CLAS-NOTE-2000-004

High-Rate Test

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1 Measurements

In order to estimate background rates at the high photon fluxes expected for Hall D, we conducted a one hour test of high intensity running with photons at the end of the g1c running period (November, 1999). We took measurements at 10, 80, 250 and 320 nA with a 10^{-4} radiator. The sequence of steps used to take the data is listed in the Appendix. We measured rates in the forward TOF scintillators (7.5-12.5 deg), the electromagnetic calorimeter (8-45 deg), and currents and occupancies in the drift chambers. For each setting we also recorded the Or of the T-counters. However, due to the high rates, T-counters 9-61 were turned off except for the lowest current setting, which could be compared to g1 running. The measured rates are given in Table 1 and drift chamber occupancies in Table 2, as well as typical rates for electron-beam operation for comparison.

Table 1: Rates recorded in the high-rate test. Typical rates during electron-beam running are also given for comparison.

Photon Beam Current (nA)	TOF (forward)[2] (KHz)	EC[2] (KHz)	Start (MHz)	Mor [1] (MHz)	r1 μA	r2 μA	r3 μA
10	0.24	2.24	0.25	9.3	20.	27.	27.
80	1.93	2.83	1.88	4.22	171.	75.	116.
250	6.00	8.13	-	11.2	477.	192.	309.
320	7.72	11.8	-	17.1	581.	231.	376.
4GeV Electron 4 nA current (typical)	6.87	9.57	-	-	444.	342.	299.

2 Rate Comparison

Although the conditions of the test did not duplicate precisely the conditions expected in Hall D, we believe that reasonable estimates can be made for what is expected by

[1]Mor (master Or rate) is the full tagger for 10 nA, but T1-8 for all other data.
[2]TOF and EC rates are averaged for sectors 1-4. Sectors 5 and 6 are a factor of two higher than other sectors due to incomplete photon beam shielding.

Table 2: Drift chamber occupancies for each superlayer (in percent) for run 21998 at the maximum beam current of 320 nA (logbook entry #7031).

Beam	Region 1 S1	Region 1 S2	Region 2 S3	Region 2 S4	Region 3 S5	Region 3 S6
Photon	2.3%	2.3%	0.3%	0.4%	0.7%	0.9%

appropriate scaling. In Table 3 we compare the differences in target, collimation and beam energy. As the majority of background results from lower energy photons, we assume the energy dependence to the measured rates is small. The rates are scaled by a factor of 1.7 (ratio of target lengths) and the beam current is scaled up by a factor of 5.33, which is the expected collimation ratio. The drift chambers in region 1 are completely unshielded by any magnetic field in CLAS, whereas the drift chambers in region 2 are shielded by the field of the CLAS torus. The 2.2 T solenoidal field for Hall D is expected to be at least as effective as a shield as the CLAS torus. Therefore, we expect the oocupancies in the Hall D drift chambers to be as low or lower than those in CLAS for comparable granularity.

Table 3: Comparison between conditions in Hall B during high rate test and anticipated running parameters for Hall D. A current of 3 μ A in Hall D corresponds to 10^8 photons/s in the coherent peak.

	Hall B Test	Hall D
Beam Current	80 nA $\rightarrow$ 320 nA	300 nA $\rightarrow$ 3 μ A
Radiator	10^{-4}	10^{-4}
Collimation keeps	80%	15%
Target Length	18 cm	30 cm
Beam Energy	2.4 GeV	12 GeV
Trigger	Restricted	Open

Extrapolating measured occupancies in region 2 to a current of 3 μA (Hall D with 10^8 photons/s in the coherent peak), we expect an occupancy of 0.6%. The rates are plotted versus electron current scaled to Hall D in Figure 2. This is well below the typical operational limits of 2.3% imposed for the region 1 drift chambers in CLAS during electron beam running, a rate at which tracks can still be reconstructed with reasonable efficiency. We note that the extrapolated rates in region 1 for a beam current of 3 μ is approximately 5%, exceeding usual operational limits by a factor of 2, but completely unshielded by any magnetic field whatsoever and thereby representing an absolute maximum to the expected rates. The rates in scintillator detectors (TOF and EC) scaled appropriately and extrapolated to the same high rate condition predict rates which are approximately 2.4 times higher than typical electron-beam operation in Hall B. We note that the operation of a polarized target in Hall B (which replaces the mini-toroid with a solenoidal field) allows running at twice the normal luminosity. Thus, we expect that for comparable segmentation, raw rates in the Hall D detector at the maximum design current, will be similar to our current experience with CLAS.

3 Conclusion

All recorded rates were linear in beam current. At the highest electron current (320 nA), the rates in the detector were within a factor of two of the rates during present operation with an electron beam (4 GeV) with CLAS and the mini-torus. Considering that the electron data is analyzable, we conclude that the Hall D detector should be able to handle rates up to 10^8 photons/s.

A Program for Tests

This appendix describes the task list for the high intensity run on November 19, 1999. Shift personnel included Volker Burkert, Dinko Pocanic, Vardan Gurjyan, Barry Ritchie, and Elton Smith. Data taking started at 9:30 p.m., approximately an hour before the beam was shutdown for this running period. The energy of the beam was 2.4 GeV. At this energy, the 1 KW limit on the beam dump (80% safety factor) allows running up to 320 nA.

A.1 Configuration

- The radiator thickness was 10^{-4} radiation lengths for the entire test.
- CLAS H_2 Target Full.
- L1 = nominal G1 TIGRIS trigger (OR of all TOF counters).
- Configuration = G1_PROD_RR.
- Turn HV off for T counters T9-61. T1-8 were the counters used by the G6 open trigger configuration.
- Turn HV off E49 (HV E1-12 on) and up (corresponding to T9-61).
- E·T coincidence ON.
- PC out of the beam.
- PS converter out.
- PS counters off.

Note: The prescale factor can be set using the old ts_config GUI.

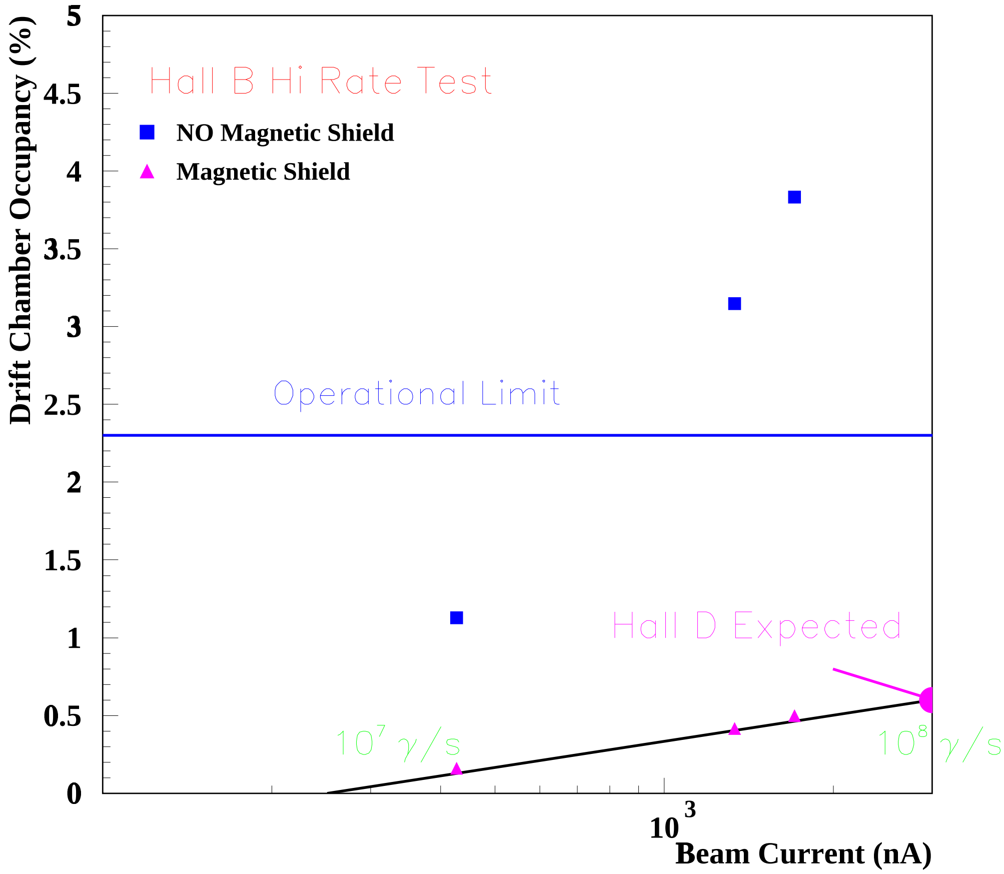

Figure 1: Drift chamber occupancies (scaled by target thickness = 1.7) plotted versus beam current (scaled by collimation factors = 5.33) expected for Hall D operation. The drift chambers in region 1 (squares) are completely unshielded by any magnetic field in CLAS, whereas the drift chambers in region 2 (triangles) are shielded from backgrounds by the main torus field. The nominal low current operation in Hall D (10^7 photons/s in the coherent peak) corresponds to 300 nA. The 2.2 T solenoidal field for Hall D is expected to be at least as effective as a shield as the CLAS torus.

A.2 I=80 nA

- I=80 nA
- T1-8
- Trigger Mor·Start·L1 (G1 production)
- Prescale = 9+1

Record:

1. Trigger Rate
2. Dead Time
3. Record Drift Chamber Currents
4. From Beam GUI, Start Counter Rates, Scintillator Rates,E C Rates
5. Print out Scalers (end of run)

Take Data 10 min.

A.3 I=250 nA

- I=250 nA
- T1-8
- Trigger Mor·L1. Start Counter OFF (Must use Expert Photon GUI)
- Prescale = 500+1

Record:

1. Trigger Rate
2. Dead Time
3. Record Drift Chamber Currents
4. From Beam GUI, Scintillator Rates, EC Rates
5. Print out Scalers (end of run)

Take Data 10 min. Trigger rate 2400 Hz, 12MB/s

A.4 I=320 nA

- I=320 nA
- T1-8
- Trigger Mor·L1. Start Counter Off
- Prescale = 700+1

Record:

1. Trigger Rate
2. Dead Time
3. Record Drift Chamber Currents
4. From Beam GUI, Scintillator Rates, EC Rates
5. Print out Scalers (end of run)

Take Data 10 min. Trigger rate 2400 Hz