On multiple scattering simulation in the GEANT-DIRAC.

O.Gorchakov

1 Results

In the GEANT program itself the simulation of multiple scattering(MS) effects is done according to the Moliere distribution. This procedure was used in GEANT-DIRAC at the beginning. Later experimental data were obtained which allowed to get the parameters of pion multiple scattering for specific materials: Nickel, Aluminum, MSGC plane material, SFD x-, y- and w-planes and IH. These materials(except of Aluminum) make the main contribution to the multiple scattering in the forward detectors. The materials of downstream detectors were not measured.

For X- and Y-projection of each measured materials the angular MS distribution was described in [1](later the values of some parameters were debugged by the authors) and they were implemented into the GEANT-DIRAC code.

For the aluminum foil these results were corrected because the two aluminum foils which were used for MS measurements corresponded to a thickness of 673μ instead of 680μ for membrane foil. Also the structure of these two aluminum foils was found to be a bit different: the radiation lengths of membrane foil and tested sample are equal to 23.6586 and 23.9058 gr/cm^2, respectively. Therefore, for the Aluminum the [1] results were increased by 1.009 in the GEANT-DIRAC program.

As these new parameters of MS were obtained only for several materials and these materials are present in the DIRAC setup in the form of very thin layers the new MS procedure looks like this: when a pion enters one of these specific materials the Moliere MS procedure is switched OFF, it means that a pion passes through this layer without MS but with all other physical interactions. When a pion leaves this layer then its angular orientation(in X- and Y-projections) is changed according to [1]. When a pion passes through other materials the GEANT Moliere procedure works in full.

Consequently the DIRAC MS procedure is independent from the description of the material properties in GEANT-DIRAC. The results of [1] may therefore be used to adjust these descriptions such that the standard Moliere MS procedure produces the same results as the DIRAC MS one.

For all previous versions of GEANT-DIRAC we used a description gave multiple scattering angles showing in Fig. 1 and 2. On the first figure the Gaussian fitted values of $\sigma(\theta_y * p/0.0136)$(p is the pion momentum) are shown and on the second one - the R.M.S. of corresponding distributions.

For comparison we also show Moliere with Fano correction. Most of Fano correction is, however, already contained in the Moliere procedure as applied in recent GEANT-DIRAC version.

We see that there is a difference between the results of Moliere and DIRAC MS procedures. It means that our description of some materials is not correct and it is better to use the DIRAC MS procedure. Concerning Fano correction. In the GEANT this correction is not used but for any case it is implemented into GEANT-DIRAC and its default value is switched off.

It is possible to make the Moliere and DIRAC MS procedures equivalent if we change the description of the materials in a proper way. The results are shown on Fig. 3 and 4. Now the difference between these two methods is about 0.2% whereas the statistical precision in [1] is about 1%.

These results(the values of relative radiation lengths) are presented also in the table:

Detector plane	Moliere MS	DIRAC MS	Moliere MS(new)
Target(Ni)	0.00451	0.00458	0.00451
MSGS1	0.00354	0.00405	0.00403
MSGS2	0.00353	0.00405	0.00402
MSGS3	0.00353	0.00405	0.00402
MSGS4	0.00353	0.00405	0.00403
SCIFIx	0.00547	0.00662	0.00657
SCIFIy	0.00547	0.00662	0.00657
SCIFIw	0.00470	0.00598	0.00596
IH1	0.00165	0.00169	0.00165
IH2	0.00167	0.00169	0.00166
IH3	0.00166	0.00169	0.00166
IH4	0.00166	0.00169	0.00166
VCMB	0.00533	0.00563	0.00567

To get these results the densities in the material descriptions of some detectors parts were increased : for fiber volumes of X and Y-SFD planes - by 26.9%, for W-plane - 48.9% , for MSGS(DESAG D263 200μm glass) - 14.8% and for Aluminum - 5.7%. In this way we can switch the Moliere option in the GEANT-DIRAC on again and switch off the DIRAC MS procedure.

DIRAC MS procedure was used in [2] , where for Monte-Carlo and real data in the DIRAC setup the $\Delta x(\Delta y)$ distributions were found enough close.
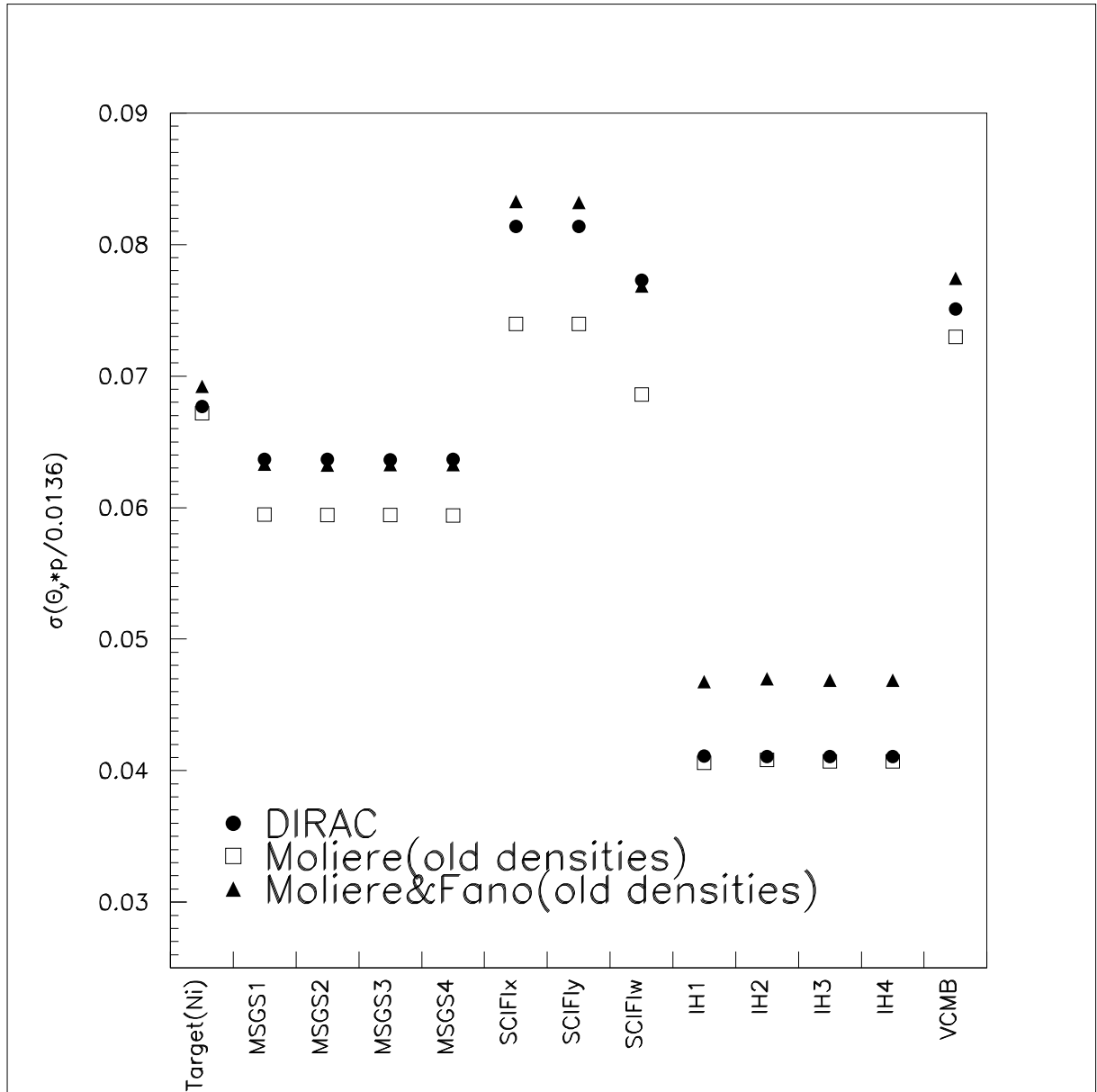
Figure 1: *The distributions of $\sigma(\theta_y * p/0.0136)$ (p is the pion momentum),where σ is the Gaussian fitted value for different materials.*
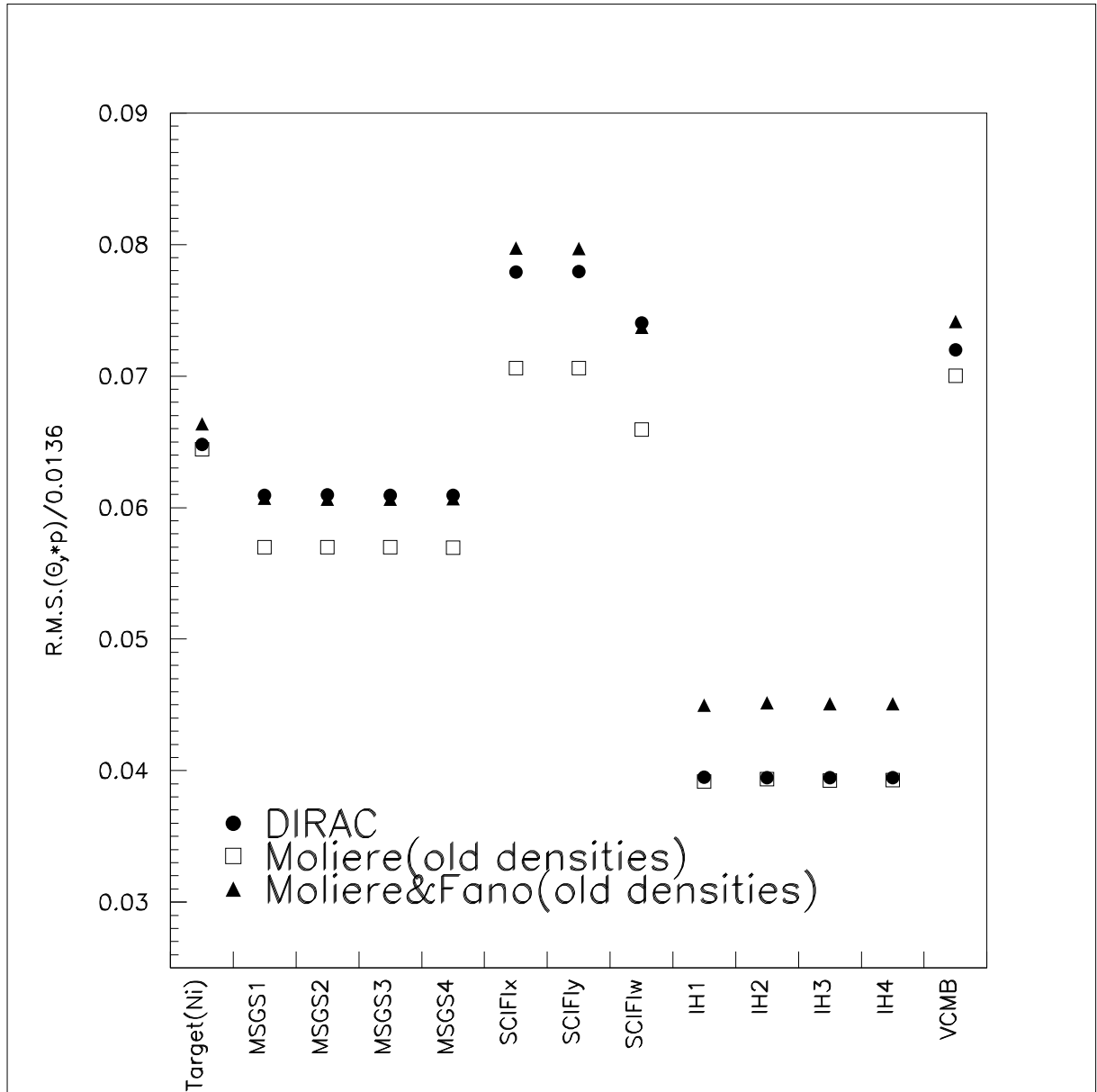
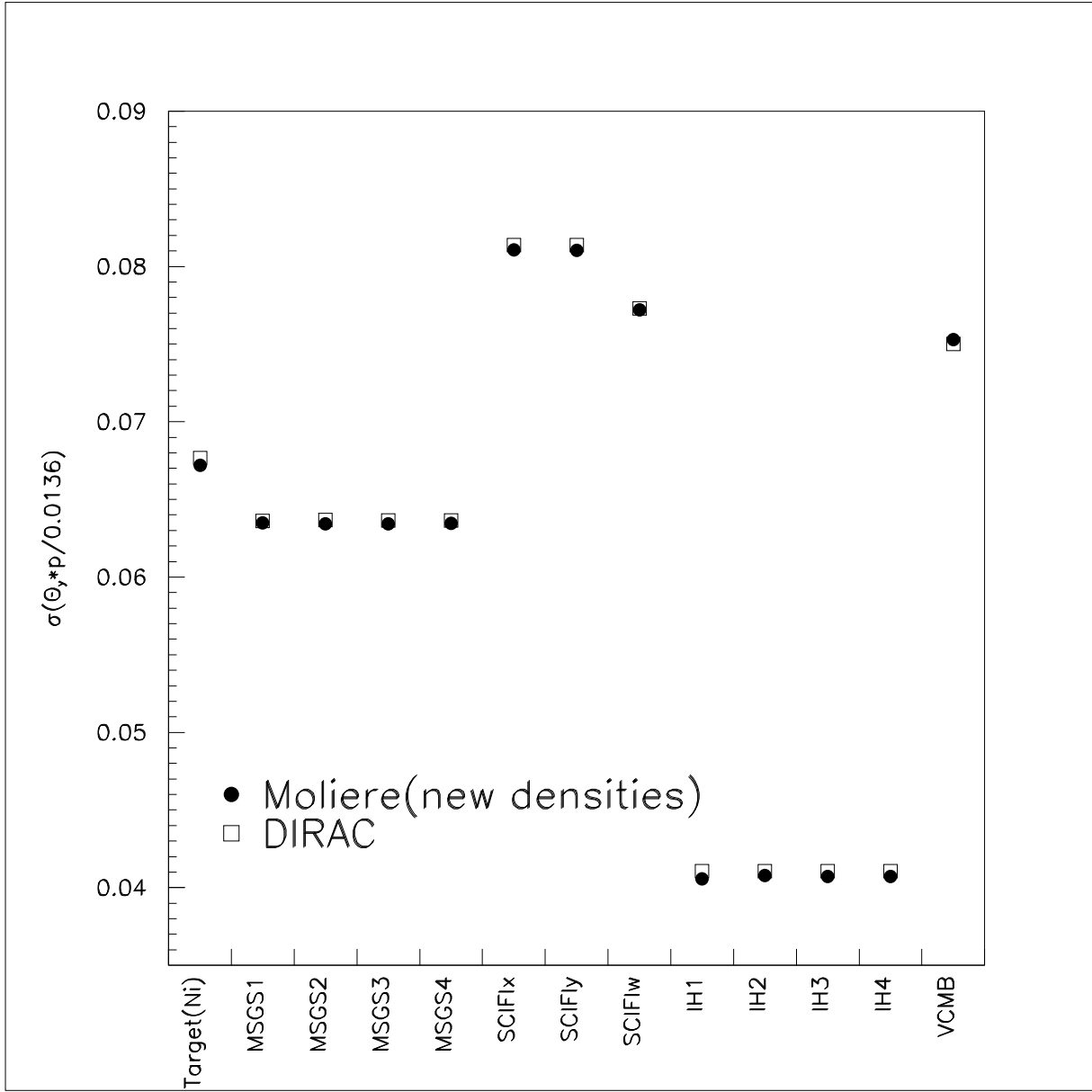Figure 2: *The distributions of R.M.S.($\theta_y*p/0.0136$)(p is the pion momentum) for different materials.*

Figure 3: *The distributions of $\sigma(\theta_y * p/0.0136)$ (p is the pion momentum), where σ is the Gaussian fitted value for different materials.*
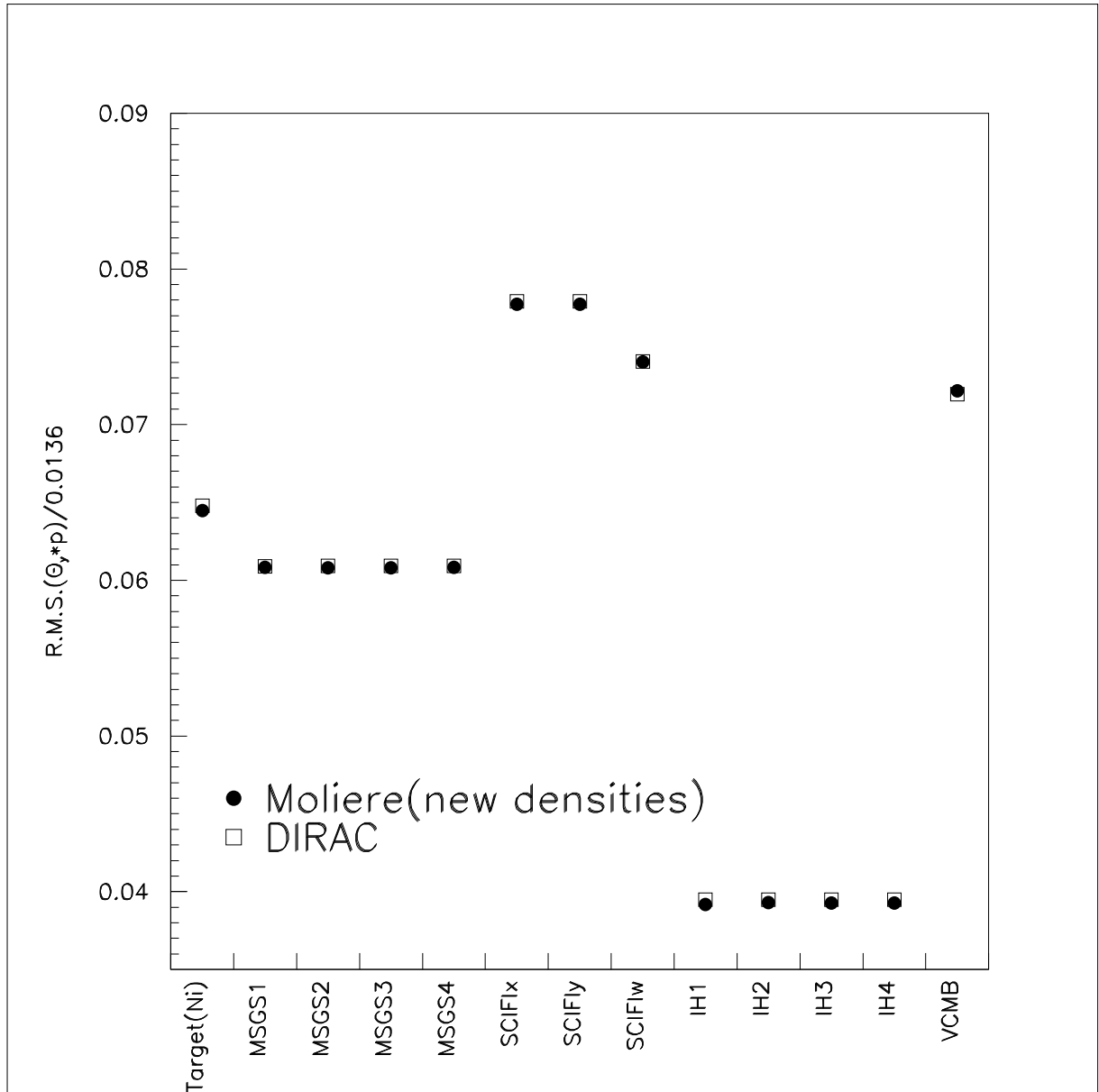
Figure 4: *The distributions of R.M.S.$(\theta_y * p/0.0136)$ (p is the pion momentum) for different materials.*

References

[1] A.Benelli,D.Drijard,O.Gorchakov,L.Tauscher,V.Yazkov, DIRAC note 06-02 and corrected results from A. Dudarev, V. Kruglov, L. Kruglova, M. Nikitin [JINR], DIRAC Note 2005-02.

[2] O.Gorchakov [JINR], DIRAC Note 2007-04.