LaseOptics Corporation

Changing the technology, one fiber at a time…

20 Years Anniversary

Over 20 years of service to the Photonics Industry

LaseOptics: Laser Applications in Science & Engineering with Fiber Optics

MADE IN THE USA WITH PRIDE

Lensed & Tapered Fibers

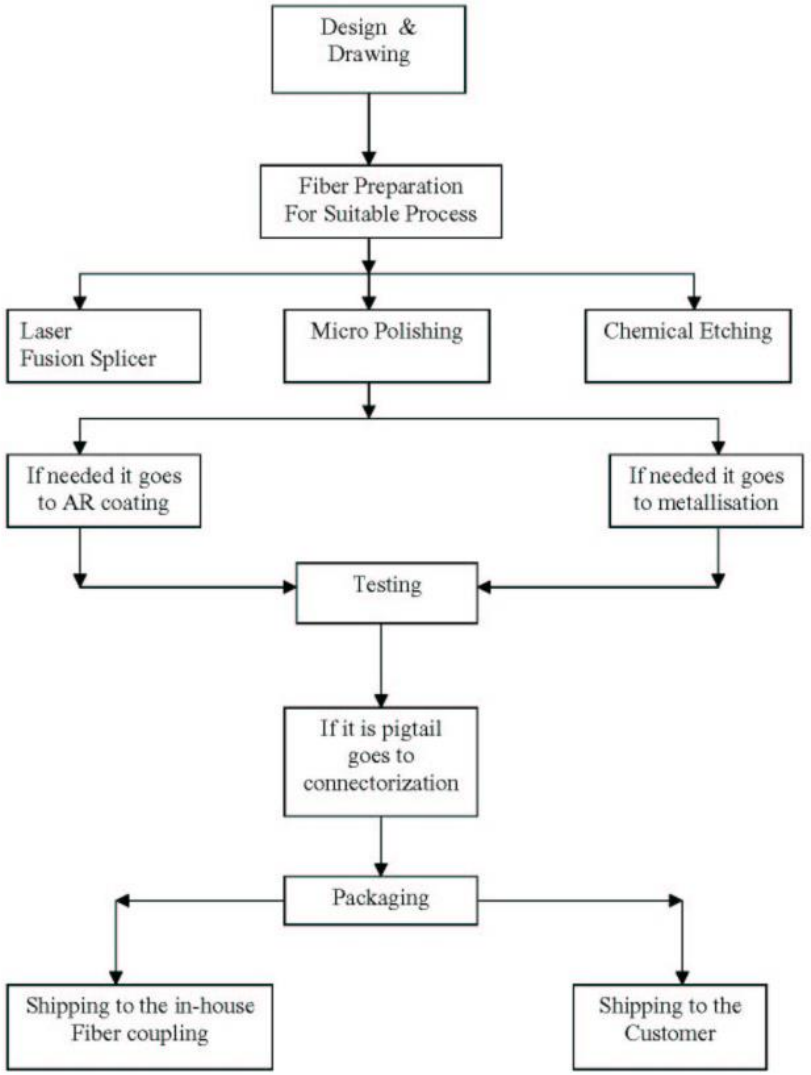
Production Capabilities

Papers Published using by Our Lensed Fibers

Presentation

We make Custom Lensed Fibers Assemblies

LaseOptics Lensed Fibers- Flow Chart



Types of Fibers:

Corning, Nufern, and Fiber Core Fibers. Custom Fiber

Single Mode: SMF-28, 405-HP; 460-HP; 630-HP; 780-HP, 980-HP, 1060-HP; & SM 2000

Multi Mode: GI 50/125; 62.5/125; SI 105/125; 200/240; 300/330; 400/440/; 600/630

Polarization Maintaining (PM) Fibers: PM-1550, PM-980; PM780-HP; PM630-HP; PM405-HP

Plastic Optical Fibers:

LaseOptics Lensed Fibers Used by Different Institutes and Scientists and Engineers in Worldwide and Published Papers.

Paper-LaseOptics-Lensed-Fiber-Used-Soton-UK-Highlighted-3P.pdf
https://eprints.soton.ac.uk/363177/1/6120.pdf (3.1-Line 4)

Paper-LaseOptics-Lensed-Fiber-Used-CalTech-Paper-Thesis-Highlighted-149P.pdf
https://thesis.library.caltech.edu/10087/57/20170529_KRF_Thesis_Ch7.pdf (7.3.2; 7.4 Fig Line 2)

Paper-LaseOptics-Lensed-Fiber-Used-By-Masdar-Institute-2016-Highlighted-14P-15P.pdf
https://opg.optica.org/oe/fulltext.cfm?uri=oe-24-11-11611&id=340803 (4.3. Line 4)

Paper-LaseOptics-Lensed-Fiber-Used-By-NIH-Goverment-2020-Highlighted-14P.pdf
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7532020/

Paper-LaseOptics-Lensed-Fiber-Used-By-OSTI-Goverment-2019-Highlighted-7P.pdf

Paper-Thesis-LaseOptics-Lensed-Fiber-Used-By-MiddleEast-Uni-Tech-2019-30P-77P.pdf

Paper-LaseOptics-Lens-fio-2016-jth2a-63-HighLighted.pdf

Paper-LaseOptics-MM-Conical-Lensed-Fiber-Used-By-B-PhoT-2018.pdf

LaseOptics Lensed Fibers Used by Different Institutes and Scientists and Engineers in Worldwide and Published Papers.

DESIGN AND DEVELOPMENT OF FIBER OPTIC MEMS MICROPHONE MEASUREMENT SYSTEM
https://etd.lib.metu.edu.tr/upload/12623979/index.pdf
Optical Fiber Sensors for Biomedical Applications (yumpu.com)

In-Hand Object Recognition with Innervated Fiber Optic Spectroscopy for Soft Grippers (nsf.gov)
https://par.nsf.gov/servlets/purl/10374030.

Down-scaling grating couplers and waveguides in single-crystal diamond for VIS-UV operation
https://iopscience.iop.org/article/10.1088/2515-7647/aaea7d/pdf

Bragg-grating-stabilised external cavity lasers in optical fiber and integrated planar silica-on-silicon circuits
https://eprints.soton.ac.uk/363177/1/6120.pdf

A microfluidic flow analyzer with integrated lensed optical fibers
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7532020/

MICROANGELO SCULPTING: WAVEGUIDE FABRICATION
https://thesis.library.caltech.edu/10087/57/20170529_KRF_Thesis_Ch7.pdf

LaseOptics Lensed Fibers Used by Different Institutes and Scientists and Engineers in Worldwide and Published Papers.

Fabrication of a phase photon sieve on an optical fiber tip by focused ion beam nanomachining for improved fiber to silicon photonics waveguide light coupling
(PDF) Fabrication of a phase photon sieve on an optical fiber tip by focused ion beam nanomachining for improved fiber to silicon photonics waveguide light coupling (researchgate.net)

Fiber-based interferometer for optical field reconstruction
https://www.osti.gov/servlets/purl/1765530

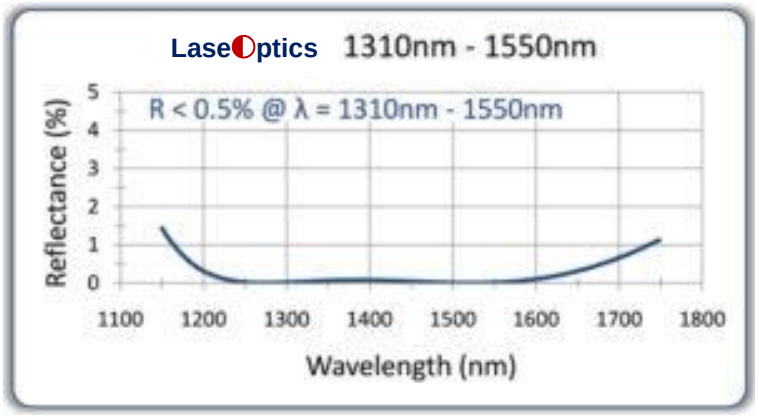
https://books.google.com/books?id=ZjhGDgAAQBAJ&pg=PA194&lpg=PA194&dq=LaseOptics+lensed+fibers&source=bl&ots=KZ0kWF04lR&sig=ACfU3U2Ix_Mf-wZOov_9zIBHMeeHxmyZ9A&hl=en&sa=X&ved=2ahUKEwjBypD0m4eFAxVYFFkFHV-xBdI4MhDoAXoECAUQAw#v=onepage&q=LaseOptics%20lensed%20fibers&f=false

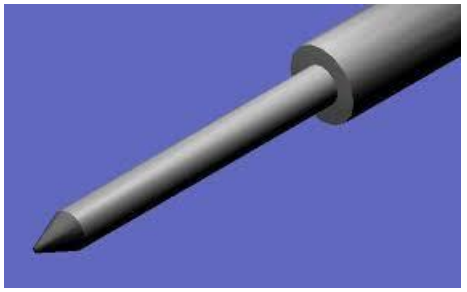
Micro-hyperboloid lensed fibers for efficient coupling from laser chips
https://opg.optica.org/oe/fulltext.cfm?uri=oe-25-20-24480&id=373719

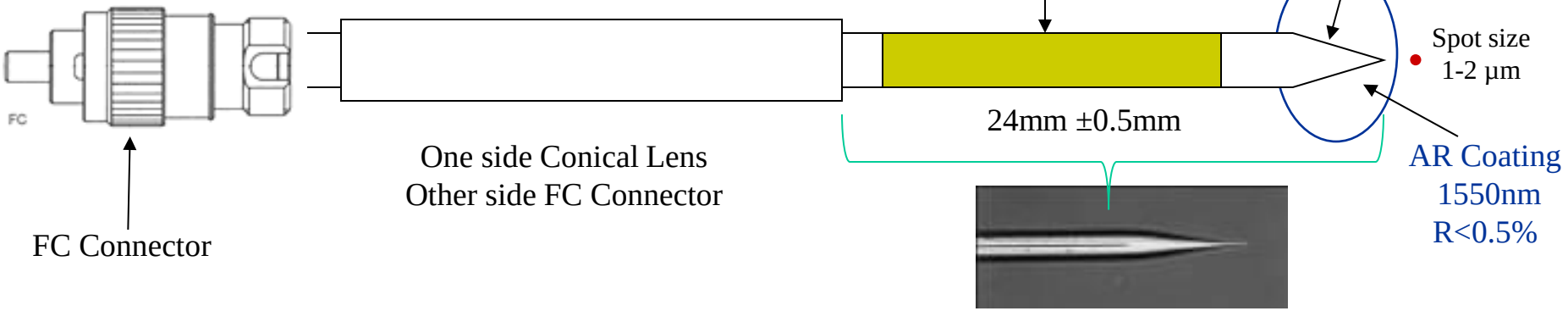
Evaluation of lensed fibers used in photodynamic therapy (PDT)
https://www.sciencedirect.com/science/article/abs/pii/S1572100020302787

POSSIBLE LENSING SCHEMES FOR FIBER-OPTIC COUPLING IMPROVEMENT
8Vol96No9.pdf (jatit.org)

Conical Lensed Fibers SMF-28 Fiber with Metallization & 1550nm AR Coating

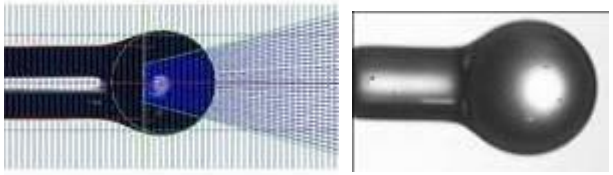






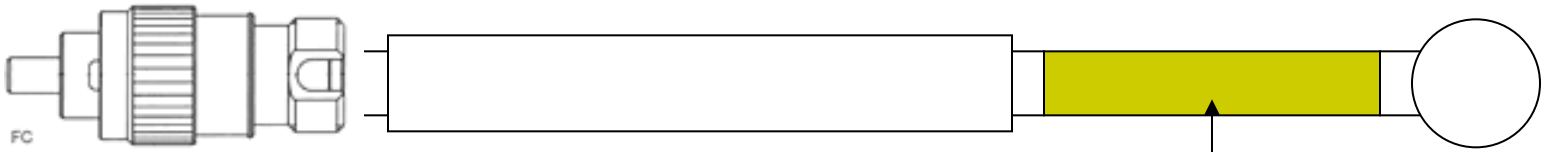
Option 1: We can make lens on bare fiber like 9/125/250 fiber without connector
Option 2: We can make 9/125/900μm tight buffer without connector
Option 3: We can make above any options with any connector FC/PC or FC/APC

Ball Lensed Fibers SMF-28 with 1310nm AR coating and Metallization



One side Ball Lens
Other side FC Connector

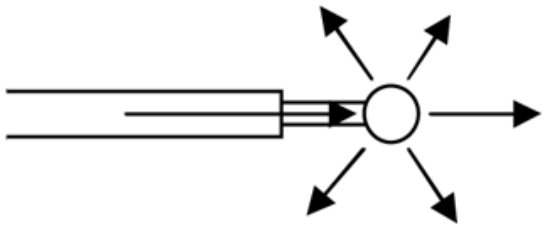
Ball Lens 300 um

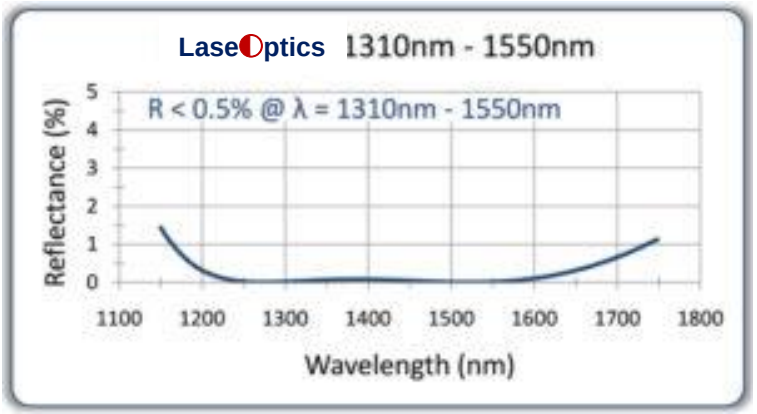


AR Coating
1310 nm
R<0.5%

FC/PC or FC/APC
Connector

Metallization Thickness 1.2~1.3μm;
Length 10mm; Ni: 1μm + Au: 0.25~0.3μm

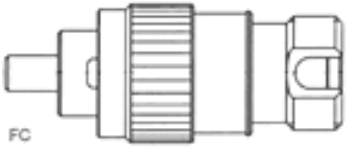




Ball & Conical Lensed Fibers of 1060-XP with AR coating and Metallization

One side Ball Lens
Other side FC Connector

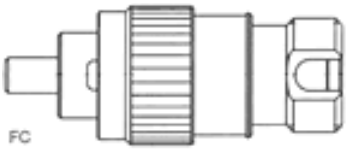
Ball Lens 300 um



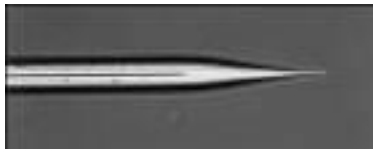
Metallization Thickness 1.2~1.3μm;
Length 10mm; Ni: 1μm + Au: 0.25~0.3μm

AR Coating
1060nm
R<0.5%

FC/PC or FC/APC
Connector

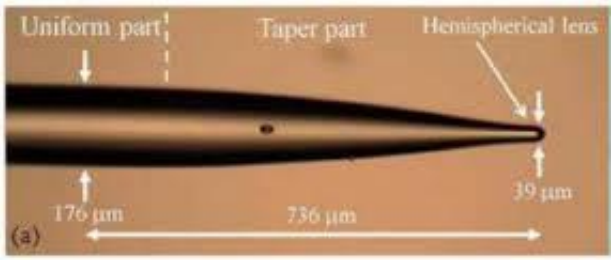


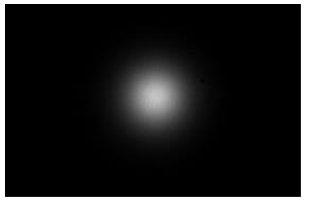
One side Conical Lens
Other side FC Connector



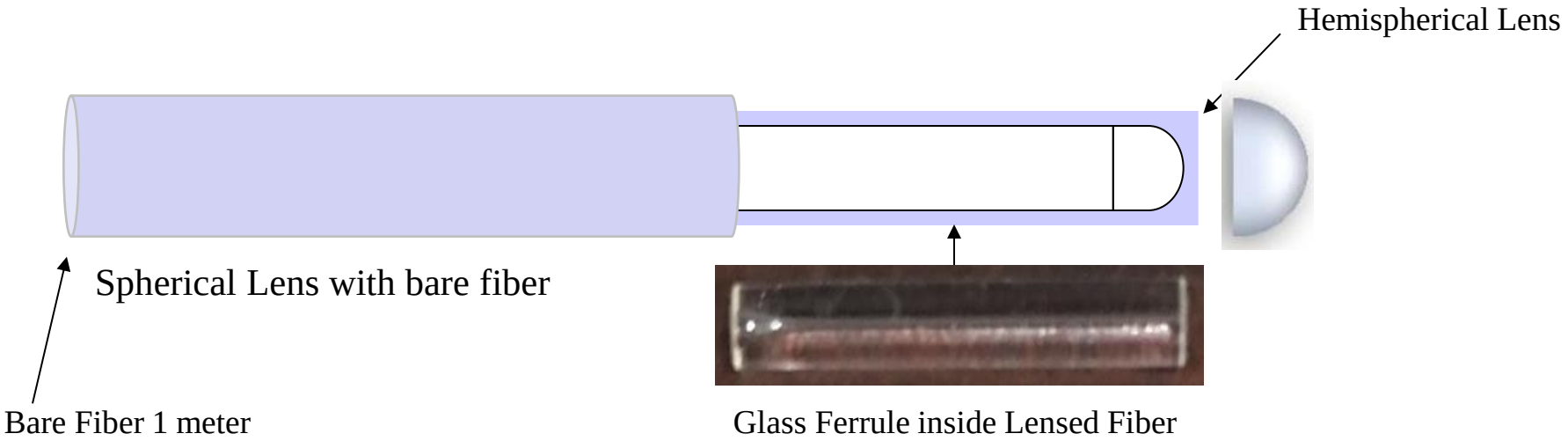
Spot size
2-3μm

Conical Lens



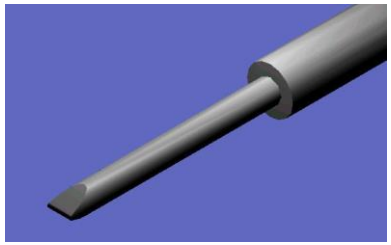


Spherical Lensed Fibers with Glass Ferrule of 1.8mm OD & 13mm Long

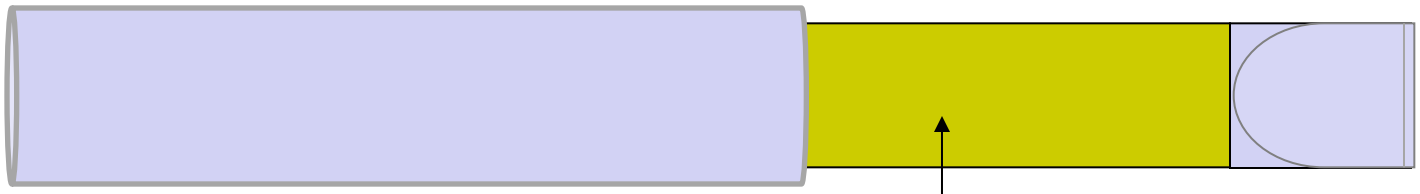


Wedged/Chisel (Screwdriver)Lensed Fibers with Metallization

Wedged/Chisel (Screwdriver) Lensed Fiber
(Bare Fiber) SMF-28: 9/125/250

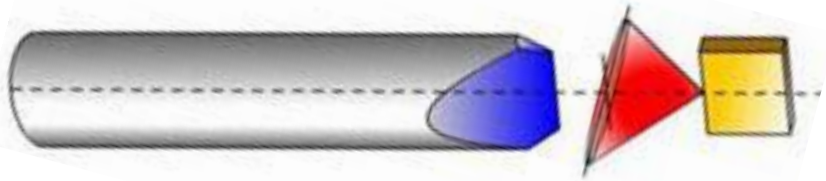


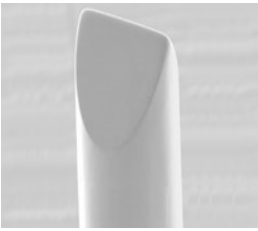
Lens Tip
thickness 2µm

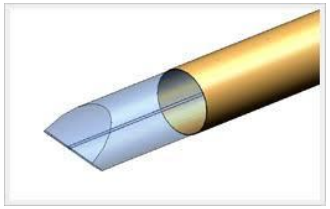


Bare Fiber
1 meter length

Metallization: Ni: 2~3 µm +Au: 0.1~0.2 µm
7mm length

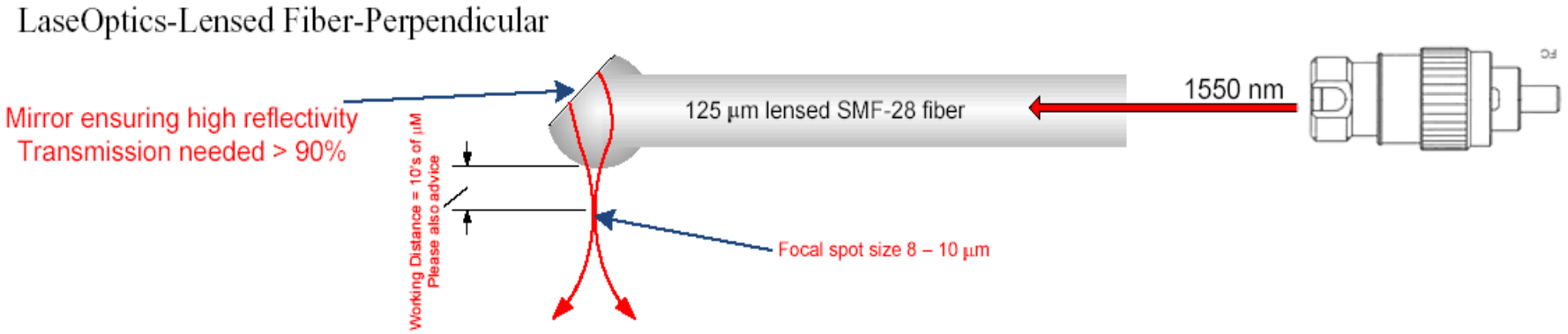


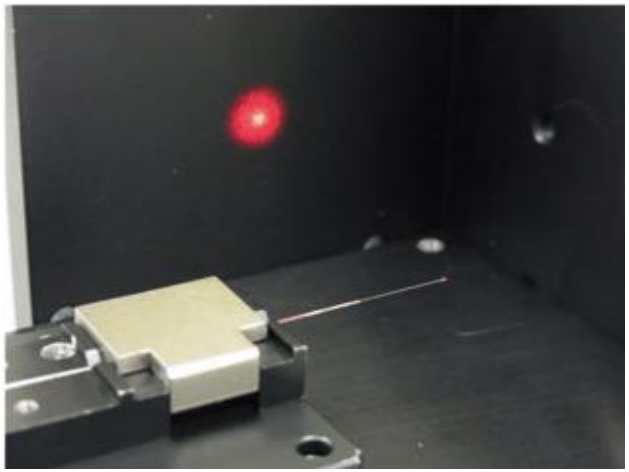




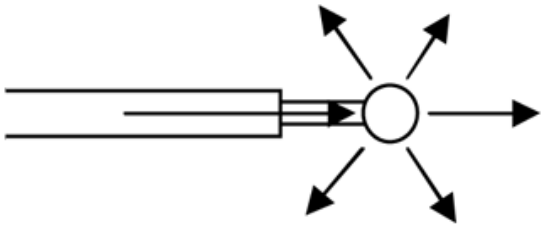
Perpendicular Lensed Fibers

Buffalo Section





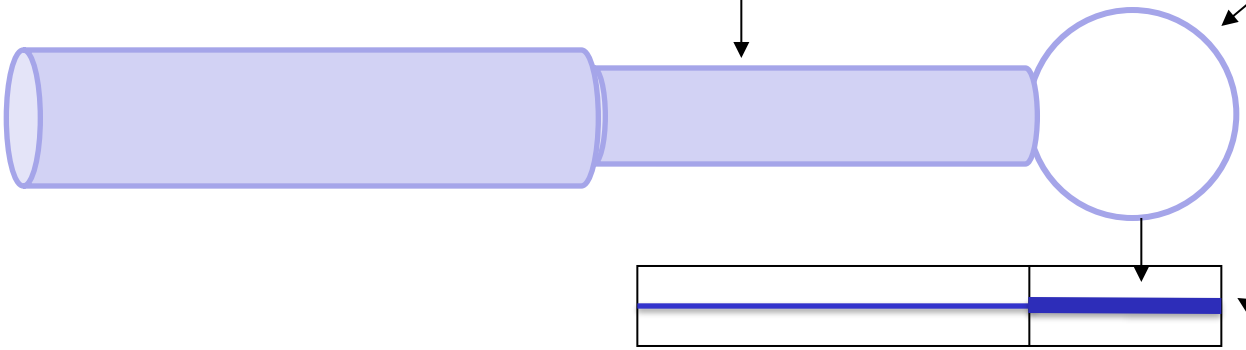
SMF-28 fiber with GIF Fiber tip with Ball Lens for Long Working Distance



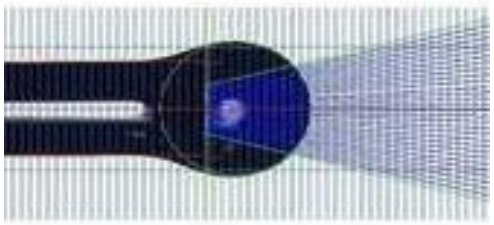
Gradient Index Fiber (GIF)
140µm fiber for Long
working distance

SMF-28 fiber

Lensed Fiber (Bare Fiber)



Gradient Index Fiber (GIF)



800nm 2x2 couple with One Terminal Lensed fiber with Ferrule

SS Ferrule OD 800µm
20mm long

FC/PC

800nm Fiber

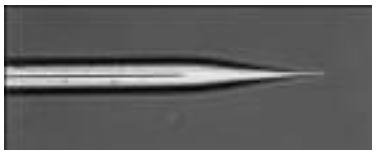
Lens 1mm out
of the ferrule

FC/PC

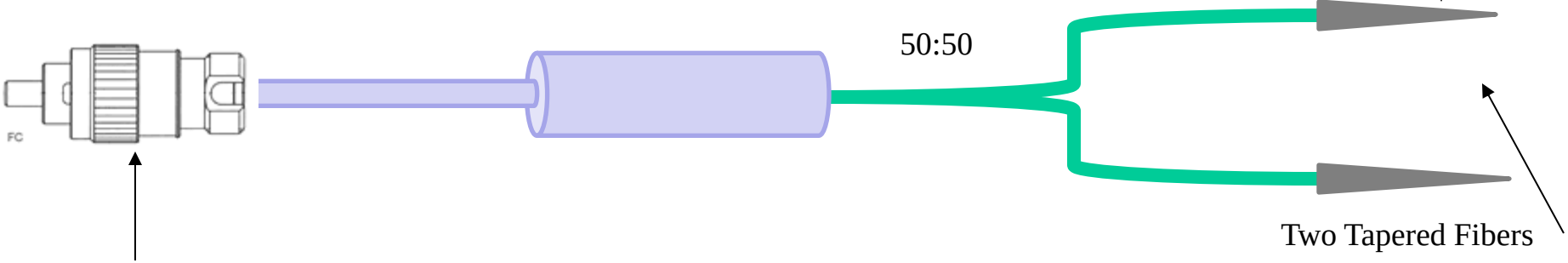
SMA or
FC/PC

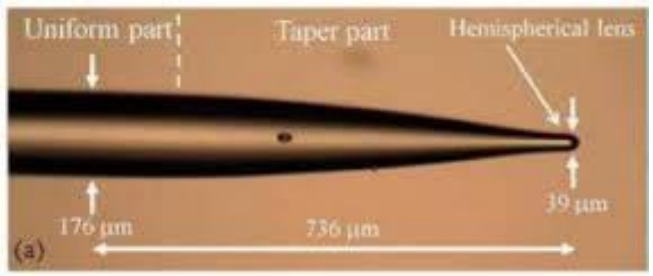
SMF-28 Fiber ½ meter

Single Mode Lensed Fiber Coupler (1 x 2) FC/PC

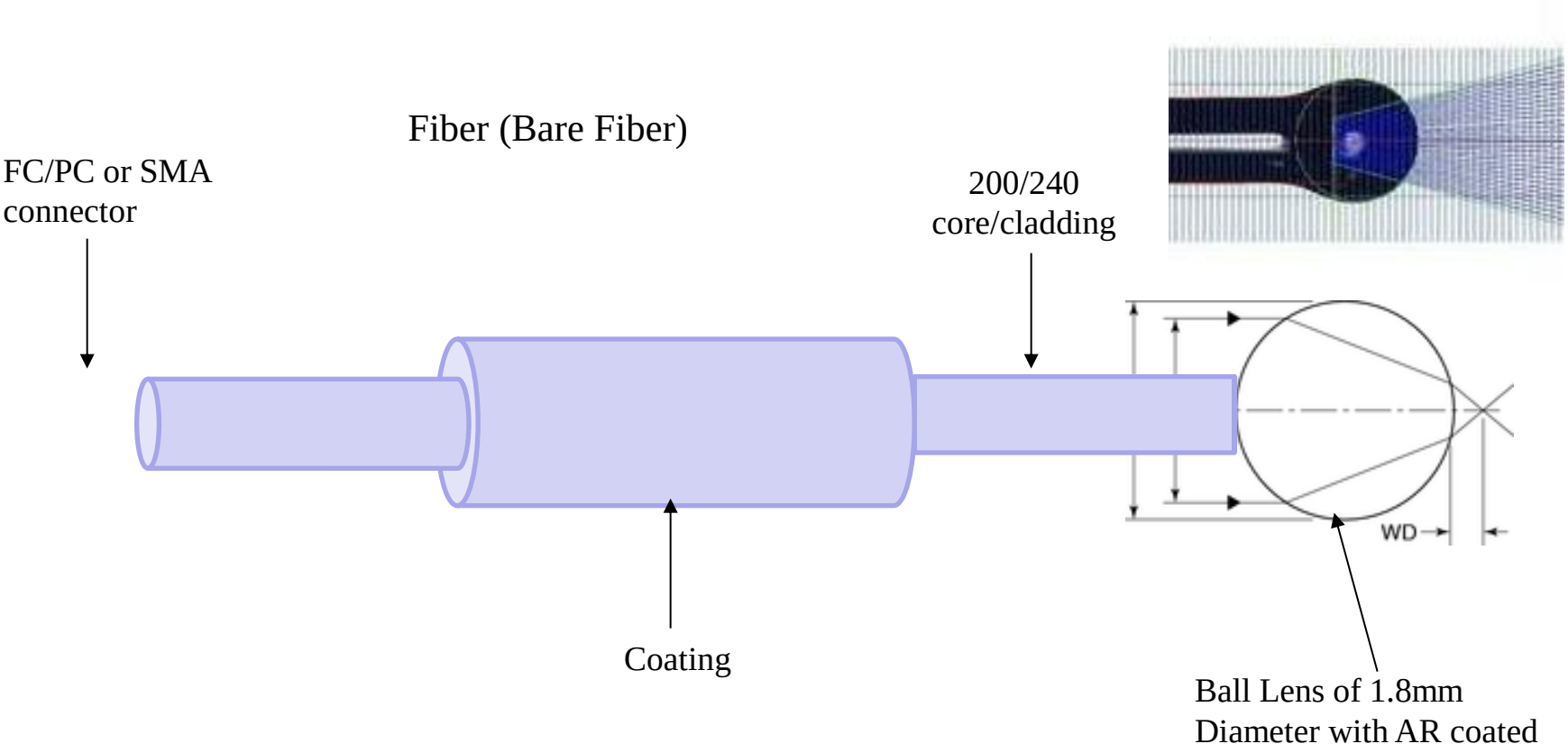


If you want, we can put on Silicon V-Grooves Chip 2CH/ MTP Connector

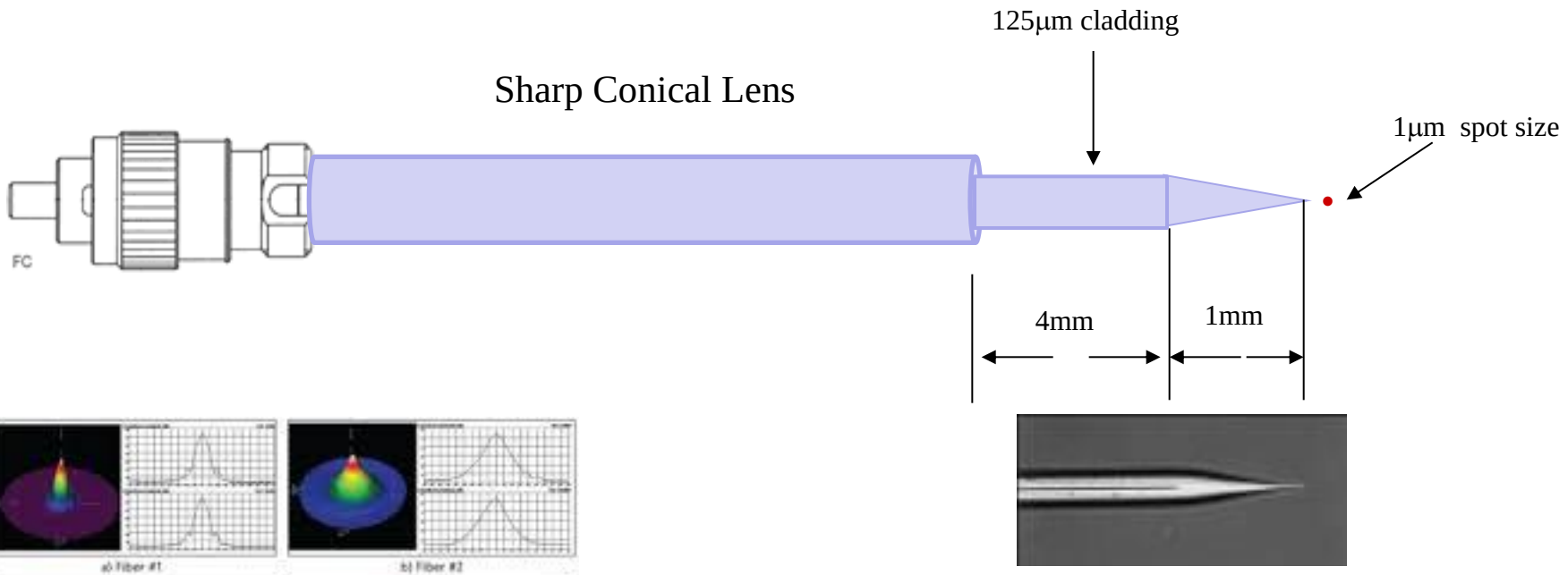


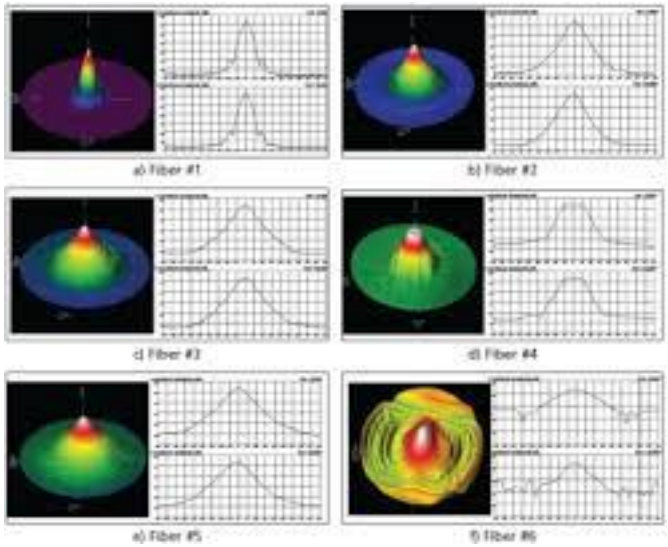


LaseOptics Multi Mode fiber of 200 core one end with 1.8mm Ball Lens on other side plain cleaved or connector



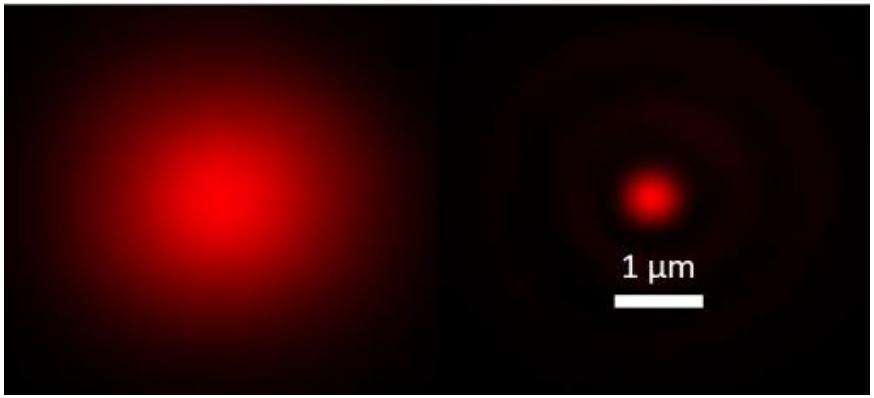
SMF-28 Fiber with Conical Lensed Fibers Spot size control with FC Connector





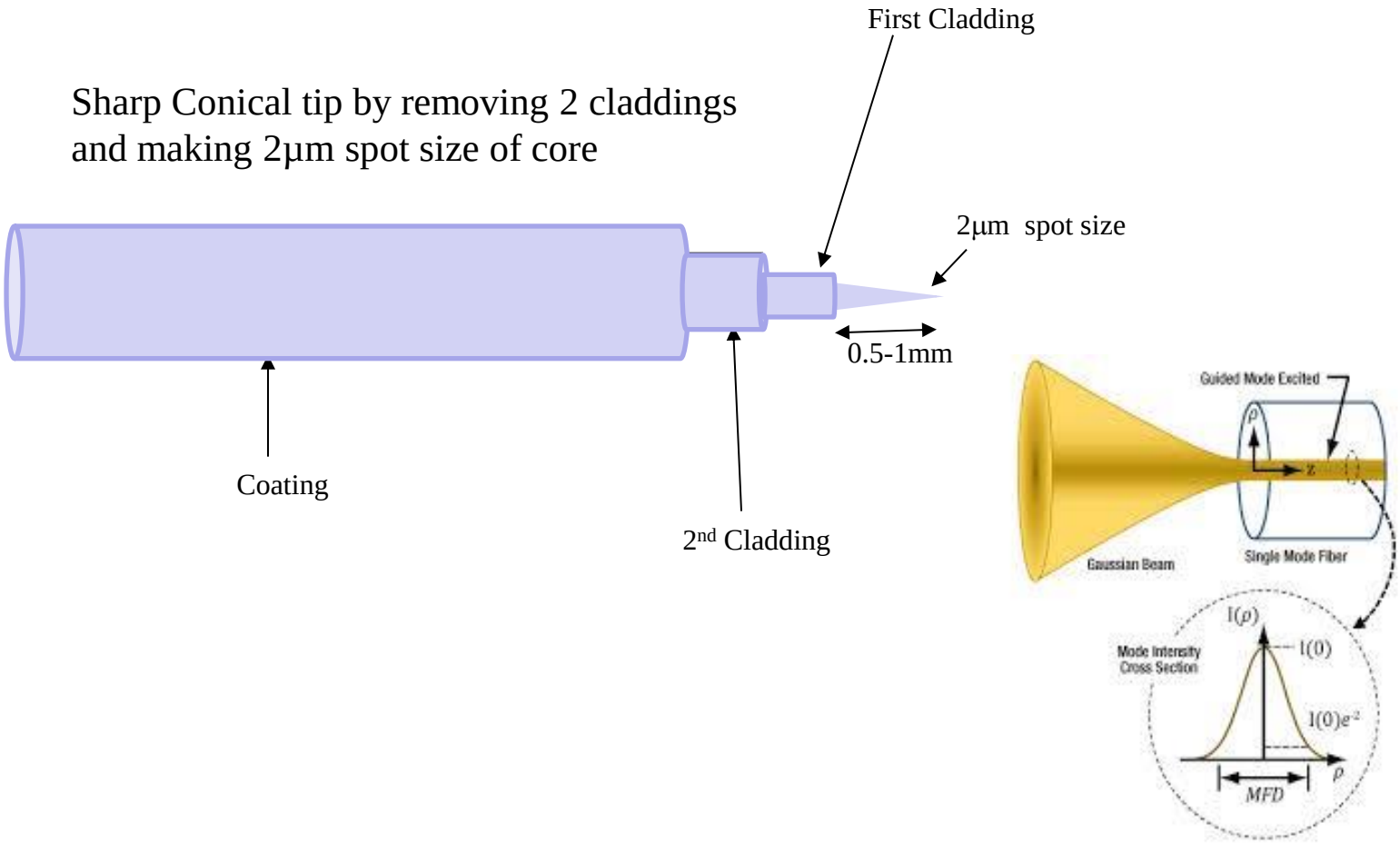
Bare fiber mode

Fresnel lens focal spot



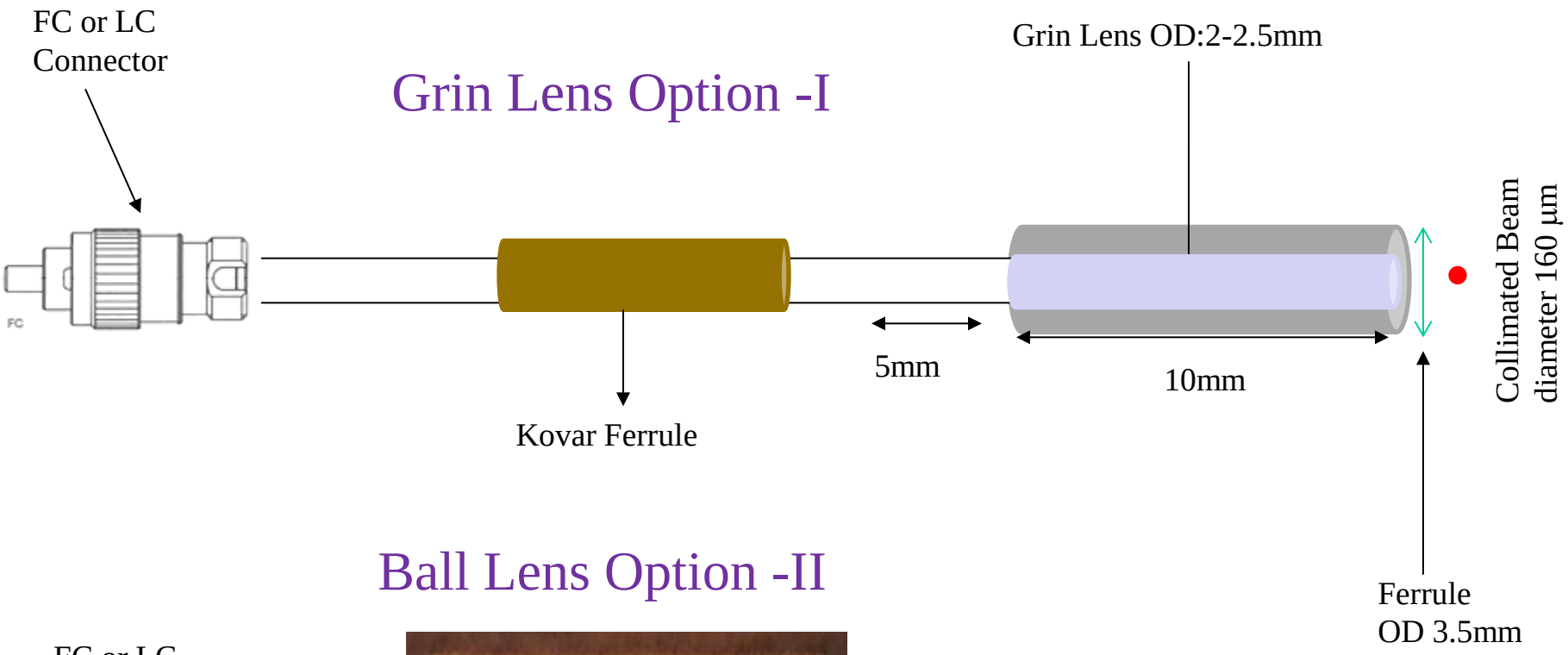
Double Clad Fiber-Lensed-Fibers-Sharp Conical Tip

Sharp Conical tip by removing 2 claddings
and making 2µm spot size of core

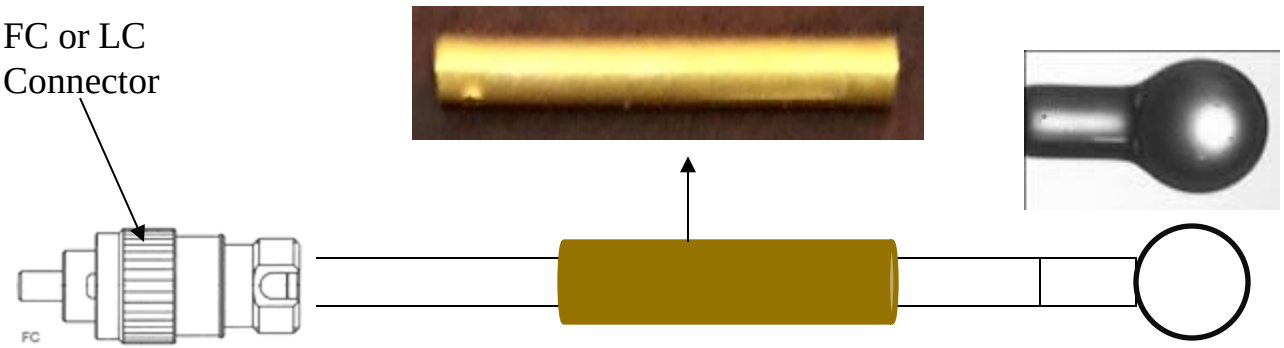


Collimated Beam Lens System for long working distance

Grin Lens Option -I



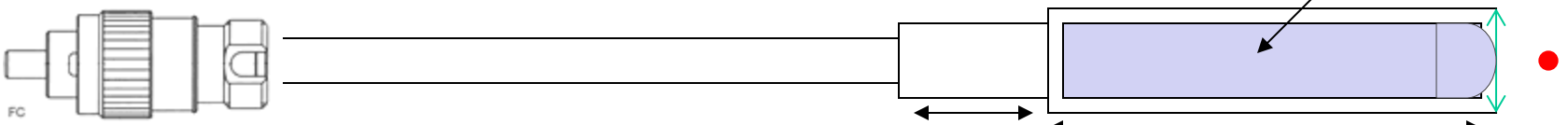
Ball Lens Option -II



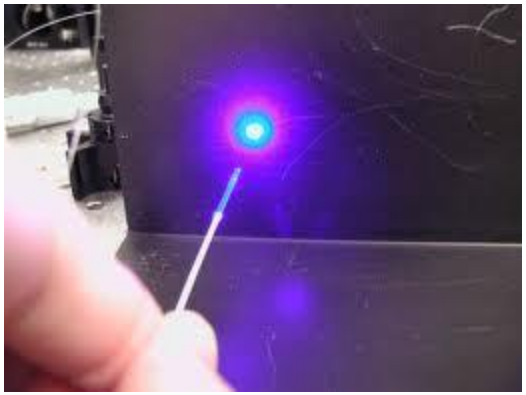
Grin Lens System for long working distance

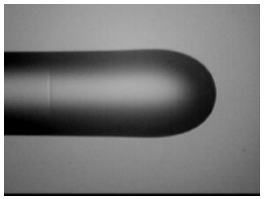
FC/APC
Connector

Grin Lens OD:140μm

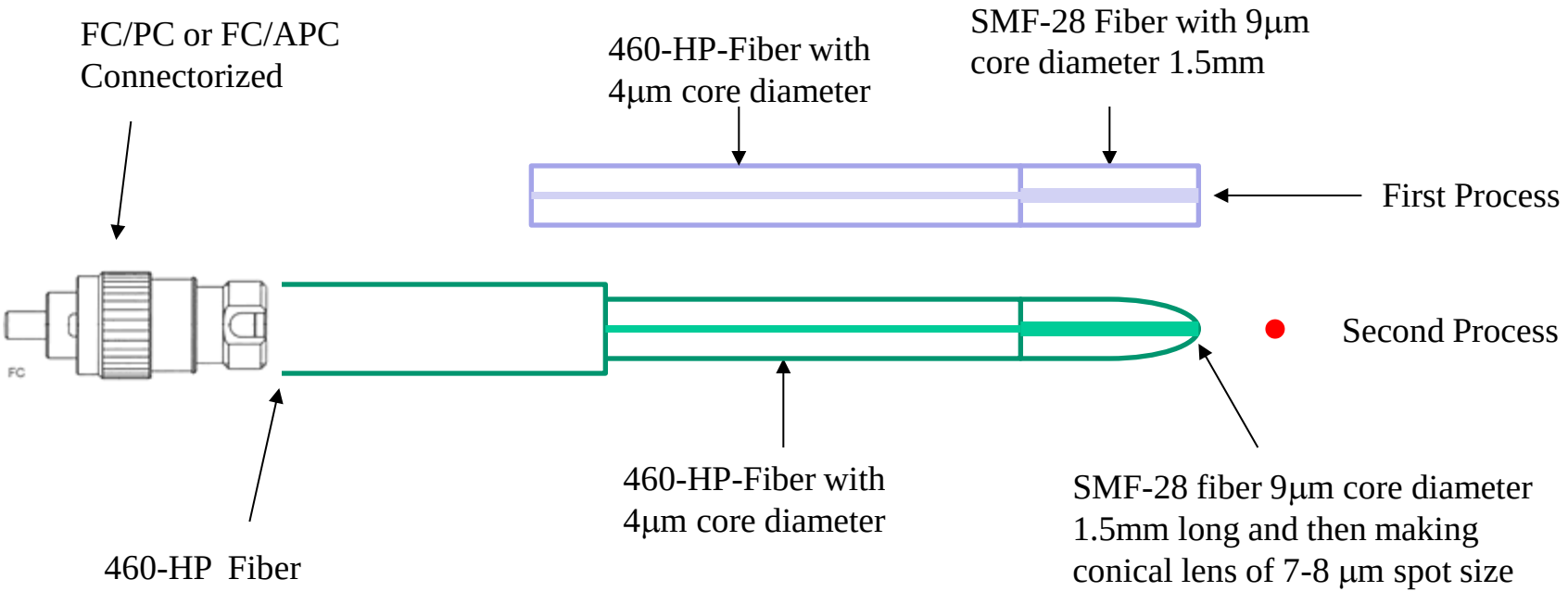


Beam waist
30-42μm Diameter





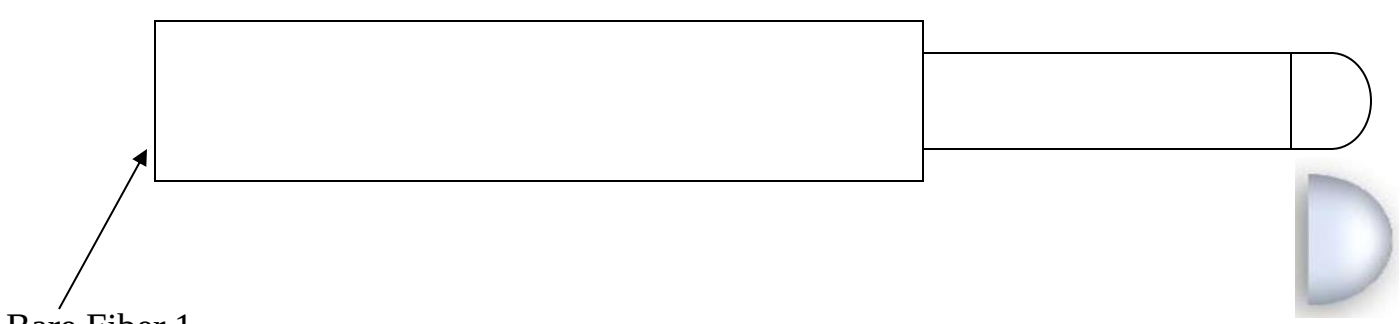
Nufern 460-HP fiber, Conical Lens with 8μm spot size pigtail assembly



Plastic Optical Fiber Tapered/Lensed of 980µm core

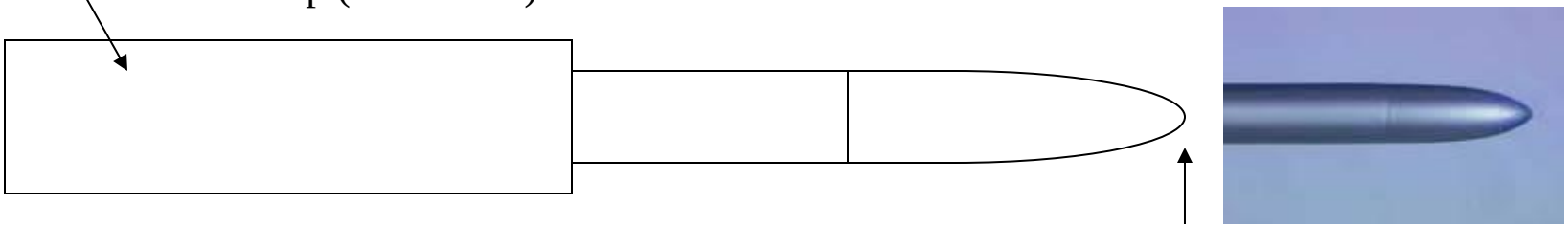
Ball Lensed Fiber (Bare Fiber)

Hemispherical Lens



Bare Fiber 1 meter length

Conical tip (Bare Fiber)



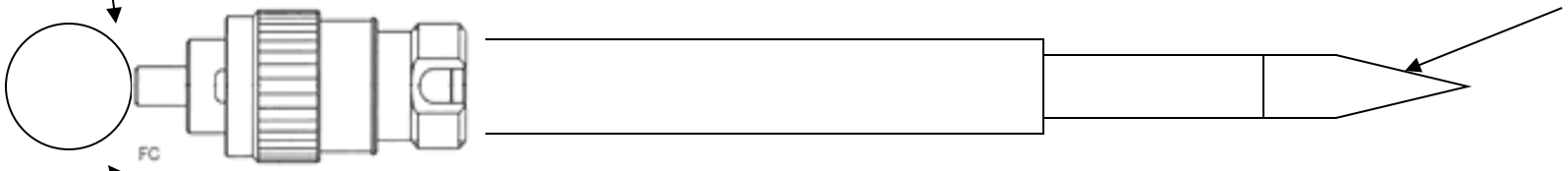
Conical Lens Tip 90 um

980μm Optical Fiber Tapered Conical & Ball

Ball Lens

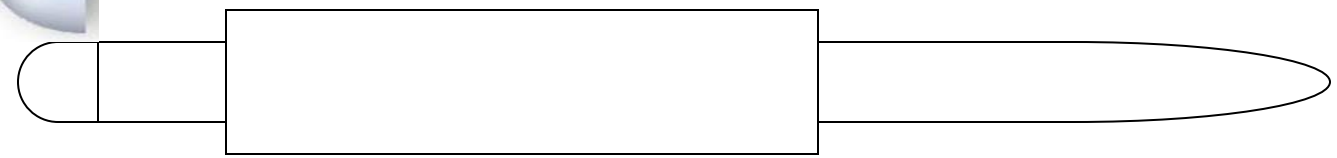
One side Ball Lens, other side Conical Lens(Bare Fiber)

Conical Lens



Ball Lens outside of the FC Connector

One side Half Ball Lens and other side
Conical Lensed Fiber (Bare Fiber)



Half Ball Lens

Conical Lens

LaseOptics- Ball Lensed to Ball Lensed Fibers Pigtail with Steel Ferrule

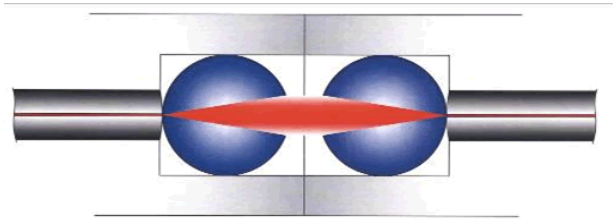
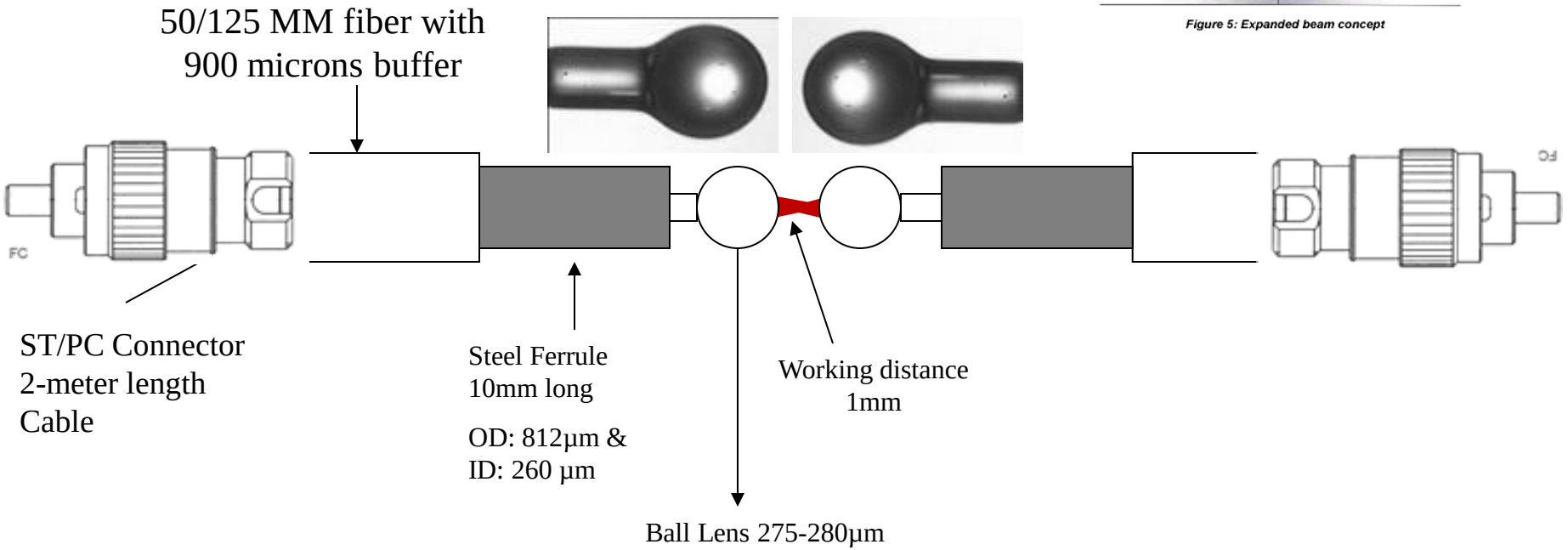


Figure 5: Expanded beam concept



Ball Lensed Fiber (Bare Fiber) 480 SM PM

Metal Ferrule

Ball Lens 275µm

FC/APC
Connector
1 meter length

Kovar Ferrule

Semi Ball

If you want we can do Metallization: Ni: 2~3 µm +Au:
0.1~0.2 µm 15mm length,

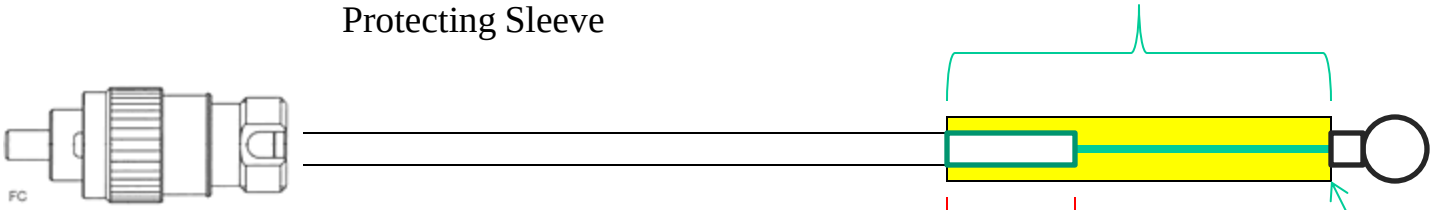
LaseOptics Lensed Fibers with Kovar Ferrule or Metallization

Ball Lens Fibers with Titanium Ferrule (Supplied by Customer) SLB-Japan

Titanium Ferrule 50mm long
OD: 1.8µm & ID: 225µm

Ball Lens
275-300µm

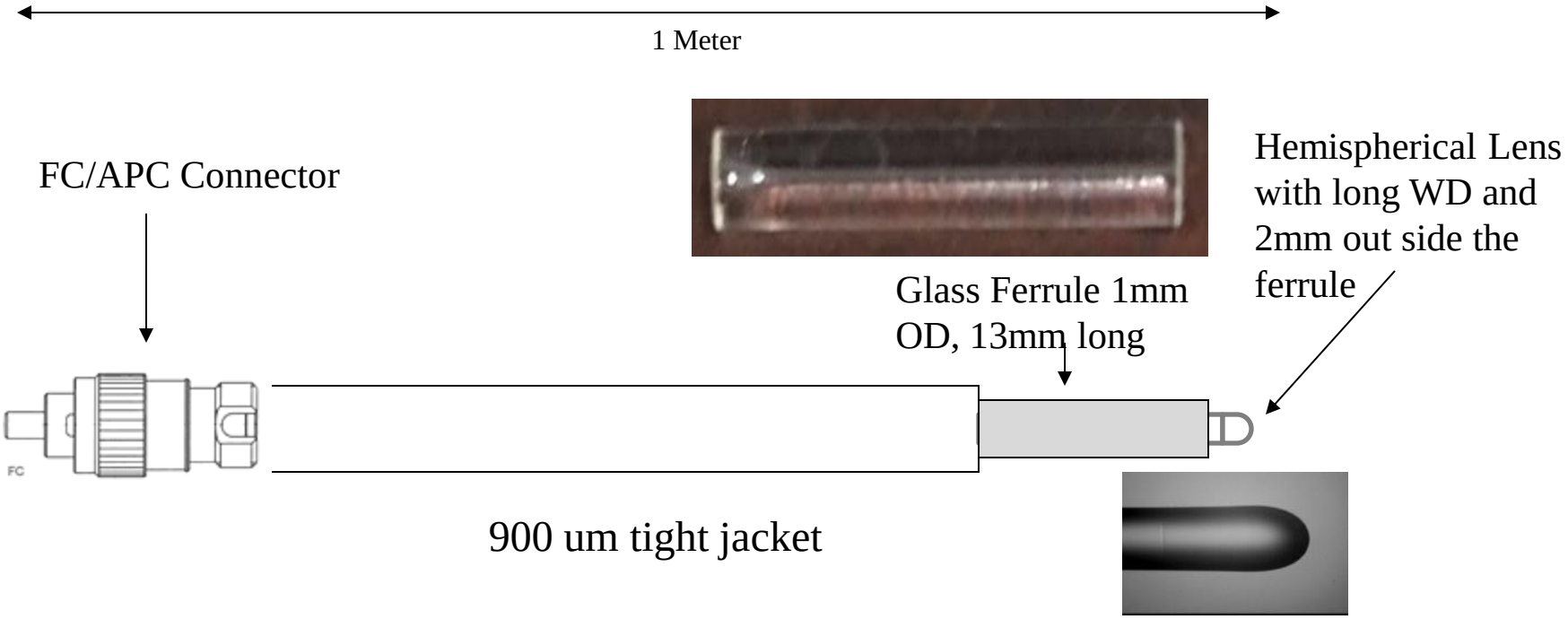
900 um hytrel sleeve
Protecting Sleeve



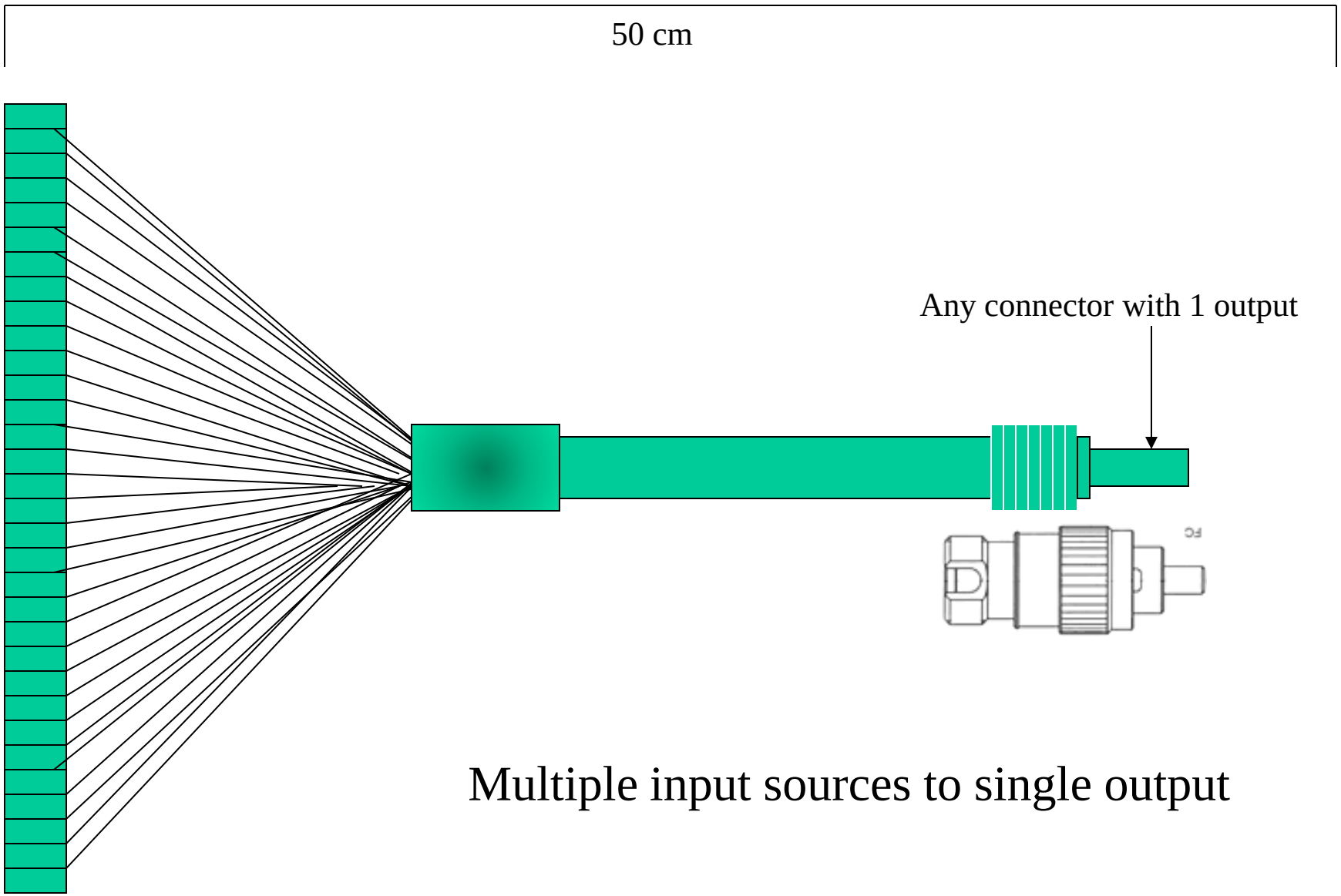
ID 900µm for 10 mm
long backside of ferrule

Front end of
the ferrule

Hemispherical Lensed Fiber with Glass Ferrule



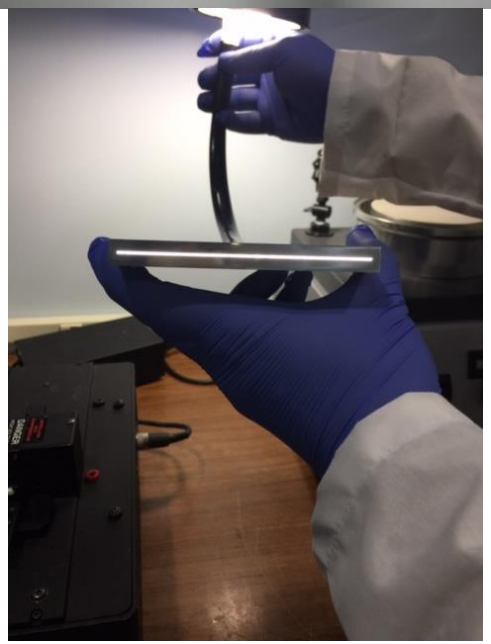
LaseOptics Lensed Fibers with Kovar Ferrule or Metallization

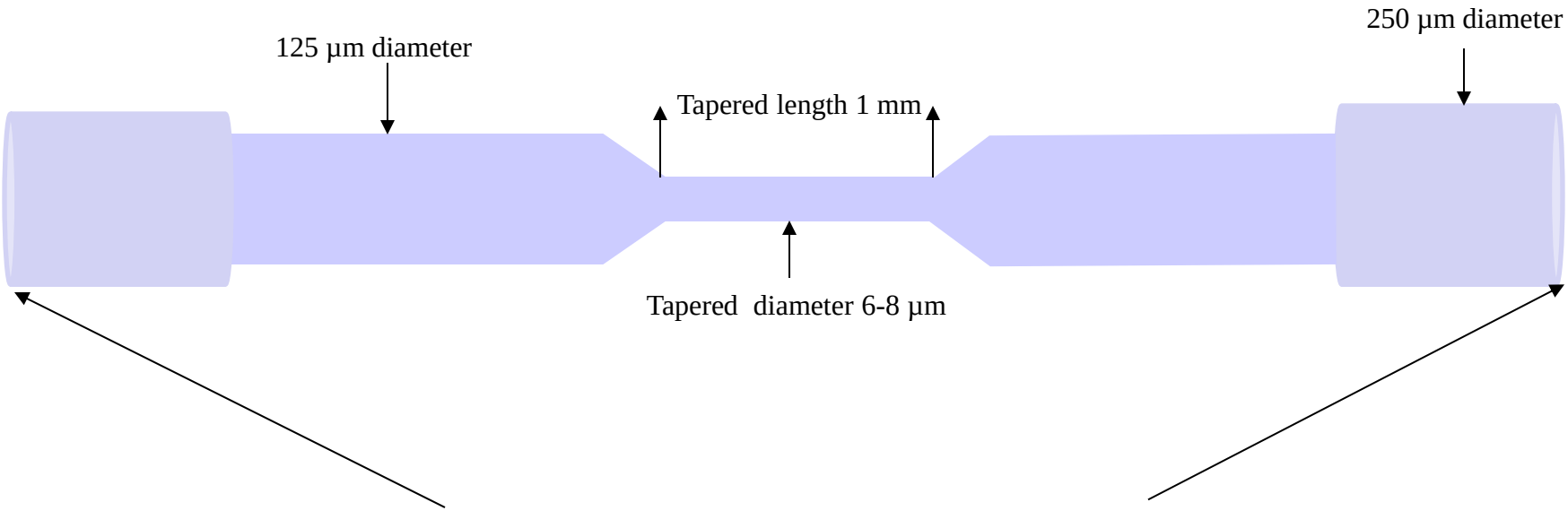


Multiple input sources to single output

100 Fiber Arrays one Output

100 fibers with One output Connector

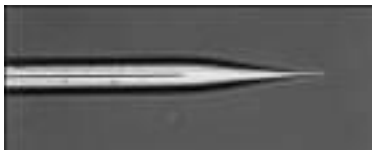


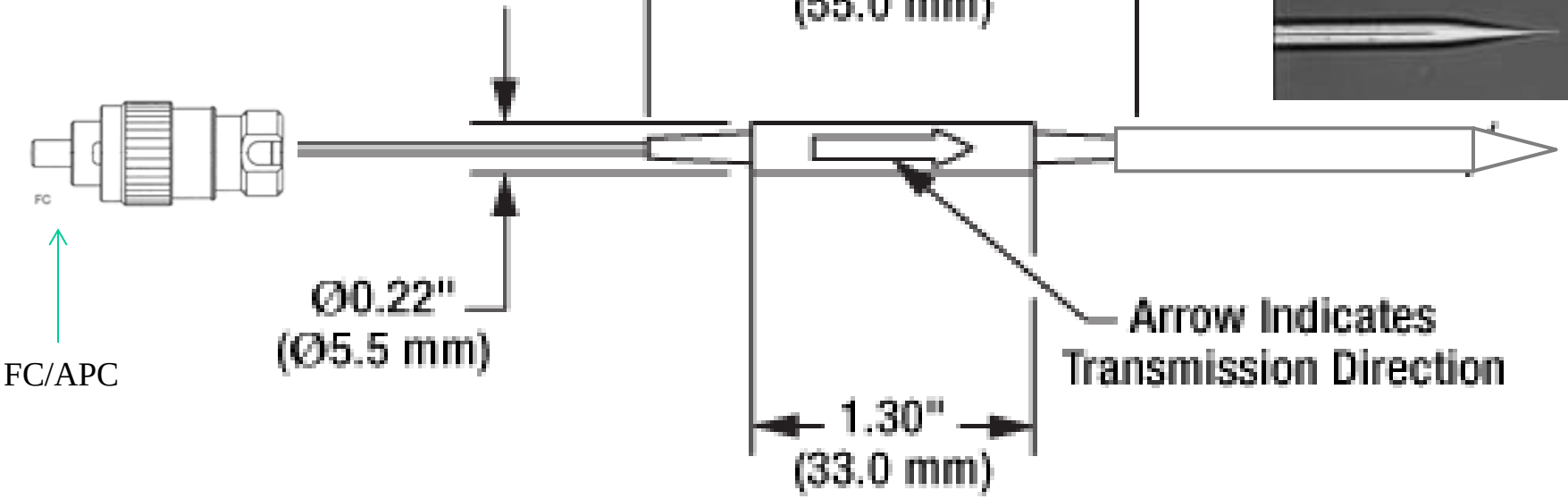


LaseOptics Center-Tapered Fiber

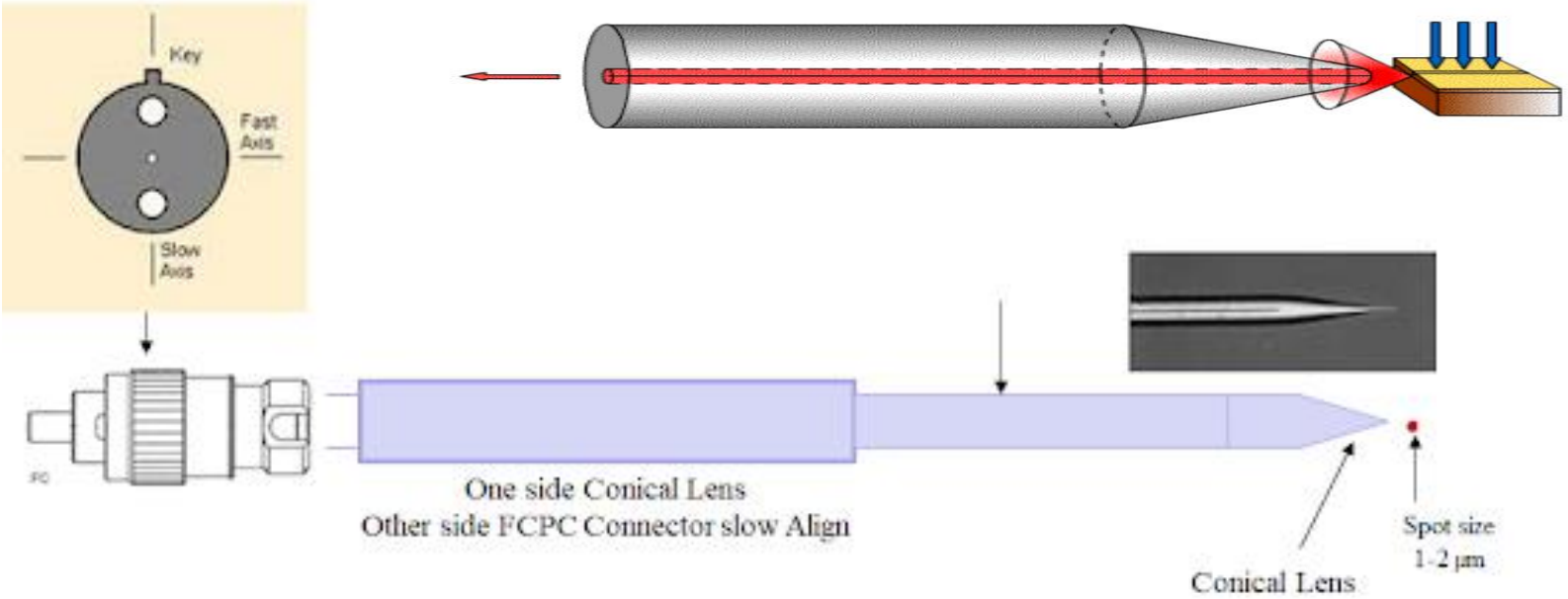
Polarization Maintaining fiber with polarizer isolator with conical lens with FC/APC connector

1-1.5 µm Spot Size and 0.9 mm WD

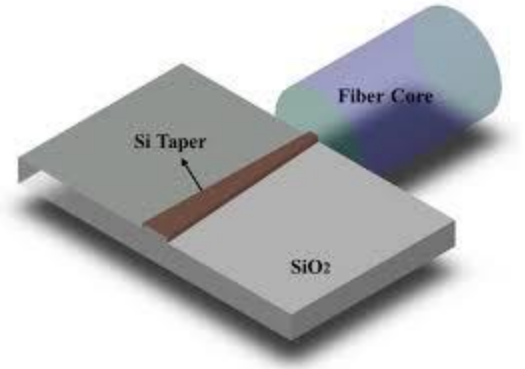


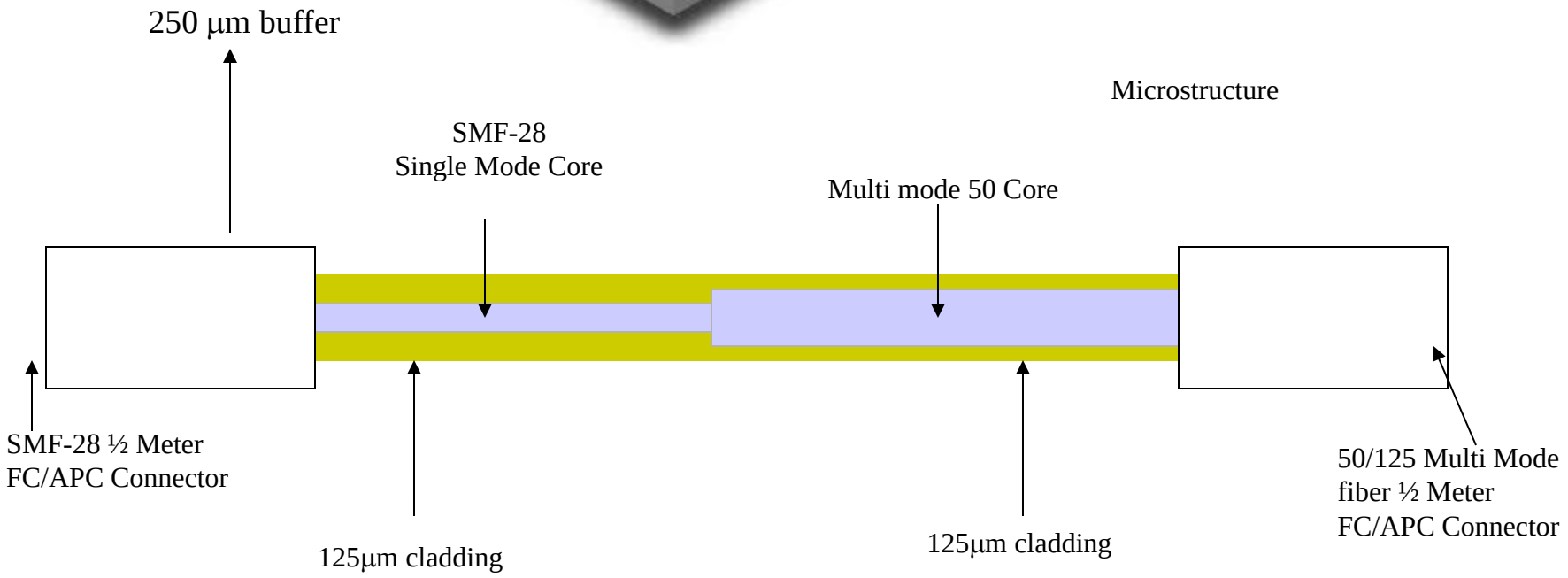


Polarization Maintaining 1550nm fiber with conical lens with FC/PC Cconnector

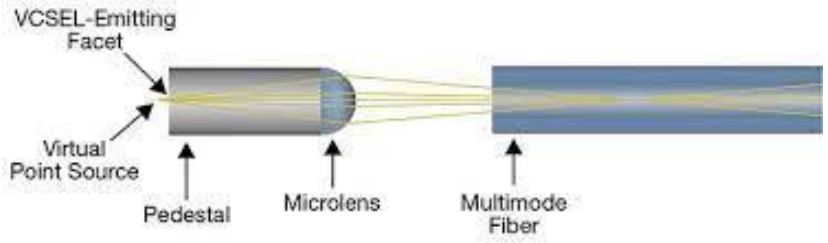


Polarization Maintaining 1550nm
Lensed Fiber with FC/PC Slow Axis

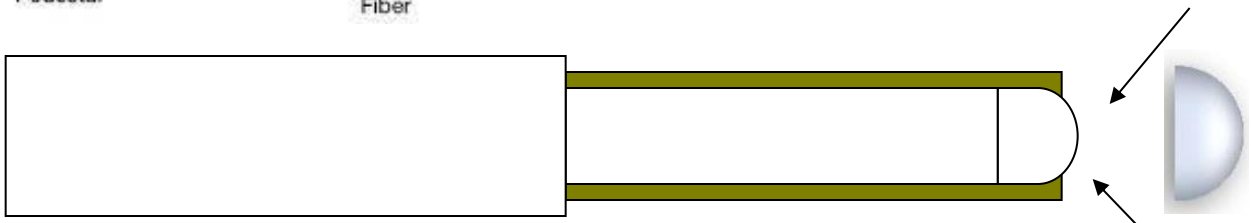




SMF-28 - Single Mode + 50µm Core Multi mode Tapering



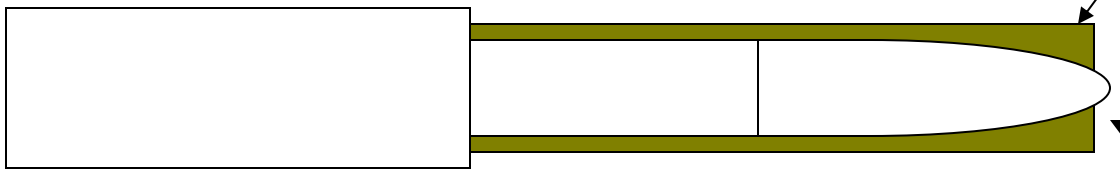
Hemispherical Lens



Bare Fiber 1
meter length

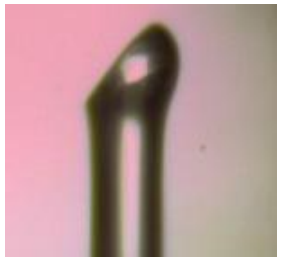
Lensed Fiber
slightly outside of
Metal Ferrule

Conical tip (Bare Fiber)

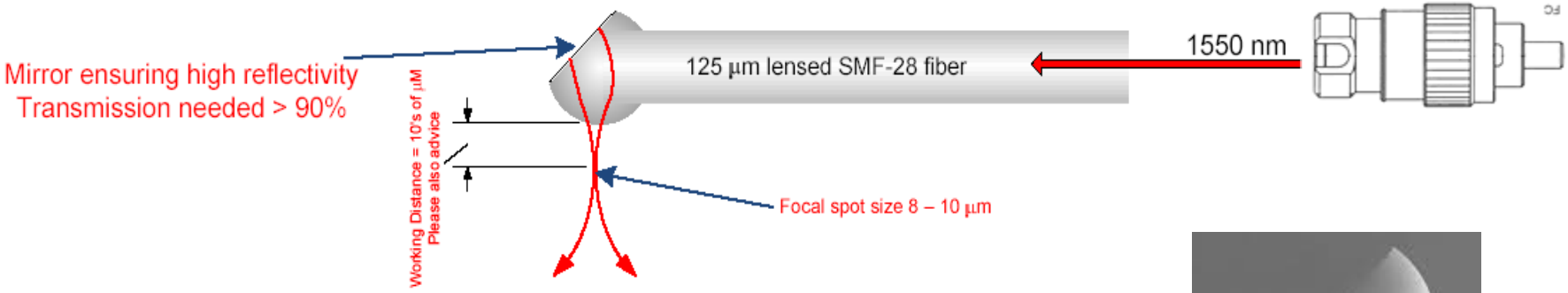


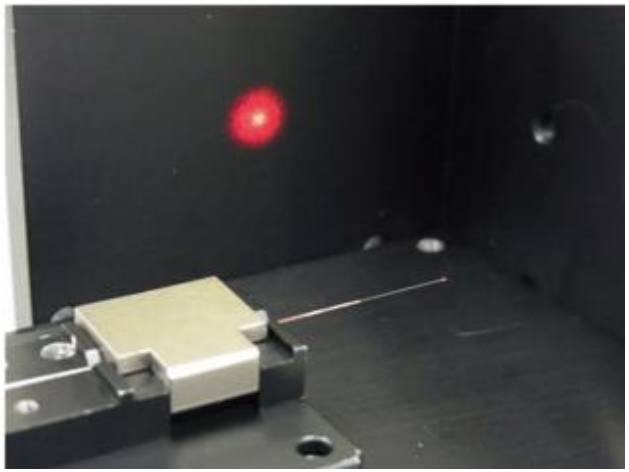
Conical Lens Tip 90 um

980µm Optical Fiber with Semi Ball & Conical lens slightly outside the Ferrule

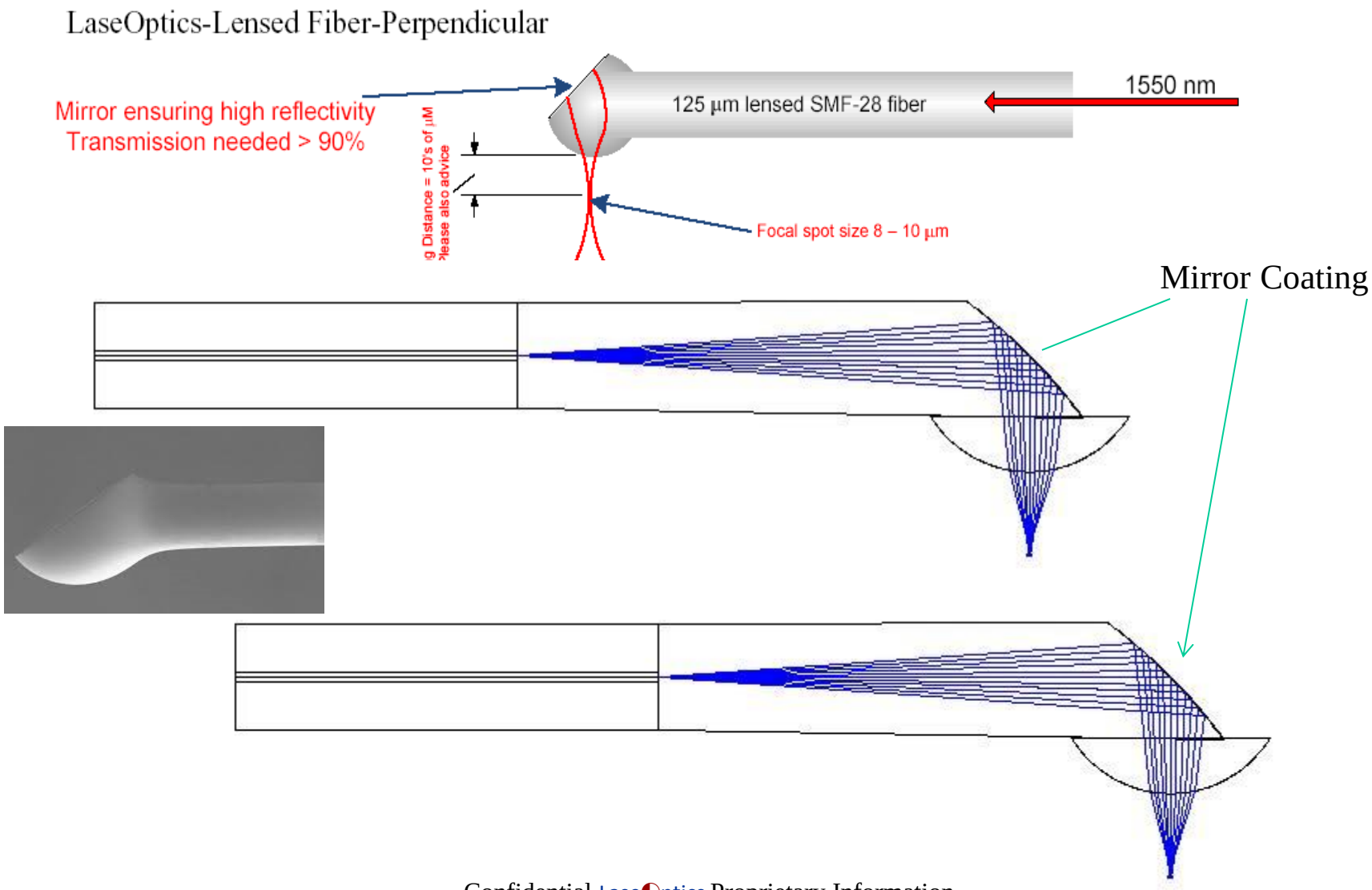


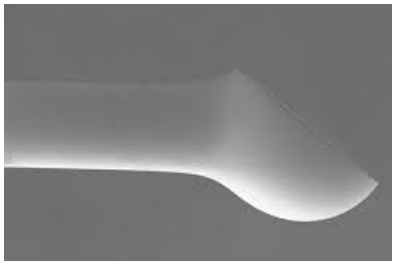
LaseOptics-Lensed Fiber-Perpendicular



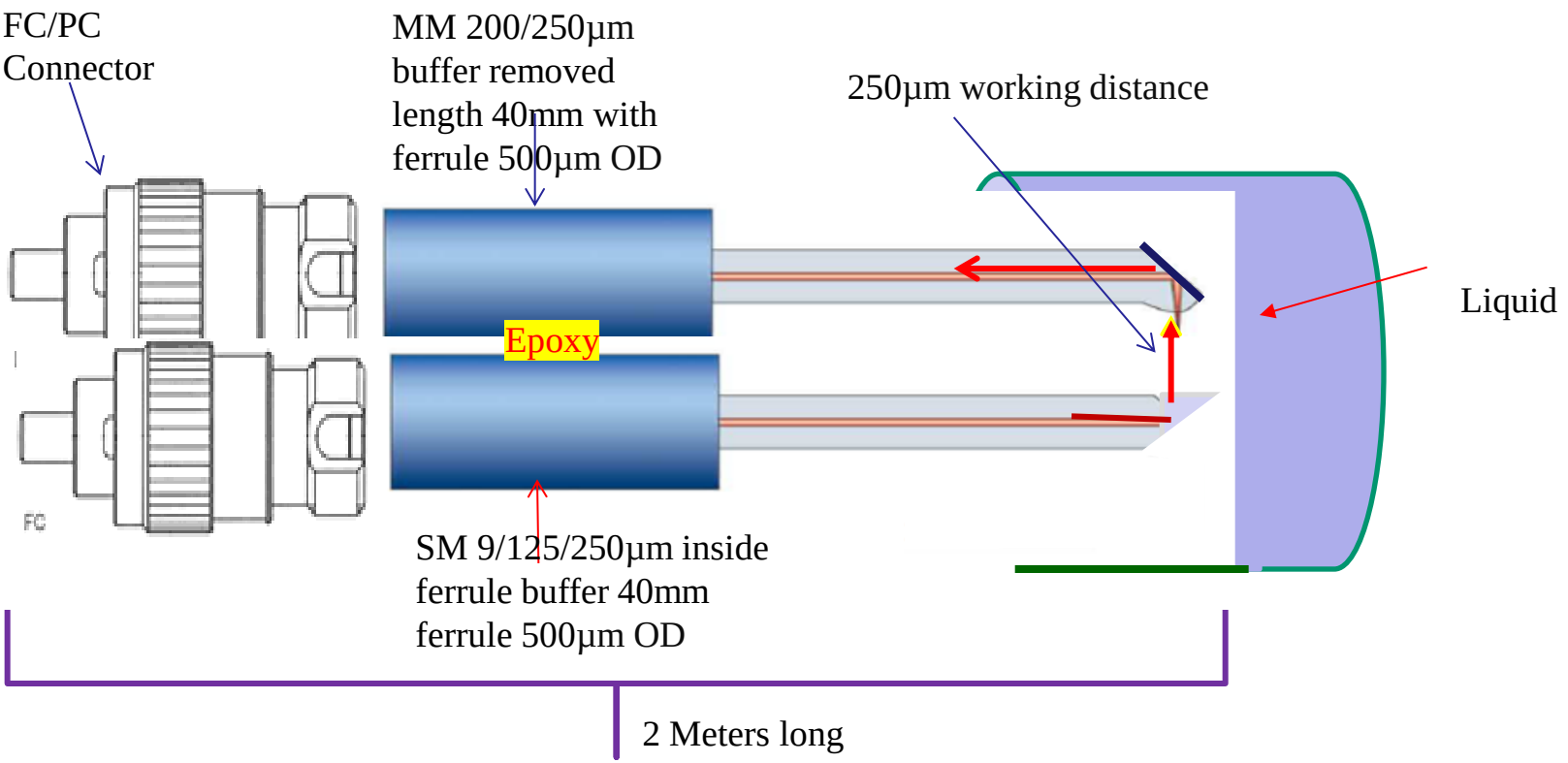


Mirror coating on micro-polished angle fibers to bring high reflectivity transmission (95%)



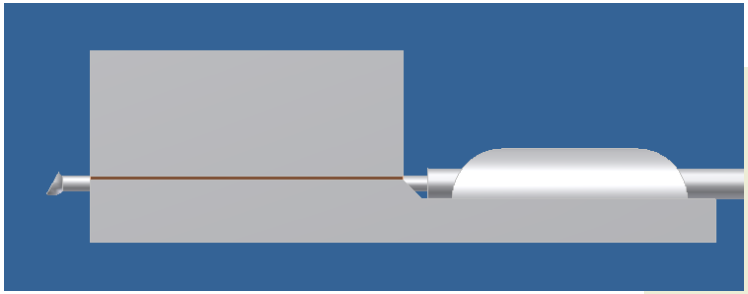


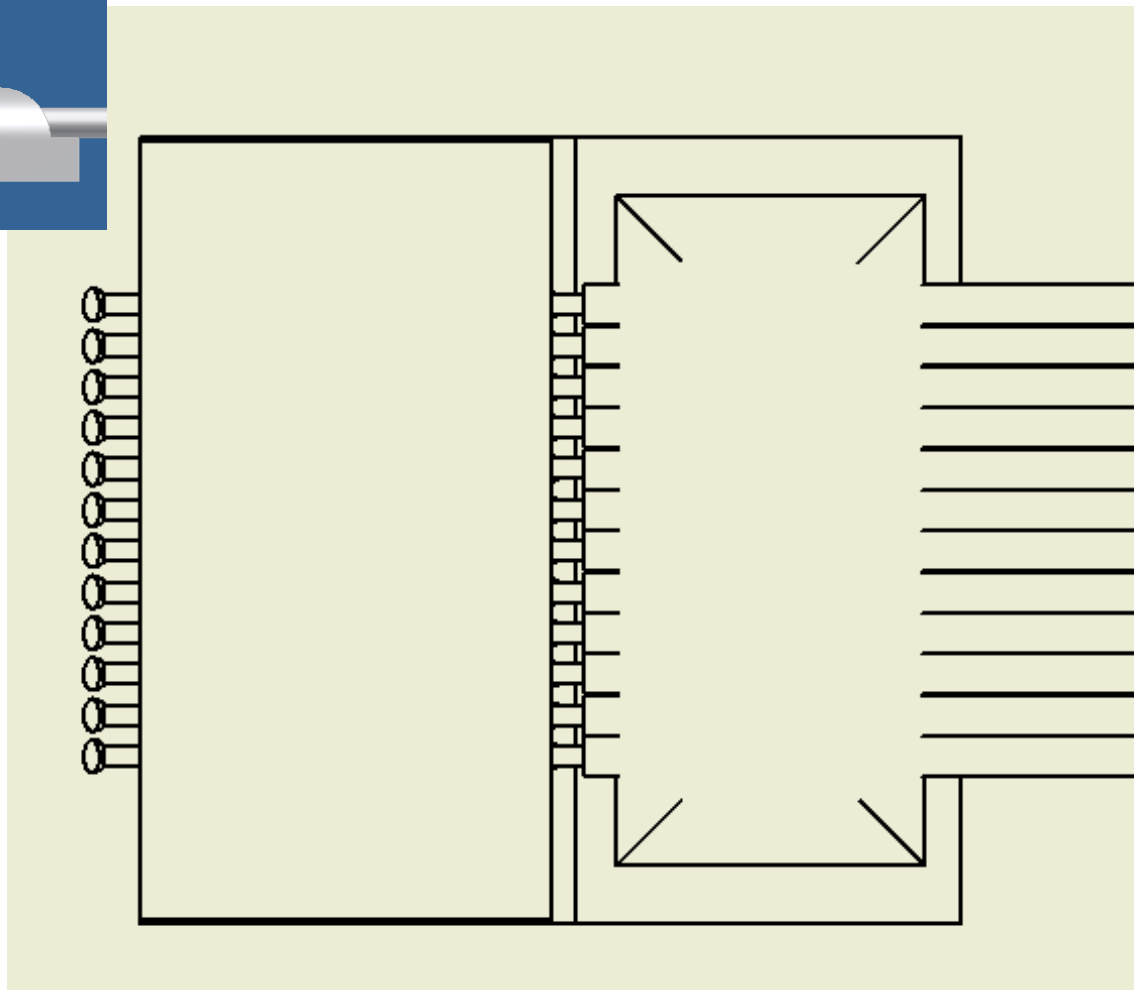
Perpendicular Lensed Fiber Array on V-grooves 4 channel



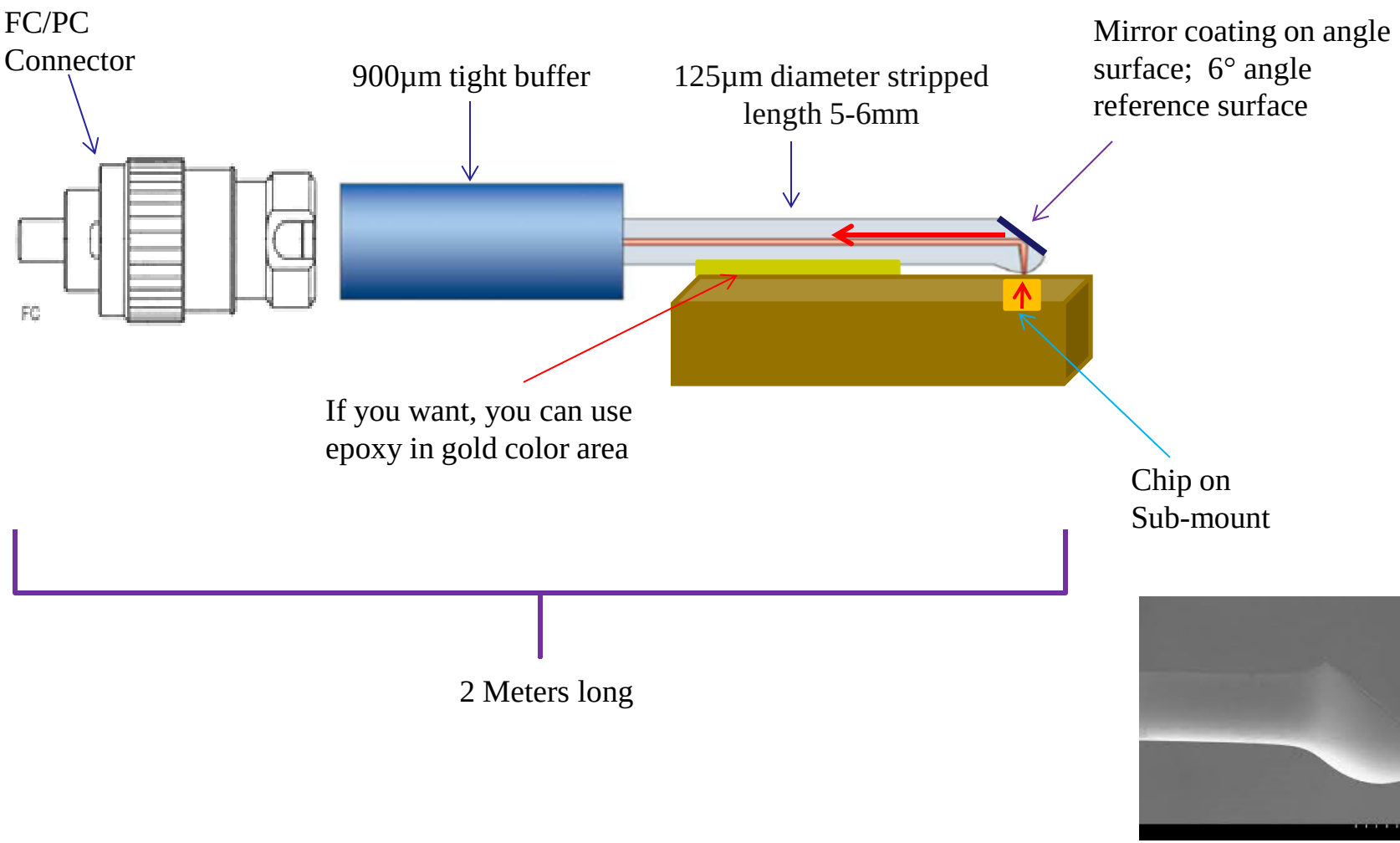
Multi mode 200/225/500, we have to remove buffer at least 40mm and where as SMF-28 stripped length 10mm only, we have use 500µm ferrule size, without buffer for MM fiber and with SMF-28 with buffer because of working distance and two ferrule are stick together

Siding firing fiber and perpendicular fiber bundle in water application

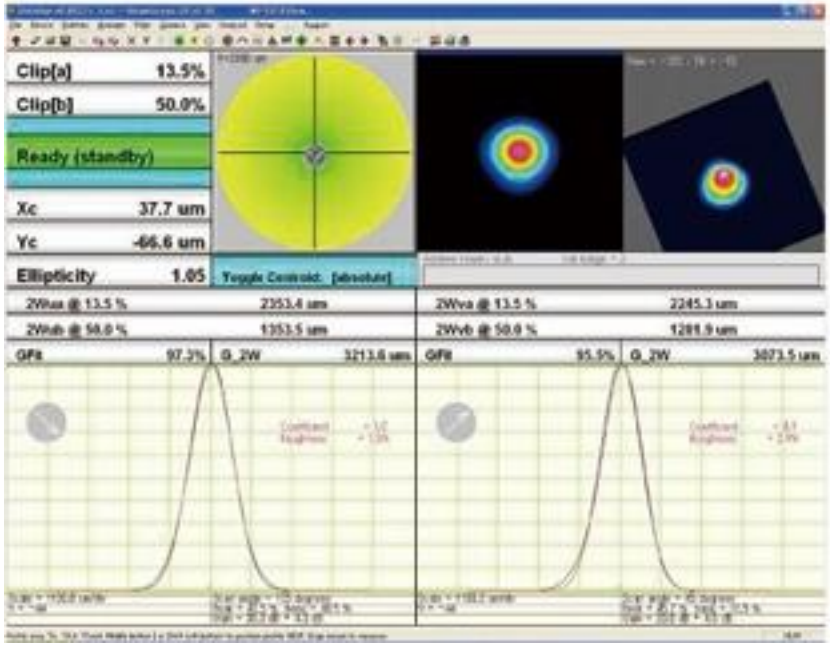


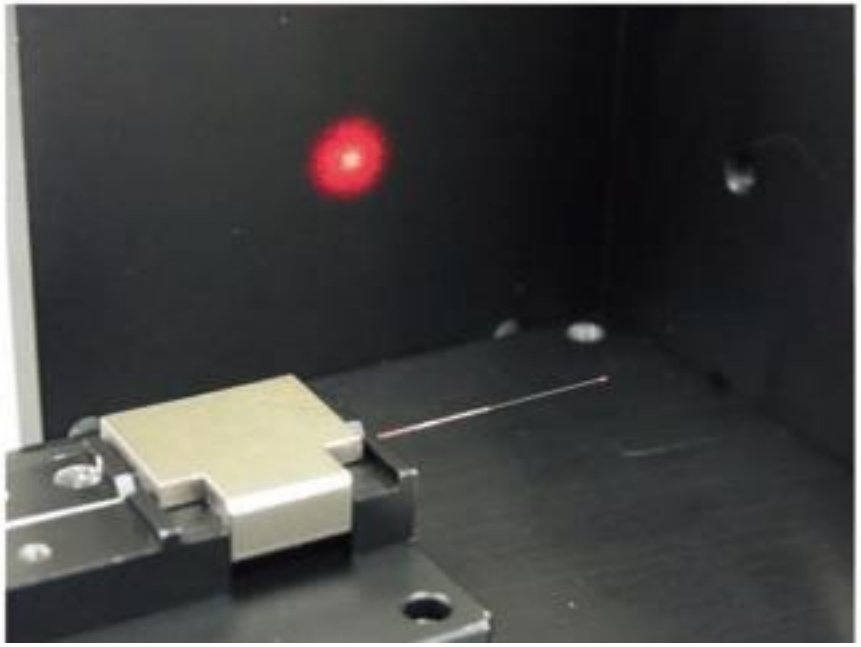


Perpendicular Lensed Fiber Array on V-grooves 12 channel



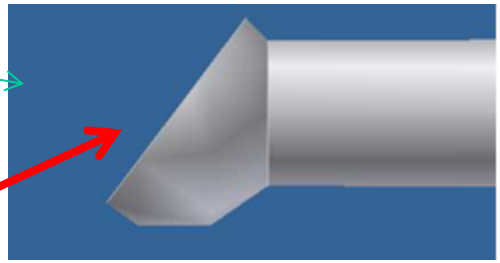
Perpendicular Lensed Fiber on Light coupling from Chip



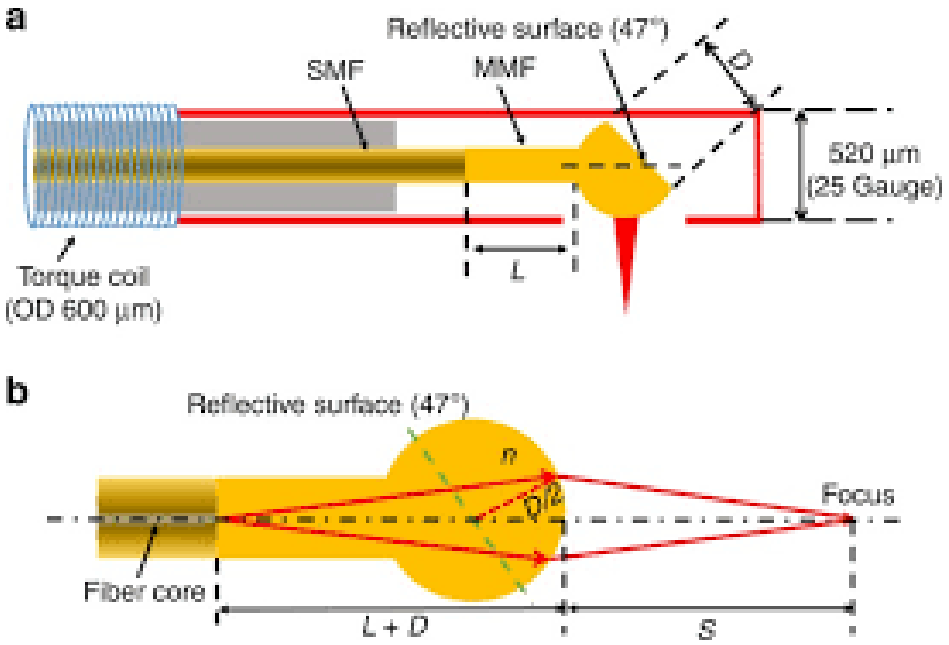


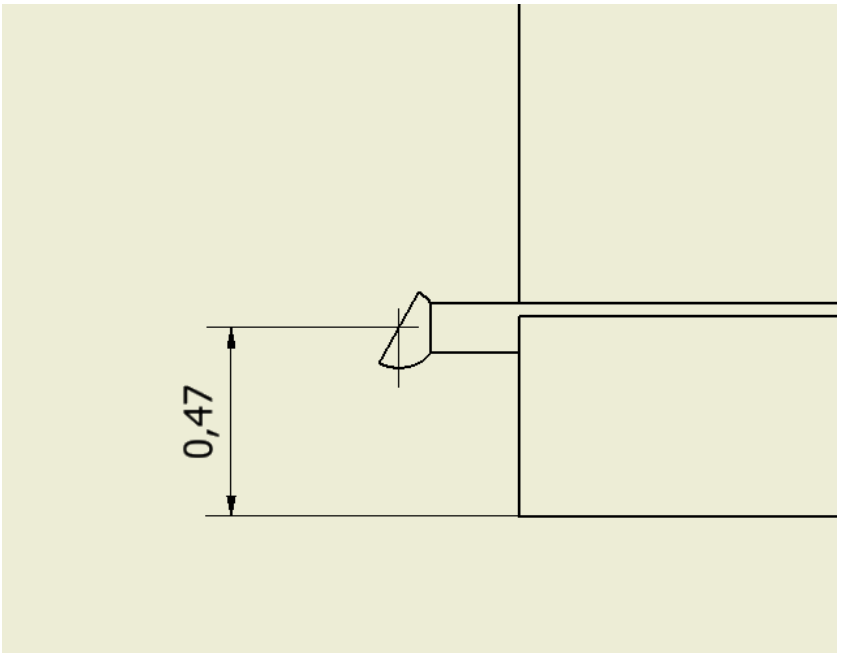
One side Perpendicular Lens other end we can put any connectors

Mirror reflective coating 36°angle perpendicular to light for total 45°angle With 8°of arriving light



Light output 8° angle





Focal point coincides with base of fiber block assembly

250 µm
Ball Diameter

250 µm Ball Diameter
Angled Micro-Polished and
Mirror Coating

Perpendicular Lensed Fiber
Micro-Polished

900 µm tight jacket

SS Metal Ferrule
OD: 0.51mm & 17mm L

Mark on the Ferrule

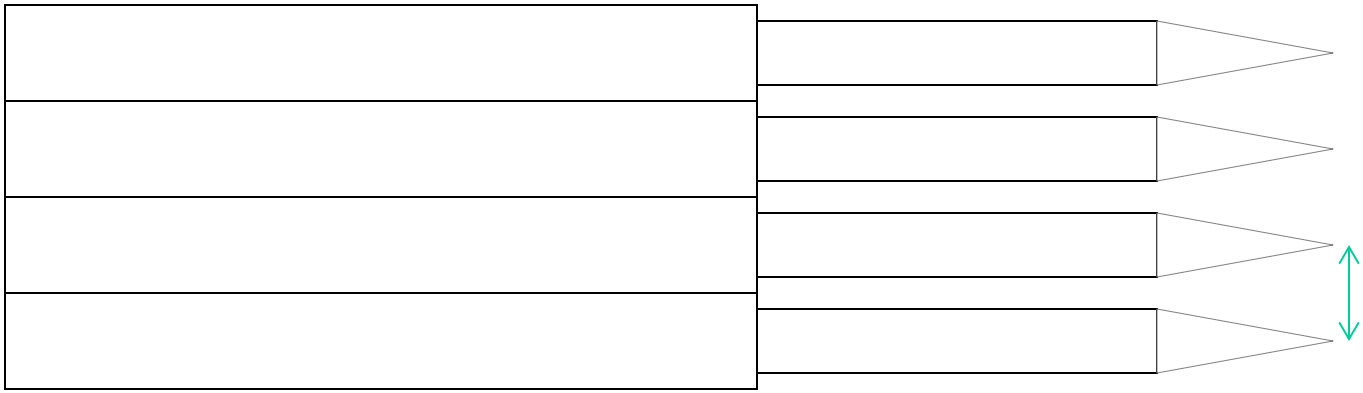
720-830µm working
distance and spot size
40-45µm

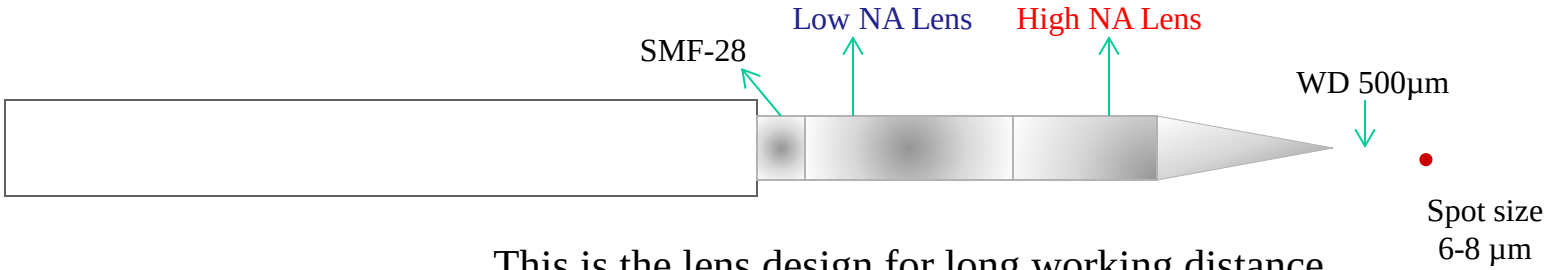
PD Chip

One side Perpendicular Lens with Ferrule with mark other side FC/PC

LaseOptics Single Mode Lensed Fibers

Conical Lensed Fiber Array SMF-28

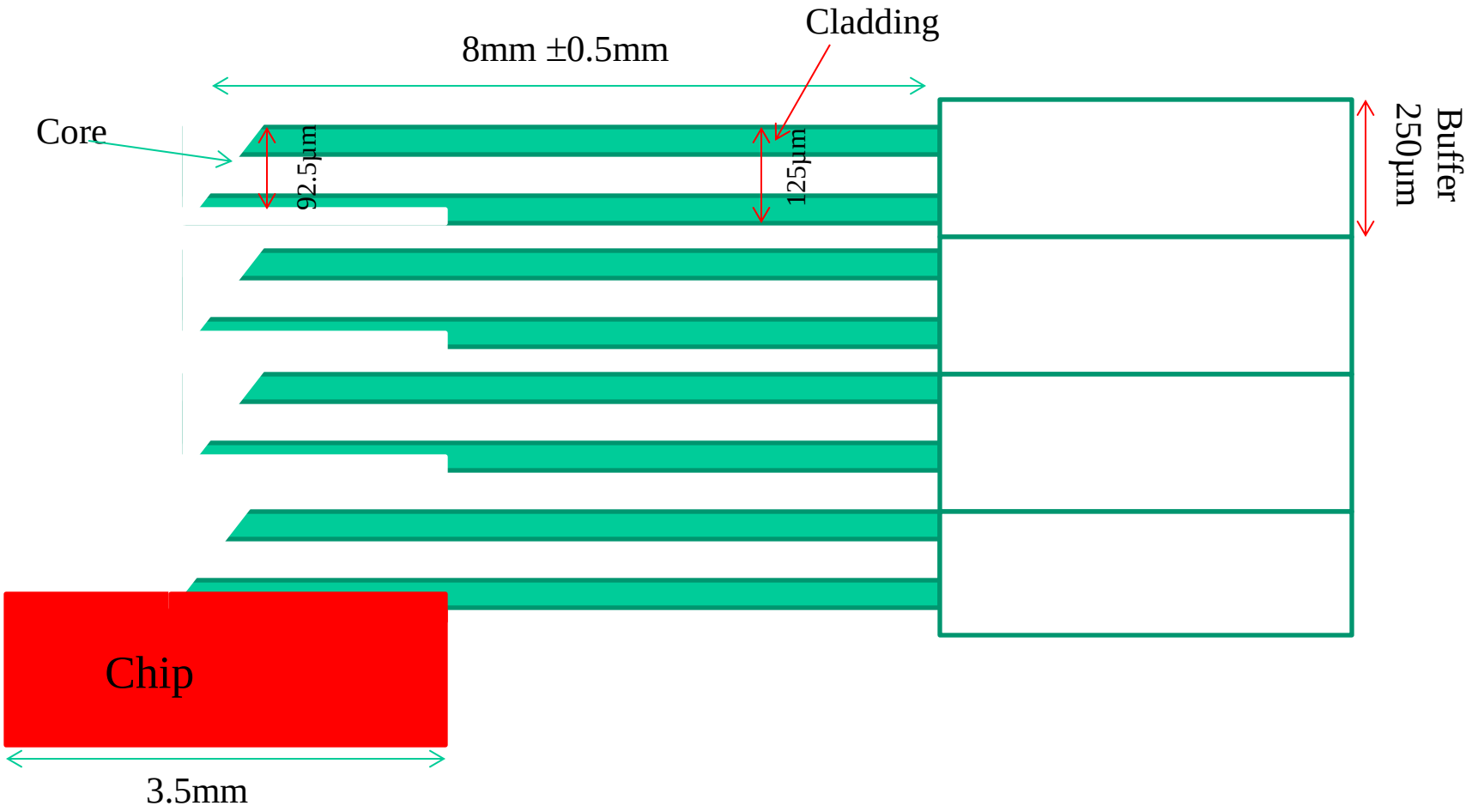




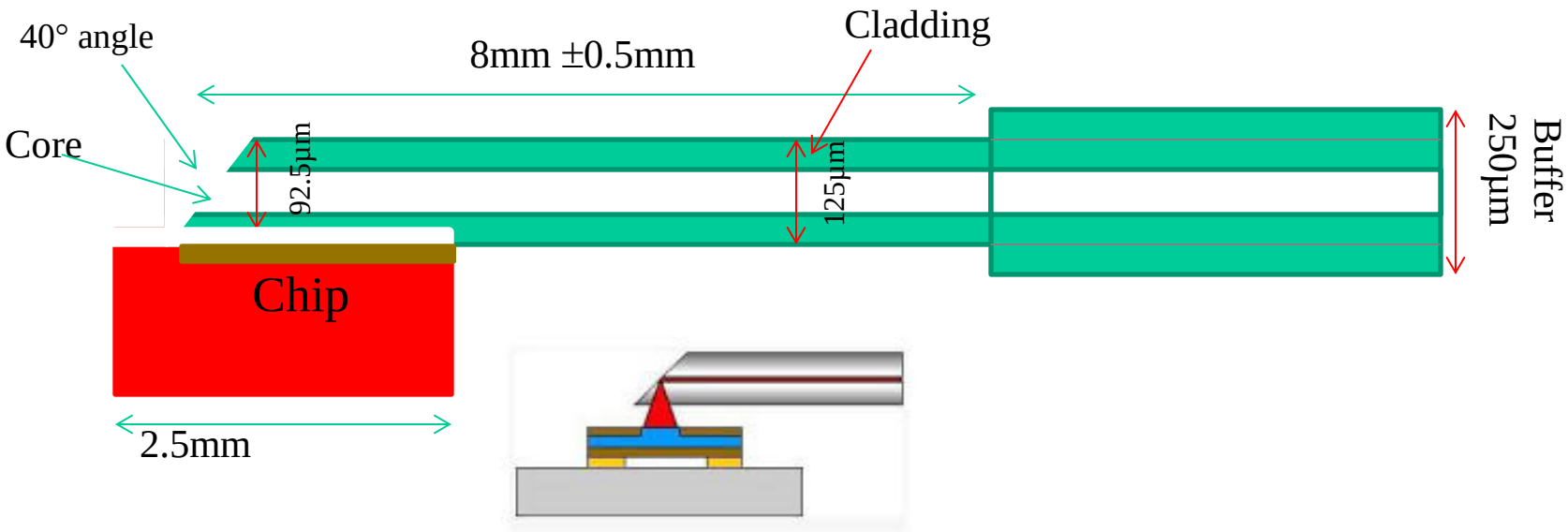
This is the lens design for long working distance

Long Working Distance Lensed Fibers

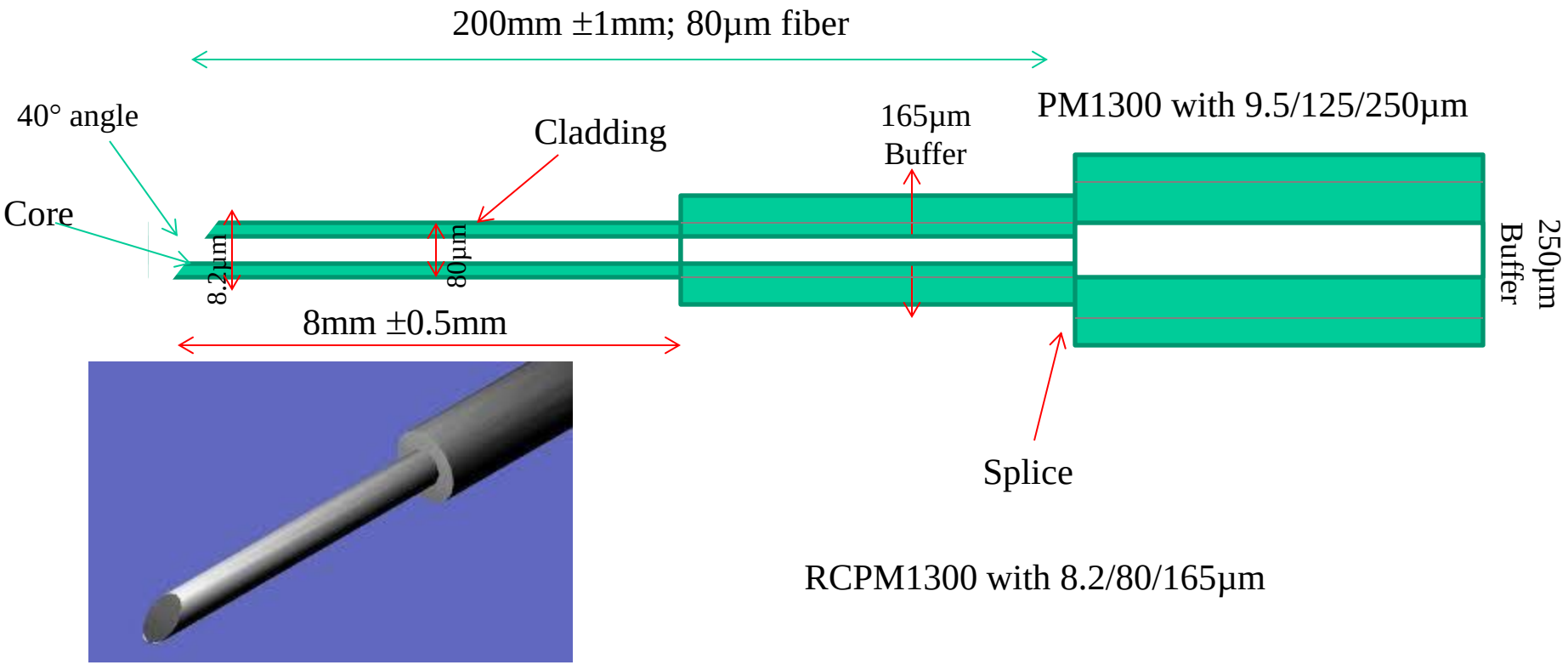
Fiber Array 4 Channel with 40° angle with reduced clad to 92.5um 3.5mm long (same 20 channels)

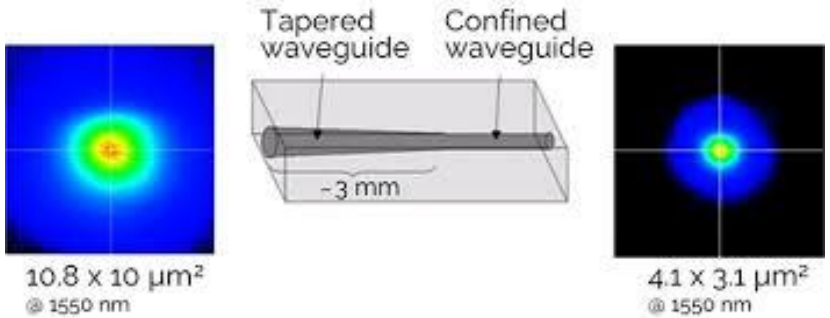


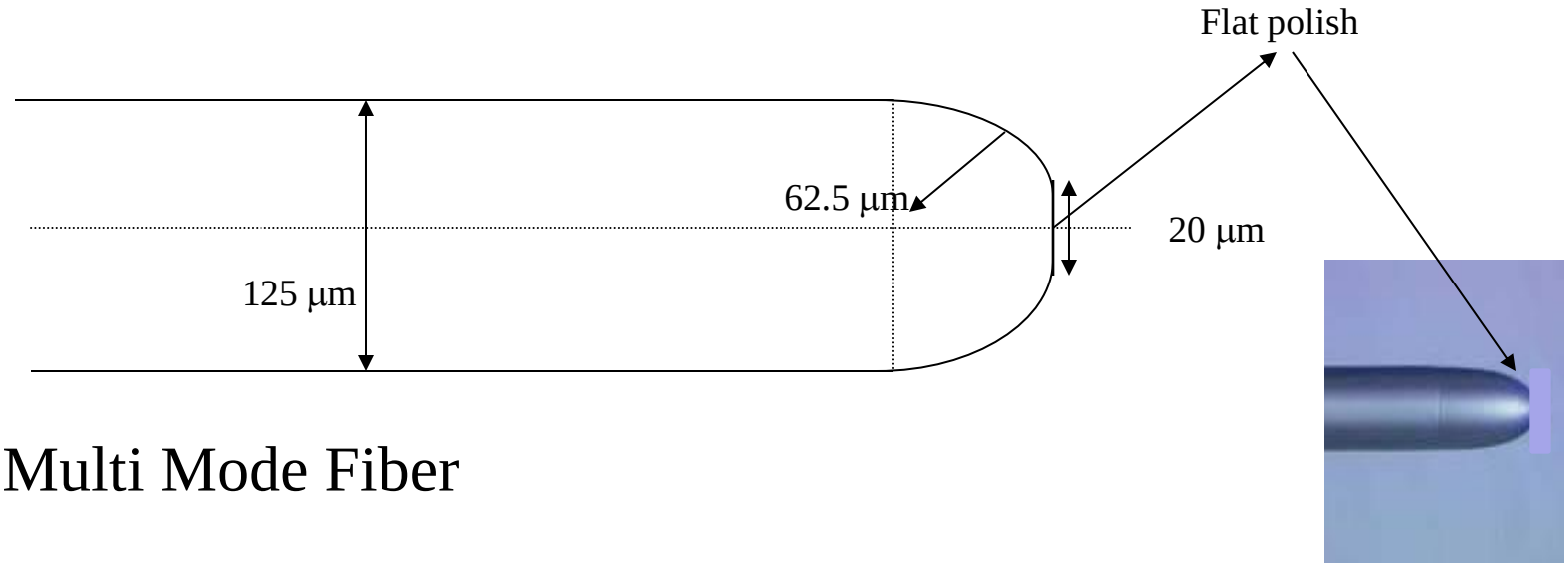
SMF-28 fiber with 40° angle with reduced clad to 92.5um of 2.5mm long



Single fiber with 40° angle with reduced clad RCPM80µm of 200mm long with PM1300 fiber.



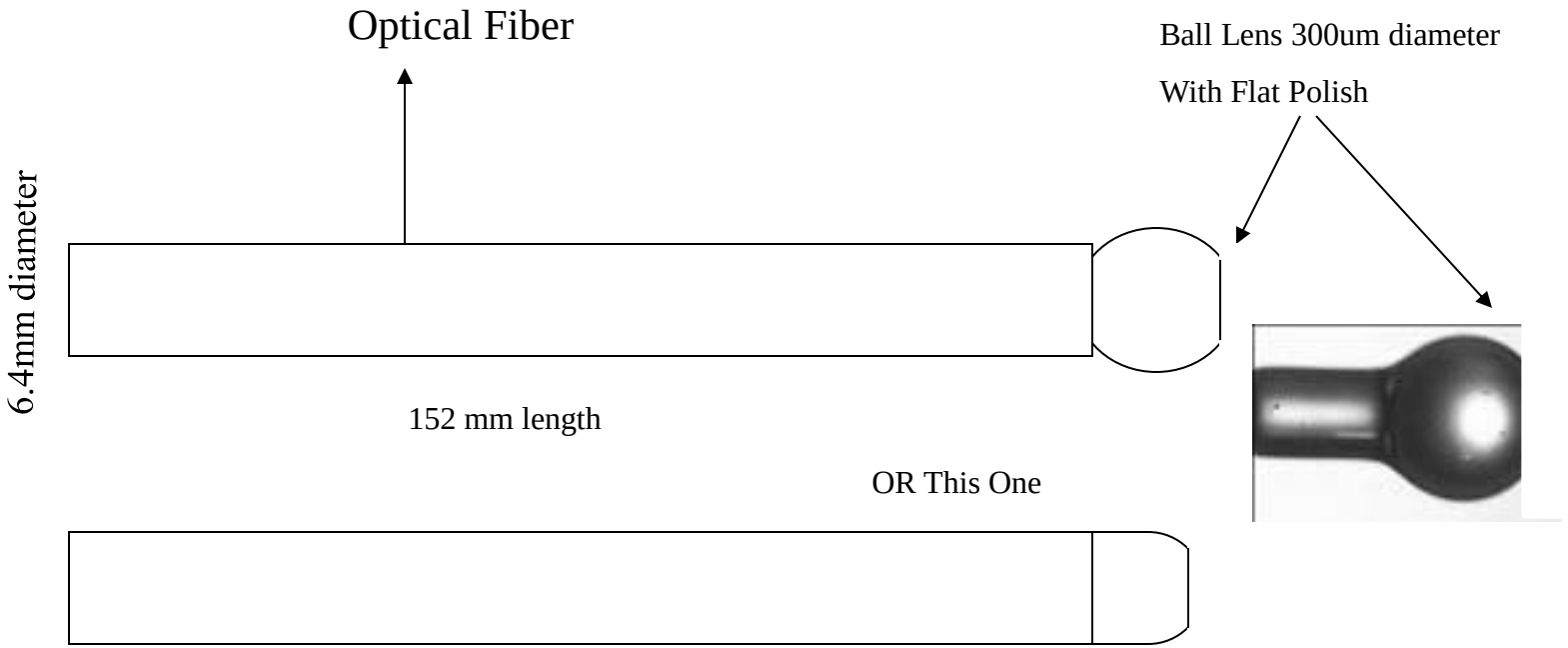


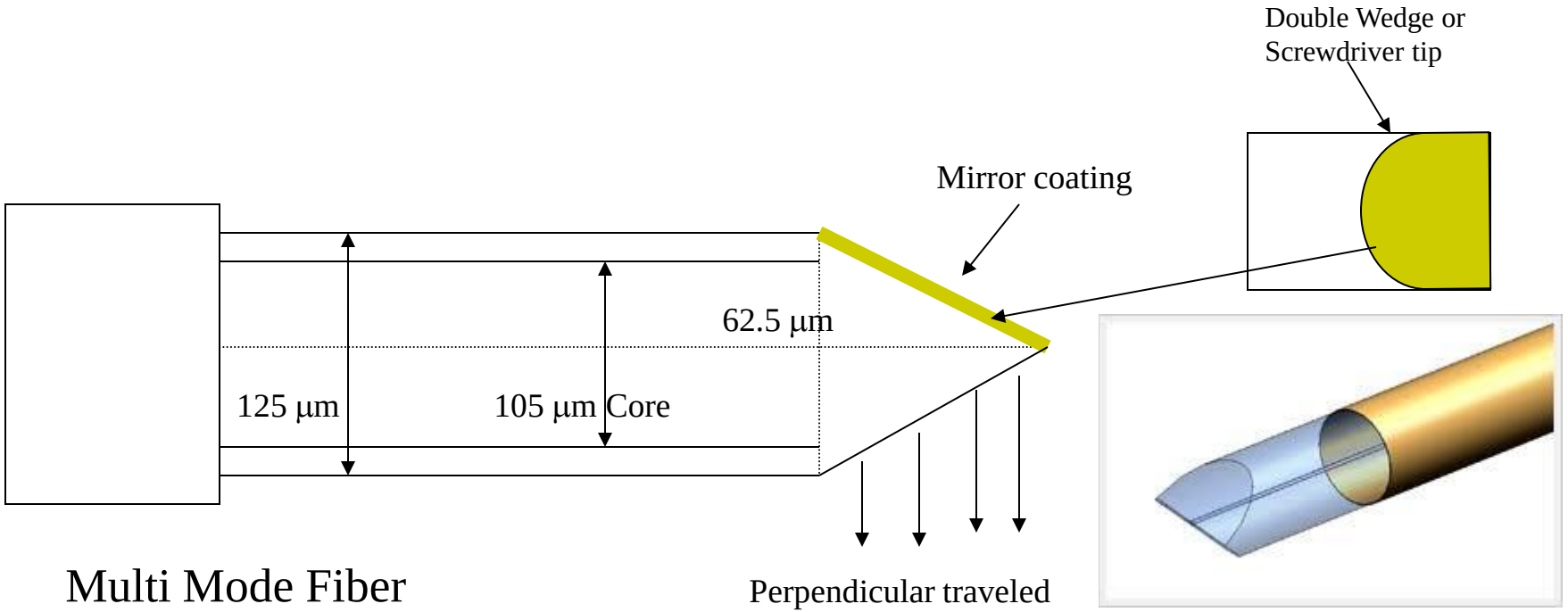


Multi Mode Fiber

LaseOptics-Curvature with Flat Polish Lensed Fiber

LaseOptics Ball Lens with Flat Polish on Image Conduit

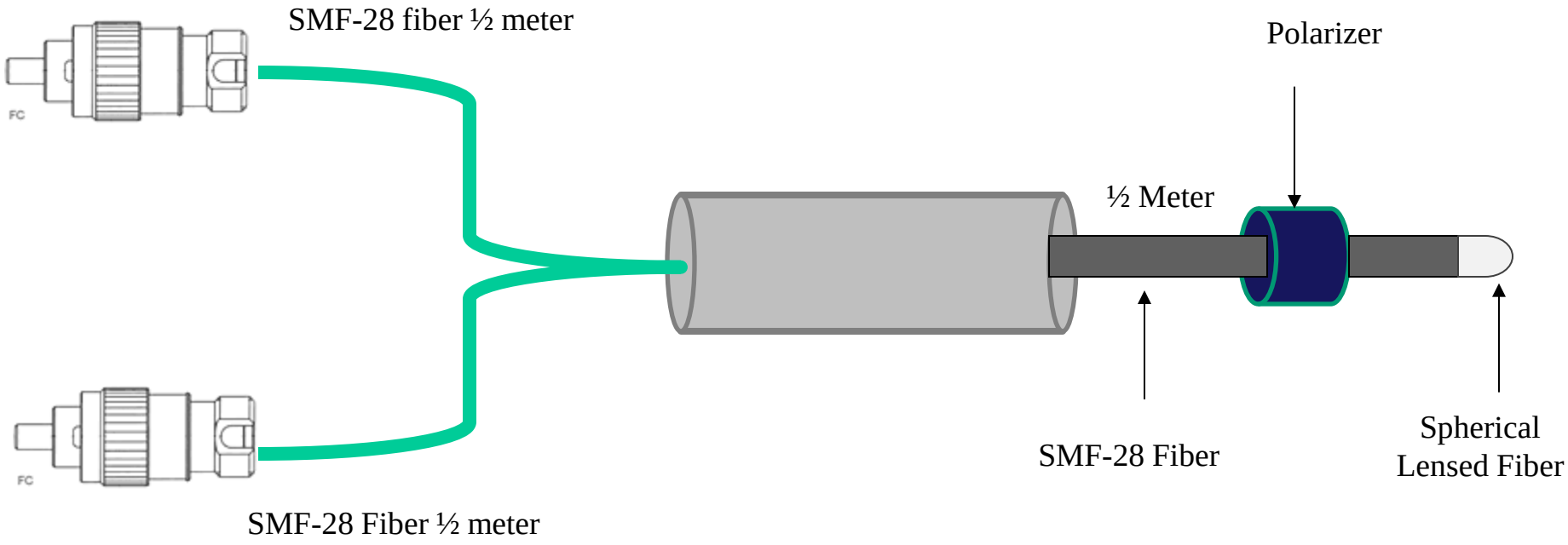




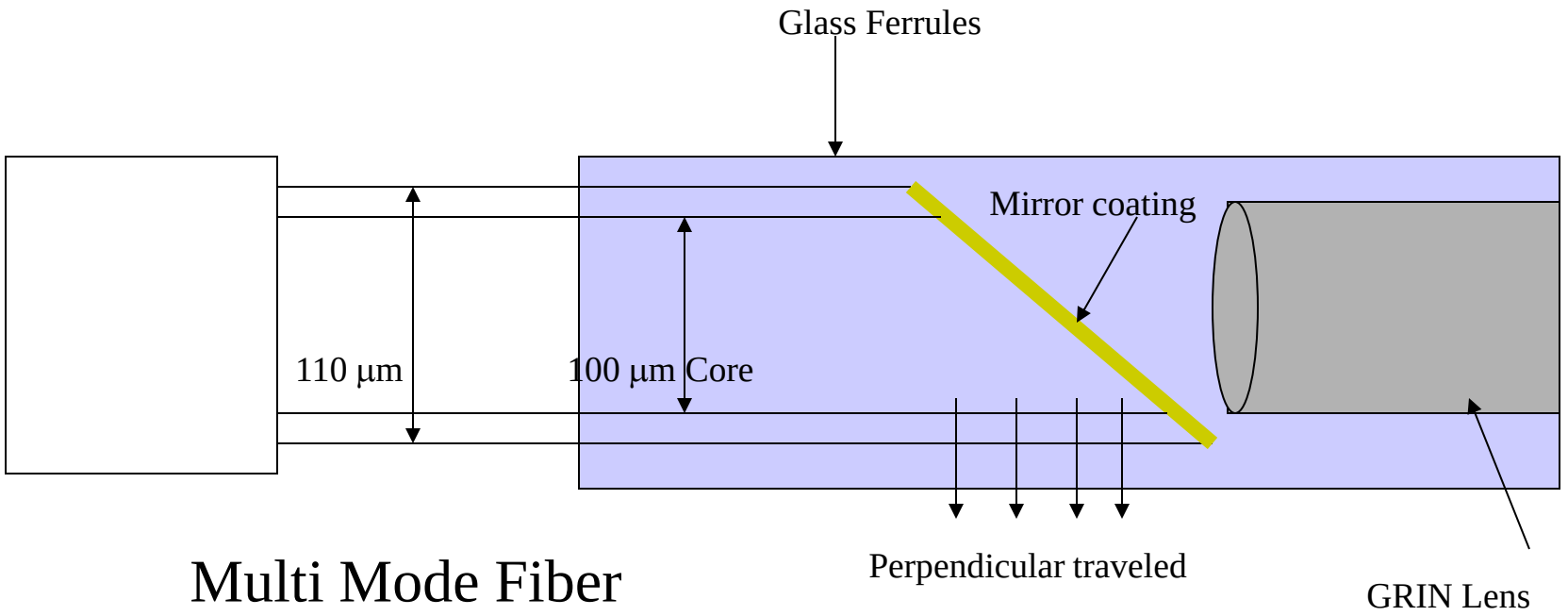
Multi Mode Fiber
Double Wedge Lens
not Conical Tip

LaseOptics-Side firing fiber with 45° Angle Mirror Coated

SMF-28 Coupler with Fiber Polarizer with Spherical Collimated Lens

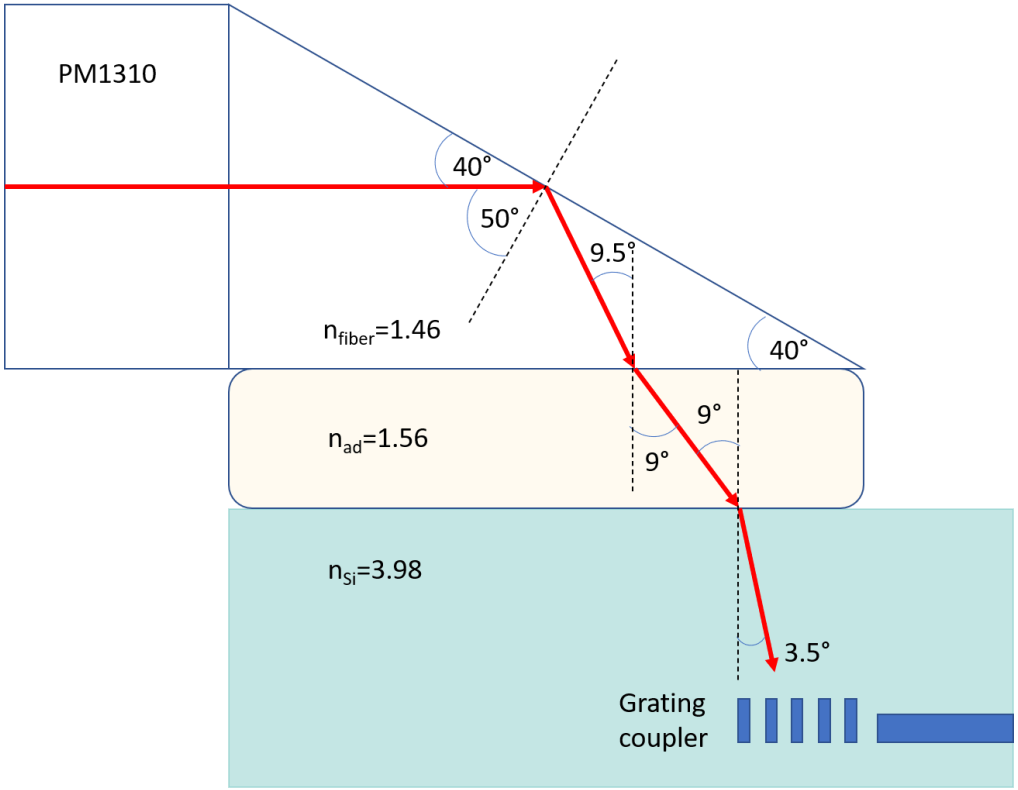


LaseOptics-Side firing fiber with 45 degree Angle Mirror Coated with Grin Lens

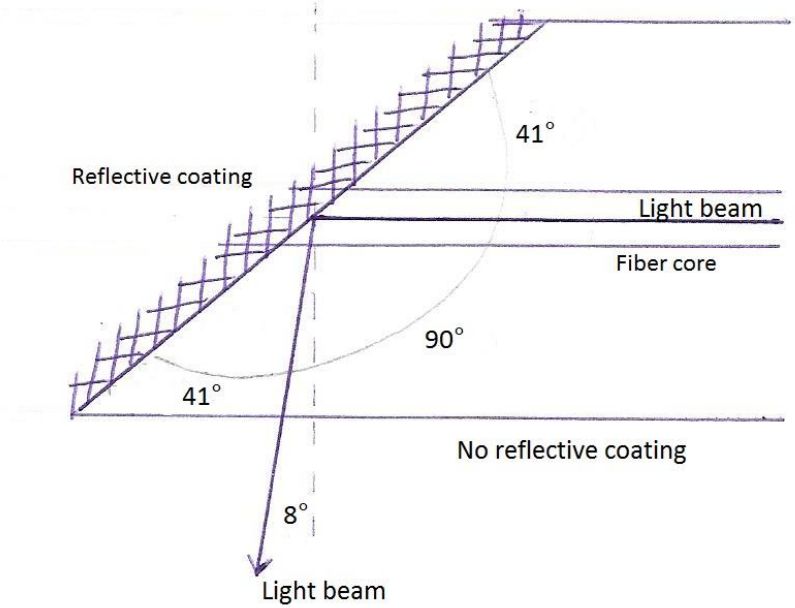


Multi Mode Fiber

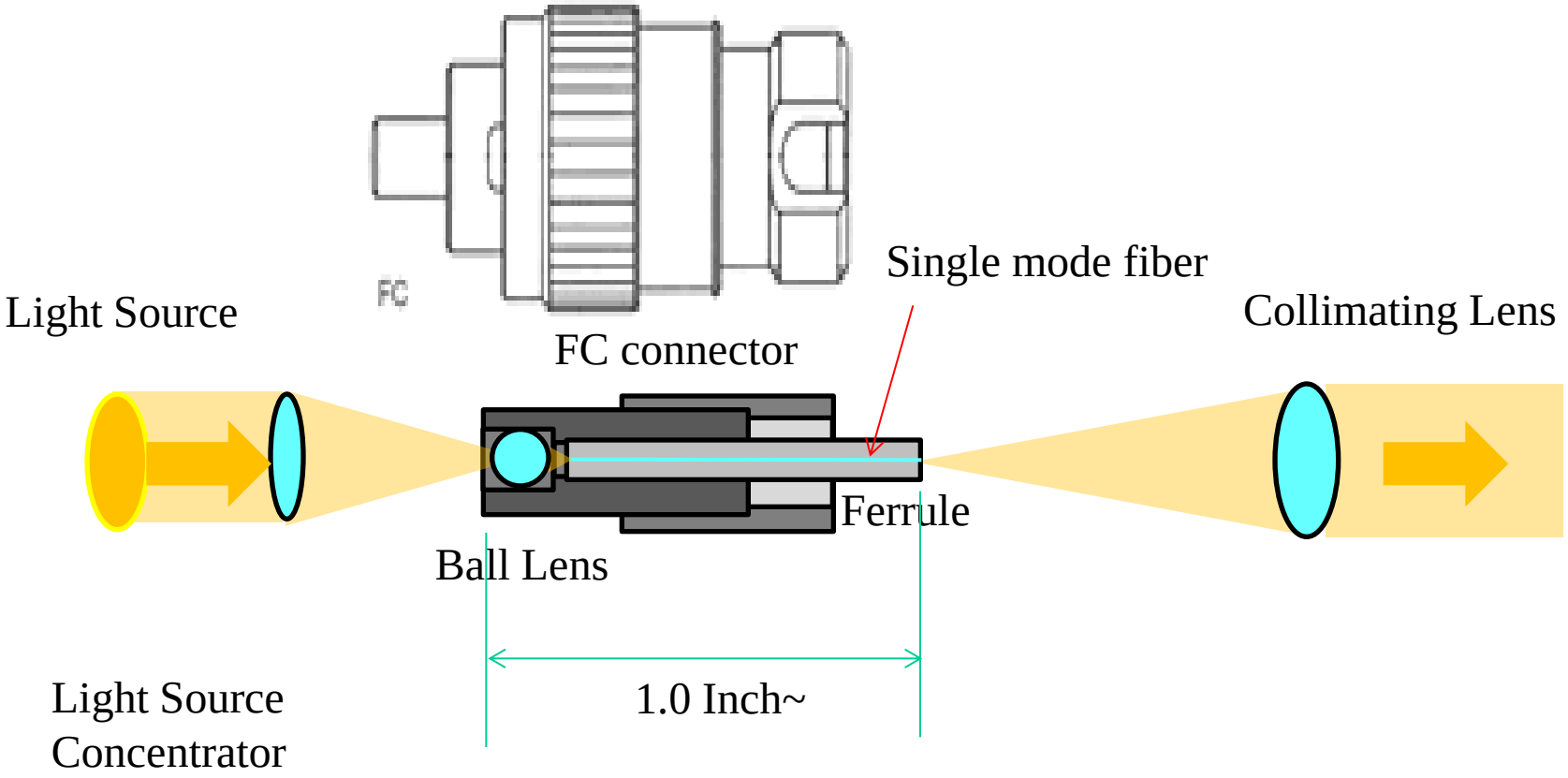
LaseOptics-Side firing fiber with 41° Angle Mirror Coated with Grin Lens



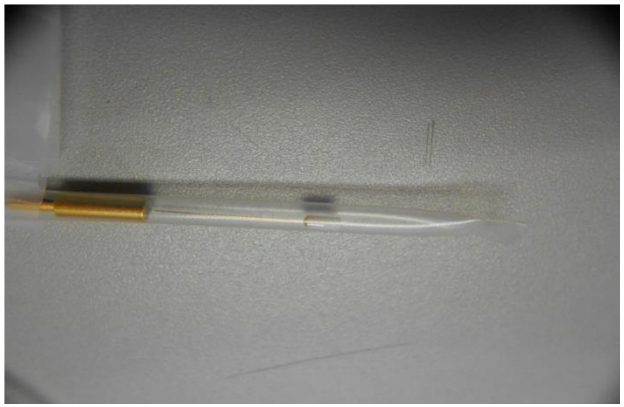
Fiber end facet: side view

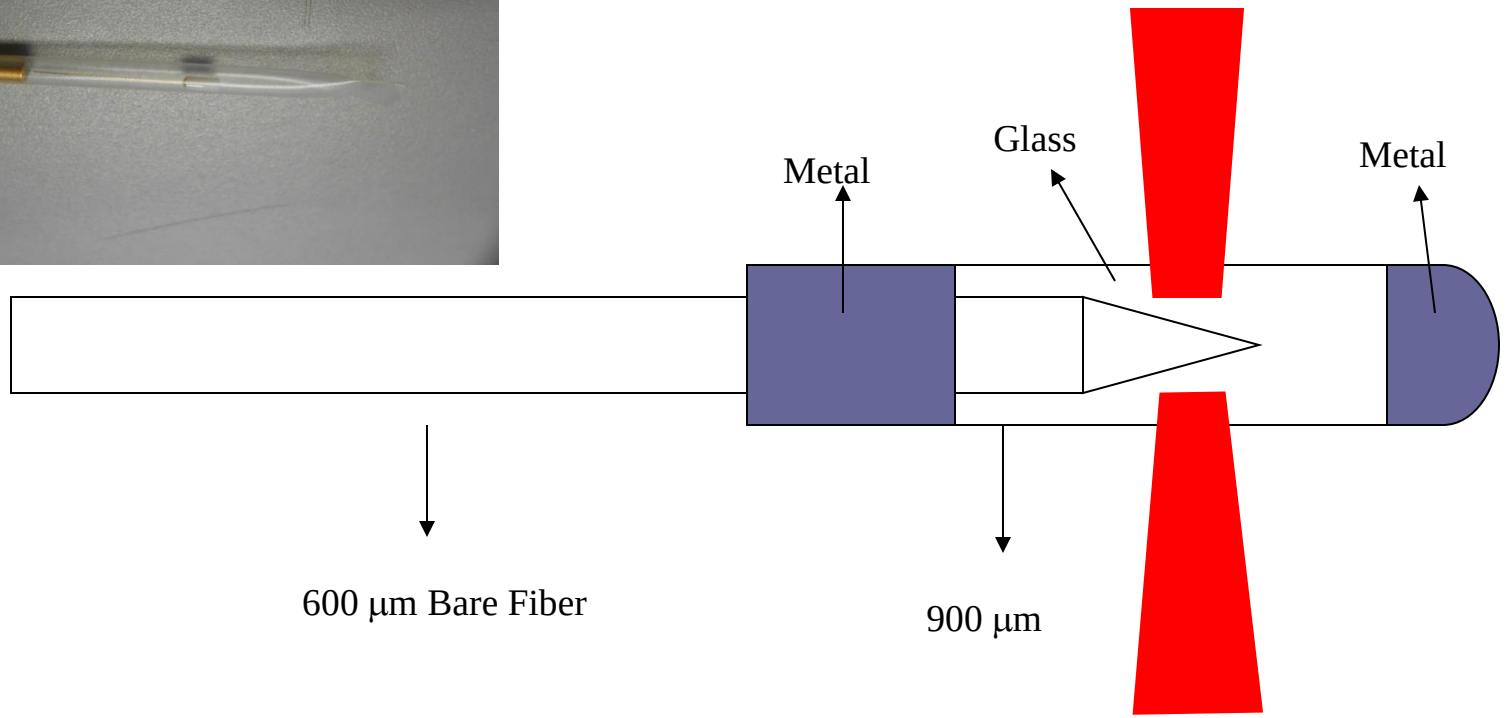


Star Tester Source with Ball Lens in FC Connector Small Package



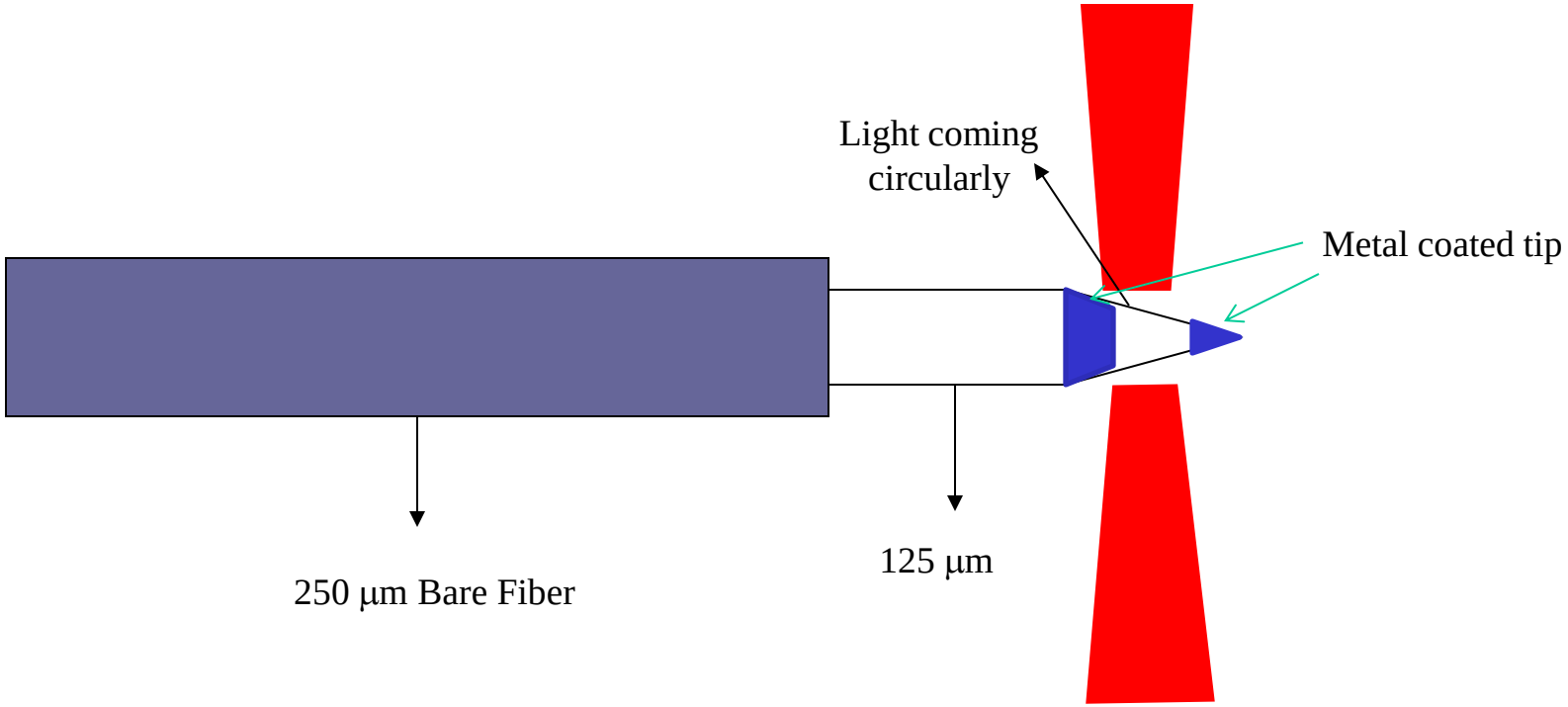
Ring Side Firing Lensed Fibers of 600/660/710 MM Fiber



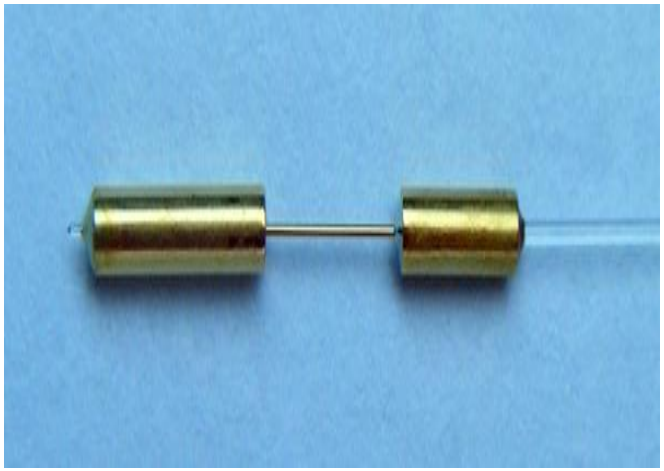


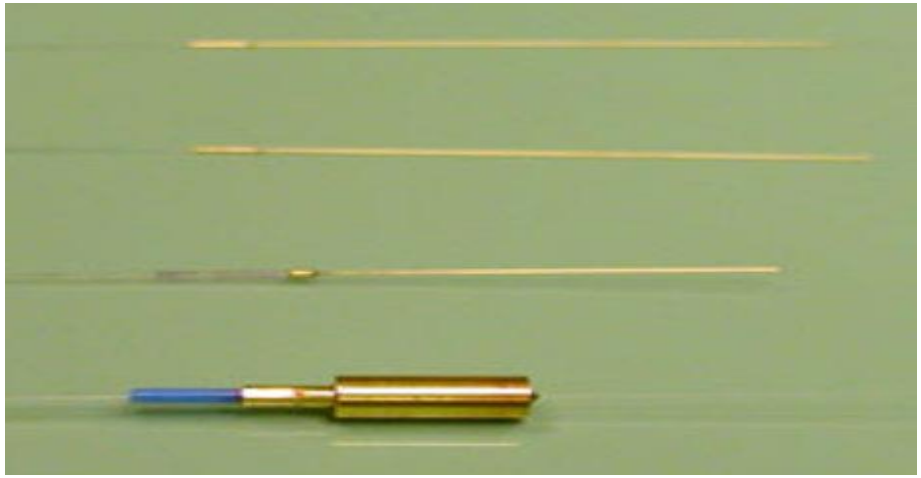
Side Firing Lensed Fiber (Bare Fiber)

Circularly/Ring Focused on Center Lensed Fibers SMF-28

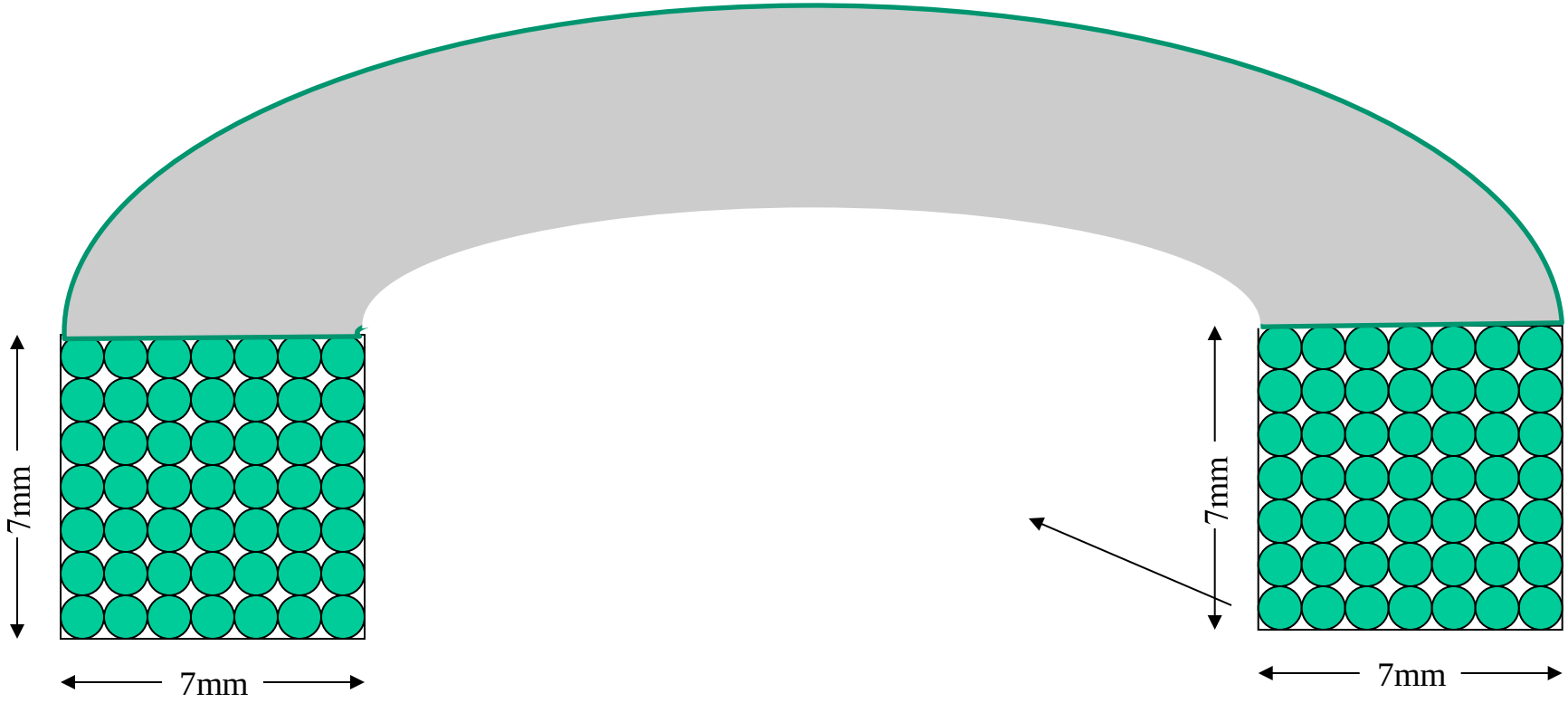


LaseOptics-Ferrule with any Lensed Fibers Packaging





300µm Diameter 2D Ball Lensed Fiber Arrays in Matrix Square Package

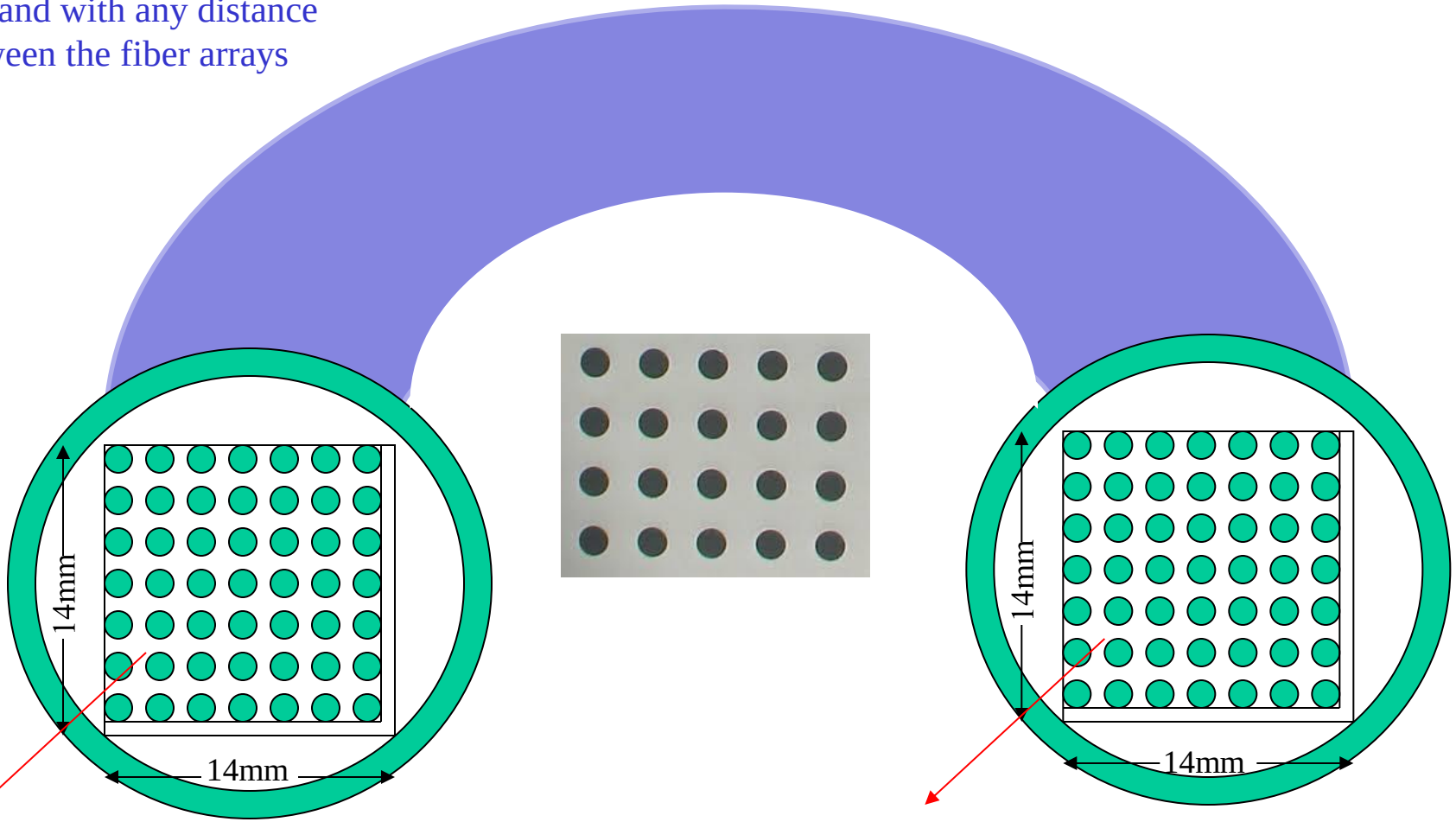


The distance between each fiber would be ~500 micron

The distance between each fiber would be ~500 micron

100/110/140 Multi Mode Fiber with 49 Ball Lenses in 2D square package

We can make any type of fibers and with any distance between the fiber arrays

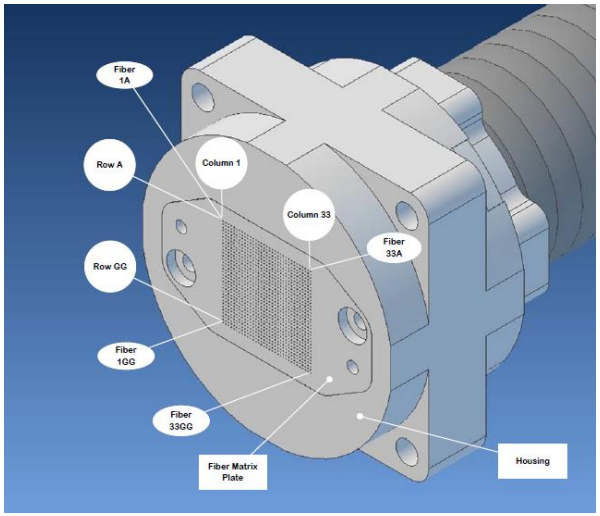


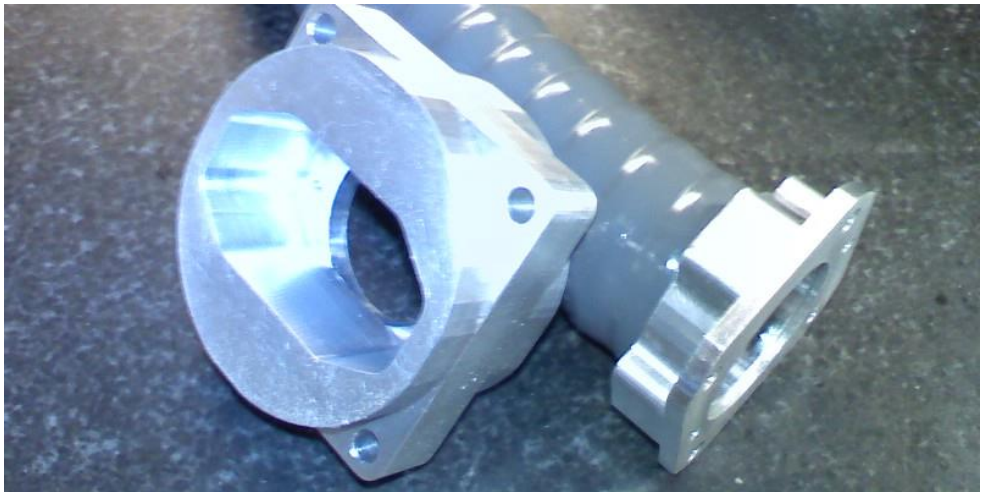
The distance between each fiber would be ~1000 micron

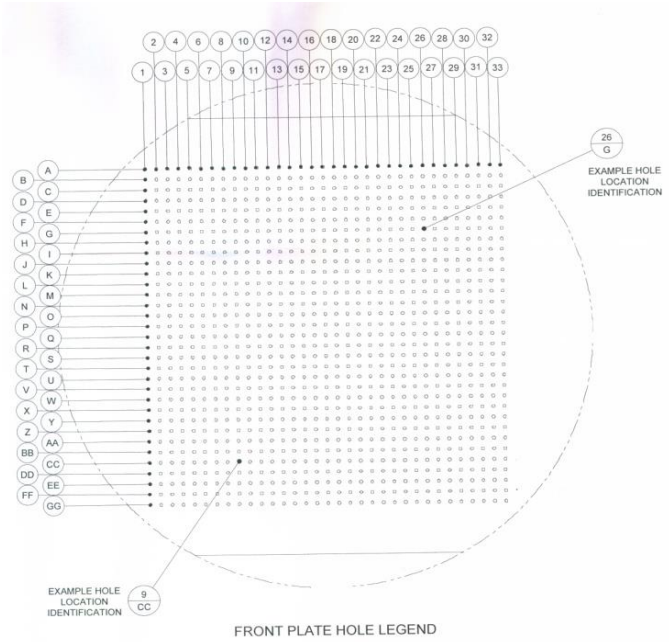
The distance between each fiber would be ~1000 micron

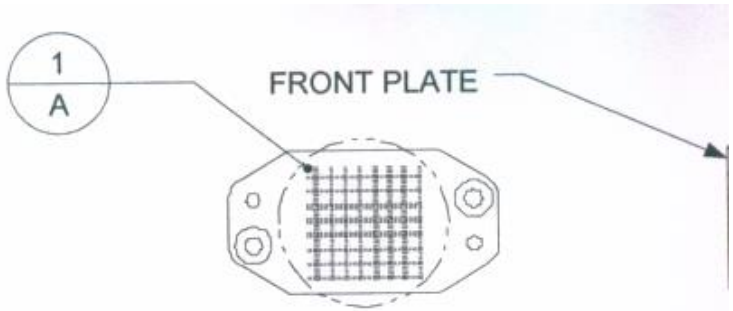
Circular Ferrule or Steel Rigid Tube

100/110/140 Multi Mode Fiber with 49 Ball Lenses in 2D square package



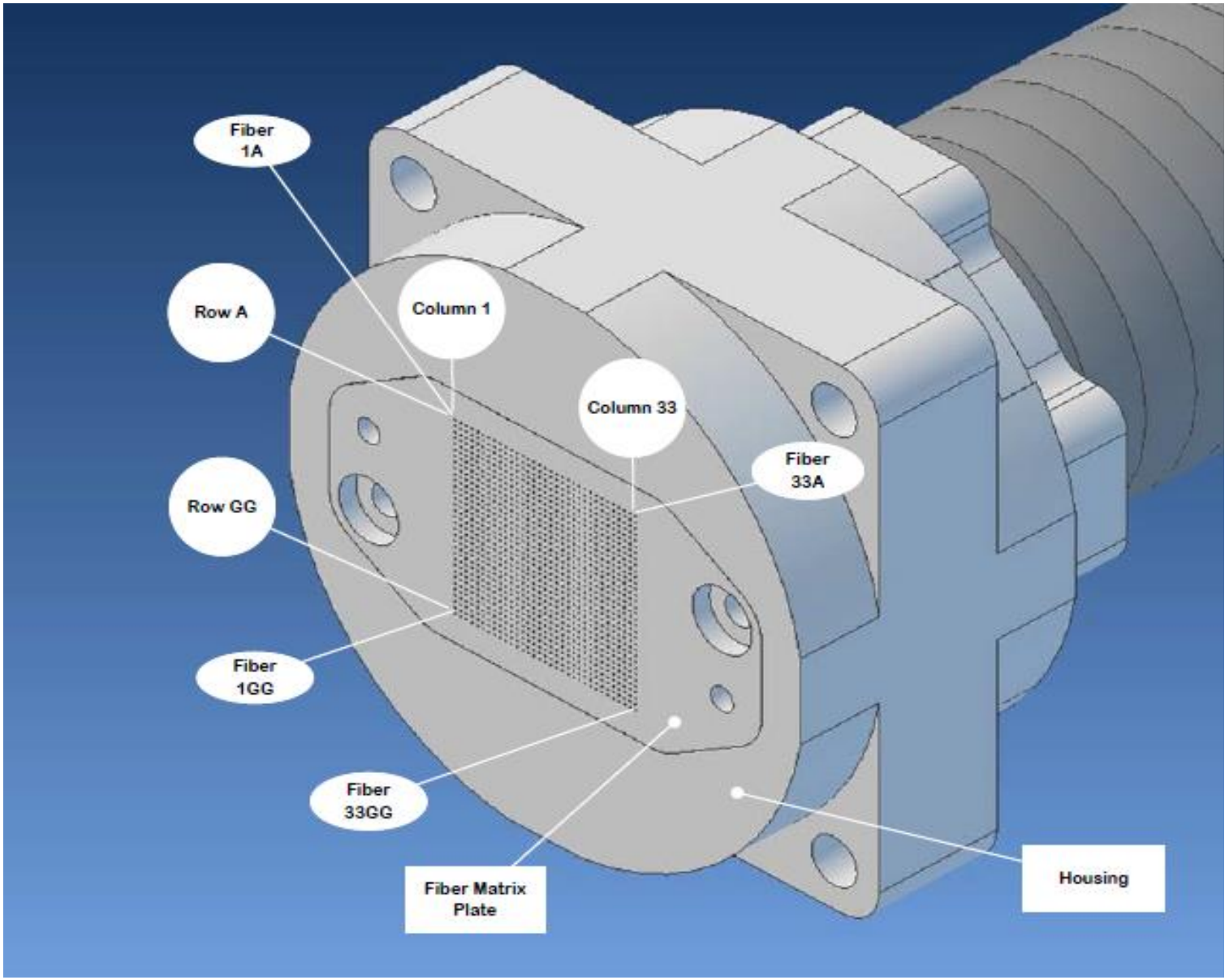




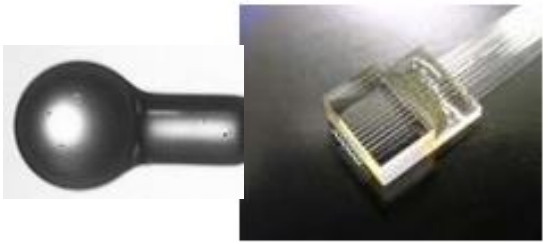


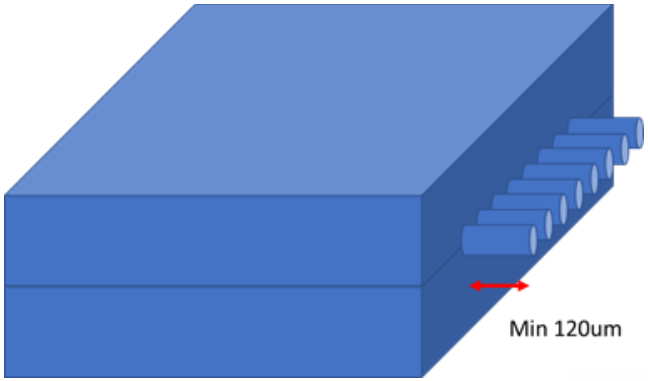
100/110/140 Multi Mode Fiber with 33 x 33 Ball Lenses in square package (1089)

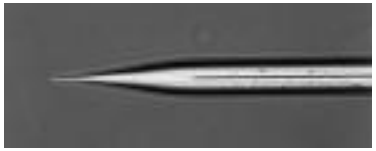
100/110/140 Multi Mode Fiber with 33 x 33 Ball Lenses in square package



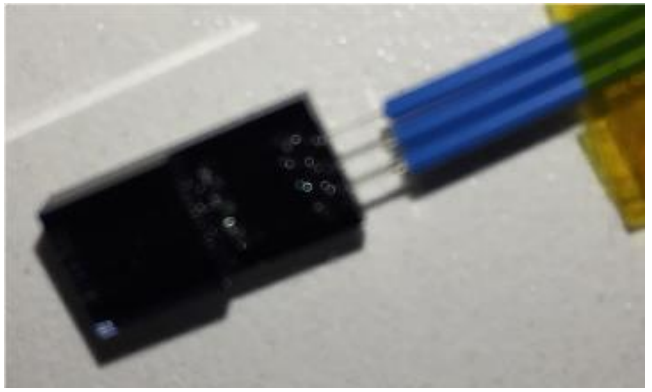
Ball Lensed Fiber Array 10 Channels

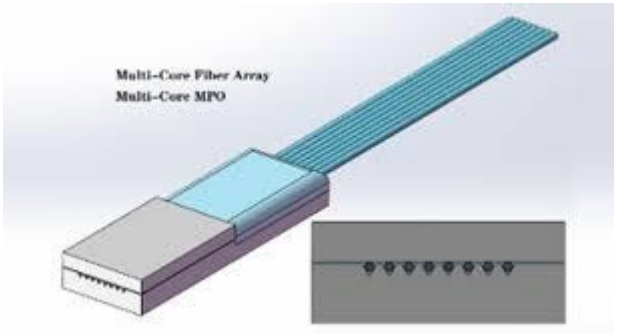






Conical Lensed Fiber Array 10 Channels

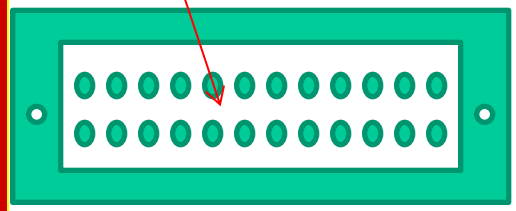


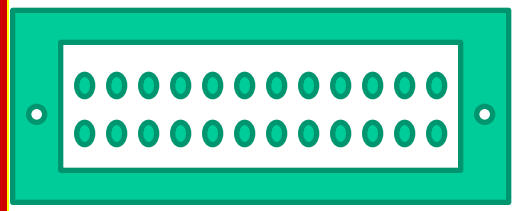


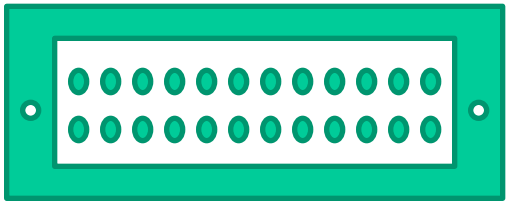
Lensed Fiber Arrays on Silicon V-grooves 4, 6, & 10 Channels

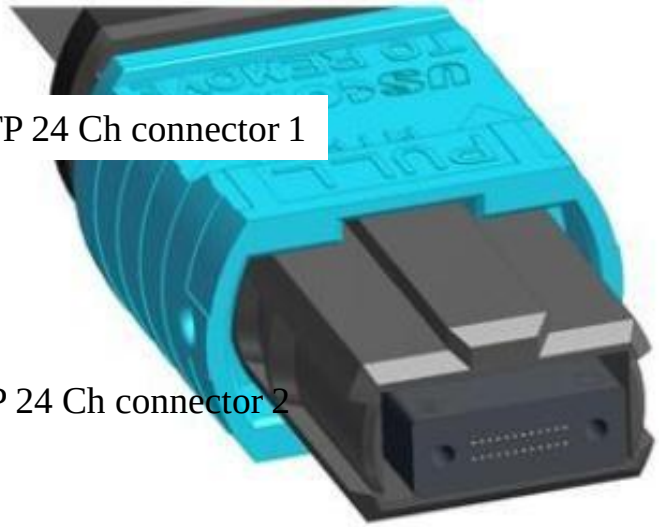
MTP connector 24 channels with multi mode fiber of 62.5/125 output end FC/PC 7 MTP connectors each MTP connector contains 24 channels/fibers 24 fibers insert into 1 FC/PC connectors of 1 MTP connector

24 Fibers 62.5/125 MM









MTP 24 Ch connector 1

MTP 24 Ch connector 2

MTP 24 Ch connector 3

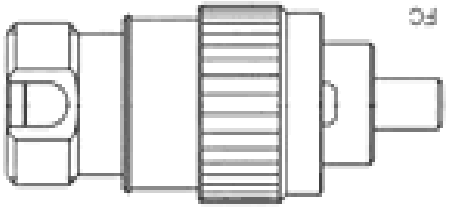
MTP 24 Ch connector 4

MTP 24 Ch connector 5

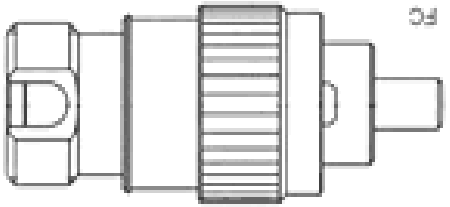
MTP 24 Ch connector 6

MTP 24 Ch connector 7

SMA 1



SMA 2



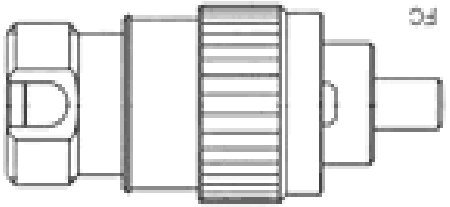
SMA 3

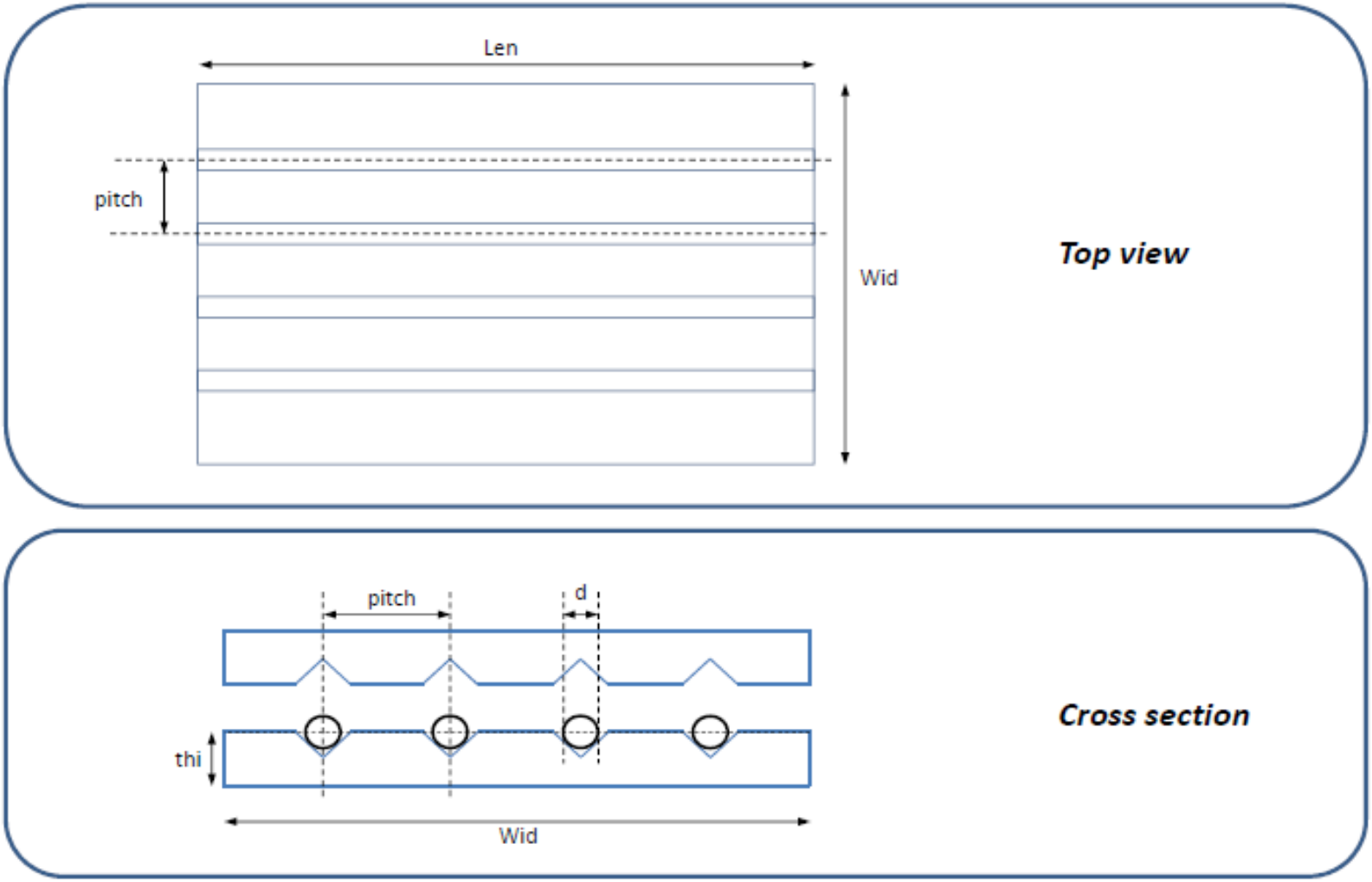
SMA 4

SMA 5

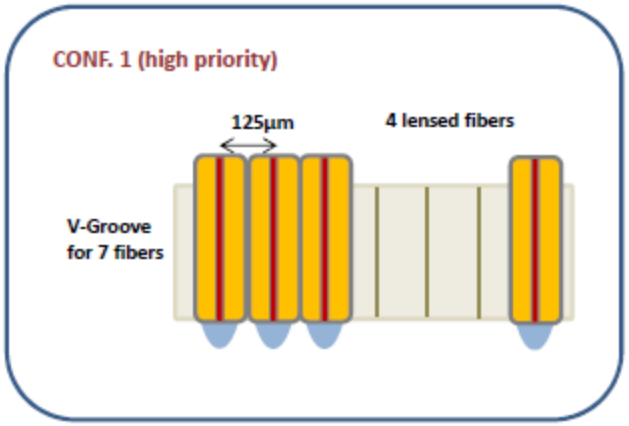
SMA 6

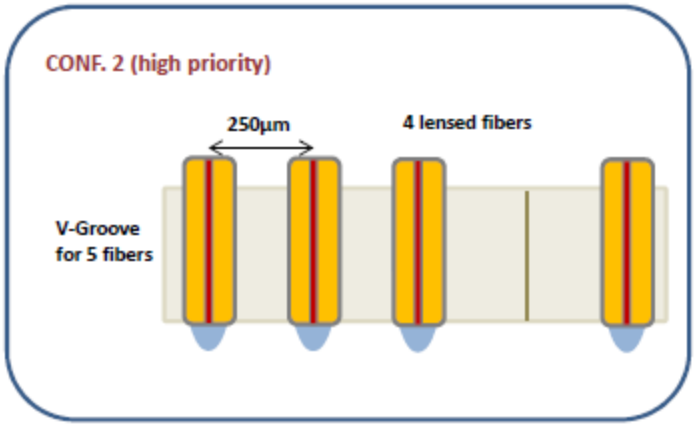
SMA 7

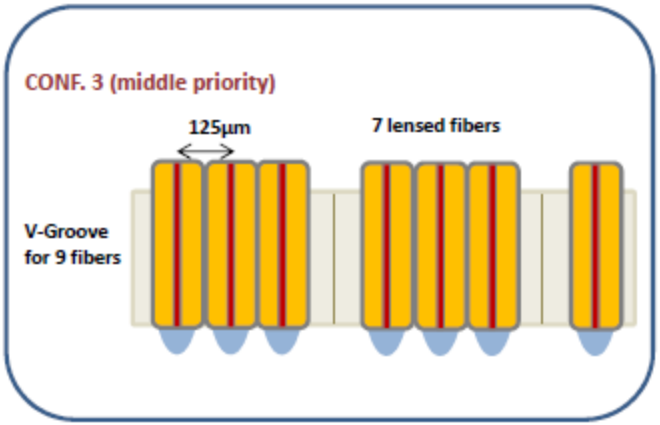


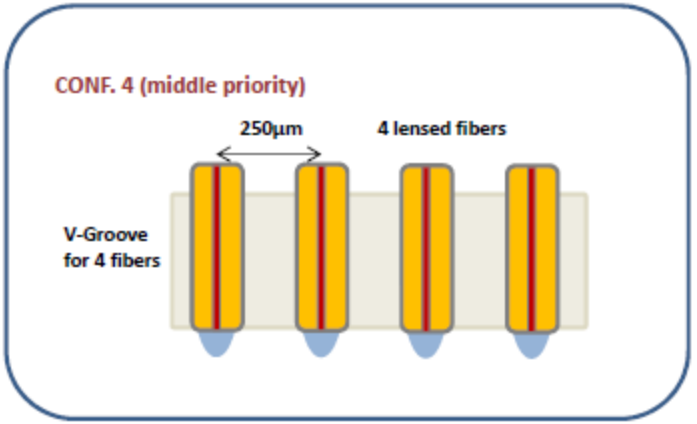


Arrays Silicon V-grooves Top & Cross Section View



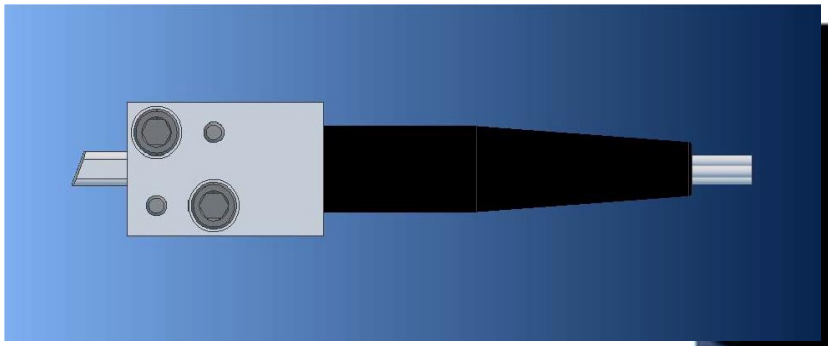


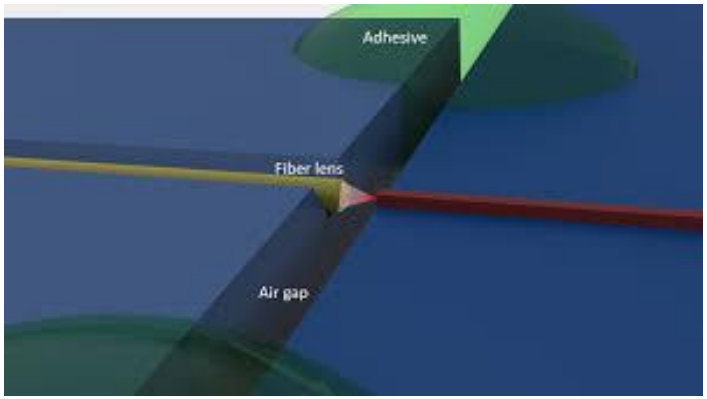


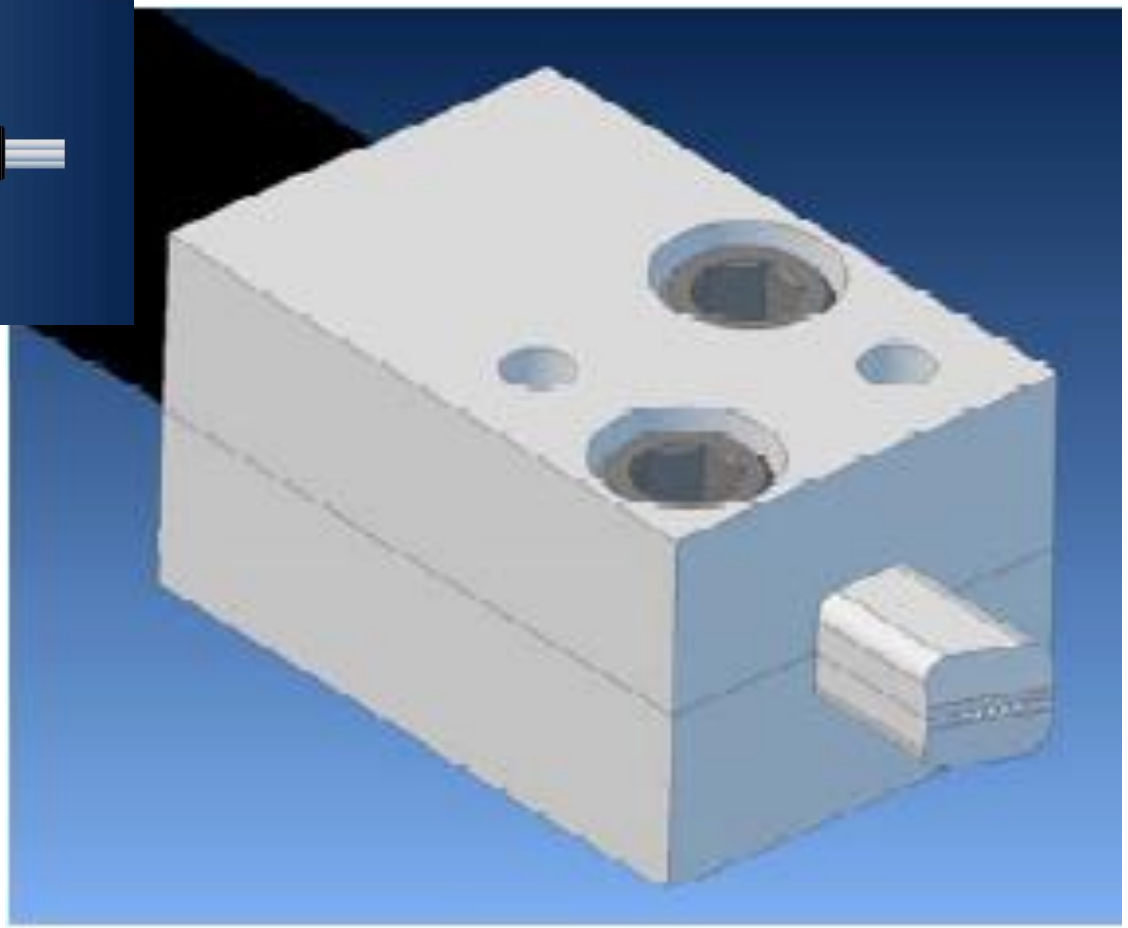


Lensed Fiber Arrays on V-grooves with skipping some channels

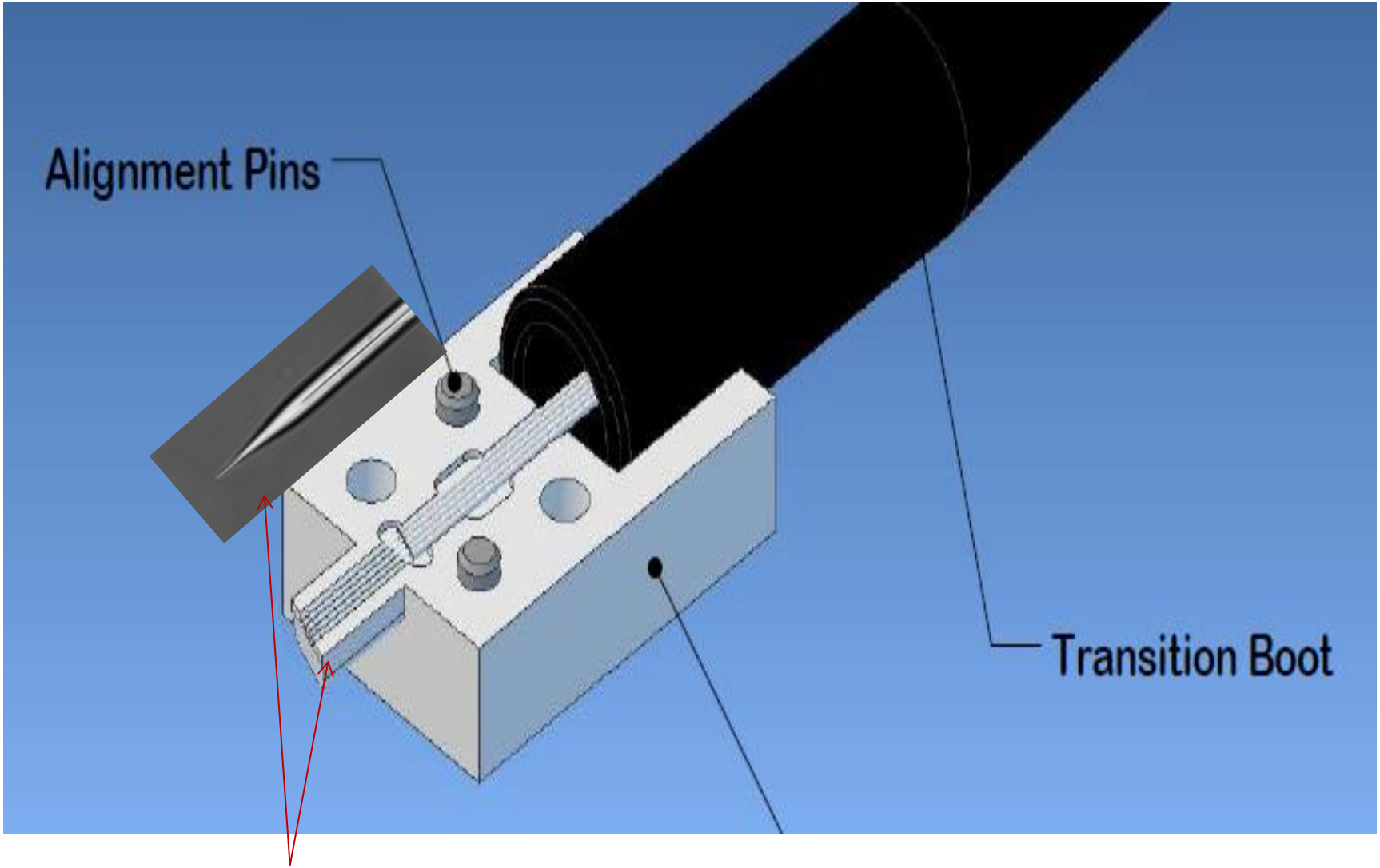
Angled Conical Lensed Fiber Array 5 Channels



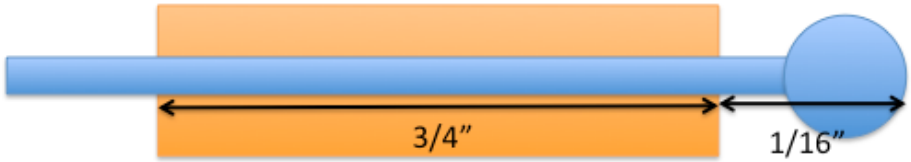


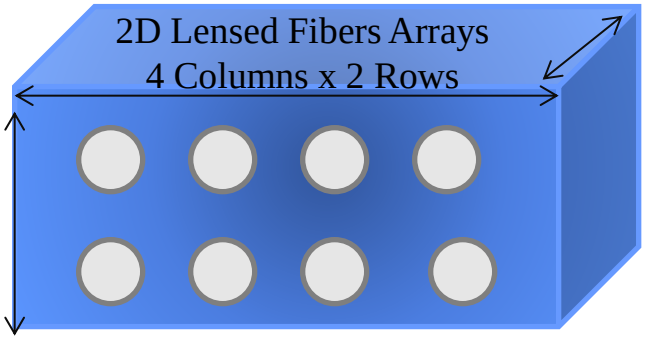


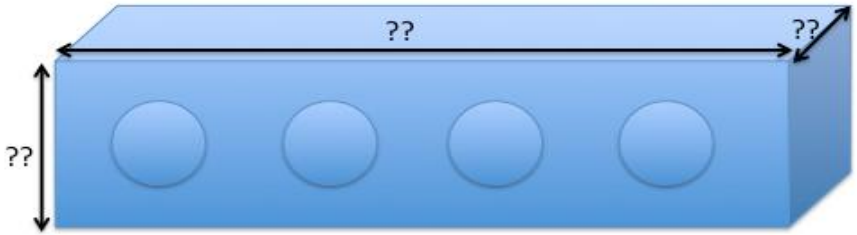
Angled Array Conical Lensed Fiber 5 Channels

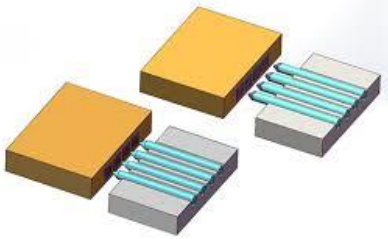


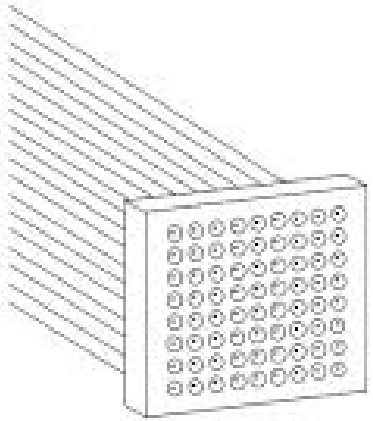
Ball Lensed 2D Fiber Arrays 4 or 6 or 8 or 10 Channels





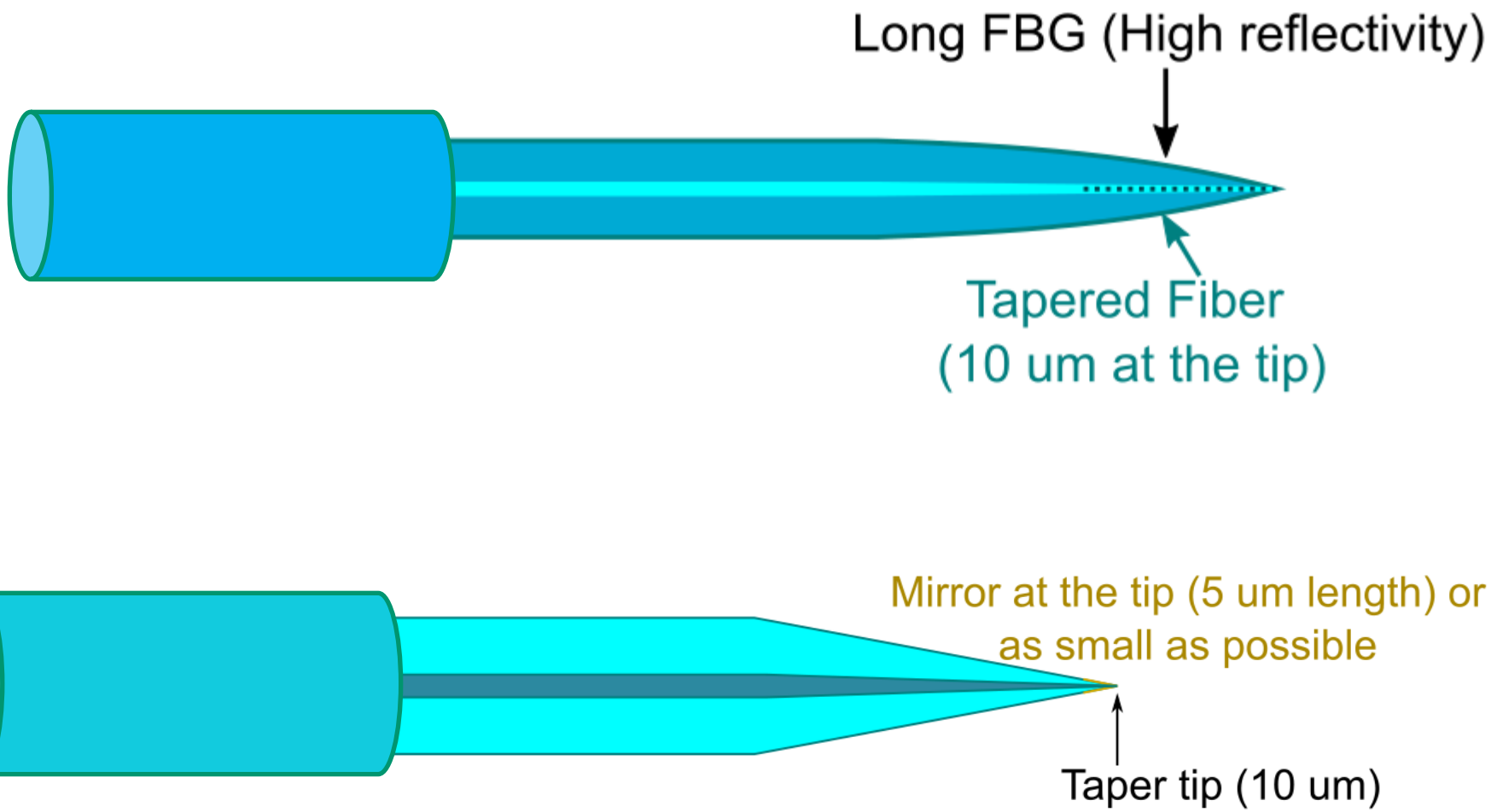




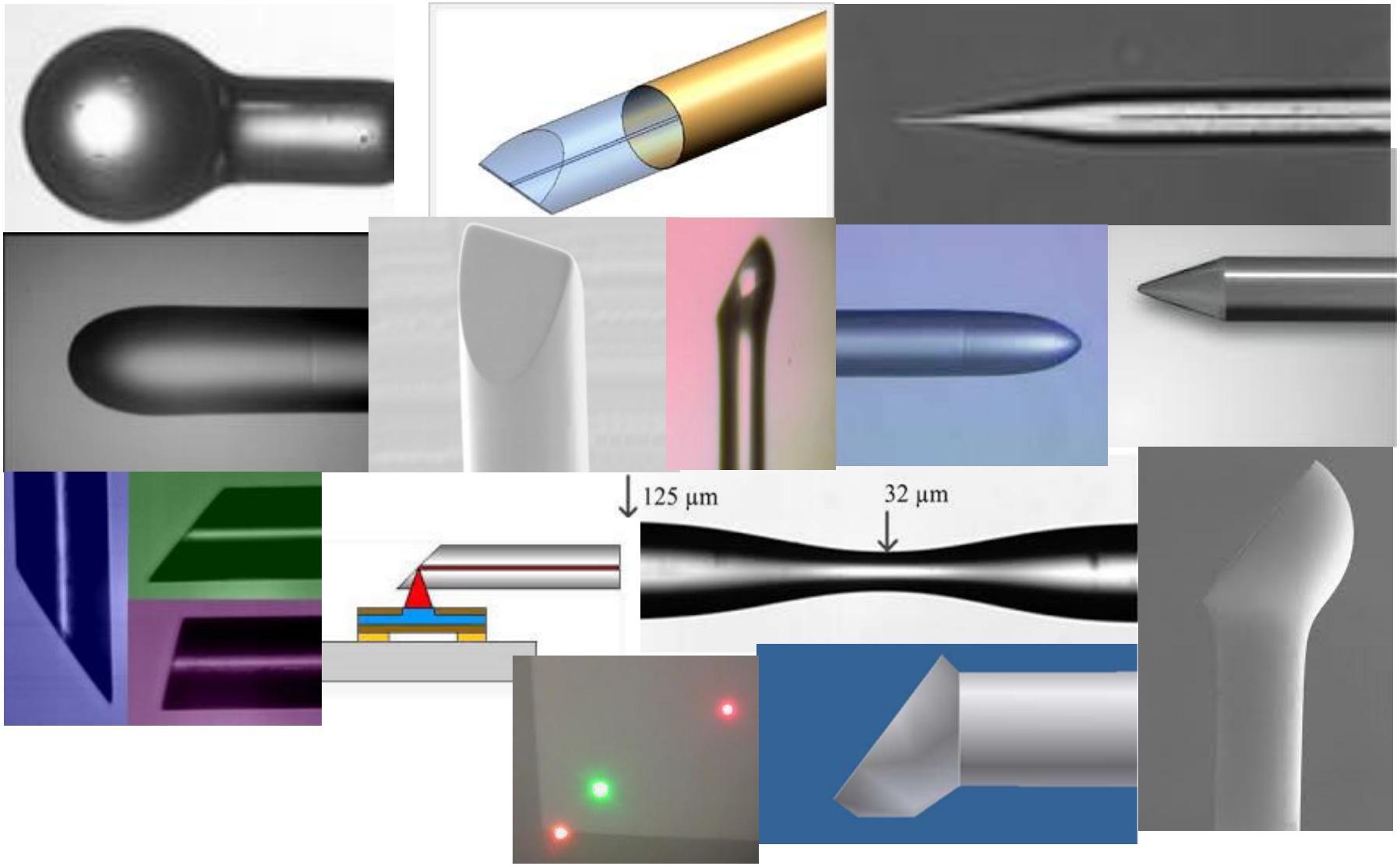


Lensed Fiber Arrays on Silicon V-grooves 4, or 2D Arrays

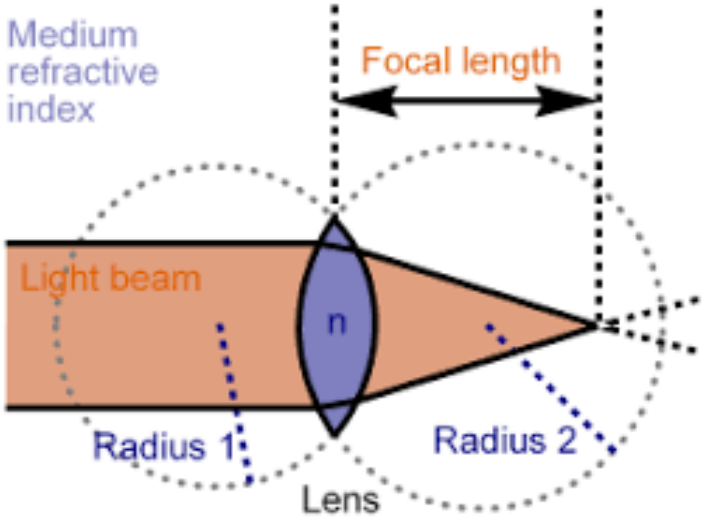
Lensed Fiber with Fiber Brag Grating

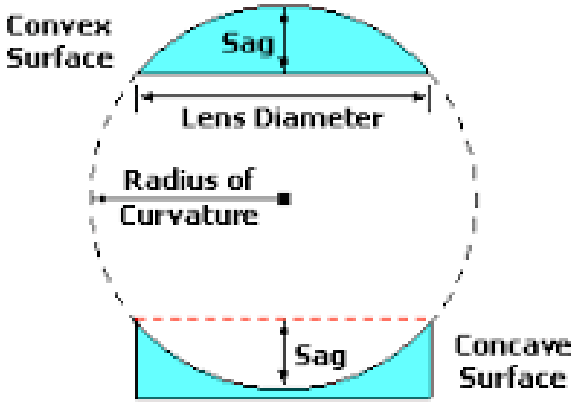


Different Shapes of Lensed Fibers for Different Application

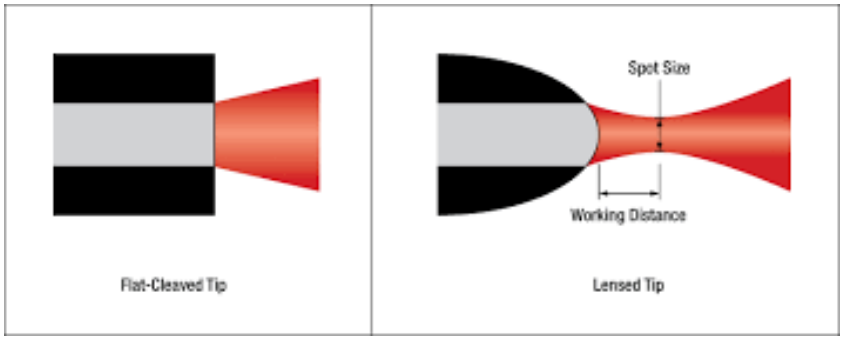


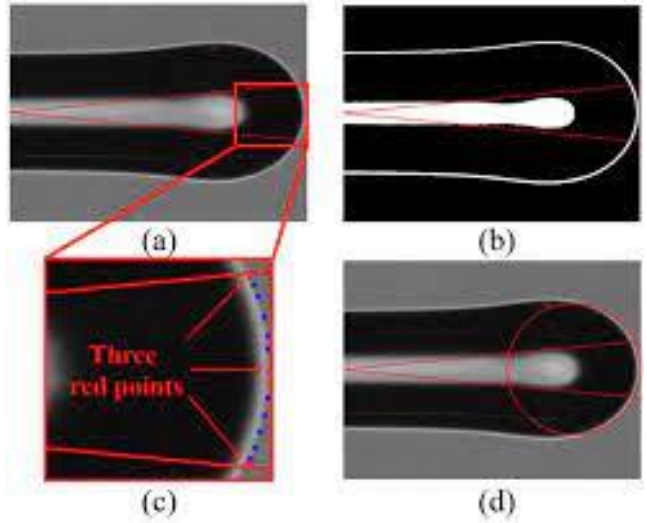
Lensed Fibers Different Parameters

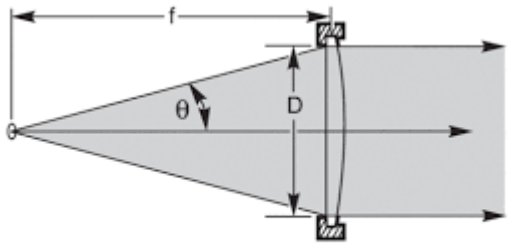




Geometry of a Lens Surface







$F\# = \frac{f}{D}$ N.A. ≈ SIN θ

THANK YOU