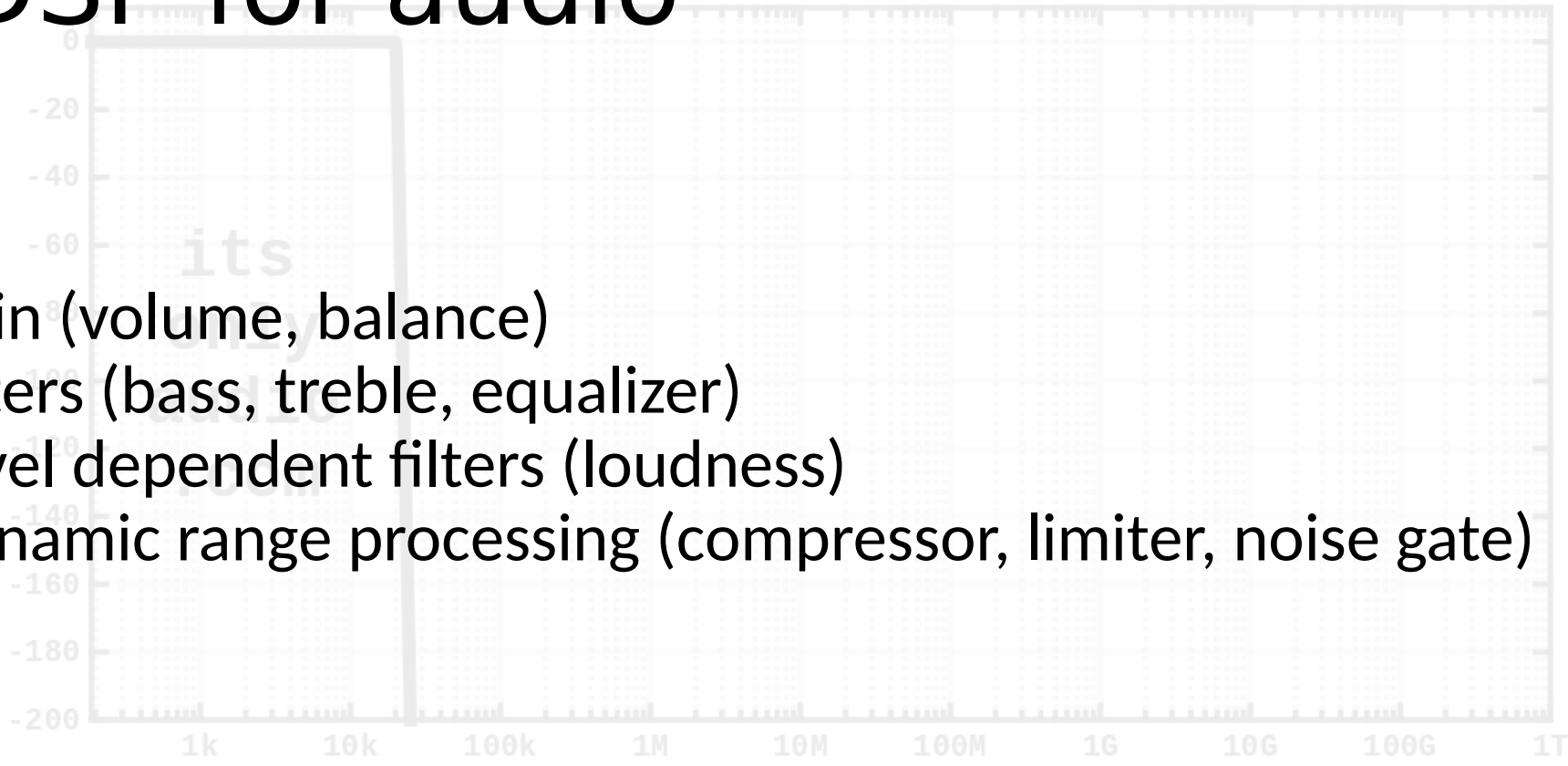
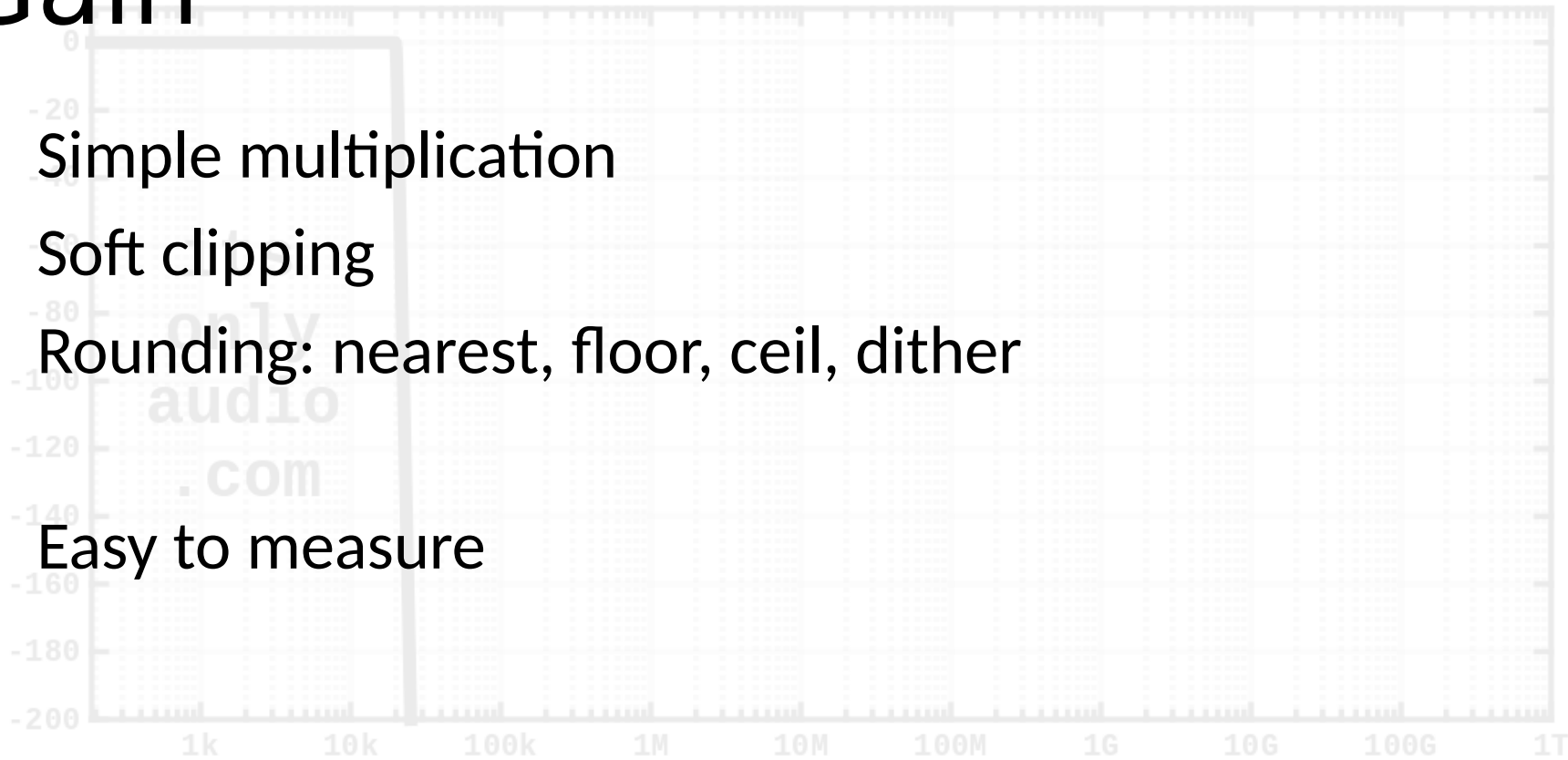
# DSP for audio




- gain (volume, balance)
- filters (bass, treble, equalizer)
- level dependent filters (loudness)
- dynamic range processing (compressor, limiter, noise gate)

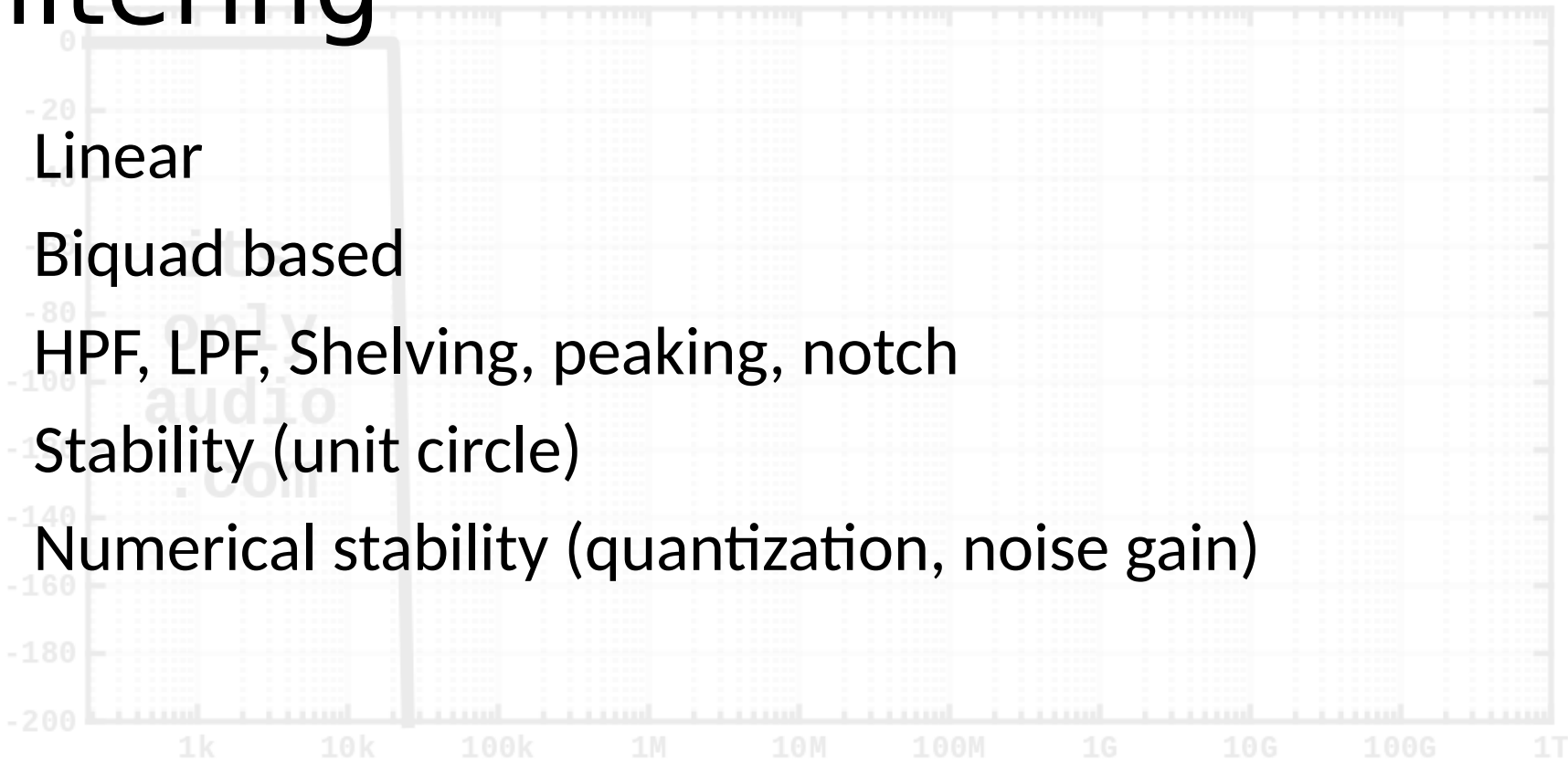
# Gain




- Simple multiplication
- Soft clipping
- Rounding: nearest, floor, ceil, dither

- Easy to measure

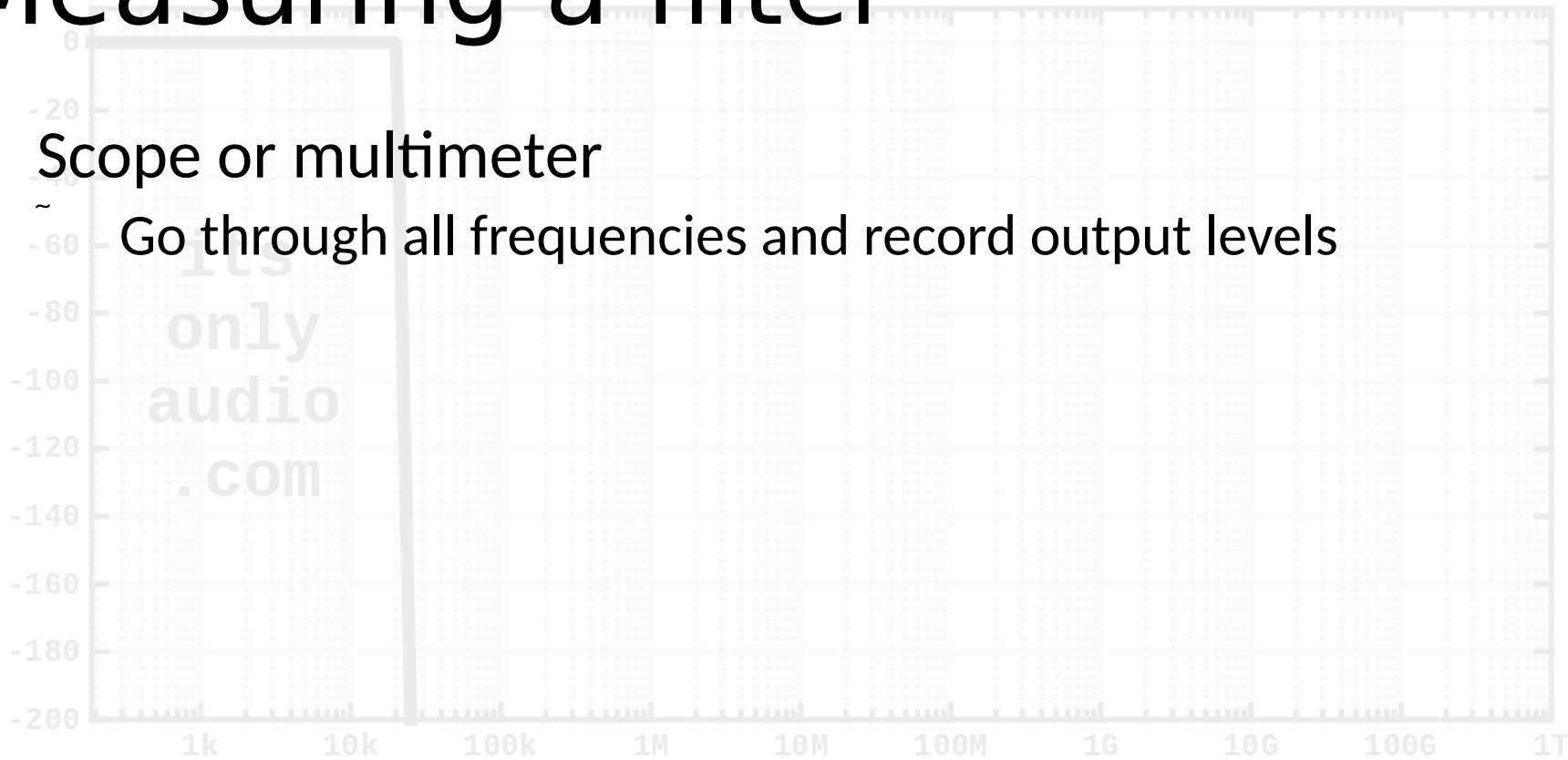
# Filtering




- Linear
- Biquad based
- HPF, LPF, Shelving, peaking, notch
- Stability (unit circle)
- Numerical stability (quantization, noise gain)

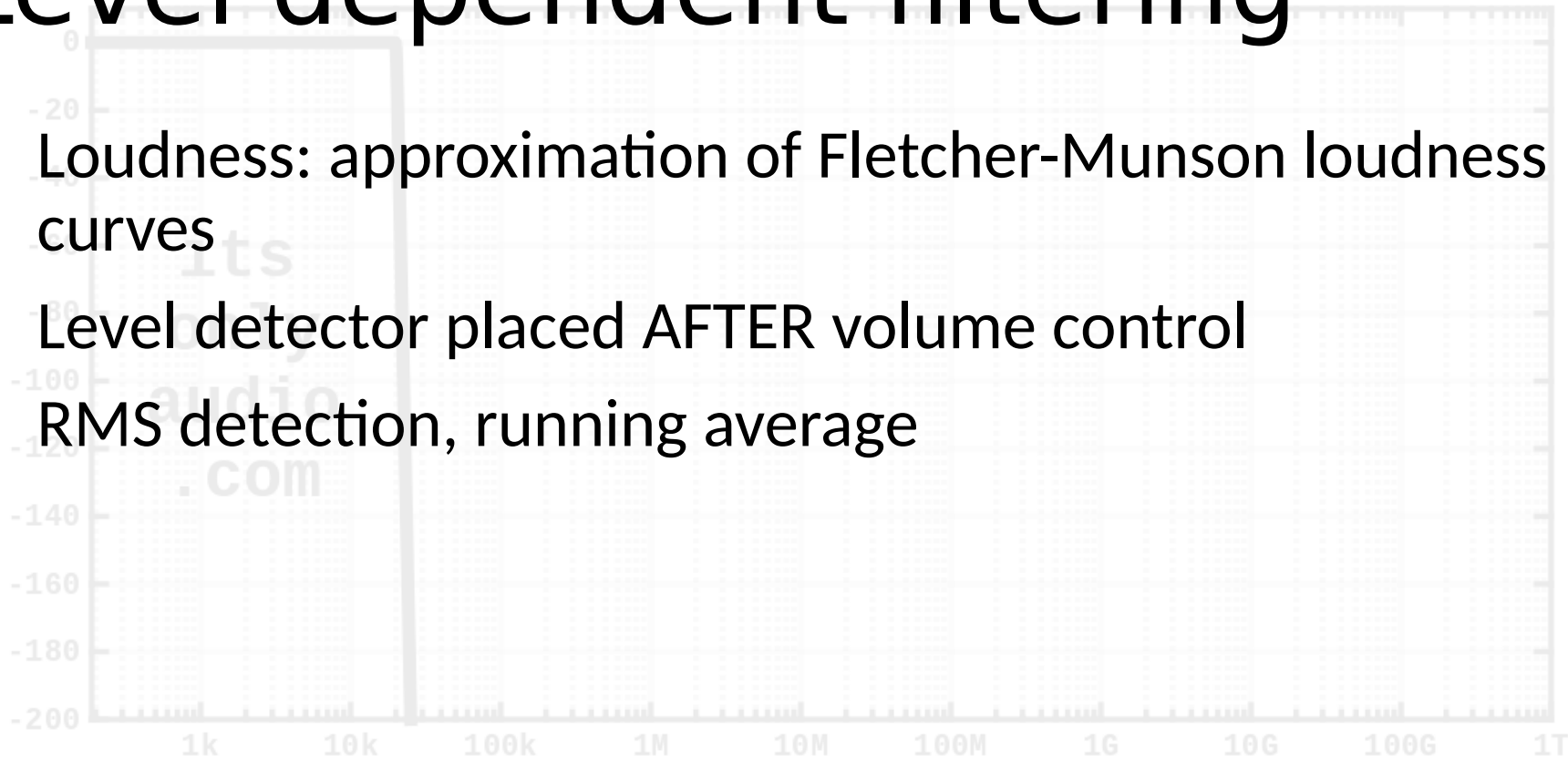
# Measuring a filter

- Scope or multimeter
  - Go through all frequencies and record output levels



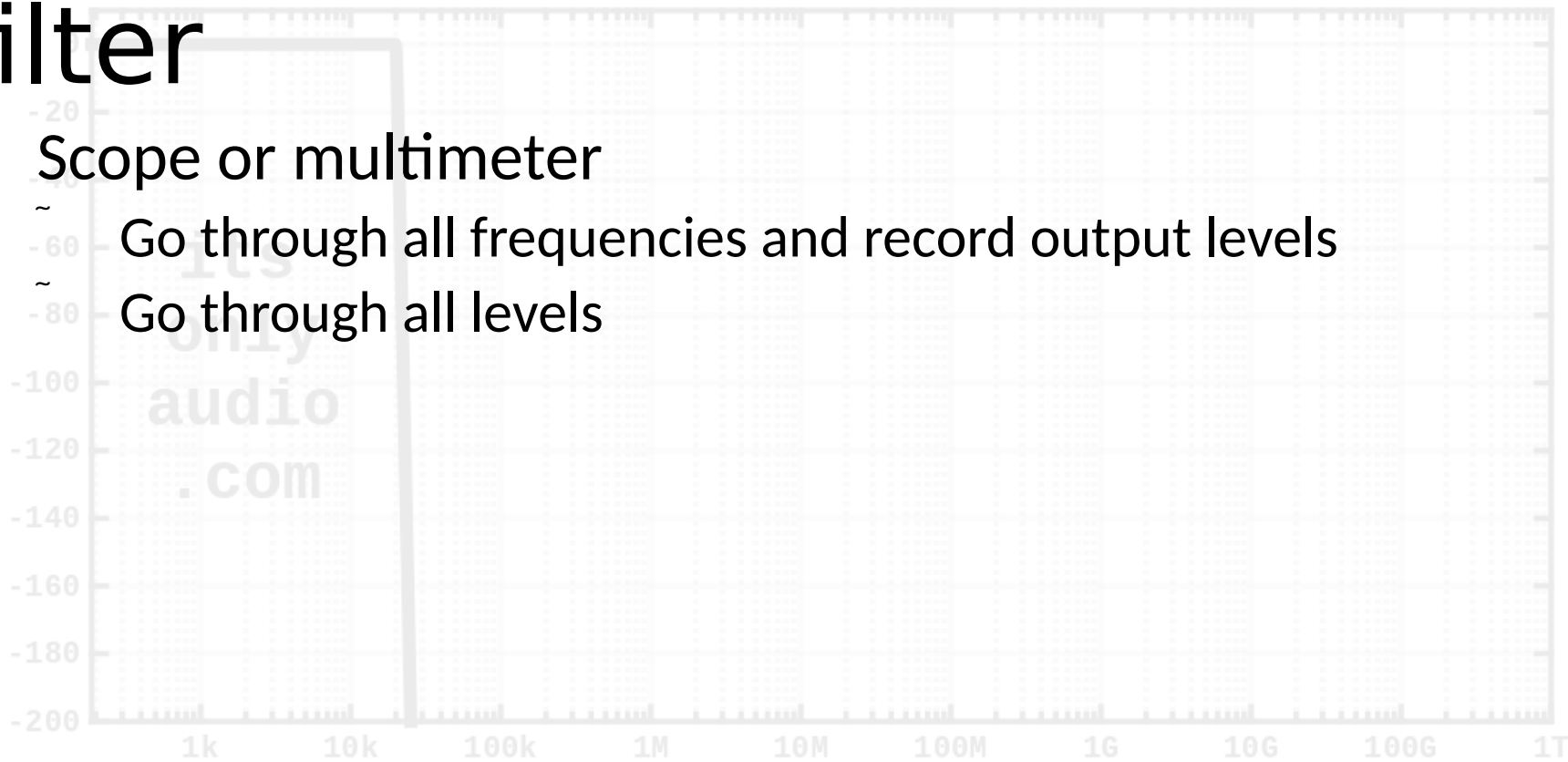
# Level dependent filtering

- Loudness: approximation of Fletcher-Munson loudness curves
- Level detector placed AFTER volume control
- RMS detection, running average



# Measuring a level dependent filter

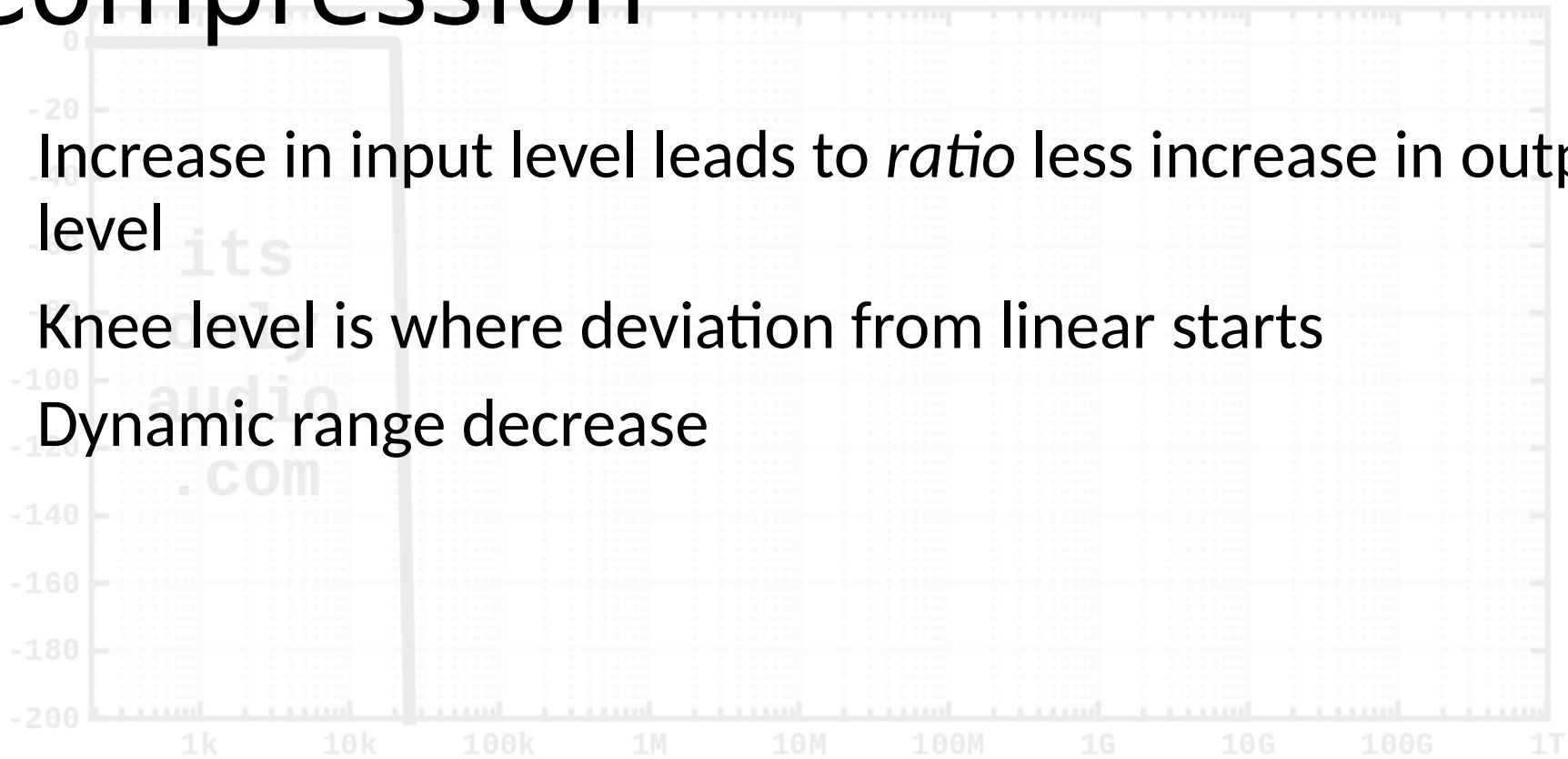
- Scope or multimeter
  - Go through all frequencies and record output levels
  - Go through all levels



# Dynamic range processing

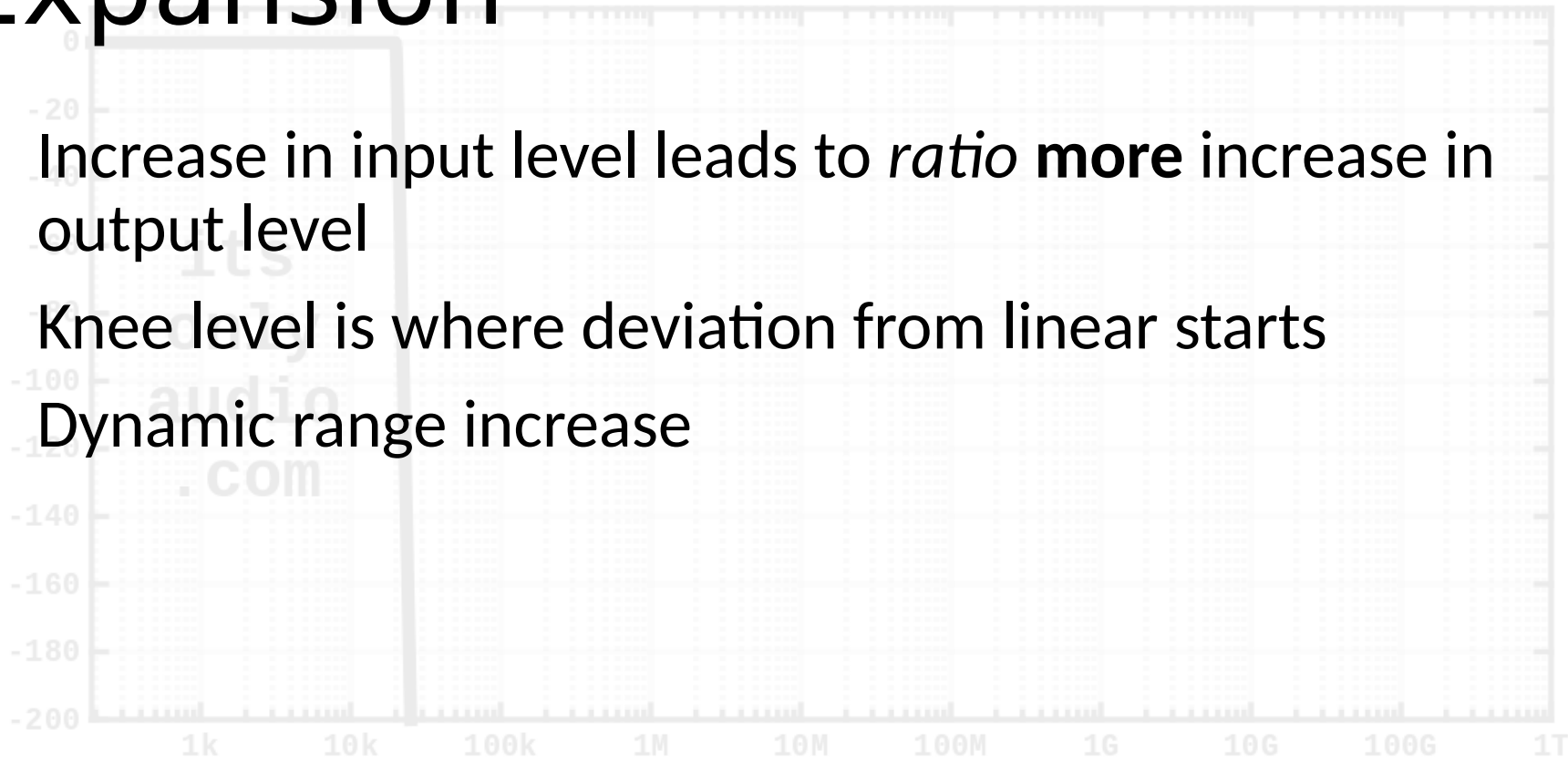
- RMS Level dependent -> instantaneous Gain
- Modes: Linear, compressing, expanding, noise gate, limiter
- Transitions between modes have time constants (attack – decay – sustain – release)
- Behavior fully dependent on settings, no one size fits all

# Compression



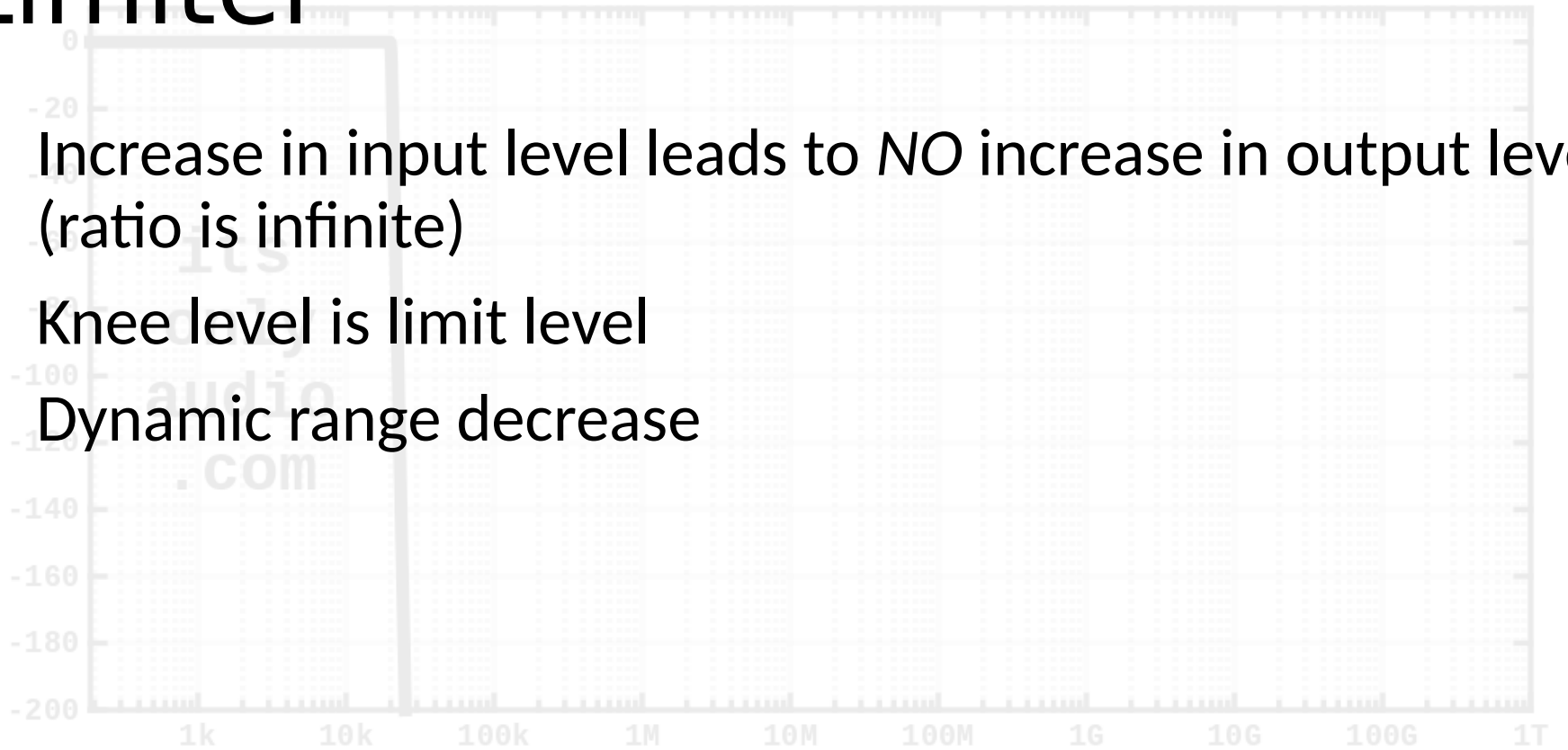

- Increase in input level leads to *ratio* less increase in output level
- Knee level is where deviation from linear starts
- Dynamic range decrease

# Expansion




- Increase in input level leads to *ratio* **more** increase in output level
- Knee level is where deviation from linear starts
- Dynamic range increase

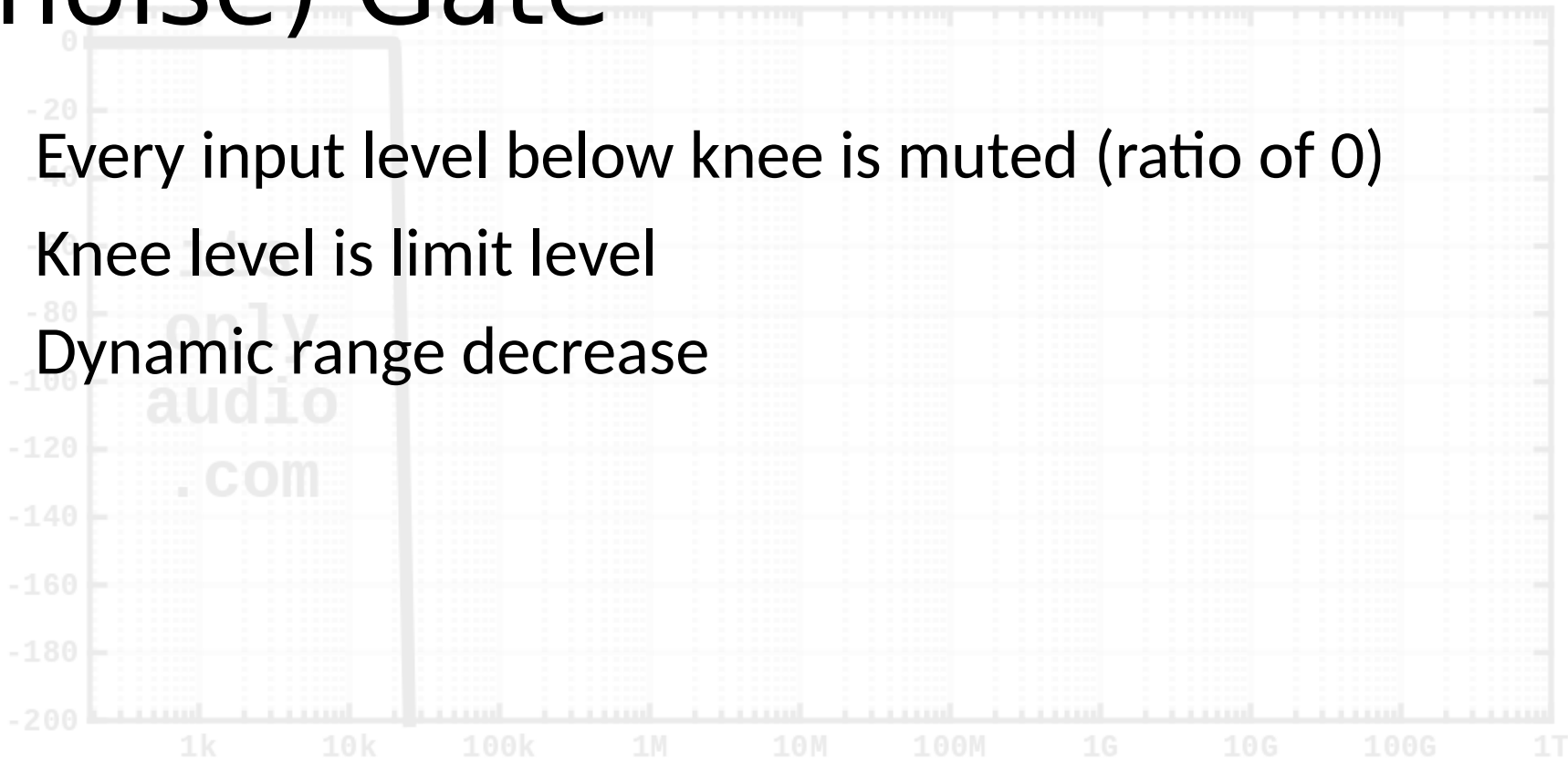
# Limiter




- Increase in input level leads to *NO* increase in output level (ratio is infinite)
- Knee level is limit level
- Dynamic range decrease

# (noise) Gate

- Every input level below knee is muted (ratio of 0)
- Knee level is limit level
- Dynamic range decrease



# Practical compressor

- Noise gate for low input levels
- Linear or expansion range
- Compression range
- Limiter range
- Post (make up) gain
- ADSR time constant settings

# Measuring a compressor

- Steady state (RMS): scope or multimeter
  - Go through all input levels and record output levels
- Transient: scope
  - Use tone bursts to verify A-D-S-R