Ku-Band Traveling Wave Slot Array Using Simple Scanning Control
Nicholas K. Host¹, Chi-Chih Chen², John L. Volakis², and Félix A. Miranda³
Applied Physics Laboratory¹, Ohio State University², and NASA John H. Glenn Research Center³

Abstract: This poster introduces a feeding concept aimed at simplifying the backend (phase shifters) of traditional phased arrays. As an alternative to traditional phased arrays, we employ a traveling wave array (TWA) using a single feedline whose propagation constant is controlled via a single, small mechanical movement with a need for phase shifters to enable scanning. Specifically, a dielectric plunger is positioned within a parallel plate waveguide (PPW) transmission line (TL) that feeds the TWA. By adjusting the position of the dielectric plunger within the PPW feeding the TWA, beam steering is achieved. A 20 element array is designed at 13GHz shown to give stable realized gain across the angular range of $-25^\circ \leq \theta \leq 25^\circ$. A proof of concept array is fabricated and measured to demonstrate and validate the concept's operation.

1 Operation Principle
- Array elements fed via propagation reconfigurable transmission line
- $k_{eff}$ reconfigured via small mechanical movement
- Phase delivered to each element a function of $k_{eff}$
- Array scanned with only the small mechanical movement

2 Transmission Line Design
- Scan range a function of element spacing and TL $k_{eff}$
  - $-30^\circ \leq \theta \leq 30^\circ$ scanning is achieved with $1.04 \leq k_{eff} \leq 2.04$
  - Element spacing of $0.65\lambda$
- Line achieves the necessary $k_{eff}$ agility at $H_s = 270\text{mil}$

3 Rectangular Cavity Backed Slot
- Cavity backed slot becomes detuned as the plunger is adjusted
- Resonant length of the cavity backed slot varies with plunger position

4 Non-Rectangular Cavity Backed Slot
- By angling the back of the cavity we lower the Q value
- $W_s$ is used to control the coupling to each element
- A large range of coupling achievable is desired

5 Array Design Procedure
- Characterize coupling from element over a range of slot widths
- Choose the element widths along the TWA to achieve the desired Kaiser taper
- Iteratively adjust slot widths to account for element reflections and mutual coupling until desired pattern is achieved

6 Initial Design Performance
- S-Parameters generally less than $-10\text{dB}$ except around boresight scan as expected
- Scanning of $-25^\circ \leq \theta \leq 25^\circ$
- Consistent realized gain level across scan range

7 Increased Manufacturability
- Reduce fabrication complexity
  - 10 Steps to approximate cavity back
  - Reduced plunger height
  - Alter TL geometry and element spacing to achieve desired scan range

8 Prototype Validation
- Measurements generally agree with simulation
- Realized gain is down compared to simulated due to differences in TL geometry
- Measured scan angle is more positive, also due to differences in TL geometry