ODEON
Non-diffuse room - Example case

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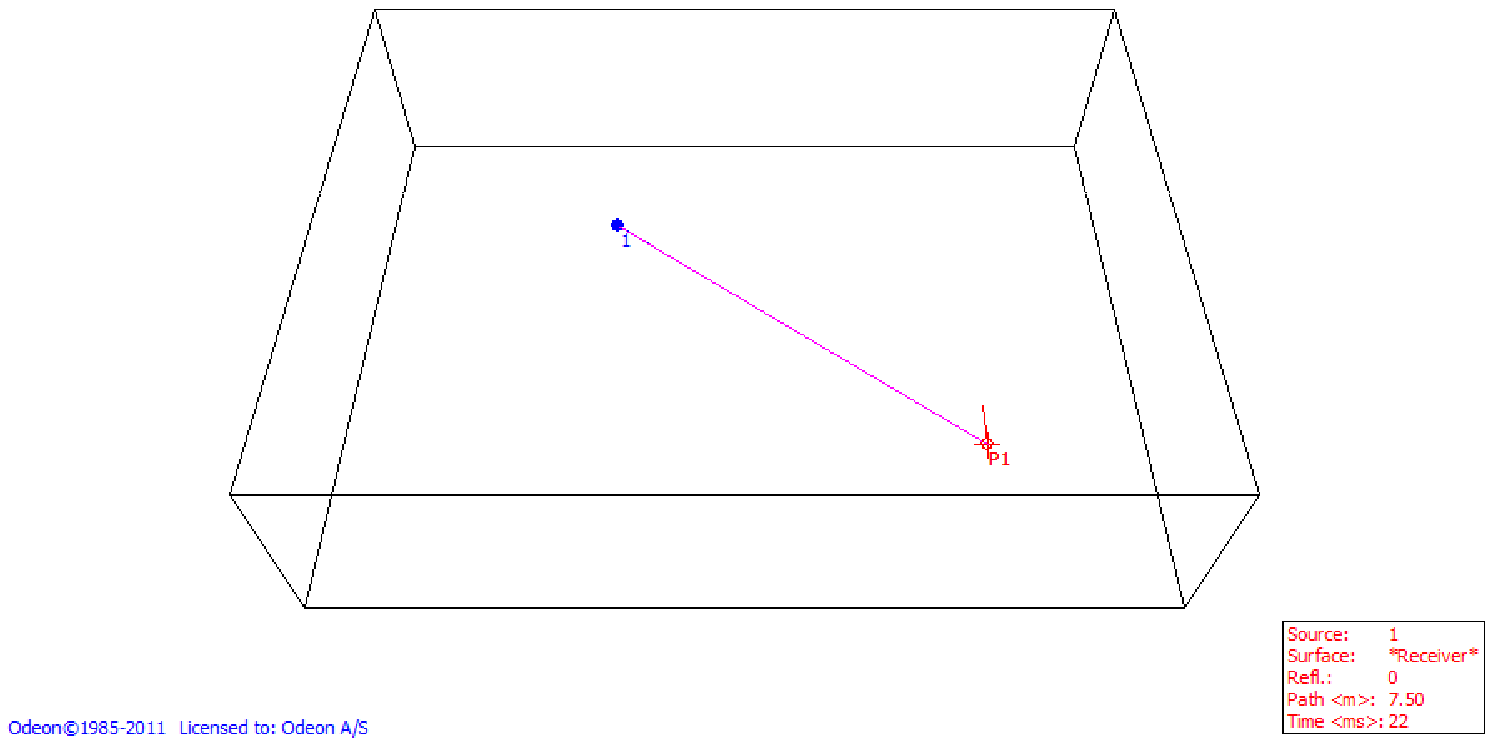
Unexpected behaviour

- Q: Is it possible that the reverberation time gets longer when increasing the absorption coefficient?
- A: Yes, it is possible in rare cases when
  - the distribution of absorption is very uneven, e.g. sound absorbing ceiling and hard walls and floor
  - Very low scattering, i.e. empty room with smooth surfaces

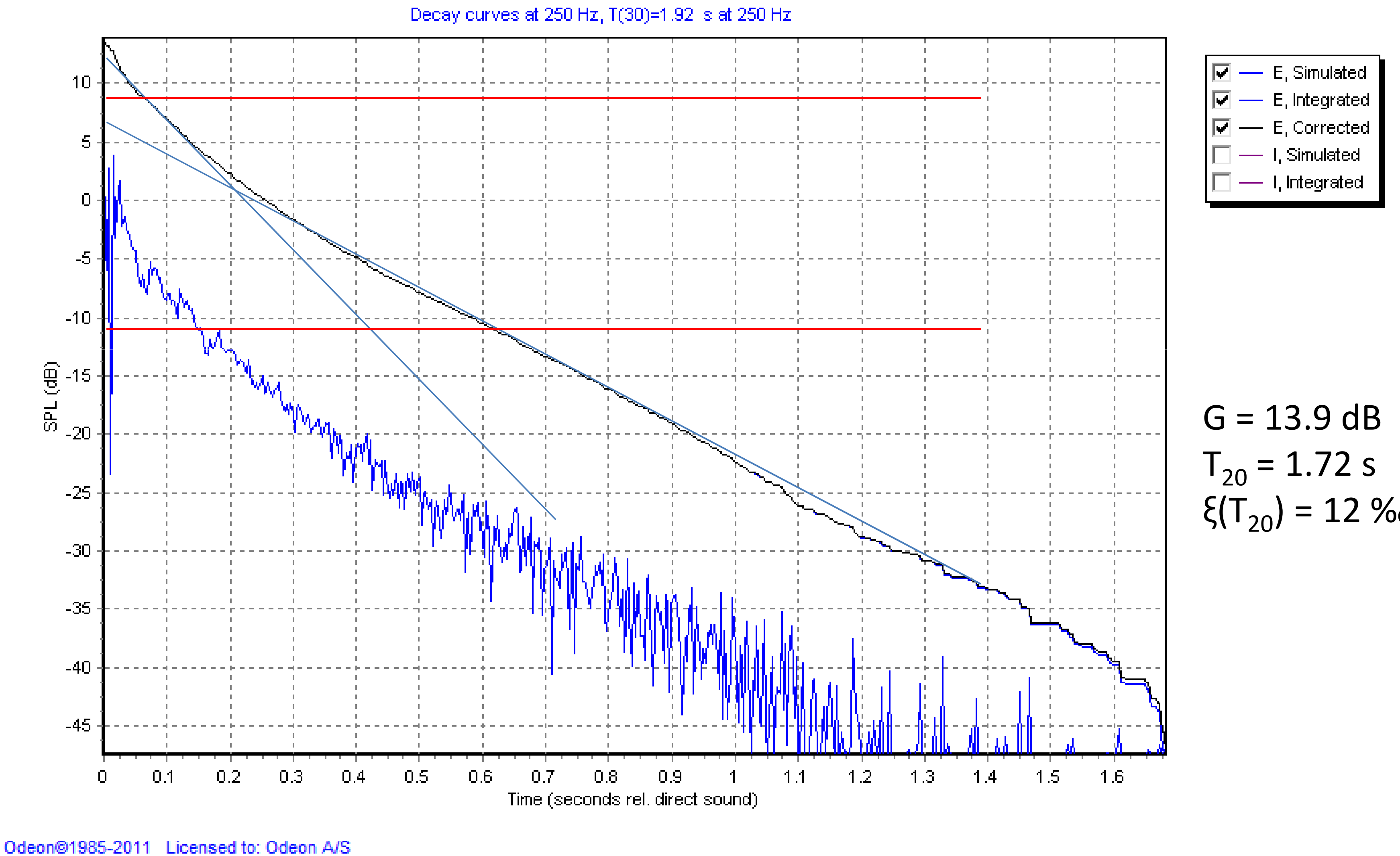
Case: Simple rectangular room



Rectangular room with smooth surfaces (low scattering)

- L*W*H = 13.5 m * 10 m * 3.5 m
- Only 250 Hz considered as example
- Floor, α = 0.04, s = 0.010
- Walls, α = 0.05, s = 0.025
- Ceiling, α = 0.90; 0.95; 1.00, s = 0.025
  - Absorption of ceiling is varied in three steps
  - Decay curves at 250 Hz are shown
  - Evaluation range for T_{20} shown with red lines

250 Hz: α = 0.90

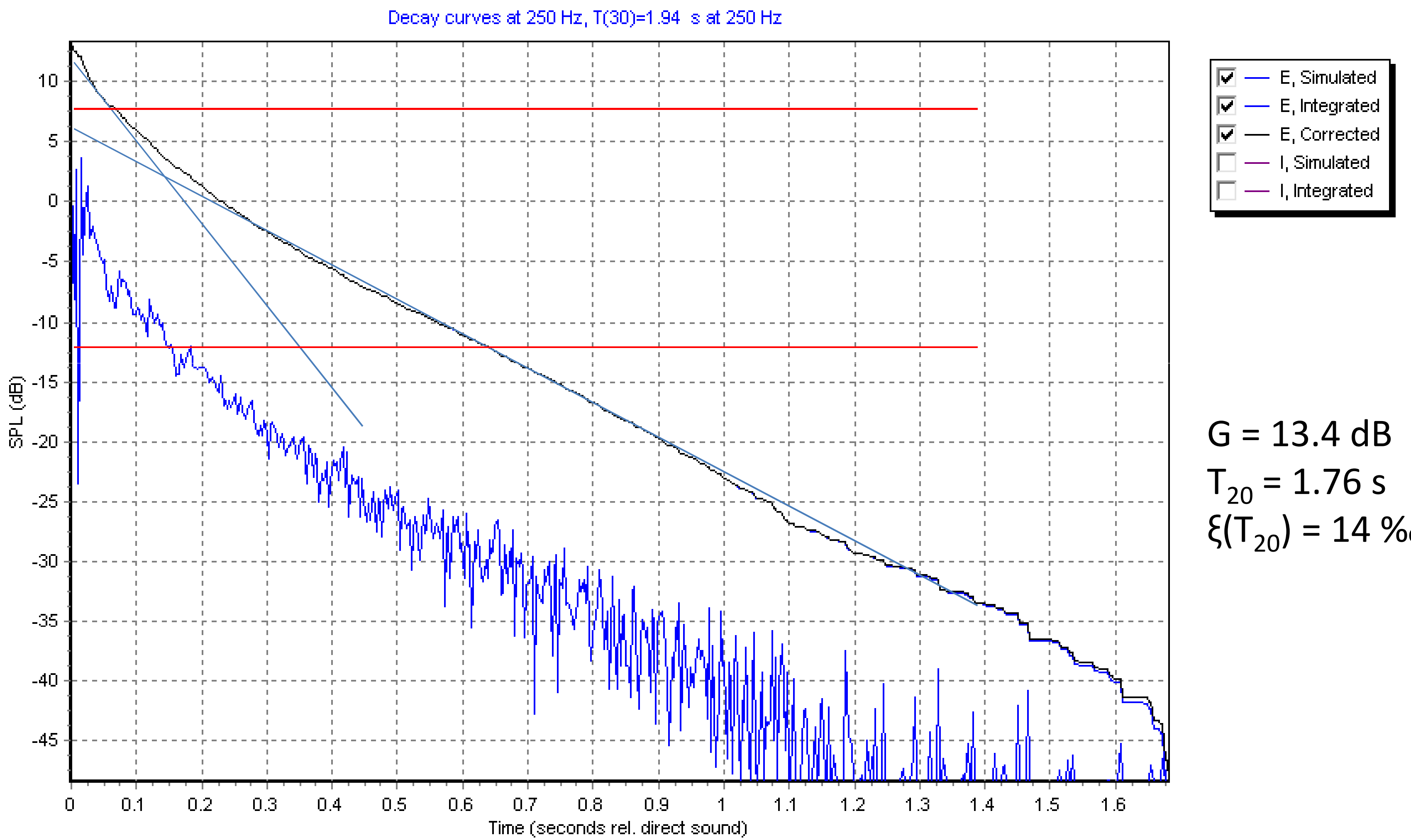


G = 13.9 dB

T_{20} = 1.72 s

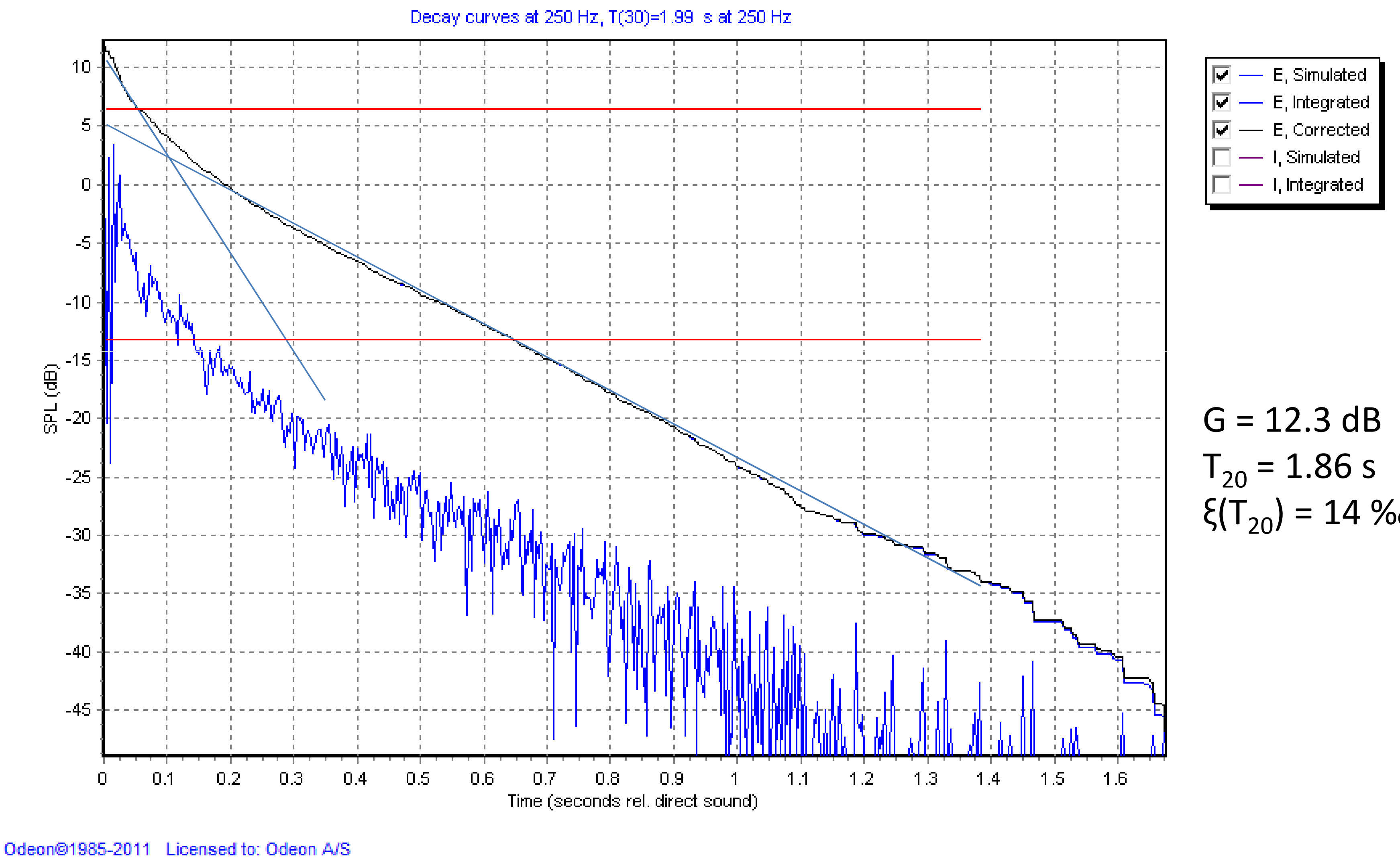
$\xi(T_{20})$ = 12 ‰

250 Hz: α = 0.95



G = 13.4 dB
T_{20} = 1.76 s
$\xi(T_{20})$ = 14 ‰

250 Hz: α = 1.00

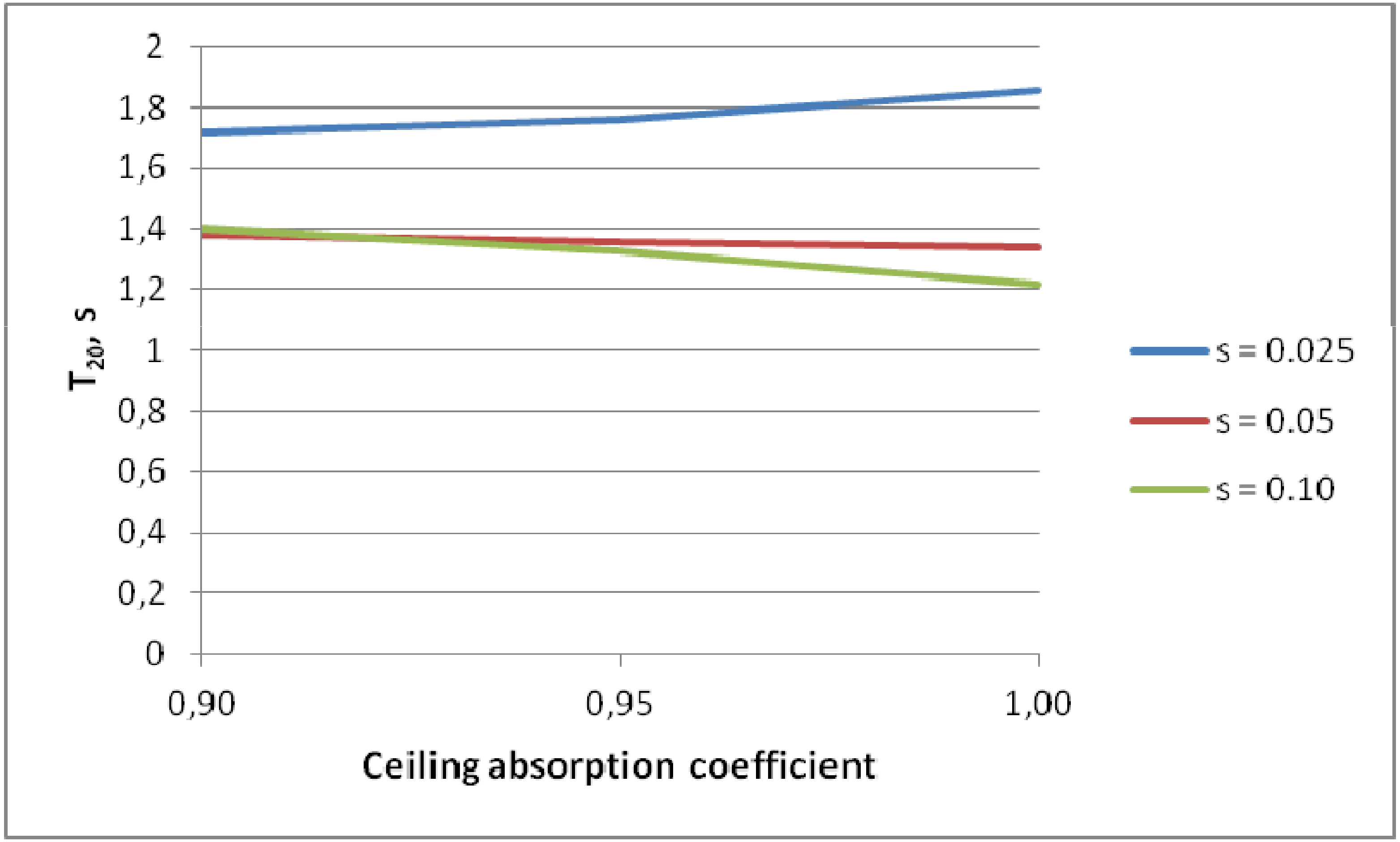


G = 12.3 dB

T_{20} = 1.86 s

$\xi(T_{20})$ = 14 ‰

Variation of T_{20} with s (walls) and α (ceiling)



Results

- The reverberation time T_{20} increases from 1.72 s to 1.86 s when α(ceiling) is changed from 0.90 to 1.00
- Note that $\xi(T_{20})$ is > 10 ‰ which is a warning that the decay curve is far from a straight line within the evaluation range (-5 to -25 dB)
- With a higher scattering coefficient of the walls (s = 0.10) the behaviour changes to a normal situation, i.e. reverberation time decreases when α(ceiling) is increased
- The steady state energy (Strength, G) decreases when α(ceiling) is changed from 0.90 to 1.00, as expected. The simulation is physically correct

Conclusion

- Decay curve has double slope
  - short RT for initial part, determined by 3D modes
  - longer RT for late part, determined by 2D, horizontal modes (not influenced by the ceiling absorption)
- Increased absorption of ceiling means
  - early part of decay gets a steeper slope, but unchanged slope of late part
  - RT increases because the late part of the decay is lifted relatively and thus becomes more important for T_{20}