



Optical Diagnostics

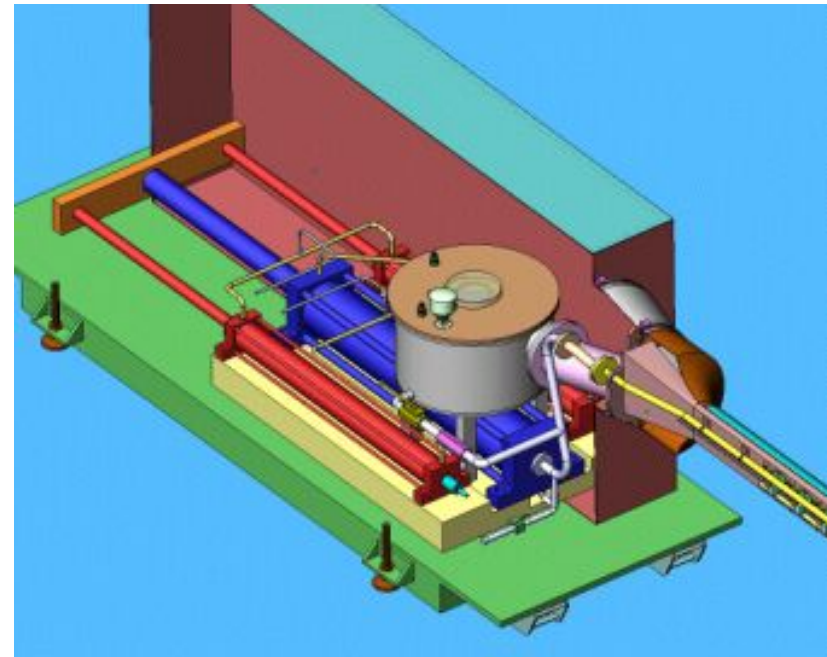
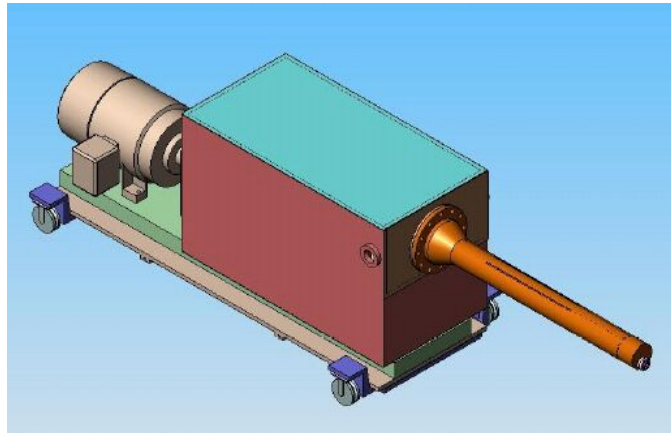
T. Tsang

BNL

(Aug. 4, 2006)



Optical Diagnostics

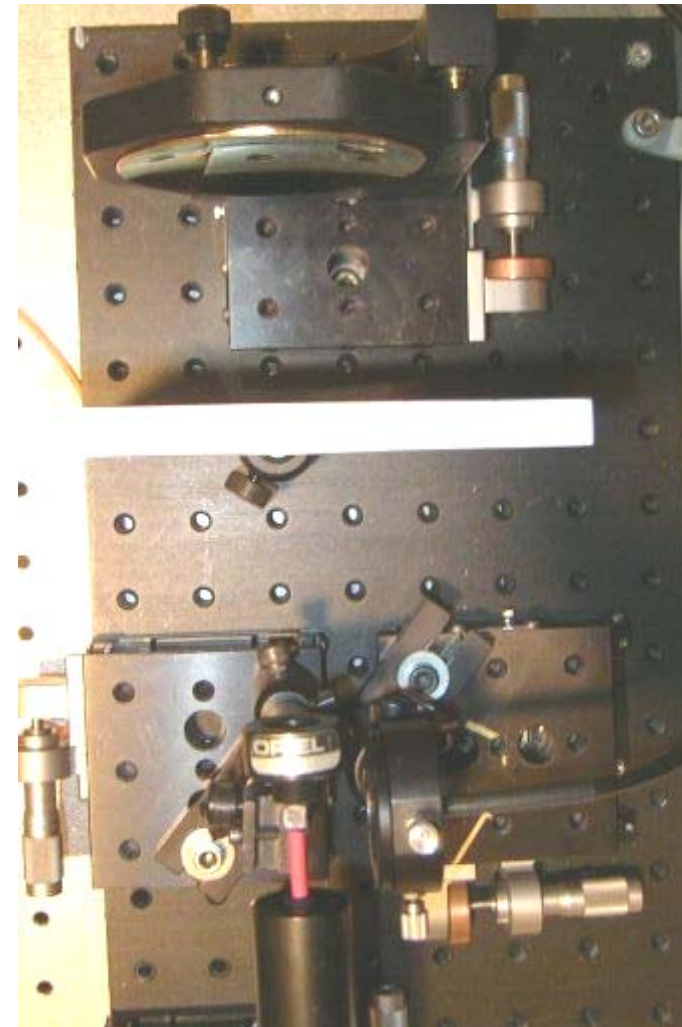
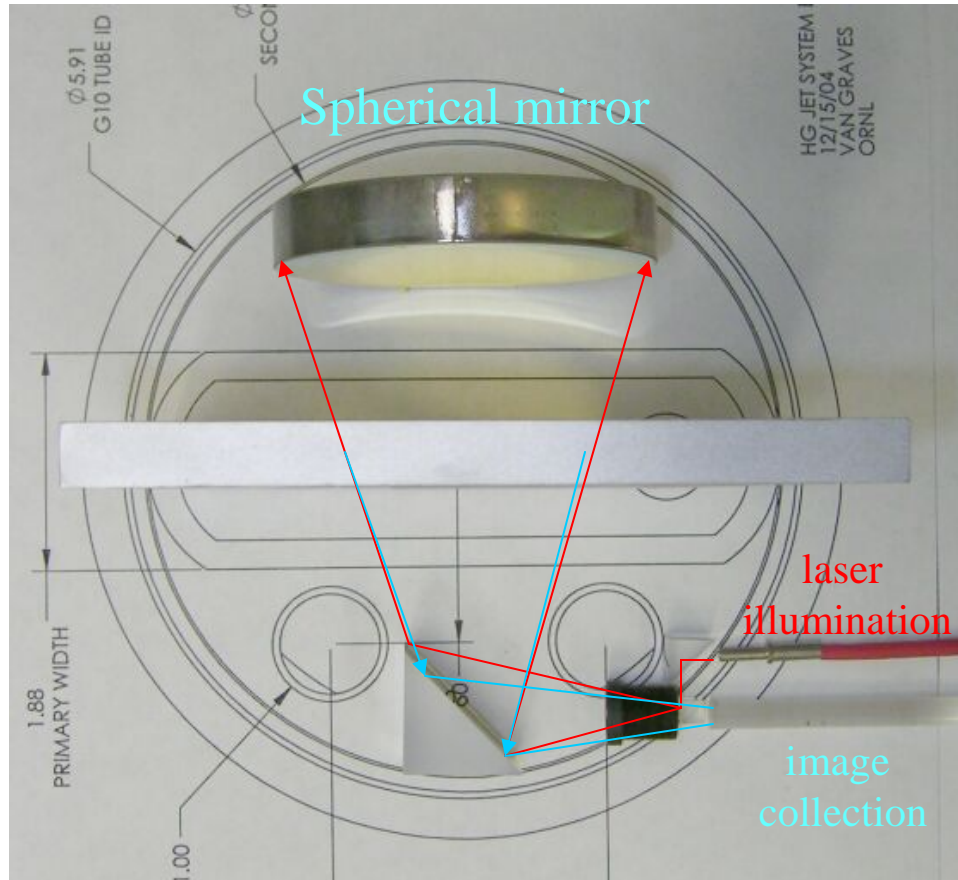


- tight environment
- high radiation area
- non-serviceable area
- passive components
- optics only, no active electronics
- transmit image through flexible fiber bundle



Optical Diagnostics

retroreflected illumination

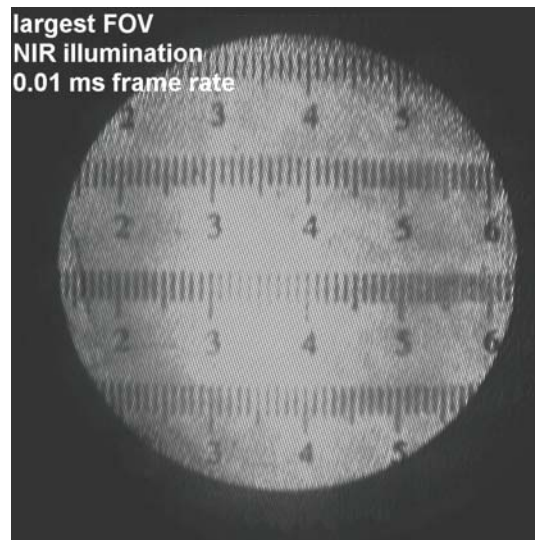
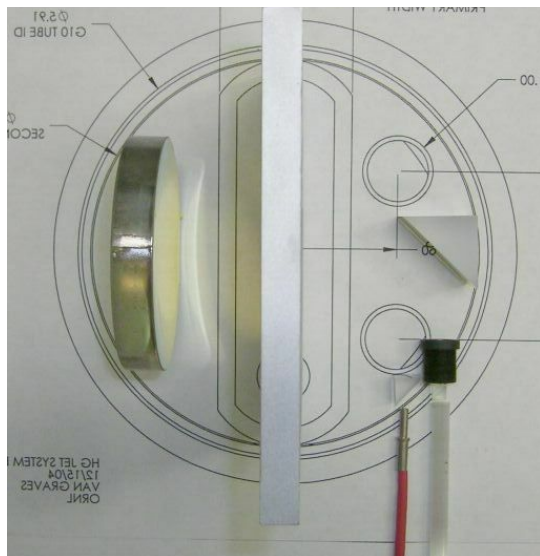
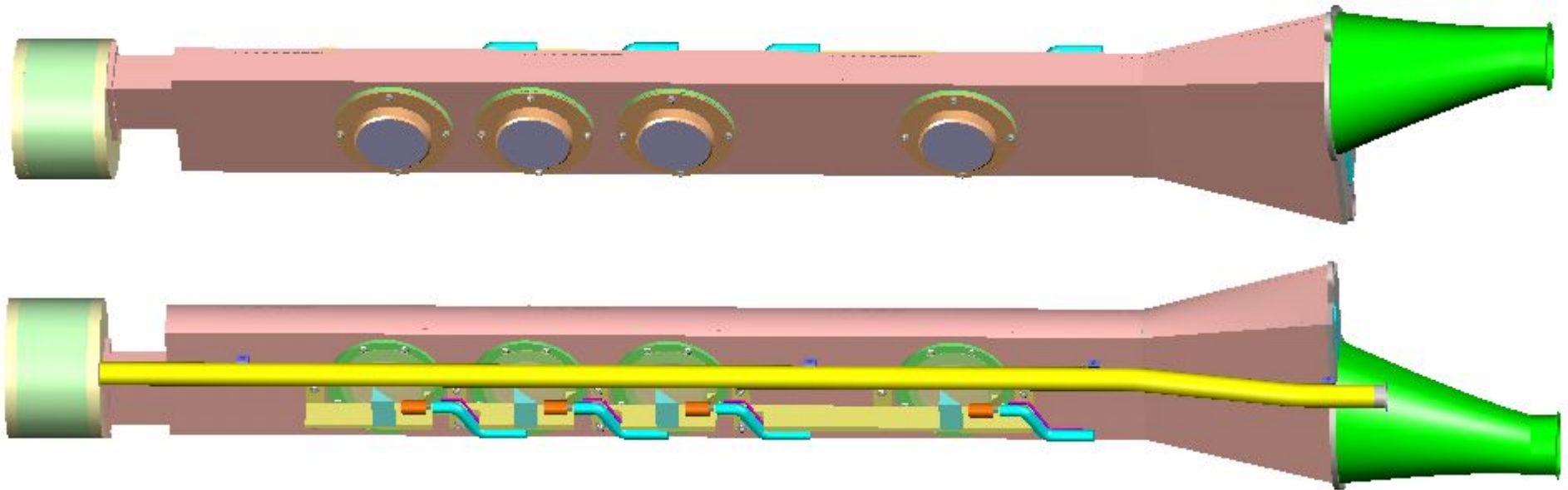


Works OK in this tight environment



Optical Diagnostics

optical design in secondary containment



One set of optics
per viewport

Conceptual design
completed

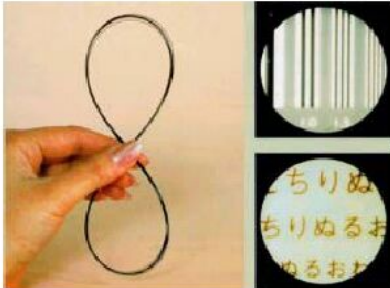
Sumitomo imaging fibers – **used in our setup**

TP03105B



Product Lineup

Rad-hard to 1 Mrad

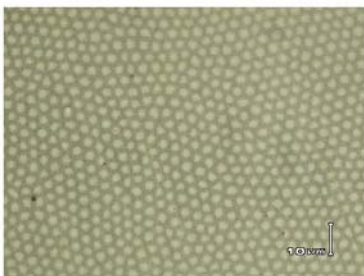


IGN-08/30 sample
0.3-meter
30,000 pixels

facet #1



50X



800X

	IGN-02/03	IGN-028/06	IGN-035/06	IGN-037/10	IGN-05/10	IGN-08/30	IGN-15/30	IGN-20/50
Number of picture elements	3,000	6,000	6,000	10,000	10,000	30,000	30,000	50,000
Jacketing diameter (um)	200	280	350	370	500	800	1,500	2,000
Picture elements area diameter (um)	180	252	315	333	450	720	1,350	1,800
Coating diameter (Primary) (um)	250	340	420	450	590	960	1,900	2,400
Coating diameter (Secondary) (um)	---	---	---	---	---	---	2,500	3,000
Circularity	>= 0.93							
Core material	GeO2 Containing Silica							
Cladding material	F Containing Silica						Pure Silica	
Coating material	Silicone						Silicone + PFA	
Numerical aperture	0.35						0.30	
Lattice defect (%)	<= 0.1							
Allowable bending radius (mm)	10	15	15	20	25	40	75	100
Allowable max temp. (C)	150							

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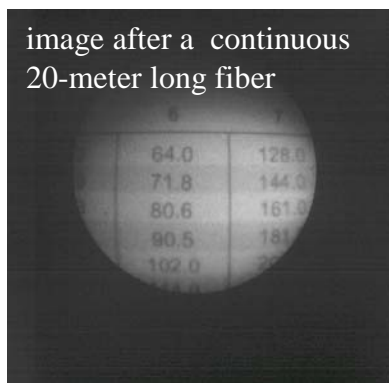
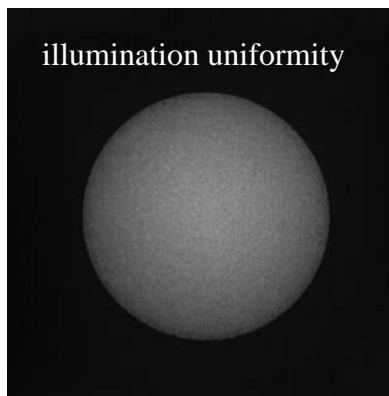


Cost per foot	\$78	\$158	\$305
Cost in 10 meter	\$2574	\$5214	\$10065
Total cost for 4 fibers (40 meter)	\$10.3k	\$20.8k	\$40.3k

Fujikura imaging fibers – Not used



Fujikura data, FIGH-30
A continuous 20-meter fiber
30,000 pixel imaging fiber



ULTRATHIN IMAGEFIBER SPECIFICATIONS (FIGH series N-Type 50k-100k)

Table 3

Item	FIGH-30-850N	FIGH-50-1100N	FIGH-70-1300N	FIGH-100-1500N
Number of picture elements(nominal)	30,000	50,000	70,000	100,000
Imagecircle diameter (um)	790 ± 50	1,025 ± 80	1,200 ± 100	1,400 ± 120
Fiber diameter (um)	850 ± 50	1,100 ± 80	1,300 ± 100	1,500 ± 120
Coating diameter (um)	950 ± 50	1,200 ± 100	1,450 ± 100	1,700 ± 150
Minimum bending radius (mm)	90 ^{*1} _50 ^{*2} _	110 ^{*1} _80 ^{*2} _	150 ^{*1} _100 ^{*2} _	200 ^{*1} _130 ^{*2} _
Coating material	Silicone resin			
Lattice defect (%)	< 0.1			
Uncircularity (%)	< 5			
length/pc	Maximum length of 1pc : 10ft Cut and rough polish are available. Cut length of 1pc : Customer order			

Cost per foot	\$85	\$250		\$540
Cost in 10 meter	\$2805	\$8250		\$17.8k
Total cost for 4 fibers (40 meter)	\$11.2k	\$33k		\$71.8k

unofficial price info

official price info

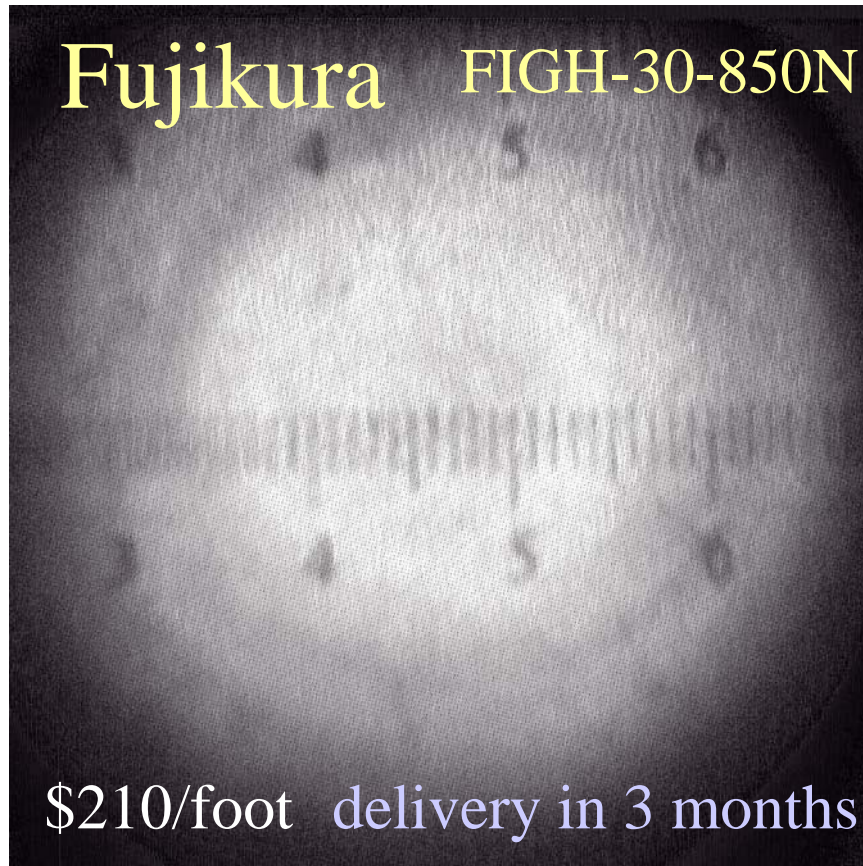
Cost/foot	\$210	\$371.4		
Cost in 10 meter	\$6,935.65	\$12,256.7		
Cost in 20 meter	\$15,607.9			
Total cost for 4 fibers (40 meter)	\$27,742.6	\$49,026.8		

Image quality comparison

25 cm long

30,000 pixels, 1-mm diameter

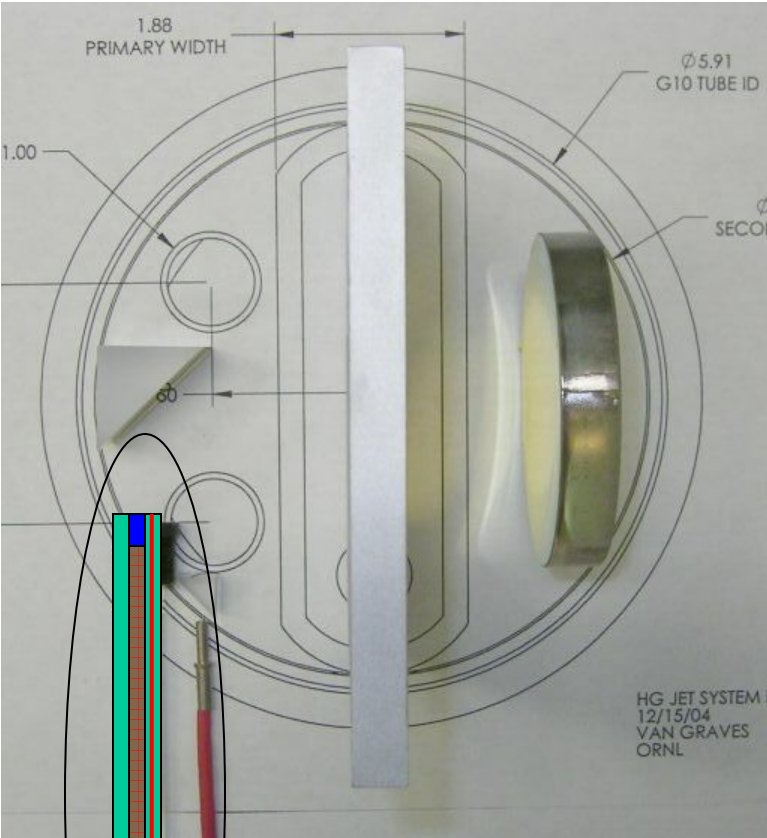
30 cm long



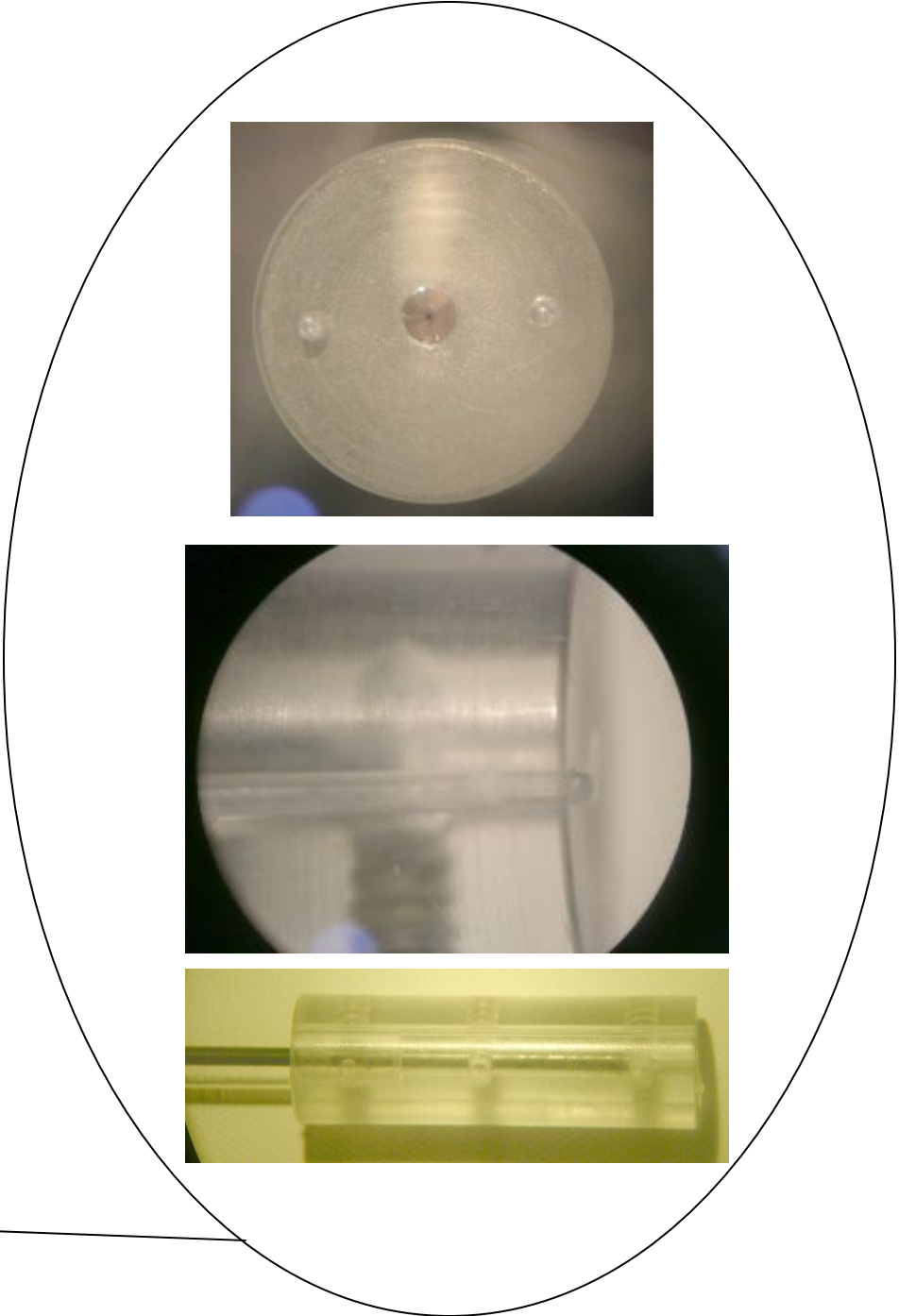
camera SMD illumination
NIR pulse, 10 us/frame

NO significant difference in image quality
Should go with Sumitomo fibers
(20 meters have been ordered)

All-in-one optical setup



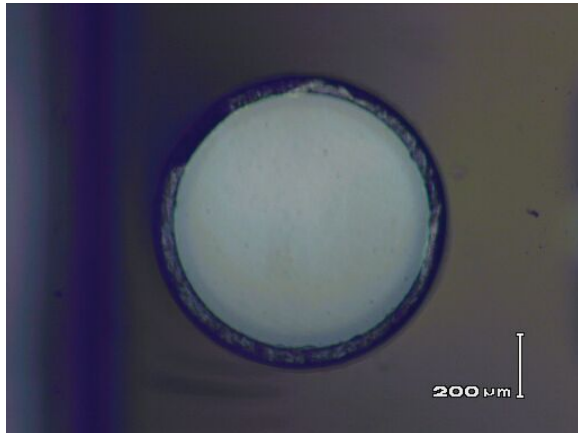
Grin objective lens
imaging fiber – 1 mm
illumination fiber
fiber holder



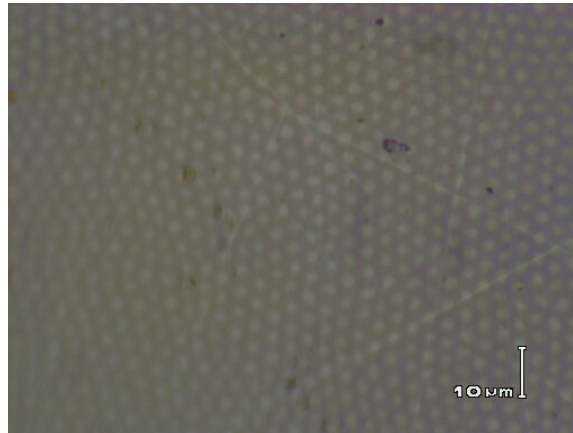
Sumitomo IGN08/30 imaging fiber – 20-meter long

July 2006

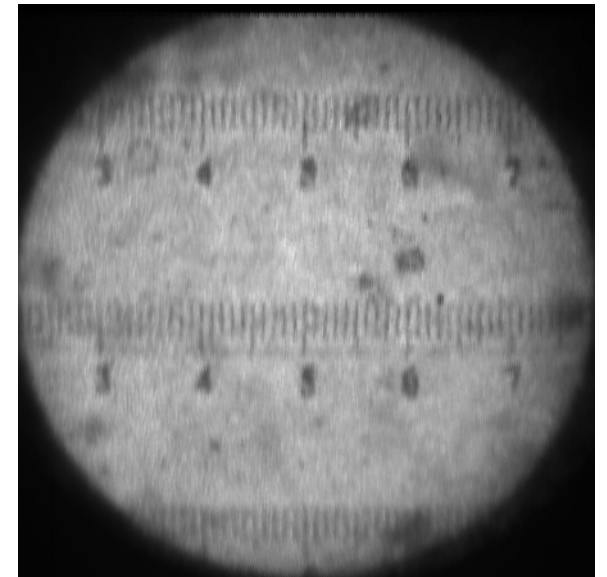
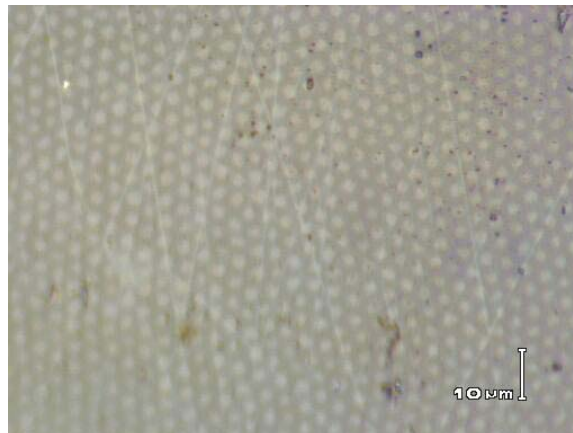
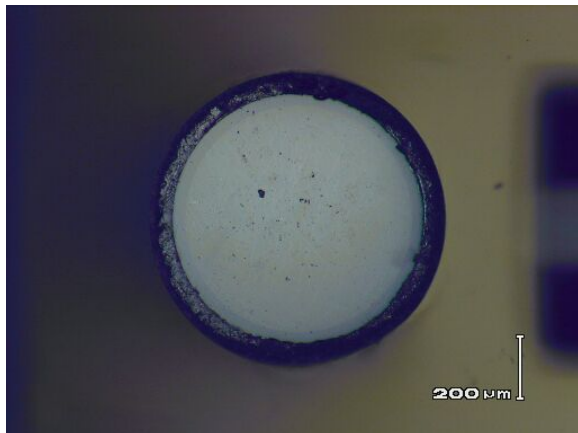
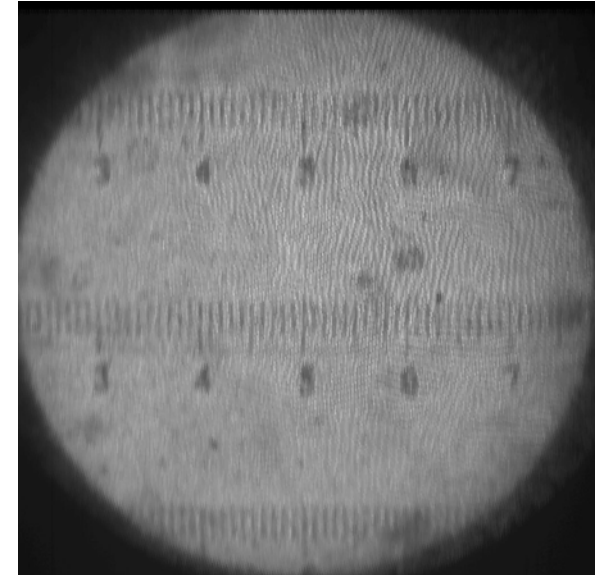
50 x



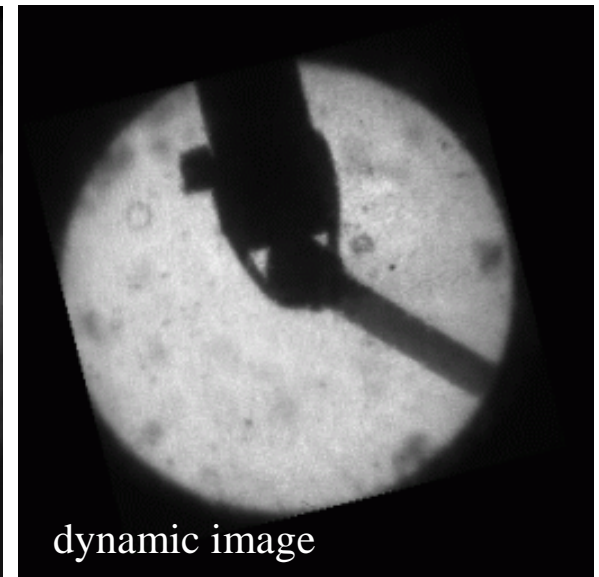
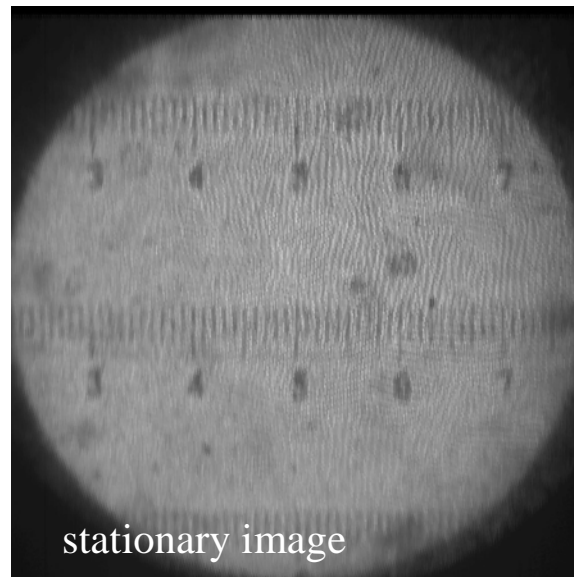
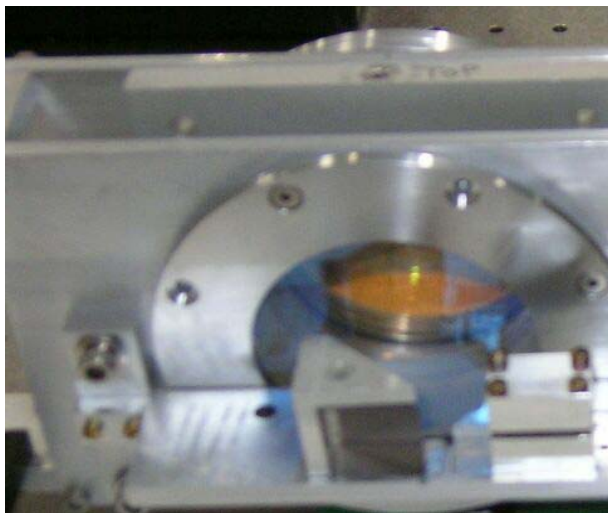
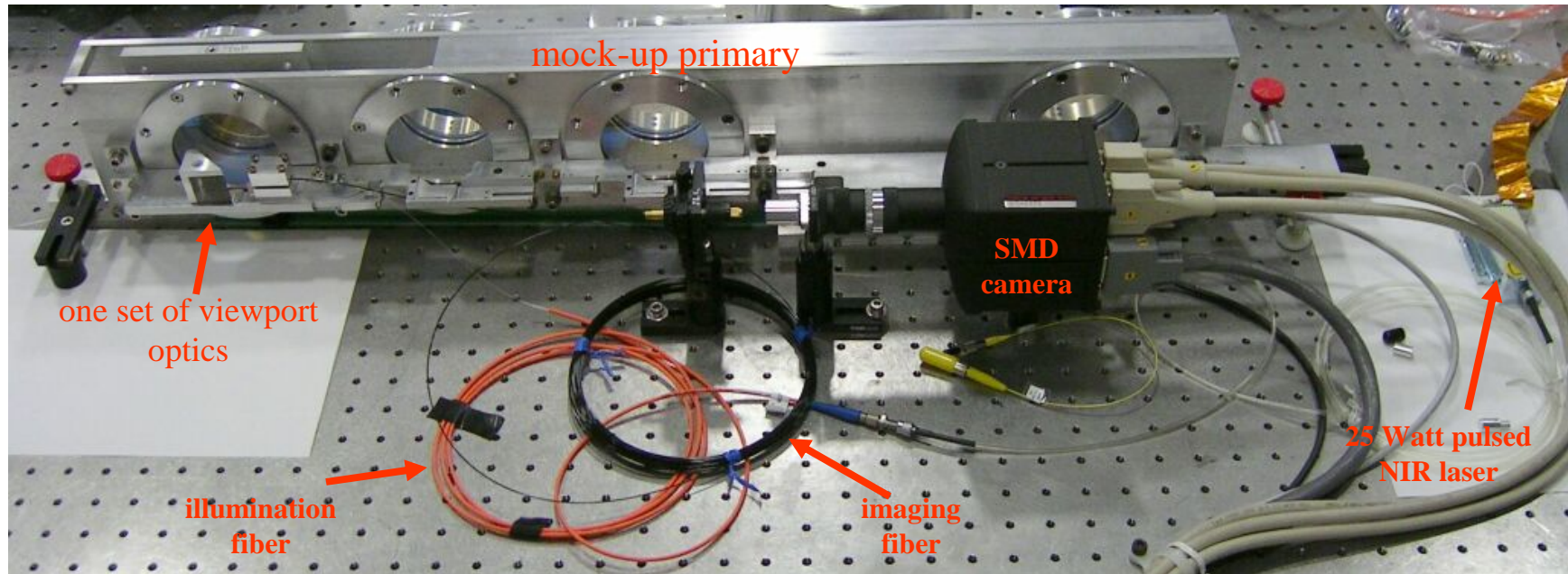
800 x



NIR 100 μs/frame static image

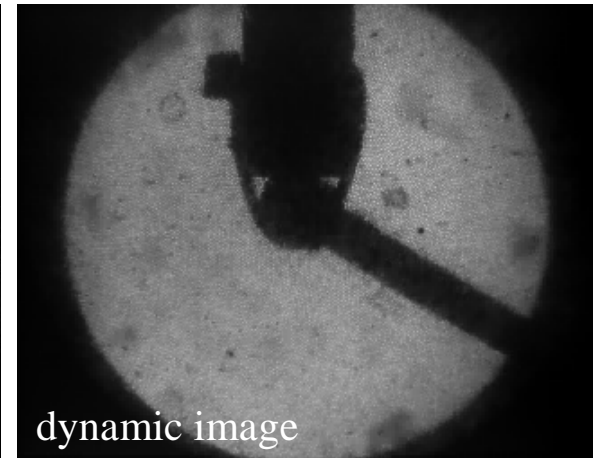
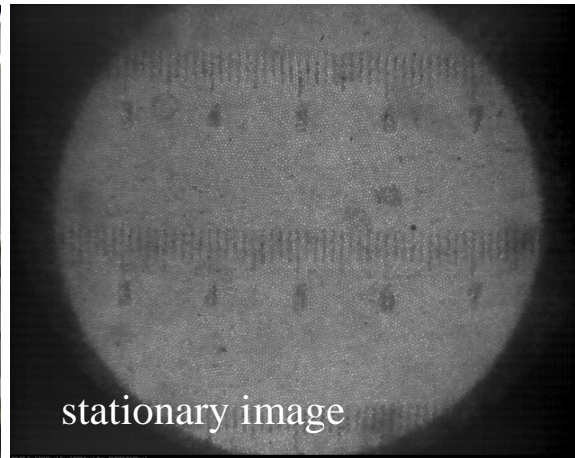
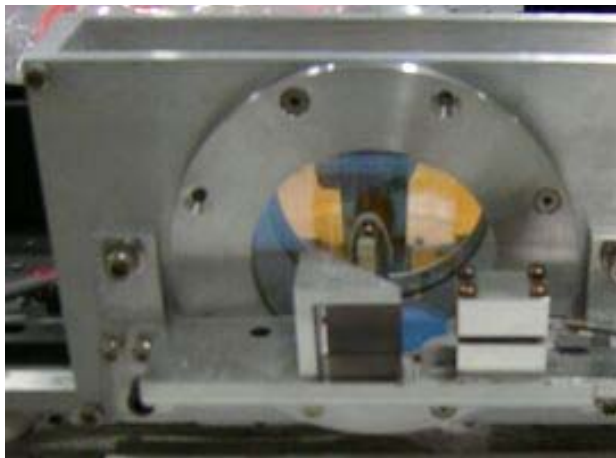
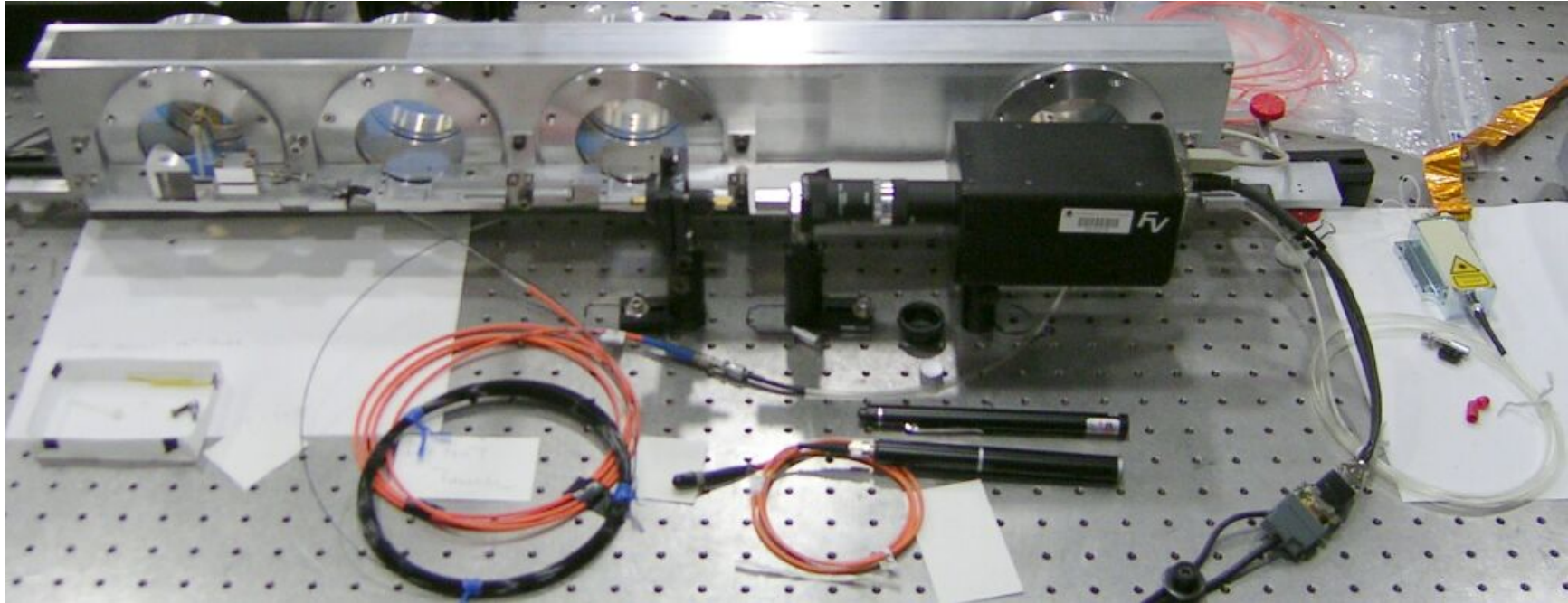


New baseplate on mock-up – SMD camera



SMD camera: NIR pulse 100 μ s/frame

New baseplate on mock-up – FastVision camera



FastVision camera: NIR pulse 2 ms/frame

Summary

- 10-meter imaging fibers will be assembled on mock-up primary
- dynamic image collection on both viewports will be tested
- 1st camera will be SMD CCD
- 2nd camera will be FastVision CCD
- 2 sets of viewport/optics/CCD will be ready by the end of August
- 3 more 10-meter long imaging fibers in order – viewports 3rd & 4th