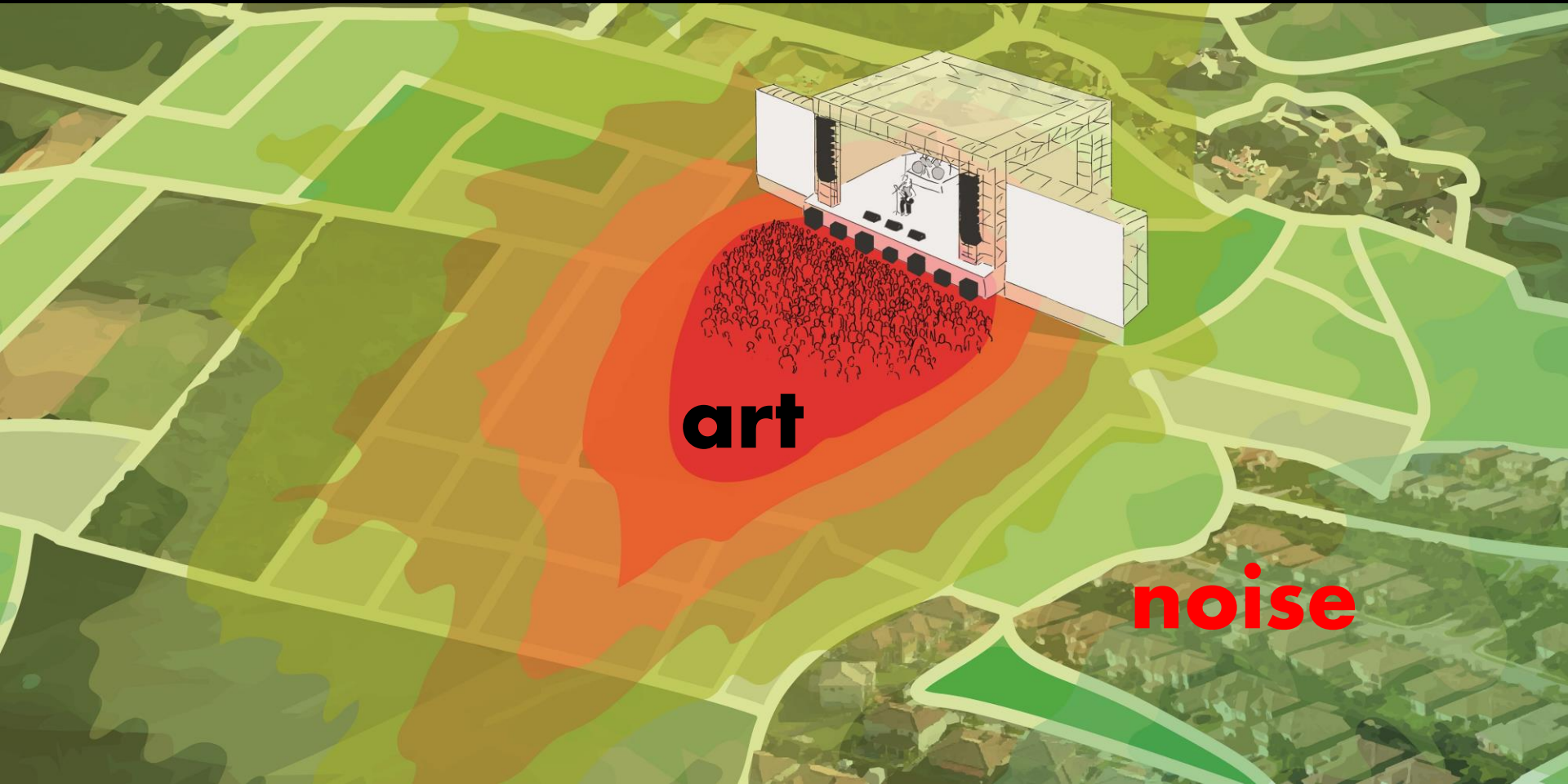
# Schallimmissionsprognosen komplexer Beschallungssystemen.

d&b audiotechnik



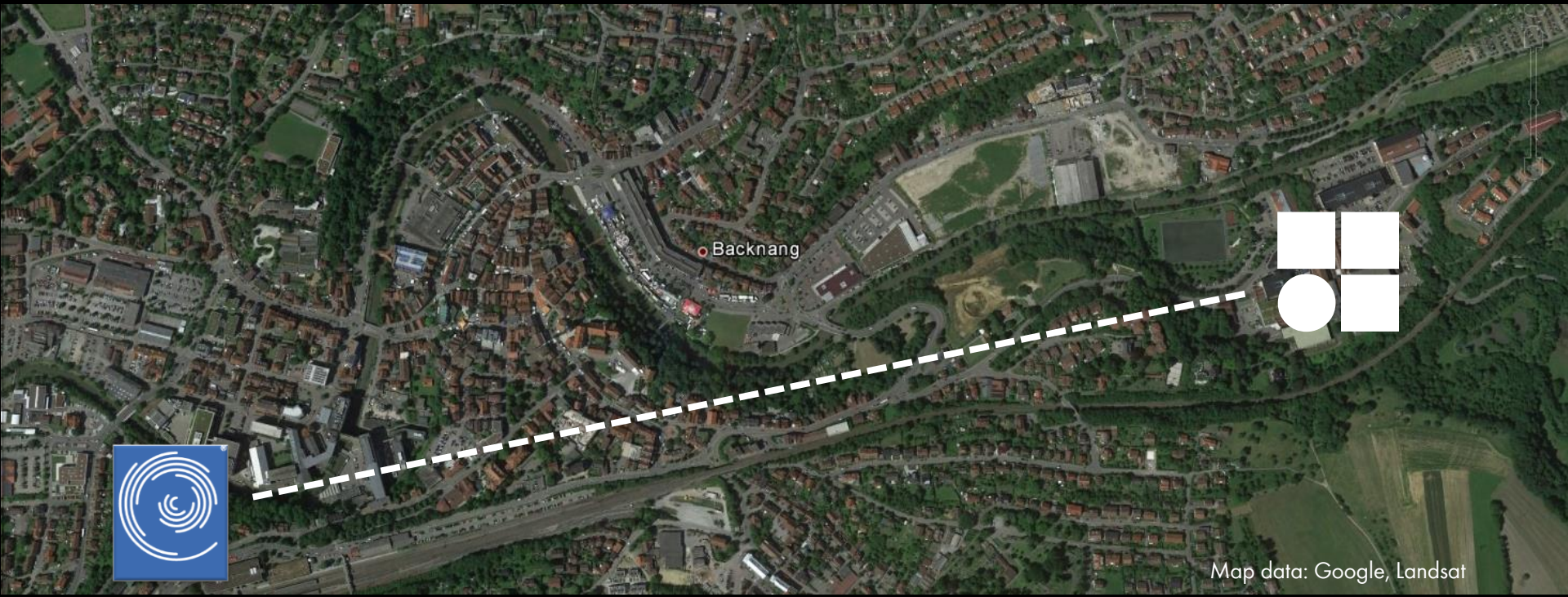
# Überblick.

- neuer Ansatz mit System-Daten

- Validierung
  - Messungen
  - Berechnungen
  - Vergleich

- Praxiserfahrung

# Kooperation SoundPLAN + d&b



# Überblick • neuer Ansatz mit System-Daten.

**Innovationen**

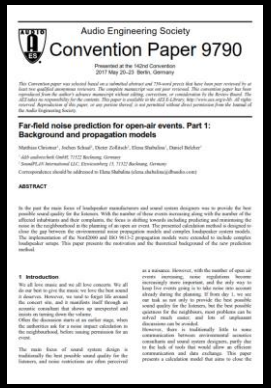
- **Komplexe Addition**
- **Import ArrayCalc Datei**

**Implementiert in**

- **NoizCalc** kostenfreies Tool für einfache Prognosen
- **SoundPLAN** professionelle Werkzeuge für Berater (SoundPLANnoise & essential)

# Veröffentlichungen.

- Internoise Konferenz, Innsbruck 2013
- DAGA 2014, Oldenburg
- Reproduced Sound Conference IOA, 2015
- AES Convention, Berlin 2017
  - Part 1 Ausbreitungsmodelle
  - Part 2 Validierung


Audio Engineering Society

Convention Paper 9790

Presented at the 142nd Convention
2017 May 20–23 Berlin, Germany

Far-field noise prediction for open-air events. Part 1: Background and propagation models

ABSTRACT

1 Introduction

Audio Engineering Society

Convention Paper

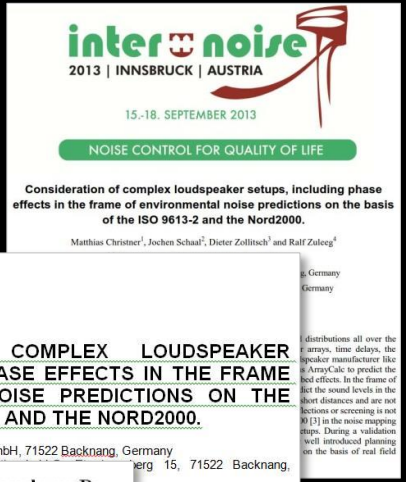
Presented at the 142nd Convention
2017 May 20–23 Berlin, Germany

Noise Prediction Software for Open-Air Events Part 2: Experiences & Validation

ABSTRACT

1 Introduction

2 Noise measurements

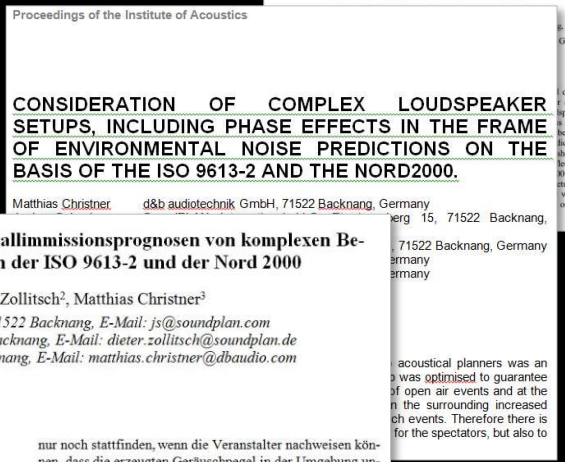

inter noise
2013 | INNSBRUCK | AUSTRIA

15.-18. SEPTEMBER 2013

NOISE CONTROL FOR QUALITY OF LIFE

Consideration of complex loudspeaker setups, including phase effects in the frame of environmental noise predictions on the basis of the ISO 9613-2 and the Nord2000.

Matthias Christner[1], Jochen Schaal[2], Dieter Zollitsch[3] and Ralf Zuleeg[4]


Proceedings of the Institute of Acoustics

CONSIDERATION OF COMPLEX LOUDSPEAKER SETUPS, INCLUDING PHASE EFFECTS IN THE FRAME OF ENVIRONMENTAL NOISE PREDICTIONS ON THE BASIS OF THE ISO 9613-2 AND THE NORD2000.

Matthias Christner d&b audiotechnik GmbH, 71522 Backnang, Germany

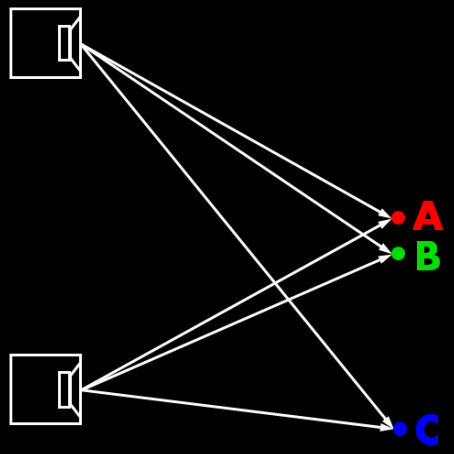
Phasenkohärente Berechnung bei Schallimmissionsprognosen von komplexen Beschallungsanlagen, im Rahmen der ISO 9613-2 und der Nord 2000

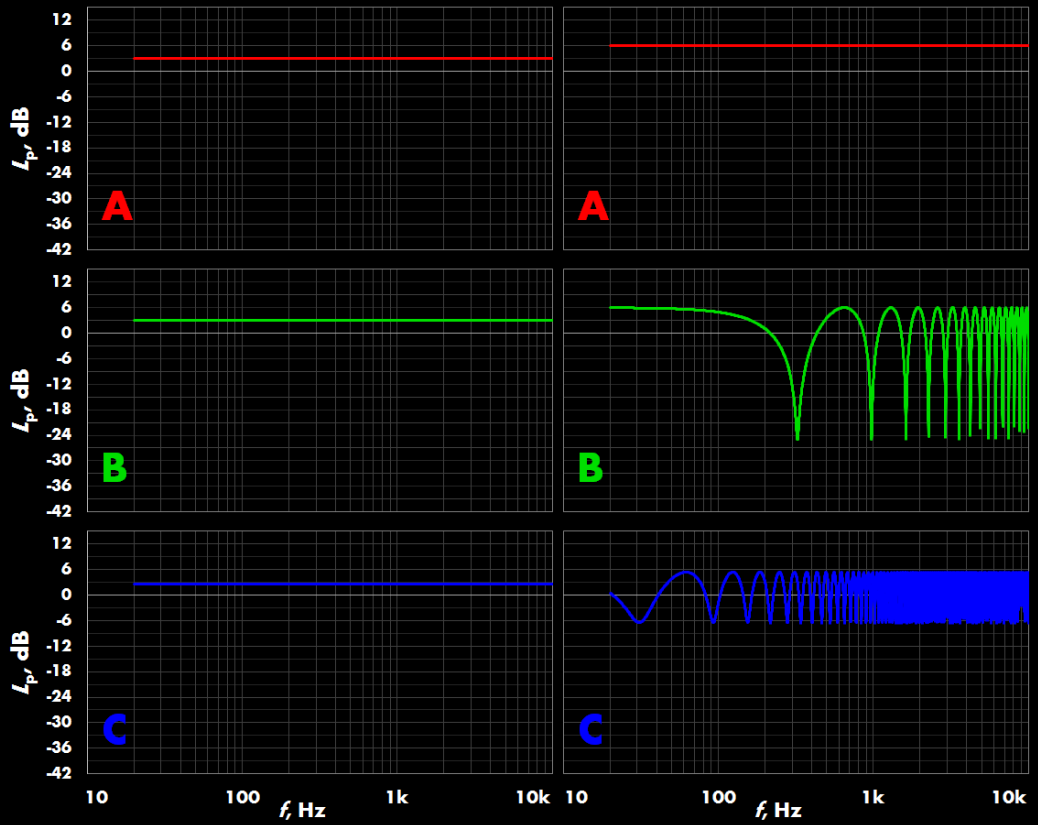
Jochen Schaal[1], Dieter Zollitsch[2], Matthias Christner[3]

[1] SoundPLAN International LLC, 71522 Backnang, E-Mail: js@soundplan.com
[2] Braunstein + Berndt GmbH, 71522 Backnang, E-Mail: dieter.zollitsch@soundplan.de
[3] d&b audiotechnik GmbH, 71522 Backnang, E-Mail: matthias.christner@dbaudio.com

Einleitung

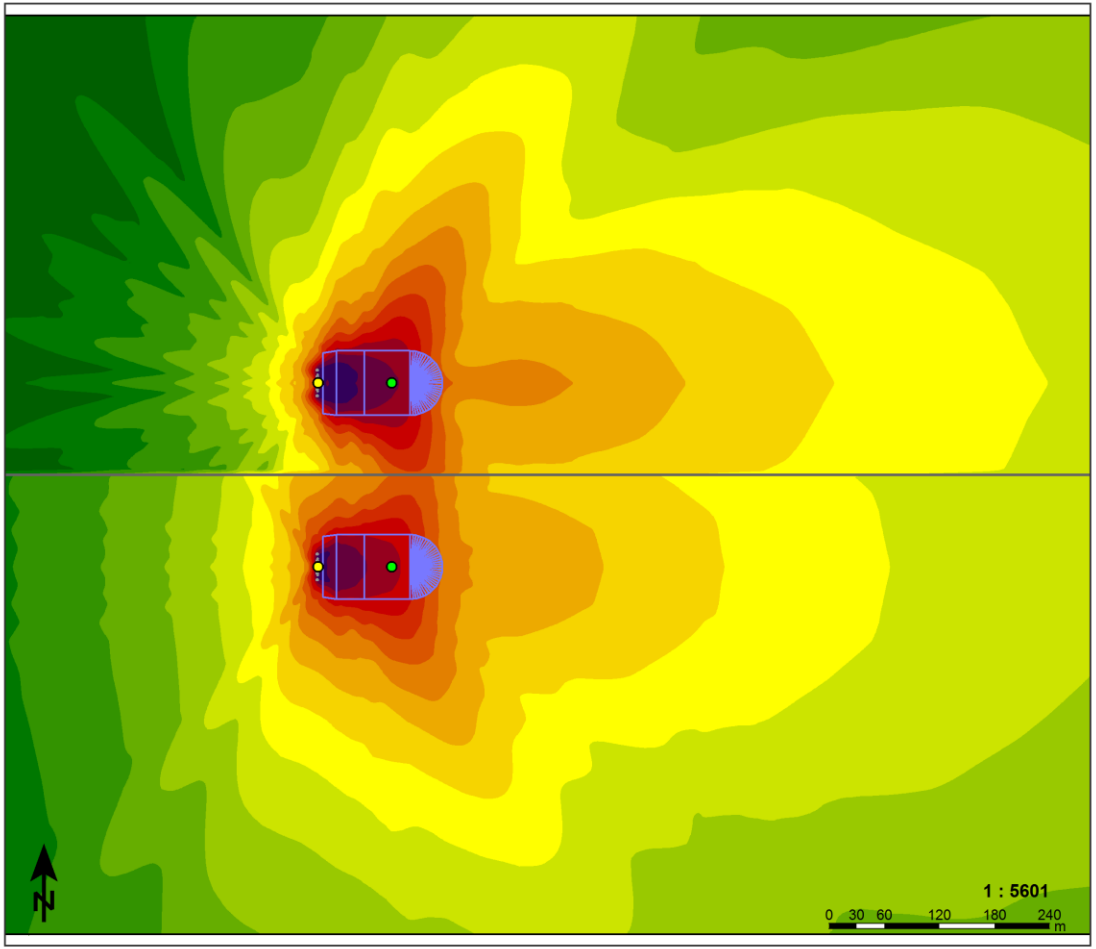
# Komplexe Addition.



NoizCalc V2.0 **Project:** complex **Date:** 14.09.2018 **Author:**

Map shows values calculated according to Nord2000 for listed stages




**Meteorology**
Wind speed: 0 beaufort (Calm)
Wind direction: 0,0 degree
Temperature gradient: 0,000 K/m

**complex all**
Spectrum: Electronic music
SPL at reference point: 120,0 dB(C)

**pow sum left**
Spectrum: Electronic music
SPL at reference point: 114,0 dB(C)

**pow sum right**
Spectrum: Electronic music
SPL at reference point: 114,0 dB(C)

**pow sum sub**
Spectrum: electro sub
SPL at reference point: 113,0 dB(C)

**Signs and symbols**
- Ground effects
- Existing wall
- Wall
- Stage
- Stage origin
- Reference point
- Loudspeaker
- Listening planes

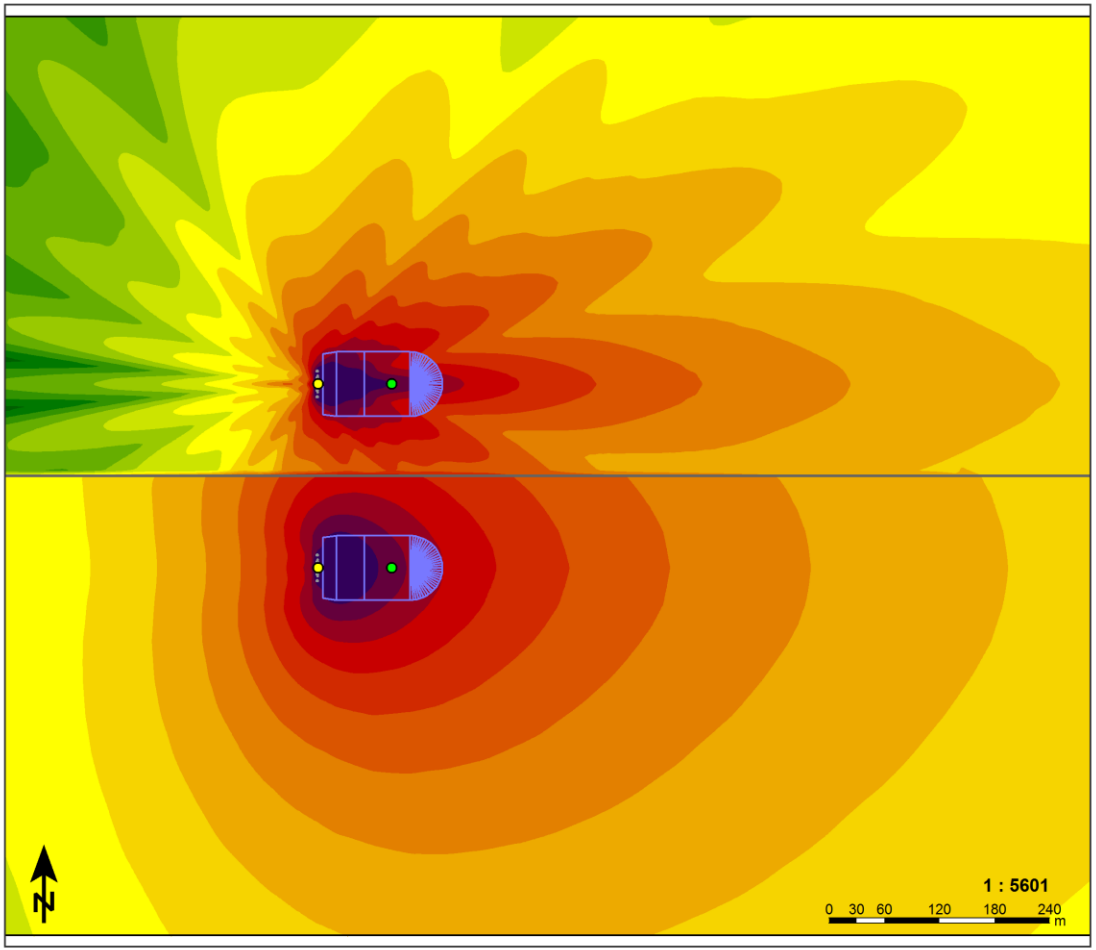
**Levels in dB(A)**
> 105
102 - 105
99 - 102
96 - 99
93 - 96
90 - 93
87 - 90
84 - 87
81 - 84
78 - 81
75 - 78
72 - 75
69 - 72
66 - 69
63 - 66
< 63

d&b audiotechnik

dB(A)

NoizCalc V2.0 **Project:** complex **Date:** 13.09.2018 **Author:**

Map shows values calculated according to Nord2000 for listed stages




**Meteorology**

Wind speed: 0 beaufort (Calm)
Wind direction: 0,0 degree
Temperature gradient: 0,000 K/m

**complex all**

Spectrum: Electronic music
SPL at reference point: 120,0 dB(C)

**pow sum left**

Spectrum: Electronic music
SPL at reference point: 114,0 dB(C)

**pow sum right**

Spectrum: Electronic music
SPL at reference point: 114,0 dB(C)

**pow sum sub**

Spectrum: electro sub
SPL at reference point: 113,0 dB(C)

**Signs and symbols**

- Ground effects
- Existing wall
- Wall
- Stage
- Stage origin
- Reference point
- Loudspeaker
- Listening planes

**Levels in dB(C)**

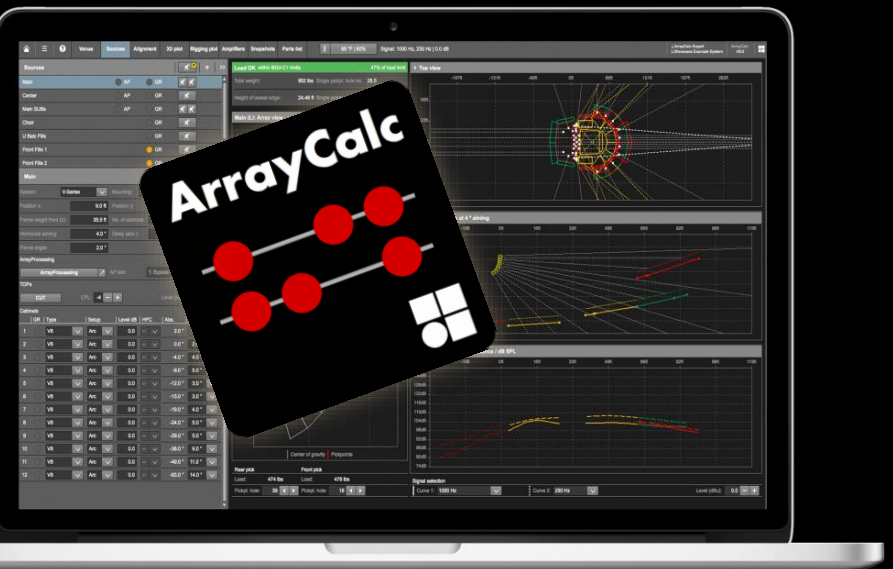
| |
|---|
| > 120 |
| 117 - 120 |
| 114 - 117 |
| 111 - 114 |
| 108 - 111 |
| 105 - 108 |
| 102 - 105 |
| 99 - 102 |
| 96 - 99 |
| 93 - 96 |
| 90 - 93 |
| 87 - 90 |
| 84 - 87 |
| 81 - 84 |
| 78 - 81 |
| < 78 |

d&b audiotechnik

d&b audiotechnik

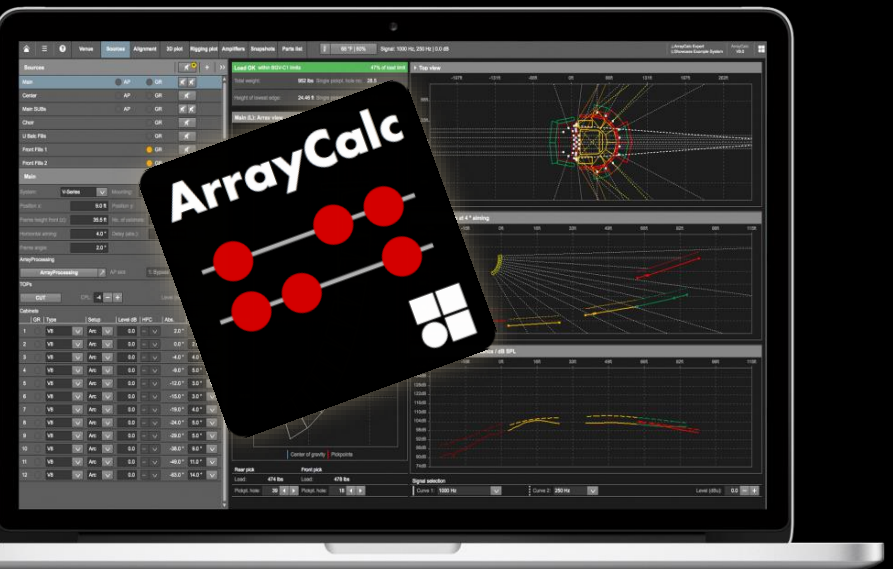
dB(C)

# Import ArrayCalc Datei in NoizCalc.



# ArrayCalc → SoundPLAN.

d&b audiotechnik



# d&b Software.

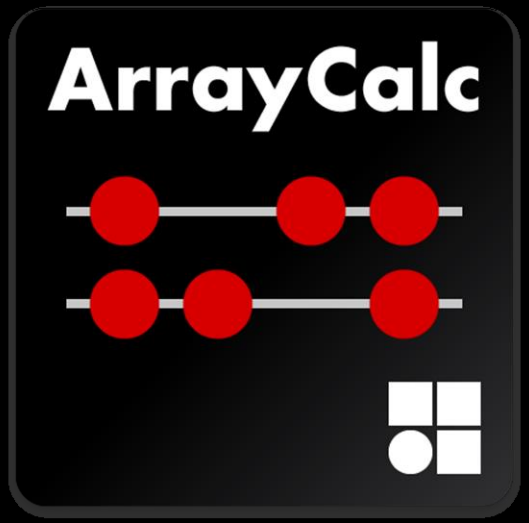
**ArrayCalc** Planung von d&b Systemen

**R1** Steuerung & Überwachung d&b Systemen

**Viewer** Mobile Anzeige bei Inbetriebnahmen

**NoizCalc** Schallimmissionsprognosen

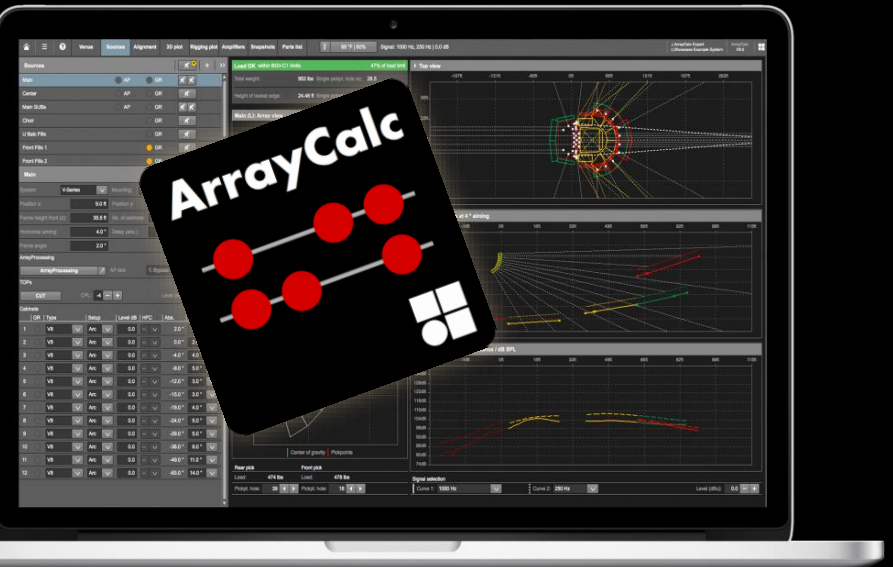
# Wird bereits von Toningenieuren verwendet: Auslegung, Simulation und Einsatz von d&b Systemen.



# ArrayCalc • Funktionen

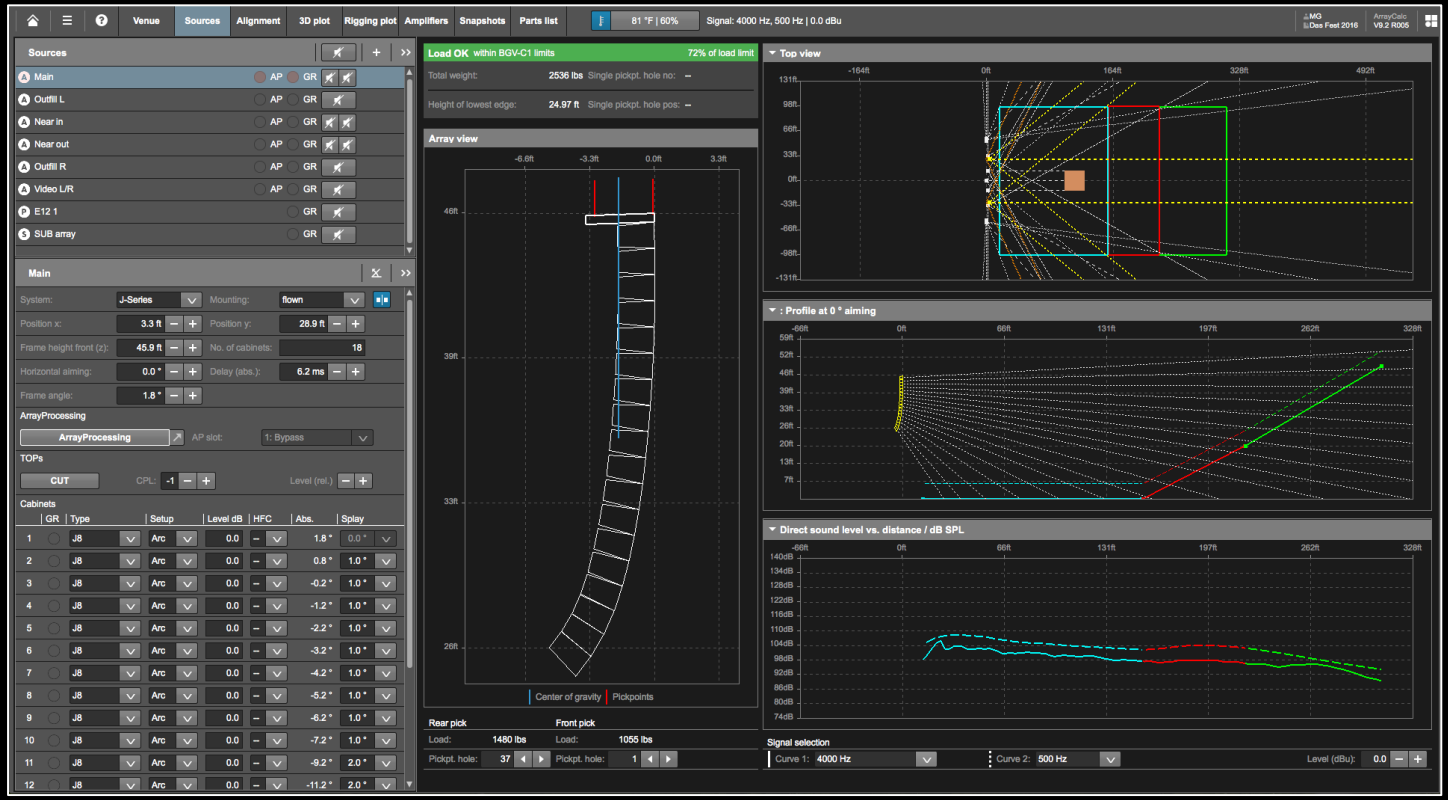
Signal routing
Obstacles
Array splay angles
Amplifier configuration
SUB array
Source setup print-outs
Safety predictions
Array weight
Import/Export sources
Printable rigging plot
ArrayProcessing
Source acoustic setup
Time alignment
dB SPL vs. distance
Loudspeaker aiming
NoizCalc
3D coverage maps
SPL calculations
Rigging plot print-outs
3D DXF export
EASE export
Collision view
Coverage maps
Point sources
Virtual wiring
Amplifier selection
Venue
Pre-built R1
Parts list
Import/Export venue
Printable coverage maps
Amp patch plot
Snapshots
Air absorption
CSV export

# ArrayCalc → R1.

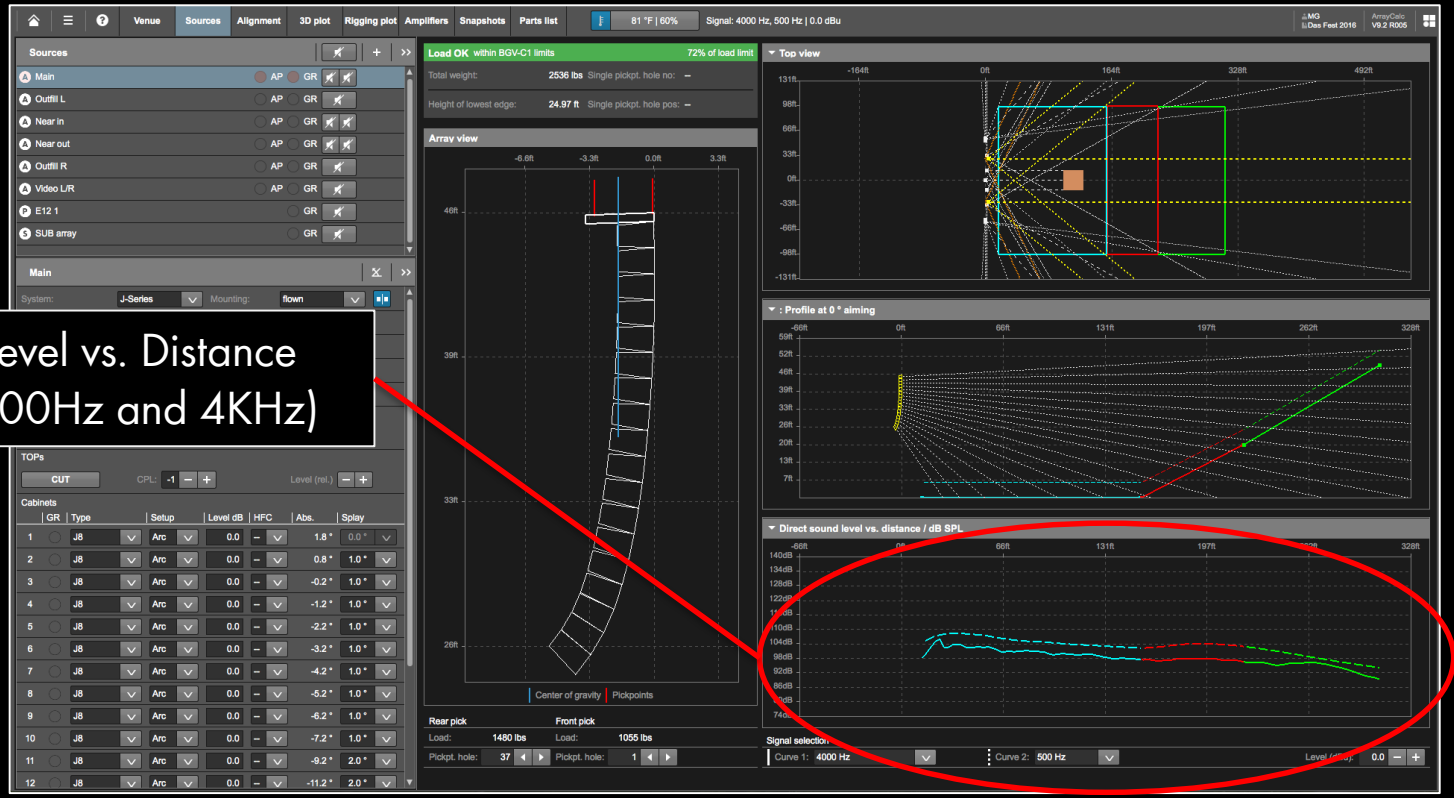


# ArrayCalc → R1.

# ArrayCalc • Sources.



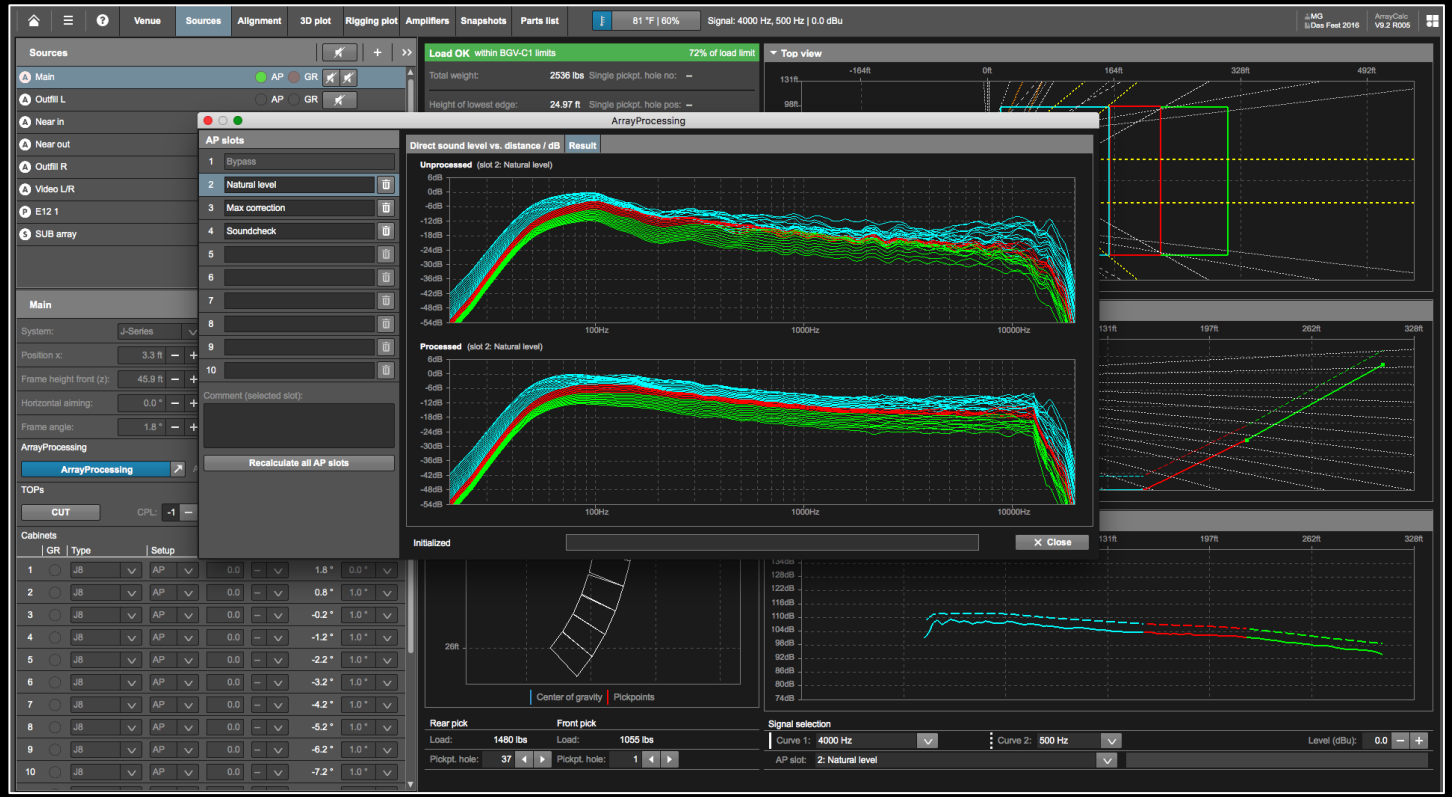
# ArrayCalc • Sources.



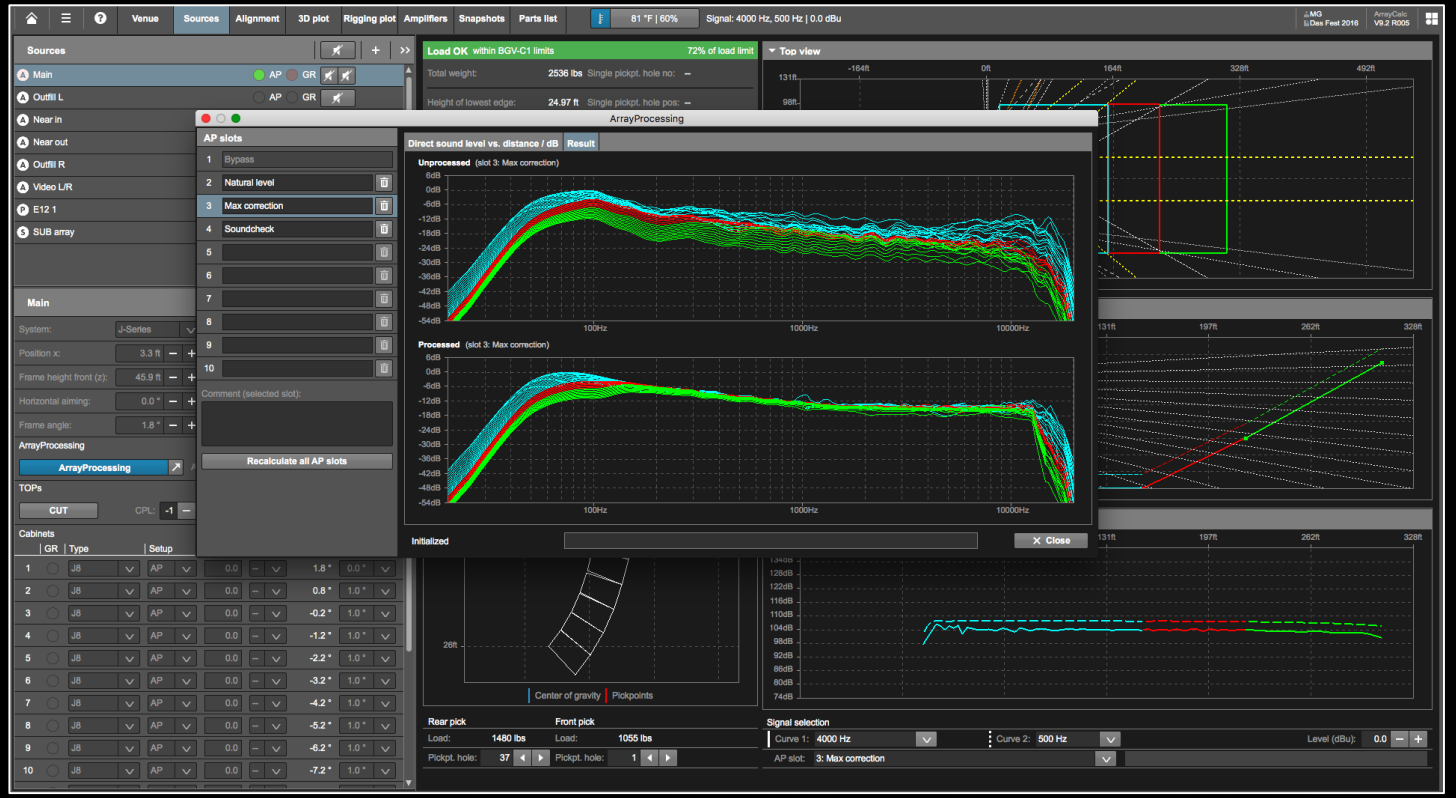

Level vs. Distance
(500Hz and 4KHz)

# ArrayCalc • Sources.

# ArrayCalc • Sources.



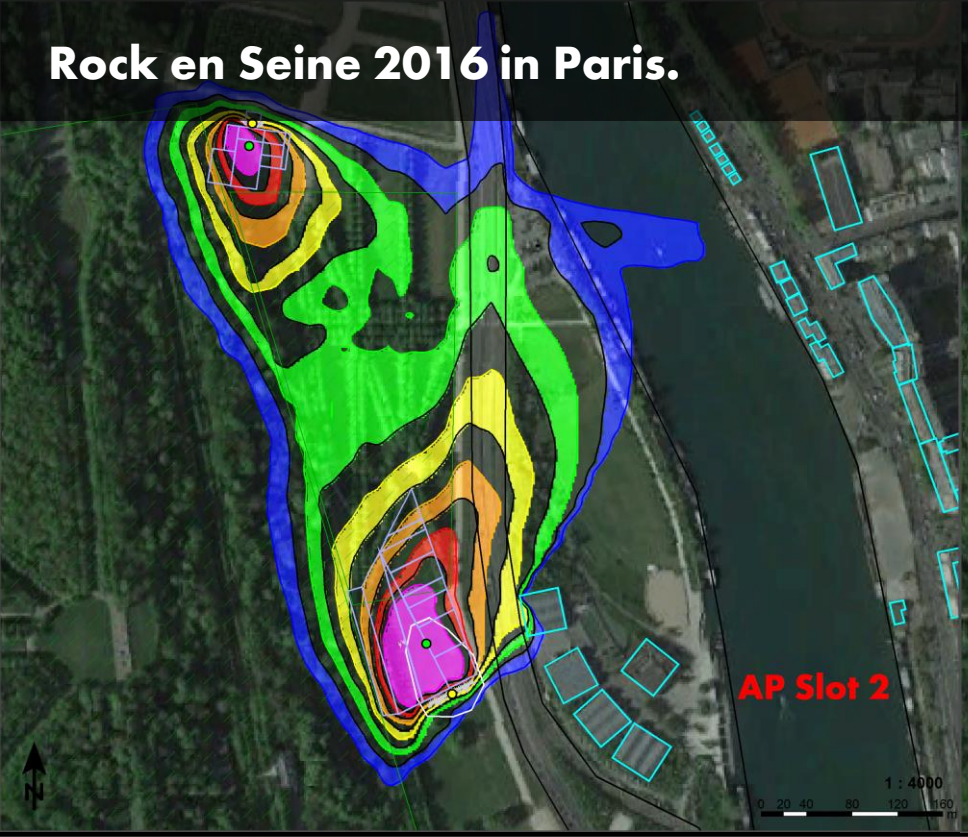
# ArrayCalc • Sources.

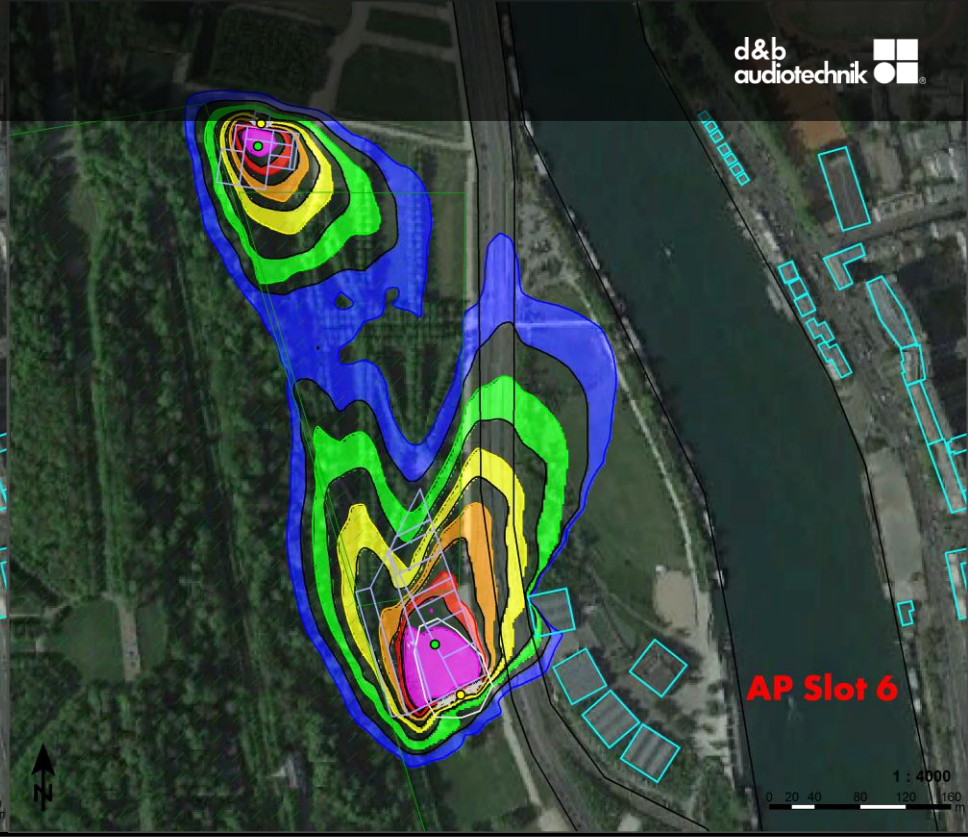


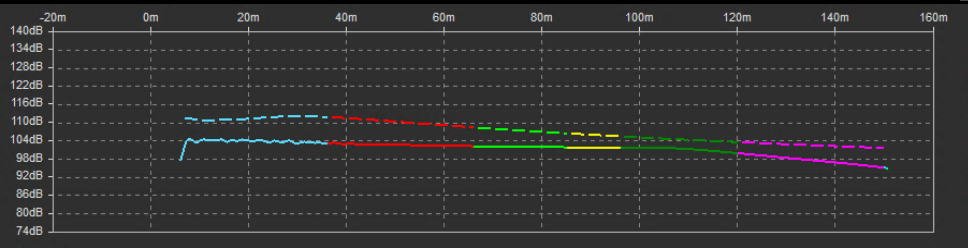
# ArrayCalc • Sources.

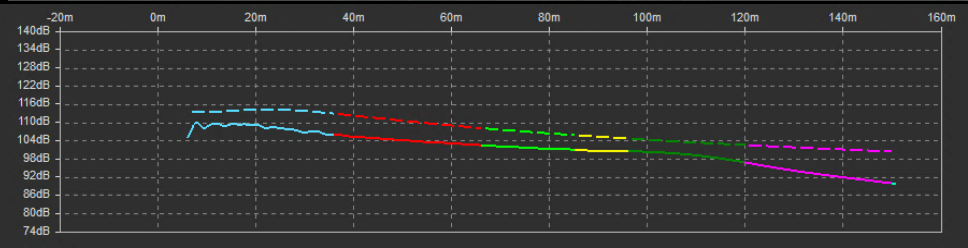
# Rock en Seine 2016 in Paris.

# Rock en Seine 2016 in Paris.



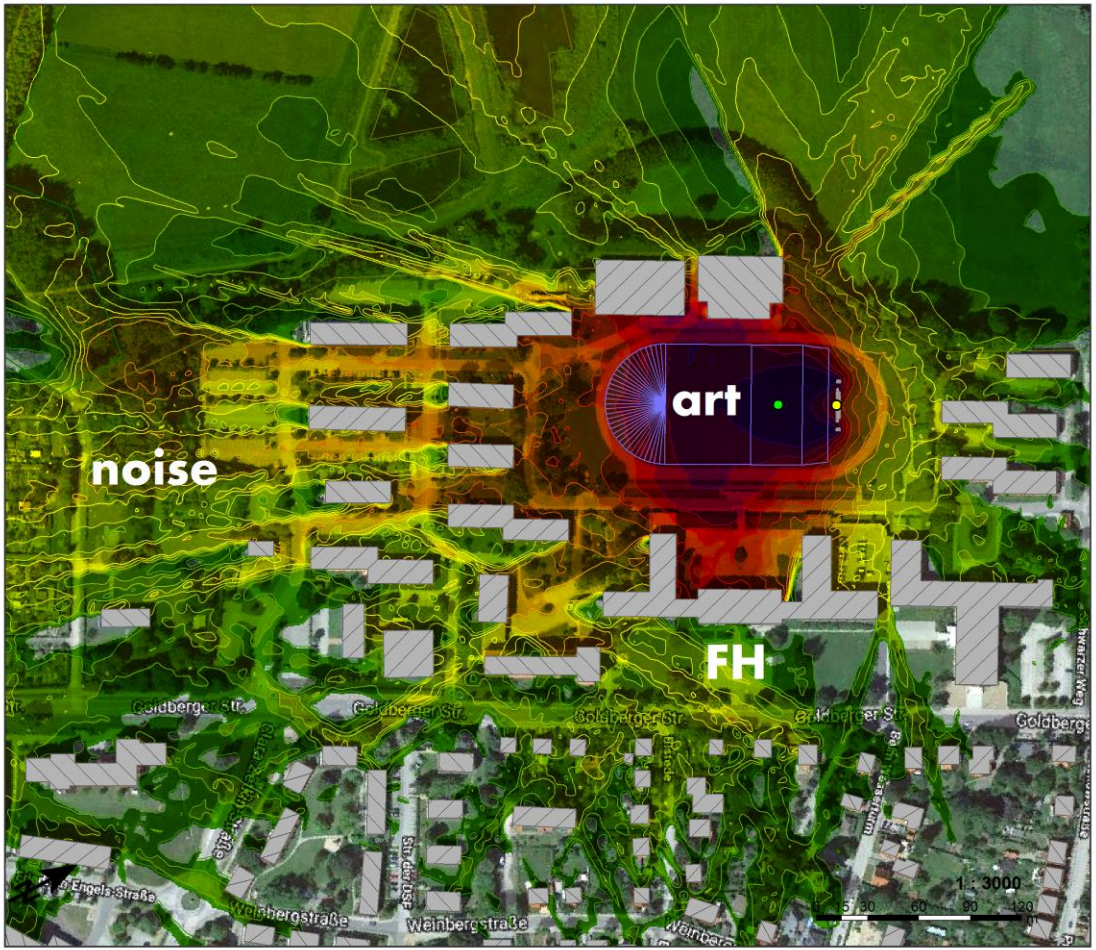



NoizCalc V2.0 **Project:** art noiz Fachhochschule Güstrow **Date:** 14.09.2018 **Author:** Daniel Belcher

Map shows values calculated according to Nord2000 for listed stages




**Meteorology**
Wind speed: 0 beaufort (Calm)
Wind direction: 0,0 degree
Temperature gradient: 0,070 K/m

**16 GSL 18 SL-SUB**
Spectrum: Rock/Pop
SPL at reference point: 99,0 dB(A)

**Signs and symbols**
- Ground effects
- Forest
- Calculation area
- Stage
- Stage origin
- Reference point
- Loudspeaker
- Listening planes

**Levels in dB(A)**

| | |
|---|---|
| > 102 | |
| 99 - 102 | |
| 96 - 99 | |
| 93 - 96 | |
| 90 - 93 | |
| 87 - 90 | |
| 84 - 87 | |
| 81 - 84 | |
| 78 - 81 | |
| 75 - 78 | |
| 72 - 75 | |
| 69 - 72 | |
| 66 - 69 | |
| 63 - 66 | |
| 60 - 63 | |
| < 60 | |

d&b audiotechnik

## ArrayProcessing

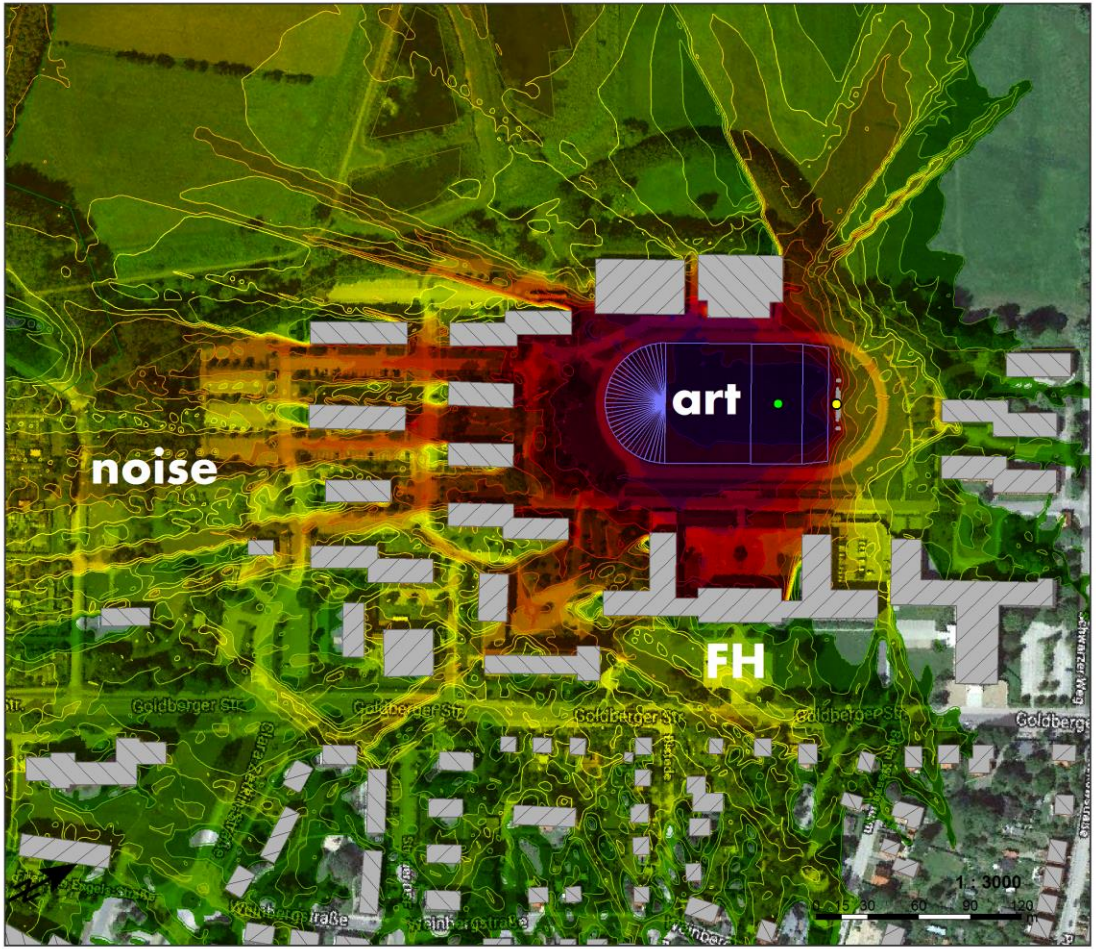
Abnahme des Pegels in dB je Verdoppelung des Abstands.

**mitte 3 dB**

**hinten 24 dB**

NoizCalc V2.0 **Project:** art noiz Fachhochschule Güstrow **Date:** 14.09.2018 **Author:** Daniel Belcher

Map shows values calculated according to Nord2000 for listed stages




**Meteorology**
Wind speed: 0 beaufort (Calm)
Wind direction: 0,0 degree
Temperature gradient: 0,070 K/m

**16 GSL 18 SL-SUB**
Spectrum: Rock/Pop
SPL at reference point: 99,0 dB(A)

**Signs and symbols**
- Ground effects
- Forest
- Calculation area
- Stage
- Stage origin
- Reference point
- Loudspeaker
- Listening planes

**Levels in dB(A)**

| |
|---|
| > 102 |
| 99 - 102 |
| 96 - 99 |
| 93 - 96 |
| 90 - 93 |
| 87 - 90 |
| 84 - 87 |
| 81 - 84 |
| 78 - 81 |
| 75 - 78 |
| 72 - 75 |
| 69 - 72 |
| 66 - 69 |
| 63 - 66 |
| 60 - 63 |
| < 60 |

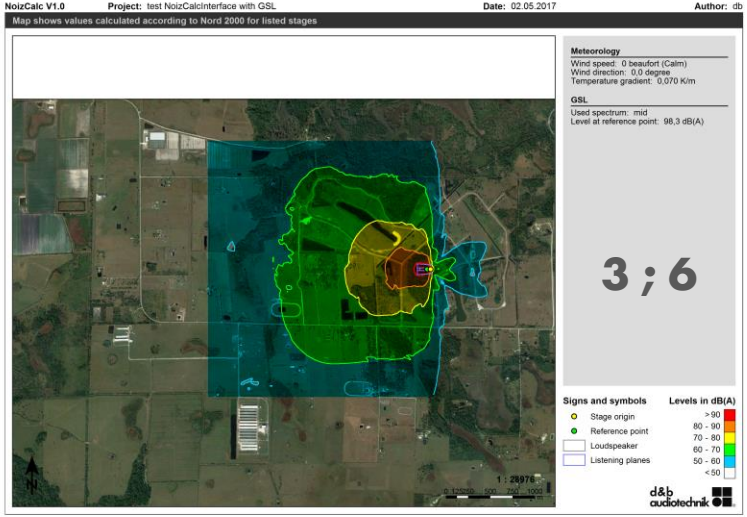
d&b audiotechnik

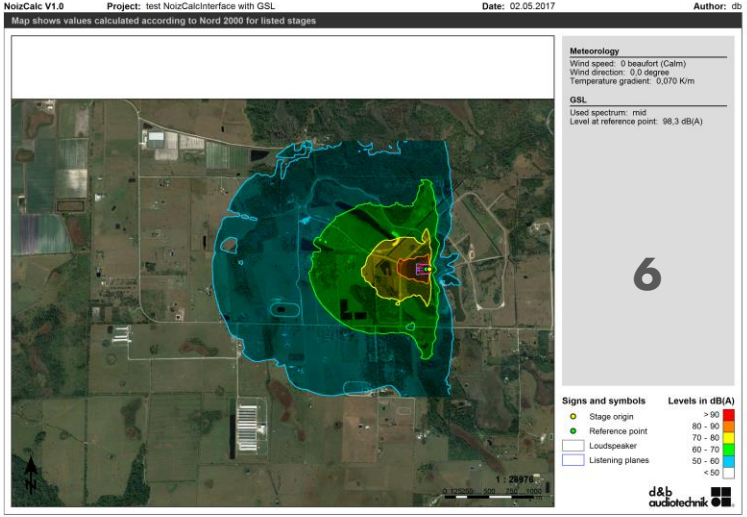
## ArrayProcessing

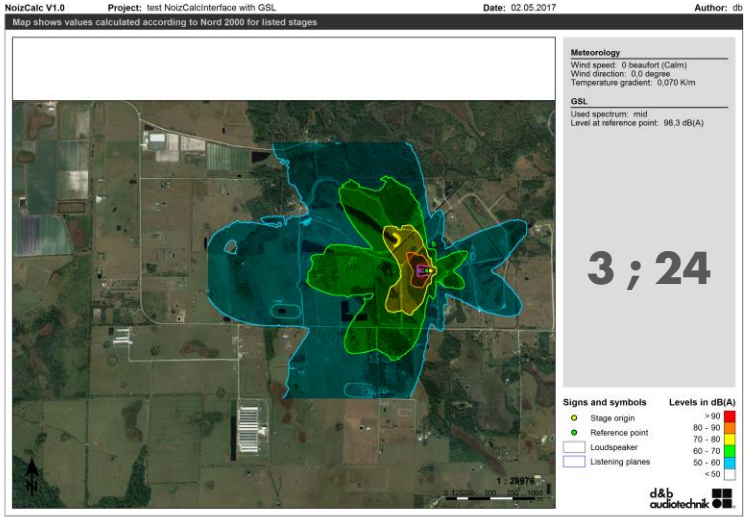
Abnahme des Pegels in dB je Verdoppelung des Abstands.

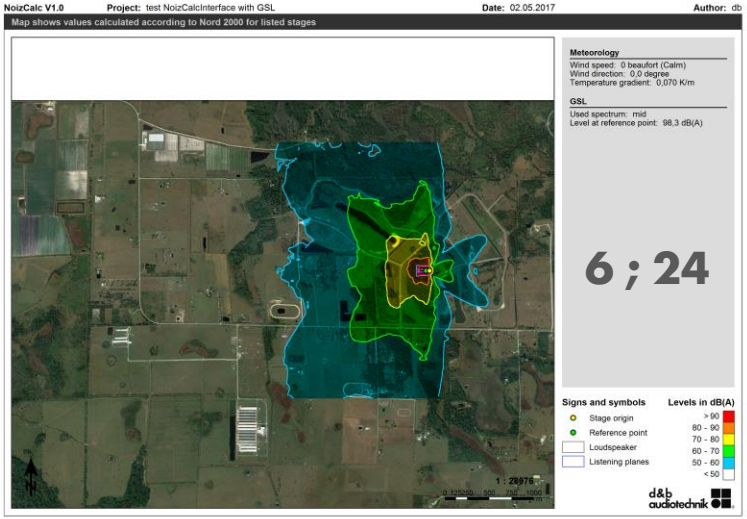
**mitte 2 dB**

**hinten 9 dB**



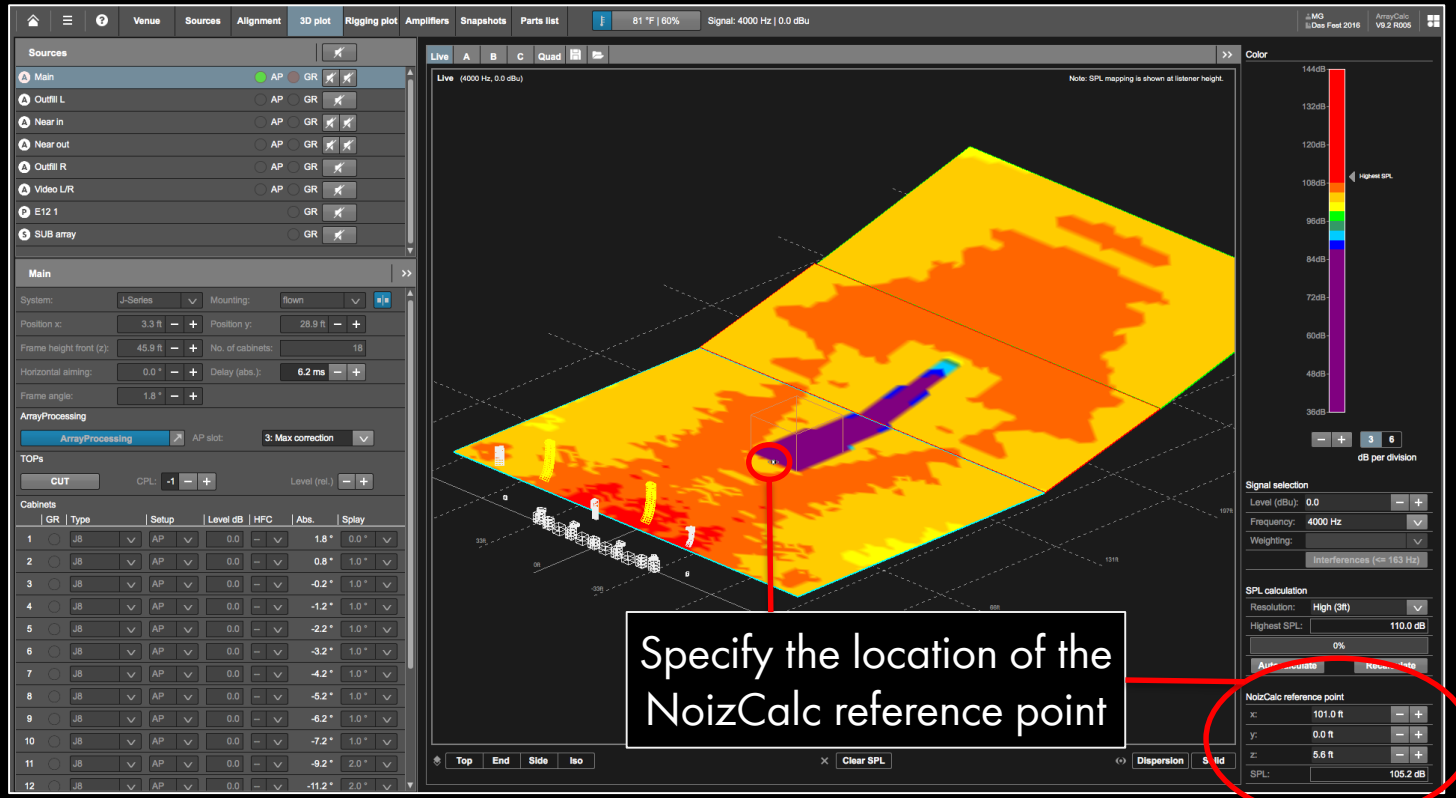

d&b audiotechnik

# ArrayProcessing

Abnahme des Pegels in dB je Verdoppelung des Abstands.

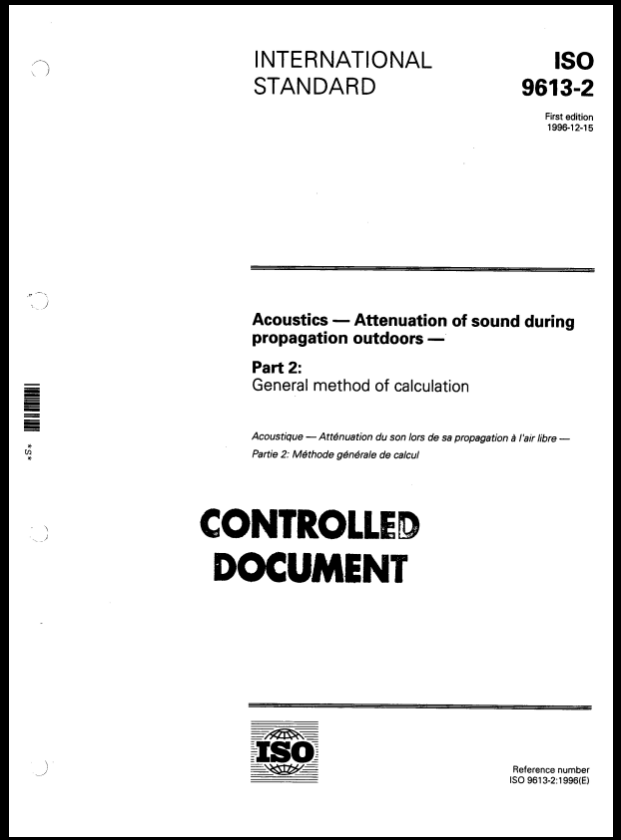
mittlere Terzen 500 Hz – 2 kHz

# ArrayCalc • 3D Plot.



# Schallausbreitungs-Standards.

## ISO 9613-2



INTERNATIONAL STANDARD

**ISO 9613-2**

First edition
1996-12-15

**Acoustics — Attenuation of sound during propagation outdoors —**

**Part 2:**
General method of calculation

*Acoustique — Atténuation du son lors de sa propagation à l'air libre —*
*Partie 2: Méthode générale de calcul*

**CONTROLLED DOCUMENT**

ISO

Reference number
ISO 9613-2:1996(E)

## Nord2000

We help ideas meet the real world

**Report**

**Nord2000. Comprehensive Outdoor Sound Propagation Model. Part 1: Propagation in an Atmosphere without Significant Refraction.**

**Client: Nordic Noise Group & Nordic Road Directorates**

AV 1849/00
Page 1 of 127

31 December 2000
Revised 31 December 2001
Revised 31 March 2006

**DELTA**
Danish Electronics,
Light & Acoustics

Venlighedsvej 4
2970 Hørsholm
Danmark

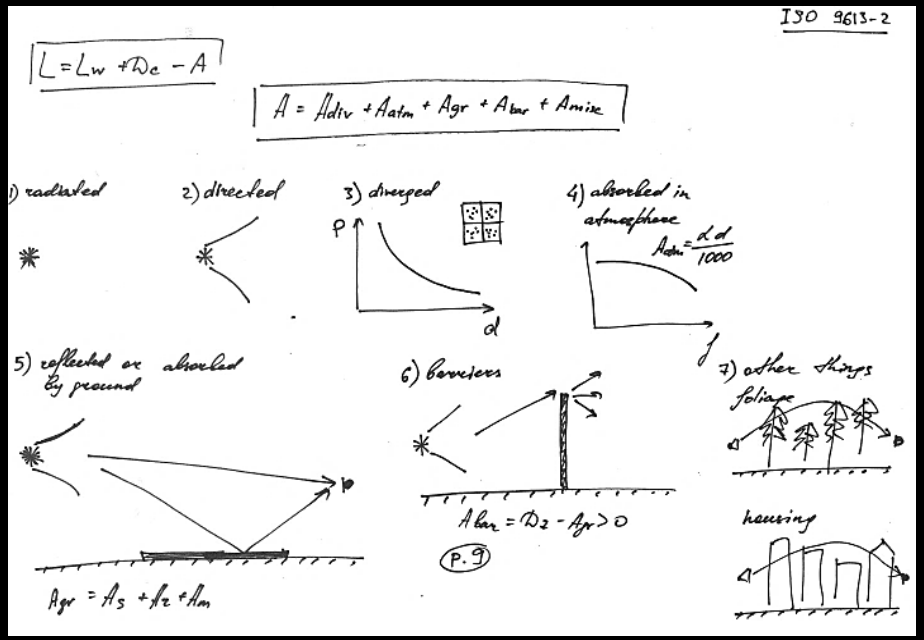
Tlf. (+45) 72 19 40 00
Fax (+45) 72 19 40 01
www.delta.dk

DELTA

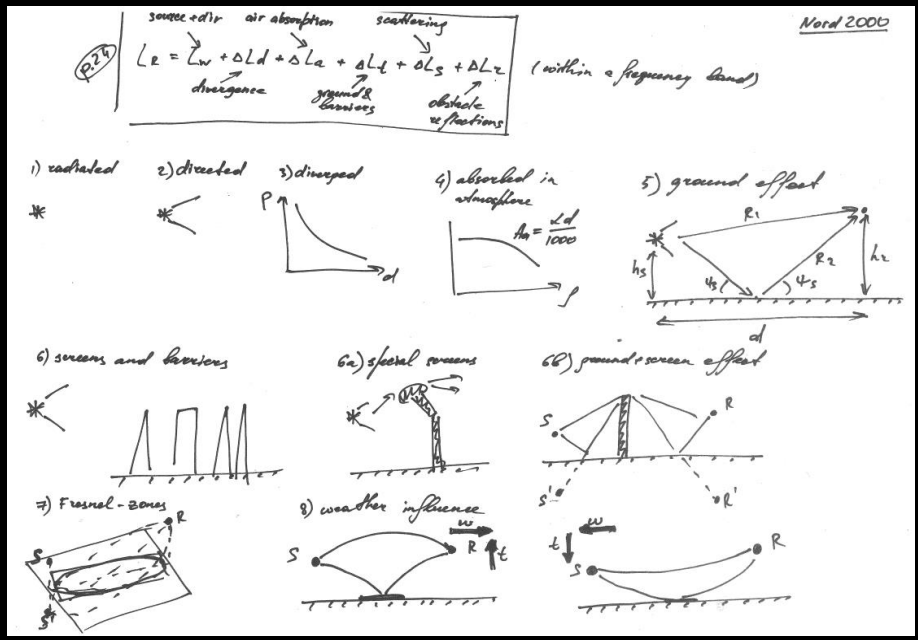
The report must not be reproduced, except in full, without the written approval of DELTA.

# Schallausbreitungs-Standards.

## ISO 9613-2




## Nord2000




*Hand drawings: Dr. Elena Shabalina*

# Bodenreflexion.

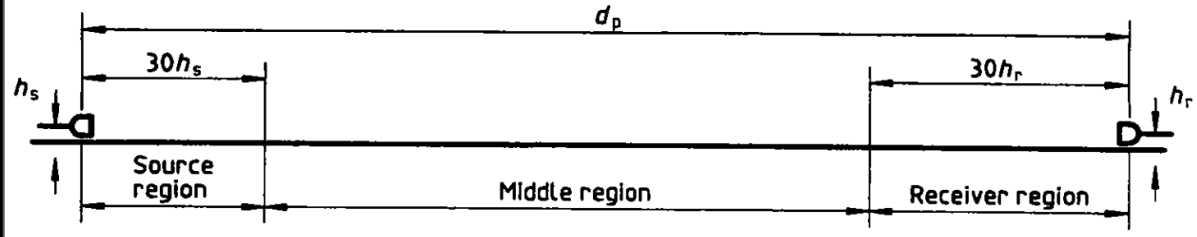



**Figure 1 — Three distinct regions for determination of ground attenuation**

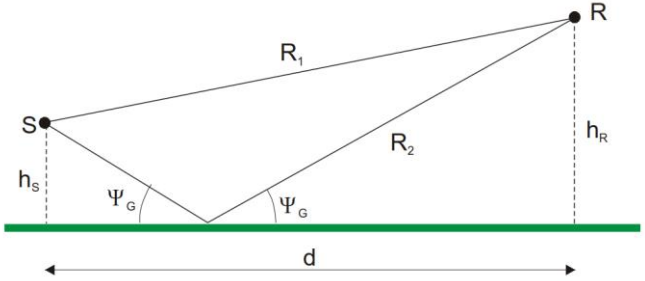



***Figure 11***
*Propagation over flat ground.*

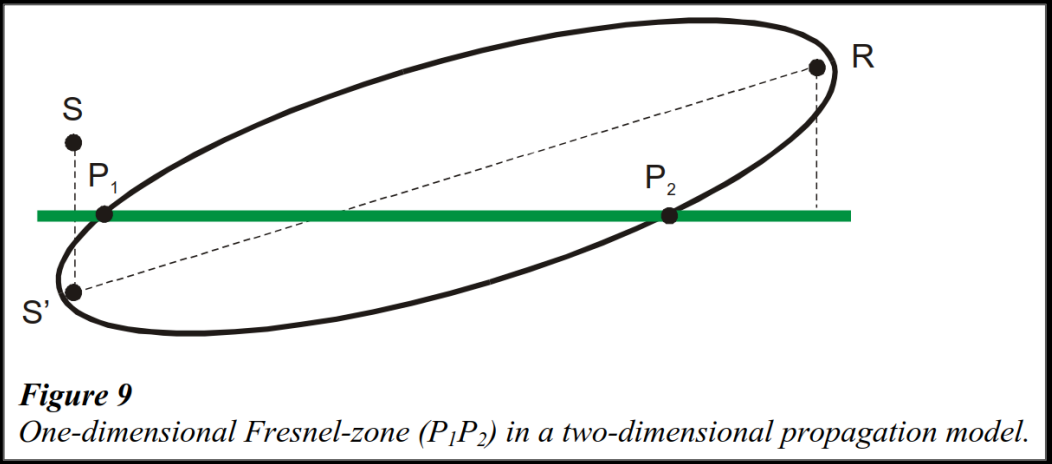



***Figure 9***
*One-dimensional Fresnel-zone ($P_1P_2$) in a two-dimensional propagation model.*

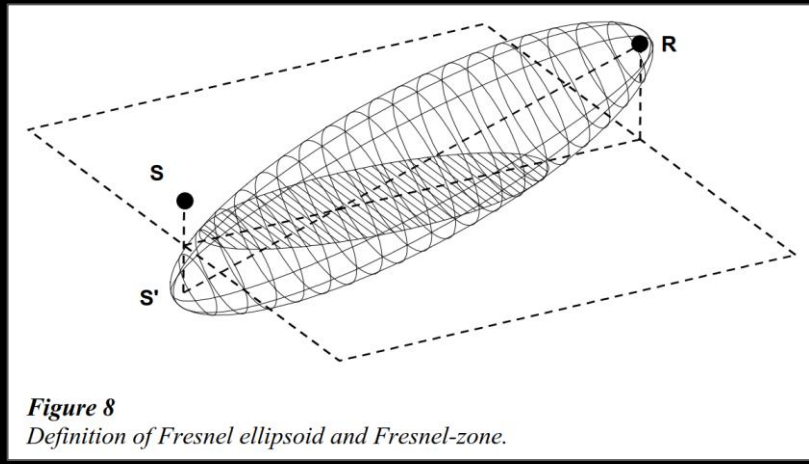
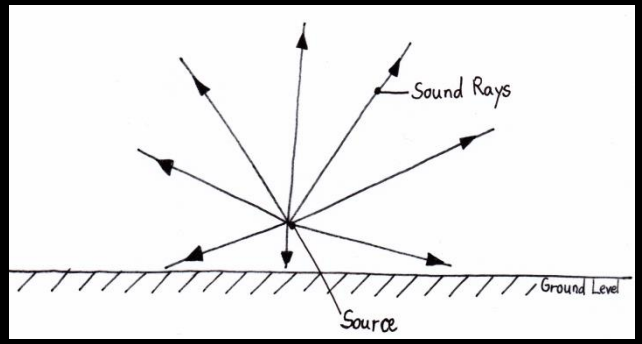
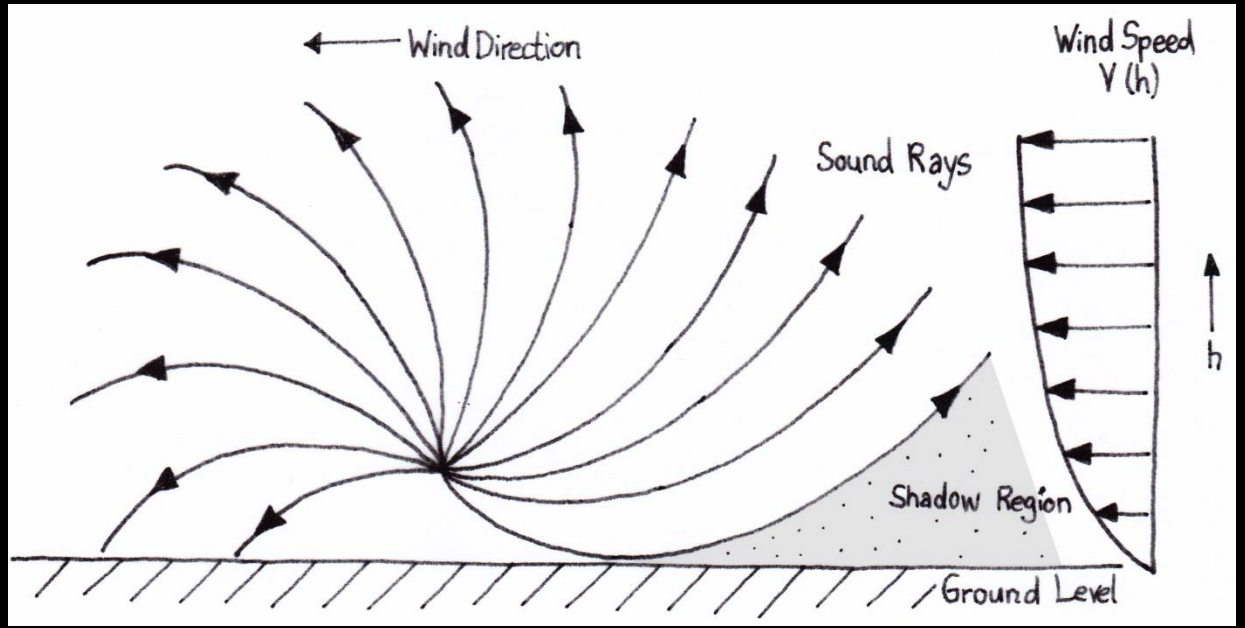


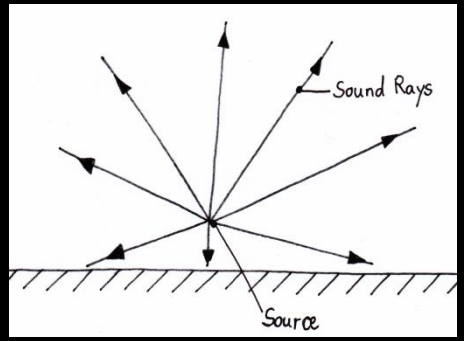

***Figure 8***
*Definition of Fresnel ellipsoid and Fresnel-zone.*

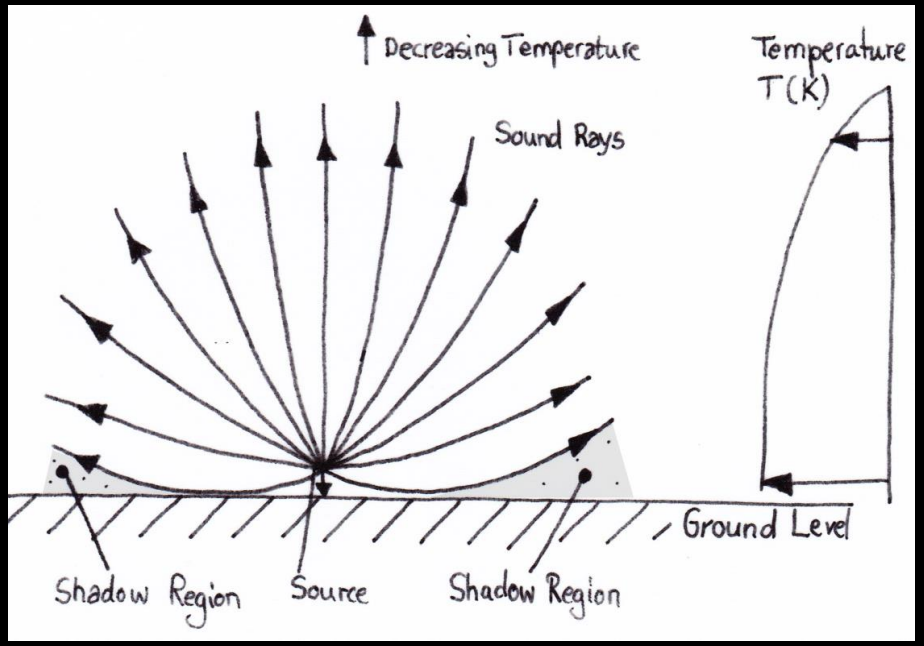
# Wind  mit Nord2000.

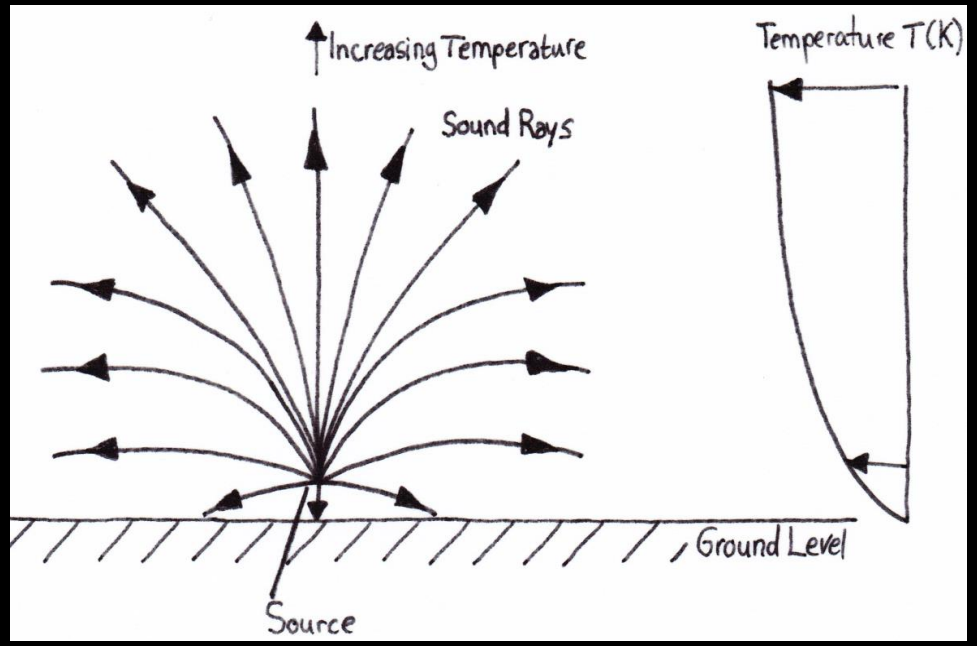


# Temperatur Gradient  mit Nord2000.

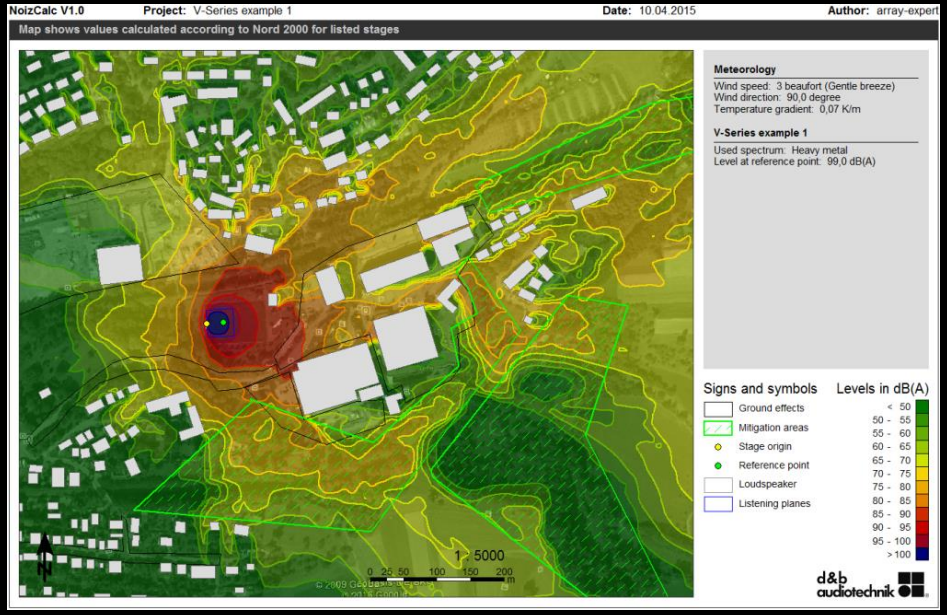


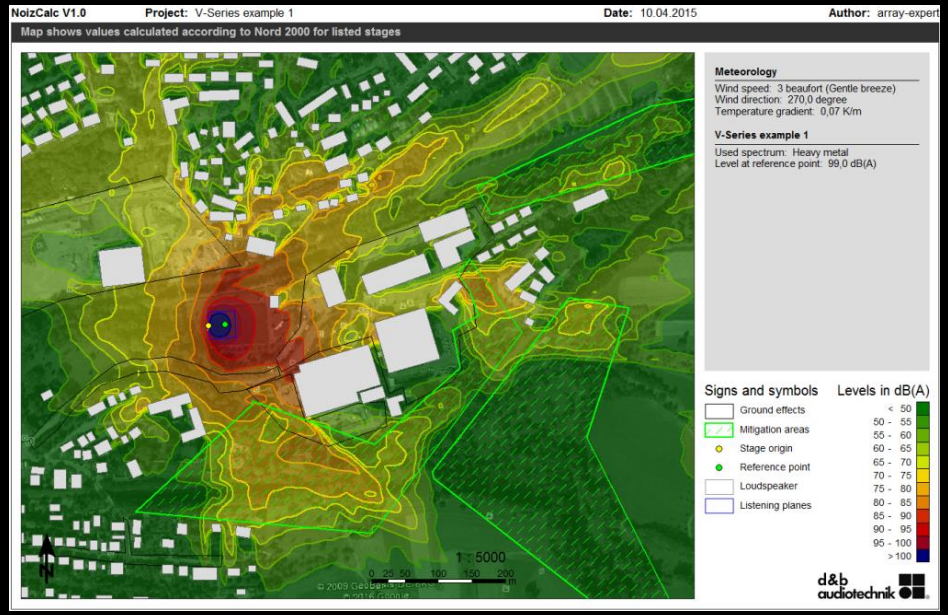



# Wind-Szenarien.

## 3 bft
## West → Ost




## 3 bft
## West ← Ost



# Praxiserfahrung & Validierung bei Open-Airs.

| Year | Event | Location | Noise concern | Data |
|---|---|---|---|---|
| 2016, 2017 | Flow Festival | Helsinki, Finland | ✓ | ✓ |
| 2016, 2017 | Das Fest | Karlsruhe, Germany | | ✓ |
| 2016, 2017 | Summer Breeze | Dinkelsbühl, Germany | | ✓ |
| 2016 | Rock en Seine | Paris, France | ✓ | |
| 2016 | Lollapalooza | Berlin, Germany | ✓ | (✓) |
| 2016 | Beyond Wonderl. | Los Angeles area, USA | ✓ | (✓) |
| 2016, 2017 | Made in America | Philadelphia, USA | ✓ | (✓) |
| 2016, 2017 | Okeechobee Fest | Okeechobee, USA | ✓ | (✓) |
| 2018 | Love Family Park | Rüsselsheim, Germany | ✓ | ✓ |
| | | ... | | |

# Messungen.

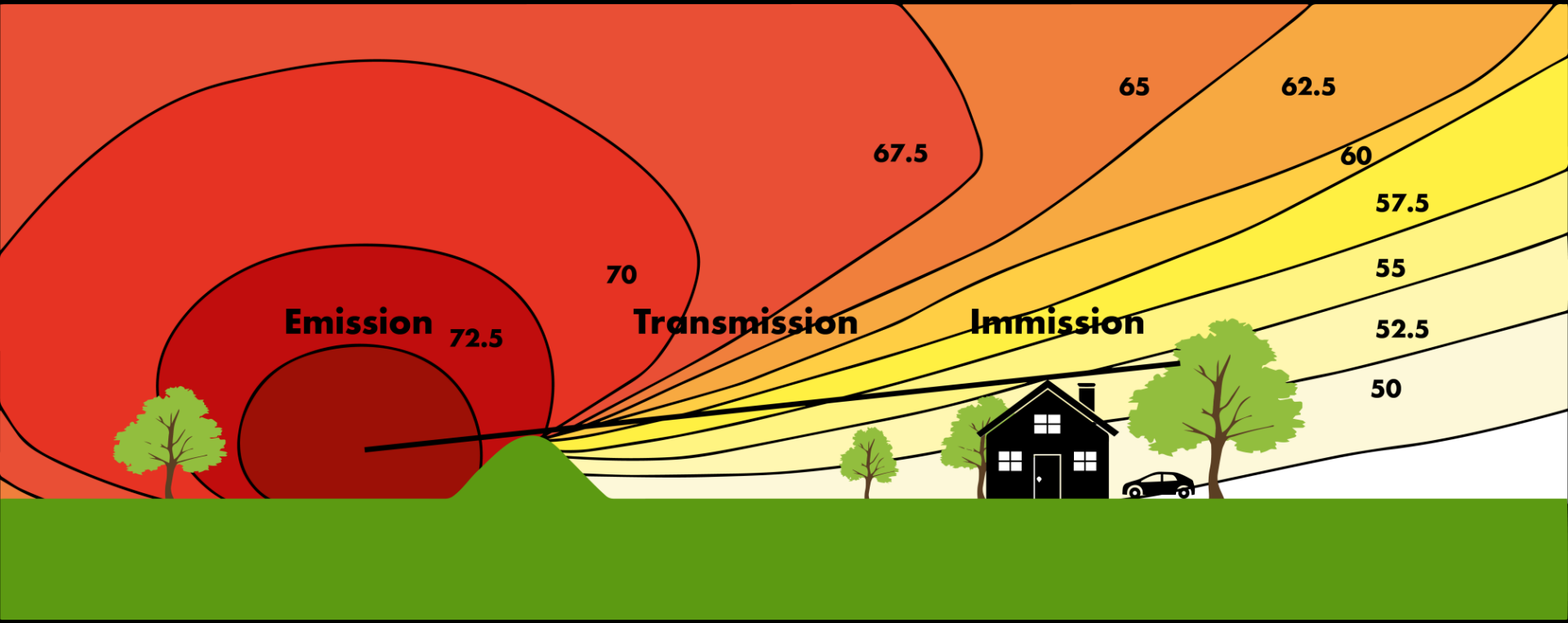
## Anforderungen

- Kalibrierte Messgeräte
- Wetter: kein Regen & kein (starker) Wind
- Störgeräusche < “Signal” – 10 dB
  - Verkehr, Industrie, …
  - Auch andere Bühnen → Programmablauf

## Für die Berechnungen

- Meteorologie: Wind, Luftfeuchte , Temperatur …
- Lokationen
  - Messpunkte
  - Bühne(n)
- Spektrum am Front of House

# Berechnungen.



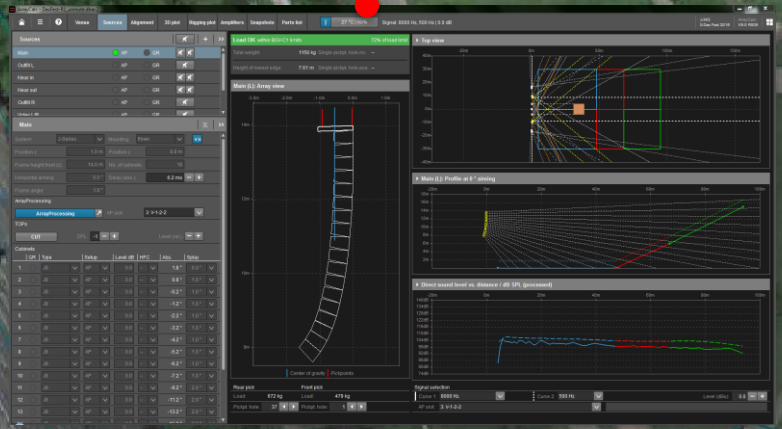

Wälder Quellen Terrain Akustische Gebäude Meteorologie

Bodenbeschaffenheiten

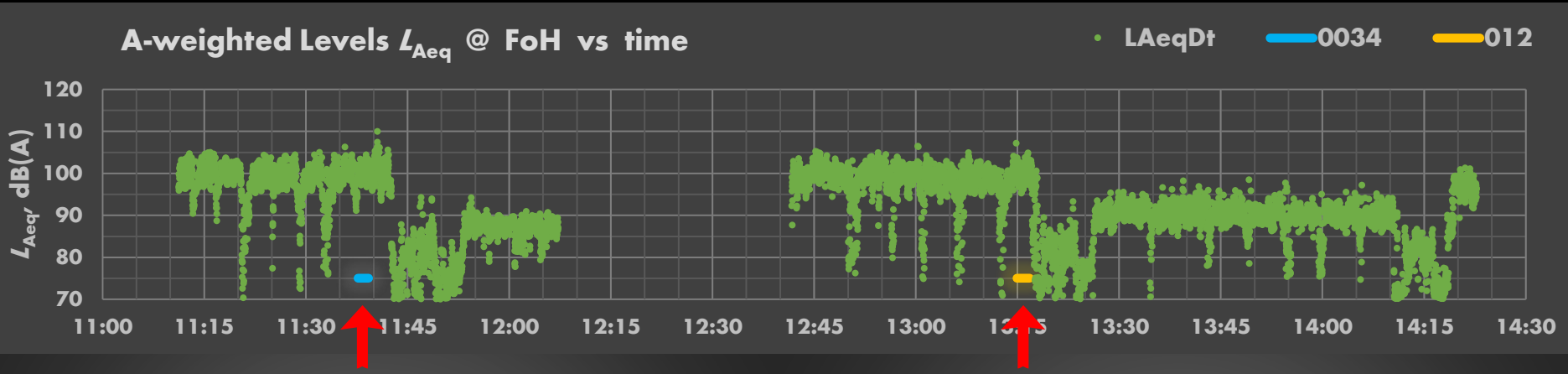
# Schallquellen.

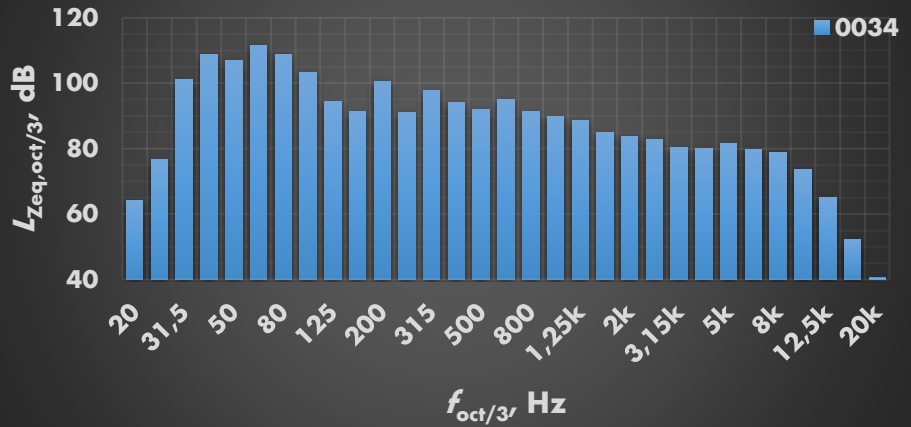
+ s1

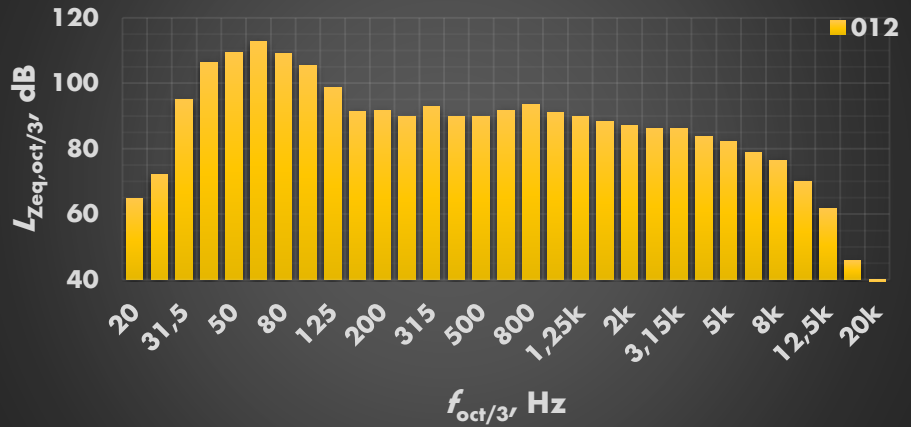
Spektrum am Referenzpunkt



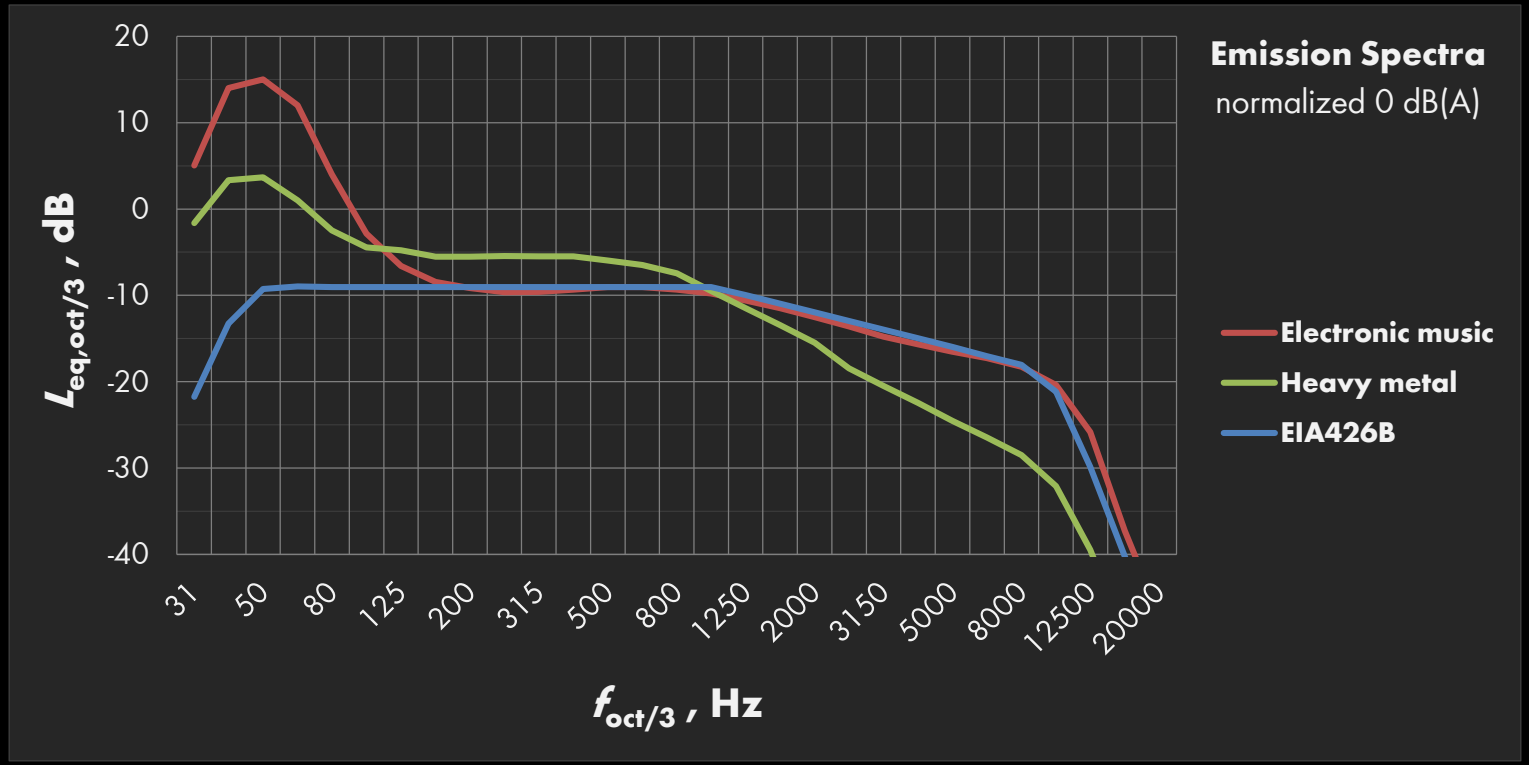
# Emissions-Spektren.



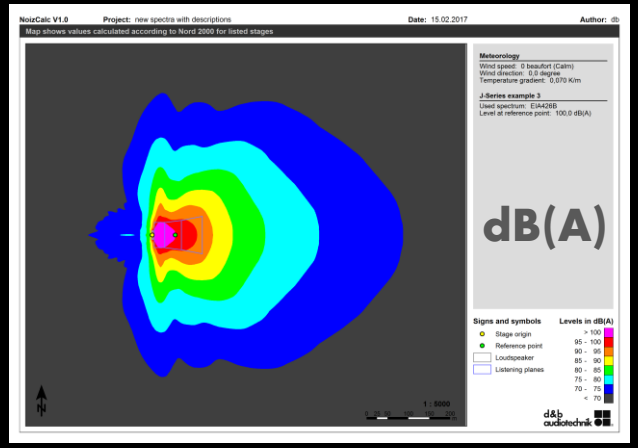



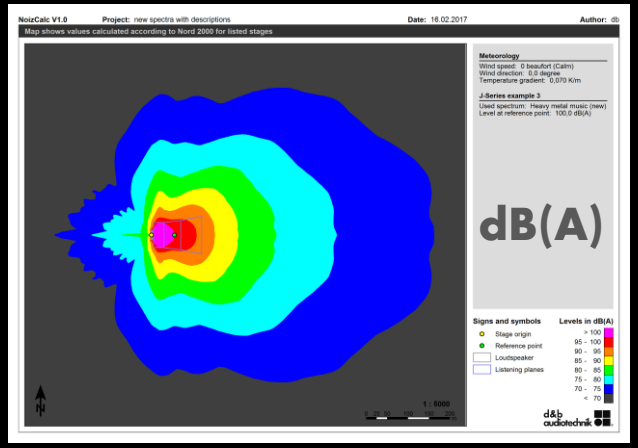



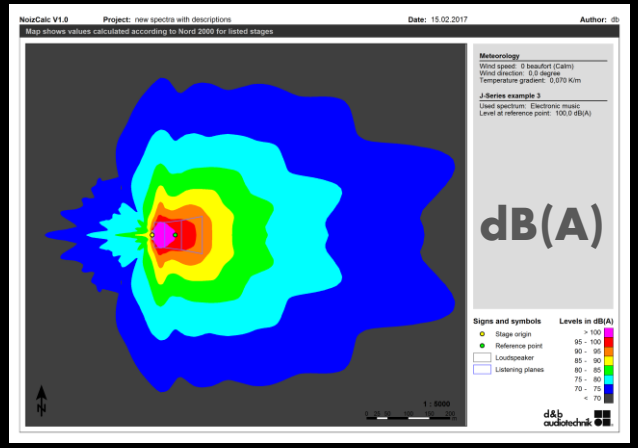
# Emissions-Spektren.

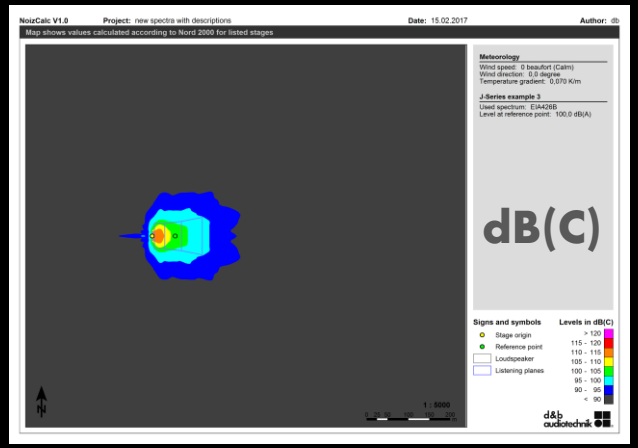


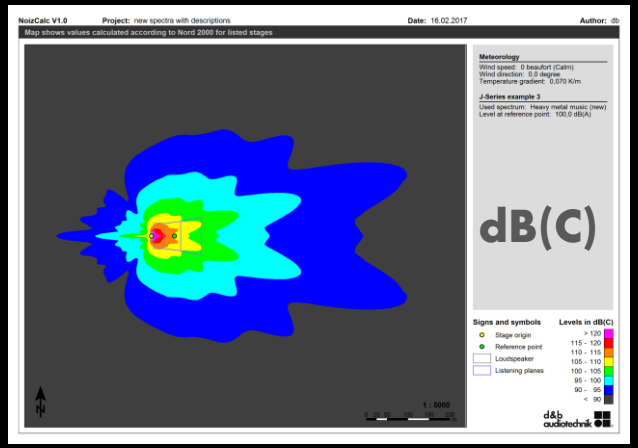
# Emissions-Spektren.

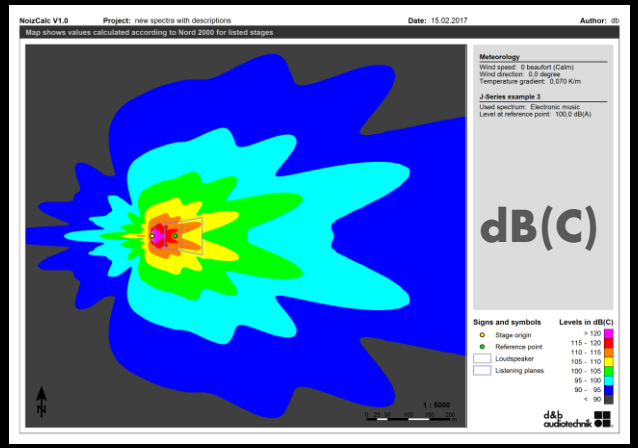


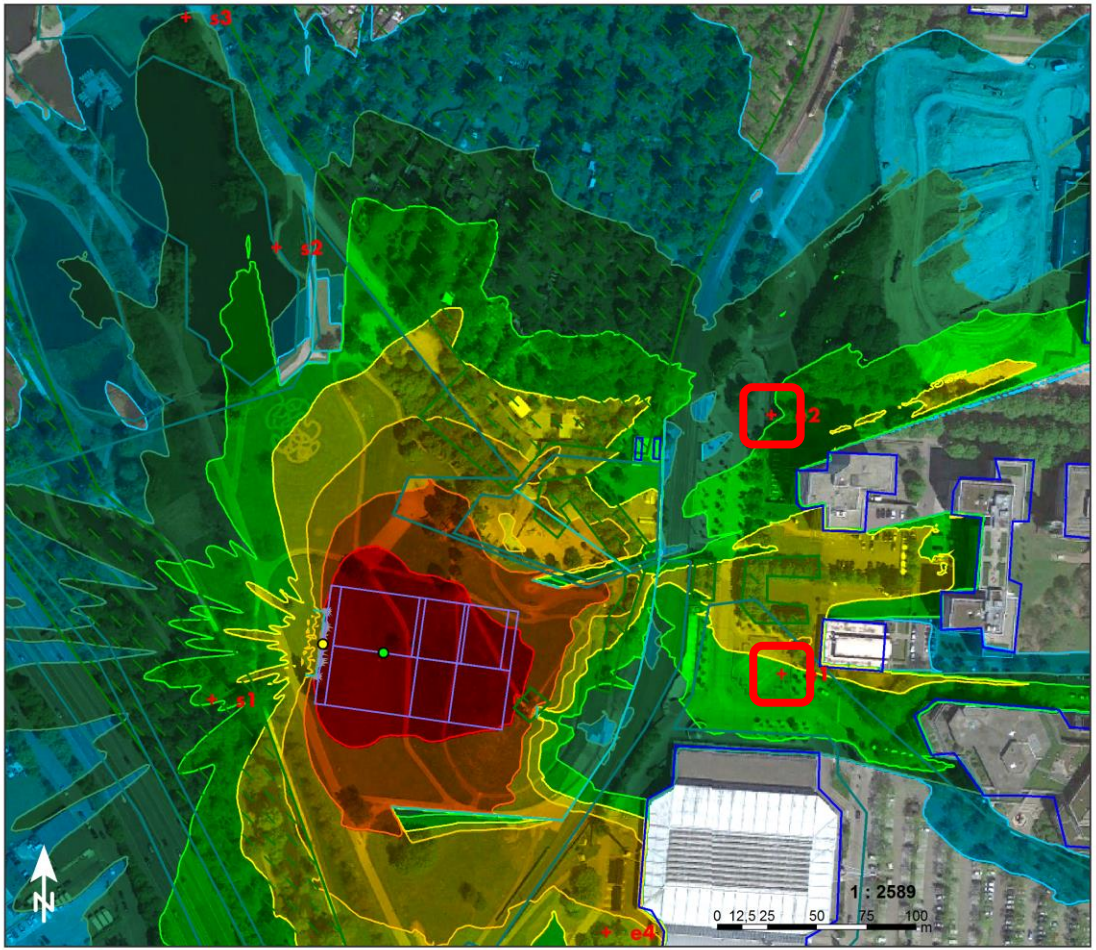



NoizCalc V1.0 **Project:** 2016 Das Fest **Date:** 25.08.2017 **Author:** db

Map shows values calculated according to Nord 2000 for listed stages




**Meteorology**

Wind speed: 0 beaufort (Calm)
Wind direction: 0,0 degree
Temperature gradient: 0,050 K/m

**Das Fest 2016**

Used spectrum: Live bands (Pop, Rock, Met
Level at reference point: 95,0 dB(A)

**Signs and symbols**

- Ground effects
- Mitigation areas
- Wall
- Calculation area
- Stage origin
- Reference point
- Loudspeaker
- Listening planes

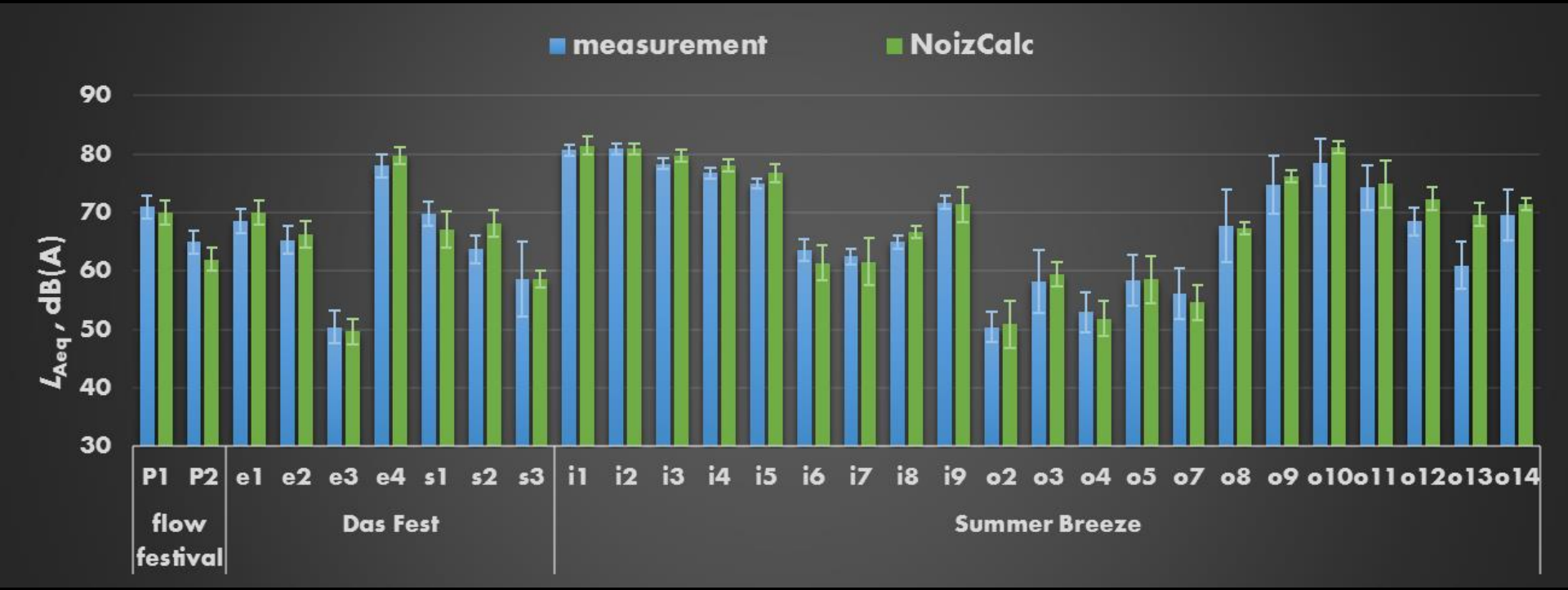
**Levels in dB(A)**

| |
|---|
| > 90 |
| 85 - 90 |
| 80 - 85 |
| 75 - 80 |
| 70 - 75 |
| 65 - 70 |
| 60 - 65 |
| < 60 |

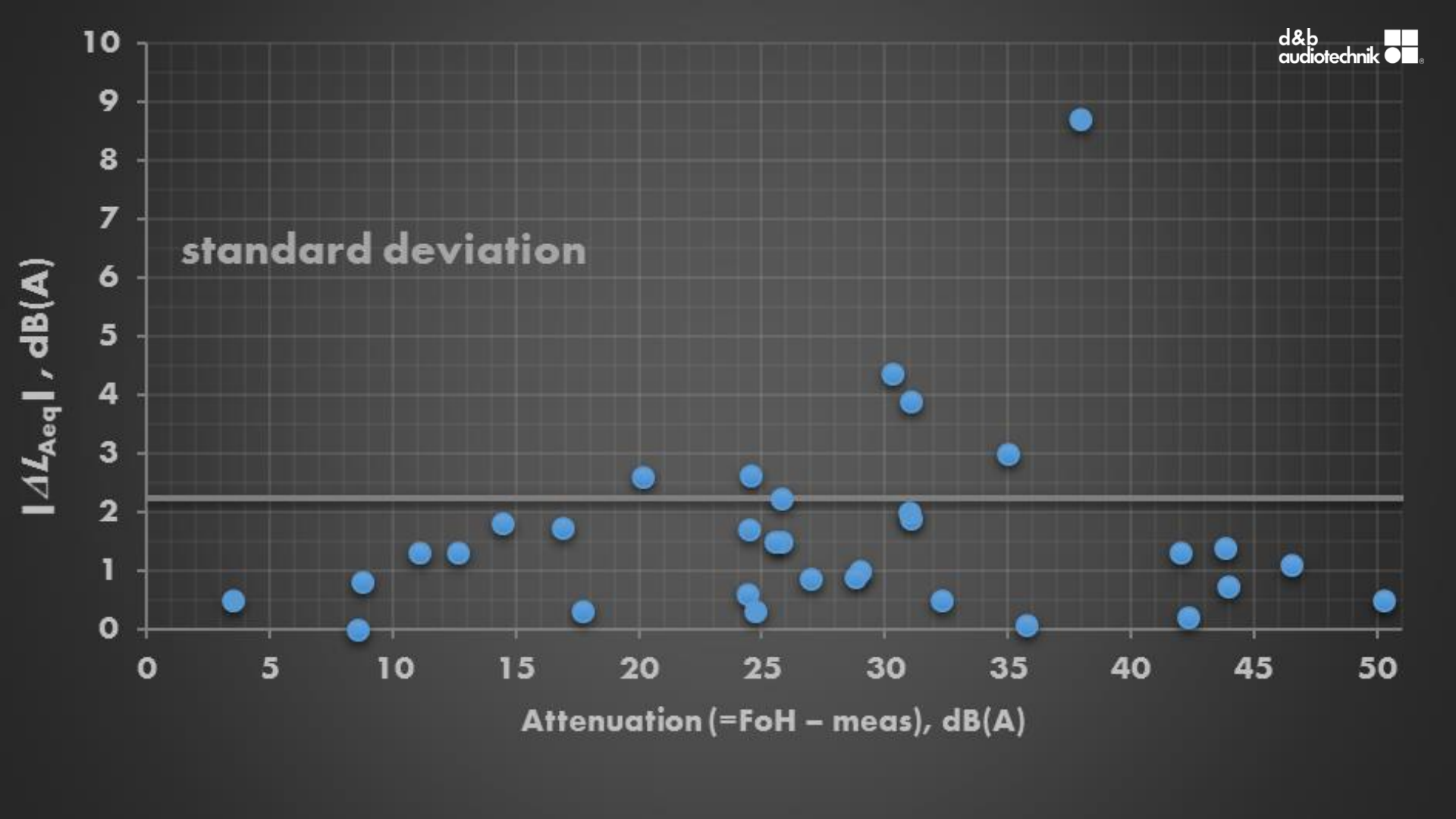
d&b audiotechnik

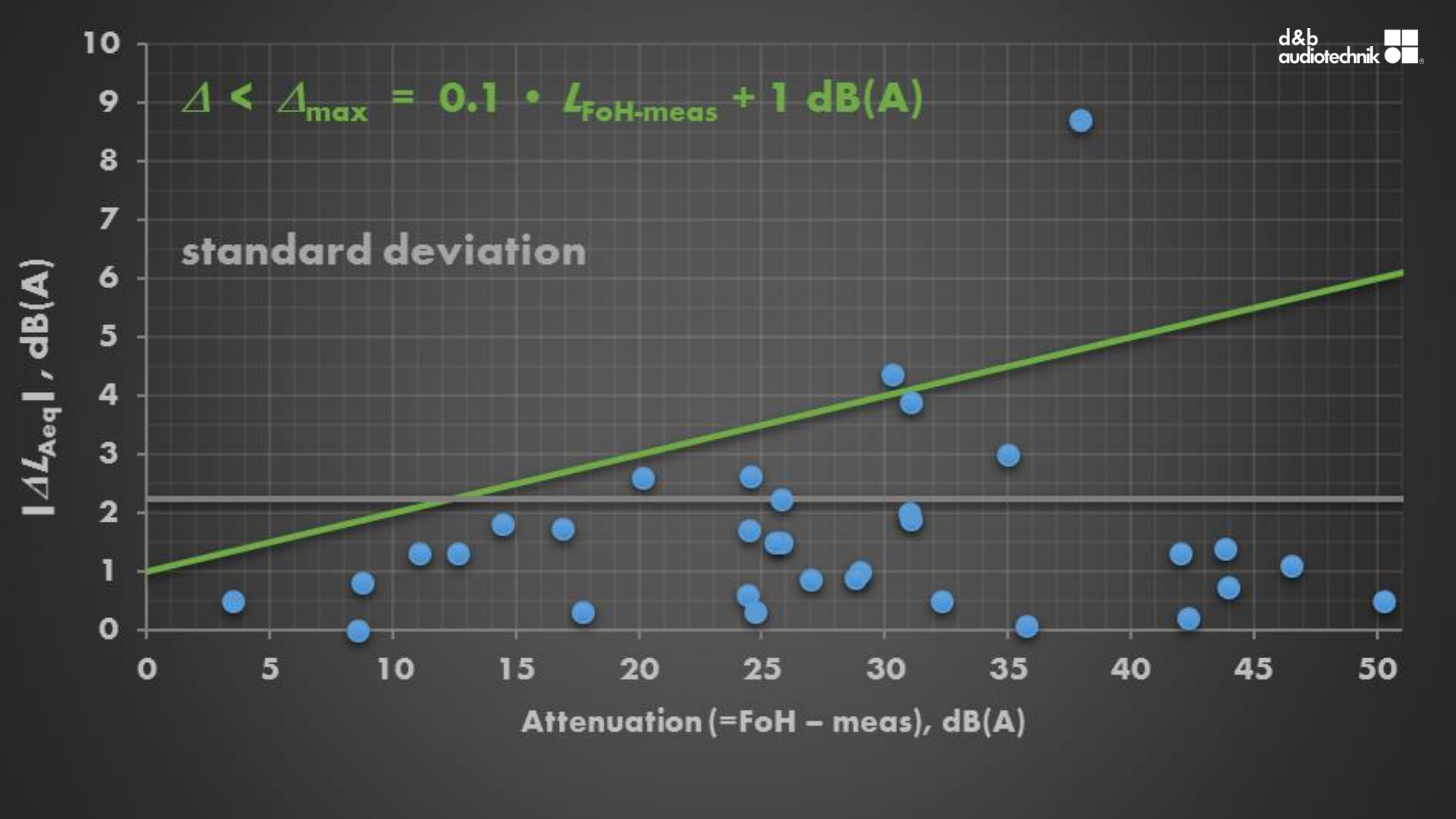
**Berechnung an jedem Messpunkt.**

# Vergleich Rechnung Messung.




$$\overline{\Delta L_{Aeq}} = \overline{L_{Aeq}^{NoizCalc} - L_{Aeq}^{meas}} = (0.8 \pm 2.2)\ \mathrm{dB(A)}$$


standard deviation
$|\Delta L_{Aeq}|$, dB(A)
Attenuation (=FoH – meas), dB(A)
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40
45
50

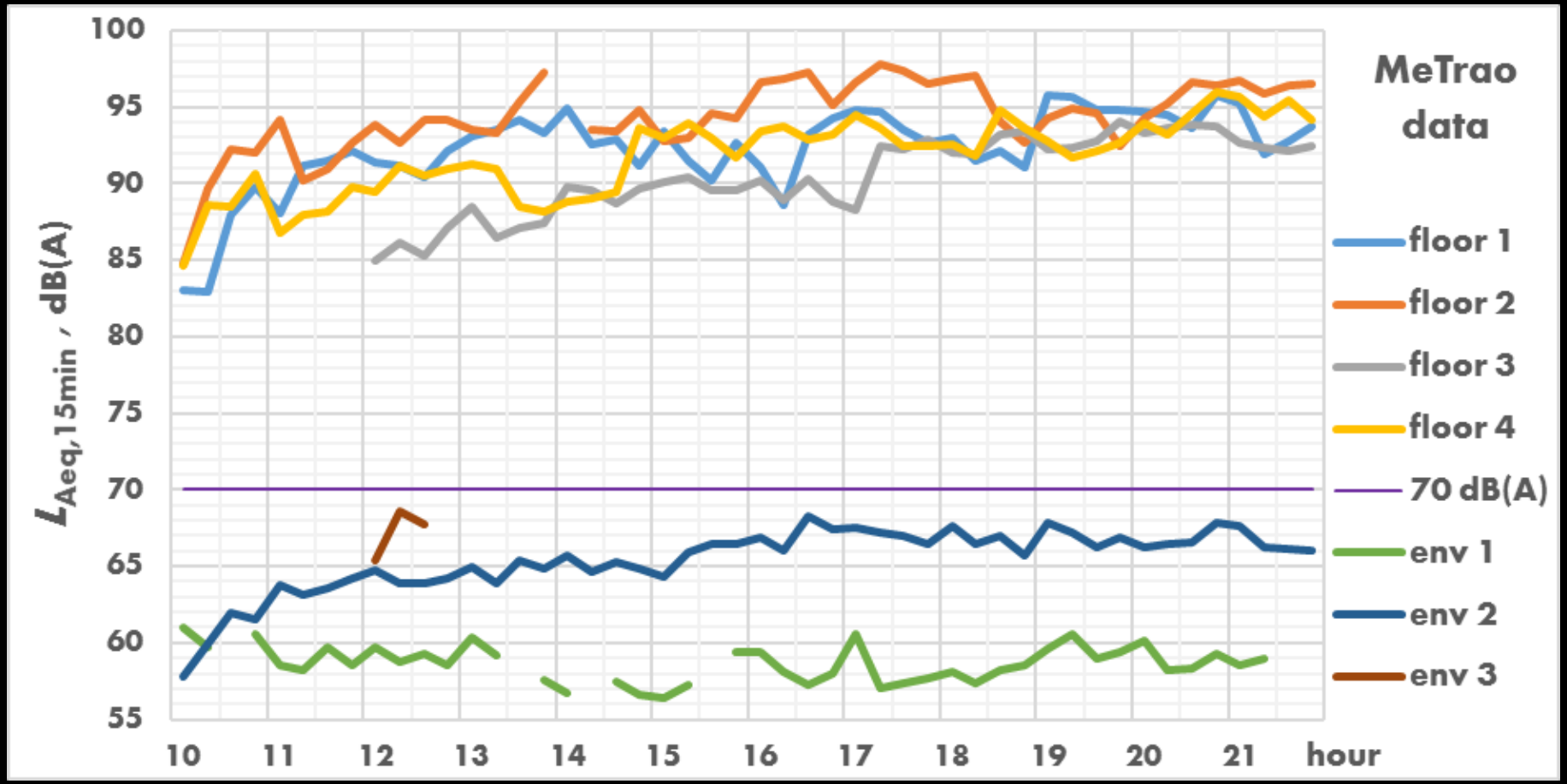

d&b audiotechnik
$\Delta < \Delta_{max} = 0.1 \cdot L_{FoH\text{-}meas} + 1$ dB(A)
standard deviation
$|\Delta L_{Aeq}|$, dB(A)
Attenuation (=FoH – meas), dB(A)
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40
45
50

# Love Family Park 2018 in Rüsselsheim.

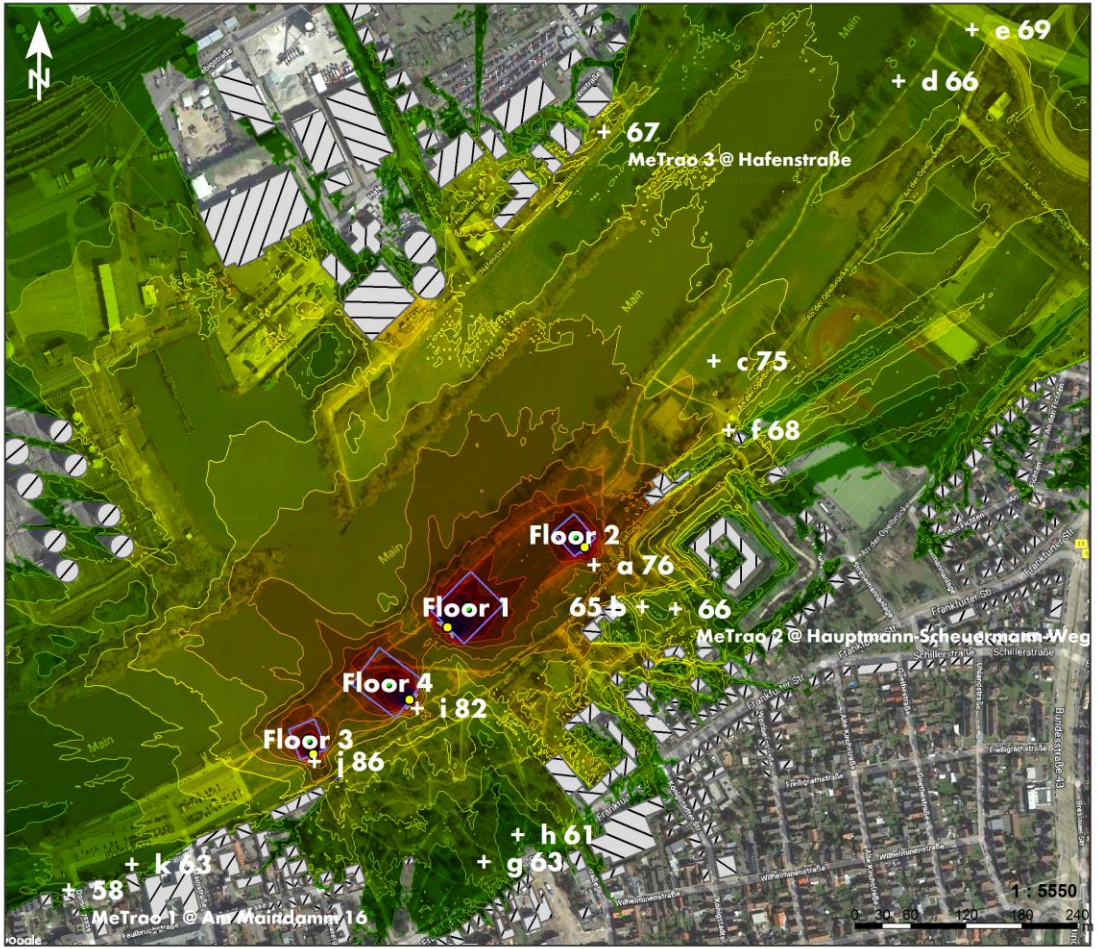
# Love Family Park 2018 in Rüsselsheim

| | |
|---|---|
| **Event** | **Love Family Park, cosmopop GmbH, Anatol Fried** |
| type, size | techno festival with **4 floors**, <20k |
| date, time | 28. July 2018, **10 am – 10 pm** (1 day) |
| location | 65428 Rüsselsheim am Main, park by the Landungsplatz |
| situation | directly next to residential areas at the heart of Rüsselsheim, limit 70 dB(A) |
| **all SL-Series** | Floor 1+4: 10x/8xGSL+20xSL-SUB, Floor 2+3: 8xKSL+12xSL-SUB |
| **NoizCalc**<br>(noise prediction) | Was used in planning phase to show differences to conventional PA.<br>Was also used on site to reproduce momentary noise situations of complaints. |
| **MeTrao**<br>(noise monitoring) | 1 station per floor @ FoH, Floor 1: mic on SUB-Array (no FoH)<br>3 environmental stations at 4 m height |
| **Manual measurements** | NTi XL2 analyser at several locations denoted by lower-case, 2 m height |

# Love Family Park 2018 in Rüsselsheim.



Map shows values calculated according to Nord2000 for listed stages




**Meteorology**

Wind speed: 2 beaufort (Light breeze)
Wind direction: 45,0 degree
Temperature gradient: 0,070 K/m

**LFP 2018_Floor1_v1.1**

Spectrum: Floor 1 GSL
SPL at reference point: 95,1 dB(A)

**LFP 2018_Floor4_v1.1**

Spectrum: Floor 4 GSL
SPL at reference point: 93,9 dB(A)

**LFP 2018_Floor3_v1.1**

Spectrum: Floor 3 KSL
SPL at reference point: 92,5 dB(A)

**LFP 2018_Floor2_v1.1**

Spectrum: Floor 2 KSL
SPL at reference point: 96,2 dB(A)

**Signs and symbols**

- Calculation area
- Stage
- Stage origin
- Reference point
- Loudspeaker
- Listening planes

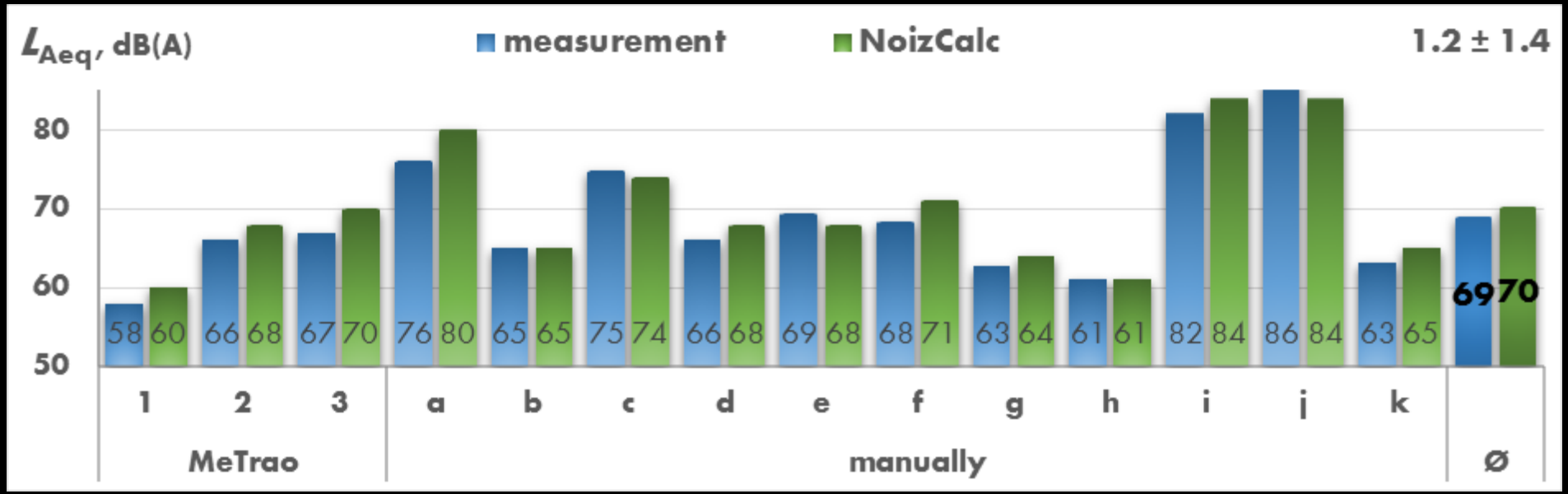
**Levels in dB(A)**

| |
|---|
| > 99 |
| 96 - 99 |
| 93 - 96 |
| 90 - 93 |
| 87 - 90 |
| 84 - 87 |
| 81 - 84 |
| 78 - 81 |
| 75 - 78 |
| 72 - 75 |
| 69 - 72 |
| 66 - 69 |
| 63 - 66 |
| 60 - 63 |
| < 60 |

d&b audiotechnik

# Love Family Park.

# Love Family Park 2018 in Rüsselsheim.



# Vielen Dank • Fragen ?