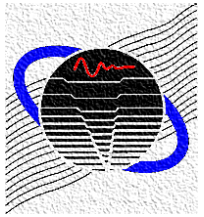
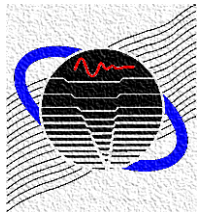
Simple and Double Tuned Expansion Chamber Simulations

Hao Zhou
University of Kentucky



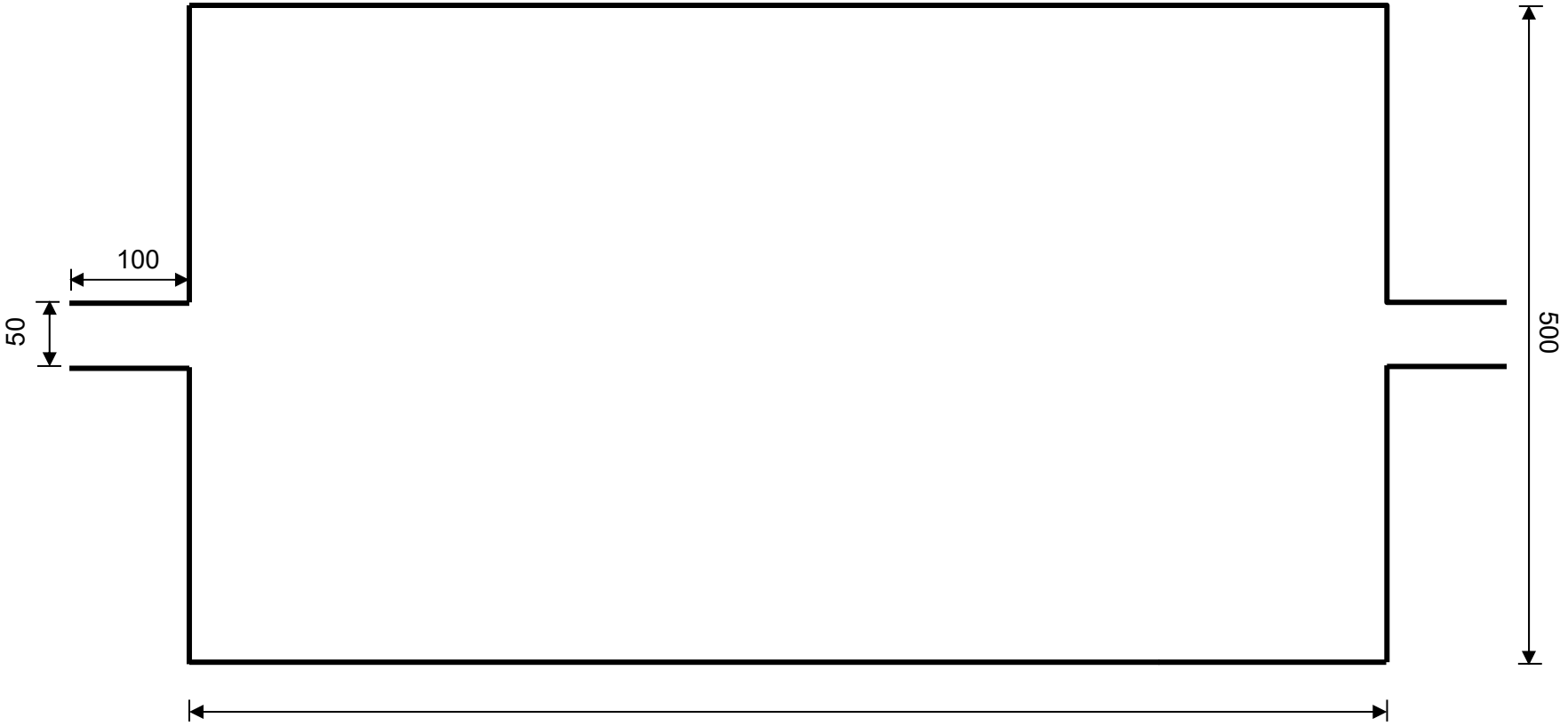
Overview

- MSC Actran is used to model a simple expansion chamber and double tuned expansion chamber.
- Ideas for improving the lower frequency attenuation of the double tuned expansion chamber are considered assuming that the total volume is not increased.



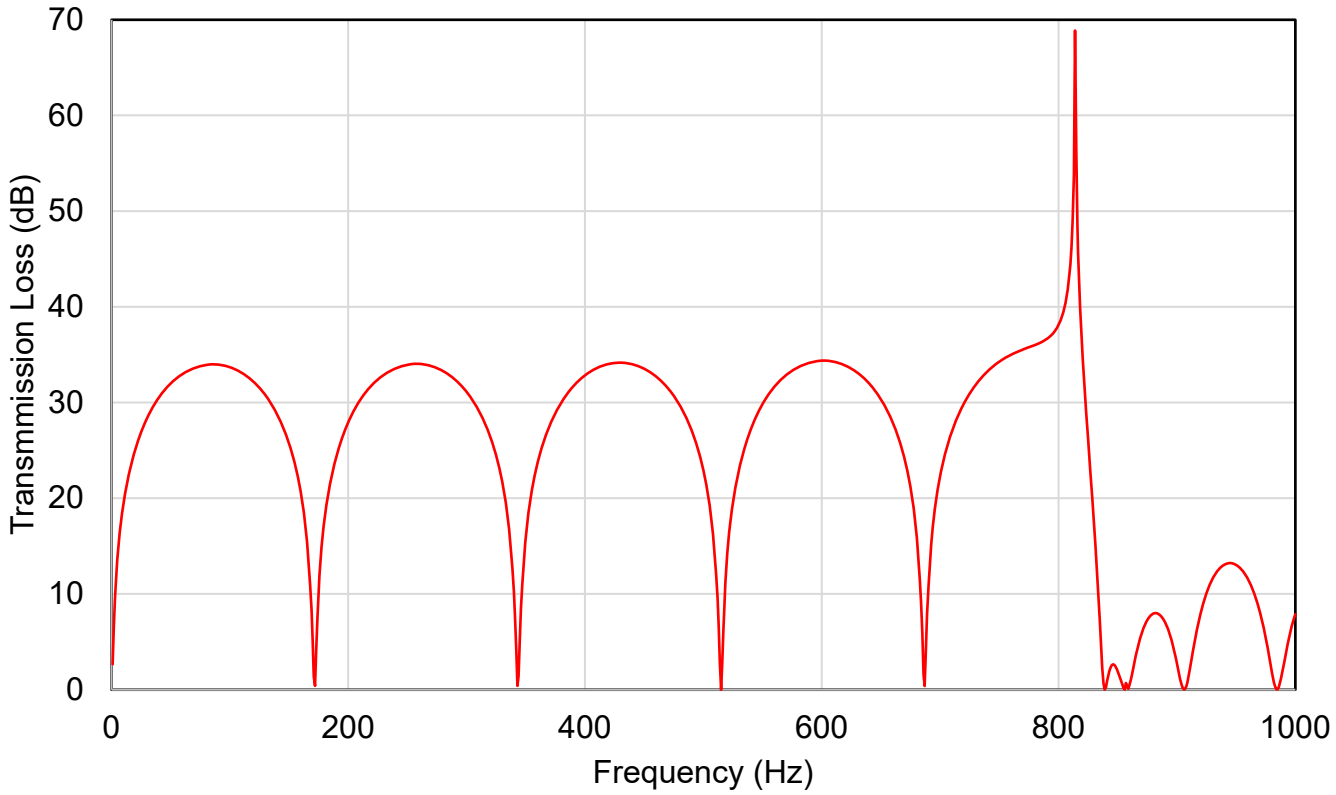
Case 1 Simple Expansion Chamber SEC

Temperature: 20 ℃

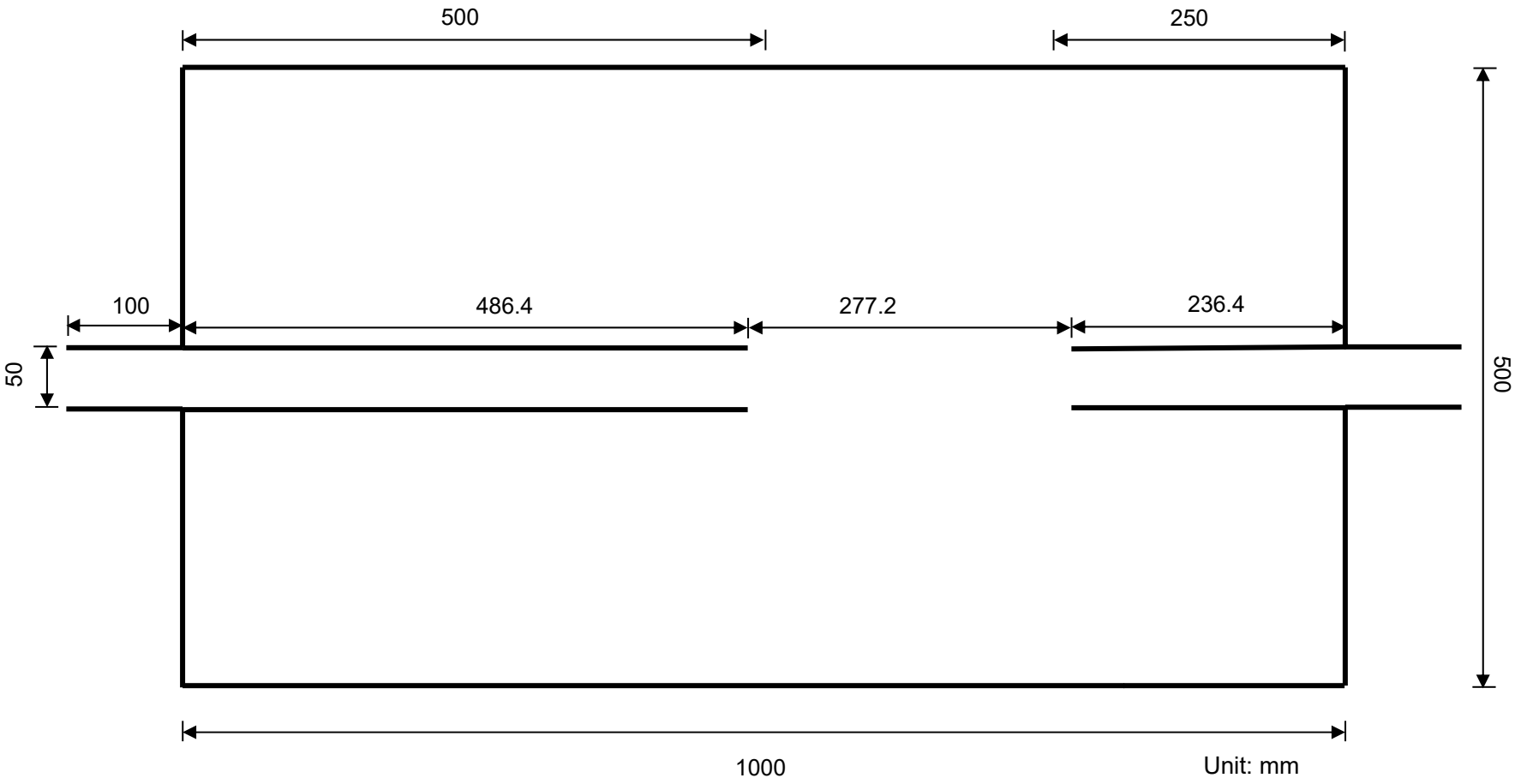


Unit: mm

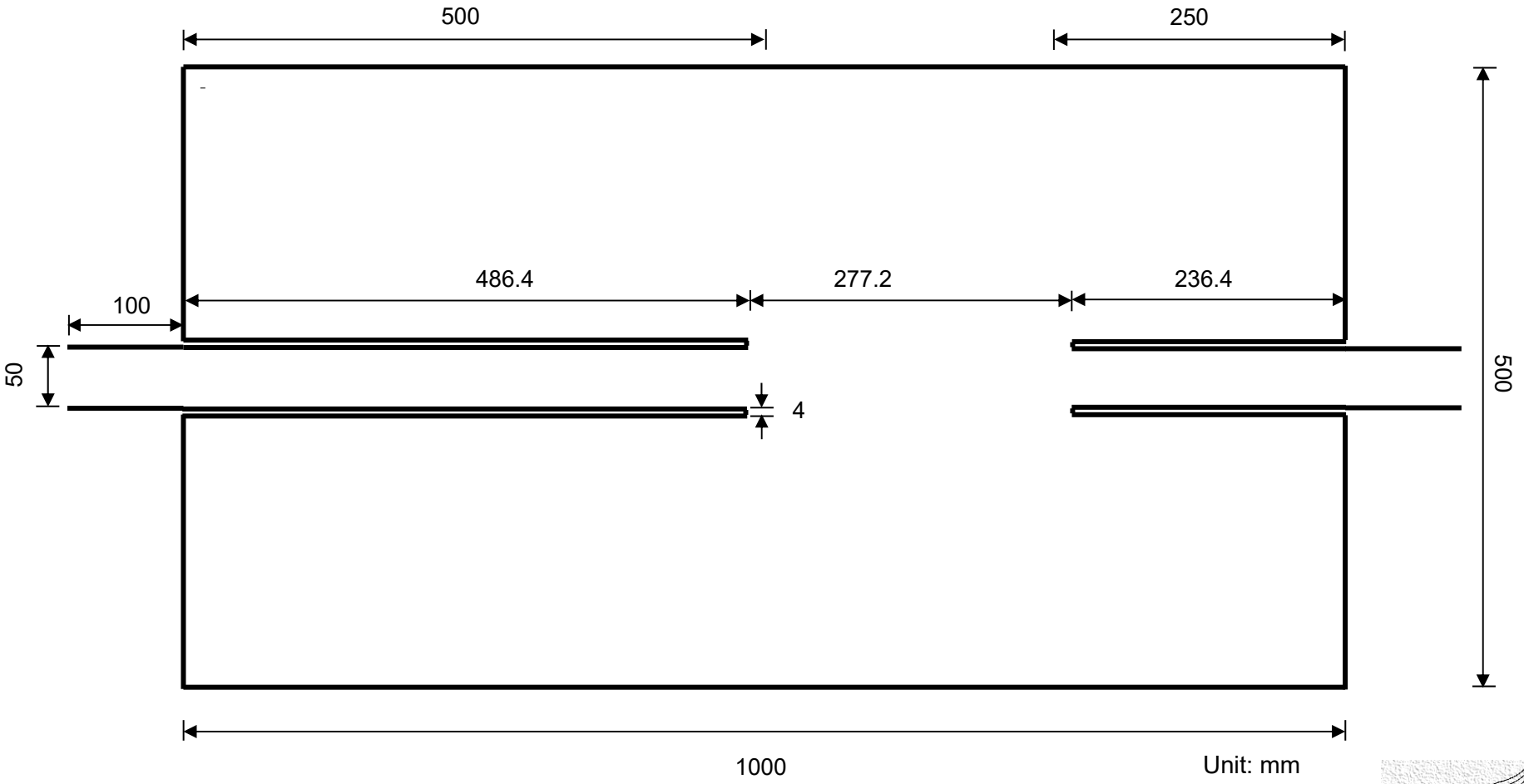
Case 1 SEC FEM Simulation



Case 2 DTEC



Case 3 DTEC with Wall Thickness



End Correction Calculations

End Corrections (all dimensions in m)

$$l_0 = d_{duct}\left(a_0 + a_1\left(\frac{d_{exp}}{d_{duct}}\right) + a_2\left(\frac{t_w}{d_{duct}}\right) + a_3\left(\frac{d_{exp}}{d_{duct}}\right)^2 + a_4\left(\frac{d_{exp}t_w}{d_{duct}}\right) + a_5\left(\frac{t_w}{d_{duct}}\right)^2\right)$$

$a_0 = 0.005177$

$a_1 = 0.0909$

$a_2 = 0.537$

$a_3 = -0.008594$

$a_4 = 0.2616$

$a_5 = -5.435$

Corrected Lengths

$$L_a = \frac{L}{4} - l_0$$

$$L_b = \frac{L}{2} - l_0$$

$$L_c = L - L_a - L_b$$

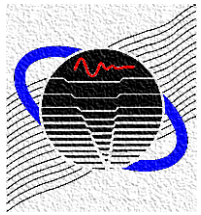
Example

$d_{duct} = 5$ cm

$d_{exp} = 50$ cm

$t_w = 4$ mm

$l_0 = 1.36$ cm



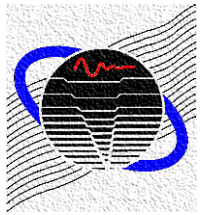
End Correction used in SIDLAB

- End Correction , l_e

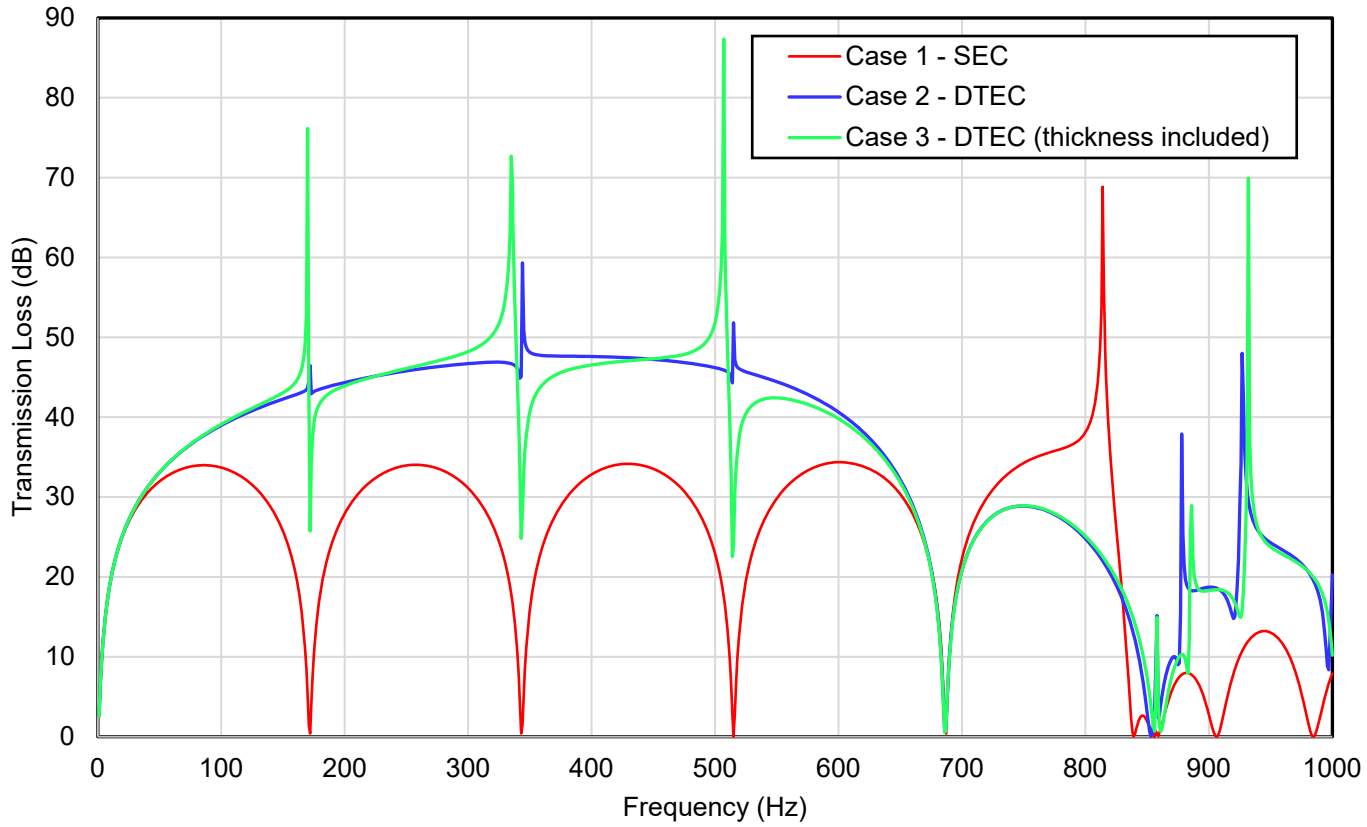
$$l_e = \frac{8 d_{duct} H(\alpha)}{6\pi}$$

$$H(\alpha) = \begin{cases} 0.875(1-\alpha)(1.371-\alpha) & 0.5 < \alpha < 1 \\ 1 - 1.238\alpha & 0 < \alpha < 0.5 \end{cases}$$

$$\alpha = \frac{d_{duct}}{d_{exp}}$$



MSC Actran Simulation Comparisons



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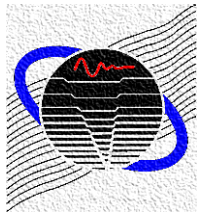
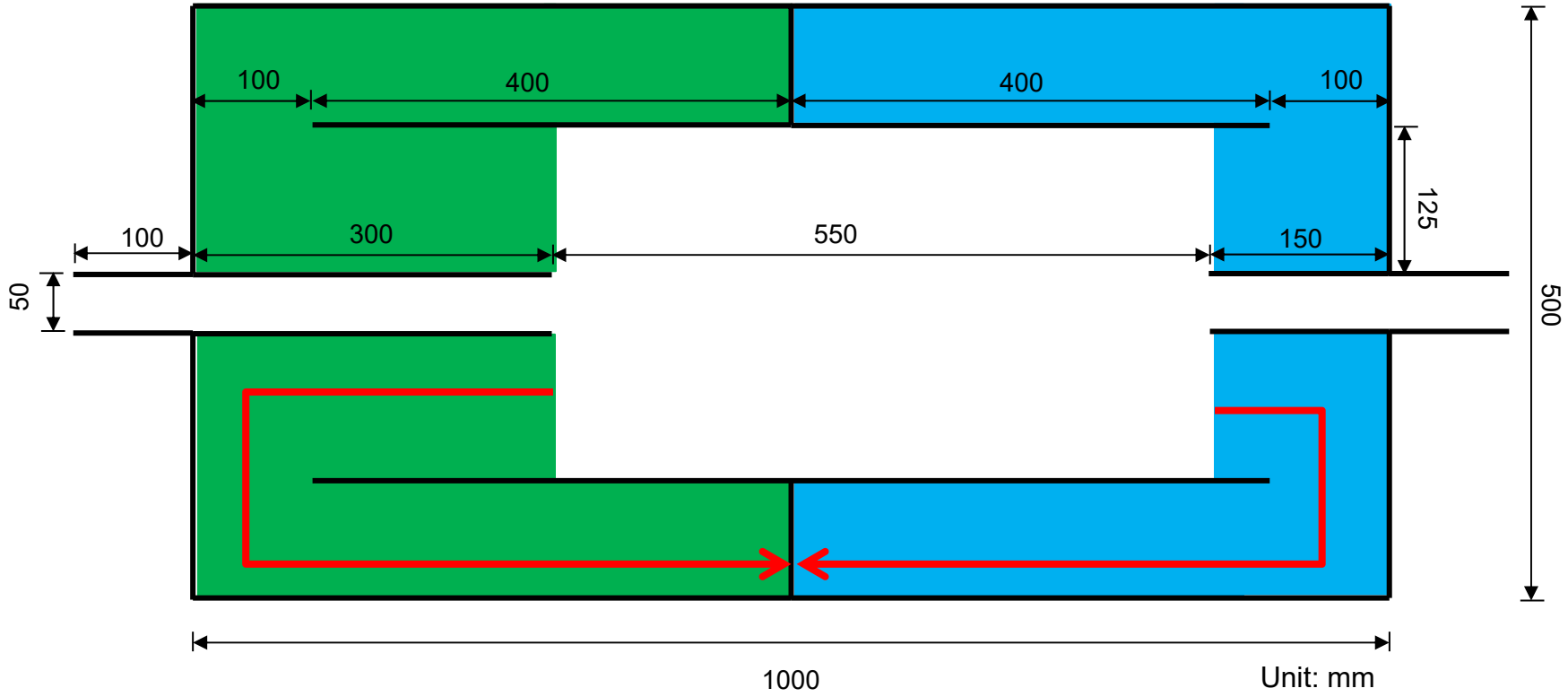
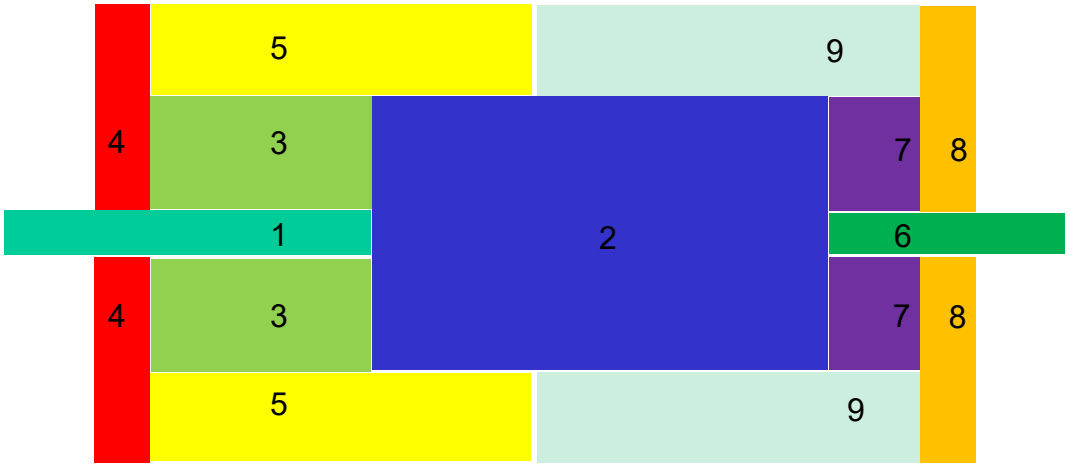
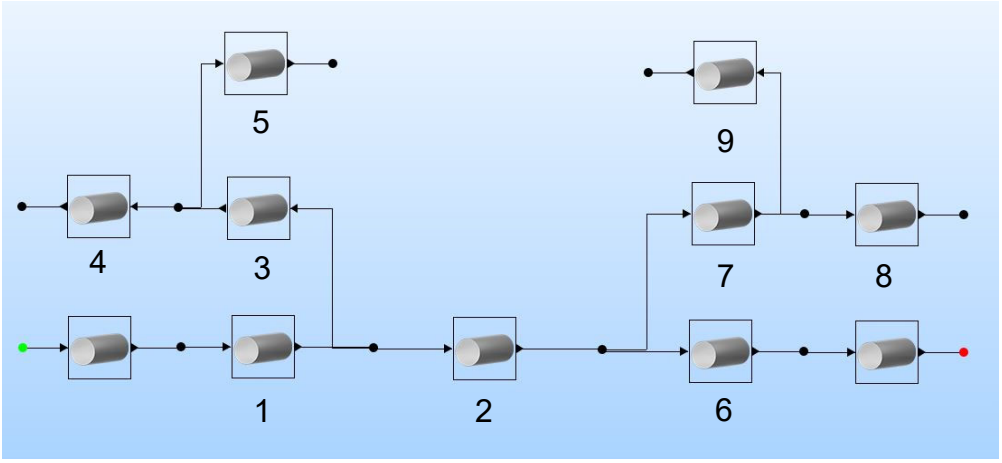


Case 4 DTEC with Extended QWT

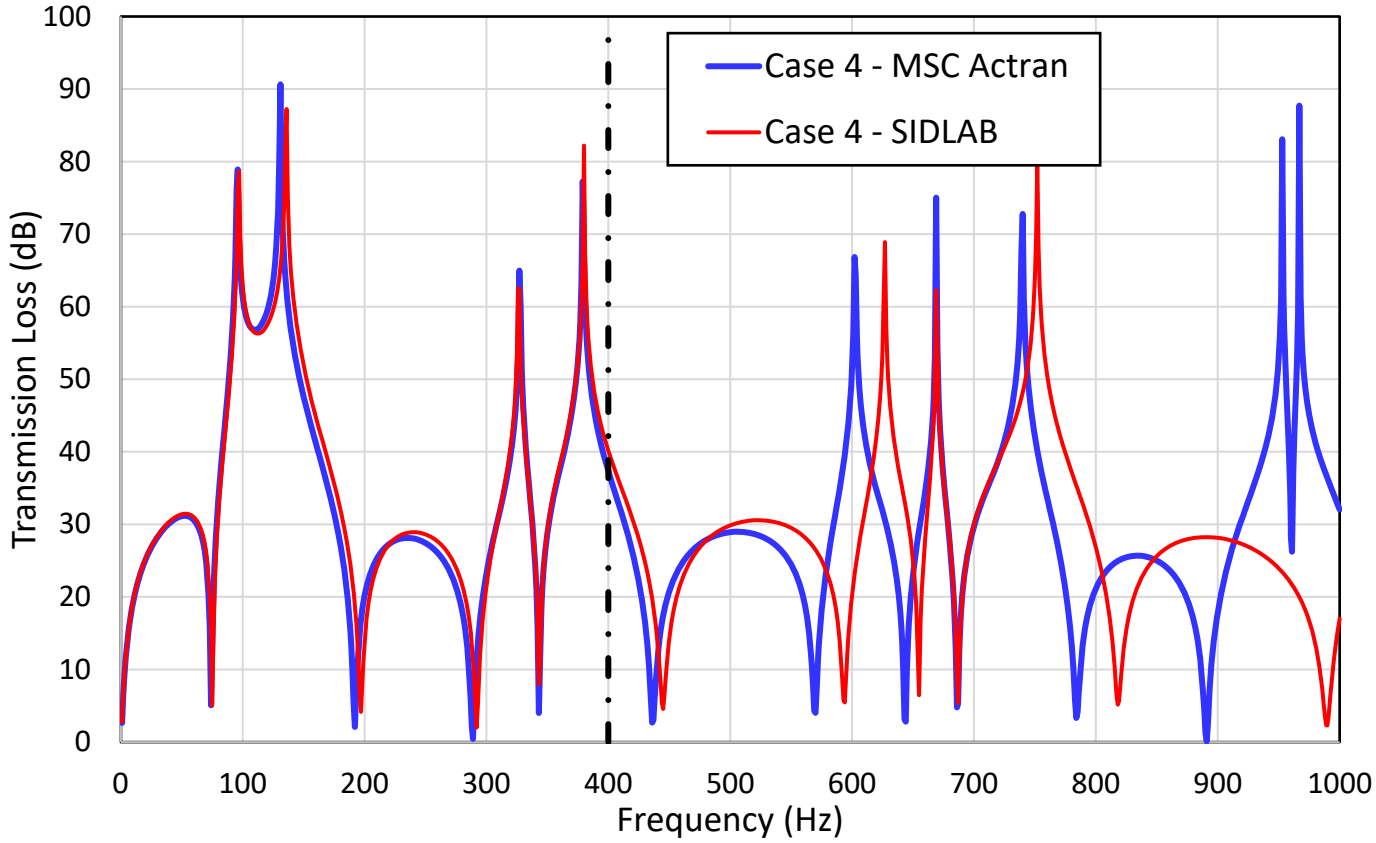


Case 4 DTEC with Extended QWT

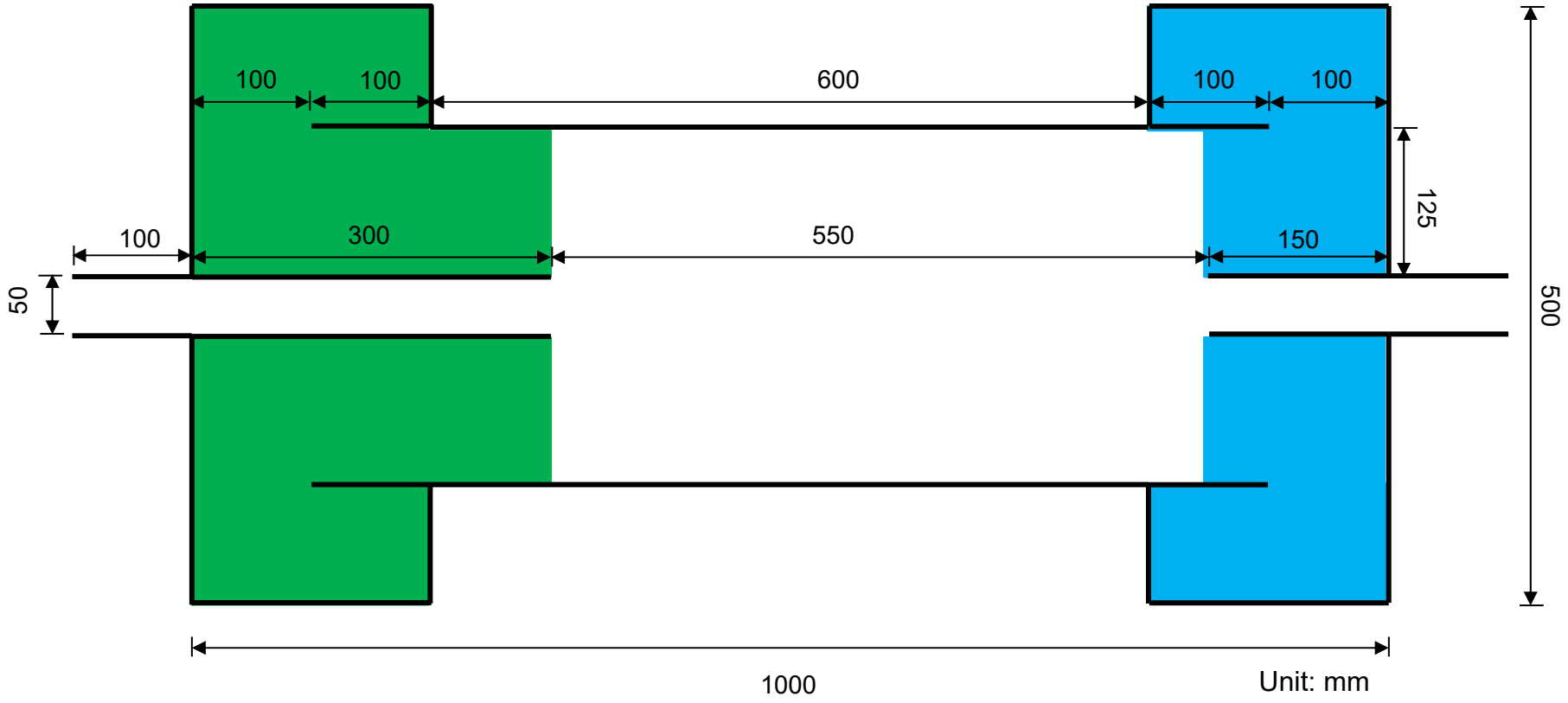




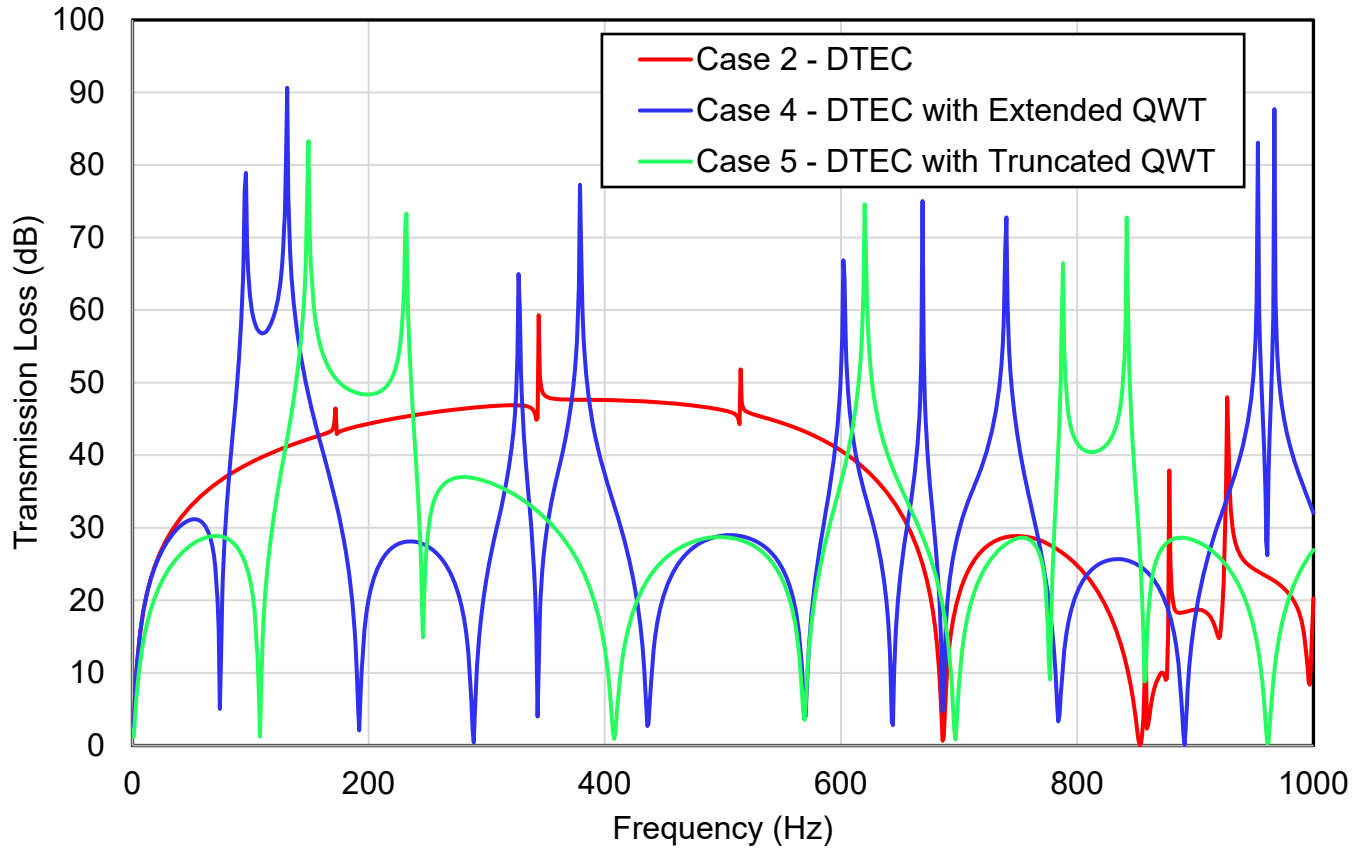
Case 4 DTEC with Extended QWT



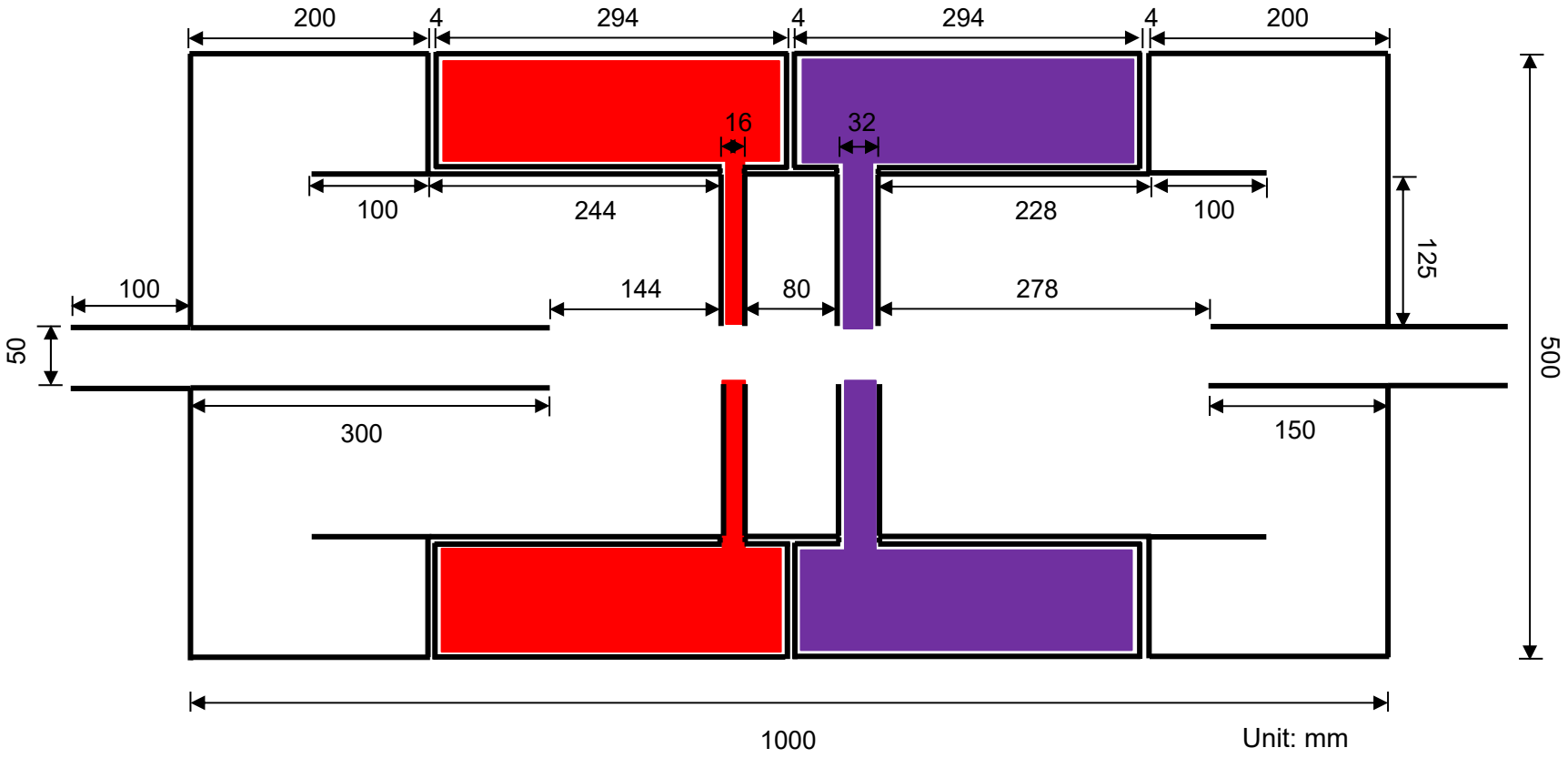
Case 5 DTEC with Truncated QWT



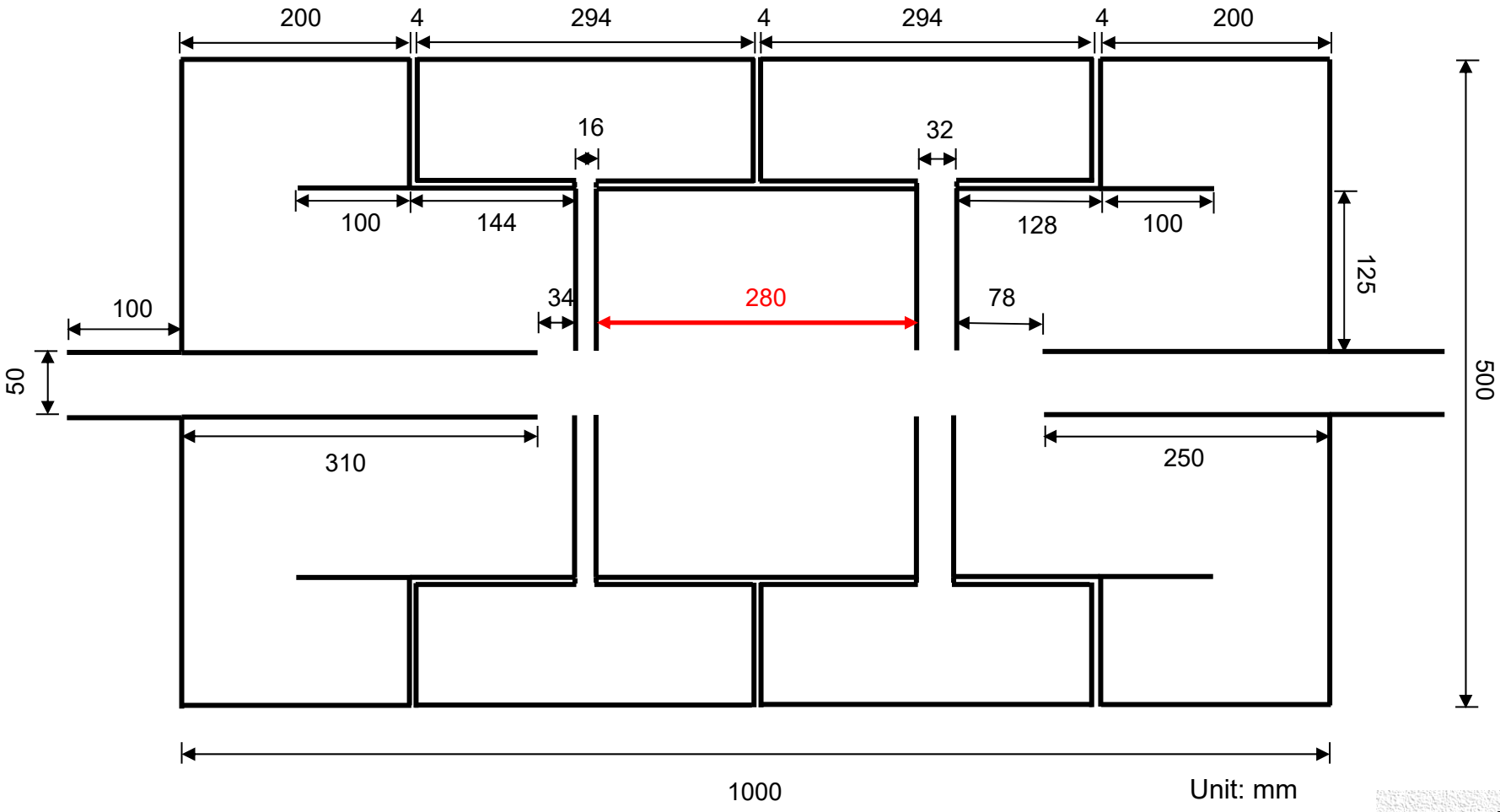
MSC Actran Simulation Comparisons



Case 6 DTEC with QWT and HR Tight



Case 7 DTEC with QWT and HR Wide



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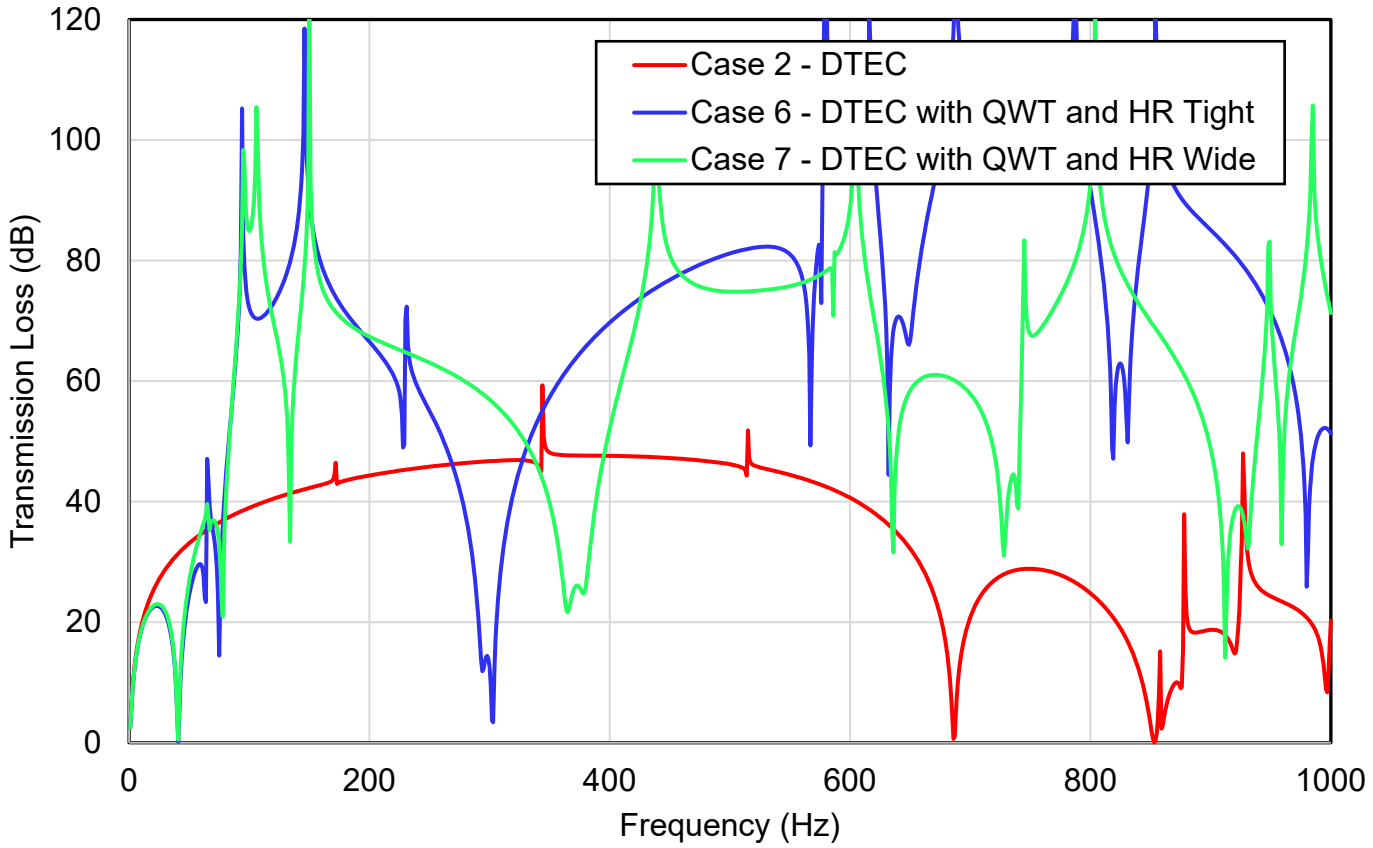
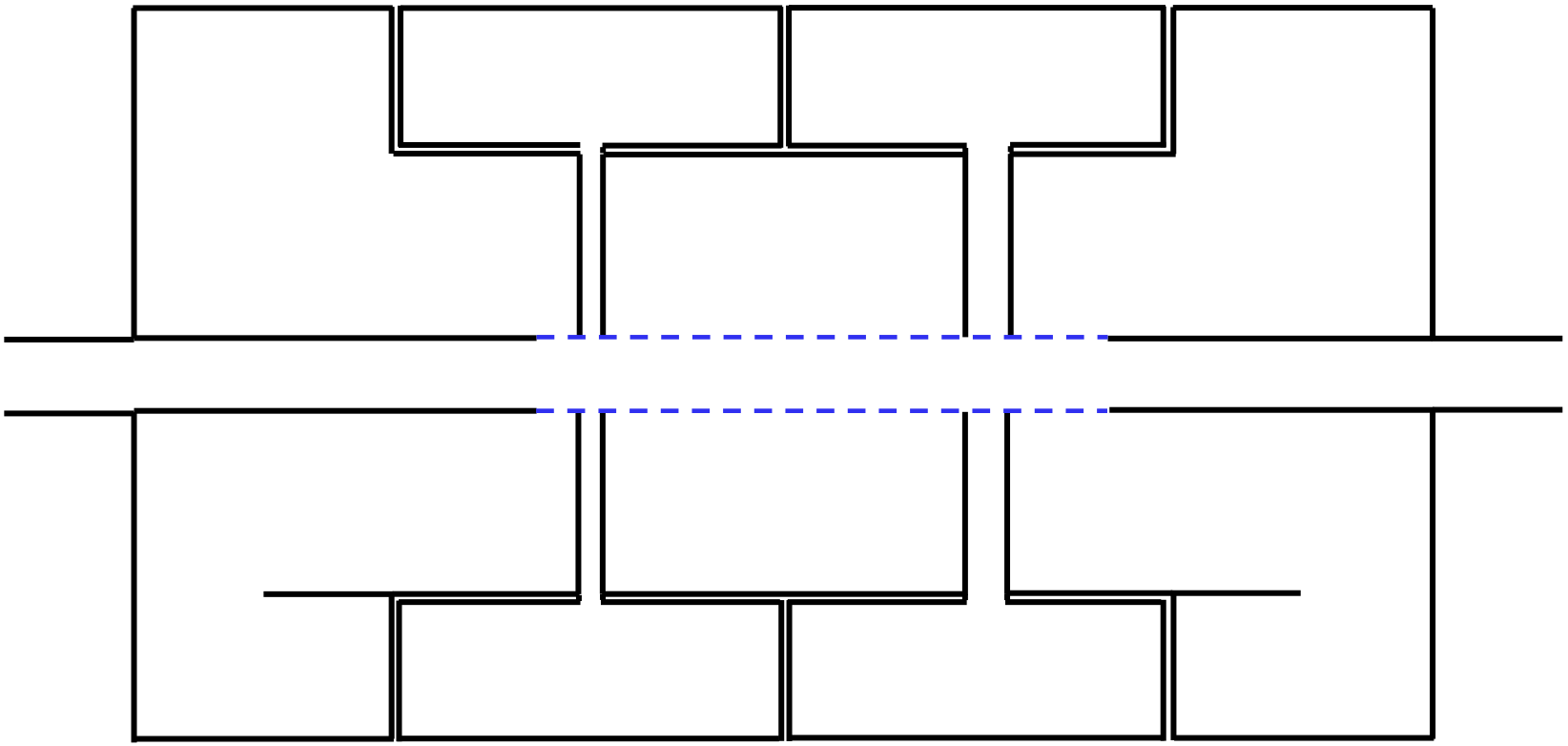


Case 7 DTEC with QWT and HR Wide



Summary

- FEM simulation is necessary to tune a DTEC.
- Alternative configurations may be used to improve the low frequency performance.