300 GeV (AND 400 GeV) PROTON INTERACTIONS IN NUCLEAR EMULSION

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Canada	:	Université d'Ottawa; McGill University; Université du Québec à Montréal.
France	:	Centre de Recherches Nucléaires de Strasbourg; Université de Nancy; Université de Paris.
Italy	:	Istituto di Fisica G. Marconi, Rome.
Roumania	:	Institute of Atomic Physics, Bucharest.
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Sweden	:	University of Lund.
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Yugoslavia	:	University of Belgrade.

ABSTRACT

The results of a recent nuclear emulsion exposure at 200 GeV incident-proton energy are compared with previous data obtained at lower energies. The decrease in the inelastic mean-free-path can be partly interpreted as being due to coherent production of resonances. This effect will be studied in more detail at 300 GeV (and 400 GeV). Projections are made for the charged-multiplicity at these higher energies.

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INTRODUCTION

High-energy proton-nucleus interactions have recently been studied in nuclear emulsion at an incident proton energy of 200 GeV [1,2]. A comparison of the inelastic mean-free-path (λ) and the mean charged multiplicity ($\langle n_s \rangle$) in the energy range from 6 GeV to 200 GeV is shown in Table 1.

Table 1

E_p (GeV)	No. of events	λ (cm)	$\langle n_s \rangle$
6.2	1769	41.0 ± 1.0	3.6
22.5 - 25	2958	35.2 ± 0.9	6.6
67	8239	37.1 ± 0.4	-
200	1798	34.7 ± 0.9	12.9

There is a marked decrease in the value of the inelastic mean-free-path between 6.2 GeV and the higher energies considered here. The variation in the inelastic mean-free-path corresponds to an increase of $\sim$ 10% in the inelastic cross-section, which could be accounted for, in part at least, by the production of resonances (coherent and incoherent) at proton energies of 22 GeV and greater. At 200 GeV we find that $\sim$ 3% of the interactions can be interpreted as coherent production. In addition, a small number of events of even multiplicity, which are apparently produced coherently, have also been observed. No explanation is ventured at this time.

A recent calculation by Trefil and Schaffner[3] shows that the cross-section for N^* coherent production in silver alone should be of the order of 40 mb at an incident proton energy of 200 GeV. Taking into account the composition of the emulsion, this result indicates that $\sim$ 4% of all the interactions at 200 GeV should be due to coherent production, which is in agreement with the experimental result.

The average charged-multiplicity, $\langle n_s \rangle$, at 200 GeV is 12.9 ± 0.15, which is markedly higher than the value predicted by the Echo Lake data[4].

The emulsion data for $\langle n_s \rangle$ as a function of p_{lab}, the incident proton momentum, is shown in Fig. 1. For comparison, we have also plotted in Fig. 1 data for p-p collisions taken from the work of Gottfried[5]. The best-fit curve for the p-nucleus emulsion data is expressed by the relation

$$\langle n_s \rangle = 1.85\ s^{1/3} \ ,$$

where $s = (E_{CM})^2$. This curve predicts values of $\langle n_s \rangle \sim 16$ at 300 GeV and $\langle n_s \rangle \sim 18$ at 400 GeV.

PROPOSED EXPERIMENTS AT 300 GeV AND 400 GeV

We propose to extend the measurements in nuclear emulsion of the inelastic mean-free-path and the charged multiplicity to incident proton energies of 300 and 400 GeV. In addition, we wish to study the interactions in which no (or little) excitation energy is imparted to the target nucleus in order to measure the coherent (and incoherent) production of resonances at these energies. A more detailed investigation will be made of the so-far unexplained even-multiplicity events (apparently produced coherently) which have already been observed at 200 GeV.

EXPOSURE REQUIREMENTS

i) We plan to expose two stacks of Ilford K5 emulsion,each containing 40 pellicles (6 cm × 15 cm × 600 μ) with the beam parallel to the emulsion surface.

Typical size of beam	:	∿ 3 cm × ∿ 8 cm (as for 200 GeV exposure)
Flux	:	10^5 protons/pulse
Total flux	:	5 pulses per stack.

ii) We also propose to expose two small stacks, each containing 20 pellicles (6 cm × 6 cm × 600 μ), the exposure in this case being normal to the plane of the emulsion

Typical size of beam	:	∿ 3 cm × ∿ 8 cm (as for 200 GeV exposure)
Flux	:	10^5 protons/pulse
Total flux	:	250 pulses (∿ 20 minutes).

The purpose of this exposure is to study the angular distribution of shower particles which can be done quickly and accurately with a semi-automatic TV-coding system in use at the University of Ottawa.

PROCESSING OF STACKS

The larger part of the processing will be carried out in Strasbourg ~~and in CERN~~. In order to reduce cosmic-ray background and latent-image fading, a small number of plates will be developed in Ottawa as soon as possible after the exposure.

* * *

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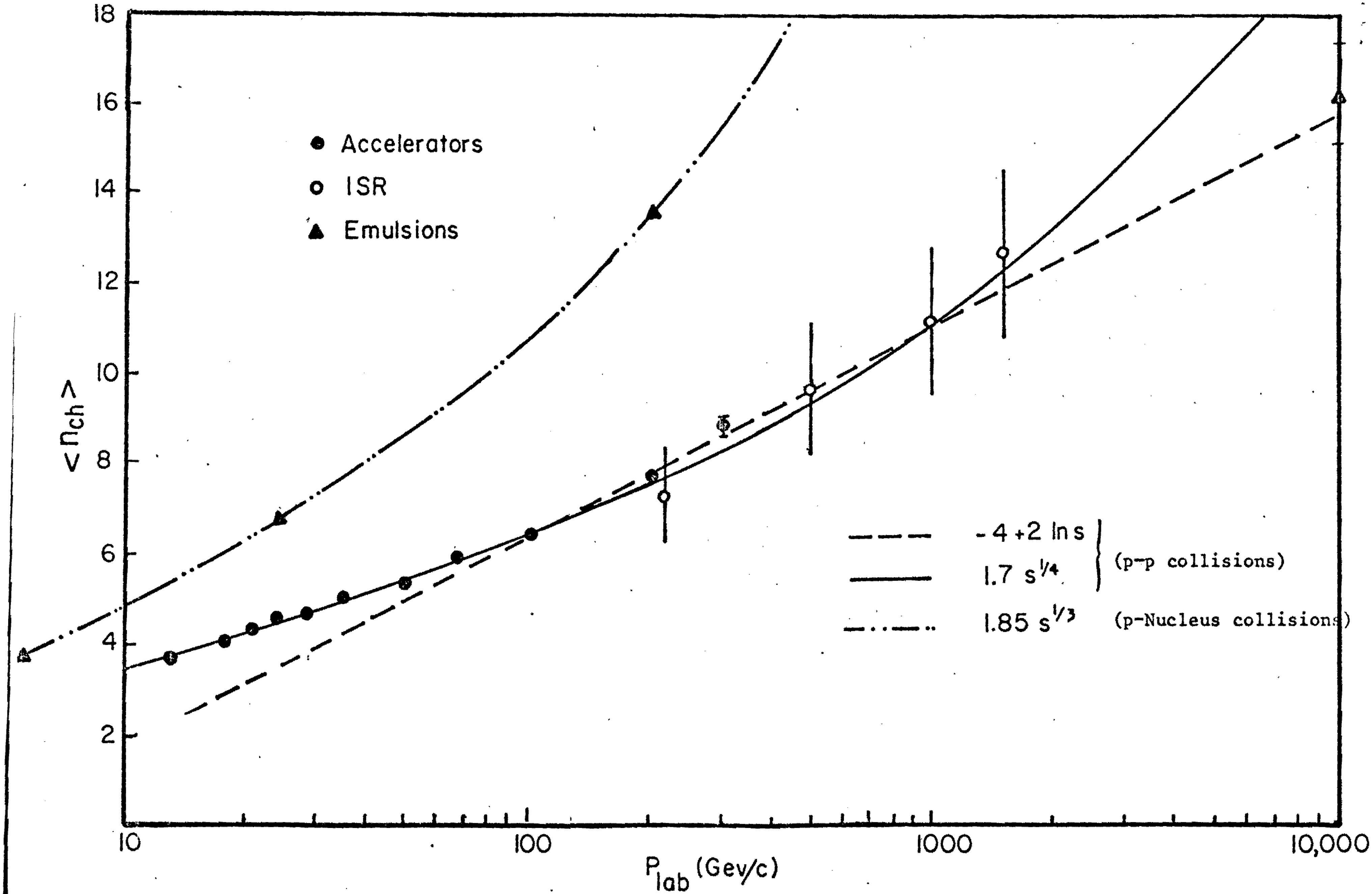
18
16
14
12
10
8
6
4
2
< n_ch >
Accelerators
ISR
Emulsions
-4 +2 ln s
1.7 s^1/4
(p-p collisions)
1.85 s^1/3
(p-Nucleus collisions)
10
100
1000
10,000
P_lab (Gev/c)

Fig. 1