Estimation of muon induced radiation in the MIPP Portakamps

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We have estimated the yield of muons in the MIPP experimental hall due to decay of particles produced by the MIPP secondary beams at beam momenta of –90,-50, -5, 5,50 and 90 GeV/c. The program MARS was used to track particles through the MIPP beamline. The tracking included particle interaction of hadrons as well as electromagnetic particles due to the secondary particles produced in the MIPP primary Copper target (20cm long) as well as those produced by the uninteracted primary proton beam. In order to obtain large enough statistics, the pions and kaons thus produced were forced to decay to muons and each such muon given an appropriate decay weight. The MARS simulation run was for 100,000 primary protons on target. The muons thus produced were tracked to the plane of the MIPP secondary target close to the TPC. These muons were then input into the Geant simulation of the MIPP experimental apparatus. This simulation has realistic field maps for the MIPP magnets the Jolly Green Giant and Rosie as well as realistic descriptions of the MIPP apparatus (TPC, Chambers, Cerenkov, RICH and Calorimeters). We have also added a realistic description of the beam dump (concrete and steel) for this simulation. Figure 1 shows the MIPP apparatus as described in Geant used for this simulation.

Figure 2 shows the tracks of muons as tracked through the apparatus in Geant. The muons shown are for a negative secondary beam momentum of 90 GeV/c. Figure 3 shows the x and y positions (x is horizontal and y vertical in the MIPP co-ordinate system. Positive z , out of the plane of the paper is the direction of the beam) of all the muons that intersect the z plane of the entrance of the portakamp. The muons in this plot are unweighted . Since the weights are approximately evenly distributed with respect to position, this plot is typical of the distribution of the muons. The portakamp is defined as a box whose cross section has dimensions 370cm X 500cm in x and y. The center of this box is located at –720., 0.0 cm in x and y. The portakamp is located at 90.7 meters downstream of the center of the Jolly Green Giant. Table 1 gives the muon statistics in the portakamp as a function of the beam momentum and the expected proton intensities. Even if we run MIPP with a slow spill of 1 second duration every 3 second, the radiation induced by muons is seen to be negligible. It should be pointed out that current scenario is promising MIPP one second slow spill every 60 seconds, which is a factor of 20 less intense. We thus conclude that the muon induced radiation is not a problem in MIPP with the current beam design and running scenario.

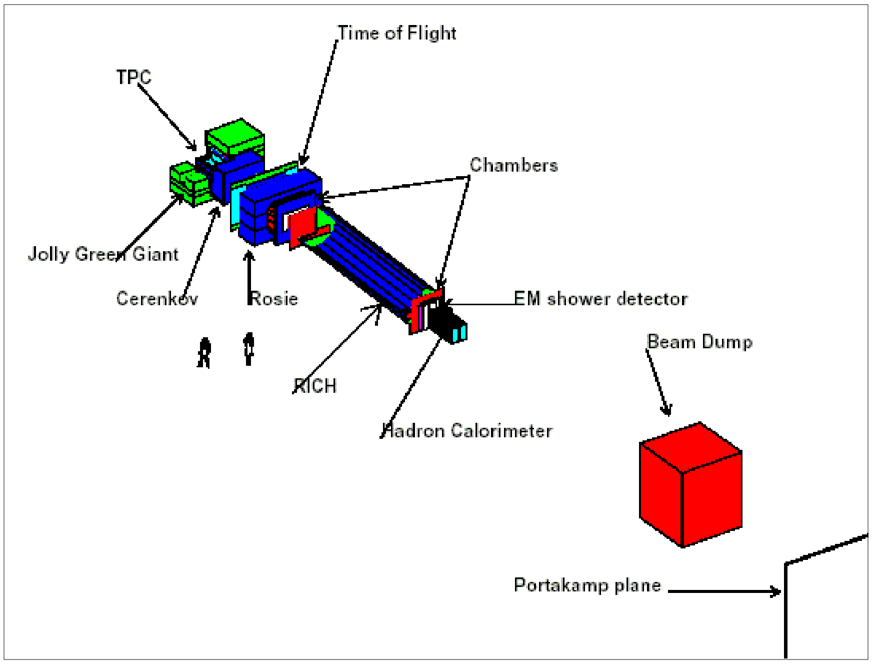

Figure 1 Geant simulation of MIPP apparatus. Beam dump and portakamp position are shown.

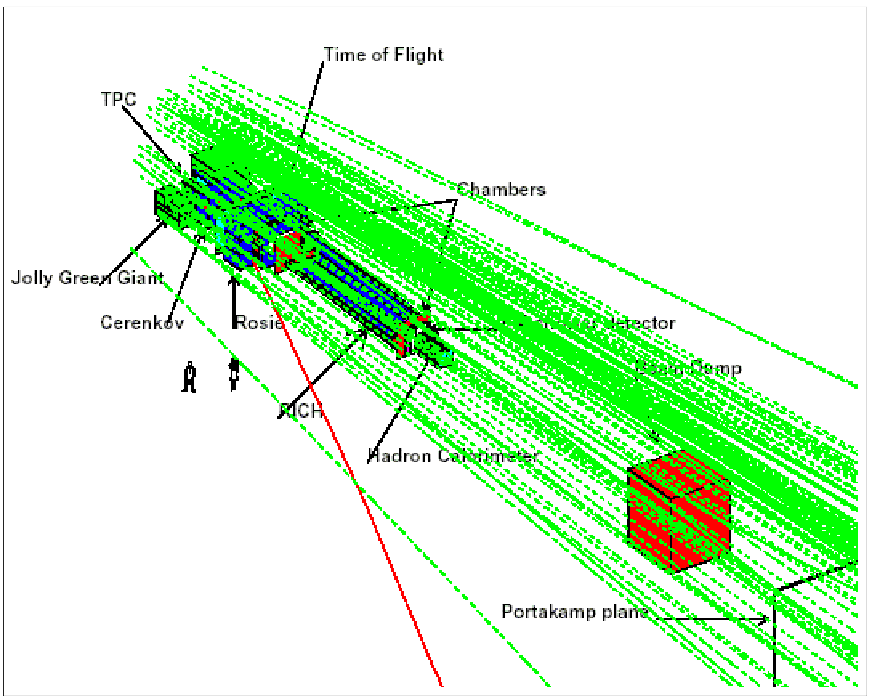

Figure 2 Geant simulation of muons produced by 90 GeV/c negative beam. Both positive and negative muons are tracked. Red track is an electron from muon decay.

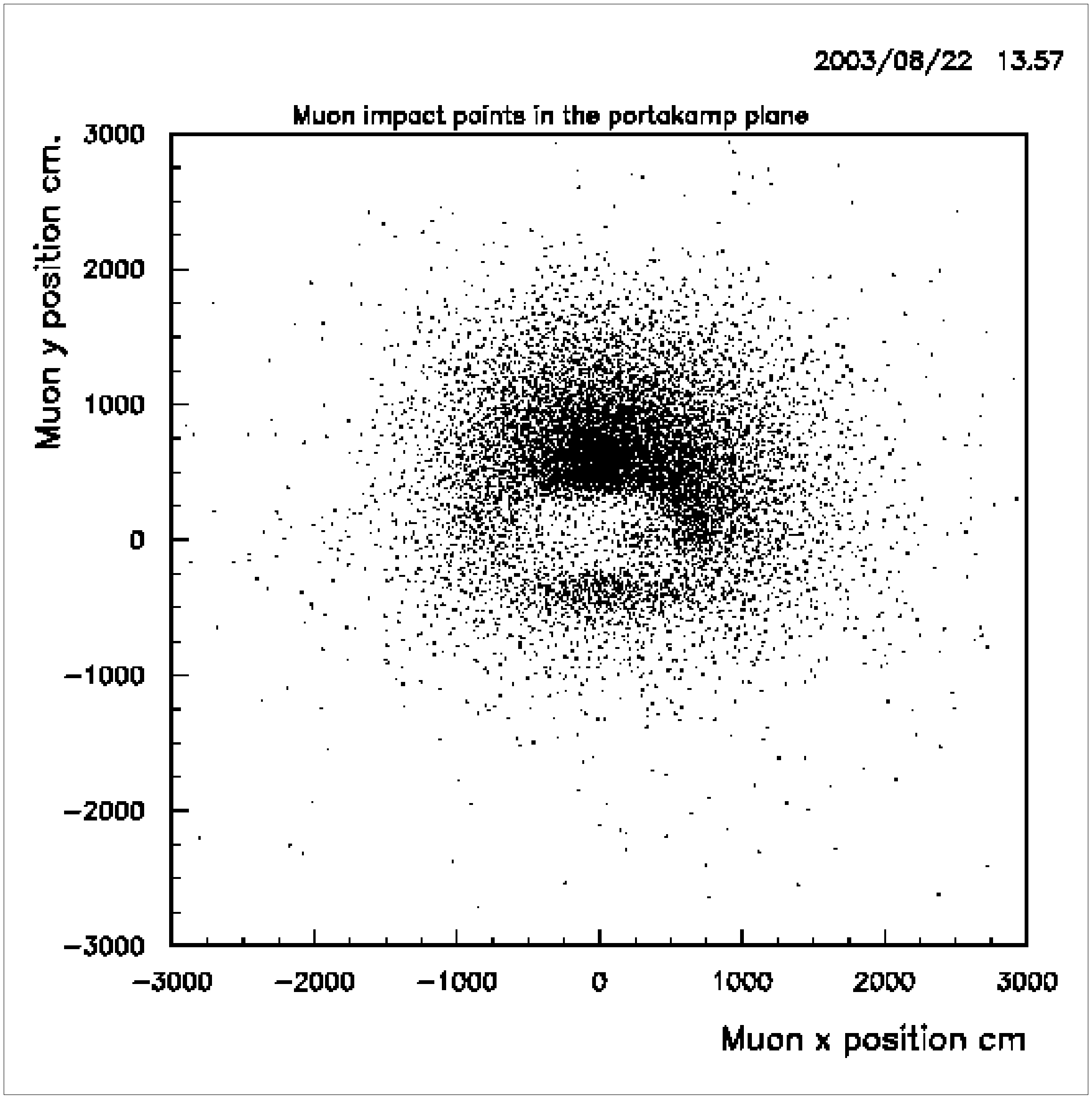

Figure 3 Muon Impact points in the portakamp plane (50 GeV/c negative beam)

Table 1Muons entering the portakamp as a function of secondary beam momentum and intensity. One second flat top is assumed every 3 seconds to work out the radiation dose due to muons in the portakamp

Beam Momentum GeV/c	*Proton Intensity /spill*	*Muons in Portakamp /spill*	*Radiation Mrem /hour*	*Average Muon Momentum in portkamp GeV/c*
5	9.66E+09	8.01E+04	2.02E-02	4.84
50	5.76E+08	8.81E+03	2.22E-03	6.38
90	2.67E+08	7.98E+03	2.01E-03	5.73
-5	1.49E+10	1.26E+05	3.19E-02	5.41
-50	5.73E+09	3.91E+04	9.88E-03	5.09
-90	7.62E+10	4.23E+05	1.07E-01	5.41