Artificial Intelligence Powered Precision Radiotherapy

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Distinguished Professor, Mathematics

THERAPANACEA

GUSTAVE ROUSSY

Top 10 worldwide oncology care centers

université PARIS-SACLAY

#1 in mathematics, **#15** in all disciplines

CHARITÉ

Perelman School of Medicine University of Pennsylvania

Cleveland Clinic

VUmc

Biogen

BRAINLAB

5 continents

150+ clinical sites

250,000+ targeted oncology patients in 2024

THERAPANACEA

Personnel

TODAY : 75

PhD: **35%**

H**60%** F **40%**

TheraPanacea's impact / clinical vision

We are **CE/FDA compliant and a class II.B** medical device company according to the new EU Medical Device Regulation (MDR) **certified** to **deploy medical devices with medium to high risk.**

TheraPanacea's excellence in innovation

We harness **state of the art research** in **computer-science, applied mathematics, artificial intelligence** and **multi-omics** approaches to improve **treatment implementation & prognosis**

TheraPanacea's Clinical & Academic Network

Fasten & ease **access to clinical expertise and data** necessary to build novel and efficient digital biomarkers through our oncology specialized network of clinical partners

Cancer :

Challenge of 21st Century

30M

New cases per year

→ 15 million deaths in 2030

Linear Accelerator

Treatment Planning Software

Radiation therapy :

60%

Cancer patients

Over the last decade :

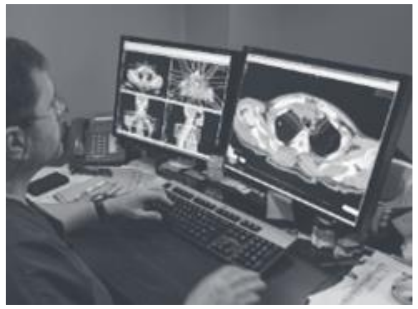
Software
(1,5BEU)
increasing importance

Hardware
(6,5B$)

Radiation therapy today

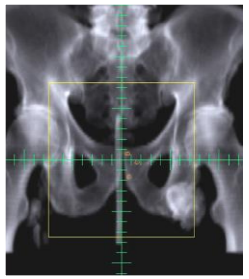
1 Planning

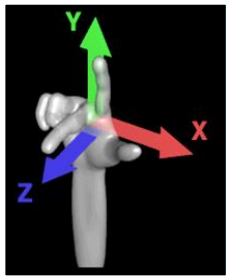
Imaging + Physics + Optimization + Simulation



2 Treatment

Imaging + Positioning + Radiation





Time

Tedious, time-consuming manual steps

Expert bias

Quality of treatment heavily depends on expertise

Anatomy's evolution

Lack of handling anatomy's evolution and physiological changes

One target equal to One dose

Inability to account for local tumor proliferation

Exploiting outcomes?

Inability to connect treatment choices with outcomes

Facts

Human expertise

3-12 h human expertise required per patient in preparation leading to sub-optimal workflows

Unequal access to treatment

Same patient treated by 2 different centers will see different clinical outcomes

Increased toxicity and Side effects

Adjusting treatment through delivery could allow decreased margins, personalization and eliminate side effects

AI-powered Radiatiotherapy

We it brings in

Time-saving

Human expertise needed from hours to minutes

Advanced solutions

Automated alerts and simple adaptation of treatment plans

Optimal clinical outcomes

Connecting the dots, understanding the outcomes, feeding them back to the patient level

Benefits

- **Treatment efficiency improved**
- **Less side effects**
- **Automation & Standardization**
- **Reduced healthcare expenses**

Predicting the future AI-RadOn

2021
Highly automated solutions

2024
Adaptive / On the fly

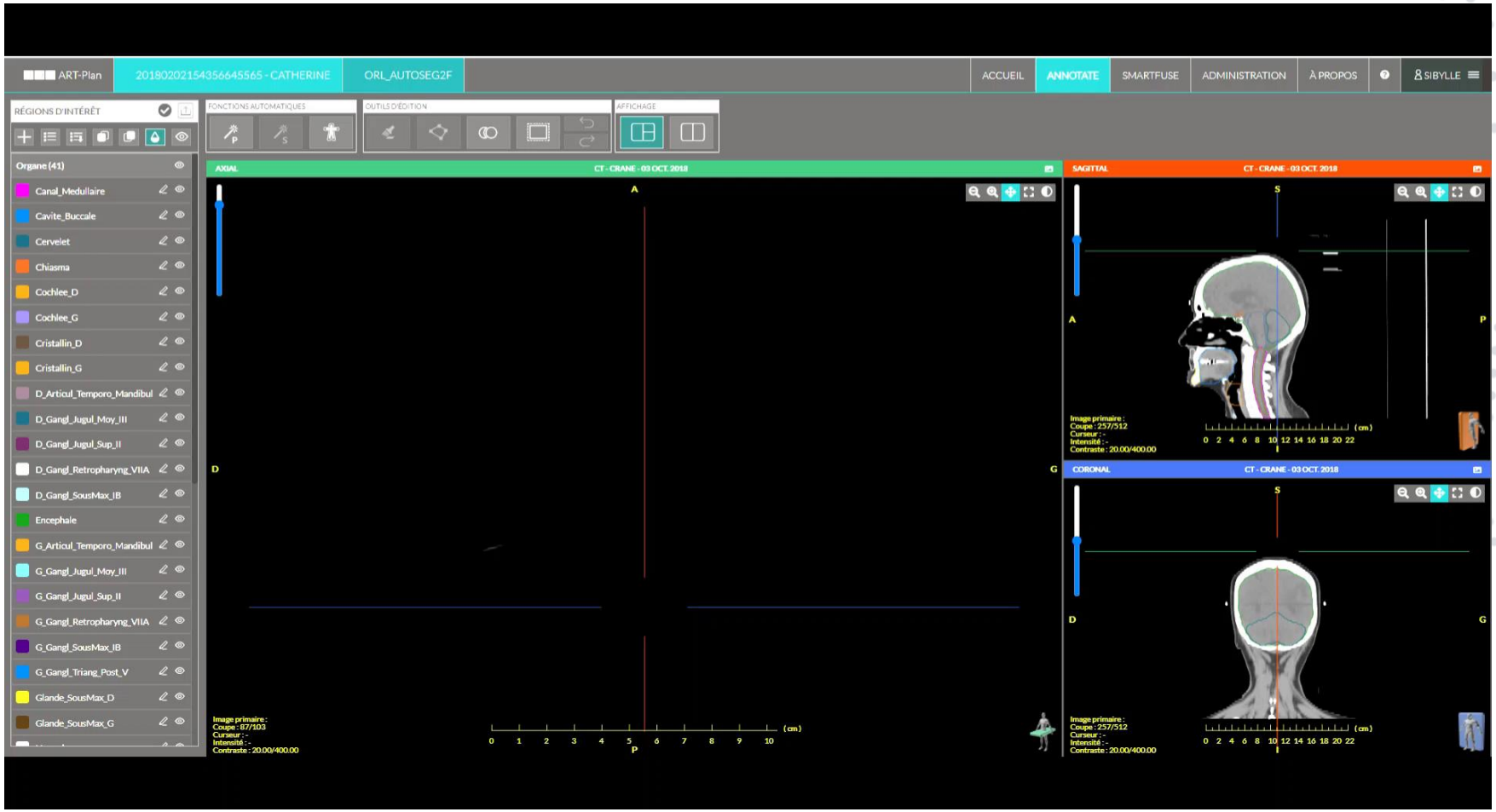
2026
Multi-parametric imaging-driven at macroscale

2028
Local Dose Control

2030
Integration of Biology / Histology @micron-scale

2032
Holistic Treatment Pathways

Segmentation of Organs at Risk



AI-segmentation vs AI-segmentation

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ORIGINAL RESEARCH article

Front. Oncol., 04 August 2023
Sec. Radiation Oncology
Volume 13 - 2023 |
https://doi.org/10.3389/fonc.2023.1213068

This article is part of the Research Topic
Prospective Utilization and Clinical Applications of Artificial Intelligence and Data-driven Automation for Radiotherapy

View all 7 articles >

A clinical evaluation of the performance of five commercial artificial intelligence contouring systems for radiotherapy

Paul J. Doolan[1*] Stefanie Charalambous[2] Yiannis Roussakis[1]
Agnes Leczynski[2] Mary Peratikou[2] Melka Benjamin[2]
Konstantinos Ferentinos[2,3] Iosif Strouthos[2,3] Constantinos Zamboglou[2,3,4]
Efstratios Karagiannis[2,3]

@ Doolan et al, 2023*

Saving time over manual contouring (20 cases per indiction)

		Mean time Manual Institution	Correction Mirada	Correction MVision	Correction Radformation	Correction RayStation	Correction Therapanacea
Breast	No. structures	10	8	8	10	5	10
	Time for 10 structures [min]	22	7.5	1.6	7.8	3.1	1.4
	Saving [min/%]		14.5/66.0%	20.4/92.8%	14.2/64.4%	18.9/86.0%	20.6/93.7%
Head and neck	No. structures	19	27	27	27	26	30
	Time for 19 structures [min]	97	8.2	9.8	22.7	4.6	4.4
	Saving [min/%]		88.8/91.6%	87.2/89.9%	74.3/76.6%	92.4/95.3%	92.6/95.4%
Lung	No. structures	6	6	6	6	5	6
	Time for 6 structures [min]	26	5.2	1.2	6.0	1.5	0.4
	Saving [min/%]		20.8/80.1%	24.9/95.6%	20.0/76.8%	24.5/94.4%	25.6/98.4%
Prostate	No. structures	10	8	9	9	5	10
	Time for 10 structures [min]	42	7.4	0.3	4.3	5.2	0.1
	Saving [min/%]		34.6/82.3%	41.7/99.3%	37.7/89.7%	36.8/87.6%	41.9/99.7%

Manual MIRADA Accelerating Cancer Care MVISION - AI for Precision Radiotherapy - RAD RaySearch Laboratories

TIME SAVINGS (%)	0%	84,8	94,6	78,1	92,2	96,7
CONTOURING CORRECTION TIME (MIN)	187	28,3	12,9	40,8	14,4	6,3

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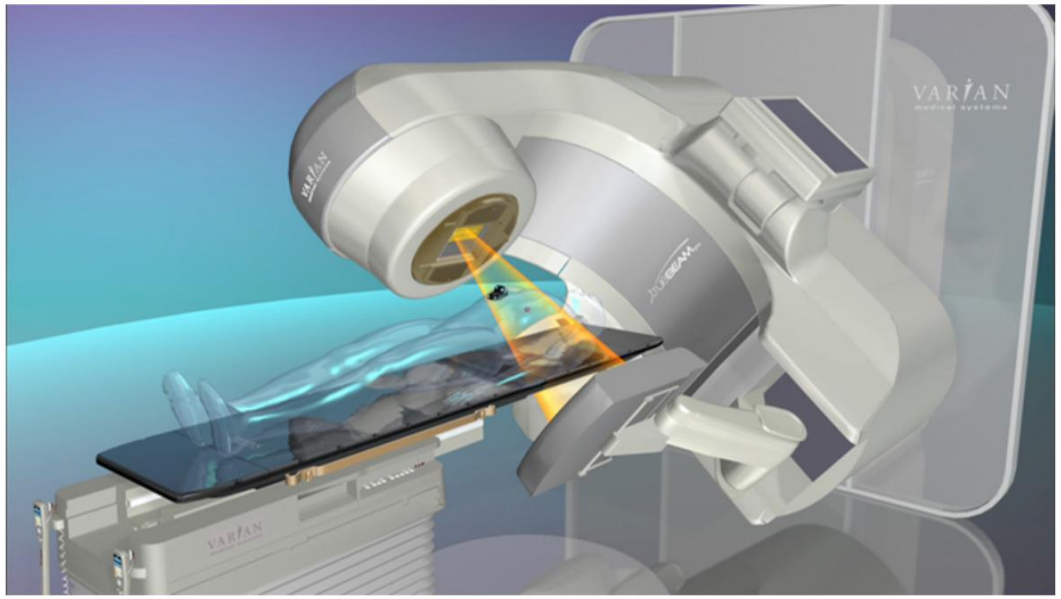
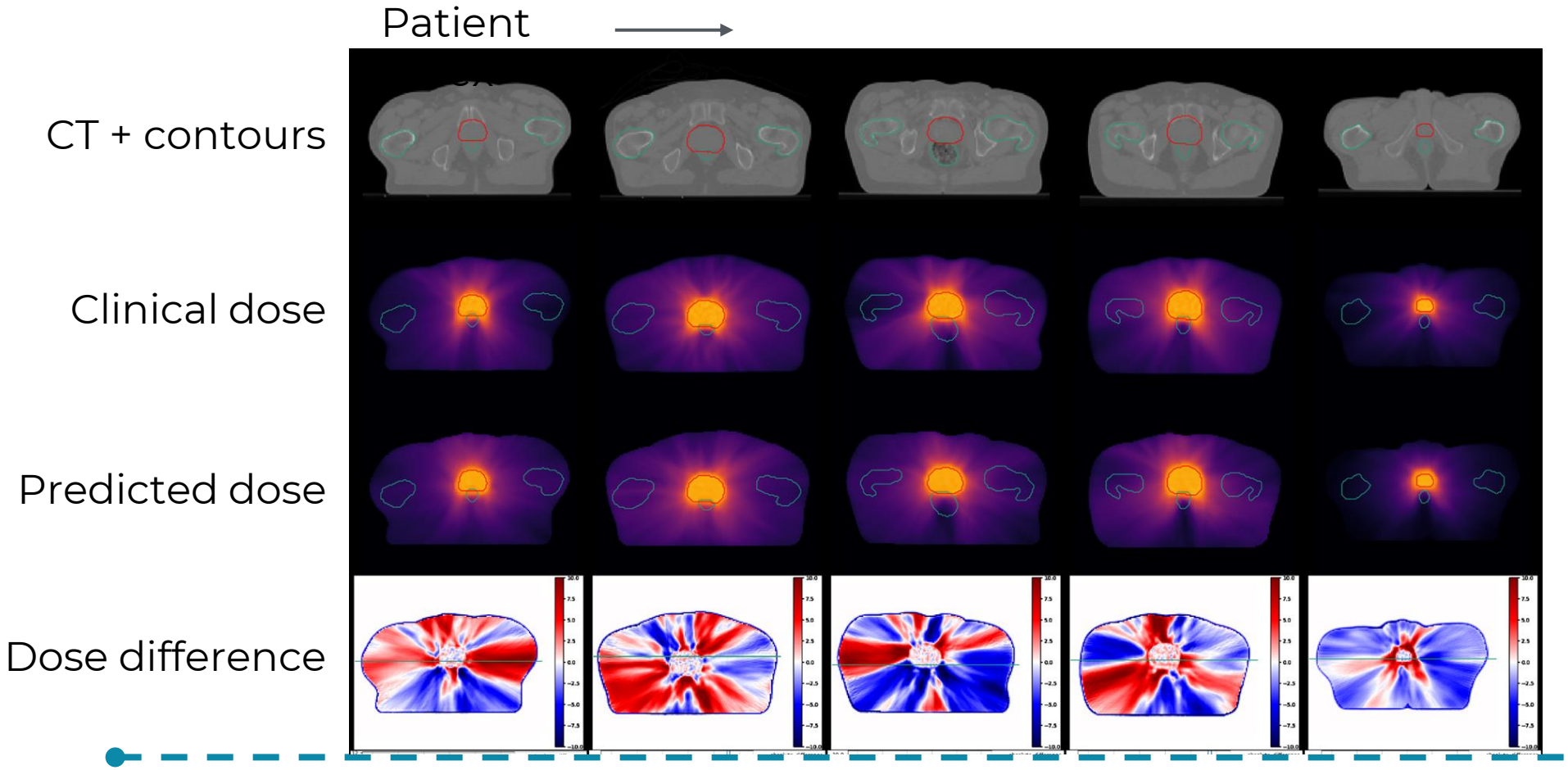
How about ? automatic planning?

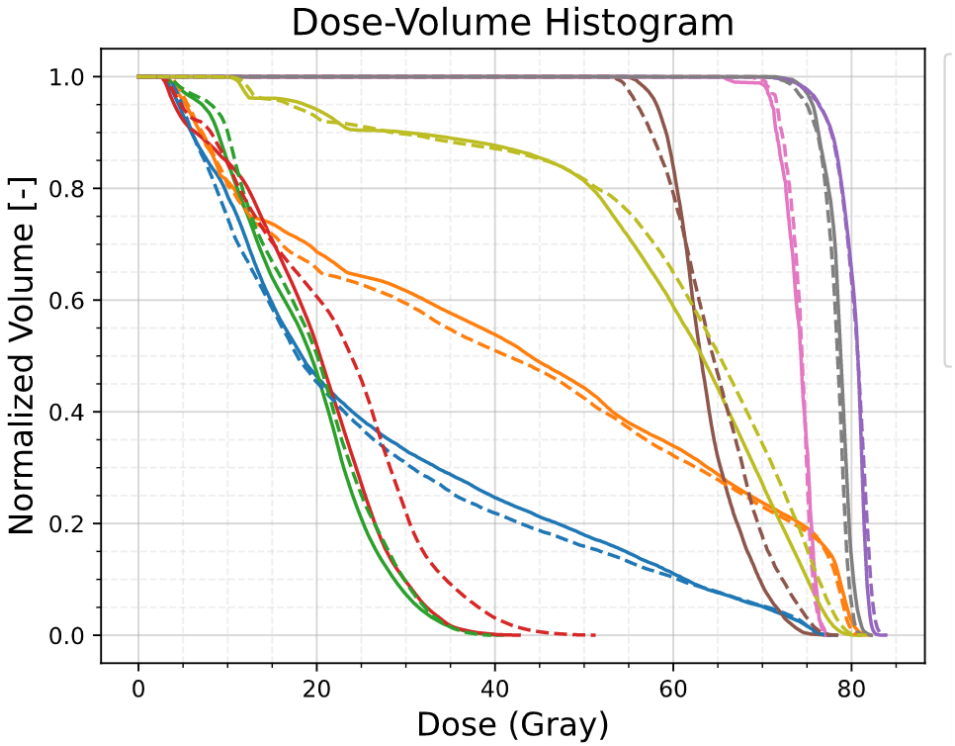
- ~3M new cancer cases per year in Europe alone
- ~50% of patients receive radiotherapy
- Side effects are serious
- High variance between practices
- Planning = clinical bottleneck



Results: Deep-learned dose predictions

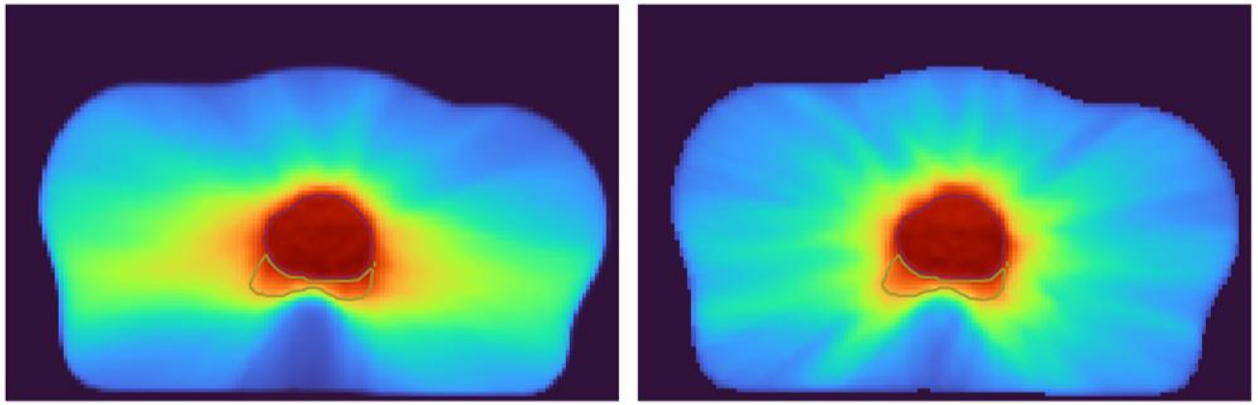


Results: TPC-optimized plans comparable to clinically-approved plans



Clinical dose

TPC dose



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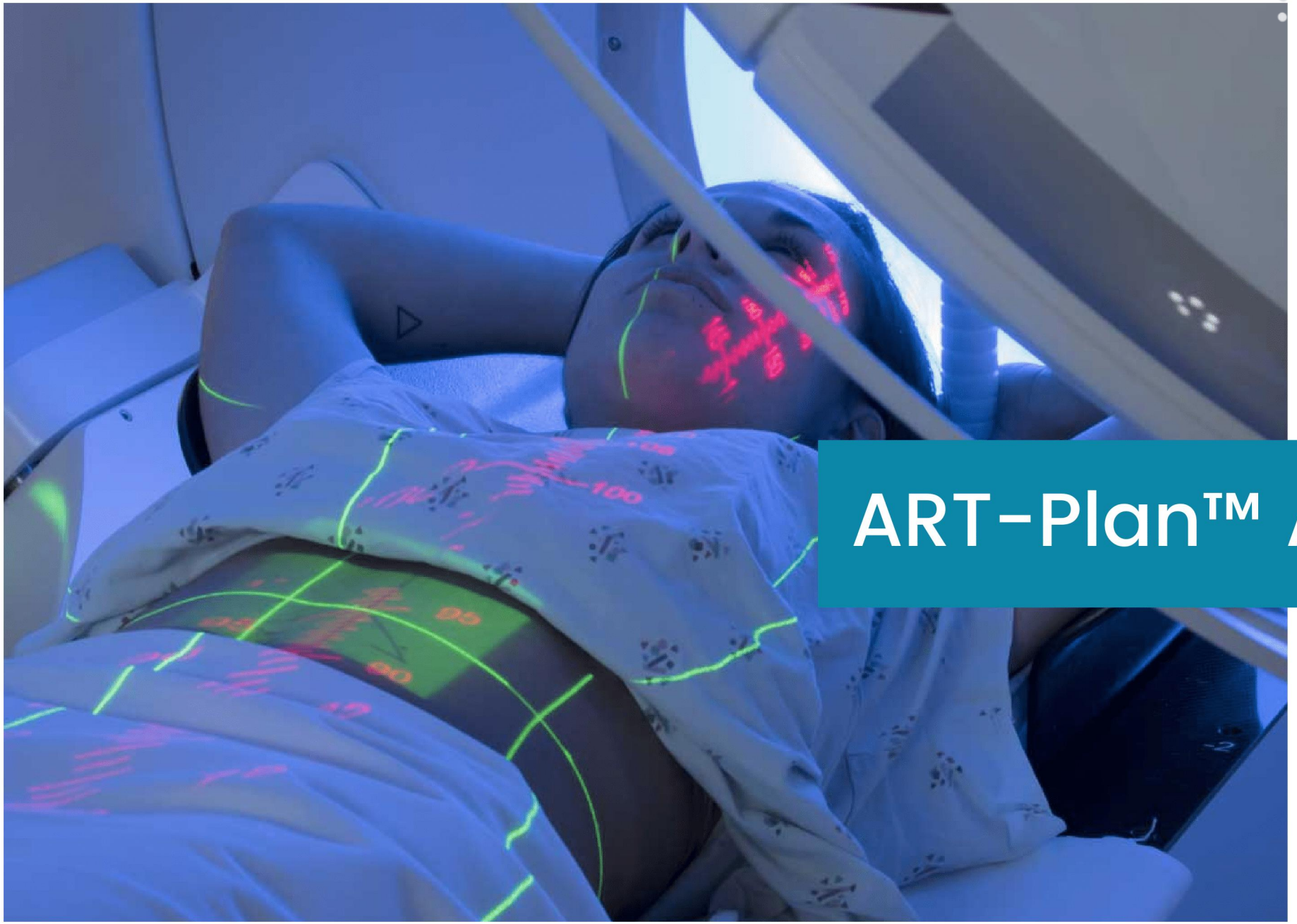


THERAPANA

Reinventing cancer care through AI

CE FDA

ART-Plan™ AdaptBox

AI-powered
Decision Making
for Re-Planning

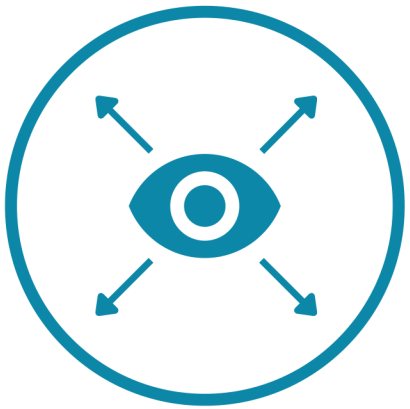
Problem

"Based on previous studies, approximately 21% to 65% of all patients undergoing head and neck cancer radiotherapy treatment may benefit dosimetrically from adaptive radiotherapy."*

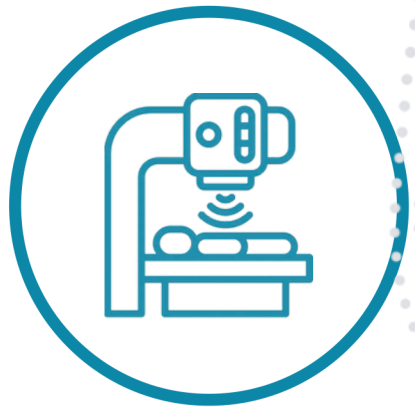
As patient's anatomy changes throughout the treatment process, the initial treatment plan may no longer reflect the actual dose delivered to the target and OARs. Repeated imaging such as CBCT can facilitate adaptation decision.

Some barriers still prevent their further clinical use:

CBCT Poor
Image Quality



CBCT Limited
Field of View



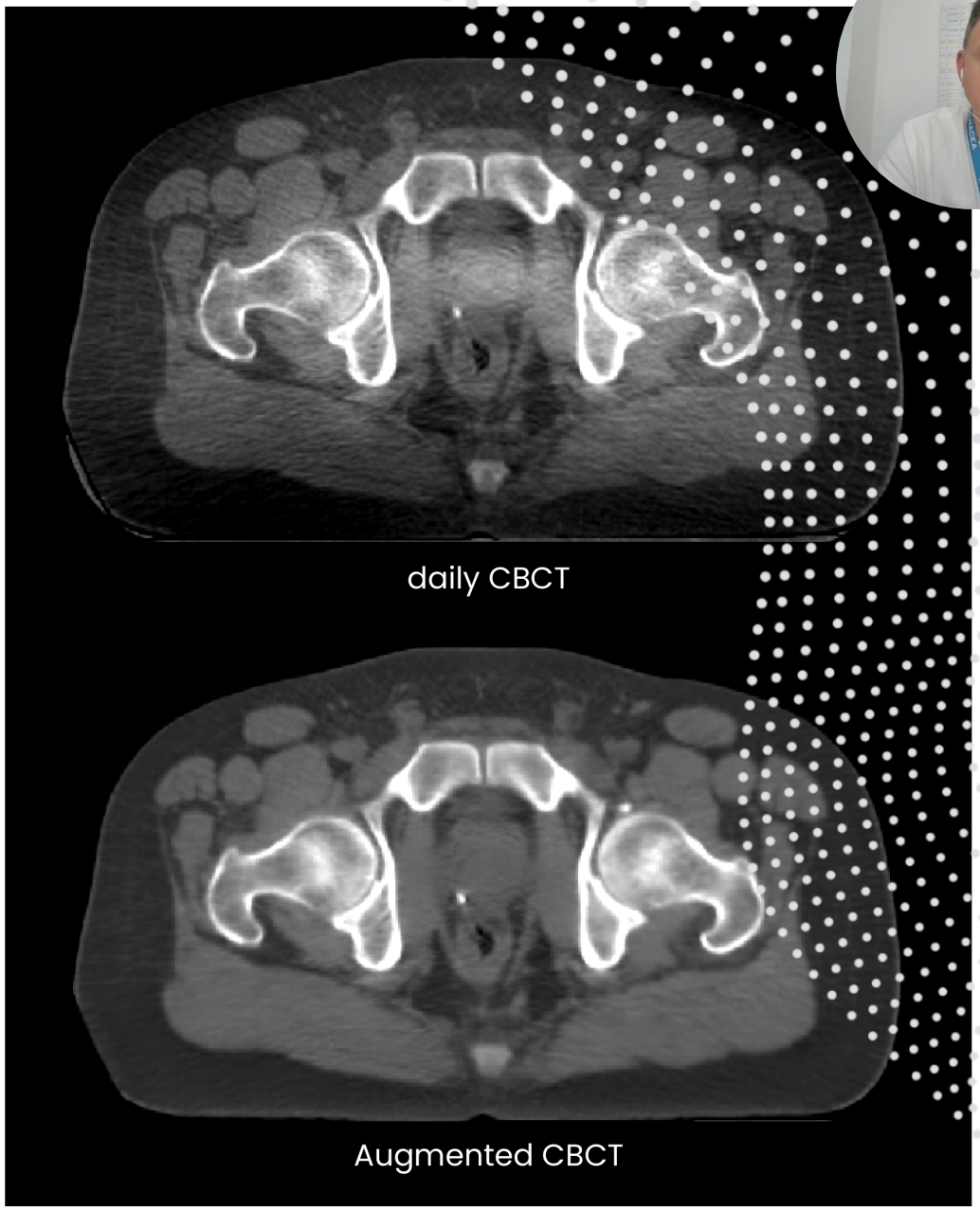
No possible
dose map generation

*Surucu, Murat et al. "Adaptive Radiotherapy for Head and Neck Cancer." Technology in cancer research & treatment vol. 16,2 (2017): 218-223.

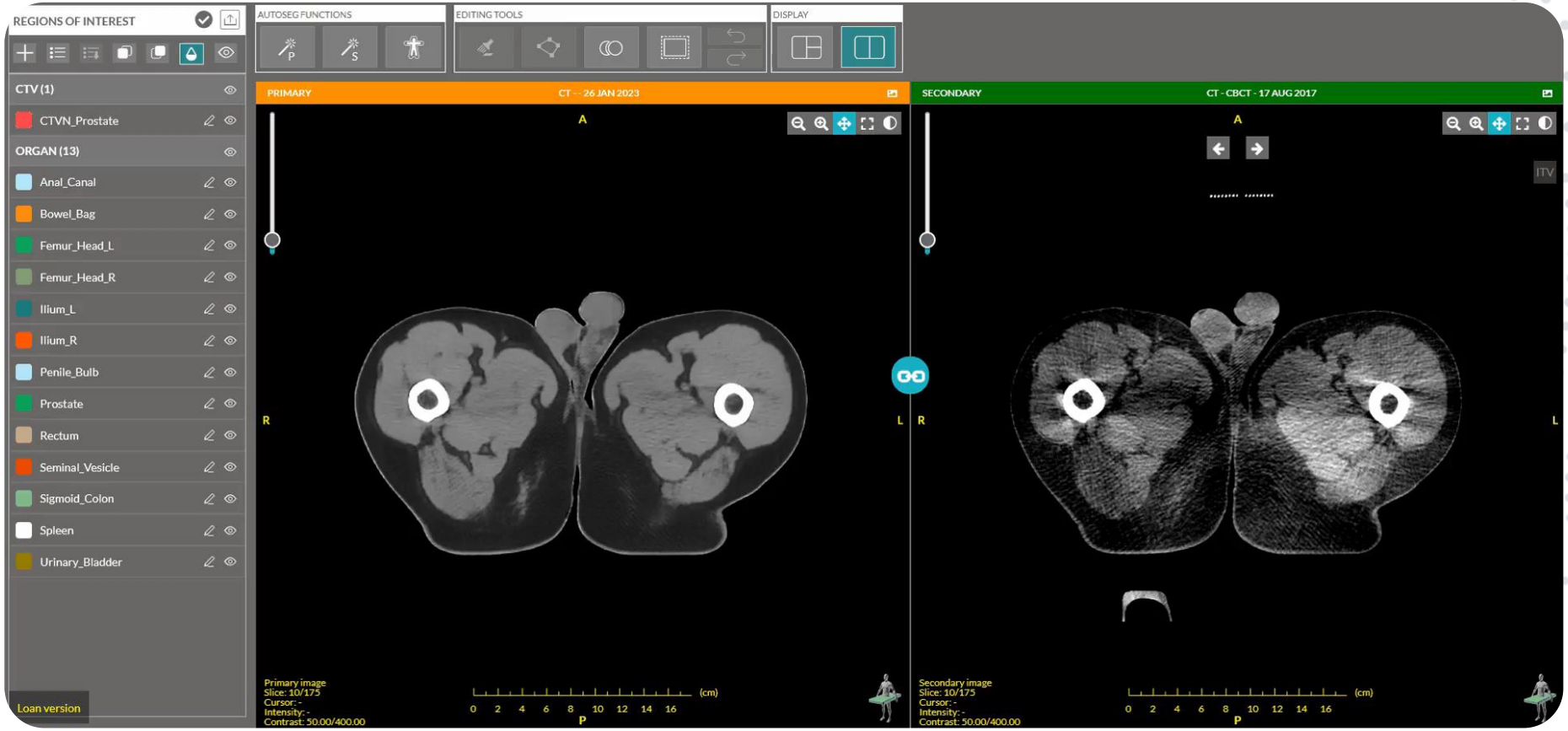
Solution

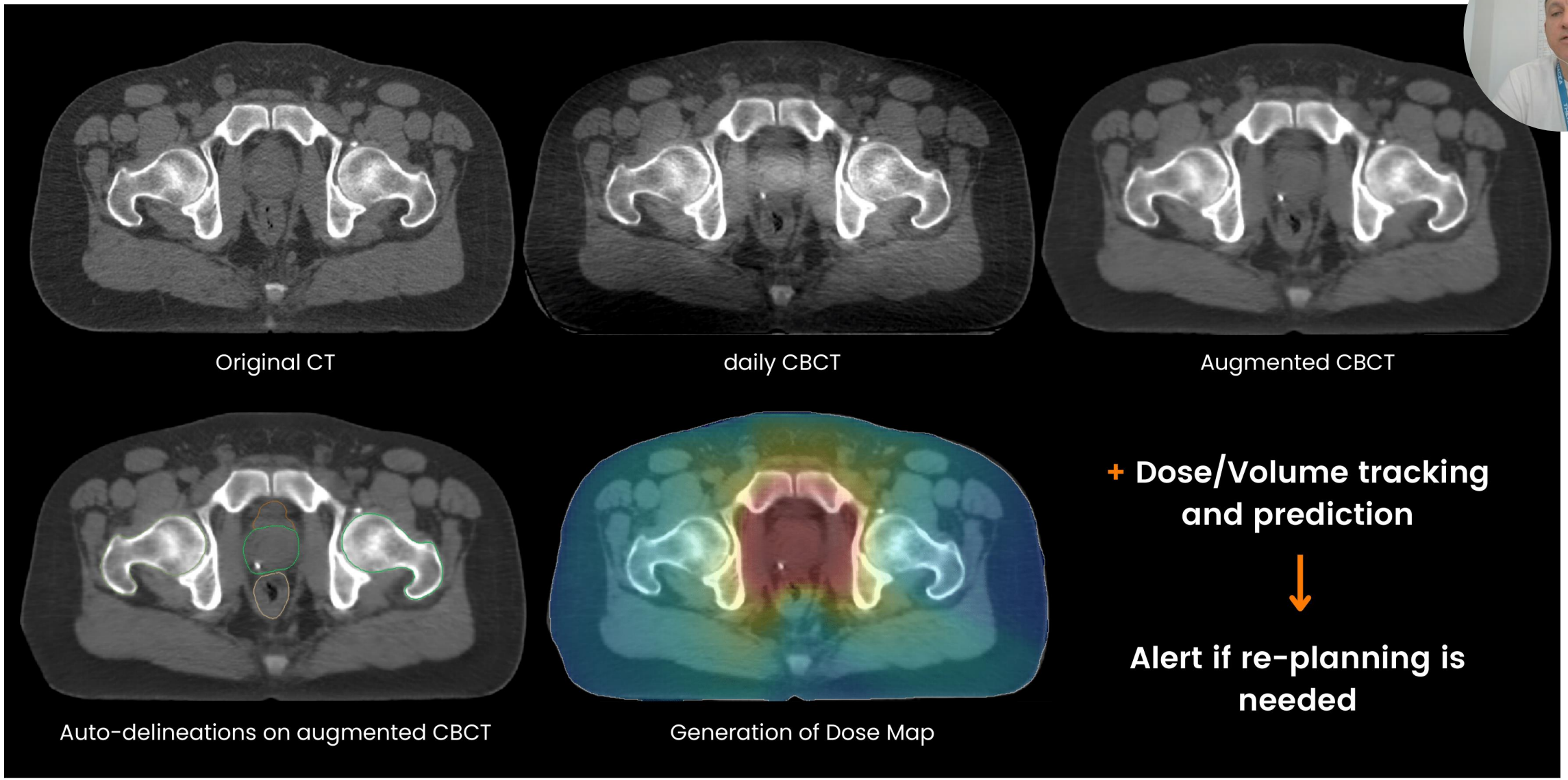
Generation of AI-based high resolution CBCT with augmented field of view for daily dose evaluation and robust patient positioning.

- Enhanced image quality
- Augmented Field of View
- Useful for effective full scale dose simulation
- Robust patient positioning
- Direct AI-powered delineations of OARs



Synthetic Cone Beam CT




Original CT
daily CBCT
Augmented CBCT
Auto-delineations on augmented CBCT
Generation of Dose Map
+ Dose/Volume tracking and prediction
Alert if re-planning is needed

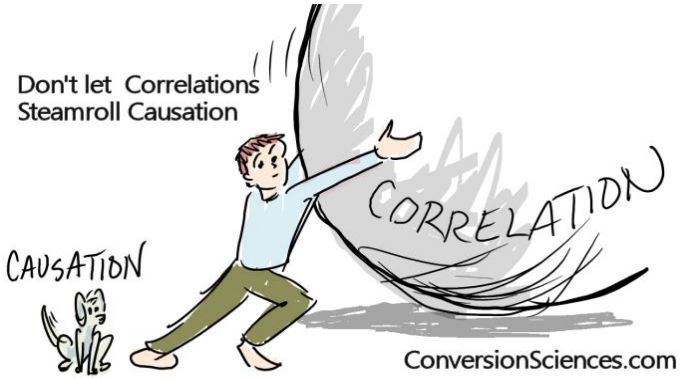
Challenges & Pitfalls of AI-driven precision medicin

Standardisation

Clinical practices are different, data as well

→ *Handling Data / Practices heterogeneity*

Correlation ? Causality



Too many variables to interpret

→ *Random Correlations*

Bias? Generalization

Unrepresentative training and testing sets

→ *Methods that do not generalize*

5
continents

200+
clinical sites

250,000+
oncology patients in 2024

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