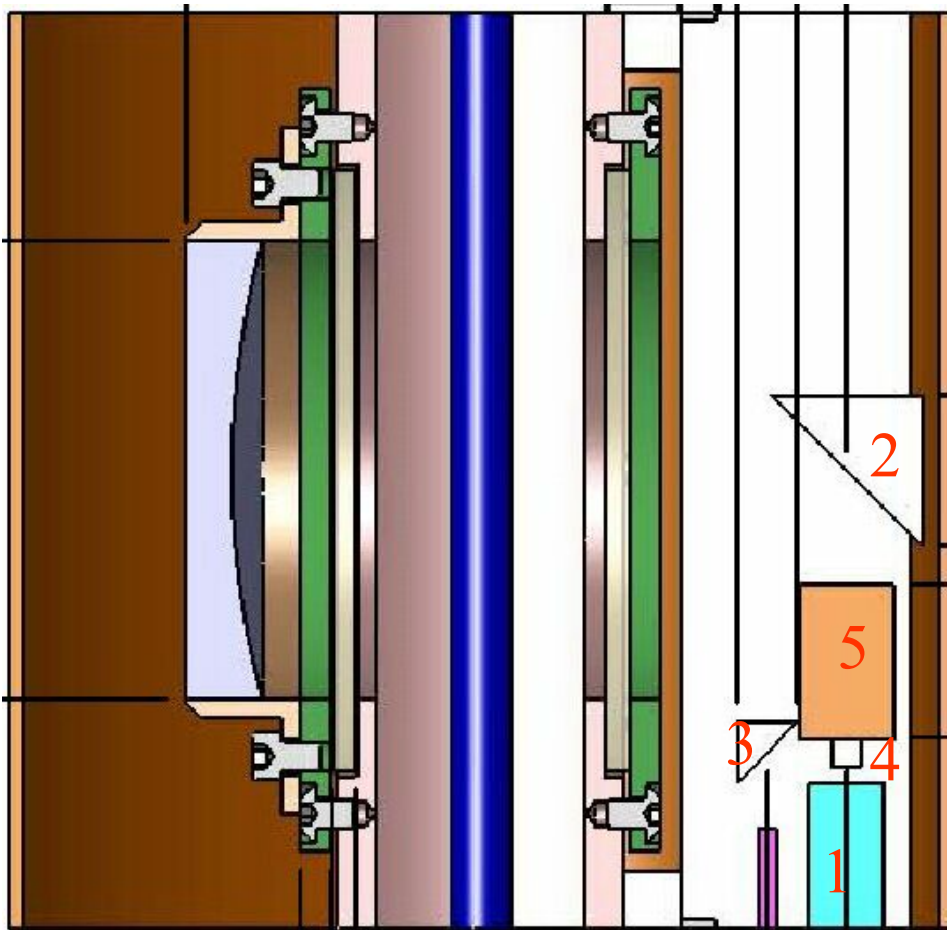


# Irradiation Studies of Optical Components



CERN, ~ April 15-24, 2005

1 GeV proton beam

$4 \times 10^{15}$  proton

Irradiation dose: equivalent to  
40 pulses of 24 GeV proton beam

Received radiation dose:  
3231 Gy,  $\sim 3.2 \times 10^5$  rad

or

$3.2 \times 10^6$  rem

(assume a quality factor of 10)

# Optical components

**Before irradiation April, 2005**



After irradiation July 13, 2005



## Irradiation summary – transmittance/reflectance measurements

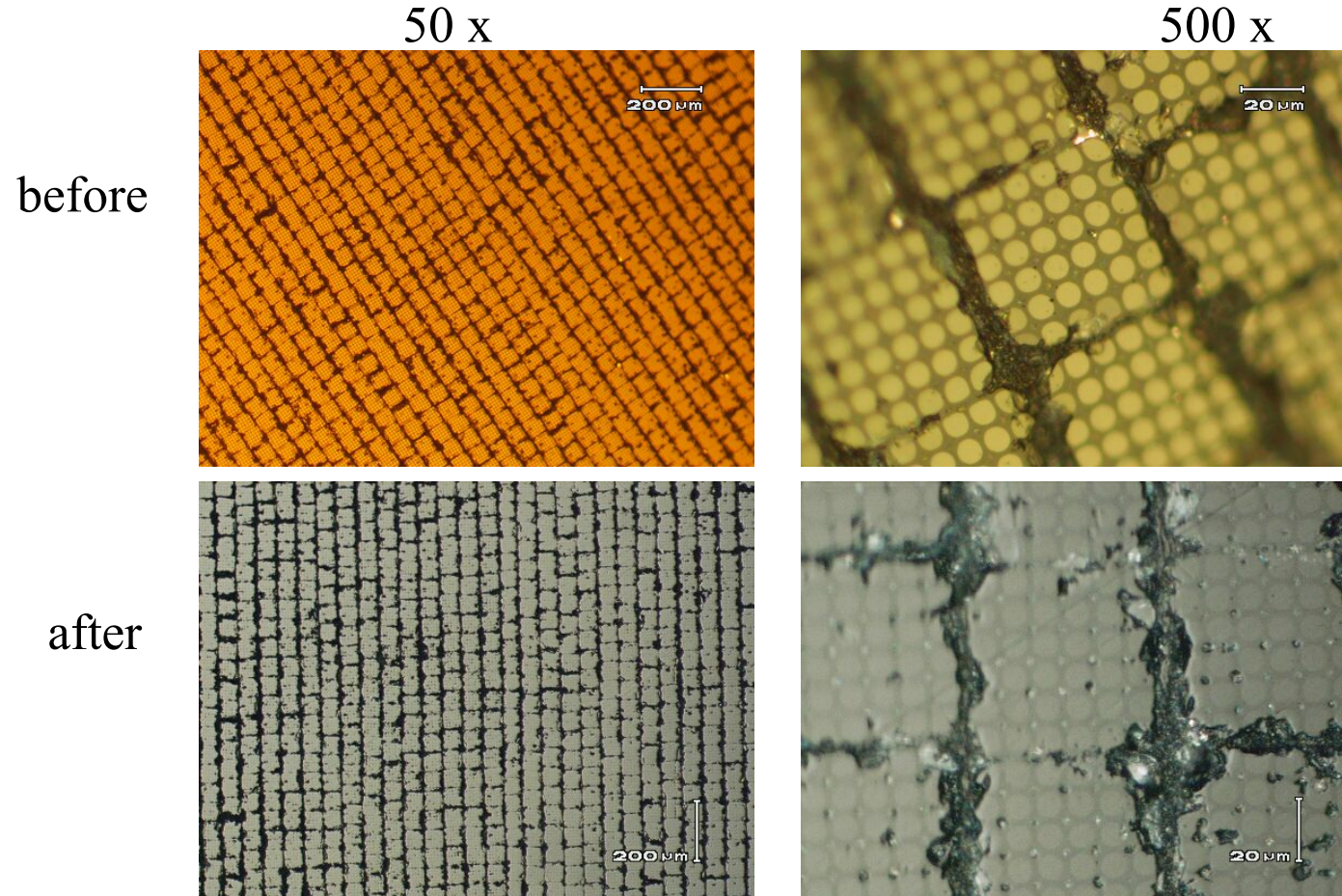
	A	B	C	D	E
1		13-Jul-2005			
2		Results of optical components irradiated at CERN on April 15, 2005			
3		proton beam energy: 1.4 GeV			
4		no. of protons: $4 \times 10^{15}$			
5		transmittance and reflectance measured at the HeNe wavelength			
6					
7	<b>item #</b>	<b>components</b>	<b>before</b>	<b>after</b>	<b>results</b>
8	2	Large gold mirror reflectance	0.910	0.920	no change
9	3	Small gold mirror reflectance	0.930	0.940	no change
10	4	50/50 beam splitter: transmittance	0.450	0.360	drop 20%
11	4	50/50 beam splitter: reflectance	0.530	0.423	drop 21%
12	5	imaging lens: transmittance	0.880	0.610	drop 31%
13	6	1-mm thick sapphire plate	0.863	0.867	no change
14	7	1-mm thick fused silica	0.914	0.859	drop 5%
15					
16	1	3-foot long imaging fiber	0.394	0.000	no measurable light transmitted
17					at the HeNe or 800 nm wavelengths
18					

Activity right after irradiation: 4 mSv/h on contact  
 30  $\mu$ Sv/h at 50 cm away

Activity ~ 1 month later (5/23/05): 0.5 mSv/hr on contact (50  $\mu$ rem/h)

Activity arrived at BNL ~ background level

# 3-feet long of Schott imaging fiber before and after irradiation



$$I = I_0 e^{-\alpha t}$$

From fused silica results:  $\alpha = 0.62$ , for  $t = 0.1$  cm

Projected transmission for  $t=3$ -ft of the imaging fiber:

$$e^{-(0.62)(91 \text{ cm})} = 3 \times 10^{-25} !!! \text{ for } \sim 40 \text{ proton pulses}$$

*If  $\alpha$  is linearly prop. to # of proton pulses, transmission for 1 proton pulse = 0.244*

# Fujikura imaging fibers

Table 3

## ULTRATHIN IMAGEFIBER SPECIFICATIONS

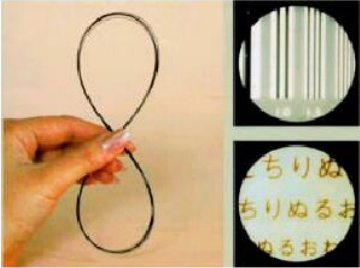
(FIGH series N-Type 50k-100k)

Item	FIGH-50-1100N	FIGH-70-1300N	FIGH-100-1500N
Number of picture elements (nominal)	50,000 (Nominal)	70,000 (Nominal)	100,000 (Nominal)
Imagecircle diameter (μm)	1,025 +80/-80	1,200 +100/-100	1,400 +120/-120
Fiber diameter (μm)	1,100 +80/-80	1,300 +100/-100	1,500 +120/-120
Coating diameter (μm)	1,200 +100/-100	1,450 +100/-100	1,700 +150/-150
Minimum bending radius (mm)	110 <sup>*1</sup> (80 <sup>*2</sup> )	150 <sup>*1</sup> (100 <sup>*2</sup> )	200 <sup>*1</sup> (130 <sup>*2</sup> )
Coating material	Silicone resin		
Lattice defect (%)	< 0.1		
Uncircularity (%)	< 5		

\*1:Minimum bending radius in storage

\*2:Recommended bending radius in use (For your reference only, possibly to be happened breakage by static fatigue.)

# Sumitomo imaging fibers



SEI

## Product Lineup

TP03105B

	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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All have small imaging area  
<2 mm diameter

>20 meter available

5 meter limit

## IGN-08/20 - sample

