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New Heart Care System based on UT-Heart for Tailor-made Medicine

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•Collaborative research with Hisada Lab. of the University of Tokyo
•Supported by Japan Science and Technology Agency

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Results of computational simulation by using UT-Heart

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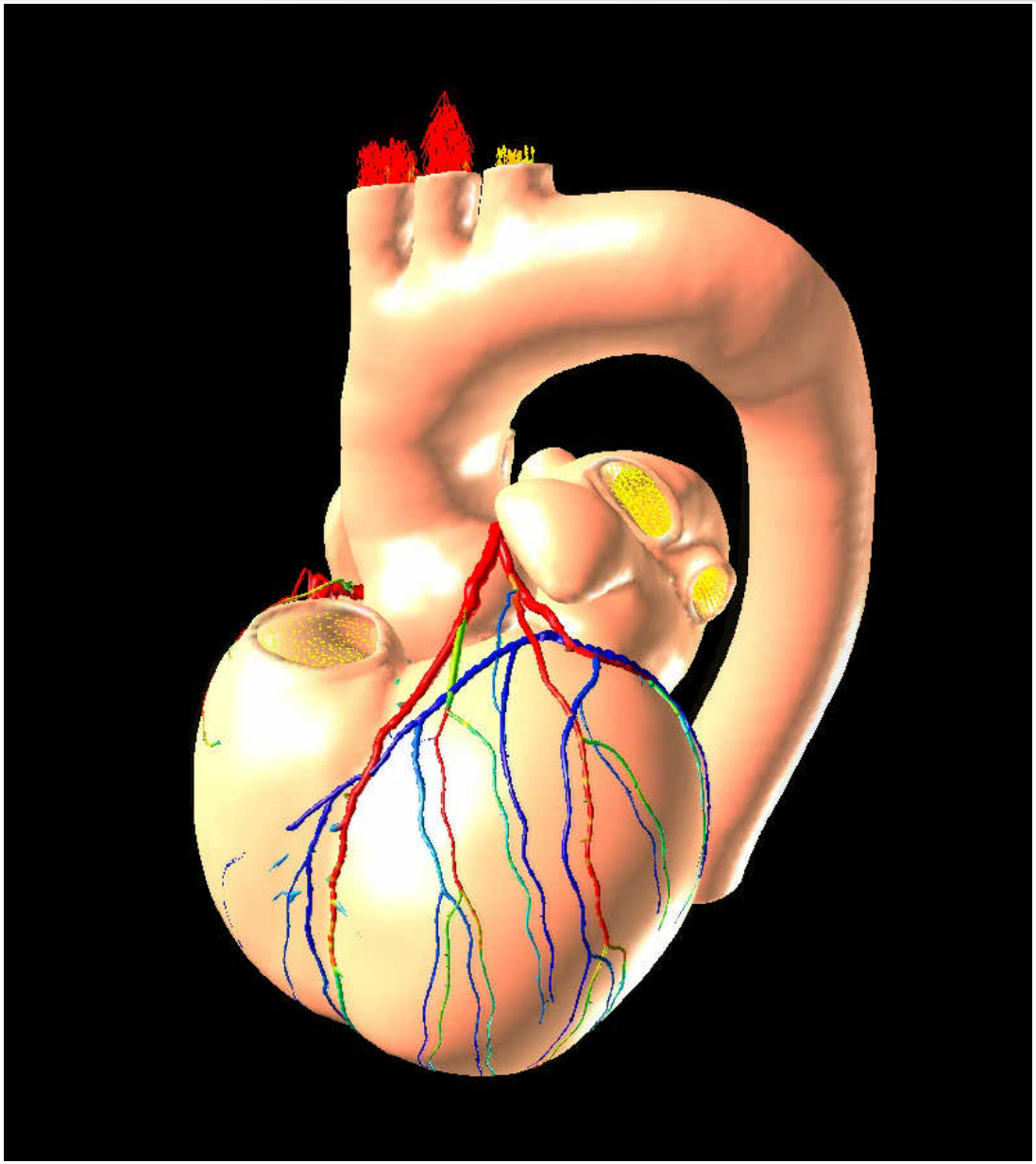

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What we are aiming at.

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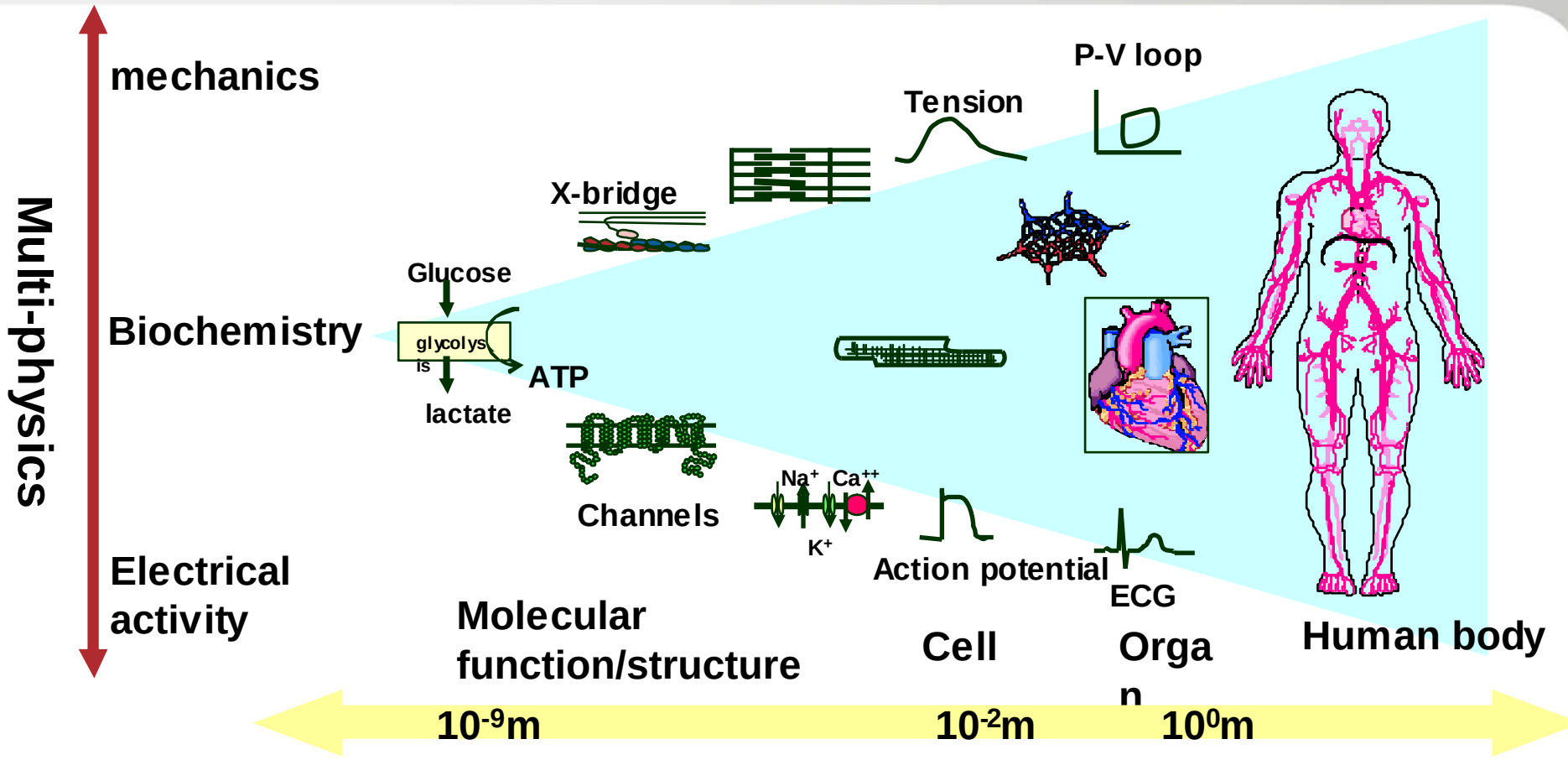

Multi-scale

Integration of knowledge → **Understanding** of human body → **Discovery**

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Construction of numerical model based on CT-images

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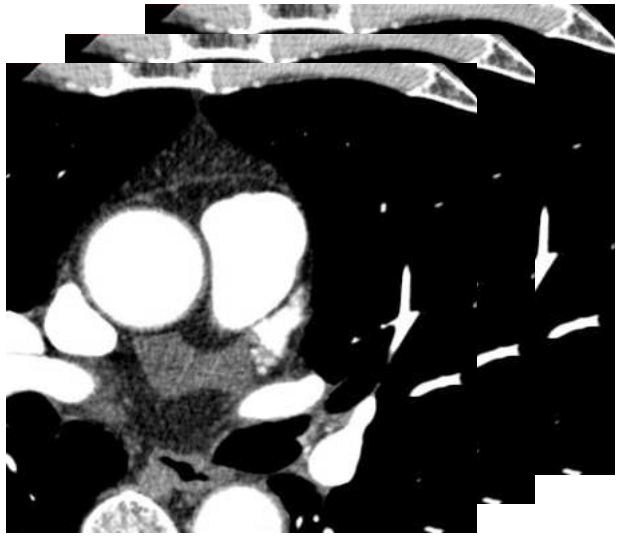
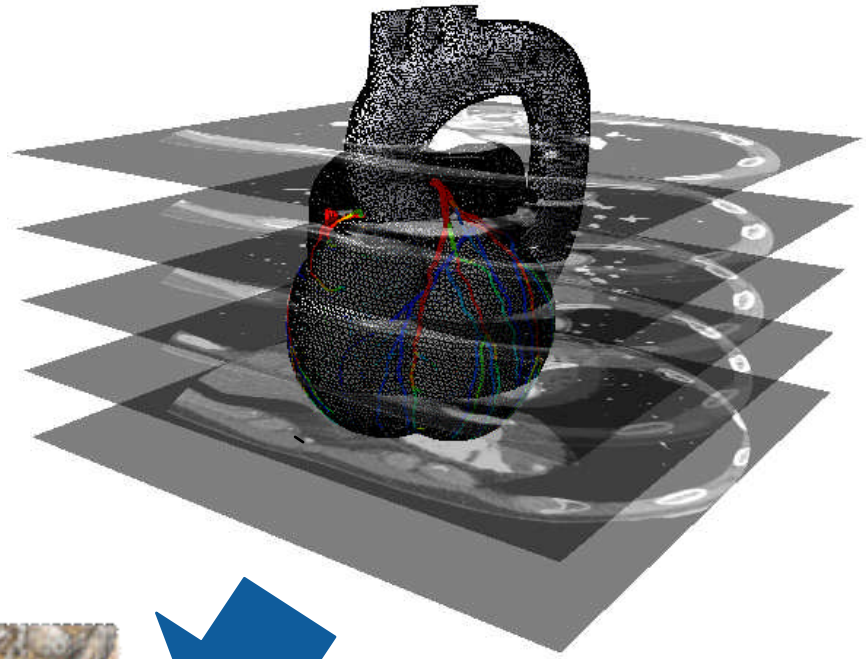
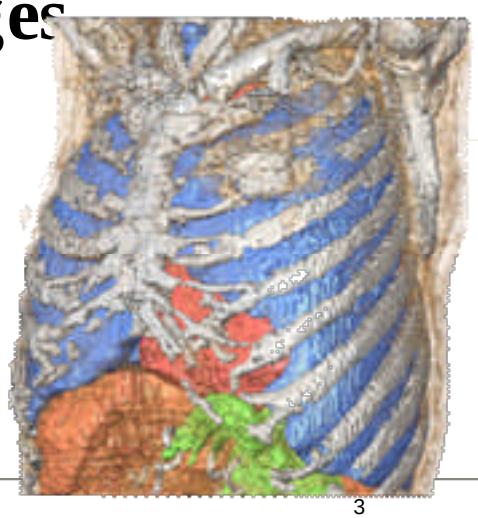
Geometry





CT-scan images



Imbedding to the torso model

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Pumping Principle of the Heart as a Blood Pump

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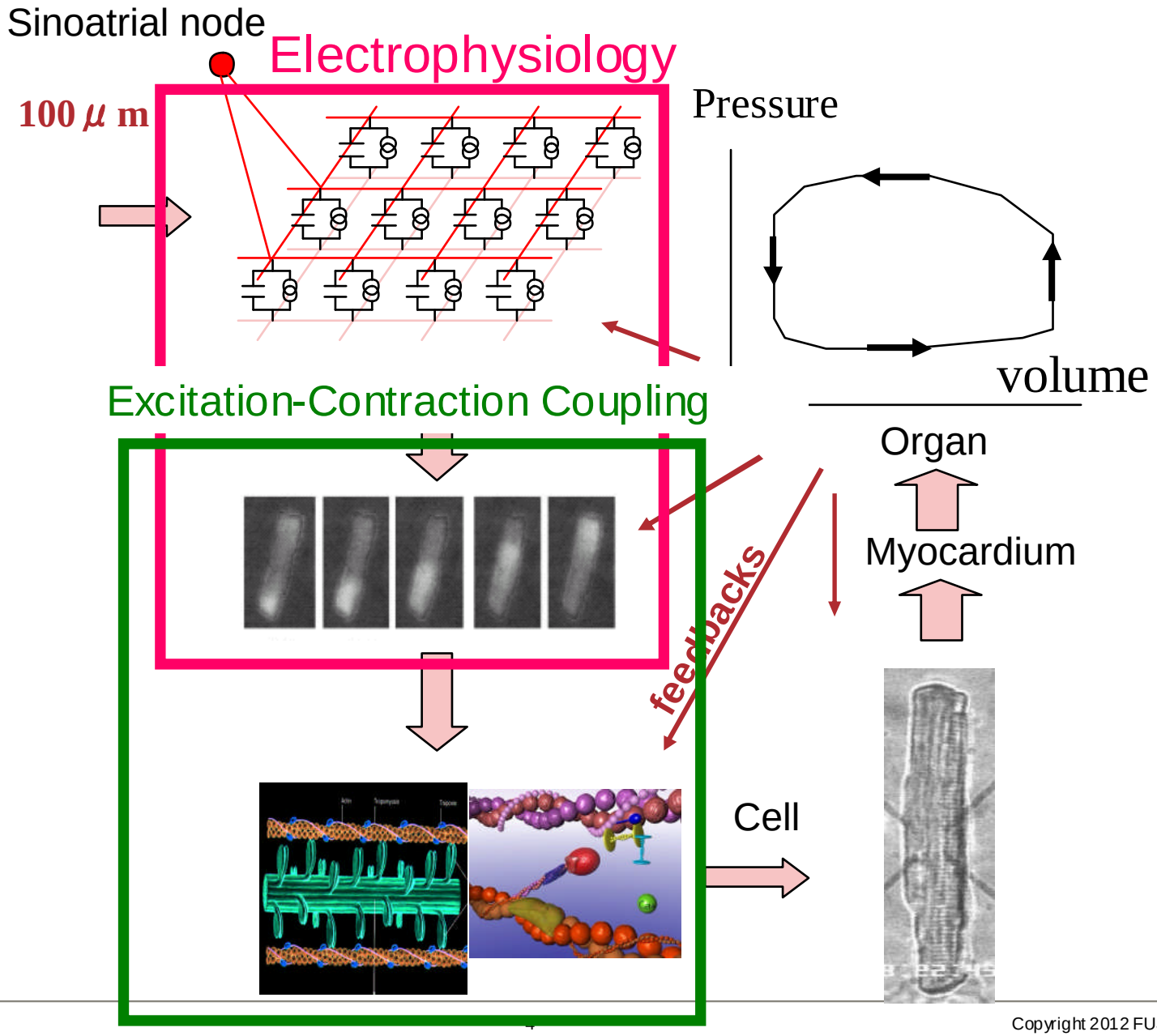

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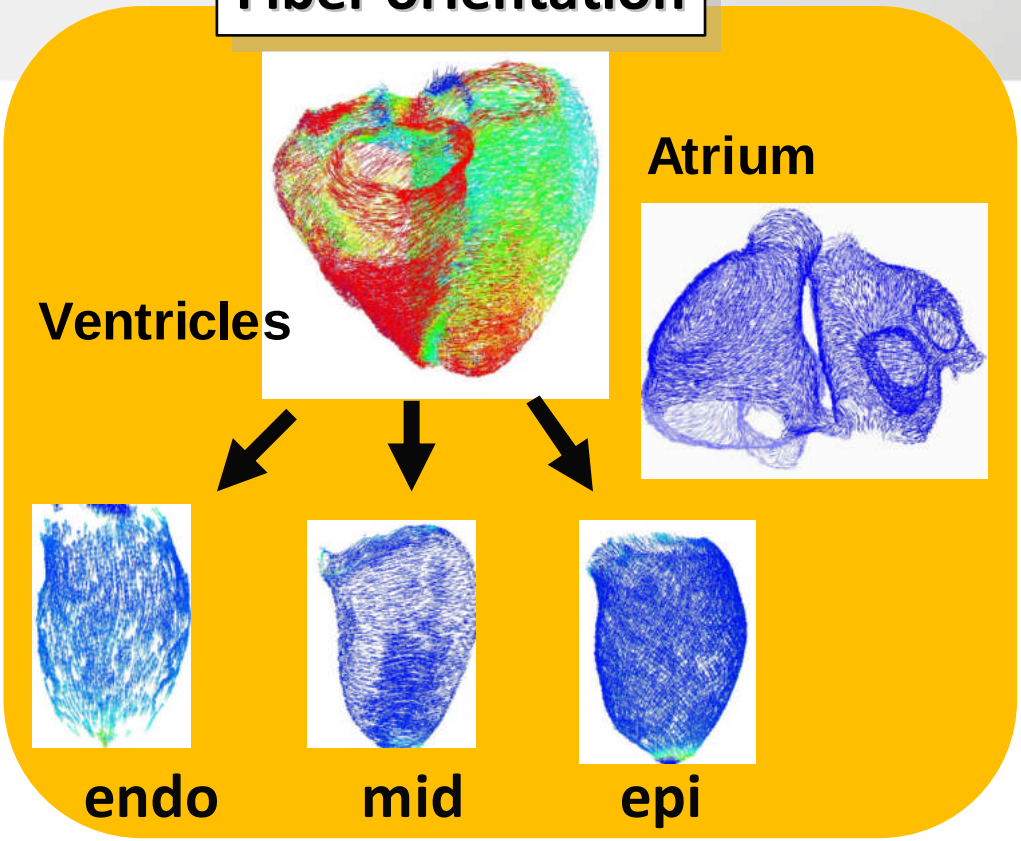
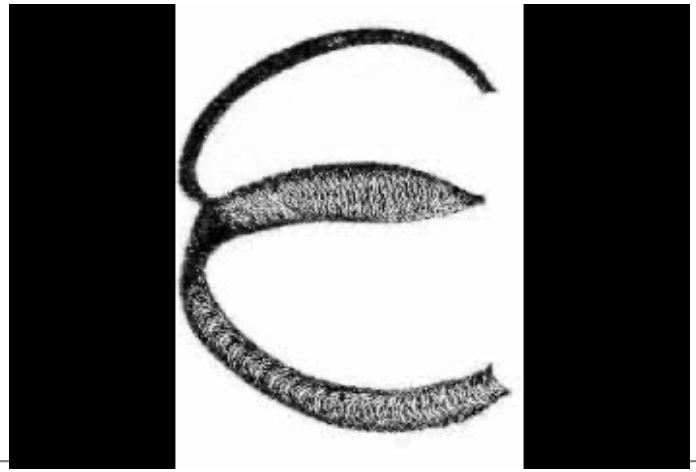
Fiber orientation





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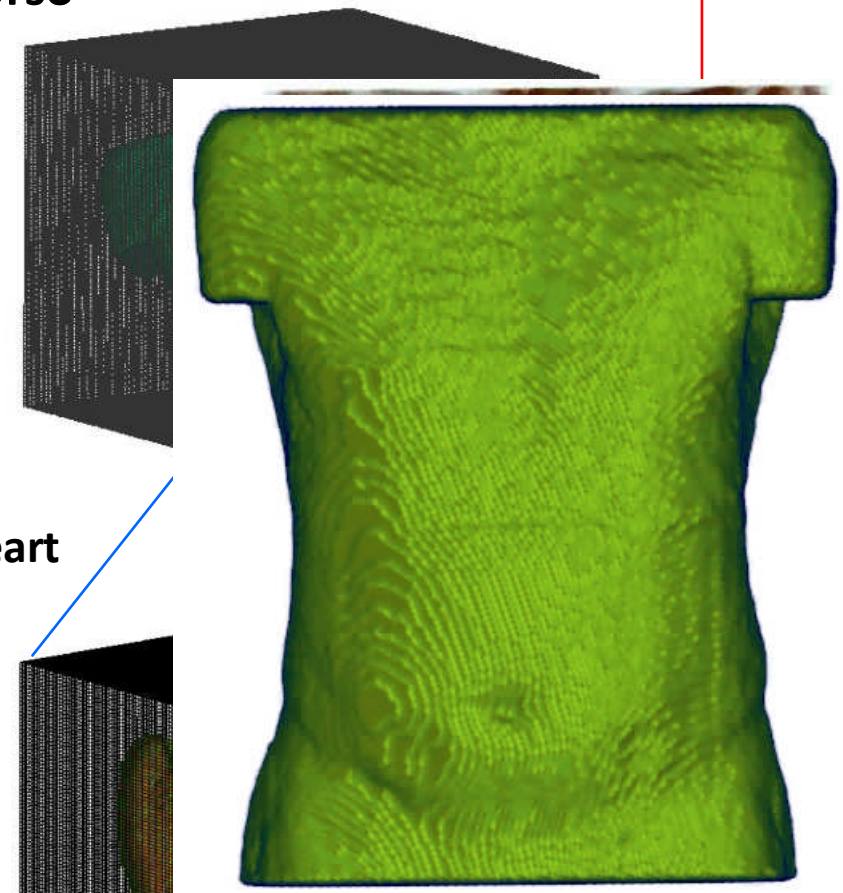
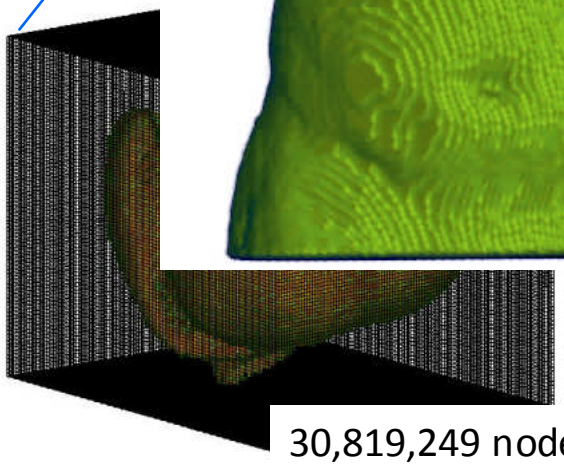
Voxel model for EP analysis

Torso



Heart

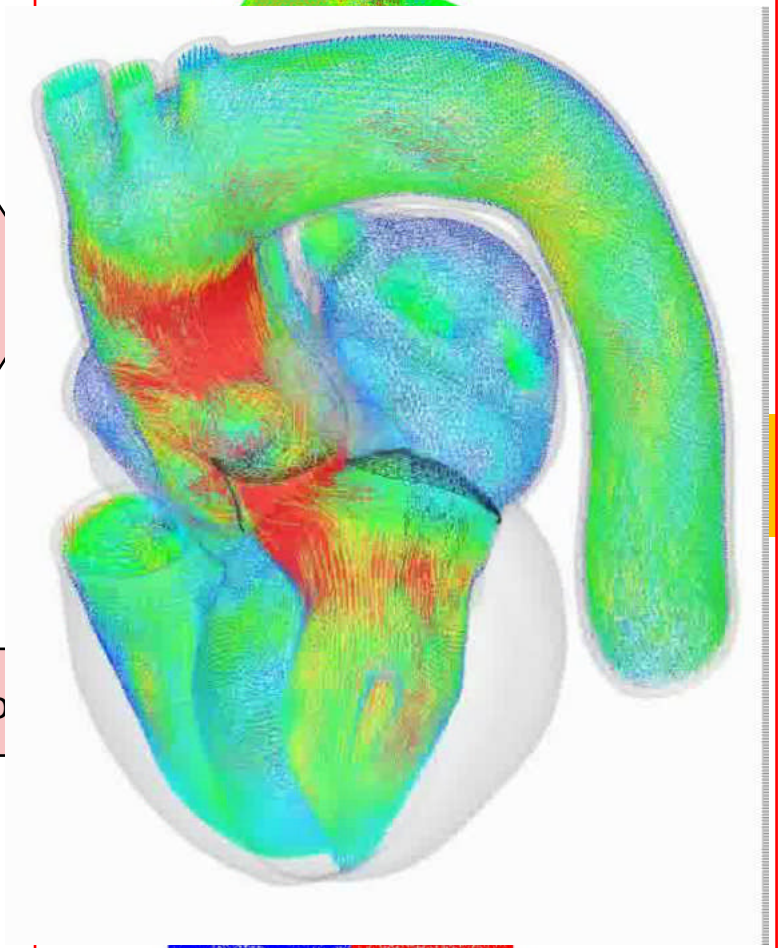


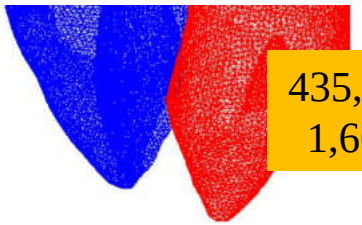
30,819,249 nodes

(Total 49,425,860 nodes)

Tetrahedral FEM model for mechanics

structure





435,227 elements
1,668,669 DOF

(total ～4.2 million DOF)

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Measurement of Electrocardiogram (ECG)

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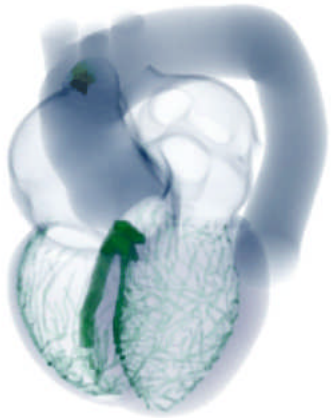
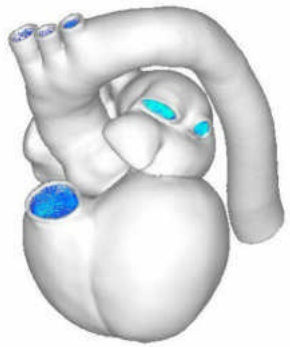
- Comparison of ECG measurement between heart simulator and human heart

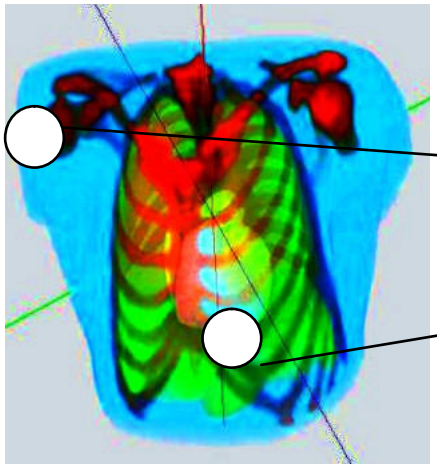
Potential Distribution on torso surface



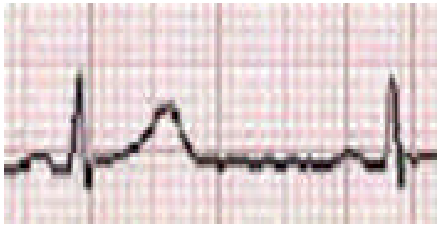
Cardiac Excitation

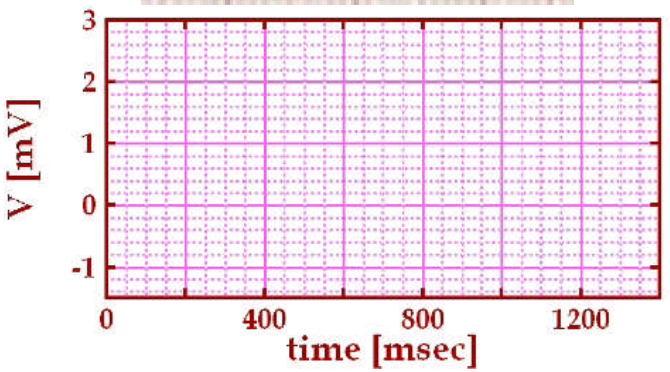


Cardiac Pumping



Lead II ECG





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Planning of Surgery for Dilative Cardiomyopathy

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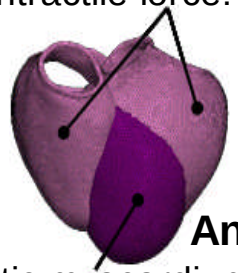
Surgery Planning of “Batista” by Heart Simulator

Contractile force: 100%



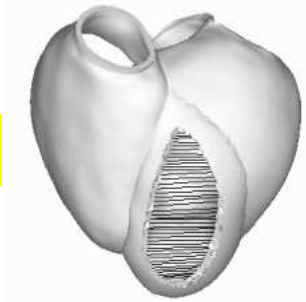
Aneurysm

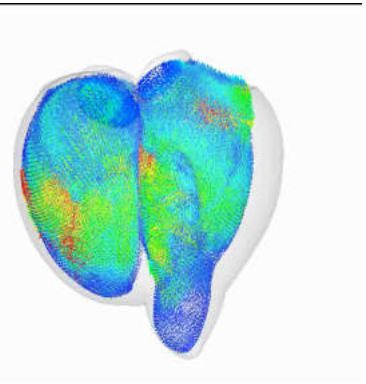
Necrotic myocardium

Contractile force: 30%

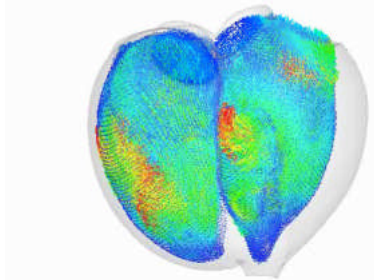
Before surgery

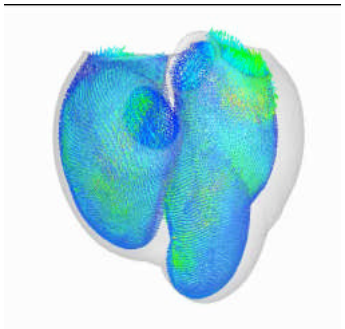
Plan A

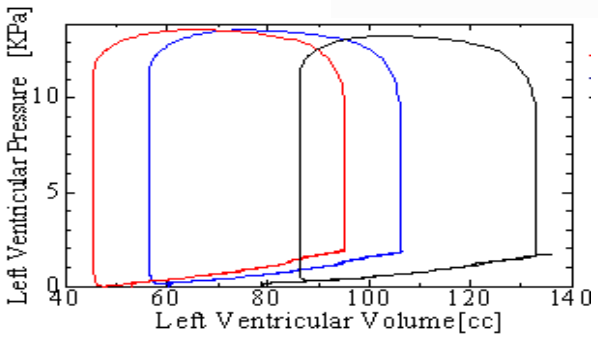




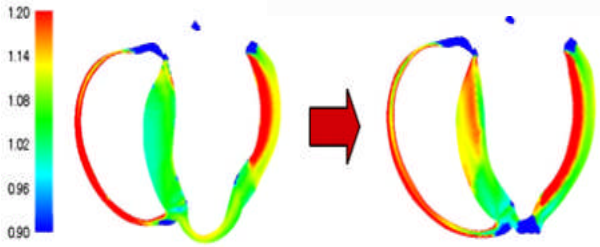
Plan B







Quantitative Prediction (QP) of Pressure - Volume



QP of Stress – Strain

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Visualization System

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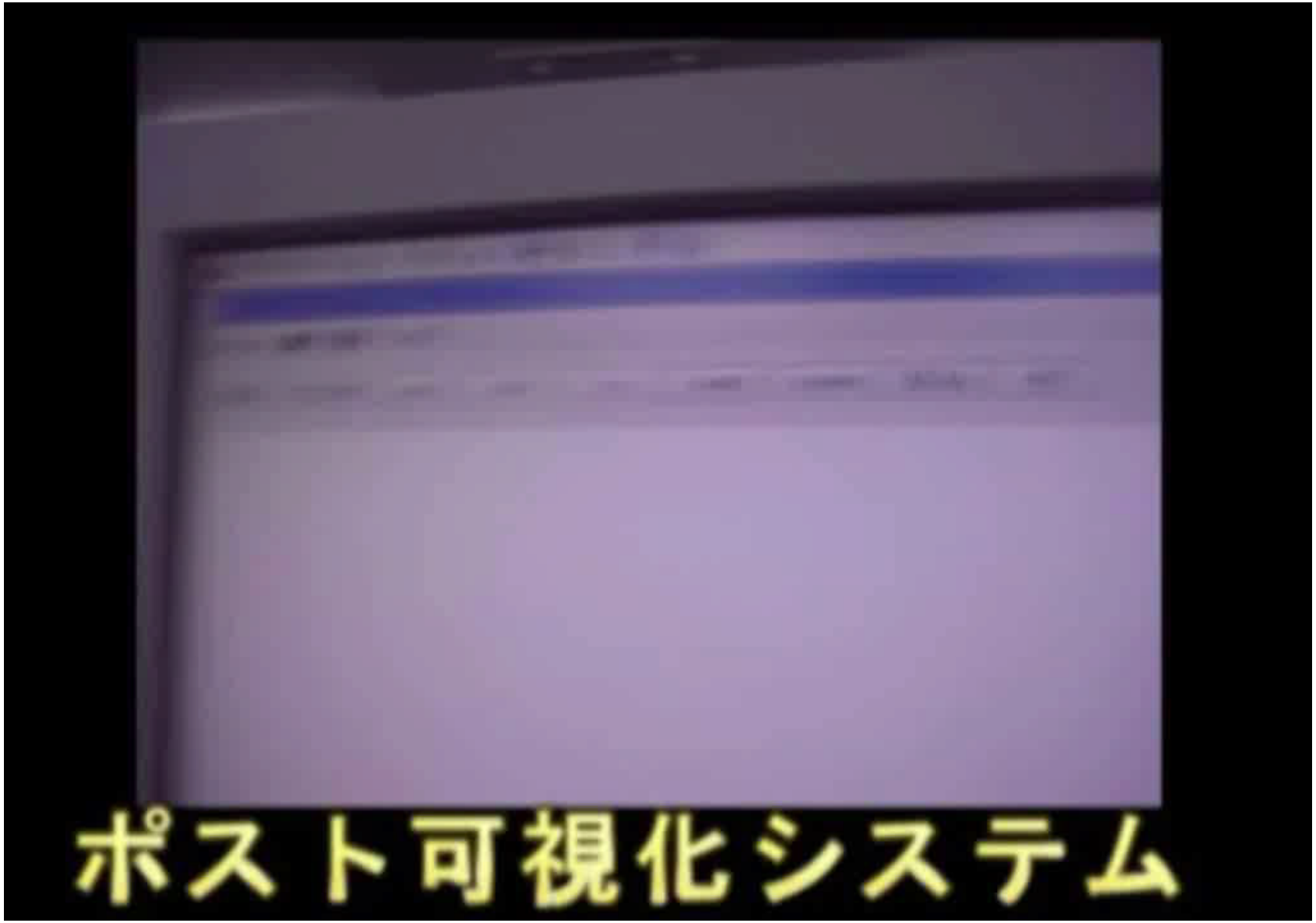

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New Medical System to realize Tailor-made Medicine in the Cloud

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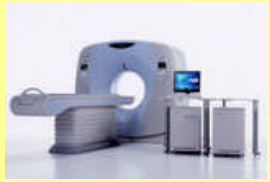
Patient data

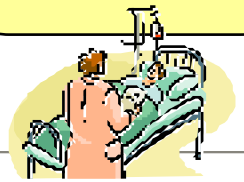
Blood pressure, electrocardiogram, and blood test

Echo



CT・MRI

Electrical Care Card



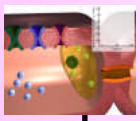
Heart Simulator

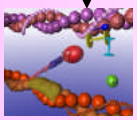
Cardiac Excitation Propagation

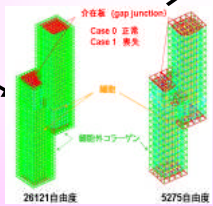
Micro Numerical Cell

Fluid and Structure Interaction

Ion channel model in Cell

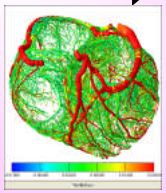






Relational model for Excitation and Contraction

Micro Model



Coronary Circulation

Valves

Interactive Visualization System

Surgery planning, Prediction of effect

Diagnostic support

Peta-scale Computer

Medical information integration data base

Prediction of administering effect

Taylor-made Medical Treatment by Heart Simulator

Treatment for Intractable disease

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Other approaches for medical therapy based on computer simulation: Examples

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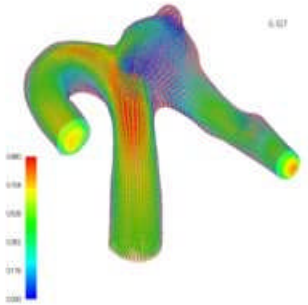
- Image-based modeling and simulation of artery circulatory system disease such as aneurysm and arteriosclerosis:

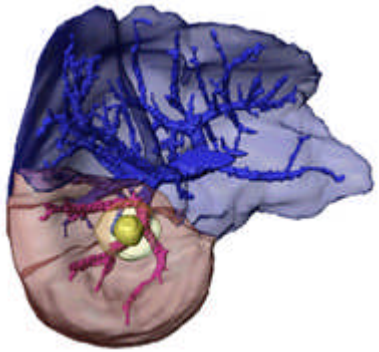
  Oshima Lab. In the University of Tokyo



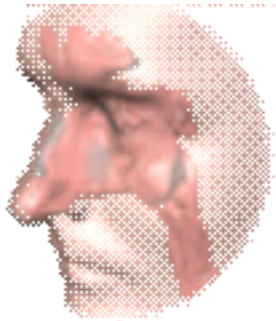
- Medical planning project in Zuse-Institute Berlin

Computer Assisted Cranio-Maxillofacial Surgery

Reconstruction of Knee Anatomy for the Analysis of Knee Kinematics



Oncological Liver Surgery Planning



ENT-Surgery under consideration of optimal nasal air flow

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Issues regarding Standardization

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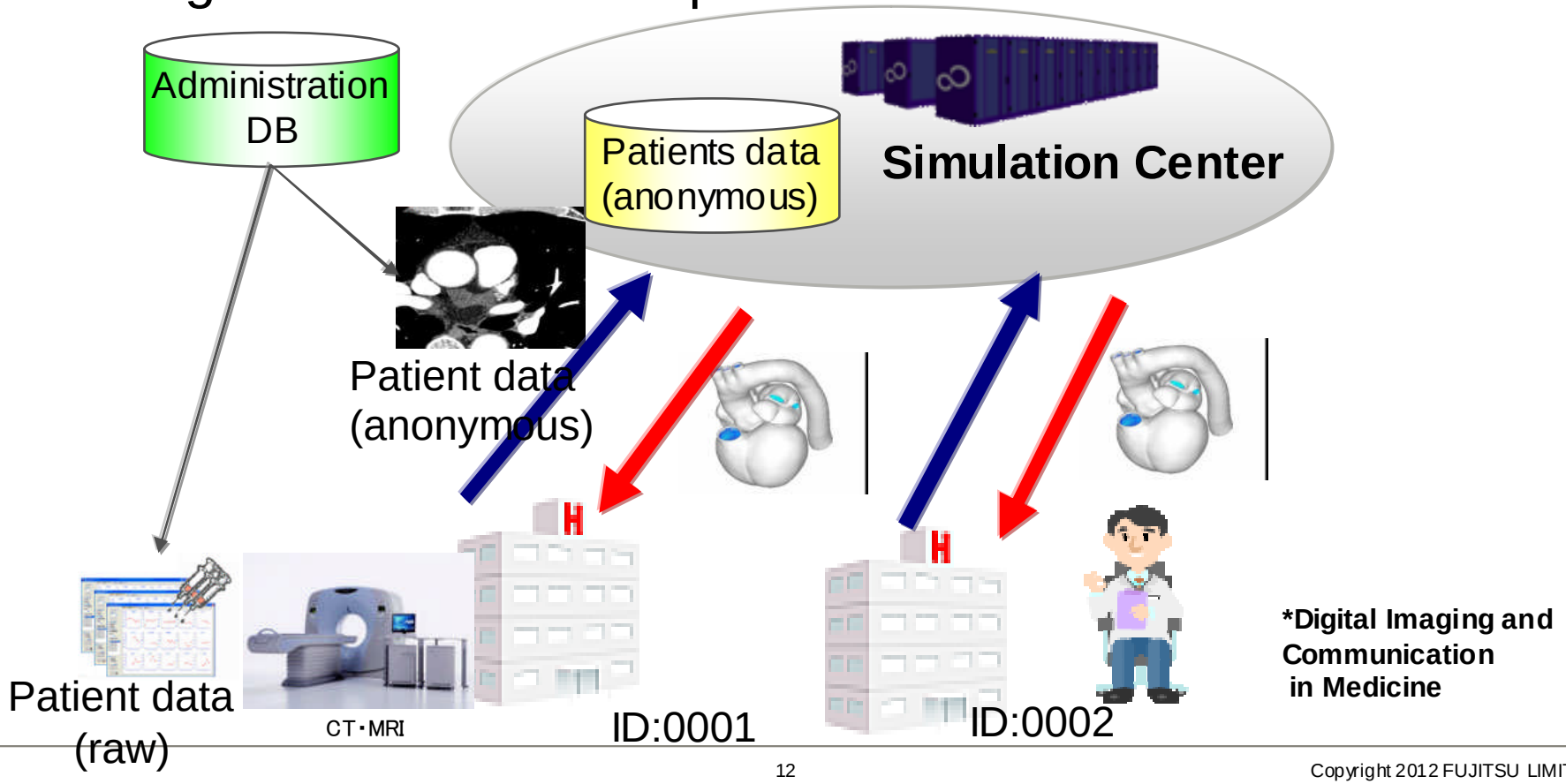
- To establish a security guide line to prevent the leaking of patients data and to implement it to all related system
- To establish a common data format to match an anonymized data with the corresponding patient raw data
- To integrate the localized specifications of DICOM* data



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Security Level and Universal QoS

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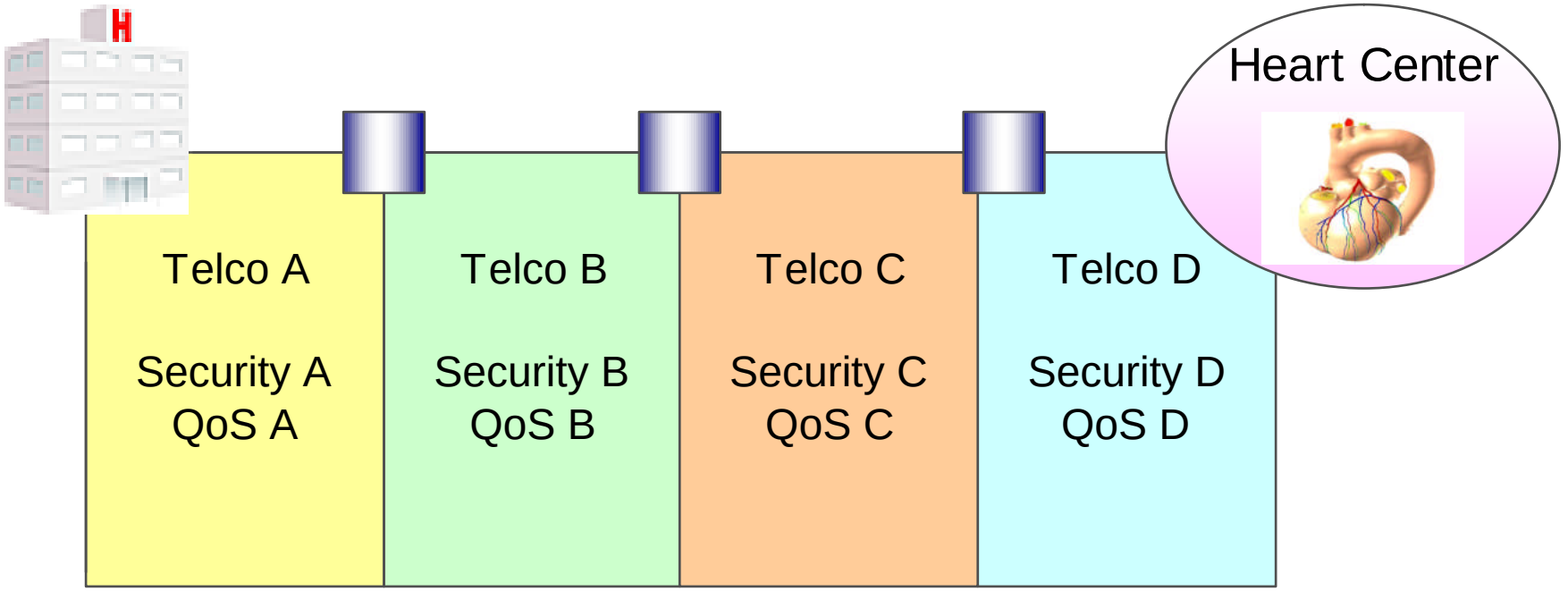
- Protection for DoS Attack
  - To guarantee Persistent Service and Emergency Response without any service interruption
- To guarantee the minimum security level and QoS for all Telcos



- International Leased Line Service across Several Telcos
  - Not Best Effort, but Band-guaranteed System with Priority Control

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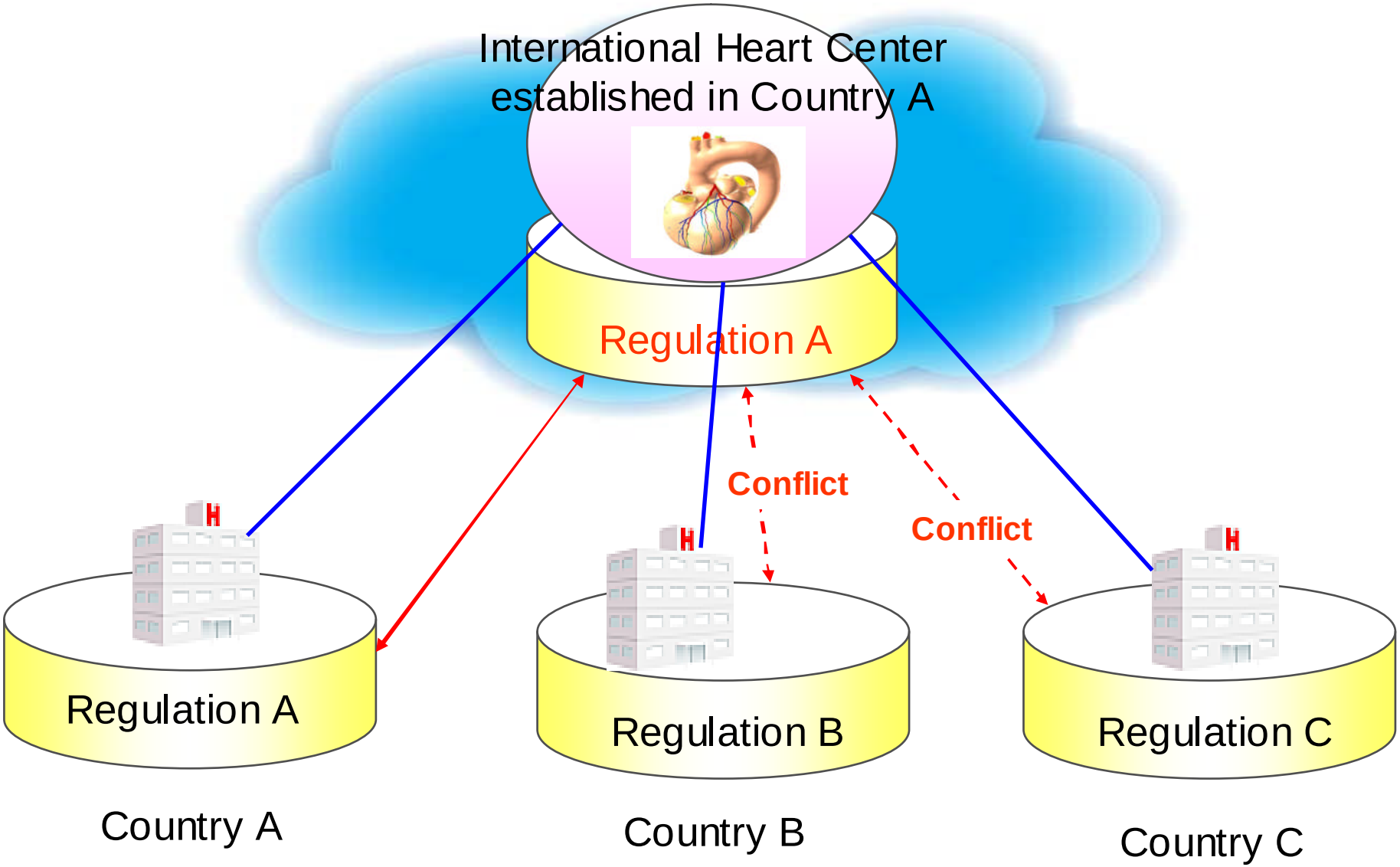
Which regulation should be applied?



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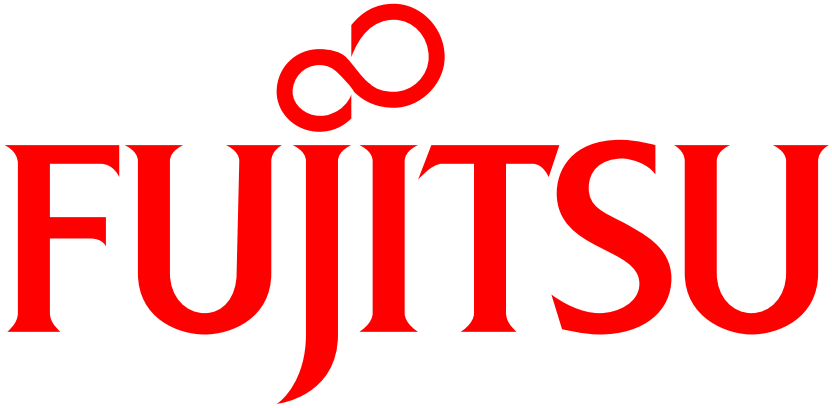

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