

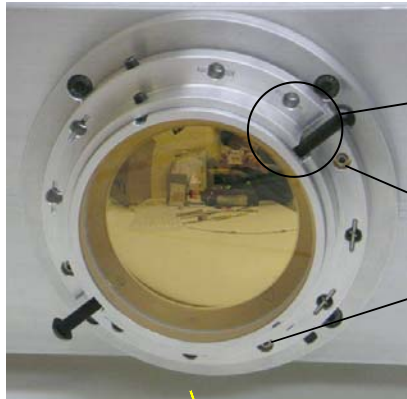
Optical Diagnostic Update

Hee Jin Park (BNL, SUNY Stony Brook)

April 12, 2006

Mock-Up Test For Optical Diagnostics

Illuminated Laser Alignment Methodology



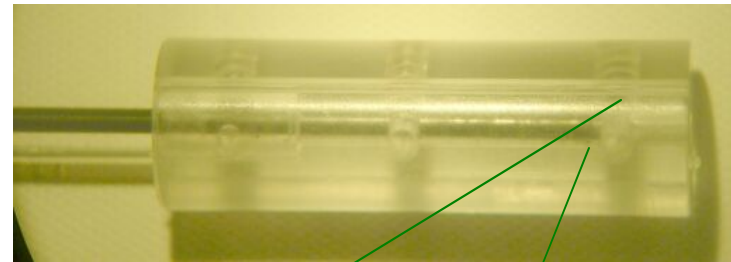
Focusing Alignment

Tilting Alignment
by Fine Adjuster

*MERIT VRVS Meeting
April 12th, 2006*

*By Thomas Tsang (BNL),
Hee Jin Park (SUNY at Stony Brook)*

*Thanks to Bill Sands (Princeton Univ.)
for the mock-up fabrication*

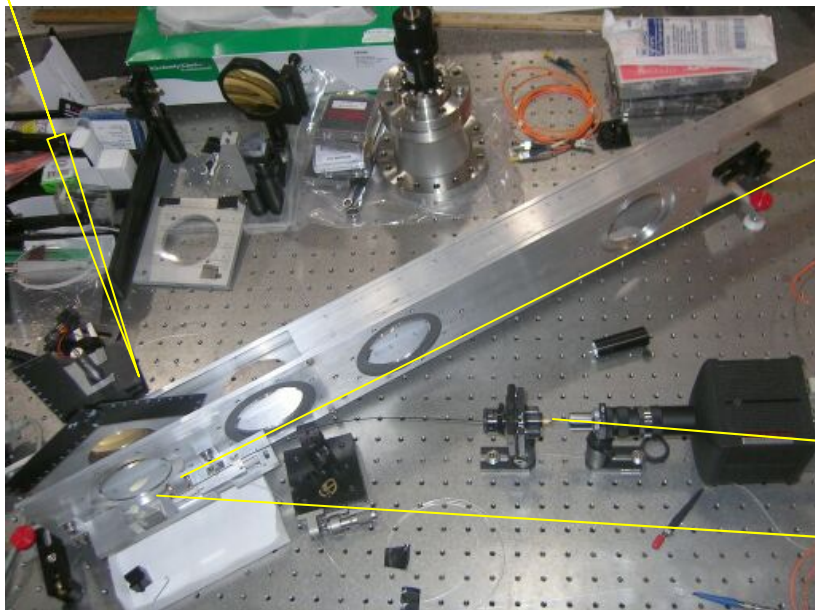


Alignment between imaging lens
and imaging fiber by sliding

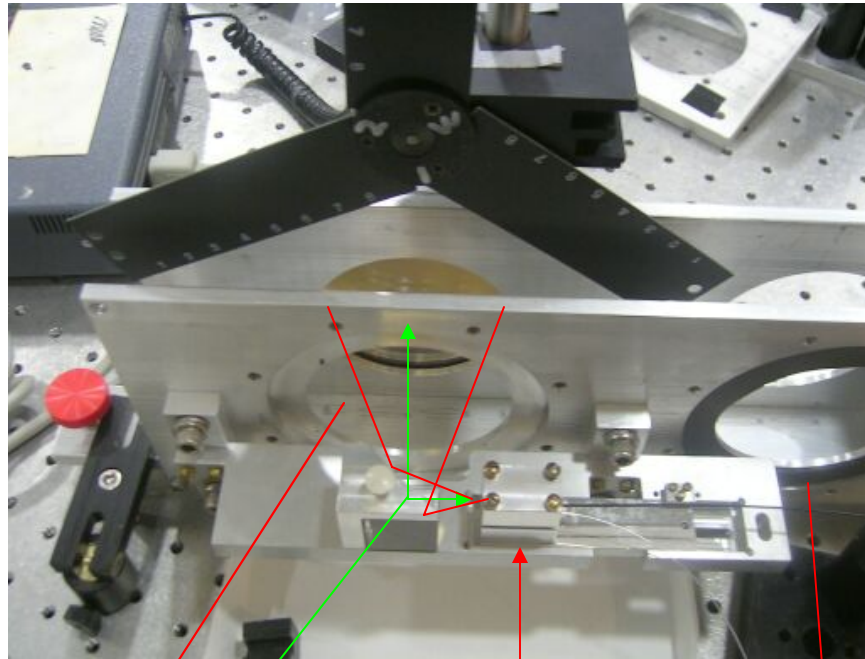
Alignment between spherical lens
and illumination fiber by sliding

Alignment between fiber and camera by sliding
and rotating

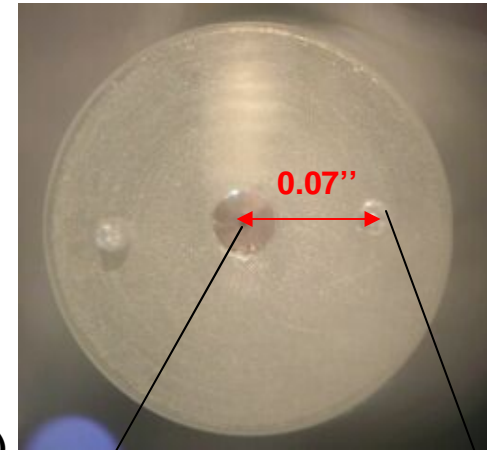
Alignment between prism mirror
and fiber holder by sliding



Design Principle & Fiber Holder Design



Less than 6"
(Secondary
Containment ID)



Imaging Lens
NA angle > 60°
Ø=1mm (Tested)
Ø=1.8mm (Test Scheduled)

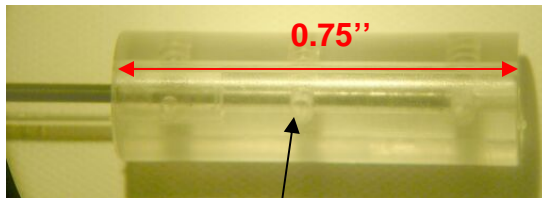
Spherical Lens
0.5mm (Tested)
1mm (Test Scheduled)

F=4.9"

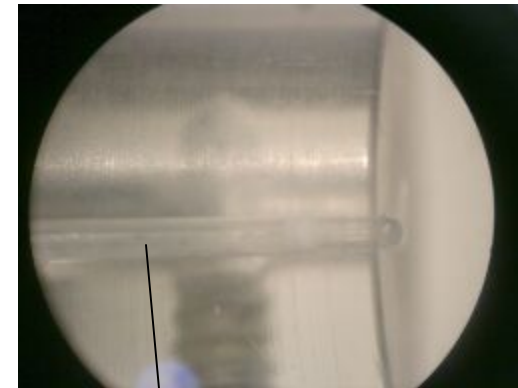
WD=±0.7"

Gasket : t= 2 X 1/32"
Mineral Particles
with Acrylic Buna-N

Ø=100mm
t=6mm
Sapphire Window

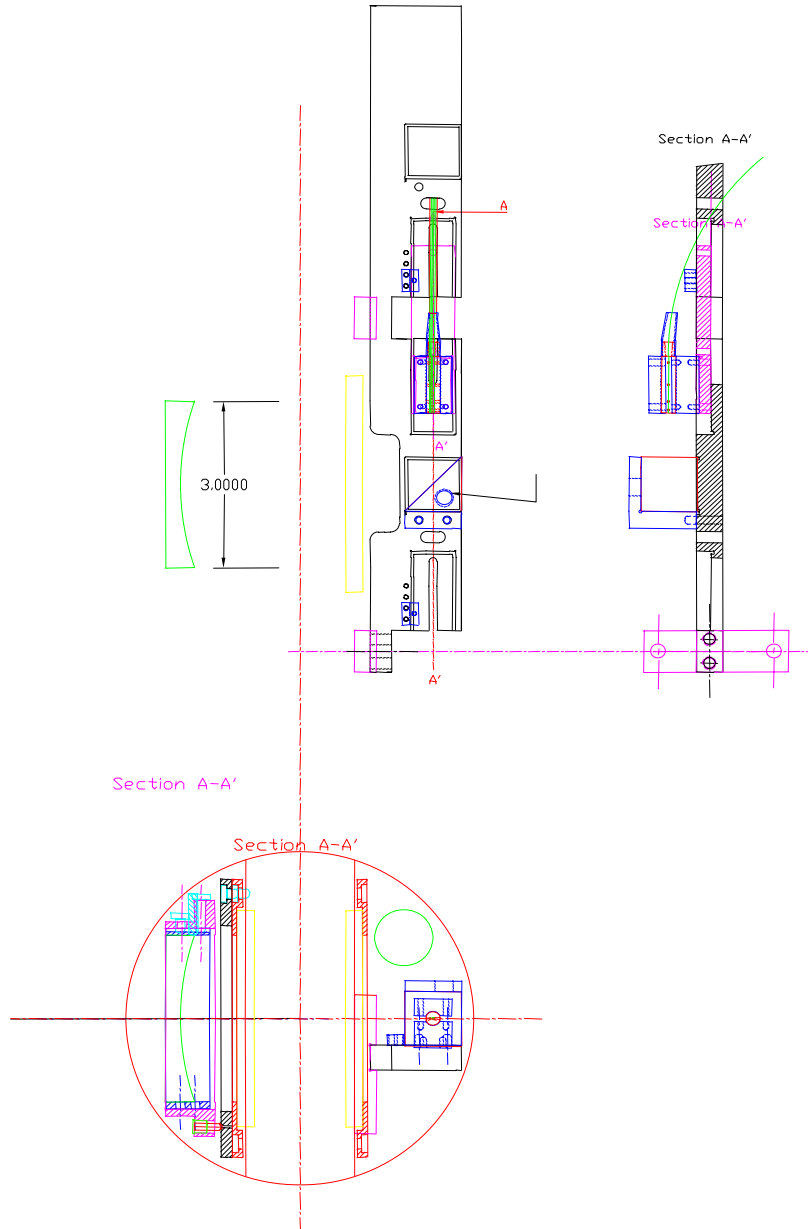


Screw Type : #0-80



Illumination fiber should be tightly inserted into hole
in order for the fiber and lens to be aligned well.

Mock-up Drawing for Optical Diagnostics



Working Principle : Shadowgraph Technique

This technique is valuable when visualizing flows in which density differences occur naturally or are artificially induced.

When used quantitatively, this technique can often be used to determine density, pressure, and/or temperature variations in the flow. From these, other properties of the flow field (e.g., laminar versus turbulent nature of the motion, boundary layer thickness, shock angles, points of separation, and reattachment) can be inferred.

It integrates the quantity measured over the length of the light beam. For this reason it is well suited to measurements in two-dimensional fields, where there is no index of refraction or density variation in the field along the light beam,

If large gradients of density are present, as in a shock wave or a flame, shadowgraph pictures can be very useful.

Quantitative measurements of such things as shock angles and the location of boundary-layer transition can be made.

In a shadowgraph system the linear displacement of the perturbed light is measured, rather than the angular deflection.

The contrast would have to be measured accurately, for example, integrated twice to determine the density distribution.

$$\frac{\Delta I}{I_T} = -\frac{Z_{sc}}{n_a} \int \frac{\partial^2 \rho}{\partial x^2} \cdot \frac{\partial n}{\partial \rho} dz$$

$$\frac{\Delta I}{I_T} = -\frac{Z_{sc}}{n_a} \int \frac{\partial^2 n}{\partial y^2} dz = -\frac{Z_{sc}}{n_a} \int C \left[-\frac{\rho}{T} \frac{\partial^2 T}{\partial y^2} + \frac{2\rho}{T^2} \left(\frac{\partial T}{\partial y} \right)^2 \right] dz$$

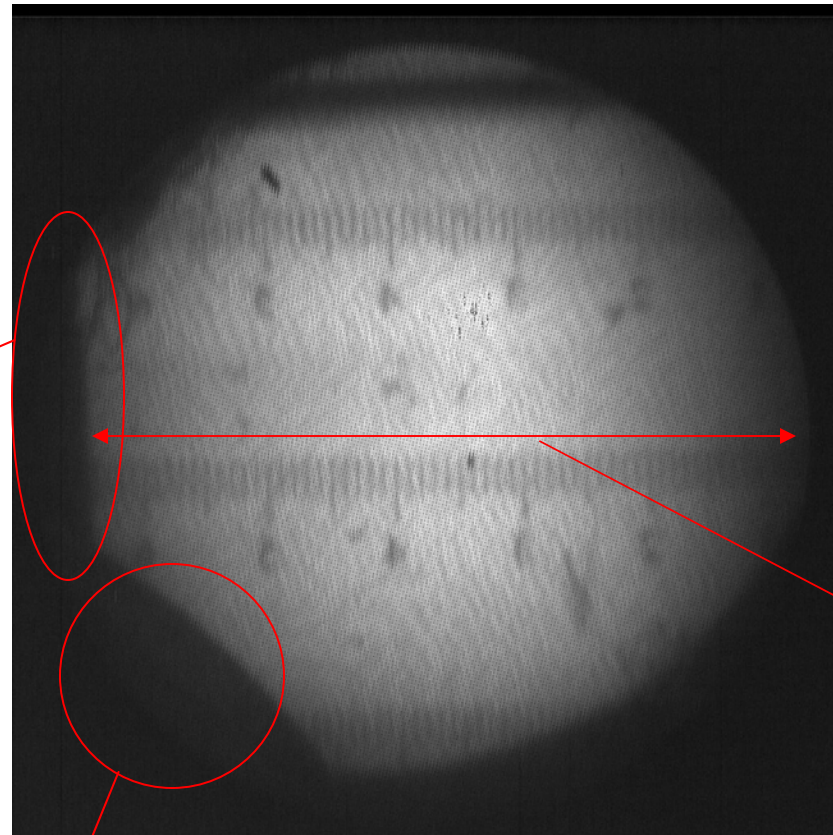
n : index of refraction
 n_a : index of refraction of ambient air

For gas or transparent liquid media, it is useful.

Stationary Image Analysis

CW Light Illuminated
65 ms/frame
Sumitomo Imaging Fiber

The illuminated laser was not covered fully by the prism mirror when we try to get the largest field of view. To prevent the asymmetry of the field of side view, the center-center between prism mirror and fiber holder set will be misaligned artificially.



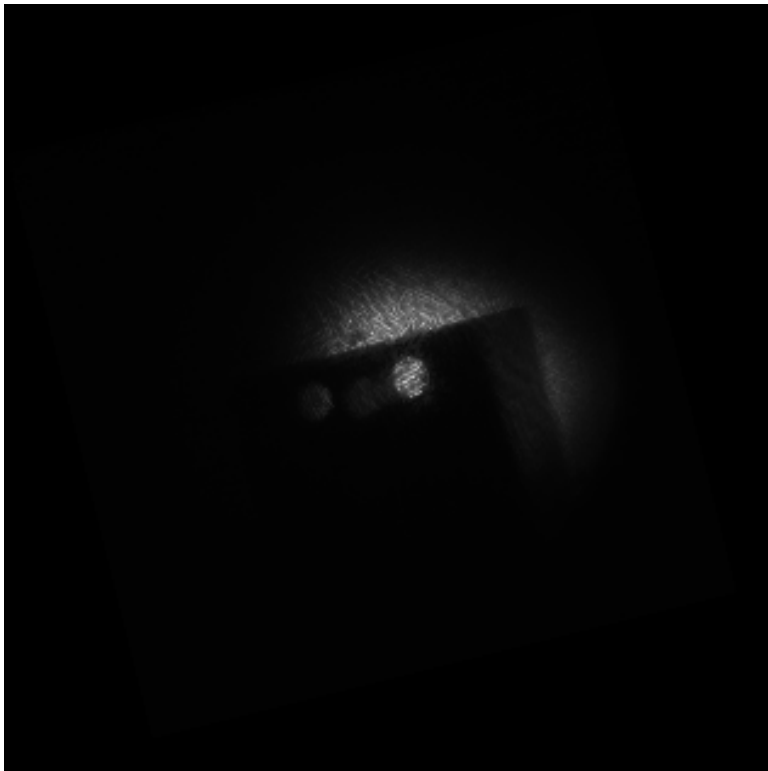
More than 5.5cm Field Of View can be measured at the center of captured image.

Imaging Fiber Defect : Stain or Crack, etc
It will be removed if the surface of fiber can be polished well.

Moving Image Analysis

**NIR Pulsed Laser Illuminated
10 μ s/frame
Sumitomo Imaging Fiber**

Measured Linear Velocity \approx 40m/s



Things To Do

- 1. The modified 4 different types of fiber holder are now under fabrication.**
- 2. $\varnothing=1.8\text{mm}$ imaging lens will be tested to see the effect of the field of view as well as illumination intensity with combination of $\varnothing=0.5\text{mm}$ & $\varnothing=1\text{mm}$ spherical ball lens.**
- 3. The hole for the fiber bunch following fiber holder will be modified to let the fiber bunch bend within the allowable bending radius (40mm)**
- 4. Polishing process of Imaging fiber will be investigated before we polish the actual 10m long imaging fiber.**
- 5. The retro-reflecting mirror assembly for 4 viewport is already now under fabrication. One whole plate for 4 viewport will be designed after modification based on the mock-up test result.**
- 6. Finally, the performance of 4 individual viewport must be tested simultaneously with the actual length of imaging fiber and illumination fiber.**