



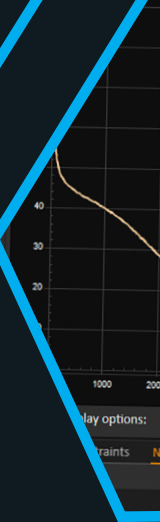


RayStation

TREATMENT PLANNING THE WAY IT SHOULD BE

Start with an idea for vastly improved treatment planning software. Take some of the world's best developers and clinical specialists. Then innovate ceaselessly for nearly two decades, drawing on insight from world-leading cancer centers. The result is RayStation®* – a treatment planning system with an extraordinary user experience and groundbreaking features that extend treatment possibilities.

*Subject to regulatory clearance in some markets



4 WHY SOFTWARE MATTERS

5 SPEED AND ACCURACY

GPU-powered computation
Monte Carlo dose calculation
Collapsed Cone dose calculation

6 MACHINE LEARNING

Deep learning segmentation
Deep learning planning

8-9 PHOTON AND ELECTRON

3DCRT
IMRT
VMAT
TomoTherapy
CyberKnife
Stereotactic planning
Electrons
MR-based planning

10 VIRTUAL SIMULATION

11 BRACHYTHERAPY PLANNING

12-15 ADVANCED OPTIMIZATION

MCO
Robust optimization
Radiobiological optimization

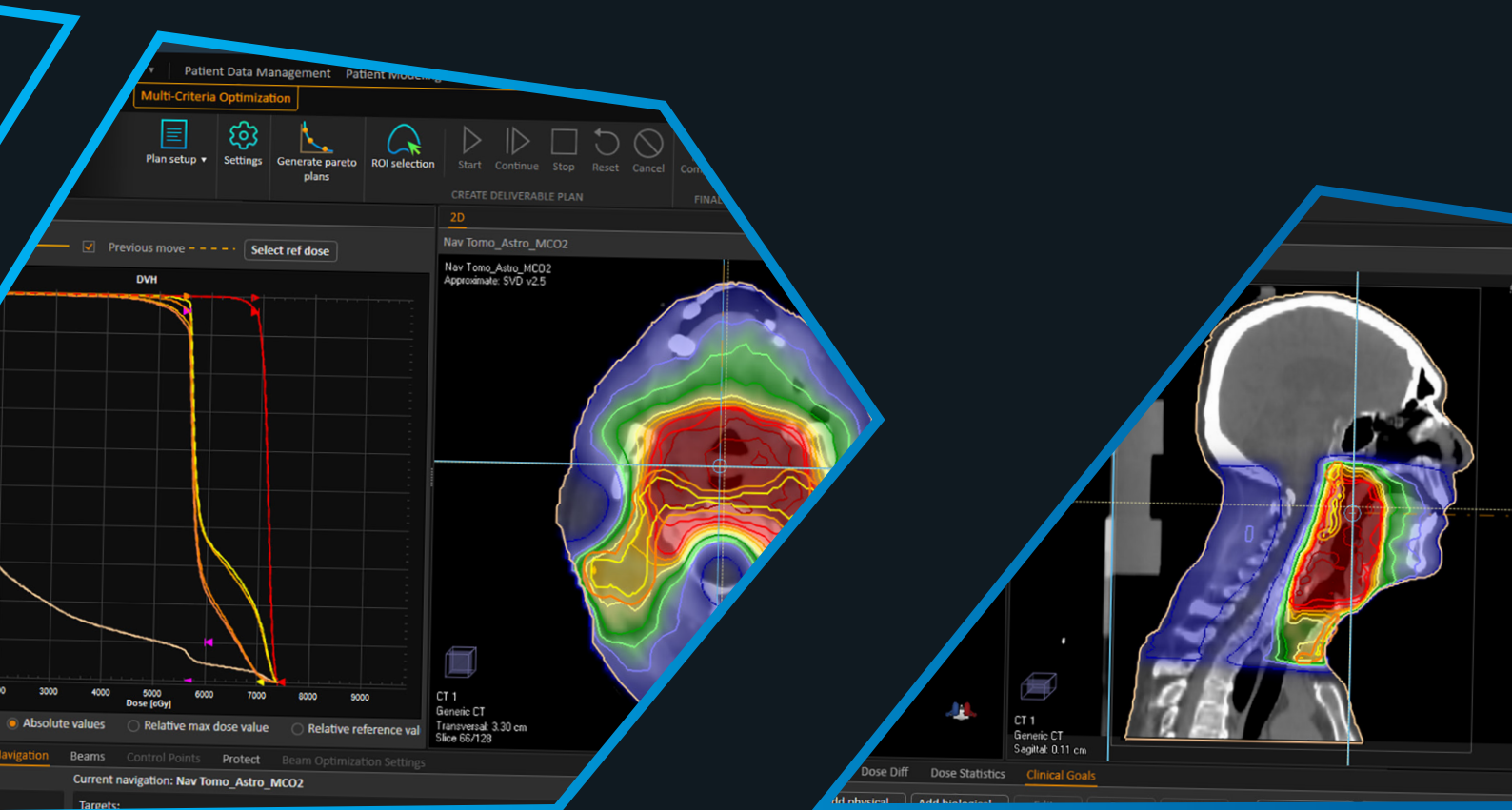
16-23 AUTOMATION

Plan Explorer
Templates and protocols
Scripting
Automatic breast planning
Fallback planning

24-29 PARTICLE THERAPIES

Proton Therapy
Carbon Ion Therapy
Helium Ion Therapy
BNCT

ADVANCING CANCER TREATMENT



30-31 **ADAPTIVE THERAPY**

32-33 **THE PHYSICIAN TOOLBOX**

- Manual and semi-automatic contouring
- Deep-learning organ segmentation
- Plan evaluation
- Robust evaluation
- Radiobiological evaluation

34-35 **PLAN EVALUATION**

- Simultaneous plan evaluation
- Robust evaluation
- Radiobiological evaluation

36-37 **COMMISSION, CHECK, GO**

- Modeling
- Quality Assurance
- Seamless connectivity
- Hardware independence

38-39 **MEDICAL ONCOLOGY**

40-41 **SERVICE OFFERING**

- Smooth go-clinical process
- A comprehensive service contract
- RayStation online community
- Trainings
- User meetings
- Professional Services overview

SOFTWARE HAS UNLIMITED POTENTIAL

No one wants to wait for better cancer treatment, and software is a way to accelerate change. Software refinements make it possible to keep pace with new techniques and discoveries in an efficient manner.

Radiation therapy equipment is a significant investment. However all too often, software is an afterthought rather than an integral aspect. Thoughtfully designed software is the key to realizing the full potential of equipment and getting the best return on investment.

But RayStation is more than just software. It incorporates the knowledge and experience of a team of experts dedicated to bringing scientific advancements in cancer treatment faster to the clinical world. RaySearch continuously enhances the system, paying as much attention to small improvements as to major additions. Every development is designed to support you in securing better outcomes and improved access to care.

RayStation makes daily work more efficient and straightforward for any clinic, as well as leading the way in advanced techniques. RaySearch believes that an intelligent combination of adaptive planning and automated planning will create a bright future for radiation therapy. As a RayStation user, you are helping to shape that future.

UNIQUE AND CONTINUOUS MACHINE COMPATIBILITY - with most linacs, OIS and third-party QA

HARMONIZE YOUR TREATMENT PLANNING - one planning platform for all your machines

FAST DEVELOPMENT PACE - you will always be at the cutting edge of treatment planning

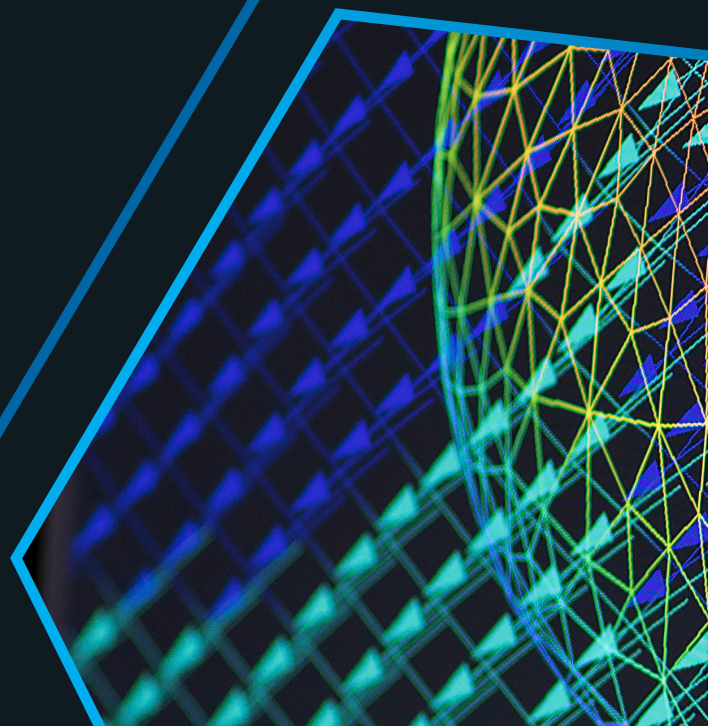
PROVEN TRACK-RECORD - a large community of enthusiastic users

WORLD-CLASS SERVICE - support where and when you need it

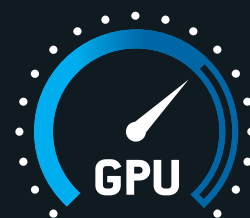
AUTOMATION - to boost efficiency and free up clinicians' time

UNRIVALED SPEED - outstanding plan quality within seconds

ACCURACY FIRST - ensuring you deliver what you planned for



SPEED AND ACCURACY YIELDS PLAN QUALITY



RayStation's unrivaled computation speed can radically transform your treatment planning process.

As the computation time is measured in seconds rather than minutes, you can efficiently produce several competing treatment plans to assess different trade-off situations and avoid interruptions.

This has been shown to contribute to overall plan quality. For example, decreasing calculation times for VMAT planning, from around 10-17 minutes for optimization and final dose calculation to around 2-4 minutes, significantly increased the fulfillment of clinical goals*.

RayStation also offers the possibility to use Monte Carlo dose algorithms, providing the highest level of accuracy. The calculations are run on GPU, enabling the outstanding results displayed to the right**.

KEY FEATURES

- Monte Carlo (MC) algorithms for photon, electron and proton PBS
- Collapsed Cone (CC) photon dose calculation engine
- Singular value decomposition photon dose calculation engine for real-time purposes
- PBS light ion dose computation using pencil-beam dose engine and RBE dose computation

* Case Study "The effect of planning speed on VMAT plan quality."

**Results may vary as dose computation time depends on several variables.

7-BEAM IMRT
PROSTATE
1.3 MILLION VOXELS
40/40 ITERATIONS

5s
OPTIMIZATION
2.5s
CC FINAL DOSE

DUAL-ARC VMAT
LUNG
4.3 MILLION VOXELS
73/80 ITERATIONS

40s
OPTIMIZATION
10.5s
MC FINAL DOSE
1% UNCERTAINTY

SINGLE-ARC VMAT
PROSTATE
1.3 MILLION VOXELS
33/40 ITERATIONS

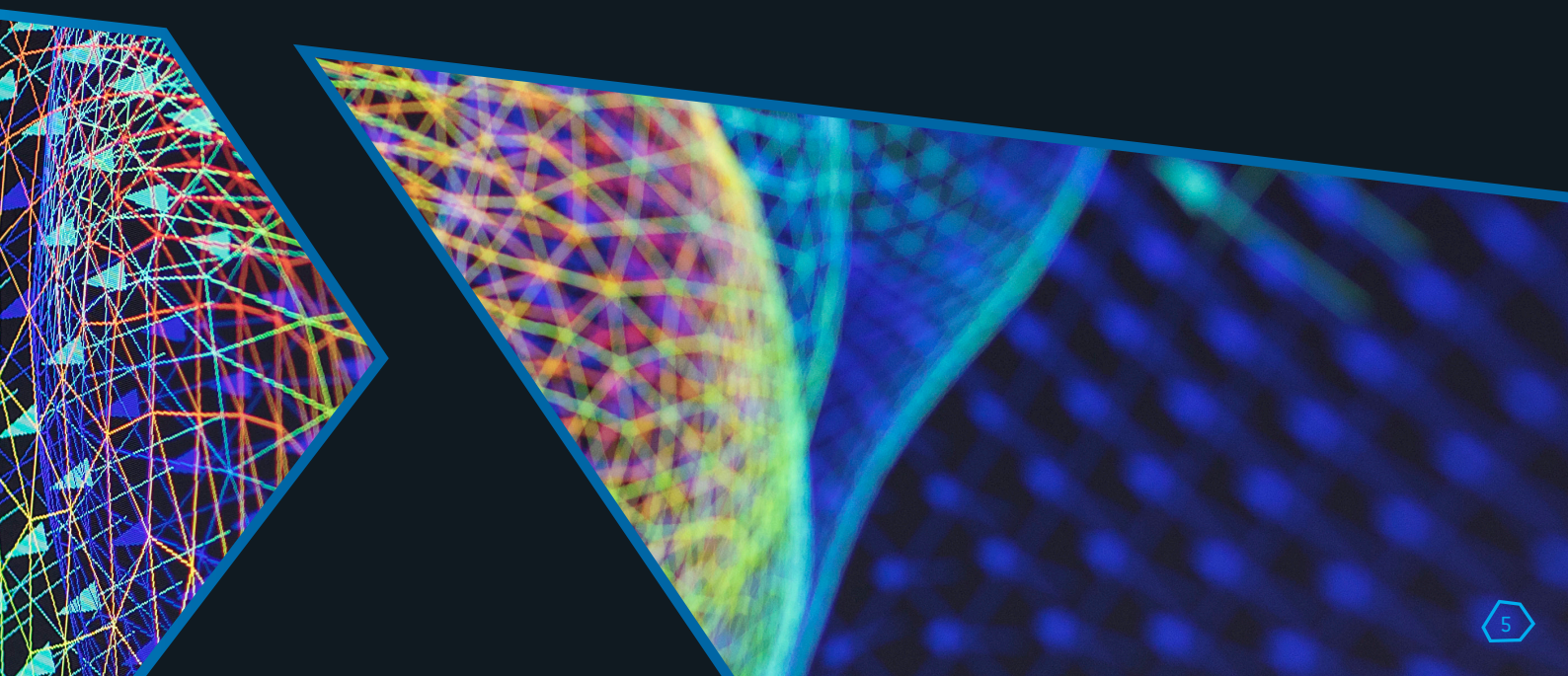
9s
OPTIMIZATION
4.5s
MC FINAL DOSE
1% UNCERTAINTY

2-BEAM IMPT
LUNG
1.2 MILLION VOXELS
64 ITERATIONS

9s
OPTIMIZATION
1s
MC FINAL DOSE
1% UNCERTAINTY

RayStation's high calculation speed provided an immediately noticeable improvement over the center's previous treatment planning system. In the PACE prostate VMAT SABR trial, RayStation cut the time for optimization and calculation of final dose from 40 minutes to just 3 minutes. This high speed also makes it possible for the planner to perform a reoptimization while the clinician is still present, ensuring a highly effective process."

— Chris Walker, Head of Radiotherapy Physics, NCCC, UK



MACHINE LEARNING FASTER AND SMARTER TREATMENT PLANNING

Machine learning is one of the fastest-growing areas of technology today. It has had a key role in advances in many fields, and its significance for the future of healthcare is potentially enormous. RaySearch already has a strong focus on automation and machine learning brings this to a new level. Through machine learning, smarter and faster software is created. Automatic treatment plan generation* and deep-learning segmentation** increase treatment planning efficiency in RayStation.

MACHINE LEARNING FRAMEWORK

The machine learning framework in RayStation allows for deployment of validated machine learning models when available. The ML models are released and upgraded several times per year and developed to adhere to common guidelines and protocols.

DEEP-LEARNING SEGMENTATION

Auto-segmentation of structures in RayStation is set to reach new heights with deep learning segmentation. The released segmentation models have been trained on carefully curated data adhering to common guidelines and thoroughly validated. The GPU-powered algorithm is fast and produces consistent segmentation results.

How does it work? Run customized structure templates or select the segmentation models you want to use and the structures are generated in less than a minute. The output is standard geometries that can be manually adjusted if needed.



"We used deep learning to contour the first patient in May 2020 and the treatment was performed 12 days later. From taking 45-60 minutes per patient, the contouring now only takes 10-15 minutes, which means a huge time saving."

*— Andreas Johansson, Medical Physicist,
Mälar Hospital, Eskilstuna, Sweden*

DEEP LEARNING TREATMENT PLAN GENERATION

Generate treatment plans automatically with deep learning driven dose prediction. The released planning models have been validated on common treatment protocols and can be configured to fit the protocol used at your clinic. One or multiple deliverable treatment plans can be automatically generated with varying target/OAR tradeoffs. The generation of plans can additionally take robustness into account, which is important especially when creating automatic proton plans.

- Automatically generate multiple deliverable plans from one deep learning planning model
- Deep learning based automated segmentation of CT structures
- Validated models are released and upgraded several times per year

** Subject to regulatory clearance in some markets. Not for marketing in the USA or Canada.*

*** Subject to regulatory clearance in some markets.*

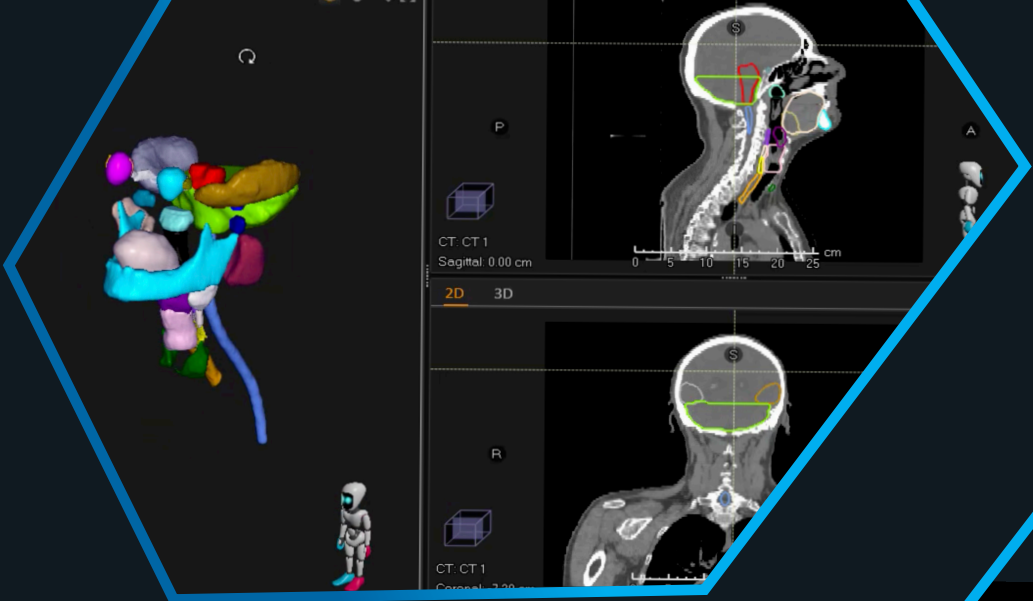
CT: CT 1
Generic CT
Transversal: -1.40 cm
Slice 36/111

Compare 1

Select dose ▾ Predicted dose

Predicted dose
Approximate: Undefined



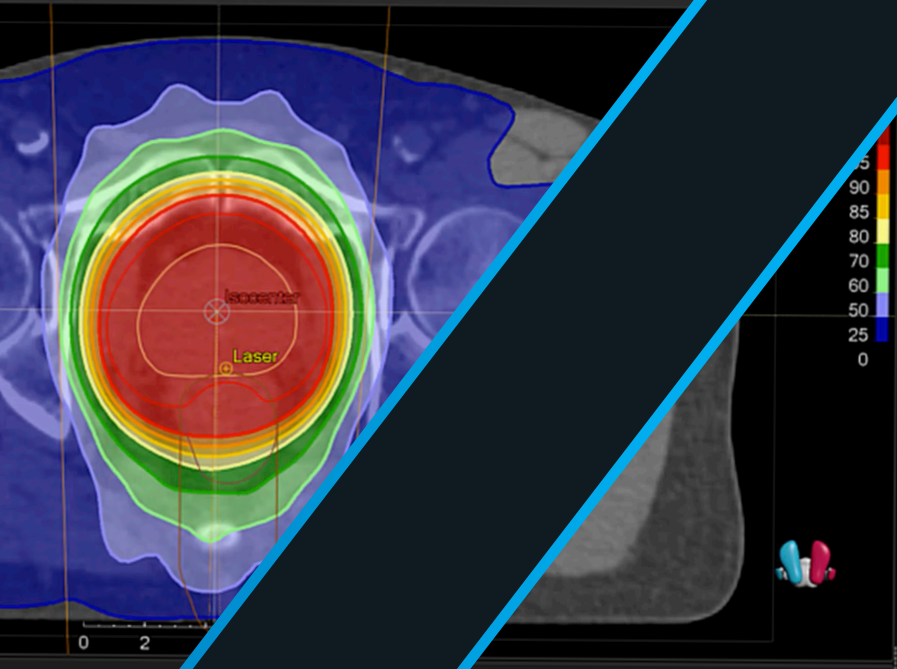


Sum doses Compute perturbed dose Simulate organ motion Interplay tool Recompute invalidated doses Stop
 Dose prediction: Running ML optimization for plan Autoplanning .

300 cGy x 20 fractions
 Median dose (D50%)
 PTV
 Value: 6209 cGy
 Plan setup

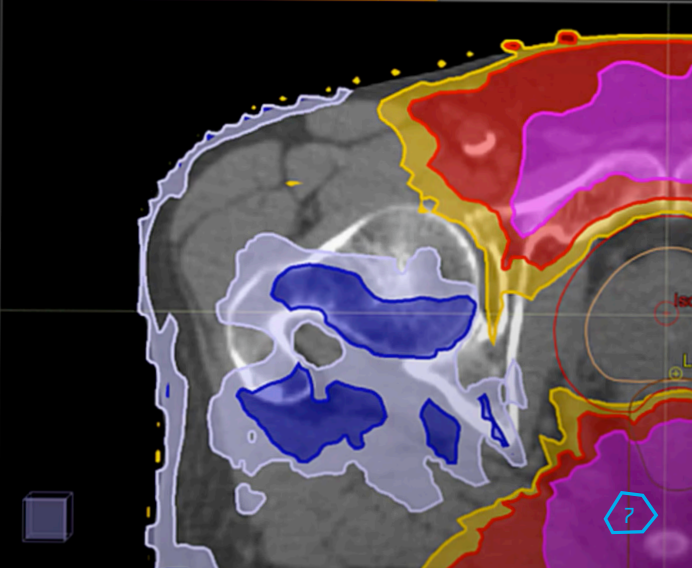
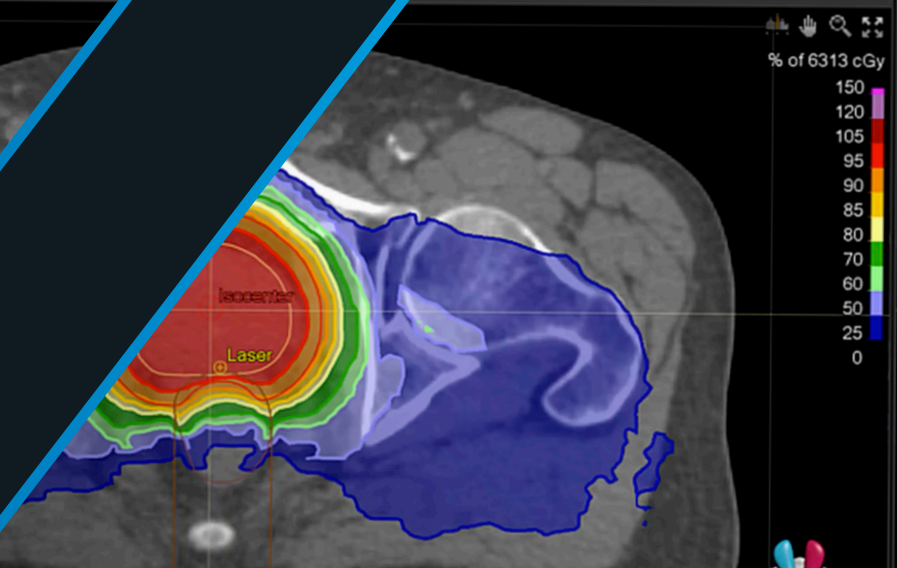
Planning (CT 1)

Dose Beams (Current)
 Dose Statistics Clinical Goals
 Plan dose: Autoplanning... Predicted dose



Dose axis: Absolute Relative max Relative dose [cGy]:

Beams (Compare 1) Control Points
 Difference: Current - Compare 1



ONE SYSTEM. ENDLESS POSSIBILITIES.

RayStation optimizes for all treatment techniques, with robust algorithms that account for density and patient setup uncertainties. RayStation's ultrafast multi-purpose optimization engine can solve virtually any optimization problem within radiation therapy, using many degrees of freedom of the treatment unit.



3DCRT

Fast and consistent conventional 3DCRT treatment planning with manual and automatic tools for conformal treatment using treat- and-protect, beam weighting, wedges, etc. Modern inverse planning techniques are provided for creating conventional 3DCRT plans, which can be automatically optimized in regard to any combination of segment shapes, segment monitor units, collimator, gantry and couch angles.



ELECTRONS

Creation of mixed electron and photon plans is enabled, with multiple coupled or independent beam sets applied in a single treatment plan. 3D visualization of the treatment setup makes it possible to inspect the physical perimeter of the selected applicator in relation to the patient geometry, which assists in collision avoidance. The electron module supports automatic generation of the cutout shape, using the same treat-and-protect tools as the 3DCRT module. The cutout can also be created and edited using manual tools.



IMRT

State-of-the-art tools make it simple to design and optimize IMRT treatment plans. Direct machine parameter optimization ensures high quality step-and-shoot and sliding window plans and speeds up the planning and delivery processes.



TOMOTHERAPY PLANNING

RayStation supports planning of TomoTherapy treatments. With access to all RayStation's advanced functionality, including multi-criteria optimization and adaptive planning, the user can efficiently design the optimal treatment plan. Optimization capabilities for the TomoTherapy machine include dynamic jaw support, delivery time constraints and the possibility to specify "protect" regions where irradiation is avoided. TomoTherapy planning can be smoothly integrated into the clinical workflow and treatment plans are sent to Accuray's integrated data management system for delivery.



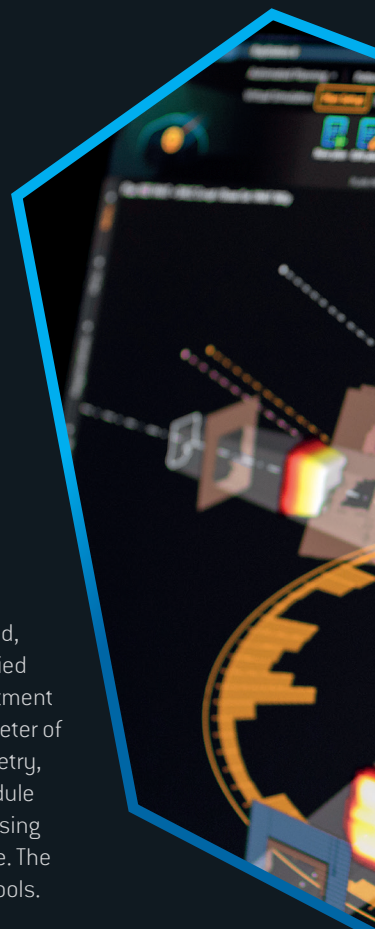
VMAT

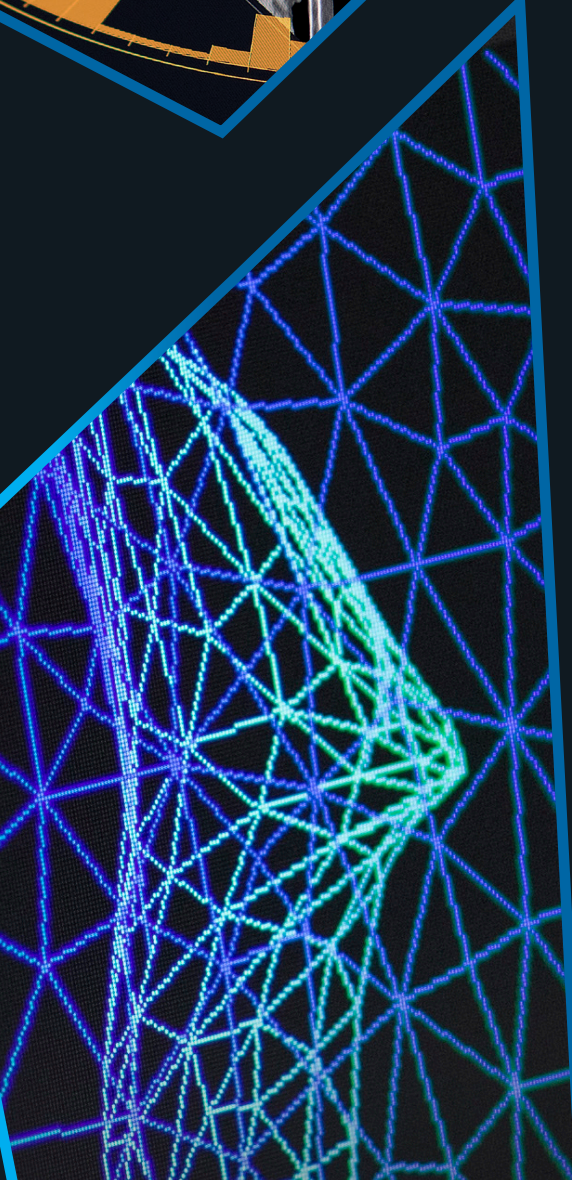
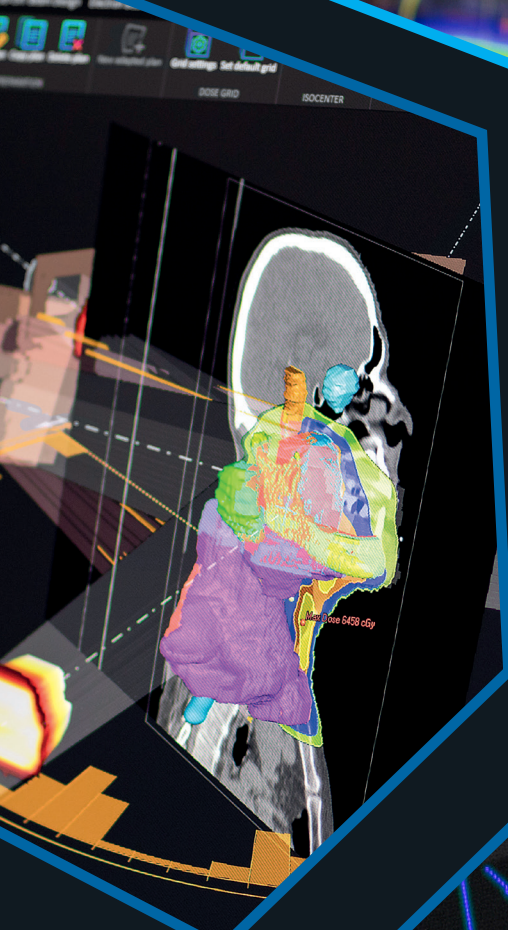
Design and optimization of single- or multiple-arc VMAT plans through an optimization procedure (inverse planning). Objectives and constraints are defined for the desired dose, and the system creates a plan that matches these criteria as closely as possible within the limitations of the treatment machine. The optimized plan is directly deliverable, without the need for post-processing that might degrade quality.



CYBERKNIFE PLANNING

RayStation includes treatment planning for CyberKnife machines. The CyberKnife optimization is available for all collimation types (fixed cone, Iris™ and Incise™ Multileaf collimator) and simultaneously optimizes all machine parameters, including beam orientations. Segment MUs and leaf positions are optimized using RaySearch's proven algorithm for direct machine parameter optimization. All CyberKnife Synchrony techniques for target tracking and real-time motion synchronization are supported.





STEREOTACTIC PLANNING

Use the same software for stereotaxis as for the rest of your treatments. RayStation offers many proven tools to support the creation of high-quality stereotactic workflows. Thanks to the GPU technology, it takes seconds to calculate complex IMRT and VMAT plans, typical for stereotactic treatments, even for dose grids with resolution as fine as 1 mm.



MR-BASED PLANNING

An MR image can be used as the planning image for photon therapy. MR images provide superior soft-tissue contrast compared to CT images, which enables better characterization of soft tissue and improved delineation of tumors and organs at risk. Planning is based on a user-defined bulk density assignment approach, which can be founded on atlas-based segmentation.



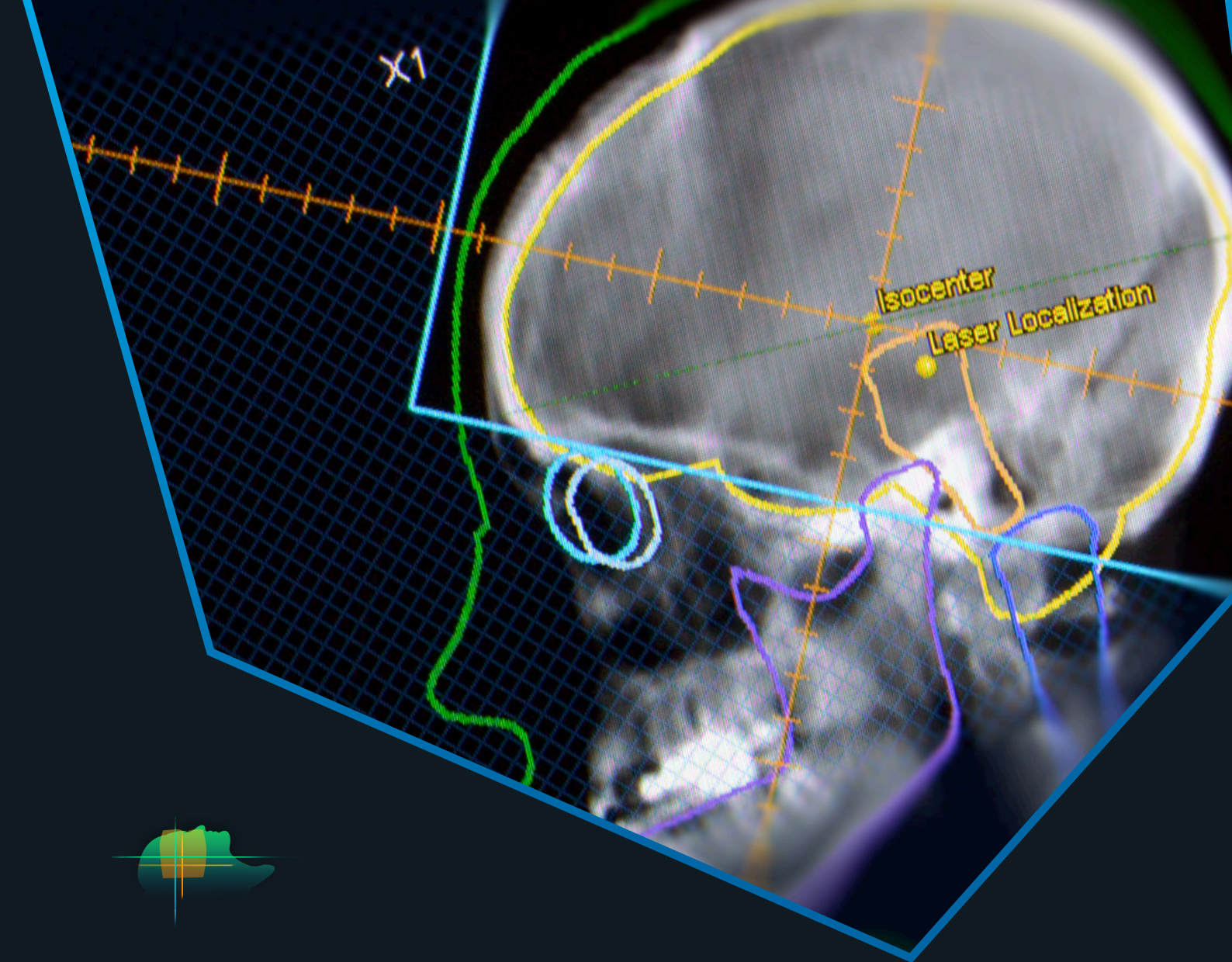
REDUCE ORGAN AT RISK DOSE OPTIMIZATION

RayStation lets you reduce the dose to the organs at risk in an existing plan while maintaining target coverage and dose homogeneity within the target structures. The functionality assures the plan is Pareto-optimal, minimizing dose to the organs at risk as far as possible without compromising another organ or reducing target coverage or target homogeneity.



CO-OPTIMIZATION OF MULTIPLE BEAM SETS

Two beam sets in a plan can be optimized simultaneously, and co-optimized beam sets share an objective function list. Objective functions can be assigned to each beam-set dose, or to their sum. This feature enables efficient planning of non-integrated boost treatments. SMLC, DMLC and VMAT are supported.

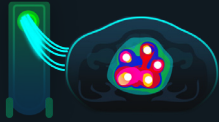


VIRTUAL SIMULATION

RayStation offers a dedicated workspace for performing virtual simulation tasks related to isocenter placement, export to patient marking systems and beam design. This will smoothen your workflow prior to planning as the virtual simulation module is integrated into RayStation.

KEY FEATURES

- Dedicated workspace for virtual simulation
- One-click creation of plan with orthogonal beam pair
- Isocenter placement using DRR pair
- Export to patient marking systems
- A multitude of beam-design tools for field shaping

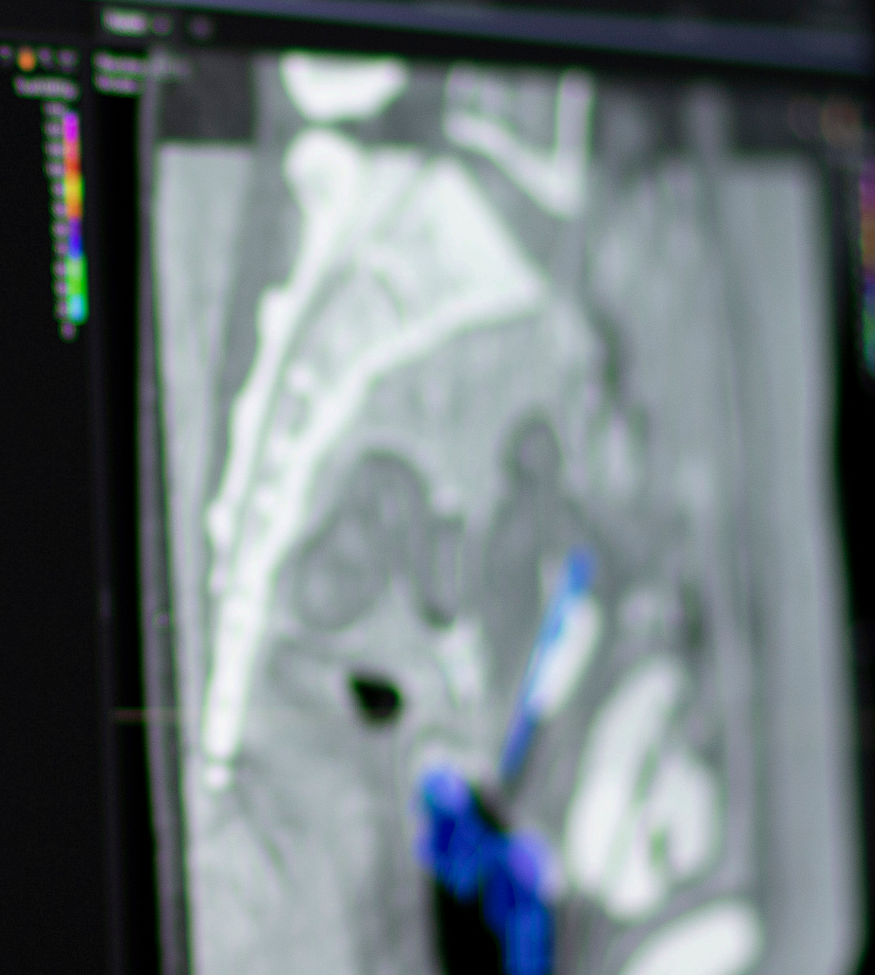
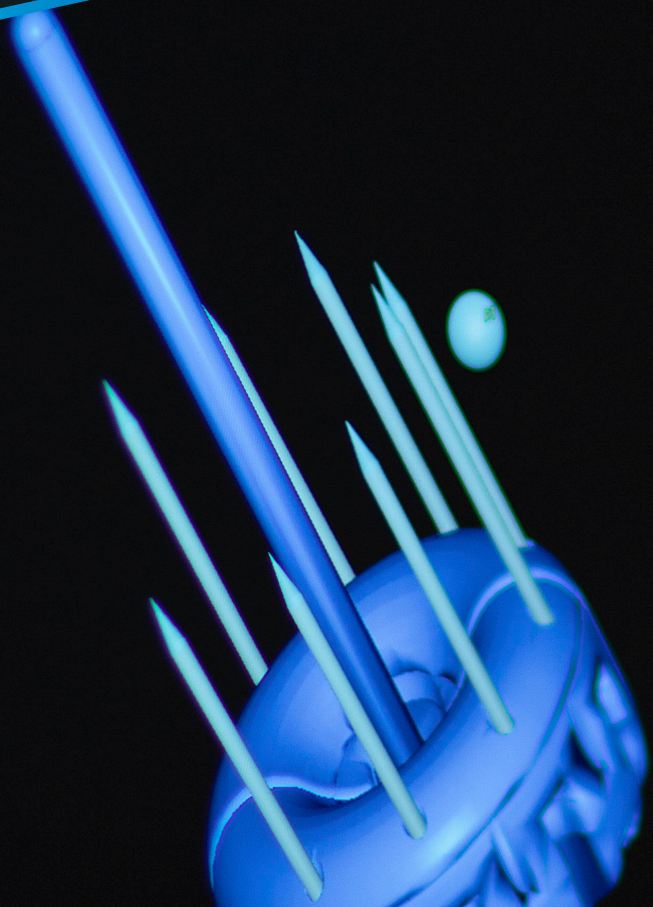


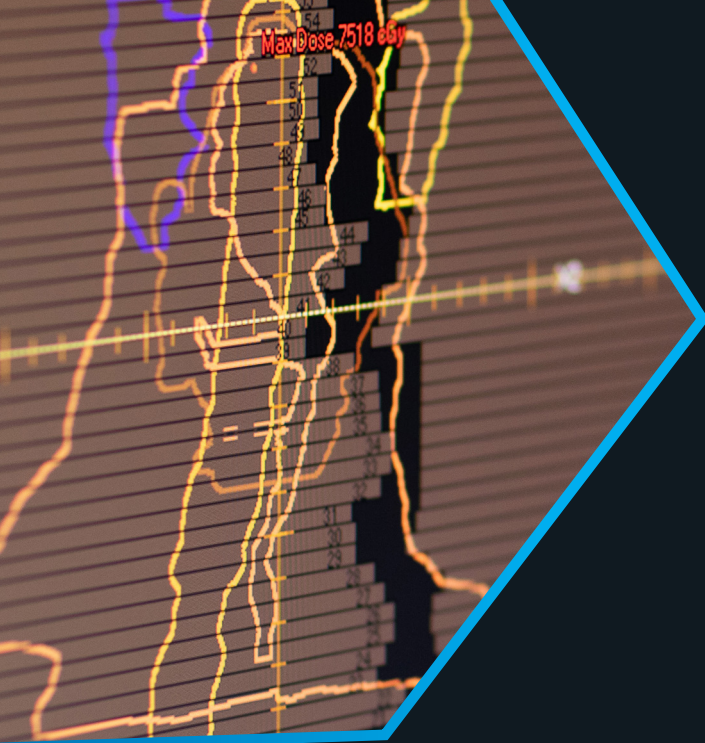
BRACHYTHERAPY PLANNING

With the brachy planning module in RayStation, it is possible to quickly create optimal and accurate high dose rate brachy therapy treatment plans. Automatic tools can be used to efficiently reconstruct the applicator and its channels. With RayStation's powerful optimization tools, optimal dwell time distributions can be obtained within seconds.

KEY FEATURES

- Create plans based on CT or MR image data, either separately, or fused together
- Automatically reconstruct interstitial applicators automatically based on the image data
- Predefine source paths for fast and accurate modeling of rigid applicators
- Compute dose and optimize dwell times within seconds
- Model arbitrary high dose rate source models, afterloaders and applicators
- Efficiently plan and evaluate combined external beam and brachytherapy treatments in one single system
- Further automate and customize your workflow using templates and scripting
- Compute full EQD2 dose distributions and set EQD2 clinical goals





MULTI-CRITERIA OPTIMIZATION

RayStation's multi-criteria optimization (MCO) makes it faster and simpler to achieve the best possible balance in prioritizing healthy tissue to spare.

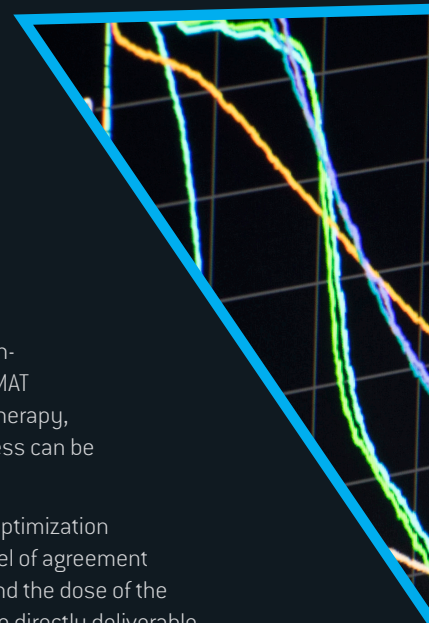
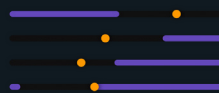
Clinical trade-offs are a constant issue in radiation therapy treatment planning. The conventional approach to resolving them involves a time-consuming manual trial-and-error process where plans are re-optimized multiple times. RayStation's MCO gives a new level of confidence, quickly generating a set of relevant treatment plans that are Pareto-optimal regarding user-specified priorities, objectives and constraints. The planner or physician can fine-tune a plan by moving sliders in real time to balance between conflicting clinical goals.

- Planners and physicians can find solutions they didn't know existed (Hong et al., Müller et al., 2008)
- Plans have been shown to yield significant improvements in organ-at-risk sparing (Kamran et al., Wala et al., 2016)
- Treatment planning time is significantly reduced without compromising plan quality (Craft et al., 2012)
- Planners with limited experience can produce clinically acceptable plans (Kierkels et al., 2015)

Supported photon delivery techniques include SMLC, DMLC, VMAT and TomoTherapy. For proton therapy, PBS is supported and robustness can be taken into account.

RayStation's segment-based optimization mode for VMAT gives a high level of agreement between the navigated dose and the dose of the deliverable VMAT plan. Plans are directly deliverable after navigation also for DMLC, proton PBS and Tomo-Therapy treatments.

RayStation offers automatic navigation after Pareto plan generation, that fulfills as many clinical goals as possible, in order of priority, for photon plans.



The typical trade-off in radiation treatment planning is target coverage versus critical structure sparing. Traditional treatment planning proceeds in a trial-and-error fashion, where the planner tries to guess at system optimization parameters that might strike the best balance between the multiple conflicting goals. But this process can be quite time consuming. Multi-criteria optimization simplifies this by presenting the planner with a set of sliders which allow them to surf across the trade-off space and quickly decide on the right balance."

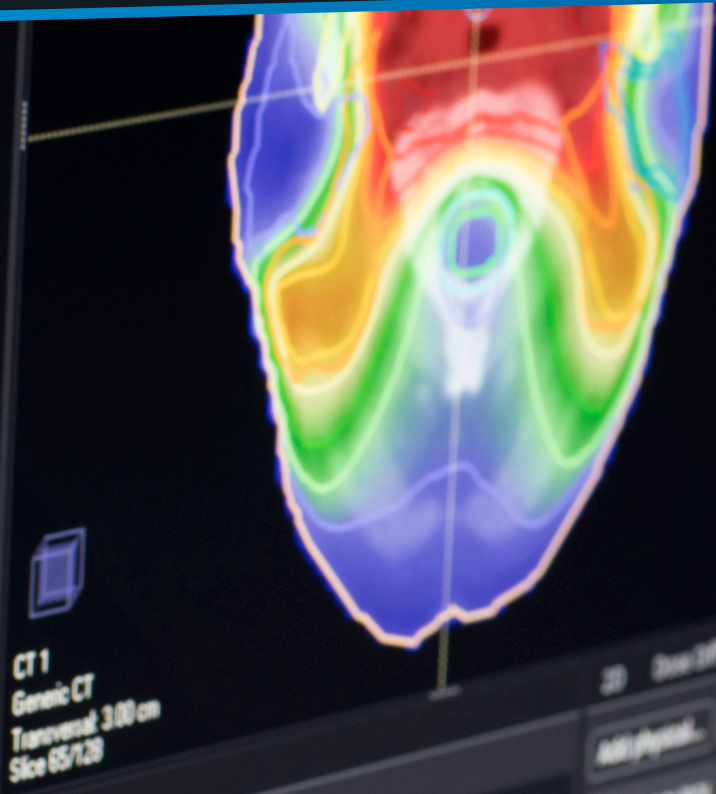
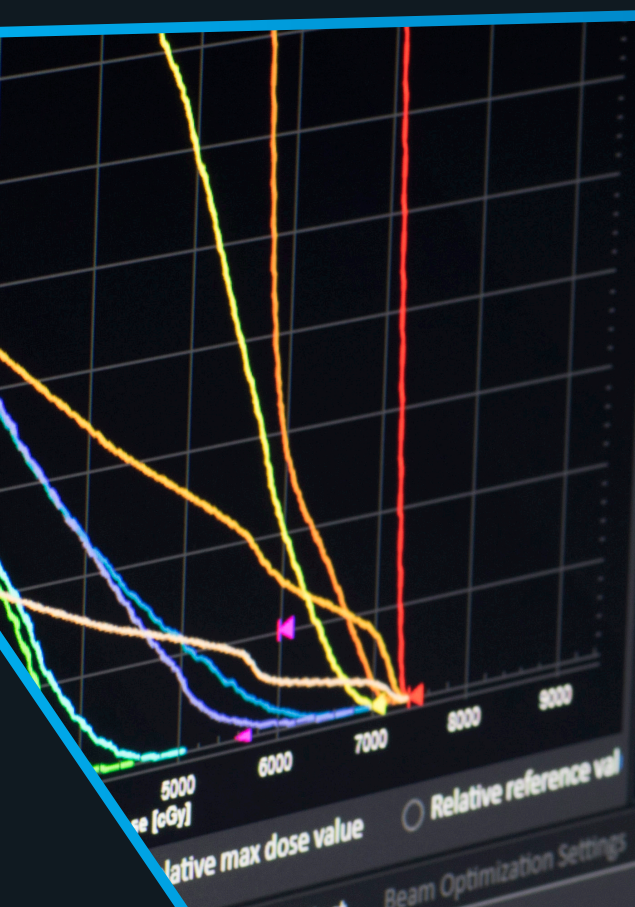
– David Craft, Assistant Professor, Department of Radiation Oncology, Massachusetts General Hospital, Boston

Patient Data

Criteria Optimization

Setup ▾ Settings Robustness Generate points plan

SETTINGS



Tomography

Protect Beam Optimization Settings

Tomography

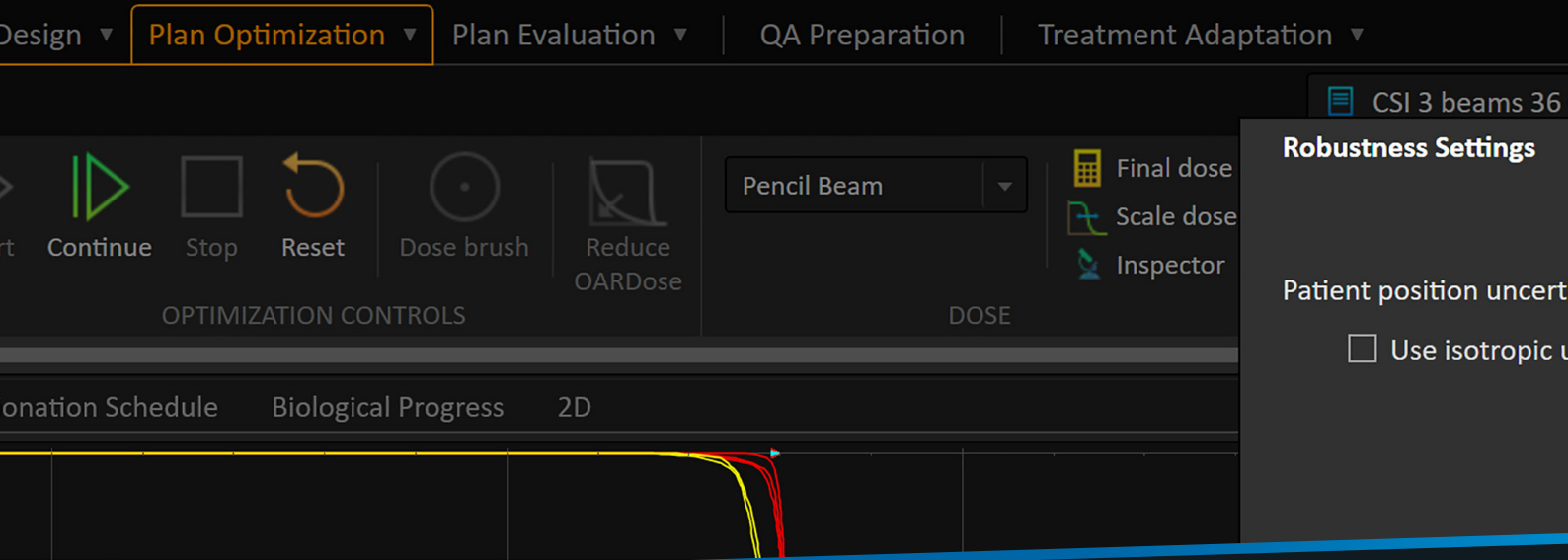
Relative max dose value

Relative reference val

Relative max dose value

Relative reference val

Structure	Value
PTV_95_95	6500
PTV_90	6000
PTV_85	5500
PTV_80	5000
PTV_75	4500
PTV_70	4000
PTV_65	3500
PTV_60	3000
PTV_55	2500
PTV_50	2000
PTV_45	1500
PTV_40	1000
PTV_35	500
PTV_30	0



Robustness Settings

Patient position uncertainty

Use isotropic uncertainty

ROBUST OPTIMIZATION AND 4D — THE END OF THE PTV

Setup errors, density errors, and organ motion can lead to delivered dose distributions that deviate significantly from the planned distributions in radiation therapy.

The conventional method for taking errors into account is to plan with margins, including the definition of planning target volumes (PTVs). In cases of heterogeneous density, and especially in particle planning, conventional margins often fail to provide the intended robustness against uncertainties.

RayStation utilizes a unique robust optimization method that takes the effects of potential changes into account and makes your plan robust to geometrical and dosimetric uncertainties. The framework includes support for a large number of different uncertainties, including systematic as well as inter- and intrafractional errors.

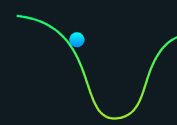
Setup errors may optionally be evaluated independently for each beam, or for each isocenter.

This technique is useful, for example, in creating robust junctions when field matching is required.

The inclusion of 4D-CT images in the robust optimization process addresses situations where there is significant relative intrafractional motion of internal organs, for example in the thorax during free breathing or partially gated treatments. Setup and density uncertainties may be added on top of the 4D image data in the optimization. The 4D data may originate from the CT itself (4D-CT), or by simulating the organ motion in RayStation. Another use case for the 4D robust optimization is to assign different material overrides to the same ROI on identical copies of the planning CT. Plans may be created that are robust, for example, against random air bubbles in the bowel of pelvic cancer patients.

“Computation speed is a key component when optimizing for multiple scenarios; RayStation is impressively fast, even when running as many as 21 scenarios for one case.”

— Anaïs Gérard, Medical Physicist,
Centre Antoine-Lacassagne, Nice, France



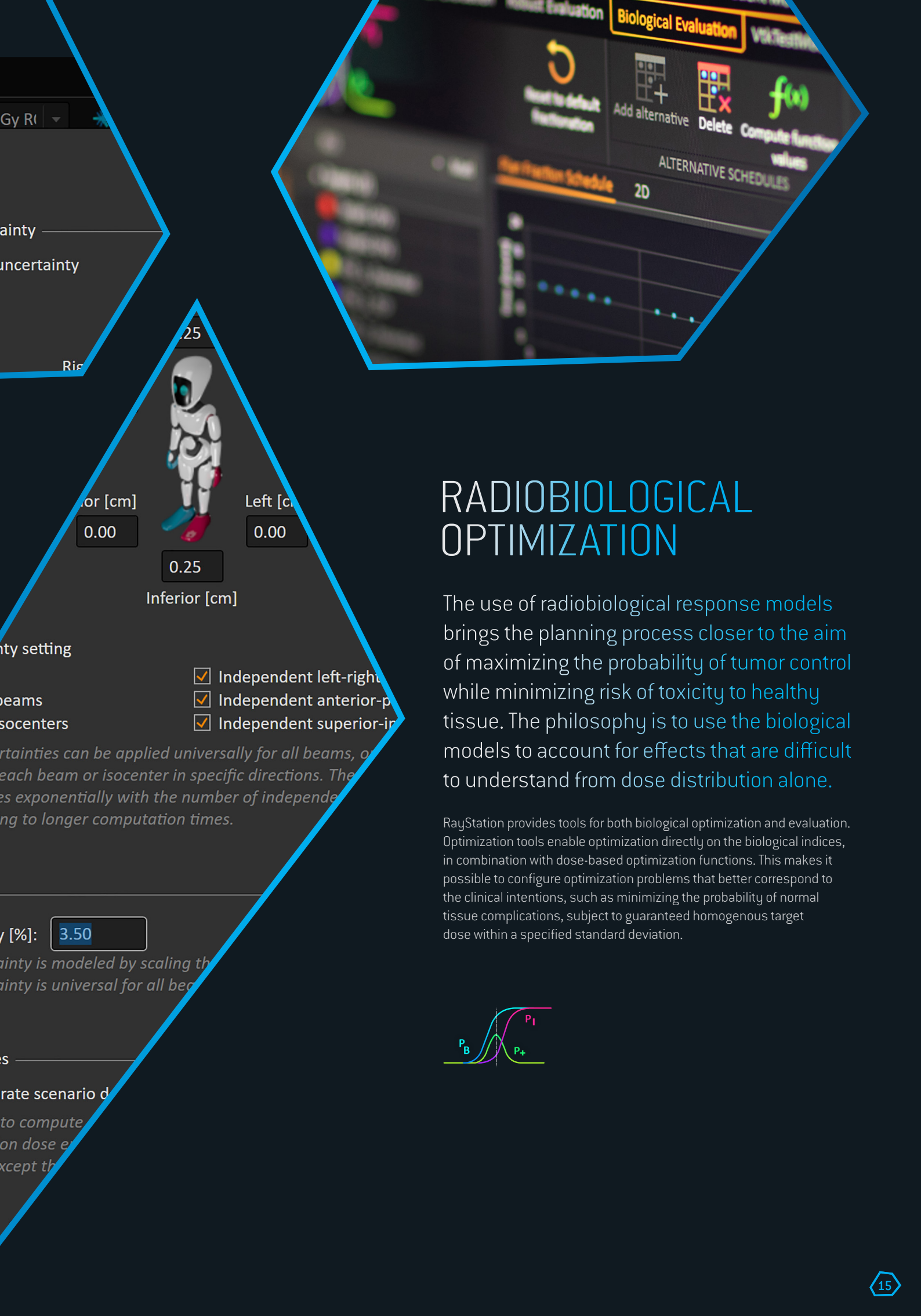
ent b
ident is
tion unce
ndently to
arios increas
(centers), leadi

ange uncertainty —
Range uncertainty
The range uncer
The range uncer

Accurate scenario dose
 Compute accurate
Select this option
chosen optimizati
for all scenarios e

Scenarios to compute:

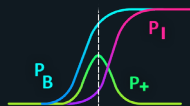
Points	
Robust	
	★
ce 0.50 cm	



RADIOBIOLOGICAL OPTIMIZATION

The use of radiobiological response models brings the planning process closer to the aim of maximizing the probability of tumor control while minimizing risk of toxicity to healthy tissue. The philosophy is to use the biological models to account for effects that are difficult to understand from dose distribution alone.

RayStation provides tools for both biological optimization and evaluation. Optimization tools enable optimization directly on the biological indices, in combination with dose-based optimization functions. This makes it possible to configure optimization problems that better correspond to the clinical intentions, such as minimizing the probability of normal tissue complications, subject to guaranteed homogenous target dose within a specified standard deviation.





WORK AT THE SPEED OF THOUGHT

We believe software should help you work at the speed of thought – not hold you back. We're taking the possibilities further, creating software that works the way you want to.

Giving you tools that free up time and resources. Cutting out repetitive tasks to enable more effective use of your clinical time. Together we are on a journey to optimal patient care, supported by resources that are as intuitive as they are efficient and powerful. You think it, we'll enable it.

REDUCE REPETITIVE MANUAL TASKS

Huge efficiency gains are possible through automating standard procedures, for example through scripting, protocols and templates. RayStation makes it easy.

PLAN-GENERATING PROTOCOLS

RayStation gives you a range of automation tools, including templates and plan generation protocols. A protocol is a list of plan-generation steps that can be applied automatically. Examples of plan-generation steps include atlas-based segmentation, plan creation, beam setup, selection of optimization functions, optimization settings, optimization, reduce OAR dose and compute dose. When a protocol is run, it will automatically create a plan using the included steps, which significantly reduces planning time.

PLAN EXPLORER

Plan Explorer brings a completely new perspective to treatment planning and radically changes the planning process. It automatically generates a large number of plans for combinations of treatment techniques and machines. It also provides an efficient way to filter and browse among plan candidates to evaluate the best option.

Physicians have more options to explore and can evaluate combinations that would have been too time-consuming to consider with a manual planning process. Plan Explorer saves planning time and enables clinics to get more from their treatment machine resources. Plans are automatically generated either using machine learning models or based on prioritized clinical goals.

POTENTIAL CLINICAL BENEFITS:

- Ensure every radiation therapy treatment is delivered with the highest possible efficiency, with an optimal combination of treatment technique and machine
- Get more from existing treatment delivery machines
- Free up time for plan evaluation

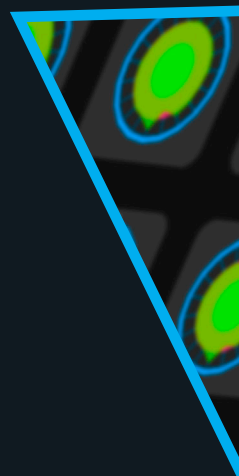
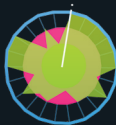
FILTERS

Filter plans easily by machine, number of beams, segments, MU or clinical goals.



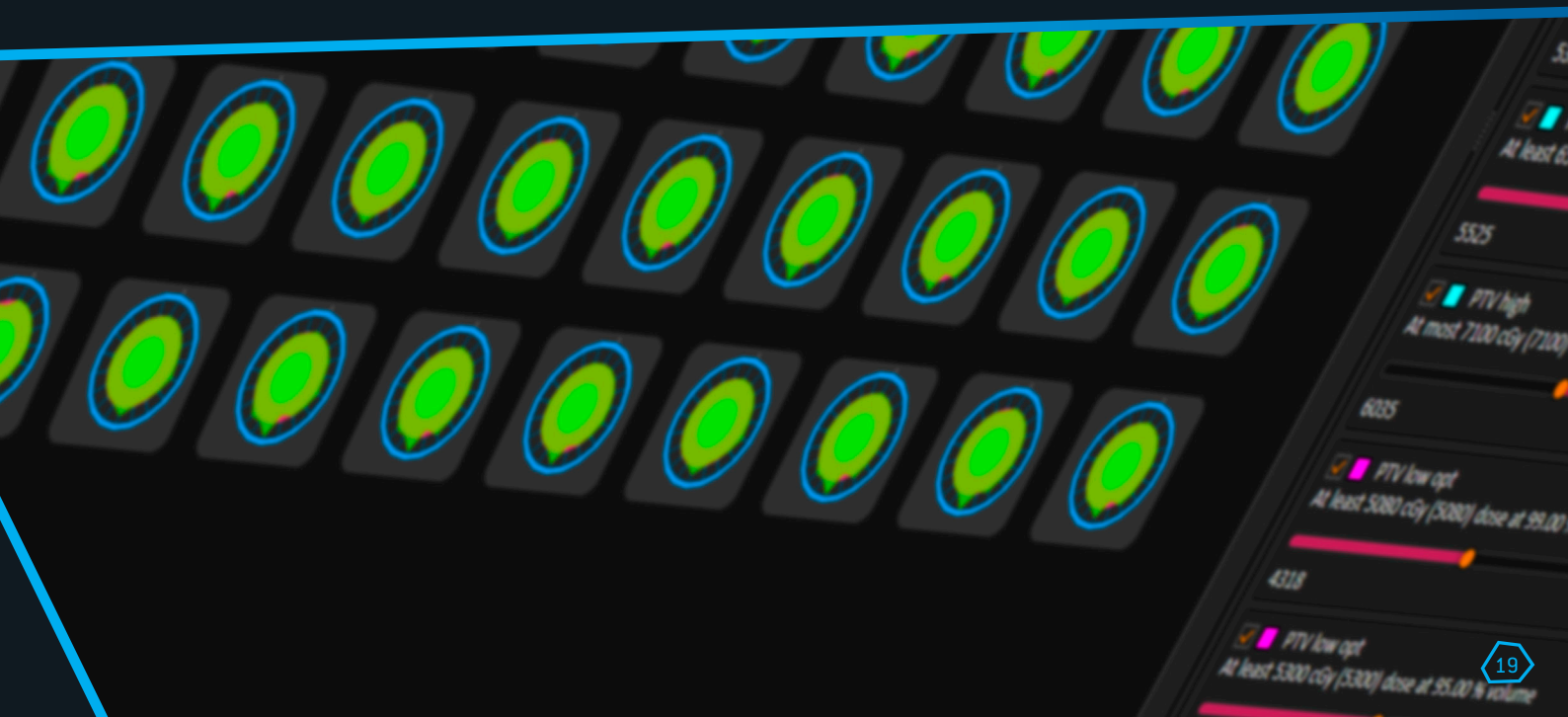
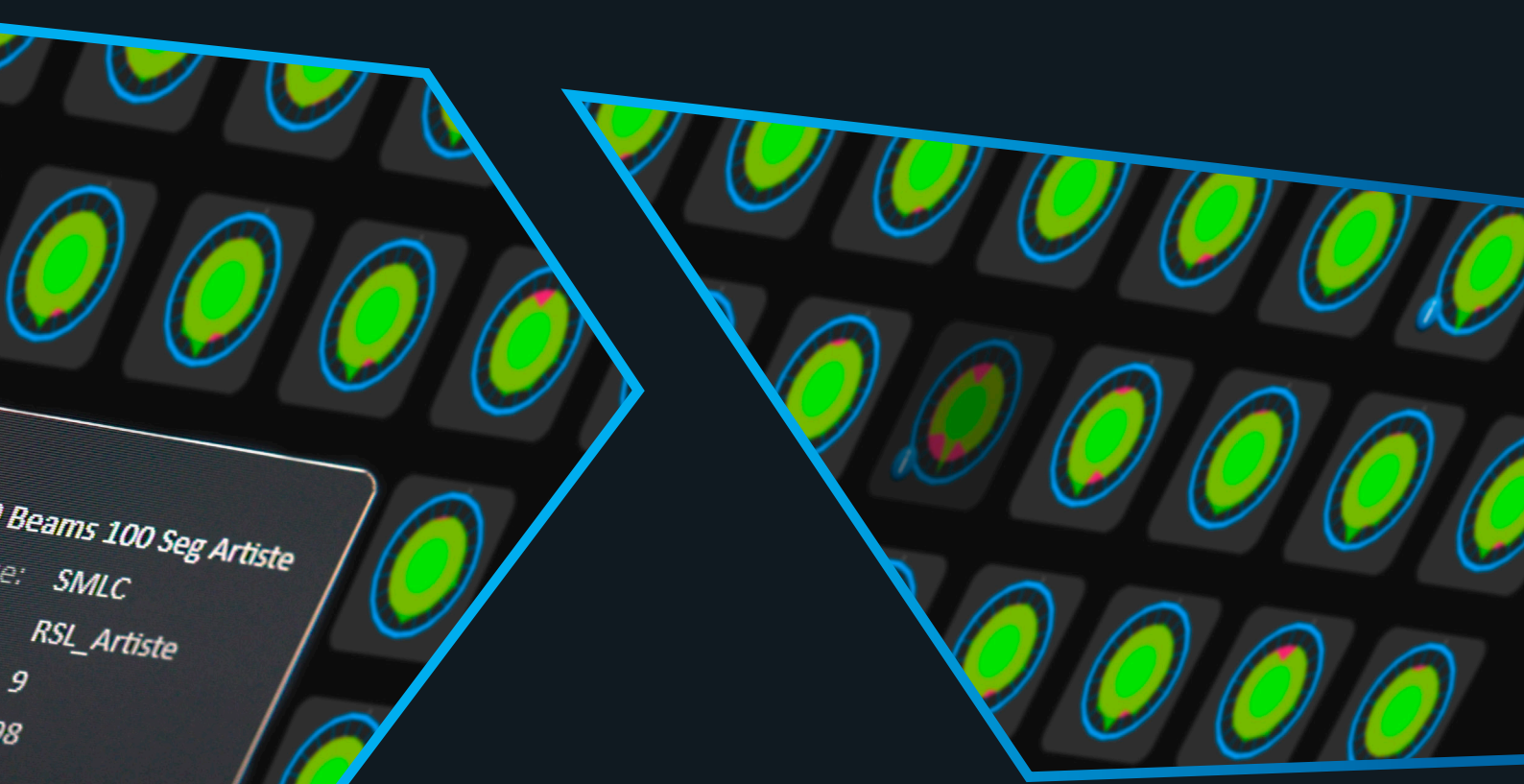
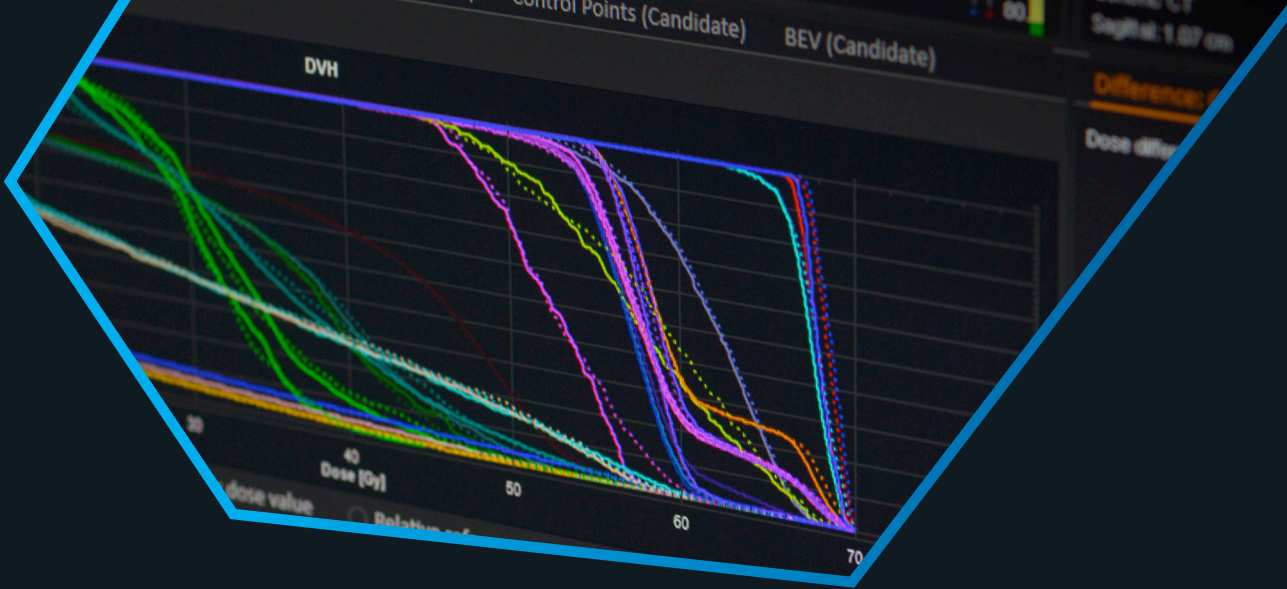
RADAR CHART

Each line in the chart represents one goal. The green color indicates that a goal is fulfilled. Pink alerts you when a goal is not fulfilled.



Plan Explorer has substantially reduced the time we spend on treatment planning. We now spend less than 45 minutes per plan, whereas manual planning took around 180 minutes. Since Plan Explorer creates the plans fully automatically in the background, we have the possibility to spend more time on other emerging technological developments in our department, such as adaptive radiotherapy and proton therapy."

*– Roel Kierkels, Medical physicist,
UMC Groeninge, The Netherlands*



SCRIPTING: YOUR IMAGINATION IS THE LIMIT

Scripting* in RayStation provides automation, connectivity and flexibility beyond the standard user interface.

Scripting with Python lets you access all capabilities of the operating system and other applications, including the ability to write files, start processes, communicate with other computers and control scriptable applications such as Microsoft Office or .NET.

AUTOMATION

Clinic-specific procedures can be automated through scripting. A script can check for properties in a plan, such as small segments, disconnected target volumes, hotspots and undesirable gantry and couch angles. The system can then display a warning message or create a report.

CONNECTIVITY

Scripting provides a way to customize the interaction between RayStation and other systems for scenarios where DICOM is not sufficient.

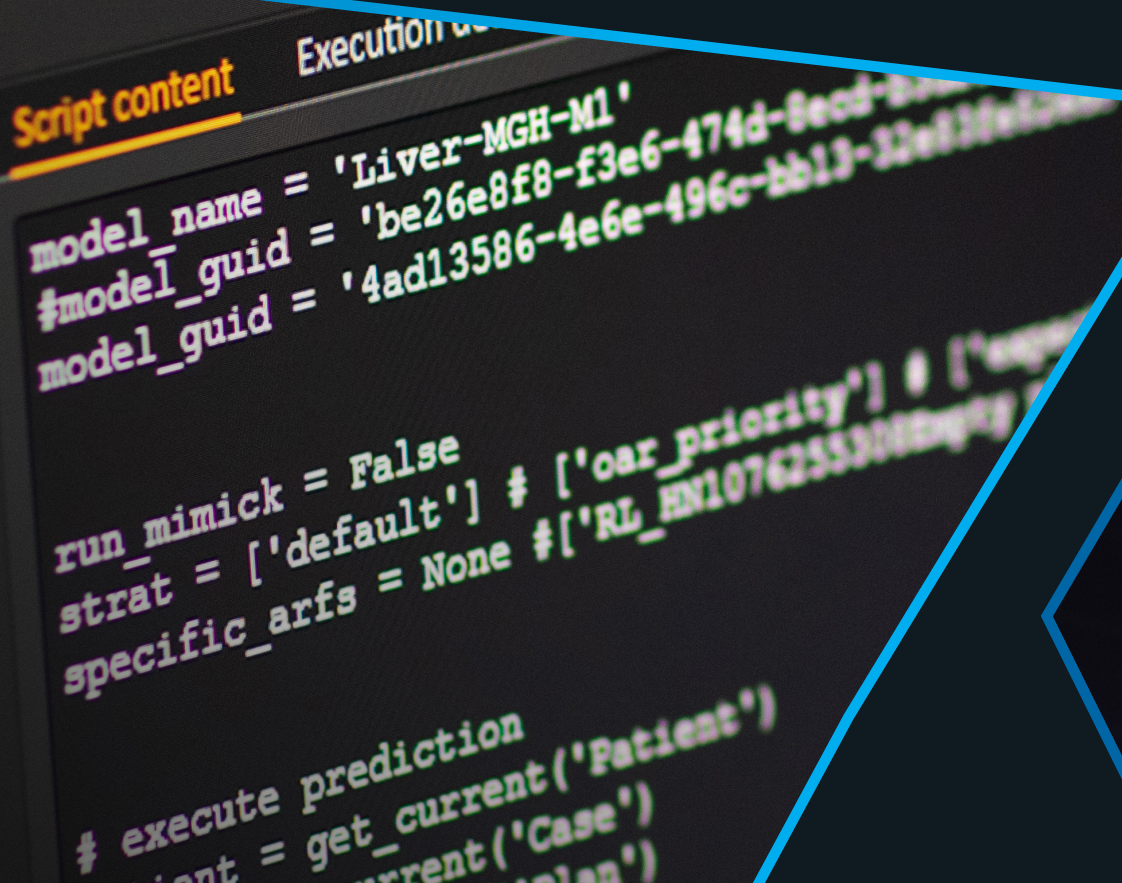
FLEXIBILITY

Scripting enables you to use the power of RayStation in the way that best serves the needs of your facility. It can be used to create functionality that is not specifically available in the standard interface. For example, automatic marker detection, export of images of non-standard dose planes and images of all control points can be utilized as desired.

DATA MINING

Clinics can easily and efficiently access any data in RayStation using the powerful scripting capabilities. It is quick and easy to obtain any information about single or multiple patients in RayStation, which can speed up any research you need to do.

**Scripting new clinical functionality outside of the RayStation scope will qualify the script as a new medical device. Creating a new medical device means taking on manufacturing responsibilities.*



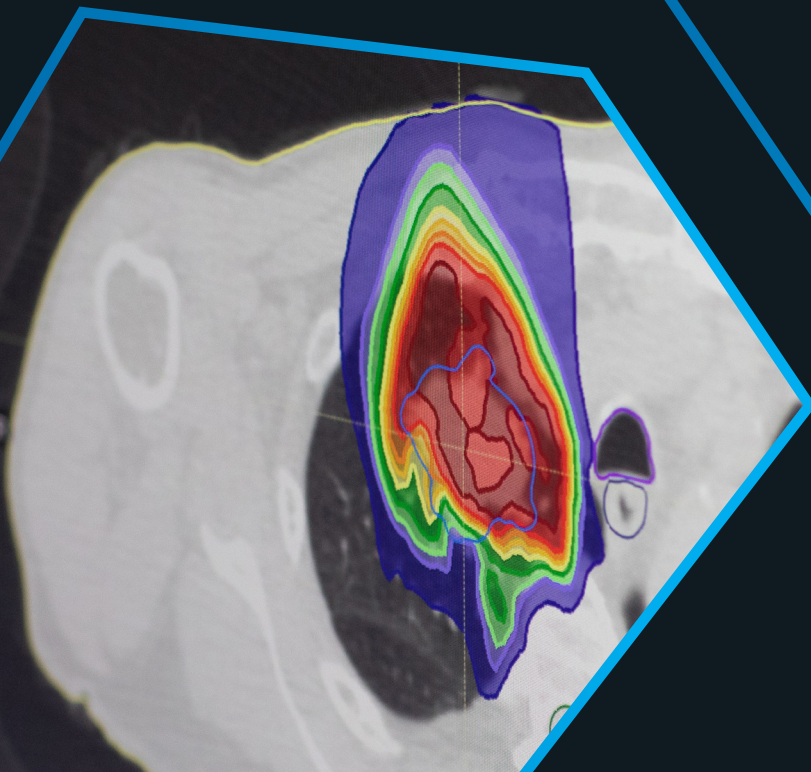
```
model_name = 'Liver-MGH-M1'  
#model_guid = 'be26e8f8-f3e6-474d-8ecd-8...'  
model_guid = '4ad13586-4e6e-496c-bb13-32e13f1e1...'  
  
run_mimick = False  
strat = ['default'] # ['oar_priority'] # ['temp...'  
specific_arfs = None # ['RL_HN1076235304204...'  
  
# execute prediction  
patient = get_current('Patient')  
current = get_current('Case')  
plan = get_current('Plan')
```



```
compute prediction
patient = get_current('patient')
case = get_current('Case')
plan = get_current('plan')
name = str(plan.Name)
generator = PlanGenerator
()
```

“Being able to use RayStation programmatically like this, with the built-in script feature, we are able to replace a surprisingly large number of manual tasks with automation. By making just a few selections in our scripts, everything is set up and, in many cases, we can get a decently optimized treatment plan from the get-go. This feels like having a flying start to the treatment planning process. Freeing up time from tedious, manual tasks allows us to put more effort into the creative part of treatment planning – ensuring that the patient receives an optimal treatment plan.”

– Christoffer Lervåg, Medical Physicist,
Ålesund Hospital, Norway



AUTOMATED BREAST PLANNING

RayStation's automated breast planning module was the first step in our ambition to automate standard procedures.

The module was initially developed at Princess Margaret Cancer Center in Toronto, Canada. Between 2009 and 2012, the center ran a large-scale clinical study to evaluate the performance of its automated treatment planning methodology for tangential breast intensity-modulated radiation therapy (IMRT). Automated planning was used with 97% of patients receiving tangential breast IMRT during the time interval studied, i.e., 1661 patients. The study showed an increase in clinical acceptance using this fully automated method.

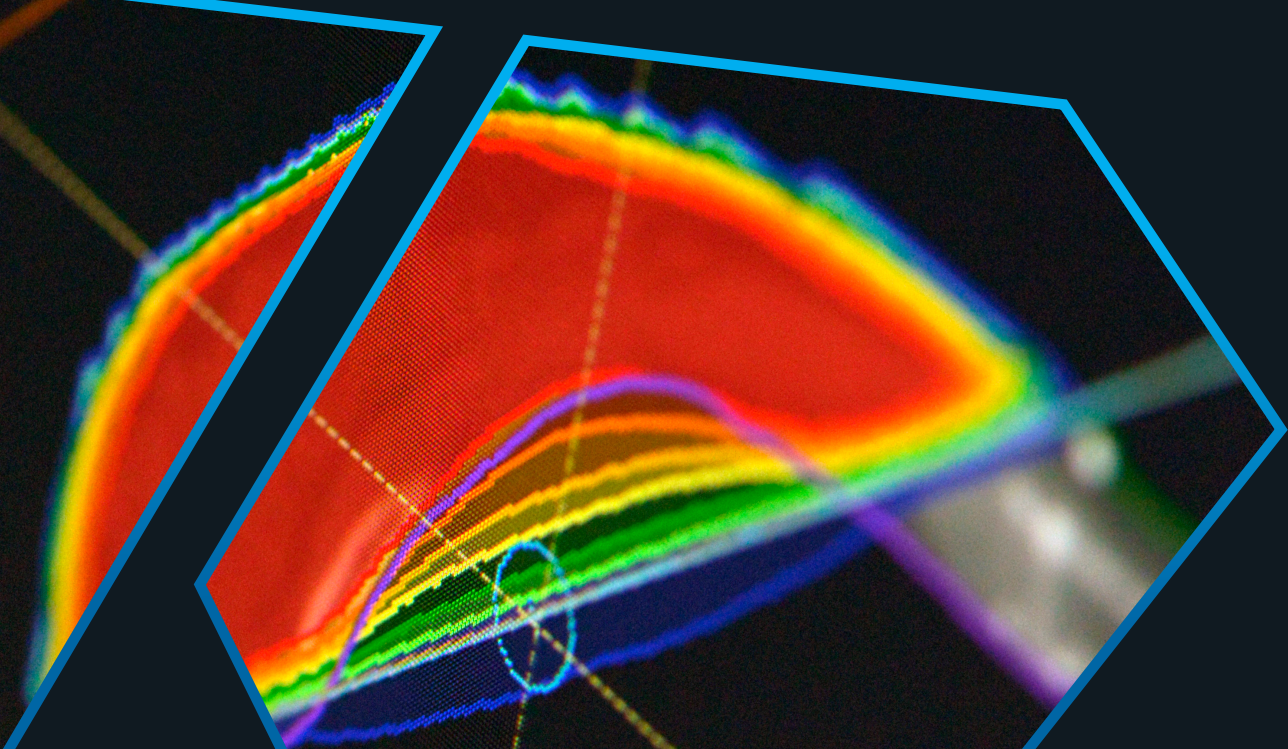
Princess Margaret Cancer Center concluded that the method could make a significant contribution to efficiency, standardization and quality in the treatment planning process, as well as speeding up adoption of IMRT and giving breast cancer patients better access to care improvements.*

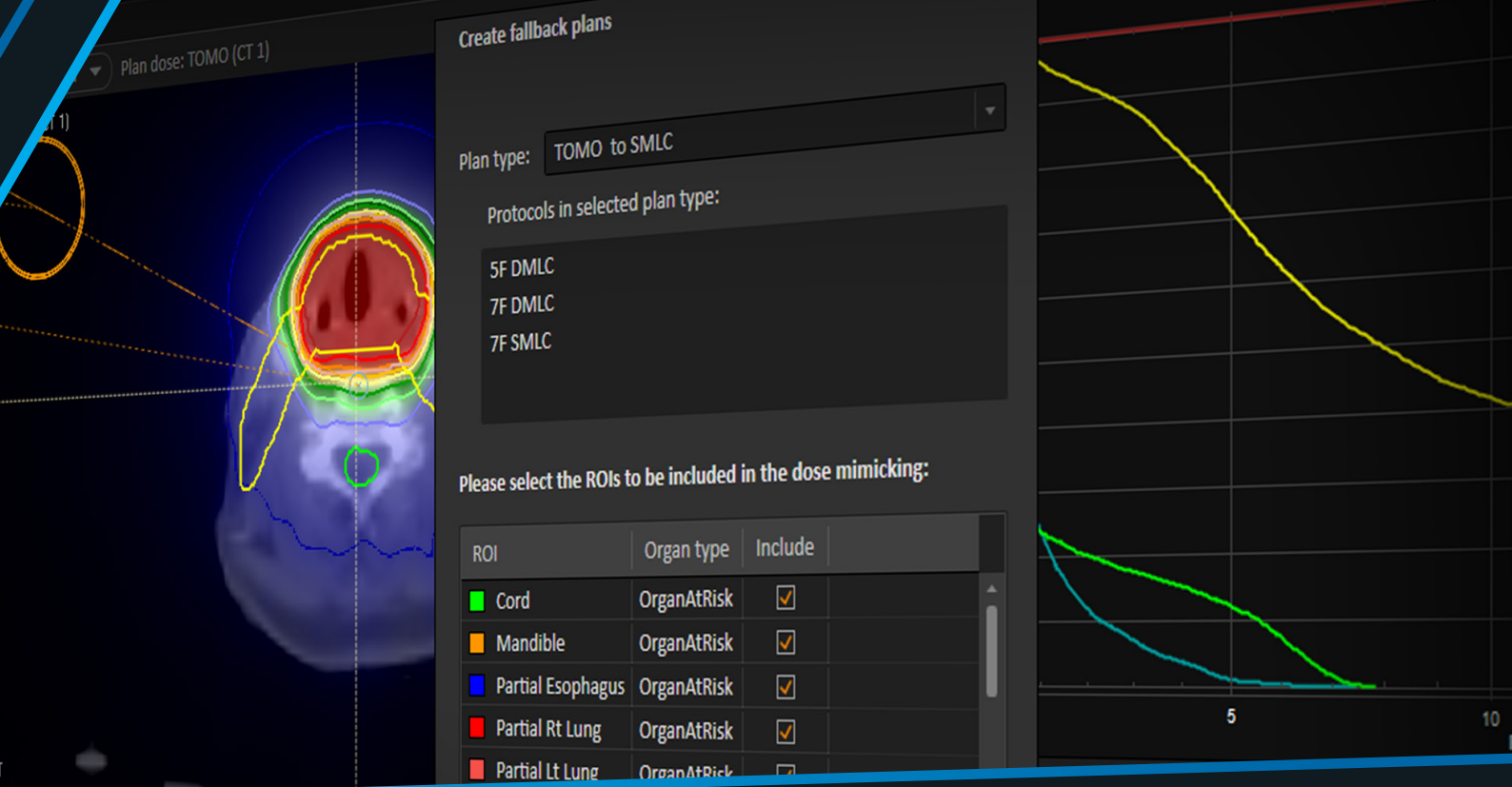
The automated breast planning module provides tools for generation of tangential breast IMRT plans using heuristic optimization.

KEY FEATURES

- Automatic detection of radio-opaque markers defining the breast
- Automatic contouring of all the relevant targets and organs at risk
- Automatic beam setup, including heuristic optimization of gantry and collimator angles
- Automatic creation of objective functions, optimization and segmentation settings and clinical goals

**Purdie, TG, et al. Automated planning of tangential breast intensity-modulated radiotherapy using heuristic optimization. Int. J. Radiation Oncology Biol. Phys. 2011 Vol. 81, No.2, pp 575-583.*





FALLBACK PLANNING: TREATMENT GOES ON NO MATTER WHAT

Fallback planning is a tool for creating additional plans in the event that a patient needs to be treated using a different machine, and even with a different modality and/or treatment technique.

The fallback planning module can dramatically reduce planning time in emergency situations, allowing treatment to continue and reducing stress on staff. Fallback planning can also be used to validate the modality selected for treatment, ensuring that the most efficient approach is utilized for each patient.

Fallback plans are generated after plan approval, based on previously created protocols. The process is fully automated, with no user interaction required. However, fallback plans can still be modified manually if needed. Plans for any modality, including proton and Tomo-Therapy, can be converted to photon plans for techniques including 3DCRT, IMRT and VMAT. Fallback planning uses a dose-mimicking function to replicate the DVH of a given plan, but with a different machine or treatment modality.

After creation, fallback plans can be compared and evaluated using visual tools (DVH curves, dose statistics, dose difference and clinical goals). A fallback plan can then be approved and used for delivery in future fractions. If the original machine becomes available again, it is possible to convert back to the original plan.

The module includes dose-summation tools that enable two plans to be combined using their delivered fractions. This makes it possible to visualize actual composite dose on the patient dataset.



REALIZE THE FULL POTENTIAL OF PARTICLE THERAPY

Particle therapy is a strong area of focus for RaySearch. This advanced modality offers many significant benefits, especially regarding dose conformance and sparing of healthy tissue. RayStation makes it possible to create outstanding treatment plans for a large variety of particle therapy delivery techniques and beamlines.

PROTON PLANNING

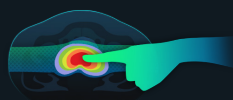
RayStation supports proton therapy systems from IBA, Hitachi, Varian, Mevion, ProNova, Mitsubishi Electric and Sumitomo, as well as several standalone synchrotron systems.

RayStation enables design and optimization of proton treatment plans for actively scanned pencil beams, with the option to include block aperture or MLC collimation.

The proton module also provides tools for efficient planning of uniform scanning, double scattering, single scattering and Sumitomo wobbling. These tools enable the creation of clinical treatment plans and subsequent milling-machine instructions, including automated production of compensators and blocks, with manual editing possibilities.

KEY FEATURES

- Monte Carlo dose calculation in a few seconds
- Robust optimization and evaluation
- LET optimization and evaluation
- 4D optimization and evaluation
- Discrete proton arc planning
- PBS optimization with apertures
- Fully integrated adaptive planning
- Simulated organ motion
- Automatic creation of backup photon plans
- Multi-criteria optimization
- Machine learning planning with robustness*



**Subject to regulatory clearance in some markets.*



The implementation of treatment planning with 4D-robust optimization and Monte Carlo dose calculation in RayStation, combined with automated volumetric-repainting beam delivery developed at Texas Center for Proton Therapy, allows us to treat lung patients and other moving targets using PBS in a safe and efficient manner. In fact, approximately 15 percent of our current patients are now treated using these techniques.”

*– Dr. Andrew K. Lee, Medical Director
Texas Center for Proton Therapy, USA*

LIGHT-ION PLANNING

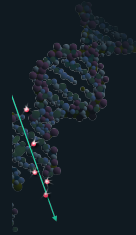
RayStation provides tools for designing and optimizing actively scanned carbon and helium ion* treatment plans.

The system includes a pencil beam dose engine to compute physical dose and RBE-weighted dose according to the Local Effect Model (LEM) or the Microdosimetric Kinetic Model (MKM). In the dedicated radiobiology application (RayBiology), you can define RBE model parameters for the tissue sets to be used for planning. All plans are directly deliverable on synchrotrons after optimization, since the minimum spot and other synchrotron-specific machine constraints are taken into account in the optimization.

*Subject to regulatory clearance in some markets.

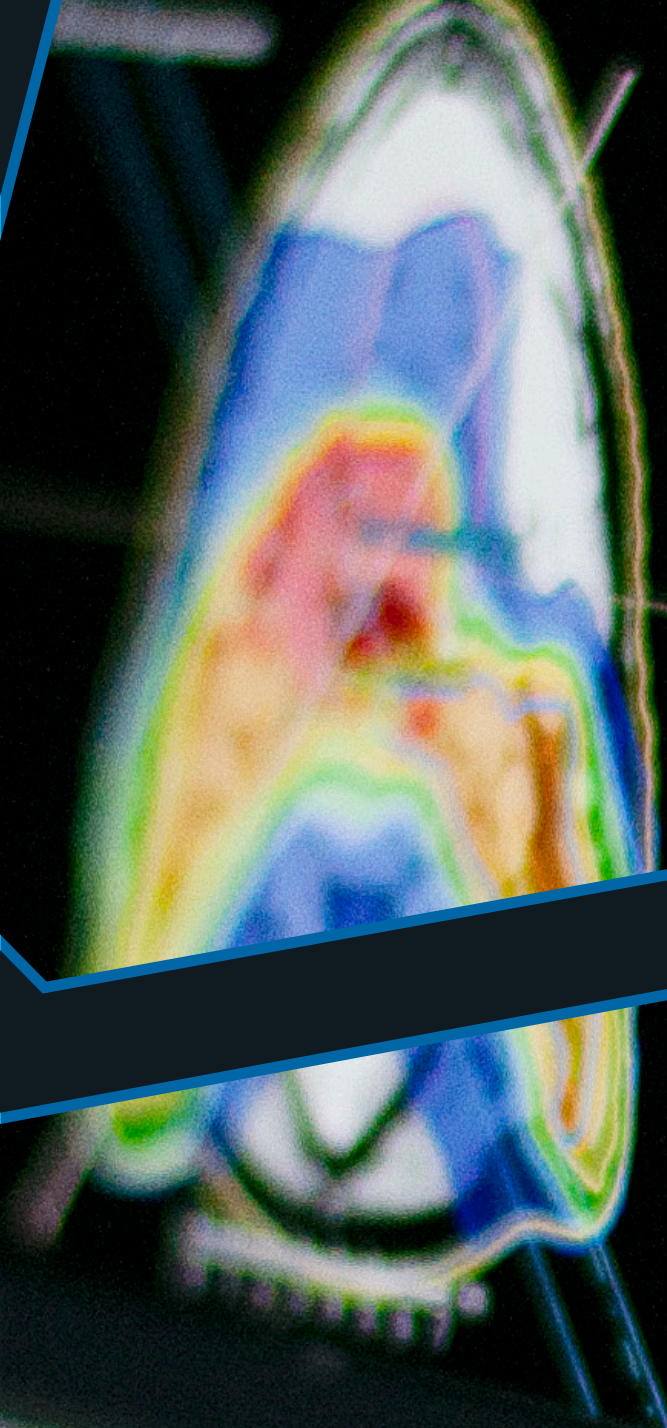
KEY FEATURES

- Already selected by ten cancer centers
- Fast GPU-based dose computation
- Robust optimization and evaluation
- LET optimization and evaluation
- 4D optimization and evaluation
- Multi-field and single-field optimization
- Plan directly deliverable on synchrotrons
- Fully integrated adaptive planning
- Simulated organ motion
- Combination planning with other modalities

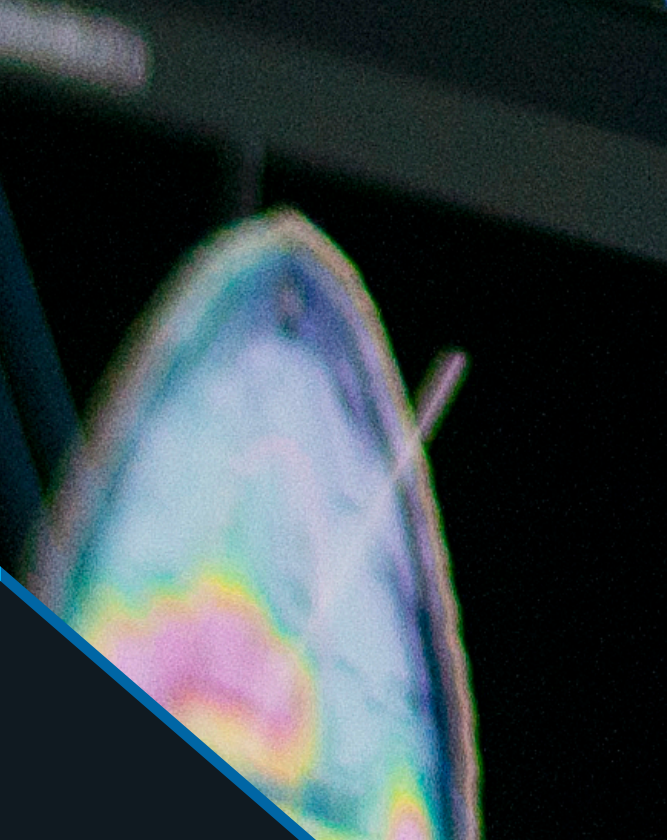
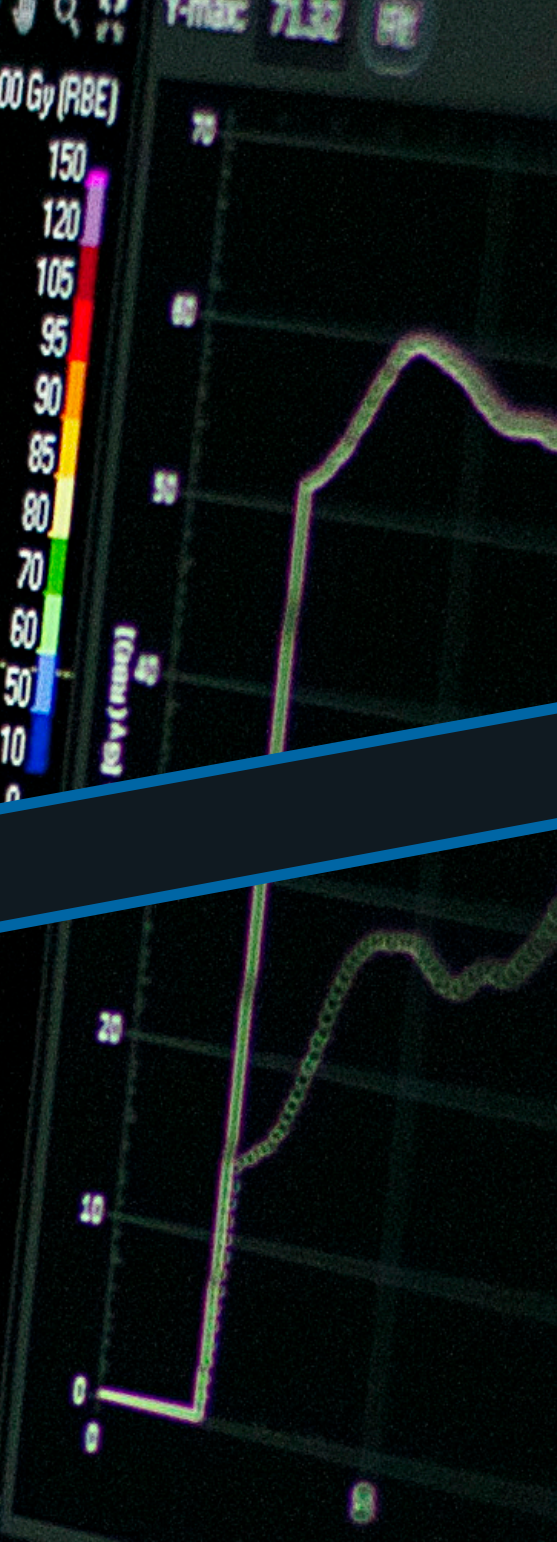


“We are really impressed by the flexibility and dedication RaySearch has shown to implement our requirements in RayStation in such a short time. A great advantage when working with RaySearch has been their collaborative spirit and willingness to let us test, review and evaluate the system continuously. This has helped us define our priorities and contributed to a good learning process, which ultimately led to a tailor-made proton and carbon ion treatment planning system.”

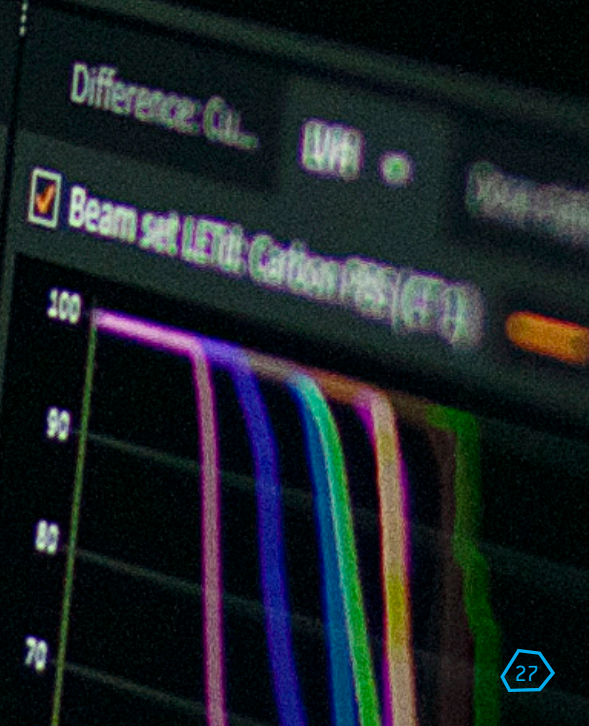
– Gabriele Kragl, Medical Physicist,
MedAustron, Wiener Neustadt, Austria

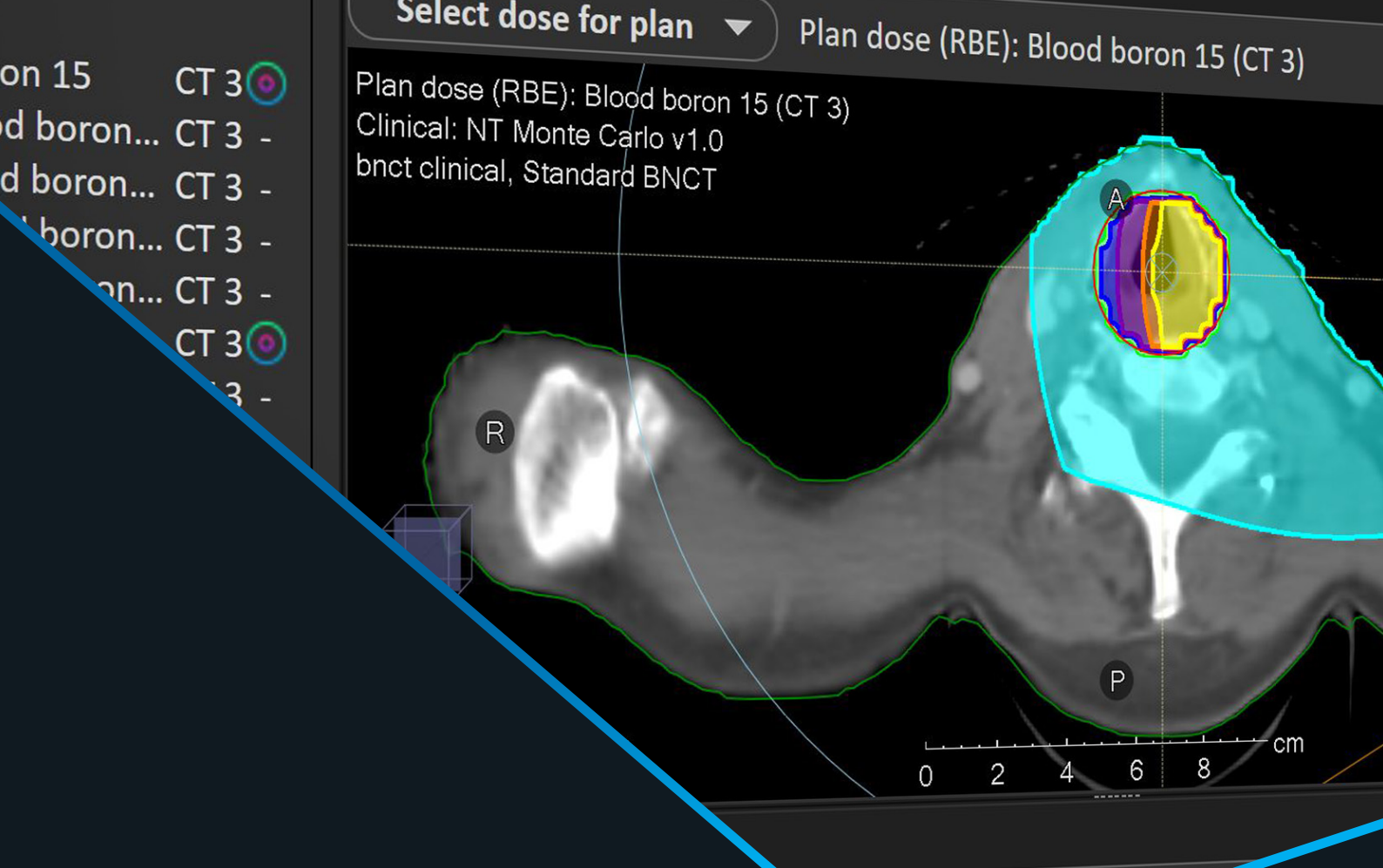


% of 66.00 Gy (RBE)



% of 60.0 keV/μm





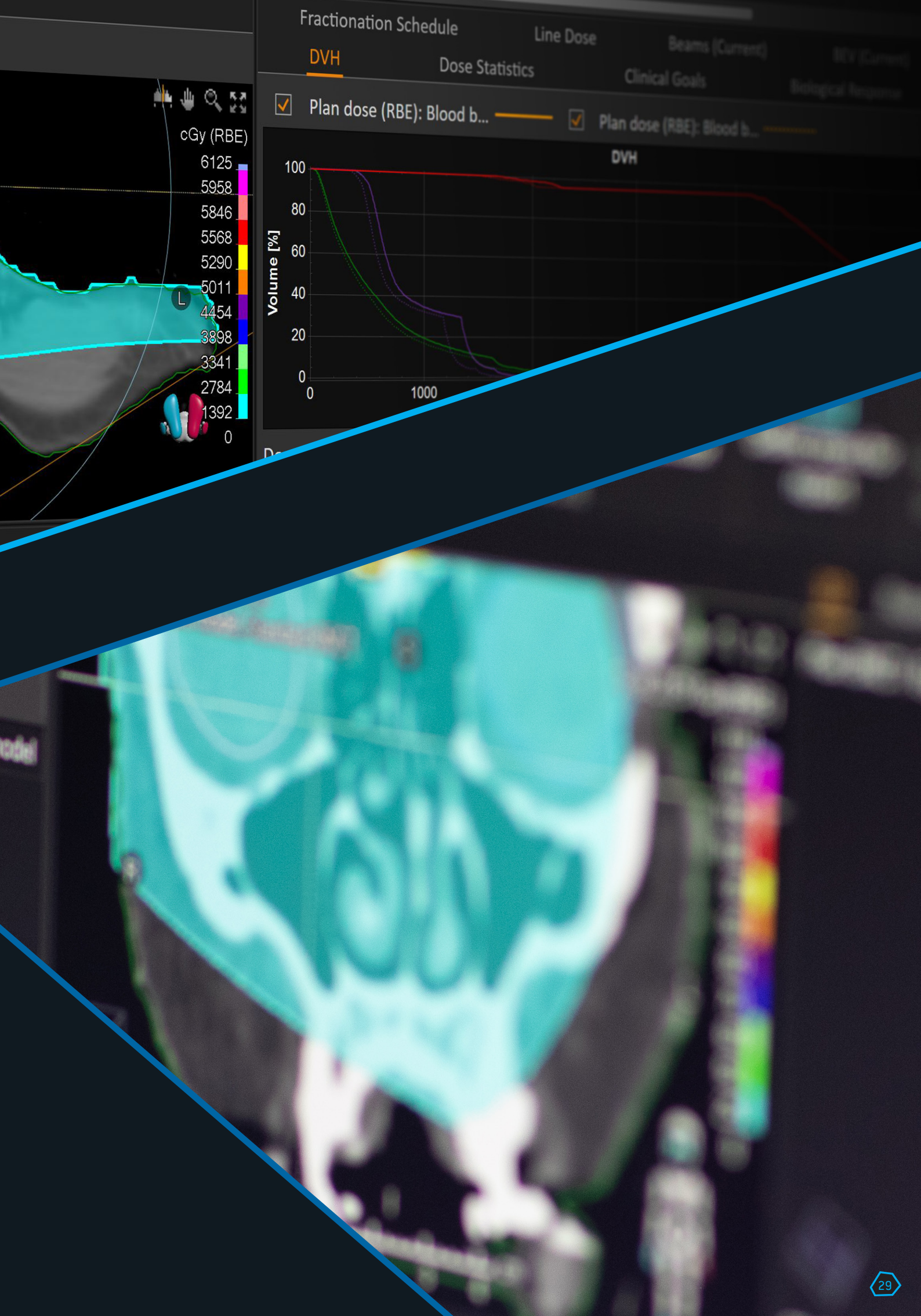
BORON NEUTRON CAPTURE THERAPY

RaySearch is now offering support to plan for Boron Neutron Capture Therapy (BNCT)*. BNCT is a unique type of radiation therapy that enables targeting of cancer at the cellular level. BNCT planning in RayStation is developed together with Sumitomo Heavy Industries, Ltd, Neutron Therapeutics, Inc., and TAE Life Sciences.

KEY FEATURES

- Support for defining BNCT-specific RBE models
- BNCT treatment plans creation. The isocenter, couch and gantry angle, collimator, and planned blood boron concentration is specified for each beam.
- Computation for four physical dose components and RBE dose with a dose engine provided by Sumitomo Heavy Industries, Ltd, Neutron Therapeutics, Inc., or TAE Life Sciences.
- Plan approval, DICOM export and plan reports.

*Subject to regulatory clearance in some markets.



Fractionation Schedule

Line Dose

Beams (Current)

BEV (Current)

DVH

Dose Statistics

Clinical Goals

Biological Response

Plan dose (RBE): Blood b...

Plan dose (RBE): Blood b...

cGy (RBE)

6125

5958

5846

5568

5290

5011

4454

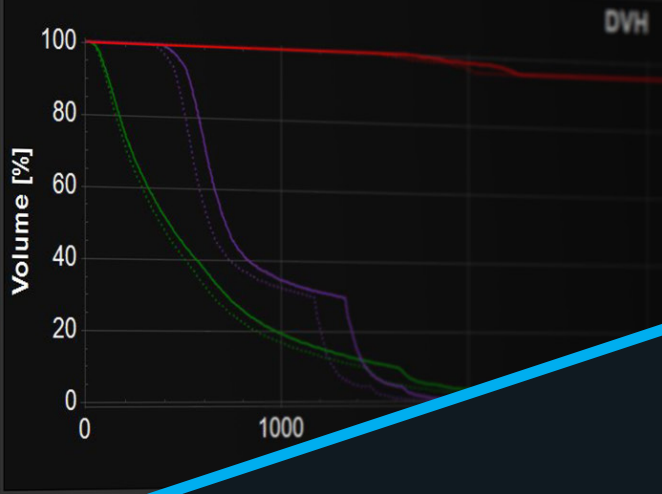
3898

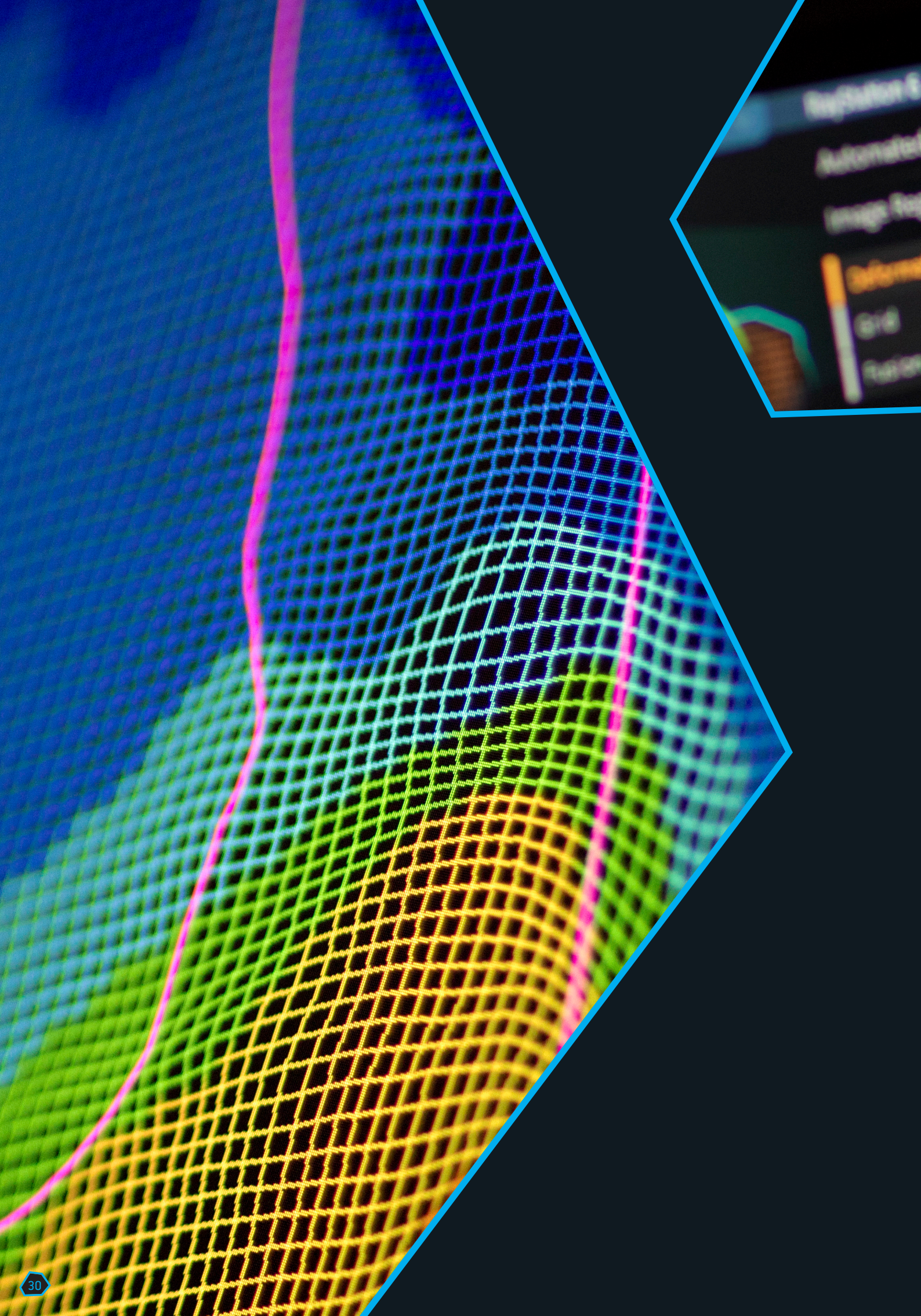
3341

2784

1392

0







ADAPTIVE THERAPY IS NOW

RayStation was designed from the outset with a strong focus on handling the dynamic aspects of radiation therapy. By explicitly representing the time dimension throughout the domain model, it provides the ultimate framework for planning and managing adaptive radiation therapy.

ADAPTIVE PLANNING

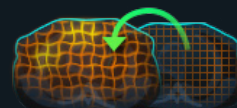
RayStation's adaptive replanning tools and powerful deformable registration algorithms help to improve the planning process and increase accuracy of treatment.

When images of the patient in treatment position, from CT, PET/ CT, cone- beam CT or MR, are acquired during the treatment course, RayStation makes it possible to establish a deformable registration between the new geometry and the planning geometry.

The dose can be recalculated on the image acquired for positioning. Using the deformable registration, the dose can then be deformed to a common geometry on which doses from different fractions can be accumulated. This makes it possible to precisely evaluate the dose delivered to the patient.

If there are deviations from the planned dose distribution that require action, a wide range of adaptive offline and online replanning tools are available that take into account the accumulated dose and observed deviations of the patient geometry.

Plans can then be reoptimized and adjusted to compensate for dose coverage problems, or to adapt to a predicted clinical goal violation. The replanning options range from simple adaptations, such as adjustments of beam weights, to complete reoptimization of beam profiles.



GENERATION OF SYNTHETIC CTs FROM CBCT

RayStation includes advanced algorithms for creating synthetic CT images from daily cone-beam CT images. The original planning CT is used as input to transfer accurate density information to the daily image.

“Investing in RayStation has given us a far superior planning infrastructure. Adaptive therapy demands a high-speed planning system, combined with high-quality imaging. It's only feasible with a system such as RayStation, which is extremely fast and has excellent tools for the clinician.”

*Giuseppe Sasso, Clinical Director,
Department of Radiation Oncology, Auckland City Hospital, New Zealand*

A COMPREHENSIVE TOOLBOX FOR PHYSICIANS

RayStation provides a comprehensive toolbox for anatomical modeling and plan evaluation. You can also benefit from innovative tools such as deep-learning segmentation of organs, deformable registration and radiobiological evaluation.

ACCURATE AND EFFICIENT CONTOURING

RayStation provides you with fast and user-friendly tools to efficiently and accurately contour the patient in the treatment planning process. It includes a comprehensive toolset, ranging from manual tools to high-end semi-automatic and fully automatic contouring tools.

DEEP-LEARNING SEGMENTATION

Auto-segmentation of structures in RayStation is set to reach new heights with deep learning segmentation. You can choose from many validated segmentation models that are released and upgraded several times per year. The GPU-powered algorithm is fast and produces consistently excellent segmentation results.

MULTI-ATLAS-BASED SEGMENTATION (MABS)

MABS lets you use multiple atlas templates to automatically contour the patient. It's fast and easy to build your own atlas templates with both anatomical and derived structures. The geometries contained in each atlas can be manually contoured or generated with MBS. RayStation uses in-house deformable registration algorithms to propagate contours from multiple datasets to the anatomy you wish to contour. Advanced automation makes the process fast, simple and accurate.

MODEL-BASED SEGMENTATION (MBS)

MBS delineates organs automatically using statistical shape models for different body sites. The adaptation to new image data utilizes a combination of greyscale gradients and shape statistics. Multiple ROI can be delineated simultaneously, which increases throughput, accuracy and reproducibility.

ROI ALGEBRA

With ROI algebra, you can create derived ROI using Boolean expressions and margins. A derived ROI remembers its expression and will automatically detect when it needs to be updated. Derived ROI also go into structure templates, saving you the time it takes to specify complex expressions.

STRUCTURE TEMPLATES

Structure templates allow you to create ROI with predefined name, type and color, which allows for consistently labeled structure sets according to your clinic's protocol. Structure templates may also include geometries including density overrides for quick retrieval of support structures.

SMART BRUSH AND SMART INTERPOLATION

The image-guided smart brush and smart interpolation facilitate contouring by snapping to image features and can help delineate organs and targets using only a few contours.

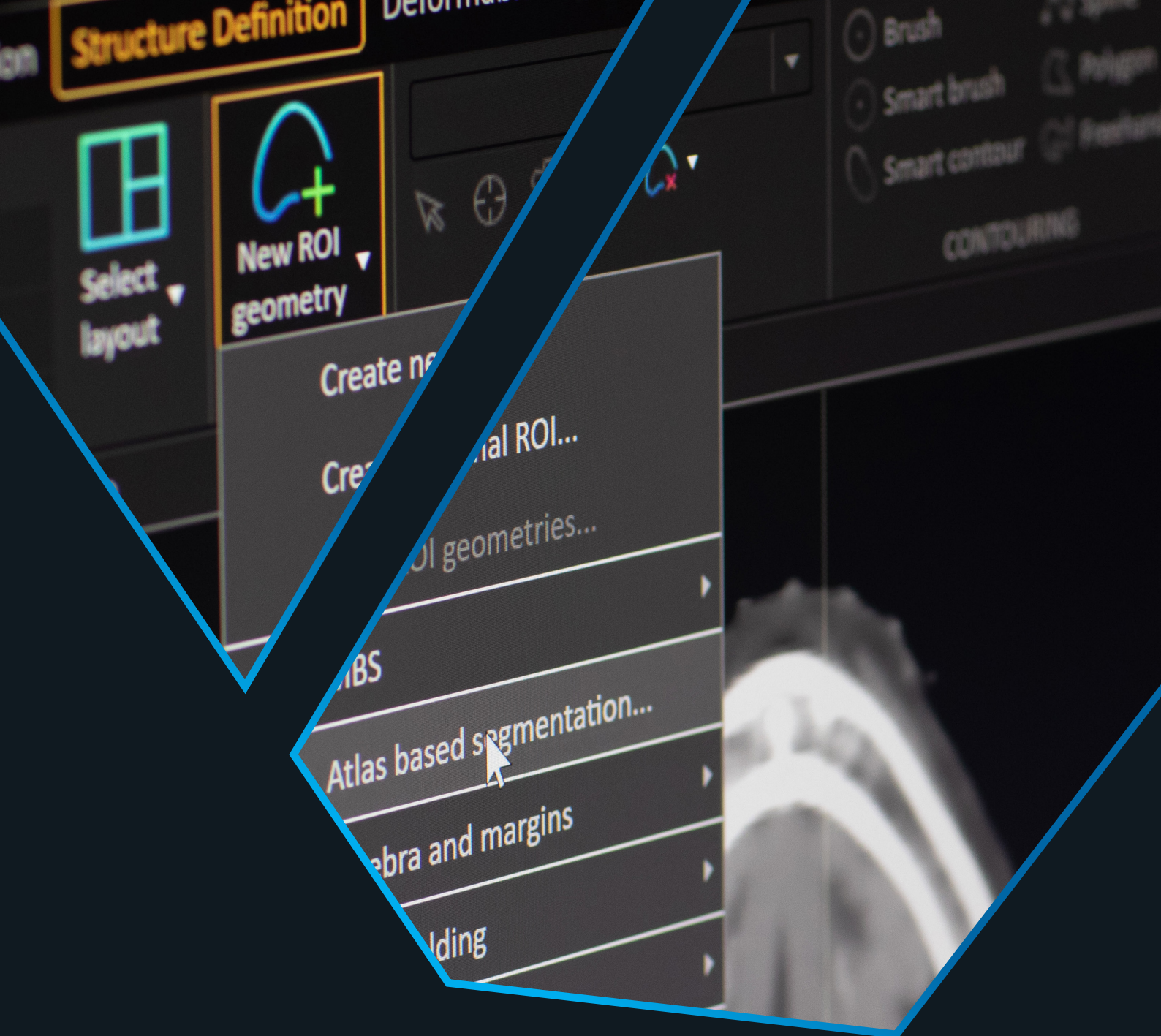
IMAGE REGISTRATION/FUSION

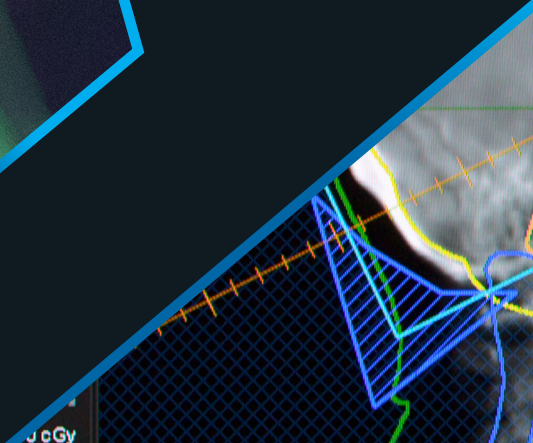
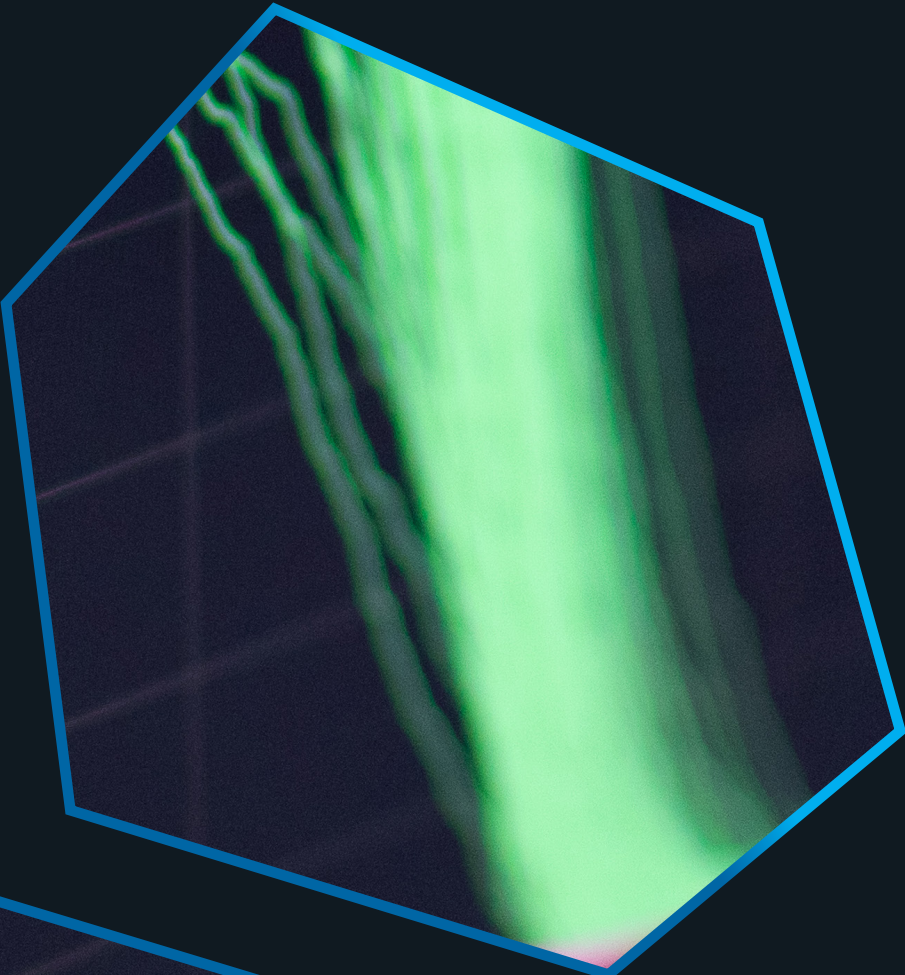
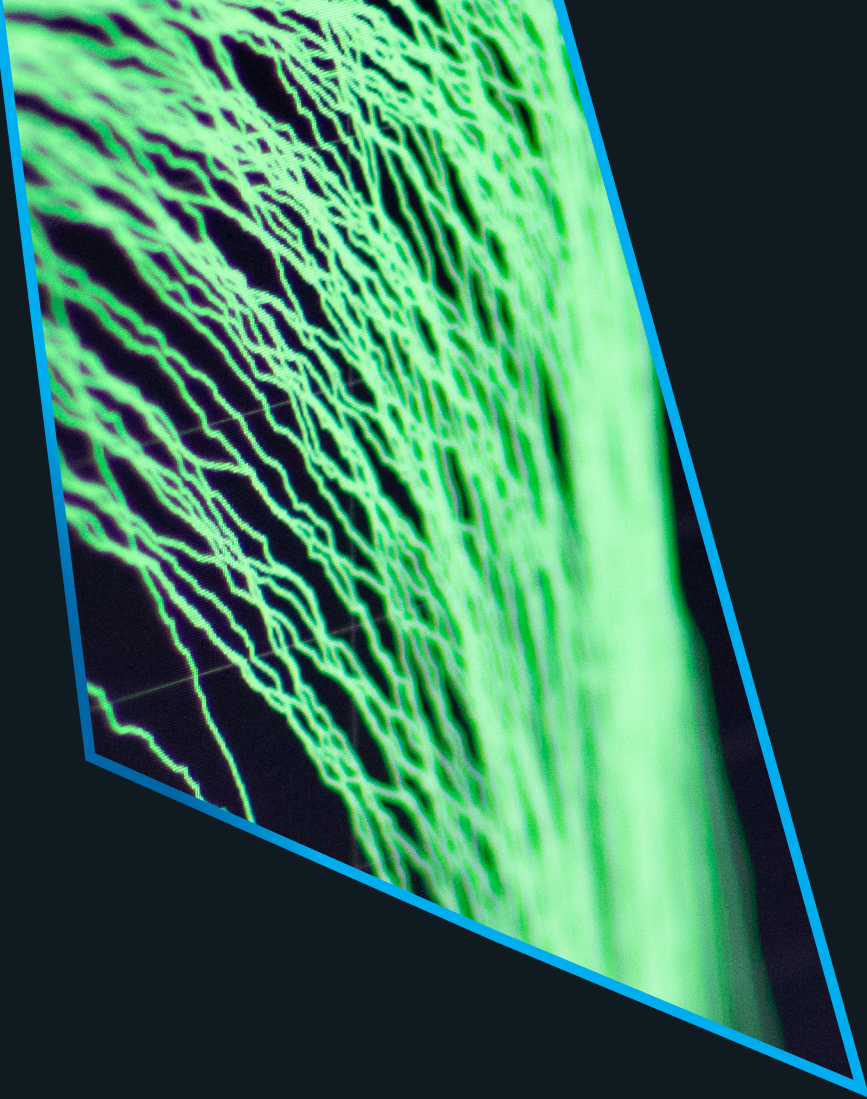
Rigid and deformable registration of multi-modality imaging CT, CBCT, PET and MR is fully supported and integrated with the adaptive radiation therapy functionality. It can be used for showing fused images as a reference while contouring, and for mapping regions or points of interest between image sets.

"The automatic segmentation is a useful tool for handling the technical complexity of head-and-neck IMRT as well as the daily management of an important patient flow. In head-and-neck cases, we have gained significantly for the contouring of healthy organs. We will soon begin using multi-atlas-based segmentation in our clinical routine for lymph node delineation."

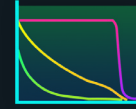
*– Xavier Liem, Radiation Oncologist,
Centre Oscar Lambret, Lille, France*







THOROUGH PLAN EVALUATION MADE EASY



RayStation offers a complete toolbox for evaluation and comparison of treatment plans and plan approval. To this, we have added a unique robust evaluation module where you can evaluate the robustness of your plans for different scenarios, accounting for defined ranges of shifts in setup and density. The physical properties of a treatment plan can also be easily investigated using the biological tools.

SIMULTANEOUS PLAN EVALUATION

Several predefined layouts are available for simultaneous comparison of dose distribution, dose statistics, clinical goals and dose-volume histograms for up to three different plans. Dose can be directly computed on additional image sets and summed up using deformable registration.

ROBUST EVALUATION

For evaluation of robustness, dose can also be computed for a density perturbation or isocenter shift. In the dedicated robust evaluation module, you can easily define groups of scenarios based on uncertainties in patient setup, patient anatomy (multiple CTs) and density interpretation of CT and evaluate them simultaneously.

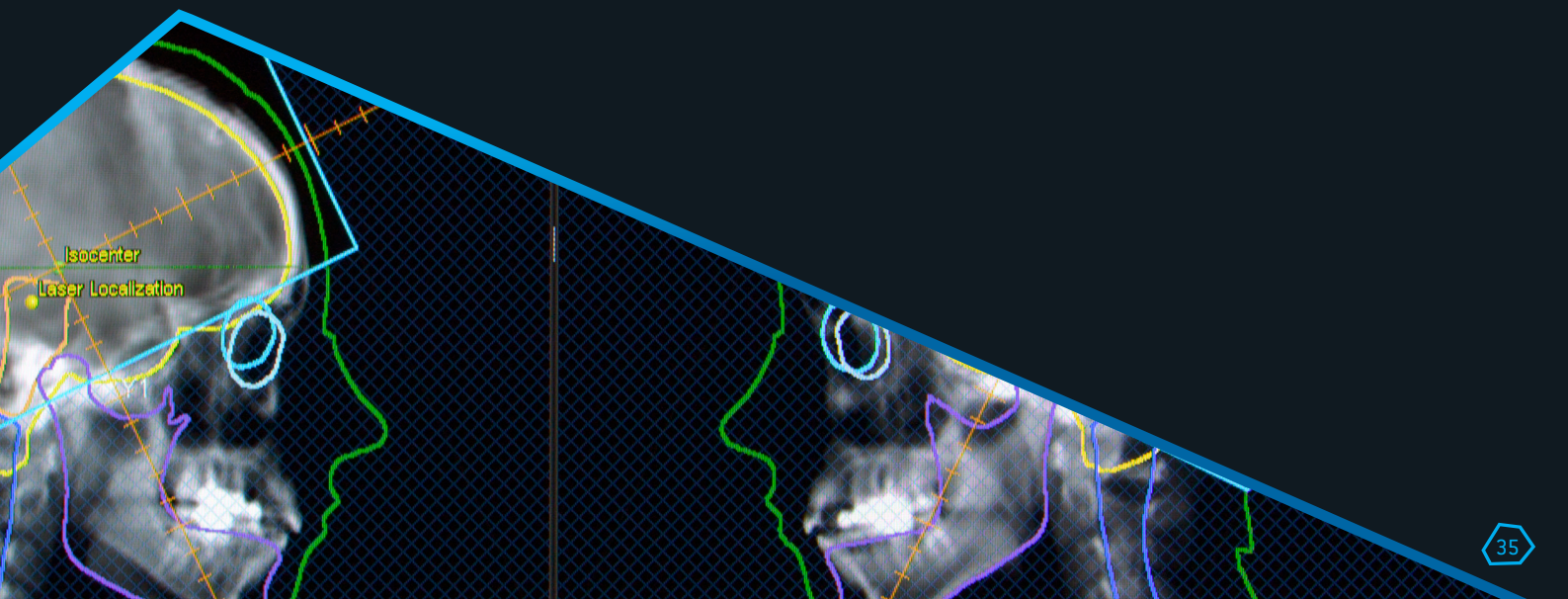
KEY FEATURES

- Evaluate all scenario DVHs simultaneously
- Evaluate clinical goals over all scenarios
- View single-scenario doses, as well as aggregated dose measures over all scenarios, e.g. voxelwise minimum or maximum, in the 2D patient views

RADIOBIOLOGICAL EVALUATION

Radiobiological evaluation tools include Tumor Control Probability (TCP) and Normal Tissue Complication Probability (NTCP) models that can be combined with tissue repair and tumor growth models.

Because the biological tools are integrated into the plan evaluation module, the physical properties of the existing plan can be easily investigated if unexpected differences in biological response are observed between different plans. There is also a biological evaluation module dedicated to exploration of the biological effects of altering the fractionation schedule of a single treatment plan.



COMMISSION, CHECK, GO

Multiple modalities. Diverse treatment machines. Numerous software systems. There's a lot to orchestrate if you want to reach the highs in treatment quality and efficiency. RaySearch takes pride in striving for seamless connectivity with the diverse software and modalities involved in the treatment. We aim to support as many treatment technologies as possible to ensure you can perform all your treatment planning in RayStation.



MODELING

A dedicated graphical user interface is available for photon, electron, proton and TomoTherapy modeling. This workspace allows for evaluation of models and treatment planning tools prior to commissioning a machine.

QUALITY ASSURANCE

The module for Quality Assurance preparation makes it straightforward to transfer the clinical plan to a phantom and recalculate dose, either beam by beam or for the entire plan. The output from the module is the dose distribution in DICOM format or a 2D dose plane, a QA report and, optionally, a new treatment plan with collapsed gantry angles.

SEAMLESS CONNECTIVITY

RayStation is compatible with most commercially available linear accelerators, OIS and third-party QA. Its data model is fully compatible with the DICOM standard, making it easy to import or export any DICOM RT object. This includes multiple CT, MR and PET image series, 4D-CT structure sets, doses and RT Plan and RT Ion treatment plans. In addition, RayStation communicates with other data sources, such as IHE RO, DICOM senders and receivers and DICOM archives, using either file transfer, DICOM storage service classes or DICOM query/retrieve. RaySearch is involved in both the technical and planning committees of the IHE RO, and we consider it a very high priority to work with these organizations and other companies in radiation oncology to assure safe and seamless connectivity where possible.



Our commissioning results were within 2% at 2 mm; well within the industry standard. When I work on beam commissioning in RayStation, I remember why we bought it. The results are so beautiful, it makes me happy to be a physicist."

*— Patricia Sansourekidou, Medical Physicist,
Health Quest Radiation Oncology, USA*

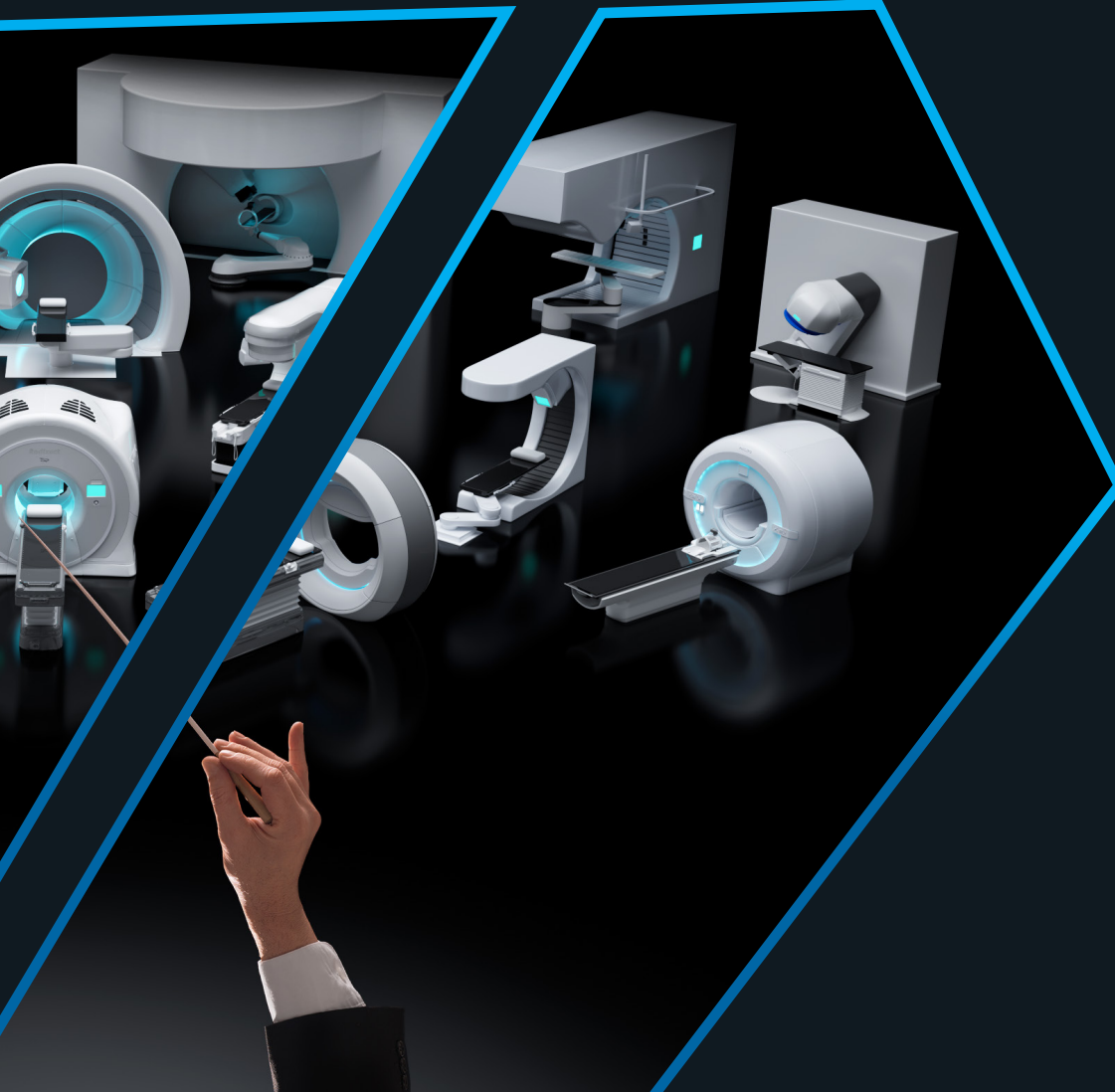
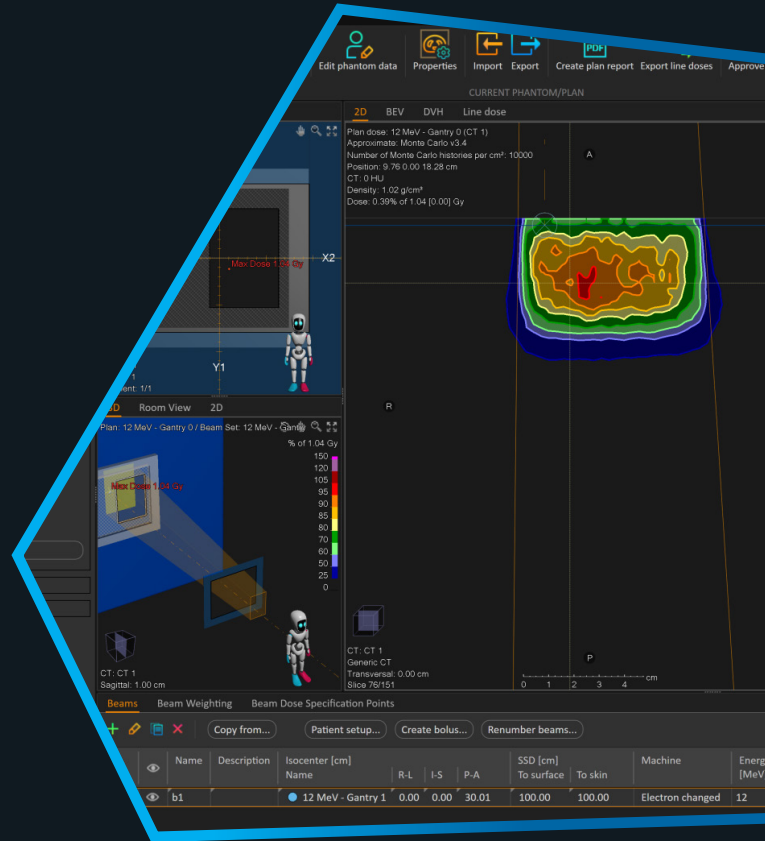


HARDWARE INDEPENDENCE AND FLEXIBLE SOLUTIONS

- Flexible setup; centers can choose to purchase their own hardware
- Floating licenses
- Unlimited patient data storage, flexible configuration of multiple parallel databases and gradual archiving
- Dose calculation based on GPU
- Flexible deployment options that can include at-desk clients or shared-server solutions

HARMONIZE YOUR TREATMENT PLANNING

RayStation has always led the way when it comes to technology integration and has been quick to adapt to new machine characteristics, as well as to take full advantage of their technical capabilities thanks to optimization expertise. Our focus on software and independence from machine vendors allow us to ensure RayStation always stays up-to-date with new treatment machines and can act as one control center for all your treatment planning needs – any equipment composition, any scale.



MEDICAL ONCOLOGY



In our ambition to provide software solutions for comprehensive cancer care, we have expanded RayStation to include a module for planning of medical oncology treatments. This way, the same system can be used for radiation therapy and chemotherapy planning. Automatic dose calculation and rounding, alerts for exceeding single and accumulated doses, and trackable dose adjustments are some of the features.

MEDICAL ONCOLOGY PLANNING

In RayStation's medical oncology planning module, the patient's individualized regimen is selected, adjusted, and approved. Begin by loading a predefined regimen template from your custom library, verify that the dose limits are fulfilled for the calculated doses, and adjust dosage or treatment days as necessary. Once a cycle is ready and approved, a report can be generated providing a treatment overview and work steps for the administration of the treatment.



PATIENT INFORMATION

Patient ID: 001
 Name: Kayley
 Gender: Female
 Date of birth: 14 Mar 1962 (57 y)

CURRENT CASE

Case 1
 Site: Lymphoma

CURRENT REGIMEN

Regimen: CHOEP 21 x 6
 Intent: Curative
 Based on template: CHOEP 21

Indications: Treatment of T-cell Non-Hodgkins Lymphoma. Age < 60 years. Adequate haematological, renal and liver status.

Contraindications: Hypersensitivity to DOXOrubicin, cyclophosphamide, etoposide, vinCRIStine sulphate or any of the excipients.

PLAN SETUP

Buttons: New plan, Load template, Edit plan, Copy plan, Delete plan, Close plan, Create regimen report, Create template from regimen

Views: **Cycle view** | Day view

Cycles: All cycles | Cycle 1 | Cycle 2 | **Cycle 3** | Cycle 4 | Cycle 5 | Cycle 6 | Cycle 7

Cycle information

Identical cycles: Cycle 3
 Cycle length [days]: 21 [Edit length...](#)

Based on regimen template
 Regimen template: CHOEP 21
 Template cycle: Cycle 1

Indications: Treatment of T-cell Non-Hodgkins Lymphoma. Age < 60 years. Adequate haematological, renal and liver status.

Contraindications: Hypersensitivity to DOXOrubicin, cyclophosphamide, etoposide, vinCRIStine sulphate or any of the excipients.

Vitals: 27 Nov 2019
 Patient weight: 65.0 kg
 Patient height: 165.0 cm

Activities

Buttons: Edit dose..., Edit time...

Seq.	Day	Admin. time [hr:min:sec]	Active substance	Dose			Route	Diluent
				Planned	Computed	Rounded		
1	1	0:00:00	Cyclophosphamide	750.00 mg/m ²	1294.52 mg	1294.52 mg	IV infusion	100-250 ml 0.9% NaCl
2	1	0:45:00	DOXOrubicin	50.00 mg/m ²	86.30 mg	86.30 mg	IV Bolus, into side arm, fast running	0.9% NaCl
3	1	1:00:00	VinCRIStine	1.40 mg/m ²	2.42 mg	2.42 mg	IV infusion	50 ml 0.9% NaCl minibag
4	1	2:00:00	Etoposide	100.00 mg/m ²	172.60 mg	172.60 mg	IV infusion	1000 ml 0.9% NaCl or 5%
5	1	2:00:00	Prednisolone	75.00 mg	75.00 mg	75.00 mg	PO	-
6	2	0:00:00	Etoposide	100.00 mg/m ²	172.60 mg	172.60 mg	IV infusion	1000 ml 0.9% NaCl or 5%
7	2	0:00:00	Prednisolone	100.00 mg	100.00 mg	100.00 mg	PO	-
8	3	0:00:00	Etoposide	100.00 mg/m ²	172.60 mg	172.60 mg	IV infusion	1000 ml 0.9% NaCl or 5%
9	3	0:00:00	Prednisolone	100.00 mg	100.00 mg	100.00 mg	PO	-
10	4	0:00:00	Prednisolone	100.00 mg	100.00 mg	100.00 mg	PO	-
11	5	0:00:00	Prednisolone	100.00 mg	100.00 mg	100.00 mg	PO	-

Administration overview

Shift days...

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Cyclophosphamide	●																					
DOXOrubicin	●																					
VinCRIStine	●																					
Prednisolone	●	●	●	●	●																	
Etoposide	●	●	●	●	●																	



MORE THAN SERVICE — A COMMUNITY

Customer satisfaction is a top priority at RaySearch. Our service department ensures you get the best experience when using RayStation through efficient product delivery, high quality training and fast and effective support – all at a local level. We listen to our customers and try our best to accommodate all enhancement requests in future versions of the software.

SMOOTH GO-CLINICAL PROCESS

We recognize that implementing a new treatment planning system or replacing an existing platform is not an easy task. We strive to streamline the installation to ensure it has very little impact on the daily work of the clinical staff. As a customer you will be assigned a dedicated RayStation Delivery Team consisting of three experts: an application specialist, an IT-specialist and a physics specialist. For each installation, we also assign a project manager who leads the dedicated team of experts and will guide you through every step of the process.

A COMPREHENSIVE SERVICE CONTRACT

The standard service contract lets you access all new software releases that are already licensed, completely free of charge, ensuring you can benefit from the latest improvements as soon as they are available. We work with you to ensure an effective implementation of RayStation's advanced technologies and workflows at your center.

RAYSTATION ONLINE COMMUNITY

Our dedicated online community gives you quick and direct access to experts from the service team, enabling you to get your questions answered and discuss the issues that matter to you.

The online community is also an easy way to connect with other RayStation users. You can ask questions, log support cases, request enhancements and browse the knowledge database for answers to frequently asked questions. All cases logged in the portal are investigated by a RayStation expert to provide the best solution to your problem within 24 hours.

TRAINING

Training is an important part of the go-clinical process, as well as an ongoing partnership with you and your teams to ensure you get the full potential from our products and benefit from the latest functionality updates. RaySearch regularly provides in-house and customized onsite trainings in application, physics, and IT for RayStation users. These training courses are approved for continuous education credits in different countries. Via the online community, you also get access to webinars to refresh or deepen your knowledge.

USER MEETINGS

Customers are invited to annual user meetings in Europe, USA or APAC. Local user meetings are also organized to allow users to communicate in their respective languages and discuss issues specific to their region.

These meetings allow you to hear about the latest product news and meet with our R&D teams to ask questions and get hands on advices. The meetings are also a fantastic opportunity to network with users from other clinics and to hear presentations about how they use the software in their clinic.



“RaySearch has some of the best support on the market. They are dosimetrists with strong clinical experience and are dedicated to helping and understanding our issues. We can continuously rely on them to respond quickly, listen to our needs and follow through with resolution.”

***– Craig McKenzie, Director of Medical Dosimetry
Miami Cancer Institute, USA***

ADVANCING CANCER TREATMENT

RaySearch is a committed pioneer of oncology software. Since 2000, we have worked in close cooperation with leading centers to improve life and outcomes for patients. We develop all our products from the ground up and continuously revise every aspect, from algorithms to user interface designs. Medical science never stands still, and neither does RaySearch — our relentless drive to do things better leads us to ever-higher performance, accuracy, safety and usability. And this is just the beginning.

We believe software is the driving force for innovation in oncology today. Our systems use groundbreaking automation and machine learning to create new possibilities. RayCare*, the next-generation oncology information system, will enable one workflow for all the oncology disciplines, ensuring fluid coordination of tasks and optimal use of resources. RayStation harmonizes treatment planning, providing one point of control for all planning needs — any equipment, any scale.

* Subject to regulatory clearance in some markets.

www.raysearchlabs.com

