Comparison of Sensitivity of E852 and Hall D at CEBAF

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In this brief note we compare the sensitivities of E852 at Brookhaven National Laboratory's AGS and the expected rates at the proposed Hall D facility at CEBAF.

E852 had a 1 foot hydrogen target, and we assume the Hall D detector will have the same. The bottom plot in figure 1 shows the live beam from the 1995 run of E852. We take from this plot the value of 6×10^5 beam particles per AGS pulse as a mean value. E852 had a beam reconstruction efficiency that we estimate to be about 80%. Thus, for E852 the sensitivity/second is given by:

$$\mathbf{Sensitivity/sec} = 5{\times}10^5 \ \frac{\pi' s}{\mathbf{spill}} \ \frac{\mathbf{1spill}}{3.7\mathbf{sec}} \ \frac{1.25\ \mathbf{event}}{\mu\mathbf{barn} - \mathbf{10^6 beam}} = 0.17/(\mu\mathbf{barn} - \mathbf{sec})$$

For Hall D at CEBAF we assume a 10^8 photons/second continuous beam. We estimate that the livetime at this beam flux will be 80

$$\mathbf{Sensitivity/sec} = 0.8 \times 10^8 \frac{1.25\ \mathbf{event}}{\mu\mathbf{barn} - \mathbf{10^6 beam}} = 100/(\mu\mathbf{barn} - \mathbf{sec})$$

The total factor in favor of CEBAF is ~ 500.

One must fold in the relative total cross sections. The total π^- cross section at 18 GeV/c on protons is ~ 30 mbarns, while the total γ cross section at ~ 5.5 GeV/c is 122 μbarns, for a factor of ~ 250 in favor of the hadron beam.

Thus there is an overall factor of ~ 2 in favor of CEBAF. However, one must remember that E852 had a fairly restrictive trigger, triggering only events with an even number of charged tracks between 0 and 4. In addition, the events with no charged tracks incorporated into the trigger the total energy seen by the lead glass, and events with multiplicity 2 incorporated the total effective mass seen by the lead glass. The total trigger rate was ~ 600 events/spill, while Hall D will run closer to 10-15 KHz, an overall factor of 20.

We now try to calculate the overall sensitivity of E852 by examining the reaction $\pi^- p \to a_2^-(1320)p$, with $a_2 \to \rho^0\pi^-$. The total a_2 cross section $\times\rho\pi$ branching ratio is measured by Evangelista, et al. [2] to be 86.4 μbarns, at 12 GeV/c^2. Figure 2 shows the acceptance corrected, $J^{PC} = 2^{++}$ spectrum, which is dominated by the a_2 at 1.3 GeV/c^2- we estimate the total number of a_2 events to be ~ 117000.

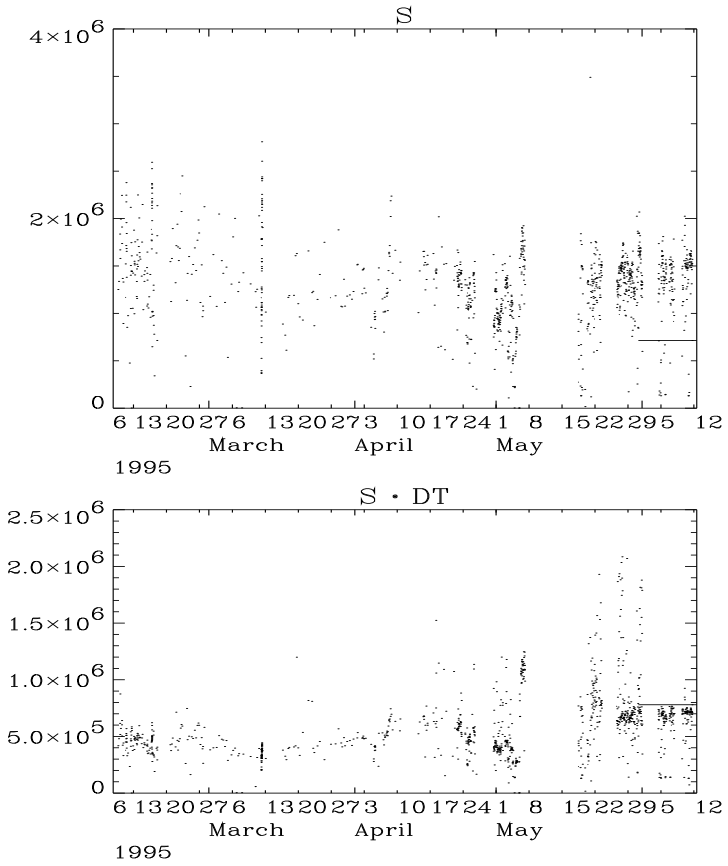

Figure 1: E852 Beam rates

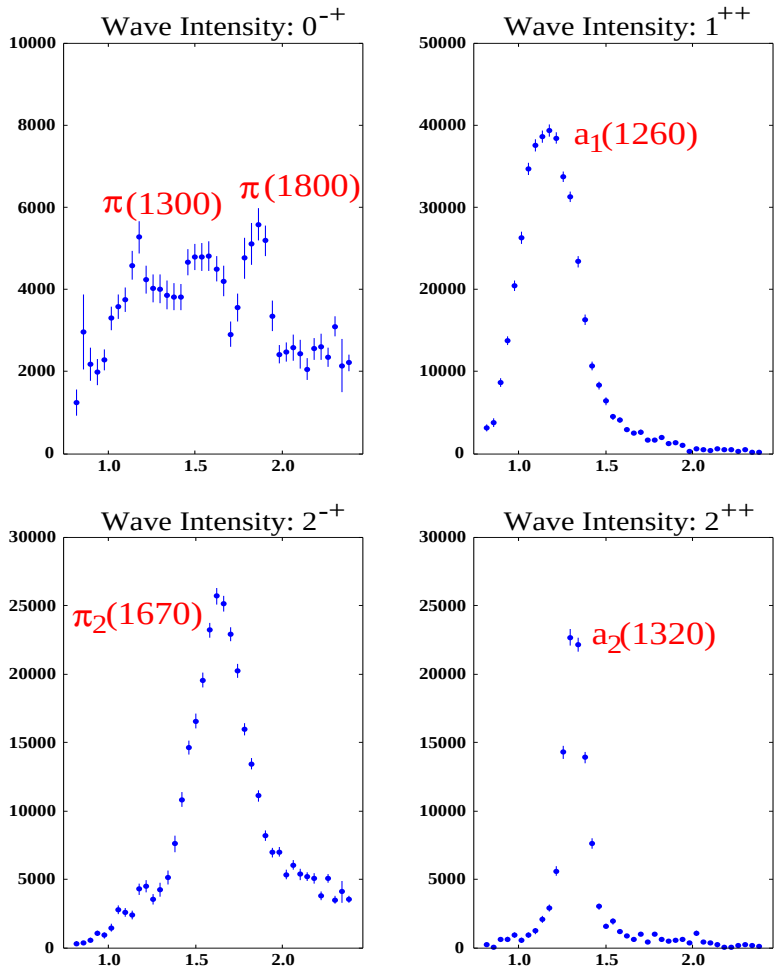

Figure 2: $\pi^+\pi^-\pi^-$ E852 Partial Wave Analysis (acceptance corrected)

From Evangelista, et al., the a_2 cross section has the form:

$$\frac{d\sigma}{dt'} \propto t' e^{-8.3t'}$$

E852 has no acceptance for $|t| < .1\ GeV^2$ (t_{min} at 18 GeV/c at the a_2 mass is $-0.16 \times 10^{-5} GeV^2$), thus, E852 sees only about 80% of the cross section, i.e. ~ 69 μbarns. Therefore, the data shown in figure 2 represents about 1700 events/μbarn, which represents about 3 hours of running. Hall D can reproduce the statistics represented in figure 2 in about an hour or two of beam.

References

[1] Meyer, PL**33B**,189 (1970).

[2] Evangelista et al., NP **B178** 197.