QUALIFORMED

QUALI*magiQ*

QUALITY CONTROL SOFTWARE
FOR RADIOTHERAPY AND MEDICAL IMAGING

The QUALIMAGIQ® platform and its modules

An optimal software solution for automatic analyses and traceability of quality controls in radiation therapy and medical imaging

For an easy, fast, organized, comprehensive and accurate QA!

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SARL

QUALIMAGIQ® software platform
→ the common base for all analysis modules

WHY CHOOSE QUALIMAGIQ® ?

■ **Interface without pull-down menus**: only buttons and tabs organized to guide you and accompany you in your work.

■ In the **automatic mode** **3 mouse clicks and 10 seconds is all it takes:**
  ⮫ 1st click - select the images to be analyzed,
  ⮫ 2nd click - analyze the selected images,
  ⮫ 3rd click - validate the analysis to generate 3 pdf reports, create a statistics point and transfer the analyzed images from the current work file to the archives file.
  ➔ **It's no longer necessary to manually – and tediously – associate images with tests!**

■ In the **step-by-step mode**: you can **customize the measurement masks and the calculation methods to meet your needs**. Even if it is "MAGIQ" (!) the software is not a mysterious black box. **You remain Master of your quality control and can observe how QUALIMAGIQ® performs its calculations**. This step-by-step mode is also a **wonderful tool to familiarize oneself with and train on our quality control software.**

QUALIMAGIQ® calculates with precision and speed

Developed with the "Image Video and Communication Team" of the Research Institute in Communication and Cybernetics of Nantes (IRCCyN), **our analysis methods** have associated scientific projects and **international publications**.

All signal extraction masks can be customized by the user, as can the calculation methods. **These masks are automatically realigned on the images to be analyzed**, ensuring correct results, even if the test objects have not been strictly aligned with the imager.

You save precious time during image acquisition – no more individual adjustment of the alignment of phantoms with the imager.

Before analysis, QUALIMAGIQ automatically sorts and controls all images. They are checked individually to make sure that they are in accordance with the protocols which you have declared. **QUALIMAGIQ thus eliminates all risk of false positive or negative results.**

QUALIMAGIQ® : a free flowing and intuitive workflow

The software platform automatically:

■ retrieves, decodes and stores the Quality Control (QC) measurements (DICOM images and dose measurements),

■ verifies that the received measurements are those excepted in the protocol programmed by the user and then sorts them, retaining only those required for that particular QC,

■ analyzes all measurements associated with a QC in just one mouse click,

■ displays a report listing all of the analysis results as well as a recap of the faulty results,

■ edits 3 QC reports in pdf format (a complete one including the analysis results together with the associated images annotated with the related measurements, a simplified report containing the results without the images and a recap of all faulty results),

■ saves the QC (measurements, analyses and pdf reports).

Use QUALIMAGIQ® software solutions to consult and track easily your Quality Controls

Here as well everything is easy, **no need to manipulate files**: just select the installation and the parameter which you wish to study over a given period. **The system then presents the time evolution curve for this parameter** with the associated "alert" and "out of tolerance" levels. **Click on any point of the curve for immediate access to the 3 pdf reports associated with this measurement.**
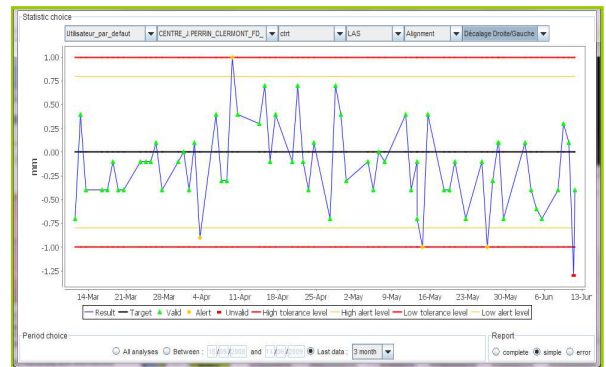
QUALIMAGIQ® adapts to all your specific requirements

It is you who decides just what kind of quality control you wish to implement, as you can fully parameterize and customize QUALIMAGIQ to meet your particular needs: settings of protocols, analysis methods, tolerances and target values. **You can also use templates of protocols and analysis methods provided as a basis to facilitate startup of the solution:**

■ The user can copy and paste these templates **which are generally in conformity with international standards,** or save all of his personalized templates.

QUALIMAGIQ® proposes 4 user levels

■ users with basic rights can analyse images,
■ intermediate users can analyze images and validate or reject an analysis,
■ super-users can also adjust protocols, analysis methods, target values and tolerances,
■ the administrator can declare users and software paths.

QUALIMAGIQ®'s architecture is structured to optimize After-Sales-Service (ASS)

To facilitate your assistance, you may grant us **remote access** to your host station directly from a QUALIMAGIQ interface. In addition, a simple right click on any exam **automatically sends an e-mail request for assistance on this exam to our ASS and deposits your faulty exam and all your program customization into your personal FTP server account.** All such program customization is contained in a single directory automatically compressed and sent by QUALIMAGIQ.

Even without an internet connection we can continue to assist you by using your program customization directory, thereby allowing us to work in our office as if we were right alongside you.

Over 95% of the time servicing consists of adjusting this customization directory and sending it back to the Client.

QUALIMAGIQ is designed to update its software itself with no need to intervene. A **test mode** is available which enables you to follow the evolution of the analysis results as the software versions evolve.

Starting up QUALIMAGIQ® with customized training

■ Hands-on training begins with basic use of the software (1-2 hours).
■ Together we complete the prescriptions for representative patients associated with your quality analyses (1-2 hours).
■ We walk you through image acquisition for the first QA (1-3 hours).
■ We parameterize the software with you, adapting it to your exact QA needs: we set protocols, analysis methods, tolerances and target values together (1-3 hours).

By the end of the training session, overall quality analysis (not just QUALIMAGIQ) is operational : you need only continue routine application !

To complete your training with the software, you can use it in **Demo mode** i.e. with a special database containing sample measurements for all types of installations and quality controls managed by QUALIMAGIQ.

Software modules for quality control of external radiation therapy treatment machines without IGRT option

Software Module MOD-EPID

Automatic analysis of an image quality control of high-energy (MV) portal imagers

Connected to the QUALIMAGIQ platform, the MOD-EPID module takes only 2 mouse clicks and 2 seconds for this module to analyze the DICOM images from the OTP-EPID, EPID-PTW or LAS VEGAS phantoms (choose either one) for detailed image quality control of a high-energy (MV) portal imager in advanced mode.
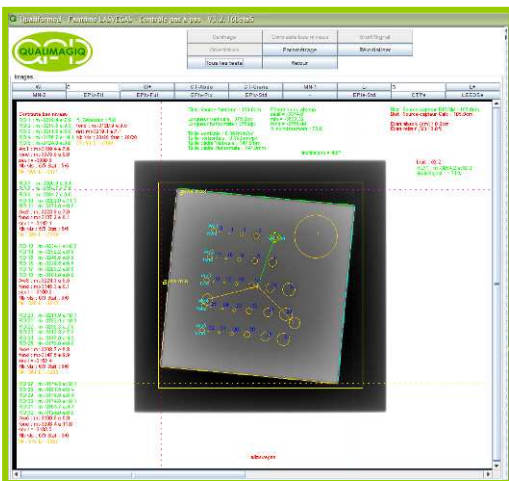
These automatic analysis consist of:

■ automatic realignment of the measurement masks onto the images to be analyzed,

■ uniformity: comparison of the average signal in 4 peripheral ROIs with the average signal of a central ROI,

■ homogeneity: comparison of the average signals in several ROIs which are uniformly distributed throughout the image,

■ noise and noise-to-signal ratio: standard deviation and the ratio of the standard deviation to the average signal in an ROI,

■ vertical and horizontal spatial resolutions (FTM with Droege and Morin method for the OTP-EPID or EPID-PTW phantoms, and with the edge spread function method for the LAS VEGAS and the OTP-EPID phantoms),

■ resolution in contrast: objective method based on a calibrated "software eye" which assigns a score in terms of visible targets,

■ vertical and horizontal geometric distortions: detection of multiple targets spaced at given intervals for the OTP-EPID and EPID-PTW test objects and detection of the edges of the phantom for the LAS VEGAS test-object,

■ linearity of the signal: measurement of the average signals behind 5, 10 or 12 metallic steps of increasing thickness and calculation of the µ of the metal,

■ uniformity of the signal linearity: in 6 regions of the sensor, measurement of the average signals behind 4 of the same 10 metallic steps (only for OTP-EPID and EPID-PTW phantoms).

Less than 15 minutes is all the time you need to perform the entire control : installation of the phantom, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module partially fulfills the requirements of the French AFSSAPS decision dated 27/07/07 regulating Internal quality control of external radiation therapy installations: points 5.9.2, 5.9.6, 5.9.7 and 5.9.10 of the annex.

Associated test objects: **OTP-EPID from QUALIFORMED, EPID-PTW from PTW, or LASVEGAS (whichever you prefer).**

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Software Module **MOD-EPID+**

Automatic analysis of a comprehensive quality control of high-energy (MV) portal imagers

Connected to the QUALIMAGIQ platform, it takes MOD-EPID+ module only 2 mouse clicks and 5 seconds to analyze the DICOM images from performance controls of a high-energy (MV) portal imager in terms of mechanical movements, field size and image quality.

This module includes all the analyses of the MOD-EPID module concerning image quality by supplementing with the following mechanical and geometrical tests:

- pixel size: comparison of dimensions in mm and in pixels of a metal frame (OTP-ALIGN phantom),
- 2D cartography of geometrical distortions with the test object OTP-DISTO,
- the mechanical play of the EPID in relation to the gantry rotation: movement of the image of a metal ball attached to the collimator (test object OTP-BALL),
- the mechanical play of the EPID in relation to its vertical movement: shift of the image of a metal ball attached to the treatment table (test objects OTP-BALL or OTP-ALIGN),
- the source-imager distance, the accuracy of the telemeter: through detection of a metal frame (OTP-ALIGN test object),
- the field size measured on the EPID: research of an iso-blackening whose level parameters can be defined by the user in an over-sampled image so it is no longer contingent upon the sensor's resolution.
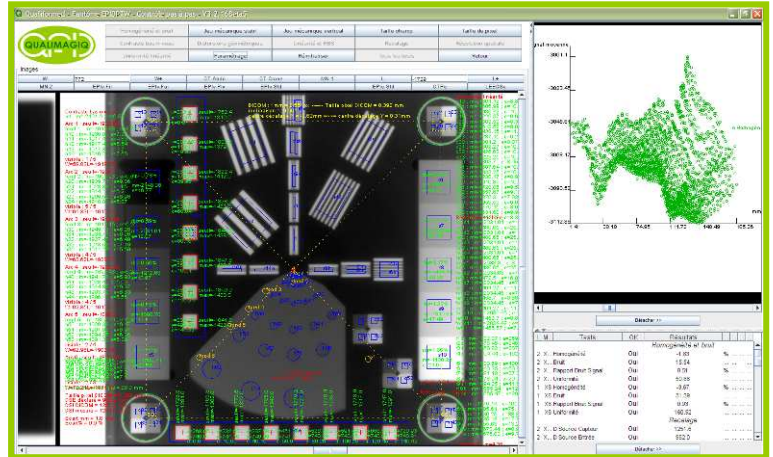
Less than 25 minutes is all the time you need to perform the entire control: installation of the phantoms, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07/07 regulating Internal quality control of external radiation therapy installations: points 5.9.2 to 5.9.10 of the annex.

Associated test objects: **OTP-EPID from QUALIFORMED, EPID-PTW from PTW or LASVEGAS (select either one) for image quality, OTP-DISTO, OTP-ALIGN and OTP-BALL for mechanical and geometrical tests.**

Software Module **MOD-ISO**

Automatic analysis of the control of the position and the size of the treatment isocenter (MV)

Connected to the QUALIMAGIQ platform, the MOD-ISO module analyzes in record time - less than 10 seconds - the many portal images made during the test proposed by Winston & Lutz to determine the size and position of the real treatment isocenter of the treatment machine (MV radiation isocenter).
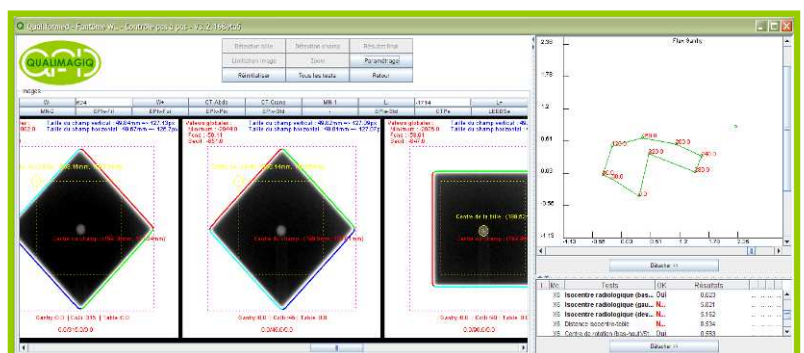
This test enables you to precisely align your various light simulations (crosshair and lasers) on the real treatment isocenter and to estimate its size (flex-maps). This test is decisive for the accuracy of patient repositioning. It is indispensable for all treatment under stereotactic conditions.

The images to be analyzed are those of an opaque metal ball placed and aligned on the theoretical isocenter of the treatment machine (intersection of laser lines).

The software performs the following automatic analyses:

- defining the region of interest on the images,
- automatic detection of the irradiation field limits and its centre or the middle of the OTP-CROSS phantom,
- automatic detection of the radio-opaque metal ball and its centre,
- determination of the position of the gantry rotation axis, the collimator rotation axis and the table rotation axis with regards to the position of the radio-opaque ball,
- determination of the position of the point closest to all three axes, i.e. of the isocenter of treatment (MV radiation isocenter),
- evaluation of the necessary realignment of the lasers on this isocenter,
- determination of the size of the treatment isocenter (MV flexmap).

Less than 30 minutes is all the time you need to perform the entire control: installation of the test object, image acquisition and analysis, yielding 3 pdf reports and statistical findings.
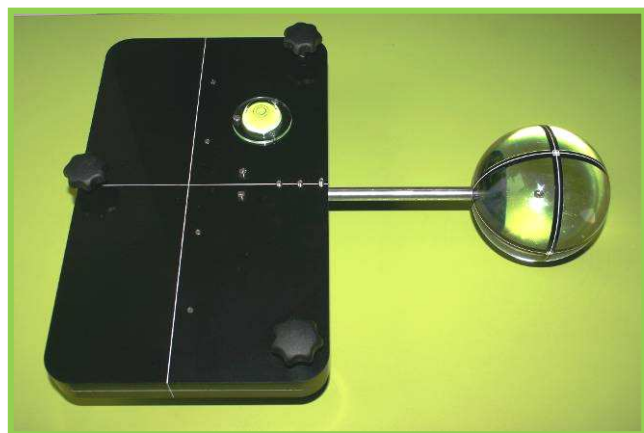
This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07/07 regulating Internal quality control of external radiation therapy installations: points 5.2.3 and 5.8 of the annex.

Associated test objects: OTP-ISO and OTP-ISO+ from QUALIFORMED or "ball-bearing phantom" from ELEKTA or BRAINLAB, and OTP-CROSS from QUALIFORMED.

Software Module **MOD-ISO+**

Automatic analysis of the control of the position and the size of the treatment isocenter (MV) and the gantry, collimator and table rotations

This module offers all the functionalities of the MOD-ISO module but also analyzes the same images to determine the real gantry, collimator and table rotation angles thanks to a unique and patented method using a modified OTP-ISO+ test object.

Less than 30 minutes is all the time you need to perform the entire control: installation of the test objects, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07 regulating Internal quality control of external radiation therapy installations: points 5.2.3, 5.2.8, 5.7.2 and 5.8 of the annex.

Associated test objects: OTP-ISO+ and OTP-CROSS from QUALIFORMED.

Software Module **MOD-MLC-stat**

Automatic analysis of a comprehensive quality control of a multi-leaf collimator

Connected to the QUALIMAGIQ platform, it takes only 2 mouse clicks and 10 seconds for the MOD-MLC-stat module to analyze the DICOM images from mechanical and dosimetric quality controls of a multi-leaf collimator in static mode, obtained via the portal imager of a linear accelerator.

The automated analyses include those associated with the controls recommended by the Belgian and French Societies of Medical Physicists and by the French Health Authority AFSSAPS (JORF dated 9/9/2007):

- the centering of the reticule in relation to the multi-leaf collimator (MLC) rotation axis,
- the size of the MLC rotation axes in relation to the reticule,
- the parallelism of the leaves in relation to the simple jaws which are parallel to them,
- the orthogonality and symmetry of the leaves in relation to the simple jaws which are perpendicular to them,
- the concordance of the prescribed MLC fields and of the light MLC fields in relation to the irradiated MLC fields,
- the accuracy of MLC leaf positioning (≠ tested fields),
- the maximal and average transmissions of the leaves (intra-leaf leakage),
- the maximal and average transmissions between two adjacent leaves (inter-leaf leakage),
- the maximal and average transmissions between two opposite leaves mechanically abutted one against the other (work in progress),
- the sagging movement of the leaf banks due to gantry rotation.

The system is compatible with all types of multi-leaf collimators.

Important Note: most of the tests use automatic detection of beam limits defined by an iso-blackening whose level can be parameterized by the user. Prior to detection the signal is over-sampled so it is no longer contingent upon the sensor's resolution. These 2 specificities render QUALIMAGIQ analyses conclusive, without false positive or false negative results.

Less than 30 minutes is all the time you need to perform the entire control: installation of the test objects, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07/07 regulating Internal quality control of external radiation therapy installations: points 5.2.1, 5.2.2, 5.2.5, 5.2.7 and 5.3.4 of the annex.

Associated test objects: OTP-FIELD28, OTP-BALL and OTP-ALIGN from QUALIFORMED.

Software Module **MOD-FIELD**

### Automatic analysis of the control of the irradiated, the light and the prescribed field sizes

Connected to the QUALIMAGIQ platform, the MOD-FIELD module analyzes in record time - less than 10 seconds - the many portal images made during quality control of field sizes.

It determines and compares the light, the irradiated and the prescribed field sizes for symmetric and asymmetric fields. The light field sizes are given in relation to the light crosshair rotation axis and the irradiated field sizes are given in relation to the X-ray collimator rotation axis. The software module also analyzes the concordances between the 3 types of fields.

This module provides two advantages: X-ray film is no longer necessary to control field sizes and it is much easier to carry out controls of gantry angles other than 0°.

In addition, this module tests the size and the position of the rotation centre of the collimator and of the associated light crosshair rotation axis, as well as the collimator's rotation angles.

Important Note: The tests use automatic detection of beam limits defined by an iso-blackening whose level can be parameterized by the user. Prior to detection the signal is over-sampled so it is no longer dependent upon the sensor's resolution. These 2 specificities render QUALIMAGIQ analyses conclusive, with no false positive or false negative results.
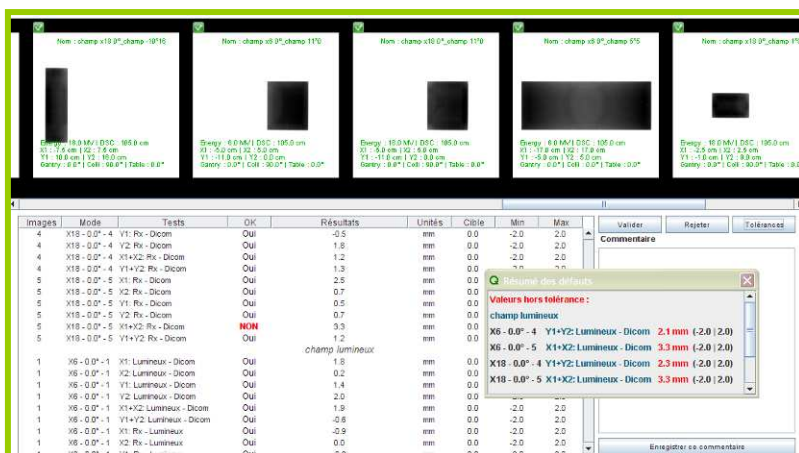
Less than 45 minutes is all the time you need to perform the entire control: installation of the test objects, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07/07 regulating internal quality control of external radiation therapy installations: points 5.2.6 and 5.3.1 of the annex.

Associated test objects: OTP-FIELD, OTP-BALL and OTP-ALIGN from QUALIFORMED.

Software Module **MOD-COLLI**

Fusion of the MOD-MLC-stat and MOD-FIELD modules

With this combined module, it is no longer necessary to repeat the crosshair rotation test for determining a light field reference position in both the MOD-MLC-stat and MOD-FIELD modules. With the MOD-COLLI module, a unique reference is used for the tests of the multi-leaf collimator and the simple collimator.

Associated test objects: OTP-FIELD, OTP-BALL and OTP-ALIGN from QUALIFORMED.

Software Module **MOD-DOSE-R**

Automatic analysis of the relative dose measurements carried out with a water tank or a matrix of detectors

Connected to the QUALIMAGIQ platform, the MOD-DOSE-R module:

- converts in DICOM-RT-dose format the many relative dose measurements (depth dose curves, profiles, dose maps) carried out during the dosimetric quality control of the linear accelerator used for radiation therapy treatments. Currently IBA and PTW proprietary formats can be converted into DICOM by the DOSE-R module.
- stores the data converted into DICOM in the QUALIMAGIQ data base.
- analyzes in less than 3 seconds all these relative dose measurements acquired in electron and photon beams. These analyses are performed according to a protocol selected by the super-user from a list of international protocols available in the MOD-DOSE-R (IAEA-277, IAEA-398, IEC-976, ICRU-35, AAPM-TG25, AAPM-TG51, DIN 6800, IPEMB, NCS, NACP, HPA, SFPM).

For the dose profiles in electron and photon modes, these automated analyses calculate:

- the size of the homogenous area, the homogeneity, the symmetry and the maximum deviation,
- the field size, the penumbrae, the field center offset,
- the slope of the wedge filter (only in photon mode).

For the depth dose curves in electron mode, these automated analyses are performed on ionization curves or on dose curves automatically calculated by the MOD-DOSE-R module. These analyses cover :

- the extrapolated dose at the surface and the X-ray contamination dose,
- the mean energy Eo and the most probable energy at the surface Epo,
- the quality index,
- the ranges at 50% and 100 % of dose, the therapeutic and practical ranges: R50, R100, Rt, Rp,
- the exit dose gradient.

For photon depth dose curves, MOD-DOSE-R module calculates :

- The extrapolated dose at the surface and the dose at 50, 100 and 200 mm,
- The quality index,
- The ranges at 50% & 100 % of the dose.

These tests are very comprehensive but it's up to the super-user to decide whether or not to enable a test.

This module allows you to analyze the relative dose measurements with the same formalism as other quality control measurements processed by QUALIMAGIQ. It benefits from the same traceability tools for quality controls (3 different types of pdf reports and time evolution curve of a tested parameter).

3 mouse clicks and less than 2 seconds is all you need to analyse automatically all the depth dose curves and profiles performed during a linac quality control and to produce the 3 associated pdf reports.

This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07/07 regulating internal quality control of external radiation therapy installations: points 5.3.2, 5.3.3, 5.3.5, 5.4.2, 5.4.3 and 5.4.4 of the annex.

Associated water tanks systems: PTW and IBA.

Specific software modules for quality controls of the **IGRT** options of **external radiation therapy** treatment machines

Software Module **MOD-ISO-KV**

Automatic analysis of the test of the size, position and correspondence of the 2 isocentres MV and KV for an IGRT treatment machine with X-Ray tube (KV mode)

Connected to the QUALIMAGIQ platform, the MOD-ISO-KV module analyses in record time - less than 15 seconds - the many portal MV and KV images acquired during the test proposed by Winston & Lutz to determine the size (flex map) and position of the MV and KV isocenters of the treatment machine.

Afterwards the software module calculates the differences between the positioning lasers and the KV repositioning isocenter with the MV treatment isocenter.

This test precisely situates the exact position and size of the treatment isocenter (MV radiation isocenter) in relation to the positioning lasers and the repositioning isocenter (isocenter KV). This enables you to realign the lasers and the KV isocenter on the treatment isocenter.

This test is crucial for an IGRT installation because it is essential to:
- make sure that the considerable additional weight on the gantry does not increase the size of the treatment isocenter (MV) and hence the geographic accuracy of the treatment,
- control the KV isocenter size, because it directly influences the quality of images acquired with a cone beam (Cone Beam CT),
- control the KV isocenter position relative to the treatment isocenter in order to realign. Any misalignment of the KV isocenter used to produce patient repositioning images deteriorates the geographical accuracy of the treatment.

The Winston & Lutz test is also indispensable for all treatments in stereotactic conditions.

The automatic analyses performed by this software module are the same as those performed by the MOD-ISO module, but here they are applied to both series of images: MV and KV portal images.

Less than 45 minutes is all the time you need to perform the entire control: installation of the phantoms, MV and KV image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07/07 (Internal quality control of radiation therapy installations) regulating internal quality control of external radiation therapy installations: points 5.2.3 and 5.8 of the annex.

Associated test objects: OTP-ISO or OTP-ISO+ from QUALIFORMED or « Ball bearing phantom » from ELEKTA or BRAINLAB, and OTP-CROSS from QUALIFORMED.

Software Module **MOD-ISO-KV+**

Automatic analysis of the control of the position and the size of the radiation isocenters (MV and KV) of an IGRT treatment machine in KV mode as well as of the gantry, collimator and table rotations

This module offers all the functionalities of the MOD-ISO-KV module, and uses the same images to determine the real gantry, collimator and table rotation angles by applying a unique and patented method using a modified OTP-ISO+ test object.

Less than 45 minutes is all the time you need to perform the entire control: installation of the test objects, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07/07 regulating internal quality control of external radiation therapy installations: points 5.2.3, 5.2.8, 5.7.2 and 5.8 of the annex.

Associated test objects: OTP-ISO+ and OTP-CROSS from QUALIFORMED.

Software Module **MOD-18FG**

Automatic analysis of the image quality control of a low-energy (KV) portal imager used for IGRT in 2D mode

Connected to the QUALIMAGIQ platform, it takes only 2 mouse clicks and 2 seconds for the MOD--18FG module to analyze the DICOM images issued from the image quality controls of the low energy (KV) imager of an IGRT installation used in 2D mode.
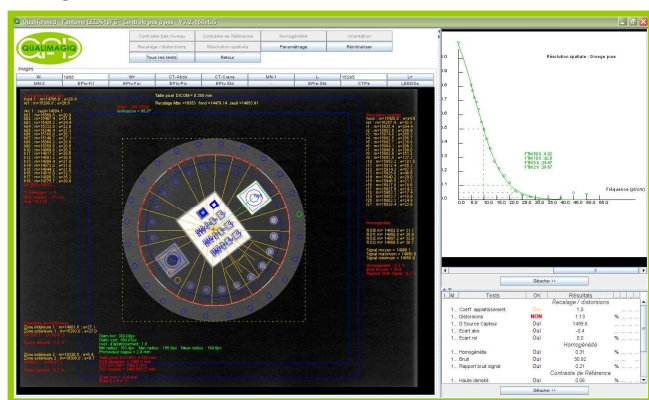
This image quality analysis consists of an evaluation of:

- uniformity: comparison of the mean signal within 4 peripheral ROIs with the mean central signal,
- homogeneity: comparison of the mean signals within multiple ROIs evenly distributed throughout the slice,
- noise and noise/signal ratio: standard deviation and standard deviation ratio to mean signal within a ROI,
- automatic realignment of the measurement masks on the images to be analyzed,
- spatial resolution (FTM with Droege-Morin method),
- resolution in contrast: objective method based on a calibrated "software eye" which assigns a score in terms of visible targets,
- reference contrasts: objective measurement of a low contrast in presence of a high signal and of a high contrast in presence of a low signal
- geometrical distortions: control of the internal vertical and horizontal diameters of a phantom.

Less than 5 minutes is all the time you need to perform the entire control: installation of the test object, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07/07 regulating internal quality control of external radiation therapy installations: points 5.9.2, 5.9.6, 5.9.7 and 5.9.10 of the annex.

Associated test objects: LEEDS pattern, either type TOR 18FG or TOR 18FL.

Software Module **MOD-18FG+**

Automatic analysis of a comprehensive control of a low-energy (KV) portal imager used for IGRT in 2D mode.

Connected to the QUALIMAGIQ platform, module MOD--18FG+ completes module MOD-18FG by analyzing the images issuing from the mechanical and geometrical controls of the low energy (KV) imager of an IGRT installation used in 2D mode.

This module includes all the analyses of the MOD-18FG module concerning image quality by supplementing with the following mechanical and geometrical tests:

- pixel size: pixel size : comparison of dimensions in mm and in pixels of a metal frame (OTP-ALIGN phantom),
- 2D cartography of geometrical distortions (OTP-DISTO phantom),
- mechanical play of the KV imager in relation to the gantry rotation: movement of the image of a metal ball attached to the collimator (OTP-BALL phantom),

- mechanical play of the KV imager in relation to its vertical movement: movement of the image of a metal ball attached to the treatment table (OTP-BALL or OTP-ALIGN phantoms),
- source-imager distance and accuracy of the telemeter: detection of a metal frame (OTP-ALIGN phantom).

Less than 20 minutes is all the time you need to perform the entire control: installation of the phantoms, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07/07 regulating internal quality control of external radiation therapy installations: points 5.9.2 to 5.9.10 of the annex.

Associated test objects: LEEDS pattern, either type TOR 18FG or TOR 18FL, for image quality tests, OTP-DISTO, OTP-BALL and OTP-ALIGN for mechanical and geometrical tests.

Software Module **MOD-CTP**

Automatic analysis of the image quality control of an IGRT imager in 3D KV mode

Connected to the QUALIMAGIQ platform, it takes only 2 mouse clicks and 10 seconds for the MOD-CTP module to analyze the DICOM images issued from the image quality controls of the on-board imager of an IGRT installation in 3D KV mode.

These automated analyses cover:

- sensitometry,
- slice thickness and sensitivity profile,
- pixel size,
- geometric distortions,
- low level contrast,
- spatial resolution (Droege-Morin & PSF methods),
- noise and noise-to-signal ratio,
- uniformity and homogeneity of the signal.
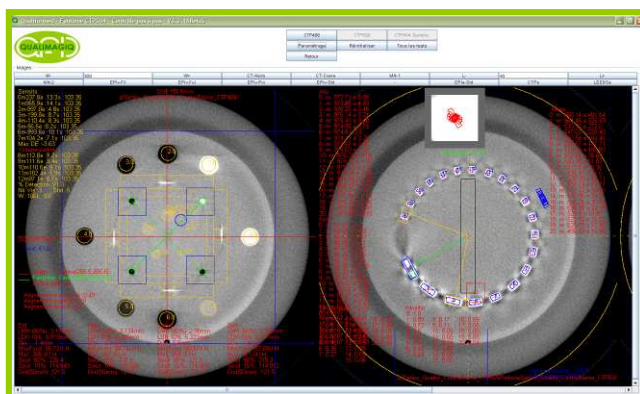
Less than 10 minutes is all the time you need to perform the entire control: installation of the phantom, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

Associated test objects: either CATPHAN 500, 503, 504 or 600 from Phantom Laboratory

Software Module **MOD-DE**

Automatic electronic density calibration of images from a CT-scanner dedicated to radiation therapy or "on-board" CT-scanner integrated on a treatment machine with IGRT option (mode 3D KV or MV)

Connected to the QUALIMAGIQ platform, it takes only 2 mouse clicks and 2 seconds for the MOD-DE module to analyze all DICOM images obtained with the CIRS 062 phantom, to construct the conversion curves scanner number – electronic density, and to control their constancy with regards to those registered in your TPS.

These automated analyses cover:

- Images coming from different voltages of the X- ray tube (KV) or from other MV energies,
- Images coming from 2 diameters of the phantom.

All the measurement masks are realigned onto the images of the phantom (translations and rotations).

The dense signals (trabecular bone, cortical bone and titanium) can be extracted separately to avoid their "artifacting" onto weak and medium signals (air cavities to soft tissue).

Furthermore, the MOD-DE module can process various image series; those from which only bony signals can be extracted, image series from which only soft tissue and air signal can be extracted and finally image series from which only titanium signals can be extracted. Of course the user may, if he or she desires, also extract the bone and the soft tissues as well as the air cavities from one single and same series.

In addition to the 3 pdf reports, for the MOD-DE module QUALIMAGIQ creates a comprehensive report in MS-Excel file format, with a separate spreadsheet for each anatomy-KV pair.

This greatly simplifies entering of calibration data into your treatment planning system.

Less than 10 minutes is all the time you need to perform the entire control: installation of the phantoms, image acquisition and analysis, yielding 3 pdf reports, 1 MS-Excel report and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS decision dated 27/07/07 regulating internal quality control of external radiation therapy installations: point 5.10 of the annex.

Associated tests object: 062 and 062A from CIRS.

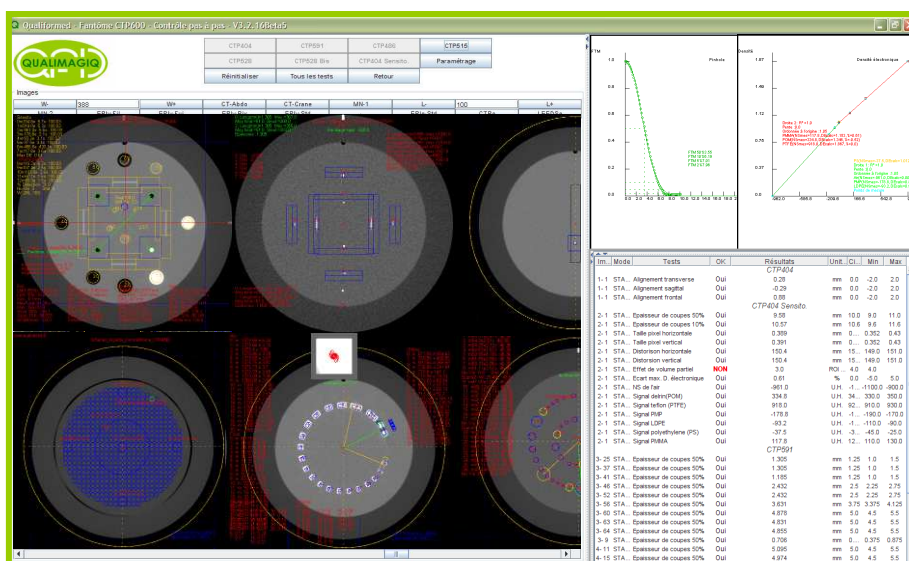# **Software modules** for the quality control of **CT-scanner** installations

Software Module **MOD-CTP**

Automatic analysis of the advanced image quality control of a CT-scanner

Connected to the QUALIMAGIQ platform, it takes only 2 mouse clicks and 10 seconds for the MOD-CTP module to analyze the DICOM images of the 6 or 5 sections of respectively the phantom CATPHAN 600 or 500 used for advanced image quality control of a CT-scanner.

These automated analyses cover:

- alignment of the internal laser positioning system,
- slice thickness for slices ≥ 0.25 mm,
- sensitivity profiles,
- pixel size,
- the effect of partial volume,
- the water signal,
- spatial resolution : FTM with Droege and Morin methods with 21 spatial frequencies and a FTM issued from the PSF,
- resolution in contrast with 41 intra and sub slice patterns,
- sensitometry with 8 or 4 different reference materials,
- noise, uniformity, homogeneity and water signal.

Less than 10 minutes is all the time you need to perform the entire control: installation of the phantom, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS Decision dated 22/11/07 regulating Quality control (QC) of CT-scanners) : points 8.4 (Internal QC) and 8.5 (External QC) of the annex.

Associated test objects: **CATPHAN 500 or 600 from Phantom Laboratory.**

Software Module **MOD-CTR**

### Automatic analysis of routine image quality control of a CT-scanner
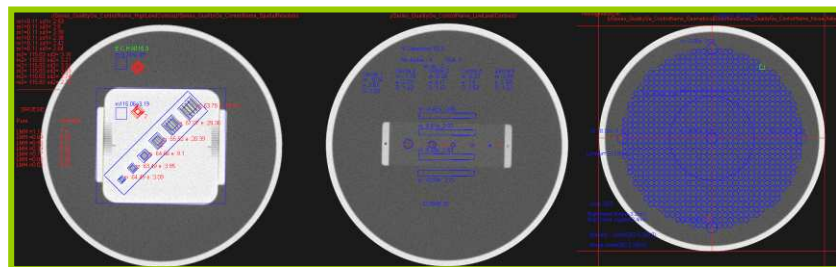
Connected to the QUALIMAGIQ platform, it takes only 2 mouse clicks and 10 seconds for the MOD-CTR module to analyze the DICOM images issued from the 1 to 4 sections of the phantoms supplied by scanner manufacturers (GE, PHILIPS, SIEMENS and TOSHIBA) and used for routine image quality controls of a CT-scanner.
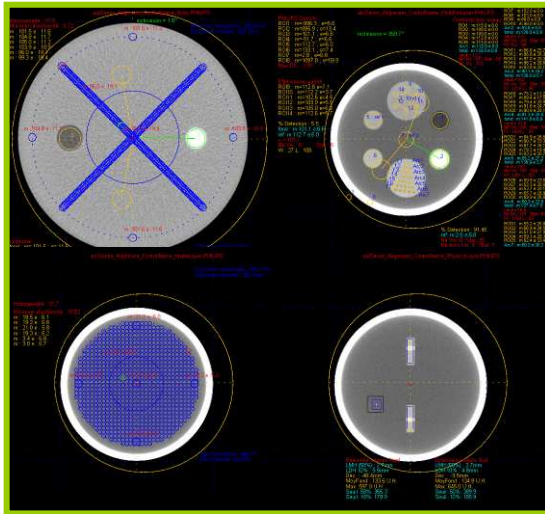
These automated analyses cover:

- sensitometry: measurement of average signals in 2 to 6 reference materials*,
- slice thickness and sensitivity profile if this is available*: method of inclined ramps,
- geometric distortion: measurement of the external vertical and horizontal diameters of the phantom,
- low level contrast (if there's an available section in the phantom*): objective method based on a calibrated "software eye" which assigns a score in terms of visible targets,
- spatial resolution: FTM with the Droege and Morin method or FTM through the PSF*,
- the water signal,
- noise and signal-to-noise ratio: standard deviation in a ROI and the ratio of standard deviation to average signal,

- uniformity: comparison of the mean signal in 4 peripheral ROIs with the mean central signal,
- homogeneity: comparison of mean signals in multiple ROIs uniformly distributed throughout the slice.
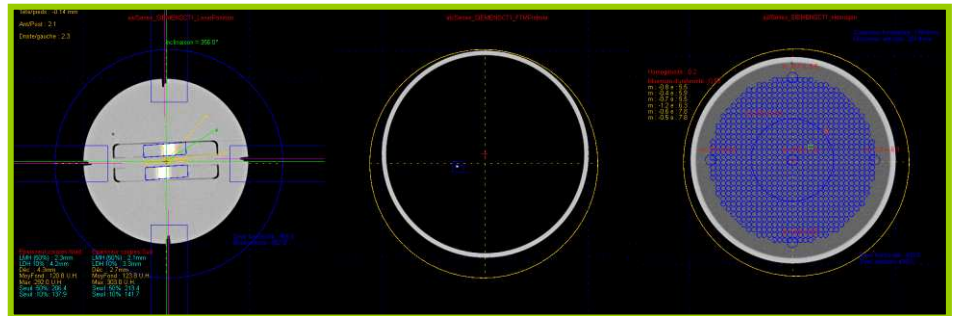
(*): depending on which manufacturer's phantom is used for the control

The module analyzes tensions (KVp) and multiple reconstruction modes. It identifies the installation and the water phantom in the test reports.

Less than 5 minutes is all the time you need to perform the entire control: installation of the phantom, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS Decision dated 22/11/07 regulating Quality control (QC) of CT scanners: point 8.4 of the annex (Internal QC).

Associated test objects: **GE, PHILIPS, SIEMENS and TOSHIBA.**

Software Module **MOD-CT**

Automatic analysis of the routine image quality control and the advanced image quality control of a CT-canner

This module combines the MOD-CTP module for advanced controls using the CATPHAN phantom of your choice with the MOD-CTR module for routine controls using the manufacturer's phantom of your choice.

Less than 15 minutes is all the time it takes to perform these 2 controls completely: installation of the test objects (2 times), image acquisition (2 times), analysis (2 times), 3 sets of pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS Decision dated 22/11/07 regulating Quality control (QC) of CT scanners): point 8.4 (Internal QC) and point 8.5 (External QC) of the annex.

Associated Phantoms: CATPHAN 500 or 600 from Phantom Laboratory for the advanced QC and GE, SIEMENS, PHILIPS or TOSHIBA for the routine QC.

QUALIFORMED

SARL

Software Module **MOD-LAS**
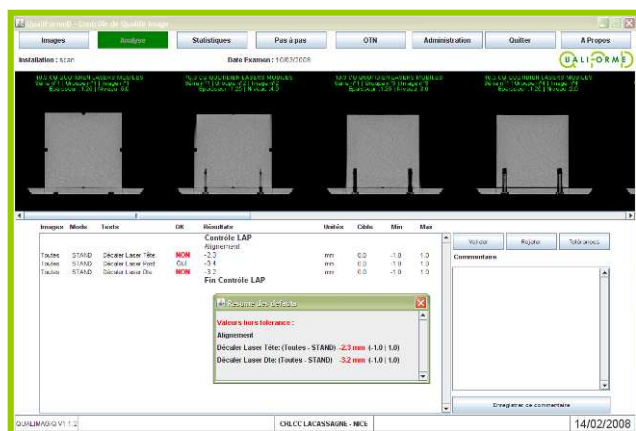
Automatic analysis of the control of the concordance between the external laser positioning system and the origin of CT-scanner dedicated for radiation therapy applications

Connected to the QUALIMAGIQ platform, it takes only 2 mouse clicks and 2 seconds for the MOD-LAS module to analyze the DICOM images issued from the Wilke phantom (LAP) or the OTP-LAS phantom (QUALIFORMED). The automated analysis consists in detecting the 4 grooves of the phantom in the CT scanner images: the sagittal groove, the 2 frontal grooves and the transverse groove.

As the external lasers have been aligned along these grooves, this module deduces the alignment of their origin in relation to the origin of the CT scanner slices.

Less than 5 minutes is all the time it takes to perform the entire control: installation of the test object, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS Decision dated 22/11/07 regulating Quality control (QC) of CT-scanners: point 8.6 of the annex, (Internal and External QC).

<u>**Associated test objects:**</u> **Wilke from LAP or OTP-LAS from QUALIFORMED**

## Software Module **MOD-PLAN**

Automatic analysis of the control in advanced mode of the external laser positioning system's alignment on a CT-scanner dedicated for radiation therapy applications, of the couch flatness and of the compliance of transversal distances by the CT-scanner

With the QUALIMAGIQ platform, the MOD-PLAN module analyzes in just 2 mouse clicks and 10 seconds DICOM images issuing from the OTP-PLAN phantom from QUALIFORMED used in the following controls: advanced control of the alignment of external laser positioning system with the scanner, control of the CT-scanner's respect of lengths and control of the flatness of the examination table.

Comprehensive quality control requires 3 scanner acquisitions using the OTP-PLAN phantom. The first with the phantom in contact with the examination table and sufficient field of vision to view the entire test object, followed by two additional acquisitions of the phantom aligned on the external lasers; first with a narrow field of vision centered around the central cube of the test object, followed by a wide angle view to capture the entire phantom.

The automated analysis consists in detecting in the scanner images:

- in the first and in the third and last scanner image: the 4 centering
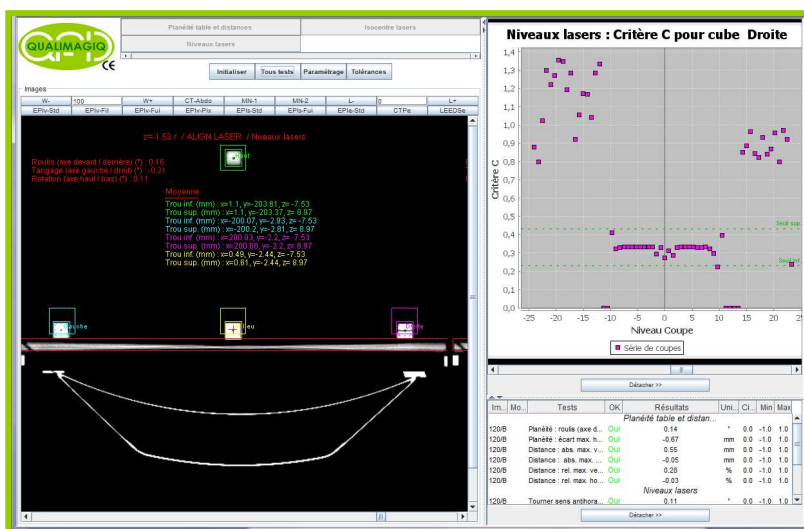
crosses contained in the 4 cubes of the OTP-PLAN phantom to compare their relative position in the images with the actual position in the test object. The flatness of the examination table, the CT-scanner's respect of the distances in the native slices, and the alignment of the external lasers with the CT-scanner's origin can then be derived from the comparisons,

- in the second zoomed image: the centering cross of the central cube of the OTP-PLAN phantom in order to derive the precise alignment of the origin of the external positioning lasers on the origin of the CT-scanner slices.

Less than 10 minutes is all the time it takes to perform the entire control: installation of the test object, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS Decision dated 22/11/07 regulating Quality control (QC) of CT-scanners: points 8.6 and 8.8 of the annex, (Internal and External QC).

Software Module **MOD-LAS+**

Fusion of the MOD-LAS and MOD-PLAN modules for an automatic analysis in routine and advanced modes of the external laser positioning system's alignment on a CT-scanner dedicated for radiation therapy applications, of the couch flatness, and of the compliance of transversal distances by the CT scanner

Associated test objects: **Wilke from LAP or OTP-LAS from QUALIFORMED for routine control and OTP-PLAN from QUALIFORMED for advanced control.**

Software Module **MOD-DE**

Automatic electronic density calibration of the images from a CT-scanner dedicated to radiation therapy and constancy control of this calibration
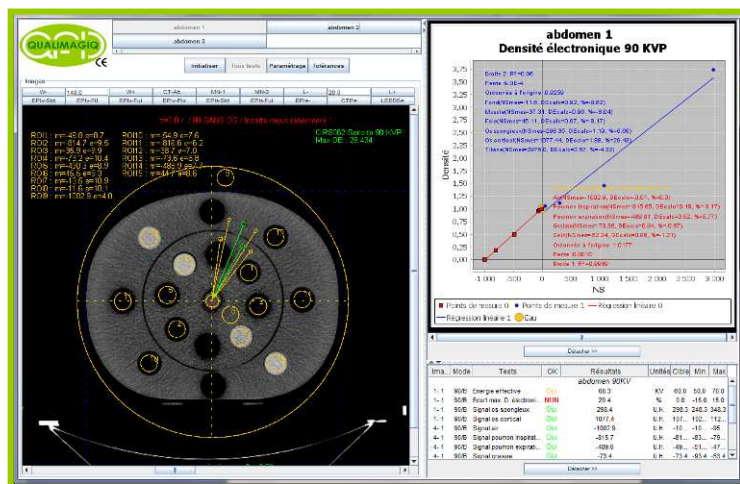
Connected to the QUALIMAGIQ platform, it takes only 2 mouse clicks and 2 seconds for the MOD-DE module to analyze every single DICOM image obtained with the CIRS 062 phantom, to construct the conversion curves of CT numbers – electronic densities and to control their constancy in relation to those registered in your TPS.

These automated analyses cover images coming from:

- different voltages of the X-ray tube (KV),
- 2 diameters of the phantom

All the measurement masks are realigned on the images of the phantom (translations & rotations).

The dense signals (trabecular bone, cortical bone and titanium) can be isolated to avoid their "artifacting" onto weak and average signals (air cavities to soft tissues). Furthermore, the MOD-DE module can process image series from which only bony signals can be extracted, image series from which only soft tissue and air signals can be extracted and finally image series from which only titanium signals can be extracted. Of course the user may, if he or she desires, also extract the bone and the soft tissues as well as the air cavities from one single and same series.

In addition to the 3 pdf reports, QUALIMAGIQ creates for the MOD-DE module a comprehensive report in MS-Excel file format, with a separate spreadsheet for each anatomy-voltage (KV) pair. This greatly simplifies entry of calibration data into your treatment planning system.
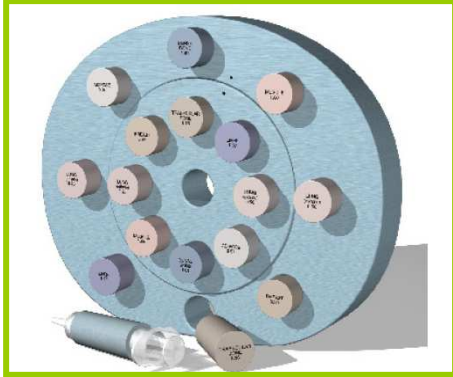
Less than 10 minutes is all the time you need to perform the entire control: installation of the test object, image acquisition and analysis, yielding 3 pdf reports, 1 MS-Excel report and statistical findings.

This module optimally fulfills all requirements of the French AFSSAPS Decision dated 27/07/07 regulating internal quality control of external radiation therapy installations: point 5.10 of the annex.

Associated test object: 062 from CIRS

QUALIFORMED SARL

Software modules for the quality control of nuclear medicine installations

Software Module MOD-PLANAR

Automatic analysis of a comprehensive quality control of a gamma camera in planar mode
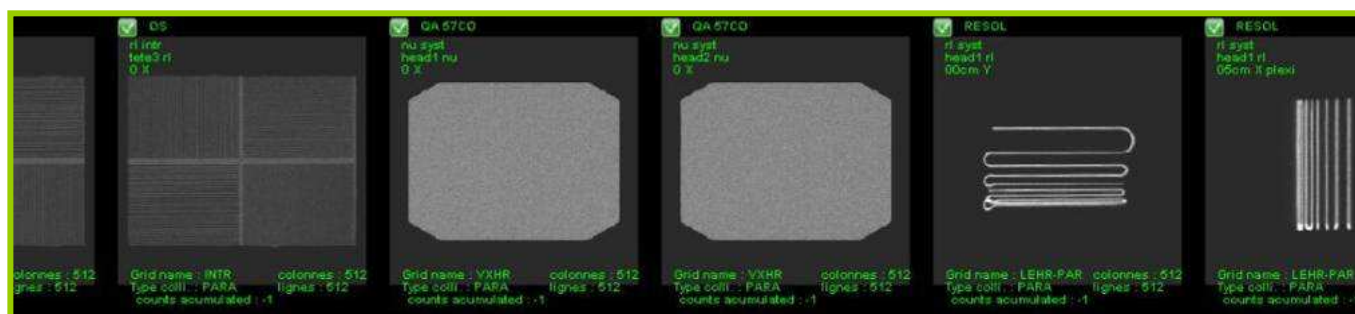
Connected to the QUALIMAGIQ platform, the MOD-PLANAR module takes only 2 mouse clicks and 10 seconds to analyze the DICOM images issued from a quality control of a gamma camera operating in planar mode.

For every head of the gamma camera, the MOD-PLANAR module automates the following tests:

- geometric distortion in tri-energy windows (5 point sources of ^{67}Ga),
- intrinsic non-uniformity,
- intrinsic spatial resolution with a 4 quadrant pattern (Hander and Droege-Morin methods),
- intrinsic spatial linearity for the 2 directions of the image plane with the same 4 quadrant pattern
- system non-uniformity,
- system spatial resolution with a multi-line phantom (^{99m}Tc serpentine source) for various thicknesses of attenuating materials and for the 2 directions of the image plane,
- system spatial linearity with the multi-line phantom (^{99m}Tc serpentine source) for various thicknesses and attenuating materials and for 2 directions of the image plane.

This module optimally fulfills all requirements of the French AFSSAPS Decision dated 25/11/08 regulating Quality control of nuclear medicine installations for diagnosis, regarding image quality control of gamma cameras in planar mode.

<u>**Associated test objects:**</u> **5 point source pattern, 4 quadrant pattern, serpentine source pattern.**

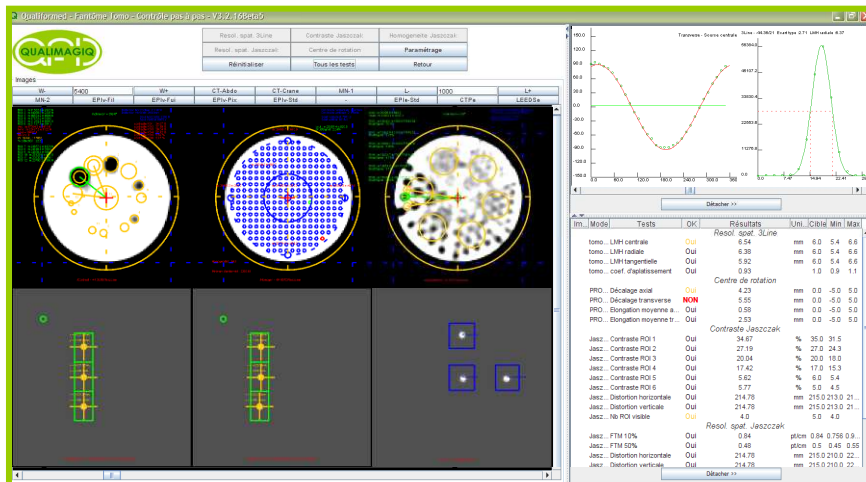## Software Module MOD-TOMO

Automatic analysis of a comprehensive quality control of a gamma camera in tomographic mode

Connected to the QUALIMAGIQ platform, it takes the MOD-TOMO module only 2 mouse clicks and 10 seconds to analyze the DICOM images issued from the quality control of a gamma camera operating in tomographic mode.

Before carrying out the tests, this module automatically processes the "image" volumes by segmenting them into perfectly identified transverse slices, by sorting these slices and by grouping them together for the requirements of certain tests.

The MOD-TOMO module automates the following tests:

- rotation center test, to determine the axial and transverse elongations and the axial and transverse shifts,
- triple line test to determine the central, radial and tangential spatial resolutions,
- noise homogeneity, noise-to-signal ratio and uniformity of the entire homogeneous section of the JASZCZAK phantom,
- spatial resolution with the Droege and Morin method in the entire hole section of the JASZCZAK phantom,

- contrast, through analysis of the signals in the 6 cold spheres of the JASZCZAK phantom's section designed for this purpose: objective method based on a calibrated "software eye" which assigns a score in terms of number of visible targets.

This module optimally fulfills all requirements of the French AFSSAPS Decision dated 25/11/08 regulating Quality control of nuclear medicine installations for diagnosis, regarding image quality control of gamma cameras in tomographic mode.

Associated test objects: triple line phantom and JASZCZAK phantom.

Software modules for the quality control of digital radiology installations

Software Module MOD-18FG

Automatic analysis of image quality control of a digital radiology installation

Connected to the QUALIMAGIQ platform, it takes only 2 mouse clicks and 2 seconds for the MOD-18FG module to analyze the DICOM images issued from the image quality controls of a digital radiology installation in radiographic or radioscopic modes.
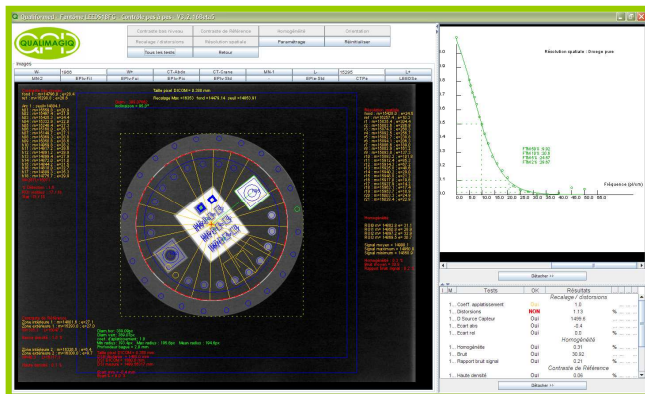
This image quality analysis consists of an evaluation of:

- uniformity: comparison of the mean signal within 4 peripheral ROIs with the mean central signal,
- homogeneity: comparison of the mean signals within multiple ROIs evenly distributed throughout the slice,
- noise and noise/signal ratio: standard deviation and standard deviation ratio to mean signal within an ROI,
- automatic realignment of the measurement masks on the images to be analyzed,
- spatial resolution (FTM with Droege-Morin method),
- resolution in contrast: objective method based on a calibrated "software eye" which assigns a score in terms of visible targets,
- reference contrasts: objective measurement of the low contrast in presence of a high signal and high contrast in presence of a low signal,
- geometric distortions: control of the internal vertical and horizontal diameters of a phantom.

Less than 5 minutes is all the time you need to perform the entire control: installation of the test object, image acquisition and analysis, yielding 3 pdf reports and statistical findings.

Associated test objects: LEEDS pattern, either type TOR 18FG or TOR 18FL.

Software modules for the quality control of nuclear **magnetic resonance imaging** (MRI) installations

Software Module **MOD-IRM-ES2**

Automatic analysis of comprehensive image quality control of a MRI installation
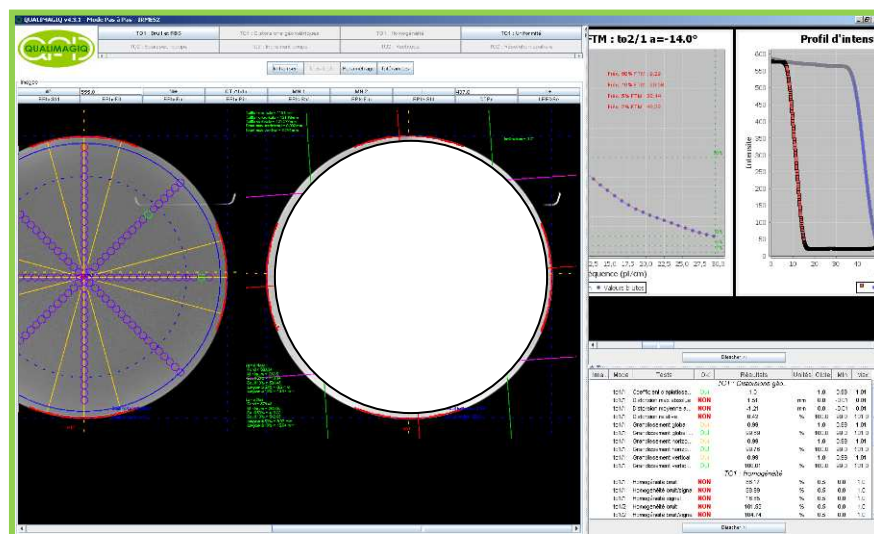
Connected to the QUALIMAGIQ platform, it takes the MOD-IRM-ES2 module only 2 mouse clicks and 10 seconds to analyze the DICOM images from the image quality control of a MRI installation.

These automated analyses are based on controls of:

- Noise, differential noise and Signal-to-Noise Ratio, noise homogeneity, signal homogeneity and rapport Signal-to-Noise Ratio homogeneity,
- Rectitude and geometric distortions,
- Slice thickness, increment and flatness,
- Spatial resolution analyzing a bar phantom and an edge spread function,
- Exactitude of relaxation times T1 and T2,
- Contrast and contrast-to-noise ratio.

Associated test objects: Eurospin II from Spin Safety Sarl and from Diagnostic Sonar Ltd.

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