

Light-Guide Repair Guide

Gabby Gelinas and Ben Scully

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1 Re-gluing Light Guides

Step 1: Clean light guide and scintillator

Materials:

- Isopropyl alcohol
- KimTech wipe
- Windex
- 2 small boxes for sorting light guides

Procedure:

1. Clean work area with a light spray of isopropyl alcohol and a kimwipe.
2. If you are removing at least one light guide from the end and middle of a row, get two boxes, lined with a kimwipe, to store the light guides in so you can keep the two of different type separate.
 - Note: light guides on the ends are asymmetric and numbered type 3434. Light guides in the middle are symmetric and number 3222.
3. Gently bend the broken light guide off of the scintillator.
4. (Optional) Using a small amount of isopropyl alcohol on a kimwipe, rub off as much glue as possible from the light guide.
5. Apply Windex to a kimwipe and remove as much of the glue as possible. Be patient, this can take a while.
6. If you are unable to remove the rest of the glue from the light guide using Windex, you can carefully use a razor blade held parallel to the light guide's surface with glue and remove the glue that way. Be careful not to scratch the light guide or slice off pieces.
7. Next, clean the glue off the scintillator using a kimwipe with Windex. Do not use a razor blade, the scintillators are too fragile and expensive to risk damaging. Alcohol can also damage the scintillator because of temperature change from evaporation; if you feel you must use it, use it *very* sparingly.

If you scratch the light guide it is unfortunate but possibly fixable by polishing the light guide.

Step 2: Applying Glue

Materials:

Materials are found in the back room of the detector support facility, the same room where the silicone is prepared.

- Jig
- Isopropyl alcohol
- Kimwipes
- Compressed air can/pressurized duster
- Long wood and cotton cotton swaps
- Small piece of kapton
- Small glass beaker (cabinet)
- Glass stirring rod (cabinet)
- Glue, EJ-500 optical cement part A - Resin (fridge)
- Hardener, EJ-500 optical cement part B - Hardener (fridge)
- Needle

SAFETY NOTE: goggles must be worn when working with the glue and hardener. A lab coat and gloves are also best practice. If either solution gets on your skin, immediately wash it off and call 7333 if you are unable to get it all off. If some gets on your clothes they will need to be washed at TRIUMF.

Gloves must **always** be worn when touching exposed scintillators. You must clean anything you touch with your gloves on so you don't dirty the scintillator.

Procedure:

1. Examine the scintillator for signs of crazing. This will appear as lots of small sparkles across the scintillator that go deeper than the surface when holding it up to light. It could also look like dust trapped inside the scintillator. If this is present, the scintillator can't be used.
 - Crazing can be caused by excessive exposure of the scintillator to light, temperature changes, or contact with oils (like from your fingers) or solvents.
2. One hour before beginning this process, take the glue and hardener out of the fridge.
3. Wipe down the orange part of the jig and any parts that will make contact with the scintillator with a very little bit of alcohol.
4. Check the end of the scintillator you will be gluing for any remaining glue.
 - If there is glue remaining, use a tiny bit of alcohol to remove it.

5. Using a can of compressed air, shoot a very small amount across the end of the scintillator. Do this by holding the can upright and only partially compressing the trigger.
6. Slide the scintillator into the rectangular part of the jig then add the clamp on top. Hand tighten the screw.
7. Put the polished and cleaned light guides in the light guide side of the jig, being mindful of the different shapes of the middle and end light guides. They won't all fit in the holder perfectly due to non-uniform polishing.
8. Secure the light guides with the clamp without the foam and hand tighten.
9. Using a very small amount of alcohol on the cotton end of a cotton swap, lightly clean the ends of the light guides and scintillator.
10. Push the light guides flush against the scintillator. You may need to use the wooden end of a long cotton swap to adjust them individually due to inconsistencies introduced in polishing.
11. Clean a piece of kapton with alcohol to use as a spacer.
12. Adjust the tall screw on the back of the light guide jig to slide it backwards a bit, being careful not to let the jig twist, so you can put a kapton spacer between the light guide and scintillator. Move the light guide jig back into place, pressing the kapton in place.
13. Now start preparing the glue. Clean a small glass beaker with alcohol.
14. Into the beaker, use the glass rod to add glue and hardener in a 1 part hardener to 4 parts glue ratio by weight.
 - A recommended quantity is 1.2 g of glue and 0.3 g of hardener.
 - Once the two solutions have been mixed you have 60 minutes to work before it hardens too much.
 - Clean the glass rod with alcohol in between solutions.
15. Pump down the solution in the vacuum pump until the bubbles go away (about 10 minutes).
 - To turn on the vacuum pump (in order): put the beaker under the glass cover with some distance from the hole, flip the vent lever down, turn the knob all the way to "bell jar", flip the power switch to "on".
 - If the vacuum pump's pressure gauge doesn't decrease below zero, put down on the glass cover while twisting.
 - If the solution starts to approach bubbling over, turn the knob partially towards "vacuum".
 - To turn off the vacuum pump: turn the power switch to "off", turn the knob all the way to "vacuum", slowly lift the vent lever.
16. Without moving any components of the jig, remove the kapton spacer.
17. Use the tip of a needle to apply a very small drop of glue (about the size of the dot created by a ball point pen) to the outer corner of one of the edge light guides, where the light guide meets the scintillator.
18. Wait and watch the glue get pulled through to cover the entire gap. Continue to add glue to this same spot until the glue extends passed the gap to the next light guide.
19. Continue this process of adding glue to the corner where the light guide meets the scintillator (if the gap was ignored), adding glue to the corner closest to the existing glue, along the length of the scintillator. Light guides must be glued in order like this or you will introduce air pockets.

20. If there are large clumps of glue at the sites where it was added, use the cotton part of a cotton swap to gently roll away the excess glue.
21. Carefully put the whole jig system in a dark box for one hour.
22. Using a small drop of alcohol on the cotton end of a cotton swap, roll away any remaining glue on the surface.
23. Return the jig system to the dark box and let it sit for 24 hours.

2 Polishing Light Guides

Note: all light guides should be 20 mm long.

Materials

- Large flat acrylic block (use wetordry paper to smooth it out if necessary) -or- granite block if available (ask Clayton or Tristan)
- Two small acrylic blocks with light guide slits, one for 3222 angled scintillators and one for 3434 angles.
- One thin rectangle of acrylic
- 2 medium sized clamps (if not using granite block)
- 2000A wetordry paper
- Scotchtape
- Thin cloth
- Windex
- Micro-gloss liquid abrasive (polishing liquid)
- Kimwipes
- Lighted magnifying glass

Procedure

1. Clamp the large acrylic block to your work table.
2. Tape a rectangle about 5" x 3" (or whatever the size of your block allows width wise) of wetordry paper to the acrylic block, taking care to tape it as flat and tight as possible.
3. Tape the thin rectangle of acrylic over the edge of the wetordry paper, running perpendicular to it.
4. Tape a similarly sized piece of cloth to the acrylic block, again trying to stretch it as tight and flat as possible when taping. If not taut enough it will bunch when trying to polish and you won't be polishing it flat anymore.

5. Identify which type of light guide you are working with. If the angle of the slopes are the same then you only need to use the 3222 block. If they are different then you must use the 3222 block for one side and the 3434 block for the other side, compare to a symmetric block to see which side is which.
6. Slide your light guide into the slot on the appropriate acrylic block, making sure that the part of the scintillator you want to polish is flat and inline with the bottom of the block and not sloping upwards. If it sloping upwards, you have it upside down for. See Figure 3 for an example.
7. Spray the wetordry paper with Windex. If at any point the light guide feels like it's dragging on the wetordry paper add another spray.
8. With the acrylic block that supports the light guide sliding over the thin acrylic rectangle and the light guide polishing surface gliding over the wetordry paper, move the light guide/block system in figure-eight motions while pushing down onto the wetordry paper and pushing the scintillator into its supporting block so it stays flush against it. Do a couple of figure-eights with one side of the scintillator supported by the block then turn the light guide around so the other side is supported by the block (keeping the same polishing surface on the wetordry paper). If polishing a 3434 asymmetric light guide you will need to use both acrylic supporting blocks to do this.
 - Motivation note: it's important that we only move in figure-eights and not along the same straight line so we do not form channels in the light guide that cannot be polished out.
 - Motivation note: it is necessary to use the wetordry paper before polishing to get rid of the scratch and remove surface imperfections so we do not end with a very shiny scratch.
 - If polishing a long side of the light guide (unnecessary when repairing a previously used light guide but necessary when introducing a new light guide) then you do not need to use a supporting block and instead just press it flat. Since it is hard to do figure-eights when holding the light guide like this, move it back and forth and after every swipe slightly turn your hand so the light guide rotates like a clock.
 - There is no need to polish the largest two faces of the light guides, even if you are using a brand new light guide, because they come pre-polished.
9. Continue until the polishing surface is uniformly scuffed. This does not take long so check on it frequently because you do not want to over sand the surface and shorten the light guide too much – should only take a couple-few figure eights. Use the lighted magnifying glass to check.
10. Move the thin rectangular piece of acrylic to the polishing cloth, orienting it the same and taping it down.
11. Add a quarter sized amount of the polishing liquid to the cloth. Reapply when the cloth goes dry.
12. Repeat the same motions and procedure as used with the wetordry paper until the polishing surface of the light guide is very shiny and uniform when held up to light. If you can see any ripples in the shiny surface, it is not polished enough. This will take longer than the sanding. Again, make sure to use figure-eight motions.

If you make a mistake and forget if you already sanded a light guide side or not, polish it, wipe off any grease with a kimwipe and then hold it up to light. An un-sanded but polished light guide will have light appear to travel across it in lines opposed to in a continuous flow.

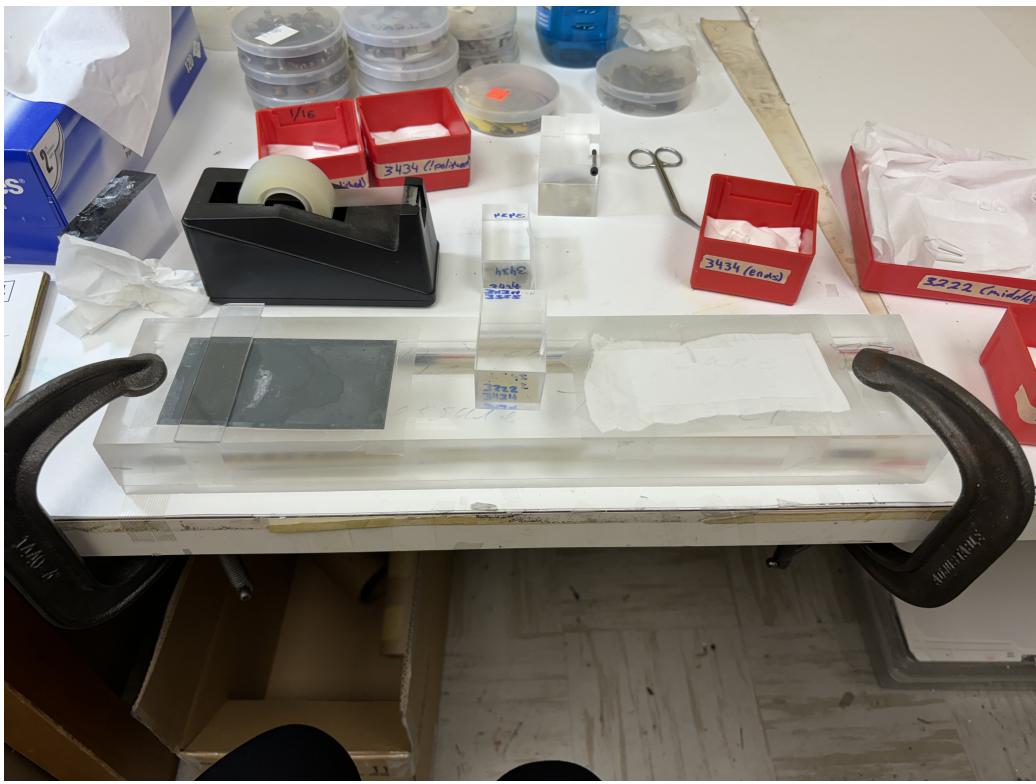


Figure 1: Set up for polishing light guides with the small support blocks shown with blue writing on them.

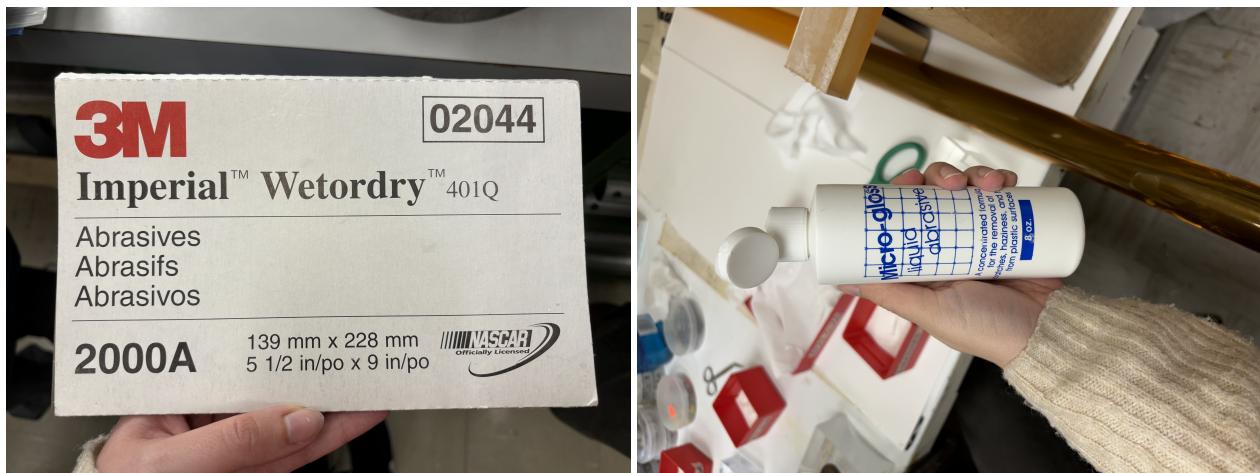


Figure 2: 2000A wetordry paper (left) and polishing liquid (right)



Figure 3: Support block and scintillator showing the correct (left) and incorrect (right) alignment.