- *Prof. Gaspare Galati*

- **Workshop :**

Evolution of Phased Array Radars towards multifunction fully digital architectures with "staring" modes

Remark: this presentation will use some concepts by, and hence, follow, the one by Dr. E. Brookner: "Phased Array and Digital Beam forming, basics, advances and breakthroughs"

Abstract

The use of array antennas in radar is as old as radar itself: in the 1930's early VHF surveillance radars such as the German *Freya* used an array of elements to get a reasonable antenna gain. The ability to steer the antenna main beam without any mechanical scanning followed soon, between 1942 and 1944, independently on both sides of the conflicting parts (*Mammut*, *Wasserman*, US Navy's fire control radar *Mark 8* with P*olyrod* antenna...). After the war, the new geo-political situation called for large, long-range phased array radars such as *Cobra Dane*, *Cobra Judy* and *Don - 3 N* (*Pill Box*), and the new jammers called for the early adaptive antenna systems (Howells, Widrow, Appelbaum) , forerunners of the MSLC and, for mobile platforms, of the STAP techniques of 1990's.

With the changed threats of the 1990's and 2000's, point defence applications found more and more room, calling from multifunction, relatively compact radars, in particular, for ship defence, where simultaneous attacks could not be contrasted with one - or a few - classical fire (and missile) control radars (tracking radars). Hence, *passive*, and then, *active* Multifunction Phased Array radars for ship defence, in S, C and X band, were industrially developed and used. The early solutions had one (or two, back-to-back) rotating planar arrays in order to keep costs and weights low enough. Some more recent, or bigger, solutions, instead, use four faces active arrays. Civil applications (e.g. Weather and Air Traffic surveillance) are being proposed and tested in the USA.

A promising architecture, presently under prototype-level laboratory trials, uses a conformal array with a circular symmetry (cylinder, frustum of cone) granting constant performance for each azimuthally pointing direction. Stacked reception beams are formed in elevation by Digital Beam Forming (DBF) , with wide-beam illumination by a separate transmitting array (quasi-bistatic system). DBF is used to generate any number of azimuth beams, up to the limit case of an "ubiquitous" or "staring" radar operation with virtually instantaneous detection and tracking of short-range threats. The data renewal interval can me made so short (100 ms) as to control anti-aircraft (and missiles) artillery. Not only hardware and radar signal processing, but also scheduling of radar resources is rather different from present, more *traditional* phased array radars.