

# USRP Hands-on Experiment

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# TA Information

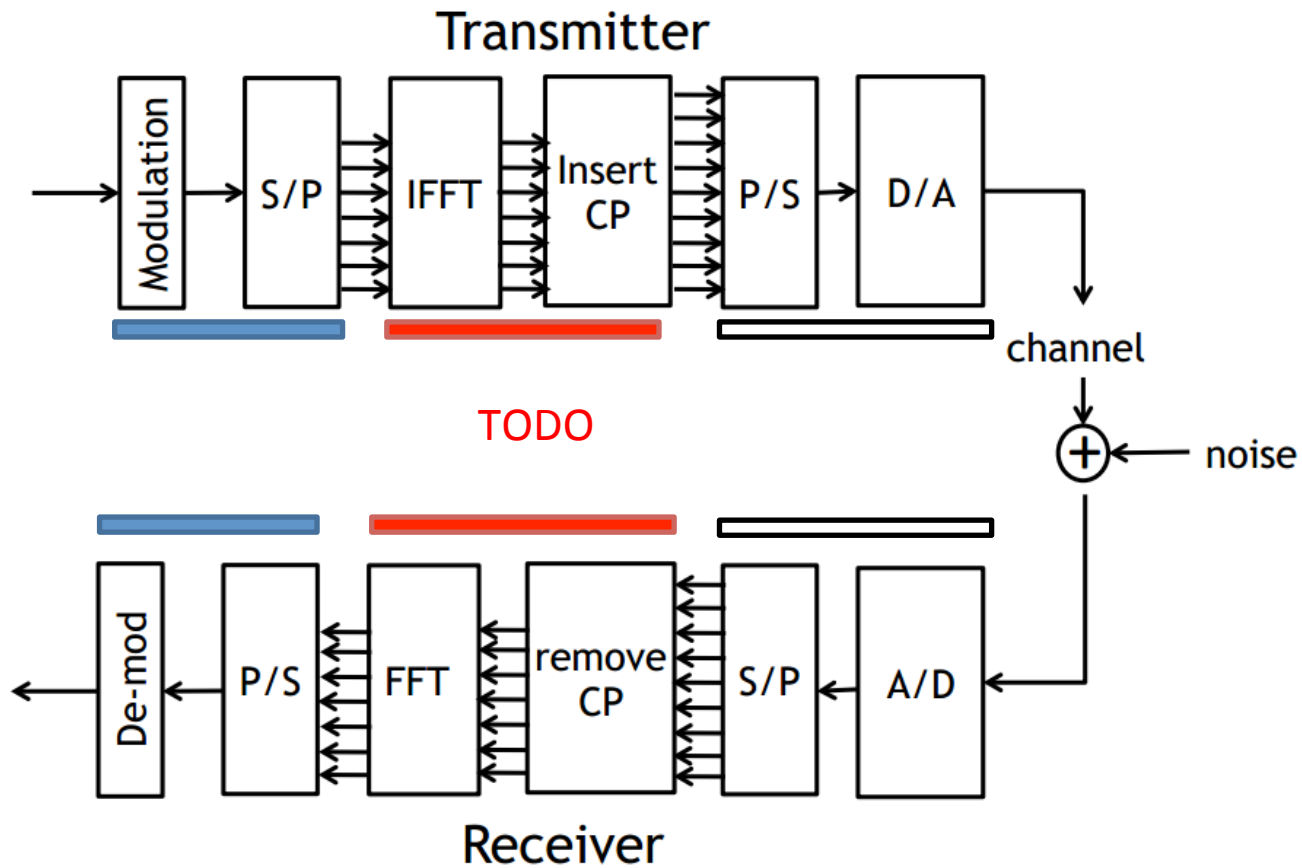
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# Outline

- USRP introduction
- What will we do?
  - Cyclic Prefix
  - Decoding
  - Analysis

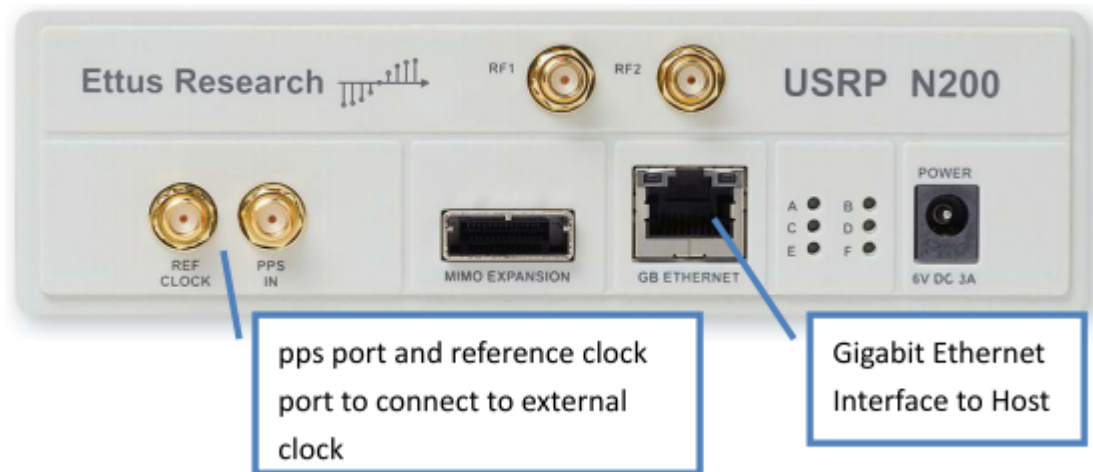
# What will we do?

## OFDM Diagram



# USRP N200

USRP N200



# USRP N200

USRP N200 and external clock



# USRP N200

- Reference clock:
  - The external clock is used as an “accurate” oscillator for USRP
  - You can try to do the experiment with/without the reference clock

# UHD

- `uhd_find_devices`:
  - This program scans the network for supported devices and prints out a list of discovered devices and their IP addresses.
- `uhd_usrp_probe`:
  - This program constructs an instance of the device and prints out its properties, such as detected daughterboards, frequency range, gain ranges, etc...



# UHD

- How to write a UHD (in C++) program?
  - Check out the example files
    - `single_tx_sync.cpp`
    - `single_rx_sync.cpp`

# UHD

- How to compile a UHD program?
  - Directory: uhd/host/examples
  - CMakeList.txt
    - Add in your file in the list
  - sudo make

# UHD

- How to run your program?

- Commandline:

- `single_rx_sync`

- `--args="addr=192.168.10.3"`

- `--clock=true`

- `single_tx_sync`

- `--args="addr=192.168.10.4"`

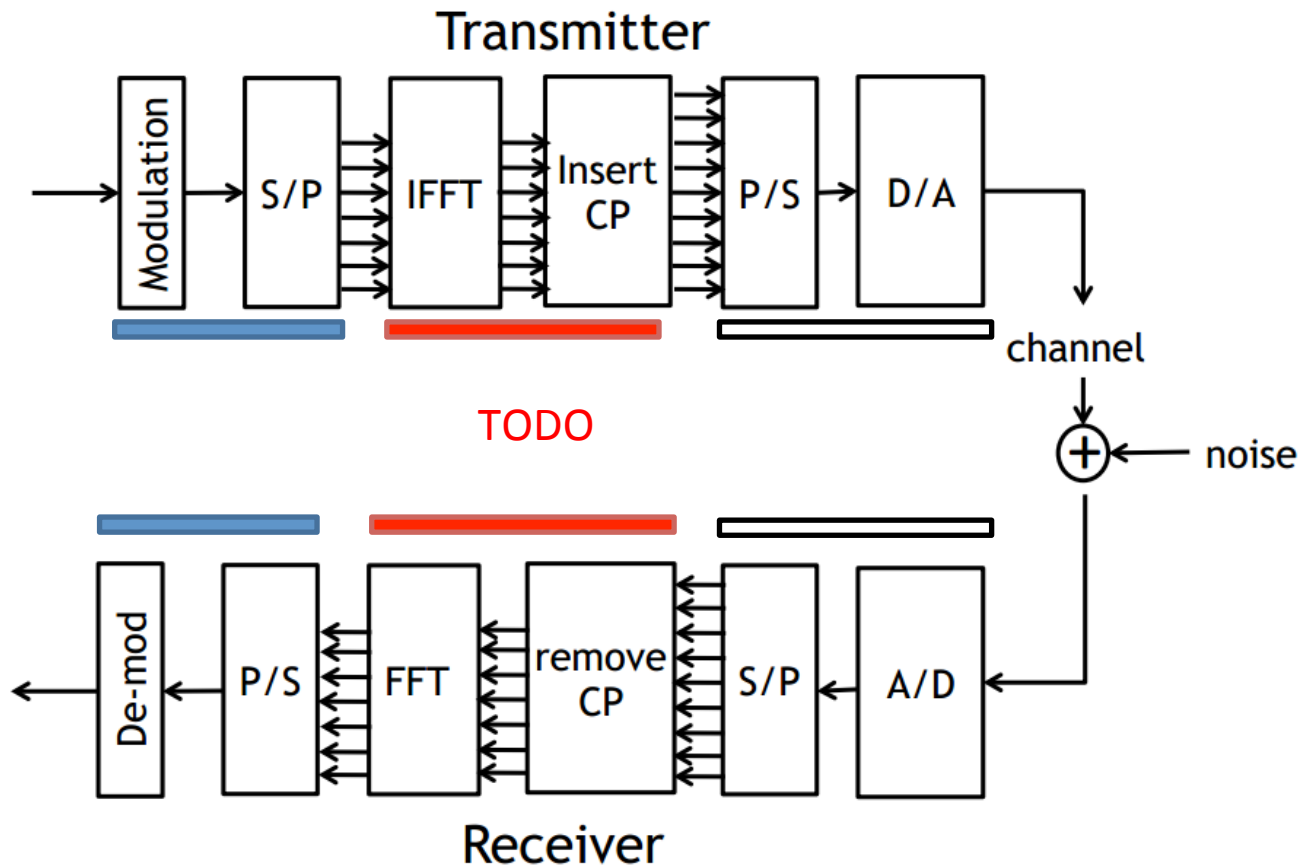
- `--thres=0.02`

- `--file="./source_test.dat"`

- `--clock=true`

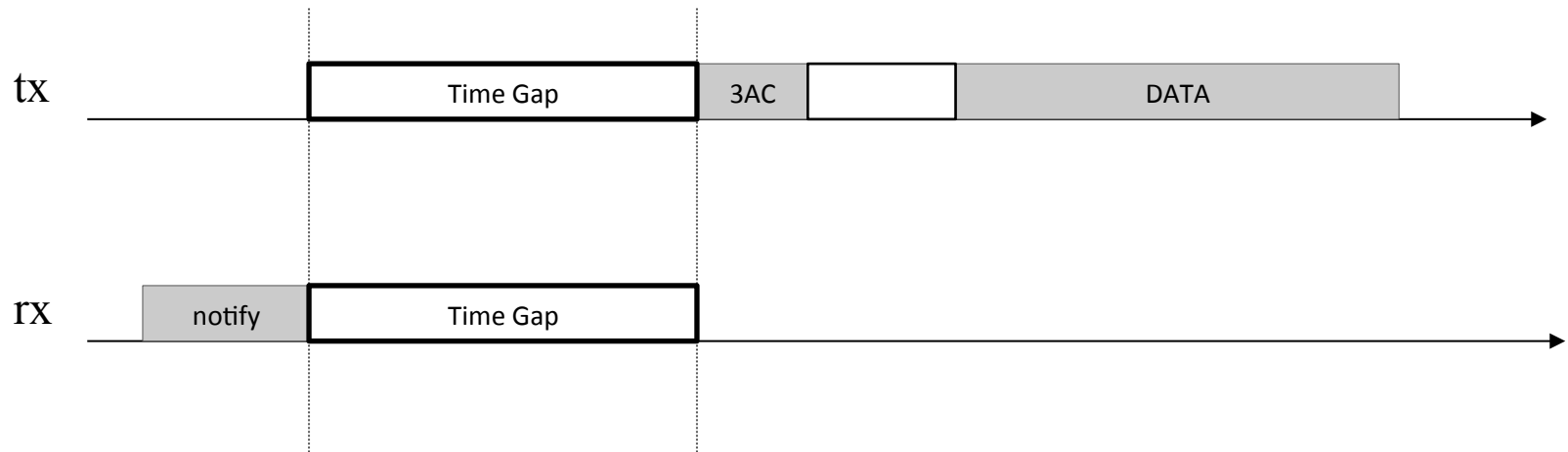
# What will we do?

## OFDM Diagram



# Synchronization

- Time line



# Action Gap

- What is this?
  - Tune the synchronization in very tiny scale
  - Please understand the purpose of action gap

# Modulation

- We have done this part for you
- The source data “source\_test.dat”
  - **Not** a bit stream
  - It contains BPSK samples (-0.05, +0.05)

# Cyclic Prefix

- This part is **TODO**
- In OFDM, CP (cyclic prefix) is crucial to fight multipath
- Add in CP before any symbol you send

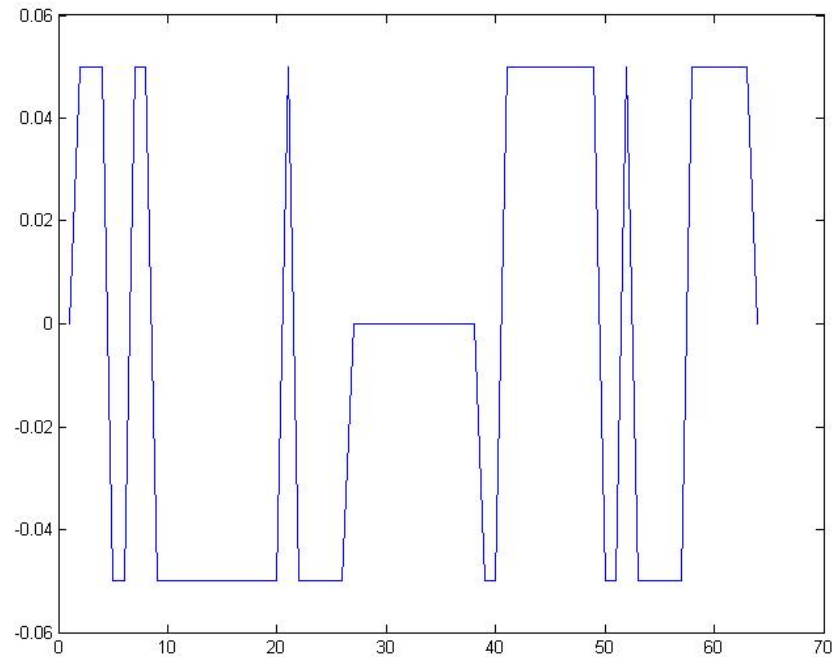


# MATLB decoding

- Symbol design
- Channel learning
- Phase tracking

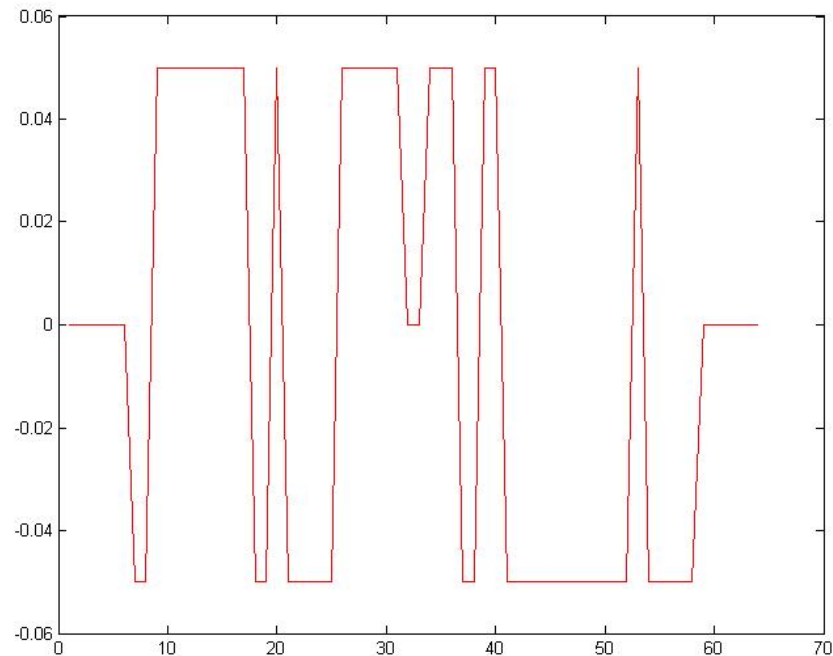
# Symbol Design

- There are blanks in the middle of tx data



# Symbol Design

- Re-allocate the symbol as following
- Then, data points [1:64] are mapped to the subcarrier [-32 ... -1, 1, ..., 32].

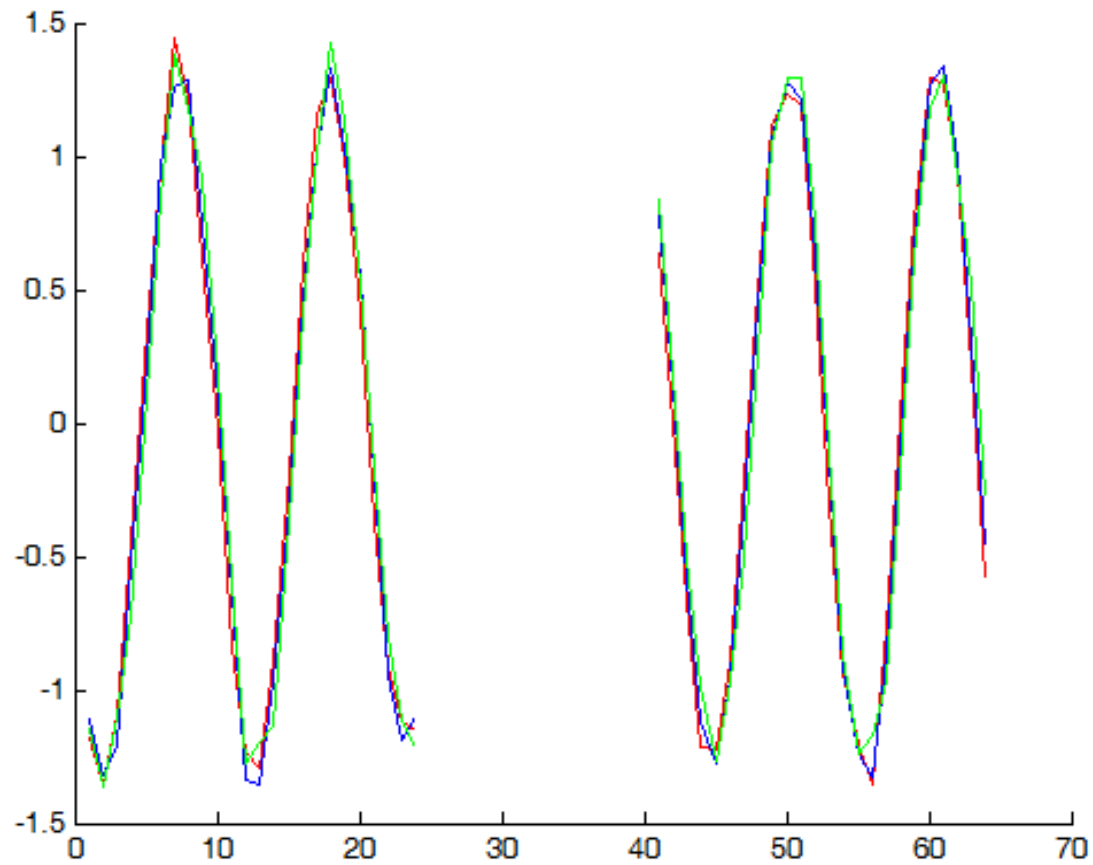


# Channel Learning

- In the timeline, 3AC are sent to learn channel
  - Both TX and RX know the pattern of 3 AC symbols
  - Use these symbols to do coherent detection

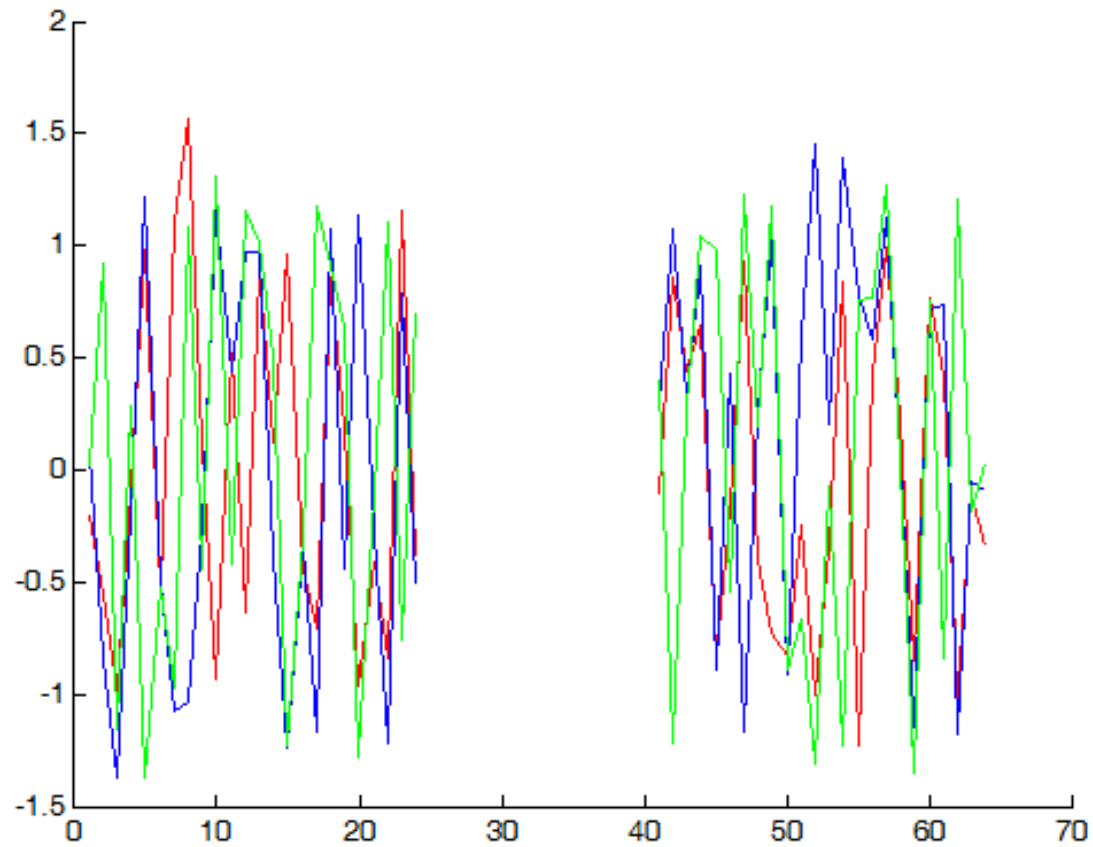
# Channel

- Good



# Channel

- Bad



# Phase Tracking

- This part is **TODO**
- Hint:
  - In most communication system, we add in some “pilots” in our transmitted symbols
  - The phase shift is **linear**
    - Do linear regression

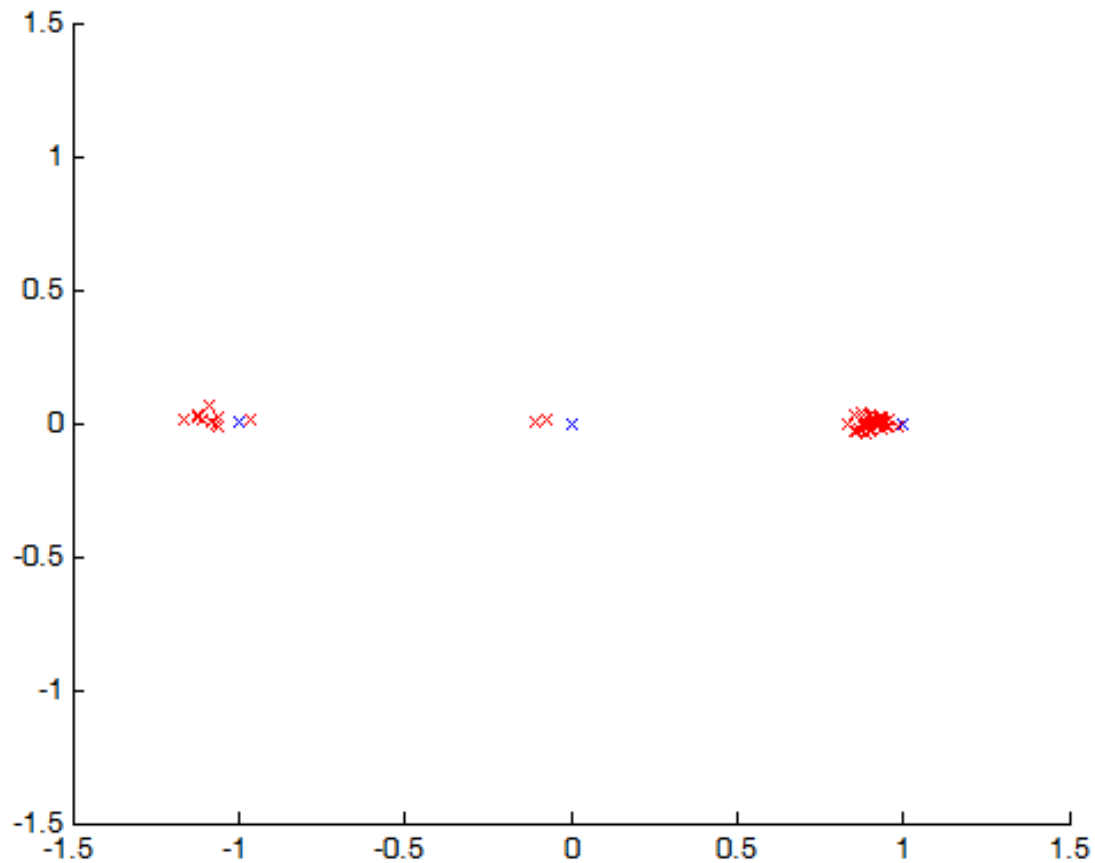
# Phase Tracking

- Reference: 802.11a
  - [http://www.vocal.com/wp-content/uploads/2012/05/80211a\\_wp1pdf.pdf](http://www.vocal.com/wp-content/uploads/2012/05/80211a_wp1pdf.pdf)
  - Check **page 9**.



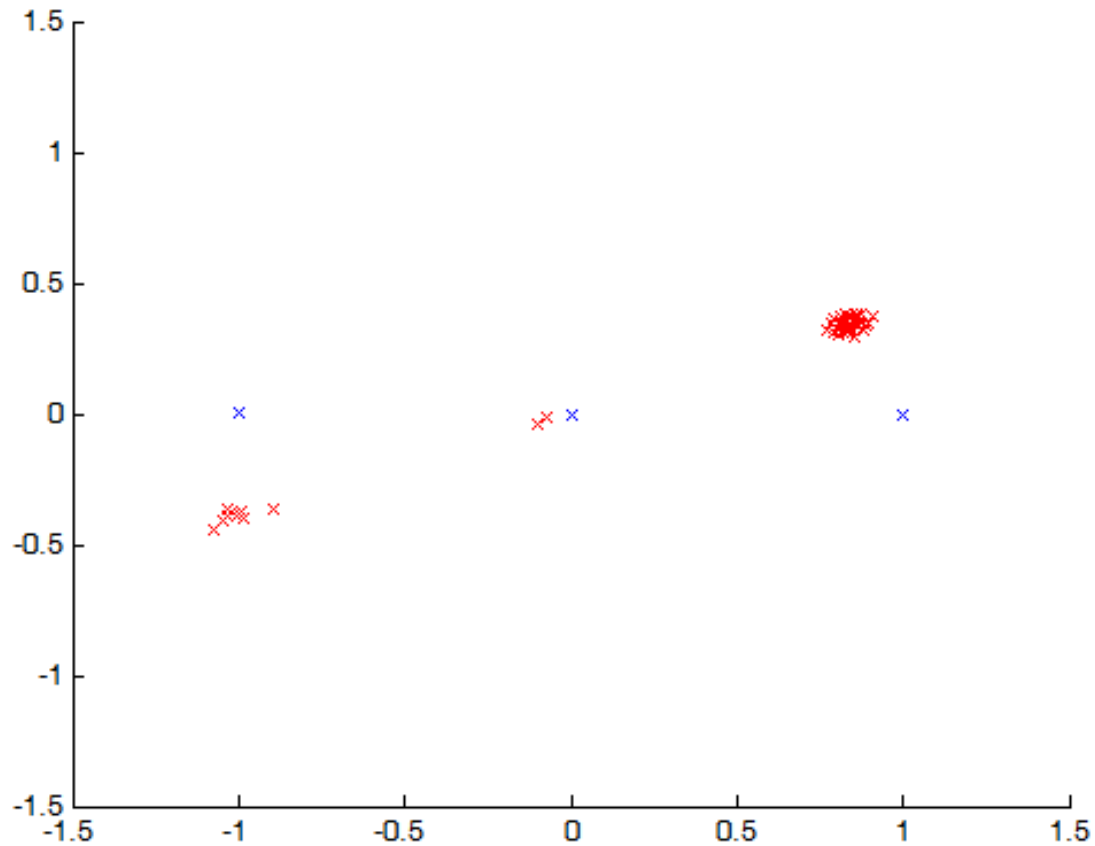
# Phase track

- With phase tracking



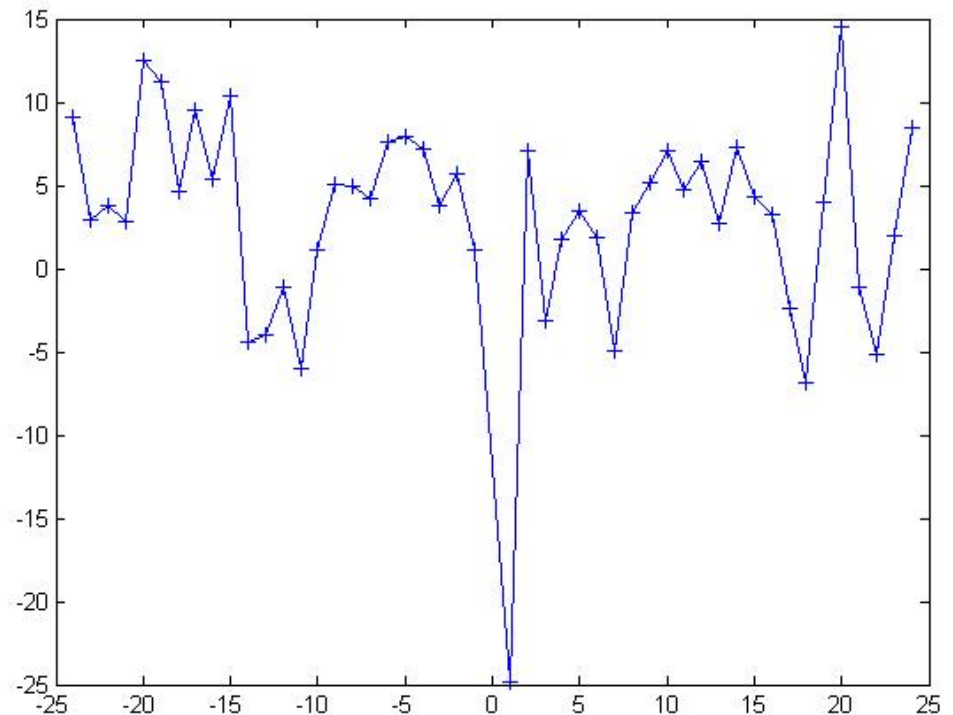
# Phase track

- Without phase tracking



# Analysis

- Output the SNR of each Symbol
- Output average SNR of each sub-carrier
- Note:
  - The data:
    - 1 preamble symbol
    - 3 AC symbols
    - 150 data symbols



# Summary

- TODO:
  - UHD:
    - single\_tx\_sync
  - Matlab:
    - decoder
    - phaseTrack function
  - Analysis:
    - Average SNR on each symbol
    - Average SNR on each sub-carrier