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MEMORANDUM

To/A : The SPSC

From/De : J.D. Dowell, Spokesman WA12

Subject/Objet : Status and plans of the SPS beam dump experiment in Omega (WA12)

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a) Trimuon search

As originally presented the main aim of the experiment was to search for the inclusive production of muons from the decay of charmed particles produced in association with the J/ψ particle. The experiment was planned to use both the S1 and H1 beams and would have explored the threshold rise in multimuon production which had been predicted.

Recently, however, two results have been reported from FNAL; that of Binkley et al. PRL 37, 578 (1976) using neutrons of average energy 300 GeV, and that of Anderson et al. (Pilcher experiment) using 225 GeV π^+ and p which was presented at Tbilisi. These experiments had respectively 2500 J/ψ events of which 4 were accompanied by a third muon, and 1666 J/ψ events, 2 with an additional muon. We have studied these results, taking into account the acceptances both for the J/ψ particles and the extra muons, as well as the expected x-distributions for the J/ψ and μ's from $\psi D\bar{D}$ production. The experiments are consistent with each other and correspond to an upper limit of the ratio $\frac{\sigma B(\psi D\bar{D})}{\sigma(\psi)}$ in the region of a few 10^{-3}, where B is the branching ratio of D decay to a muon.

In both experiments the rates are consistent with the expected background from π and K decay.

The cross section ratio at 80 GeV is expected to be lower by a factor between 5 and 10 and would give in our apparatus less signal than background. Even though we expect an order of magnitude more J/ψ events than either of the other experiments it is clear our experiment is not worthwhile. Consequently we have decided not to proceed with the experiment in the H1 beam.

The proposal mentioned several other possible experiments using the same method of muon detection. We envisage two studies of di-muon production using the S1 and EL beams which are of topical interest. These are discussed below. At least for one of them, early results can be reasonably expected and interference with the eγ programme is tolerable.

b) Di-muon production at 40 GeV/c using the S1 beam

Up to the present time the J/ψ particles have only been observed produced by photons, nucleons and pions, apart from one possible anti-proton event detected by Antipov et al. using a 43 GeV/c negative beam at Serpukhov (preprint 76-42). This one event at the J/ψ mass is among 11 at all masses. There is obviously considerable interest in measuring the cross sections and the x and p_t ditributions for ψ production by kaons and anti-protons. In particular the comparison of $\bar{p}$ with p offers the most direct way of understanding the contribution of the valence quarks in J/ψ production.

The beam is expected to contain the following proportions of particles:

1.7% $\bar{p}/\pi^-$, 4% K^-/π^-, 29% $p/p + \pi^+$, 5% $K^+/p + \pi^+$

Furthermore we are already providing particle identification by means of three threshold counters. The cross section for J/ψ production at $x \geq 0$ using 43 GeV/c π^- on a Be target has been measured by Antipov et al. who quote a value of 150 ± 60nb/nucleus, about 1/5 of the value measured at 150 GeV/c and in agreement with our proposal estimate. On the basis of this number we have calculated the rates we might expect for different incident particles in the S1 beam assuming we can work at a total flux of 10^7/burst. (Tests in the South Hall encourage us to believe we can handle this flux). We have further assumed:

10^4 bursts/day (i.e. 6 sec repetition rate, 70% efficiency)
$\sigma_{\bar{p}} = \sigma_{K^-} = \sigma_{K^+} = \sigma_{\pi^-} = 3\sigma_p$
30cm Be target

This gives 1000 ± 400 J/ψ per day from π^-. If we assume a linear A dependence the use of copper or tungsten targets should increase the rate by a factor of at least 3. We then allow a factor 2 reduction for dead time and other losses and obtain for an 8-day run:

200 ± 80 ψ from $\bar{p}$
470 ± 190ψ from K^-

Note that the cross section should be higher for $\bar{p}$ than that assumed.

A 4-day run with positive beam would allow about 600 ψs from protons to be obtained for comparison and ∿ 150 from K^+.

We have considered the possible gain from the use of the beam in a separated mode. A compelling point is that kaons can only be separated up to ∿ 32 GeV/c which in view of the rapid dependence of the cross section on beam momentum would not lead to a worthwhile gain. Furthermore the useful anti-proton flux would only increase by a factor ∿ 7.

The basic physics answers would obviously be obtained quite adequately from the unseparated beam. In view of the simplicity of the experiment and its use of existing tested equipment an early run seems appropriate, with the expectation of quick results.

In summary we request 8 days with negative beam, 4 days with positive beam and 3 days setting-up time in the S1 beam. We would need at least 10^{11} protons incident on the primary target. The apparatus needed is essentially complete. New counters etc. are being tested at the PS. The analysis programs have been prepared and are now being tested with simulated data.

c) Photon Beam Dump Experiment (Intent)

There may be other quarks beyond u, d, s, c, especially if heavy leptons exist. If so, then "super-ψ's" exist(1), and can be most favourably produced in a e^+e^- collisions or via photoproduction. If we assume $\Gamma_{ee} \simeq 1.25$ KeV (5 KeV) for $e_q = -1/3$ (+2/3), then the fine(2) and very fine scans(3) done at SPEAR leave little room for S(super-ψ's) with $M_S < 7.65$ GeV/c^2. The large y $\bar{v}/v$ anomaly may be used as an argument to look for S of mass 8-10 GeV/c^2.

Using reasonable physical assumptions about the photoproduction cross section $\sigma(\gamma p \to Sp) \sim M_S^{-4}$, normalisation on $\sigma(\gamma p \to \psi(\phi)p$ for $e_q = +2/3$ (-1/3), about its energy dependence(4), and about the leptonic branching ratio $B_{\mu\mu} \sim 1/(R+2) = 0.14$, we find that photon beam dump experiments at NAL and even in the West Hall with the SPS could be done now to extend the search for S to higher masses.

We have investigated in some detail the possibility of doing this experiment in Omega with the E1 beam and a layout (Figure 1) which is intermediate between the standard and the WA12 layout. The electron beam produces γ's on a thick $0.5X_o$ radiator. The γ's impinge on a 50cm Be target. $40X_o$ of absorber prevent e's and γ's from spoiling the Omega detectors. The hadrons are mainly absorbed behind the detectors, in the return yoke and additional concrete. The trigger is unchanged, and excludes 90-95% of the Bethe-Heitler $\mu\mu$ pairs.

The following Table gives the event rates expected from 5 10^{12} electrons of 86 GeV, using the above assumptions, for a) ψ's above 30 GeV, b) a hypothetical object of M = 4.7 photoproduced at the $\sigma \cdot B$ level at which an indication is seen at NAL[5], and c) S in the mass range 7.7 - 9 GeV/c^2. Here, the lower figure gives a"pessimistic" estimate based on an effective threshold "delayed"[4] by 1 GeV, and $d\sigma/dt \sim \exp(4t)$, leading to appreciable t_{min} losses. The higher figures are "optimistic", with normal S-nucleon threshold and a flat exp(t) distribution.

TABLE

Mass, GeV/c^2		3.1	4.7	7.7	8.5	9.0
$\sigma x B_{\mu\mu}$, asymptotic, nbarn	$e_q = 2/3$	2.5		.11	.08	.06
	$e_q = -1/3$		.04	.03	.02	.015
Events, per 5 10^{12}	$e_q = 2/3$	30000		50-270	10-90	3-35
e of 86 GeV	$e_q = -1/3$		300	12-70	2-22	1-9

The main problem is the electron beam energy and intensity. The above figures can be reached in 10 days, with 10^{13} protons per burst, of $\sim$ 215 GeV/c, incident on T3, yielding 2.7 10^7 electrons of 86 GeV/c per burst; and one burst every 3.6 sec, with an overall running efficiency of 75%.

d) Conclusions

We wish to abandon the trimuon search, in view of the results obtained in the USA since we submitted our proposal.

We propose to carry out an exposure of 12 days in the S1 beam, with an amount of testing time which we anticipate to be short, at a very early stage of SPS running, with the main purpose of measuring ψ hadro production from $\bar{p}$'s and $K^{\pm}$ at 40 GeV/c. This experiment uses a rather simple and well tested setup, has very modest requirements for proton intensity ($\sim 10^{11}$ ppp), and is expected to yield early results.

We refrain from proposing the E1 beam dump experiment now,before clarification of the heavy uncertainties connected with the very high beam requirements; we wish however to perform a short test, with electrons of 60-80 GeV, in order to

References

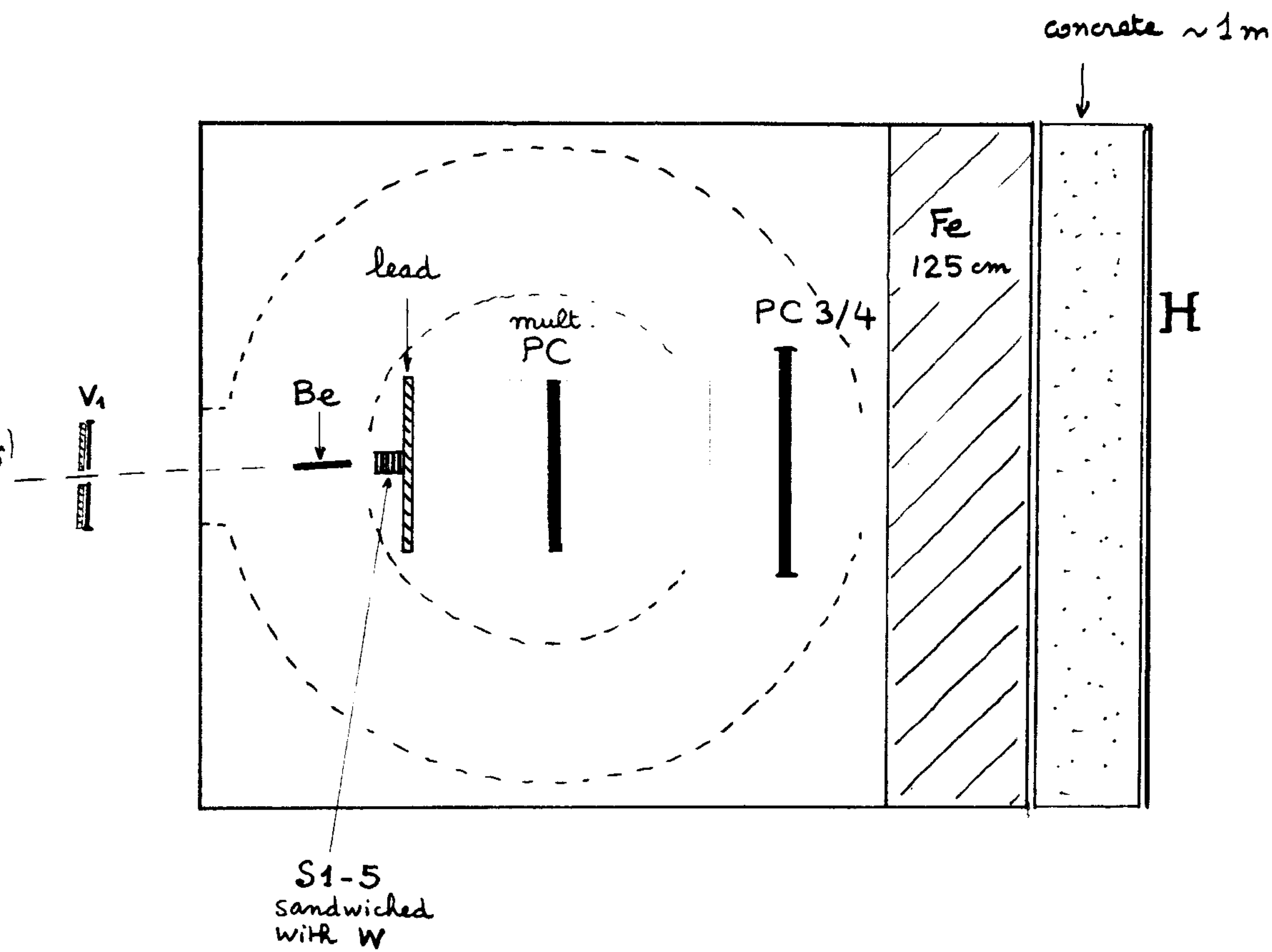
1. T.F. Walsh, DESY 76/47.

2. R.F. Schwitters, p.10, in Proc. 1975 Int. Symposium on Lepton and Photon Physics (Stanford 1975).

3. H.L. Lynch, SLAC - PUB - 1750 (May 1976).

4. V. Barger, R.J.N. Phillips, Phys. Letters 58B, 433 (1975).

5. O. Gaines, private communication.


concrete ~1m
Fe
125 cm
H
lead
mult
PC
PC 3/4
Be
V1
S1-5
sandwiched
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