7.7.4.2 Damping of longitudinal waves

Chapter 7.7.4.1 had shown that a coupling of transversal string-vibrations occurs at the bridge and at the nut (or fret). In addition, transversal and longitudinal oscillations exchange part of their oscillation energy, as well (Chapters 1.4 and 7.5.2). The dilatational waves induced that way showed high loss factors in the decay measurements: individual partials decay rapidly, i.e. they exhibit short decay times. For the following vibration measurements, a **Fender US-Standard Stratocaster** was used with its tremolo (aka vibrato) genre-typically adjusted to be *floating*. The investigated string was plucked fretboard-normally close to the nut; an oscillation analysis was made close to the bridge using a laser vibrometer.
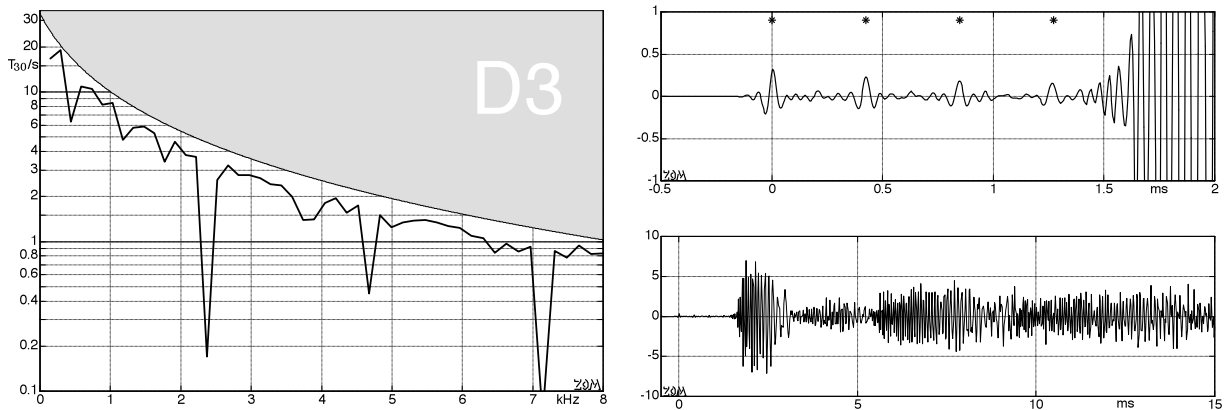

Fig. 7.70: Decay (left) and time function of the fretboard-normal velocity. Dilatational wave period = 0.42 ms.

For the fretboard normal velocity, the left-hand image in **Fig. 7.70** shows the decay time of the D_3-partials. Damping maxima – i.e. T_{30} minima – can be identified at 2.36, at 4.7 and at 7.1 kHz; **resonances of dilatational waves** can be assumed to be the cause. In the time function we can see that - even before the transversal wave arrives at the measurement point – small impulses with a periodicity of 0.42 ms occur. Although the laser vibrometer (which is sensitive to lateral string oscillations) cannot itself detect the dilatational waves, it does capture their secondary waves (Chapter 1.4). Apparently, dilatational waves are absorbed efficiently in the wound D-string, and a selective damping arises at a frequency of 2.36 kHz (and its multiples).

Depending on how well the resonance frequency of the dilatational wave matches the frequency of the partials, this dilatational-wave damping can be more or less pronounced. The measurements done until now let us assume that especially the fretboard-normal oscillation can transfer its energy to the dilatational wave; the cause could be the curvature of the string at the bearing (Chapter 7.5.2). In **Fig. 7.71**, the level drops of the partials of the D-string are represented: the fretboard-normal oscillation decays very fast at 2364 Hz, while the fretboard-parallel oscillation exhibits a decay time as it is found with the adjacent tones.
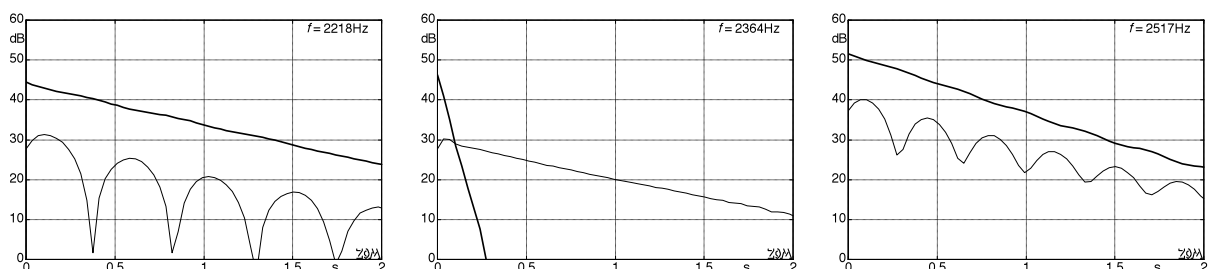

Fig. 7.71: Level drop of partials; bold = fretboard-normal oscillation, thin = fretboard-parallel oscillation