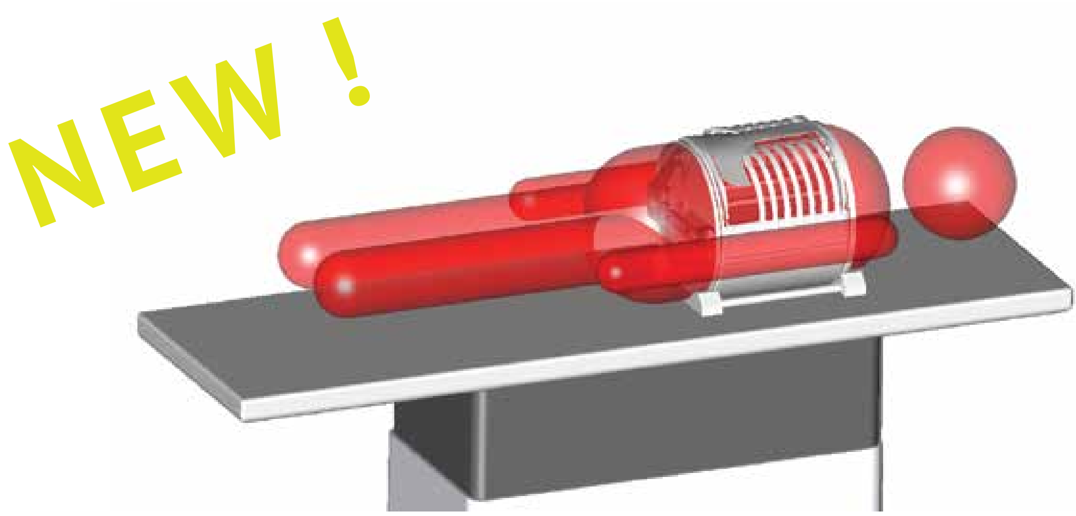
dose point

We bring dosimetry to the point

The Next Generation of QA Devices in Radiation Therapy :

The virtual**PATIENT** *for* END-to-END Process QA



Increasing Patient Safety and Treatment Success with smart solutions!

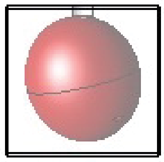
RT-smart**TOOLs** *and the* virtual**PATIENT**

The concept of providing a complete toolset for comprehensive QA and Verification in Radiation Therapy is a growing task with always new ideas and new applications.

RT-smartIMRT as cylindrical phantom is ideal for adding more features, and so already some years ago the idea came up to make this universal device convertible to a 'virtual**PATIENT**'.

With a set of new components the RT-smartTOOLs family is now ready for comprehensive Quality Assurance and Verification of the entire treatment process, starting from the Imaging all way through to Therapy Beam Delivery:

End-to-End Process QA for Radiation Therapy



INTRODUCTION:

As usual in life there is a story behind the 'virtual**PATIENT**':

For a new smartIMRT module with respiratory motion we checked the capability of 3D-Printer moving mechanics. The *'dose.point simple approach'* for software-controlled motion in 3 dimensions was to adapt this innovative open source technology to medical devices. Finally the printer was used for building 1st prototypes of mechanical parts.

3D-Printing normally is aiming to excellent outside surface geometry and smoothness, with infill to give the give the objects mechanical strength at low weight.

The virtual Tumor was created with focus on the dense and textured infill, and less on the correct outside shape. With special software and intentionally generated imperfections we can create objects with tissue-like appearance in diagnostic imaging as from CT and MRI.

These objects are made of thermoplastic material, and are designed with 3D-CAD software with some special (and unusual) settings. The specific printing parameters for density and texture allow designing 'virtual**TUMORs**' with Hounsfield values between -740 to 130, and even within separate density volumes in the same object!

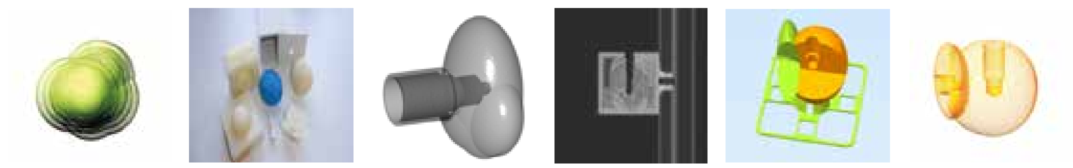
This innovative and revolutionary 'virtual**TUMORs**' are key to simple and efficient Process QA, and also inexpensive as 3D-printing is an affordable, flexible and matured technology.

Another positive side effect: the respiratory motion simulating modules 'moving**SKIN**' and 'moving**TARGET**' are now working with just one motor, without any electronics or software.

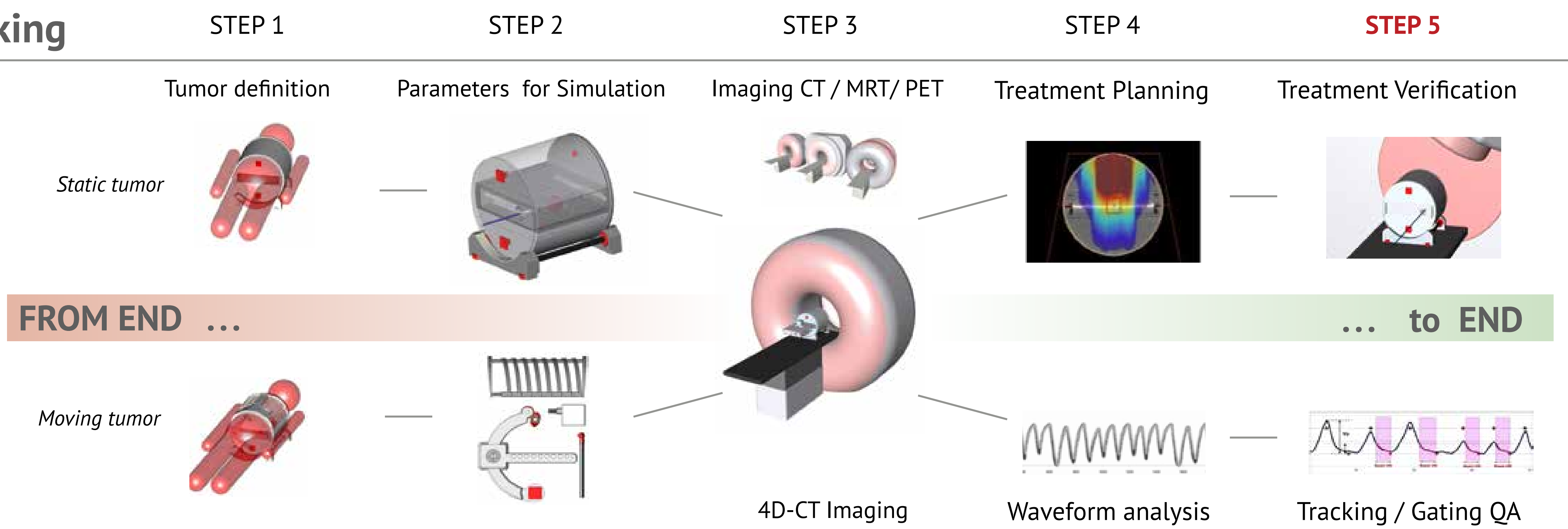
Benefit: simple, precise and highly efficient QA from Imaging to Beam Delivery with a new smart technology!

END - to - END

KEEP IT SIMPLE !



The virtualPATIENT, what is required and how it is working



The CONCEPT:

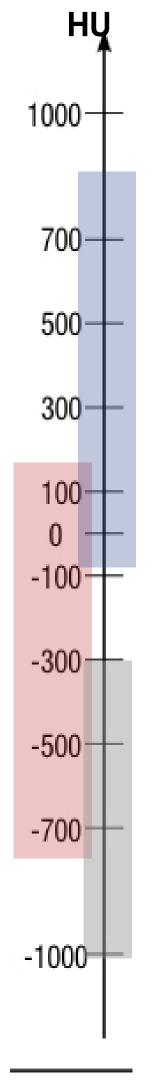
The concept is simple: an irregular object made of durable plastic material inside a body-like phantom simulates a tumor, on which the complete chain for tasks in radiation treatment is applied. The process starts with diagnostic imaging, the object appears as 'tissue' because texture and density can be selected in order to give this object a 'virtual Tumor' appearance.
Two new modules, movingSKIN and movingTARGET, allow to simulate patient breathing and induces tumor motion.

The virtualPATIENT can be used for regular ***End-to-End Process QA***. As is doesn't change the properties any change of parameters in the reatment chain will be detetced.
Due to the design of the virtualPATIENT a lot of different setups can be simulated, which makes it ideal for testing particular parameters. So it is perfect as well for simulation and education / training purposes.

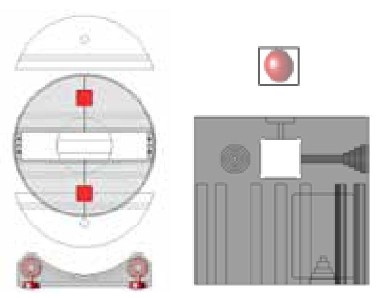
The BENEFITs:

The virtualPATIENT is a novel tool for regular constancy checks on all procedures in the Radiation Therapy treatment chain, from Imaging to Beam Delivery.

- Simple and efficient
- Modular with only few components
- Device handling as 'real patient'
- Easy to integrate in daily routine
- Versatile and reproducible
- Fast setup and alterations to other QA / Verification tasks
- virtualTUMORs as 3D-printing parts easily customizable.



Equipment for static Tumor Simulation



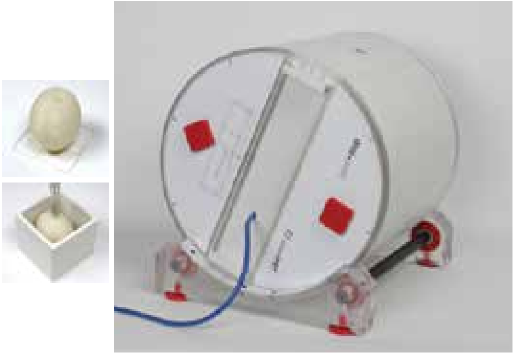
The benefit of a product family is that components fit together.

smartCUBE-*VT*, containing the virtualTUMOR, fits perfectly inside the smartCTQA, and this inside the smartIMRT.

There are hundreds of different positions and of orientations for the virtualTUMOR inside the cylinder, and additionally the cylinder can be rotated to predefined angle displayed on a scale.

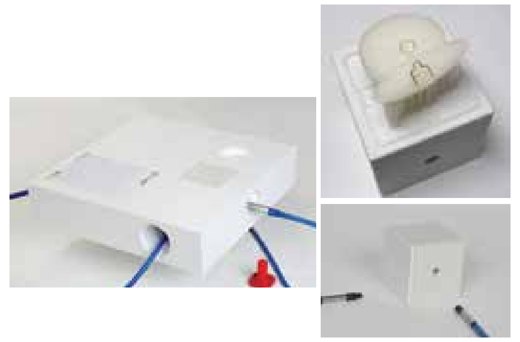
For static single Tumor

The virtualPATIENT offers a huge number of individual setups by combining just 3 modules: smartCUBE-VT, smartCTQA and smartIMRT, plus one detector for the verification of point doses in the ISO center.
The smartCTQA offers another feature, as in one section boreholes contain inhomogeneity inserts, which can be used as absorbers in order to make the Process QA more complex.
With the boreholes in direction of the smartIMRT rotational axis the virtualTUMOR is close or in the phantom center, and only RW3 material around.
When the smartCTQA is rotated 90°, the virtualTUMOR is off-center and the beam also going through the absorbers during delivery., reslting in higher complexity QA.

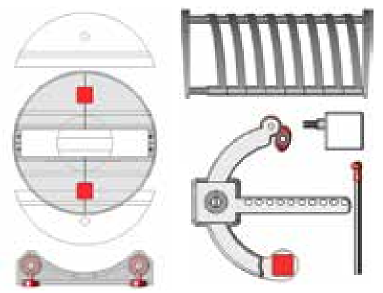


For static Tumor / Risk Organ

With a special combination od 3D-CAD and 3D-printer software it is possible to produce objects which contain different textures and densities in different interconnected volumes.
So we provide virtualTUMOR plus risk organ in one smartCUBE-*VT* housing with 2 perpendicular ports for small volume radiation detectors, fitting well inside the RT-smartCTQA.
This is new and exciting, as with only a 4 extra holes in the smartIMRT side plates the virtualPATIENT can be used for checking point dose values between 2 nearby points.



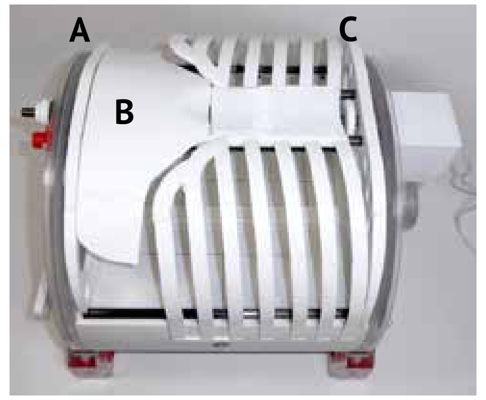
Equipment for Respiratory Motion Simulation



First a concept with 6 motors, and now just one, which normally is turning the table in microwave ovens. Very simple mechanics as in every car engine: camshaft.
The alteration of smartIMRT from Plan-verification with 2D-Array to a device for respiratory motion QA takes only few minutes.
The motor can be attached directly to the phantom, via long cardan-shaft. So the motor is far away from the phantom, which can be used in CT and MRI: no metal, no artifacts.

For Chest Motion

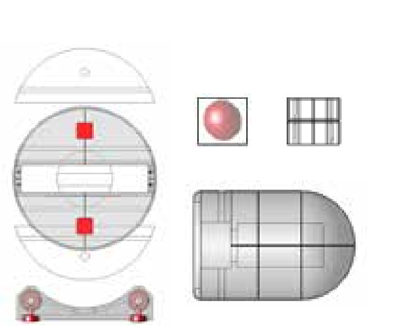
The chest is a bridge design with a set of ribs and sternum plus a separate surface for abdominal (***B*** for Belly) motion. All parts are replacing the upper segment of smartIMRT, alteration is done in 2 minutes. Changes in the smartIMRT frame are not necessary.
The rib cage is moved vertically by cam plates close to the 2 acrylic disks of the smartIMRT, ***A*** for Abdominal and ***C*** for Chest.
The amplitude is 10 or 15 mm on each side, the cam plates can be exchanged with plates of different amplitde or profile. The cam plates are fixed on the slowly rotating tube, so the phase of motion on either side can be adjusted.
The belly surface has a separate motion with amplitude of up to 40 mm.
The entire chest can be covered with bolus material or patient fixation for placing markers. The ribs are covered with plaster for better CT imaging, the cage is dynamically expanding at the sides during breathing cycles as option.



For Tumor Motion

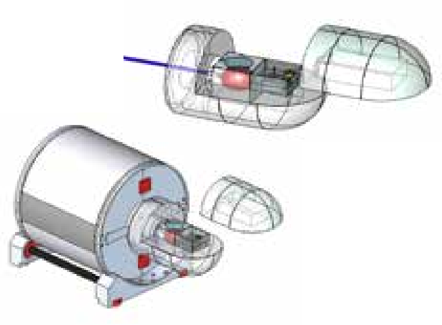
The movingTARGET inside the smartIMRT box is connected to the same drive as the the movingSKIN. The outer cam plate is available with different profiles and can be attached and fixed with defined phase to the chest motion.
The movingTARGET is a small volume 3D-printed virtualTUMOR with low density and cavity for small ion chambers as Semiflex or PinPoint.
Mounted on the tip of a carbon fiber tube it is easy to fix it in specific positions, given by 9 mounting holes.
The proper tumor tracking is simulated best by narrow pencil beam and check of dose rate constancy.

For Stereotaxy:



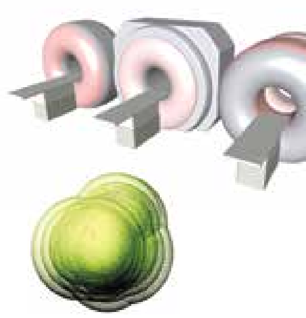
The long-term project for the smartSTAXY phantom got a kick by the concept of virtualTUMOR inside the RT-smartCUBE. The size of 7 cm edge length is ideal for the acrylic head phantom, which has space for 2 cubes.

One for the virtualTUMOR with small volume and small volume detector, plus one more smartCUBE which contains either contrast, resolution tests or geometrical marks for test of auto-positioning systems for the couch.



For Auto-contouring

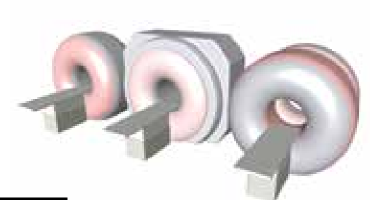
3D-printing is amazing, objects can be made with different internal stucture and densities, all in one single manufacturing process.
As example: the onion-like structure with shell-wise increasing density from surface to inside is nothing which can be made with other technologies thet easily.
Application: this objetct in the smartCUBE housing is a simple and perfect tool for regular check of auto-contouring algorithms after imaging.
Many orientations are possible, and a virtualTUMOR with reduced density steps and lower contrast the QA can be made more selective.
This method can be applied also to MRI when the virtualTUMOR is soaked with liquids.

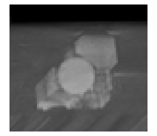


For Image Merging / Fusion

Object with well known parameters related to shape and dimensions can made in order to check the Image Merging / Fusion capabilities as routine QA task.

The virtualTUMOR is inside the smartCUBE-*VT* housing and capable of CT and MRI, and the geometry in different orientations after registration process shows if fusion comes to the good result. Volumes with higher or smaller density gradients can be combined in the same object.





***RT*-smartTOOLs are:**

RT-smartIMRT

movingSKIN

movingTARGET

RT-smartCTQA

RT-smartCUBE*VT*

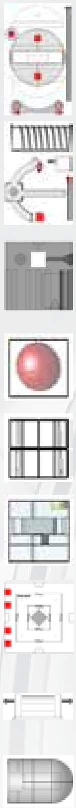
RT-smartCUBE*ISO*

RT-smartCUBE*Qx*

RT-smartQA+
RT-smartQA
RT-smartFILM

RT-smartSLAB

RT-smartSTAXY



dose.point

We bring dosimetry to the point

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RT-smartCUBExxx product familly except smartCUBE ISO, movingSKIN and movingTARGET: Work in Progress, product release in 2016.

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