LIGO Laboratory / LIGO Scientific Collaboration

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ISCTEY Measurements

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Abstract

This document gives an overview of the measurements taken during the assembly of the ISC table for the End Y station (ISCTEY).

1 Introduction

The document tree for ISCTEY can be found in E1200161. The ISCTEY optical layout can be found in D1100607-v1, and is portrayed in Fig. 1 for reference.

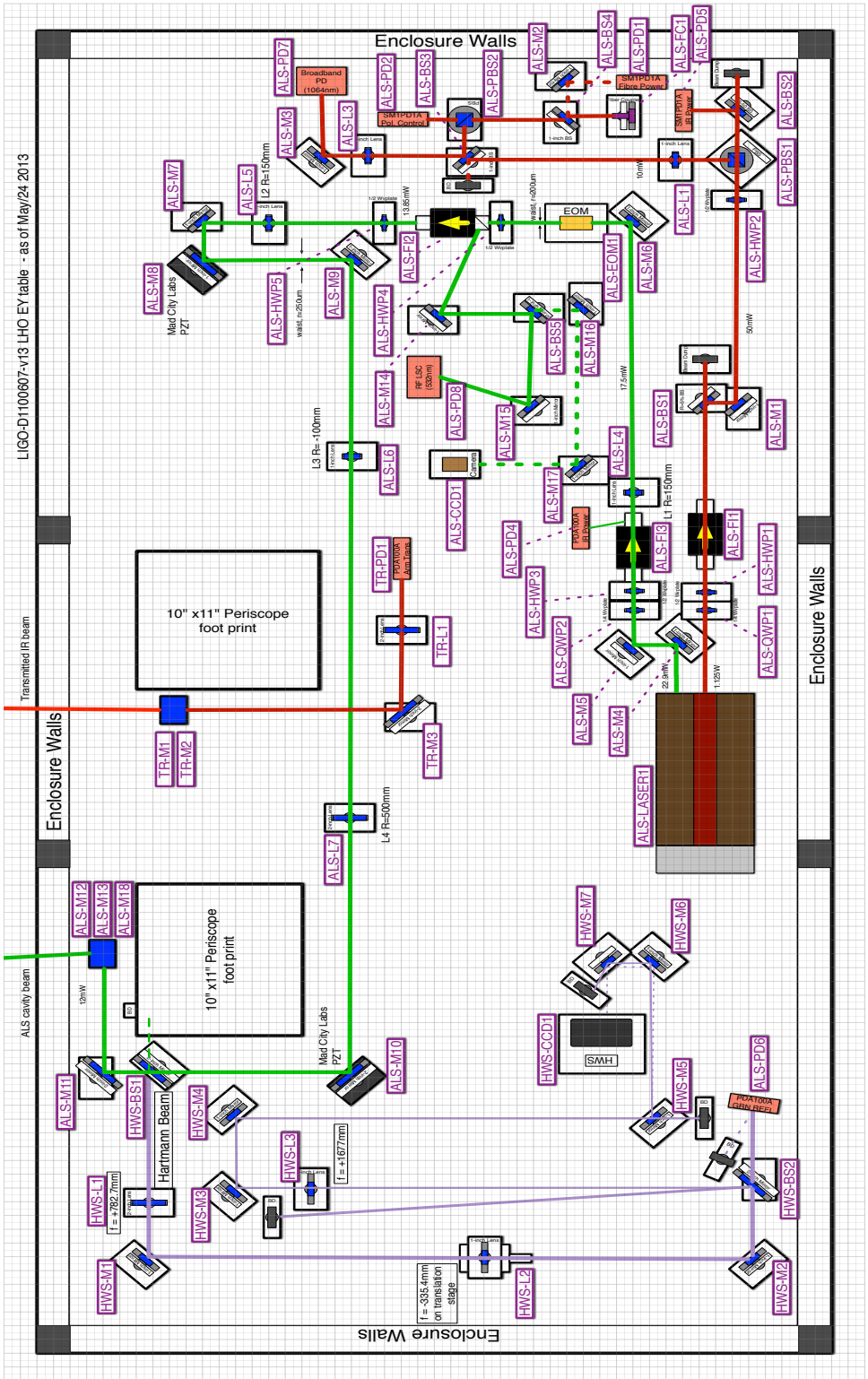

Figure 1: ISCTEY optical layout

2 Layout updates

Several adaptions were made to the optical layout; these changes are listed below:

- Shin was placed below FI to obtain 4 in required height (09/11/13)
- Moved laser toward path by 1 inch so the bream profile calculations need to be shifted accordingly (09/12/13)
- Placed ALS-L4 4 inch from ALS-FI3 (09/13/13)
- Added a ROC=50mm between ALS-PS2 and ALS-B4 (09/18/13)
- Switched ALS-L1 and ALS-L3 (09/18/13)

3 Laser Configuration

With the ISCTEY Prometheus laser set as follows,
PPKTP Crystal @ 32.27 C
NPRO Crystal @ 24.00 C
Diode A @ 23.00 C
Diode B @ 21.00 C
we measured the Current (A) vs Power(W) out of the laser aperture for the 1064 nm beam (see Fig. 2).

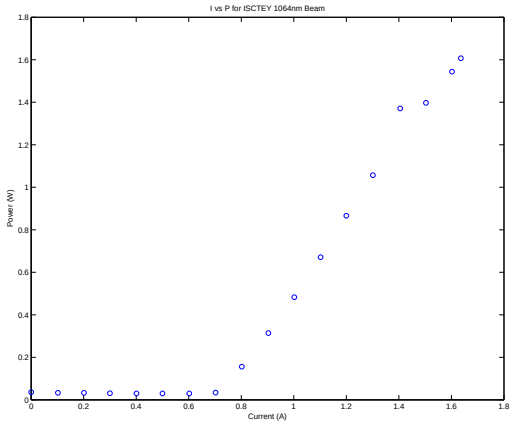

Figure 2: Current vs Power for 1064 nm beam

We found the optimal configuration for the laser to be,

PPKTP Crystal @ 33.81 C
NPRO Crystal @ 24.00 C
Diode A @ 23.00 C
Diode B @ 21.00 C
Current 1.503A

such that at the aperture, the power of each beam was,

1064nm: 1.371W
532nm: 40.1mW.

4 IR Beam Path

In the optimal configuration described in Section 3, the power after the quarter-wave plate (QWP), half-wave plate (HWP), and Faraday Isolator (FI) for the 1064 nm beam was measured to be 1.282 W. Thus, the throughput of the ALS-FI1 is about 93% (09/09/13). Using the Nanoscan, a couple of beam profiles were examined:

- Fig. 3 shows the beam profile immediately following the aperture of the laser.
- Fig. 4 shows the beam profile after the FI with the current set to 0.803 A (10mW at profiler) using ALS-M1 as reference point
- Fig. 5 shows the beam profile after the FI with the current set to 1.503 A (100mW at profiler) using ALS-M1 as a reference point

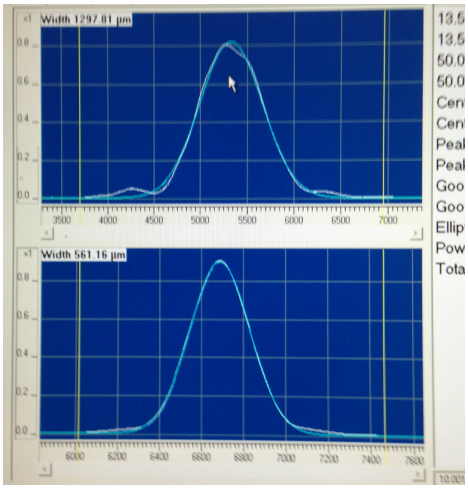

Figure 3: Beam Profile for 1064 nm at Laser Aperture

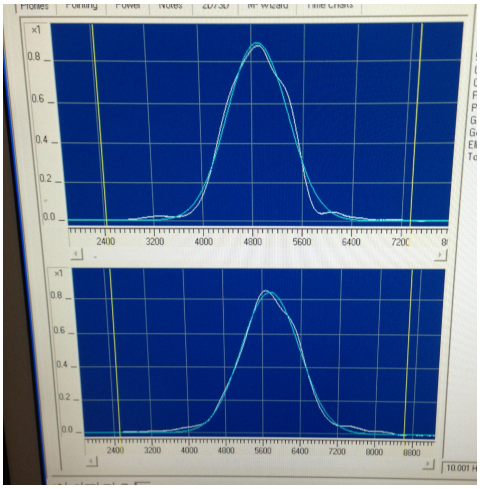

Figure 4: Beam Profile for 1064 nm after ALS-FI1 with Low Current

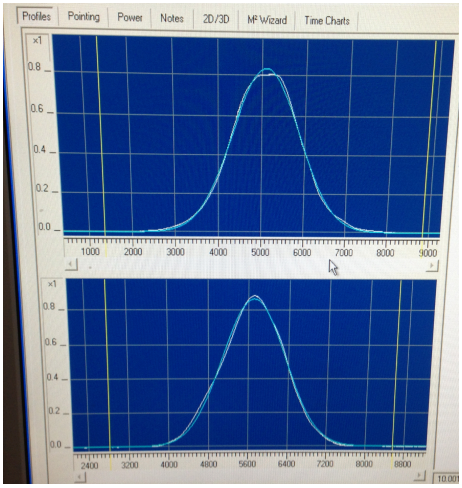

Figure 5: Beam Profile for 1064 nm after ALS-FI1 with Nominal Current

In these images, the top graph is of the horizontal profile and the bottom graph is of the vertical profile. Immediately after the laser aperture, we see a nice gaussian profile for the vertical profile. As expected, the horizontal profile does not fit a gaussian as nicely. After the FI, the vertical profile deviates from the gaussian shape. We attempted to adjust the FI alignment in order to improve this profile; however, it only worsened the profile.

Fig. 6 is a graph displaying the beam profile of the 1064 nm beam at the nominal current with ALS-M1 as a reference. Using the 13.5% width (or $1/e^2$ diameter) of both the horizontal and vertical profiles, the radii for the two profiles were determined at various distances from the reference point. In addition, the graph includes error bars of one standard deviation. A line of best fit was produced, and the difference between the line of best fit and the data points was plotted in the lower portion of both figures.

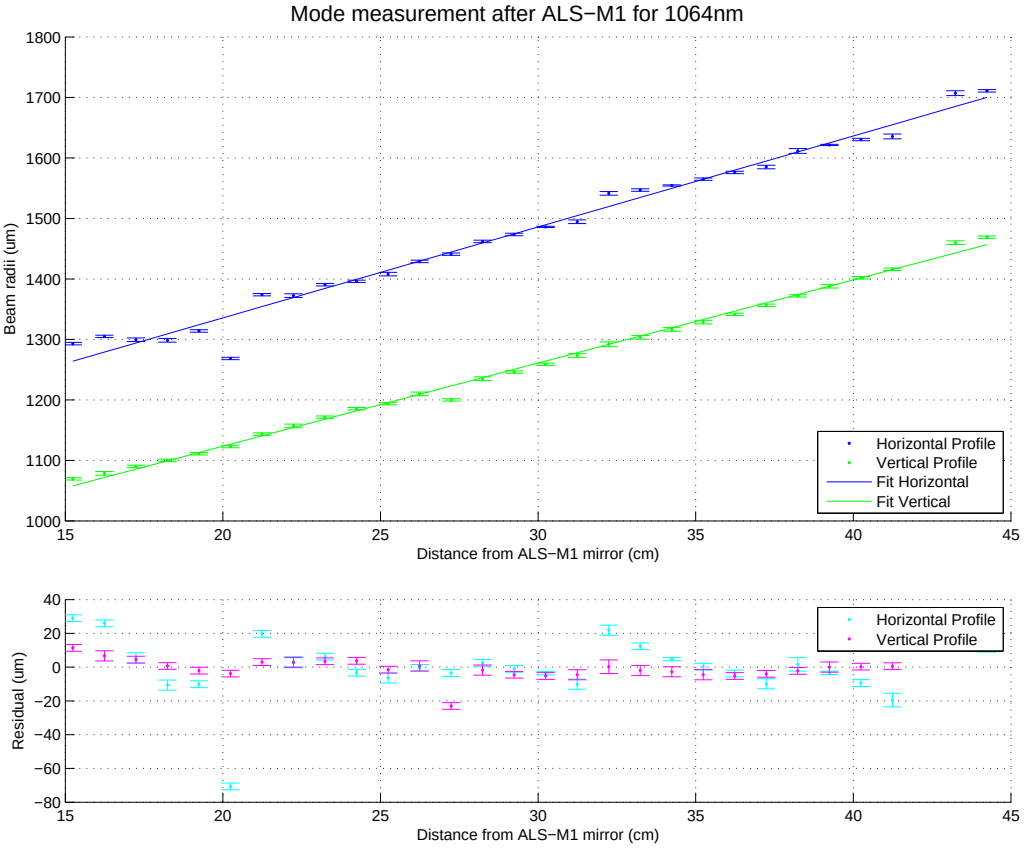

Figure 6: Beam Profile for 1064 nm

Adopting the changes listed in Section 2, beam profiles of the 1064nm path from the fiber and from the auxiliary laser with ALS-BS3 as a reference were taken; the results are seen in Figs. 7, 8. This data was taken with L1 placed 9 inches past ALS-PBS1 (7 inch

before ALS-BS3). Meanwhile, the additional ROC=50 mm lens is place 2.25 inch in front of ALS-PBS2 with the fiber located at 9 inch from ALS-PBS2 and 13 inch from ALS-BS3. In this configuration, the seed locations are (approximately):

- ALS-L1: waist size = 4.869e-5 m, waist location = -0.01 m from ALS-BS3
- Fiber : waist size = 4.695e-5 m , waist location = -0.01 m from ALS-BS3

Given the experimental error in this data set, ALS-L1 and the fiber sufficiently mode matched in the afore mentioned configuration.

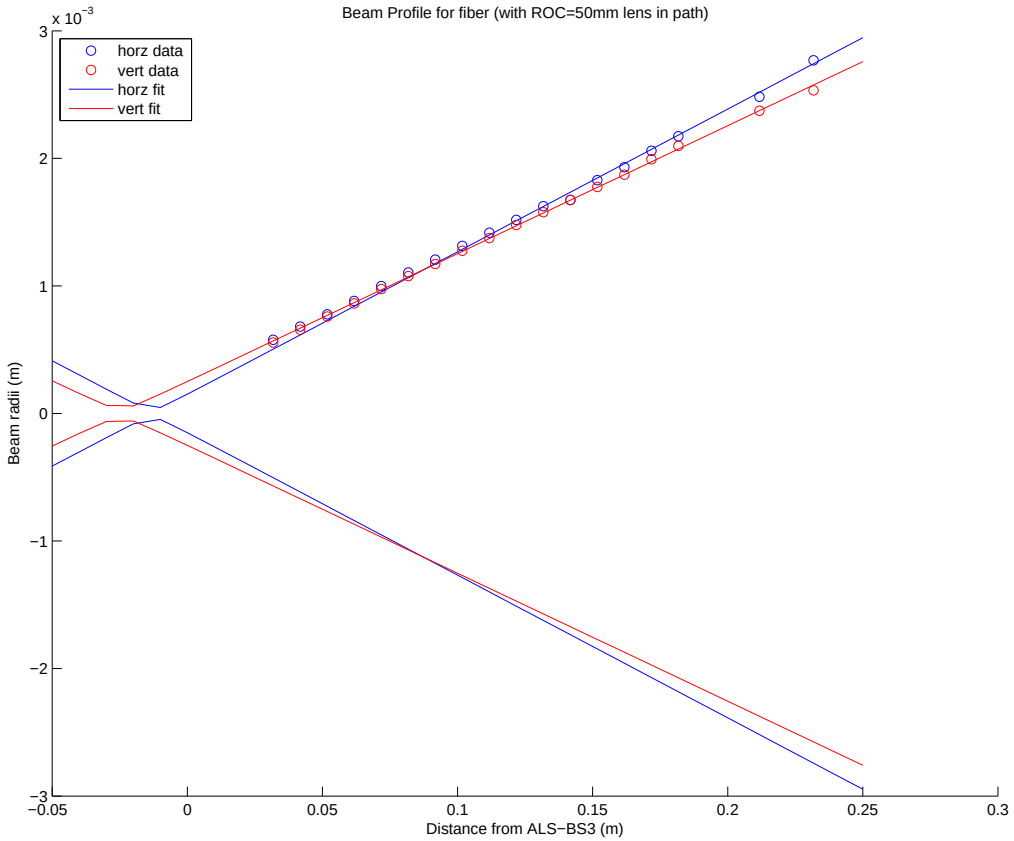

Figure 7: Beam Profile for Fiber with ROC=50mm lens in path

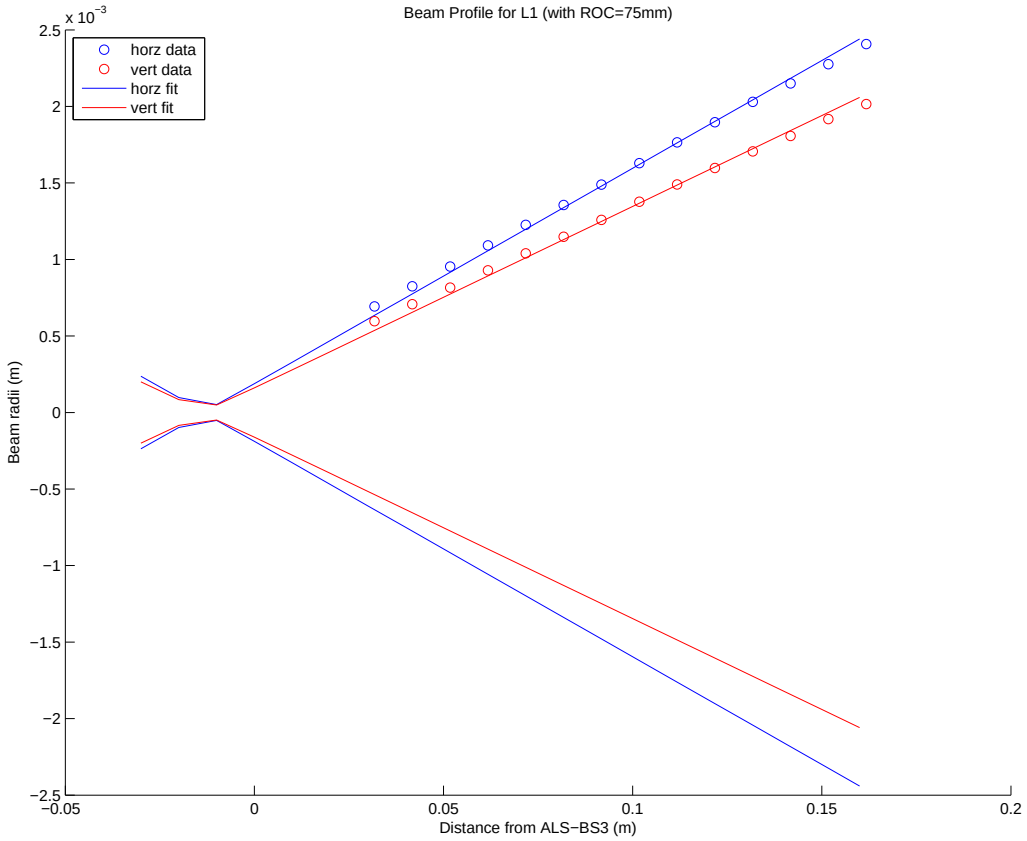

Figure 8: Beam Profile for ALS-L1 (with ROC=75mm)

Using this beam profile and linear fit of Fig. 6, a seed waist of the laser was determined and used for mode matching. Meanwhile, information from Fig. 7 was used to set a target waist. ALS-L1 was placed according to the previous discussion, and ALS-L3 is placed such that the beam enters ALS-PD7. Fig. 13 is the "a la mode" plot.

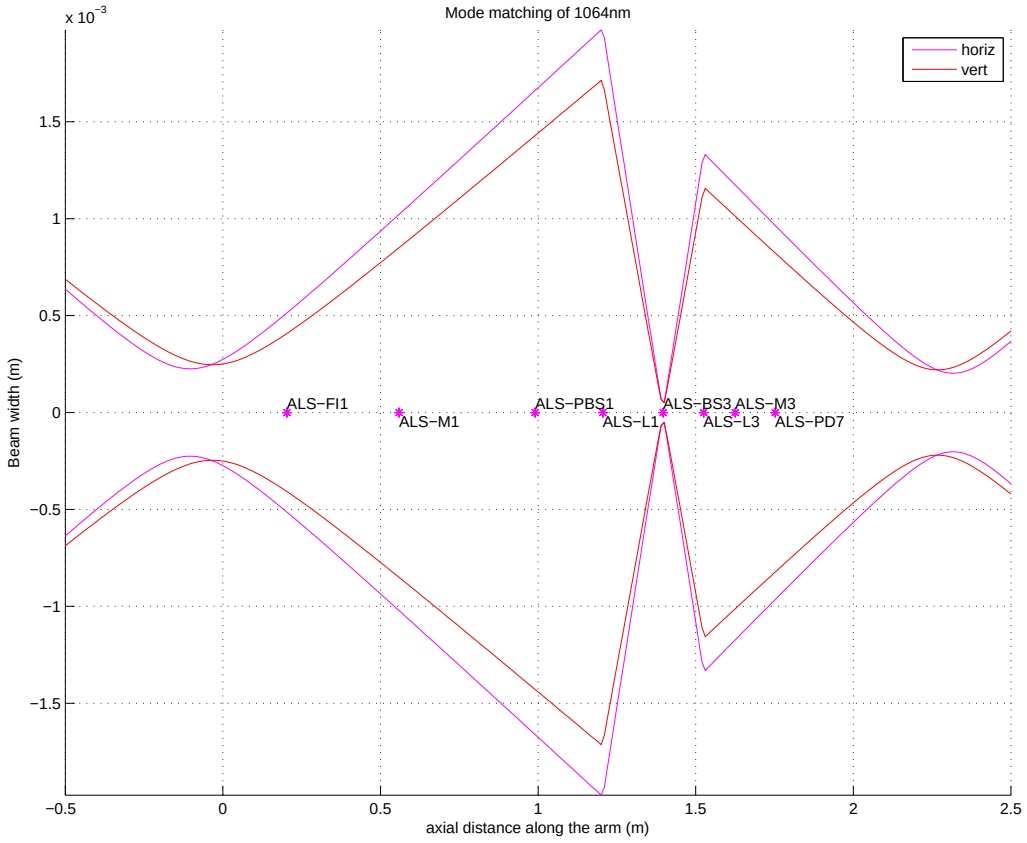

Figure 9: Mode Matching

With the nominal laser configuration, the power level was measured throughout the IR path. Fig. 10 is a sketch of part of the layout with the power measurements.

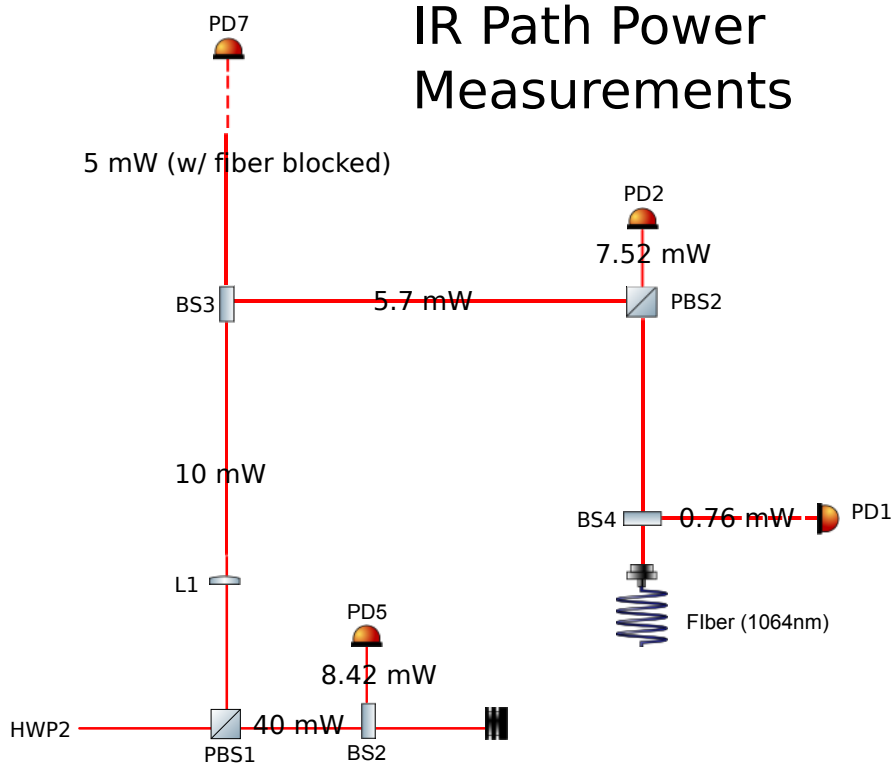

Figure 10: Sketch of IR path with Power Measurements

5 Green Beam Path

In the optimal laser configuration as described in Section 3, the power before ALS-FI3 is 39.7 mW, while is it approximately 37.6 mW after the FI. Thus, the throughput of the ALS-FI3 is about 94.7%. Fig. 11 shows the beam profile after ALS-FI3 with the current set to 1.503A (37.6mW at the profiler) (09/09/13). In addition, the isolation for ALS-FI3 was confirmed to be sufficient at about 40 dB. With ALS-FI3 as a reference, the green path exhibits a gaussian shape in both the vertical and horizontal profiles.

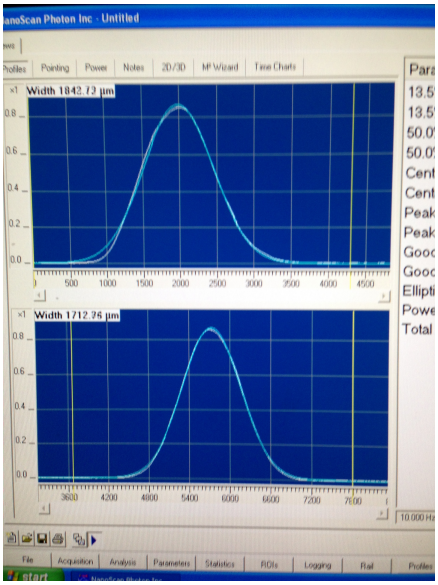

Figure 11: Beam Profile for 532 nm

Fig. 12 is a graph displaying the mode measurement of the 532nm beam with ALS-FI3 as a reference (this plot was created using the same technique as described in Section 4).

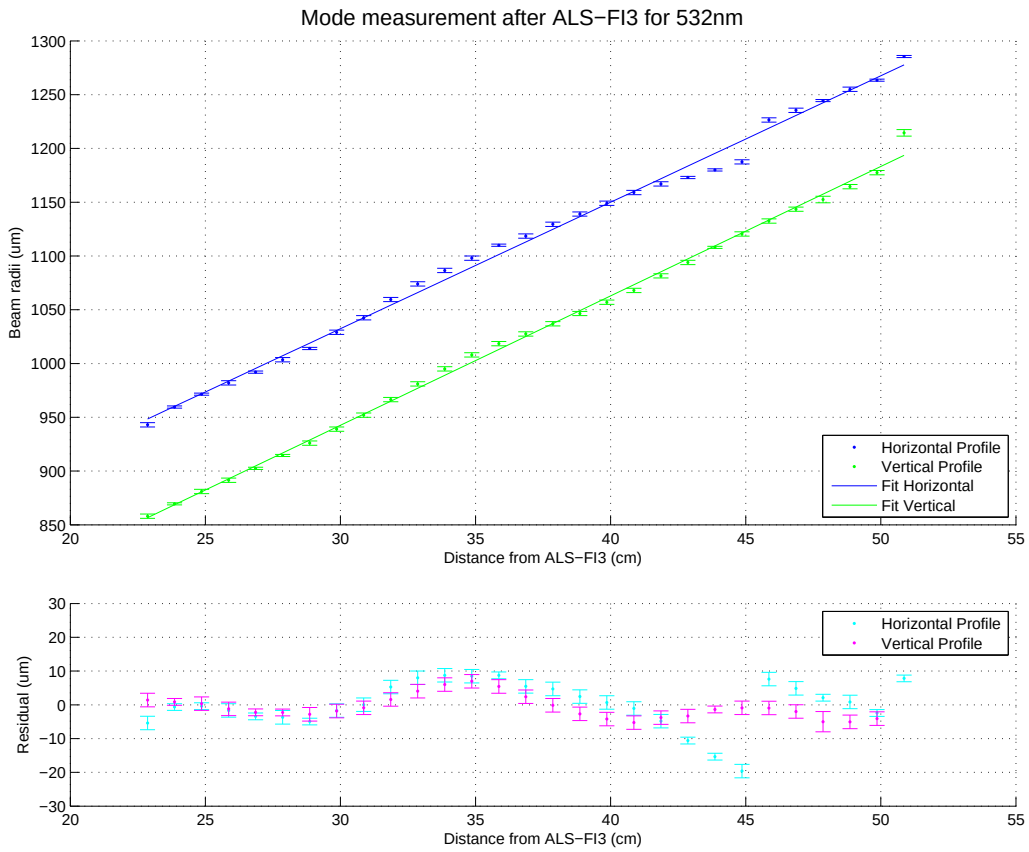

Figure 12: Mode Measurement for 532nm

Using this beam profile and linear fit of Fig. 12, a seed waist of the laser was determined and used for mode matching. The first lens that was aligned on the table was ALS-L4, which was placed 4 inch from ALS-FI3. Fig. 13 is the "a la mode" plot with data collected from the Nanoscan. A target waist size of 2.2 mm was used at 5 m from the laser.

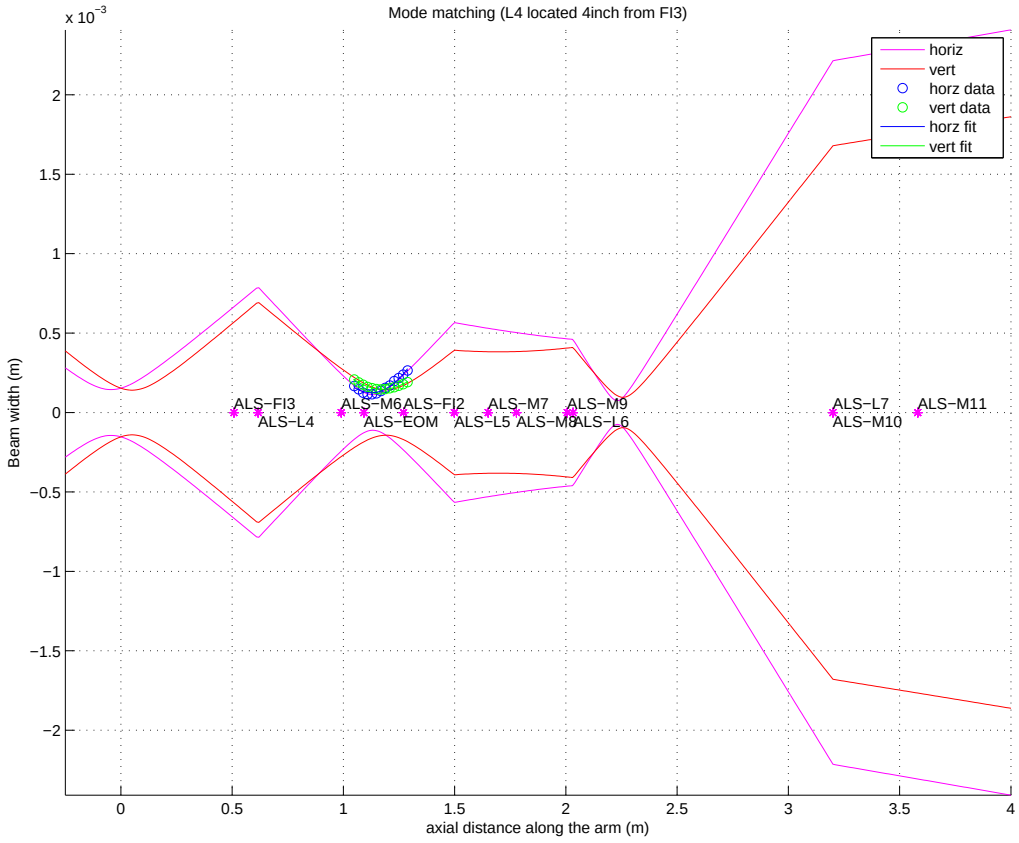

Figure 13: Mode Matching

The isolation of ALS-FI2 was optimized at around 35-40 dB. The power before and after the FI was measured to be 35.9mW and 30.5mW respectively. Thus, the throughput of ALS-FI2 is about 85% (09/16/13).

The polarization of the green beam into the cavity is s-pol. Along the green path, we have:

- Input polarization of FI3: horizontal
- Output polarization of FI3: 45deg
- EOM polarization: vertical

- Input polarization of FI2: horizontal
- Output polarization of FI2: 45deg
- After HWP5 for remainder of path: vertical

IMPORTANT NOTE: ALS-L5 and ALS-L7 are missing, so the mode matching is incomplete; the alignment is complete however.

6 Cabling

Below is a list of cables required for the table:

ALS Cable Lenghts - ISCTEY

heigth of cable rack above 4" beam height 32 inch

spare length 4 inch

ALS_Cable_Lengths_vNEW.xlsx 20/09/13

lengths in inches from connector end to connector end

filled means done and in hand

Location	Component	#	Signal	Length [in]	Qty Req	Qty In-hand	Side A	Side B (patch panel/Int. Box)	Comments
End	ALS-Laser1	15	PZT	117	1		BNC	TNC	
End	ALS-EOM1	10	RF	61	1		angled SMA	TNC	
End	ALS-PD1 (Thorlabs SM1PD1A)	11	DC-signal	50 (55)	1		BNC	TNC	Fiber output power
End	ALS-PD2 (Thorlabs SM1PD1A)	11	DC-signal	44	1		BNC	TNC	Polarisation monitor
End	ALS-PD4 (Thorlabs PDA100A)	11	DC-signal	50 (72)	1		BNC	BNC	GRN Power to Interface Box
		12	power	50 (72)	1		3-pin M12 Male	3-pin M12 Male	
End	ALS-PD5 (Thorlabs SM1PD1A)	11	DC-signal	50 (60)	1		BNC	TNC	IR Power
End	ALS-PD6 (Thorlabs PDA100A)	11	DC-signal	89	1		BNC	BNC	GRN REFL to PD Interface Box
		12	power	89	1		3-pin M12 Male	3-pin M12 Male	
End	ALS-PD7 (BBPD)	16	DC-signal	105	1		BNC	BNC	Fiber Beat to PD Interface Box
		17	power	105	1		3-pin M12 Male	3-pin M12 Male	
		18	RF	60 (70)	1		SMA	TNC	
End	ALS-PD8 (LSC RF Diode)	1	RF	60 (80)	1		angled SMA	straight TNC	
		2	DC-signal	60 (80)	1		angled SMA	straight TNC	
		3	power + mon	60 (80)	1		15-pin D-sub Female	15-pin D-sub Male	
End	TR-PD1 (ThorlabsPDA100A)	11	DC-signal	70 (65)	1		BNC	BNC	IR Trans to PD Interface Box
		12	power	55 (65)	1		3-pin M12 Male	3-pin M12 Male	
End	PD Interface Box	19	DC-signal	40 (85)	1		9-pin D-sub Male	9-pin D-sub Female	
		20	power	40 (85)	1		3-pin D-sub Female	3-pin D-sub Male (PP)	
End	ALS-CCD1 (REFL Camera)	13	Video	110 (100)	1		BNC	TNC	IR Trans beam
		14	power	110 (100)	1				normal Watec camera
End	ALS-SHUTTER (DNE)			132					located between L4 and M6
End	ALS-FIBRE		Fiber	50			FC-APC	FC-APC	Optical fibre
End	ALS-M8 (MCL PZT 1)		sensor + actuator	197	2	2	built-in to PZT, X and Y individual	9-pin D-sub Male	Provided
End	ALS-M10 (MCL PZT 2)		sensor + actuator	197	2	2	built-in to PZT, X and Y individual	9-pin D-sub Male	Provided
End	MCL Controller 1		sensor and actuator	32	1		9-pin D-sub Female	9-pin D-sub Male	
			sensor and actuator	32	1		9-pin D-sub Female	9-pin D-sub Male	
End	MCL Controller 2		sensor and actuator	32	1		9-pin D-sub Female	9-pin D-sub Male	
			sensor and actuator	32	1		9-pin D-sub Female	9-pin D-sub Male	

the #-column refers to the cD1100670

Figure 14: Cable

The red indicates suggested lengths with old values in parenthesis.