White paper

Four benefits of High-V MRI

siemens-healthineers.co.uk/magnetom-free-max

SIEMENS Healthineers

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Introduction

MAGNETOM Free.Max[1] represents an entirely new kind of MR imaging defined as 'High-V MRI'. The term 'High-V' indicates the high value that this new standard in MRI offers: wider access to advanced diagnostic imaging and promising added value for certain clinical applications.

High-V MRI describes the combination of our fundamental innovations in the field of digitalization at the core of image acquisition and reconstruction deliberately applied to a new field strength of 0.55T, which has inherent clinical benefits.

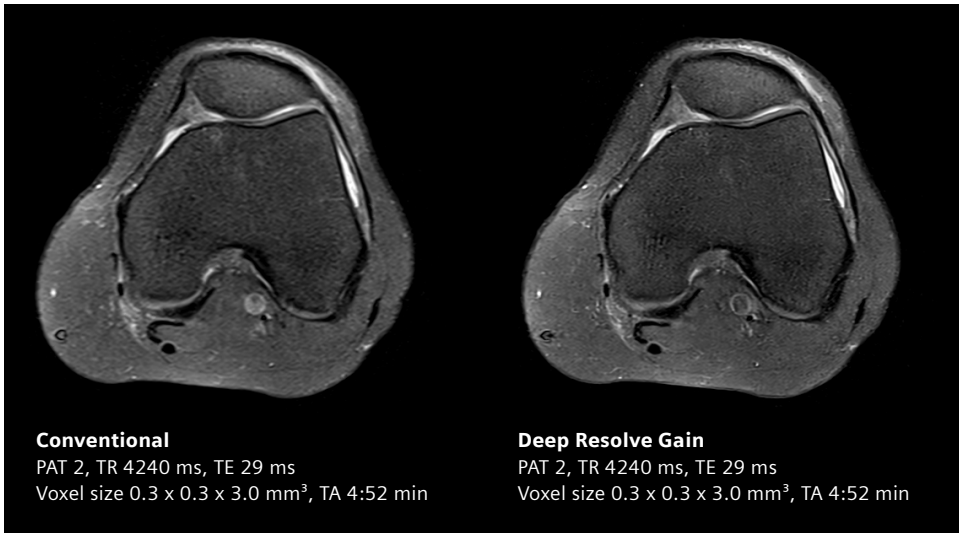
Almost four decades of experience in the field of MR imaging have enabled the development of High-V MRI. Building on extensive knowledge and expertise, we set out to rethink MR physics and challenge the old mantra that a higher field strength is always better. The result is High-V MRI – a new standard in MR imaging – that provides unique capabilities and added value in diagnostic imaging.

In the following, four reasons are provided to underline the value of High-V MRI.

1. No compromise on image quality

The first criteria in developing High-V MRI was to improve value without compromising on image quality. Inherently, the signal-to-noise ratio (SNR) per unit time decreases as the field strength is lowered. Combining unique technological advances in image processing with a state-of-the art superconductive magnet design from Siemens Healthineers overcomes this barrier to deliver unprecedented image quality at 0.55T with High-V MRI.

As with many other fields, the advent of deep learning has substantially impacted the MR world. Siemens Healthineers offers intelligent and network-based algorithms to take advantage of artificial intelligence with High-V MRI. Deep Resolve Gain (Fig. 1) is a method to boost the apparent SNR for uncompromised diagnostic quality. Deep Resolve Sharp (Fig. 2) pushes spatial resolution to regions that you



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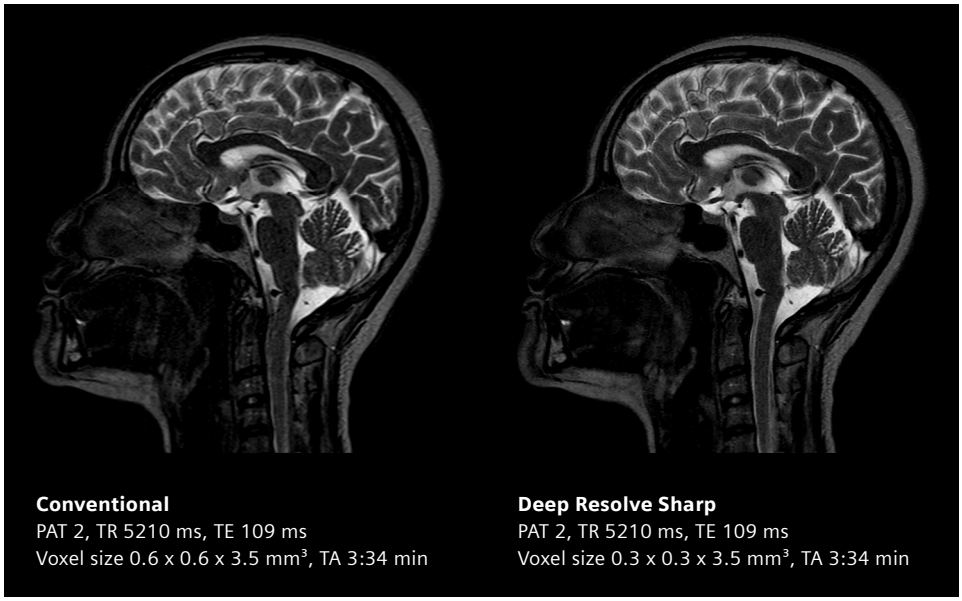
1 Benefits of Deep Resolve Gain.



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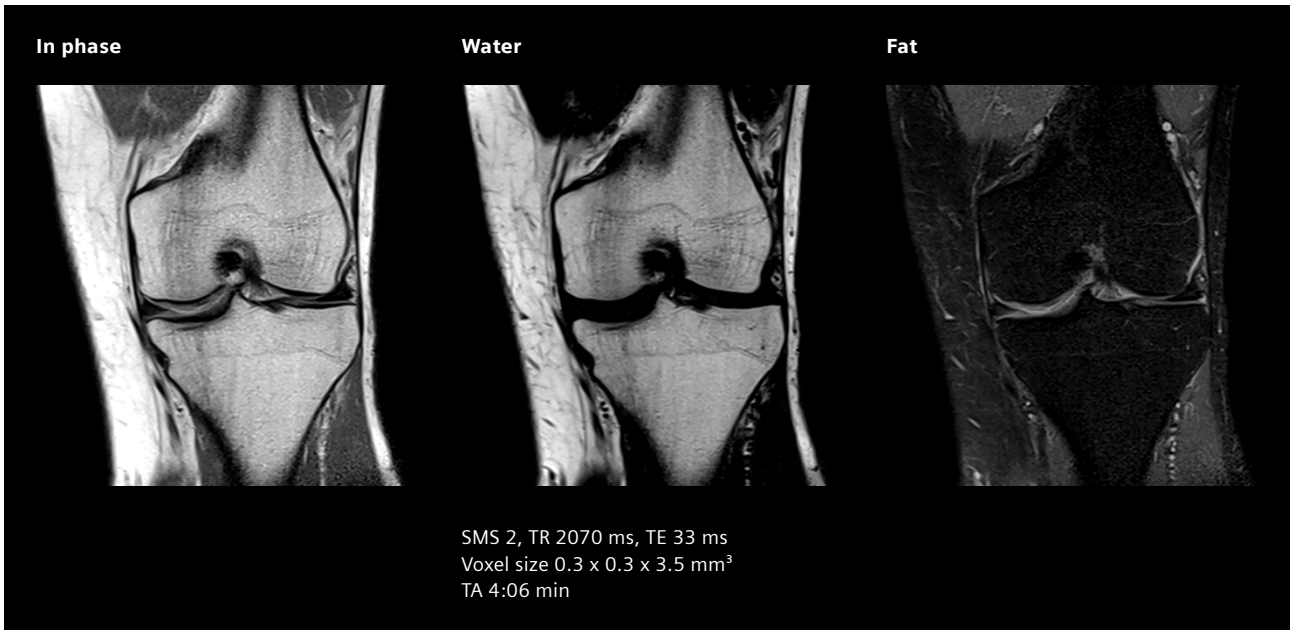
2 Benefits of Deep Resolve Sharp.



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3 SMS TSE is a technique exclusive to Siemens Healthineers that reduces scan times.

expect from higher field strength systems. With these latest reconstruction methods based on intelligent algorithms, High-V MRI is exclusively equipped to deliver the clinical image quality that customers can expect from the MRI market leader.

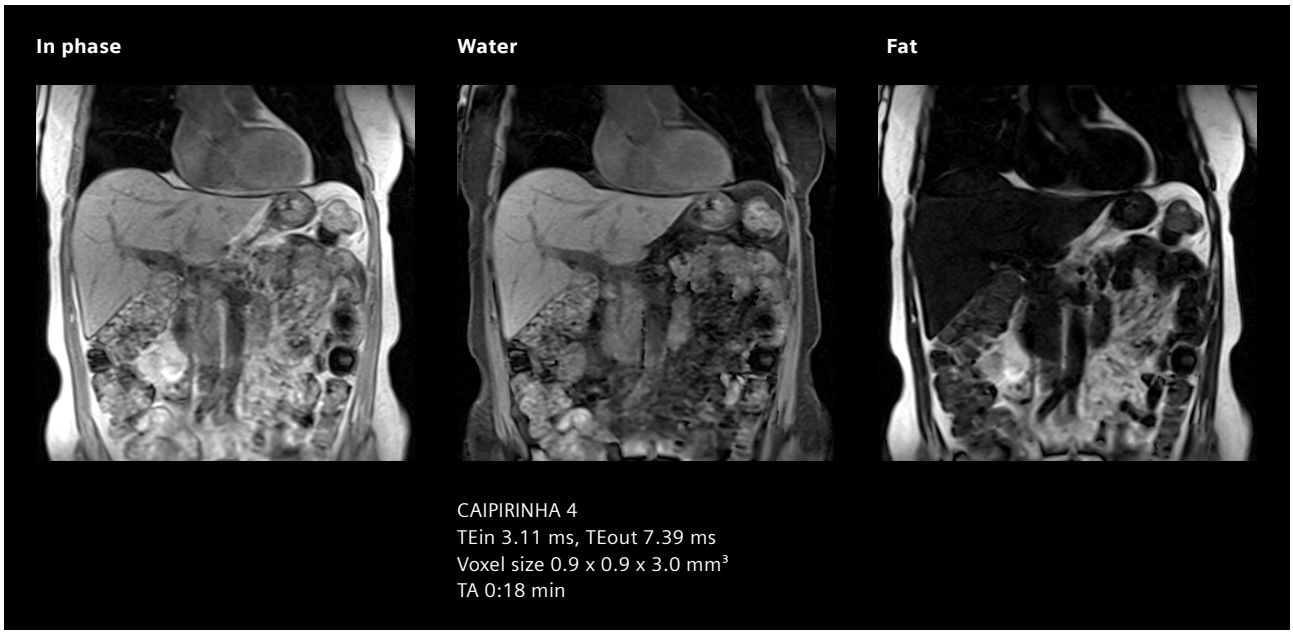
Also incorporated into High-V MRI is Simultaneous Multi-Slice (SMS) for TSE, an imaging technique developed by Siemens Healthineers whereby several slices are acquired simultaneously. For MSK, neuro, and spine applications especially, SMS reduces acquisition times by approximately 50% for clinical routine TSE contrasts. SMS TSE therefore allows high spatial resolution to be maintained in the acquired images to support diagnostic accuracy. (Fig. 3)

CAIPIRINHA is another technique exclusive to Siemens Healthineers that enables highly accelerated 3D volumetric imaging and adds particular value in abdominal imaging. It makes dynamic liver imaging feasible, with a whole volume ready within a single breath hold, without compromising on spatial resolution. (Fig. 4)

3D imaging in MRI is gaining increasing clinical interest. Compressed Sensing SPACE (CS SPACE) is a well-established technique from Siemens Healthineers already available on 1.5T and 3T systems. High-V MRI now also benefits from this image reconstruction method, leveraging its potential to deliver optimized image quality while keeping scan times within reasonable ranges in neuro, spine, and MSK applications. (Fig. 5)

Moreover, our well-established techniques SMS EPI for accelerated DWI and GRAPPA for parallel imaging in all body regions, which have been proven in clinical routine for almost two decades, are also incorporated into High-V MRI. (Fig. 6)

In summary, High-V MRI includes all cutting-edge imaging technologies from Siemens Healthineers that have been pioneered on our 1.5T, 3T, and 7T scanners. With our exclusive SMS and CAIPIRINHA technology and our recently developed Deep Resolve, imaging at 0.55T provides diagnostic image quality without compromise.



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4 CAIPIRINHA is an acceleration technique from Siemens Healthineers that allows abdominal volumetric imaging in a single breath-hold.

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5 MRCP with a Compressed Sensing acceleration factor of 10.

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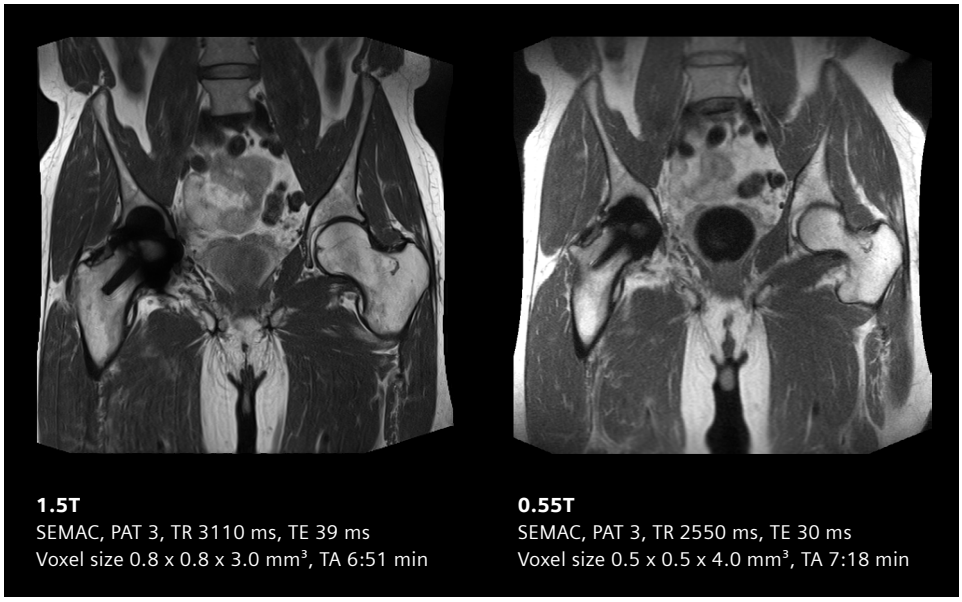
6 PAT2 in a coronal T2w BLADE FS.

2. Inherent physics benefits of High-V MRI support new clinical applications

Moving to a higher field strength in MR imaging has always been associated with the positive result of gaining available signal. However, many phenomena that pose challenges for MR imaging also scale with field strength: Relaxation times become less favorable; susceptibility effects increase; and SAR limitations impact clinical scanning. It follows that these phenomena behave more favorable at lower field strengths.



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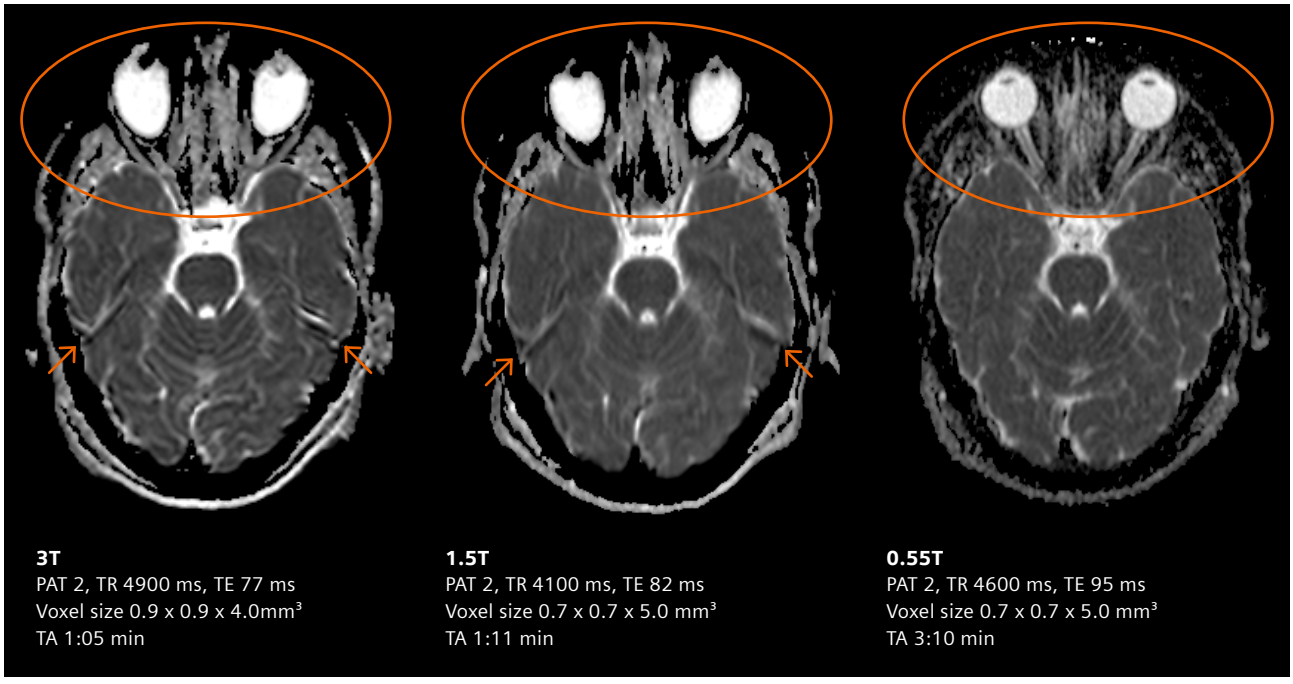
7 Reduced metal artifacts with High-V MRI.



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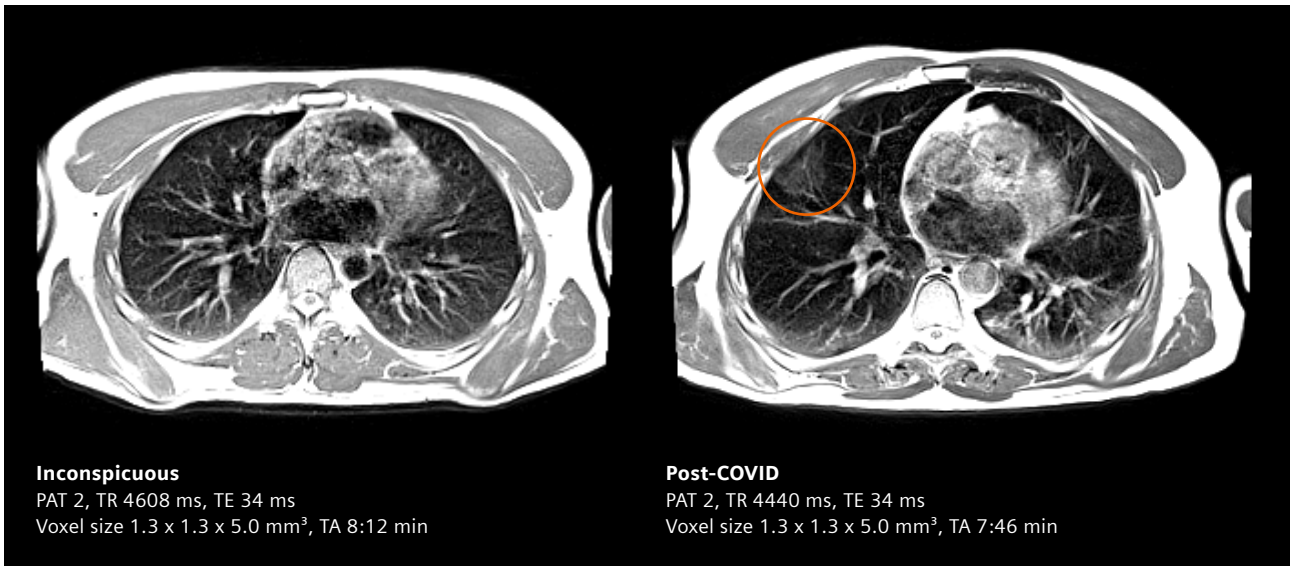
8 Reduced geometric distortion in diffusion imaging with High-V MRI.



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9 Lung imaging is a promising new clinical application with High-V MRI. In the post-COVID case, typical ground glass opacity can be observed (orange circle). Image courtesy of University Hospital Erlangen, Germany.

The relaxation times T1, T2, and T2* are positively impacted by moving to lower field strengths: T1 decreases, allowing faster repetition times that mitigate the additional scan time required for a lower field strength. T2 and T2* increase with T2* in particular allowing longer spin echo trains and longer gradient echo readouts. Due to these physical benefits, the SNR penalty can be compensated to provide uncompromised clinical value. Susceptibility artifacts are substantially lower with High-V MRI delivering crisper, less distorted DWI imaging in challenging areas such as orbits, internal auditory canal, or near the sinuses. Implant imaging can also benefit significantly from fewer susceptibility-induced field distortions, potentially providing safer and clearer scanning of passive implants (e.g., hip or dental implants). (Fig. 7)

Thinking beyond passive implants, imaging of patients with active devices such as ICDs and DBSs has great potential with High-V MRI as the SAR is also substantially lower at 0.55T (approx. 7.5 times less compared with 1.5T). There is also potential for interventional scans at a safer field strength. (Fig. 8)

Finally, imaging challenging anatomies such as the lung is more promising with High-V MRI. Pulmonary imaging is problematic at higher field strengths due to susceptibility-induced signal decay in the lungs.

However, at 0.55T the MR signal of lung parenchyma is more pronounced, resulting in improved pulmonary MR imaging with High-V MRI. Given the increase in chronic pulmonary diseases such as cystic fibrosis or chronic obstructive pulmonary diseases (COPD) as well as numerous follow-up scans required in patients recovering from COVID-19, pulmonary imaging with High-V MRI offers a promising complement to computed tomography. (Fig. 9)

To conclude, High-V MRI has unique physics advantages that result in improved diagnostics for certain applications and offer promising opportunities in currently untapped clinical fields.

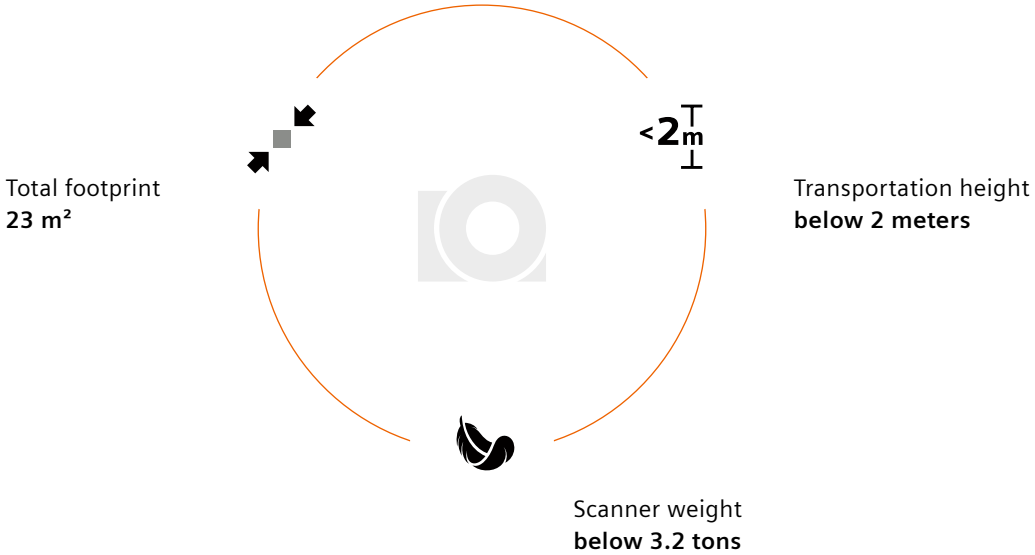
3. High-V MRI provides cost-effective access to advanced diagnostic imaging

Over the last decade, healthcare systems have seen a rapid decrease in reimbursement rates for diagnostic imaging. As a result, imaging practices have been forced to optimize workflows and rethink the required investments. In this context, High-V MRI can play an essential role as it enables cost-effective access to MR imaging. Given that material and manufacturing costs of an MRI scale up with increased magnetic field strength, High-V MRI offers an economic platform to expand the reach of MRI. Furthermore, High-V MRI has the advantage of incorporating a groundbreaking 80 cm patient bore while maintaining an overall attractive cost position.

4. High-V MRI has reduced infrastructure requirements and provides greater flexibility in siting

Conventional MRI systems impose significant and costly infrastructure constraints, not least due to the large space and floor-load capacities required by the scanner. Apart from the associated costs, this also limits places where an MRI scanner can be sited.

High-V MRI has a solution that reduces the above-mentioned infrastructure constraints significantly. Thanks to its unique design, it allows an MRI scanner to be installed with a benchmark overall siting space of only 23 m². As the first High-V MRI on the market, MAGNETOM Free.Max is the now most compact super-conducting whole-body MRI system. With a benchmark overall footprint of 23 m² and a total weight of less than 3.2 tons in the scanner room, MAGNETOM Free.Max reduces the infrastructure requirements and offers greater flexibility in siting. With its reduced transportation height of below 2 meters, it offers new possibilities to use existing corridors and doors when installing the MRI scanner instead of costly and complex building reconstruction as previously required with conventional MRI scanners.



Summary

In summary, High-V MRI represents a completely new kind of MR imaging that provides significant added value to increase MRI accessibility and open up new clinical application fields. Enabled by our latest innovations in the field of digital image processing as well as a state-of-the art magnet design, High-V MRI delivers excellent diagnostic quality in clinical routine. In addition, the combination of digitalization and the inherent benefits of the new 0.55 T field strength offers added value for improving implant imaging, strengthening pulmonary MRI, and reducing susceptibility challenges for MRI in general. Given that many magnet design requirements scale up with the magnet field strength, High-V MRI provides cost-effective access to MRI that also manages to significantly reduce infrastructure requirements for increased flexibility in siting. The future of High-V MRI has remarkable promise.

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