

KU Unilateral Head and Neck (KU_UniHN) RapidPlan Model Description

Purpose:

This document describes the context in which the Unilateral Head and Neck (KU_UniHN) Model should be used, as well as how it was configured and validated. All instructions needed to use this model in your clinic can be found when you **read the first 18 pages of this document.**

Applicability:

Note *RapidPlan knowledge-based planning and its models are not intended to replace clinical decisions, provide medical advice or endorse any particular radiation plan or treatment procedure. The patients' medical professionals are solely responsible for and must rely on their professional clinical judgment when deciding how to plan and provide radiation therapy.*

Note *The performance of the KU_UniHN model may vary depending on the contouring and planning guidelines. Each site should validate the model with institution-specific contouring and planning guidelines before clinical use.*

Note *You should validate every DVH estimation model before using it clinically. This applies to any model, whether Varian provided, peer provided or the models you create yourself.*

- KU_UniHN is intended to be used for RapidArc plans of 2-3 partial arcs on Halcyon/Ethos or TrueBeam.
- KU_UniHN was generated with Eclipse v18.0. Plans were copied to an ARIA v15.6 system to generate a copy of the model compatible with Eclipse v15.6 and beyond. Both the v18.0 and v15.6 models are available for use.
- KU_UniHN is meant to be used for treatment plans where head and neck target volumes are treated in the unilateral setting.
- KU_UniHN supports a range of dose schemes and doses can be scaled accordingly. All cases in this model were planned to 33 fractions with 2-3 dose levels; dose schemes included PTV_6996, PTV_5940, and PTV_5412 in accordance with NRG HN-009. Several cases with 2 dose levels were included in the model.
- Ipsilateral and contralateral submandibular and parotid glands need to be delineated and matched to the model accordingly.
- An associated 52 metric dosimetric scorecard should be used to evaluate plan quality and automatically generate the optimization structures needed (see page **Annex A1-A2** for details or manual creation)
- Due to the large number of structures the “Generate Estimates and Objectives” step when applying this model can take time (5+ minutes), the system isn’t locked, please be patient.
- The “**Automatic Intermediate Dose**” function of the Photon Optimizer was utilized with **MR4** return and **convergence mode: ON** selected in the calculation options which provide best results. These **settings should be changed prior to starting the optimization or plan quality will be compromised.** For increased homogeneity, consider re-optimizing the finished plan back to MR2, continuing the optimizing with the current plan dose. This has been a successful strategy in improving homogeneity within the target structures and helping to improve ipsilateral lung and heart DVH metrics.

- The KU_UniHN model was created using the guidelines described below.

Target contouring guidelines:

Standard Target Name	Example Description
PTV_5412	(CTV_5412 + 3mm margin) - skin
PTV_5960	(CTV_5940 + 3mm margin) - skin
PTV_6996	(CTV_6996 + 3mm margin) - skin
PTV5412OPT	(PTV_5412 - (PTV_5940 + 3mm margin)) - (PTV_6996 + 10mm margin)
PTV5940OPT	PTV_5940 - (PTV_6996 + 6mm margin)

All target contouring shall be in accordance to published guidelines, see <https://econtour.org/references> for various guidelines.

Contour templates have been generated in Radformation AutoContour (New York, NY, USA) to assist in structure creation. A contour template is included with this model to facilitate plan automation for AutoContour users.

Organ At Risk contouring guidelines:

OAR Standard Name	Description
Bone_Mandible	This includes the entire bony structure of the mandible from TMJ through the symphysis. It is recognized that for oral cavity cancers, this may overlap with PTVs.
BrachialPlexus	To contour the brachial plexus use a 5-mm diameter paint tool. Start at the neural foramina from C5 to T1; this should extend from the lateral aspect of the spinal canal to the small space between the anterior and middle scalene muscles. For CT slices where no neural foramen is present, contour only the space between the anterior and middle scalene muscles. Continue to contour the space between the anterior and middle scalene muscles; eventually the middle scalene will end in the region of the subclavian neurovascular bundle. Contour the brachial plexus as the posterior aspect of the neurovascular bundle inferiorly and laterally to one to two CT slices below the clavicular head. The first and second ribs serve as the medial limit of the OAR contour. See Figure 5.2.5.2 and https://www.redjournal.org/article/S0360-3016(08)00416-1/fulltext for more details
Brain	The whole brain parenchyma includes all intracranial contents, inclusive of target volumes, contoured using the CT dataset.
Brainstem	The most inferior portion of the brainstem is at the cranial-cervical junction where it meets the spinal cord (or distal edge of foramen magnum). For this study, the most superior portion

	of the brainstem is approximately at the level of the top of the posterior clinoid. The brainstem shall be defined based on the treatment planning CT scan.
Brainstem_03	Planning Risk Volume (PRV) brainstem defined as Brainstem + 3 mm in all directions.
BuccalMucosa	Extends from the bottom of the maxillary sinus to the upper edge of the teeth sockets. Extends anteriorly towards the lips and posteriorly to the pterygoid. Laterally extends to buccal fat and medially to the outer surface to the mandible and maxilla.
Cavity_Oral	The oral cavity will be defined as a composite structure posterior to lips consisting of the anterior 1/2 to 2/3 of the oral tongue/floor of mouth, buccal mucosa, and superiorly the palate, and inferiorly to the plane containing the tip of the mandible (external to PTVs).
Cochlea_L/R	The cochlea should be defined using bone window (suggested window width 3000 to 4500 and window level of 400 to 800). It is well visualized near the most lateral extent of the internal auditory canal. The spiral canals of the cochlea appear as small curved or round lucencies within the temporal bone. The cochlea should be defined in its entirety limited by vestibular apparatus posteriorly and middle ear laterally
Esophagus	Upper Cervical Esophagus, a tubular structure that starts at the bottom of pharynx (cricopharyngeal inlet) and extends to the level of the carina.
Eye_L/R	Includes entire globe.
GlnD_Thyroid	The thyroid is easily visible on a non-contrast CT due to its preferential absorption of iodine, rendering it "brighter" or denser than the surrounding neck soft tissues. The left and right lobes of the thyroid are somewhat triangular in shape and often do not converge anteriorly at mid-line. All "bright" thyroid tissue should be contoured.
Larynx	This will be defined as the glottic and supraglottic larynx, including the tip of the epiglottis, the aryepiglottic folds, arytenoids, false cords, and true cords, bounded by the thyroid cartilage laterally, anteriorly including the anterior edge of the pre-epiglottic fat, and posteriorly bounded by the anterior edge of the pharyngeal wall or the posterior edge of the arytenoid and/or cricoid cartilage.
Lobe_Temporal_L/R	Extends from the base of skull (squamous portion of temporal bone + greater sphenoid wing) inferiorly to the lateral sylvanian fissure superiorly. Includes CSF space medial to temporal bone to the CSF space surrounding the brainstem on each side. Should include the anterior 2/3, cutting off posteriorly by the imaginary line dividing the cranium.
Lips	The lip contour extends from the inferior margin of the nose to the superior edge of the mandibular body. The lateral border is at the lateral commissure. The lip contour should include the inner surface of the lips. Lips will be defined in their entirety (upper and lower) based on the treatment planning CT scan.
Lungs	Low density structures, contoured together.
Musc_Constrict	This will be defined as the pharyngeal mucosa and wall plus adjacent constrictor muscles. This extends from the superior constrictor region (level of the inferior pterygoid plates) to the cricopharyngeal inlet (inferior level of the posterior cricoid cartilage). The posterior border is the pre-vertebral muscle.
OpticChiasm	Located above the pituitary fossa, the optic chiasm includes both anterior and posterior limbs. It is best visualized on pre-operative or postoperative T2/FLAIR MRI (or MPRAGE) sequence but should be confirmed on CT dataset due to potential variation in CT/MRI fusion (if available).
OpticNrv_L/R	Connecting from the eye to the optic chiasm, this structure is best contoured using the CT data set.

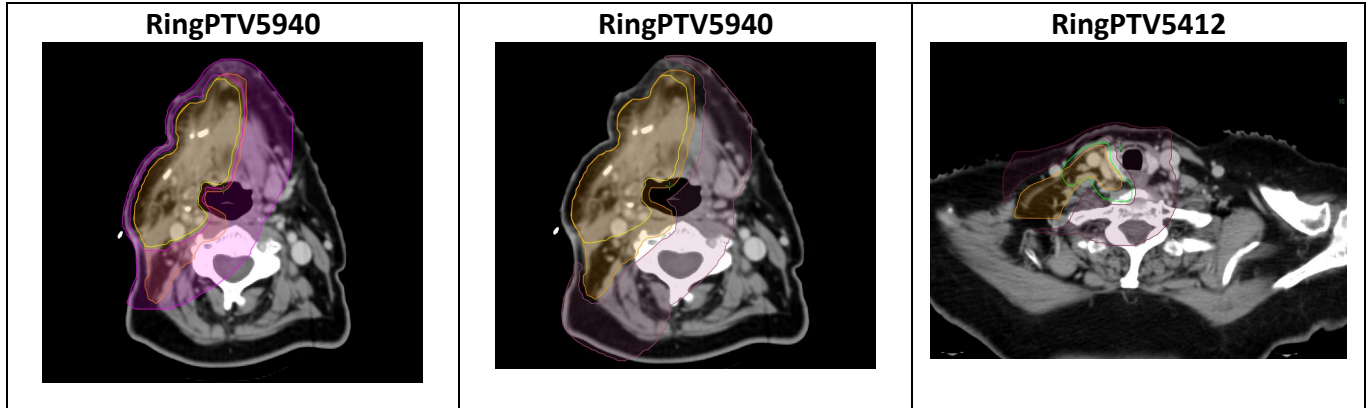
Parotids: ParotidCont and ParotidIpsi	Parotid glands will be defined in their entirety (superficial and deep lobes) based on the treatment planning CT scan. The parotid gland is an irregular shaped gland wedged between the ramus of the mandible and the mastoid process. The superior border is the zygomatic arch, inferiorly, the gland extends to the angle of the mandible. The anterior border is the masseter muscle; in 20% of cases the parotid gland extends anteriorly over the surface of the masseter muscle, and posteriorly, to the anterior border of the sternocleidomastoid. Laterally, it extends to the platysma and medially, to the posterior belly of the digastric muscle, styloid process and parapharyngeal space. The retromandibular vein is included in the parotid gland contour.
Pituitary	Sits within the Sella Turcica
ShouldIpsi	Ipsilateral humeral head.
SpinalCord	The spinal cord begins at the cranial-cervical junction (i.e., the top of the C1 vertebral body). Superior to this is brainstem and inferior to this is cord. The inferior border of the spinal cord volume will be defined at approximately T3-4 (i.e., 2-3 cm below the lowest slice level that has PTV on it). The spinal cord shall be defined based on the treatment planning CT scan.
SpinalCord_05	Planning Risk Volume (PRV) spinal cord defined as SpinalCord + 5 mm in all directions.
Submandibulars: SubmandCont and SubmandIpsi	Submandibular glands will be defined in their entirety based on treatment planning CT scan. The submandibular glands are paired salivary glands composed of a large superficial lobe and a smaller deep process that are continuous with each other around the posterior border of the mylohyoid muscle. The superior border is the mylohyoid muscle and medial pterygoid muscle. Inferiorly, the gland abuts fatty tissue. Anteriorly, the gland is adjacent to the lateral surface of the mylohyoid muscle and posteriorly it abuts the parapharyngeal space and sternocleidomastoid. The lateral border is platysma and the mandibular surface. The medial border is the lateral surface of the mylohyoid muscle and the anterior belly of the digastric. The submandibular gland is often hypodense on CT and can be distinguished from surrounding structures.
Trachea	Begins at the bottom of the larynx and continues until the carina inferiorly
External	External border of the patient

The planning target volumes (PTV) and the organs at risk (OARs) are contoured on the planning CT.

Optimization structure guidelines:

Model Structure	Derived Boolean/Expansion
PTV5412OPT	{<PTV_5412> SUB <{PTV_5940}> +3mm SUB <{PTV_6996}> +10mm}
PTV5940OPT	{<PTV_5940> SUB <{PTV_6996}> +6mm}
Larynx-PTV	{<Larynx> SUB <{PTV_all}>}
Lungs	{<Lung_L> OR <{Lung_R}>}
Mandible-PTV	{<Bone_Mandible> SUB <{PTV_all}>}
OCavity-PTV	{<Cavity_Oral> SUB <{PTV_all}>}
ParotidIpsi-PTV	{<ParotidIpsi> SUB <{PTV_all}>}
ParotidCont-PTV	{<ParotidContra> SUB <{PTV_all}>}
PharConst-PTV	{<MuscConstrict> SUB <{PTV_all}>}
RingPTV5412	{<PTV_5412> +30mm SUB <{PTV_5412}> +2mm SUB <{PTV_6996}> +12mm SUB <{PTV_5940}> +6mm AND <BODY>}
RingPTV5940	{<PTV_5940> +30mm SUB <{PTV_5940}> +2mm SUB <{PTV_6996}> +9mm SUB AND <BODY>}

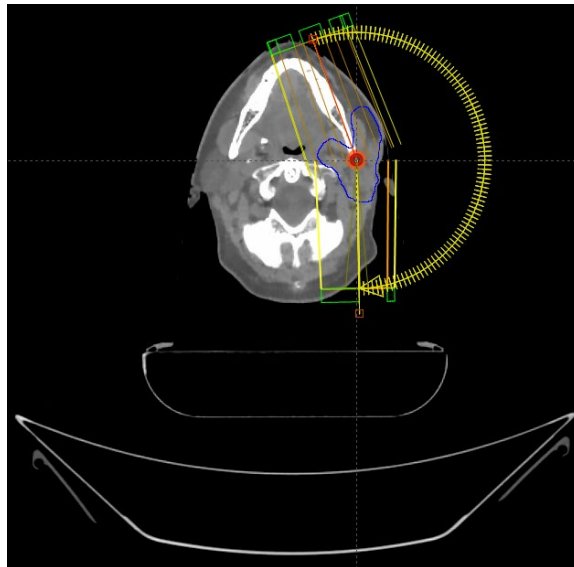
RingPTV6996	{<PTV_6996> +30mm SUB <{PTV_6996}> +2mm AND <BODY>}
Skin	{<BODY> SUB <{BODY}> -3mm }
SubmandIps-PTV	{<GInd_SubmandIpsi> SUB <{PTV_all}>}
Thyroid-PTV	{<GInd_Thyroid> SUB <{PTV_all}>}



Treatment planning guidelines:

All cases used to train and validate the model were planned using head-first supine positioning. Patients are immobilized in a head and shoulder mask using a head rest. Patients arms are typically at their side or holding a ring over their chest.

- 2-3 partial-arc fields spanning approximately 180-200 degrees (Goal is to make field span large enough to increase dose conformity without irradiating through nearby OARs)
- Field size along the X-axis should be limited to 15 cm; for large PTV targets, it is better to add a third arc (Increasing x-field size for large targets will likely lead to decrease sparing of OARs)
- Isocenter placement considers optimal coverage of field, as well as laterality of PTV groups
- Typically, collisions are not of a concern in unilateral HN, but highly lateral target volumes should be checked for possible collisions (good practice). If the user has collision check software, it is prudent to run prior to optimization
- All plans for this model were performed on a TrueBeam with Millenium MLC. We have successfully tested the model on Halcyon models as well



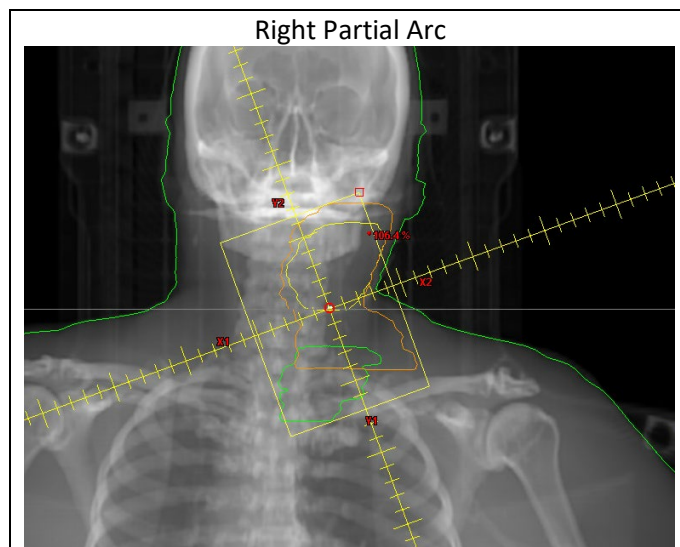
Arc setups for a typical left-sided Unilateral HN case would include:

- 1) G340-179 (CW), C20
- 2) G179-340 (CCW), C340
- 3) G340-179 (CW), C15

Arc setups for a typical right-sided Unilateral HN case would include:

- 1) G181-20 (CCW), C340
- 2) G20-181 (CW), C20
- 3) G181-20 (CCW), C345

The following should result in a plan that provides adequate PTV coverage and minimizes OAR dose. Below is a sample field for a right head and neck with three PTV Levels. Note the x-jaws do not enclose all PTVs.



Target Clinical Goals

The following prescription and planning guidelines were used for the cases to train and validate the model. The 33 fraction regimen follows NRG HN-009 and has been adopted by several institutions, including the University of Kansas.

Standard Target Name	Dose [Gy]	Fraction Size [Gy]	# of fractions	Dose specification technique
PTV_6996	69.96	2.12	33	>=95% of PTV should receive 100% of target Rx
PTV_5940	59.40	1.8	33	>=95% of PTV should receive 100% of target Rx
PTV_5412	54.12	1.64	33	>=95% of PTV should receive 100% of target Rx

This model is compatible (trained and validated) with the above fractionation scheme. Other fractionation regimens have been successfully tested (Tucker, Guida; AAPM Annual Conference 2025:

<https://aapm.confex.com/aapm/2025am/meetingapp.cgi/Paper/20108>). The poster is attached in **Annex A3**.

However, use caution if scaling this model by a significant amount, as rings suggested in this document may need to be adjusted depending on dose drop-off from one PTV level to the next.

To match target volumes that do not match these standards, we suggest:

- 1) Match the PTV_High with PTV_6996. This should correspond to 200-220cGy/fx
- 2) For PTVs with 180-200cGy/fx, this should correspond with PTV_5940 and the corresponding ring.
- 3) For PTVs with 150-180cGy/fx, match these with PTV_5412 and the corresponding ring.

For cases with two or fewer targets, we suggest to follow the matching scheme above. Each case should have a PTV_6996 corresponding to the high PTV. Based on the dose level of the lower PTV, judge accordingly based on dose per fraction.

PTV and OAR Clinical Goals:

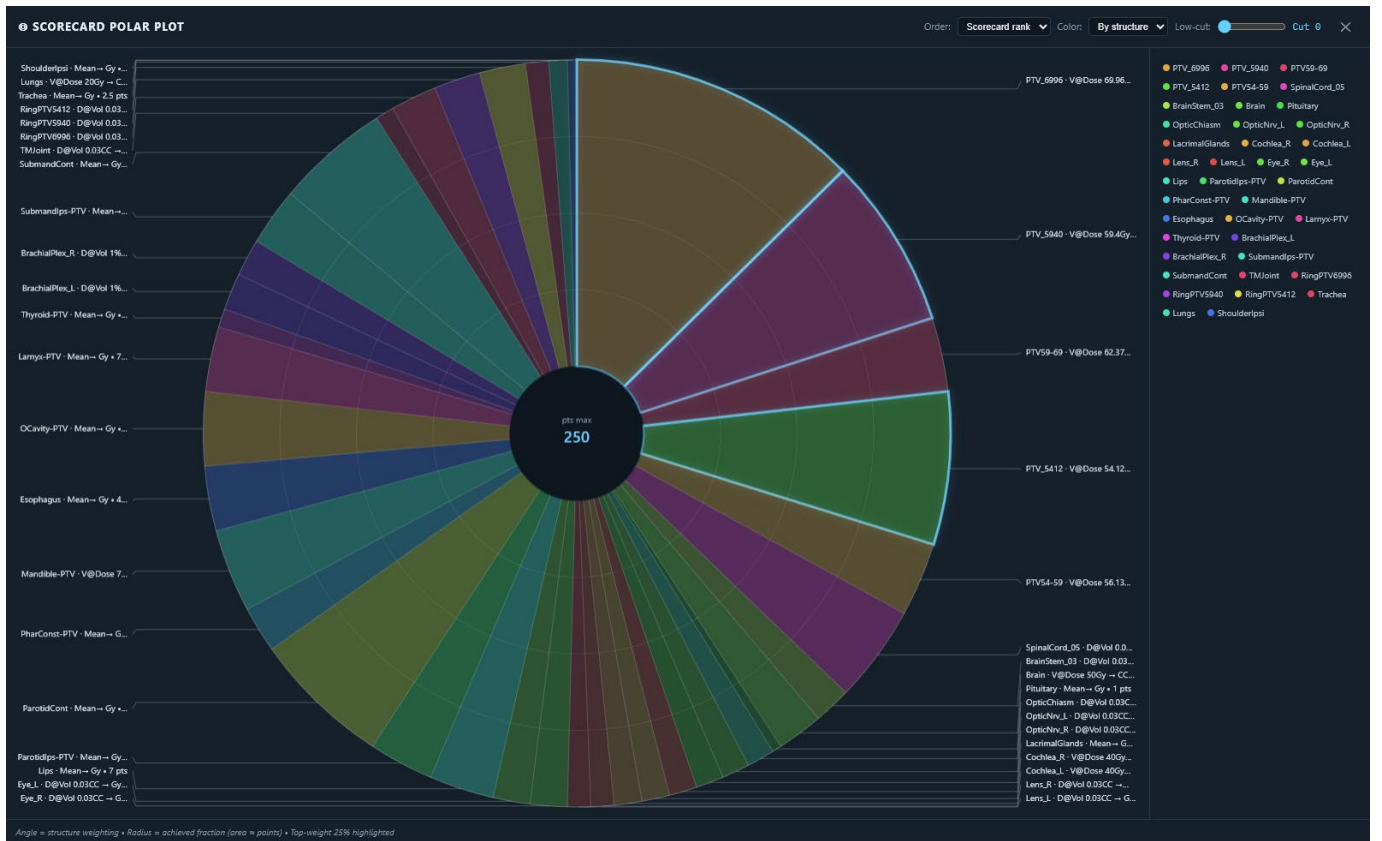
Name of Structure	Dosimetric parameter	Goal	Variation Acceptable
PTV_6996	D95%(%)	>100%	>=98%
	D0.03cc[%]	<= 108%	<112%
PTV_5940	D95%(%)	>100%	>=98%
PTV_5412	D95%(%)	>100%	>=98%
SpinalCord	D0.03cc[cGy]	<4500cGy	<4800cGy
SpinalCord_05	D0.03cc [cGy]	<4500cGy	<5000cGy
Brainstem	D0.03cc [cGy]	<3500cGy	<5400cGy
Brainstem_03	D0.03cc [cGy]	<5000cGy	<5400cGy
ParotidIps-PTV	Dmean [cGy]	<1800cGy	<3500cGy
Parotid_L	Dmean [cGy]	<2200cGy	<2600cGy
Parotid_R	Dmean [cGy]	<2200cGy	<2600cGy
Cavity_Oral	Dmean [cGy]	<3500cGy	<4000cGy
OCavity-PTV	Dmean [cGy]	<3000cGy	<3200cGy
	D0.03cc [cGy]	<6000cGy	
GInd_Submand_L	Dmean [cGy]	<3200cGy	<3800cGy
GInd_Submand_R	Dmean [cGy]	<3200cGy	<3800cGy
SubmandR-PTV	Dmean [cGy]	<1950cGy	<3900cGy
SubmandL-PTV	Dmean [cGy]	<1950cGy	<3900cGy
Bone_Mandible	D0.03cc[%]	<= 105%	
	D3.0%[cGy]	<7000cGy	
Mandible-PTV	V7000cGy[%]	<6.5%	
	V6000cGy[%]	<14.0%	
	V5000cGy[%]	<30.0%	
Larynx	Dmean [cGy]	<2500cGy	<3500cGy
Larynx-PTV	Dmean [cGy]	<1500cGy	<2000cGy
Musc_Constrict	Dmean [cGy]	<4000cGy	<5000cGy

Lips	Dmean [cGy]	<2000cGy	<2500cGy
Esophagus	Dmean [cGy]	<4500cGy	<5000cGy
Thyroid-PTV	Dmean [cGy]	<2500cGy	<4000cGy
Cochlea_R	Dmean [cGy]	<3000cGy	<4000cGy
Cochlea_L	Dmean [cGy]	<3000cGy	<4000cGy
Lens_R	D0.03cc[cGy]	<800cGy	<1000cGy
Lens_L	D0.03cc[cGy]	<800cGy	<1000cGy

Dosimetric Scorecard overview-points only:

Summary of 52 metric, 250-point dosimetric scorecard, based on various clinical goal sets, guided this work.

Metric Id	StructureId	Metric Text	Max Score	Metric Id	StructureId	Metric Text	Max Score
0	PTV_6996	Volume at 69.96Gy [%]	20	26	Eye_L	Dose at 0.03CC [Gy]	2
1	PTV_6996	Dose at 99.5% [Gy]	1.5	27	Eye_L	MeanDose [Gy]	2
2	PTV_6996	Dose at 0.03CC [Gy]	10	28	Lips	MeanDose [Gy]	7
3	PTV_5940	Volume at 59.4Gy [%]	17	29	ParotidIps-PTV	MeanDose [Gy]	7
4	PTV_5940	Dose at 99.5% [Gy]	1.5	30	ParotidCont	MeanDose [Gy]	15
5	PTV59-69	Volume at 62.37Gy [%]	8	31	PharConst-PTV	MeanDose [Gy]	5
6	PTV_5412	Volume at 54.12Gy [%]	15	32	Mandible-PTV	Volume at 70Gy [%]	5
7	PTV_5412	Dose at 99.5% [Gy]	1.5	33	Mandible-PTV	Volume at 60Gy [%]	2
8	PTV54-59	Volume at 56.13Gy [%]	8	34	Mandible-PTV	Volume at 50Gy [%]	2
9	SpinalCord_05	Dose at 0.03CC [Gy]	6.5	35	Esophagus	MeanDose [Gy]	4
10	SpinalCord_05	Volume at 40Gy [%]	2	36	Esophagus	Dose at 0.03CC [Gy]	3
11	SpinalCord_05	Volume at 30Gy [%]	2	37	OCavity-PTV	MeanDose [Gy]	6
12	BrainStem_03	Dose at 0.03CC [Gy]	4	38	OCavity-PTV	Dose at 0.03CC [Gy]	2
13	Brain	Dose at 0.03CC [Gy]	2	39	Larynx-PTV	MeanDose [Gy]	7
14	Brain	Volume at 50Gy [CC]	3	40	Thyroid-PTV	MeanDose [Gy]	2
15	Pituitary	MeanDose [Gy]	1	41	BrachialPlex_L	Dose at 1% [Gy]	4
16	OpticChiasm	Dose at 0.03CC [Gy]	3	42	BrachialPlex_R	Dose at 1% [Gy]	4
17	OpticNrv_L	Dose at 0.03CC [Gy]	3	43	Submand-PTV	MeanDose [Gy]	6.25
18	OpticNrv_R	Dose at 0.03CC [Gy]	3	44	SubmandCont	MeanDose [Gy]	12.25
19	LacrimaGland	MeanDose [Gy]	3	45	TMJoint	Dose at 0.03CC [Gy]	2
20	Cochlea_R	Volume at 40Gy [%]	3	46	RingPTV6996	Dose at 0.03CC [Gy]	5
21	Cochlea_L	Volume at 40Gy [%]	3	47	RingPTV5940	Dose at 0.03CC [Gy]	5
22	Lens_R	Dose at 0.03CC [Gy]	2.5	48	RingPTV5412	Dose at 0.03CC [Gy]	5
23	Lens_L	Dose at 0.03CC [Gy]	2.5	49	Trachea	MeanDose [Gy]	2.5
24	Eye_R	Dose at 0.03CC [Gy]	2	50	Lungs	Volume at 20Gy [CC]	2
25	Eye_R	MeanDose [Gy]	2	51	ShoulderIpsi	MeanDose [Gy]	1

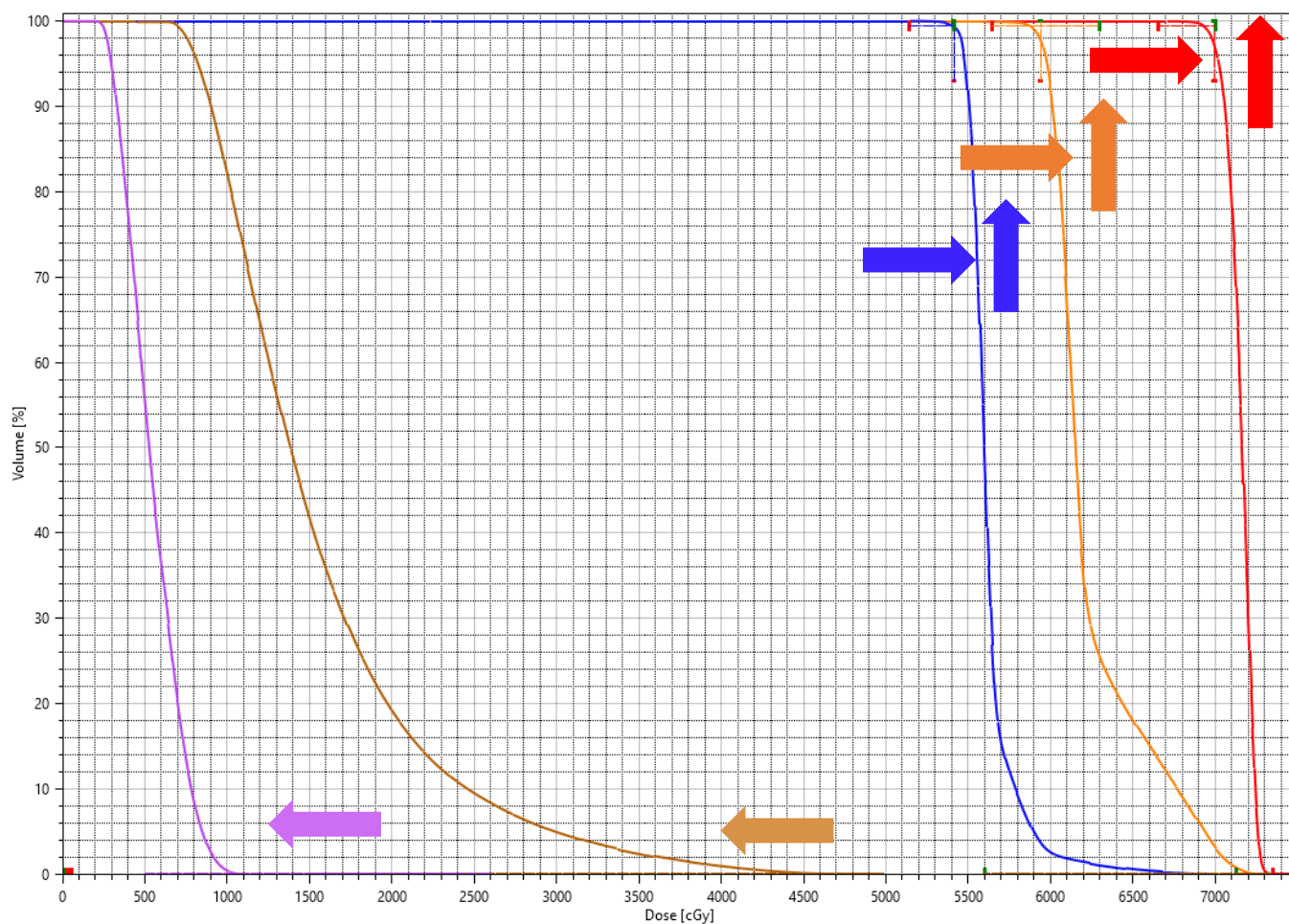


Polar plot of point distribution from Metrix-RT Dosimetric Scorecard.

In general, how points are assigned between the various competing metrics on a dosimetric scorecard represents the physician's preference insofar as relative weighting. Each function spans a DVH value range of two or more values (ranges not pictured, see Annex A1-A2); each range consists of a starting, failing value (0 points) through the maximum achievable point value. The zero value represents a failure and is the first order priority. Depending on the metric, intermediate point values were added in between the failing point and the maximum achievable point value, covering the piecewise linear function shape and providing multiple levels of reasonably expected DVH values; metrics that contain ideal and acceptable goals typically have 3 or more points. Ideally, most maximum values are not achievable as to continue to quantify additional improvement in already "very good" treatment plans. Care must be taken when attempting such a precise articulation of clinical intent. The full dosimetric scorecard provides a singular objective measure of dosimetric plan quality for a specific intent from which the RapidPlan optimization objective tuning can be manually iterated upon. This laborious model tuning process can prove worthwhile when such a RapidPlan model is deployed in a clinic and works as a single button press auto planning solution of high quality (as defined by its associated dosimetric scorecard).

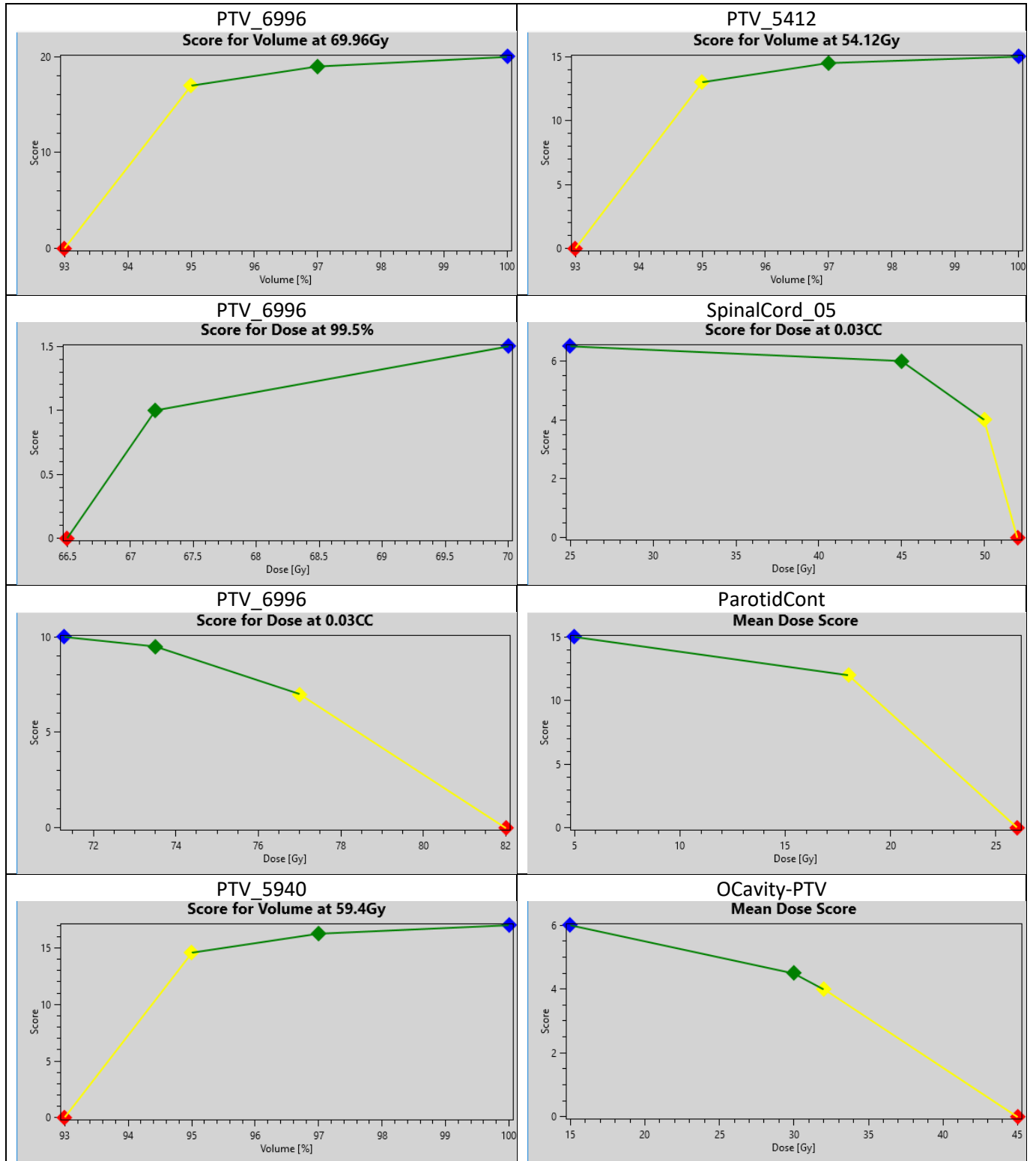
Example metrics for five structures – PTV_6996 (red), PTV_5940 (orange), PTV_5412 (blue), OCavity-PTV (brown), and ParotidCont (purple) are shown below.

Dosimetric Scorecard selected piecewise linear metrics plotted on DVH:



DVH for a clinical HN case. PTV_6996 (red), PTV_5940 (orange), PTV_5412 (blue), OCavity-PTV (brown), and ParotidCont (purple) are shown here in the DVH, with arrows pointing in the direction to improve the plan scorecard.

Metric plots for PTV_6996, PTV_5940, PTV_5412, SpinalCord_05, ParotidCont, and OCavity-PTV are included:



Structure codes:

Recommended structure code assignment:

PTV_5412	PTV_Low (99VMS_STRUCTCODE)
PTV_5940	PTV_Intermediate (99VMS_STRUCTCODE)
PTV_6996	PTV_High (99VMS_STRUCTCODE)
PTV5412OPT	PTV_Low (99VMS_STRUCTCODE)
PTV5940OPT	PTV_Intermediate (99VMS_STRUCTCODE)
Bone_Mandible	52748 (FMA)
BrachialPlexus	5906 (FMA)
Brain	50801 (FMA)
BrainStem	79876 (FMA)
BrainStem_03	79876 (FMA)
BuccalMucosa	NormalTissue (99VMS_STRUCTCODE)
Cavity_Oral	20292 (FMA)
Cochlea_L	60203 (FMA)
Cochlea_R	60202 (FMA)
Esophagus	7131 (FMA)
Eye	12515, 12514, 264089 (FMA)
GlnD_Thyroid	9603 (FMA)
LacrimalGlands	59103, 59102 (FMA)
Larynx	55097 (FMA)
Larynx-PTV	55097 (FMA)
Lips	59815 (FMA)
Lungs	68877 (FMA)
Mandible-PTV	527487 (FMA)
Musc_Constrict	54966 (FMA)
OCavity-PTV	20292 (FMA)
OpticChiasm	62045 (FMA)
OpticNrv_L	50878 (FMA)
OpticNrv_R	50875 (FMA)
ParotidCont	Parotids (99VMS_STRUCTCODE)
ParotidIpsi	Parotids (99VMS_STRUCTCODE)
ParotidIps-PTV	Parotids (99VMS_STRUCTCODE)
PharConst-PTV	54966 (FMA)
Pituitary	13889 (FMA)
ShoulderIpsi	NormalTissue (99VMS_STRUCTCODE)
SpinalCord	7647 (FMA)
SpinalCord_05	9680 (FMA)
SubmandCont	Submandibular (99VMS_STRUCTCODE)
SubmandIpsi	Submandibular (99VMS_STRUCTCODE)
SubmandIps-PTV	Submandibular (99VMS_STRUCTCODE)
Thyroid-PTV	9603 (FMA)
Trachea	7394 (FMA)
RingPTV5412	Ring (99VMS_STRUCTCODE)
RingPTV5940	Ring (99VMS_STRUCTCODE)
RingPTV6996	Ring (99VMS_STRUCTCODE)

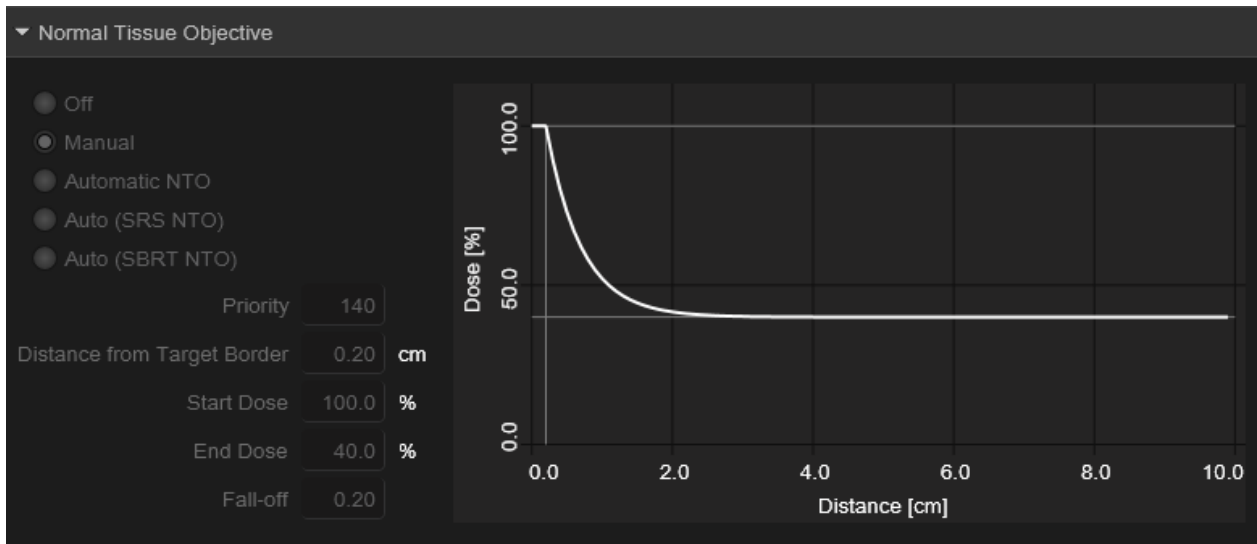
Optimization objectives:

The following optimization objectives were defined in the model and will be generated when the model is applied to a new case (v15.6 and v18.0):

Target	ID	Vol [%]	Dose	Priority	gEUD a		
Yes	PTV_5412						
	Lower	100.0	101.0 %	300			X
Yes	PTV_5940						
	Lower	100.0	101.0 %	300			X
Yes	PTV_6996						
	Upper	0.0	104.5 %	315			X
	Upper	2.0	103.5 %	225			X
	Lower	100.0	101.0 %	300			X
Yes	PTV5412OPT						
	Upper	0.0	105.0 %	300			X
	Upper	2.0	103.5 %	225			X
	Upper gEUD		105.0 %	180	40.0		X
Yes	PTV5940OPT						
	Upper	0.0	105.0 %	300			X
	Upper	2.0	103.5 %	225			X
	Upper gEUD		105.0 %	180	40.0		X
	Bone_Mandible						
	Upper (fixed vol., generated dose)	0.0	Generated	175			X
	Line (preferring target)	Generated	Generated	75			X
	BrachialPlexus						
	Upper	1.0	6000.0 cG	100			X
	Upper	6.0	5600.0 cG	65			X
	Upper (fixed vol., generated dose)	0.0	Generated	100			X
	Line (preferring OAR)	Generated	Generated	60			X
	Brain						
	Upper (fixed vol., generated dose)	0.0	Generated	100			X
	Upper gEUD		Generated	85	40.0		X
	BrainStem						
	Upper (fixed vol., generated dose)	0.0	Generated	150			X
	Upper gEUD		Generated	100	40.0		X
	Line (preferring OAR)	Generated	Generated	50			X
	BrainStem_03						
	Upper (fixed vol., generated dose)	0.0	Generated	125			X
	Upper gEUD		Generated	100	40.0		X
	Line (preferring OAR)	Generated	Generated	45			X
	BuccalMucosa						
	Upper gEUD		Generated	75	1.0		X
	Line (preferring target)	Generated	Generated	50			X
	Cavity_Oral						
	Upper (fixed dose, generated vol.)	Generated	3500.0 cG	85			X
	Mean		Generated	90			X
	Line (preferring target)	Generated	Generated	85			X
	Cochlea_L						
	Mean		Generated	80			X
	Line (preferring target)	Generated	Generated	65			X
	Cochlea_R						
	Mean		Generated	80			X
	Line (preferring target)	Generated	Generated	65			X
	Esophagus						
	Upper (fixed dose, generated vol.)	Generated	4500.0 cG	50			X
	Upper (fixed dose, generated vol.)	Generated	3500.0 cG	50			X
	Upper (fixed vol., generated dose)	0.0	Generated	90			X
	Lungs						
	Line (preferring target)	Generated	Generated	50			X
	Mandible-PTV						
	Upper (fixed vol., generated dose)	1.0	Generated	130			X
	Upper gEUD		5000.0 cG	60	12.0		X
	Upper gEUD		Generated	80	40.0		X
	Line (preferring target)	Generated	Generated	95			X
	Musc_Constrict						
	Mean		Generated	75			X
	Line (preferring target)	Generated	Generated	85			X
	OCavity-PTV						
	Upper (fixed dose, generated vol.)	Generated	3500.0 cG	95			X
	Upper (fixed dose, generated vol.)	Generated	4500.0 cG	95			X
	Upper gEUD		Generated	105	1.0		X
	Line (preferring target)	Generated	Generated	115			X
	OpticChiasm						
	Upper	0.0	4500.0 cG	100			X
	Upper (fixed vol., generated dose)	0.0	Generated	40			X
	OpticNrv_L						
	Upper	0.0	4500.0 cG	100			X
	Upper (fixed vol., generated dose)	0.0	Generated	45			X
	OpticNrv_R						
	Upper	0.0	4500.0 cG	100			X
	Upper (fixed vol., generated dose)	0.0	Generated	45			X
	ParotidCont						
	Mean		Generated	115			X
	Line (preferring target)	Generated	Generated	135			X
	Parotidpsi						
	Mean		Generated	40			X
	Line (preferring target)	Generated	Generated	40			X
	Parotidpsi-PTV						
	Mean		Generated	55			X
	Line (preferring target)	Generated	Generated	60			X
	PharConst-PTV						
	Mean		Generated	95			X
	Line (preferring target)	Generated	Generated	100			X
	Pituitary						
	Line (preferring target)	Generated	Generated	45			X
	RingPTV5412						
	Upper	0.0	5141.0 cG	250			X
	Upper gEUD		Generated	100	40.0		X
	RingPTV5940						
	Upper	0.0	5643.0 cG	250			X
	Upper gEUD		Generated	100	40.0		X
	RingPTV6996						
	Upper	0.0	6650.0 cG	250			X
	Upper gEUD		Generated	100	40.0		X
	Shoulderpsi						
	Upper (fixed vol., generated dose)	0.0	Generated	100			X
	Line (preferring target)	Generated	Generated	55			X
	SpinalCord						
	Upper (fixed vol., generated dose)	0.0	Generated	200			X
	Upper gEUD		Generated	100	40.0		X
	Line (preferring OAR)	Generated	Generated	50			X

Target	ID	Vol [%]	Dose	Priority	gEUD a	
Esophagus (7131)						
Upper (fixed dose, generated vol.)	Generated	4500.0 cG	50	X		
Upper (fixed dose, generated vol.)	Generated	3500.0 cG	50	X		
Upper (fixed vol., generated dose)	0.0	Generated	90	X		
Mean	Generated	90	X			
Line (preferring target)	Generated	Generated	95	X		
Eye (12515, 12514, 264089)						
Line (preferring target)	Generated	Generated	100	X		
Olnid_Thyroid (9603)						
Mean	Generated	48	X			
Line (preferring target)	Generated	Generated	60	X		
LacrimalGlands (59103, 59102)						
Line (preferring target)	Generated	Generated	40	X		
Larynx (56097)						
Mean	Generated	75	X			
Line (preferring target)	Generated	Generated	60	X		
Larynx-PTV (56097)						
Mean	Generated	105	X			
Line (preferring target)	Generated	Generated	115	X		
Lips (59815)						
Mean	Generated	95	X			
Line (preferring target)	Generated	Generated	105	X		
SpinalCord_05 (9680)						
Upper (fixed dose, generated vol.)	Generated	4000.0 cG	60	X		
Upper (fixed dose, generated vol.)	Generated	3000.0 cG	55	X		
Upper (fixed vol., generated dose)	0.0	Generated	200	X		
Upper gEUD	Generated	100	40.0	X		
Line (preferring OAR)	Generated	Generated	75	X		
SubmandCont (Submandibular)						
Mean	Generated	115	X			
Line (preferring target)	Generated	Generated	135	X		
Submandpsi (Submandibular)						
Mean	Generated	40	X			
Line (preferring target)	Generated	Generated	40	X		
Submandpsi-PTV (Submandibular)						
Mean	Generated	65	X			
Line (preferring target)	Generated	Generated	60	X		
Thyroid-PTV (9603)						
Mean	Generated	45	X			
Trachea (7394)						
Mean	Generated	75	X			
Line (preferring target)	Generated	Generated	85	X		

The default manual NTO settings for both v18.0 and v15.6:



Optimization Tips and Tricks

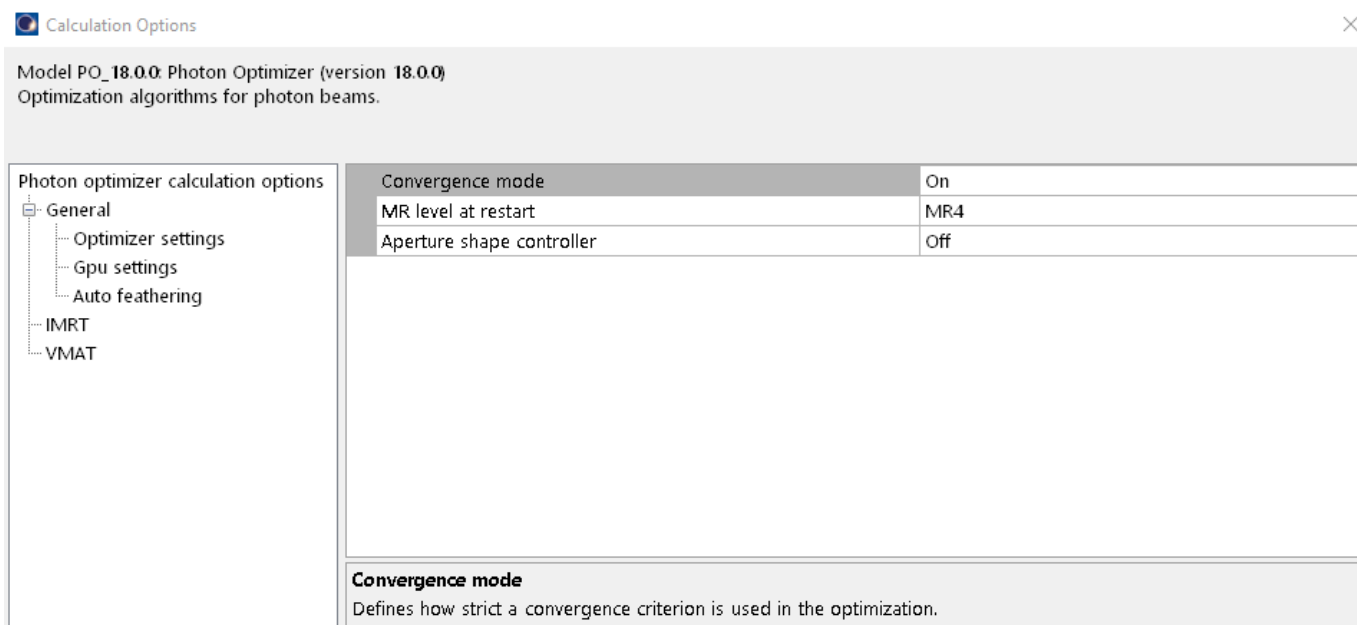
Contouring:

Our institution utilizes Radformation's AutoContour software, where we have created templates for unilateral HN cases to help automate normal tissue contouring and planning structure generation. AutoContour, ClearCheck, and Varian Clinical Goals templates have been attached in the example patient ZIP file.

Optimization:

Optimization Parameters

We suggest turning Convergence Mode ON for all plans. Aperture Shape Controller is typically turned to OFF for HN planning. As for MR Level at Restart, MR3 or MR4 can be utilized if continuing the optimization. We have found success rolling the optimizer back to MR2 manually and continuing the optimization from there to further tune coverage and OAR sparing.



Photon optimizer calculation options	
Convergence mode	On
MR level at restart	MR4
Aperture shape controller	Off

Convergence mode
Defines how strict a convergence criterion is used in the optimization.

Weights/Priorities

The model provides constraints and weights. The user is encouraged to adjust weights to their liking.

Normal Tissue Optimizer

For plans with excess modulation or lack of coverage, the NTO can be turned off and the user can rely on the ring structures to provide adequate falloff. The default weight is 140.

Hot Spots

If your plan has hot spots after optimization and the plan is close to completion, we recommend contouring the 105%, 107%, and 110% (if applicable) isodose lines and rerunning the optimizer from MR4. We suggest adding mean dose constraints to each level and upper of 0% and pull these isodose contours down with the optimizer paused. This should help reduce hot spots on the virtual and TXCT data sets.

Collimator Rotation

Use the BEV to identify the optimal collimator rotation for each case. Finding optimal rotations can allow users to reduce their X-jaw width, thus helping reduce MLC leakage and, thus, OAR dose.

Different Rx from Model

If using the model for a fractionation scheme that differs from the model, it is best to adjust PTVopt and Ring structures to account for dose gradients from one dose level to the next. Failing to do so can cause some issues when running the optimizer and may impact modeling and optimization.

Brachial Plexus

Previous models have utilized an optimization PTV for the high dose volume overlapping the brachial plexus (Magliari, et.al: [https://www.meddos.org/article/S0958-3947\(24\)00043-8/fulltext](https://www.meddos.org/article/S0958-3947(24)00043-8/fulltext)). We did not include a PTV_6996_opt in this model, as our physicians prefer to treat the target even if there is overlap. However, we suggest minimizing hot spots in areas of overlap with the brachial plexus.

Brain vs Temporal Lobes

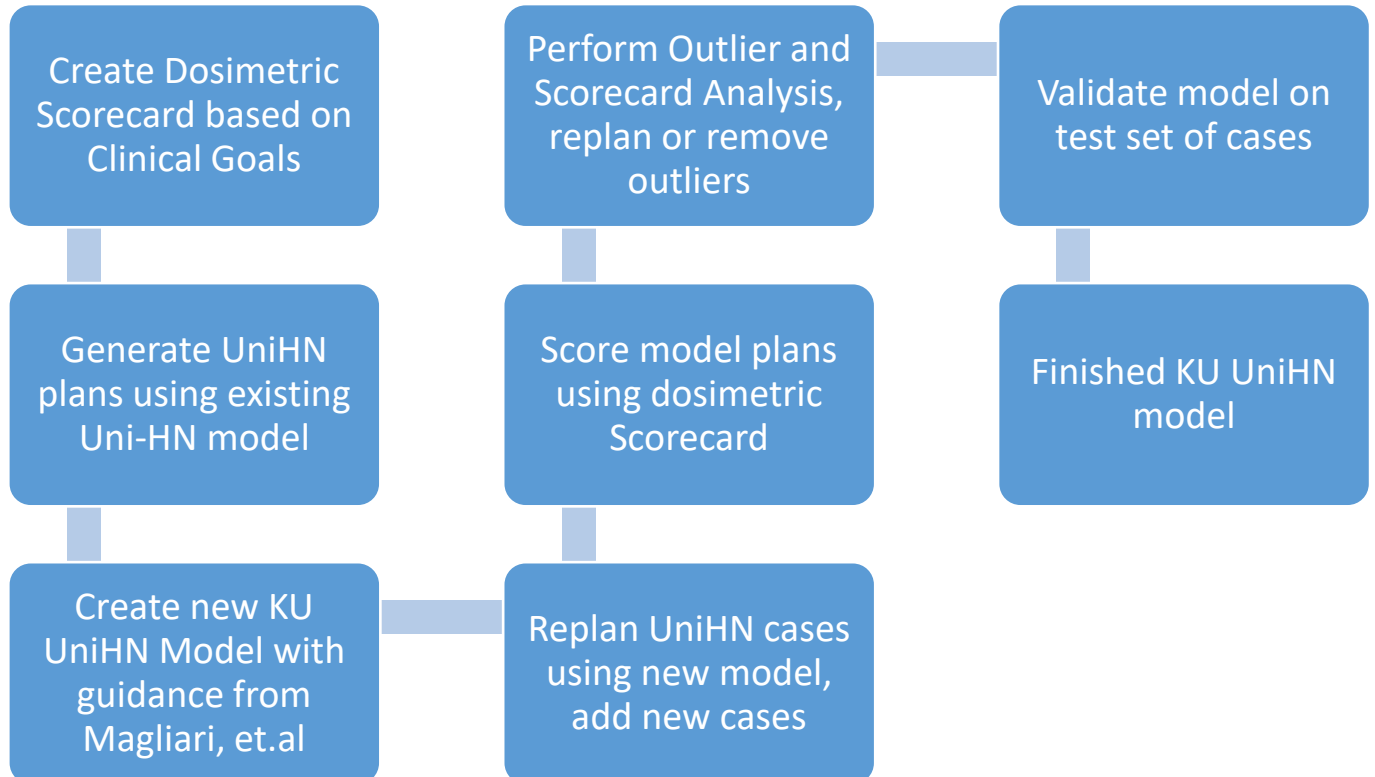
One can substitute the ipsilateral temporal lobe for the brain contour during optimization, with the thought that the optimizer may work harder on the small lobe structure as compared to the whole brain.

Model Training and Validation:

The KU UniHN model was originally trained with a set of 70 VMAT plans to aid in planning unilateral head and neck cases and improving throughput through Knowledge-Based Planning and Automation. All cases come from our institution and were planned to our clinical standards, which are largely based on established tolerances from clinical trials, including NRG HN-009. Cases used for modeling include a near 50-50 split of left and right-sided cases.

Initial plans for the model were generated via our original UniHN model. Upon reviewing the Varian Medical Affairs Bilateral HN Model (Magliari, et. al 2025: [https://www.meddos.org/article/S0958-3947\(24\)00043-8/fulltext](https://www.meddos.org/article/S0958-3947(24)00043-8/fulltext)), we decided to rework our unilateral model to mirror the bilateral model, which had been very successful in our clinics. Planning structures were added based on the guidance of Magliari, et. al. More plans were generated and added, taking the total to 70, to generate our next iteration of KU UniHN model. Plans in the model were then re-optimized with the model in an attempt to further OAR sparing. The results of this work lead to our final model iteration.

70 cases were initially in the model, but through outlier and dosimetric scorecard analyses, the total was reduced to 54 in the final model. A dosimetric scorecard, based on clinical goals and constraints, was utilized to assess all plans added to the model. Plans with low scores, by our clinical standards, were heavily scrutinized and were re-optimized to improve the score. A scorecard threshold of 78% was enacted to remove low quality plans and further tune the model. A validation subset of 10 plans (3 left, 7 right) not included were used for testing the model. The final yielded an average plan score of $85.7 \pm 4.8\%$, an improvement of over 10% from the original clinical plans.



Annex Directory

Annex A: Scorecard Details

A1 UniHN Scorecard Sample

A2 PlanScoreCard ESAPI tool: where to find

A3 KU UniHN Poster

Annex B: Acknowledgements

Annex C: Distribution and compatibility

Annex A1 - Example Scorecard

Scorecard: H/N 6996/5940/5412 Gy (SIB) - Head-and-Neck






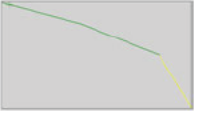

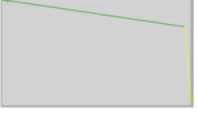

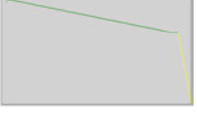

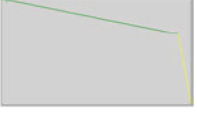

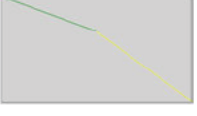
Summary:






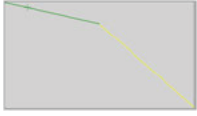

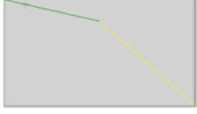

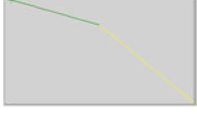

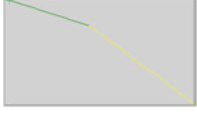

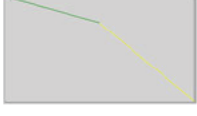
Plan Scores:










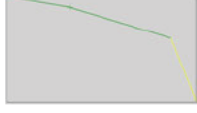

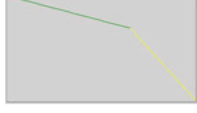

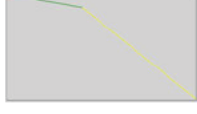
██████████ [RP Model Uni] Validation: 225.69/250.00 (90.28%)










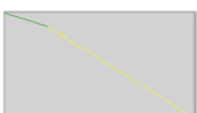




Structure	Patient	Plan	Value	Score	Max	
PTV6996	██████████	Validation	97.93 %	19.31	20.00	<p>Score Stats Max=19.31 Mean=19.31 Min=19.31</p> <p>Variation @ 95% 93.00 100.00</p>
<p>SUB-OPTIMAL[0] VARIATION[17] GOOD[19] IDEAL[20]</p>						
PTV6996	██████████	Validation	69.31 Gy	1.38	1.50	<p>Score Stats Max=1.38 Mean=1.38 Min=1.38</p> <p>Dose [Gy] 66.50 70.00</p>
<p>VARIATION[0] GOOD[1] IDEAL[1.5]</p>						
PTV6996	██████████	Validation	74.27 Gy	8.95	10.00	<p>Score Stats Max=8.95 Mean=8.95 Min=8.95</p> <p>Variation @ 77Gy 71.30 82.00</p>
<p>IDEAL[10] GOOD[9.5] VARIATION[7] SUB-OPTIMAL[0]</p>						
PTV5940	██████████	Validation	96.41 %	15.76	17.00	<p>Score Stats Max=15.76 Mean=15.76 Min=15.76</p> <p>Variation @ 95% 93.00 100.00</p>
<p>SUB-OPTIMAL[0] VARIATION[14.57] GOOD[16.25] IDEAL[17]</p>						
PTV5940	██████████	Validation	57.79 Gy	1.06	1.50	<p>Score Stats Max=1.06 Mean=1.06 Min=1.06</p> <p>Dose [Gy] 56.43 63.00</p>
<p>VARIATION[0] GOOD[1] IDEAL[1.5]</p>						
PTV59-69	██████████	Validation	39.47 %	6.04	8.00	<p>Score Stats Max=6.04 Mean=6.04 Min=6.04</p> <p>Variation @ 40% 10.00 75.00</p>
<p>IDEAL[8] GOOD[7.5] GOOD[6] VARIATION[0]</p>						






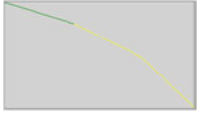



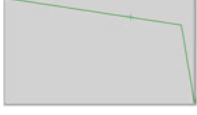

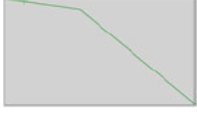

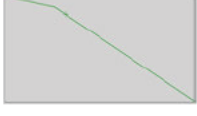
PTV5412	██████	Validation	99.57 %	14.93	15.00	Score Stats Max=14.93 Mean=14.93 Min=14.93		
SUB-OPTIMAL[0] VARIATION[13] GOOD[14.5] IDEAL[15]								93.00
PTV5412	██████	Validation	54.17 Gy	1.50	1.50	Score Stats Max=1.50 Mean=1.50 Min=1.50		
VARIATION[0] GOOD[1] IDEAL[1.5]								51.41
PTV54-59	██████	Validation	15.25 %	7.99	8.00	Score Stats Max=7.99 Mean=7.99 Min=7.99		
IDEAL[8] GOOD[7.5] GOOD[6] VARIATION[0]								15.00
SpinalCord05	██████	Validation	39.90 Gy	6.13	6.50	Score Stats Max=6.13 Mean=6.13 Min=6.13		
IDEAL[6.5] GOOD[6] VARIATION[4] SUB-OPTIMAL[0]								25.00
SpinalCord05	██████	Validation	0.02 %	2.00	2.00	Score Stats Max=2.00 Mean=2.00 Min=2.00		
IDEAL[2] GOOD[1.5] VARIATION[0]								0.00
SpinalCord05	██████	Validation	13.12 %	1.78	2.00	Score Stats Max=1.78 Mean=1.78 Min=1.78		
IDEAL[2] GOOD[1.5] VARIATION[0]								0.00
BrainStem03	██████	Validation	23.30 Gy	3.67	4.00	Score Stats Max=3.67 Mean=3.67 Min=3.67		
IDEAL[4] GOOD[3] VARIATION[2] SUB-OPTIMAL[0]								10.00









Brain		Validation	25.34 Gy	1.91	2.00	Score Stats Max=1.91 Mean=1.91 Min=1.91	 Variation @ 70Gy	15.00	72.00
IDEAL[2]	GOOD[1.5]	VARIATION[0]							
Brain		Validation	0.00 CC	3.00	3.00	Score Stats Max=3.00 Mean=3.00 Min=3.00	 Variation @ 100CC	0.00	500.00
IDEAL[3]	GOOD[2.75]	VARIATION[0]							
Pituitary		Validation	2.27 Gy	0.98	1.00	Score Stats Max=0.98 Mean=0.98 Min=0.98	 Variation @ 45Gy	0.00	54.00
IDEAL[1]	GOOD[0.8]	VARIATION[0.5]	[0]						
OpticChiasm		Validation	1.67 Gy	2.98	3.00	Score Stats Max=2.98 Mean=2.98 Min=2.98	 Variation @ 54Gy	0.00	56.00
IDEAL[3]	GOOD[2.25]	VARIATION[0]							
OpticNrvL		Validation	1.61 Gy	2.97	3.00	Score Stats Max=2.97 Mean=2.97 Min=2.97	 Variation @ 56Gy	0.00	60.00
IDEAL[3]	GOOD[2]	VARIATION[0]							
OpticNrvR		Validation	1.63 Gy	2.97	3.00	Score Stats Max=2.97 Mean=2.97 Min=2.97	 Variation @ 56Gy	0.00	60.00
IDEAL[3]	GOOD[2]	VARIATION[0]							
LacrimalGlands		Validation	1.03 Gy	2.94	3.00	Score Stats Max=2.94 Mean=2.94 Min=2.94	 Variation @ 17.5Gy	0.00	35.00
IDEAL[3]	GOOD[2]	VARIATION[0]							

CochleaR		Validation	0.00 %	3.00	3.00	Score Stats Max=3.00 Mean=3.00 Min=3.00				
IDEAL[3]	GOOD[2]	VARIATION[0]						0.00	Volume [%]	80.00
CochleaL		Validation	0.00 %	3.00	3.00	Score Stats Max=3.00 Mean=3.00 Min=3.00				
IDEAL[3]	GOOD[2]	VARIATION[0]						0.00	Volume [%]	80.00
LensR		Validation	1.18 Gy	2.38	2.50	Score Stats Max=2.38 Mean=2.38 Min=2.38				
IDEAL[2.5]	GOOD[2]	VARIATION[0]						0.00	Variation @ 5Gy	10.00
LensL		Validation	1.07 Gy	2.39	2.50	Score Stats Max=2.39 Mean=2.39 Min=2.39				
IDEAL[2.5]	GOOD[2]	VARIATION[0]						0.00	Variation @ 5Gy	10.00
EyeR		Validation	1.71 Gy	1.97	2.00	Score Stats Max=1.97 Mean=1.97 Min=1.97				
IDEAL[2]	GOOD[1.5]	VARIATION[0]						0.00	Variation @ 25Gy	50.00
EyeR		Validation	1.15 Gy	1.97	2.00	Score Stats Max=1.97 Mean=1.97 Min=1.97				
IDEAL[2]	GOOD[1.5]	VARIATION[0]						0.00	Variation @ 20Gy	45.00
EyeL		Validation	1.63 Gy	1.97	2.00	Score Stats Max=1.97 Mean=1.97 Min=1.97				
IDEAL[2]	GOOD[1.5]	VARIATION[0]						0.00	Variation @ 25Gy	50.00

EyeL		Validation	1.06 Gy	1.97	2.00	Score Stats Max=1.97 Mean=1.97 Min=1.97					
IDEAL[2]	GOOD[1.5]	VARIATION[0]						0.00	Variation @ 20Gy	45.00	
Lips		Validation	13.62 Gy	6.64	7.00	Score Stats Max=6.64 Mean=6.64 Min=6.64					
IDEAL[7]	GOOD[6.5]	VARIATION[5]	SUB-OPTIMAL[0]						10.00	Variation @ 20Gy	30.00
Parotidlips-PTV		Validation	31.57 Gy	1.52	7.00	Score Stats Max=1.52 Mean=1.52 Min=1.52					
IDEAL[7]	GOOD[6.5]	VARIATION[4]	SUB-OPTIMAL[0]						10.00	Variation @ 26Gy	35.00
ParotidCont		Validation	6.57 Gy	14.64	15.00	Score Stats Max=14.64 Mean=14.64 Min=14.64					
IDEAL[15]	GOOD[12]	VARIATION[0]						5.00	Variation @ 18Gy	26.00	
PharConst-PTV		Validation	25.39 Gy	4.48	5.00	Score Stats Max=4.48 Mean=4.48 Min=4.48					
IDEAL[5]	GOOD[4.5]	VARIATION[3]	SUB-OPTIMAL[0]						10.00	Variation @ 50Gy	56.00
Mandible-PTV		Validation	0.00 %	5.00	5.00	Score Stats Max=5.00 Mean=5.00 Min=5.00					
IDEAL[5]	GOOD[3.5]	VARIATION[0]						0.00	Variation @ 6.5%	10.00	
Mandible-PTV		Validation	0.72 %	1.99	2.00	Score Stats Max=1.99 Mean=1.99 Min=1.99					
IDEAL[2]	GOOD[1.75]	VARIATION[0]						0.00	Variation @ 14%	35.00	

Mandible-PTV		Validation	23.73 %	1.69	2.00	Score Stats Max=1.69 Mean=1.69 Min=1.69	
IDEAL[2]	GOOD[1.6]	VARIATION[0]					0.00 Variation @ 31% 62.00
Esophagus		Validation	3.96 Gy	4.00	4.00	Score Stats Max=4.00 Mean=4.00 Min=4.00	
IDEAL[4]	GOOD[3.75]	VARIATION[3]					5.00 Variation @ 15Gy 56.00
Esophagus		Validation	27.75 Gy	3.00	3.00	Score Stats Max=3.00 Mean=3.00 Min=3.00	
IDEAL[3]	GOOD[2.5]	VARIATION[0]					56.00 Variation @ 60Gy 70.00
OCavity-PTV		Validation	31.63 Gy	4.09	6.00	Score Stats Max=4.09 Mean=4.09 Min=4.09	
IDEAL[6]	GOOD[4.5]	VARIATION[4]					15.00 Variation @ 32Gy 45.00
OCavity-PTV		Validation	61.29 Gy	1.58	2.00	Score Stats Max=1.58 Mean=1.58 Min=1.58	
IDEAL[2]	GOOD[1.75]	VARIATION[0]					56.00 Variation @ 60Gy 73.50
Larynx-PTV		Validation	18.40 Gy	6.24	7.00	Score Stats Max=6.24 Mean=6.24 Min=6.24	
IDEAL[7]	GOOD[6.75]	VARIATION[6]					10.00 Variation @ 20Gy 40.00
Thyroid-PTV		Validation	16.24 Gy	1.90	2.00	Score Stats Max=1.90 Mean=1.90 Min=1.90	
IDEAL[2]	GOOD[1.75]	ACCEPTABLE[1.25]					10.00 Variation @ 25Gy 66.00

BrachialPlexL		Validation	61.89 Gy	2.40	4.00	Score Stats Max=2.40 Mean=2.40 Min=2.40	 50.00 Dose [Gy] 66.00
IDEAL[4]	GOOD[3.5]	VARIATION[0]					
BrachialPlexR		Validation	20.20 Gy	4.00	4.00	Score Stats Max=4.00 Mean=4.00 Min=4.00	1  50.00 Dose [Gy] 66.00
IDEAL[4]	GOOD[3.5]	VARIATION[0]					
SubmandIps-PTV		Validation	0.00 Gy	6.25	6.25	Score Stats Max=6.25 Mean=6.25 Min=6.25	1  19.50 Variation @ 38Gy 70.00
IDEAL[6.25]	GOOD[5]	VARIATION[3]	VARIATION[0]				
SubmandCont		Validation	7.07 Gy	11.89	12.25	Score Stats Max=11.89 Mean=11.89 Min=11.89	 5.00 Variation @ 18Gy 38.00
IDEAL[12.25]	[10]	GOOD[0]					
TMJoint		Validation	49.79 Gy	1.64	2.00	Score Stats Max=1.64 Mean=1.64 Min=1.64	 0.00 Dose [Gy] 75.00
IDEAL[2]	GOOD[1.5]	VARIATION[0]					
RingPTV6996		Validation	70.35 Gy	4.87	5.00	Score Stats Max=4.87 Mean=4.87 Min=4.87	 70.00 Dose [Gy] 73.50
IDEAL[5]	GOOD[4.5]	VARIATION[0]					
RingPTV5940		Validation	60.35 Gy	4.14	5.00	Score Stats Max=4.14 Mean=4.14 Min=4.14	 59.40 Dose [Gy] 62.37
IDEAL[5]	GOOD[4.5]	VARIATION[0]					

RingPTV5412		Validation	56.24 Gy	1.64	5.00	Score Stats Max=1.64 Mean=1.64 Min=1.64		
IDEAL[5]	GOOD[4.5]	VARIATION[0]						54.12 Dose [Gy] 56.83
▲								
Trachea		Validation	10.11 Gy	2.20	2.50	Score Stats Max=2.20 Mean=2.20 Min=2.20		
IDEAL[2.5]	GOOD[1.75]	VARIATION[0]						0.00 MeanDose [Gy] 65.00
▲								
Lungs		Validation	1.86 CC	2.00	2.00	Score Stats Max=2.00 Mean=2.00 Min=2.00		
IDEAL[2]	GOOD[1.5]	VARIATION[0]						0.00 Volume [CC] 1000.00
▲								
ShoulderIpsi		Validation	0.14 Gy	1.00	1.00	Score Stats Max=1.00 Mean=1.00 Min=1.00		
IDEAL[1]	GOOD[0.8]	VARIATION[0]						1.00 MeanDose [Gy] 25.00
▲								

A2 PlanScoreCard ESAPI tool: where to find

[Varian-MedicalAffairsAppliedSolutions \(https://github.com/Varian-MedicalAffairsAppliedSolutions/MAAS-PlanScoreCard\)](https://github.com/Varian-MedicalAffairsAppliedSolutions/MAAS-PlanScoreCard)

Currently, the source code is shared on the Varian Medical Affairs Applied Solutions GitHub where it can be downloaded and compiled with Visual Studio 2022 (including with the free community edition), now in the releases section users can find precompiled binaries ready to run in all compatible versions of Eclipse (v15.6+). PlanScoreCard is made available under the Varian Limited Use Software License Agreement.

Download full Scorecard(json), DICOM case example and this RapidPlan model: [Siemens Healthineers - Unilateral Head&Neck 69.96/59.4/54.12Gy \(SIB\) \[RapidPlan\(KU\)\]](#)



When Protons are Unavailable: The Importance of High Quality Knowledge-based Planning Models for the Treatment of Unilateral Head and Neck Patients

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ABSTRACT

Purpose: Intensity modulated proton therapy (IMPT) is associated with greater OAR sparing for unilateral head and neck cancers. While this is the preferred modality, sometimes proton treatments are unavailable due to machine downtime or insurance denials. Typically, in these cases, backup photon plans are created prioritizing speed over plan quality. Using a combination of Radformation's AutoContour and in-house RapidPlan model, the workflow for creating a backup photon plan for unilateral head and neck cancers is both efficient and produces high-quality plans. This increase in quality ensures higher quality of life with no impact to therapeutic gain.

Methods: 10 retrospective proton unilateral head and neck plans were reoptimized using an in-house RapidPlan model. CTV coverage and dose metrics for 19 OARs were scored and compared for each modality. T-tests were used to establish significance in differences.

Results: IMPT plans scored higher than VMAT, on average, (90.8% to 84.7%, $p=6.2e-06$). CTV coverages were comparable between the IMPT and VMAT ($p=0.11$), scoring 97.6% and 95.7%, respectively. Differences in metrics for brain, cochlea_contra, cochlea_ipsi, esophagus, larynx, and trachea sparing were unremarkable ($p>0.1$ for all). VMAT plans reduced parotid_ipsi Dmean (average: 44Gy versus 51Gy, $p<0.05$). IMPT delivered near-negligible dose to OARs outside of the beam path; however, VMAT reduced OAR dose to well within clinical standards, as in the case of contralateral parotid and submandibular glands, which achieved Dmean of 5.6Gy and 6.3Gy, respectively.

Conclusion: This study demonstrated the potential of a well-constructed KBP model in planning unilateral HN cases. For instances when IMPT is unavailable, clinicians would benefit from a KBP model that ensures that a high level of plan quality remains achievable.

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INTRODUCTION

IMPT has emerged as a standard of care for unilateral head and neck (HN) cancers due to superior OAR sparing. With the increase of proton centers nationally, patients have greater access to care. However, for cases of insurance denial, machine downtime, or inaccessibility to IMPT, high-quality VMAT plans are necessary¹. The goal of this study is to drive automated planning through the use of an in-house knowledge-based planning (KBP) model to produce unilateral HN VMAT plans that are dosimetrically comparable to IMPT.

METHODS AND MATERIALS

10 unilateral HN IMPT cases were retrospectively planned with VMAT using an in-house KBP model. Plans involved 2-3 target volumes with hierarchal prescription dose schemes (range 50-70Gy) delivered in 30-35 fractions. IMPT cases were planned with Raystation² v2023B and utilized three beams. VMAT cases were planned with three partial arcs in Eclipse³ v18.0 with RapidPlan for plan optimization. Dosimetric scorecards, based on departmental standards, were used to compare IMPT and VMAT plan quality.

RESULTS

Proton (mean = 90.83%) plans produced higher scoring plans than photon (mean = 84.65%) plans (p -value = 6.222E-06) (Table 1). However, differences in metrics for brain, cochlea_contra, cochlea_ipsi, esophagus, larynx, and trachea sparing were unremarkable ($p>0.1$ for all) (Table 2). VMAT plans reduced parotid_ipsi Dmean (average: 44Gy versus 51Gy, $p<0.05$).

Table 1. Plans with score and comparison. As expected, proton plan were superior in plan quality versus photon. Yet the KBP model for the photon plan still gave acceptable scores. For three patients, the proton plans did not yield statistically significant differences.

Patient	Photon	Proton	P-Value
1	88.41%	90.82%	0.89
2	80.31%	87.79%	1.79E-02
3	88.96%	96.36%	3.35E-02
4	94.15%	96.62%	0.87
5	84.33%	90.31%	0.20
6	90.14%	97.04%	3.56E-03
7	80.35%	87.25%	1.87E-02
8	76.89%	83.83%	6.61E-03
9	78.53%	87.20%	2.21E-04
10	84.43%	91.11%	2.51E-04
Mean Score	84.65%	90.83%	
P-Value	6.22E-06		

Table 2. CTV and OAR scoring and dose data. While the proton plans yielded better values, the photon plan still met every metric for plan quality. This supports the conclusion that the in-house KBP model could be used clinically as an alternative to proton planning.

OAR	Photon Score	Proton Score	P-Value	DVH Metric	Photon	Proton
Bone_Mandible	94.19%	96.56%	7.71E-04	'Volume at 70Gy [%]'	0.62	0.18
				'Volume at 60Gy [%]'	6.41	5.04
				'Volume at 50Gy [%]'	19.54	13.73
Brain	95.48%	95.26%	0.439	'Dose at 0.03CC [Gy]'	39.87	41.08
				'Volume at 50Gy [CC]'	0.04	0.04
Brainstem	65.16%	88.89%	8.12E-05	'Dose at 0.03CC [Gy]'	22.36	9.14
				'MeanDose [Gy]'	25.22	12.66
Cavity_Oral	56.84%	76.18%	6.04E-05	'Dose at 0.03CC [Gy]'	58.10	53.17
				'Volume at 40Gy [%]'	0.00	16.30
Cochlea_Contra	100.00%	81.37%	0.167	'Volume at 40Gy [%]'	10.00	0.01
Cochlea_Ipsi	90.00%	99.99%	0.343	'Volume at 40Gy [%]'	10.00	0.01
Esophagus	93.92%	94.54%	0.130	'MeanDose [Gy]'	8.71	7.90
				'Dose at 0.03CC [Gy]'	34.86	33.13
Eye	97.98%	99.78%	1.18E-06	'MeanDose [Gy]'	1.36	0.12
				'Dose at 0.03CC [Gy]'	2.35	0.29
GlnD_Submand_Contra	88.14%	99.24%	7.47E-07	'MeanDose [Gy]'	6.28	0.40
GlnD_Submand_Ipsi	33.26%	35.82%	0.422	'MeanDose [Gy]'	58.34	57.10
GlnD_Thyroid	68.57%	74.94%	1.08E-04	'MeanDose [Gy]'	27.57	23.13
Larynx	84.70%	85.39%	0.166	'MeanDose [Gy]'	13.82	11.94
Lens	94.56%	99.46%	1.34E-05	'Dose at 0.03CC [Gy]'	1.36	0.13
Lips	85.25%	99.26%	3.27E-06	'MeanDose [Gy]'	9.34	0.47
Musc_Constrict	82.11%	87.33%	5.63E-04	'MeanDose [Gy]'	30.89	24.45
Parotid_Contra	78.49%	99.94%	1.25E-07	'MeanDose [Gy]'	5.60	0.02
Parotid_Ipsi	7.27%	2.36%	2.47E-02	'MeanDose [Gy]'	44.08	51.02
				'Dose at 0.03CC [Gy]'	26.08	7.51
				'Volume at 40Gy [%]'	1.95E-05	3.58E-05
SpinalCord	87.18%	98.67%	2.07E-04	'Volume at 30Gy [%]'	2.76	3.58E-05
				'MeanDose [Gy]'	11.43	12.45
Trachea	86.28%	85.06%	0.282	'MeanDose [Gy]'	11.43	12.45

EXAMPLE CASE

For a right-sided tonsil case, both KBP VMAT and IMPT achieved V100% of 99% for three PTV levels and scored 88.4% and 90.8%, respectively. Whereas IMPT greatly improves mandible (mean of 15Gy to 25Gy) and oral cavity (mean of 10.4Gy to 25Gy) metrics, KBP VMAT ensured that both contralateral parotid and submandibular glands were appropriately spared, reducing mean doses to both OARs to 5.3Gy and 6.8Gy, respectively. Conversely, the VMAT plan ensured the ipsilateral parotid gland achieved a mean dose under the desired 26Gy threshold. Other OARS, including the larynx, show minor differences between VMAT and IMPT planning. Automation of VMAT planning through KBP ensured that a high-quality alternative photon plan would be readily accessible.

CONCLUSIONS

This study aimed to show that using a KBP model to produce backup photon plans for unilateral head and neck proton treatments is a viable solution when faced with the loss of ability to treat. While the proton plans were superior, the photon plans were still of high quality and allowed for acceptable outcomes in the absence of a proton option.

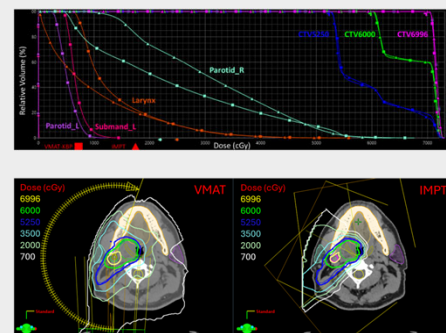


Figure 1. DVH and Isodose comparison for a right tonsillar lesion. Both VMAT and IMPT achieve high plan scores of 88% or greater, with VMAT matching target coverage achieved by IMPT and adequately sparing nearby OARs.

REFERENCES

- Laughlin, Brady S. et al. "Implementation of Photon Treatment Back-up Workflow at a High-Volume Proton Center: Safety, Quality, and Patient Considerations", Practical Radiation Oncology, Volume 12, Issue 5, doi: 10.1016/j.prro.2022.01.016
- RaySearch Laboratories AB.
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Annex B: Acknowledgements

Initial Plans created from KU Unilateral HN model by Kenny Guida, DMP, DABR, Wesley Tucker, PhD, and KU Dosimetry Team

KBP-Optimized plans created by Wesley Tucker, PhD, and Kenny Guida, DMP, DABR

All data generated and compiled by Wesley Tucker, PhD, and Kenny Guida, DMP, DABR

Model generation and editing by Wesley Tucker, PhD; Kenny Guida, DMP, DABR; Lesley Rosa, CMD; Ryan Clark, MS, CMD

Dosimetric Scorecard and derived structures designed by Kenny Guida, DMP, DABR; Ryan Clark, MS, CMD; Anthony Magliari, MS, CMD; Lesley Rosa, CMD

Model generated validation plans created by Wesley Tucker, PhD; Kenny Guida, DMP, DABR; Jonathan Cornelisse, MS, CMD; Megan Smith, MS, CMD;

Clinical Description document created by Wesley Tucker, PhD; Kenny Guida, DMP, DABR; Gregory Gan, MD, PhD

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Current publication: <https://aapm.confex.com/aapm/2025am/meetingapp.cgi/Paper/20108>

Please reference future publication: **TBD**

Annex C: Distribution and compatibility

This RapidPlan model is to be distributed exclusively via the links found on Varian Medical Affairs:

[Siemens Healthineers - Unilateral Head&Neck 69.96/59.4/54.12Gy \(SIB\) \[RapidPlan\(KU\)\]](#)

Please do not re-distribute this model as number of downloads will be tracked (strictly to judge the success of this project).

This RapidPlan model was built with Eclipse v18.0 and rebuilt and validated from Eclipse v15.6 RapidPlan for maximal compatibility.