IMS2020 MicroApps

A 24 GHz Radar Evaluation and Development Platform

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Analog Devices

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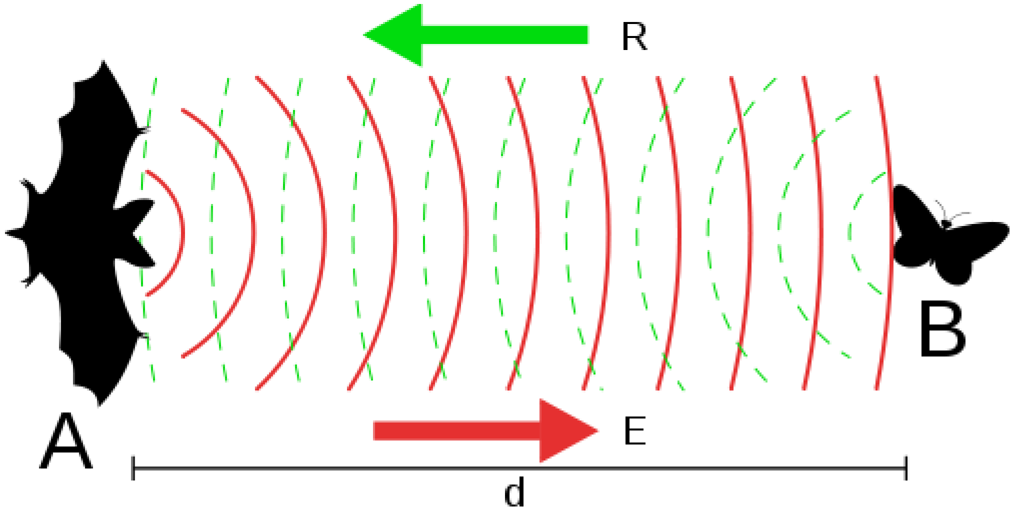
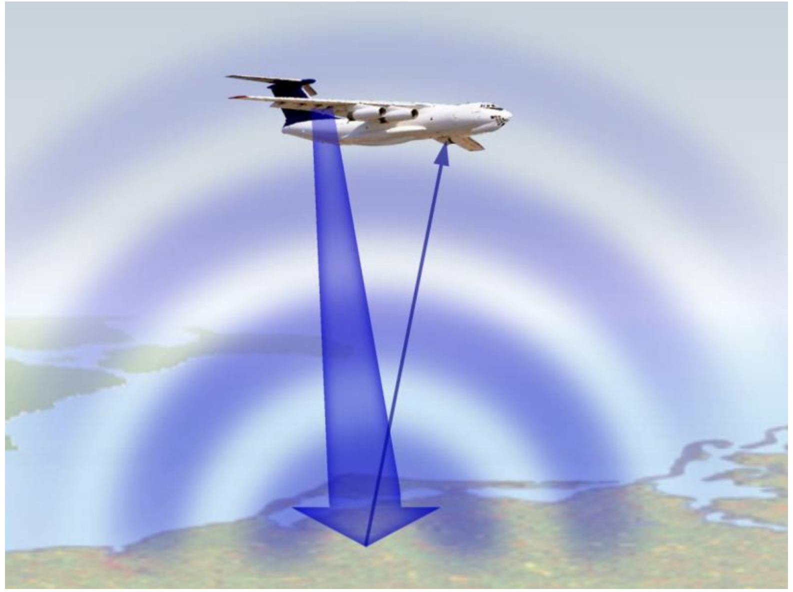
Introduction

- Background of FMCW radar and some basic info
- Issues and challenges with implementing a radar system
- The purpose of a 24GHz radar development kit
- Our solution, the TinyRad platform
- TinyRad features and specifications
- How to use the TinyRad platform in practice

Radar Basics

- In a very basic sense radar measures the “echoes” of electromagnetic waves in order to find the distance, velocity and/or position of an object.
- It was, like many things, developed in secret during WWII and became commonplace after
- It now can be found used in things such as aviation/drone altimeters, in automotive blind spot detection, industrial tank level sensing, missile targeting and also defence, and so on





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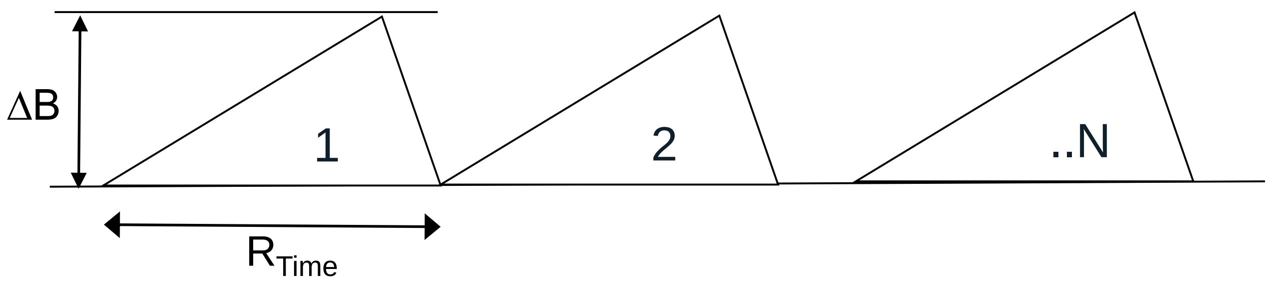
Some radar background

- This presentation will focus on FMCW radar. Example of a transmitted signal and received "echo" in red:



  - Range Resolution $\Delta R = \frac{c}{2 * \Delta B}$
  - Velocity Resolution $\Delta V = \frac{\lambda}{2 * N * Rtime}$
  - Angle Resolution $\Delta \theta = \frac{\lambda}{D}$
- 24GHz falls within ISM band. 24GHz radar systems can be used for any application without regulation
  - Limited to ~200MHz BW
  - 77GHz (4GHz BW non-ISM band) can offer better performance and smaller systems, but can only be used for automotive applications

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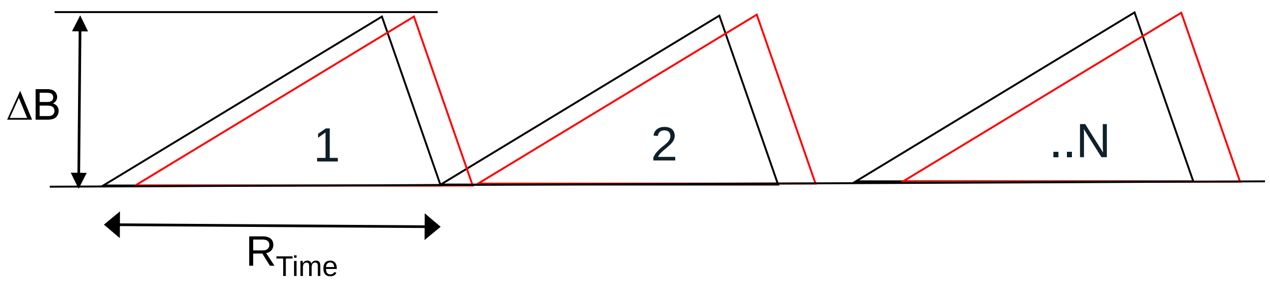

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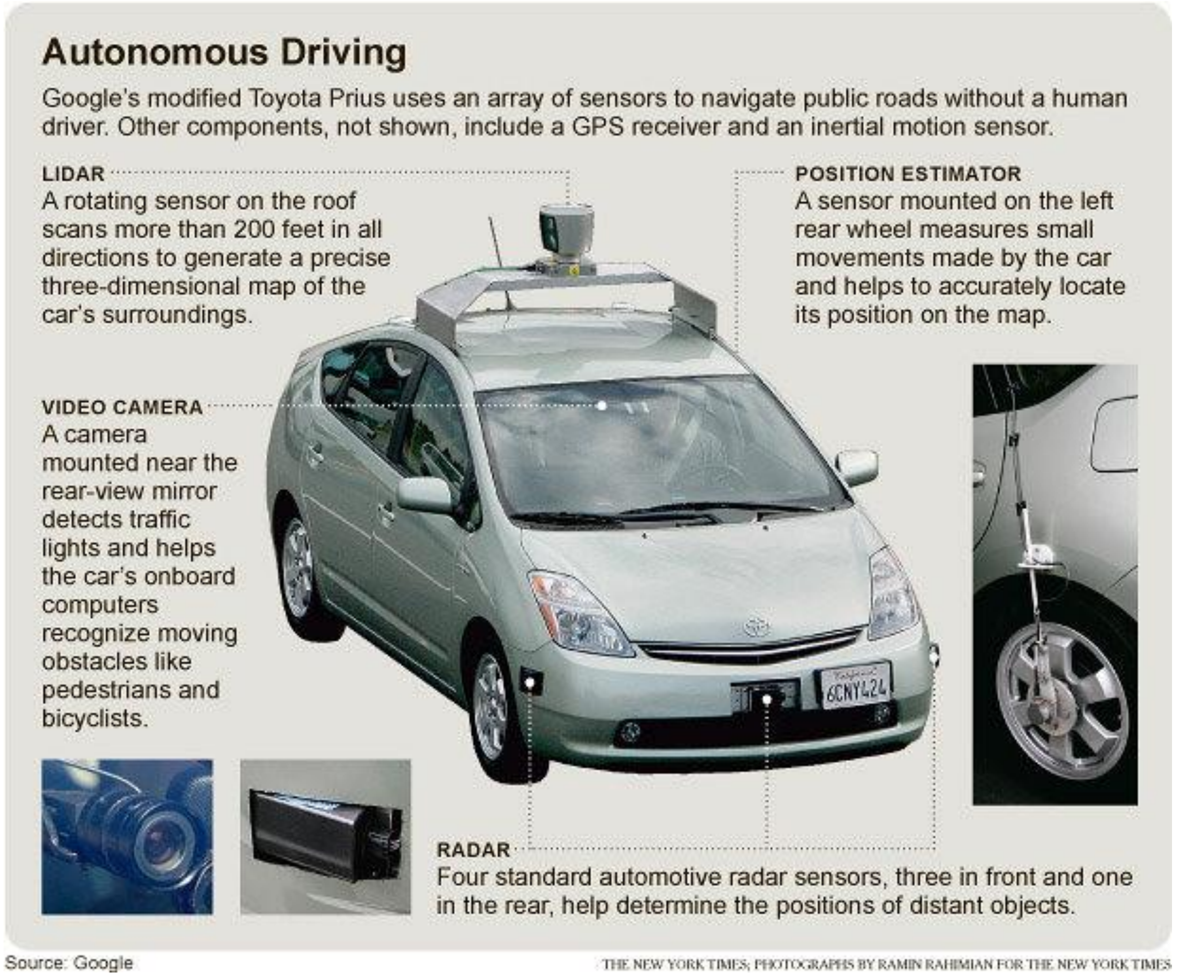
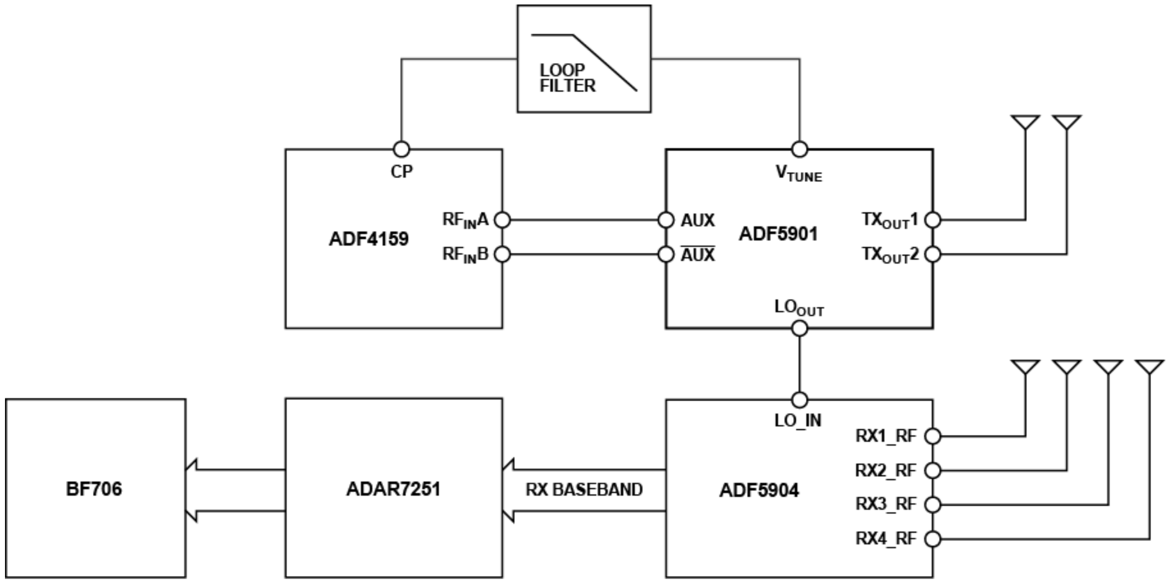
When considering the evaluation of a radar system

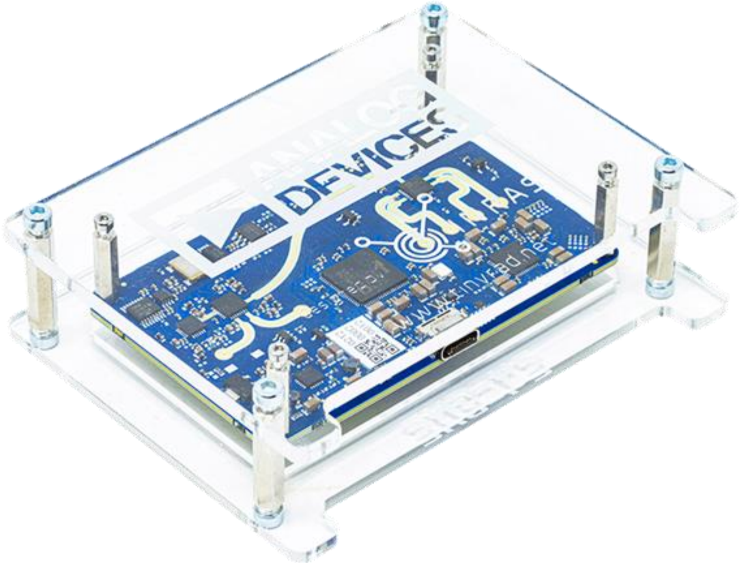
  - Some existing options for detection: Radar, LIDAR/Lasers, Camera (IR and visible light), Ultrasound
  - Each have their own benefits and drawbacks
    - Example: Radar can operate in harsh conditions.
  - Two or more sensors can be used in conjunction to cover each other’s weaknesses
    - Example: Camera for a perimeter security system with a radar backup
- Can require specialist RF knowledge on top of software development
- Complexity in the design stage
  - RF layout, antenna design, configuring chirps, sampling and interpreting raw data
  - There is a need to simplify and speed up and simplify the process of bringing a radar solution to market
- Is a radar sensor even going to be a good fit for the given application?

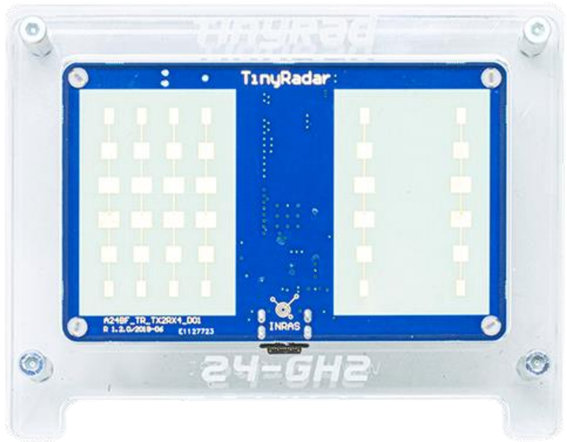


TinyRad platform

- 24GHz MIMO FMCW front end
  - 2 Tx and 4 Rx channels, ADC and DSP on board
- Credit card sized system
- Powered from USB-C connection
- Designed for Range-Doppler and MIMO processing







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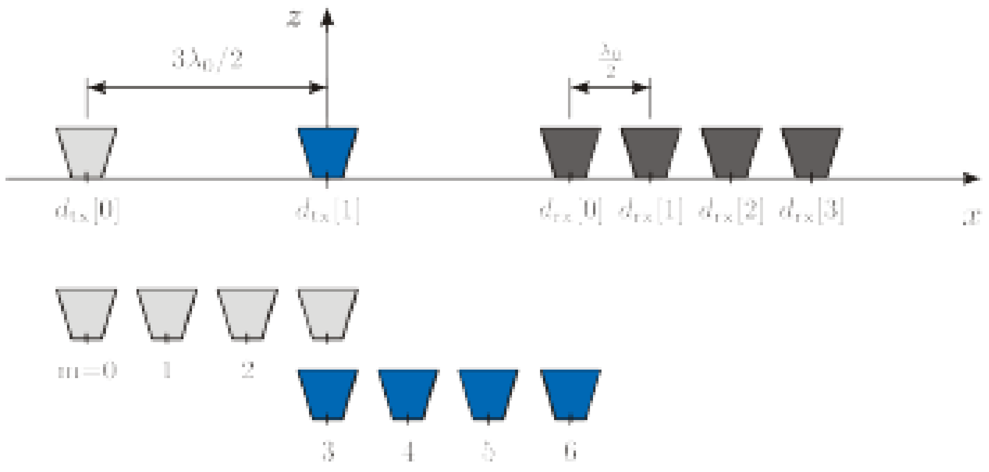
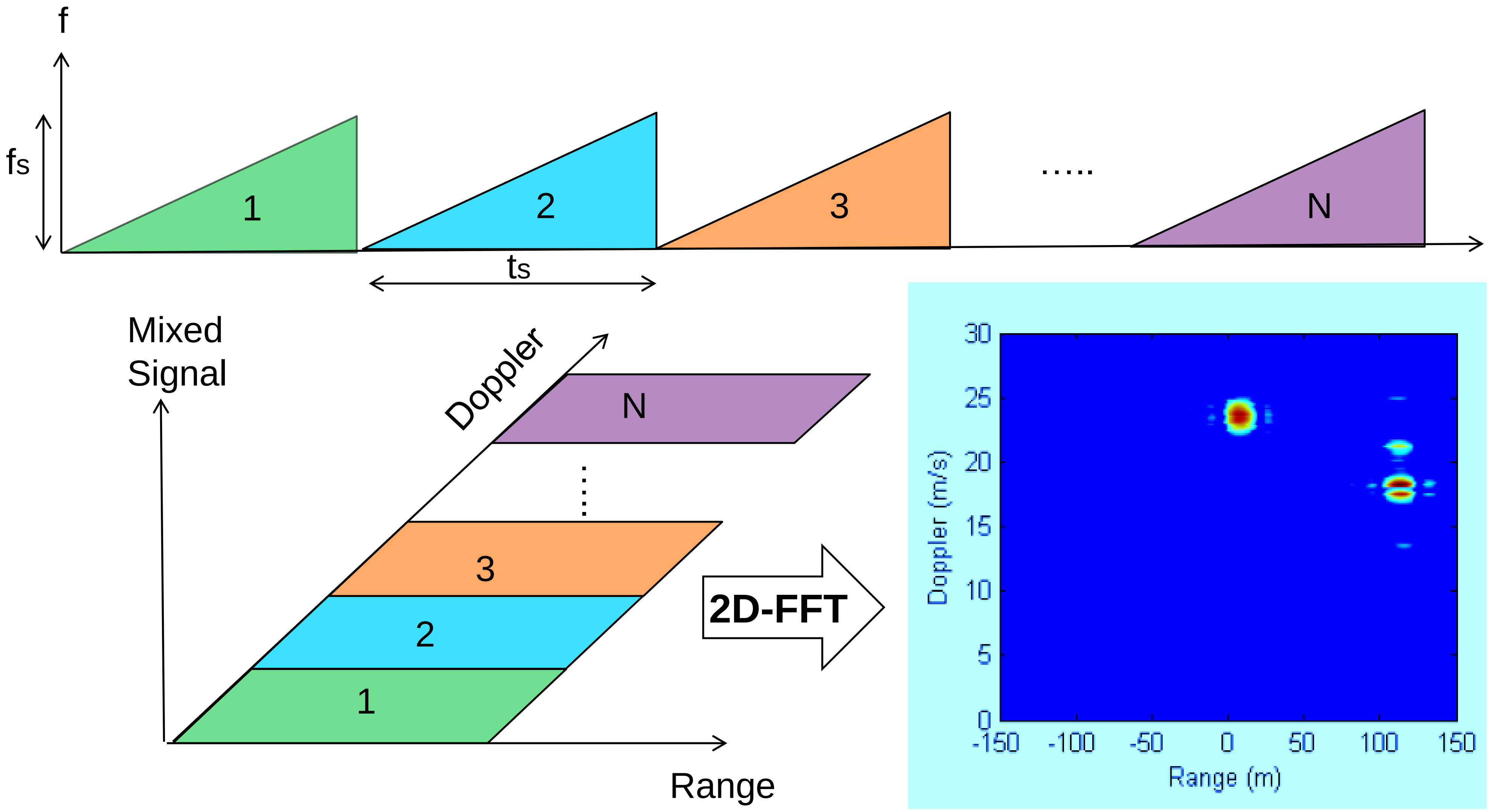
TinyRad specifications



- 24GHz ISM band operation
- 1MSPS per IF channel sample rate
- Customisable FMCW timings
- Range resolution ~60 cm (with BW = 250MHz)
- Maximum range 100m (with target RCS = 1m^2)
- 2 Tx and 4 Rx channels
  - Antenna array setup with spacing to allow 7 virtual elements when using both Tx for increased resolution
  - Angular horizontal 3dB width 76.5 °
  - Angular vertical 3dB width 17.6 °
- Post processing of data on host PC, with the option to use embedded DSP code

Basic Radar Algorithm and Data Format



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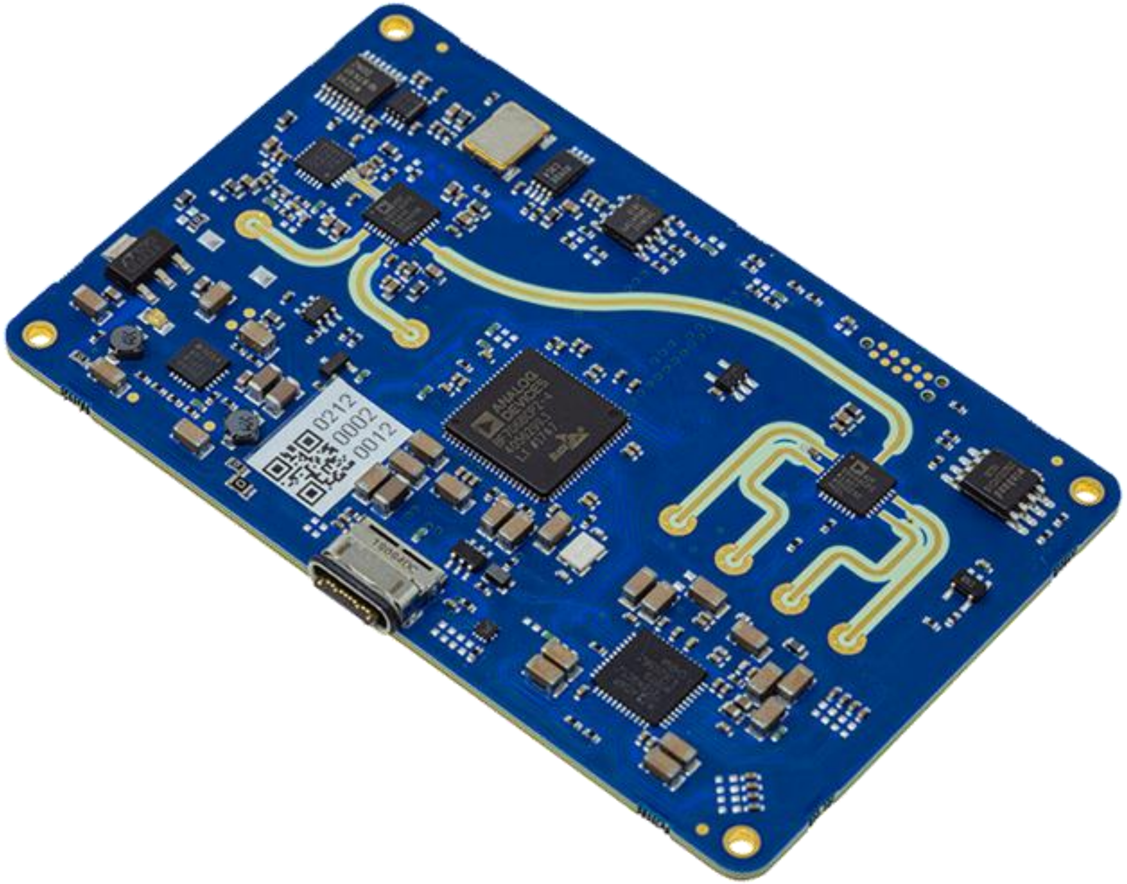
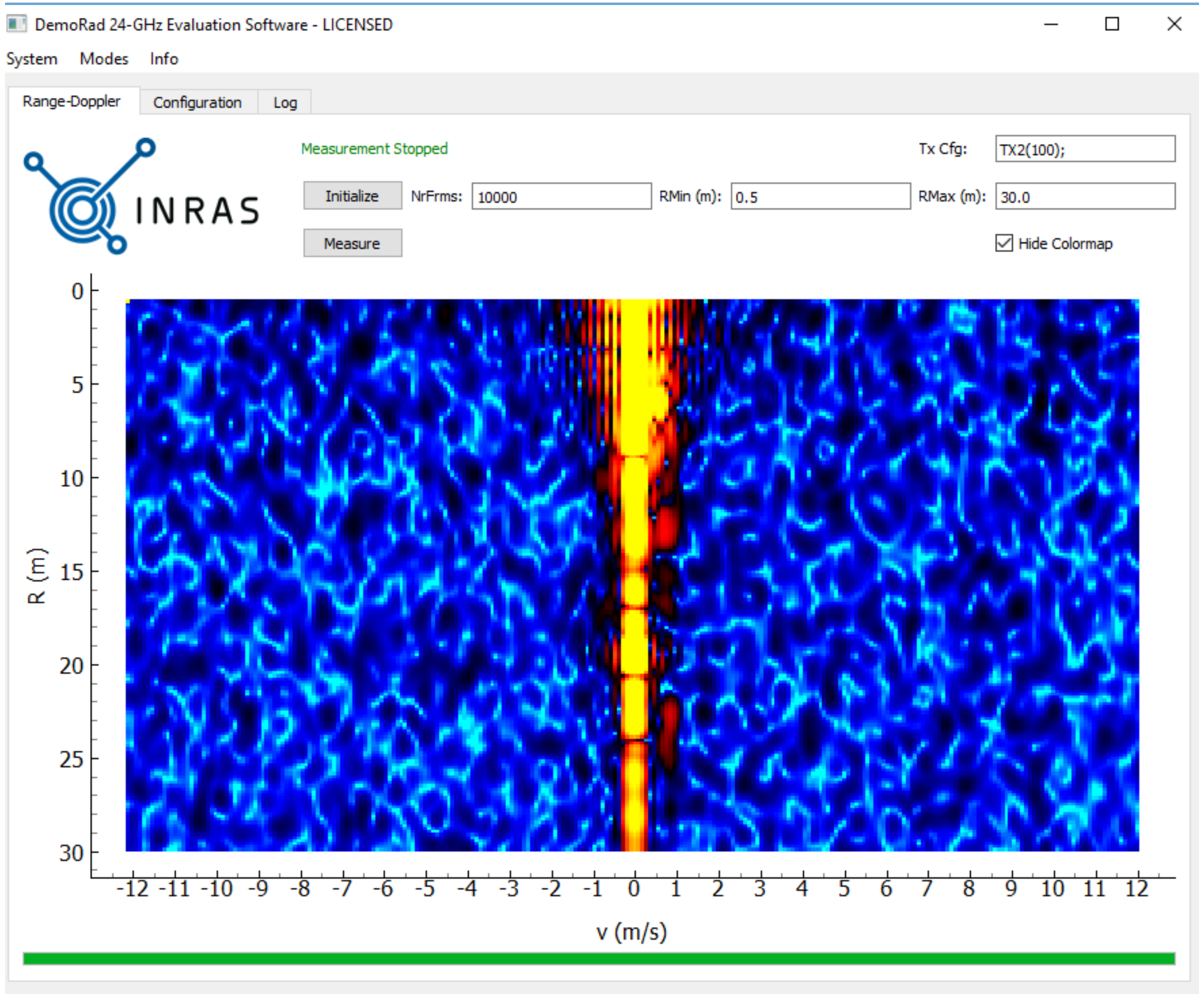
The purpose of this platform

- Remove the need for time to be spent on the hardware design stage
- Allows radar as a solution to be taken for a “test drive” first
- Makes radar accessible to a broad range of applications
- A radar system can be implemented by those who would otherwise consider it too resource intensive due to specialist knowledge
- Act as a platform to quickly allow algorithms to be developed for the specific application



Using the TinyRad kit

- Laptop, TinyRad board and a USB cable are all that are required to get radar up and running
- Included software GUI which allows kit to be used quickly out of the box



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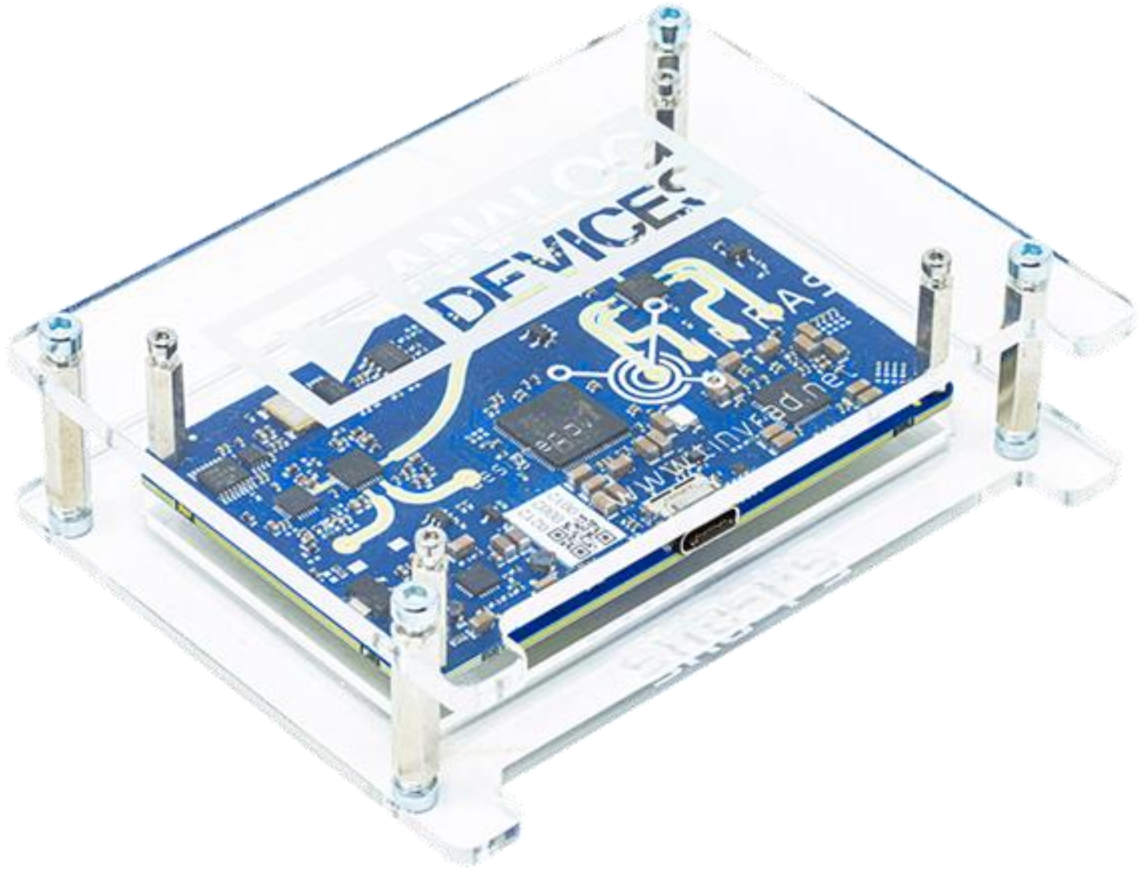
Example design procedure

- **Step 1:** Purchase TinyRad kit and use small form factor to set it up in given application
  - For example car blind spot detection. Board being low profile can be attached to car side view mirror.
- **Step 2:** Use packaged GUI to quickly see if radar will be a good fit for the application
  - TinyRad with GUI can be up and running in 5 minutes. Algorithms that are supplied are basic but allow range doppler and MIMO to be evaluated
- **Step 3:** Open up example code files in chosen format and refine given algorithms to better fit specific application
  - The TinyRad board can be given to software engineers and used as a radar algotithm development platform.
  - All classes and example source code are supplied in Matlab and Python format. Excellent starting point for further development e.g. for target detection algorithms.
- **Step 4:** System design stage. Use TinyRad design files (are supplied by us) for the radar portion
  - Schematic, BOM, Gerber files are all included with TinyRad kit

Conclusion

- Some basic radar background has been given as well as some information on why radar might be chosen for an application
- The reasoning behind developing TinyRad has been explained
- Shown that it can be effectively used to evaluate FMCW radar for a given application
- The data format used in the TinyRad system has been explained
- If proceeding with design, the TinyRad kit is useful as an algorithm design platform



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