Th2F-3

Instrumentation for the Time and Frequency Domain Characterization of Terahertz Communication Transceivers and their Building Blocks

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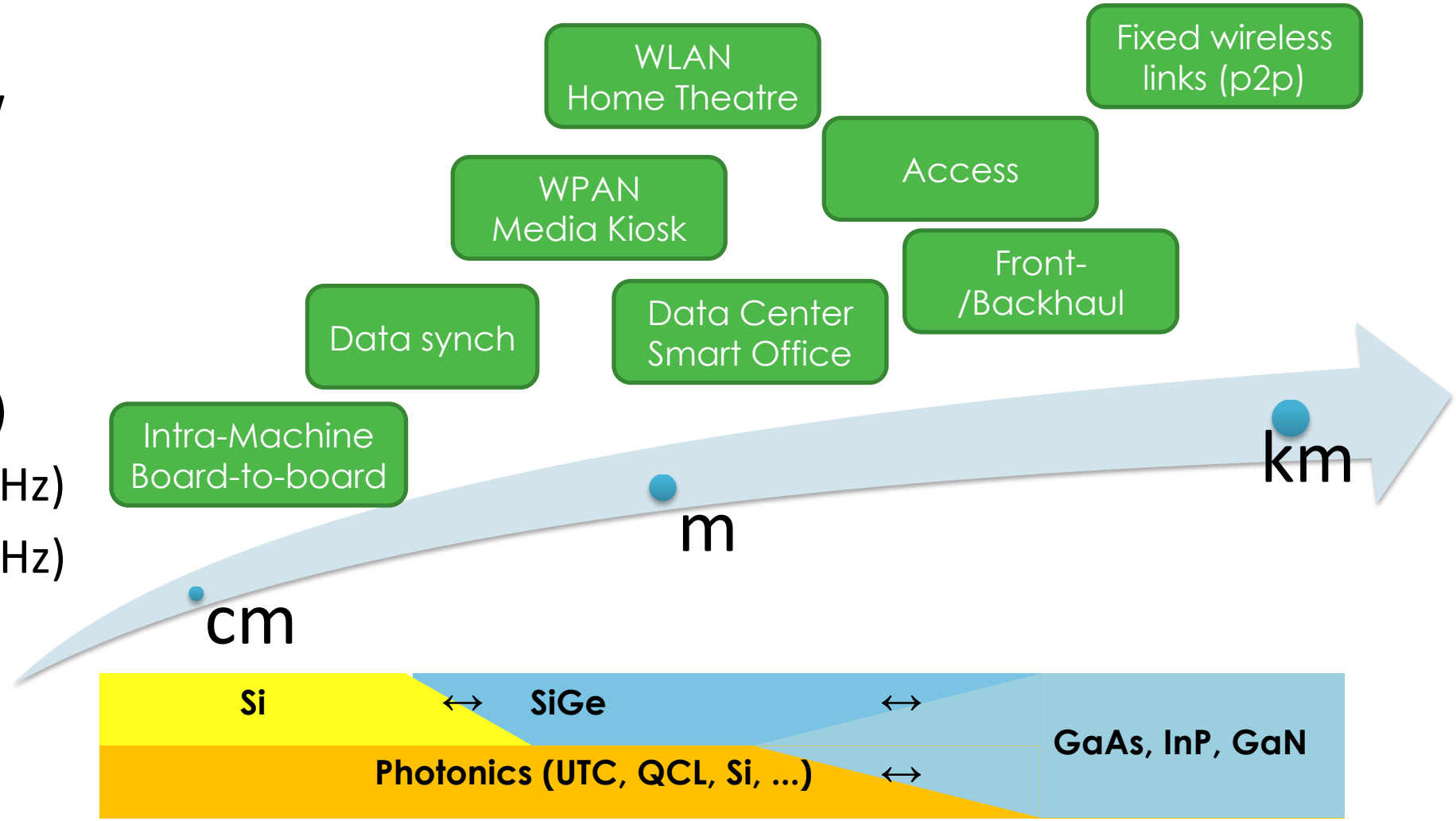
Outline

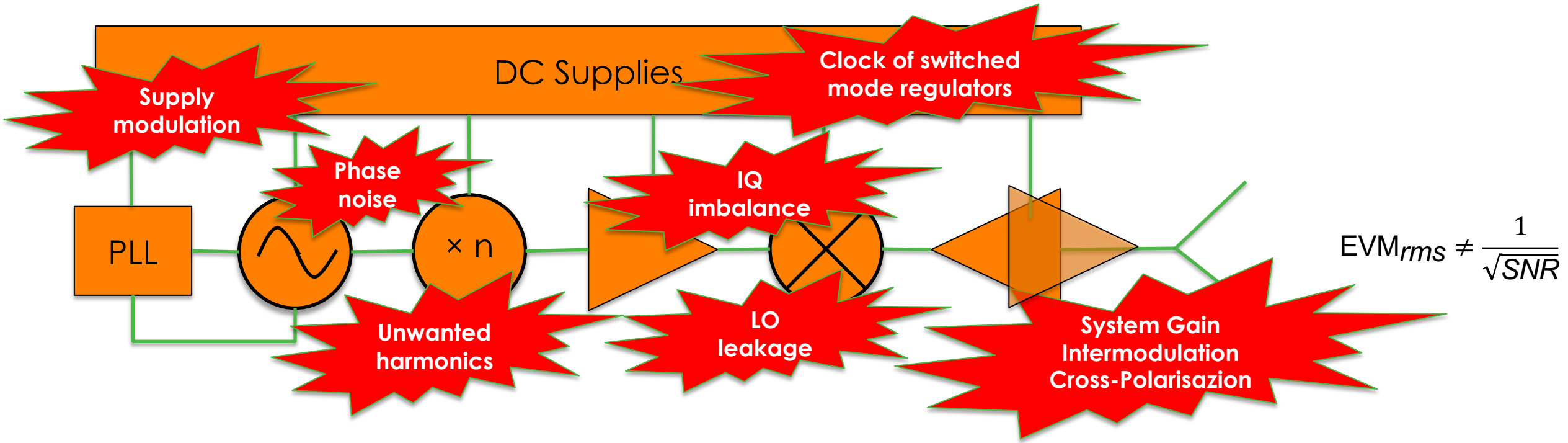
- Motivation – Terahertz Communication in 6G
- The “CrossLink” Instrumentation
- W- and H-Band Waveform Calibration
- Conclusion

Terahertz Communication in 6G

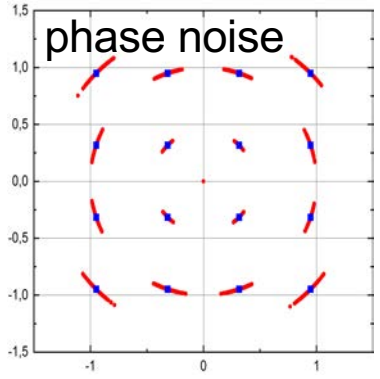
- Transceivers for exploitation of new spectrum in 6G applications
- Popular bands
  - E-band (60-90 GHz)
  - D-band (110-170 GHz)
  - H-band (220-325 GHz)

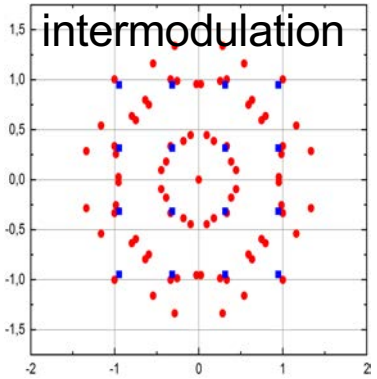


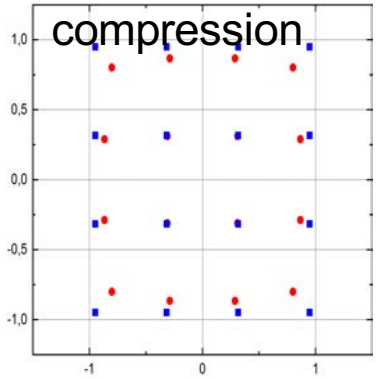
Transceiver Non-Idealities

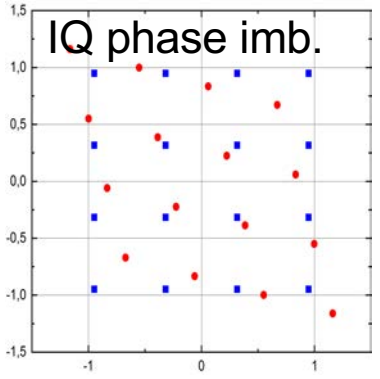


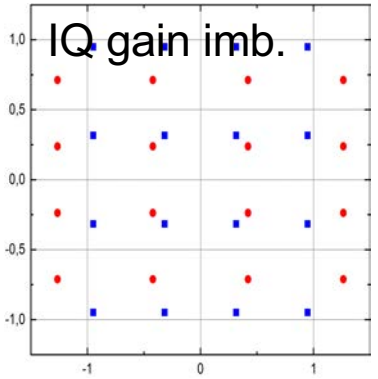
$$EVM_{rms} \neq \frac{1}{\sqrt{SNR}}$$

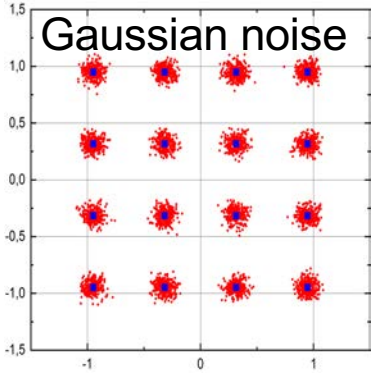










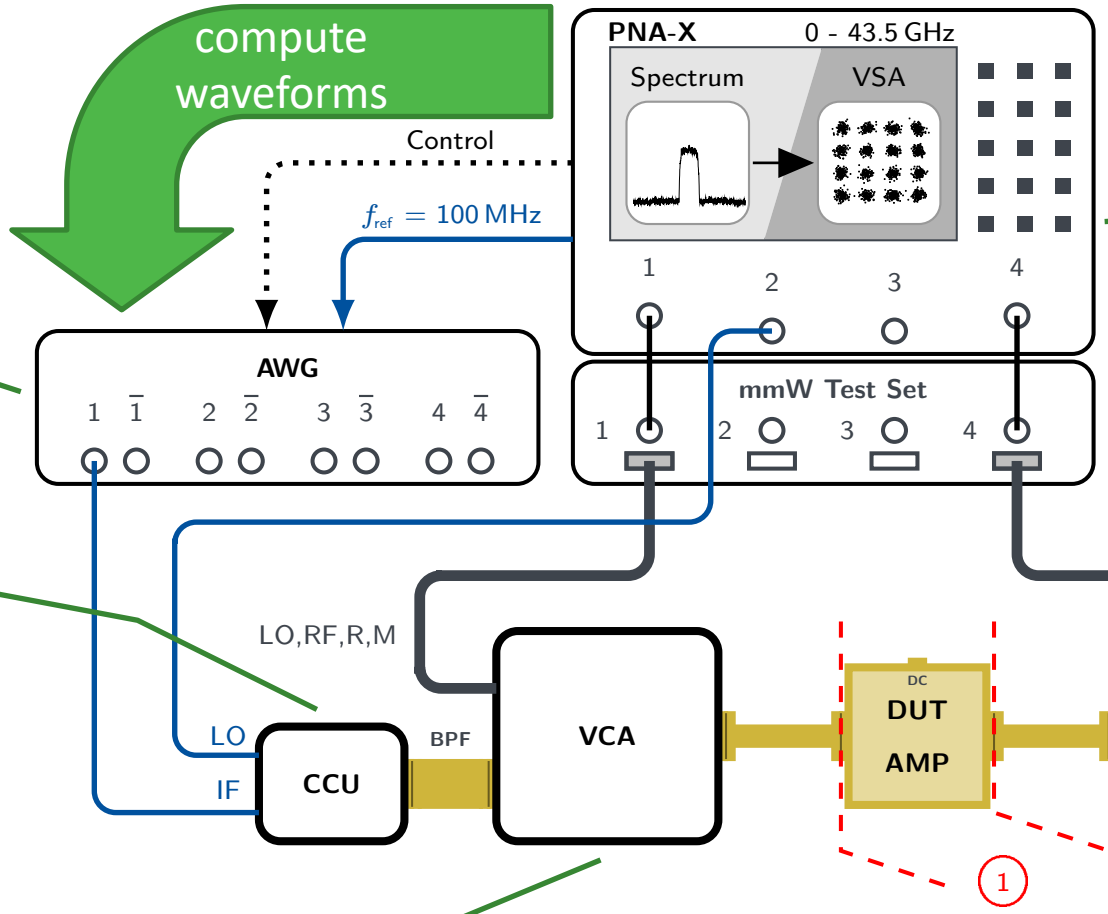


The CrossLink Instrumentation

Wideband time-domain signal source

Compact up-conversion (full-band)

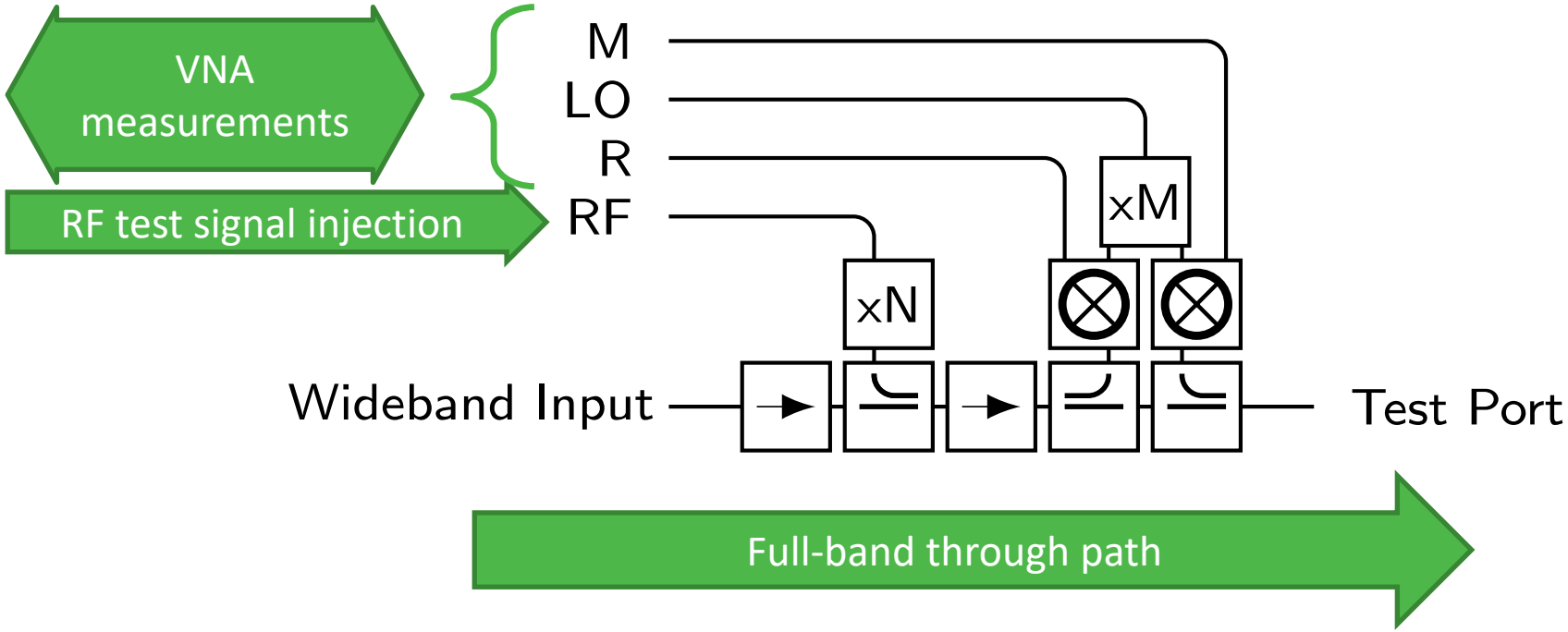
Custom frequency extention unit (full-band)



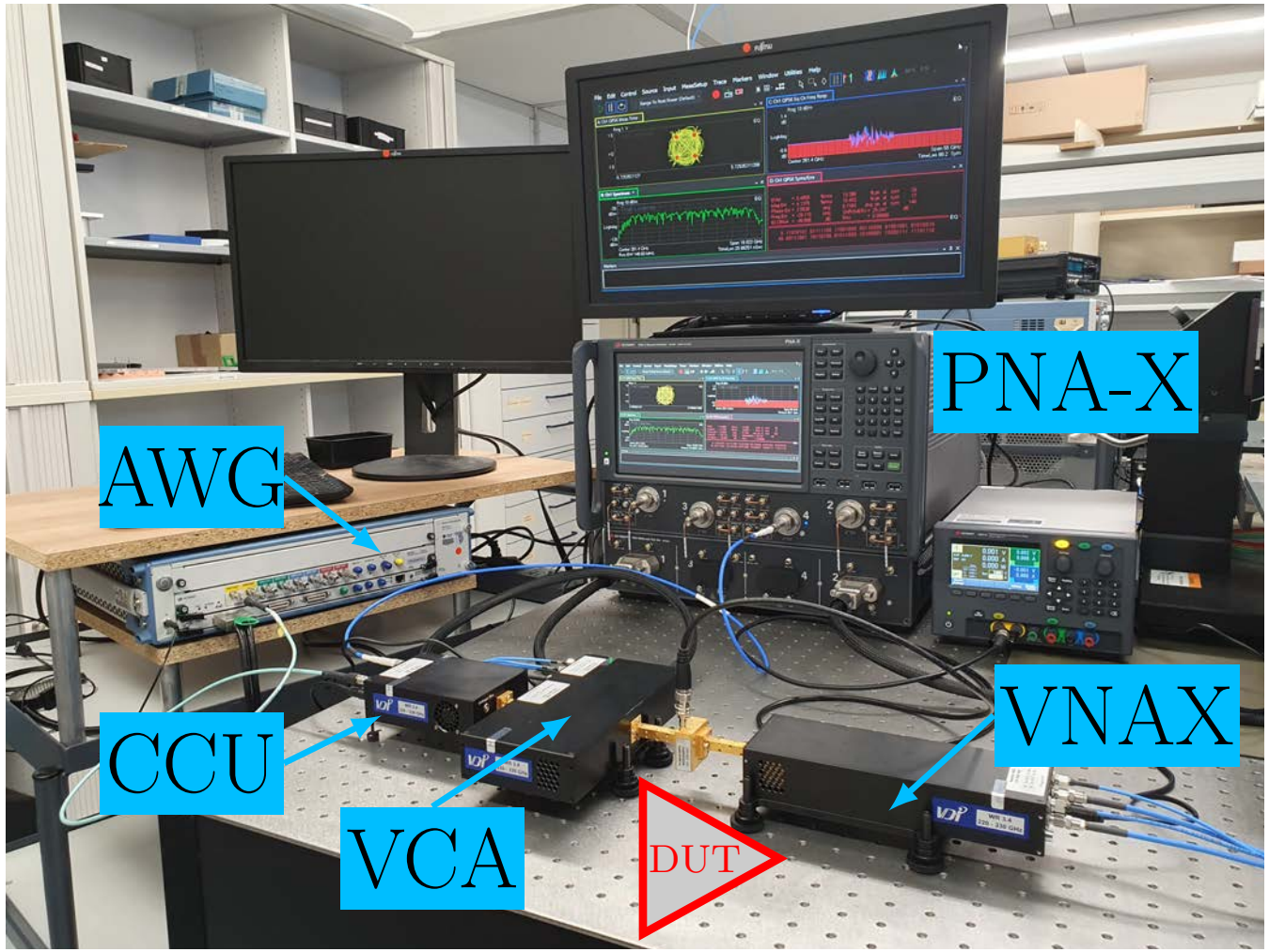
PNA-X w/ mmW test set w/ built-in multiprocessor system on a chip (MPSoC)

Frequency extension module

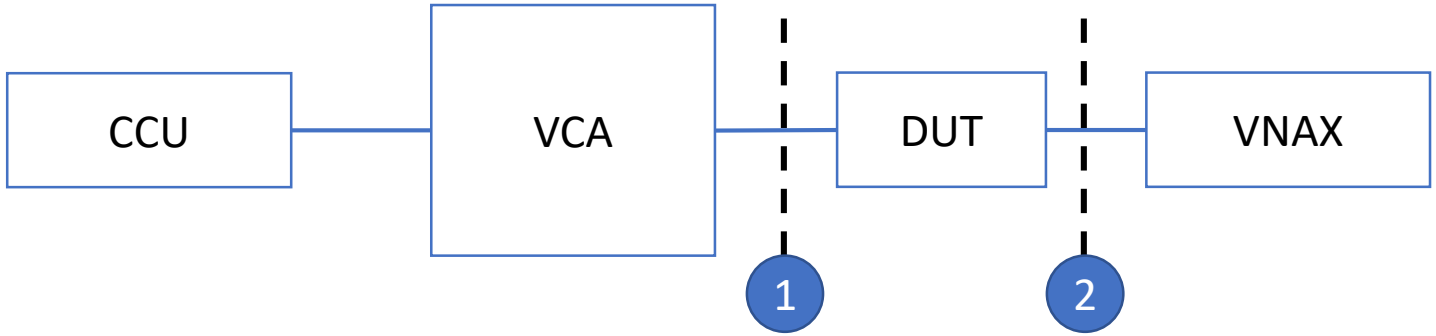
Custom Frequency Extention Unit (VCA)



The CrossLink Instrumentation



Calibration Reference Planes



1 uncal

Upconverted basedband signal (AWG)

Distortions from CCU

1 cal

Calibrated VCA output

Provide “clean” test signal to DUT

2 cal from 1

Measurement of DUT

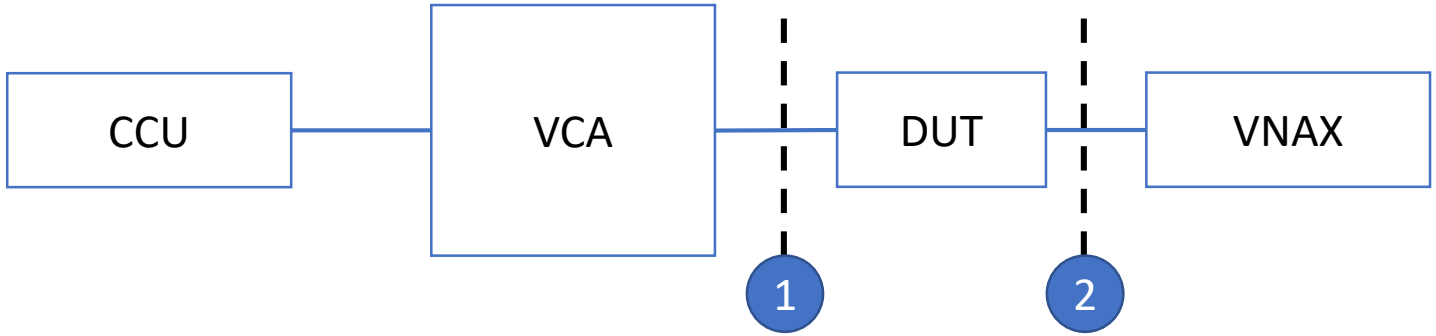
Measure distortions from DUT

2 cal

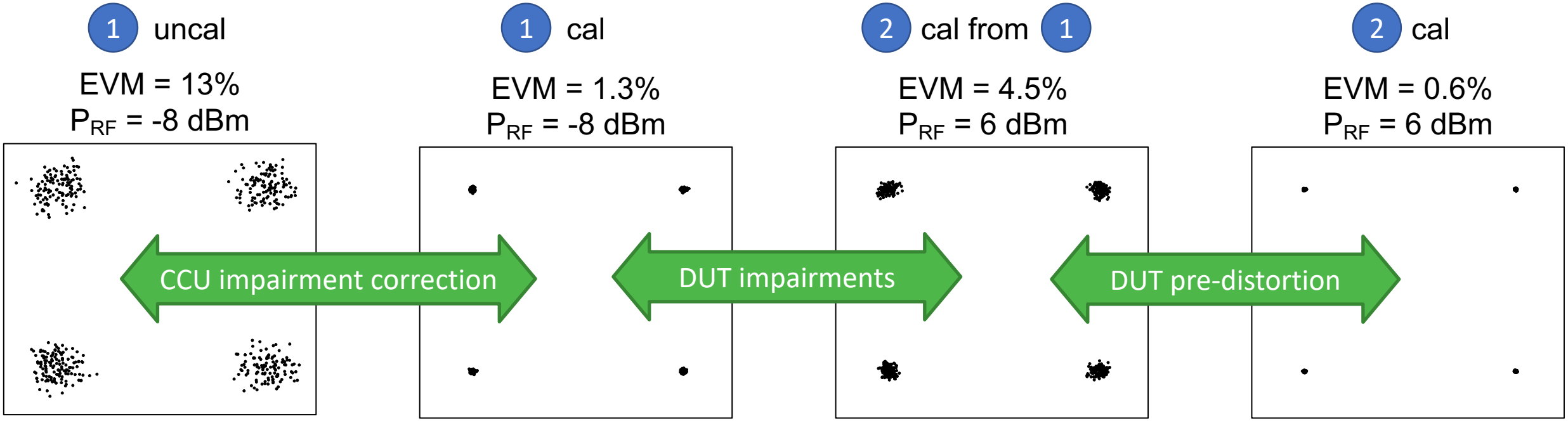
Calibrated DUT output

Cp. offline digital pre-distortion

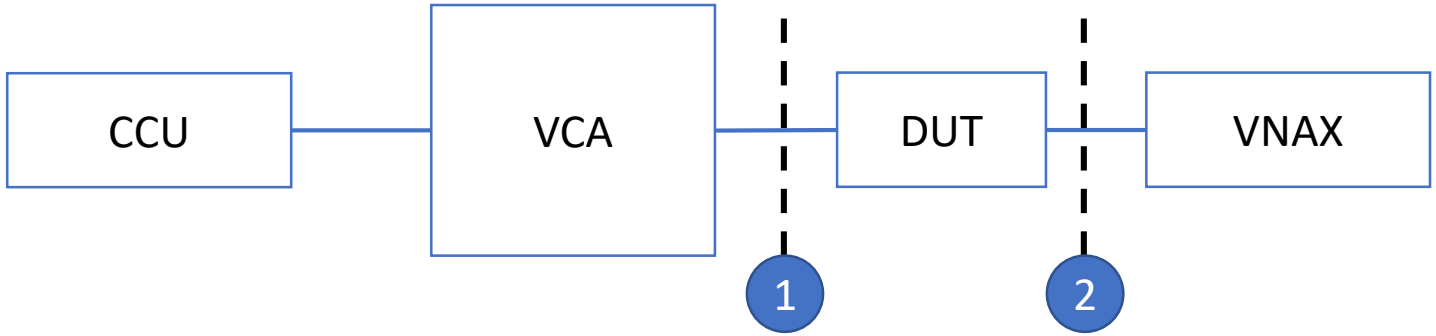
W-Band Calibration @ 77.5 GHz
Waveform: QPSK 1 GBd, $\alpha = 0.35^{(*)}$



(*) roll-off factor digital pulse-shaping filter

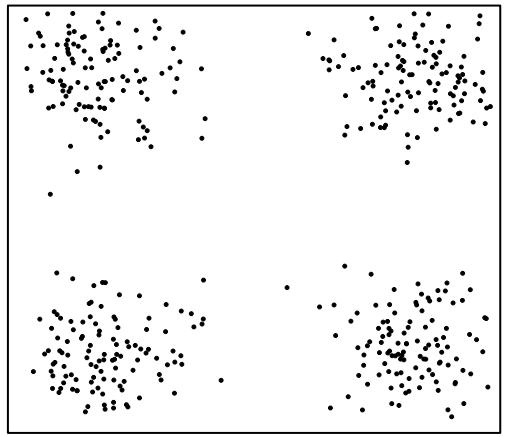


W-Band Calibration @ 77.5 GHz
Waveform: QPSK 4 GBd, α = 0.35



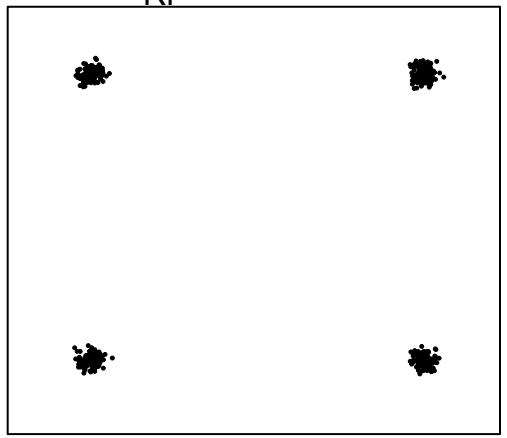
1 uncal

EVM = 27%
P_{RF} = -4.5 dBm



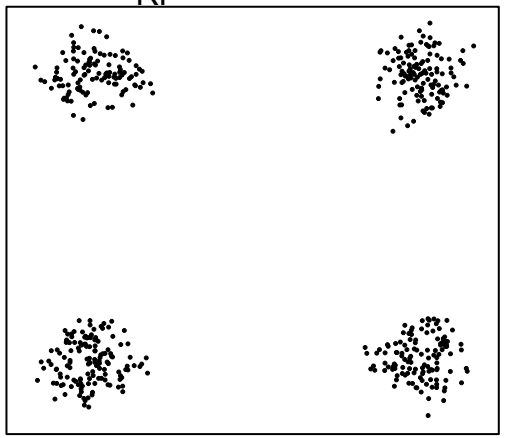
1 cal

EVM = 3.8%
P_{RF} = -5 dBm



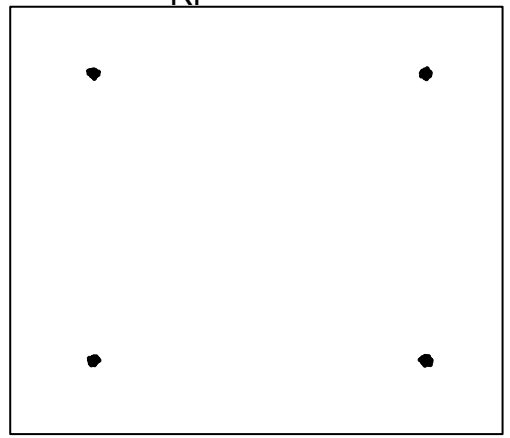
2 cal from 1

EVM = 14%
P_{RF} = 9 dBm

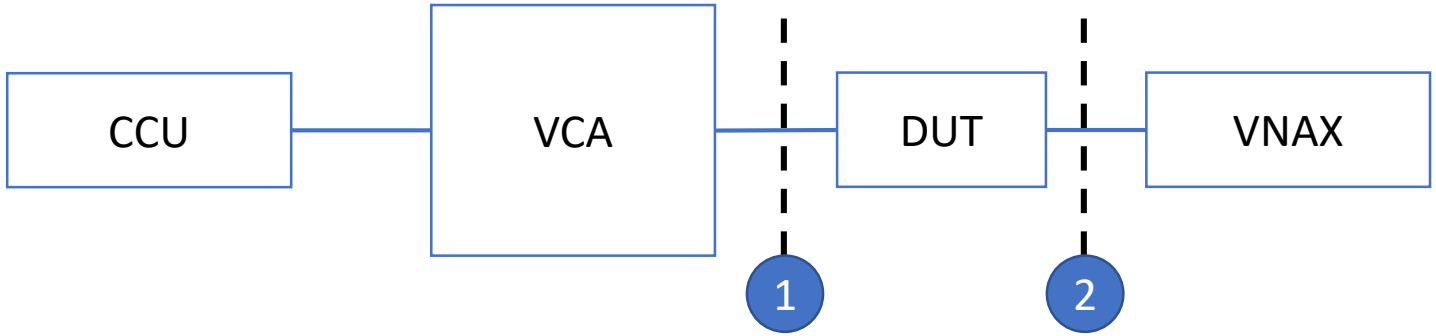


2 cal

EVM = 1.2%
P_{RF} = 9 dBm



W-Band Calibration @ 77.5 GHz
Waveform: 256QAM 1 GBd, α = 0.35



1 uncal

EVM = ---

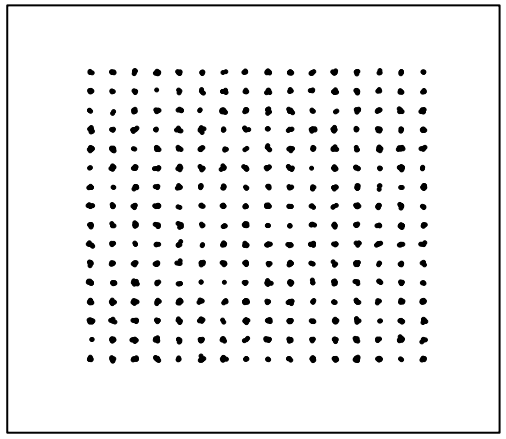
P_{RF} = -8 dBm

no sync

1 cal

EVM = 0.6%

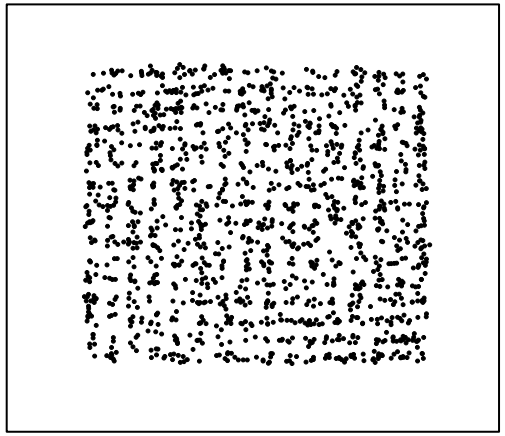
P_{RF} = -8 dBm



2 cal from 1

EVM = 3%

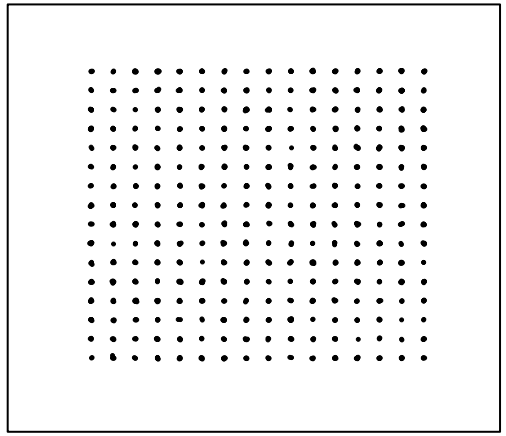
P_{RF} = 6 dBm



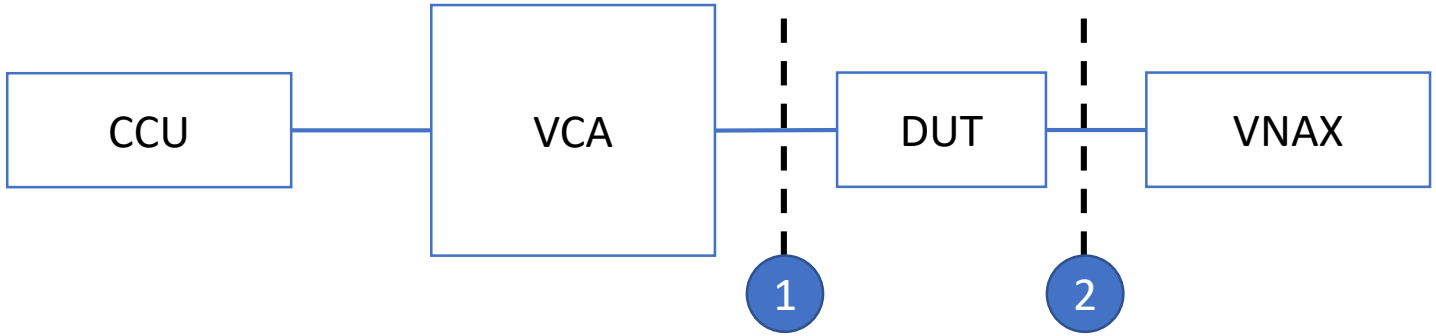
2 cal

EVM = 0.3%

P_{RF} = 6 dBm



W-Band Calibration @ 77.5 GHz
Waveform: 256QAM 4 GBd, α = 0.35



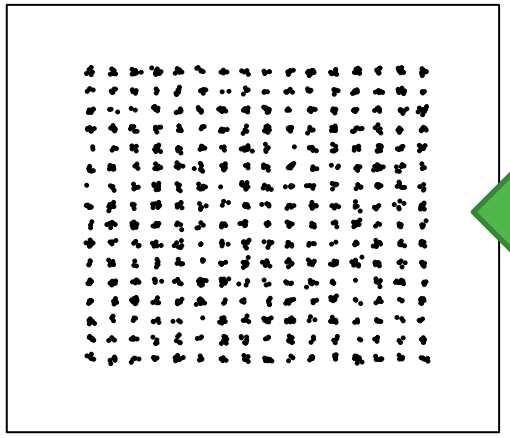
1 uncal

EVM = ---
P_{RF} = -4.5 dBm

no sync

1 cal

EVM = 1.2%
P_{RF} = -5 dBm



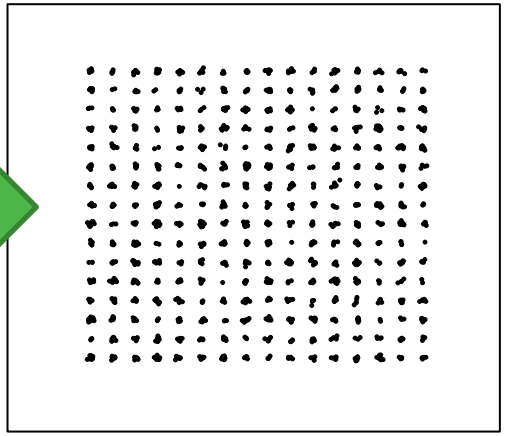
2 cal from 1

EVM = ---
P_{RF} = 9 dBm

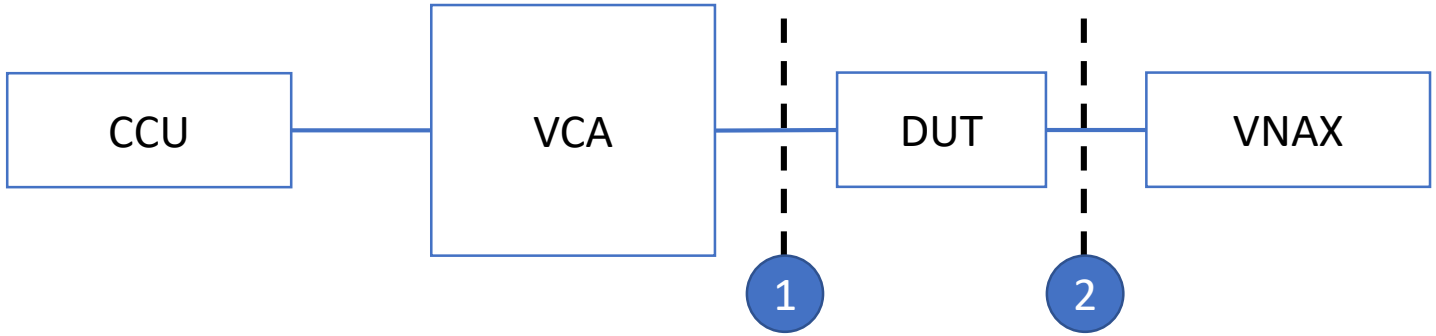
EVM correction improvement
at higher signal levels

2 cal

EVM = 0.9%
P_{RF} = 8 dBm



H-Band Calibration @ 300 GHz
Waveform: 64QAM 1.6 GBd, α = 0.25



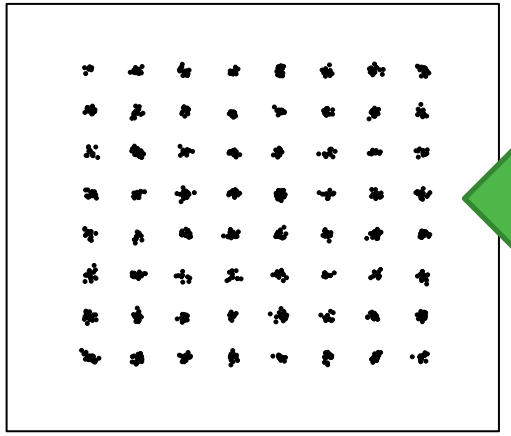
1 uncal

EVM = ---
P_{RF} = ---

no sync

1 cal

EVM = 1.9%
P_{RF} = -30 dBm



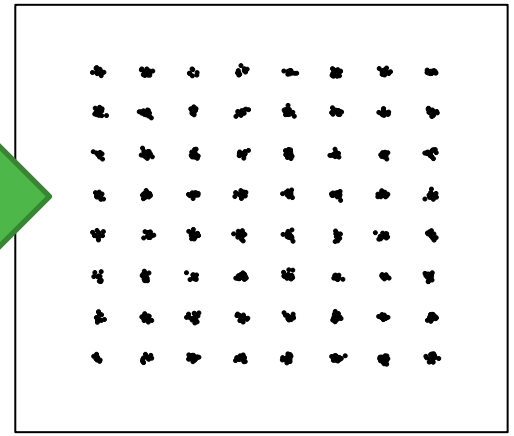
2 cal from 1

EVM = ---
P_{RF} = ---

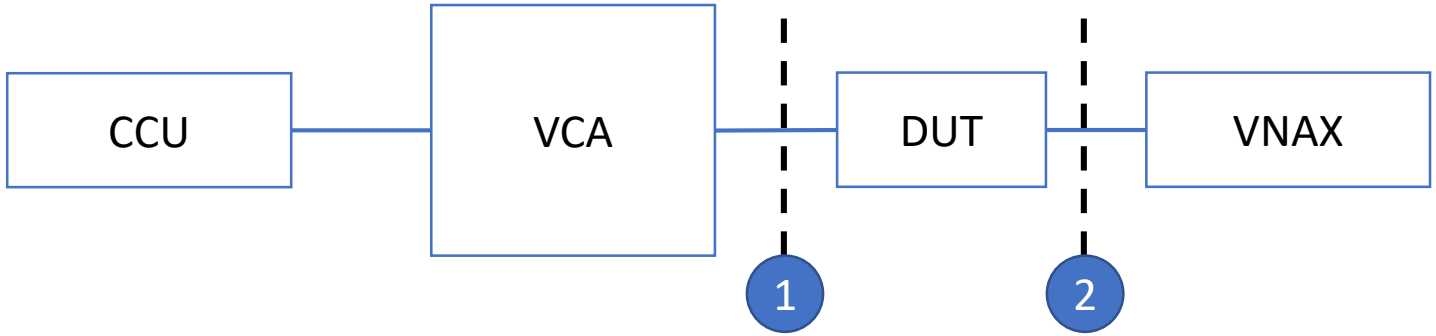
EVM correction improvement
at higher signal levels

2 cal

EVM = 1.6%
P_{RF} = -9 dBm



H-Band Calibration @ 300 GHz
Excitation: QPSK 16 GBd, α = 0.25



1 uncal

EVM = ---

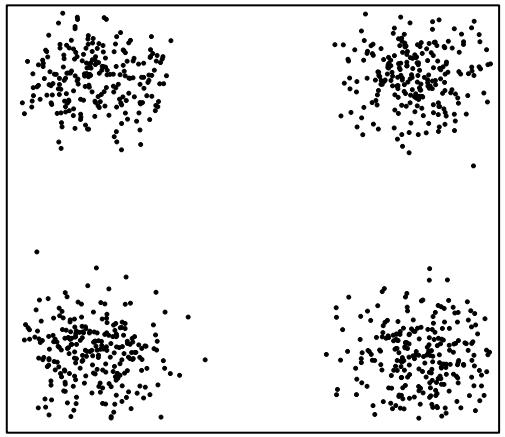
P_{RF} = ---

no sync

1 cal

EVM = 22%

P_{RF} = -28.5 dBm



2 cal from 1

EVM = ---

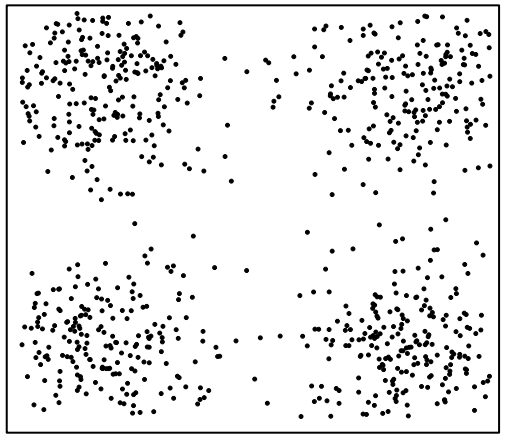
P_{RF} = ---

no sync

2 cal

EVM = 35%

P_{RF} = -7.5 dBm



Conclusion

Novel CrossLink instrumentation offers versatile platform for the characterization of transceivers and transceiver components dedicated to 6G wireless communication

- Realized in W-band and H-band
- Custom VCA unit for Inline time and frequency domain characterisation
- Inline calibration of wideband complex modulated communication signals at DUT input and DUT output