Spin fX

User's Tutorial

V1.0

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This Tutorial

This handout is a tutorial for the reader to become acquainted with the controls for the accelerator operations of the *Spin fX* experiment. We will review portions of this tutorial, but you should read through it carefully before sitting shifts on the experiment. Ask me questions, make notes.

A glass-case located in the MCC Control Room (behind the PSS stations) stores manuals and spares for this experiment. The *Spin fX User's Manual* is located there and ncludes this tutorial and other important information referred to in this handout.

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1.1.0 Polarized Gun

This experiment requires a high polarization (>70%) electron beam (~3uA). Presently, the only laser that can produce both is the Hall A laser. The measuring device for the physics being studied is the Hall C Moller polarimeter at 4 pass. Therefore, the Hall A laser is setup initially to produce the beam that transports to Hall C. Subsequent adjustments to the Hall A seed laser, attenuator, control level, chopping aperture, etc. have a direct consequence on the beam quality for this experiment.

Separately, Hall B is running at 3 pass during this period. Because of the configuration of the PGun Hall B does receive beam from the Hall C laser. A specific consequence is that the GUI/laser server which normally maintains the Hall B beam current using the laser attenuator *ATTENB* must control the Hall C laser attenuator *ATTENC* instead. This issue is being addressed presently.

1.1.1 Pockels Cell

The Pockels cell is a device which is used to create the two senses of circularly polarized light used to produce the polarized electron beam in the photocathode. The Pockels cell has two high voltage setpoints, one for each sense of the circularly polarized light. If either, or both, of these high voltage levels fail the beam loses its respective sense of polarization. See figure 1.

The reason we “flip” between the two senses of polarization is because the methods for measuring the beam polarization (at the Mott and Moller) rely on comparing a difference in the physical process (Mott scattering or Moller scattering) between the two senses of the polarized beam scattering from their respective targets.

For this experiment the beam polarization is flipped, or selected, at 30 Hz. The mode of flipping will be “Toggle Mode”. To produce this helicity sequence the Helicity Timing Source (HTS) in rack IN01B04 must be set to “15 Hz” and “Toggle”. The “15 Hz” refers to the square waveform which produces helicity flipping at 30 Hz.

1.2.0 Spin Rotations

The polarization of the electron beam from the PGun is uniquely pointing with or against the beam momentum (direction) as it leaves the gun depending upon the sense of the circular laser polarization described above.

This experiment requires rotating the beam polarization from this initial orientation, before it leaves the injector, to a series of unique orientations over the course of the experiment. The injector rotations are chosen such that the beam polarization has a specific orientation as it reaches the entrance of arc 7. This is necessary to study the angular dependence of the beam polarization to this effect.

Because we speak of polarization directions and orientations often during this experiment I describe the co-ordinate system convention here. Note that this convention is for *describing* the beam polarization or beam position, not for describing the setpoints of devices, such as magnets, etc. which may have their own convention altogether.

Most importantly, make clear logbooks entries of what you mean. Pictures and diagrams are good because I can use them later to figure out exactly what you meant. Also, if I make an error in prescribing a setup configuration it allows me to later understand the measurement.

1.2.1 Spin Rotators

All devices in the accelerator that change the beam momentum (direction) can in principle change the beam polarization (direction). Many of them, such as the recirculation arc dipoles do, by much.

However, three magnets in the injector are specifically designed to allow the user to rotate the beam polarization by fixed amounts. These three magnets are located in the front end of the injector in the 1I and 0I regions.

The first is the Wien Filter magnet (MWF1I04). The Wien Filter is a device that can rotate the beam polarization in the machine bend-plane (x-z) with a magnetic field, yet maintain the beam orbit with a compensating crossed electric field. The convention for the Wien Filter is that a positive setpoint (BdL or Current or Angle) produces a rotation from +z ---> -x. The range of the Wien Filter is roughly +/- 110 degrees.

The second and third magnets are both compound solenoids which are called SOL1 and SOL2. Both are described as compound solenoids because each is constructed of two separately powered solenoid coils which are packed into one magnetic iron case. The two halves of the second magnet, SOL1, are MFQ1I04A & MFQ1I04B. The two halves of the third magnet, SOL2, are MFA0I02A & MFA0I02B. The “A” and “B” refer to the upstream and downstream coils in each magnet.

The magnet as a whole rotates the polarization out of the machine bend plane (x-y). The convention of the two solenoids are such that a current in *A* larger than in *B* (sign is important) produces a rotation from +x ---> +y. The range of SOL1 is roughly +/- 48 deg, SOL2, roughly +/- 43 deg.

Finally, both magnets not only serve as spin rotators, but also serve as optical focusing elements of the electron beam. The setpoints for each half of a magnet are determined such that they (a) provide the desired spin rotation, but also (b) maintain the same focal length. The solution for the currents in each half of the magnet satisfying these conditions is non-linear. A table of the current setpoints to get desired spin rotations, without disturbing the focal length, is provided in the *Spin fX User's Manual*.

1.3.0 Injector Steering

Beyond the normal injector setup required to get a good baseline orbit, injector steering is a task that accompanies each change of the spin rotators - which will be one to a few times per shift. Refer to the injector songsheet 28405-E-0001, figure 2, for details.

Early in the program, once a good baseline injector orbit is had, the *100 keV Autosteer* script should be started. The injector BPM's zero-pos'd and the auto-steering selection to RELS.

It is very important that good injector setups during the course of the run program be save, to disk, by printout, preferrably both - specifically, the 1I and 0I magnet values. This will save time for hard-to-steer polarization orientations.

The autosteer script works very well after adjustment to the Wien, it works largely well after adjustment to SOL1, and it does not work after adjustment to SOL2. I typically autosteer in tune mode once, however, practice is also to autosteer in tune mode, and then re-autosteer in CW mode.   I largely see no difference, but this is acceptable.

The process I use for steering the injector (when there is more than one spin rotator change) is iterative. For example if I plan to change the Wien, SOL1, and SOL2 I first make a good save of my baseline orbit. I then change the Wien and re-establish a good orbit. I then change SOL1 and re-establish a good orbit. I then change SOL2 and re-establish a good orbit.

Setting both SOL1 and SOL2 for large rotations (~45 deg) is tricky because of the associated steering. One method I used to accomplish this was using Autosteer to set the Wien and SOL1. I then switched to viewer limited beam and looked at viewers through the injector. I took SOL2 off-loop and made small incremental steps toward the desired final setpoint. Although I iteratively must improve transmission at each step by adjusting upstream correctors to best transmit the beam to a downstream viewer, it converges and the beam is not "lost"

In the *Spin fX User's Manual* a section will describe which correctors to use and which not to use for manual steering through the three spin rotators.

1.4.0 Mott Polarimeter

The Mott polarimeter, located in the injector, is the only device in the accelerator prior to the endstations that can measure the beam polarization. Because the Mott polarimeter is extensively used by the injector group and operations you may already be familiar with its use.

The Mott polarimeter measures the polarization of the electron beam. The polarization has three components; two are transverse (Px & Py) and one longitudinal (Pz) to the beam momentum. The Mott polarimeter measures only the two transverse components. The UP and DOWN detectors determine Px (horizontal transverse component). The LEFT and RIGHT detectors determine Py (vertical transverse component).

The Mott is typically used to measure the magnitude of the beam polarization. Because the polarization is usually kept in the bend-plane of the accelerator, measuring Px and knowledge of the Wien setpoint determine the magnitude of the polarization accurately.

However, in this experiment the beam polarization will be rotated, using the described spin rotators, to a series of non-standard orientations, most of which are out of the machine bend plane. We use the Mott polarimeter to measure and verify that these orientations are properly set. The exact values extracted from the Mott data will then be used in the data analysis for the experiment. To measure these orientations all four detectors must be operational. Collected spectra should be “Re-Read” until all four spectra are acceptable.

The Mott polarimeter is setup initially at the beginning of the program. The polarimeter can be setup using the Mott setup Tcl script called from *monticello=>P-Gun=>Mott Setup*. The target will be the 1 micron gold foil, located in target position #1. The beam current for the experiment and the Mott runs is ~3uA CW. Typically Mott runs are taken between 1-2 uA CW, however 3uA is acceptable. The detector PMT gain will be set by a series of typical detector high voltage iterations using ~3uA CW beam. The pulse height spectra Mott elastic peak should be set near channel 770. Subsequent gain adjustment may be required over the course of the experiment.

With each new polarization orientation and otherwise during the course of the run program a series of Mott data will be taken. Each series of Mott data should consist of at least three (3) runs, each using 3uA CW and lasting for 100 seconds. This corresponds to a 900 uA-sec run. If for some reason the Mott runs are taken at different beam currents, number of runs, or run durations, scale the Mott series to maintain ~900 uA-sec. For each series make at least one full page printout of the pulse height spectra, carefully annotated. These are used later to quickly verifiy boundaries for analyzing the pulse height spectra off-line.

The polarimeter should be left available. The only difference between the straight-ahed mode and the Mott mode are that the:

- GSET and PSET values for 0L02 are different for these two modes
- Mott beamline correctors should be zeroed during straight-ahead mode
- 5 MeV dipole must be set for straight-ahead mode

1.4.1 Beam Helicity Tracking

The beam helicity describes, as alluded to earlier, whether the beam polarization points with (helicity=+1) or against (helicity=-1) the beam momentum (direction). This is the case, for instance, just when the beam is produced at the photocathode. Devices like the Pockels cell or the half-wave plate are configured in the PGun laser system to select the electron beam helicity state by creating the desired sense of laser polarization incident to the photocathode.

Many experiments at JLab ultimately determine the beam helicity (sense of the polarization) at a target location by analyzing their data. This experiment measures the beam helicity at both the injector (Mott polarimeter) and at the end station (Hall C Moller polarimeter).

The beam helicity can later be later extracted from the Mott data, however, we measure the beam helicity at the beginning of the experiment as referenced by the Helicity Timing Source (HTS) and then latch that value (+1 or -1) into a time-stamped EPICS channel, *M5_HEL_SET*. This value is simply a calibration factor between the Helicity Timing Source and the actual laser polarization produced by the Pockels cell. This channel is monitored and saved to each Mott logfile. The Mott analysis code then calculates not just the magnitude of the polarization, but also the actual orientation accurately.

This “Beam Helicity Tracking” testplan and a copy of an explanatory physics note on this measurement is located in the *Spin fX User’s Manual*. The MEDM screen to set this epics channel is found at *monticello=>Mott=>MottCombined=>SetBeamHelicity*. See figure 3.

A logbook entry of the beam helcity value will be made when the EPICS channel is initially set. If IOCIN3 is re-booted the value will have to be manually restored because this channel does not yet restore. If the value is not restored after a re-boot the default is “0” and the Mott analysis code will calculate “0” polarization.

2.1.0 Arc 7 Magnets

Four air core magnets specially dedicated for this experiment are used to excite beam orbit errors in recirculation arc 7. Two of these magnets are located near the beginning of the arc proper (MCJ7E03V & MCK7A02V) to create an orbit error. Two are located near the end of the arc proper (MCK7R04V & MCL7R06V) to remove the orbit error. See songsheets 28405-E-0009 through 28405-E-0017 for details on the east recirculation arcs.

These magnets are all air core. They contain no iron and have no hysteresis. The EPICS field describing the magnet's hysteresis state, *.KMOL*, is automatically set to 1 (no hysteresis) when the Oribt Run Control script is started.

If the *.KMOL* value is set to 0 for either of the magnets it will cycle through its B vs I curve after being adjusted (increased or decreased ?). If this happens either use *caput* to correct the magnet hysteresis field or quit the Orbit Run Control and re-start making sure you have channel access to the magnet iocs.

Note that positive setpoints (BdL and Current) steer the beam upward and vice-versa. The beam energy in recirculation arc 7 for this experiment is ~2989 MeV, so the angular impulse to the beam orbit in terms of the magnetic field integral is:

The following tables provide data and software names for the four air core magnets.

2.1.1 7EAR Air Core Magnet Specs

Magnets - The 4 air core magnets are located in recirculation arc 7. Two magnets are located near the beginning of the arc proper to introduce a defined perturbation to the beam orbit. Two magnets are located in the recombiner region to remove the perturbation to the beam orbit.

Region	Magnet	Pipe Size	B-dl/I (G-cm/A)	Last Inspected
7E03	MCJ7E03V	2”	496.6	17 Feb 99 - ok
7A02	MCK7A02V	1”	783.4	17 Feb 99 - ok
7R04	MCK7R04V	1”	783.4	17 Feb 99 - ok
7R06	MCL7R06V	1”	783.4	17 Feb 99 - ok

Trim Cards - The 4 trim cards listed below have been modified to accept either an EPICS control set point or an externally applied voltage signal. The control box that determines this option must be set to REMOTE for EPICS and LOCAL for the externally applied voltage signal. In either case the trim card is bipolar and drives current through the magnet using the conversion 10 amps / 3 volts.

Magnet	Trim Card Location	Control Box Location
MCJ7E03V	ME201B11, Channel 3	
MCK7A02V	ME201B09, Channel 20	
MCK7R04V	MSA01B11, Channel 9	
MCL7R06V	MSL01B01, Channel 5	

Software Control - In REMOTE mode the currents being driven through the 4 air core magnets are controlled by EPICS channel name set points.These set points are selected using either an EPICS magnet control screen or a Tcl control script. A 4 amp limit exists.

Magnet	Integrated Field Setpoint (G-cm)	Current Setpoint (A)	Current Readback (A)
MCJ7E03V	MCJ7E03V.BDL	MCJ7E03V.S	MCJ7E03VM
MCK7A02V	MCK7A02V.BDL	MCK7A02V.S	MCK7A02VM
MCK7R04V	MCK7R04V.BDL	MCK7R04V.S	MCK7R04VM
MCL7R06V	MCL7R06V.BDL	MCL7R06V.S	MCL7R06VM

Hardware Control - No hardware control, e.g., waveform generator is presently used.

2.2.0 Arc 7 Beam Orbit

There are basically three orbits types that will be used during the experiment. They are named “Orbit A”, “Orbit B”, and “Orbit C”. They refer not to the exact values of the magnets used to produce an orbit, but rather to the type of orbit that the corrector magnets create. See figure 4.

- *Orbit A* is a vertical orbit error with a positive vertical position at IPM7A17.
- *Orbit B* is a vertical orbit error with a negative vertical position at IPM7A17.
- *Orbit C* is the nominal beam orbit (the flat orbit). It is where the beam should be when neither Orbit A nor Orbit B is requested.

Note that all four magnets are vertical correctors. Adjustment to these correctors result in changing the vertical orbit. This vertical steering can affect the horizontal orbit because of x-y beam coupling and errors in the magnet mounting, however they are small relative to the vertical motion.

This residual *horizontal* orbit change can be minimized by tweaking the two magnets (MCK7R04V & MCL7R06V) to better remove the *vertical* orbit error, because it can reduce downstream x-y coupling, however don't be alarmed that it exists.

The four magnet values to produce Orbit A (and four others to produce Orbit B) are chosen such that the beam orbit is relatively symmetric about the center of the recirculation arc (IPM7A17). This is done to enhance the effect being measured because the recirculation arc proper has four magnetic "superperiods", describing the beam transport optics, which are also symmetric about the center of the recirculation arc.

The minimum beampipe aperture in the arc proper is 7/8" (22.2mm) ID in quadrupole grider locations. With this limt you can expected no more than +/-11.1mm of vertical aperture in the best case. However, since the flat (Orbit C) beam orbit is not entirely in the vertical center of the beampipe we will shoot for +/-8 mm. +/-4mm is cake. The available aperture will be determined during the first couple of shifts of the experiment.

2.2.1 Machine BPMS

The machine BPMS useful for this experiment are those extending from the beginning of arc 7=>south linac=>4th pass transport channel (8T)=>Hall C line. The BPMS in this series are 4-channel with the exception of those in the south linac and the Hall C line.

All of the BPMS will respond to ~3uA CW beam, however their response falls off with lower current and their accuracy is non-linear at larger amplitudes (greater than 5 or 6 mm). The resolution to the beam current issue is to maintain ~3uA CW beam, a measureable orbit for the duration of the experiment. The resolution for the second issue is that even for the largest amplitude orbit errors, it will be the BPMS that read the smaller orbit positions which provide the most accurate scaling for the orbit size overall.

As you know the BPMS (Absolute or Relative) for the accelerator display +/-5mm in both planes. Since the beam position readbacks will exceed these values the spike charts for recirculation arc 7 can be modified to display various amplitudes. An entry box to choose the size in millimeters and a button included in the Orbit Run Control (ORC) script will adjust these display amplitudes. After setting the new display amplitude the MEDM screen must be closed and re-opened.

2.2.2 Orbit Locks

The orbit locks for recirculation arc 7 need to be kept off during this experiment because they would try to remove the orbit errors being purposely created.

3.1.0 Orbit Run Control (ORC)

The orbit run control (ORC) is a Tcl/Tix software script which controls the beam orbit modulation in arc 7, Hall A laser power level, accelerator data acquisition, and provides EPICS channel and real-time orbit gate signals to the Moller DAQ system. See figure 5.

In short, after setting up the injector parameters and determing the arc 7 magnet setpoints this script provides the manual and automatic run control during the data collection with the Hall C Moller polarimeter.

This script communicates by reading and setting EPICS channels with *cdev* commands. The logging of EPICS channels is the exception; it uses the program *ezlog* for sampling EPICS channels and writing the data to disk.

3.2.0 Magnets

This script only communicates to the four magnets MCJ7E03V, MCK7A02V, MCK7R04V, and MCL7R06V..

3.2.1 Setpoints & Readbacks

The upper right corner of the ORC shows user entry boxes for **SETPOINTS (G-cm)** for the four magnets. The columns **A**, **B**, and **C** are for magnet setpoints for each orbit type respectively. Note: Entering values into these boxes *does not* change the magnet setpoint immediately like that for an MEDM entry box. A command button must be pressed to cause any magnet to be set.

3.2.2 Orbit Ramping

This script does not actually set the magnet **SETPOINTS (G-cm)** directly. Rather , it ramps to the magnet setpoints. When a magnet setpoint is requested the script first records the present magnet values. It then records the requested final setpoint. The ramping routines looks at the difference between these values and determines an incremental step which is 10% of the difference.

At this point the script requests an adjustment of the four magnets by the incremental size (which is in general different for each magnet), then waits a **Ramp** delay, then requests an adjustment of the four magnets by another incremental size, and so forth until the final setpoints are reached. It is in this way that I describe the ramping of the magnets as quasi-asynchronous.

The **Ramp** delay can be set by the user in the entry box at the left of the interface. The value is in milliseconds. So, if the delay is set for 400 and there are 10 interations the total ramp time is 4 seconds.

The default setpoint for **Ramp** is 750, but we will likely run with a value of 300-400.

3.2.3 Magnet Scaling

The upper right corner of the ORC shows another two **SETPOINTS (G-cm)** columns, **Amax** and **Bmax**. Below the orange bar there are two entry boxes, **Orb-A-Frac** and **Orb-B-Frac** just to the left of a **Scale** command button. Depressing the **Scale** button multiplies the **Amax** (**Bmax**) values by **Orb-A-Frac** (**Orb-B-Frac**) and then automatically writes those values into the **A** (**B**) setpoints.

This allows the user to enter a set of magnet setpoints into a “maximum” column and then scale all the magnets easily, saving calculator time.

When the ORC is started the scaling values are set to 0.25 arbitrarily and **Amax** and **Bmax** are set to magnet values that were useful during a past run. They too are just arbitrary starting setpoints.

3.2.4 Orbit Ramping - Manual

There are four command buttons on the screen that when pressed force the four magnets to their respective setpoints.

- **Ramp to A** will ramp the magnets to the **A** setpoints.
- **Ramp to B** will ramp the magnets to the **B** setpoints.
- **Ramp to C** will ramp the magnets to the **C** setpoints.
- **Initial** will ramp the magnets to the setpoints that existed for the magnets when the script was started.

If you attempt to ramp the magnets to the **A** or **B** setpoints and they have not been set yet you will be notified with an “Out of Range” message box.

3.2.5 Orbit Ramping - Automatic

There are two command buttons on the screen named **Ossy ON** and **Ossy OFF** which turn the automatic toggling of the beam orbit on and off. Both buttons are normally green (*SeaGreen2* to be specific). When the **Ossy ON** button is pressed both buttons will change to red indicating that orbit toggling is processing.

Once processing, the magnets will ramp to orbit **A**. The automatic mode always begins by ramping to **A** first. Once the ramping is complete a short delay (~0.5 sec) is set. Orbit **A** remains valid for a duration set by the entry box **Orbit**. The value is processed in seconds. After the duration,the magnets will ramp to orbit **B** and then remain there for the **Orbit** duration. This process repeats until the **Ossy OFF** button is pressed or the script terminated.

When the **Ossy OFF** button is pressed the magnets will immediately begin ramping to the **C** orbit. This is the unperturbed baseline orbit. The two buttons return to green to indicate that the automatic orbit ramping is inactive.

3.3.0 Laser Control

Because the quasi-asynchronous ramping of the arc 7 magnets can result in beam loss, typically causing a BLM fault in Hall C, the ORC has controls to adjust the Hall A laser control level, reducing the beam current during the magnet ramping.

This control level sets the amplifier laser current and thus the Hall A laser power. The beam current is proportional to the laser power so this control adjusts the beam current. Specifically, it provides modulation of the beam current; ~3uA CW during normal operation for the experimental and some lower value during the magnet ramping process.

The Hall A laser controls are located in the upper left corner of the ORC interface.

3.3.1 Setpoints

There are five setpoints for the Hall A laser controls.

- ***Lo value*** - the user entered value associated with the reduced beam current.

- ***Hi Value*** - the user entered value associated with the nominal beam current.

- ***Lo Time*** - for testing purposes, the time in seconds that the control level is low when the **StrtLas Mod** button has been pressed.

- ***Hi Time*** - for testing purposes, the time in seconds that the control level is high when the **StrtLas Mod** button has been pressed.

- ***Laser Delay*** - when laser modulation is active, this is the time in milliseconds before the orbit ramping can occur after the laser power is reduced, and then the time after the orbit ramping ends before the laser power is returned to normal.

3.3.2 Manual Control

There are two command buttons, **Laser Go LO** and **Laser Go HI** which immediately force the Hall A laser control level to their respective values. These buttonsmay be helpful determing the control levels for corresponding beam current to a Faraday Cup or BCM.

3.3.3 Automatic Control

There are two command buttons, **Strt LasMod** and **Stop LasMod**. The **Strt LasMod** button starts a process which sets the **Lo Value**, waits the **Lo Time**, set the **Hi Value**, waits the **Hi Time**, over and over again. It may be helpful for testing or setup purposes in cases which are not associated with magnet ramping.

3.3.4 Laser Modulation

This toggle button **Laser Modulation** selects whether to modulate the Hall A laser control level between the **Lo** and **Hi** values during magnet ramping. When it is pressed the toggle button will appear red. When this is the case the laser modulation will occur on any magnet ramping. The **Laser** delay is effective when the laser modulation toggle button is active.

3.4.0 Readbacks and Status Messages

Below the orbit ramping command buttons are two sets of readbacks and status messages. The first set is on the left and shows the status of important ORC processes:

- ***Orbit Message*** - Reports the status of the orbit selection indicating which orbit is presently valid or which orbit the ORC is ramping towards.

- ***Counter*** - During orbit modulation (**Ossy ON**) this counter reports how long either orbit **A** or **B** has been valid. For example, if the **Orbit** duration is set for 150 seconds, the **Counter** will display “0” once a new orbit is set and will then count towards “150” before the next magnet ramping occurs. *Do not be alarmed* if the **Counter** appears to suddenly skip a second or two. The display is not real-time, but rather an updated difference between the last time the process looked at the system clock and the system clock time at the time the orbit became valid.

- ***Control Level*** - Reports the readback value of the Hall A laser control level.

- ***Orb-A Gate*** - Is set to 1 when orbit A is valid and 0 otherwise.

- ***Orb-B Gate*** - Is set to 1 when orbit B is valid and 0 otherwise.

The second set is on the right and shows the **BdL Setpoint**, **Current Setpoint**, and **Current Readback** for the four arc 7 magnets. These are the same values you see on the MEDM screen.

3.5.0 Data Acquisition

The data acquistion portion of the interface is located below the second orange bar. The data acquistion options perform two functions.

First, they provide each orbit during the entire experiment with a run number which is read by the Moller DAQ system. This is the method used to correlate all of the Moller runs to the state of the accelerator.

Second, the controls to actually log the state of the accelerator are contained here. The options for logging files manually or automatically is described below.

3.5.1 Run Sequence & Run Number

The run sequence is a user entered number which is the starting value for a series of run numbers. A separate run sequence will be assigned to each individul set of measurements performed during the experiment.

To start a run sequence enter the prescribed value in the entry box and press the command button **Set Run Sequence**. This immediately updates **Run Sequence** and **Run Number** displays with the new sequence. It also writes the new value to the EPICS channel *enlk9A:floatspare1* which holds the run number which the Moller DAQ system reads.

From this point on every time a new orbit is reached (**A**, **B**, **C**, **A or B in Ossy Mode**, **Initial**) the run number will be incremented by 1. This is one of two methods the run number increments. Another is described below.

3.5.2 EPICS Logging

During the experiment the ORC can log EPICS channels to disk using the logging program *ezlog*. We start *ezlog* with three parameters passed from the user through the ORC.

The first parameter is the filename containing a list of EPICS channels to log which is entered into the user entry box **EPICS_List**. The list of channels we record is in a file named *epics_sfx*. This file is located at */usr/opweb/spinfx/data/epics_sfx*. In ORC all you need to enter is the filename, not the path.

The second parameter is the rate in seconds at which the EPICS channels are logged which is entered into the user entry box **Rate**. We typically log channels at a rate of 5, which is the number of seconds between each sample, i.e., 0.2 Hz.

The third is the prefix of the logfile which is written to disk, entered into the user entry box **Prefix**.

A logfile name is created automatically each time *ezlog* is requested (either manually or automatically). The logfile name is simply the concatentation of the prefix with the run number. The full filename then looks like Prefix.RunNumber. The data is written to the directory */usr/opweb/spinfx/data/*

3.5.3 EPICS Logfile Reduction

At a sample rate of 0.2 Hz the ORC will, using *epics_sfx* as the EPICS list, log about 350 bytes/second to disk. At the maximum sample rate of 1 Hz the logging rate is five times larger, or 1750 bytes/second to disk.

Estimating an upper bound five day run program at 1 Hz the total disk usage is about 0.8 Gbytes. Of course, this is the upper bound, but at least once per day we will compress the logfiles using the program *gzip*.

The command to compress a file named ***joe.grames*** is

gzip ***joe.grames***

It will produce a file named **joe.grames.gz** The command to un-compress a file named **joe.grames.gz** is

gzip -d joe.grames.gz

Wildcards are allowed.

3.5.4 DAQ - Manual

Two command buttons **Start Logging** and **Stop Logging** start and stop the *ezlog* program. You will notice that when the start button is pressed in manual mode only the **Run Number** increments by 1. This is the only other way the **Run Number** increments. This new run number is also written to the EPICS field for the Moller DAQ.

Once the new **Run Number** is valid the logfile name is written to the display **Logfile** and a status message describes which EPICS_List is being saved to the logfile. The **Logfile** display and buttons turn red and *ezlog* begins loggings the data to disk.

When you want to terminate the data logging press the **Stop Logging** command button. This will return the **Logfile** display and logging buttons to green again.

3.5.5 DAQ - Automatic

There is a toggle button **autoDAQ** which automatically initiates the *ezlog* process when the **Ossy ON** orbit mode is selected. This option basically allows the user to setup the orbit modulation, the laser modulation (if desired), and then have the *ezlog* program take data automatically. The user can then sit back and monitor things hands-off.

For this to work the ORC needs to know when to start and stop the *ezlog* process during each stable beam orbit. We do not want it to collect events during the orbit ramping. There are two user entry boxes **Strt Frac** and **Stop Frac** which are multiplied with the **Orbit** duration to find the **Start** and **Stop** times. If this process is running the actual start and stop time (in seconds) is displayed in the **Strt** and **Stop** displays.

For example if **Strt Frac** = 0.10, **Stop Frac** = 0.90, and **Orbit** = 100 then when the **autoDAQ** is active during the **Ossy ON** mode the *ezlog* program will start 10 seconds into the orbit and stop 90 seconds into the orbit.

Still, the user had to have already entered the **EPICS_List**, **Rate**, and **Prefix** information.

4.1.0 MEDM Screens

In addition to the MEDM screens accessible through *monticello.adl* a screen has been developed specifically for this experiment. The screen can be started with the command button **MEDM ORC**. If you are already running MEDM it will attach itself to that process, otherwise it will start MEDM for you as well.

4.1.1 MEDM ORC

The MEDM ORC screen provides four basic pieces of information (although it may have more by the time the experiment begins).

- *Moller Orbit Gate Bits* - when the ORC sets either orbit **A** or orbit **B** is sets a respective bit on a XYCOMM-244 digital I/O card located in IOCIN3, rack IN01B03. Each respective bit turns on or off a 24 volt output from the I/O card. The two outputs go to a signal translator (located in the former Oribt Control Card box, IN01B04) which produces a respective optical fiber signal. These outputs are transported to the Hall C counting room where they are again translated to NIM levels and gated to the Moller DAQ electronics. When the respective orbit is valid by the ORC the MEDM display is green. When it is not valid the display is red.

- *Run Number* - the EPICS channel *enlk9A:floatspare1* which holds the ORC run number is displayed here.

- *Related Displays* - opens other MEDM screens and application scripts.

- *Magnet Controls* - the BdL and Current setpoints/readbacks for the four arc 7 magnets and the three injector spin rotator magnets are located here. Aside from being used for their main purpose the related displays for these magnets are also accessible here.

5.1.0 Logbooks

A hardcopy logbook and binder will be the record for the experiment. Please date and initial all work, adjustments, ideas, etc sequentially into the logbook.

For printoutsdate/annotate well, add to binder, and make a logbook entry.