Computer-Assisted Mitral Valve Measurement Using an Optical Tracking System – a New Approach for Planning Mitral Valve Reconstruction. The Surgeon‘s Vision

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University Heidelberg - Germany

Transregional Collaborative Research Centre 125

Cognition-guided Surgery

Computer-Assisted Mitral Valve Measurement Using an Optical Tracking System – a New Approach for Planning Mitral Valve Reconstruction. The Surgeon‘s Vision

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Sandy Engelhardt, PhD
Div. Medical and Biological Informatics - Germany

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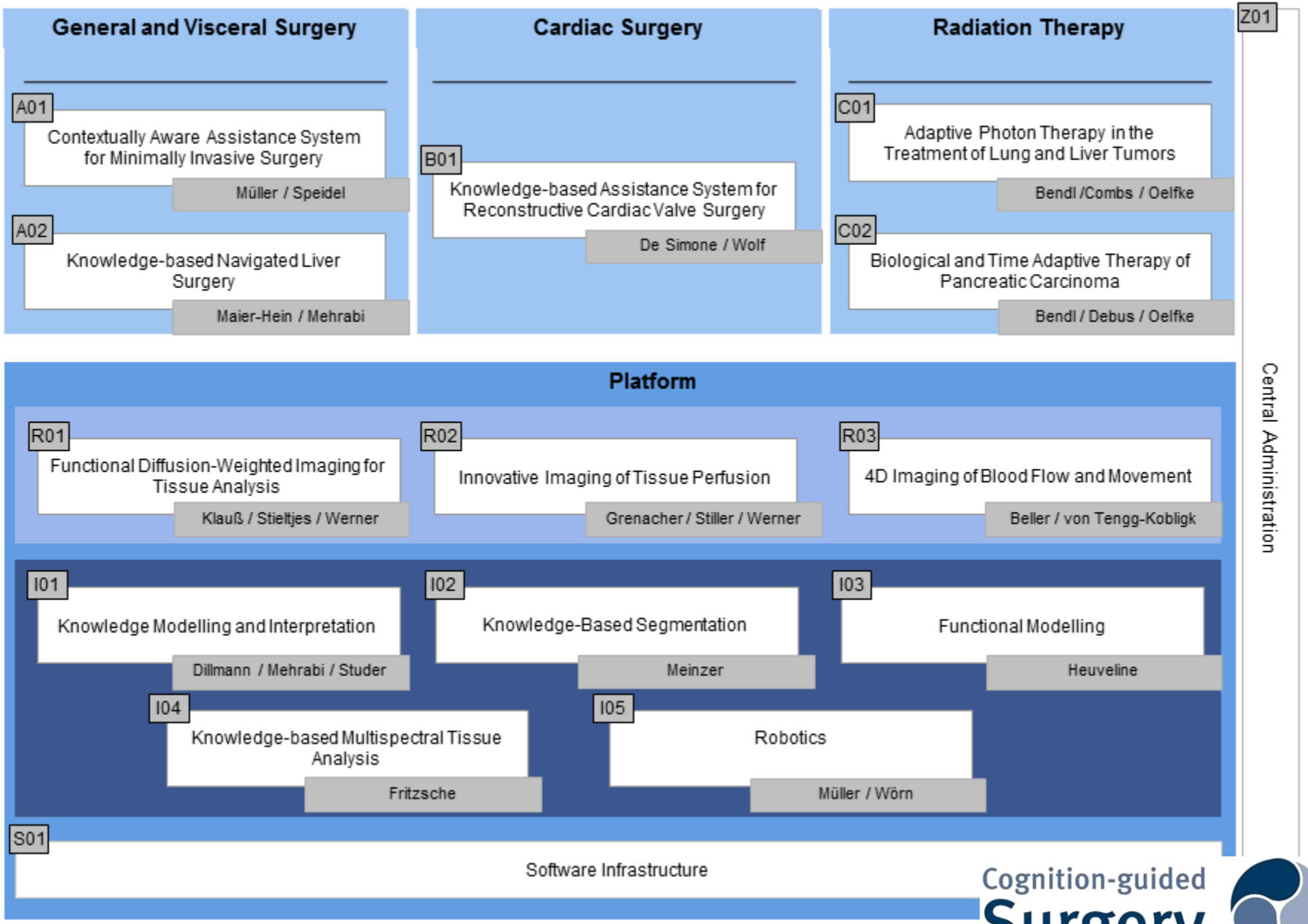
Cognition-guided Surgery

Cognition Guided Surgery – Projects Overview



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Cognition-guided Surgery

Computer-Assisted Mitral Valve Measurement Using an Optical Tracking System – a New Approach for Planning Mitral Valve Reconstruction. The Surgeon‘s Vision

Surgeon’s Dreams

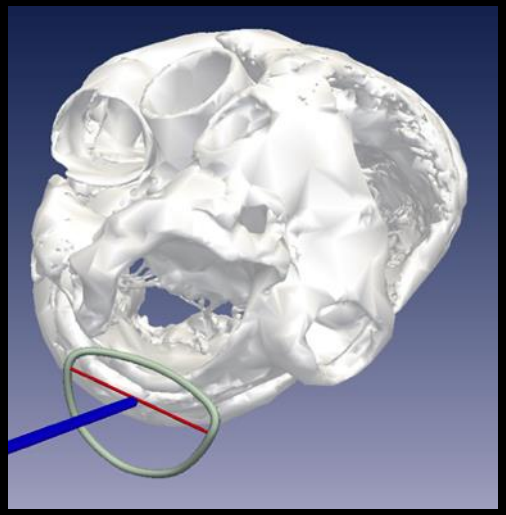
- Reconstructive Surgery (respect tissue and organs, not resect
- Assistance (knowledge, mechanical)
- Quantitative Approach (science/teaching)

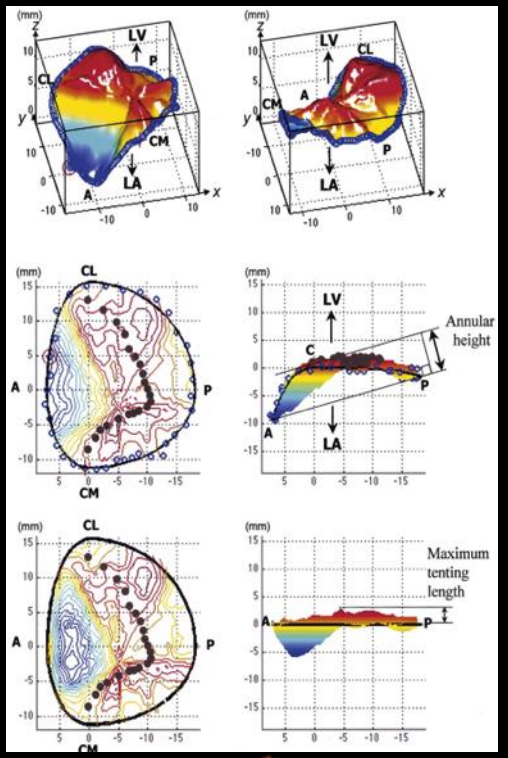
Vision of B01 in SFB 125 - Knowledge-based assistance system for reconstructive valve surgery

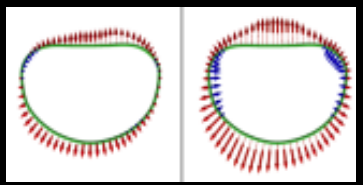
Pre-OP Planing

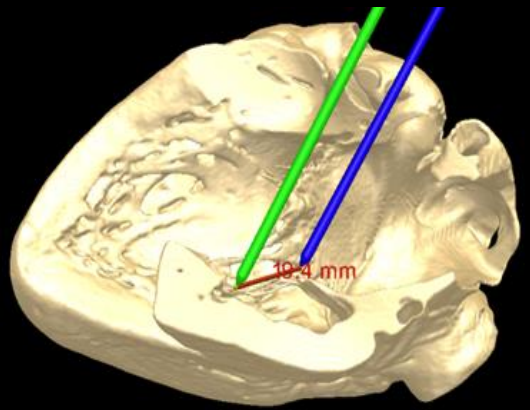
Intra-OP Decision Making

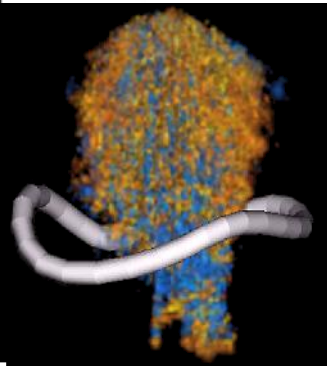
Post-OP Functional Results











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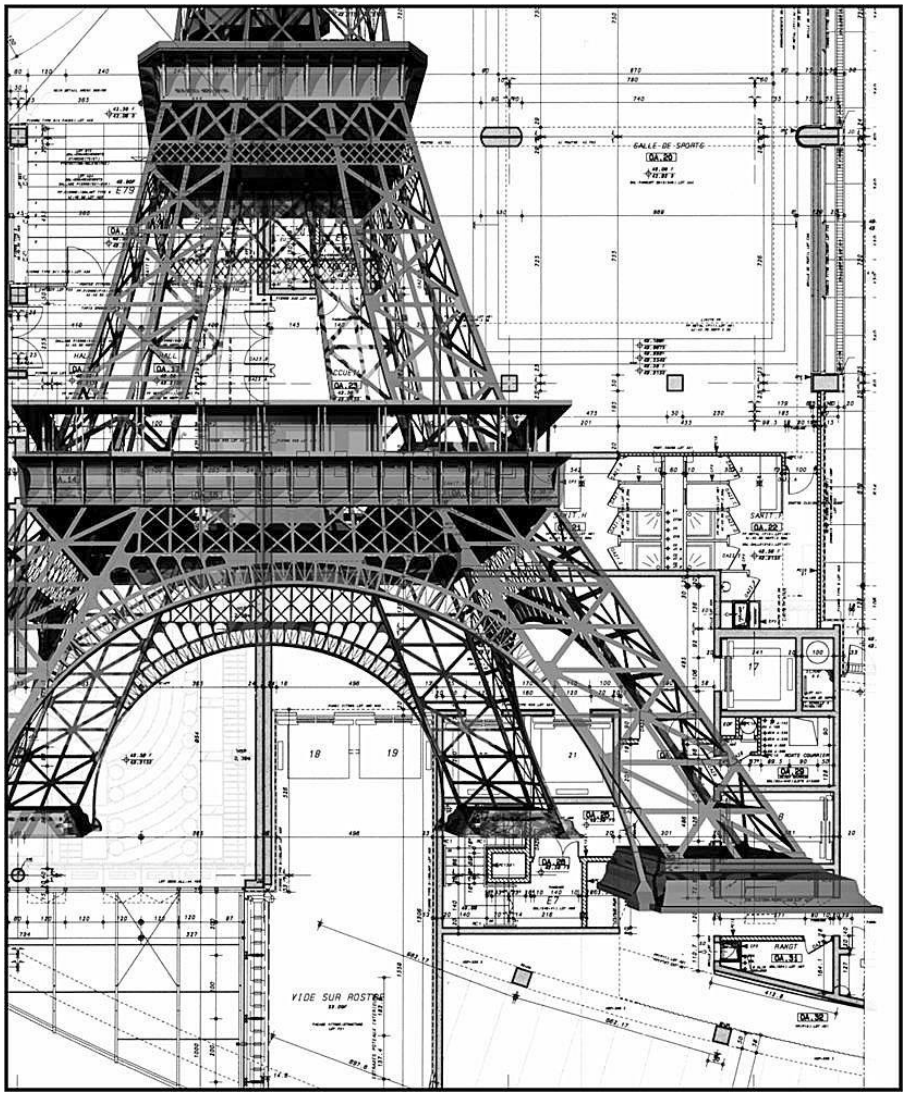
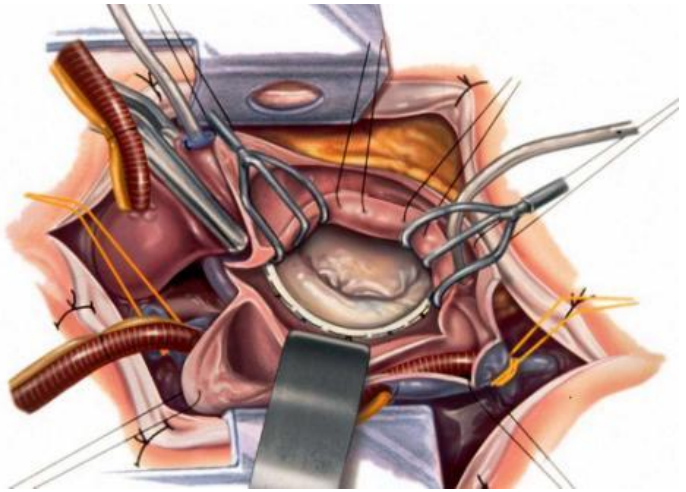
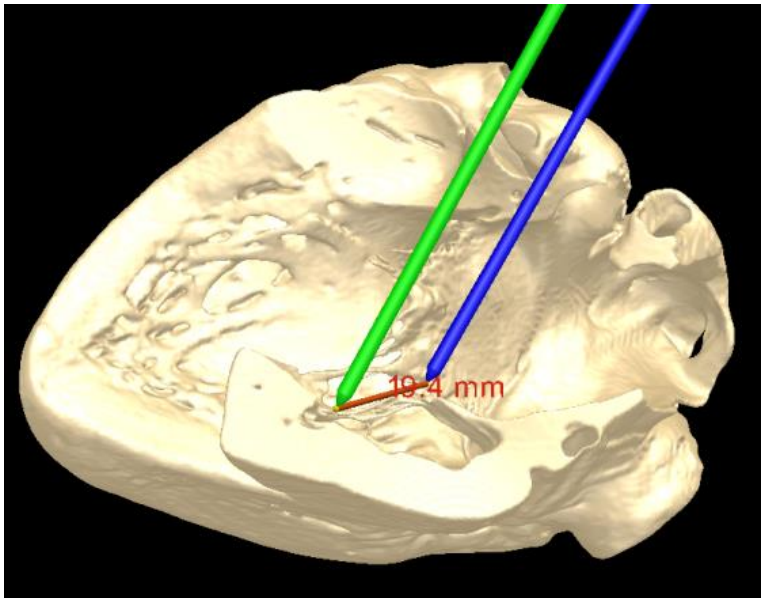
Mitral Valve Reconstruction – Quantitative Approach







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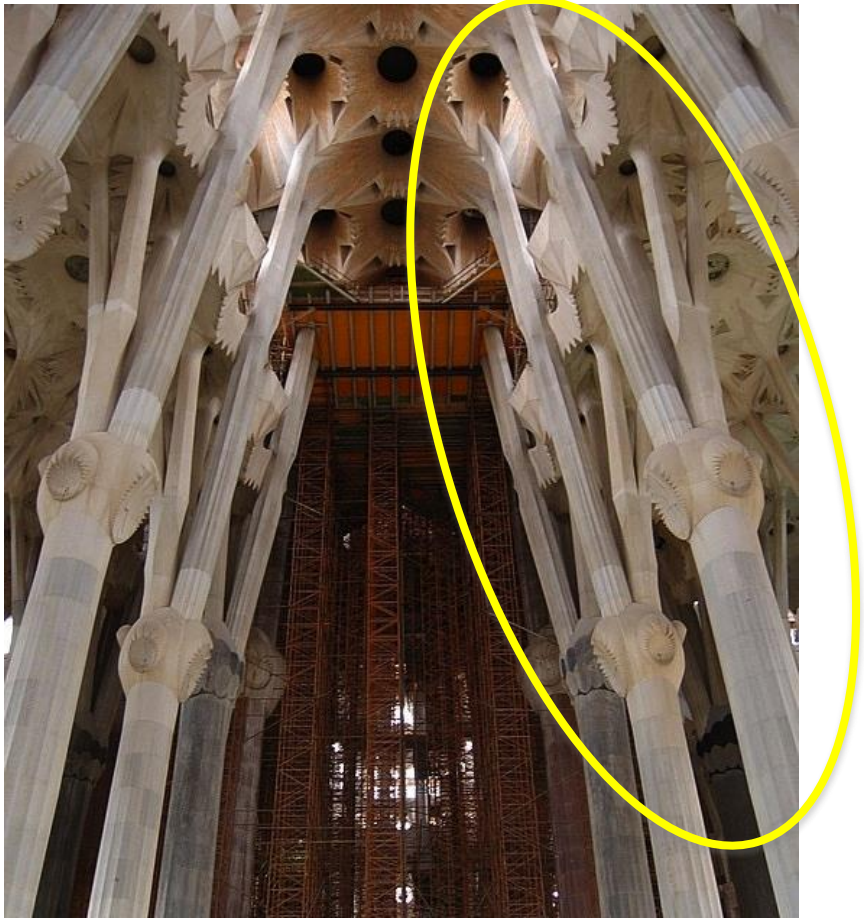
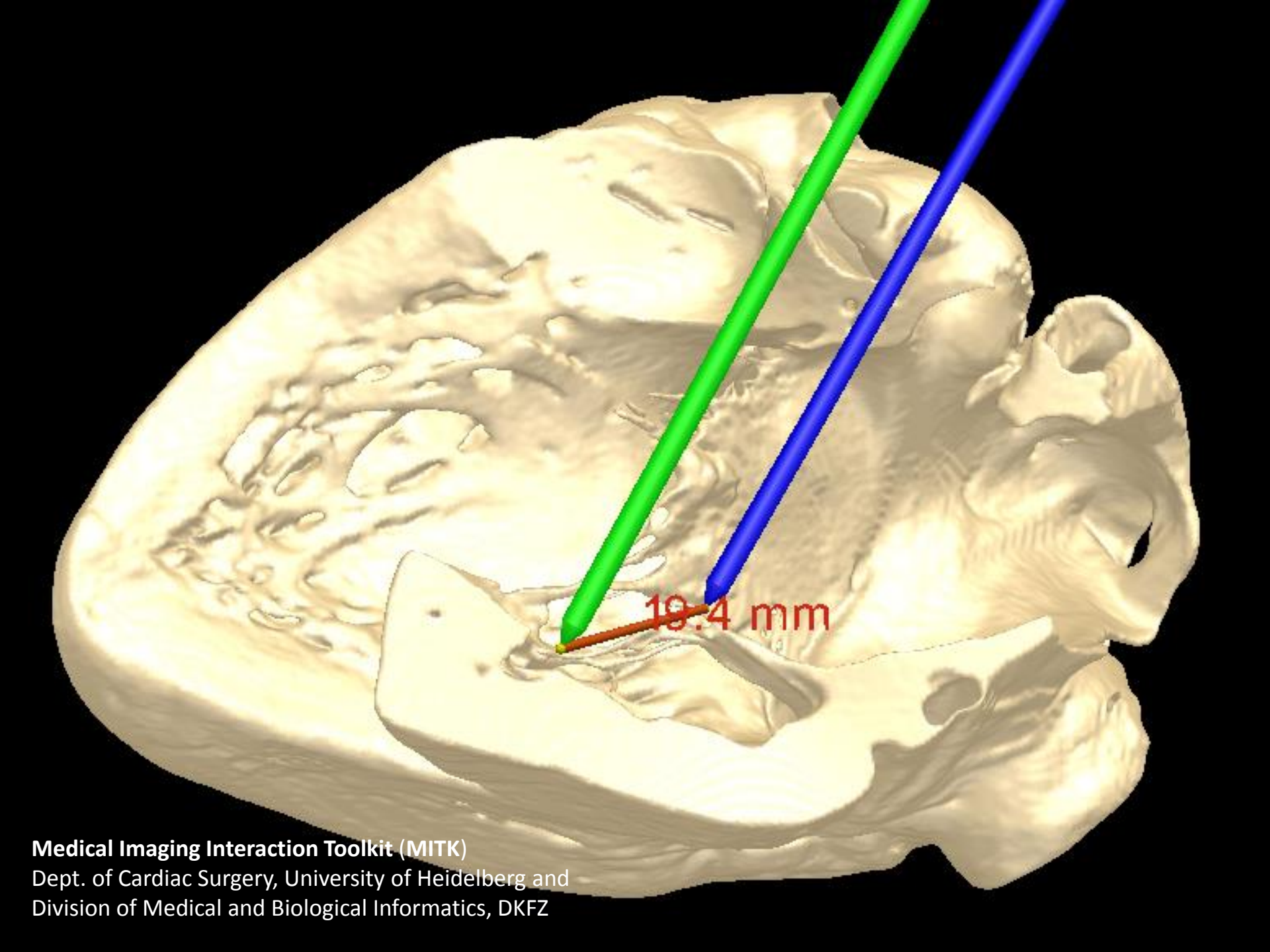
Mitral Valve Reconstruction – Quantitative Approach

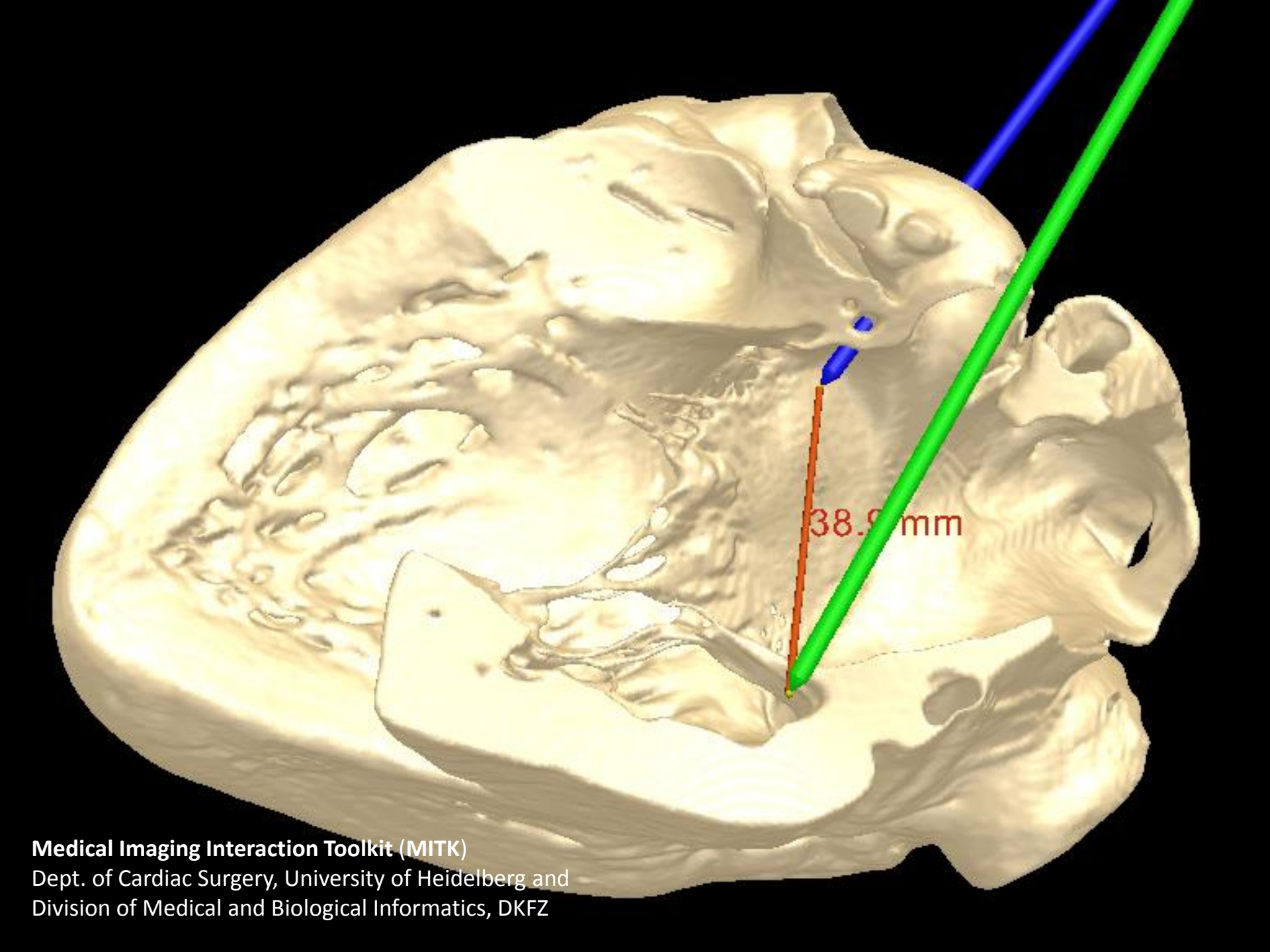
Mitral Valve



Gaudi - Sagrada Familia - Barcelona



Medical Imaging Interaction Toolkit (**MITK**)
Dept. of Cardiac Surgery, University of Heidelberg and
Division of Medical and Biological Informatics, DKFZ



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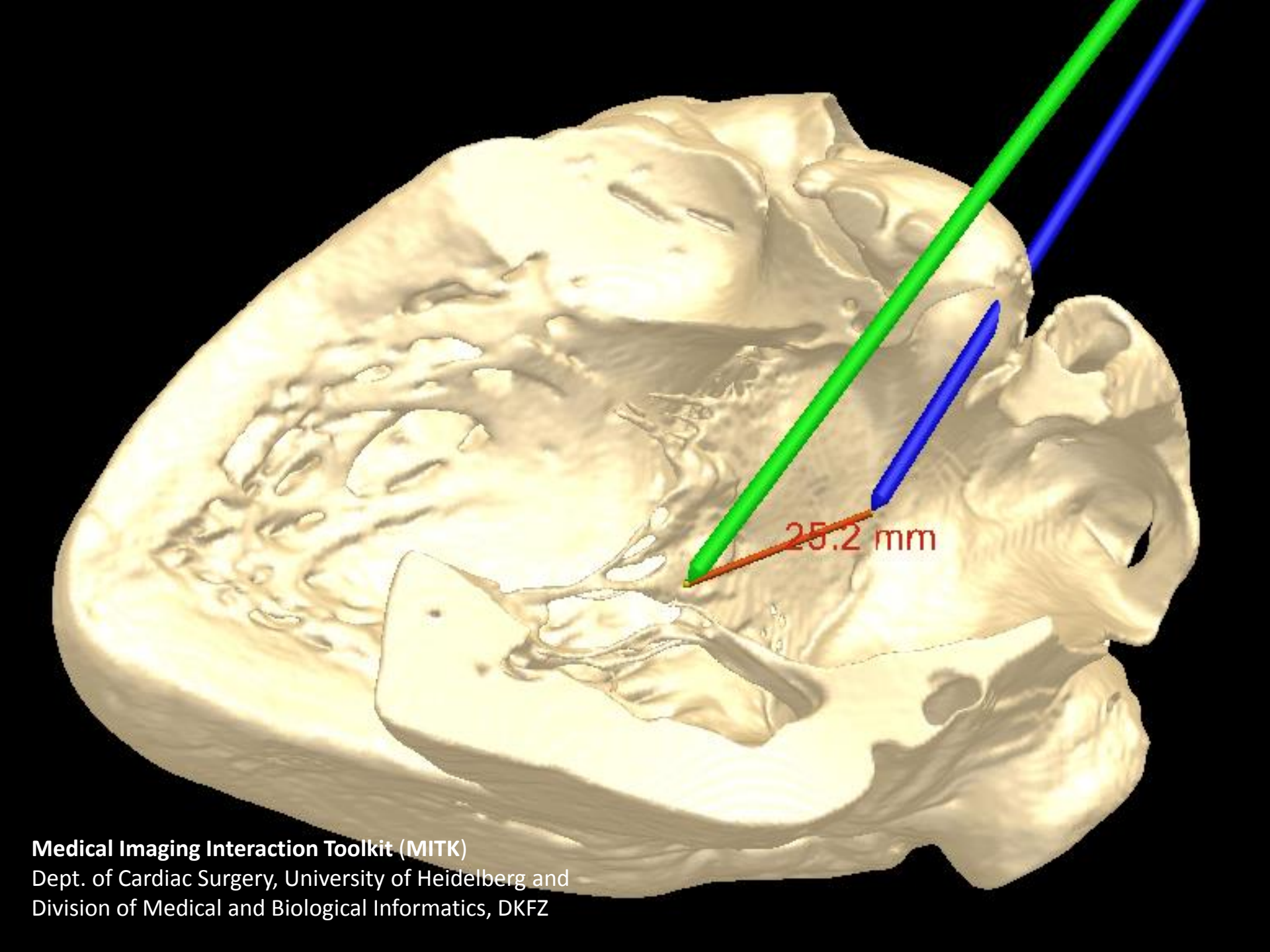

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Computer-Assisted Mitral Valve Measurement Using an Optical Tracking System – a New Approach for Planning Mitral Valve Reconstruction. The Surgeon‘s Vision

Surgeon’s Dreams

- Reconstructive Surgery
- Assistance
- Quantitative Approach (Science/Teaching)

"To measure is to know“

"If you can not measure it, you can not improve it“

"In physical science the first essential step in the direction of learning is to find methods for measuring some quality connected with it.

When you can measure what you are speaking about (and express it in numbers), you know something about it;

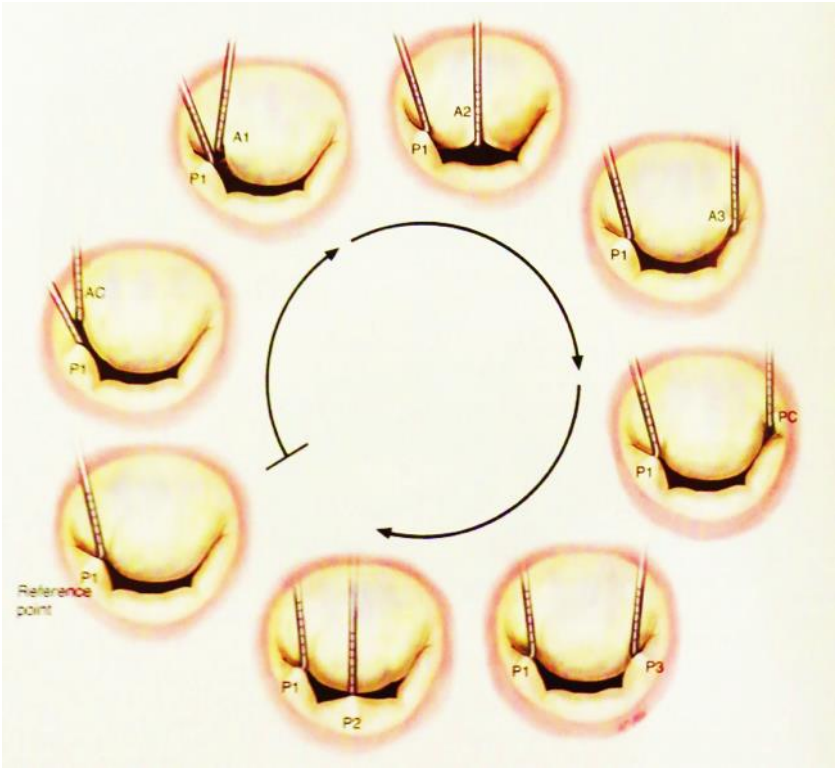
but when you cannot measure it (when you cannot express it in numbers), your knowledge is of an unsatisfactory kind.

[PLA, vol. 1, "Electrical Units of Measurement", 1883-05-03]

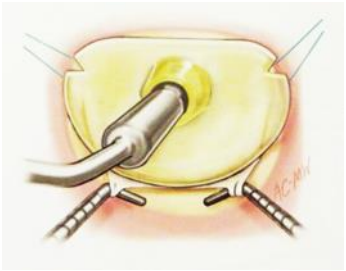
Lord Kelvin (Sir William Thomson)

Intraoperative Valve Analysis

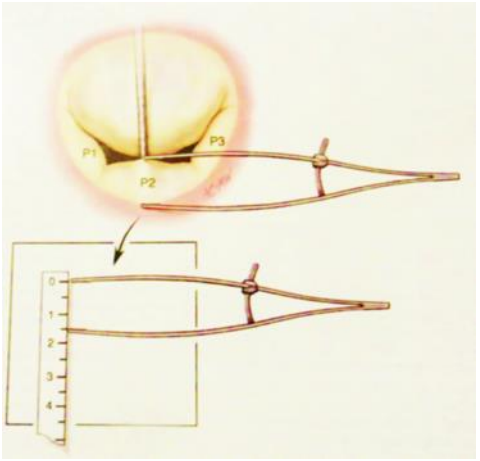
Subjective Visual Assessment of Anatomy by the Surgeon



functional analysis of leaflet segments with nerve hooks



anterior leaflet (sizer)

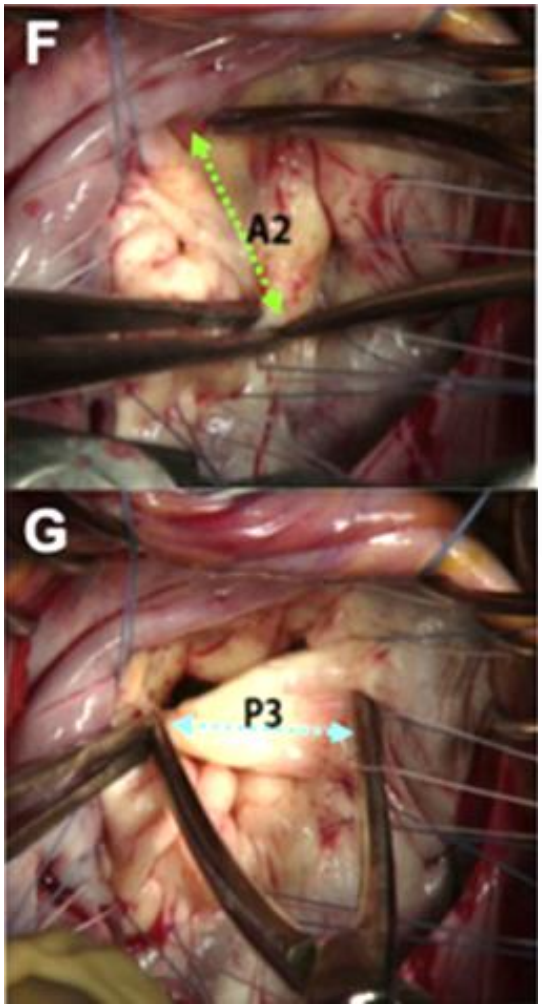


posterior leaflet (forceps)

Mohr-Caliper to measure chordae length

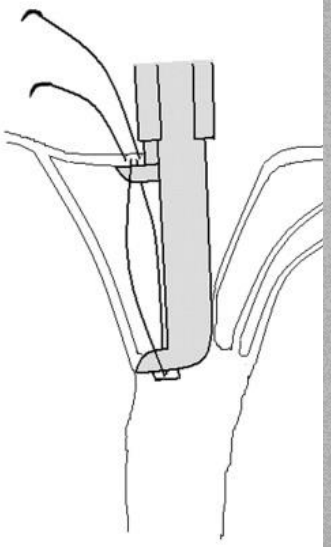
- **Problems:** variability of methods, poor reproducibility, no data to record for learning and teaching purposes

Intraoperative Valve Analysis



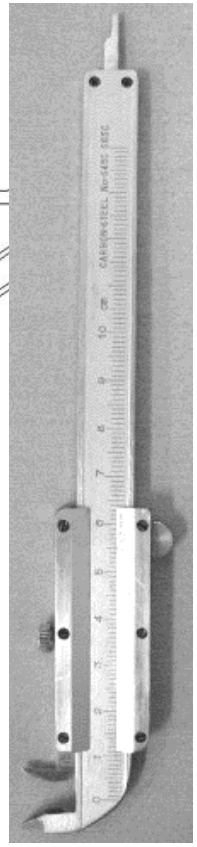
[1]

Kelly clamp



Gold Standard

rigid/flexible metric ruler



[2]

calipers

[1] Biaggi, P., Jedrzkiewicz, S., Gruner, C., et al., 2012. Quantification of Mitral Valve Anatomy by Three-Dimensional Transesophageal Echocardiography in Mitral Valve Prolapse Predicts Surgical Anatomy and the Complexity of Mitral Valve Repair. Journal of the American Society of Echocardiography 25, 758–765.
[2] Doi, A., Iida, H., et al. , 2009. Intracardiac Calipers for Artificial Chordae Replacement in Mitral Valve Repair. The Annals of Thoracic Surgery 87, 326–328.

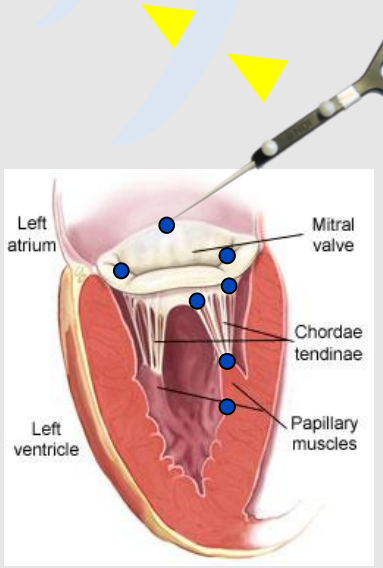
Computer-Assisted Mitral Valve Analysis (1)

Optical Tracking

Intraoperative system

NDI Polaris

Viewstation



measurement (tracking)

Workstation

Dept. of Cardiac Surgery, University of Heidelberg and
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Methods: Computer-Assisted Valve Analysis – Optical Tracking

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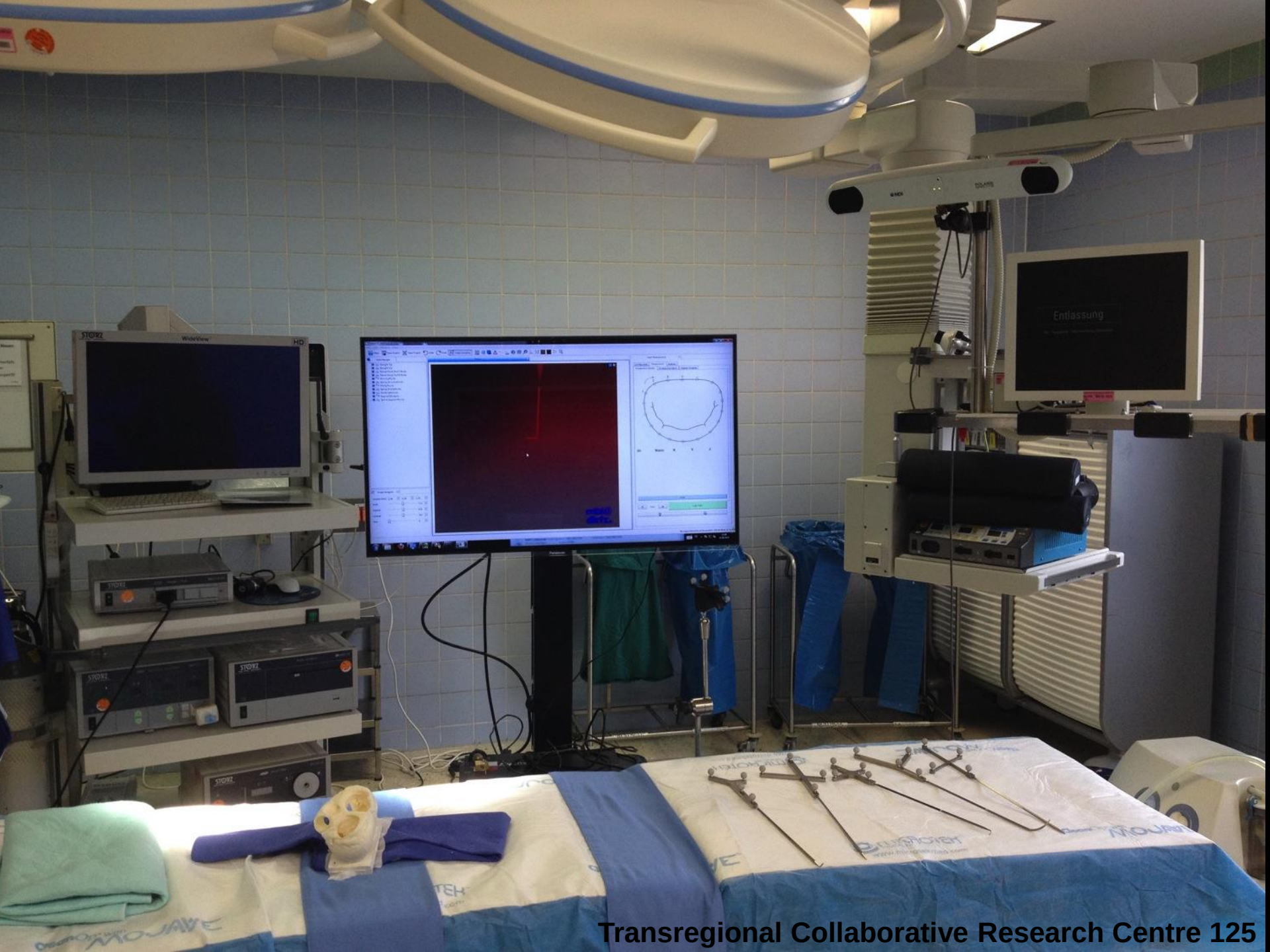

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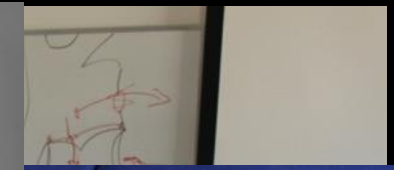
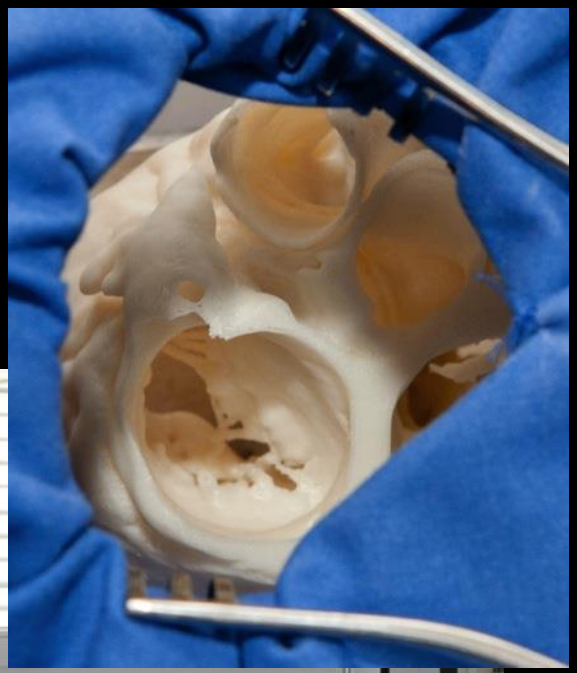
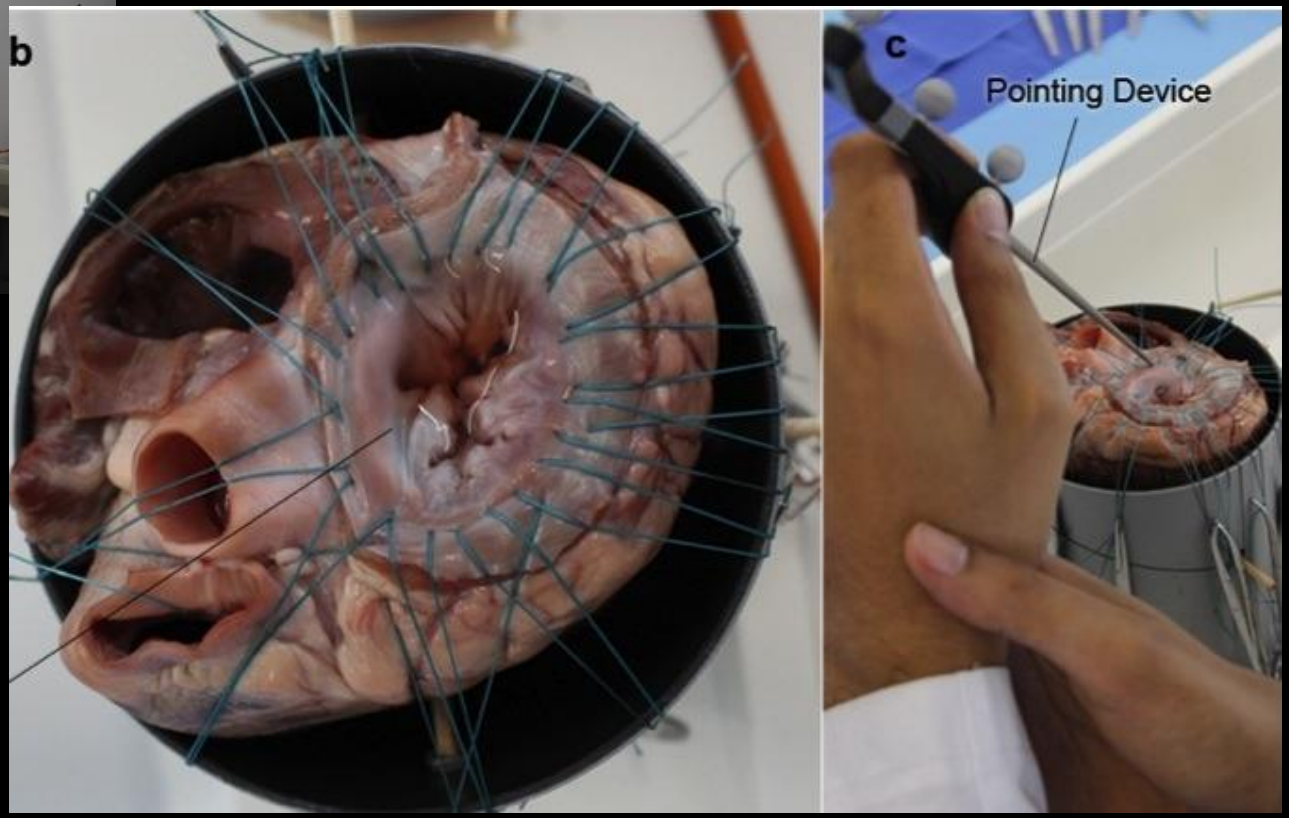
Repeated Measurements on a Rapid Prototyping Heart Model

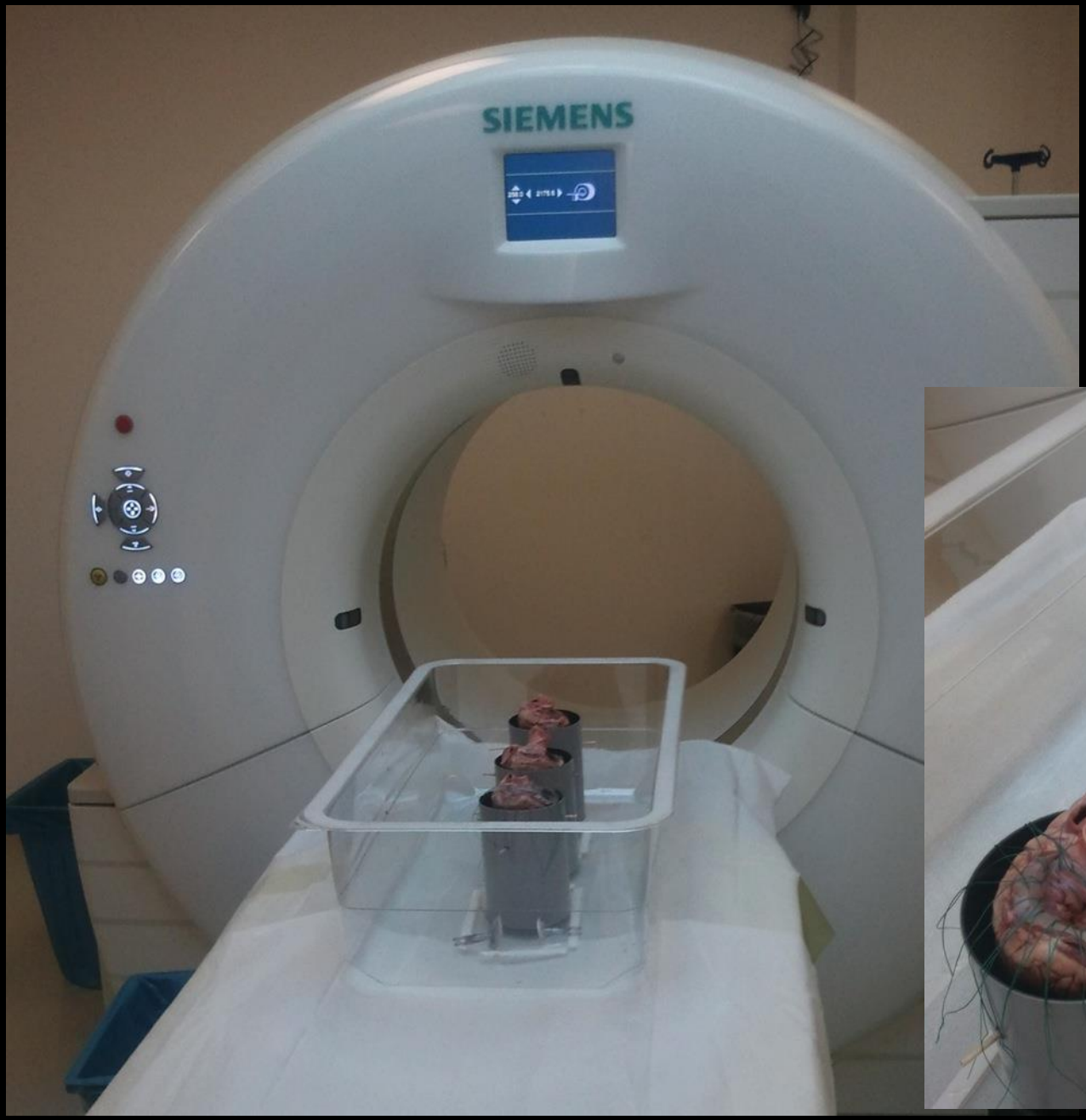




Measurements on Swine Hearts



CT-Scan



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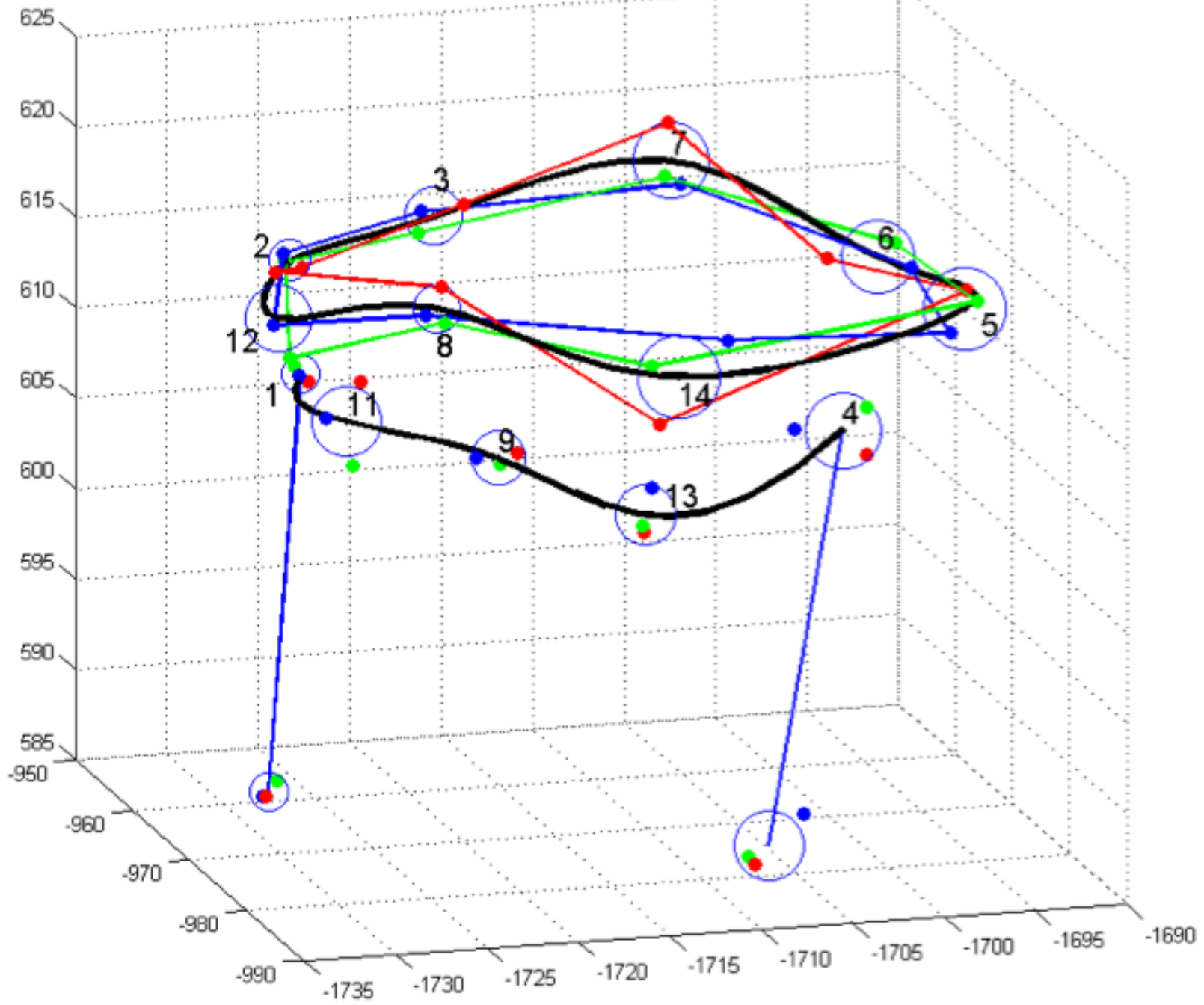
Geometry of Porcine Hearts – Repeated Meaurements (mean ± SD)

		Longitudinal annulus diameter (mm)	Septolateral annulus diameter (mm)	Anterolateral distance PM (mm)	Posteromedial distance PM (mm)	Coaption Line (mm)
Expert 1	Versuch 1	32,85	26,89	8,79	11,22	41,30
	Versuch 2	33,12	26,10	8,61	13,25	39,67
	Versuch 3	31,80	28,15	4,39	10,63	34,37
	Mean	**32,59**	**27,05**	**7,26**	**11,70**	**38,45**
	SD	**0,70**	**1,03**	**2,49**	**1,37**	**3,62**
Expert 2	Versuch 1	29,05	25,22	9,82	10,65	26,42
	Versuch 2	30,64	26,84	15,82	13,37	22,04
	Versuch 3	32,90	23,82	13,10	12,88	27,40
	Mean	**30,86**	**25,30**	**12,91**	**12,30**	**25,29**
	SD	**1,93**	**1,51**	**3,00**	**1,45**	**2,85**
Expert 3	Versuch 1	38,10	25,55	6,50	15,99	34,33
	Versuch 2	31,45	22,85	7,28	16,68	27,26
	Versuch 3	34,21	23,67	7,91	16,39	25,78
	Mean	**34,59**	**24,02**	**7,23**	**16,35**	**29,12**
	SD	**3,34**	**1,38**	**0,71**	**0,35**	**4,57**
Expert 4	Versuch 1	28,32	21,55	12,38	10,66	23,89
	Versuch 2	29,31	18,61	7,02	9,11	22,25
	Versuch 3	28,21	18,89	8,43	10,52	24,03
	Mean	**28,61**	**19,68**	**9,28**	**10,10**	**23,39**
	SD	**0,60**	**1,62**	**2,78**	**0,86**	**0,99**
Mean:		**31,66**	**24,01**	**9,17**	**12,61**	**29,06**
95% -CI		**1,81**	**1,96**	**2,03**	**1,64**	**4,24**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620
615
610
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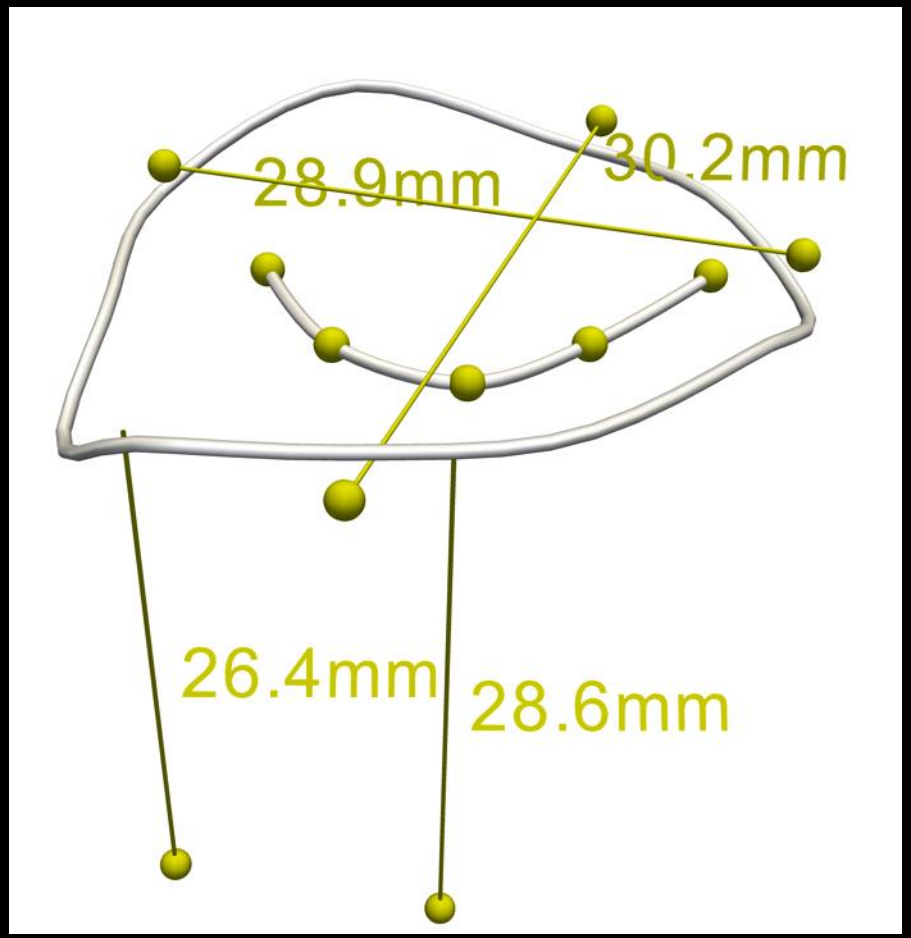
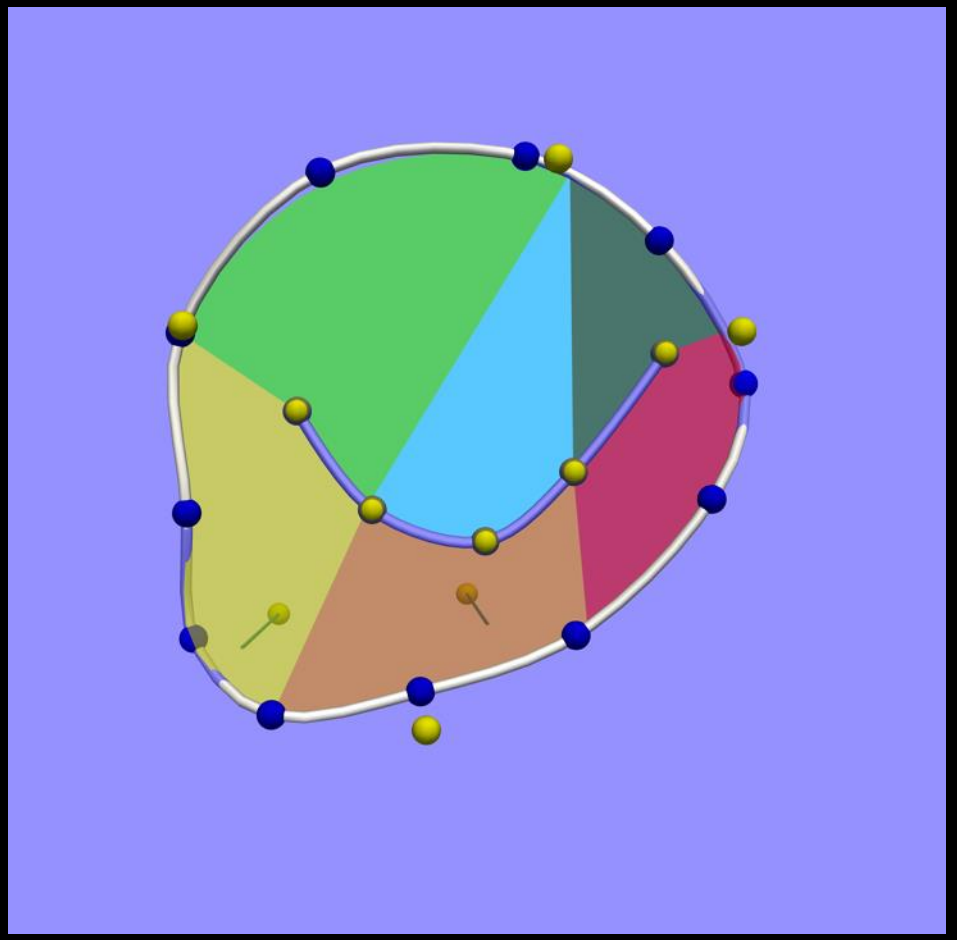

28.9mm
30.2mm
26.4mm
28.6mm




NDI Polaris
Viewstation
Table
Tracker
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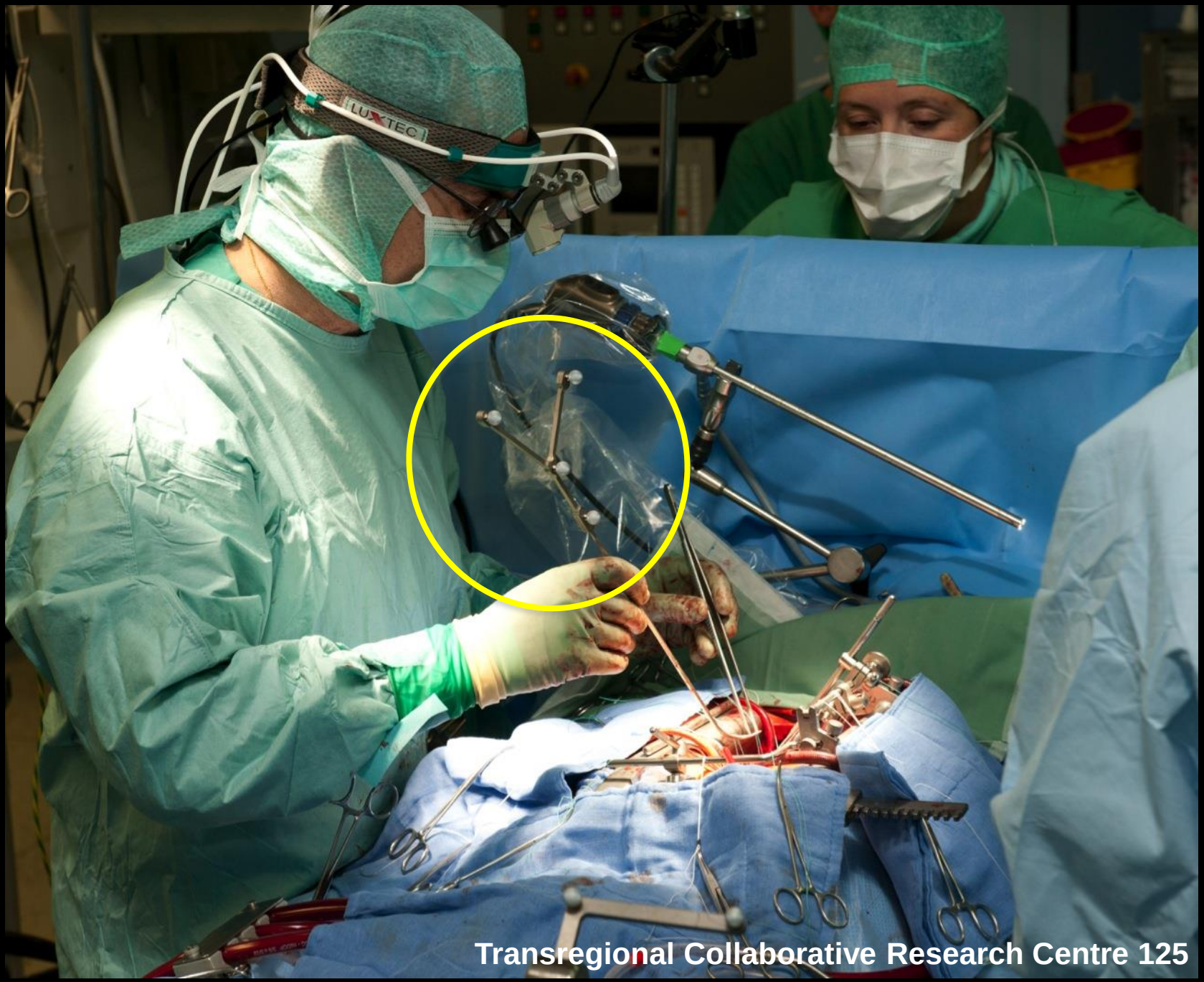
LUXTEC
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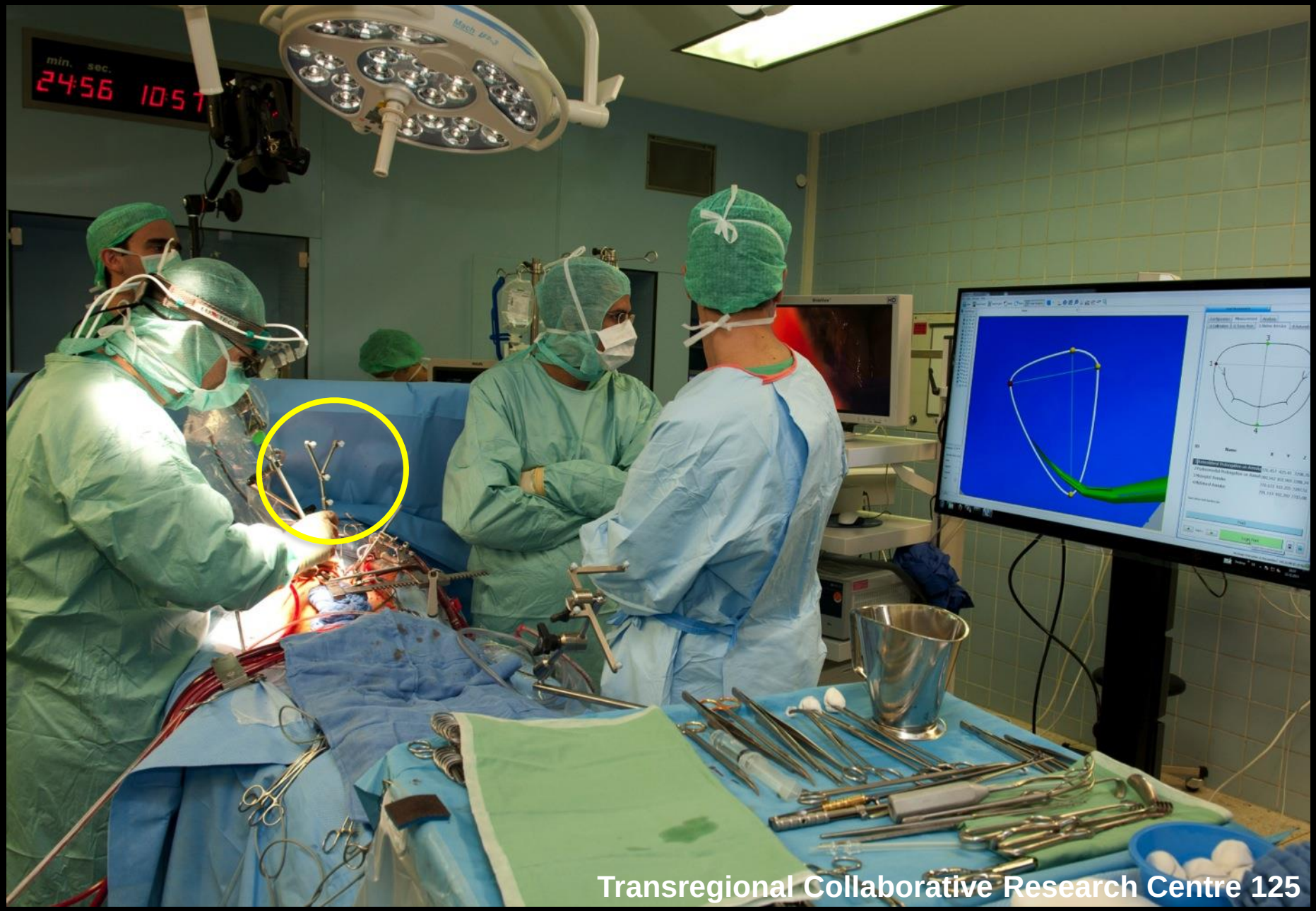
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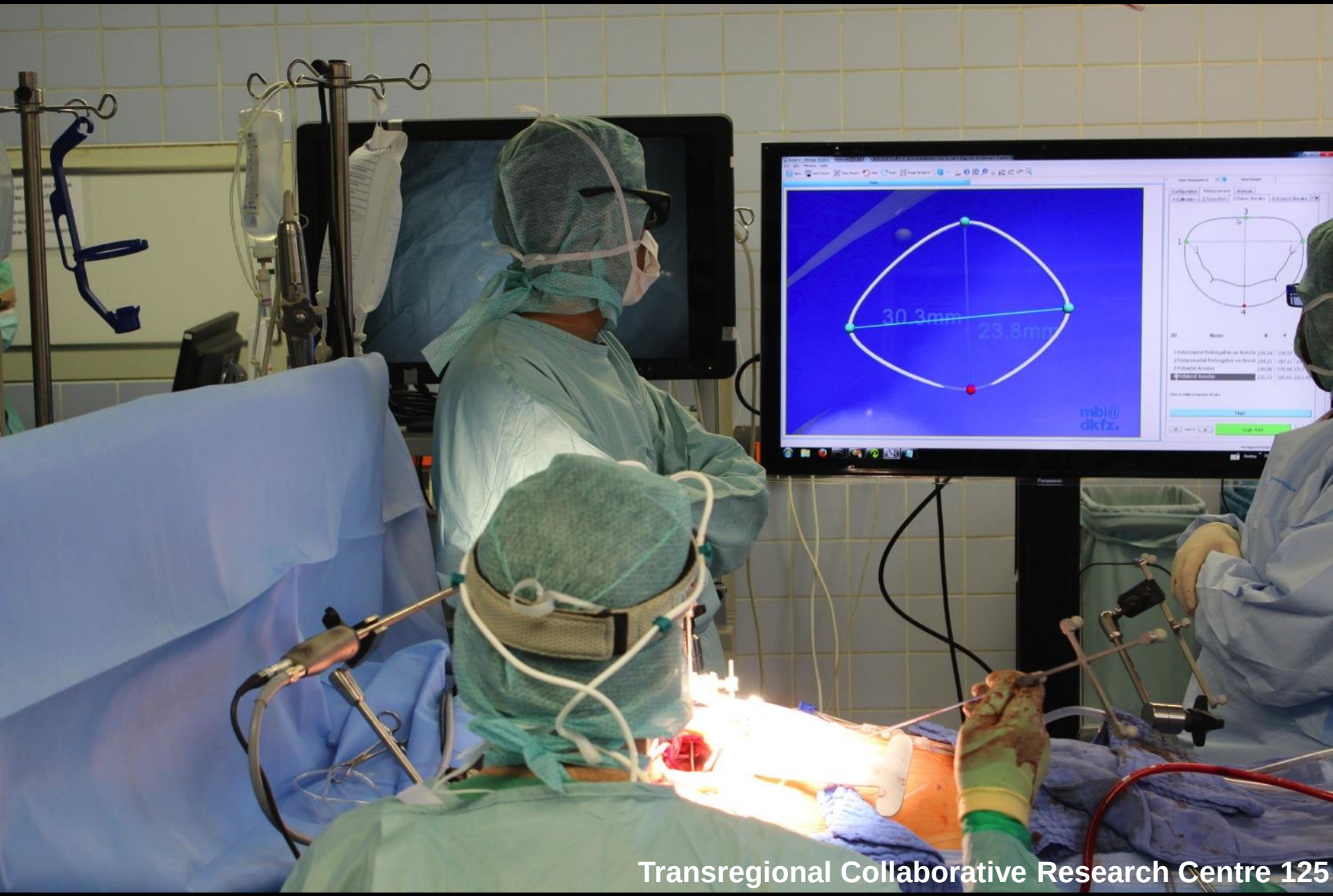

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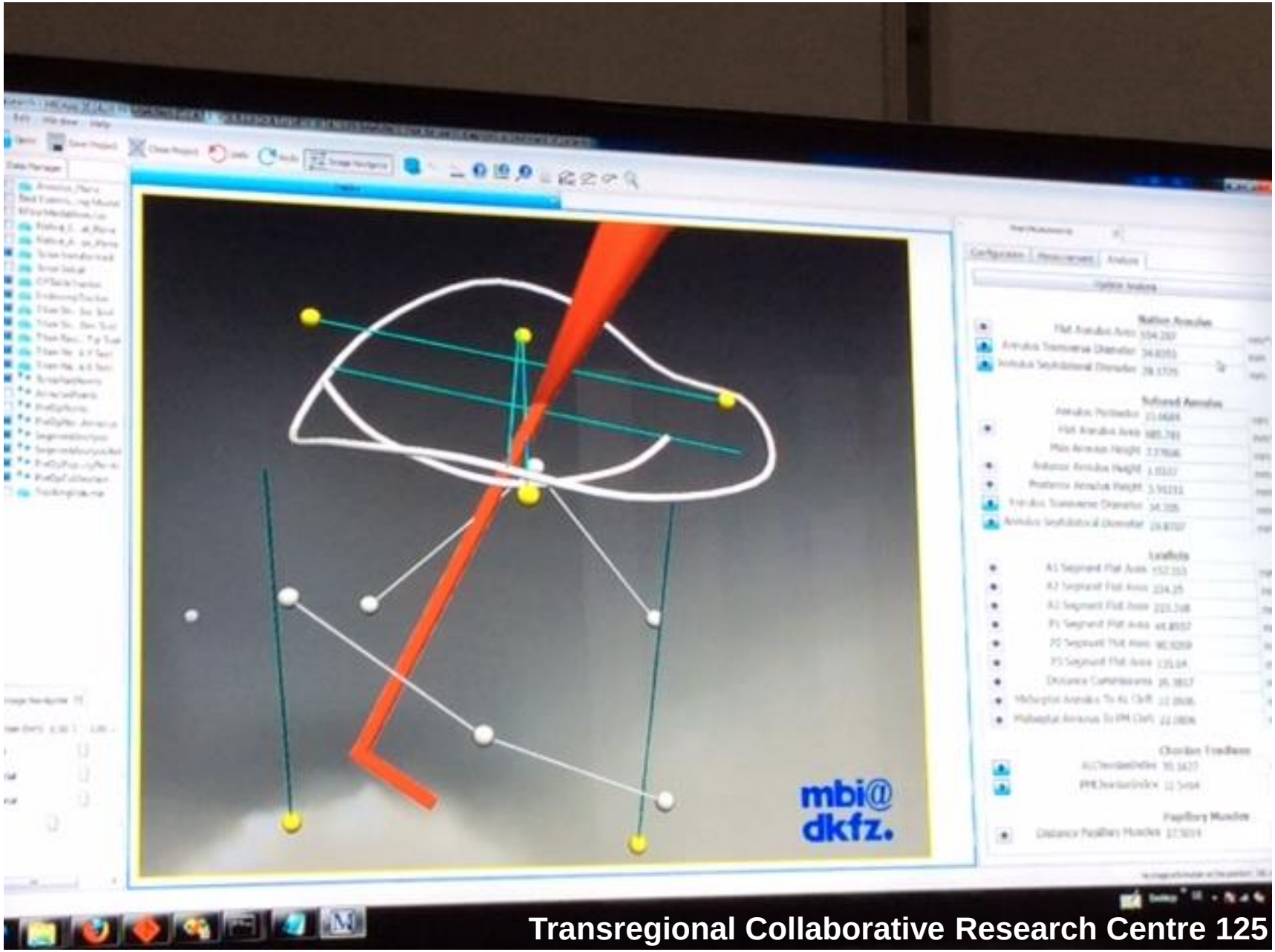
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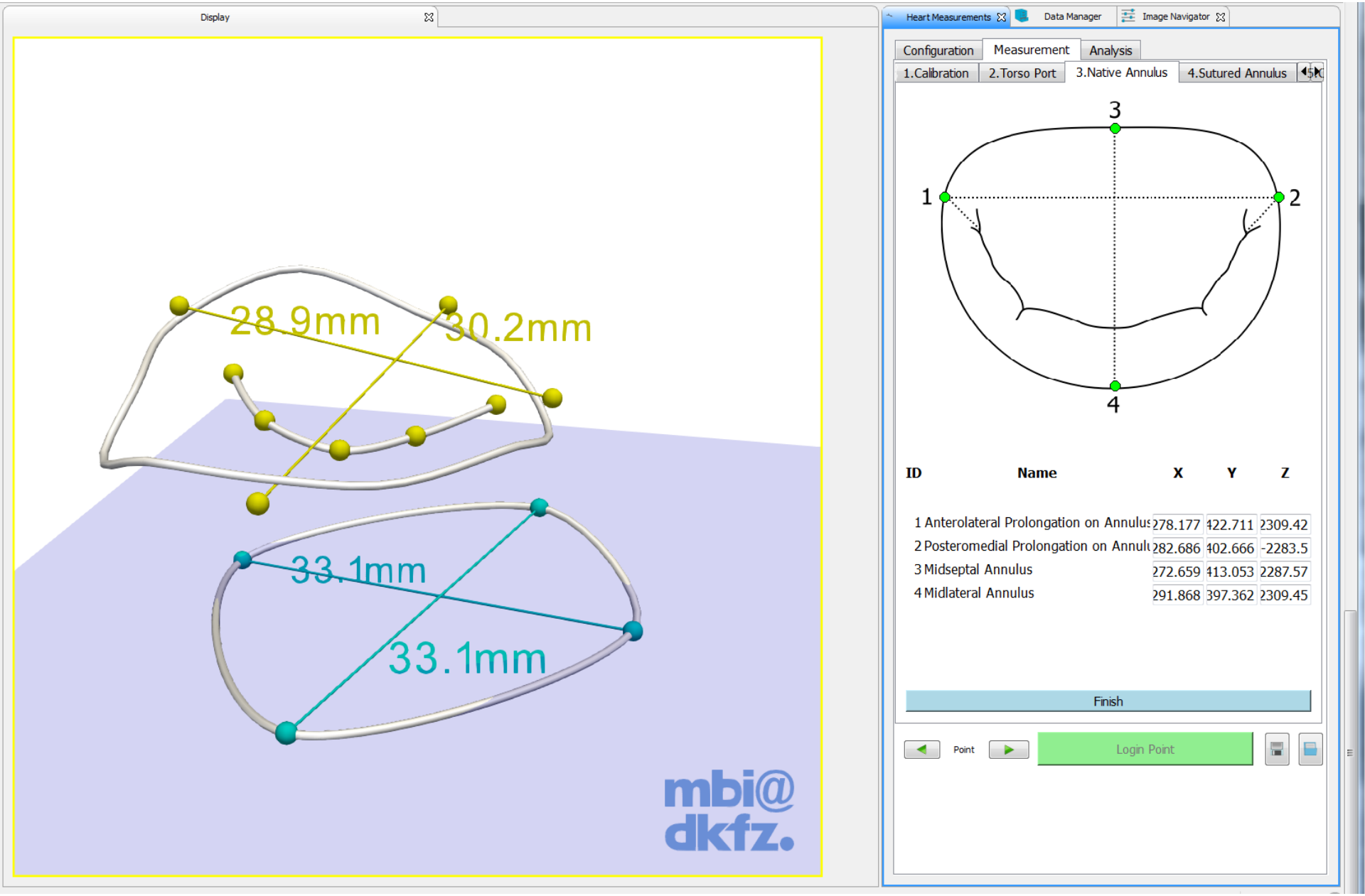

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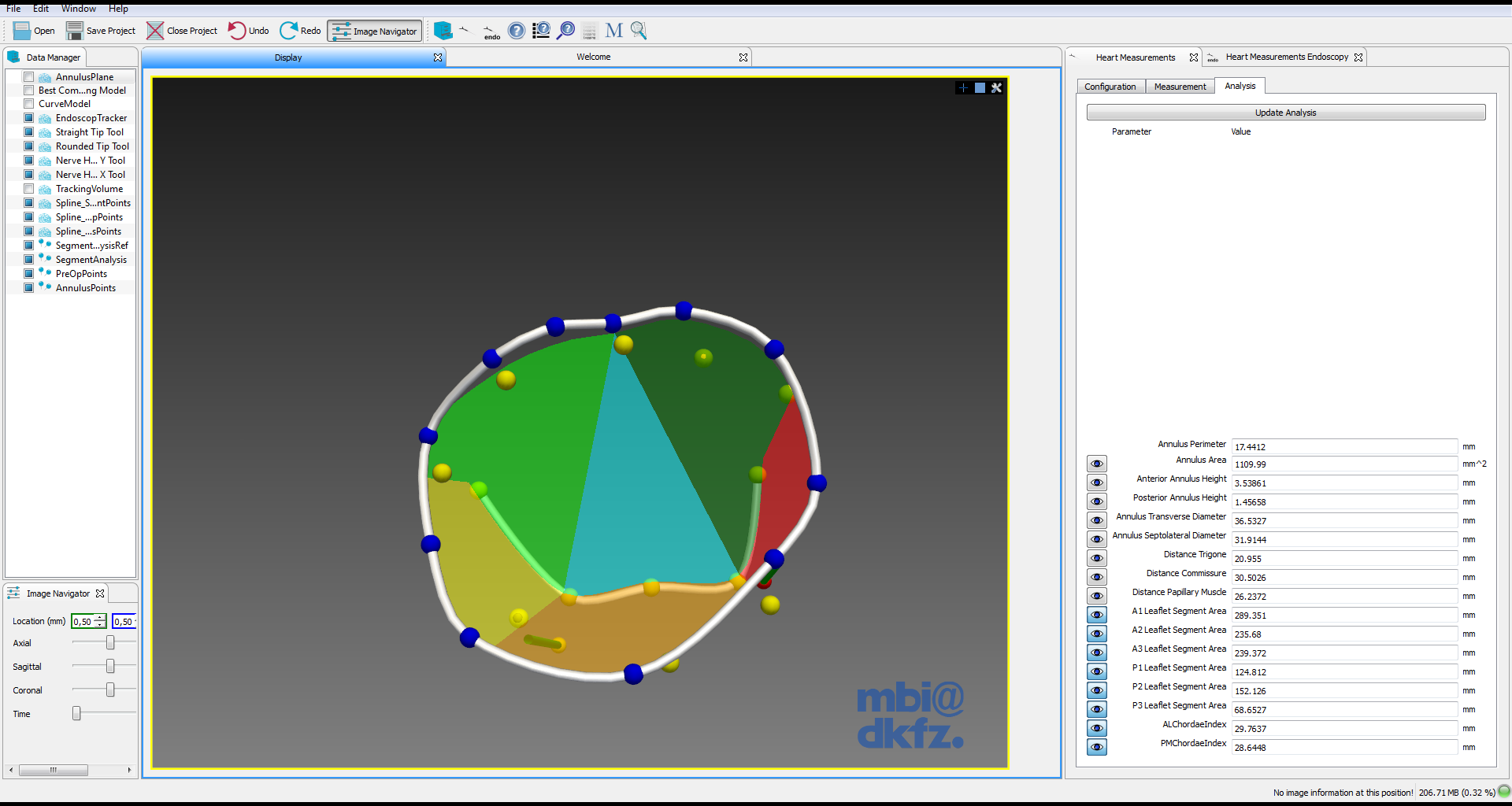

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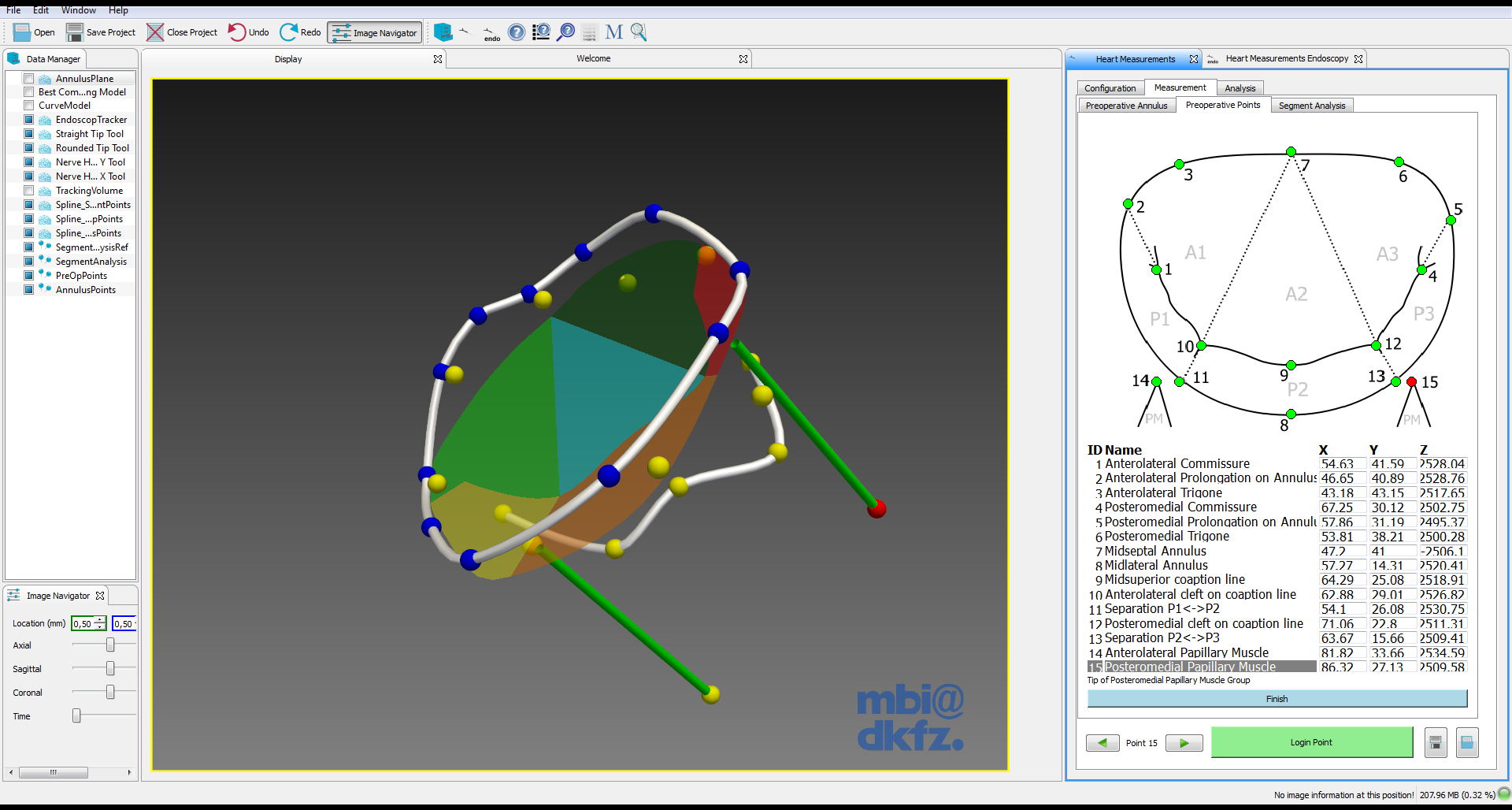

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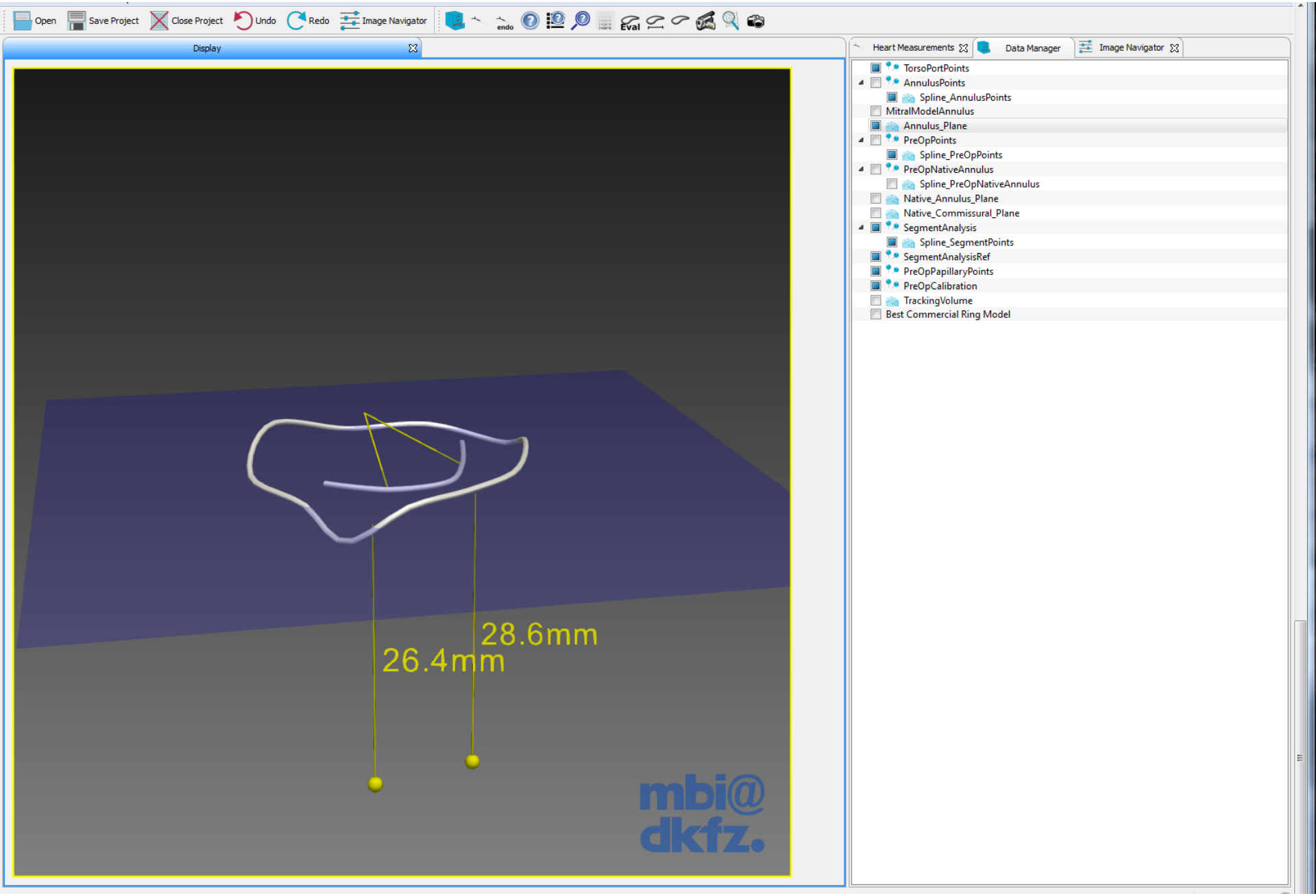

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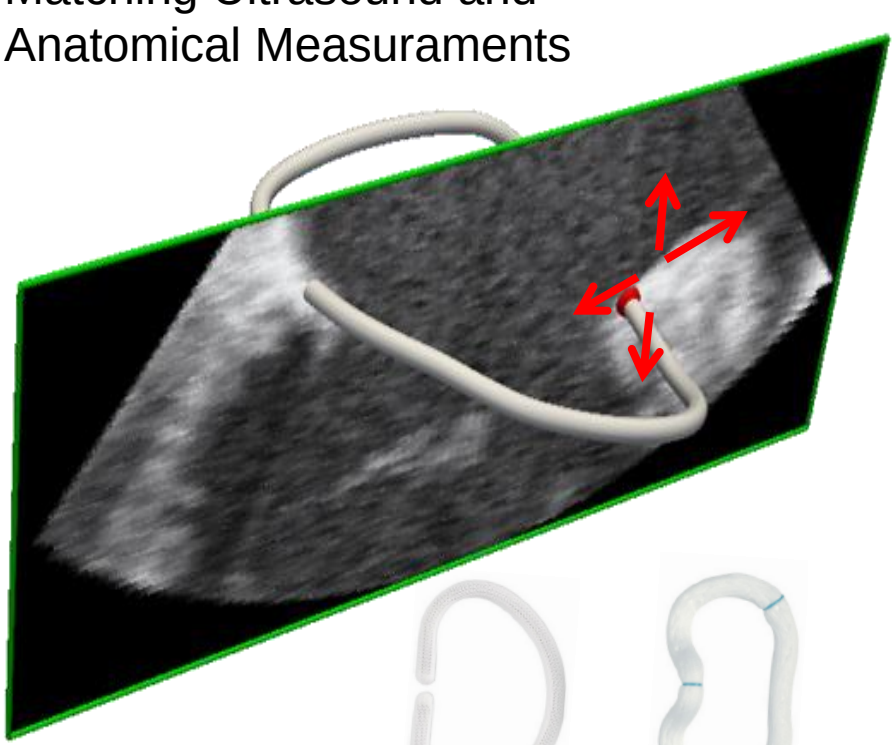
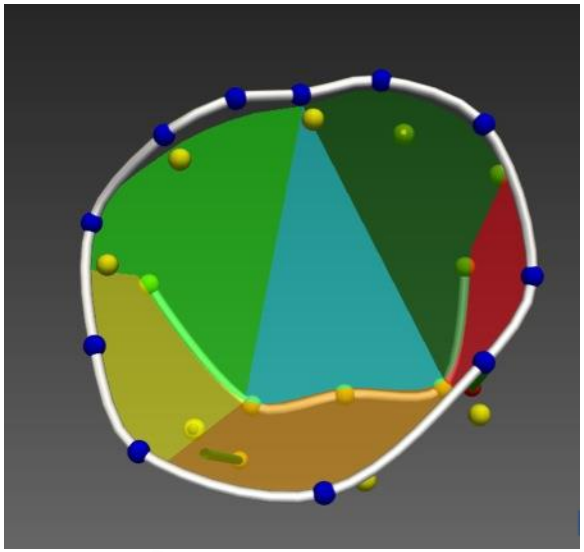
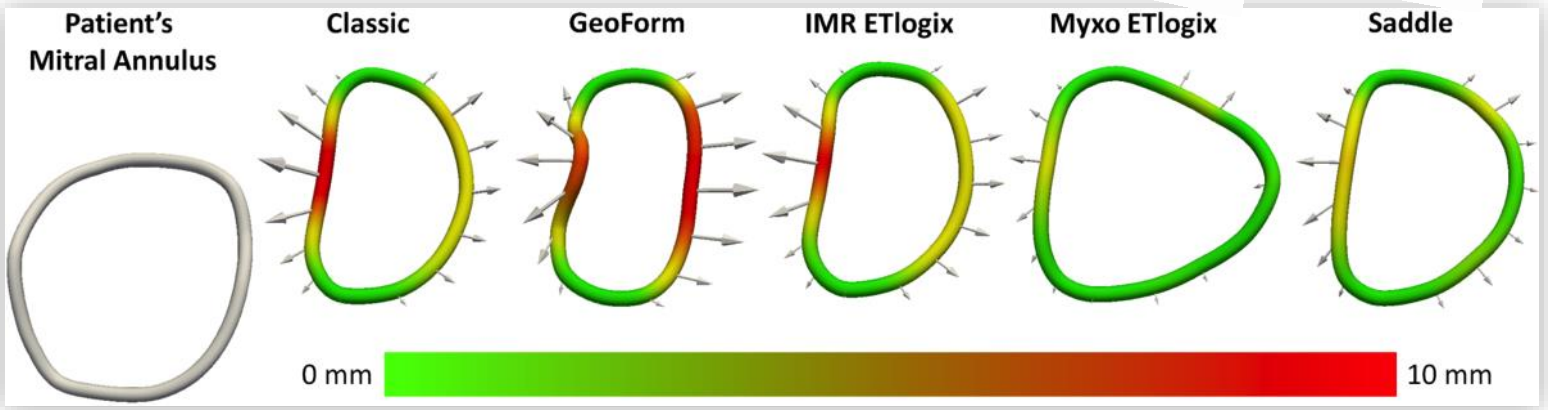
Matching Ultrasound and Anatomical Measurements







Graser, De Simone et al.; Computer Assisted Annuloplasty – DGTHG 2014 - SJM Award

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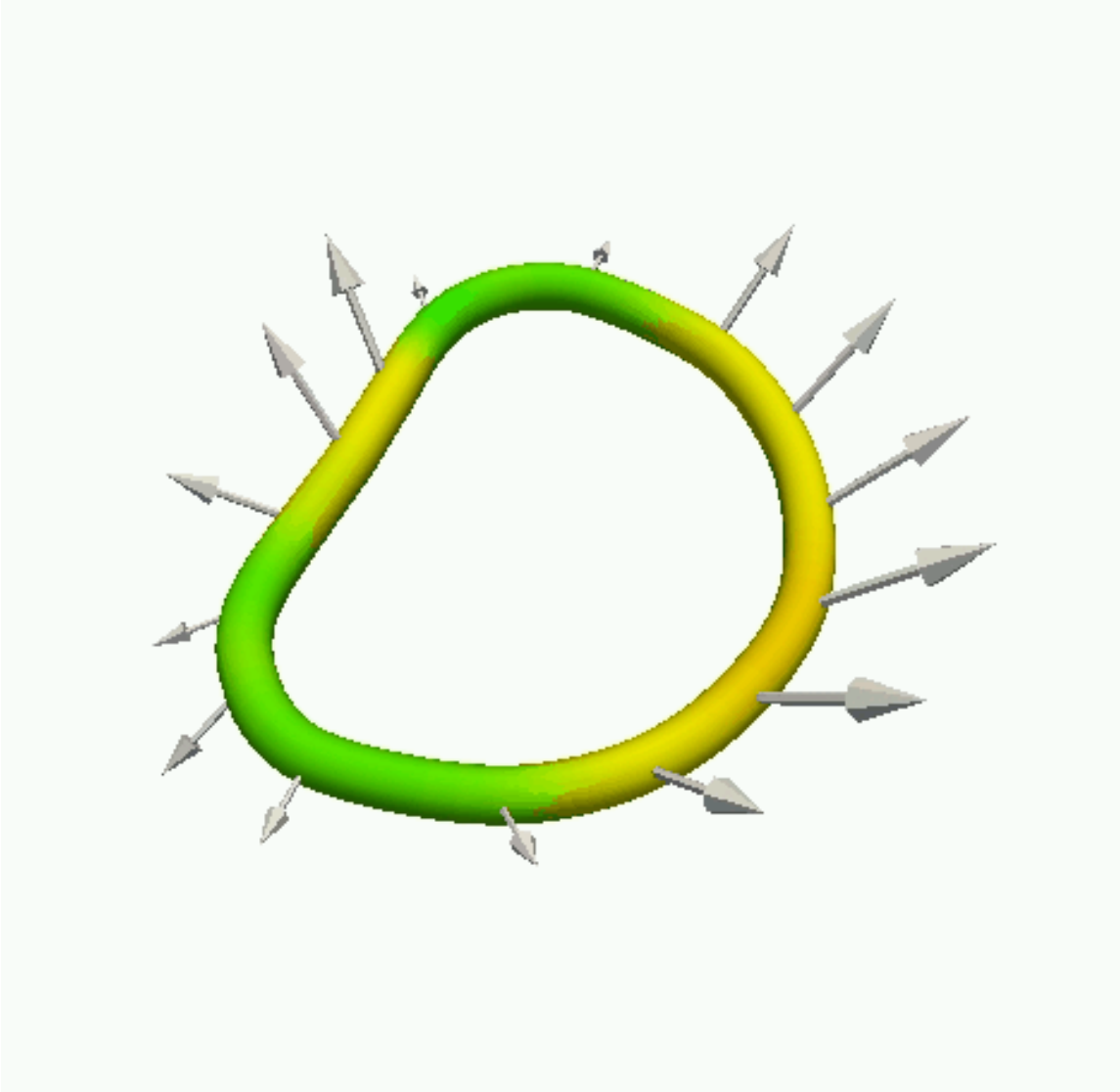


Graser, De Simone et al.; Computer Assisted Annuloplasty – DGTHG 2014 - SJM Award

Conclusions

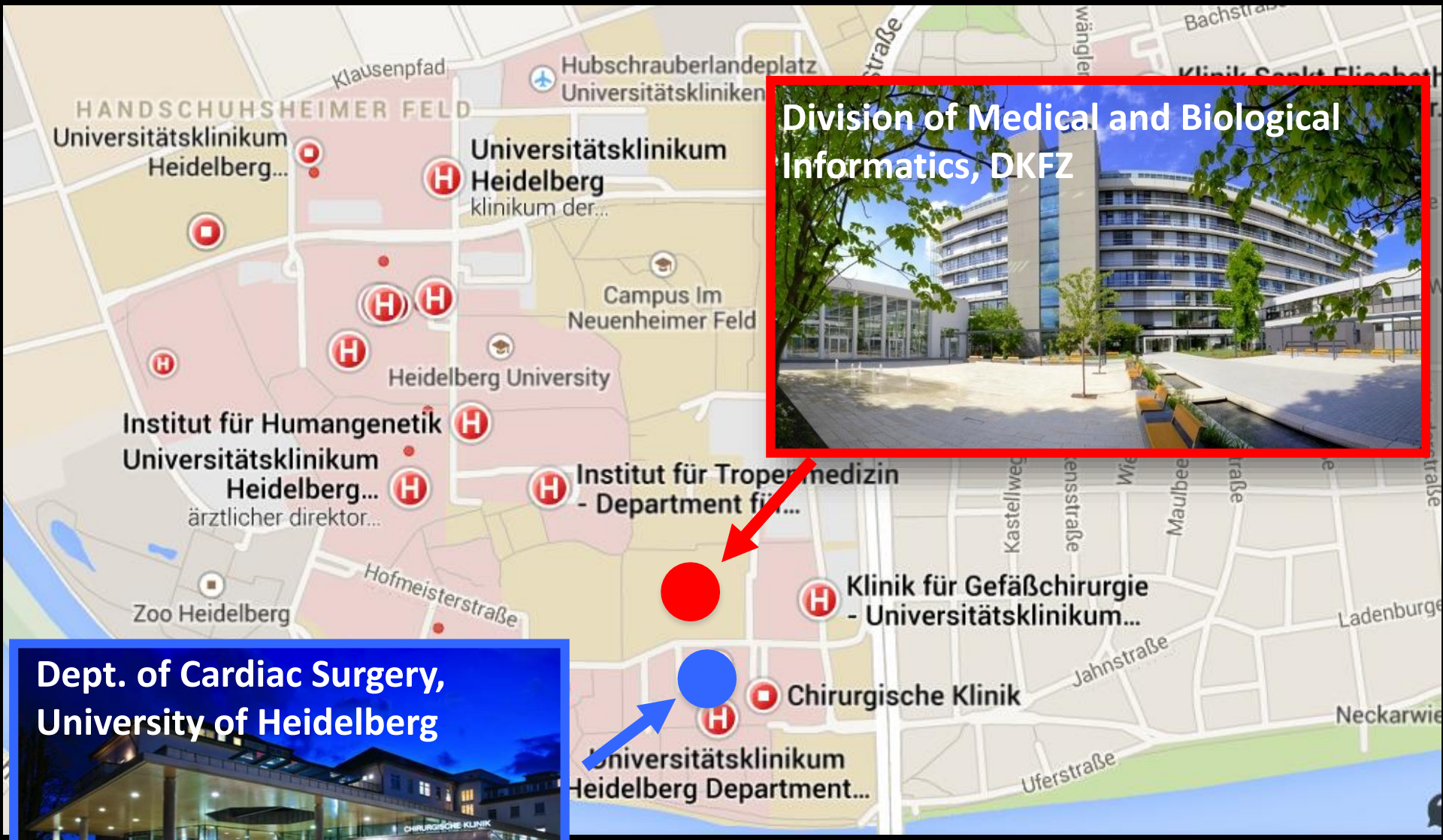
Anatomical parameters tracked by our infrared stereo camera system showed good accuracy and reproducibility.

Computational models allow a more precise quantitative assessment of mitral valve geometry.

Possible advantages of precise intraoperative sizing of anatomy

- guide the surgeon to choose the most suitable reconstruction procedure
- provide a learning tool for training surgeons
- improve outcome of mitral valve repair

University Campus Heidelberg



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Cognition-guided Surgery