

BHD Mode Matching

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1 AS Path

1.1 Plan 1

Table 1: Telescope design for AS path (plan 1).

Component	AS1	AS2	AS3	AS4
Position z [m]	0.7192	1.2597	1.8658	2.5822
RoC [m]	2.8	Inf	-0.60	2.0

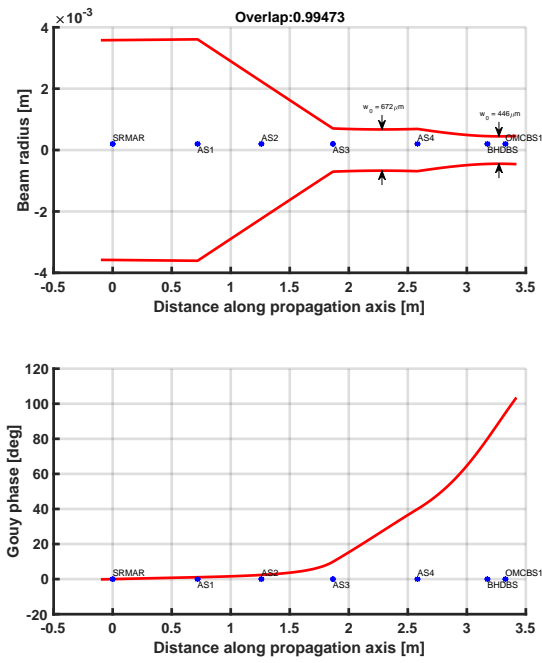
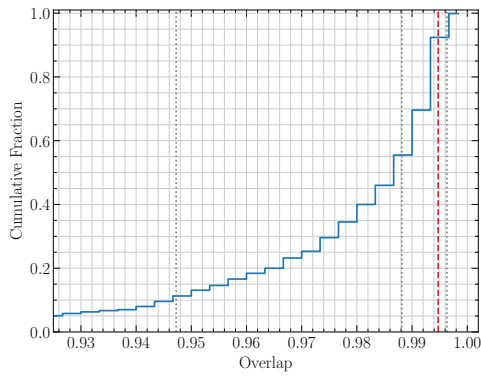
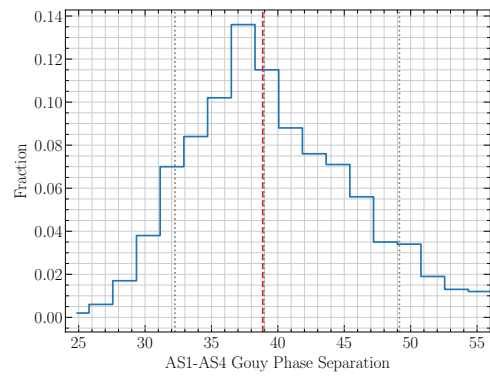


Figure 1: Beam profile for the AS path; plan 1.



(a) Cumulative histogram of overlap.



(b) Histogram of Gouy phase separation.

Figure 2: Left: cumulative histogram of mode overlap. Right: histogram of gouy phase separation between the two actuator mirrors. In both plots, the dashed-red traces are the nominal value and the dotted-grey ones are the (10, 50, 90) percentiles of the distribution. When generating the distribution, we have assumed a Gaussian error on the location z of each component $\sigma_z = 3$ mm, and a fractional error on the RoC $\sigma_{\text{RoC}} = 1\%$. This plot is for AS path plan 1.

1.2 Plan 2

Table 2: Telescope design for AS path (plan 2).

Component	AS1	AS2	AS3	AS4
Position z [m]	0.7192	1.2597	1.8658	2.5822
RoC [m]	2.5	Inf	-0.50	0.60

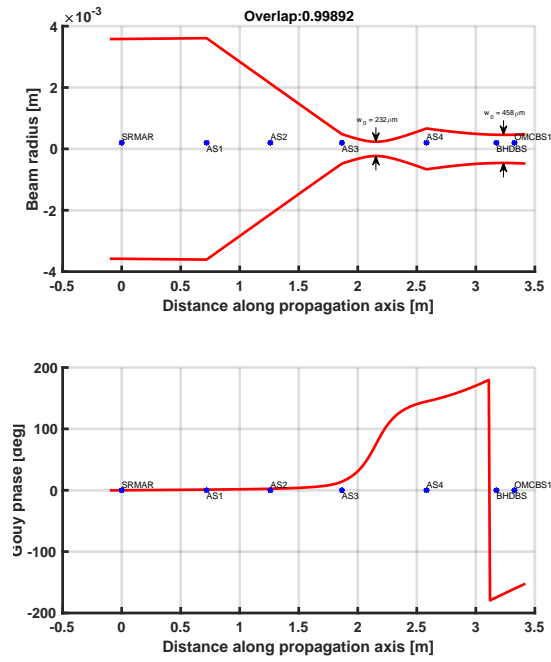
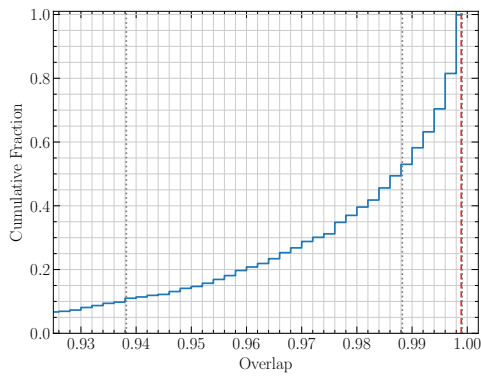
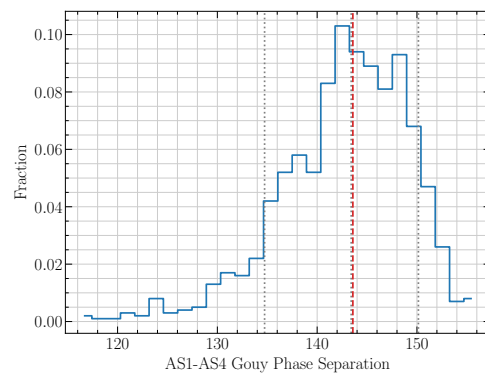


Figure 3: Beam profile for the AS path; plan 2.



(a) Cumulative histogram of overlap.



(b) Histogram of Gouy phase separation.

Figure 4: Similar to Fig. 2 but for AS path plan 2.

2 LO Path

2.1 Plan 1

Table 3: Telescope design for LO path (plan 1; elog 15334).

Component	LO1	LO2	LO3	LO4
Position z [m]	0.4027	2.9835	4.5955	4.8880
RoC [m]	10	Inf	15	Inf

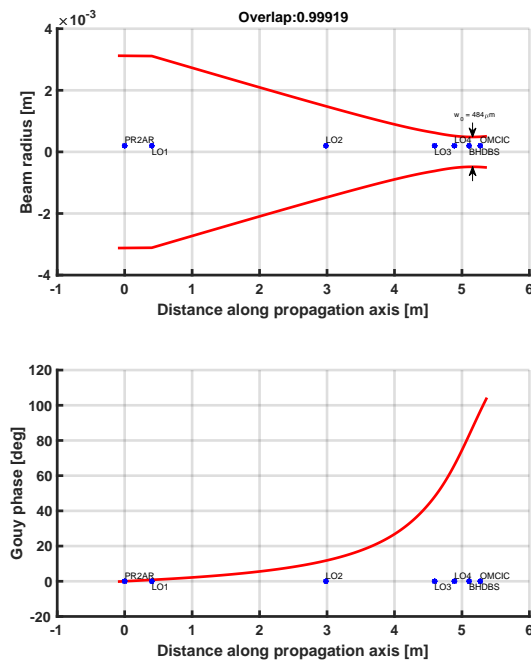
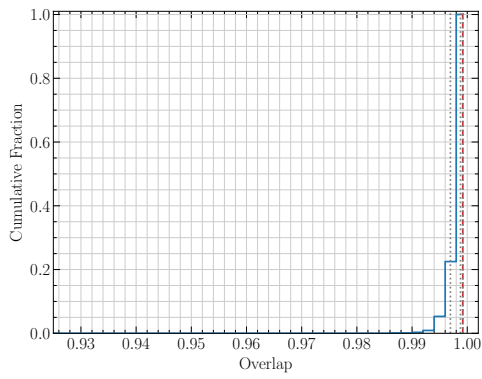
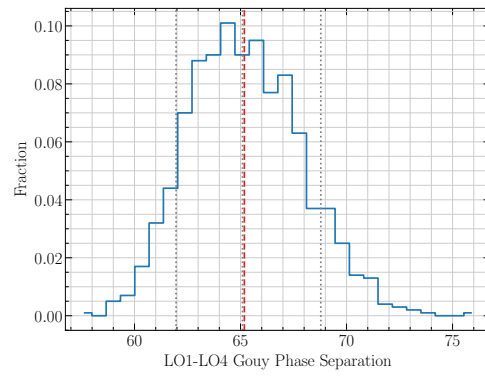


Figure 5: Beam profile for the LO path; plan 1 (the one in elog 15334). The actuators needs to be LO1 and LO4 in this case.



(a) Cumulative histogram of overlap.



(b) Histogram of Gouy phase separation between LO1 and LO4.

Figure 6: Similar to Fig. 2 but for LO path plan 1.

2.2 Plan 2

Table 4: Telescope design for LO path (plan 2).

Component	LO1	LO2	LO3	LO4
Position z [m]	0.4027	2.9835	4.5705	4.9006
RoC [m]	6.0	Inf	0.75	-0.45

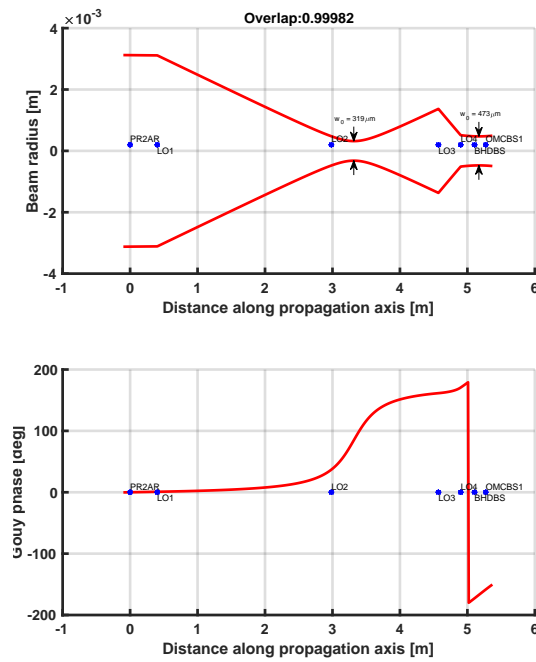
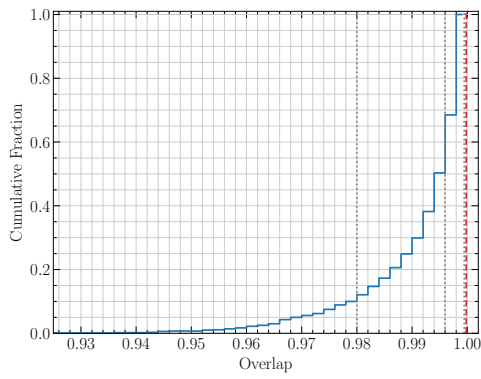
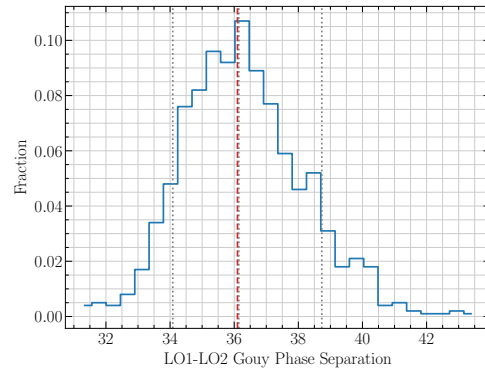


Figure 7: Beam profile for the LO path; plan 2. The actuators are LO1 and LO2 in this case.



(a) Cumulative histogram of overlap.



(b) Histogram of Gouy phase separation between LO1 and LO2.

Figure 8: Similar to Fig. 2 but for LO path plan 2.

A Condition number vs. Gouy phase

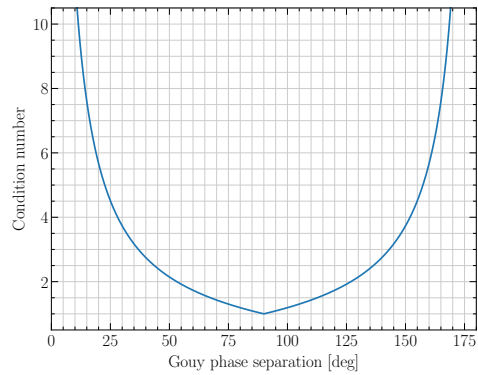


Figure 9: Sensing matrix condition number vs. Gouy phase separation, assuming we have perfect sensing (two sensors separated by 90°). We want to have actuators so that the condition number < 3 for robust inversion. This requires a Gouy phase separation of $35^\circ < \eta < 145^\circ$.