Commissioning Plan for the $HRS_{Electron}$ in Hall A

Eddy Offermann and Mohammad Khayat

Activity for Weekend of Aug. 16th, 1996

Abstract

Starting on the 16^{th} of August the electron specrometer (Q1, Q2, dipole and Q3) will become available for operation and the start of its commissioning activity. As it has been planned these commissioning activities will take place on weekends, thereby allowing the engineering staff access for work in the Hall during week days. Initially solid ^{12}C and BeO targets will be available; a waterfall target will become available after the September shutdown of the accelerator. Here we will outline the early commissioning activity using the two solid targets. The objectives of this run are:

- Shakedown of the magnetic spectrometer including its controls
- Shakedown of the detector package consisting out of the VDC package and scintillators S1 and S2.
- Accumulating particle tracks to get a first glance at the spectrometer optics with the complete set of magnetic elements.
- Check the reproducibility of elastic peak position after cycling the spectrometer magnets.
- Study the spectrometer optics by moving an elastic peak across the focal plane (delta scan) using the rectangular collimator.
- Study the spectrometer optics by moving an elastic peak across the focal plane (delta scan) using the sieve collimator.

The setup parameters of the incoming electron beam, target and spectrometer are given in table 1. Two different kinematics are planned for single-arm electron scattering from Carbon: elastic and quasi-elastic scattering. In the next two sections the current/magnetic settings of the spectrometer elements are given together with count rates for each of the kinematic settings. It is assumed that detector parameters like timing offsets and pedestals have been determined with cosmic runs or from the results obtained in the May run. In the quasi-elastic run there will be enough statistics over the whole focal plane to check these numbers. In the elastic runs, two collimators (rectangular and sieve) will be used; in each case a delta scan will be performed by moving the elastic peak accross the focal plane. In addition to the Carbon target, a BeO target will also be used with the rectangular collimator for further optics studies.

All count rate estimates are based on a Carbon spectrum taken at MAMI Mainz in nearly identical kinematic settings.

Variable	Description	Value	
E_0	energy of incoming electron beam	845.0	MeV
I_{av}	average electron current (cw)	1 - 5	μA
target		Carbon	
α	target angle, defined as the angle between the incoming beam direction and the normal to the target surface	8.0	deg
d	nominal target thickness	50.0	mg/cm^2
θ_0	spectrometer angle	16.0	deg

Table 1: Setup parameters of beam, spectrometer and target.

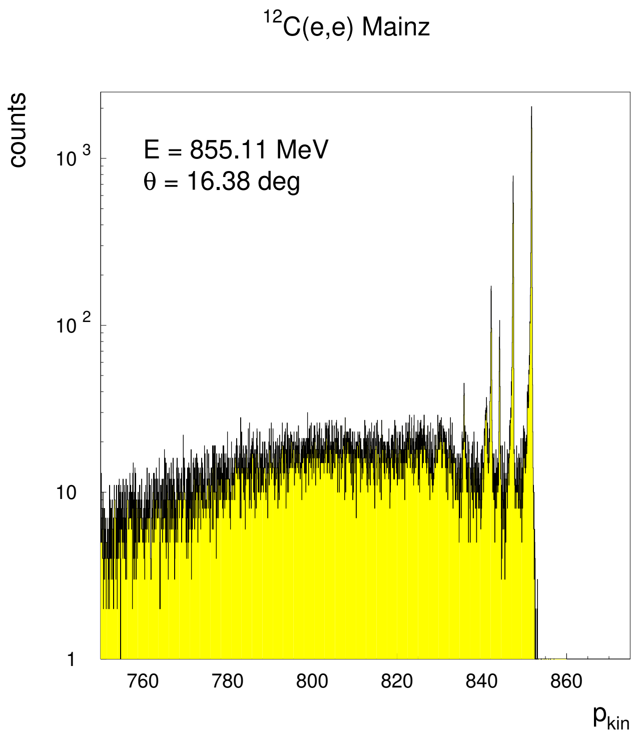

Figure 1: momentum spectrum of ^{12}C(e,e') taken at MAMI Mainz.

1 Elastic electron scattering and Delta Scan

Additional setup parameters for performing an elastic run are given in table 2. The field settings are for a central momentum of 845 MeV/c.

Variable	Description	Value	
I_{Q1}/B_{Q1}	current/field setting of Q1	-638.25/-0.2907	A/T
I_{Q2}/B_{Q2}	current/field setting of Q2	-365.18/ 0.1984	A/T
I_{Q3}/B_{Q3}	current/field setting of Q3	-353.68/ 0.1923	A/T
I_D/B_D	current/field setting of dipole	325.90/ 0.3356	A/T
$\Delta\Omega$	Rectangular collimator in front of Q1	7.2	msr
$\Delta\Omega$	Sieve collimator in front of Q1	7.2×10^{-3}	msr
trigger	trigger pattern between S1 and S2 programmed in the MLU	OPEN	

Table 2: Additional setup parameters for elastic run.

We plan to use both C and BeO targets to perform a delta scan of the HRS. The delta scan will be done in $\Delta p/p = 1.5\%$ steps relative to the central momentum setting of the spectrometer ($845 MeV/c$):

$$\Delta p/p = 0., \pm 1.5, \pm 3.0, \pm 4.5\%$$

for a total of 7 magnetic settings per target. For the BeO target only the rectangular collimator will be used; for the C target both rectangular and sieve collimators are to be used.

The solid angle of the Rectangular collimator is 7.2-msr. The expected rate for the elastic peak is 3870 Hz/μA. We assume a data acquisition rate of 100 Hz. To make a measurement with 10000 counts in the elastic peak (corresponding to approximately 35000 over the whole focal plane) we will have to run for about 6 minutes with an average current of $I_{av} = 0.6\mu$A.

The solid angle of the sieve is 0.1% of the 7.2-msr collimator. The expected rate for the elastic peak is 3.9 Hz/μA, and 11.6 Hz/μA over the whole focal plane. So we can accumulate in 8.5 minutes using $I_{av} = 5\mu$A 10000 counts in the elastic peak.

As the magnetic fields require approximately 40 minutes to settle down to their final values, resetting the spectrometer magnets constitues a large overhead in time. It should be noted that the change of collimators requires an access to the experimental hall; the target change however can be done remotely from the counting house.

2 Quasi-Elastic electron scattering from ^{12}C

Additional setup parameters for performing a quasi-elastic run are given in table 4. The field settings are for a central momentum of 800 MeV/c, the center of the quasi-elastic peak.

Element	$\Delta p/p$						
	+4.5%	+3.0%	+1.5%	0.0%	-1.5%	-3.0%	-4.5%
I_{Q1} $[A]$	-609.53	-619.10	-628.68	-638.25	-647.82	-657.40	-666.97
B_{Q1} $[T]$	-.2776	-.2820	-.2863	-.2907	-.2950	-.2994	-.3038
I_{Q2} $[A]$	-348.75	-354.22	-359.70	-365.18	-370.66	-376.14	-381.61
B_{Q2} $[T]$	.1895	.1925	.1954	.1984	.2014	.2044	.2073
I_{Q3} $[A]$	-337.76	-343.07	-348.37	-353.68	-358.99	-364.29	-369.60
B_{Q3} $[T]$	.1837	.1866	.1894	.1923	.1952	.1981	.2010
I_{DI} $[A]$	311.23	316.12	321.01	325.90	330.79	335.68	340.57
B_{DI} $[T]$	.3205	.3255	.3305	.3356	.3406	.3456	.3506

Table 3: Current and field settings for Delta Scan runs; $\Delta p/p = 0\%$ corresponds to a central momentum setting of 845.0 MeV/c.

Variable	Description	Value	
I_{Q1}/B_{Q1}	current/field setting of Q1	-604.26/-0.2752	A/T
I_{Q2}/B_{Q2}	current/field setting of Q2	-345.73/ 0.1878	A/T
I_{Q3}/B_{Q3}	current/field setting of Q3	-334.84/ 0.1821	A/T
I_D/B_D	current/field setting of dipole	308.54/ 0.3177	A/T
$\Delta\Omega$	Rectangular collimator in front of Q1	7.2	msr
trigger	trigger pattern between S1 and S2 programmed in the MLU	OPEN	

Table 4: Additional setup parameters for quasi-elastic run.

The rate will be 3100 Hz/μA. So to accumulate a quasi-elastic spectrum with approximately 1000 counts/wire or $4 \cdot 10^5$ counts over the whole focal plane, and limiting the data acquisition rate to 100Hz, we will have to run for 1.1 hours with $I_{av} = 1\mu$A.

3 Run Plan

The run plan is designed to check the reproducibility of the spectrometer magnets when they are cycled. We will obtain both elestic and quasi-elastic runs as well as perform a delta scan.

Therefore, the run plan for this test run calls for:

- Begin with an elastic run on C for $\Delta p/p = 0\%$ with Rectangular collimator. Acquire data for 10 min @ 1μA.
- Change target to BeO ($\Delta p/p = 0\%$, and Rectangular collimator). Acquire data for 10 min @ 1μA.
- Change Collimator in front of Q1 to Sieve (require Hall access $\sim$ 30 minutes).
- Change target to C. Acquire data for 10 min @ 5μA ($\Delta p/p = 0\%$).
- set the spectrometer for $\Delta p/p = +4.5\%$ (wait for approximately 40 min. for fields to settle); see table 3.
- Acquire data for 10 minutes on C with Sieve collimator @ 5μA.
- Change Collimator in front of Q1 to Rectangular (require Hall access $\sim$ 30 minutes).
- Acquire data for 10 minutes on C with Rectangular collimator @ 1μA.
- Change target to BeO.
- Acquire data for 10 minutes on BeO with Rectangular collimator @ 1μA.
- Change target to C.
- Change spectrometer magnet setting to that of a quasi-elastic run table 4. Wait for approximately 40 min. for fields to settle. Acquire data for 1.1 hour on C with Rectangular collimator @ 1μA.
- cycle the magnet to set the fields for $\Delta p/p = -4.5\%$. Wait for approximately 40 min. for fields to settle.
- Acquire data for 10 minutes on C with Rectangular collimator @ 1μA.
- Change target to BeO.
- Acquire data for 10 minutes on BeO with Rectangular collimator @ 1μA.

- Change Collimator in front of Q1 to Sieve (require Hall access ~ 30 minutes).
- Acquire data for 10 minutes on C with Sieve collimator @ 5μA.
- Set the spectrometer for $\Delta p/p = -3.0\%$ (wait for approximately 40 min. for fields to settle); see table 3.
- Acquire data for 10 minutes on C with Sieve collimator @ 5μA .
- Change Collimator in front of Q1 to Rectangular (require Hall access).
- Acquire data for 10 minutes on C @ 1μA .
- Change target to BeO.
- Acquire data for 10 minutes on BeO @ 1μA.
- ...
- repeat this procedure for the other spectrometer settings, in increasing $\Delta p/p$ order, and allowing only one entry to the hall per magnetic setting for change of collimator.
- ...

We anticipate that $\sim 2 - 2.5$ hours are needed for the completion of the data aquisition plus overhead for each magnetic field setting in the elastic set of runs. Therefore the elastic measurements would require ~ 22.5 hours. Including the quasi-elastic run, the necessary time is about 24 hours with no beam interruption or other major down times.

In addition to the above program, a number of tests can be performed to check various triggering choices. These test runs can be taken for example during the periods when magnets are settling down. A list follows:

- Try the buffering mode of trigger supervisor. It was already tested with cosmics.
- Try trigger patterns involving different combinations of detectors.
- Vary the rate by 2 orders of magnitude, verify deadtime correction. Observe effects on data.
- Insert random pulser triggers. Already tested.

If you have other wish lists for detector tests, please e-mail one of us: Khayat@cebaf.gov or Offerman@cebaf.gov