MEMORANDUM

CERN/PSCC/90-29
PSCC/P124 Add.2

October 10, 1990

To: PSCC

From: P124 Collaboration

Subject: **Test of CCD Performance for X-ray Detection in P124**

For a future high accuracy measurement of protonium X-rays, we have proposed the use of CCD's as X-ray detectors for the Lyman transition, and in combination with a crystal spectrometer, for the Balmer transition in this exotic atom. Novel CCD's with a depletion depth of 30 microns are foreseen for the measurement of the K X-rays in order to obtain sufficient detection efficiency, whereas for the L X-rays a depletion depth of 7 microns is sufficient. The latter CCD's have already been used successfully, in connection with a crystal spectrometer to measure pionic hydrogen X-rays at PSI.

During a recent P118T test run at LEAR using a 72 MeV/c beam, it was possible to demonstrate the power of the CCD detector techniquer at an antiproton beam. The detectors were placed at 43 cm distance from the gas volume in the borehole of the cyclotron trap during the tuning of the beamline. The antiprotons were decelerated and stopped in 4 mbar Nitrogen and 2.5 to 50 mbar Helium, respectively. Only 20 to 30 percent of the full antiproton beam could be stopped in the gas volume. The rest annihilated on the beampipe near the detectors, thus causing a huge background. This is seen in Figure 1, where the raw spectrum (7 micron CCD exposed to a nitrogen target) is compared with the same spectrum after background cut. The significant background reduction results from requiring single pixel hits only.

Most important, we have now proved that the new 30 micron CCD's for the higher energy X-rays are working as expected in the antiproton environment. This is shown in Figure 2, for an antiprotonic helium spectrum after background reduction. The resolution at 4 keV is 158 eV, and the background measured in a 1 keV bin at 8 keV corresponds to a (estimated) peak to background ratio of 0.70 for the K_α in the protonium atom. The best peak to background so far achieved with high resolution detectors, i.e. with Si(Li), never exceeded 0.17 (expt. PS175).

A peak to background of about 0.8 is expected from the bremsstrahlung of the charged annihilation products. Therefore, we conclude from our measurements, that the background suppression in the CCD's is already almost complete, although the detectors were placed in a position where the "incoherent" background induced by the electromagnetic showers from the cryostat walls has maximum intensity (point of strongest magnetic field). For the proposed experiment P124, the CCD's will be moved closer to the gas volume (12 cm), where the showers have not yet fully developed, and where the solid angle for antiprotonic X-rays is one order of magnitude larger. In addition, it is known from PS175 that 90% of the antiproton beam is stopped in the gas volume using the 105 Mev/c LEAR beam.

Combining the unique features of the LEAR antiproton beam with the cyclotron trap, a crystal spectrometer and the novel CCD X-ray detectors, a high precision measurement of antiprotonic hydrogen X-rays is now within reach.

For the P124 collaboration: D. Gotta (spokesman)

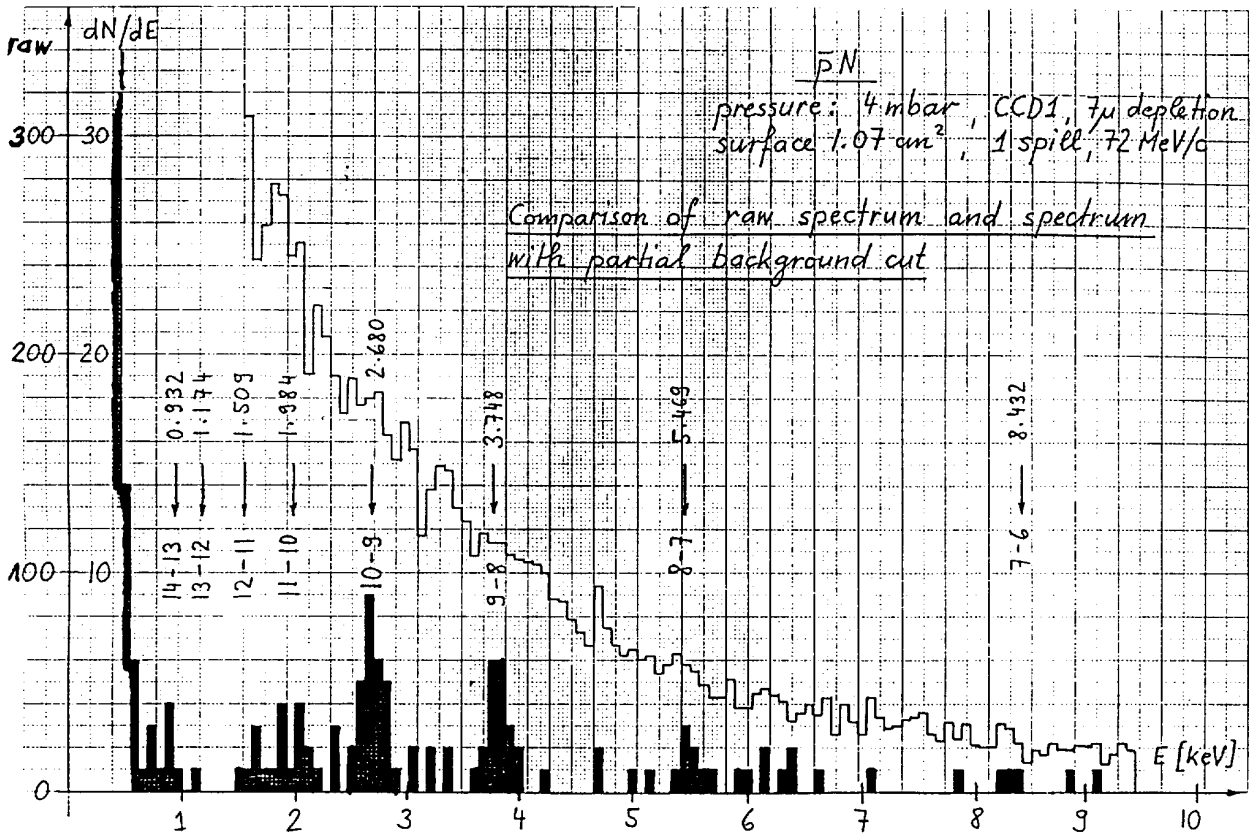
raw
dN/dE
300
30
200
20
100
10
0
1
2
3
4
5
6
7
8
9
10
E [keV]
p̄N
pressure: 4 mbar, CCD1, 7μ depletion
surface 1.07 cm², 1 spill, 72 MeV/c
Comparison of raw spectrum and spectrum
with partial background cut
0.932
1.174
1.509
1.984
2.680
3.748
5.469
8.432
14-13
13-12
12-11
11-10
10-9
9-8
8-7
7-6

Fig. 1

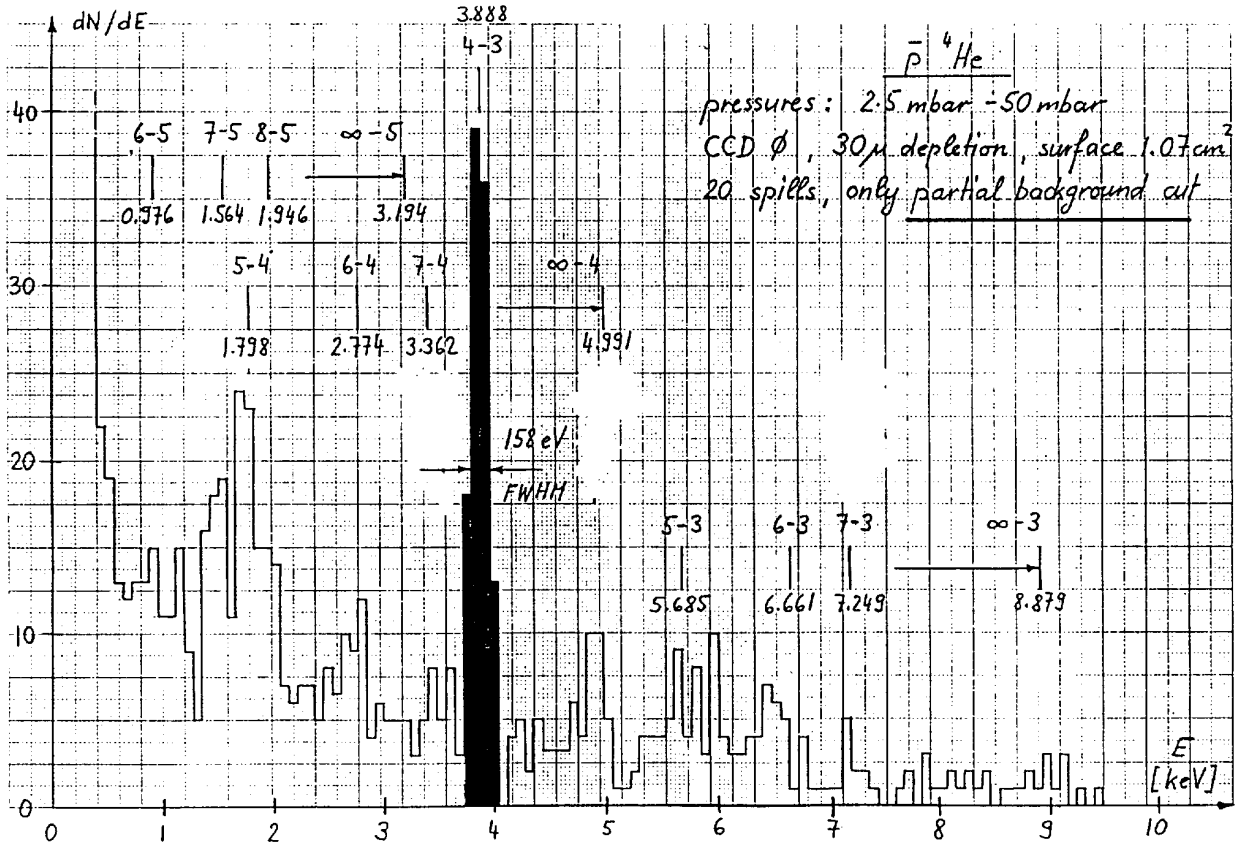
dN/dE
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
E [keV]
p̄ ⁴He
pressures: 2.5 mbar - 50 mbar
CCD Ø, 30μ depletion, surface 1.07cm²
20 spills, only partial background cut
3.888
4-3
6-5
7-5
8-5
∞-5
0.976
1.564
1.946
3.194
5-4
6-4
7-4
∞-4
1.798
2.774
3.362
4.991
158 eV
FWHM
5-3
6-3
7-3
8-3
5.685
6.661
7.249
8.879

Fig. 2