

# Letzte Entwicklungen bei der HF-Spektrumsanalyse

7. Dezember 2017  
Salzburg / Ö

Christian Bauer  
[x.test GmbH](#)



# Eckdaten

❖ Firmengründung 1. Mai 2010, als Partnerfirma von Agilent Technologies

Agilent Technologies ist nun Keysight Technologies



Unlocking Measurement Insights for 75 Years

❖ heute ca. 10 Mitarbeiter für Vertrieb, Schulung, Service, Support, ...

# Unsere Partner

- ✘ Keysight Technologies (SA, NA, OSC, SG, PS, ...)
- ✘ Adlink, Ztec (modulare Messtechnik)
- ✘ EMSCAN, EMC, Haefely (EMV Messtechnik)
- ✘ FLIR (Thermographie)



Unlocking Measurement Insights for 75 Years



# Agenda

- Spektrumanalyse
  - Frequenzbereich
  - DANL / NFE
  - Analysebandbreite
  - Real-Time Spektrumanalyse
- EMV-Analyse
  - PreCompliance
  - EMxpert

# Agenda

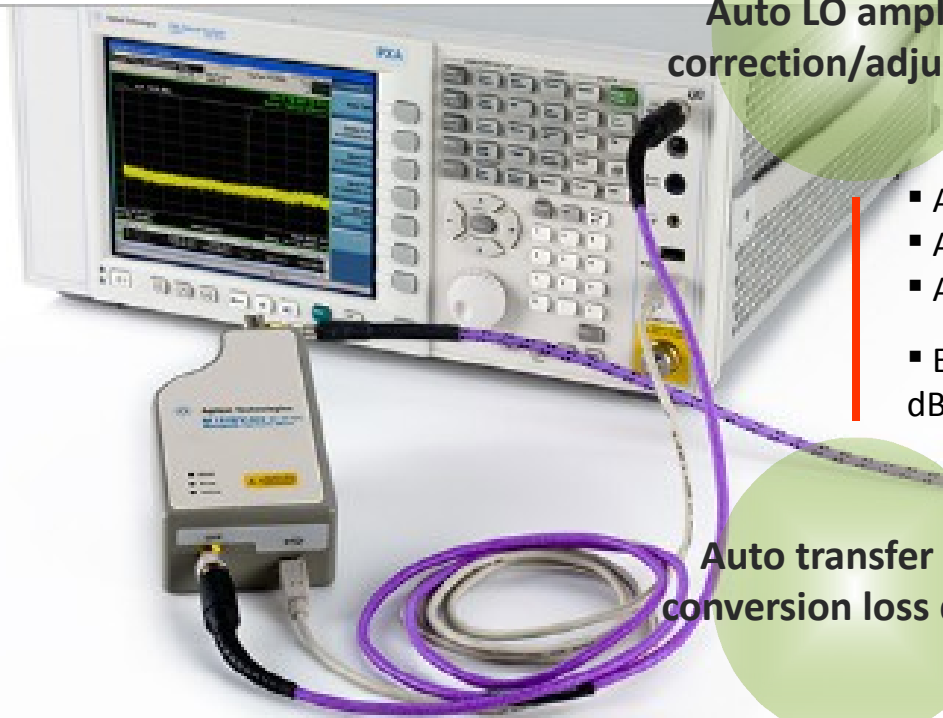
- **Spektrumanalyse**
  - **Frequenzbereich**
  - DANL / NFE
  - Analysebandbreite
  - Real-Time Spektrumanalyse
- EMV-Analyse
  - PreCompliance
  - EMxpert

# What are *smart harmonic mixers*?

## Product Description

- M1970V and M1970W are un-preselected waveguide harmonic (USB) mixers used to extend the frequency range of the PXA from 50 to 75/80 GHz, and 75 to 110 GHz respectively.

## Embedded Smart Features



Auto LO amplitude correction/adjustment

Auto detect mixer model/serial number

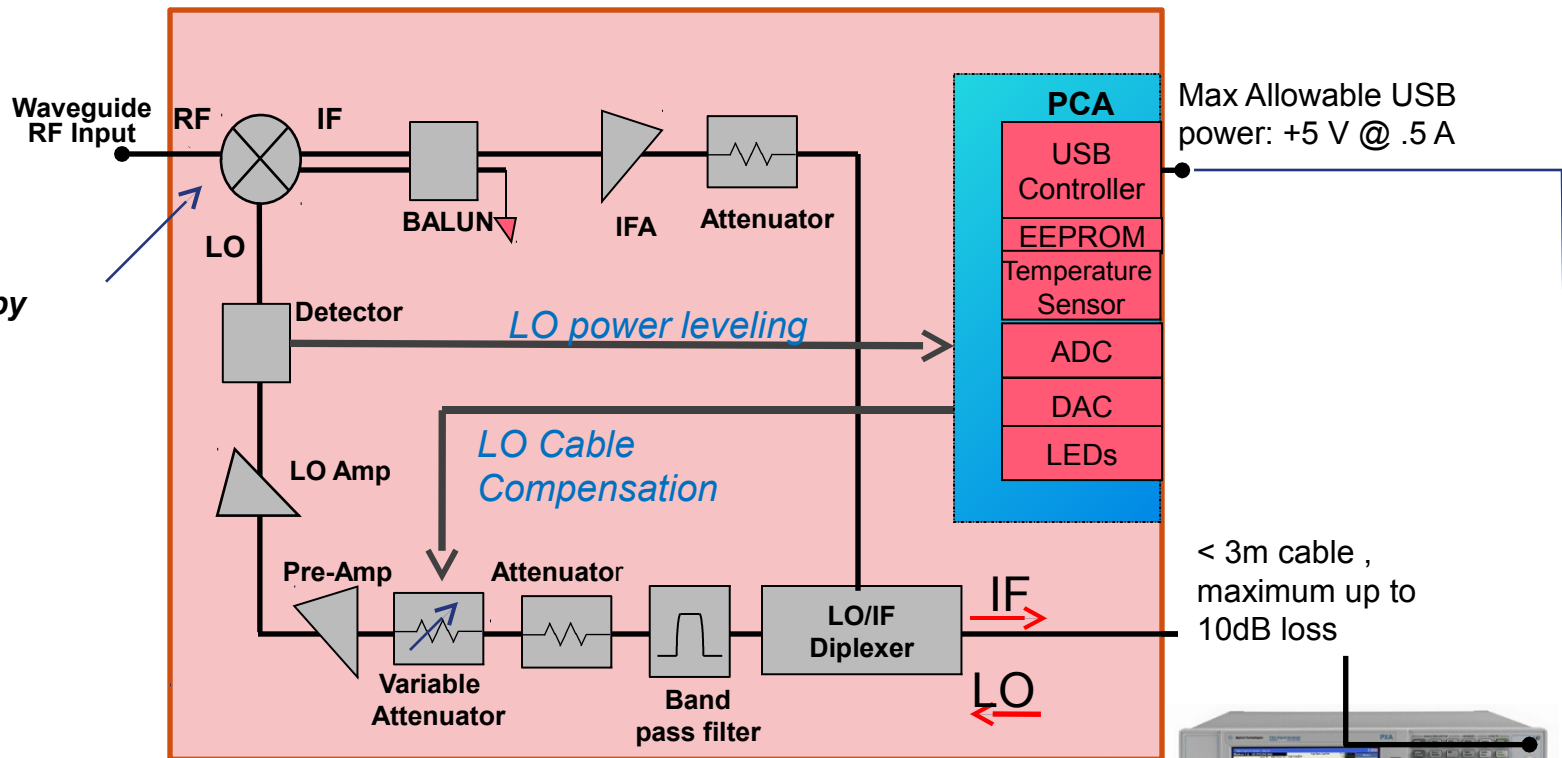
- Auto setting freq and LO harmonics
- Auto LO alignment at start up
- Auto calibration – temp/time change
- Excellent calibration accuracy: +/- 2.2 dB and conversion loss of 25 dB max

Auto transfer of conversion loss data

Improved overall system DANL and accuracy

# Functional block diagram

Mixer IC developed by TLO-HFTC



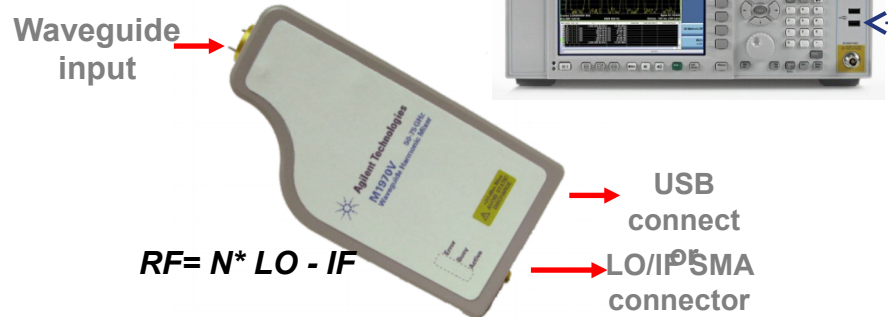
RF range: 50-75GHz (V) , 75-110 GHz (W)

LO range: 8.3GHz – 13.8GHz

IF range : 200MHz – 500MHz

V band LO harmonics N =-6

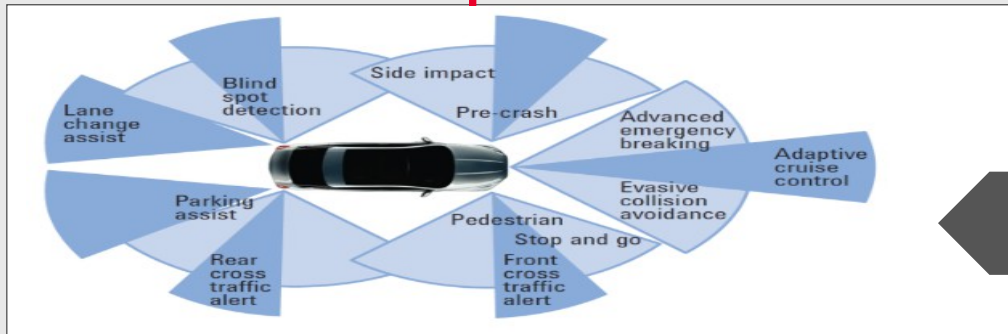
W band LO harmonics N=-8



# Industry Challenge

Need smaller components

## High frequency leads to smaller components



## Design and measurement challenges

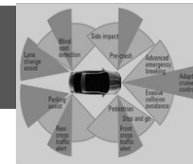
### Small dimensions & complex test setups

- Smaller, fragile cables, adaptors
- Need external mixers with images to get to > 85 GHz

## Automotive Radar



Resolve Small Targets in Dense Environments



Compact, Mobile Platforms

Multiple mounted radars

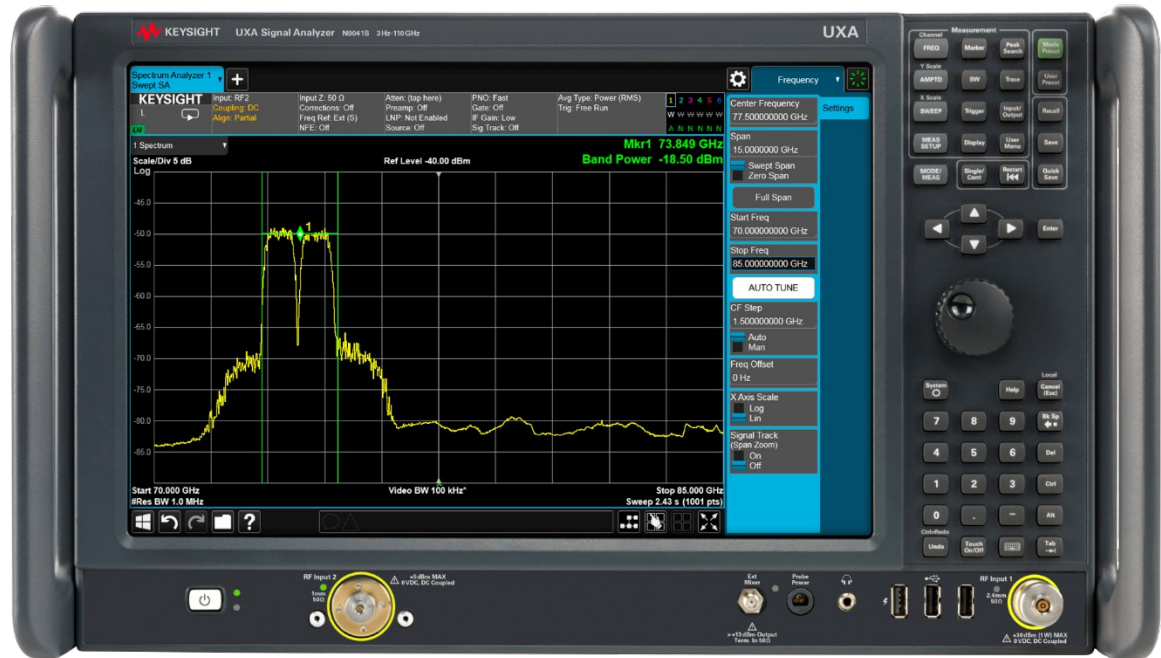
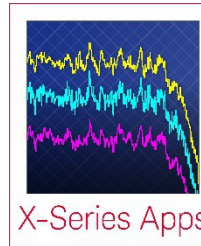


# The New N9041B UXA Signal Analyzer, 110 GHz

“See the Whole Picture” to 110 GHz

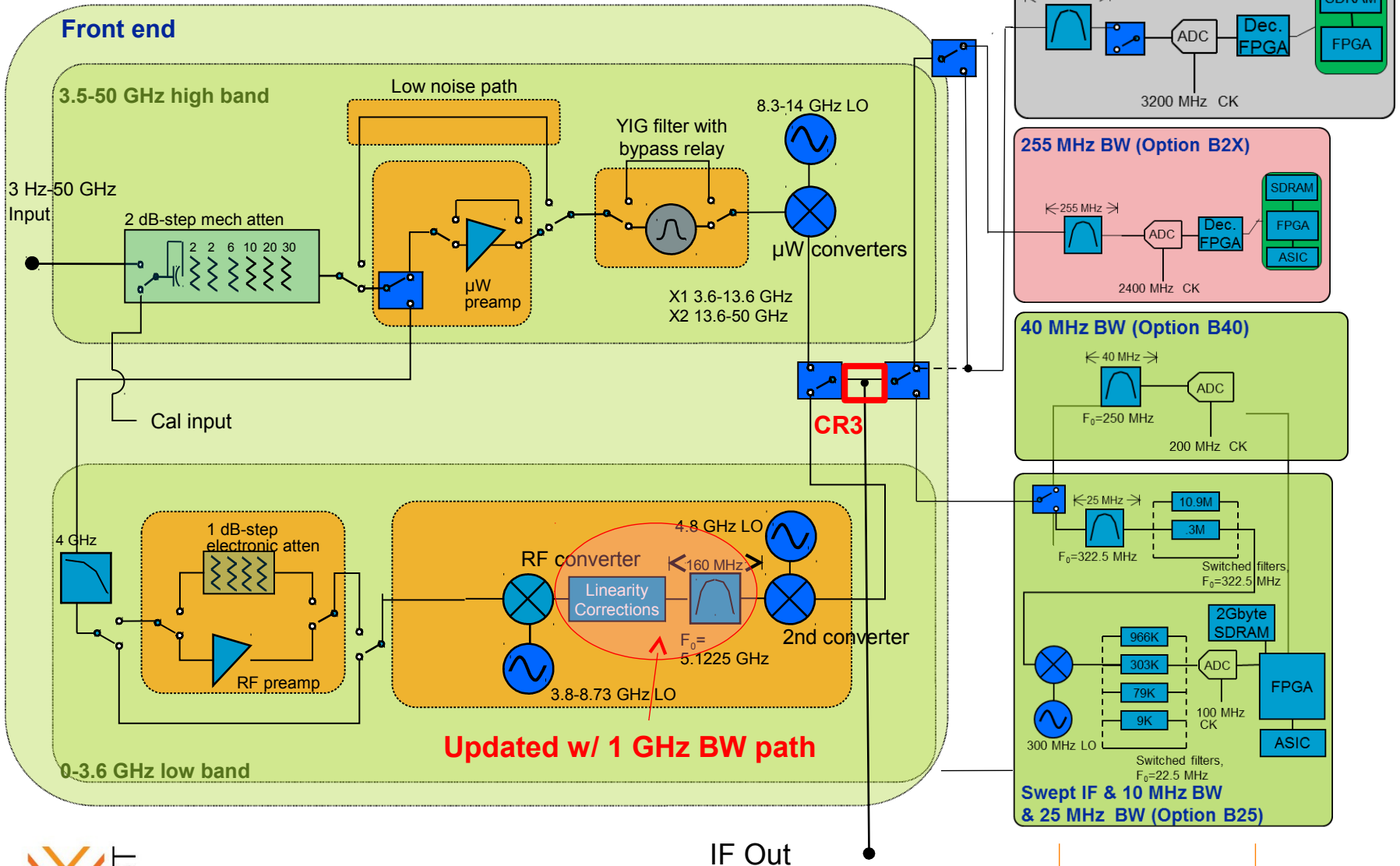
1<sup>st</sup>

3 Hz - 110 GHz  
Continuous sweeps



# UXA Simplified Block Diagram

1 GHz BW *not* compatible with B5X

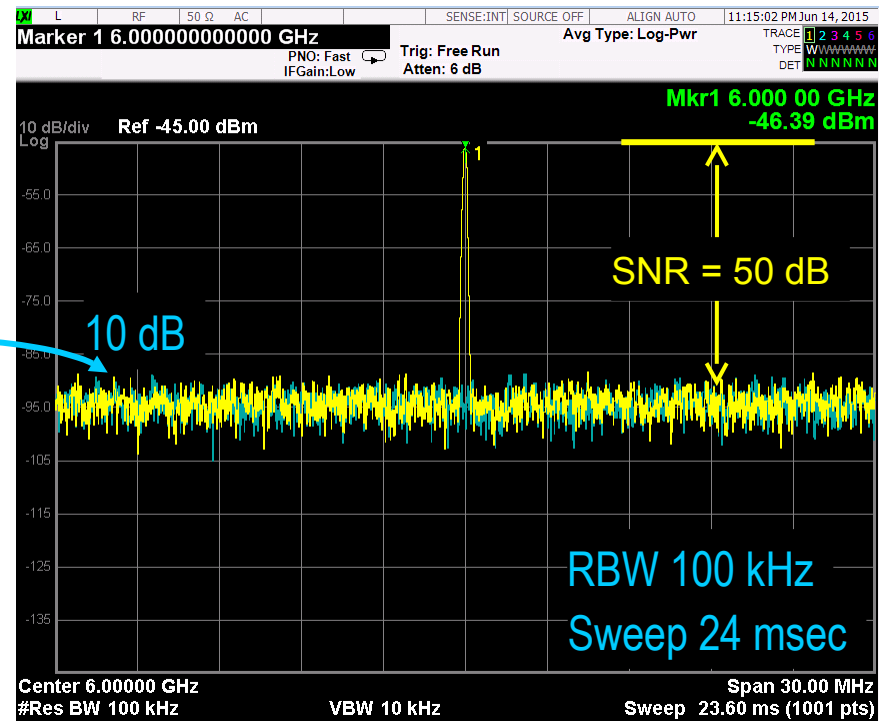
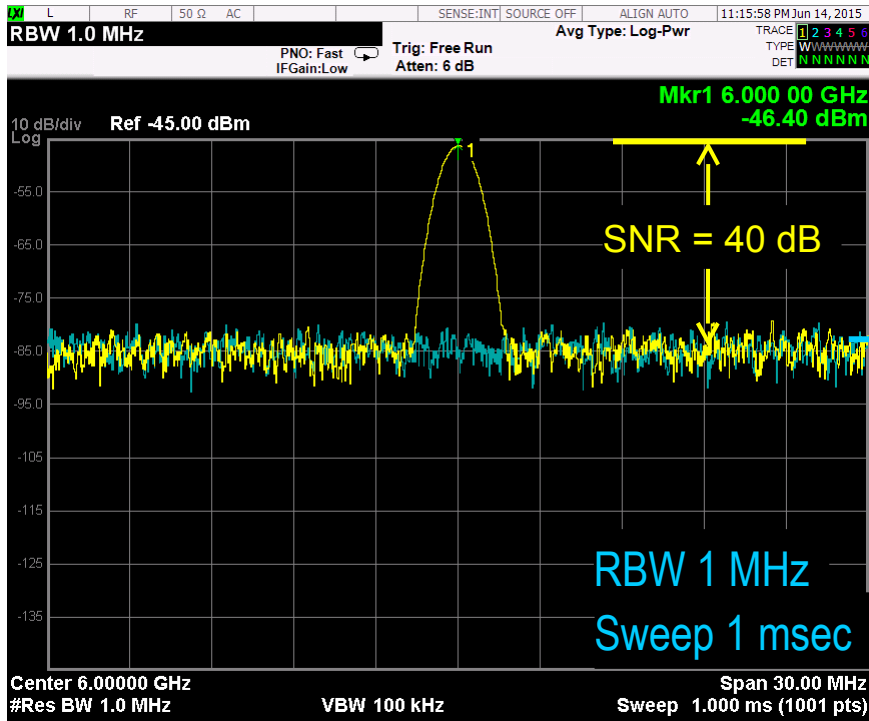


# Agenda

- **Spektrumanalyse**
  - Frequenzbereich
  - **DANL / NFE**
  - Analysebandbreite
  - Real-Time Spektrumanalyse
- EMV-Analyse
  - PreCompliance
  - EMxpert

# Techniques to Improve Sensitivity

## Reduce RBW

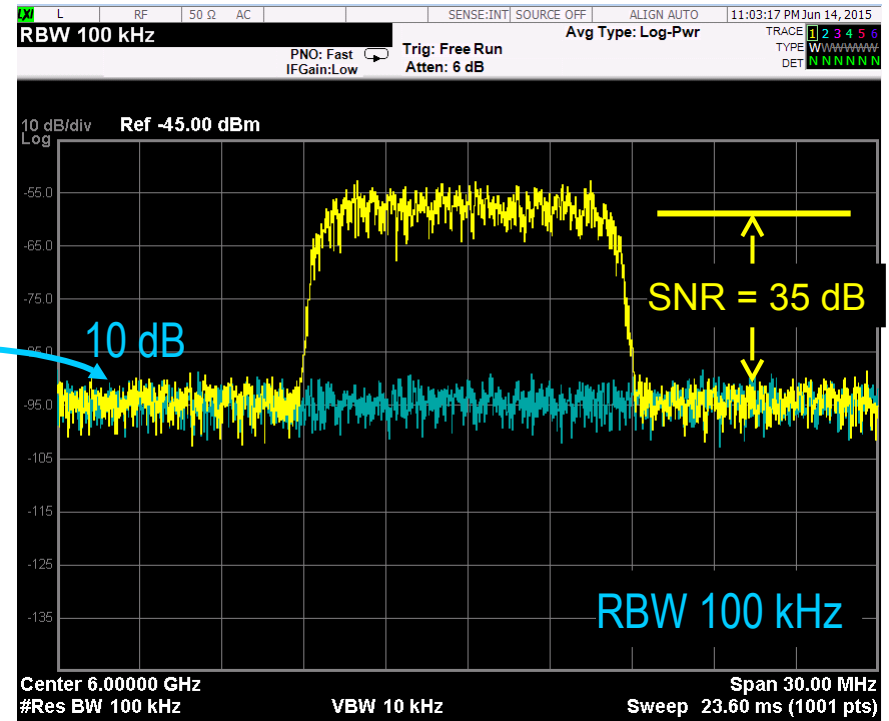
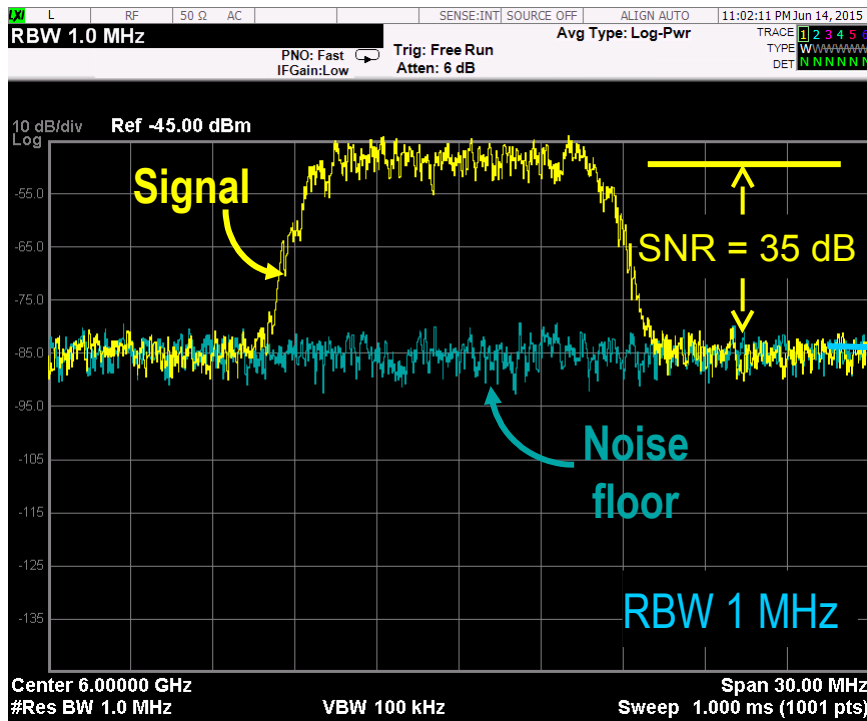


- + Improve SNR
- + Ideal for CW and narrowband signals
- + Improve accuracy
- Increase sweep time

# RBW and Wideband Signals

What happens with modulated signals? Does reducing RBW still improve SNR?

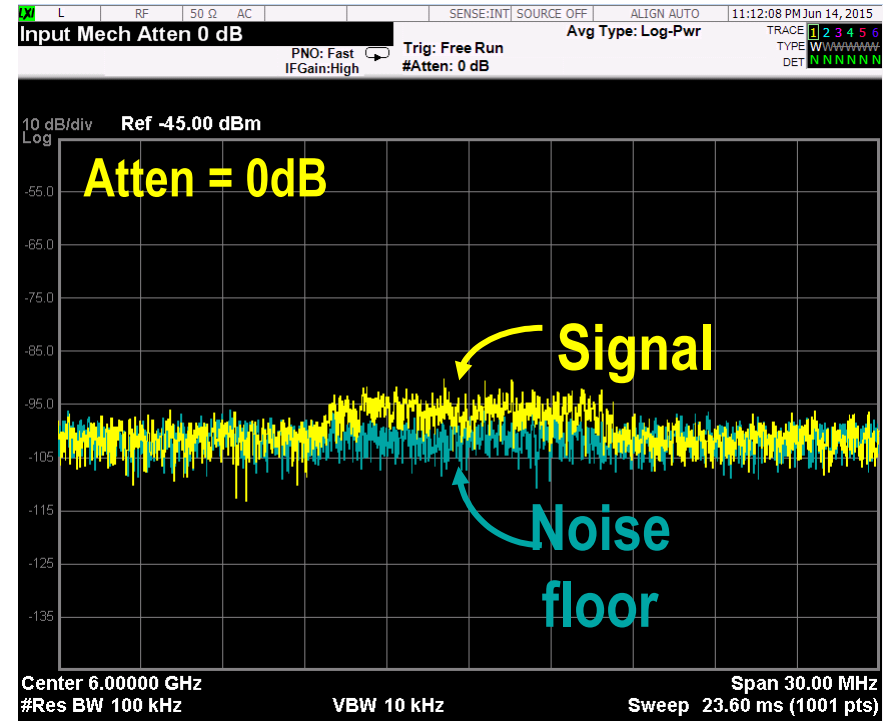
Wideband signals appear as noise



Decreasing RBW does not improve SNR for wideband signals

# Techniques to Improve Sensitivity

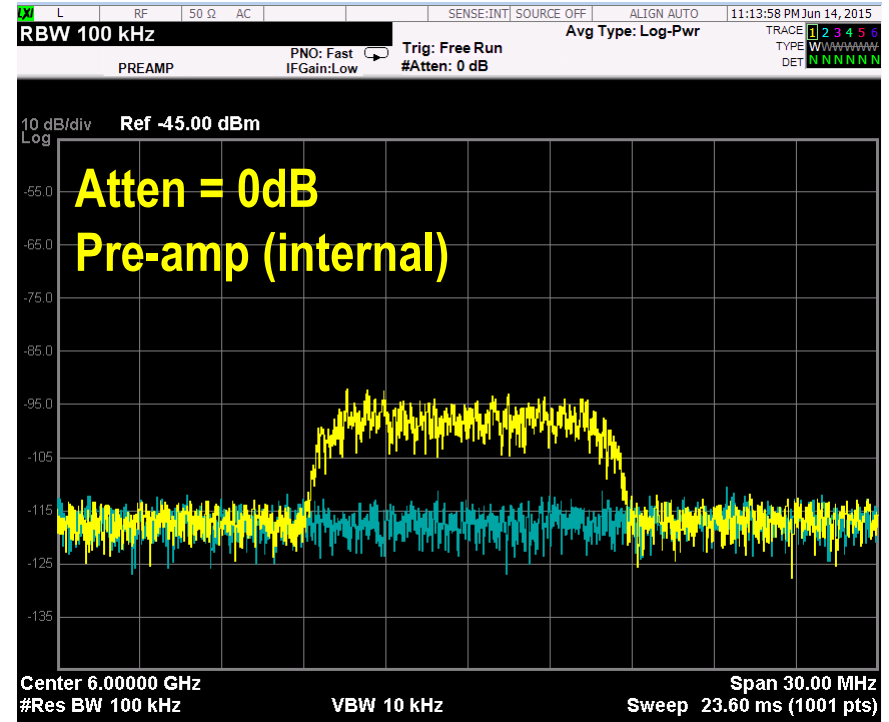
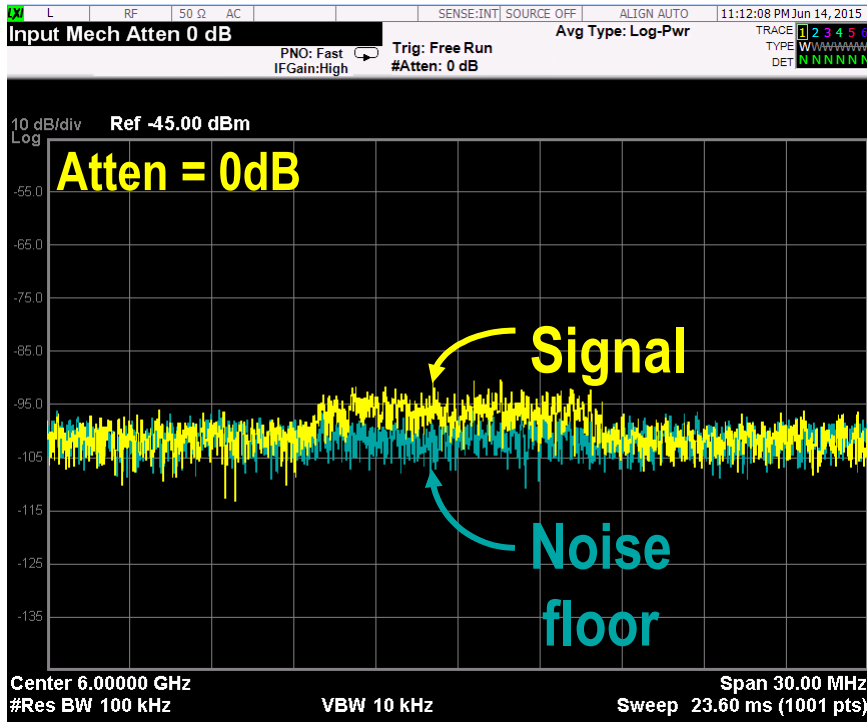
## Reduce attenuation



- + Improve SNR
- + Ideal for any signal type: CW and wideband
- + No increase in sweep time
- Increased mismatch
- Caution: front-end compression and IF overload

# Techniques to Improve Sensitivity

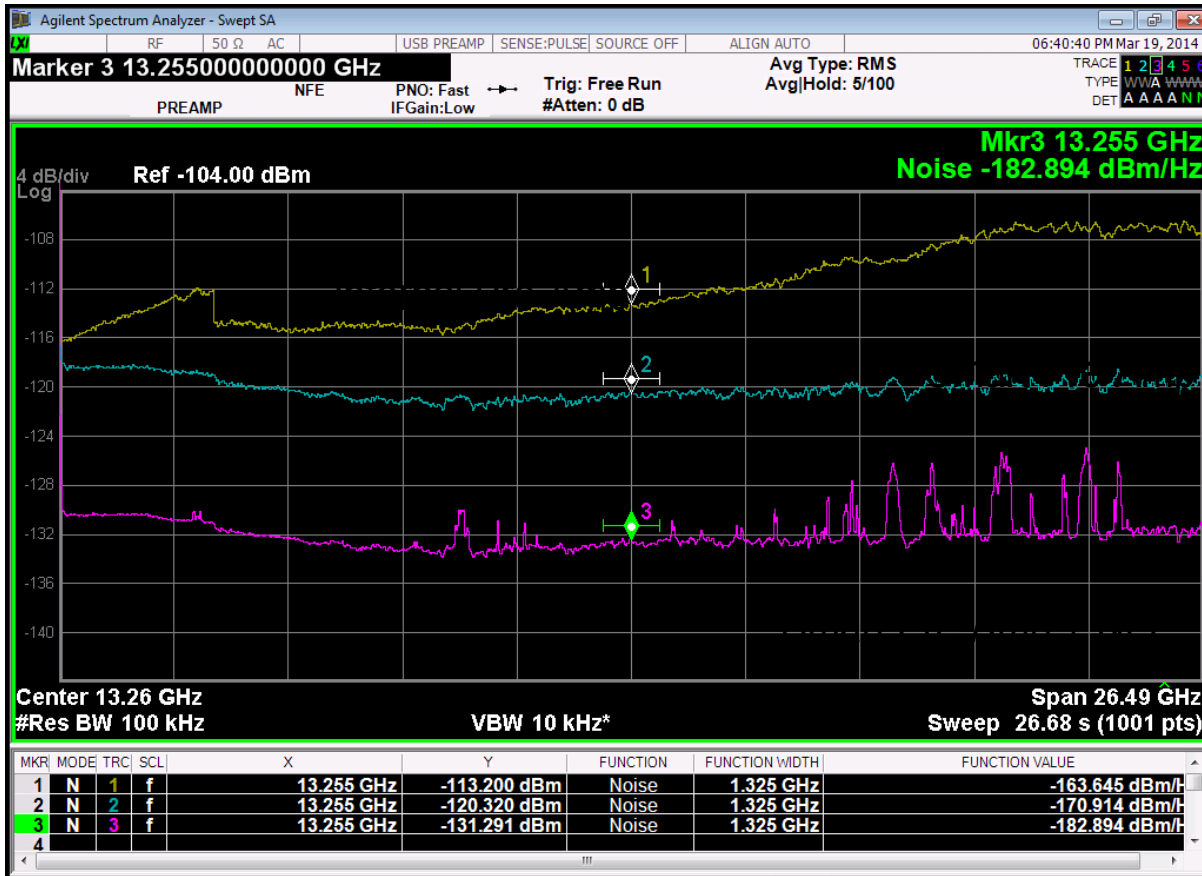
## Include pre-amplifier



- + Improve SNR
- + Ideal for any signal type: CW and wideband
- + No increase in sweep time
- Caution: front-end compression and IF overload

# Techniques to Improve Sensitivity Smart Pre-Amplifier

Measured noise floor across 26.5 GHz span



**Measurement Insight:**  
Smart pre-amp yields  
highest performance

Smart Pre-Amp  
(U7227)



- + Improve flatness
- + Gain correction
- + Temperature compensation
- + Download cal data (USB)
- + Powered by USB
- + 10MHz to 50 GHz

*Industry's only smart pre-amplifier*

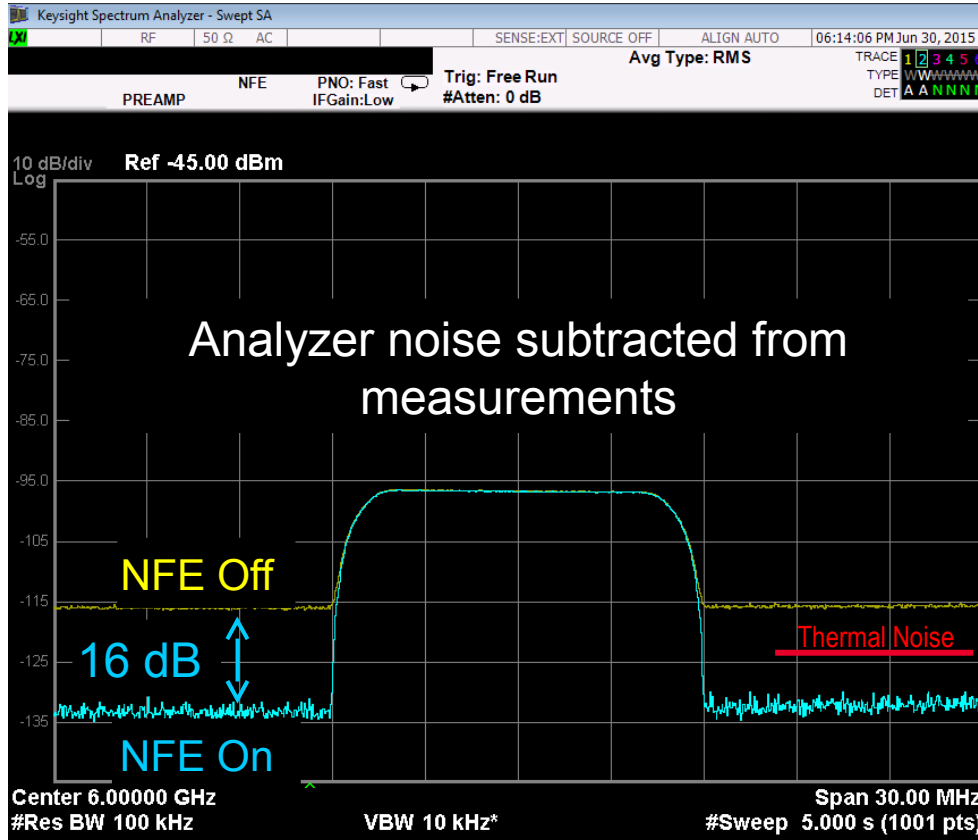




# Techniques to Improve Sensitivity

## Noise floor extension (NFE)

<http://literature.cdn.keysight.com/litweb/pdf/5990-5340EN.pdf>



- + DANL reduced over 8-10 dB
- + Works with any analyzer setting
- + Simple to use – one-button
- + No user cal required
- + Ideal for any signal type
- + Improves accuracy
- + Removes kTB noise
- Could require additional averaging

**Measurement Insight:**  
NFE subtracts analyzer noise for highest sensitivity

*Large advantage over traditional methods*



# Agenda

- **Spektrumanalyse**
  - Frequenzbereich
  - DANL / NFE
  - **Analysebandbreite**
  - Real-Time Spektrumanalyse
- EMV-Analyse
  - PreCompliance
  - EMxpert

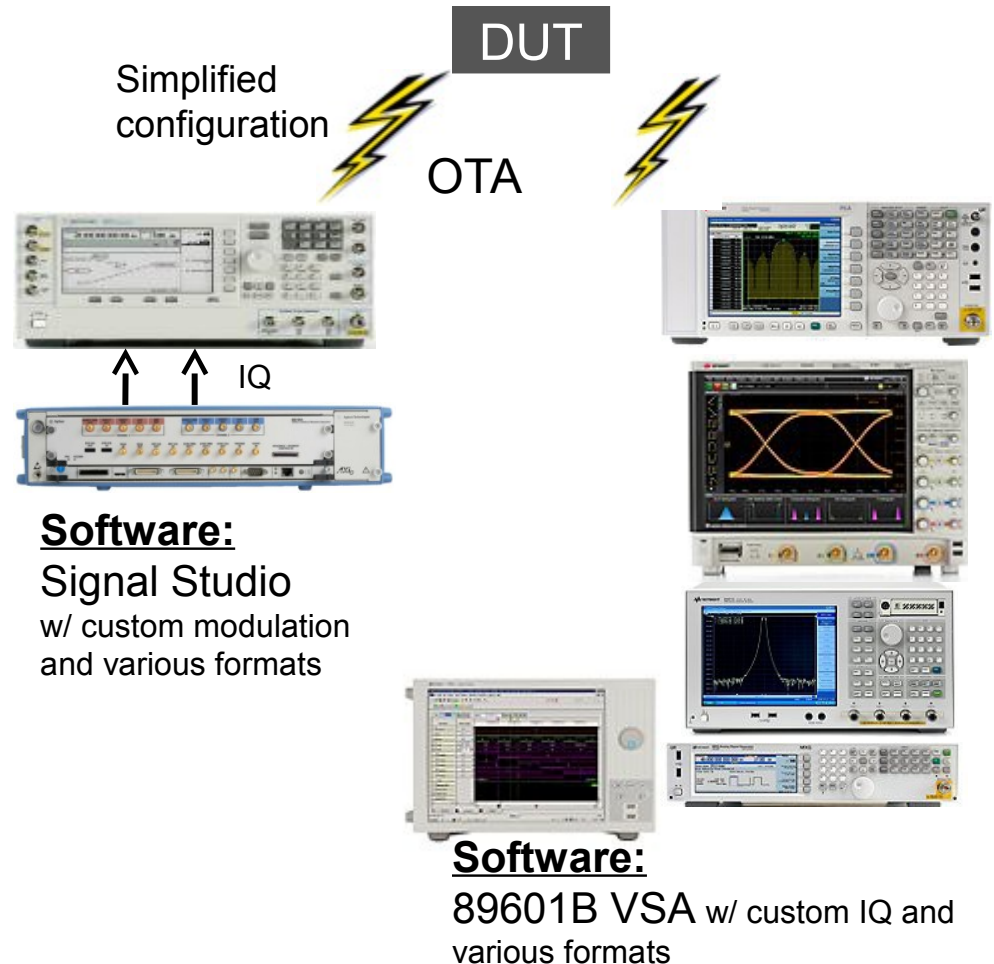
# 5G TESTBED Success – Intel, 4 sites

Application: 5G Modem & RF unit parametric test

**Need:** Equip 5G standards labs with testbed solution for multiple sites

## Key Requirements:

- Measurement systems sub 6 GHz & 28 GHz
- Aggregated BW to **800 MHz, ADC/DAC up to 1.25 GHz**
- Scalable to mmWave frequencies & up to 8 layer MIMO



# The New N9041B UXA Signal Analyzer, 110 GHz

“See the Whole Picture” to 110 GHz

1<sup>st</sup>

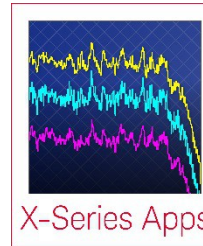
3 Hz - 110 GHz  
Continuous sweeps

1<sup>st</sup>

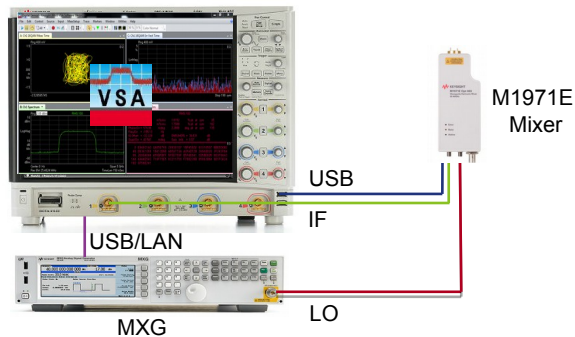
5 GHz BW (with  
external oscilloscope)

1<sup>st</sup>

Up to 1 GHz  
internal BW



# E-Band Signal Analysis Solution



## Description

- **Low cost E band bundle** for 5G, WiGig, Automotive Radar and mmW backhaul customers
- Full E-band coverage for demodulation measurements
- Provides a lower cost point to current full featured solutions (Z9071B) and R&S B2000 options.
- Consists of:
  - DSOS404A S-Series scope
  - N5183B MXG Analog Sig Gen
  - M1971E Smart Mixer
  - N8838A External Mixer Assistant
  - 89601B VSA

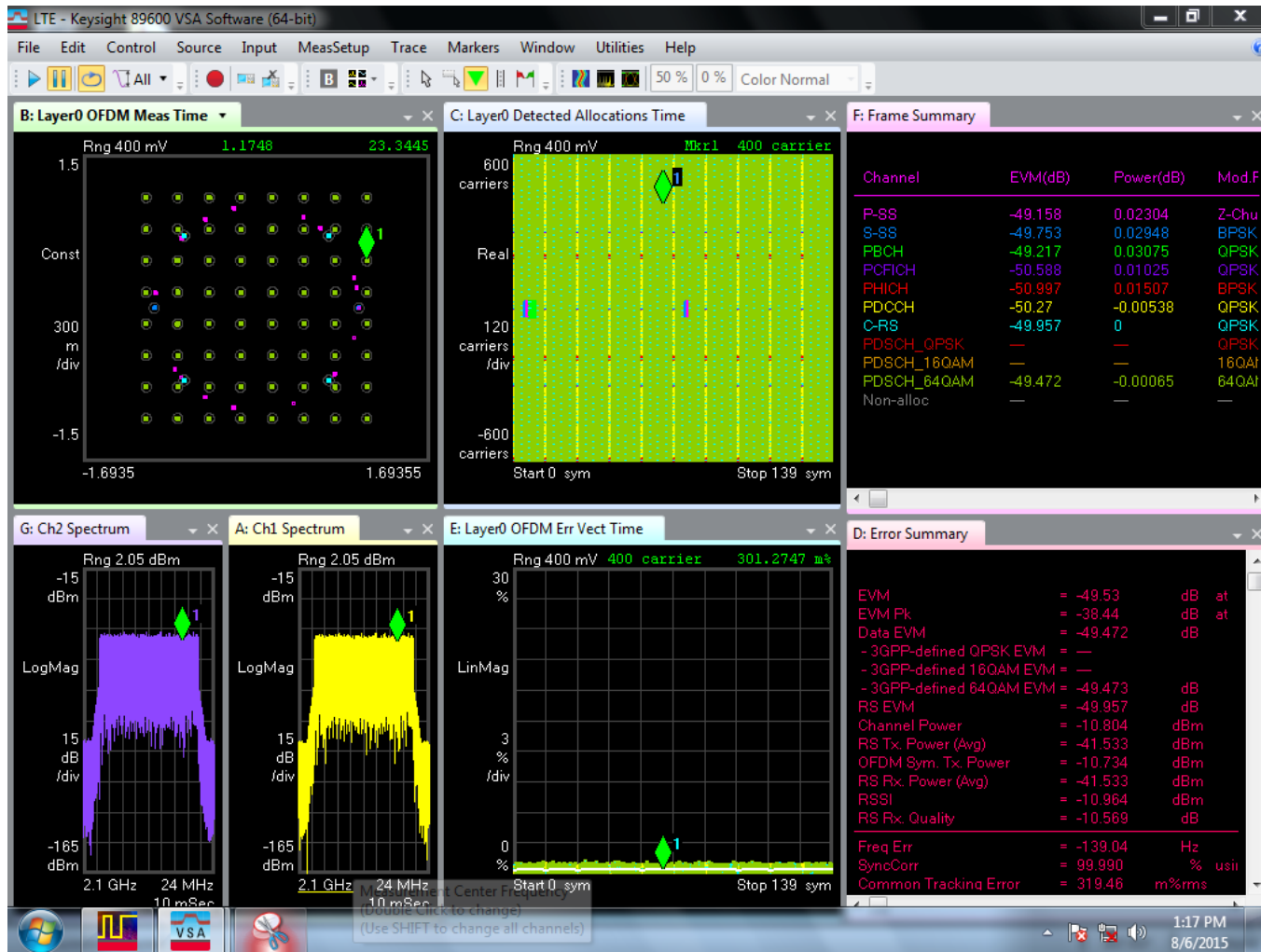
## Target Customer / Market

- 5G, 802.11ad (WiGig), Automotive Radar and mmW backhaul

## Key Specifications:

- 55-90 GHz frequency coverage
- Mixer supports >2 GHz modulation bandwidth
- 10-bit scope, 4 GHz bandwidth
- Infiniium SW integration for FFT measurements without VSA
- VSA software for demodulation measurements

# VSA Demo

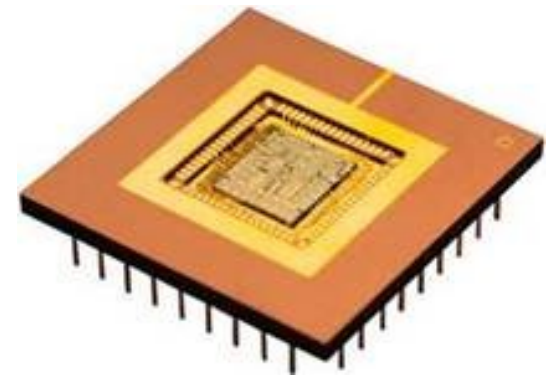
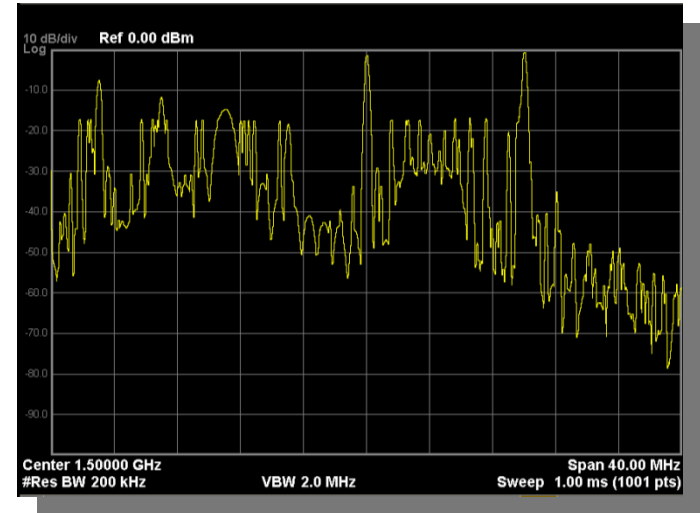


# Agenda

- **Spektrumanalyse**
  - Frequenzbereich
  - DANL / NFE
  - Analysebandbreite
  - **Real-Time Spektrumanalyse**
- EMV-Analyse
  - PreCompliance
  - EMxpert

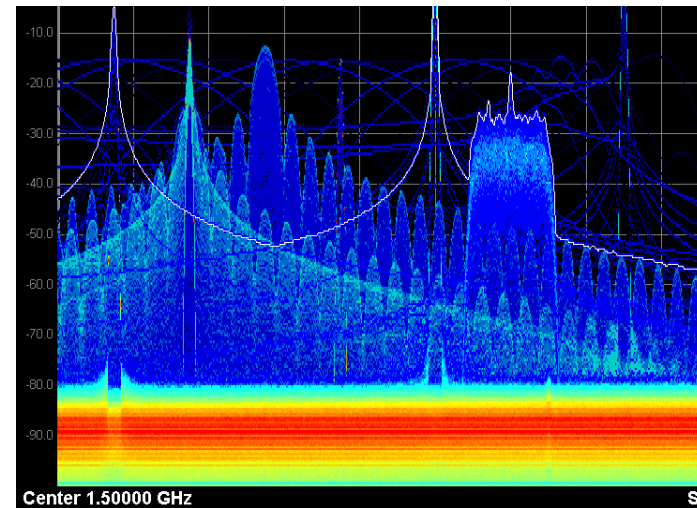
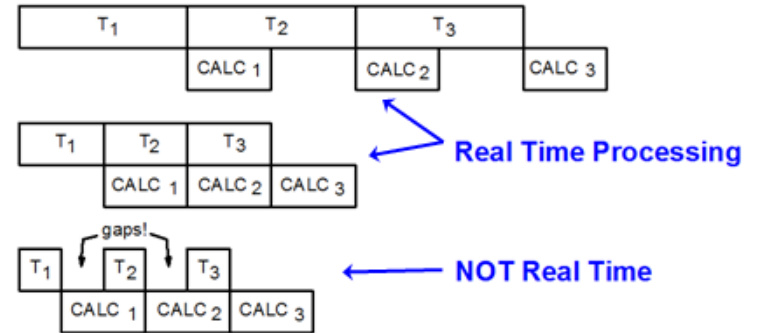
# What are Real Time Analyzers?

(Different from “Real Time Analysis”)



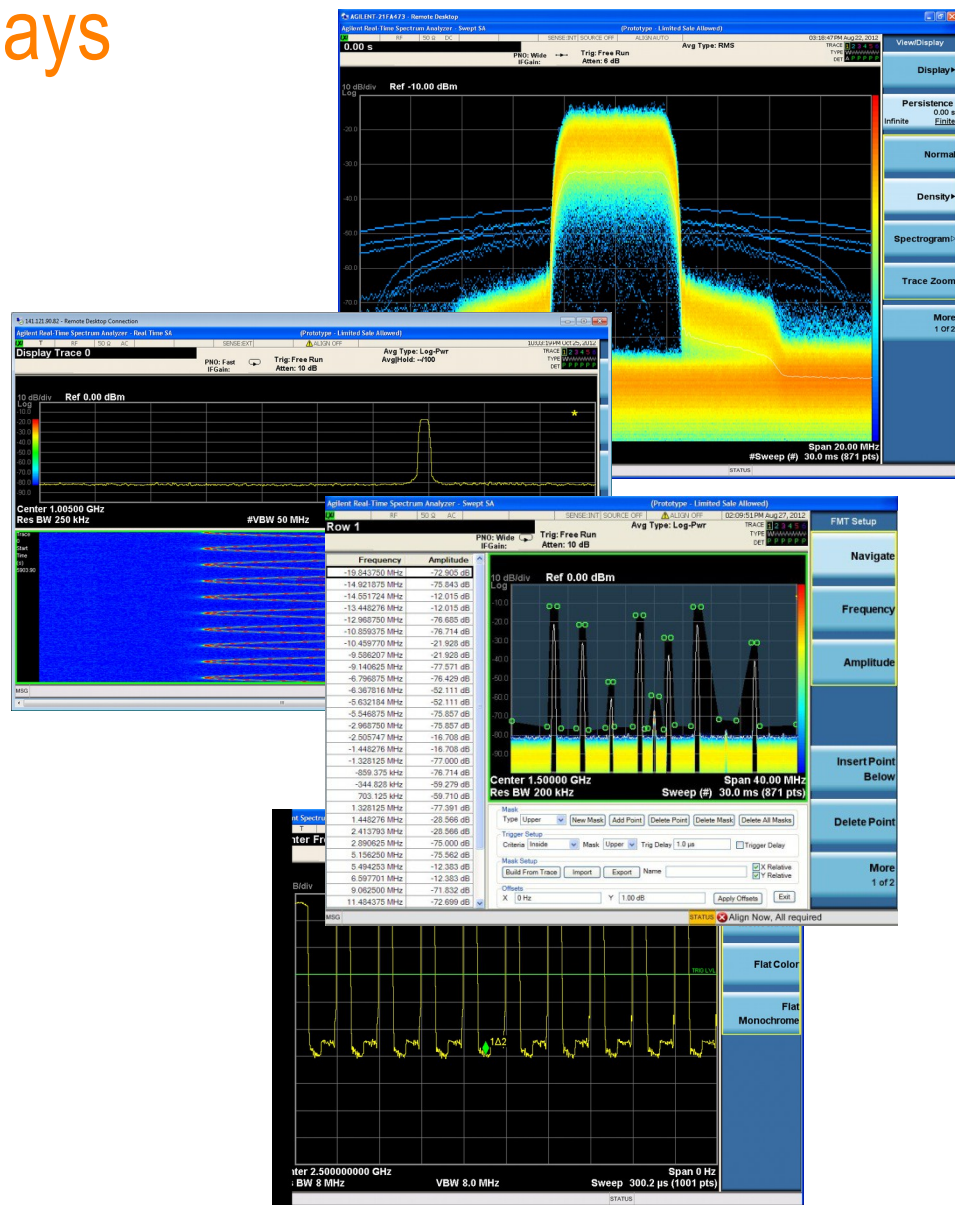


# What are Real Time Analyzers?



# RTSA Measurement Displays

- Density persistence histogram
- Spectrogram
- Real-time spectrum
- Frequency Mask Trigger\*
- Power vs. Time (in dev)



# RTSA Key Features in the PXA

- 100% (not miss a trigger) POI – 3.57 us (various POI's are calculated in majority from the bottom 3 parameters)
- 200 Msa/s Sample Rate
- FFT rate of 292,969 per second
- 6 variable RBW's
  - 32-1024 point FFT
- Frequency Mask Trigger
  - Internal and VSA (to be covered in next module)
- 871 x 225 display points

# Agenda

- Spektrumanalyse
  - Frequenzbereich
  - DANL / NFE
  - Analysebandbreite
  - Real-Time Spektrumanalyse
- **EMV-Analyse**
  - **Full- und Pre Compliance**
  - EMxpert

# New Multi-Touch User Interface C Models

## 802.11ax, Bluetooth 5, NB-IoT/eMTC and Advanced Pulse

N9077C-8xx/Mxx 802.11ax  
N9081C-3xx Bluetooth 5  
N9080C-3xx NB-IoT/eMTC  
N9067C-2xx Advanced Pulse

The image displays a collage of Keysight software interface screenshots. Key components include:

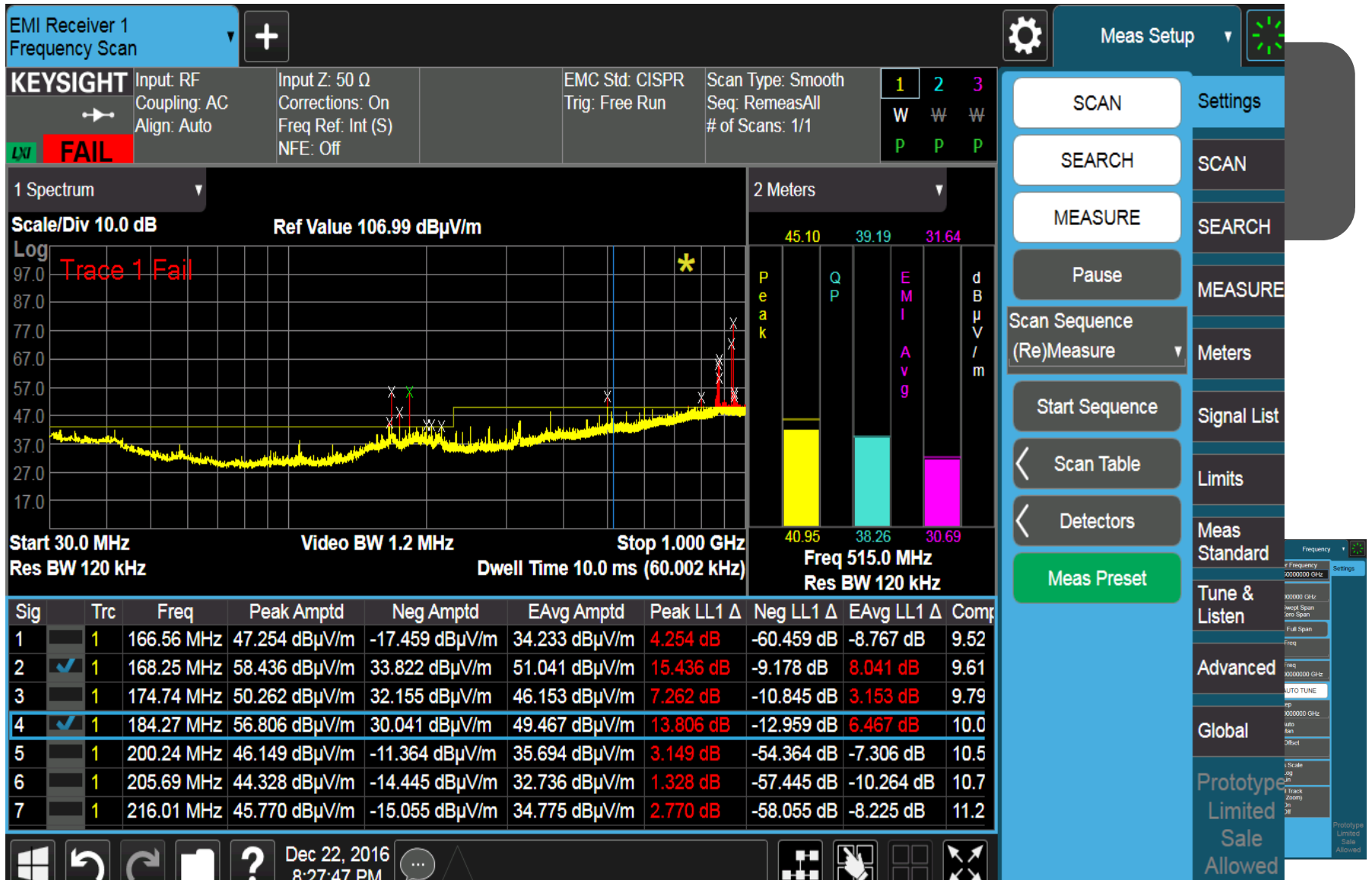
- 1 RF Envelope:** A plot showing signal amplitude over time with a scale of 10.0 dB and a resolution of 3.000 MHz.
- 2 Demod Waveform:** A plot showing the demodulated signal waveform.
- Modulation Analysis:** A plot showing modulation characteristics with a center frequency of 2.404 GHz and a resolution of 10.000 kHz.
- 3 RF Spectrum:** A plot showing the RF spectrum with a center frequency of 2.404 GHz and a resolution of 10.000 kHz.
- 4 Quad Metrics:** A plot showing various modulation metrics such as Average Power, Peak Power, and Error Rate.
- 5 Error Vector Spectra (EVS):** A plot showing the Error Vector Spectra with a center frequency of 2.404 GHz and a resolution of 10.000 kHz.
- 6 Error Vector Spectra (EVS) Table:** A table listing various modulation metrics for different channels.

Chan	Mod	Level	Loss	Equip	Proc	DR	Rate	Rate	Fall	Fall	Width	DR	Freq	Phase
		(dBm)	(dB)	(dB)	(dB)	(dB)	(kbps)	(kbps)	(ms)	(ms)	(MHz)	(Hz)	(MHz)	(deg)
20	LTM	-21.4	25.75	4.39	0.18	0.00	0.10	1.072	3.033	1.573	1.11	29.74	172.4	4.164
21	LTM	-4.6	16.61	2.33	0.18	0.00	0.10	2.278	6.72	3.453	1.11	13.94	10.84	51.51
22	LTM	-8.44	34.18	5.71	0.18	0.00	0.10	1.4	2.611	5.613	1.11	20.30	6.53	85.84
23	LTM	-2.13	20.75	7.22	0.18	0.00	0.10	1.4	2.611	5.613	1.11	15.30	10.83	47.88
24	LTM	-9.65	32.67	5.42	0.18	0.00	0.10	1.6	2.611	5.613	1.11	21.11	6.91	189.11
25	LTM	-4.46	25.66	7.33	0.18	0.00	0.10	1.6	2.611	5.613	1.11	15.30	10.83	47.88
26	LTM	-6.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
27	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
28	LTM	-6.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
29	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
30	LTM	-9.65	32.67	5.42	0.18	0.00	0.10	1.6	2.611	5.613	1.11	21.11	6.91	189.11
31	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
32	LTM	-6.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
33	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
34	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
35	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
36	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
37	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
38	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
39	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
40	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
41	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
42	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
43	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
44	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
45	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
46	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
47	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
48	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
49	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11
50	LTM	-4.46	31.41	5.61	0.18	0.00	0.10	2.0	2.611	5.613	1.11	11.31	4.40	110.11



X-App Update FTD  
Mar 2017

# New Multi-Touch User Interface C Models



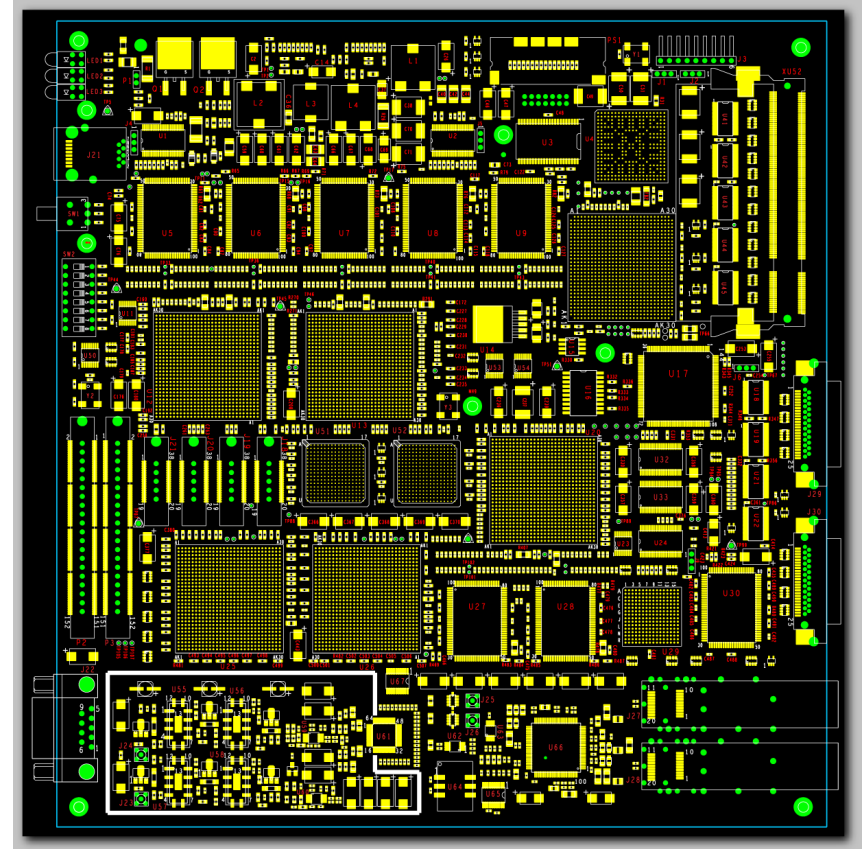
# Agenda

- Spektrumanalyse
  - Frequenzbereich
  - DANL / NFE
  - Analysebandbreite
  - Real-Time Spektrumanalyse
- **EMV-Analyse**
  - Full- und Pre Compliance
  - **EMxpert**



# PCB's EMC Design Problems

- EMC prevention an afterthought
- Little interest in EMC
- EMC as a black art

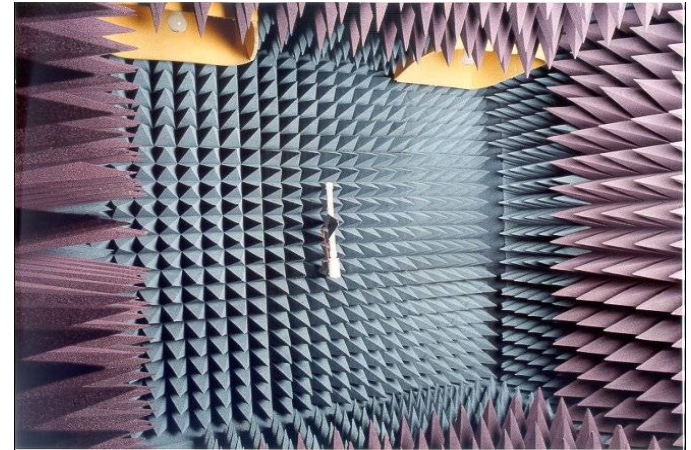




# Existing Solutions

## ● Anechoic Chambers

- Slow, as in hours
- High CAPEX (in-house) / OPEX (third party)
- Real-estate
- Qualified technicians



## ● Automated probes

- Slow
- Resolution mm

## ● Handheld probes

- Slow
- Resolution at pin level



## ● Simulation software XFDTD / IE3D



- Extensive training required
- Time consuming to customize per PCB

# Paradigm Shift: EMxpert

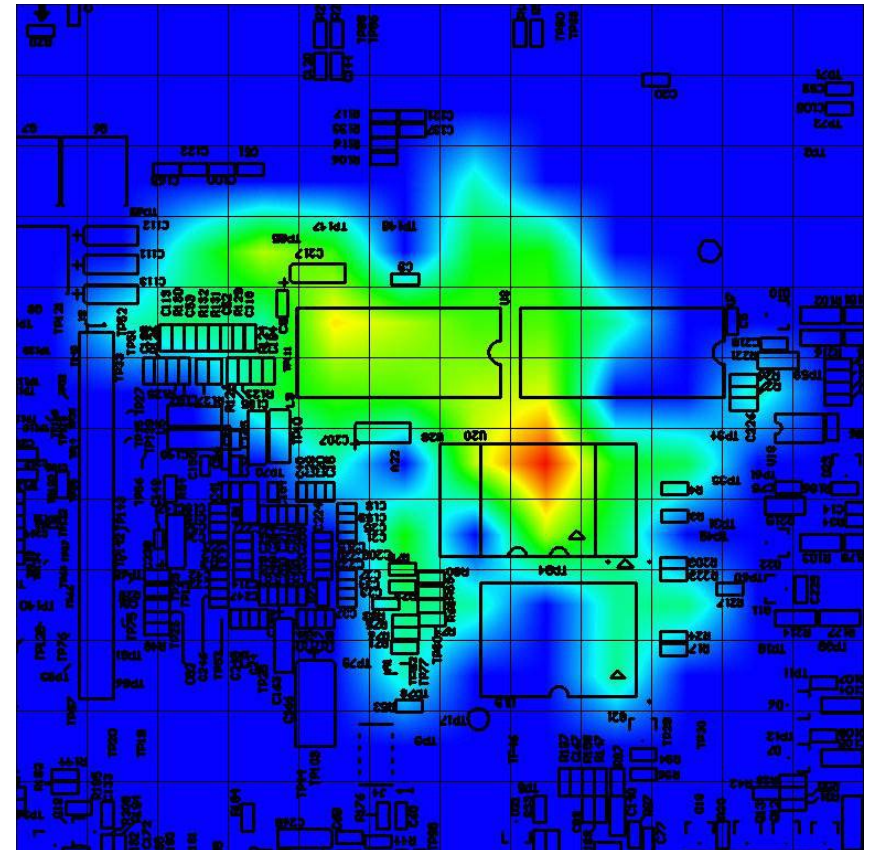
## Directly addresses the challenges

- Real-time measurement results ( <1 sec)
- Immediate analysis and comparisons
- Comprehensive measurements
- Compact tabletop
- Ease-of-use
- Cost effective solution



# Functionality

- Spectral scans, spatial scans, and combined spectral and spatial
  - Problem frequencies
  - Sources of radiated emissions
- 50 kHz to 4 GHz
- Constant or time-based emission sources
- RF current loops and hot spots
- Subtract ambient signals
- Compare design versions
- Correlate PCB design overlays



# Advantages

- Continuous peak hold scan for spurious events
- Multi-frequency current loops and hot spots
- Real-time and real-fast
- Low CAPEX
- Zero OPEX

# AXAWARD 2018

Der **AUSTRIAN X.TEST AWARD** kurz **AXAWARD**,

als österreichischer **Technik-Nachwuchswettbewerb** bekannt, findet heuer zum fünften Mal statt.

**Über ~1000 Teilnehmerinnen und Teilnehmer hatten sich seit dem ersten Mal um den AXAWARD beworben.**

Auch **2018** freuen wir uns wieder auf zahlreiche Bewerbungen **engagierter** und **motivierter Masterminds!**

**[www.axaward.at](http://www.axaward.at)**



# DANKE SCHÖN!

[christian.bauer@xtest.at](mailto:christian.bauer@xtest.at)

0676 / 889766 733