KEYSIGHT WORLD2018

Automotive Radar Design and Test Lifecycle

DES Automotive Business Manager / Keysight Technologies

Jungik Suh

Automotive Radar Design and Test Lifecycle

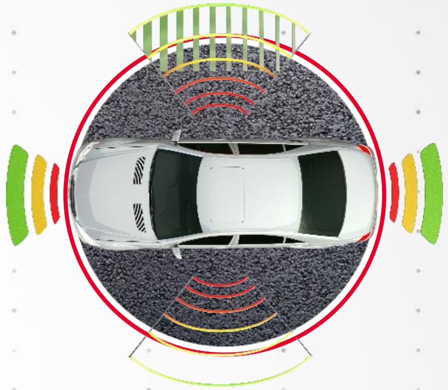
TOPICS

- Automotive Radar Review
- Enabling Technologies
- Design & Test Challenges / Solutions

Automotive Market & Innovation Drivers



Safety 1.23M Road Deaths	Environment +50% CO, NOx Emission	Connection / Convenience In Vehicle
Wireless / RF / mmWave / Digital	**Power / Energy**	**Wireless / Digital / Optical**



Autonomous Driving

e-Mobility

Data Source: WHO, US EPA

Santa Rosa Fire Took 5,643 homes, 22 lives, $1.2B costs

Automotive Market & Innovation Drivers

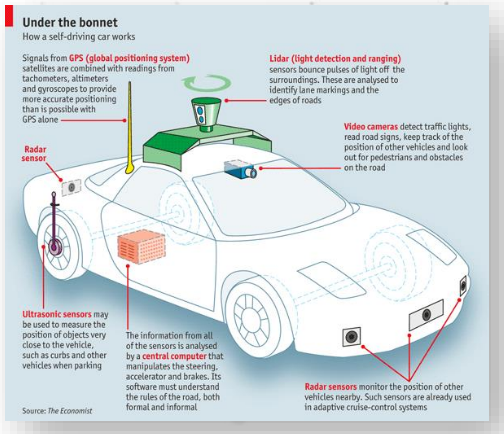
AUTOMOTIVE TECHNOLOGIES CAN SAVE LIVES!

Dad’s Six Sense!

Autonomous Driving System

ENABLING TECHNOLOGIES

- Sensors
  - Radar
  - LIDAR
  - Camera
- Wireless connections
  - 2/3/4G and coming 5G
  - 802.11p DSRC
- Automotive Ethernet
  - BroadR-Reach, 100 / 1000 BASE-T
- Navigation systems
- Processors
- Artificial Intelligence
- High Definition Mapping
- More



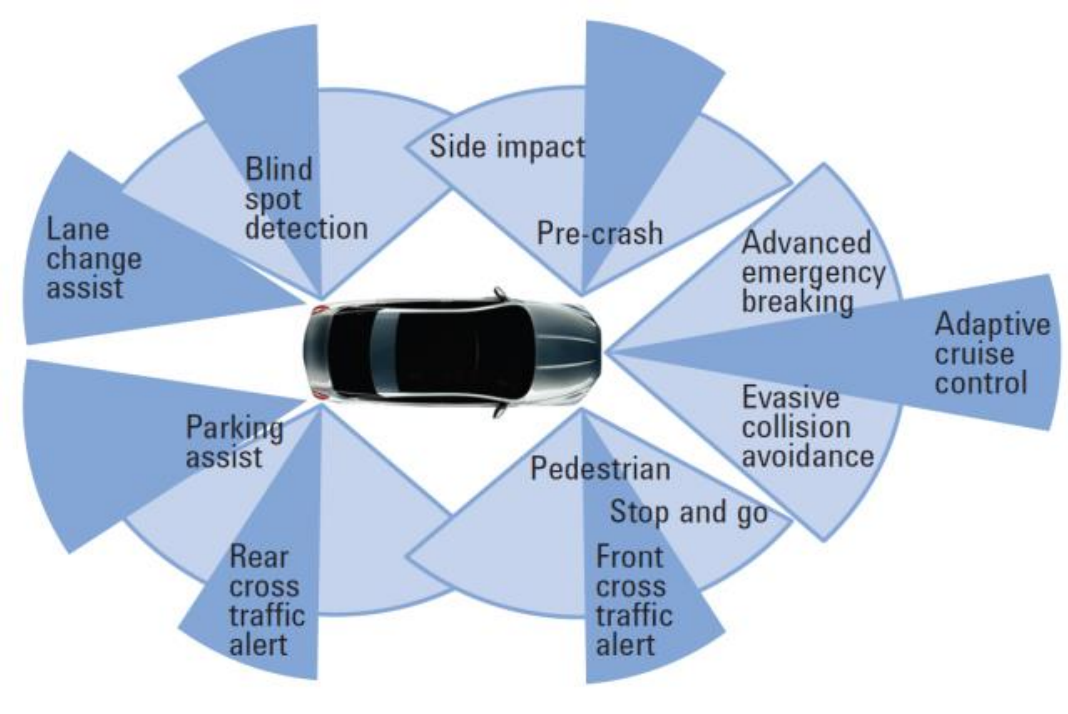
Autonomous Driving System

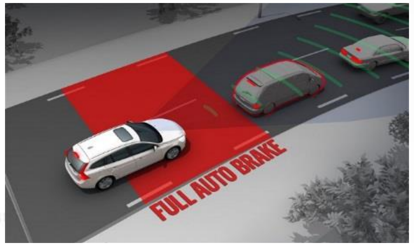
SENSORS

	RADAR	Camera	LIDAR
Used for	• Detection - distance (range) and motion (velocity, angle) by radio waveforms	• Recognition, classification by images	• 360° 3D view by laser / light
Applications	• Adaptive Cruise Control, Automatic Emergency Braking Systems, Blind Spot Detection, Parking Assistance	• Traffic Sign Recognition, Land Keep Systems, Parking Assistance, Blind spot detection, ACC, AEBS	• Emergency Brake Assist for Pedestrian, Crash Imminent Braking, Mapping
Advantages	• Working in all environmental conditions • Light weight • Longer detection distance than LIDAR	• Lower cost • Smaller sensor size • High resolution • Color recognition • Imaging processing	• High accuracy • High resolution • Intelligent signal processing with large amount of captured data
Limitations	• Limited information of detected obstacles • Lower resolution than LIDAR	• Various performance in some environments (e.g. weather, lighting)	• (still) expensive sensor • (still) big sensor size • Expensive and complicated signal/data management • Affected by weather

Automotive Radar

APPLICATION EXAMPLES

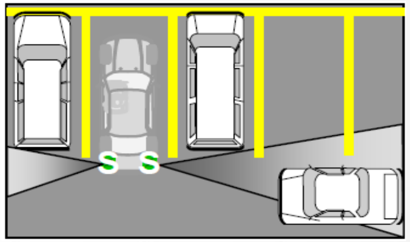




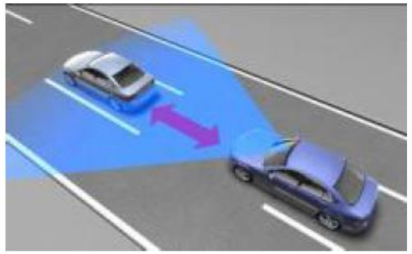
Auto Emergency Braking / Pre-tensioning Seatbelts

Blind Spot Monitoring

Lane Change Assist



Real Collision Protection



Adaptive Cruise Control

Stop & Go Cruise Control

Making Roads Safer with 360 Degree Vision!

Making Autonomous Driving Possible!

Automotive Radar

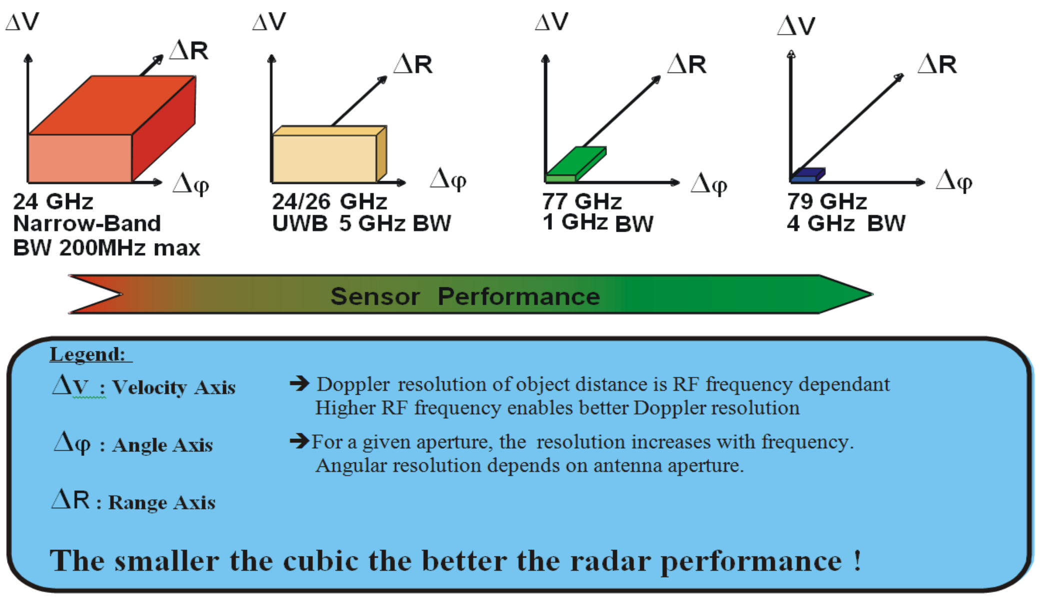
MAJOR TECHNOLOGIES

- High Frequency and wide bandwidth millimeter wave (24, 77, and 79GHz)
- Modulation (FMCW)
- Antenna
- Automotive Ethernet / Serial Buses (BroadR-Reach, 100 BASE-T, CAN/CAN FD)
- Power Control (ETSI conformance specification, EN 302 264 for 79GHz)
- More

Automotive Radar Major Technologies

HIGH FREQUENCY & WIDE BANDWIDTH MILLIMETER WAVE (77/79 GHZ)

- Benefits
  - Better spatial angular (smaller wavelength), velocity (doppler), and range resolution
  - Higher range (up to 300 meter)
  - Smaller and lighter sensor
  - Rapid signal attenuation (better for interference), improved interference mitigation
  - Higher attenuation per km → higher spectrum re-use (sharing) scheme on the busy road
  - Better power efficiency (less emission power → lower possibility of interference issue)



Source: CEPT Report 37

Fig.1 Comparison of sensor performance showing key parameters Angular resolution, Range resolution, Doppler resolution

KEYSIGHT TECHNOLOGIES

Automotive Radar Major Technologies

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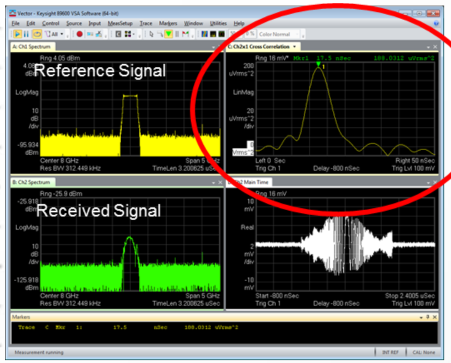
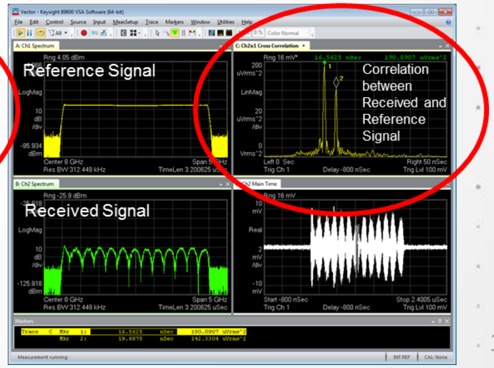
- Challenges
  - Higher propagation loss
  - Phase noise, IQ and frequency response errors degrade
  - Repeatability
  - More noise to impact on EVM
  - Complex test set up
  - Generate and characterize accurate wide bandwidth millimeter wave signals





Automotive Radar Major Technologies

MODULATION (FMCW)

- Benefits
  - Avoid high peak-to-average power ratio (PAPR) in transmission
  - Simplifies the design process for antennas and RF components (narrow-band IF processing)
  - Good performance with simplified RF components → small size, light weight, and low cost.
  - Improved noise floor
  - Interference tolerance
  - Reduced RF intermodulation
  - Simpler / easier waveform to generate (compared to very narrow, high power pulsed)
  - Constant high average power, without requiring high peak powers, managed close-in blind-range issues (always transmitting and receiving)

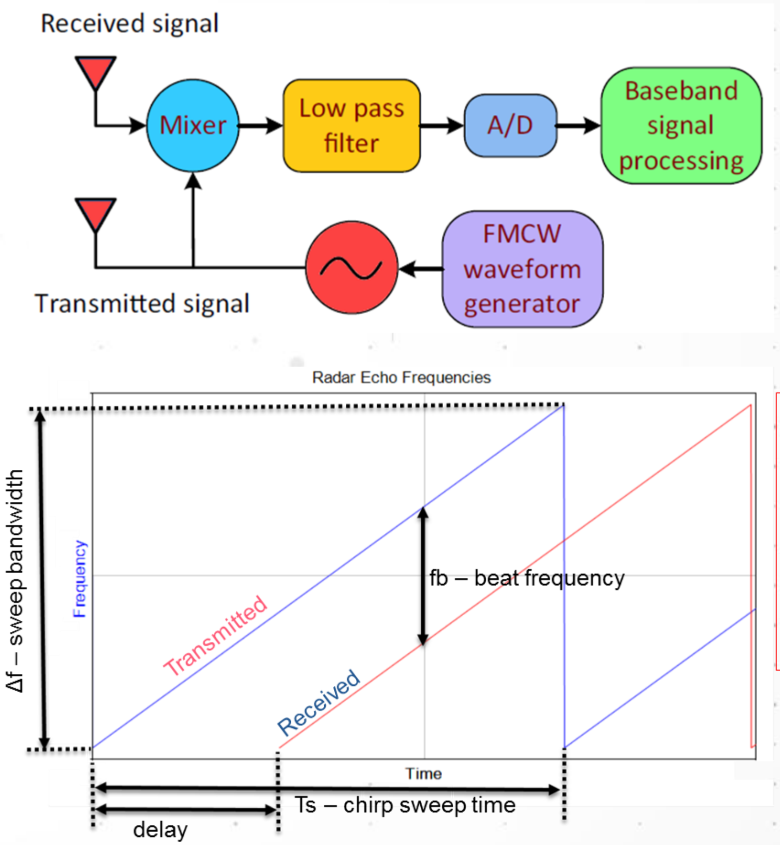


Fig.4 FMCW diagram and frequency detection

Range Estimate

$$\tau = \frac{2R}{C} = \frac{f_b T_s}{\Delta f}$$

$$R = \frac{f_b T_s C}{2\Delta f}$$

Automotive Radar Major Technologies

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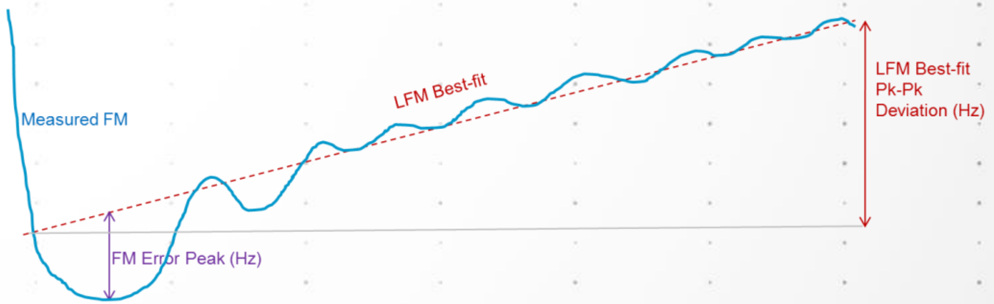
- Challenges
  - FM Linearity modulation quality
  - Phase Noise and AM Noise of transmitter
  - RF leakage from Tx to Rx
  - Dealing with clutter from multiple undesirable reflections between sensor and targets
  - Dealing with interference from other radar sensor band users
  - Thermal Power Challenges



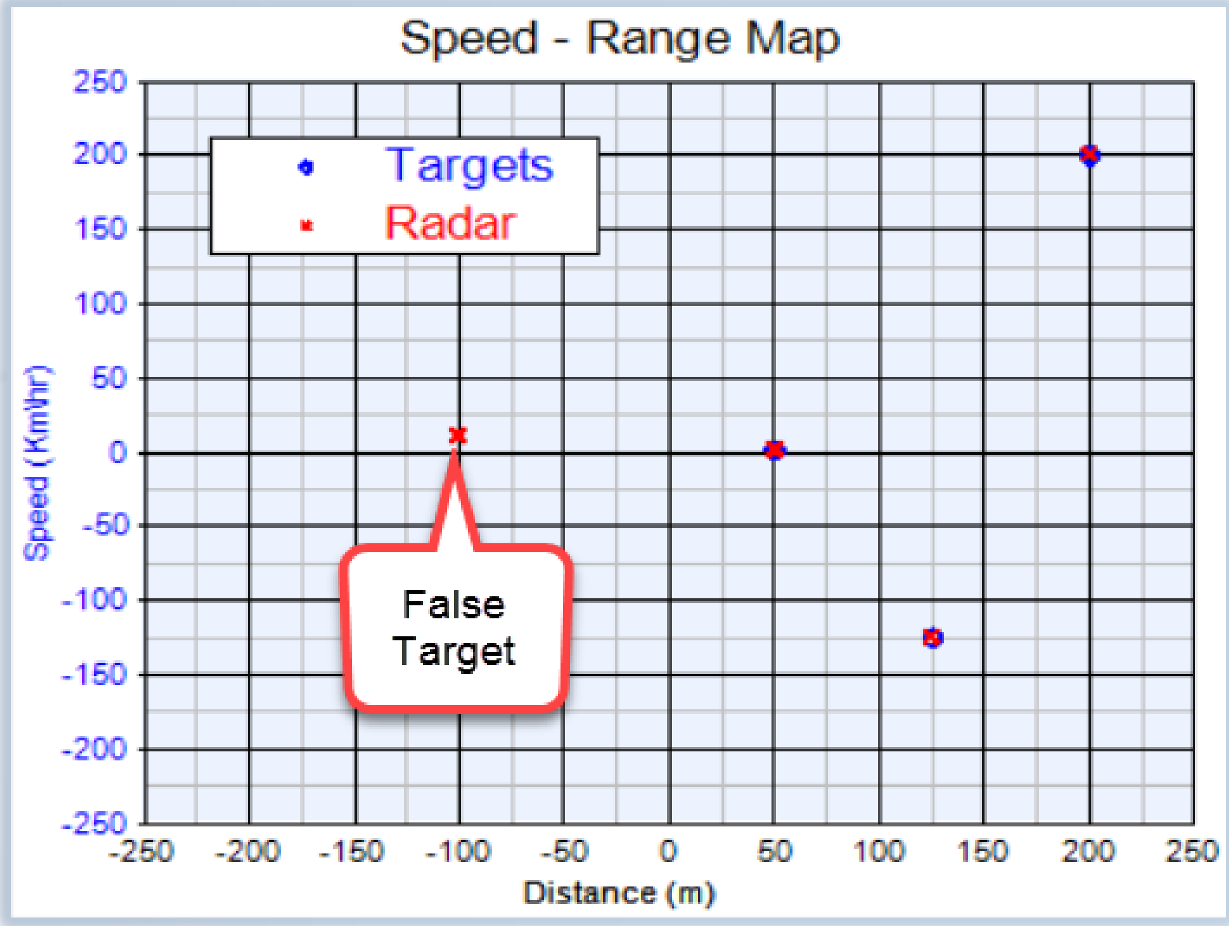
FM Error Peak (Hz) = max(Measured FM – LFM Best-fit)

INL Best-fit (%) = [FM Error Peak (Hz) / LFM Best-fit Pk-Pk Deviation (Hz)] * 100

KEYSIGHT TECHNOLOGIES

Automotive Radar

RESULT OF DESIGN AND CHANNEL IMPAIRMENTS



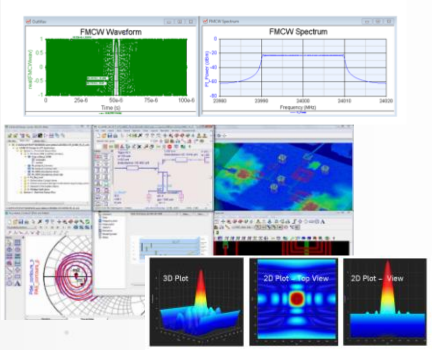
Why is there a false target? What can I do to eliminate this false target?

Target Dist	Radar Dist est.	Target Speed	Radar Speed est.
0	-100.93	0	11.121
200	199.362	200	201.039
125	124.414	-125	-124.045
50	49.965	1.8	2.566

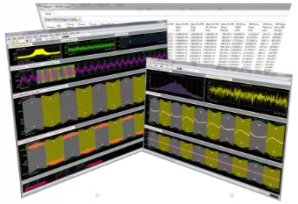
Keysight Automotive Radar Solutions

OVER WHOLE DESIGN AND TEST LIFECYCLE

Value of Keysight #1



W1908 SystemVue Simulation SW



89600 VSA SW with FMCW option

E8740A-060 Performance SA

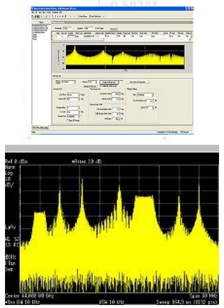
PXI Modular VSA/VSG/Digitizer /Network Analyzer

E-Band Power Sensor and Meter

Architecture / Design → Development → Validation & Mfg.

E8740A-070 Performance SG

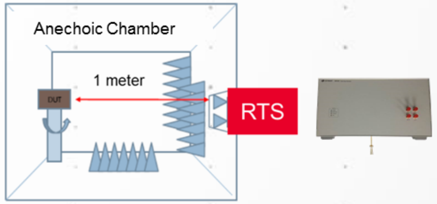
E8267D PSG Vector Signal Generator



Signal Studio for Pulse Building

Signal Source Analyzer

PNA Network Analyzers Banded mmW Solution



Radar Target Simulator (RTS)

From Design Simulation, Wide Bandwidth mmWave Signal Generation & Analysis, Precise Power and Component Measurements to Manufacturing Tests

KEYSIGHT TECHNOLOGIES

Automotive Radar Design Simulation

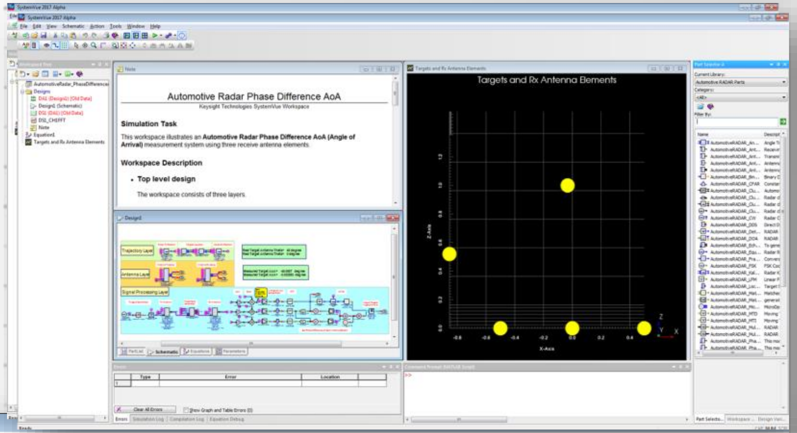
ADVANTAGES OF SYSTEMVUE AUTOMOTIVE RADAR LIBRARY

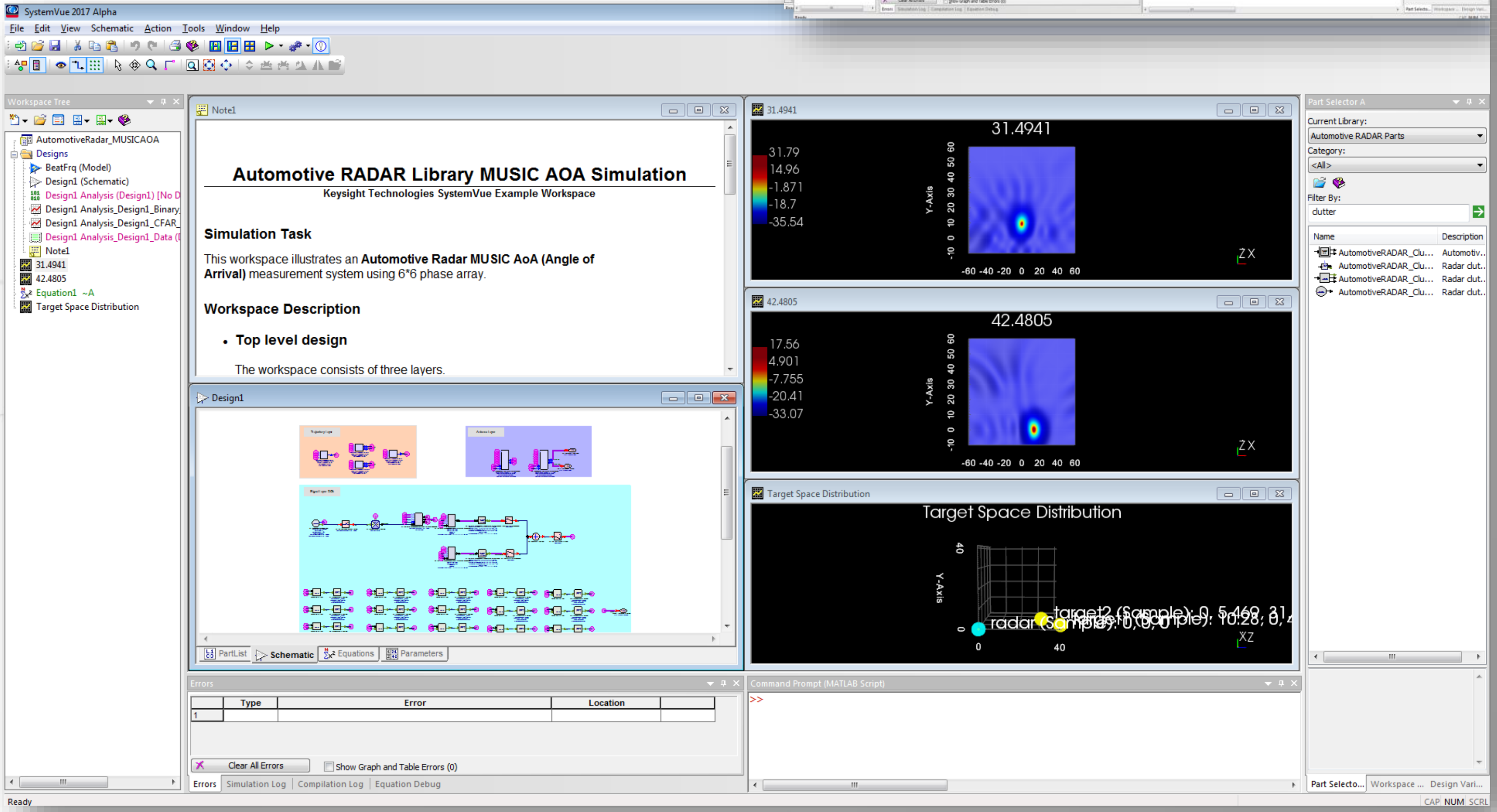
Simulation Framework	• DSP layer, Antenna layer, Trajectory layer
Reference DSP Modeling	• Variable waveforms (Fast chirp, Triangle FMCW, MFSK, PRBS) • MIMO Radar • 2D-FFT, CFAR, multi-target tracking
Environment modeling	• Target (continue to enhance) • Propagation loss modeling (Rain loss, antenna dome loss) • Clutter (Different road condition)
RF/Antenna modeling	• Antenna pattern import (HFSS, EMpro, CST) • New RF modeling example (phase noise, amplifier nonlinearity)

Automotive Radar Design Simulation

MUSIC AOA SIMULATION

- MUSIC AoA
  - Multiple Signal Classification, algorithm used for frequency estimation and emitter location
  - High resolution digital beamforming method with sensor array is required
  - Estimated by investigating the phase difference by a time delay

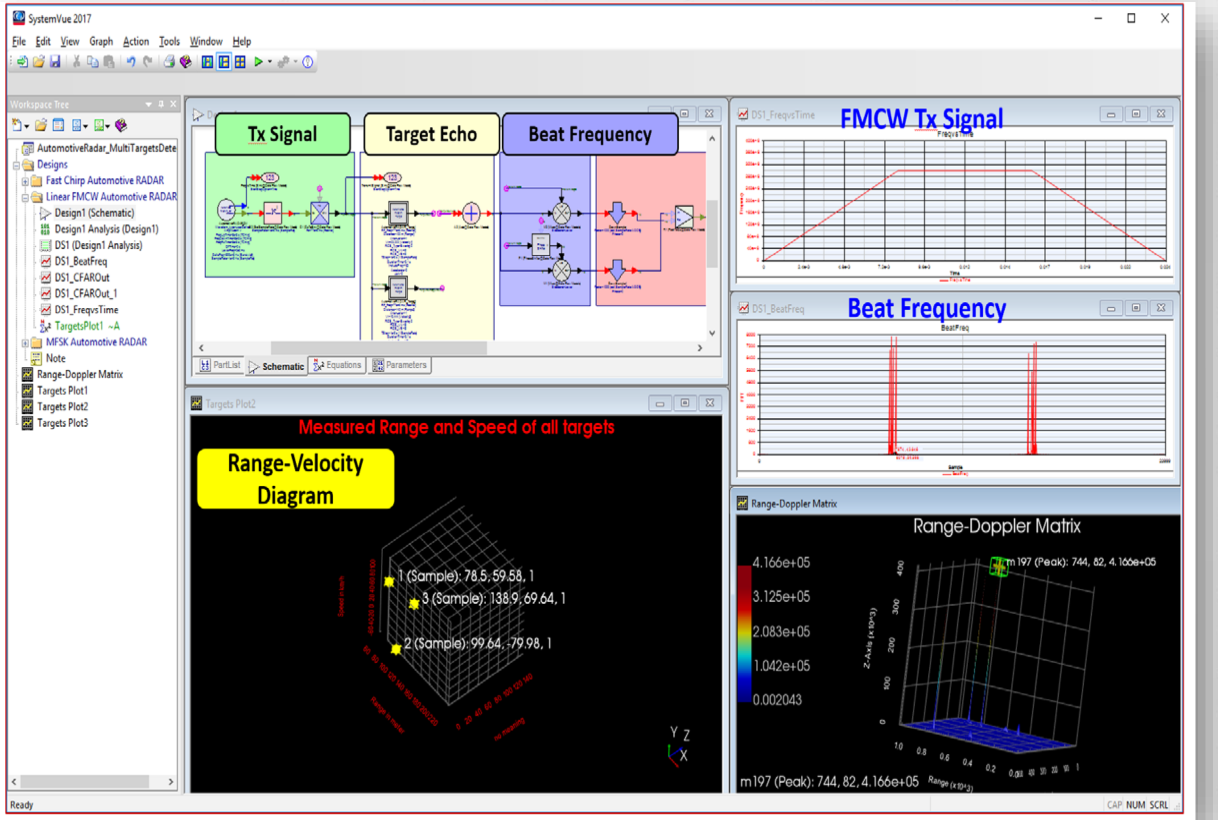




Automotive Radar Design Simulation

LINEAR FMCW MULTI-TARGET DETECTION

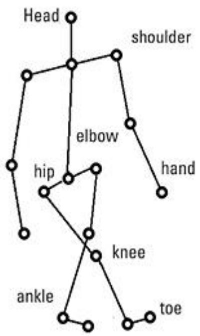
- Using single tone of linear FMCW signal with up-chirp and down-chirp with echo and beat frequency of every targets, users can simulate the multi target detection and show them in range-velocity diagram.
- Showing three targets detected and shown in range-velocity diagram

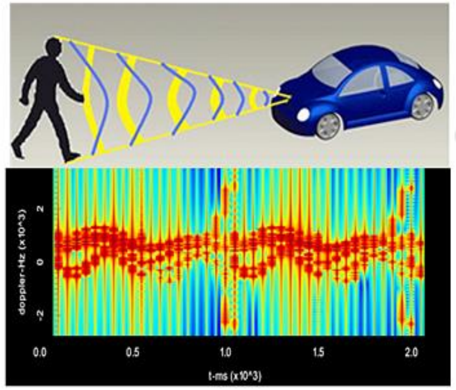


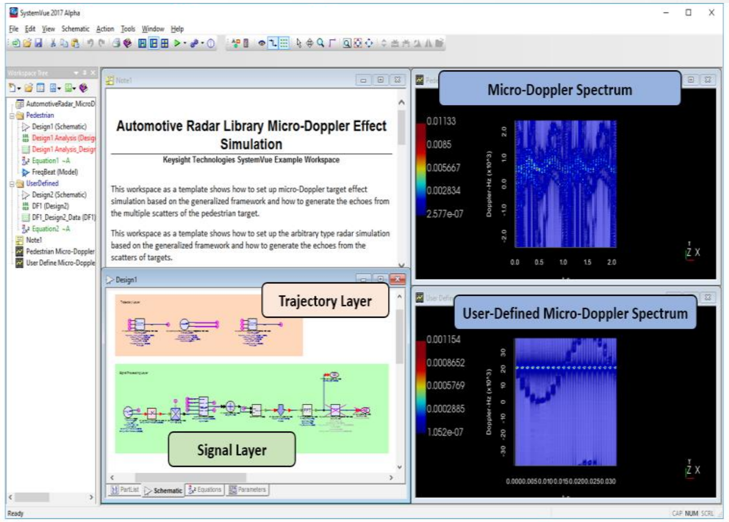
Automotive Radar Design Simulation

MICRO-DOPPLER

- Using the micro-Doppler spectrum distribution to distinguish the targets from pedestrian or vehicle
- Pedestrian target has more sub parts like arm, leg, head, neck, and torso with different instantaneous velocity
- The arms and legs move periodically in walking; the Doppler spectrum is changing periodically in time
- A common scenario model with
  - Pre-defined walking passenger
  - Pre-defined running passenger
  - Pre-defined moving car
  - Custom scenario with customized trajectory





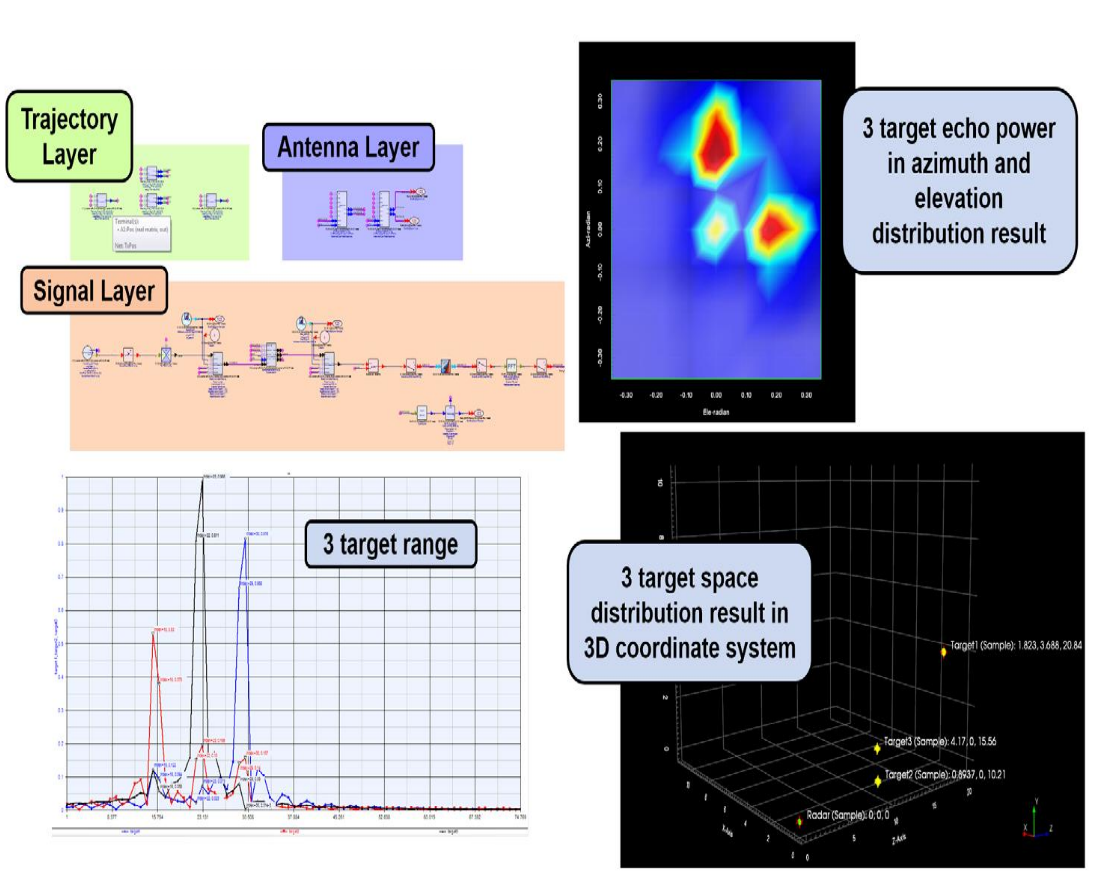


- 10+ scatters for a walking passenger
- Accurate modeling for moving trajectory for each scatter
- Reference radar data processing to identify micro-Doppler signature of the walking passenger

Automotive Radar Design Simulation

3D AUTOMOTIVE RADAR SCAN

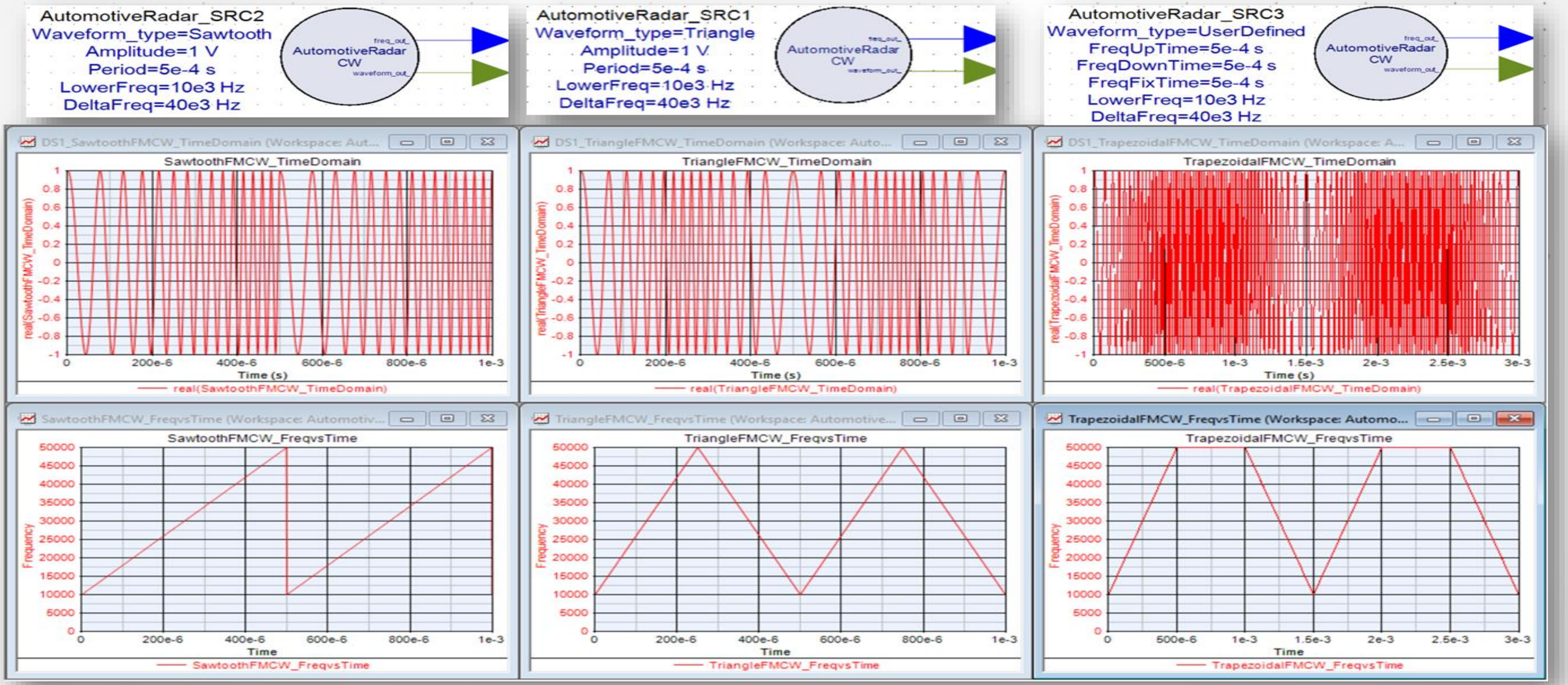
- Needed target elevation angle information
  - Azimuth angle as well as range and velocity
- 3D Automotive radar scan
  - Leveraging 2D scan system, additional elevation region scan is needed
  - With MN planer array, the spaces can be divided into azimuth, elevation, and angle grids to realize and visualize 3D scan
- Designers can obtain the various simulation results in numeric, sliced 2D and 3D space distribution in SystemVue



Creating 3D scan scenarios with platform and target position, velocity, target RCS and more parameters, designers can visualize the results in various traces and distribution plots.

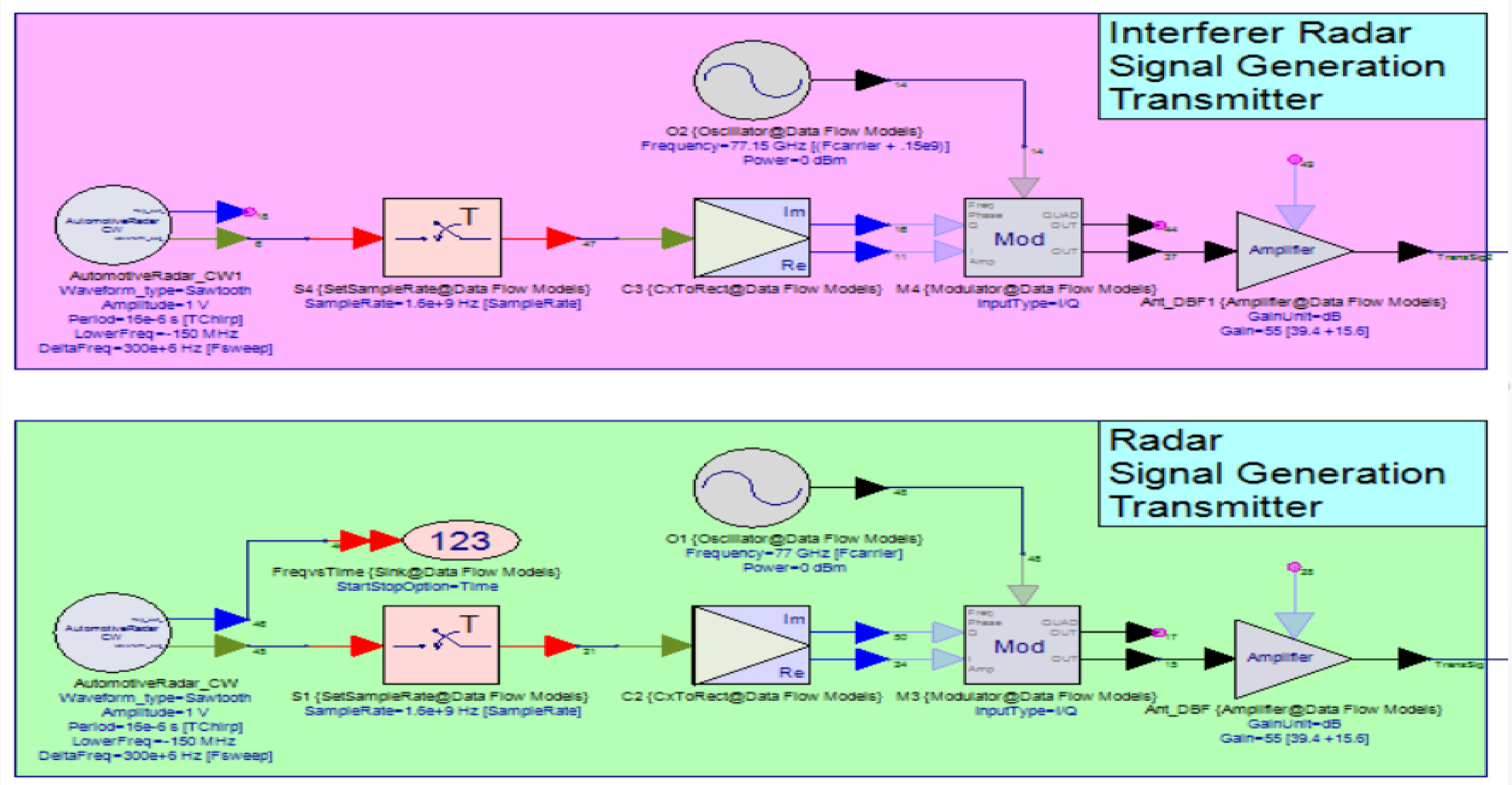
Automotive Radar Design Simulation

FLEXIBLE AUTOMOTIVE RADAR SIGNAL GENERATION WITH SYSTEMVUE



Automotive Radar Design Simulation

AUTOMOTIVE FAST CHIRP SIGNAL GENERATION & TRANSMISSION



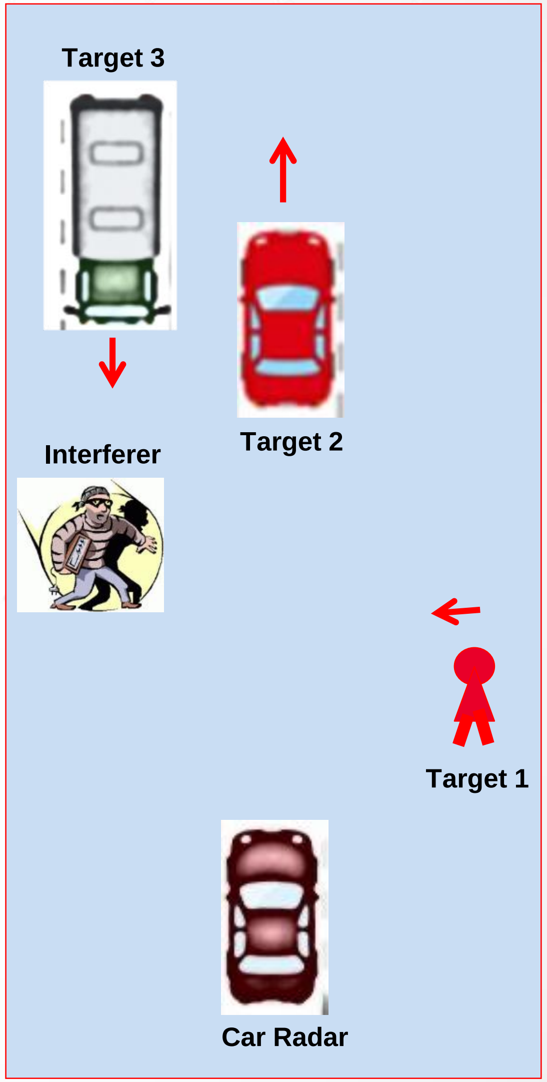
Automotive Radar Design Simulation

```
% Automotive Fast Chirp Radar Design
RFfreq = 77e9;        %Radar Frequency in Hz
RFBW   = 300e6;       %Chirp Frequency Bandwidth in Hz
TChirp = 16e-6;       %Fast Chirp Time Period in seconds
ADCfs  = 64e6;        %Receiver analog to digital converter sampling frequency in Hz
Nchirp = 512;         %Number of chirps in one CPI
lspd   = 299792458;  %light speed in m/s

RangeFFTSize     = floor(ADCfs*TChirp);          %Slow time FFT size
DopplerFFTSize   = Nchirp;                       %Fast time FFT size

dR = lspd/2/RFBW;                                %Range resolution in m
dV = 3.6*lspd/2/RFfreq/DopplerFFTSize/TChirp;    %Velocity resolution in km/hr

maxR = RangeFFTSize/2 * dR;                      %Maximum Range in m
maxV = DopplerFFTSize/2 * dV;                    %Maximum Velocity in Km/hr
```

ADCfs	64e+6
RFBW	300e+6
RFfreq	77e+9
TChirp	16e-6
dR	0.5
dV	0.855
maxR	255.823
maxV	219.004

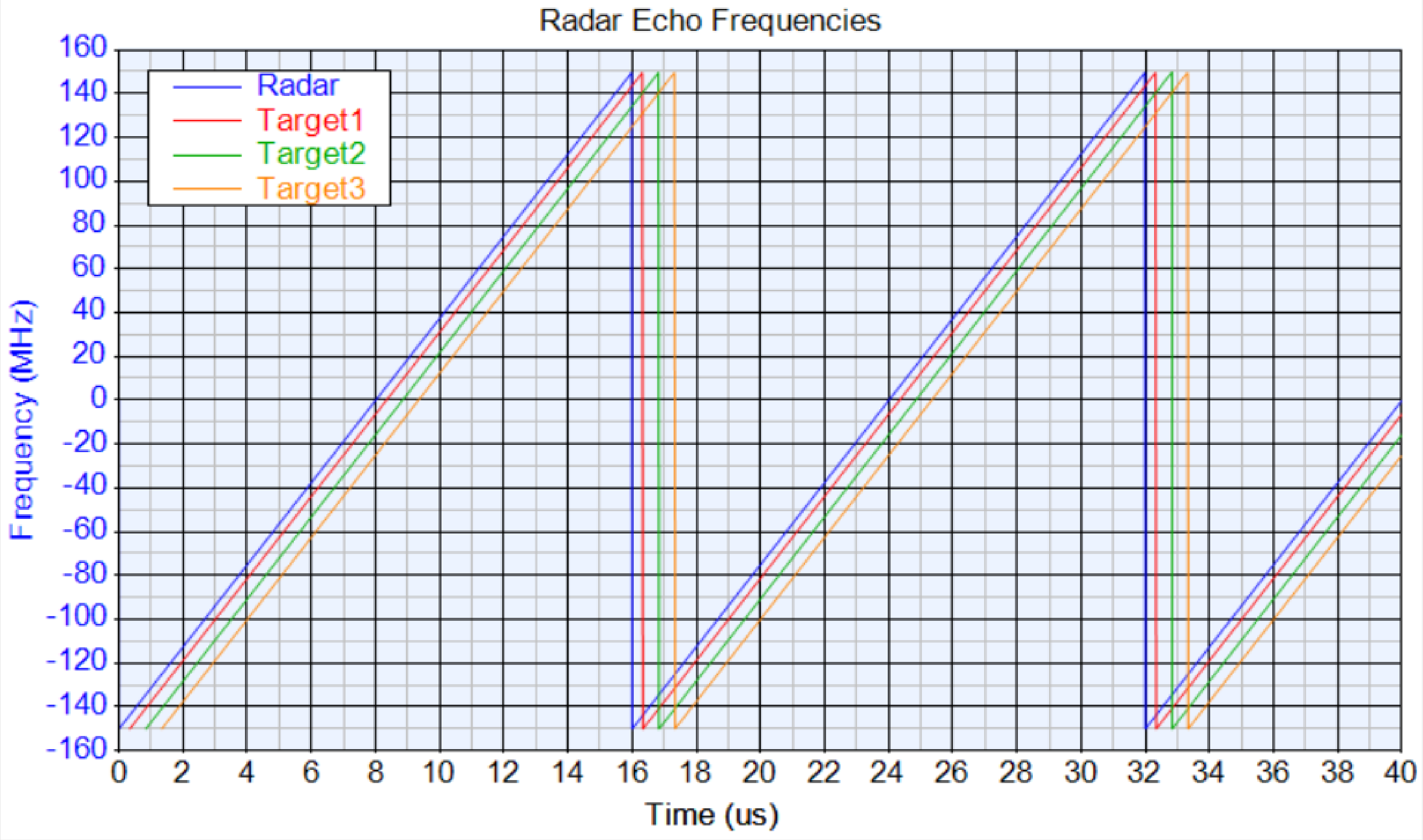
T1_rcs	1
T1_rng	50
T1_spd	1.8
T2_rcs	100
T2_rng	125
T2_spd	-125
T3_rcs	100
T3_rng	200
T3_spd	200

Int1_rng	75
Int1_spd	10



Automotive Radar Design Simulation

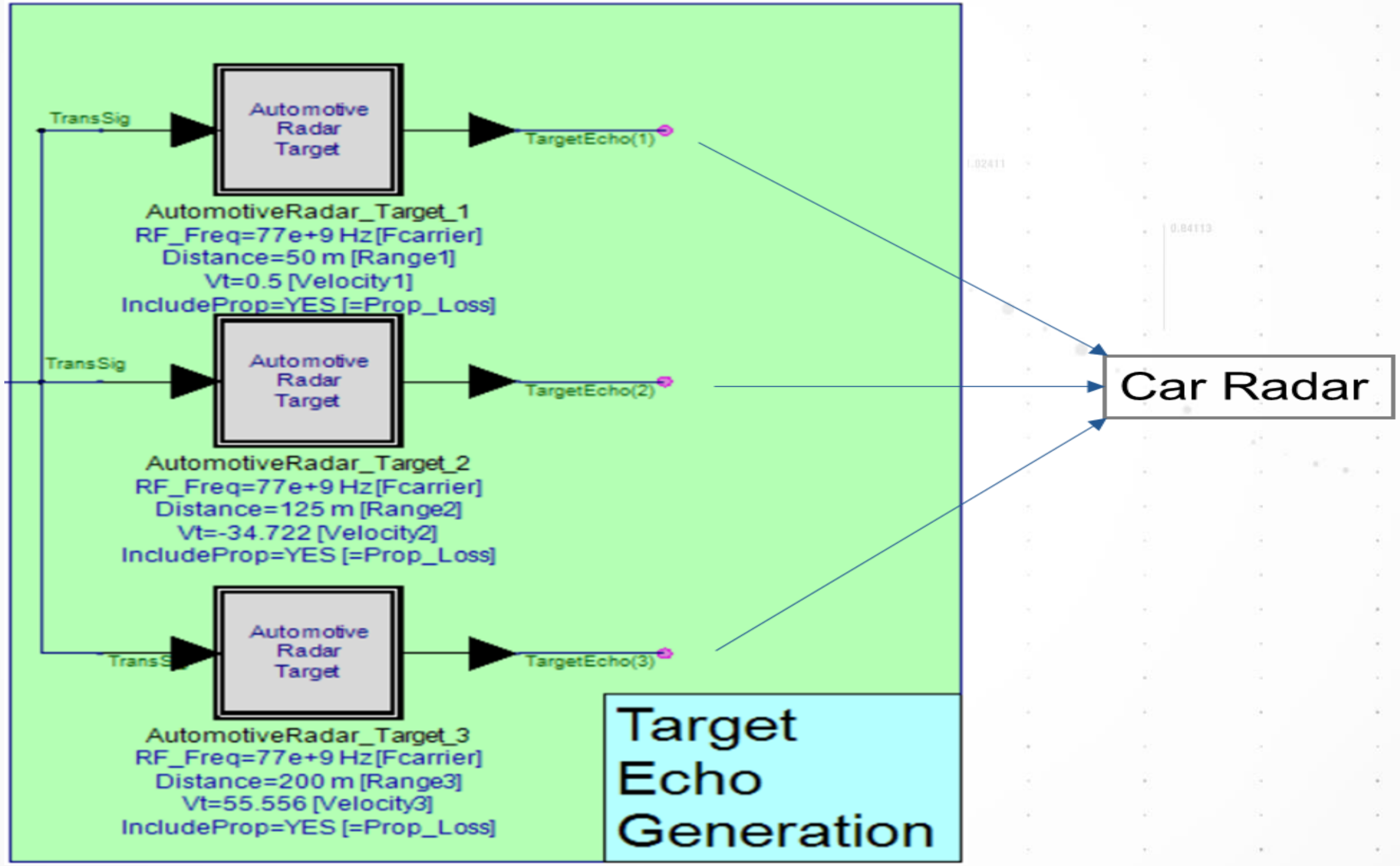
SCENARIO CHIRP FREQUENCIES – RECEIVER INPUT



Radar echoes are easily captured at the input of the receiver.

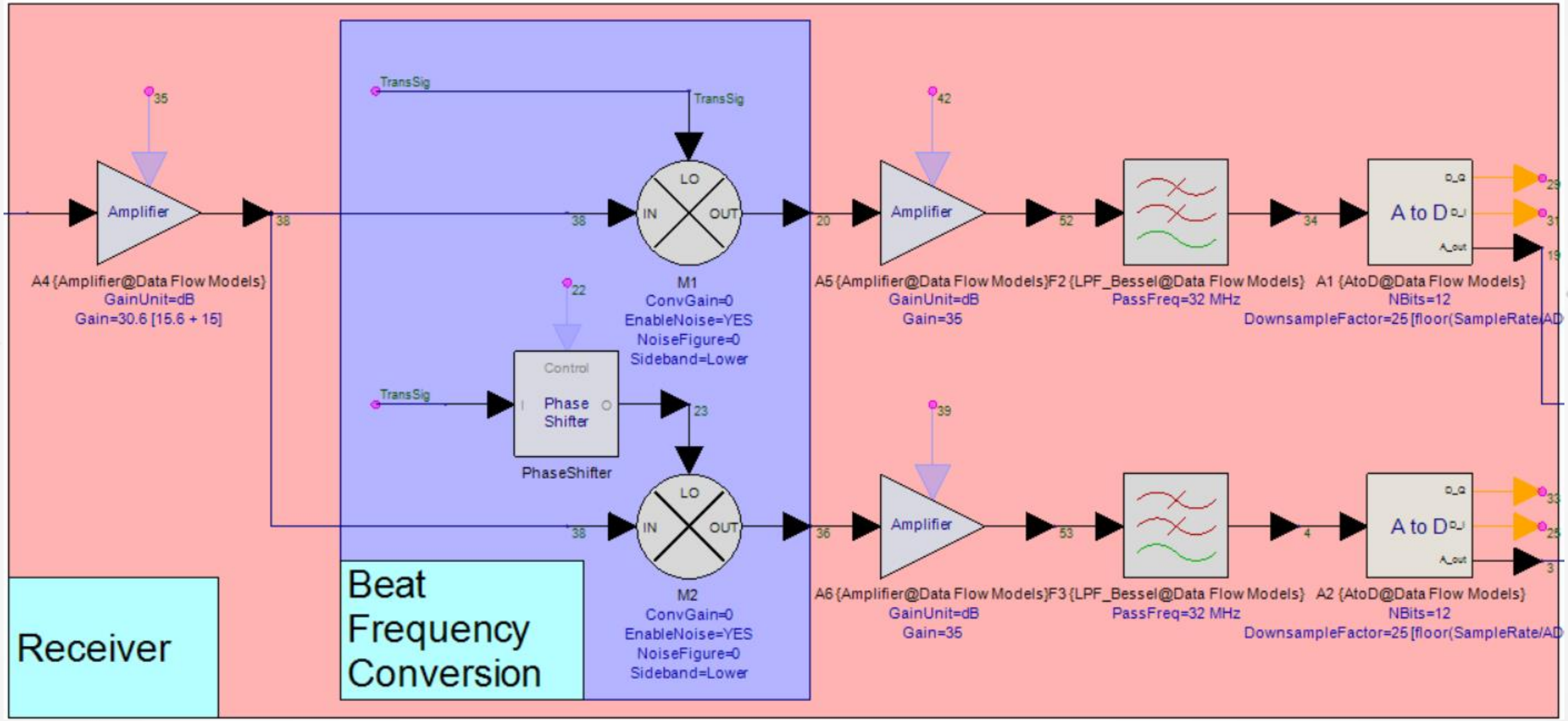
Automotive Radar Design Simulation

TARGET LOCATION AND MOVEMENT



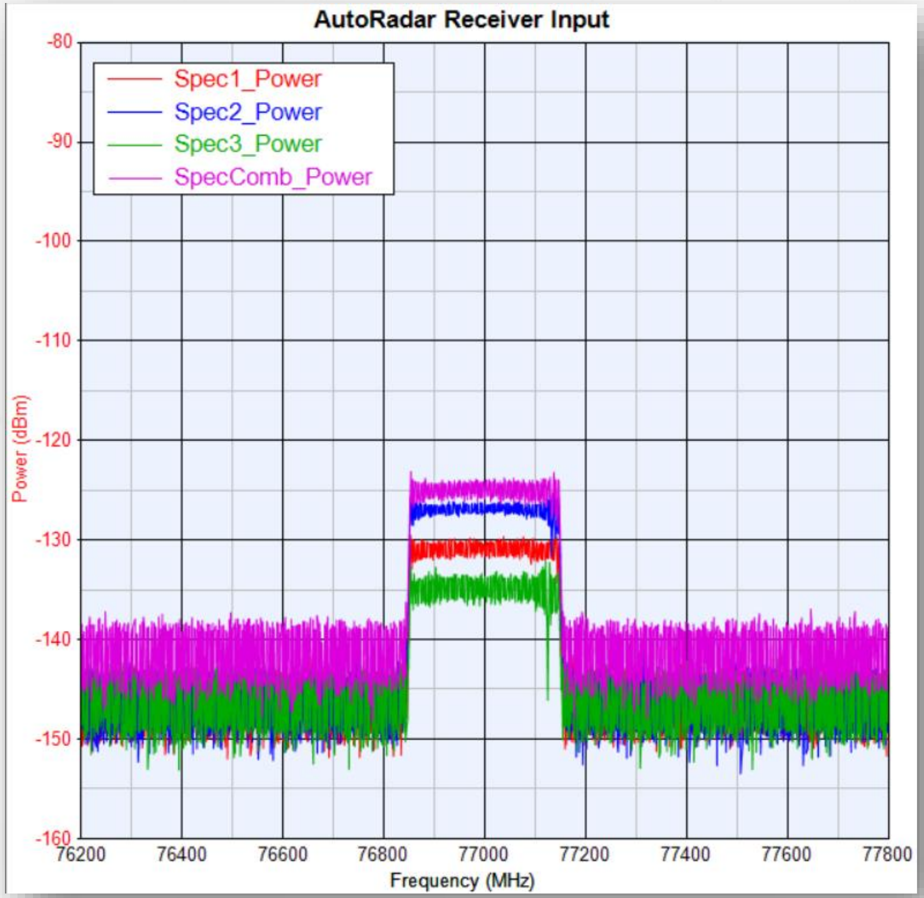
Automotive Radar Design Simulation

RECEIVER DESIGN - ADC OUTPUT

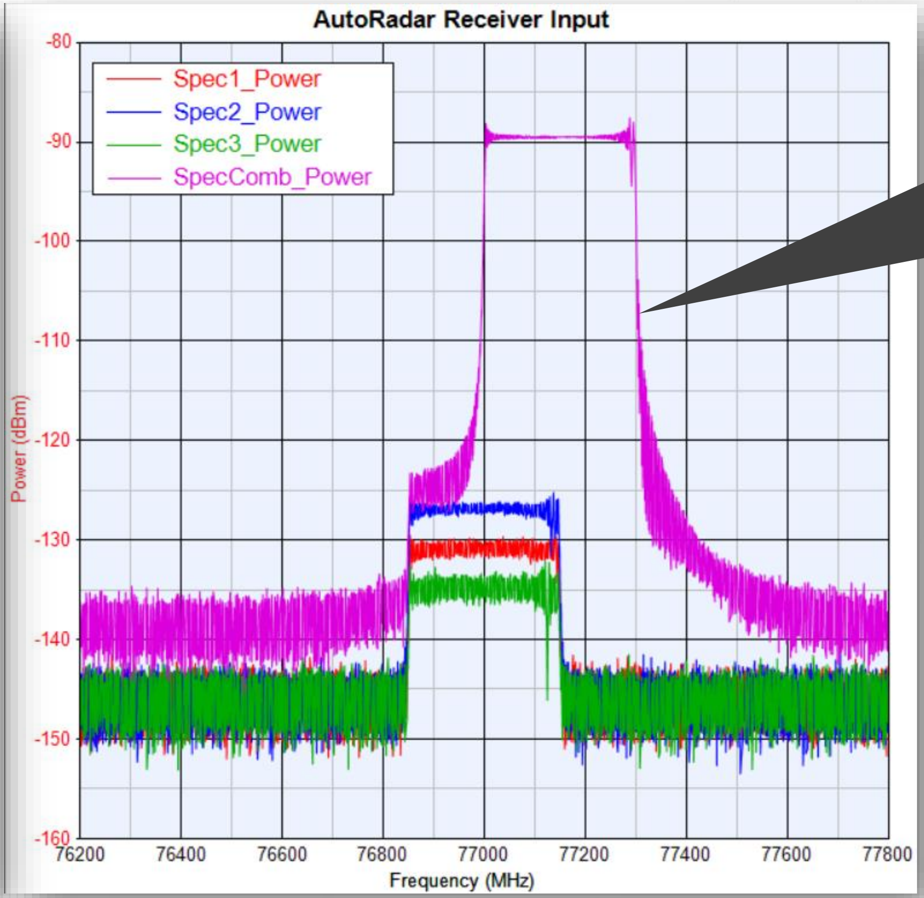


Automotive Radar Design Simulation

SCENARIO RECEIVER INPUT



No Interferer Baseline



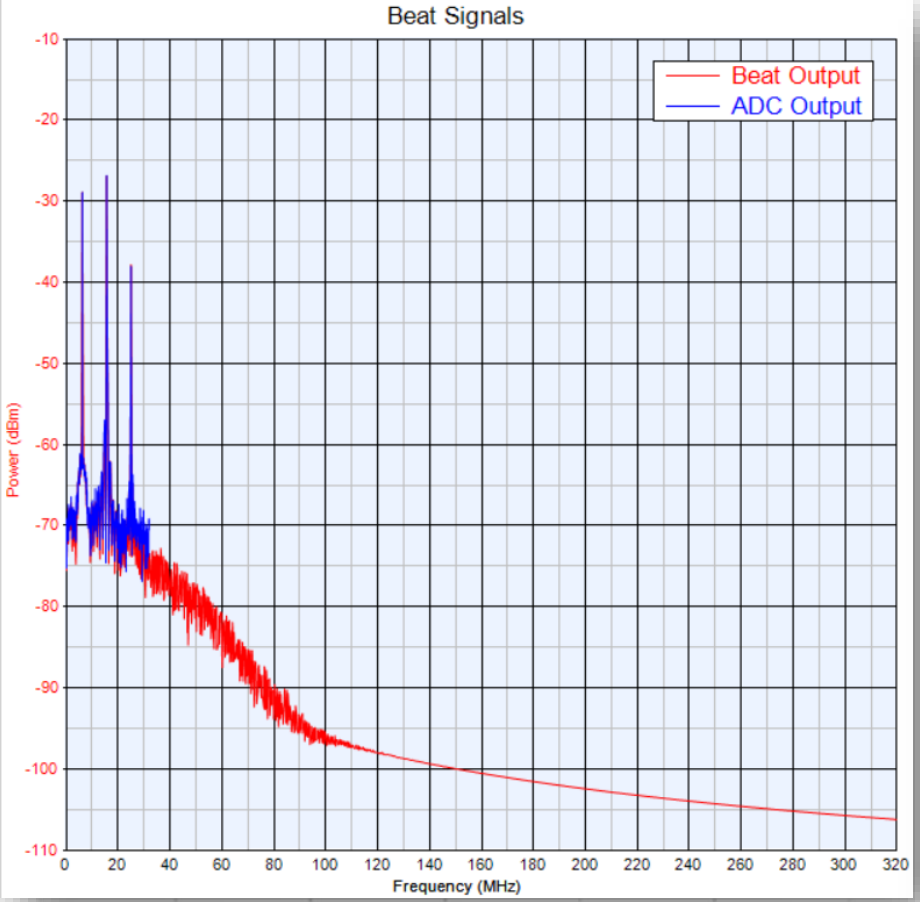
Radar Interferer Present

Interferer can cause RF front end saturation issues and is overtaking the desired Target signals.

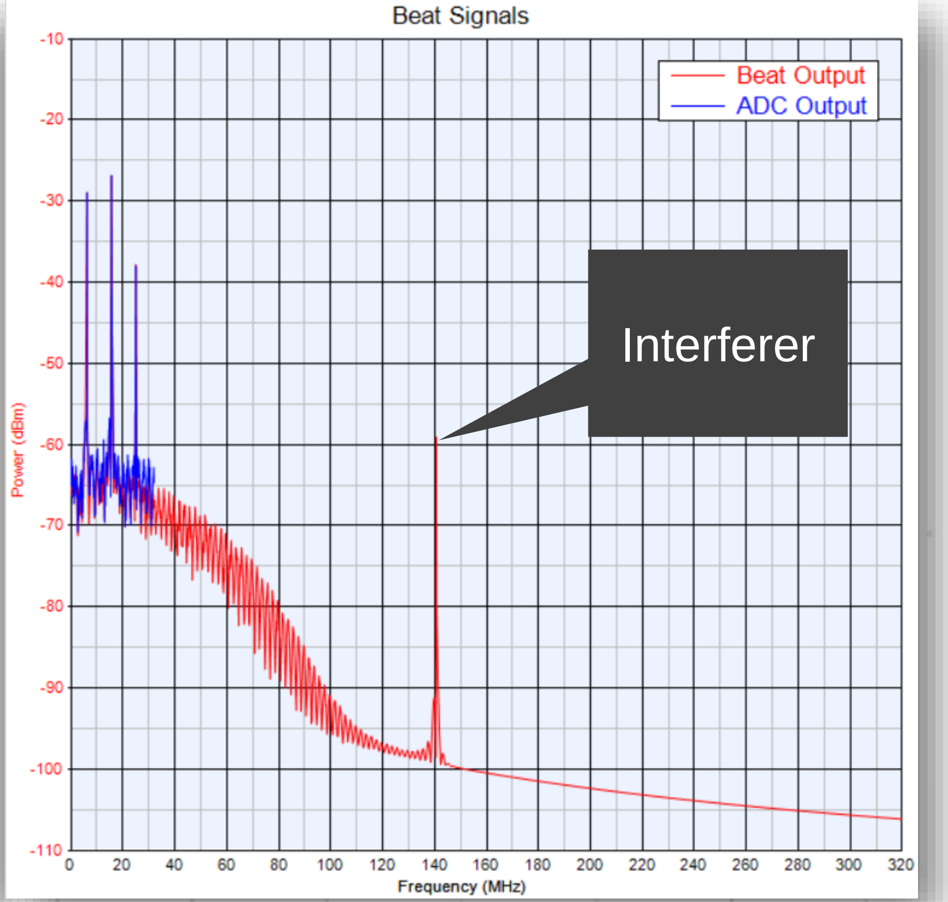
KEYSIGHT TECHNOLOGIES

Automotive Radar Design Simulation

BEAT TONES



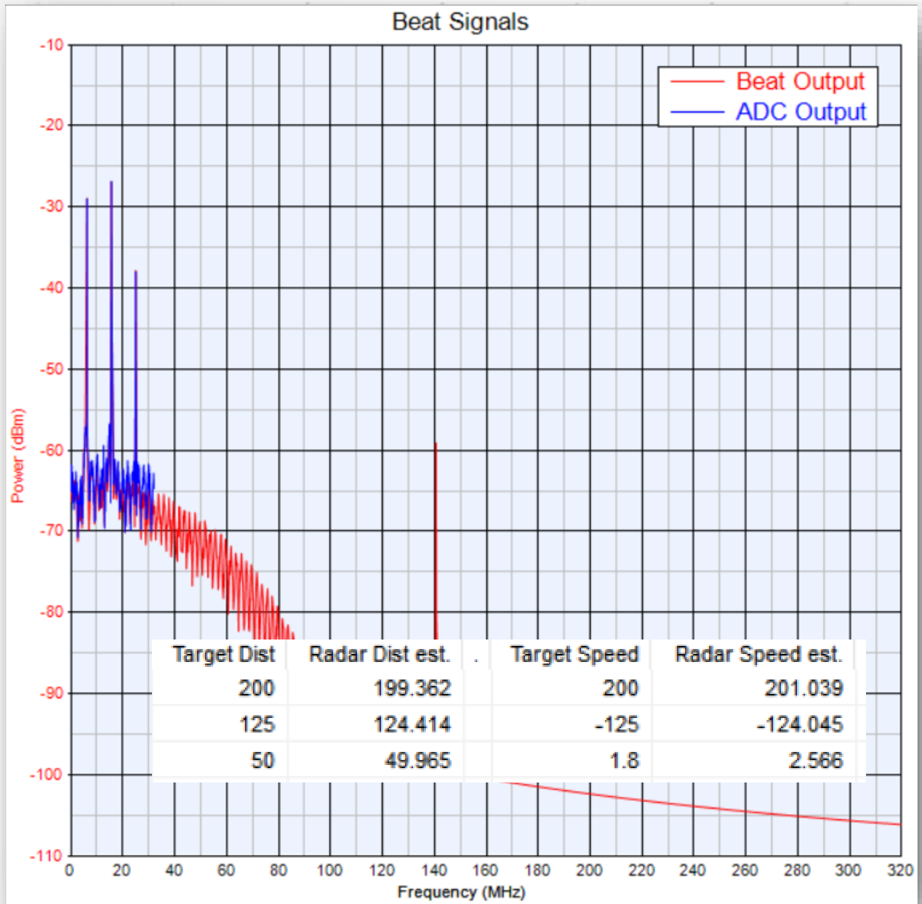
No Interferer Baseline



Radar Interferer Present

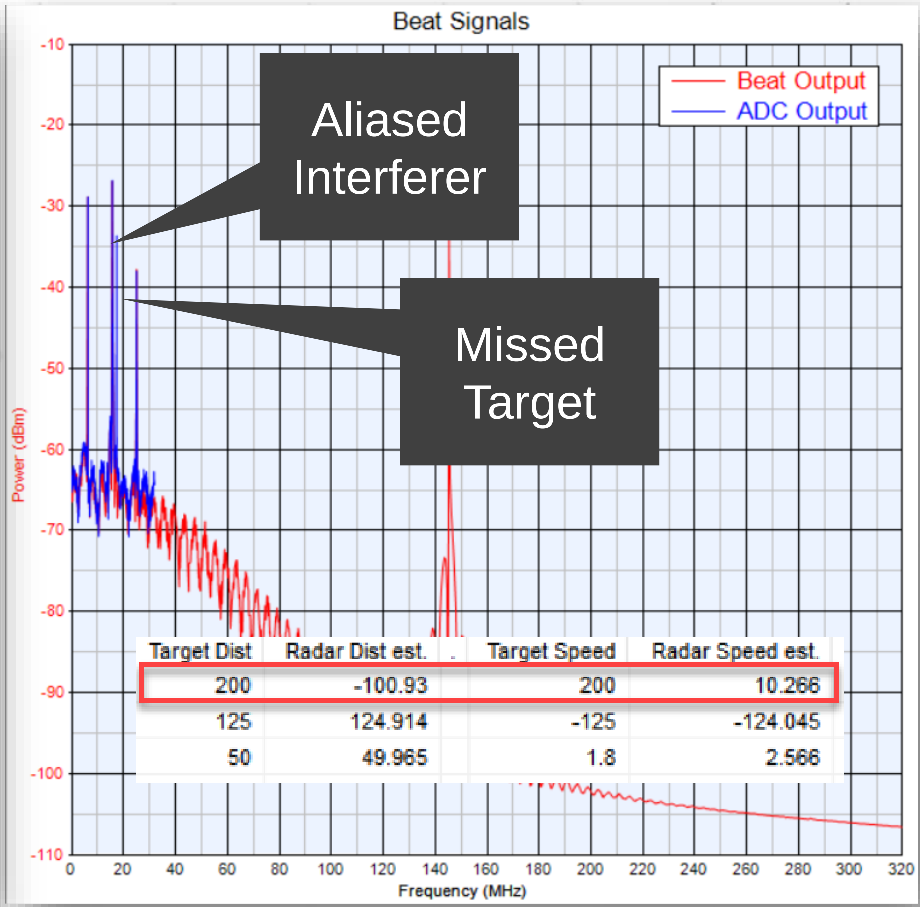
Automotive Radar Design Simulation

BEAT TONES



Target Dist	Radar Dist est.	Target Speed	Radar Speed est.
200	199.362	200	201.039
125	124.414	-125	-124.045
50	49.965	1.8	2.566

ADC pre-Filter properly specified

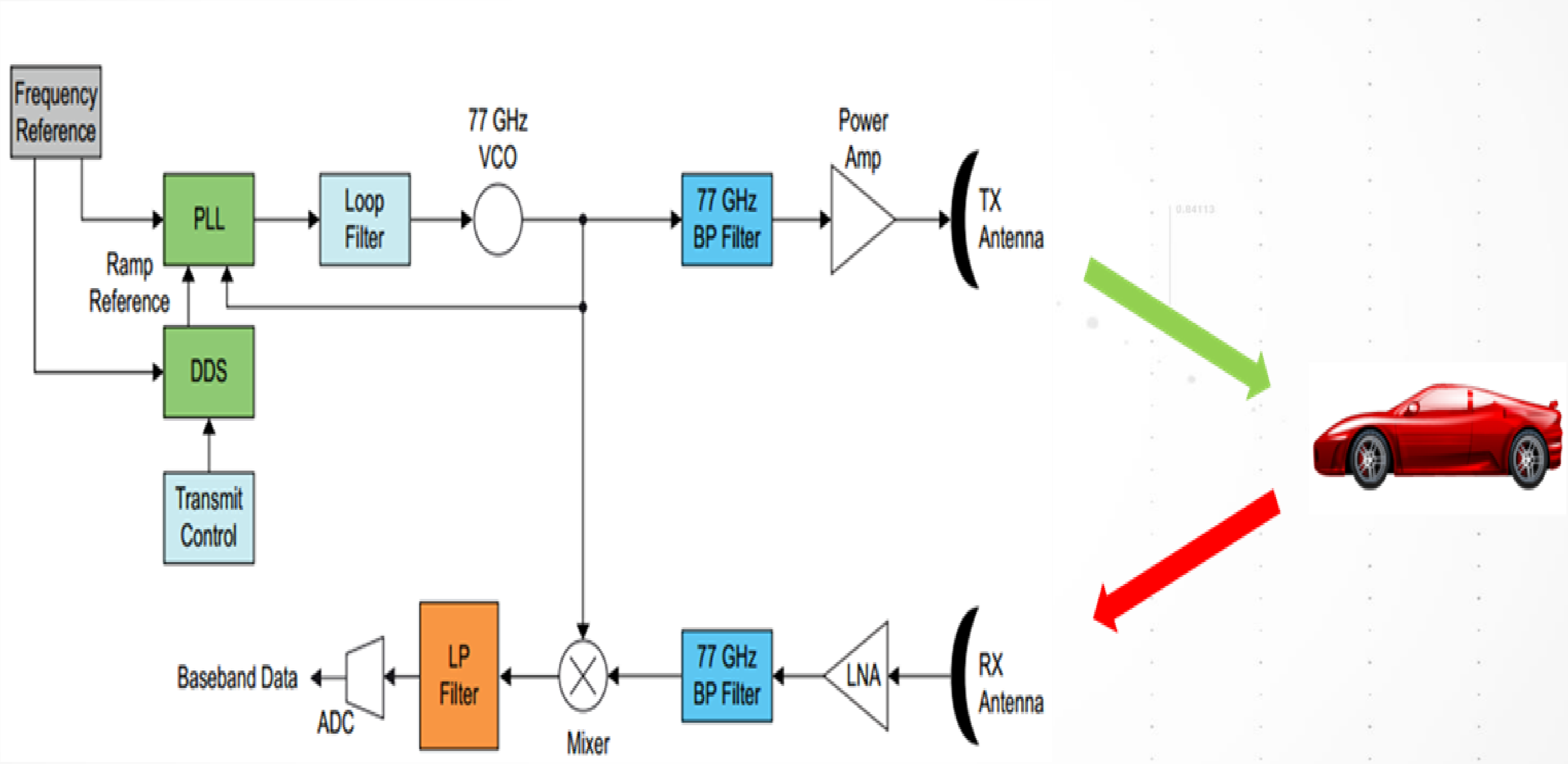


Target Dist	Radar Dist est.	Target Speed	Radar Speed est.
200	-100.93	200	10.266
125	124.914	-125	-124.045
50	49.965	1.8	2.566

ADC pre-Filter does not have enough rejection of the interferer beat tone.

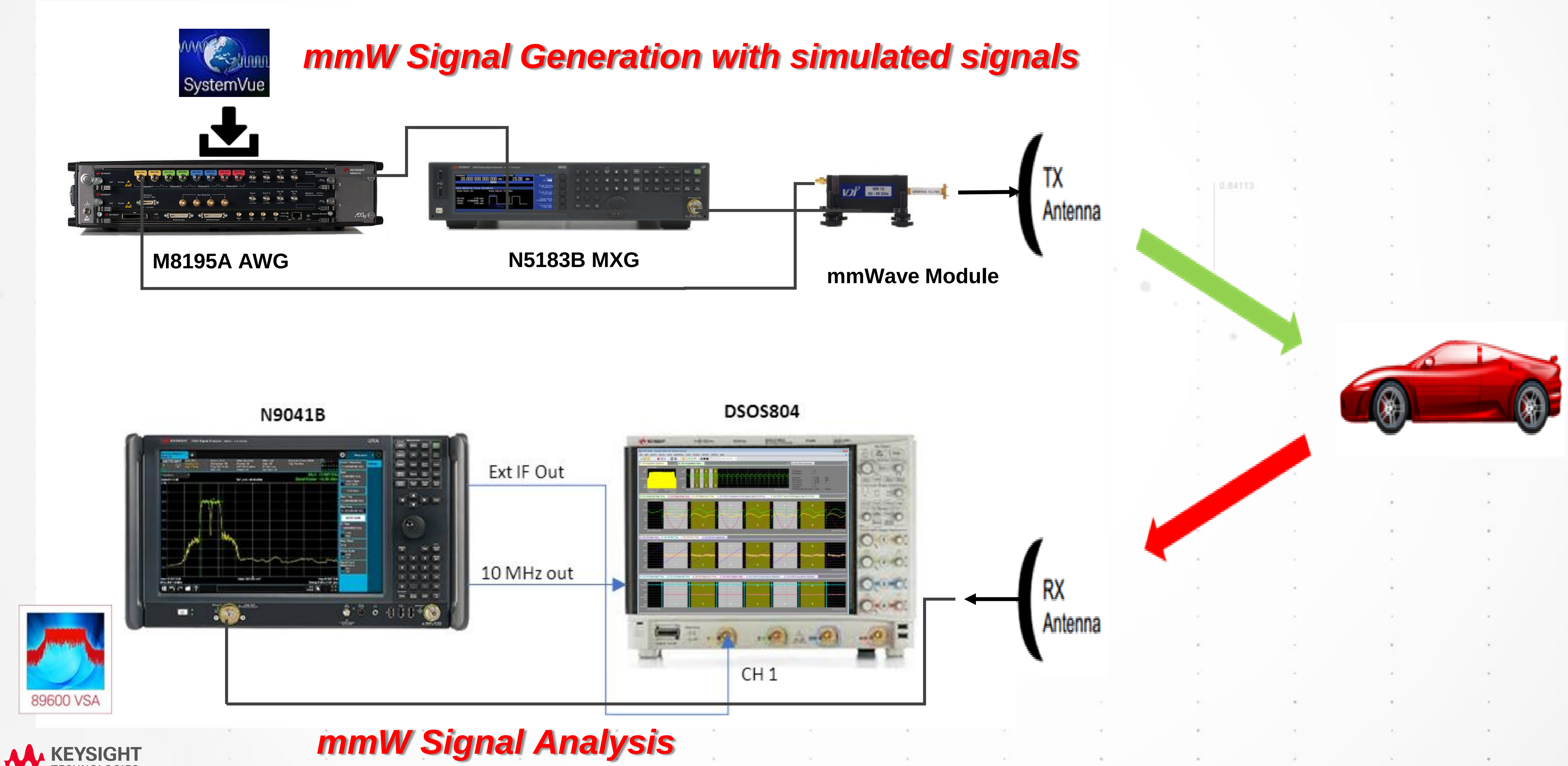
Automotive Radar Development

MILLIMETER WAVE TEST SET UP EXAMPLE



Automotive Radar Development

MILLIMETER WAVE TEST SET UP EXAMPLE

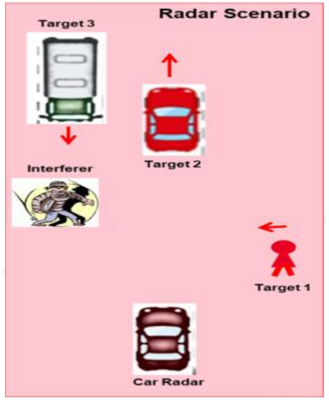


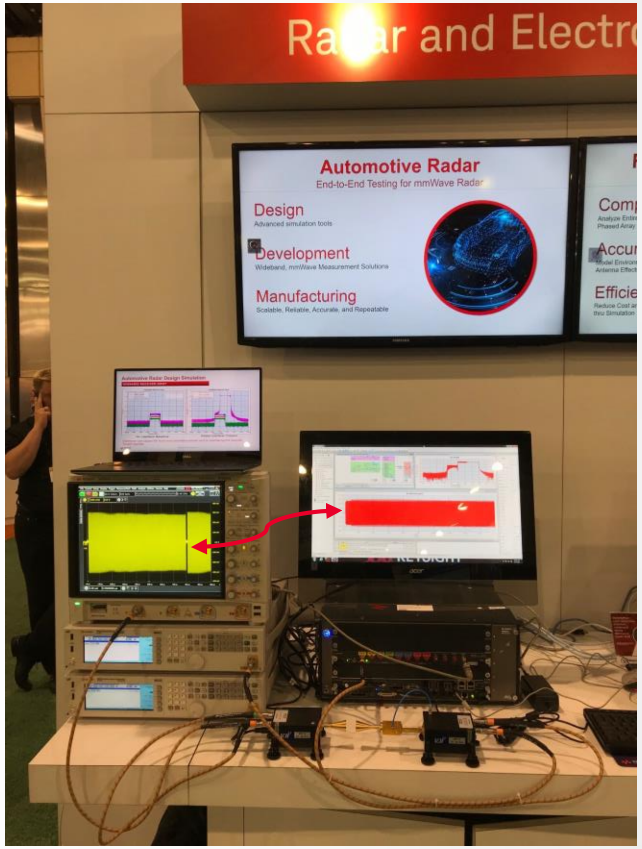
Automotive Radar Development

Value of Keysight #2

SIMULATION AND MEASUREMENT CONNECTED SOLUTION

- Unique 79GHz FMCW automotive radar simulation and measurement connected solution consists of W1908 SystemVue and Keysight AES HW
- Real-time comparison of 24 / 77 / 79 GHz FMCW automotive radar simulation result and test result to help automotive radar engineers to bring their design to market faster and safer

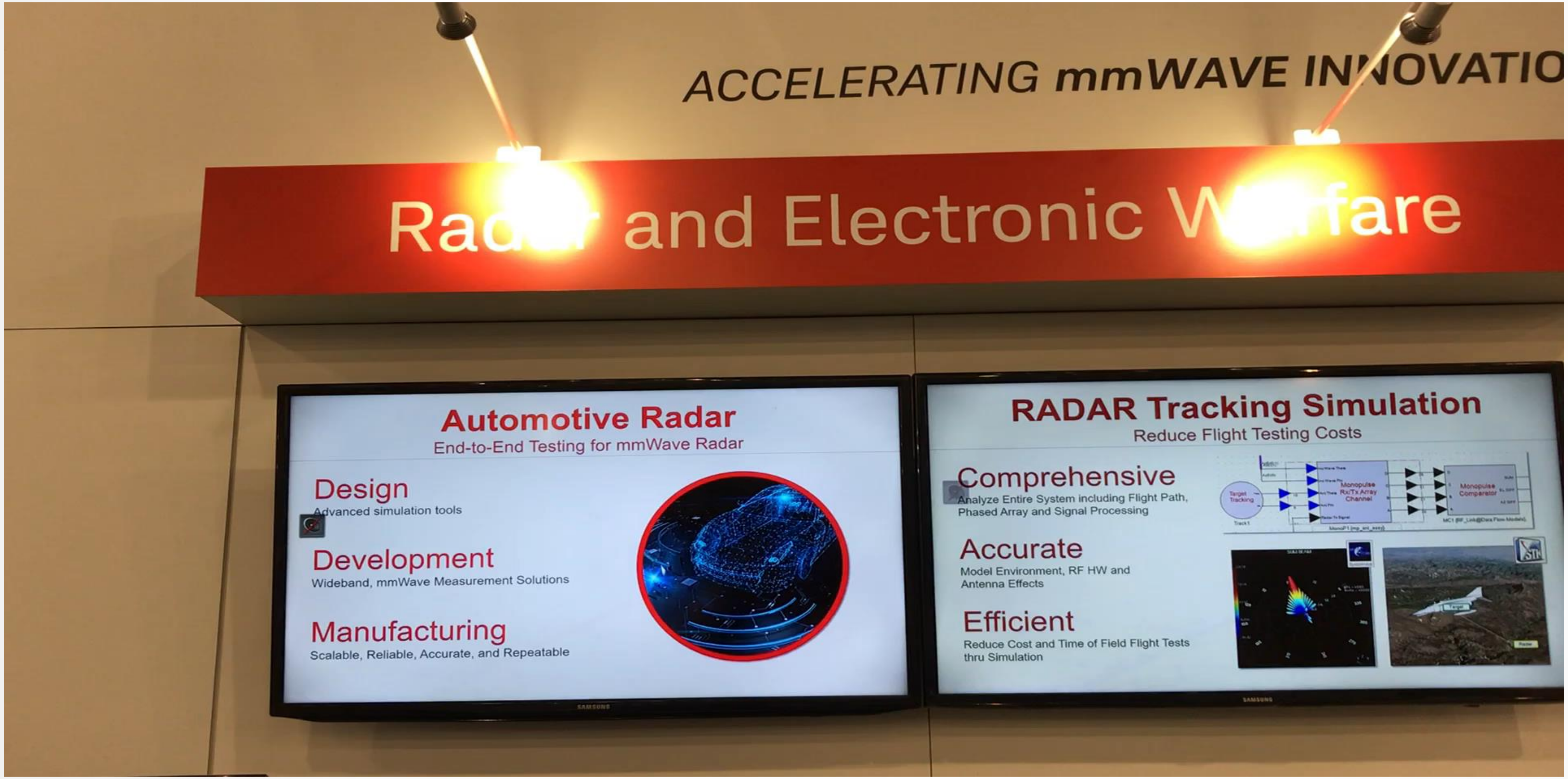


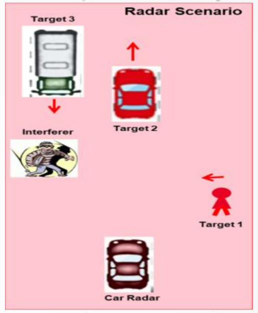


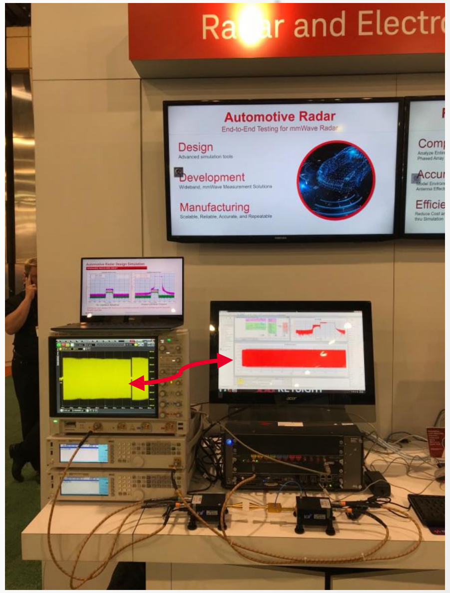
Automotive Radar Development

SIMULATION AND MEASUREMENT CONNECTED SOLUTION

Value of Keysight #2



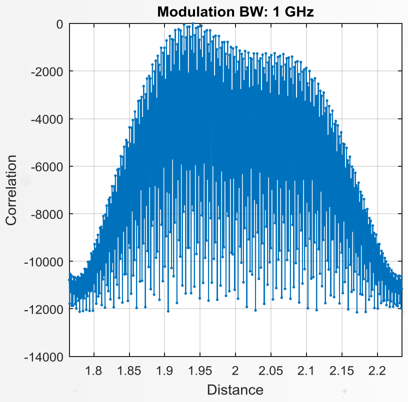


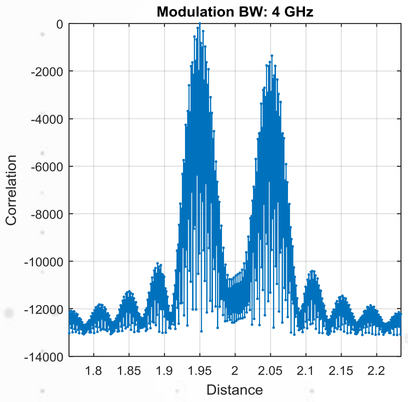


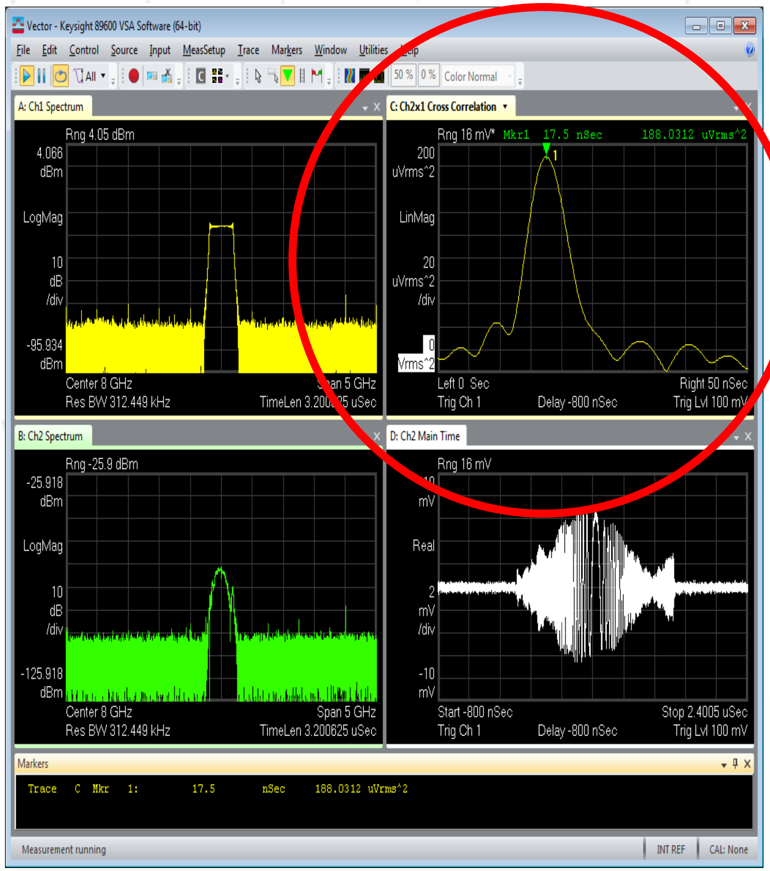
Automotive Radar Development

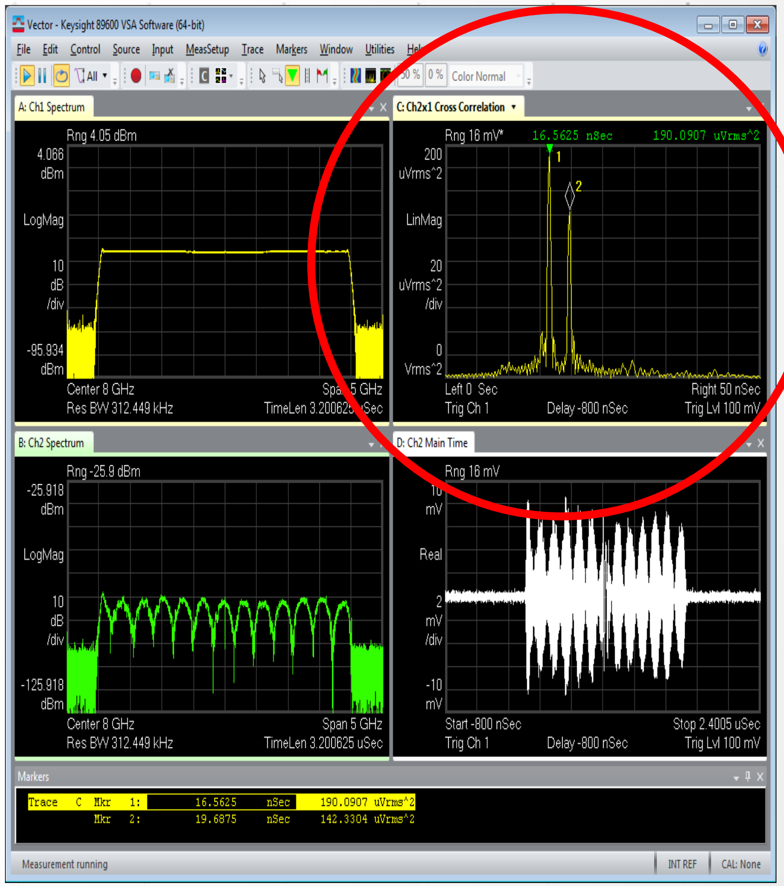
SIMULATION AND TEST RESULTS

- Two objects, 10 cm apart, FMCW, 1 GHz and 4 GHz modulation bandwidths
- Simulation result (left) and Measurement result (right)







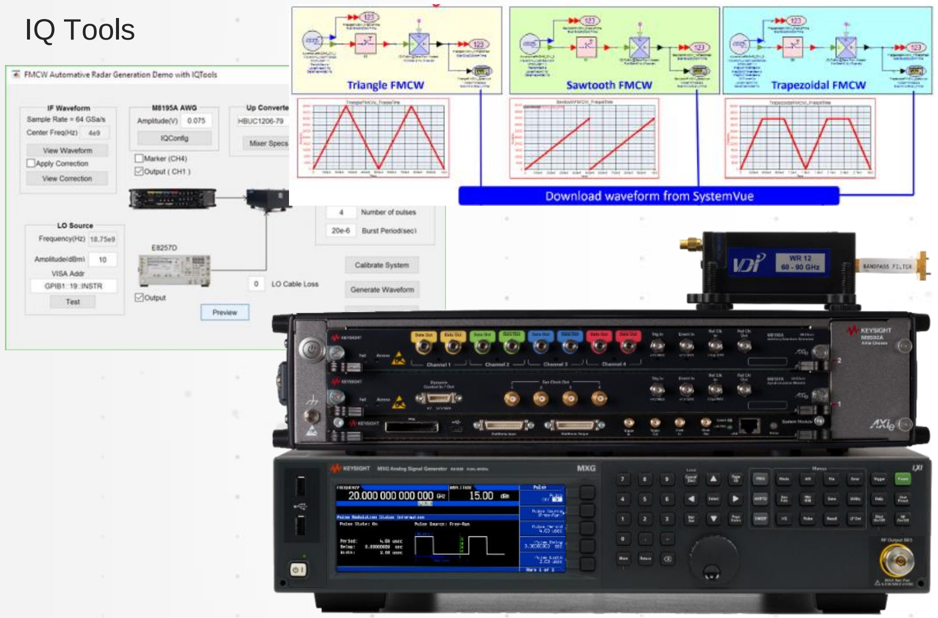


Automotive Radar Development

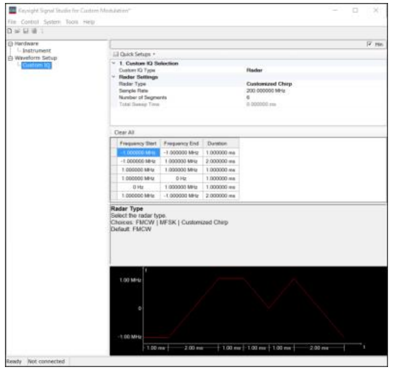
FLEXIBLE AND COMPLEX MODULATION SIGNAL GENERATION

IQ Tools

W1908 SystemVue Auto Radar Library



N7608C Signal Studio



Parameters	E8740A-070 Performance SG
Frequency Range	DC to 25GHz, 60GHz to 90GHz
Signal Bandwidth for IF/RF	IF/RF up to 25GHz
3dB Bandwidth for mmW	5GHz for FMCW @ 79GHz Fc (with correction)
Pout1dB	-14.6dBm@76GHz -13.5dBm@79GHz
Amplitude flatness (at SMA connector,* compensated for sin(x)/x)	±2 dB (typ), fout= DC to 10 GHz +2 dB, -3 dB (typ), fout = 10 to 25 GHz (typ)
Amplitude resolution	200uV (nom)
DAC resolution	8Bit
AWG Sample rate	13.44 GSa/s to 65GSa/s
Sample Memory (Internal / extended)	1 MSa / 16GSa
Frequency Switching time	505us / 38ps (opt FSW)
MIMO and beam forming	Expandable to 16 synchronized channels
mmW Modulation signals	FM, PM, FMCW, pulse sequence, MFSK, custom OFDM,……

*Measured at Data Out.

Key Features

- Download Radar FMCW signals from either: SystemVue, *IQ Tools, Signal Studio, or others*
- Generate ideal reference signals (replace Tx LO / VCO)
- Generate interferer, clutter, jamming test signals (Rx Test)

KEYSIGHT TECHNOLOGIES

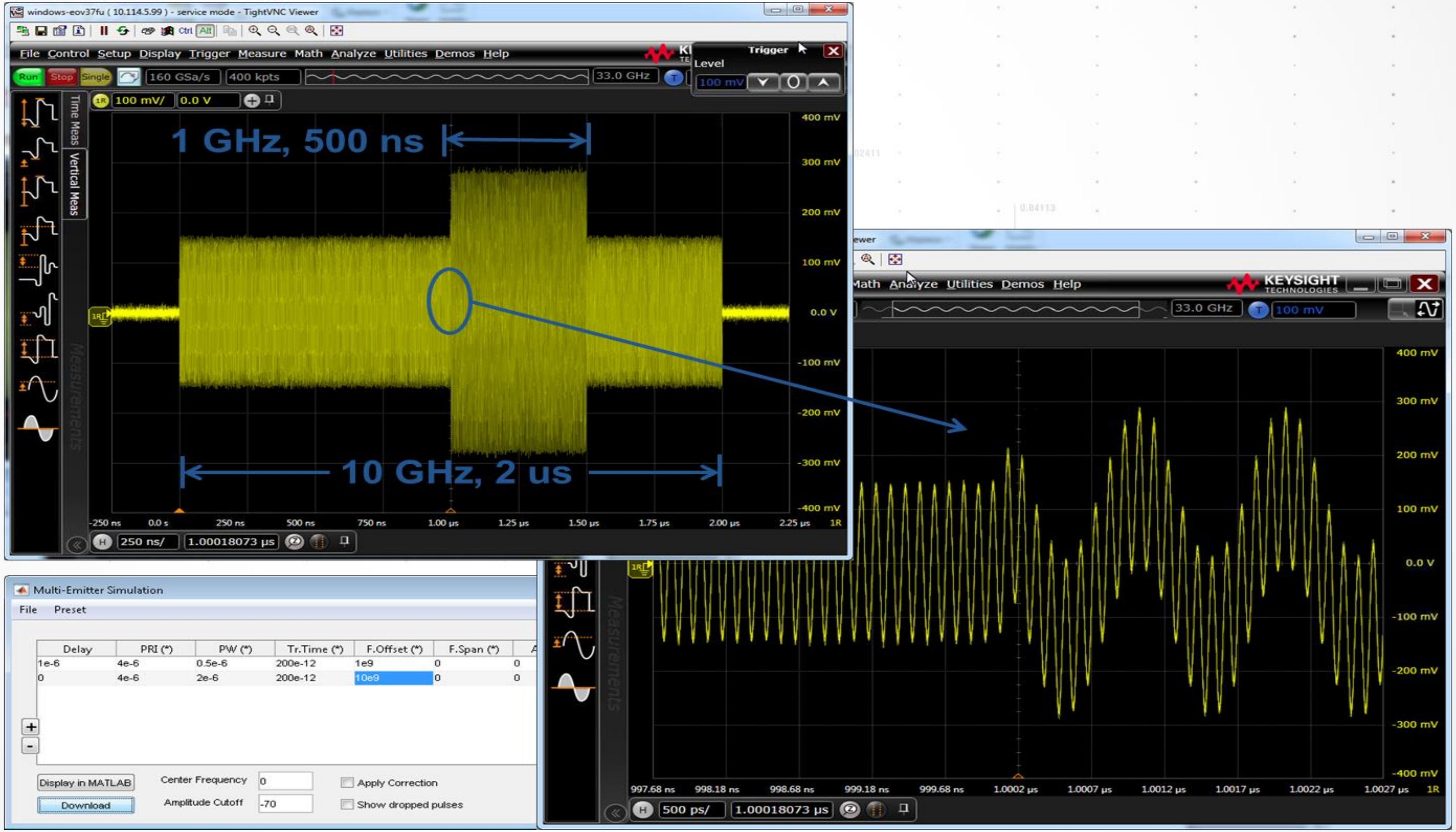
Automotive Radar Development

BENEFITS OF HIGH-SPEED ARBITRARY WAVEFORM GENERATOR

High Speed AWG functionality	Benefit for Radar Testing
Extremely **wide modulation bandwidth** (e.g. DC to 32 GHz)	**Discern targets** that are close together **Finer resolution** of a given object
Instantaneous **frequency hopping** **Overlapping pulses** at different frequencies	**Realistic simulation** of multiple emitters that are transmitting simultaneously
Phase-coherent, **multi-emitter, multi-channel** pulse generation	**Economical setup** to for testing multi-channel radar receivers (e.g. DOA)
Repeatable phase from pulse-to-pulse and channel-to-channel, perfect frequency ramps	**Repeatable** test results
Flexible modulation formats	Develop new modulation schemes that are more **tolerant to interference**
No **images** or **carrier feedthrough.** **Flat magnitude- and phase response** (after calibration)	Testing your device and not the instrument!

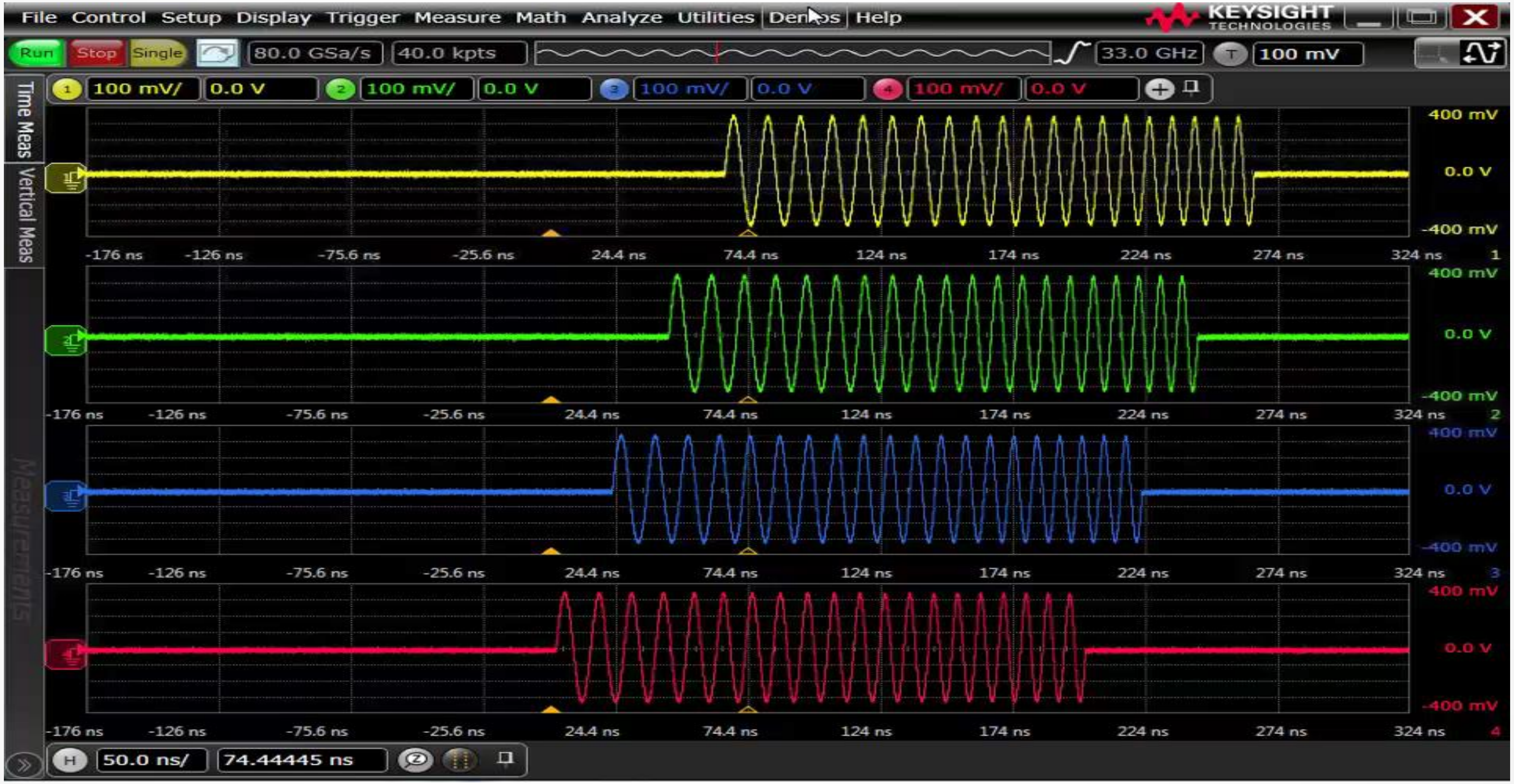
Automotive Radar Development

OVERLAPPING PULSES AT DIFFERENT FREQUENCIES



Automotive Radar Development

SYNCHRONIZED MULTI-CHANNEL PULSE GENERATION

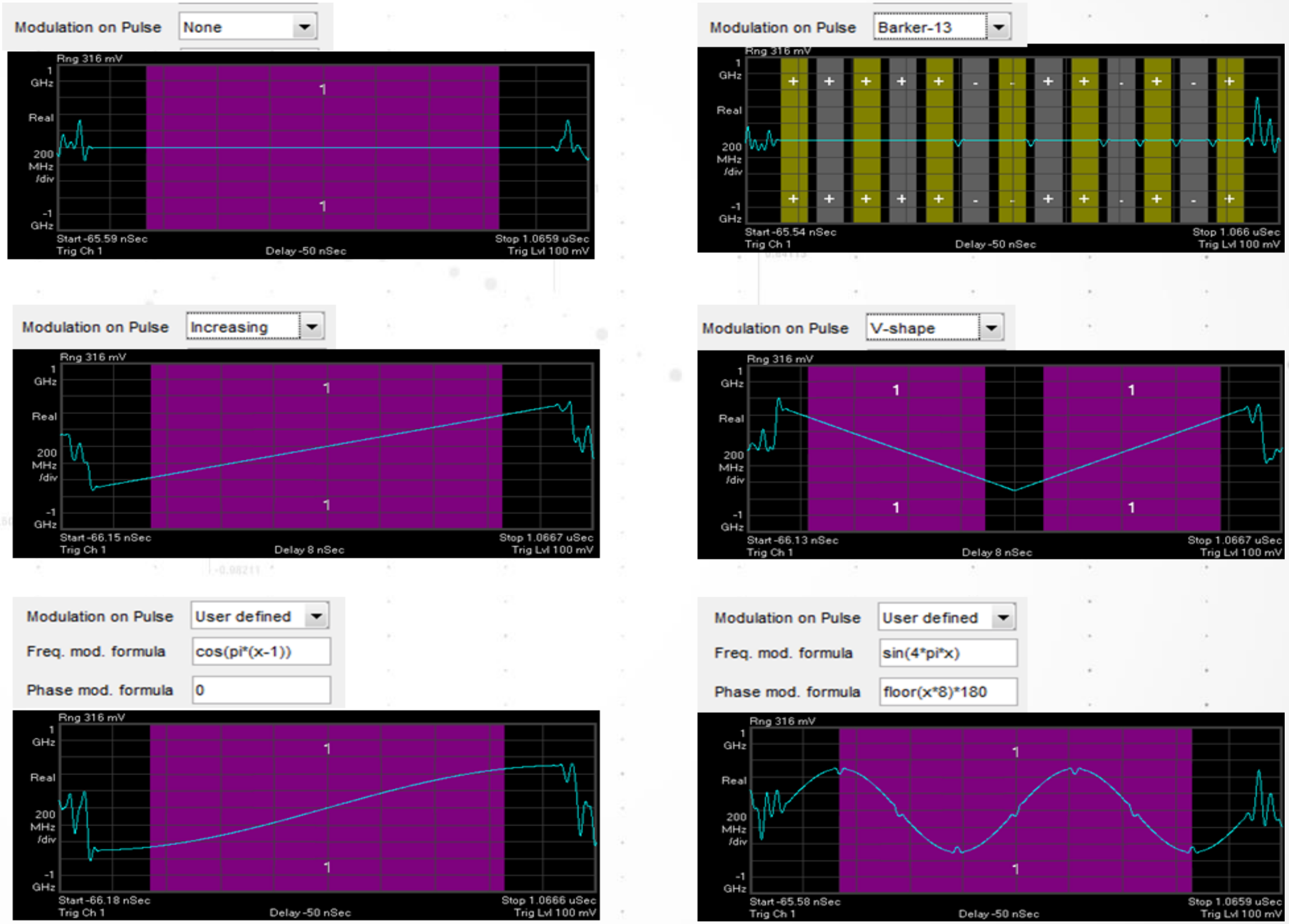


Click here to start animation

Automotive Radar Development

FLEXIBLE MODULATION FORMATS

- Any mathematical expression can be used to describe the modulation on the pulse including CW, FMCW, LFM chirp, Barker, non-linear chirp, user-defined frequency- and phase modulation



Automotive Radar Development

INDUSTRY'S MOST POWERFUL AUTOMOTIVE RADAR SIGNAL ANALYSIS

E8740A-060 Performance SA

Key Features

With N9041B UXA

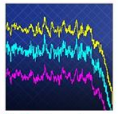
- Continuous Freq sweep 3Hz~ 110GHz
- 5GHz BW (with external oscilloscope)
- Up to 1GHz internal BW with adding opt H1G
- -150dBm/Hz DANL up to 110 GHz
- Dual input rugged 2.4mm and 1mm connector
- 50M RBW with adding opt H1G and opt RBE
- RF Power, Harmonic and spurious, Spectrum Emissions, OBW, Frequency Stability
- Phase Noise with N9068C
- Noise Figure with N9069C and opt P50 at input port 1 (up to 50GHz)

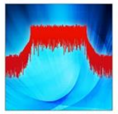
With DSOS804A Scope and VSA s/w

- 10 Bit ADC up to 8GHz bandwidth with minimum resolution : 0.781 mV) 4x better resolution than RTO 8 bit ADC
- Analog/Digital I/Q input

Key Measurements

- RF Power
- Spectrum Emissions
- Phase Noise
- Frequency Stability
- Modulation Quality


X-Series Apps


89600 VSA

1st — 3 Hz - **110 GHz** Continuous sweeps

1st — **5 GHz BW** (with external oscilloscope)

1st — Up to **1 GHz internal** BW

1st — **-150 dBm/Hz** DANL up to 110 GHz

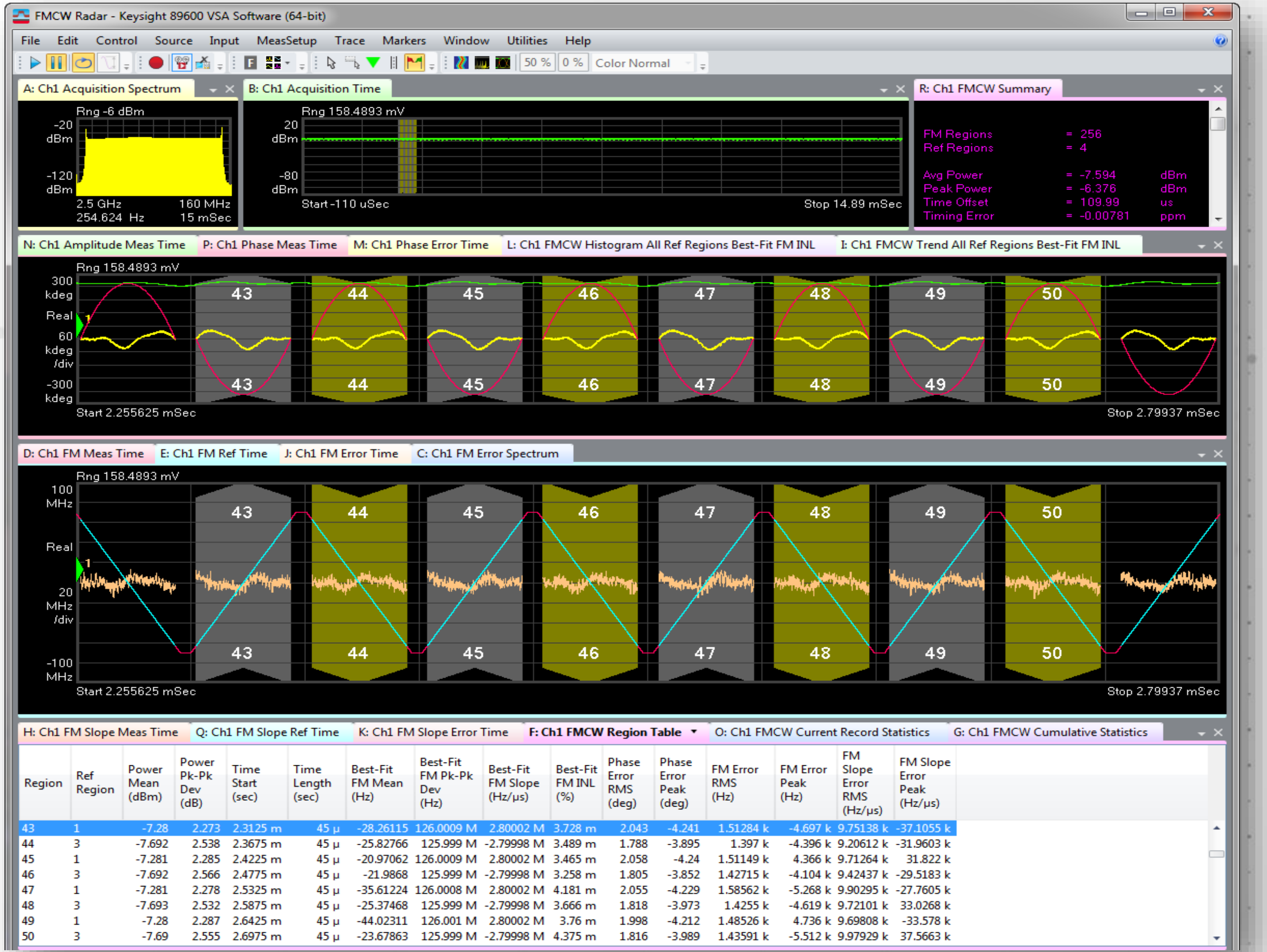
1st — Dual input **rugged 2.4 mm** and 1 mm connector

Automotive Radar Development

FLEXIBLE FMCW SIGNAL ANALYSIS IN SPECTRUM & TIME DOMAINS

89600 VSA Key Features:

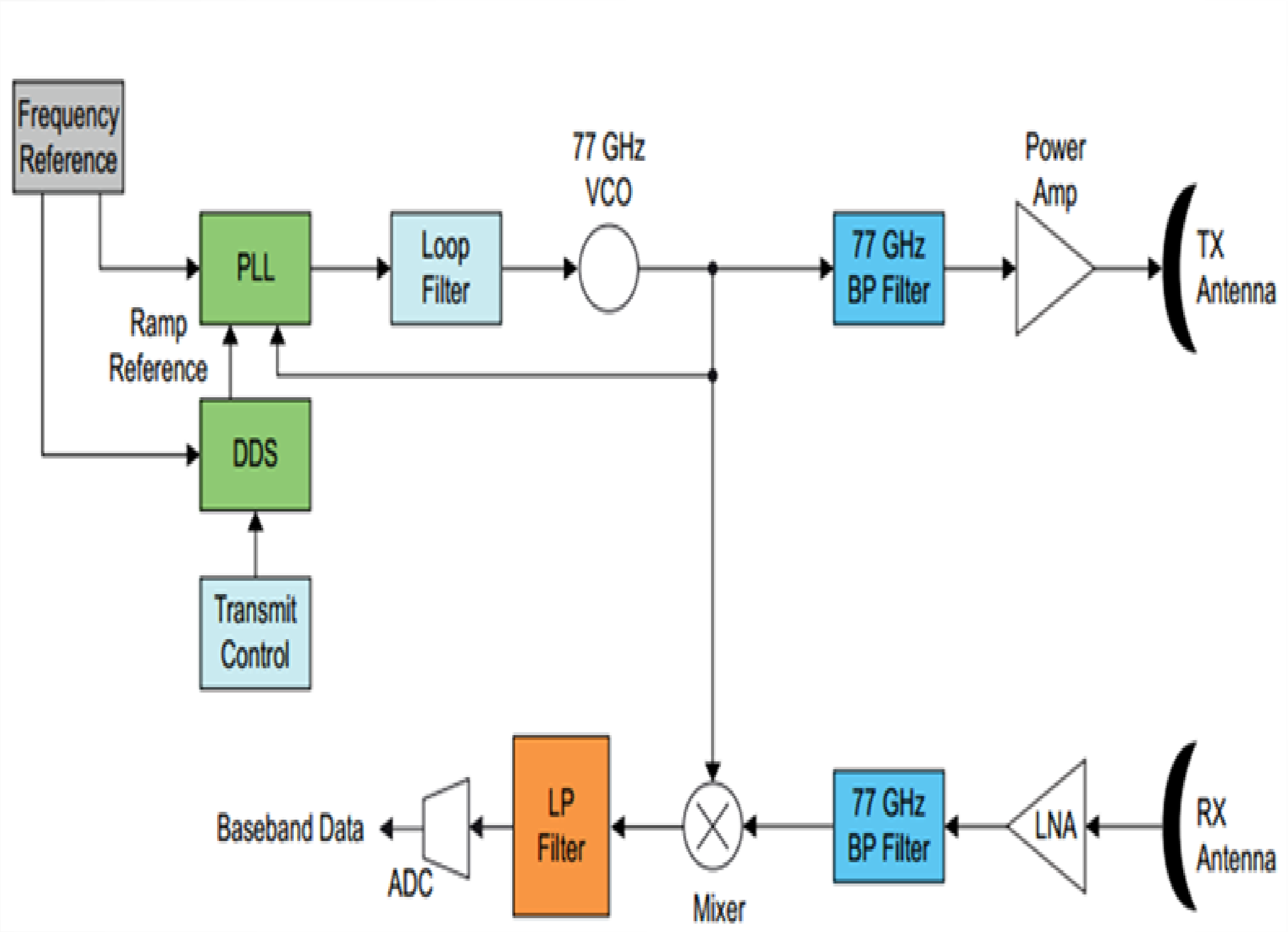
- **Automatically synchronize** to **FMCW radar signals** comprised of multi-chirp linear FM modulation patterns.
- Synchronized **Amplitude** & **Phase**
- Synchronized **Frequency (FM)** Modulation
- FMCW Region Tabular metrics
  - **Power** and **Time**
  - **Best-Fit FM**
  - **Phase Error**
  - **FM Error**
  - **FM Slope Error**



Region	Ref Region	Power Mean (dBm)	Power Pk-Pk Dev (dB)	Time Start (sec)	Time Length (sec)	Best-Fit FM Mean (Hz)	Best-Fit FM Pk-Pk Dev (Hz)	Best-Fit FM Slope (Hz/μs)	Best-Fit FM INL (%)	Phase Error RMS (deg)	Phase Error Peak (deg)	FM Error RMS (Hz)	FM Error Peak (Hz)	FM Slope Error RMS (Hz/μs)	FM Slope Error Peak (Hz/μs)
43	1	-7.28	2.273	2.3125 m	45 μ	-28.26115	126.0009 M	2.80002 M	3.728 m	2.043	-4.241	1.51284 k	-4.697 k	9.75138 k	-37.1055 k
44	3	-7.692	2.538	2.3675 m	45 μ	-25.82766	125.999 M	-2.79998 M	3.489 m	1.788	-3.895	1.397 k	-4.396 k	9.20612 k	-31.9603 k
45	1	-7.281	2.285	2.4225 m	45 μ	-20.97062	126.0009 M	2.80002 M	3.465 m	2.058	-4.24	1.51149 k	4.366 k	9.71264 k	31.822 k
46	3	-7.692	2.566	2.4775 m	45 μ	-21.9868	125.999 M	-2.79998 M	3.258 m	1.805	-3.852	1.42715 k	-4.104 k	9.42437 k	-29.5183 k
47	1	-7.281	2.278	2.5325 m	45 μ	-35.61224	126.0008 M	2.80002 M	4.181 m	2.055	-4.229	1.58562 k	-5.268 k	9.90295 k	-27.7605 k
48	3	-7.693	2.532	2.5875 m	45 μ	-25.37468	125.999 M	-2.79998 M	3.666 m	1.818	-3.973	1.4255 k	-4.619 k	9.72101 k	33.0268 k
49	1	-7.28	2.287	2.6425 m	45 μ	-44.02311	126.001 M	2.80002 M	3.76 m	1.998	-4.212	1.48526 k	4.736 k	9.69808 k	-33.578 k
50	3	-7.69	2.555	2.6975 m	45 μ	-23.67863	125.999 M	-2.79998 M	4.375 m	1.816	-3.989	1.43591 k	-5.512 k	9.97929 k	37.5663 k

Automotive Radar Manufacturing

SOLUTION

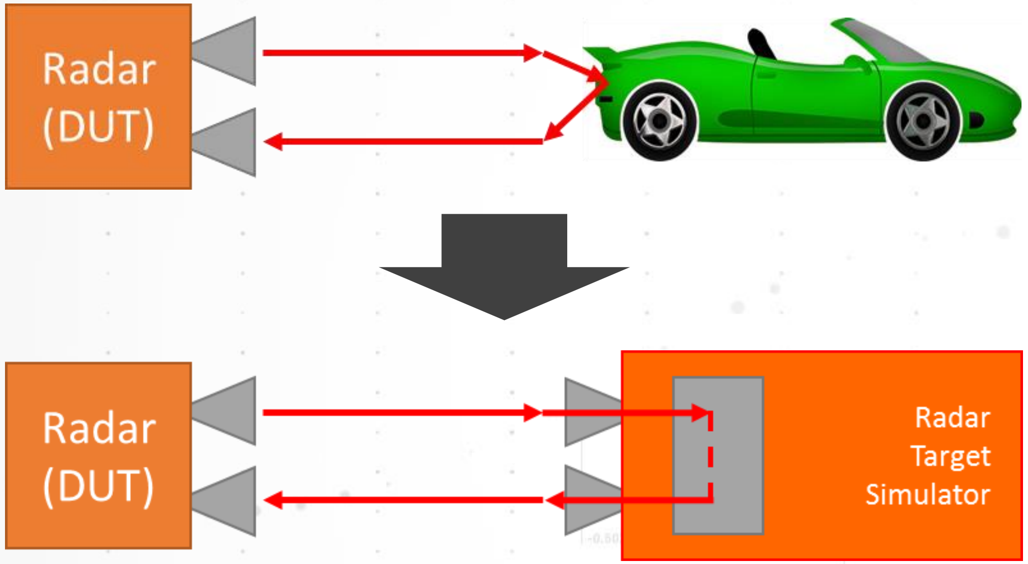


Tx Power
OBW
Linearity
Phase Noise
Timing
…

Sensitivity,
Immunity against Interferers,
DSP processing validation
…

Automotive Radar Manufacturing

RADAR TARGET SIMULATOR (RTS) BASIC FUNCTIONALITY



1 meter min. physical distance

Basic Functionality

1) Radar DUT signal is received
2) Signal is manipulated in the Radar Target Simulator
3) Signal is then re-transmitted back to the Radar DUT

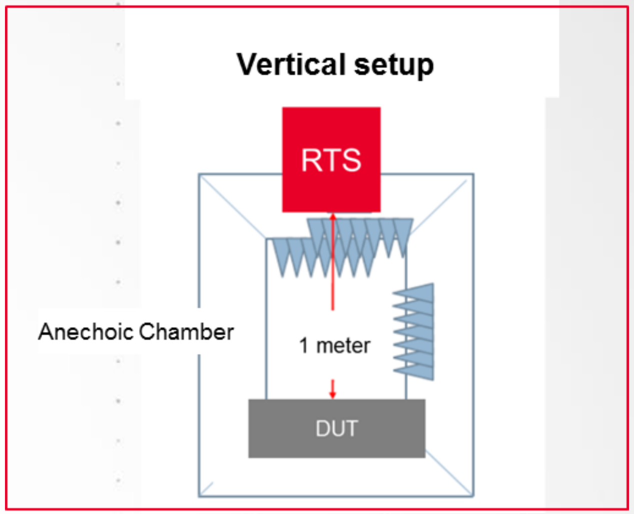
Radar Target Simulator will apply…	to simulate…
Time delay	Range (Distance)
Doppler Frequency Shift	Radial Velocity (Speed)
Attenuation	Radar Cross Section (Object Size)

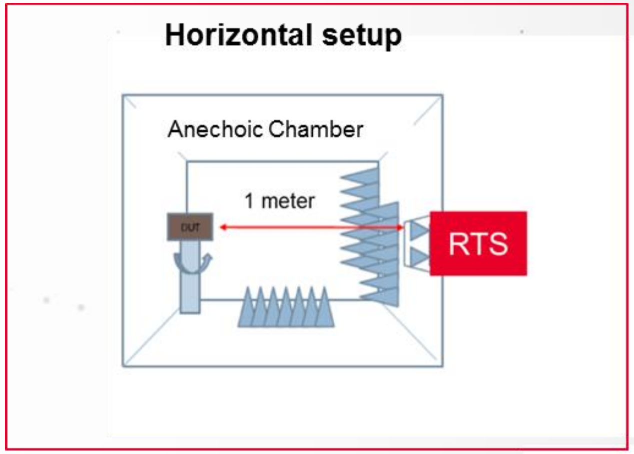
Automotive Radar Manufacturing

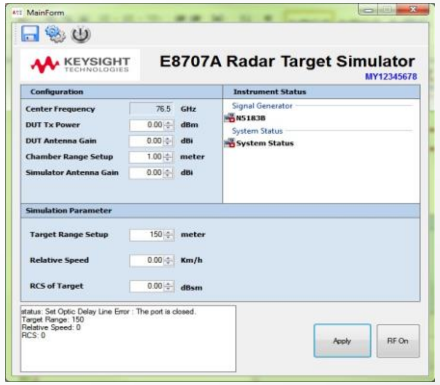
RADAR TARGET SIMULATOR (RTS) OVERVIEW

<u>Manufacturing Test concept and Capabilities</u>

- Frequency Band : 77 GHz
- Bandwidth 1GHz
- Single Target
- Range 10m to 450m
- RCS Range 63.5 dB attenuation at 1 GHz BW
- Speed 0 to +/- 360Km
- Benefits
  - Wide simulated range coverage with ***minimum distance starting from 10m***
  - ***1GHz*** Bandwidth support wide range of module without the need of changing center frequency
  - ***Scalable*** for both Manufacturing and R&D test
    - Basic – Fixed range simulation (ie 75m & 150m)
    - Comprehensive – Full range, RCS, Doppler & DUT Transmit Power
  - ***Reliable***, ***accurate*** and ***repeatable*** performance
  - ***Ease of use GUI*** and ***API*** where all parameters controllable in ***C++ & C# programming environment***
  - Designed, manufactured and ***supported by single company Keysight Technologies***
  - ***World wide support***, calibration and warranty
  - CE and Safety certified





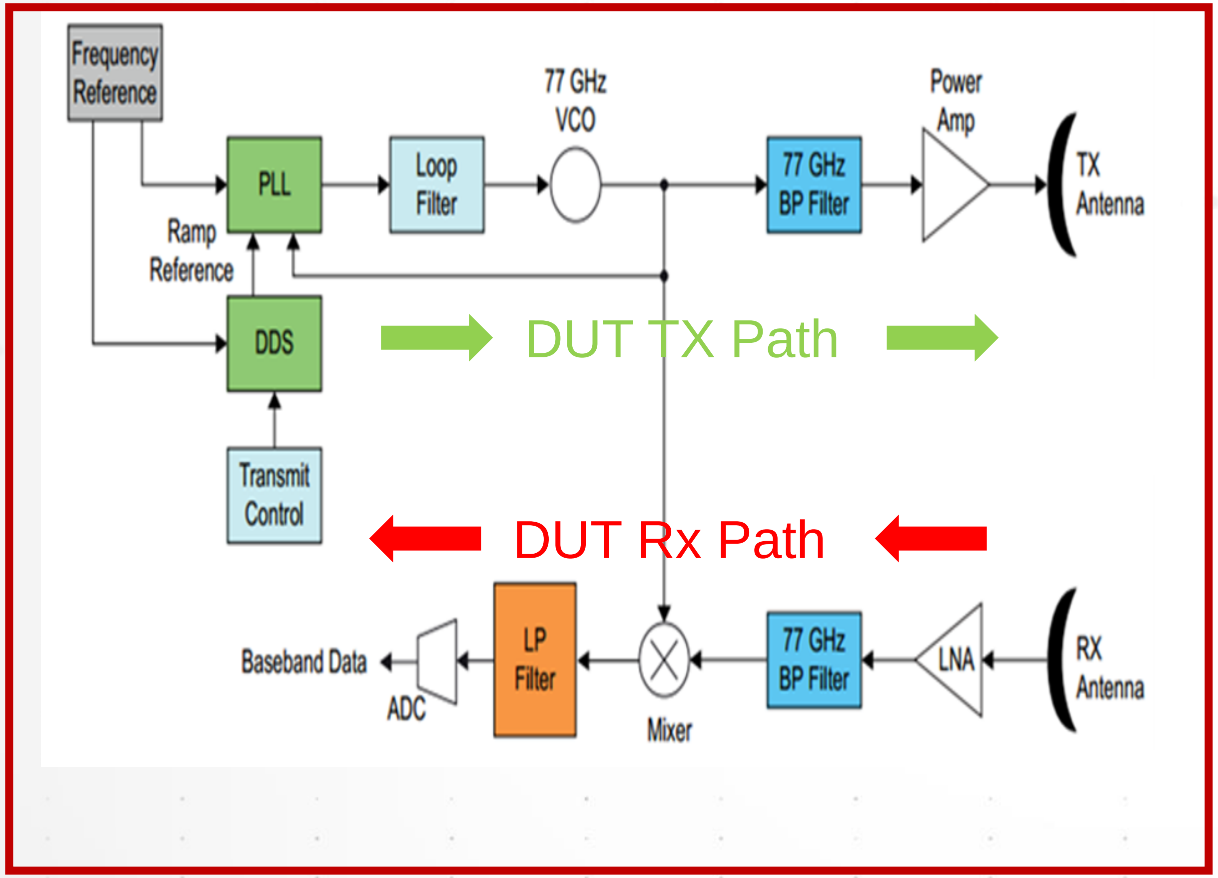


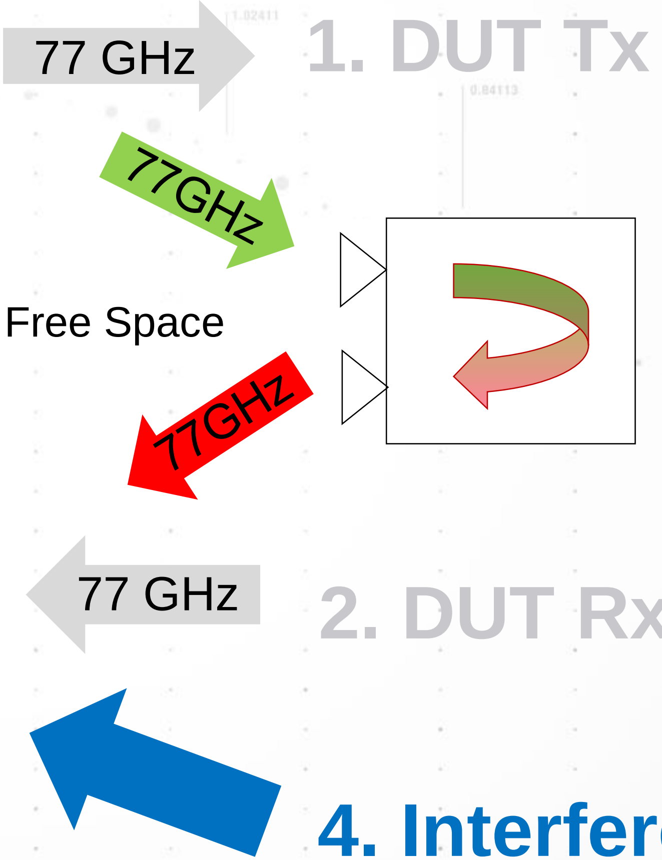
User Interface

Automotive Radar Measurements

THE ~~THREE~~ FOUR TYPICAL RADAR DUT TEST TYPES

DUT / UUT (Typical Radar Sensor)





1. DUT Tx Test



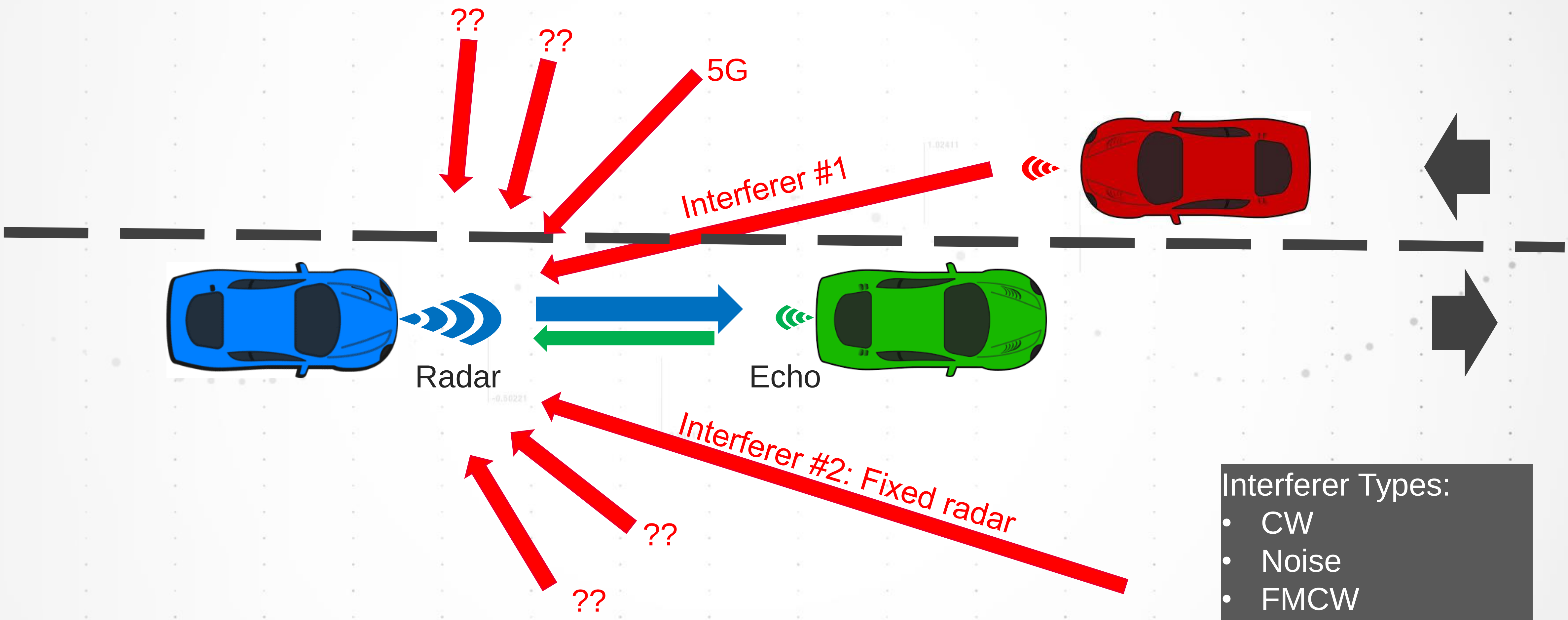

3. Target Simulation

2. DUT Rx Test

4. Interference Tests

Interference Sources and Scenarios

INTERFERERS – WHO ARE THEY ALL ? WHICH ARE THE (MOST) CRITICAL ONES ?

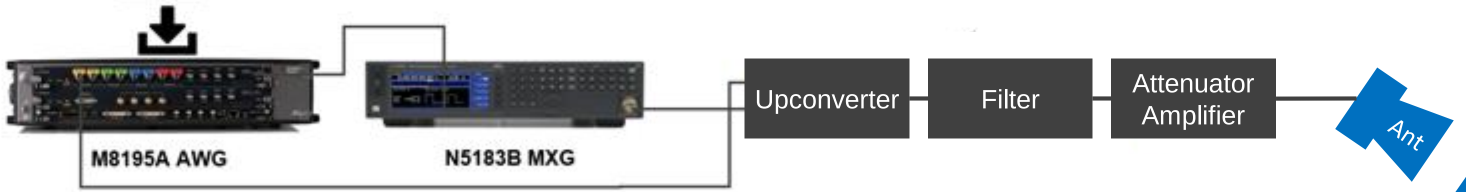


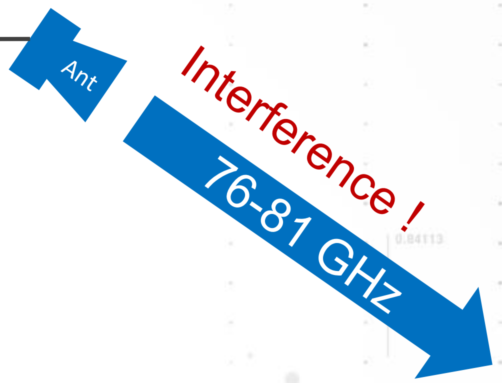
Interferer Types:

- CW
- Noise
- FMCW
- Fast Chirps
- OFDM
- ….

Keysight Solution Setup - Interference

Interference Signal Generation





- generate “traditional” interference signals (CW, noise, FMCW)
- generate new, critical interference signals (5G, OFDM)
- generate “any” interference signals
- generate a complex set / mix of interference signals
- capture and replay / replay + modify e.g. other Tier1 radar modules

Radar Module UUT / DUT

Radar Target Simulator

Interference Scenarios:

- Set object at x m distance, inject t.b.d.interference signal with increasing power until object disappears
- Move object from x m distance with speed of y km/h,
  inject t.b.d.interference signal with increasing power until emergency brake does not work anymore

LEADER IN AUTOMOTIVE & ENERGY

Value of Keysight #3

Collaborations

ETSI, 3GPP, 5GAA, IWPC, Autotech Council, Car 2 Car, and more

R&D Centers

in Germany, Detroit, , Bay Area, and Singapore

Over
50 Solutions
launched in 2017 alone

Automotive Radar Design and Test Lifecycle

SUMMARY

- Advanced automotive radar with millimeter frequency and wide bandwidth are now an indispensable part of Advanced Driver Assistance Systems (ADAS) and autonomous driving vehicles
- Growing demand of advanced technologies, such as 79GHz frequency with 4GHz modulation bandwidth and micro-Doppler to detect and protect pedestrians, has led to new design and test challenges
- Keysight Automotive Radar solutions from early design simulation through Research & Development (R&D) and manufacturing to solve current and future automotive radar design and test challenges
  - Value #1- Entire design and test lifecycle solutions
  - Value #2- Connected solution consists of design simulation software and measurement
  - Value #3- Leadership in current and future automotive technologies

KEYSIGHT
WORLD2018

Thank you!

Jungik Suh, DES Automotive Business Manager
jungik.suh@keysight.com