



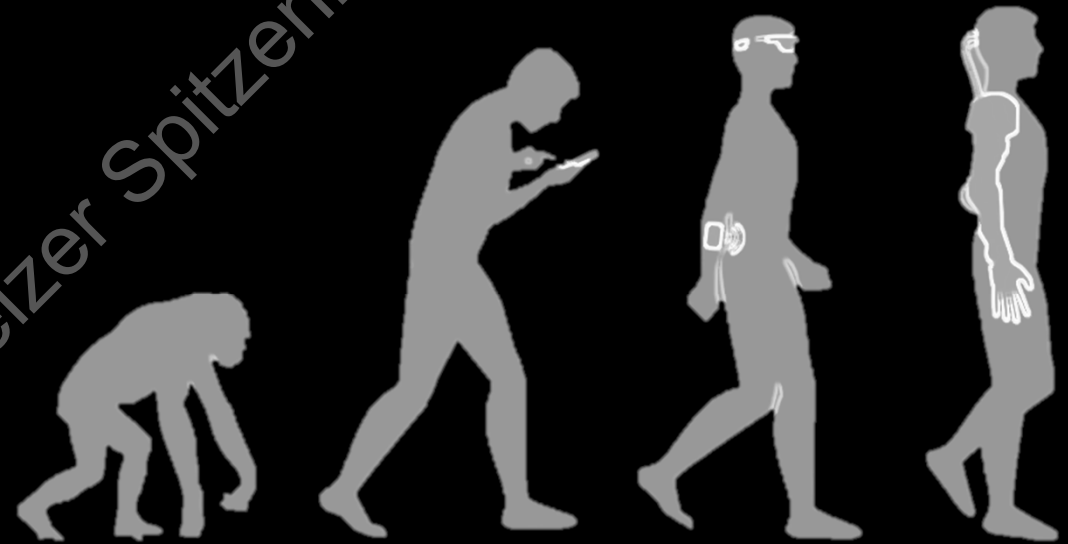
Universität
Zürich ^{UZH}

Der **Balgrist**

THE AUGMENTED HUMAN

Prof. Dr. Mazda Farshad, MPH

*Chair of Orthopaedics UZH
Medical Director,
University Hospital Balgrist*



Symposium Schweizer Spitzenmedizin 2017

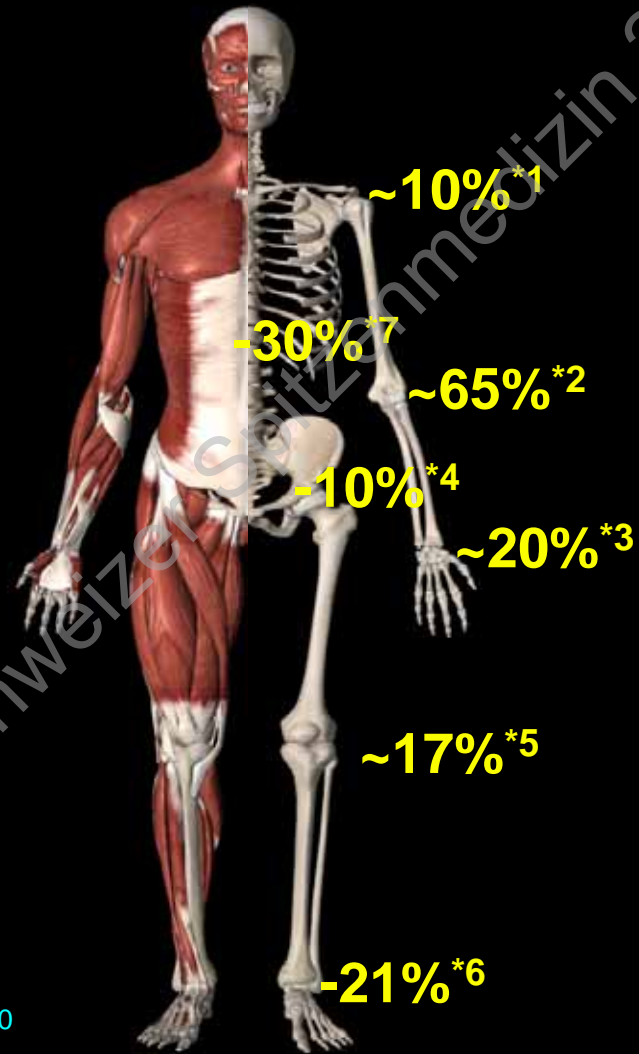
www.balgrist.ch

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BUT:STILL NOT PERFECT RESULTS



*1 Jacobs CA et al, JSES, 2016

*2 Dalemans A et al, JSES, 2013

*3 Sagerfors M et al, J Hand Surg Am. 2015

*4 Lindgren JV et al, Bone Joint J. 2014

*5 Robertsson O et al, Acta Orthop Scand. 2000

*6 Gougoulias N et al, Clin Orthop Relat Res. 2010

*7 Helgeson MD et al, Spine J. 2013



Outcome
depending on...

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Outcome
depending on...

- ... experience
- ... knowhow
- ... talent
- ... mood



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Outcome
depending on...

- ... experience
- ... knowhow
- ... talent
- ... mood

human factors

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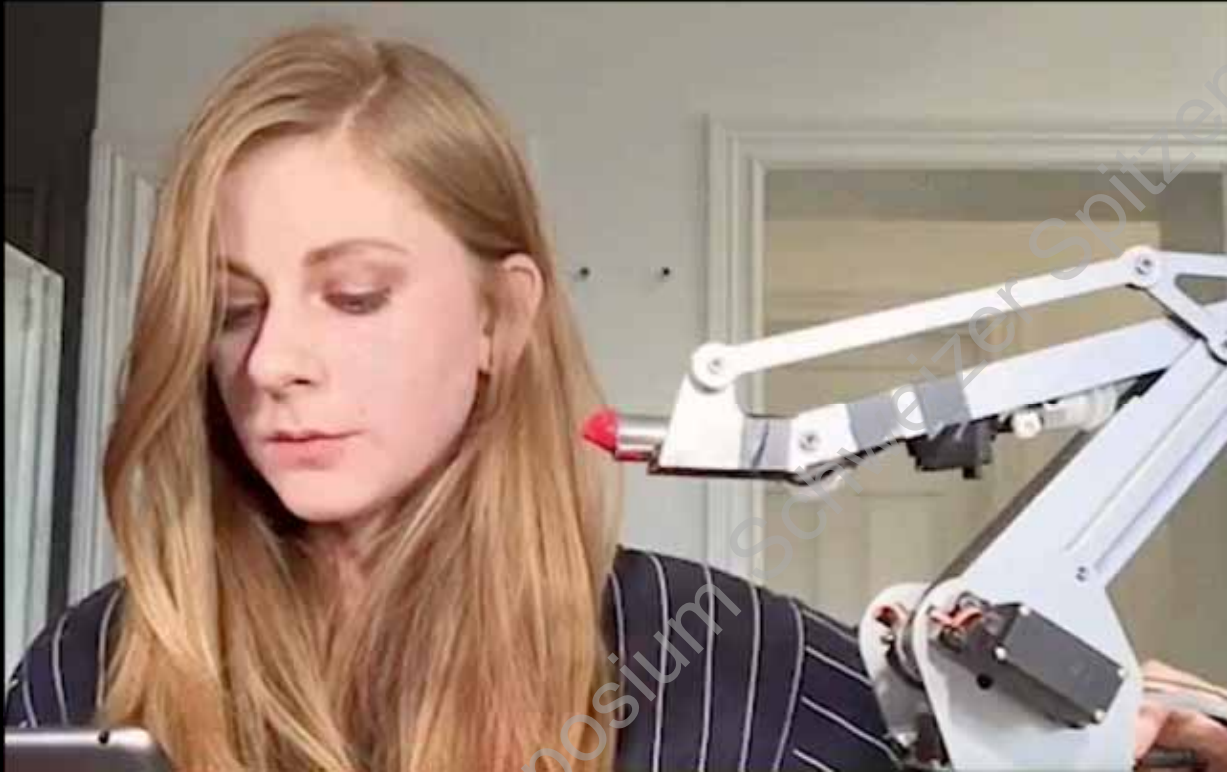


Outcome
depending on...

- ... experience
- ... knowhow
- ... talent
- ... mood

human factors





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human



robot

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human



**augmented
human**



robot

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HISTORY OF AVIATION



Wright Brothers 1903



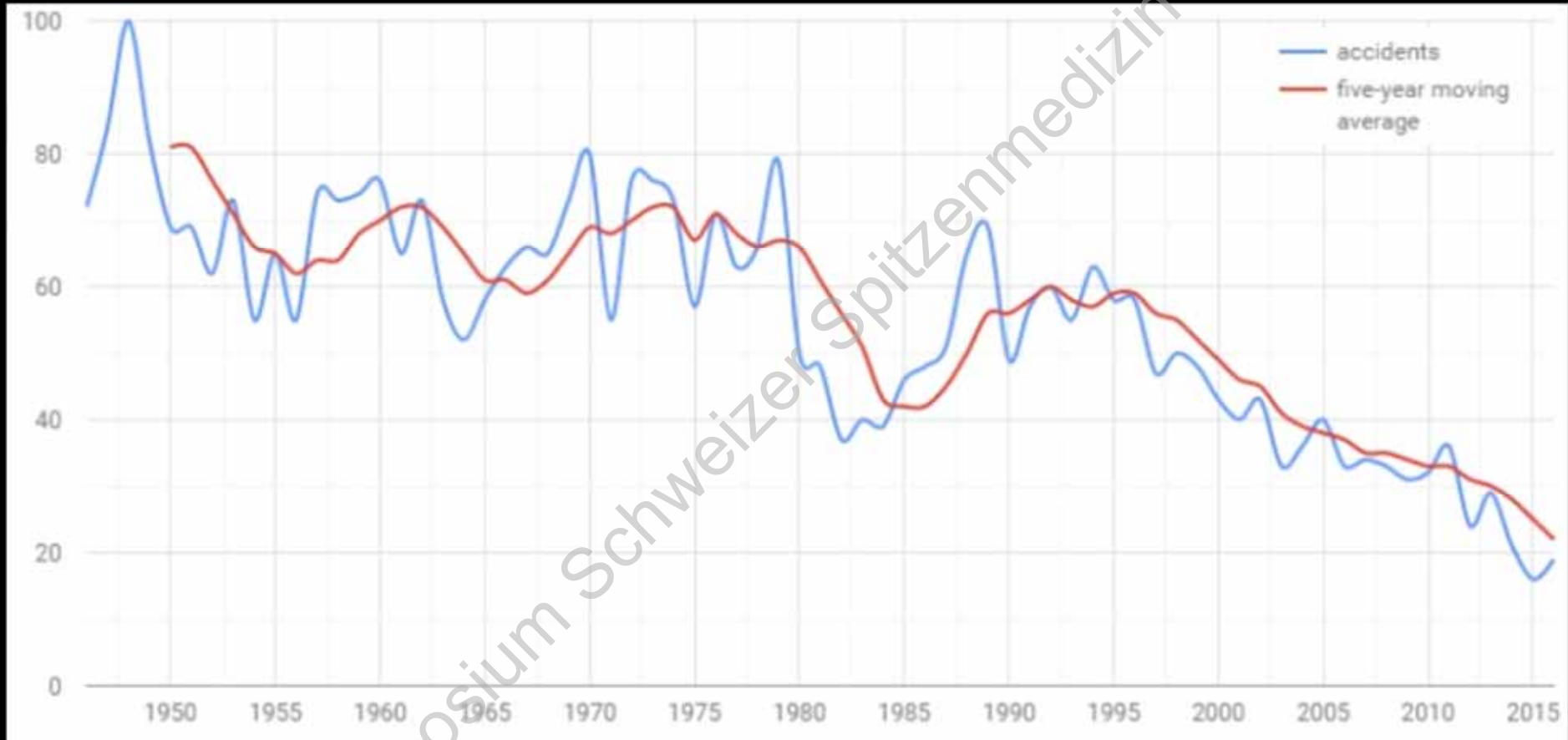
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AIRLINE CRASH STATISTICS



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Outcome
depending on...

- ... experience
- ... knowhow
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- ... mood



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Outcome
depending on...



- ... experience
- ... knowhow
- ... talent
- ... mood



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Outcome
depending on...



Analysis/planning: quantitativ
Training: patient-specific
Execution: technology-augmented

- ... experience
- ... knowhow
- ... talent
- ... mood



augmented
human/ surgeon

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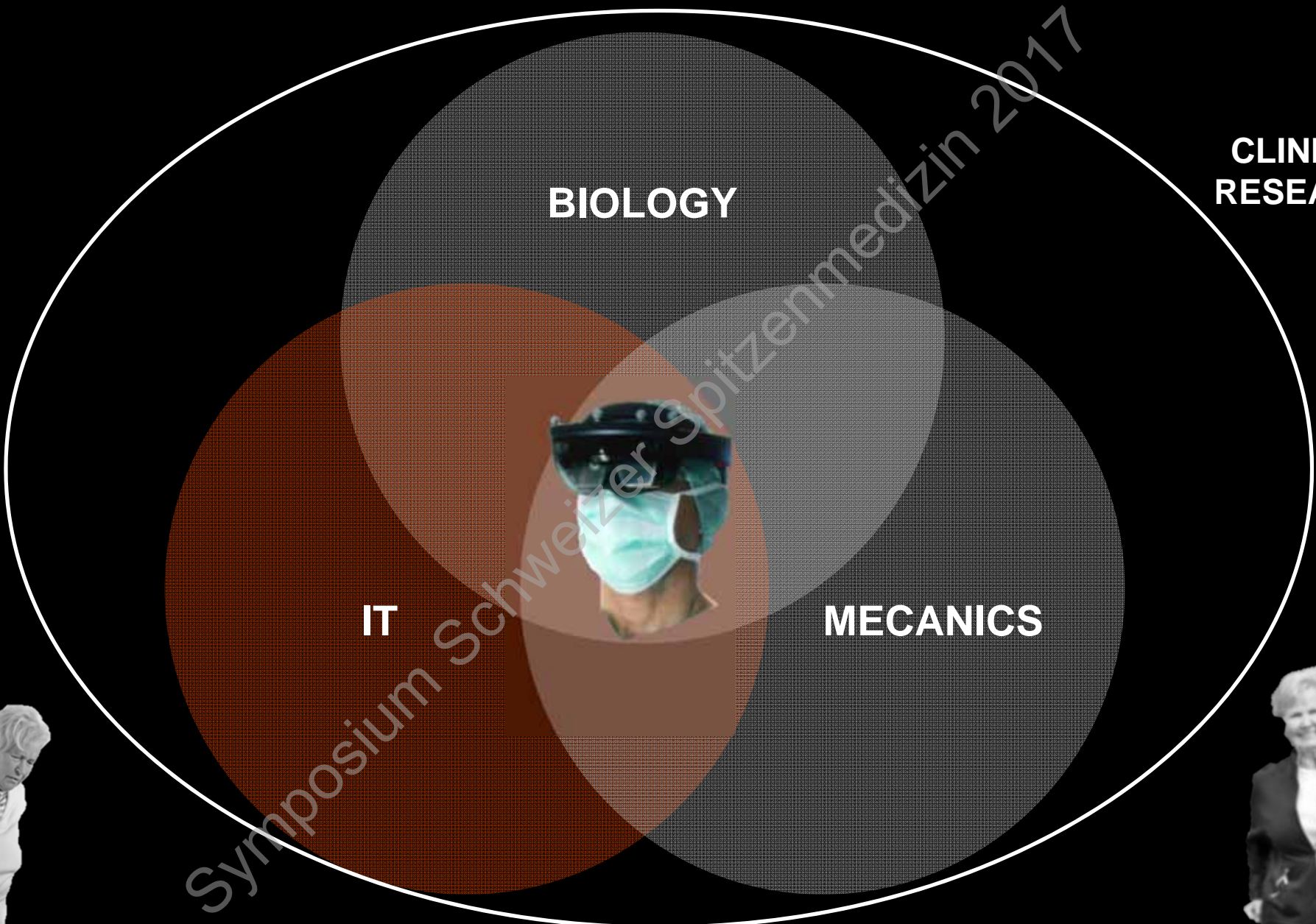
BIOLOGY

**CLINICAL
RESEARCH**



MECHANICS



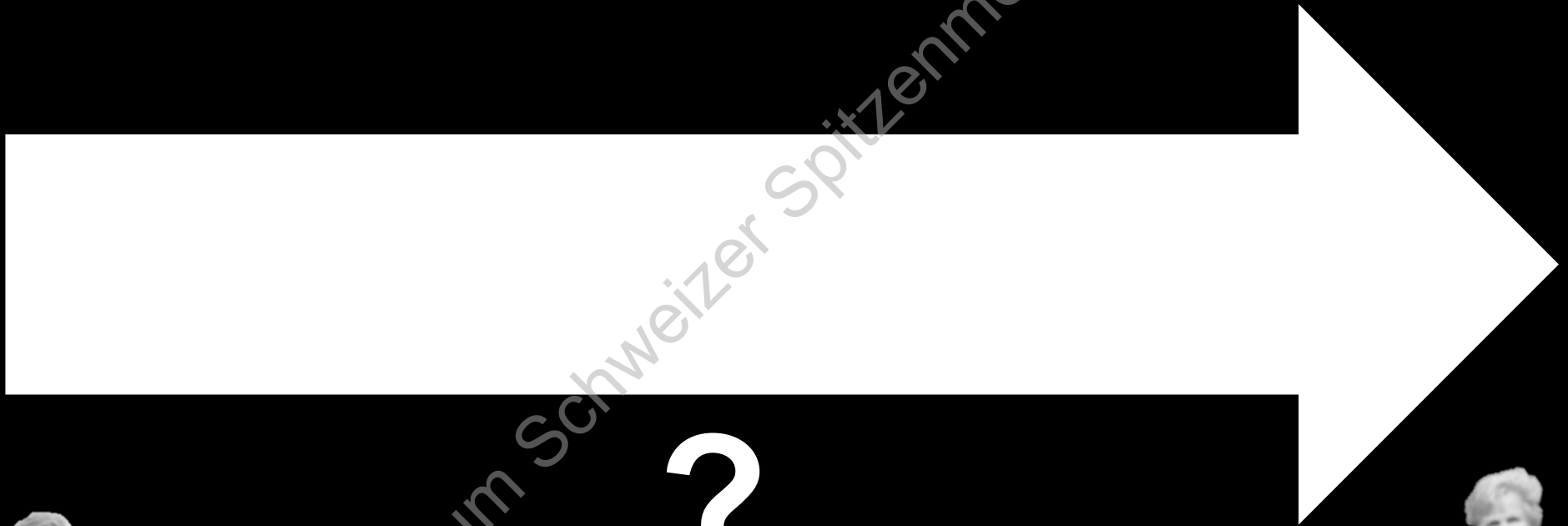


**CLINICAL
RESEARCH**



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?



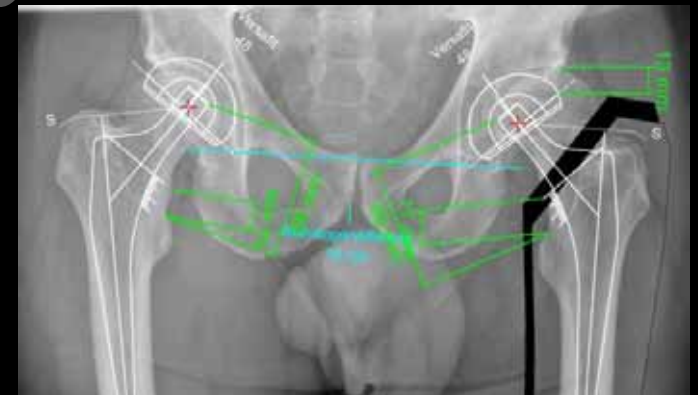
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CURRENT PREOPERATIVE PLANNING: SIMPLE GEOMETRY

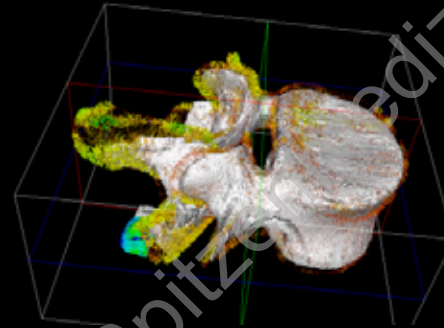


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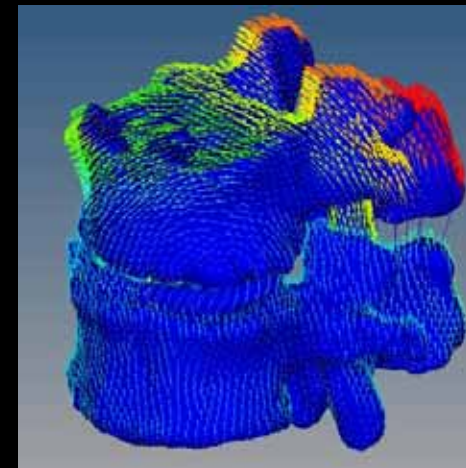
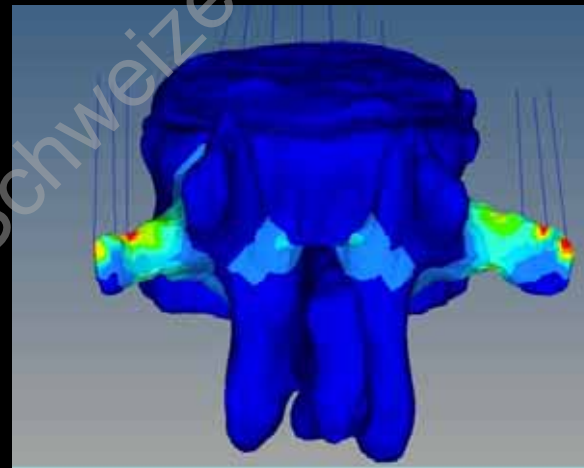
PATIENT-SPECIFIC SIMULATION/ PLANNING



model scaling



statistical shape modeling



FE-simulation

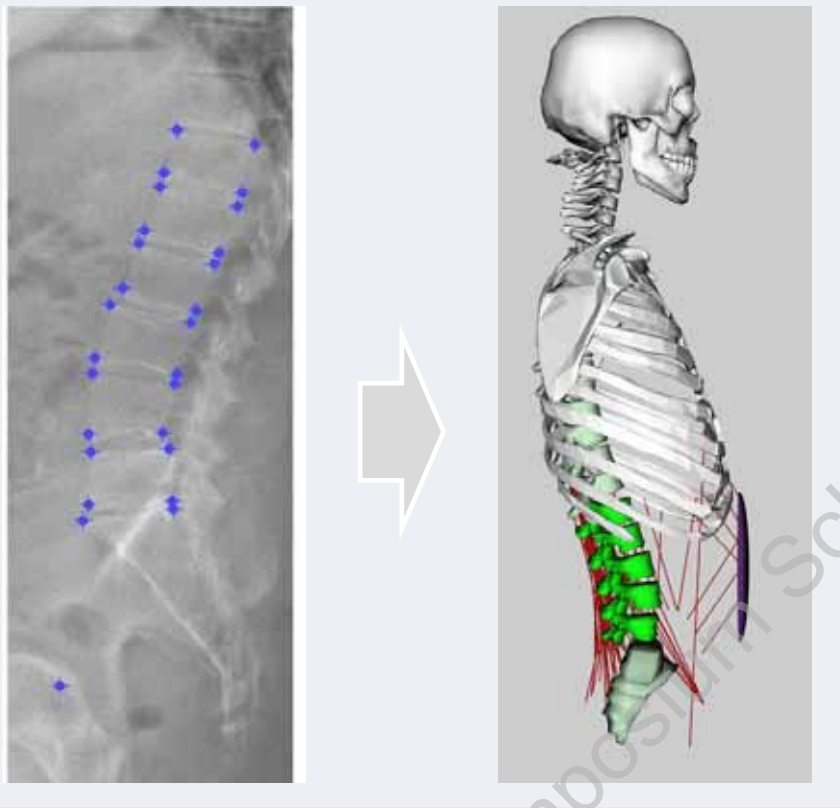
Der **Balgrist**

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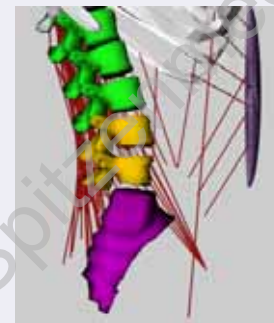
PATIENT-SPECIFIC PLANNING



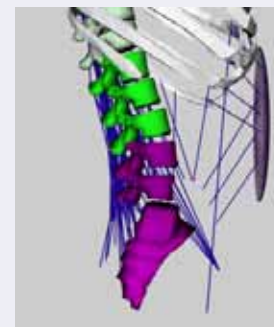
Patient-specific modelling



Simulation of surgical options



**Fusion L4-S1
with lordosis correction**



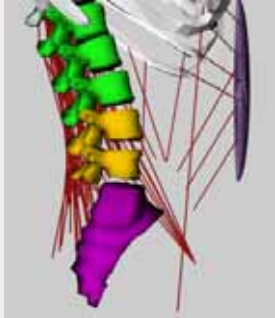
**Fusion L4-S1
in Situ**

Preoperative status as benchmark

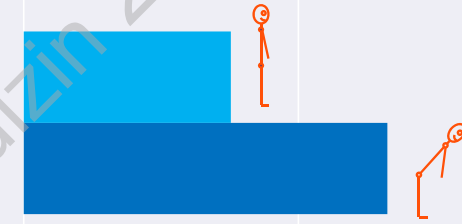
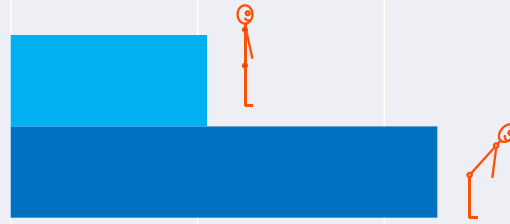
Adjacent segment L3/4

shear (anterior) [N]

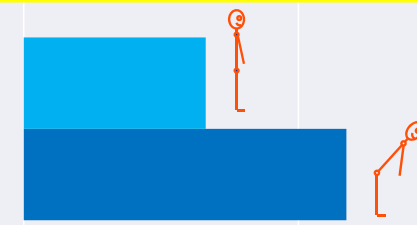
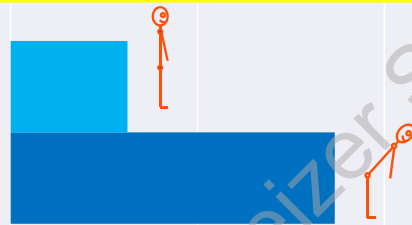
compression [N]



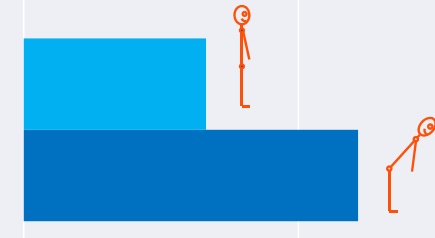
**Fusion L4-S1
with lordosis
correction**



**Fusion L4-S1
in Situ**



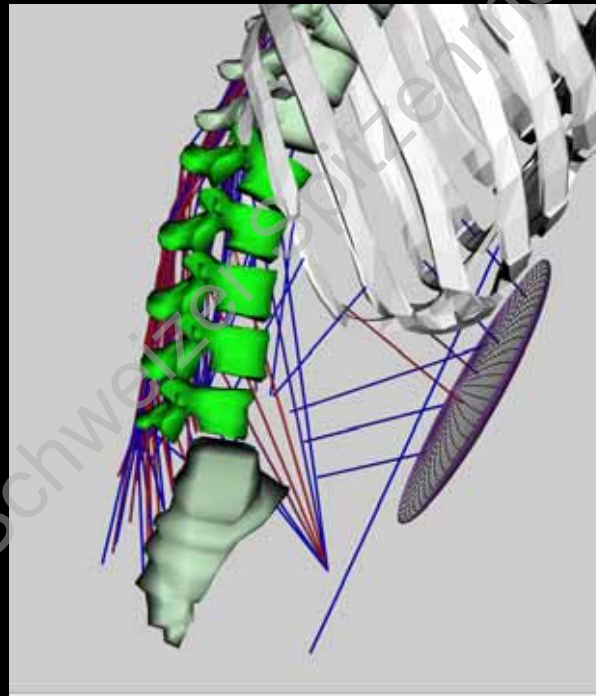
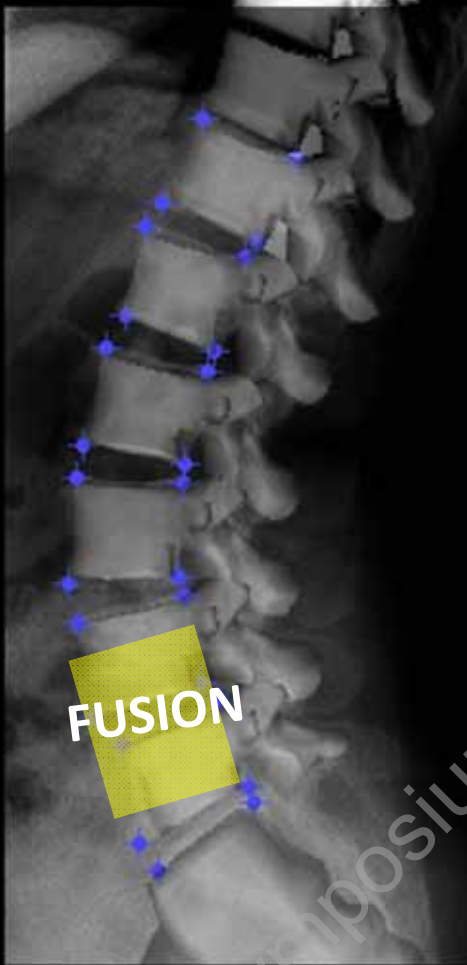
**Preoperative status as
benchmark**



0 50 100 150 0 500 1000

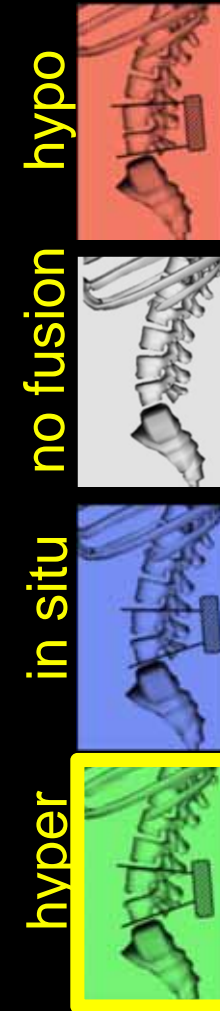
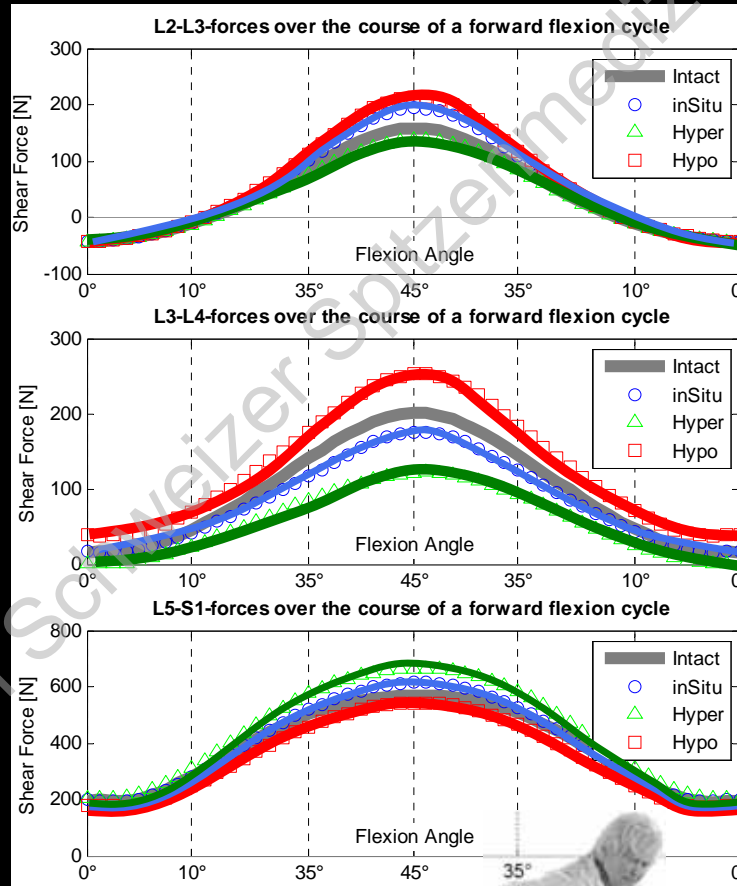
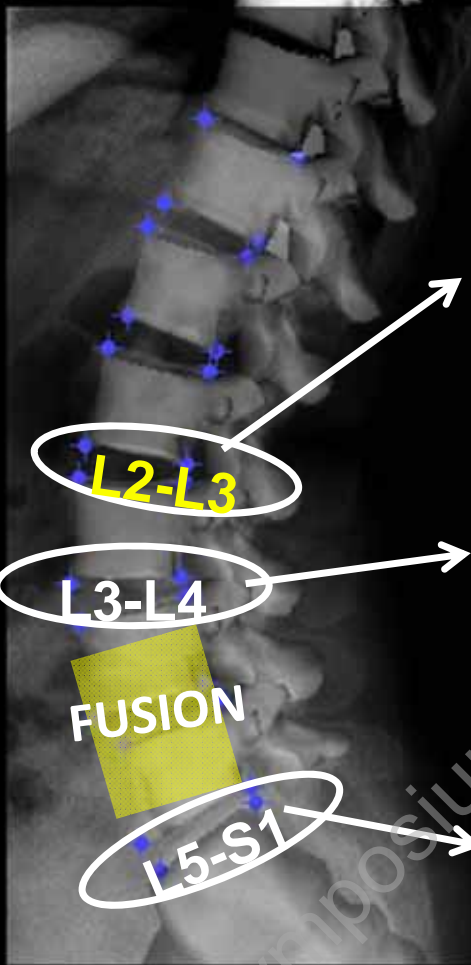
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PATIENT-SPECIFIC PLANNING



Senteler M et al, J Orthop Research, 2016

PATIENT-SPECIFIC PLANNING



Senteler M et al, J Orthop Research, 2016

TODAYS SURGIAL TRAINING?

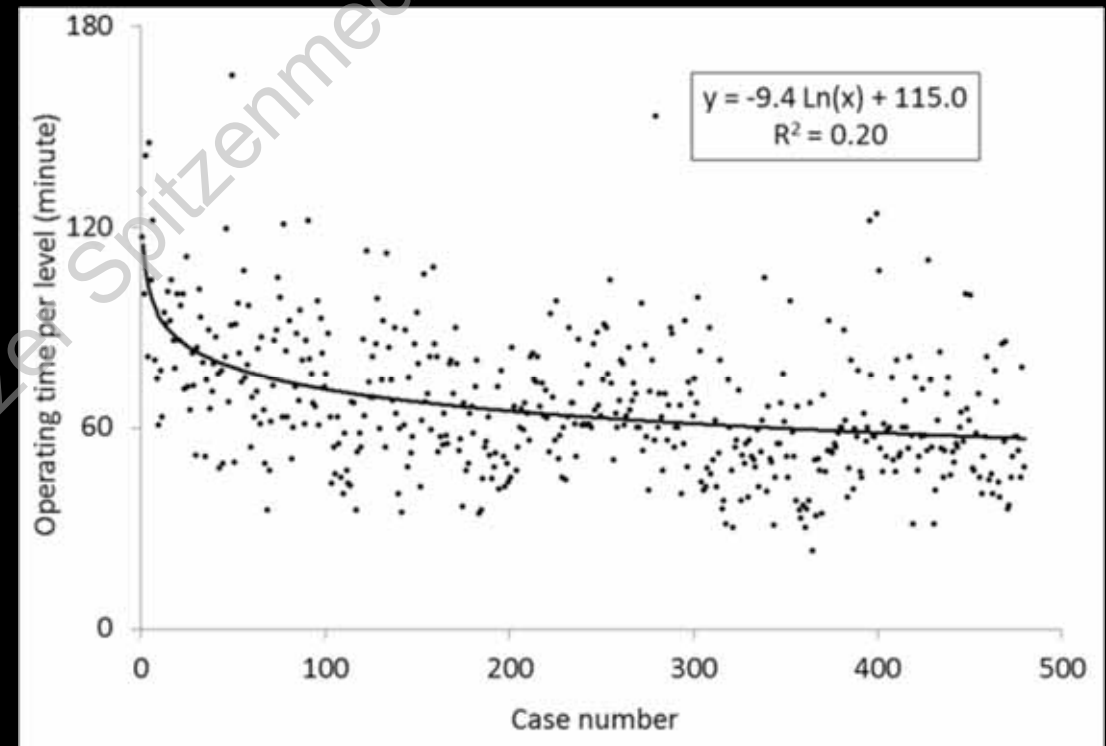


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TODAYS SURGIAL TRAINING: LEARNING BY DOING



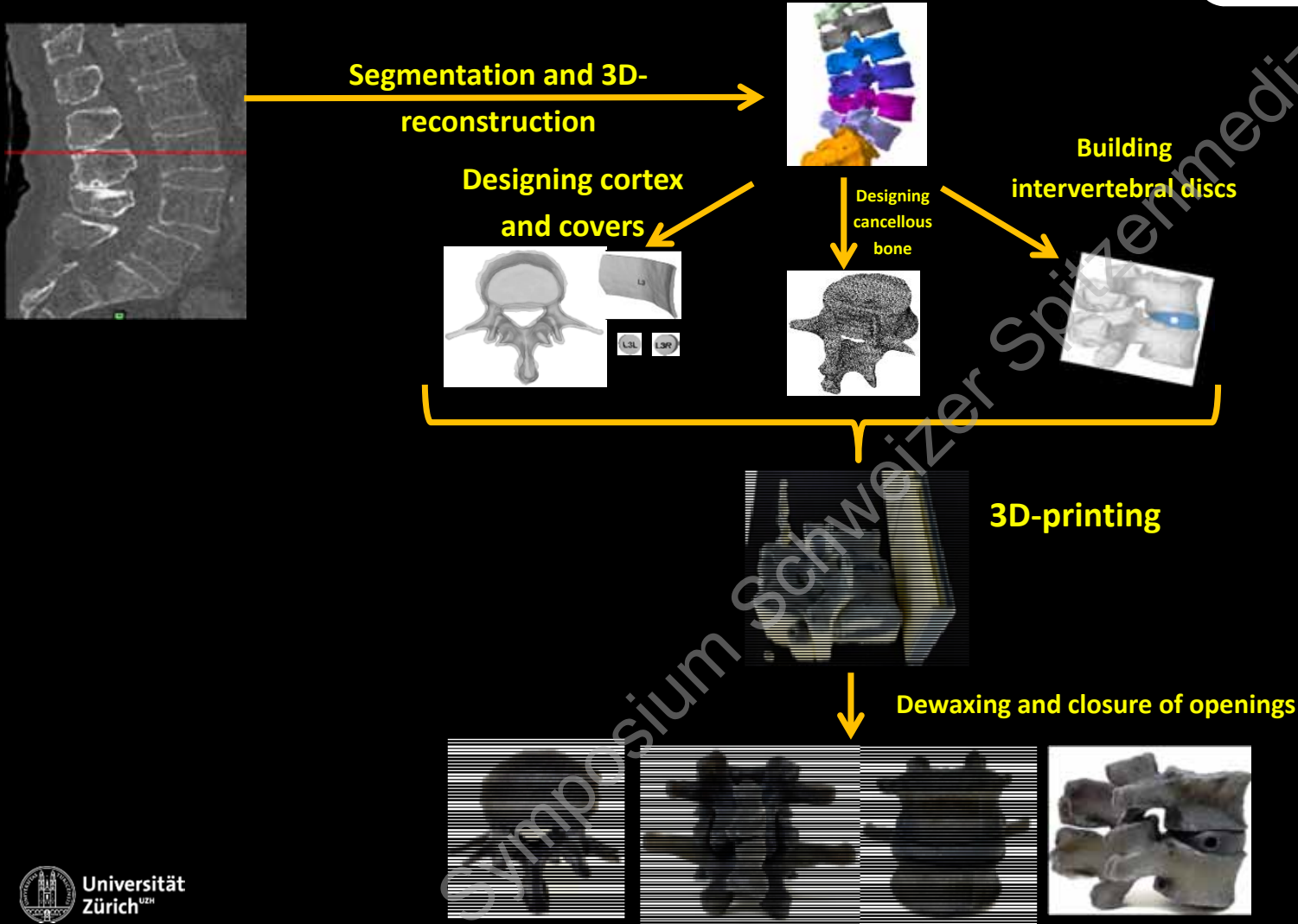
Example: nerve decompression



TRAINING BEFORE EXECUTION



PATIENT-SPECIFIC TRAINING



Führnstahl P, Gerber C, Farshad M,
HSM project

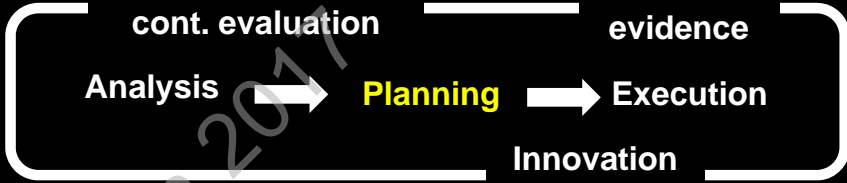
Der **Balgrist**

PATIENT-SPECIFIC TRAINING



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PATIENT-SPECIFIC TRAINING



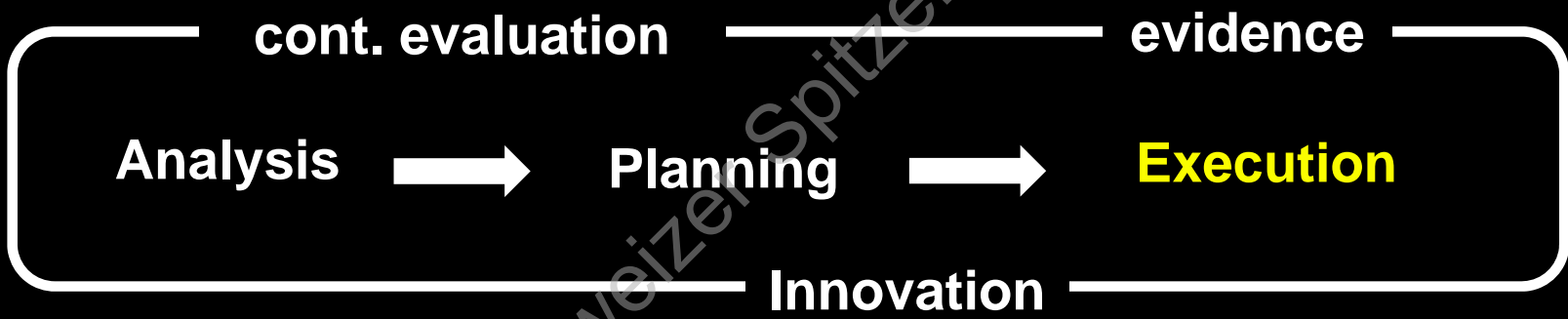
Data of 3D anatomy

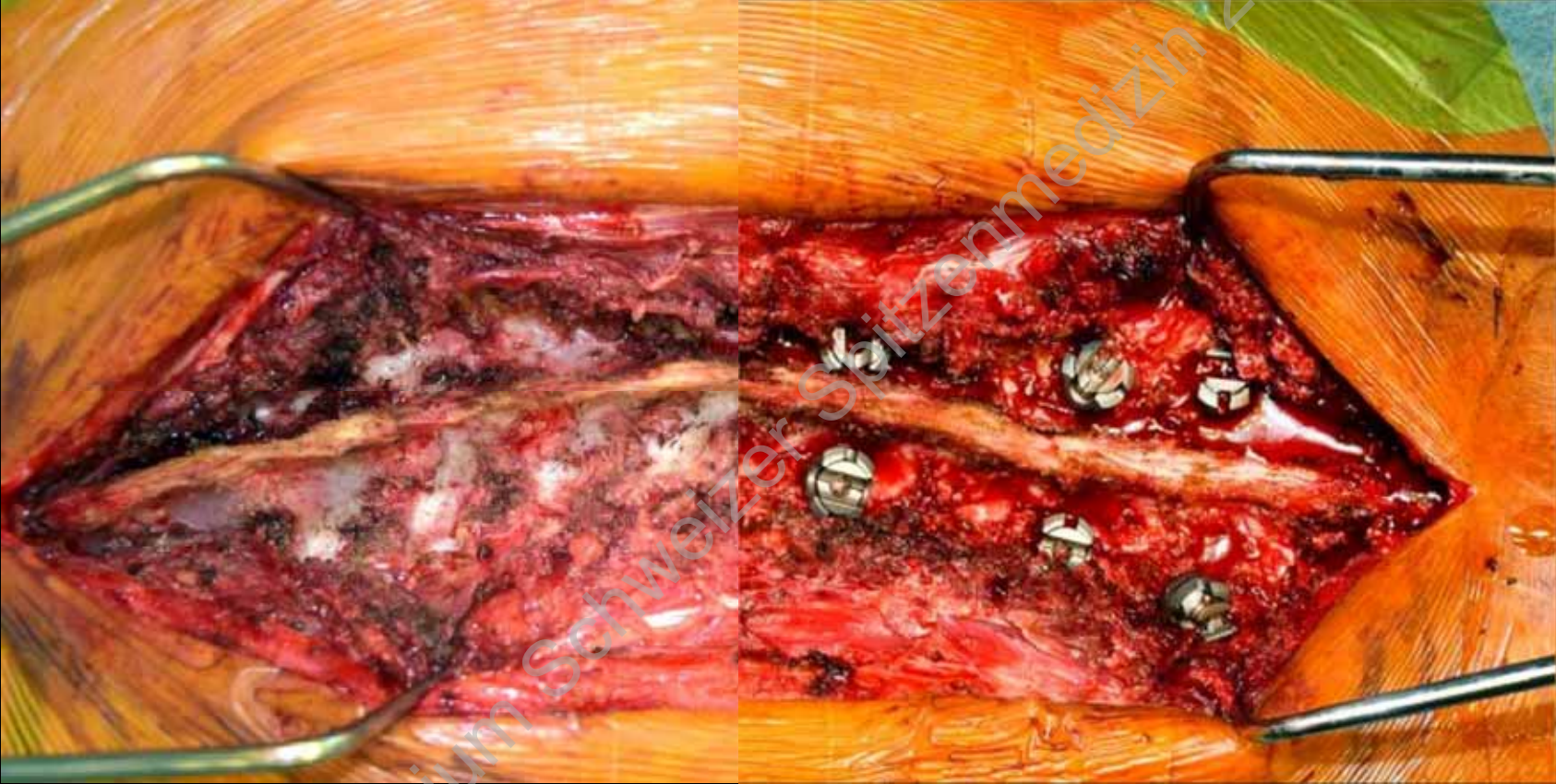


3D print

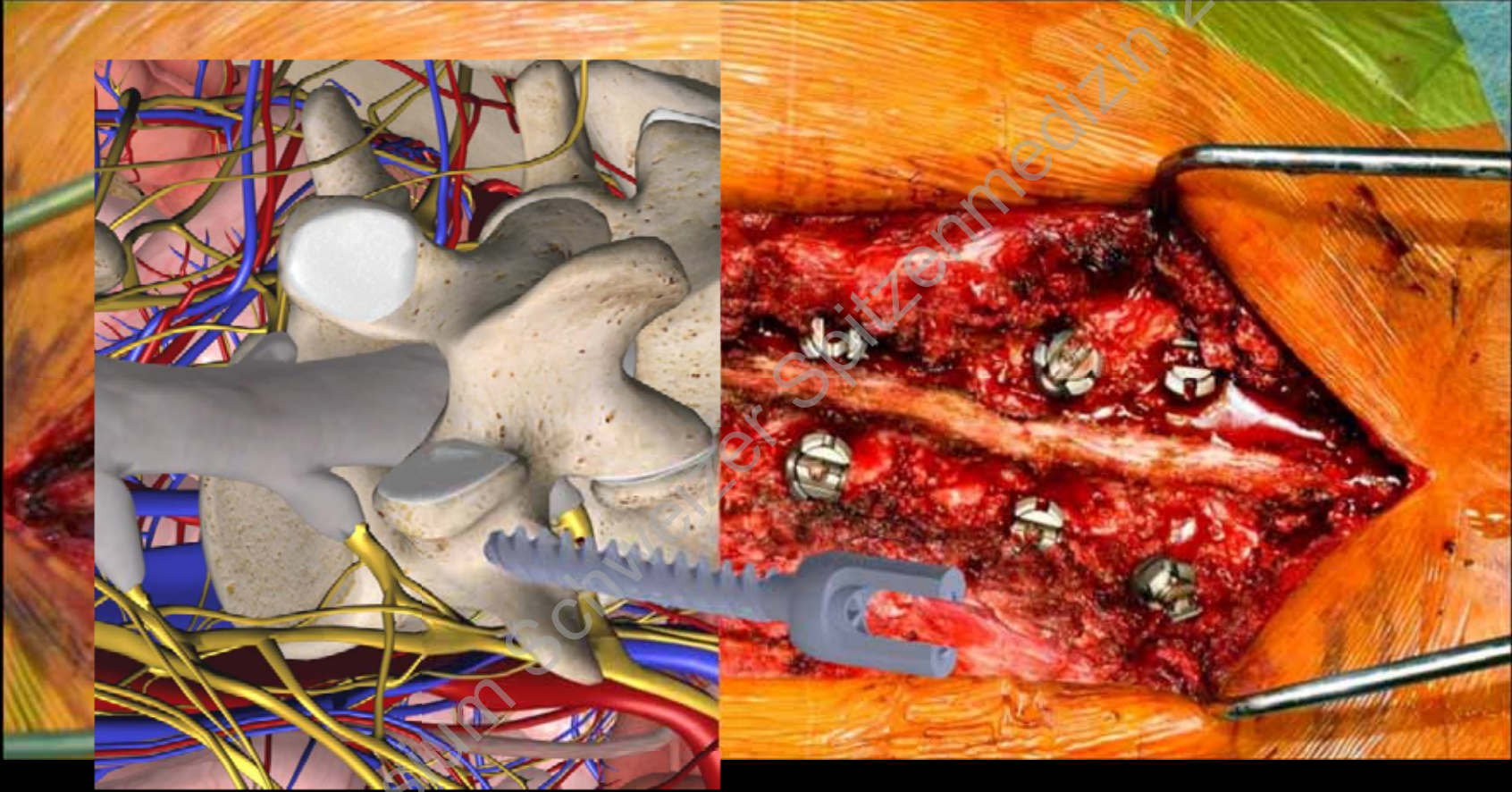


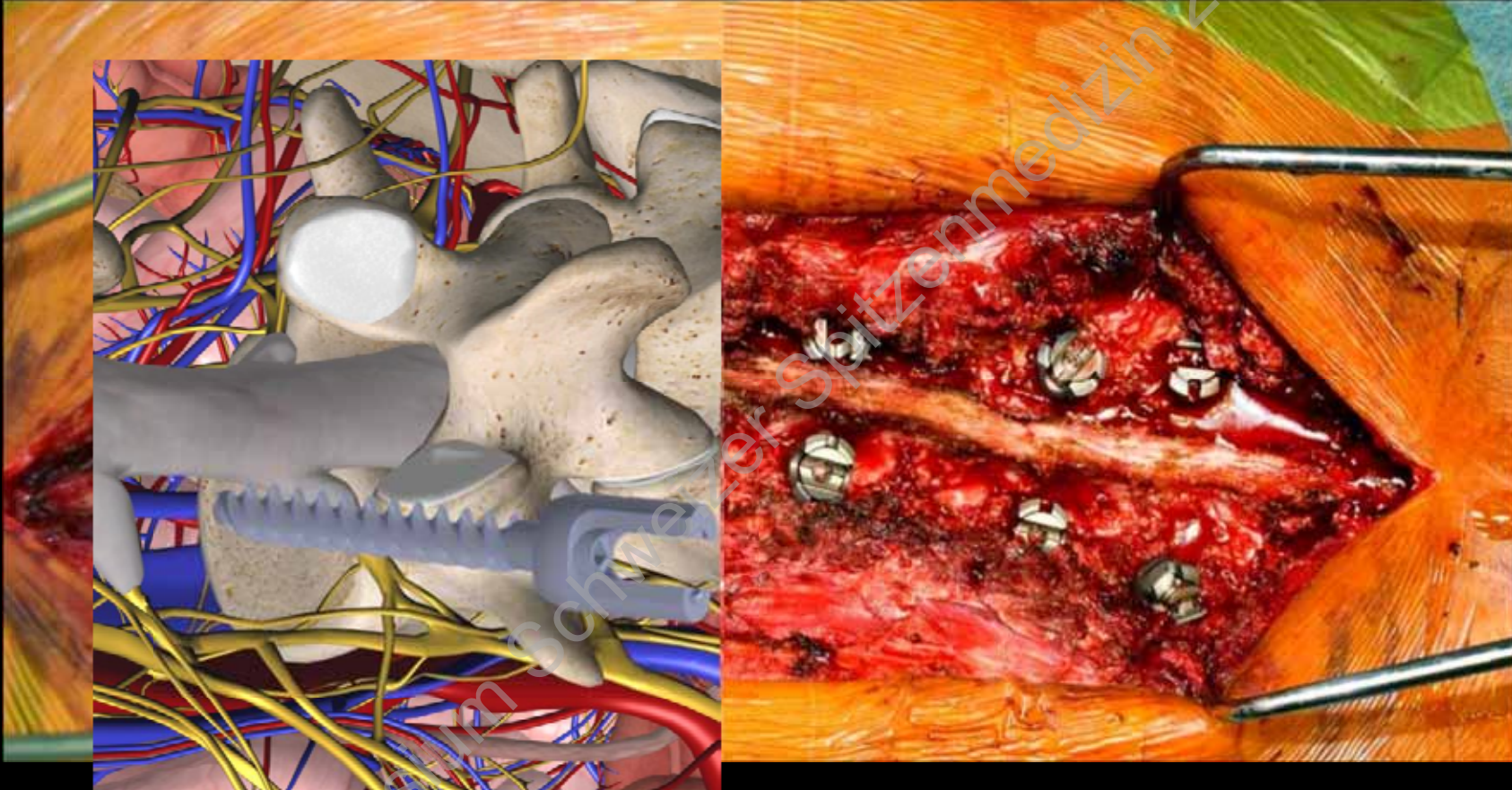
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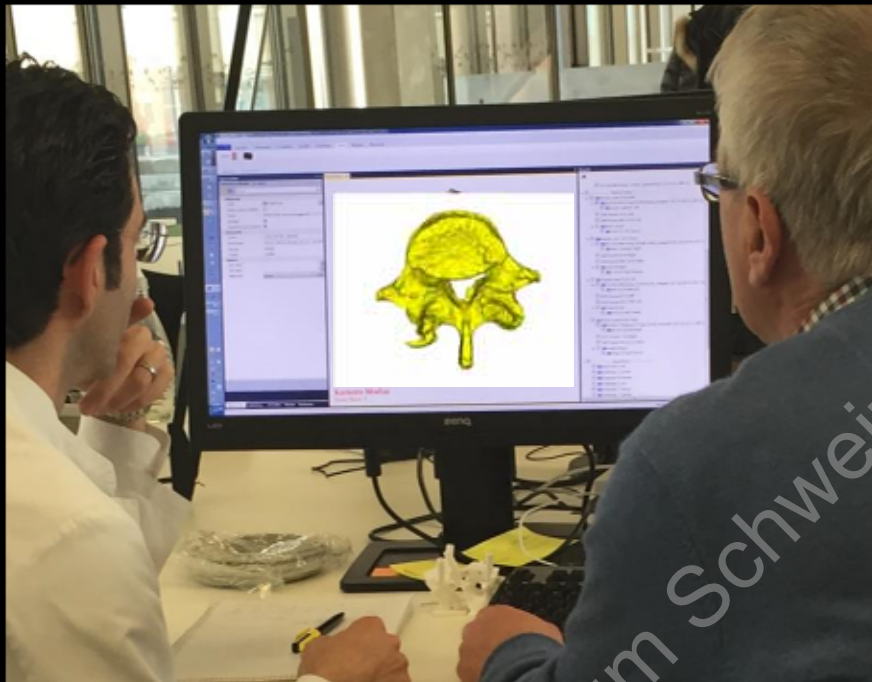




standard: 69-94%* intra-pedicular

*Gelalis ID et al, Eur Spine J. 2012

PATIENT-SPECIFIC EXECUTION

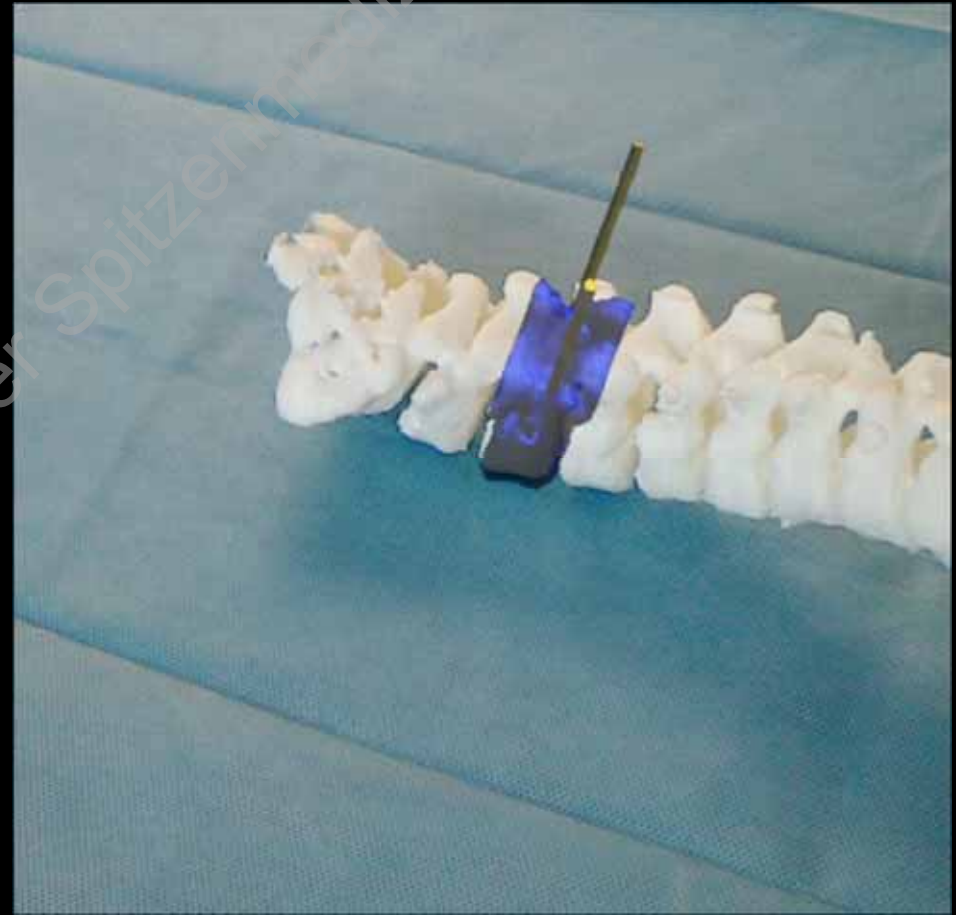
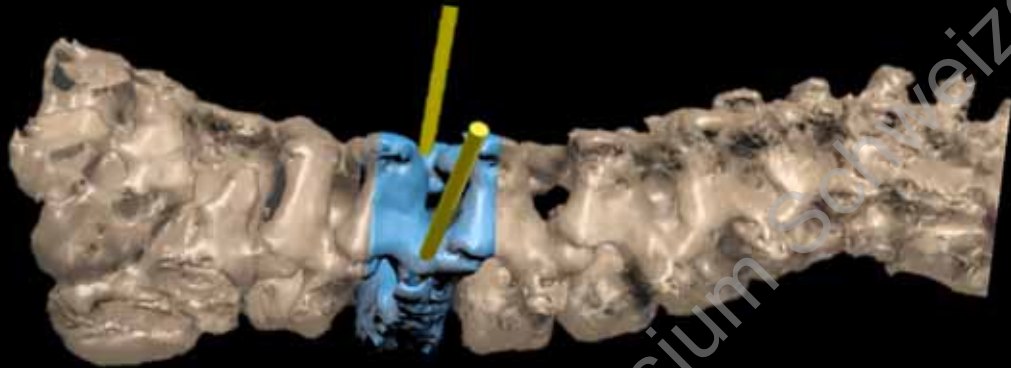
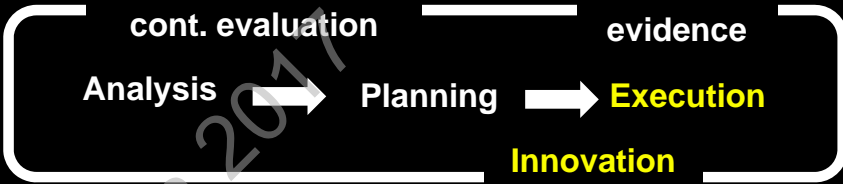


surgeon

IT/ Computer Science

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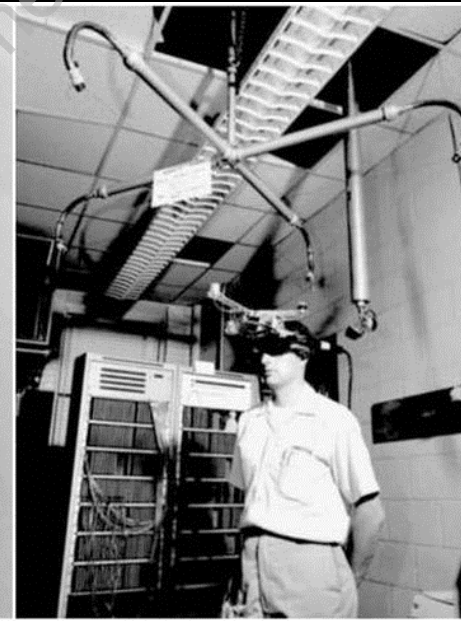
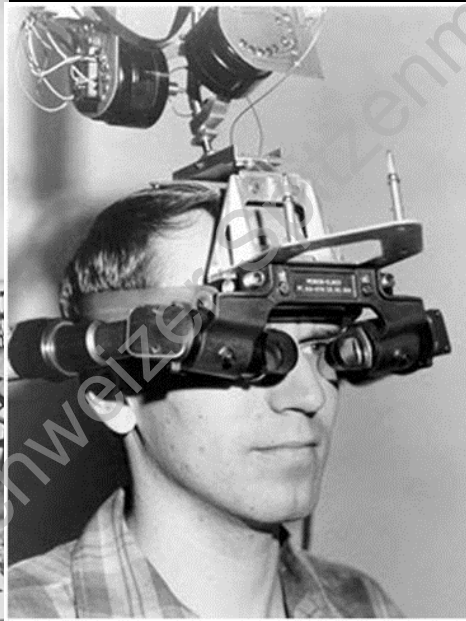
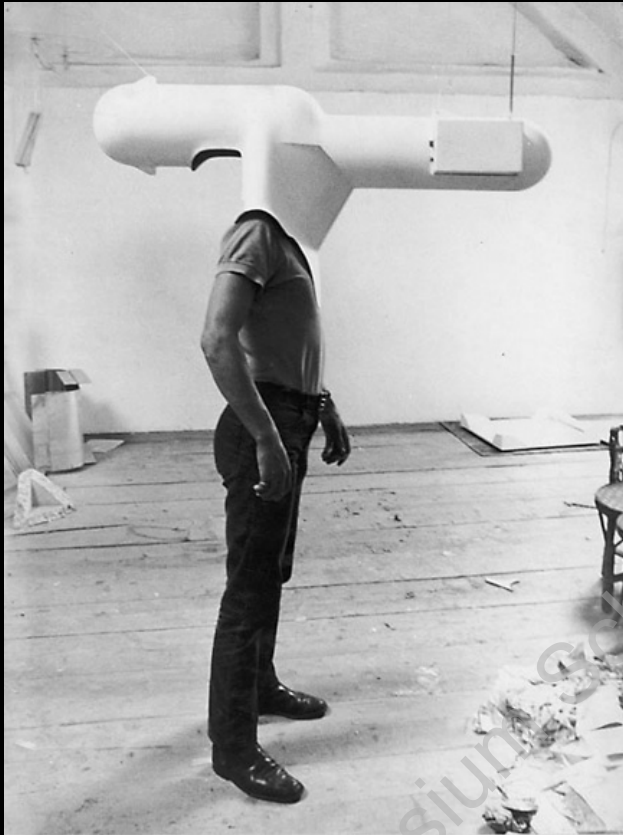
PATIENT-SPECIFIC EXECUTION



AUGMENTED REALITY



AUGMENTED REALITY HISTORY



Walter Pichler (AT), TV helmet/ portable living room, 1967

Ivan Sutherland's 'Sword of Damocles'. The first virtual reality headset. 1968

AUGMENTED REALITY HISTORY



PATIENT-SPECIFIC EXECUTION

Augmented Reality

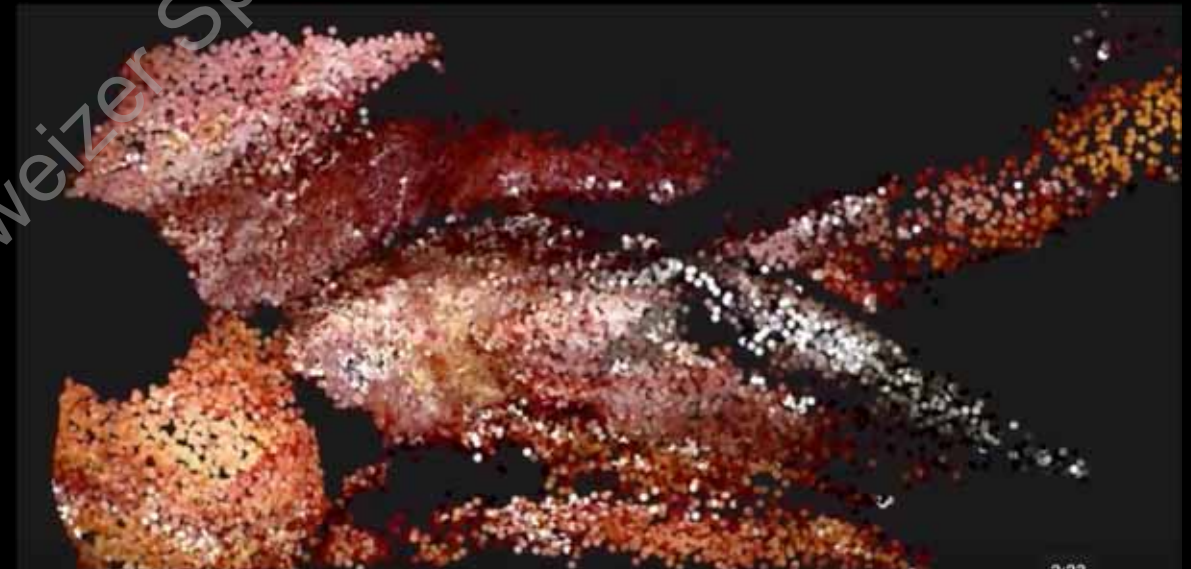


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AUGMENTED REALITY



firm structures*



soft structures

AUGMENTED REALITY “OVERLAY”



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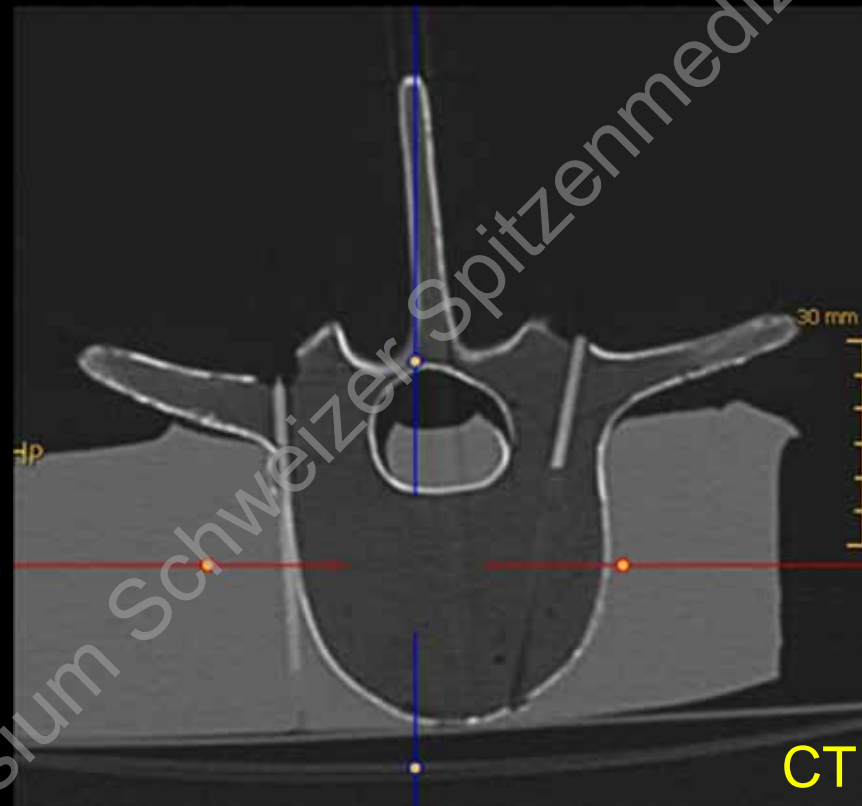
AUGMENTED REALITY OVERLAY STABILITY



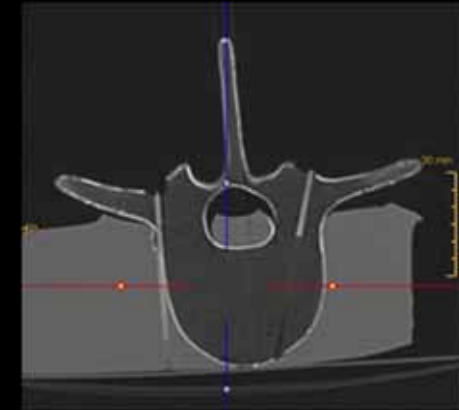
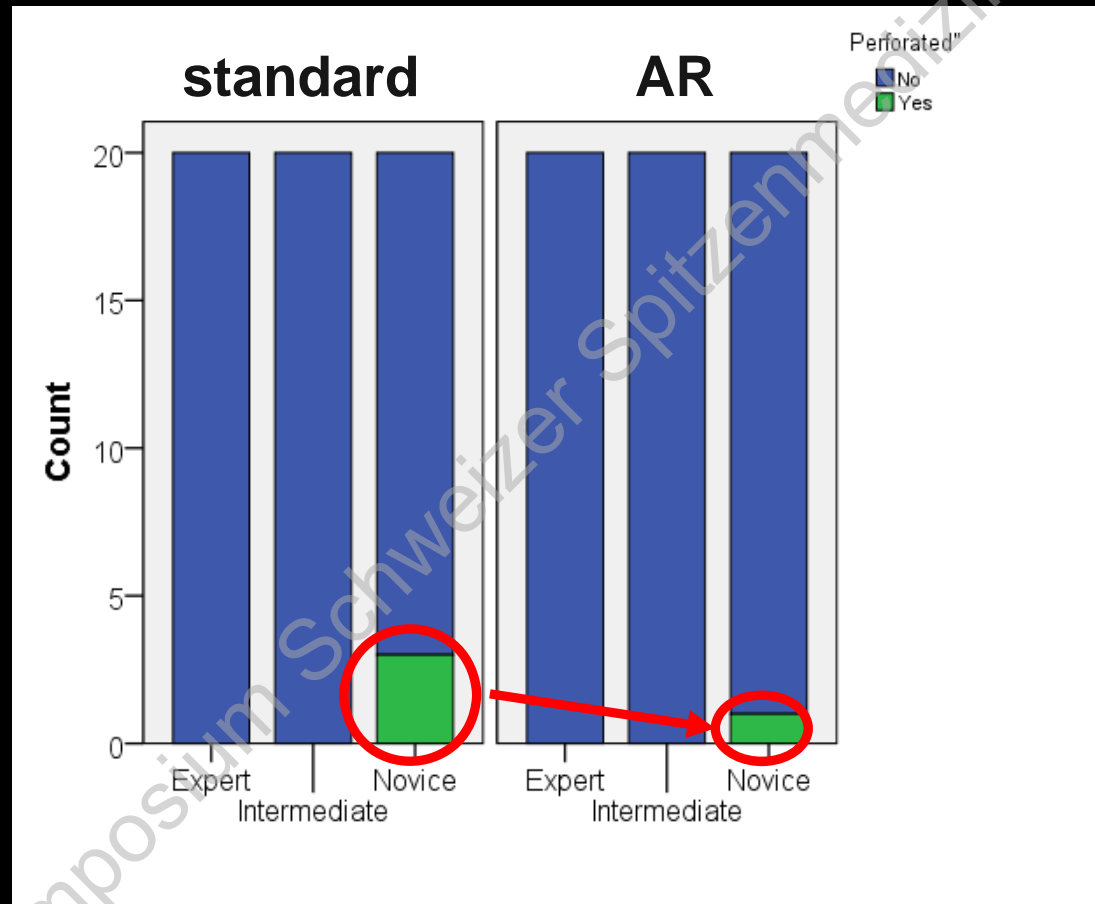
AUGMENTED REALITY PRECISION PEDICLE SCREW PLACEMENT



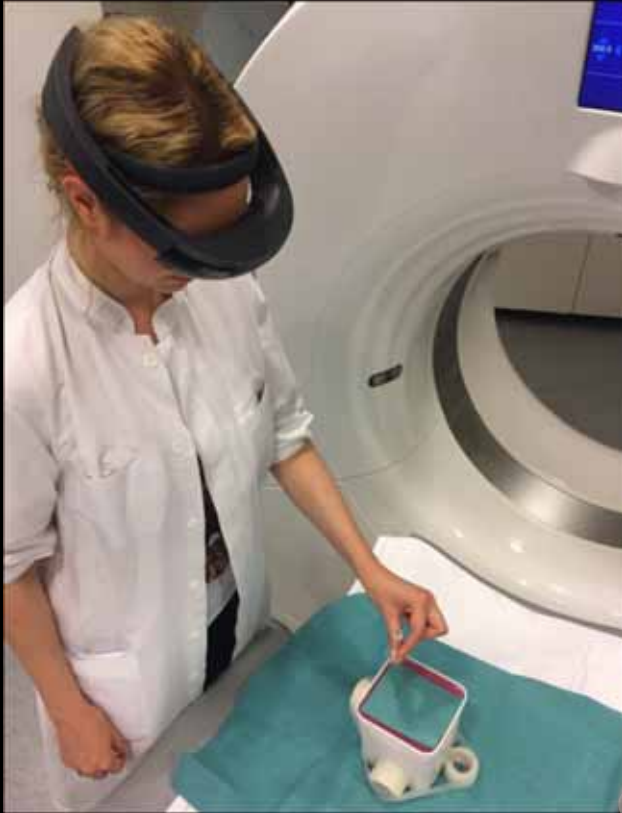
AUGMENTED REALITY PRECISION PEDICLE SCREW PLACEMENT



AUGMENTED REALITY PRECISION PEDICLE SCREW PLACEMENT



AUGMENTED REALITY PRECISION of FACETT INFILTRATIONS



		Modality		P-value
		AR	CT	
Radiologist 1	Perfect	13	16	.398
	Acceptable	6	4	
	Incorrect	1	0	
	Unsafe	0	0	
	Total	20	20	
Radiologist 2	Perfect	17	19	.602
	Acceptable	3	1	
	Incorrect	0	0	
	Unsafe	0	0	
	Total	20	20	

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HAND SURGERY



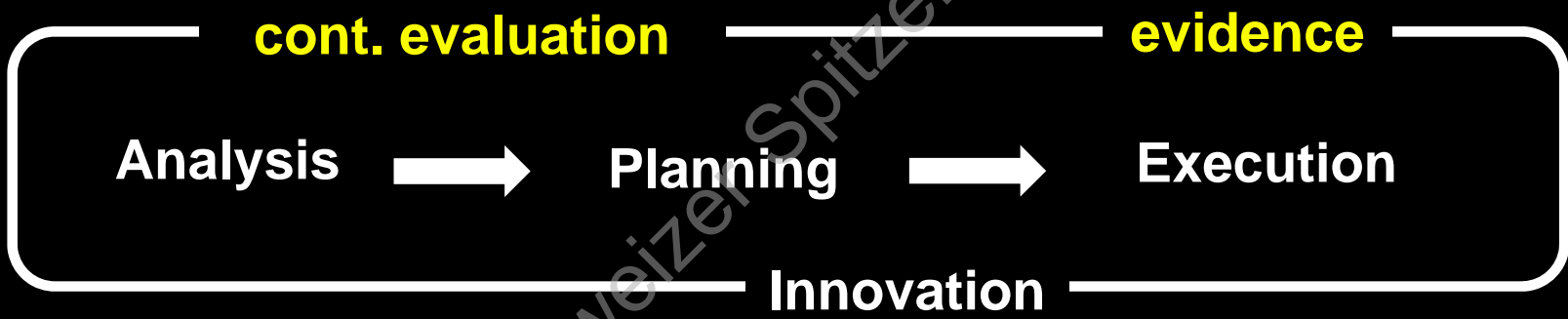
Symposium Orthopädie und Sportmedizin 2017

KNEE SURGERY - OSTEOTOMY



Symposium Schweizer Gelenkmedizin 2017

Symposium Schweizer Spitzenmedizin 2017



**UNIT FOR
CLINICAL AND
APPLIED
RESEARCH**



CURATORIUM

LEAD

RESEARCH-ADMIN

- Process optimization
- Ethics /GCP
- Management Research Personal

RESEARCH-COORDINATION

- registers
- SOPs
- Monitoring
- ISO-certification

METHODOLOGY

- Study management
- Study design
- Quality control
- compatibility-check
- Scientific conduct
- statistics

DATA-MANAGEMENT

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INSTRUMENTS

and

INFRASTRUCTURE



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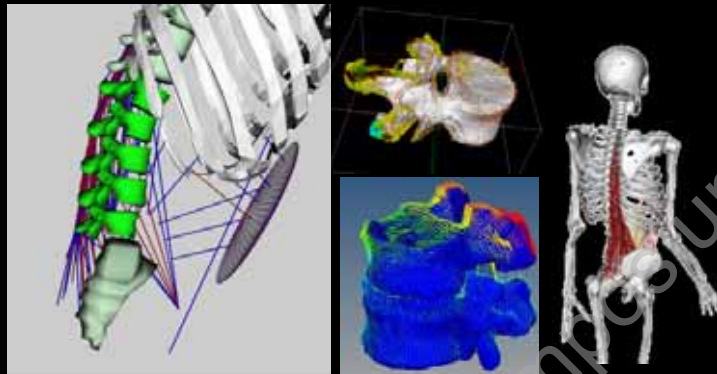
INSTRUMENTS



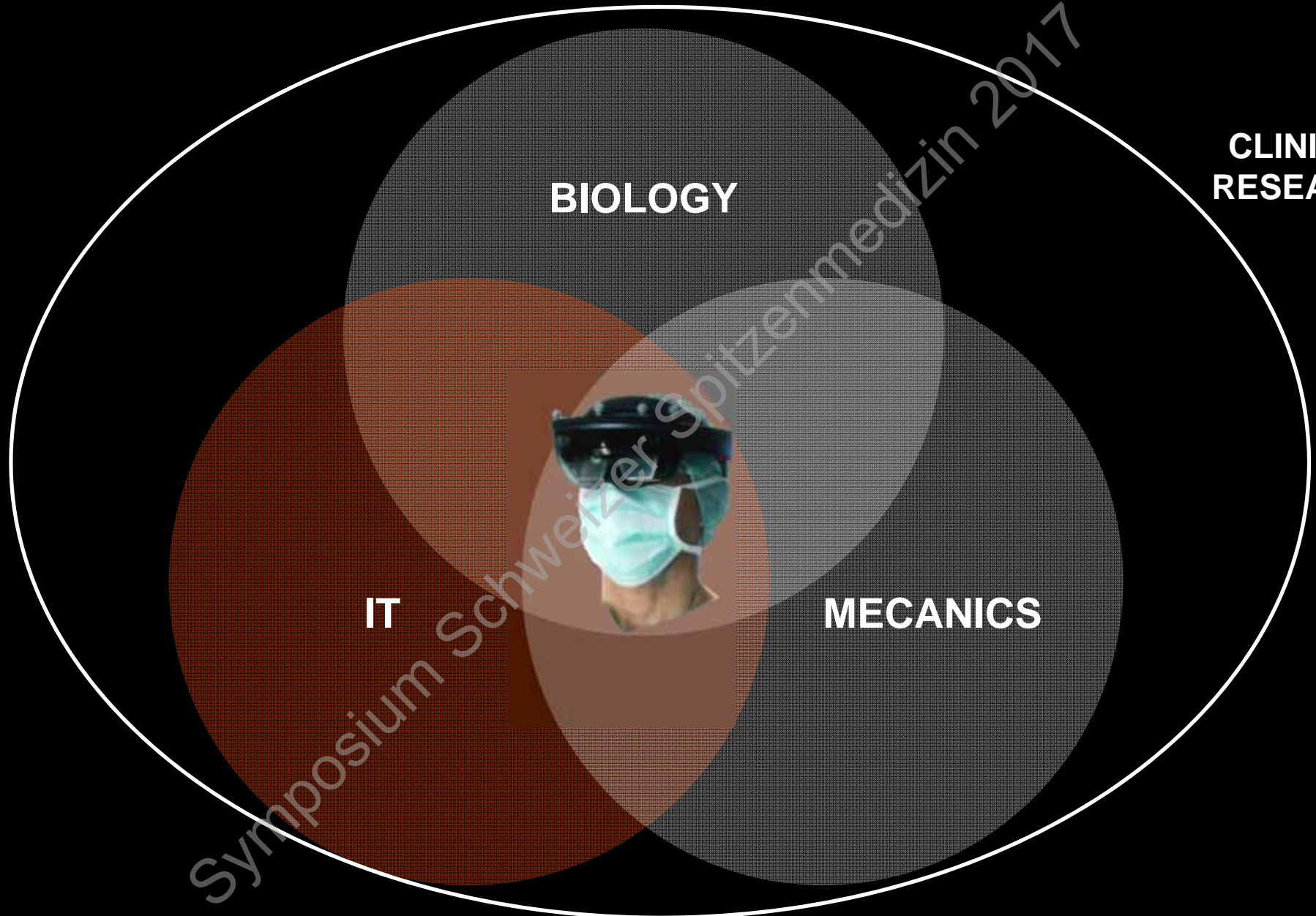
and



INFRASTRUCTURE



Balgrist Campus



BIOLOGY

**CLINICAL
RESEARCH**

IT

MECANICS

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THANK YOU

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