ETH zürich

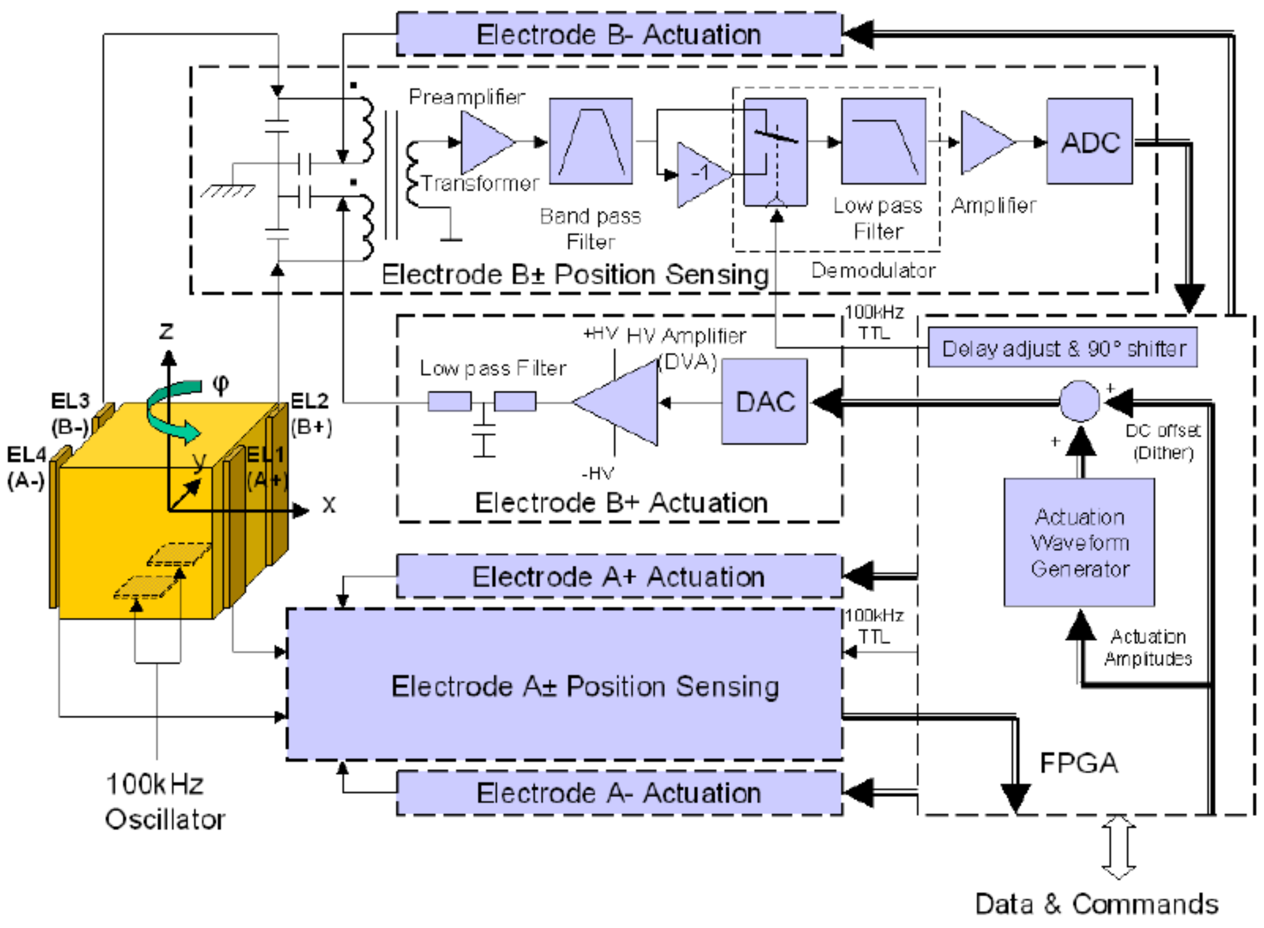
LISA GRS FEE test campaign at ETH Zürich

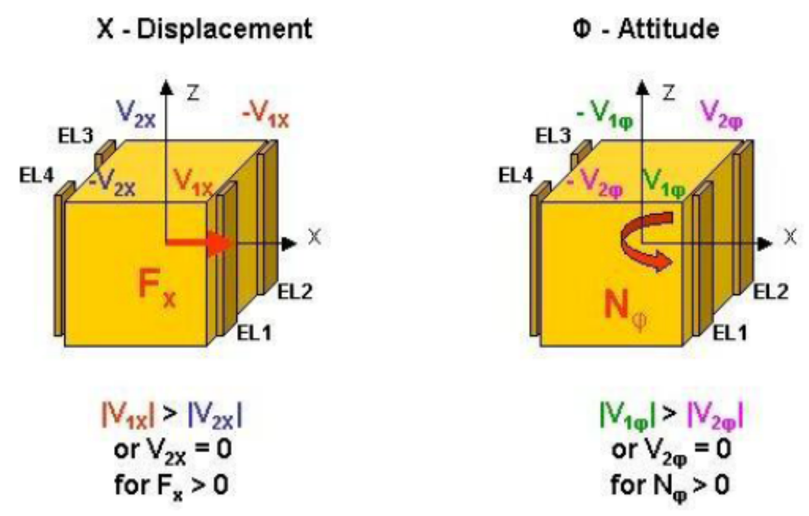
Luigi Ferraioli, Davor Mance, Jan ten Pierick, Jonas Zollinger, Peter Zweifel and Domenico Giardini
Departement Erdwissenschaften, Institute of Geophysics, ETH Zürich

LISA GRS Front End Electronics

The TM is electrostatically suspended between surrounding electrodes and its motion along x or φ causes an imbalance in capacitance, i.e. in currents in primary windings of both transformer bridges (between electrodes A+/- and B+/-). The imbalance in currents reflects in the level and sign of the current flowing in the secondary winding of each transformer. The corresponding preamplifier detects the current and converts it to a voltage.

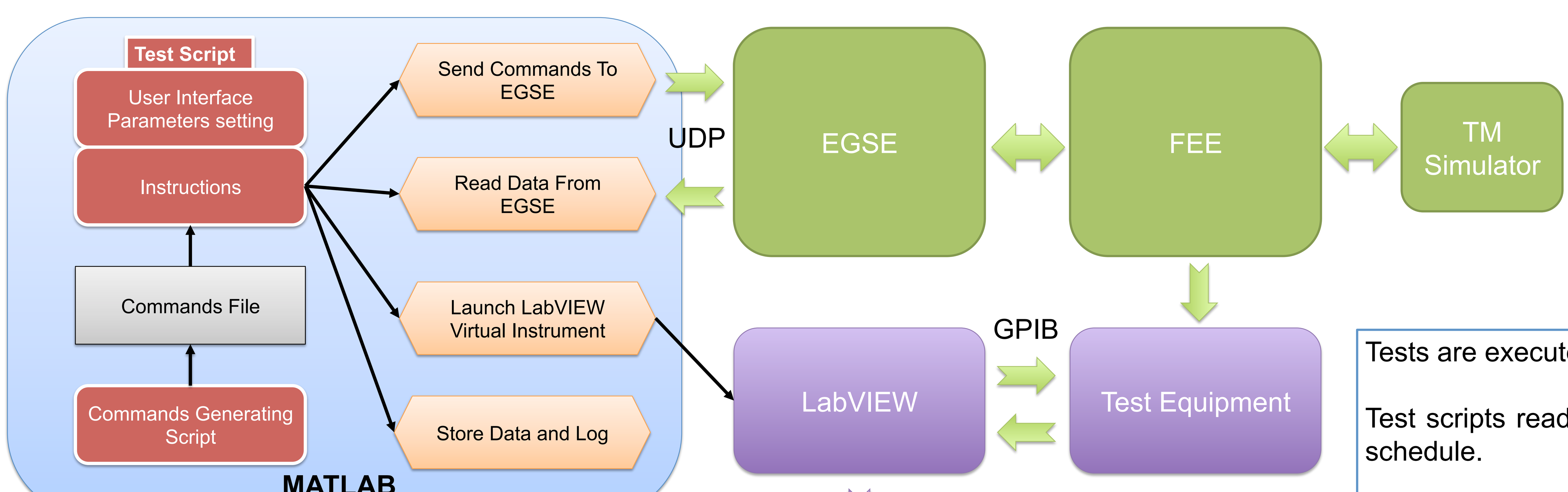
The TM is biased by 100 kHz AC bias via separate injection electrodes. To allow for high sensitivity of capacitive measurement, the transformer with high quality factor Q is operated at resonance matching the injection bias frequency, for which capacitors are added in parallel with primary windings. As the output of the preamplifier is an amplitude-modulated signal with amplitude representing the displacement, the injection bias reference (carrier) signal is also needed for the phase-sensitive detectors in the sensing circuitry chain (the demodulators).

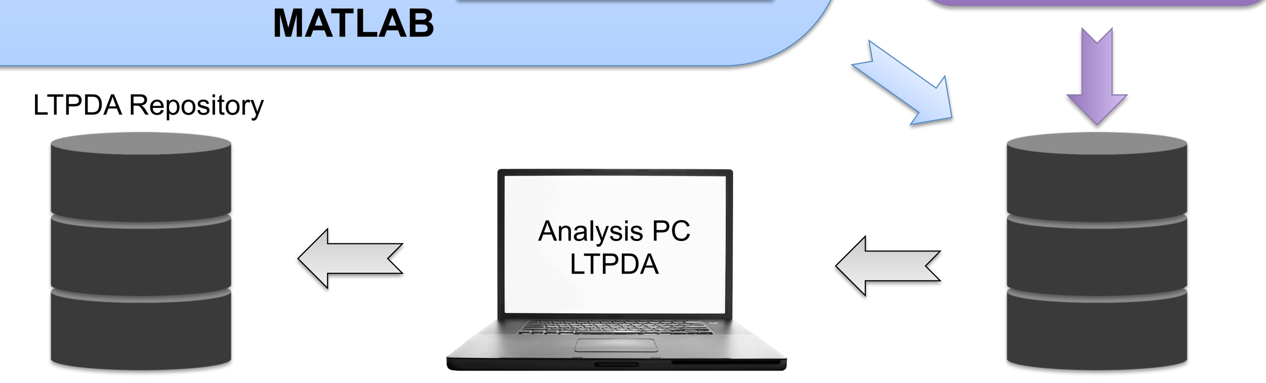




In order to reduce the stray acceleration on TM, the force signal are provided by numerically synthesized AC waveform at low audio frequencies (60 – 270 Hz). To apply strong forces on TM in the Wide Range (WR) Mode, large AC voltages are used. The force signal for each electrode is Digital to Analog converted and amplified by a corresponding Drive Voltage Amplifier. The actuation signals are further low-pass filtered to reject higher frequencies that could interfere with the sensing circuitry.

LISA GRS FEE Test Campaign – Test Setup





Tests of sensing performances require a Test Mass Simulator. Sensing data are acquired by the FEE sensing electronics and sent to the controlling PC by the EGSE via the UDP interface.

Tests of actuation performances do not require TM simulator. Actuation signals are read by test equipment (e.g. Digital Multimeter, Lock-In Amplifier) that is controlled by LabVIEW.

Raw data are converted to Analysis Objects and analyzed with LTPDA.

Raw data and analysis products are finally stored in the local LTPDA repository.

Tests are executed by MATLAB Test Scripts.

Test scripts read ASCII files with the instructions for the EGSE and the test schedule.

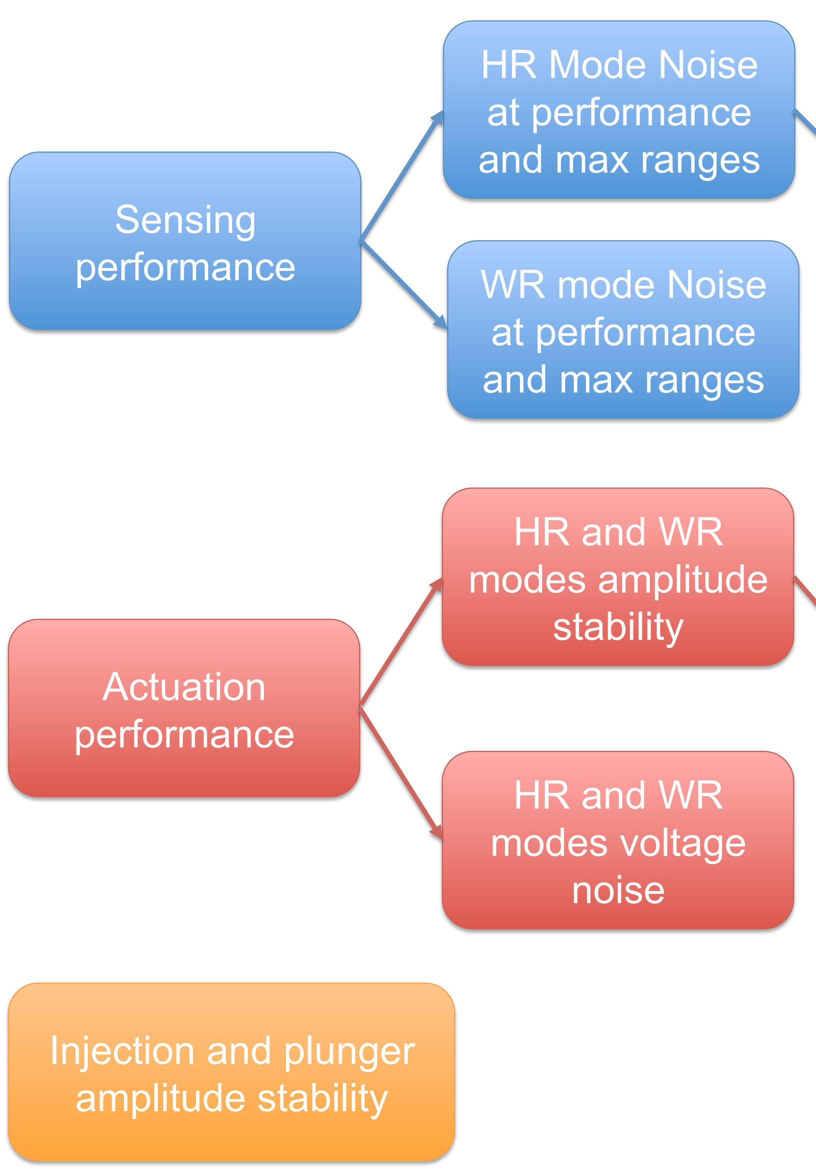
Test scripts are standardized and require only minimal user customization.

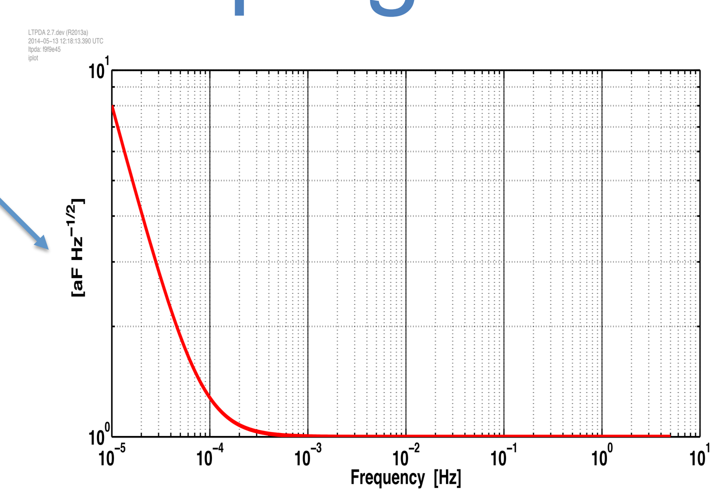
EGSE is controlled via the UDP interface provided by the Instrument Control Toolbox.

LabVIEW VIs are launched as background jobs.

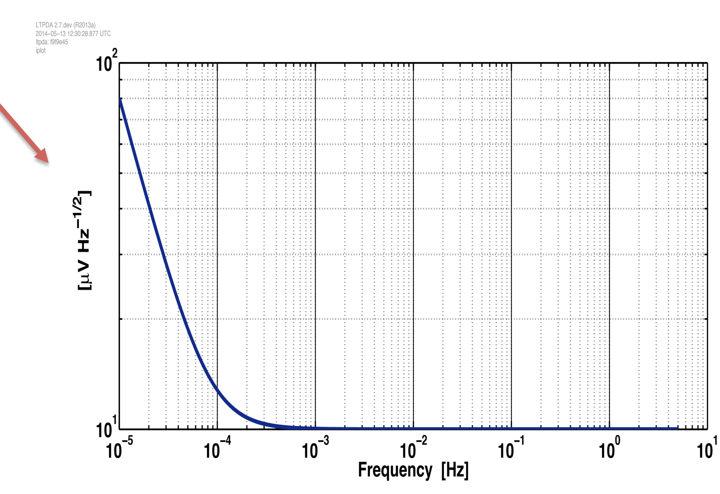
Data from EGSE and LabVIEW are stored in ASCII files.

LISA GRS FEE Test Campaign



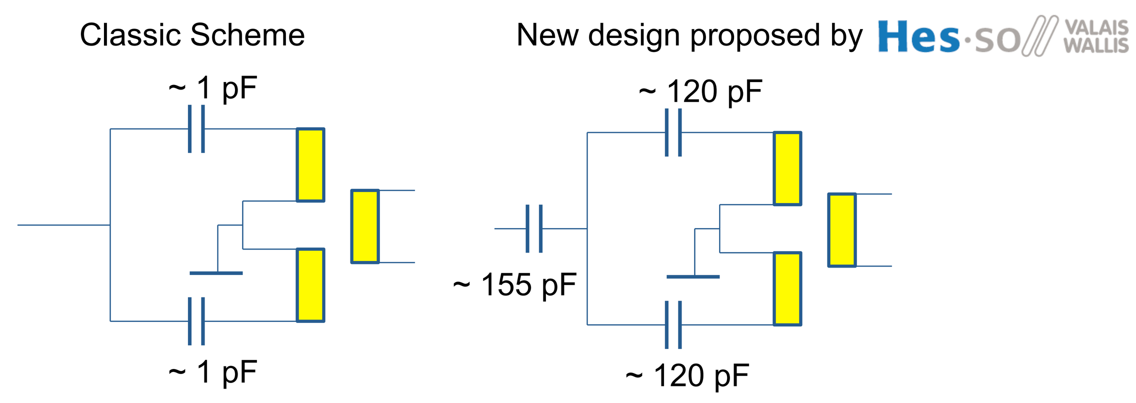


HR Mode Sensing Noise Requirement @ performance range



HR Mode Actuation Amplitude Stability Requirement

Test Mass Simulator

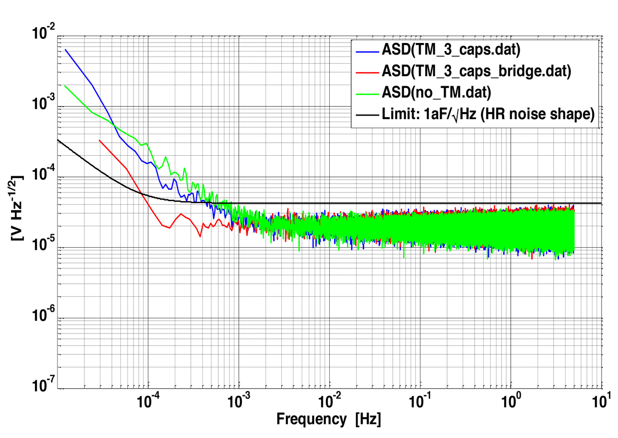


Instead of dual 1 pF capacitor simulator a triple capacitor design is implemented using large capacitors

The nominal current trough the transformer is maintained and the resonance tuning capacitance is adapted to maintain the total required capacitance

The parasitic capacitances now have negligible effect on large simulator capacitors since their value is ~ 100 times larger than old design

Variation between the capacitors have ~ 100 times smaller effect on the noise



Preliminary results with a prototype

Luigi Ferraioli et. al., 10th International LISA Symposium, University of Florida, Gainesville, Florida USA, May 18 - May 23, 2014
Email: luigi.ferraioli@erdw.ethz.ch