



# IMPROVING PERFORMANCE OF BIO-RADARS FOR REMOTE HEARTBEAT AND BREATHING DETECTION BY USING CYCLOSTATIONARY FEATURES

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CReATION - Cognitive Radio Transceiver Design for Energy Efficient Data Transmission

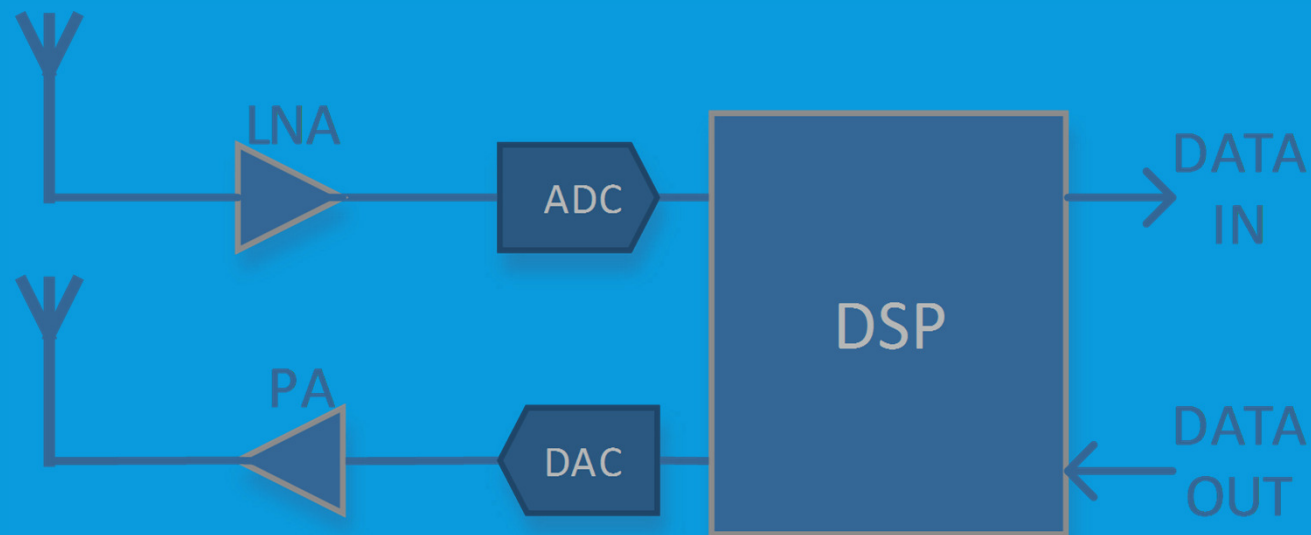
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# INTRODUCTION – SOFTWARE DEFINED RADIO

**Software Defined Radio** is a highly digital configurable radio that allows for the majority of processing to be done digitally



The processing needs to be flexible and able to be reconfigured in real time.

Software Defined Radio

# INTRODUCTION – COGNITIVE RADAR

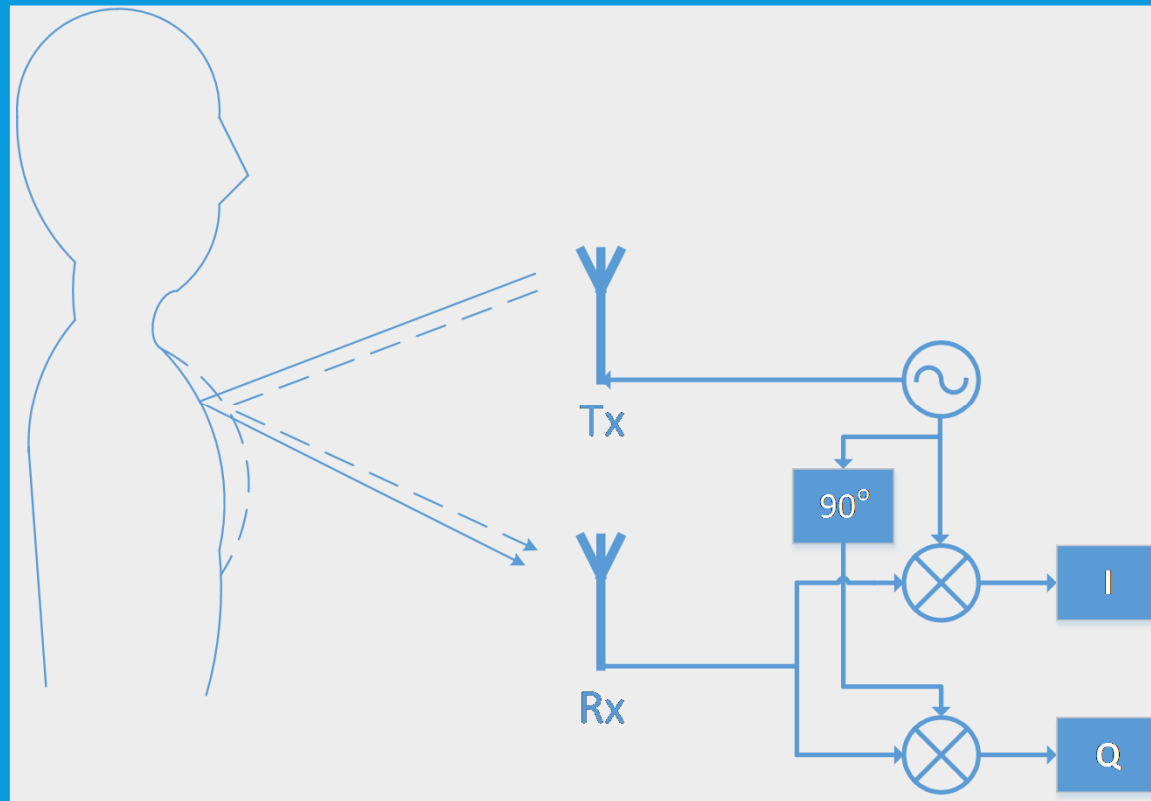
New generation of radars need to be aware of their environment, allowing:

- Usage of multiple radars without interference
- Intelligent usage of spectrum in order to get the best SNR



# INTRODUCTION – BIO-RADAR

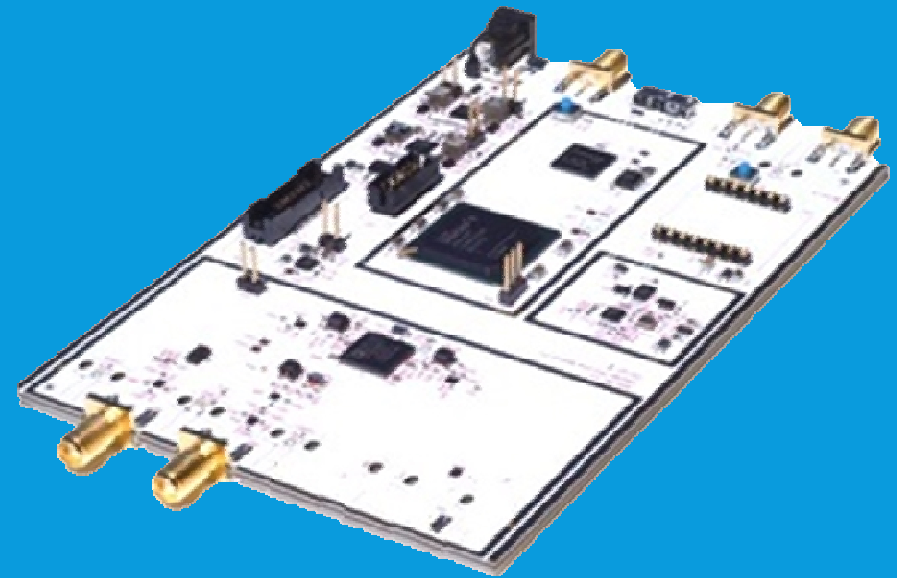
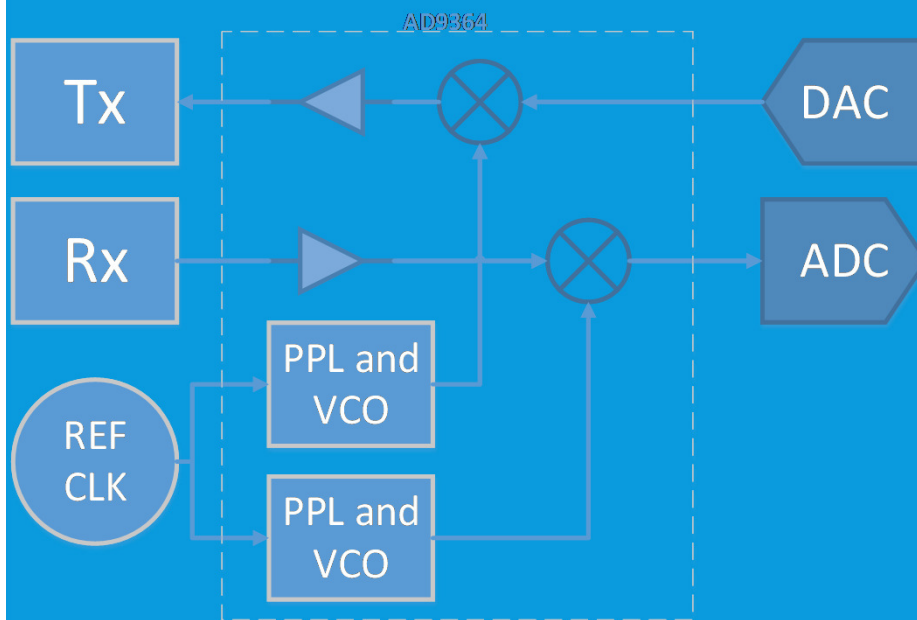
Heartbeat and breathing pattern detected thanks to doppler effect from the reflection on the emitted sinusoid



Chest movement can be used to determine bio signals

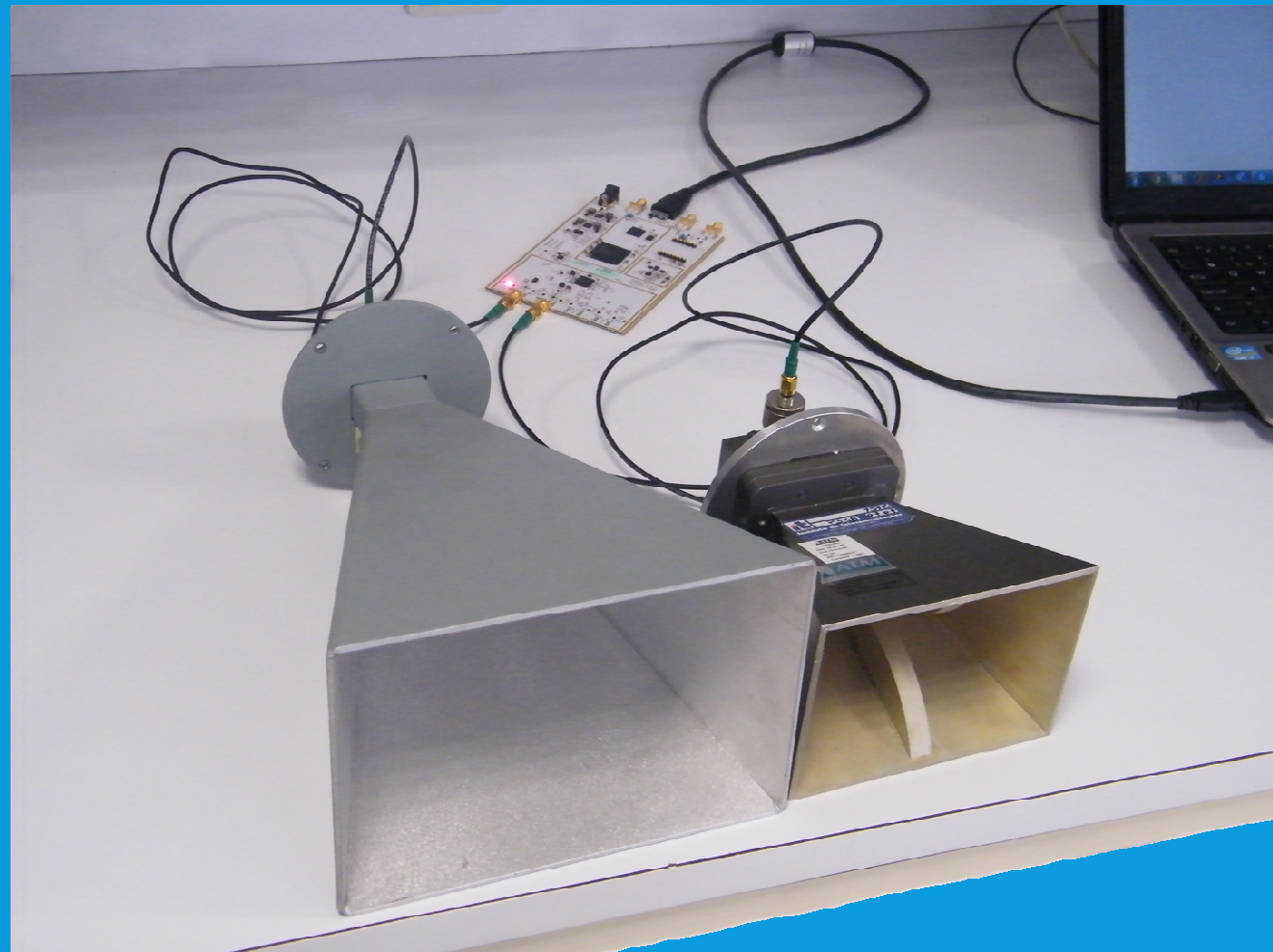
# USED SYSTEM - USRP B200 SDR

Shared clock at the Tx and Rx allow for Homodyne detection allowing to avoid any fluctuations in the mixer frequency



# USED SYSTEM - USRP B200 SDR

- CW with a frequency of 2,7GHz
- Emitted power of 5mW
- Subject under test seated at 1meter

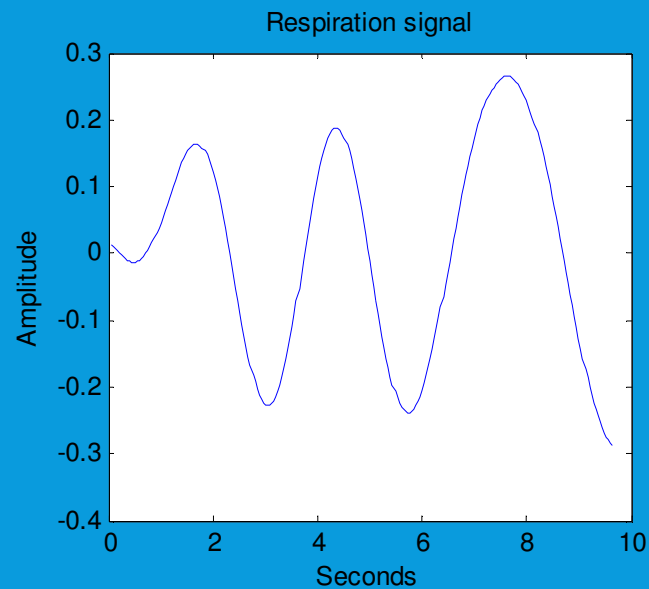
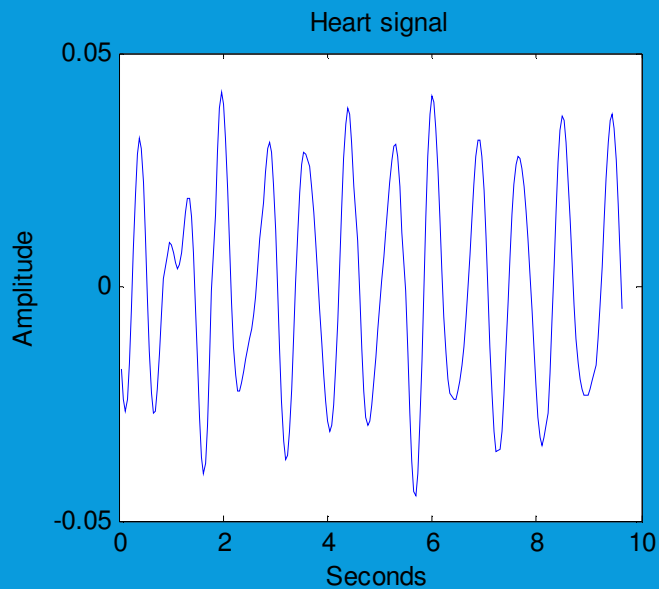


# CARDIORESPIRATORY SIGNALS

- Bio-radar acquired signals for a person at rest

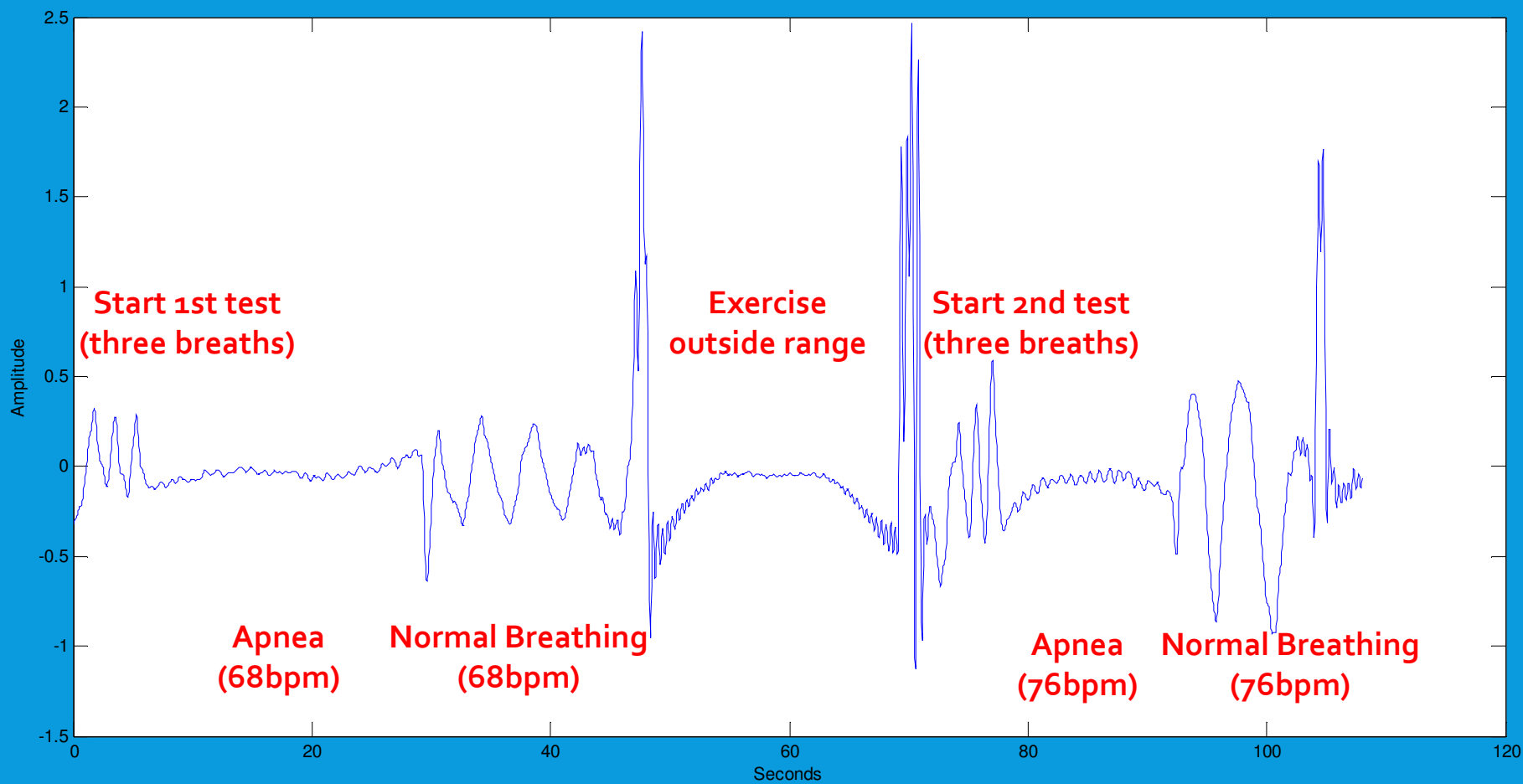
Typical values  
in humans:

Repiration  
**0.1–0.8Hz**  
Heart Rate  
**0.8–2Hz**





# TEST PROCEDURE



# CYCLOSTATIONARITY

- A signal shows cyclostationarity if:
  - Auto-correlation function is periodic with time
  - The mean also shows periodicity
- What signals are cyclostationary:
  - Biosignals like breathing and heartbeat show periodic features

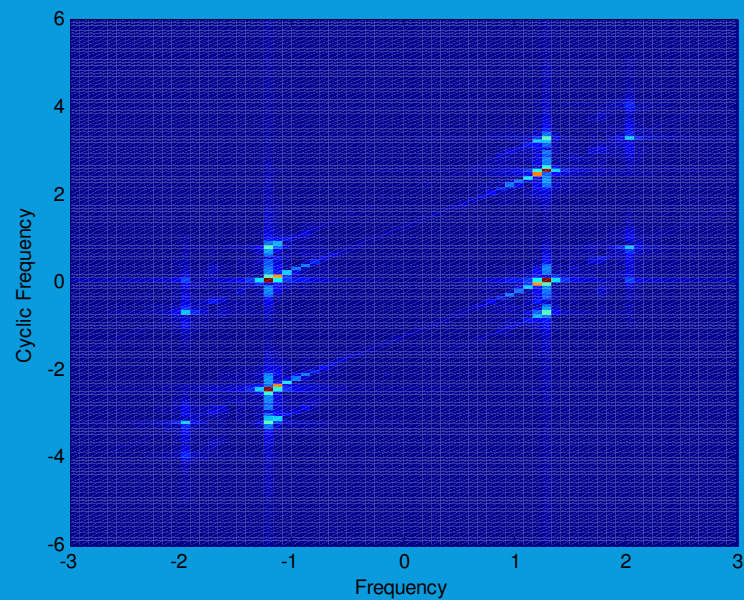
Periodic auto-correlation



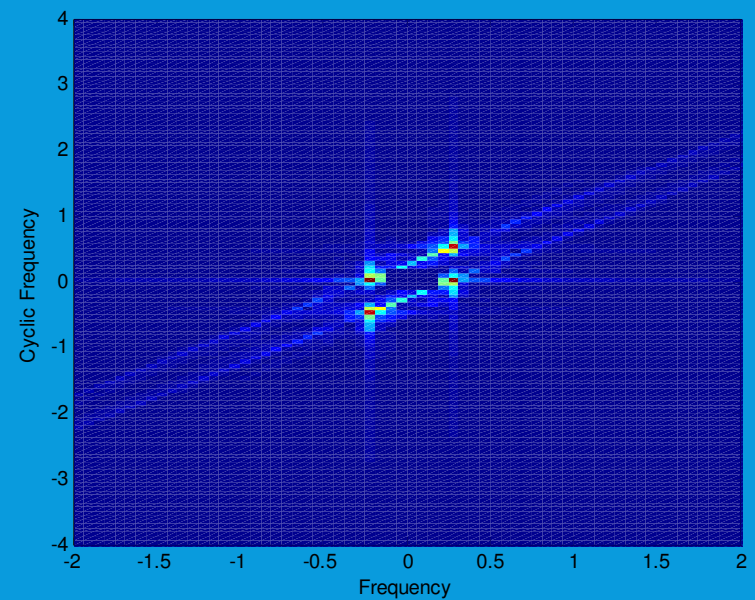
Cyclostationarity

# CYCLOSTATIONARITY FEATURES

- Cyclic spectrum heartbeat and breathing cyclostationarity features



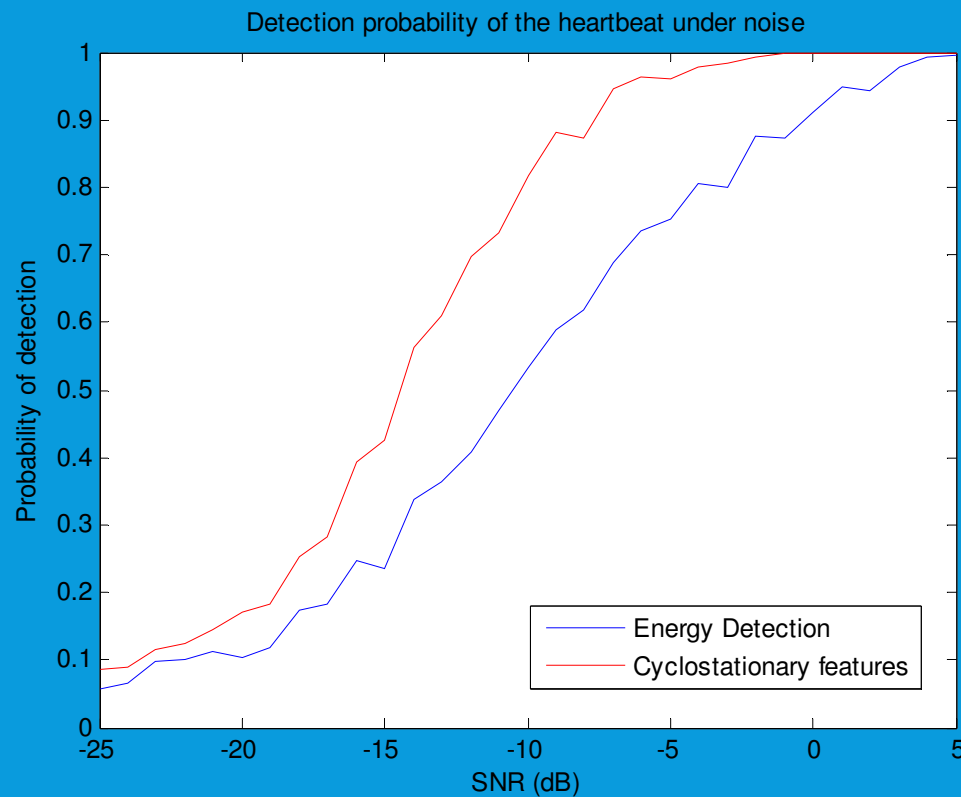
Heartbeat



Breathing

# METHODS COMPARATION

- Energy detection by using peak of FFT
- Cyclostationary by using cyclic spectrum peak



- Improvement of **6dB** for probabilities of detection higher than 80%

# CONCLUSIONS

- It's feasible to use a software defined radio to build a bio-radar and acquire respiration and heartbeat
- With a emitting power  $<10\text{mW}$  we can acquire the heartbeat from 1meter away and breathing for more than 5 meters
- Cyclostationary analysis improve the performance of this type of radars comparatively to simple energy detection schemes

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# QUESTIONS?

