Madame Roswitha RAHMY
Listes 6 et 18 = 2 ex.

Memorandum

To: The PSNC
From: Exp. PS174
Subject: Request for LEAR beam in 1986

1) We request $4 \times 10^9 \bar{p}$ at 105 MeV/c, and
2) thank, and admire the tremendous efforts of, P. Lefevre and D. Simon
   and their groups in quickly establishing 105 MeV/c p, and extend our
   appreciation to the operators of the other accelerators which provided a
   steady supply of p.

The experiment examines $p\bar{p}$ (p+d) L and K X-rays in the ranges 1.7-3.1
and 8-12 keV ($\times 7/3$ for p+d energies) from a gas target with a high
resolution SiLi detector. Continuum background is reduced by using a low-mass
system and Compton suppression, and by varying the gas density so as to
stop 80% of the $\bar{p}$ (with constant $\Delta p/p$, the required density falls as the
beam momentum decreases). The possibility of line background is reduced by
using a large flask of high-purity Al and collimating the SiLi so that
it views $\bar{p}$ only in the gas. The spectral regions between the L and K
X-rays and out to 25 keV fix the continuum background and can be searched
for sister contaminant lines. The pHe spectra fully calibrate the system
and also provide strong interaction shifts and widths [Phys. Lett. 145B
(1984) 319] and determine the pHe cascade (to be published).

The shift and width of the $p\bar{p}$ (p+d) K X-rays compared with QED predic-
tions measures the effect of the $p\bar{p}$ (p+d) nuclear interaction on the 1S state,
giving the complex s-wave scattering length. The total yield of the
L X-rays compared with that of the K$_\alpha$ line determines the p$^-$ wave absorption.
By knowing L X-ray spectra at several densities, one can constrain the manner
in which the spectral distribution of the much rarer K X-rays change with
density.

We have obtained a line in the p$^-$ K X-ray region at 10 $\rho_{STP}$ (300 MeV/c)
and also the same line at 2 $\rho_{STP}$ (200 MeV/c), each of 3-4$\sigma$ significance.
The same number of p$^-$ incident on deuterium at 10 and 2 $\rho_{STP}$ gave no such
structure (H$_2$ and D$_2$ have the same $\bar{p}$ stopping distribution and X-ray
absorption). The L X-ray data at these densities and also at 1 $\rho_{gpp}$ sug-
gested that from 10 to 1 $\rho_{STP}$ the total K X-ray yield would change little
and be dominated by the higher transitions. We thus identified the peak
as $K_\alpha$ and $K_\delta$ . . . Here the line separations are small compared with their
width, so that we could extract [Phys. Lett. 162B, (1985) 71]

$$\Gamma_{1S} = 0.85 \pm 0.39 \text{ keV}, \quad \Delta \Gamma_{1S} = -0.73 \pm 0.15 \text{ keV}.$$
At the PSCC 37 of November 1984, we predicted that as the hydrogen gas density was reduced below 1 $\rho_{\text{STP}}$, the X-ray intensity would transfer from the higher transitions to $K_\alpha$, being equal at approx. $\frac{1}{3} \rho_{\text{STP}}$. Hence two X-ray peaks from $\bar{p}p$ at $\frac{1}{3} \rho_{\text{STP}}$ of comparable magnitude, the same width, and 2.8 keV separation would provide very strong confirmation that $K$ X-rays had been seen and would permit a measure of p-wave annihilation.

We have just completed a run at 105 MeV/c that permitted $\frac{1}{3} \rho_{\text{GSPC}}$. Free-fitting the $\bar{p}p$ data with several Gaussians in the K X-ray region provided two peaks, one with the same width and position as our published line, the other of comparable magnitude and similar width but 2.8 keV lower in energy. The peaks are, respectively, of 3.5 and 4.0 significance. These peaks are not present in the $\bar{p}d$ data; neither set of data showed contaminant lines.

Now $\bar{p}d$ K-rays are predicted to be broader and have yields lower by an order of magnitude. So we have built several gas scintillation proportional counters (GSPCs). These have areas several times greater than those of our Silli detectors, and tests at the end of the 105 MeV/c run with the GSPCs showed continuum backgrounds several times lower and for only a small loss in resolution. They are efficient at the energies of $\bar{p}d$ K X-rays and have been designed to work in the very large backgrounds from $\bar{p}d$ annihilation.

In 1986 we would like i) $2 \times 10^9 \bar{p}$ to make a definitive measurement of the $pp$ 1$\sigma$ level shift and width; ii) $2 \times 10^3 \bar{p}$ to observe and measure $\bar{p}d$ K X-rays with two GSPCs. A momentum of 105 MeV/c is preferred since the continuum background is lower (much reduced degrader) yet the K yield is higher. There were insufficient $\bar{p}$ in our present run because the correct decision to stretch the spill to 50 minutes, in order to maximize the physics from the other experiments, reduced the total number of $\bar{p}$ by $\times 3$ and because our remaining allocation permitted only a reduced share of the beam. We welcome sharing with the North branch but request 50:50 division of 20-minute spills. If time and resources permit, then cooling at 105 MeV/c and stable power supplies to avoid 50 Hz in the beam would be welcome.

J.D. Davies
Spokesman