FUTURE CIRCULAR COLLIDER

Arc Half-Cell Mock-Up Meeting #7

Status on vibration and dynamic stability studies

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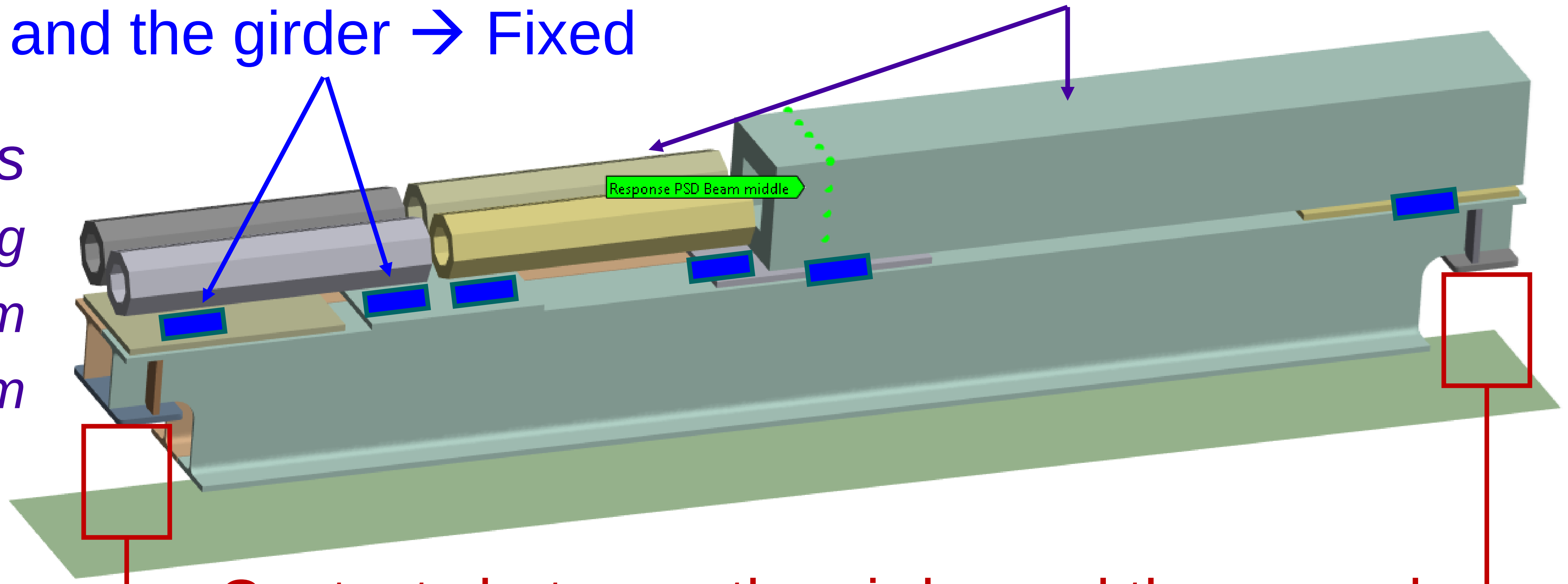
Thursday 11th May 2023

1. Girder stability – methodology

Magnets modeled by beams

Contacts between magnets and the girder → Fixed

Sextupoles
Mass = 500kg
Envelop = Ø300mm
Length = 1400mm



Quadrupole:
Mass = 5300kg
Envelop = 500x500mm
Length = 3500mm

Contacts between the girder and the ground
→ Springs with stiffness equivalent to jacks

Assumptions:

→ *Beams model magnets of equivalent mass → J. Bauche*

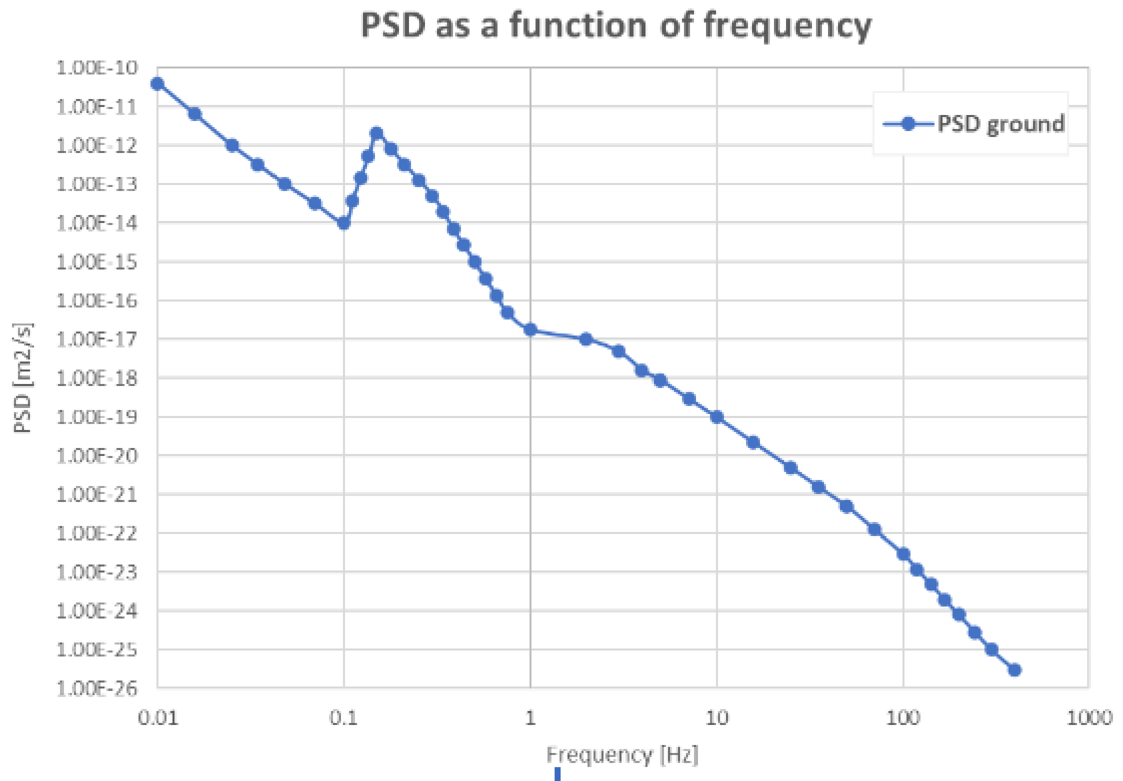
→ *Connection between girder and magnets → Alignment strategy to be defined (shimming) (H. Mainaud Durand)*

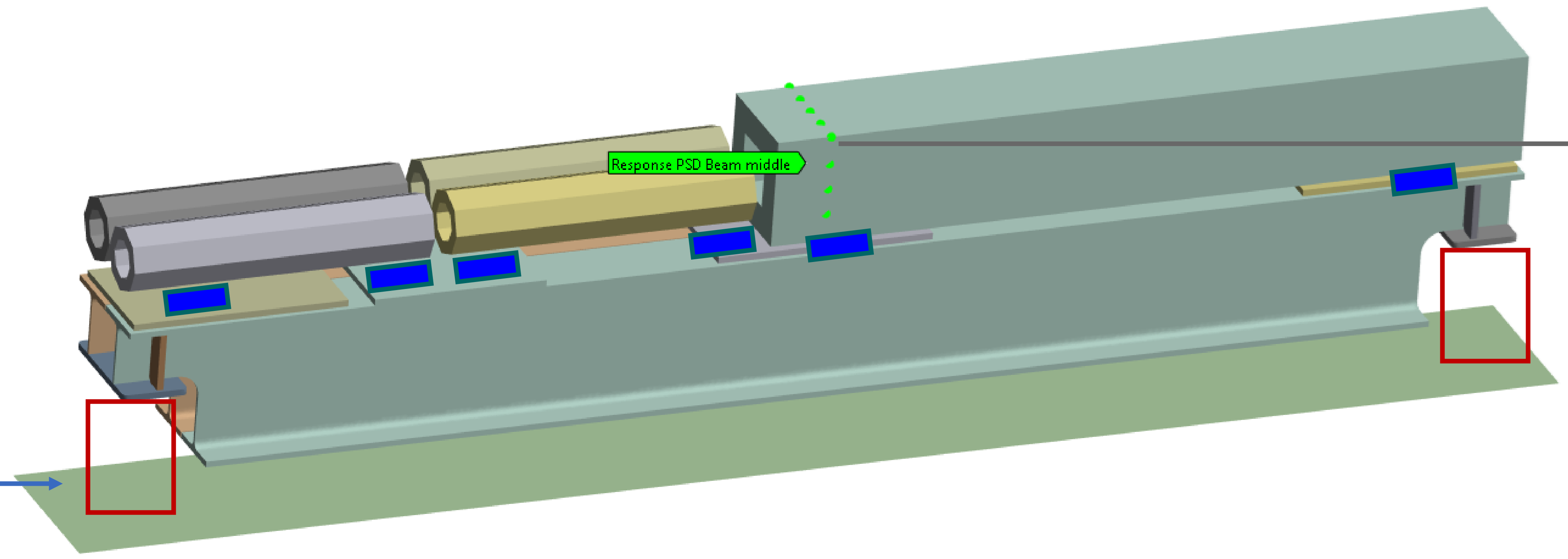
→ *Value of the stiffness of the jacks → M. Sozin, M. Noir*

→ *Damping of material = 2% → To be checked with a suitable mock-up*

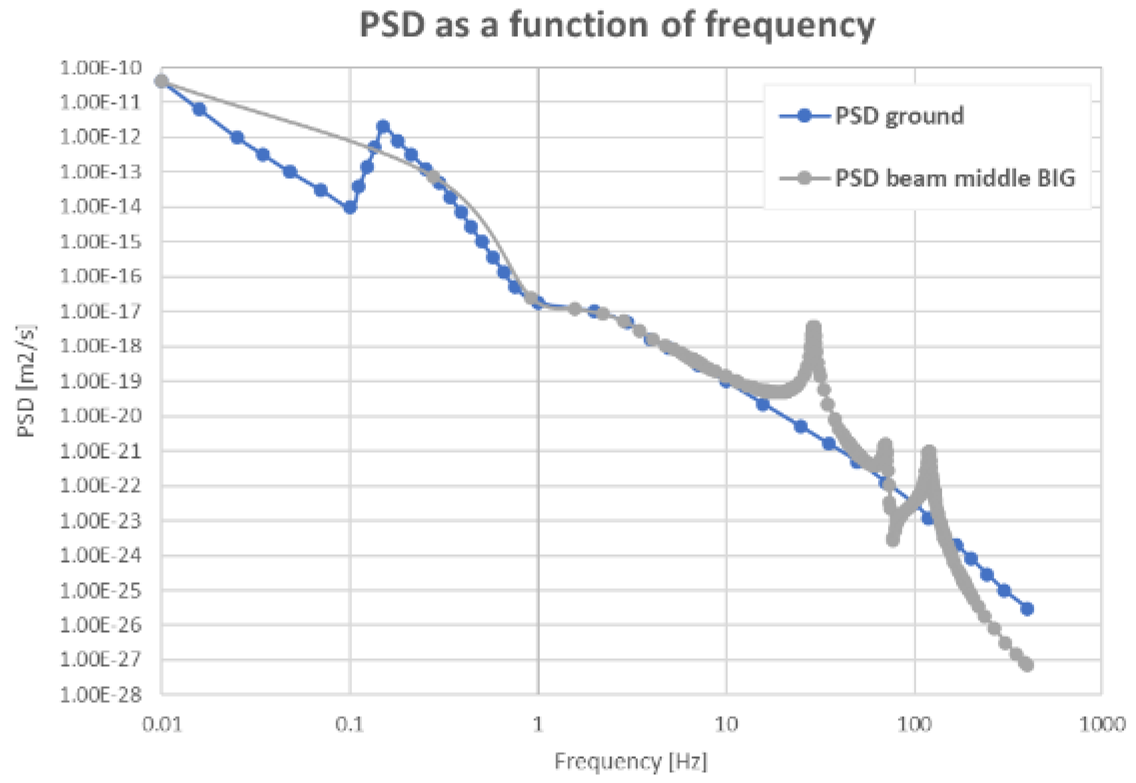
1. Girder stability – methodology

PSD of the ground motion

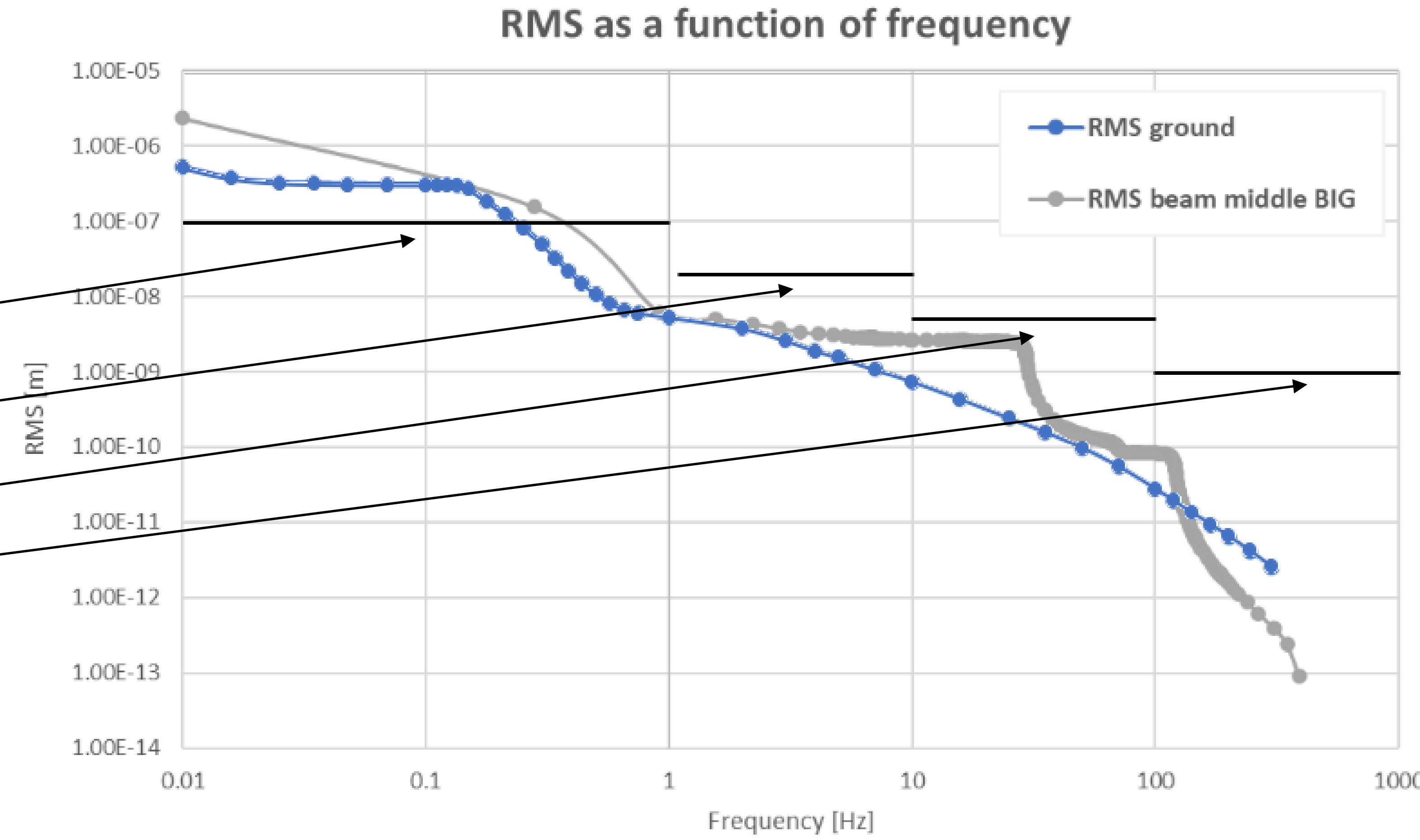




PSD at the level of the beamline



RMS of the ground and the beam



Assumptions:

→ *Beams model magnets*
→ *Connection between girder and magnets*
→ *Value of the stiffness of the jacks*
→ *Damping of material = 2%*
→ *PSD input = envelop of measurement graphs (LHC tunnel measurements)*

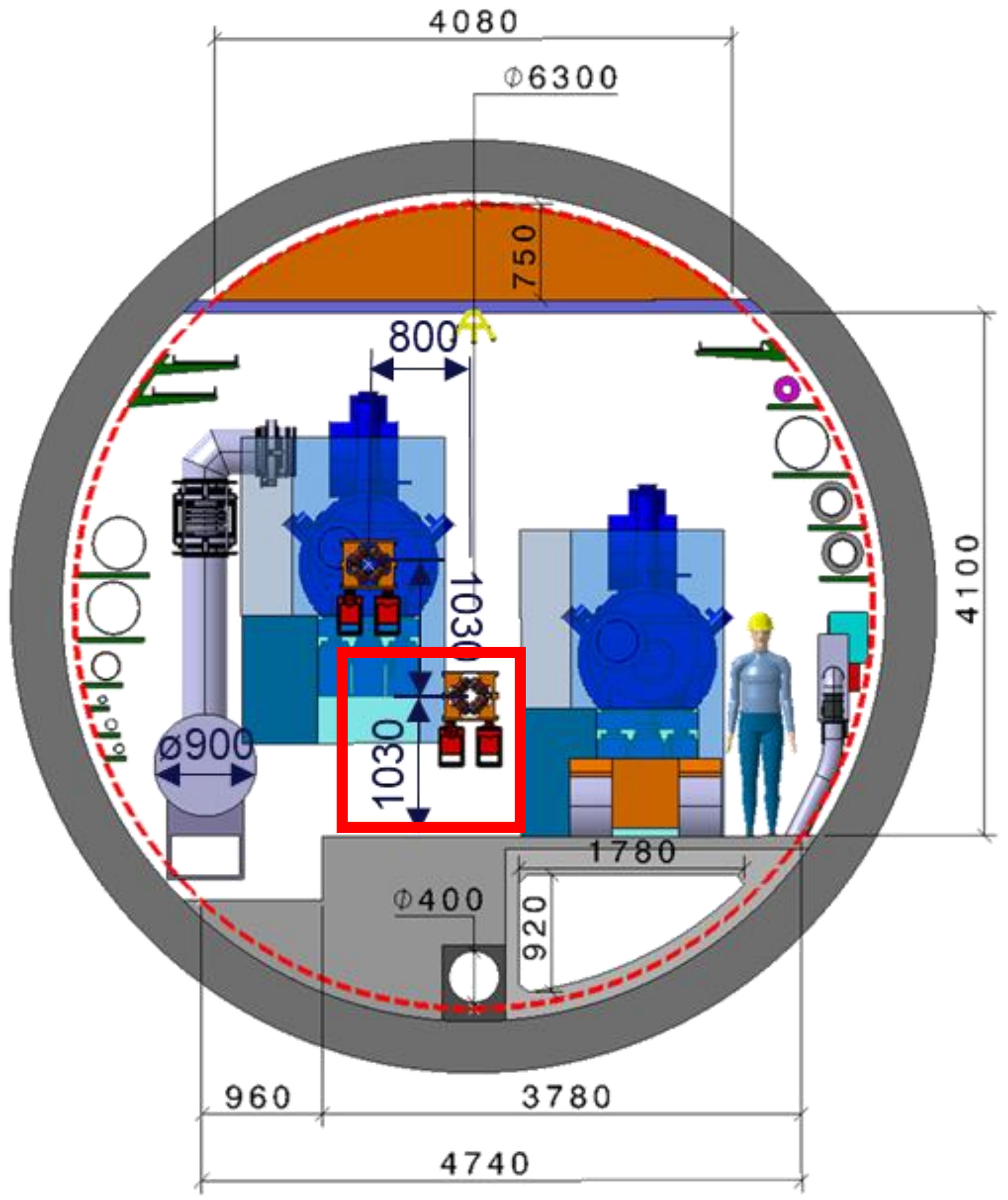
Specifications:

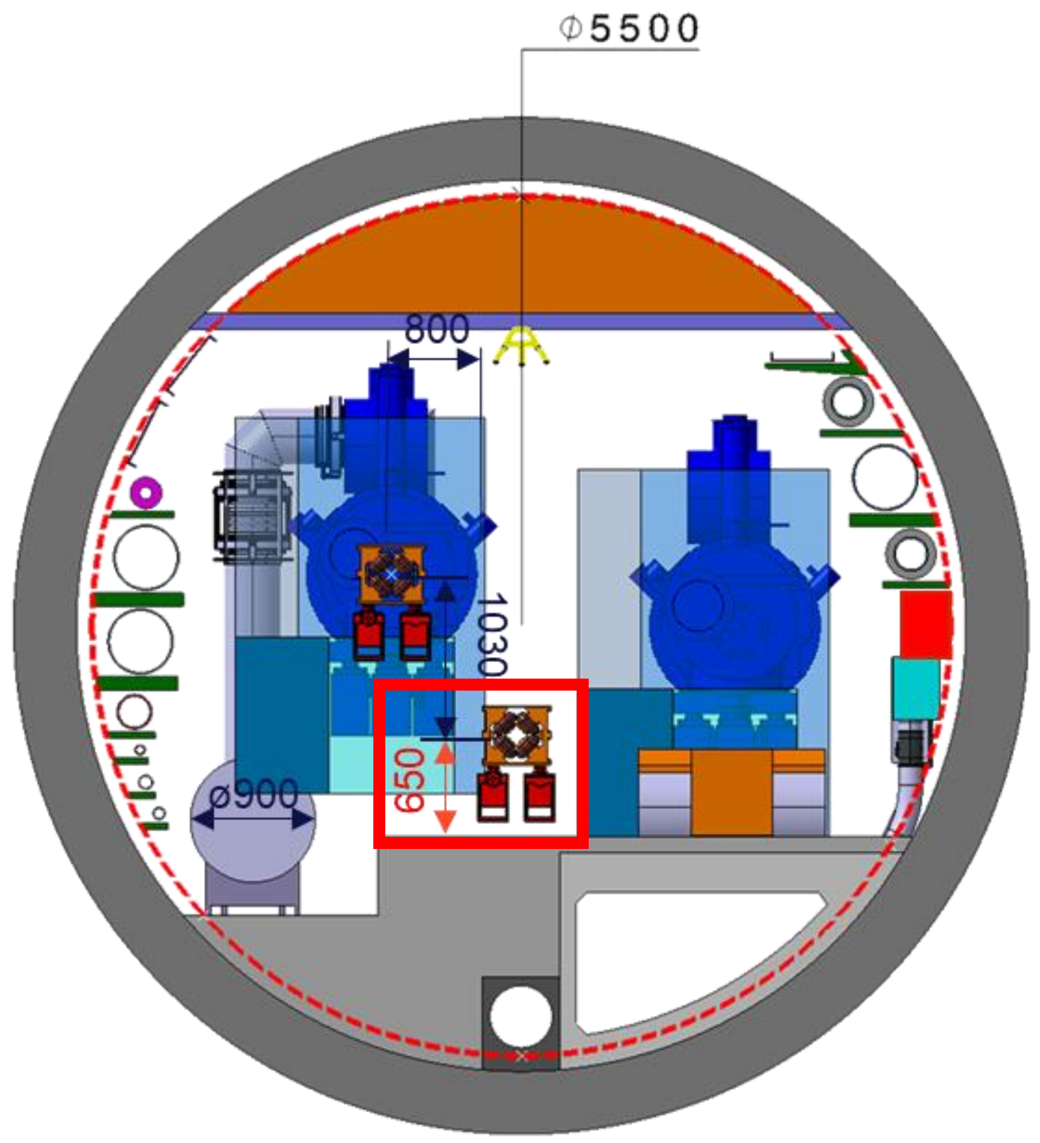
Frequencies	Tolerance
1 > f > 0.01 Hz	100 nm
10 > f > 1 Hz	20 nm
100 > f > 10 Hz	5 nm
f > 100 Hz	1 nm

Given by T. Raubenheimer at FCCIS workshop

PSD = *Power Spectral Density*
RMS = *Root Mean Squared*

1. Girder stability – impact of lowering the beamline





Integration issues at the level of the RF sections

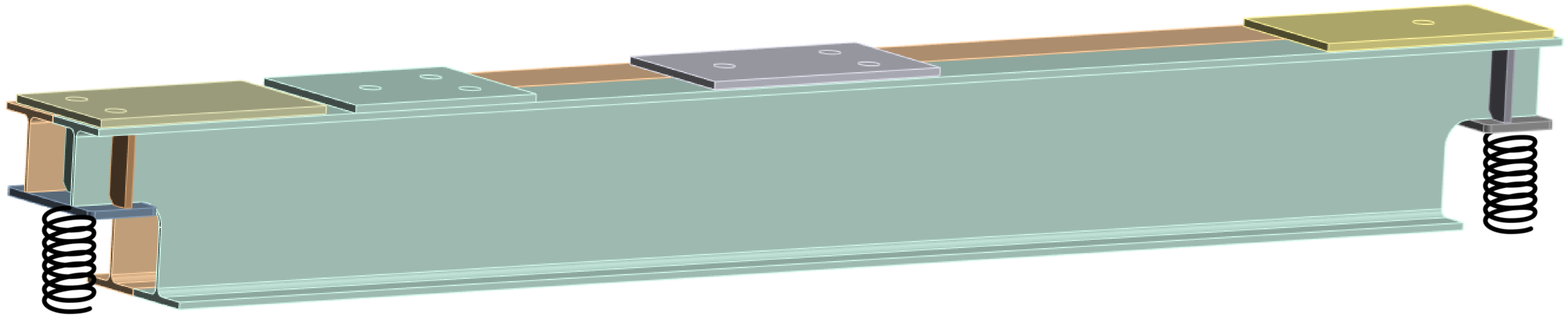
The idea → lower the beamline of the collider from **1030** to **650** mm

What is the impact on the girder supporting the collider?

1. **Geometry of the girder** ✗
2. **Stiffness of the jacks supporting the girder** ✓

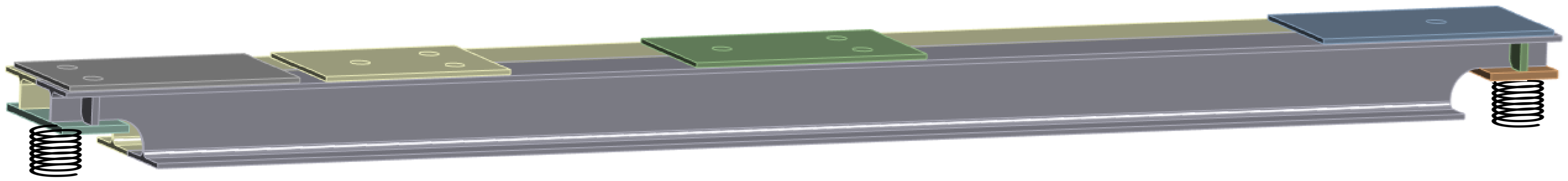
What is the impact on the booster's support?

Collider beamline = 1030mm



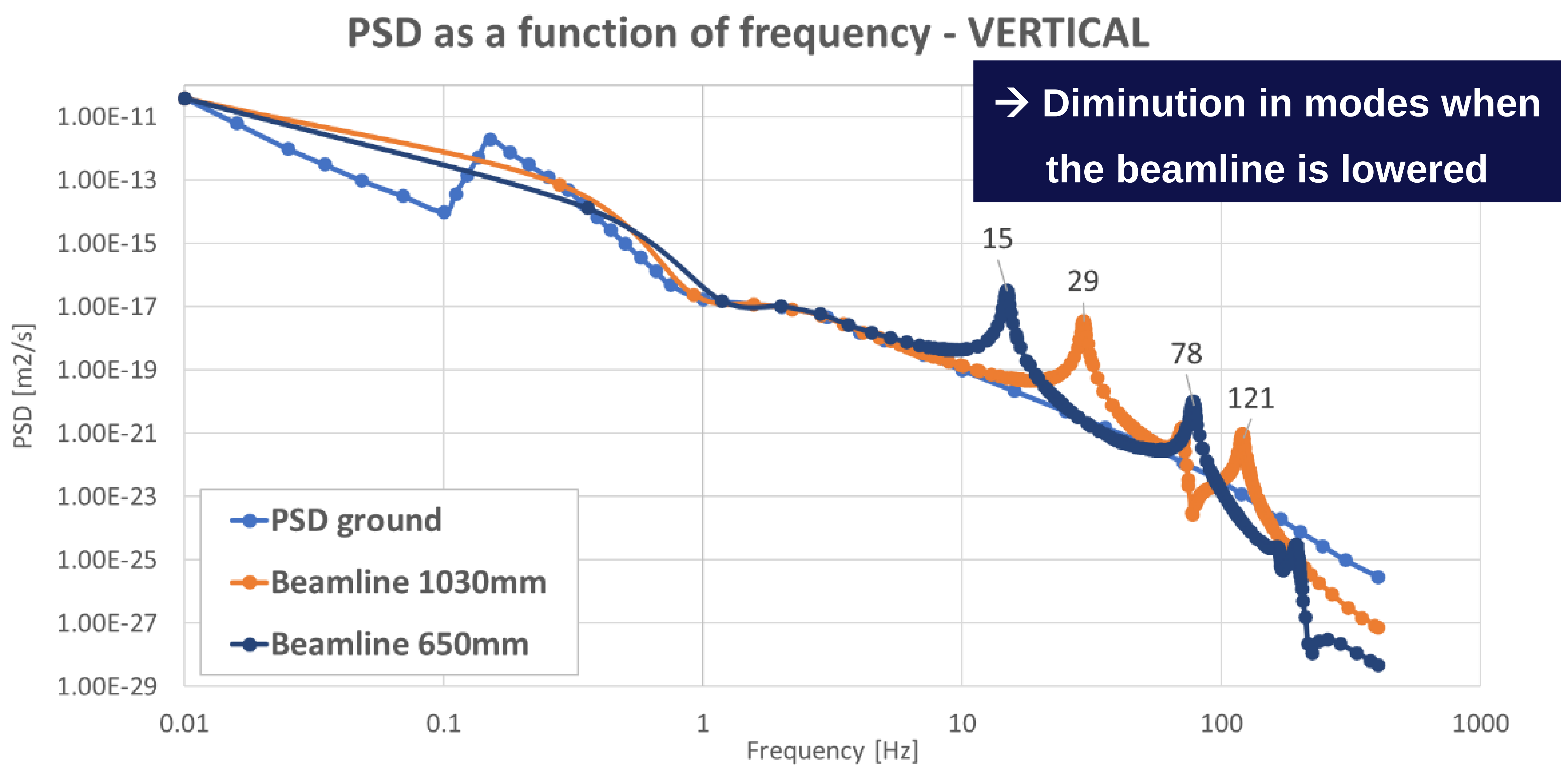
Height of the girder	720mm
Height of jacks	360mm
Stiffness of jacks	800kN/mm *(vert.)* 40kN/mm *(long. and trans.)*

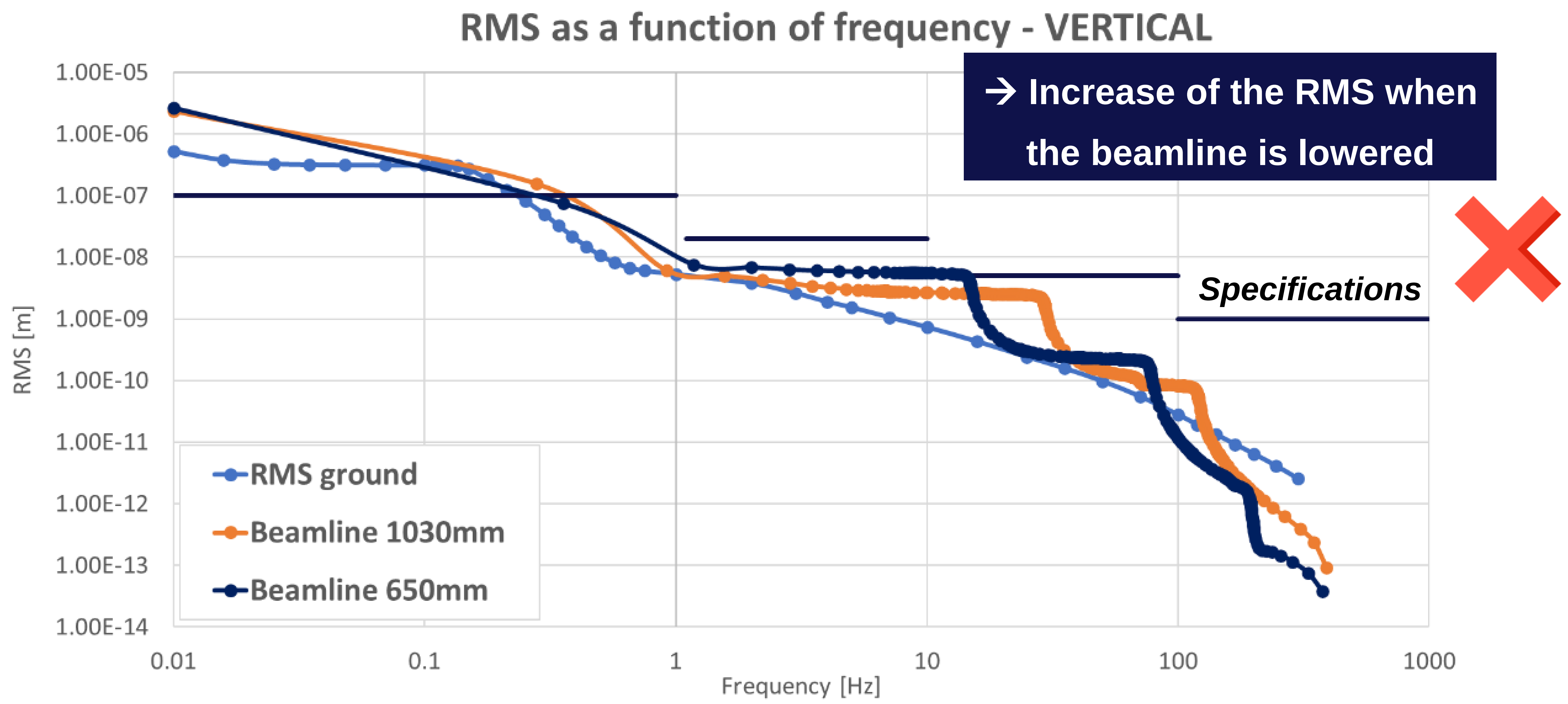
Collider beamline = 650mm

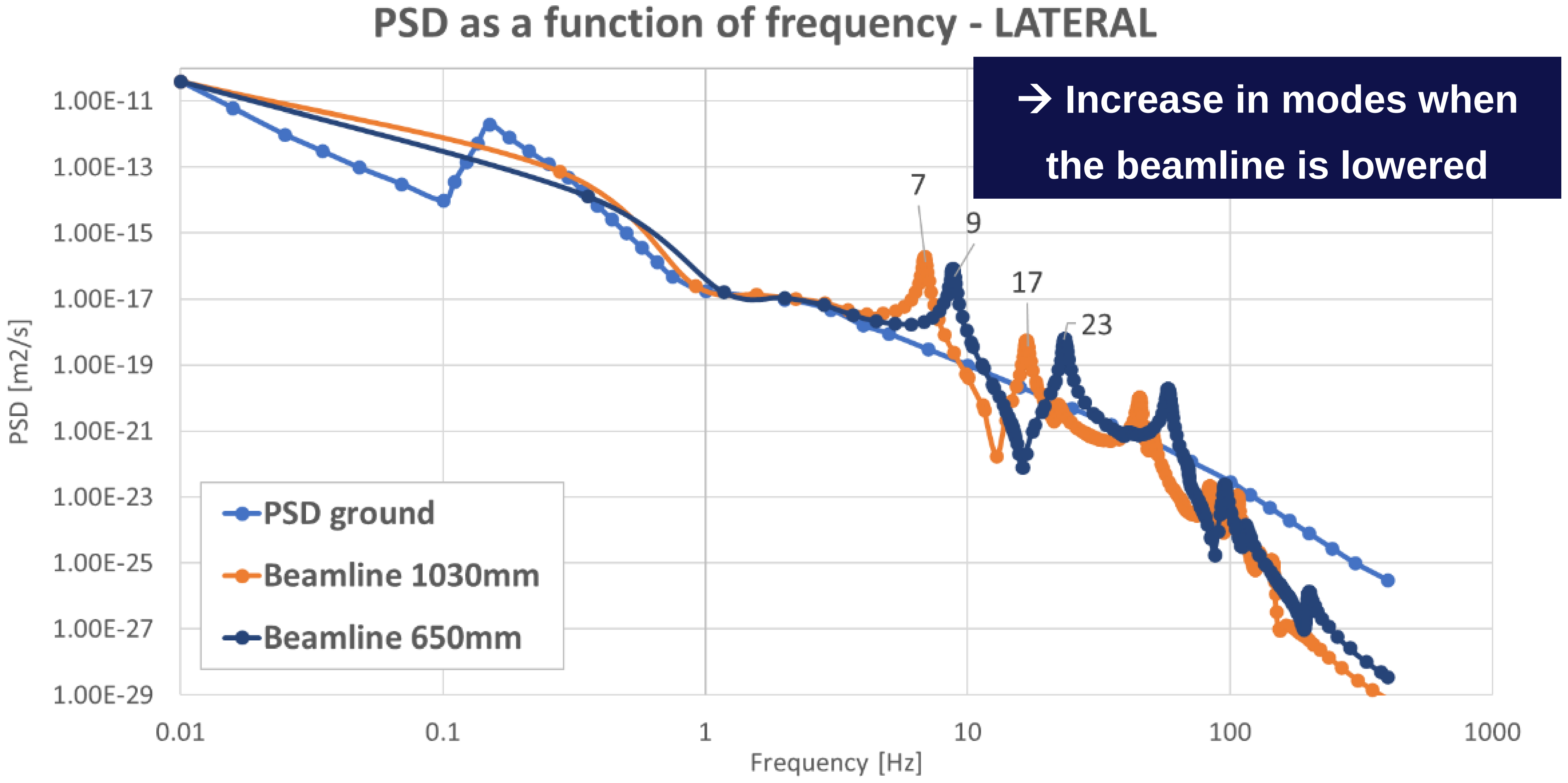


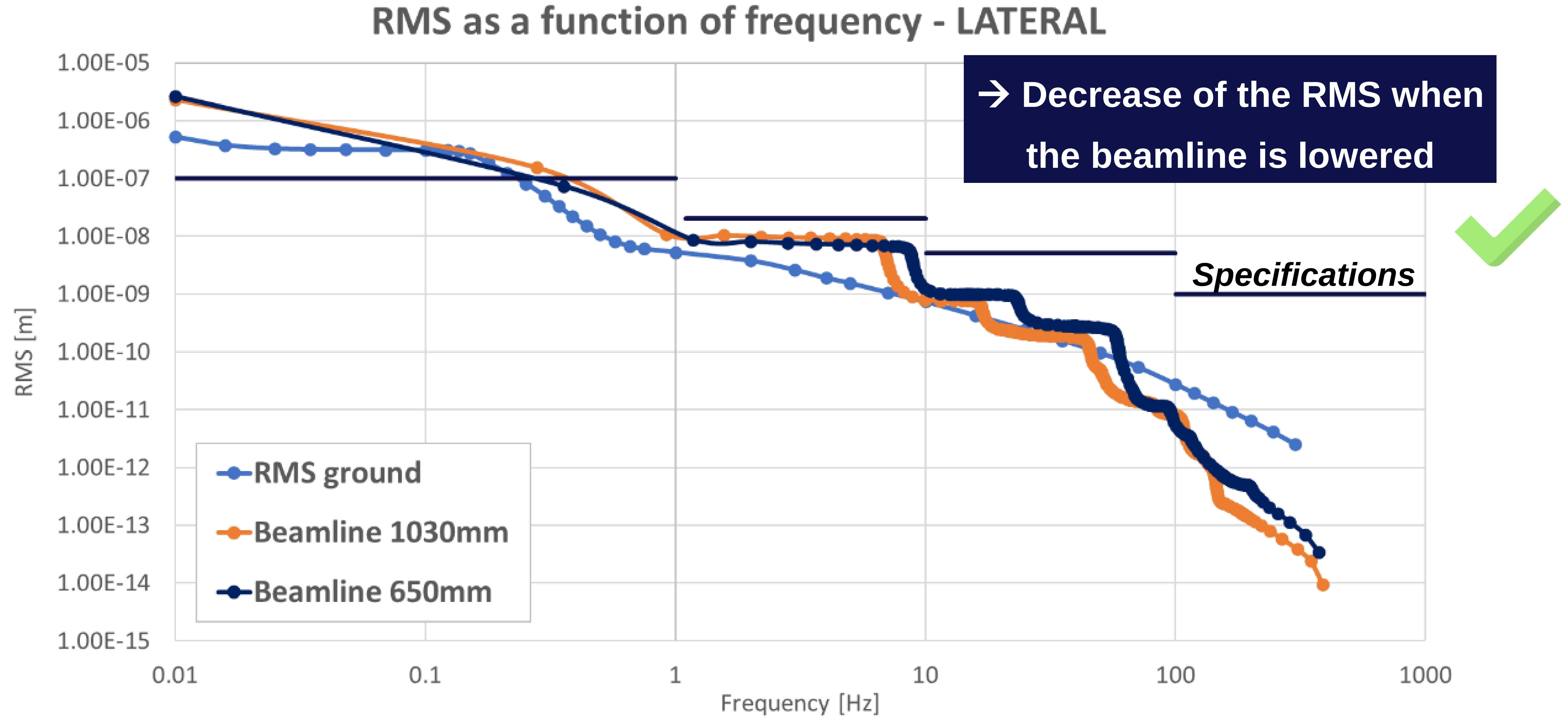
Height of the girder	340mm
Height of jacks	150mm
Stiffness of jacks	1600kN/mm *(vert.)* 320kN/mm *(long. and trans.)*

1. Girder stability – results





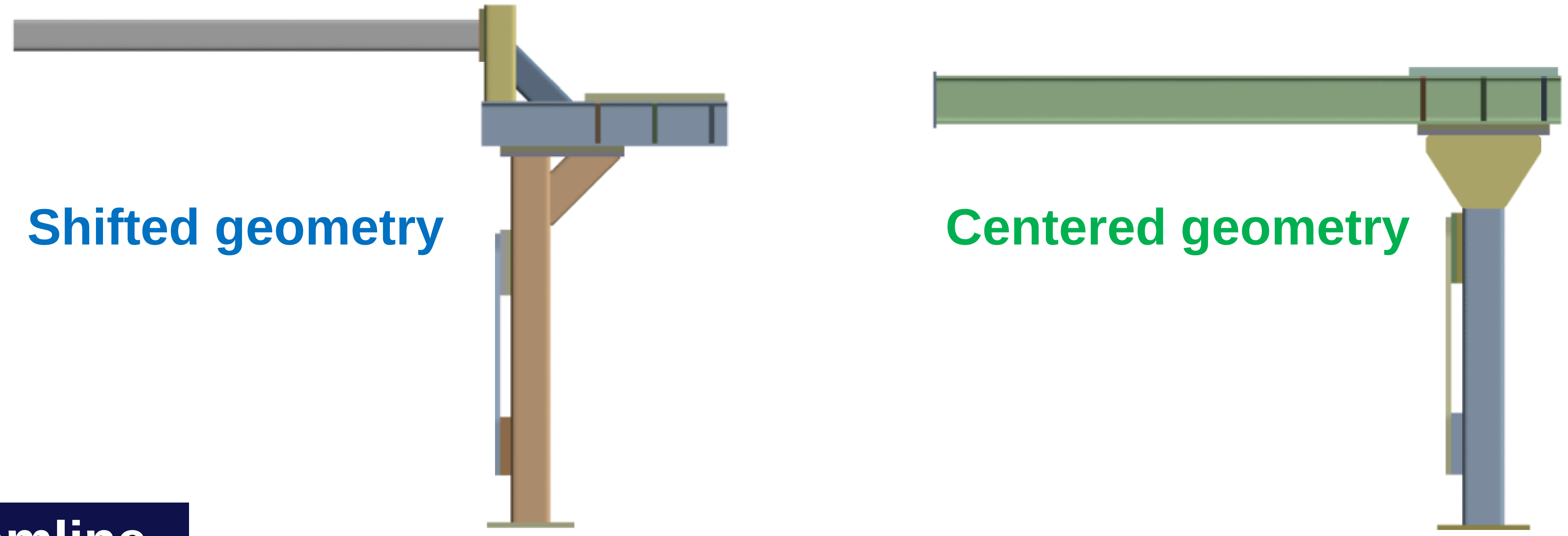




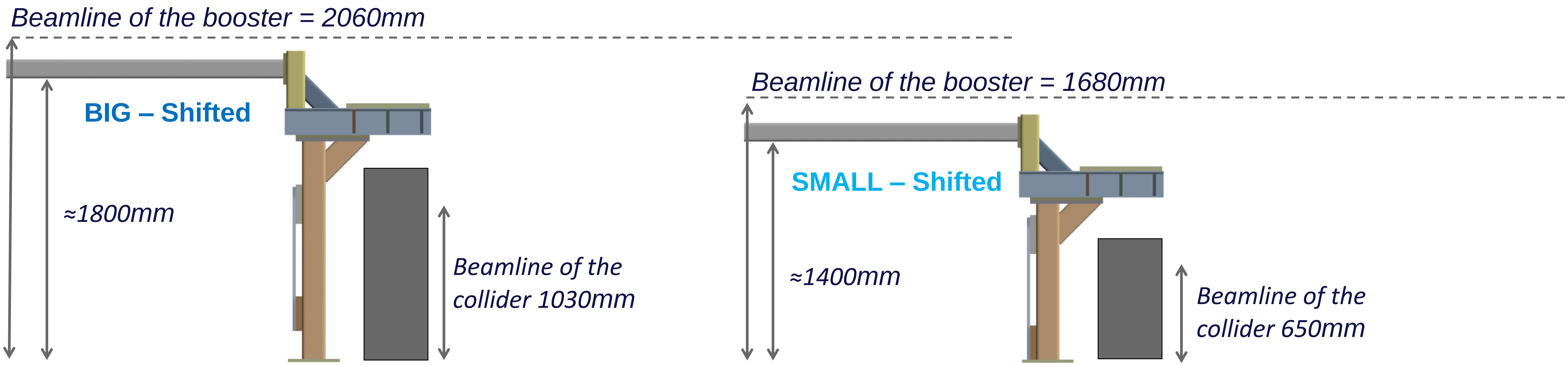
2. Booster support stability – methodology

→ There are two discussions, two points to be determined:

1. Type of geometry



2. Height of the booster beamline



2. Booster support stability – methodology

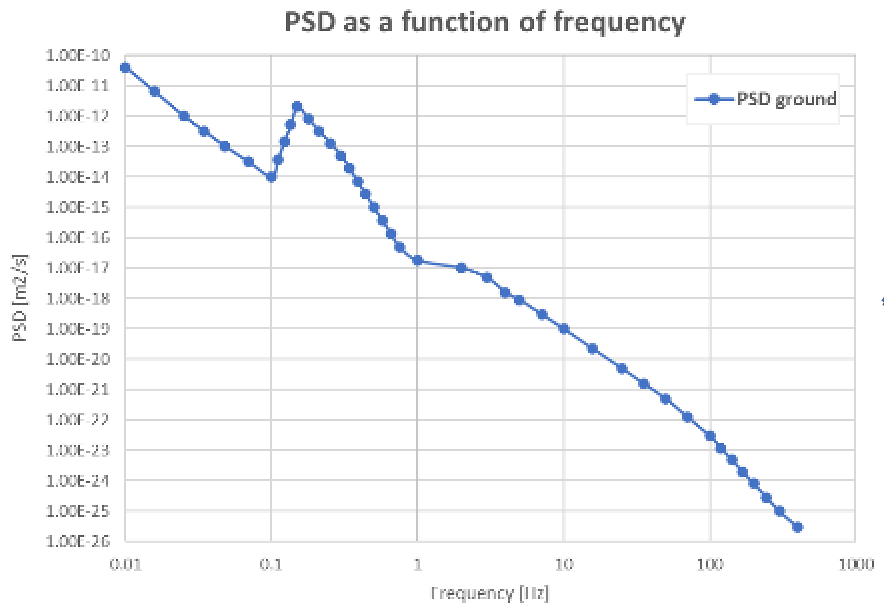
Quadrupole:
Mass = 2000kg
Envelop = 500x500mm
Length = 1500mm

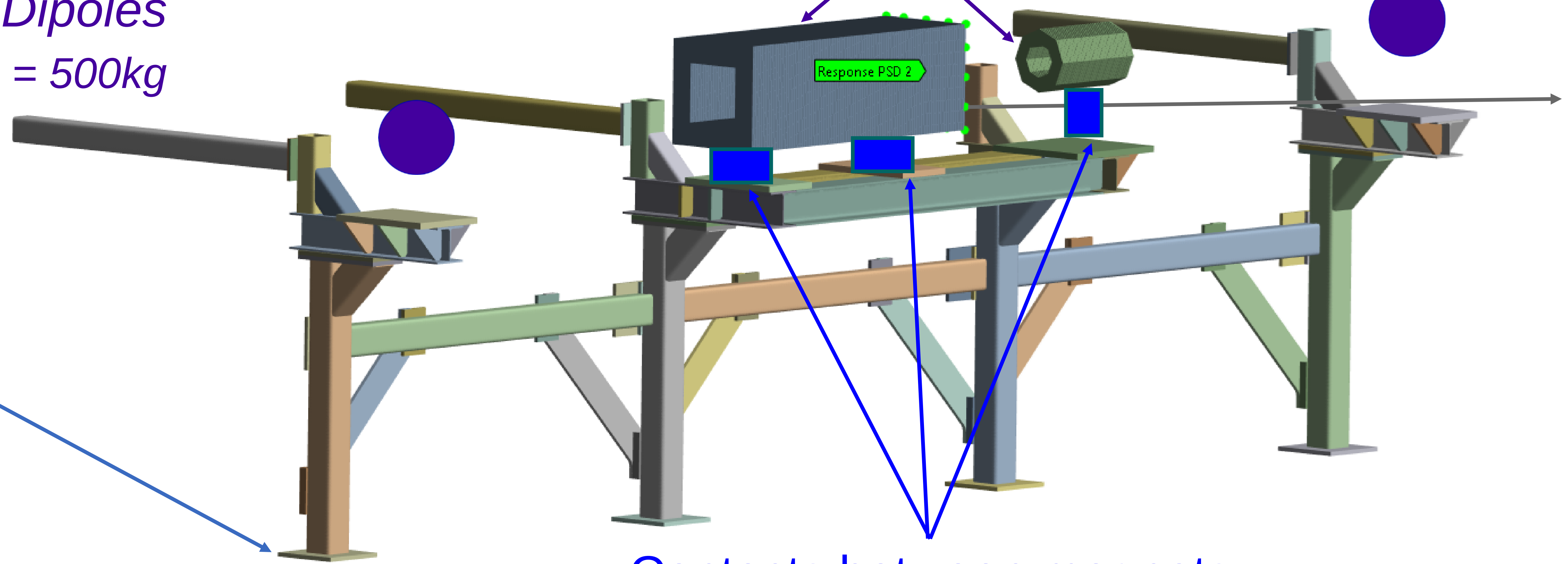
Magnets modeled by beams and point mass

Sextupole
Mass = 200kg
Envelop = Ø300mm
Length = 500mm

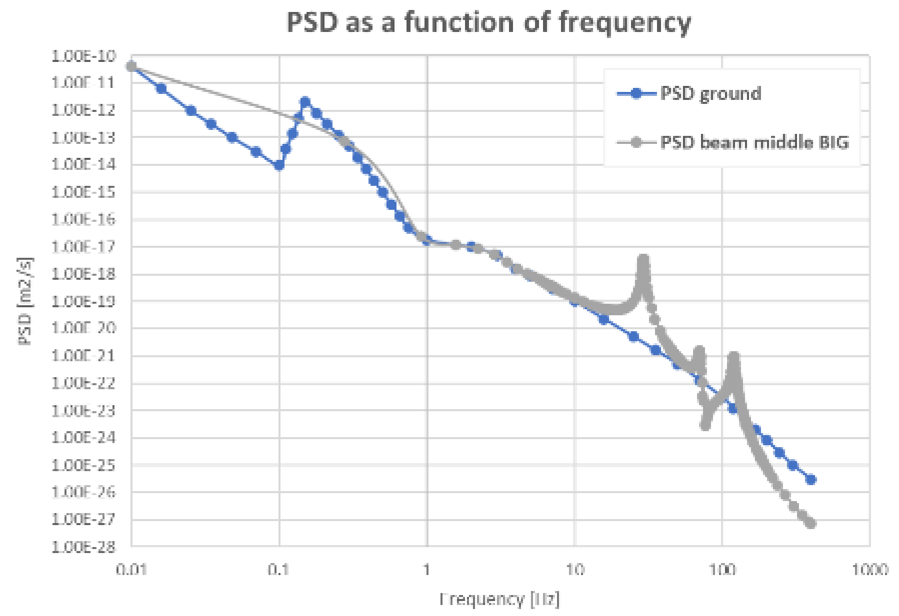
½ Dipoles
Mass = 500kg

PSD of the ground



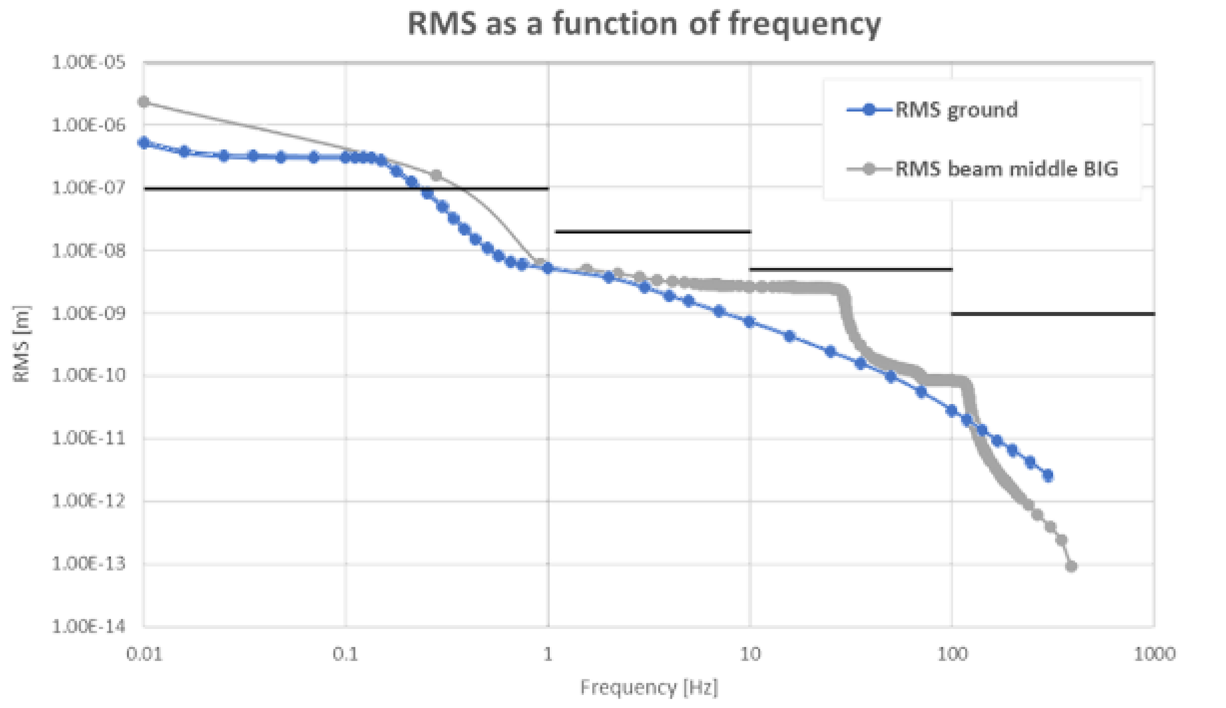


PSD at the level of the beamline



Contacts between magnets and the girder → Fixed

RMS of the ground and the beam

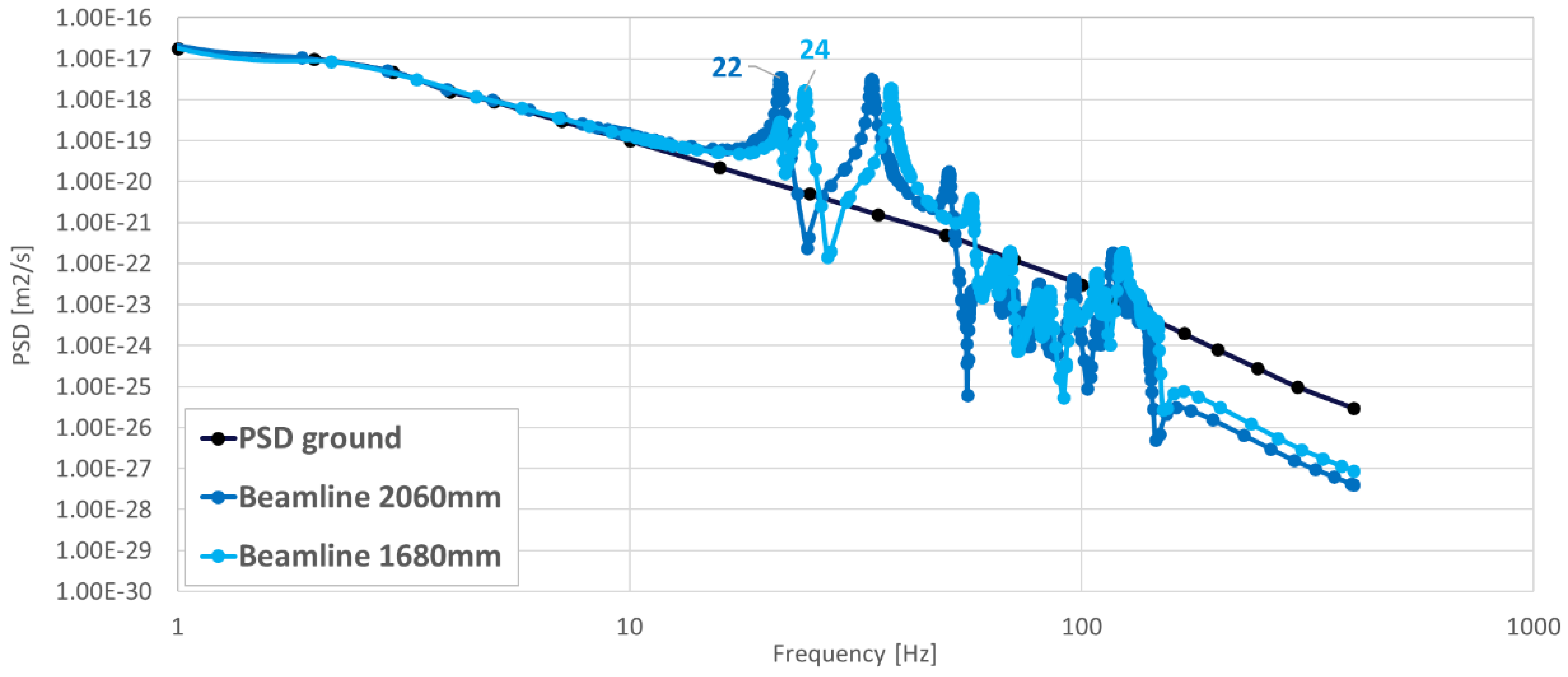


Assumptions:

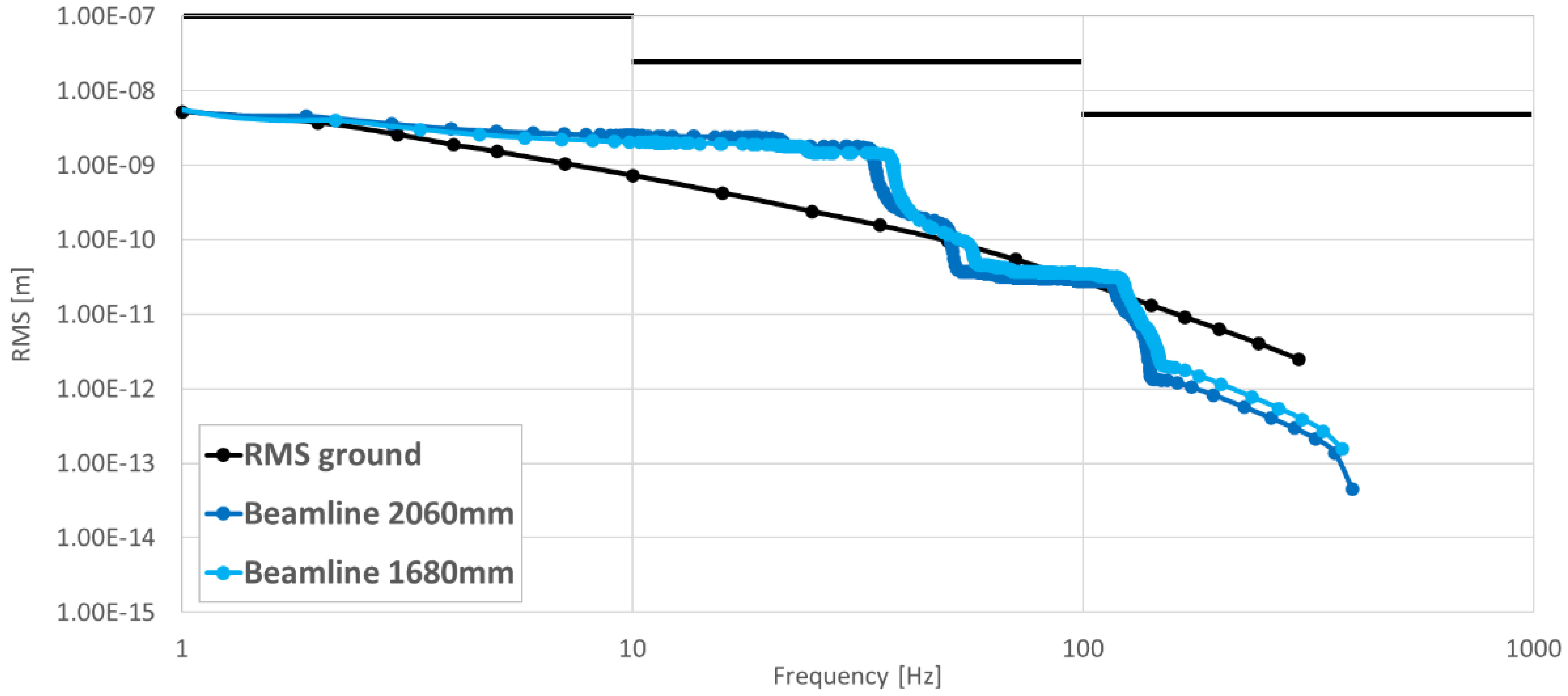
→ Beams model magnets
→ Connection between girder and magnets
→ Damping of material = 1%
→ PSD input = envelop of measurement graphs (LHC tunnel measurements)

2. Booster support stability – results

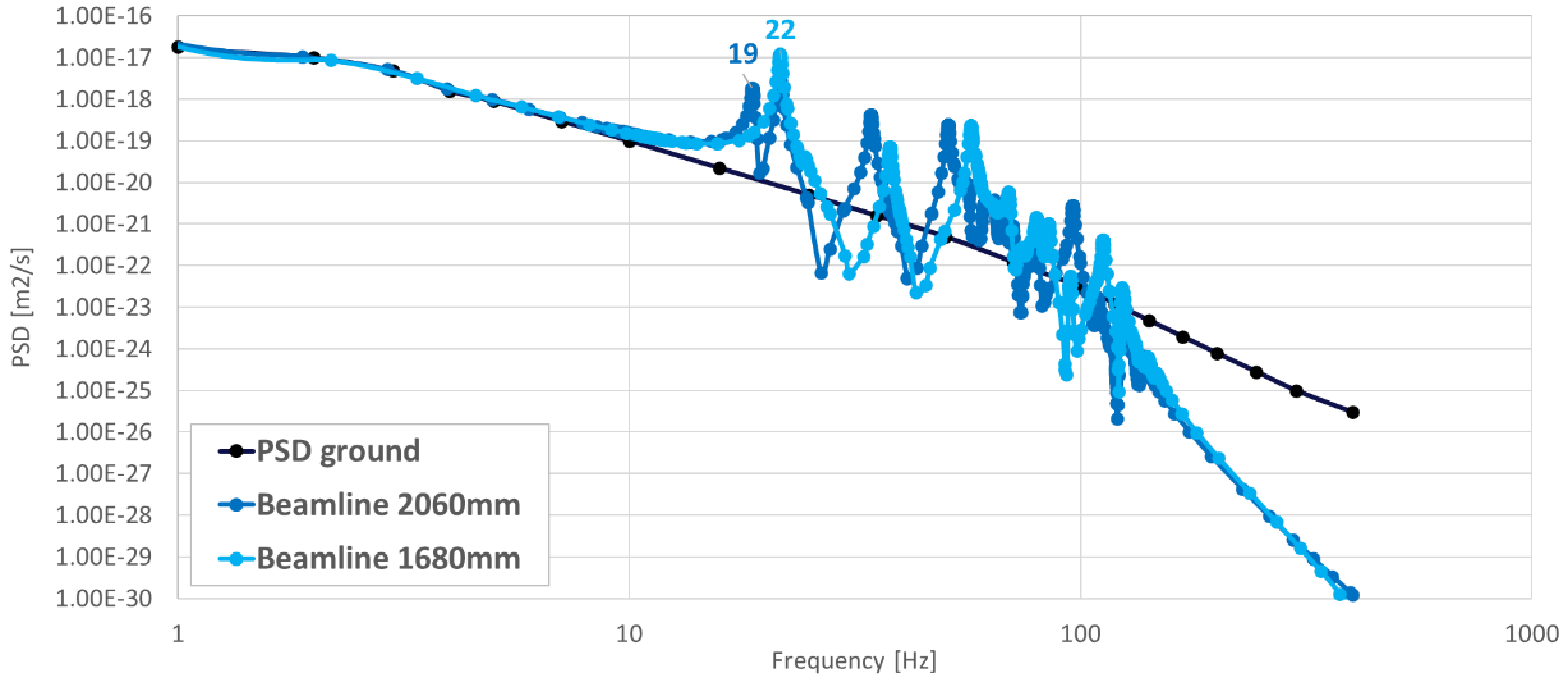
PSD as a function of frequency - VERTICAL



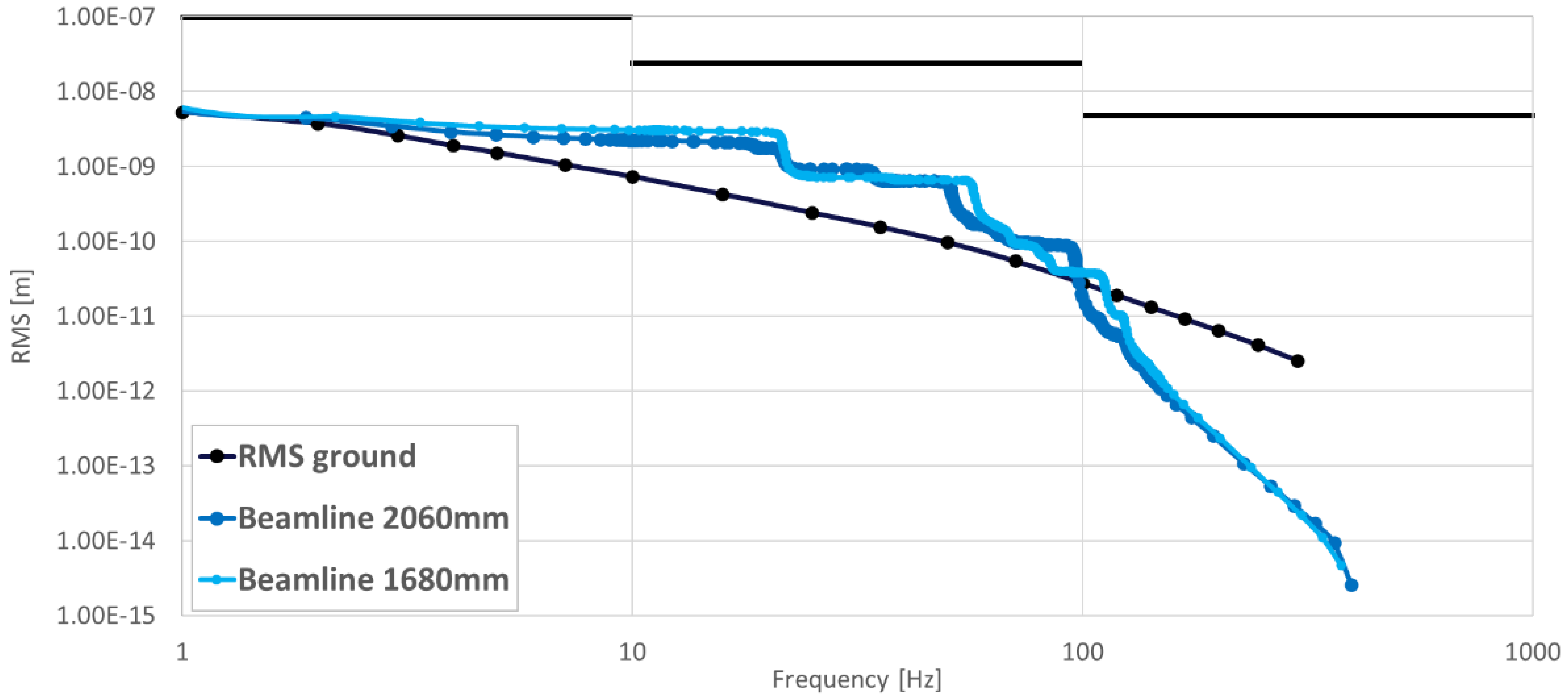
RMS as a function of frequency - VERTICAL



PSD as a function of frequency - LATERAL



RMS as a function of frequency - LATERAL



3. Conclusions

→ The methodology for assessing the dynamic stability of the collider and booster support systems has been established.

↳ *It allows to compute an RMS at the beamline which can be compared to specifications*

→ According to the first results calculated, the **specifications** are in general **met (/!\ many assumptions have been made)**

→ The position of the high and low beamline is manageable in terms of stability

→ BUT these results were obtained by making several **assumptions**

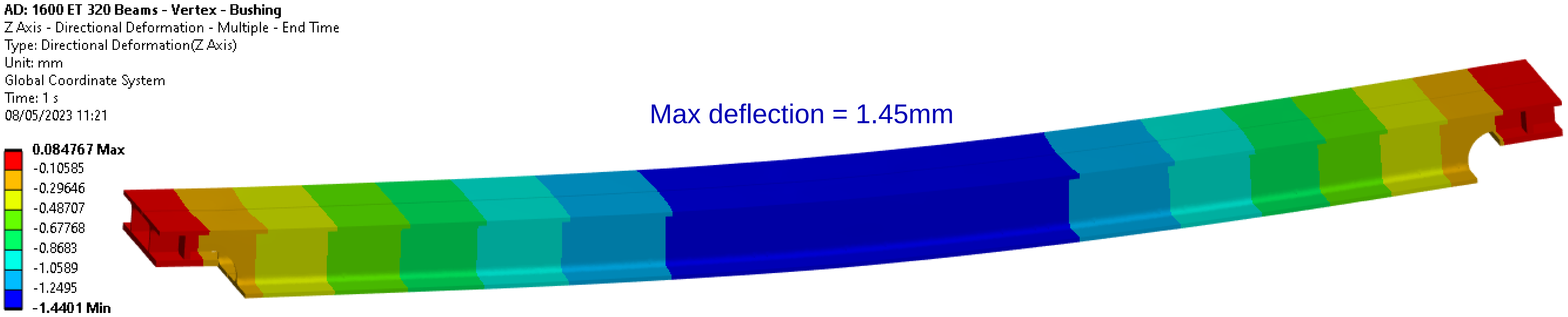
↳ *The assumptions can then be refined*

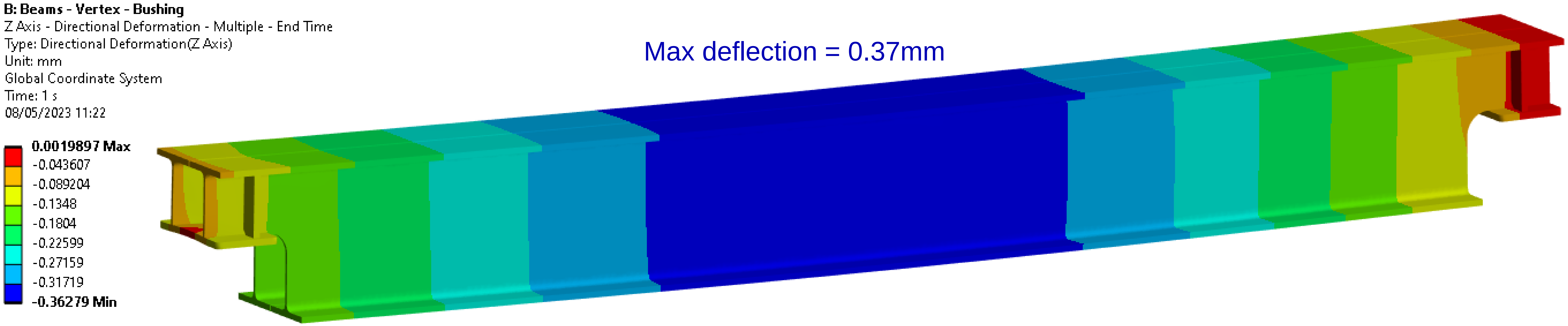
→ NEXT STEPS: study crosstalk between booster and collider

Thank you for your attention

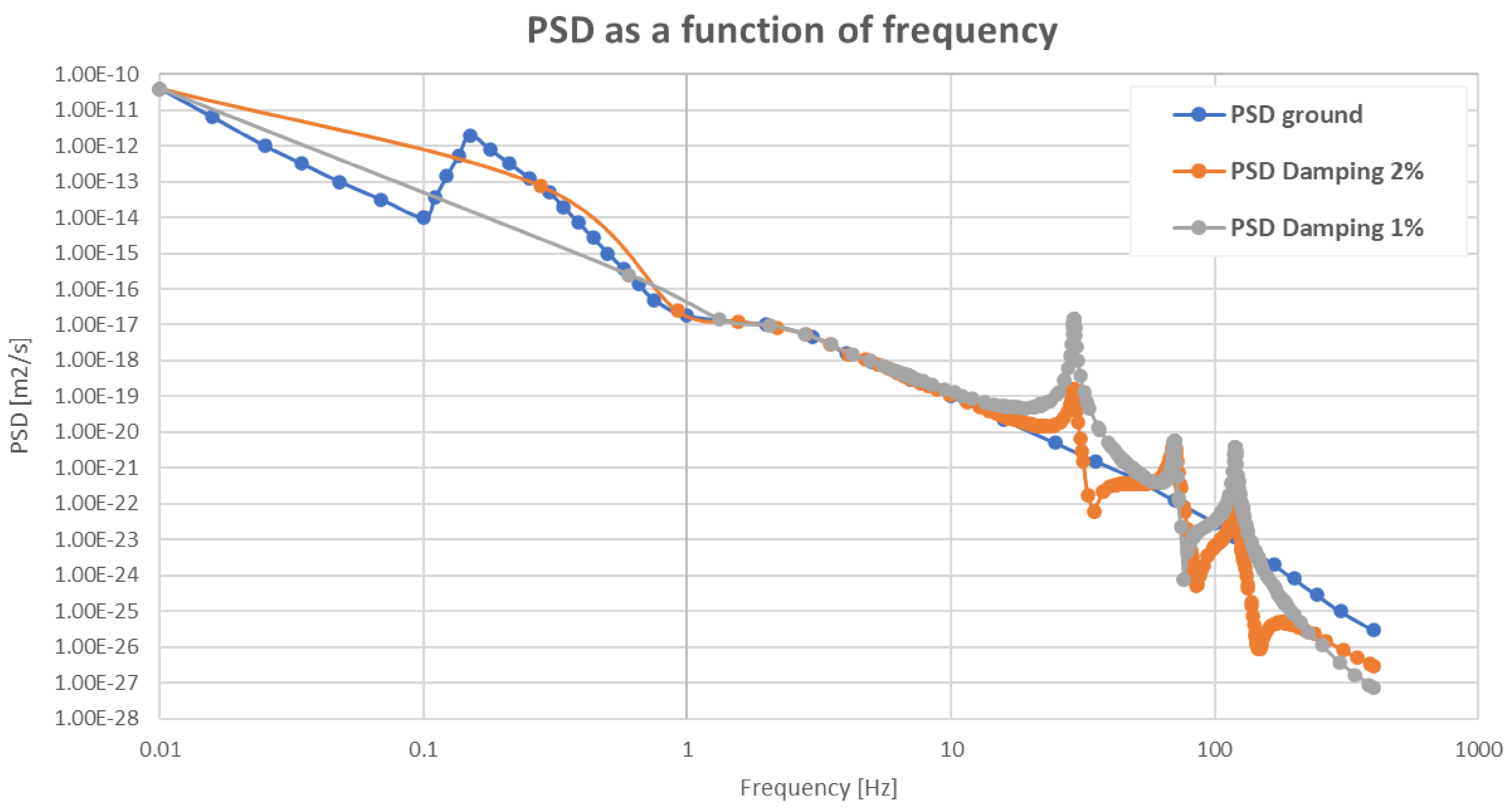
FUTURE CIRCULAR COLLIDER

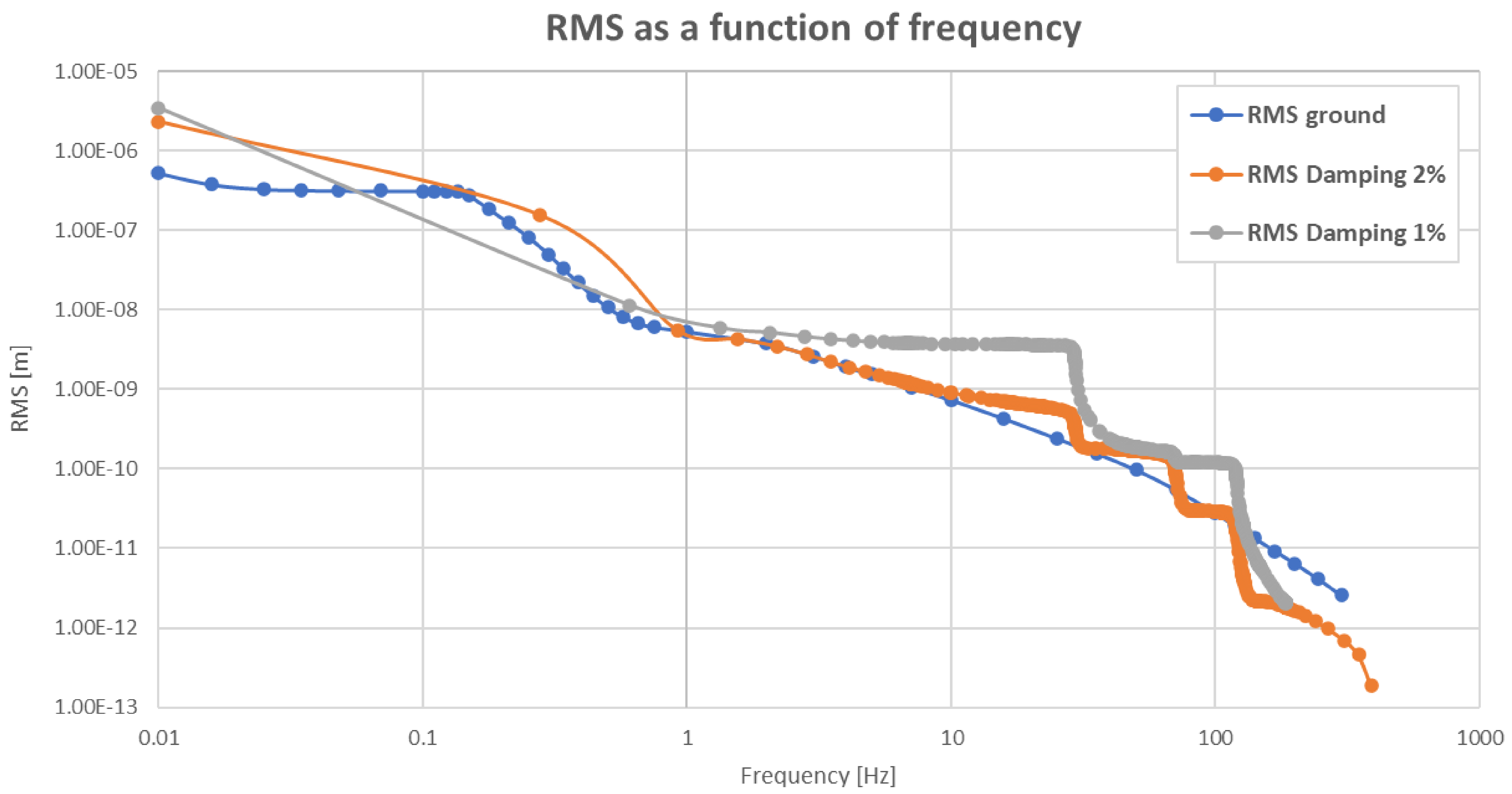
Deflection of the girder





Simulations assumptions – DAMPING





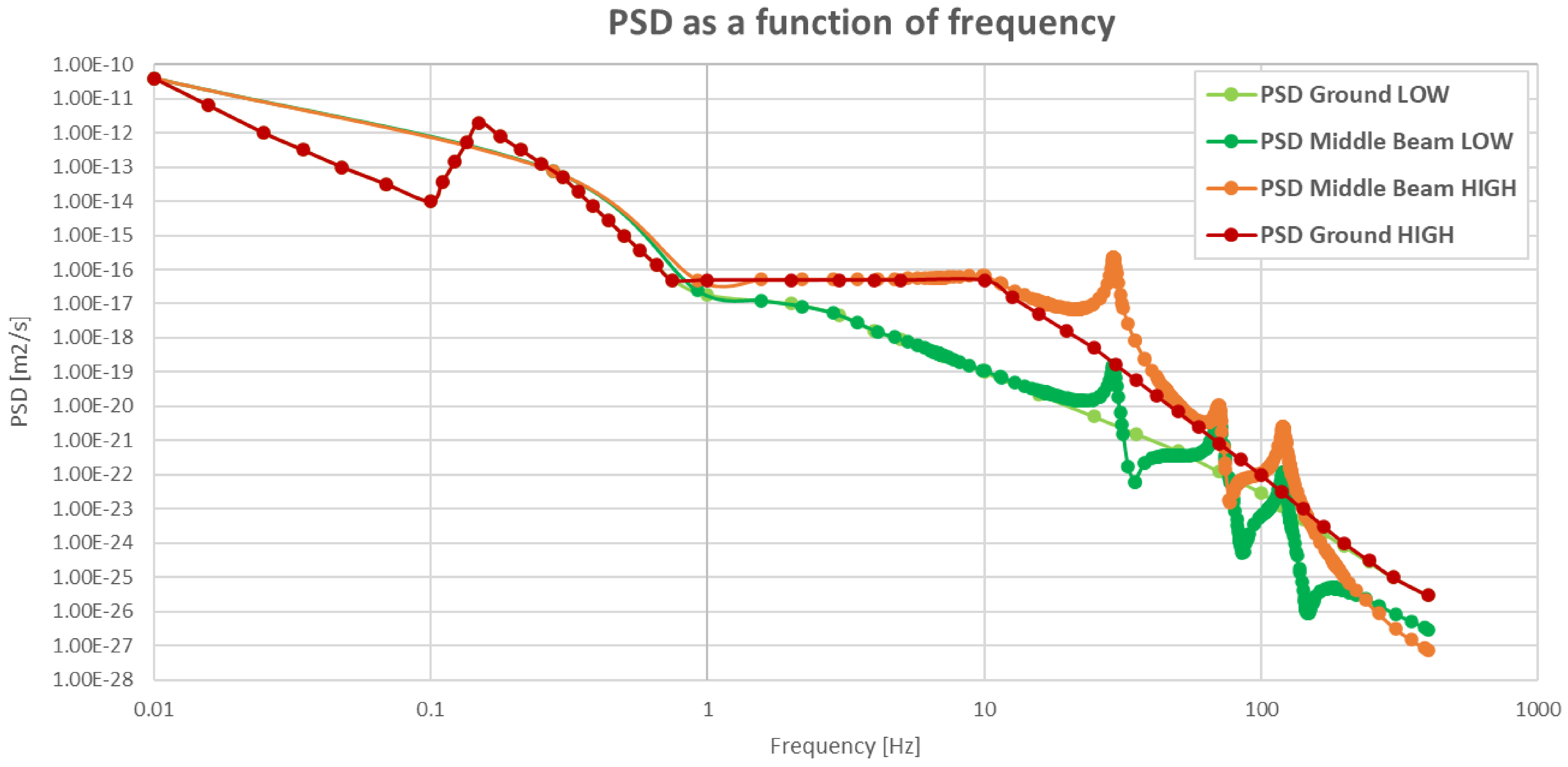
RMS ANSYS from 400Hz to 1Hz (Middle)

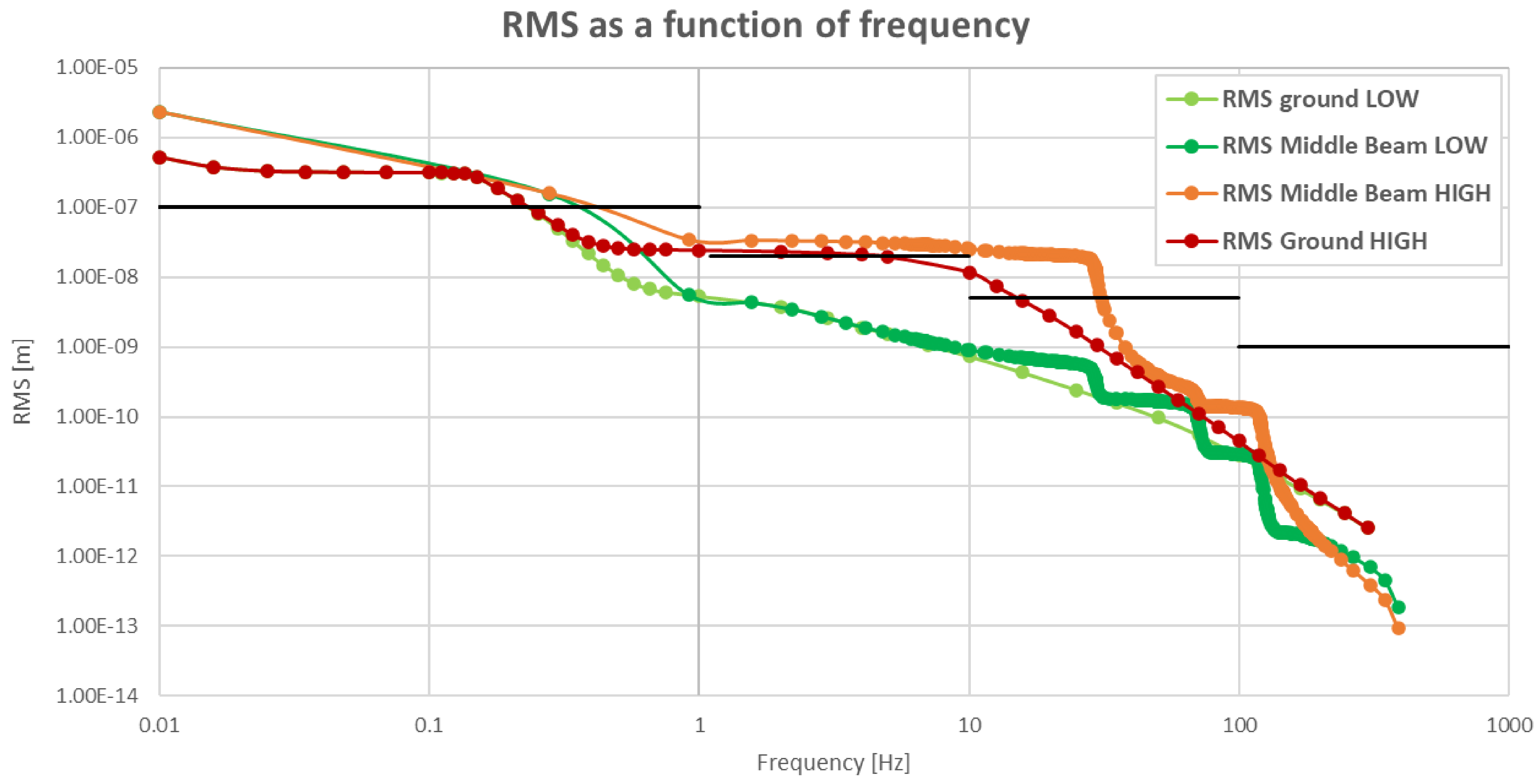
1%	6.3853E-09 m
2%	5.8250E-09 m

RMS ANSYS from 400Hz to 10Hz (Middle)

1%	3.72E-09 m
2%	2.68E-09 m

Simulations assumptions – PSD INPUT





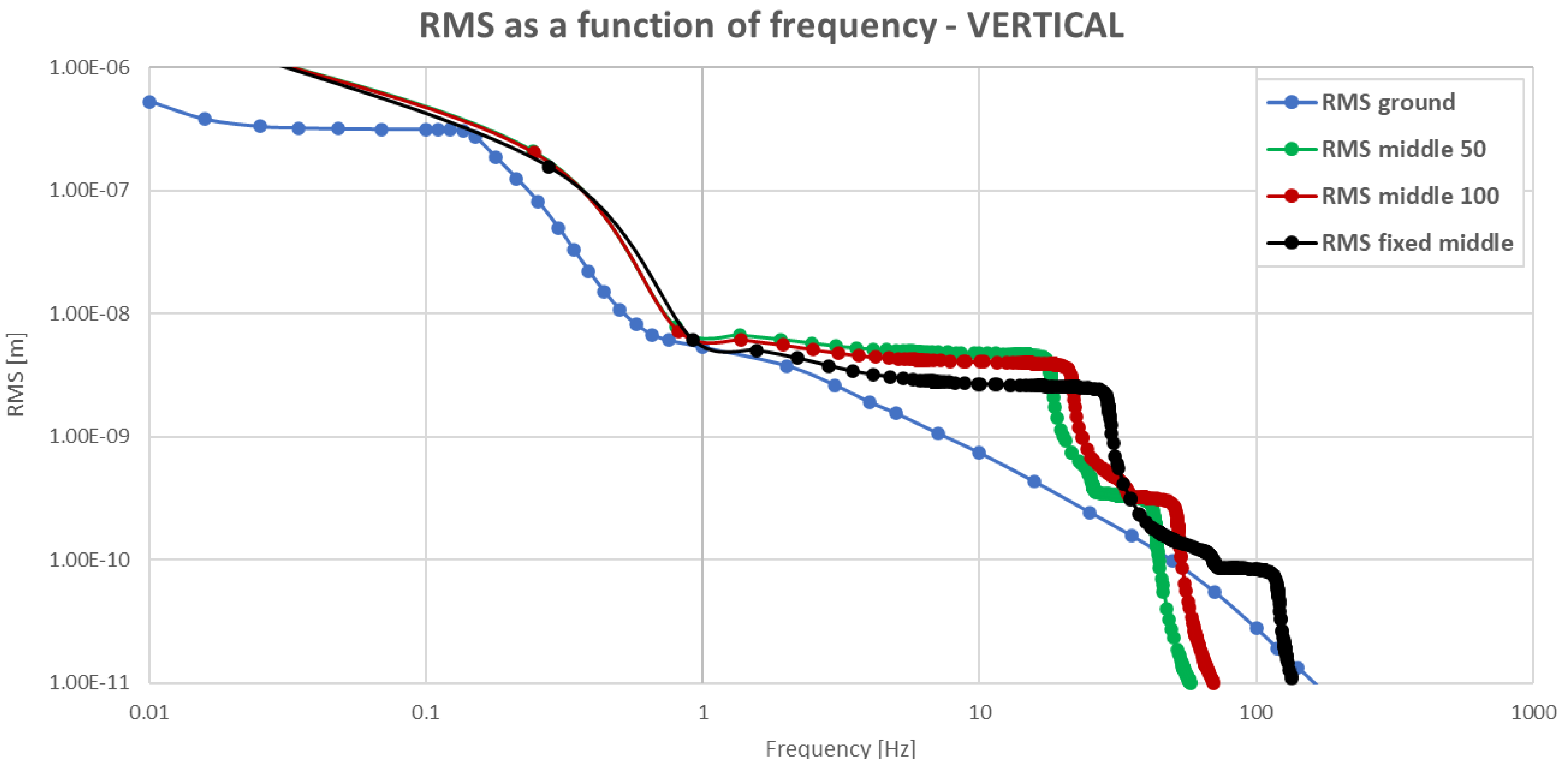
RMS ANSYS from 400Hz to 1Hz (Middle)

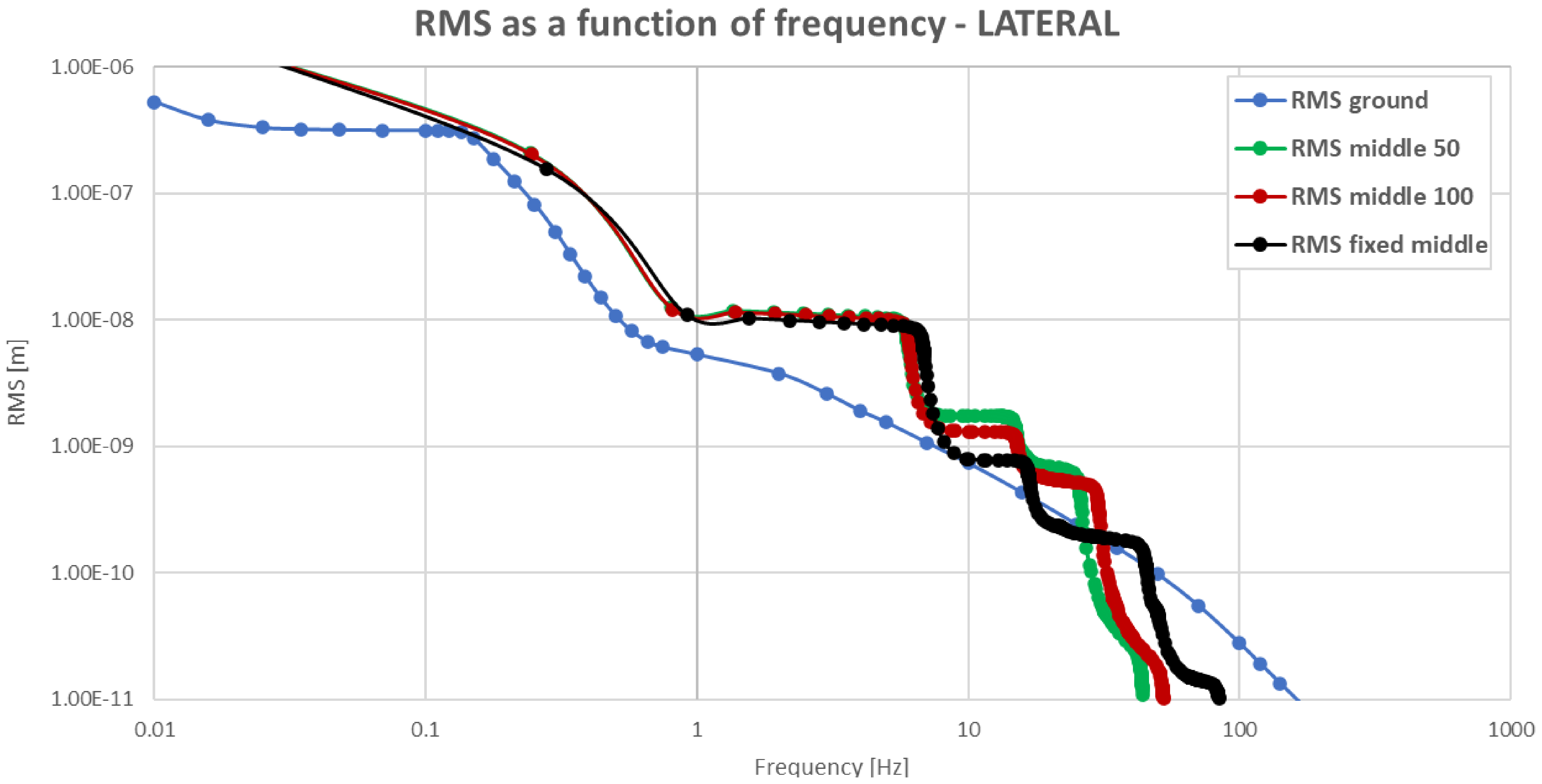
LOW	5.8250E-09 m
HIGH	3.3993E-08 m

RMS ANSYS from 400Hz to 10Hz (Middle)

LOW	2.680E-09 m
HIGH	2.544E-08 m

Simulations assumptions – CONTACT MAGNETS





Black → The contacts between magnets and girder are **fixed**

Green → The contacts between magnets and girder are modelled by springs with a **stiffness** equal to **100kN/mm**

Red → The contacts between magnets and girder are modelled by springs with a **stiffness** equal to **50kN/mm**