PhD Course: "Robust and Wideband Sensor Array Processing. Part I and Part II"
Teacher: Prof. Elio D. Di Claudio, DIET
Part I: Duration: 18 h (3 CFU); broad review of theory and state of the art techniques for array processing in telecommunications, acoustics and remote sensing.
Part II: Duration: 18 h (3 CFU); focus on recent issues in detection, statistical modeling and algorithm performance analysis"
Language: English. Italian only if all participants have Italian as mother tongue.
Recommended for PhD tracks in: Telecommunications, Remote sensing, Electromagnetic Fields, Audio and Multimedia.
Part I: for PhD students that started their courses this year or that did not follow the similar 2014 array processing course.
Part II: for all PhD students.

The idea of this PhD Course stems from the converging paths of telecommunications, remote sensing and aerial acoustics toward the use of wide- and ultra-wideband (larger than an octave) signals, received by a sensor array, made up of antennas, microphones, hydrophones, etc….
However, the models commonly adopted in open literature are extremely simplified and neglect relevant application issues, such as sensor non-ideality and mis-calibration, the continuous change of propagation and signal models with frequency, the presence of echoes and reverberation, that impair the consistency of Maximum Likelihood parametric estimators, their suboptimal subspace approximations and MIMO transmission models.
Some scientific contributions, though dispersed into several disciplines, can be used to build a unitary framework and derive improved and innovative solutions for real world telecommunication, remote sensing, that can be generalized to pattern analysis in photographic and SAR images.
The course is focused on the following themes:

Part I:

1) Background on basic narrowband array models and related classical approaches for parametric source localization and adaptive beamforming.
2) Statistical perturbation of signal models and related statistics because of finite sample errors, array mis-modeling or channel estimation errors (MIMO communications) and consequent application issues[1].
3) Robust signal analysis.
4) Wide band array models: frequency channelization and binning, time difference of arrivals, spatial focusing and steering. Specific wideband array geometries.
5) Wideband array model mismatches. Robust ML wideband beamforming and parametric direction finding with non-conventional, though near-optimal, robust statistics (WAVES, ML-STBF, matched field and Laguerre expansions).

Part II:

1) The source detection problem.
2) Large-array, low sample environments.
3) Wide-band model and estimator consistency issues.
4) Array models for linear pattern estimation in images.

Prof. Elio D. Di Claudio is the author of several state of the art approaches for wideband beamforming and spatial localization with sensor arrays and the generalization of these models to image processing and pattern matching.

[1] This year a part dealing with compressive sensing concepts for beamforming and detection will be introduced.