SIEMENS Healthineers

Expanding Precision Medicine

with AI-Powered Integrated Decision Support

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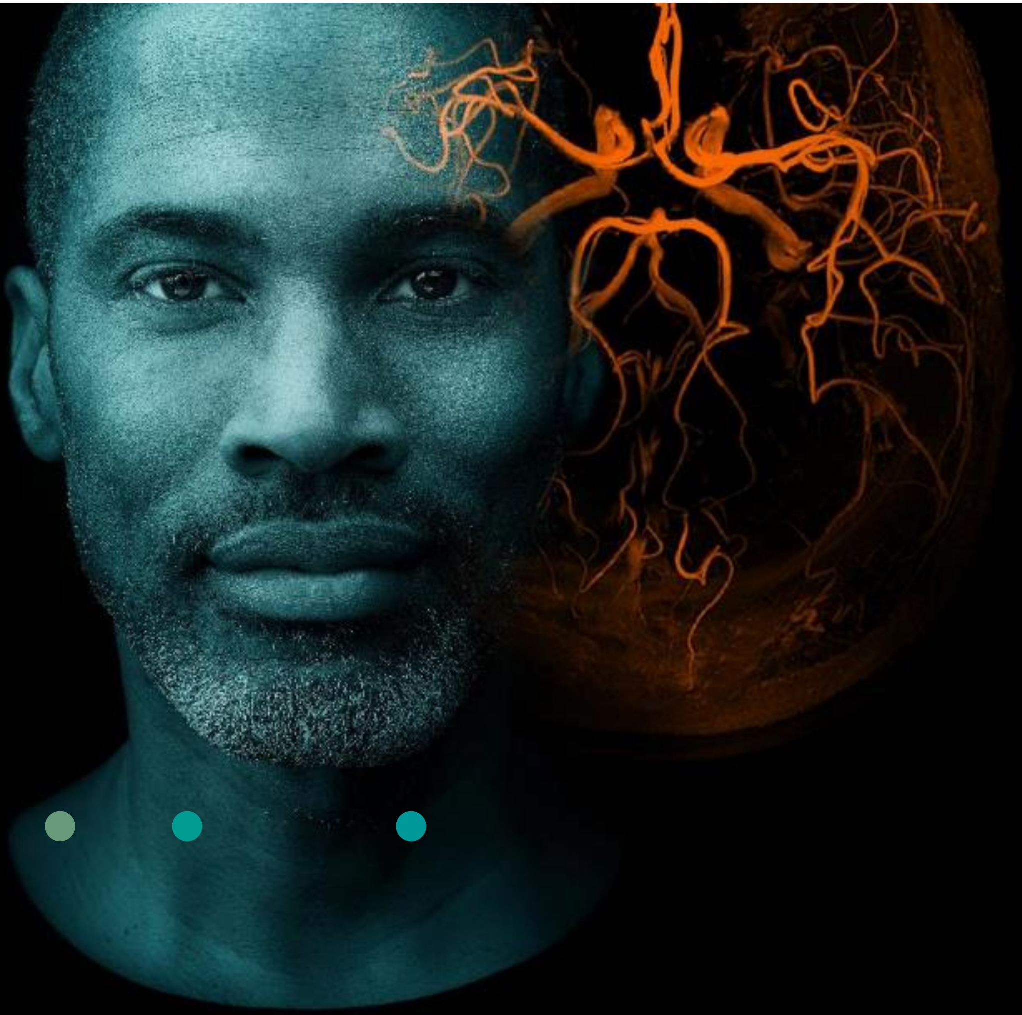
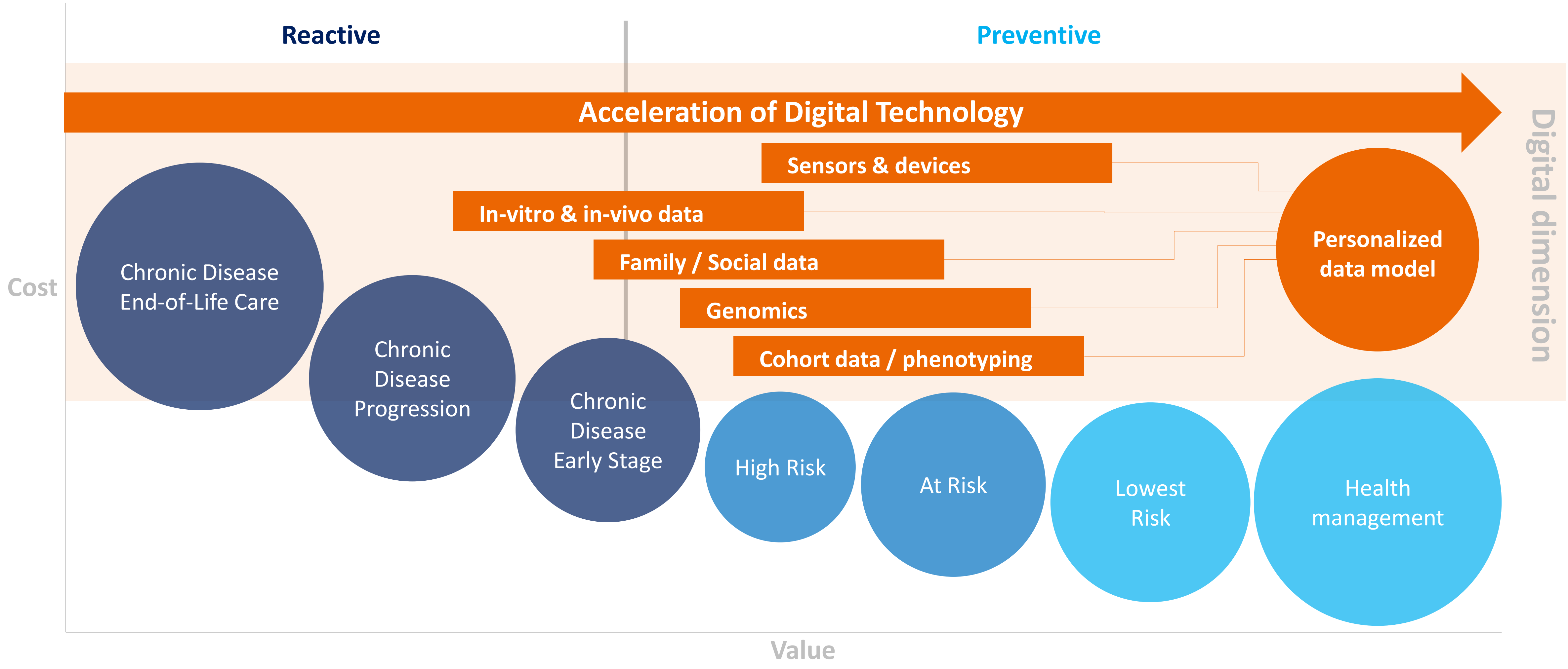
Head of Digitalizing Healthcare, VP Marketing

October 11, 2018



From disease- to health management through data integration



The transformation from digital data to actionable insights

Generate data	Aggregate data	Analyse data	Operationalize data
Enable digital processing	Enable utilization of available information	Transfer data into knowledge	Utilize knowledge to take actions for better care

Generating meaningful insights from disparate data at the point of decision making

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Diagnostic accuracy

25%

of patients said their health care provider has **had to re-order tests** to have accurate information for diagnosis[1]

Data integration

50%

of patients report that **information necessary to their care was not available when needed**[1]

Diagnostic precision through quantification

Cognitive factors (perception, failed heuristics) **contribute to the diagnostic error** in

74%

of cases[2]

[1] Best care at lower cost: the path to continuously learning healthcare in America, Institute of medicine

[2] Cognitive and System Factors Contributing to Diagnostic Errors in Radiology American Journal of Roentgenology, 201, September 2013

Computed Tomography at Siemens Healthineers
40+ years of Innovation

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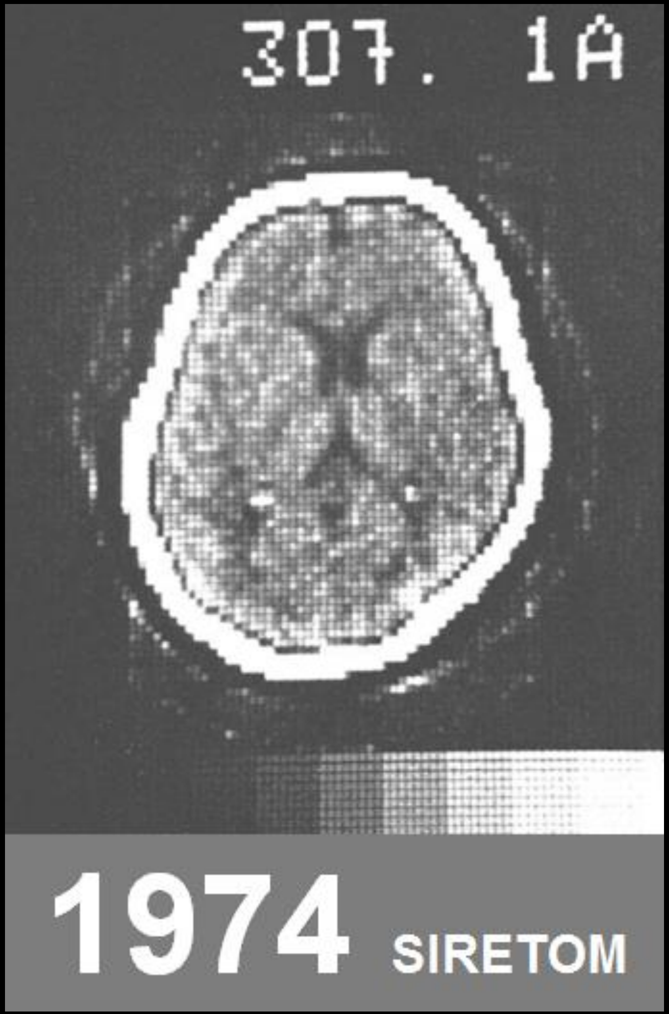

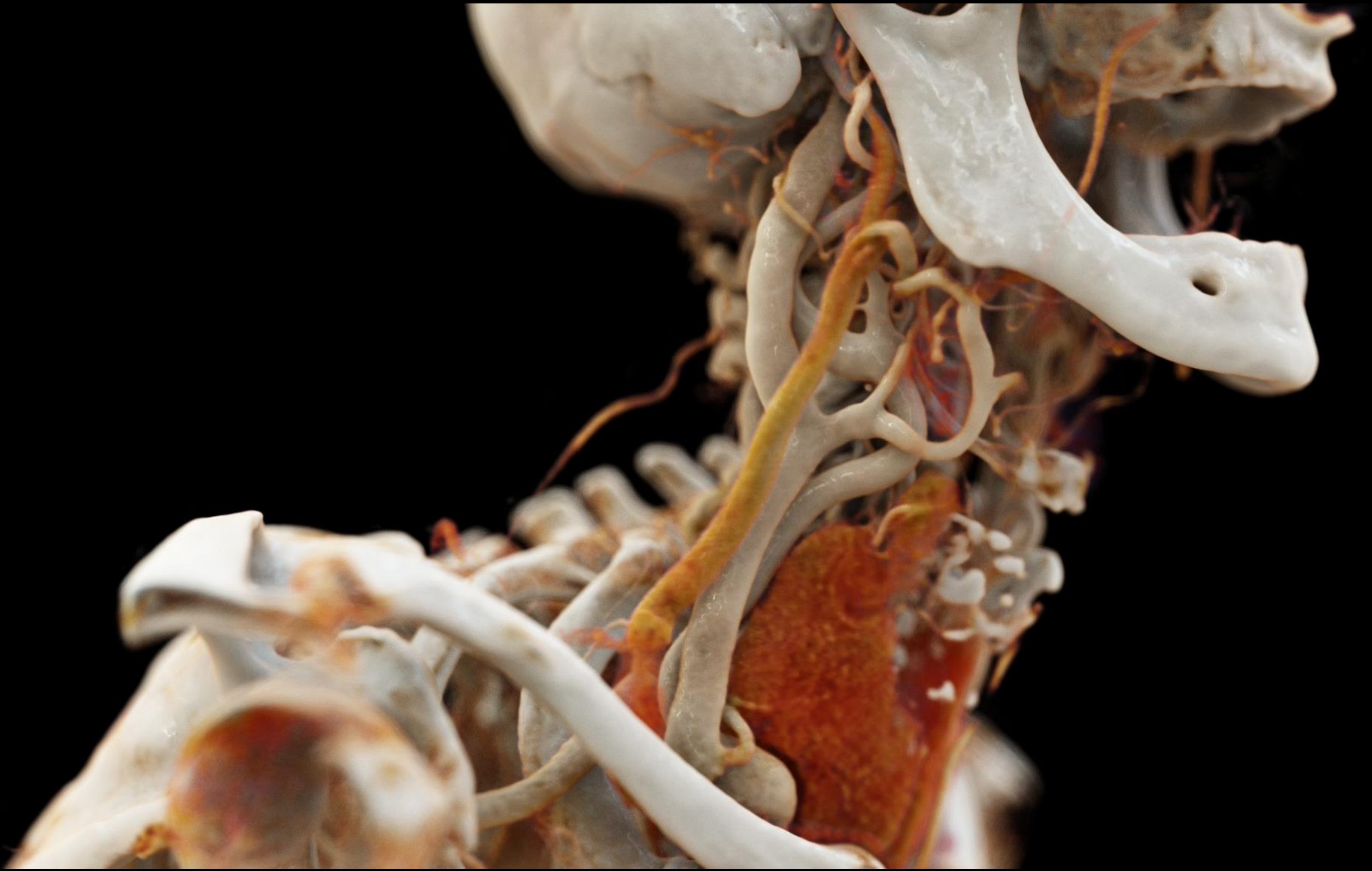

Data courtesy of Israelitisches Krankenhaus, Hamburg, Germany
Cinematic Rendering: Research use only. Not for clinical use

Diagnostic Imaging can give functional insights

Data courtesy of CUBRIC, UK
Cinematic Rendering: Research use only. Not for clinical use

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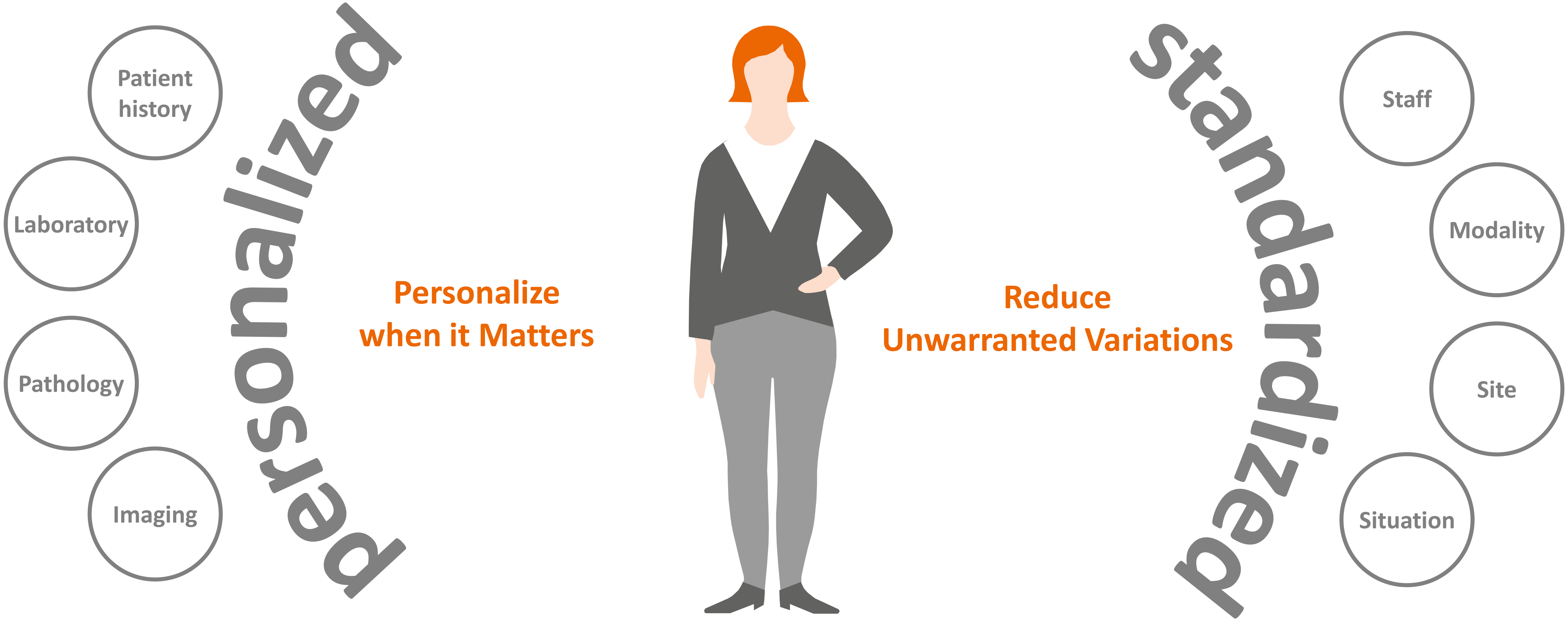
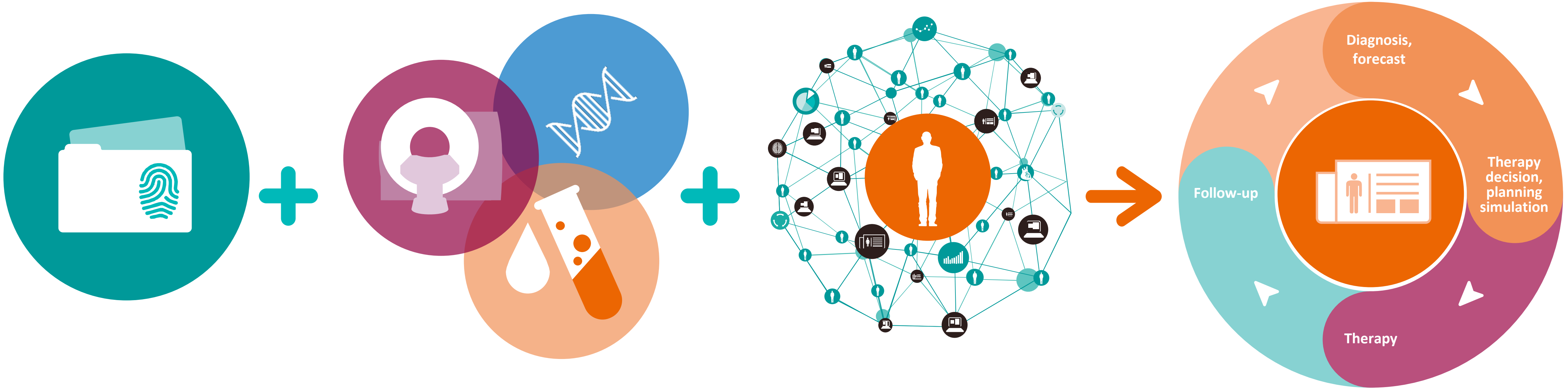


Precision Medicine

Integrated diagnostics for precise diagnosis confirmation and personalized treatment decision



Historical patient data from EMR

Combining in-vivo and in-vitro biomarkers incl. genomics data

Real-time correlation to reference data and population cohorts

Personalized diagnostics and treatment decision

Integrated decision support through information integration

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INTELLIGENT
Information Representation

CONFIRMATION
Right Diagnosis

DECISION
Right Therapy

IMPROVE
Measure KPIs
Time, Cost, Quality

Integrated Decisions

Siemens Healthineers Digital Ecosystem -
A community where digital and social assets interconnect and interact

Siemens Healthineers Digital Ecosystem -
Members contributing data & knowledge

>4.4k
Clinical collaborations

>3.0k
Providers connected to Siemens Healthineers cloud[1]

~30k
Users of web-enabled technical service[2]

>330k
Sessions of digital training platform[3]

1) teamplay: April 2018
2) LifeNet: October 2017
3) PEPconnect: in FY 2017

Siemens Healthineers Digital Ecosystem -
Data benefiting members with actionable insights

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>35m + >12m
Usage + dose studies (imaging data)[1,2]

250m
Curated clinical images[3]

10-15k / year
POC results data per hospital[4]

~5GB
Genomic data (patient raw data)[4]

1) Since January 2016 until April 2018
2) Dose studies typically overlap with Usage studies, there is a small number of dose report only studies (not counted in Usage studies)
3) Data from February 2018

We are building our AI capabilities systematically from the ground up

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Integration, access, complexity

Scope of data integration		Data examples	
Patient Cohort	• Population health management • Outcome analysis, quality care, meaningful use	Comprehensive health data (EMR level and beyond) across patients and care settings	Enabling large scale data aggregation, analytics and prediction
Patient Centric	• Predict, plan, prescribe • Clinical decision support/ Digital Twin	Clinical ("omics"), behavioral, functional, social data (integrated for a single patient)	
Reading/ Reporting Post-Processing/ Guidance	• Measure and quantify • Detect, diagnose and guide	• Images, test results from single sample/study • Multiple studies/sources (e.g., multi-modality views/fusion)	Embedded AI, enabling quantification and automation
Scanner/ Instrument Technology	• Workflow automation • Reconstruction, advanced physics	Scanner/instrument control (parameters, protocols, positioning, etc.)	

Availability of Data and Digital Infrastructure hold great potential to solve challenges with Artificial Intelligence

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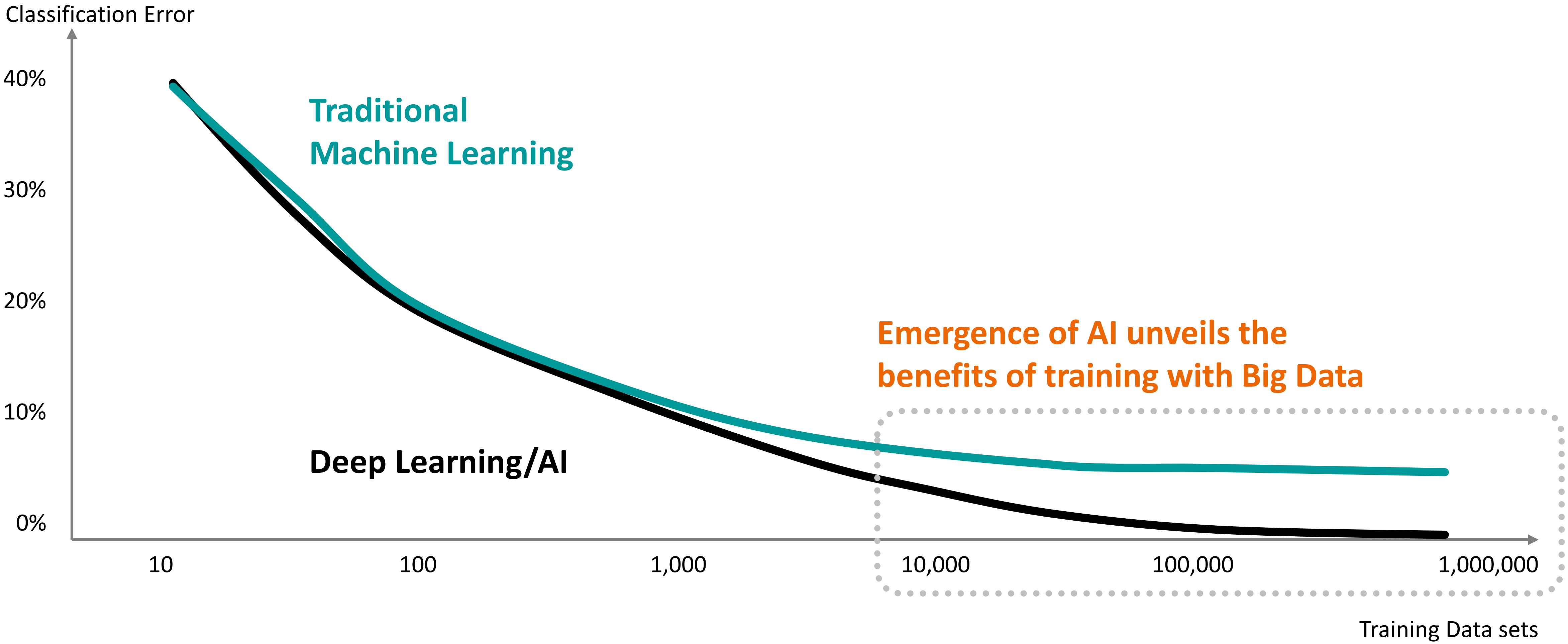

Powerful platform combined with long-term experience for Artificial Intelligence

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600,000 imaging, laboratory and point-of-care systems

300,000,000

touching 209,000 patients every hour

curated images, reports, operational data

Dedicated **annotation team**

Close clinical **collaborations**

AI competence center with awarded Data Scientists

Regional **supercomputing** data centers

More than **30 AI-enriched offerings** on the market

400 patents and patent applications in **machine learning**

100 in **deep learning**

Applying traditional machine learning and deep learning to Radiology Workflow

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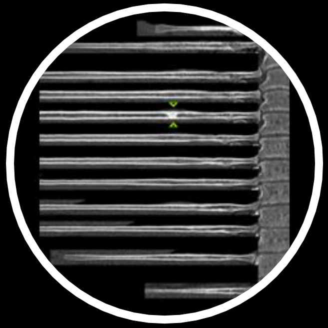
AI powered Acquisition & Examination

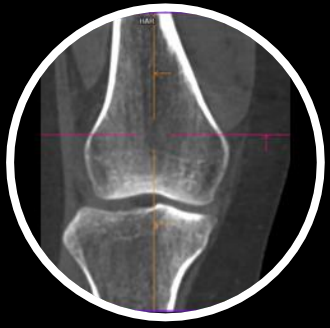
AI powered Processing & Interpretation

AI powered Guidance & Workflow

Accurate patient positioning

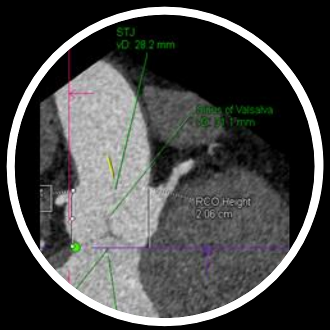


Spine and rib unfolding

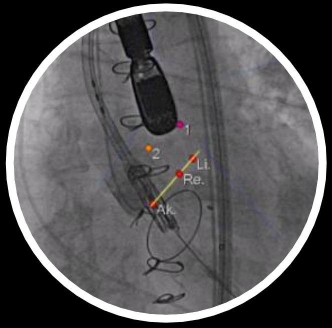


ALPHA Anatomical Ranges

Anatomy Visualiser

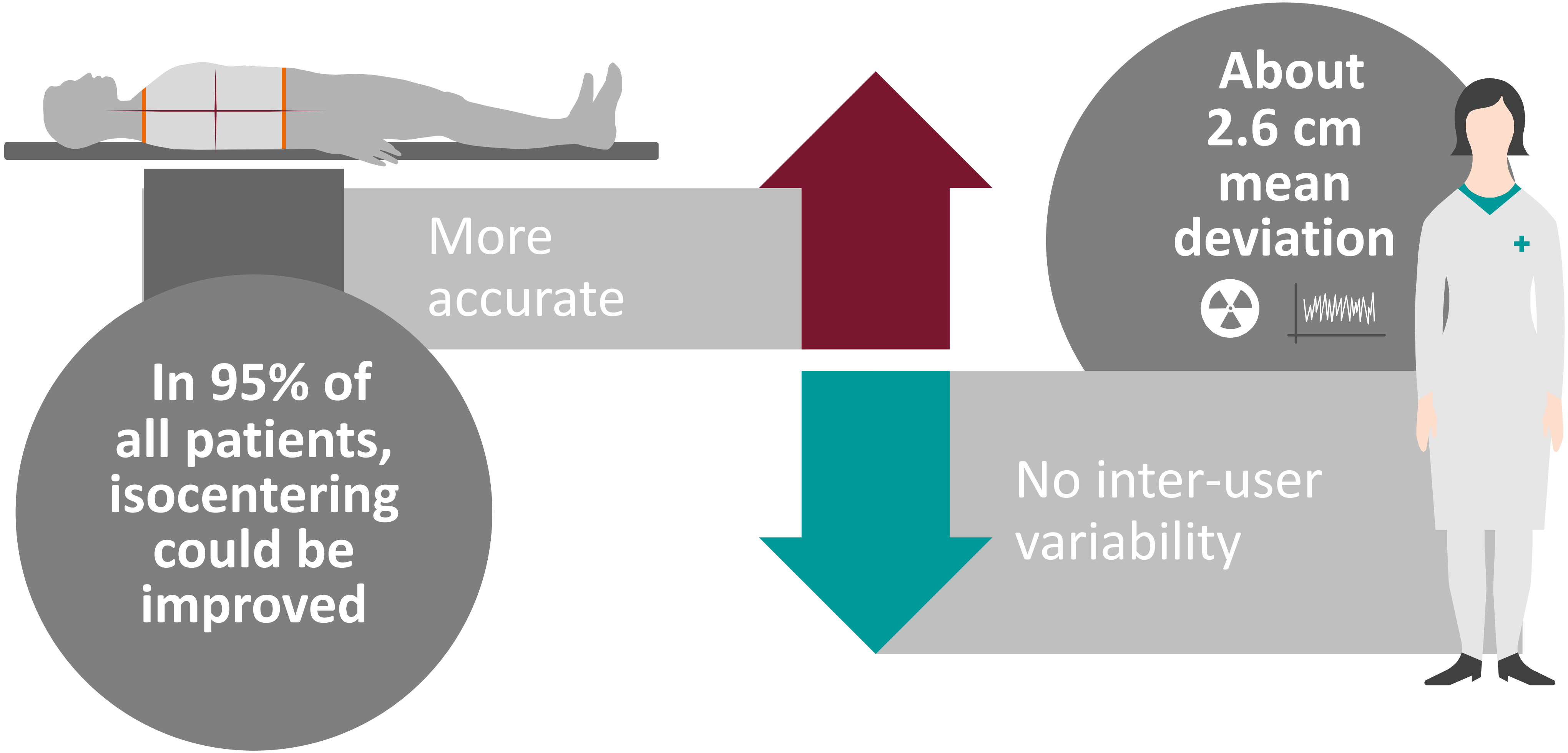


Cardiovascular TAVI-Planning



True fusion

AI helps to reduce unwarranted variations with accurate patient positioning



Source: Li J, Udayasankar UK, Toth TL et al. Automatic patient centering for MDCT: effect on radiation dose. AJR 2007; 188: 547 – 552 and Kaasalainen T, Palmu K, Lampinen A et al. Effect of vertical positioning on organ dose, image noise and contrast in pediatric chest CT-phantom study. Pediatric radiology 2013; 43: 673 – 684

Deep learning algorithms help to care for patients more individually

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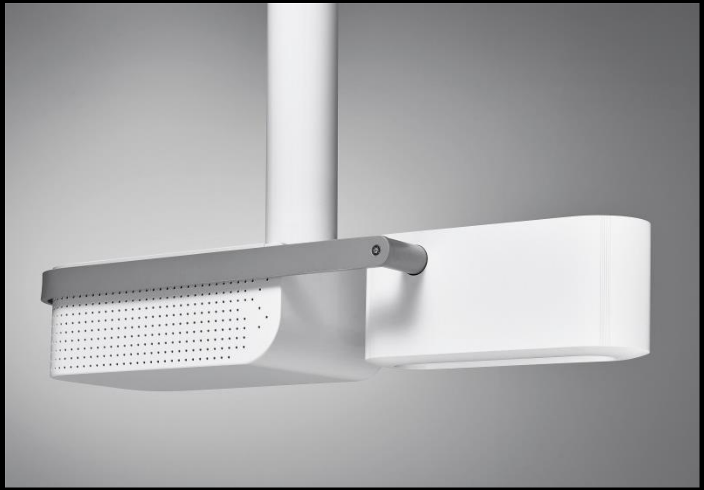
Input

Color Image Data
3D Depth Image Data
Infrared Image Data



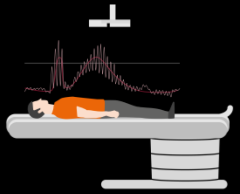
FAST Integrated Workflow incl. unique FAST 3D Camera

AI

Based on deep learning algorithms the following are possible:

- Landmark detection
- Range detection based on protocol input
- Range adaption to user changes over time
- Isocenter positioning
- Patient direction analysis

Output



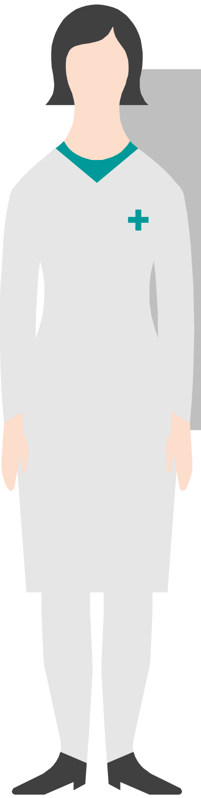
Right dose modulation with **FAST Isocentering**

Right scan direction with **FAST Direction**

Correct and complete body region with **FAST Range**

The system is pending 510(k) clearance, and is not yet available in the United States.

AI helps increased precision with time savings & providing reliable results independent from user skills



No inter-observer variability

Less than **1** minute exam-time variation[1]

Save up to $14K per tech and year in workforce overtime salary[2]

Potential for time savings

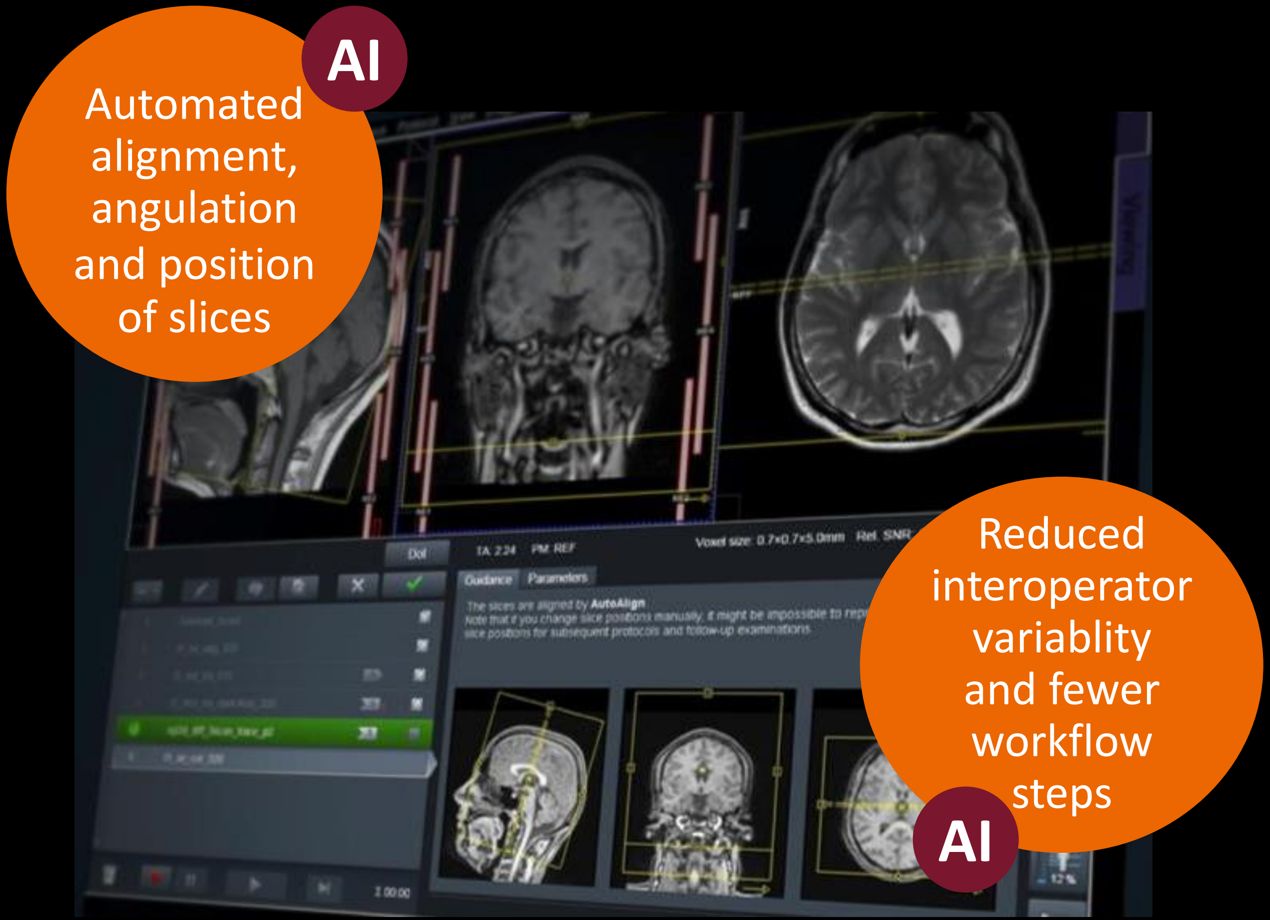
[1] Zhongshang Hospital Fudan University, Fudan, CN, Abdomen Dot Engine Workflow Study;
[2] Calculation based on: 38h/week; 48 working weeks/year; average annual salary $70K equals ~$40/h

AI based image analytics can drive automation – AutoAlign enables standardized image results

Standardized planning
Easy and accurate slice positioning without operator intervention - can be applied in many anatomic areas (e.g. Liver, Heart, MSK)

Improved clinical workflow
Allows better patient throughput by reducing possible errors in planning

Reproducibility and robustness
Standardization of image quality from patient to patient. Allows accurate follow-up scans



Radiology is characterized by high volumes of examinations at low reimbursement

Numbers represent Medicare reimbursement only. Calculation based on 2015 Medicare reports.
Sources: CMS Statistics, Journal of the American Radiology 2017:14:337-342

AI based image analytics can drive automation – helping to read chest imaging faster

Abnormality highlighting
Helps avoid missed abnormalities and identify incidental findings.

Augmented reporting
Provides standardized, reproducible quantitative reports using automated information extraction from images.

Image-based biomarker
Assists with differential diagnosis for lung disease

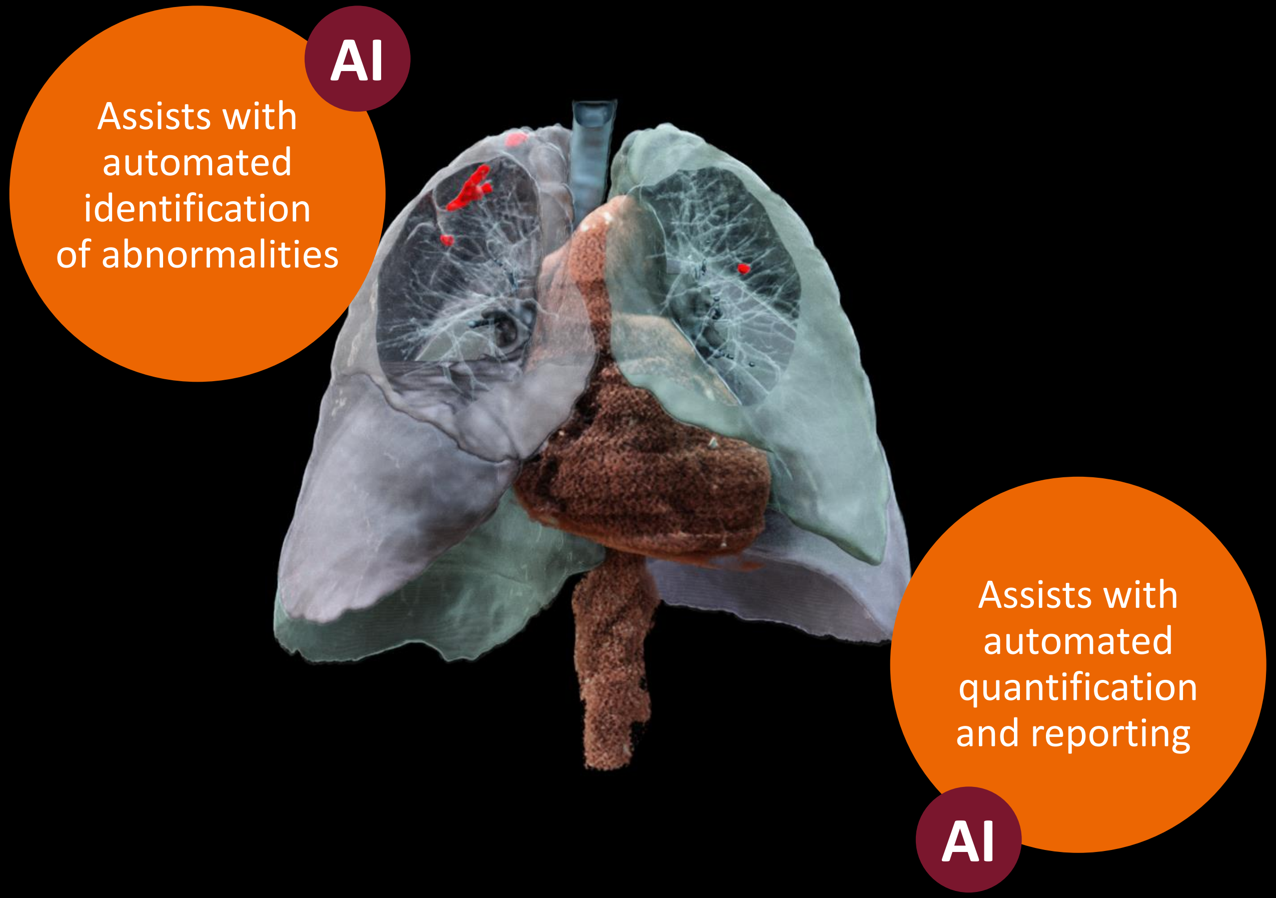


Image courtesy: https://wiki.cancerimagingarchive.net/display/Public/LIDC-IDRI, LIDC-IDRI-0463
This feature is based on research, and is not commercially available.
Due to regulatory reasons its future availability cannot be guaranteed.

AI may help increase precision and reduce variability in prostate cancer risk assessment

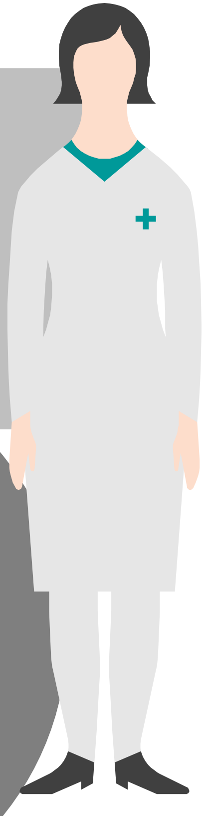
Conventional TRUS biopsy detects **only 48%** of clinically significant prostate cancers.[1]

Studies show **Multiparametric MRI** to be a potentially significant improvement.

Low accuracy of prostate cancer risk assessment

High inter-observer variability

Even experienced radiologists achieve **only moderate reproducibility** in prostate mpMRI evaluation[2]



[1] PROMIS study, Ahmed et al., Lancet 389: 815 (2017)
[2] Rosenkrantz et al., Radiology 280: 793 (2016)

Artificial Intelligence technology assists prostate cancer risk assessment and supports ease of reporting

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Augmented mpMRI reading
Leverage algorithms trained on expert findings and correlations with pathology

Augmented reporting
Pre-populate PI-RADS (Prostate Imaging Reporting and Data System) structured report

Enable broad access to mpMRI for early detection of clinically significant prostate cancer
Enable fast, high-quality adoption beyond specialist centers

AI
Helps identify and characterize lesions

AI
Augmented reporting according to PI-RADS standard

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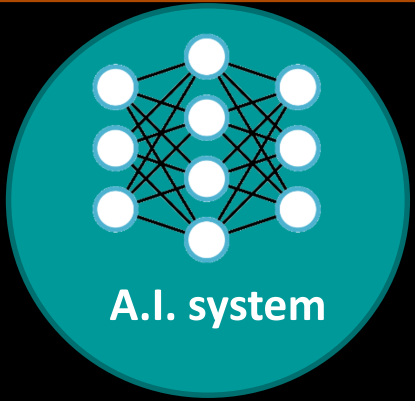
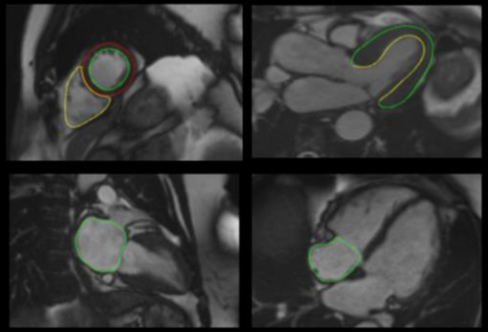
inline Cardiac MR analysis

Cine CMR exam



Deep I2I

LV, RV, LA & RA on short & long-axis



- Auto 4-chamber cardiac function
- Auto view recognition

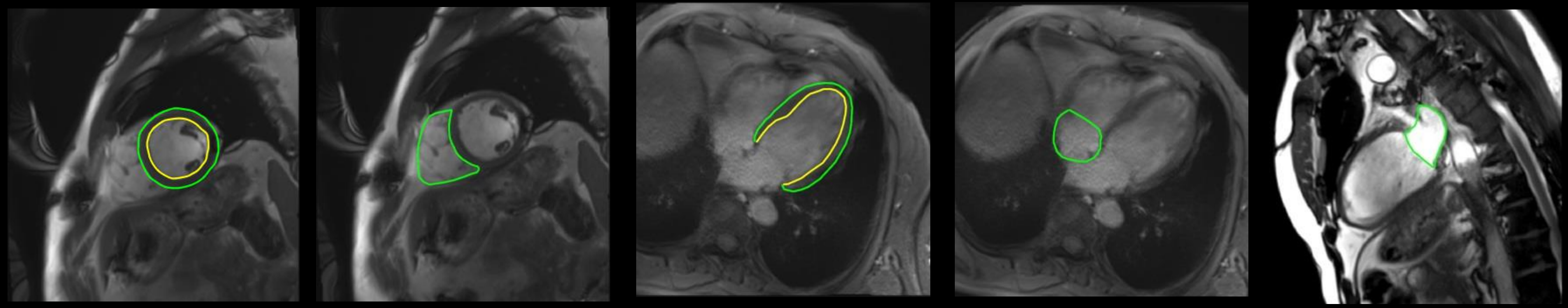
- Trained on ~60,000 expert annotated images

Chamber	Performance (DICE)
Left ventricle	0.93
Right ventricle	0.88
Left atrium	0.93
Right atrium	0.95

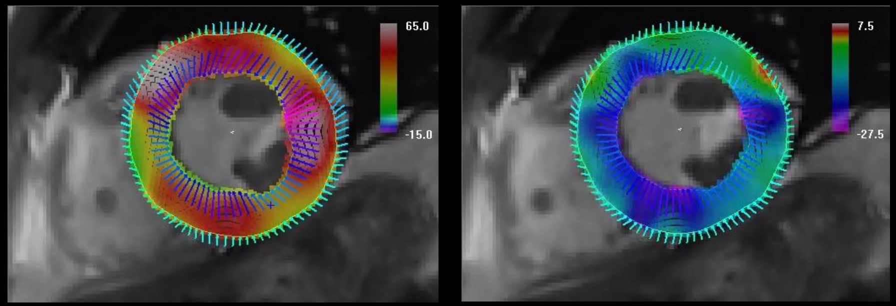
Courtesy of UK Biobank

My Cardiac Exam

AI algorithm computes 193 measurements, regional and global



LV, RV (short-axis), LV, RA and LA (long-axis)



LV radial and circumferential strain

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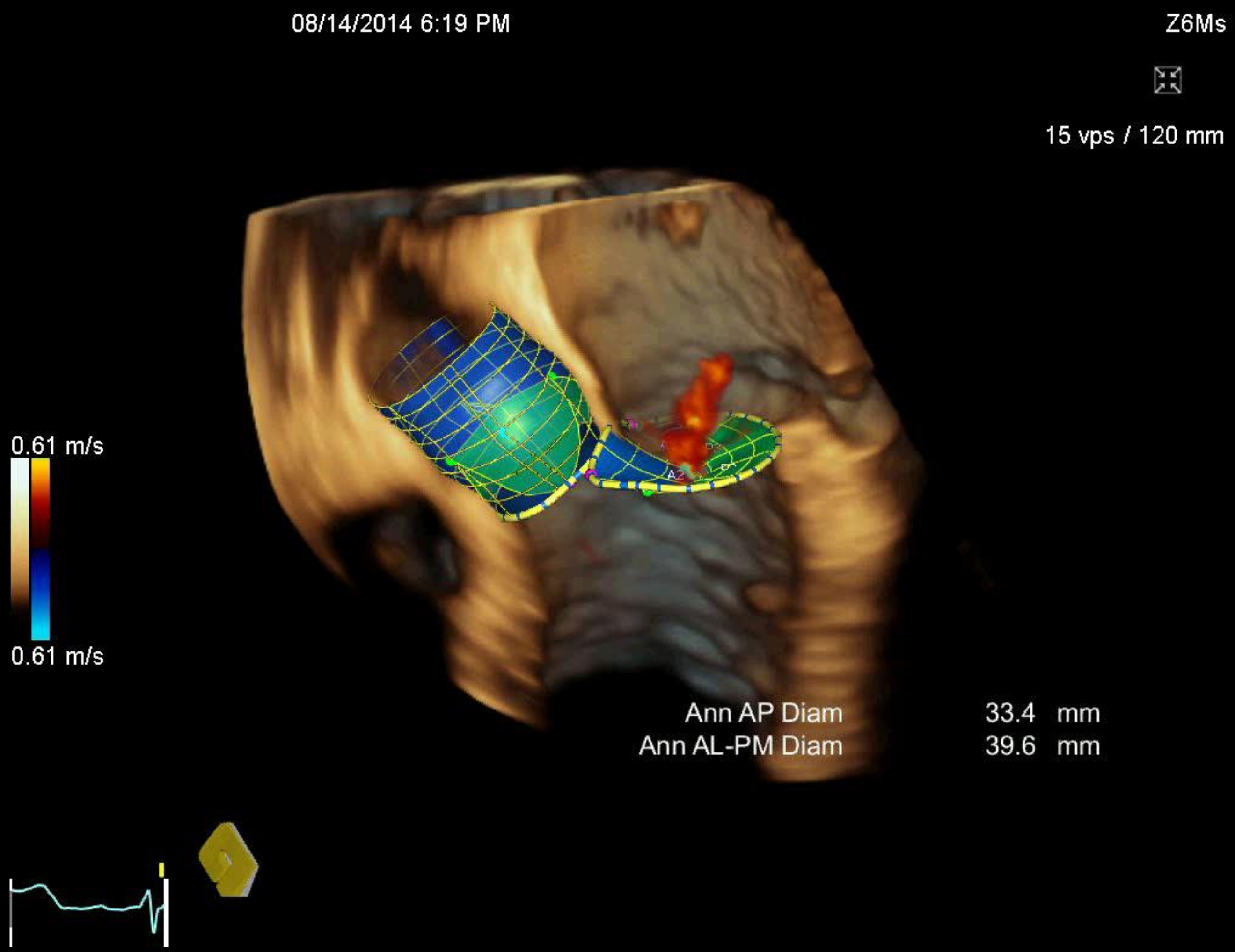
TransEsophageal Echocardiography
Volume TEE, Real-Time 3D Doppler, 3D+t Valve Analysis



eSieValvesTM Analysis

Personalized Assessment of Cardiac Valves within seconds

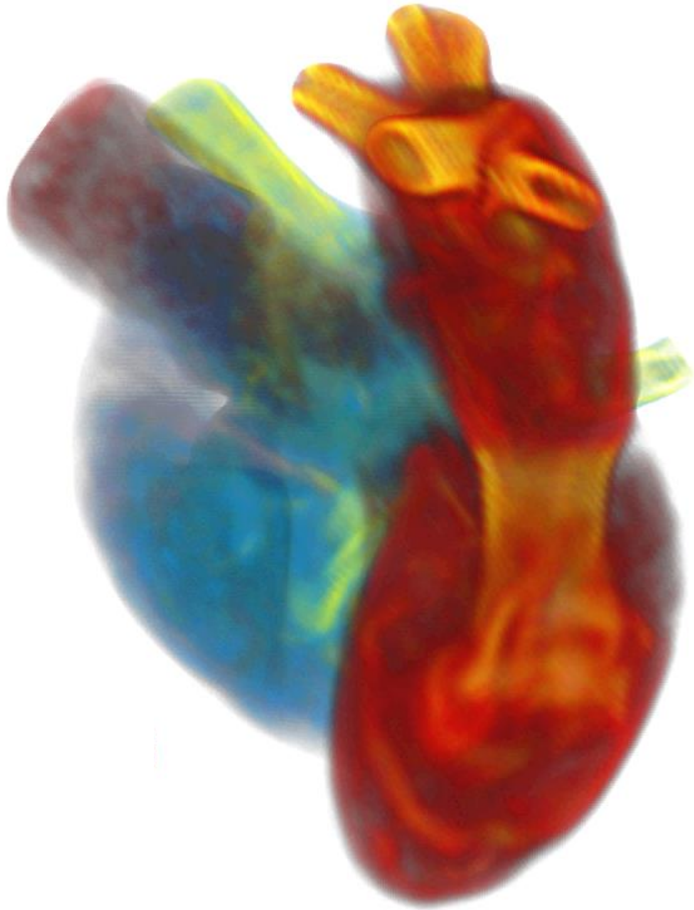
Visualization of anatomy, landmarks, and associated measurements in 3D

S. Grbic, et al., Personalized Mitral Valve Closure Computation and Uncertainty Analysis from 3D Echocardiography, Medical Image Analysis, 2016

Data Courtesy of Piedmont Heart Institute, Atlanta GA

Towards a personalized data model

Digital twin –
lifelong, personalized physiological model updated with each scan, exam



Patient-centric, holistic treatment

Comaniciu et al, Shaping the Future through Innovations:
From Medical Imaging to Precision Medicine, Medical Image Analysis, 2016.

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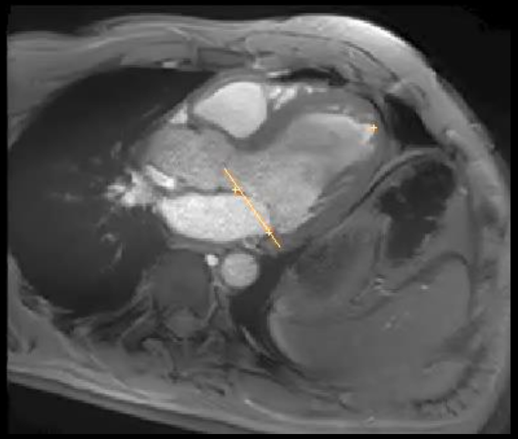
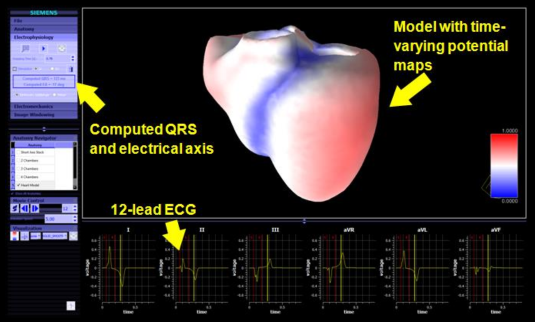
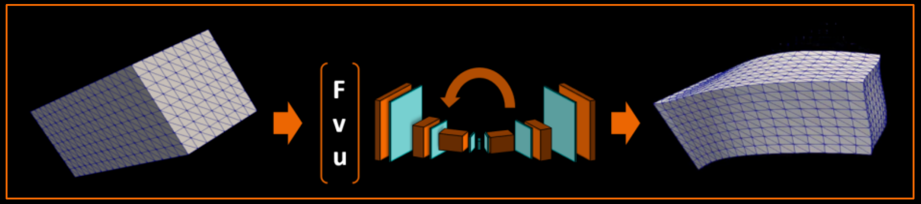
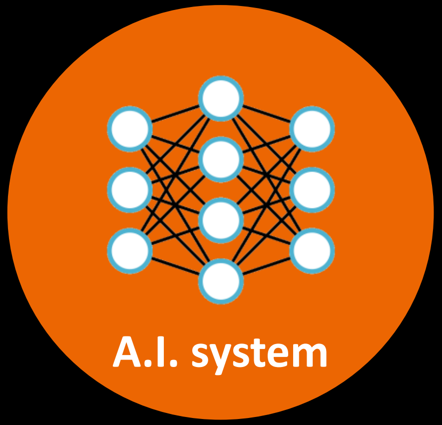
AI helps building digital twin of a heart

CMRI and EP info fed into twin builder, trained with synthetic data









Digital twin of colleagues heart

Shape, kinematics, stress and strain

This feature is based on research, and is not commercially available. Due to regulatory reasons its future availability cannot be guaranteed.

Our Ambition – Digitalizing Healthcare Enabled by Artificial Intelligence

SIEMENS Healthineers

Expanding **precision medicine**

Transforming **care delivery**

Improving **patient experience**

Digitalizing healthcare

AI drives quality of care

- Increasing reliability of measurements
- Reducing unwarranted variations

AI drives efficiency and productivity

- Enabling increased workforce productivity through automation
- Optimizing clinical operations

AI drives outcomes that matter to patients

- Prioritizing complex/acute cases
- Avoiding unnecessary interventions

Thank you

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