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Multi-satellite formations and constellations of CubeSats and their potential in NGGMs

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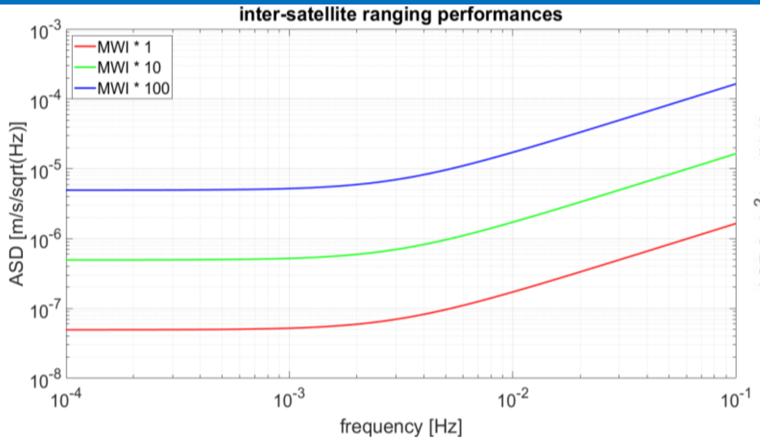
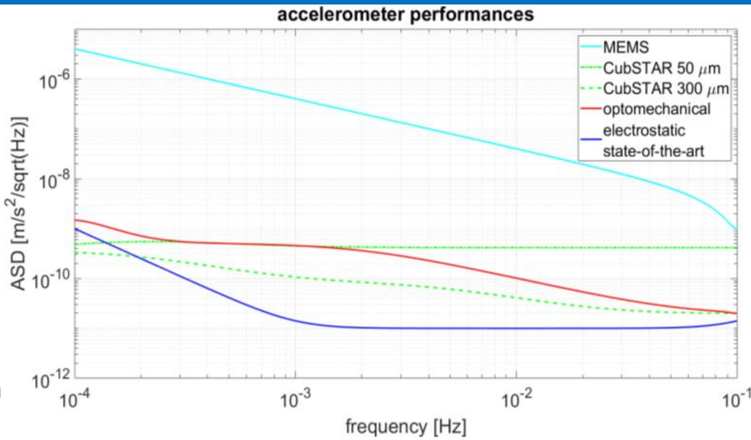
Introduction

For considering CubeSats in a NGGM, further miniaturization of gravity-relevant components, in particular accelerometers and inter-satellite link (ISL) is required.

Since no potential candidates could be identified for the ISL so far, the GRACE-FO Microwave Ranging Instrument[1] (MWI) with different performance gradation (factor 1, 10, 100) are used for the gravity field simulations (see image on the right).

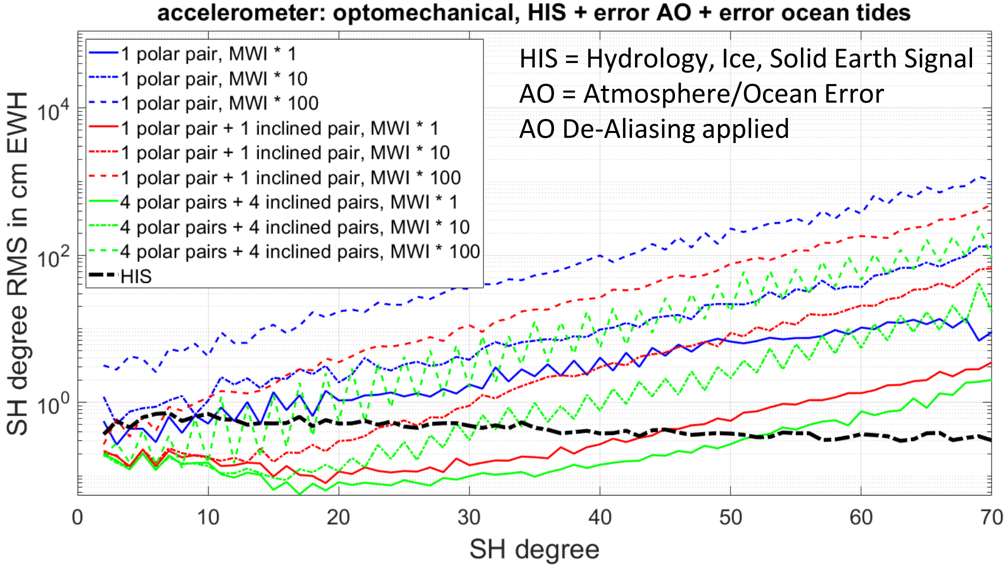




Simulation Setup

Four possible accelerometer sensors could be identified for a CubeSat mission: MEMS[2], CubSTAR[3] with 50 and 300 µm gap (electrostatic), optomechanical[4]. A GRACE-type electrostatic instrument[5] serves as a reference for state-of-the-art performance (see image on the left).

In numerical-closed loop simulations the impact of the different ISL and accelerometer performances on time-variable gravity field solutions is evaluated.

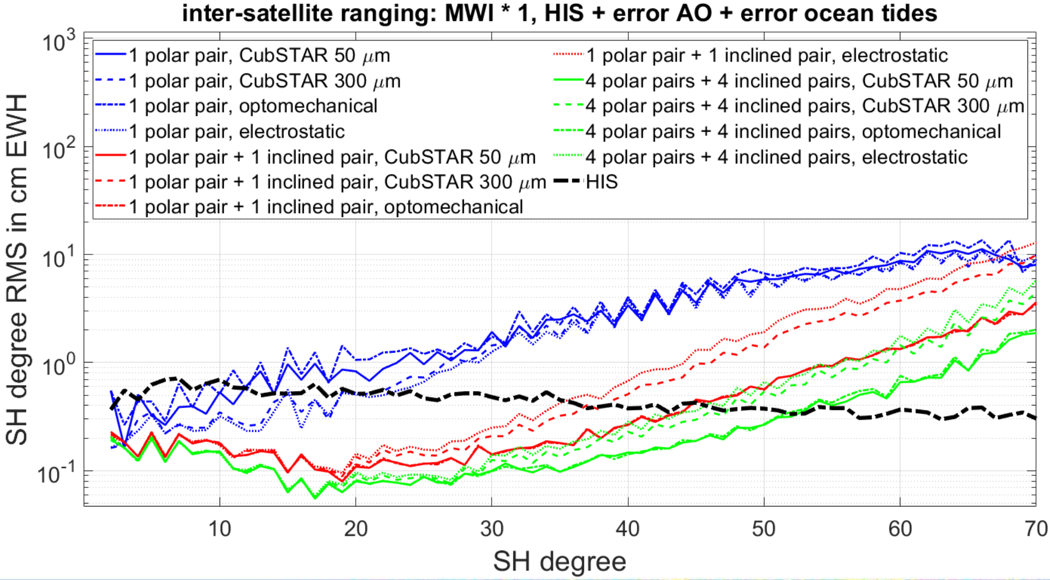


Results

Three different constellations of satellites pairs (1,2 and 8 pairs in polar and/or inclined orbits) are investigated.

Fixed accelerometer and variable ISL performance (see left image):
ISL dominates the retrieval error and exceeds the monthly temporal signal when degrading the MWI performance (more than 1).

Fixed ISL and variable accelerometer performance (see right image, MEMS excluded due to bad performance):
For all accelerometer sensors, its noise is not the dominant error source and below the temporal signal.



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