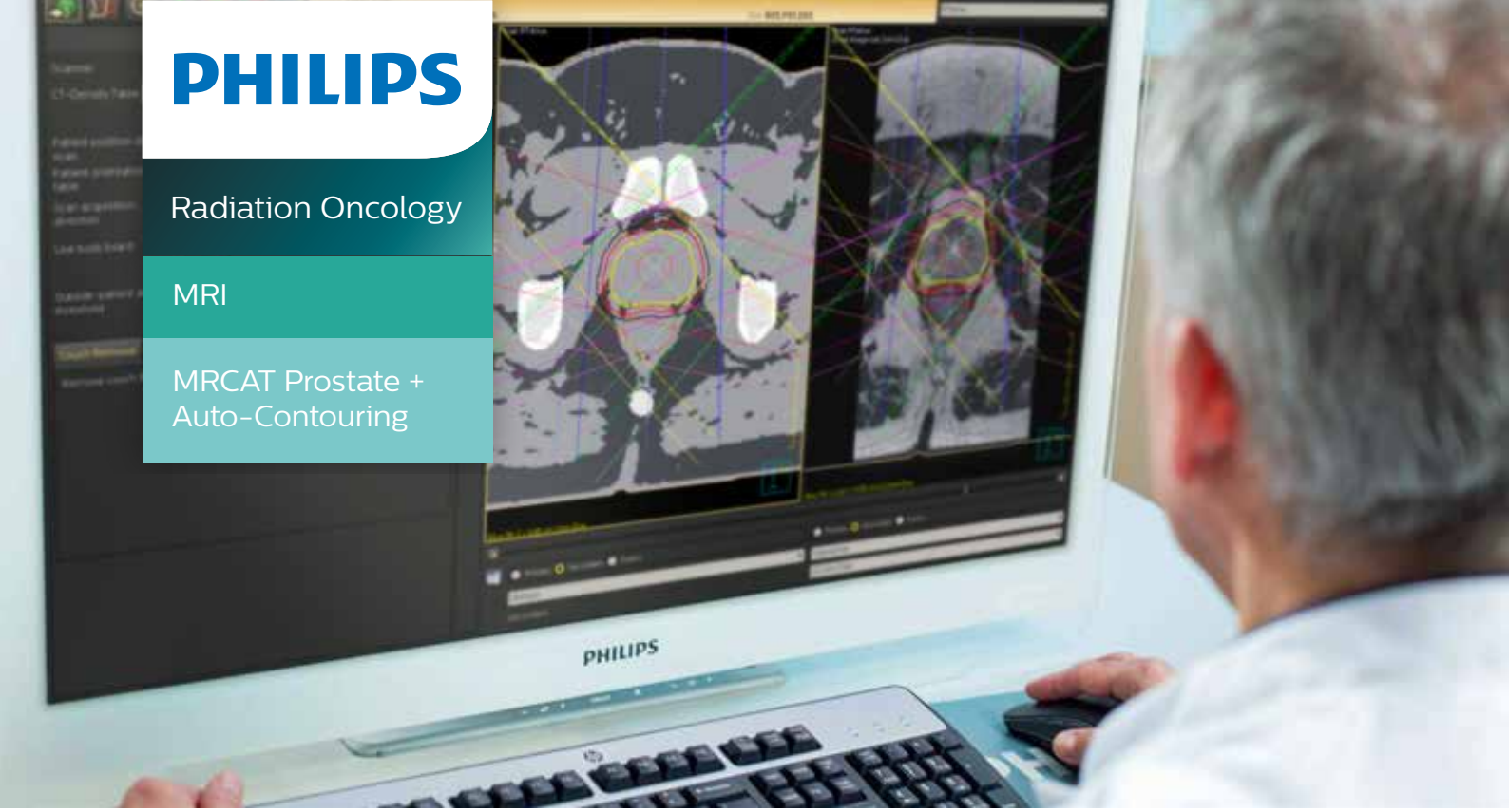


Drive speed, accuracy and consistency

MRCAT Prostate + Auto-Contouring

As a plug-in clinical application to Ingenia MR-RT, MRCAT Prostate + Auto-Contouring provides density information for dose calculations and accurate MR-based contours in as little as 20 minutes – all in a repeatable 'one-click' workflow. Because MRCAT Prostate + Auto-Contouring requires input from MR images only, it reduces the organization and coordination of scans, eliminates the effort involved in MR-CT registration, and saves the patient from undergoing multiple procedures.

Moreover, Auto-Contouring automates standard, labor-intensive and repetitive tasks, while at the same time reducing variability and errors caused by manual steps. This improves consistency and reproducibility – for more confidence in the planning process.

The combination of MRCAT Prostate and Auto-Contouring allows you to plan prostate radiotherapy using MRI only. As a single-modality solution, it eliminates errors introduced by MR-CT registration, leverages MRI's exceptional soft tissue contrast, and increases consistency and efficiency in contouring, allowing better use of departmental resources.

Fast, consistent imaging protocol
A dedicated, standardized imaging protocol includes a T1W mDIXON XD and a T2W TSE scan as source data for the generation of MRCAT (MR for Calculating ATtenuation) density maps and MR-based Auto-Contouring. Compressed SENSE acceleration keeps the total scan time short, which promotes patient comfort by minimizing time in the scanner and helps to boost productivity.

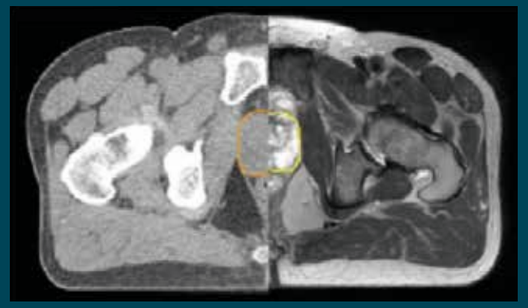
Automatic generation of synthetic CT images
MRCAT Prostate automatically generates attenuation maps using the high-resolution mDIXON scan as source. Smart, validated algorithms enable automatic tissue segmentation and assignment of Hounsfield units to deliver MRCAT images with CT-like density information for dose calculations. As the density information is generated directly on the MR console, the resulting data is available at the console for immediate review. This potentially reduces the need to call patients back for repeat exams.

Accuracy in dose planning
The MRCAT Prostate scanning protocol and generation algorithms have been designed with the strict accuracy requirements of RT in mind. MRCAT Prostate images have high geometric accuracy[2] and validation studies have shown that MRCAT-based dose plans are robust and equivalent[3] to CT-based plans promoting confidence in dose planning.

Create accurate[4] contours with little to no user interaction
MR-based Auto-Contouring automatically creates contours of prostate and OARs, reducing repetitive tasks and time spent, compared to manual methods. It uses dedicated MR imaging data based on the 3D T2W TSE and T1W mDIXON XD sequences and model-based adaptive algorithms. Auto-Contouring delineation of prostate and OARs has been found to be accurate (average distance < 1.5mm)[4] in at least 70% of contours evaluated[5]. This significantly reduces the need for manual contouring or manual adaptations, while increasing consistency.

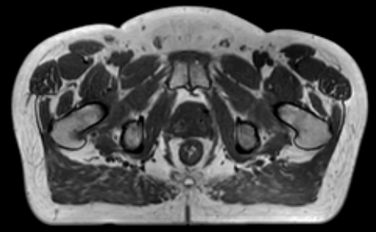
MRI as primary image set in treatment planning
The MRCAT images generated on the MR console conform to the DICOM standard (modality CT) and hence can be exported to treatment planning systems (TPS) as the primary image dataset. Together with the generated contours (RTSTRUCT) and the ability to generate MRCAT-based digitally reconstructed radiographs (DRRs), you can replace your traditional CT-based workflow with an MRI-only radiotherapy workflow from imaging and planning to position verification.

Enhance prostate target contouring with MRI's excellent soft-tissue contrast
Target delineation is one of the most critical steps in the radiotherapy chain. MRI offers superior soft-tissue contrast compared to CT, supporting greater target contouring accuracy, while aiding in the structural visualization of organs at risk. CT-based delineation often overestimates the prostate volume as compared to MRI and multiple studies have shown that MR imaging can reduce the volume of contoured prostate by approximately 30%[1].



MRCAT Prostate + Auto-Contouring at a glance

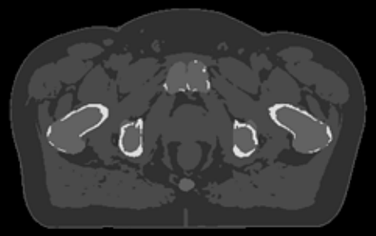
Dedicated MRCAT imaging protocol



Axial T1W mDIXON XD

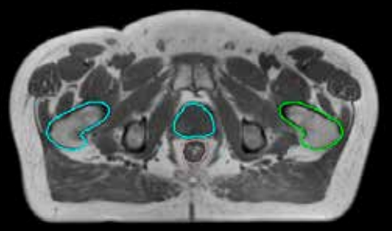
Sagittal 3D T2W TSE

MRCAT generation



MRCAT

Auto-Contouring



Automated contours overlaid on T1W mDIXON

MR-based Auto-Contouring

T1W mDIXON

T2W TSE

Automatically generated RT structures are:
- Body outline
- Femoral heads (right and left)
- Bladder (inner and outer wall)
- Rectum
- Penile bulb
- Seminal vesicles
- Prostate

Images acquired on Ingenia MR-RT 1.5T

MRCAT Prostate + Auto-Contouring

Anatomy supported	Prostate
Compatibility MR system	Ingenia 1.5T and 3.0T MR-RT, Ingenia Ambition 1.5T MR-RT and Ingenia Elition 3.0T MR-RT
Duration MR-only imaging and automated prostate and OAR contouring	Within 17 minutes
Imaging protocol	• Axial 3D T1W mDIXON XD, accelerated by Compressed SENSE • Sagittal 3D T2W TSE sagittal 3D • Axial 3D bFFE internal marker scan for visualizing prostate seeds
Post-processing includes	• Automatic MRCAT generation based on T1W mDIXON sequence • Automatic contour creation based on T1W mDIXON and 3D T2W TSE scan • Automatic axial reformatting of data

DICOM conformance

MRCAT images	DICOM CT
MR images	DICOM MR
Auto-contoured structures	DICOM RT Structure Set

MRCAT Prostate

MRCAT generation	Running parallel to image acquisition on the MR console, embedded post-processing generates MRCAT images using: • Automated segmentation and tissue classification • Automated assignment of CT-based density values
Auto-segmentation	Five different classifications: water, fat, spongy bone, compact bone, air
Geometric accuracy – essential performance	• MRCAT provides < ± 1 mm total geometric accuracy of image data in < 20 cm Diameter Spherical Volume (DSV)
	• MRCAT provides < ± 2 mm total geometric accuracy of image data in < 40 cm Diameter Spherical Volume (DSV)[6]
Dose plan accuracy	The simulated dose based on MRCAT images does not differ in 95% of prostate cancer patients when compared with the CT-based plan for photon treatment planning[3]

MR-based Auto-Contouring

Contours created automatically	Anatomical prostate, seminal vesicles, bladder (inner and outer), rectum, penile bulb, femur head (left and right), body outline.
Auto-Contouring performance/accuracy	AutoContouring delineation of anatomical prostate and prostate organs at risk (OARs) has been found accurate (average distance < 1.5mm)[4] in at least 70% of contours evaluated[5]
Auto-Contouring method	• Model-based adaptive approach. Body contour and femoral head are derived from the T1W mDIXON XD source scan • Organs are modelled and segmented as separate structures using both the T1W mDIXON XD source scan and the T2W TSE Auto-Contouring scan • Organ shape variations are modelled
Bulk motion correction	Yes, bulk motion is corrected by bone registration of the T1W mDIXON XD and T2W image sets
Editable Auto-Contouring colors and names	Yes, already at MR scanner
Auto-Contouring calculation time	In parallel with scanning, <5 minutes

1 Rasch et al. IJROBP, 43(1):57-66, 1999.Hentschel et al. StrahlentherOnkol,187(3):183-90, 2011.Tanaka et al.RadiatRes.,52(6):782-8, 2011.
2 MRCAT provides < ± 1 mm total geometric accuracy of image data in < 20 cm Diameter Sperical Volume (DSV) and < ± 2 mm total geometric accuracy of image data in < 40 cm DSV[6].
3 The simulated dose based on MRCAT images does not differ in 95% of prostate cancer patients (Gamma analysis criterion 3%/3 mm realized in 99% of voxels exceeding 75% of the maximum dose) when compared with the CT-based plan for EBRT.
4 Accurate means 95th percentile modified Hausdorff distance <5mm compared to contours made by experts manually. Average distance is <1.5 mm and is measured as average modified Hausdorff distance compared to contours made by experts manually.
5 Based on 49 cases (each for anatomical prostate, bladder, rectum, penile bulb and femur heads).
6 Limited to 32 cm in z-direction in more than 95% of the points within the volume.

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