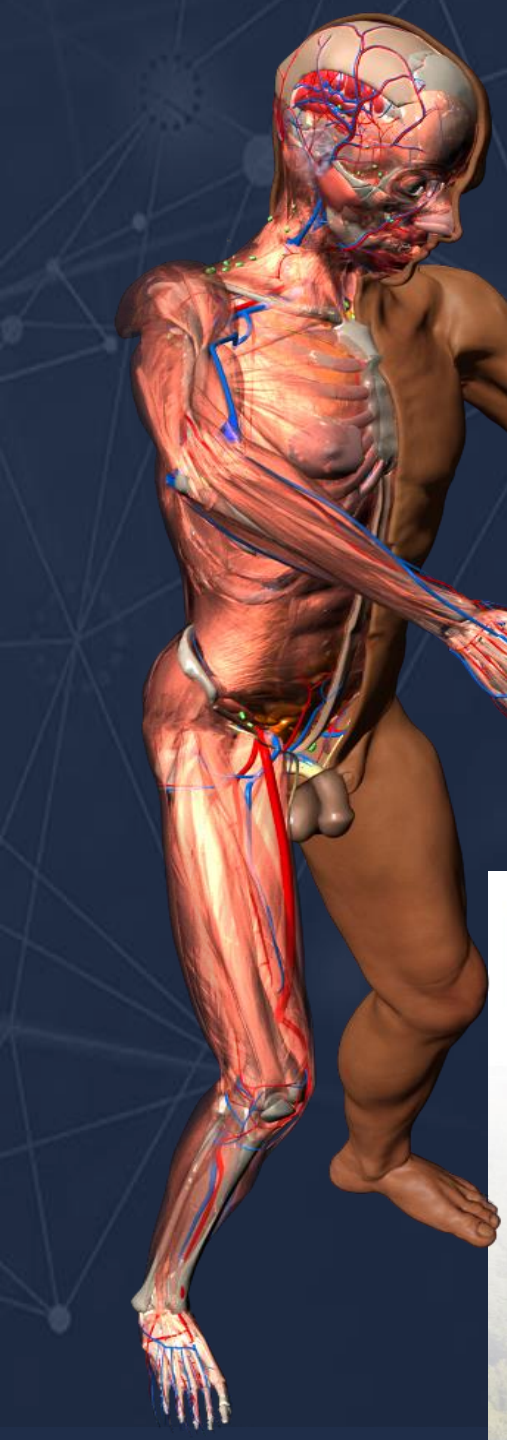


Computational personal dosimetry using flexible phantoms and staff tracking in decommissioning

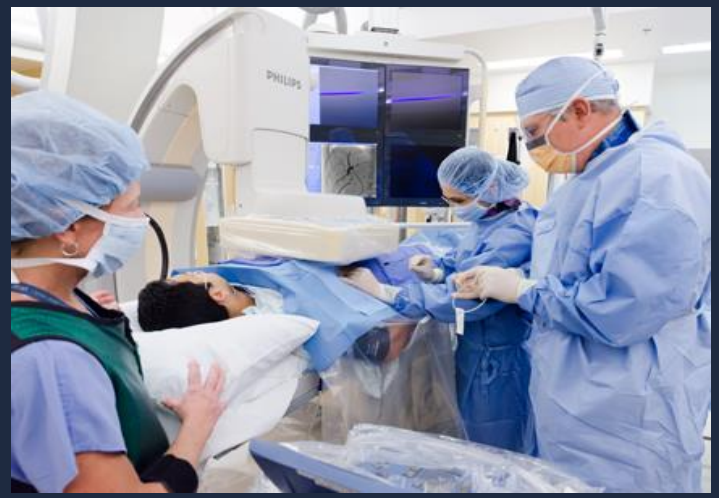
Filip Vanhavere, P. Lombardo, M. Abdelrahman, O. van Hoey

DigiDecom 2021 – DIGITAL

Online international workshop focusing on digital transformation, robotics and other game changing trends in nuclear decommissioning

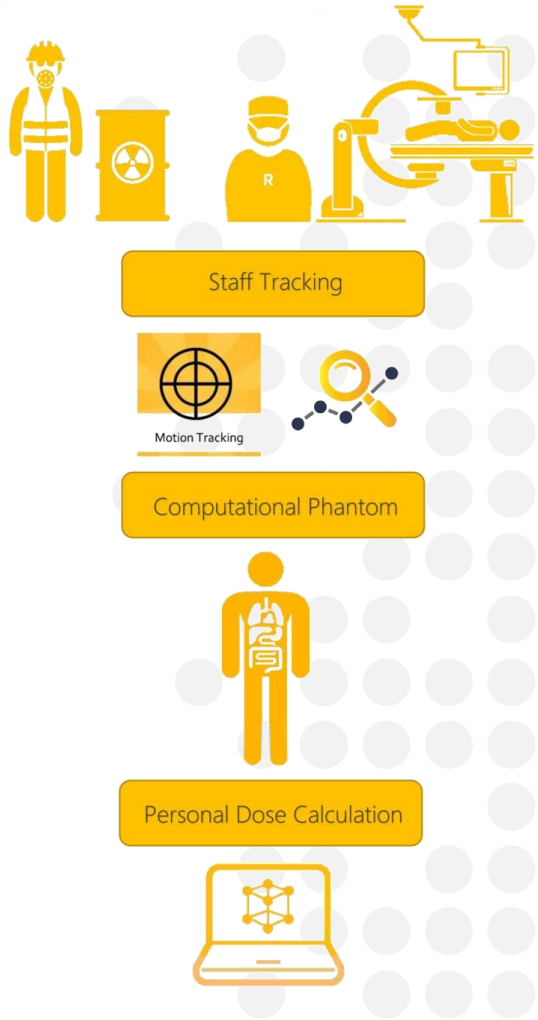
PODIUM project (2018-2020)

- CONCERT funded project of two years (2018-2020)
- Objective: to improve occupational dosimetry by the development of an online dosimetry application based on computer simulations
- 7 European partners, coordinated by **SCK.CEN**
- Two main applications: interventional radiology & neutron fields



PODIUM
Personal Online Dosimetry
Using computational Methods

EUROPEAN JOINT PROGRAMME FOR THE INTEGRATION OF RADIATION PROTECTION RESEARCH
CONCERT



Limitation of dosimetry: **practical aspects**

- Physical dosemeters are **not ideal** to wear and to handle
  - Incorrect positioning can affect dose assessments
  - Dosemeters require storage and handling
  - The use of multiple dosimeters is not practical and can hinder work

- Dosimetry requires manual **workload** from the staff and extra costs related to read-out

Limitations of dosimetry: **safety aspects**

- **Limited accuracy:** dosemeters are subject to high uncertainties (up to **50%)**, especially in highly **inhomogeneous fields**.
- In the last 50 years occupational dosimetry has been **evolving very slowly**, and its methods are falling behind the times.
- The quantities that can be assessed by physical dosemeters are **only** the **operational dose equivalents**, and **not individualized tissue/effective doses**

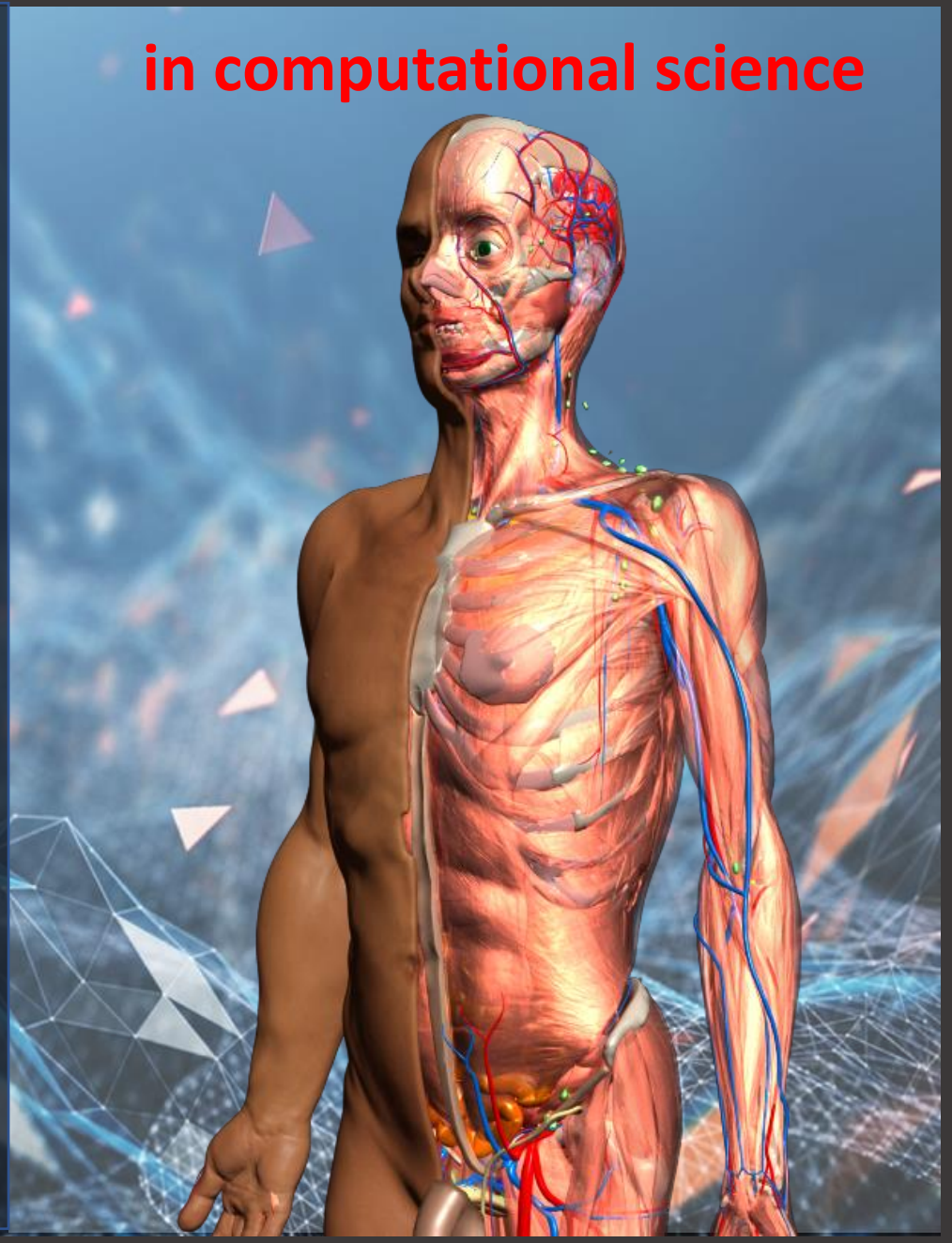
A computational system for real-time dose assessments

What's our objective?

- **Innovative:** marker-less system for person tracking and real-time dose estimations, providing both dose equivalents **and organ** and **effective doses**.
- **Accurate:** computational framework based on **Monte Carlo** simulations, advanced phantoms and accurate source modeling. We aim for organ dose uncertainties lower than 20%.
- **Practical** and **cost-effective**: **practical** thanks to **no need of dosimeter;** cost effective thanks to cheap hardware, lack of calibration and of readout processes. Our system can be framed as a subscription based service

Exploiting most advanced technologies

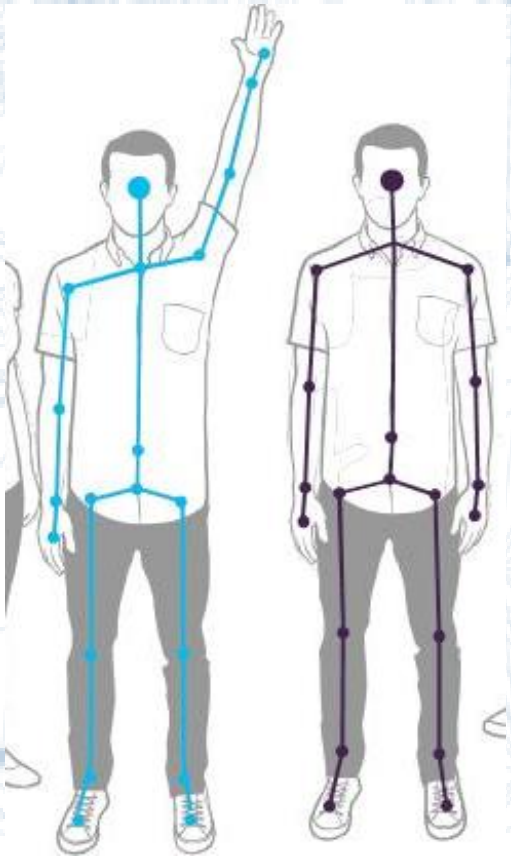
in computational science



Architecture of the Computational Dosimetry System

Commercially available camera

Person recognition and skeleton tracking



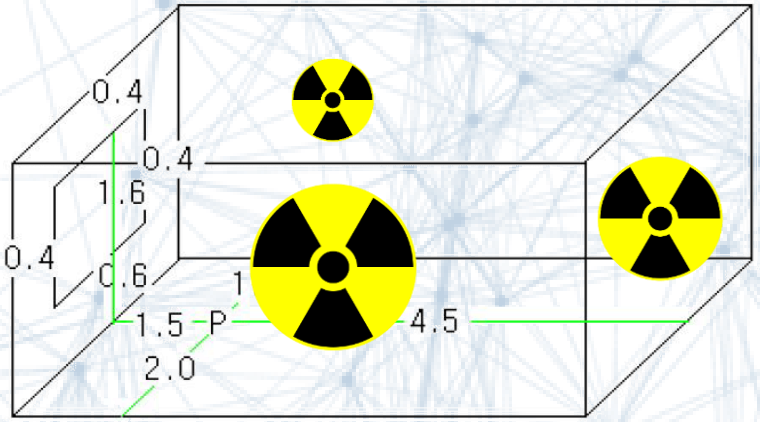
PODIUM
Personal Online DosImetry
Using CoMputational Dosimetry

Computational framework

A.I. + Monte Carlo

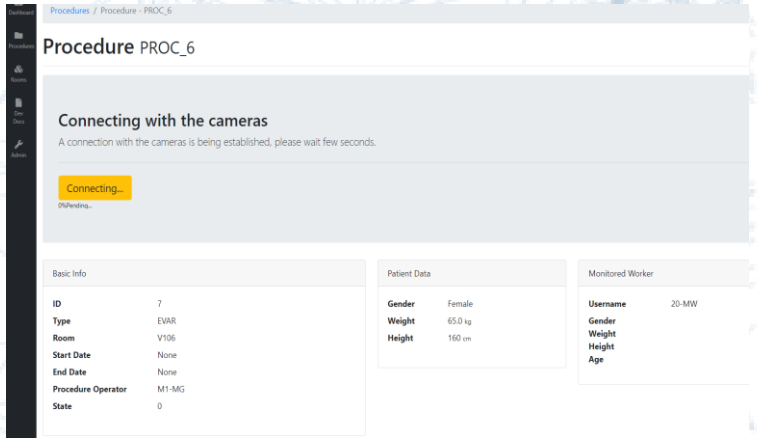
PODIUM
Personal Online DosImetry
Using CoMputational Dosimetry

Source parameters + room geometry



PODIUM
Personal Online DosImetry
Using CoMputational Dosimetry

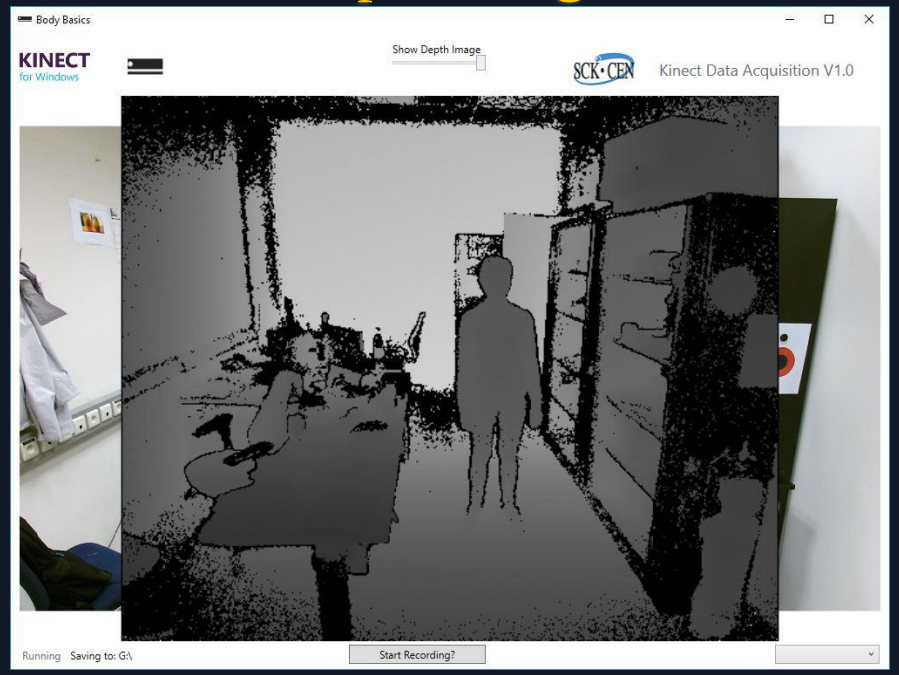
Web-app interface



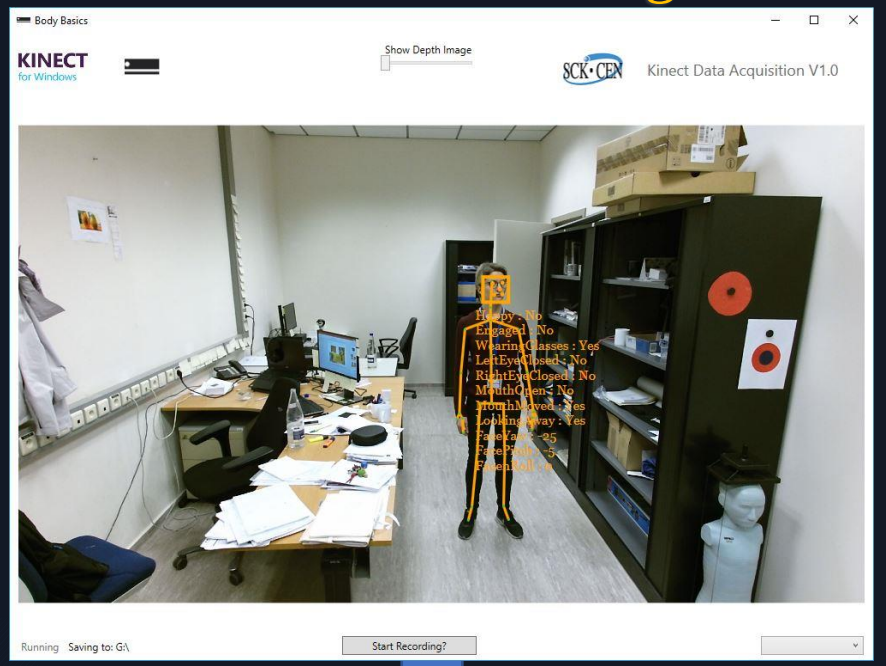
Staff Motion Tracking

Tracking system based on depth cameras

Depth Image



Skeleton Tracking



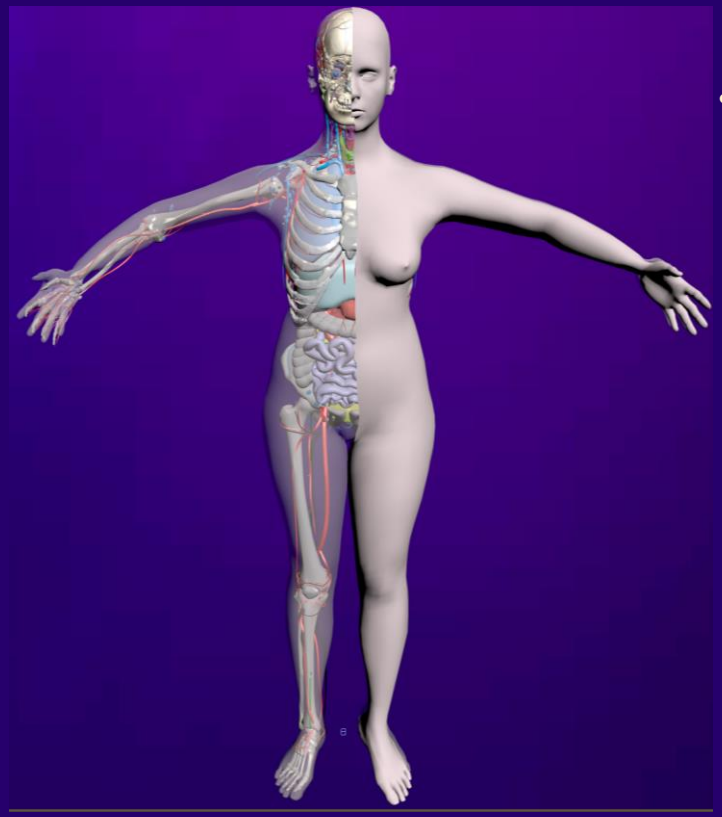
Real-time processing

Storing XYZ coordinates or send to a cloud

RAF phantoms family (2018-2021)

- **Polygonal Mesh B-Rep** phantom designed with 3Ds Max

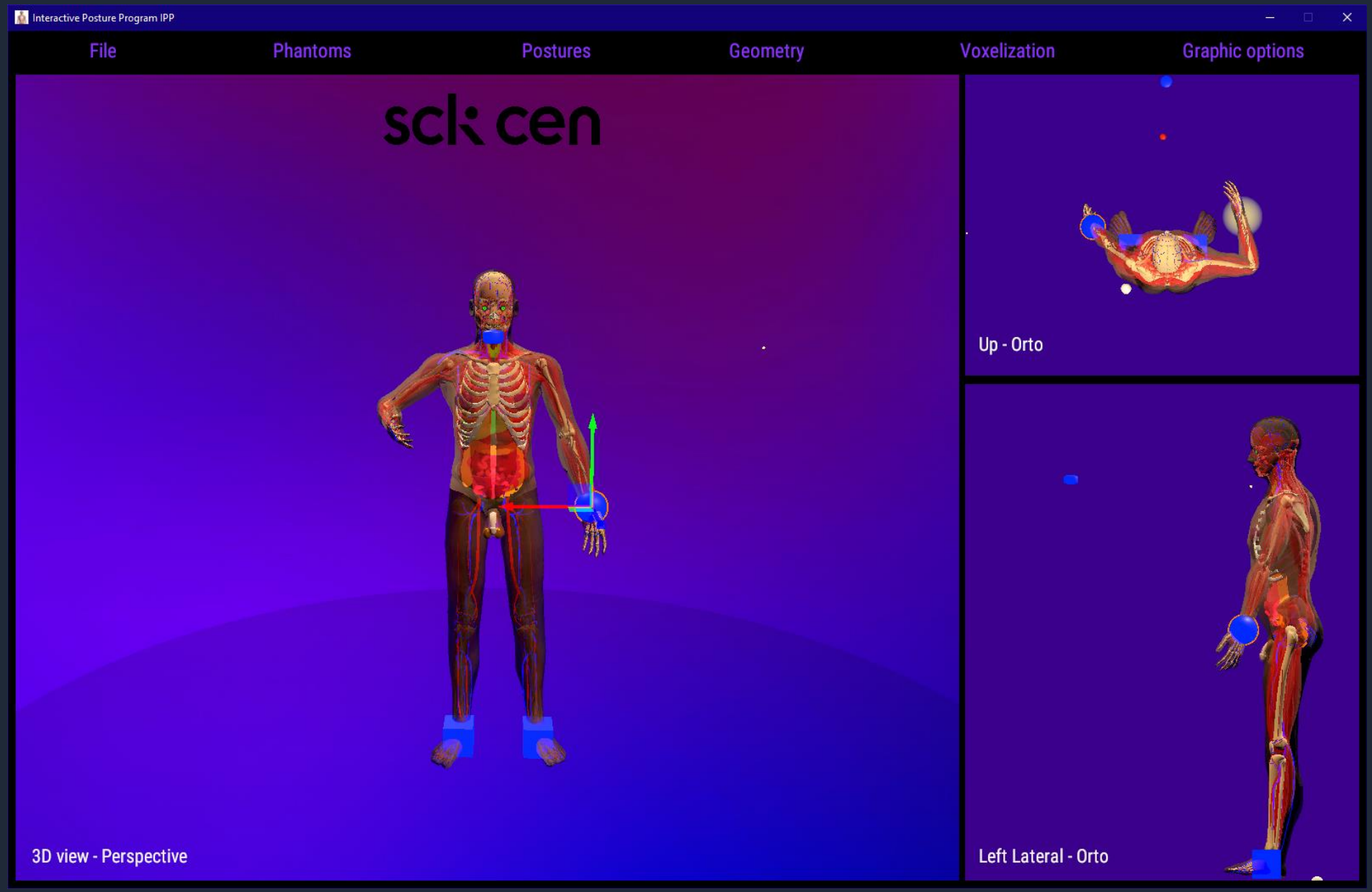
- **Tissue masses** (without blood) were **fit to ICRP 89**, with differences within ±10%.



- We performed a **dosimetric validation** for idealized external irradiation by comparing with **ICRP 116**. For most of the organs and energies, **differences were within ± 30%.**

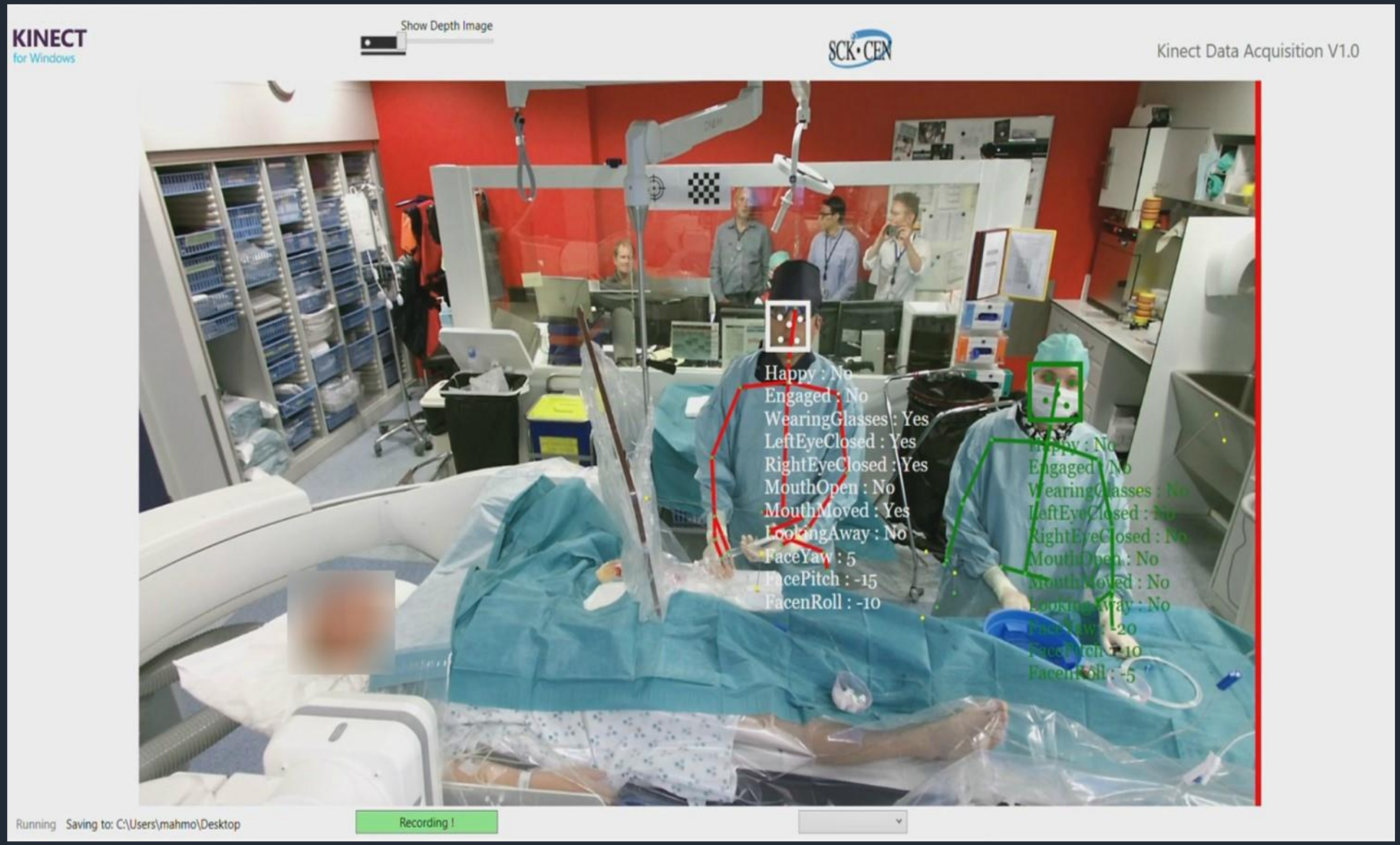
RAF phantoms postural flexibility

Interactive Posture Program (IPP)

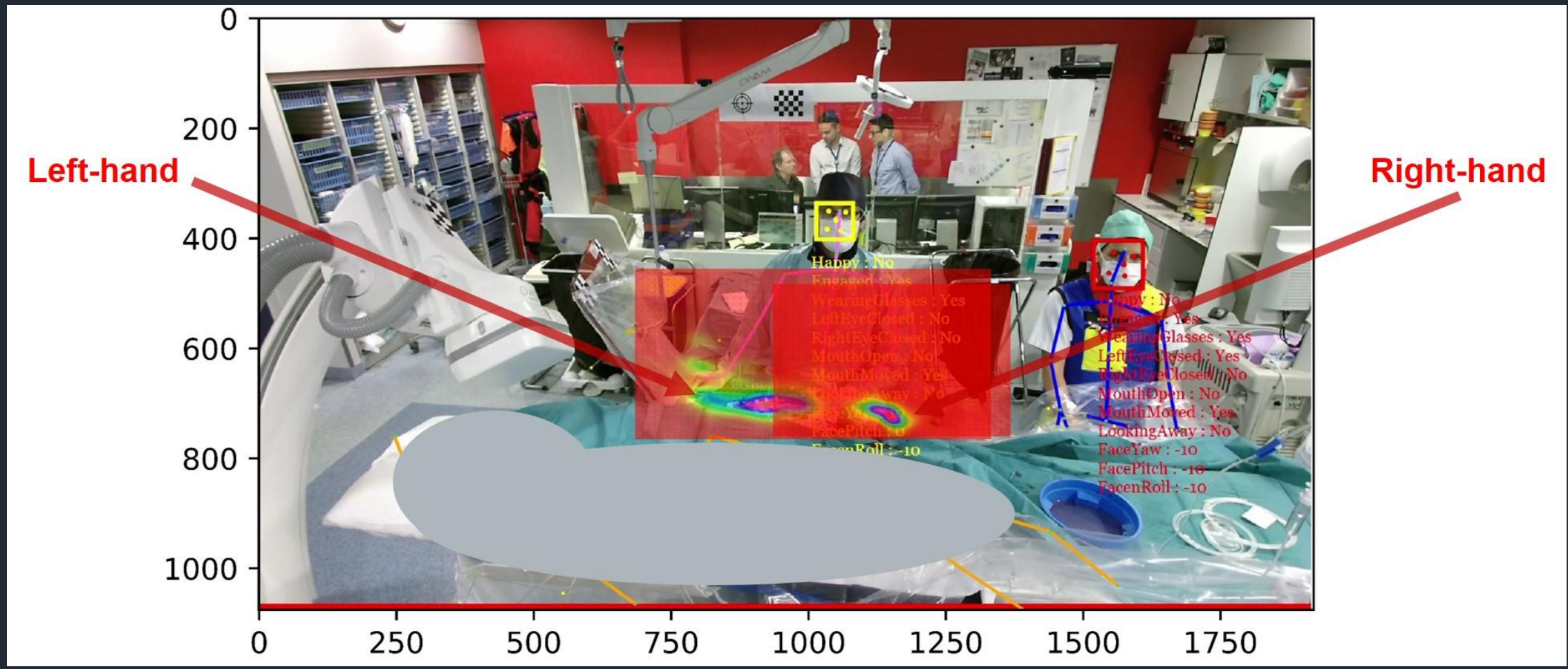


Interventional Radiology

Interventional Radiology



Interventional Radiology



Decommissioning

Online Dosimetry System for D&D (2022 ->)

We will develop a specialized version of the Online Dosimetry System to answer dosimetry requirements for D&D

New challenges:

- larger area to be monitored in the tracking the workers, including tracking of scattering/shielding objects -> use of newest Computer Vision algorithms based on Neural Network for person and object recognition
- Implement radioactive sources and PPE in the Monte Carlo models -> for the source, we will rely on radiological inventories, while PPE geometry will be modeled and added to the RAF phantom in Polygonal Mesh format
- Develop a virtual/augmented reality interface to efficiently and effectively inform/guide the D&D process -> use of 3D engines (Unity) and AR glasses (Hololens)

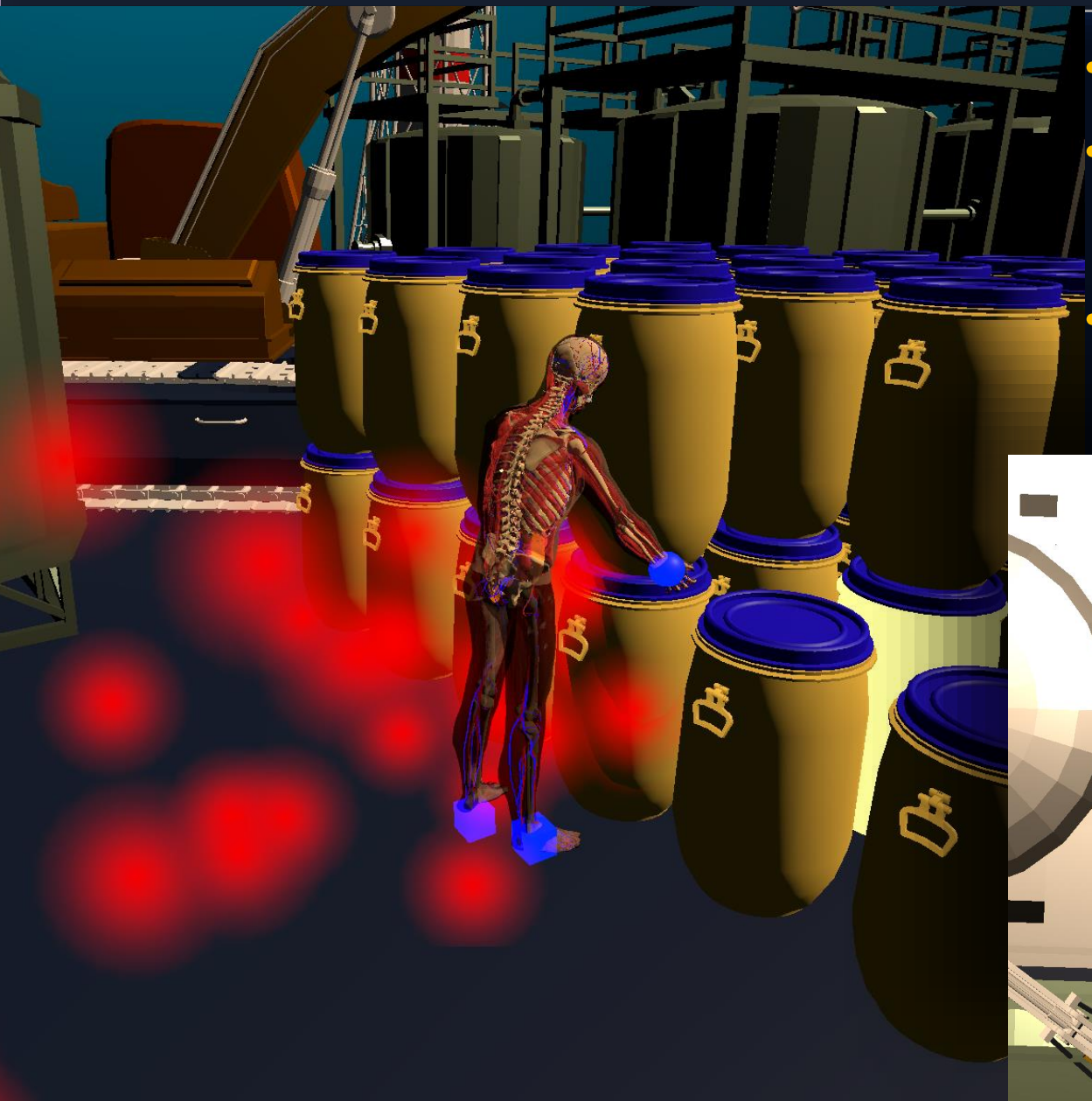
Online Dosimetry System for D&D (2022 ->): applications

Real time dosimetry monitoring

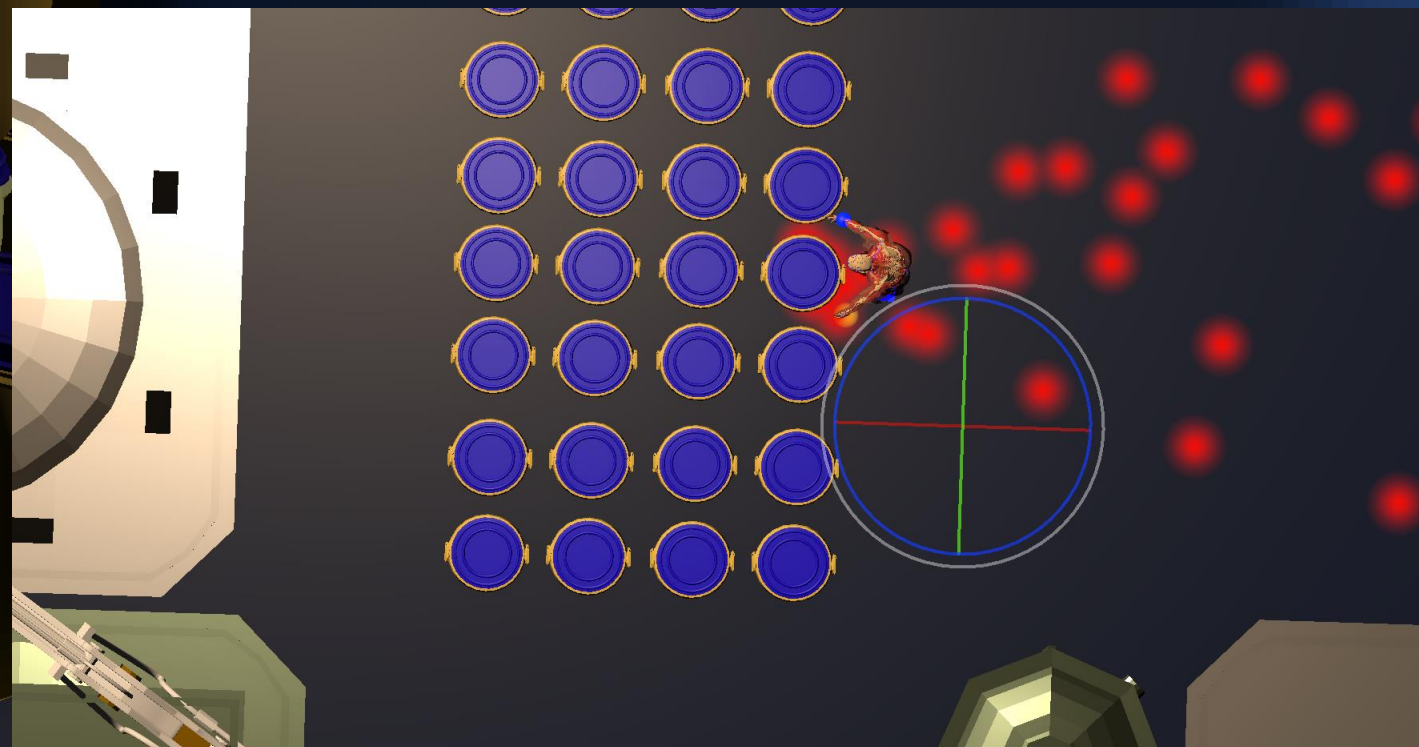
- Real time MC simulations
- Dosimetry data visualization through **Augmented Reality** including warnings for high dose rates

ALARA planning and training tool

ALARA planning and training tool

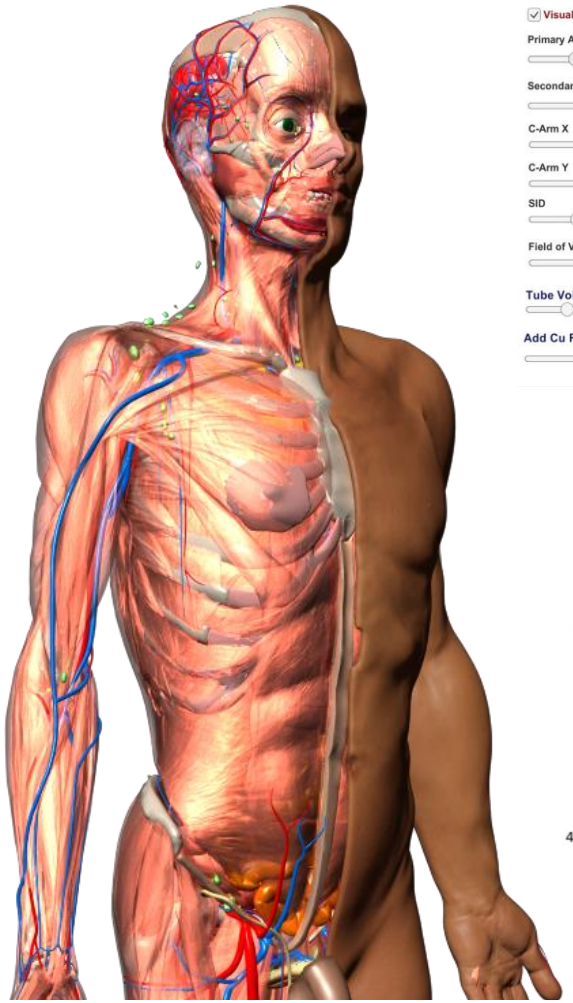


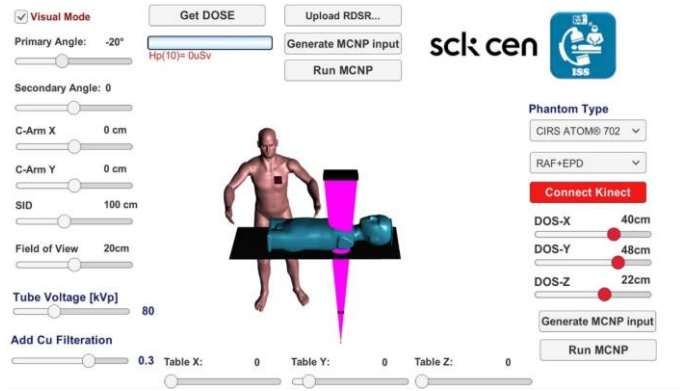
- **Accurate** MC simulations using flexible phantoms
- **Planning and analysis** dosimetry tool visualizing data in Virtual Reality environment
- **Neural Network** based framework for optimizing dose calculations and support D&D process workflow

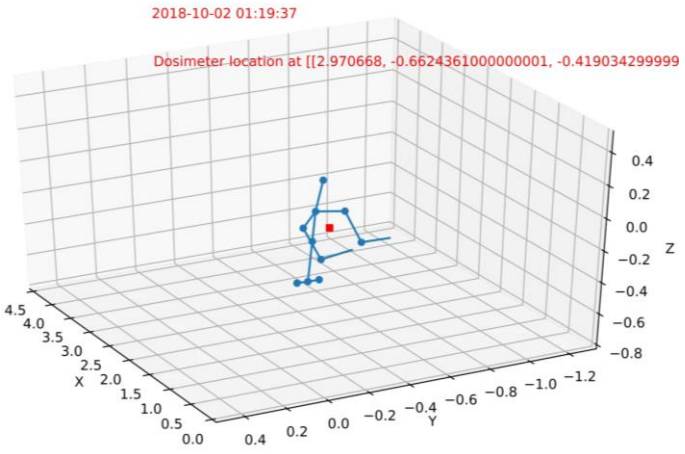


Real time dosimetry monitoring

- Real time Hybrid MC-Neural Network based simulations
- Dosimetry data visualization through **Augmented Reality** including warnings for high dose rates

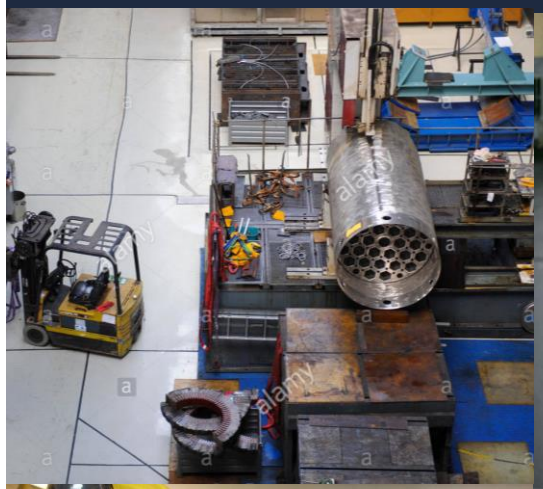






We are looking for collaborations!

sck cen



Institute for Energy Technology · IAEA International Atomic Energy Agency · Halden Reactor Project · NEA Nuclear Energy Agency · EPRI · VTT · cea

DigiDecom 2021 – DIGITAL

Online international workshop focusing on digital transformation, robotics and other game changing trends in nuclear decommissioning

filip.vanhavere@sckcen.be