	Z min (cm)	ΔZ (cm)	R1 (cm)	R2 (cm)	R3 (cm)
absorber 1 - first superlayer	1611.5	23.5	4.14	4.28	15.
absorber 2	1635.	15.	4.28	4.37	13.
absorber 1 - second superlayer	1738.5	20.5	4.88	5.0	15.
absorber 2	1759.	11.	5.0	5.07	13.
absorber 1 - third superlayer	1869.	18.	5.65	5.76	15.
absorber 2	1887.	13.	5.76	5.83	13.
absorber 1 - fourth superlayer	1900.	67.	5.83	6.22	15.
absorber 2	1967.	23.	6.22	6.36	13.
absorber 3	1990.	7.5	6.36	6.4	15.
absorber 4	2002.5	30.	10.2	10.2	20.

Table 5: Positions and sizes of the cylindrical iron absorbers in the RUN-98 muon detector geometry. (Z min) is the starting Z position, ΔZ is a length along Z, R1 is the inner radius at Z=Zmin, R2 is the inner radius at Z=Zmin+ΔZ and R3 is the outer radius of the absorber.

16-c and 16-d show the occupancies per pixel as a function of the distance between the pixel center and the proton beam. The distributions are shown for the first two superlayers. The occupancy decreases strongly with this distance and is almost 10 times larger for the first muon superlayer than for the second.

Figures 17-a and 17-b show the occupancies of the pad chamber wires in the third and forth superlayers respectively. The corresponding occupancies of pads are shown in figures 17-c and 17-d. The x-coordinate of the wire or pad center is used as the parameter.

7 Time Optimization.

The time necessary for the generation of one inelastic event was measured on hydra.ifh.de - a SGI computer at IfH-Zeuthen. 500 inelastic events were generated and the consumed CPU-time per event is listed in the first two rows of table 6. The first row lists the time with full tracking through the muon detector and the second row lists the time without tracking through the muon detector. Tracking through the muon system increases strongly the event simulation time.

	time per event (sec)
normal tracking	150.
no tracking in muon system	96.
tracking with time optimization	128.

Table 6: CPU-time for generation of one inelastic event.

Detailed studies of the GEANT simulation show that slow electrons are tracked in iron with a small step size due to the dominance of soft bremsstrahlung. The suppression of this by setting energy cuts is dangerous because it can affect the development of electromagnetic showers near the boundaries of the hadron absorber. Slow electrons, which are deep inside the hadron absorber have no chance to go out from the iron absorber. To solve the problem a routine MUTURB is called in each GEANT tracking step inside the muon detector, which, for electron with momenta less 0.5 GeV/c, compares the range in the absorber with the distance

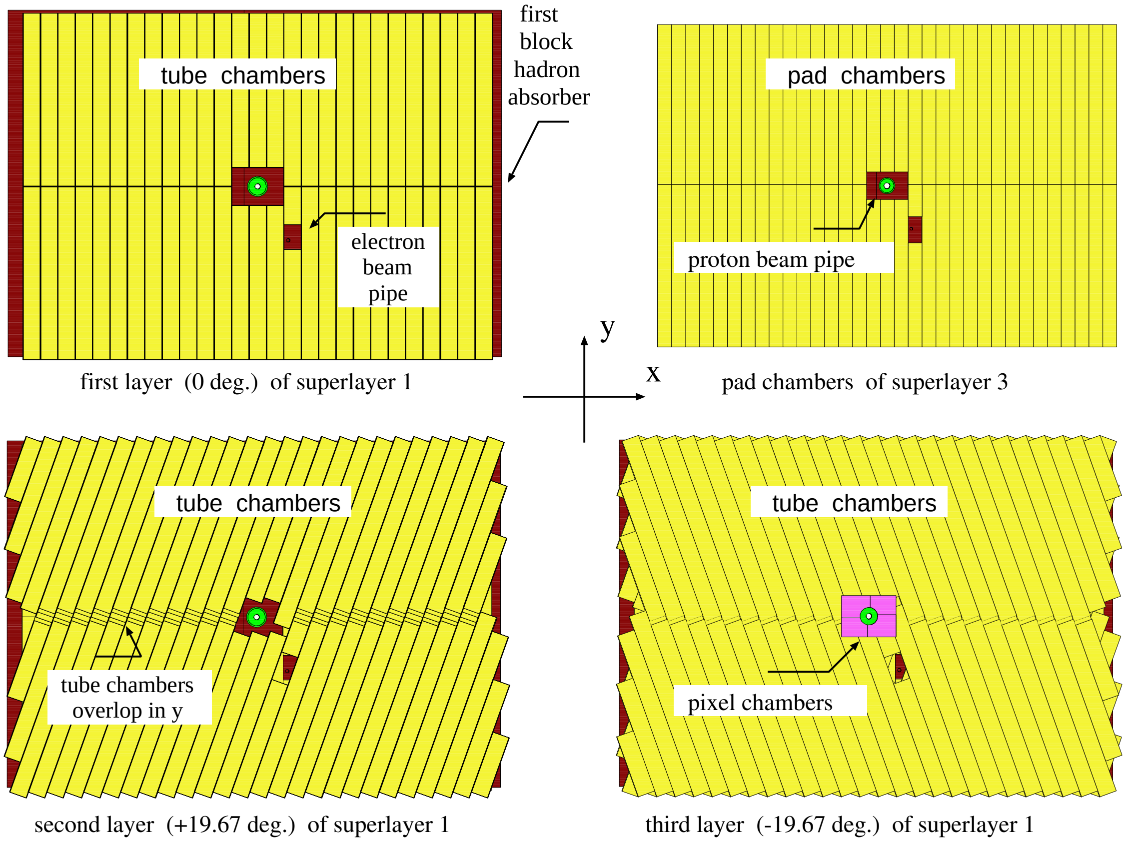

Figure 10: The front view of the RUN-98 muon detector chambers in projection on X-Y plane.

to the nearest exit point. This routine stops the track if the range is less than this distance multiplied by the safety factor.

The procedure was tested using 12000 inelastic events. The occupancies obtained with the optimization are in agreement with the occupancies without optimization. The time per inelastic interaction with this time optimization is listed in table 6.

8 Ideas for Further Development.

One of the problems in the present version is that the inner structure of the muon chambers is not implemented in HBGEAN. Since the number of the GEANT tracking steps inside chamber volumes is in the order of a few percent of all steps in the muon detector, it seems possible to implement the inner geometry of chambers without problems with CPU time. This development may simplify the digitization program and make the digitization faster.

It should be mentioned that parts of the muon detector (for instance the frames fixing the muon chamber positions) are not yet implemented in HBGEAN.

Improvements of the detector geometry are under discussion and changes in the muon system of HBGEAN are possible.

It is necessary to prolong the study of the time optimization.