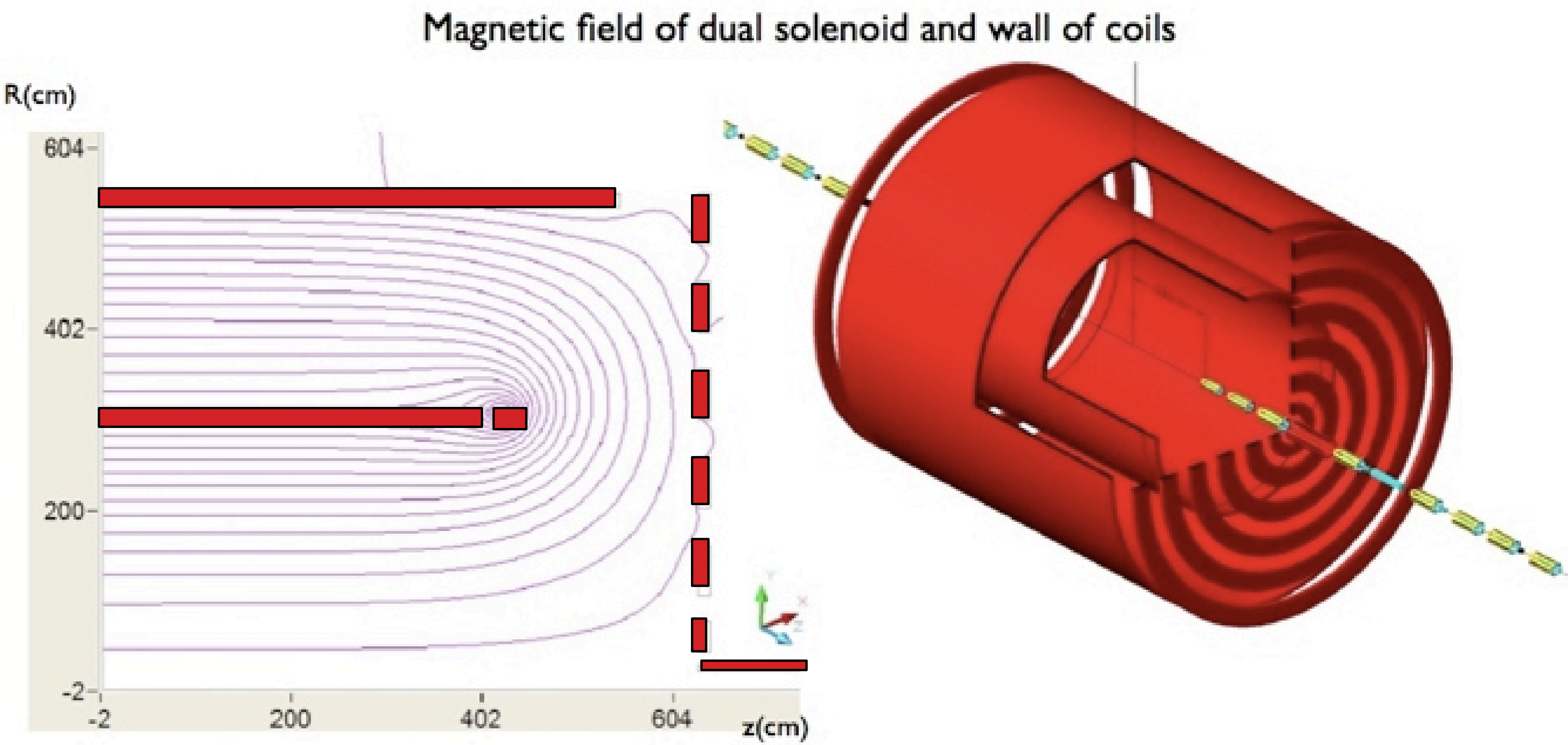
•Precision muon tracking outside the calorimeter in a B=1.5T 2-meter free space provies a strong kinematic constraint on the supposed muon.

• Dual readout calorimetry provides unique and powerful particle identification.

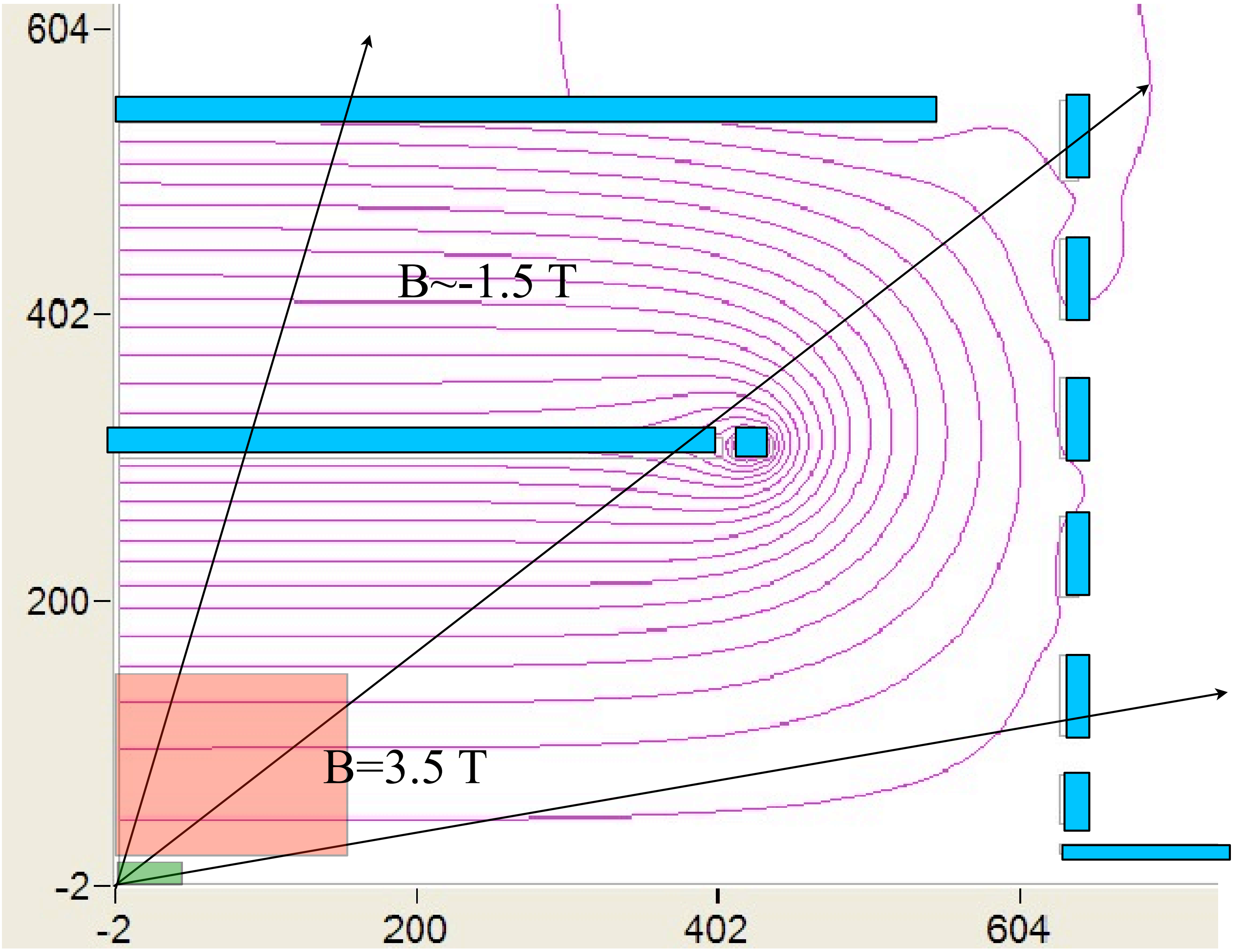
(A judgment will be ATLAS vs. CMS)

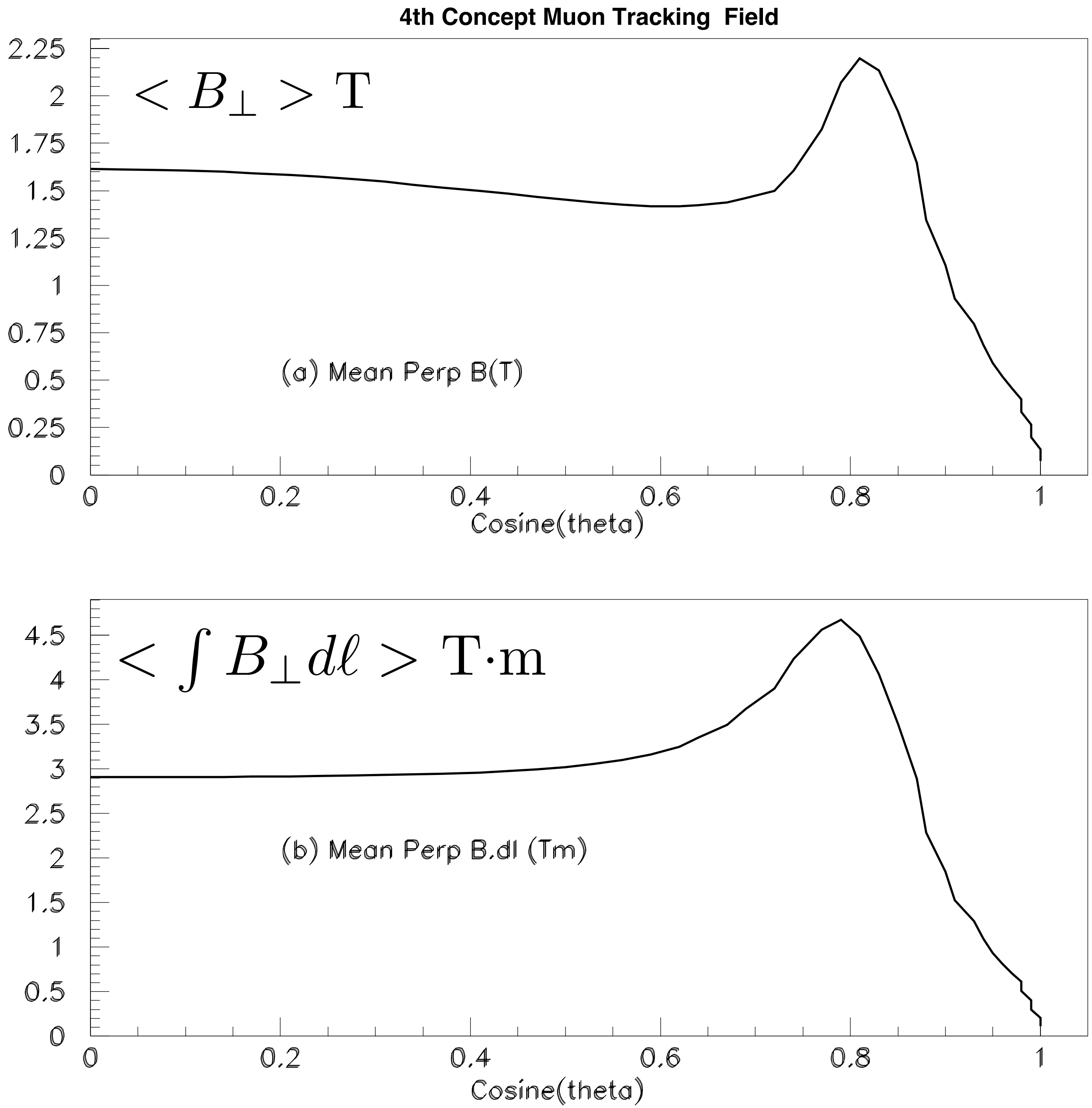

Outer solenoid
Inner solenoid
Muon tracking volume
Dual readout
Calorimeters

New magnetic field, new ``wall of coils'', iron-free: many benefits to muon detection and MDI, Alexander Mikhailichenko design



Muon trajectories from the interaction point





Dual solenoid

tracking along muon trajectories in the annulus between solenoids.

cluster counting drift tubes for muon tracking.

The conventional Fe-chamber sandwich muon system is limited to a momentum resolution of

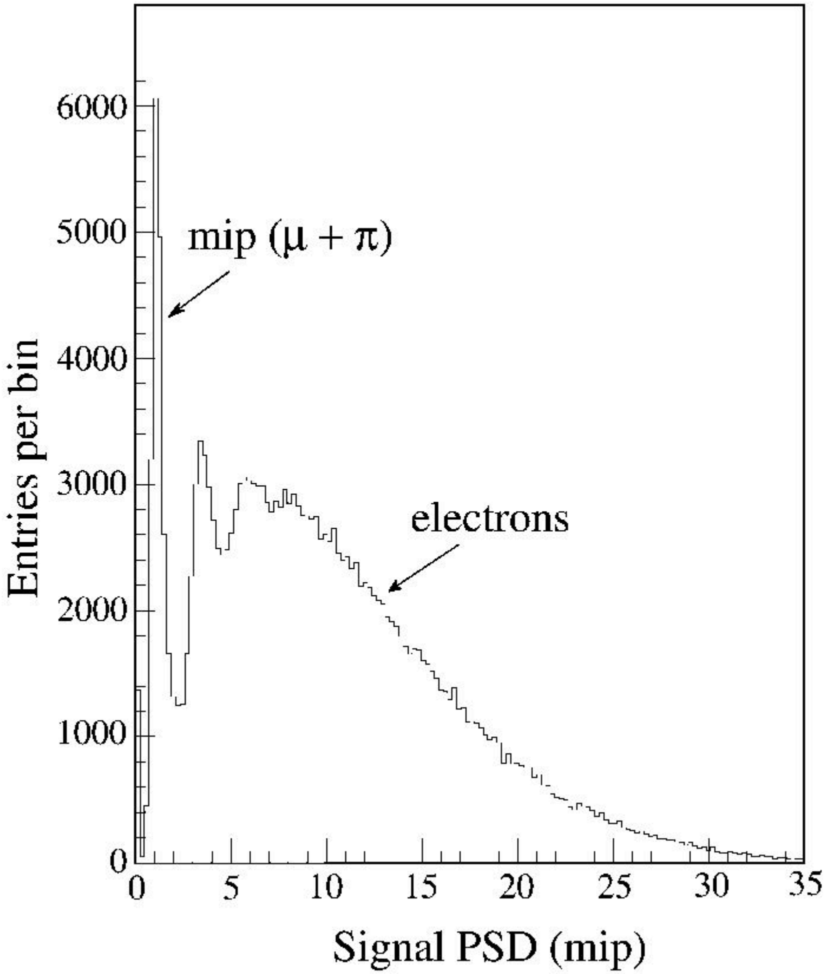
$$\sigma_p/p \leq 10\%/\sqrt{L}$$

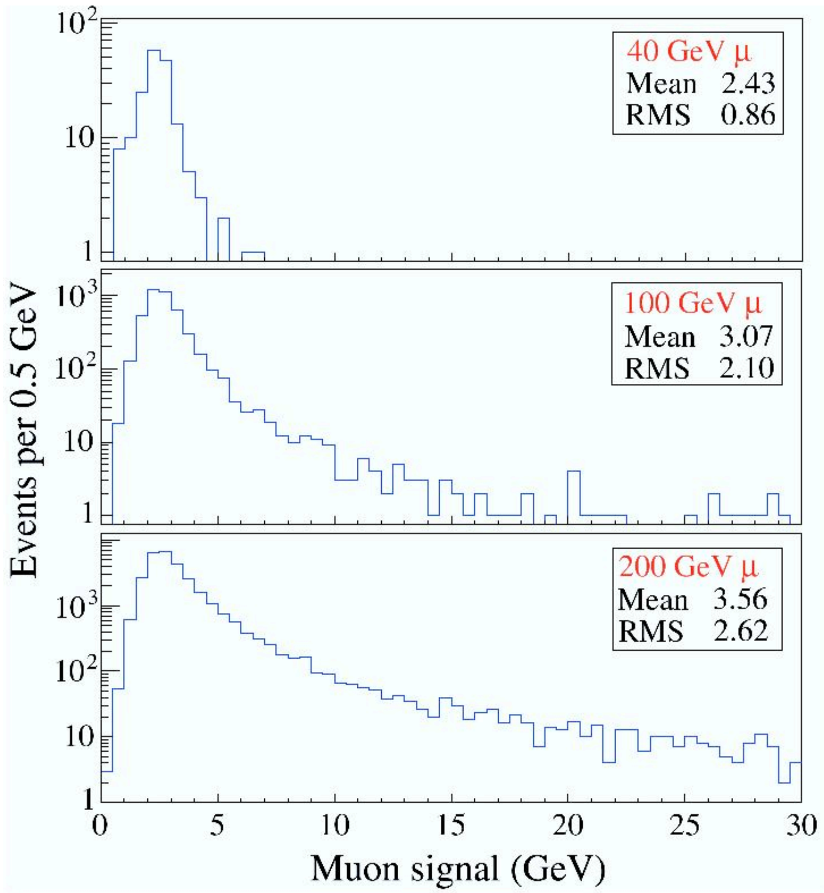
This iron-free muon system has much better momentum resolution and can more strongly impose an energy constraint on tracks

$$p_{TPC} \approx E_{CALOR} + p_{MUON}$$

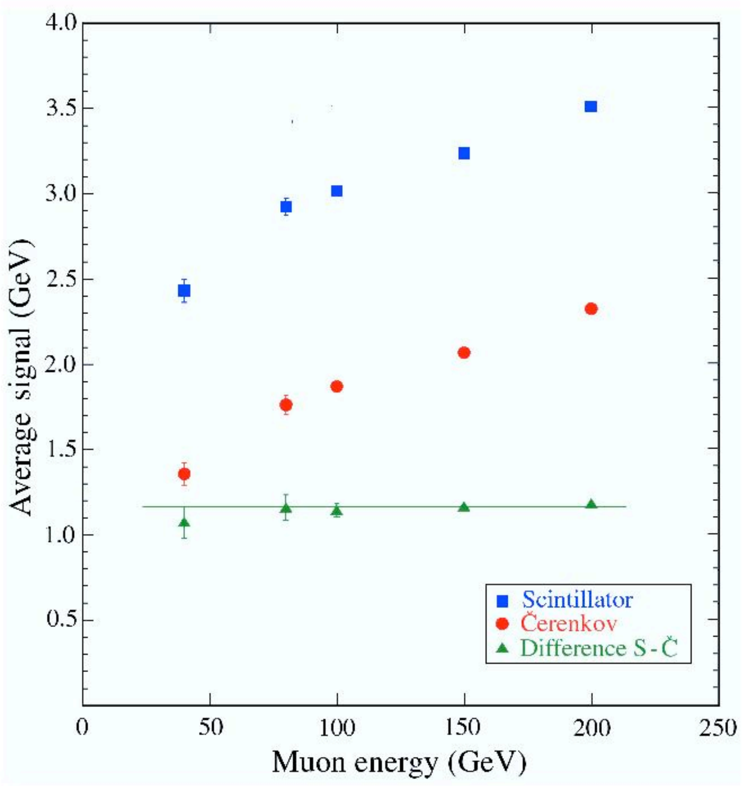
One can argue that this is a small gain: 10% vs. ~1%

NIM A533 (2004) 305.





Muons through a dual-readout calorimeter:
separation of ionization and radiative processes

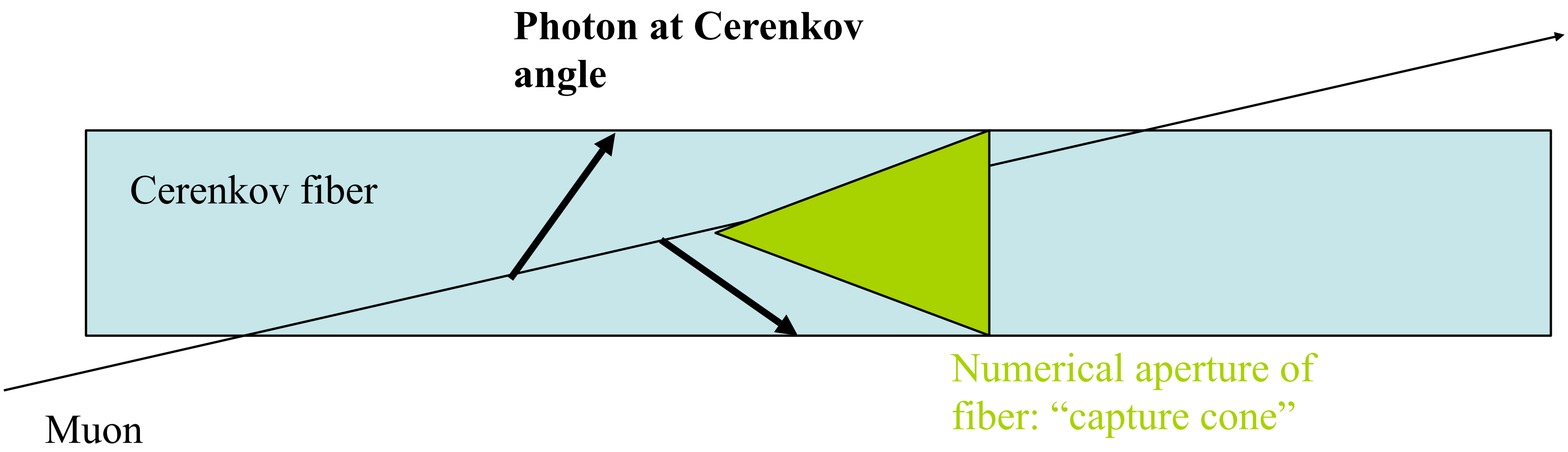


Scintillation: ionization + bremsstrahlung + pair production

Cerenkov: bremsstrahlung + pair production

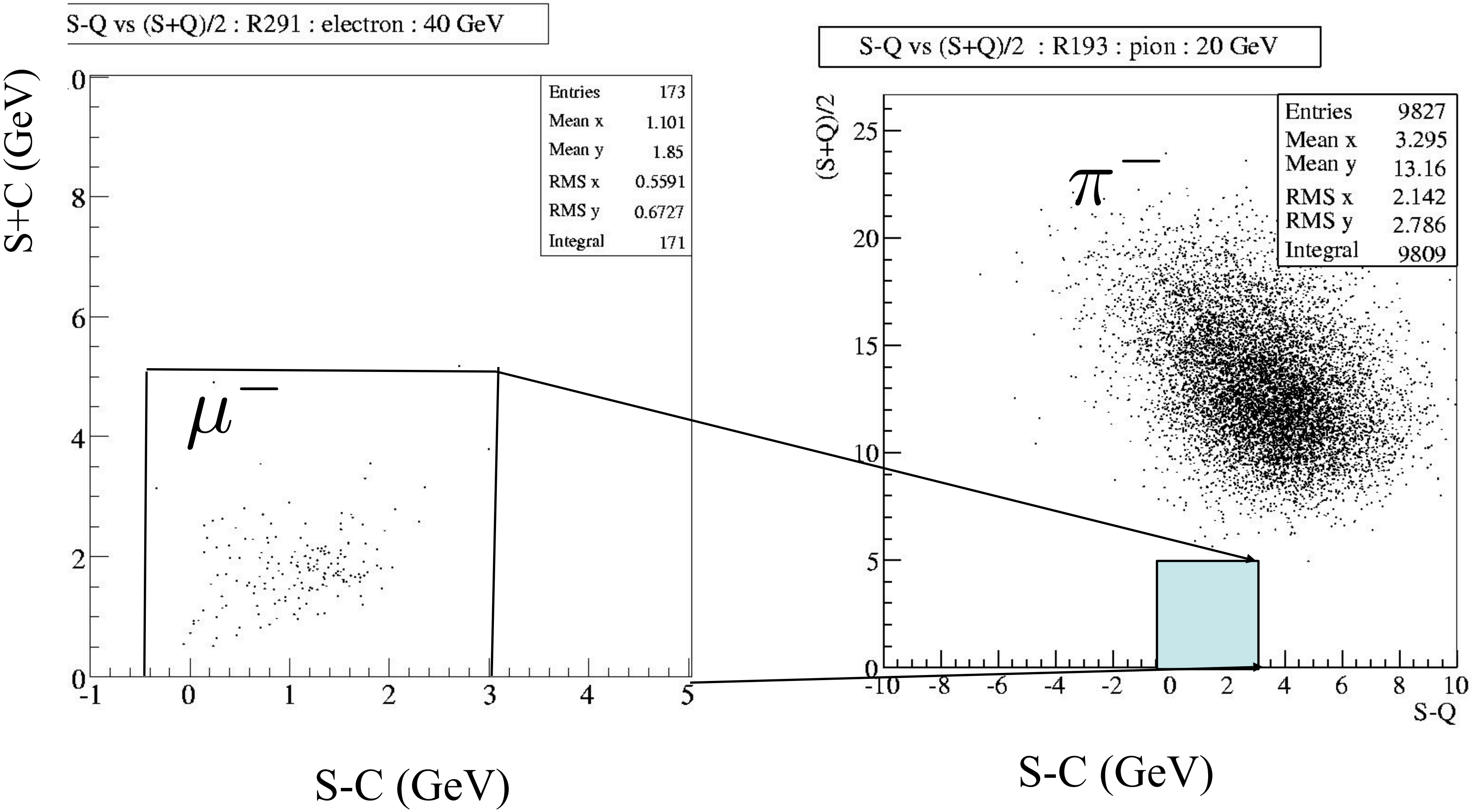
Difference S-C is ionization and is constant, independent of muon energy. This is a unique muon tag.

The Cerenkov signal from an approximately aligned, non-radiating muon is zero

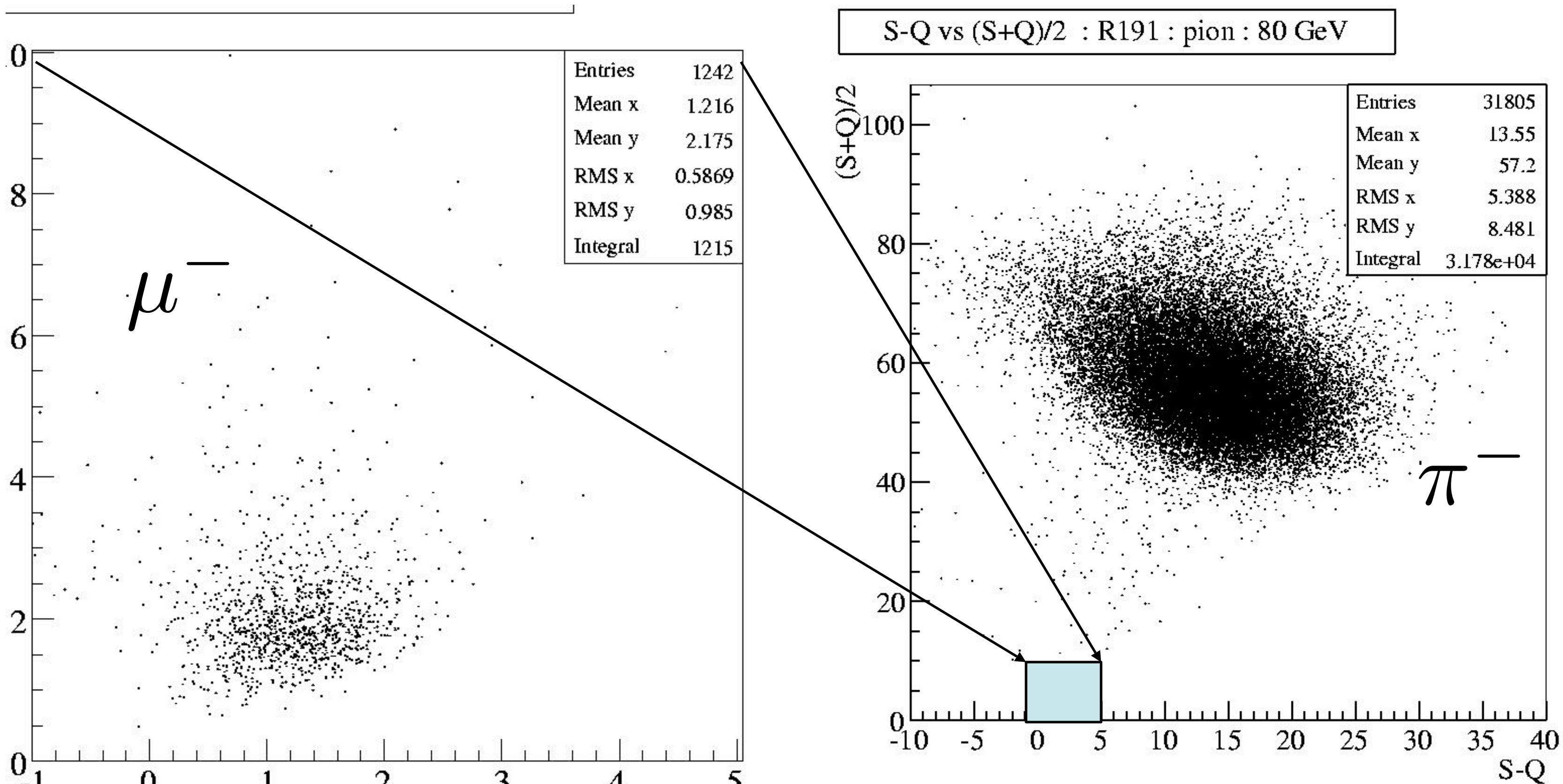


All of the Cerenkov light of an approximately aligned muon falls outside of the numerical aperture.

Muons (40 GeV) & Pions (20 GeV)

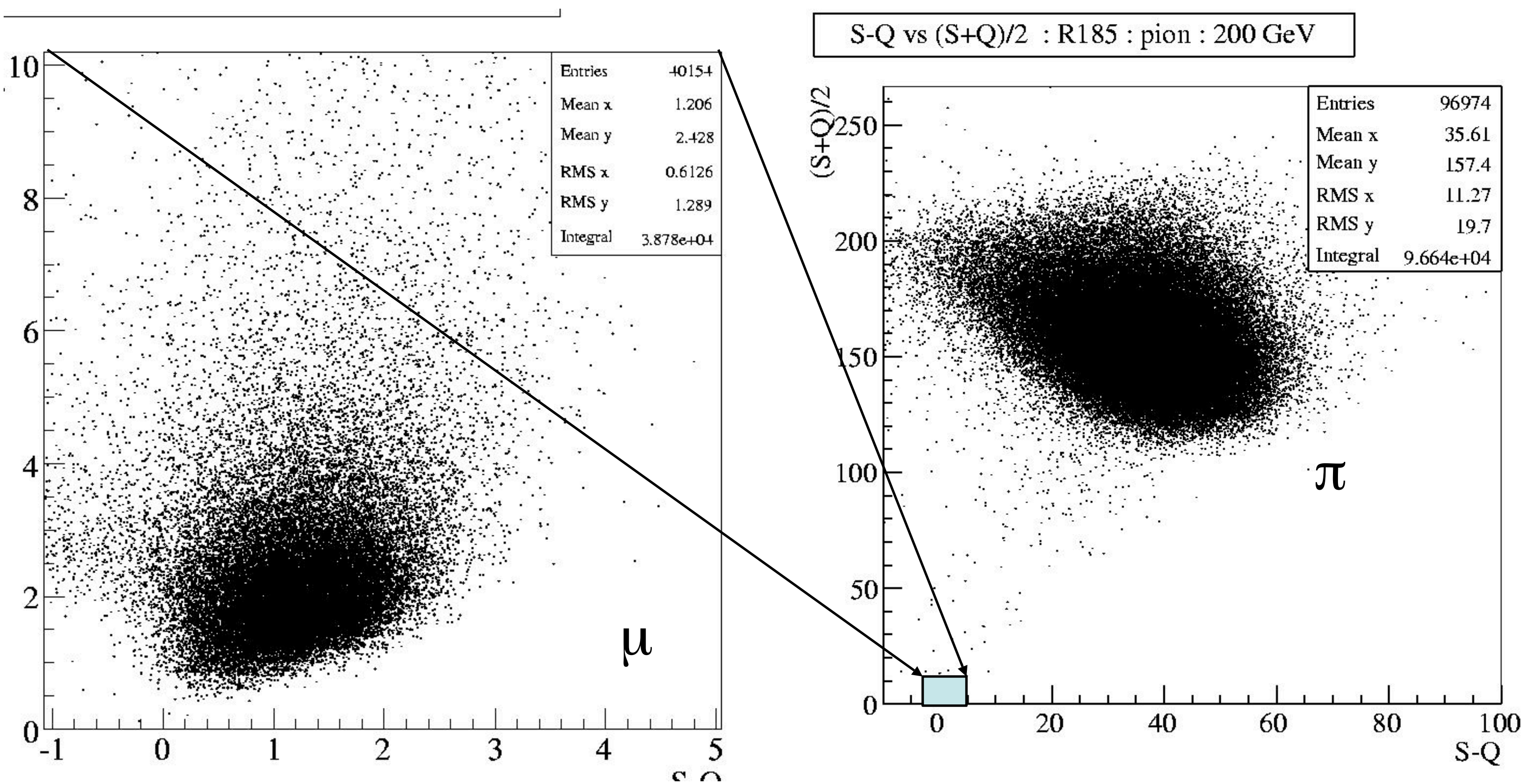


Muons and Pions (80 GeV)



S-C (GeV) S-C (GeV)

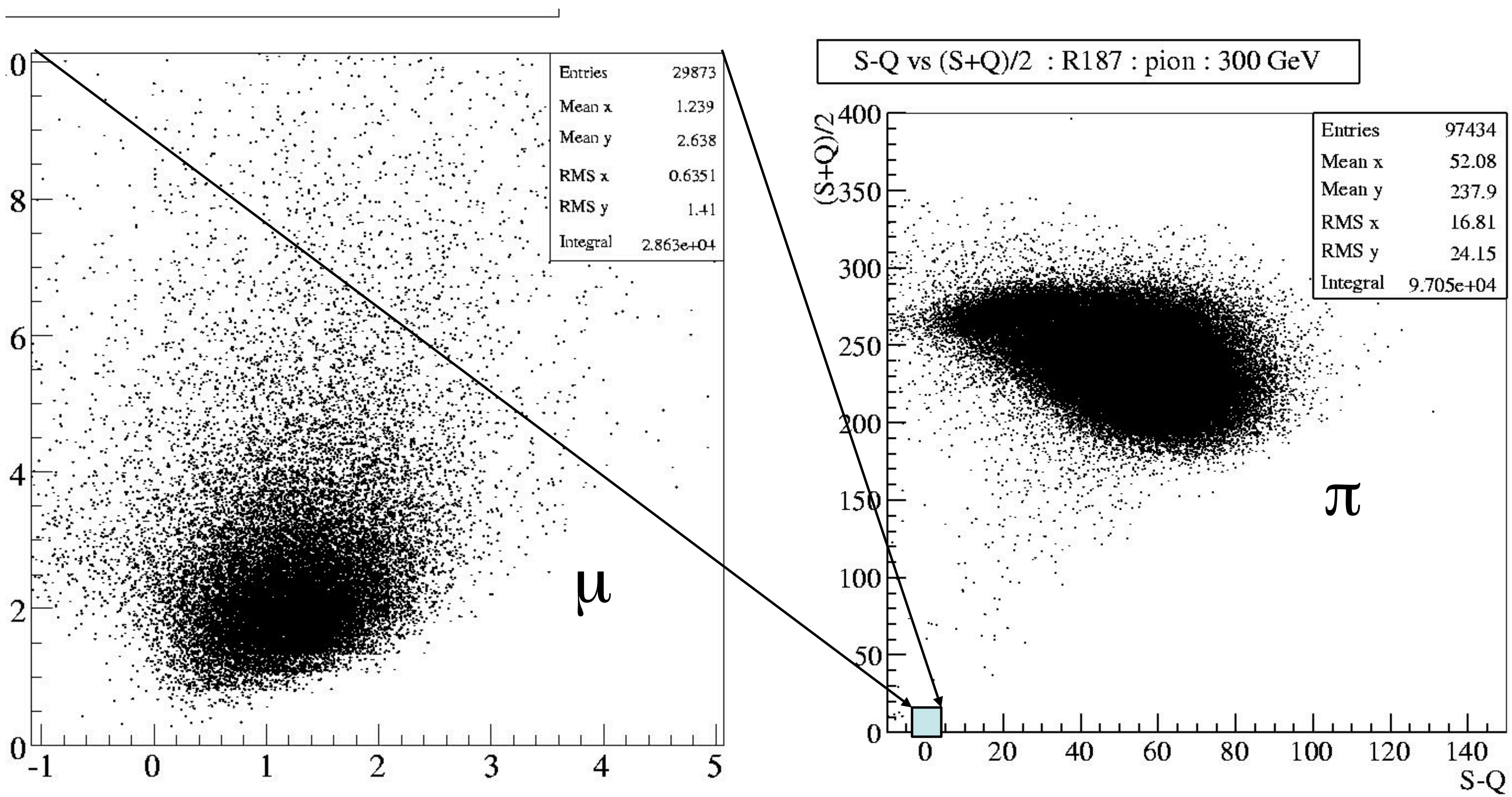
Muons and Pions (200 GeV)



S-C (GeV)

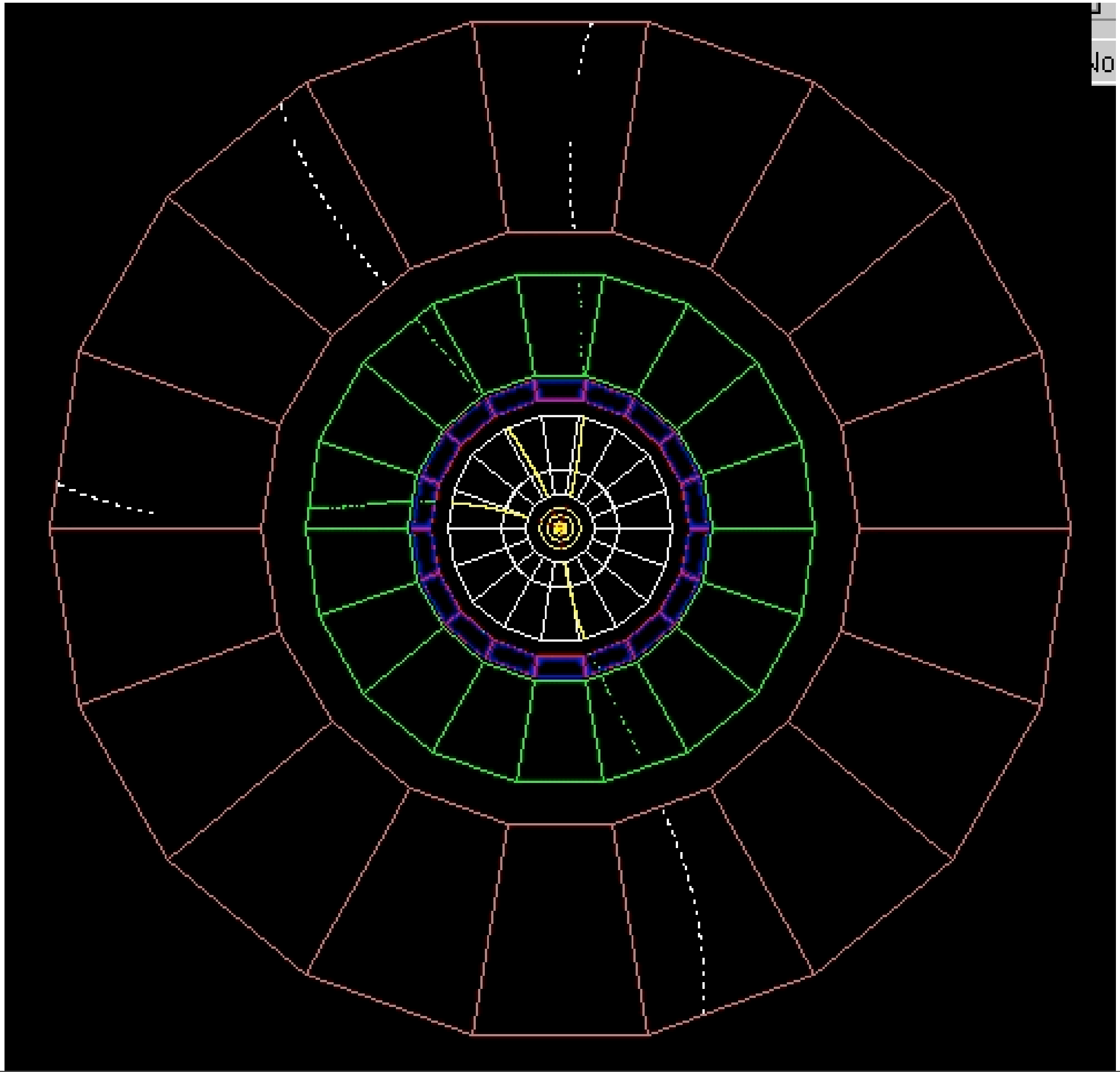
S-C (GeV)

Muons and Pions (300 GeV)



S-C (GeV) S-C (GeV)

Four 5-GeV muons through detector as test



Muons are clean and obvious;

Acceptance at 5 GeV is good;

Momentum and energy measurements must add up for a real muon;

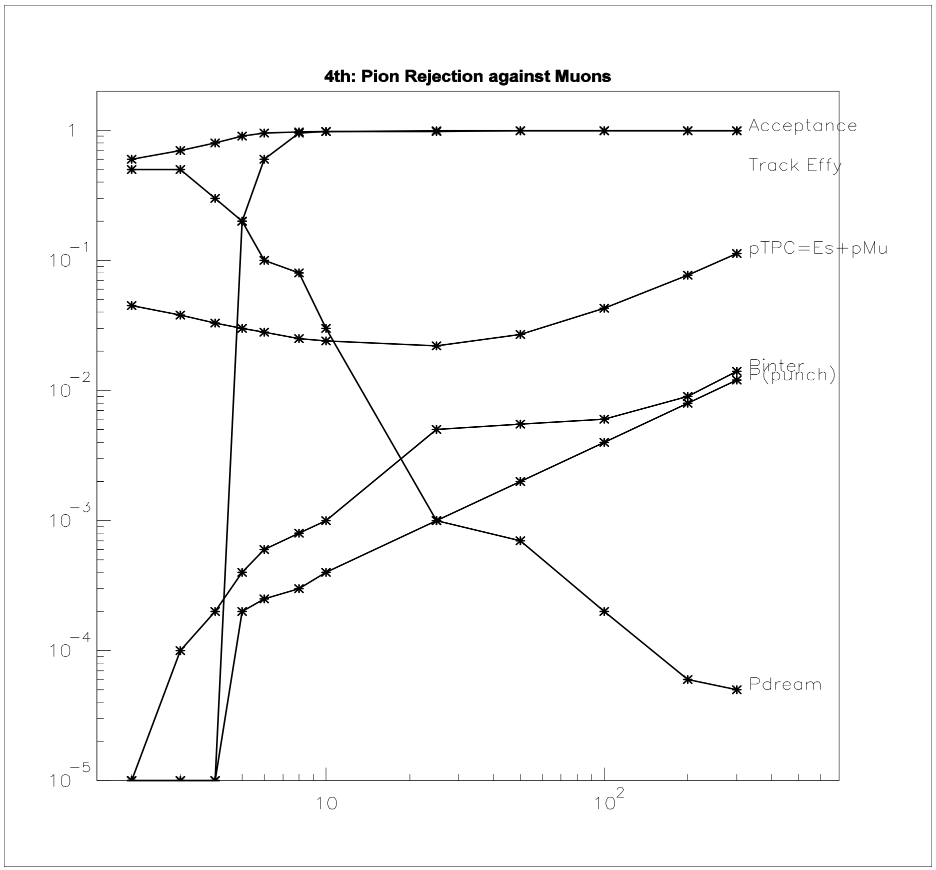
GEANT simulation in very good shape in a very short time;

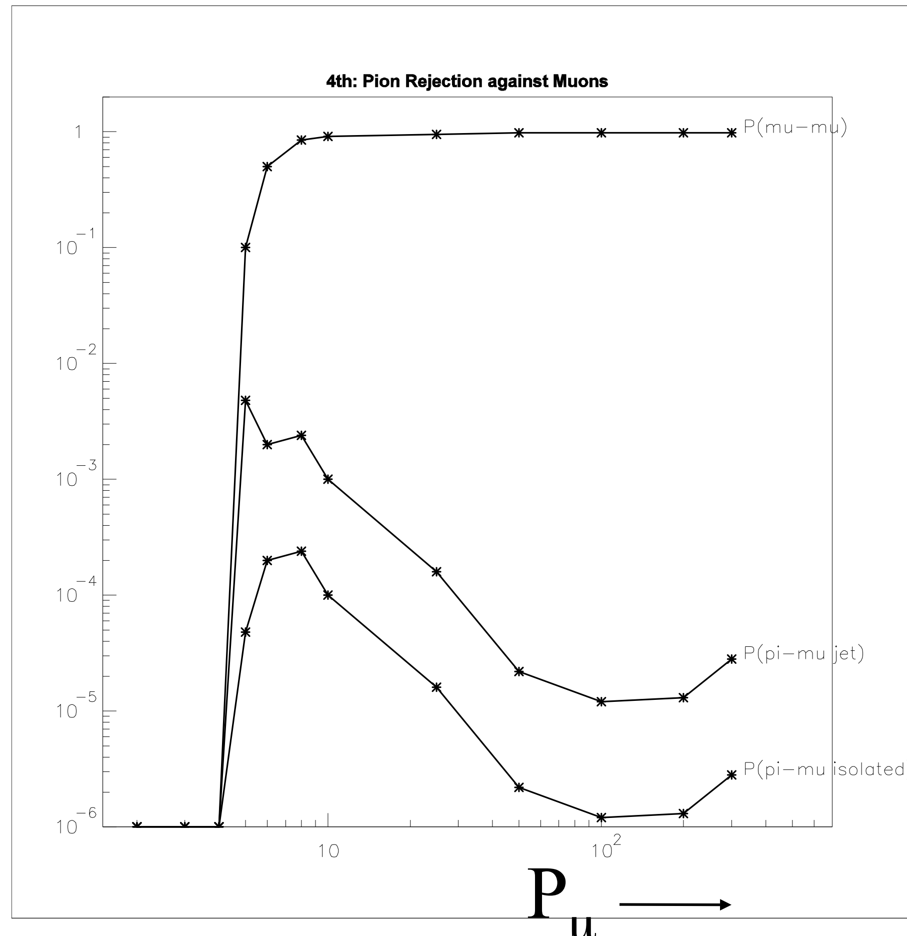
Still, there is more fun work to do.

Overall pion rejection

- Drift tubes. $\sigma/p^2 \sim 10^{-4}\ (\mathrm{GeV/c})^{-1}$
- Reject pions by energy balance:

$$P_{TPC} \sim E_{DREAM} + P_{MUON}$$





At high momenta, too good; at low momentum, we don't know yet.