E158 Detector Operations Manual

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I. Annulus Operation

Description

The annulus serves as a rotary support for the hodoscopes and Cerenkov detectors. The hodoscopes (which are not described in this document) were constructed as a group effort by the University of Massachusetts, Amherst, and Smith College, and are attached to the incoming beam side of the annulus. The Cerenkov detectors are attached to the down-beam side of the annulus. From a position arbitrarily chosen as zero degrees, rotation takes place CCW (counter-clockwise) -- looking at the annulus from the incoming beam side -- through an arc of 180 degrees.

Angular Encoder, Linear Voltage Position Sensor

The angular position of the annulus is derived from a rotary encoder. The output of the rotary encoder is split by a splitter box in the cabling service tunnel. One output is connected to the nu-Drive power amplifier. This amplifier, in turn, informs the LabView V.I. running on an adjacent computer. The other output from the splitter is converted to an analog voltage that is read by the DAQ. Rotation and therefore all position readings are CCW (counter clock-wise). When the annulus rotates from 0° to 180° it is moving in the CCW direction as viewed from upstream. Positions of the annulus may be determined from the following table:

Annulus Position	Encoder Counts	Voltage
Approx. -16º (CW limit)	1,464,933	0.000 V
0º	1,321,450	0.269 V
176.82º (home*)	0	2.742 V
180º	-22,800	2.785 V

*approached from 0° side (CCW motion)

II. Cerenkov Detectors Operation

Description

The Cerenkov detectors are mounted to linear drive on the downstream side of the annulus. These detectors consist of quartz radiators fixed within cylindrical light pipes and are mounted on linear drives on the dowstream side of the annulus. Each one is bolted to the mounting carriage of a linear translator and can move within a radial range defined by two limit switches.

Linear Drive Limit Switches / Linear Encoders

Each linear drive is fitted with three position sensors set at the innermost, intermediate or "home", and outermost positions. The radial position of each quartz radiator is determined independently by a rotary encoder and a linear pot. The table below shows the positions – as measured from the beam axis – at the limit and home positions as read by rotary encoder counts and linear pot voltage. **Note**: the home position must always be approached from the most distant position relative to the beam axis. The currently read and set positions of the detectors, measured in rotary encoder counts, is as follows:

	Inner Limit			**Home**			**Outer Limit**		
Detector	Radius* cm	Encoder counts	DAQ volts	Radius cm	Encoder counts	DAQ volts	Radius cm	Encoder counts	DAQ volts
Cerenkov 1	1.43**	144,560	0.36	not measured	0	1.05	not measured	-35,259	3.80
Cerenkov 2 ("NC2")	1.00-1.15 ±0.05***	-127,948	0.63	not measured	0	1.37	not measured	38,566	3.84
Cerenkov 3	1.57**	-146,174	0.30	not measured	0	1.07	not measured	39,729	3.90
Cerenkov 4 ("NC4")	1.05-1.15 ±0.05***	-134,238	0.21	not measured	0	0.92	not measured	36,333	3.51

* These values are the distance between the detector outer pipes and the beam pipe.
**These are the values that were measured by P. Decowski and M. Breuer in February 16 , 2002. No estimated error was determined for these values.
***These values were measured by R. Hicks and C. Arroyo on March 17, 2002.
- The lower value for C2 exists when the annulus is at 90 degrees; the upper when at 0 and 180 degrees.
- The lower value for C4 exists when the annulus is at 0 and 180 degrees; the upper when it is at 90 degrees.
- Both variances above are the result of a slight play in the concentrically outer tube of C2 and C4.

Estimated distance of detector element center to beam center†

Detector	Distance, in cm
Cerenkov 1	16.29
Cerenkov 2 ("NC2")	16.43
Cerenkov 3	16.42
Cerenkov 4 ("NC4")	16.21

† This information was derived from E158 logbook entry #4013 by P. Decowski, February 19, 2002.

III. Polarimeter Operation

Description

The E158 Polarimeter is designed to measure longitudinal beam polarization by recording assymetries in scattering of electrons with opposite helicities from longitudinally polarized target electrons, and to provide this information by scanning vertically from immediately beneath the beam pipe to approximately 18" beneath the pipe. The input end of the detector is composed of a stack of alternating plates of quartz and tungsten. Cerenkov radiation produced in the stack reflects horizontally along a tube lined with a reflective material known as Alzak. The light rays reflect off a 45º mirror at a bend in the tube and are thus directed downward toward a 2" diameter photomultiplier tube. A voltage in the neighborhood of -800V powers the photomultiplier. Signal from the tube is conducted along a coaxial cable to an analog-to-digital converter housed in Building 420. The then digital signal is routed from Building 420, via another coaxial cable, to Building 61, the Counting House, wherein it terminates at a data-collecting computer.

Linear Drive Limit Switches, Linear Drive Voltage Encoder / Rotary Encoder

The Parker brand linear drive is fitted with three limit switches along its length. These are fixed at the inner, home and outer locations, which correspond to a minimal, intermediate (home*) and maximal radial detector distance, respectively, from the beam pipe. The positions of the polarimeter linear drive limit switches are given in units of microsteps sent to the stepping motor, relative to an arbitrary reference position. As with the Cerenkov detectors, the Polarimeter is also fitted with a potentiometer position sensor in which resistance is a linear function of position.

The pitch of the drive screw of the linear drive is such that the drive advances 0.5 cm per rotation. Since it takes 2000 microsteps to move the screw through one rotation, 4000 microsteps = 1.0 cm of linear motion.

The linear drive motor typically has a rotary encoder attached in order to provide additional position information. At this time the encoder is not attached. A replacement has been ordered and will be fitted on the motor when it is received.

Position	Distance of Detector Stack from Beam Line Center	Limit Switch / Drive Motor Pulses	Voltage Value
Uppermost (closest to beam pipe)	16.0 cm	61,417	(not yet recorded)
Home*	31.4 cm	0	1.78 V
Lowermost (furthest from beam pipe)	58.6 cm	-109,057	3.89 V

* Moving from the lowermost to the uppermost position

Pneumatically Actuated Mirror

Description

Photons produced through the interaction of polarized electrons and the detector quartz and tungsten elements are horizontally guided to a mirror at the end of the horizontal tube and reflected vertically downward from there, via a rotating mirror, to the photo-multiplier tube of the detector. In order to obtain a background signal reading from the photo-multiplier, the mirror is rotated 180º to temporarily block most of the photons. The mirror is oriented at 45 degrees, and is fixed to a vertical, rotating mounting shaft. The mounting shaft rotation is achieved by using a pneumatic actuator (company name Bimba) operating from an air line supplied with approximately 70 lbs./square inch pressure.

Operation
Mirror rotation is controlled at the Counting House control panel labeled "3MIR1 – TP MOVER." Rotation is initiated by reversing the switch located between the "Open" and "Close" indicator lights. As rotation takes 3-5 seconds there will be a time delay between when the switch is thrown and when the opposite indicator light comes on. When the mirror is in the "Open" position the mirror is reflecting photons to the photo-multiplier tube. When the mirror is in the "Close" position, the mirror is blocking photons from the photo-multiplier tube so that a background signal may be obtained.

Limit sensors
The "Open" and "Close" positions are sensed by the closing of one of two limit switches located beneath the rotating mirror mounting "cap" of the polarimeter. In the event of failure, this is where they are located for replacement.

Note to operators: Please see other documentation for performing detector moves and annulus rotations.

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