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MICHIGAN STATE UNIVERSITY

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PHYSICS-ASTRONOMY BUILDING

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Dear Gentlemen:

On behalf of PS183, I am answering your inquiry of October 12 concerning our requirements for antiprotons from LEAR in 1983.

It is our somewhat biased opinion that the experimental identification of gamma-ray lines emitted to bound states of the $\bar{N}N$ system would have a very profound impact on elementary particle physics, and nuclear physics in the conventional sense. As you know, there have been previous indications of lines reported from work done at the PS by Pavlopoulos <u>et al</u> (<u>Phys. Lett. 72B</u>, 415, 1978). Based on the talk presented by Pavlopoulos at the $\bar{N}N$ meeting held in Santiago de Compostela in September, I understand they now claim to have established the existence of four lines at 102, 175, 220 and 550 MeV. This is the result of the original published experiment, as well as more recent unpublished experiments done in 1979 and 1980.

There are also new results from Experiment 708 at Brookhaven (BNL-DOE-Michigan-Syracuse Collaboration). These preliminary results were presented by myself at Santiago and I shall send each of you a copy of my talk just as soon as it is available. In the meanwhile, let me briefly summarize our work to date. We have initially concerned ourselves with the gamma-ray spectrum below ~150 MeV. In the attached figure I show the spectrum taken with a magnet current of 1250 Amperes and selecting only electron pairs created in the downstream thin radiator. These two criteria give good resolution, which is ~6 MeV FWHM as measured at 129 MeV with stopped π^- in the target. The solid line in (a) is a smooth 7-term polynomial fit to the data over the entire spectrum. The purpose of this fit is to establish if there are any local departures from smoothness in the data. Residuals to the fit are shown in the lower portion of the graph (b). Indeed, the spectrum from ~95-130 MeV appears to be quite irregular. We have subsequently made fits to the spectrum of (a), including gaussian line shapes and a smooth background. These fits confirm two structures, one at 105±2 MeV and a second at 125±2 MeV. The second line is very likely due to π^- from $\bar{p}p$ annihilation which stop in the target, producing the characteristic 129 MeV line. <u>The first line at 105±2 MeV may be new physics and the same as reported by Pavlopoulos at Santiago at 102±1 MeV</u>. Both lines occur at the level $R_\gamma \cong 5\times10^{-3}$ per annihilation.

Naturally, one asks how quickly could PS183 confirm the 105 MeV line at LEAR? I attach a table from my talk at Erice this year, in which sensitivities at various energies are given as a function of R_γ, assuming $5x10^{11}$ antiprotons. Since sensitivity scales as the square root of the exposure, I may observe that the 105 MeV line, if it is real, will appear as a five standard deviation enhancement after an exposure of $\sim 7x10^{10}$ antiprotons. This corresponds to a nominal data run of $\sim$65 hours at $3x10^5$ antiprotons per second. Allowing for $\sim$ 185 hours of antiprotons for apparatus checkout, this means the line at 105 MeV could be seen with good confidence with less than 250 hours of beam. The various assumptions made in this estimate are consistent with those given in my memorandum of March 30, 1982 to one of you (K.K.).

The arguments we have presented here suggest that PS183 can produce significant results with a few hundred hours of beam in 1983. We have emphasized the region near 100 MeV because (a) it is close to the peak energy in terms of gamma-ray yields and (b) there are suggestions from experiments at both the CERN PS and BNL AGS of structure nearby. We believe this represents an excellent risk from the standpoint of the CERN investment in LEAR physics and urge that PS 183 be scheduled accordingly. Of course, our overall goals, as outlined in detail in the Erice paper, are to explore the entire spectrum from threshold to $\sim$ 900 MeV with good sensitivity.

Please feel free to contact me if you have further questions.

Sincerely yours,

Gerald A. Smith
Professor and
Spokesman, PS183

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enclosures: preliminary figure, Santiago paper
page 15, Erice paper

Table 4[a,b,c]: Sensitivities (# standard deviations) to gamma-ray lines at 100, 300 and 500 MeV for $R_\gamma=10^{-3}-10^{-5}$.

	E_γ (MeV)		
R_γ	100	300	500
10^{-3}	49	57	113
10^{-4}	4.9	5.7	11.3
10^{-5}	.49	.57	1.13

(a) FWHM resolutions at 100, 300 and 500 MeV are 0.85, 3.40 and 7.08 MeV respectively.
(b) Acceptances at 100, 300 and 500 MeV are 0.1×10^{-2}, 0.4×10^{-2} and 0.6×10^{-2}, respectively, for good quality events.
(c) Assumes 5×10^{11} $\bar{p}$ exposure, resulting in $\sim 189\times10^6$ triggers.

detect the direction and energy of the companion gamma-ray from a π°. Studies of such a detector are presently in progress.

Because $\pi^\pm$ data rates are approximately a factor of twenty larger than those for gamma-rays, in principle short runs are possible, provided practical maximum data acquisition rates can be increased upward from those anticipated for gamma-ray runs. For instance, as discussed previously, acquisition of 6,250 bpi, 150 ips tape drives would increase the presently designed data rate a factor of eight.

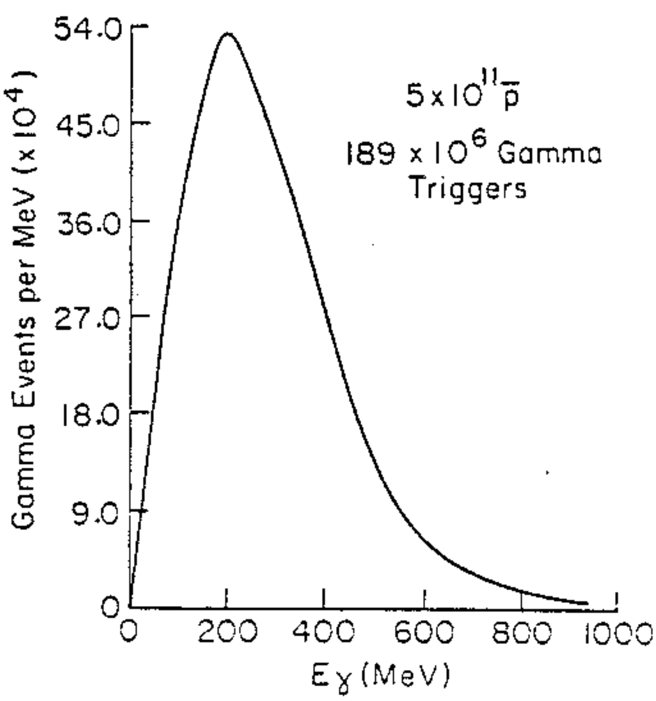

Fig. 14. Estimated energy distribution of background gamma-rays detected in the pair spectrometer

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