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How Quality Fiber Optics and Connectors Affect PDV Data

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A continuing education from PDV experimenters

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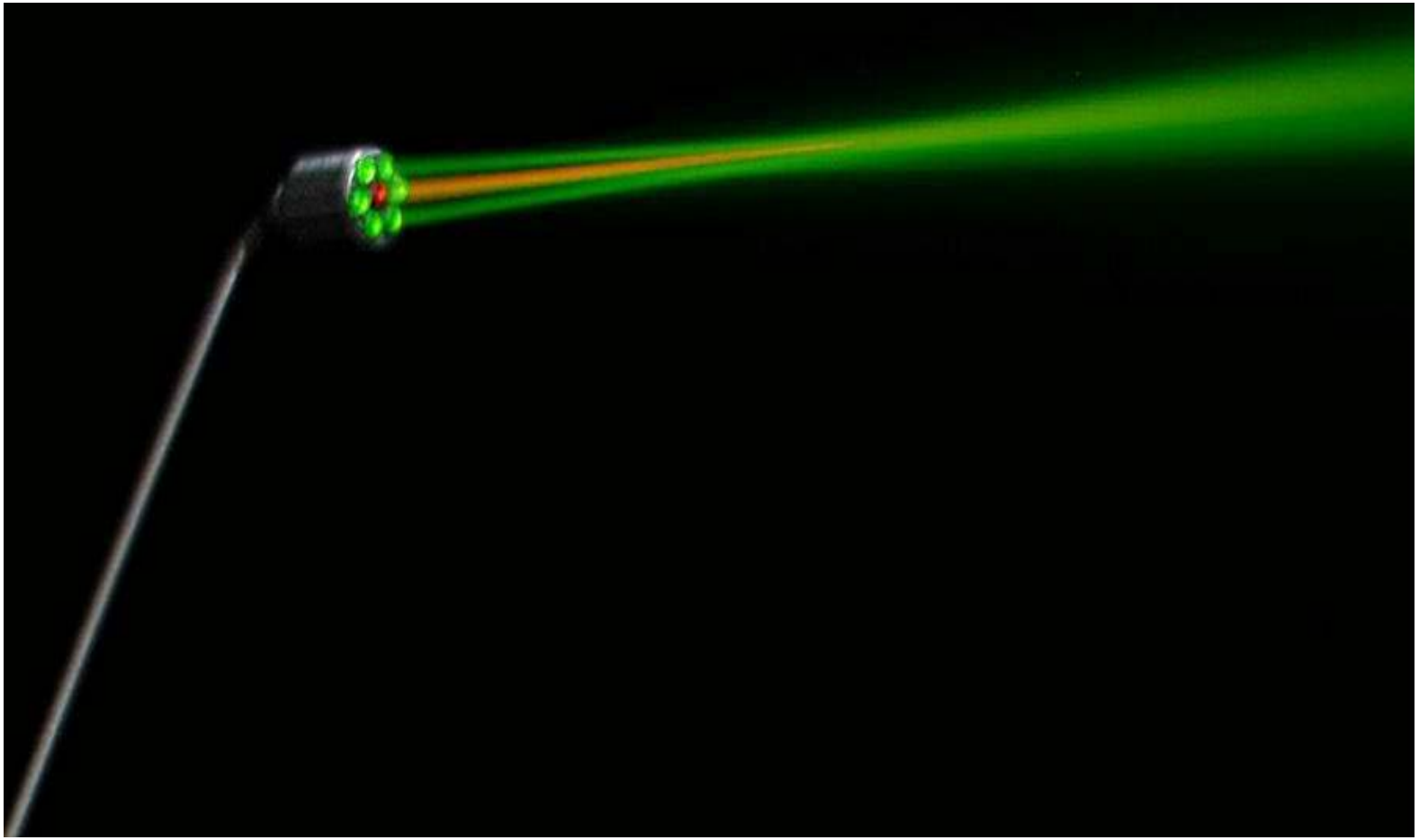
Fiber optic torch



Excellent Probes Give Excellent Data

Good Probes Give Good Data

Bad Probes Give Bad Data

Excellent Probes

Plus
Bad Connectors

equals

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This talk covers the following topics:

- Basic theory of PC polish for connectors
- Fusing fiber optics versus FC/APC connectors
- Types of FC/APC connectors
- Types of connector feed-thrus
- Testing of connectors
- Different probes

FC/PC Connectors:
The FC/PC connector is one of the original 2.5 mm ferrule technology designs. Starting out as the **FC connector** (**sometimes known as face contact**), the FC/PC connector (**PC is sometimes referred to as physical contact**) is an improvement of the original design. The radiused ferrule end face of the FC/PC connector allows the optical fibers to touch, thus eliminating the air gap that usually results with the original FC design. With the optical fibers in contact the attenuation decreases and the amount of light reflected back (Return Loss) to the source also decreases. A typical FC connector has a return loss of about -14 dB ---- where an FC/PC connector will have a return loss of -30dB. Using special polishing techniques an **FC/PC connector can be made to have Super PC (-40 dB) or Ultra PC (-50 dB) return loss characteristics**.

FC/PC is always narrow key and wide slot.

The FC/APC (Angled Physical Contact) connector provides

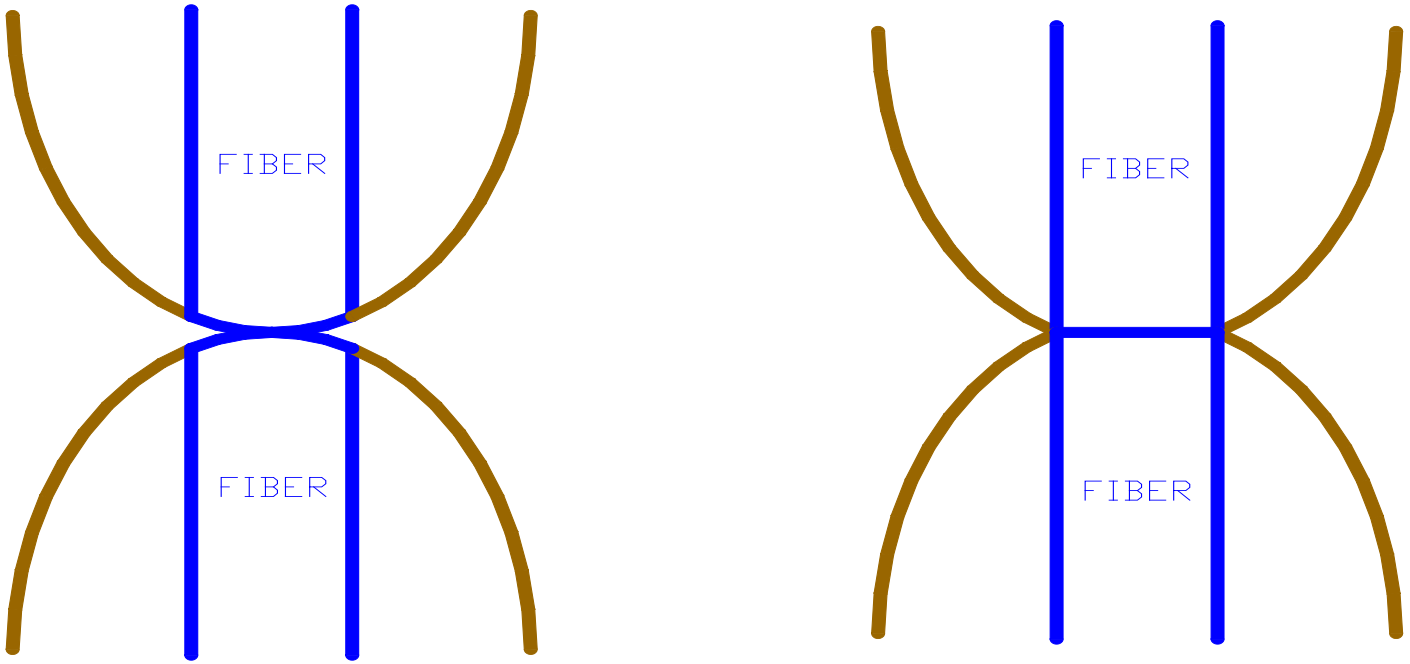
return loss better than -60dB

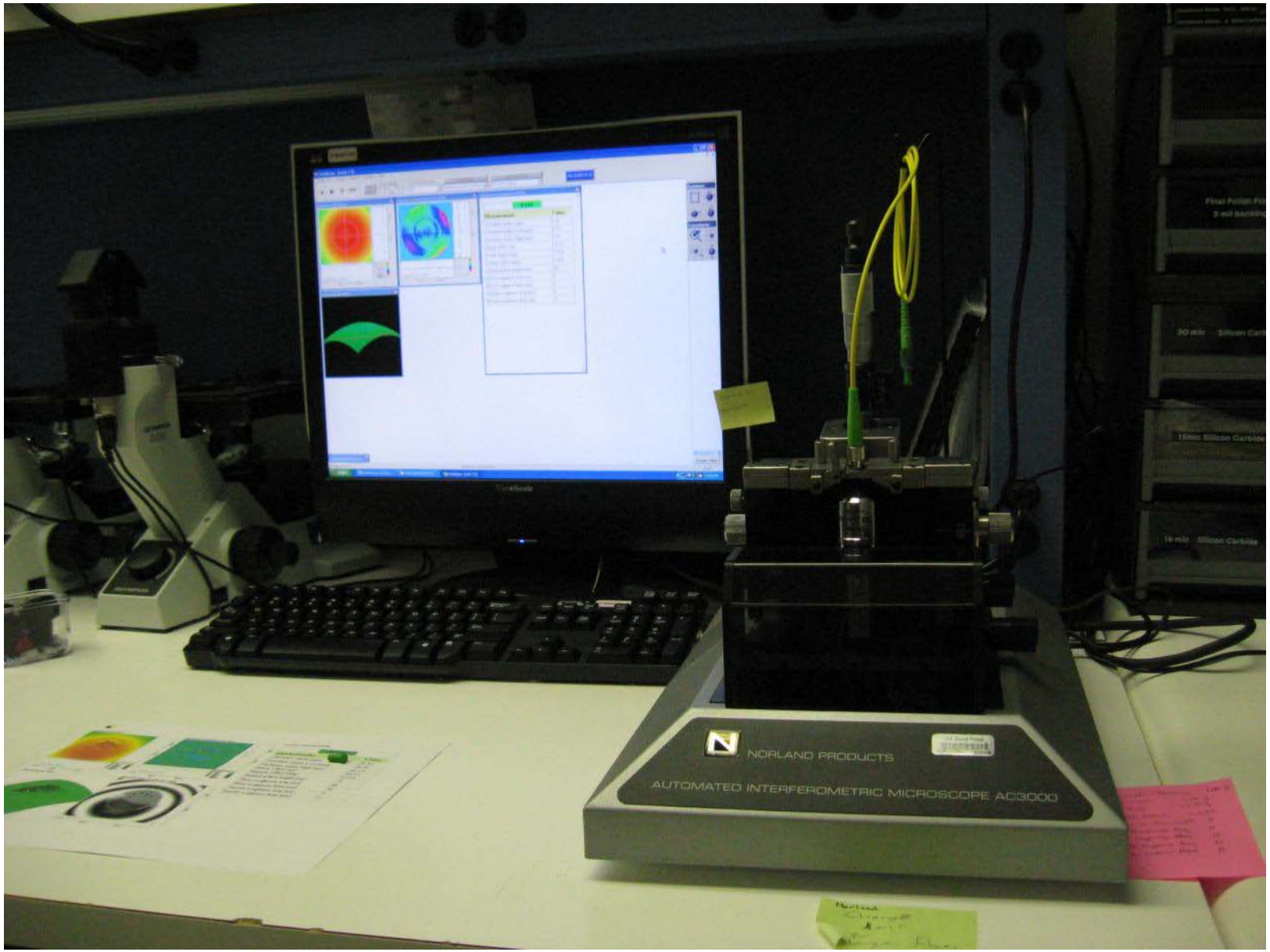
and has a **tight-fit key** **configuration to improve performance. This ensures a minimum insertion loss and a maximum return loss. The FC/APC connector is intended for CATV & telecommunication network applications.**

PC polish concept

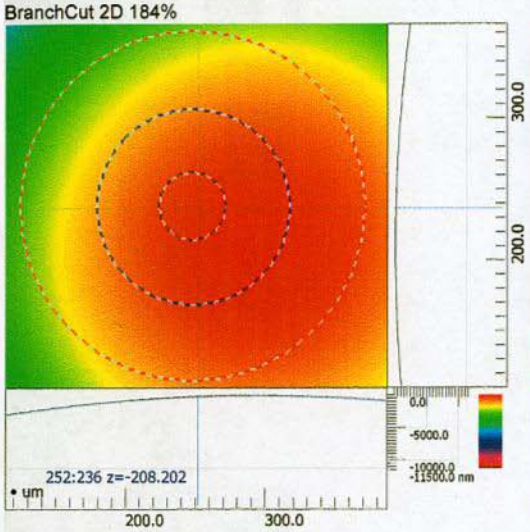
On Connection

- Fibers meet in intimate optical contact. No air gap.
- Fibers compress until ferrules contact.
- Ferrules take majority of compressive force.

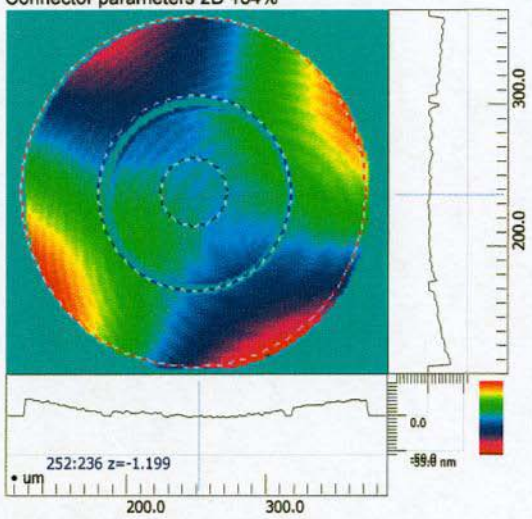



NORLAND PRODUCTS
AUTOMATED INTERFEROMETRIC MICROSCOPE AC3000

BranchCut 2D 184%



Connector parameters 2D 184%



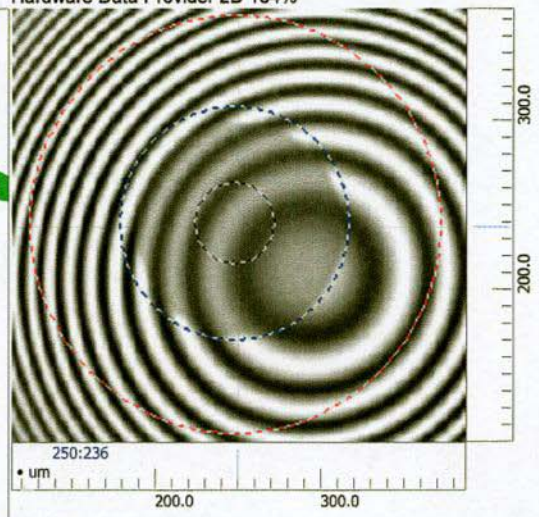
Connector parameters HTML

FAIL

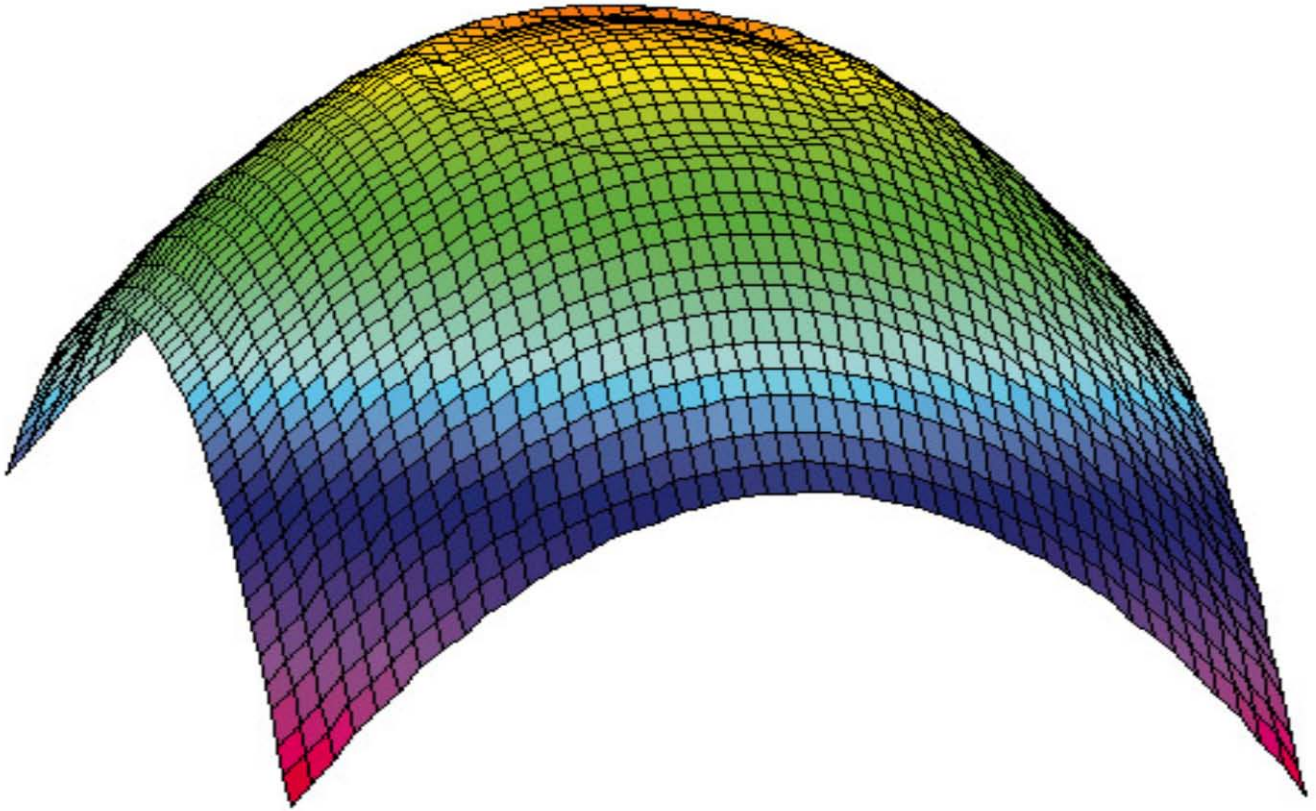
Measurement	Value
Curvature radius (mm)	5.43
Curvature radius Low (mm)	5.25
Curvature radius High (mm)	5.61
Linear offset (um)	48.24
Polish Angle (deg)	8.280
Keying Offset (deg)	0.425
Spherical fiber height (nm)	25
Fiber roughness Avg (nm)	5
Fiber roughness Max (nm)	6
Ferrule roughness Avg (nm)	20
Ferrule roughness Max (nm)	23

BranchCut 3D 184%

Hardware Data Provider 2D 184%

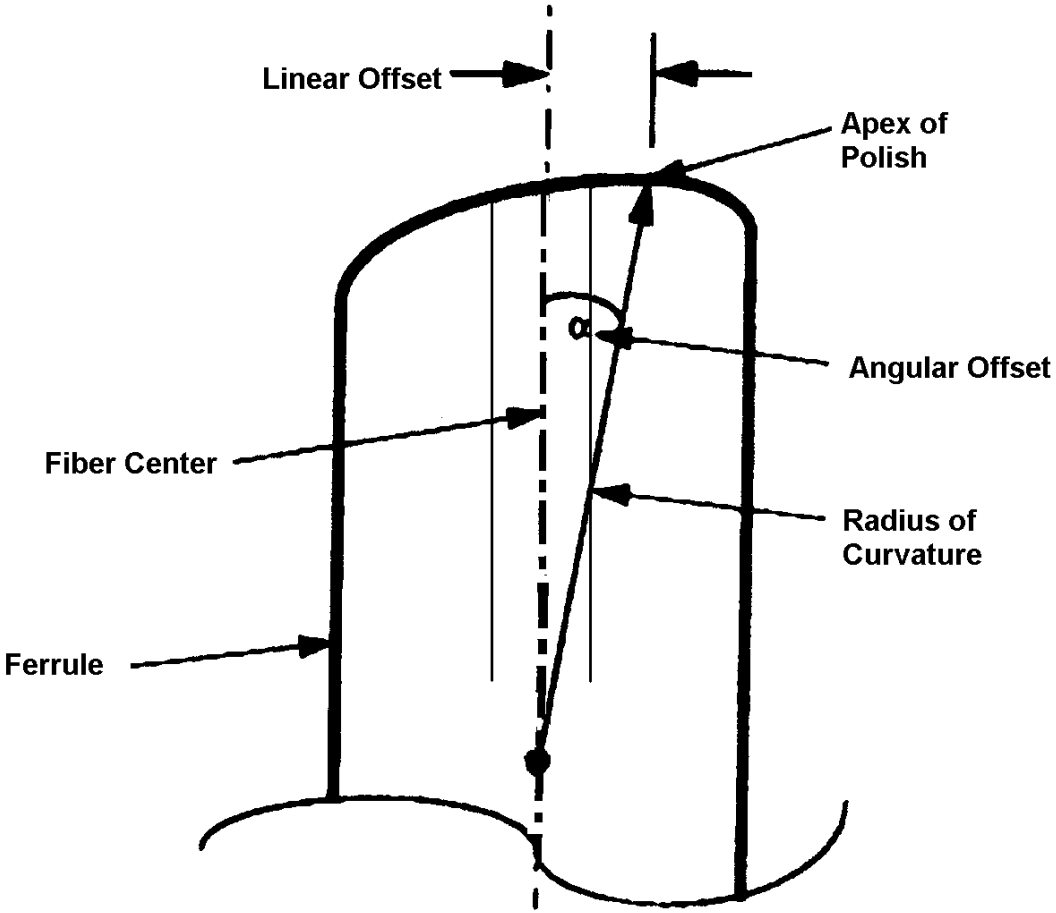


3-D measurement



Offset of polish

Distance from center of fiber to highest point of ferrule



Fusing fiber optics verses FC/APC connectors

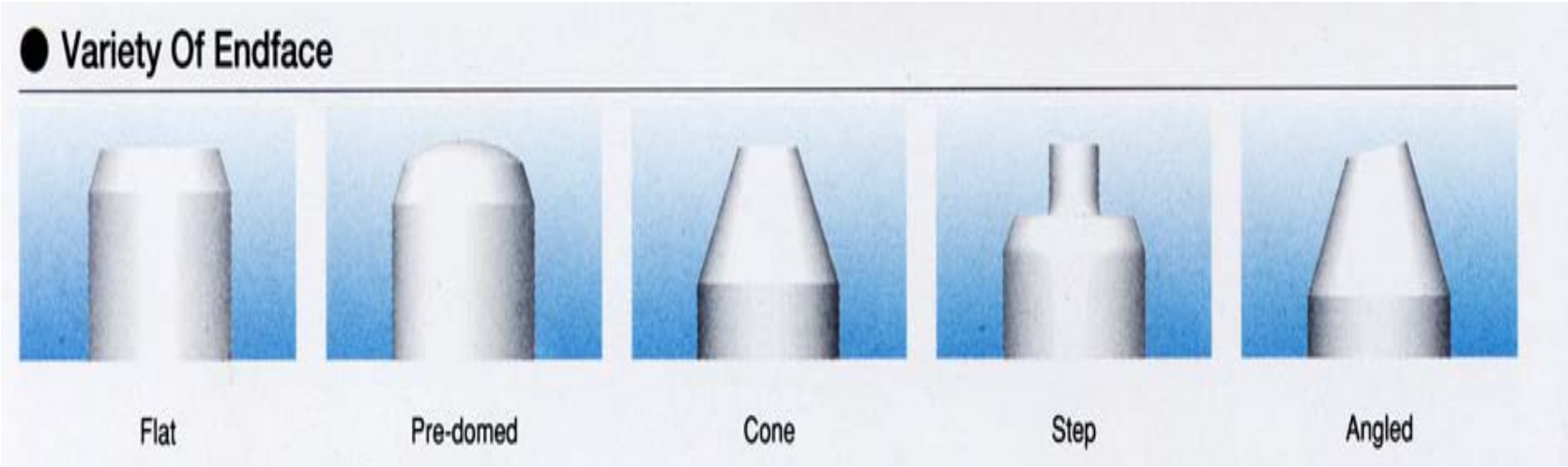
- 9/125 Single mode fiber
  - TIA/EIA-568-B.3 **Fiber loss in cables**
    - inside plant cable MAX LOSS 1550 nm 1.0 dB/km
    - outside plant cable MAX LOSS 1550 nm 0.5 dB/km

- Fusion or mechanical splicing:
  - ANSI/EIA/TIA-455-34 Method A
  - Attenuation not to exceed −0.3 dB should be −0.03
  - Back reflection: better than −75 dB

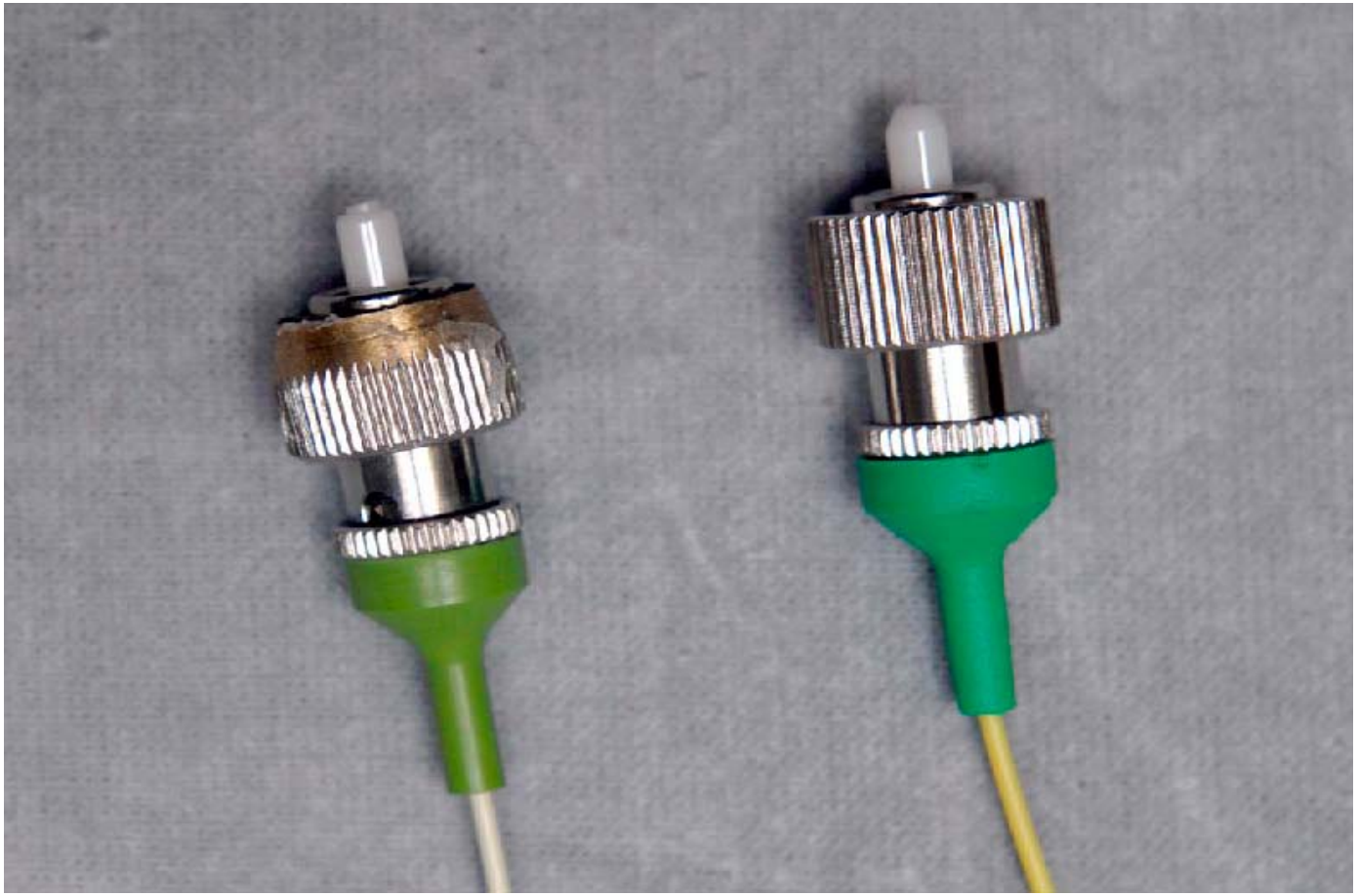
- **FC/APC connector could have results as good as fusing**
  Attenuation: <−0.3 dB typically −0.03 dB
  Back reflection 8° connector typically > −75 dB

Types of FC/APC connectors

- Die-cast nickel-plated zinc housing
- Glass composite body housing
- Plastic interbody
- Zirconia ferrule
- Pre-polished versus pre-angled
- Wide or narrow key
- Wide or narrow slot – feed-thru
- APC bulkheads are not a standard



Purchased a laser with this (left) connector, which was modified to fit into a feed-thru to avoid the heads on a screw
Loss was 25% ALL APC connectors are a green boot



Types of FC/APC connectors

- ALL FC/PC are narrow key with wide slot
- FC/APC are narrow key and narrow slot
  [except Molex Japan Institute Standard (JIS)]
- Glass composite interbody with die-cast nickel-plated zinc threaded nut (everybody but 3M)

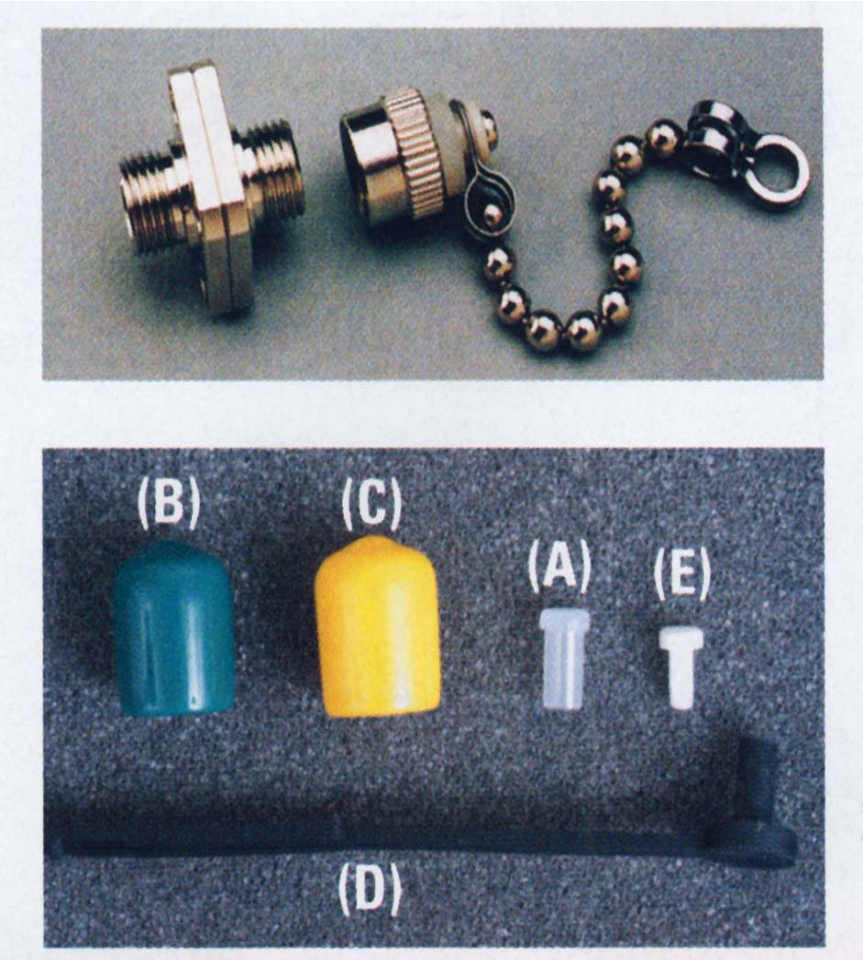
  Nickel flakes off with use and contaminates ferrule; unable to clean off. Needs to be re-polished.
- Glass composite inter-body and threaded net (3M only)

FC/APC	Die-cast, Nickel-Plated Zinc	Die-cast Nut	Glass Composite Nut	Glass Composite Interbody	Feed-thru, Narrow Slot, 2.02 mm	Feed-thru, Wide Slot, 2.14 mm	Pre-angled & Pre-polished	Pre-angled FLAT
Molex	X	X				X	X	
Corning	X			X	X			X
3M			X	X	X		X	X
AMP	X	X		X	X			X
FIS	X	X			X		X	
Seiko	X	X			X			X

Reference: Jim Inman Engineer @ Fiber Instrument Sales

Cleaning the FC/APC connector

- **Clean** every single time and check with microscope
- High-power laser will burn plastic caps
- Static cling on ferrules attracts dirt
- Dirt can attract on both ends
- Turn off laser when cleaning and viewing in microscope



APC feed-thrus

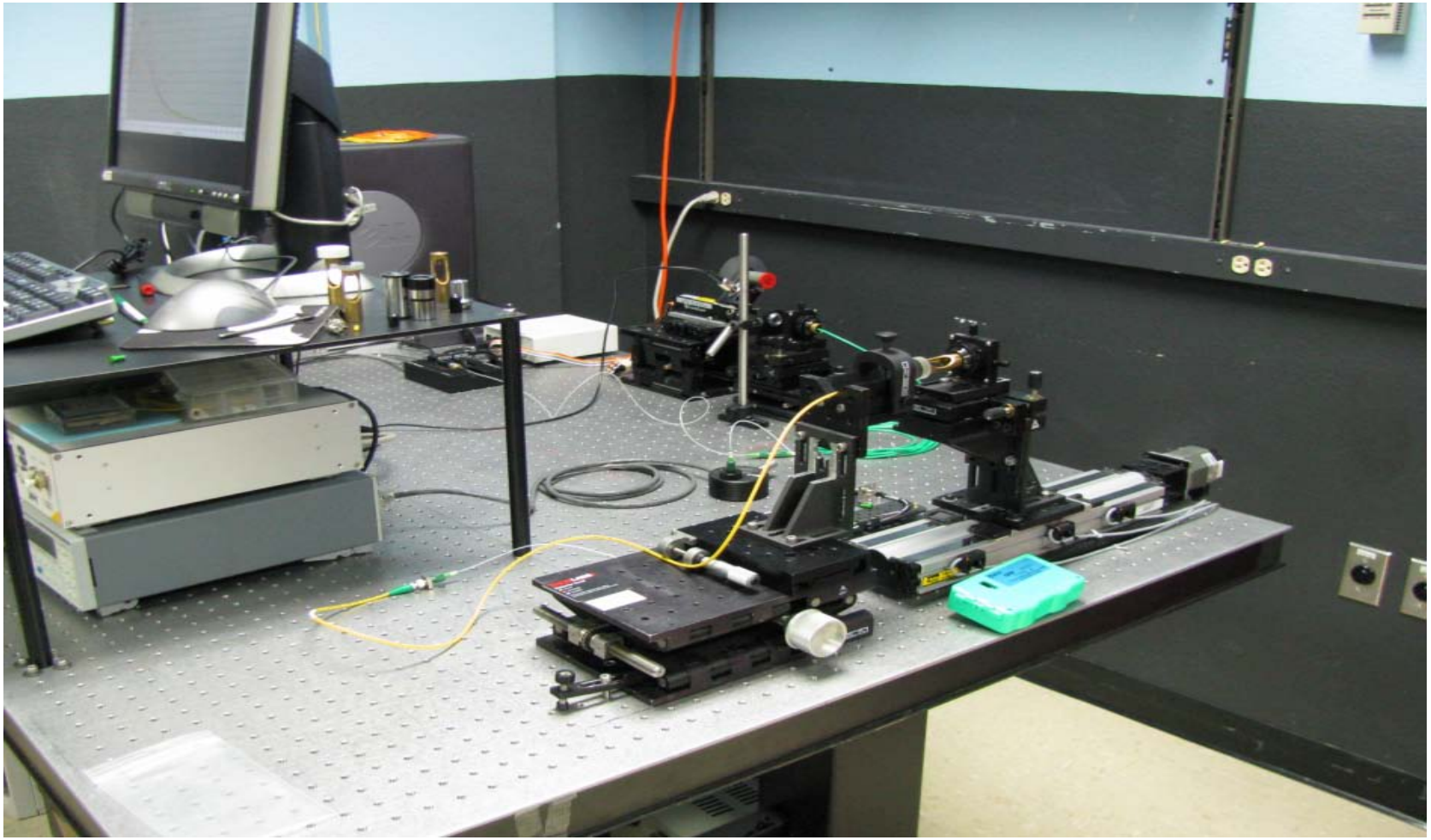
- Wide slot
- Narrow slot
- Brass insert
- Ceramic insert

Testing FC/APC connectors

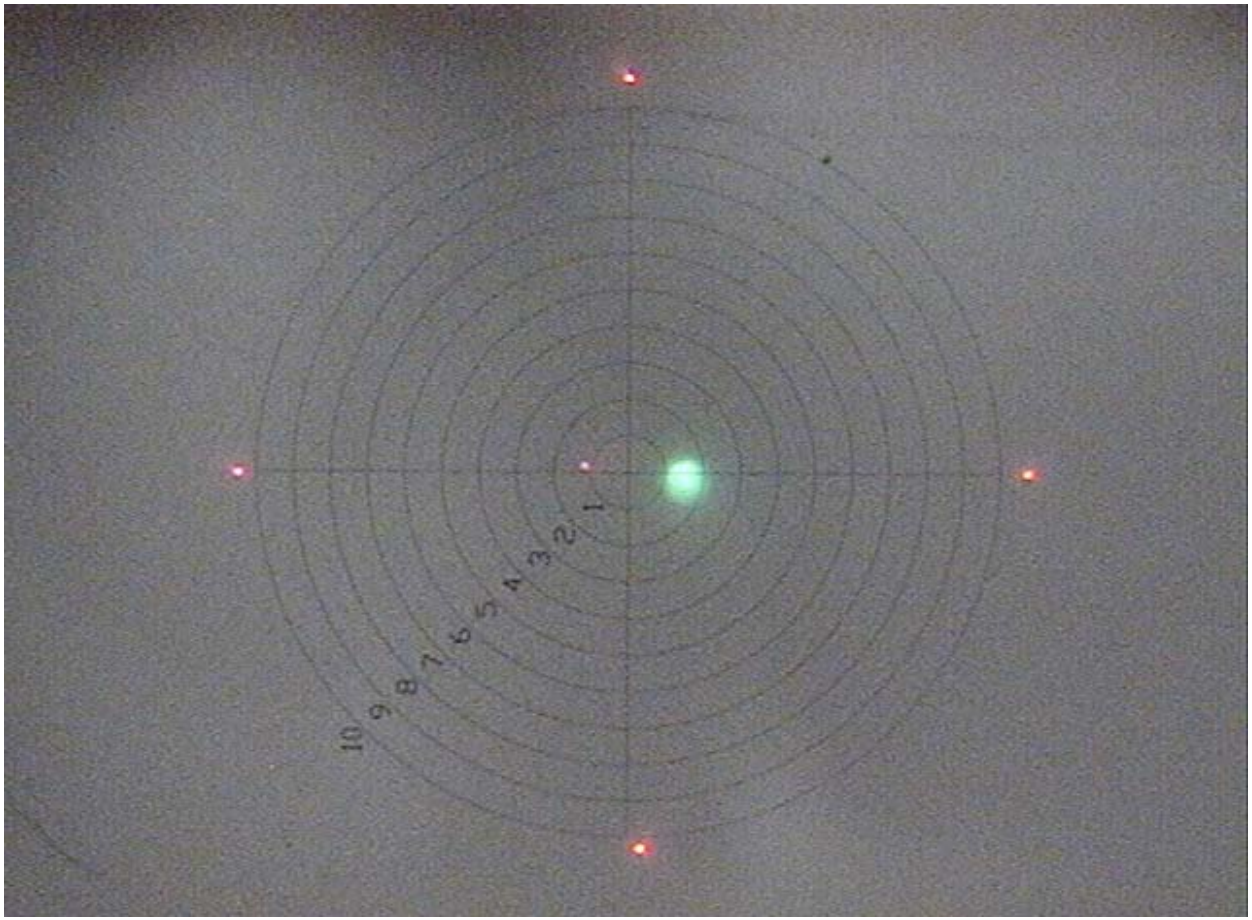
Clean every single time and check with microscope

- Microscope (video microscope is safer)
- Alcohol & wipes
- Connector cleaner
- Interferometer
- Laser source
- Radiometer
- Back reflection meter

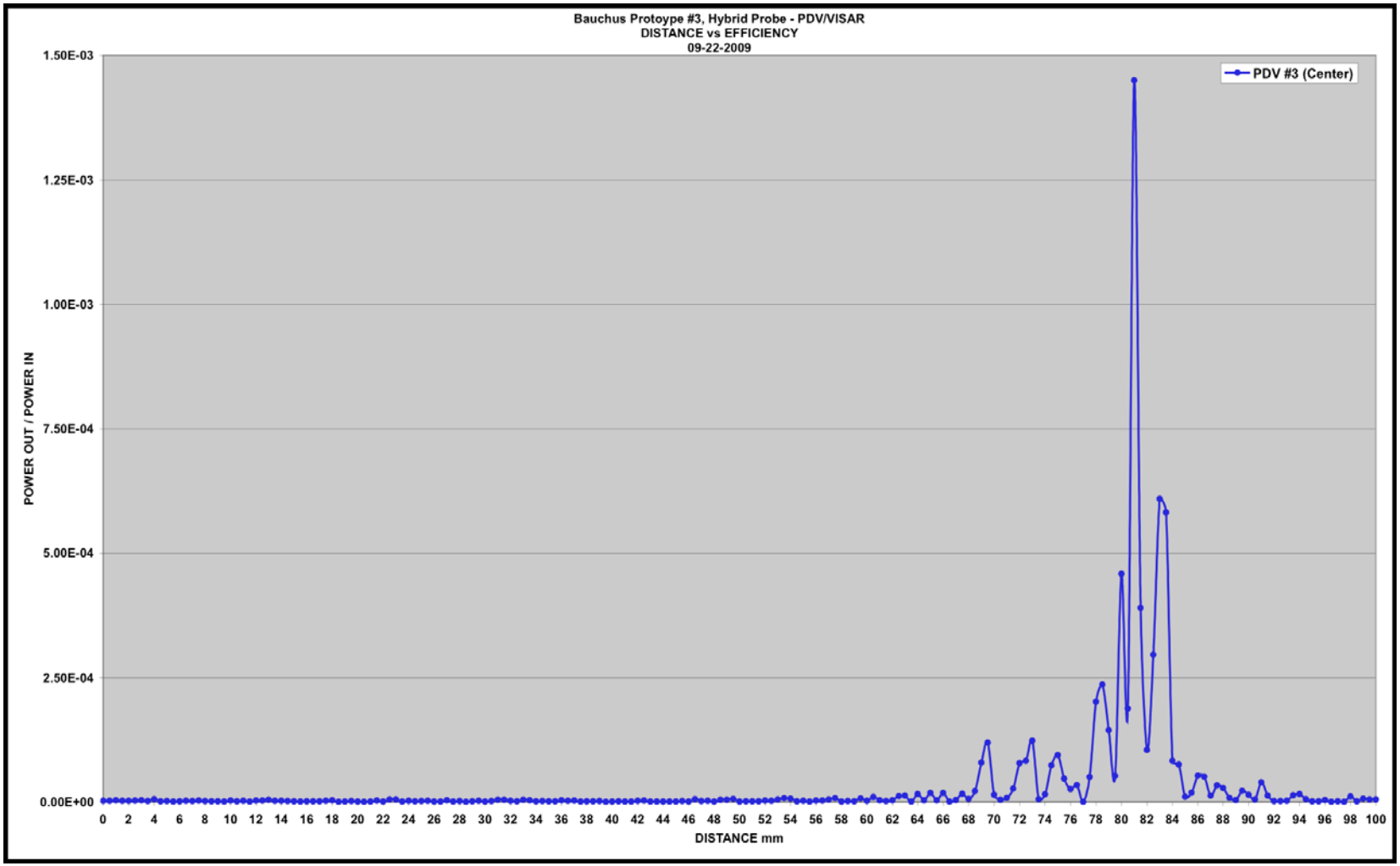
Fiber optic probe test bench



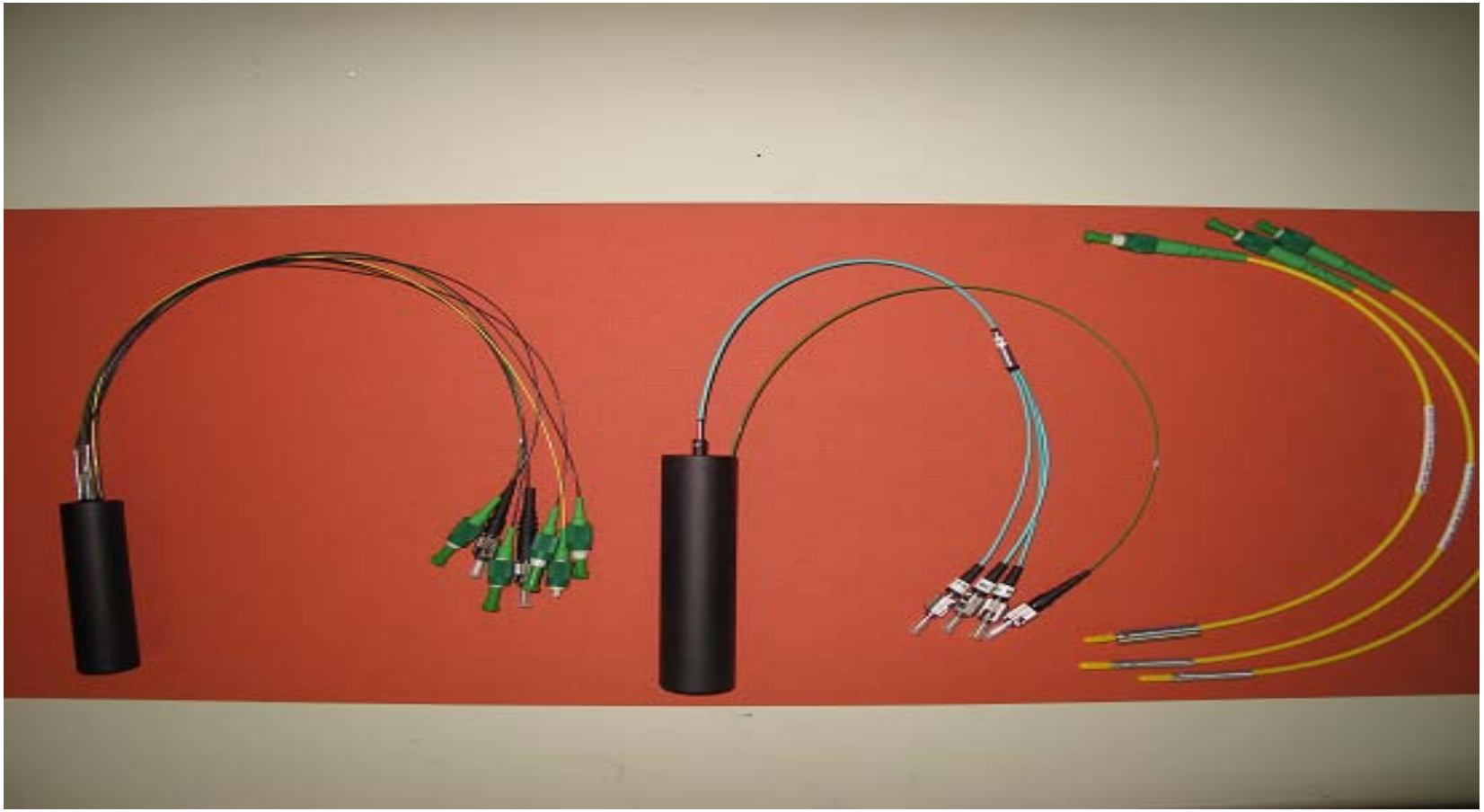
Hybrid PDV & VISAR
Spatial position measurement



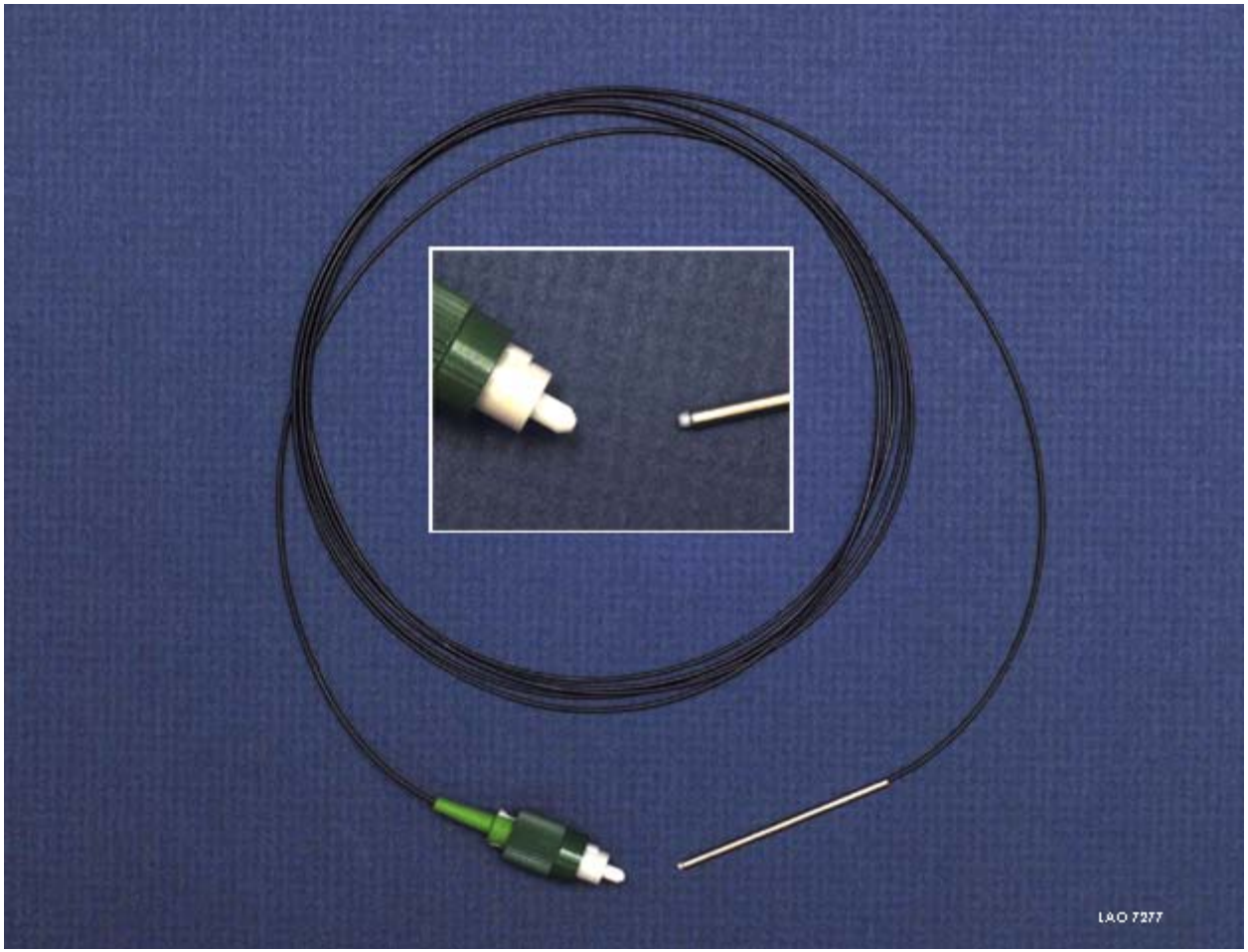
PDV scan


Bauchus Protoype #3, Hybrid Probe - PDV/VISAR
DISTANCE vs EFFICIENCY
09-22-2009
PDV #3 (Center)
POWER OUT / POWER IN
1.50E-03
1.25E-03
1.00E-03
7.50E-04
5.00E-04
2.50E-04
0.00E+00
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100
DISTANCE mm

NSTec VISAR & PDV probes



NSTec PDV probe
Single fiber, no lens, 8-degree polish



NSTec high-pressure or vacuum feed-thru, single-mode or multimode