A D D E N D U M

CERN/SPSC/81-26
SPSC/P 82/Add.1
11.3.1981

Addendum to SPSC/77-24/P 82 and SPSC/79-90/M 193



To : The members of the SPSC

From : WA42/62 Collaboration

Re : Time request for the Y1 beam (see our memo in SPSC 81-1/M 274)

Date : 10 March 1981

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1. Introduction

In our memorandum of 15 December 1980, we presented a physics programme which could be performed in the Y1 beam with the existing apparatus. In view of this programme, the chairman of the SPSC asked us to present a revised programme assuming an end of operation of the hyperon beam in Spring 1982. We were also asked to state our priorities more clearly and also to provide more information on the study of radiative decays. We wish to emphasize that the programme given in this addendum is only a part of what we would like to have done in the Y1 beam.

A progress report on the analysis of WA42 (Part I) and WA62 will be presented at the SPSC Open Session on 31 March.

2. Priorities

Amongst the 5 physics topics described in Section 2 of our memo, we set the following order of priority.

a) Production of $\Xi^*$ and $\Omega^*$ resonances in $\Xi^- N$ interactions and of $\Sigma^*$ in $\Sigma^- N$ interactions. Measurement of resonance masses, widths, production cross sections, decay branching ratios and if possible spin. With the $\Xi^- N$ data sample recorded in the total cross section experiment (about $10^7$ $\Xi^-$ triggers), we achieved a sensitivity for low mass $\Xi^*$ (below 2 GeV/$c^2$) of 1 to 3 events per $\mu$ barn and per decay channel for $-t < 0.5$ (GeV/c)$^2$, or to put it in other words we observed a cross section times branching ratio for a single resonance decaying into a specific channel of typically 100 $\mu$b. Given these large cross sections, our present goal is to reach a sensitivity of about 10 events per $\mu$b per channel up to masses of 3 GeV/$c^2$.

b) Study of radiative decays. Rate and asymmetry of $\Lambda \to n\gamma$ decay and rate of $\Sigma^+ \to p\gamma$ decay. Having studied a small sample of $\Xi^- \to \Lambda\pi^-$, $\Lambda \to p\pi^-$ decays recorded during Expt. WA42, we feel confident that we can measure the rate to better than ±20% and the asymmetry to ±0.3 at least. For the $\Sigma^+ \to p\gamma$ we wish to cross check the decay rate measured by the HYBUC collaboration (Ref. 1) and to improve on their accuracy of ±18%. More details are given in Section 3.

We emphasize the fact that these radiative decays will be measured with the same apparatus in exactly the same configuration as for the resonances. The only changes will be the removal of the target and slight modification in the trigger logic.

The Primakoff effect and the elastic scattering are put at a lower priority level. A continuation of the $A^0$ search might be proposed after completion of the present WA62 analysis.

## 3. Measurement of radiative decays

### 3.1 $\Lambda \to n\gamma$ decay

With the experimental layout proposed for the baryonic resonances, $\Lambda \to n\gamma$ decays can be recognized in the decay chain

$$\Xi^- \to \Lambda\pi^- , \quad \Lambda \to n\gamma . \tag{1}$$

They have to be separated from the usual decay mode

$$\Xi^- \to \Lambda\pi^- , \quad \Lambda \to n\pi^0 , \quad \pi^0 \to \gamma\gamma \tag{2}$$

which is expected to be 10 to 100 times more abundant. The trigger requires an incident $\Xi^-$ and one and only one forward charged track. In the reconstruction, events of type (1) are recognized i) from the missing mass to the $(\Xi^-\pi^-)$ system that should be equal to the $\Lambda$ mass within errors and ii) from a $\gamma$ shower and a n shower in the Liquid Argon Detector (LAD). Clearly the difficulty arises from the $\Lambda \to n\pi^0$ decays with only one $\gamma$ shower measurable in the LAD. Monte Carlo studies show that there should be little difficulty separating the two decays with kinematical fits. This method is currently being checked experimentally on a data sample taken in June 1980 during a 12 hour test run. The performance of the LAD has been demonstrated by direct reconstruction of the $\Lambda$ mass in decay (2) from the three observed showers (see Fig. 4 in our memo of 15 December). From preliminary results we feel confident that we can identify decay (1) although we cannot yet give any value for the branching ratio.

Another way of separating decays (1) and (2) is to take advantage of the fact that about 25% of the $\gamma$ from decay (1) have an energy greater than any $\gamma$ from decay (2). This method has been checked by Monte Carlo but still has to be applied to the test data sample. From the acceptances and efficiencies obtained in this preliminary study, and from the branching ratio of $\sim$ 1% predicted by Close and Rubinstein [2], we expect about 150 decays of type (1) per day for a flux of 200 $\Xi^-$ per SPS burst.

Since the $\Lambda$ from $\Xi^-$ decay are 40% polarized, it will also be possible to measure the asymmetry parameter in the $\Lambda \to n\gamma$ decay. A conservative estimate indicates that we should be able to measure this asymmetry to better than ±0.3.

### 3.2 $\Sigma^+ \to p\gamma$ decay

With the same apparatus also, and with similar techniques, the decay

$$\Sigma^+ \to p\gamma \qquad (3)$$

can be separated from the

$$\Sigma^+ \to p\pi^0 , \quad \pi^0 \to \gamma\gamma \qquad (4)$$

decay. The trigger requires a $\Sigma^+$ identified in the positive hyperon beam. In the analysis, one requires a kinked charged particle track between the DISC and the first magnet and a single photon shower in the LAD or in the lead glass array. The main background comes from decay (4) in which one of the $\gamma$ escapes detection. Monte Carlo simulation shows that 29% of the $\gamma$ from decay (3) have energies too great to be simulated by decay (4) at the same point in the $\gamma$ detection.

Using the measured branching ratio of $(1.24 \pm 0.18) \times 10^{-3}$ [1], a flux of 70 $\Sigma^+$ per burst as determined in Expt. WA2, and the usual efficiency factors, we estimate an acquisition rate of 40 $\Sigma^+ \to p\gamma$ decays per day.

Having performed a new estimate of polarized $\Sigma^+$ fluxes obtained by wobbling of the incident 250 GeV/c proton beam, we conclude that a measurement of the asymmetry parameter $\alpha$ in decay (3) cannot be performed within the time available.

## 4. Time request

The time request for these experiments depends not only on the considerations given above but also on the West Area operating conditions. During the $A^0$ experiment, the data collection rate was frequently limited by background from the H5 test beam and other West Area beams. If we are to be able to complete a worthwhile part of our physics programme in the time available to us, we must be given a reasonable priority in determining the West Area and SPS operating conditions. In particular, we request a spill time of 2 s to the West Area.

Assuming this, we ask for the following beam time allocation:

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| $\Xi^*$ and $\Omega^*$ | 50 days |
| $\Sigma^*$ | 20 |
| $\Lambda \to n\gamma$ | 10 |
| $\Sigma^+ \to p\gamma$ | 15 |
| Total | 95 days |

plus setting-up time.

*Note:*- We do not require the PIB vertical wobbling any more.

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## REFERENCES

[1] A. Manz et al., Phys. Lett. 96B (1980) 217.

[2] F.E. Close and H.R. Rubinstein, RL-80-013 T.262 preprint, and private communication.