Amplification of Seismic Input due to 1D, 2D and 3D effects, and their Importance for NPP Structures

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Outline

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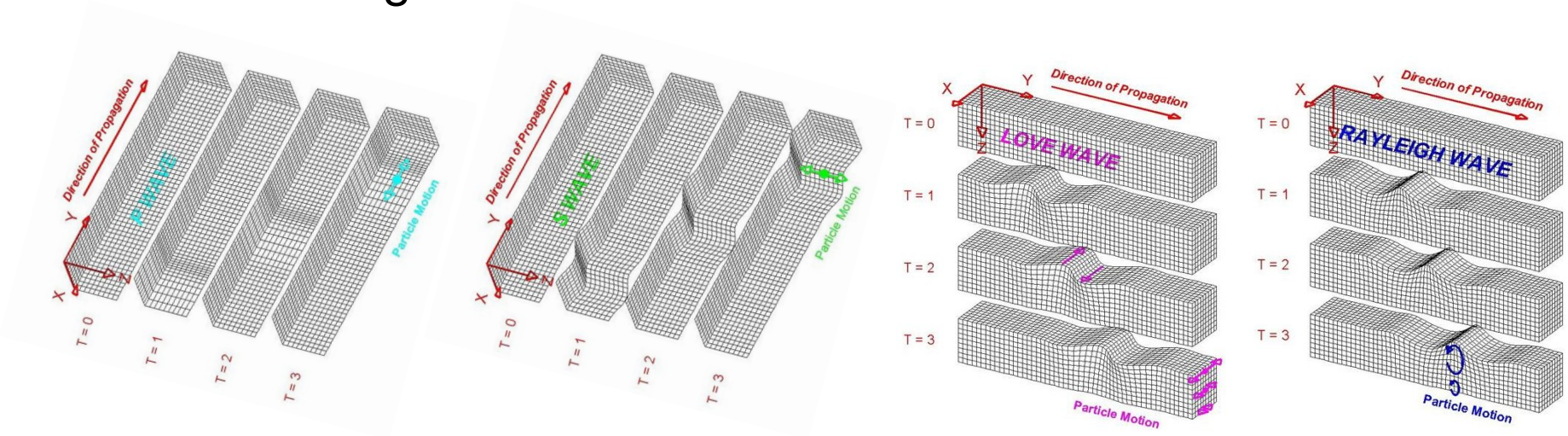
Introduction

- High fidelity numerical simulations of seismic effects on NPPs
  - Realistic seismic motions (3D, inclined motions, surface and body waves, lack of correlation, etc.)
  - Realistic material behavior (elastic, elastic-plastic, etc.)
  - Realistic solids and structures modeling (solids, beams, shells, contacts, isolators, etc.)
- Understanding modeling issues related to 3D, 2D, and 1D (reduced dimension) modeling

Outline

Seismic Motions: Body and Surface Waves

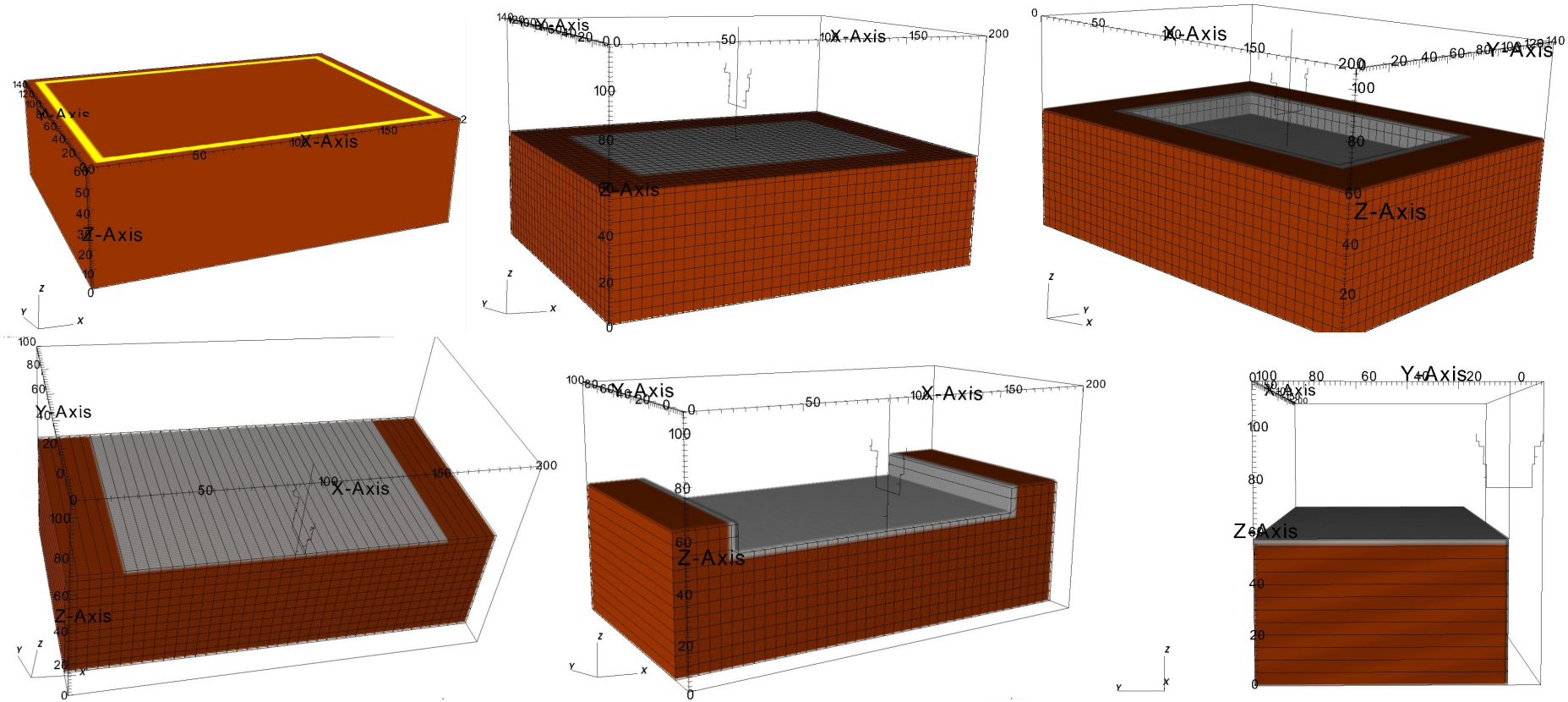
- Full 3D (3 translations and 3 rotations) seismic motions
- Inclined waves
- Lack of correlations (incoherence)
- Body and Surface waves
- Surface waves carry most of the energy
- Modeling: 3D and/or 2D and or 1D?



Seismic Motion Development for 3D, 2D, and 1D

- Green's functions regional model up to 15Hz
- Prof. Hisada's program
- Seismic waves propagated to NPP site
- Motions input using the Domain Reduction Method
- Lack of correlation inherent in regional ground motion modeling

3D, 2D and 1D, Free Field and SSI Models

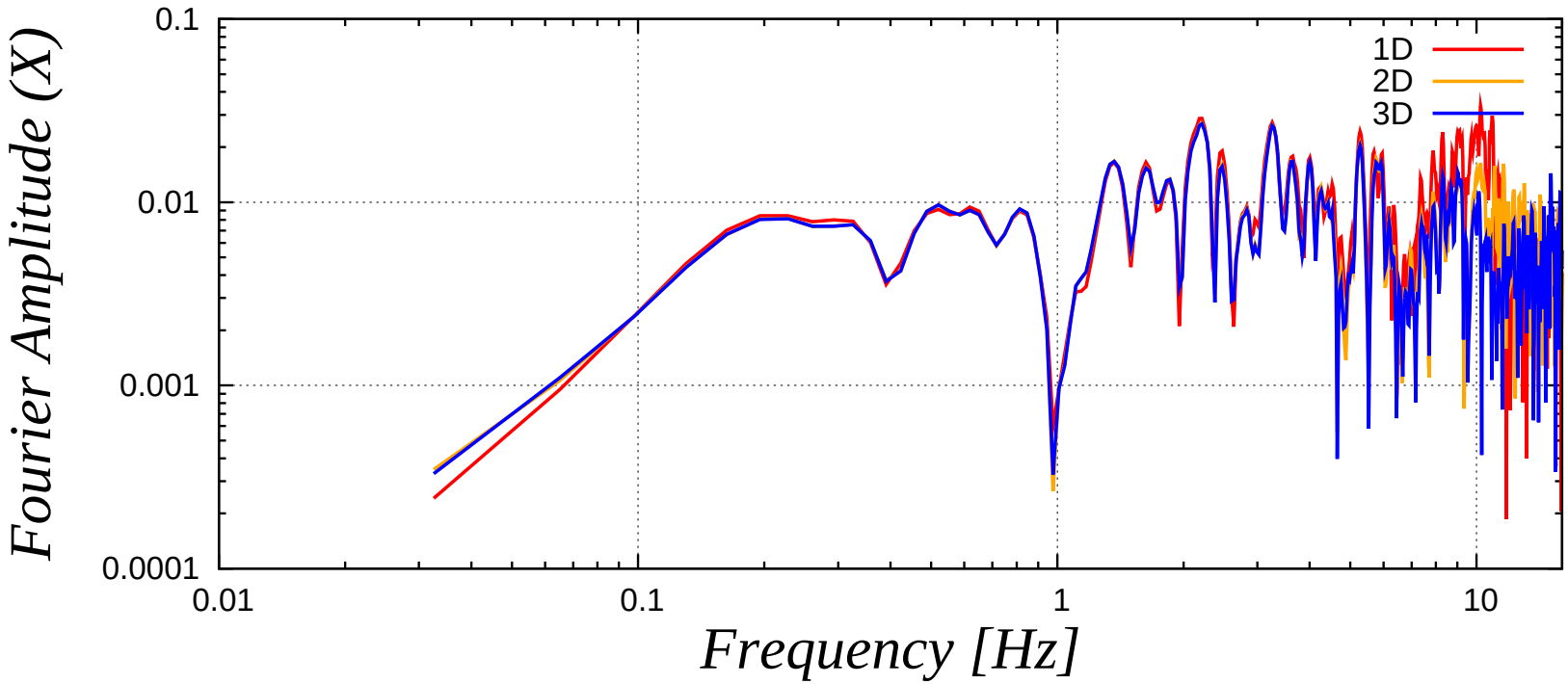


3D, 2D and 1D, Models on Rock and Soil Sites

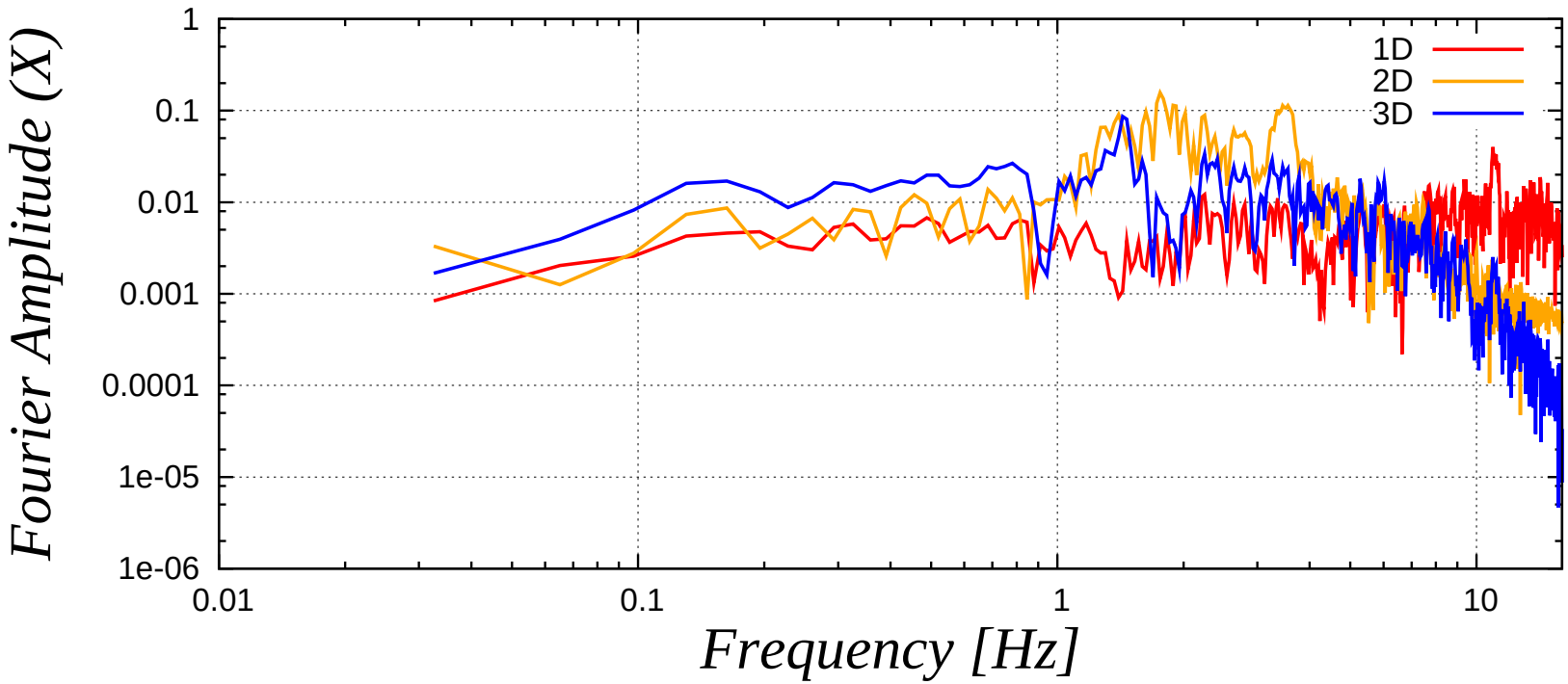
- Hard rock profile, case #1, $V_s = 2600$m/s
- Rock profile, case #2, $V_s = 1500$m/s
- Soil profile, case #8, $V_s = 300$m/s
- Observing free field, and base and top of containment on surface foundations for 3D, 2D, and 1D models

Outline

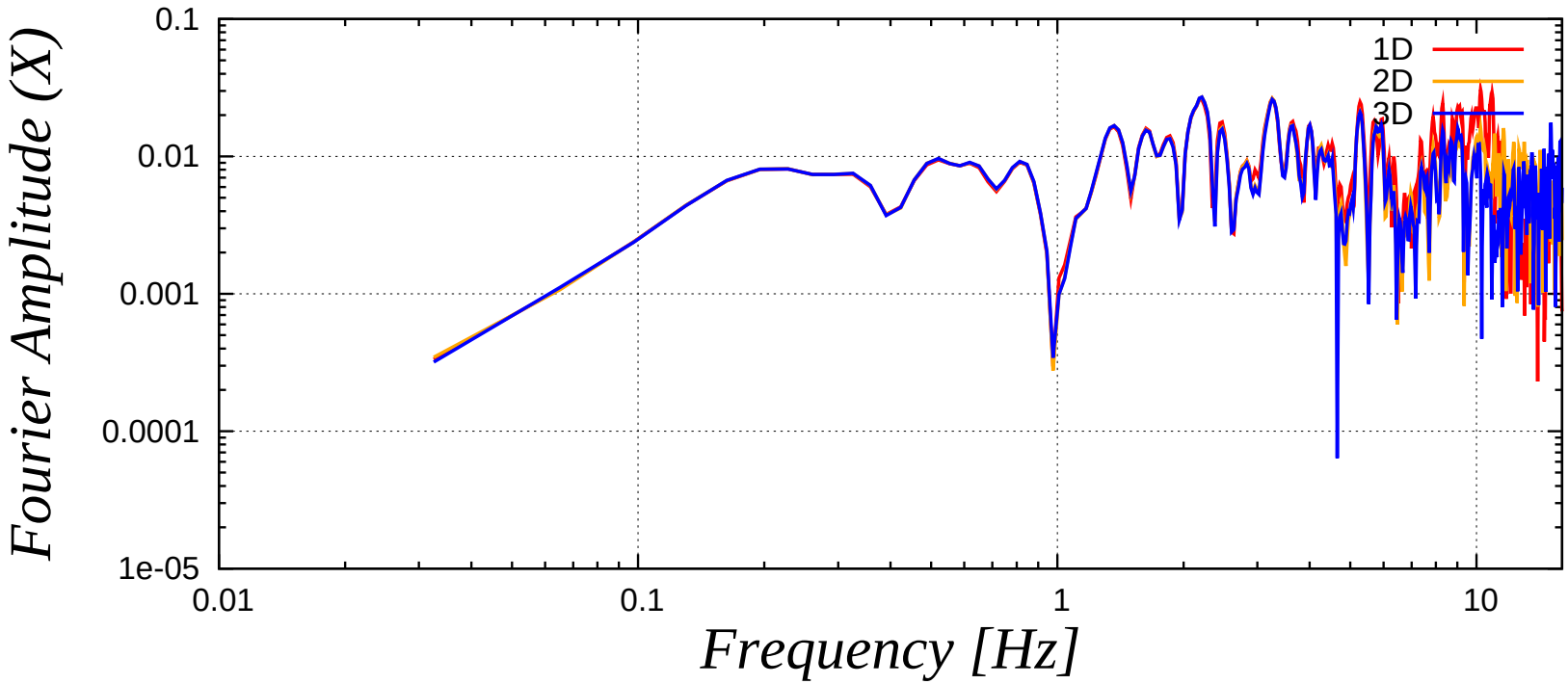
3D vs 2D vs 1D Free Field, Hard Rock (Case 1)



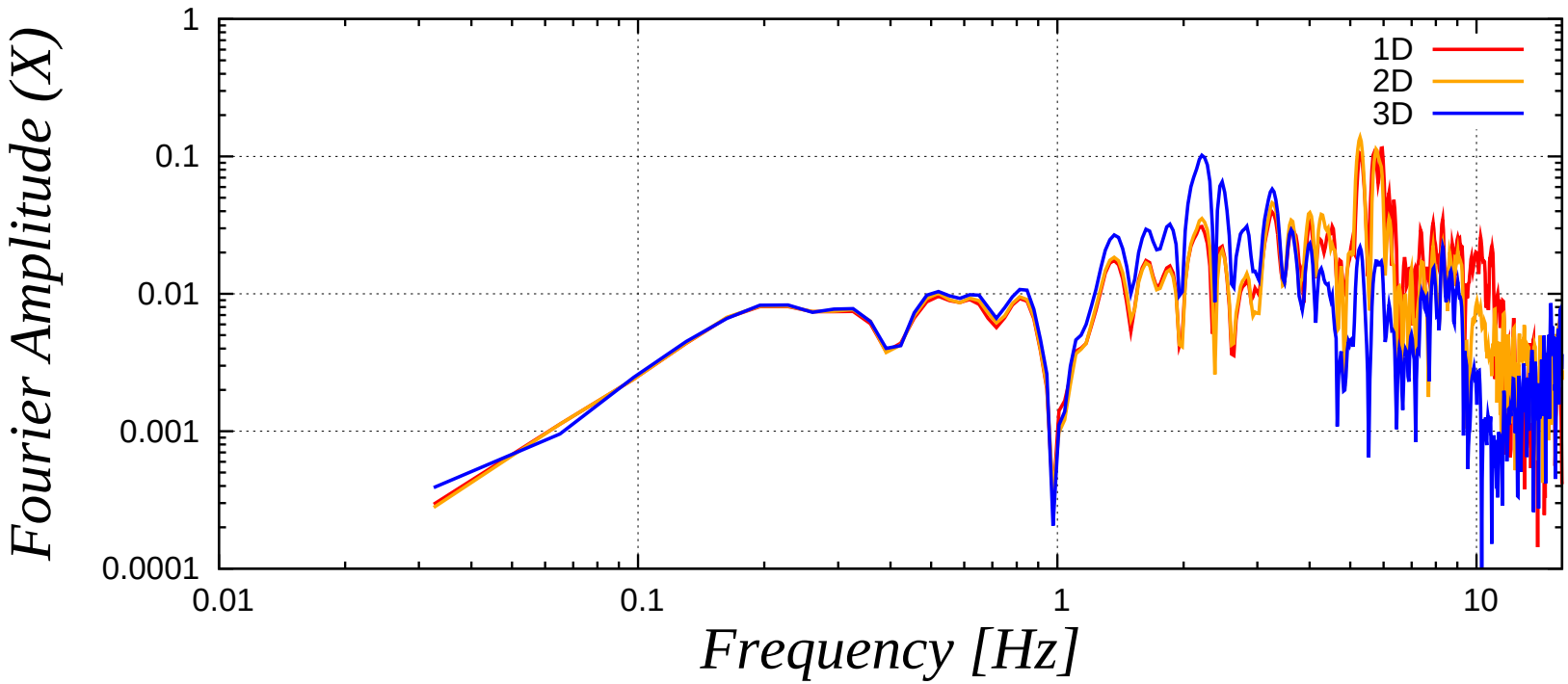
3D vs 2D vs 1D Free Field, Soil (Case 8)



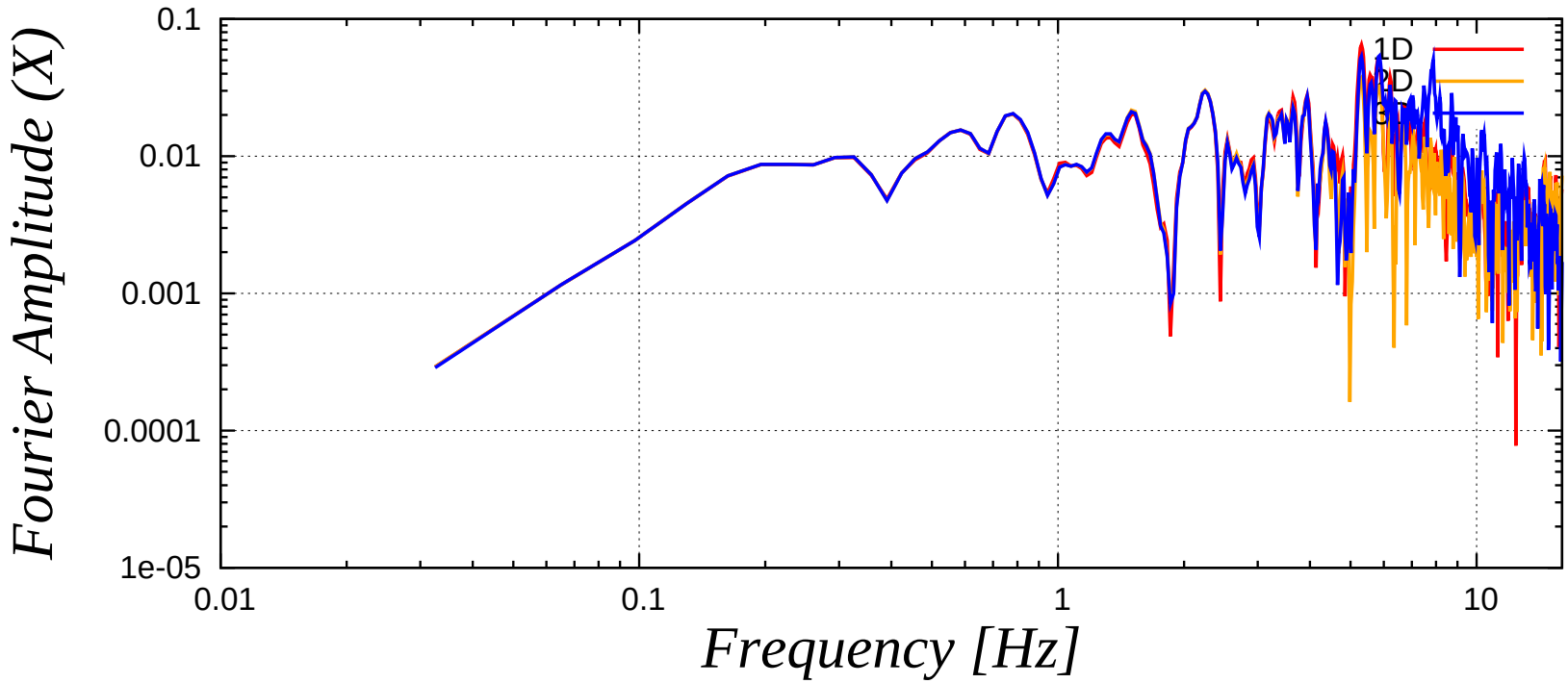
Base of Containment Structure, Hard Rock (Case 1)



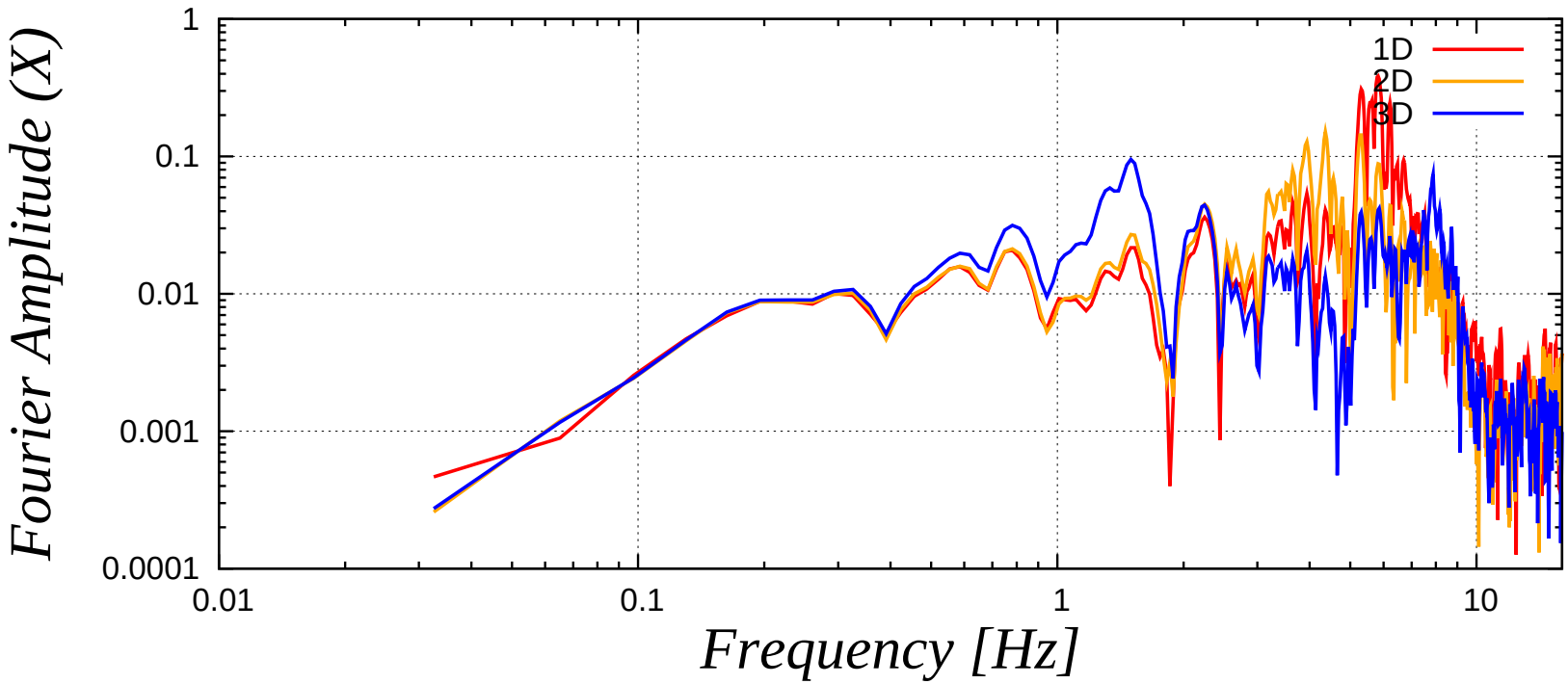
Top of Containment Structure, Hard Rock (Case 1)



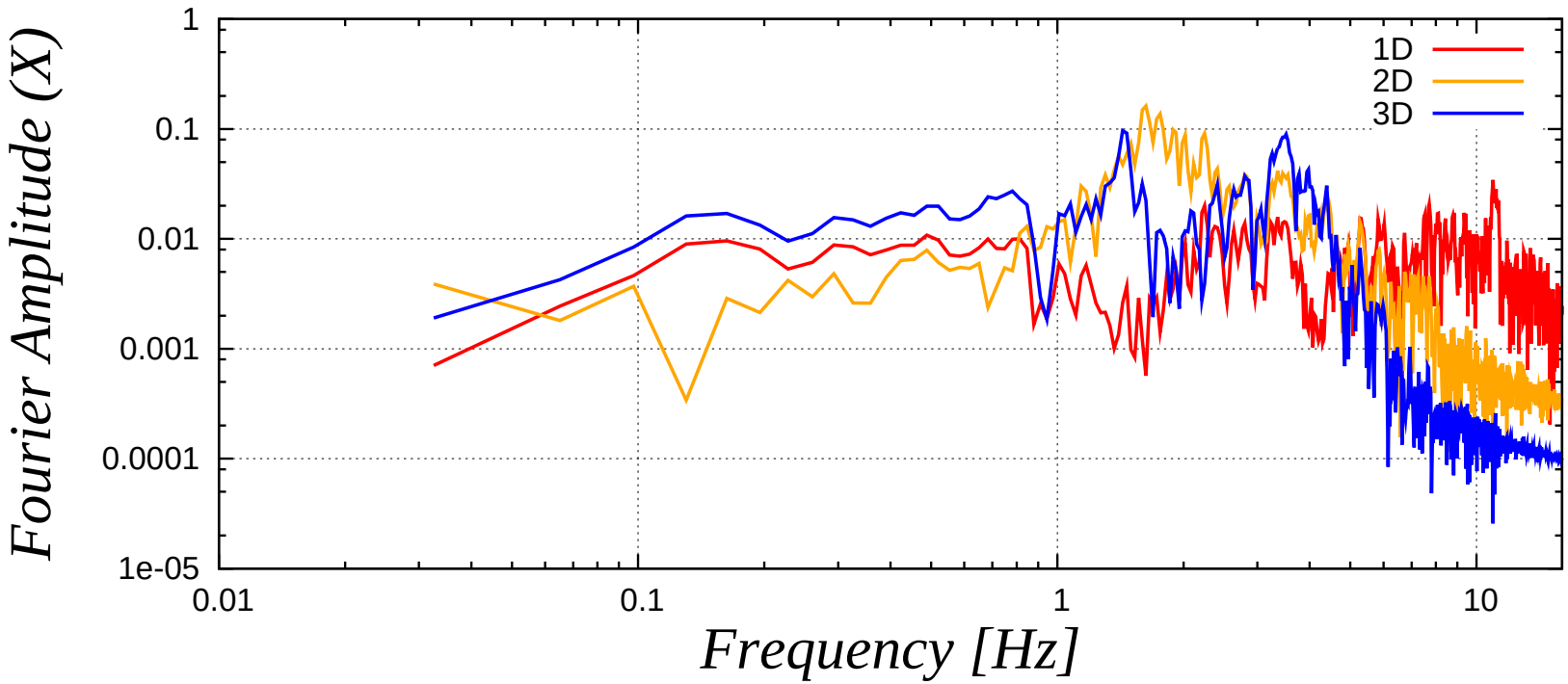
Base of Containment Structure, Rock (Case 2)



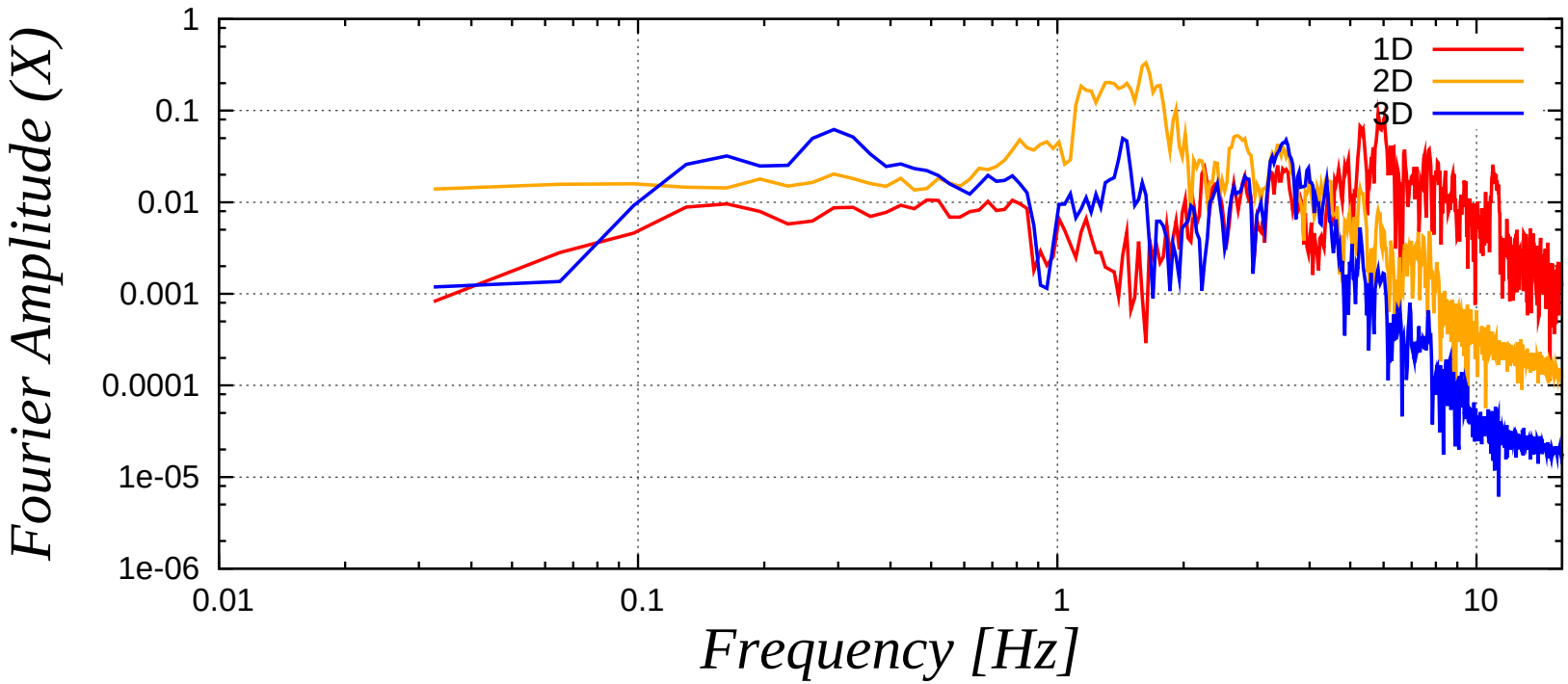
Top of Containment Structure, Rock (Case 2)



Base of Containment Structure, Soil (Case 8)



Top of Containment Structure, Soil (Case 8)



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Summary

- Reduce modeling uncertainty
- Incident seismic waves are 3D, inclined, uncorrelated, contain body and surface waves...
- High Fidelity modeling and simulations are important, preferable (low modeling uncertainty) so do full, realistic 3D
- Funding by and Collaboration with the CNSC is gratefully acknowledged