High Frame Rate Arterial Monitoring via Wi-Fi 6 on a 32-channel Wearable Ultrasound Probe

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1 Introduction

Background and Motivation:

Cardiovascular Monitoring: key application for **wearable ultrasound** (WUS)

Multi-channel, high framerate ultrasound needed for e.g., efficient **vessel diameter extraction**
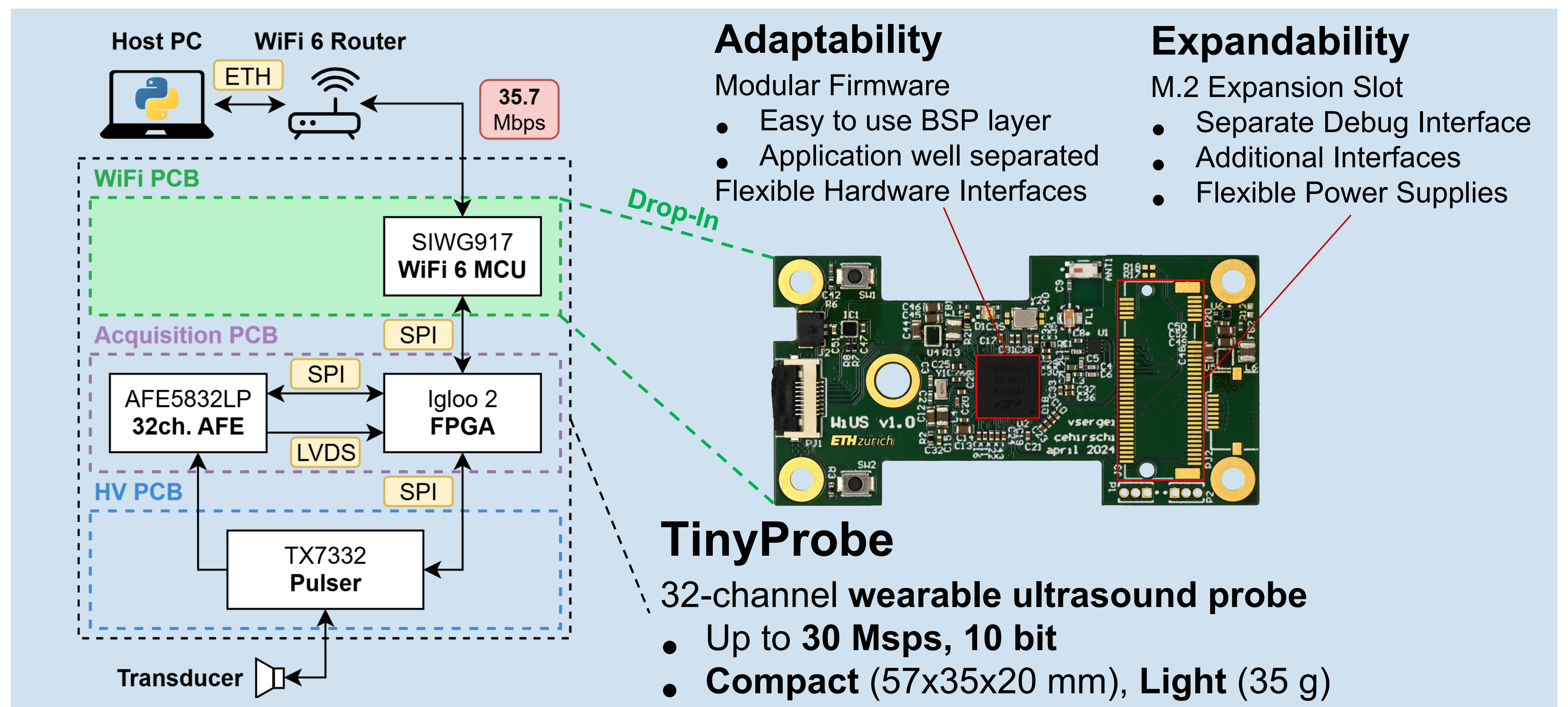
Current solutions **limited** to typically **≤50 Hz framerates** by their **wireless links**

Goal:

Develop Wireless Link with considerably **increased throughput**

→ While respecting **Wearability**

2 System Design

Host PC — WiFi 6 Router — ETH
35.7 Mbps
WiFi PCB
SIWG917 **WiFi 6 MCU** — SPI — Drop-In
Acquisition PCB
AFE5832LP **32ch. AFE** — SPI — Igloo 2 **FPGA**
LVDS
HV PCB — SPI
TX7332 **Pulser**
Transducer

Adaptability
Modular Firmware
• Easy to use BSP layer
• Application well separated
Flexible Hardware Interfaces

Expandability
M.2 Expansion Slot
• Separate Debug Interface
• Additional Interfaces
• Flexible Power Supplies

TinyProbe
32-channel **wearable ultrasound probe**
• Up to **30 Msps, 10 bit**
• **Compact** (57x35x20 mm), **Light** (35 g)

3 Experimental Verification

Verification with **arterial phantom**
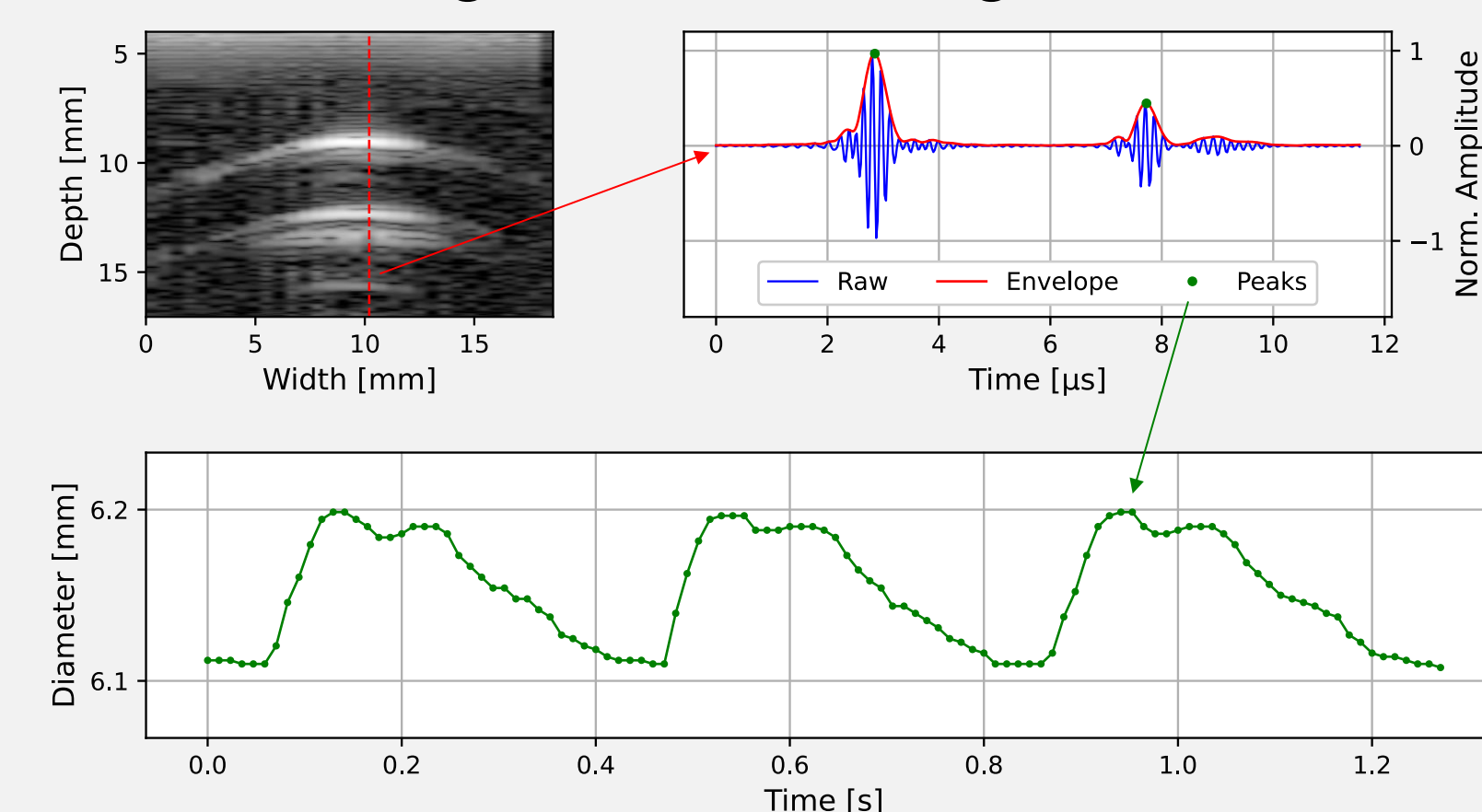Pulsatile flow up to **130 bpm** (DOPFLOW) [2]
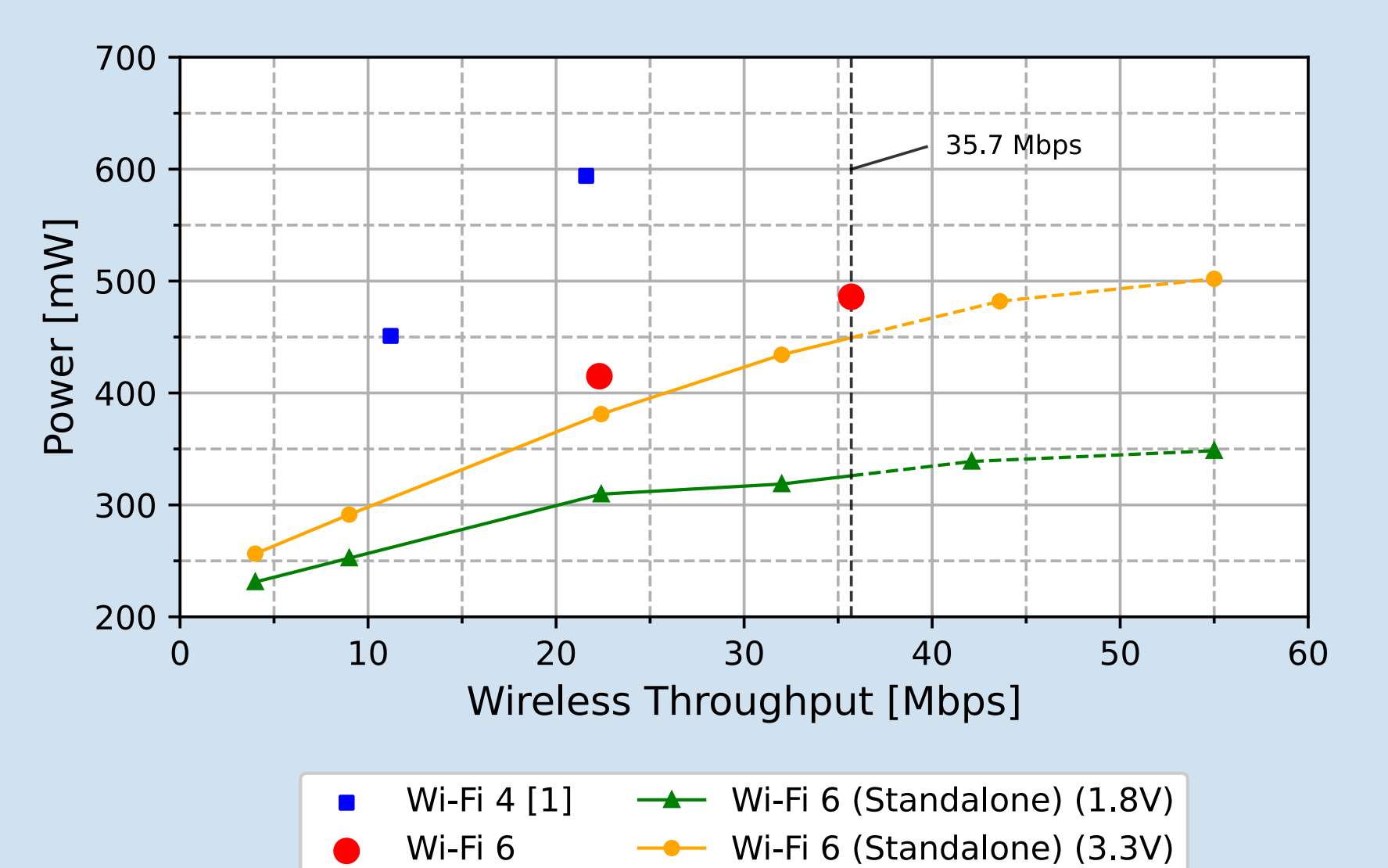32-channel, 2.25 MHz linear array

Processing:
Bandpass filtering, envelope extraction
Peak extraction for arterial walls
B-mode image beamforming

4 Power and Throughput Profiling

- Wi-Fi 4 [1]
- Wi-Fi 6
- Wi-Fi 6 (Standalone) (1.8V)
- Wi-Fi 6 (Standalone) (3.3V)

Compared to Wi-Fi 4 [1]:

• **46%** better **transmission efficiency**

• **65%** higher **end-to-end throughput**

• **72%** higher **wireless throughput**
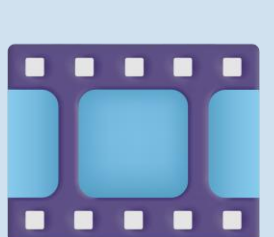
5 Conclusions

Compact **(54 x 27 mm)**
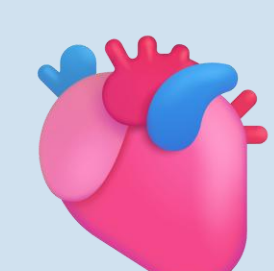High-throughput **(35.7 Mbps at 486 mW)**

Best in class power efficiency:
73.5 Mbps/W

For the first time:

Wearable 32-ch. frame-rate up to
175 Hz

Arterial wall tracking at high BPM:
130 bpm

Easily **adaptable** and **expandable** for many other use cases

• Other Wearables
• On-device inference

Design available **open-source**

https://github.com/pulp-bio/TinyProbe

References

1. S. Vostrikov *et al.*, "TinyProbe: A wearable 32-channel multi-modal wireless ultrasound probe," *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, vol. 72, no. 1, pp. 64–76, 2024

2. ——, "Open-source fully-programmable flow phantom for doppler ultrasound," in *2024 IEEE Ultrasonics, Ferroelectrics, and Frequency Control Joint Symposium (UFFC-JS)*. IEEE, 2024, pp. 1–4.