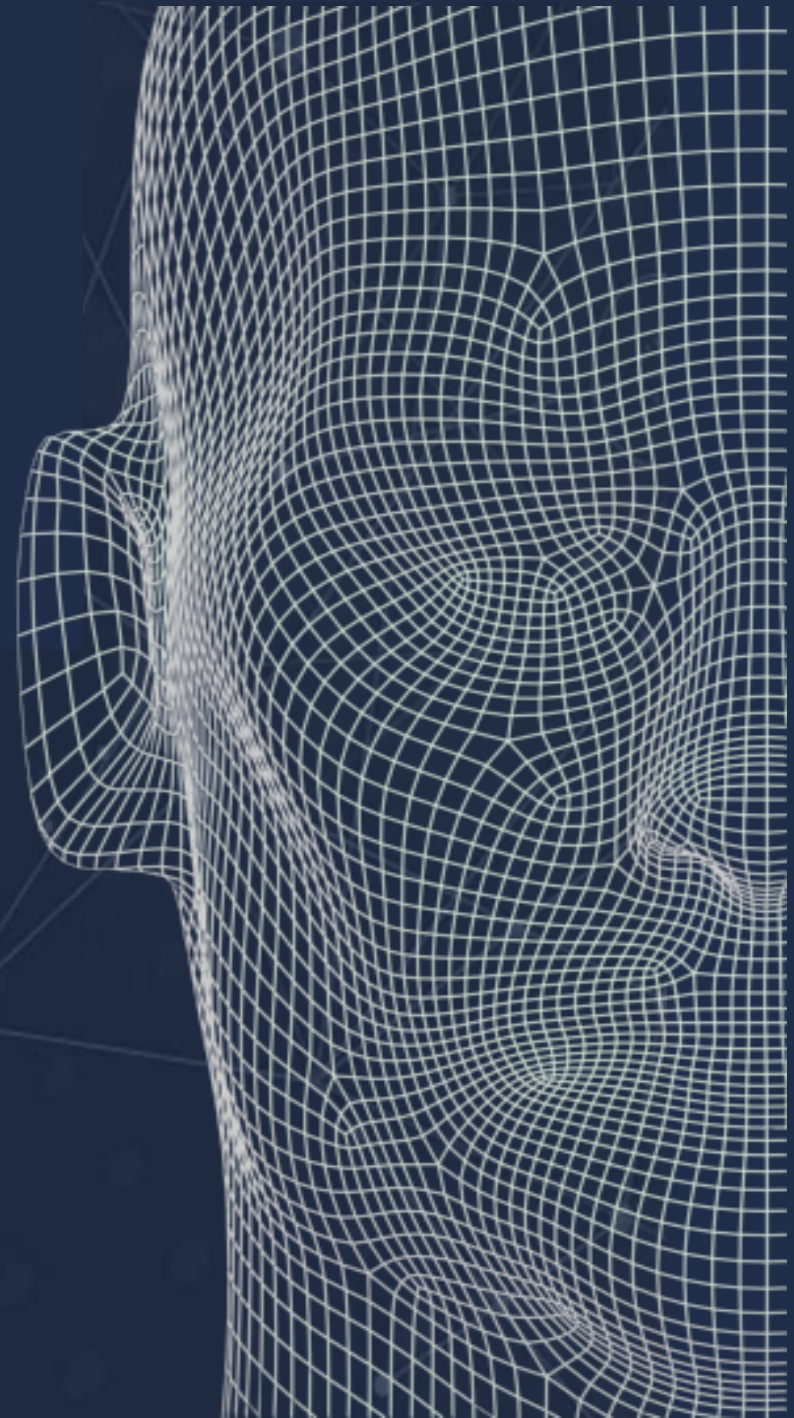




1100111000110010111011101010
00110101110111011001000000111
0000110110100101100111101100
1110010001111101000100111100
10100010101110010100100110100
11000101111011010101101000001
01011101110000101111001001111
11000111001110111101101010001
10000100110110100111110000101
00001011000101010010100101100
00001001110110110000111110100



PODIUM: Applications in Interventional Radiology and Interventional Cardiology

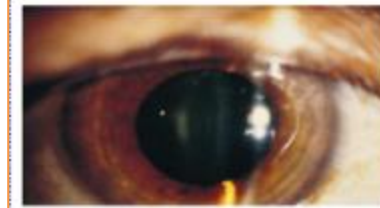
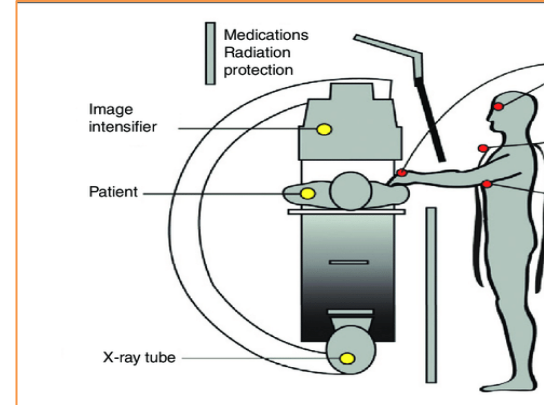
Una O'Connor, St James's Hospital, Dublin, Ireland

and PODIUM team

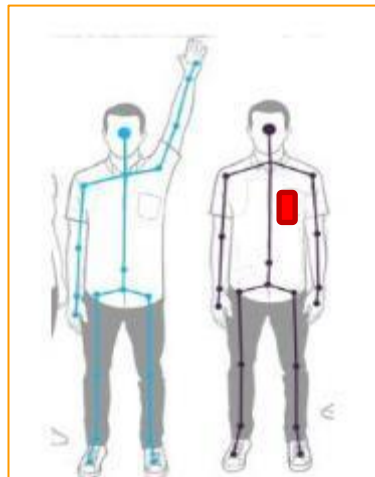
EURADOS Webinar, 20/10/2022

Motivation in IR/IC

- Practical Limitations of Personal Dosimetry
- Positioning errors
- Compliance with wearing
- Time to receive dose readings
- Management of large numbers of staff
- Costs
- Lost dosimeters
- Number of badges +++

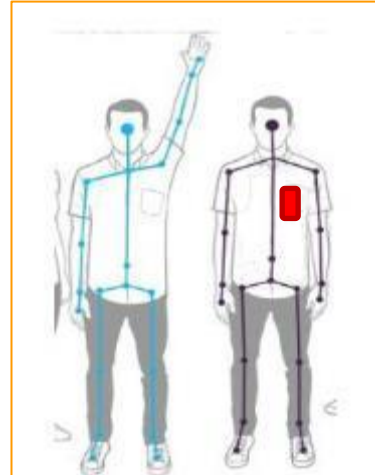
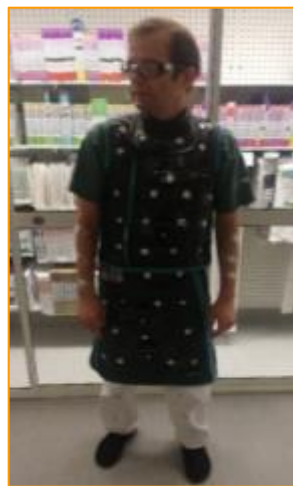


Feasibility in a Clinical Setting



Aims

1. Experiments in the clinic using phantoms
2. Test the application during clinical interventions
3. Explore hospital usability



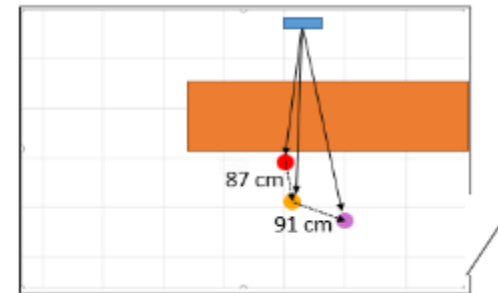


Test of motion tracking system

a) The Kinect is appropriate to use in the clinic b) Challenges to track **the operator** only

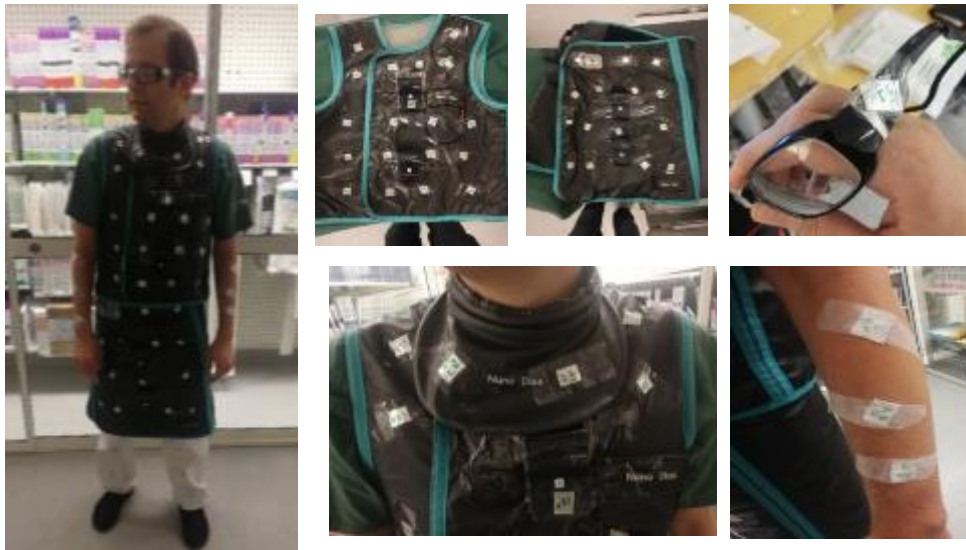


Distance upper torso to Kinect	Laser measure (m)	Kinect cal. (m)	Diff (m)
Position A	3.026	3.044	0.018
Position B	3.832	3.795	0.037
Position C	4.186	4.084	0.102



Measurements in the clinic

Measurement points



- Four Mirion DMC 3000 and 35 NaCl pellets
- Renal artery angiography

Simulation points



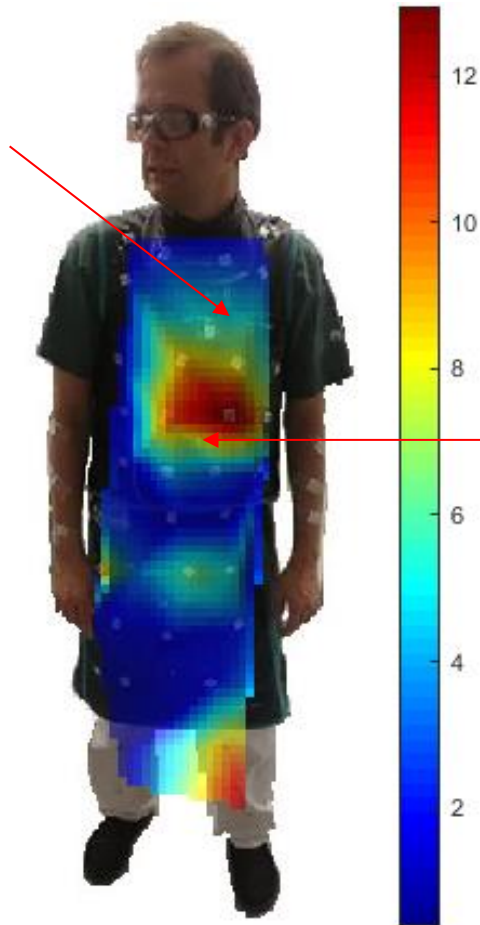
MCGPU-IR



Measurement results

Heat map: NaCl pellets

Mirion DMC 3000
Hp(10) = 7 μ Sv



Mirion DMC 3000
Hp(10) = 30 μ Sv

Simulation results

Simulated
36.59 μ Sv

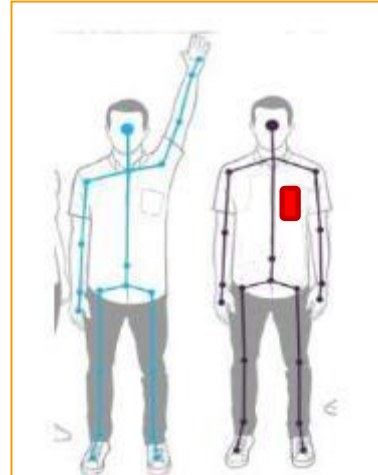


PERSONAL DOSIMETRY USING MONTE-CARLO SIMULATIONS FOR OCCUPATIONAL DOSE MONITORING IN INTERVENTIONAL RADIOLOGY: THE RESULTS OF A PROOF OF CONCEPT IN A CLINICAL SETTING

A. Almén^{1,2,*}, M. Andersson¹, U. O'Connor³, M. Abdelrahman⁴, A. Camp⁵, V. Garcia⁵, M.A. Duch⁵,
M. Ginjaume⁵ and F. Vanhavere⁴

Aims

1. Experiments in the clinic using phantoms
2. Test the application during clinical interventions
3. Explore hospital usability



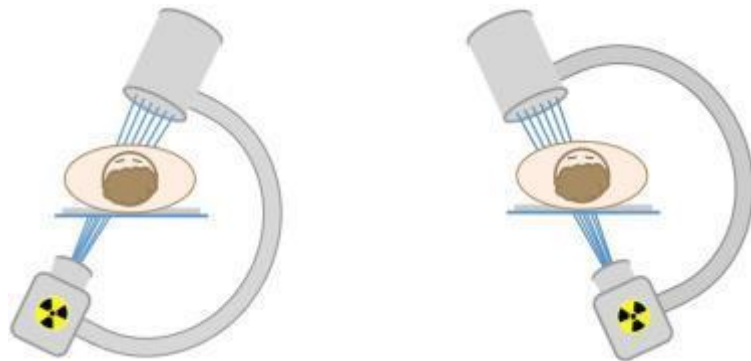
Key Input: RDSR

X-Ray spectrum

- Tube potential (kVp value)
- Dose at the reference point or DAP
- Added filtration
- Field size: collimated area (cm²)
- Source-detector distance (cm)
- Patient's table position (x,y,z)
- Position of the source (x,y,z)

Tube Angulation

- C-arm projections



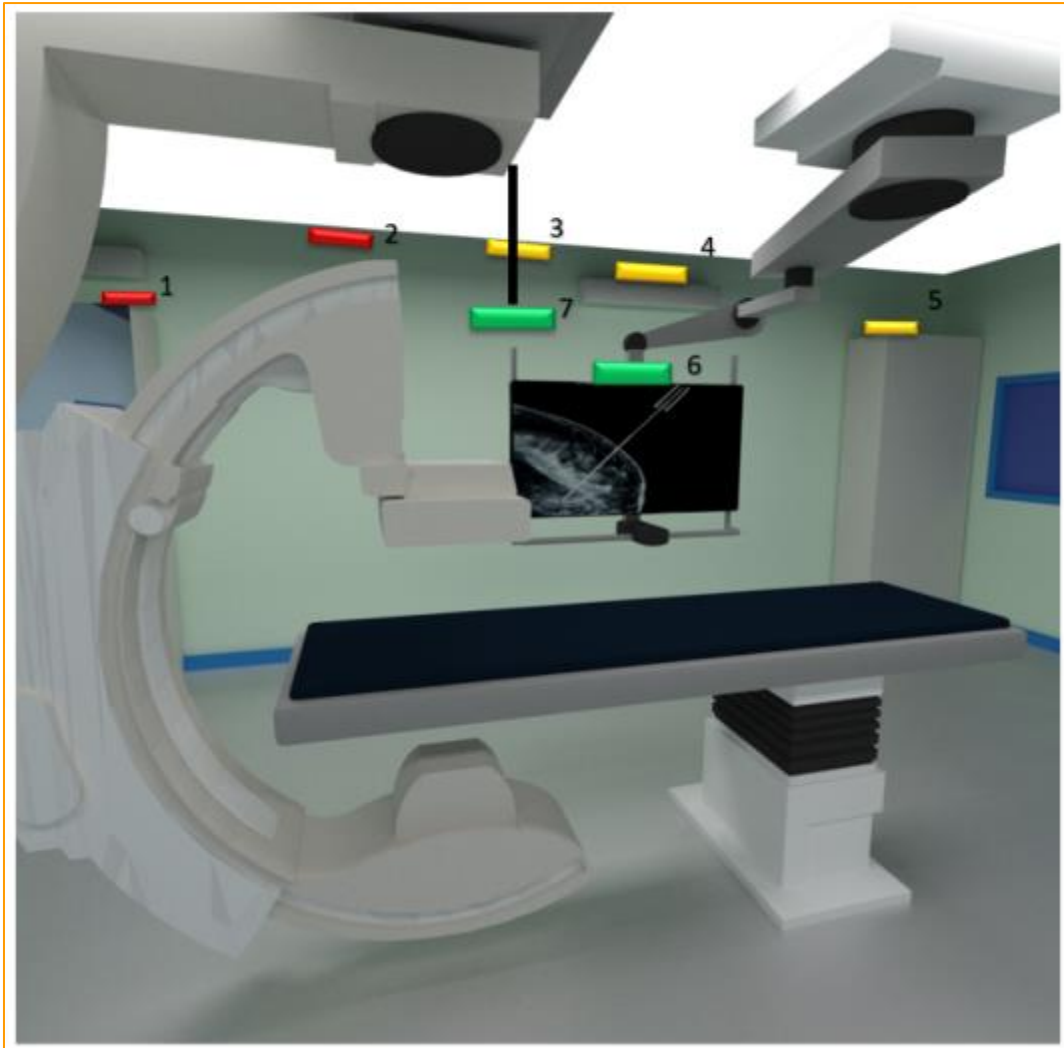
Interventional Radiology/Cardiology Parameters


Parameter	Range
High Voltage	60-120 kVp
Intensity	5-1000 mA
Inherent filtration	3-6 mm Al _{eq}
Additional filtration	0.2-0.9 mm Cu
Energy range of scattered spectra	20 keV – 100 keV

Patient's data:



- Gender
- Height, weight
- Anatomical region

SJH Equipment and camera location



Procedure Type	System	Age	RDSR?
Endovascular	Siemens Artis Q	4yrs	OK 



Cardiac	Philips Allura FD10-10 Bi-plane	5yrs	Installed during PODIUM  
---------	---------------------------------	------	--

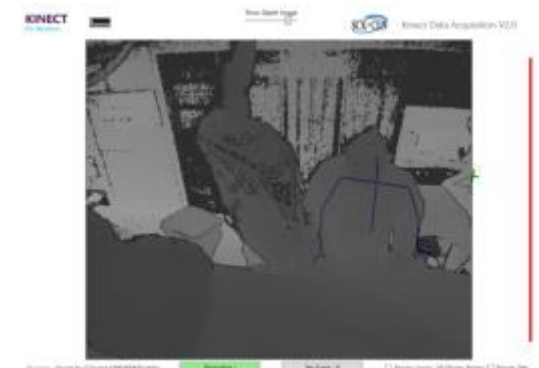


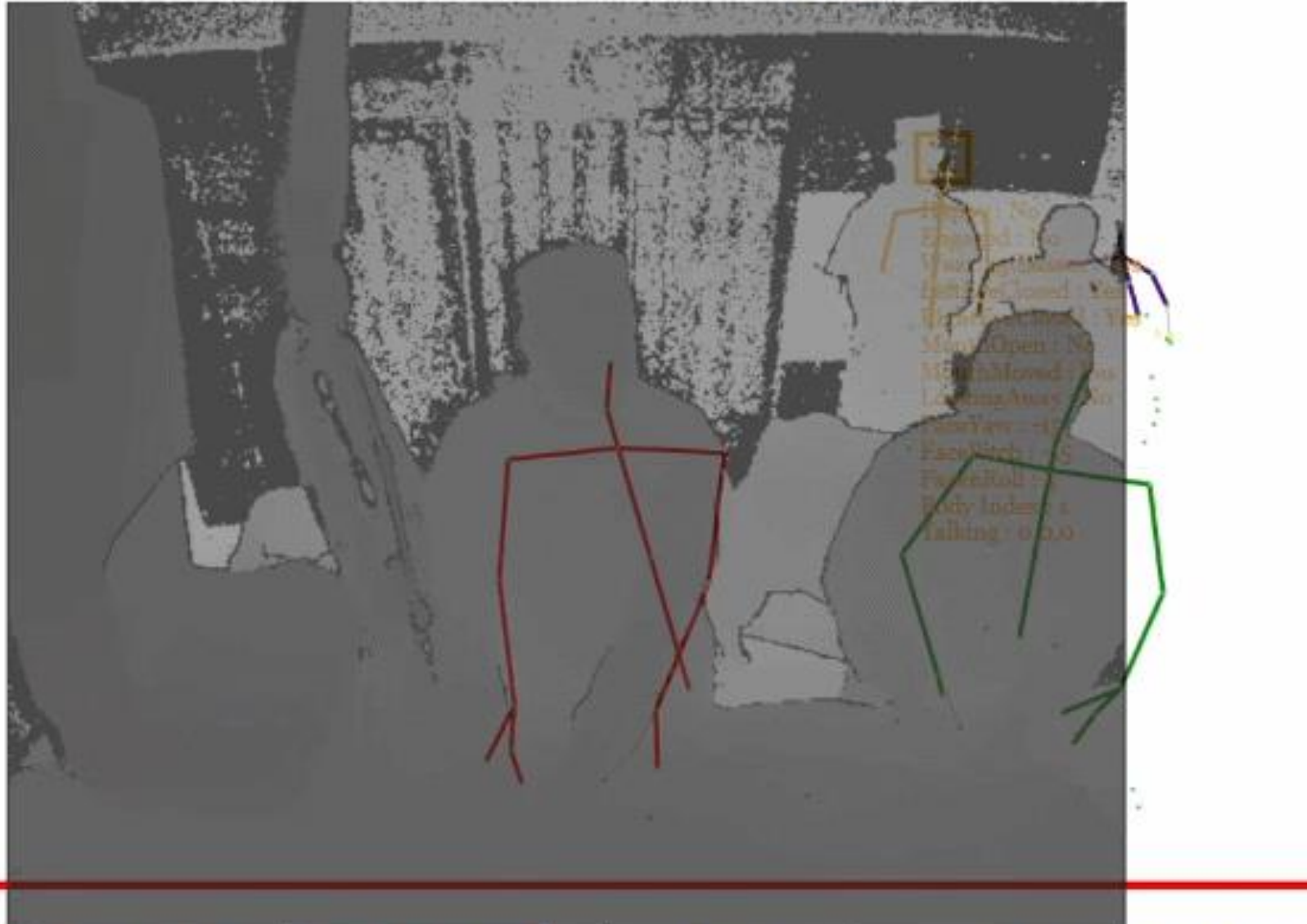
Example: Cardiac Case 1

- Measurement of $H_p(10)$
- Cardiologist during PCI
- APD over lead apron

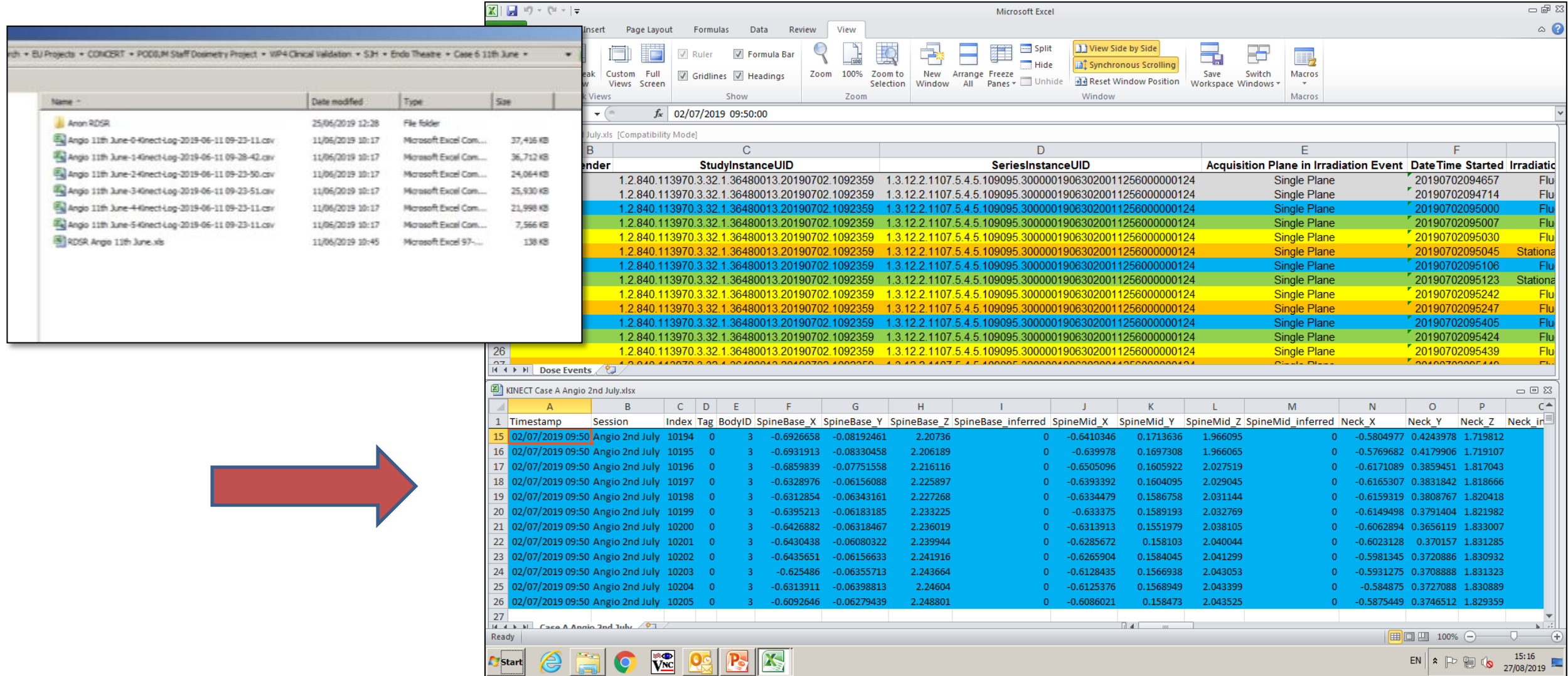
- Dataset prepared including:
 - Operator position (per second)
 - RDSR from Philips DoseWise™
 - Observations and measurements

- Anonymised, validated
- Shared via secure file manager
- Dose Simulation
 - - several methods used





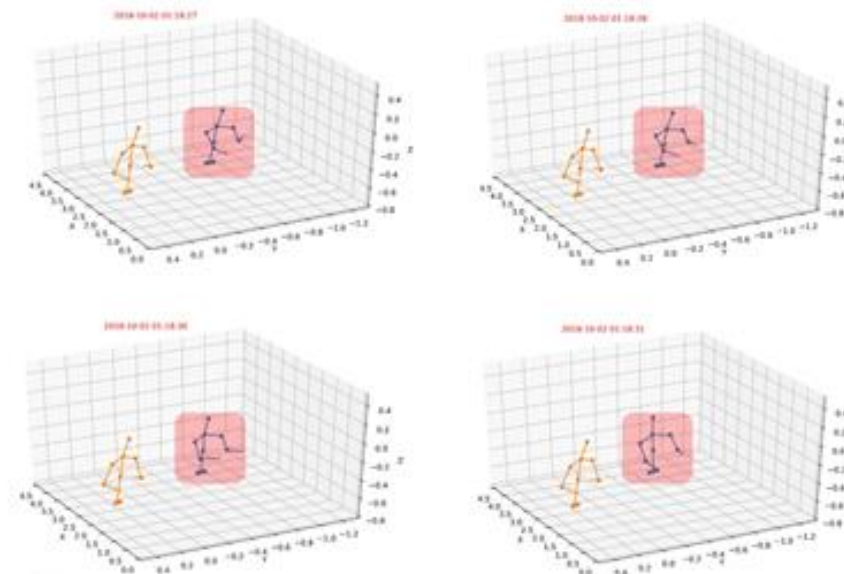
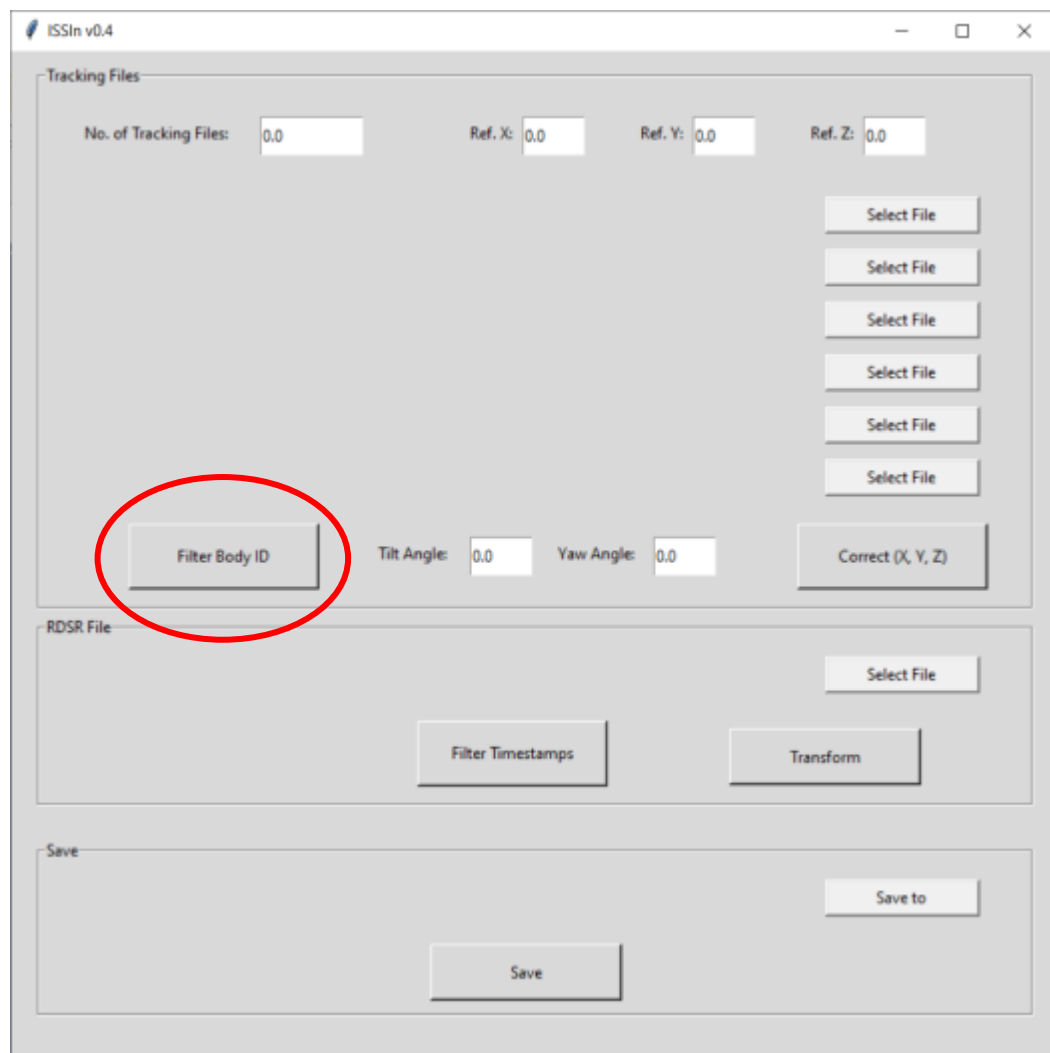
Manual preparation of files



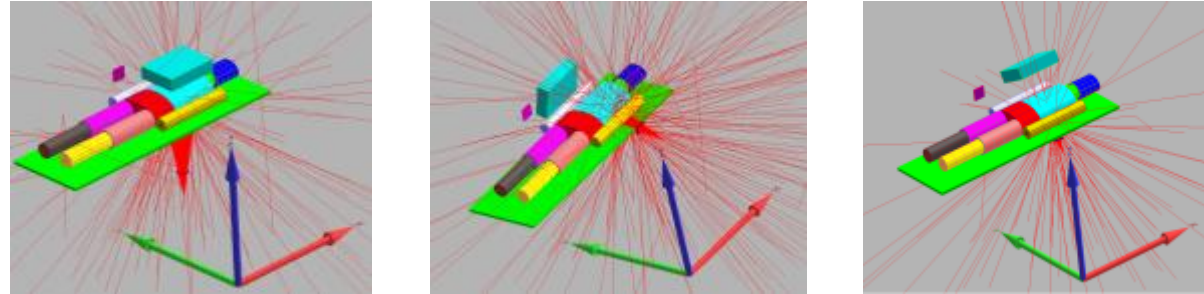
The screenshot displays a Microsoft Excel spreadsheet with a file explorer window overlaid on the left. The file explorer shows a list of files, including several 'Angio' log files and an 'RDGR' file. The spreadsheet contains data for 'Dose Events' with columns for Timestamp, Session, Index, Tag, BodyID, SpineBase_X, SpineBase_Y, SpineBase_Z, SpineBase_inferred, SpineMid_X, SpineMid_Y, SpineMid_Z, SpineMid_inferred, Neck_X, Neck_Y, Neck_Z, and Neck_inferred. A red arrow points from the file explorer to the spreadsheet data.

Timestamp	Session	Index	Tag	BodyID	SpineBase_X	SpineBase_Y	SpineBase_Z	SpineBase_inferred	SpineMid_X	SpineMid_Y	SpineMid_Z	SpineMid_inferred	Neck_X	Neck_Y	Neck_Z	Neck_inferred
02/07/2019 09:50	Angio 2nd July	10194	0	3	-0.6926658	-0.08192461	2.20736	0	-0.6410346	0.1713636	1.966095	0	-0.5804977	0.4243978	1.719812	
02/07/2019 09:50	Angio 2nd July	10195	0	3	-0.6931913	-0.08330458	2.206189	0	-0.639978	0.1697308	1.966065	0	-0.5769682	0.4179906	1.719107	
02/07/2019 09:50	Angio 2nd July	10196	0	3	-0.6859839	-0.07751558	2.216116	0	-0.6505096	0.1605922	2.027519	0	-0.6171089	0.3859451	1.817043	
02/07/2019 09:50	Angio 2nd July	10197	0	3	-0.6328976	-0.06156088	2.225897	0	-0.6393392	0.1604095	2.029045	0	-0.6165307	0.3831842	1.818666	
02/07/2019 09:50	Angio 2nd July	10198	0	3	-0.6312854	-0.06343161	2.227268	0	-0.6334479	0.1586758	2.031144	0	-0.6159319	0.3808767	1.820418	
02/07/2019 09:50	Angio 2nd July	10199	0	3	-0.6395213	-0.06183185	2.233225	0	-0.633375	0.1589193	2.032769	0	-0.6149498	0.3791404	1.821982	
02/07/2019 09:50	Angio 2nd July	10200	0	3	-0.6426882	-0.06318467	2.236019	0	-0.6313913	0.1551979	2.038105	0	-0.6062894	0.3656119	1.833007	
02/07/2019 09:50	Angio 2nd July	10201	0	3	-0.6430438	-0.06080322	2.239944	0	-0.6285672	0.1581103	2.040044	0	-0.6023128	0.370157	1.831285	
02/07/2019 09:50	Angio 2nd July	10202	0	3	-0.6435651	-0.06156633	2.241916	0	-0.6265904	0.1584045	2.041299	0	-0.5981345	0.3720886	1.830932	
02/07/2019 09:50	Angio 2nd July	10203	0	3	-0.625486	-0.06355713	2.243664	0	-0.6128435	0.1566938	2.043053	0	-0.5931275	0.3708888	1.831323	
02/07/2019 09:50	Angio 2nd July	10204	0	3	-0.6313911	-0.06398813	2.24604	0	-0.6125376	0.1568949	2.043399	0	-0.584875	0.3727088	1.830889	
02/07/2019 09:50	Angio 2nd July	10205	0	3	-0.6092646	-0.06279439	2.248801	0	-0.6086021	0.158473	2.043525	0	-0.5875449	0.3746512	1.829359	

Problem solved with Python Algorithm



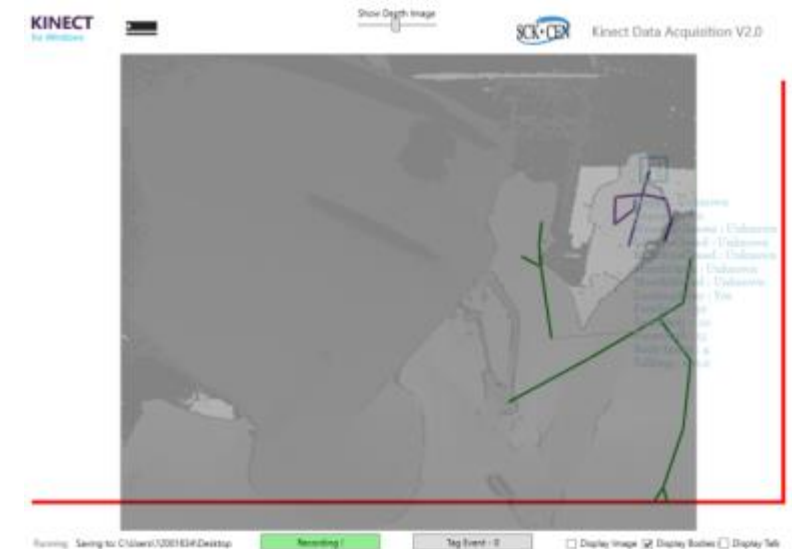
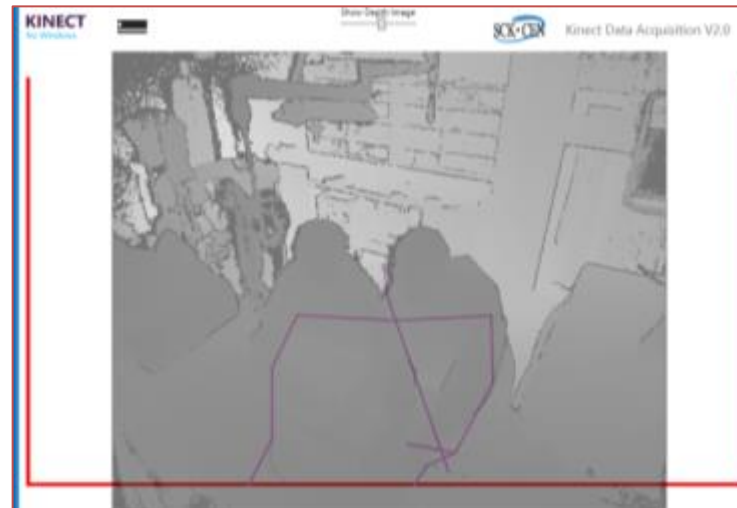
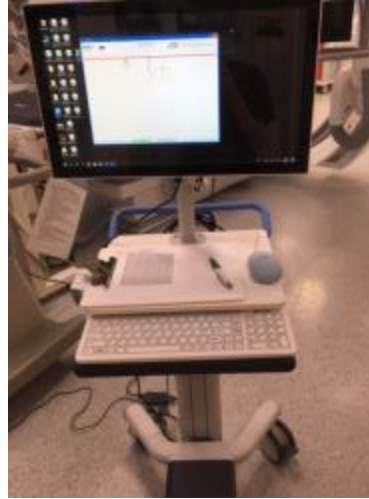
Results: Measured vs. Simulated Staff Dose



Validation Case	Patient DAP (Gy.cm ²)	EPD Measured H _p (10)	Simulated H _p (10)		
			MCNPX	PenEasyIR	MC-GPU-IR
EndoVasc E2 (Angioplasty)	14.8	55μSv	34.5μSv (37%)	32.4μSv (41%)	35.3μSv (36%)
Cardiac C1 (PCI)	76	31μSv	109μSv (252%)	95μSv (206%)	47μSv (52%)
Cardiac C3 (PCI)	33	16μSv	21μSv (31%)	3.6μSv (78%)	5μSv (69%)

Clinical Feasibility: Challenges

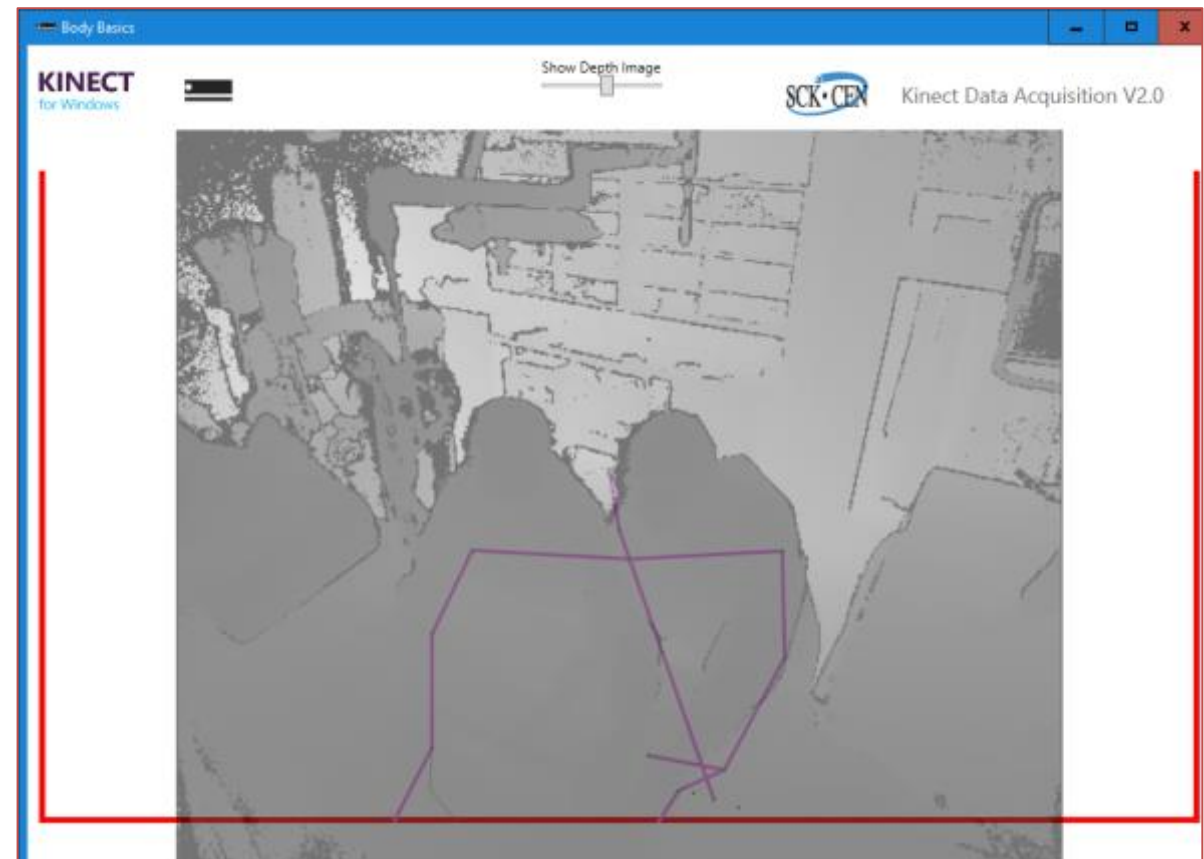
- Complex multi-vendor environment
- Location for camera, cables, PC, electrical safety
- IT performance
- Consent
- Observations
 - Who is the main operator
 - Movement of C-arm
 - Use of Ceiling screen
- Low dose cases
- Occlusions



Clinical Validation: Challenges



14:40:04



14:57:58

The Interface in the Clinic



The screenshot shows the main dashboard of the PODIUM system. The left sidebar contains navigation options: My PODIUM, Dashboard, Doses, Procedures, Admin, Hospital, Users, Runners, Docs, and More... The main content area is titled 'Dashboard / Overview' and 'Dashboard'. It features a 'Quickstart' section with 'Prev' and 'Next' buttons, and a 'My Roles' section showing the user's role as 'Radiation Protection Expert (RP)'. A text block explains that an RP can analyse and track monitored worker radiation doses and provides a starting point for navigation.

This screenshot shows the 'Doses - SJH Cardiac 1' interface. The left sidebar is identical to the dashboard view. The main content area is titled 'Doses / Doses - SJH Cardiac 1' and includes filters for MG, RP, MW, and DC. It is divided into three main sections: 'Monitored Worker' (showing a profile for SJH-MW01), 'Procedure information' (listing procedure name, start/end dates, type, room, and radiation source), and 'Calculate doses' (with a dropdown menu set to 'IPPSE' and a 'Calculate doses' button). Below these sections is a 'Doses' table with one entry: Method: PYPENEASY, 11/25/19, 12:38 PM. The table lists three dose measurements: Hp(10) at 388 +/- 0.36 µSv, Hp(3) at 281 +/- 0.17 µSv, and Hp(0.07) at 2962 +/- 5.88 µSv.

Method	Date/Time
PYPENEASY	11/25/19, 12:38 PM

Hp(10)	388 +/- 0.36 µSv
Hp(3)	281 +/- 0.17 µSv
Hp(0.07)	2962 +/- 5.88 µSv

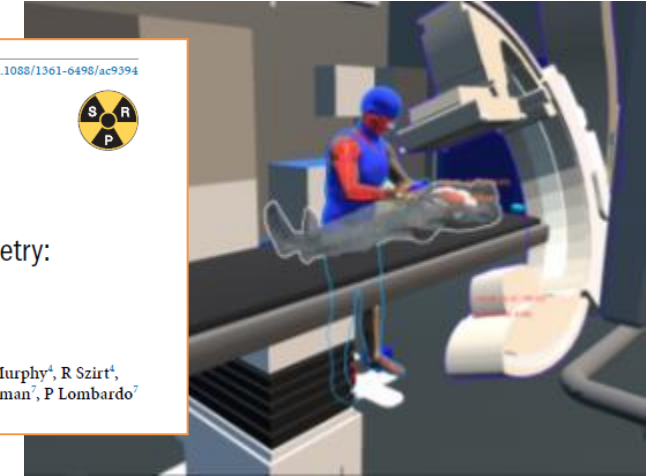
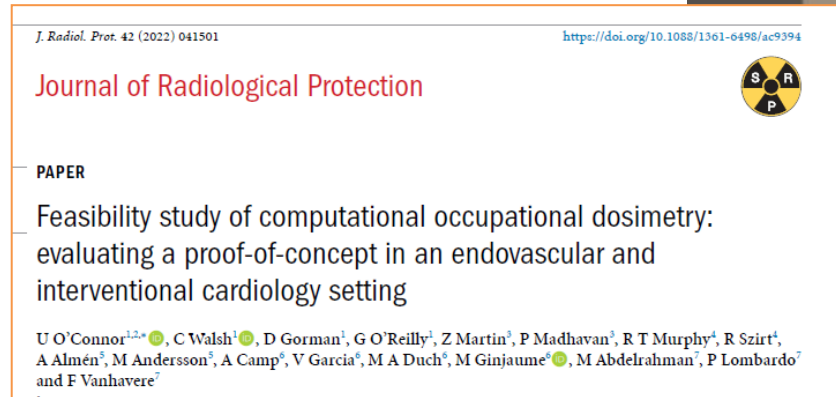
Hospital Usability: Recommendations

1. Integrated, wireless, safe for the clinical environment
2. Automated and reliable tracking of the operator
3. Automated tracking of ceiling-lead screen and C-arm
4. Minimum technical requirements for X-ray system (RDSR)
5. Link with vendors and standards bodies
6. Minimum technical requirements for IT solution
7. Detailed user manual, and a training programme
8. Privacy, ethics and data protection aspects
9. Fast and user friendly
10. Legal aspects for approval of PODIUM should continue
11. Further validation in clinical setting needed



Conclusion

- Feasible to simulate doses
- Live cases in complex clinical setting
- PODIUM concept has merit
- Welcomed by clinical staff
- The computational dosimetry system can overcome limitations of physical dosimeters
- Proof-of-concept over 2 year period
- Challenges requiring further stage of development
- Potential as ALARA training tool, and approved dosimetry service in the future



www.podium-concerth2020.eu



Thank you for your attention



<https://podium-concerth2020.eu/>



PODIUM is part of the CONCERT project.

It has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 662287.