EIB-SAS ground connected mode

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1 Description

The external injection bench seismic attenuation system (EIB-SAS) locking system, or 'ground connected mode', has been designed to fix the bench in a static position to allow for working on the EIB and the pre-alignment of the optics. EIB-SAS will be installed in such a way that the working point of the (attenuated) EIB will coincide with its ground connected position. Like any seismic attenuation system the ground connected mode is not meant as an alternative to the usual seismic attenuating working configuration.
The ground connection system consists of separate horizontal and vertical stages. The horizontal stage constitutes two vertical screw-pins on the grounded plate underneath the spring-box, that can be screwed up into conical shaped holes in the lower plate of the spring-box. In Fig. 1.1 two photo's show one of the horizontal locks in its locked and unlocked positions. If, in time, the locked horizontal position is no longer the working point of the bench (due to shifting foundations of the central building etc) then it will be possible to move the position of the horizontal locks on the grounded plate by ± 1 mm in the horizontal plane.
Vertically EIB-SAS is locked with four vertical screw pins, one at each corner of the spring-box top plate. They need to be screwed upwards until they just touch the optical bench intermediate plate. Then to secure the bench onto the locks a weight of roughly 1 kg must be placed above each lock. Fig. 1.2 illustrates the locked and unlocked configurations of the vertical locking system. If it is required that the bench be brought to a reproducible, known position, then the screws can be adjusted until the correct LVDT values are obtained.

2 Ground connected performance

2.1 Translational motion projection

To anticipate the bench top motion of the ground connected EIB-SAS at the Virgo site, the measured transfer functions of the ground connected EIB-SAS can be multiplied by the expected seismic motion of the central building. These are shown for the vertical (y) and horizontal (z, ITF beam direction) motion in Fig. 2.1. The vertical seismic motion has also been plotted and shows that the ground connected EIB-SAS is (vertically) stiff below 4 Hz, its motion here determined by the seismic motion. The RMS displacement values do not exceed 2 μm and are dominated by the micro seismic peak at 0.4 Hz.
To make a comparison with the initial Virgo EIB the square root of the quadrature sum of the three translational degrees of freedom are calculated. This 'total' displacement is plotted together with the total displacement of the initial Virgo EIB in Fig. 2.2.

(a) (b)

Figure 1.1: a) Unlocked horizontal lock. b) Locked horizontal lock

(a) (b)

Figure 1.2: a) Unlocked vertical lock. b) locked vertical lock. A weight of roughly 1 kg has also been placed on top of the bench above the locks at each corner.

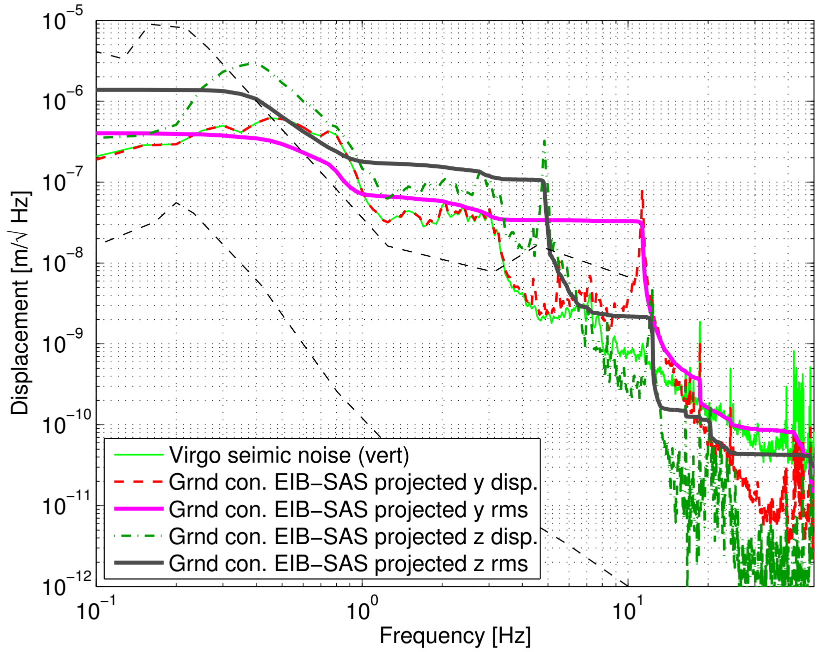

Figure 2.1: Projected translational motion of the locked EIB-SAS by using measured transfer functions and seismic motion of the central building. The vertical seismic motion is included as the dashed light green curve. The dashed red and dark green curves are the projected locked EIB-SAS displacements in the vertical and horizontal direction respectively. The solid magenta and dark grey curves indicate the respective integrated RMS values. The thin black dashed curves are the Peterson high and low noise models indicating generally high and low seismic background noise levels respectively.

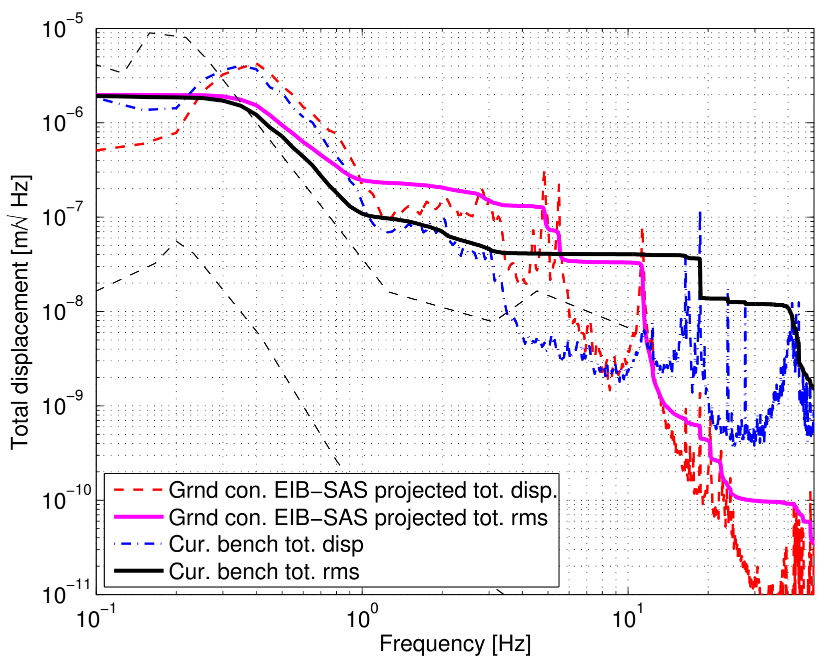

Figure 2.2: Total displacement of the projected EIB-SAS motion and measured motion of the current EIB. The solid magenta and black curves are the corresponding RMS displacements. The low frequency RMS is dominated by the microseismic peak around 0.4 Hz. The thin black dashed curves indicate the Peterson high and low noise models.

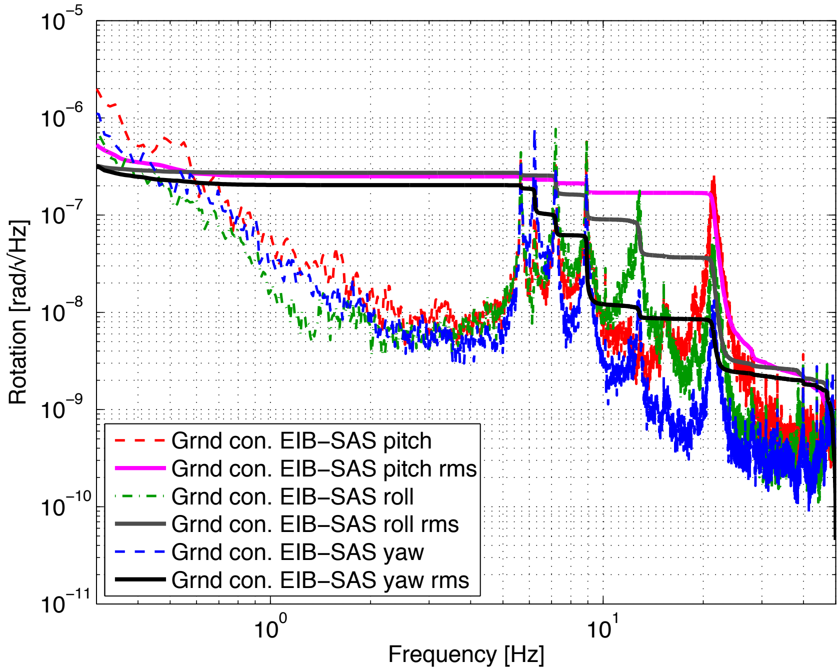

Figure 2.3: Rotational spectra and corresponding RMS values for the angular degrees of freedom of the locked EIB-SAS at Nikhef. Data were taken during high seismic activity.

2.2 Measured angular motion at Nikhef

It is not possible to create a projection of the rotational motion of the ground connected EIB-SAS because the rotational transfer functions are unknown. However because the seismic noise displacement at Nikhef is generally of the same order as that at Virgo (this is true up to 10 Hz, above 10 Hz the Nikhef seismicity is larger than that of Virgo) it is possible to provide an indication of the ground connected EIB-SAS performance in the angular degrees of freedom. The measured pitch, roll and yaw motion of EIB-SAS at Nikhef during high seismic activity is shown in Fig. 2.3.

3 Discussion

A comparison has been made between the translational motion of the ground connected EIB-SAS and the initial Virgo EIB. The motion of both benches are comparable up to the first resonance modes of the ground connected EIB-SAS around a few Hz. The RMS values here do not exceed 2 μm and are dominated by the micro seismic peak. Above 10 Hz the ground connected EIB-SAS improves on the initial bench. A 40 dB improvement of RMS motion is evident above 20 Hz.
The angular motion measured at Nikhef gives an indication of what could be expected at Virgo. Once again the low frequency ground connected EIB-SAS motion is expected to be dominated by the microseismic peak and of a similar value as the current bench. At frequencies above 1 Hz the motion is dominated by the resonant modes of the locked structure resulting in RMS angular displacements of around 0.3 μrad.