Response of a PMI Chamber exposed to Mixed High-Energy Radiation Fields

Simulations and Measurements

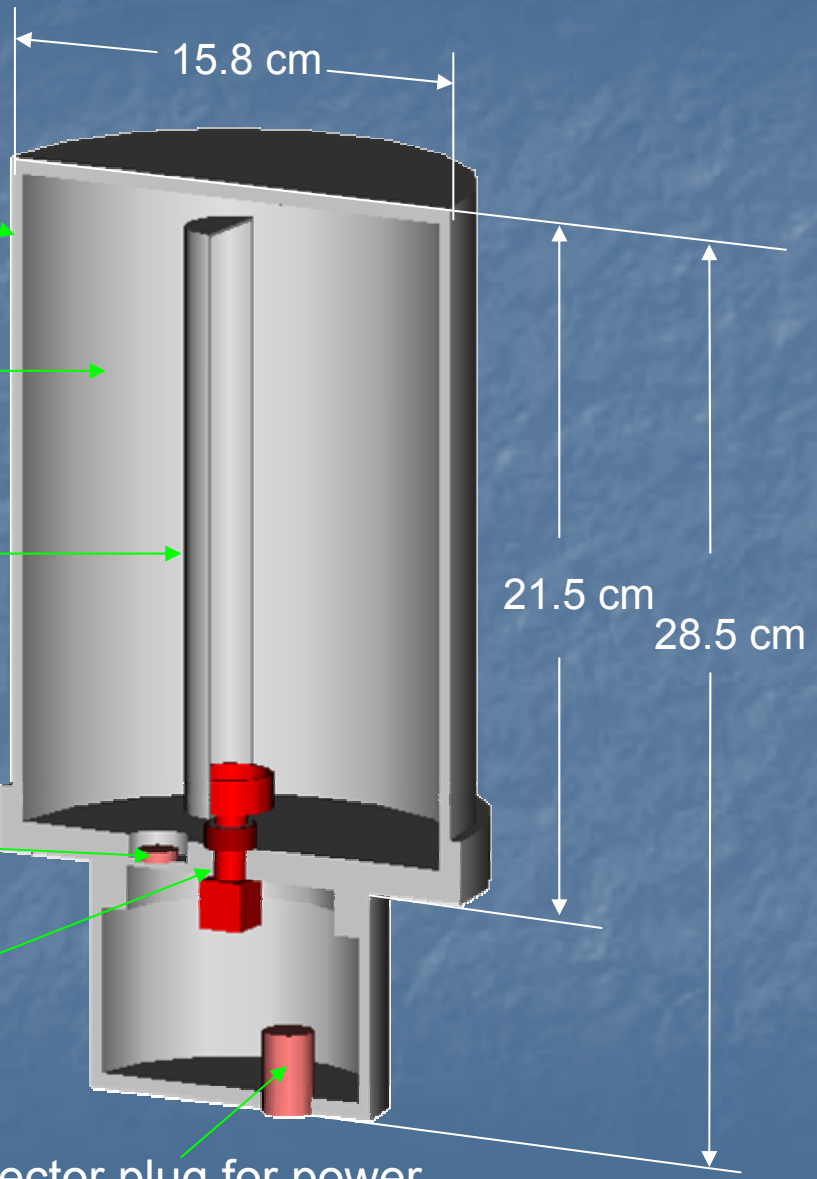
Helmut Vincke, Norbert Aguilar, Doris Forkel-Wirth, Michele Pangalo, Daniel Perrin, Michel Renou, Chris Theis

TIS-RP

Contents

- Details about PMI chamber
- Experimental area + set-up
- Simulation results
- Measurement results
- Comparison between simulation and measurement
- Conclusion

Simulation picture of the PMI chamber



PE hull (4mm) / inside graphite coated

Active volume

Anode: PE / graphite coated

Connector to cathode

Connector to anode

Connector plug for power supply and signal outlet

Hull composition: C-H_2

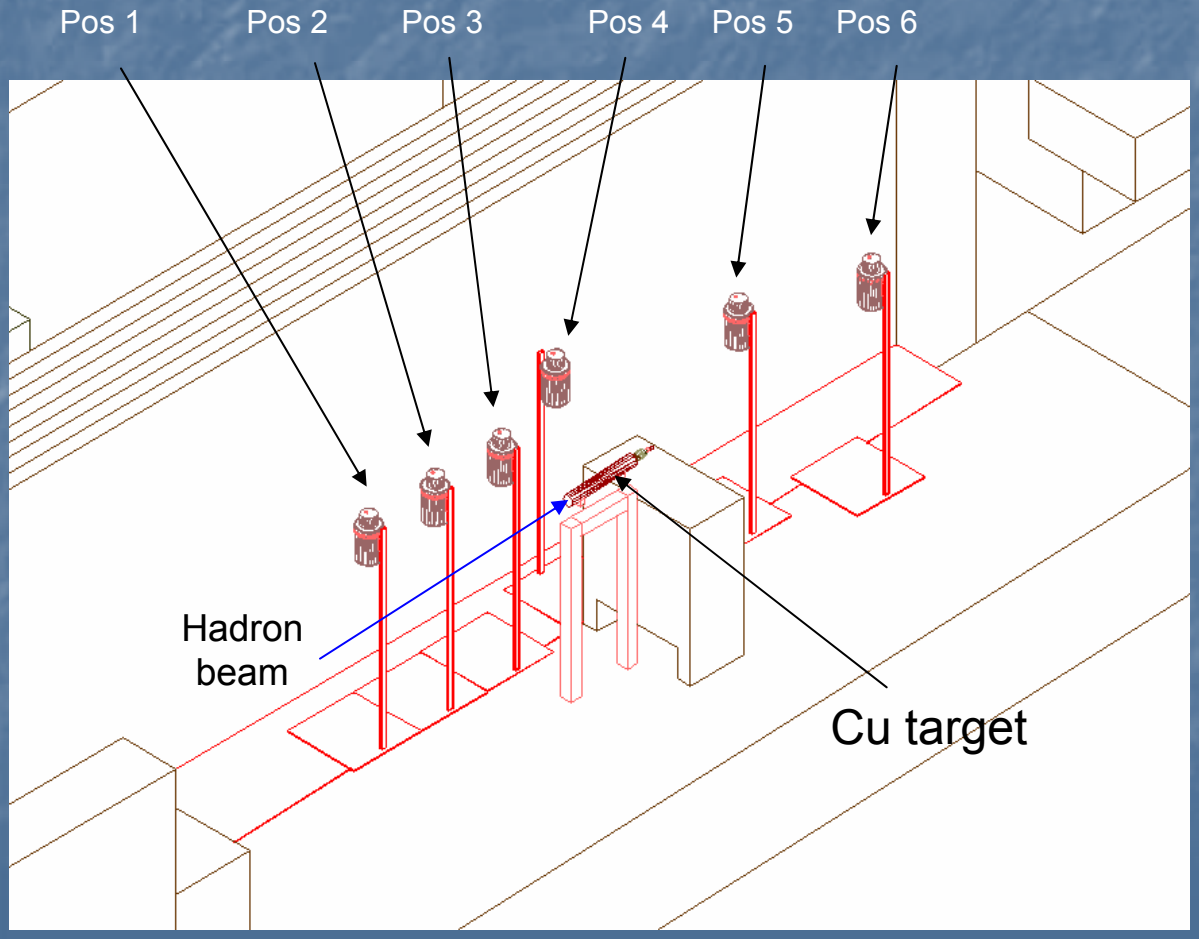
Filling gas: air atmospheric pressure

Active volume: 3l

Working voltage: ~460 V

Experimental set-up in the CERF target area

SPS secondary hadron beam is hitting a copper target ➔ leading to irradiation of the PMI chambers with different radiation fields at various positions.



Beam parameters:

Momentum:
120 GeV/c

Intensity:
$9*10^7$ hadrons/
SPS extraction

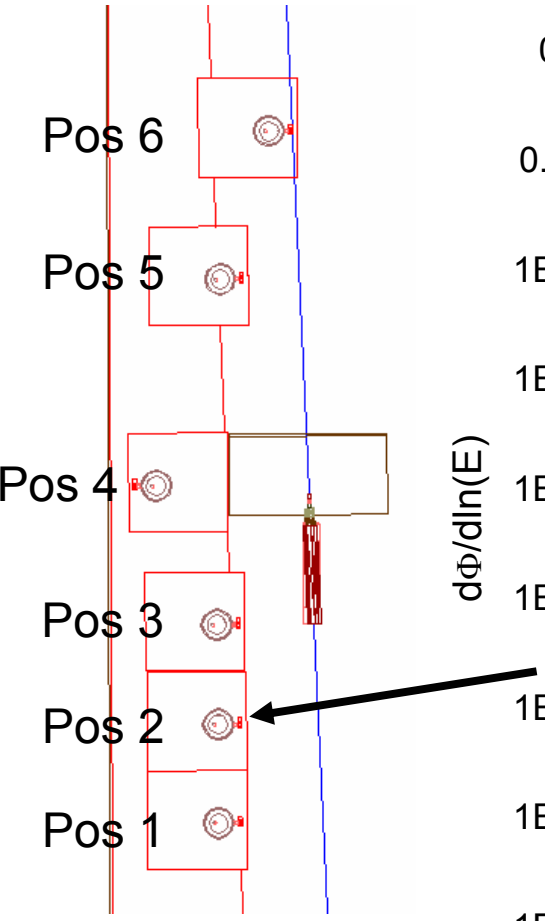
Beam composition:
60.7% π^+
34.8 % protons
4.5 % K^+

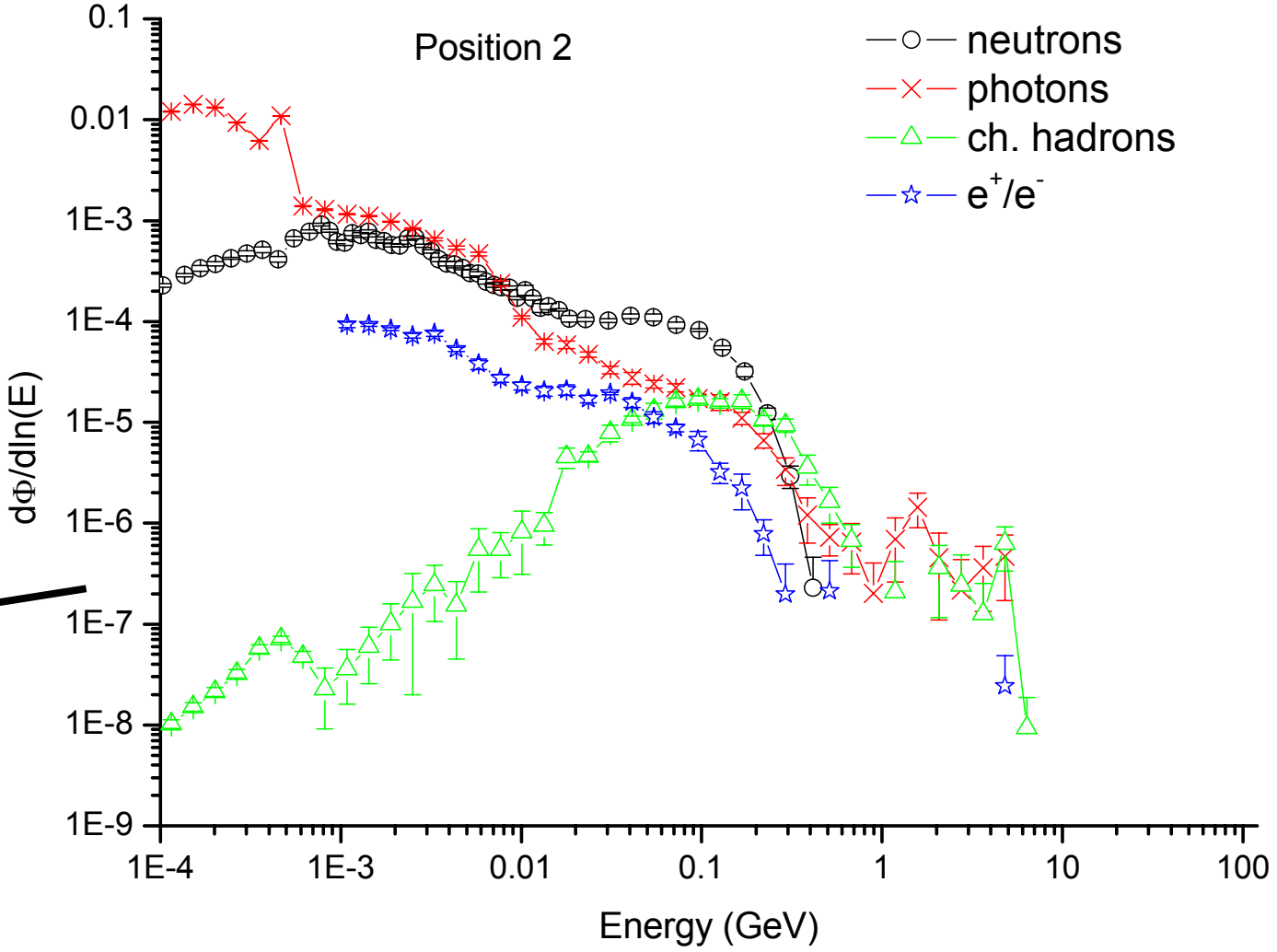
Simulation results

- Analysis of the fluence reaching the various detector positions.
- Analysis of the simulated counting rate at the various detector positions.

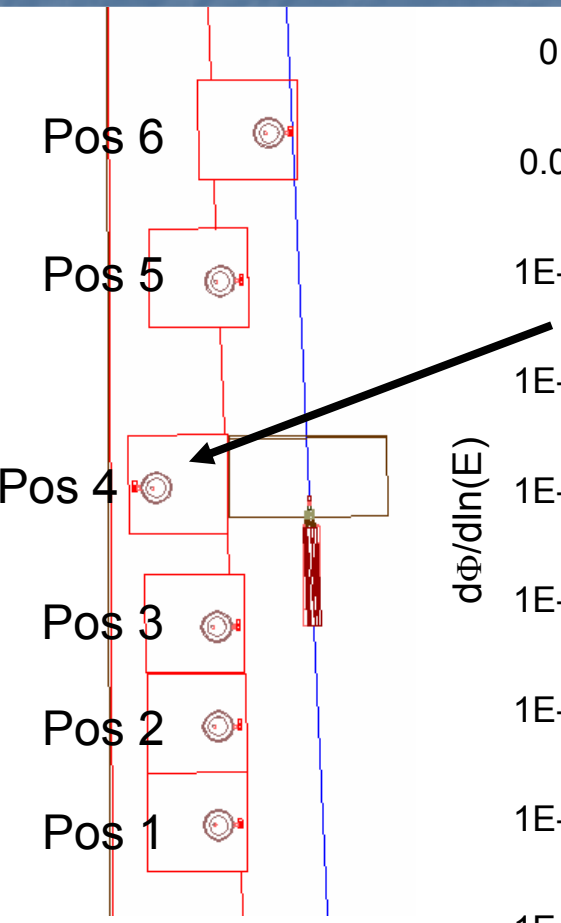
Analysis of the fluence reaching the various detector positions

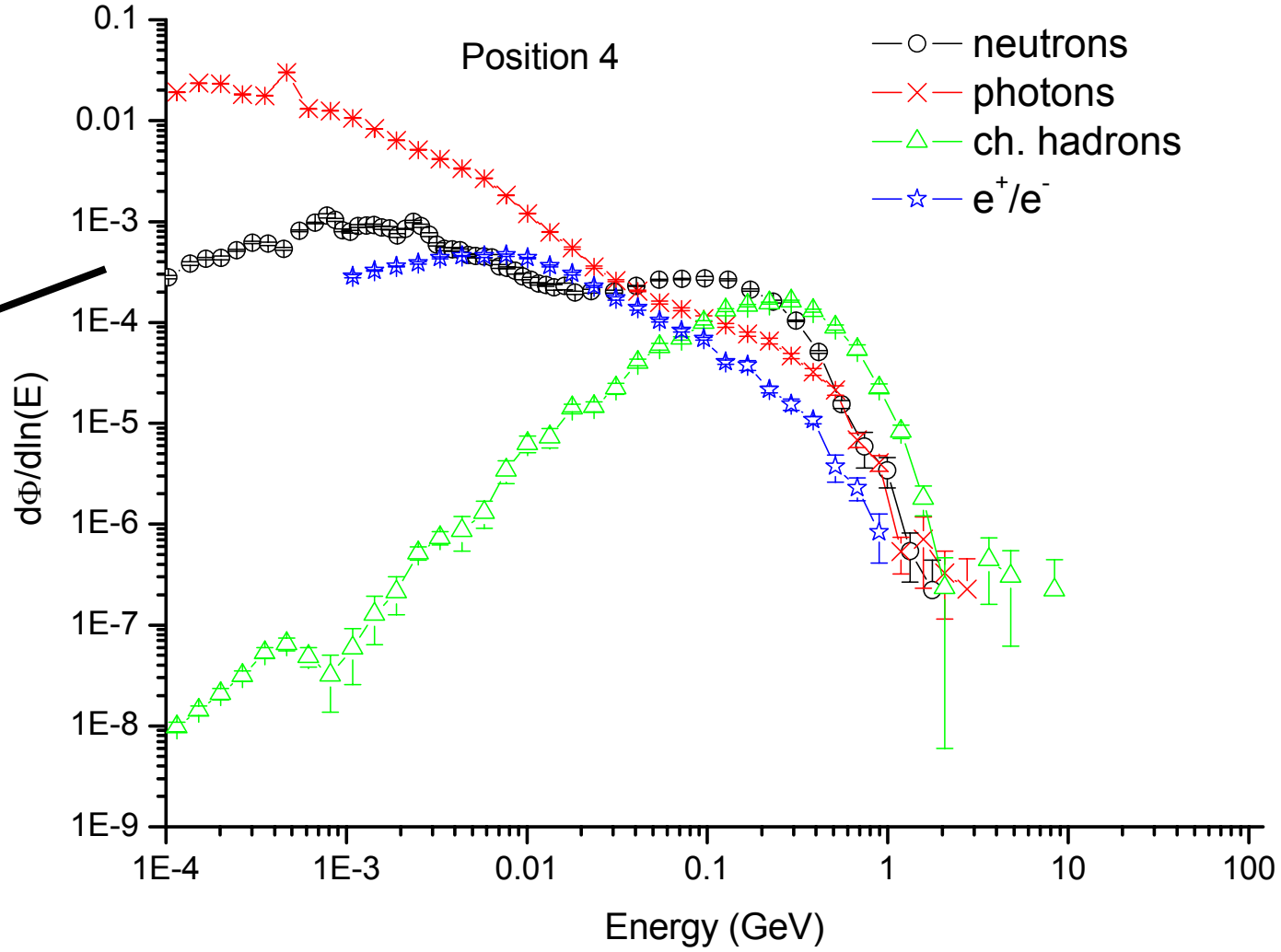
Particle fluence at detector position 2



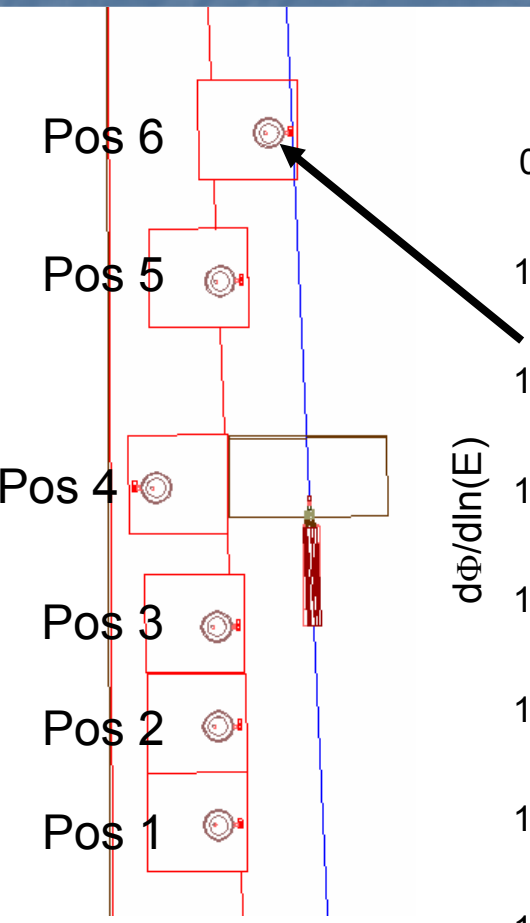


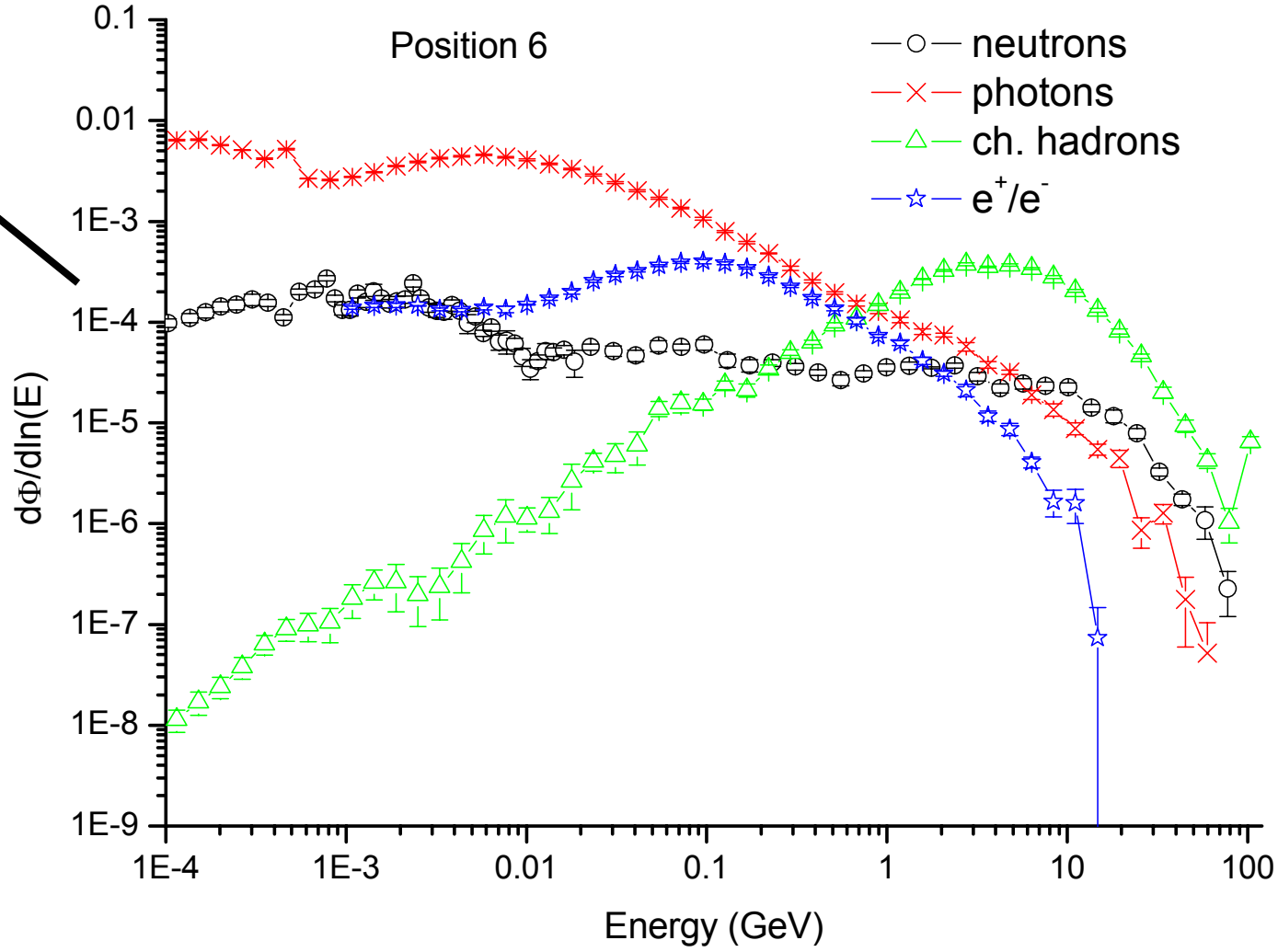
Particle fluence at detector position 4



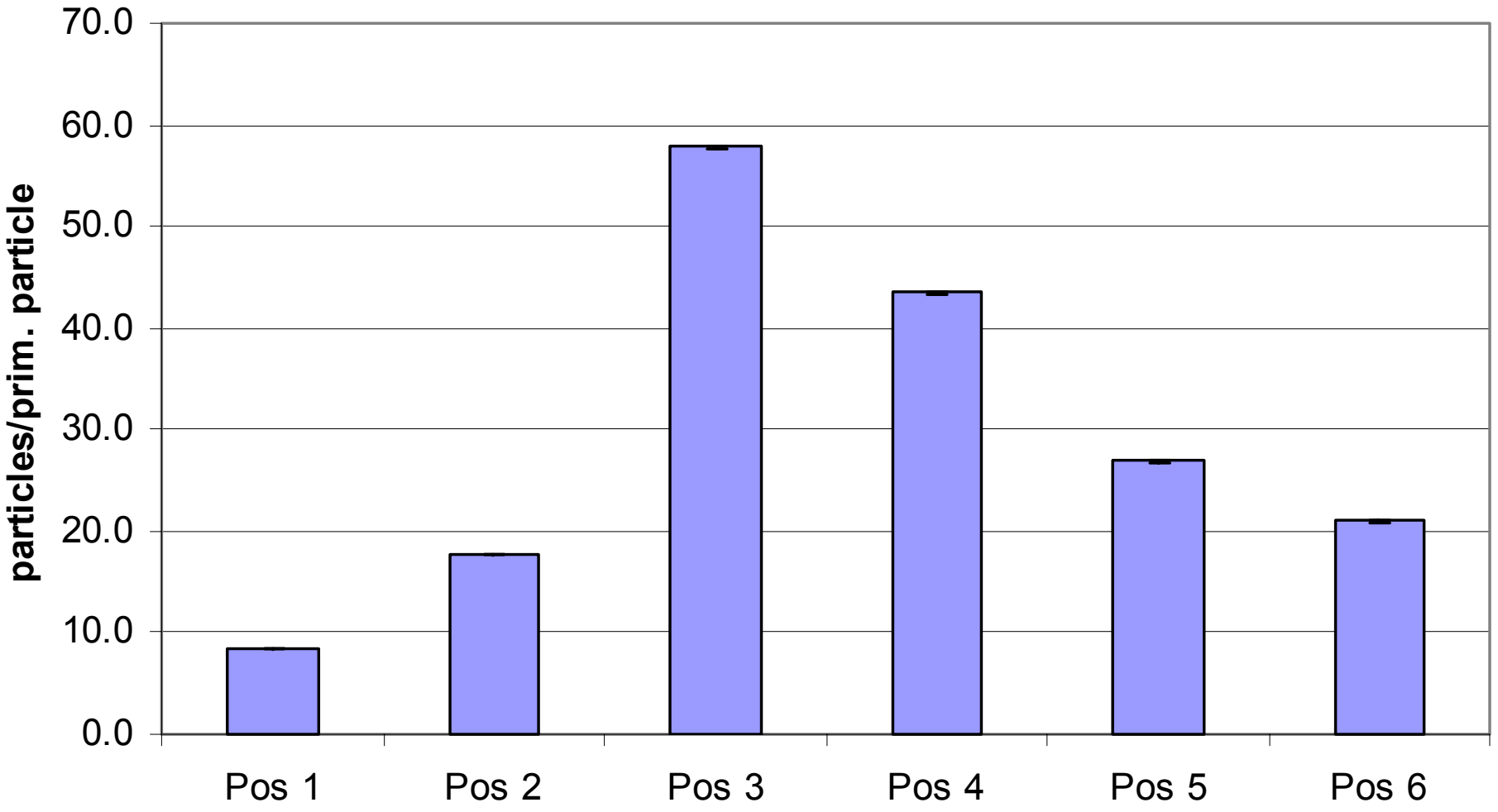


Particle fluence at detector position 6

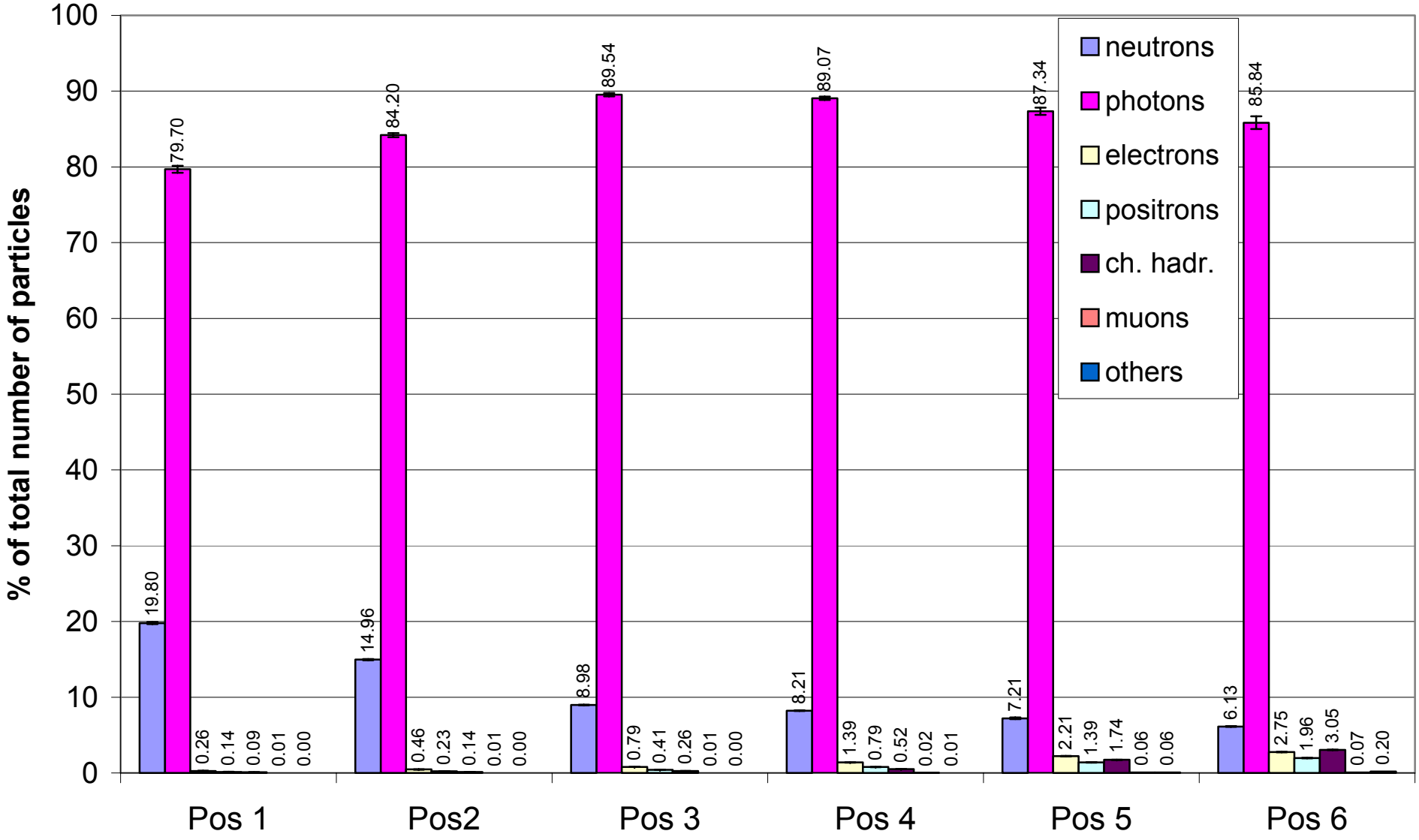




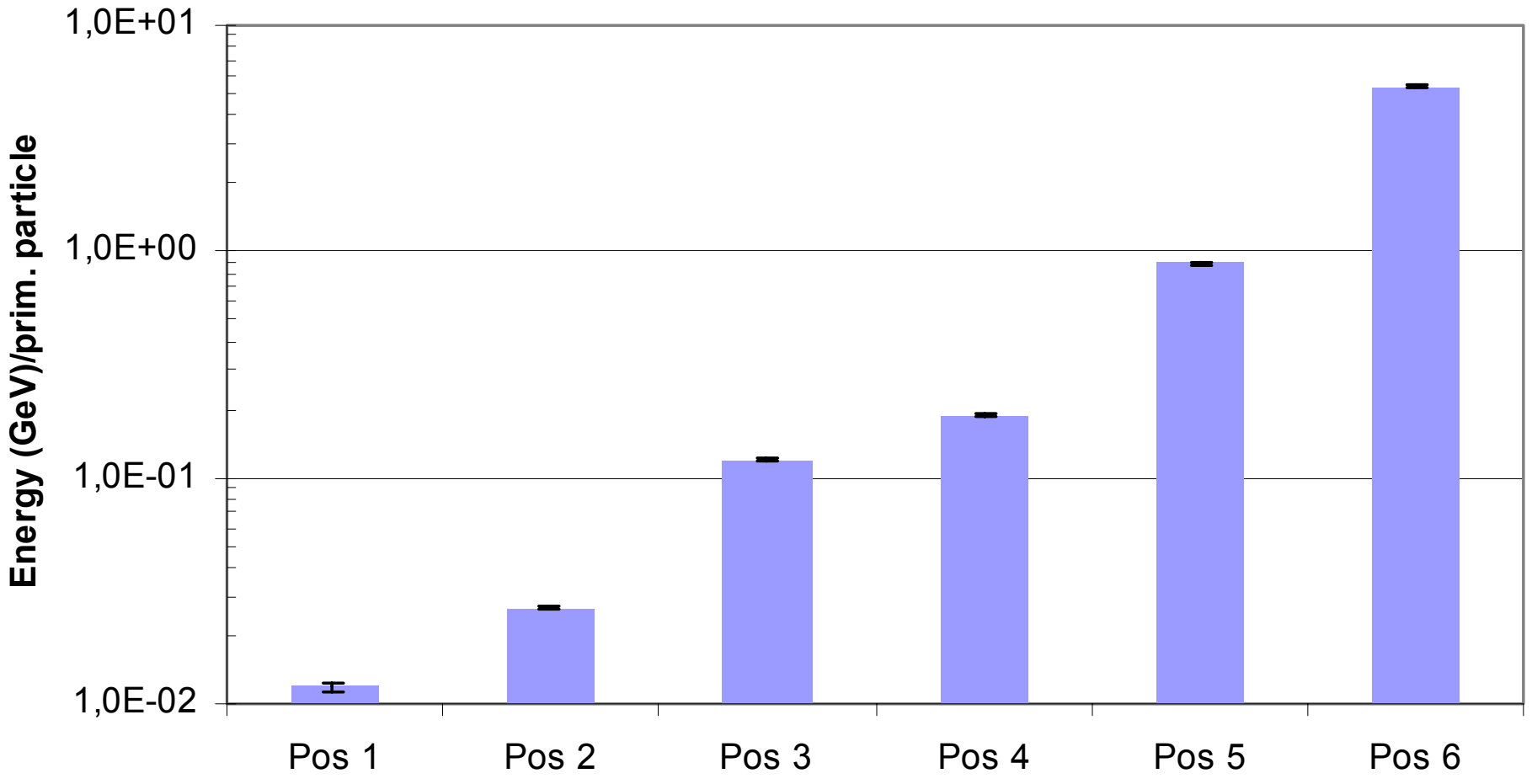
Number of particles per primary particle hitting the various detector positions (including also particles below 0.1 MeV)



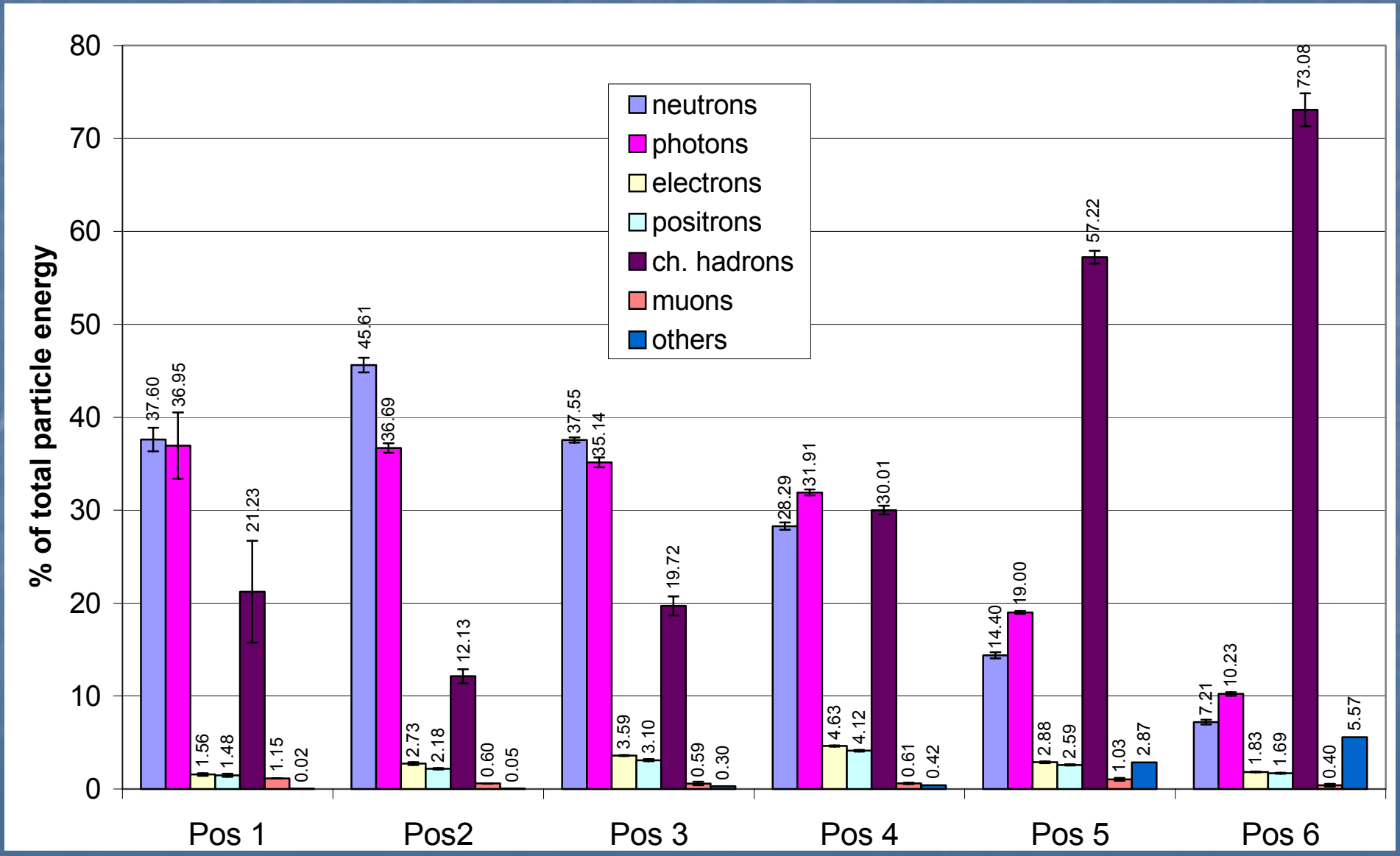
Fraction of the particle types reaching the various detector positions



Energy per primary particle transported towards the various detector positions



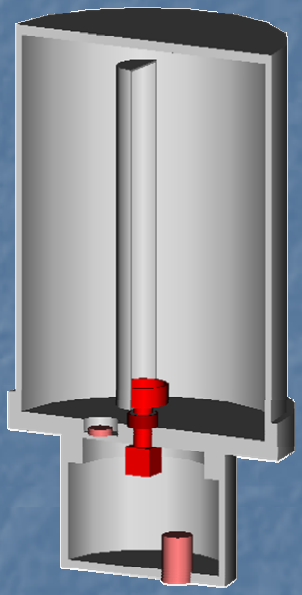
Fraction of the energy as a function of the particle types reaching the detector positions



Analysis of the simulated counting rate at the various detector positions

Procedure to achieve simulated counting rate

FLUKA calculation of energy deposition in active volume of chamber

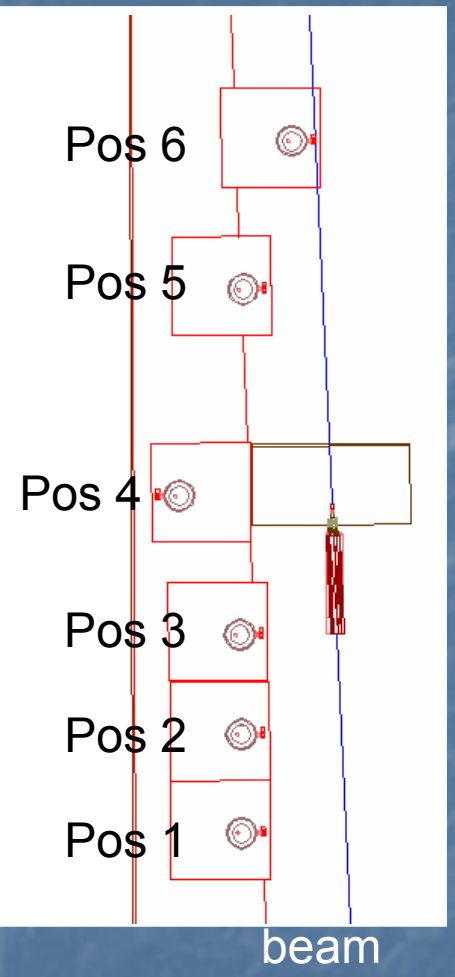


"Energy to ion^+/e^-" conversion factor leads to number of produced ion^+/e^- pairs.

Conversion of number of ion^+/e^- pairs into pC.

One pC corresponds with one PMI counts.

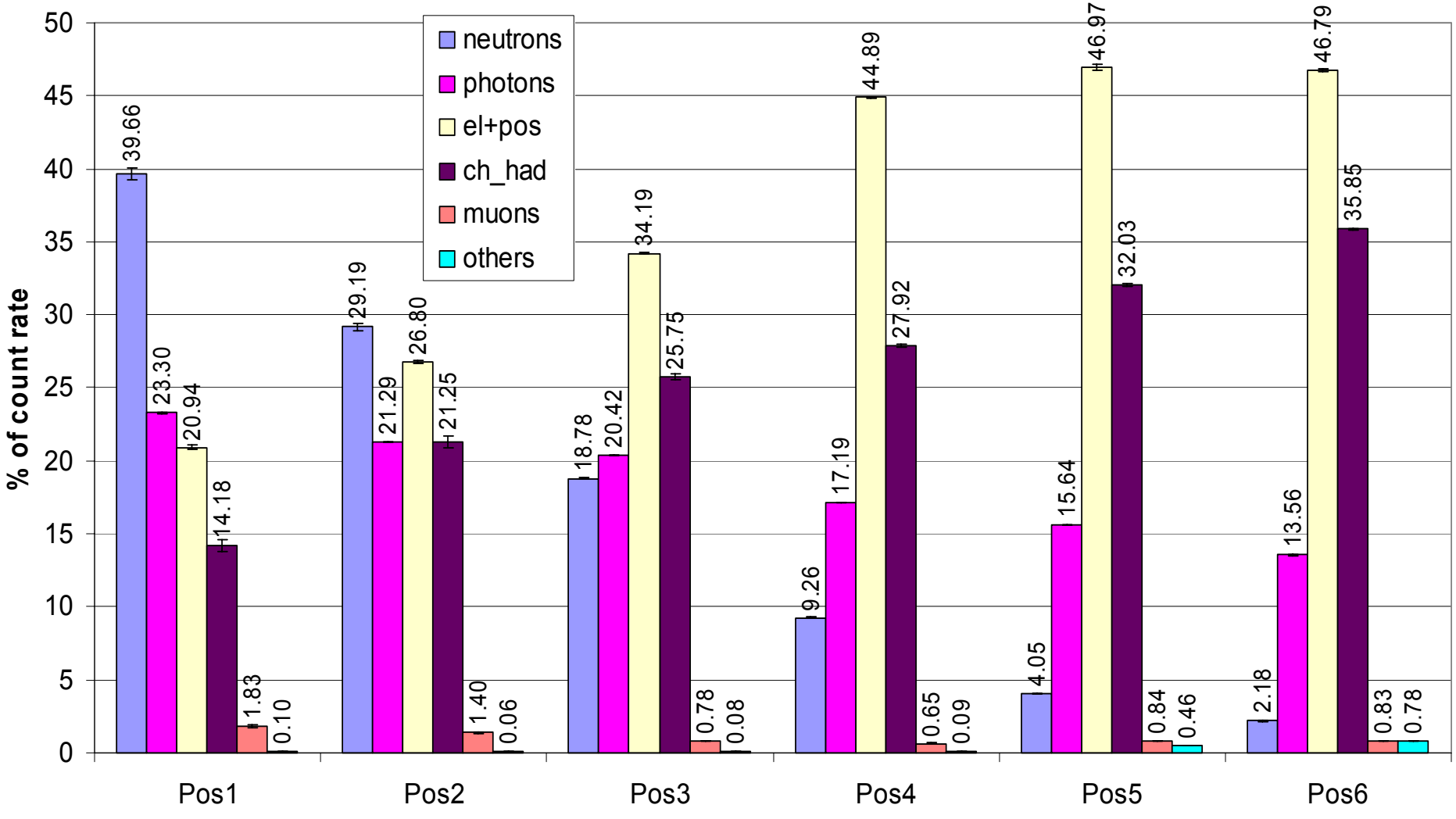
Simulation result of the counting rate



Position	Counts/ prim. particle $*10^{-6}$	Error of mean $*10^{-6}$
Pos 1	**5,63**	**± 0,12**
Pos 2	**16,06**	**± 0,44**
Pos 3	**67,46**	**± 0,73**
Pos 4	**85,33**	**± 0,64**
Pos 5	**96,20**	**± 1,26**
Pos 6	**108,31**	**± 0,82**

1 Counts = 10 nGy deposited in active volume

Influence of the different particle types (%) to the final counting rate of the detectors at the various positions



Comparison between simulation and measurement results

Position	Simulation Counts/ prim. part. $*10^{-6}$	Simulation error $*10^{-6}$	Measurement Counts/ prim. part. $*10^{-6}$	Measurement error $*10^{-6}$	Simulation/ Measurement .	Error
Pos 1	**5,63**	**± 0,12**	**5,64**	**± 0,56**	**0.998**	**± 0.102**
Pos 2	**16,06**	**± 0,44**	**15,58**	**± 1,56**	**1.031**	**± 0.107**
Pos 3	**67,46**	**± 0,73**	**67,25**	**± 6,93**	**1.003**	**± 0.104**
Pos 4	**85,33**	**± 0,64**	**79,00**	**± 8,67**	**1.080**	**± 0.119**
Pos 5	**96,20**	**± 1,26**	**89,39**	**± 9,47**	**1.076**	**± 0.115**
Pos 6	**108,31**	**± 0,82**	**115,74**	**± 17,99**	**0.936**	**± 0.146**

1 Counts = 10 nGy deposited in active volume

Conclusion

- PMI monitor response measurements in the CERF radiation field were performed in August 2003

- Simulations of these measurements were done in order to understand the physics leading to the counting rate results.

- Very good agreement between the simulations and the measurements was achieved

- In terms of number of particles reaching the PMIs, photons dominate in all 6 positions.

- Neutrons dominate the energy transported towards Position 1, charged hadrons the one towards Position 6.

- The contribution to the final counting rate is dominated by neutrons in Position 1 and by electrons and positrons in Position 6.

END