



save energy

keep track

anticipate

lower cost

save time

stay tuned

improve performance

feel secure



**Holst Centre**

Open Innovation by imec and TNO



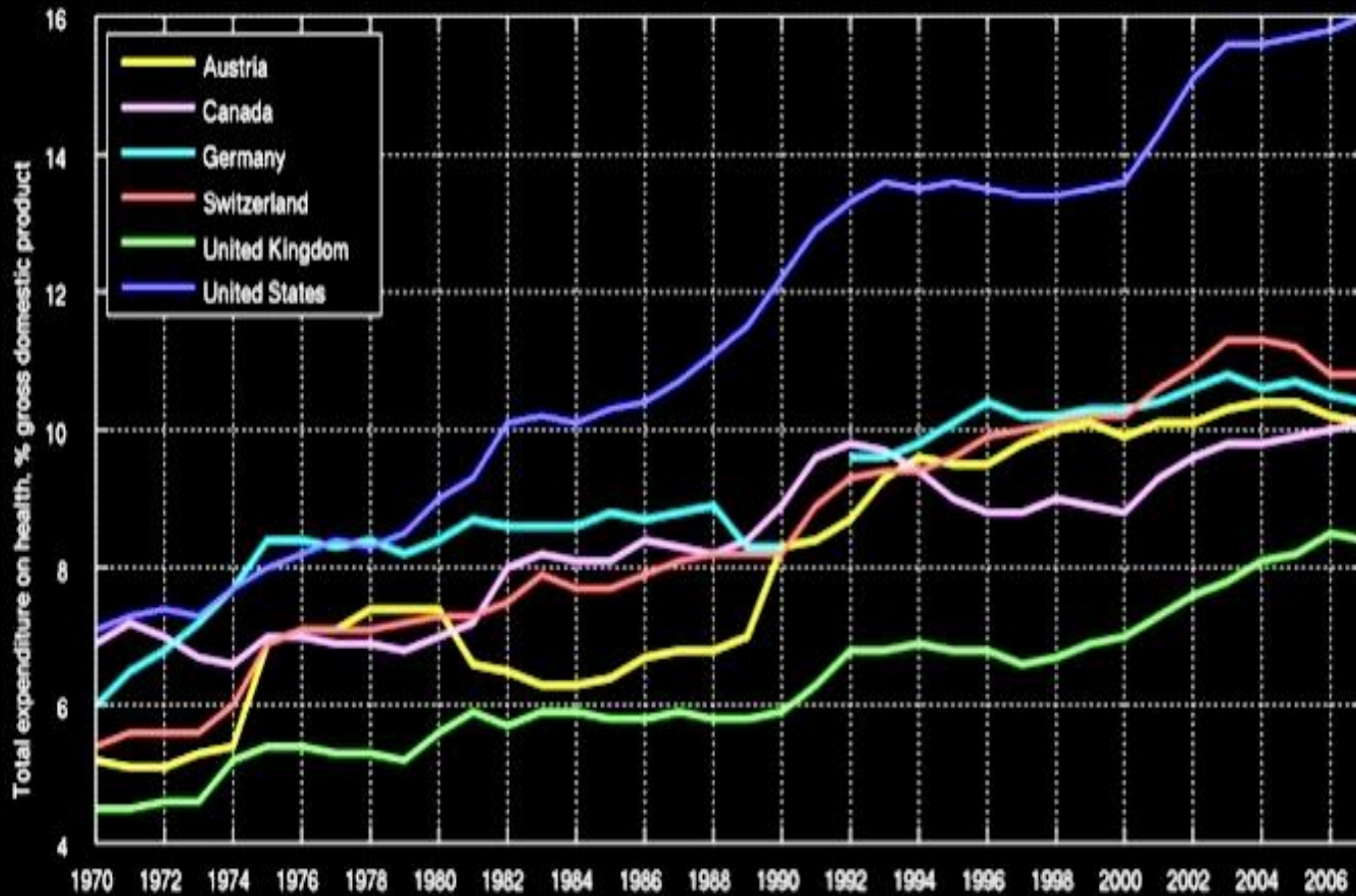
# MINIATURIZED SMART SYSTEMS FOR HEALTH AND LIFESTYLE APPLICATIONS

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*SENIOR PRINCIPAL SCIENTIST*



# OUR HEALTHCARE SYSTEM



**IS UNSUSTAINABLE**



**BY 2020: 50% increase in CHRONIC DISEASE SPENDING**



**BY 2025: 1.2 BILLION PERSONS 65+**

# INNOVATION CHALLENGES

IMPROVE

ILLNESS  
MANAGEMENT

ENABLE

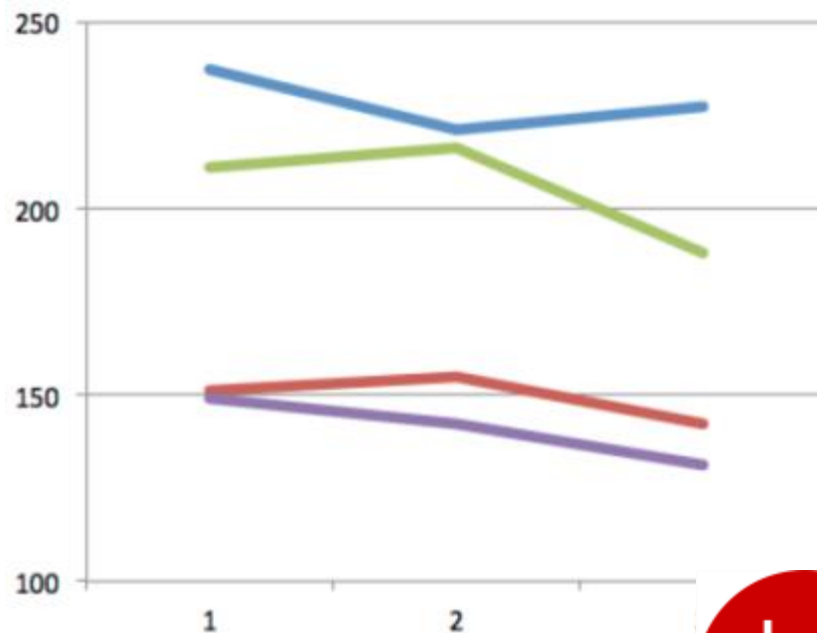
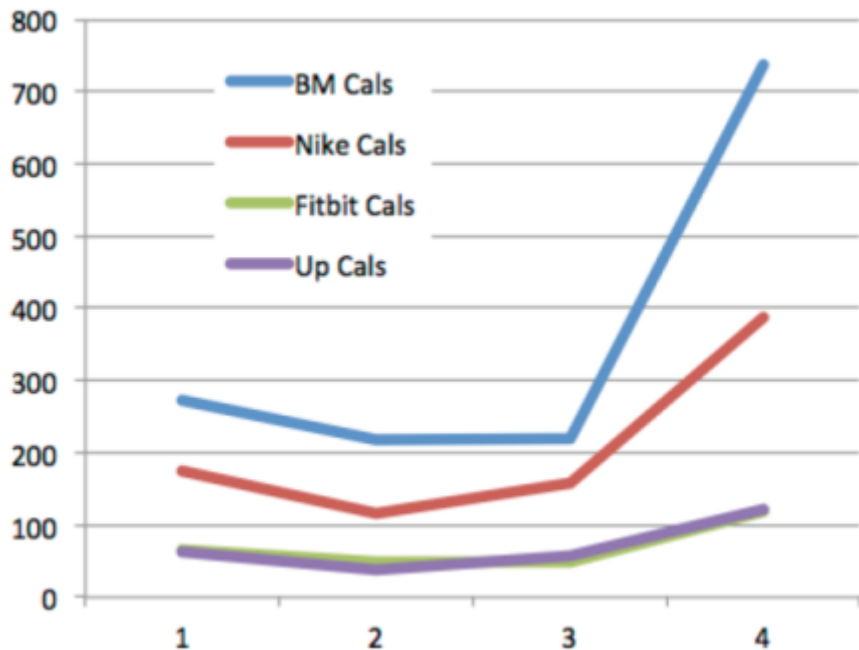
HEALTH  
MANAGEMENT



# A multitude of devices ...

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	
1	Site	<a href="http://www.bodymedia.com/">http://www.bodymedia.com/</a>			<a href="#">Link</a>			<a href="#">Link</a>	expected June 2013	no manual found		mytrak and Rhythm are the same	Heart Rate Monitor		
2	Click on Logo for	Multi-sensor Body Monitor							<a href="#">Link</a>						
3	Product Type				bodybugg®	bodybuggSP™	exerspy™	Multi-Sensor™	amigo™	BASIS	myTREK	SEOSENSE	myTRAK™	adidas miCoach	
4	Product Appearance														
5	Application Appearance														
6	Sensors**	Skin Temp., GSR, HF, 3-axis accelerometer	Skin Temp., GSR, HF, 3-axis accelerometer	Skin Temp., GSR, HF, 3-axis accelerometer	Skin Temp., GSR, HF, 3-axis accelerometer	Skin Temp., GSR, HF, 3-axis accelerometer	Skin Temp., GSR, HF, 3-axis accelerometer	Skin Temp., GSR, HF, 3-axis accelerometer	Heart rate sensor, HR, HF, Skin Temp.	OPF, Body Temp., 3-Axis Accelerometer, Multi-lead Temp., GSR	HR (w/ forearm strap), Accelerometer	HR (optical)	HR (w/ forearm strap), Accelerometer	HR (w/ forearm strap)	
7	On-Body	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes (Optical) and No (Kick-Clip)	Yes	Forearm	Forearm	No	Chest Strap	
8	Calorie Accuracy	>50%	>50%	>50%	>50%	>50%	>50%	>50%	Unpublished	Unpublished	Unpublished	Unpublished	Unpublished	Unpublished	
9	Clinically validated to be	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
10	MONITORED DATA														
11	Measures Calories	✓	✓	✓	✓	✓ (Moderate)	✓ (Moderate)	✓	✓	✓	✓	✓	✓	✓	
12	Measures Physical Activity	2 (Moderate & Vigorous)	2 (Moderate & Vigorous)	2 (Moderate & Vigorous)	1 (Moderate)	1 (Moderate)	2 (Moderate & Vigorous)	2 (Moderate, Vigorous)	Type of exercise						
13	Measures Heart Rate	(w/ 3rd party strap)	(w/ 3rd party strap)	(w/ 3rd party strap)				(w/ 3rd party strap)	✓	✓	✓	✓	✓	(w/ 3rd party strap)	
14	Measures Steps	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
15	Measures Speed / Pace	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
16	Measures Distance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
17	Sleep	(Duration, Patterns and Efficiency)	(Duration, Patterns and Efficiency)	(Duration, Patterns and Efficiency)				(Duration, Patterns and Efficiency)	(Duration, Patterns and Efficiency)	✓	✓	✓	✓	✓	
18	Stress														
19	Data Measured vs. Targets & Goals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
20	TRACKABLE DATA														
21	Daily Food Logging	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
22	Daily Calorie Estimates	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
23	Detailed Nutrition Breakdown	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
24	Calorie Balance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
25	Health Parameters (Weight, Waist)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
26	Workout Log	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
27	FEATURES														
28	Mobile App	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
29	Real time visual feedback (Mobile App)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
30	Real time visual feedback (display)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
31	Coaching / Training	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
32	Trending Reports	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
33	Continuous 24/7 wearability / comfort	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
34	Personal Bests	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
35	Facebook Integration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
36	Twitter Integration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
37	GPS/Map Tracker	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
38	PRICING														
39	Price	\$195.00	\$195.00	\$195.00	\$195.00	\$195.00	\$195.00	\$195.00	\$195.00	\$195.00	\$195.00	\$195.00	\$195.00	\$195.00	

# but how to extract relevant information







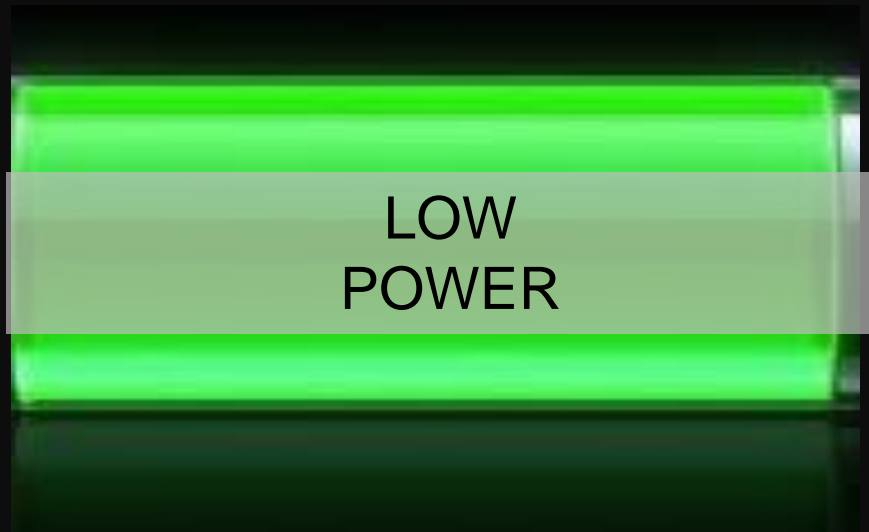
QUALITY  
OF DATA



DESIRABLE  
FORMFACTOR



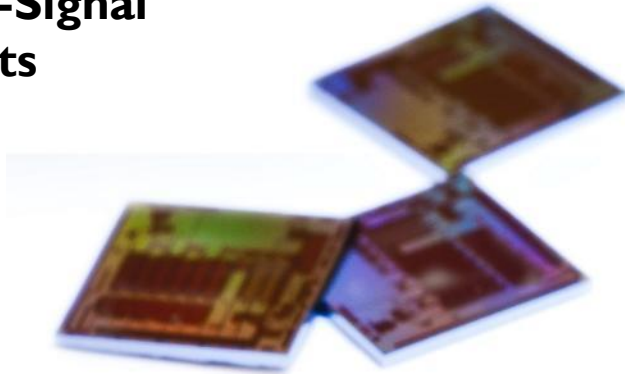
LOW  
COST



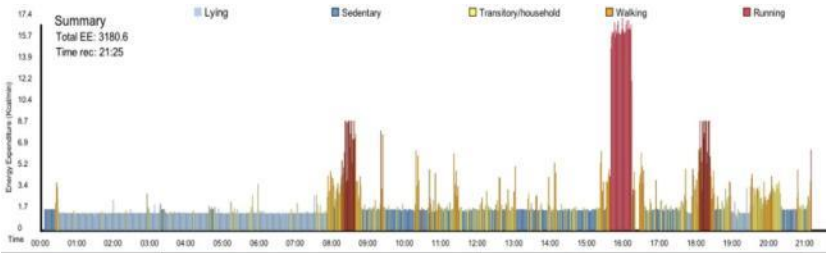
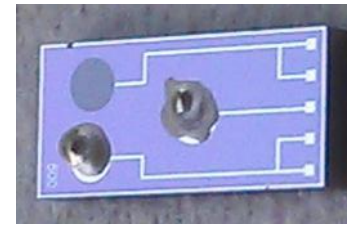
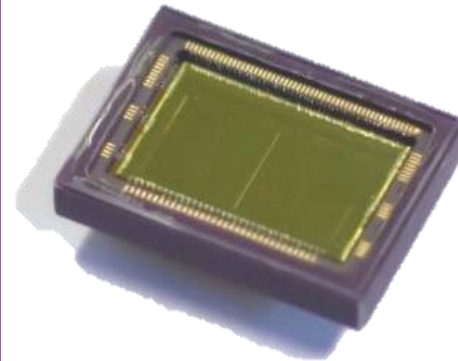
LOW  
POWER

# FULL SYSTEM DEVELOPMENT

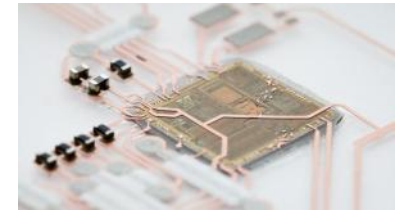
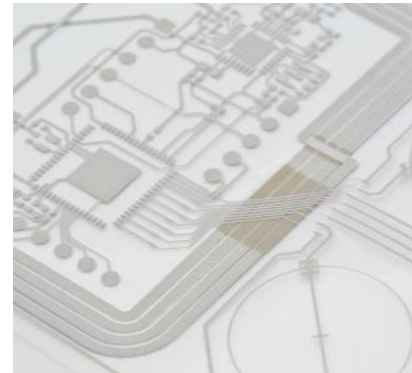
## Mixed-Signal Circuits



## Sensors



## Apps & algorithms



## Conformable Integration

# SENSOR PLATFORMS AND APPLICATIONS

Patch



Headset



Wristband



## Applications

- Cardio monitoring
- Physical Activity
- Energy Expenditure
- Emotion/stress monitoring
- Sleep monitoring
- .....

# Health wristband

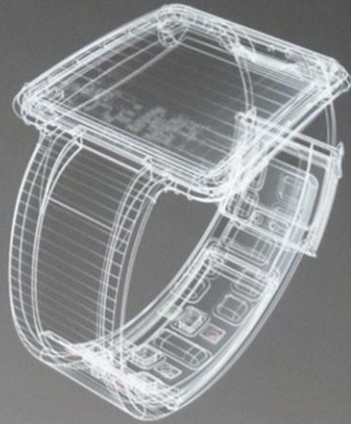
## User friendly wristband for continuous health tracking

- ▶ **Target apps:** physical activity, energy expenditure, stress, hypertension, air quality
- ▶ **Multi-parameter**
- ▶ **Quality & intelligent**
- ▶ **Comfort & ease of use**



# SIMBAND

*Samsung's open digital health initiative*



Samsung **SIMBAND**



## WIRELESS EEG



### EEG monitoring made easy

- ▶ Dry electrodes
- ▶ Active electrodes
- ▶ Low-noise
- ▶ Low-power
- ▶ Easy and fast to set-up
- ▶ Allowing accurate EEG monitoring at home

# From platform to product



- **imec** generic EEG development platform

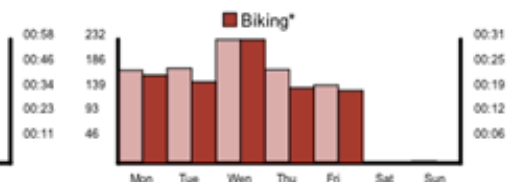
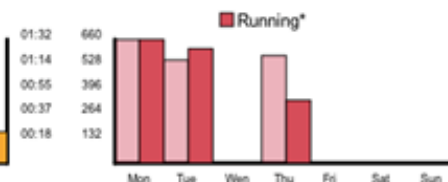
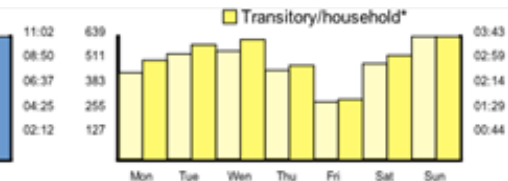
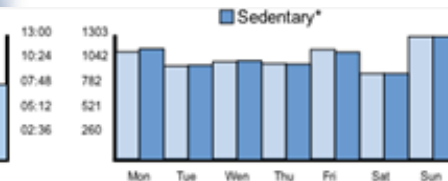


**NeuroPro** specific EEG system created with **imec** circuits and **imec** system electronics

# ECG PATCH

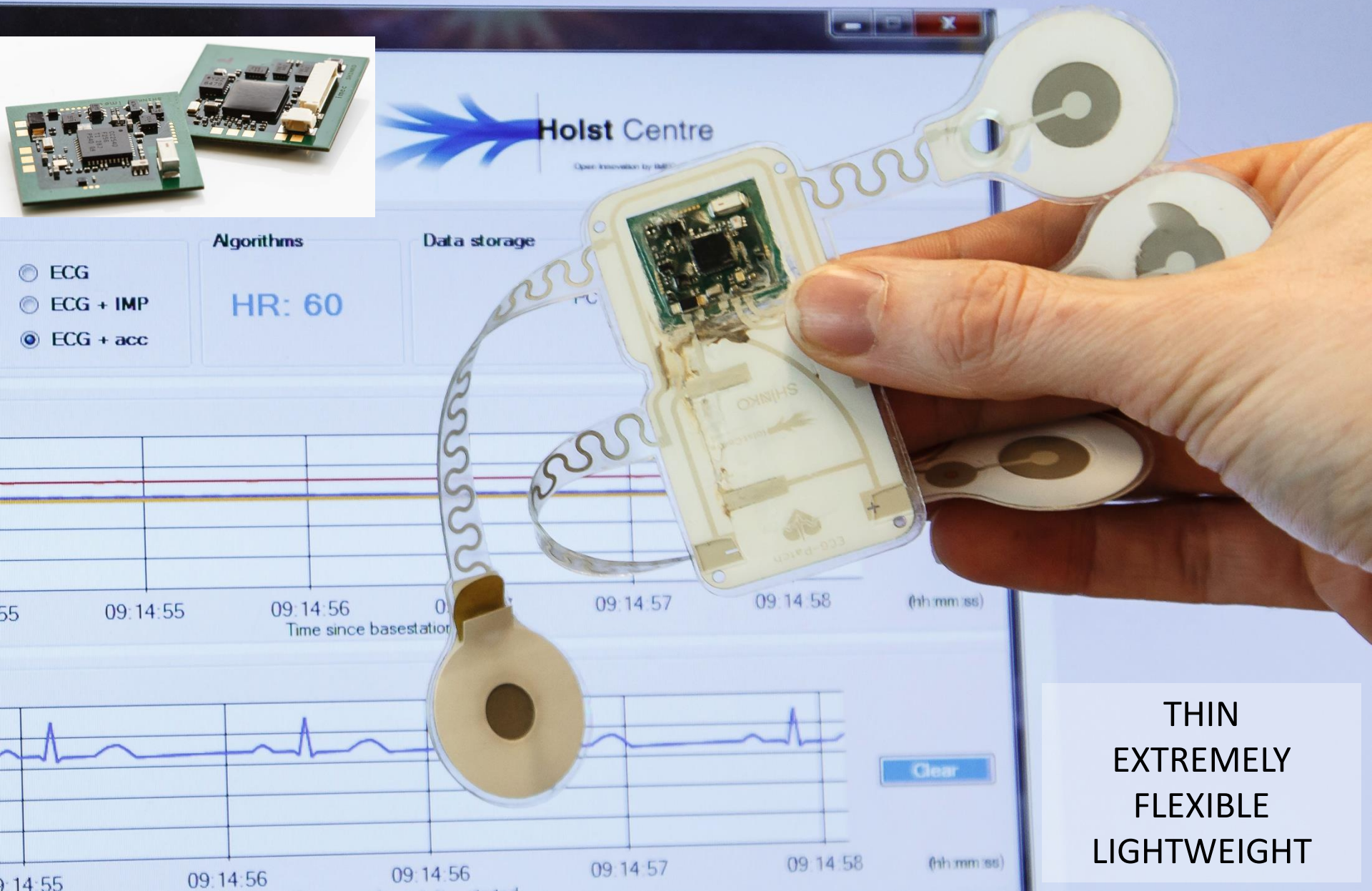
## Lowest power, smallest & robust

- ▶ Ultra-low power ECG & actimetry measurement
- ▶ Bluetooth low energy
- ▶ Embedded artifact reduction
- ▶ Accurate rhythm analysis
- ▶ Activity tracking & energy expenditure
- ▶ 30 days autonomy





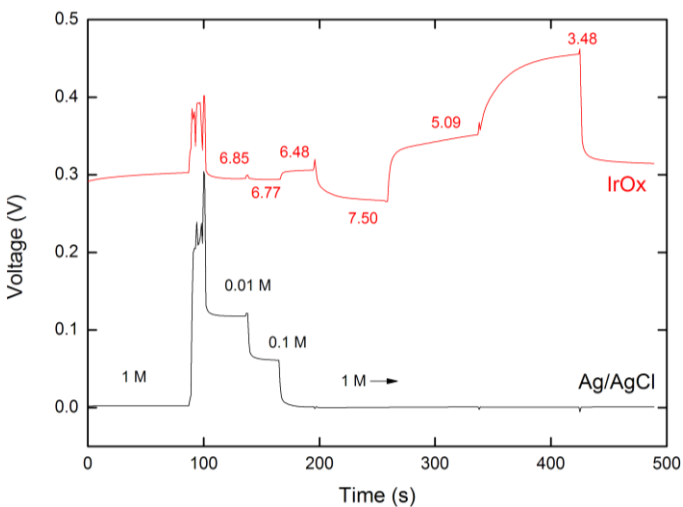
# Miniaturized (highly) flexible ECG Patch



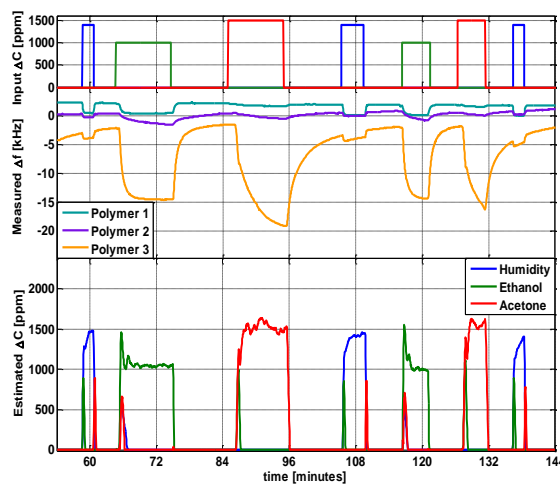
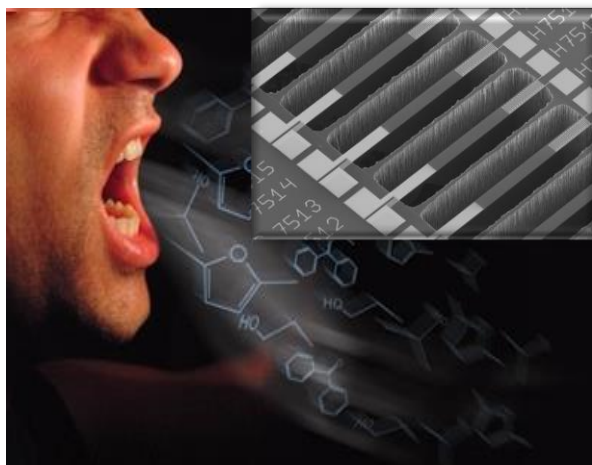
THIN  
EXTREMELY  
FLEXIBLE  
LIGHTWEIGHT

# The next wave: Chemical analysis

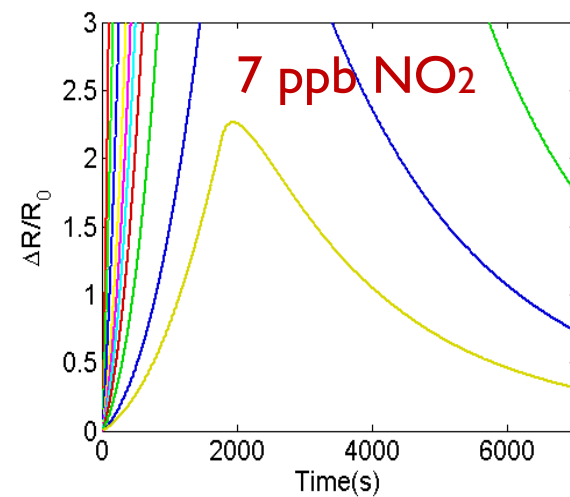
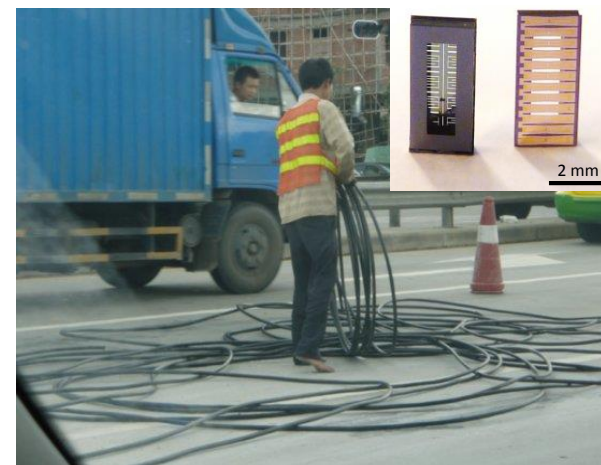
## Bodily fluids



## Bodily odors



## Air quality



**consumer healthcare  
is NOT  
low-quality care**

**(otherwise the result is a gadget)**

**consumer healthcare**

**IS**

**quality care**

**at a consumer price**



Holst Centre  
innovates by providing  
**medical quality  
data**  
in a convenient form  
factor, and  
at ultra-low power