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# MICH coupling to the GW channel of an ET-HF interferometer

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## 1 Introduction

For the designing the central interferometers of ET, consisting of the beam splitter, the input test masses and the recycling mirrors, it is important to know how noise originating from within the central interferometer couples to the Gravitational Wave readout channel. Noise sources within the central interferometer include for example thermo-refractive noise from the beam splitter and input test masses.

## 2 Comapring MICH and DARM coupling for a ET HF interferometer

In the following we are only interested in two length degrees of freedom: The differential arm cavity length (DARM) and the differential arm length of the central Michelson interferometer (MICH).

We used a numerical interferometer simulation (Finesse [1]) to simulate the coupling function from DARM and MICH noise to the GW channel of an ET high frequency interferometer with the parameters described in [3] or [2].

Figure 1 shows the result with signal recycling and for comparison also without signal recycling. We find that the overall spectral shape of the MICH and DARM coupling is roughly similar in both cases (with and without signal recycling), though of course different in absolute values. This result suggests:

- Noises originating from within the central interferometer do not need to be corrected for the arm cavity pole.
- If there was a correction required, one would have to correct for the effective pole of the combination of arm cavities and resonant side band extraction.
- However, as DARM and MICH see the 'same' pole no spectral correction of MICH noise is required (only an absolute scaling factor depending on the finesse of the arm cavities needs to be applied).
- This indicates that a flat (or 1/f) noise inside the central interferometer should show up flat (or 1/f) in the overall noise budget of the GW detector.

## 3 Outlook

These simulation results need to be extended to the ET low frequency interferometer which makes use of detuned signal recycling. In addition we plan to include radiation pressure effects ...

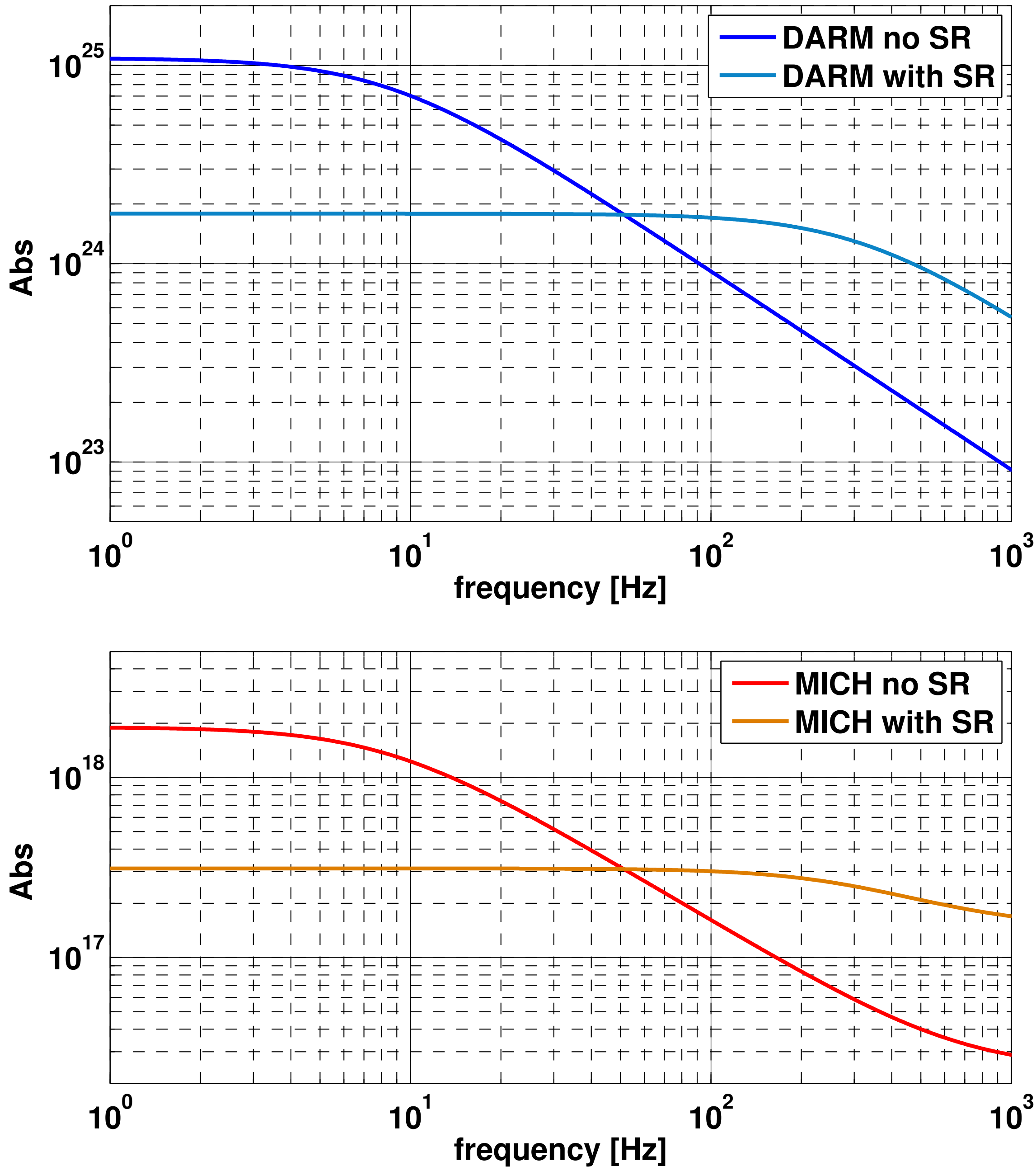


Figure 1: Simulation of DARM and MICH coupling to the GW channel of the ET-HF interferometer with and without Signal Recycling. Radiation pressure effects are not taken into account.

# References

[1] A. Freise *et al*: "Frequency-domain interferometer simulation with higher-order spatial modes", *Class. Quantum Grav.* **21** (2003)1067–1074. 1

[2] S.Hild, S.Chelkowski, A.Freise, J.Franc, N.Morgado, R.Flaminio and R.DeSalvo: "A Xylophone Configuration for a third Generation Gravitational Wave Detector" *CQG* **vol. 27**, pp015003 (2010). 1

[3] S. Hild *et al*: "Sensitivity Studies for Third-Generation Gravitational Wave Observatories", arXiv:1012.0908v1 [gr-qc], submitted to CQG. 1