Tu4D-3

Widen Linearization Angle of Beamforming Arrays With Semi-Partitioned Digital Predistortion

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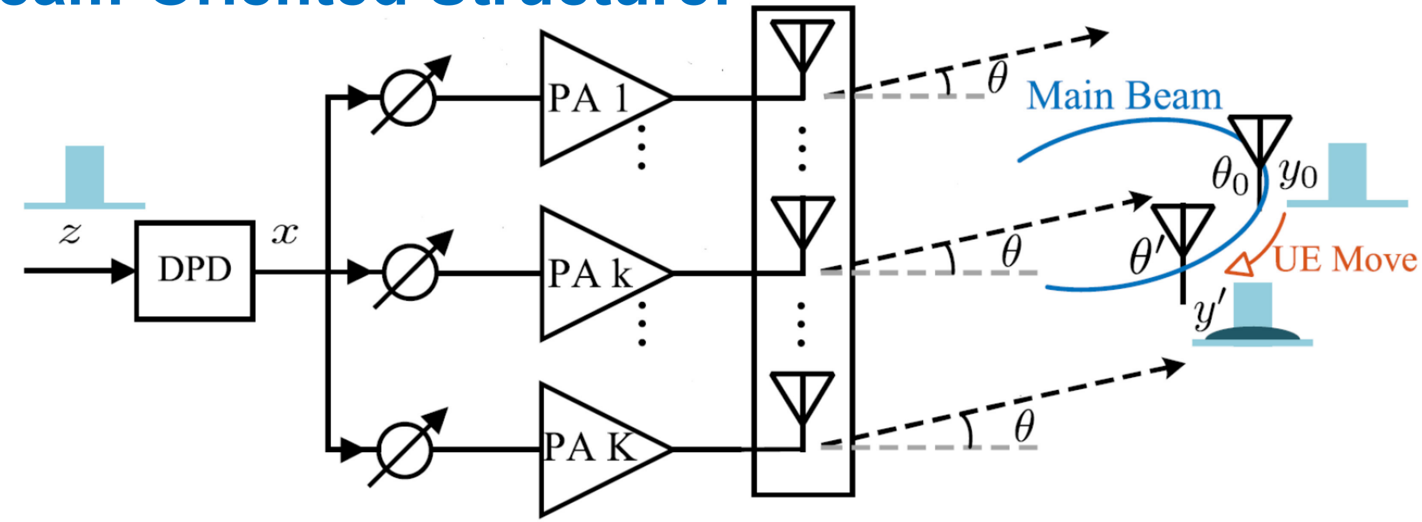
Outline

- ❑ Introduction
- ❑ Semi-partitioned DPD
- ❑ 2-target model-reference extraction (iterative learning control)
- ❑ DPD performance
- ❑ Conclusion

Introduction

- Massive MIMO transmission
  - Nonlinearity still exists
  - DPD system cost/power/volume consumption

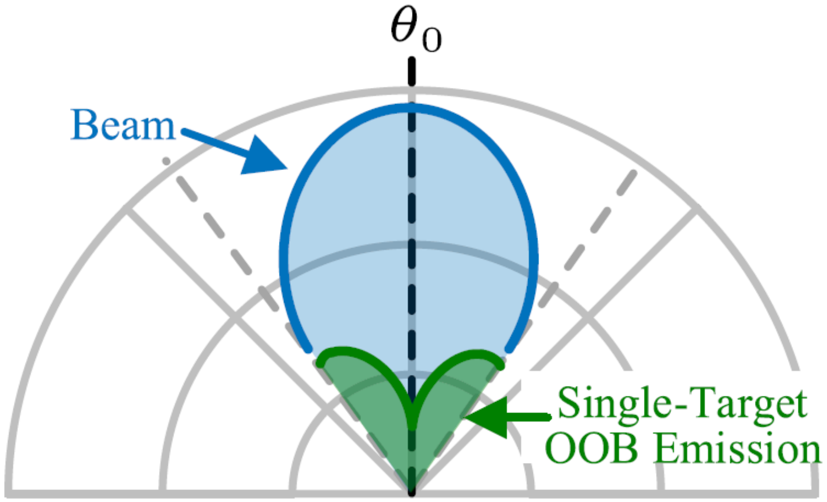
√ Beam-Oriented Structure:



Different phase-weighted combination:

$$y_n = Y_n[x] = \sum_k \{R_k[x] e^{-j\pi \sin((\theta_n - \theta_0)\pi/180)(k-1)}\}$$

X Linearization Angle Problem:



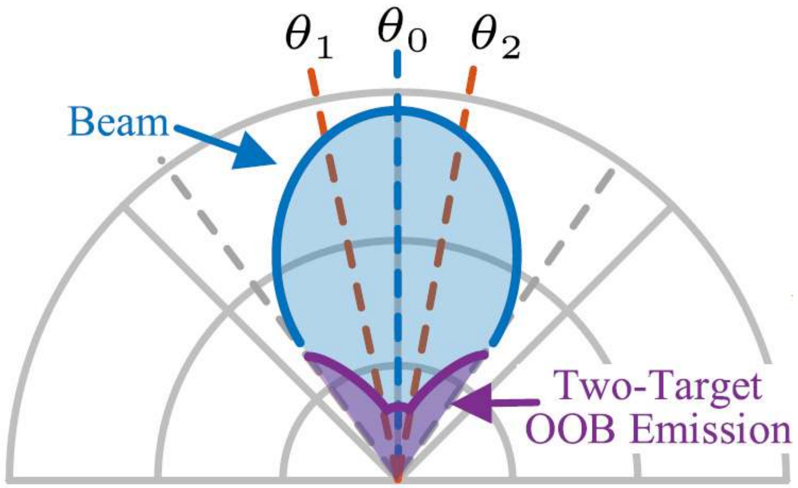
$$\begin{cases} y_0 = Y_0[x] = z \\ y_1 = Y_1[x] = z \end{cases}$$ X

↑

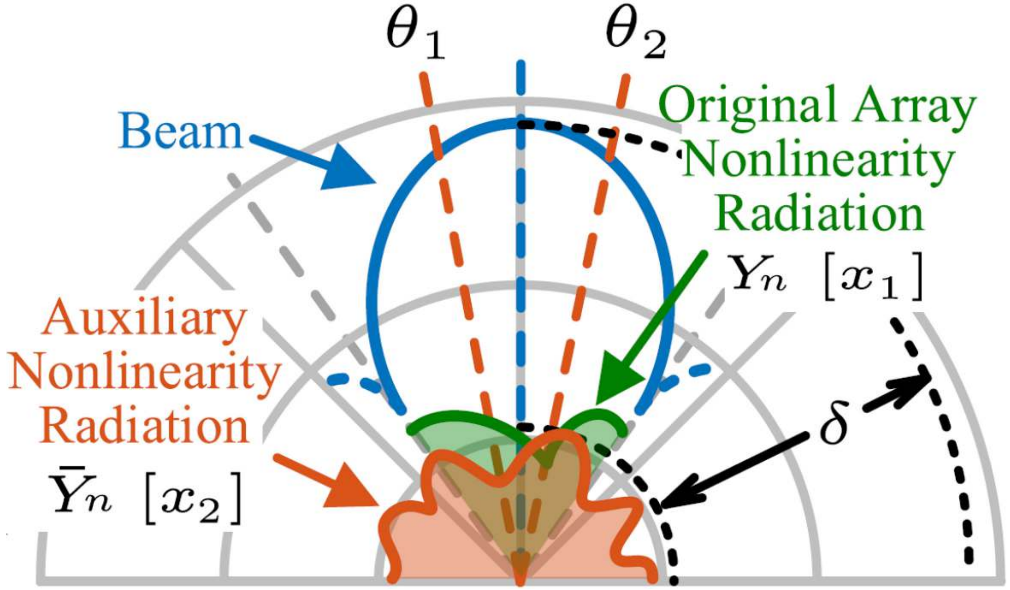
→ $Y_0 \neq Y_1$

Introduction

- Linearization Angle Widened DPD (LAW)



? Two-target DPD exists



√ Two different nonlinearity radiations

↑

√ Two DPD outputs (two variables)

$$\begin{cases} y_1 = Y_1[x_1] + \bar{Y}_1[x_2] = z \\ y_2 = Y_2[x_1] + \bar{Y}_2[x_2] = z \end{cases}$$

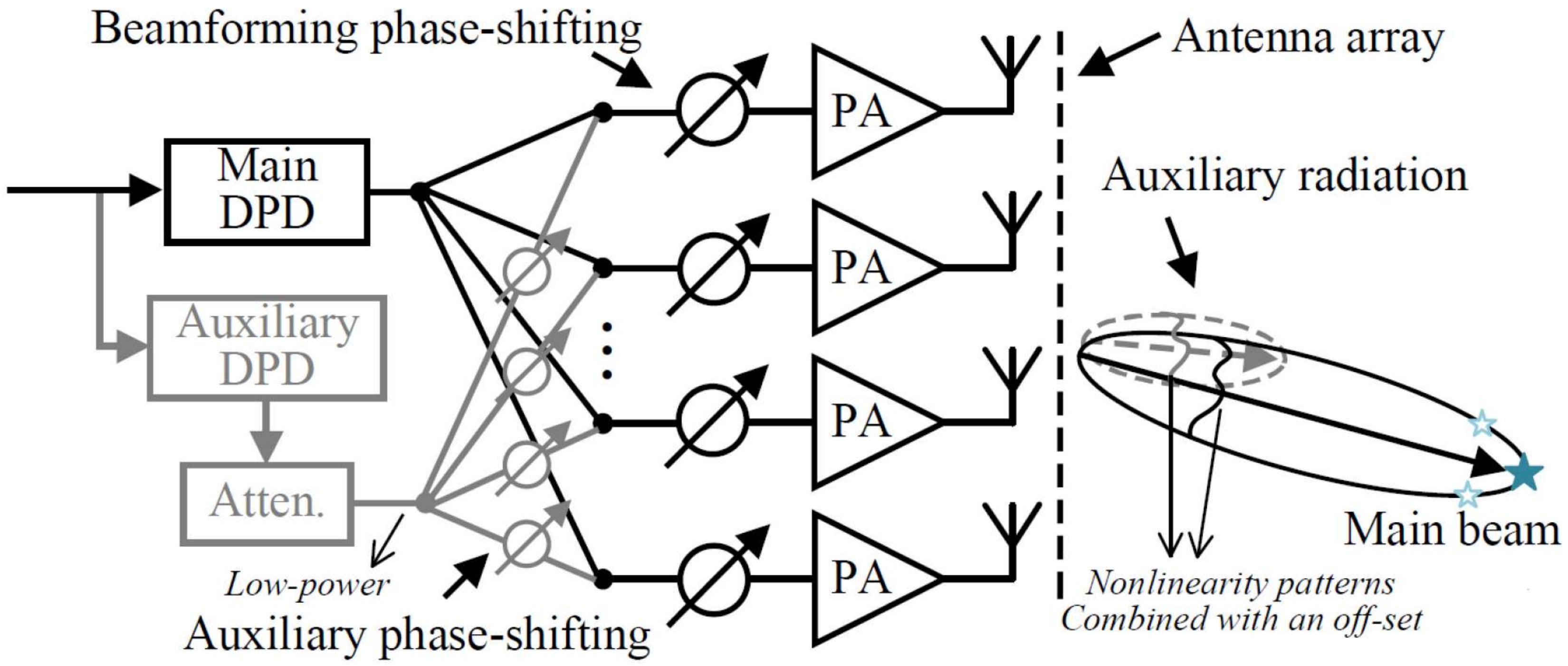
→

$$\bar{Y}_n \neq Y_n$$

(Nonsingular: row full rank)

Introduction

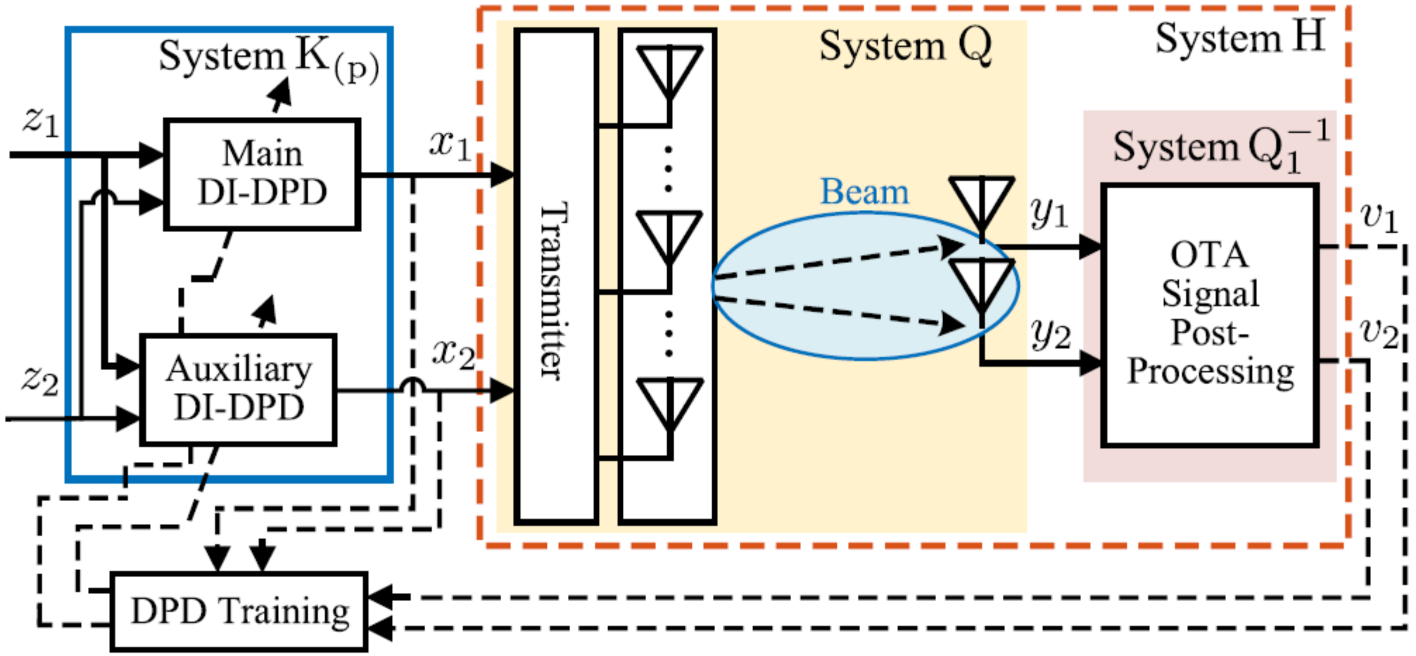
- Conventional LAW DPD



✗ **Inserting auxiliary phase shift network** { **Selecting parameters** / **Hybrid beamforming incompatible** }

Introduction

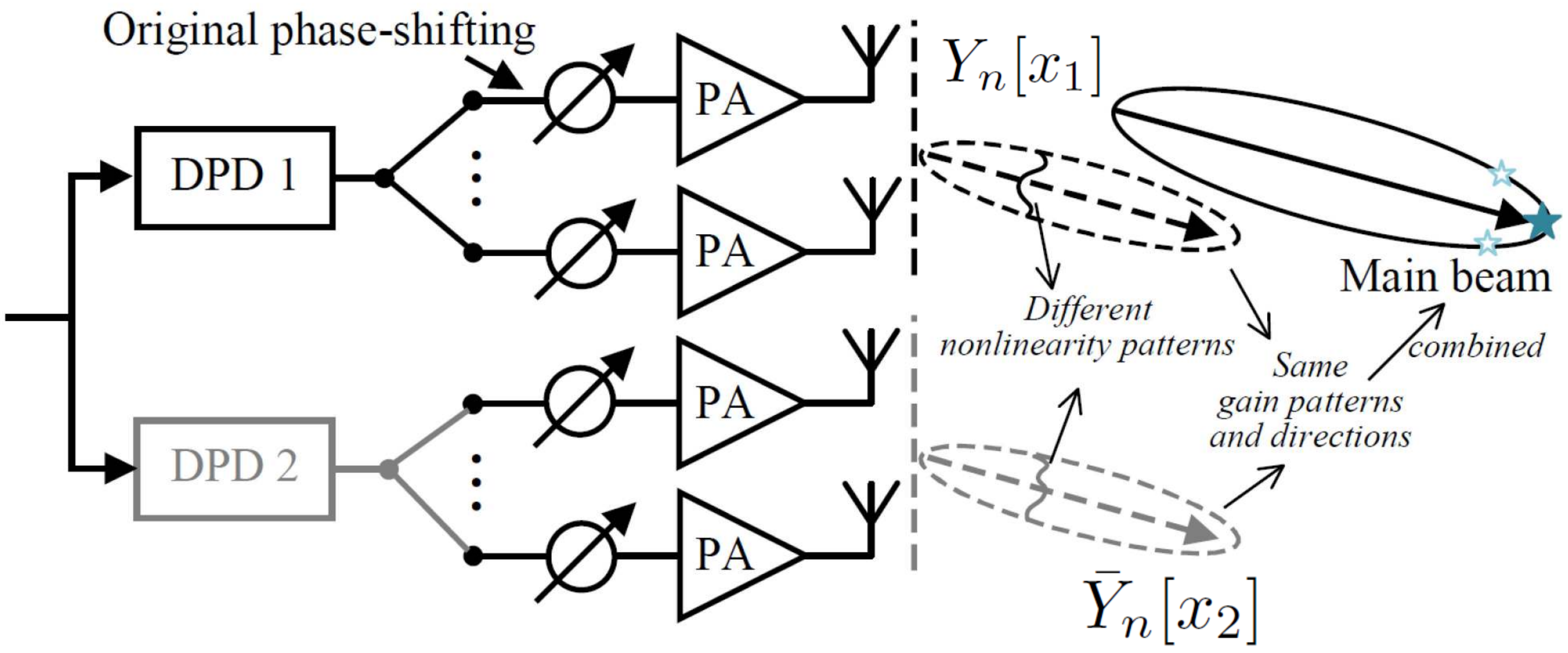
- Conventional LAW DPD



✗ DPD extraction { Offline indirect learning
Dual-input DPD models
Two uncorrelated signals }

Semi-Partitioned DPD

- DPD signal process is split into two branches

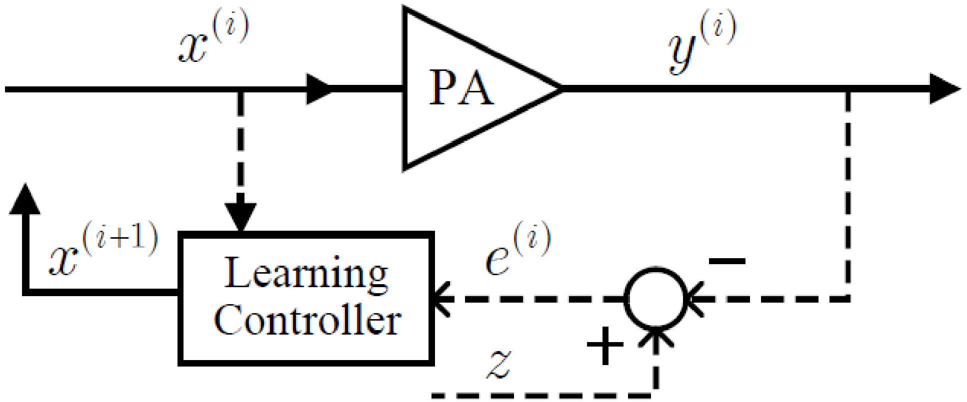


√ Two different nonlinearity radiations ($\bar{Y}_n \neq Y_n$), no auxiliary parameters

√ Adaptive to hybrid beamforming naturally

2-Target Model-Reference Extraction

- Model-reference structure:
  - DPD coefficients online updating
  - Using single-input model



$$\mathbf{c}^{(i+1)} = \mathbf{c}^{(i)} + \gamma(\mathbf{F}(\mathbf{z})^H\mathbf{F}(\mathbf{z}))^{-1}\mathbf{F}(\mathbf{z})^H\mathbf{e}^{(i)T}$$

  - Linear ILC-DPD (nonparametric)

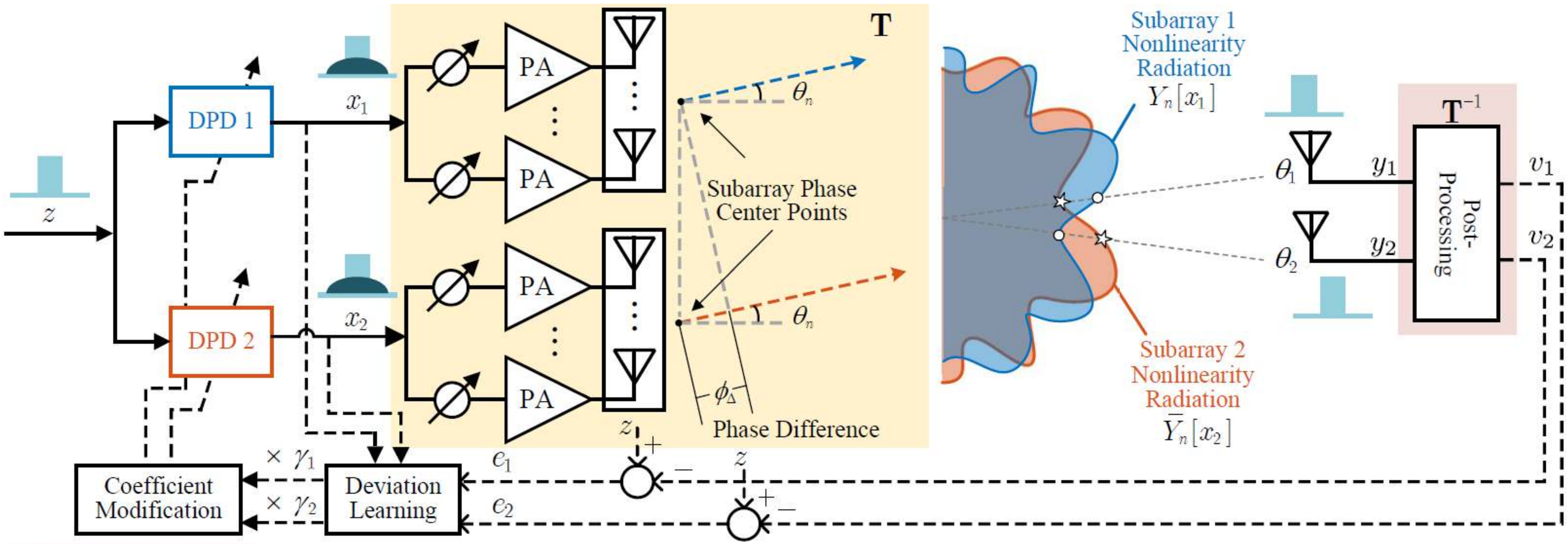
$$\mathbf{x}^{(i+1)} = \mathbf{x}^{(i)} + \gamma\mathbf{e}^{(i)}$$

Question:
How to construct the proper error signal for each DPD block?

2-Target Model-Reference Extraction

- Steps
  - Estimate Linear transmission matrix T
  - Calculating error signals with OTA post-processing
  - Updating DPD coefficients

√ Convergence has been proven

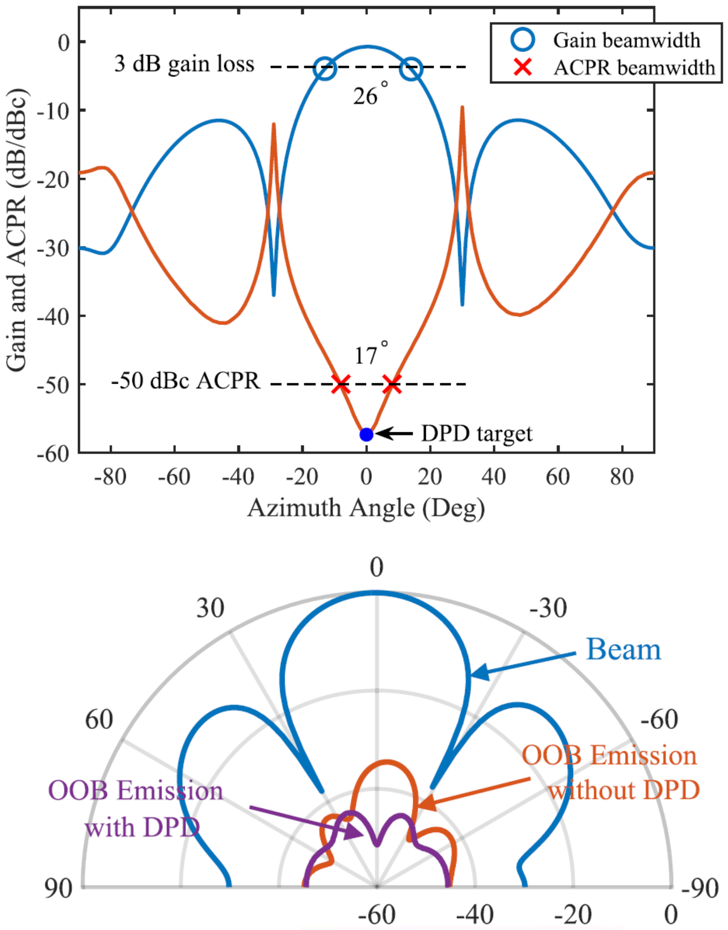


DPD Performance

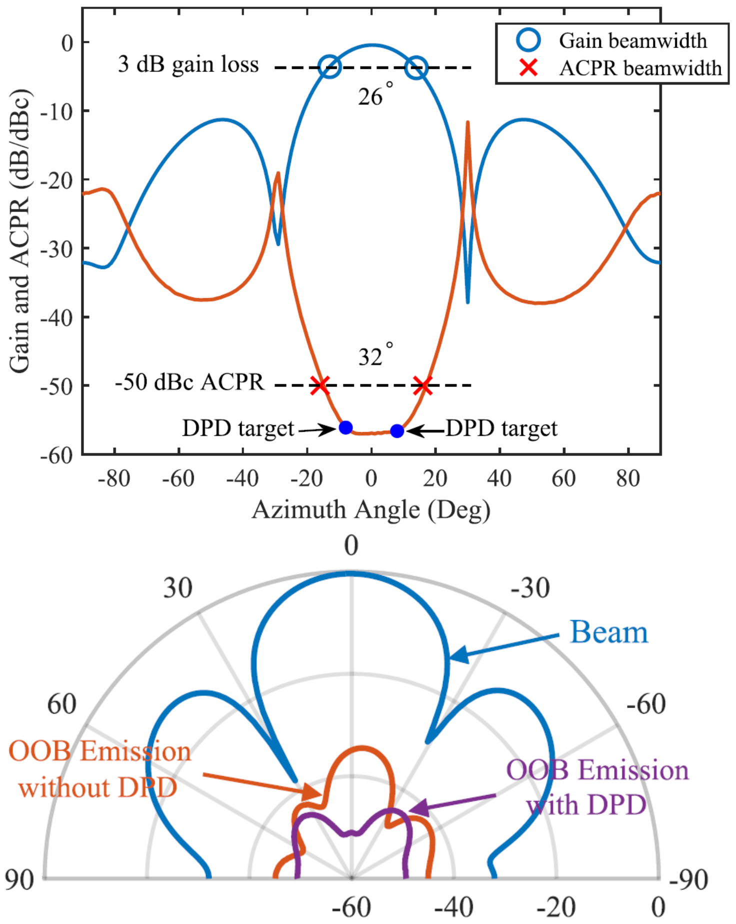
- Simulation comparisons

√ Linearization angle widened

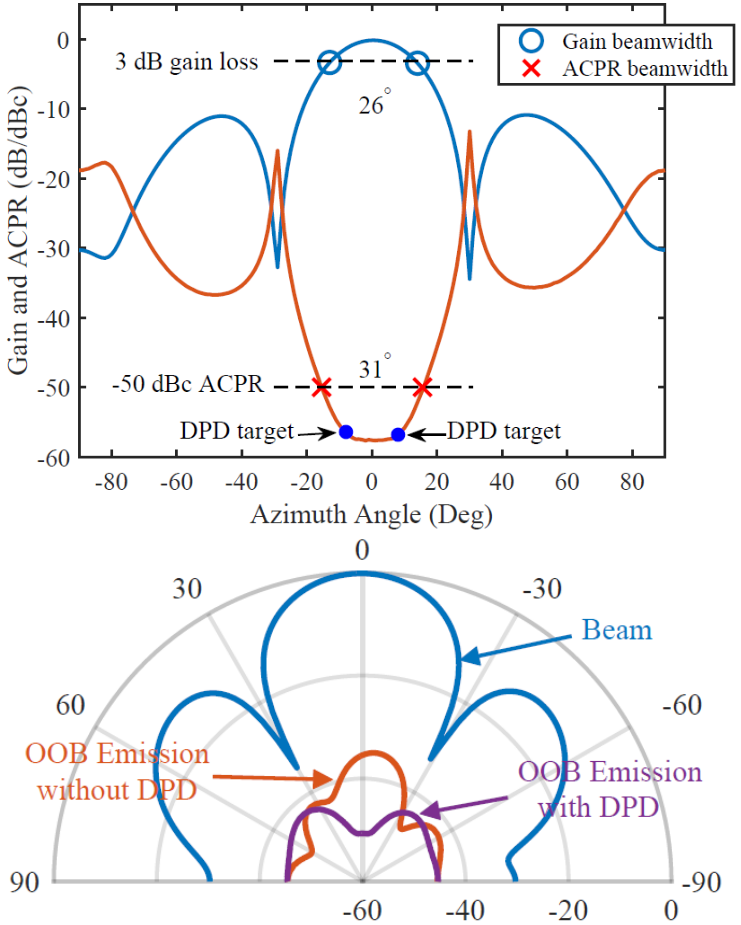
BO-DPD



LAW-DPD

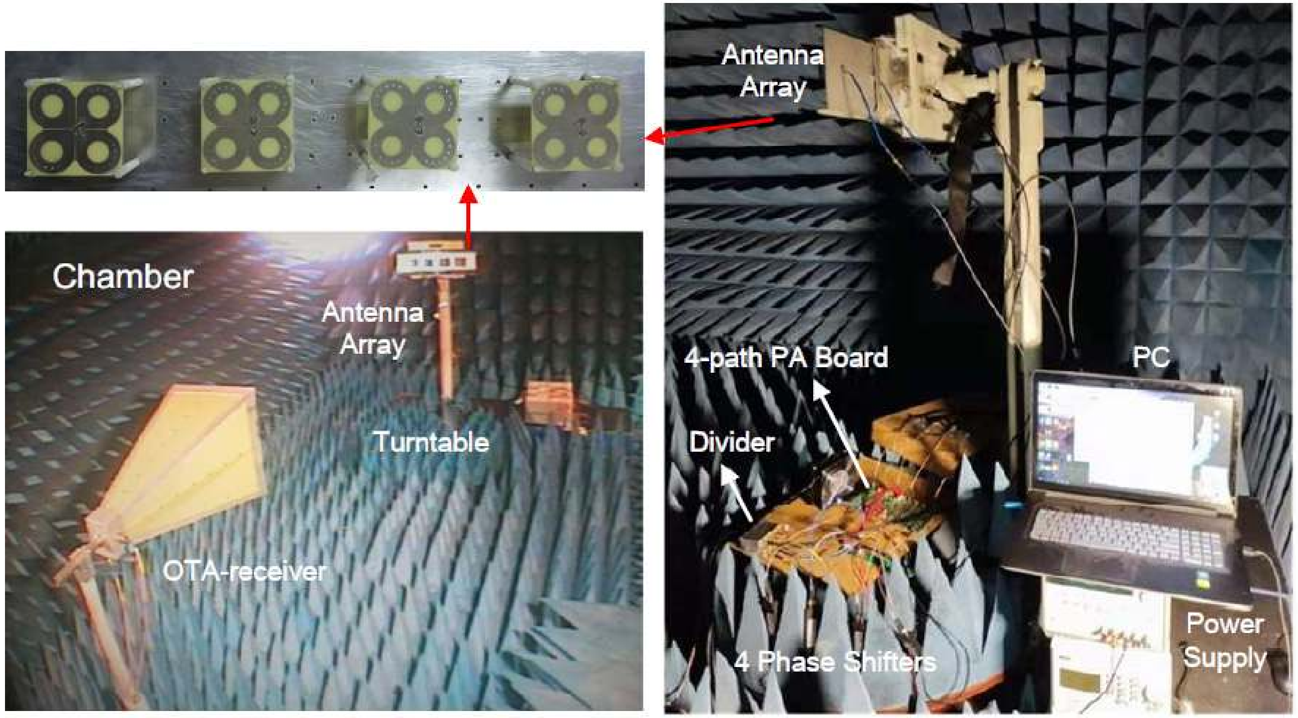


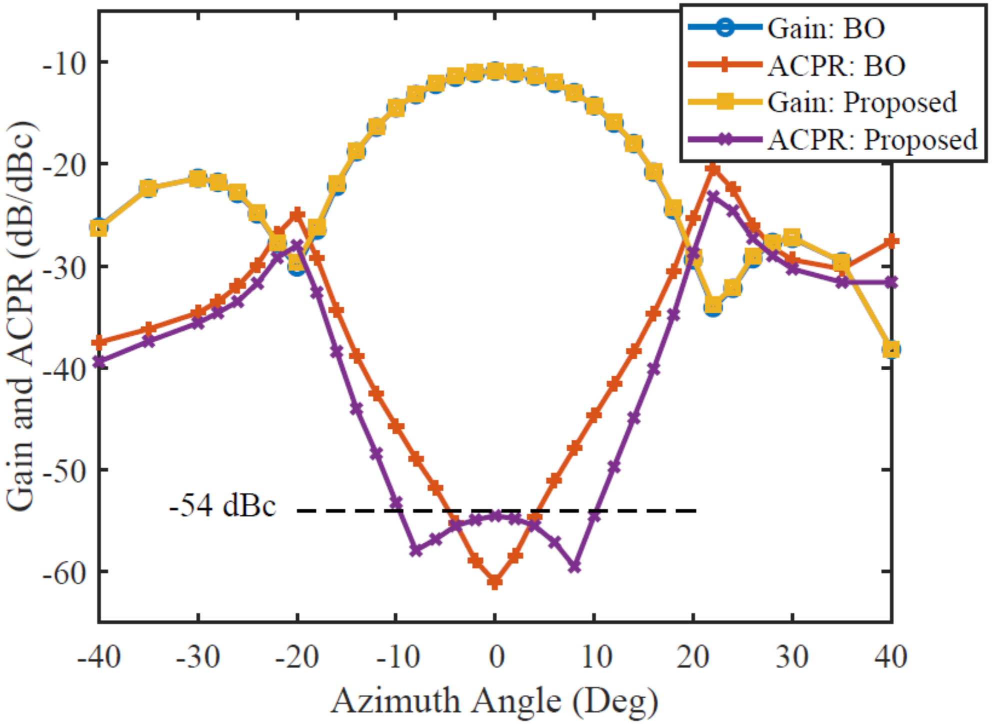
Semi-Partitioned DPD



DPD Performance

- Experiment
  - **2×2 hybrid**
  - **Non-ideal calibration**





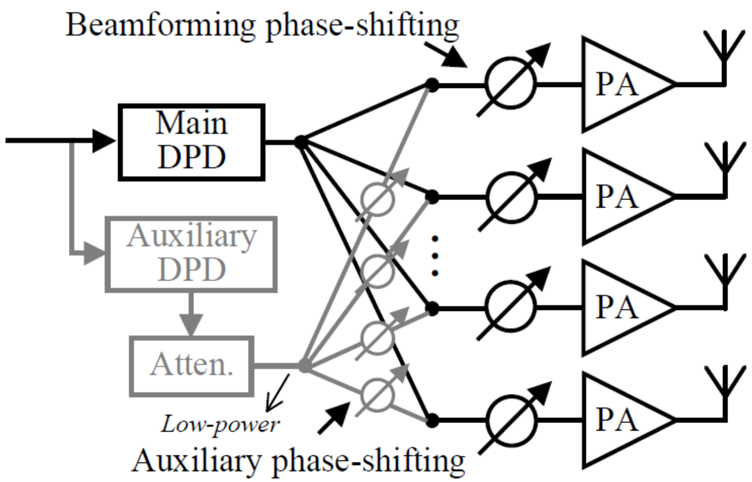
√ 10° → 20° (< -54 dBc)

√ Gain pattern is not affected

Conclusion

Advantages:

1. 2-target DPD structure is simplified
2. DPD extraction complexity is reduced significantly
3. Online DPD is possible
4. Adaptive to hybrid beamforming
5. The technique can be extended to other multi-target scenarios



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