Epiqa

Epiqa

Artemis

ARTEMIS
RapidArc® QA

Hera

HERA
IMRT QA

Athena

ATHENA
MACHINE QA

Hermes

HERMES
TPS QA

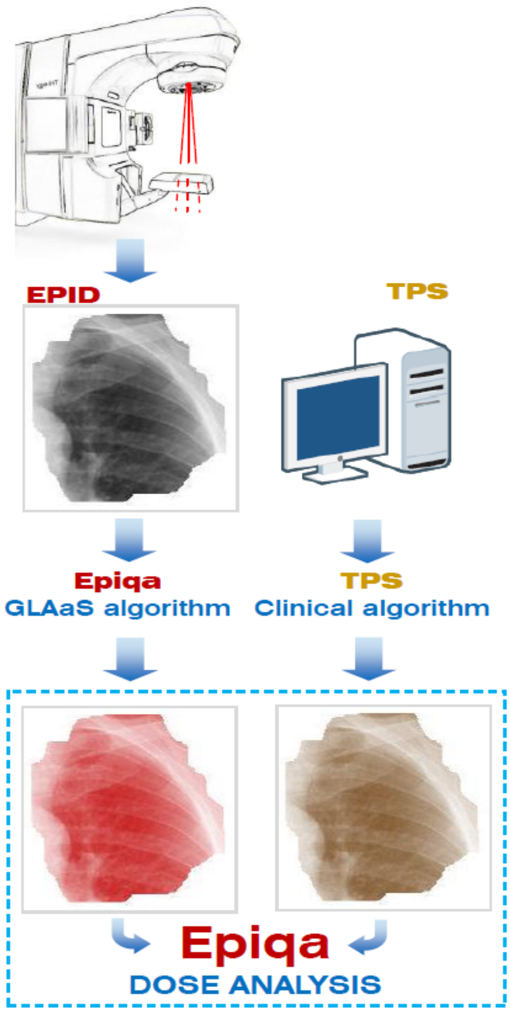
COMPLETE EPID DOSIMETRY

Epiqa™ is a program that allows to convert a dosimetric image acquired by an EPID into a dose map and to compare the dose map with a reference dose distribution. It is possible to utilize Epiqa for a verification of static as well as intensity modulated fields, including RapidArc® fields.

The conversion of a dosimetric image into a dose map is only possible if a response of the imager to a beam is known. The EPID's response shows very good linearity, but exhibits rather strong energy dependence, which causes a difference in response to primary and MLC transmitted radiation. Epiqa overcomes this limitation by the calibration process that takes the energy dependence of the detector into account. For the purpose of calibration, a set of integrated images for open and transmission fields of different field sizes are acquired and consequently imported into Epiqa together with the output factor table (measured by a conventional detector such as ionization chamber) to establish basic algorithm configuration data.

Based on the knowledge of jaws position and the trajectory of MLC leafs (for an IMRT field), a calibration factor can be determined for every pixel of an EPID by weighting the contribution of primary and transmitted radiation and by applying an interpolation among the data of the calibration dataset. The pixel based calibration relates the readout of a pixel to a dose at the depth of d_{max} in water equivalent homogenous medium. By applying the conversion to all pixels of the EPID, a planar dose distribution at the d_{max} in water is obtained.

The image-to-dose conversion algorithm (GLAaS) is often confused with portal dose image prediction algorithms (PDIP). As described in the previous paragraphs, the GLAaS derives calibration factors for EPID's pixels using *empirically* measured dataset. The obtained dose map is compared against dose distribution calculated by clinically used dose algorithm (typically AAA). It is therefore an *independent method of verification of the dose distribution* calculated by a treatment planning system and verification of the delivery device performance. The PDIP estimates a response of the imager for the theoretical incidental fluence. In other words, the algorithm predicts a pattern that will be created on the imager and a user has then a possibility to compare it with the real one. This method checks the *reproducibility in delivery of the incidental fluence*, meaning it verifies the technical accuracy of the delivery (which is usually very good) and not the dose distribution/dose calculation algorithm itself.



A detailed description of the GLAaS image-to-dose algorithm can be found in [1].

Epiqa benefits

- resolution comparable to film dosimetry
- no phantom and no build-up needed
- very good long term stability
- independent of TPS
- calibration based on data measured by user

Reference

[1] Nicolini G, et al.: *GLAaS - an absolute dose calibration algorithm for an amorphous silicon portal imager. Applications to IMRT verification.* Med Phys 2006; 33: 2839-2851.

RapidArc QA

ARTEMIS

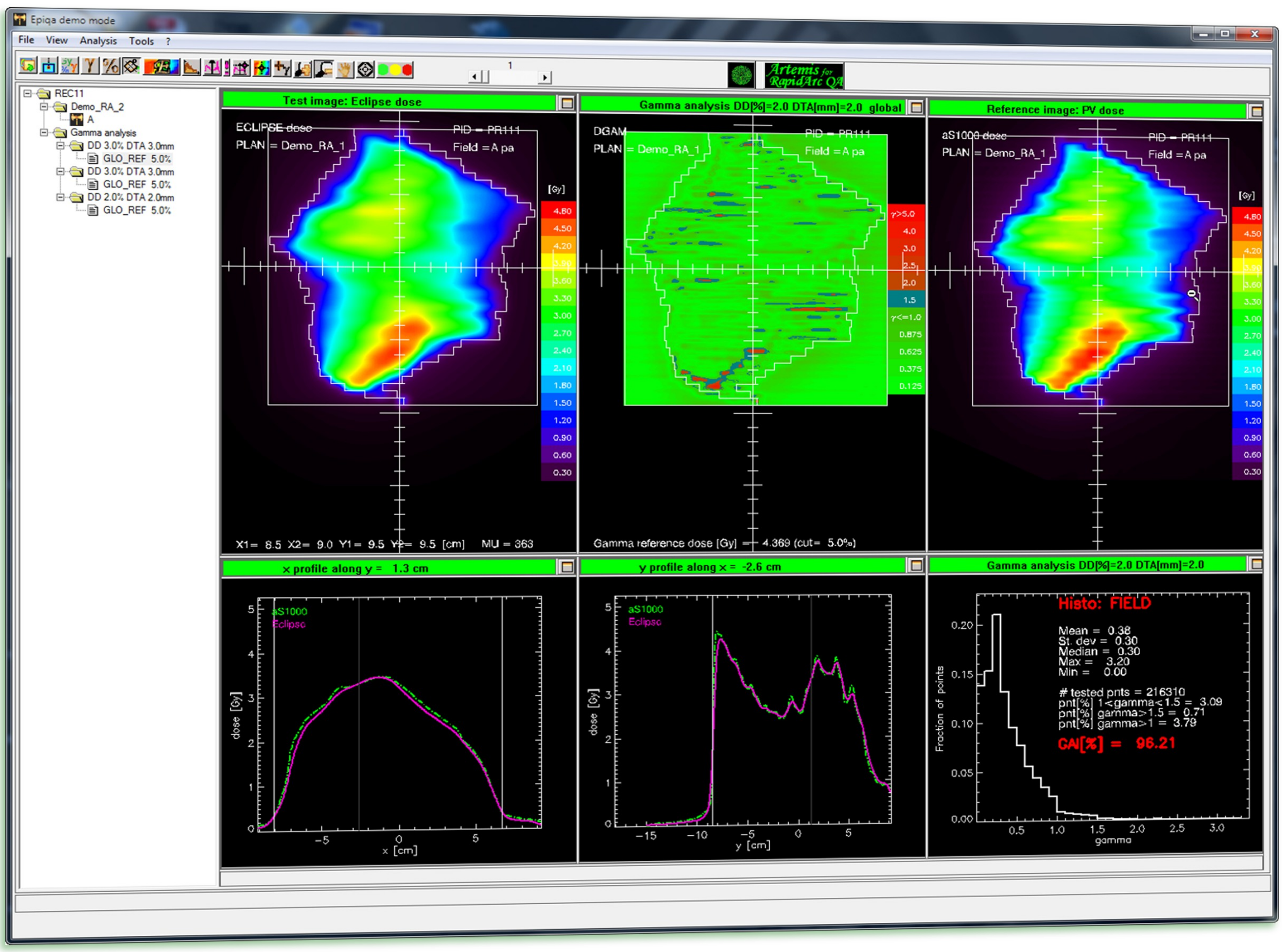
PATIENT plan RapidArc QA

Use your portal imager as absolute dosimeter to verify RapidArc plans following these steps

- Replace patient 3D model with water phantom and reset gantry angles to zero for dose calculation
- Calculate verification plan using YOUR CLINICAL dose calculation algorithm
- DICOM export dose plane at d_{max} as a reference matrix
- Deliver the RapidArc plan normal way while acquiring integrated image
- Compare calculated versus acquired dose matrices using Epiqa

Benefits of using Epiqa for RapidArc plan QA

- Simple QA plan preparation
- Instant detector preparation for measurement - just deploy Portal Vision arm
- Easy QA plan delivery - can be performed by therapist
- Fast data export - export only 4 DICOM objects
- The method verifies not just the delivery device but also TPS performance
- Quick results evaluation. In just few minutes user can print final protocol for approval



Reference

[1] Nicolini G. et al: *The GLAaS algorithm for portal dosimetry and quality assurance of RapidArc, an intensity modulated rotational therapy*, Radiation Oncology 2008, 3:24 .

ARTEMIS

RapidArc

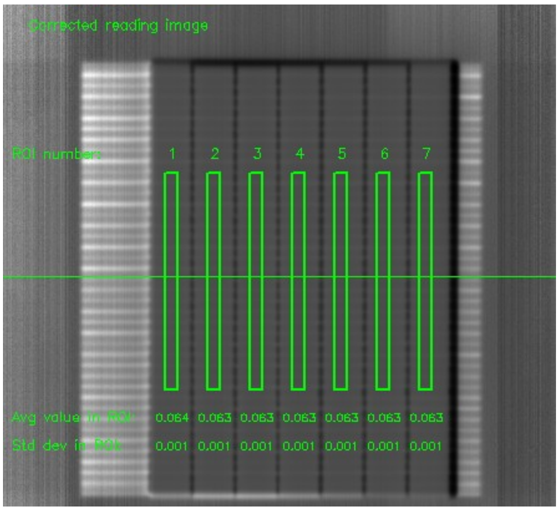
Machine QA

Epiqa

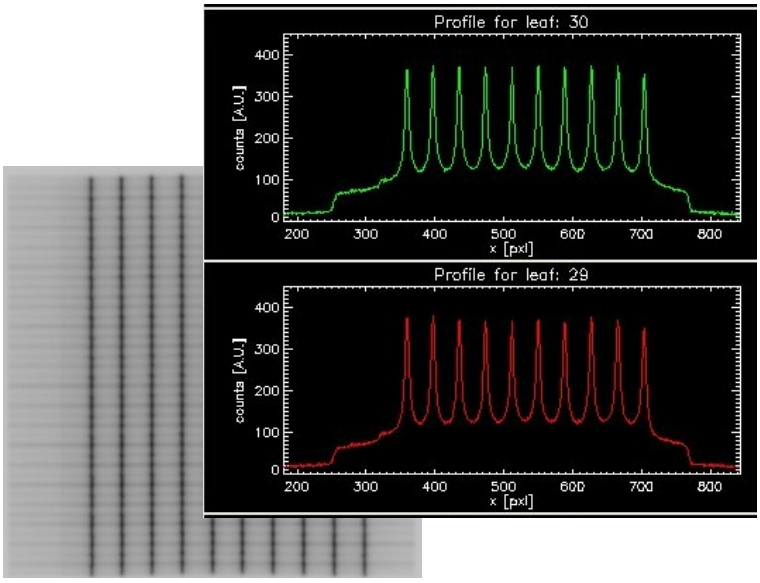
MACHINE commissioning for RapidArc

**Verify accelerator and MLC performance using standard tests recommended by Varian.
Use Portal Vision dosimetry acquisition and Epiqa to evaluate results.**

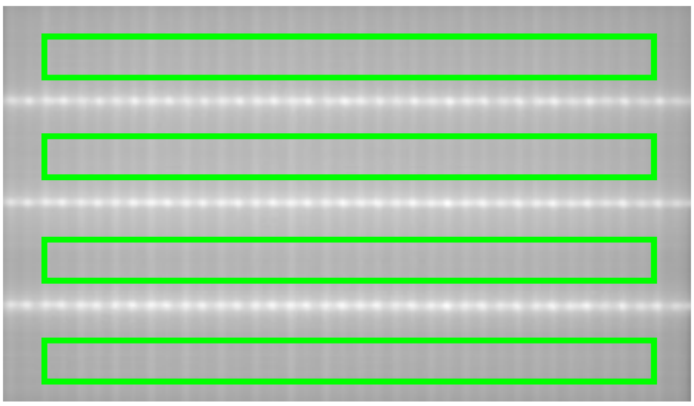
1. Accurate control of dose rate for several gantry speeds and 7 different dose rates. Each strip is delivered with 30 MU and ROI is analyzed for its average value and standard deviation.



2. Precise MLC positioning during gantry rotation. Picket fence test is performed using sliding window technique while gantry rotates over 330 degrees. Epiqa allows visual and qualitative analysis of the performance of each leaf pair separately.



3. Accurate control of MLC leaf speed during gantry rotation for 4 different leaf speeds. Results of this tests are influenced by correct performance of MLC motions but also by gantry speed and correct dose rate. Each of the 4 strips are irradiated for 30 MU with the combination of different leaf speed, dose rate and gantry speed. ROI is analyzed for its average value and standard deviation.



ROI analysis

ROI number	Deviation from reference value [%]
1	-1.43
2	-0.27
3	1.26
4	0.44
Tolerance [%]:	± 2.00

Reference average value: 0.0599 ± 0.0007

IMRT QA

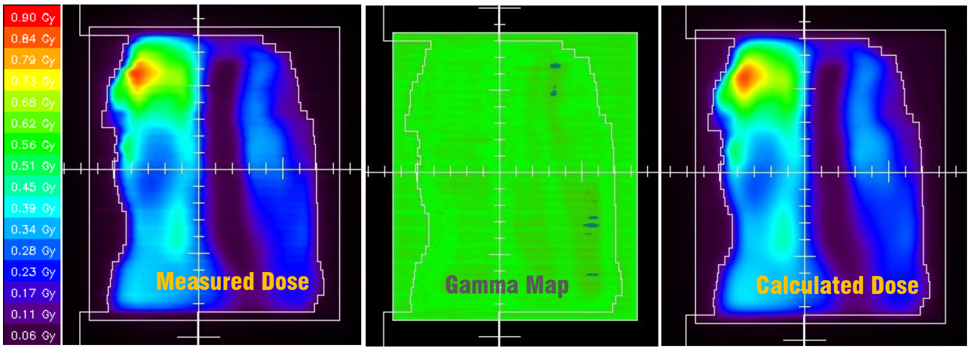
HERA

IMRT PATIENT PLAN & DYNAMIC MLC QUALITY ASSURANCE

Patient plan IMRT QA

Test IMRT plan delivery versus TPS calculation in the treatment gantry position

- Replace patient 3D model with water phantom and calculate dose distribution per field separately
- Calculate verification plan using YOUR CLINICAL dose calculation algorithm
- DICOM export dose plane at d_{max} as a reference matrix
- Deliver the IMRT plan normal way while acquiring integrated image for each field
- Compare calculated versus acquired dose matrices using Epiqa

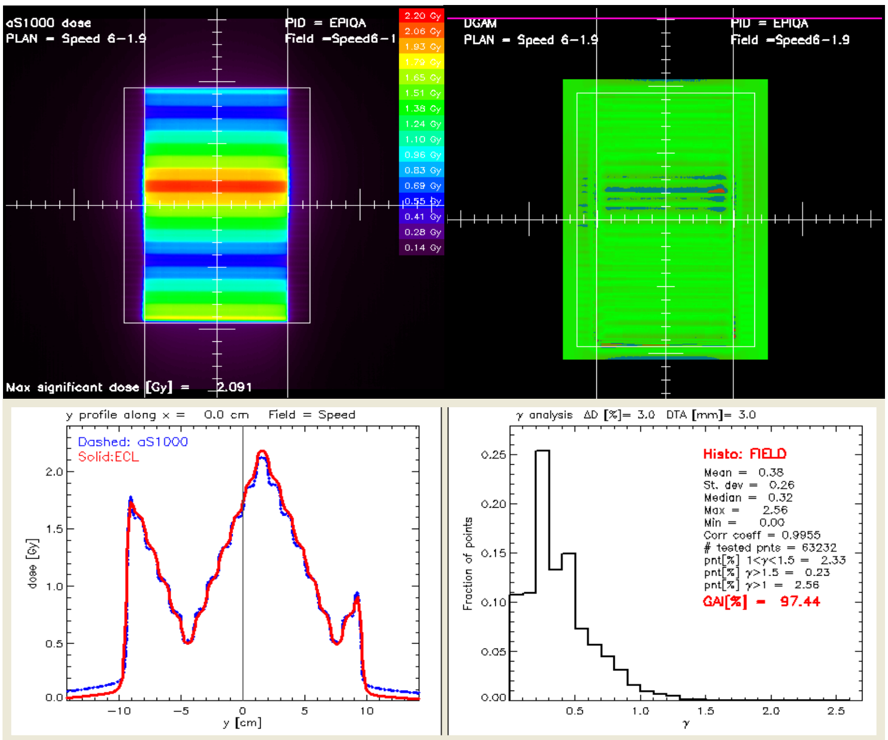


Example of some evaluation tools

- Profiles comparison
- Point evaluation - dose difference, gamma
- Results histogram and statistics
- Flexible definition of local or global gamma criteria

Verify dynamic MLC performance using classic tests recommended in the literature. Use Portal Vision dosimetry acquisition and Epiqa to evaluate results.

Leaf speed test evaluation - TPS vs. measurement or long term stability comparison.



Chair test evaluation *

Dynamic leaf gap and leaf transmission are key parameters for correct modeling of sliding window field calculation. Epiqa provides qualitative analysis of calculated vs. measured chair test field to investigate correct values.

*The sliding slit test for dynamic IMRT: a useful tool for adjustment of MLC related parameters I Chauvet et al 2005 Phys. Med. Biol. 50:563

Reference

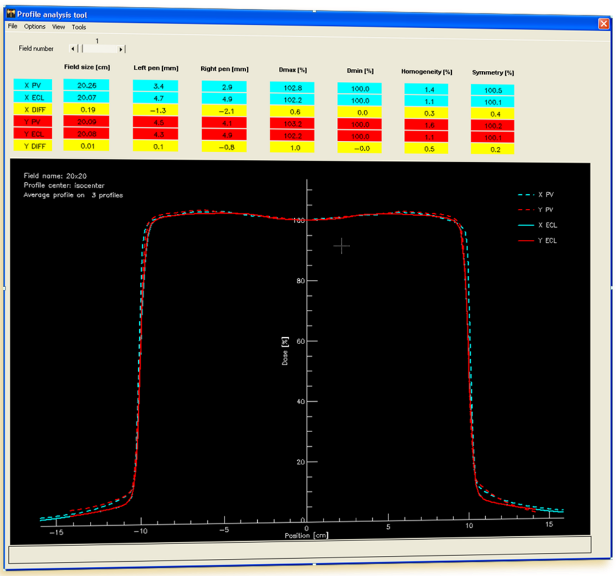
[1] Nicolini G, et al.: *GLAaS - an absolute dose calibration algorithm for an amorphous silicon portal imager. Applications to IMRT verification*. Med Phys 2006; 33: 2839-2851. to IMRT verification. Med Phys 2006; 33: 2839-2851.

Machine QA

MACHINE AND TPS COMMISSIONING & QUALITY ASSURANCE

Machine QA module provides physicist with following tools

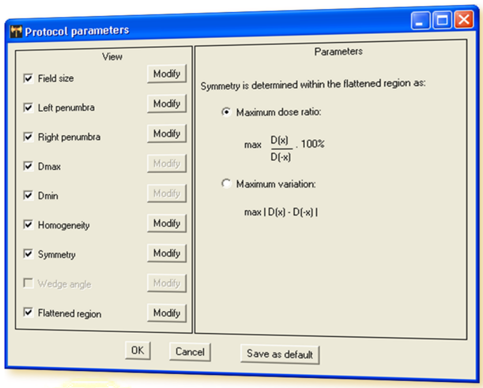
Beam symmetry and homogeneity evaluation - determination of the core beam parameters and its long term stability. 2D map comparison of the reference and measured dose map provides instant results for your morning checkout protocol.



Profile Analysis Window

Example of OPEN FIELD analysis

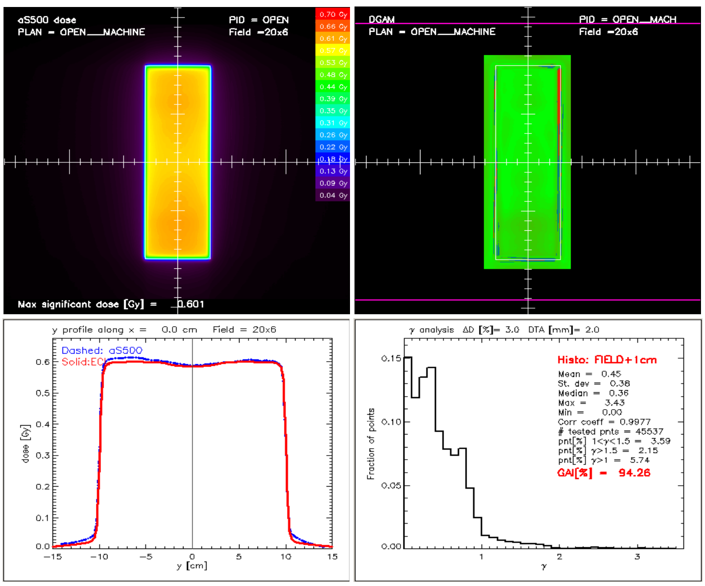
- **Solid line** - Eclipse
- **Dashed line** - measurement



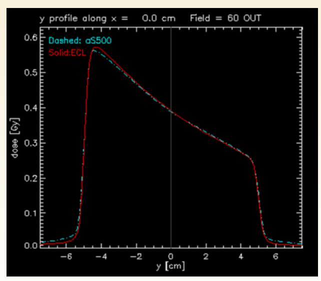
Beam energy stability verification - using small build up phantom placed on the surface of the imager. Analysis of single phantom image provides dose information of 4 different depths along the depth dose curve measured in water.

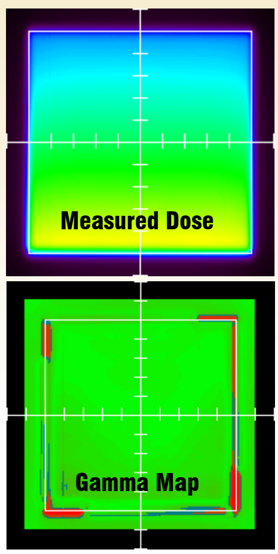
Qualitative analysis of the TPS performance after initial beam data collection - by comparing calculated open fields and wedged fields module Athena provides great help to quickly asses TPS output with the real beam without need to use film or water phantom.

Open field evaluation - TPS vs. measurement comparison at 2D level.



Wedge field evaluation - mechanical and dynamic wedge calculation vs. measurement analysis using profiles and gamma method based on dose maps.





Reference

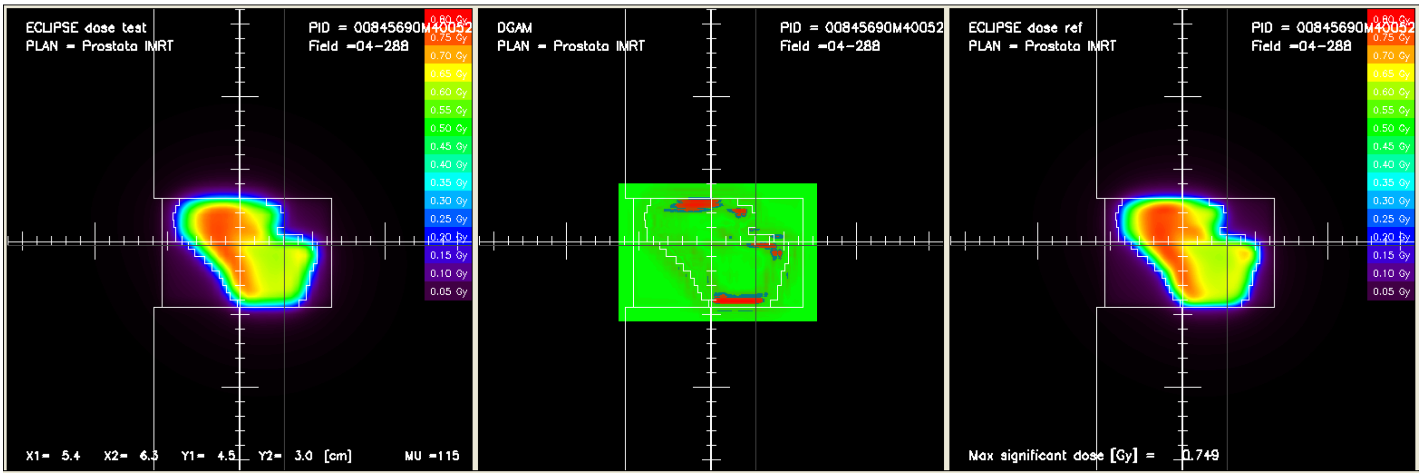
[1] Nicolini G, et al.: *Testing the portal imager GLAaS algorithm for machine quality assurance.* Radiation Oncology 2003; 3:14.

TPS Algorithm Performance Evaluation

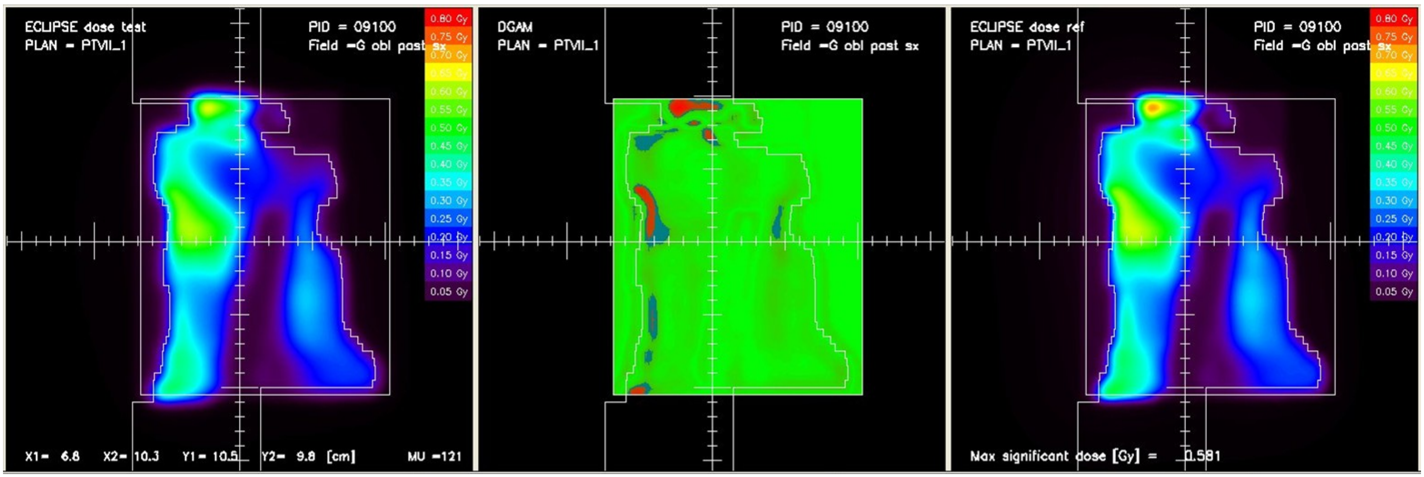
Module Hermes supports treatment planning system algorithm performance evaluation supporting following use cases

- Quantitative comparison of calculated 2D dose matrices provides independent information about results calculated with different calculation options
- Use Epiqa for continuing TPS QA by comparing equal calculations in the past and today, e.g. after Eclipse upgrade
- TPS quality assurance testing by comparing calculation result obtained by different calculation algorithms, e.g. PBC vs. AAA

1. Example of calculation matrix influence - comparison of the AAA algorithm results for calculation matrix 2.5 (right) vs. 5 mm (left).



2. Example of calculation algorithm influence - comparison of the AAA algorithm results (right) and PBC algorithm (left).



COMPLETE **EPID** DOSIMETRY

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