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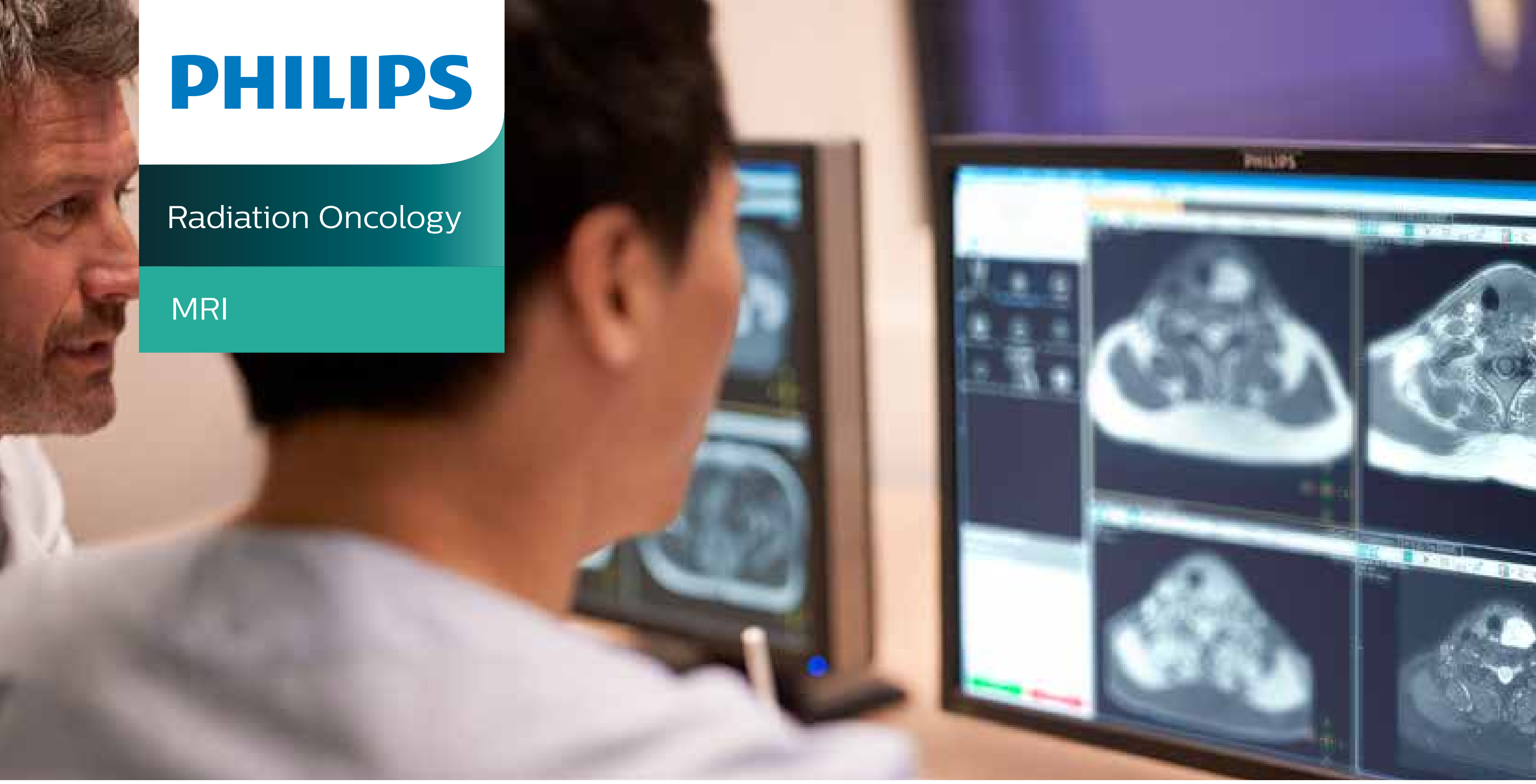
Radiation Oncology

MRI



What's the right MRI field strength for radiation therapy planning?

MR scanners are becoming an integral part of radiation oncology workflows as hospitals experience the benefits of using MRI for radiation therapy planning. But do you need a 1.5T or 3.0T MRI system?

To help you answer this question, we turned to Marielle Philippens, MD, PhD, who has experience using both. As a medical physicist in the Department of Radiotherapy at the University Medical Center in Utrecht (UMCU), the Netherlands, Dr. Phillippens has worked with several Philips Ingenia MR-RT (1.5T and 3.0T) systems since 2013.

Do you need a 1.5T or 3.0T MRI system?

Site-specific patient population
“The high 3.0T field strength provides higher SNR and spatial resolution than 1.5T. However, at 1.5T distortions tend to be fewer than at 3.0T. The choice between 1.5T and 3.0T can depend on the anatomies that will need to be scanned and the desired balance between the required resolution and the ability to interpret distortions. For instance, the head-neck area is more sensitive to distortions than the prostate.”

MRI knowledge and experience of the staff
“3.0T MRI requires a higher staff expertise than 1.5T. So, for an oncology department starting out in using MRI for radiation therapy planning, choosing 1.5T can help the team become accustomed to the new workflow.”

Treatment planning only or broader use
“If treatment simulation is the main use, I recommend to consider starting with 1.5T, as it is easier for reducing distortions, although resolution and contrast for brain and pelvic tumors are not as good as with 3.0T. If MRI is also used for response monitoring and functional imaging of the tumor, I think 3.0T should be the first choice, although it has to be considered that thoracic imaging (esophagus and lung) are not feasible on 3.0T.”

Combination with 1.5T MR-linac
“For simulation of a treatment at a 1.5T MR-linac, 1.5T is the most obvious choice as contrast on this scanner is similar to the contrast on the MR-linac. In this way, the same imaging parameters can be used on the MR simulator and on the MR-linac. It also helps to estimate susceptibility effects on the geometric accuracy of the images. A 3.0T scanner can be used as well to simulate MR-linac treatments without major disadvantages.”

When both 1.5T and 3.0T are available
“If a hospital has access to both 1.5T and 3.0T, I’d recommend doing MRI for prostate and rectal cancer planning on 3.0T, and asking the radiologist for a preference on other applications, because the choice depends on the patient and the disease,” says Dr. Philippens. “It also depends on the knowledge of the staff and the medical physicist, who need to adjust the ExamCards and sequences between the two field strengths.”

This information is extracted from the FieldStrength publication “Approaches for including MRI in radiation therapy planning”.

Marielle Philippens, MD, PhD

Marielle Philippens, MD, PhD, has been a radiobiologist and medical physicist with focus on MRI physics in the department of Radiation Oncology at University Medical Center Utrecht since 2008. Her research interest is functional imaging for oncology, with particular focus on diffusion weighted MR imaging. Her research focus areas are head and neck cancer, rectal cancer and breast cancer

Differences between field strengths

This table summarizes the view of the radiation therapy department at UMC Utrecht on differences between 1.5T or 3.0T field strengths for use in radiation therapy applications.

Acquisition techniques	1.5T rating	1.5T	3.0T rating	3.0T
T2W TSE	Effective, but with some tradeoffs	Voxel size: 0.7 x 0.7 x 3 mm^3	Most effective	Voxel size: 0.45 x 0.45 x 3 mm^3
T1W TSE	Most effective		Most effective	
DCE-MRI	Effective, but with some tradeoffs	↓ Spatial/ ↑ temporal resolution	Most effective	↑ Spatial/ ↓ temporal resolution
DWI-EPI	Most effective		Not preferable, but possible	↓ Geometric accuracy
Non-EPI DWI	Not feasible	↓↓ SNR	Most effective	
PseudoCT/MRCAT for MR-only simulation	Most effective		Effective, but with some tradeoffs	↓ Geometric accuracy

Treatment simulation, imaging in treatment position	1.5T rating	1.5T	3.0T rating	3.0T
Brain	Most effective	Consider for stereotactic treatment	Most effective	Consider for non-stereotactic treatment
Pelvis: prostate, rectum, cervix, bladder	Most effective	↓ Resolution	Most effective	↑ Resolution
Head and neck	Most effective	↑ Robustness	Most effective	↑ Resolution
Thorax: esophagus	Most effective		Not feasible	Artifacts due to motion sensitivity and susceptibility
Abdomen: pancreas, liver	Most effective		Not preferable, but possible	Motion sensitivity concerns
Breast	Most effective		Not preferable, but possible	Susceptibility artifacts

Tumor visualization and response monitoring	1.5T rating	1.5T	3.0T rating	3.0T
Brain	Effective, but with some tradeoffs	↓ Contrast, ↓ Resolution	Most effective	↑ Contrast, ↑ Resolution
Pelvis: prostate, rectum, cervix, bladder	Effective, but with some tradeoffs	↓ Resolution	Most effective	
Head and neck	Most effective		Most effective	
Thorax: esophagus	Most effective		Not feasible	Artifacts due to motion sensitivity and susceptibility
Abdomen: pancreas, liver	Most effective		Not preferable, but possible	Motion sensitivity
Breast	Not preferable, but possible	DWI better than on 3.0T, ↓ Resolution	Most effective	↑ Resolution

System-related considerations	1.5T rating	1.5T	3.0T rating	3.0T
Geometric accuracy	Most effective		Effective, but with some tradeoffs	Larger susceptibility changes
SAR	Most effective		Effective, but with some tradeoffs	SAR limits in high temporal imaging

Staff	1.5T rating	1.5T	3.0T rating	3.0T
Expertise	Most effective	Modest level	Not preferable, but possible	High level
Training	Most effective	Modest level	Not preferable, but possible	High level

Not feasible · Not preferable, but possible · Effective, but with some tradeoffs · Most effective

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