Optical Diagnostics

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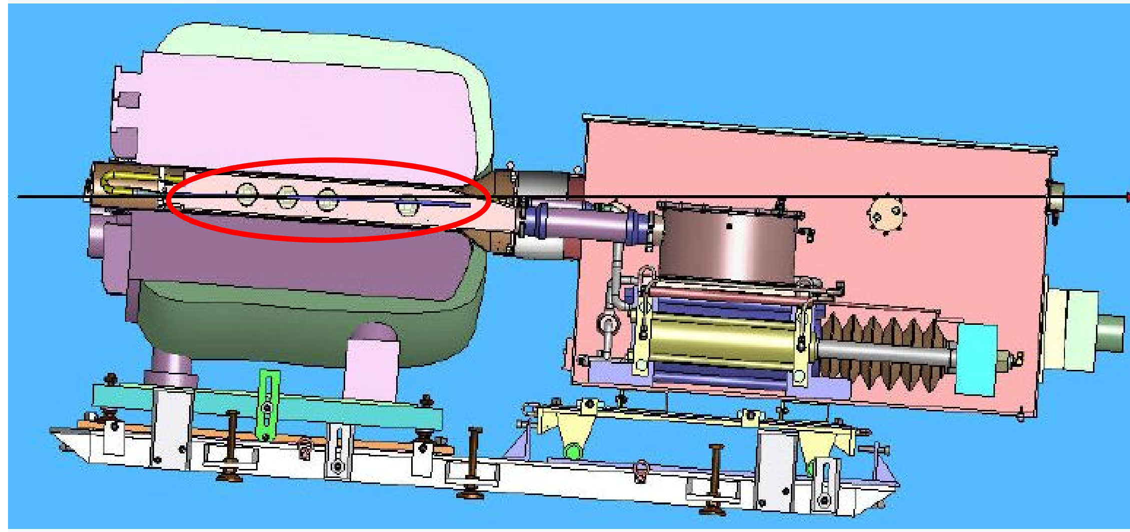
Design Specification

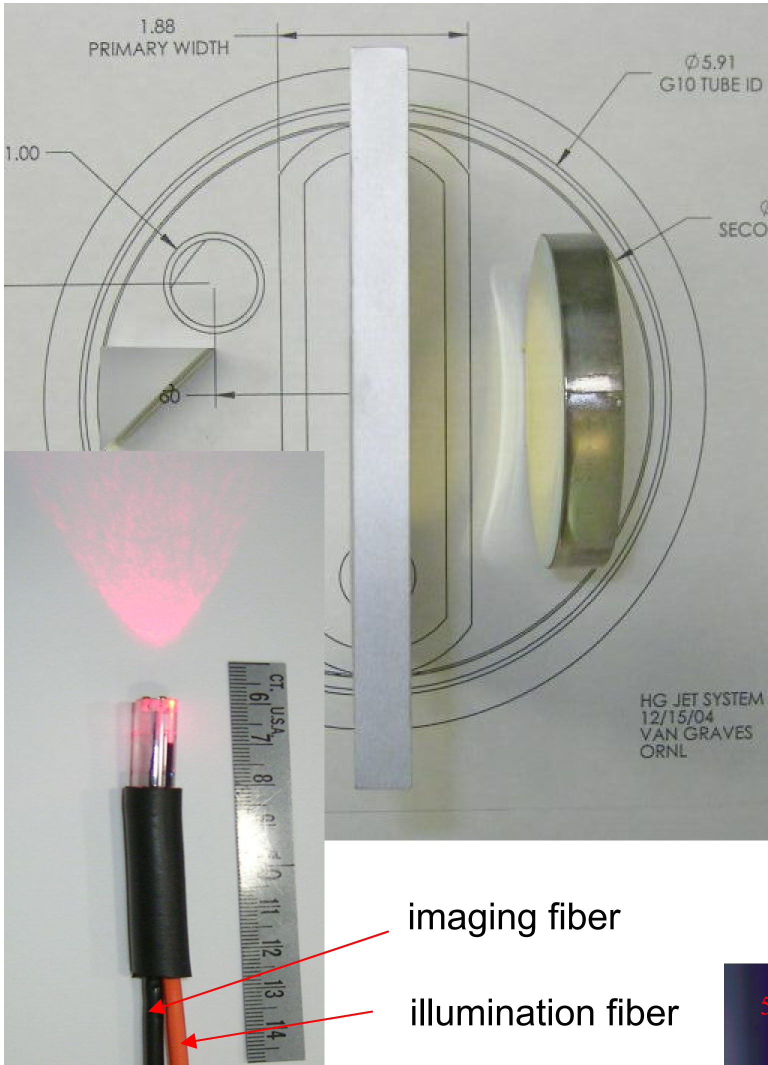
- Limited space
- High radiation area
- Non-serviceable area
- Passive components only,
  no active electronics
- Image transmits through flexible
  imaging fiber bundle

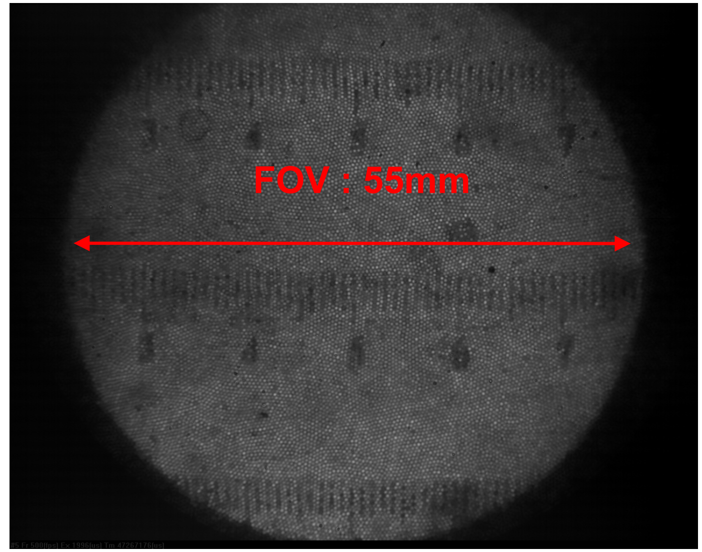


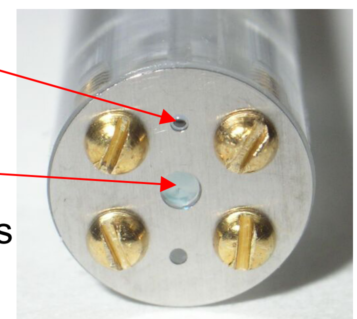
Optical Diagnostics Principle : Shadowgraphy technique

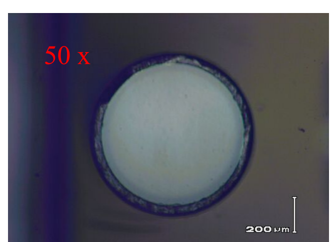
- Synchronized arrival of short laser pulses illuminate onto the target
- Freeze the image of events using high speed camera to record transient fluid dynamics.
- 2-dimensional image

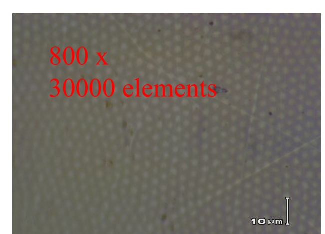
Optical Setup











d=0.5 mm sapphire ball lens, increase the NA of illumination to Φ ~ 45 degree

High Speed Cameras and Laser Sources

SMD 64KIM camera
CCD size: 13.4 x 13.4 mm
Pixels: 960x960
Single frame: 240x240 pixels
57,600 picture elements
frame rate: 16 frames up to 1 μs/frame

FastVision (2)
CCD size: 15.4 x 12.3 mm
Pixels: 1280x1024
Single frame: FPGA programable
1.3 M picture elements
Frame rate: 500/s @ full resolution
500k/s @ 1x1280

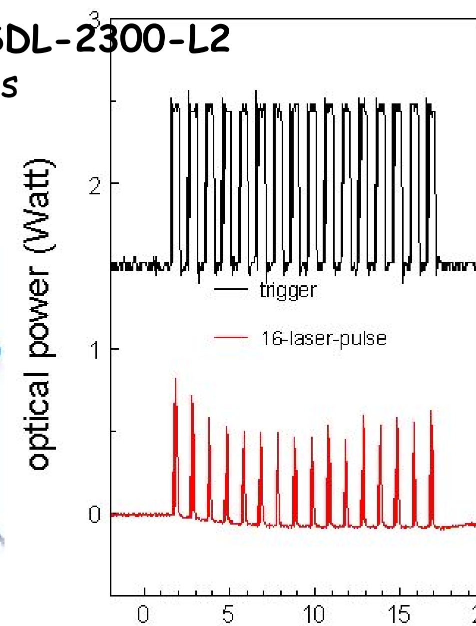
CERN Olympus Encore PCI 8000S
4 kHz recording rate, 25 us electronic shutter

Bright Solutions, BDL20-808-F6

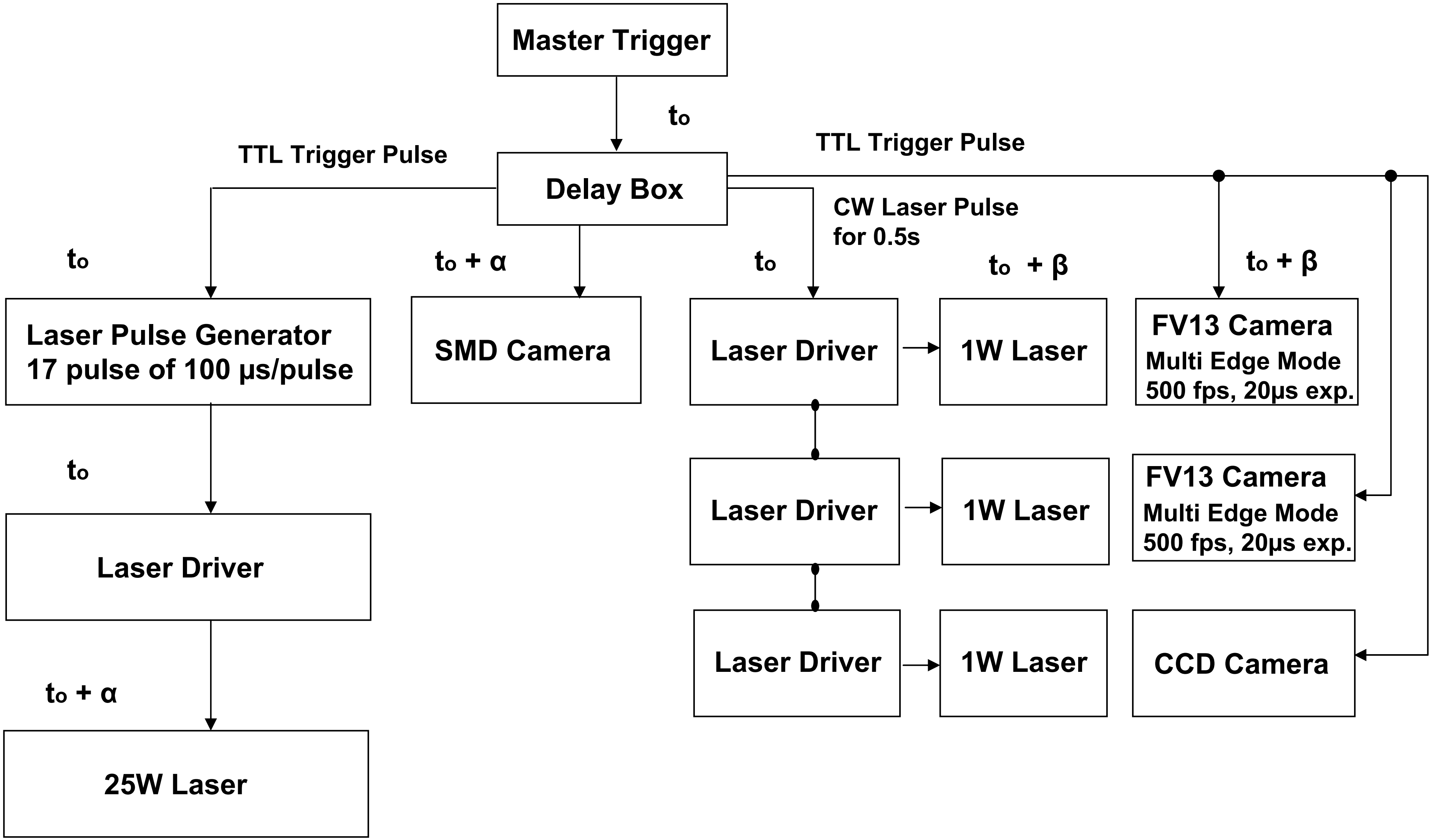
Parameter	Value	Unit
Temperature	25	°C
Rated power	20	W
Current at rated power	35.38	A
Maximum current	41.63	A
Threshold current	9.2	A
Center wavelegth	808.6	nm
Linewidth FWHM	2.64	nm

min. pulse width ~150 ns

JDS Uniphase
Laser diode, SDL-2300-L2
Power = 1 Watts
I_{th}= 0.3 Amp
λ -= 850 nm



Experimental Setup: Schematic Diagram



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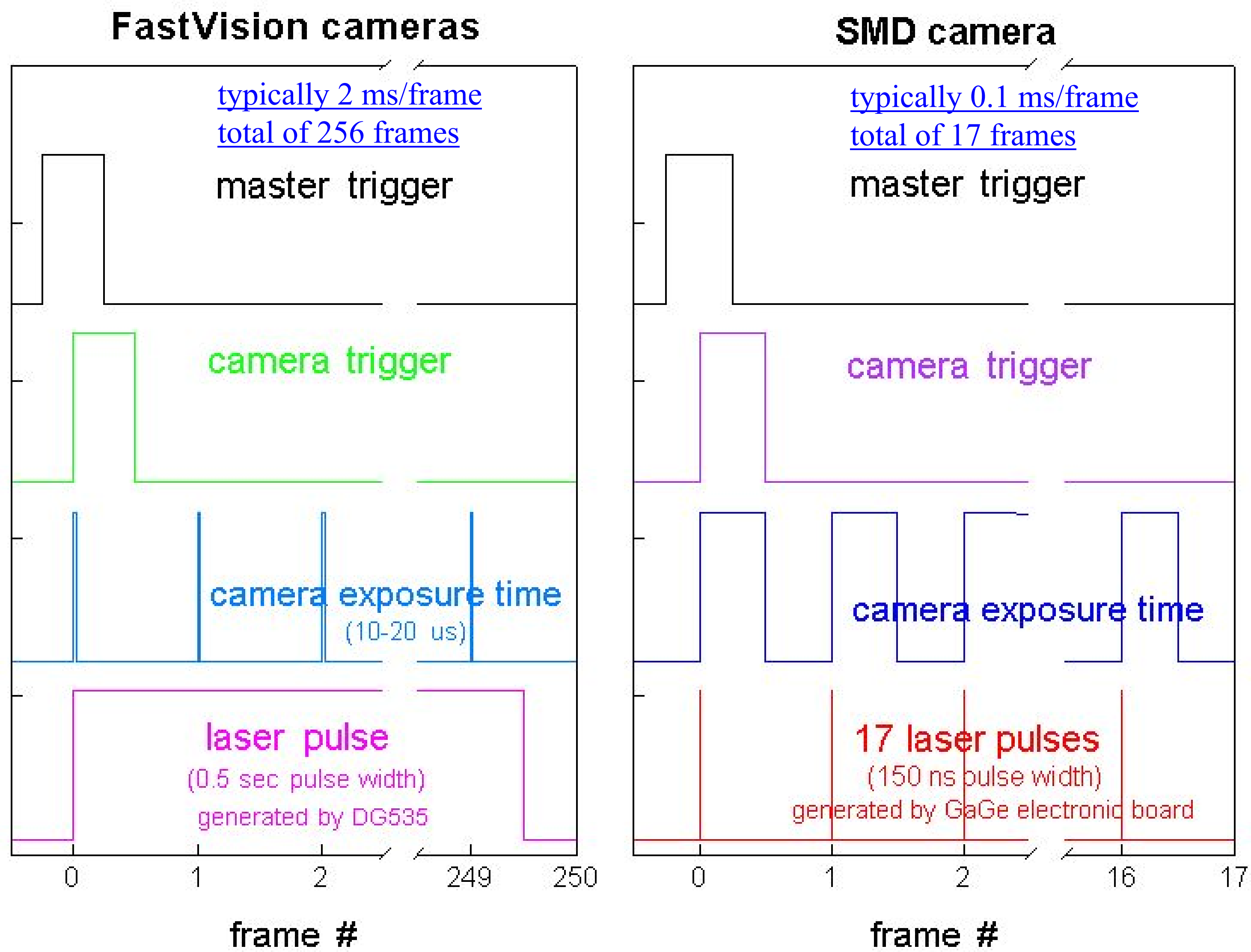
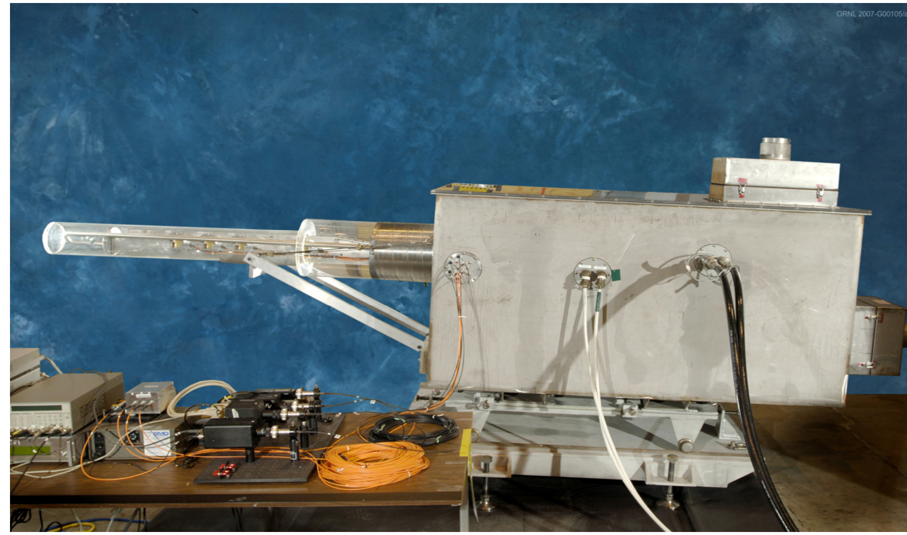
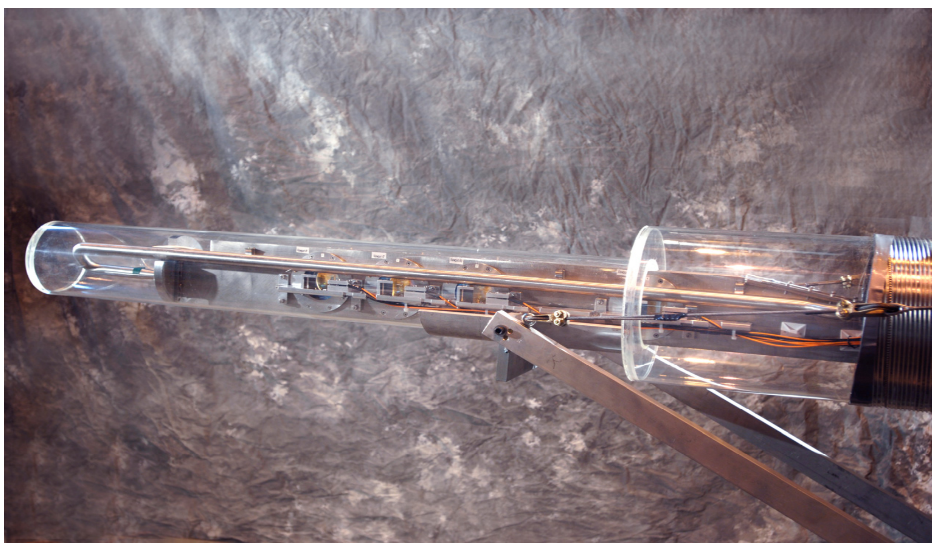
Experimental Setup: Trigger Pulse Sequence



Muon Collaboration

Experimental Setup at ORNL





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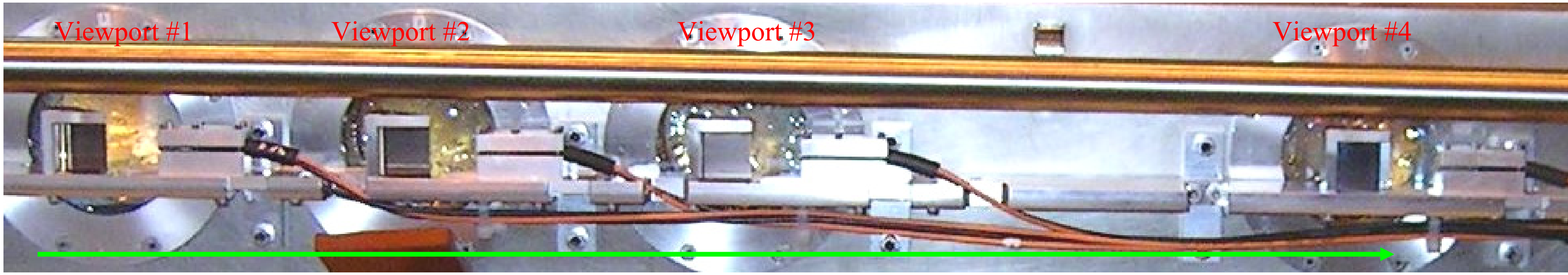
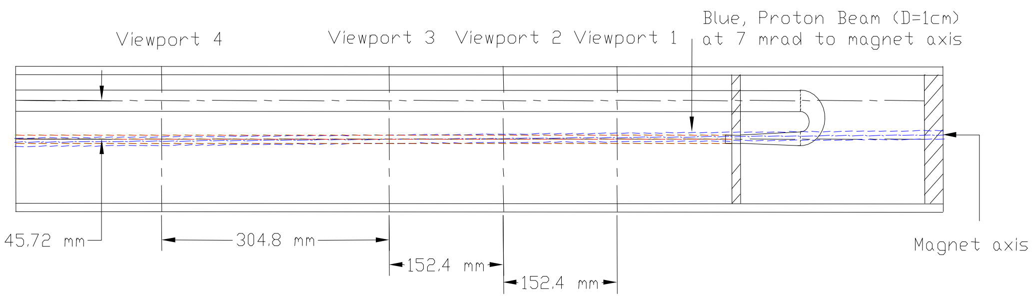
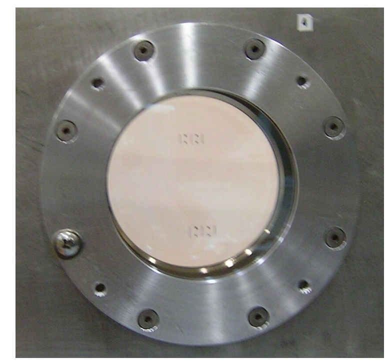
Viewport Configuration

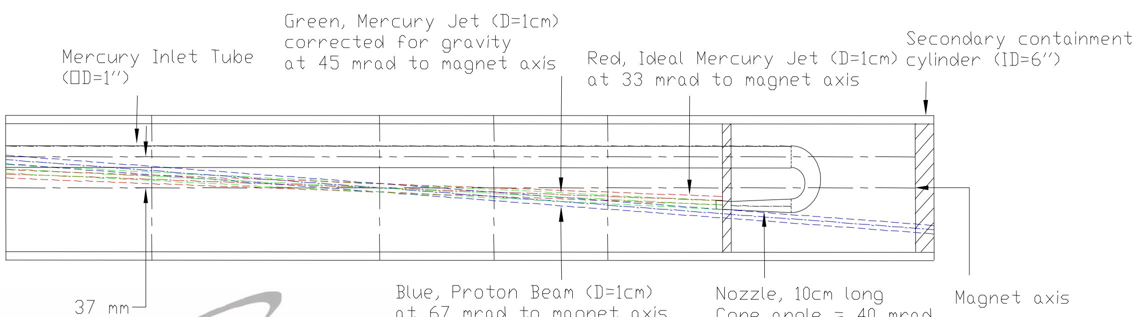




Top View



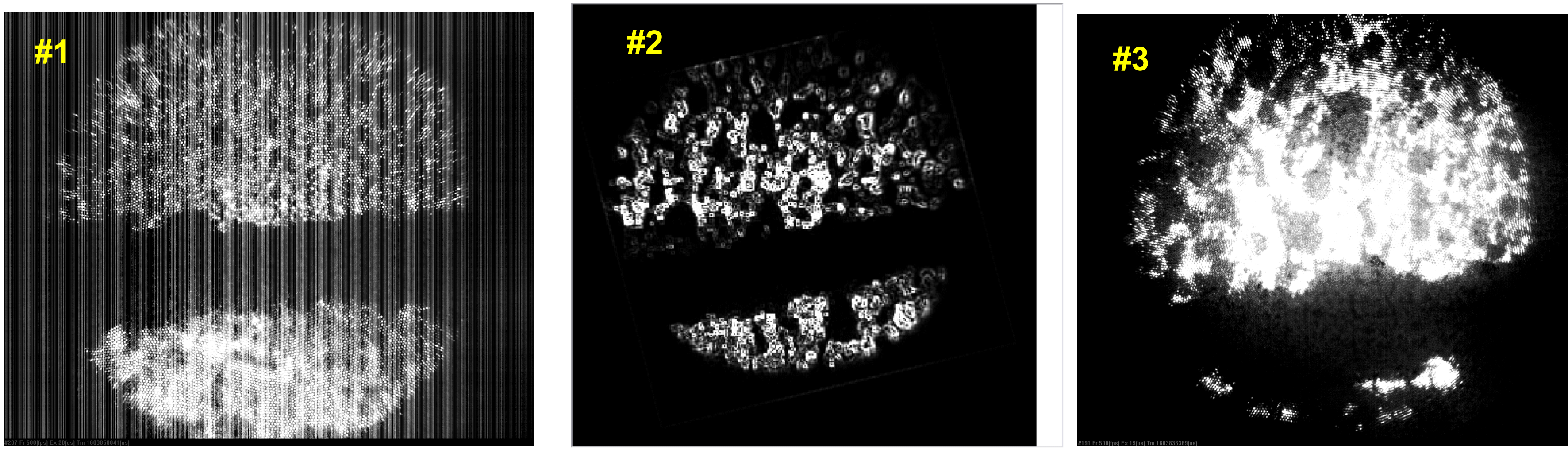
No leak detected on every 8 windows.
Holds 21 psi for over 17 hrs



Side View

Observation of Water Jet

20 m/s shot, Reduced SS nozzle after 180 degree bend (Tested at ORNL, Nov 30, 2006)



20 m/s shot, Reduced Ti nozzle after 180 degree bend, Tested at ORNL, Jan 25, 2007)

Measured Result

Tested at ORNL, Nov 30, 2006

View port #2	Velocity(m/s)		Jet Width(mm)	Jet Width(mm)
Nozzle #	10 m/s shot	20 m/s shot	10 m/s shot	20 m/s shot
A Nozzle	9.82	19.64	9.20	27.57
B Nozzle	9.82	19.64	10.19	38.59
C Nozzle	9.82	21.61	9.85	10.28
D Nozzle	9.82	19.64	10.07	20.08

Tested at ORNL, Jan 25, 2007

Ti Nozzle	Velocity (m/s)		Jet Width (mm)	
	10 m/s shot	20 m/s shot	10 m/s shot	20 m/s shot
View port #1	-	-	11 ~ 14	8 ~ 15
View port #2	11.4	15.3	11.7 ~ 13	7.2 ~ 9.5
View port #3	-	-	8.6 ~ 12.4	6.3 ~ 8.1

Nozzle C showed stable shape and uniform velocity.

Clear typical surface motion should be observed to get accurate velocity measurement. It could lead to measurement error.

For Ti nozzle, jet width decreases as the jet moves to downstream.

Summary

- four 10-meter long imaging fibers assembled on SS primary
- SS primary are pressure tight (20 psi)
- Dynamic image collection on all viewports were tested
- Channel #0 - scintillating fiber
- Channel #1 - 1st viewport, old FastVision camera
- Channel #2 - 2nd viewport, SMD camera
- Channel #3 - 3rd viewport, new FastVision camera
- Channel #4 - 4th viewport, video camera/Olympic Encore
- Magneto hydro dynamic effect to the jet shape will be observed / measured at MIT after solenoidal magnet is integrated.