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Alignment accurary requirements for Advanced Virgo

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1 Alignment requirements

This notes describes a first set of angular control accuracy requirements for each mirror in Advanced Virgo, both in the MSRC and NDRC configurations. The results are obtained using modal simulations [1]. The basis principle is to consider the maximum acceptable fluctuation of carrier and sideband powers inside the ITF due to alignment residual RMS motion. During VSR2 the typical power fluctuations were of the order of 10^{-2}. It seems reasonable to require power fluctuations to be 10 times lower in Advanced Virgo, meaning of the order of 10^{-3}.

In the simulation static misalignment of single mirrors are introduced and the power levels inside power recycling and arm cavities are computed. The static mis-alignment that changes powers at the 10^{-3} level is used as requirement.

In the power recycling case the carrier and first sideband is considered. In the signal recycling case the second sidebands are considered.

In the signal recycling case another requirement is added concerning the sensitivity. The shot-noise limited sensitivity is computed at 100, 300 and 1000 Hz with the baseline SRC detuning. It is required to change less than 1%.

In all simulations longitudinal tunings are optimized as explained in [2].

The parameters used for arm cavities are those of the Advanced Virgo baseline [3]. The NDRC recycling cavity design comes from one of the latest J. Marque's talks [4].

Plots are shown in appendix and results are summarized in tab. 1.

Mirror	**MSRC**	**NDRC**
PRM1	10	1500
PRM2		300
PRM3		30
Arm input	1	3
Arm end	1	3
SRM1	100	1000
SRM2		800
SRM3		50

Table 1: Maximum residual RMS motions (in nrad) of single mirrors in Advanced Virgo to have power fluctuations smaller than 10^{-3} and sensitivity fluctuations smaller than 10^{-2}.

A Marginally stable recycling cavities

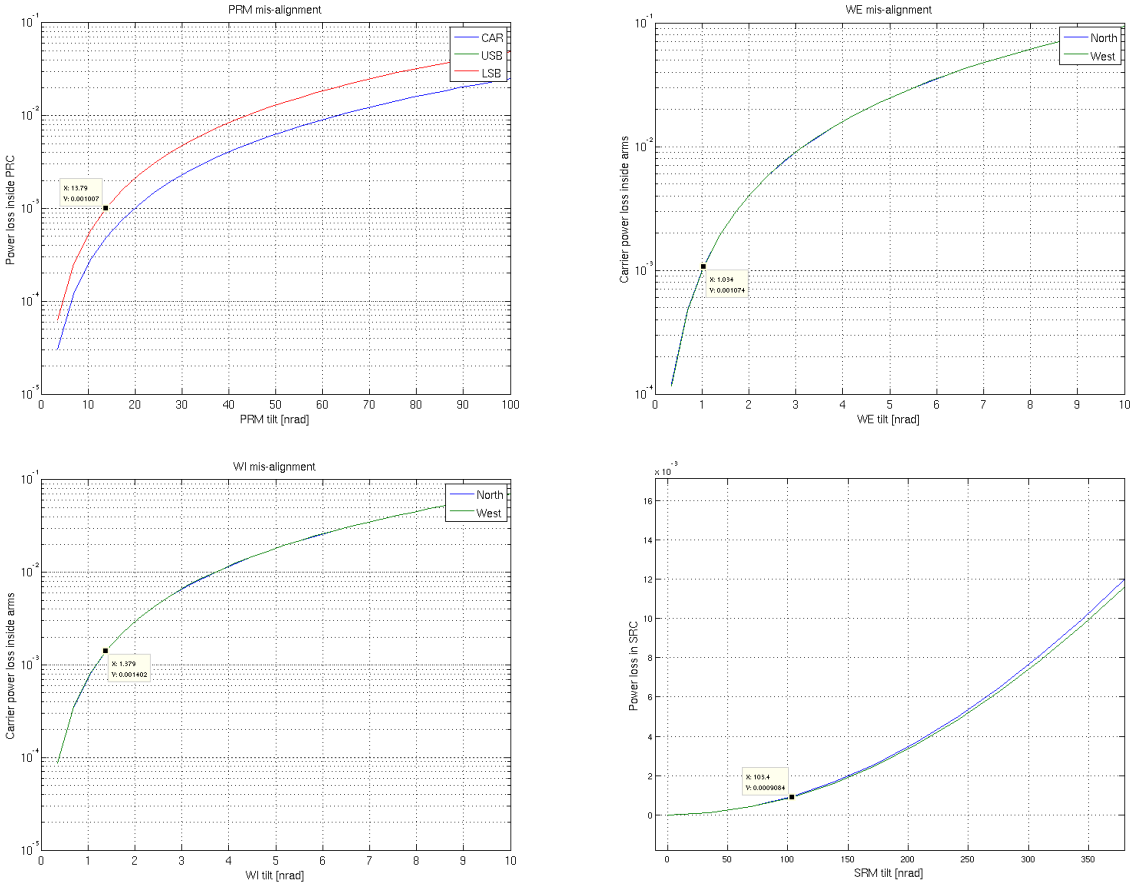

Figure 1: Relative power change due to mirror mis-alignments in MSRC.

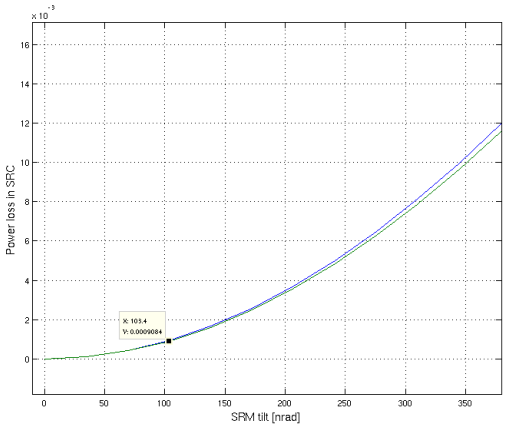

Figure 2: Shot-noise limited sensitivity change due to SRM mis-alignment in MSRC.

B Non-degenerate recycling cavities

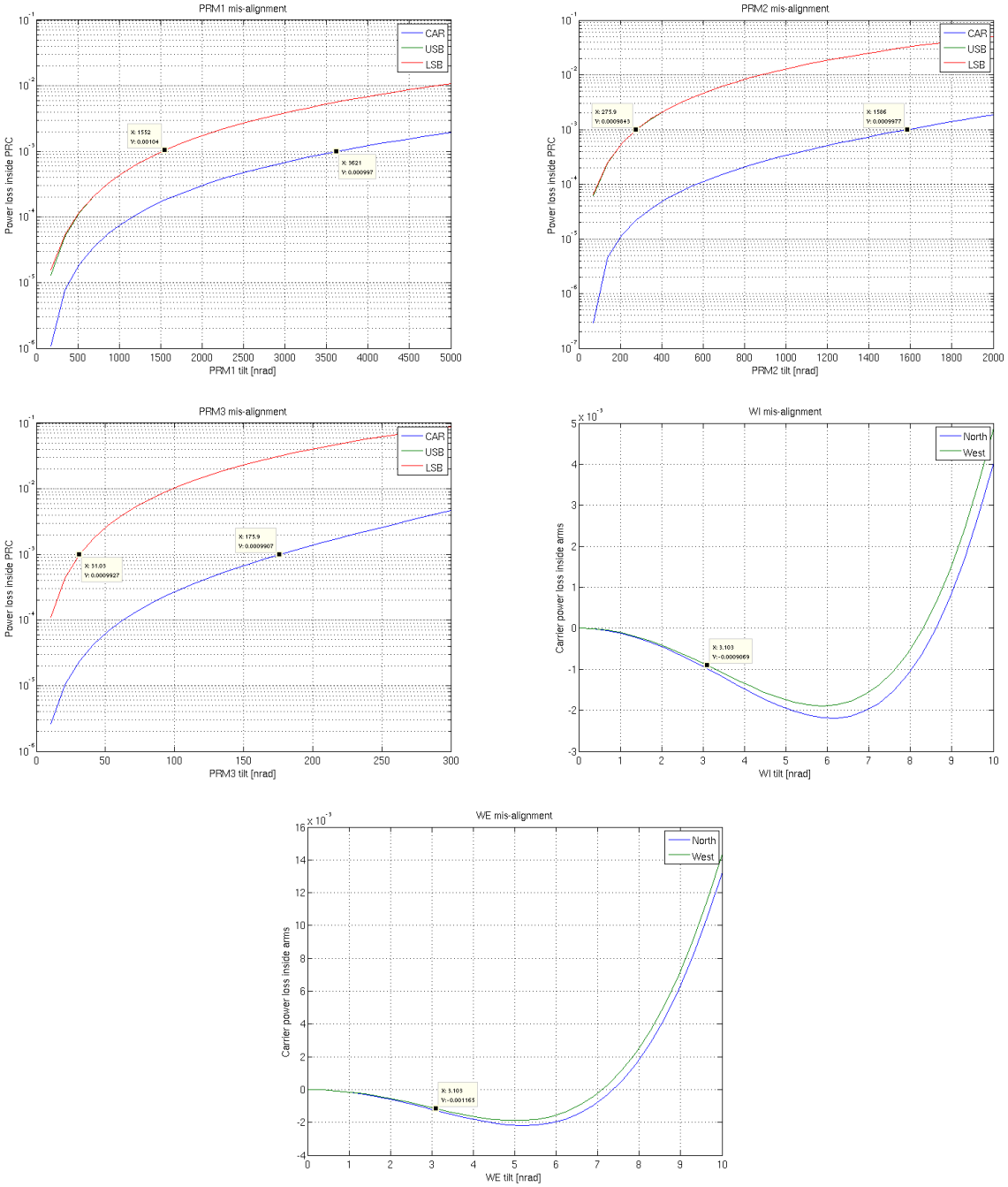

Figure 3: Relative power change due to mirror mis-alignments in NDRC.

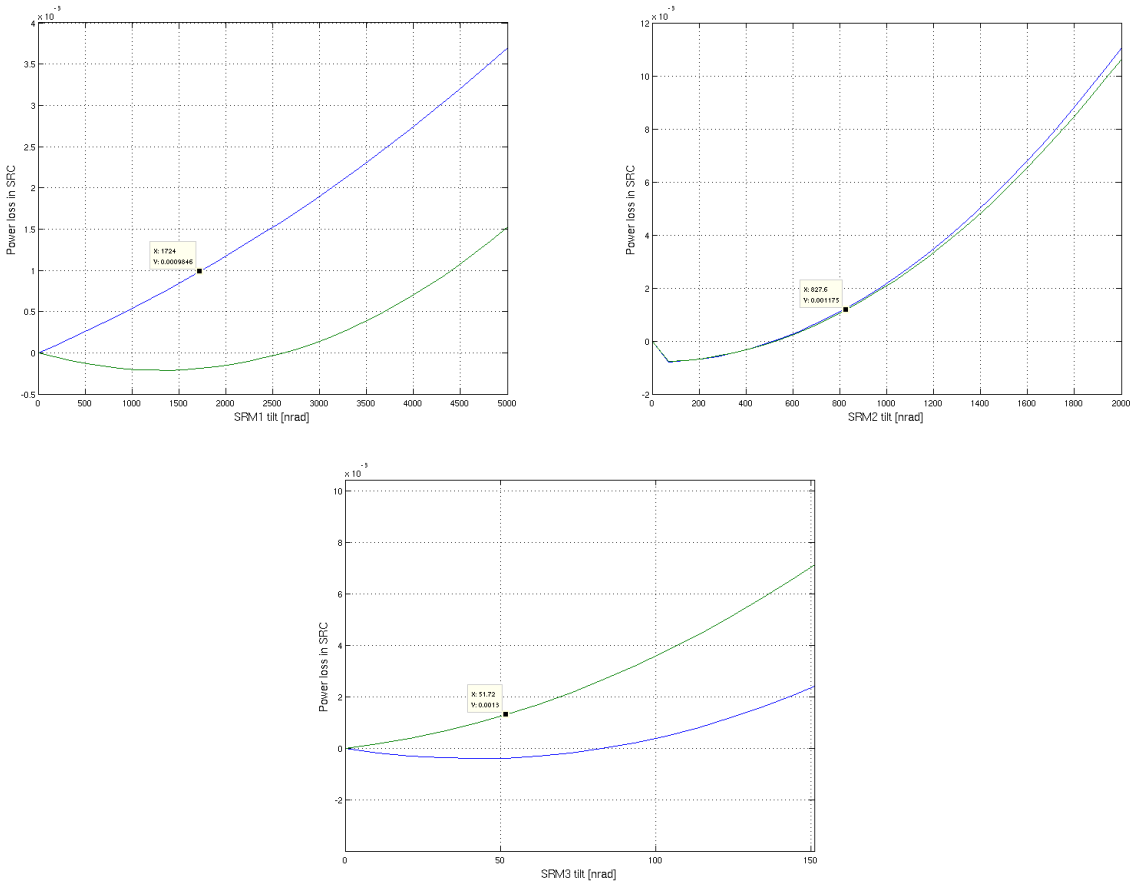

Figure 4: Relative power change due to mirror mis-alignments in NDRC.

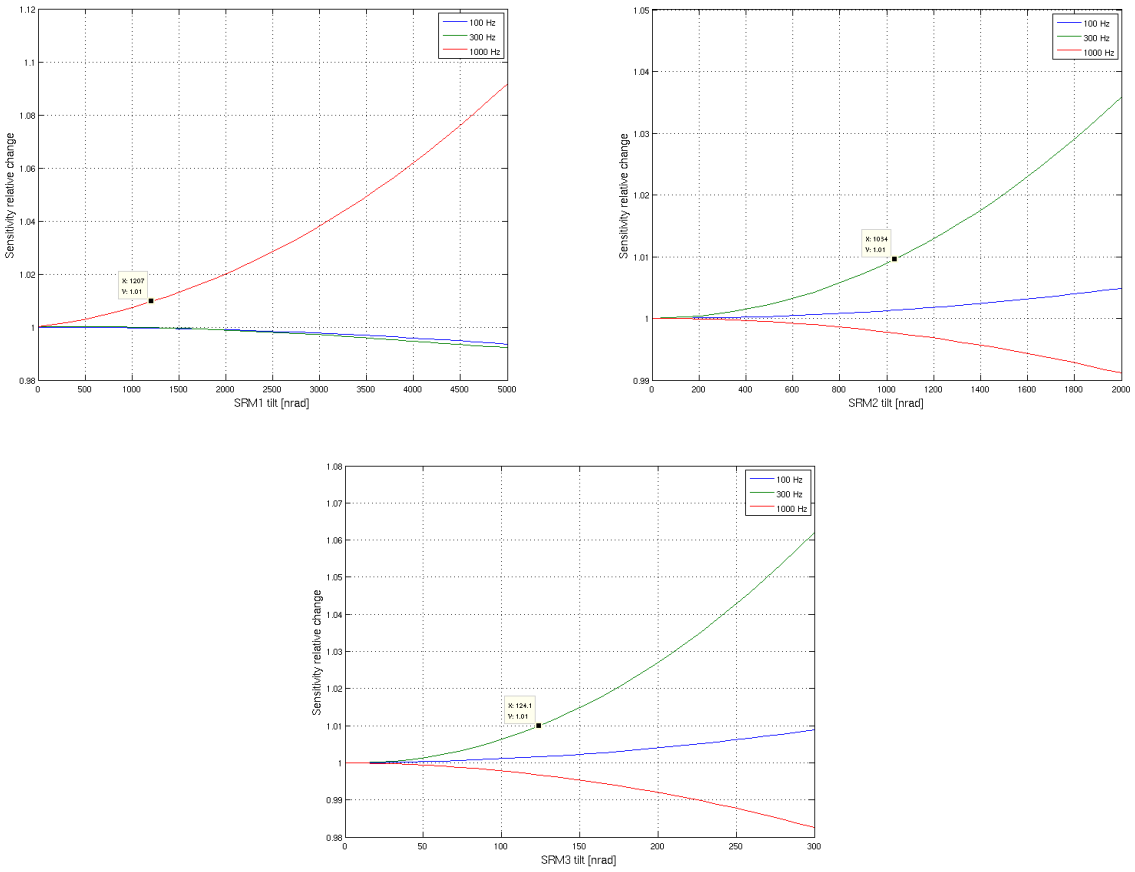

Figure 5: Shot-noise limited sensitivity change due to SRM mis-alignment in NDRC.

References

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[4] J. Marque *AdV optical layout: Complete layout with RM3 mirrors off-centered in INJ/DET*, VIR-0229A-10 (2010)

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