## Experimental Verification of Pickup Nonlinearity

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#### July 11, 2014



## Introduction – the magnetic pickup

The electromagnetic field that surrounds the pickup is not homogeneous.



The relationship between a string vibration and a corresponding pickup signal is a nonlinear function and it is different for the string that vibrates in the vertical plane, compared to the string that vibrates in the horizontal plane.

## Measured bass guitar



A thin cotton thread is looped around the string at a desired location x, and a triangular shaped initial condition is induced with a suitable amplitude as well as in the desired direction. The thread snaps when burned with a flame.





The string displacement is video recorded by using a high-speed line scan camera.

#### Camera set-up



The mirror is placed under a  $45^{\circ}$  angle relative to *y*-axis. The vertical and horizontal displacement are recorded simultaneously.

# Examples of recordings



a) Triangular shape initial condition

b) Plucked with a plectrum

## Pluckud string vibration - plectrum



### Measurement results - vertical excitation





#### Measurement results - horizontal excitation





# Accuracy of the mapping curves, application

$$u_{\varepsilon m}(t) = Z(u_z(t)) + Y(u_y(t))$$



Possible application: physics based sound synthesis of the magnetic pickup

- The nonlinearity of the magnetic pickup was experimentally verified
- String vibration in two perpendicular planes and the corresponding magnetic pickup signal were measured
- The string vibrations were measured by using a novel optical measuring technique based on the application of the line scan camera
- The accuracy of the measured mapping functions was demonstrated and a possible application of the measurement was proposed