



Beam loss monitoring study @GSI

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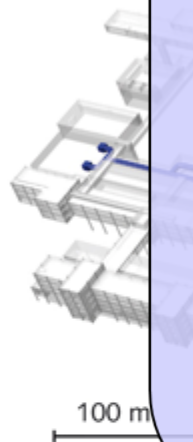
2nd FLUKA Advanced Course and Workshop – Vancouver 2012 (September 15-20, 2012)

Motivation

BUT some problems:

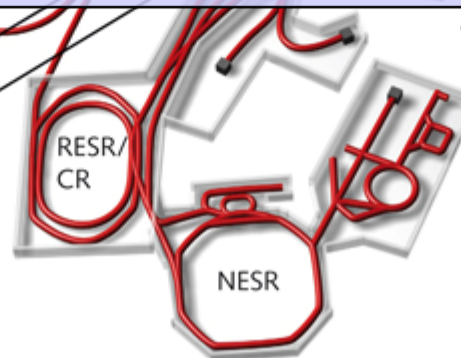
We have to

- know: **how**, **where**, **how many** particles we lose
- prevent of superconducting magnet quenching
- protect the machine components from radiation damage
- protect the personnel against unwanted activated radiation from components of the machine



Highest Beam Intensities
Brilliant Beam Quality
Higher Beam Energies
Highest Beam Power

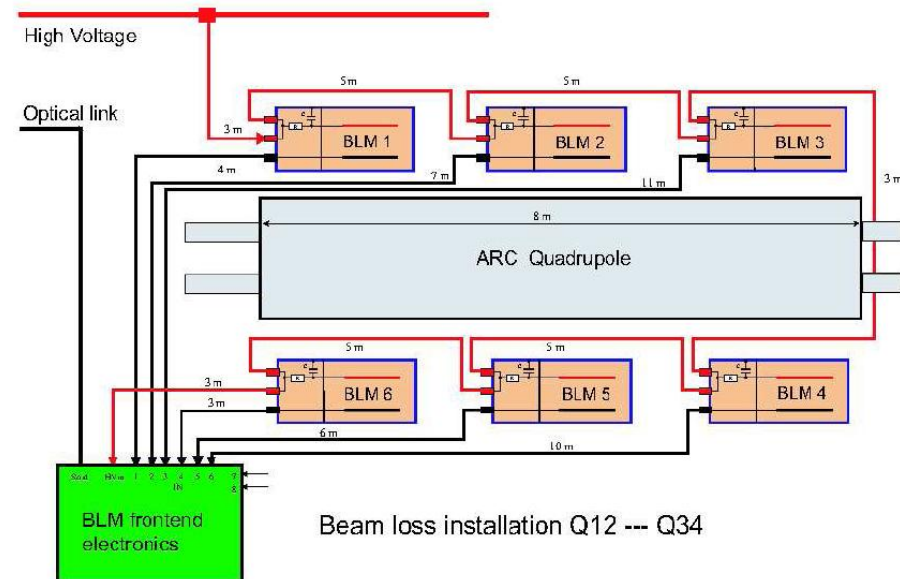
Plasmaphysik
Atomphysik



- existierende Anlage
- neue Anlage
- Experimente

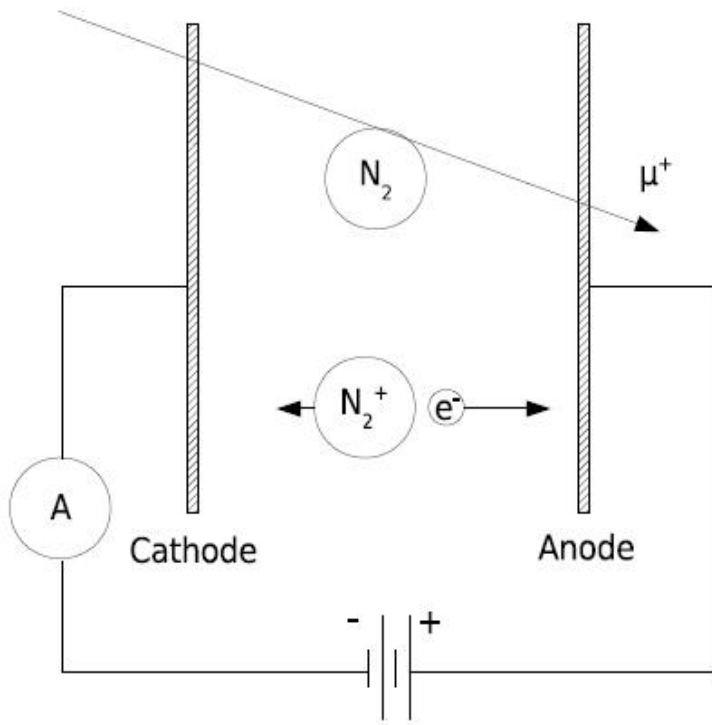
BLM system @ CERN (1)

- 6 detectors around the quadrupole magnet
- total amount: 4000
- closer to beamline
- Critical parameter for magnet quenching: few $\frac{mJ}{cm^3}$



Source: M. Stockner. Beam Loss Calibration Studies for High Energy Proton Accelerators, PhD Thesis

BLM detectors @CERN (2)



- Type: Ionization chambers
- Working gas: Nitrogen
- W-factor: 25-35 eV/e-ion pair
- Sensitive volume



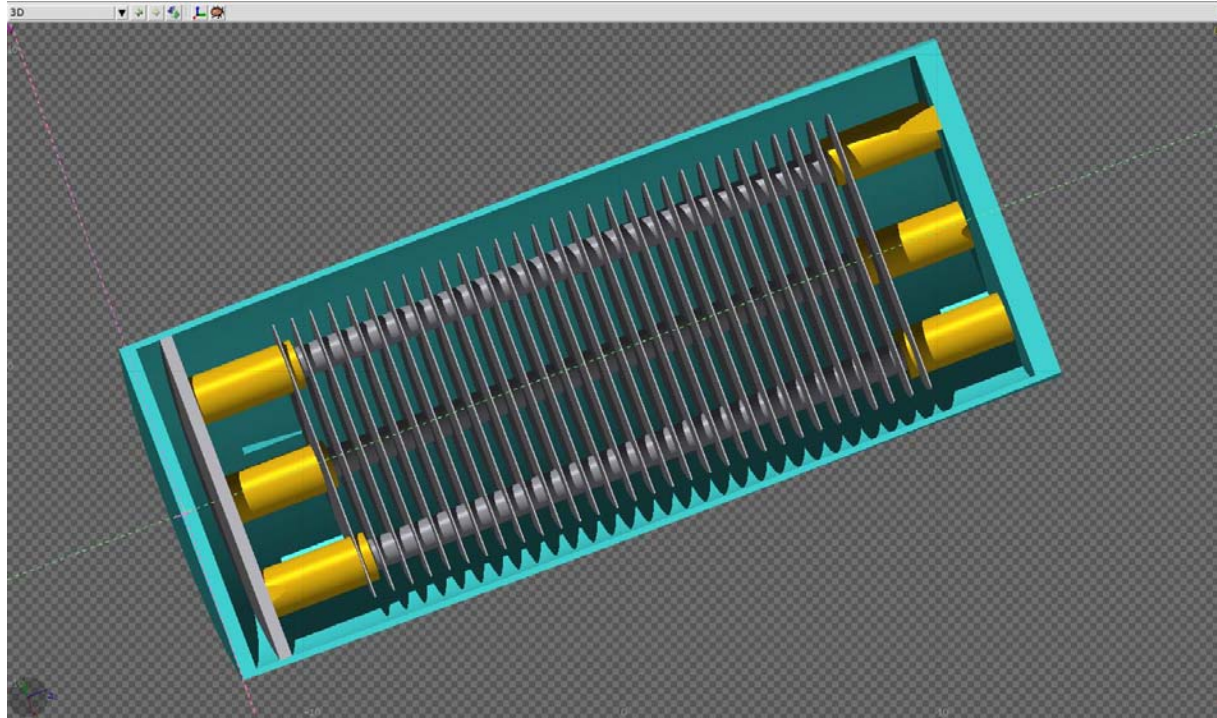
LHC type



SPS type

Simulation of SPS and LHC ionization chamber response

- FLUKA model of SPS ionization chamber. **GeoViewer 3D Plot**

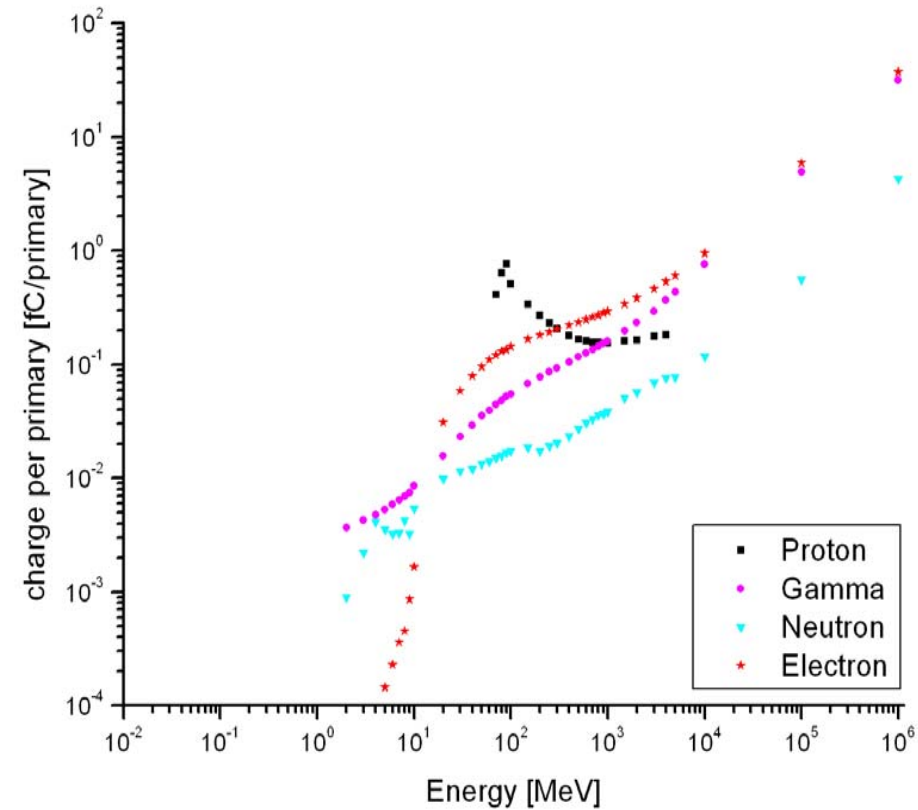


- Two tasks were solved:
 - Benchmarking FLUKA/Geant4
 - Response function for SPS ionization chamber
- The strategy of simulation:
 - Calculation of ED (energy deposition): [GeV/primary particle]
 - Calculation of the charge: [fC/primary particle]

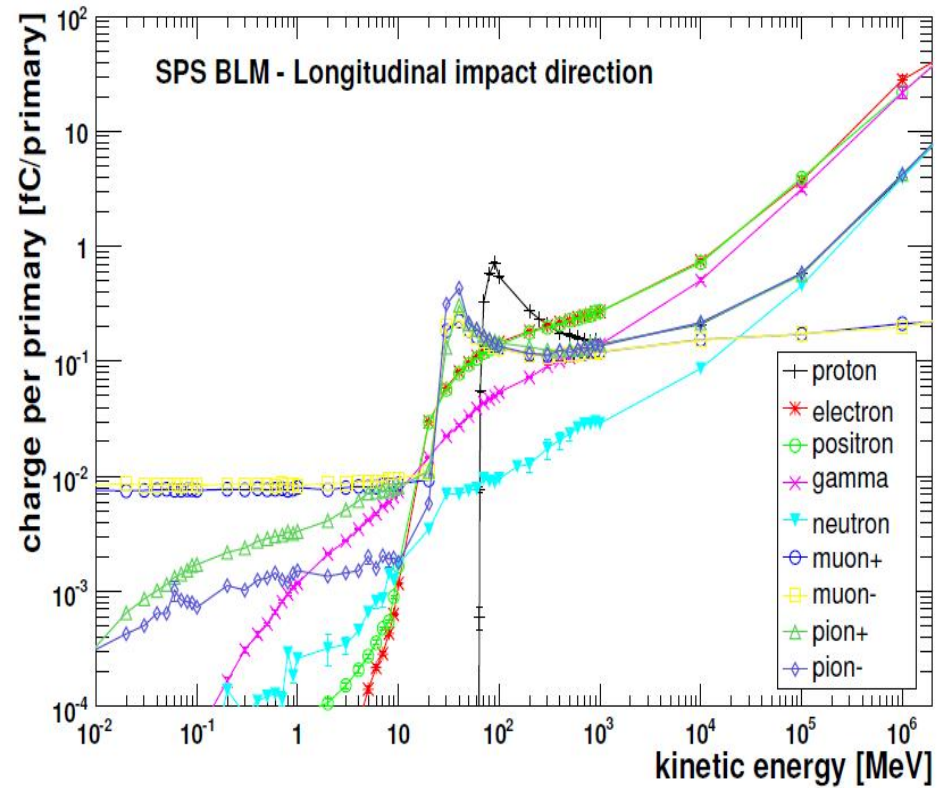
$$\text{Charge} = ED \cdot 0.04603 \cdot 10^{-10} \frac{C}{\text{primary}}$$

USRBIN		Type: Region ▼		R1from: EFV1 ▼	Unit: 22 ASC ▼	Name:
Part: ENERGY ▼		R2from: ▼	R3from: ▼	R1to: EFV30 ▼	R2to: ▼	Step1: 1.0
				R3to: ▼		Step2:
						Step3:
*...+...1...+...2...+...3...+...4...+...5...+...6...+...7...+...						
USRBIN	12.	ENERGY	22.	EFV30		
USRBIN	EFV1			1.0		
						&

SPS ionization chamber response (benchmarking) (1)

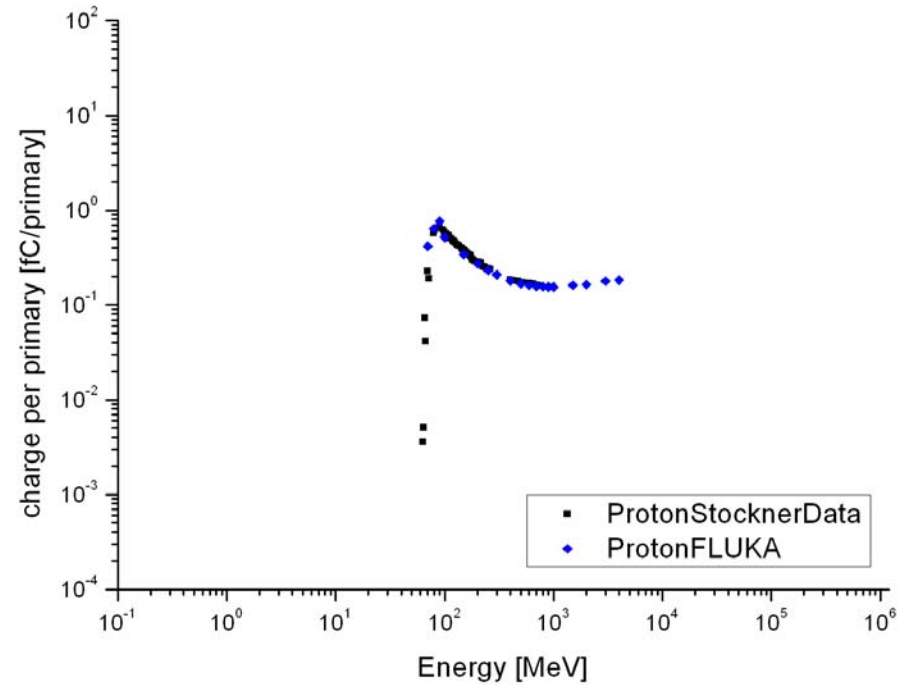
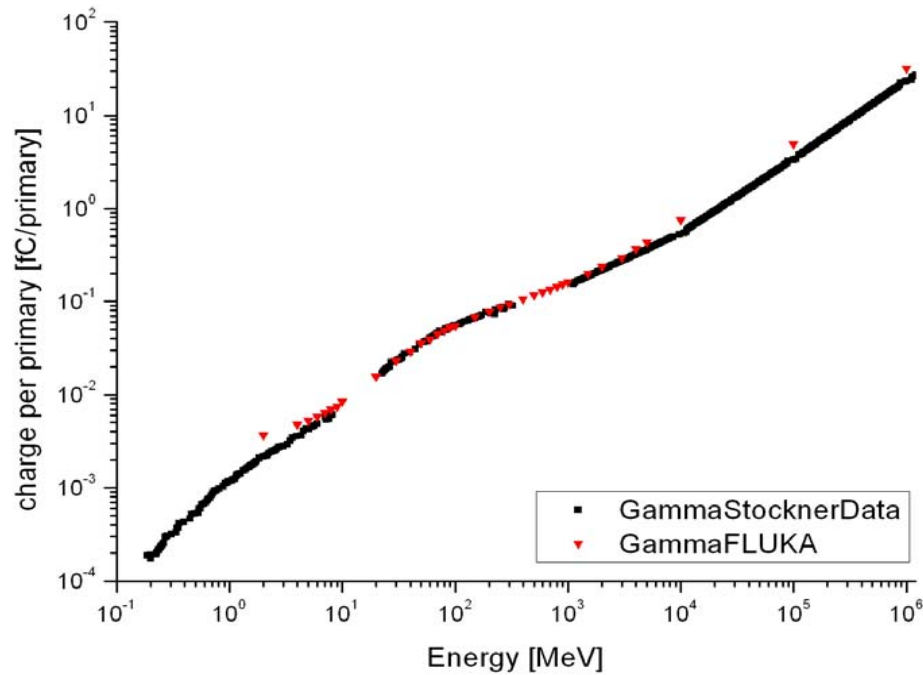


FLUKA simulation



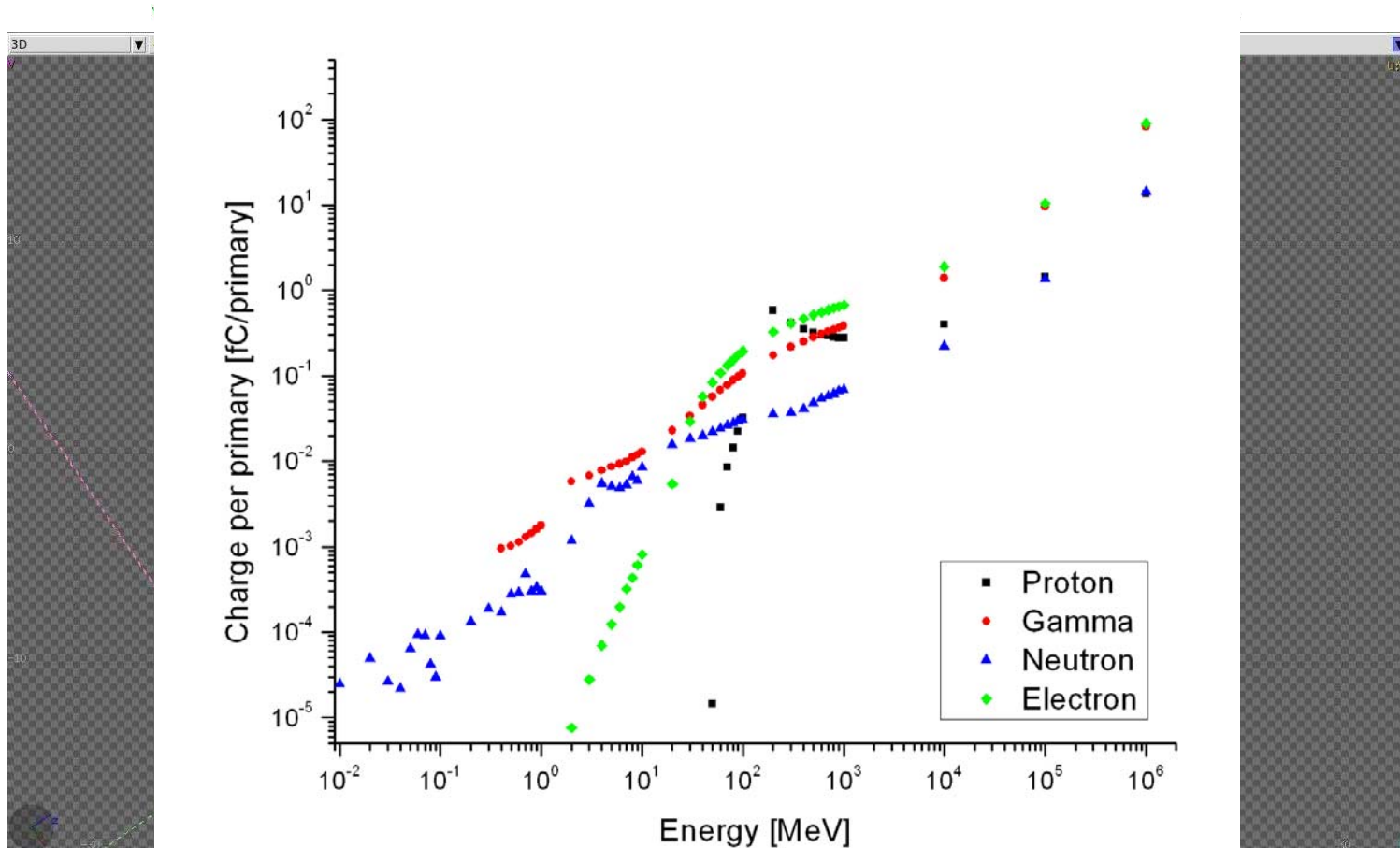
GEANT4 simulation

SPS ionization chamber response (benchmarking) (2)



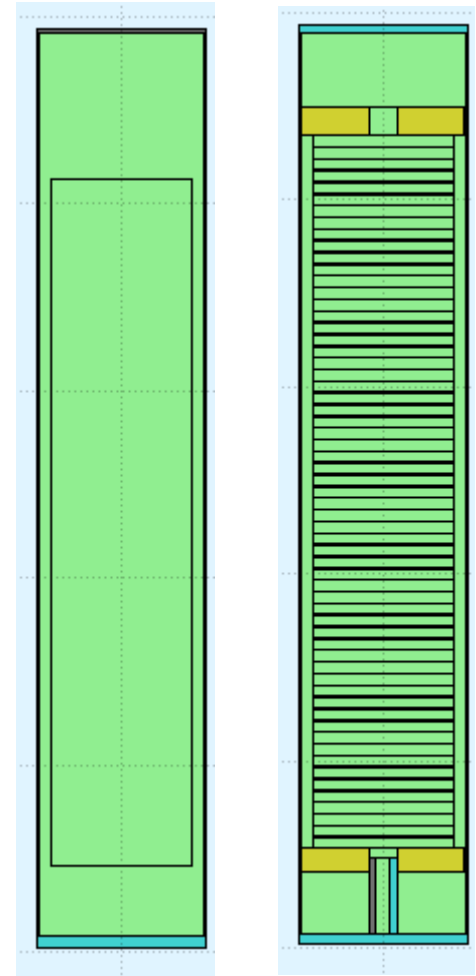
LHC ionization chamber response

FLUKA model of LHC ionization chamber. *GeoViewer Cuts and 3D Plot*



Beam-loss experiment @HTP (1)

- Beam loss target: Copper cylinder
 - 8cm diameter
 - 2cm length
- Take into account target holder
 - Aluminum
- Beam parameters:
 - Uranium ions
 - Energy: 300MeV/u – 900MeV/u
 - Intensity: 10^7 – 10^9 particles
- Place:
 - HTP cave
- Tasks for simulation:
 - Contribution into energy deposition from different particles
 - BLMs response without the inner structure
 - BLM response with the inner structure
 - Comparison: experimental data vs. simulation



Beam-loss experiment @HTP (2)

Scheme of the experiment



Beam-loss experiment @HTP (3)

Energy deposition inside the BLM effective volume for different particles

- Beam Loss Monitor 1
- Beam energy 900 MeV/u
- Inner structure is not taken into account

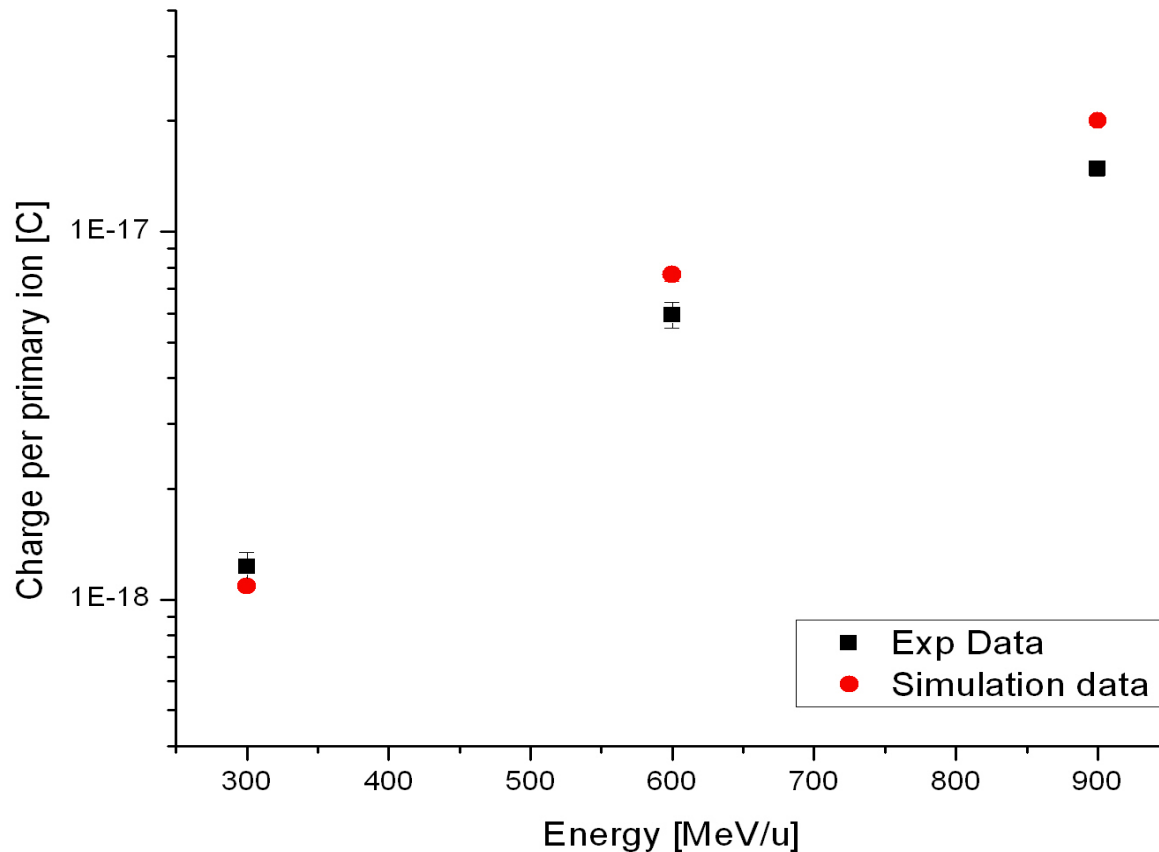
AllPart	Proton	p+	p-	Neutron	e+	e-	mu+	mu-	Photon
100	69.3	1.4	3.0	3.5	2.8	7.6	0.2	0.2	1.15

Particles inside the BLM1

USRBIN	Type: Region ▼ Part: ENERGY ▼	R1from: EffV ▼ R2from: ▼ R3from: ▼	Unit: 21 BIN ▼ R1to: EffV ▼ R2to: ▼ R3to: ▼	Name: 1stDtAIP Step1: Step2: Step3:
AUXSCORE		Type: USRBIN ▼ Det: 1stDtAIP ▼	Part: ALL-PART ▼ to Det: 1stDtAIP ▼	Set: ▼ Step:
USRBIN	Type: Region ▼ Part: ENERGY ▼	R1from: EffV ▼ R2from: ▼ R3from: ▼	Unit: 22 BIN ▼ R1to: EffV ▼ R2to: ▼ R3to: ▼	Name: 1stDtProt Step1: Step2: Step3:
AUXSCORE		Type: USRBIN ▼ Det: 1stDtProt ▼	Part: PROTON ▼ to Det: 1stDtProt ▼	Set: ▼ Step:

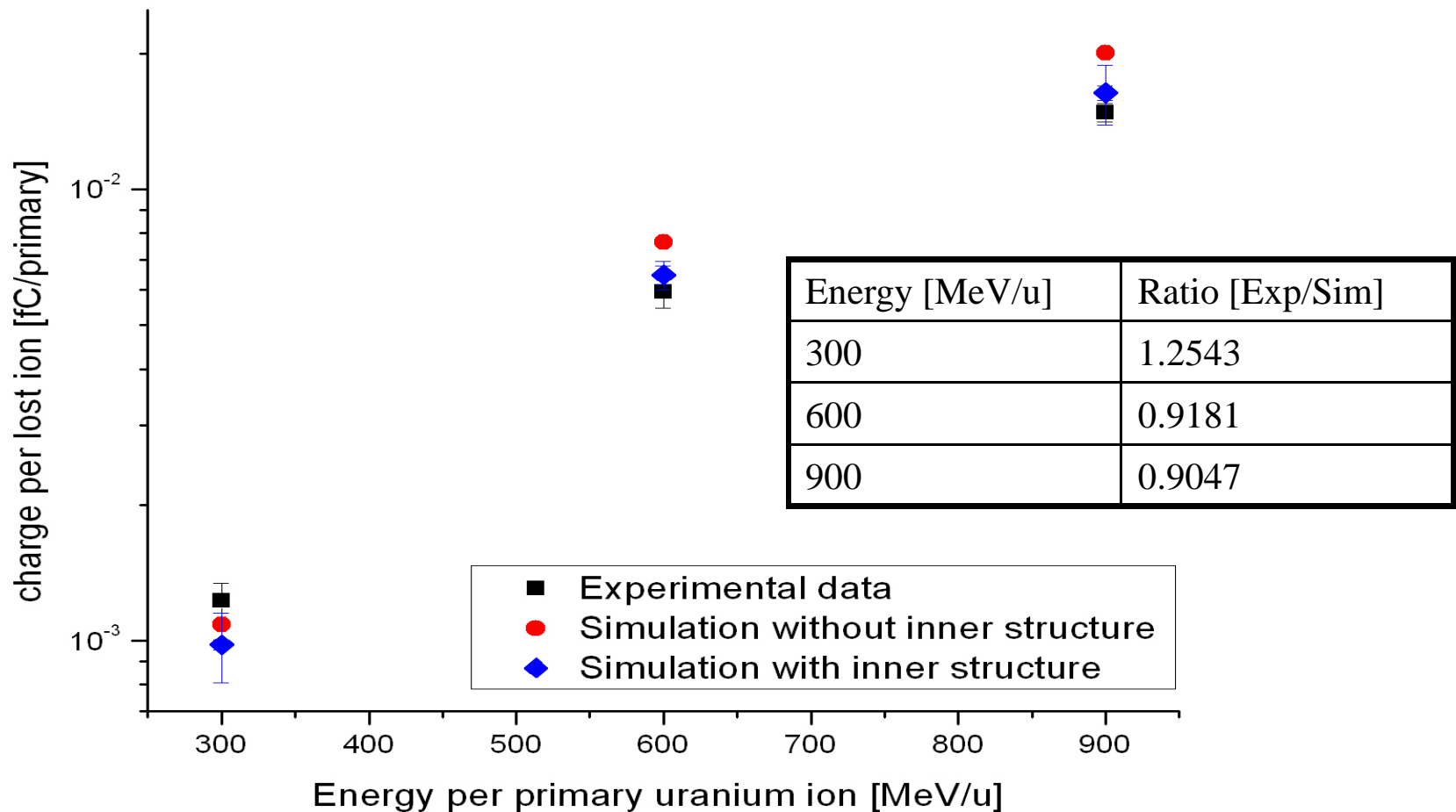
Beam-loss experiment @HTP (4)

- Response function: experimental data vs. simulation.
 - Beam Loss Monitor 1
 - inner structure is **not** taken into account



Beam-loss experiment @HTP (4)

- Response function: experimental data vs. simulation.
 - Beam Loss Monitor 1
 - inner structure is **taken** into account



Summary

- Fluka simulations were done:
 - SPS Response
 - LHC Response
 - Simulations of real beam-loss experiment were done
- Experimental data were obtained
- Comparison between simulation and experimental data was done
- Next steps
 - Definition of beam loss scenario for simulation:
SIS18, SIS100
 - Estimate signal from BLMI