Photonic Doppler velocimetry probe used to measure grain boundaries of dynamic shocked materials

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New Mexico Operations

Las Vegas Operations

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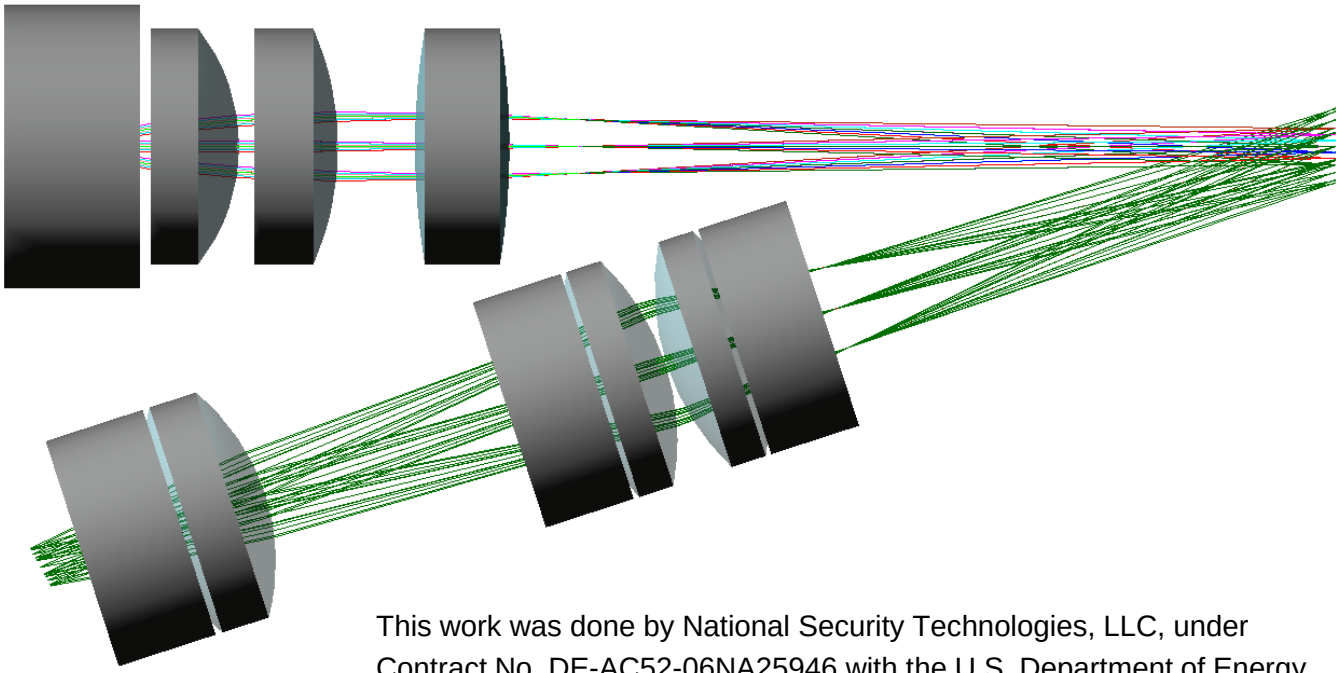

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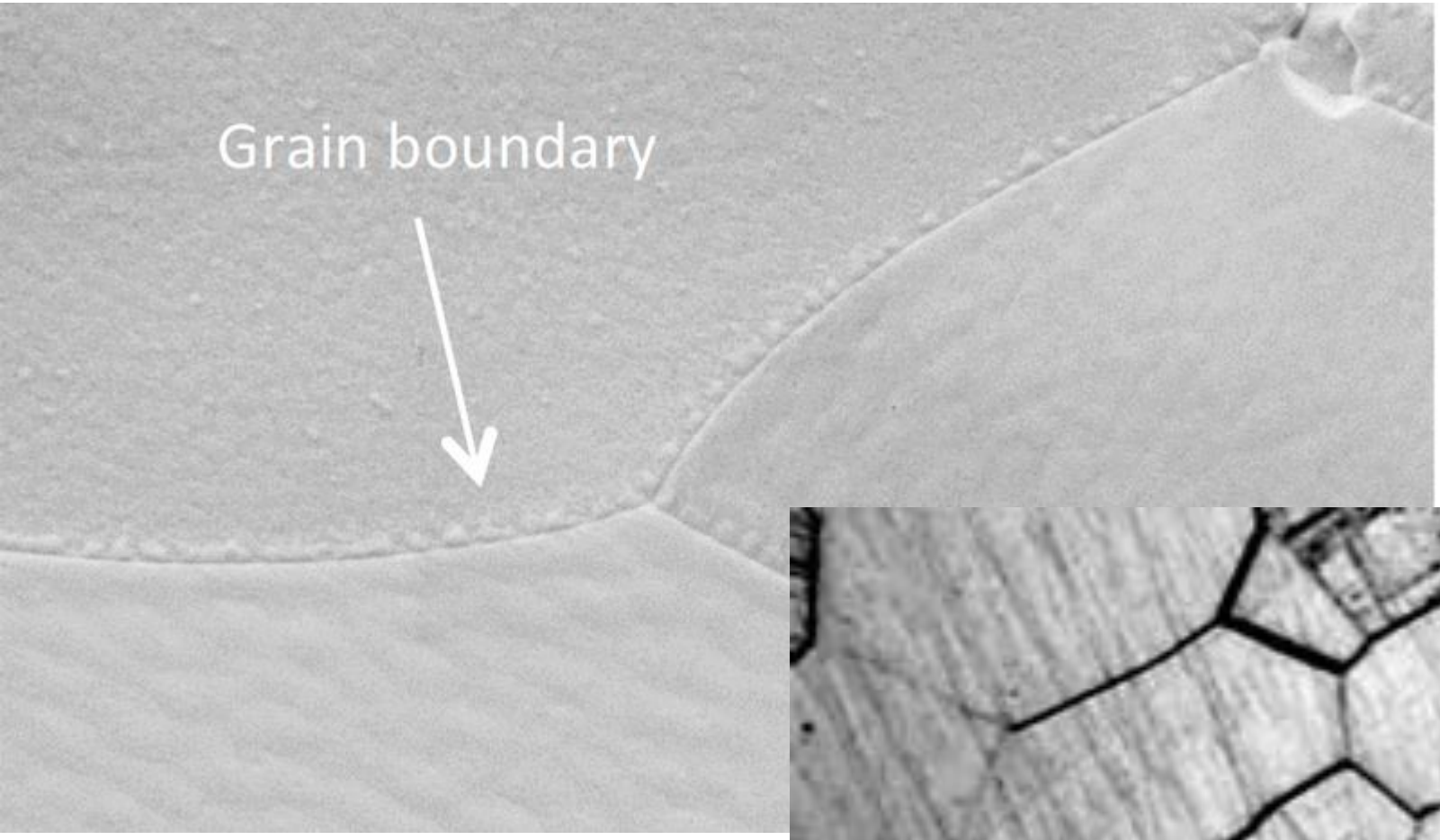
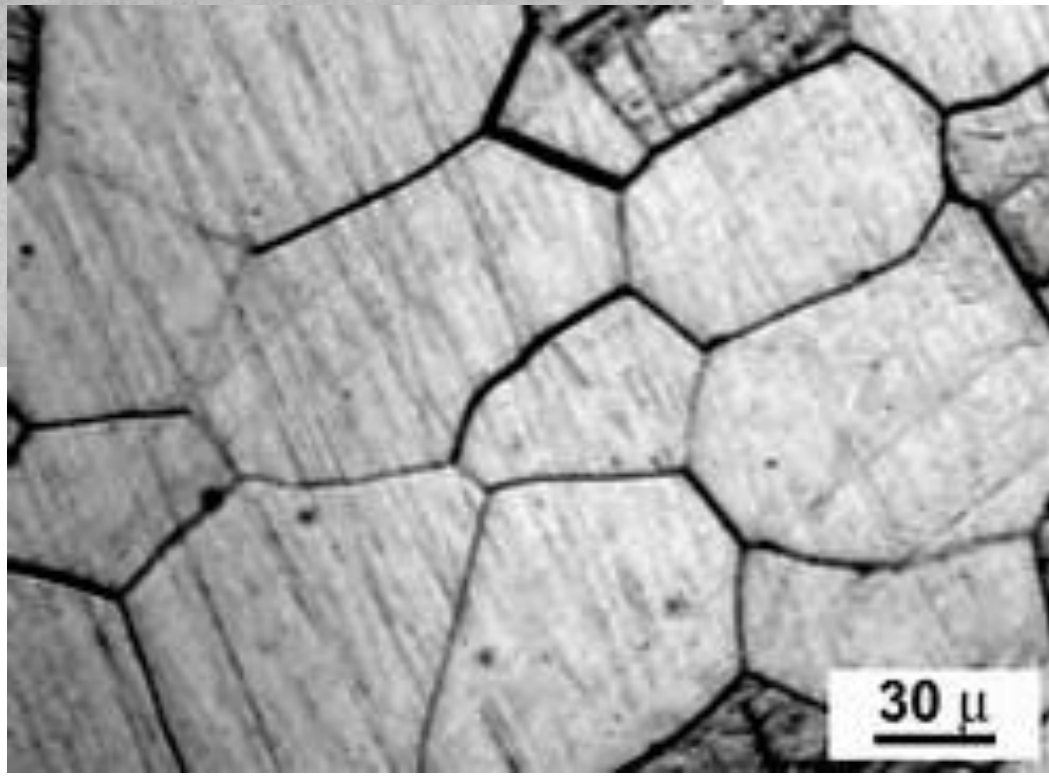
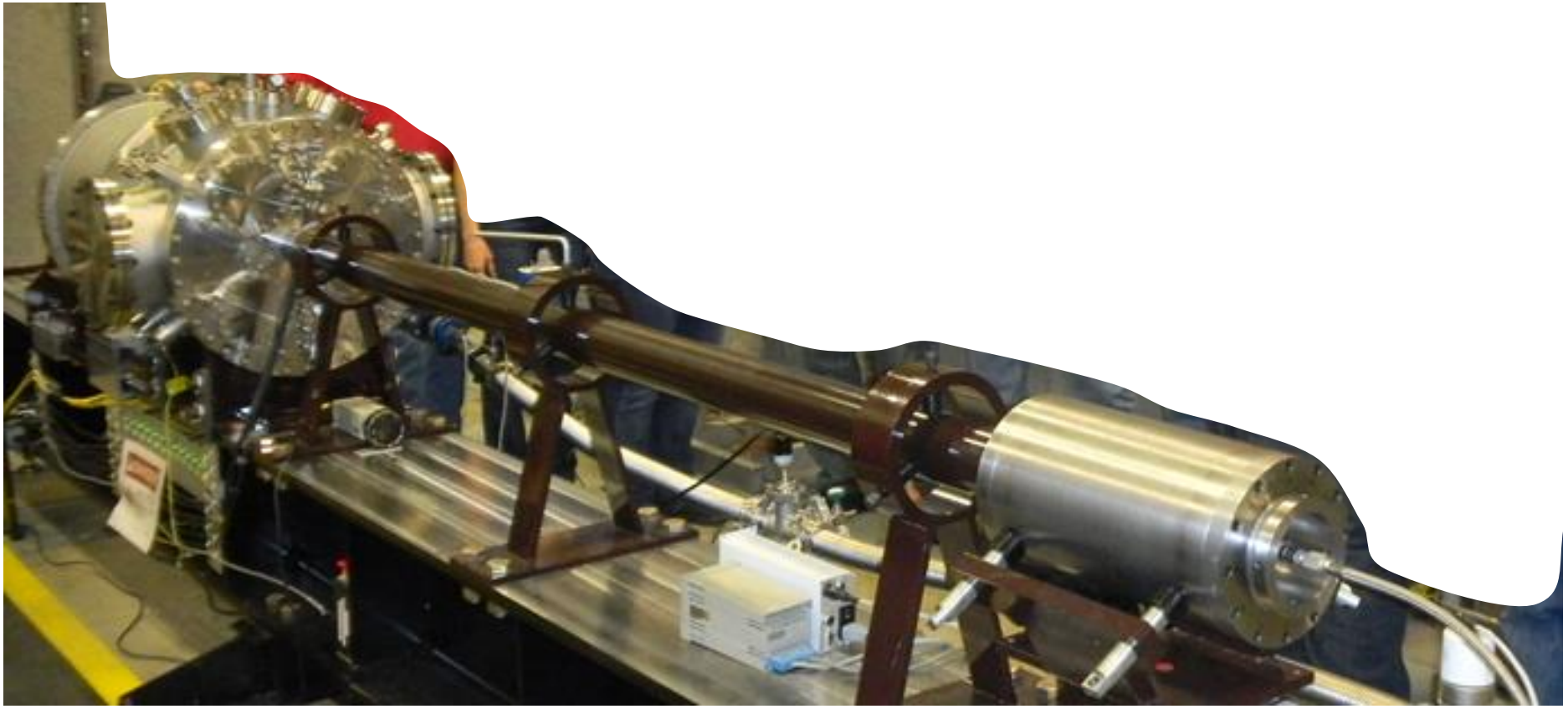
This work was done by National Security Technologies, LLC, under Contract No. DE-AC52-06NA25946 with the U.S. Department of Energy.

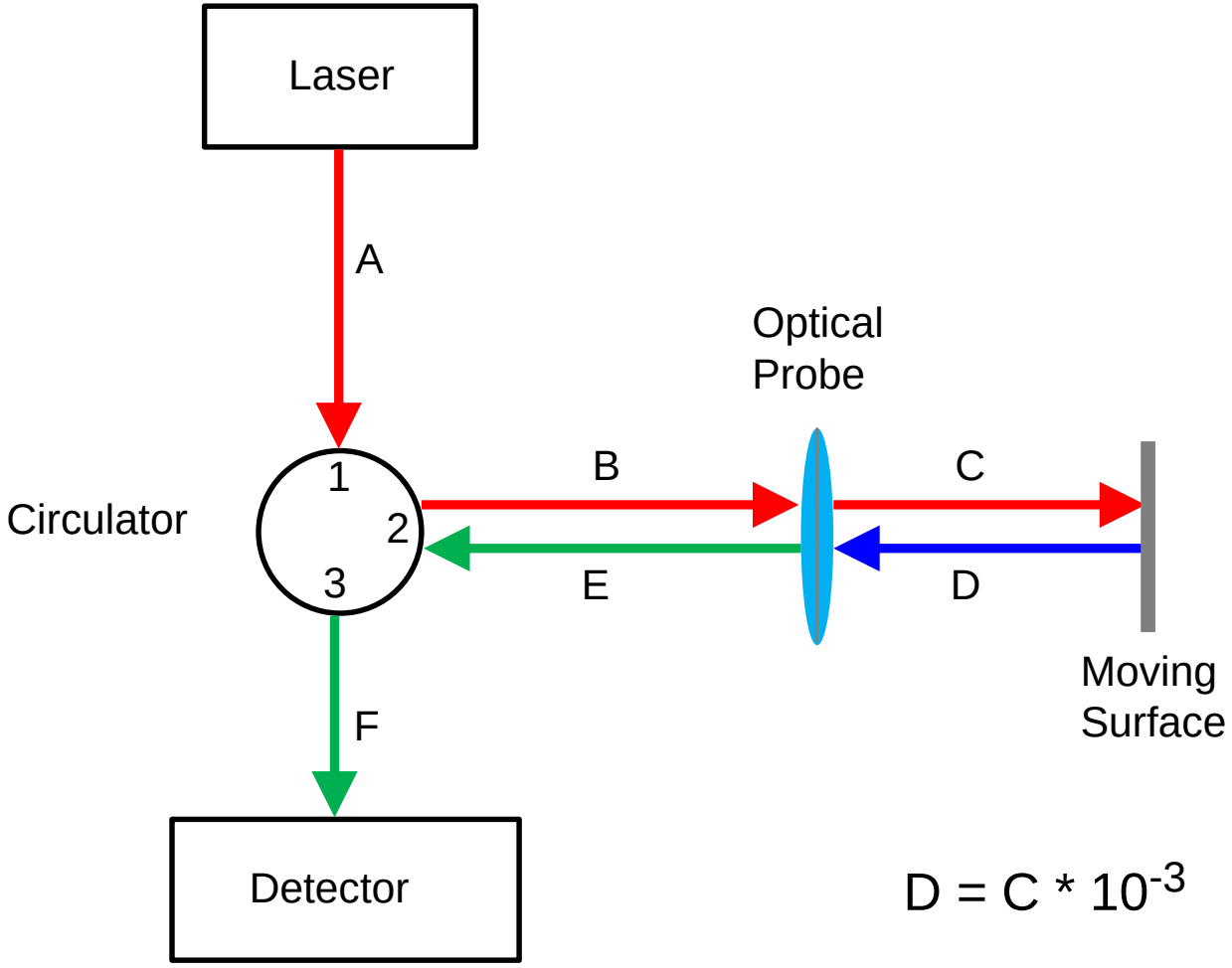

Grain boundary


30 µ

Gas gun fires projectile from right to left. Projectile inters into catch tank where it hits the target material. Target undergoes shock compressions.

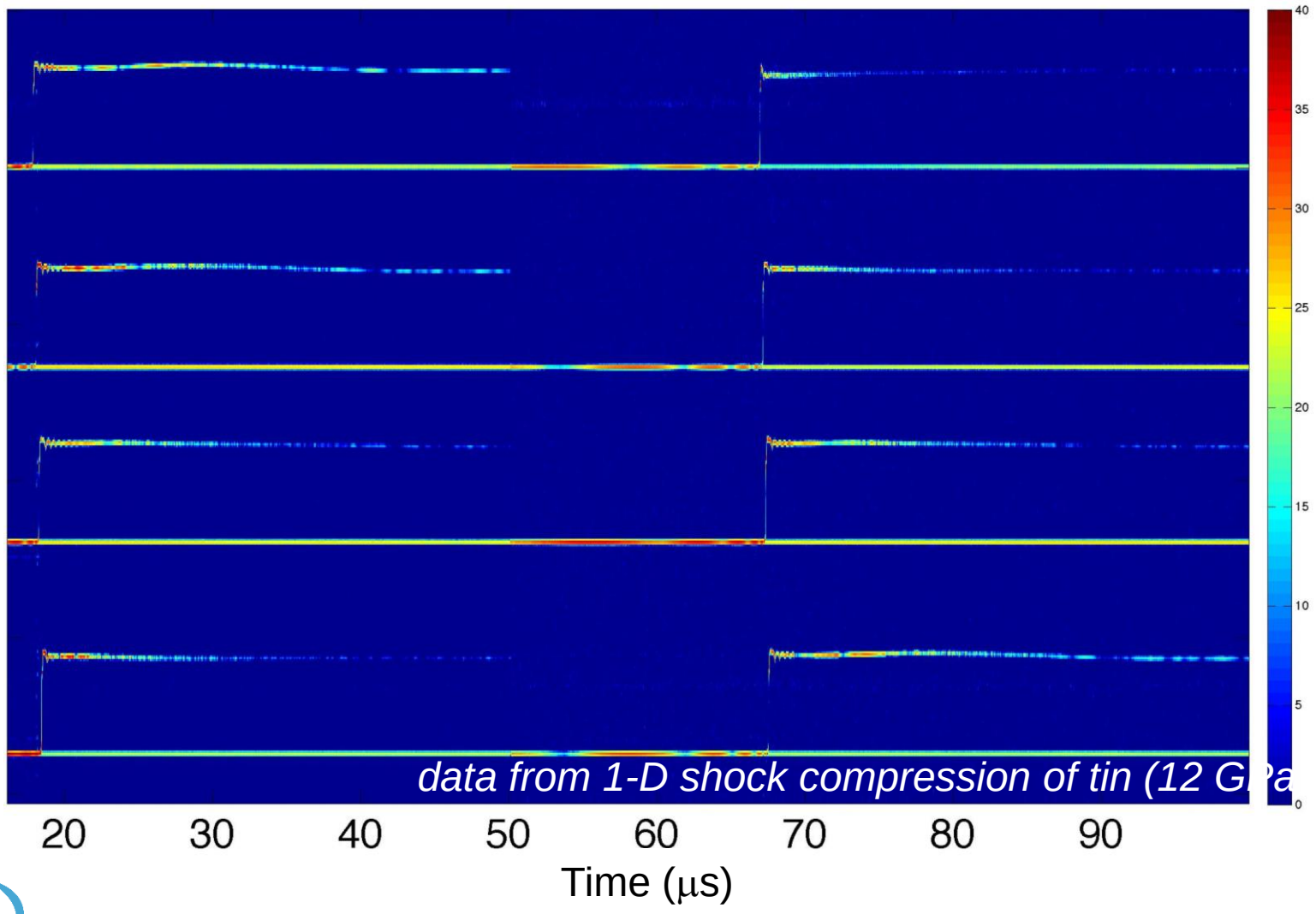


Photon Doppler Velocimetry (PDV)

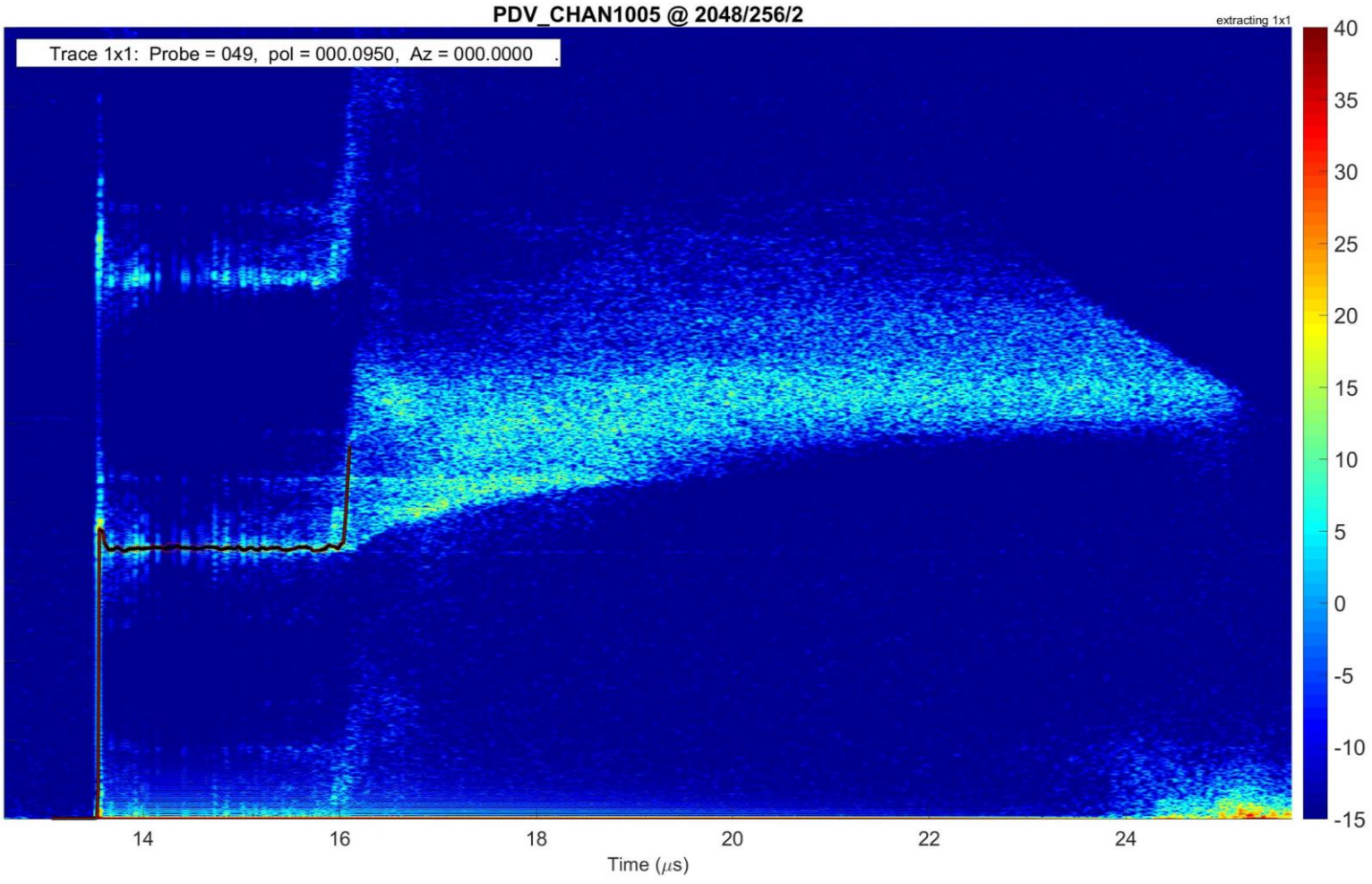


Simplified schematic diagram of PDV showing the unshifted (reference) light in red, the Doppler shifted light reflecting off the moving surface in blue, and the combined unshifted plus shifted light in green.

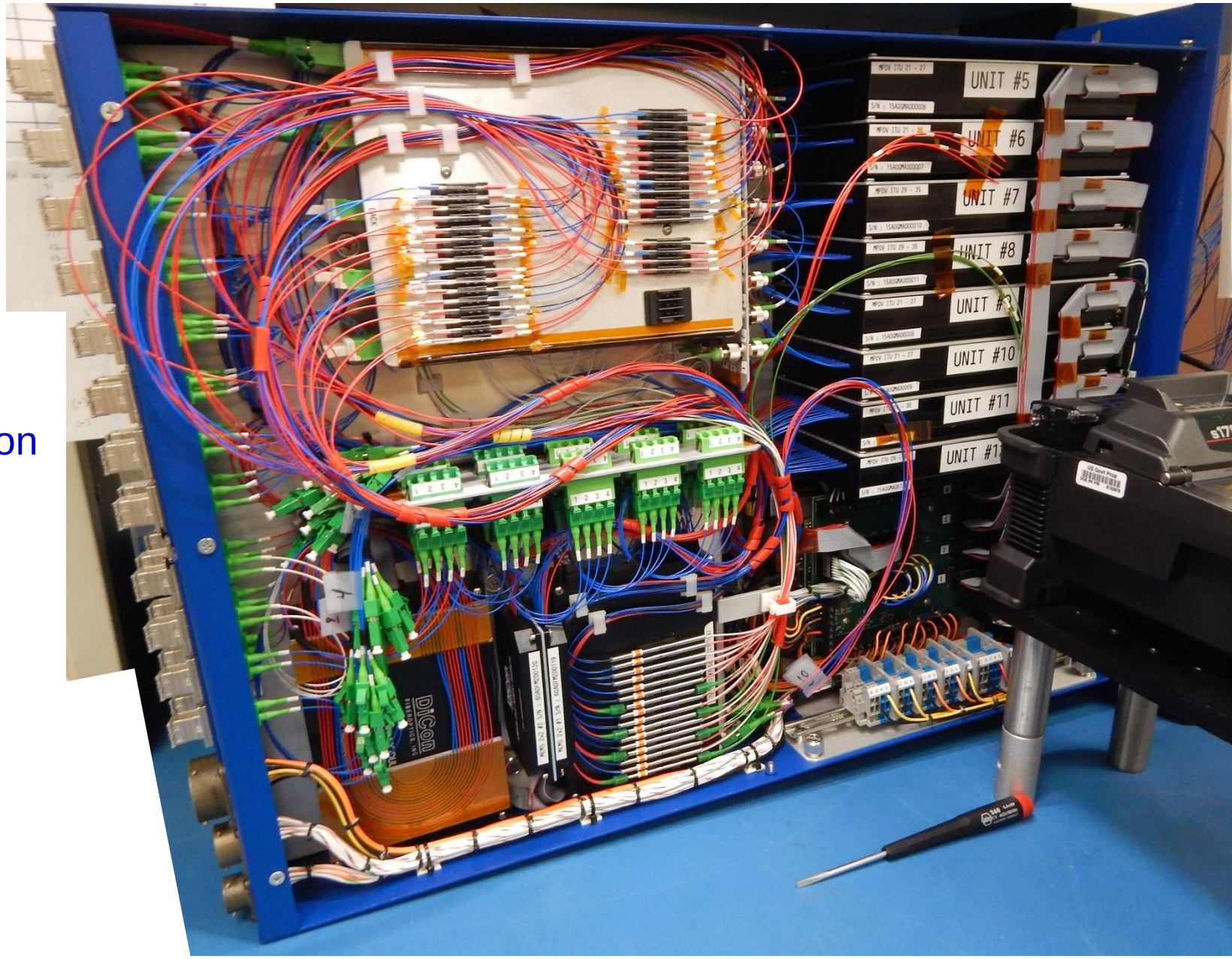
Spectrogram of eight PDV data records, recorded on a single digitizer

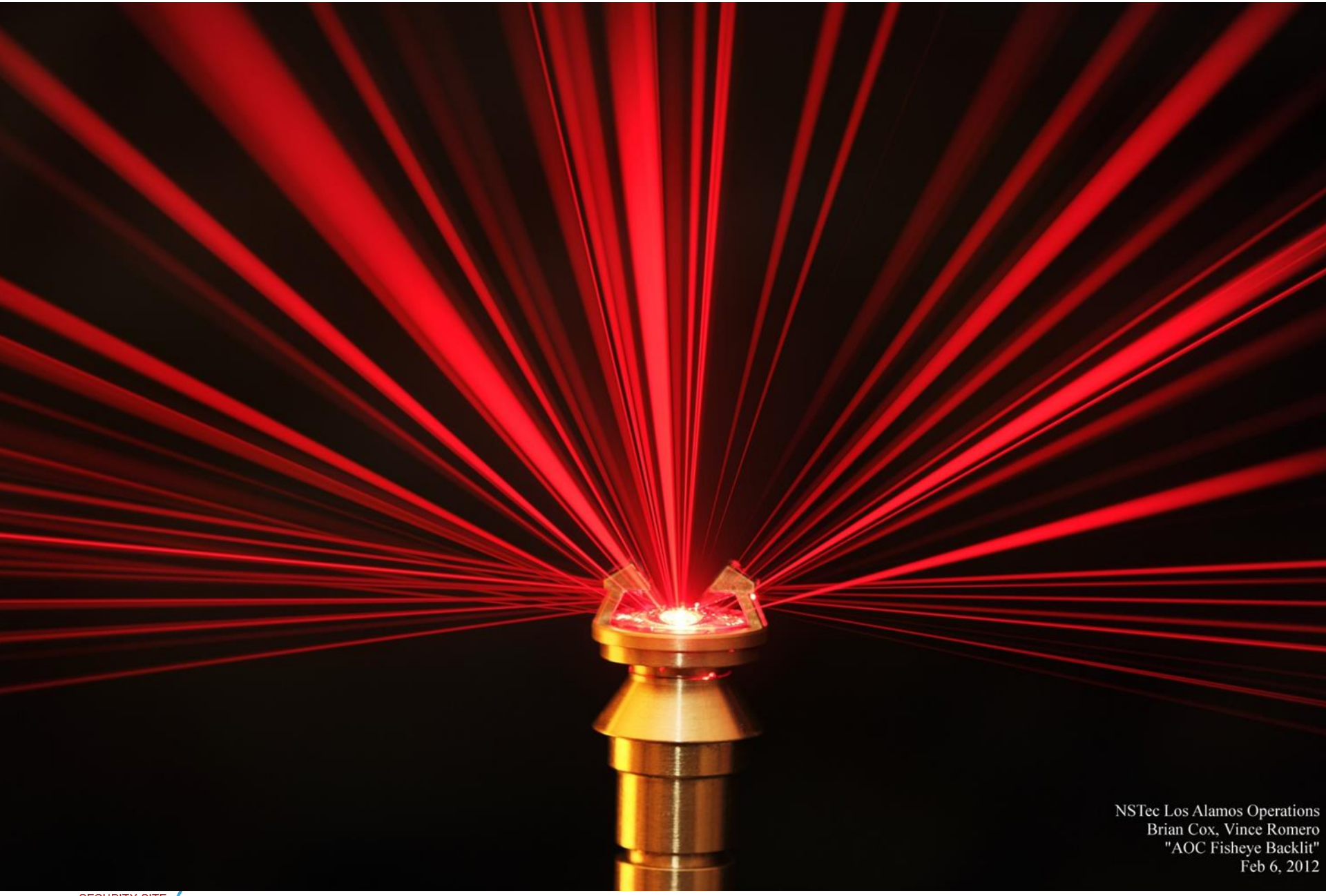


This metal underwent a double shock producing ejecta traveling faster than the moving surface.

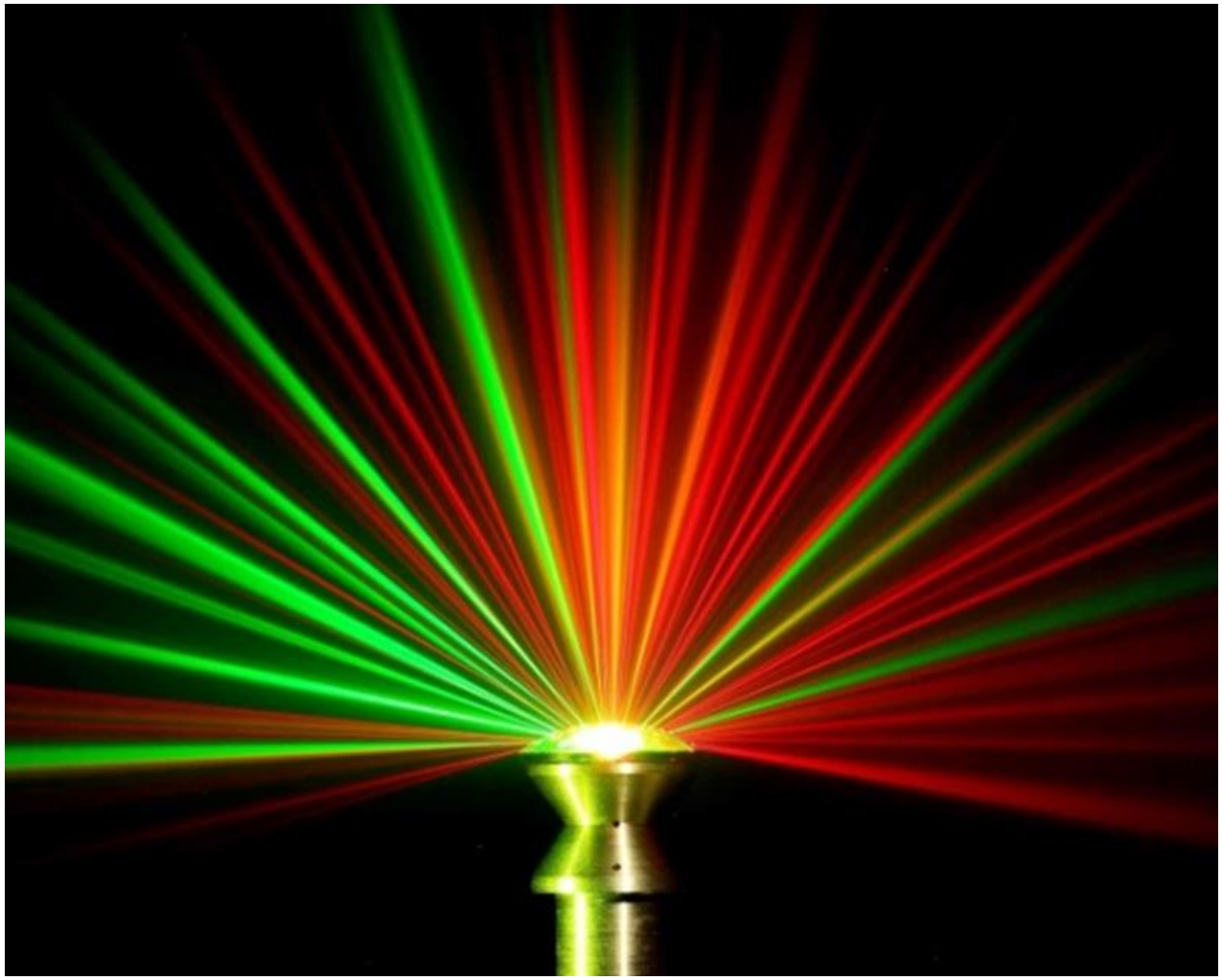


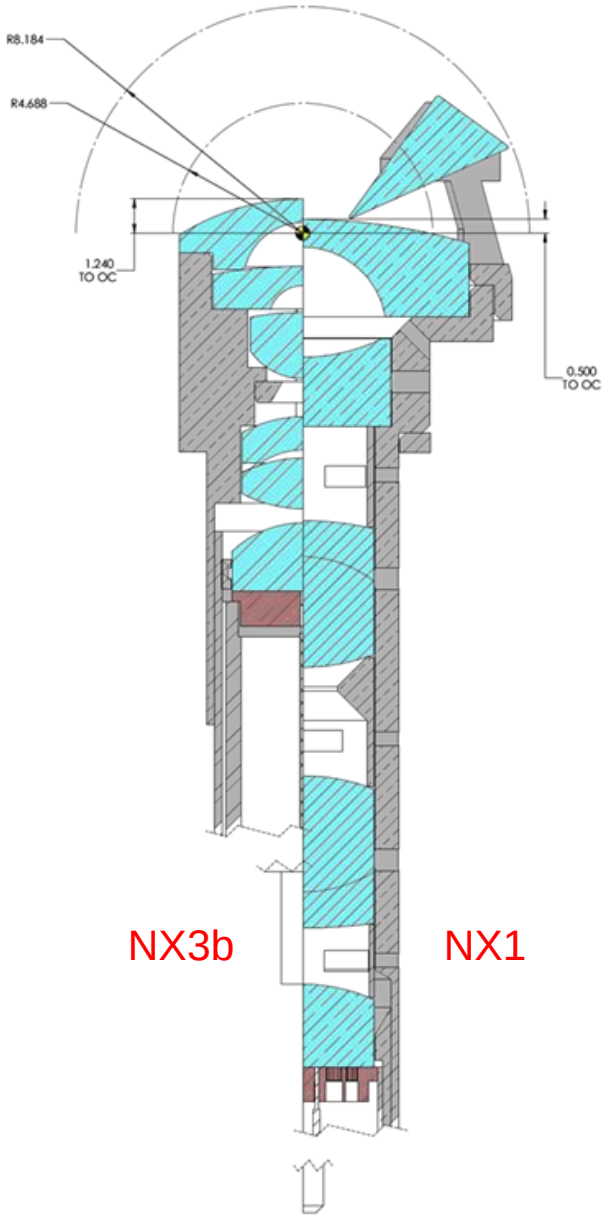
Fiber Channel Organization



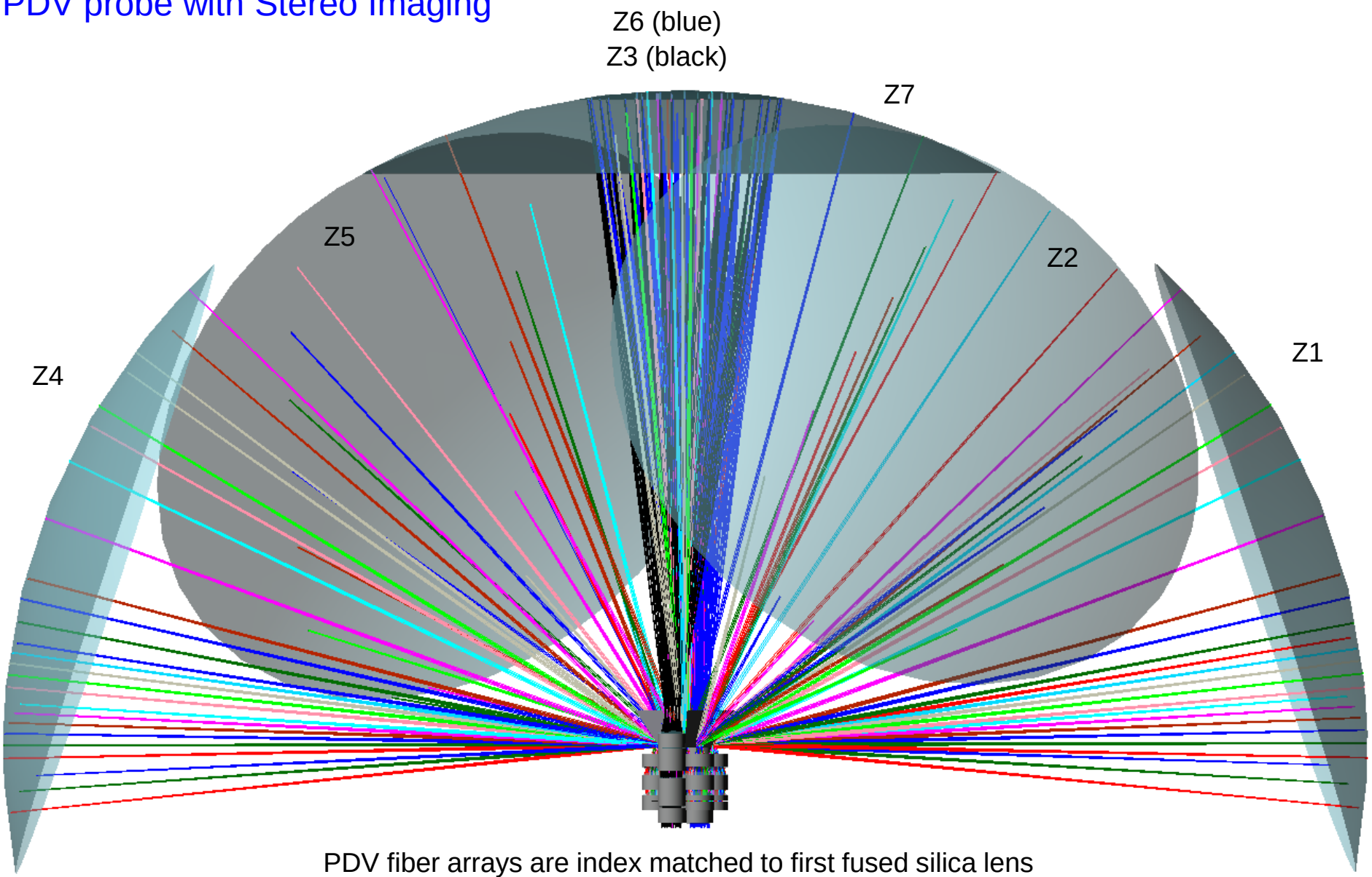

NSTec Los Alamos Operations
Brian Cox, Vince Romero
"AOC Fisheye Backlit"
Feb 6, 2012

Improved fisheye PDV probe design. Turning mirrors have been eliminated.





PDV probe with Stereo Imaging



PDV fiber arrays are index matched to first fused silica lens

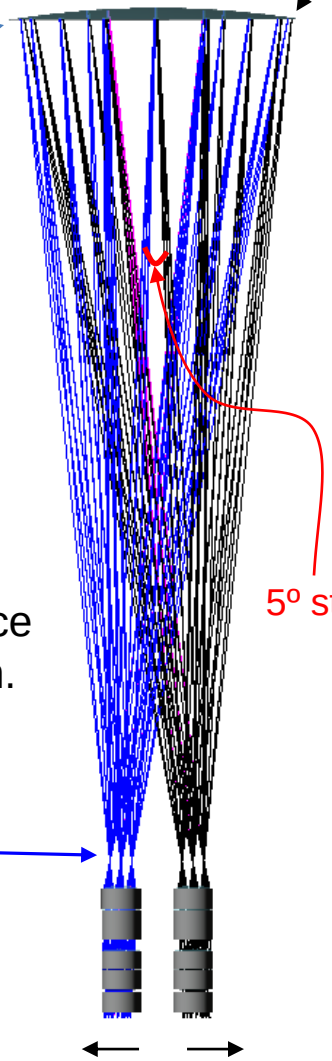
Bugeye probe could be used for stereo PDV and stereo imaging

24 mm diameter zone for imaging (blue & black rays); 10x magnification

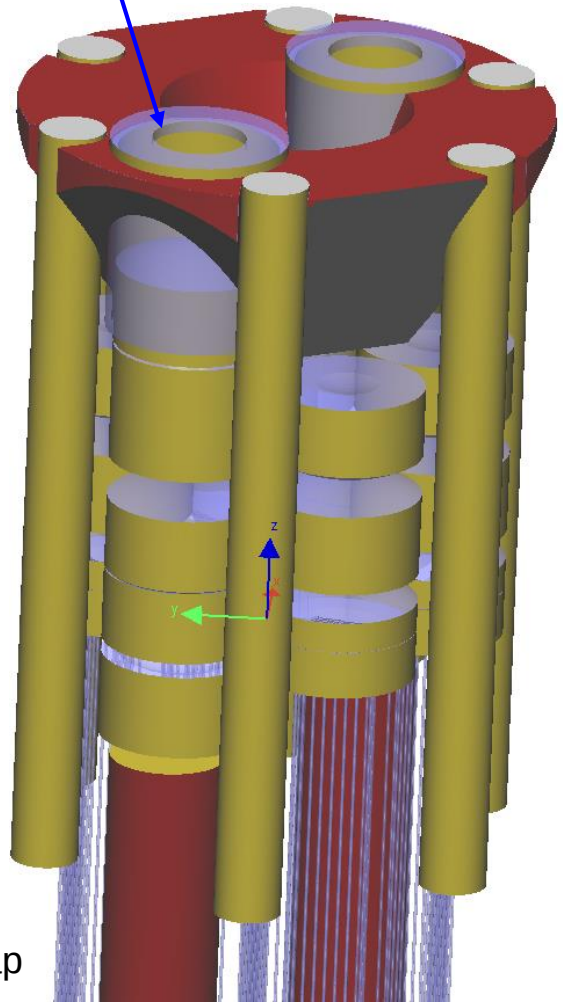
F/# of surface collected light is 36

Imaging stop (2.1 mm dia.)

The stop diameter determines the NA of collected light and also the depth of focus



5º stereo angle



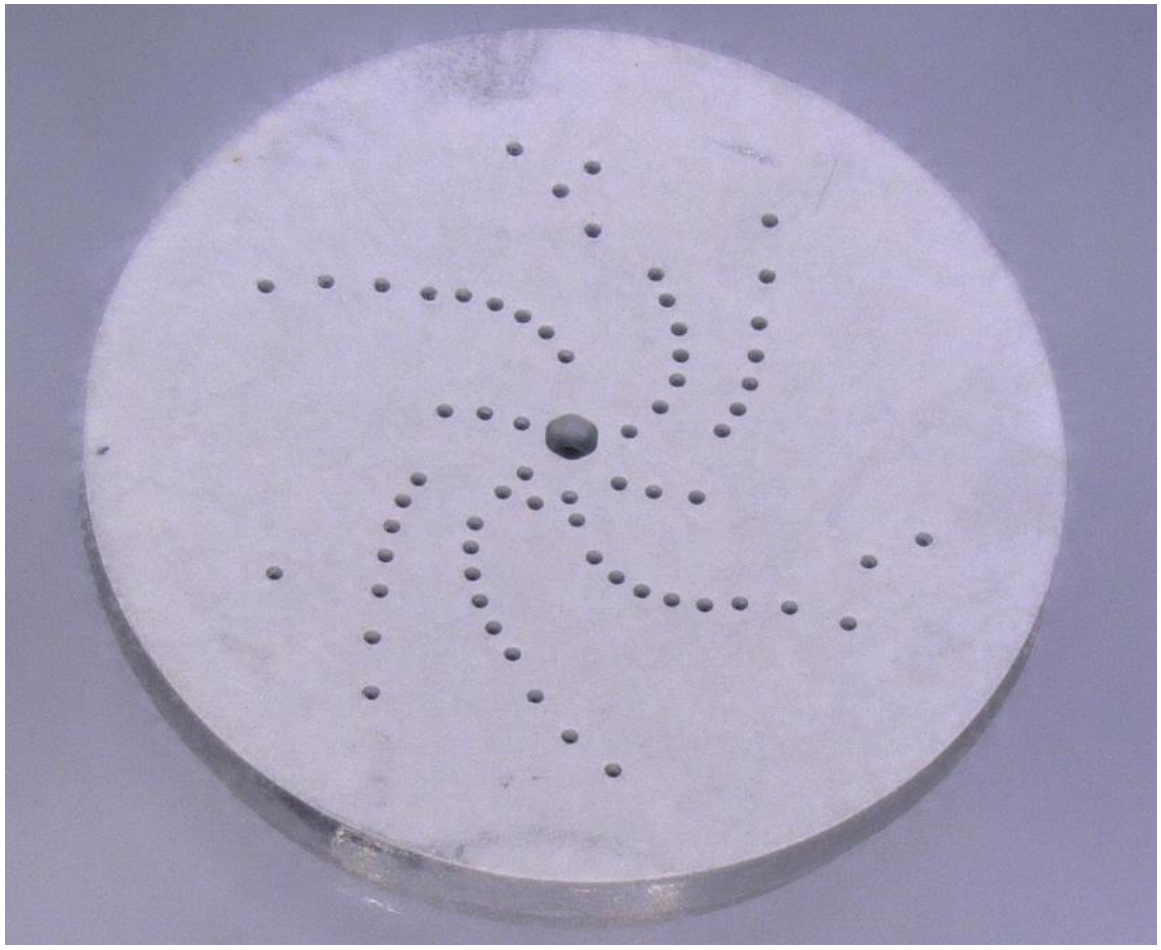
Assuming 24 mm diameter FOV at surface and 2.4 mm diameter bundle at 50 lp/mm. Resolve 200 µm at surface (5 lp/mm).

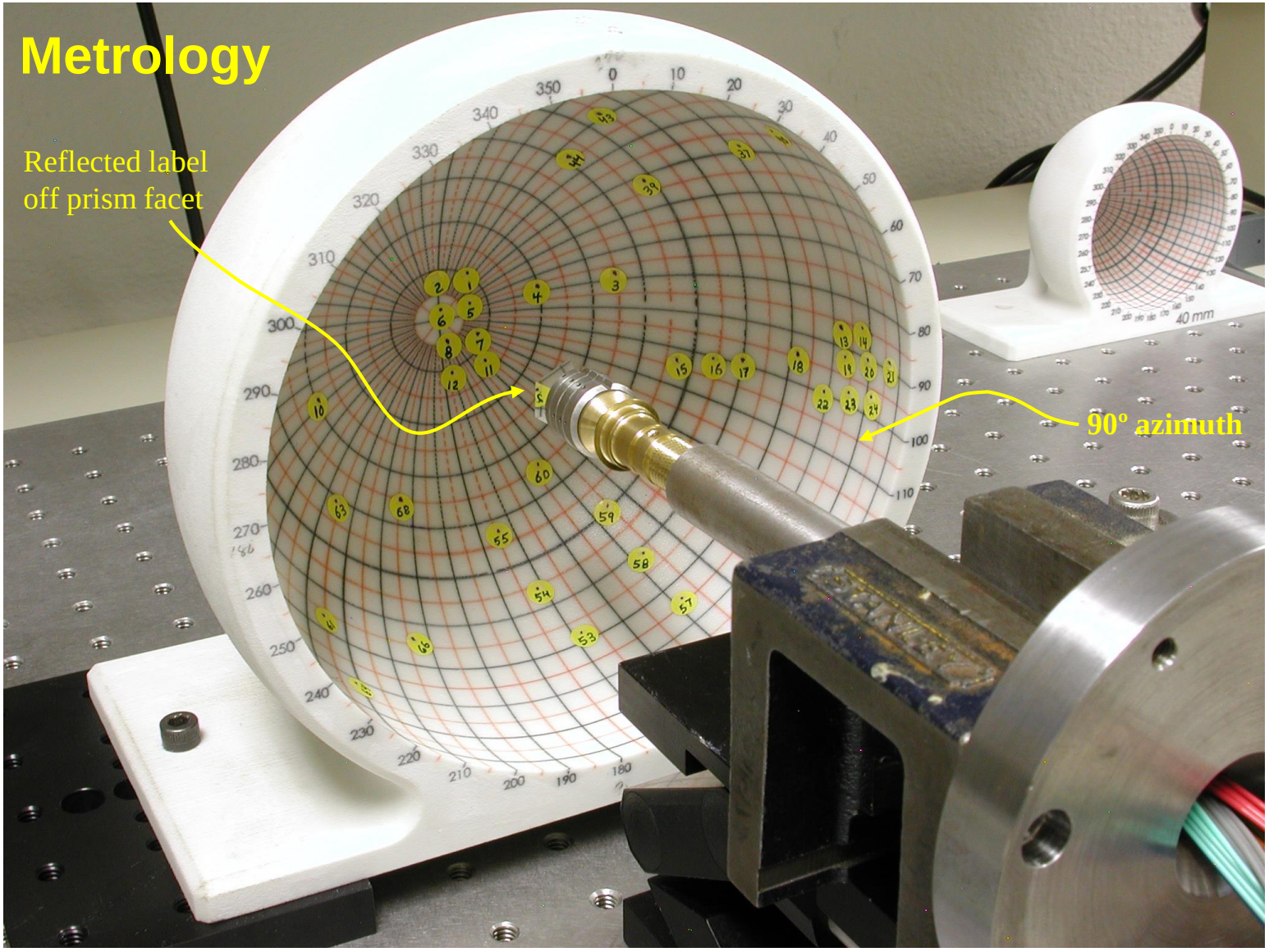
2 thin stop “washers” rest on top of prism

Coherent bundles are translated 0.314 mm, so that the image areas overlap

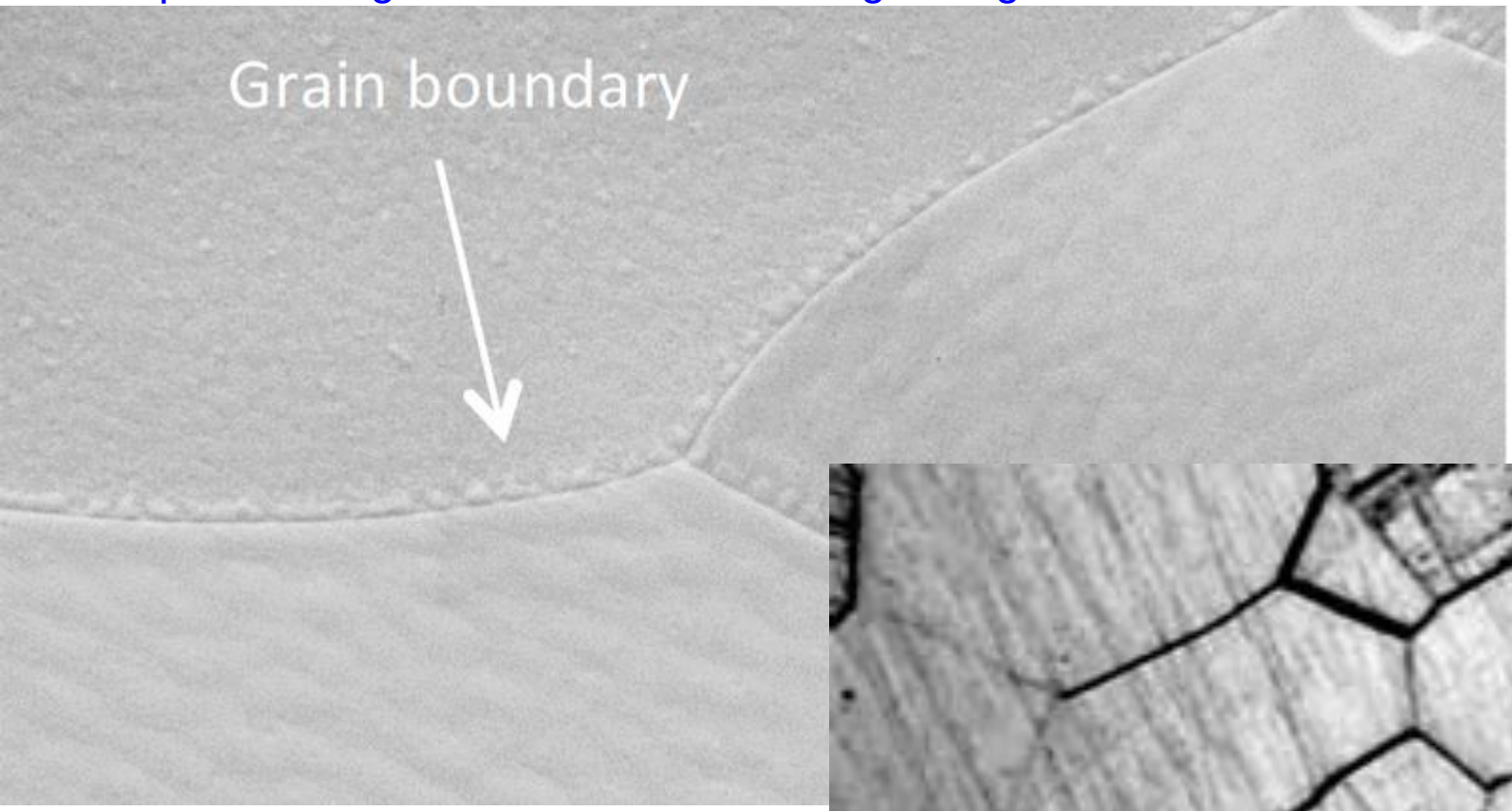
PDV Details

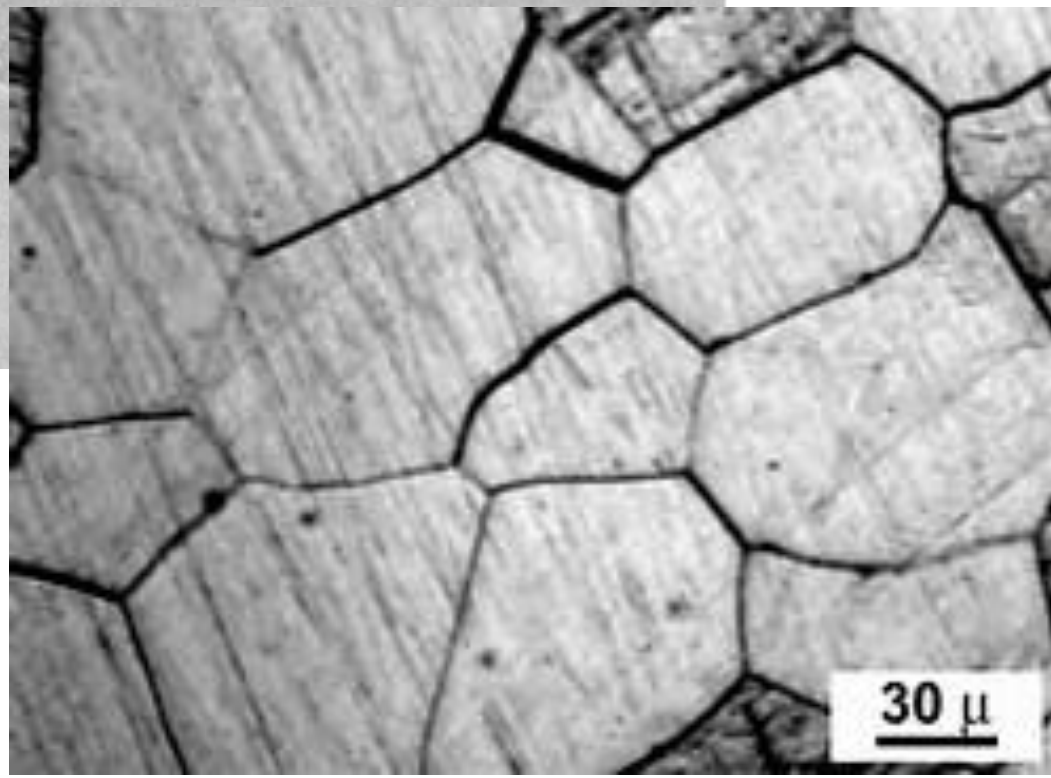
Ceramic mask for fiber arrays
(Photoveel II)
8 mm diameter,
1.5 mm thick,
126 µm tapered holes




Metrology
Reflected label
off prism facet
90° azimuth
40 mm

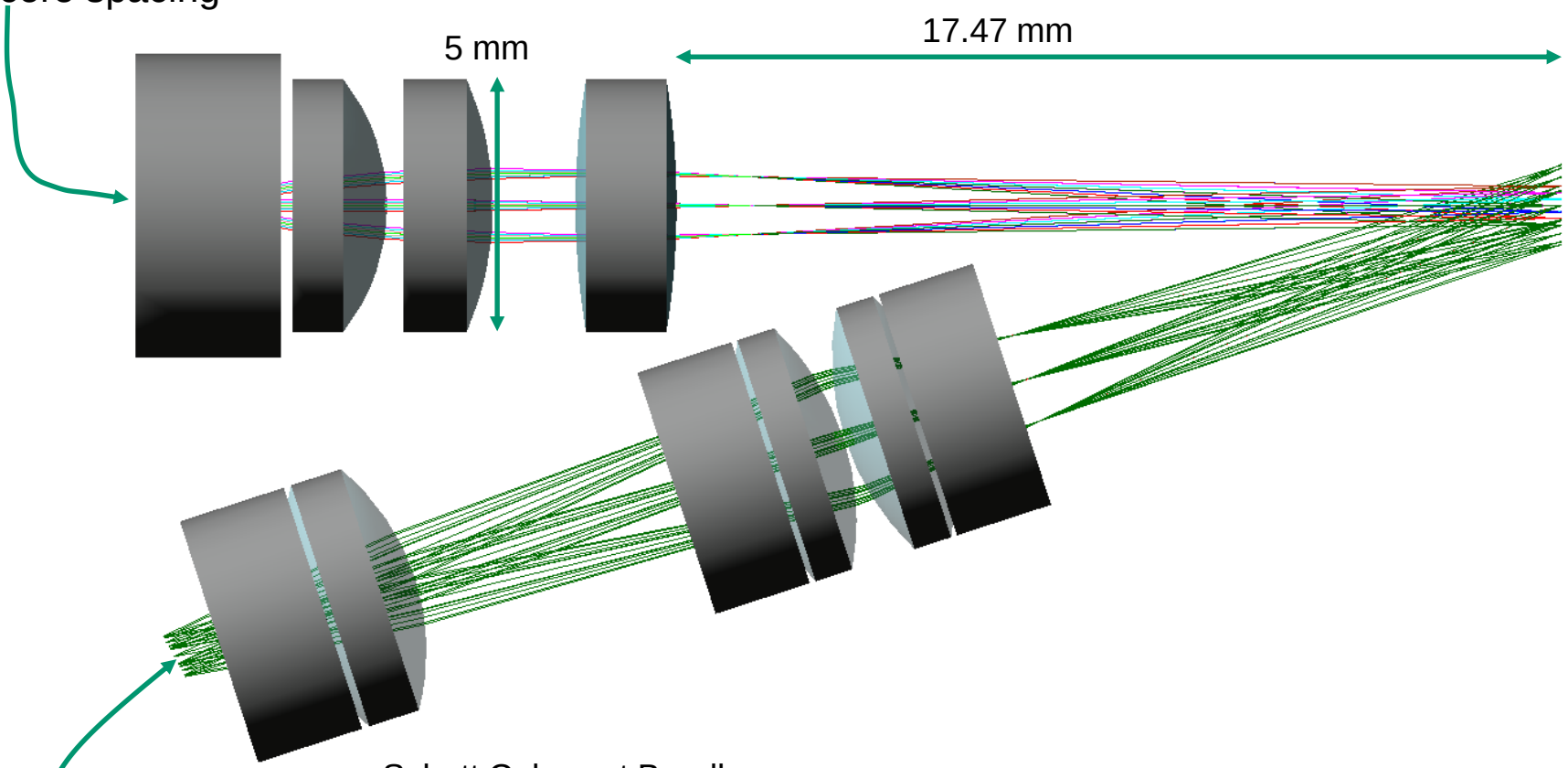
Future probe designs are for understanding how grain boundaries are affected by shocks





Gas Gun PDV microscope

37 fiber 2D PROFA fiber array
10 µm core
37 µm core spacing



Schott Coherent Bundle
0.9 mm active diameter
7.4 µm pixel size
18,000 pixels
121 resolution elements across the diameter,
Imaging designed for 800-900 nm wavelength band

Gas Gun PDV microscope

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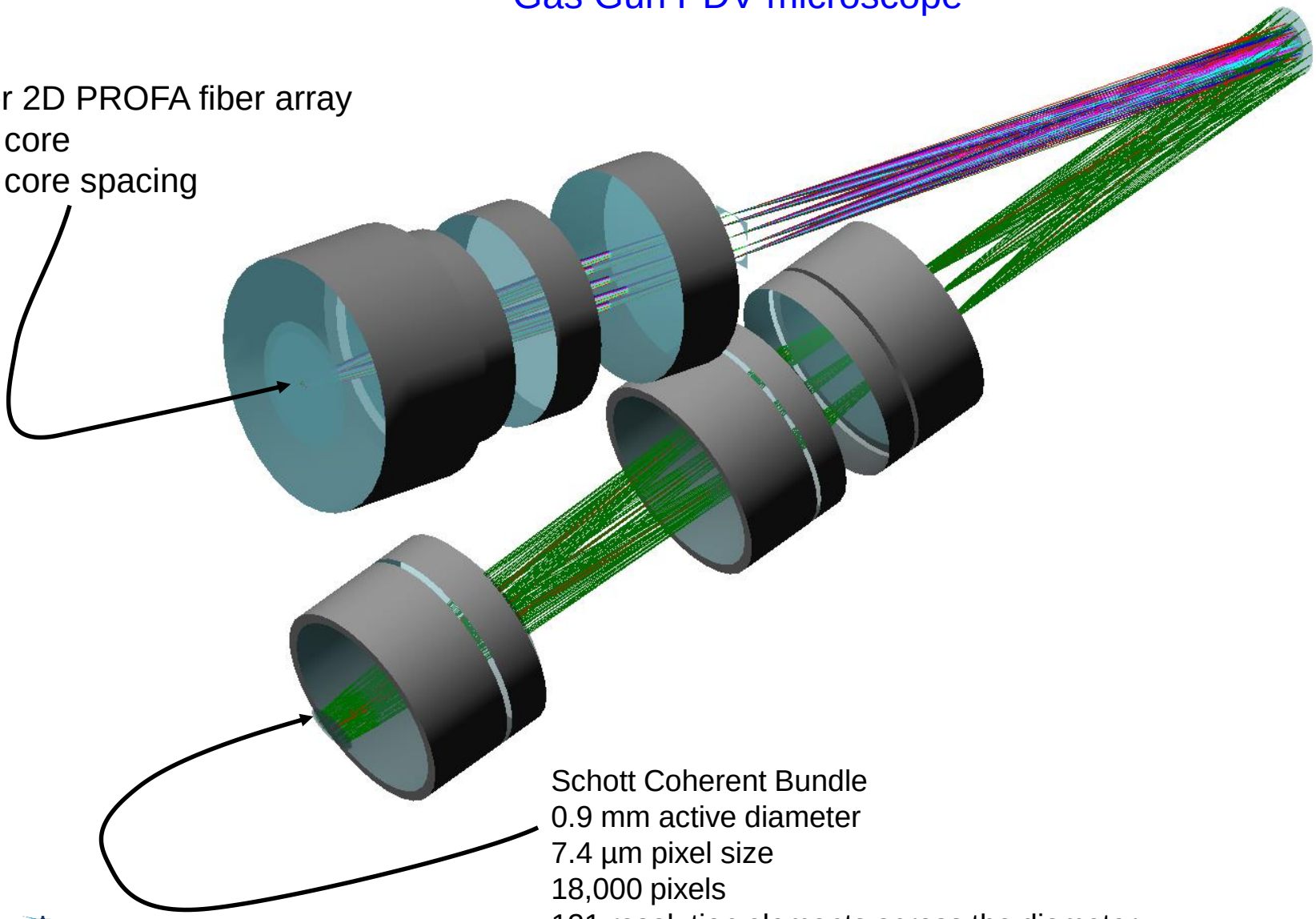
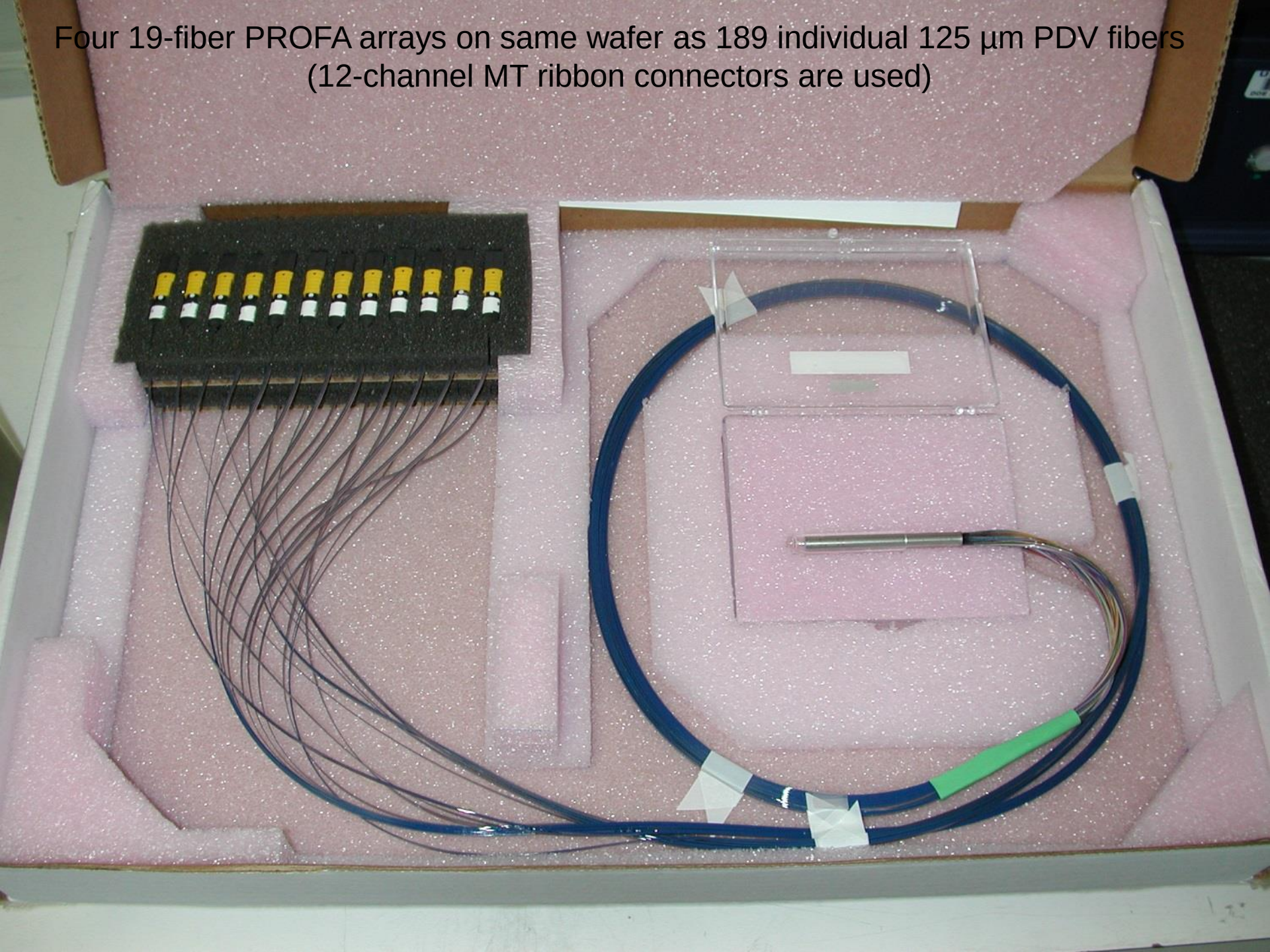
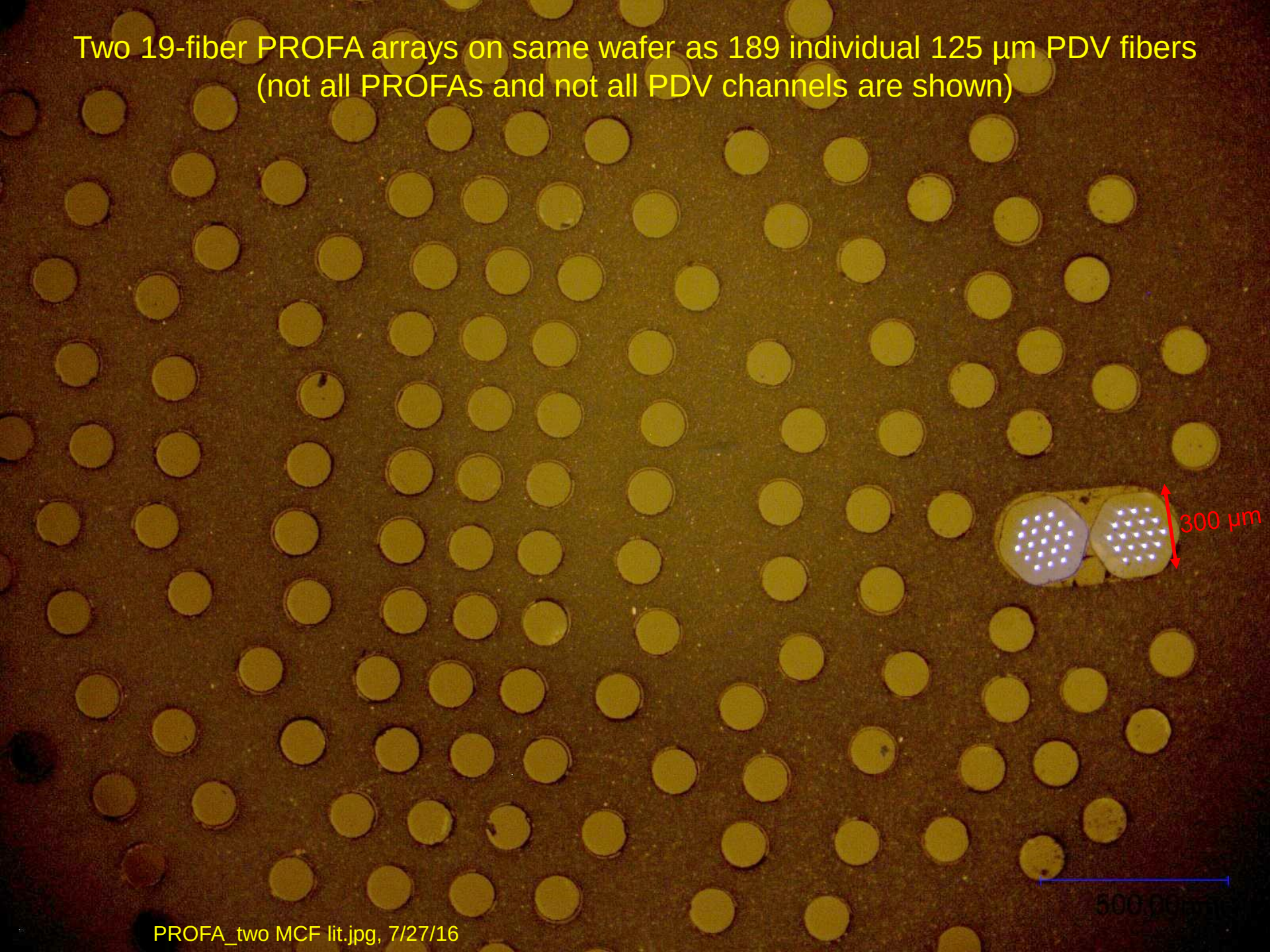


Schott Coherent Bundle
0.9 mm active diameter
7.4 µm pixel size
18,000 pixels
121 resolution elements across the diameter,
Imaging designed for 800-900 nm wavelength band

Four 19-fiber PROFA arrays on same wafer as 189 individual 125 µm PDV fibers
(12-channel MT ribbon connectors are used)

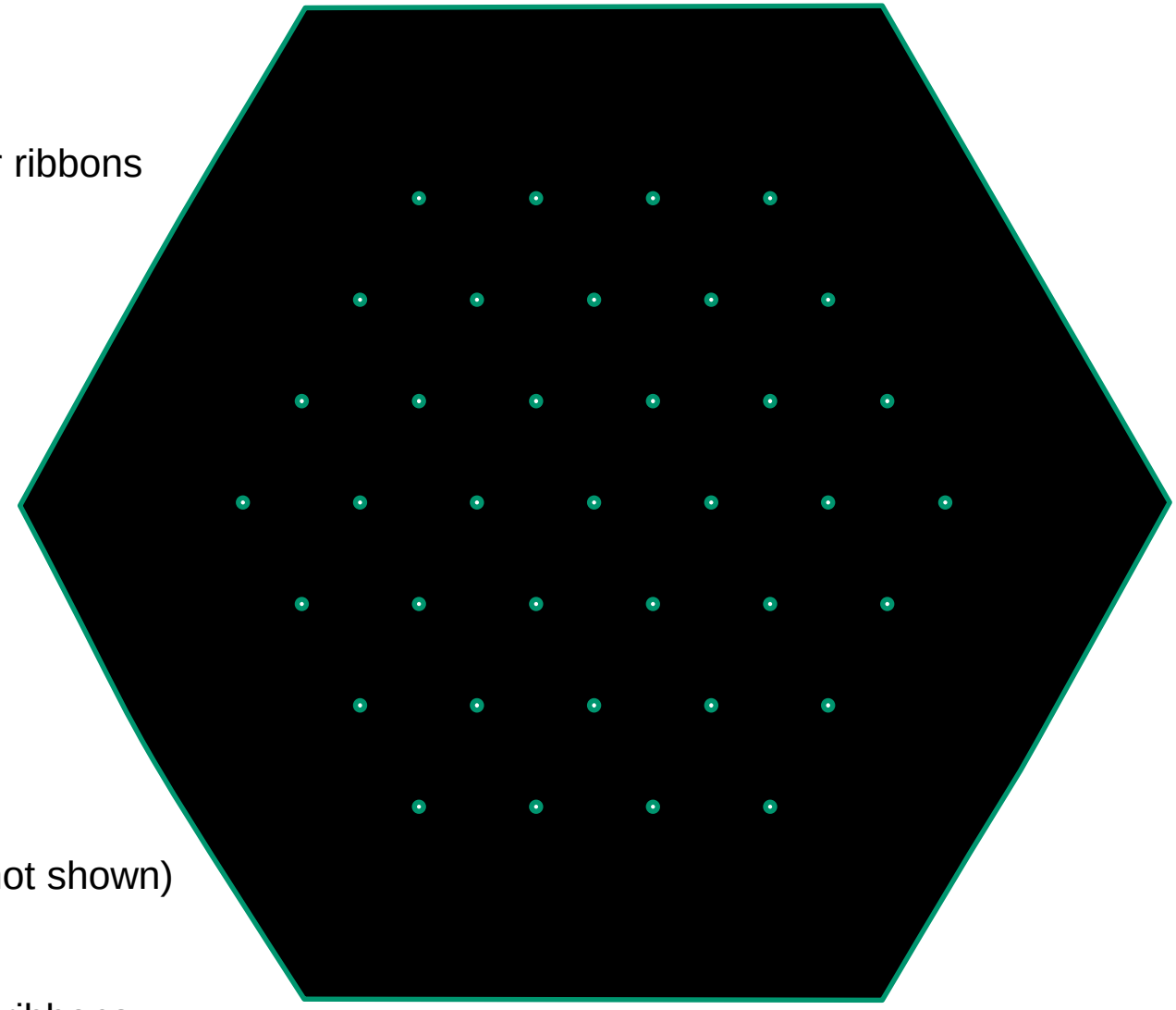


Two 19-fiber PROFA arrays on same wafer as 189 individual 125 µm PDV fibers
(not all PROFAs and not all PDV channels are shown)

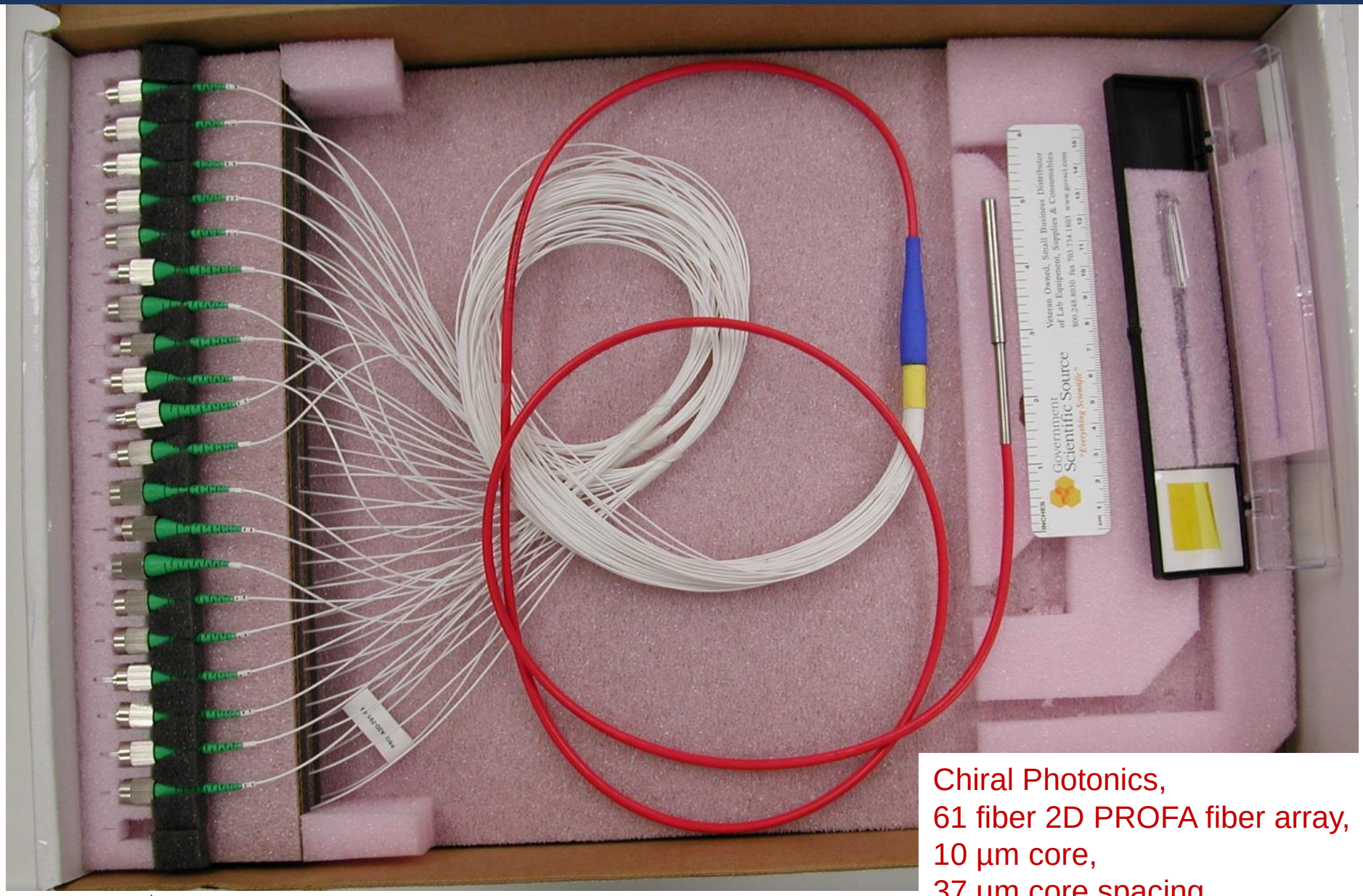


PROFA_two MCF lit.jpg, 7/27/16

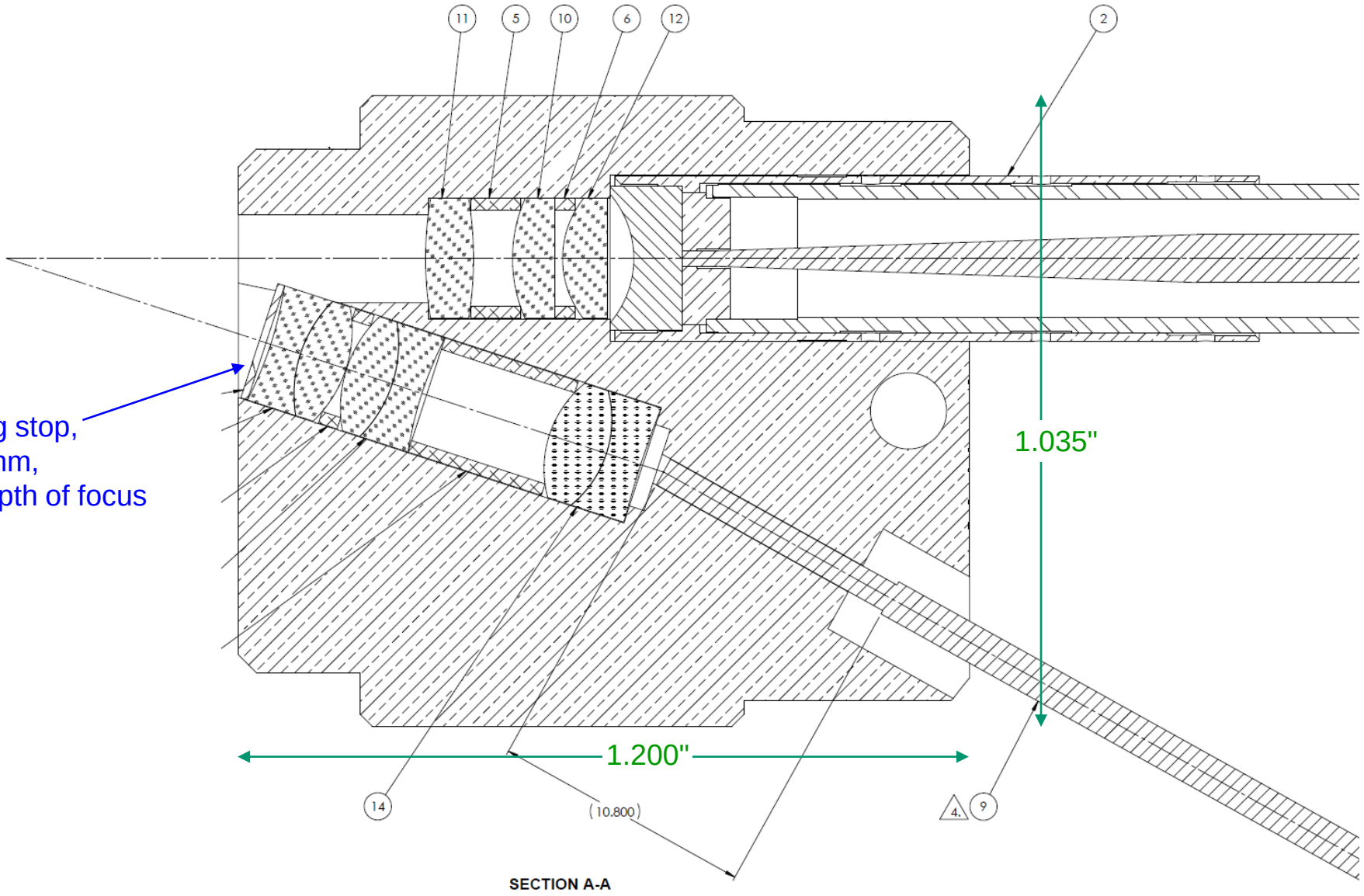
37 fiber 2D PROFA fiber array
10 µm core
37 µm core spacing
MTP connectorized into 12-fiber ribbons
$2,620

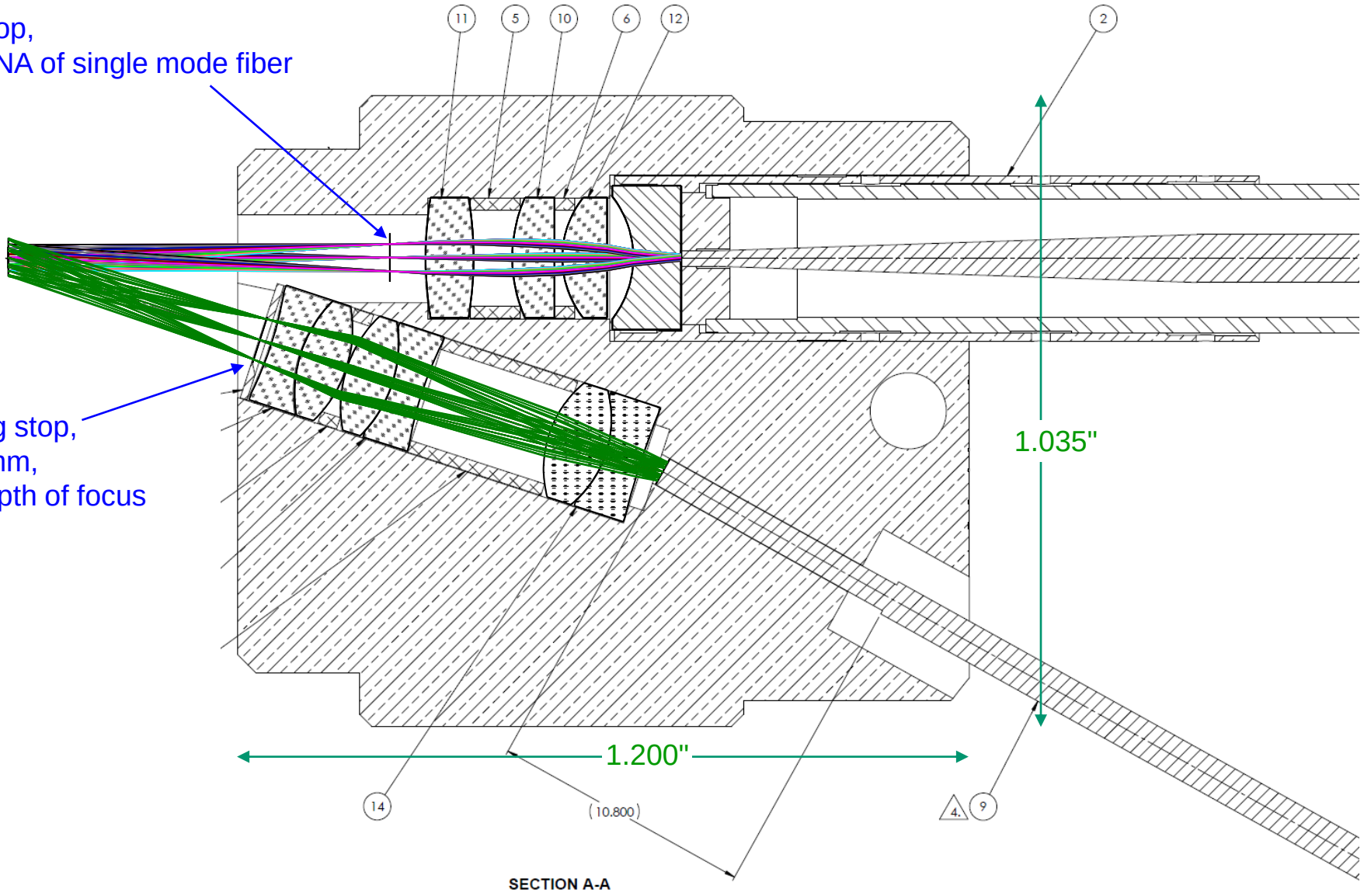


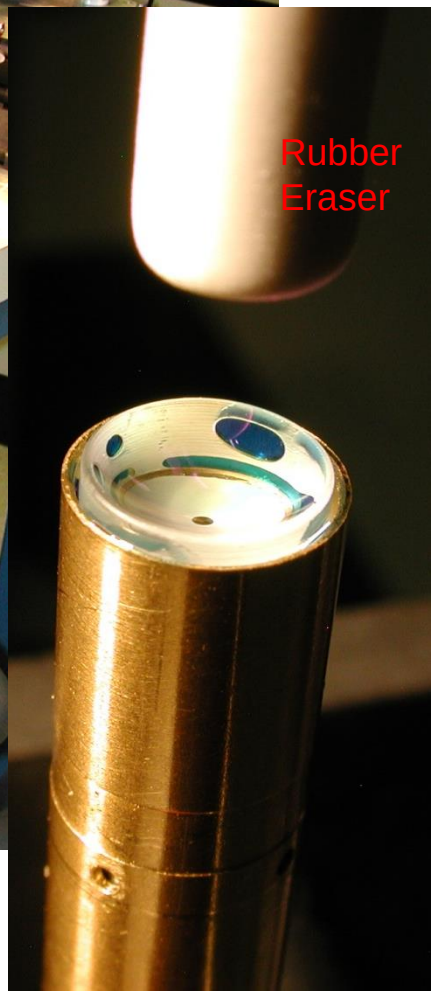
Another option:
61 fiber 2D PROFA fiber array (not shown)
10 µm core
37 µm core spacing
MTP connectorized into 12-fiber ribbons
$3,720



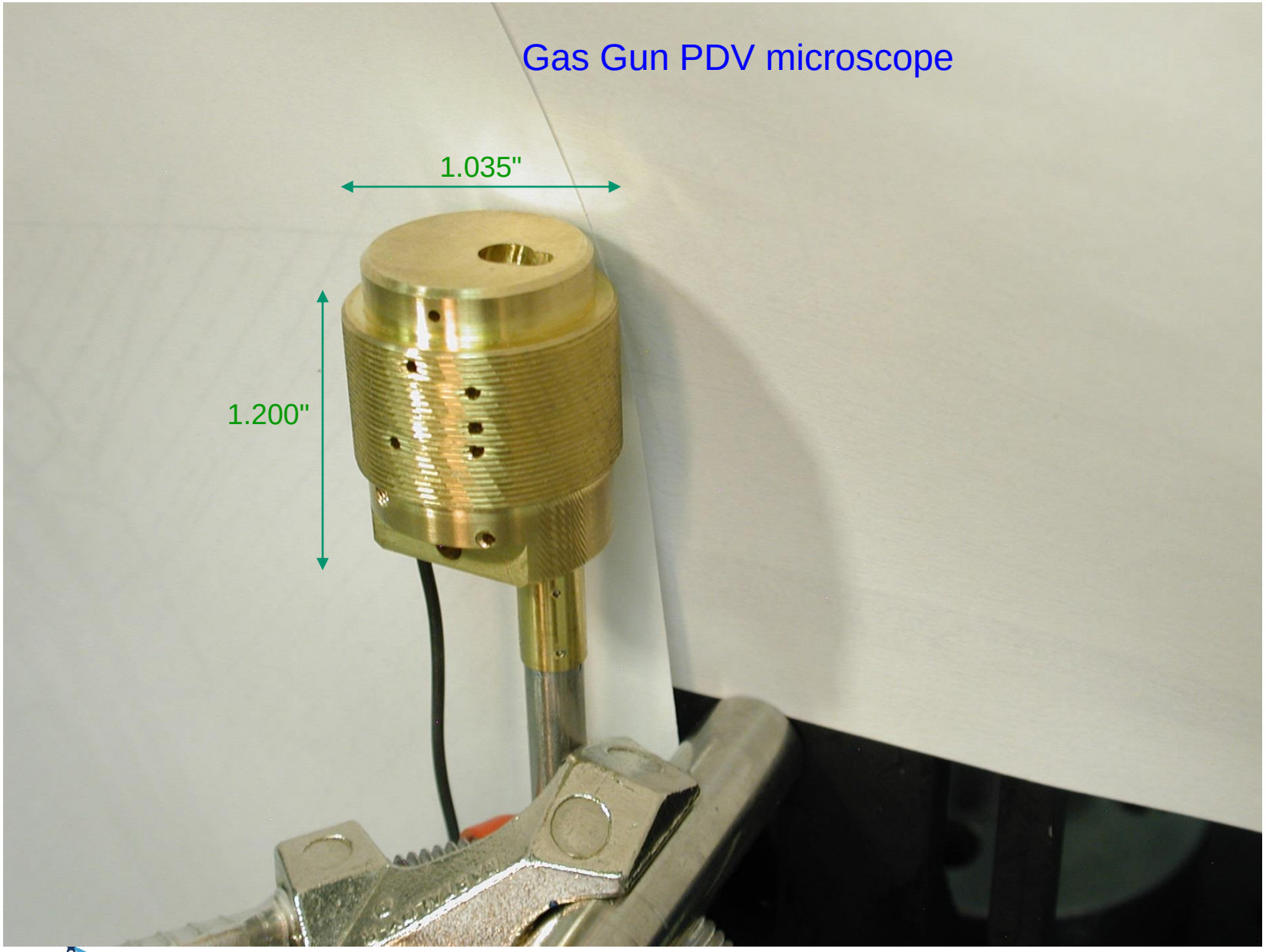
Chiral Photonics,
61 fiber 2D PROFA fiber array,
10 µm core,
37 µm core spacing,
FC/APC connectors,
$5,865


11
5
10
6
12
2
Imaging stop,
Ø 1.8 mm,
sets depth of focus
1.035"
1.200"
14
(10.800)
4.
9
SECTION A-A


PDV stop,
Set by NA of single mode fiber
Imaging stop,
Ø 1.8 mm,
sets depth of focus
11
5
10
6
12
2
1.035"
1.200"
14
(10.800)
4.
9
SECTION A-A

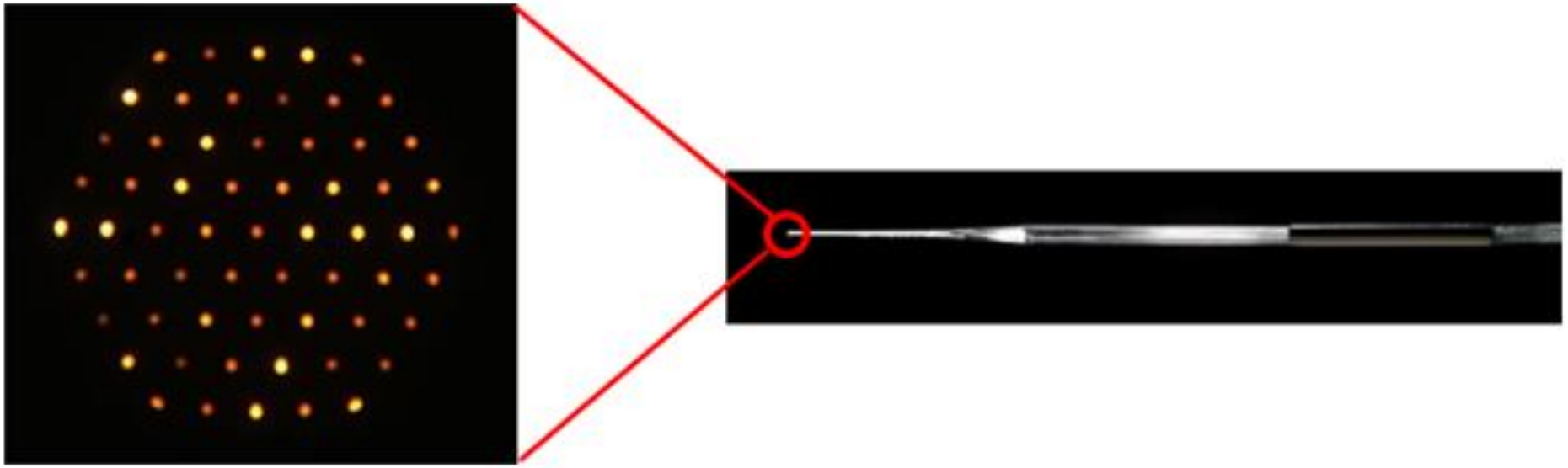


Measuring dB loss at PROFA array interface to Fused Silica lens, while glue is setting.

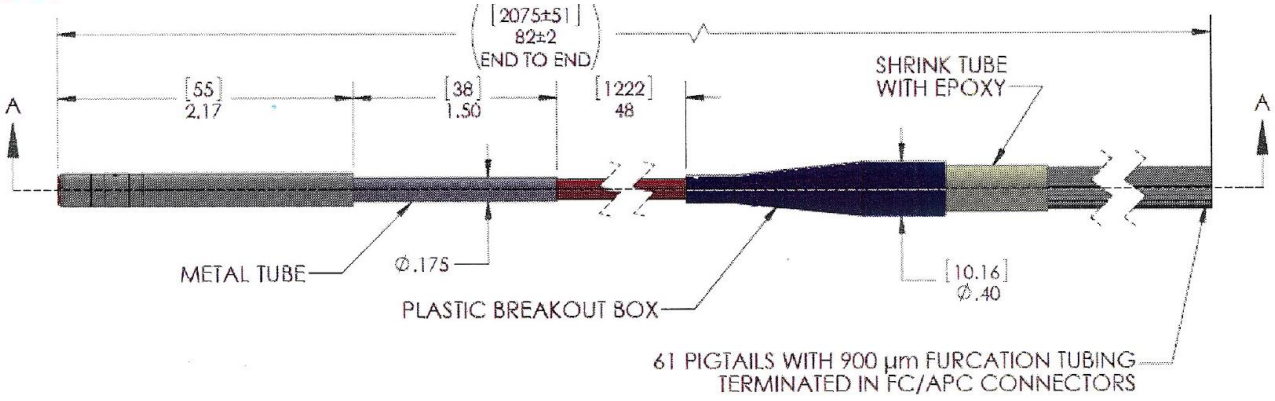

Gas Gun PDV microscope
1.035"
1.200"

61 fiber 2D PROFA fiber array,
10 µm core,
37 µm core spacing,
FC/APC connectors,
$5,865

PROFA array pattern for 61 fibers



Pitch 37 µm
Average error in spacing 0.5 µm
Maximum error in spacing 1.8 µm



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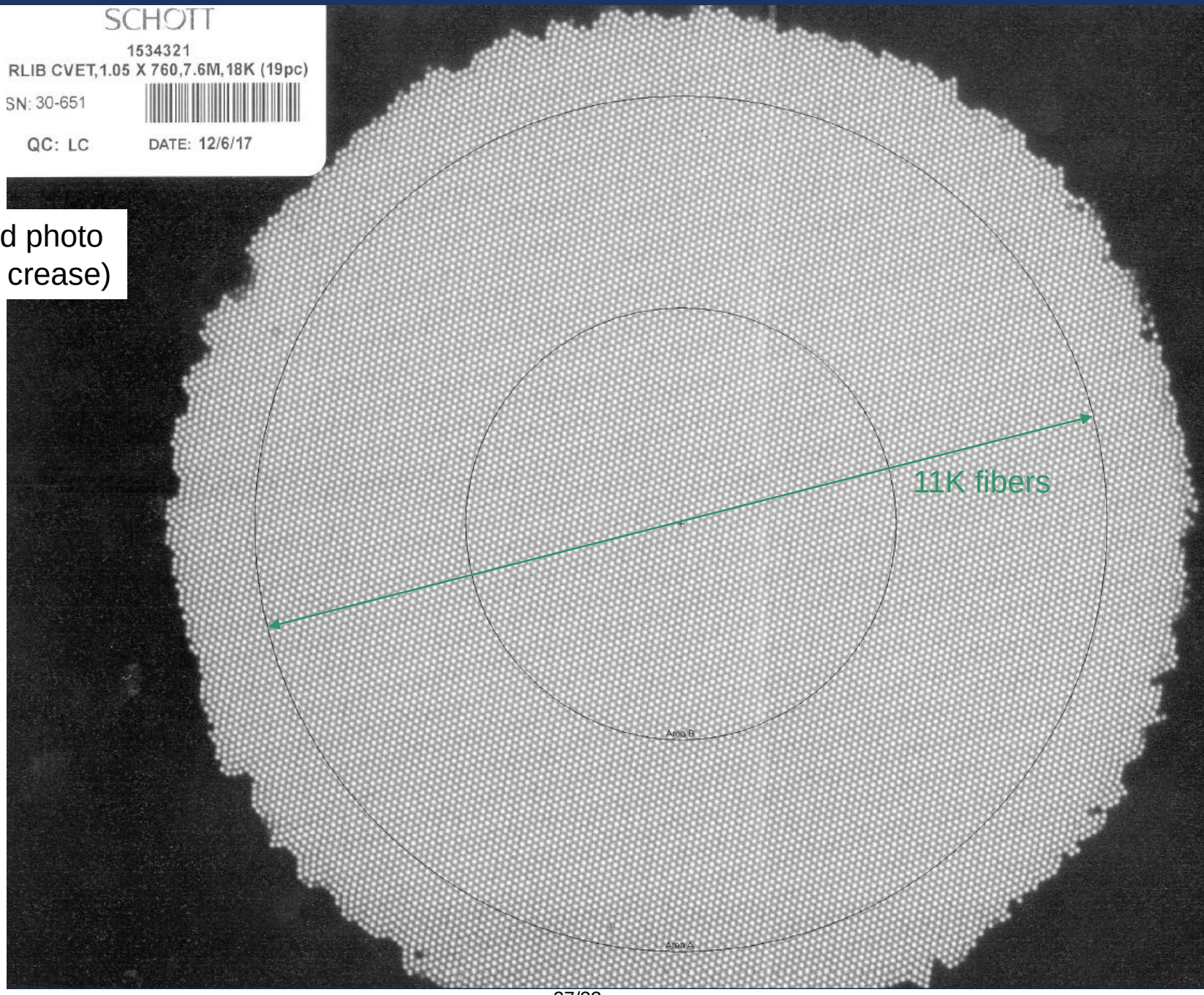
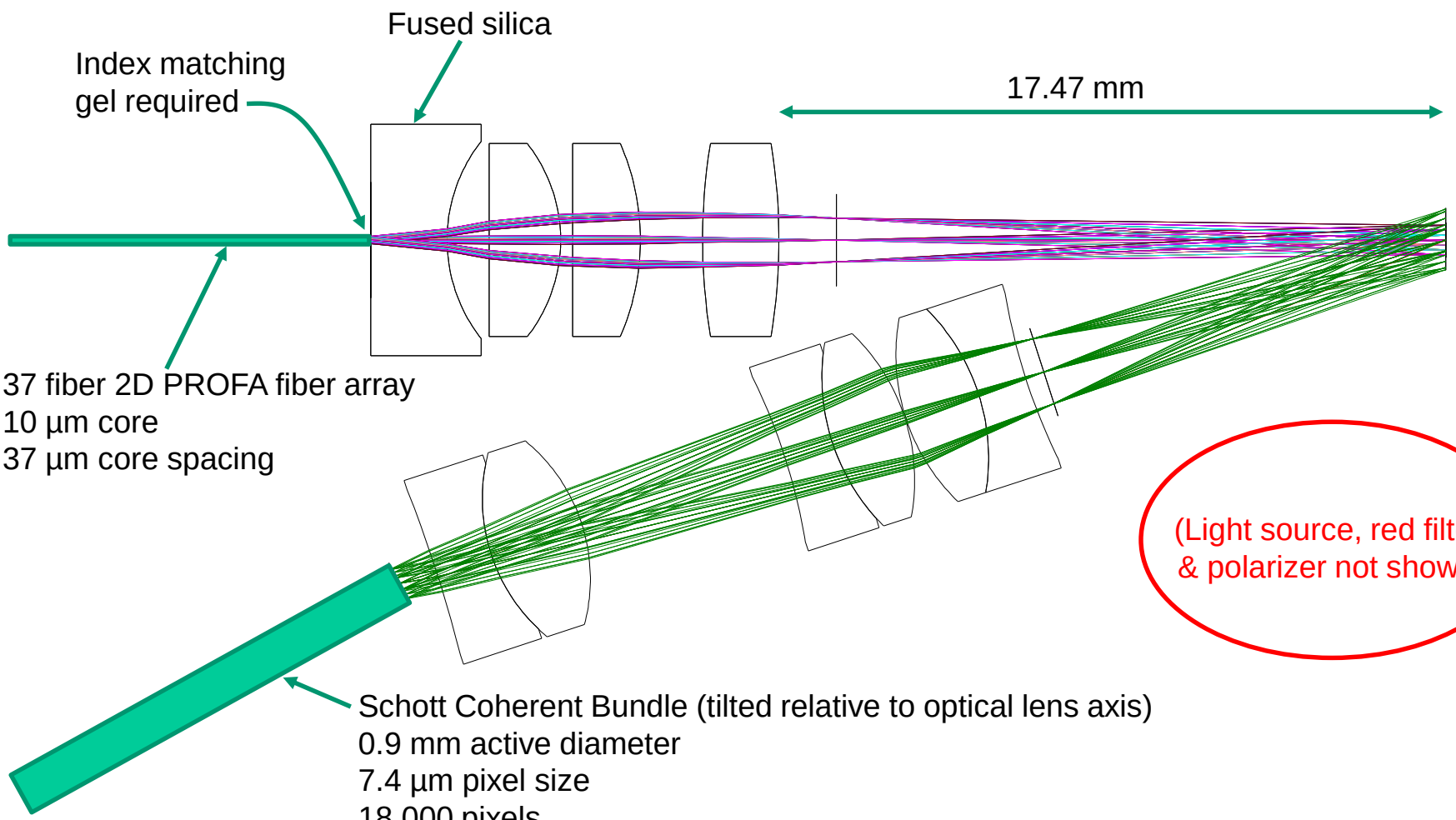
OD Outer Diameter (mm)	Length (mm)	Quality Area Diameter (mm)	Pixel Size (µ)	Pixel Count (k)	Distal Ferrule Diameter (mm)	Proximal Ferrule Diameter (mm)
1.05	760	0.9	7.4	18	1.22 x 5.60	1.22 x 12.80

Scan of folded photo
(should be no crease)



Imaging system tilted at 18°

Gas Gun PDV microscope



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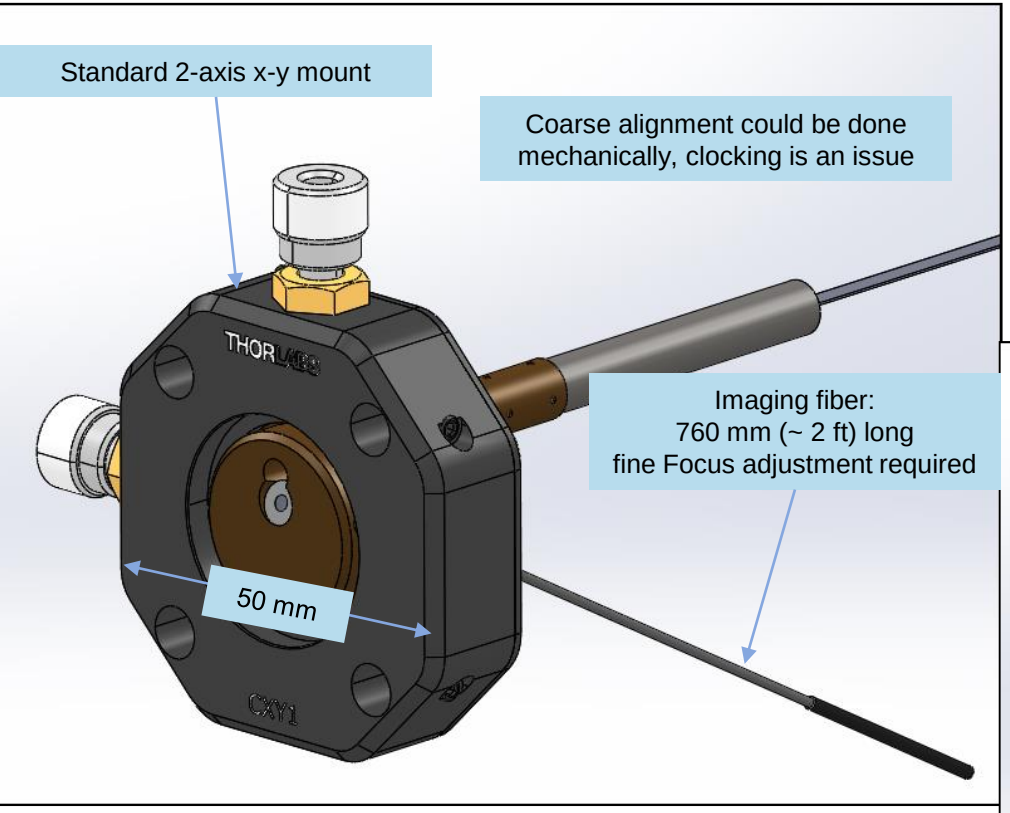
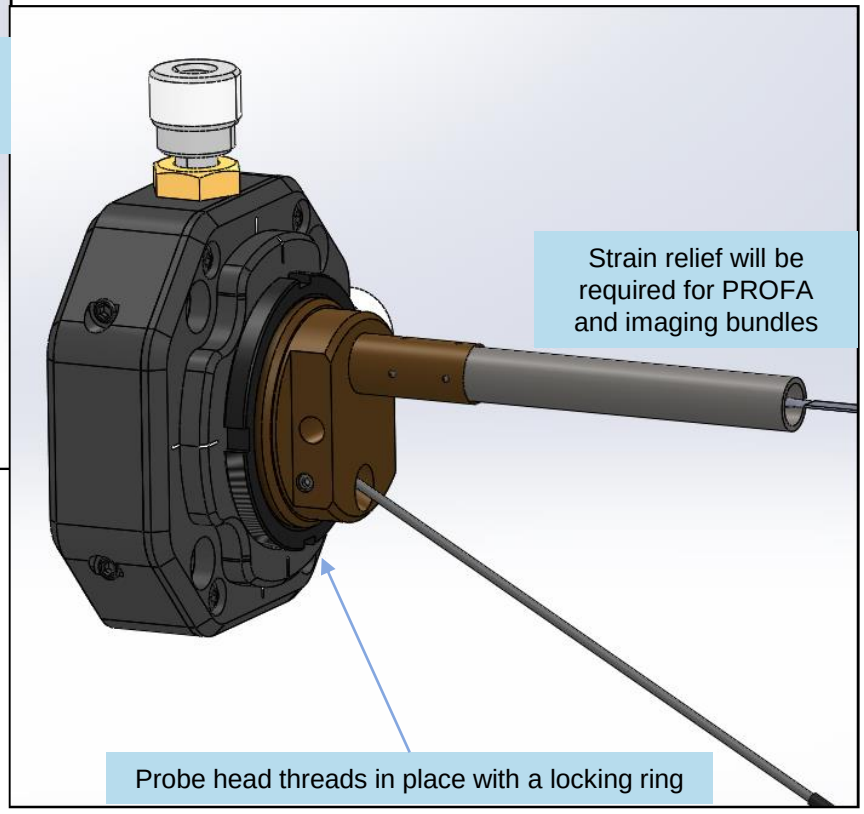
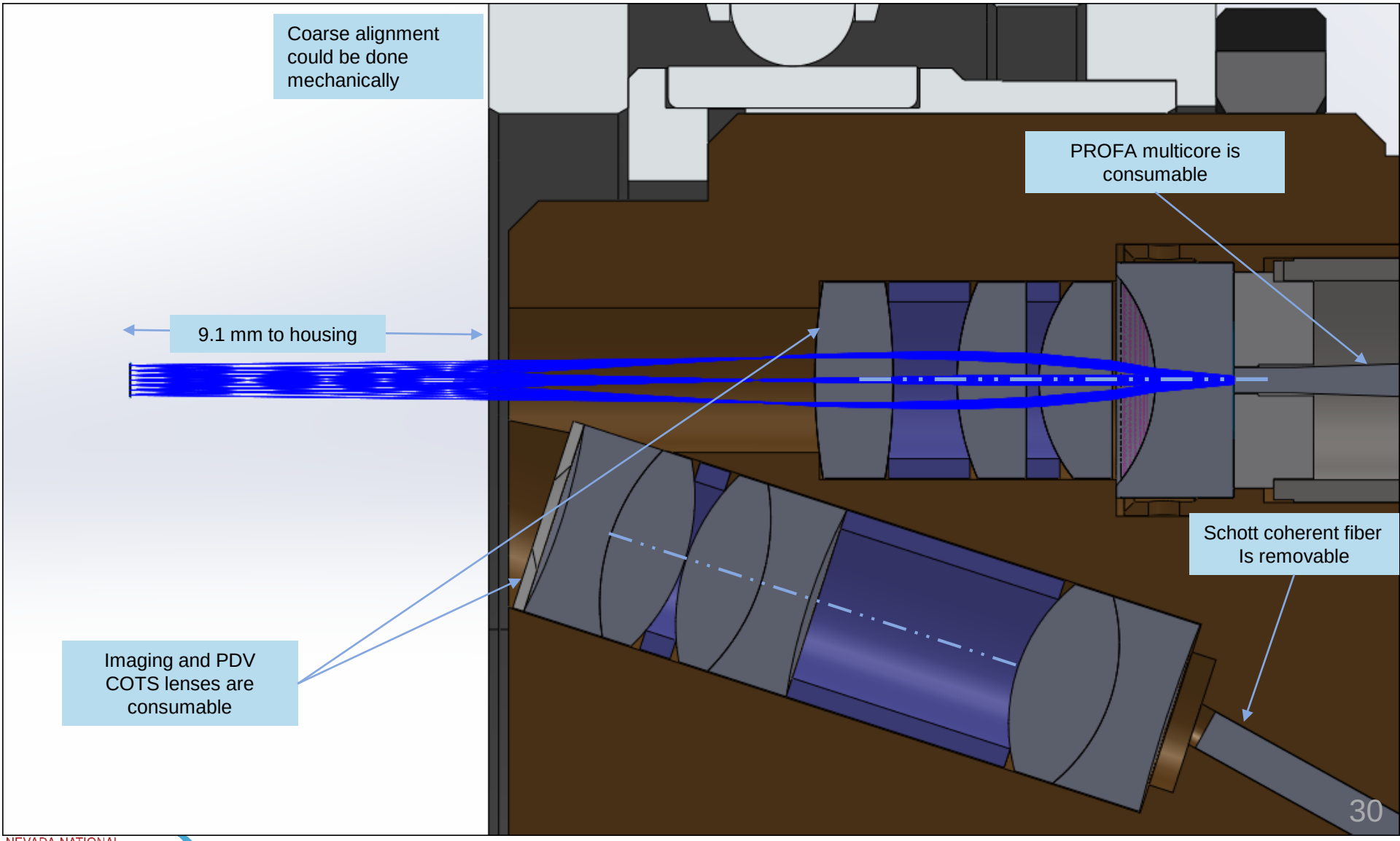
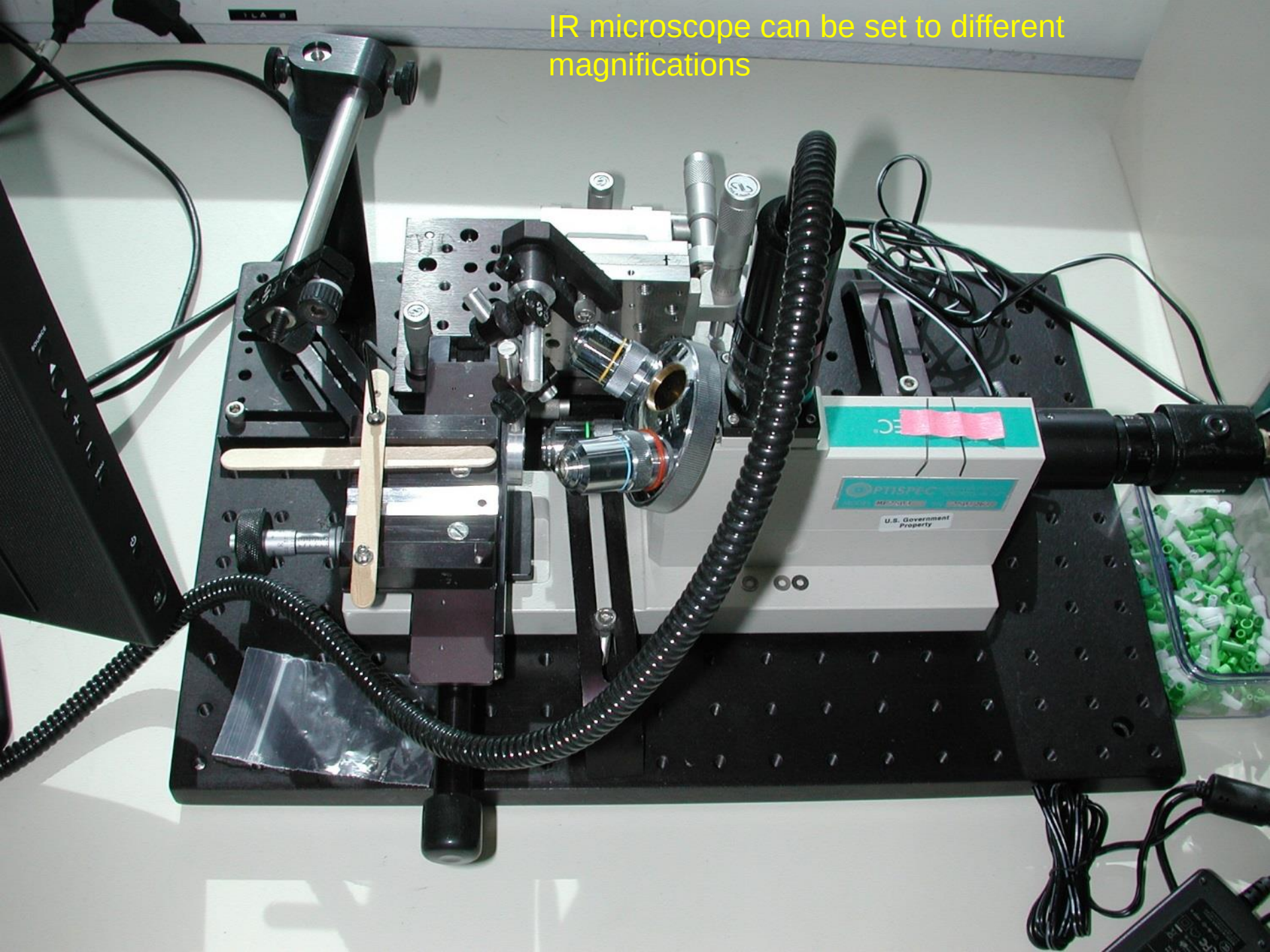
Optomechanical design: monolithic approach



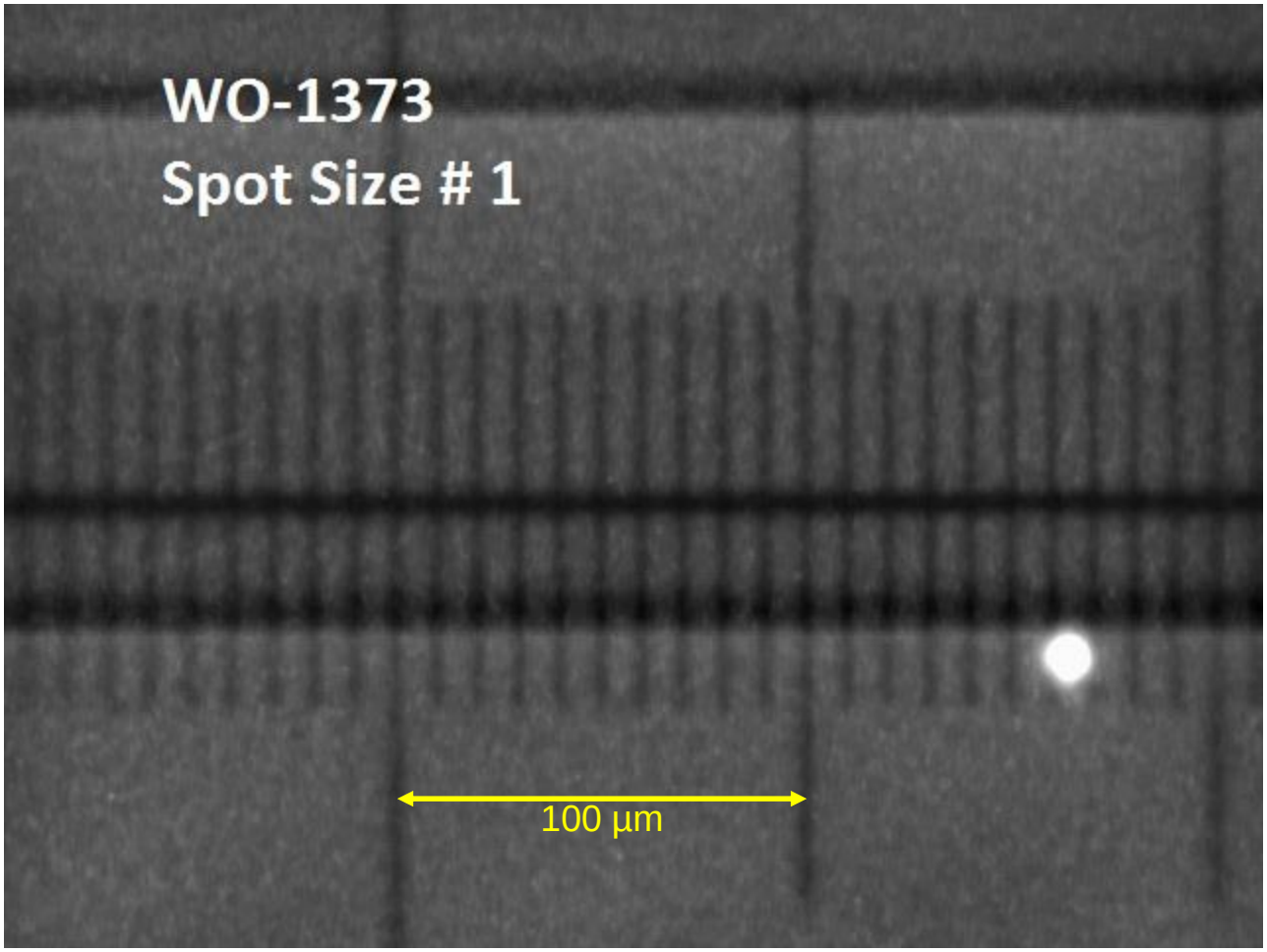


Monolithic design: customer concerns




IR microscope can be set to different magnifications
U.S. Government Property

10 µm spot size from PDV fiber probe, seen at 1550 nm on the IR microscope



In this photo, the intensity of PDV spot is saturating camera. So, some spot size blooming occurs.

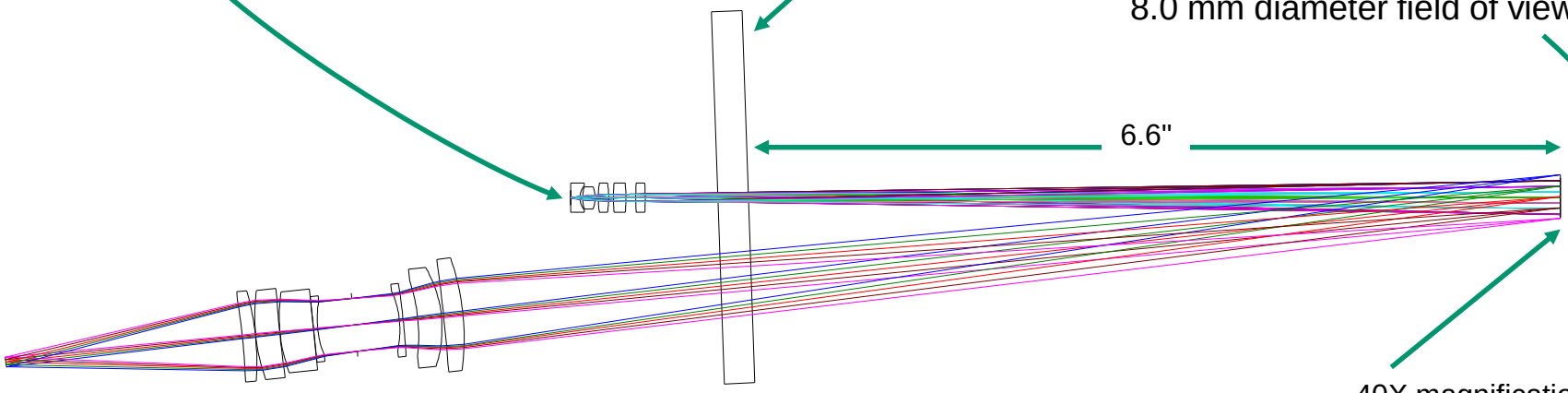
PDV_Spot_Size_from_IR_microscope_10-micron_grid_lines.jpg

37 fiber 2D PROFA fiber array
10 µm core
37 µm core spacing
MTP connectorized into 12-fiber ribbons
$2,620

BK7 window,
3" diameter,
1/4" thick

8.0 mm diameter field of view

6.6"



40X magnification

50 mm f/3.8 lens

Needs 100 mm EFL macro lens

2 mm diameter coherent bundle

35.00 MM