

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN/PS/C/85-38
PSCC/P 80/Add. 1
10 July 1985

Addendum to the proposal P 80

SPECTROSCOPY AT LEAR USING AN INTERNAL HYDROGEN TARGET

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In the CERN/PSSC/84-67 we have proposed an experiment at LEAR to look for exotic states in the mass region between 2. and 2.4 GeV. In this paper we present more calculations and resume the most important aspects of the physics and of the technique we propose.

* subject to the approval of IN2P3

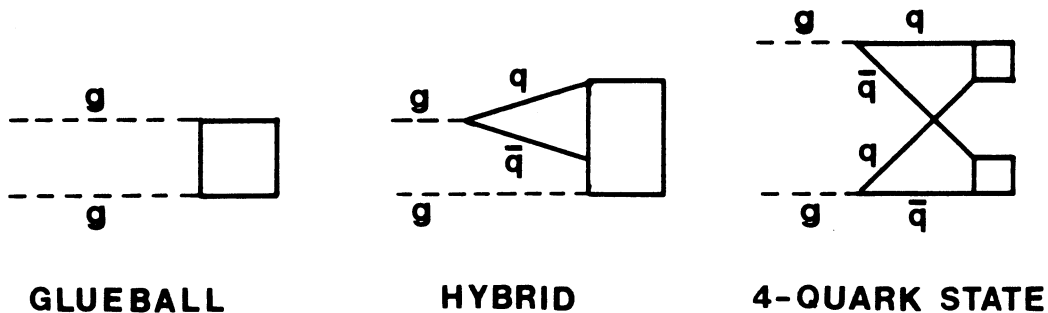
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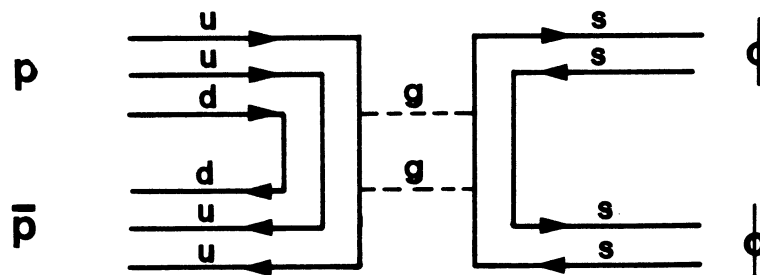
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1. The physics and the choice of the final state

The coupling between gluons is a consequence of QCD and many models based on it predict the existence of exotic states: glueballs, hybrids, 4-quarks...

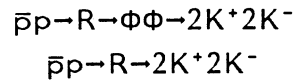


A possibility to create a 'hard gluon factory' consists in looking at final states that are not connected to the initial ones by quark lines. This has also the advantage that the background is suppressed by the OZI rule. Following this line we have proposed to detect the $\Phi\Phi$ final state produced in the $\bar{p}p$ coherent annihilation:



From the experimental point of view, the best way to detect the Φ 's through their decay into K^+K^- : in fact the branching ratio $\Phi \rightarrow 2K$ is high (49) and the signature of the $\Phi\Phi \rightarrow 4K$ event is strong. Other channels, interesting from the point of view of the ratio signal/background, are those with a partial s content and rather high mass values, like $2K^+2K^-$, $\omega\Phi$, $\rho^0\Phi$, $\eta\Phi$, $\omega\eta$, $\eta\eta$, $\Phi'\pi^0$, whose respective intermediate states can be a mixture between annihilation and quark rearrangement.

The simultaneous measurement of the 4K channel and the other above mentioned ones would imply many experimental difficulties mainly due to the need of a very large acceptance. So our choice is to start with a detector as simple as possible and to measure



2. The technique

The proposed technique consists in using the LEAR internal antiproton beam and a hydrogen jet target. The final state is used only to select the signal from the background .

The resonance excitation curve is obtained varying the internal beam momentum by small steps.

This method has the following unique advantages:

1. the accuracy in determining the resonance characteristics is due to the machine parameters only; the mass resolution is given by:

$$\Delta M = \beta\gamma m / \sqrt{2(\gamma+1)} \Delta p/p$$

where $\Delta p/p$ is the internal beam momentum resolution. If $\Delta p/p \approx 3 \times 10^{-4}$, $\Delta M \approx 150$ keV. So for resonance width of a few MeVs the excitation curve will directly reproduce the resonance shape without distortion.

2. The integrated luminosity is the maximum one can obtain for a given number of injected antiprotons. In fact, if the stochastic cooling works as foreseen, the \bar{p} 's will circulate in the machine until they interact (inelastically) with the protons of the jet. With 10^{10} antiprotons and a jet density of 1×10^{-10} g/cm², we obtain an integrated luminosity of ~ 100 nb⁻¹/day.
3. The interaction volume is very small (~ 1 cm³); this simplifies the experimental apparatus and the analysis.

4. The scan in energy is done by changing the energy of the coasting beam; a short time is needed to operate this change.

3. Acceptance and background

The dimensions of the two detector arms have been increased; they cover always the same θ angular region but the ϕ acceptance now varies between 139° and 80° when θ varies between 17° and 66° .

The range detector has been increased to stop the kaons from the Φ 's produced at 2.4 GeV c.m. energy.

In table 1 are shown the acceptance for $\bar{p}p \rightarrow \Phi\Phi + 4K$ and $\bar{p}p \rightarrow 4K$ at different energies taking into account the kaon decay.

4. Time schedule and running requests

During the internal target operation one could foresee to use the CERN anti-proton complex just once a day injecting 10^{10} \bar{p} 's in LEAR; this will represent a very small fraction of the accumulated beam in the ACOL era.

As stated before, this will give an integrated luminosity of $\sim 100 \text{ nb}^{-1}$ per day to the jet experiment. In 30 days we can accumulate $\sim 3000 \text{ nb}^{-1}$, spread over an energy scanning related to the experimental results.

The PS Division has already started the study of what the installation of the jet implies for the machine. A possible schedule will be given by them; in our opinion the operation could start at the beginning of the ACOL shutdown.

It is our intention to contribute with people and money.

Once the target is installed, we would test it and the final state detector with short runs of accumulated protons in such a way to be able to start running with the \bar{p} 's when the new antiproton complex (ACOL AA) begins to work.

Table 1: Acceptance (%)

Reaction	2.1 GeV	2.2 GeV	2.4 GeV
$\bar{p}p \rightarrow \Phi\Phi \rightarrow 4K$	0.6	3.8	10.3
$\bar{p}p \rightarrow 4K$	1.2	1.6	2.0