Fiber Optic Construction & Termination

Jeff Hite
University of Oregon/NSRC
jeffh@uoregon.edu

UNIVERSITY OF OREGON

NSRC
Network Startup Resource Center

Campus Network Plant Construction

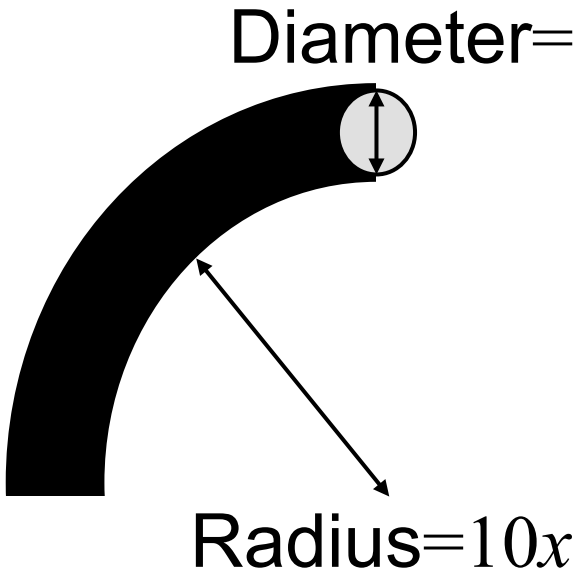
- Fiber Selection
- UTP Copper
- Pathway Construction
- Installation Guidelines
- Termination

Fiber Package Selection

- Use outdoor rated cable between buildings
  - Armored Loose tube (to protect against rodents)
    - Un-armored loose tube in conduit if rodents not an issue
    - Indoor/Outdoor tight buffer if possible
- Use indoor rated cabling inside buildings
  - tight buffer
- Standardize Connectors
  - Multi mode: ST or SC (epoxy or hot melt)
  - Single mode: SC or LC (fusion Splice factory UPC pigtail) (Can hand polish for short runs <2 km)

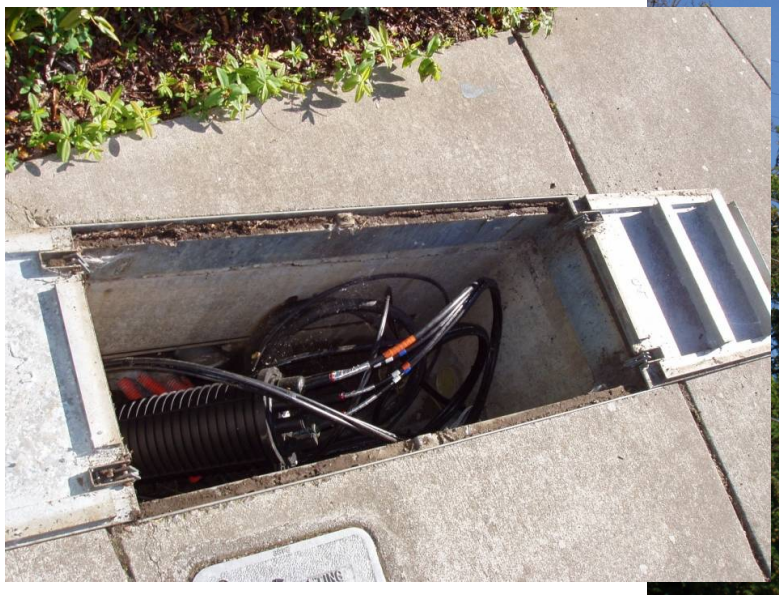
Fiber Optic Cable Construction

- Fiber has bend radius issues
- Keep bends ≥ 10x cable diameter



Fiber Optic Cable Construction

- Leave slack loops, usually 10m per location



Outdoor loops in Thailand

Small Vault Slack Loop

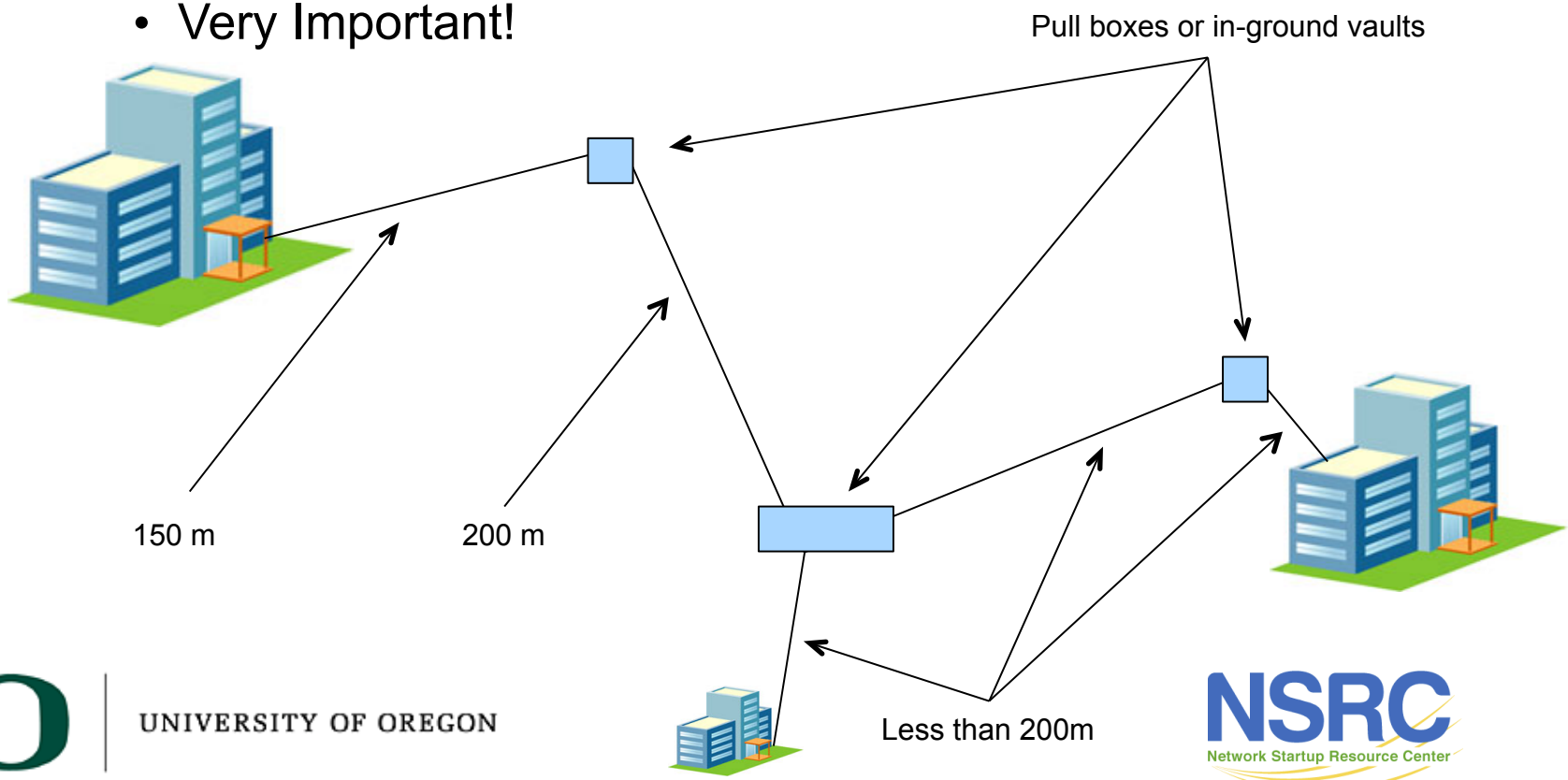
Closet Slack Loops

Conduit Construction

- Sizing Pathway
  - Bigger is better, allows installation of more than one cable package per conduit
  - Install additional runs of pathway (100% more than you need today)
  - Plan for the future, think of strand count
  - Install a pull-rope with the fiber
  - Label conduits if possible
- Identifying Fiber
  - Label at each end, strand count, type and destination
  - Label slack loops, Where from? Where to?

Conduit Construction Hints

- For cable installed in underground conduit:
  - No more than 200m between pull points
  - Reduce distance by 50m for every 90 degrees of bend
  - Do not exceed 270 degrees
  - Survey the site and do the arithmetic
    - Very Important!



Fiber Color Codes

(May vary by region)

Blue	Red
Orange	Black
Green	Yellow
Brown	Violet
Slate (Gray)	Rose (Pink)
White	Aqua (Light Blue)

After the 12th Fiber or Tube a black stripe is added to differentiate between groups.

Construction Guidelines
for
Copper and Fiber Optic installations

UNIVERSITY OF OREGON

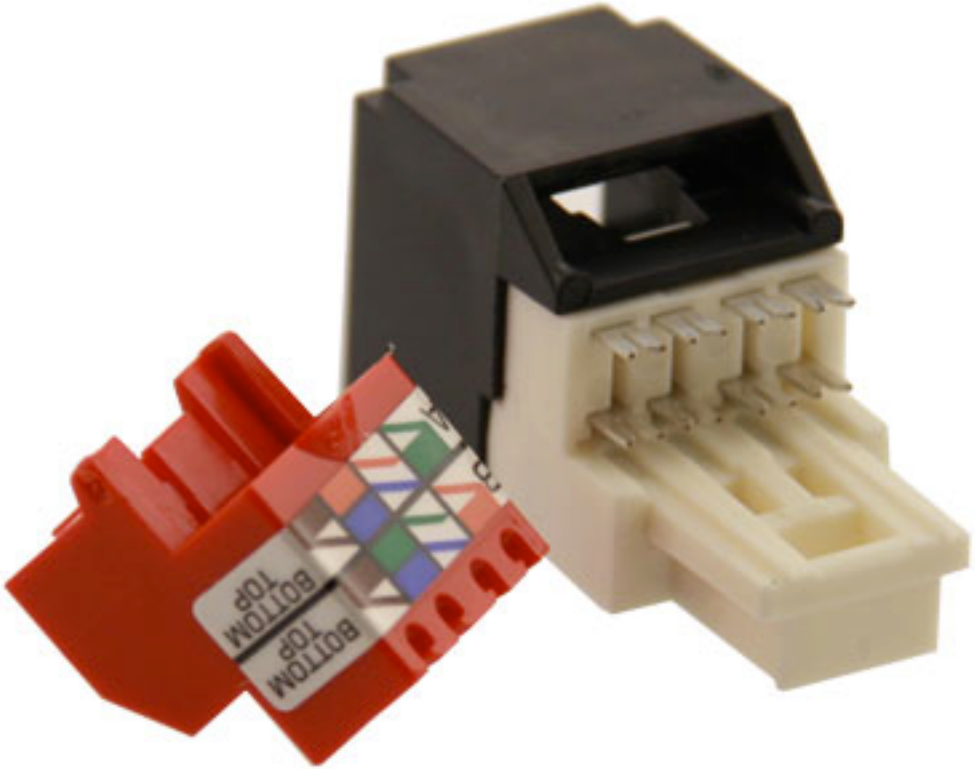
NSRC
Network Startup Resource Center

Instructions to Contractors

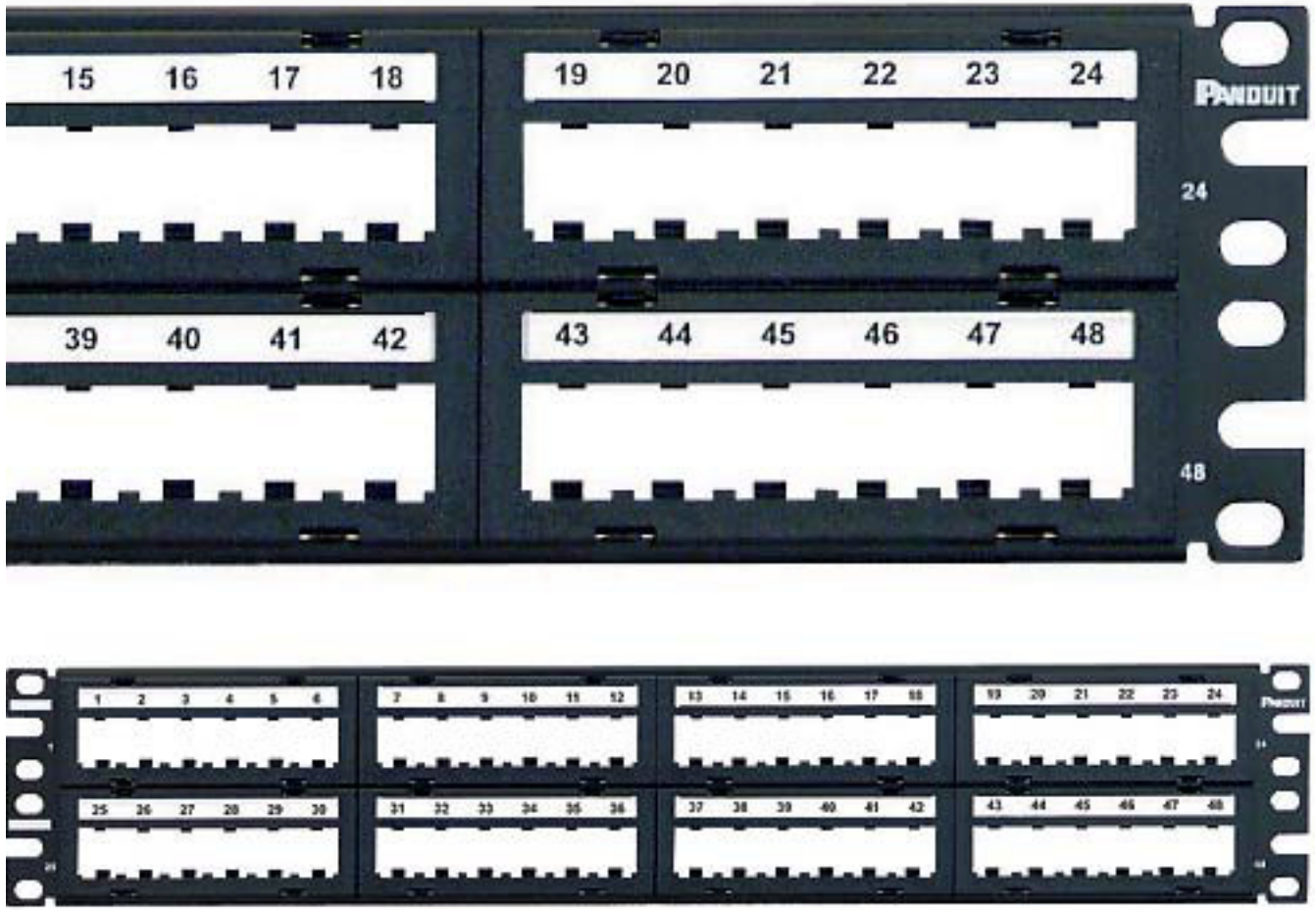
- Please refer to the web site for this workshop to retrieve document that gives complete instructions to contractors for
  - Category 5e cabling
  - Fiber optic cabling
  - Installation of underground conduit and vaults
- Download and edit this document to meet your needs.
  - http://203.159.31.222/CND/01.3_Cabling_Systems_Specifications.doc

Modular UTP Jack

Modular Jack Rear View



48-Port M6 Patch Panel



UNIVERSITY OF OREGON

NSRC
Network Startup Resource Center

Unshielded Twisted Pair Cable (UTP)

- Always terminate in Jack Panel
- Labeling is a key to reduce work later
- Pull more than one cable

110 Termination Patch Panel

110 Termination Technique

Fiber Package Selection

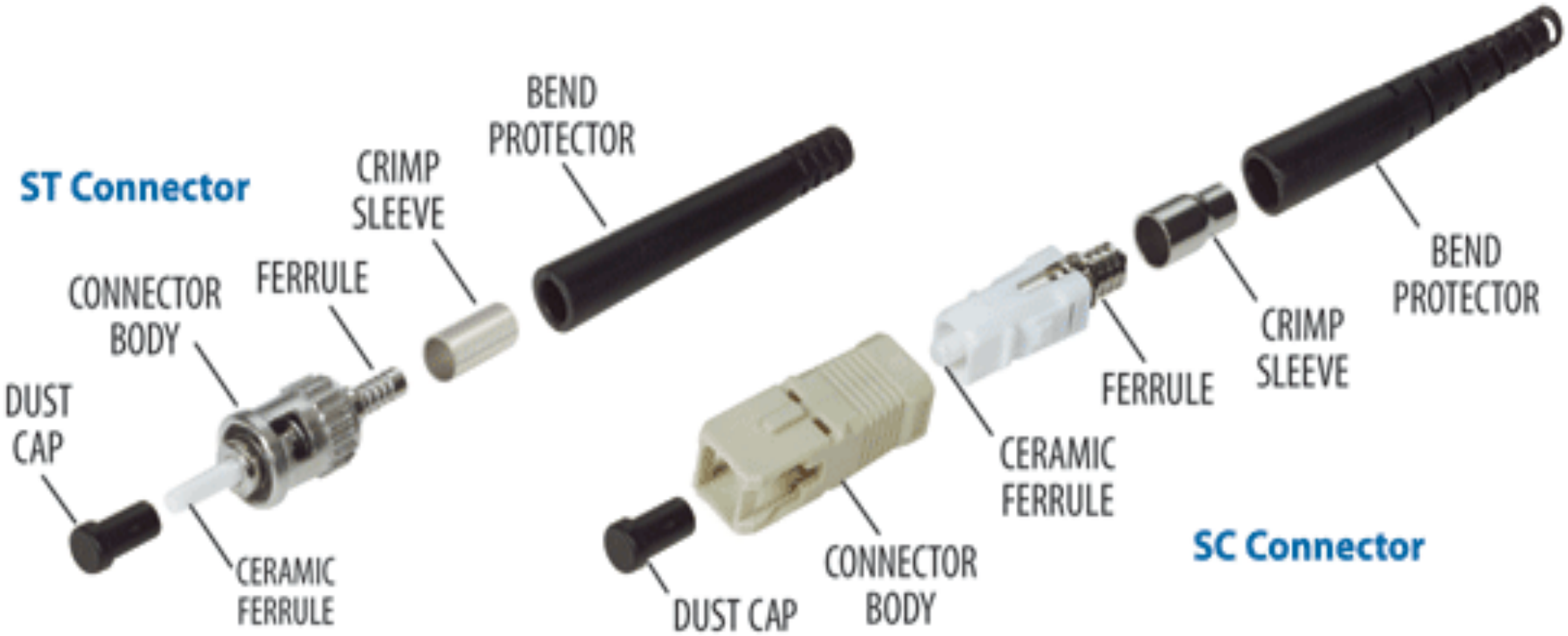
- Use outdoor rated cable between buildings
  - Armored Loose tube (to protect against rodents)
    - Un-armored loose tube in conduit if rodents not an issue
    - Indoor/Outdoor tight buffer if possible
- Use indoor rated cabling inside buildings
  - tight buffer
- Standardize Connectors
  - Multi mode: ST or SC (epoxy or hot melt)
  - Single mode: SC or LC (fusion Splice factory UPC pigtail) (Can hand polish for short runs <2 km)

Fiber Panel Connectors & Patch Cords

- Connectors
  - Many types of connectors are available
  - Choose connectors to differentiate fiber types
    - Very Important!
  - ST connectors are suitable for MM
  - SC connectors are suitable for SM
  - LC are useable for both types

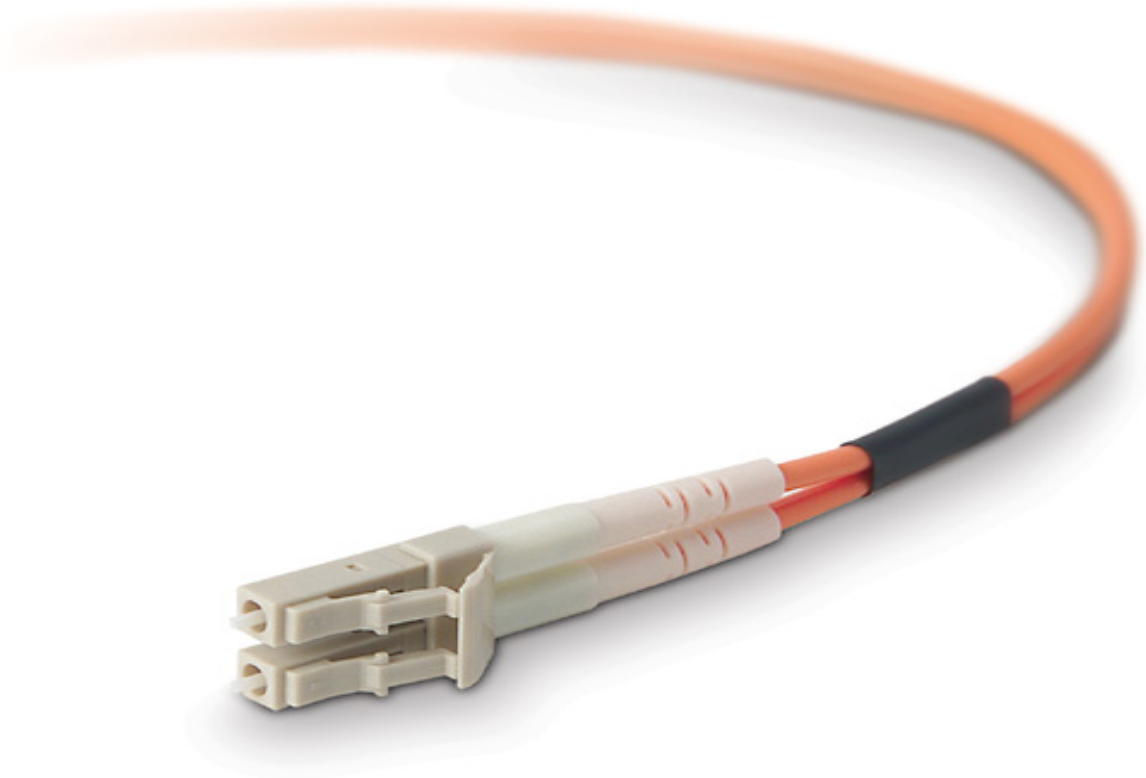
  Patch Cords
  - OM1 are generally Orange but other colors are used
  - OM2 OM3 OM4 use Aqua
  - OS2 cords are exclusively yellow

ST & SC Fiber Optic Connectors

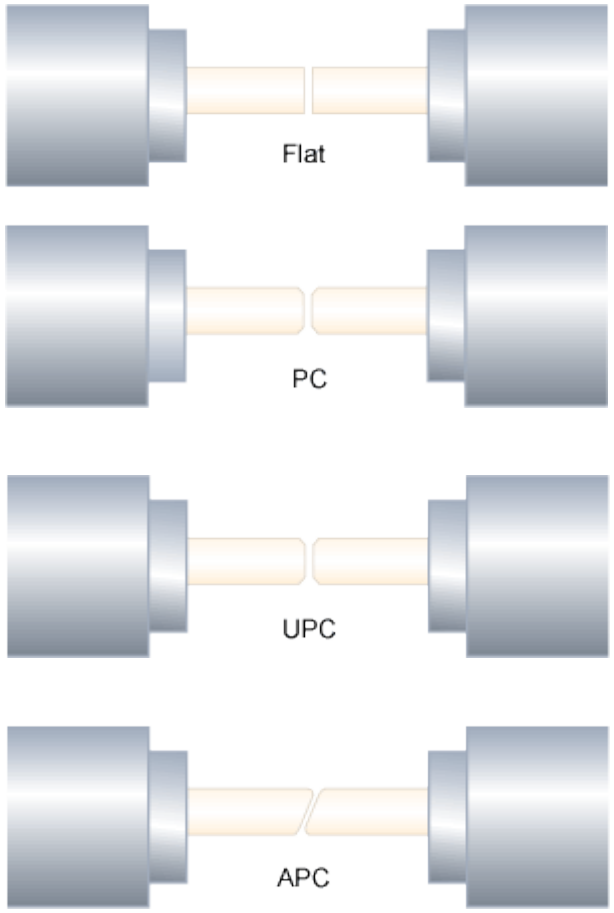


LC Connector

Duplex LC Connector



Connector tip

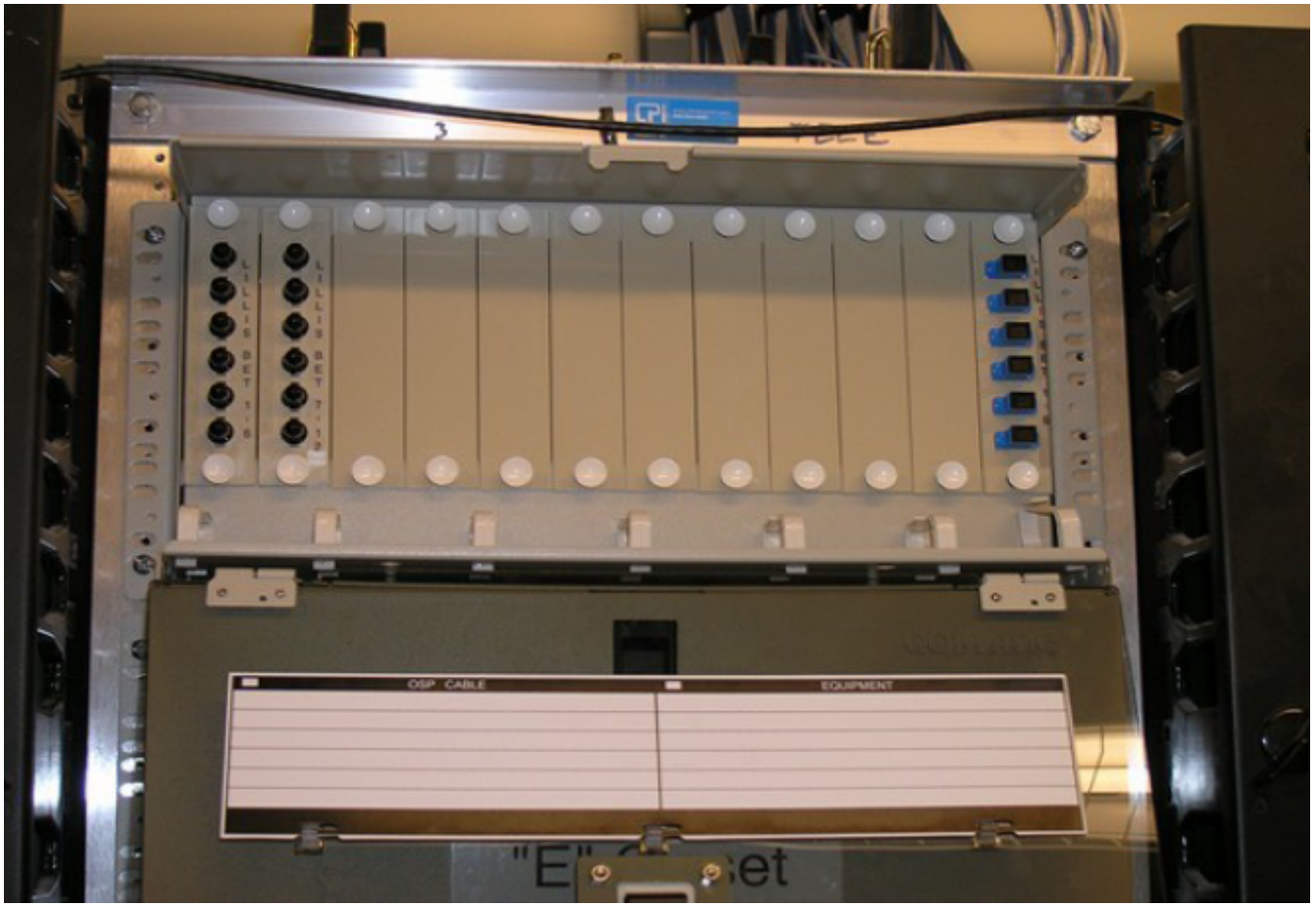


- Flat: air between surfaces, back reflection -14dB
- Physical contact: slanted end, no air, back reflection -40dB
- Ultra Polish Connector: more polishing, back reflection -55dB
- Angled Polish Connector: back reflection -70dB, analog signal

UNIVERSITY OF OREGON

NSRC
Network Startup Resource Center

Fiber Patch Panel



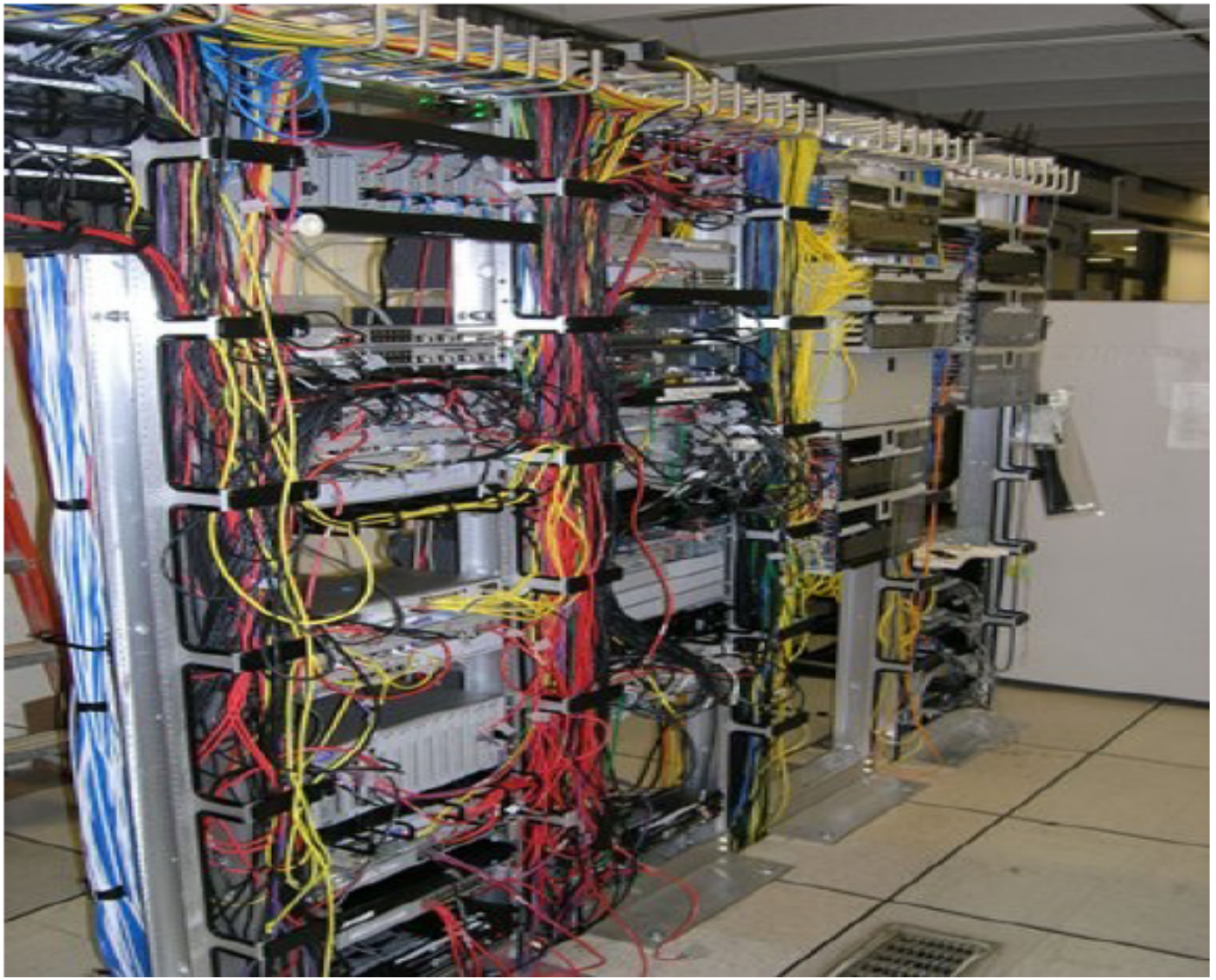
SC Connector Panel

ST Connector Panel

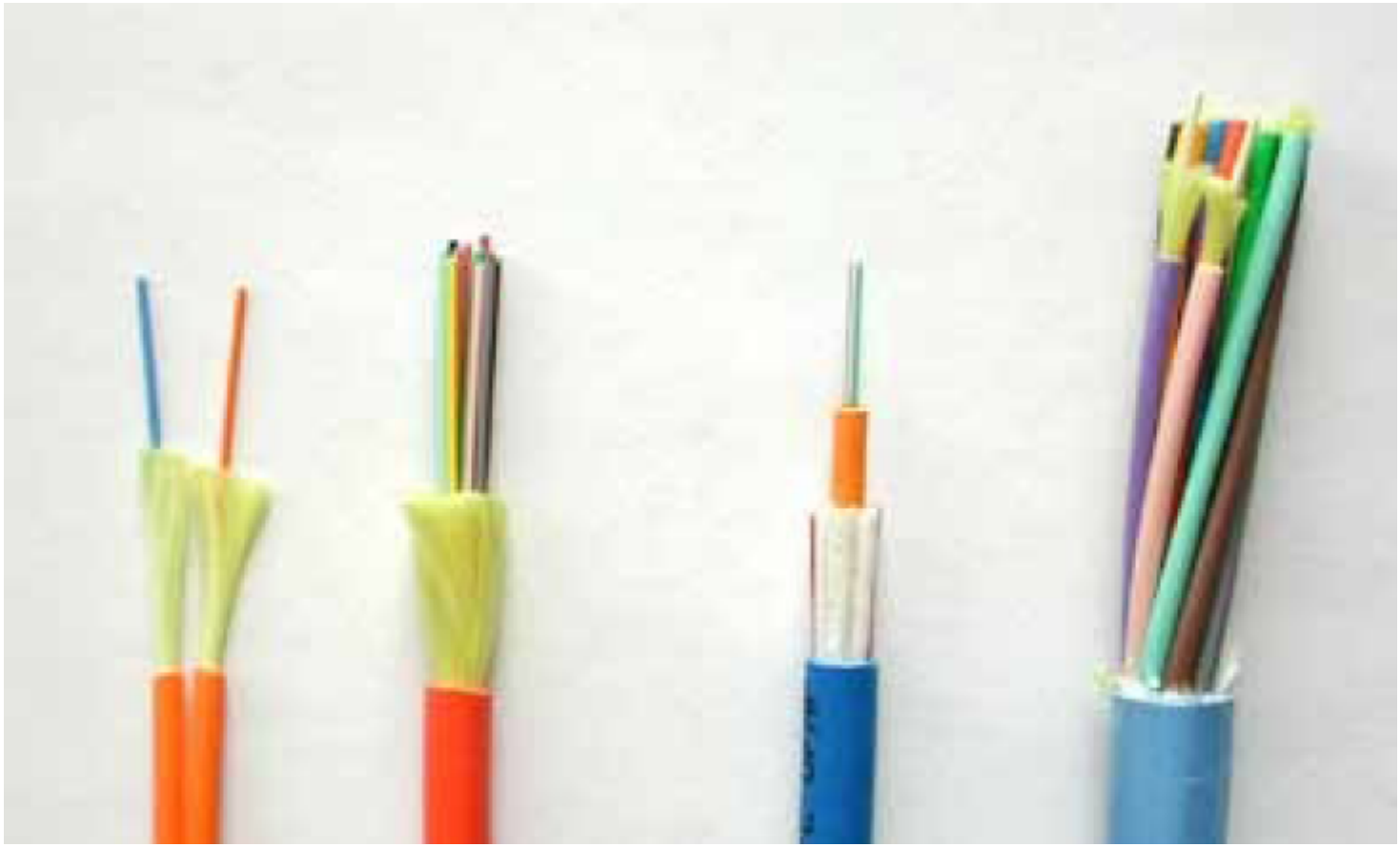
UNIVERSITY OF OREGON

NSRC
Network Startup Resource Center

Relay Racks

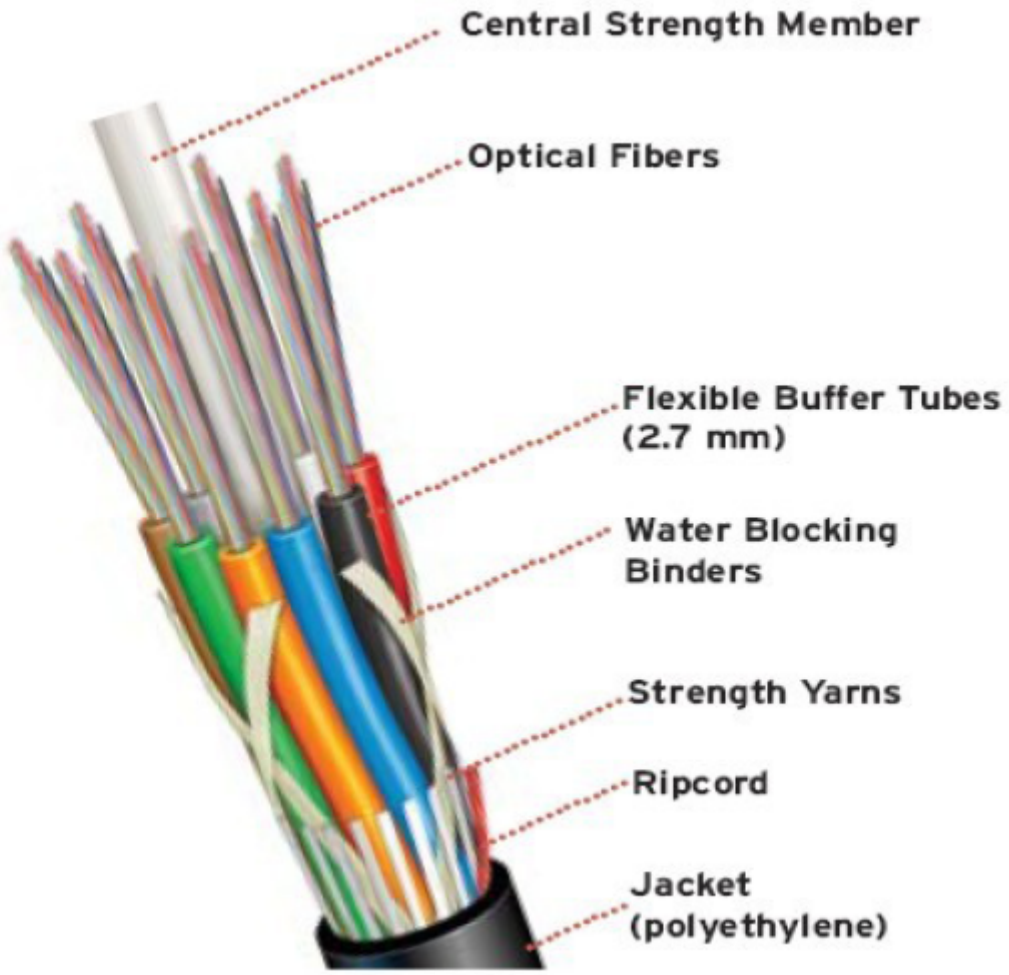


Indoor Fiber Packages

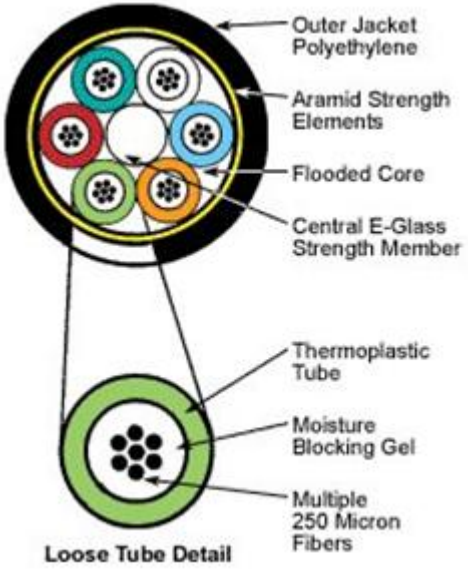


Outdoor Loose Tube Armored Cable

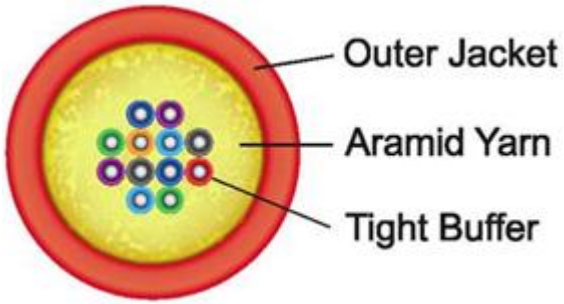
96 Fiber Loose Tube Outdoor Non-Armored



Loose Tube vs. Tight Buffer



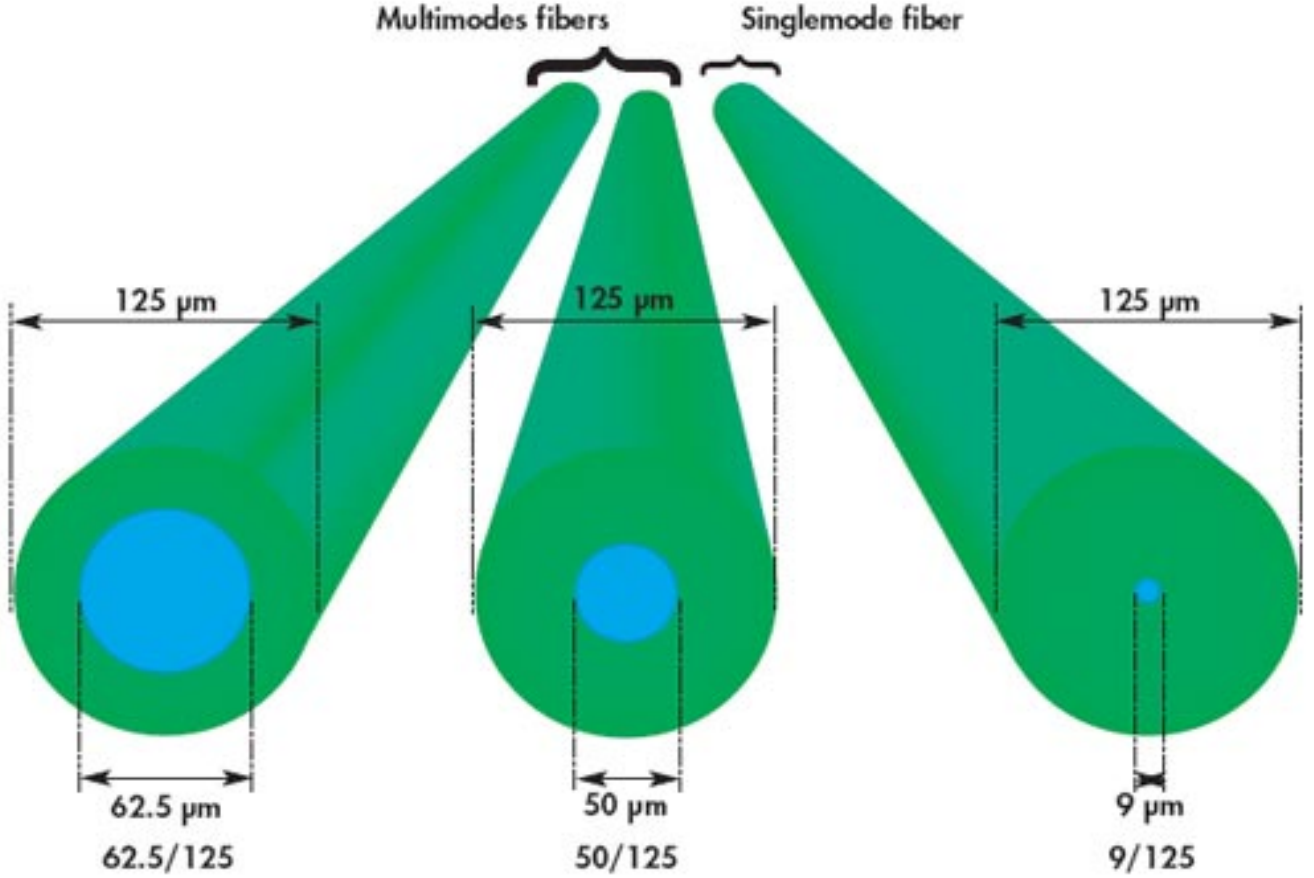
- Loose Tube: several fibers 250 micron in a buffer tube, gel filling, more compact, fragile, outdoor.



- Tight Buffer: one fiber in a 0.9mm buffer, no gel, bigger, sturdier, in/outdoor.

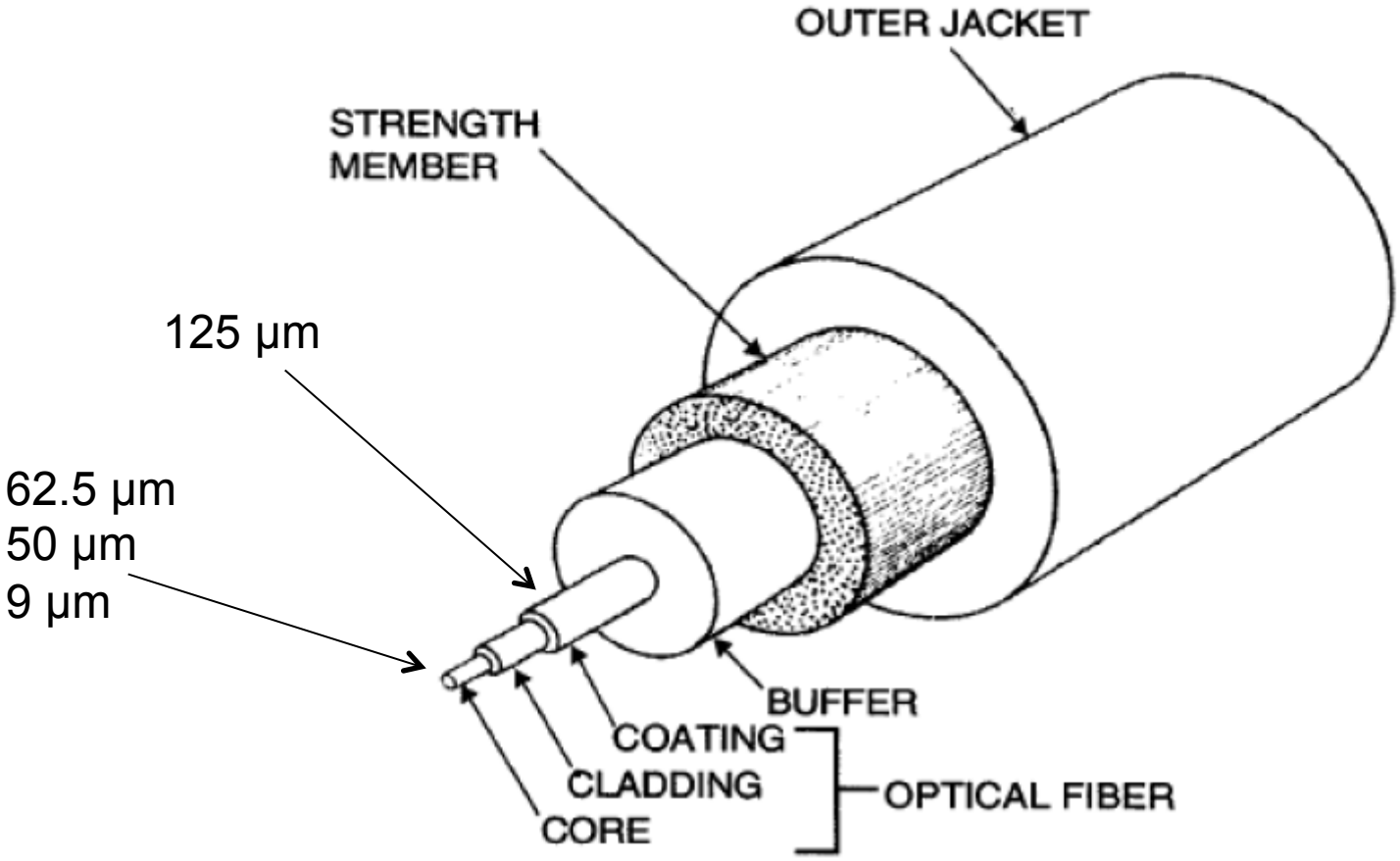
Break Out Kits (Furcation)

Types of Optical Fiber



OM 1 OM 2,3,4 OS 2 (G.652D)

Fiber Cable Construction



Fiber Termination Techniques

- Hand Polishing (Epoxy or Hot Melt)
- Mechanical connectors (do not use)
- Fusion Splicing

Fiber in Ferrule – no back light

Top View

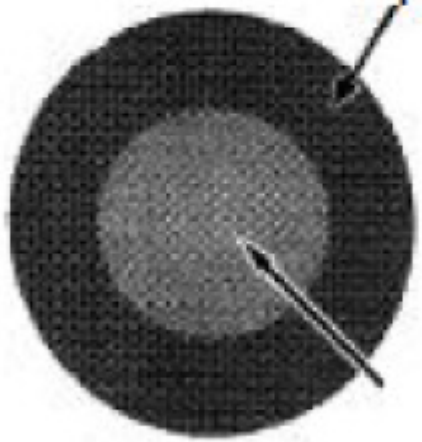
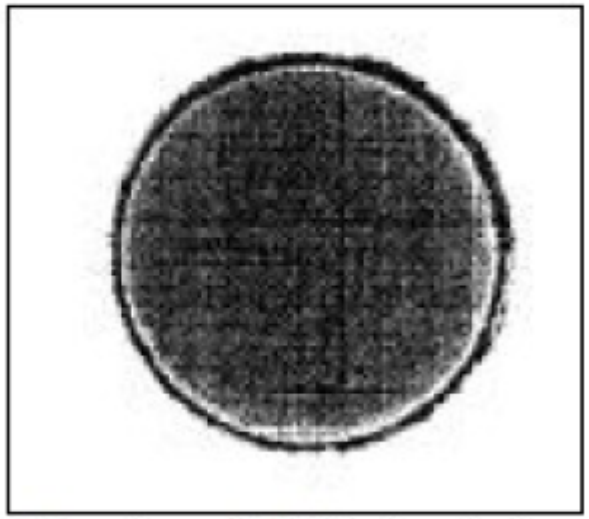
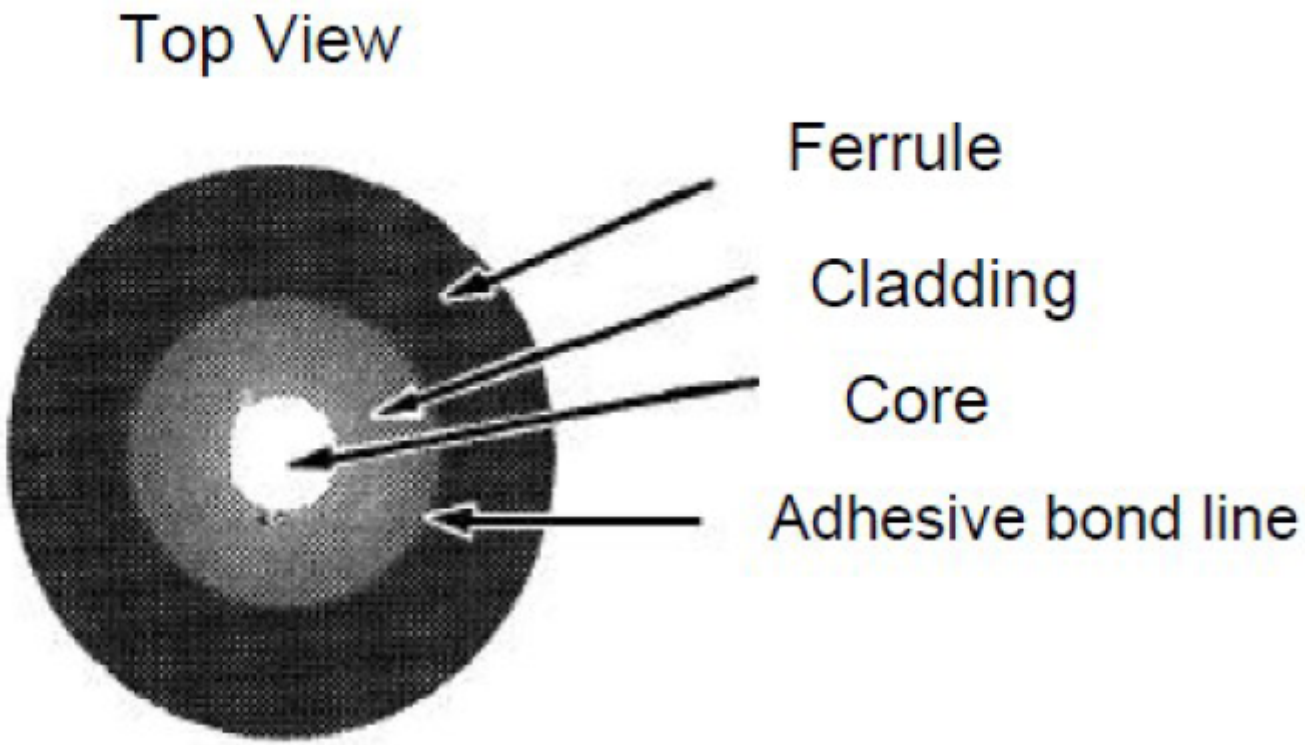


Photo Image

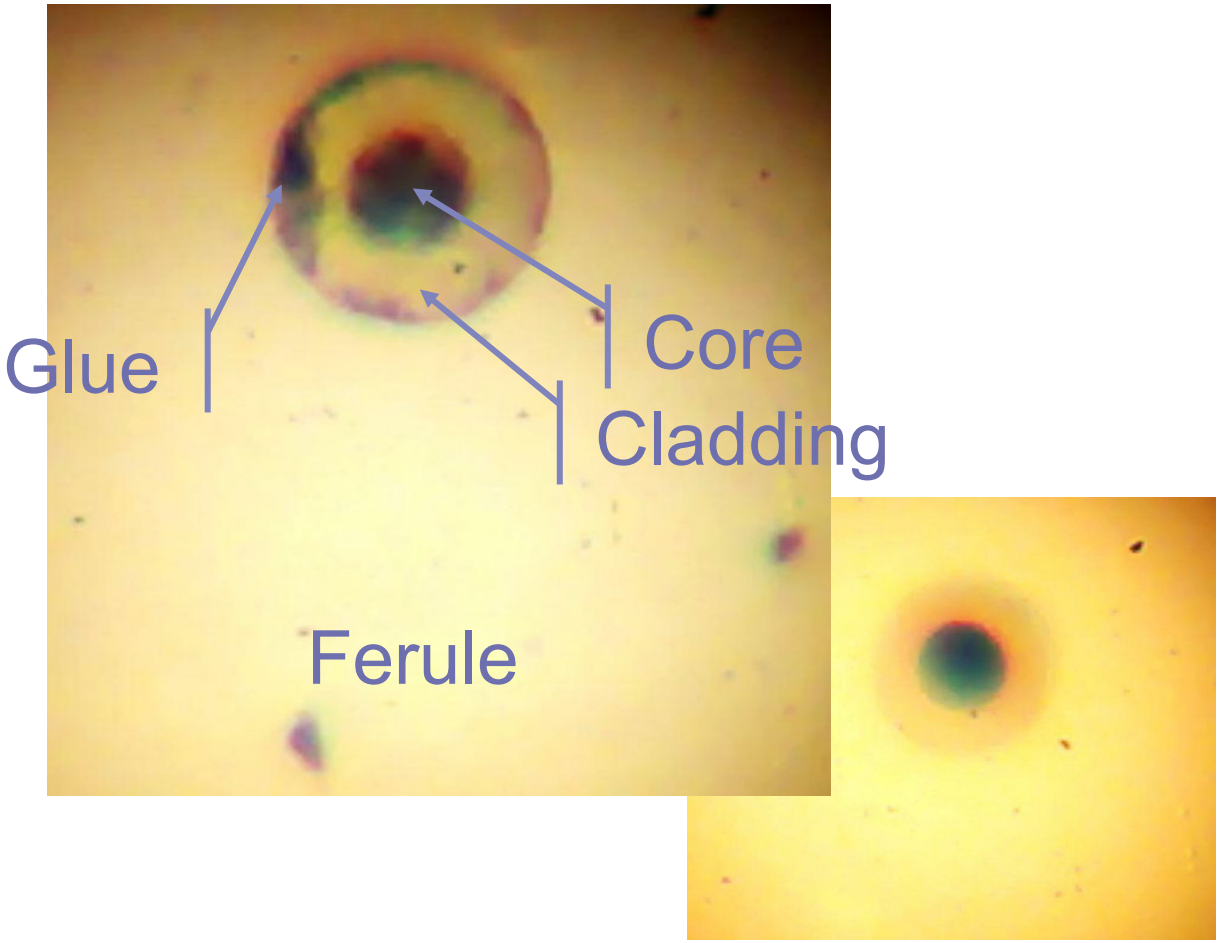


* Ferrule not visible in photo

MM Fiber in Ferrule – Back Lit

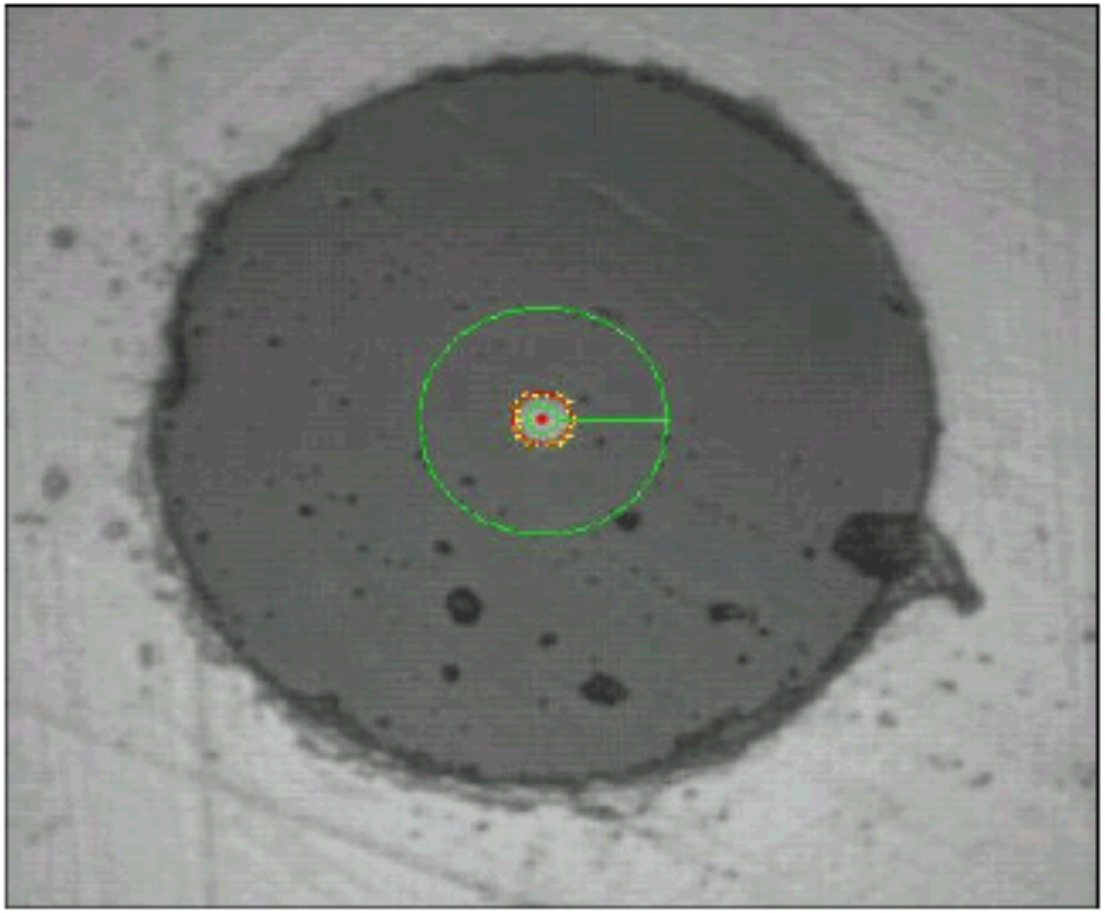


MM fiber with 100x microscope



- Manually polished MM connector shows many defects whereas industrial one is perfect.

Single Mode Fiber - Back Lit



Questions?

UNIVERSITY OF OREGON

NSRC
Network Startup Resource Center

Demo of fiber optic termination

This part is for reference only.

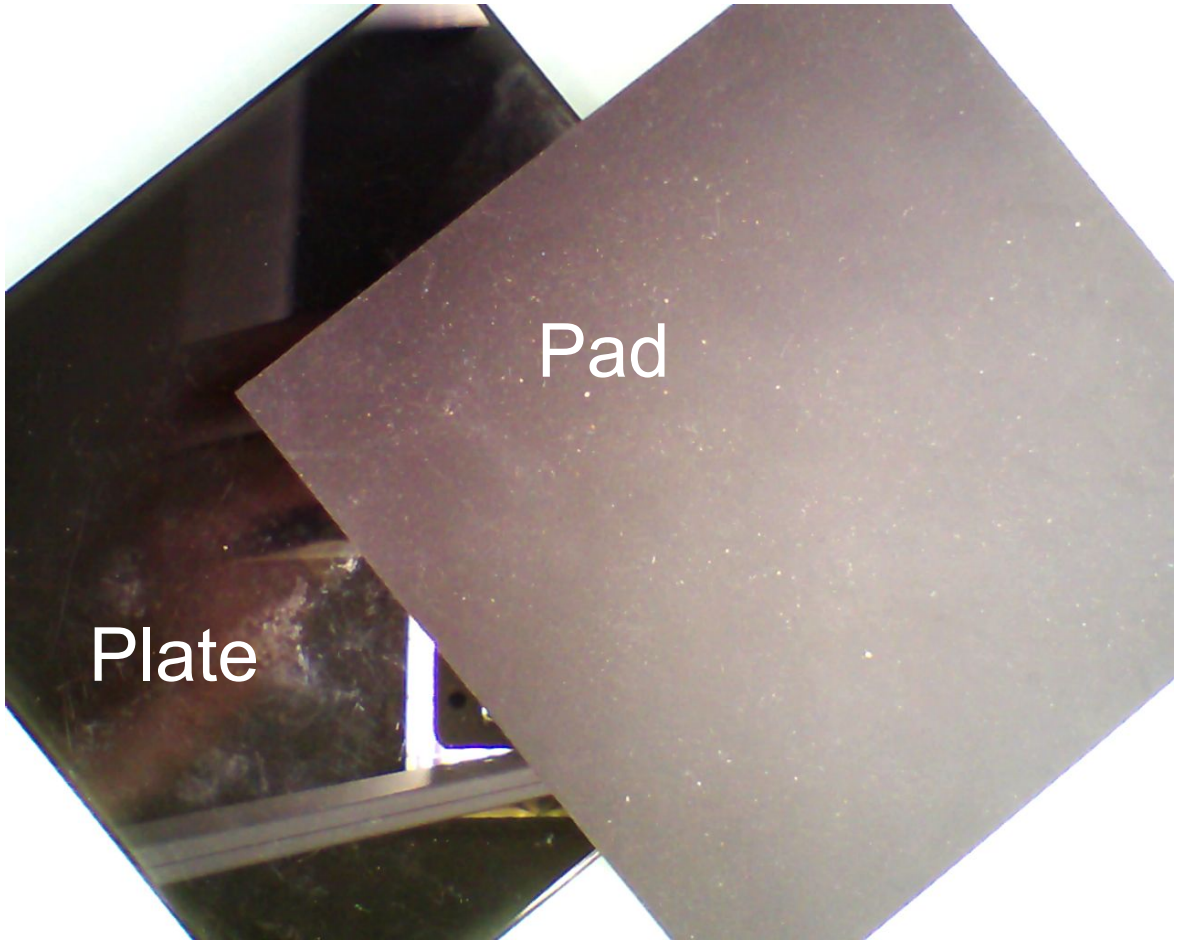
UNIVERSITY OF OREGON

NSRC
Network Startup Resource Center

The tools we use

- The stripper is used to remove the buffer and coating.

The tools we use



- The plate and the rubber pad provide a flat, smooth and soft surface for polishing.

The tools we use

5 micron polishing film

- Polishing Film, this is coated with ceramic or diamond .

The tools we use

- The cleaning tape is used with terminated connectors.
- Gently brush the ferule with figure of 8 motions, on a clean portion of tape.

The tools we use

x100 illuminated microscope

Laser cable tester

- Never flash the laser to the eye.

The tools we use

- The scribe is sharper than a razor blade; always recap it.

The tools we use

- Use the fiber disposal bottle to dispose of pieces of core fiber.
- Stripped fiber is very sharp and can damage your eyes.

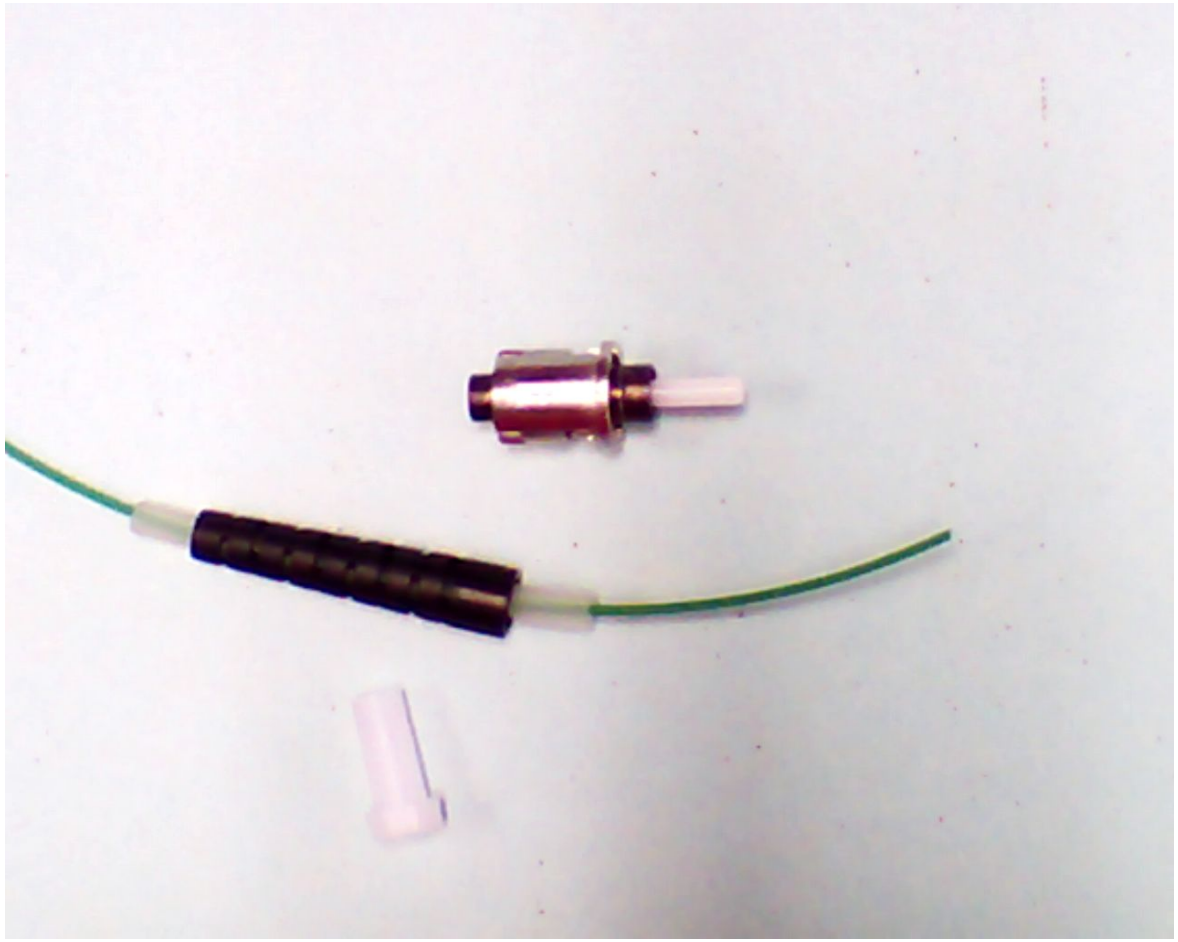
Where to buy the tools?

- Fiber Network Tools (buy online) http://www.fnttools.com/store/pc/home.asp
- Specialized Products Company (buy online) http://www.specialized.net/Specialized/FIBER-OPTIC-5768.aspx
- Ellsworth Adhesives Thailand (glue) http://www.ellsworth.co.th/product/surface/surface/1672.html

Termination Procedure

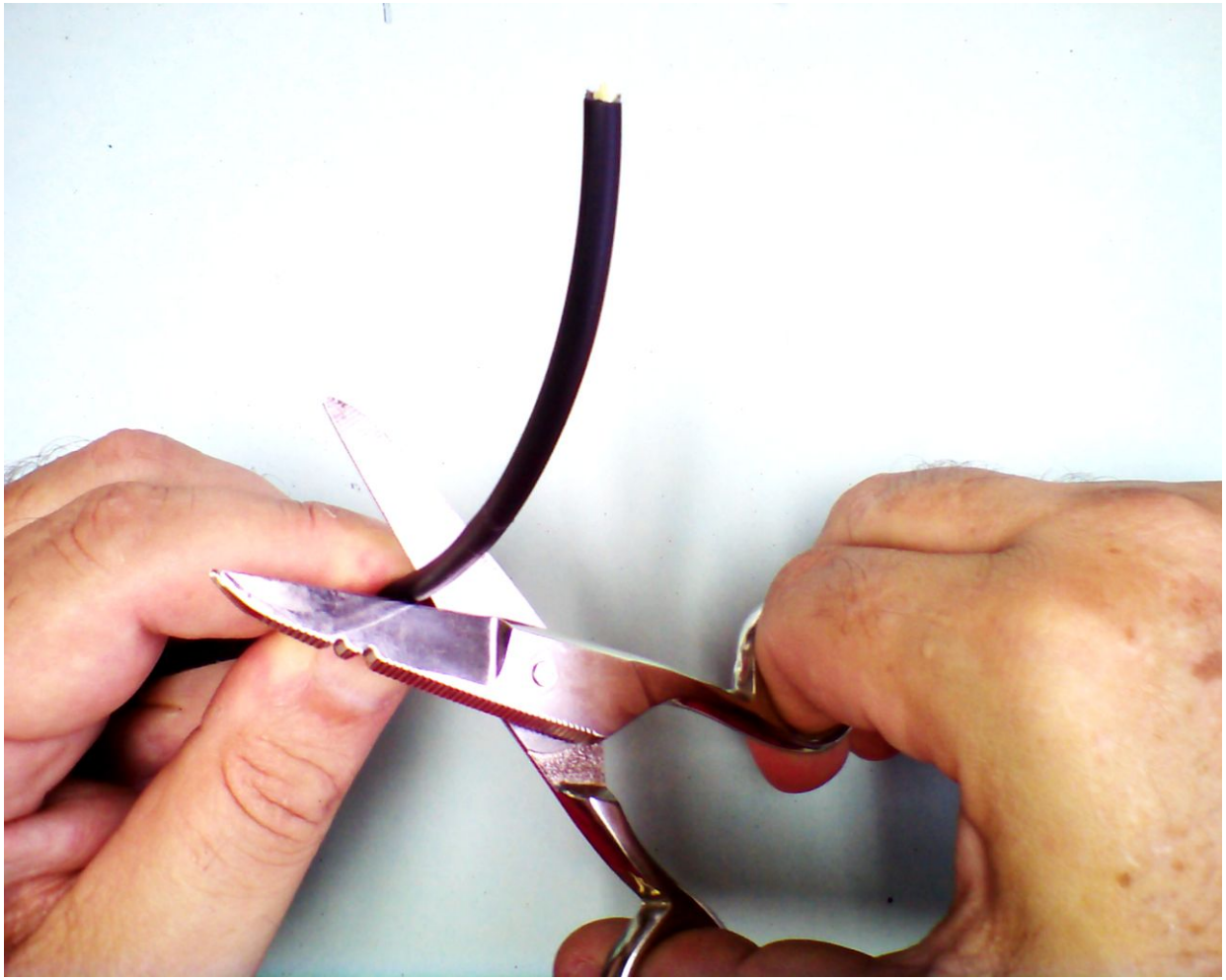
- The following slides show the termination procedure for an ST connector

Prepare the connector



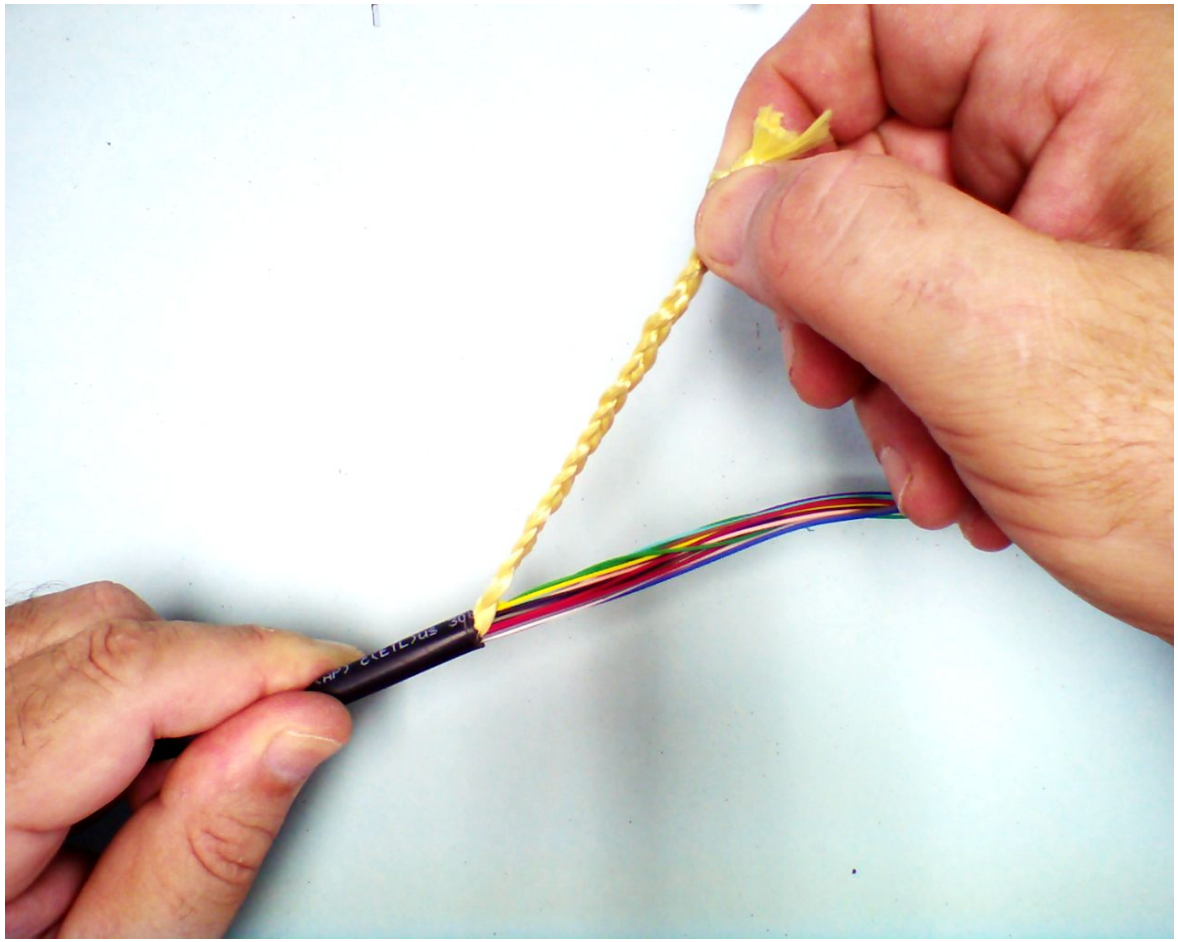
- Slide the plastic tube and the bend protector on the fiber.

Remove the jacket



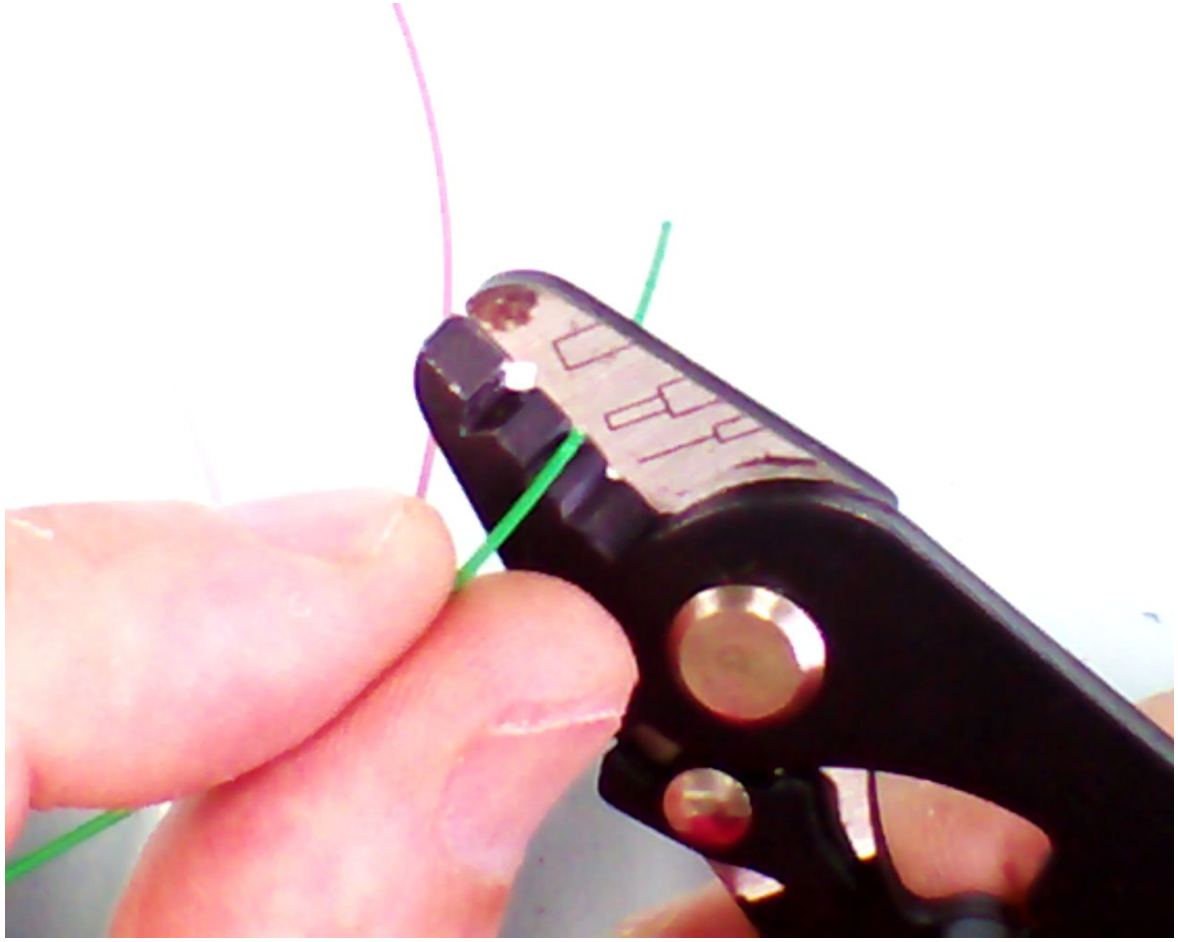
- Use scissors to score jacket.
- Plan enough length to install in patch panel. Usually .5 meter is sufficient.

Make a pull string



- Weave the yarn to make a pull string.
- It is useful to secure the fiber in the cabinet.

Strip off the buffer

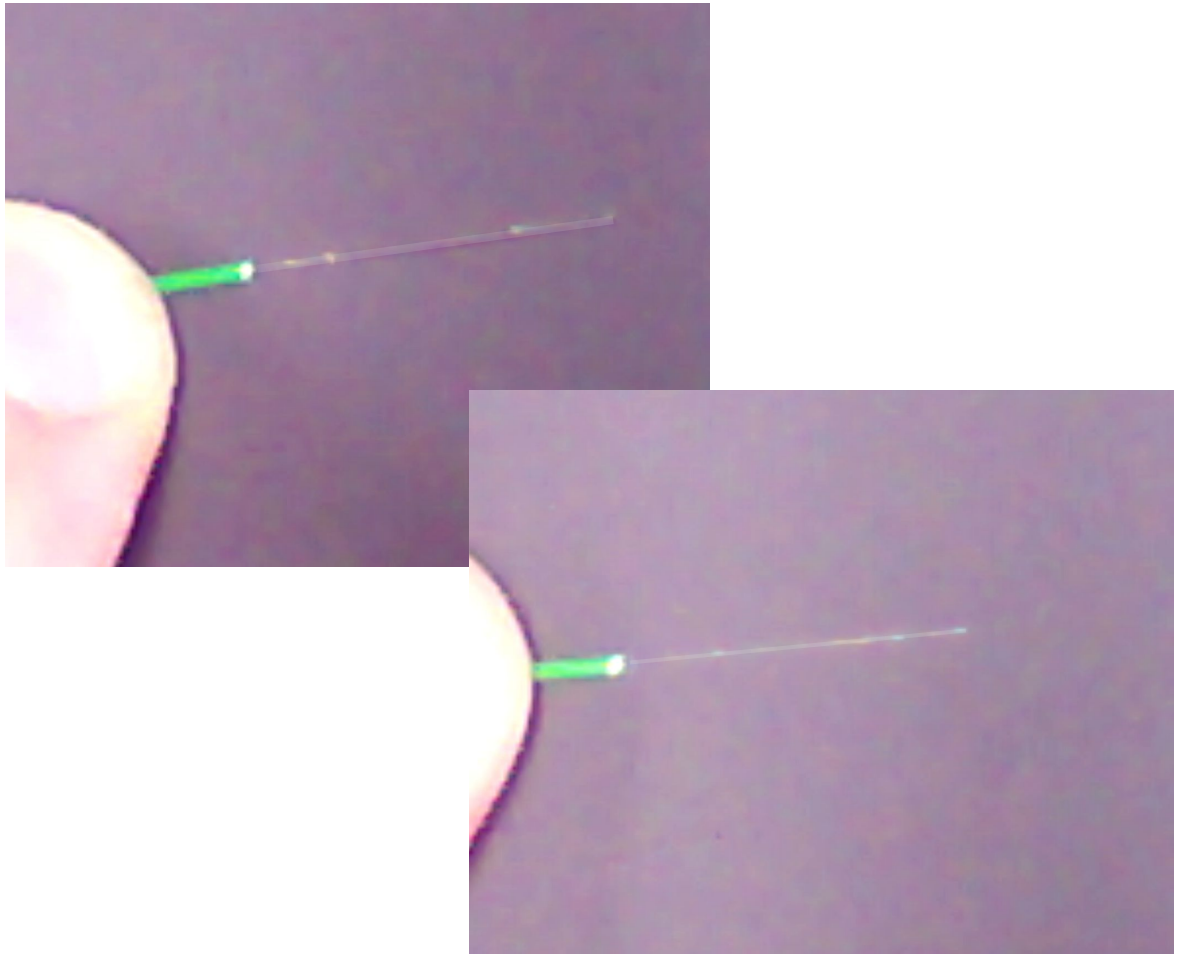


- Use middle slot of the stripper tool to remove the plastic buffer.

Strip off the coating

- Use the smaller slot of the stripper tool to remove the coating.
- You have stripped to 125 micron fiber, dispose the waste properly.

FO with and without coating

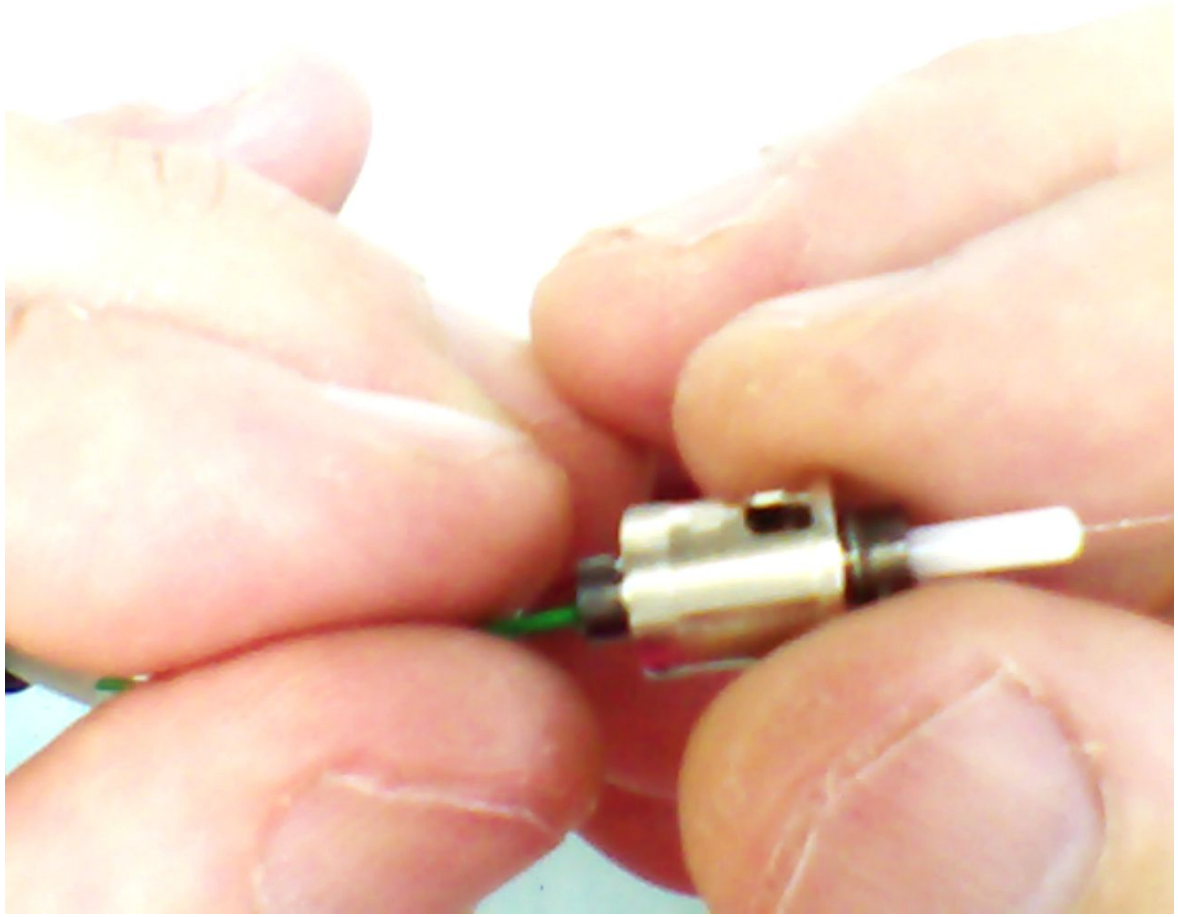


- Before and after you remove the coating.
- Without coating the fiber is thinner.

Prepare the glue

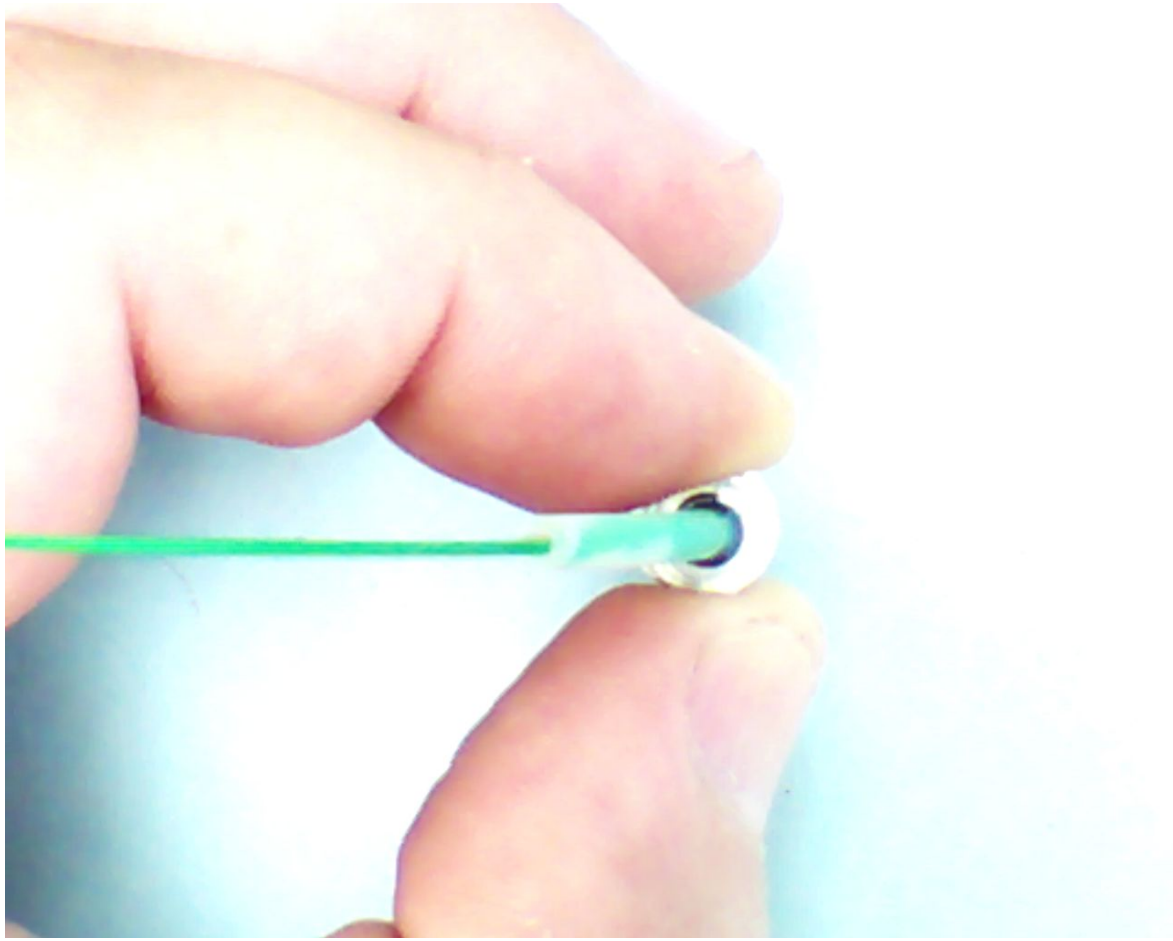
- Fill the ferule with glue (red bottle).
- Be careful with the glue.

Insert the fiber



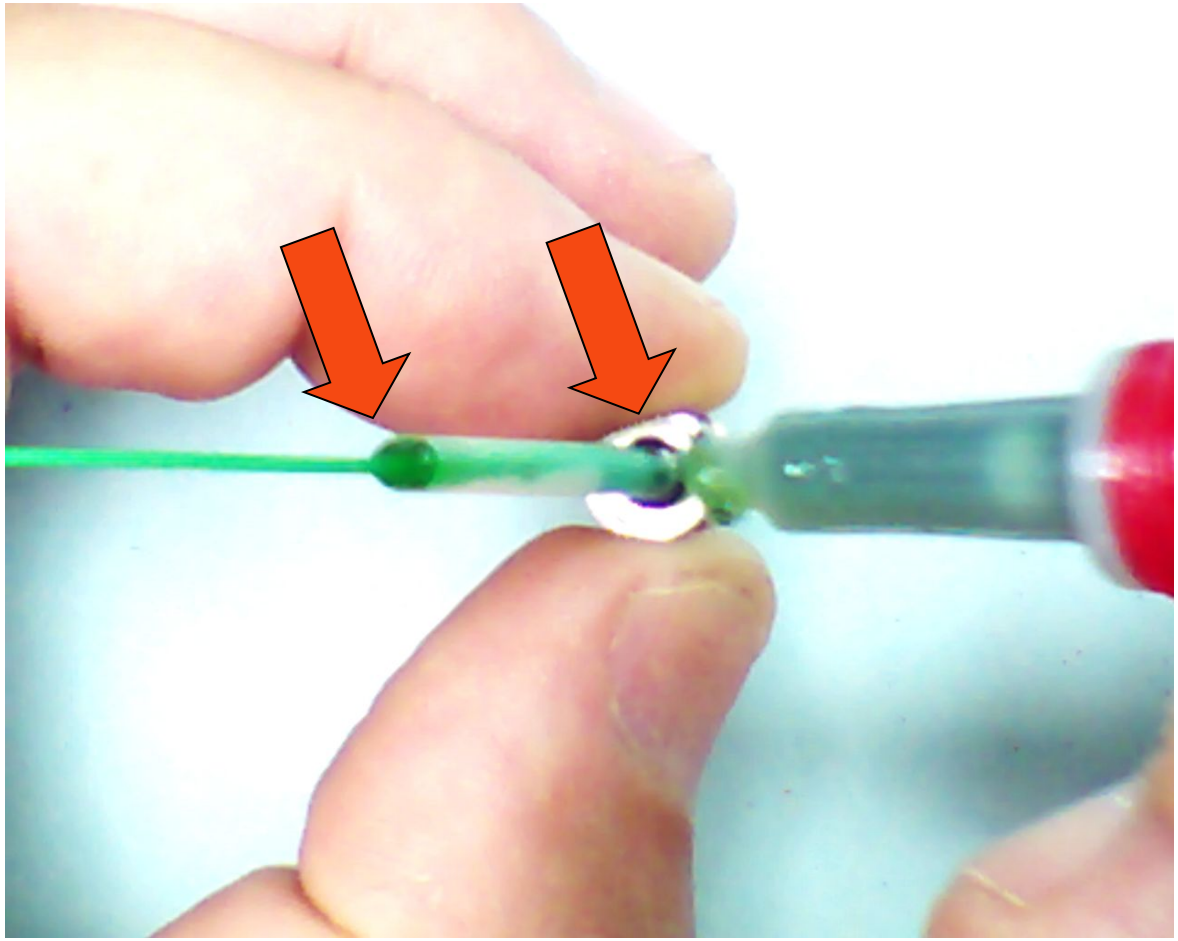
- Gently insert the fiber through the connector you will see it come out of the ferrule.

Push the plastic tube



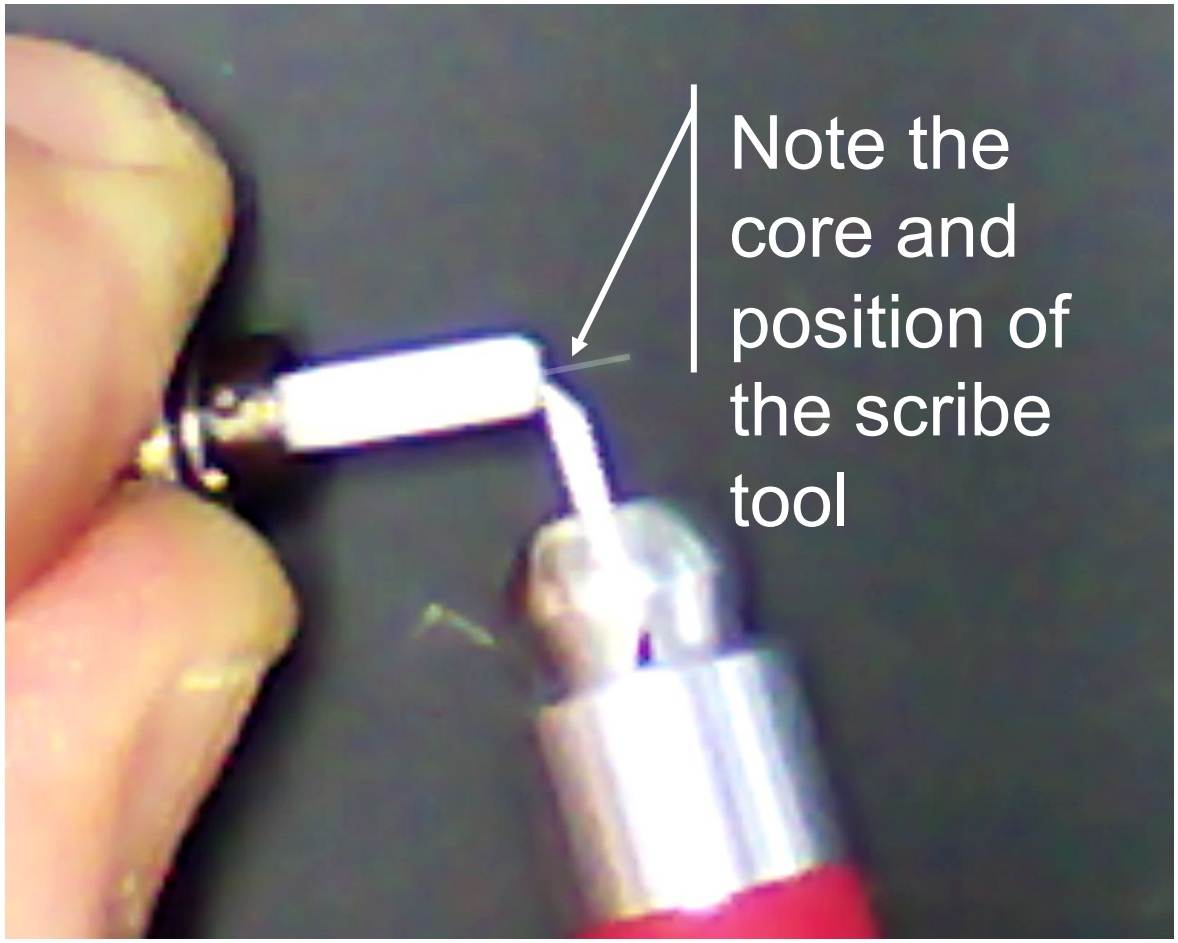
- Push the plastic tube in place, inside the connector and ferule.

Finish gluing



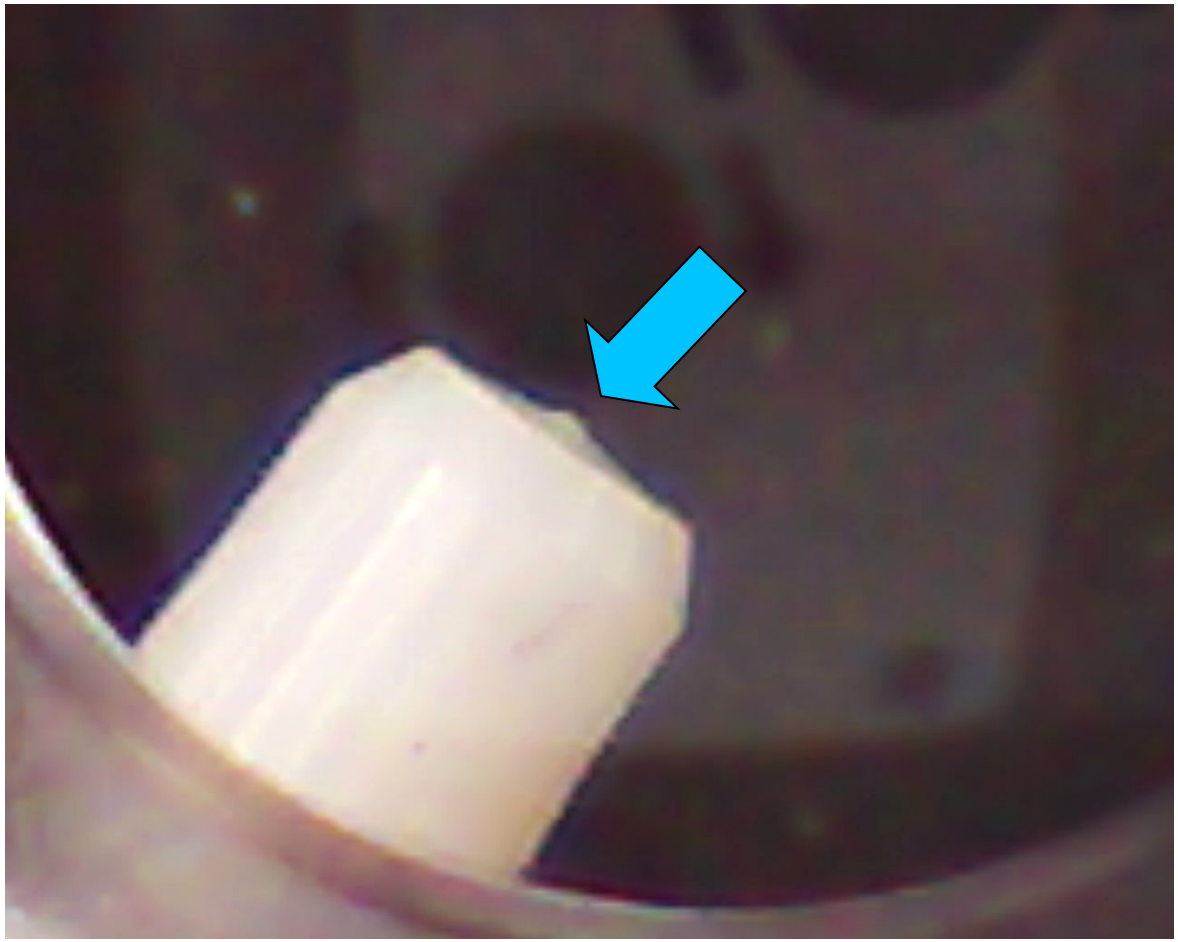
- Add the catalyst (white bottle) at top of plastic tube and at the connector where the fiber protrudes from the ferrule.

Scribe the excess fiber



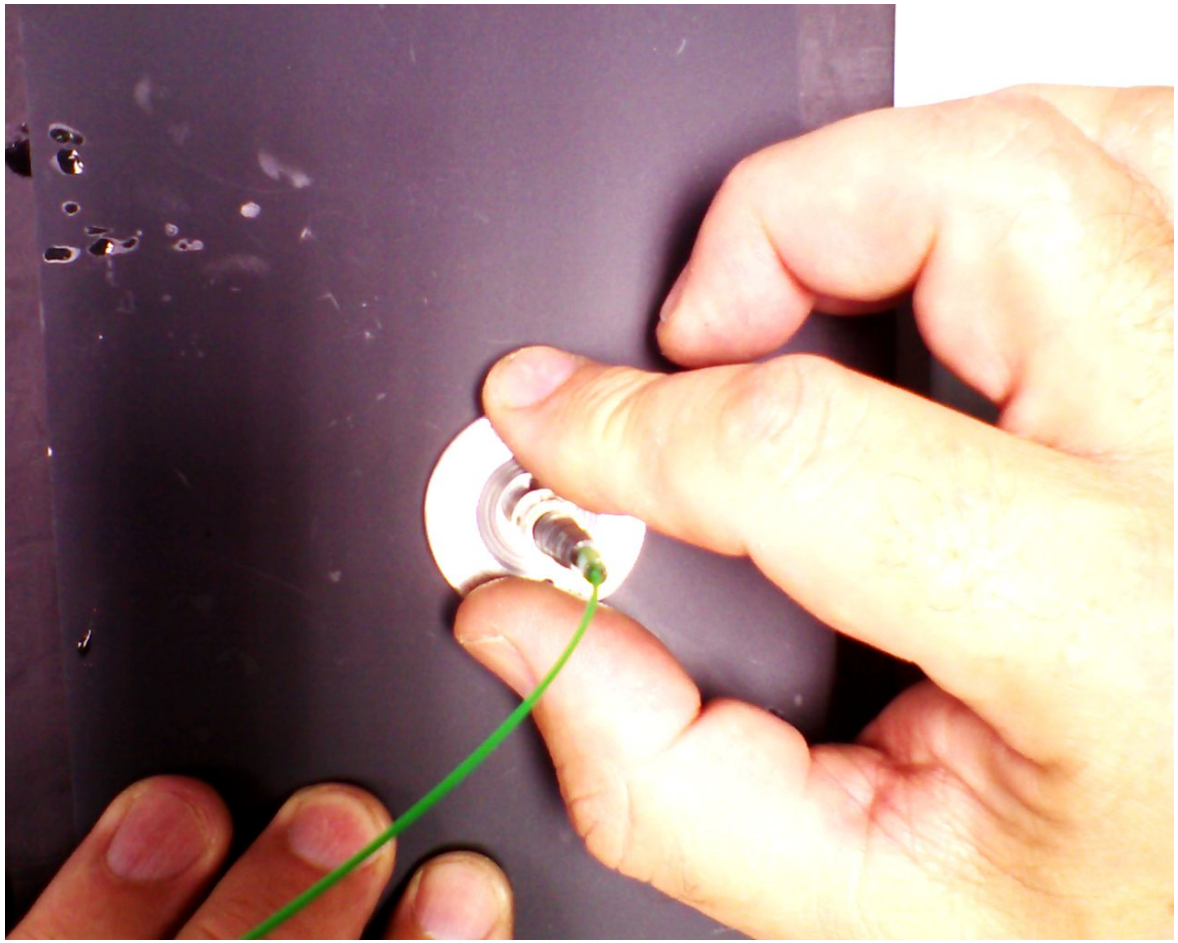
- Use the scribe tool to gently score around the fiber. After scoring pull the fiber straight up and dispose in the fiber trash can.

Note the stump



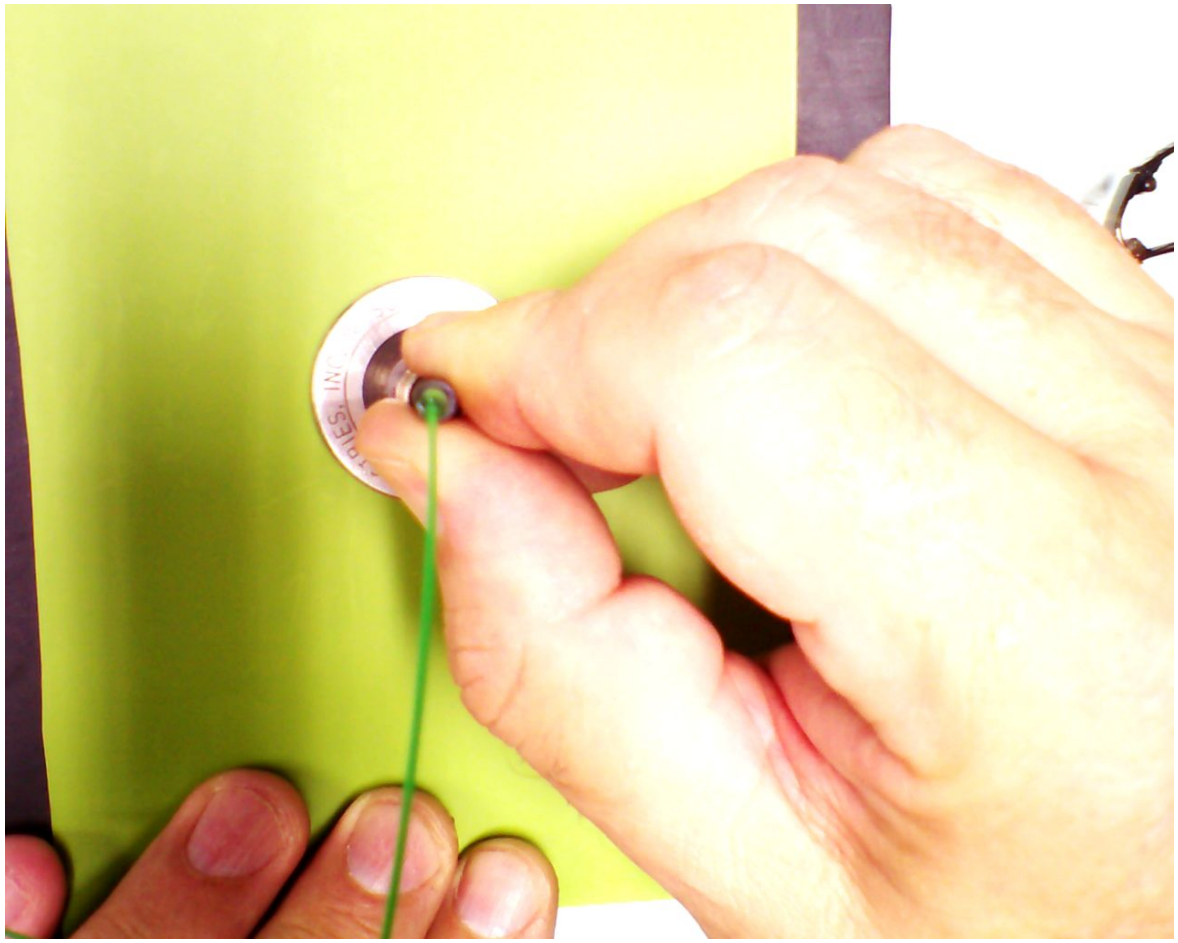
- With the magnifier you can clearly see the stump made by the glue and the core.

Polish on 5 micron



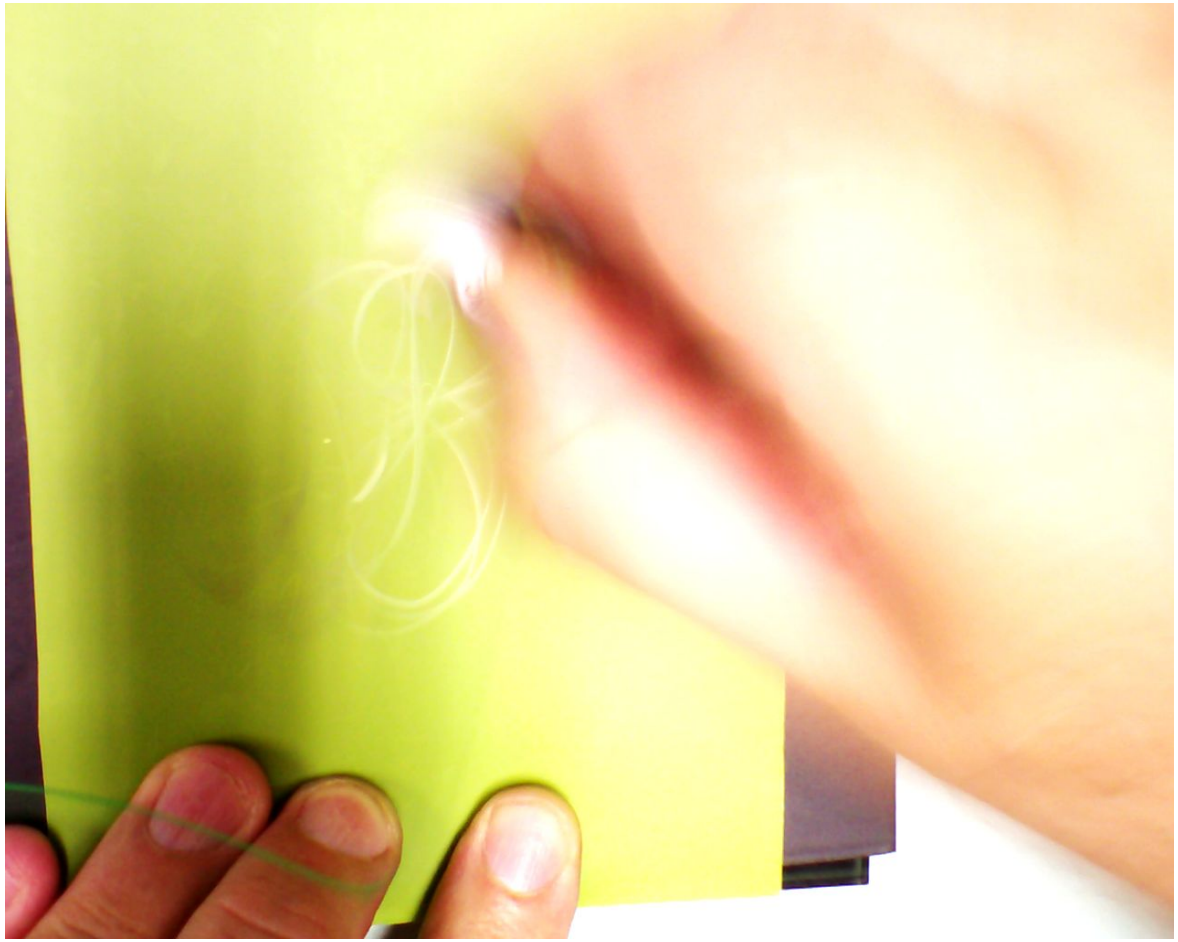
- Hold the puck only.
- Make 50 figure 8's on 5 micron (black) polishing film.
- Use the plate and pad as support.

Polish on 1 micron



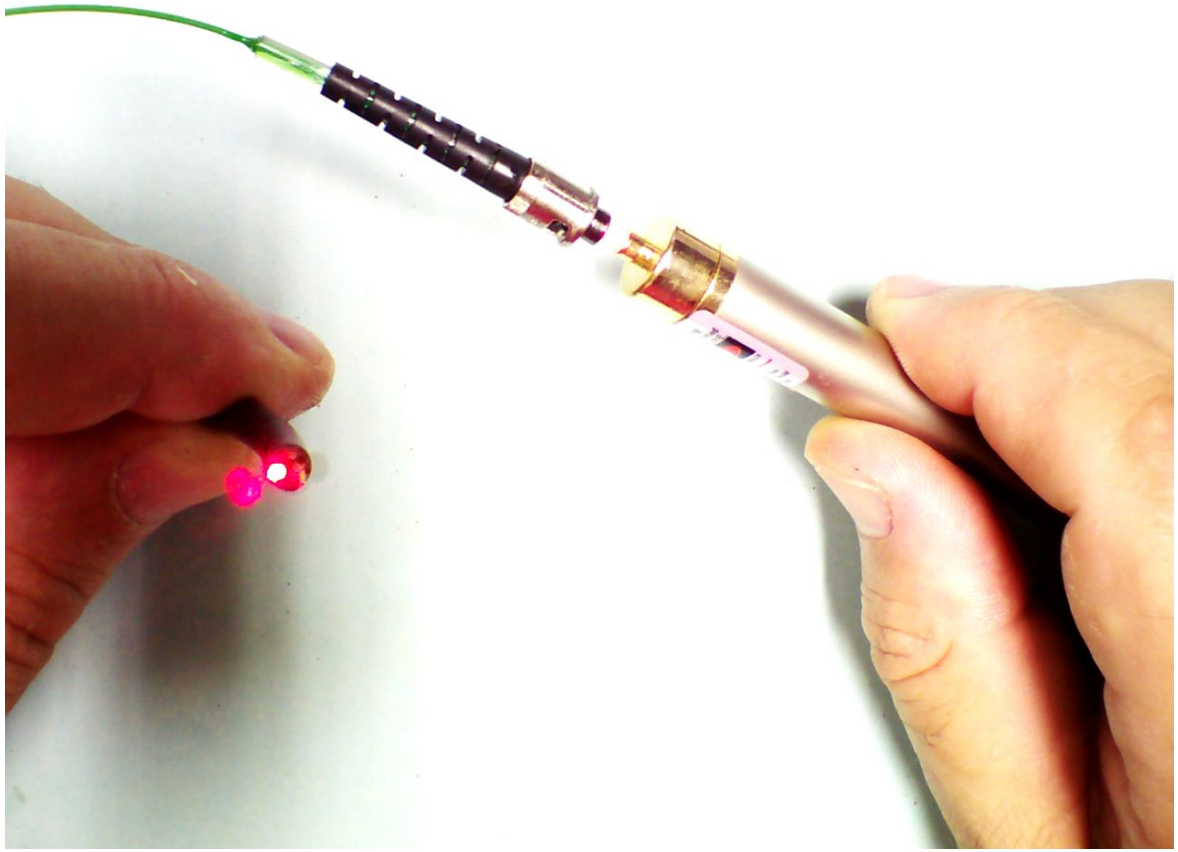
- Use the 1 micron (green) polishing film. Hold firmly on the connector and press down. Make 50 figures of 8. use plate and pad.

Note the figure 8's



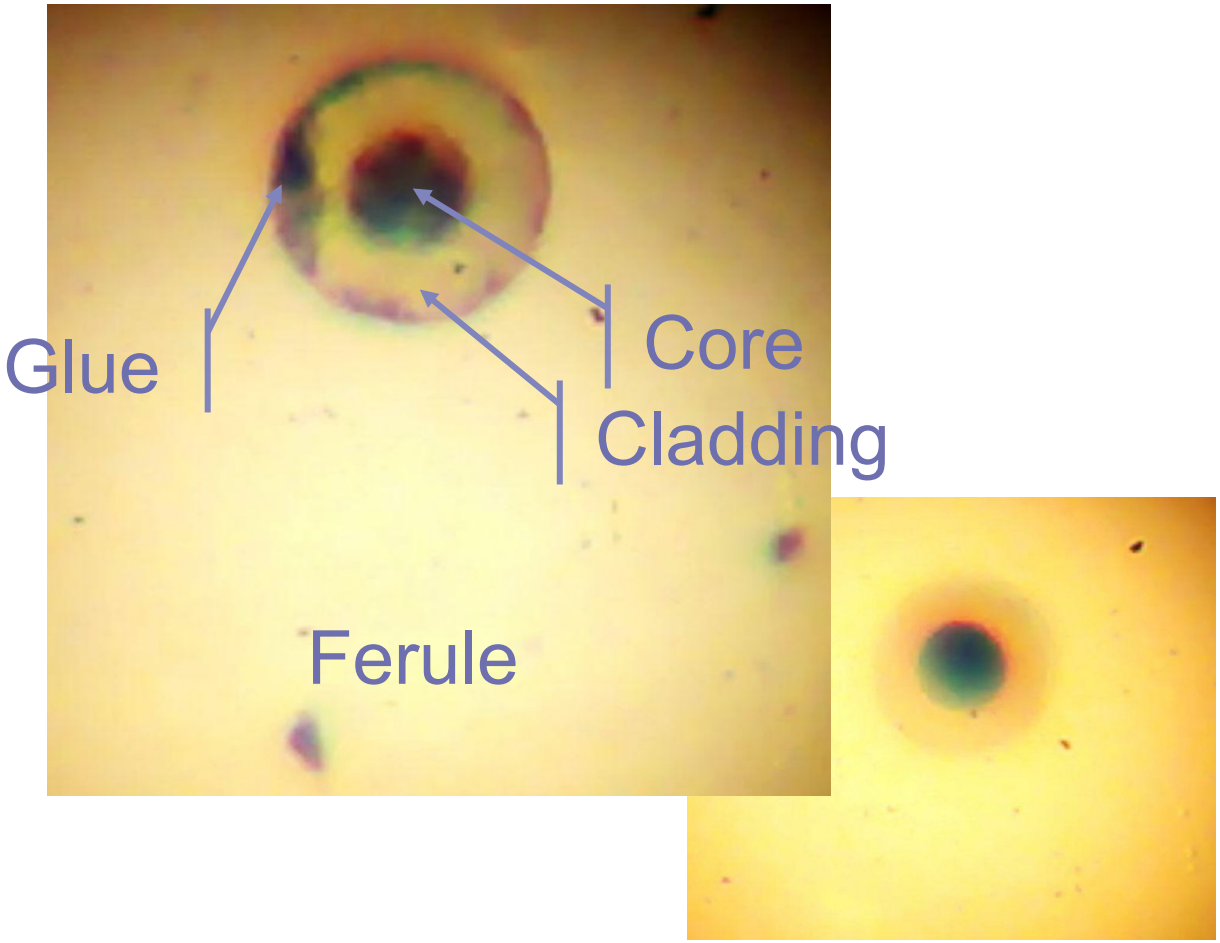
- During the process the polishing film shows marks in shape of 8.
- The film can be reused a couple of times.

Check your work



- Use the laser tool to verify that the light can pass through the fiber and connectors.
- Do not point the laser directly into the eye.

Check with the microscope



- Manually polished MM connector (left) and factory machine polish (right).
- Note the difference.

Thank You and Good Luck in Building your Network Plant!

UNIVERSITY OF OREGON

NSRC
Network Startup Resource Center