GlueX/Hall-D Solenoid Current Studies

Interim Report

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Studies Performed

- Two final states chosen for the study:

  $\gamma p \rightarrow p\pi^+\pi^-\pi^+\pi^-\pi^0$

  $\gamma p \rightarrow p\pi^+\pi^-\pi^0$

  $\gamma p \rightarrow p\pi^+\pi^-\eta$

- Reactions examined with detected proton.

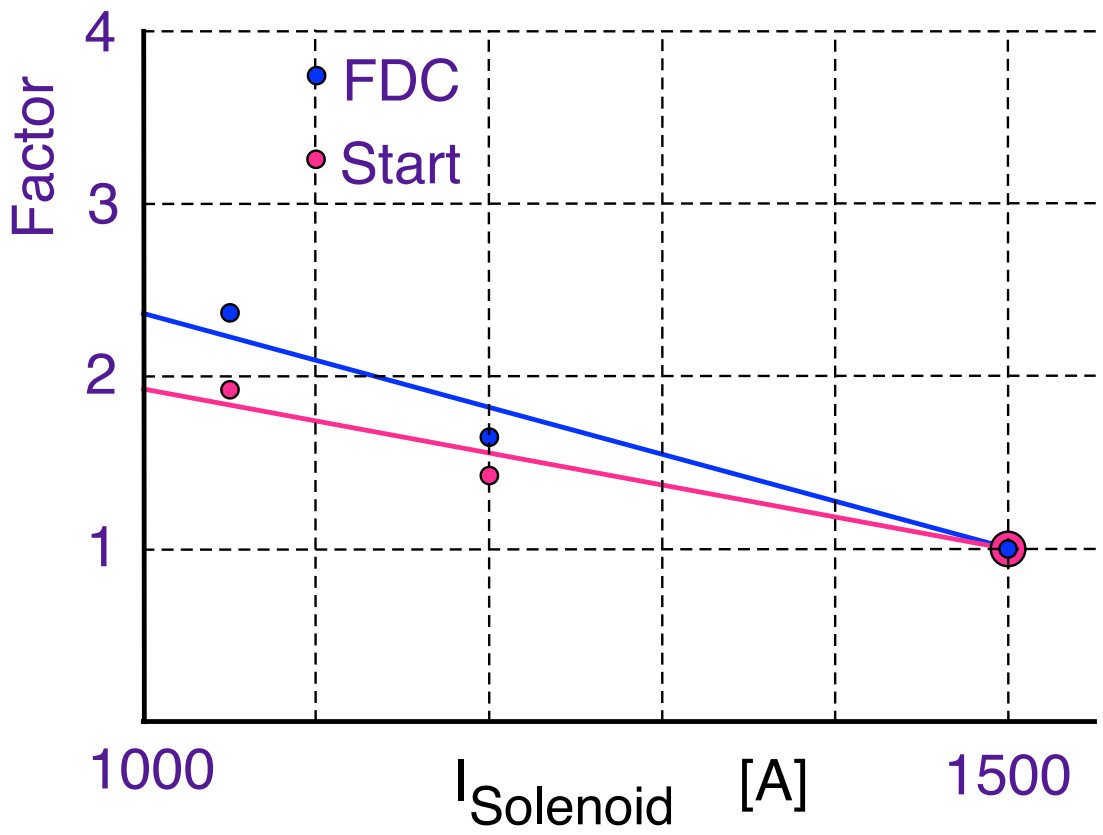
Studies Performed

- Four solenoid currents were chosen:
  - 1500 A (Design current)
  - 1350 A
  - 1200 A
  - 750A
- Two electromagnetic background rates were examined:
  - 1 (10^7) γ/s in coherent peak (Phase III Running).
  - 5 (10^7) γ/s in coherent peak (Phase IV Running).
- Results taken from earlier study on electromagnetic rates in detector elements.

Quantities Examined

- Electromagnetic background rates in the detector.
- Momentum resolution of charged particles.
- Angular resolution of charged particles.
  - In the lab frames.
  - In the Gottfried-Jackson frame.
- Invariant mass resolution.
- Reconstruction efficiency at 90% and 99% purity.

Electromagnetic Rates



1300A current leads to rates that are 50% higher than 1500A current.

Worst case is 50% longer running for the same result. Our high-intensity proposal assumes a factor of 2 below design rates.

- Rates increase by 20% to 30% for each drop of 100A in solenoid current.
- Absolute rates will not be known until we have data.

Momentum and Angular Resolutions

- Momentum resolution decreases linearly with the magnetic field strength. Running at 1300A decreases the momentum resolution by 13% (as expected).
- Angular resolution in both the lab and GJ frame appear independent of the magnetic field (as expected).
- Invariant mass resolution decreases less rapidly than momentum resolution. A 20% drop in momentum resolution led to a 10% increase in the width of an invariant mass.

Reconstruction Efficiency

- Simple cuts-based analysis through a kinematic fit to an exclusive final state.
- Cut on kinematic fit confidence level.
- Use the same cuts for all solenoid currents and photon beam rates.
- Report ``reconstruction efficiency", ``purity'' and ``Signal/Background''.

Numerical Results

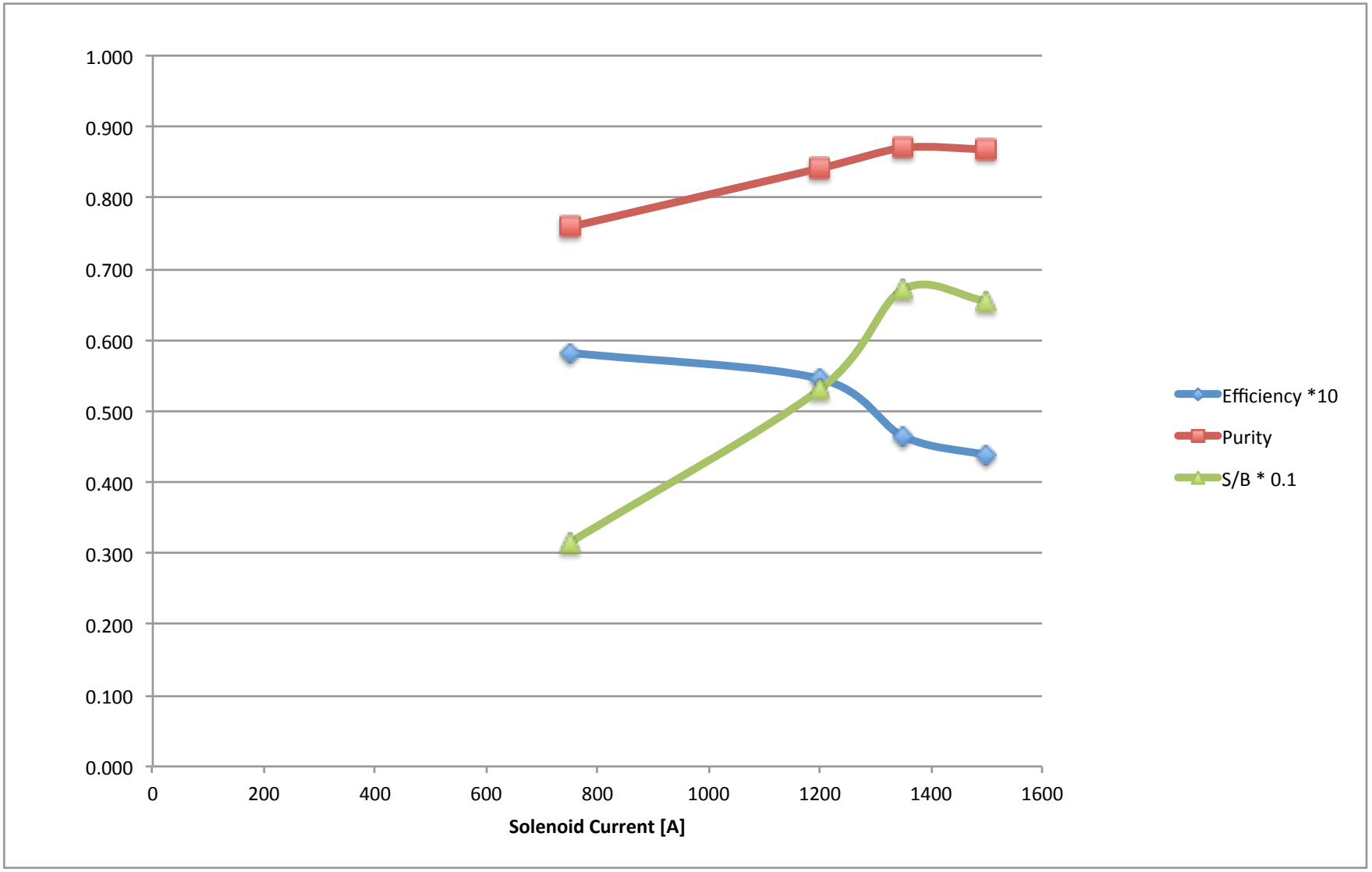
I_S (A)	γ/s	Reconstruction Efficiency	Signal Purity	Signal/Background
750	1×10^7	5.82%	75.9%	3.15
1200	1×10^7	5.45%	84.1%	5.31
1350	1×10^7	4.64%	87.0%	6.71
1500	1×10^7	4.38%	86.8%	6.55
1200	5×10^7	4.60%	83.7%	5.12
1350	5×10^7	4.20%	86.9%	6.66
1500	5×10^7	4.00%	87.3%	6.90

Table 1: The reconstruction information for the $\gamma p \to \pi^+\pi^-\pi^+\pi^-\pi^0$ reaction.

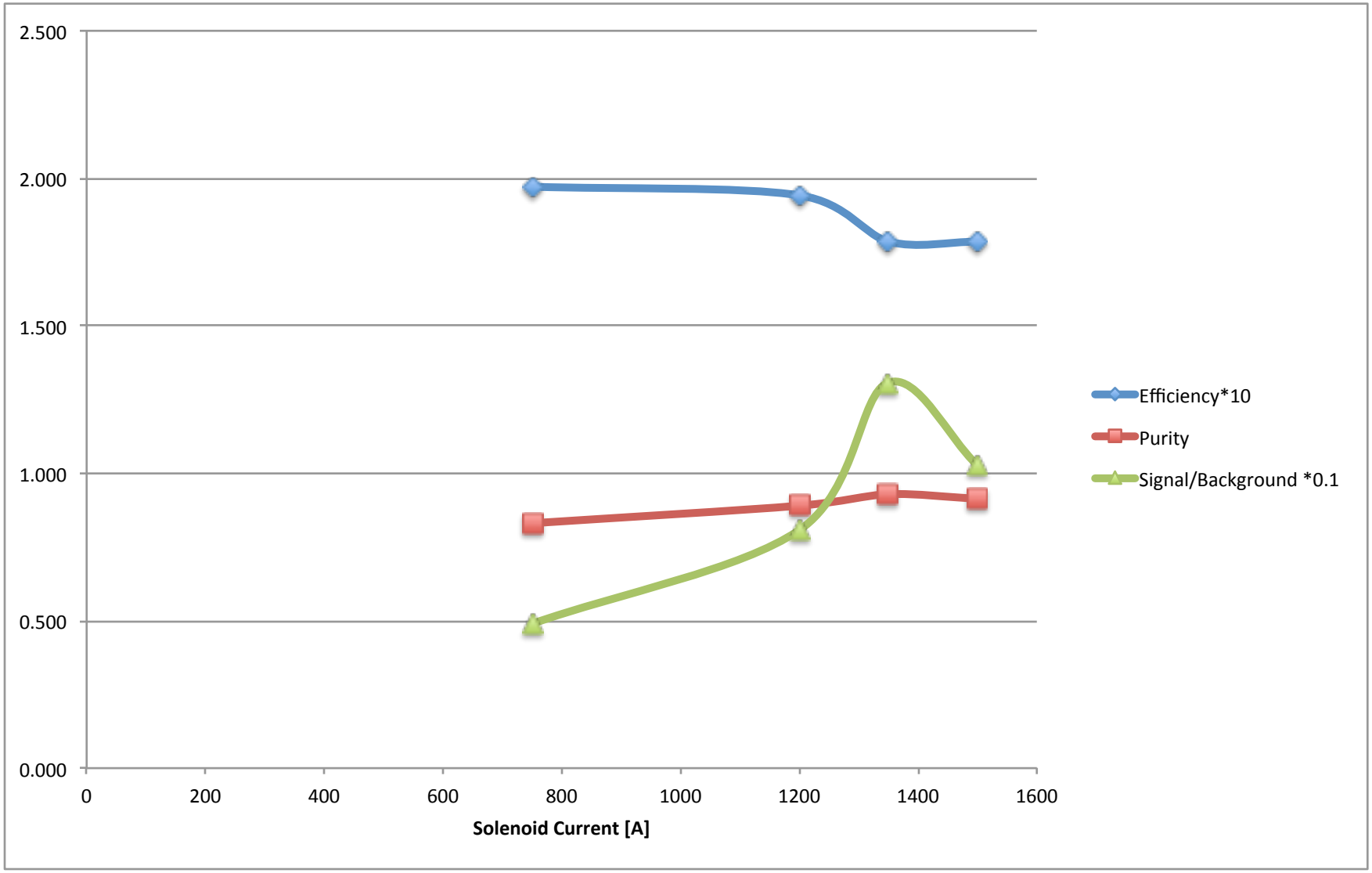
I_S (A)	γ/s	Reconstruction Efficiency	Signal Purity	Signal/Background
750	1×10^7	19.71%	83.0%	4.89
1200	1×10^7	19.42%	89.0%	8.07
1350	1×10^7	17.86%	92.9%	13.07
1500	1×10^7	17.86%	91.1%	10.26
1200	5×10^7	17.3%	88.9%	8.037
1350	5×10^7	16.1%	92.6%	12.593
1500	5×10^7	16.6%	91.1%	10.175

Table 2: The reconstruction information for the $\gamma p \to \pi^+\pi^-\pi^0$ reaction.

$$\gamma p \to p\pi^+\pi^-\pi^+\pi^-\pi^0$$



$\gamma p \to p\pi^+\pi^-\pi^0$



Results

- The higher beam rate has a small effect on our ability to reconstruct final states.
- Reconstruction efficiency increases as the solenoid current is decreased, but there appears to be a plateau below 1000A.
- Purity falls as the solenoid current is decreased.
- Signal/Background has a plateau in the 1300A to 1500A region, and falls rapidly below this current.
- Under current situations, the optimal solenoid current is in the 1300A to 1350A range.

Conclusion

- From what we see now, we feel that our initial program will not be negatively impacted, and will likely be improved by running the solenoid at a current of 1300A-1350A.

- The high-intensity running may be limited due to EM backgrounds in detector elements and solenoid currents higher than 1300A-1350A to limit this. The answer to this will require actual running with photon beams.

Remaining Work

- Look at the original study carried out by Elton and make sure that it is consistent with what we now see. I believe we have these data.
- Include the data on $\gamma p \to p\pi^+\pi^-\eta$
- Finish off the report (currently about 2/3 done).