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Beam Request for 2003

The NA49 Collaboration

Abstract

This document presents the plans of the NA49 collaboration concerning the SPS Heavy Ion period in 2003. NA49 requests participation in the foreseen In-run, both for the study of In+In and of n+p interactions.

S.V. Afanasiev[8], T. Anticic[20], D. Barna[4], J. Bartke[6], L. Betev[9], H. Białkowska[18], C. Blume[7], B. Boimska[18], M. Botje[1], R. Bramm[9], R. Brun[10], P. Bunčić[9,10], V. Cerny[3], O. Chvala[15], P. Csató[4], I. Damgov[17], N. Darmenov[16], A. Dimitrov[16], P. Dinkelaker[9], H.G. Fischer[10], Z. Fodor[4,10], P. Foka[7], V. Friese[7,13], J. Gál[4], M. Gaździcki[9], V. Genchev[17], G. Georgopoulos[2], E. Gładysz[6], S. Hegyi[4], C. Höhne[13], K. Kadija[20], A. Karev[14], V.I. Kolesnikov[8], T. Kollegger[9], R. Korus[12], M. Kowalski[6], I. Kraus[7], M. Kreps[3], M. van Leeuwen[1], P. Lévai[4], L. Litov[16], M. Makariev[16], A.I. Malakhov[8], M. Mateev[16], B.W. Mayes[11], G.L. Melkumov[8], C. Meurer[9], A. Mischke[7], M. Mitrovski[9], J. Molnár[4], S. Mrówczński[12], G. Pálla[4], A.D. Panagiotou[2], D. Panayotov[16], K. Perl[19], A. Petridis[2], M. Pikna[3], L. Pinsky[11], F. Pühlhofer[13], R. Renfordt[9], W. Retyk[19], C. Roland[5], G. Roland[5], M. Rybczyński[12], A. Rybicki[10,6], A. Sandoval[7], P. Seyboth[14], F. Siklér[4], B. Sitar[3], E. Skrzypczak[19], G. Stefanek[12], R. Stock[9], H. Ströbele[9], T. Susa[20], I. Szentpétery[4], J. Sziklai[4], P. Vankov[17], D. Varga[4], M. Vassiliou[2], G.I. Veres[4], G. Vesztergombi[4], D. Vranić[7], S. Wenig[10], A. Wetzler[9], Z. Wlodarczyk[12], I.K. Yoo[13], J. Zaranek[9], J. Zimányi[4]

[1]NIKHEF, Amsterdam, Netherlands.
[2]Department of Physics, University of Athens, Athens, Greece.
[3]Comenius University, Bratislava, Slovakia.
[4]KFKI Research Institute for Particle and Nuclear Physics, Budapest, Hungary.
[5]MIT, Cambridge, USA.
[6]Institute of Nuclear Physics, Cracow, Poland.
[7]Gesellschaft für Schwerionenforschung (GSI), Darmstadt, Germany.
[8]Joint Institute for Nuclear Research, Dubna, Russia.
[9]Fachbereich Physik der Universität, Frankfurt, Germany.
[10]CERN, Geneva, Switzerland.
[11]University of Houston, Houston, TX, USA.
[12]Institute of Physics, Swietokrzyska Academy, Kielce, Poland.
[13]Fachbereich Physik der Universität, Marburg, Germany.
[14]Max-Planck-Institut für Physik, Munich, Germany.
[15]Institute of Particle and Nuclear Physics, Charles University, Prague, Czech Republic.
[16]University of Sofia, Sofia, Bulgaria.
[17]Inst. for Nucl. Physics and Nucl. Energy, Bulgarian Academy of Science, Sofia, Bulgaria.
[18]Institute for Nuclear Studies, Warsaw, Poland.
[19]Institute for Experimental Physics, University of Warsaw, Warsaw, Poland.
[20]Rudjer Boskovic Institute, Zagreb, Croatia.

1 Introduction

The NA49 detector represents an exceptional tool for the study of hadronic interactions due to its high performance, large acceptance tracking and particle identification system. In a sustained effort over the past eight years, a unique data base on hadronic reactions has been built up by exploiting virtually all possibilities offered by the SPS fixed target programme. These data cover, for the first time in hadronic physics within the same detector system, all types of interactions reaching from elementary hadron–nucleon via hadron–nucleus to central nucleus–nucleus collisions.

Correspondingly, the analysis of NA49 data provides competitive and unique physics results to practically all topics of interest in the field, with the only exception of leptonic observables. Such results have been communicated to the Committee in a series of progress reports [1, 2, 3] and are documented in publications and conference proceedings [4, 5, 6, 7, 8, 9, 10, 11].

The experimental situation in the non-perturbative sector of QCD is far from satisfactory due to the absence of quantitative theoretical treatment as well as uncertainties in the interpretation and intercorrelation of experimental results, in particular concerning the indications of new physics in Heavy Ion collisions. This is why the NA49 collaboration has pursued a widespread physics analysis programme over the past years. For the timely completion of this programme there are two areas of fundamental interest which we feel are not covered sufficiently by our present data sets.

- The first area concerns the dependence of hadronic observables on the size of the colliding nuclei.
- The second area has to do with the prevailing presence of neutrons in heavy nuclei and the fact that practically no data on neutron fragmentation into identified hadrons are available.

We therefore request to fully participate in the last SPS Heavy Ion run planned for 2003. Below we give our main reasoning for this request.

2 Heavy Ion Collisions with Indium Beam

After a first exploratory phase mainly concentrating on central Pb+Pb collisions, the NA49 collaboration embarked upon a wide research programme aimed at continuous and complete coverage of interaction channels, cms energy and system size. Indeed, if any lesson is to be drawn from the past decade of endeavours in this field, it is that singular, isolated experimental claims are not sufficient to allow decisive new conclusions. The reasons for this lie hidden in the very complexity of non-perturbative QCD and its experimental consequences.

NA49 has therefore pioneered a systematic energy scan in Pb+Pb collisions [12, 13] covering the complete range available at the SPS and reaching down close to AGS energies. This scan has been successfully completed in 2002 and results concerning part of its range have been published [4, 10].

In addition NA49 has already obtained as the only experiment at the SPS data on small size nuclear reactions (C+C and Si+Si) where the light projectiles were produced from Pb-ion fragmentation. First results [11] underline the importance of system size dependence for essentially all hadronic observables, evidence that is further enhanced by similar studies in p+A collisions with controlled centrality [6, 8]. Decisive questions are to be answered here, as the interpretation of results from nuclear collisions depends very essentially on the way in which they evolve from elementary interactions. These questions are of special topical interest in view of the new results now available from the RHIC collider in a different energy regime. Let us quote a few examples:

– Is there a smooth evolution of hadronic yields with system size or are there transition phenomena?
– To which extent may results from nuclear collisions be normalized to the number of participant nucleons?
– As deviations of this normalization from the proportionality to the number of participants are usually called enhancement phenomena, how can those be classified as function of nuclear size and centrality?
– Is there a variable that will describe this classification in a universal fashion?
– Is the number of collisions per participant the essential variable? This question is particularly important in relation to the accessibility of the perturbative sector at RHIC and the eventual transition to it from the SPS energy range.
– Are in this context global energy density or local collision density better choices?

NA49 has made a continuous attempt to scrutinize these questions whenever the corresponding experimental material became available [14, 11], always keeping in view the corresponding elementary interactions [6]. The accessibility of In-ions which are right in the center of the range of nuclear size would allow NA49 to complete the studies concerning these essential questions. A running period of 2 weeks with In-beam would be sufficient to obtain the number of events necessary to perform the study of hadronic signatures up to cascade and Omega production.

3 Neutron Fragmentation

NA49 has submitted in early 2002 a detailed Addendum [3] which contained a request for running with deuteron beam yielding clean n+p collisions by spectator tagging. The motivation for this request came from results obtained with a pilot sample [6, 7] of n+p interactions indicating an important – and generally unexpected – influence of projectile isospin rotation on final state hadron yields. These effects are particularly important in view of baryon pair and strangeness production.

The request was favourably received and strongly recommended for approval by the SPS committee but later rejected by the CERN Research Board with the argument that it was ”somewhat late in the heavy ion programme to open up a new line of research” [15].

We reiterate this request here with the remark that these measurements do not represent a new line of research. They constitute, as explained in our Addendum 10, a completion of already existing data with a view at increasing their statistical relevance and at allowing a clarification of isospin correction factors up to cascade production.

This kind of effects has not received proper attention so far. It is now or never that this important point can be elucidated, the more so as it seems difficult if not impossible to perform comparable measurements at the RHIC Collider.

We consider a running period of 3 weeks with deuterons as necessary to reach the required statistics, in particular concerning the measurement of cascade baryon production.

4 Manpower and Financial Consequences for CERN

In connection with the beam request for 2002, a very detailed study of manpower and financial consequences for CERN was conducted involving all five CERN Divisions concerned (EP, IT, ST, LHC, SL). As a result, the only financial charge is given by the power consumption of the He liquifiers of the Vertex Magnets amounting to 9 kCHF per week of operation. The only manpower need at CERN is given by the NA49 group in EP Division with 2 FTE physicists.

This manpower is - independent of the running schedule - indispensible for the completion of the physics analysis programme of the collaboration. All other expenses and manpower needs are covered by the collaboration.

5 Conclusion

The NA49 collaboration requests full participation in the SPS run with In-ions in 2003. The foreseen beam period will be shared between In+In and n+p collisions.

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