WARNINGS

A laser aperture is located on the back panel of ODH-4 as shown in Figure 2-2. In normal operation, the light emitted by ODH-4 is completely contained within an optical fiber. The user must ensure appropriate controls are in place to prevent unauthorized personnel breaking the continuity of the fiber, causing emission of Class 4 invisible laser radiation.

Always switch off Laser Enable Keyswitch, and remove the key, before disconnecting, or breaking continuity of, the fiber. Failure to do so could expose the user to hazard, and also damage the IU.

Do not operate ODH-4 without an optical fiber connected.

START-UP

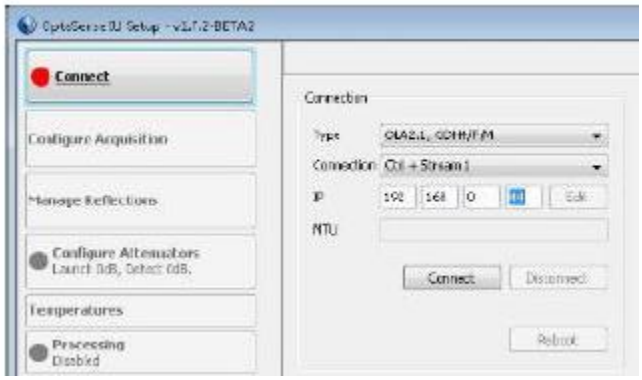
1. Connect the sense fiber, ethernet cable(s) and power

2. Turn on the **main power switch** on the rear panel
    - The "Power" LED on the front panel will momentarily illuminate RED → turn GREEN once internal power supplies have been stabilized.
    - The "Status" LED on the front panel will initially be orange (typ. <10 sec) → alternate red/green during boot (typ. <1 min, but sometimes up to 10 min)
      (→ remain RED → turn GREEN once pulse balancing is completed/canceled)

IU SET-UP

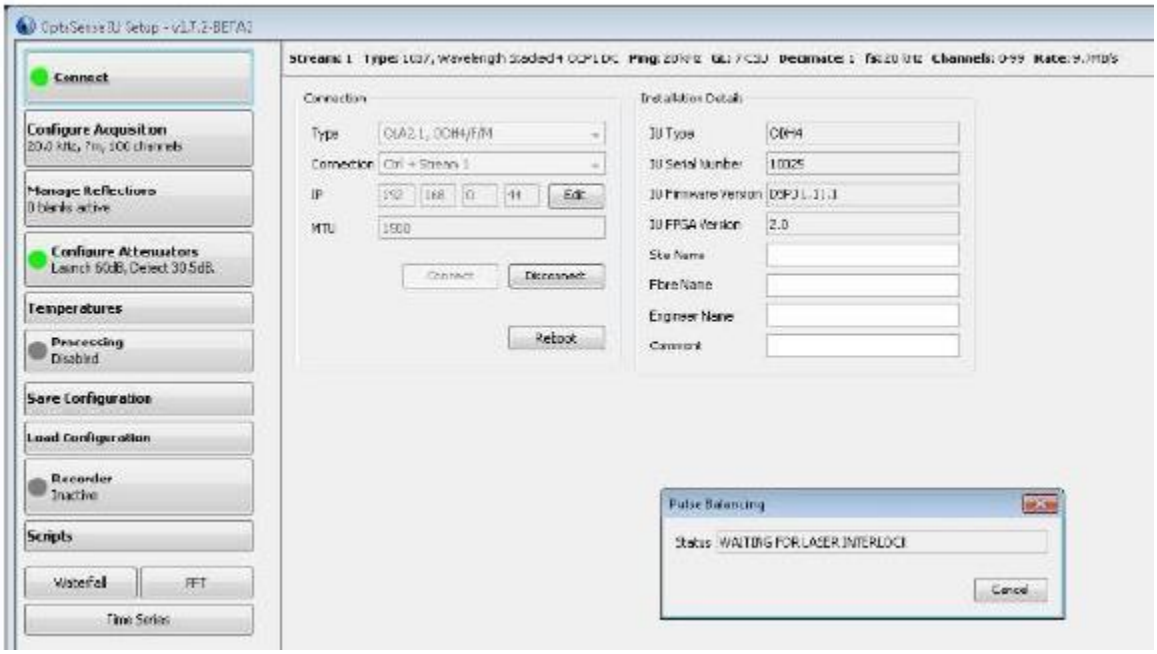
1. Open L.A 2.00 → Go to "Optical Setup"
    - On initial launch, the connection will show RED

2. On Connect tab, choose Connection: **Ctrl + Stream 1**



3. Click on "Connect" button → connect to the unit

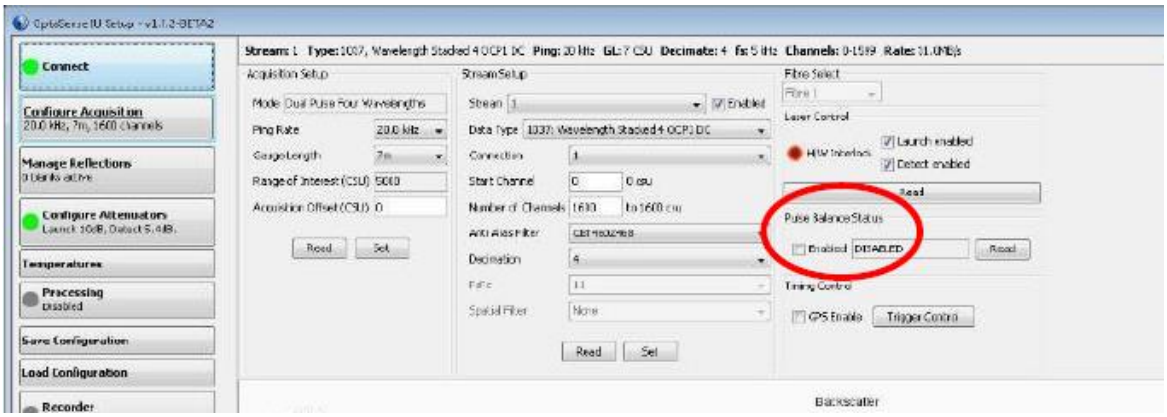
4. A Pulse Balancing dialogue box will appear that will initially say "Waiting for Laser Interlock"



    - Look at the value of launch attenuator in the Configure Attenuators panel

    - <u>If the value is at its maximum (= 60 dB)</u>
      → **just turn on BOTH laser key switches (vertical position)**
      → wait a few minutes for the laser to stabilize

- <u>If the value is NOT at its maximum</u>
  → click on "Cancel" button in the Pulse Balancing dialogue box
  → on the Configure Attenuators tab, set the launch attenuation to 60
  → on the Configure Acquisition tab, click on "Enable" button in the Pulse Balance Status section



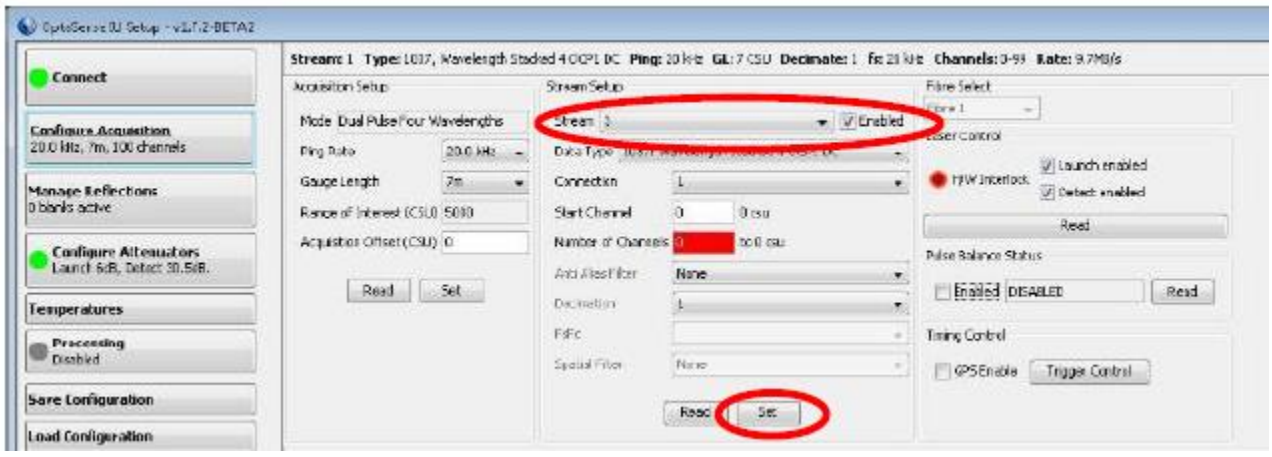
→ will bring back up the Pulse Balancing dialogue box

→ THEN turn on the laser key switches (vertical position)

→ wait a few minutes for the laser to stabilize

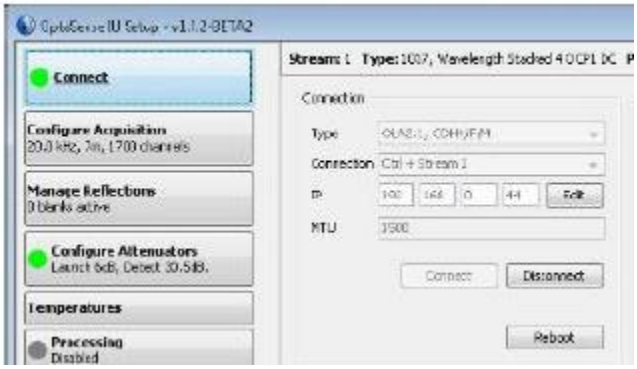
<u>Note</u>: after you make the initial connection, the system wants to pulse balance → equalize the amplitude of the pulse pairs → ensure the same optical power is transmitted on all four wavelengths → the four wavelengths are set for optimum operation

5. On Configure Acquisition tab, select **Stream 3** & **Data Type 1035**
   (→ and if required, click on the "Enable" button)
   → click on "Set" button



<u>Note</u>: We have initially connected to Stream 1, but we have to switch to **Stream 3** (which is used for setting up the attenuator levels)
-- In the ODH4, two streams of data (Stream 1 and Stream 3) are transmitted from the IU

6. On Connection tab, click on “Disconnect button”

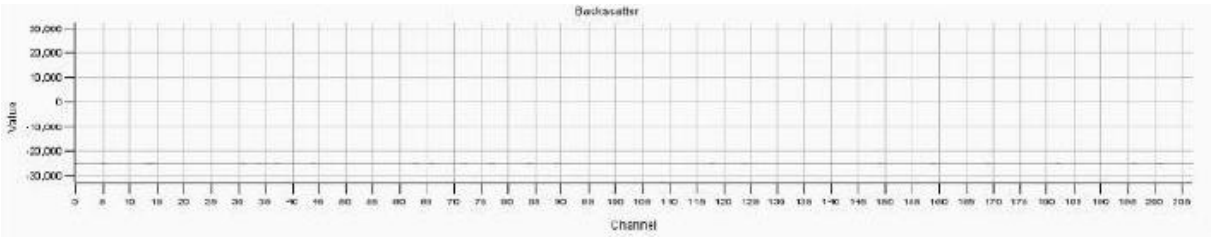


→ change the connection to **Ctrl + Stream 3**

→ click on “Connect” button

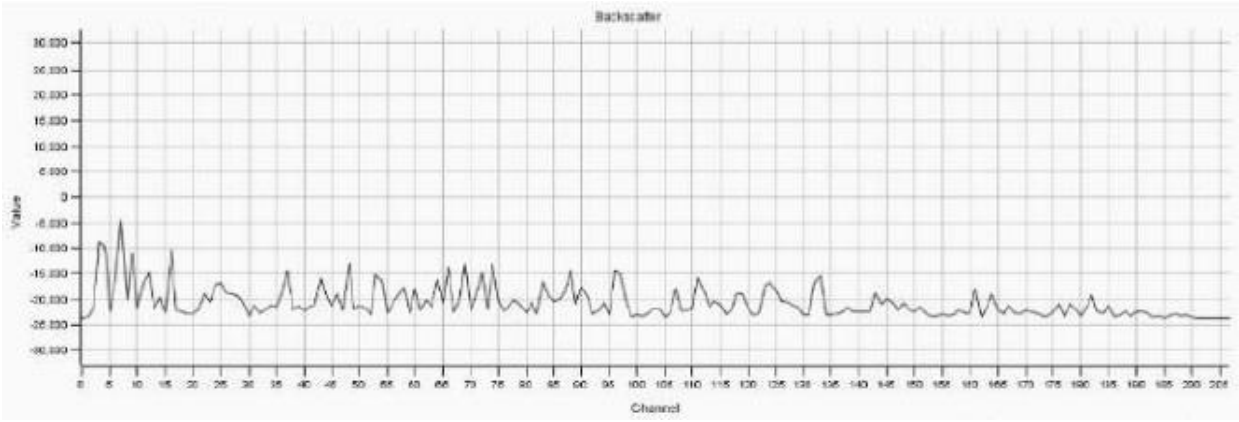
7. On Configure Acquisition tab, choose:
   - Data Type: **1035: Scope Data 4**
   - Ping rate, determined by $\boldsymbol{PR_{max}\ [kHz] = \frac{100}{length\ of\ fiber\ [km]}}$
     - E.g., if L = 1 km, choose 100 kHz
     - E.g., if L = 5 km, choose 100 / 5 = 20 kHz
     - Use the nearest ping rate from the drop down that is smaller than the calculated maximum
   - Gauge length: Usually, **2 m** is best
   - Number of Channels → should cover the whole fiber + slightly further
     - Initially set to 0 (and highlighted in RED to show it’s invalid)
     - Choose number of channels by using: $\approx 8\ m/channel$, $1\ CSU = 1.027\ m$
     - E.g., if 1km = 1000m of fiber, choose 1000m/8m = 125 channels + alpha
     - E.g., if 5km = 5000m of fiber, choose 5000m/8m = 625 channels + alpha (which should give roughly 5000/1.027 ~ 5000 CSUs)

<u>Note</u>: you should see THE END OF THE FIBER (last channel), after which there’s no optical signal. If your plot doesn’t end at 0, it means you have too few channels



8. On Configure Attenuators tab:
   ** there is just 1 launch attenuator but 4 separate detect attenuators (for each of the 4 wavelengths)
   ** the values left in by the pulse balancing routine can be used as a starting point
   ** adjust the detect attenuators ONE AT A TIME.
   ** always wait a few seconds between each click → enable the attenuator settings to update
   ** zoom in: left click on the trace and drag a box over the section of interest
   ** zoom out: right click

   1. Slowly try decreasing the detect attenuation value
      → initially, the whole level of the trace should slowly rise (but remain flat)
      → if there are persistent spikes in particular channels → there are reflections at those points
      → if you need to clean the fiber: TURN OFF THE LASERS and then clean the fiber
      ** the channel number of the spike should be used to calculate the distance along the fiber of the reflection
   2. Slowly decrease the detector attenuator until ~ 10
   3. Slowly decrease the launch attenuator → will gradually cause the backscatter level near the start of fiber to become higher
   4. (after fixing back reflections, if necessary) Slowly decrease the launch attenuator until ~ 5
   5. Should look something like this:



(again, the fiber end should be visible at the last channel, after which there is no optical signal)

Note:
-- Launch attenuator: adjusts amount of launched light → limits the light in a long fiber → ensures operations are within the linear regime
-- Detect attenuator: adjusts received light level → ensures it's not limiting or clipping at the detector

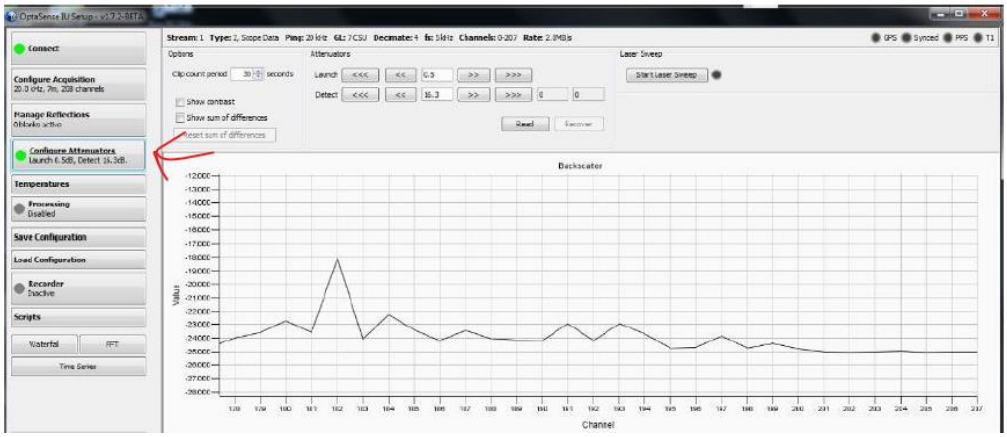
Setting the Launch attenuator:
Decrease its value one at a time until you start seeing nonlinear effects

1. Zoom in on the last ~50 channels
2. The pattern of the peaks should be relatively stable (if the fiber is in a quiet and temperature-stable environment) → makes it easier to set the attenuator

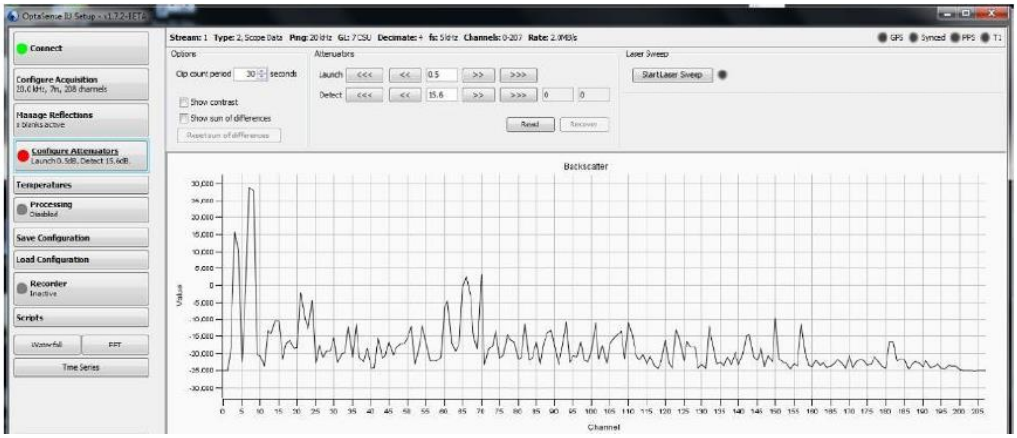
** we adjust the launch attenuator → maximize the amount of light being transmitted into the fiber *without* inducing any non-linear optical effects

** when operating the linear regime: decreasing the launch attenuator a little → shape of the peaks will remain the same but with bigger amplitudes throughout
** if you're starting to induce nonlinear effects: decreasing the launch attenuator → relative heights of the peaks change, and the general level does NOT become higher

IF at any stage, the button on the left of the Configure Attenuators tab goes RED (even intermittently), slowly increase the detect attenuator setting until it remains green:

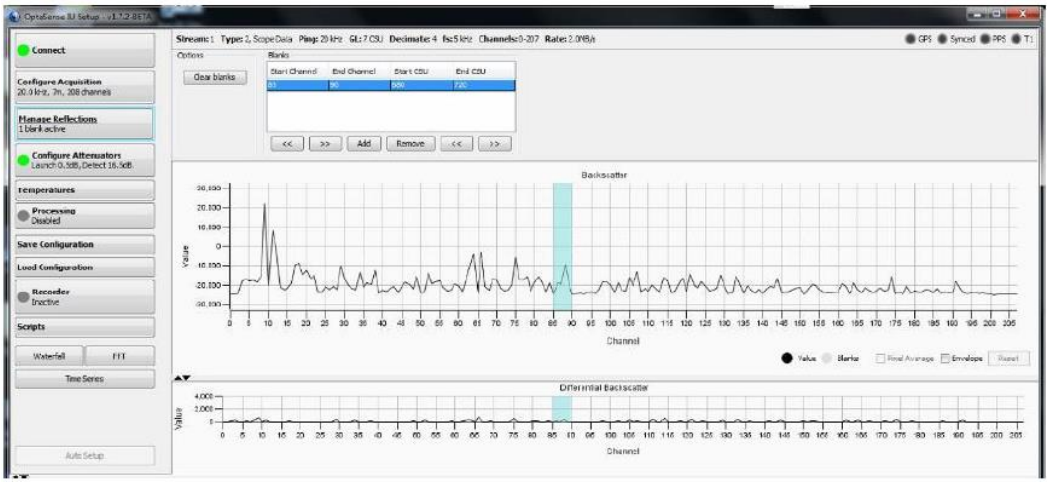


Setting the Detect attenuators:
Decrease one at a time until some spikes reach the top of the display and the button in the Configure Attenuator tab regularly turns red



Adding blanks → Managing reflections:

1. Go to Manage Reflections tab
2. Click on “Add” button
3. Type in the start and stop channels
4. Adjust the position of the blank → ensure the spike is actually removed



Note: quite a complicated situation because the same optical component is being used to block the light from all 4 lasers (although the pulses from the 4 lasers are transmitted at different times). → means the blank will cover different channels on different wavelengths! → need to carefully adjust the width of the blank → so that the reflection is blocked at each of the 4

When using ODH4 *without STU:*

Clean the fiber end connected to the pavement

(1) Lift the lid using pliers



(2) Carefully lift the cover and spray with a liberal amount of alcohol
(3) Dab carefully with a Kim wipe (don't move the wipe around to avoid scratching the surface)

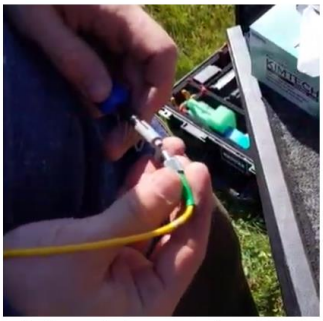

(4) Press down the cleaner a few times to clean properly

1

Connect the FC/APC to the fiber (pt. 1)



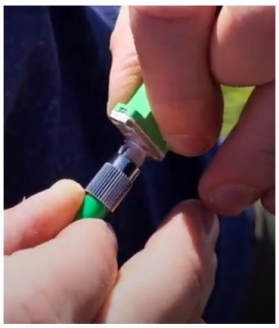
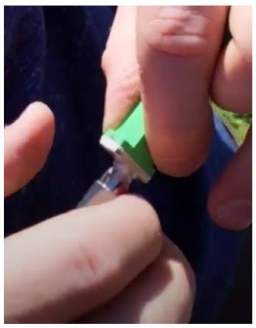

(1) Attach a coupler to the fiber

(2) Take out the FC/APC connector and clean it (no need to clean with alcohol if it's just been sitting in the lab)

Connect the FC/APC to the fiber (pt. 2)



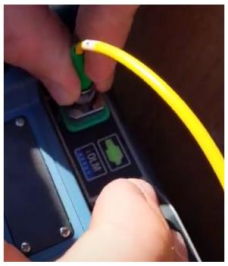

Screw them together

Peter's comment:
"2 kinds of hardware in the lab"
-- cheap hardware, purchased from "fis" of "four labs"
-- much more expensive hardware, purchased from "Diamond"

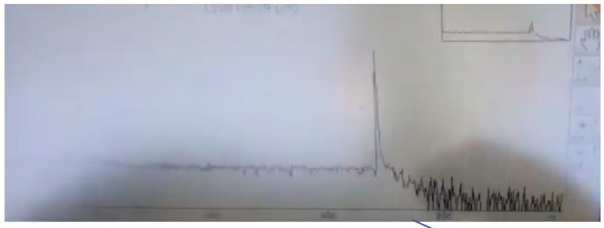
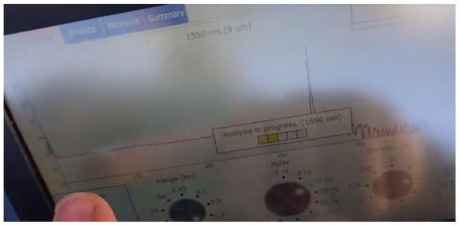
If you use something from Diamond, don't treat it as a disposable but keep good track of it

Connect the fiber to the EXFO OTDR






(1) Connect the fiber end to the OTDR
(2) Turn on the OTDR

(3) Set the parameters (Length, Pulse, Duration) and click the green rectangle button

For the RFS pavement: ***~ 1km length, 10 ns pulse rate, and 15 s duration*** *(but you can use another duration value too)*

← Shows that we have a good connection of around 700 m.
← But there's about 10 decibels at the front (it's probably a bit dirty)
--- better to have higher power
--- so, need to splice on a new connector

4

Splice the cable (pt. 1)

(1) Cut off the splice

Fun fact from Peter: This cable is REALLY good. This road has been driven on every day by the garbage trucks that serve the University of California. (This building used to be for testing airplane cockpits and landing gear. Now, it's used for storing garbage trucks.) So it's a cool proof-of-concept: the fiber can withstand being driven on everyday by all these garbage trucks…

(2) Length of razor blade is made specific for the coating. Take ~ 2 cm → squeeze → turn fully several times to cut through (DON'T EVER ROTATE WITH THE RAZOR BLADE; JUST CUT)

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