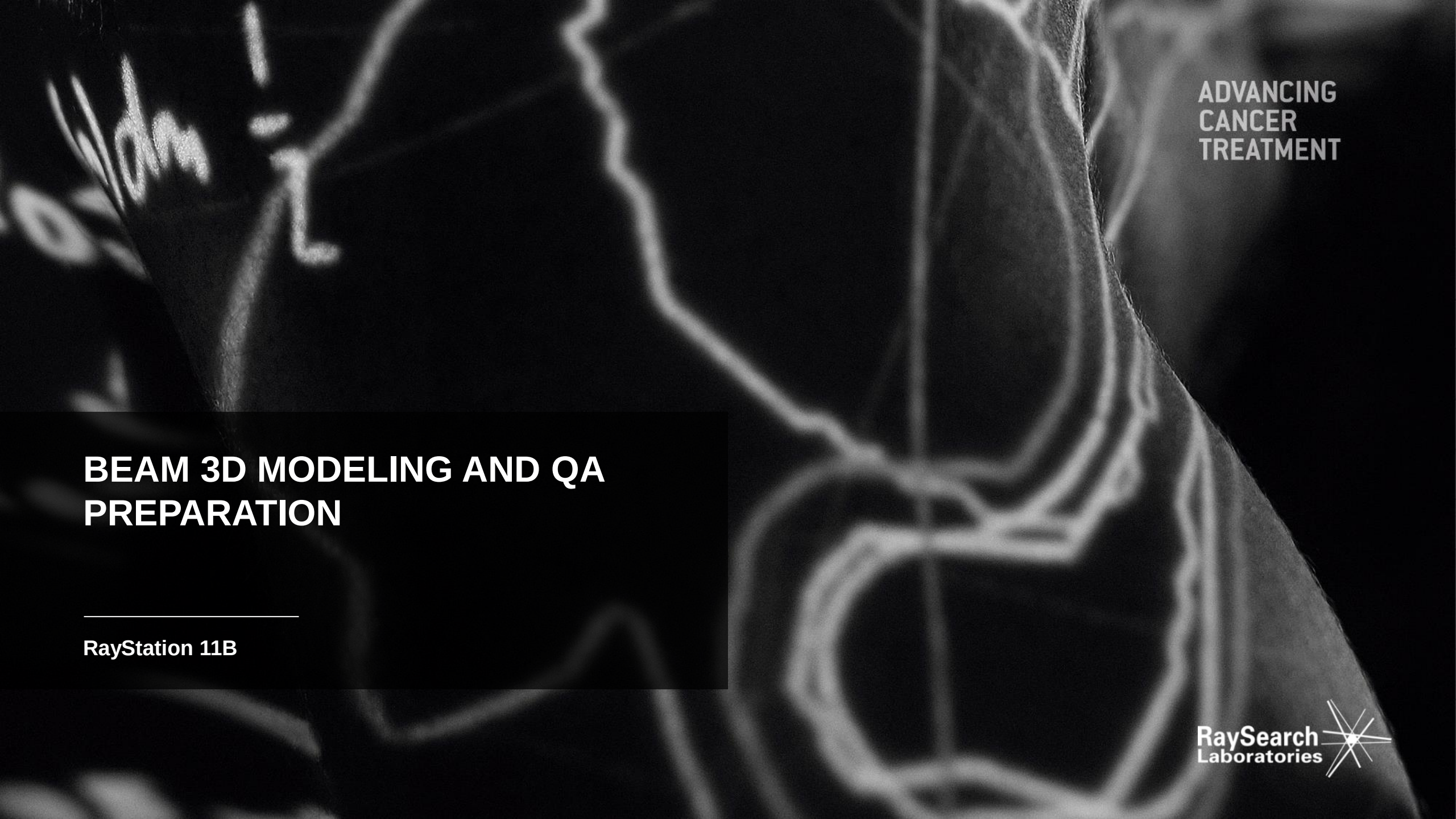

BEAM 3D MODELING AND QA PREPARATION

RayStation 11B

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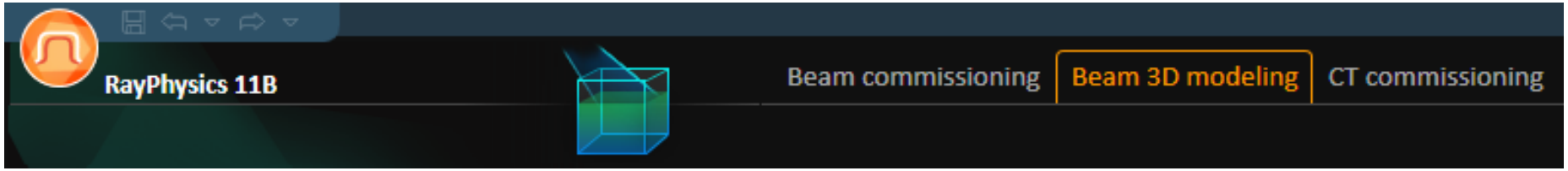
CONTENTS

- Beam 3D modeling module
- Beam model validation
- EPID Dosimetry (new in RayStation 10A)
- QA preparation



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BEAM 3D MODELING MODULE

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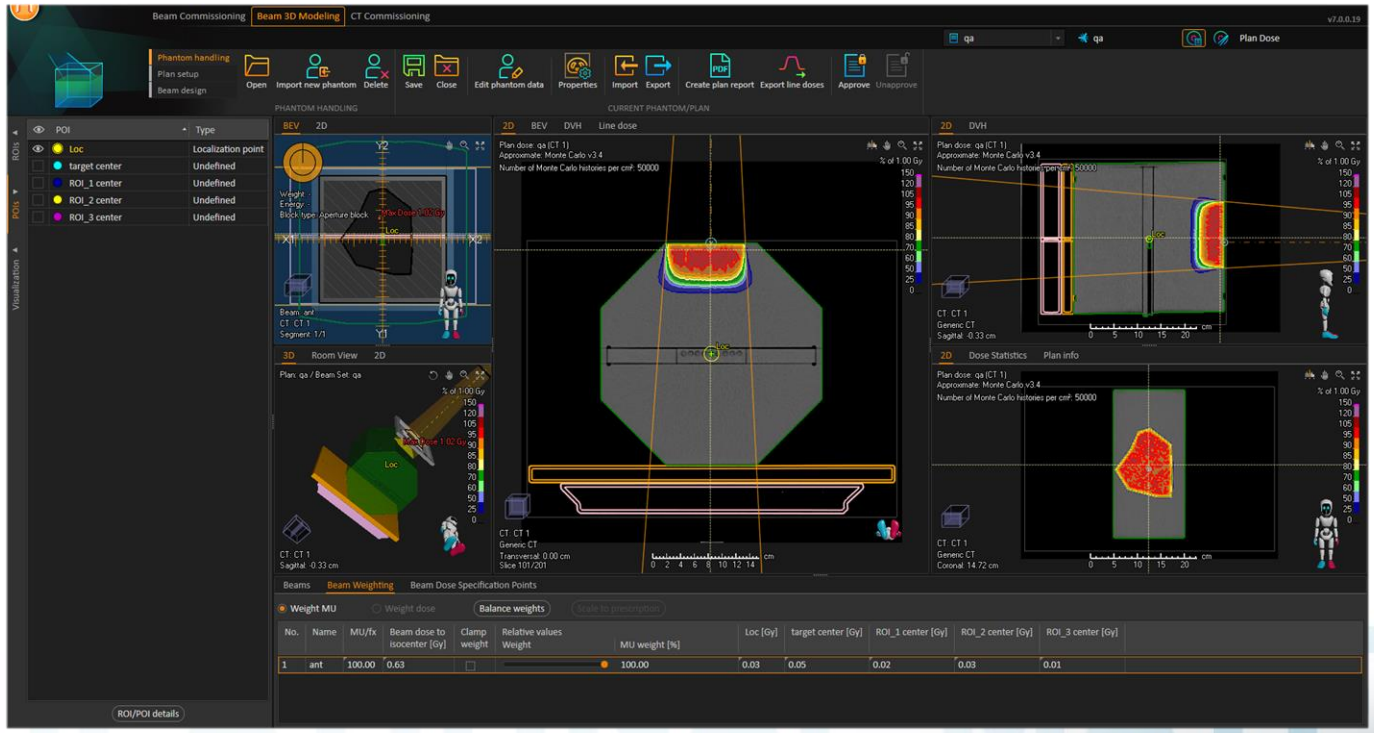
BEAM 3D MODELING MODULE

- Test dose calculation with uncommissioned machines
- Dose can be computed for imported plans
- Simple test fields can be created for photon or electron beams
- QA phantom management



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BEAM 3D MODELING MODULE

- **Beam 3D modeling** mimics RayStation **3D-CRT planning**
- Possible to DICOM import or create 3D-CRT plans and calculate dose with commissioned or uncommissioned machines
- Possible to DICOM import and calculate dose also on SMLC, DMLC and modulated-arc plans
- Dose is calculated with the collapsed cone dose engine but is not considered to be clinical. It can, however, be used for irradiation
- Machines are listed with commissioning time brackets.
- No prescriptions entered, but number of MUs

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BEAM MODEL VALIDATION

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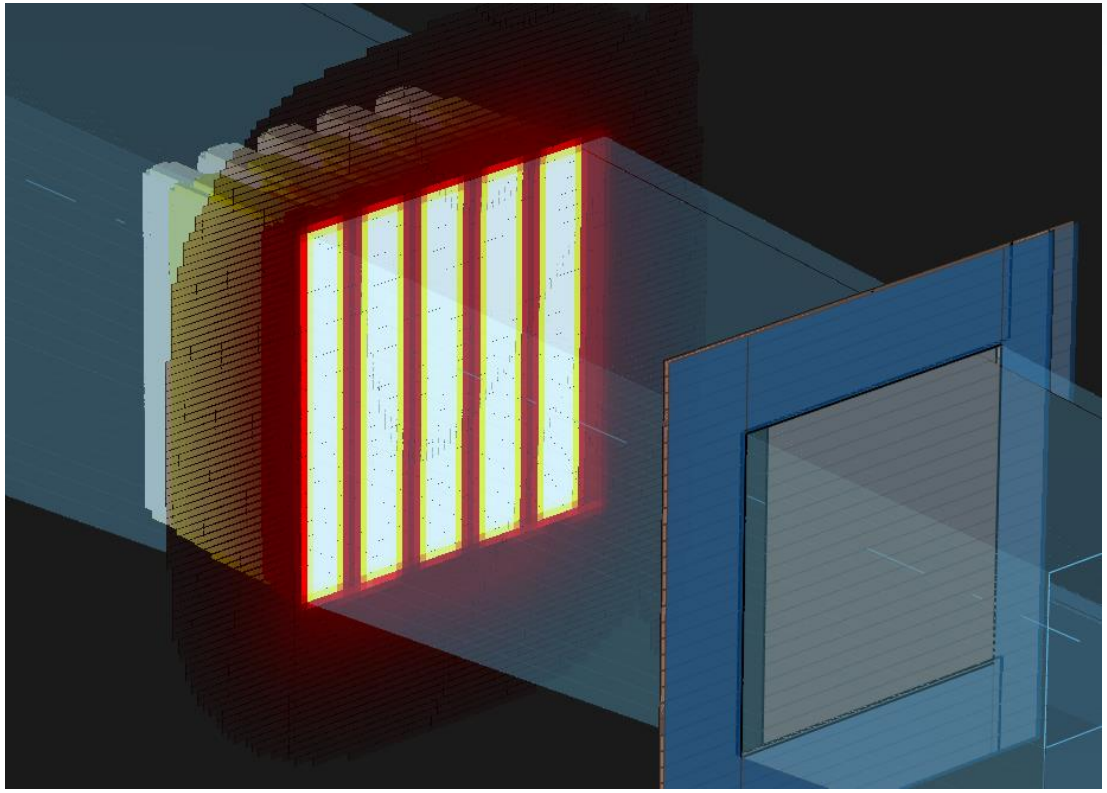
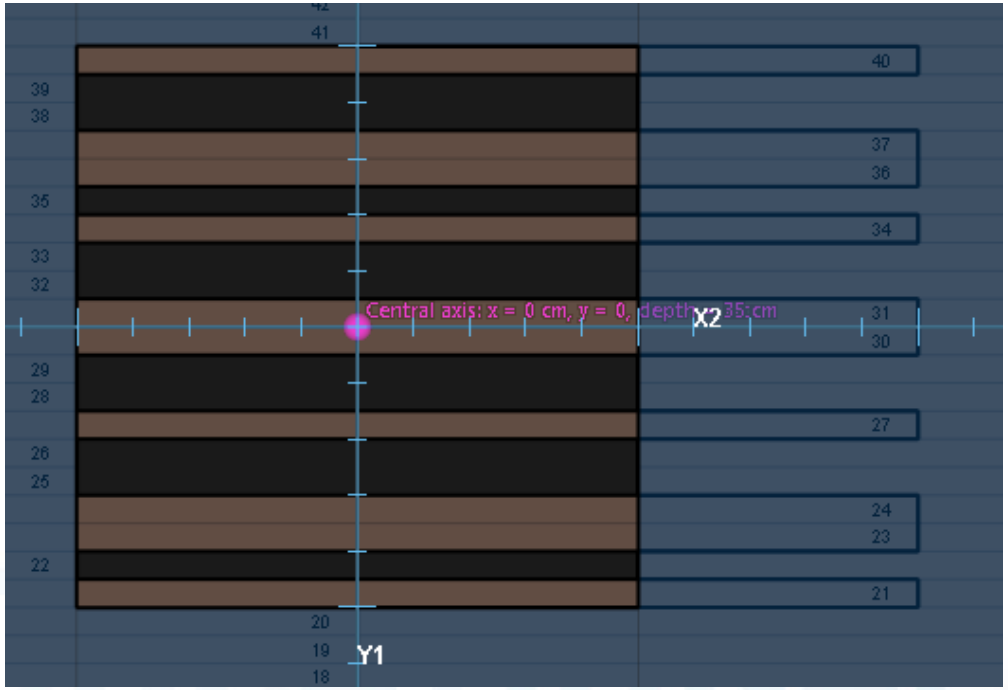
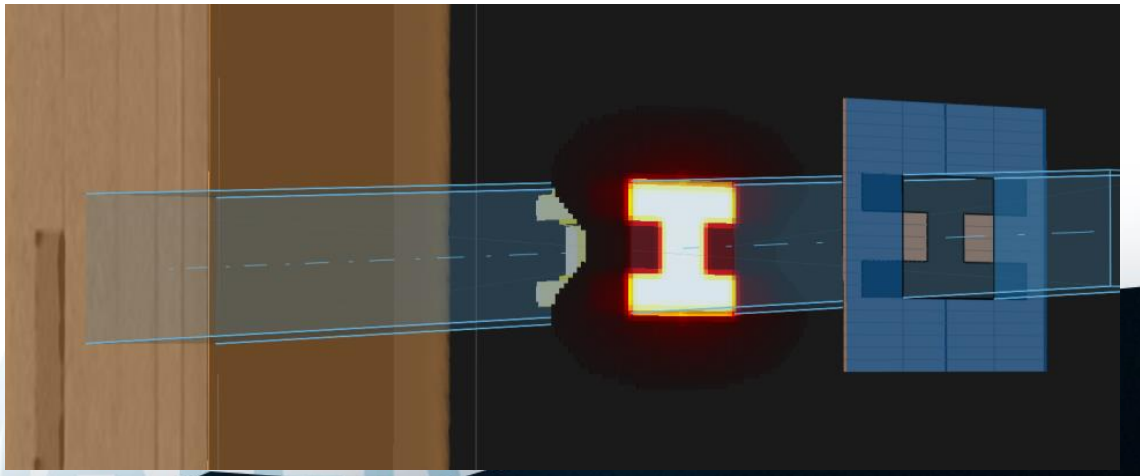
TEST FIELDS – EXAMPLES

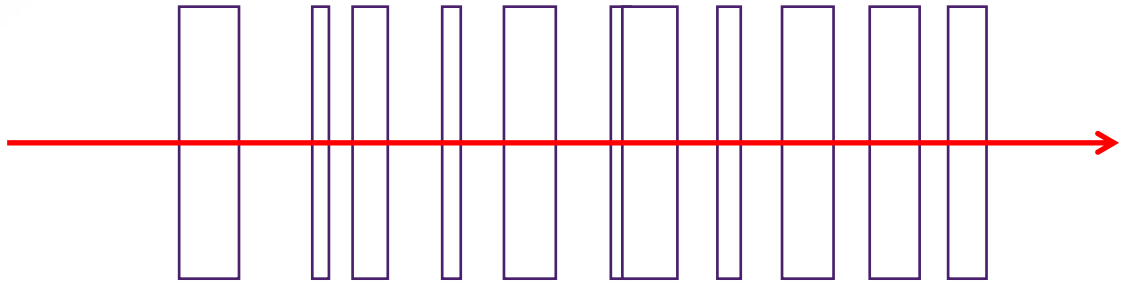
- Clinically relevant single segment beams in relevant positions
- Picket fence/ garden fence
- IMRT fields

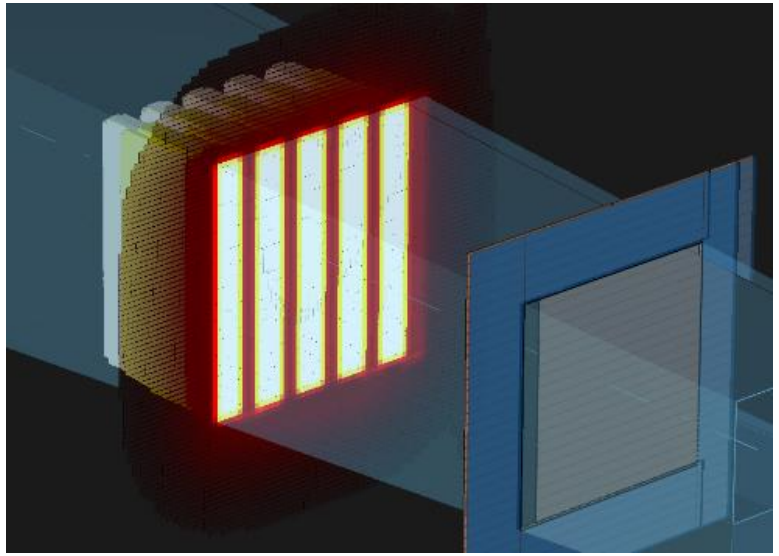


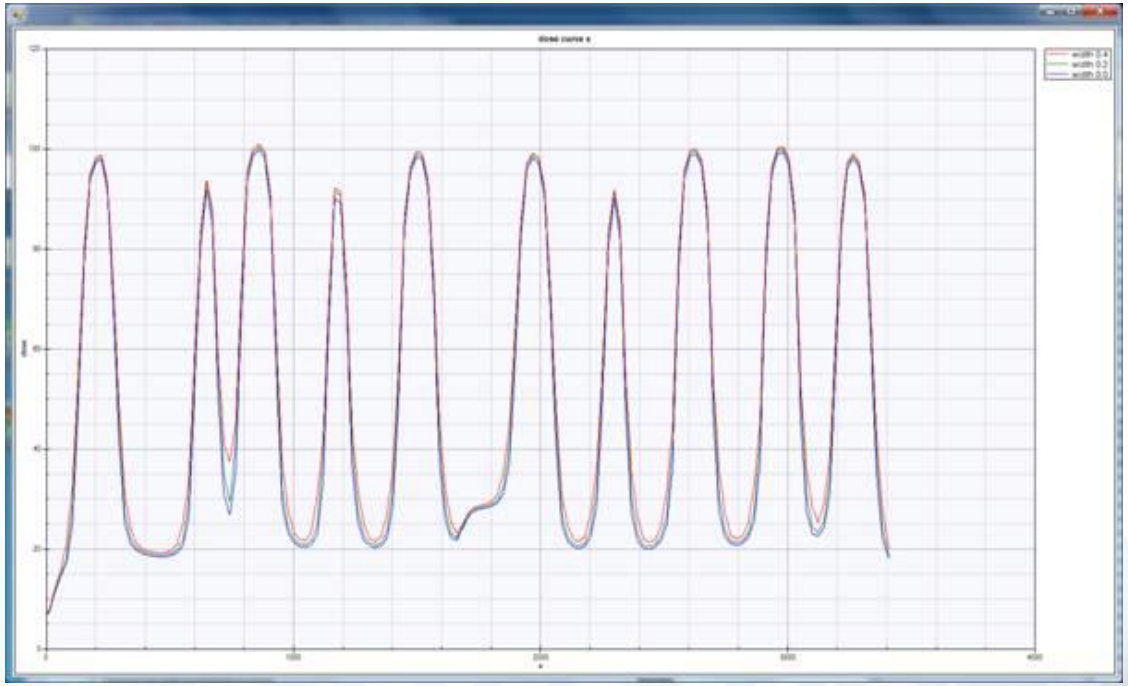




TEST FIELDS – EXAMPLES







Leaf tip widths:
red – 0.4 cm
green – 0.2 cm
blue – 0 cm

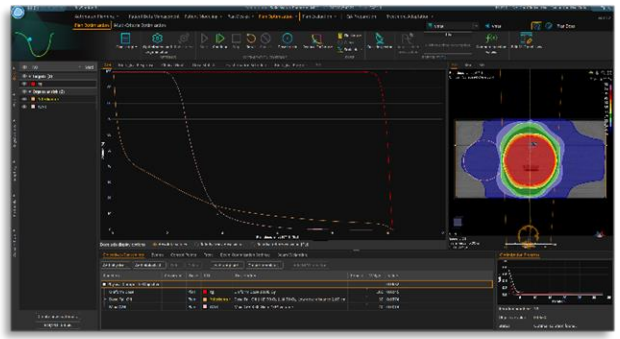
COMPUTE DOSE WITH UNCOMMISSIONED MACHINE

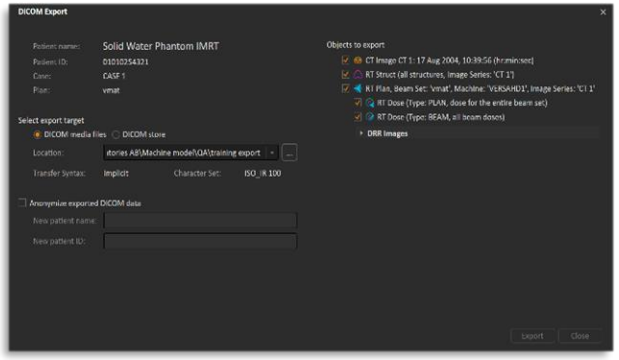
- Beam 3D modeling can re-compute dose from a plan optimized in Raystation with **uncommissioned** machines.
- Works with same model of linac and/or same MLC as long as some mechanical differences used in the plan doesn't interfere *(for example MLC maximum tip distance or MLC maximum leaf speed)*
- Can be very useful for fine tuning MLC parameters such as leaf-tip width, tongue&groove, MLC offset/gain/curvature, etc.

COMPUTE DOSE WITH UNCOMMISSIONED MACHINE

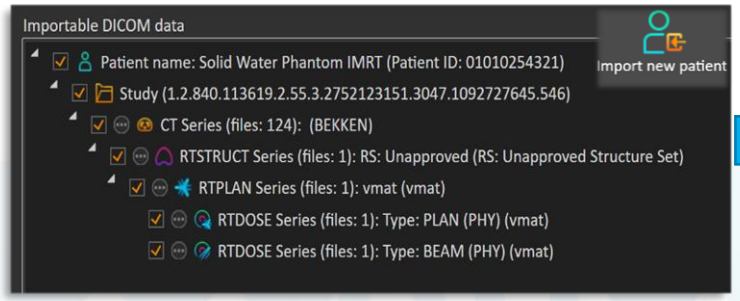
In Raystation:

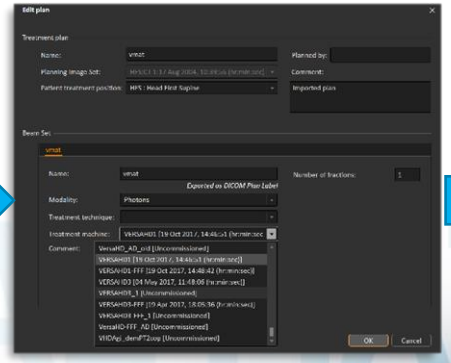
Prepare a plan (3D/IMRT/VMAT) on any CT, run the final dose and then export it on a DICOM media file

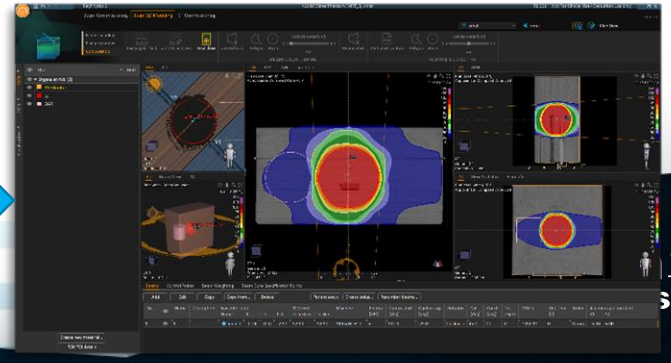




In RayPhysics/Beam 3D modeling:
Import the plan files previously exported from Raystation and edit the plan by changing the machine, then calculate final dose. New dose distribution (RTDose or line dose) can be exported by the export function. Dose grid size can also be modified.







EPID DOSIMETRY

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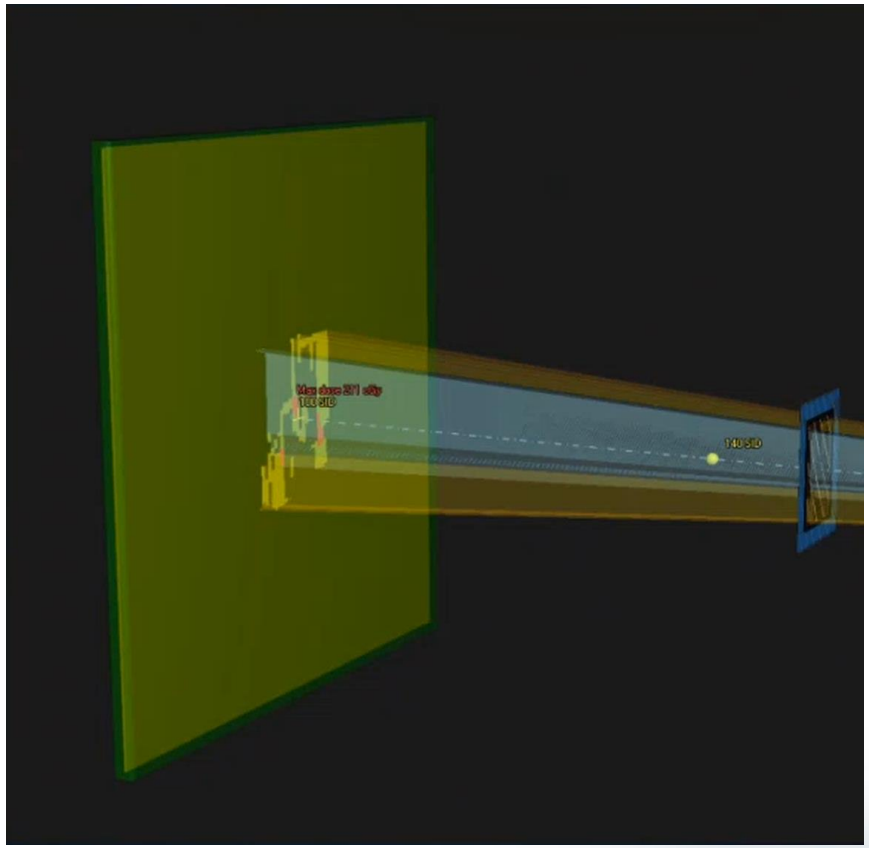
EPID SOLUTION (NEW IN 10A)

- Predict **relative** EPID response using
  - a special phantom
  - CC dose engine
- Predict EPID response exported as a DICOM RTImage
- Comparison to the measured response can be made in an external tool
- Included in RayStation and RayPlan
  - requires license rayEpidQA
- Launched by a script and part of the functionality is inside a validated script

EPID PHANTOM

- Phantom includes two thin slabs
  1. An ROI replicating the metal plate of the EPID detector
     - Material override set to water density 4 g/cm^3
  2. The first ROI is enclosed inside an External ROI with material override set to Air

- The thicknesses and material overrides have been optimized to replicate the response in Varian EPIDs
  - Method fine-tuned for Varian Clinac with aS500 detector, for 8 MV



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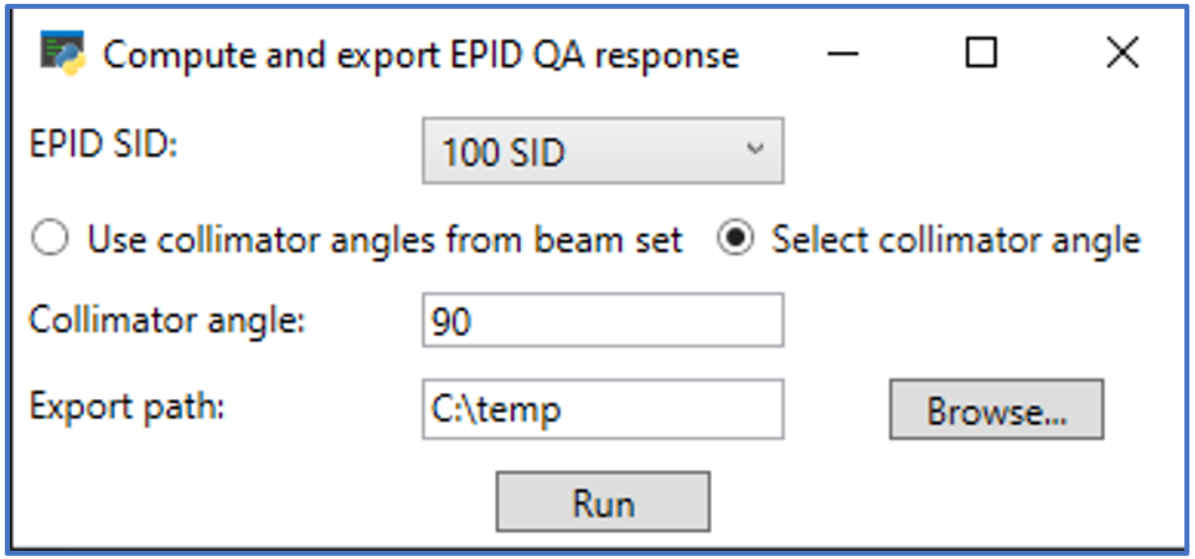
EPID COMPUTATION

- EPID response is computed for each beam or arc using the CC dose engine
- The computation is ***flood field corrected*** to account for the difference in pixel sensitivity over the detector plane
  - The same correction is made in the measured image
  - The flood field is computed for the maximum, open field size
  - Each pixel value in the predicted response is divided by the corresponding pixel value in the flood field

- What happens in RayStation?
  1. EPID QA plan is created in RayStation using the validated phantom, and the CC dose is computed
  2. For the flood field computation, a corresponding plan and QA plan is created
  3. The dose in step 1 is corrected with the flood field
  4. The resulting corrected dose is exported as an RTImage

PREREQUISITES

- To be able to compute pre-treatment EPID QA response, the following is needed
  - rayEpidQA-license (contact IT support)
  - Validated phantom to be used for EPID QA
  - Validated RayStation script (two .py files)
  - A user-defined scripting environment
- Output: one RTImage per arc/beam
- Contact support to get access



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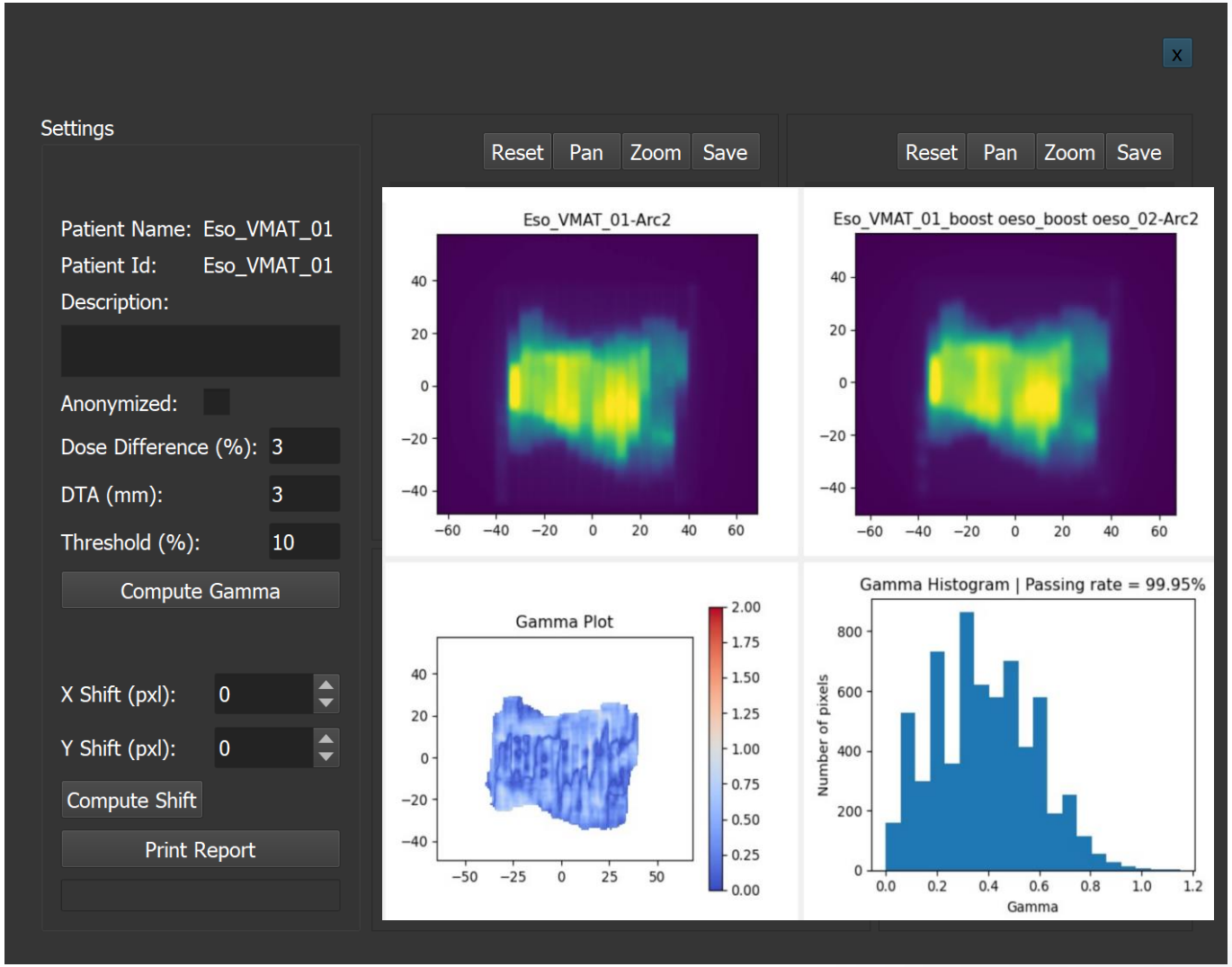
COMPARISON TOOL

- Output from script: one RTImage per arc/beam
- Image_comparison_tool available upon request



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QA PREPARATION

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QA PREPARATION IN RAYSTATION

- QA Preparation is a module in RayStation.
- Generates a QA plan by copying a beam set of a plan to a QA phantom and computing dose.

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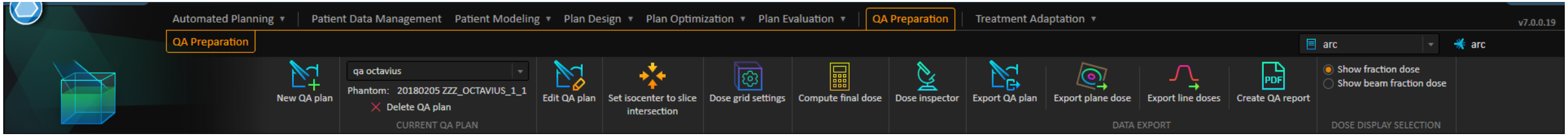
QA PREPARATION - EXPORT AND REPORT

- DICOM export of RTPlan, RTDose (per beam and beam set, 3D), RTStruct and image data
- 2D Plane dose export – as tiff image, OmniPro opg file (text based) or on DICOM RTDose format.
- QA plan report in pdf format



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QA PREPARATION – QA WORKFLOW

- All work in QA Preparation is **per beam set** (but will sometimes be referred to as a plan instead for simplicity).
- As the QA phantom is used per fraction QA all doses displayed and exported in the QA phantom are fraction doses per beam or beam set.

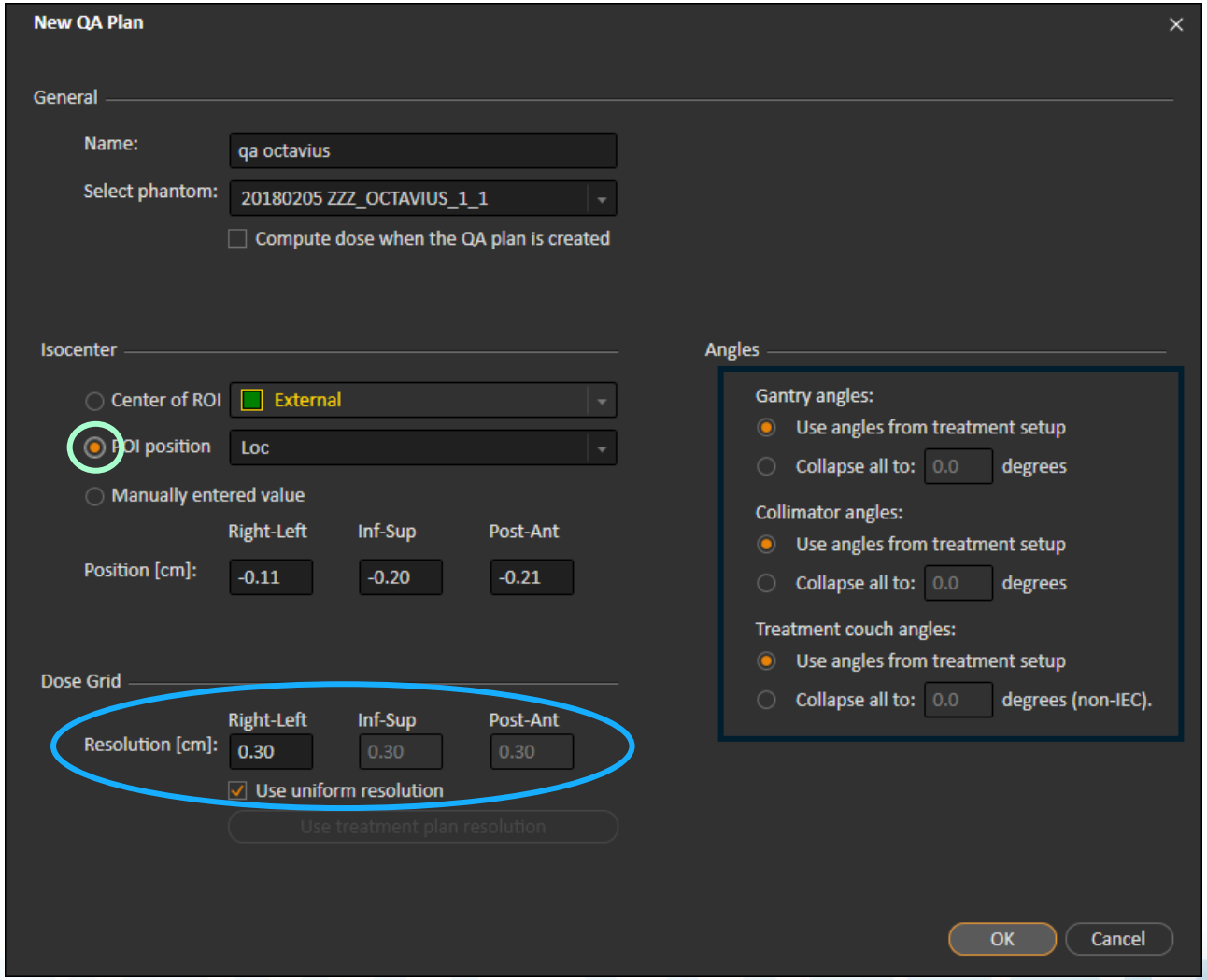
Note: *This is in contrast to all other pre-treatment workspaces in RayStation where always total dose is used.*

- Gantry, collimator and treatment couch angles can be kept from treatment setup or collapsed to desired angles.
- Dose grid size can be modified (uniform or not)

QA PREPARATION – QA WORKFLOW

To enable use of phantom set up parameters the data set must have a POI of type ‘Localization point’.

Dose grid can be modified



Collapse any type of angle

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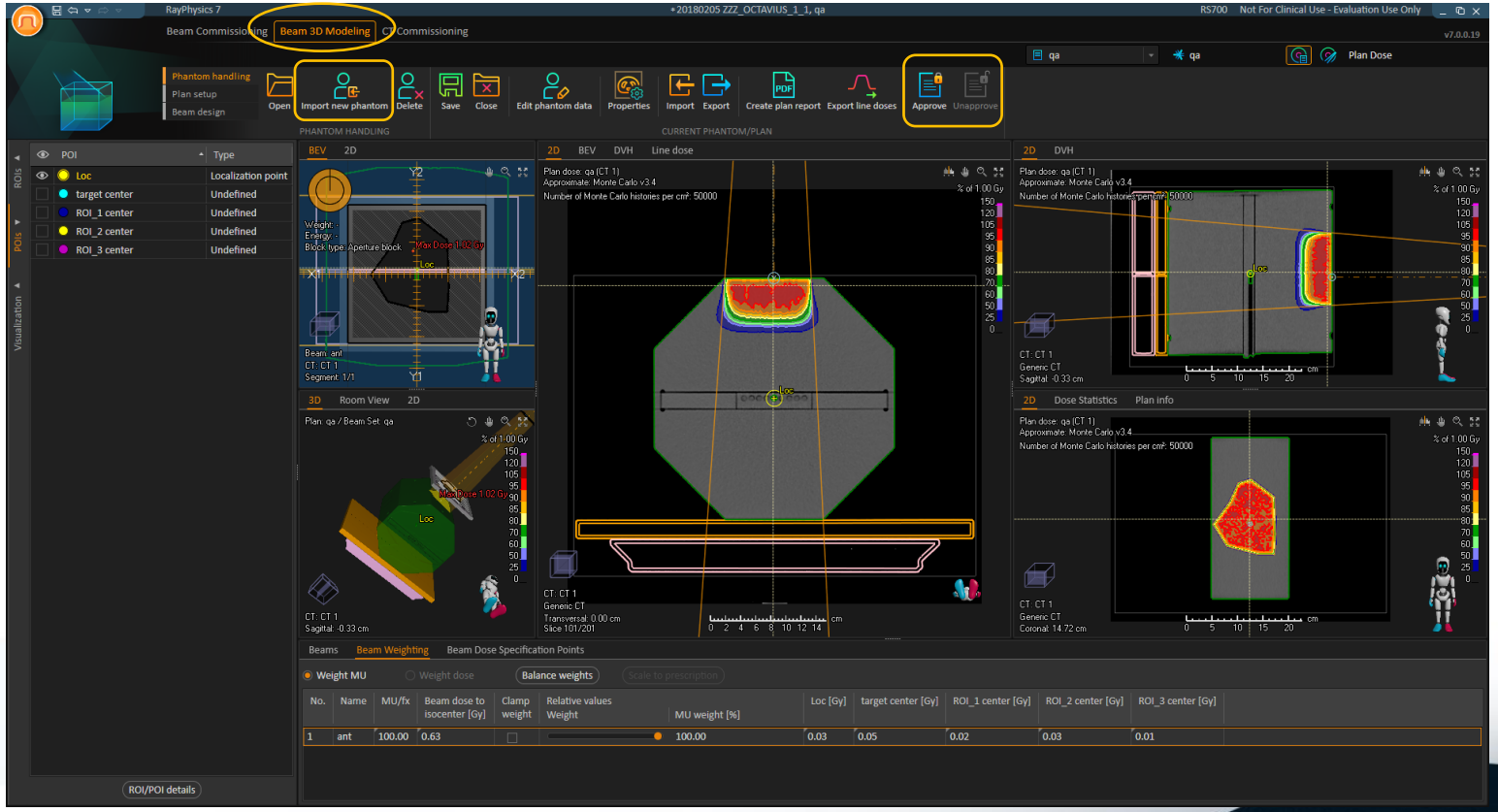
QA PHANTOM APPROVAL IN RAYPHYSICS

- Phantom approved in RayPhysics Beam 3D Modeling module before use in QA preparation is possible
- QA phantom = any DICOM CT image set you can import, for example: CT scanned Matrixx ion chamber detector array, CT scanned water phantom, Synthetically constructed phantom, Patient CT series, etc.



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QA PHANTOMS - ROI AND POI REQUIREMENTS

- There are no structure definition tools in RayPhysics so phantom ROIs and POIs need to be created in **RayStation** first.

- A data set to be used as a QA phantom must have at least one ***External ROI*** in the structure set.

- To faster further point measure dose analysis, representative points of interest and volumes can be set in **Raystation** (cavity of ion chamber for example).

  - When preparing a patient QA, dose to these points or volume will be display in the “dose statistics” tab in QA preparation

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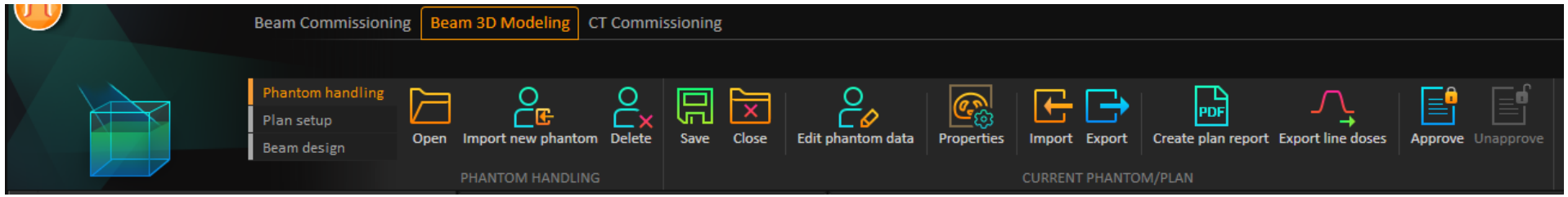
QA PHANTOMS - DATABASE HANDLING



- The QA phantoms are stored in the same database as the patients. However, the tag "**IsPhantom**" is set to true for phantoms, which make them invisible in RayStation, but they are in the database which is why name conflicts can occur.
- A QA phantom is set up in RayStation. It is entered into the database by DICOM import to and approval in RayPhysics Beam 3D Modeling module.
- A QA phantom used in a verification plan can be deleted from the phantom database.
- In the GUI, the phantom is referred to as 'patient'.
- Upon DICOM export of a QA plan, it is named after which phantom was used. (Or named after Patient – set in Clinic Settings)

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QA PHANTOMS - APPROVAL STATUS

- Approved phantoms are locked and cannot be edited.
- Approved phantoms will not appear in RayStation QA Preparation module until RayStation is restarted.
- Approved phantoms in RayStation can be unapproved again, even if used for verification plans in RayStation QA Preparation module.

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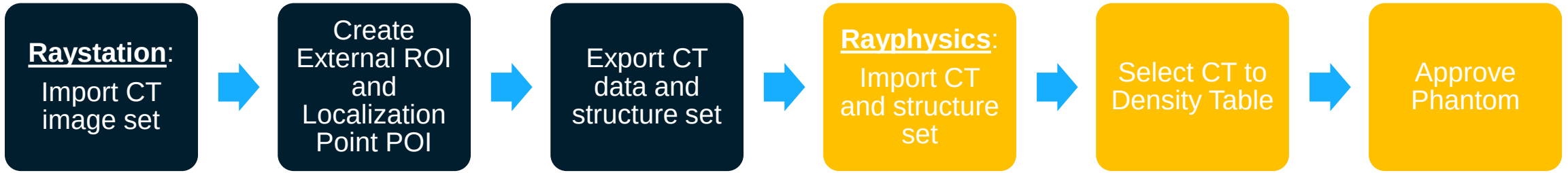
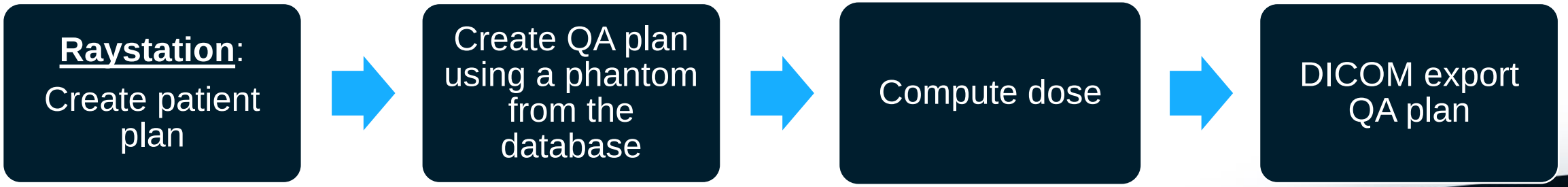
QA PREPARATION - WORKFLOW

Create Phantom and store it in Phantom database:



Create QA plan:



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