



Integrated Microelectronics Laboratory

System-on-Chip with Machine-Learning

P-FCB / BAN / Biomedical SoC with AI / Mobile Ultrasound

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Principal Investigator

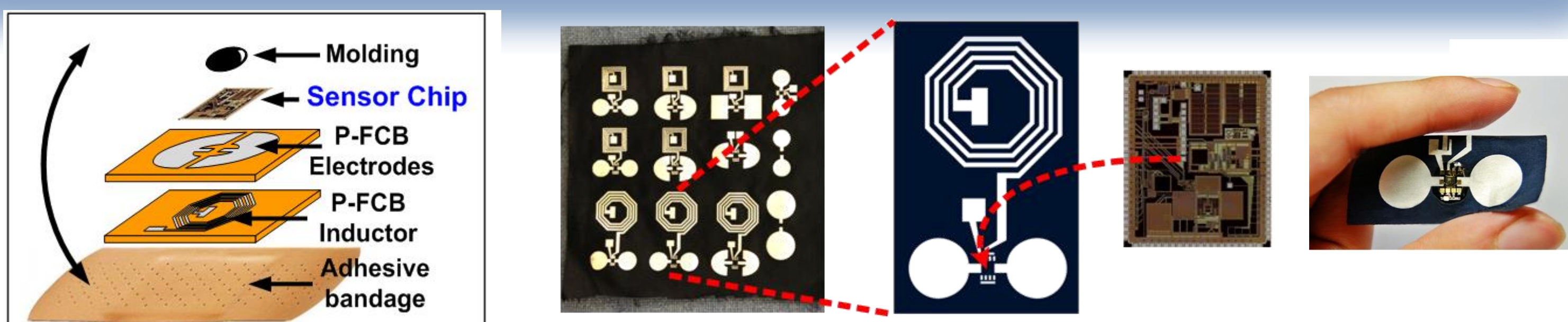


- 유담 (Jerald Yoo), jyoo@ieee.org
- BS (2002), MS (2007), PhD (2010), all at KAIST
- Visiting Scholar, MIT, USA ('10-'11)
- Asst, Assoc. Prof., Masdar Inst., UAE ('10-'16)
- Assoc. Prof. National Univ. Singapore ('17-'23)
- Assoc. Prof. Seoul National Univ. ('24-)

- Citation=3650 (ISSCC, IEEE JSSC, Nature Electronics, etc.)
- Distinguished Lecturer, IEEE SSCS ('17-'18) / CASS ('19-'21)
- Executive Committee, ISSCC / TPC, ISSCC, CICC, A-SSCC, etc.
- Awards: Best Paper (ISCAS2015), Best Demo (ISSCC'22&'20, etc.)

Group Website: <https://www.jeraldyyoo.com> for details

1. Planar Fashionable Circuit Board (P-FCB)

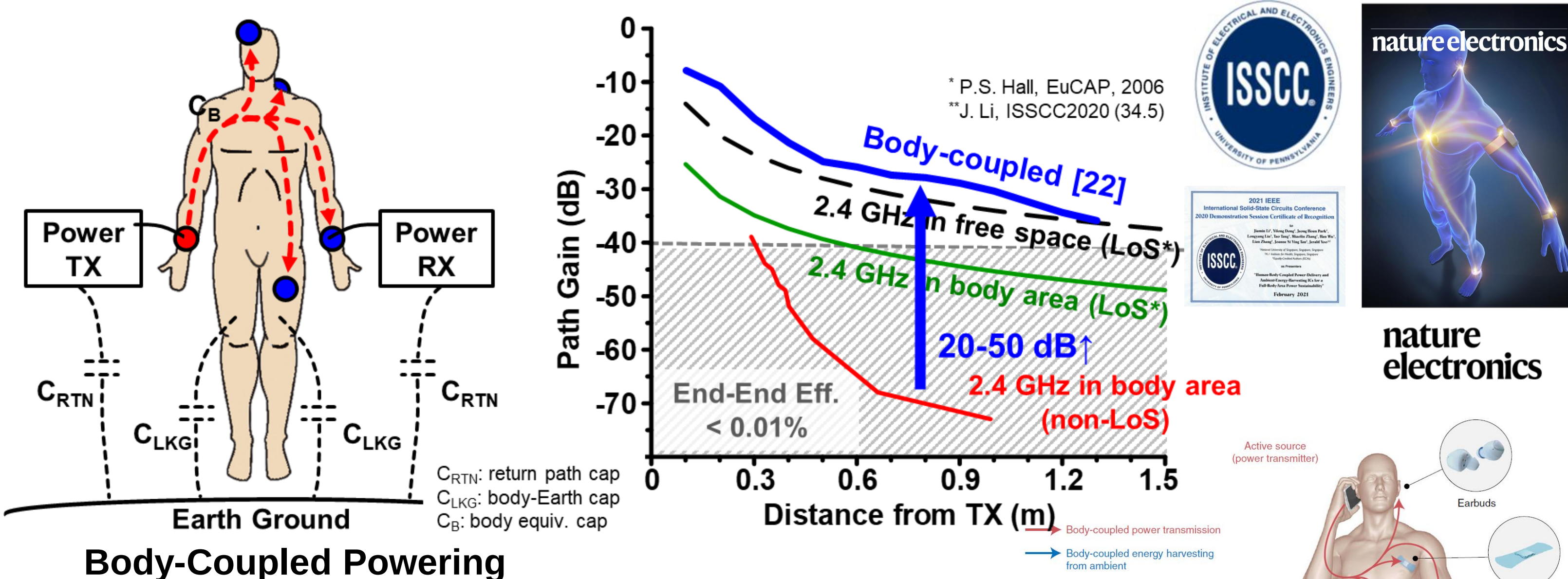


KAIST (2014),
Brain-disorder
headgear

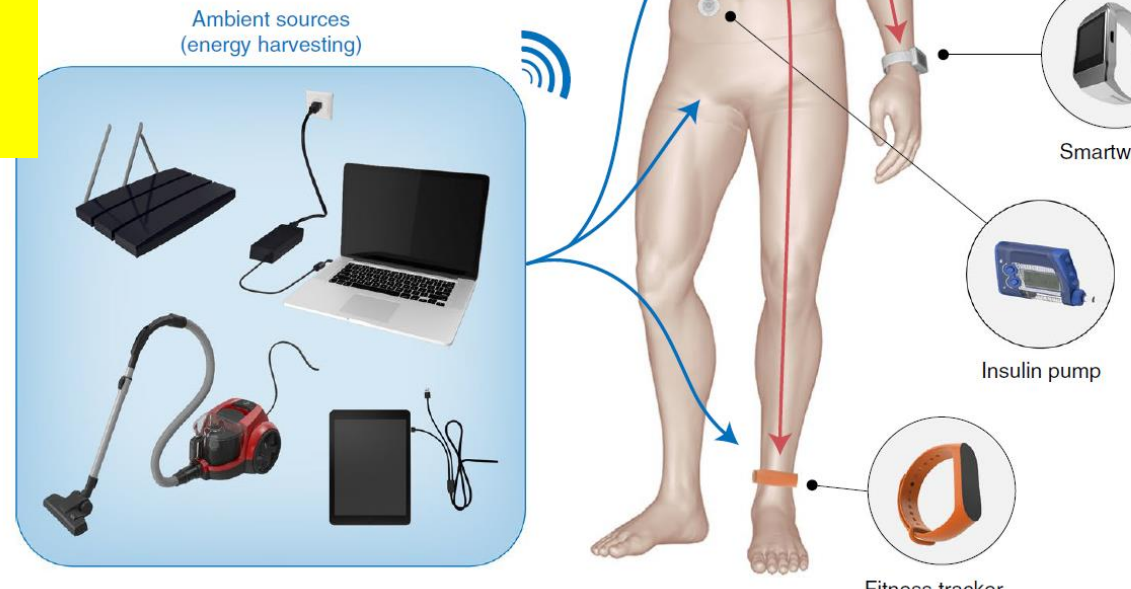
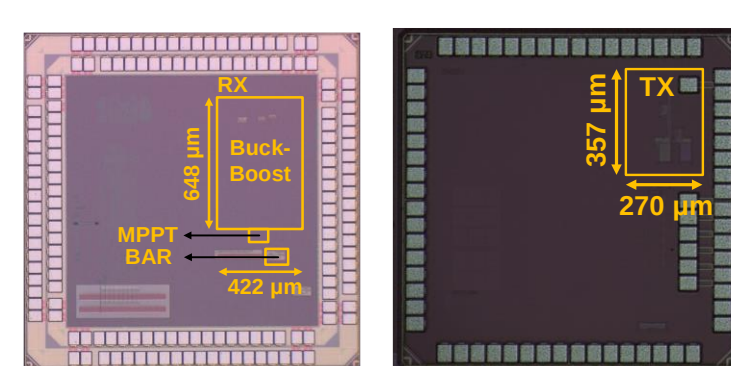
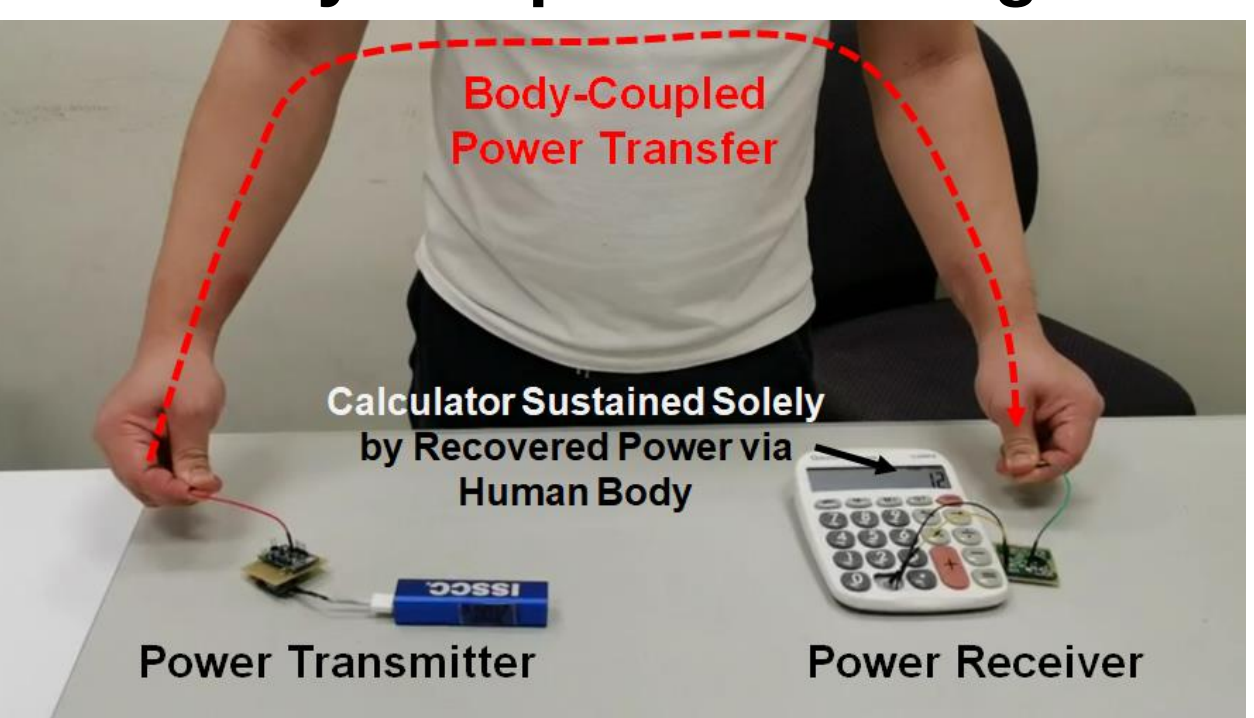
- ❖ Ambulatory Bio-Medical Devices
- ❖ Screen Printing for Naturally Wearable Platform
- ❖ Patch Type Sensors with Signal Processing
- ➔ DEC: Disposable, Easy-to-use, Convenient
- ➔ Power and Area Efficiency Required

2. Body-Coupled Comm and Powering

- Connectivity and powering on wearables
- Conventional RF or Energy Harvesting
 - We do not want to charge 10 different wearables every night!
 - Human body absorbs majority of the energy at 2.4GHz
 - Interferences, security issues
 - Location mismatch: PVs cannot be used for chest sensors
- Body Coupled Comm (BCC) and Powering (BCP) ¹
 - Human body as a comm. and powering medium
 - No antenna → lower power consumption → lower J/b
 - Powering sensor on entire body / harvesting energy using body
 - Smartphone can power up rest of the wearables through BCP!



Demo Video
(click)



3. Patient-Specific Biomedical System-on-Chip

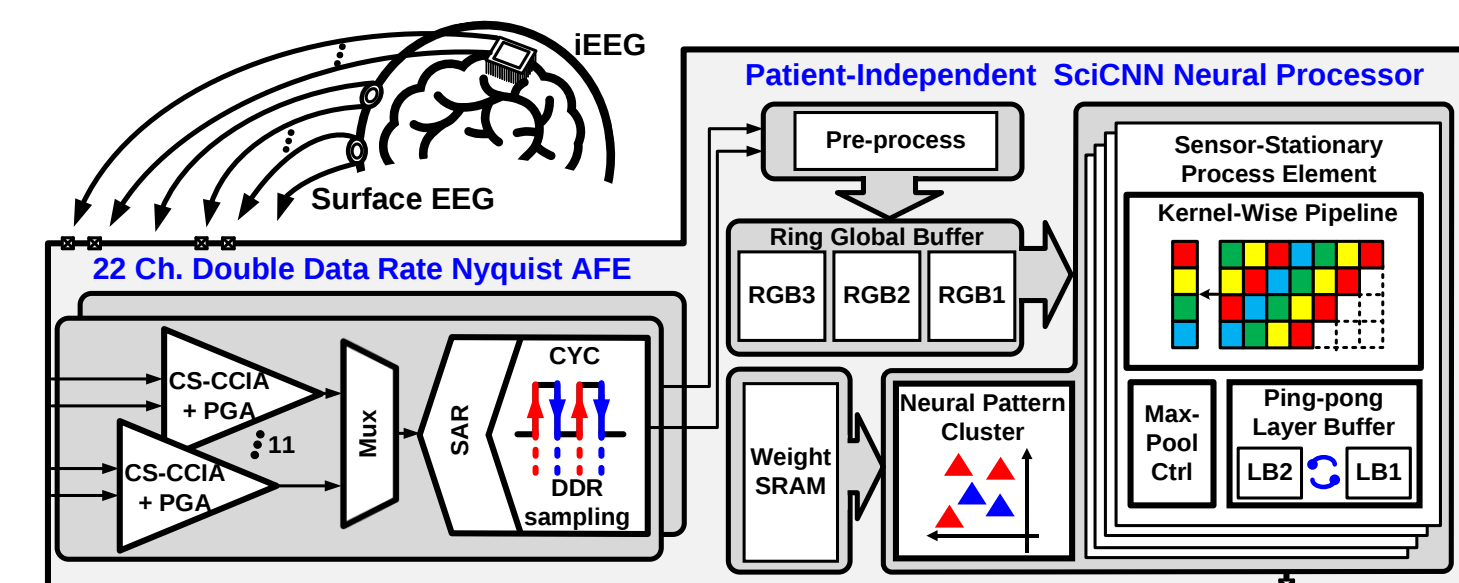


Wired-Bulky System
(Not comfortable)
Current Seizure
Detection Systems

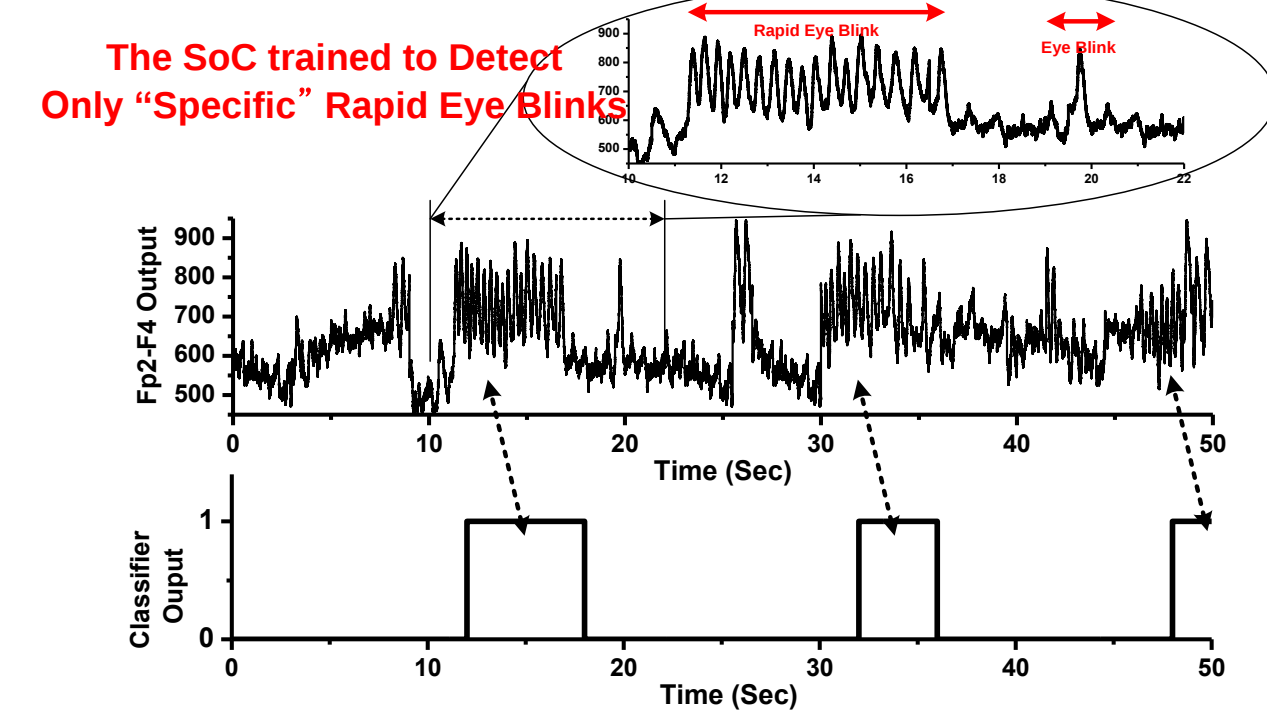
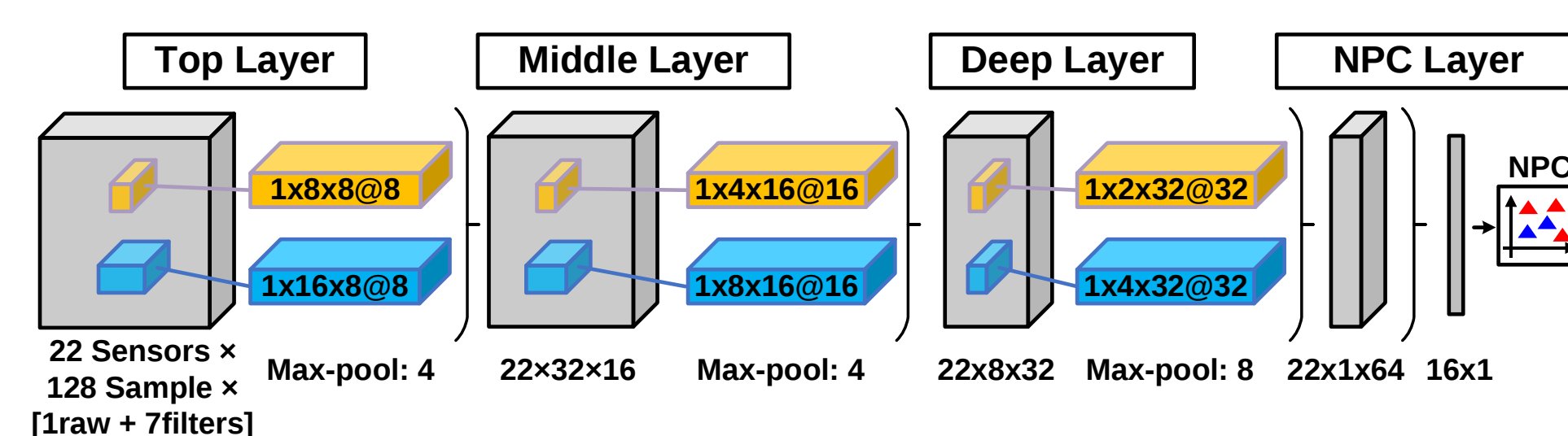


Integrated on Patch
Sensor

- >70 million people suffering epilepsy worldwide*
- Around 30% of epileptic patients cannot be treated with medication
- Long-term seizure detector SoC^{2,3}
 - Onset Detection with AI²
 - Recording Abnormal EEG data



Demo Video
(Click)



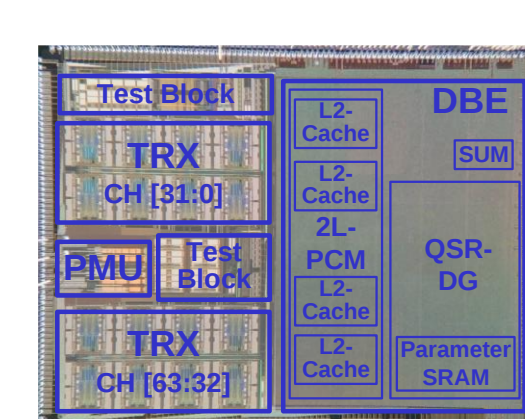
- World-First Patient-Specific Epilepsy Detection SoC (2012) ²
- World-First Patient-Independent Epilepsy Detection SoC (2023) ³
 - The first full integration of AFE and DBE at once
 - On-Chip Machine-learning enables patient-specific detection
 - On-Chip 0-Shot-Retraining SciCNN for patient-independent tracking

4. Mobile Ultrasound Imaging System (UIS)



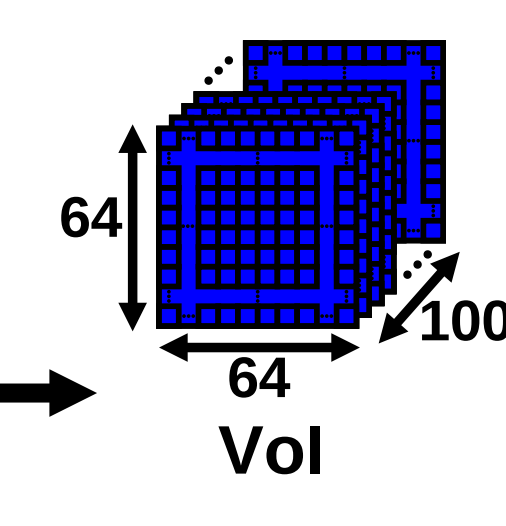
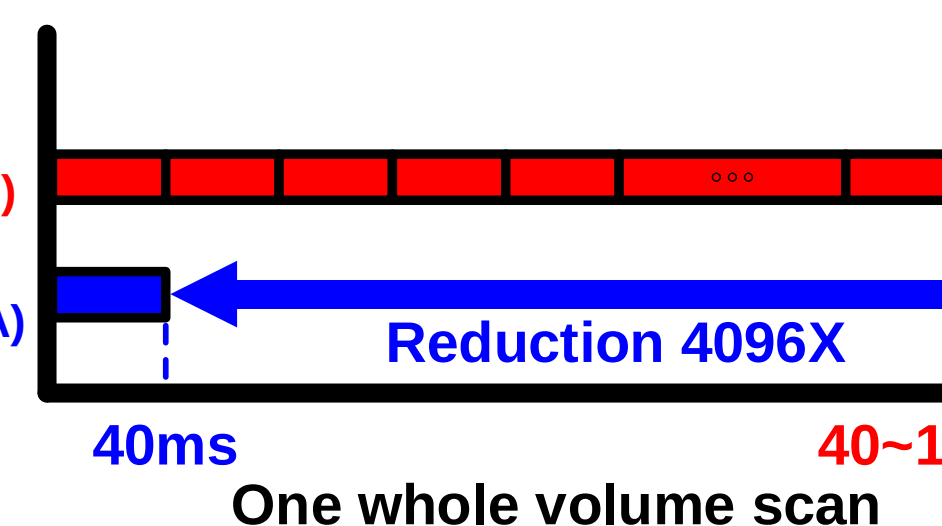
BatDrone: Ultrasound Imaging System

- All-Weather Imaging System for Drones
- Requires high-frame rate (>24fps) with >7m range
 - Lidar: too pricy, limited under fog
 - Camera: limited under night-time
 - Conventional ultrasound: too slow
- ➔ Solution: 1-shot TX Ultrasound UIS⁴

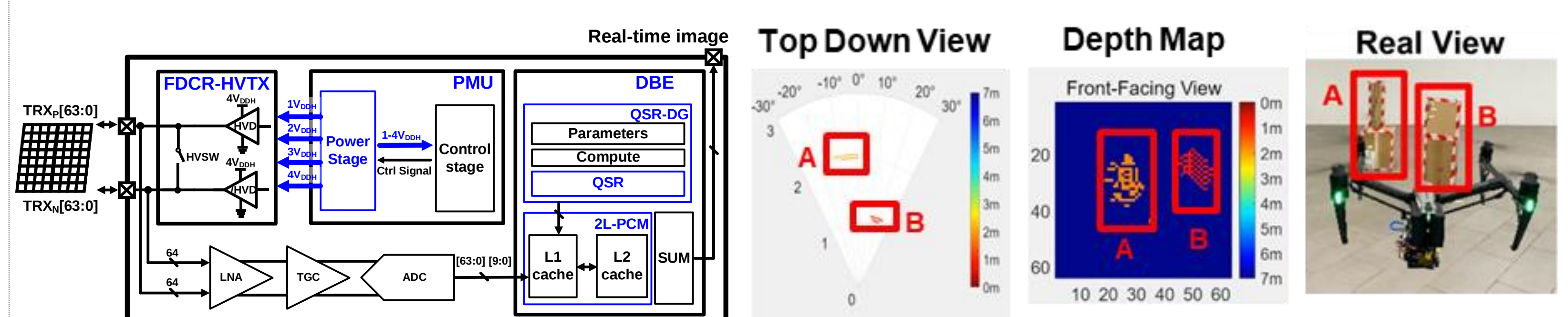


Conv. Work
(example 4-1MLA)

This Work
(equal to 4096MLA)



Demo Video
(Click)



신입생 모집 현황 (2024학년도)

- 석박 통합, 박사, 석사 (2024학년도 후기) 신입생을 모집합니다.
- 반도체 회로설계 및 시스템 구현
- 바이오메디컬 회로 및 시스템/AI, 드론/의료용 초음파, 웨어러블 전력전송
- 연락처: 유담 교수 jerald@snu.ac.kr

[1] J. Li et al., "Body-coupled power transmission and energy harvesting," Nat. Electron. 4, pp. 530-538, Apr. 2021. (ISSCC2020 Demo Award Winner)

[2] J. Yoo et al., "An 8-channel Scalable EEG Acquisition SoC with Patient-Specific Seizure Classification and Recording Processor," IEEE Journal of Solid State Circuits (JSSC), vol.48 No. 1 pp. 291-293, Jan 2013.

[3] C. Tsai et al., "SciCNN: A 0-Shot-Retraining Patient-Independent Epilepsy Tracking SoC," IEEE Int Solid-State Circuits (ISSCC), Feb. 2023

[4] L. Wu et al., "BatDrone: A 9.83M-focal-points/s 7.76ps-Latency Ultrasound Imaging System with On-Chip Per-Voxel RX Beamfocusing for 7m-Range Drone Applications," IEEE Int Solid-State Circuits (ISSCC), Feb. 2022 (ISSCC2022 Demo Award Winner)