Beam Loss Monitors

Tests on ionisation chambers

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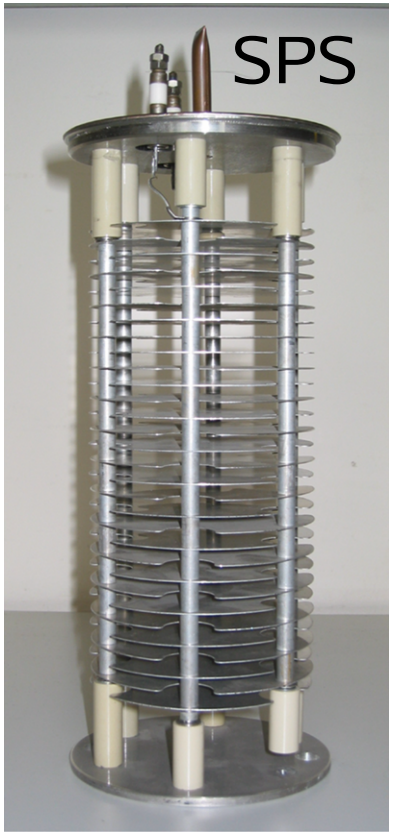
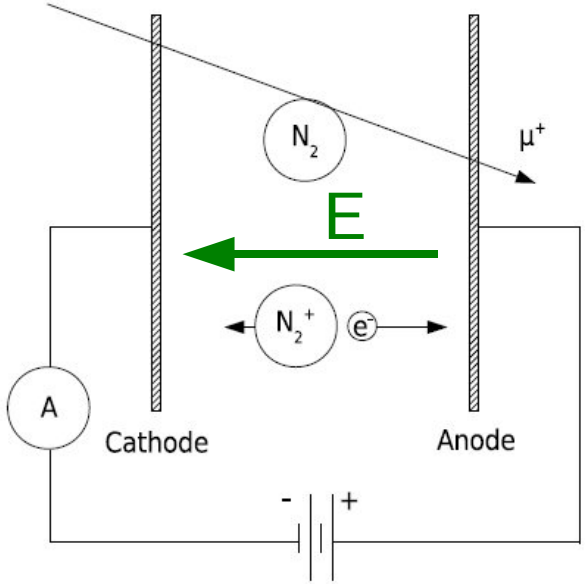
Contents

- Simulations
- Tests with beam
- Accuracy
- Saturation
- Comparison measures/simulations

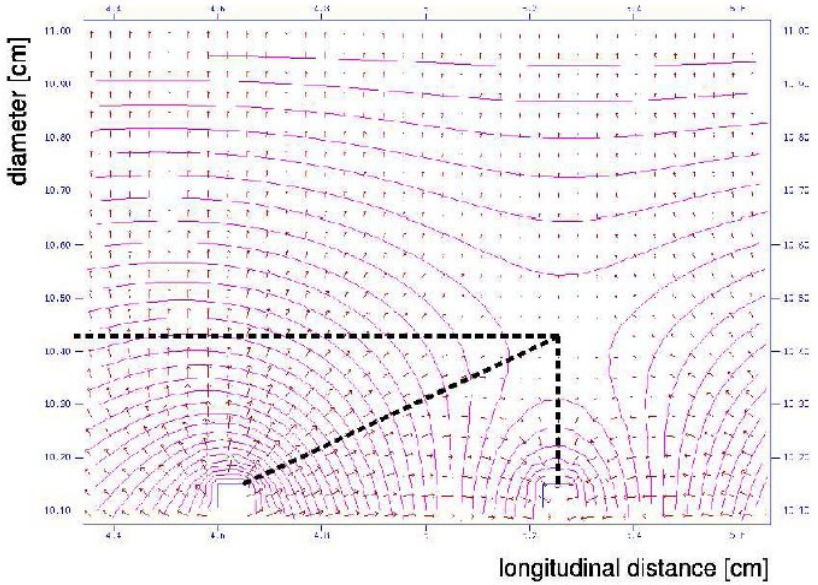
Ionisation chambers: global presentation



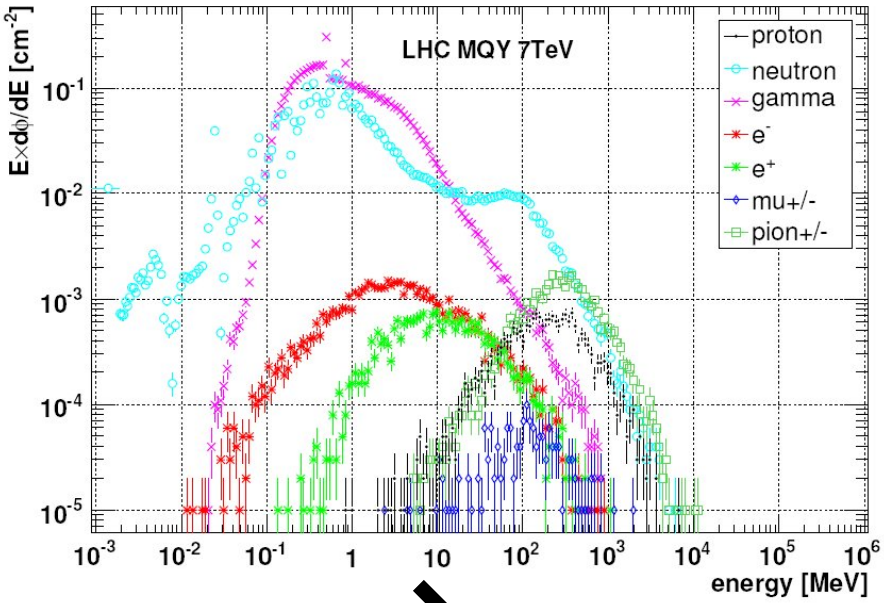


LHC: U = 1500 V
E ≈ 3000 V/cm

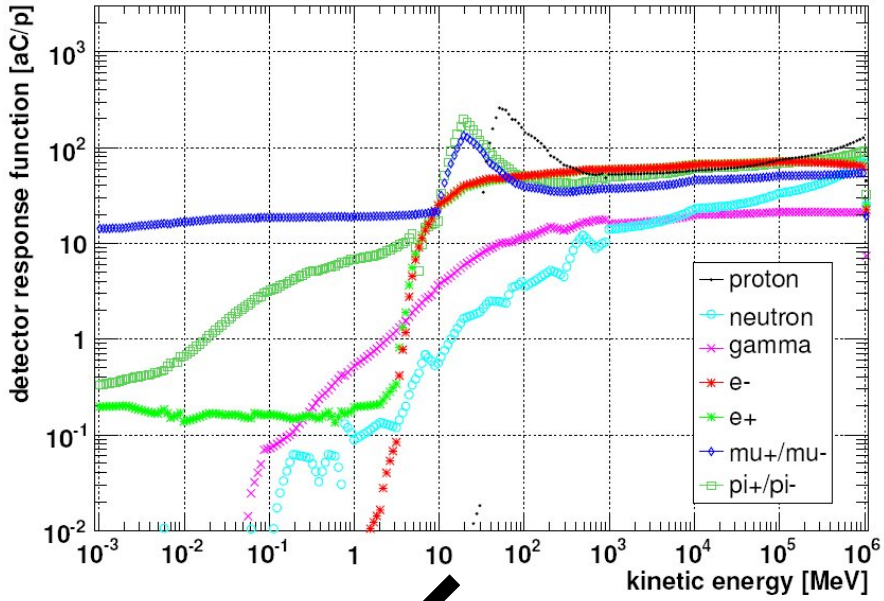
N_2: 1.1 bar



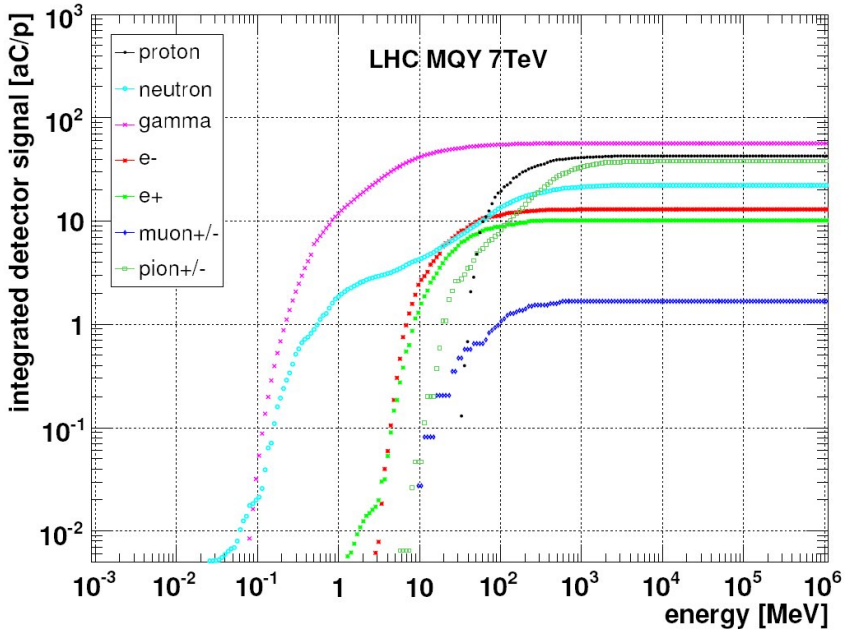
Charge deposition



Particles spectrum

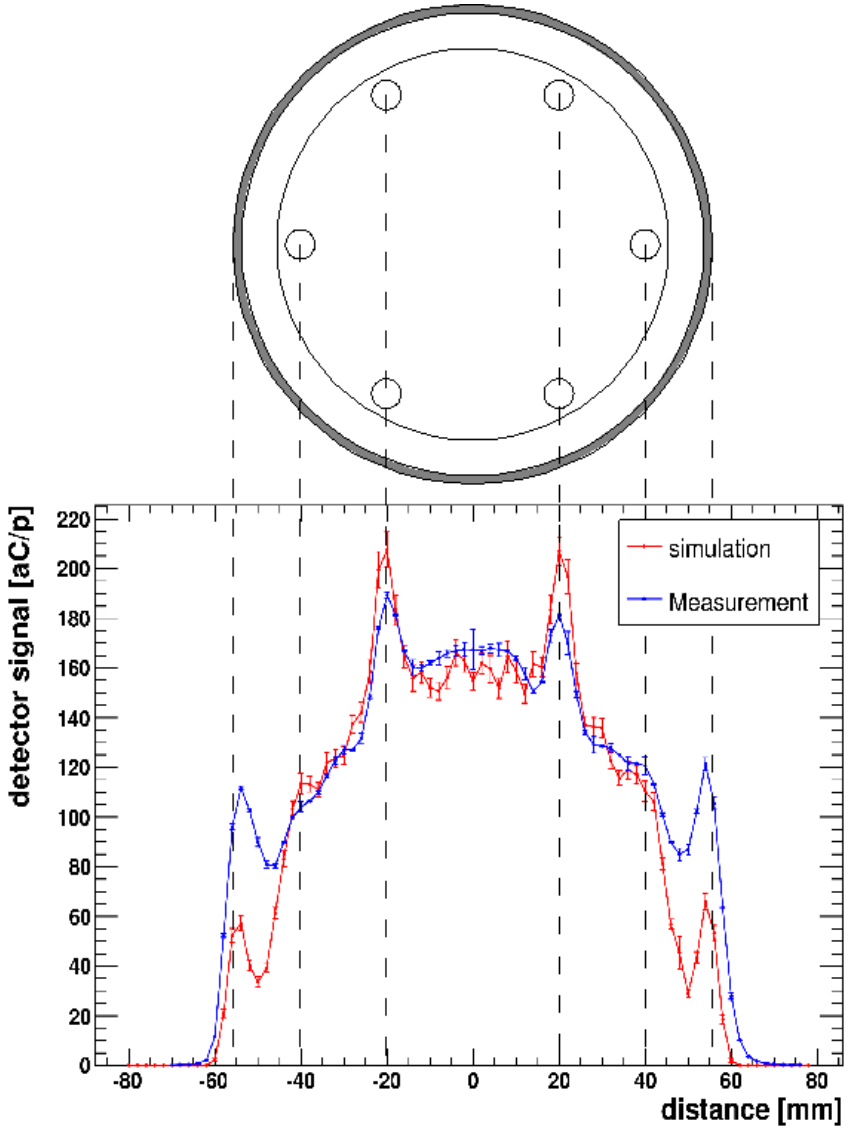


Detector response

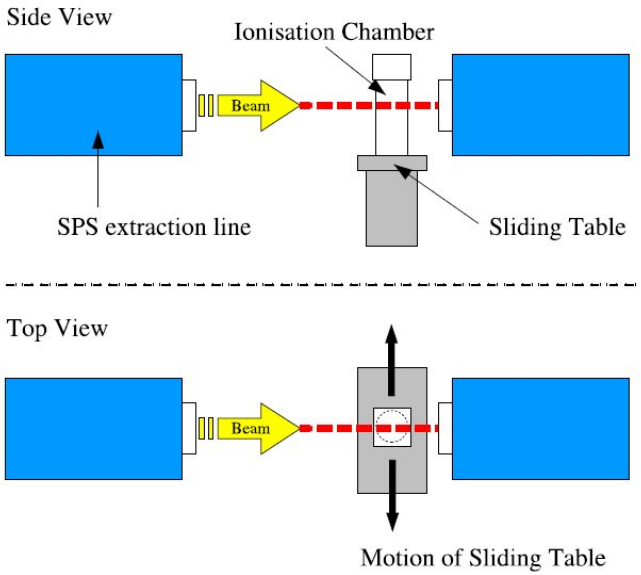


Integrated detector signal

Longitudinal impact direction



- Effect of the position of the beam
- When hitting electrode rods:
  - more secondary particles are created
  - Signal is about 50% larger



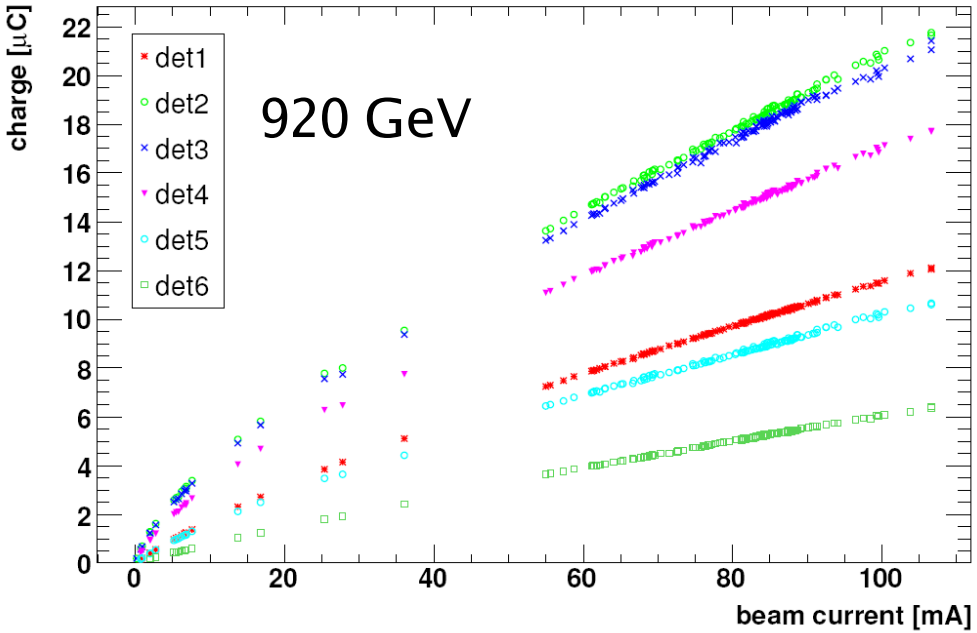
Tests with different particles

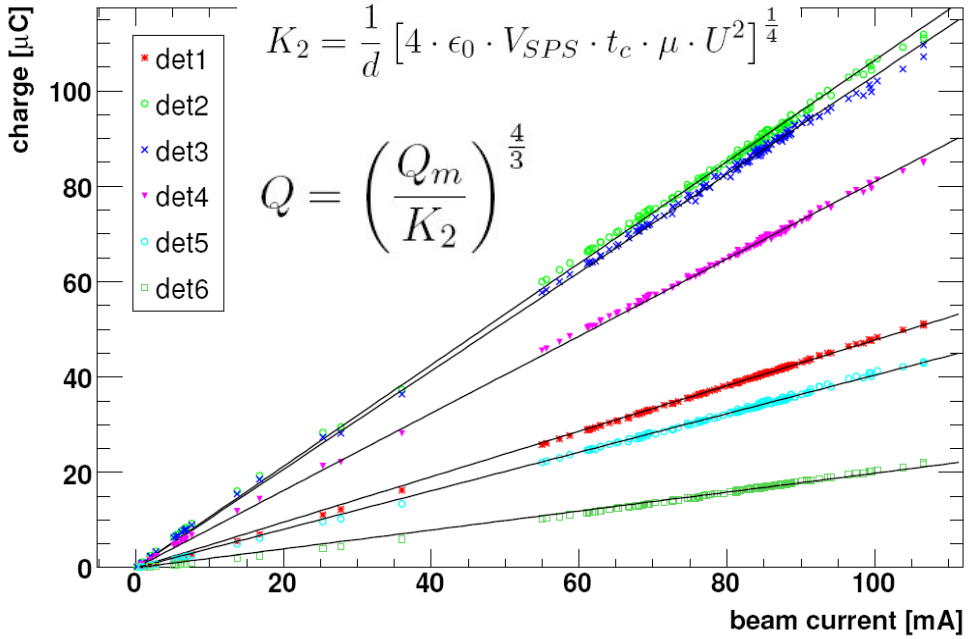
- Protons: SPS T2 extraction line, 400 GeV
  - Systematic uncertainty (inner structure): 11%
  - Measurements/simulations: 13%
- γ rays: ^{137}Cs, 662 keV, 30 μSv/h to 3 mSv/h
  - Measurements/simulations: 14%
  - Uncertainty: 12% (geometry in simulation, dose to fluence conversion factors)

Tests with different particles

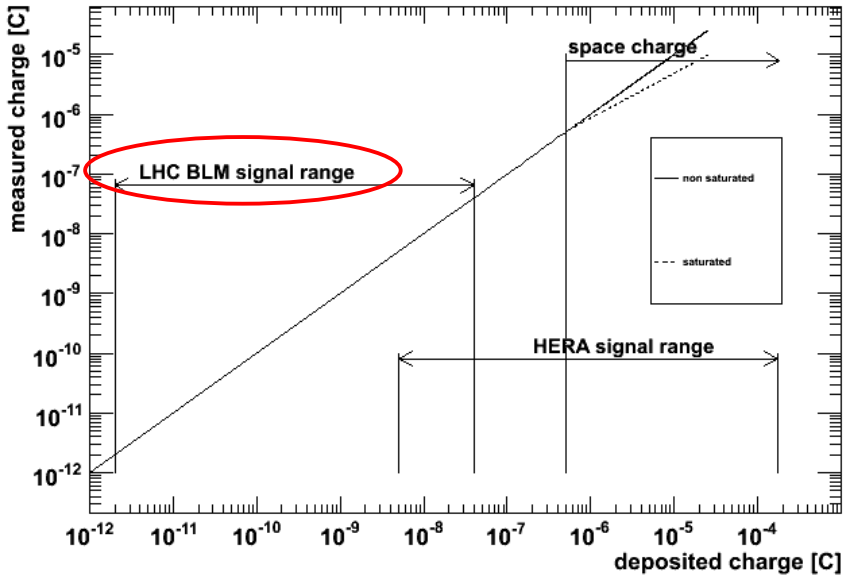
- Neutrons: 174 MeV, Svedberg Laboratory
  - Longitudinal: 13%±11.4%
  - Transversal: 37%±13.9%
- Mixed radiation field: CERF,
  - Copper target in a shower of 120 GeV/c hadrons
  - 6 detectors
  - Measurements/simulations: 12%
  - Detector 1: 21% (threshold on low energy particles)

Saturation effects
Correction factors

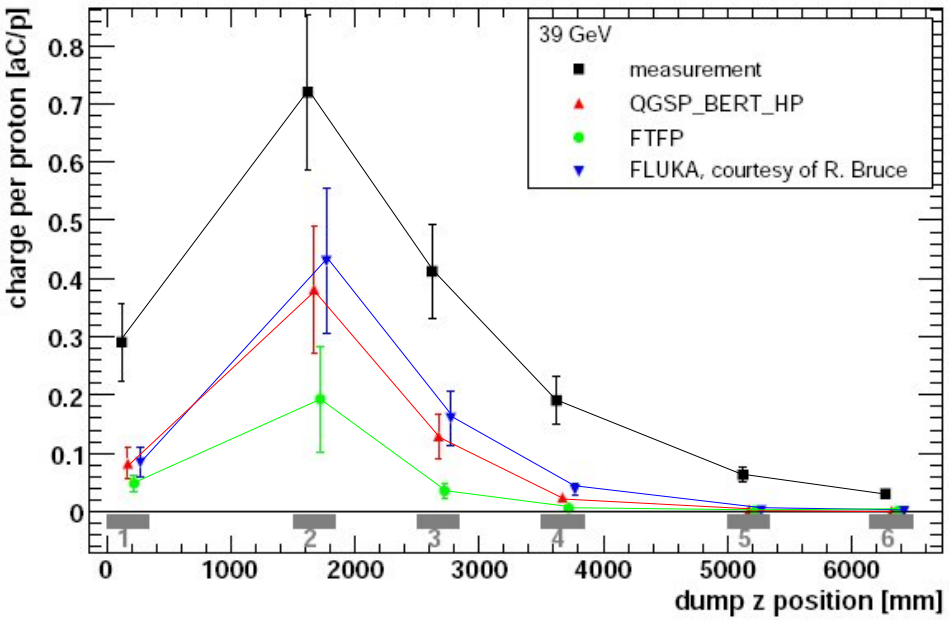


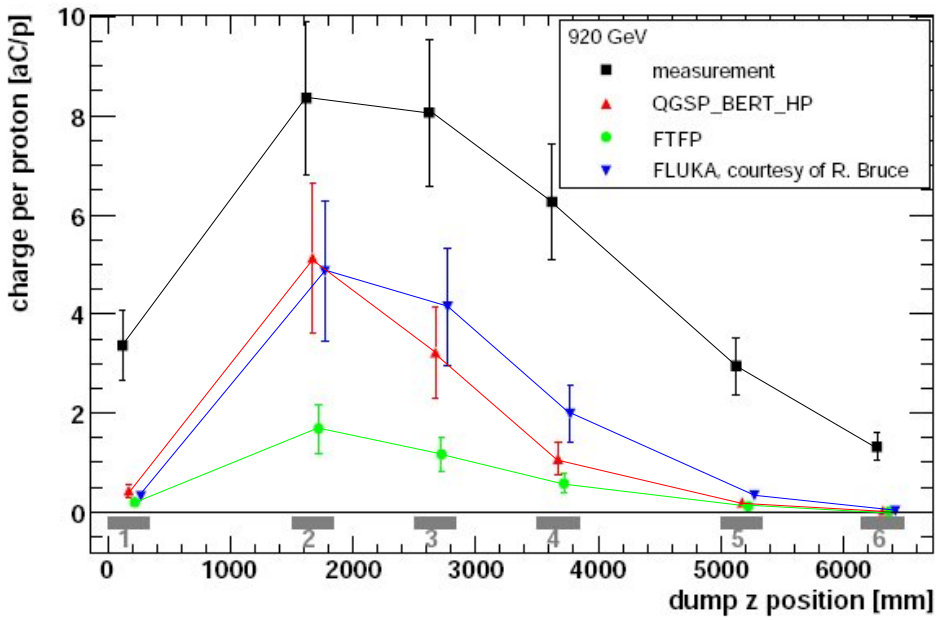


- Space charge effect
- Recombination losses
- Correction factors up to 5.12
- Depends on:
  - Exposition time (20 μs)
  - Voltage
  - Beam intensity
  - Created charges

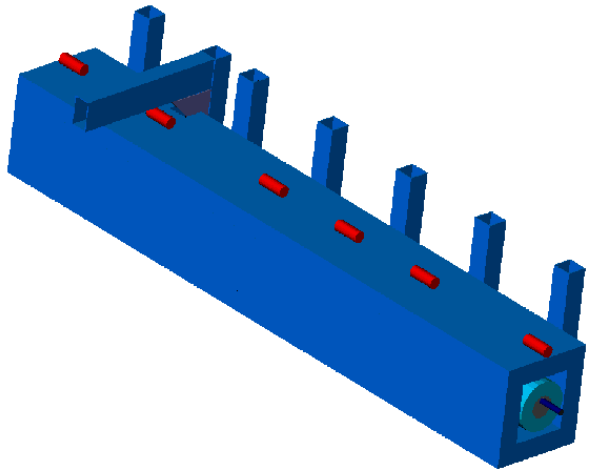


Measurement/simulation for HERA

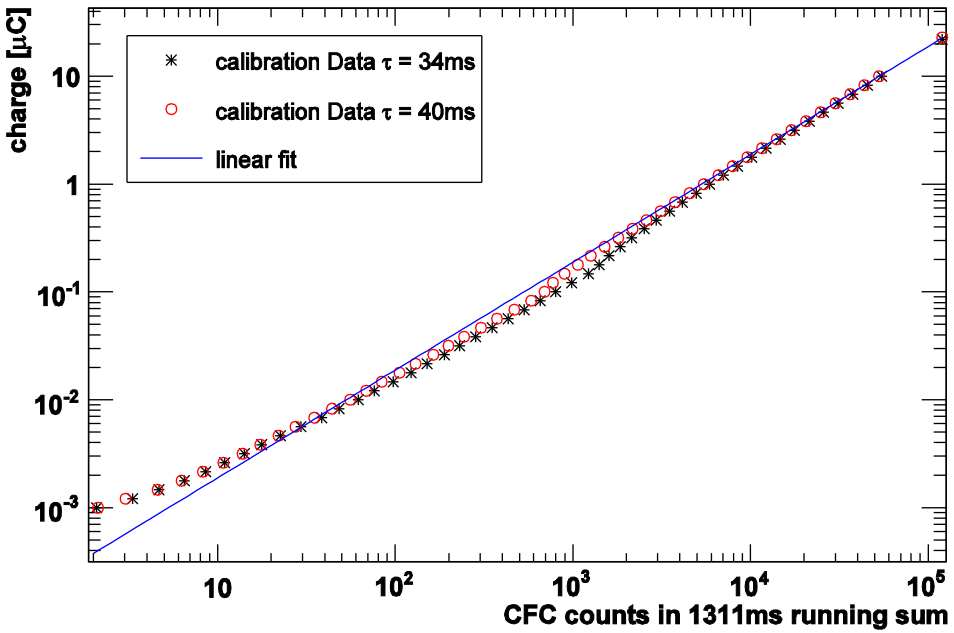




- Measurement results are higher than simulation
- FLUKA simulations are the most accurate ones
- Global shape OK, but 70% below measurements
- First detector: simulations far too low
- Difference between Hera and LHC is nuclear interaction length:
  - Hera: 16 λ_0
  - LHC: 10 λ_0



Calibration of the electronics



Induced charge
vs. CFC counts

- Non-linearity of electronics was corrected for charges lower than 0.15μC
- Counts measured in the 1311 ms running sum can be converted into μC

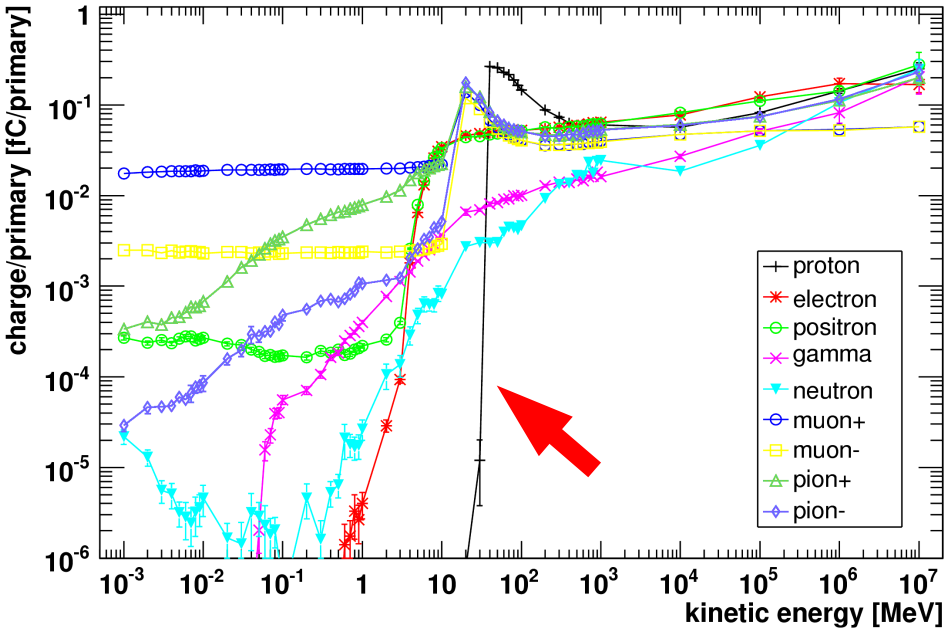
Conclusion

		rel. diff. [%]	Error [%]
protons experiment		13.1	11.4
gamma experiment		-14.3	12.1
neutrons experiment	long.	-12.6	11.4
	trans.	-37.4	13.9
CERF experiment	det.		
	1	-21	14.1
	2	-	-
	3	5	10.9
	4	12.5	11.4
	5	11.7	10.8

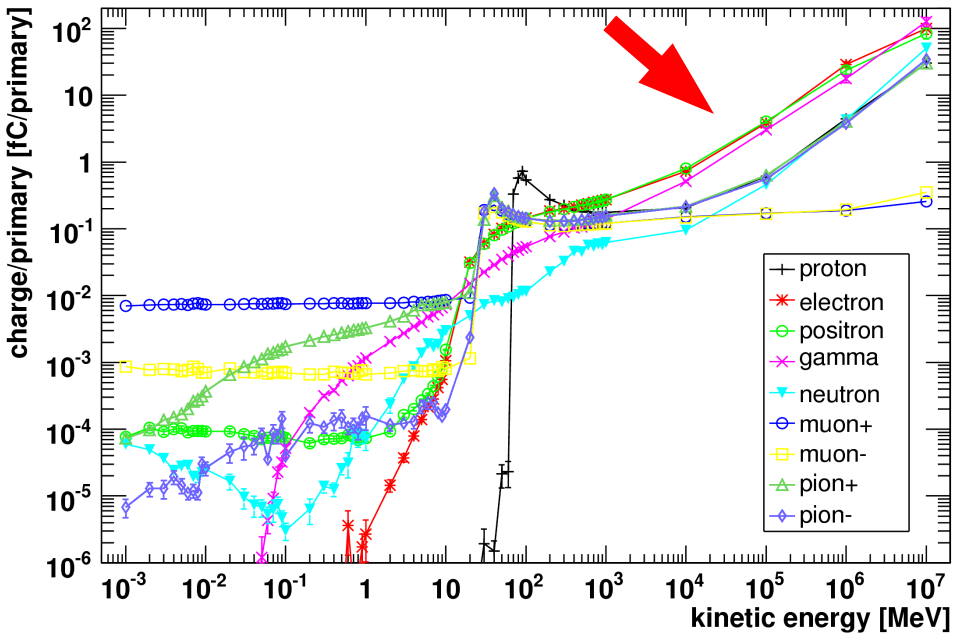
Extra slides

Charge deposition

Transversal:
steel wall thickness = 2 mm

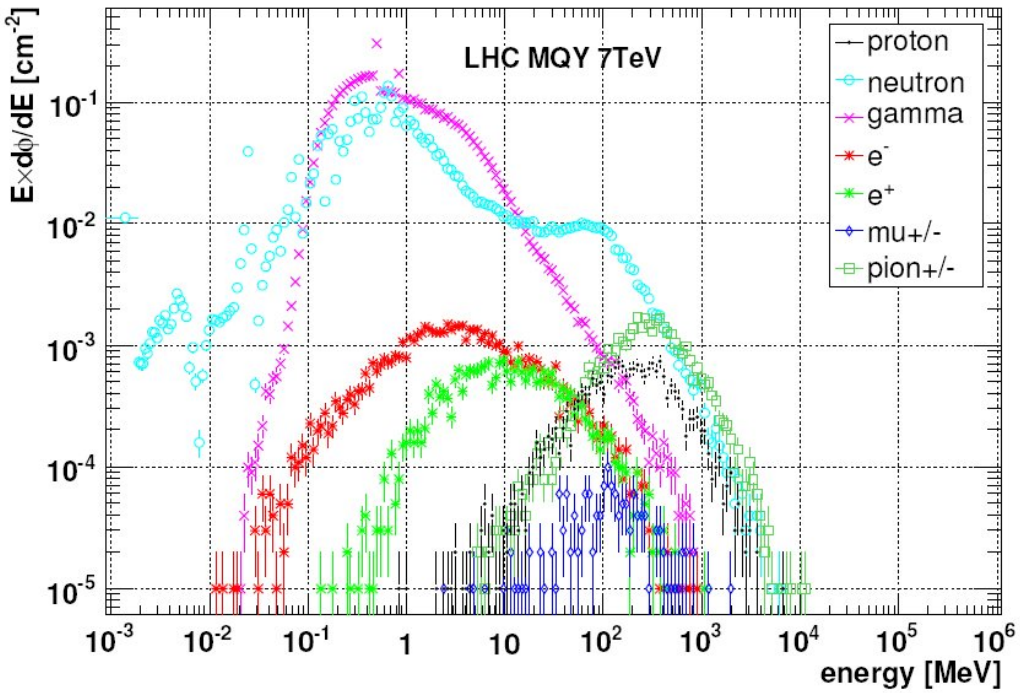


Longitudinal:
steel wall thickness = 5 and 8 mm



- Particles are able to create a secondary shower
- Threshold: energy needed to go through the steel wall

Charge deposition



Particles spectrum

Convoluted response