The Demand Side: Radio Power, Data Rates, and Duty Cycle

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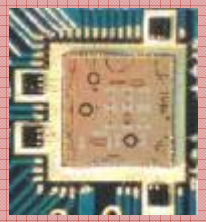
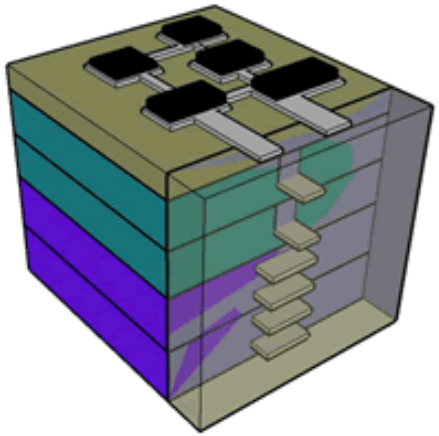
Jesse Richmond, Wenting Zhou, Yuhui Chee, Brian Otis,
Nathan Pletcher, Fred Burghardt, Jan Rabaey

Wireless Sensor Node

Low Power Radio



Power Storage



"Picocube"

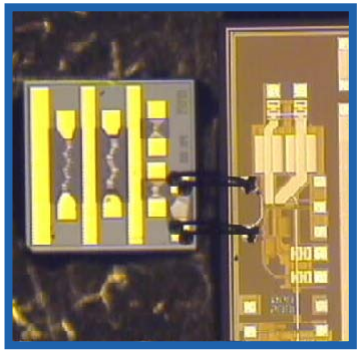
Sensor

Renewable Power

Supply

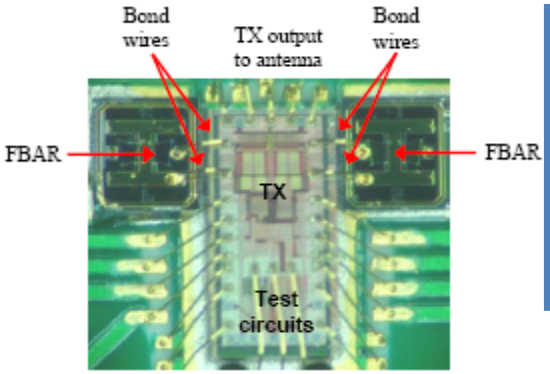
(Condensed) Radio History in Our Group

FBAR-based low power oscillator



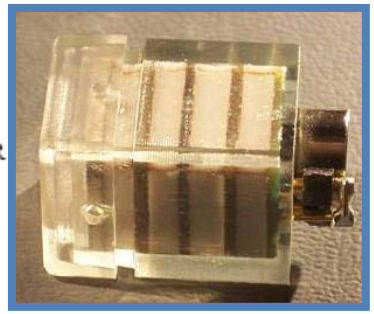
ESSCIRC 2002 (Otis)

Active Antenna Transmitter



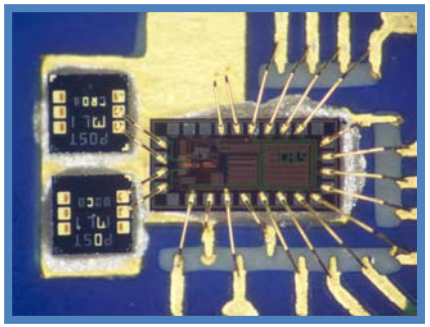
VLSI 2006 (Chee)

PicoCube



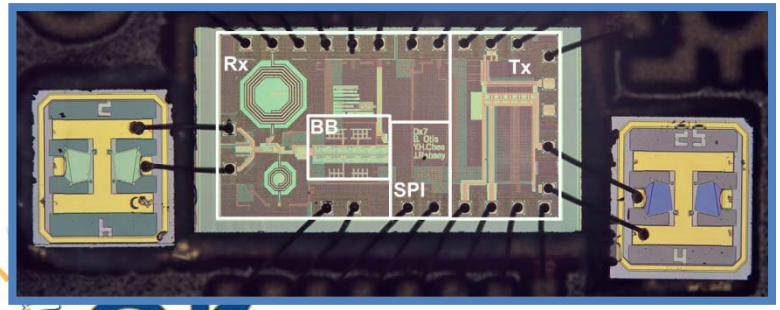
ISSCC / DAC 2008 (Burghardt et al)

Interpolative FBAR VCO



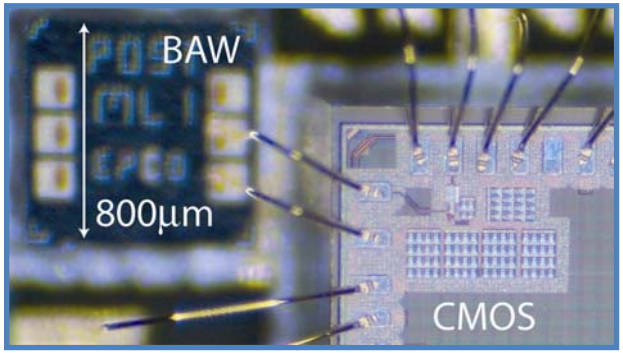
ISCAS 2009 (Mark)

Super-Regenerative Transceiver



ISSCC 2005 (Otis /Chee)

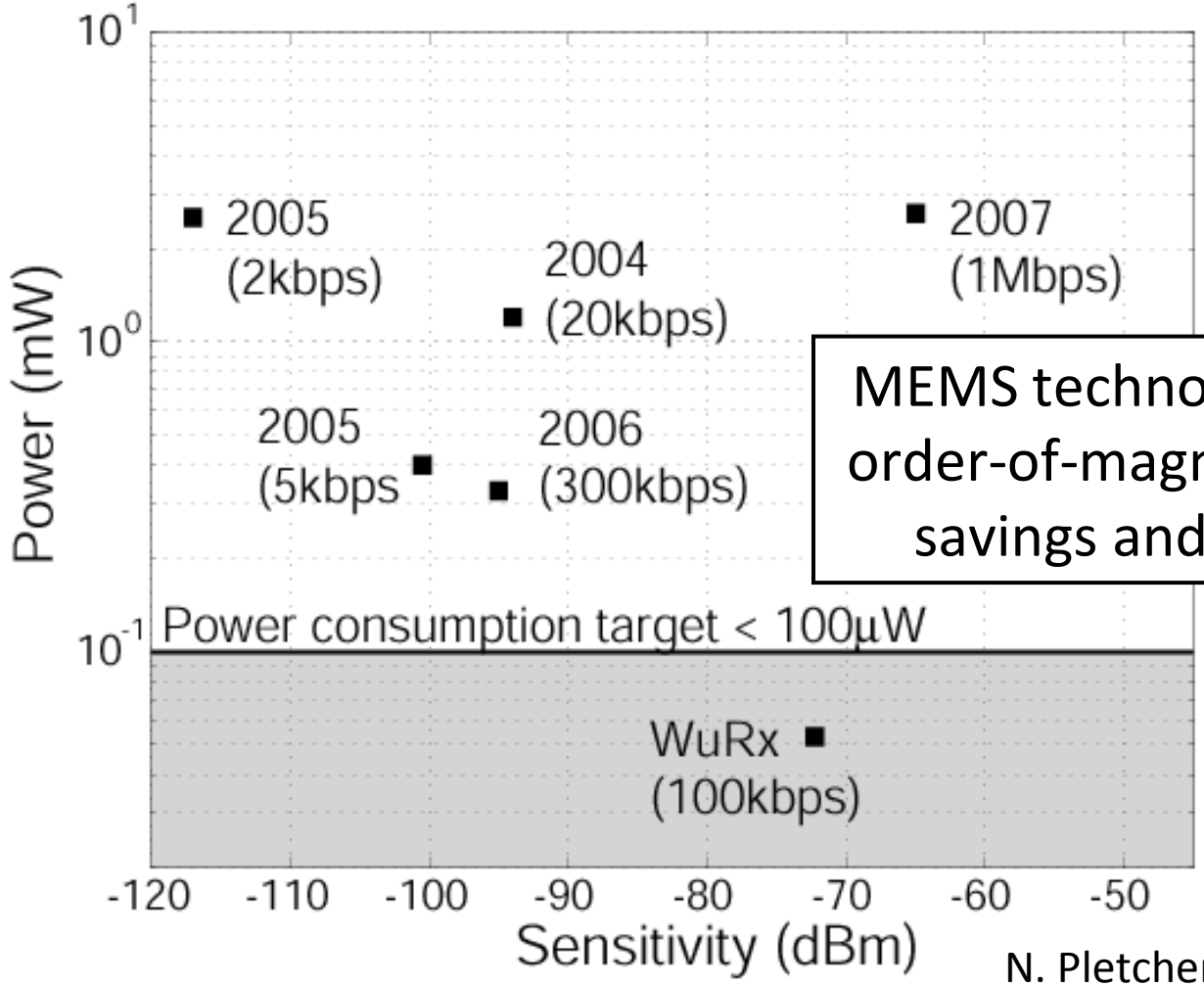
Wakeup Receiver



ISSCC 2008 (Pletcher)

PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

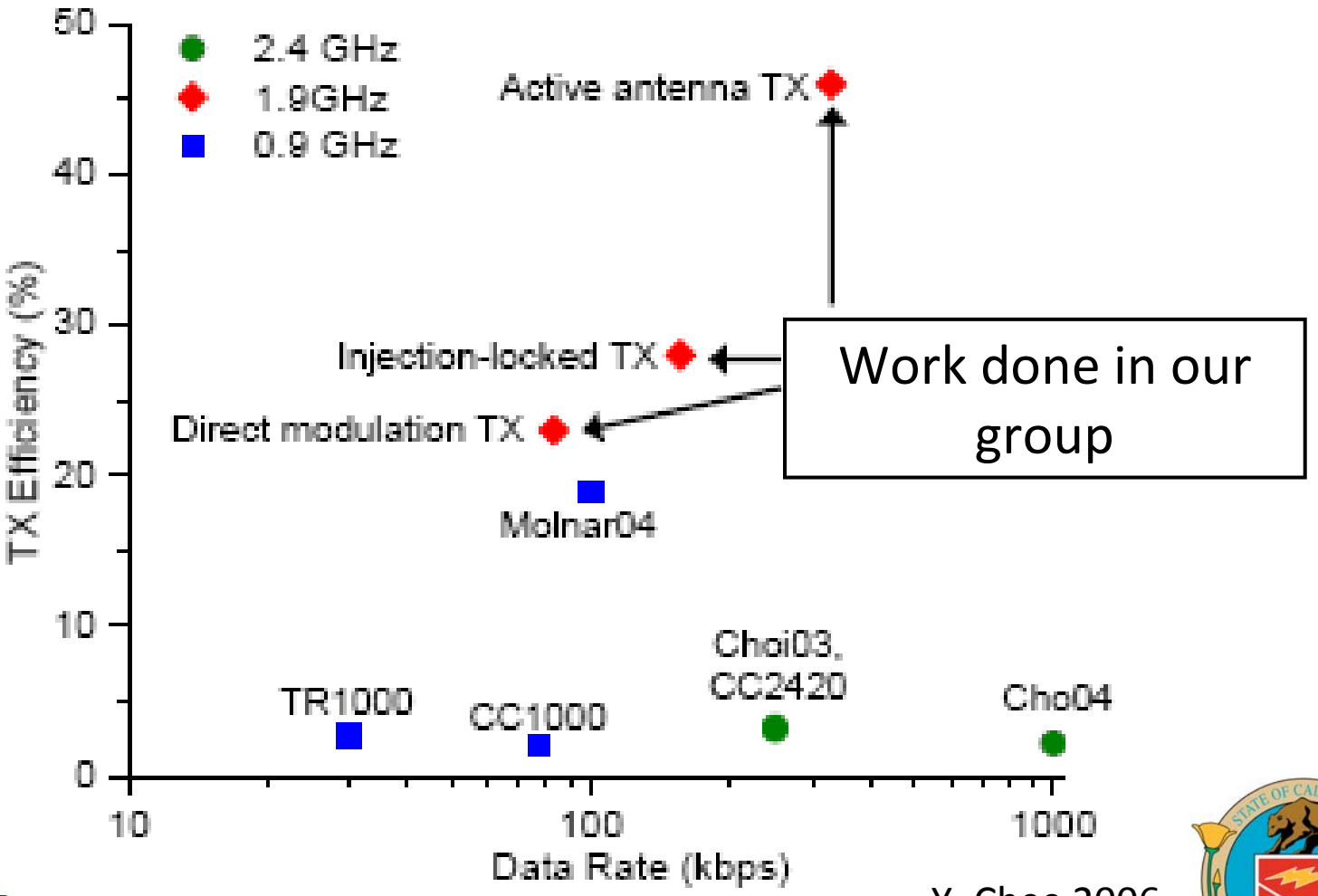
Breaking New Ground in ULP Receivers …



MEMS technology enables order-of-magnitude power savings and small size

N. Pletcher 2008

… and Transmitters



Y. Chee 2006

What's Keeping us Busy

- Novel circuits & architectures utilizing electrostatic resonators (J. Richmond)
- Communication schemes enabled by ultra – low power radios
  - Low power active RFID tag (W. Zhou)
- Radios for novel applications
  - Neural implants (D. Chen, M. Mark)
  - Cm – range communication (S. Gambini)

How Much Power Do We Need?

- Receiver (Uncertain IF)
  - **52 µW** @ 0.5 V (100 kbps, -73 dB Sensitivity)
- Transmitter (Active Antenna)
  - **1.35 mW** @ 0.65 V (P_{TX} ≈ 0 dBm, 330 kbps, 50% OOK data)
  - < 2 µW in sleep mode
- System (Picocube)
  - transmitting 6 bytes every 6 seconds @ 10 kbps
  - **≈ 6 uW** @ 1.2 V

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- GSRC
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