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# Hardware Reduction for a Retrodirective System

*UCLA*

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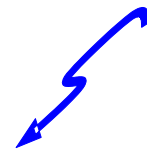
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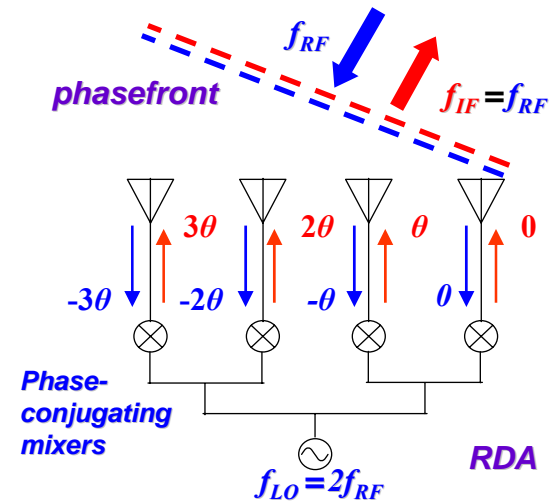
*UCLA Microwave Electronics Lab*

# Motivation

- Increasing application for RFID – passive transponders with various functionality
- Identification Friend of Foe (IFF) – high speed secure source tracking
- Simple low-cost high-performance systems desired



Onboard transponder

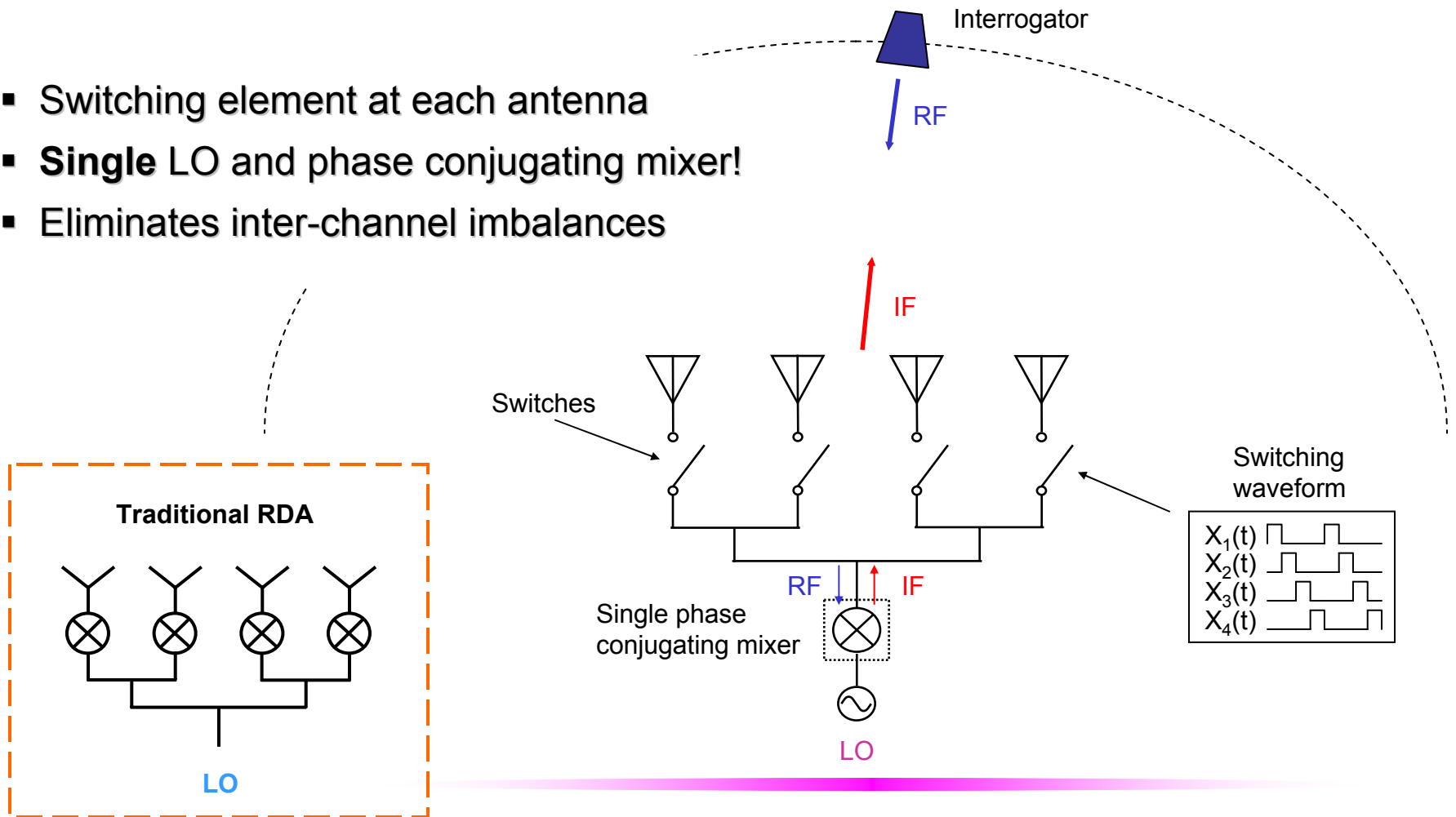


- ✓ Retrodirective arrays (RDAs) are ideal candidates for passive transponders
- ✓ Automatic high-speed directive response to interrogation over omni-directional coverage
- ✓ Goal: reduce/simplify hardware requirement



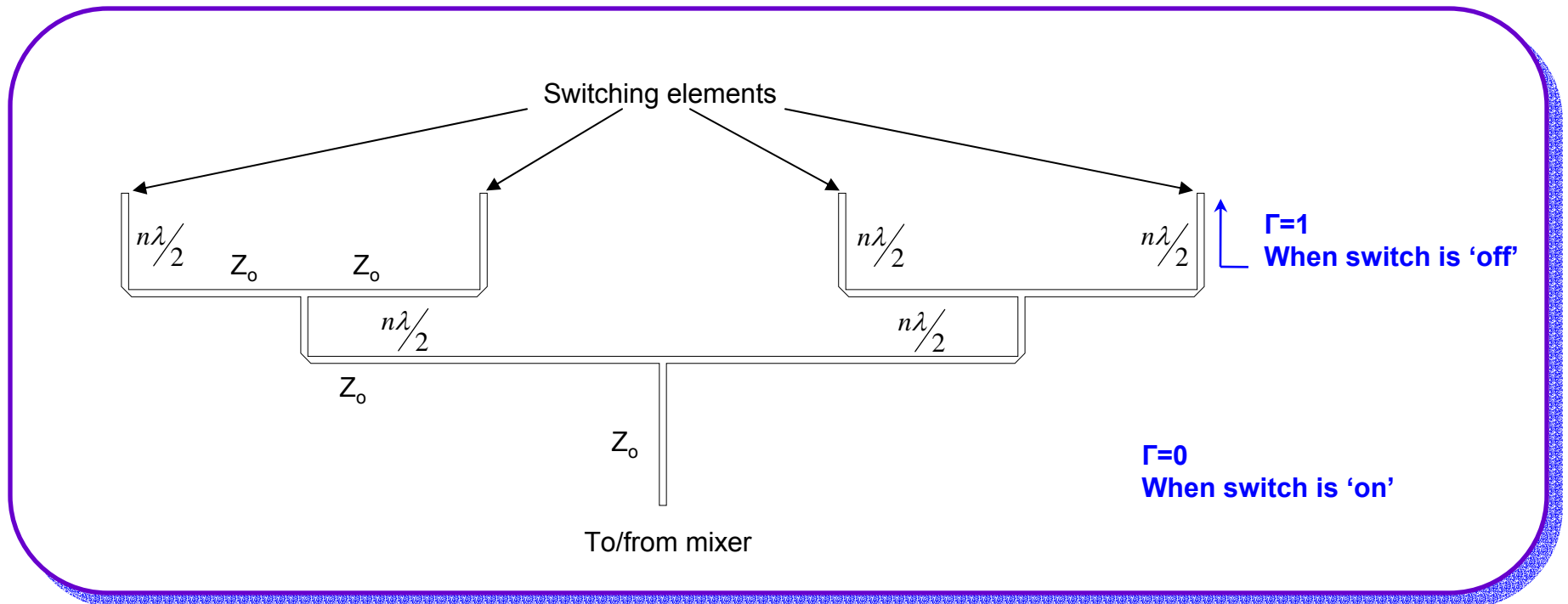
# Switched Antenna Retrodirective Concept

- Switching element at each antenna
- **Single** LO and phase conjugating mixer!
- Eliminates inter-channel imbalances



# Switching Feed Network

- Symmetric unconventional feed network –  $Z_0$  @ all T-Junctions
- Always matched to a single antenna
- Relies on open circuit approximation of switch in “off” state

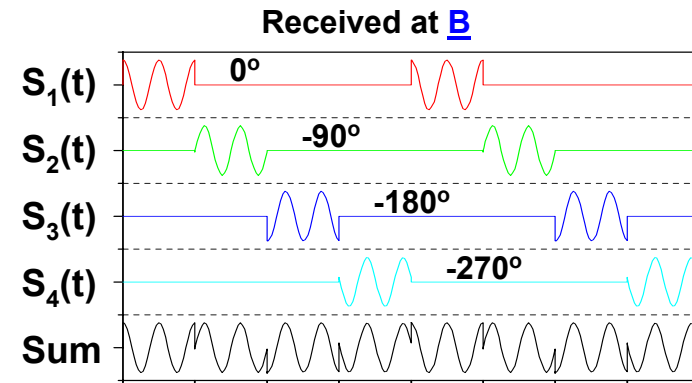
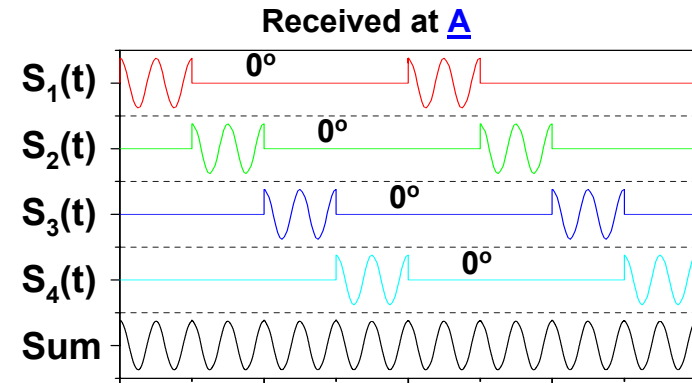
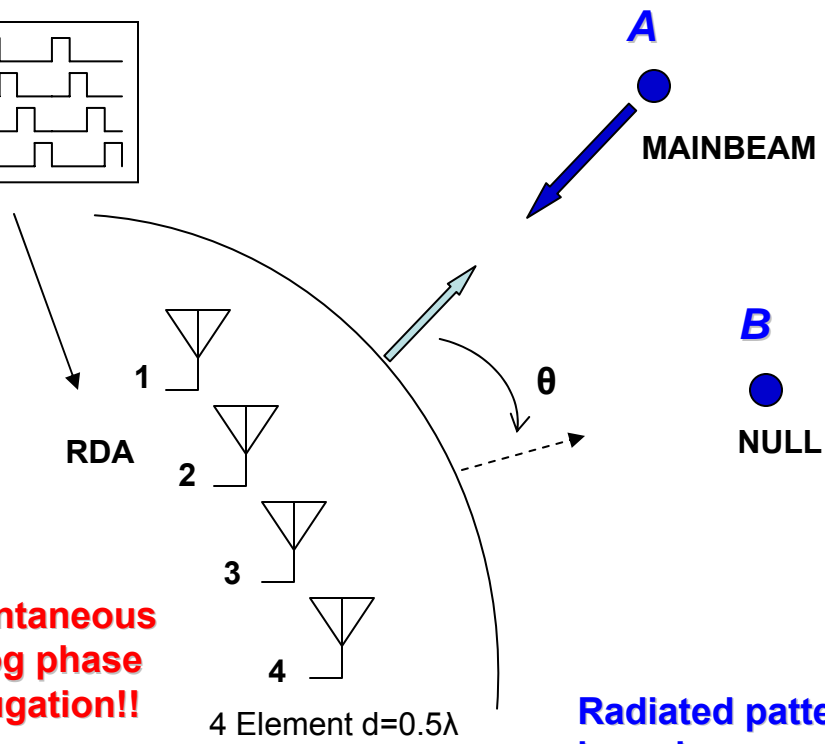
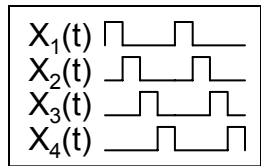


# System Operation

Phase-conjugated retransmitted signal at each channel:

$$S_n(t) = x_n(t) \cdot \frac{1}{2} V_{RF} \cdot V_{LO} \cdot [\cos(\omega_{IF}t - \theta_{RFn})]$$

Conventional phase-conjugated signal



Complete switching period

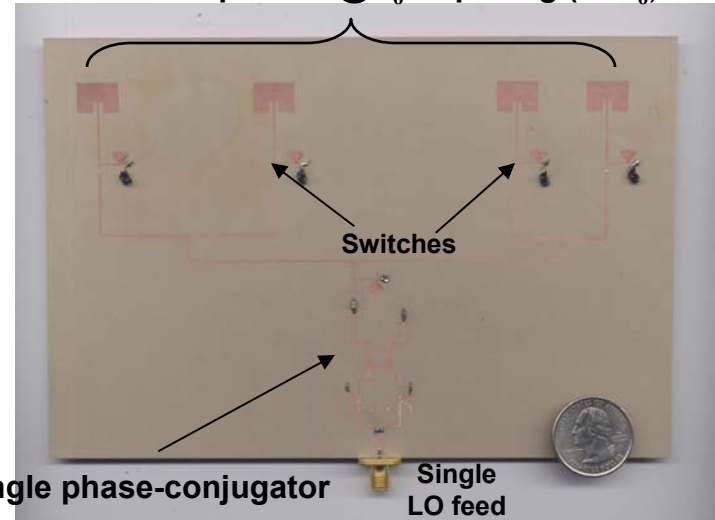


# Switching Scheme Integrated with Sparse Array

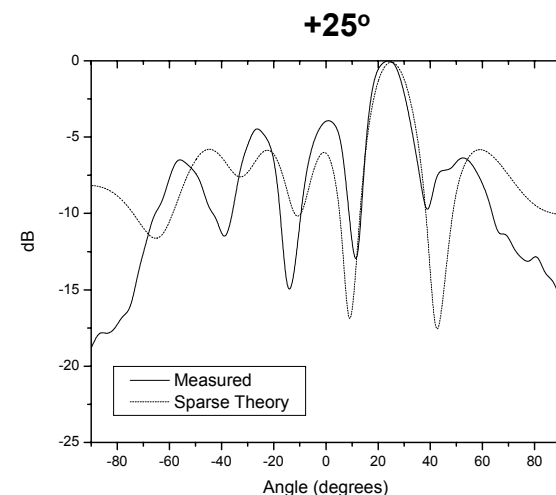
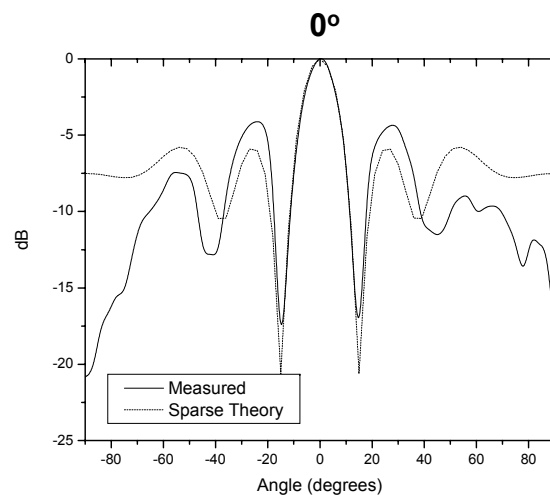
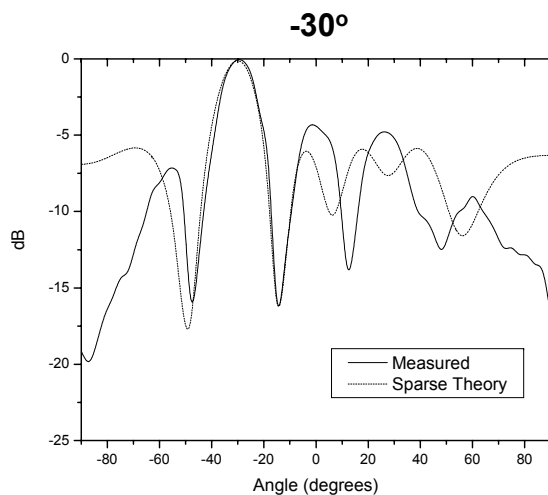
Further hardware reduction with sparse architecture!

\* A conventional retrodirective array with same aperture typically would require 6 radiators and 6 mixers.

6-element aperture @  $\lambda_0/2$  spacing ( $2.5\lambda_0$ )



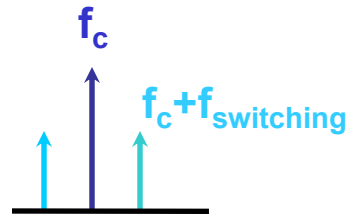
## Measured Bistatic Patterns:



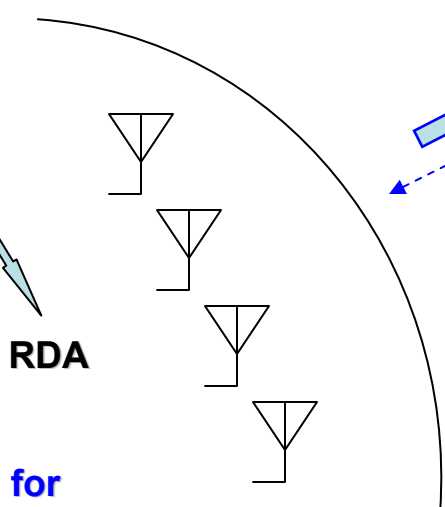
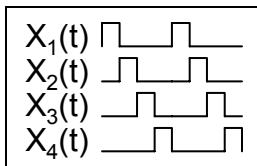
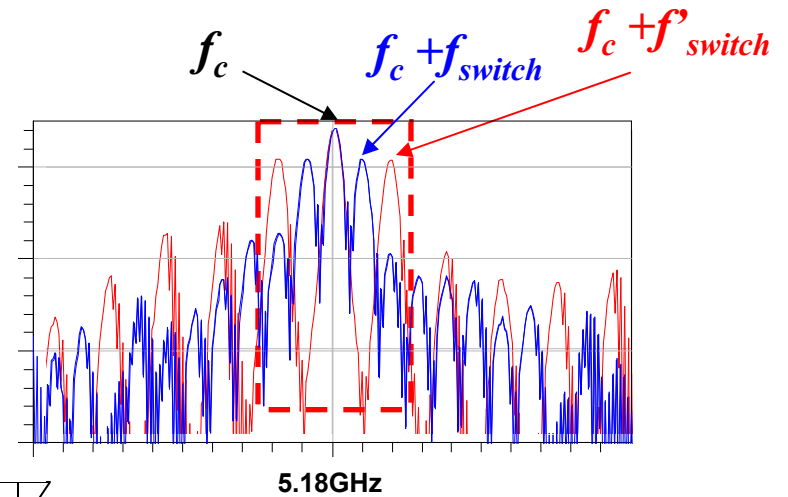
# Built-in Modulation Scheme

Retransmitted signal will contain sidebands based on the switching frequency

Switching waveform controls modulation index



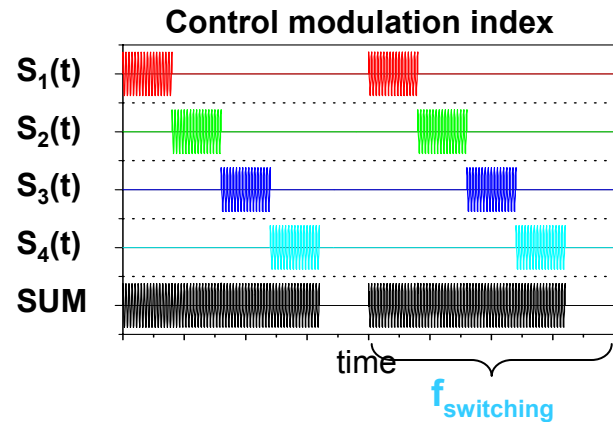
Received spectrum at interrogator



Change  $f_{switching}$  for simple data transfer

Interrogator

$f_c$



# Summary

- Switching scheme offers an **N to 1 hardware reduction**
- Maintaining **directive transmission** response based on array theory
- Flexible scheme allows for integration of **amplification** and **external LO elimination**

