KOBE
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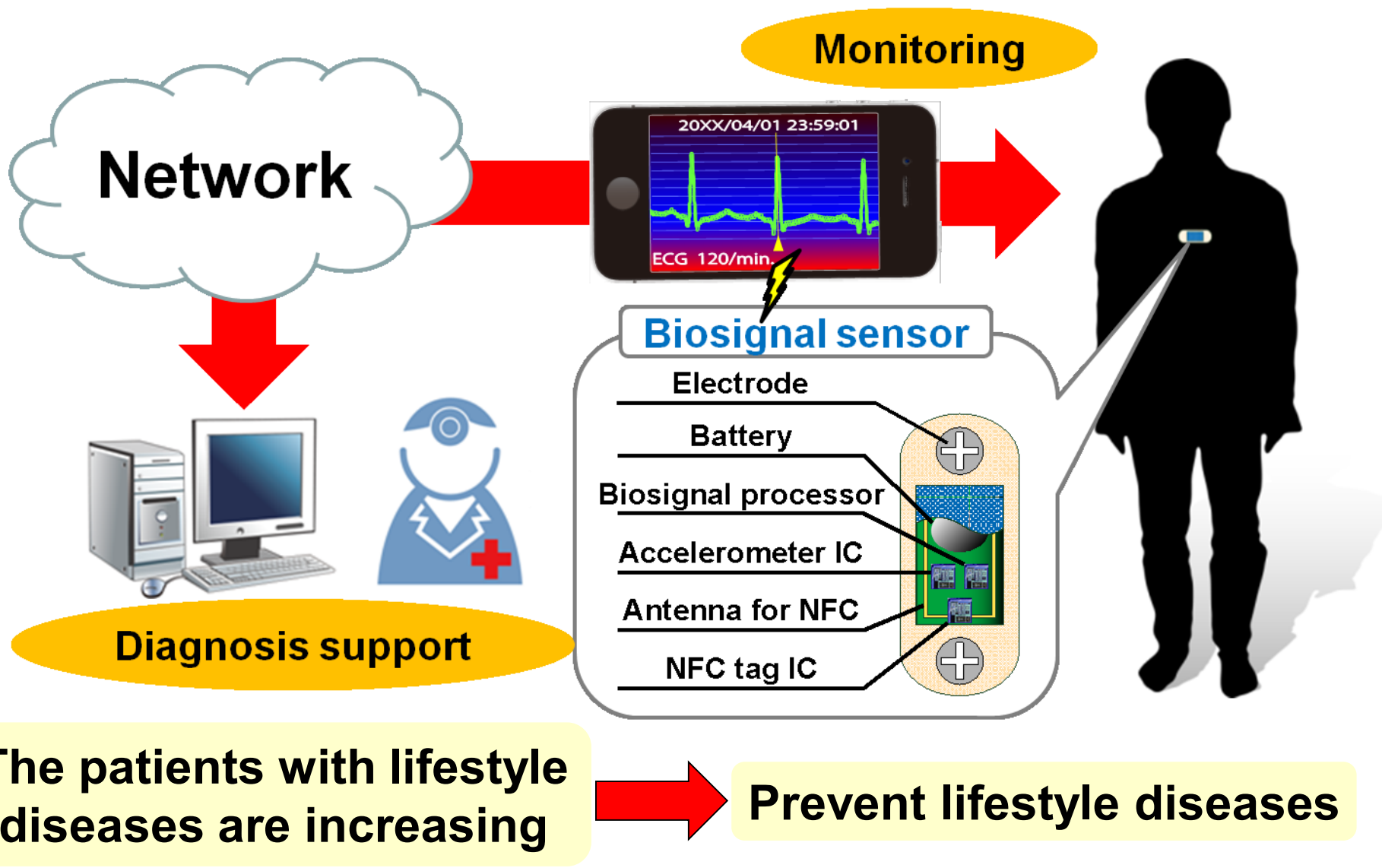# A 14μA ECG processor with Noise Tolerant Heart Rate Extractor and FeRAM for Wearable Healthcare Systems

Yozaburo Nakai, Shintaro Izumi, Masanao Nakano, Ken Yamashita, Hiroshi Kawaguchi, and Masahiko Yoshimoto

Kobe University, Japan

Background

Monitoring

20XX/04/01 23:59:01
ECG 120/min.

Biosignal sensor
- Electrode
- Battery
- Biosignal processor
- Accelerometer IC
- Antenna for NFC
- NFC tag IC

Network

Diagnosis support

The patients with lifestyle diseases are increasing → **Prevent lifestyle diseases**

Normally-Off computing

	Frequency component
ECG	0.1 - 150Hz
EEG	0.5 - 60Hz
VEP	0.5 - 60Hz
EMG	few kHz

< **Operational clock**
- ✓ CPU
- ✓ MPU

etc...

- **Frequency range of biosignal is low**
  - → **Standby power reduction is effective**

Standby   Active   Standby

Power

—— Volatile memory
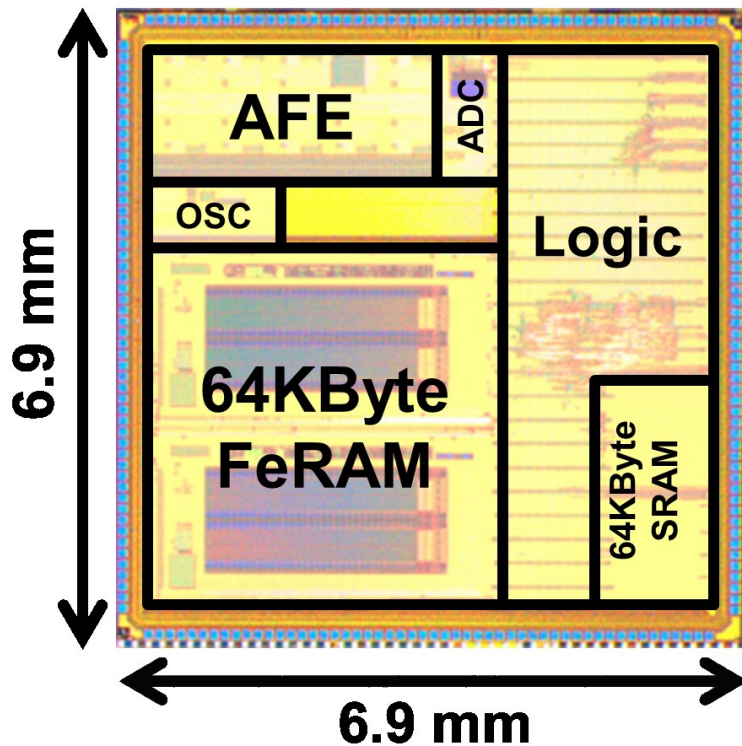
—— Non-Volatile memory

Time
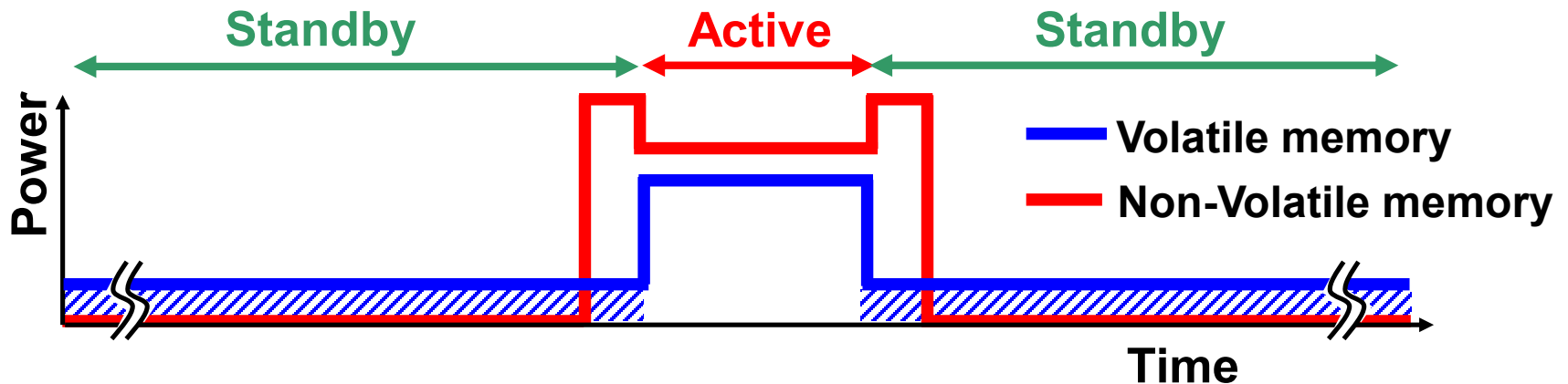
We use Normally-Off technique to the memory

Heart rate detection algorithm
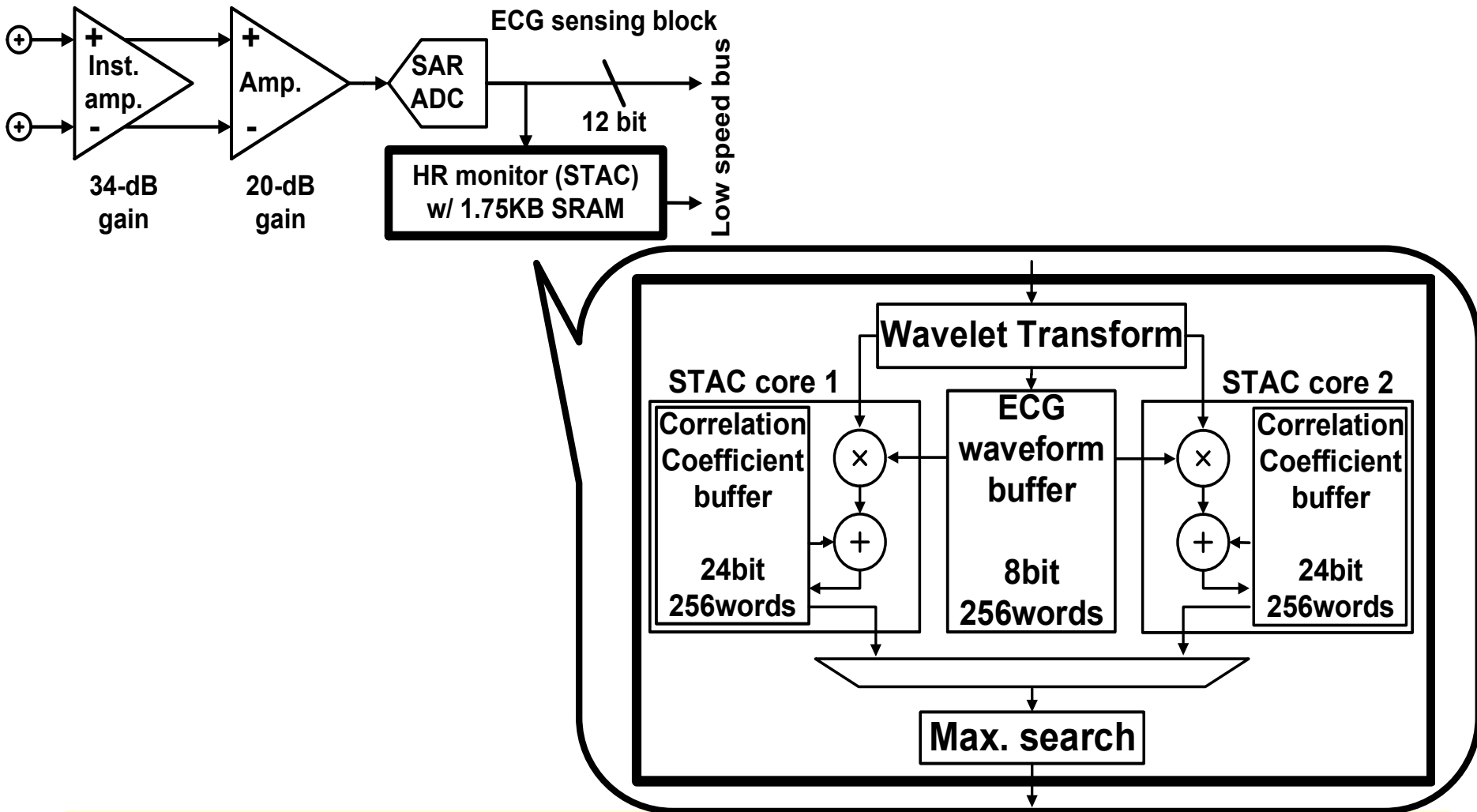
Use the correlation coefficient to calculate a heart rate

Chip photograph

Technology		130-nm CMOS
Supply voltage		1.2V (Digital, SRAM, ADC, AFE)
		3.0V (FeRAM, 32kHz OSC, I/O)
Chip area		6.9 mm × 6.9 mm
Frequency		24 MHz (for MCU)
		32 kHz (for other blocks)
MCU		32-bit Cortex M0
On chip memory		64-KB FeRAM (for logging data)
		64-KB SRAM (for MCU)
		1.75-KB SRAM (for IHR detector)
ADC	Resolution	12 bit
	Current	0.5 μA@128 S/s, 1.4 μA@1 kS/s
AFE	Gain	54 dB
	Bandwidth	0-100 Hz
	CMRR	73 dB
	Current	3.4 μA
Total current		13.7 μA (for heart rate logging)

Performance evaluation
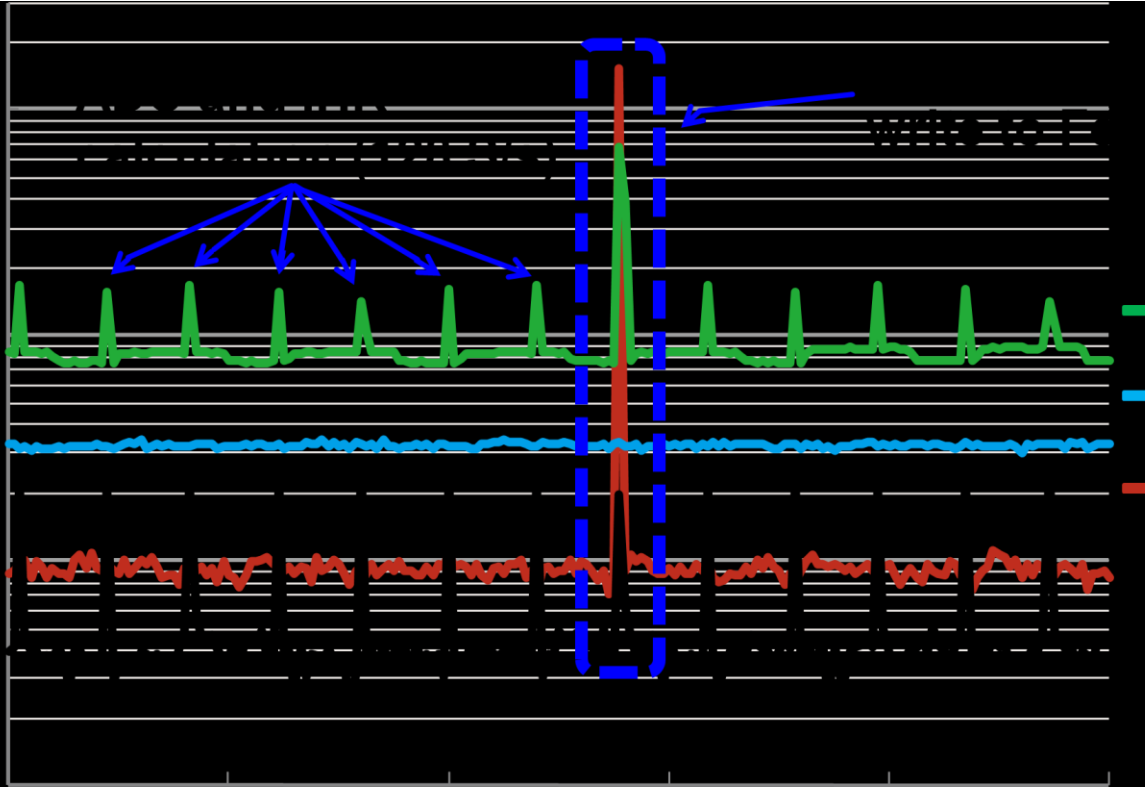
The measured total current consumption is **13.7**μA for the heart rate logging application