

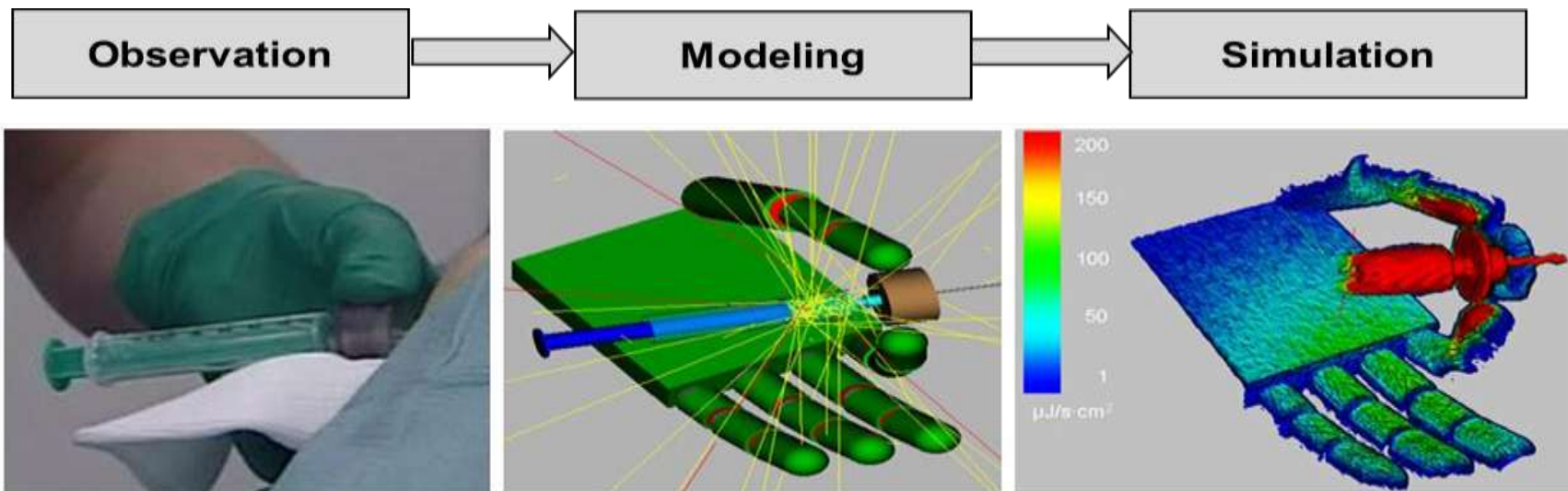
# APPLICATION OF HAND PHANTOMS IN SIMULATIONS TO DETERMINE THE RADIATION EXPOSURE OF MEDICAL STAFF

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INSTITUTE FOR NUCLEAR WASTE DISPOSAL - RADIATION PROTECTION RESEARCH



# CT-Fluoroscopy staff dosimetry



December 2009

## Thousands of New Cancers Predicted Due to Increased Use of CT

“

What is becoming clear . . . is that the large doses of radiation from such scans will translate, statistically, into additional cancers.

”

**Doses Higher and More Variability**

**Women Face Greater Risk**

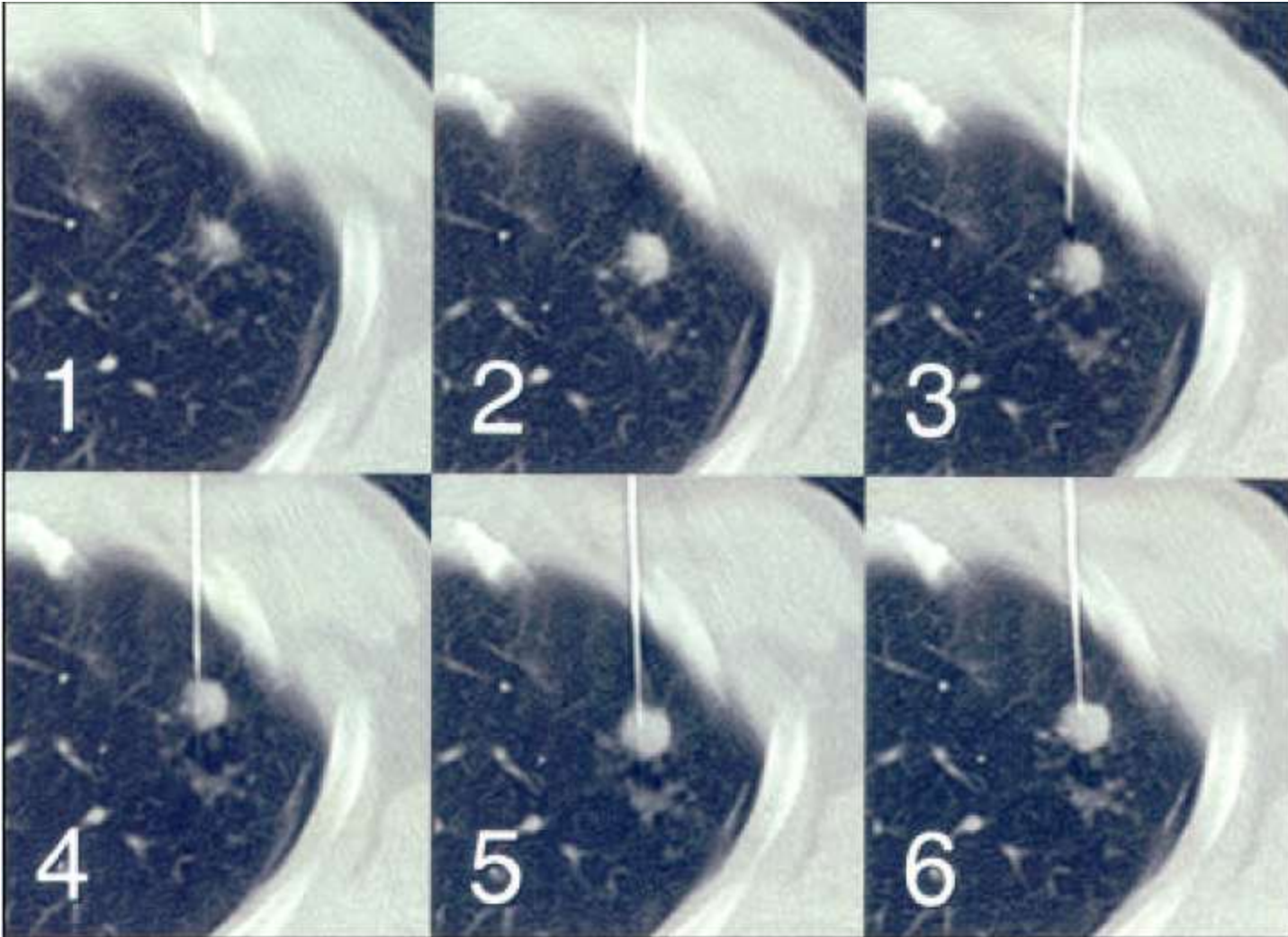
**Thousands of Future Cancers?**

# CT-Fluoroscopy - staff dosimetry



Typical situation in CT fluoroscopy (Siemens)

# CT-Fluoroscopy - staff dosimetry



CTF biopsy showing biopsy needle and lesion (Katada, Fujita Health University, JP)

# CT-Fluoroscopy - staff dosimetry

Location	Dose Rate ( $\mu\text{Gy/s}$ )	Dose for typical 120s procedure (mGy)	Number of procedures for 3/10 Dose Limit
Skin (hands, in x-ray beam)	3-4 mGy/s	n/a	n/a
Skin (hands, with needle holder)	17 $\mu\text{Gy/s}$	2 mGy	75
Body Trunk (above lead apron)	9 $\mu\text{Gy/s}$	1 mGy	6
Eyes	1.5 $\mu\text{Gy/s}$	0.4 mGy	375 *

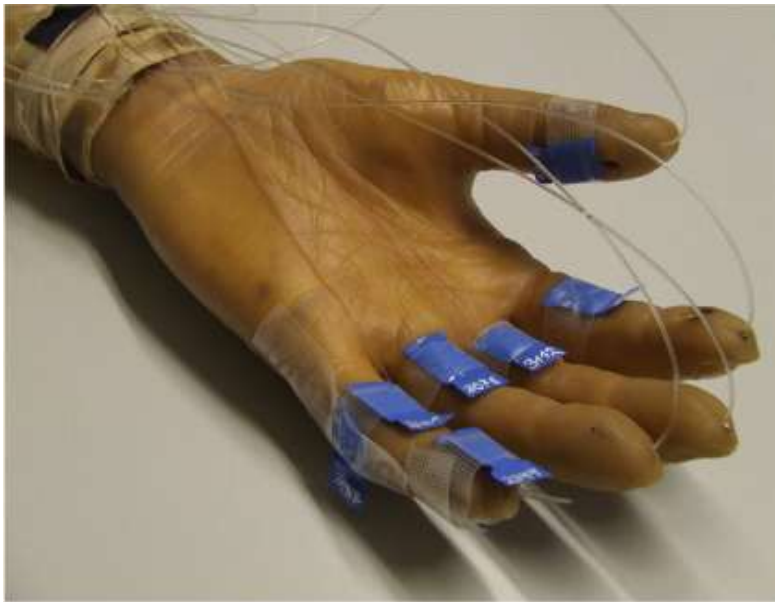
Scattered dose rates to equipment operator from CT  
 (Exposure parameters: 120 kV, 50 mA)

\* New recommendation limit 20 mSv : 50 procedures

# CT-Measurements and Simulations => EURADOS

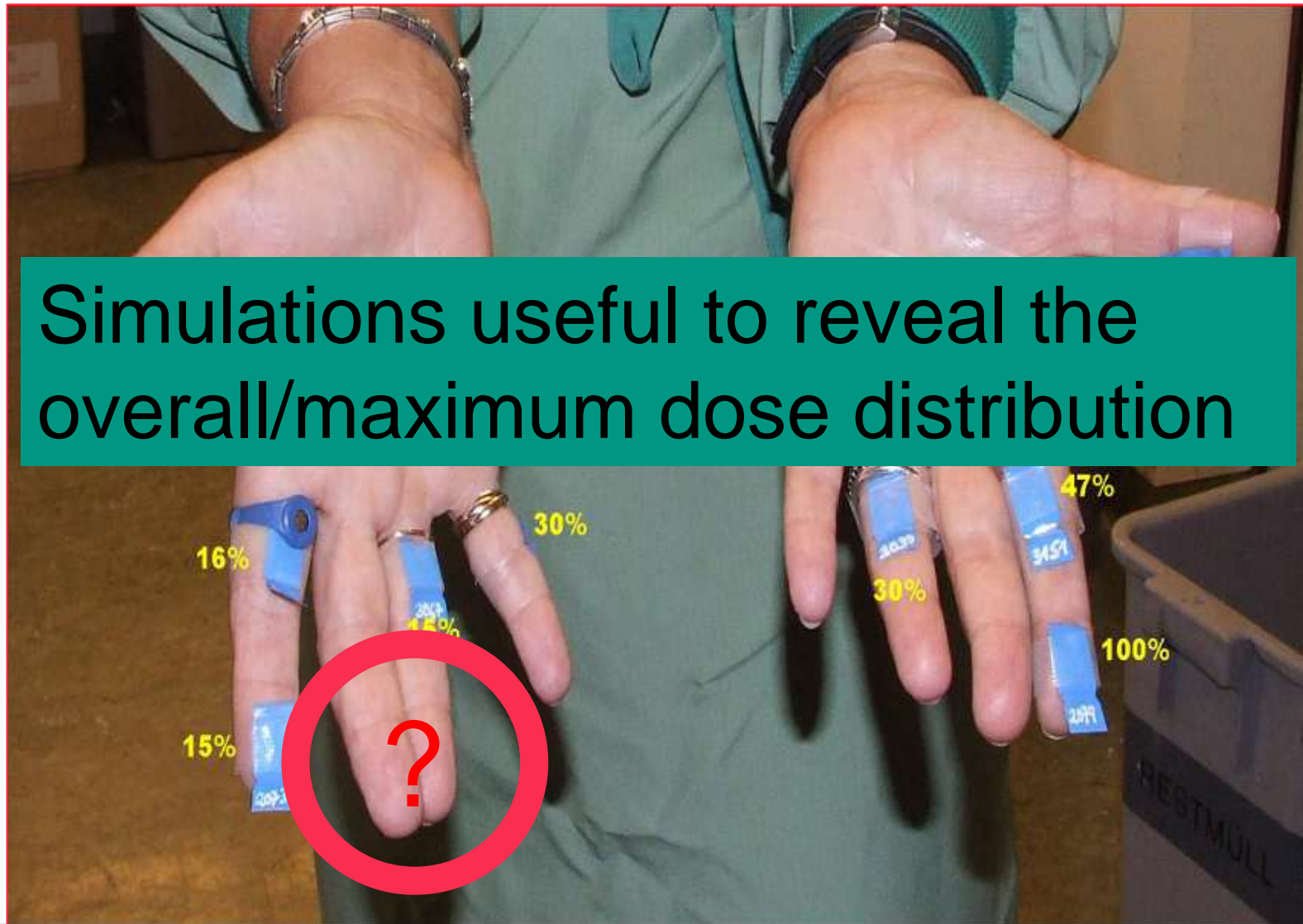


# Measurements with Handphantoms



phantom from LPS Berlin

# Typical Dose Distribution $H_p(0.07)$ on Hands





# CT-Fluoroscopy - staff dosimetry



CT devices

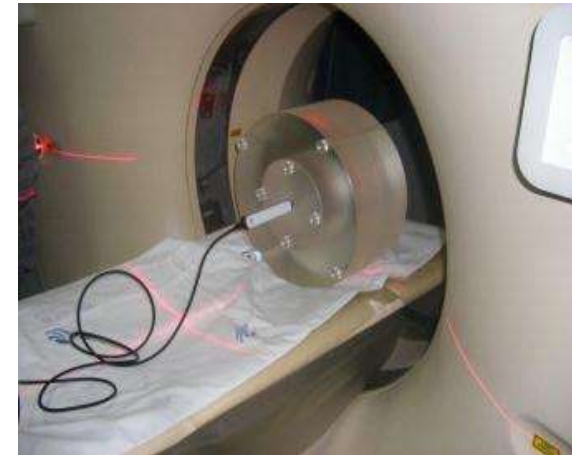
in Karlsruhe



and



Coimbra



# CT-Fluoroscopy - staff dosimetry



Measurements in Karlsruhe and Coimbra (cont.)

# CT-Fluoroscopy - staff dosimetry

Simulations in of the scenarios – validation of two programs

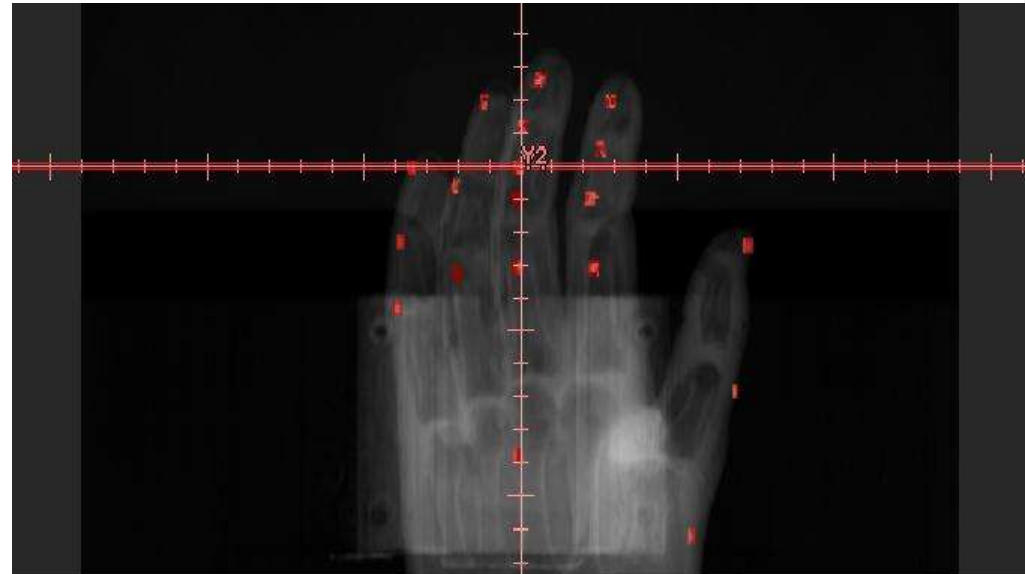
C. Figueira:

- MCNPX
- Voxel Phantoms from DICOM-Files
- Rotational movement simulated by 36 source positions

F. Göpfert:

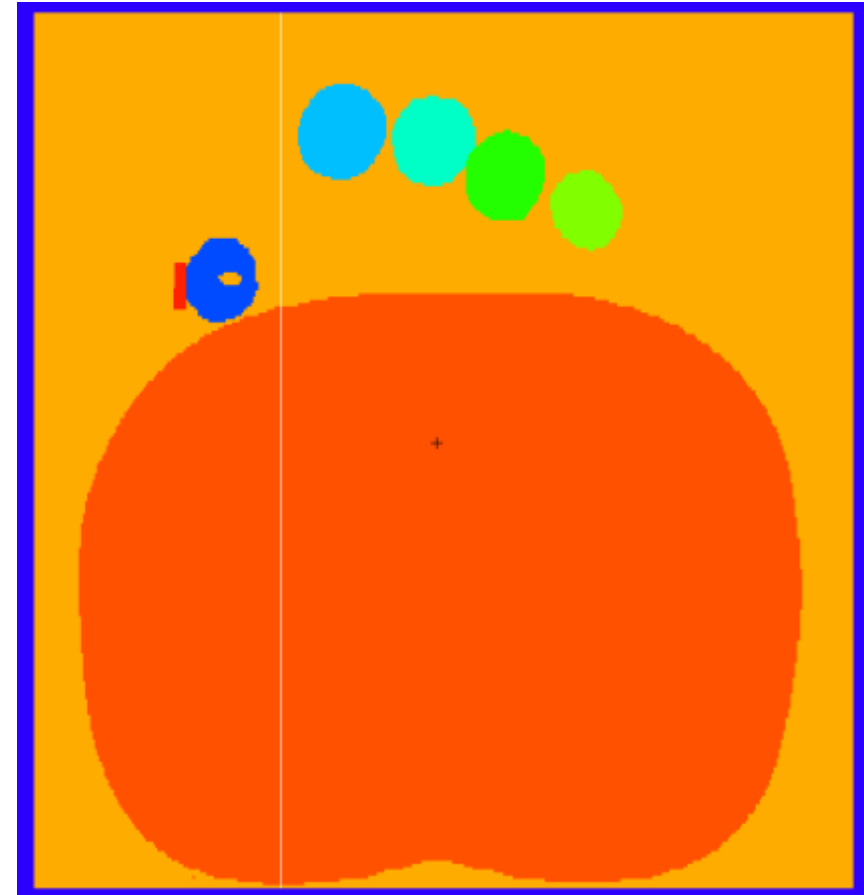
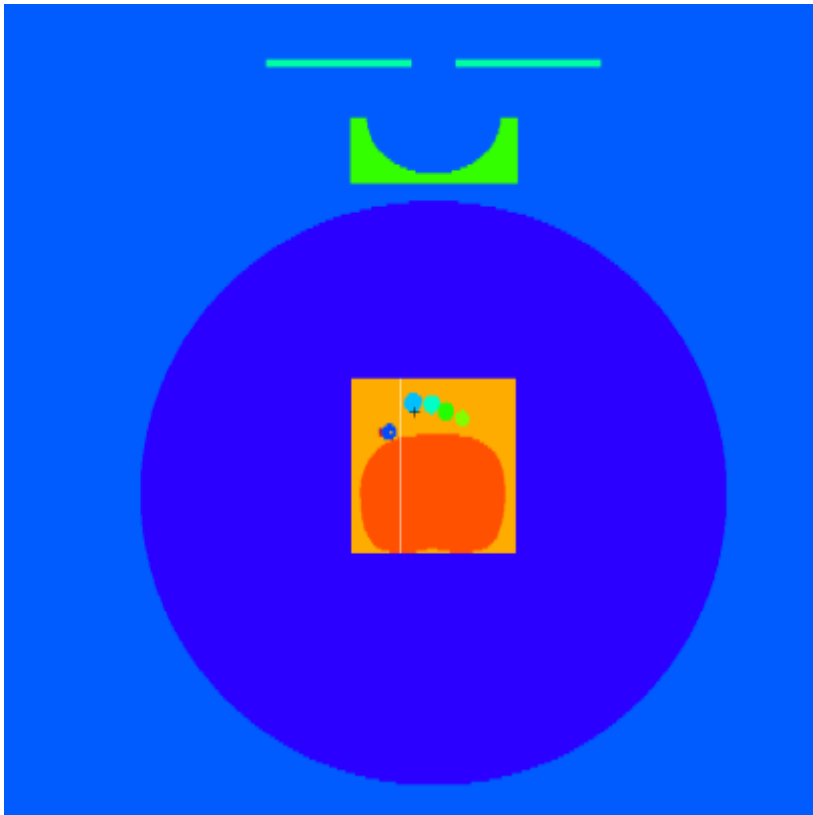
- GMctdospp developed by Ralph Schmidt, Giessen
- GUI to handle EGSnrc
- Rotation mode in EGSnrc available
- DICOM-Files directly accepted in DICOM-RT-STRUCT format

# CT-Fluoroscopy - staff dosimetry



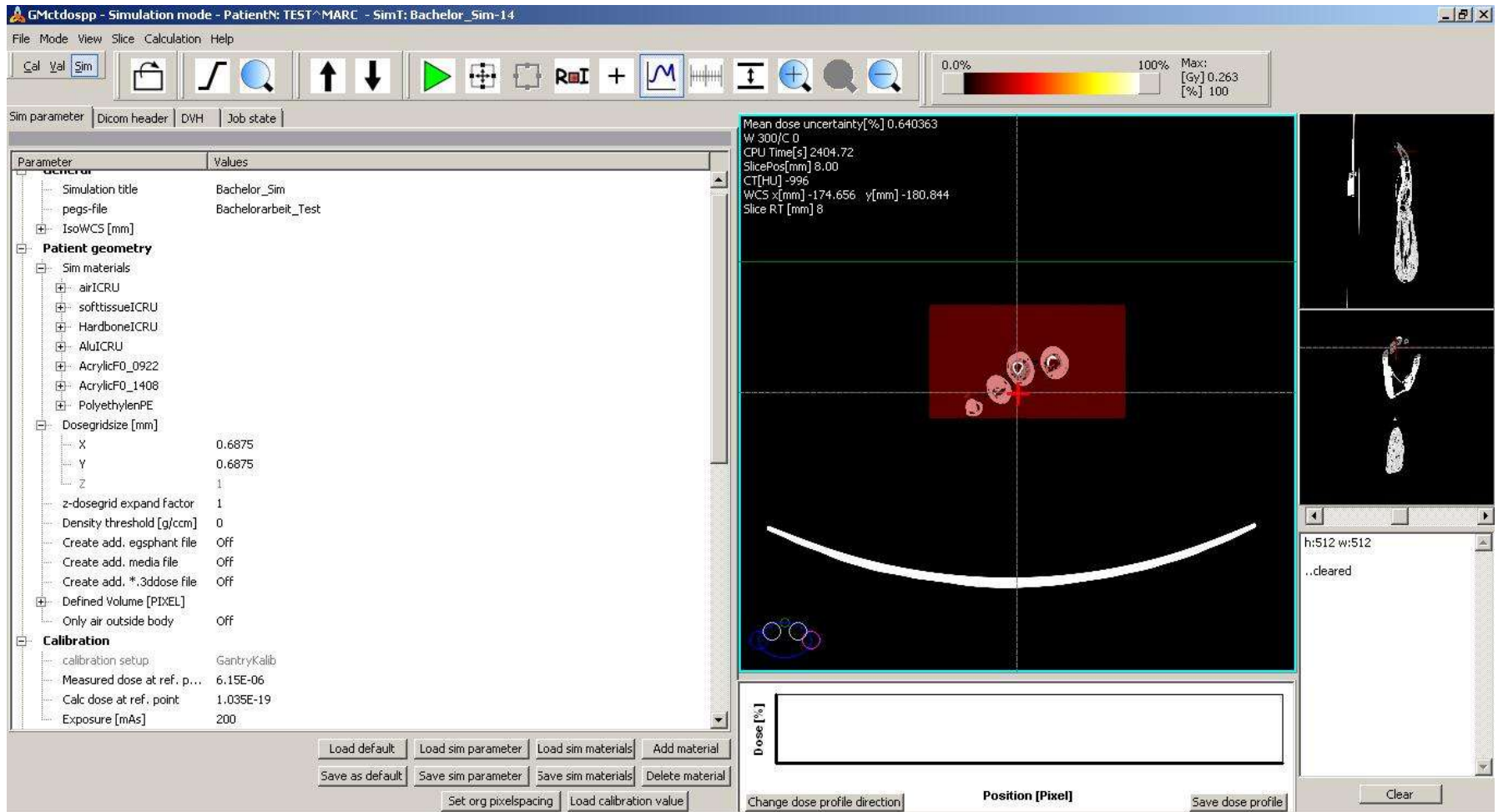
DICOM-Files

# CT-Fluoroscopy - staff dosimetry



MCNPX

# CT-Fluoroscopy - staff dosimetry



**GMctdospp - Simulation mode - PatientN: TEST^MARC - SimT: Bachelor\_Sim-14**

File Mode View Slice Calculation Help

Cal Val Sim [Icons]

0.0% 100% Max: [Gy] 0.263 [%] 100

Sim parameter | Dicom header | DVH | Job state |

Parameter	Values
<b>General</b>	
Simulation title	Bachelor_Sim
pegs-file	Bachelorarbeit_Test
<b>Patient geometry</b>	
Sim materials	
airICRU	
softtissueICRU	
HardboneICRU	
AluICRU	
AcrylicF0_0922	
AcrylicF0_1408	
PolyethylenPE	
Dosegridsize [mm]	
X	0.6875
Y	0.6875
Z	1
z-dosegrid expand factor	1
Density threshold [g/ccm]	0
Create add. egsphant file	Off
Create add. media file	Off
Create add. *.3ddose file	Off
Defined Volume [PIXEL]	
Only air outside body	Off
<b>Calibration</b>	
calibration setup	GantryKalib
Measured dose at ref. p...	6.15E-06
Calc dose at ref. point	1.035E-19
Exposure [mAs]	200

Mean dose uncertainty[%] 0.640363  
w 300/C 0  
CPU Time[s] 2404.72  
SlicePos[mm] 8.00  
CT[HLU] -996  
WCS x[mm] -174.656 y[mm] -180.844  
Slice RT [mm] 8

h:512 w:512  
...cleared

Dose [%]  
Position [Pixel]

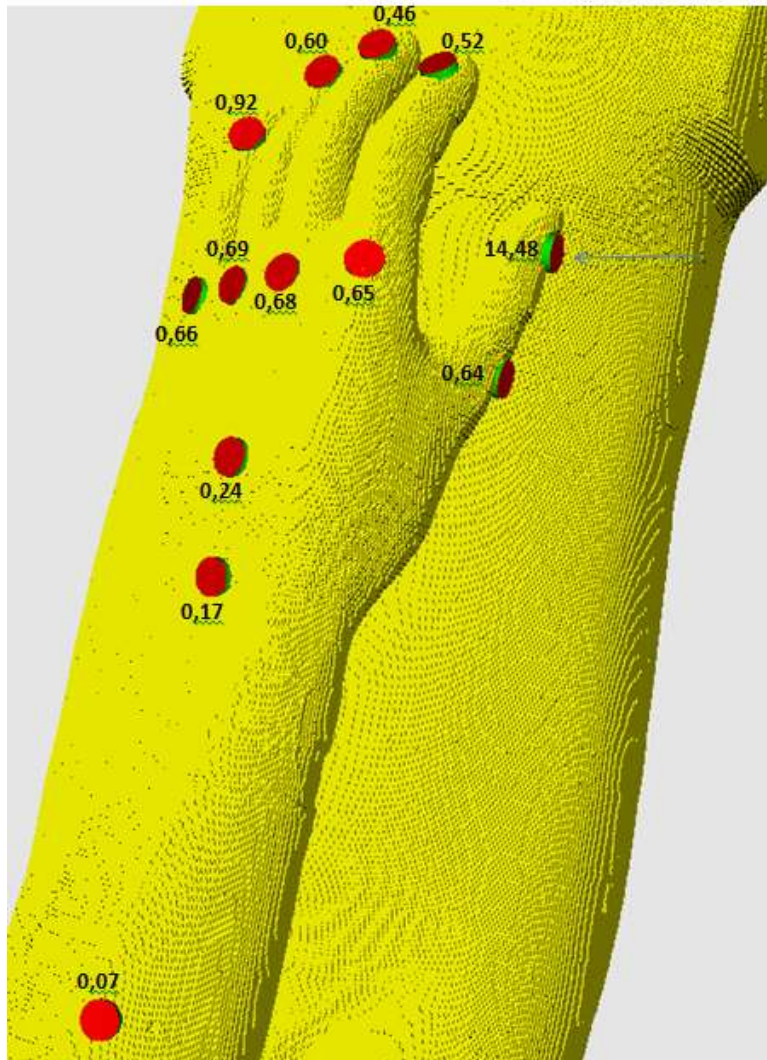
Change dose profile direction | Save dose profile | Clear

GMctdospp

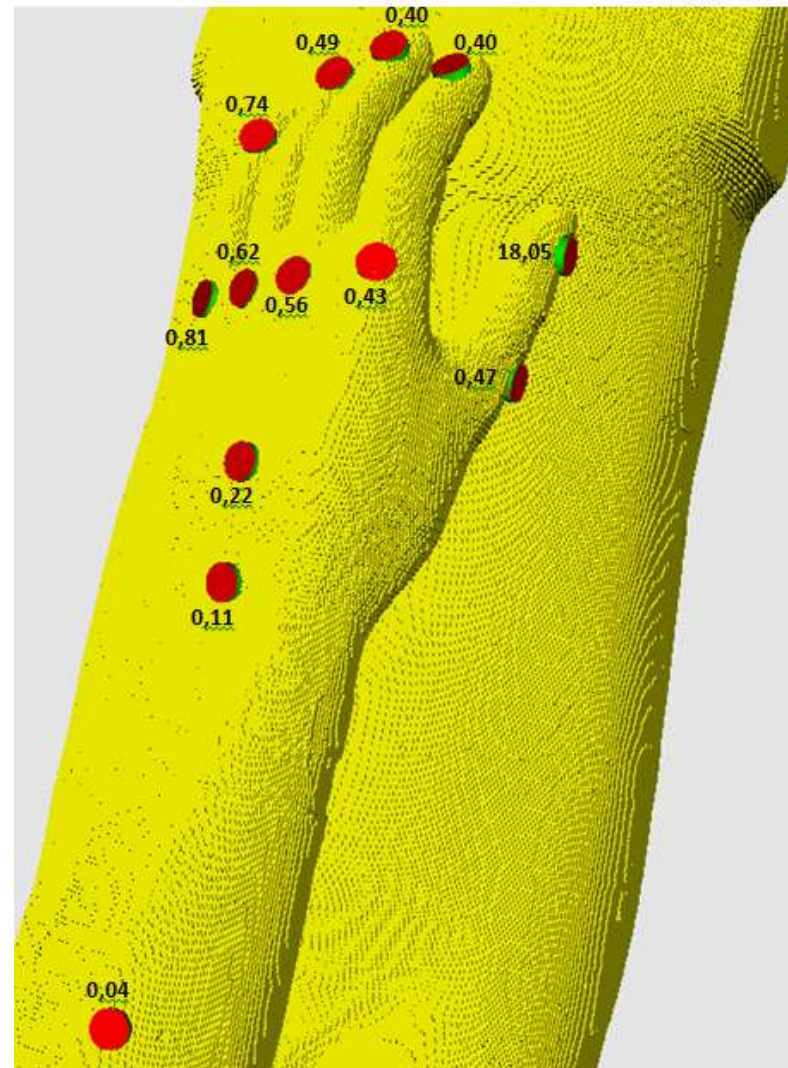
# CT-Fluoroscopy - staff dosimetry



Placing TLIDs in DICOM-RT-STRUCT files with the program ProSema



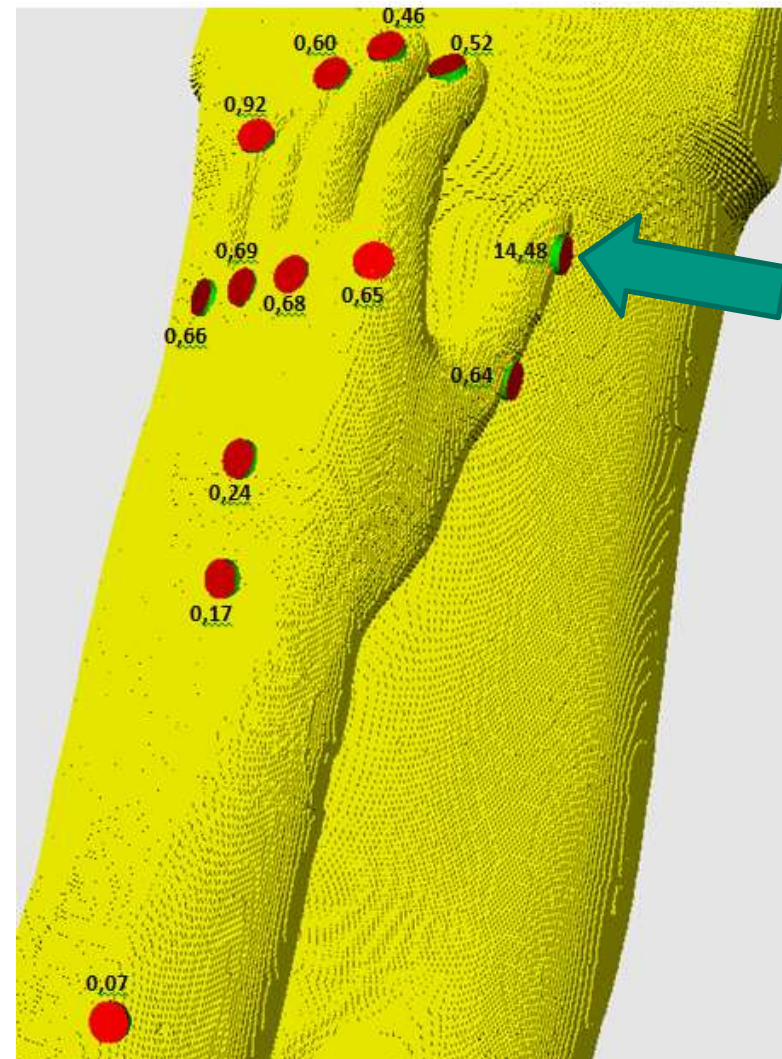
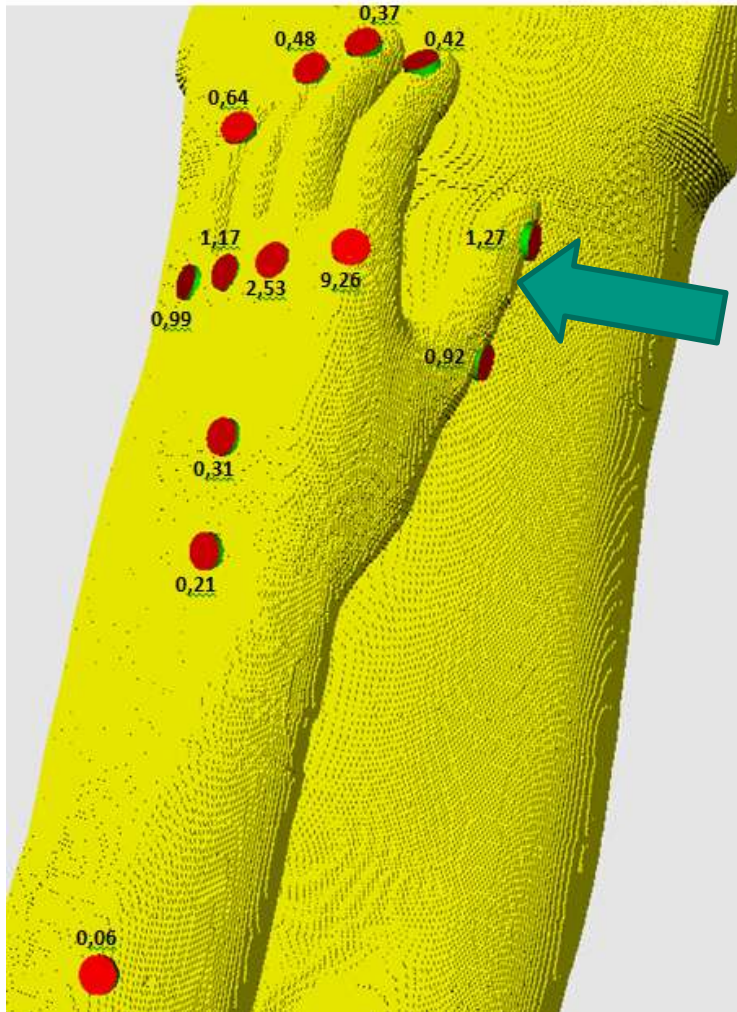
Simulations



Measurements

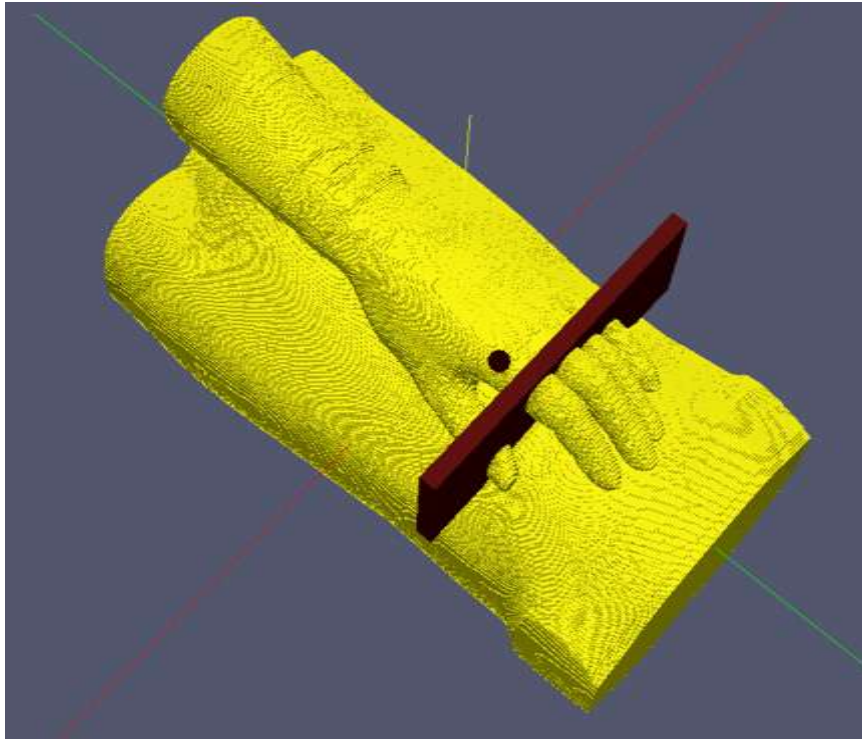


# CT-Fluoroscopy - staff dosimetry

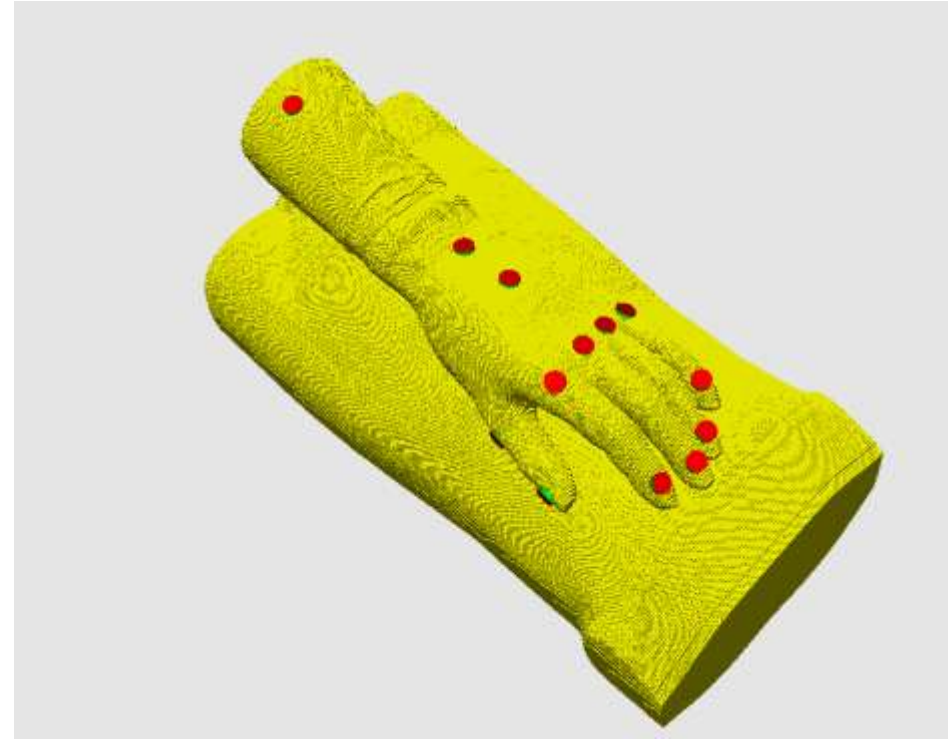


Strong beam spot influence (simulations)

# CT-Fluoroscopy - staff dosimetry

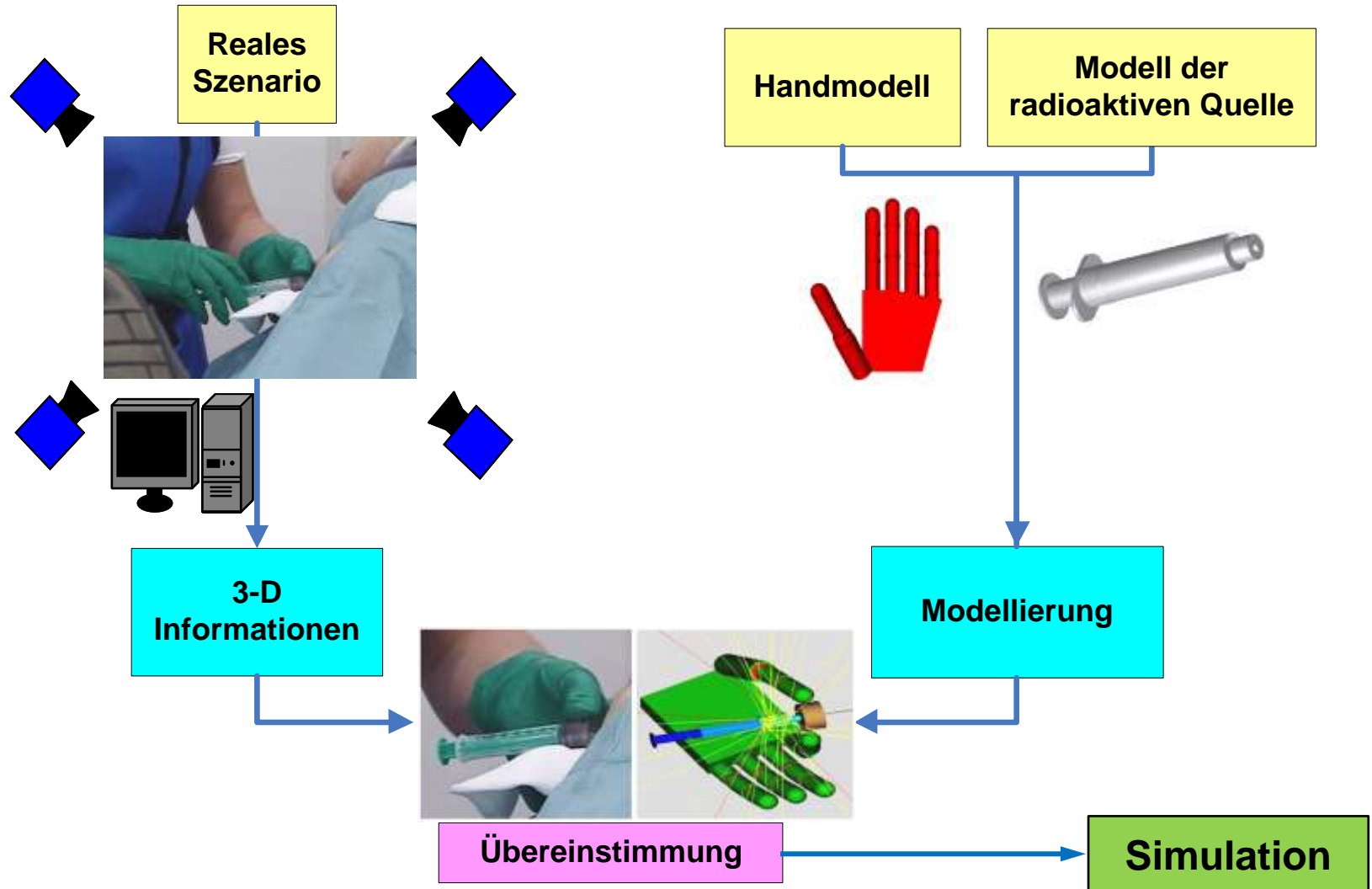


Beamspot

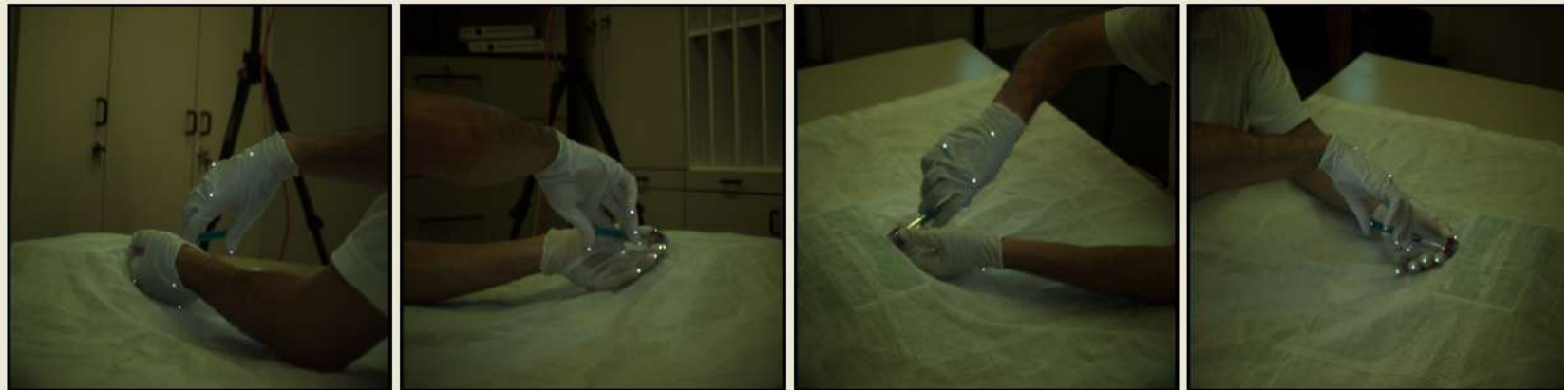


Dosimeters

Simulations



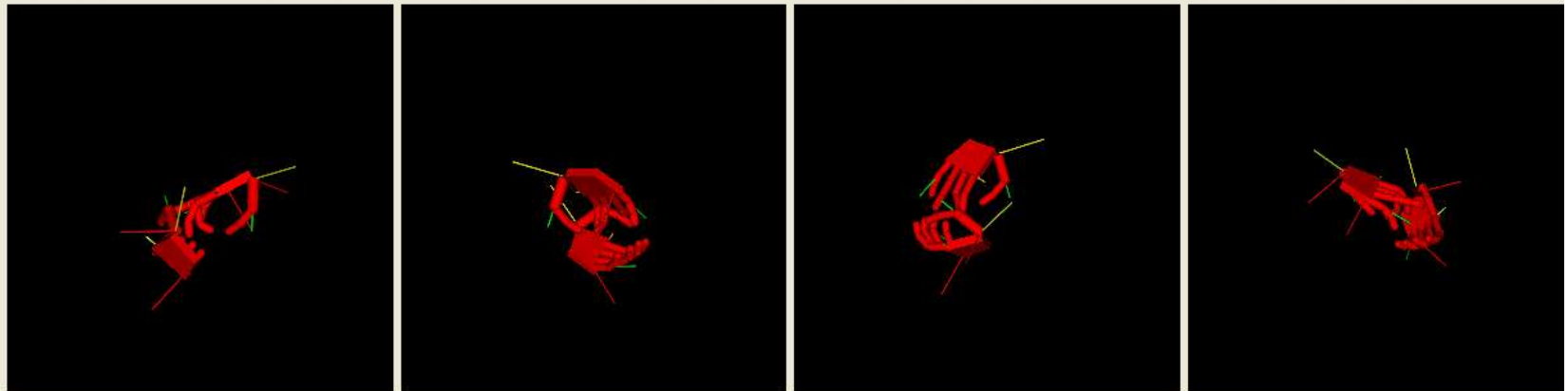
# Markers and Position Tracking



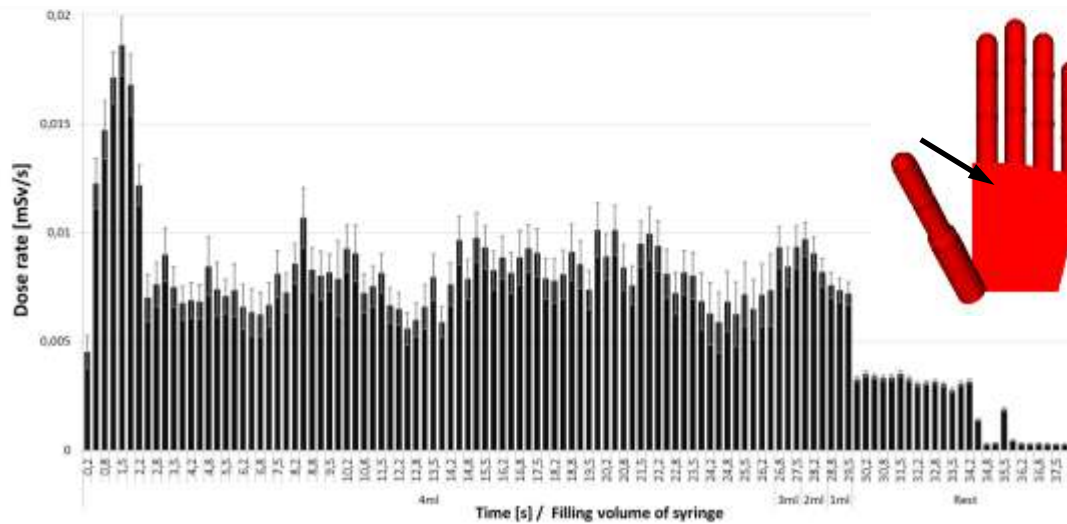
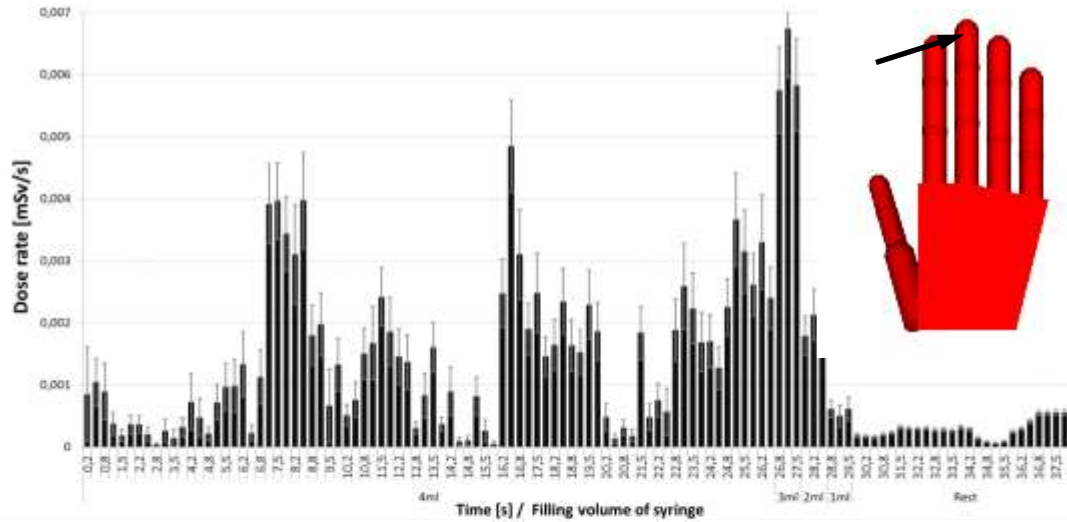
Video abspielen

Match

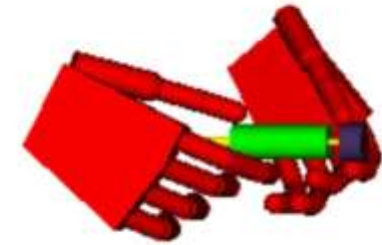
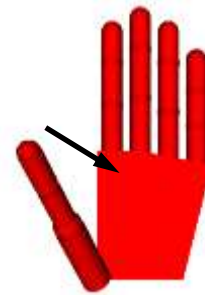
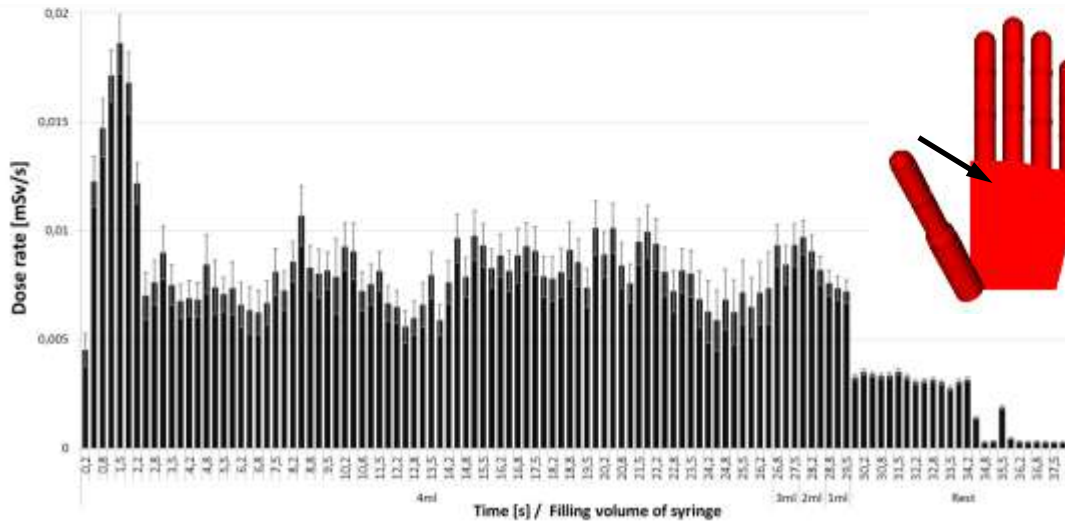
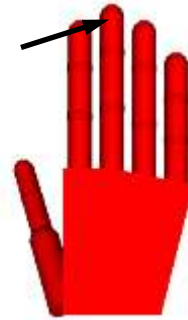
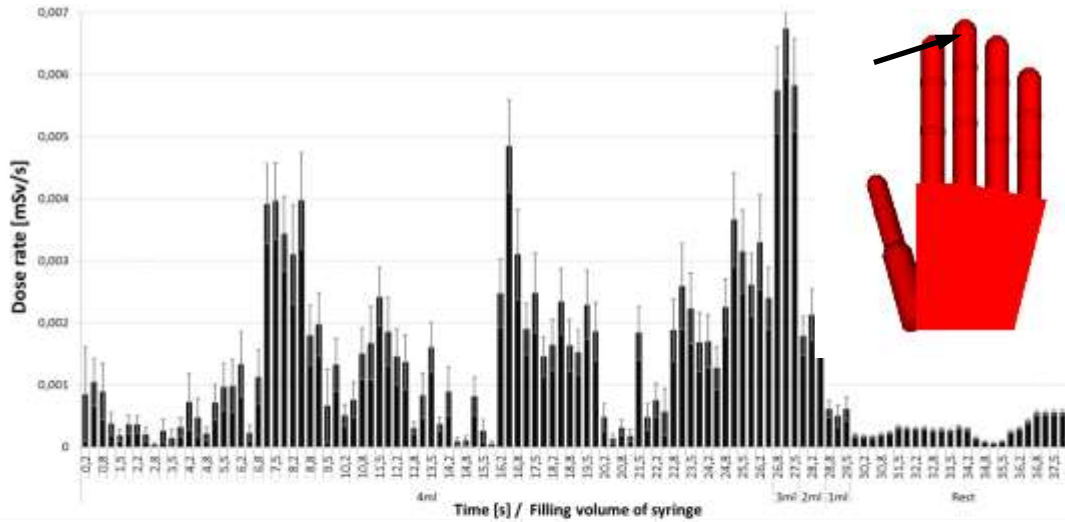
Kameraeinstellungen laden



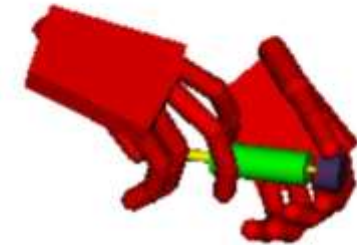
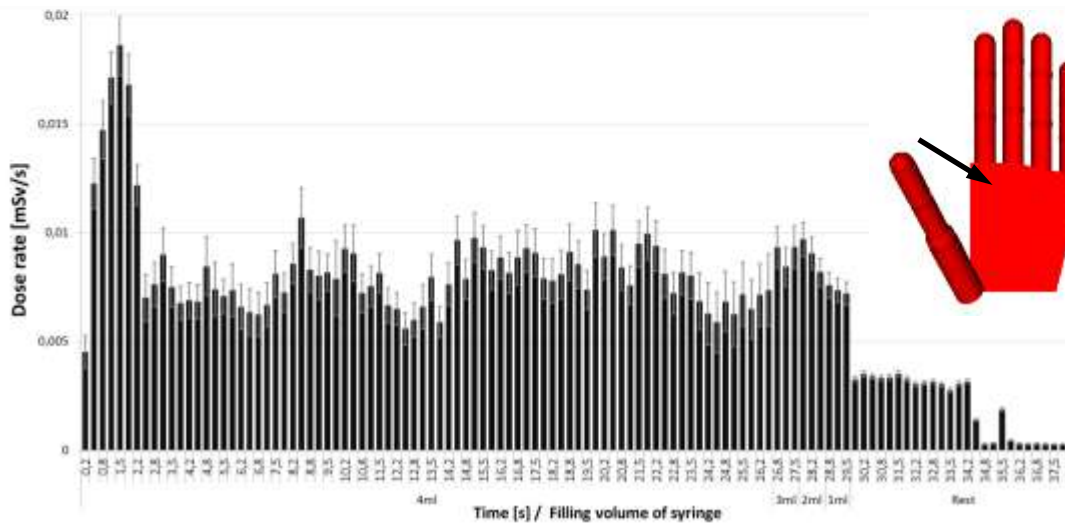
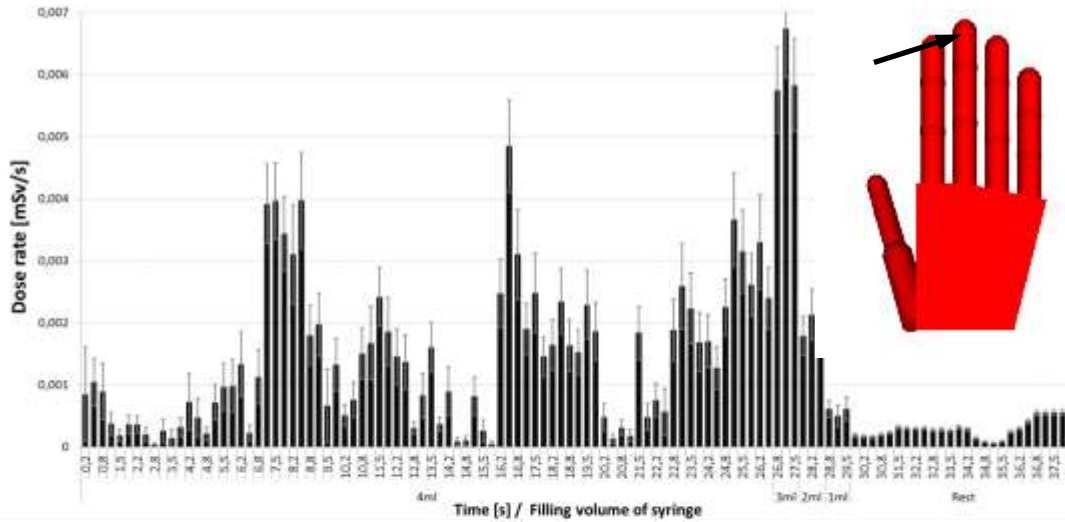
# Dose Rate during Injection



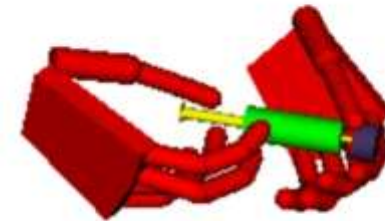
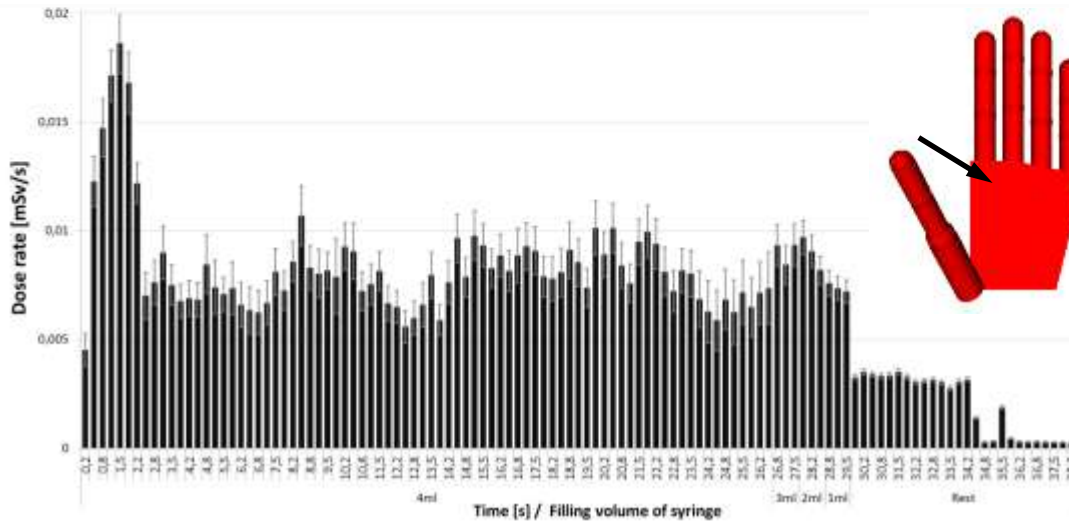
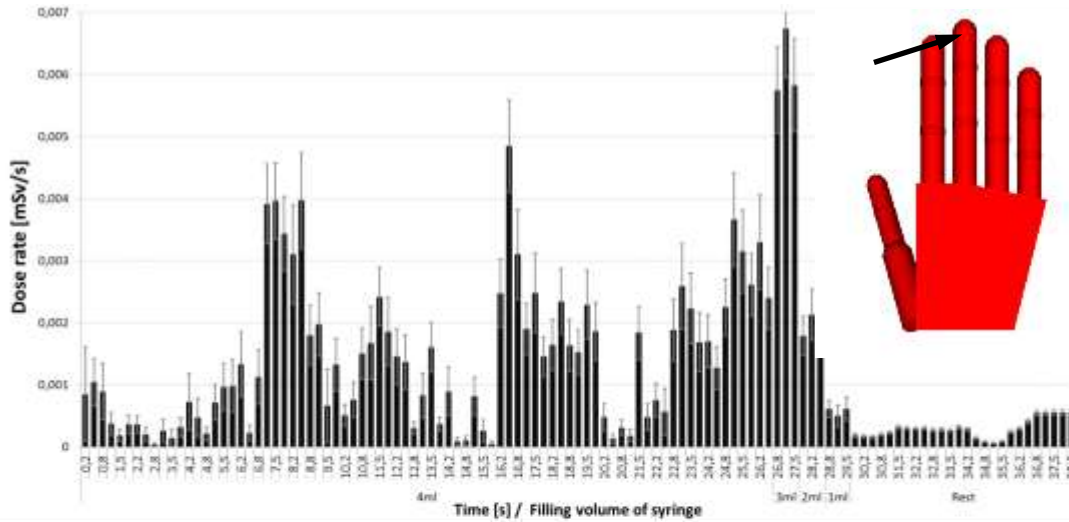
# Dose Rate during Injection



# Dose Rate during Injection

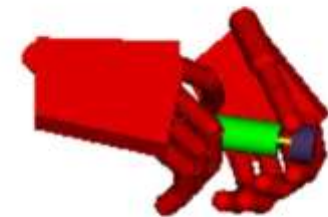
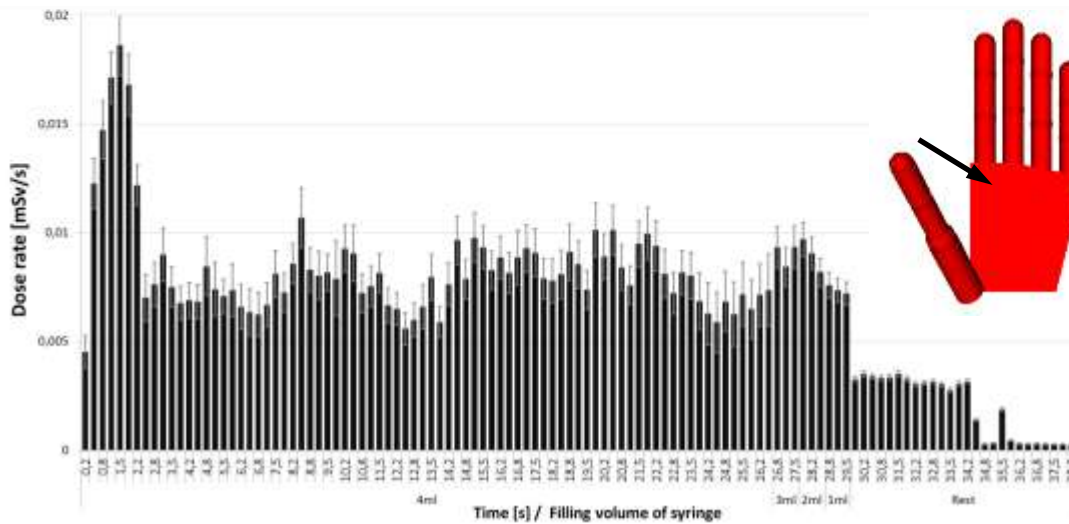
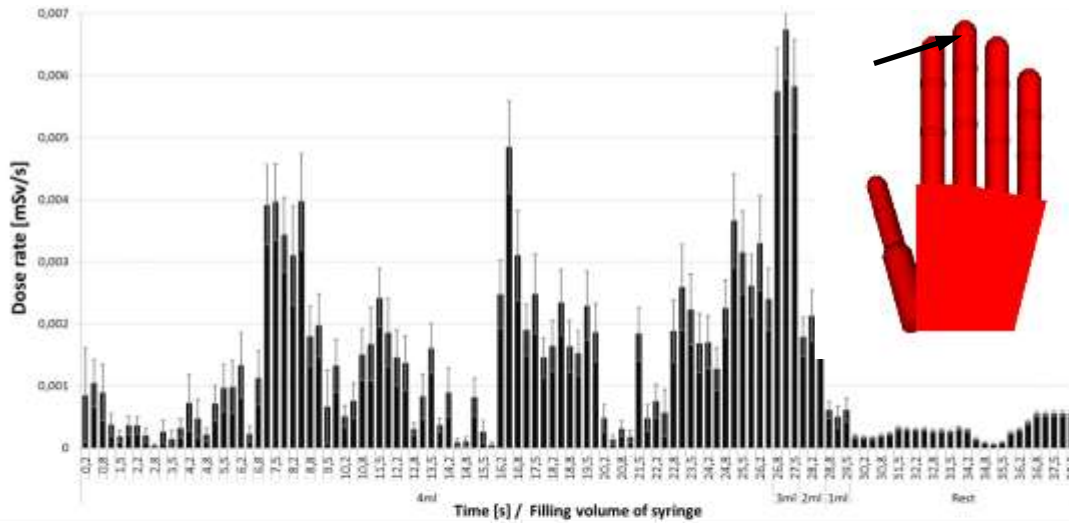


# Dose Rate during Injection

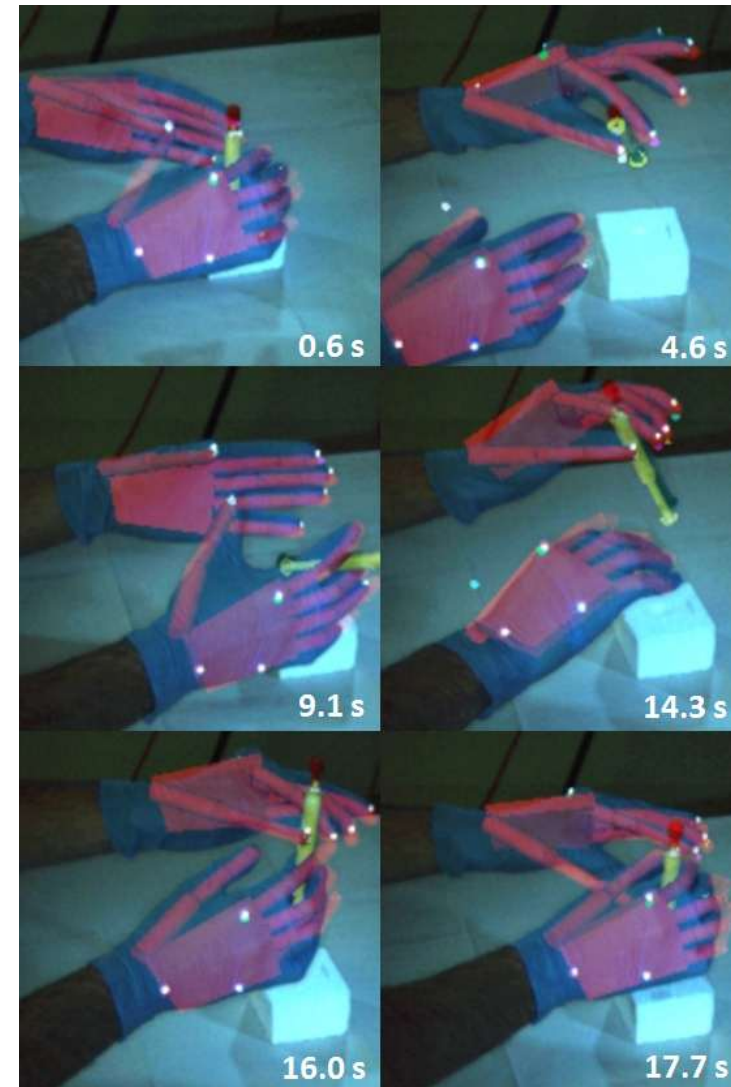
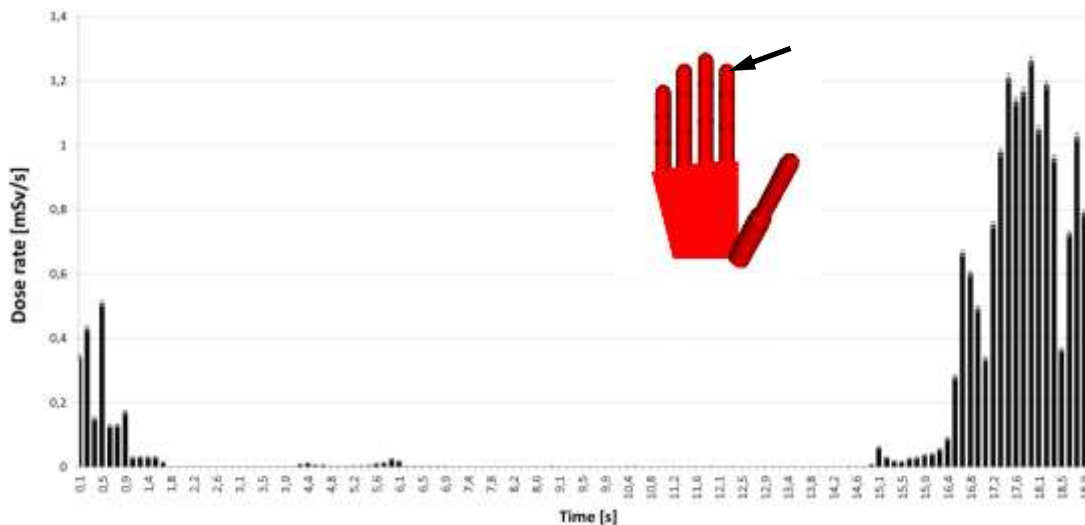
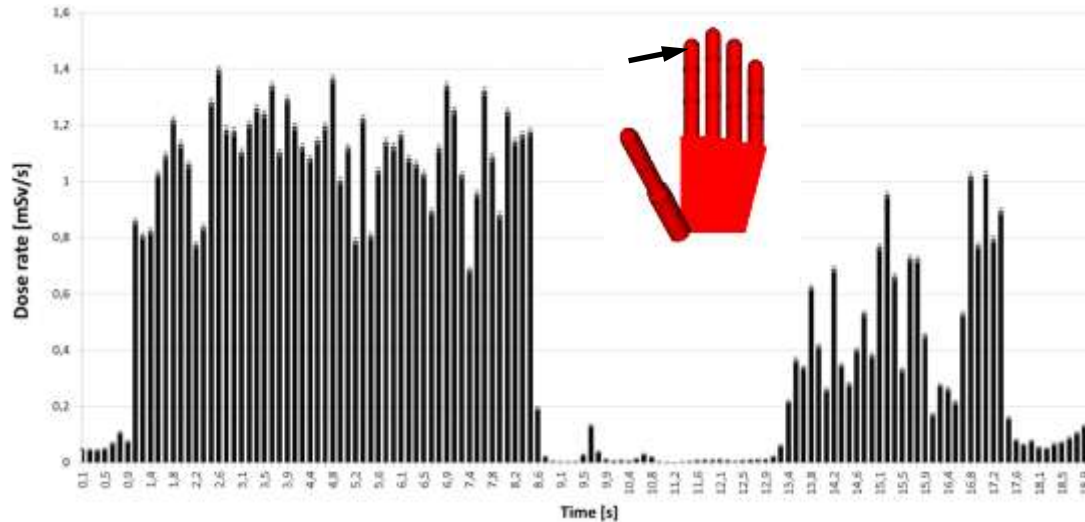




# Dose Rate during Injection



# Dose Rate during Handling under Laboratory Conditions



# Video + Hand Simulation

Ch. Blunck,  
PhD Thesis

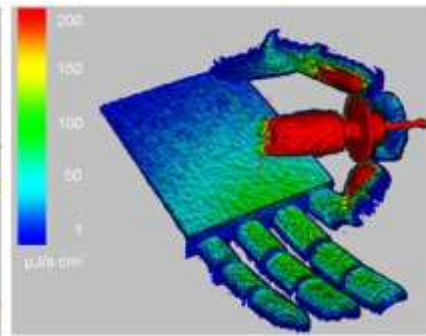
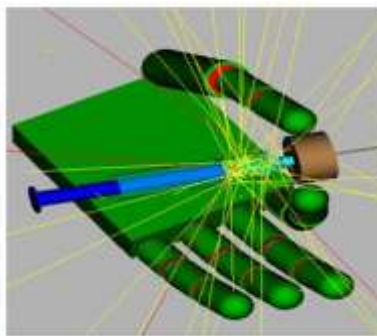


# Near Future: KIT and BOOSTER – Gamma Camera

- BiO-dOSimetric Tools for triage to Responders
- Contribution to WP 300 – Fast Evaluation

Include sensors in existing tracing systems for dosimetry analysis - superimposition with “visible” images

- carrying the gamma camera
- Camera for detection of substances
- medical projects and tests
- substances
- nuclear medicine therapy within a group of people



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<sup>2</sup> ITN,

<sup>3</sup> Radiology Department of Hospital dos Covões

<sup>4</sup> College of Health Technology of Coimbra

<sup>5</sup> LPS Berlin