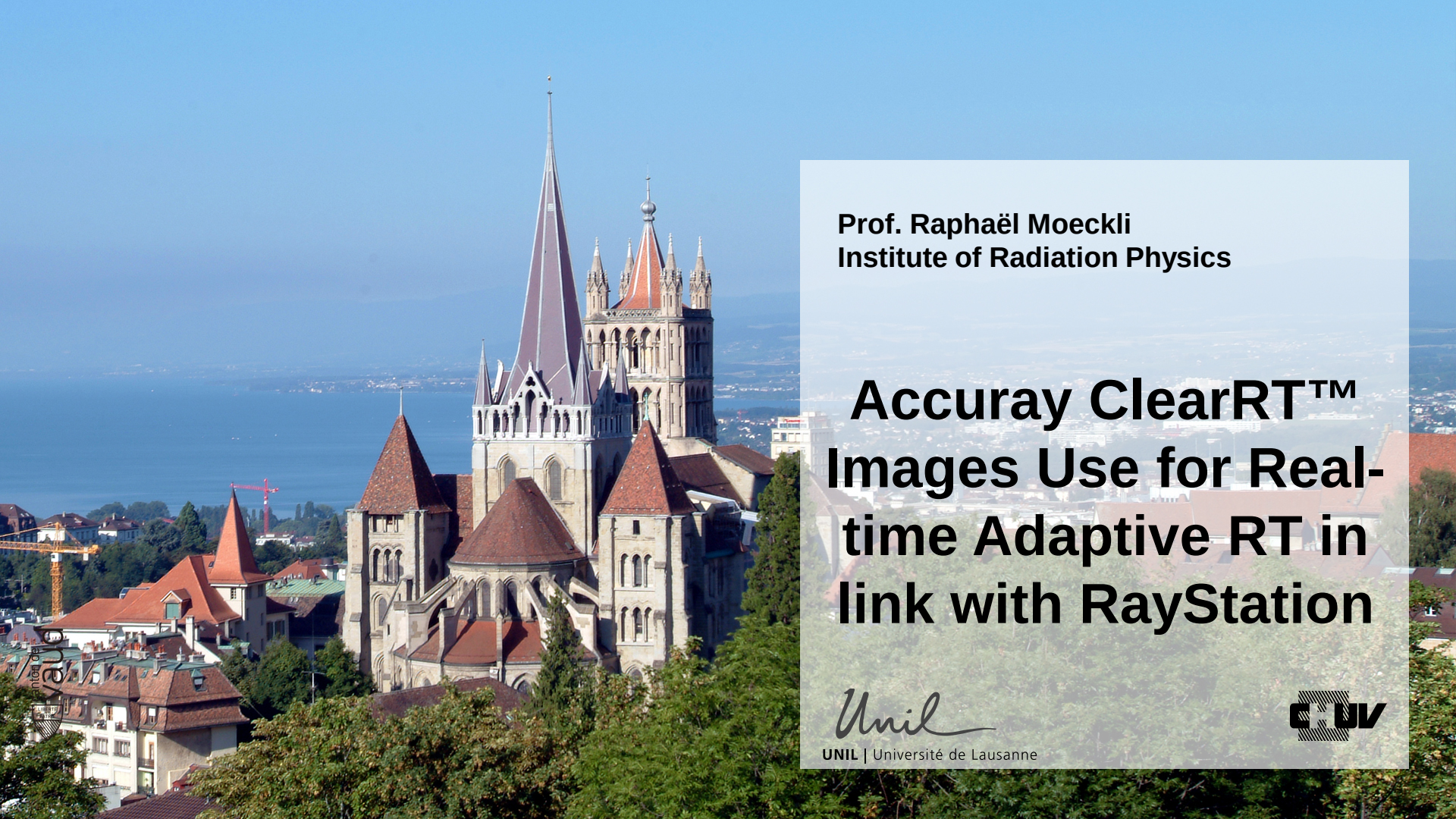

Prof. Raphaël Moeckli
Institute of Radiation Physics

Accuray ClearRT™ Images Use for Real-time Adaptive RT in link with RayStation

UNIL | Université de Lausanne

Conflict of interest

Accuray
Paid travel costs and honorarium
Funding a PhD project in adaptive RT QA

RaySearch
for AI and automation in RT projects
Partnerships with **IntraOp**, **PMB** and **CERN**
for FLASH projects

ADAPTIVE RADIATION THERAPY

What is needed for adaptive RT ?

Real time imaging for

- **Daily structure auto-contouring**
- **Daily dose auto-calculation**

Efficient flux between systems

- **Real time imaging – TPS**
- **TPS – treatment machine**

Plan QA

Can we do that with X-rays ?

What is needed for adaptive RT ?

Real time imaging for

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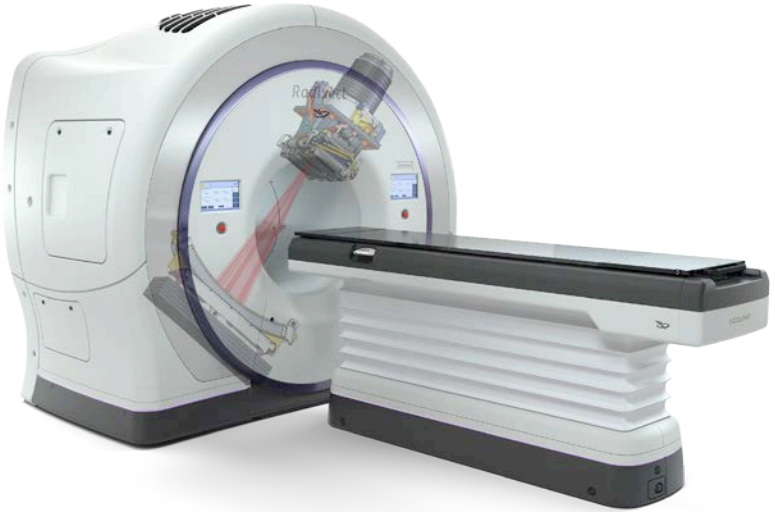
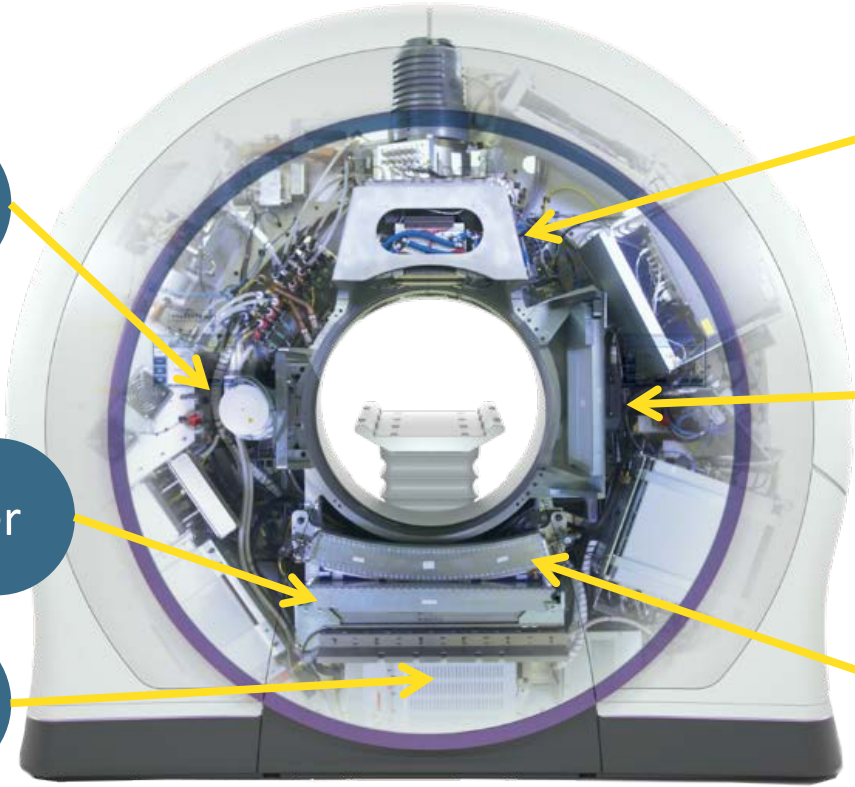
Plan QA



Can we do that with X-rays ?

REAL TIME IMAGING

ClearRT kVCT



kV source

Beam stopper

Generator

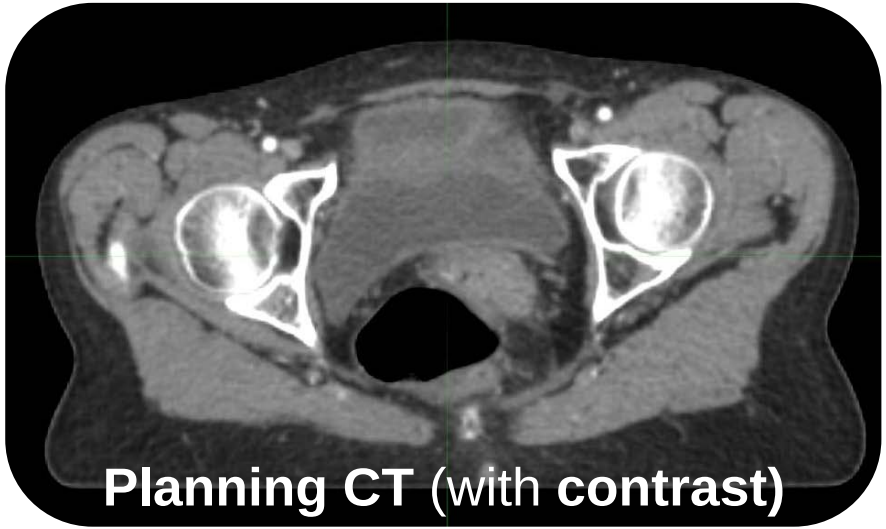
LINAC, jaws, & MLC

kV detector

MV detector

ClearRT™ is the tradename for the Radixact® fan beam helical kVCT

ClearRT kVCT



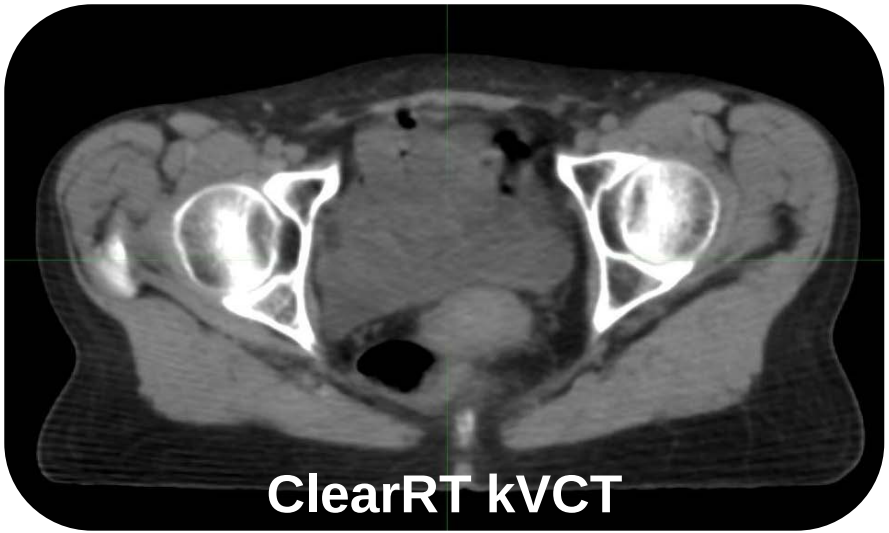
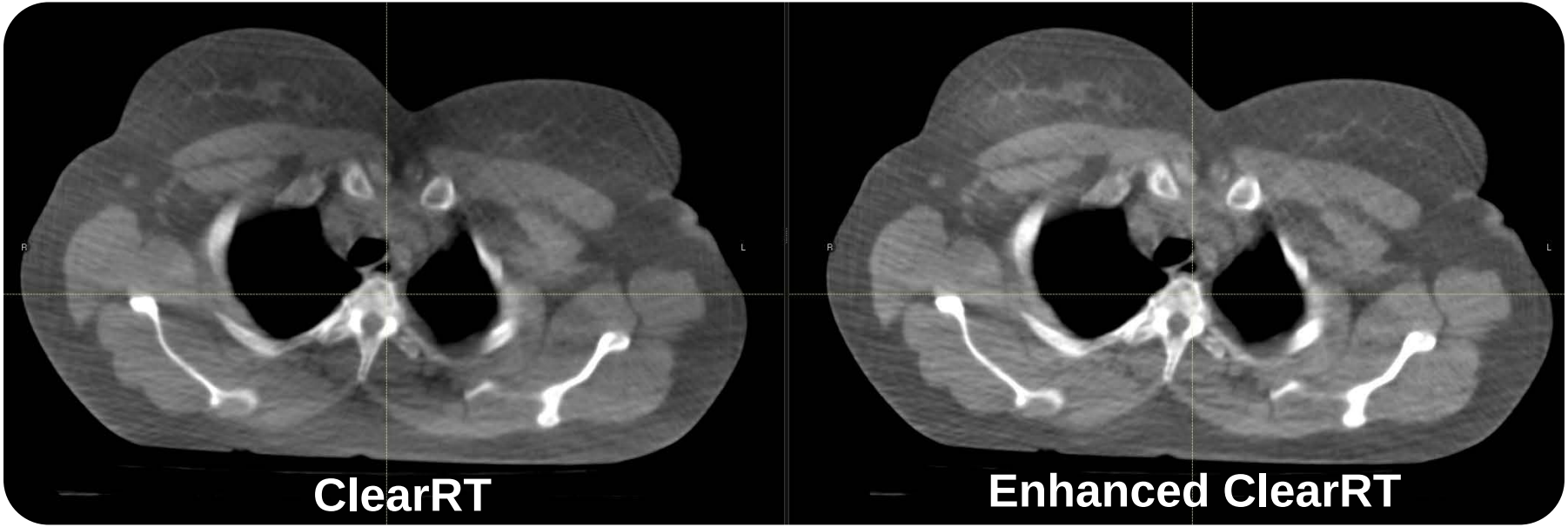


Image post-processing

Use of existing tools in RayStation

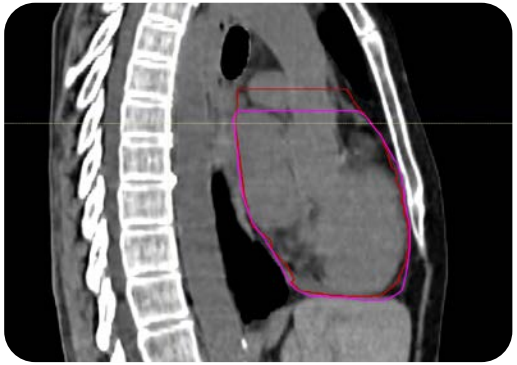
- Registration planning CT and ClearRT
- Remove low frequency artefacts
- HU conversion from CBCT to ClearRT
- If small FOV: add information from planning CT

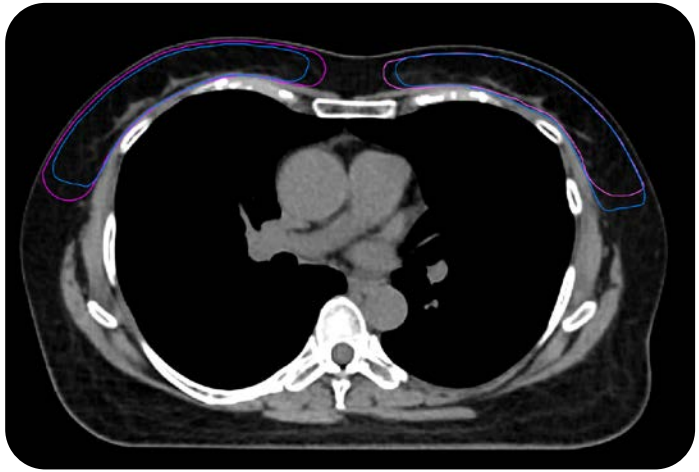
Breast: ClearRT vs enhanced ClearRT



DAILY STRUCTURE CONTOURING

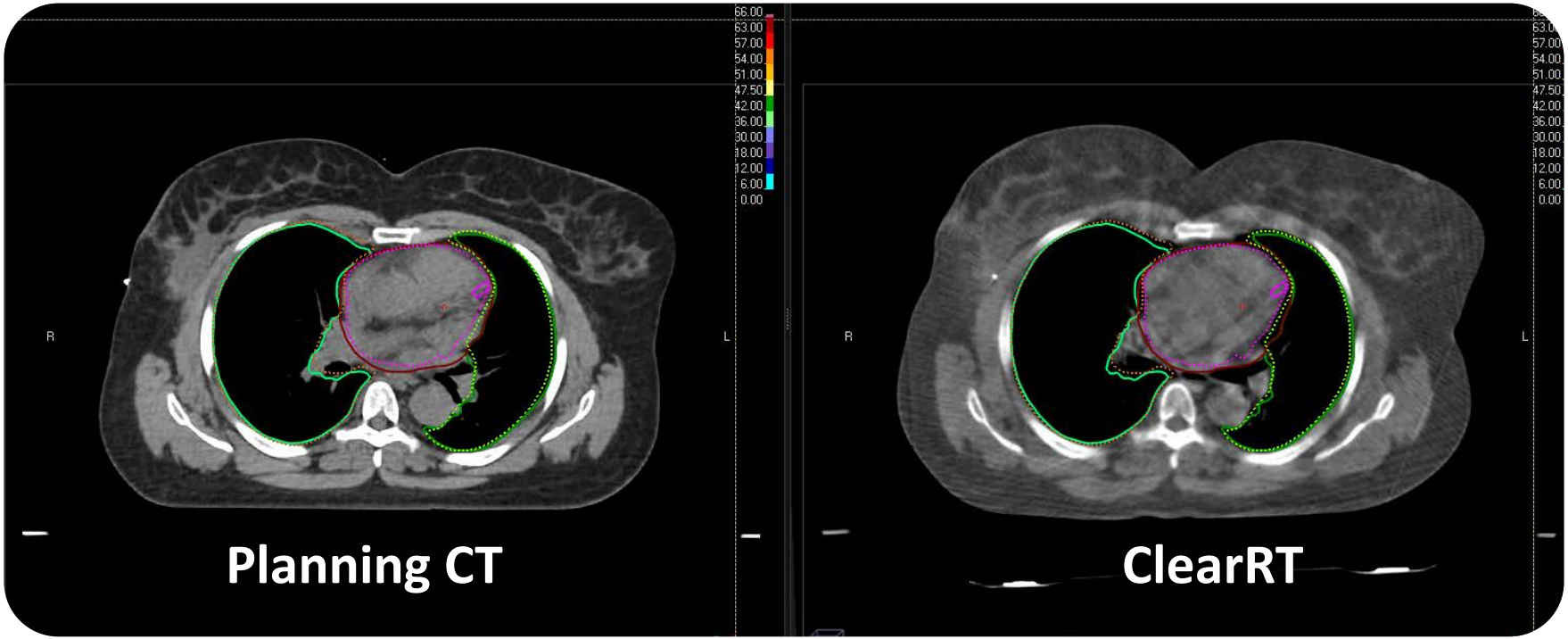
AI model validation (planning CT)





Cauda Equina	0.3	Breast L	1
Espohagus	2.4	Breast R	1.2
Heart	1.4	Humeral Head L	2.7
LAD	2.4	Humeral Head R	2.4
Lung L	2.8	LN Ax L1 L	2.6
Lung R	2.8	LN Ax L1 R	2.4
Spinal Canal	2.8	LN Ax L2 L	2.8
Spinal Cord	0.6	LN Ax L2 R	2.6
Thyroid Gland	3	LN Ax L3 L	2.6
Trachea	2.8	LN Ax L3 R	1.8
Gallbladder	1.7	LN Ax L4 L	1.8
Kidney L	2.6	LN Ax L4 R	2
Kindney R	2.6	LN Ax Pectoral L	2.6
Liver	2.4	LN Ax Pectoral R	2.4
Pancreas	1.4	LN IMN L	2.2
Spleen	2	LN IMN R	2
Stomach	2.2		

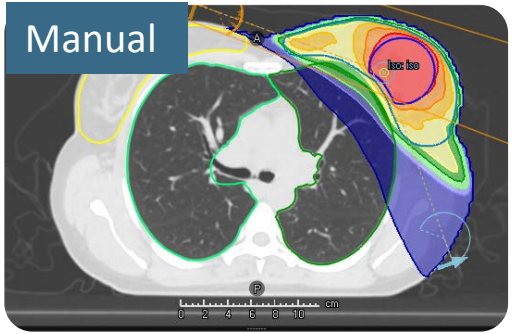
AI model on ClearRT



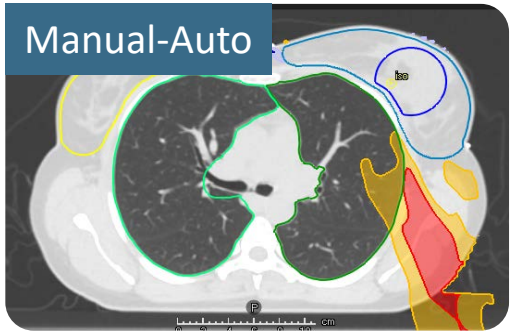
DAILY DOSE CALCULATION

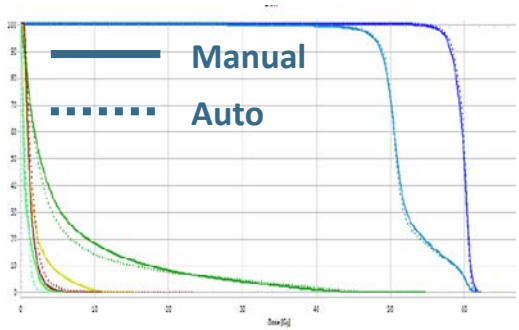
AI model* validation (Planning CT)

Manual

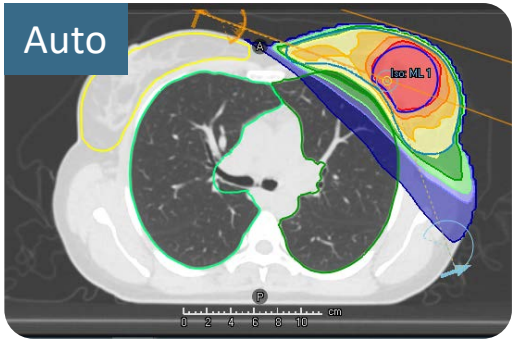


Manual-Auto





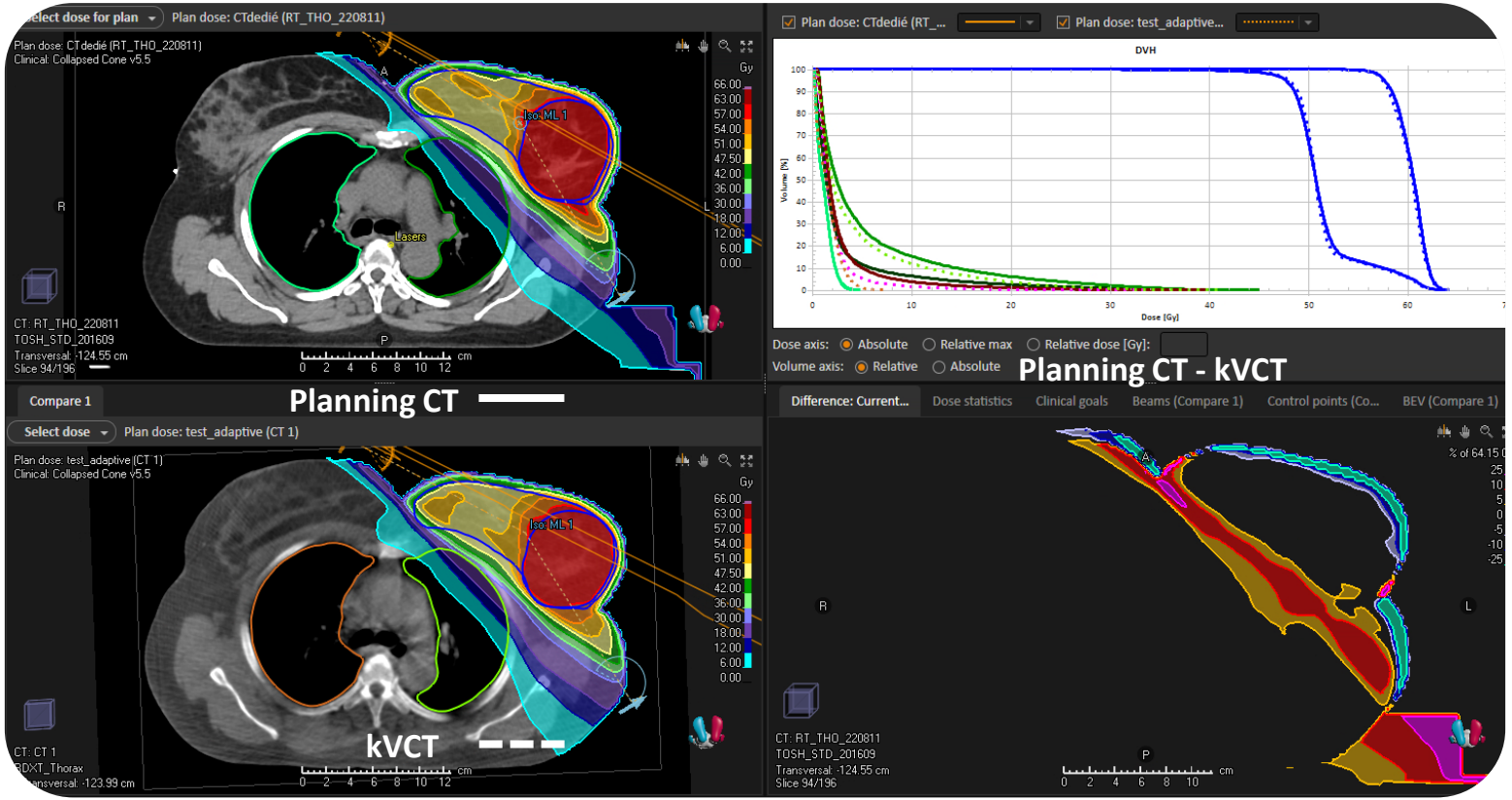
Auto



Model	01_001t		01_002t		01_003t		01_004t		01_005t	
	PTVs	OARs	PTVs	OARs	PTVs	OARs	PTVs	OARs	PTVs	OARs
v 1.0							NA	NA	NA	NA
v 1.1										
v 1.2										
V1.3										

* Pending 510(k) clearance under review by the FDA

AI model* on enhanced ClearRT

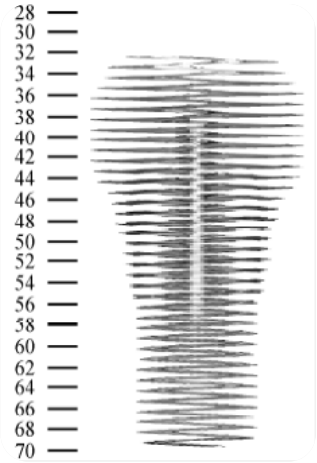


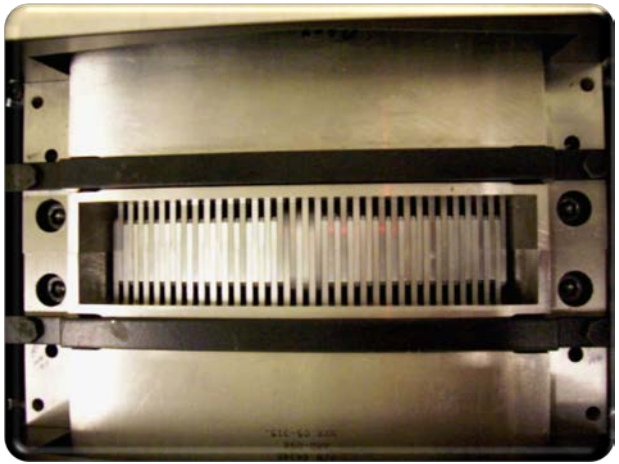
* Pending 510(k) clearance under review by the FDA

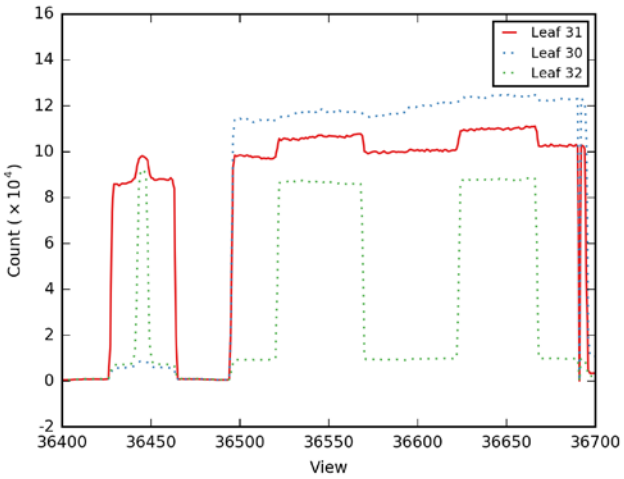
PLAN QA

Leaf open time measurement

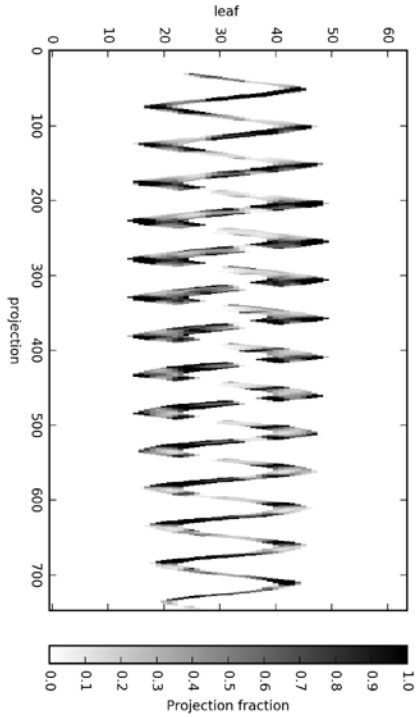
Use of online detector (MVCT)
Delivered sinogram measurement



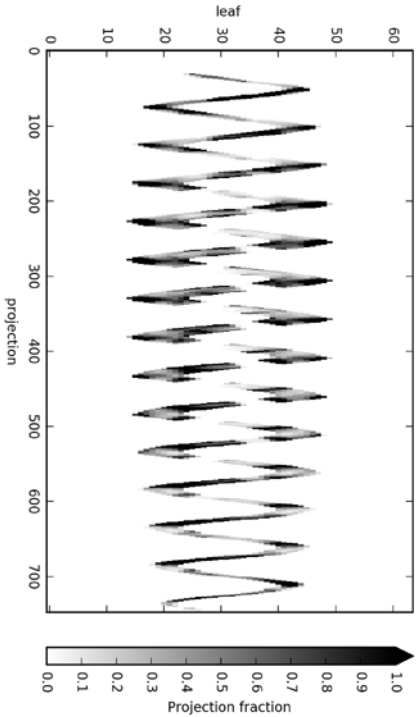




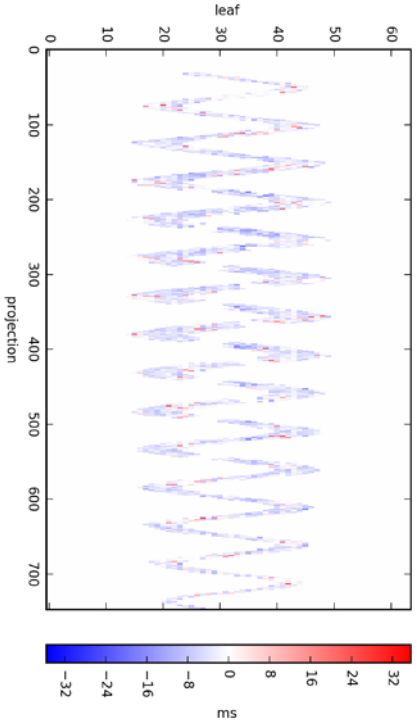
Planned vs delivered sinogram



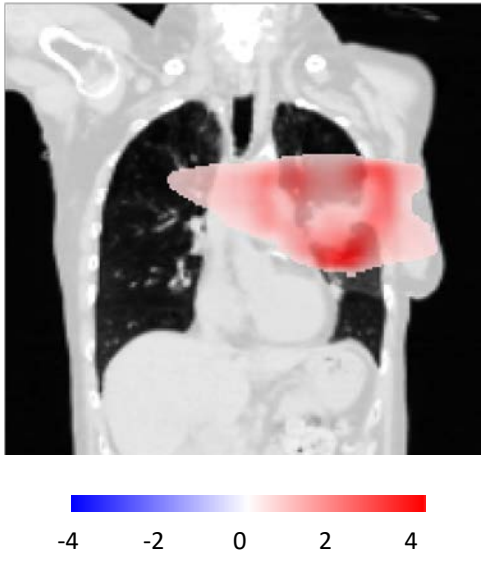
Planned sinogram



Delivered sinogram

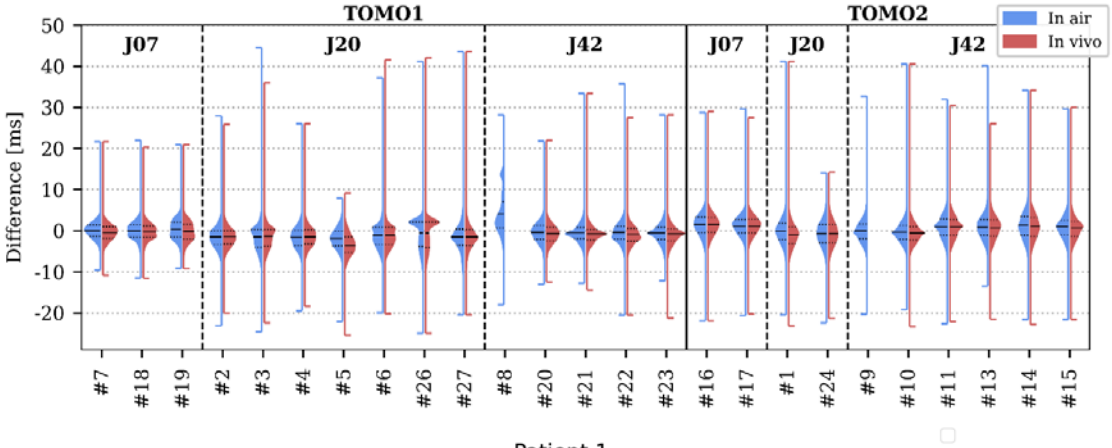


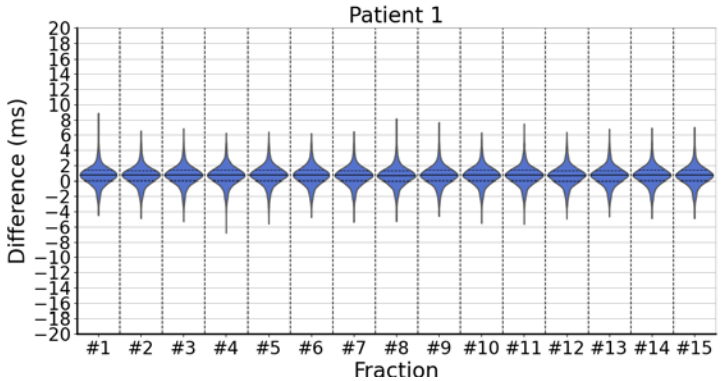
Difference



Difference [%]

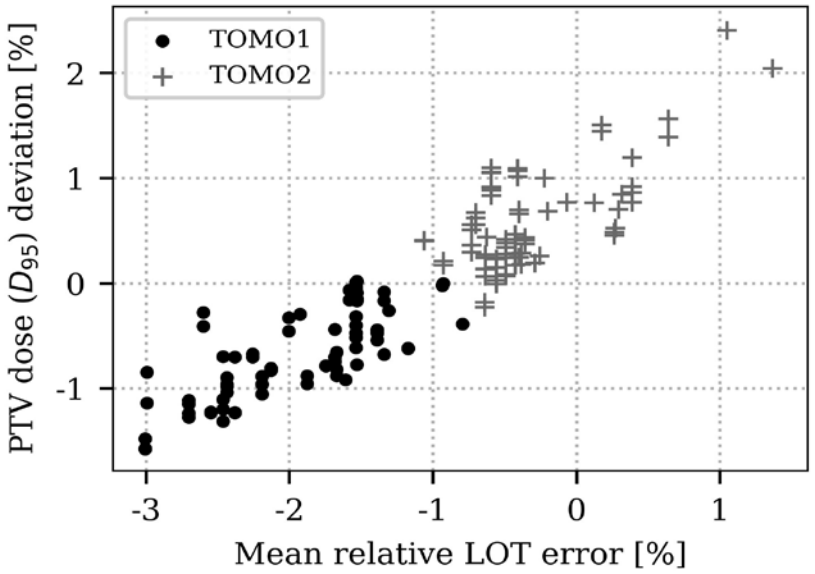
Leaf open time analysis

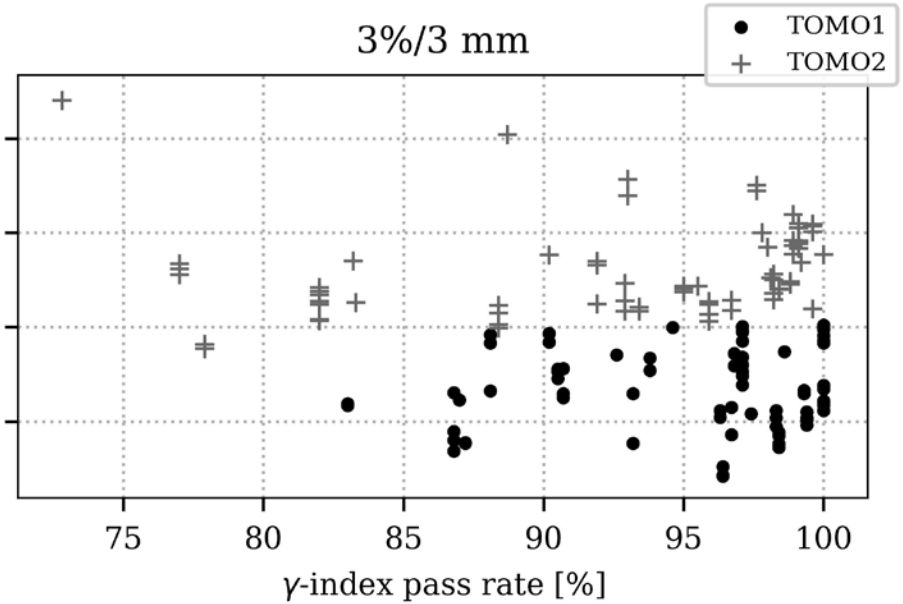




Schopfer 2019; Nasrallah in prep.

QA sensitivity





Conclusion

Real time imaging for

- Daily structure auto-contouring
- Daily dose auto-calculation

Efficient flux between systems

- Real time imaging – TPS
- TPS – treatment machine

Plan QA

Is real time adaptive RT possible with X-rays ?

YES

Acknowledgements

David Patin
Michele Zeverino
Marie Nasrallah