



ArgonCube Replacement Procedure

UNIT: PMT Box

CONTACT PERSONNEL:

Howard Budd, 814-810-8591

Steve Hahn, 630-352-6971

Required Training:

1. FN000380: NuMI/MINOS Underground Safety training

People

1. Person in charge, PIC
 - a. Runs the repair, ensures the repair is done safely both for the people and detector.
 - b. On the catwalk during the repair.
 - c. Gives approval that the lift extension can be extended over the detector, and verifies (by viewing the crash buttons) that the lift is off.
2. Person requesting the fix, DAQ person
 - a. Could be present or on Zoom
 - b. Explains what needs to be done & runs the DAQ
3. Repair person in lift
 - a. Does the actual repair or replacement of the FEB or PMT
 - b. Repair trained, fall protection trained, and lift trained
 - c. Hits the crash button on the lift control panel such that the lift cannot be moved after the lift extension is properly located.
4. 2nd lift person
 - a. Helps with task and lift
 - b. Fall protection and lift trained

Equipment

1. Scissors lift on downstream side of ArgonCube MINERvA planes.
2. The scissors lift should have foam pads in the lift so the repair person can be comfortable laying on floor of lift.
3. Hardware needed for the replacement.

4. Harness for repair person

Location of Spare: A replacement PMT may be kept in the cabinet in the MINOS Hall. Good PMTs are located at in the long aluminum box at Lab F. Be sure the electrical connector side of the PMT has the nylon screws to hold the FEB. Check that a FEB fits on the nylon screws. If you are unsure of whether a PMT is good to use or of the PMT location you can contact the ArgonCube MINERvA planes expert.

Spare Check-Out Procedure:

5. Select a spare PMT in the MINOS Hall or Lab F if one is not available in the MINOS Hall
6. Fill out PMT exchange form in the location you take the PMT box

Preparation for Replacement:

1. The PIC, person in charge, should be chosen for the repair.
2. This replacement requires the people described above.
3. If you suspect a PMT has a problem (dead channels, high cross-talk etc.) inform the run coordinator. PMTs may only be switched after approval from the run coordinator or DAQ expert, a swap must be scheduled.
4. The DAQ expert should determine the electronics location of the PMT to be replaced. This is determined either from Run Control or the online monitoring plots. The DAQ expert must supply this information to the PIC. The drawing in DOCDB-26202 will enable you to go from electronic space to module set/board .
5. The DAQ person should get the PMT and FEB number from DOCDB-24439. You will need to verify that both these match the PMT and FEB when you are replacing the PMT.
6. All members of the replacement crew will need to check out an underground key from MCR or have a permanent underground key issued to them. You need MINOS underground training and either GERT or Radiation Worker training to check out a key or receive a permanent key.
7. Only specific people can replace the PMTs, contact the ArgonCube ELO or run coordinator to contact those people.

Critical Safety Instructions are highlighted in red:

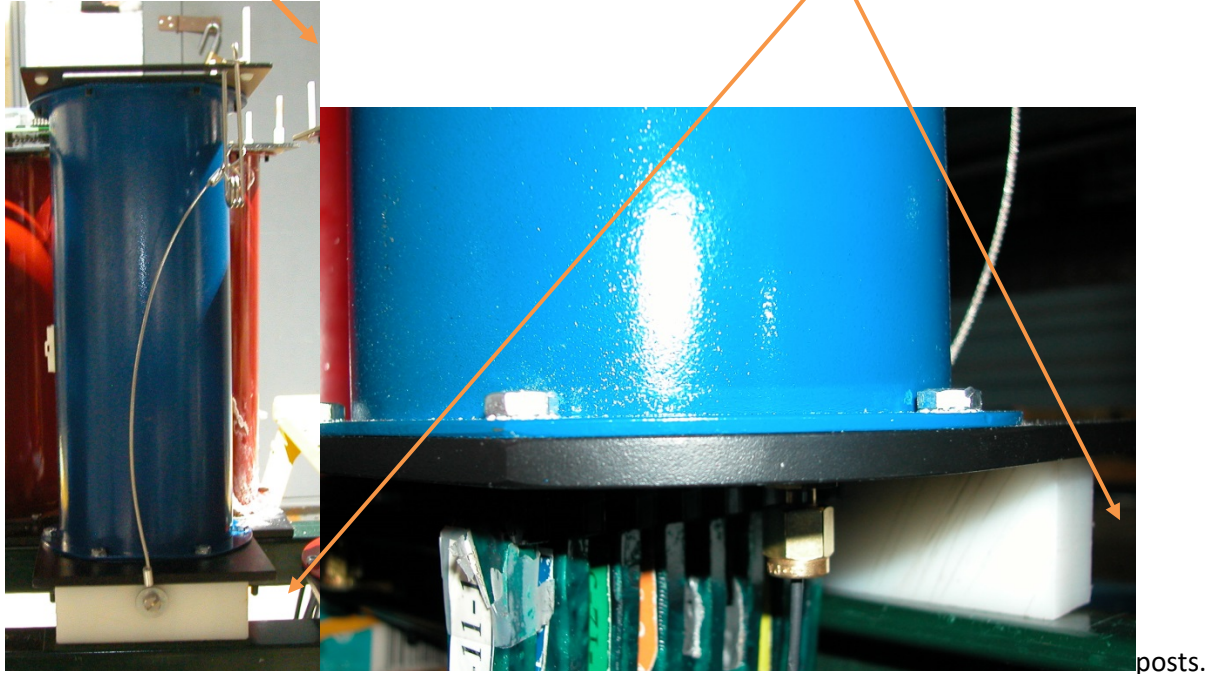
Replacement Instructions:

1. The DAQ person needs to set the HV to zero for PMT replacements
 - a. open a terminal and kerberize as yourself
 - b. Login to the online machine as minerva and launch the slow control:

- c. ssh minerva@acd-gw03.fnal.gov, ssh acd-srv03
 - d. source slowcontrol.sh
 - e. file->Find Hardware
 - f. Click through VME-BRIDGE->V2718->CROCE:1->CHE:0->FE1->read
 - g. Set 'HV enable' to zero
 - h. Write to all the FEBs
 - i. To check this has worked go to the actions menu and select start monitor. Check the HV values are decreasing then stop the monitor
 - j. Once the HV has been powered down you can replace the PMT box.
 - k. If you are doing just a FEB replacement you do not have to power down the HV or turn the detector off
2. All parties involved should locate the PMT using DOCDB 26202 and should agree on its location. It is easy to make a mistake here and replace the wrong tube.
 3. The repair person and the 2nd lift person should go on the lift. The repair person should be wearing a harness. The replacement hardware and foam knee pads should be on the lift. Position the scissors lift in front of the PMT to be replaced.
 4. They should empty their pockets of all items. Remove your wristwatch and hard hat.
 5. The PIC and the 2nd catwalk person should go to the catwalk to watch the lift. The ground lift person should be at the lift.
 6. The scissors lift should be raised up so that the bottom of the platform is above the detector so the extension does not damage the detector when extended.
 7. **When the PIC says it's OK, the repair person in the lift should turn off the lift via the crash button.**
 8. The lift extension should be moved over the detector and positioned so the repair person can access the hardware that needs to be replaced. **The PIC should watch to be sure the extension does not hit the detector.**
 9. The repair person should lie down on the foam pads with their shoulder facing upstream. **For fall prevention, the second lift person should attach the harness lanyard to the anchor point on the back of platform extension.** The repair person can then extend their shoulder over the end of the lift, so they can reach down to do the replacement. Foam is provided so the repair person can be comfortable while lying down. Foam is provided to cushion their shoulders from the small kickplate at the bottom of the safety fencing.
 10. First remove the plastic FEB shield. Unplug the two ethernet cables from the FEB. Disconnect the power cable. The power cable is at 3.9 volts DC and will be at 3.9 volts when you disconnect it. As far as we know from 9 years of replacing FEBs, no risk is involved in connecting or disconnecting the power cable with voltage on it.
 11. Remove the FEB from the PMT
 12. **IMPORTANT:** Make sure you place all cables (optical, ethernet, power, LI) in places where they won't fall into the detector. It might be difficult to retrieve them later on. If necessary, you may need to bundle the cables with a cable tie or Velcro.
 13. Disconnect the FEB and check that its number is the same as the number you got from DOCDB-4086. If not you may be replacing the wrong PMT.

14. Lift out the PMT. There is a varying amount of slack available on the clear fiber cables. Most boxes can be lifted up by a 1-2 inches while others have more slack to work with. It is important to not pull against any of the cables and to be aware of how much slack you have to play with.

Clip the spacer tool to the PMT top plate. Then, guide the spacer tool on the bottom PMT guide



Make sure the offset is towards the fiber cables.

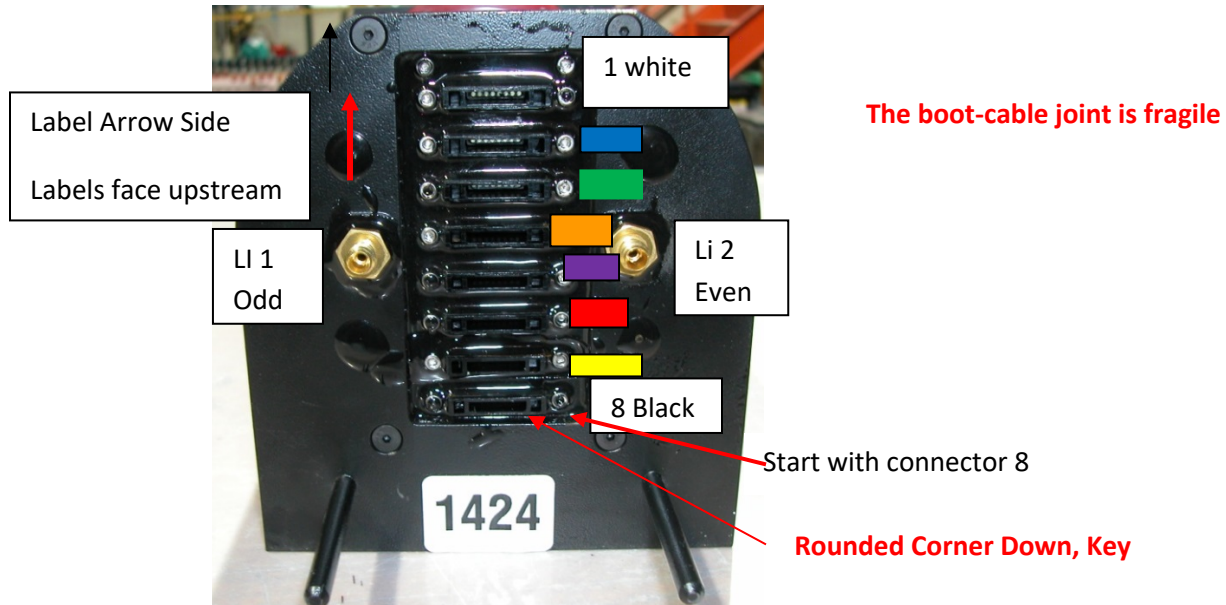
15. Once the PMT is free from the support unistrut make sure it does not hit neighboring PMTs. Have one person hold the PMT and unscrew the 2 LI fiber; the 2d person may be of assist here. The LI fibers are labeled; the fiber with an odd number is located on the west side of the tube, and the even number fiber is located on the east side of the tube. Note which LI fiber goes with which LI socket. Do not allow anything to touch the face of the LI fibers
16. Disconnect the 8 fiber optical cables attached to the face of the PMT. Squeeze the tabs on either side of the connector to release the optical cables from PMT box face. The optical cables are tied together. Move cables to the side and be sure they are accessible.
17. NOTE: When handling the LI fibers and clear fiber cables be sure to not twist or bend them and to protect the polished surfaces of the fiber or optical cables.
18. NOTE: For PMTs with less than 8 cables plugged in, blanks will be used to keep the PMT box light tight, these are easy to drop. Additional cable blanks can be found in the MINERvA cabinet.
19. Pull the PMT out and check that its number agrees with the number that you got from DOCDB-24439
20. The new PMT can now be inserted.
 - a. For the first and last PMTs on a chain the long data cable is cable-tied to the PMT box. This cable tie will need cutting and a new one will need to be installed after the PMT is replaced. Cable tie cutters and cable ties can be found in the PMT toolbox. Additionally

the new PMT will have to have a tie-block mounted on its side to attach the cable tie to. These can also be found in the PMT toolbox.

21. Installing the new PMT

- a. Remove the electrical tape protecting the connectors off the bottom of the tube and spray the connectors with 'dust-off'. 'Dust-off' can be found in the MINERvA cabinet. Spray all 8 optical cables with 'dust-off'.
- b. While holding the PMT box, connects the optical cables in the correct order. Connecting the optical cables is mostly done by feel, it is very easy to miss a connector or to connect them in the wrong order. The optical connectors are 'keyed' and can only be inserted in one way. Be sure the connectors latch in, i. e. they click in. If not tell the PIC. DO NOT TRY TO FORCE A CONNECTOR.
- c. The order to connect them in is:
 - i. Connector 8 first (black label; most downstream connector) through to connector 1 last (white label; most upstream connector). The connector labels should face upstream so the connector key is correctly oriented.
 - ii. The cable order is 8(black), 7(yellow), 6(red), 5(purple), 4(orange), 3(green), 2(blue) &, 1(white).
- d. After installing all cables, verify the cables are securely locked into position on the PMT by pushing up on them and pulling on them.
- e. Once the optical cables are connected, connect the LI fibers, these should be inserted until they stop. Once pushed all the way in, screw on LI fiber nut . The odd LI fiber goes on the west side of the tube, the even LI fiber goes on the east side of the tube. Make sure the LI fibers are not twisted around the PMT cables and don't over tighten the LI fasteners.
- f. Gently lower PMT into guide holes, being careful not to trap any LI fiber or optical cable under the tube. The PMT face plate should sit in direct contact with the G-10 insulating strip.
- g. Connect the FEB and attach the power cable. The power cables should be threaded through the handle or drilled hole on the top of the PMT.
 - i. NOTE: The power cable is 'keyed' and can only be inserted one way. Do not force the connector; by plugging it in incorrectly you could blow fuses on the FEB. Be sure the connector is not of
- h. Attach both Ethernet cables. Ethernet cable restraints for 1st and last PMT are on the side
- i. Press the FEB reset on the FEB boards. If there are two green lights then the FEB is housed correctly if not (either 1 green light or a red light) check to make sure the FEB is seated correctly.
- j. You should also check all other FEBs on the chain, FEBs nearby and the FEBs located on the other-side of the bridge in case one was knocked by your foot. Push on the center of the FEBs to seed them properly. If any FEBs don't have 2 green lights, reset the board it until all FEBs are have 2 green lights. The FEB might need to be reseeded.
- k. A quick eye-scan of all the FEBs on the detector is also a good idea.

22. When the repair is finished the repair person can move back into the lift. The Lanyard can be disconnected from the anchor point and the repair person can stand up.
23. The DAQ person should go through the QC. This includes light leak test, LI test and if running beam test. Be sure no additional dead channels show up in the LI near the PMT which was replaced.
24. The lift extension can be brought back.
25. When the PIC and the 2d catwalk person give approval the lift can be turned back on at both points. The lift can be brought to floor level.
 - a. Place the clear plastic protective cover over the FEB.



26. Powering up and checking the PMT
 - a. For the DAQ expert, on the MINERvA DAQ PC:
 - i. `source slowcontrol.sh`
 - ii. If no errors appear and all the lights on the boards are green for the crate.

Return to Service Instructions:

1. Quality control tests should be done while the repair crew is at the PMT

Repair Submission Instructions:

1. Leave the faulty PMT in Lab G with a detailed note explaining where the PMT was removed from and the problem).

Notification of In-Service status:

1. On completion of switching the PMT the appropriate paperwork must be completed. An entry into the Dune ECL must be made using the Hardware/PMT Swap_Box form. The location of this form can be seen below:

2. PmtSwapForm_ScreenPrint02.jpg, The form is self-explanatory, Note this does not exist right now but I have left it in
 - a. Enter the swapped out PMT box serial number
 - b. The last run before the swap
 - c. The new PMT serial number
 - d. The first run number after switching a PMT
 - e. A new run series should be started after a PMT swap as this will start a numip run (i.e. take pedestal data).
 - f. The location of the swapped PMT in electronics space (CRATE, CROC, CHAIN, BOARD)
 - g. The swappers
 - h. The reason for the swap
 - i. The location of the removed PMT**.
3. Notify management.

Supporting Documentation:

1. Dune DocDB 1532: Distributed Power Architecture
2. Dune DocDB 26202: DAQ CME Crate0 for 2x2