Optical Diagnostics

Thomas Tsang

BROOKHAVEN NATIONAL LABORATORY
Instrumentation Division Ultrafast Laser Laboratory

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

Optical Diagnostics

More imaging fibers

BROOKHAVEN NATIONAL LABORATORY
Instrumentation Division Ultrafast Laser Laboratory

New imaging fiber bundle
Core size: 12 μm, diameter: 1/8”

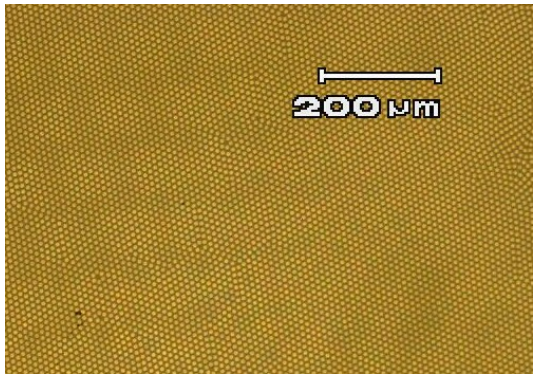
SMD camera

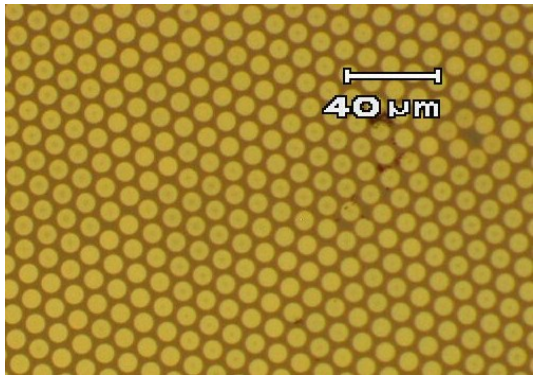
CCD size:	13.4 x 13.4 mm
Pixels:	960x960
Single frame:	240x240 pixels
Reduced pixel size:	56 x 56 um

Total fiber counts ~50,000 in 3.17 mm diameter
Imaging ~243 x 243 fibers on 960 x 960 CCD array

~1 imaging fiber on ~4x4 pixels on full frame

~1 imaging fiber on ~1 pixel on a single frame



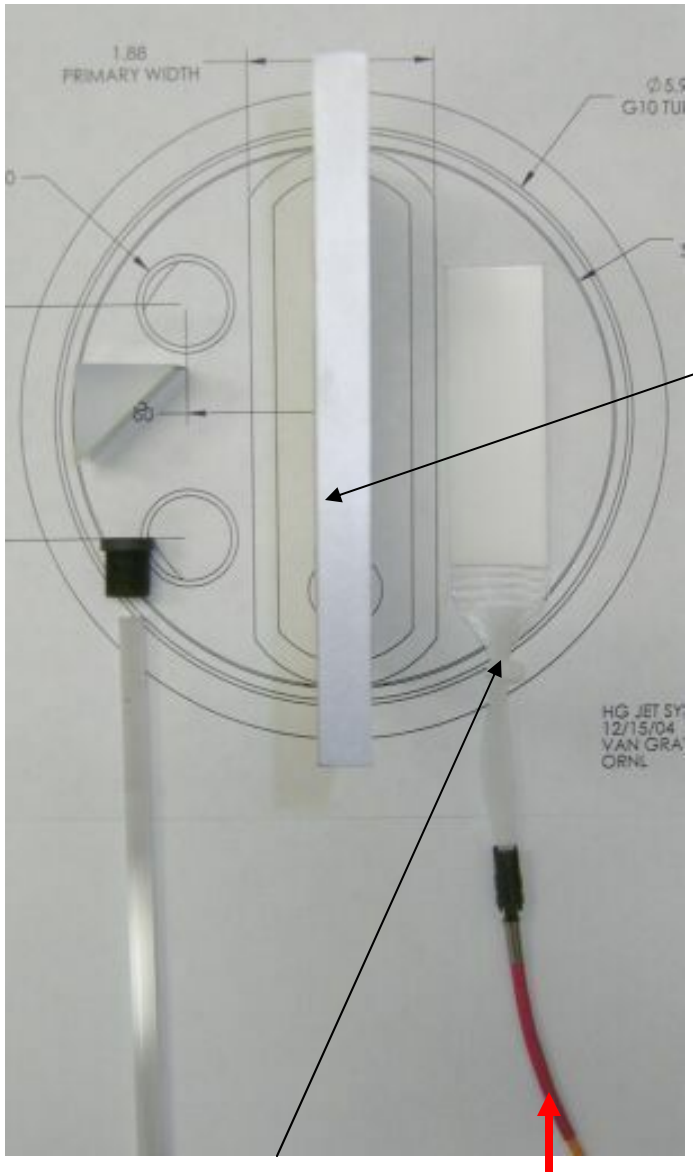


Optical Diagnostics

Backlight illumination results

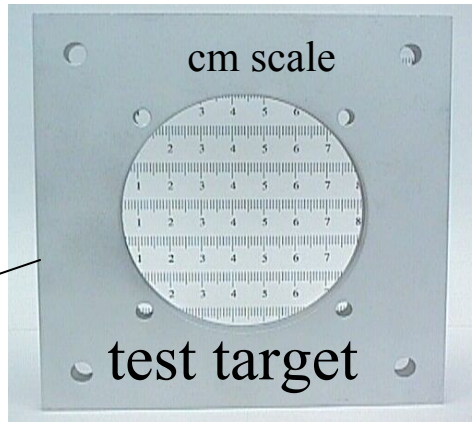
BROOKHAVEN NATIONAL LABORATORY

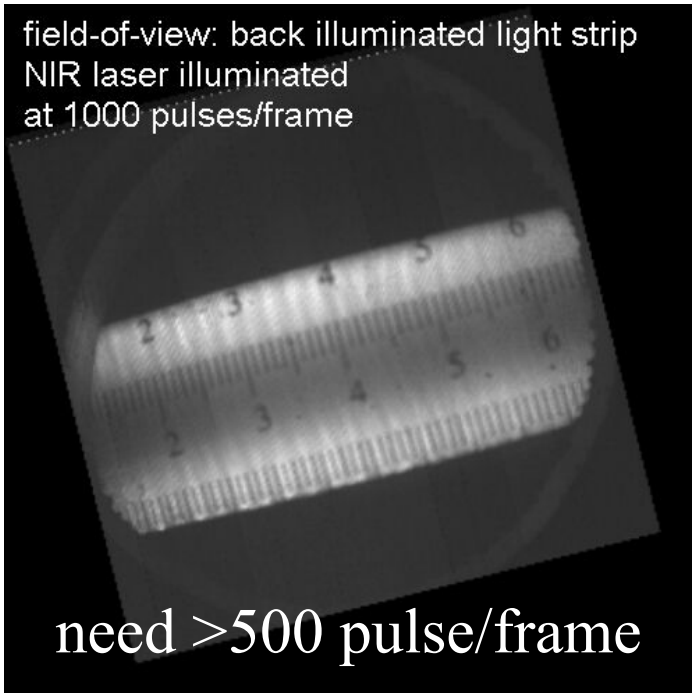
Instrumentation Division Ultrafast Laser Laboratory



fiber backlight

laser light input





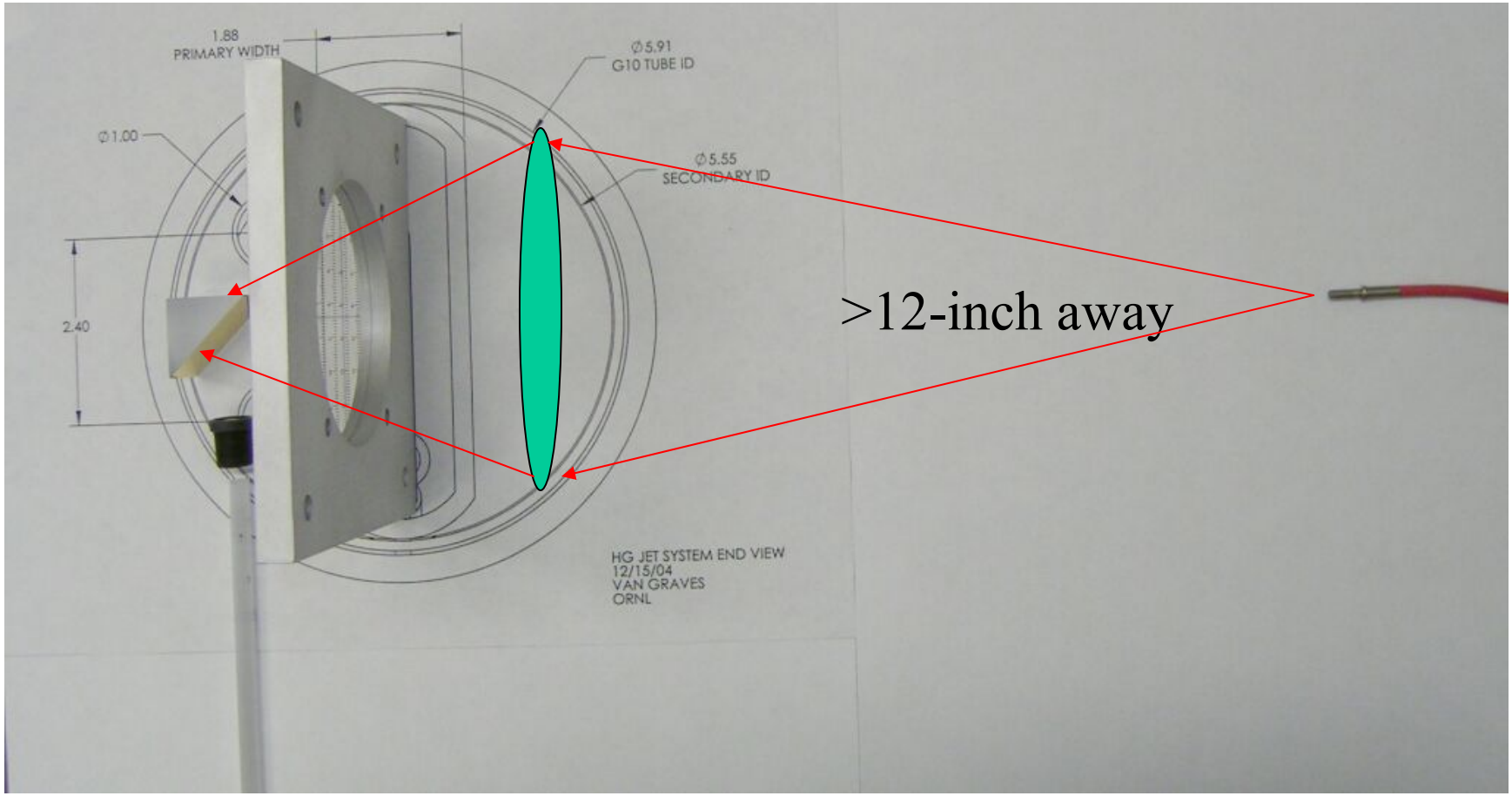
~mJ/pulse in 1-MHz reprate !!

Optical Diagnostics

Conventional shadow illumination approach ?

BROOKHAVEN NATIONAL LABORATORY

Instrumentation Division Ultrafast Laser Laboratory



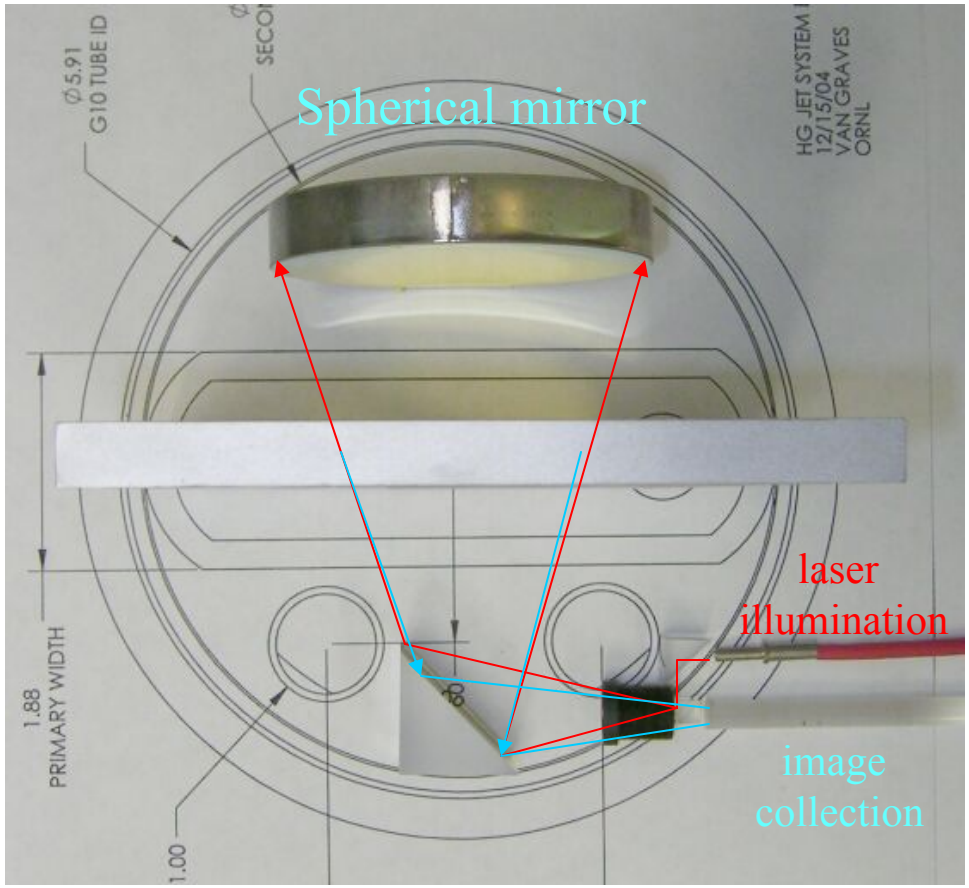
Can NOT be implemented in this tight environment !

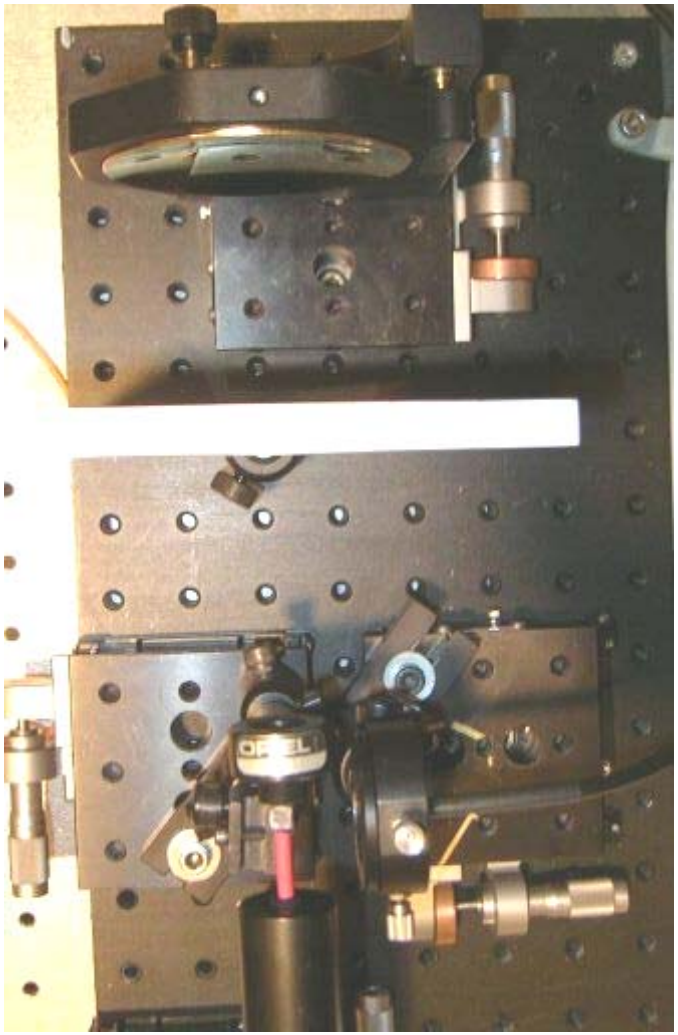
Optical Diagnostics

retroreflected illumination

BROOKHAVEN NATIONAL LABORATORY

Instrumentation Division Ultrafast Laser Laboratory



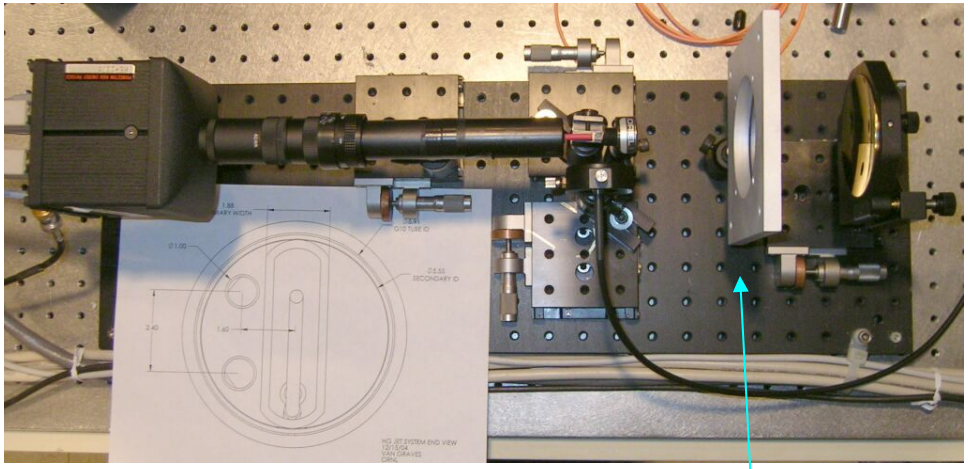


Works OK in this tight environment

Optical Diagnostics

Exp test setup

BROOKHAVEN NATIONAL LABORATORY
Instrumentation Division Ultrafast Laser Laboratory



Optical Components

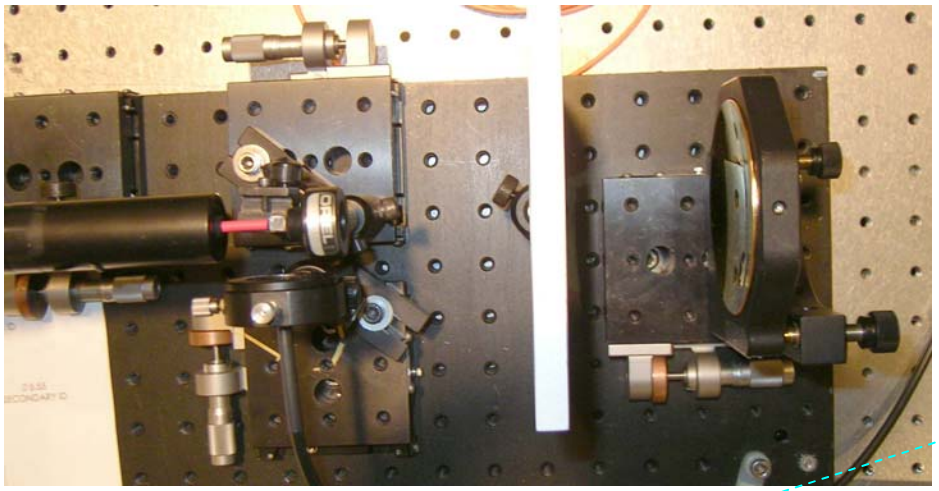
- 50/50 beam splitter: Edmund, 0.5 cm cube
- spherical mirror: Edmund, f=3-in, D=3in< Au coated
- small prism mirror: Edmund, 1x1x1.4 cm, Au coated
- large prism mirror: Edmund, 2.5x2.5x3.54 cm. Au coated
- imaging fiber Edmund: ⅛-in diameter, 12-µm core, 0.55 NA
- illumination fiber: ThorLabs, 0.22 NA, SMA-905 840 -µm core
- imaging lens: Sunex, f=0.38-cm, f/# 2.6, diagonal FOV 54°, φ1.4-cm x 2.0 cm

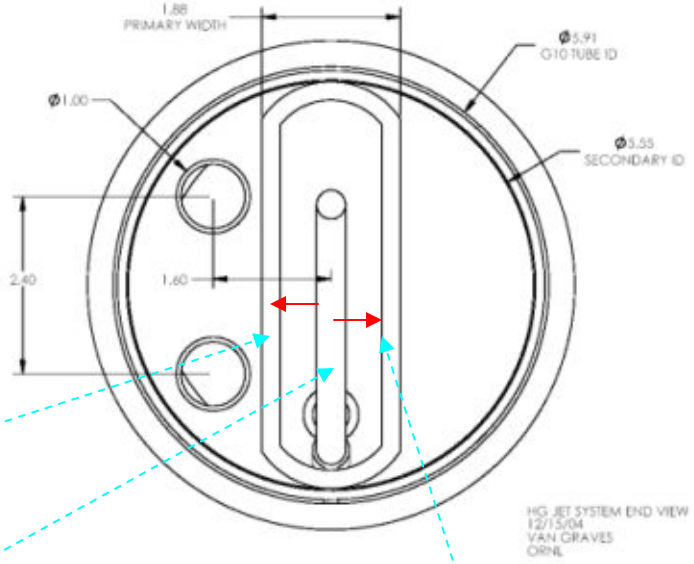
Optical Diagnostics

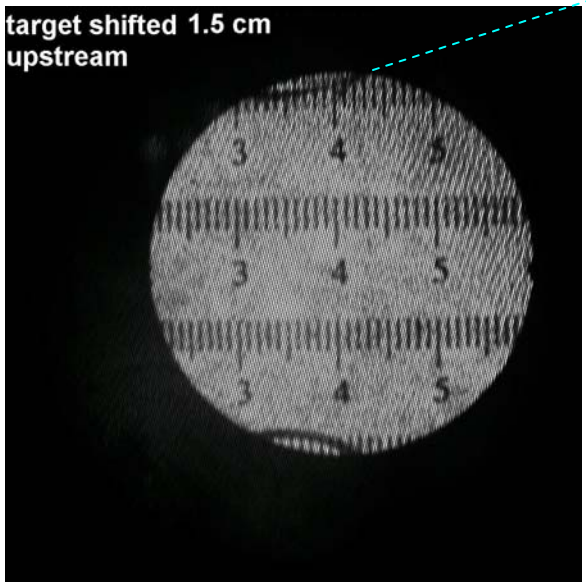
Field of view – NIR laser illumination & imaging

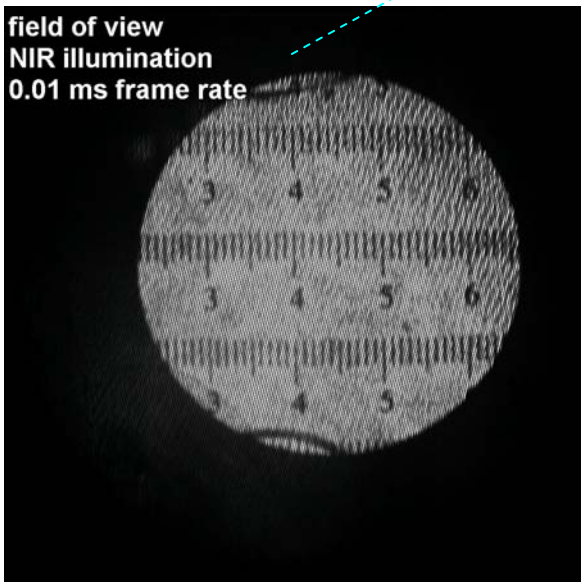
BROOKHAVEN NATIONAL LABORATORY

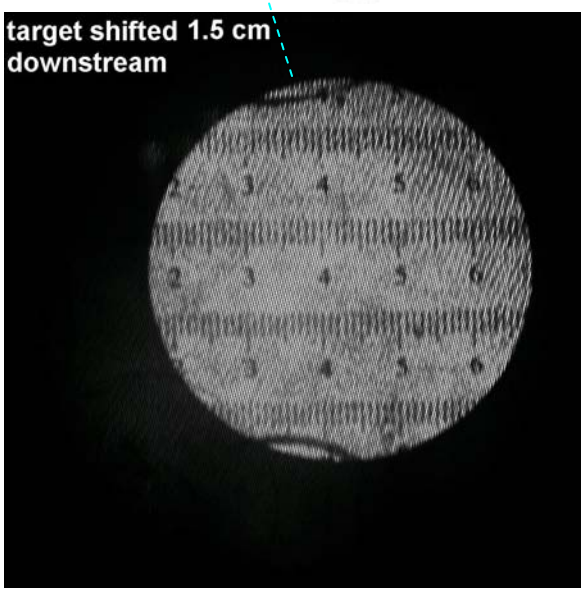
Instrumentation Division Ultrafast Laser Laboratory









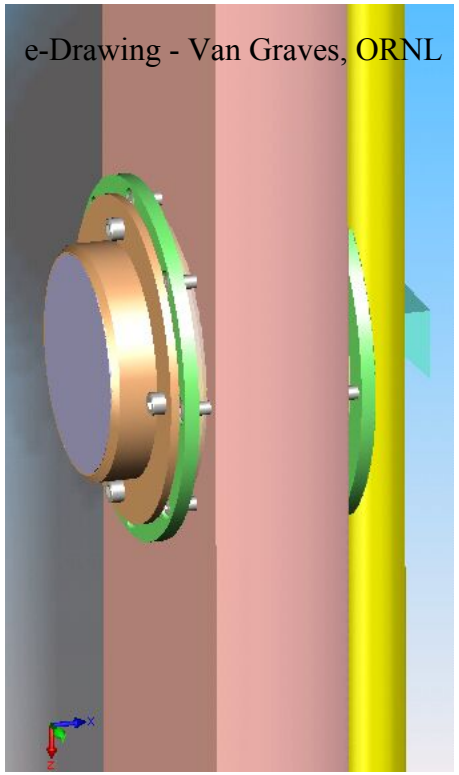


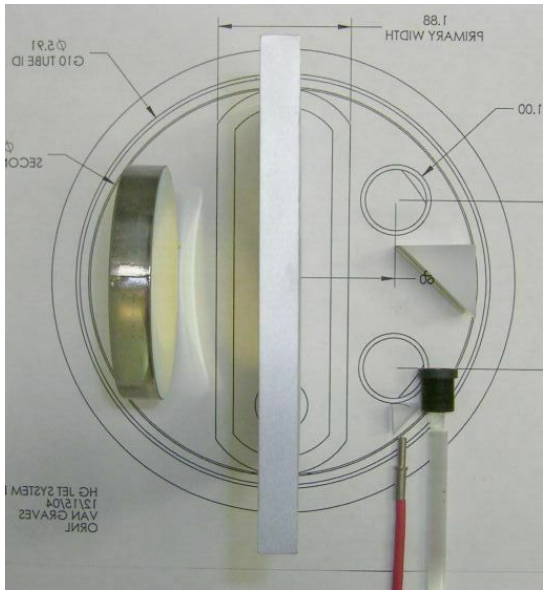
Optical Diagnostics

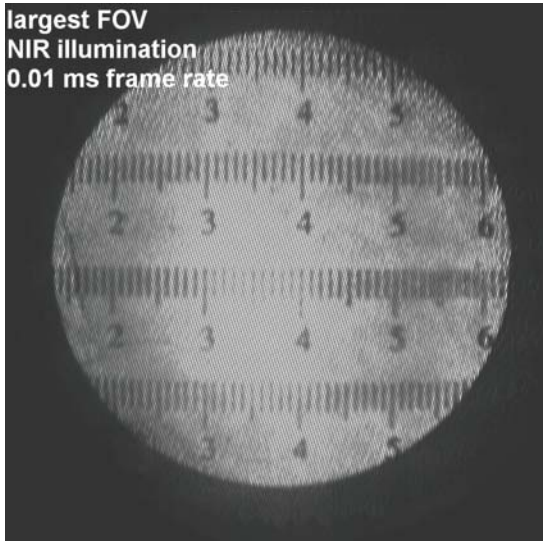
optical design in secondary containment

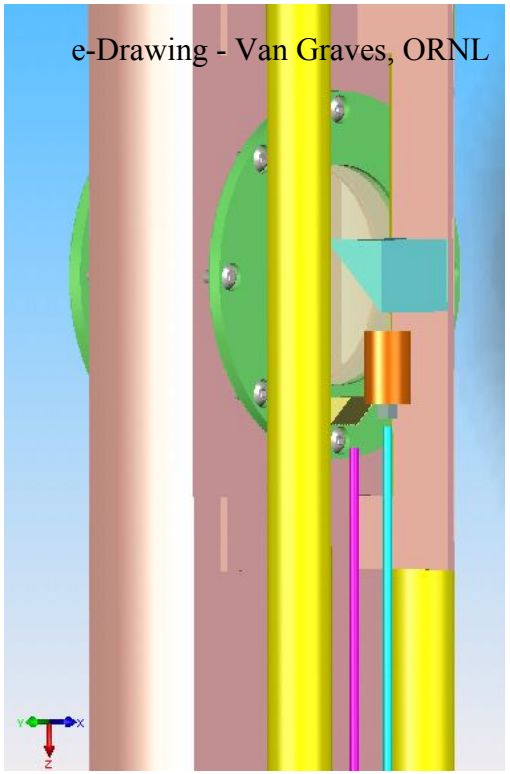
BROOKHAVEN NATIONAL LABORATORY

Instrumentation Division Ultrafast Laser Laboratory









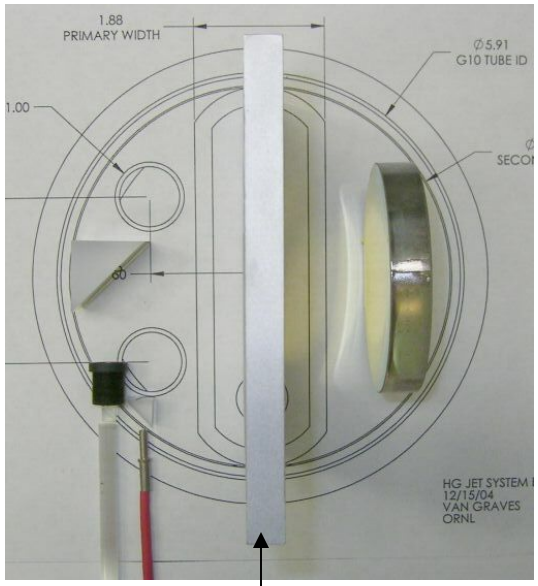
One set of optics per viewport

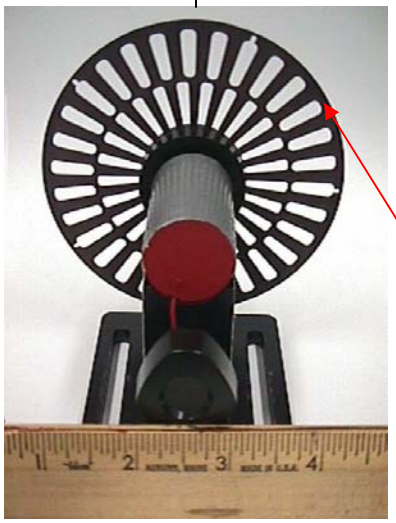
Optical Diagnostics

An optical chopper in motion @ 4 kHz

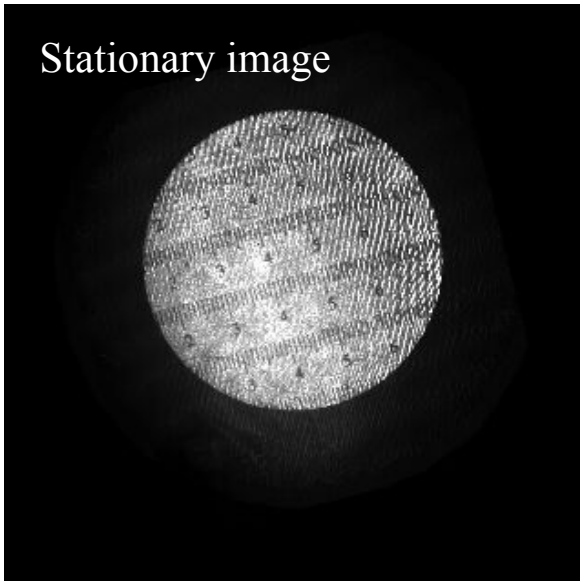
BROOKHAVEN NATIONAL LABORATORY

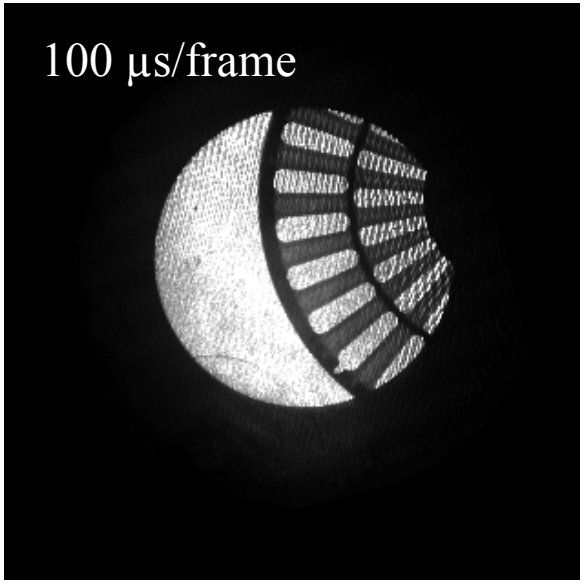
Instrumentation Division Ultrafast Laser Laboratory

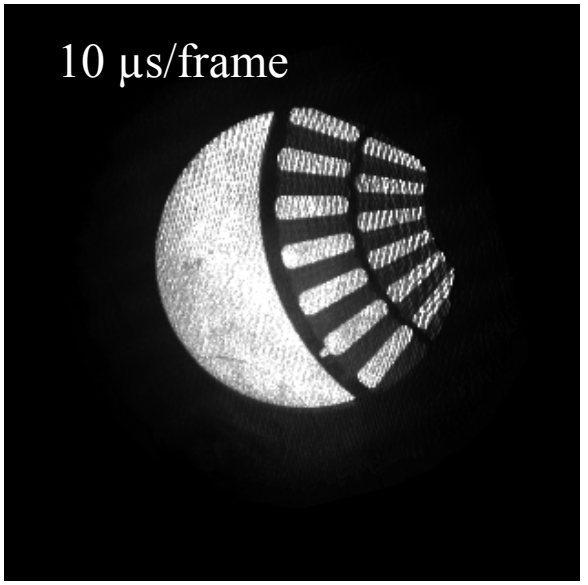




Velocity
@ ~40 meter/sec







Optical Diagnostics

Other issues:

1. Laser power increase to ~40 W/pulse (instead of 10 Watt/pulse)
2. ~50-m long flexible, square shaped imaging fiber – Schott
3. Depth of focus → apparent image size variation
4. 3-in dia. spherical mirror (lens/mirror) with the right focal length
5. Anti-reflection coated (@ 800 nm) viewports
6. Number of viewports ?
7. Location of the viewports ?
8. How many fast CCD camera ?
9. Switch from one viewport to the next with one laser/camera system ?
10. Glass rather than fused silica optics ok ?
11. …