



Provincial Health Services Authority

Artificial Intelligence in Radiation Oncology

Marco Carlone

Outline

- Where AI is used in Radiation Oncology?
- AI in treatment planning
- Commercial products implementing AI in Treatment planning

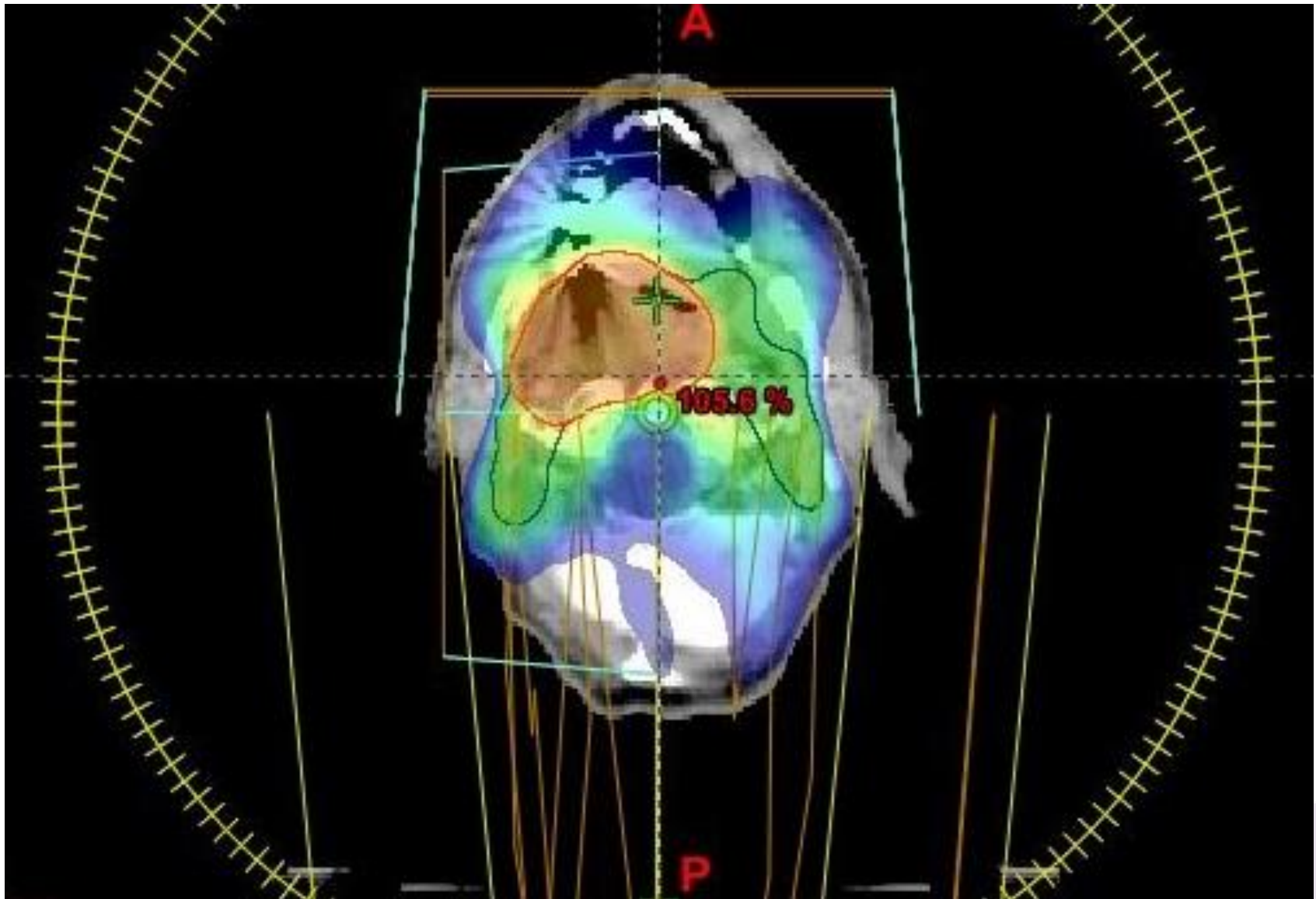
Where is AI used in Radiation Oncology?

- Treatment planning
- Linear Accelerator Quality Assurance
- Potential future areas:
 - Teaching
 - Management
- Everywhere!

AI in Radiotherapy Treatment Planning

1. To automate tasks that we do often?
2. To create more consistent outcomes in radiotherapy planning?
3. To save time?
4. To employ less people?
5. To increase the number of patients we can treat at our facility?

Treatment planning at a high level



Treatment planning is not an efficient process

Inputs are not always uniform

1. Lack of good radiotherapy protocols
2. Lack of information at the start of the treatment planning process
3. Competing goals of radiotherapy are not always defined at the beginning of the radiotherapy planning process

Two principle areas of AI use in radiotherapy planning

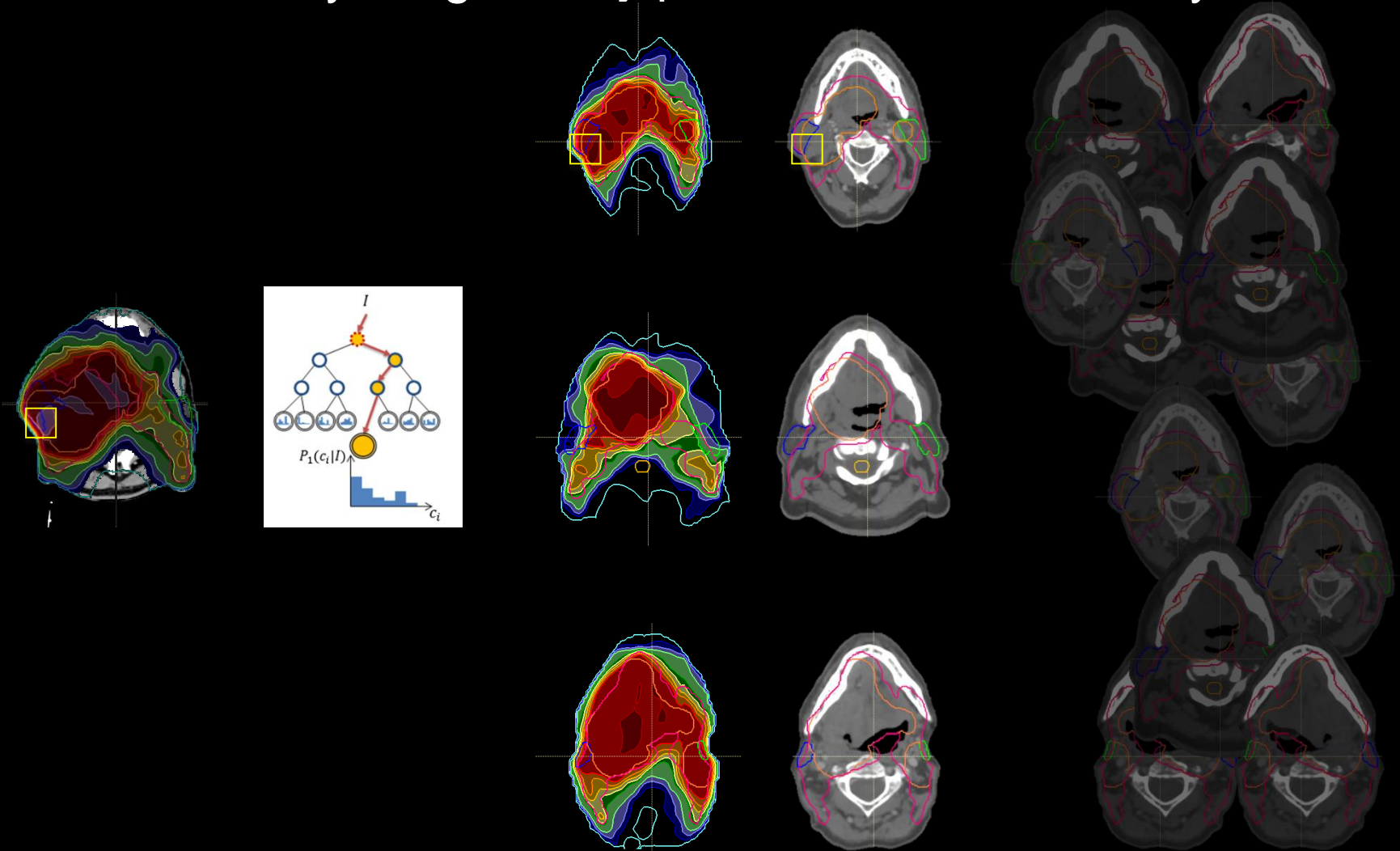
1. Knowledge based planning
2. Multi parameter optimisation

Two principle areas of AI use in radiotherapy planning

- 1. Knowledge based planning**
2. Multi parameter optimisation

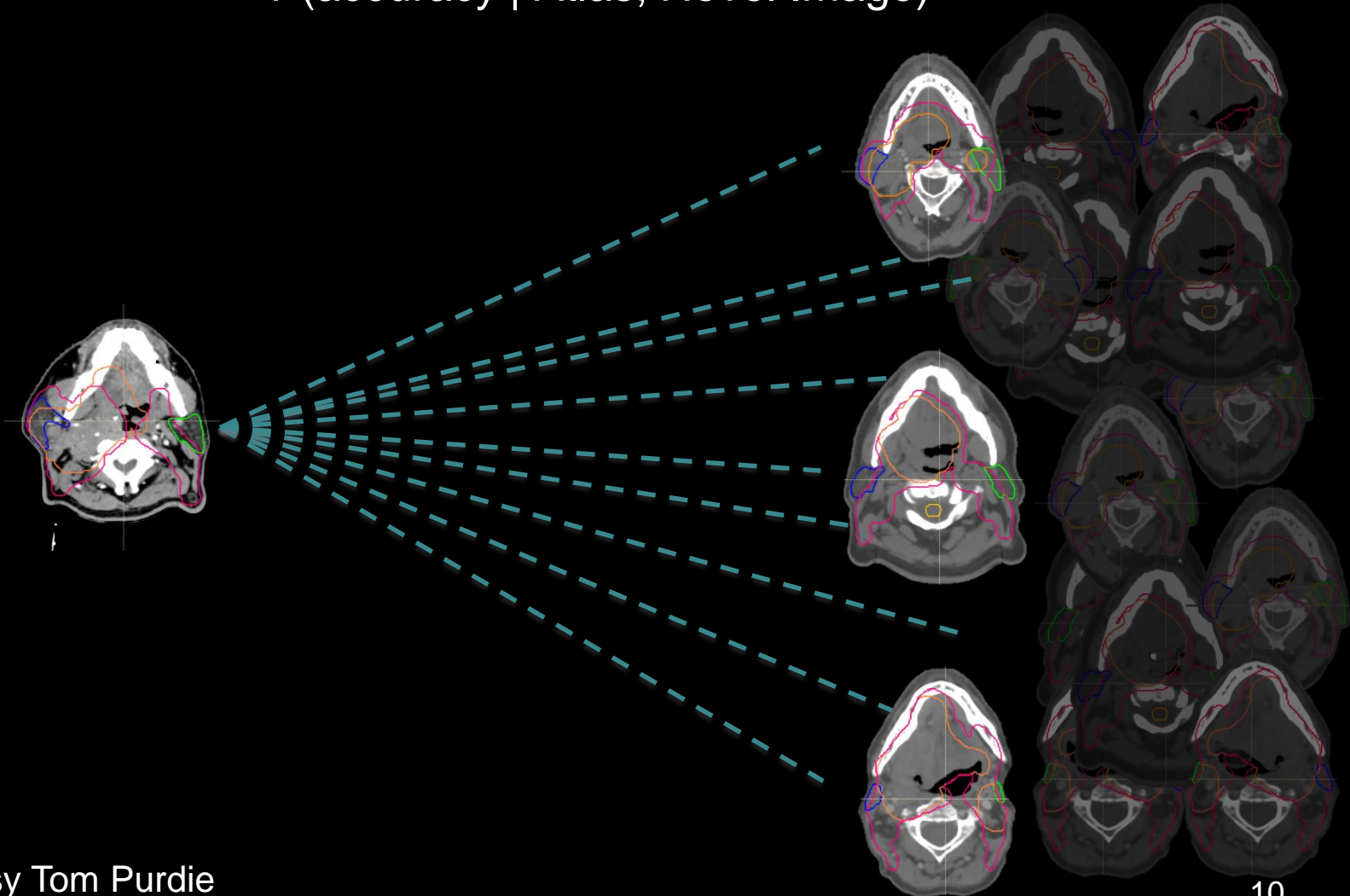
Dose Inference

Atlas Regression Forests are
inversely weighted by predicted atlas accuracy



Atlas-Selection Learning

- Density estimates over observed features are computed
- Additional Regression Forests learn distances:
 - $P(\text{accuracy} \mid \text{Atlas, Novel Image})$



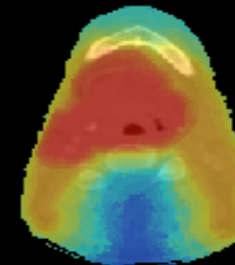
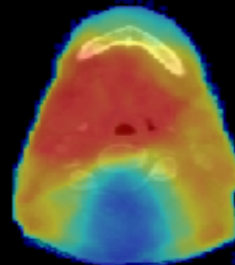
Example Planning Results

PTV Contours

Clinical Dose

Predicted Dose

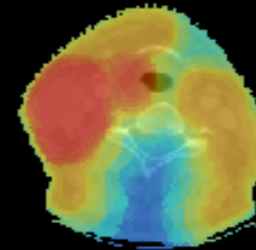
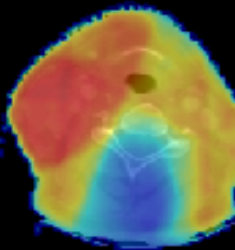
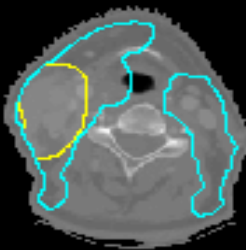
Patient 1



73 Gy



Patient 2



CREATE HIGH QUALITY PLANS QUICKLY & EFFICIENTLY.

RapidPlan Knowledge-Based Planning



Home > Oncology > Products > Software

SHARE    

Overview

Webinars

Resources

Videos

Contact



RapidPlan™ Knowledge-Based Planning Software

Cancer center teams around the world trust RapidPlan™ knowledge-based treatment planning software to create consistent, efficient, higher quality plans for individualized radiation treatment planning. By leveraging existing clinical expertise, your team can now move beyond templates to build the right plan, faster. RapidPlan models can be used as baselines for developing plans for virtually every type of external beam radiotherapy.

Read more about [RapidPlan](#) and view the [RapidPlan frequently asked questions \(FAQ\)](#). You can also learn what to expect and get familiar with the software by accessing the [RapidPlan full demo](#) (login to MyVarian required).



RapidPlan Knowledge-based Planning in Clinical Use Worldwide

Two principle areas of AI use in radiotherapy planning

1. Knowledge based planning
- 2. Multi parameter optimisation**

Multi parameter optimisation

*Dose Painting Head & Neck, Oropharyngeal_1, MCO PBS 3 - RayStation v1.8.1.18 - Not for Clinical Use

Automated Planning Patient Data Management Patient Modeling Plan Design Plan Optimization Plan Evaluation QA Preparation Treatment Adaptation

Plan Optimization Multi Criteria Optimization Patient: Dose Painting Head & Neck, Oropharyngeal_1 Plan: MCO PBS 3 Beam Set: MCO PBS 3 Plan Dose

Settings Generate pareto plans ROI selection Start Continue Stop Reset Cancel Compute Cancel Scale dose Auto scale to prescription Plan setup

6600 cGy as average dose in PTV primary

CREATE DELIVERABLE PLAN FINAL DOSE PRESCRIPTION

ROIs: ROI - Matl

POIs: Organ at risk (14)

- Tissue
- Brain Stem
- Mandible
- Parotid (L)
- Parotid (R)
- Spinal Cord
- Oral Cavity
- Larynx
- esophagus_constrict
- Submandibular (I)
- External Avoidant
- Normal Tissue
- DCR
- PTV CB

Scripting: Target (15)

- GTV_p
- CTV_p
- CTV_left_neck
- ctv_right_neck
- ctv_lower_left
- ctv_lower_right
- GTV_exp
- PTV primary
- PTV_left_neck
- ptv_right_neck
- ptv_lower_left
- ptv_lower_right
- PTV R N OBJ
- PTV L N OBJ
- PTV R L N OBJ
- Unknown (1)
- Contour

Protocols: Visualization

Dose axis display options: Absolute values Relative max dose value Relatf

Tradeoffs/constraints Navigation Beams Energy Layers Beam Computation Settings Beam Weighting IDCAS Collision Avoidance

Doses:

- Aux 21: ptv_lower_left Larynx
- Aux 22: PTV primary PTV_left_neck
- Aux 23: Spinal Cord PTV primary
- Aux 24: ptv_lower_right Parotid (L)
- Aux 25: PTV_left_neck Parotid (L)
- Aux 26: ptv_lower_left esophagus_constrictors
- Aux 27: Spinal Cord Parotid (L)
- Aux 28: esophagus_constrictors Oral Cavity
- Aux 29: Larynx Mandible
- Aux 30: ptv_right_neck Parotid (L)

Current navigation: All green

Targets:

- PTV primary, Uniform Dose
- PTV_left_neck, Uniform Dose
- ptv_lower_left, Uniform Dose
- ptv_lower_right, Uniform Dose
- ptv_right_neck, Uniform Dose

Organs at risk:

- Brain Stem, Max EUD
- esophagus_constrictors, Max EUD
- Larynx, Max EUD
- Mandible, Max EUD
- Oral Cavity, Max EUD
- Parotid (L), Max EUD
- Parotid (R), Max EUD

2D 2D - Ref Dose

All green Clinical: Percil Beam v3.3

CT1 Generic CT Transversal: 24.13 cm Slice 97761

All green Clinical: Percil Beam v3.3

CT1 Generic CT Sagittal: 20.90 cm

2D Dose Diff Dose Statistics Clinical Goals

Add physical... Add biological... Edit... Copy Delete Load tem

Dose	ROI/POI	Result	% outside grid
All green	Brain Stem	A: 4	0%
All green	esophagus_constrictors	A: 3	0%
All green	Larynx	A: 4	0%
All green	Mandible	A: 3	0%
All green	Mandible	A: 4	0%
All green	Oral Cavity	A: 2	0%
All green	Parotid (L)	A: 2	0%
All green	Parotid (R)	A: 2	0%
All green	PTV primary	A: 6	0%
All green	PTV_left_neck	A: 5	0%
All green	ptv_lower_left	A: 5	0%
All green	ptv_right_neck	A: 5	0%
All green	Spinal Cord	A: 4	0%
All green	Submandibular (R)	A: 3	0%

Live navigation: Off Max

New Copy Rename Delete

ROI/POI details

Multi parameter optimisation

The screenshot displays the 'Multi Criteria Optimization' window in a radiotherapy planning system. The interface is divided into several sections:

- Navigation:** 'Current navigation: All green' is displayed at the top.
- Targets:** A list of target volumes with their optimization goals:
 - PTV primary, Uniform Dose
 - PTV_left_neck, Uniform Dose
 - ptv_lower_left, Uniform Dose
 - ptv_lower_right, Uniform Dose
 - ptv_right_neck, Uniform Dose
- Organs at risk:** A list of organs at risk with their optimization goals and checkboxes:
 - Brain Stem, Max EUD
 - esophagus_constrictors, Max EUD
 - Larynx, Max EUD
 - Mandible, Max EUD
 - Oral Cavity, Max EUD
 - Parotid (L), Max EUD
 - Parotid (R), Max EUD
- Parameter Sliders:** Each target and organ at risk has a horizontal slider with a blue knob, allowing for manual adjustment of the optimization weight.
- Live navigation:** A toggle switch at the bottom right is currently set to 'Off'.
- Left Panel:** A tree view showing 'ROIs' (Organ at risk, Tissue) and 'Targets' (PTV primary, PTV left neck, etc.).
- Right Panel:** A 'Dose' distribution plot showing the percentage of 6500 cGy, with a color scale from 0 to 120.

What Happened?



DC
CAN