Belgian Nuclear Research Centre
Belgium

Maastricht University
The Netherlands

University of Antwerp, inViLab
Belgium

Antwerp Hospital, GZA
Belgium

University Hospital Centre Zagreb
Croatia

in vivo patient-specific real-time dosimetry for adaptive radiotherapy - VERIFIED

TOPIC 2 - Individualised diagnostic and therapeutic procedures with regard to optimisation of the benefit/risk ratio.

Duration – 4 years **Start date** – Q1/2024, 6 WPs

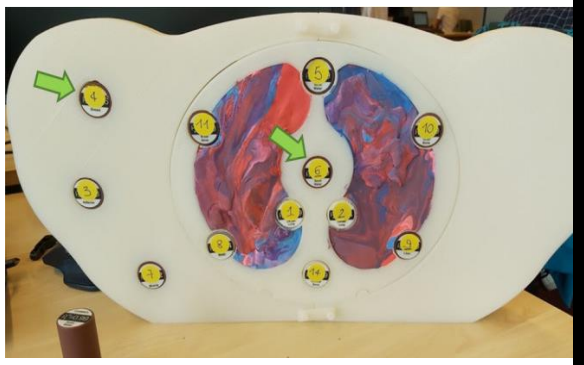
Luana de Freitas Nascimento, SCK-CEN - Project coordinator
Hrvoje Hrsak – KBC Zagreb

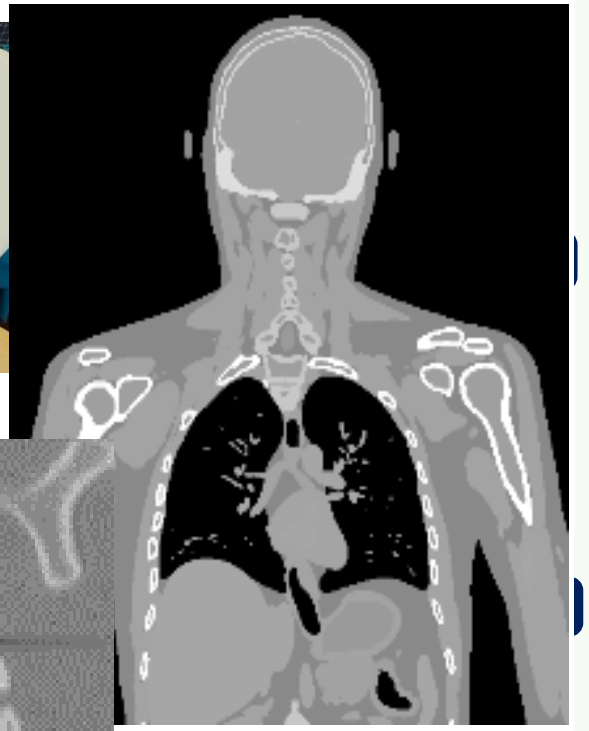
GZA/MIPRO
InViLab, KBC
SCK CEN

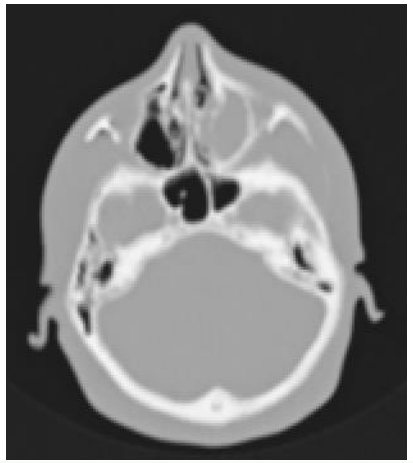
WP 1 - Development of Anthropomorphic Phantoms for Adaptive Radiotherapy

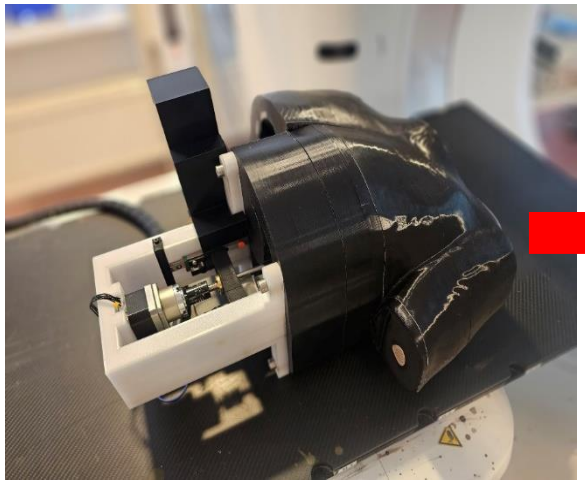
1. Phantoms for ART-VMAT: non-small-cell lung cancer patients with large tumor lesions and bladder tumors
2. Phantom for adaptive hfGKRS: large brain metastasis.

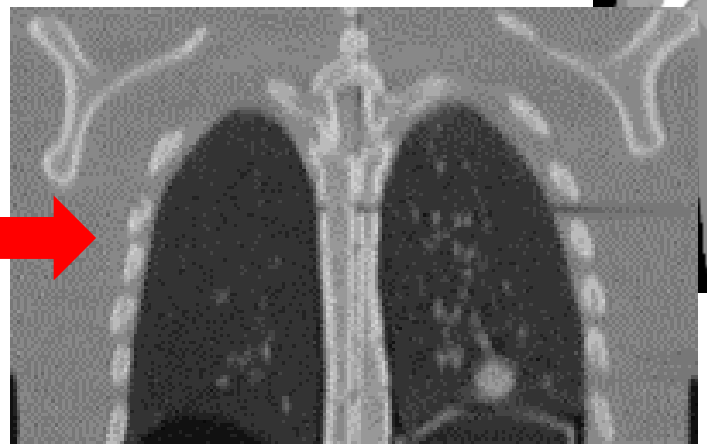
Development of tissue equivalent (lung, muscle, liver, breast, adipose, brain, bone), customized models of tumors in dynamic and compressible phantoms











WP 1 - Development of Anthropomorphic Phantoms for Adaptive Radiotherapy

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1. Phantoms for ART-VMAT: non-small-cell lung cancer patients with large tumor lesions and bladder tumors
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WP 2 - Real-Time Dosimetry System Integration ART-VMAT

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Fully integrated real-time dosimetry system validated in the WP1 phantoms (lung and bladder)

WP 6 – Management and dissemination

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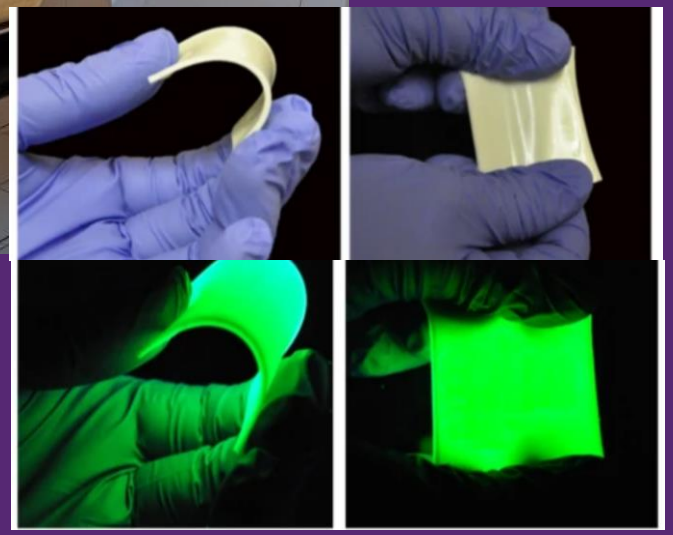
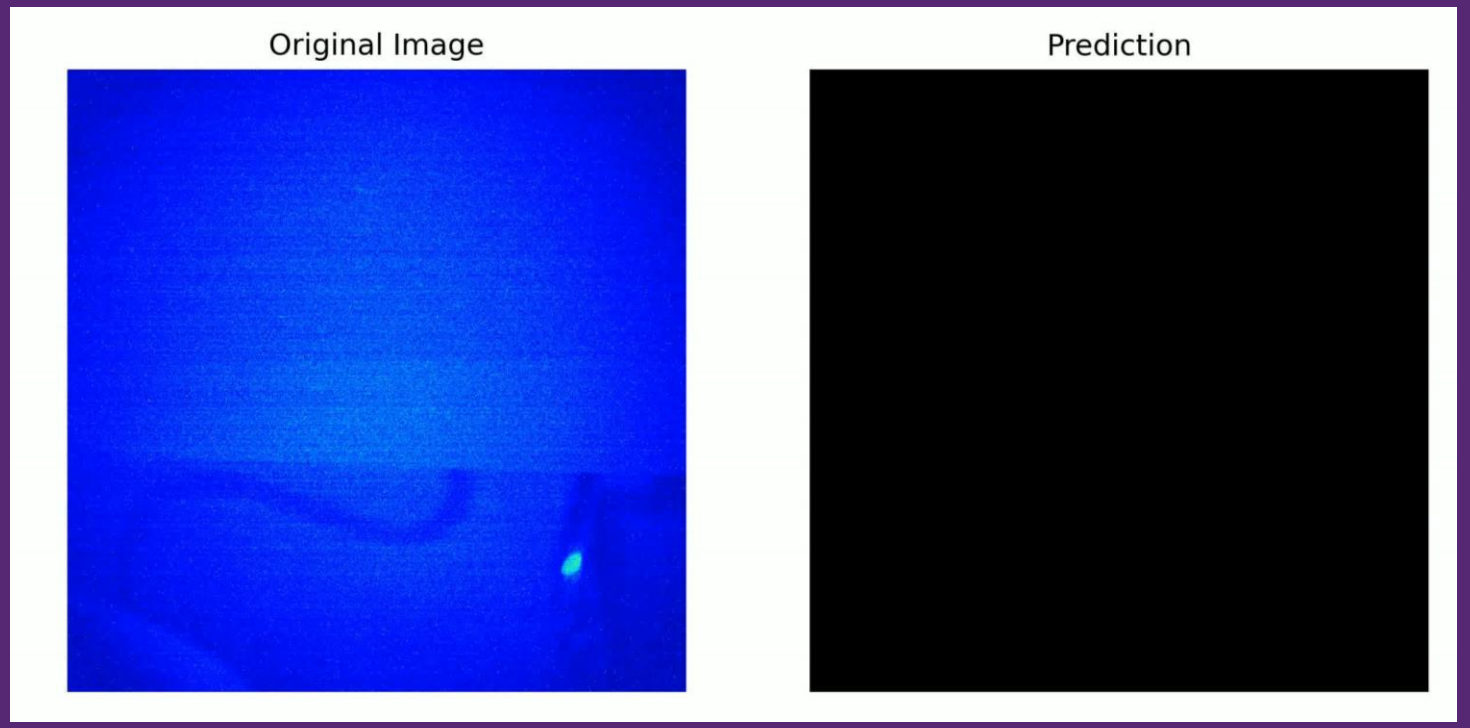
Status reports, meetings, data management plan, dissemination strategy

WP 2 - Real-Time Dosimetry System Integration – ART-VMAT



The dosimetry system will capture and analyze dose distributions in real time, providing valuable feedback on treatment. That compares 2D and 3D dosimetry images with information of the treatment planning system. The machine learning algorithm will be trained on a large range of measurements on the UM phantoms (WP1).



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WP 2 - Real-Time Dosimetry System Integration ART-VMAT

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WP 3 - Image-based Monitoring for hfGKRS

UM, Zagreb
SCK CEN

Development of an image-based monitoring system for capturing the patient head surface during treatment

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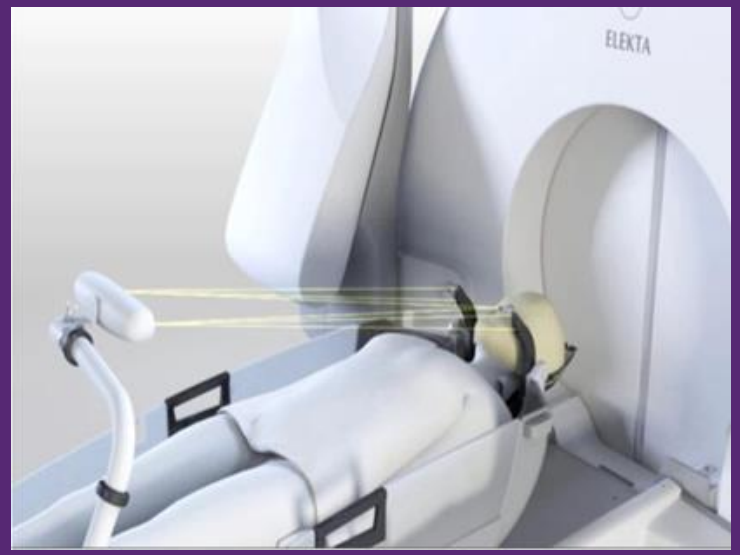
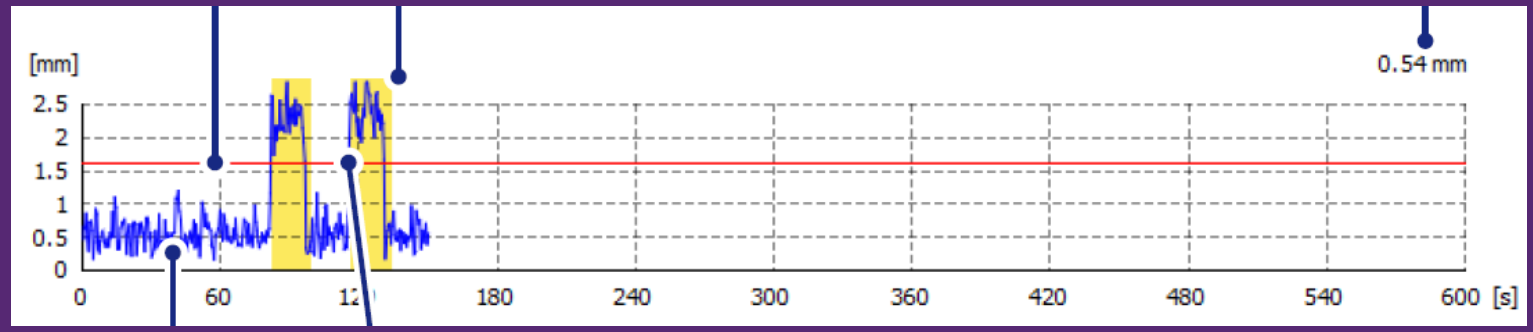
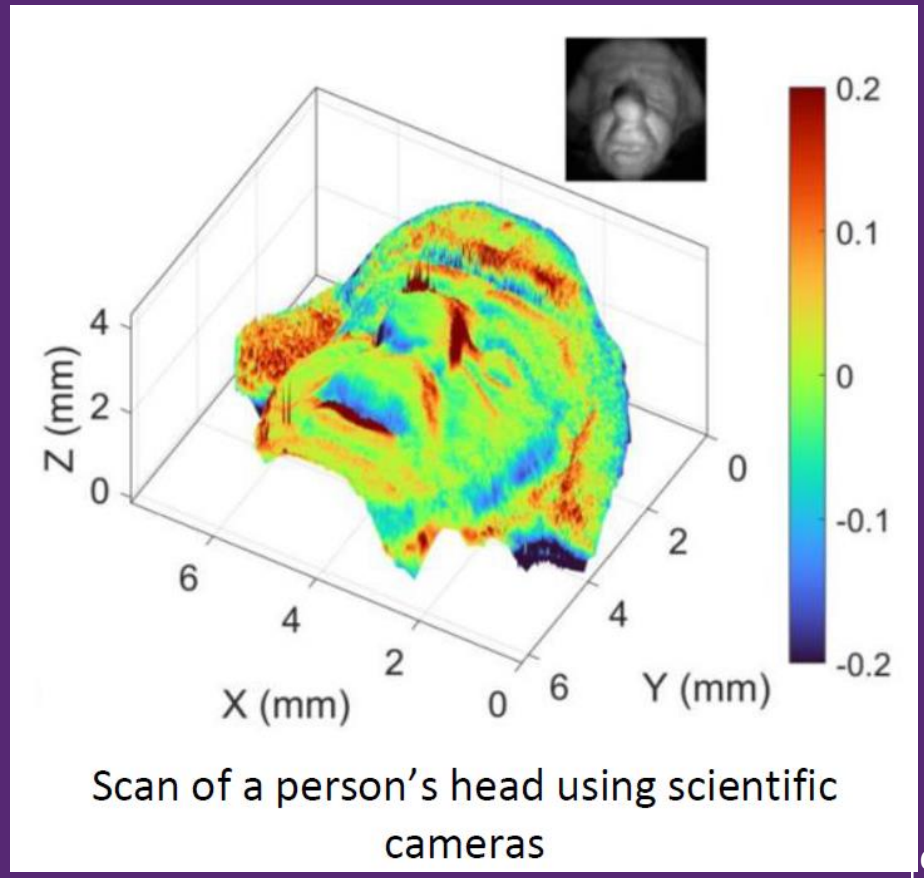
WP 3 - Image-based Monitoring for hfGKRS

Image-based system for monitoring the patient head surface during adaptive hypofractionated Gamma Knife radiosurgery. Currently, the infrared-based camera system monitors a single point on the patient's nose to track intrafractional patient motion. However, this work package aims to enhance the monitoring capability by utilizing image-based techniques to capture and analyze the entire patient head surface in real time.



Frac. time up to 50 min





Scan of a person's head using scientific cameras

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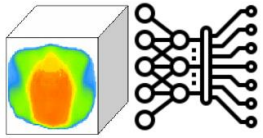
WP 4 - Real-time Dose Prediction for ART-VMAT using Deep Learning



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Deep learning model (CNN+RNN) using patient-specific anatomical information and imaging data into the dose prediction system

WP 6 – Management and dissemination

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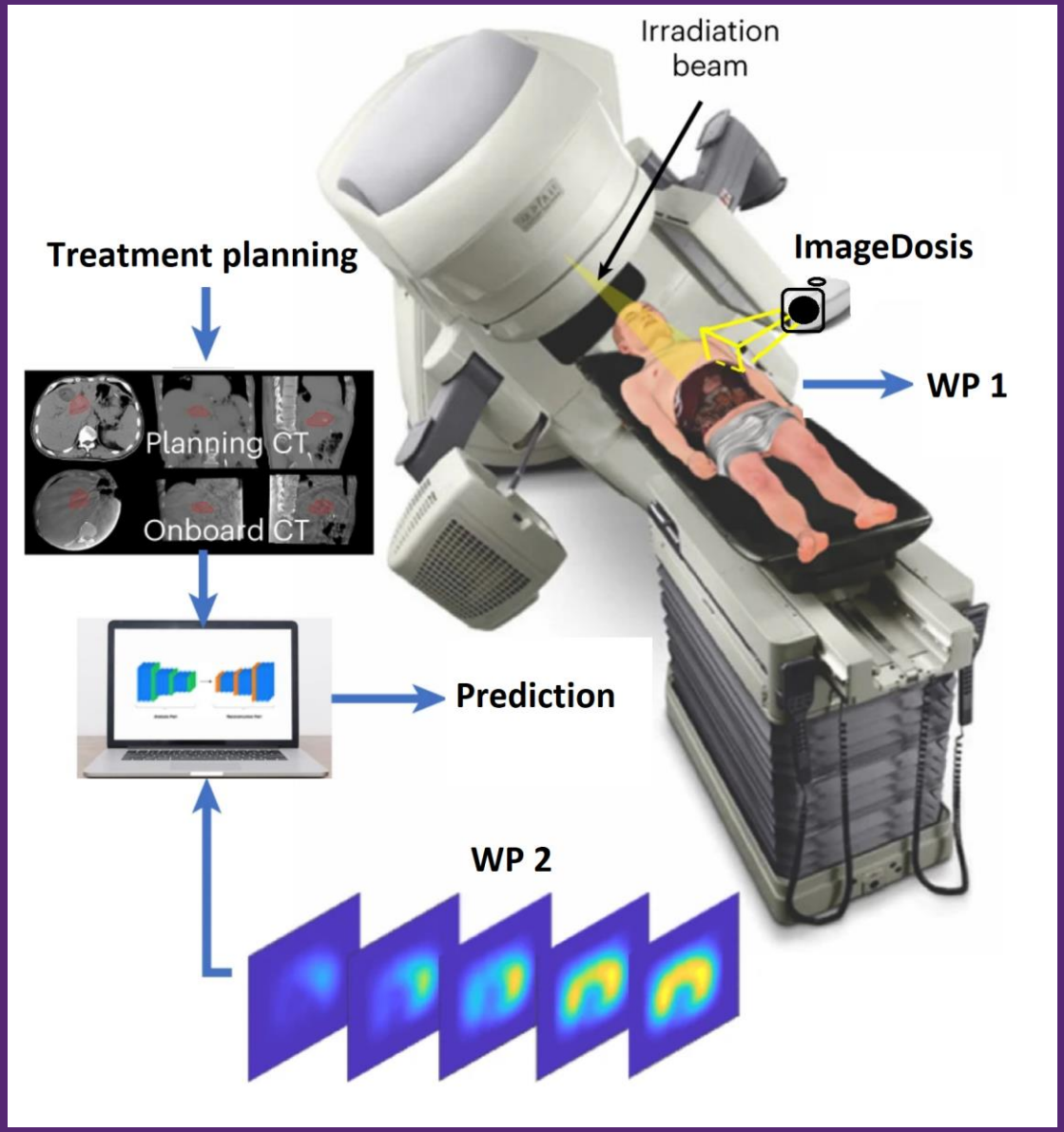
Status reports, meetings, data management plan, dissemination strategy

WP 4 - Real-time Dose Prediction for ART-VMAT using Deep Learning



1. Collection of a diverse and extensive dataset that includes treatment planning data, patient images and delivered dose information acquired using SCK CEN cameras (WP1 + WP2).

2. Development of a deep learning model combining Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) for real-time dose prediction.

3. 1600 (Antwerp) and 400 (Croatia) lung and 300 (Antwerp) bladder patients treated with volumetric modulated arc will be retrospectively studied using the developed method.

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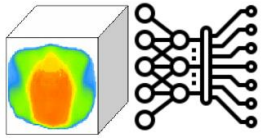

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Deep learning model (CNN+RNN) using patient-specific anatomical information and imaging data into the dose prediction system

WP 5 - Patient Selection for hfGKRS using Deep Learning

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SCK CEN

Training a deep learning algorithm to assess patient eligibility for adaptive hfGKRS and use model from WP4 for dose predictions

WP 6 – Management and dissemination

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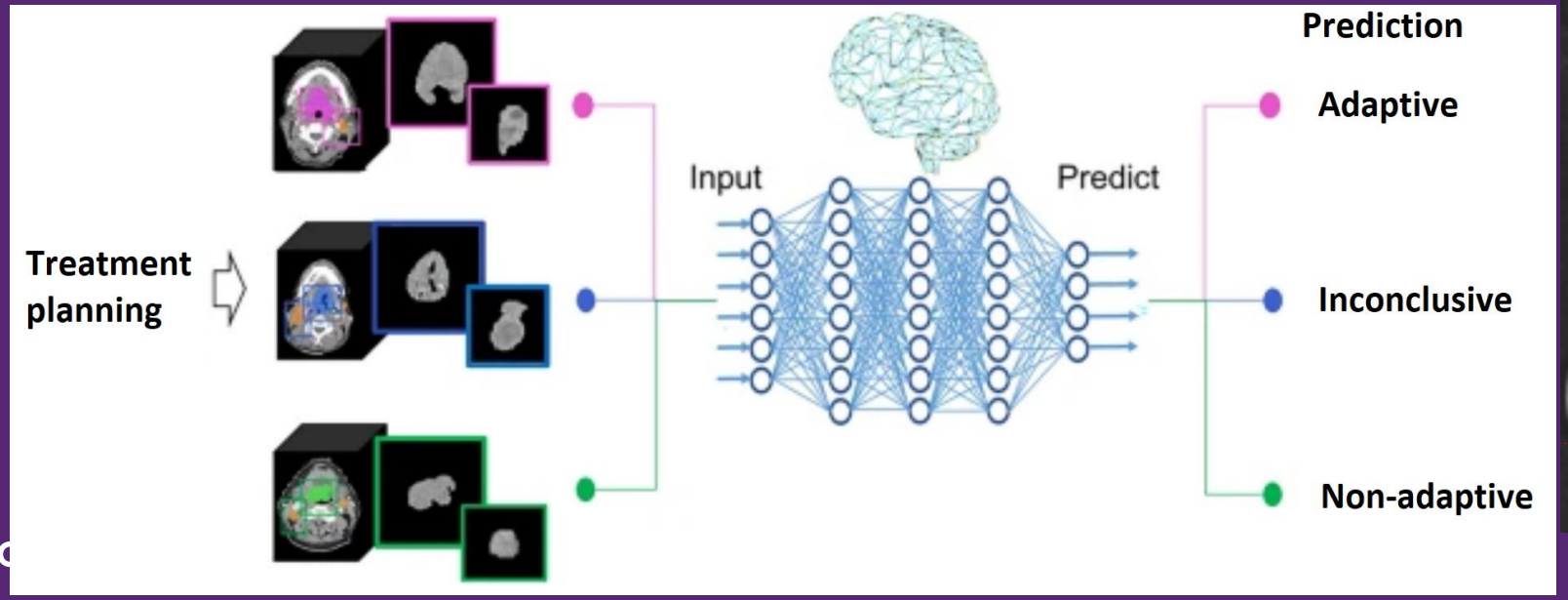
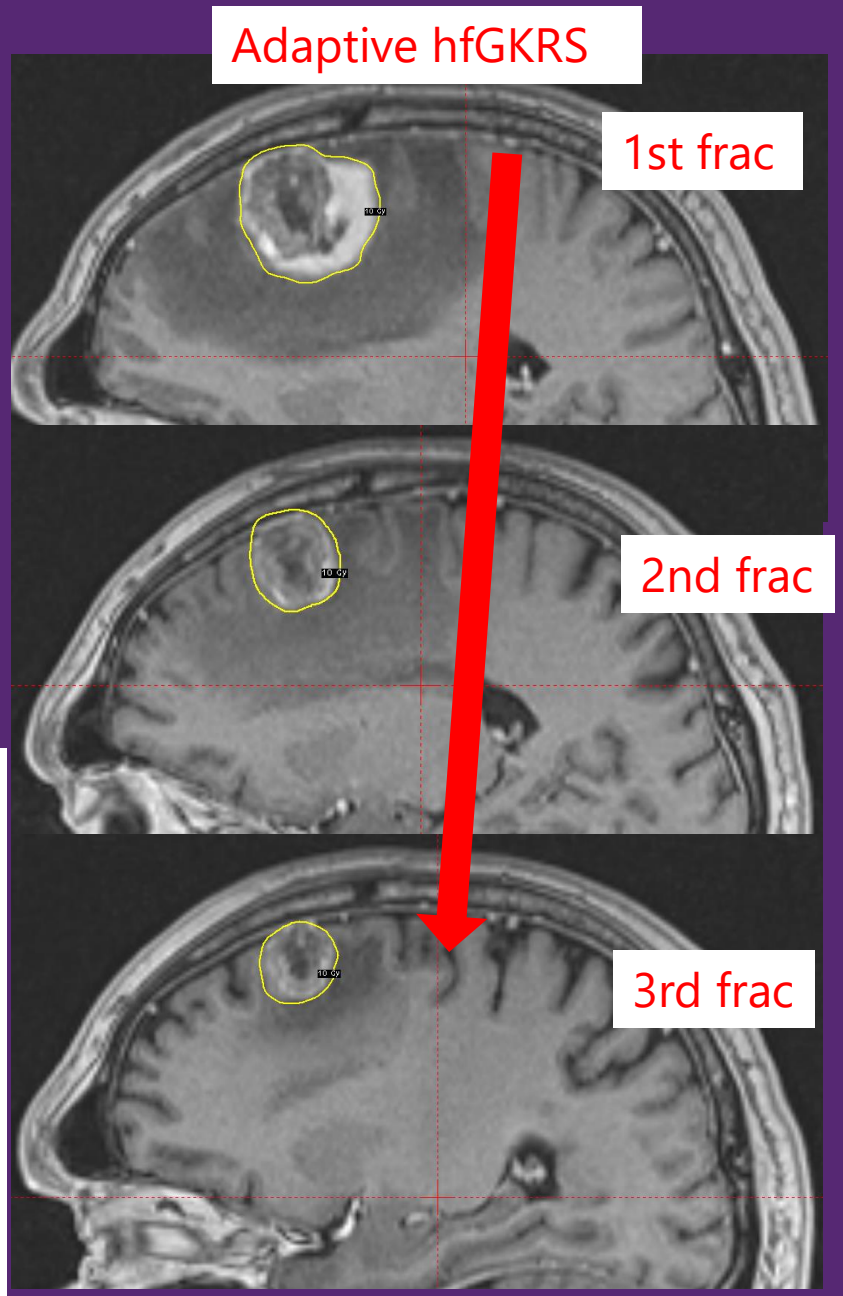
WP 5 - Patient Selection for hfGKRS using Deep Learning

Deep learning-based algorithm to select patients for adaptive hypofractionated Gamma Knife radiosurgery, combining Generative Adversarial Networks (GANs) and Reinforcement Learning (RL) to analyze tumor volume and dose distributions metrics (WP1) and tumor position (WP 3)

In total we have available 2500 patients. Of which 60 are hfGKRS treated with mask, and 20 are hfGKRS treated with stereotactic frame. The rest are 2420 patients treated with the single fraction, mostly with stereotactic frame, and rarely treated with mask.





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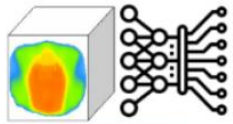

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WP 5 - Patient Selection for hfGKRS using Deep Learning

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S1 2024
S2 2024
S1 2025
S2 2025
S1 2026
S2 2026
S1 2027
S2 2027

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