

An abstract, flowing purple graphic in the top left corner, resembling a stylized flame or a dynamic, organic shape with multiple pointed ends.

# THE IMEC SENSING ENGINE: AN INTRODUCTION

**CREW TRAINING DAYS 2014, GHENT**

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# OVERVIEW

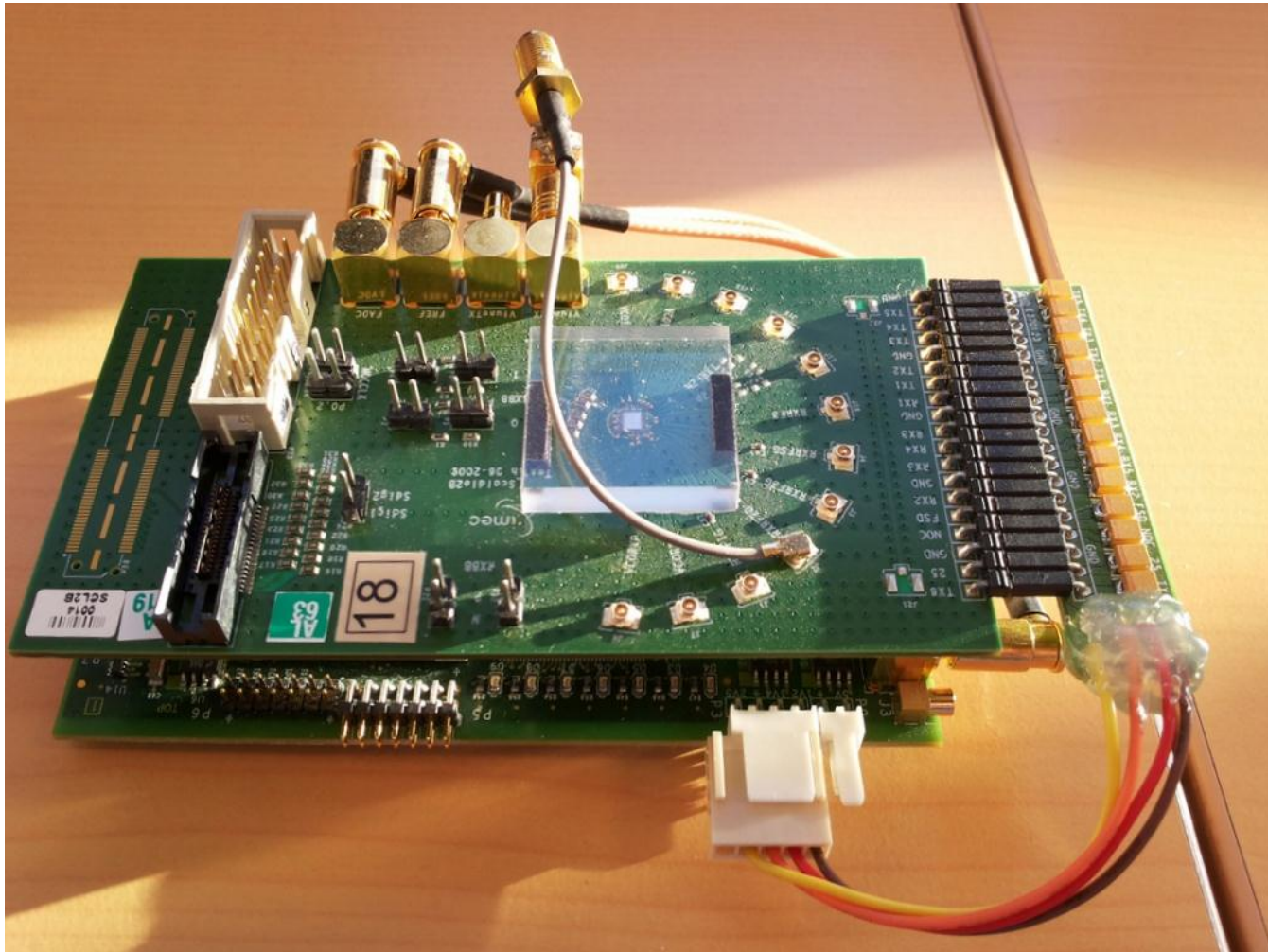
- ▶ **Introduction**
- ▶ Overview of the different components
- ▶ Different modes of operation
  - Specifications
  - Generated output
- ▶ Configuration and control
- ▶ Examples of usage
- ▶ Hands-on / demonstration

# SENSING @ IMEC: OVERVIEW

- ▶ Working on SDR both baseband and analog frontend
- ▶ Focus on next-gen handheld/mobile: low-power, high throughput
- ▶ SDR ideal match for cognitive radio
- ▶ No sensing = no cognitive radio
- ▶ The imec sensing engine is an essential part of the imec SDR platform



# WE BUILT A COMPACT AND FLEXIBLE SENSING ENGINE



# OVERVIEW

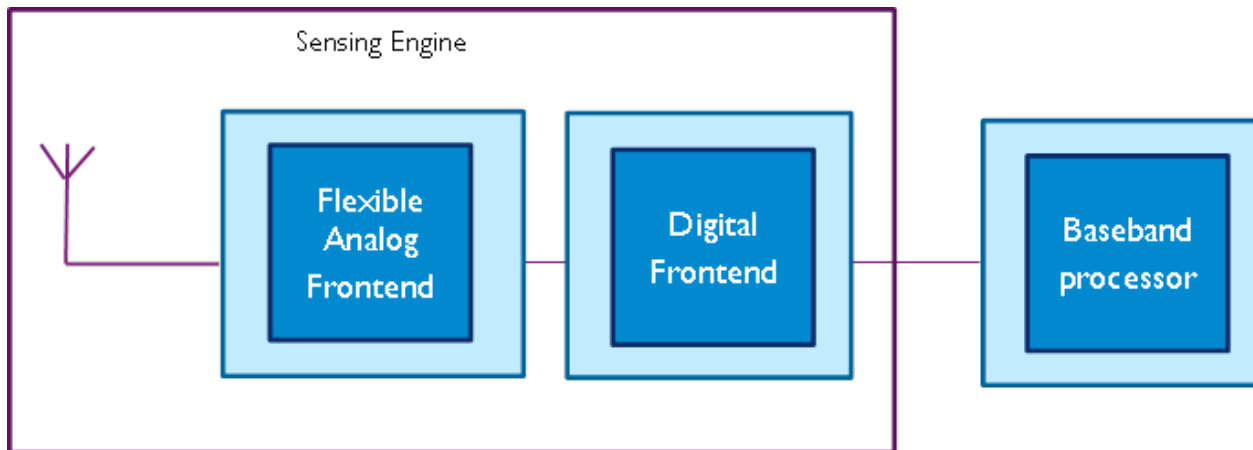
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# MAIN FEATURES OF THE IMEC SE

- ▶ DIFFS digital front-end
  - Small area, low power ASIC
  - Filtering, auto/cross-correlation, multi-band energy detection
- ▶ Range of analog frontends
  - SCALDIO analog front-end (imec)
    - Small area, low power
    - Highly reconfigurable, wide operating range
    - Low LO settling time
  - WARP radio interface
    - 802.11 a/b/g radio bands
- ▶ Sensing functionality
  - Basic energy detection
  - Advanced feature detection

# OVERVIEW OF THE DIFFERENT COMPONENTS IN CREW OC3

- ▶ DIFFS
- ▶ Spider
- ▶ WARP



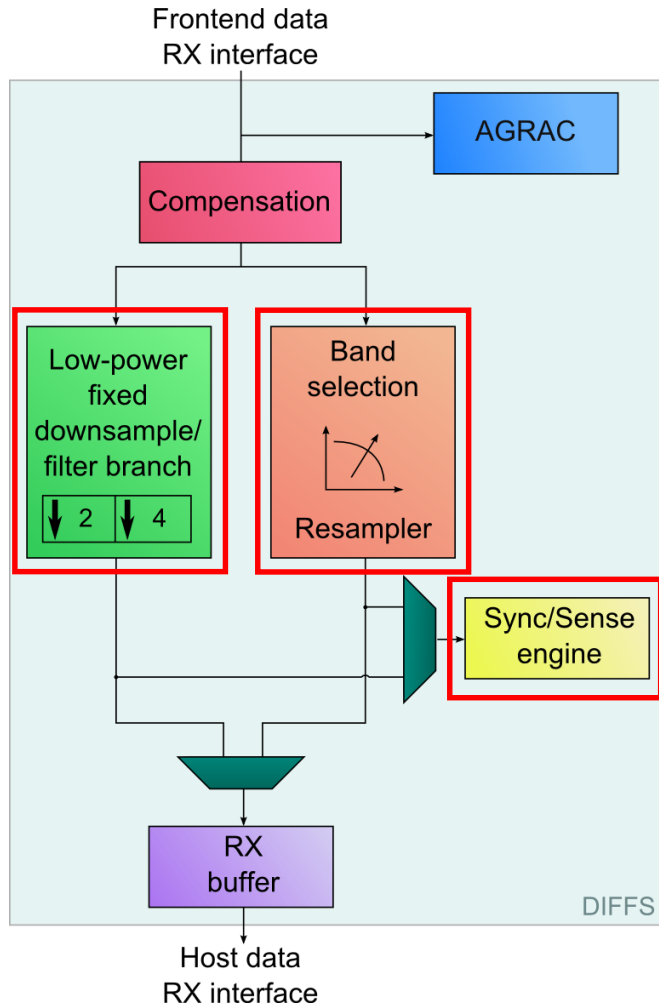
# OVERVIEW OF THE DIFFERENT COMPONENTS: DIFFS

- ▶ Digital Frontend for Spectrum Sensing





# SENSING-ENABLED DFE READY FOR THE FUTURE



Low-power synchronization

Flexible filter/mixer/resampler

- support for  $\Sigma\Delta$
- future standards
- concurrent reception/sensing

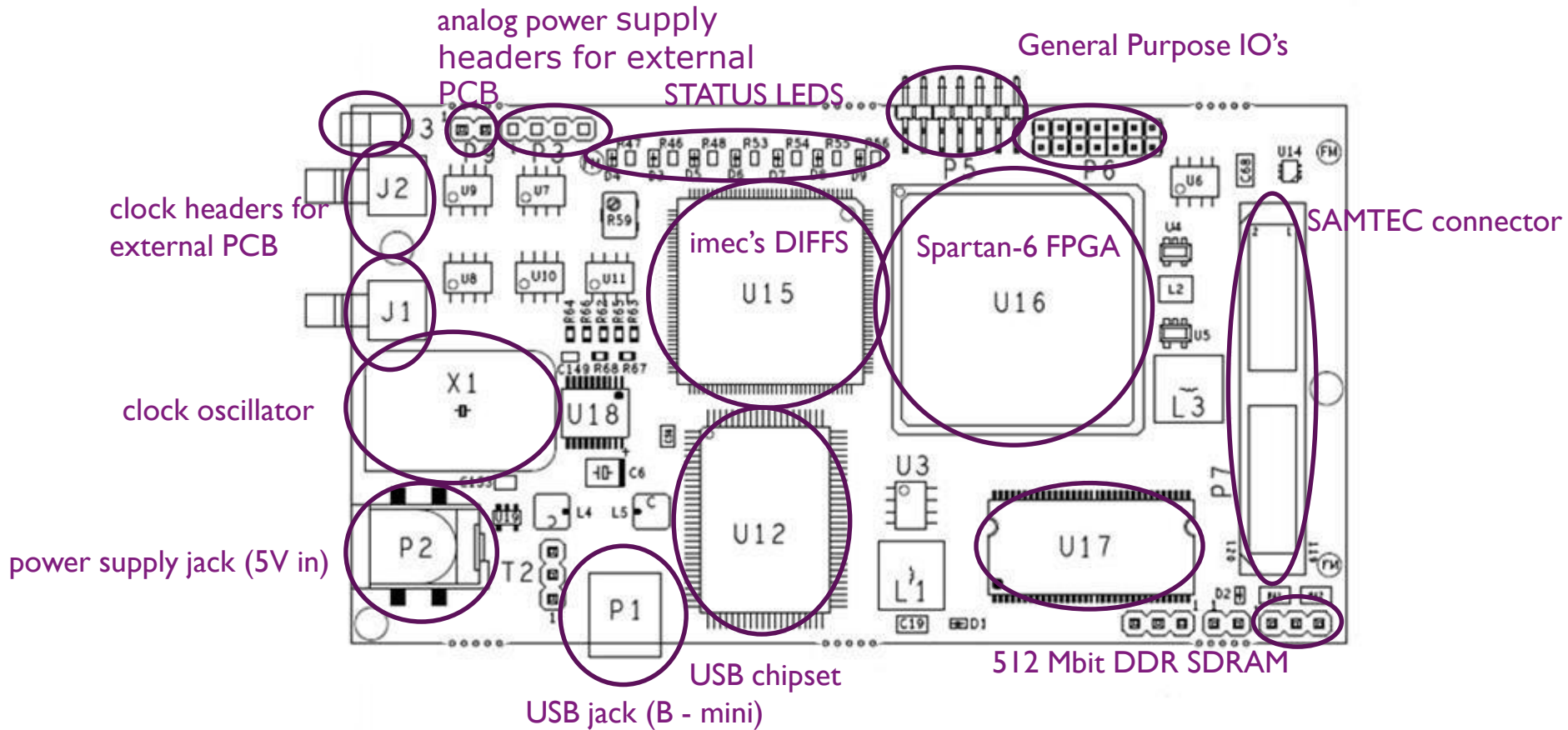
Sync/sense engine: SIMD

- dedicated accelerator cores
- capable of "sensing" + "syncing"

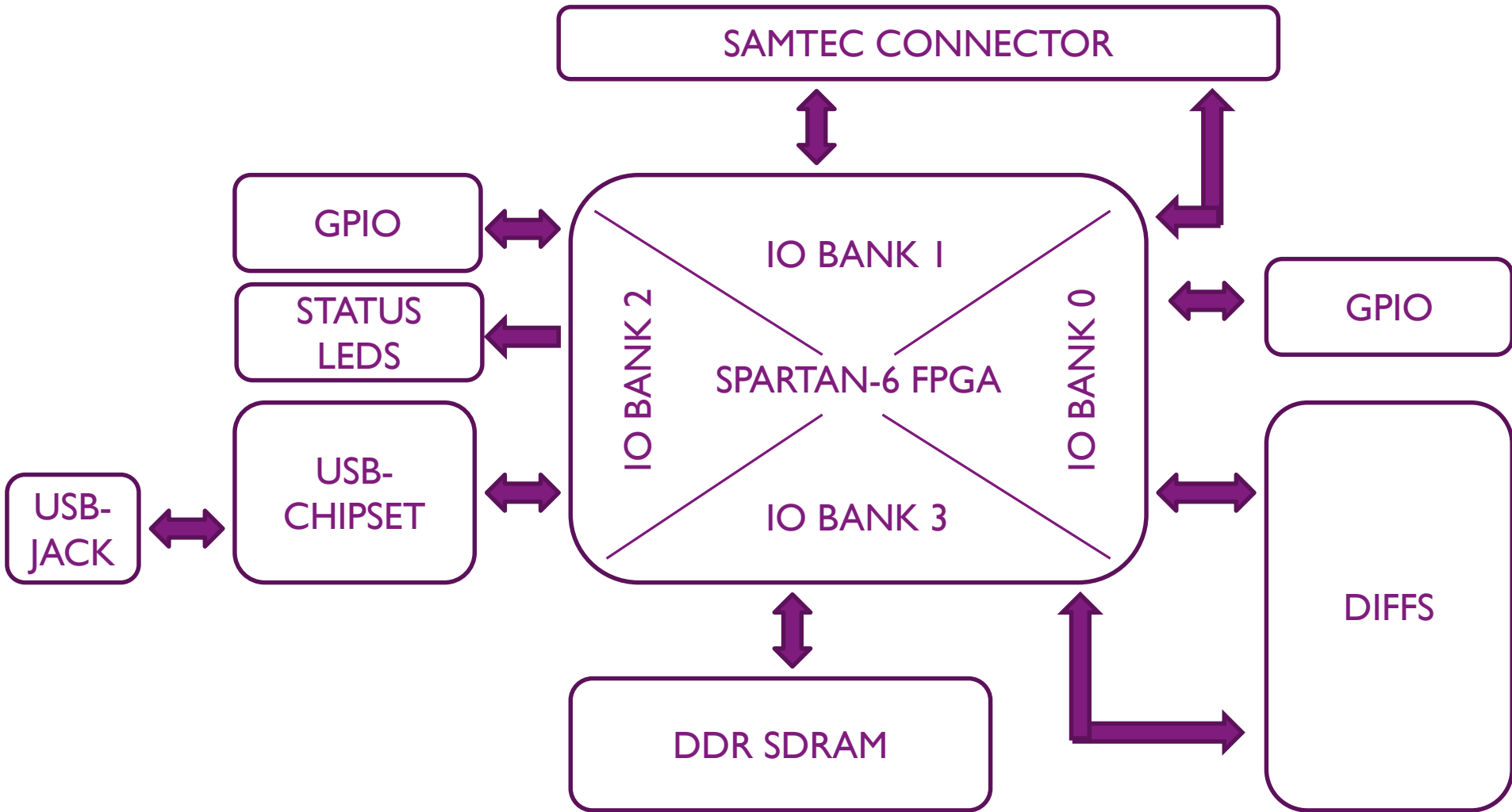
# OVERVIEW OF THE DIFFERENT COMPONENTS: SPIDER



# SPIDER: COMPONENTS



# SPIDER BLOCK DIAGRAM

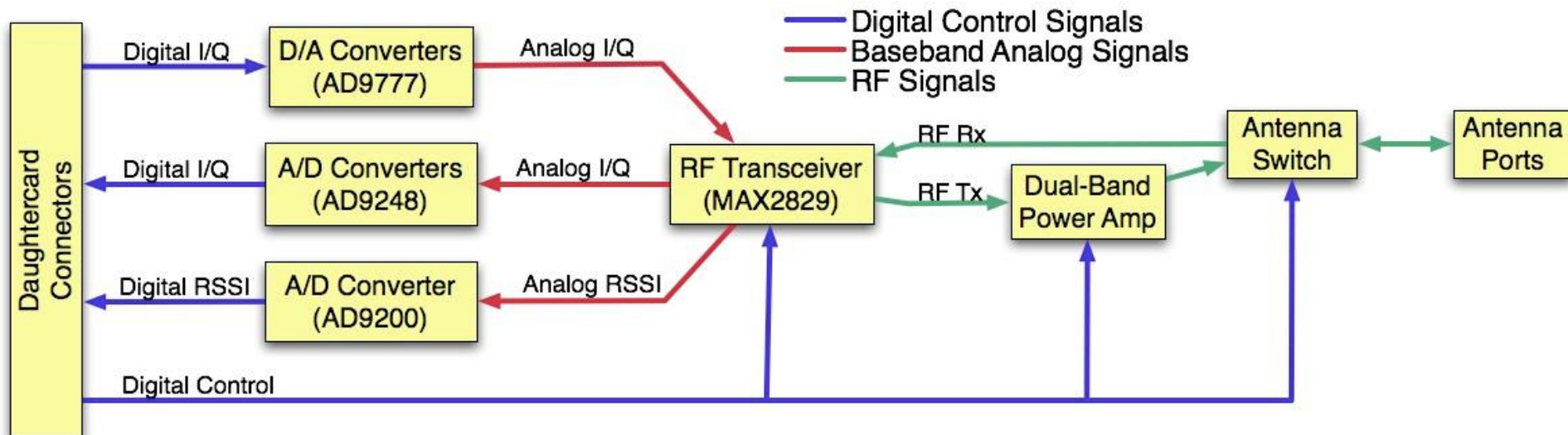


# OVERVIEW OF THE DIFFERENT COMPONENTS: WARP



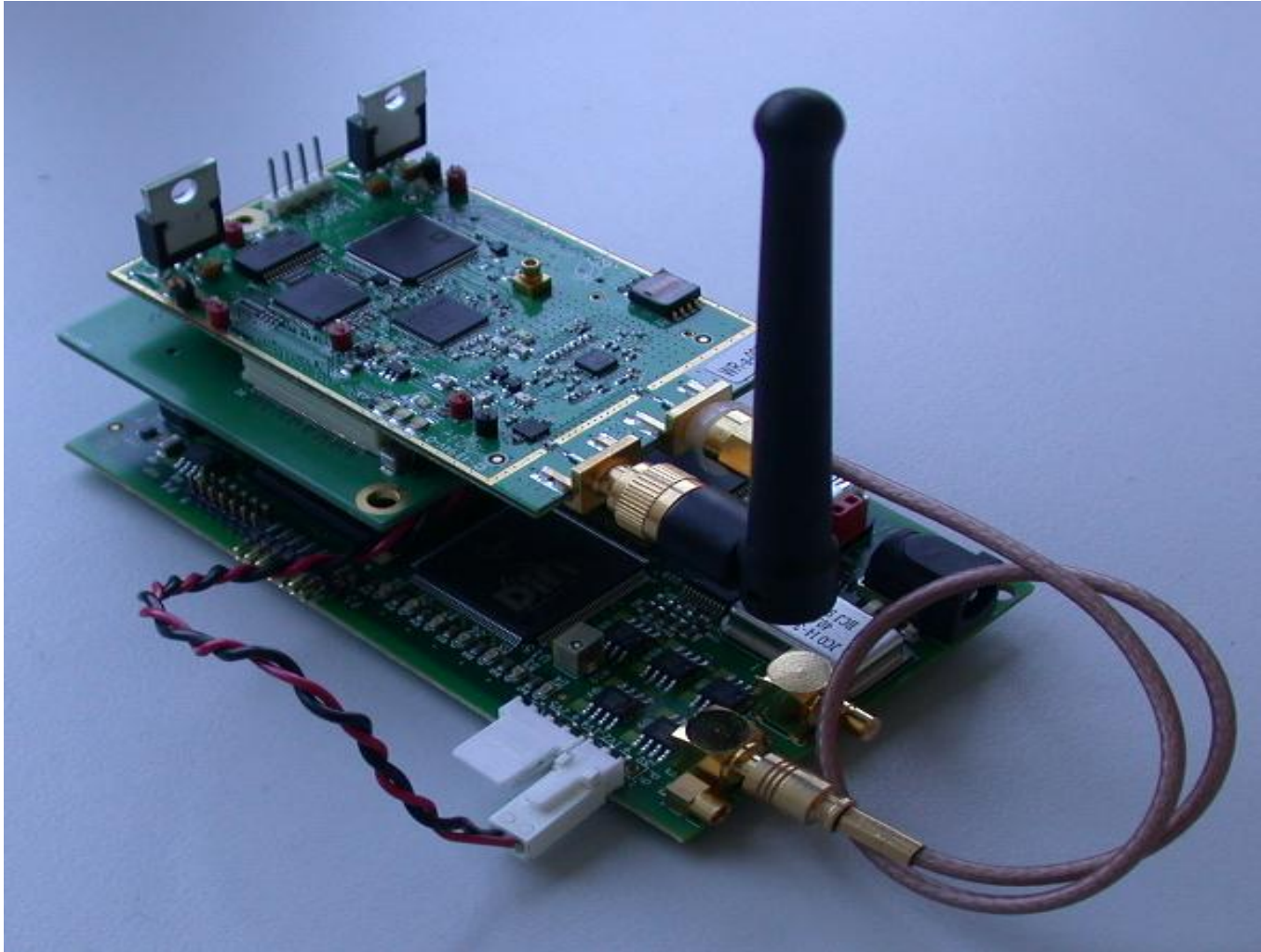
# WARP RADIO BOARD

- ▶ Wireless Open Access Research Platform developed at Rice University
- ▶ Dual-band IEEE 802.11a/b/g Transceiver
- ▶ 2 antenna ports, MIMO capable
- ▶ On board DAC, ADC, RSSI ADC and dual band PA





# SENSING ENGINE WITH WARP RADIO BOARD



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# DIFFERENT MODES OF OPERATION

## ▶ FFT-sweep

- Full Analog Frontend frequency range
  - 500 MHz – 6 GHz for Scaldio
  - 2.4 GHz – 2.5 GHz and 4.9 GHz – 5.875 GHz for WARP Radio board
- 128-points hardware accelerated FFT for each 20 MHz subband (“channel”)
- Programmable RX gain

## ▶ Output:

- Power value in dBm
- 128 bins per channel

# DIFFERENT MODES OF OPERATION

## ▶ WLAN-G

- IEEE 802.11g power assessment
  - 14 channels
  - Accumulated power value for x samples
- Fast reconfiguration and “processing”
- Programmable RX gain
- Programmable threshold

## ▶ Output:

- 1 power value per channel
- Binary comparison to threshold

# DIFFERENT MODES OF OPERATION

## ▶ WLAN-A

- IEEE 802.11a power assessment
  - 23 channels
  - Accumulated power value for x samples
- Fast reconfiguration and “processing”
- Programmable RX gain
- Programmable threshold

## ▶ Output:

- 1 power value per channel
- Binary comparison to threshold

# DIFFERENT MODES OF OPERATION

- ▶ Zigbee
  - IEEE 802.15.4 power assessment
    - 16 channels
    - Accumulated power value for x samples
  - Fast reconfiguration and “processing”
  - Programmable RX gain
  - Programmable threshold
  
- ▶ Output:
  - 1 power value per channel
  - Binary comparison to threshold

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# CONFIGURATION AND CONTROL

See the imec sensing engine manual:

<http://www.crew-project.eu/portal/imecdoc>

How to use it in wilab2:

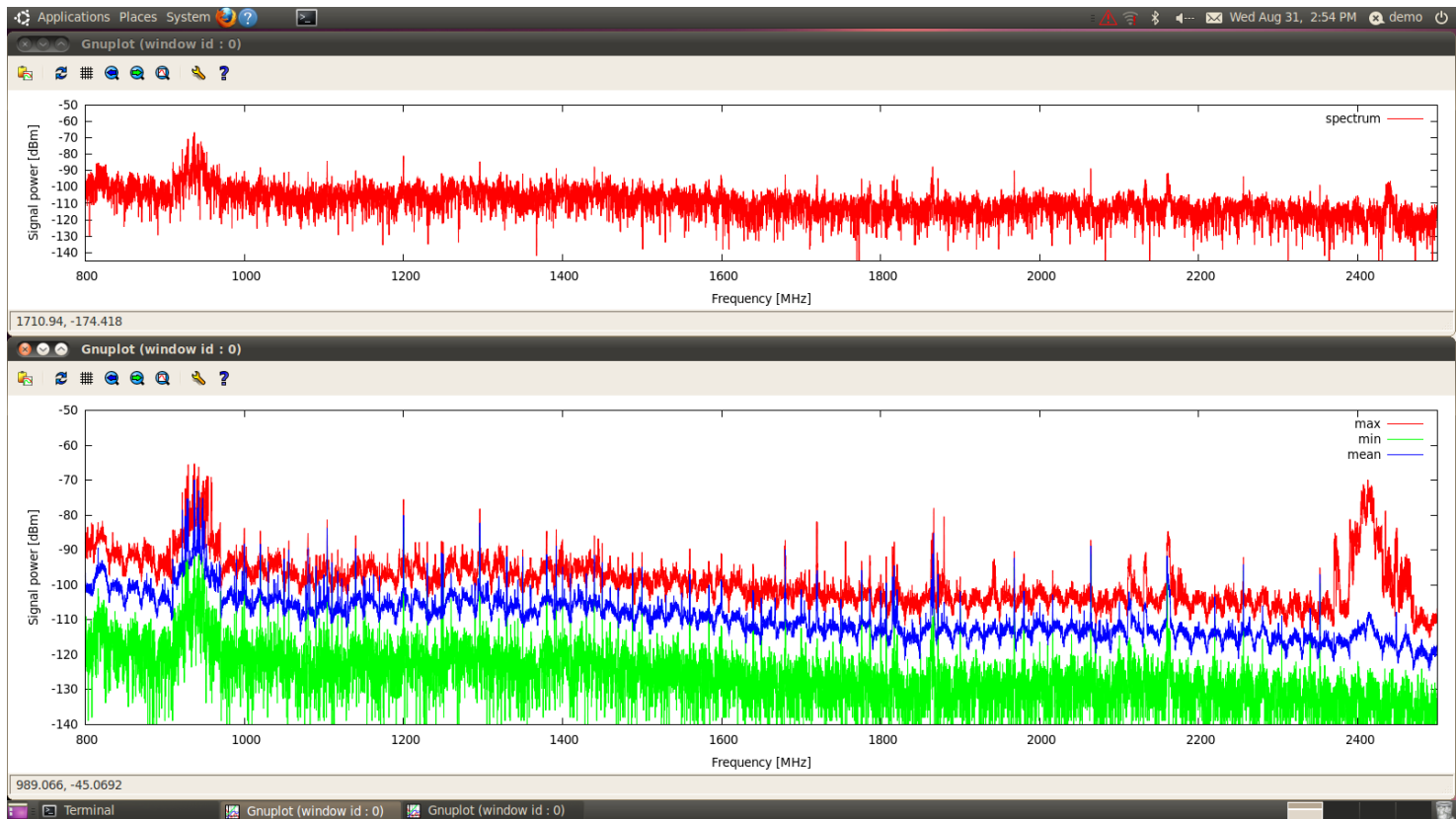
<http://www.crew-project.eu/content/imec-sensing-engine-w-ilabt-zwijnaarde-testbed>

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# STANDALONE DEMO I SPECTRUM SWEEPING

## Wide-range frequency running on DIFFS and SCALDIO

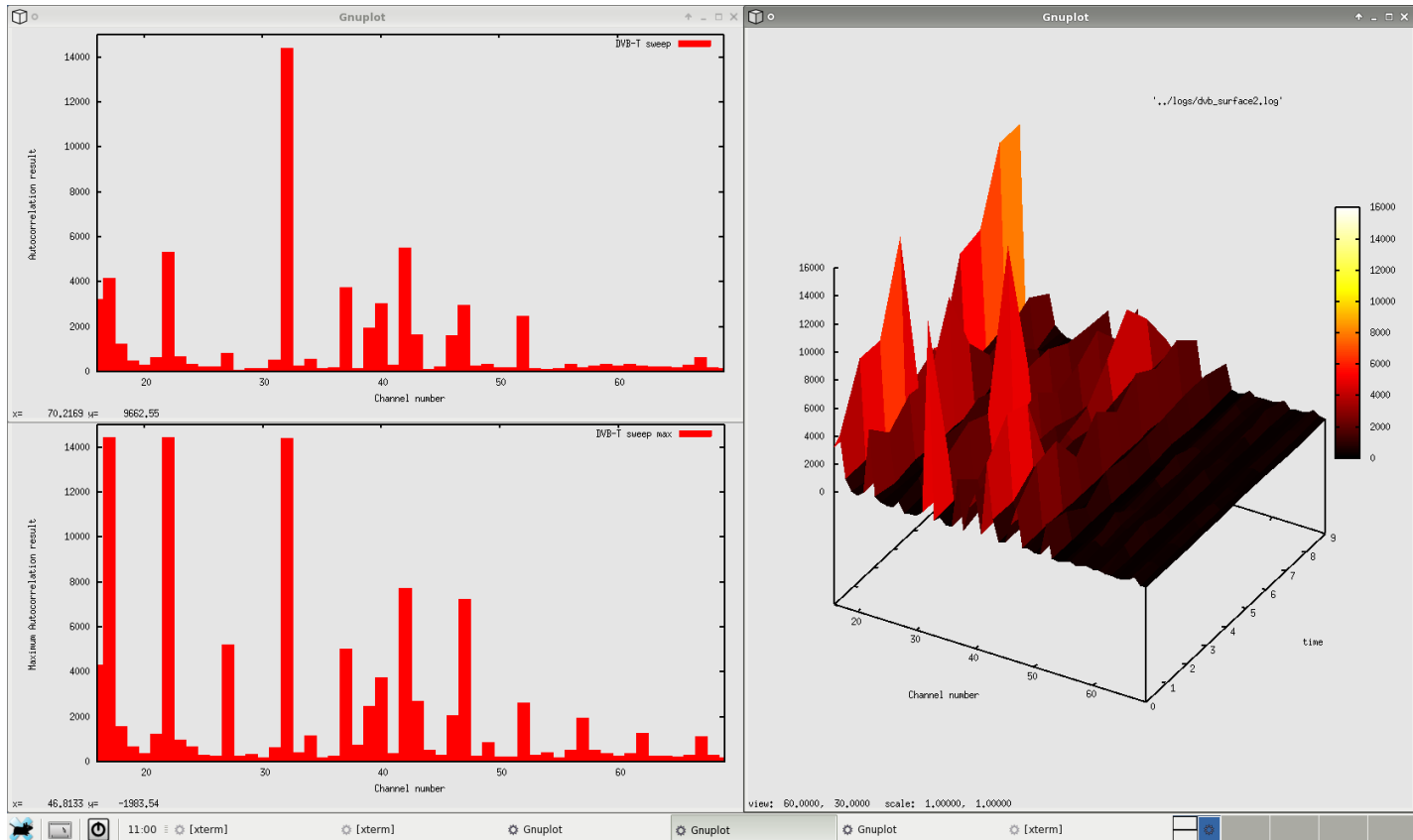




# STANDALONE DEMO 2

## DVB-T SENSING

DVB-T band sensing running on DIFFS and SCALDIO (multiple DVB-T modes 2k/8k)



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# HANDS-ON / DEMONSTRATION

Will be demonstrated as part of the iMinds training section in the next session.

An abstract graphic in the top-left corner consisting of several overlapping, flowing, purple shapes that resemble liquid or smoke, creating a sense of movement and depth.

# THE IMEC SENSING: AN INTRODUCTION

**QUESTIONS?**

**REMARKS / FEEDBACK**

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