



# Revolutionizing Cardiac Health Monitoring and Early Detection of Heart Diseases





**+10 year**

of research & clinical  
validations

**+20**

peer-reviewed  
publications

**7+1**

patent families  
protecting the  
gyrocardiography  
method

**Medical device**

CE class IIa medical  
device, 510(k) exempt  
medical device

A decorative, thin, dark grey wavy line that starts on the left side of the image, curves upwards and then downwards, crossing itself once, and continues as a long, low wave towards the right edge of the image.

**+200k**

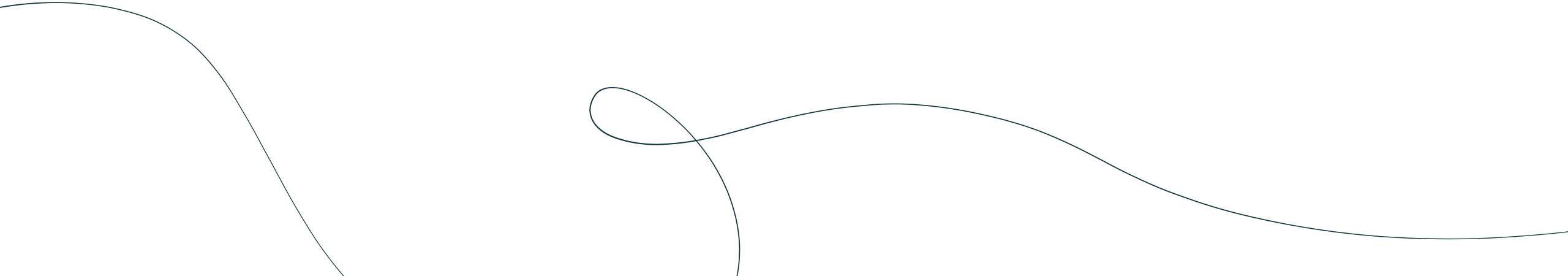
have used the  
application

**5,000**

Android phone  
models and all  
iPhones with  
required sensors

**ISO**

Certifications  
ISO 13485  
ISO 27001



# Meet Our Team



**Juuso Blomster**  
CEO, co-founder

- MD, PhD, Cardiologist
- International biopharma and clinical trial experience
- Extensive background in executing and leading cardiac research



**Tero-Pekka Alastalo**  
CMO, President  
CardioSignal Inc

- MD, PhD, Paediatric Cardiologist
- Previously: Co-founder and executive at Blueprint Genetics, acquired by Quest Diagnostics
- Previously lead commercial, operational, and medical/scientific affairs teams in US healthcare market



**Kristiina Santalahti**  
Research and Quality director

- 10+ years experience in clinical studies and project management
- QMS and regulatory lead



**Marko Mattila**  
CTO

- +20 years of experience in IT solutions, coding and mobile industry
- Management experience with several multinational teams



**Juulia Simonen**  
Director, Brand & Comms

- Brand, PR, and comms. 10+ years
- Recently brand & communication at Blueprint Genetics
- Creator of thought leadership in health, science, and technology growth companies



**Lasse Leppäkorpi**  
Chief Executive, Operations

- 20+ years experience in health tech
- Commercialization of both hardware and software in United States
- Co-founder of health tech company Beddit, acquired by Apple in 2017
- Scientific background in biomedical engineering focusing on ballistocardiography

## Advisory Team



**Kenneth Mahaffey**  
Professor of Medicine,  
Stanford University  
Advisor



**Jukka Valkonen**  
Health and care  
delivery expert  
Advisor



# Board of Directors



**Leena Niemistö**  
Chairwoman of the Board,  
Ph.D. MD Physiatics

- 30 years of clinical and leadership experience
- A CEO in a private healthcare company Dextra (2003-2016) and a deputy CEO in a social and healthcare company Pihlajalinna (2013-2016)
- A board member in several publicly listed companies, startups, organisations and foundations



**Ursula Burns**  
Member of the Board

- Served as Chairwoman of the Board of Directors and CEO of Xerox Corporation and VEON
- Counsels the United States government on key policies.
- On the Board of Directors of Uber Technologies, Inc., Endeavor Group Holdings, Inc., ExxonMobil Corporation, and IHS Holdings.
- A member of the Mayo Clinic and the Metropolitan Museum of Art's Board of Trustees.



**Ilkka Kivimäki**  
Member of the Board

- Co-founder and Partner at Maki.vc, a seed-stage fund partnering with deep tech & brand-driven companies.
- A serial entrepreneur-turned-investor with over 20 years of experience
- Worked as CEO and Co-Founder of Wicom Communications



**Risto Lähdesmäki**  
Member of the Board

- Investor, startup advocate
- Product, user experience and brand expert
- Previously a Co-founder and CEO of Idean, acquired by Capgemini
- Based in San Francisco Bay Area



**Petri Niemisvirta**  
Member of the Board, LL.M.

- An expert in the finance and insurance sector, with nearly 30 years of experience
- The Managing Director in Mandatum Life and Mandatum Holding (part of the successful Sampo Group)
- Currently he is the Chairman of the Board at Kaleva Mutual Insurance Company, and a board member in several other companies,

# 01 The Problem



# Cardiac Diseases – a Major Unsolved Health Burden



The prevalence of CVDs and related risk factors are growing



The disparity in health care is widening



CVD-related healthcare costs are increasing

# Cardiac Diseases – Burden of Delayed Diagnostics



## Atrial fibrillation (Afib)

>35% of new strokes are caused by undetected Afib



## Heart failure (HF)

20-40% of HF is first diagnosed in ER despite of having symptoms months before



## Coronary Artery Disease (CAD)

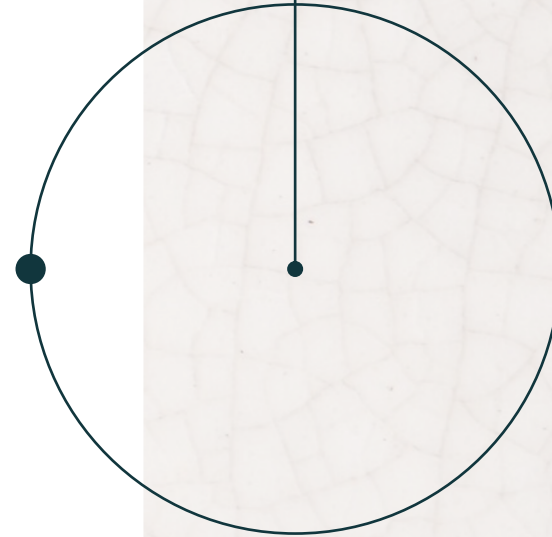
~15% of CAD is first diagnosed when the disease has progressed to a heart attack



Enhancing early diagnostics would improve outcomes and lower costs!



Virtual Care and Digital  
Applications Could Offer  
the **Most Accessible** and  
Scalable Strategy for Early  
Diagnostics.



# Current Remote Monitoring Technologies in Cardiology Are Not Enough



ECG, PPG, blood pressure cuffs, scales



Very limited diagnostic capability



Hardware required



Poor scalability and accessibility





A close-up, side-profile shot of a middle-aged Black man with a mustache, wearing a blue t-shirt, running outdoors. He has a determined expression with his mouth open and his right fist clenched. The background is a blurred green landscape. The text is overlaid on the left side of the image.

We need technological innovations  
for major heart diseases that are  
reliable and accessible to  
everybody in the society.





## Our Mission

Transform cardiovascular care by broadening the clinical spectrum of heart disease detection and make it accessible to everyone in the society with a smartphone.

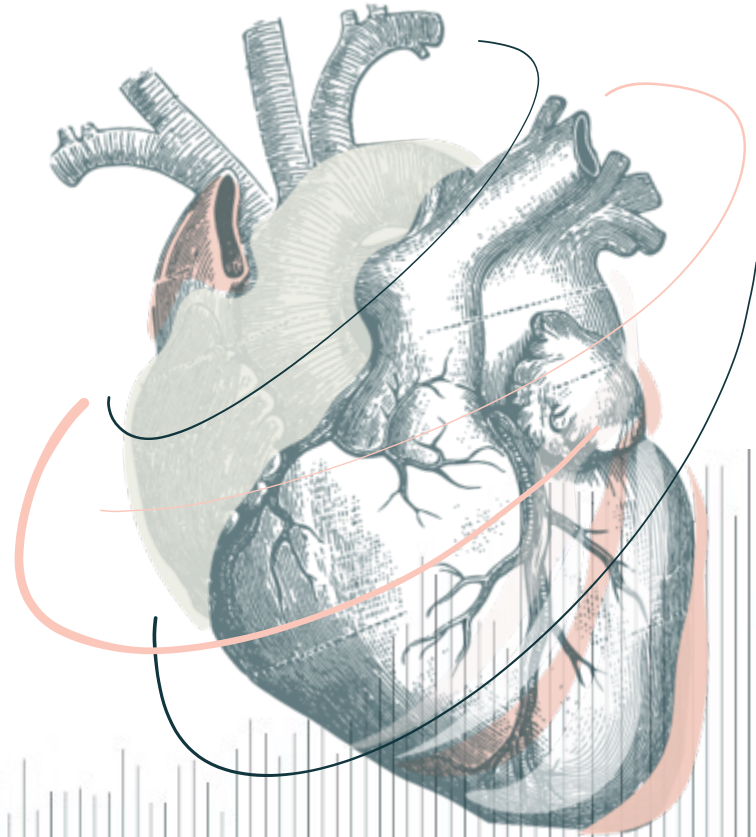


## 02 The Solution



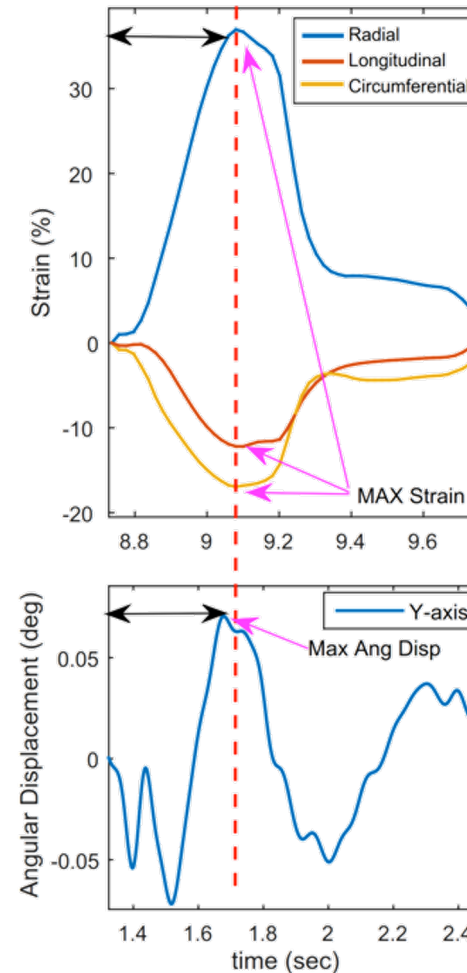
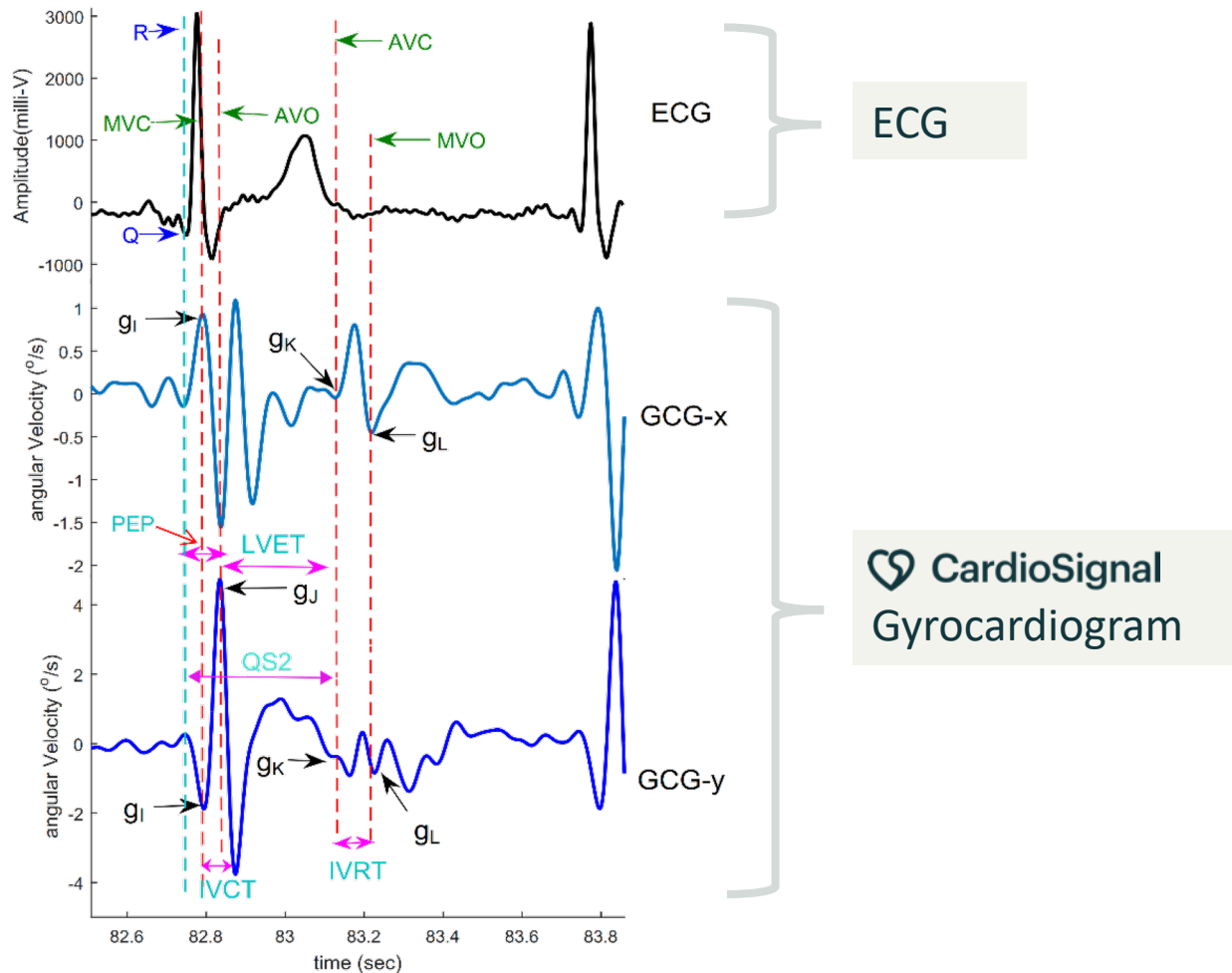
Measuring the Heart Directly

Our ground-breaking  
**Gyrocardiography**  
**technology** utilizes motion  
sensors to monitor angular  
velocities/rotation motion  
of the heart.





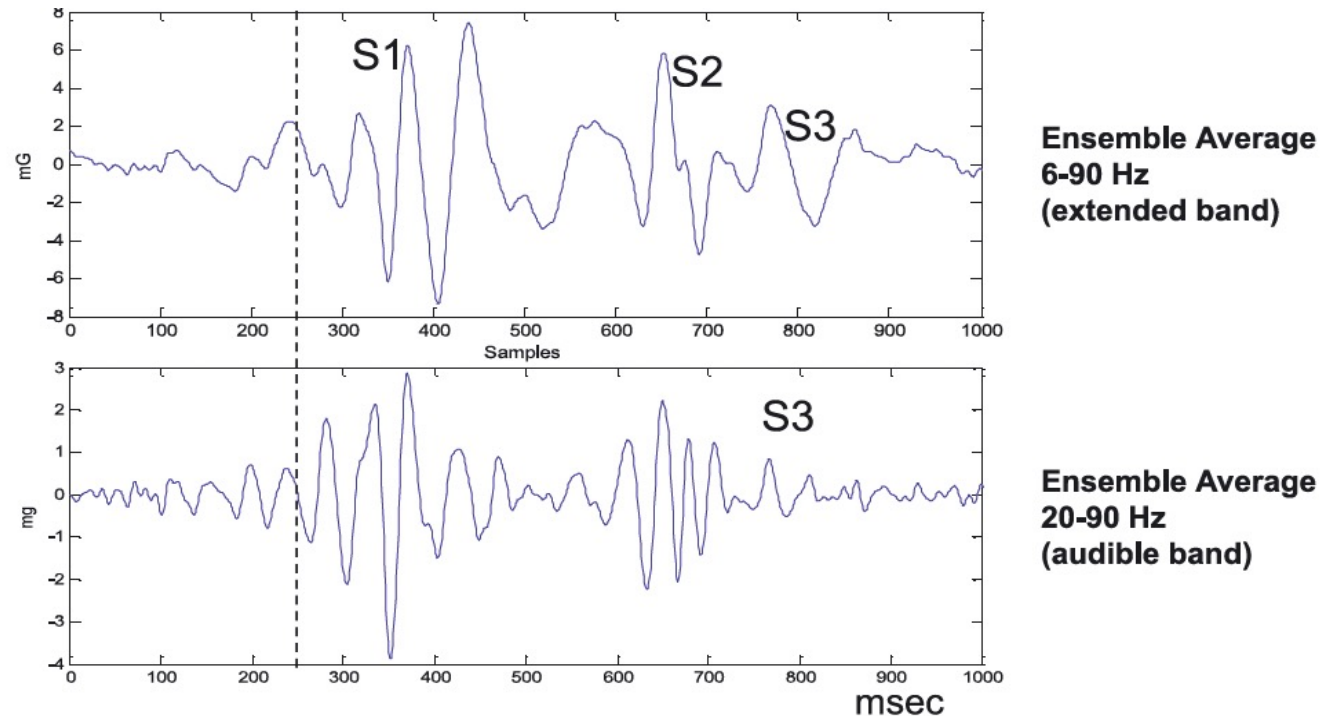
# Gyrocardiography Method Validation – High Resemblance to Existing Clinical Methods



# Motion Sensors Provide a Stethoscope on Steroids

## The main events of the cardiac cycle, “the Heart Sounds”

- Heart sounds are essentially mechanical wave motions originating from cardiac and hemodynamic motion
- Motion sensors are capable of detecting these wave motions also under 20 Hz frequency, this infrasonic level is not audible
- Amplitudes, durations and energy can be measured (like ECG)
- FDA: A phonocardiograph is a device used to amplify or condition the signal from a heart sound transducer. This device furnishes the excitation energy for the transducer and provides a visual or audible display of the heart sounds.



Concrete measurable features  
- amplitudes, time intervals and energies

# Rapid and Accurate Digital Biomarkers for Major Heart Diseases and Vital Signs From a 60s measurement

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## Pathology:

- Atrial fibrillation
- Heart failure
- Coronary artery disease\*
- Valve disease (aortic stenosis)\*
- Pulmonary artery hypertension\*

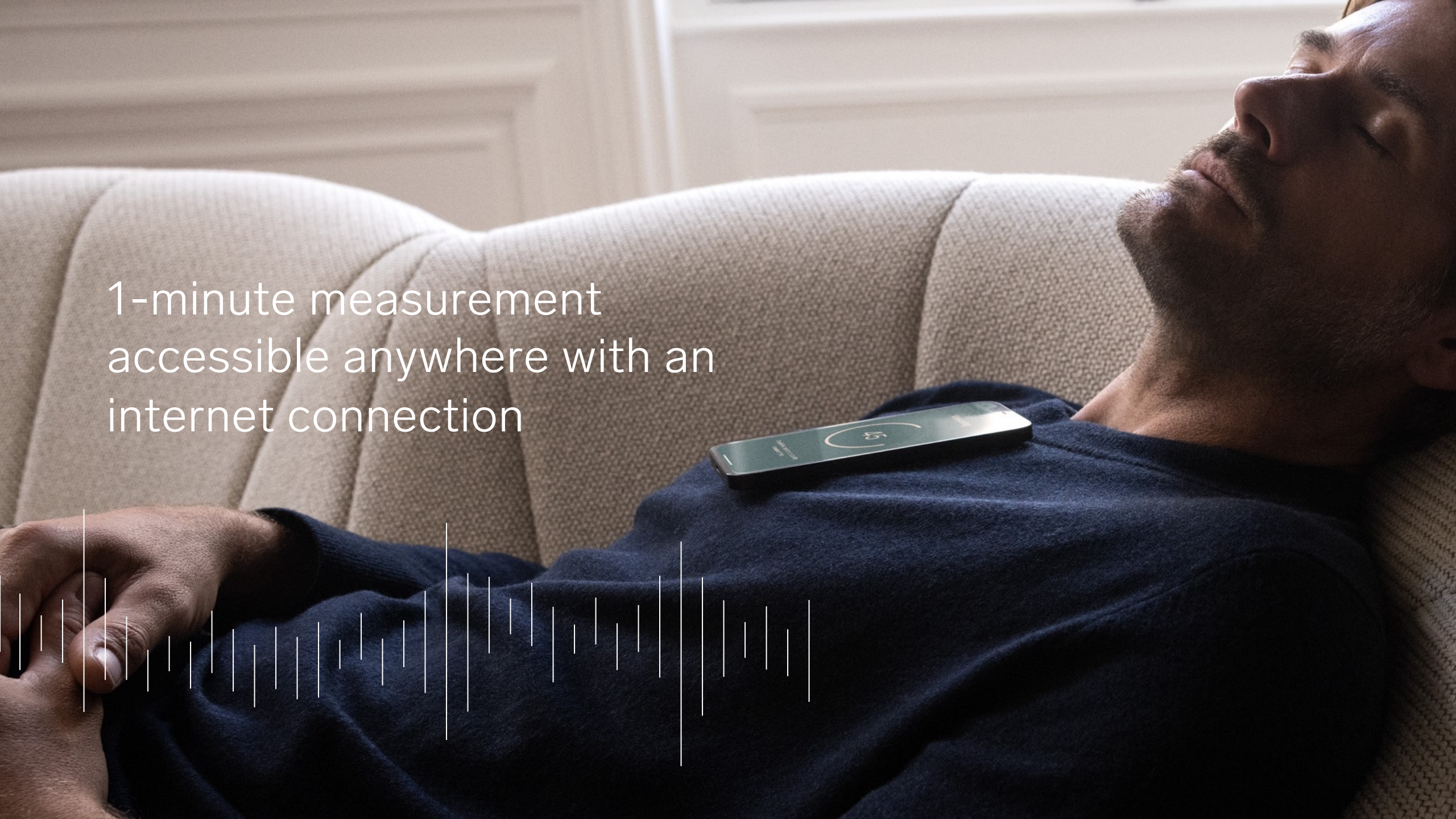
## Heart Physiology

- Heart rate
- HRV
- Respiratory rate
- VO2 Max\*

***\*Phase III development***



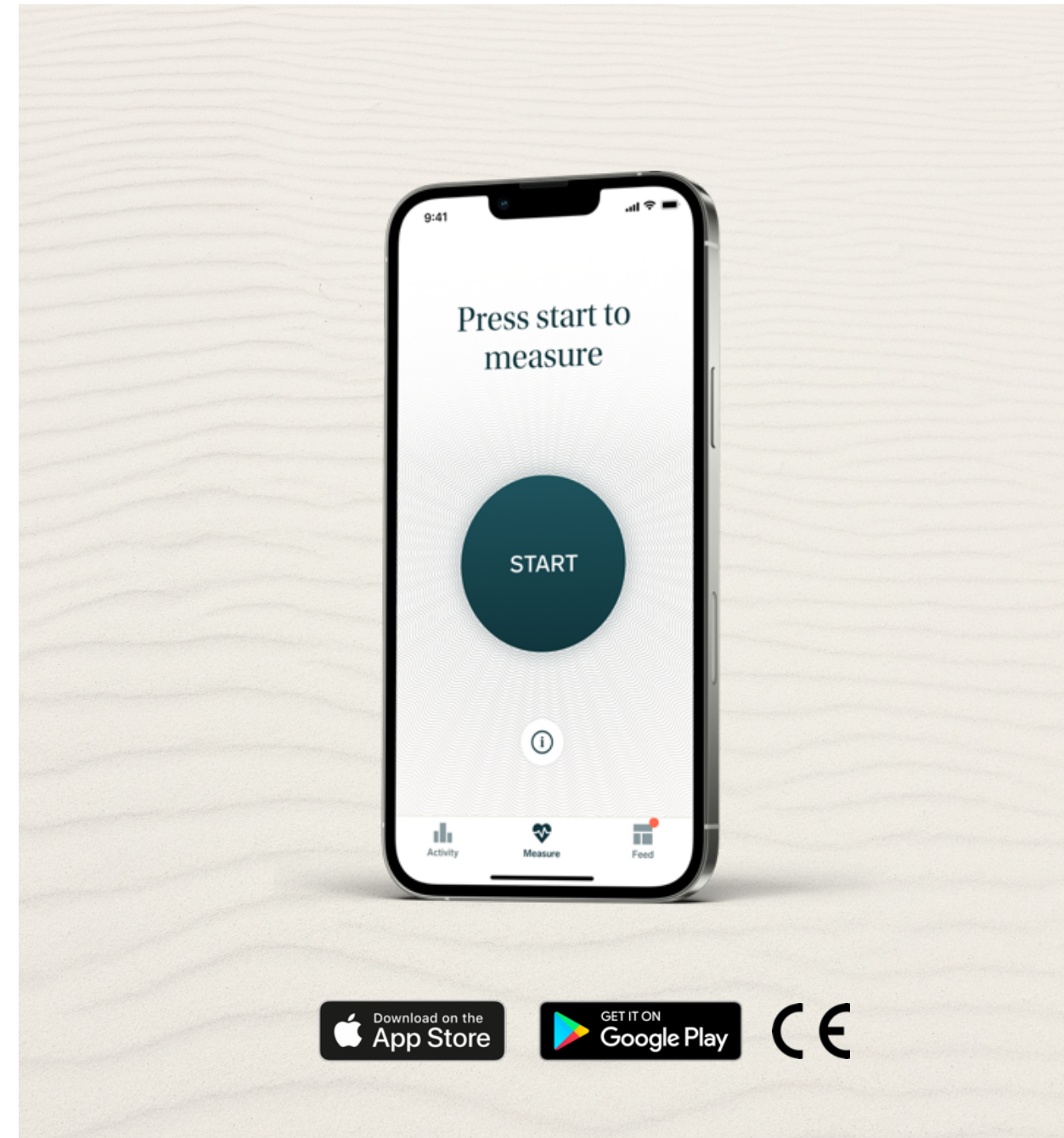
1-minute measurement  
accessible anywhere with an  
internet connection





# Disrupting Virtual Care Market With Our Cardiac Health Monitoring Service

- A smartphone application— accessible to 'everyone / everywhere'
- Easy-to-use — experience with >150k users
- Can be offered with low costs enabling access to global markets and closing gaps in healthcare disparity
- Detection capability with digital cardiac biomarkers for major common heart diseases +vitals



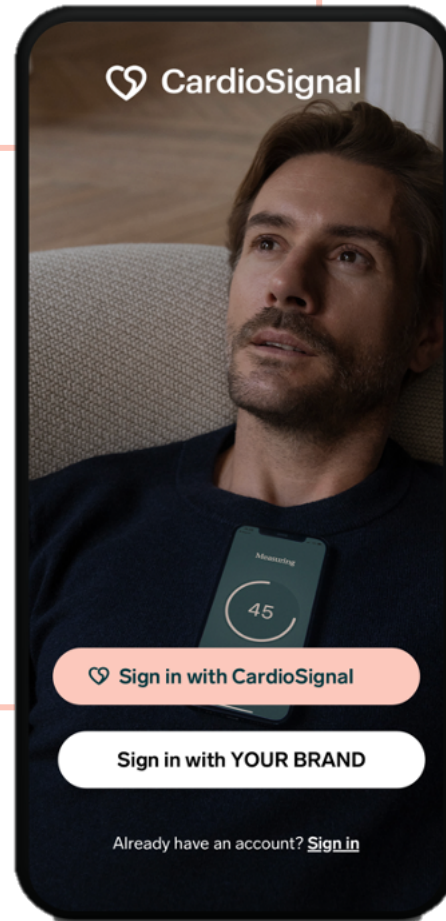
# Flexible Technology and Integrations Maximize Collaboration Opportunities

## Integration models

- Service-to-Service Integration
- OpenID Integration
- OpenID and Service-to-Service Integration
- App2App & Service Integration

## Access is possible also without integration:

- A user can be granted a access for a given time



## Secure Cloud Solution

- Certified as a medical device
- REST API & API key management
- Measurement analysis & data
- Does not contain any identifiable data (PII)
- Rigorous privacy practices (3rd party audits, penetration testing)

## Examples of flexible integration capabilities:

- App-to-app linking
- The user can be authenticated with partner's identity provider
- User information does not necessarily need to be shared

# 03 Clinical Overview

## Academic partners & Investigators



Juhani Airaksinen MD, PhD: Heart Center, Turku University Hospital and University of Turku, Emeritus professor of cardiology  
>600 publications, <https://www.researchgate.net/profile/Juhani-Airaksinen>



Juhani Knuuti, MD, PhD: Turku University Hospital · Turku PET Centre, Professor, the chairman of ESC 2019 guidelines for the diagnosis and management of chronic coronary syndromes  
>900 publications, <https://www.researchgate.net/profile/Juhani-Knuuti>



Antti Saraste, MD, PhD : Heart Center ,Turku University Hospital and University of Turku, professor of Cardiology  
>400 publications, <https://www.researchgate.net/profile/Antti-Saraste>



Kenneth W. Mahaffey MD, PhD, Stanford University, professor of Cardiology, Vice chair of Stanford Center for Cardiovascular Research  
~800 publications, <https://www.researchgate.net/scientific-contributions/Kenneth-W-Mahaffey-38697567>



Francois Haddad MD, PhD, Cardiologist, Stanford University, Associate professor of Cardiology  
>400 publications, <https://www.researchgate.net/profile/Francois-Haddad>



# Accurate Detection of Atrial Fibrillation

Performance	
Sensitivity	95.1
Specificity	96
Accuracy	96
$\kappa$ coefficient	0.91

Clinical validations were executed with single measurement – In practice, we require a confirmation measurement to minimize the burden of false positives

- Clinical validation study with consecutive unselected patients; 150 patients identified with AF and 150 with sinus rhythms (total: 300)
- Blinded gyrocardiography analysis against ECG
- BMI, heart rate, respiratory rate or supraventricular extrasystole did not correlate with false positives

## Circulation

Volume 137, Issue 14, 3 April 2018; Pages 1524-1527  
<https://doi.org/10.1161/CIRCULATIONAHA.117.032804>



## CORRESPONDENCE

### Mobile Phone Detection of Atrial Fibrillation With Mechanocardiography

The MODE-AF Study (Mobile Phone Detection of Atrial Fibrillation)




Jussi Jaakkola, MD\*, Samuli Jaakkola, MD\*, Olli Lahdenoja, DSc, Tero Hurnanen, MSc, Tero Koivisto, MSc, Mikko Pänkäälä, DSc, Timo Knuutila, PhD, Tuomas O. Kiviniemi, MD, PhD, Tuija Vasankari, RN, and K.E. Juhani Airaksinen, MD, PhD

# Heart Failure Detection



*Article*

## **Mechanocardiography-Based Measurement System Indicating Changes in Heart Failure Patients during Hospital Admission and Discharge**

Tero Koivisto <sup>1</sup>, Olli Lahdenoja <sup>1</sup>, Tero Hurnanen <sup>1</sup>, Juho Koskinen <sup>1</sup>, Kamal Jafarian <sup>2,\*</sup>, Tuija Vasankari <sup>3</sup>, Samuli Jaakkola <sup>3</sup> , Tuomas O. Kiviniemi <sup>3</sup>  and K. E. Juhani Airaksinen <sup>3</sup> 

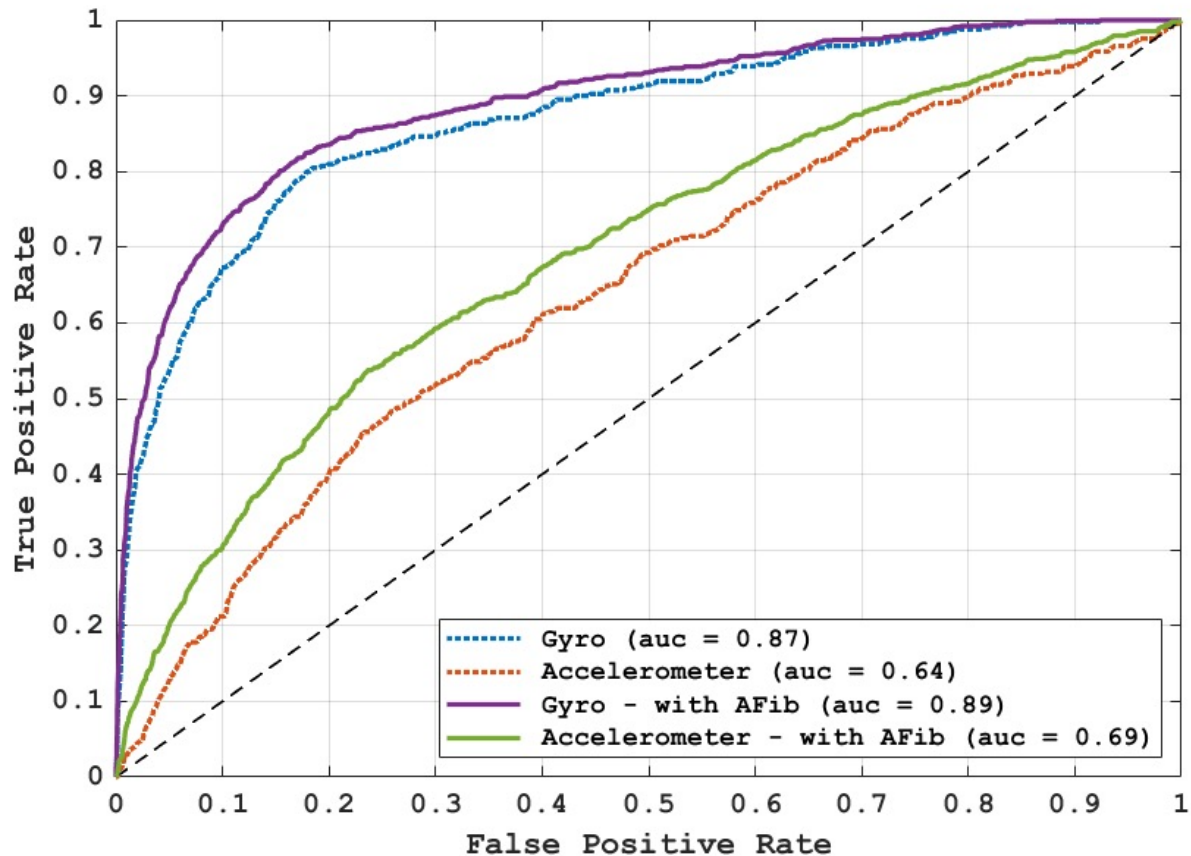
- We found three important signs indicating the worsening of the disease: an increase in signal RMS (root-mean-square) strength (across SCG and GCG), an increase in the strength of the third heart sound (S3), and a decrease in signal stability around the first heart sound (S1).
- The best individual feature (S3) alone was able to separate the recordings, giving >85.0% accuracy regarding all signals.

# CardioSignal: Digital Biomarker for Heart Failure

Performance	
Sensitivity	85
Specificity	88
Accuracy	88
AUC	95

- Clinical validation of commercially available smartphone to detect heart failure
- Multi-center studies with consecutive un-selected **~1000 patients** in analysis in USA and Finland
- Controls were non-HF cardiac patients visiting the clinic, with suspected CAD
- Up to 3 months follow-up monitoring
- Physical characteristics such as BMI, BSA, gender, age, present atrial fibrillation did not affect the accuracy

# Gyroscope vs Accelerometer in Heart Failure Detection



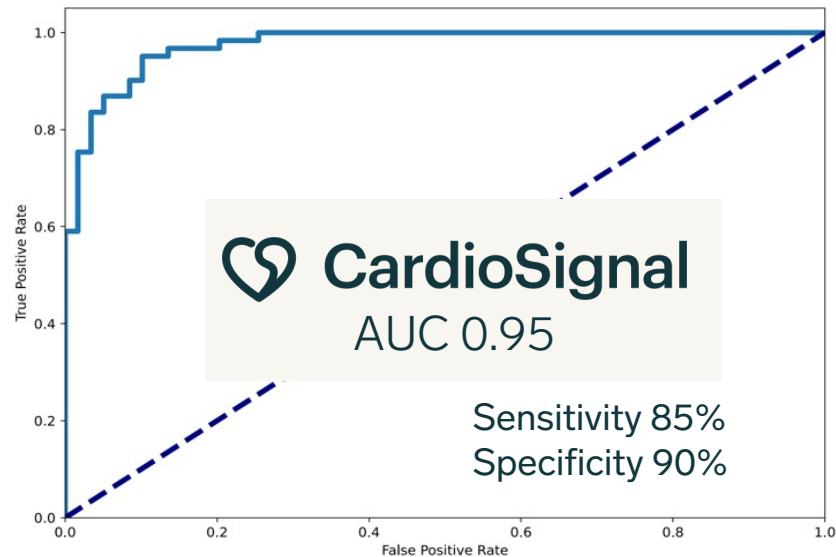
The motion sensor raw signal characteristics in detection of heart failure: the difference between accelerometer and gyroscope signals in detection of heart failure.

Results presented in both groups with sinus rhythm only (N=842) and sinus rhythm and atrial fibrillation (N=914).



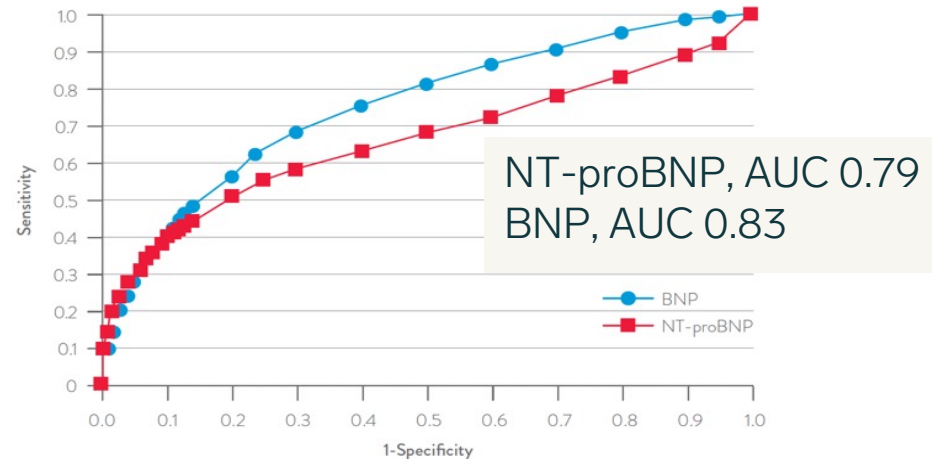
# CardioSignal: Actionable Digital HF Biomarker for Heart Failure

~1,000 Patients Multicenter Study in EU & USA



CardioSignal HF detection first results (subgroup),  
presented in HFSA 2022  
Full paper in peer-review to be published

FIGURE 1: DIAGNOSIS AND EXCLUSION OF ACUTE HEART FAILURE IN DYSPNEIC PATIENTS<sup>17</sup>



General performance of BNP and NT-proBNP,  
Roberts et al., 2016

Implications for a clinically feasible detection of HF with CardioSignal without the burden of a blood test

# Technology Capabilities Comparison

CAPABILITITES	CARDIOSIGNAL	PPG-BASED APPLICATIONS	APPLE WATCH	HOME ECG MONITORS	LAB SCREENING (NT-PROBNP, TROPONIN)	CORONARY CT (HOSPITAL)	HEART ULTRASOUND (HOSPITAL / DR OFFICE)
Does not require a separate device	✓	✗	✗	✗	✗	N/A	N/A
Atrial fibrillation	✓	✓	✓	✓	✗	✗	✓/✗
Coronary artery disease	✓	✗	✗	✗	✓	✓	✓/✗
Heart failure	✓	✗	✗	✗	✓	✗	✓
Aortic stenosis	✓	✗	✗	✗	✗	✗	✓
Cost of examination*	1x	1x	5x	2-4x	2x	10-20x	10-20x

\*ballpark estimates, different CardioSignal pricing for Afib, HF and CAD

# 04 Go-to-Market



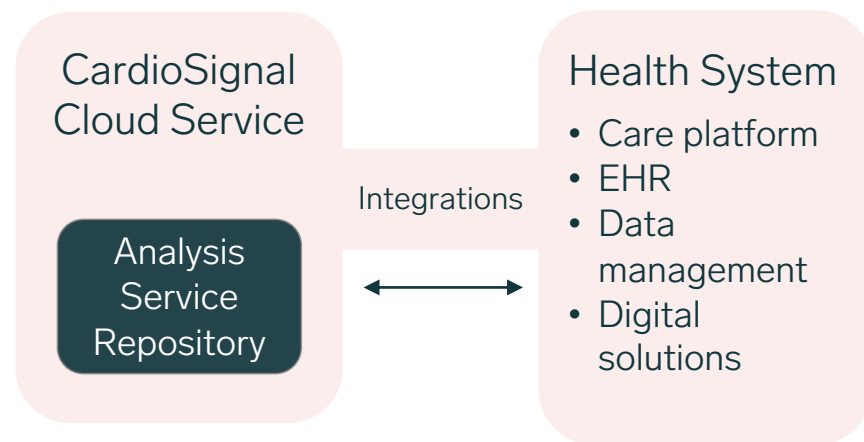
# CardioSignal Service Platform to Serve Healthcare Organizations in Their Clinic & Home Care Models

## Home measurements - Patient

- Patient uses own smartphone
- Virtual care models
- Available for atrial fibrillation detection



Measurement data & Analysis results



## Clinic use -HCP

- Professional use
- Point-of-care on smart devices
- Available for atrial fibrillation detection



Results & reporting





# Atrial Fibrillation Detection: Market Validation, Clinical Impact & Product Value Proven in Existing Collaborations

In EU market for 3 years, CE class IIa medical device

Is used in a Novo Nordisk clinical trial

Has received great customer satisfaction results in surveys

Successful usage in population health programs by health systems



Is integrated to OMRON Connect 2.0 platform

Is integrated in Roche cobas pulse® clinic use device

*Product value proven by existing collaborations*

**OMRON**

 **MEHILÄINEN**

 **JISEKI**

 **Boehringer Ingelheim**

 **Roche**

*Has been tested in an RPM program for HF patients in Switzerland (tablet)*

# Adding Heart Failure Detection to CardioSignal Medical Device Application

## Phase I

Point-of-care/clinic environment use by healthcare professionals.

Rapid detection tool for patients with suspicion of heart failure / atrial fibrillation.

2024

## Phase I-II

Early detection of disease in home environment, patients using their own phone.

Population health and remote patient monitoring tool.

2024–2025

## Phase III

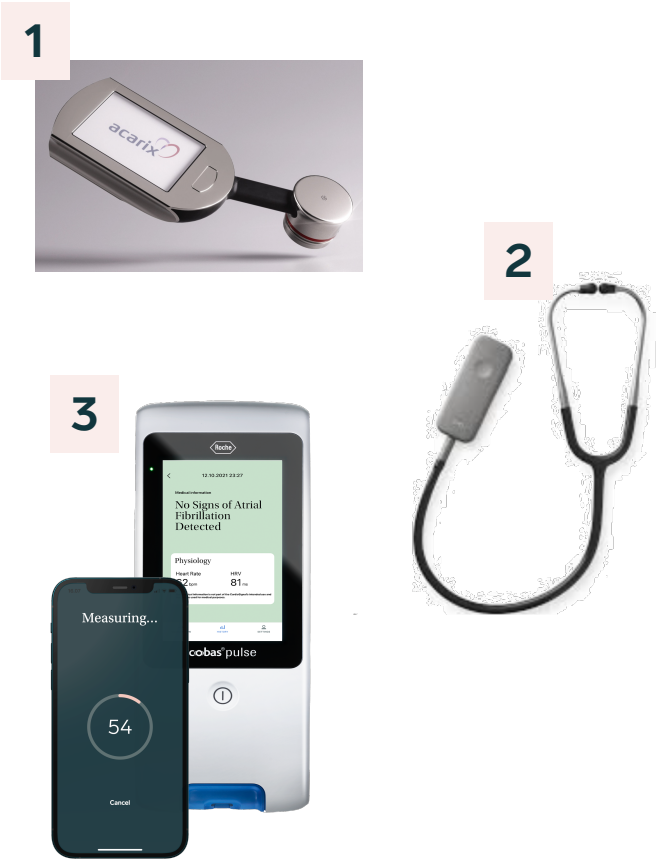
Disease progression and treatment efficiency monitoring, in home environment.

Heart failure patient remote patient monitoring.

2026

*Phased product launch serves the launch of other CVDs such as valve diseases, pulmonary hypertension, coronary artery disease.*

# Clinic Use: Technology Comparison



Device	1. Acarix	2. EKO	3. CardioSignal
Method	Microphone + Accerometer	ECG + Microphone	GCG
Atrial fibrillation	NO	YES	YES
HFrEF	YES?	YES	YES
HFpEF	NO	NO	YES
Accuracy HF	?	86%	88%
Sensitivity HF	?	91.90%	85%
Specificity HF	?	80.20%	88%
AUC HF	?	0.91	0.95
Aortic stenosis	NO	NO	YES
Pulmonary hypertension	NO	NO	YES
CAD	YES?	MO	YES
Measurement	10min	2x 15s	1x 60s
Hardware	Acarix device	ECG stethoscope +App	App
Price	\$2600 + \$20/patch	\$399 + \$3/month	\$500/year
Scalability	+	++	+++
Ease of use	+	++	+++

# Point-of-Care – Immediate, Non-Invasive Diagnostics

## Benefits

- ✓ HCPs can quickly detect CVDs (Pharmacies, Elderly Care, Home Care, Diabetes Clinics, Primary Care including Occupational Medicine)
- ✓ 1-minute measurement integrates smoothly to routine flow of any basic health & wellness examination
- ✓ CardioSignal Point of Care Testing (POCT) app can run on any device with the right sensors

## Revenue Model

- ✓ 19,000 CVS + Walgreens, > 450,000 Home Care Provider Businesses, 15,600 Nursing Homes, >140,000 PC businesses, >250,000 PCPs in USA
- ✓ HCP charges patient/payer \$10/ measurement (minimum detection: AF+HF), 1,000 measurement/year:  $* 1,000 * \$10 = \$30k$  annual revenue for single App license
- ✓ 10,000 CS licenses from PCP and health system network: \$500/license/year  $* 10,000$  (\$5M ARR for CardioSignal);

## Case example

Roche Diagnostics cobas® pulse

Used in pharmacies, hospitals and primary care

To be available in ~90 countries. Target of selling 500,000 devices by 2027

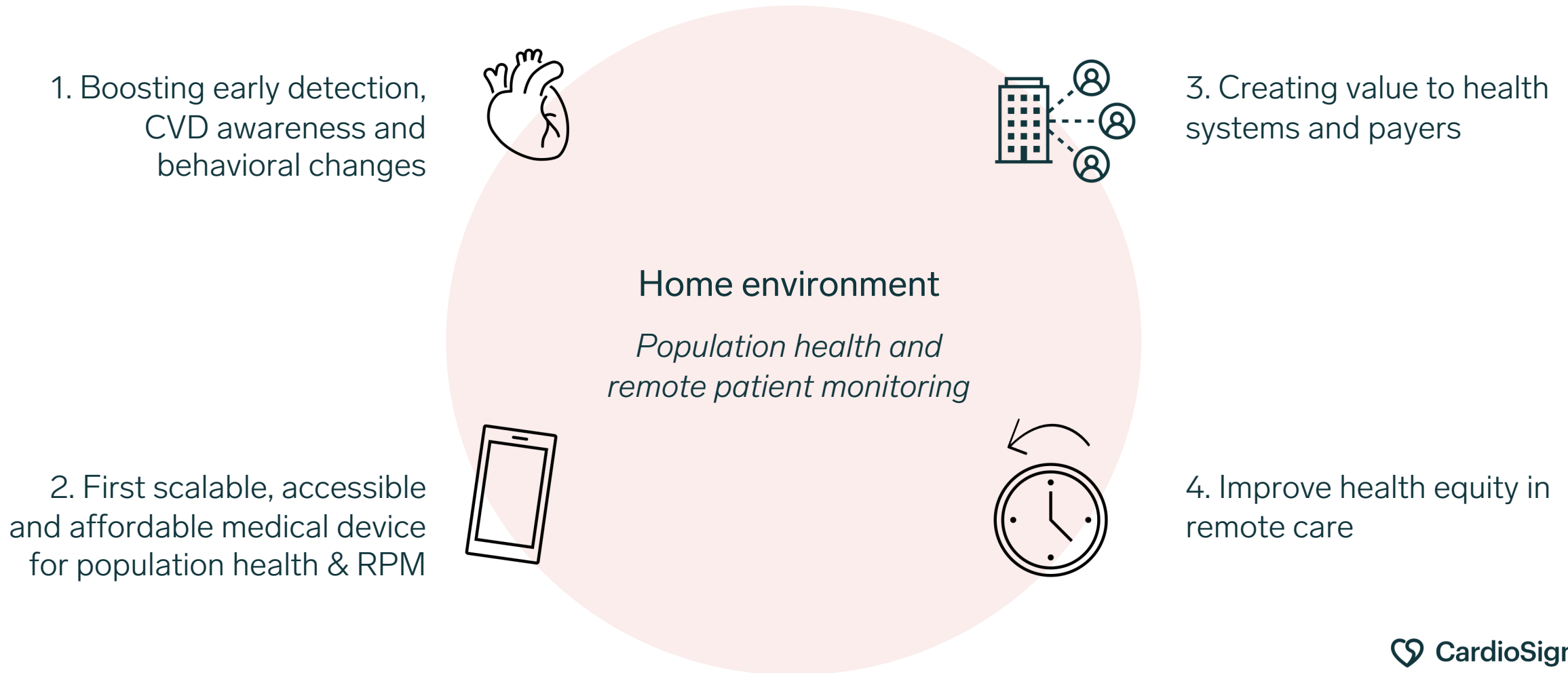
CS AF/HF detection: \$500/device/year

Roche team in charge of global distribution





# CardioSignal-Powered Virtual Care: Atrial Fibrillation Detection & Vitals Available in EU & US market



# Population Health Models to Serve Health Systems & ACOs

## Benefits

- ✓ Drives right patients to right at right time
- ✓ Creates an optimal cohort for reimbursed RPM service
- ✓ Improves outcomes (cost savings)
- ✓ New patient acquisition
- ✓ Improves patient/customer retention
- ✓ Reduces unnecessary ED visits

## Revenue Model

- ✓ 600+ health systems, 7000+ hospitals, >119M 50+ years old in USA
- ✓ 10k high-risk patient cohort  
\$25/patient/year costs \$250,000 for health system
- ✓ ~3% are driven to care by app usage:  $300 * \$5000 = \$1.5M$  revenue for health system (+added revenue from behavioral changes/awareness)
- ✓ CS opportunity by 2024: 15 health systems sponsor for 10k:  
 $15 * 10k * \$25 = \$3.75M$  ARR

## Case example

Mehiläinen, the largest private health system in Scandinavia

**~200%** ROI for sponsoring health system

**93%** said using the app was easy or extremely easy

**95%** wants to continue after 1 year

**>3%** reported getting afib diagnosed thanks to the app



# Powering Remote Patient Monitoring with CardioSignal

## Benefits

- ✓ Expands RPM opportunity. Enables measurements that comply with RPM requirements without hardware
- ✓ Adds value to existing RPM. Ease of use ensures monthly measurements. Improves engagement & retention in long-term RPM
- ✓ Creates new payer models for RPM-type service thanks to low-cost scalable solution
- ✓ Promotes early detection of CVD. Detects patterns of concern

## Revenue Model

- ✓ >50 RPM platforms; 25% of PCPs offering RPM; >30M people under RPM by 2024
- ✓ CS can 2-3x reimbursed RPM revenue by removing complexity and friction associated with current hardware use and logistics
- ✓ Model: 0.5% of RPM patients use CS by 2024.  $0.5\% * 30M * \$25/\text{patient}/\text{year} = \$3.7M \text{ ARR}$

## Case example

HSGC program in Switzerland

**71** heart failure patients under CS-based RPM

**156 days** was the average length of RPM

**70%** of patients used daily, high patient satisfaction with CS

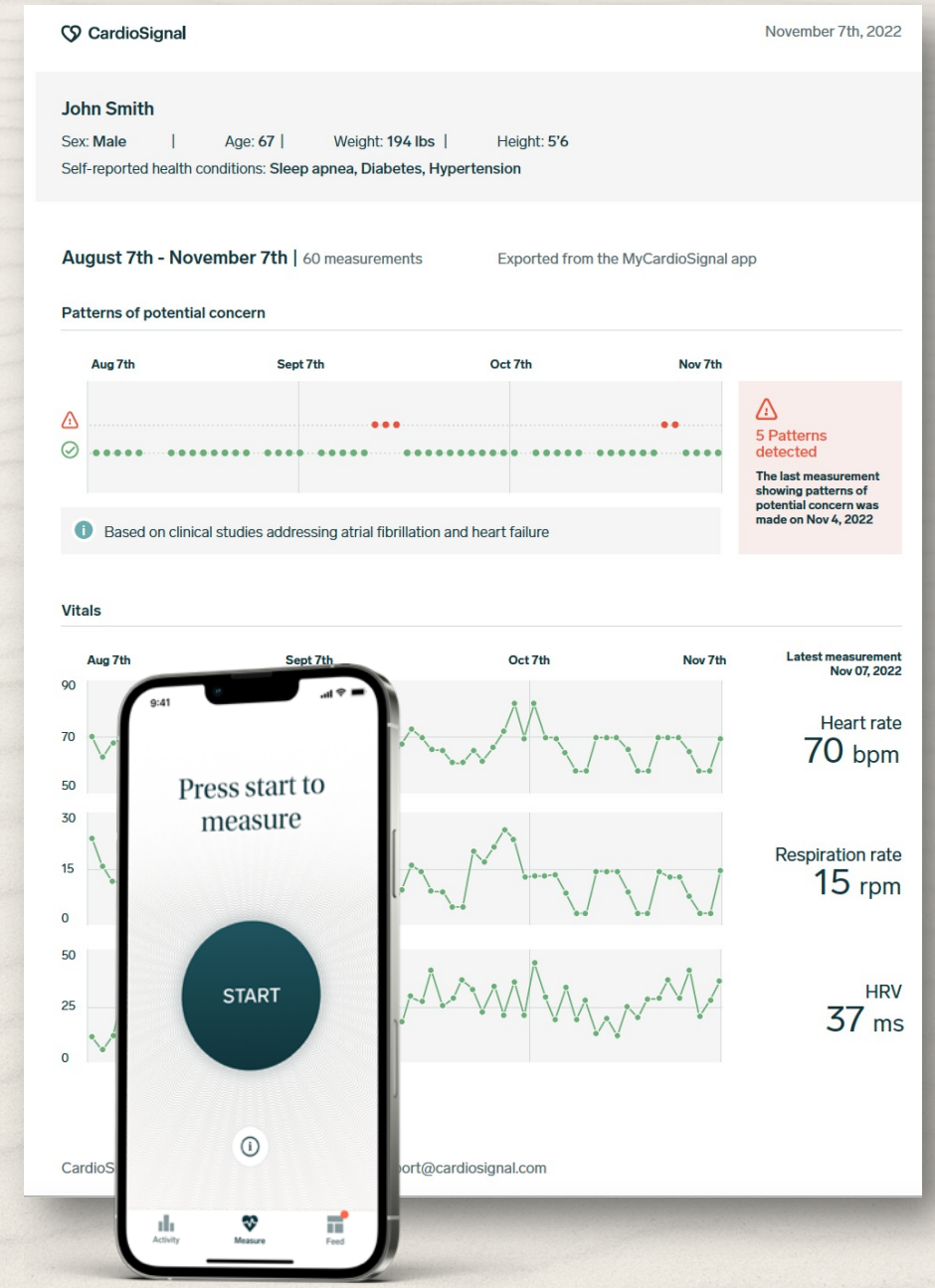
Partnership with Jiseki: Launch an RPM service program in USA (spring '23)

# Supportive Business Models

Focus areas based on current collaboration models.

Wellness platforms – patient engagement and empowerment in self-care. AF + vital signs.

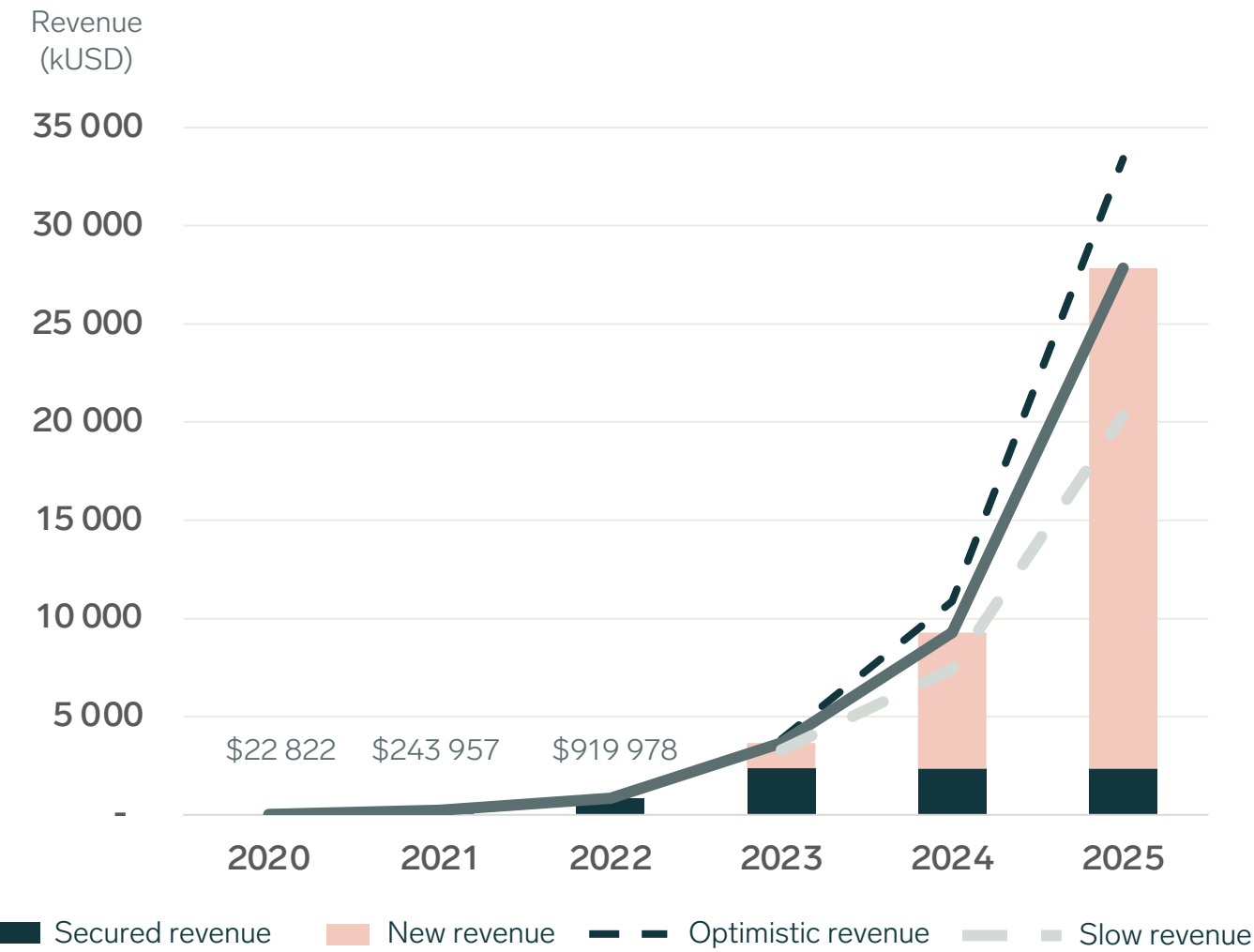
Biopharma – clinical trials and patient identification





# 05 Financials

# Revenue 2020–2025

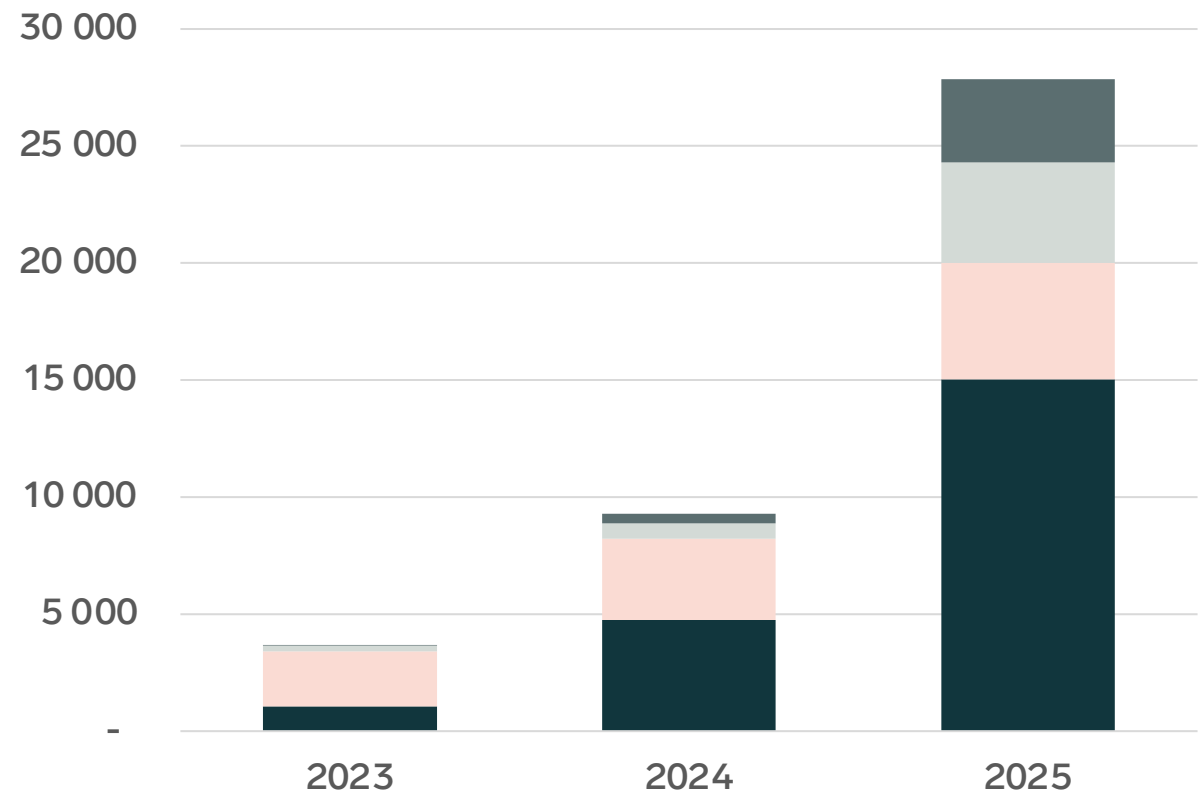


- Demonstrated evidence on successful commercial execution
- Existing contracts, ongoing negotiations, US product launch are expected to drive more growth in 2023-2024
- Emerging capabilities in heart failure and aorta stenosis will drive the company to a faster growth in 2024–25

	2023	2024	2025
Projected revenue	3 670 539	9 282 731	27 844 086
Secured revenue	2 361 747	2 344 343	2 343 304
New revenue	1 308 792	6 938 388	25 500 782
Optimistic scenario	3 854 066	10 860 795	33 412 903
Slow scenario	3 303 485	7 426 184	20 326 183

# Business Category Breakdown

Revenue  
Breakdown kUSD



- Graph describing business category break down and revenue projections
- Population health and virtual care business category is expected to drive most growth in 2024–25
- Pharma, point of care and wellness sector will drive additional growth

	2023	2024	2025
Point of Care	5 085	414 066	3550 673
Consumer & Wellness Platforms	262 478	642 158	4 284 584
Pharma	2 341 200	3 469 440	4 969 440
Population Health & Virtual Care	1 061 775	4 757 067	1 5039 389



CardioSignal