Analysis of the Ni 2001 data with the Yazkov tracking

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The aim of this work is to analyse the Ni 2001 data with the Yazkov tracking and to compare the results with the analysis done (by Christian Schuetz) using the Basel tracking. For all details, numbers and procedure of this latter work you could read Christian's Thesis.

1 The method

In order to perform the analysis using the Yazkov tracking we have used:

- For experimental data : the ntuples that have been produced (by V. Brekovski) from the experimental data using the Yazkov tracking. We did separate the runs with the 94 micron target from the 98 micron target and considered them as two different sub-periods to analyse separately.
- For MonteCarlo data : we have used the generated events from Christian (in order to have a common sample of event) for the 94 and 98 micron targets, with the Geant simulation of run 3734 and 4091 respectively, for the different channels : atoms, accidentals (ACC) , non-Coulumb (NC) , Coulumb (CC).

The various steps of the analysis were :

- 1) Process the Atoms and CC MC data with Ariane.
- 2) Tune of the SFD detector. In order to do so, I had to re-run the CC and Atoms data few times changing the parameters that in the MC modify the SFD response.
- 3) Process the ACC and NC MC data with Ariane using the same parameters.
- 4) Perform the fit.

1.1 MC data

Christian S. did generate for the 2001 Nikel analysis the events given in Table 1.

channel	94 micron target	98 micron target
atoms	8x75000	8x75000
cc	500x75000	500x75000
nc	200x75000	200x75000
acc	200x75000	200x75000

Table 1: Number of generated events.

Cristian did use the generator provided by Cibran Santamarina. His generator is now part of the geant-dirac code.

We did pass the MCs through Ariane, with the code that V. Yazkov normally uses to create his own ntuple (main304 35.f), We just added to the ntuple some information : the trigger simulation results and the original momenta and the Q, Qx, Qy, Ql information of the two pions at the generation vertex.

We have used the 30435 version of Ariane.

1.2 SFD simulation

In order to have a good simulation of our detector we had to tune the SFD response of the SFD.

A first, very good parametrisation of the SFD is already in the default version of Ariane. But a finer tuning of the detector was necessary.

Thus we did build an histogram that contains the information of the distance between the two reconstructed tracks in units of slabs of the SFD (X and Y). Then we compare these distributions of the exprimental data with the MonteCarlo. If the agreement is of the order of few % (for $\Delta(SFD) < 3$) we consider the simulation of the SFD good. Otherwise it is needed to change the SFD parameters and re-run the MC data till we obtain a good agreement.

From past experience we have seen that the Atoms and CC are enough to calibrate the SFD. Add the information about NC and ACC would only increase the time spend submitting jobs.

Form picture 1 you see that the agreement between Data and MC is very good.

For example, for the 2001 94 micron data we have used in my FFreadInput:

ScifiPar1 1.6150 0.001 1.1 4. 1.1 0.30

ScifiPar2 1.6150 0.001 1.1 4. 1.1 0.30

These values have been used afterward for the totality of the MC events, including ACC and NC.

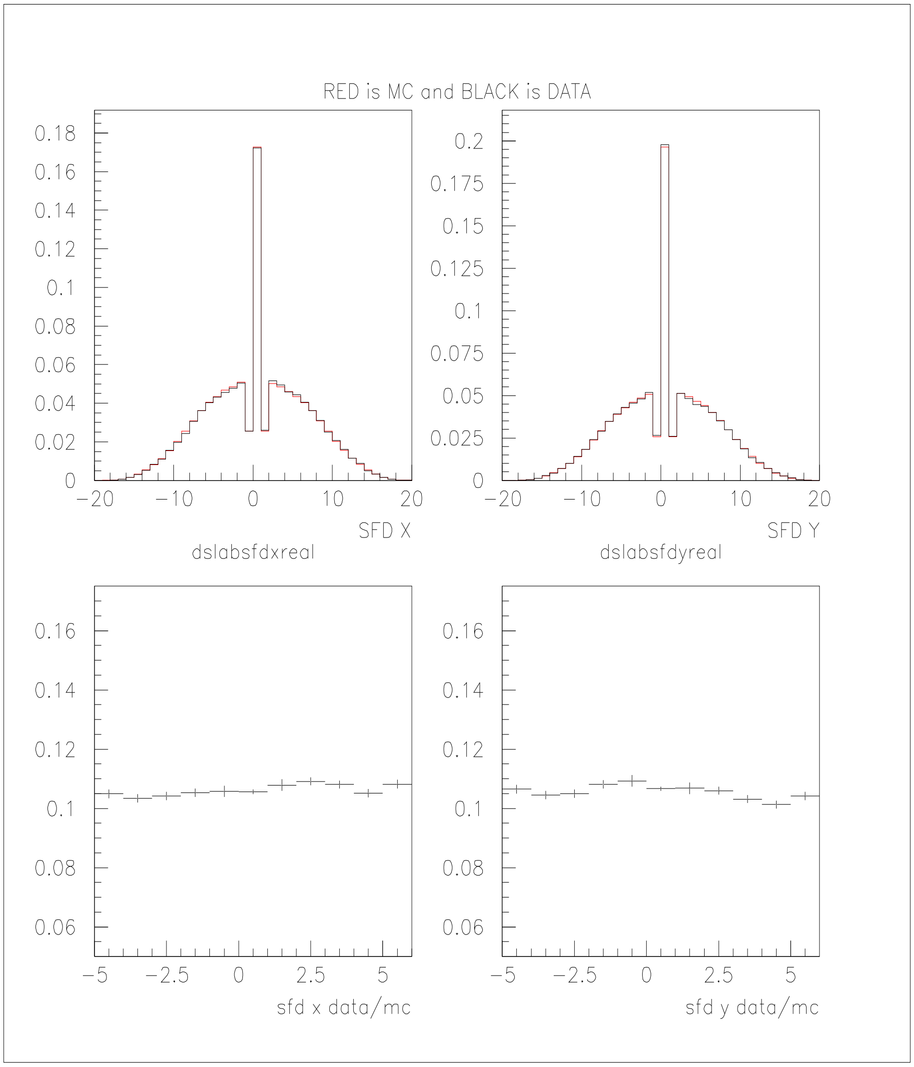

Figure 1: SFD simulation.

1.3 Event selection

In order to have a good agreement between Data and MC, we apply the same cuts to the two samples. They are shortly described here :

- $Q_l < 15$ MeV and $Q_T < 4$ MeV.
- MuonFlag $= 0$ and Cherenkov amplitudes $< 75, 62$ respectively for the two arms.
- The sum of the reconstructed momenta of the two tracks $3 < GeV(P1 + P2) < 8.4$ GeV and $P2 < 4$ GeV.
- The trigger simulation of T1 T4 and DNA should be satisfied.
- The time difference between the two traks should be
  - $\Delta(t) < 0.5ns$ if I select prompt events or MC channels,
  - $-15ns < \Delta(t) < -5ns$ if I select Experimental Accidentals.

- If two tracks share the same SFD slab hit for the tracking, the should have a double ionization in the corresponding Dedx detector. This should be valid for both the X and Y plane of the SFD.
- A correction has to be applied in the Q and Q_l distributions due to a phase-space inaccuracy in the generation of the events. More details are in the following subsection.

After all these cuts we are left with the events given in Table 2.

channel	94 micron target	98 micron target
atoms	158889	157779
cc	3106223	3116251
nc	1099226	1092762
acc	993693	993625
Exp. Data Prompt	406540	135171
Exp. Data Acc	594142	206494

Table 2: Number of reconstructed events.

1.3.1 Phase-space correction

After the event reconstruction and the fit procedure of data and MC we can evaluate how good is the agreement between the CC distribution of Q and Q_l for MC and Data. In order to do so, we have subtracted from the Prompt Experimental Data the contribution of Atoms and Non-Coulomb+Accidentals depending on the integrated number of events given by the fit for these channels. In this way we are left with the Coulomb contribution in the Experimental Data and we can just compare it with the MC one. What we did notice was a deviation in the Q_l distribution for $Q_l > 10$ MeV. The MonteCarlo overestimate the number of events in this region, as you see in fig 2. Fig 3 shows the ratio between the distribution of the Experimental Data and the MonteCarlo one.

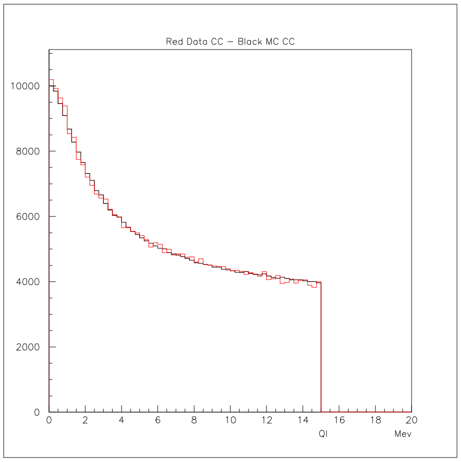

Figure 2: Q_l distributions for CC Data and Montecarlo.

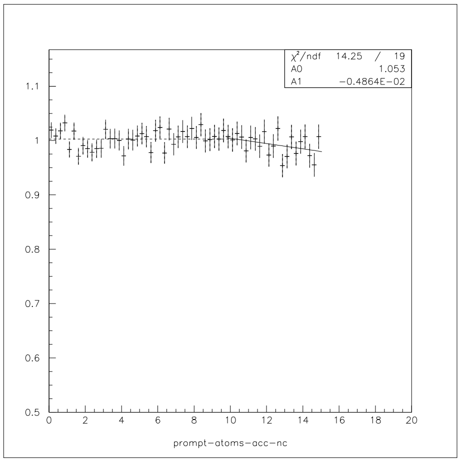

Figure 3: Ratio of Q_l distributions for CC Data and Montecarlo.

Once we have find this effect and correct for it all MC events, we re-perform the fit. Then we check the value of the residual slope till it's compatible with 0. This process brought us to correct the Q and Q_l MC distributions fot $Q_l > 10$ with a slope of the order of $(-0.7 \pm 0.2)\%$ for the 94 micron target and of $(-0.4 \pm 0.4)\%$ for the 98 micron one.

In order to explain where this effect could come from, we did generate with Genbod 1M events of the type :

$$Proton + Proton ---> 5pions + 2Protons.$$

Then we did calculate the Q distribution for every different pair of pions in an event.

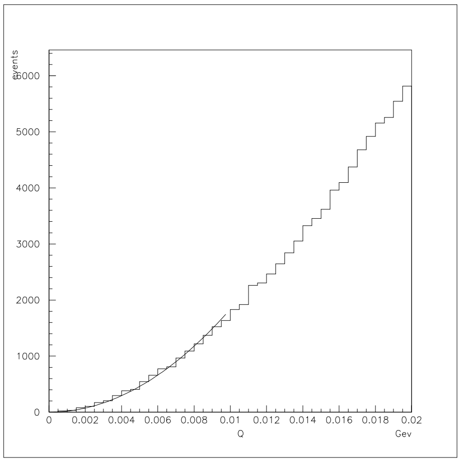

Figure 4: Distribution of the “Genbod events” for the 24 GeV energy protons.

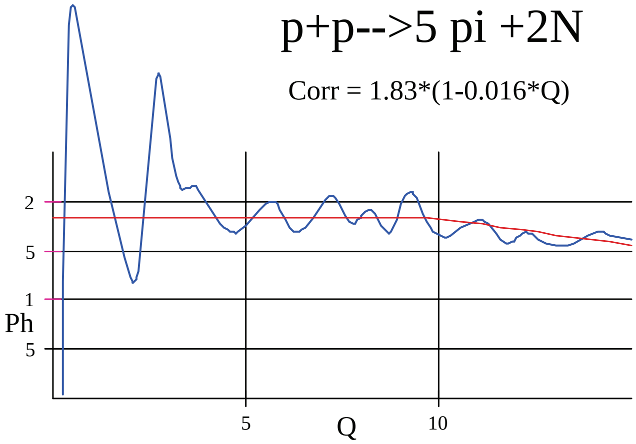

Figure 5: Deviation of the Q distribution of the “Genbod events” from Q^2 .

Since the generator used by Geant-Dirac uses a Q^2 dependances for the phase-space we did fit the Genbod ditribution with this function. The fit till 10 MeV is good, but then it deviates for higher values of Q. In Fig 4 you see the Q distribution of any two pions generated with Genbod fitted with a Q^2 function for small Q. Then Fig 5 is the deviation of the Genbod distribution from a Q^2 distribution.

We conclude that this could be the right explanation for the effect we see in the MC data.

1.4 Fit procedure

In order to evaluate the number of Atoms and Coulomb we have in our data we perform a fit between the experimental Q and Ql distributions and the equivalent MC one, given by the sum of the different contributions. You could find all the details of the fit in Christian S. Thesis's.

The outputs of the fit are :

- The number of Atoms, Coulomb, Acc, Nc found for $Q < 4$ MeV and for $Q_L < 2$ MeV.
- The total number of Coulumb, Nc and Acc found in the selected spectra $Q_L < 15$ MeV .

We have not seen any difference in taking into considering the NC and ACC MC as two different sources of background. For this reason in our final result we have used only the NC MonteCarlo in order to get the shape of Q and Q_l. Thus the number of NC in Table 3 and 4 is actually the sum of Non-coulomb and Accidental contribution. The results of the fit are summarised in Table 3 and 4.

1.5 K factor

In order to extract the Breakup Probability from the Atoms and CC estimations in our spectra, we need the K factor. For the K factor calculation we need the number of generated events for Atoms and CC, the subsection of them with original Q : $Q_{MC} < 2$ MeV, and the number of reconstructed events with respectively $Q < 4$ MeV and $Q_l < 2$ MeV. These numbers we obtain for Ni 2001 94 and 98 micron target are in Table 3 and 4.

94 micron target ATOMS	Yazkov	Basel	K_{factor}^{exp}	Yazkov	Basel
$Q < 4$ MeV/c	5730 ± 348	5096 ± 328		0.1425 ± 0.0002	0.1384 ± 0.0002
$Q_l < 2$ MeV/c	5722 ± 306	5063 ± 290		0.1854 ± 0.0002	0.1774 ± 0.0002
98 micron target ATOMS	Yazkov	Basel	K_{factor}^{exp}	Yazkov	Basel
$Q < 4$ MeV/c	1859 ± 194	1422 ± 178		0.1424 ± 0.0002	0.1383 ± 0.0002
$Q_l < 2$ MeV/c	1769 ± 170	1446 ± 157		0.1856 ± 0.0002	0.1776 ± 0.0002

Table 3: Number of signal Atoms and corresponding K factor.

The result of the fit for this analysis are shown in tables 4 and 5 .

1.6 Conclusion

The two tracking methods have been compared and they show a different efficiency, this could be evaluated looking at the two different K factors.

As a consequence of this different efficiency we obtain two different evaluations of the number of Atoms. But if we take everything into consideration, and we calculate the Breakup probability for the two methods we obtain values that are in perfect agreement, see Table 3.

The performed analysis has shown a very good agreement with the analysis performed using the Basel tracking.

Fit signal	K factor	Atoms	Coulumb	Non Coulomb	Br.Pobability
$Q < 4$ MeV/c	1.425 ± 1.6E-04	5730 ± 348	87633 ± 1460	18016 ± 843	0.459 ± 0.03
$Q_l < 2$ MeV/c	1.854 ± 2.1E-04	5722 ± 306	67049 ± 1117	13057 ± 611	0.460 ± 0.03
Total ($Q < 15$)			304977 ± 5083	95916 ± 4489	

Table 4: Ni 2001 94 micron target, Data analyis with MC.

Fit signal	K factor	Atoms	Coulumb	Non Coulomb	Br.Pobability
$Q < 4$ MeV/c	1.424 ± 1.6E-04	1859 ± 194	28975 ± 834	5816 ± 482	0.45 ± 0.05
$Q_l < 2$ MeV/c	1.856 ± 2.1E-04	1769 ± 170	22127 ± 637	13057 ± 611	0.43 ± 0.04
Total ($Q < 15$)			100872 ± 2606	30980 ± 2568	

Table 5: Ni 2001 98 micron target, Data analyis with MC.

94 micron target BR. Prob	Yazkov	Basel
$Q < 4$ MeV/c	0.459 ± 0.03	0.454 ± 0.03
$Q_l < 2$ MeV/c	0.460 ± 0.03	0.455 ± 0.027
98 micron target BR. Prob	Yazkov	Basel
$Q < 4$ MeV/c	0.450 ± 0.05	0.406 ± 0.052
$Q_l < 2$ MeV/c	0.430 ± 0.04	0.416 ± 0.046

Table 6: Breakup Probability .