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STATUS AND PLANS OF NA49 P+P AND P+A PROGRAMME

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1 General Considerations

The pp and pA programme of the NA49 Collaboration has been developed since 1996 in full recognition of the fact that improved knowledge of the elementary hadron+hadron interactions as well as a detailed scrutiny of the hadron+nucleus sector is indispensible for the quantitative understanding and interpretation of the more complex nucleus+nucleus collisions. As such it has to be seen as a fully complementary part of the overall effort of the NA49 experiment. Given the possibilities offered by the excellent performance of the NA49 detector and by the versatility in beam particle and target combinations granted by the SPS accelerator environment, the program has evolved over several years of experimentation into a more ambitious effort concerning a model-independent approach to soft hadronic physics and thereby to the non-perturbative sector of QCD. Both aspects of our work have been periodically reviewed in a number of documents to the SPSC [1 - 6] and will again be touched upon in the open presentation.

Fig.1 shows the coverage of the target/projectile plane in terms of events collected between 1996 and 2002.

In the field of soft hadronic interactions at SPS energy it can be claimed that for certain combinations (e.g. n+p or p+A collisions) event samples of about 100k events already offer exploration potential. This is due to the practical absence of data or the limitations in event statistics, particle identification and phase space coverage of preceding work. Samples of about 500k events are to be regarded as superior to any existing data and samples of several M events allow for a new step in precision studies.

Our original plans aimed at obtaining Mevent samples for most of the combinations shown in Fig.1 and a three year programme in this direction was discussed with the SPSC in the years 2000 to 2002 [3, 4, 5] These plans were finally curtailed by several circumstances

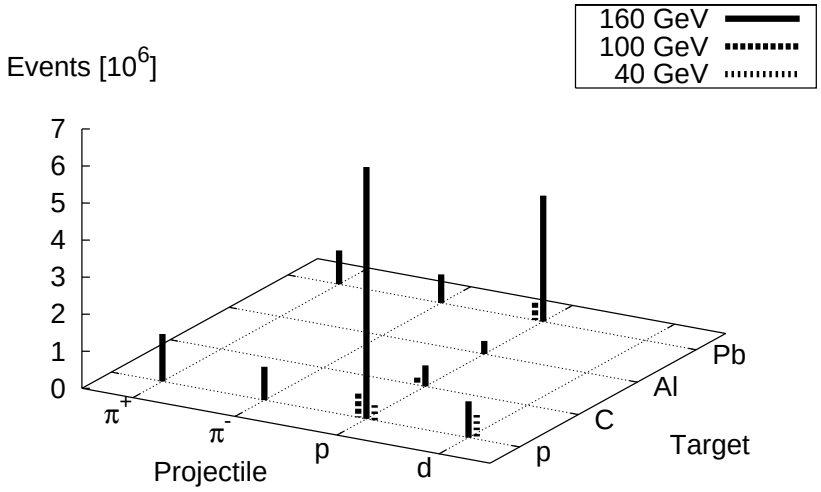

Figure 1: Event samples acquired between 1996 and 2002

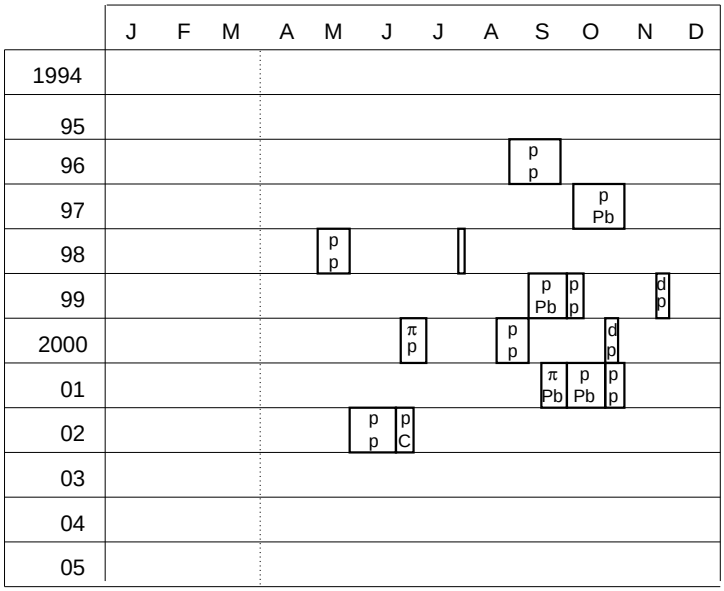

Figure 2: Run time repartition

exterior to our influence. This may be understood by looking at the repartition of the running periods obtained in the years 1996-2002 and shown in Fig.2.

Two main limitations emerge:

(1) The NA49 experiment is located in the H2 beam line upstream of the CMS hadronic calorimeter test area. In negotiations with this priority activity only short and scattered periods of hadron beam time could be obtained.

(2) After 2001 a general sharp cut in manpower and budget allocation was imposed on the SPS programme. This led to a shutdown of the NA49 experiment for data taking already for 2003 in spite of strong support of the SPSC concerning our requested n+p running [6].

2 Linking Hadron+Hadron, Hadron+Nucleus and Nucleus+Nucleus Data

With the existing data sets, and in fulfillment of the SPSC request to see results after each data taking period, a number of studies mostly concerning the link between hadron+hadron, hadron+nucleus and nucleus+nucleus interactions was undertaken and presented to the SPSC in a series of documents [1 - 6]. A limited selection of these studies may be summarized as follows:

(1) Investigation of longitudinal transfer of net baryon number [9 - 13]. This field of activity contained the first model-independent demonstration of the two-component nature of net baryon production, of its factorization against different projectile types, of the onset of transparency in the central region, and of the separability of target and projectile components in hadron+nucleus collisions. To this end, heavy use had to be made of the collected data on pion+proton and pion+nucleus as well as n+proton collisions.

(2) Study of the transverse evolution of particle densities. Here the effective increase of average transverse momenta and of the production yields up to $p_T \sim 2\mathrm{G}eV/c$ was studied in all three types of interactions. In particular the proper extraction of p_T distributions in the central region of hadron+nucleus collisions was demonstrated and confronted with the claims of transverse expansion in Pb+Pb reactions [13].

(3) The production of charged kaons was investigated with special attention to the reported enhancements of K^+/π^+ and K^-/π^- ratios in A+A collisions [11, 17, 18]. For these

studies the first measurement of neutron fragmentation into kaons available from our n+p data was of decisive importance, allowing for the proper application of isospin invariance in the neutron-rich nuclei.

(4) Comparative study of cascade baryon production. In a series of analyses containing the first determination of the Ξ^- and $\bar{\Xi}^+$ cross sections in p+p interactions, the evolution of cascade yields in p+Pb collisions was quantified and compared to the enhancement observed in Pb+Pb. This study made again full use of the expected isospin effects [13, 14].

In summary of the above studies we state that in all cases a smooth evolution of the observed quantities from elementary to nuclear collisions was evident, with no indication of a special place to be occupied by nucleus+nucleus interactions. On the contrary, all observed quantities show a common trend where the number of subcollisions per participant (or the depth of nuclear matter traversed by the participant hadron) is the common relevant variable. Specifically, the phenomena of transverse expansion and strangeness enhancement, often claimed as "signatures" of novel physics and possibly quark-gluon plasma formation in heavy ion collisions, can be understood as a direct consequence of processes already present in elementary reactions.

3 A Fresh Look at the Problems of Soft Hadronic Physics

The results quoted above lead us to look beyond the peculiarities and claims made around A+A collisions, to the more general status of understanding of soft hadronic interactions. This field has been largely abandoned by the particle physics community as a consequence of the apparent absence of quantitative theoretical predictability in the area of non-perturbative QCD. We feel that, given the consistent and high-quality data set as it is available to us via the NA49 data, a renewed effort is definitely worthwhile if a purely experimental, model independent approach is chosen. In this sense we see hadron+nucleus and nucleus+nucleus interactions as a unique laboratory to extend our experimental tools beyond the elementary collisions.

We have used the past year to consolidate our data sets which are spread partially over several years of data taking, to perfect the necessary corrections and to extend our physics analysis in the directions mentioned above. We plan to publish a series of detailed data papers documenting each studied collision channel. We reiterate here that this will yield a unique set of novel results which are going far beyond existing data at least in the SPS energy range. A first paper on pion production in p+p interactions is just being published [20]. The data papers will be supplemented by physics analysis studies. An example of such studies concerning the imprint of resonance decay on the inclusive particle distributions leads to results which touch on the understanding of pion production at large x_F and p_T, which are both shown to originate from resonance decay. This puts a question mark on the generally accepted ideas about the origin of these pions from partonic effects, either from valence parton fragmentation or recombination at low p_T, or from hard parton scattering at high p_T. This work will be commented on in the open presentation.

It is clear that the analysis programme described above is far from being terminated. We foresee indeed a continued effort which should extend well beyond the year 2007. We therefore ask the committee to support the continuation of this analysis programme with a view to the optimal use, with minimal manpower and budget investment, of the existing high quality data sets.

In the framework of this project, 9 MSc, 13 PhD, 2 CERN Fellowships, 1 Curie Fellowship and 3 Habilitations have been obtained or are in progress.

References

Remark: All references quoted below can be found, for convenience, on our Web site: `http://cern.ch/spshadrons`

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