Construction and Calibration of The Fermilab Detector

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Purpose:

To construct a muon Scintillator with optimum efficiency and calibrate the voltages of its Photo-Multiplier tubes to eliminate noise while optimizing sensitivity.

Materials:

Extruded polystyrene Scintillator panels with attached light guide

Reflective aluminum foil

Electrical tape

Teflon tape

Heavy-duty cloth tape

Photo-multiplier tubes which can mate to light guides (same amount of Tubes as Scintillator panels)

Variable voltage supply capable of delivering voltages necessary for Photo Multiplier Tubes

Quarknet DAQ Board

Computer with an RS-232 port and a terminal program capable of communicating through the serial port

Oscilloscope

Construction Procedure:

Step One: While wearing gloves place Scintillator panels on sheets of aluminum foil

large enough to cover Scintillators without any holes in foil.

Step Two: Wrap Scintillators with the least amount of seams possible while avoiding taping the foil directly to the Scintillator.

Step Three: When Scintillators are fully wrapped reinforce the edges and corners with the cloth tape. If tyvek light shielding is obtainable add it at this stage and tape edges with cloth tape.

Step Four: Wrap the Light Guide with Teflon plumbing tape to ensure a slight cushion between the Photo-Multiplier Tube and the light Guide.

Step Five: Add a small quantity of optical grease to the light guide and abut the PMT to it.

Step Six: Add a few strips of Cloth Tape radiating at 15° From the Light Guide to ensure that the PVC support does not damage the surface of the Scintillator panels.

Step Seven: Wrap Electrical tape around the PMT to keep it butted close to the light guide.

Step Eight: Position the PVC support to fully encase the PMT and stabilize it.

Calibration Procedure:

Step one: Set the voltage going into the PMT's at a reasonable base voltage that will

produce some counts and plug the coaxial cables into an oscilloscope capable of displaying a trigger level, Hertz rate, and voltage.

Step Two: If the oscilloscope is showing any signal, adjust the trigger level to a point where a number of large signals trigger every few seconds. If the signal is a fairly smooth drop-off and a smooth return, there is a good chance that the signal is a real count. A signal that is noise tends to look like a more jagged and abrupt drop and rise. Adjusting the trigger level to a point where most of the signals are smooth will help to adjust the discriminator voltage to a point where most noise is filtered out. When the optimal noise filtering trigger level is reached, take the trigger level (in mV), multiply it by a factor of 10 (so a 50 mV trigger level is .5 V), and dial the setting into the discriminator of the DAQ board.

Step Three: Isolate two Scintillator panels into the first two channels (channels 0 and 1 respectively), connect the board via RS-232 to the awaiting computer, open HyperTerminal (set to 19200 bitrate, Xon Xoff flow control), and reset the board via the board reset button near the power inputs.

Step Four: When the board registers into the computer a stream of data will display into the console, to arrest this stream of data type in CD into the console. For plateauing set one of the tubes to a high arbitrary voltage that will display a singles hertz rate of approximately 200 hertz (read through the oscilloscope), Adjust the one that you are varying to a voltage that allows for incremental adjustment of voltage.

Step Five: Enter into the HyperTerminal window

RE

CD

WT 00 00

WT 00 02

WC 00 1F

WC 00 13

SA 1

Step Six: Set a timer for a time of between 1 and 5 minutes. As you start the timer, enter **RB** into HyperTerminal, at the end of the timer interval, enter **DS** into the window and enter the Hexadecimal Values into a hexadecimal to decimal converter. S0 is channel 0's singles rate, S1 is channel 1's singles rate and S4 is the coincidence rate. Repeat the test with different voltages while recording the coincidence rate onto a graph. When the graph is completed a visible leveling off point should be evident. The middle of this area is the ideal voltage to set the PMT which you are varying to.

Step Seven: Repeat steps one through six varying the other voltages.