Rub & Buzz testing beyond the Human Ear

Wolfgang Klippel,
Stefan Irrgang

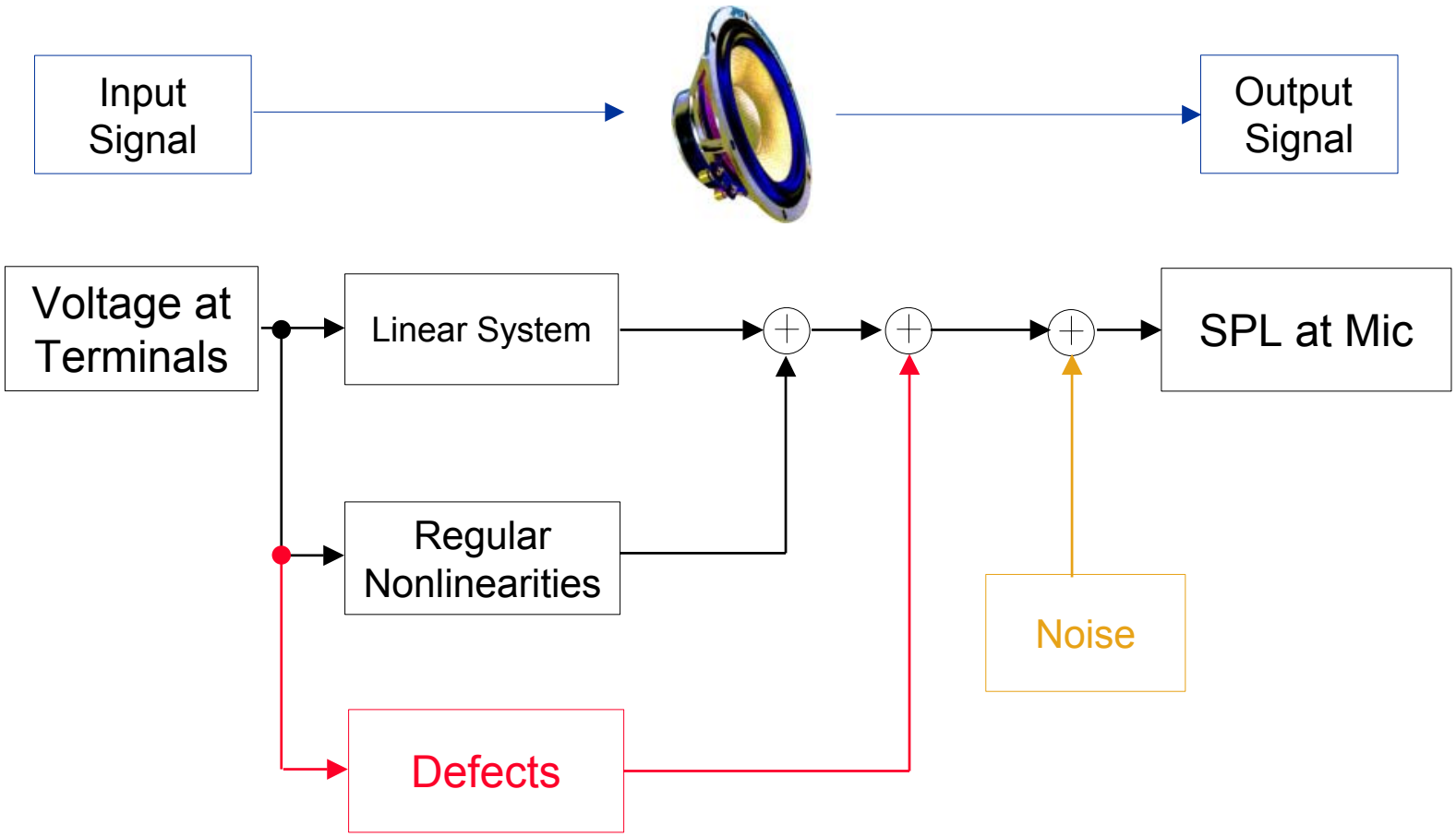
KLIPPEL GmbH

Winter Symposium ALMA International 2006

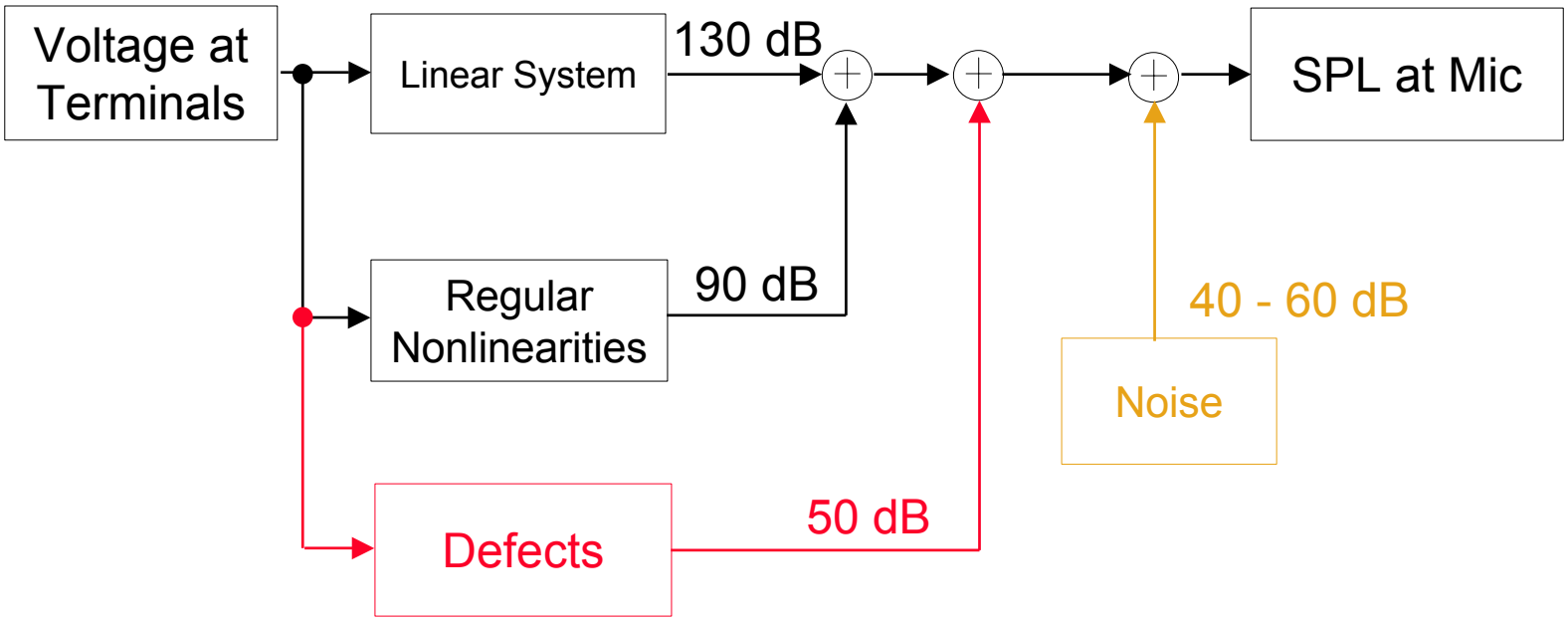
Requirements for 100 % testing

1. reliable detection of defect units
2. robustness against ambient noise
3. high speed
4. flexibility for customer‘s needs
5. simple use
6. cost effective solutions
7. *In future → on line diagnostics ?*

Generation of Signal Distortion



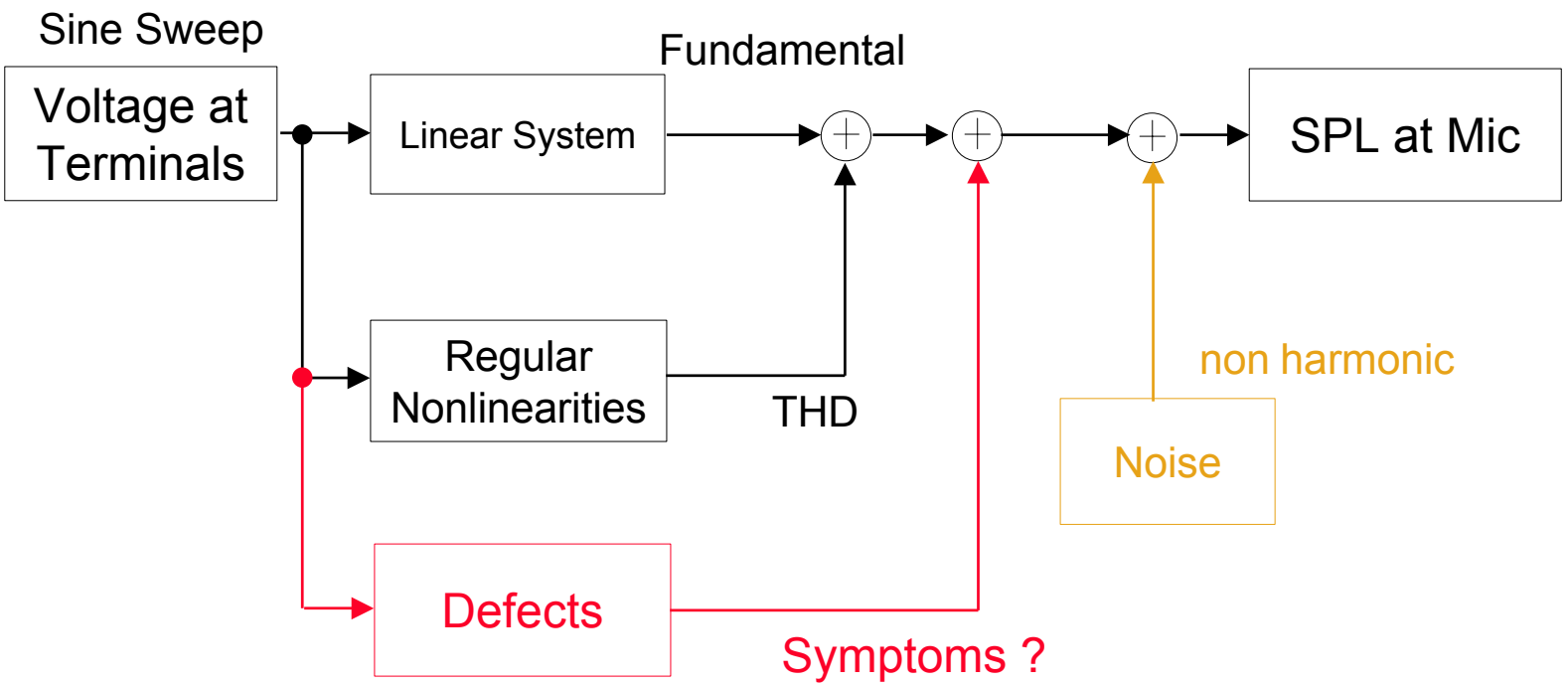
Level of the Signal Components



Problems:

- symptoms of defects are very small (but still audible)
- ambient noise in a production environment

Analysis with Sinusoidal Excitation

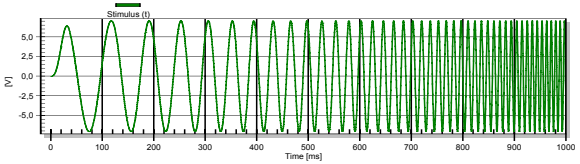


Advantages:

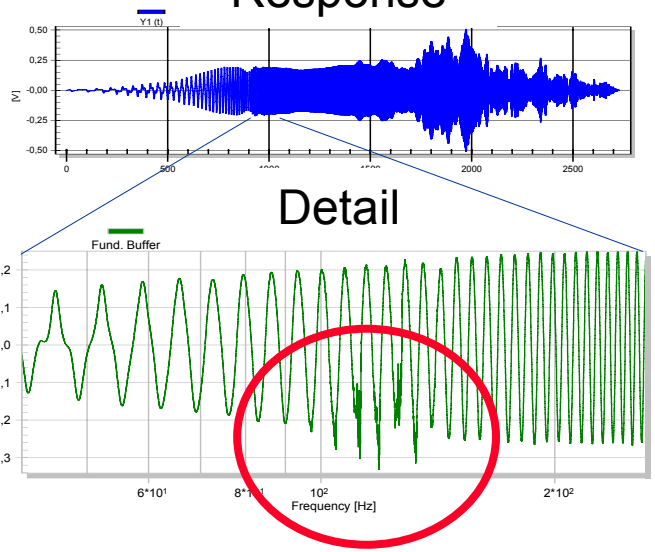
- Simple separation using High-Pass
- Minimal masking of defects for human testing
- Exciting all frequencies

Excite ALL Frequencies

Stimulus



Response

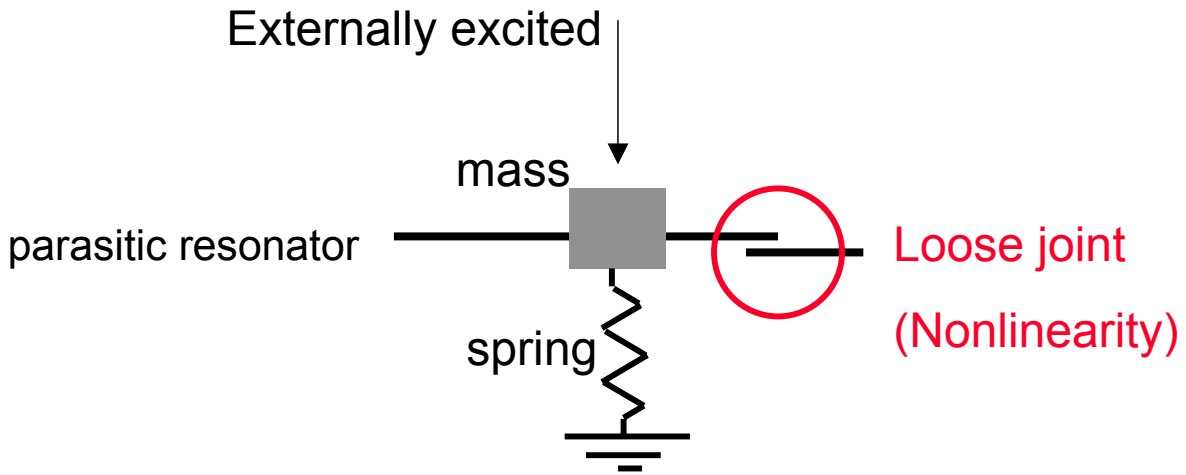


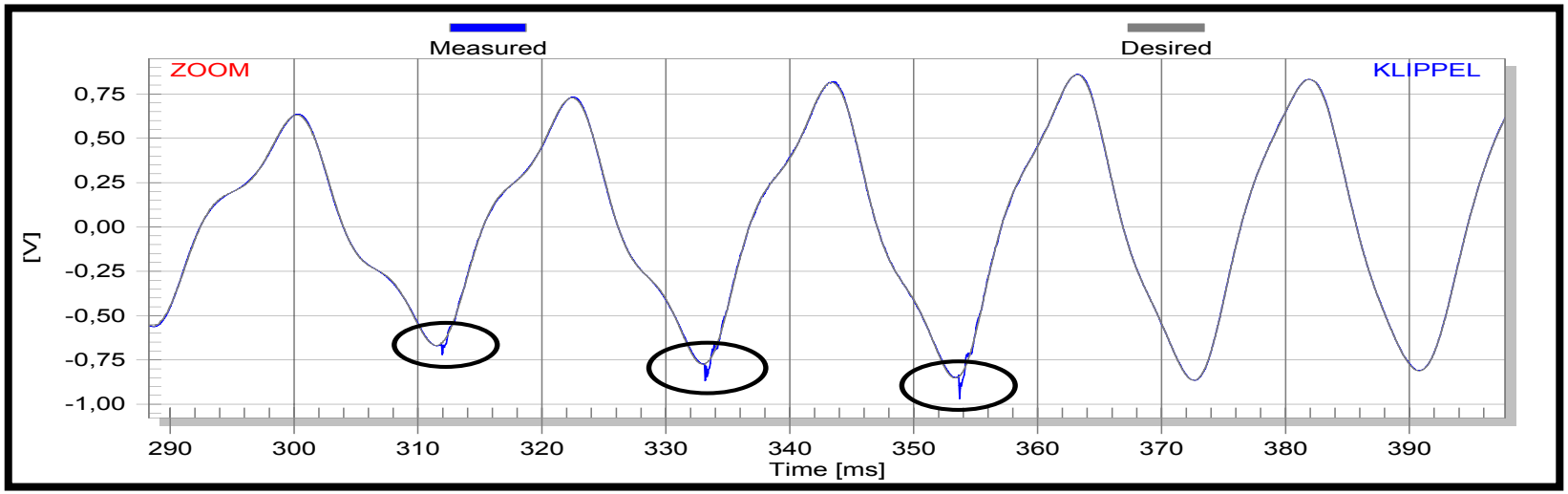
Why using continuous sweep?

- Defects: high Q resonators
- Missed, if not excited exactly
- Critical: Stepped excitation with low resolution

Physics of a Loudspeker Defect

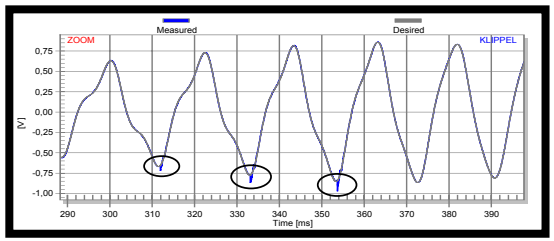
Example: glue problem





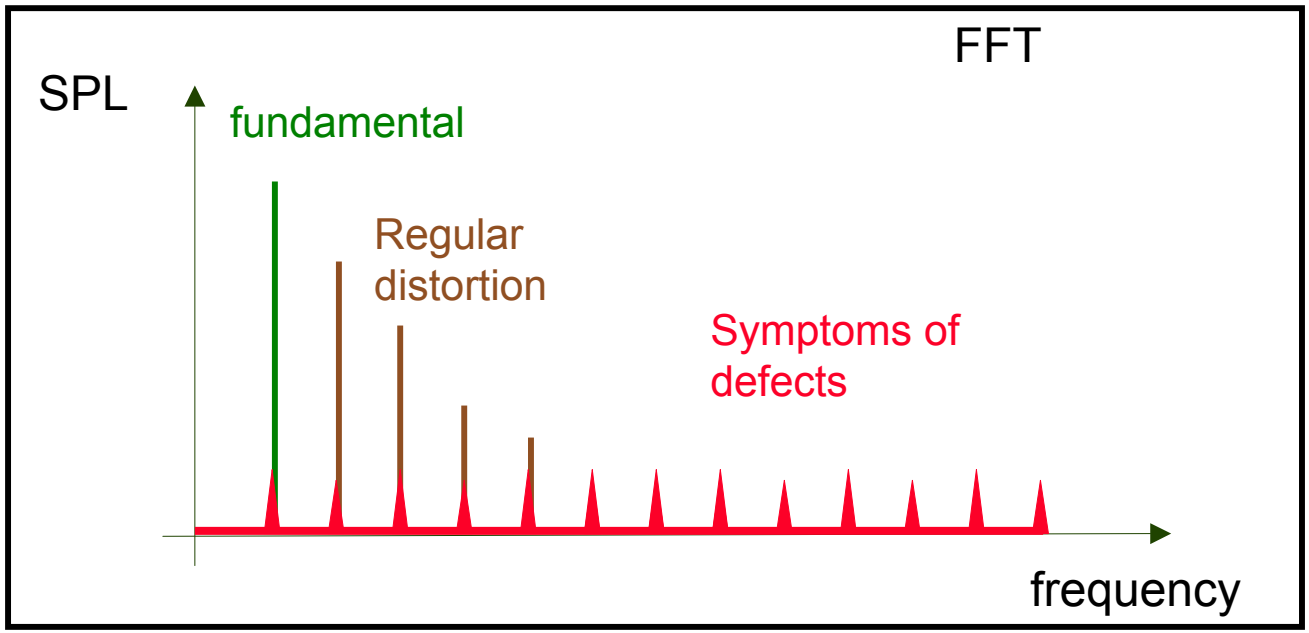
Spectral Analysis of Defects

Sinusoidal Excitation



Time-domain

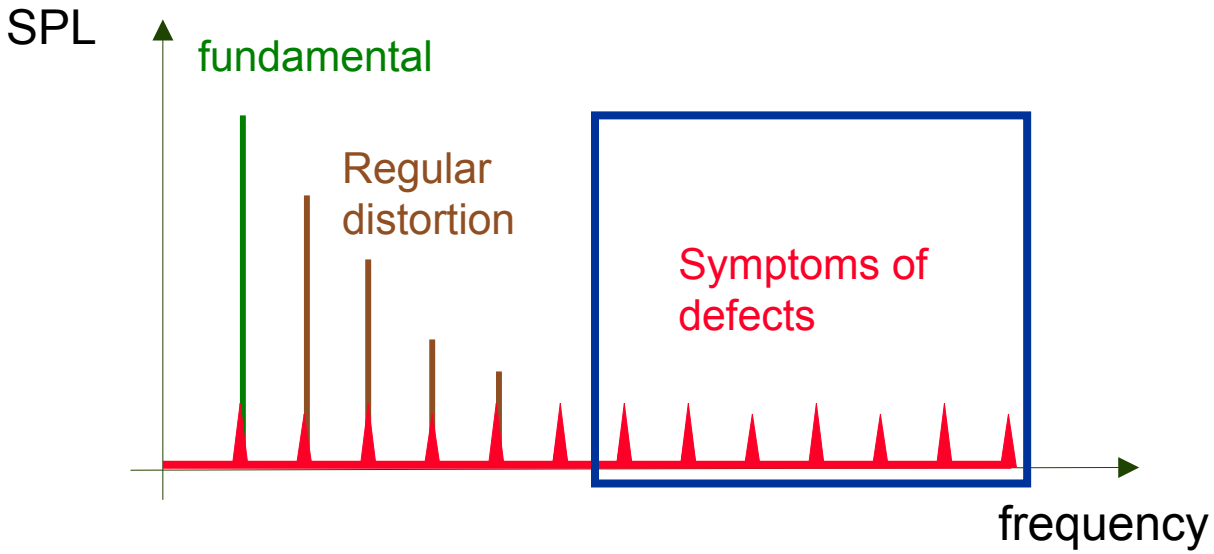
FFT



Frequency domain

Symptoms of Defects

1. Separation from Fundamental

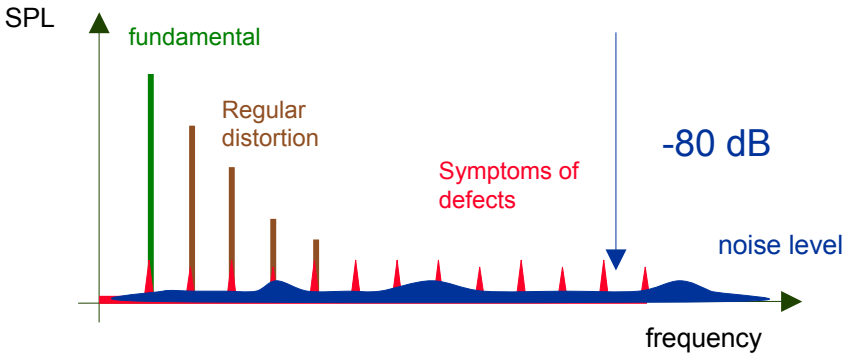


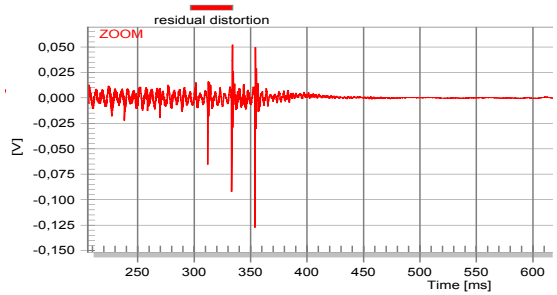
Measurement of higher-order harmonics :

- Tracking filter (→ Ortophon, K&K, Etani)
- Band-pass filter (→ NTI)
- FFT (→ Listen)

Symptoms of Defects

2. Collecting energy in time domain





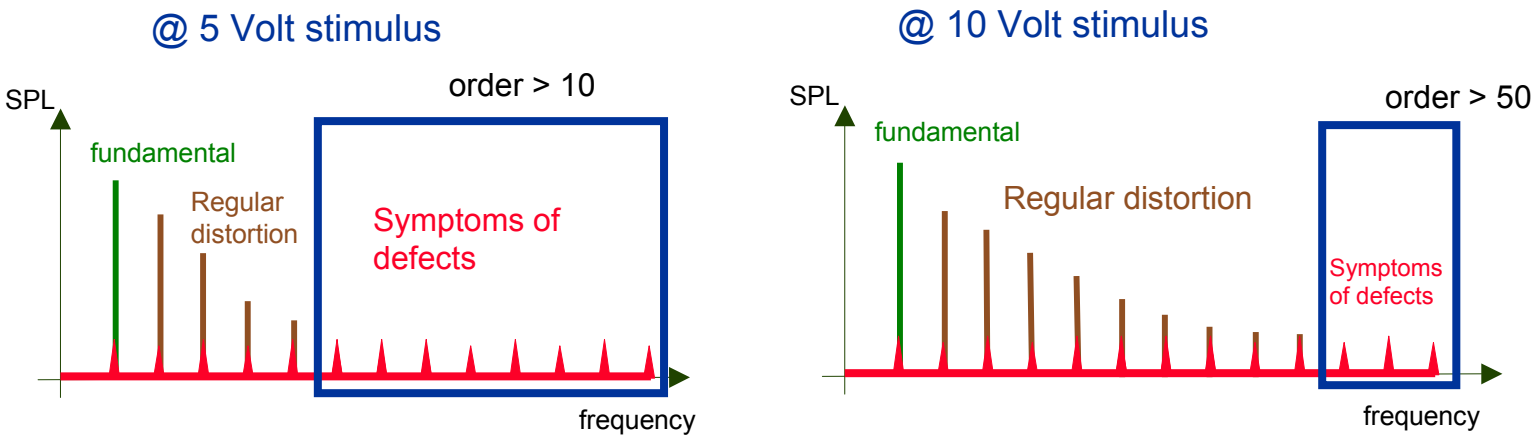
Frequency Domain

Time Domain

- Rms value of higher-order harmonics is close to noise level
- Solution → back to the time domain
- exploiting amplitude and phase of higher-harmonics
- envelope and peak value reveal small transients (clicks)

Symptoms of Defects

3. Dependency on Amplitude



- Regular distortion rise with amplitude
  → masking of higher-order harmonics
- Filter with higher cut-off frequency required
  → symptoms have less energy (noise problems)
  → defects hardly detectable
- Some defects start to appear at high levels!
  → High levels are needed

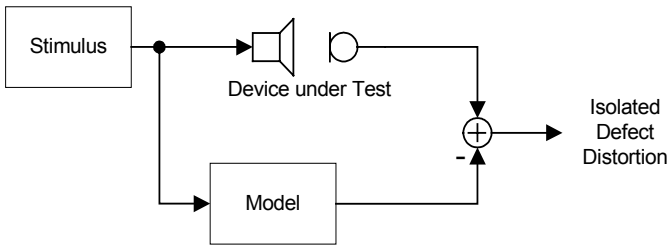
Problem: Missing or Masking (?)

Symptoms of Defects

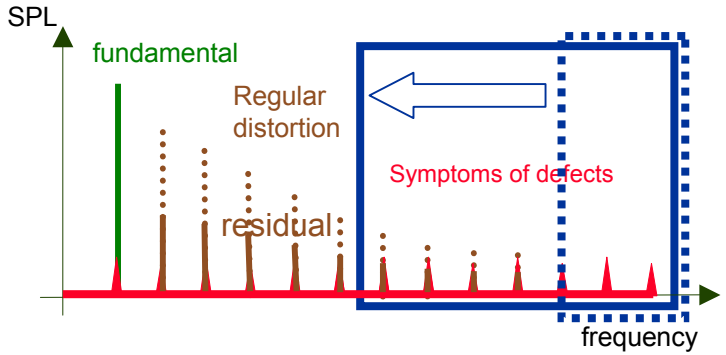
4. Measurement at high amplitudes

Solution:

Regular distortion are predictable



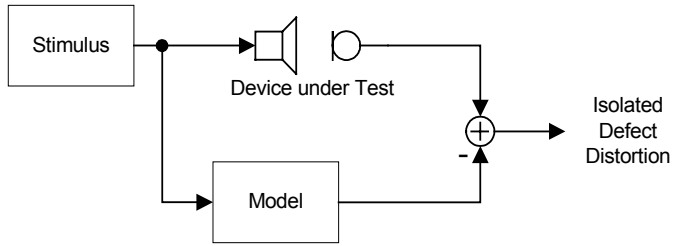
@ 10 Volt stimulus



→ active compensation
(meta-hearing technology)

- Masking by regular distortion can be removed
- Higher bandwidth for symptoms
- More destinct symptoms for defects

Meta-hearing technology

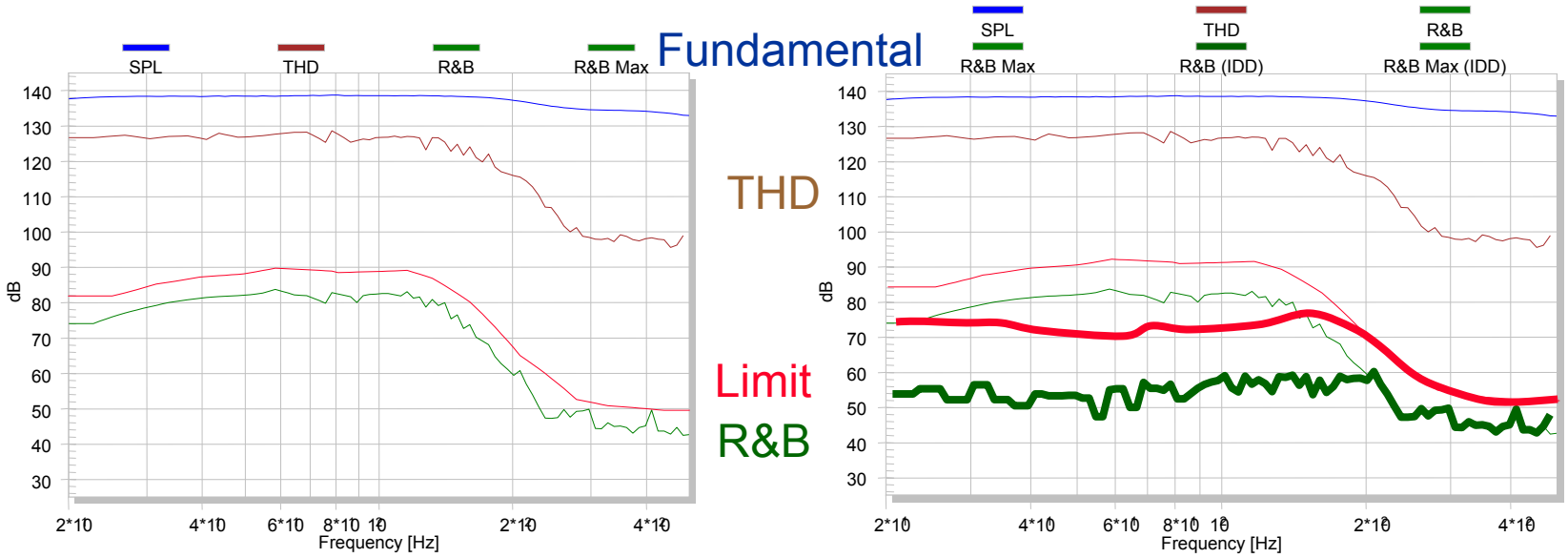


Benefits:

- Test of driver at maximal amplitude becomes possible
- Simple definition of PASS / FAIL thresholds
- Detection of defects with low energy (loose particles)
- Detect failures even if they are inaudible

  (getting worse in final application)

Example: Meta-hearing Technology

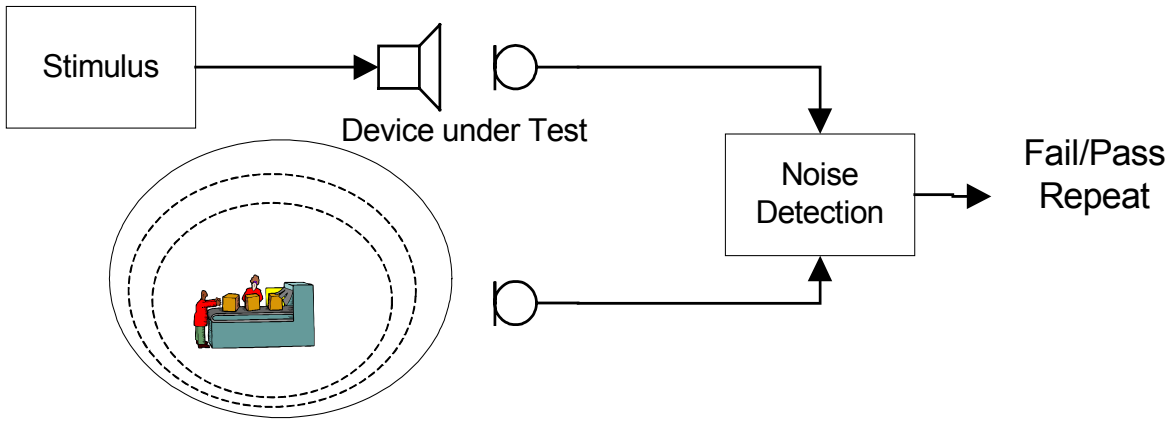


Without compensation

With compensation

→ Reduction of Limit below uncompensated measurement

Robustness against ambient noise



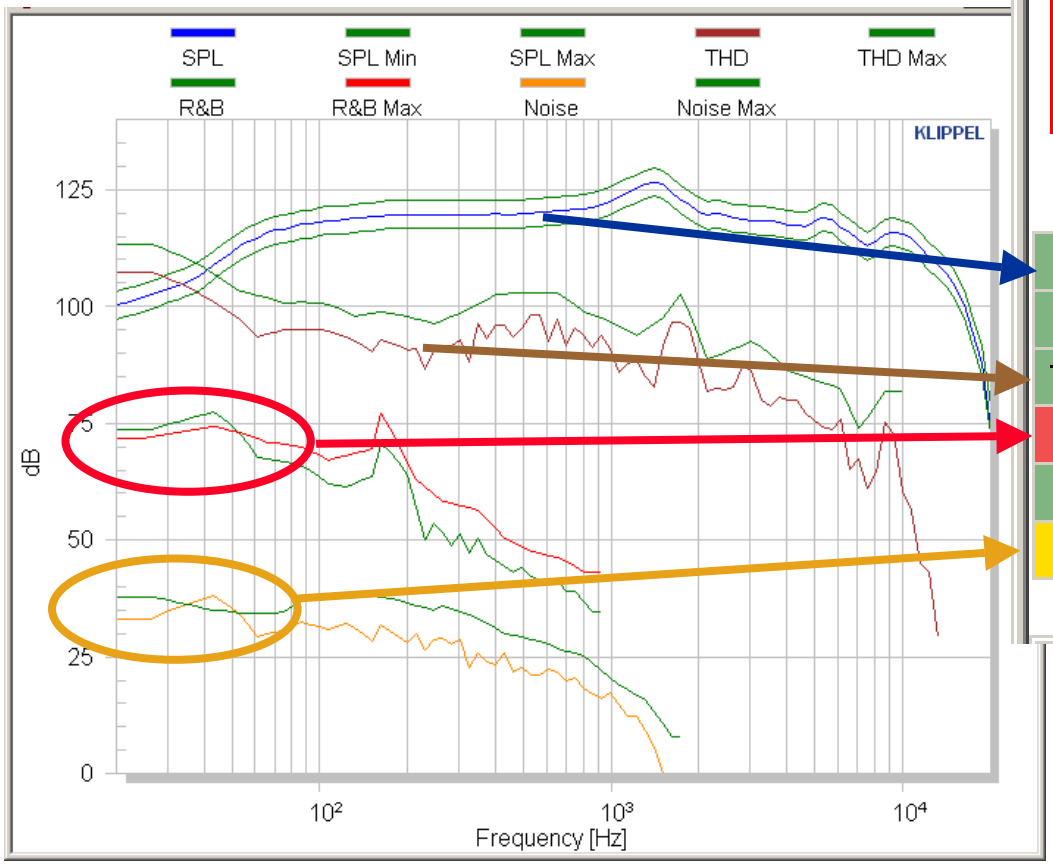
Solution:

→ Measure noise in the far field

→ Predict noise at the near field

→ Repeat corrupted measurements

Example: Ambient Noise Immunity



FAIL

- SPL
- Level
- THD
- Rub+Buzz IDD
- Polarity
- Noise

→Repeat Measurement

→Isolate Box

Requirements for 100 % testing

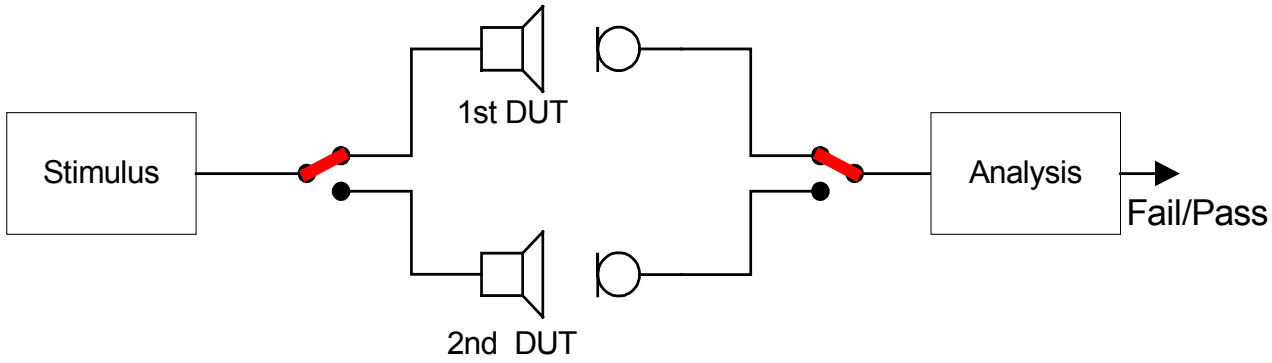
1. reliable detection of defect units
2. robustness against ambient noise
3. high speed
4. flexibility for customer‘s needs
5. simple use
6. cost effective solutions
7. *In future → on line diagnostics ?*

High Speed Performance

Solution:

→ Alternating measurement

handling one while measuring a second DUT



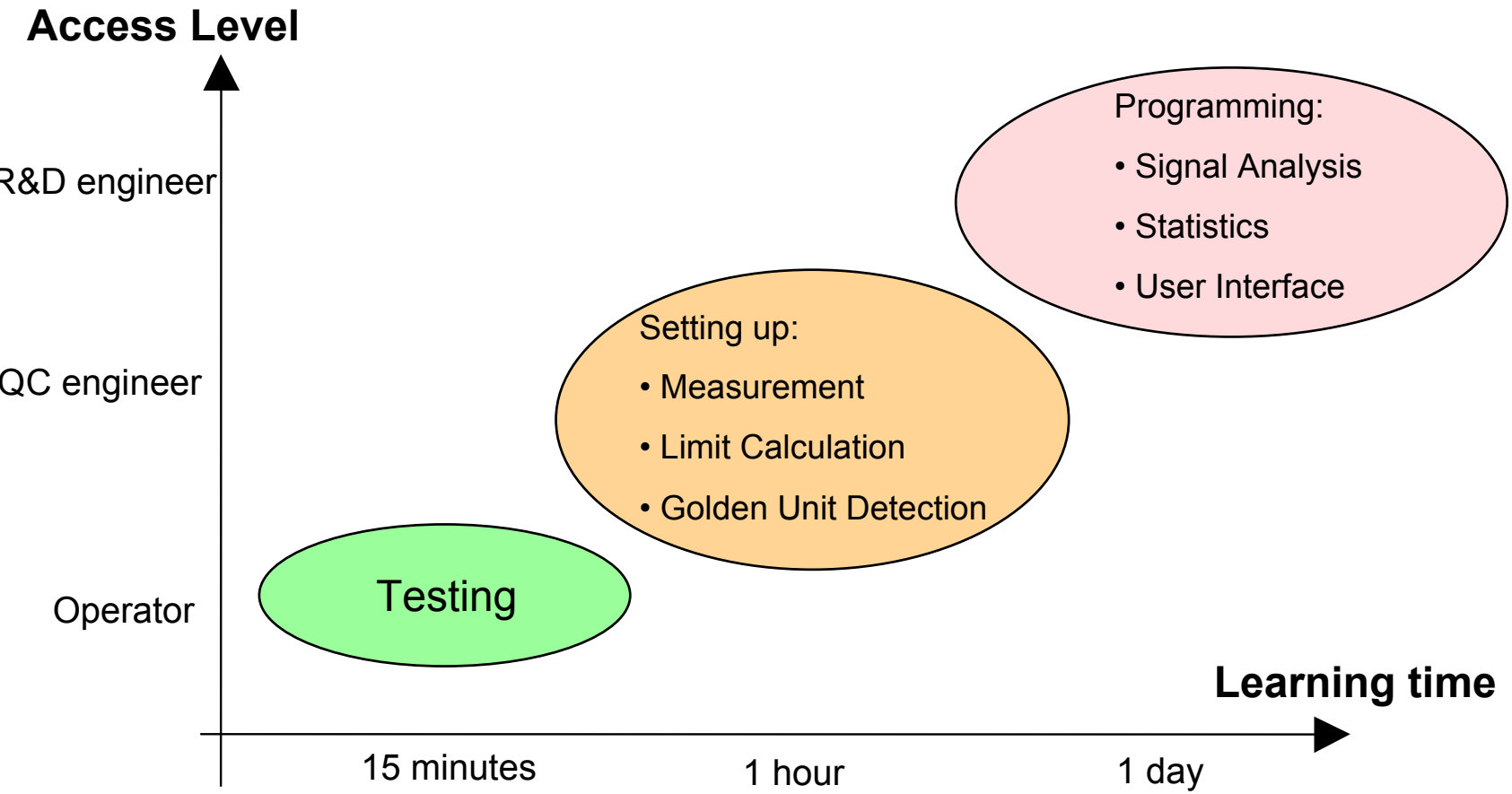
→ Signal processing parallel to measurement

result available after excitation, minimal latency

→ Using very short test signals (<0.5s)

reproducible results from transient responses

Simple use


Access Level
R&D engineer
QC engineer
Operator
Programming:
• Signal Analysis
• Statistics
• User Interface
Setting up:
• Measurement
• Limit Calculation
• Golden Unit Detection
Testing
Learning time
15 minutes
1 hour
1 day

Flexibility

Each manufacturer wants a different QC-tool

Company:

- Know how
- Constraints
- Customers
- Standards

Setup

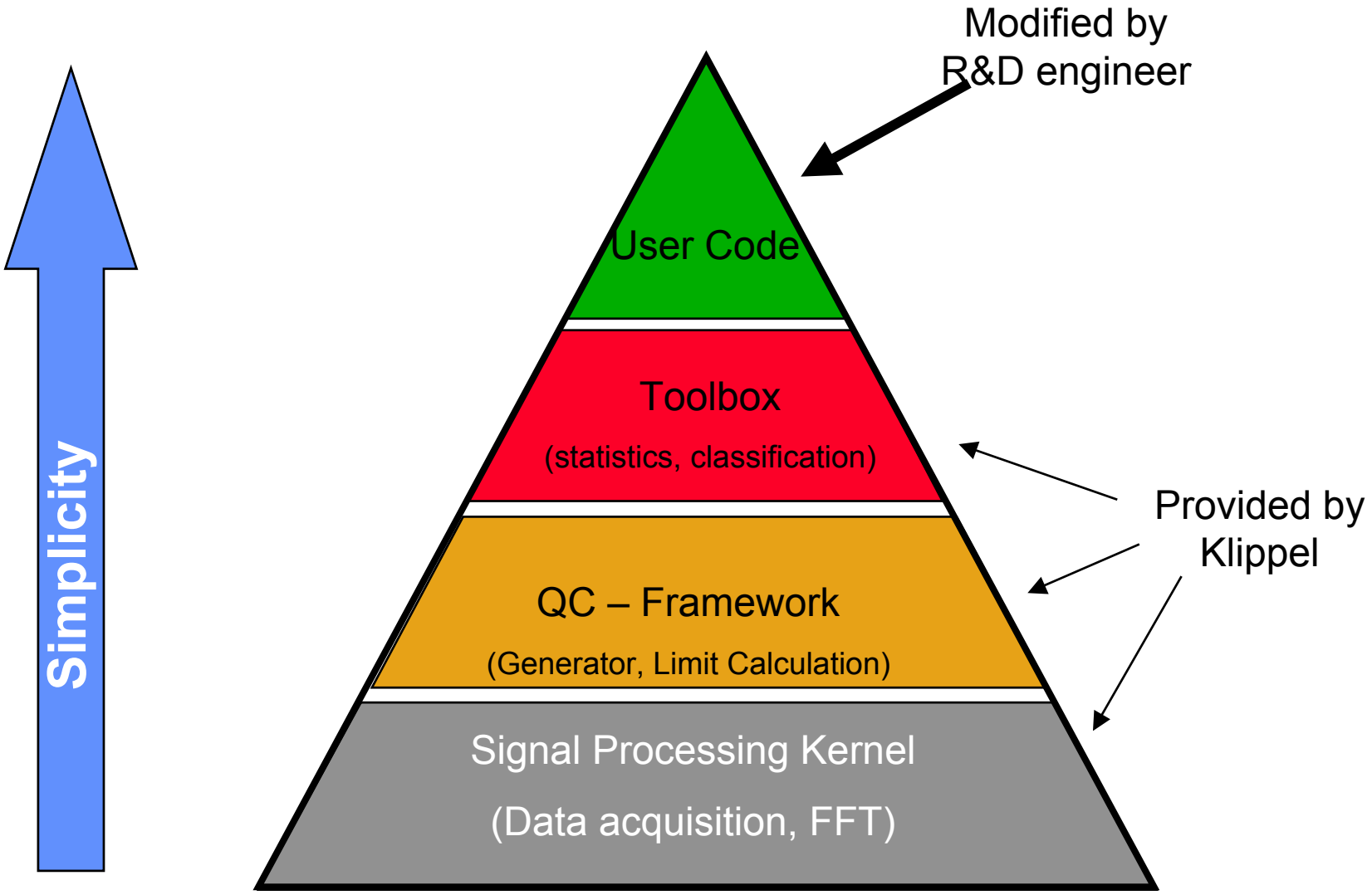
- Measurement
- Graphics
- Result Formatting

Algorithms

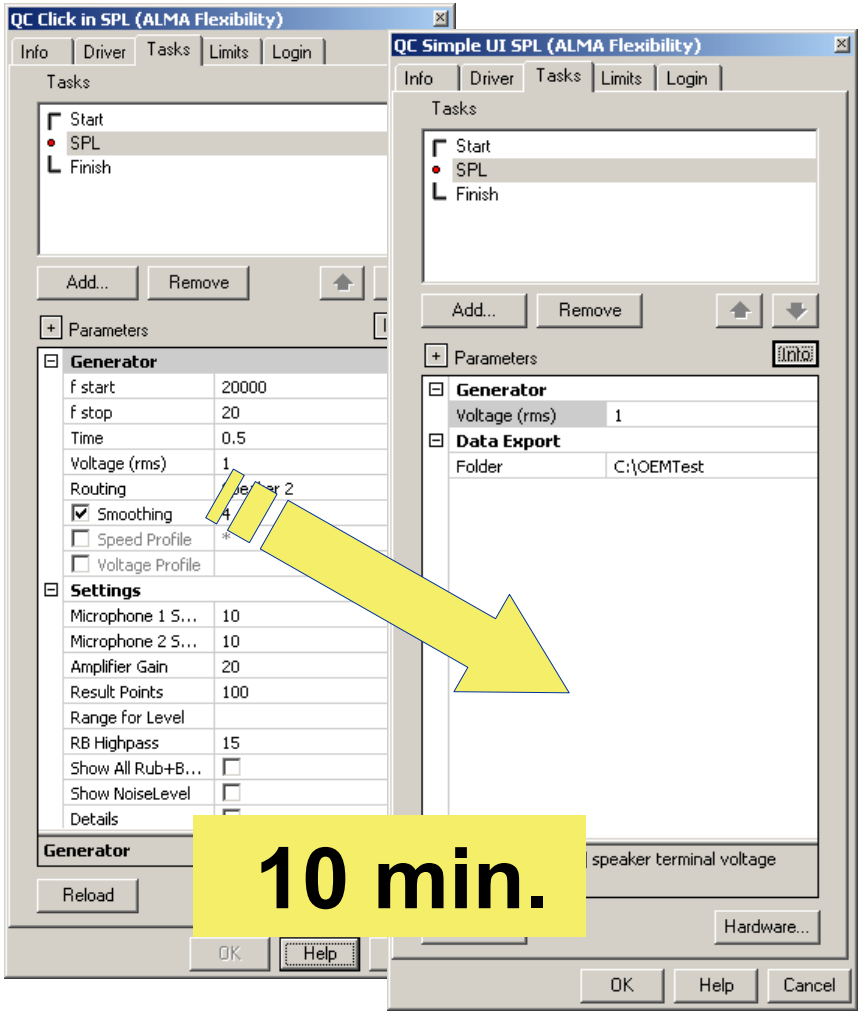
- Limit Calculation
- Golden DUT Handling
- Reports / Statistics

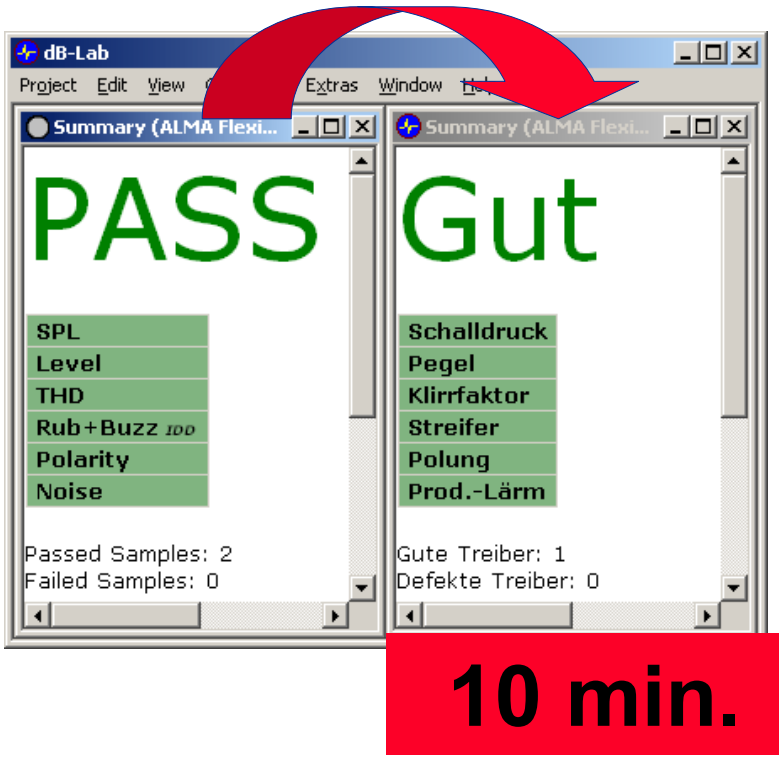
universal customization **BUT** simple to use !

Keep Programming simple

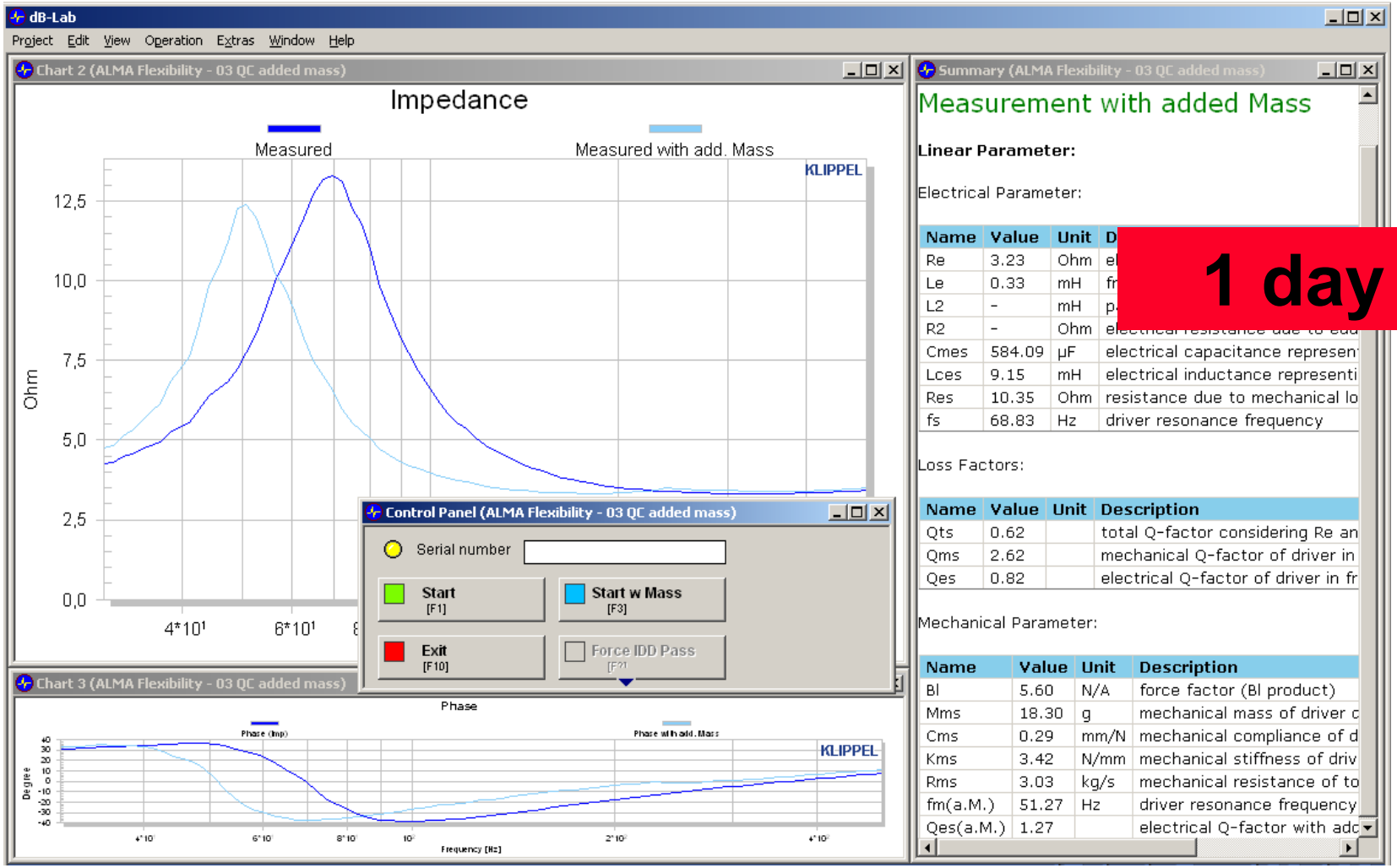


User-Interface can be adjusted





Implement specific algorithms



→ Code can be protected

Summary

- Be ready for 100 % testing
- Test at the physical limits (Speed, Level)
- Automatic Testing should be more reliable and sensitive than a human ear
- Noise immunity needed to ship all good units
- Provide Flexibility with dedicated architecture