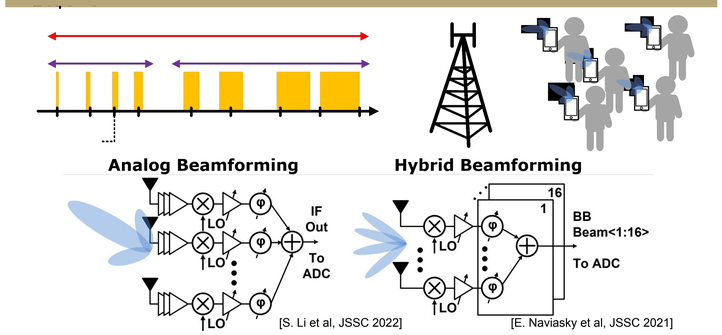
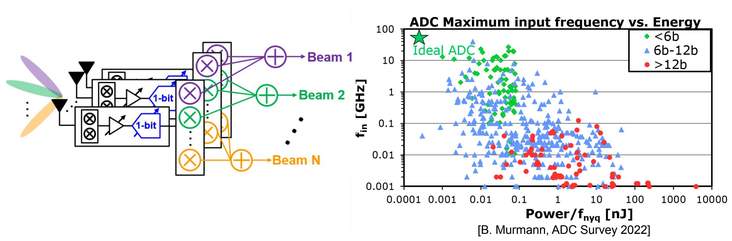
A Millimeter-Wave Digital Beamforming Receiver using Low-Resolution ADCs

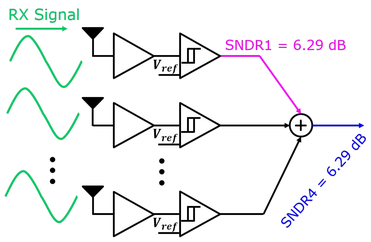
STUDENTS: DENIZ DOSLUOGLU

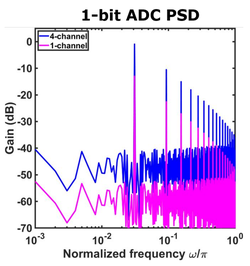
Millimeter-Wave Receivers for 5G

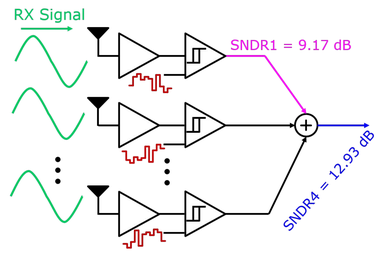


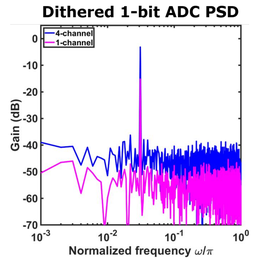
Digital Beamforming with Low-Resolution ADCs



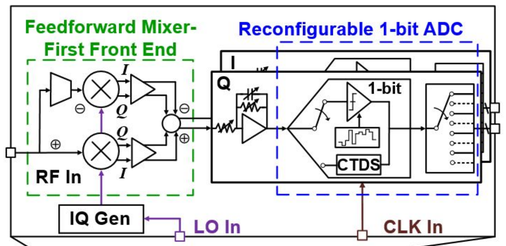




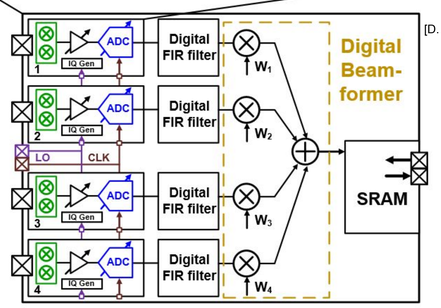




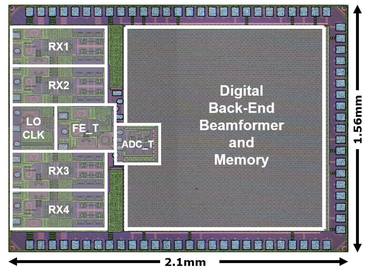
Prototype Chip



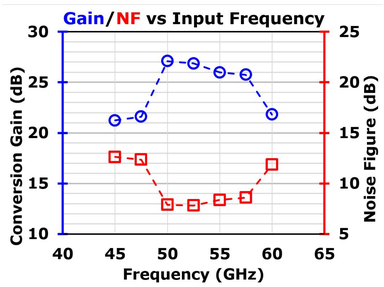
- 4 Elements
- LO: 45-60 GHz
- CLK_{MAX}: 4.8 GHz
- 10b beamforming weights
- 0.5 Mbit SRAM
- TSMC 28-nm CMOS
- Total area: 3.3 mm^2

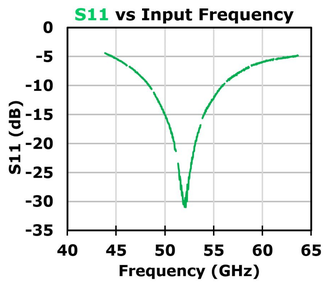


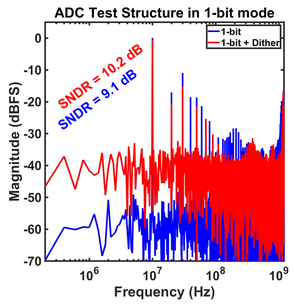
[D. Dosluoglu et al., ESSCIRC 2022] [D. Pena-Colaiocco et al., ISSCC 2022]

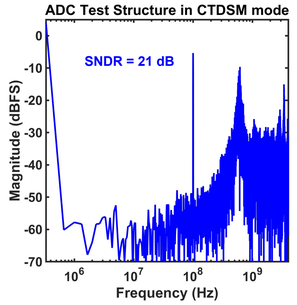


RF Front-End and ADC Test-Structure Measurements

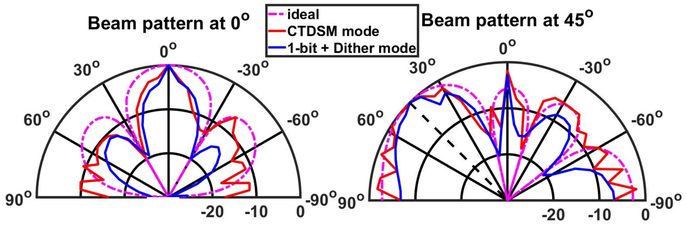




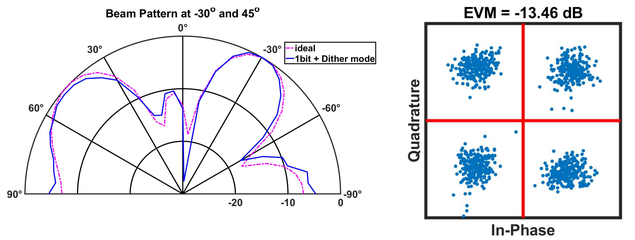




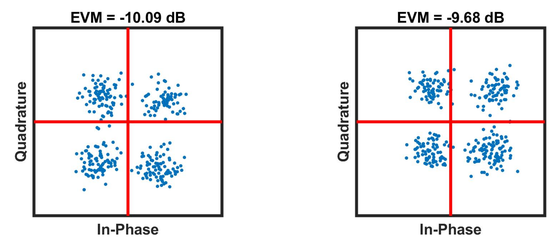
System-Level Measurements



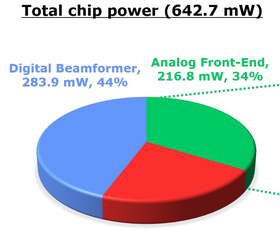
Dithered 1-bit ADC 1-beam 400 MS/s



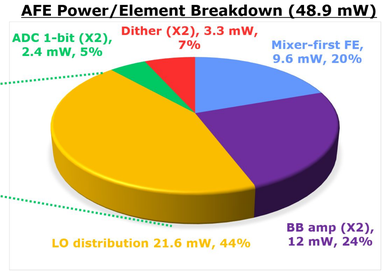
Dithered 1-bit ADC 2-beam 333 MS/s ($0^\circ, 30^\circ$)



Total chip power (642.7 mW)



AFE Power/Element Breakdown (48.9 mW)



1. S. Li et al., "An Eight-Element 140-GHz Wafer-Scale IF Beamforming Phased-Array Receiver With 64-QAM Operation in CMOS RFSOI," in *IEEE Journal of Solid-State Circuits (JSSC)*, vol. 57, no. 2, pp. 385-399, Feb. 2022.
2. E. Naviasky et al. A 71-to-86-GHz 16-Element by 16-Beam Multi-User Beamforming Integrated Receiver Sub-Array for Massive MIMO. IEEE JSSC, 56(12):3811–3826, 2021.
3. B. Murmann, *ADC Performance Survey 1997-2021*, [online] Available: https://web.stanford.edu/~murmann/adcsurvey.html.
4. D. Dosluoglu et al. "A Reconfigurable Digital Beamforming V-Band Phased-Array Receiver," *ESSCIRC 2022- IEEE 48th European Solid State Circuits Conference (ESSCIRC)*, Milan, Italy, 2022, pp. 493-496.
5. D. Pena-Colaiocco et al. "An Optimal Digital Beamformer for mm-Wave Phased Arrays with 660MHz Instantaneous Bandwidth in 28nm CMOS.", IEEE International Solid-State Circuits Conf (ISSCC) 2022.

ELECTRICAL & COMPUTER ENGINEERING
UNIVERSITY of WASHINGTON

ADVISORS: JACQUES C. RUDELL

SPONSORS: ELECTRICAL & COMPUTER ENGINEERING DEPARTMENT, UNIVERSITY OF WASHINGTON, BOEING, NSF, QUALCOMM, CDADIC