Light Injection Installation and Testing

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1 Pulser box testing

A laptop PC with relevant software, a PICO parallel-port oscilloscope, a custom multi-PIN unit with associated fibre bundle, and a pulser control cable (RS232-RS485 converter) are provided for pulser box testing. Required from Soudan resources: an oscilloscope (preferably digital), soft lint-free cloths (e.g. Safewipes) and isopropyl alcohol.

- Connect PC serial port to pulser box RS485 socket with the pulser control cable: the end that has the flying lead to a 9V battery plugs into the PC. Connect the battery or other 9V supply.
- Connect "pulse monitor" to PICO external trigger input.
- Connect fibre bundle connectors to the 20 PIN diode inputs, and connect the output of the multi-PIN unit to the PICO oscilloscope (channel A). Note that when using the PICO unit instead of a regular (grounded) oscilloscope the multi-PIN circuit should be grounded to its own case using the front-panel switch.
- Connect the PICO to the parallel port of the PC. Turn on power to all components.
- Use the "sequential flashing" software to flash each LED in turn, at the brightest settings and highest frequency (height = 1000; width = 7; delay = 1), and confirm by visual inspection that all fibres on all connectors do pulse, and that the fibres are ordered correctly.

- Attach the multiway connector at the end of the fibre bundle to the first connector on the pulser box. **Pulser box back panel connectors are indexed from left to right, top to bottom, just as if reading a book.**

- Start the LabView testing routine. You will be prompted to change connectors when the output has been measured from all of the LEDs.

The outputs from the non-PIN-diode connectors should be in the region of 300 mV peak voltage, and there should be about a factor of 2 difference from highest to lowest output of any given LED. The variation between different LEDs should be much smaller than the variations within a single LED's fibres.

The PIN diode connectors should generally have outputs in the region of 500-1500 mV.

2 Pulser box installation

High voltage to all MUX box PMTs served by any pulser box must be turned off before any pulser box and/or LI fibre bundle connectors are exposed to light. Remember that light can enter the system via unterminated optical connections on the pulser box.

Pulser boxes are to be installed at the top of each mid-level (VME) rack. The back panel, with the optical connectors, faces the detector. At the time of installation, **all** connectors should be covered with "optical terminators" to prevent light entering the system via unused fibres.

The front panel contains the following inputs/outputs/indicators:

- LEDs at the top, to indicate (i) power on, (ii) programmed and ready to pulse, (iii) pulsing.

- RS485 control line (9-pin D connector). This must be connected to the ethernet-to-RS485 converter.

- Inhibit input (BNC connector). TTL input to inhibit pulsing. (NB I need to check, but if memory serves, shorting this input will inhibit pulsing).

- Trigger input (BNC connector). TTL input to trigger from external source.

- Pulse monitor output (BNC connector). TTL output synchronised with flashes from the LEDs in the box.
- Red reset button.
- Fuse holder.

3 Fibre bundle installation

Remember that optical fibres are delicate, even though they look like electrical cables. Do not tread on them, pull them, or otherwise treat them roughly.

The optical connector surfaces should remain covered for protection for as long as possible.

Minimum bend radius (not diameter) for LI fibres is 25 mm (one inch).

Fibre bundles are labelled with Far Detector (FD)/SM number/plane number/ East or West side.

Spare bundles are labelled FD/spare/E or W/type A or B/numbers 1-5. Type A has the 20 fibres labelled in order, 1-20, and is for use on planes 1,2,5,6,...4n+1,4n+2. Type B has the 20 fibres labelled 20,1,2,...19, and is for use on planes 3,4,7,8...4n-1,4n. The five bundles of each side and type (numbered 1-5) are identical, and should be long enough to serve as replacements for any damaged fibre bundles.

Fibres are to be plugged into the plane while it is on the ground. The single-fibre connectors are to be plugged into the LIMs such that connector number 1 serves the set of strips that will be lowest on the plane when it is raised, and subsequent connectors are plugged in consecutively until number 20, which serves the uppermost set of strips.

Spare fibre should be left coiled so as to be out of harm's way when the plane is raised. It should be attached near the "exit point", which is the nearest support to the cable tray that will be used.

Light sealant, e.g. black RTV, should be applied around each of the single-fibre connectors where it penetrates the inner wall of the LIM.

Once the plane is in place, the fibre bundle can be routed directly across to the horizontal cable tray (either upper or lower as appropriate), and thence to the rack with the pulser box, going up or down the vertical cable tray as necessary.

Fibres are routed around to the north side of the first pair of vertical support posts (which interfere with the first few planes), and to the south side of subsequent vertical supports.

The first pulser box serves planes 1-64; the second serves 65-128; the third, 129-192; the forth, 193-242. The first half of the fibre bundles served by each box (planes 1-32, 65-96, 129-160 and 193-217) use the vertical cable tray on the south of the rack; the remainder use the vertical cable tray on the north side.

The bottom row of 3 connectors on each pulser box contains one "spare" connector (nominally for the monitor PMT, if it is ever installed), and two connectors to carry light to PIN diodes. Excluding this bottom row, fibre bundles are connected, broadly speaking, from the edges to the middle: on the west side, the columns will be filled in order 1, 2, 4, 3, and on the east side in order 4, 3, 1, 2, in each case filling from the top for the upper bundles and from the bottom for the lower bundles. This gives the greatest ease of access.

Before connecting, the optical surfaces should be cleaned with a soft, lint-free cloth (e.g. Safewipes) using isopropyl alcohol. Any optical couplant applied to the clear signal fibre connectors may also be applied to LI connectors.

4 PIN fibre installation

PIN fibres run from the two connectors at the middle of the bottom row of each pulser box back panel. The single fibres at the end of each PIN fibre bundle plug into the PINs on the front-end boards of MUX boxes intended for that purpose: some MUX boxes have internal wiring that is inappropriate. Ordering of which fibre goes to which MUX box is unimportant. However, the two PIN fibres from any given LED (which will have the same number on each of the two bundles from the pulser box) should be plugged into *different* MUX boxes, so that if calibration of one PIN is lost when a PMT is changed, the calibration will still be held by the second PIN. Thus, the 20 fibres from the first bundle should be plugged into the first 20 available sockets (in 10 MUX boxes) with, e.g., odd-numbered LEDs in the high-gain channel and even-numbered LEDs in the low-gain channels; then the 20 fibres from the second bundle should be plugged into the next 20 available sockets, with the odd-numbered LEDs this time taking the low-gain channels. As light

output from the PIN fibres is even less uniform than in regular channels, the designation "high" and "low" gain is somewhat arbitrary, and it may be desirable to swap some channels at a later stage.

5 Trigger PMT installation

The trigger PMT sits in a special MUX box that is to be situated under eight other MUX boxes in the most southwesterly top-level rack. It is to use the spare HV cable supplied to that rack, and readout will be to a spare channel in the VARC just as with any other MUX box. The high voltage to this MUX box must be off during installation of ANY trigger PMT fibre, which is a part of the installation of a pulser box.

The optical connection to this MUX box has 16 fibres that terminate in SMA connections. These connectors should be fixed to the rear of a rack-mounted patch panel below the MUX box. **The fronts of all of these connectors must be covered when no fibre is plugged in, to prevent daylight from reaching the M16.**

There are sixteen fibres, each 50 m in length: one for each pulser box. Spare fibre should coil up at the bottom of this same rack. One end of each of these fibres attaches to the patch panel; the other end attaches to the SMA connector situated adjacent to the mains lead on each pulser box.

An attenuator (which could be, e.g., a piece of paper cut to size) should be inserted between the two halves of the connector at the MUX box as the light from the trigger LED is extremely bright, and may cause premature deterioration of the M16 photocathode. In addition the trigger PMT should be run at a low voltage.

The trigger PMT can be tested by pulsing the relevant pulser box and looking at the M16 output on an oscilloscope, or else reading the output from the DAQ system.