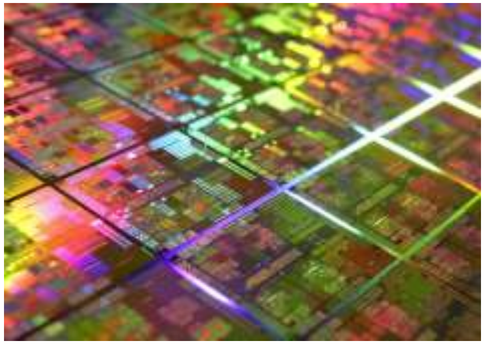
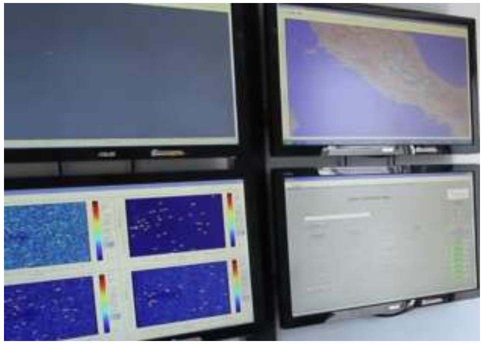
Advances in RF and Microwave Measurement Technology

New Demands in Modern RF and Microwave Test



In semiconductor and wireless, technologies such as carrier aggregation and DPD require instruments to have increasingly higher **dynamic range**.

Modern **radar** test systems require increasingly wider instantaneous **bandwidths** and signal processing capabilities.



Signal intelligence and electronic warfare systems require combinations of extremely flexible instrumentation and wide instantaneous **bandwidth**.

NEW Products for Microwave Test

PXIe-5668R 26.5 GHz Vector Signal Analyzer (VSA)

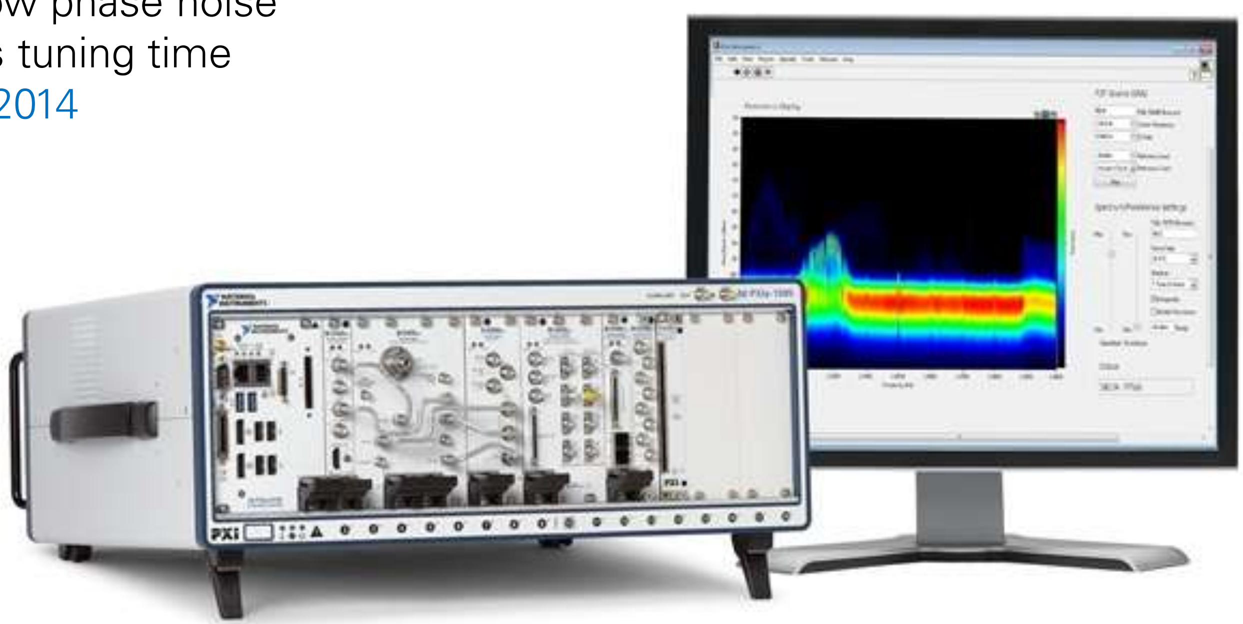
- Industry-Leading RF Performance and Bandwidth
- World’s Fastest Measurement Speed
- Customizable with LabVIEW FPGA

Releasing Oct 2014

PXIe-5654 20 GHz CW Source

- Extremely low phase noise
- Best-in-class tuning time

Releasing Dec 2014



Signal Analysis: *RF Performance*

Dynamic Range

Bandwidth

Phase Noise

Signal Analysis: *RF Performance*

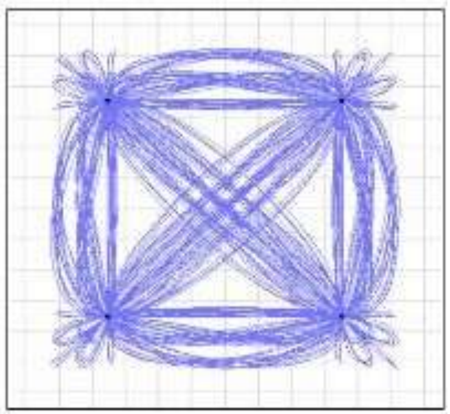
Dynamic Range

Bandwidth

Phase Noise

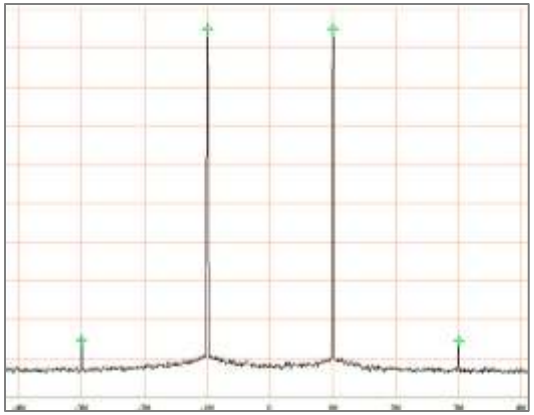
When Does VSA Dynamic Range Matter?

Modulation Quality



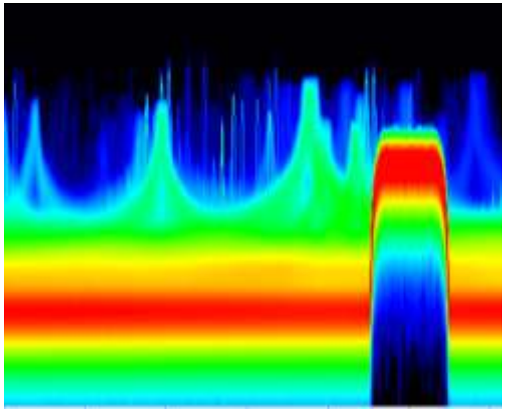
Noise and nonlinearity limit the "EVM floor" of the instrument.

Intermodulation Distortion



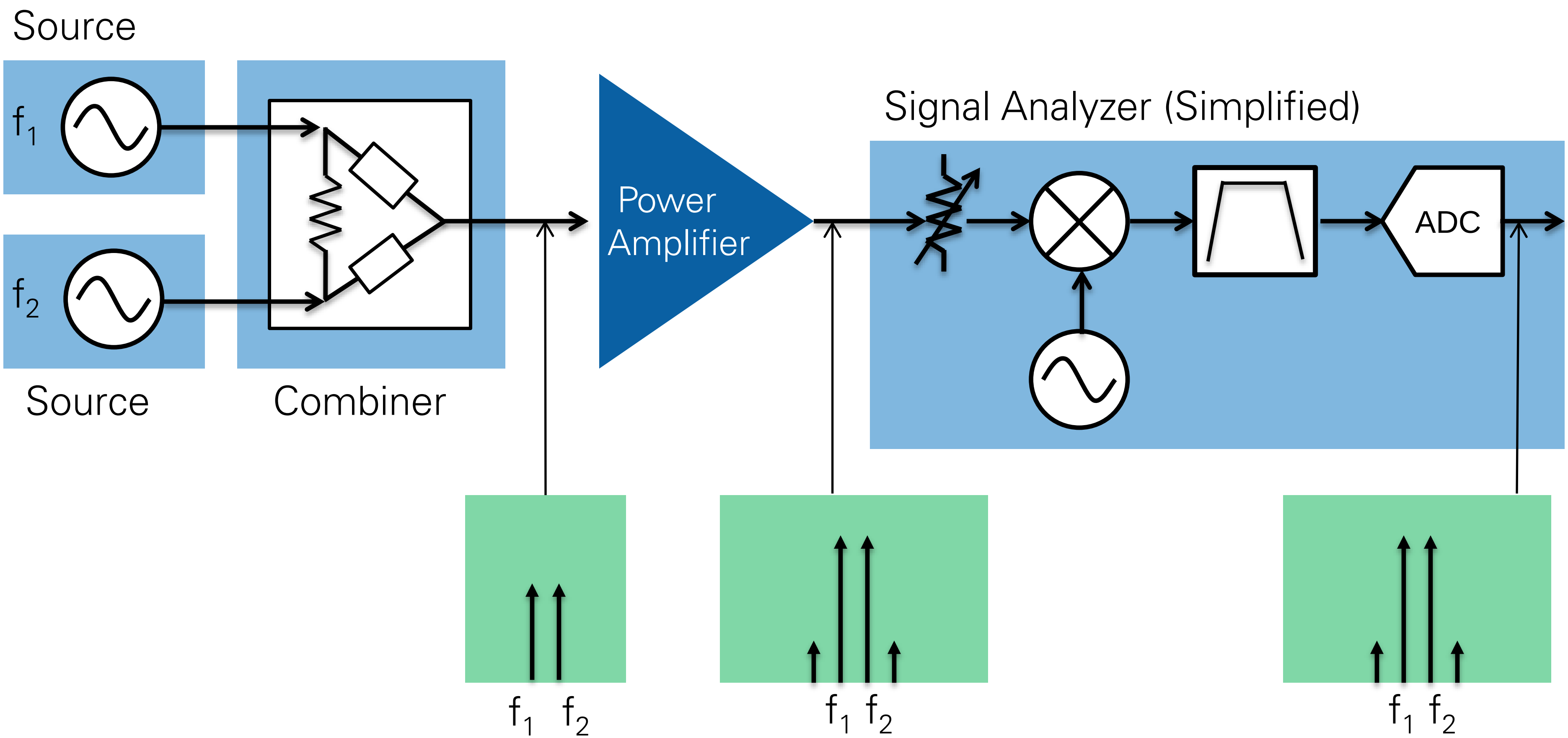
High dynamic range ensures that the instrument does not obscure IMD products with its inherent nonlinearity or noise.

Spectrum Monitoring



High dynamic range allows the instrument to simultaneously see both large and small signals.

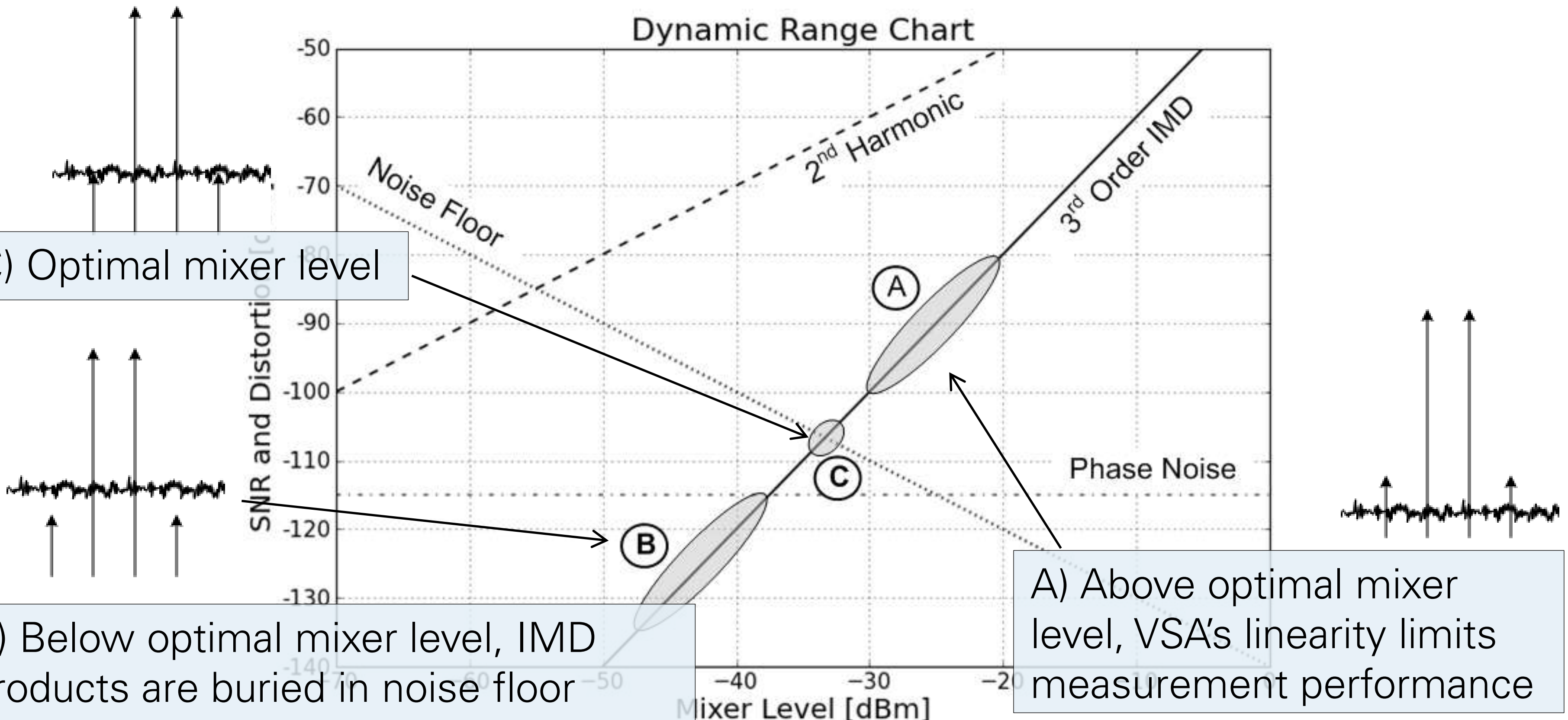
Example IMD Test Setup



To ensure accurate IMD measurements, we must ensure that the visible third-order distortion products are due to the DUT rather than the instrument

VSA Dynamic Range Chart

- Dynamic range chart reveals which IMD products can be measured
- Explains trade-off between linearity and noise floor

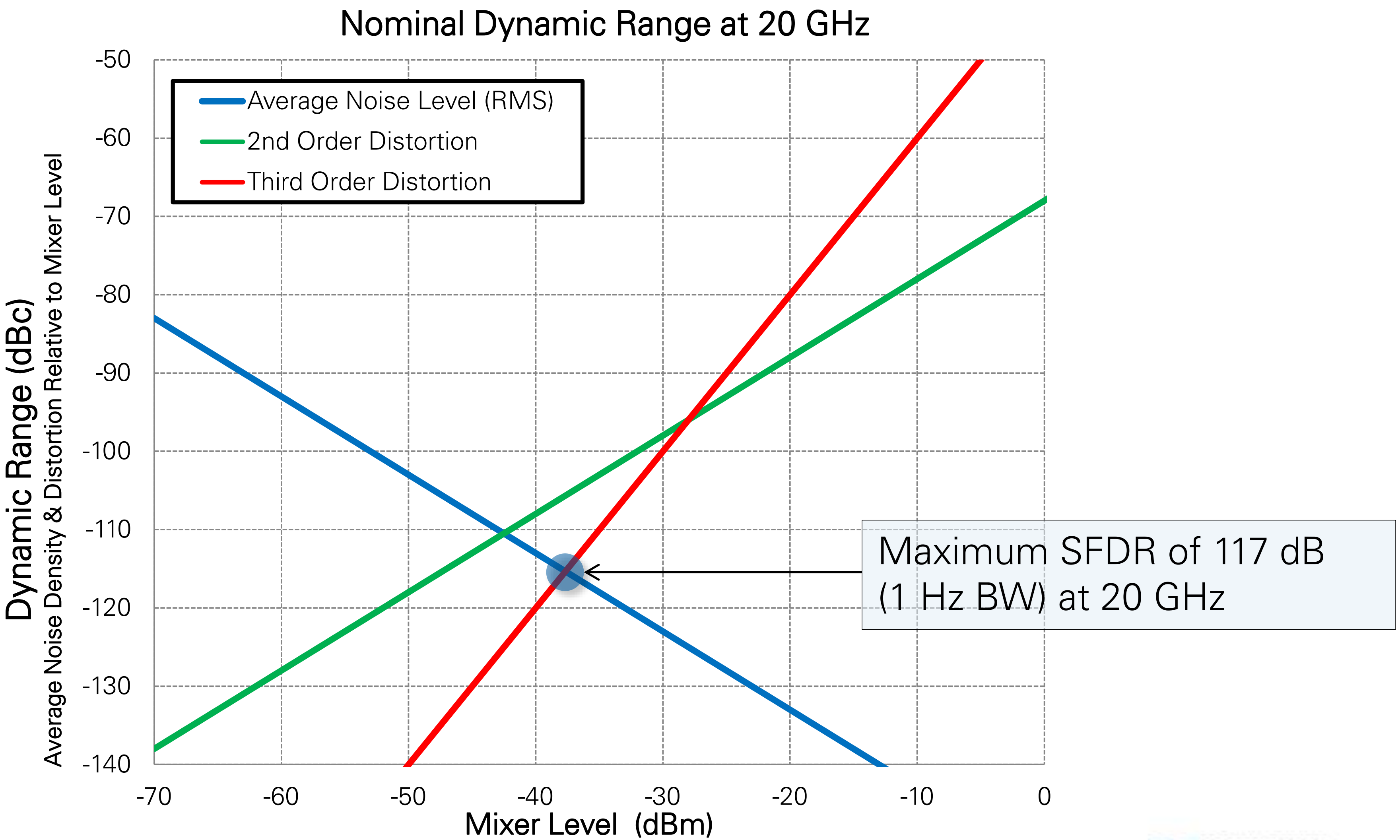


C) Optimal mixer level

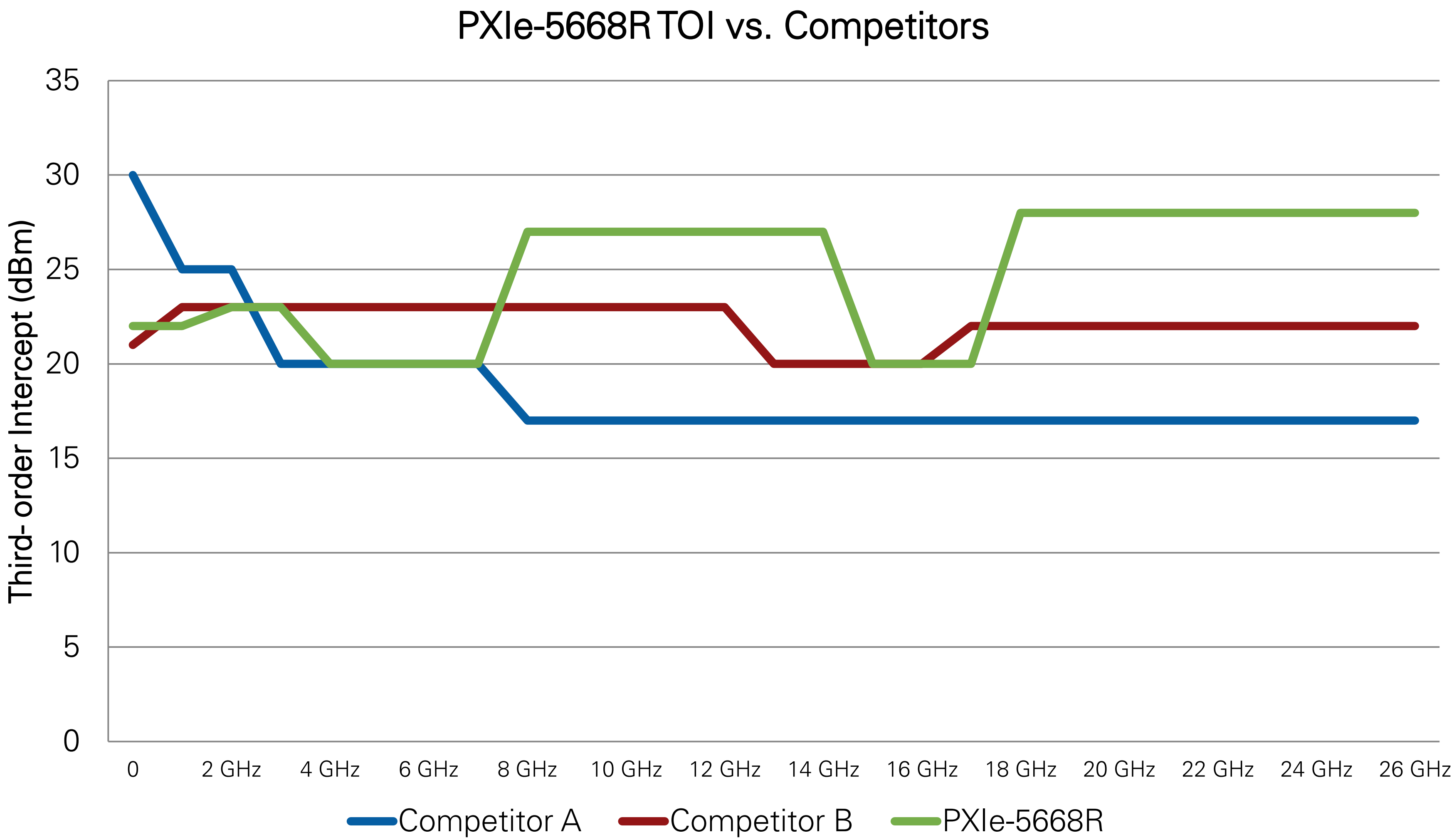
B) Below optimal mixer level, IMD products are buried in noise floor

A) Above optimal mixer level, VSA's linearity limits measurement performance

NI 26.5 GHz Analyzer: Dynamic Range (20 GHz)

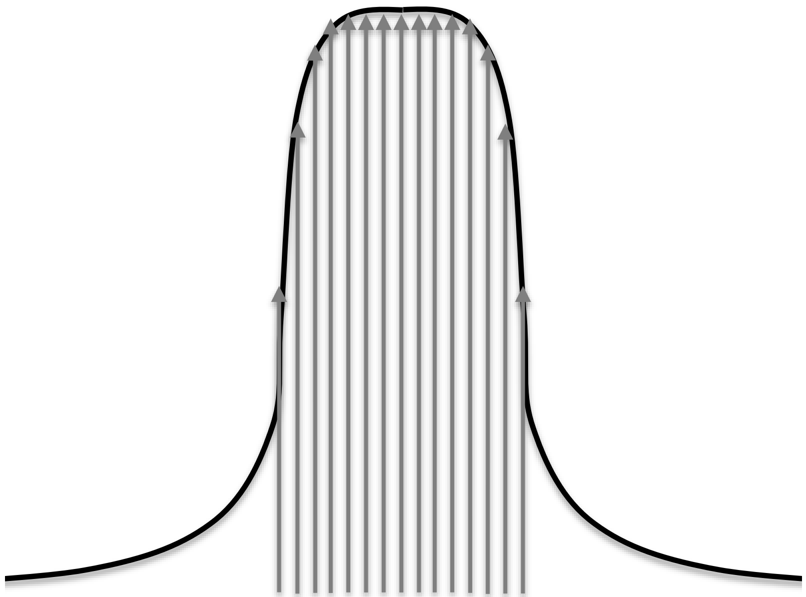


NI 26.5 GHz Analyzer TOI vs. Competitive Instruments

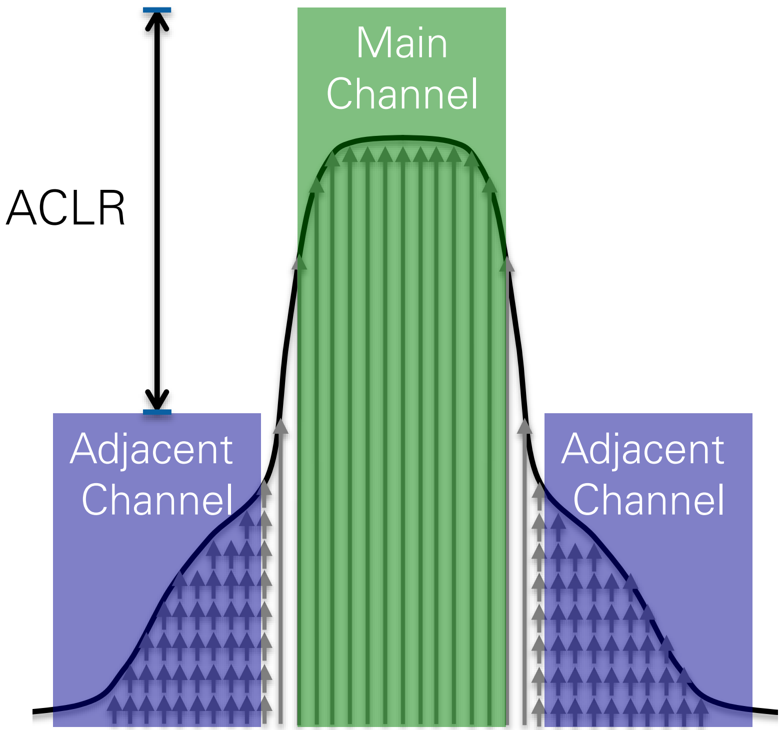


Instrument third-order intercept (TOI) is the standard metric of instrument linearity and is specified using 0 dB of attenuation.

IMD and Noise Determine ACLR Performance

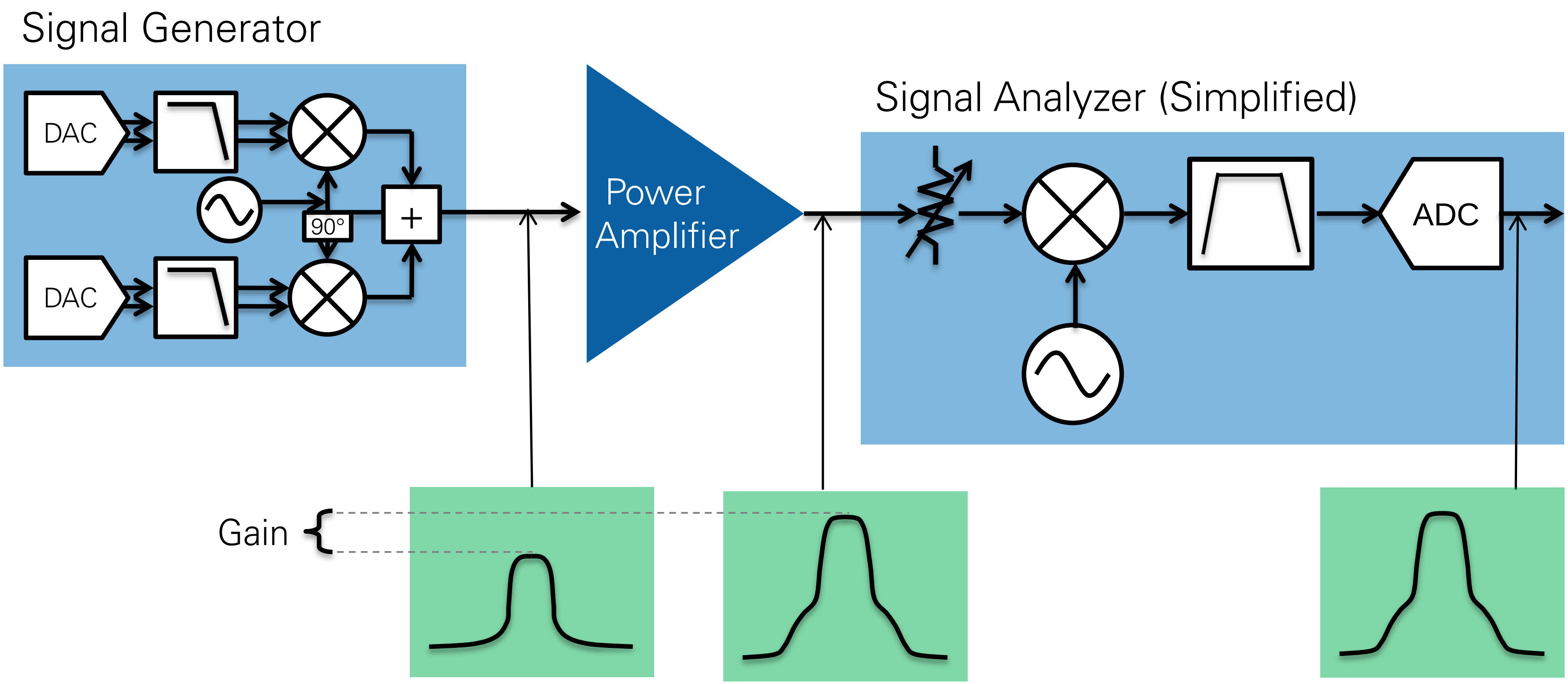


In the frequency domain, we can consider a modulated signal as a series of tones.



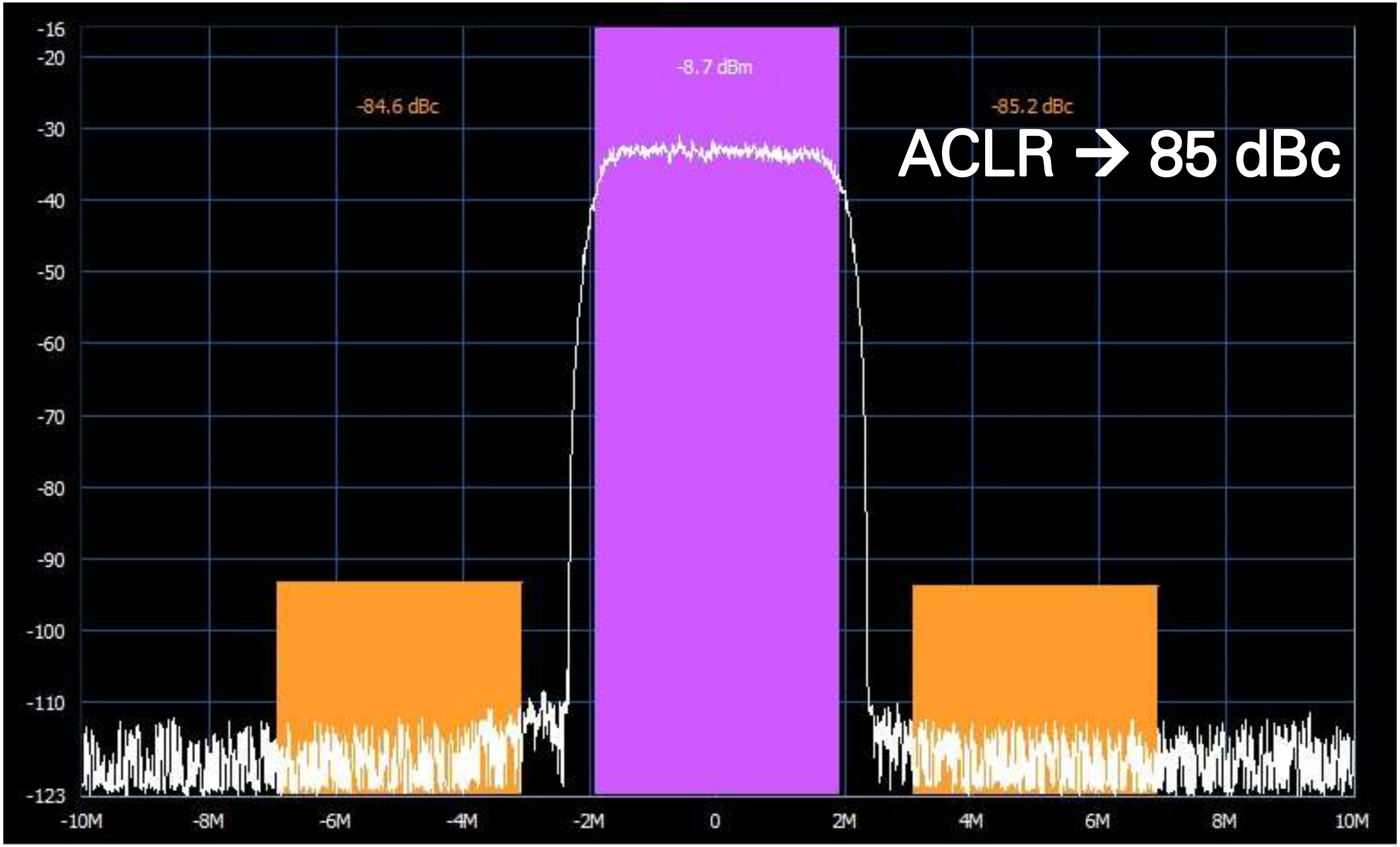
Third-order distortion products form in adjacent bands and are called spectral re-growth.

Example WCDMA PA Test Setup



A high-performance signal analyzer can measure ACLR without contributing inherent noise or nonlinearity. Often, a signal analyzer can employ "noise correction" to remove its inherent noise contribution.

Example ACLR Performance



Signal Analysis: *RF Performance*

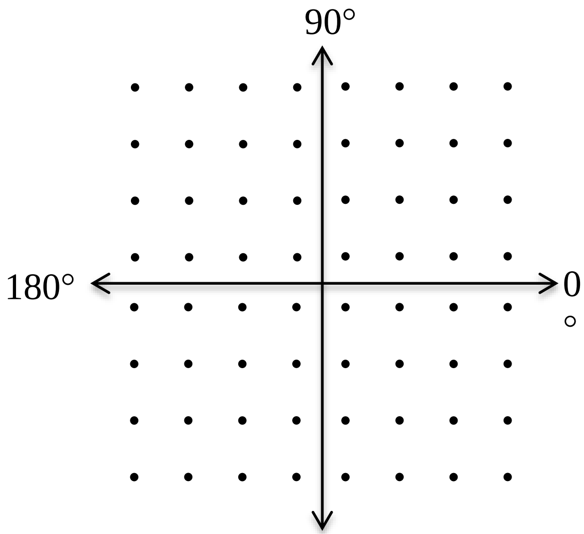
Dynamic Range

Bandwidth

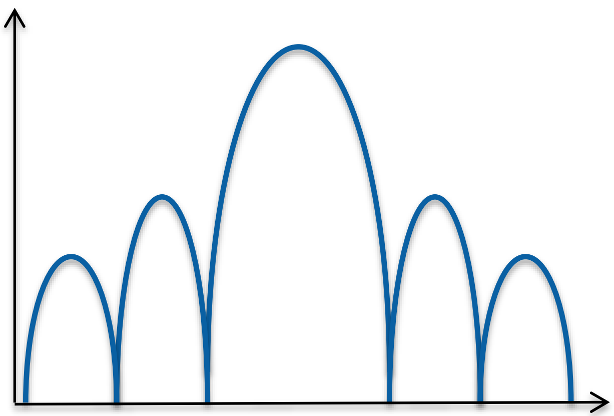
Phase Noise

When Does Bandwidth Matter?

Modulation Measurements



Pulsed Measurements

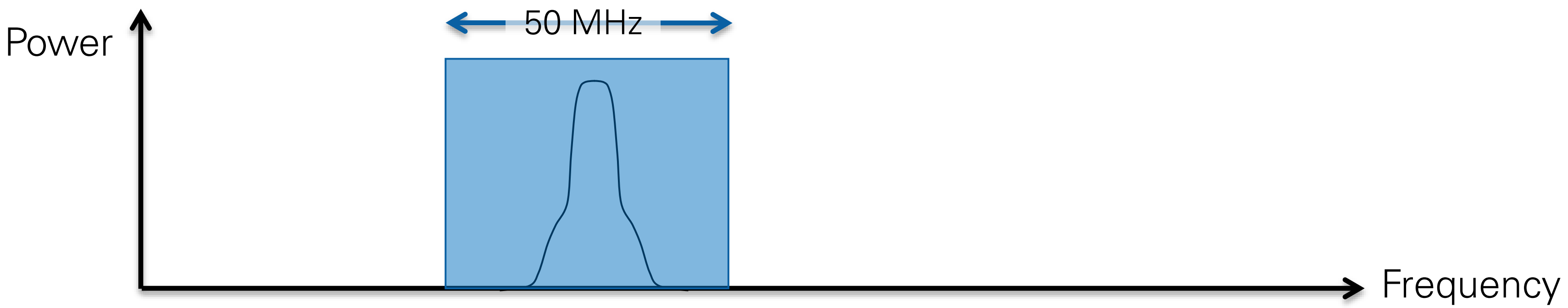


Demodulation requires instantaneous bandwidth larger than the bandwidth of the acquired signal.

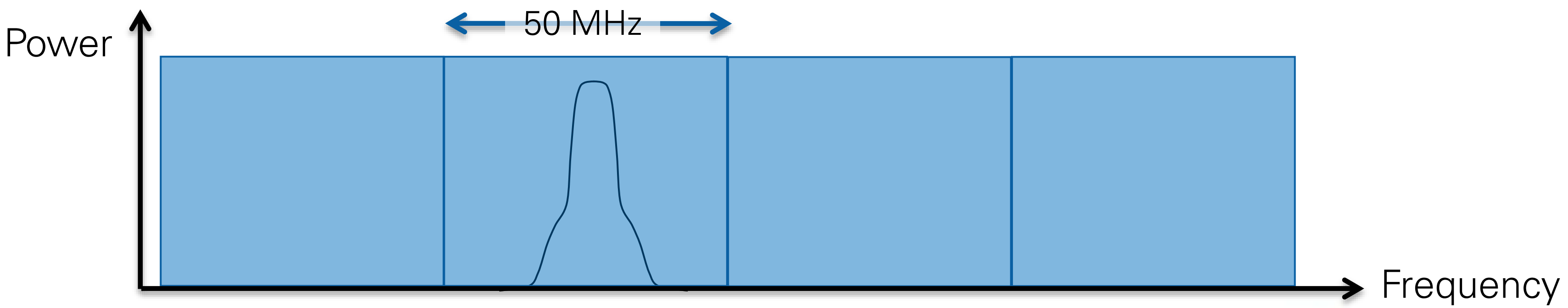
Pulsed signals produce wideband sidelobes in the frequency domain and require 500 MHz or more of bandwidth.

How an FFT Analyzer Works

If span < instantaneous bandwidth, VSA captures signal in one acquisition and performs FFT.

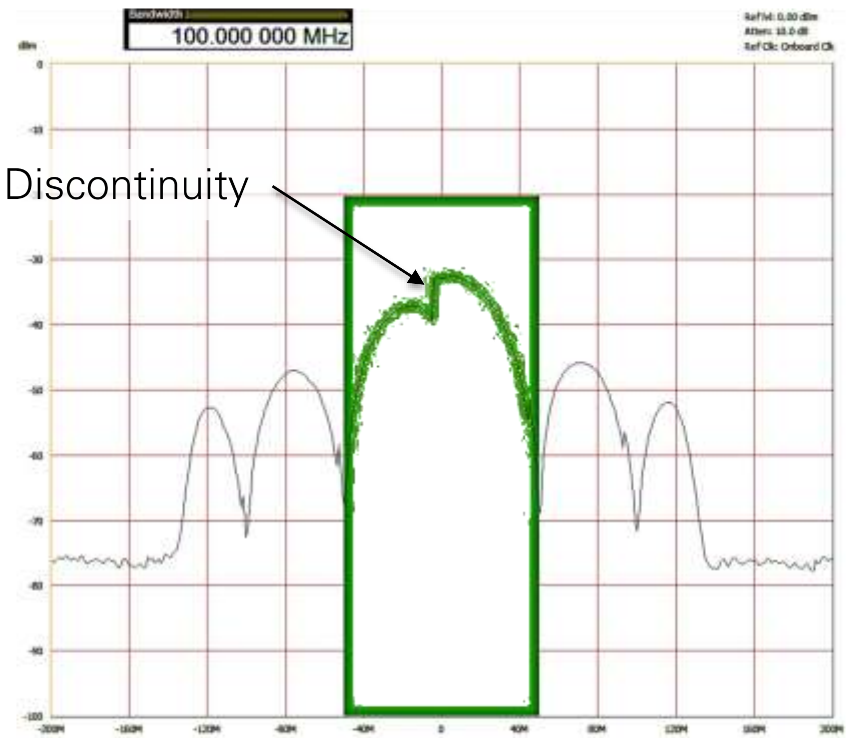


If span > instantaneous bandwidth, VSA captures signal in multiple acquisitions and stitches FFTs together to display entire span.



FFT Analyzers and Wideband Signals

Instrument BW < Signal BW



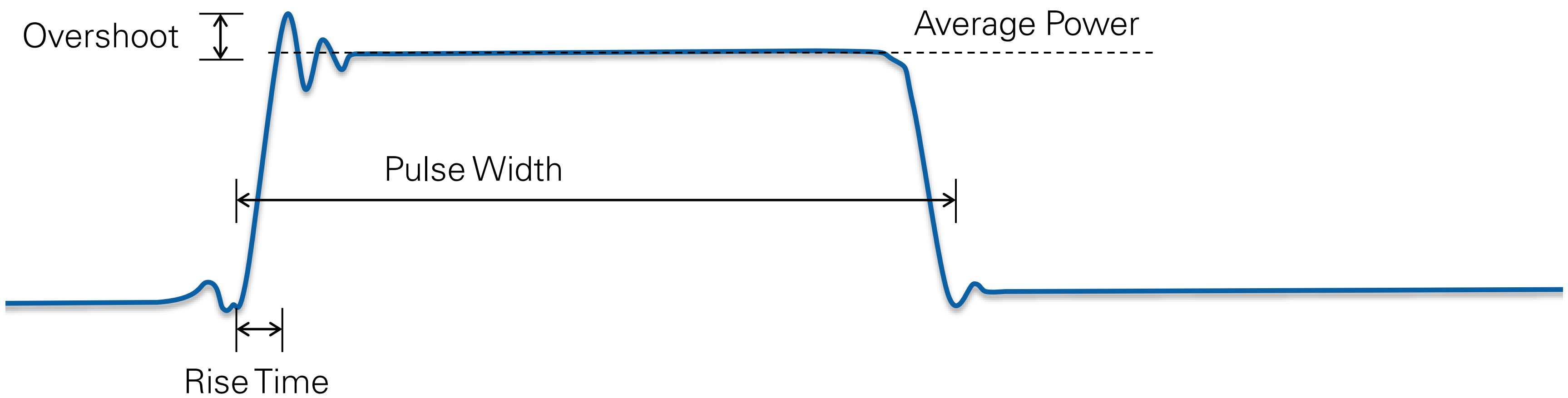
Spectrum acquired in multiple acquisitions

Instrument BW > Signal BW

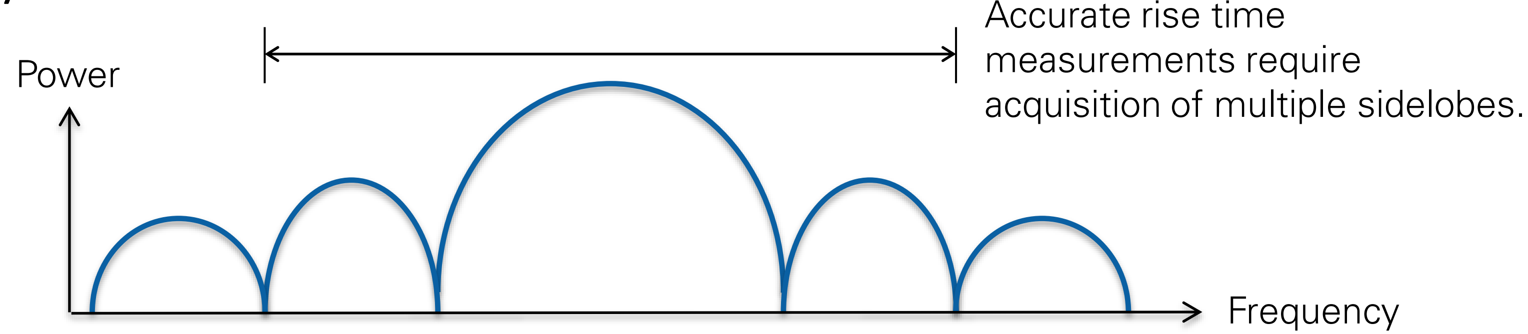
Spectrum acquired in a single acquisition

Example: Radar Pulse Measurements

Time Domain



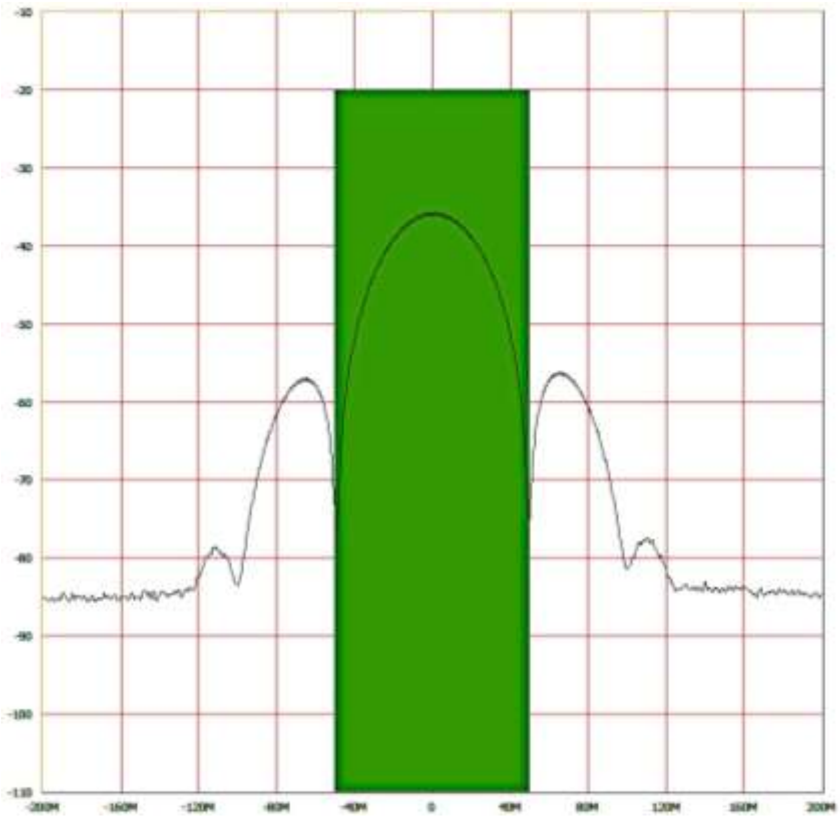
Frequency Domain



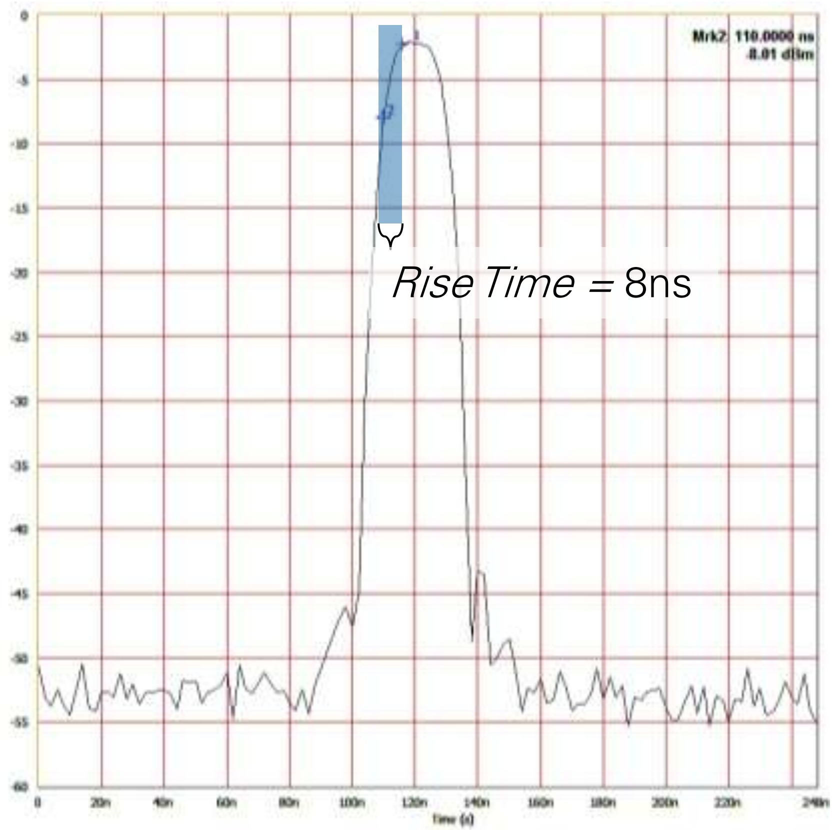
NATIONAL INSTRUMENTS

Bandwidth and Pulsed Signals

Frequency Domain

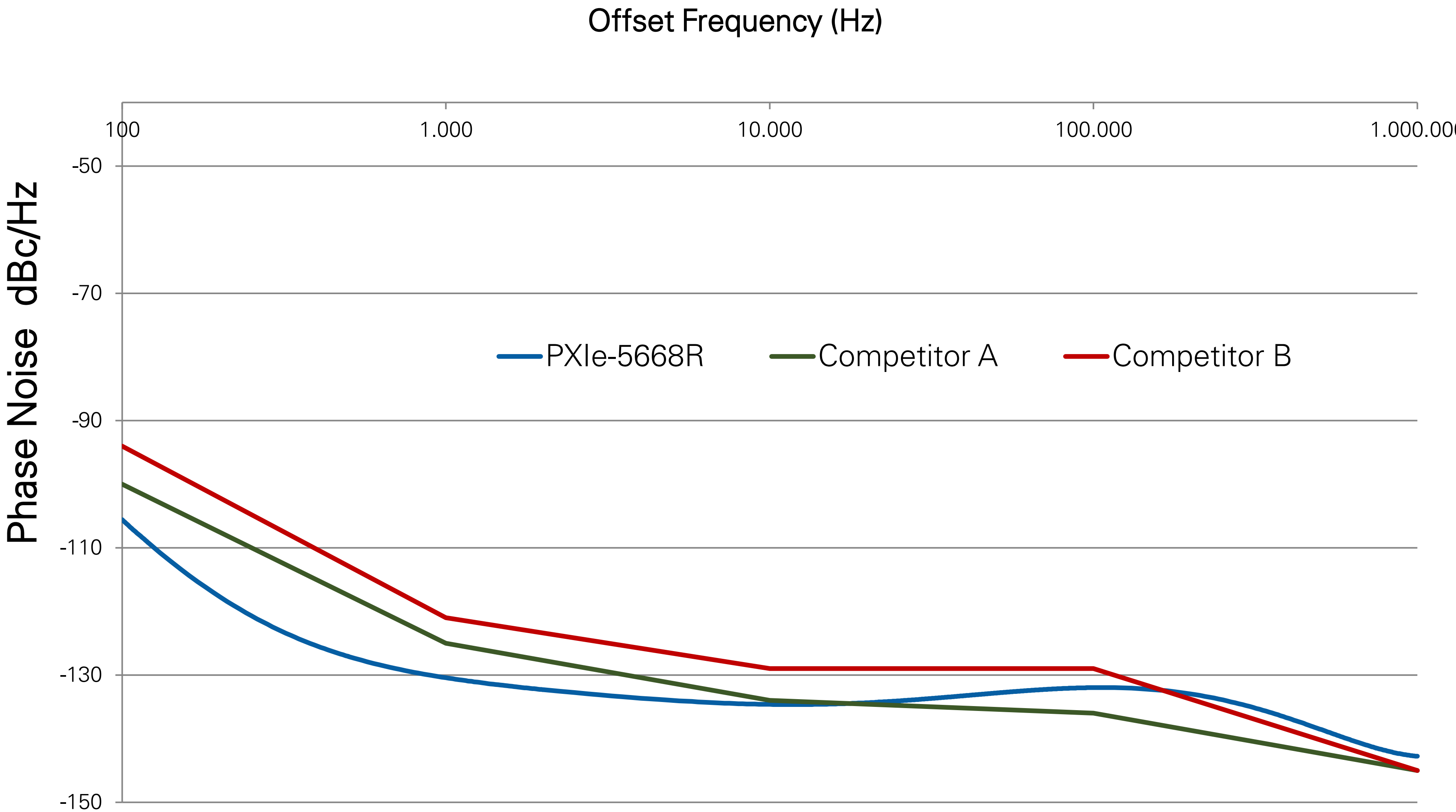


Time Domain



Pulse bandwidth is inversely related to pulse width, with shorter pulses translating to wide bandwidths. In a continuous wave pulse, the bandwidth of the main lobe is (2 / pulse width).

NI 26.5 GHz VSA Phase Noise vs. Competition at 1 GHz



Signal Analysis: *Flexibility*

FPGA Programming

RF Recording

Multichannel and MIMO

Signal Analysis: *Flexibility*

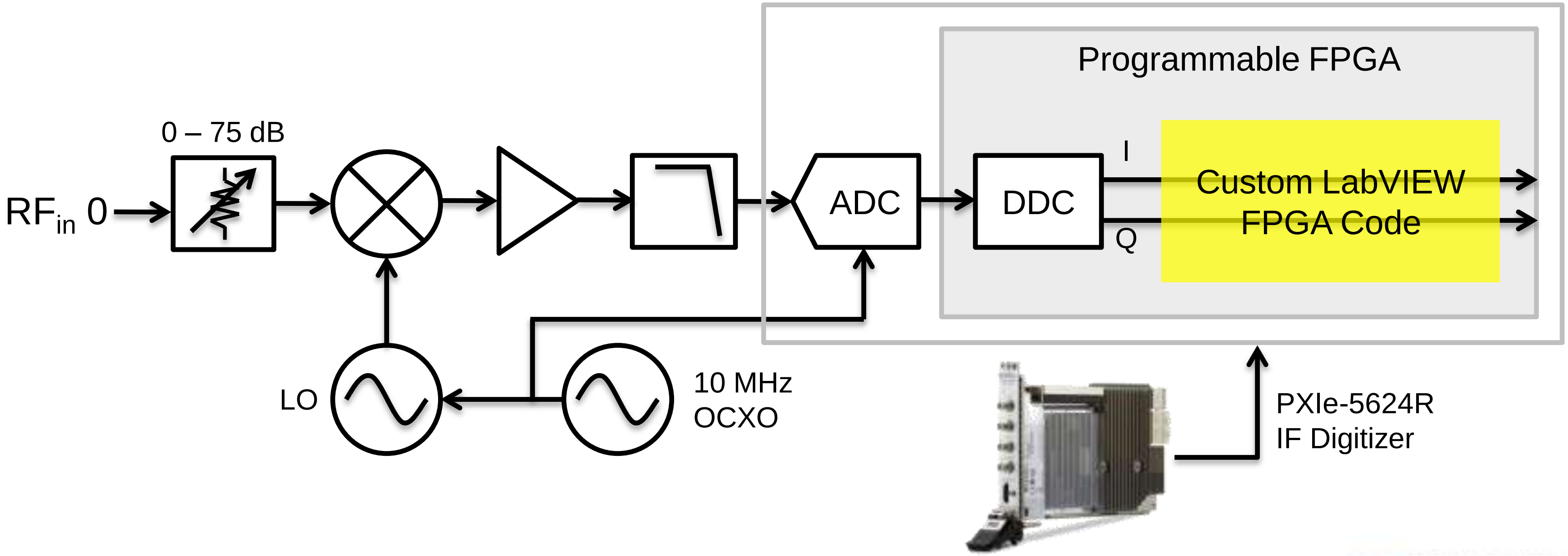
FPGA Programming

RF Recording

Multichannel and MIMO

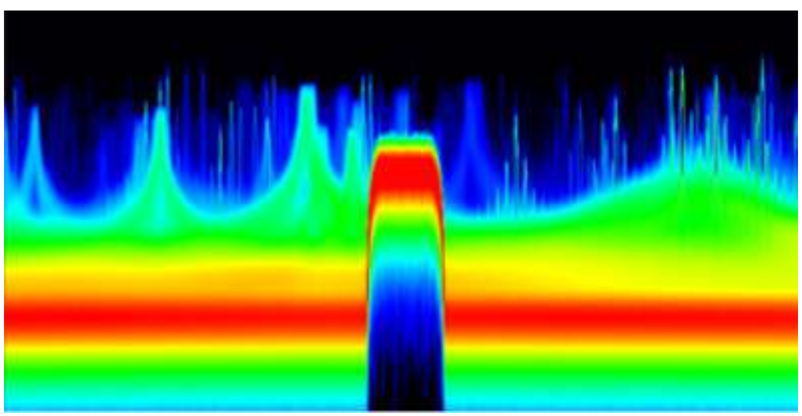
Using the 26.5 GHz Analyzer Onboard FPGA

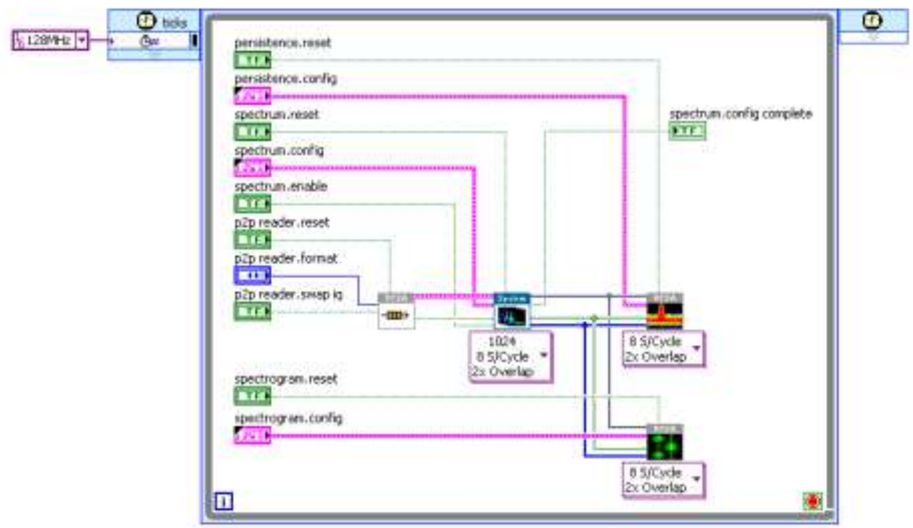
- PXIe-5668R is LabVIEW FPGA programmable “target”
- FPGA characteristics:
  - Xilinx Kintex-7 410T
  - Native IP includes DDC, equalization, power triggering and so on.
  - Can be augmented with custom IP



Example: Real-Time Spectrum Analysis

- Gapless persistence, spectrogram, and trace statistics (max hold, min hold, average) calculated on FPGA
- Process up to 2 M FFTs/s using overlapped, windowed FFTs
- Real-time frequency mask triggering
- 100% probability of intercept (POI) minimum duration options:
  - 1 μs or >15 μs
- Source available upon request





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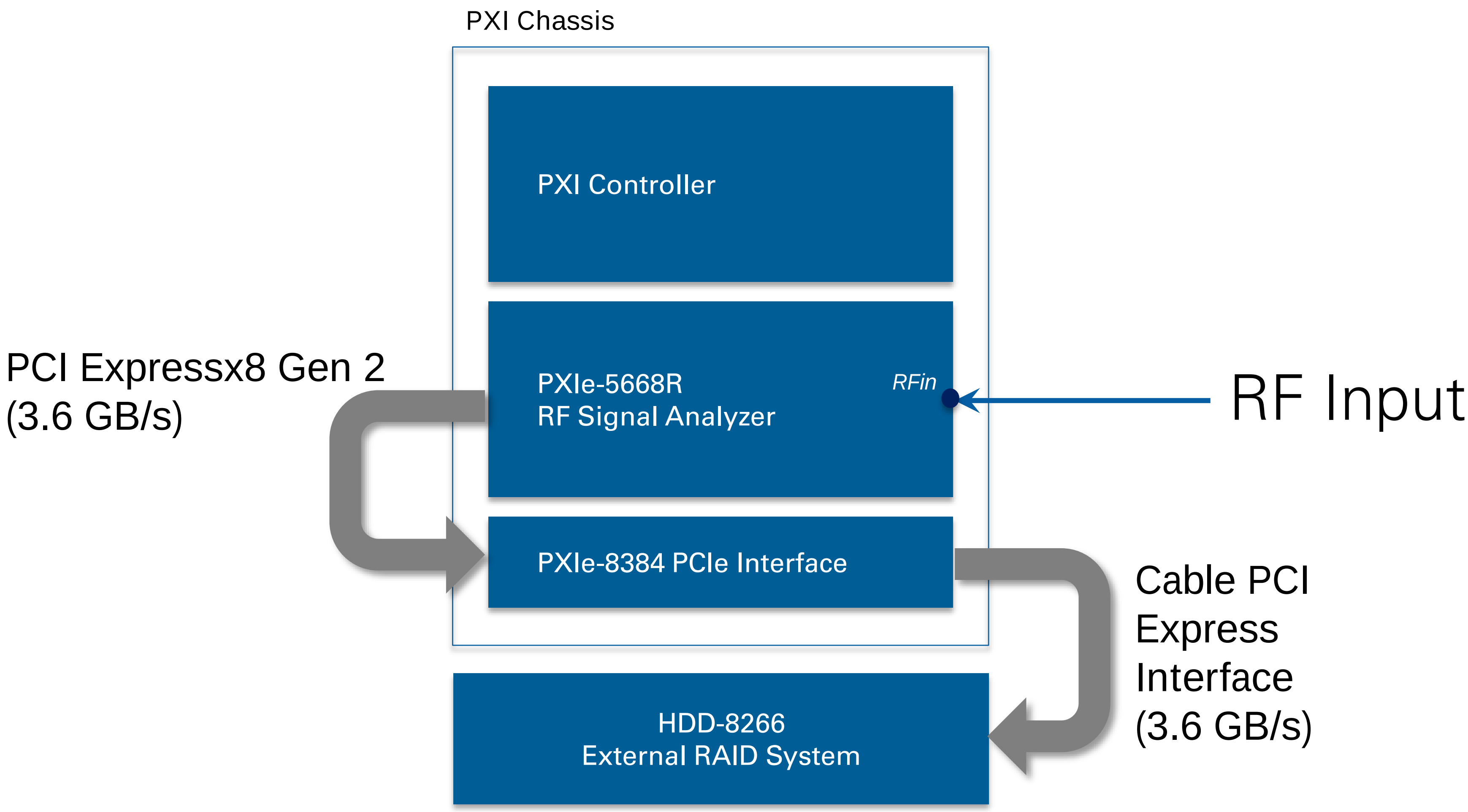
NI 26.5 GHz Analyzer Recording System Architecture



Signal Analysis: *Flexibility*

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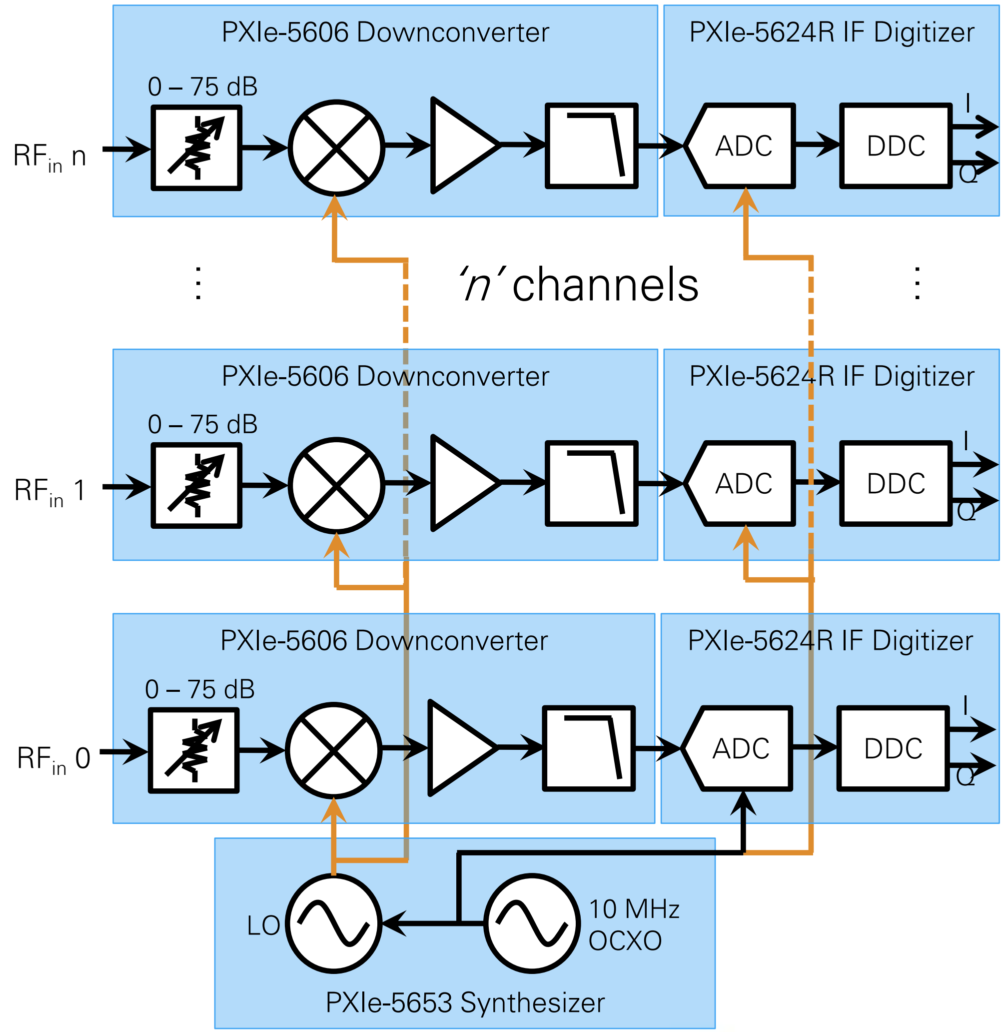
Multichannel Vector Analysis

- LO can be cascaded to multiple downconverters
- 10 MHz reference can be shared across multiple PXI chassis
- Up to 3 channels per PXI chassis



Summary

- Wireless communications and crowded radio spectrum drive the need for better performance from test instruments

- RF test market is evolving to meet application needs

YOU and NI are at work to solve the challenges of our generation!