



# CREW



## Cognitive Radio Experimentation World

### Spectrum Sensing Supported and Enabled Increased Radio Environmental Awareness [SIRI]

Experimenter: Ss. Cyril and Methodius University in Skopje (UKIM), Macedonia

#### Goals

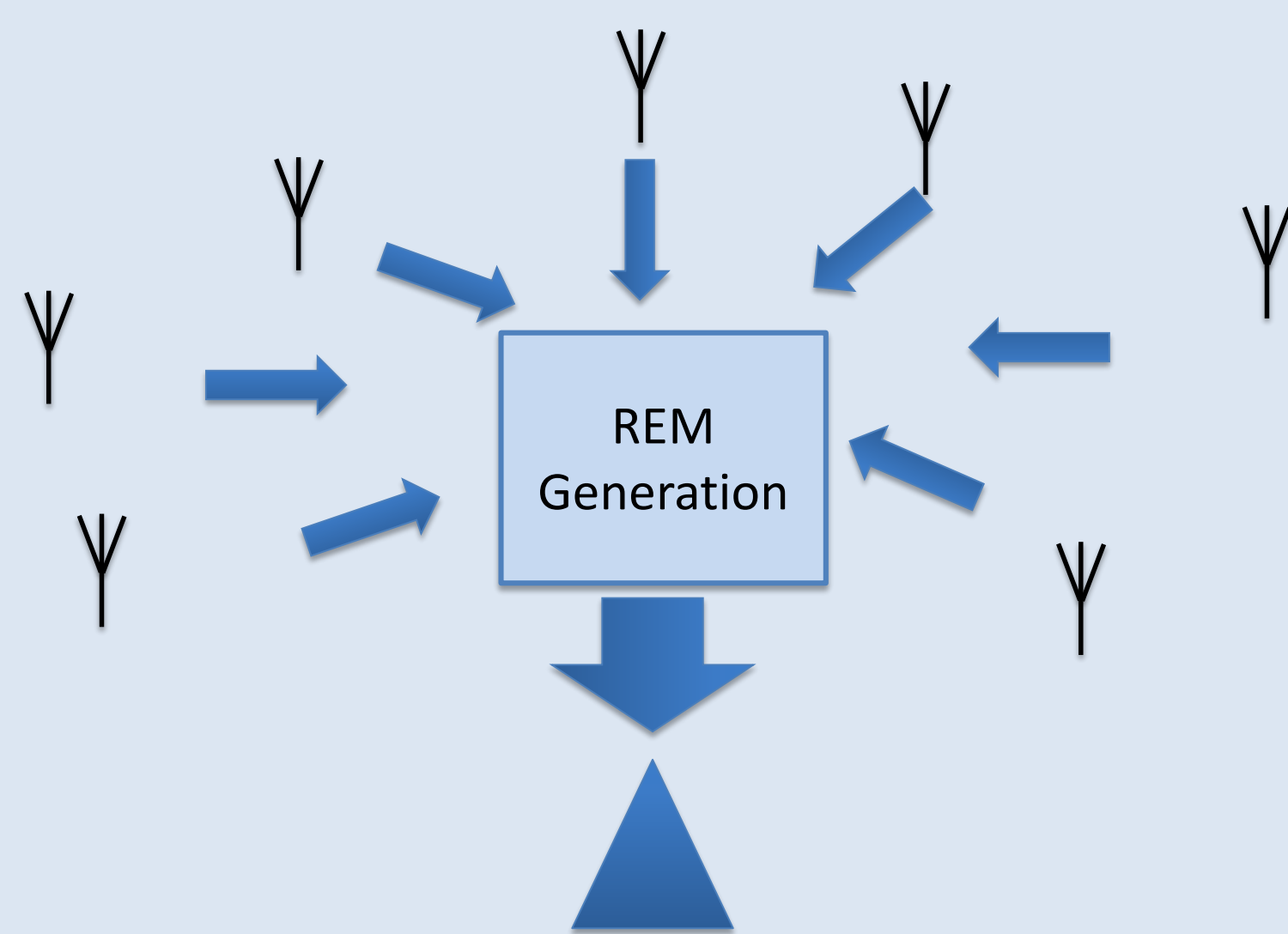
- Investigate Radio Environment Maps (REM) that can be utilized for the optimization of small cells.
- Span several test-beds of the CREW facilities (supported by TCD, JSI, iMinds, imec), and deploy algorithms for radio environmental awareness.

#### Challenges

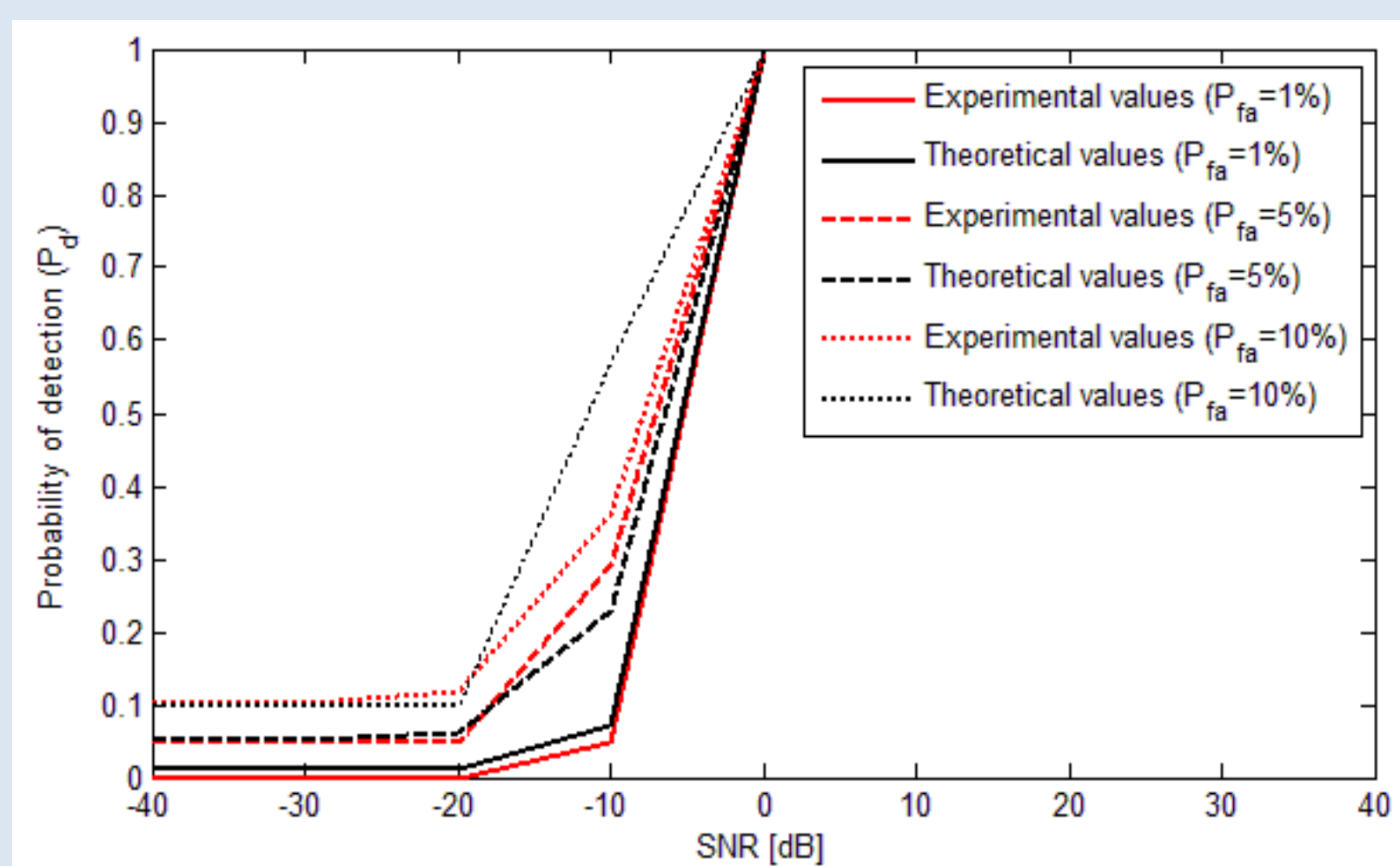
- Real-time performance assessment of the REM.
- Resource manager toolbox design of the REM Manager.
- Dynamic allocations of small cells.
- Dynamically monitoring via the REM, including appearance of new emissions, changes in propagation characteristics, etc.

#### Experiments

- Evaluation of key features of the spectrum sensing process (iMinds testbed)

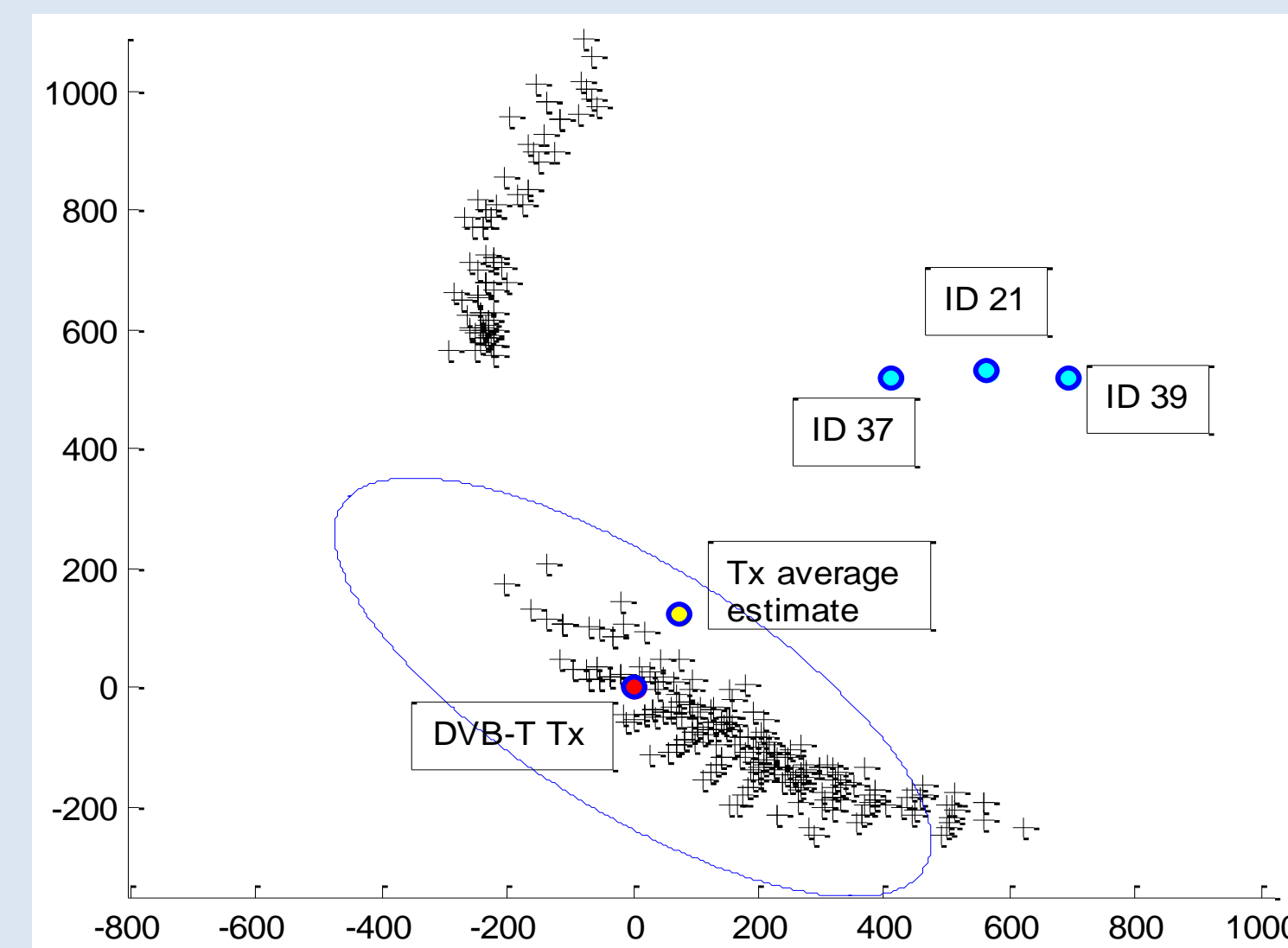


- Evaluate the detection probability ( $P_d$ ) vs. the receive SNR (for different false alarm probabilities ( $P_{fa}$ )).
- The experimental results **match** the theoretical ones, **proving** the **validity** of the analytical expressions.
- The discrepancy in the results slightly **increases** with **higher**  $P_{fa}$  values due to the **non ideal** noise estimation process.



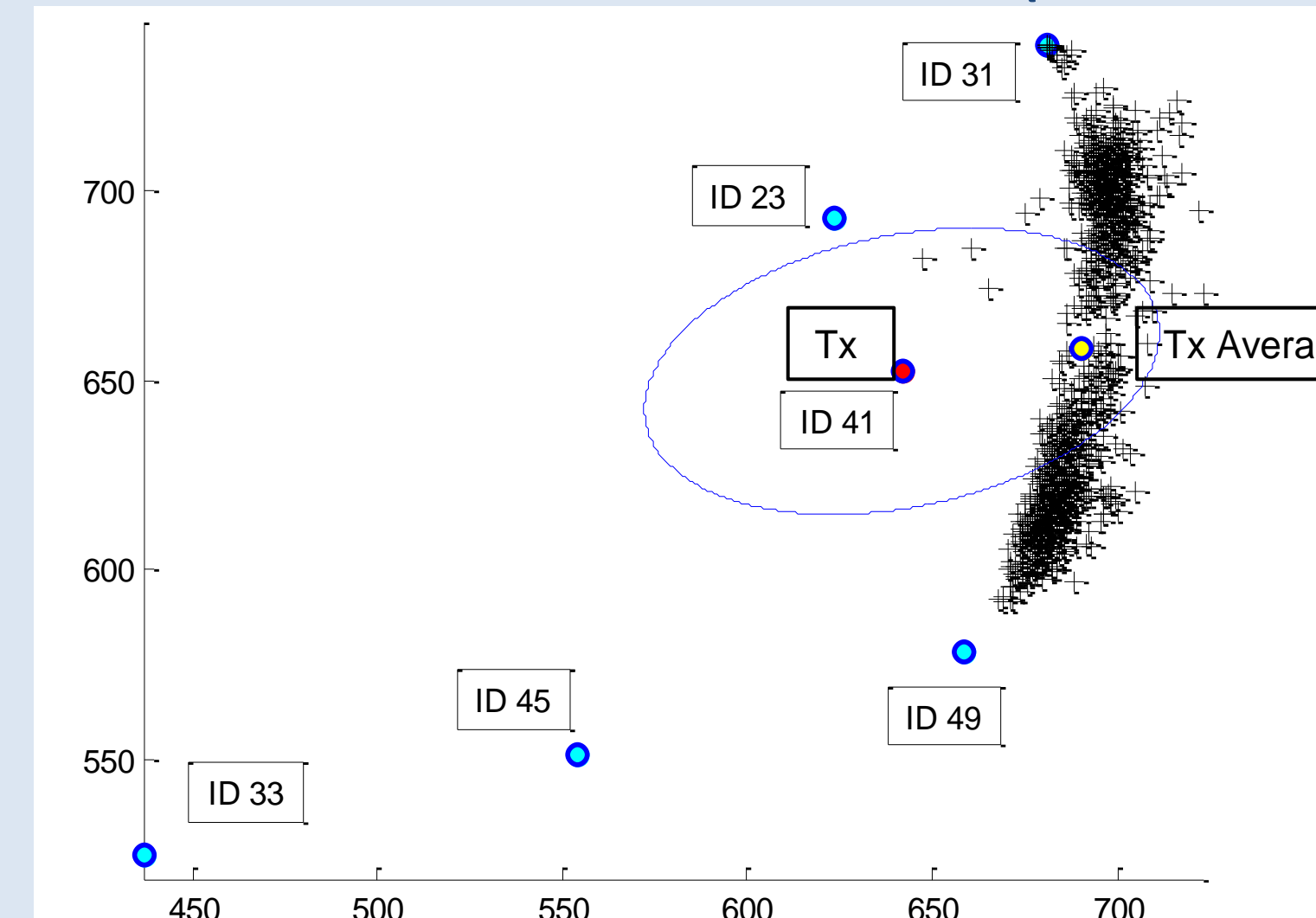
#### Experiments

- DVB-T transmitter localization results (JSI testbed)



- The average DVB-T position estimate **falls within** the 90% confidence ellipse
- However, a set of position estimates **fall outside** the 90% confidence ellipse, due to **incorrect** propagation **model** and **poor** sensor **layout**.

- ISM band localization (JSI testbed)



- The average transmitter position estimate **falls within** the 90% confidence ellipse.
- A high number of position estimates **fall outside** the 90% confidence ellipse, due to **bias** in the estimation process.

#### Results

- UKIM extended the test bed with a Radio Environment Map (REM) generator, to enhance the operation of small cells.
- Several experiments showed the benefit of using these REMs for obtaining an improved cell planning.

- Accurate REMs could be generated for small cell scenarios, and several alternative techniques were validated.
- The results were shown by means of a demo during the year 4 review meeting.

#### Conclusions

- REMs can provide accurate information for highly dynamic scenarios, such as indoor small cells.
- The small-cell scenarios can significantly benefit from the REM features, especially the Radio Interference Fields, the transmitter locations, the propagation models, historical spectrum occupancy, etc.
- REM can facilitate the process of Dynamic Small-Cell Optimization.

#### Testimony

- The IRIS software radio package provided by TCD provided superior flexibility and re-configurability compared to other tools. (e.g. GNU Radio, Matlab, and LabView).
- JSI provided a testbed that is easy to access and use, featuring good documentation to guide experimentation.
- iMinds/imec provided a very polished (easy to access and use) system through Emulab.



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#### PROJECT DATA

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