HY-330

fall semester 2024

Introduction to telecommunication systems theory

University of Crete
Computer Science Department

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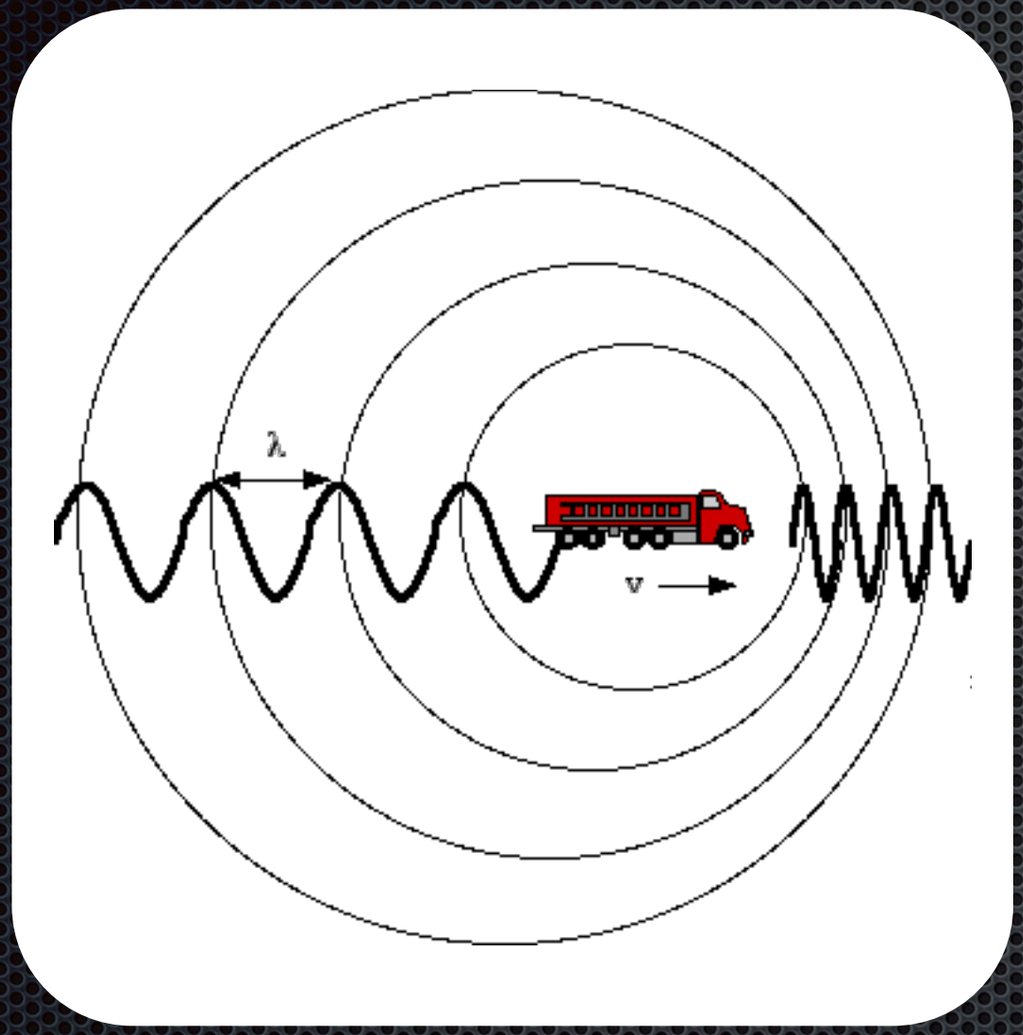
Degradation causes

- Doppler effect/shift
  - CFO estimation
- Inter Symbol Interference
  - Cyclic Prefix, Guard Interval
- I - Q imbalance

Doppler effect/shift



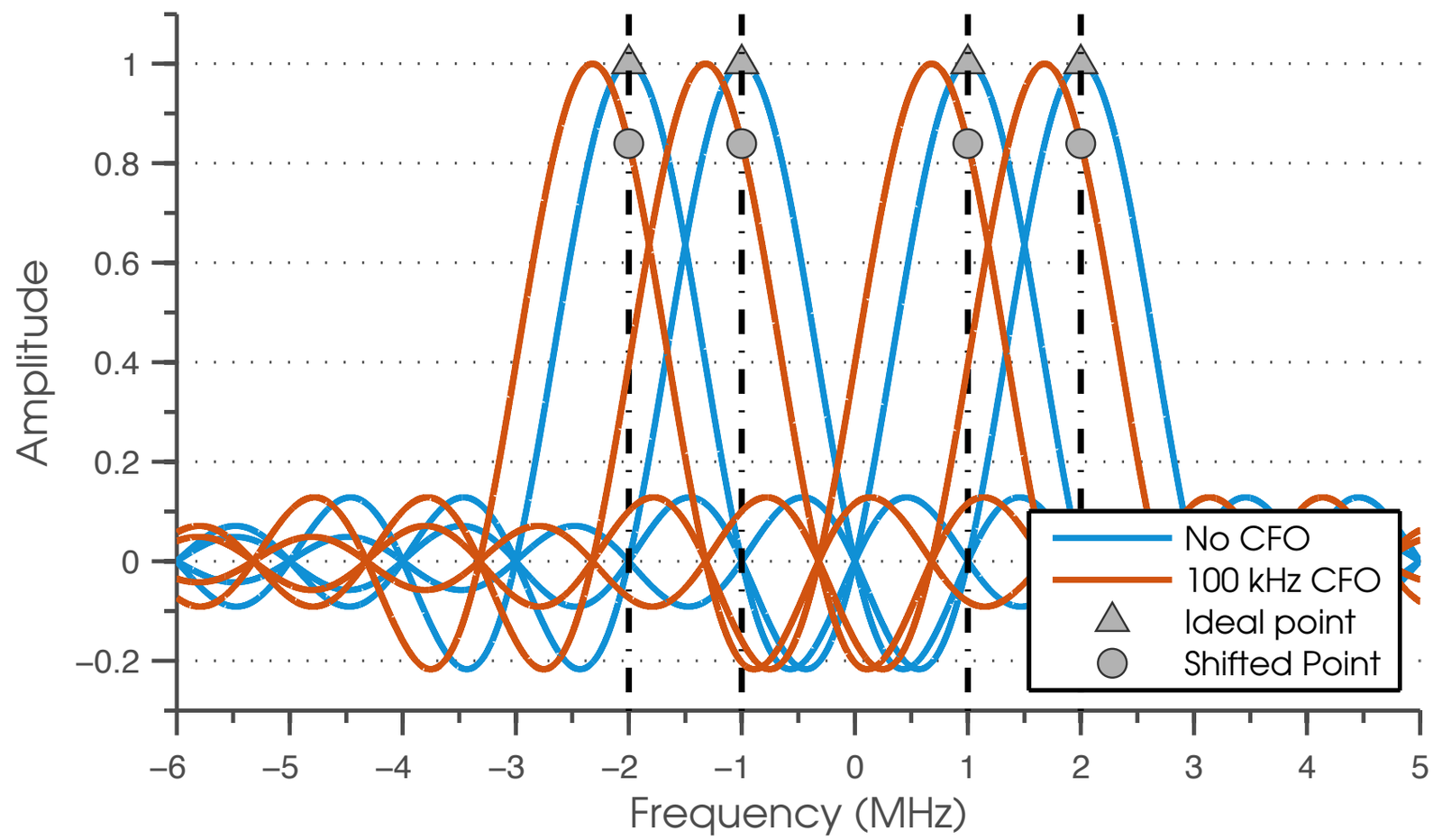
$$f = \left(\frac{c + v_{Rx}}{c + v_{Tx}}\right) f_0$$

$$f = \left(1 + \frac{\Delta v}{c}\right) f_0$$

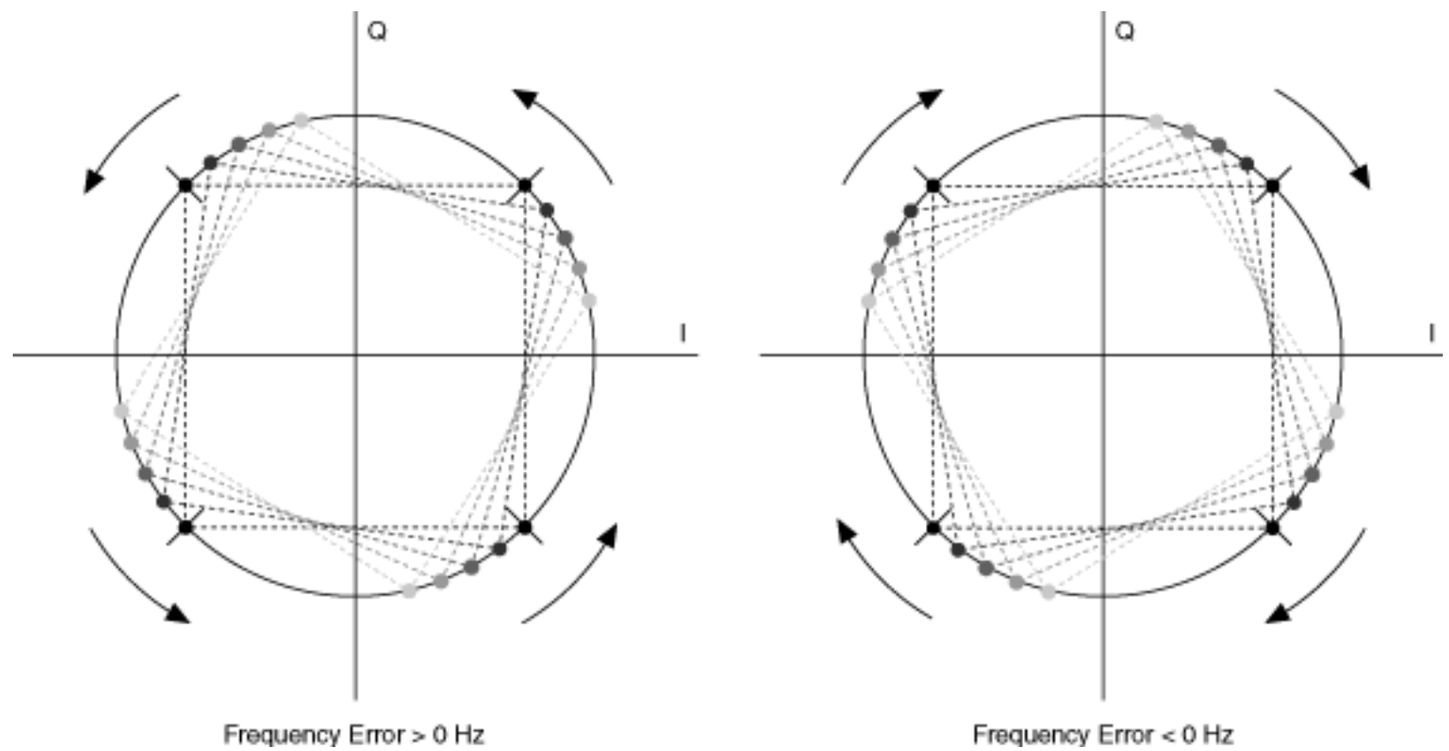
$$\Delta f = \frac{\Delta v}{c} f_0$$

$$\Delta f = f - f_0 \quad \Delta v = v_{Rx} - v_{Tx}$$

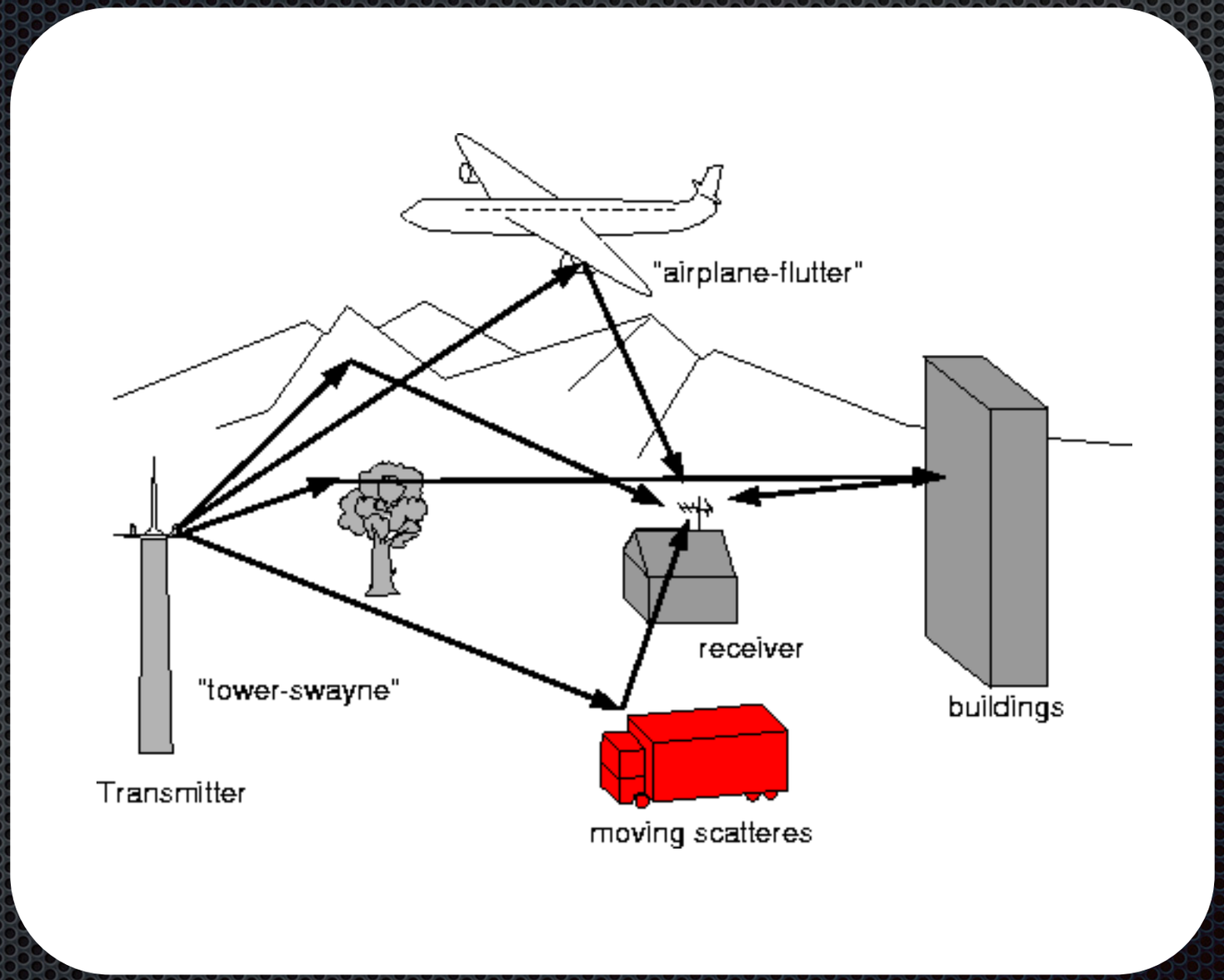
CFO in frequency domain



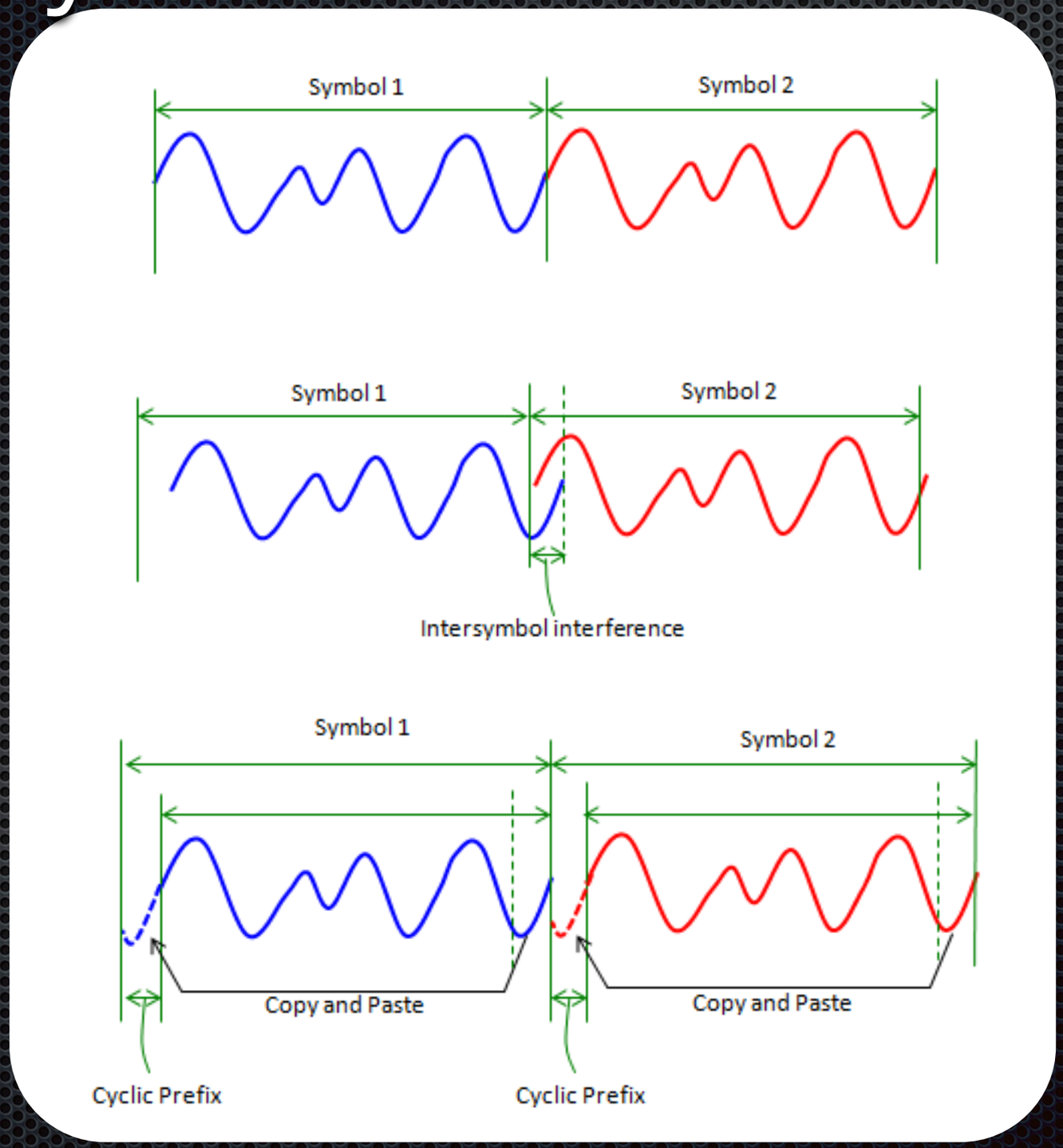
CFO in constellation



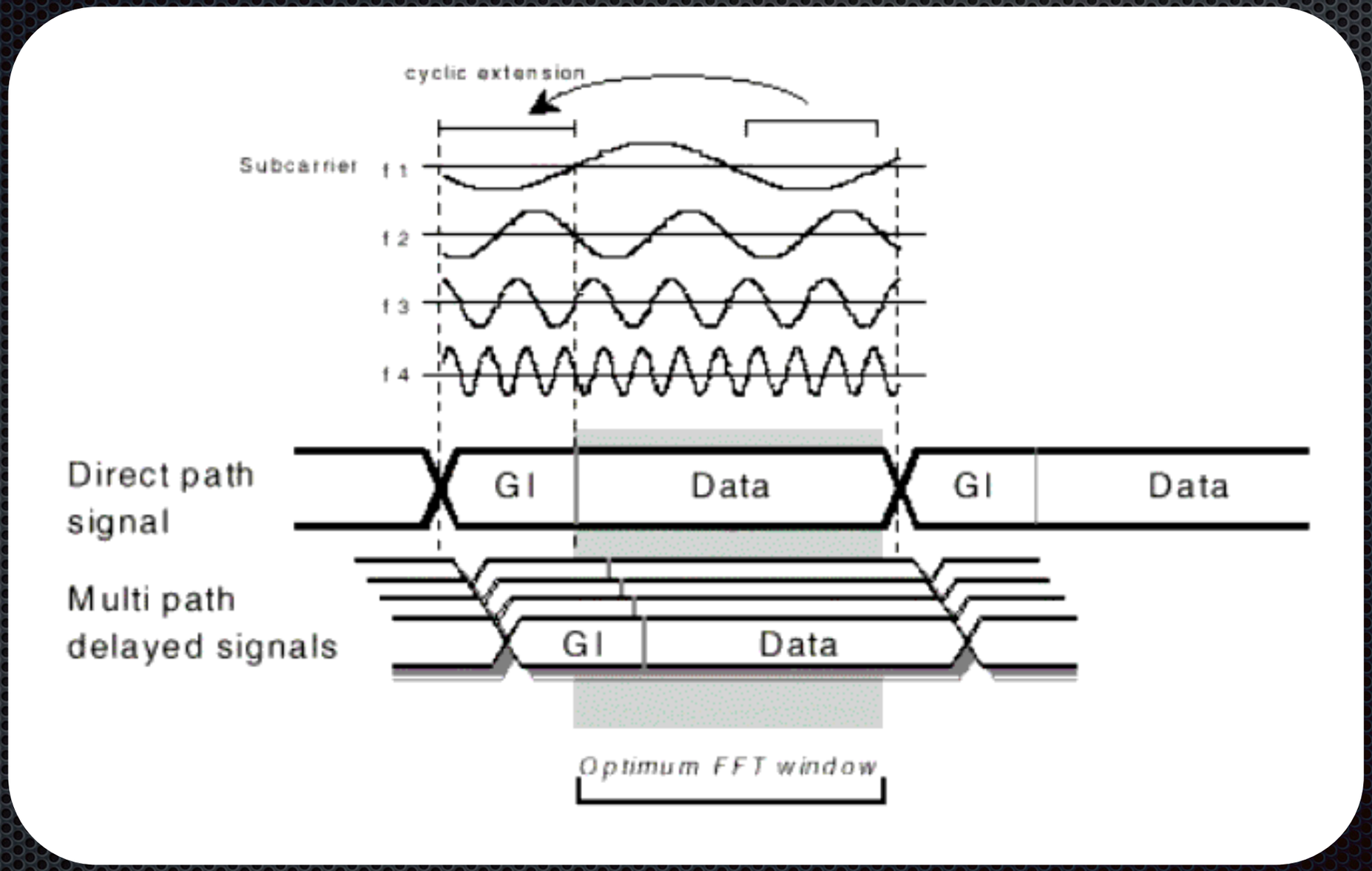
Multipath


"airplane-flutter"
receiver
"tower-swayne"
buildings
Transmitter
moving scatteres

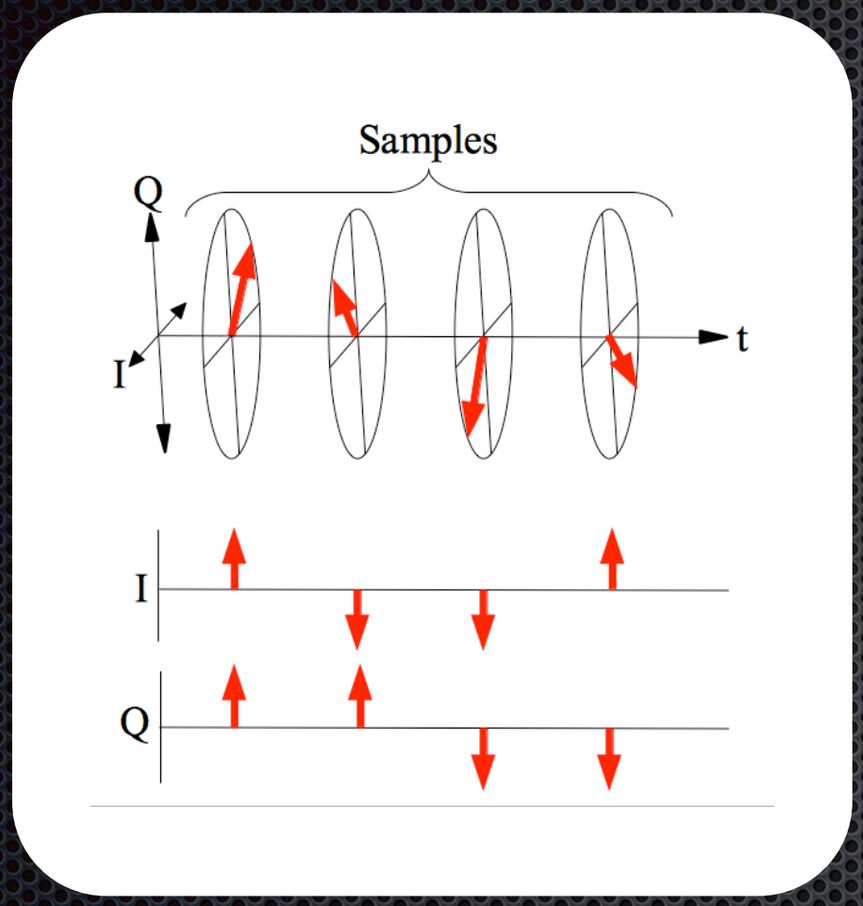
Inter Symbol Interference

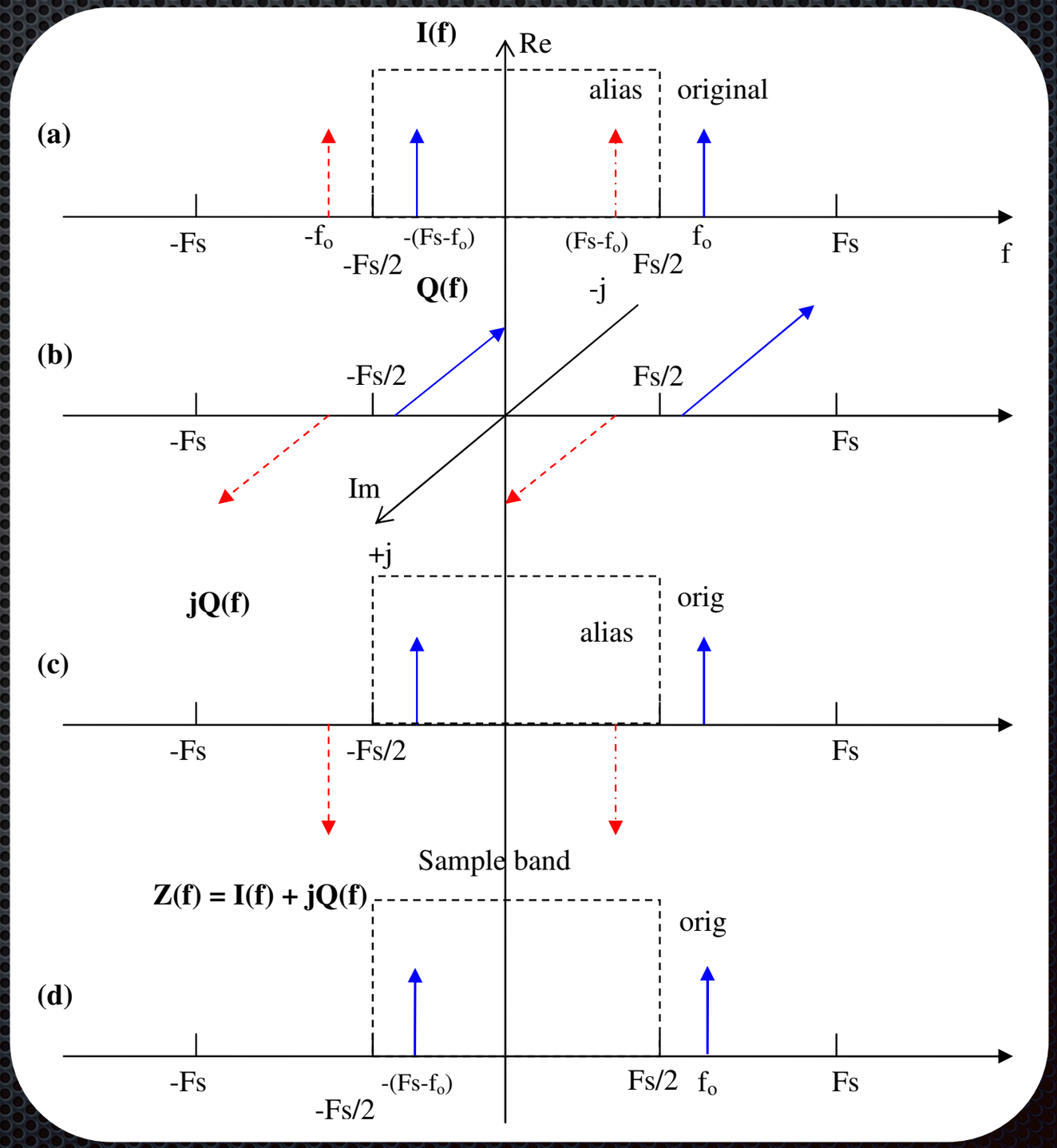


Cyclic Prefix

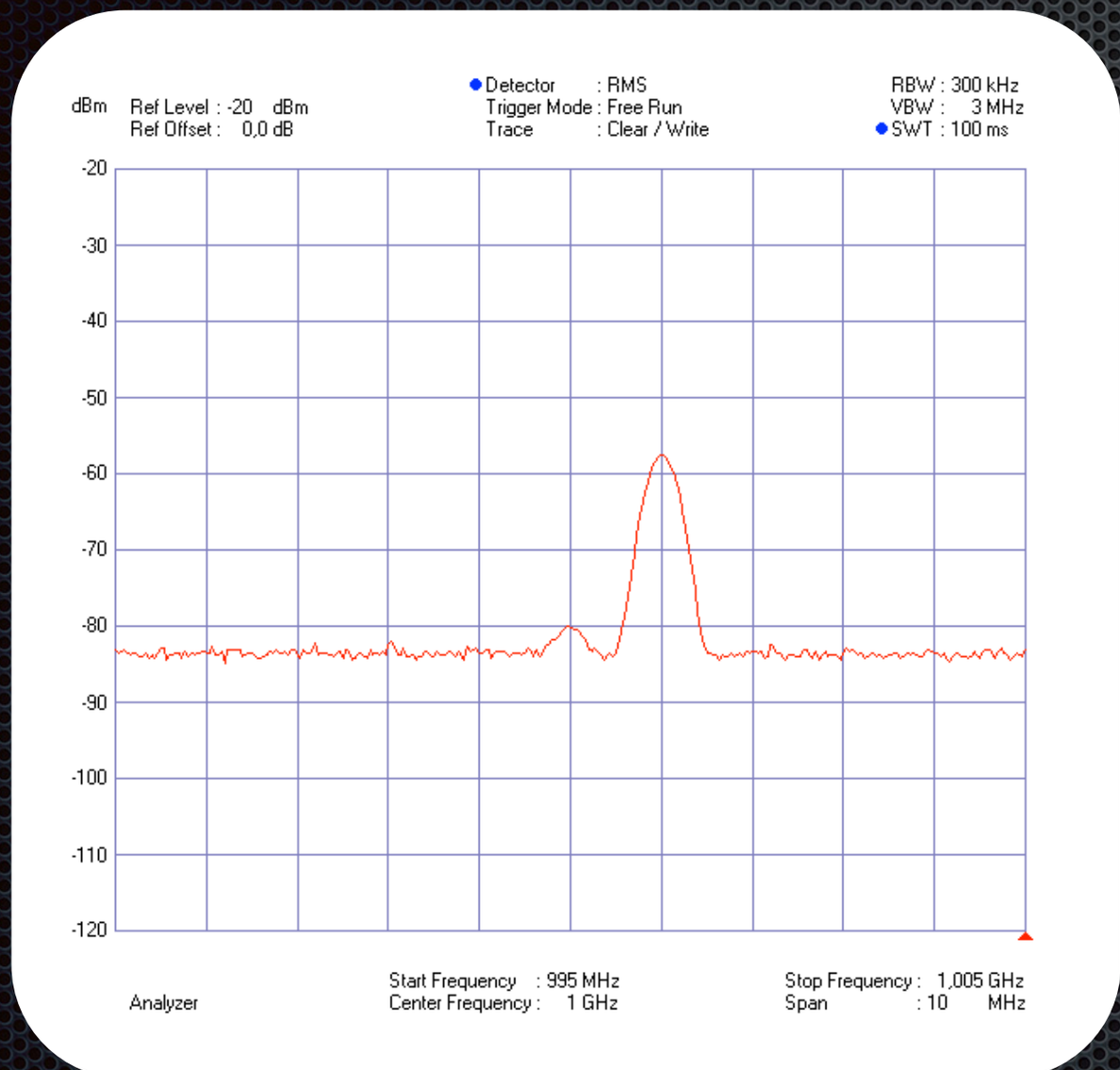


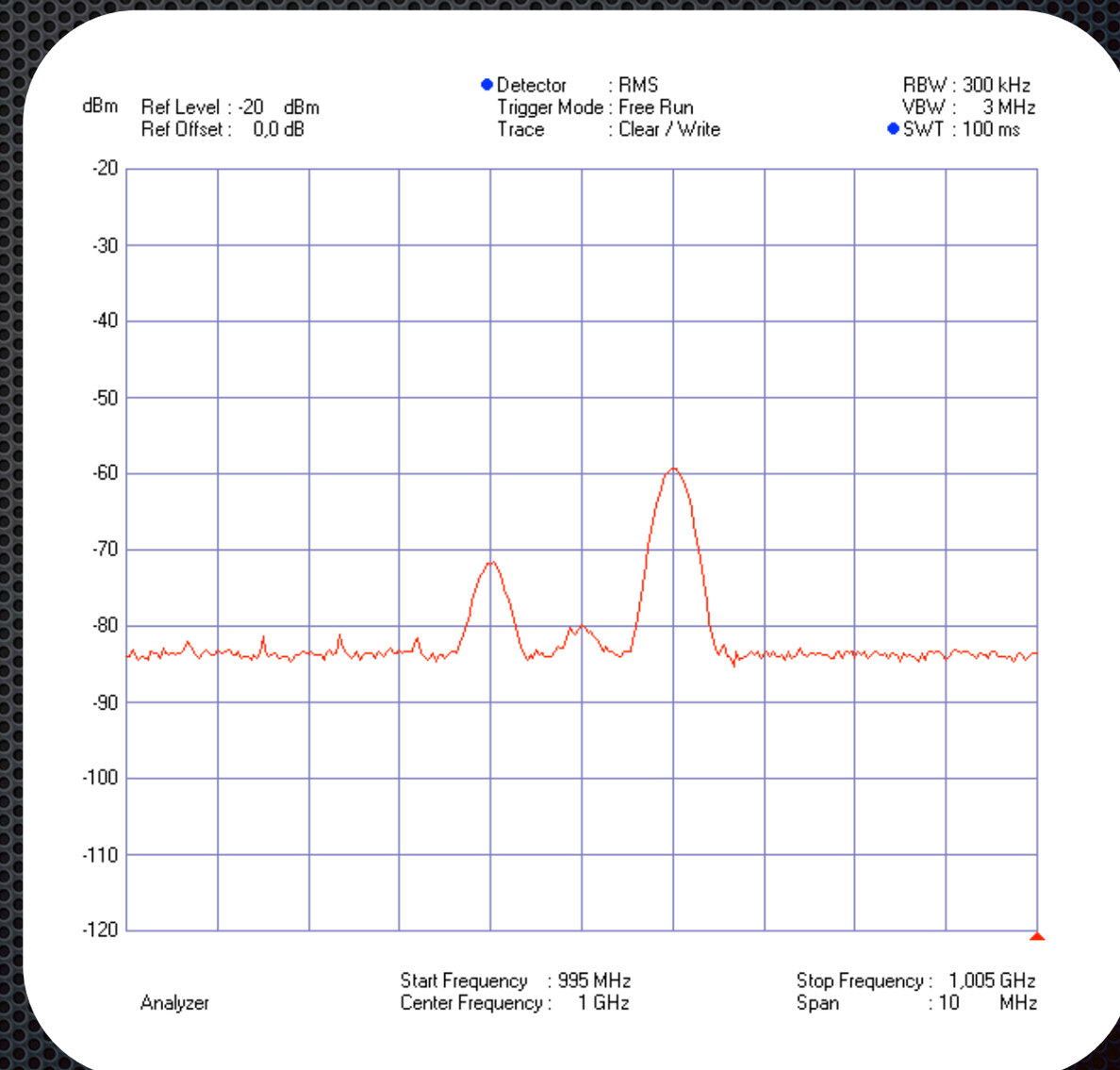
I-Q imbalance



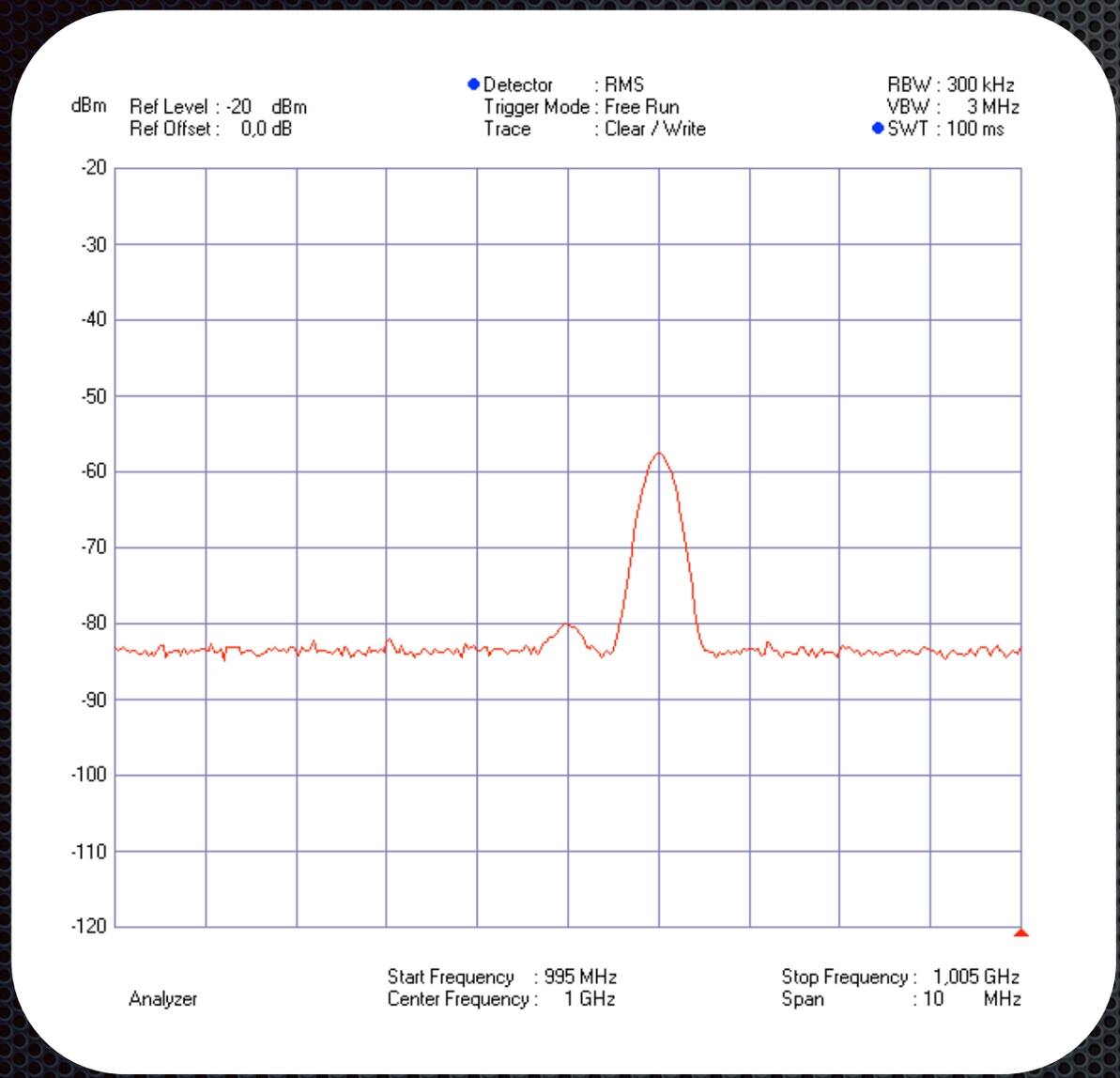


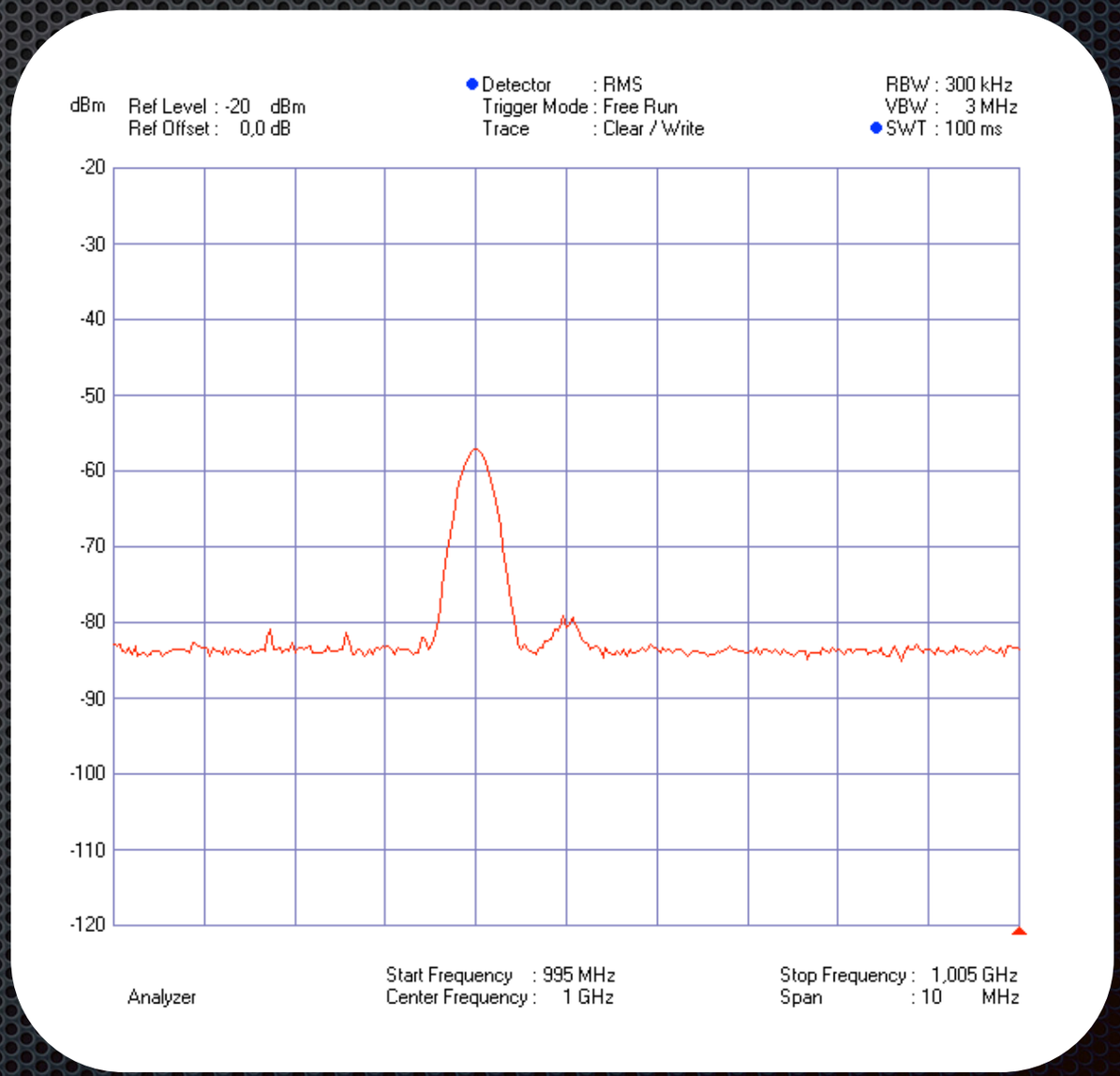
IQ imbalance





IQ swap


dBm
Ref Level : -20 dBm
Ref Offset : 0,0 dB
Detector : RMS
Trigger Mode : Free Run
Trace : Clear / Write
RBW : 300 kHz
VBW : 3 MHz
SWT : 100 ms
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
Analyzer
Start Frequency : 995 MHz
Center Frequency : 1 GHz
Stop Frequency : 1,005 GHz
Span : 10 MHz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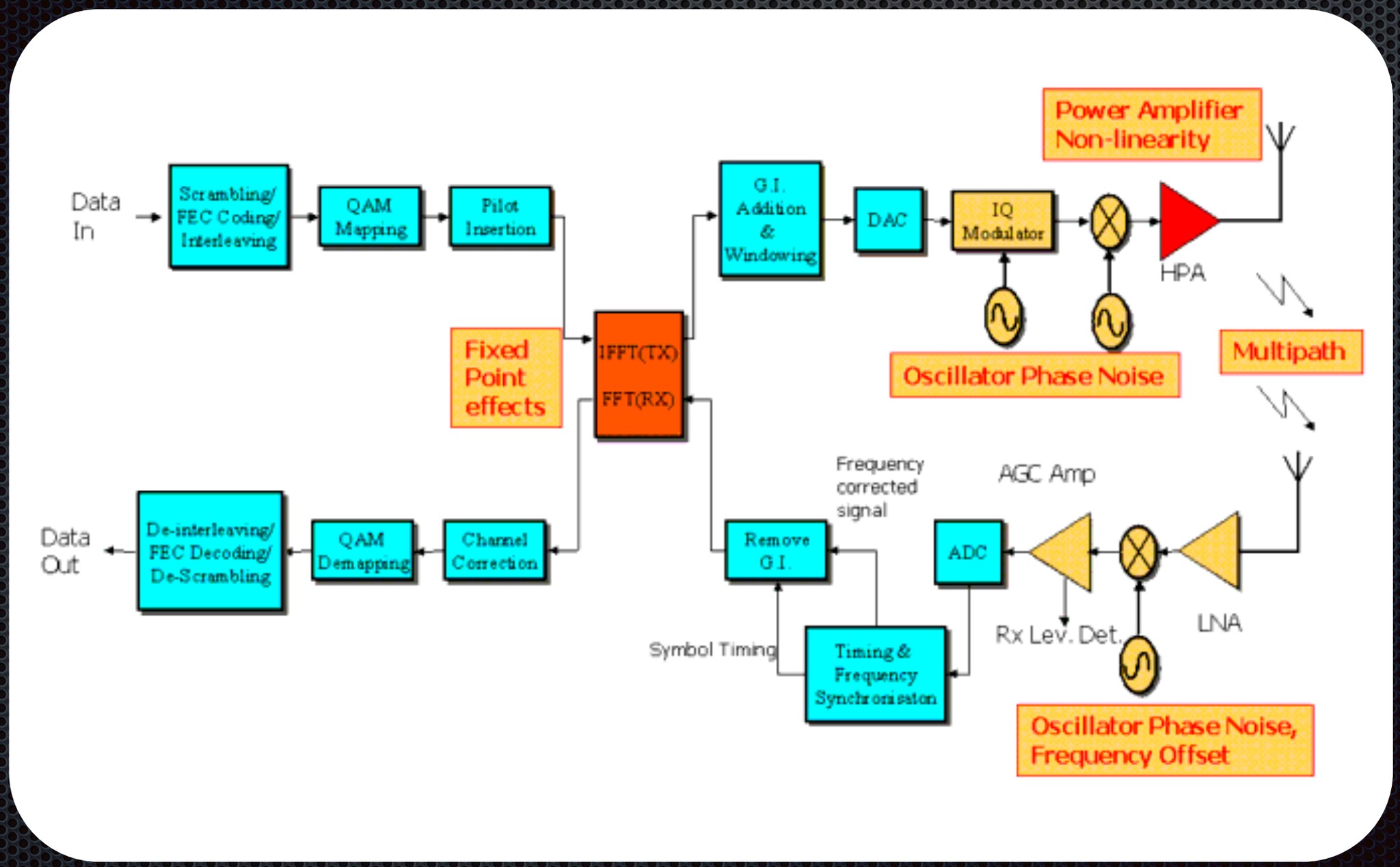
Problems in the Tx-Rx chain