SEVENTH FRAMEWORK PROGRAMME

IP CREW

Cognitive Radio Experimentation World

The imec sensing engine

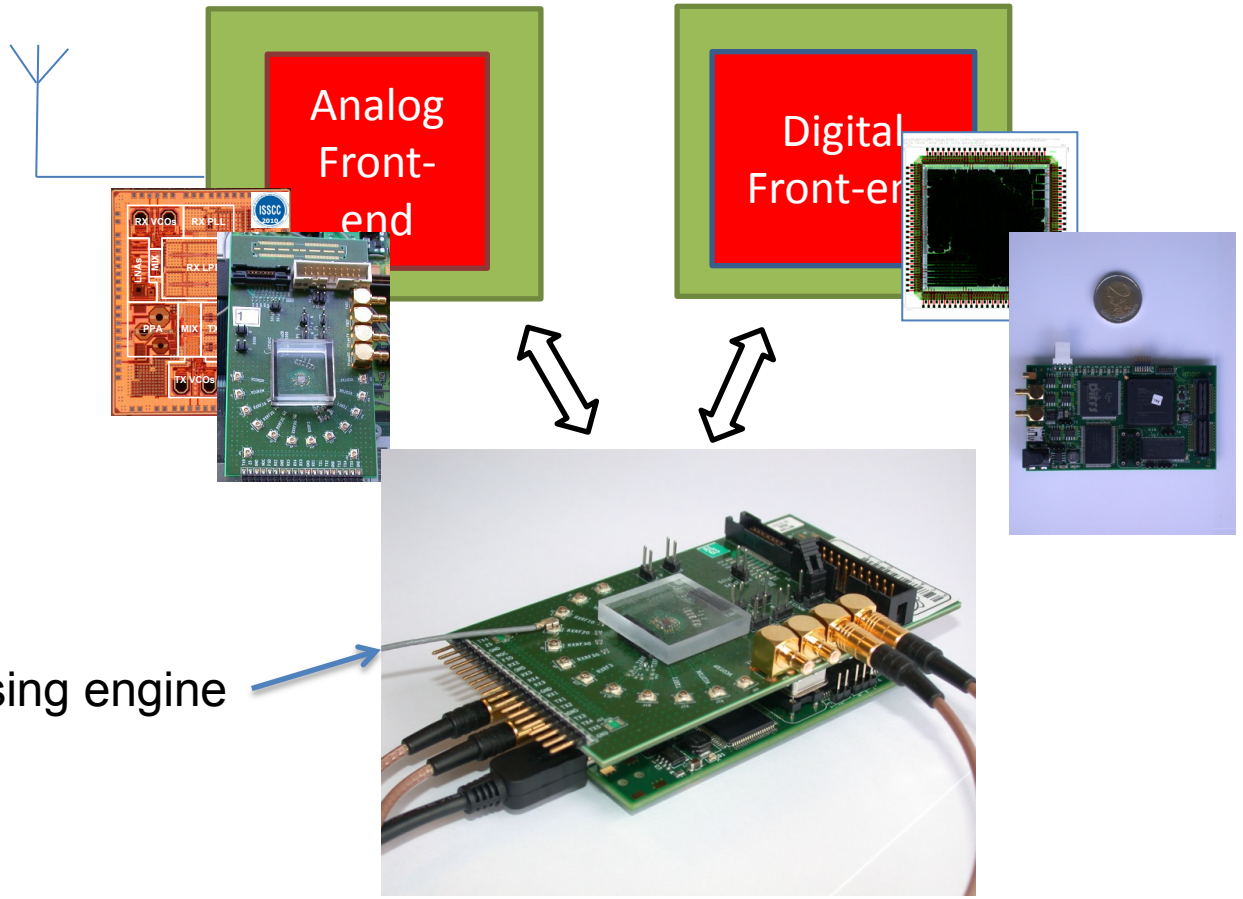
The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 258301 (CREW project).

ibbt imec ctvr TU berlin TECHNISCHE UNIVERSITÄT DRESDEN THALES EADS

The imec sensing engine

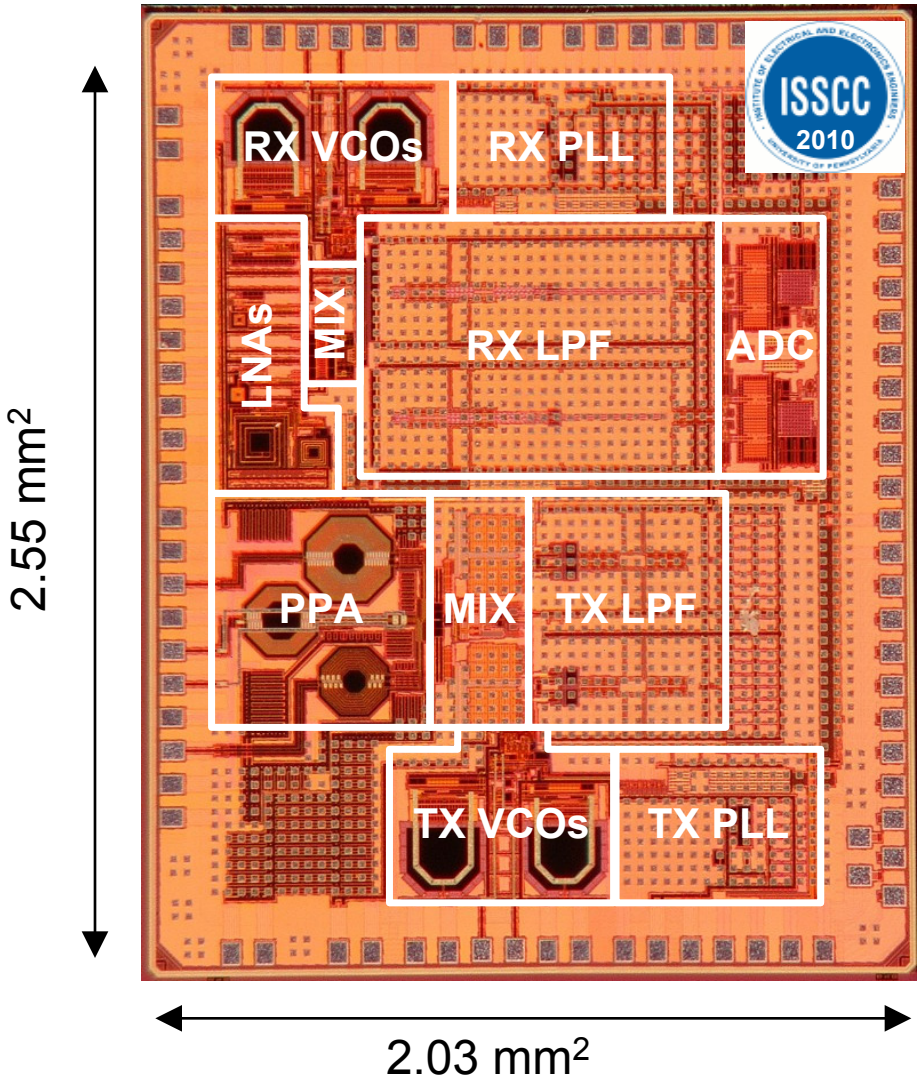
- **Hardware overview**
  - The sensing engine
  - Analog front-end
  - Digital front-end
- **Some examples**
  - Fast sweep
  - LTE, DVB-T, ISM
- **How to use it**
- **Conclusions**

imec advanced spectrum sensing

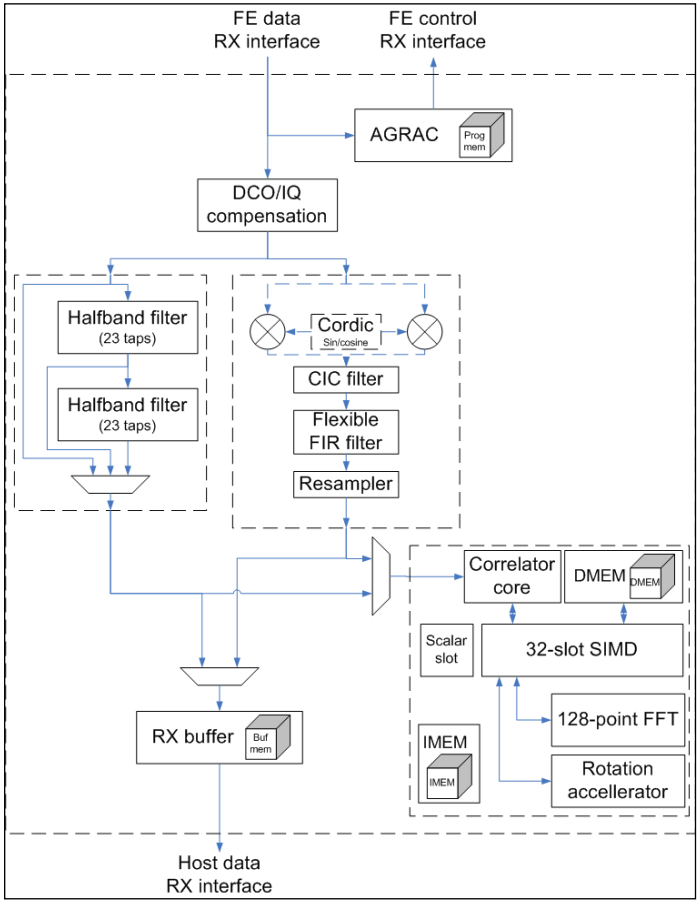


Scaldio-2b: a 5 mm² reconfigurable transceiver in 40nm CMOS

- Full transceiver
- RF input from 100MHz up to 6 GHz
- Baseband BW from 1 up to 40 MHz
- On chip SAR-ADC
  - 10b
  - 65 Ms/s
- 40nm digital 1.1/2.5V CMOS TSMC technology
- Performance comparable to SotA single-mode radios
  - Area: 5 mm²
  - Power consumption: 40-100 mW depending on mode



Digital front-end for sensing (DIFFS)



Low-power synchronization

65 nm TSMC

Flexible filter/mixer/resampler

- support for ΣΔ
- future standards
- concurrent reception/sensing

Sync/sense engine: SIMD

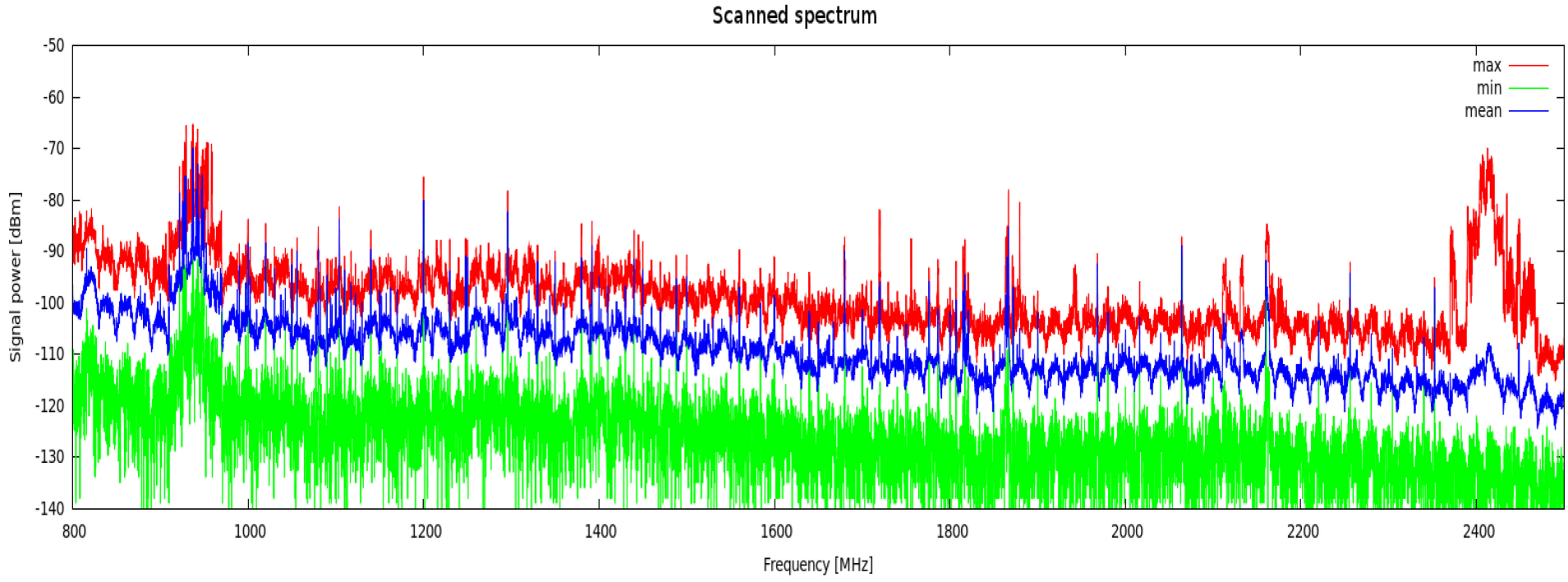
- dedicated accelerator cores
- capable of “sensing” + “syncing”

The imec sensing engine

- **Hardware overview**
  - The sensing engine
  - Analog front-end
  - Digital front-end
- **Some examples**
  - Fast sweep
  - LTE, DVB-T, ISM
- **How to use it**
- **Conclusions**

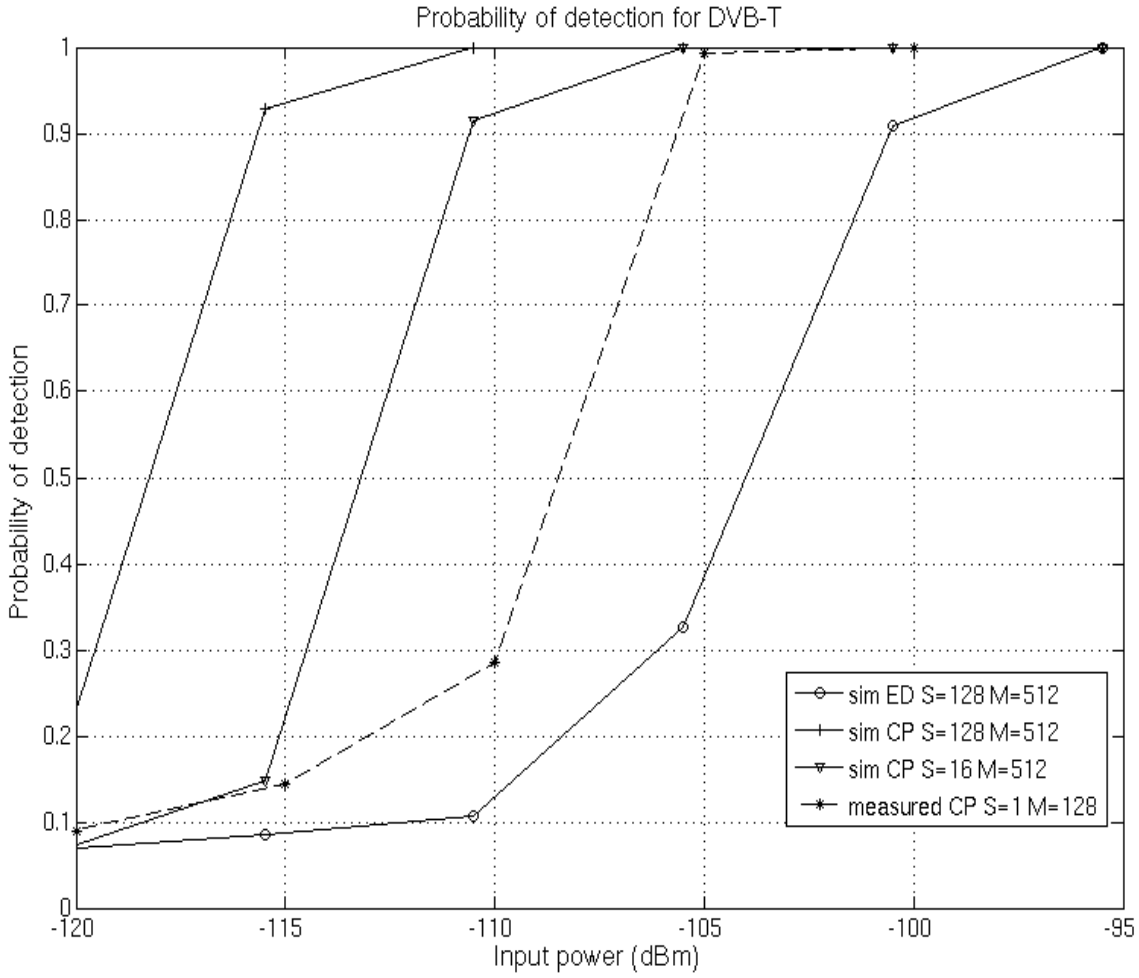
Very fast sweep

- **20 MHz and 128-point FFT per snapshot**
  - Resolution of approx. 150 kHz
- **15mW**
- **< 10ms**



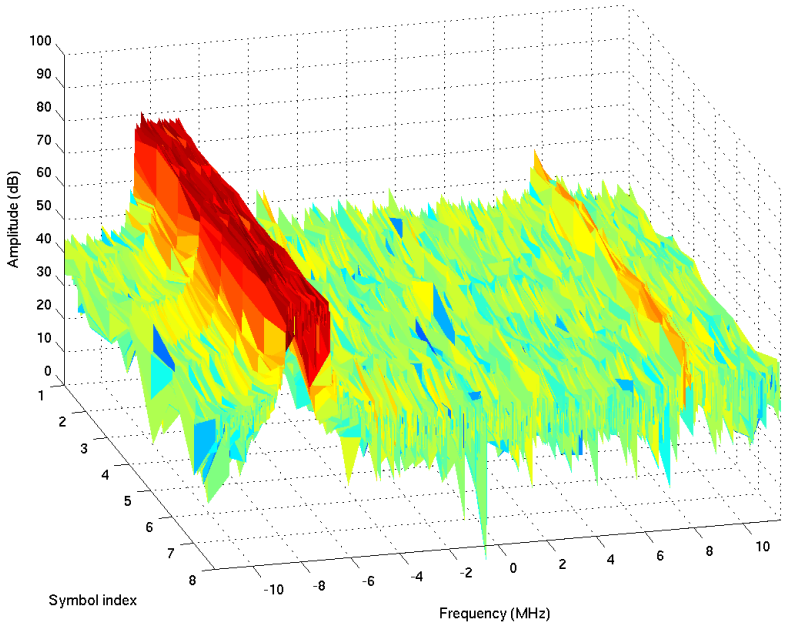
Sensing of DVB-T

- **Simulations and measurements for autocorrelation-based sensing**



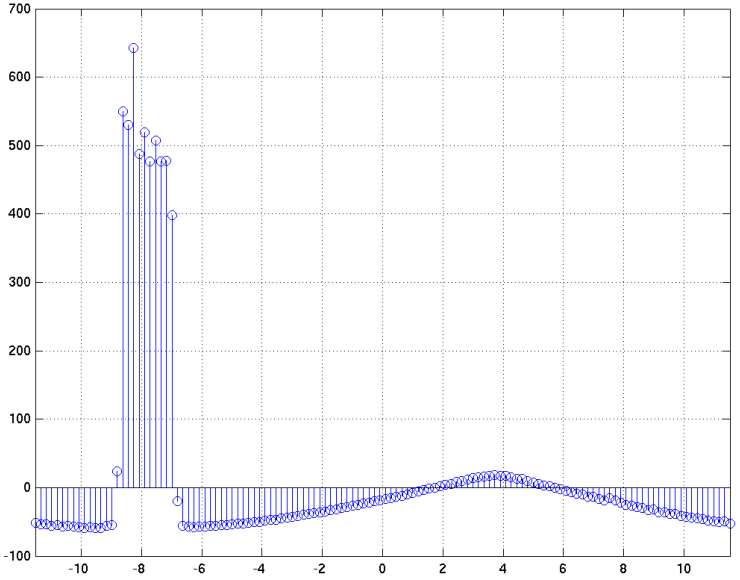
Sensing of LTE

Sensing of LTE: the TUD LTE-signal



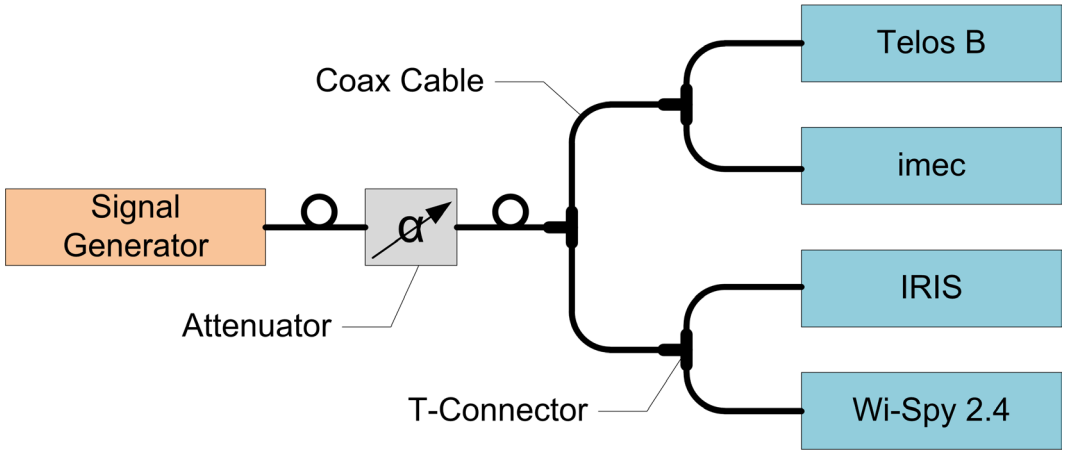
20 MHz LTE signal with 10 active PRB's
Wirelessly transmitted
2.6 GHz band

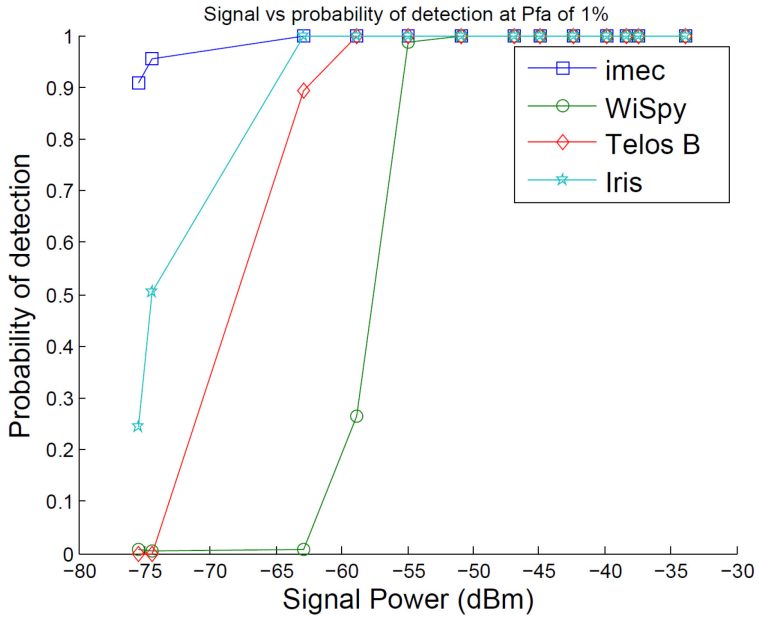
Synced and active PRB's found

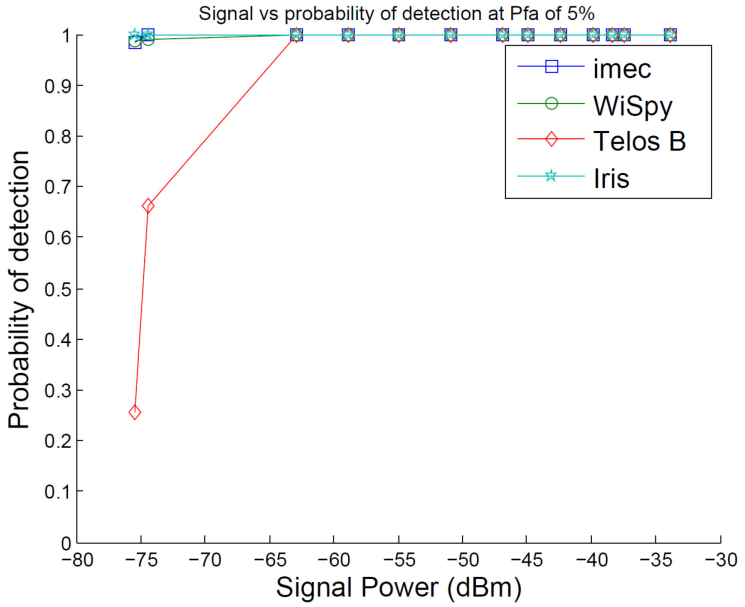


Sensing in the ISM band CREW results

Probability of Detection of the Signal vs. TX Power for Coax Cable Connection







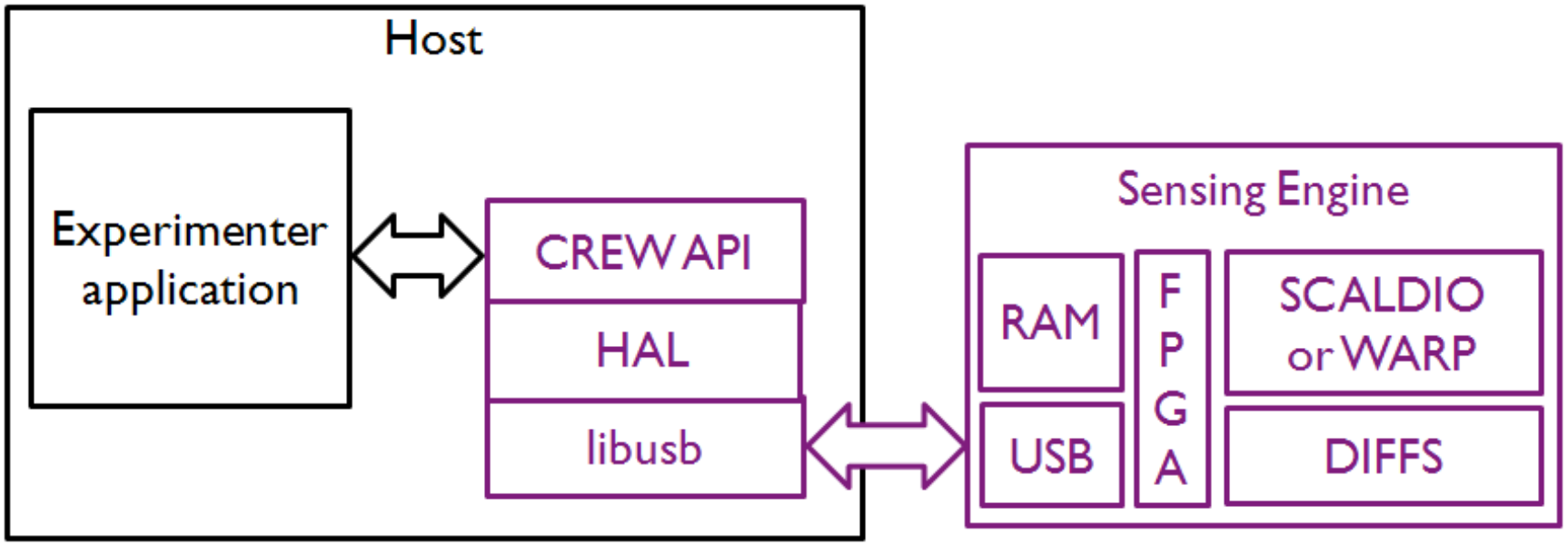
Prob. for False Alarms: 1 %

Prob. for False Alarms: 5 %

The imec sensing engine

- **Hardware overview**
  - The sensing engine
  - Analog front-end
  - Digital front-end
- **Some examples**
  - Fast sweep
  - LTE, DVB-T, ISM
- **How to use it**
- **Conclusions**

Ways to interact with the sensing engine

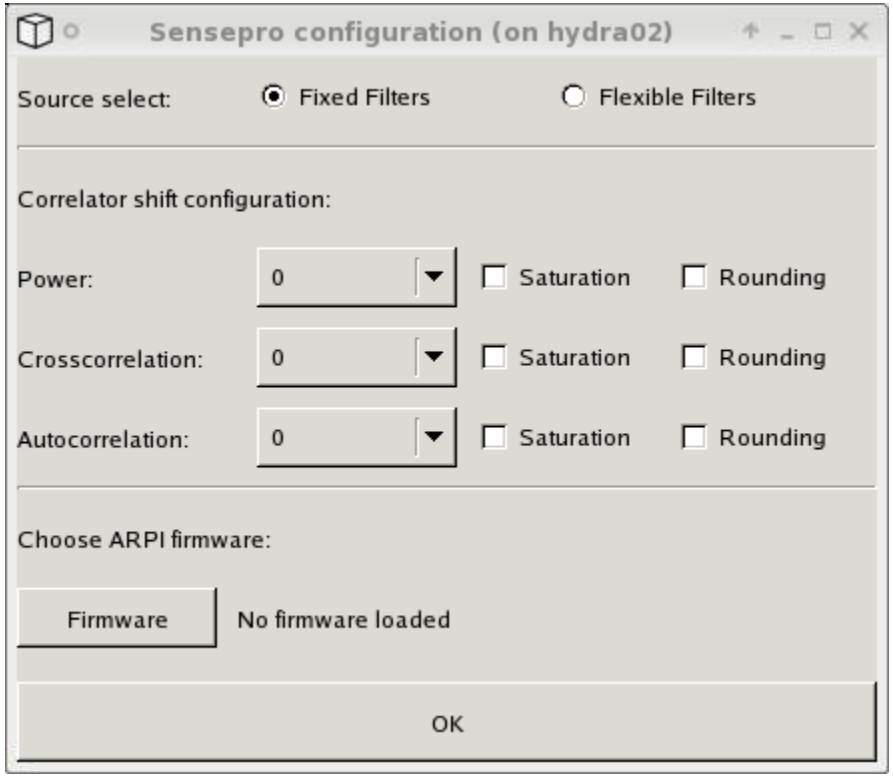


E.g., API support for the WARP RF front-end

- **Detector**
  - Algorithm
    - Power measurement (vs threshold)
    - FFT (vs threshold) - [32/64/128] bins
  - Gain configuration
    - Automatic Gain Control
    - Fixed gain
- **Mode/channels**
  - Bluetooth / 1 .. 80
  - Zigbee / 1 .. 15
  - WLANg / 1 .. 13
  - WLANn / 1 .. X

E.g., Configuring the DIFFS through the HAL

- Input datapath selection
- Correlator configuration
- Firmware selection for the SIMD processor



Many more information in the CREW deliverables/portal

The imec sensing engine

- **Hardware overview**
  - The sensing engine
  - Analog front-end
  - Digital front-end
- **Some examples**
  - Fast sweep
  - LTE, DVB-T, ISM
- **How to use it**
- **Conclusions**

Conclusions

- **Sensing solution is ready to be used**
  - With SCALDIO front-end
  - With WARP front-end
  - With some example code/functionality
  - Integrated in IBBT wilab.t testbed

- **We are open to your ideas for meaningful sensing experiments**
  - New algorithms
  - New approaches (database, distributed)
  - New scenarios