

**GE Healthcare**  
Tomorrow Today

# OncoWorks

**SIGNA™Works**  
Fueling the future of MR



# SIGNA™Works

The new standard is extraordinary

Our new SIGNA™Works productivity platform redefines productivity across the breadth of our core imaging techniques. It takes full advantage of Total Digital Imaging (TDI), further advancing diagnostics and quickening throughput, while improving patient outcomes and your ROI. It is upgradeable and customizable with additional applications to suit your growing practice.

## Standard Applications

Energize your clinical capabilities with all the tools you need to complete an exam. Imaging solutions cover a variety of contrasts, 2D and 3D volumetric data and motion correction capabilities.



## Innovative Applications

Expand your expertise to the next level, to deliver improved image quality, higher efficiency and a more streamlined workflow, so you perform better than ever before.



# SIGNA™Works

The new standard is extraordinary



## ► Standard Applications Innovative Applications

### **BodyWorks**

One of the fastest growing areas in MR, BodyWorks allows you to image abdominal and pelvic anatomy with user flexibility to adapt to different patient types.

### **CVWorks**

Gain crucial insights into vascular structure and flow dynamics and access morphology, flow, function and tissue viability with CVWorks.

### **NeuroWorks**

This one-stop solution enables you to image brain, spine, vascular and peripheral nerve anatomy with exceptional tissue contrast.

### **OncoWorks**

Delivers robust tissue contrast, motion-insensitive, high temporal and spatial resolution imaging techniques that capture anatomical and morphological data for oncological assessment.

### **OrthoWorks**

This extensive library of musculoskeletal imaging techniques enables you to image bone, joint and soft tissue with remarkable tissue contrast.

### **PaedWorks**

Delivers distinctive child-centered imaging techniques that provide ease of use for the user and clinical excellence for your smallest, most fragile patients.

# SIGNA™Works

The new standard is extraordinary



## Standard Applications

### ► **Innovative Applications**

#### **HyperWorks**

HyperWorks means hyper scanning with astonishing imaging and impressive speed. It includes HyperSense, which can deliver higher spatial resolution images or reduced scan times.

#### **ImageWorks**

ImageWorks boosts your overall MR performance. READYView visualization and MAGiC one-and-done scanning help ensure consistent and clear results.

#### **SilentWorks**

SilentWorks is GE's most advanced noise reducing technology. Traditional exams can be extremely loud. SilentWorks brings the sound level down to ambient noise.

#### **ViosWorks**

ViosWorks reduces the complexity and cost of cardiac imaging. For the first time, all 7 dimensions of information can be captured in a cardiovascular scan in 10 minutes or less.

# OncoWorks

OncoWorks is an extensive library comprised of robust tissue contrast, motion-insensitive, high temporal and spatial resolution imaging techniques used for oncological assessment.

- Standard Applications
- Elective Applications
- Innovative Applications

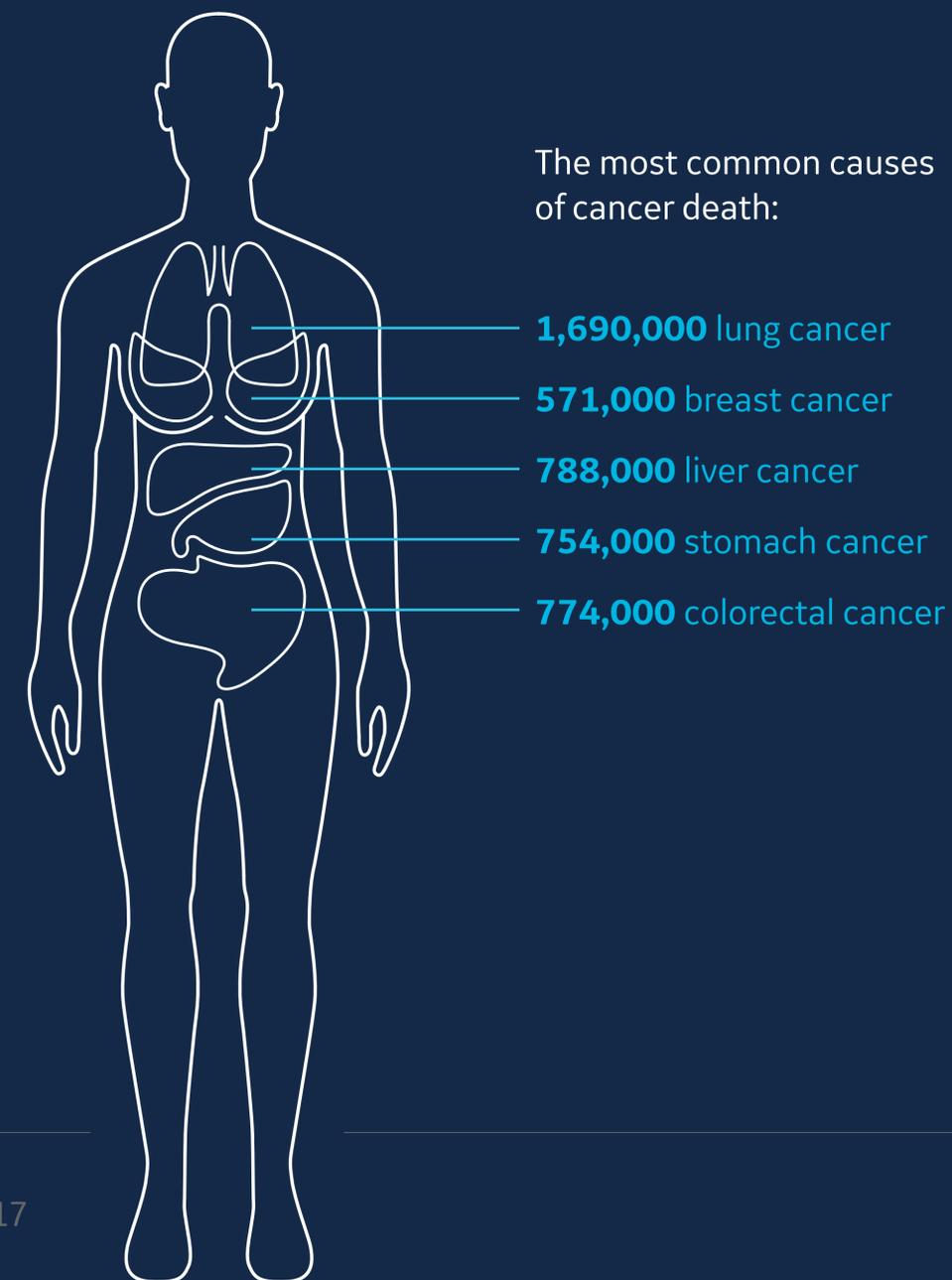
Cancer is a leading cause of death worldwide. Number of cancer-related deaths in 2015:

**8.8**  
million

Between  
**30–50%**  
of cancers can  
currently be  
prevented

World Health Organization  
Cancer Fact sheet, February 2017

The most common causes of cancer death:



OncoWorks

Standard Applications

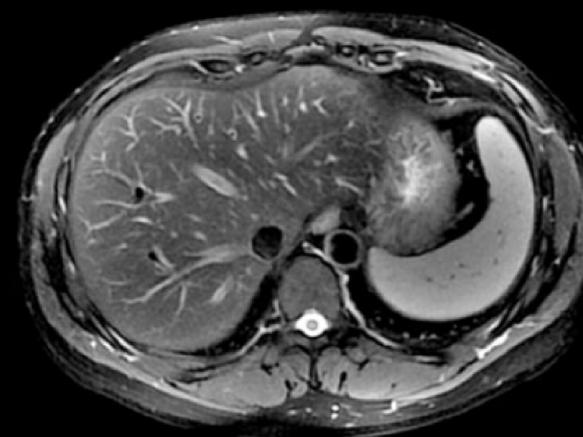
# PROPELLER

PROPELLER Multi-Blade (MB) is a multi-shot approach that preserves tissue contrast regardless of weighting while also reducing motion artifacts and providing a more signal-rich image. Additionally, this technique allows for all contrasts for 2D FSE: T1, T2, STIR and PD weightings.

## Clinical benefits:

- Delivers motion-artifact-free diagnostic images (respiration and peristalsis)
- Increases productivity and decreases the number of repeated scans
- Enables sedation-free scanning and increases patient tolerance

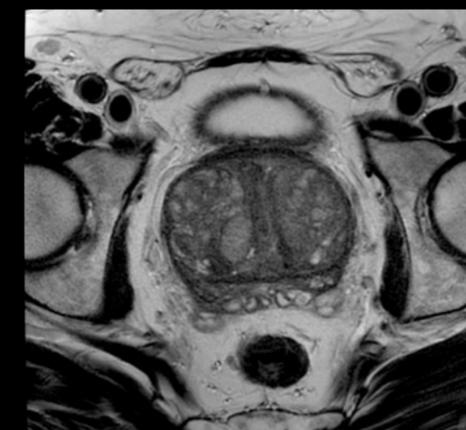
T2 FatSat PROPELLER, 320 x 320



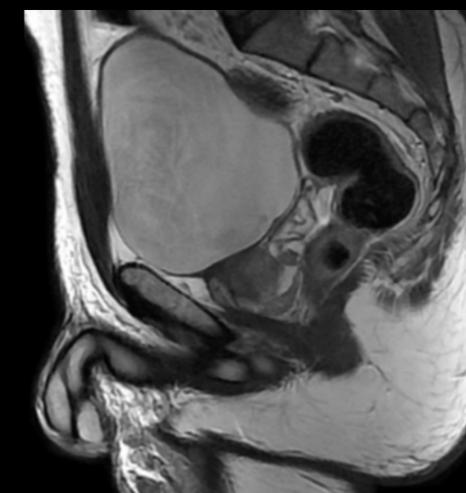
T2 PROPELLER, 320 x 320



T2 PROPELLER  
320 x 320, FOV 19cm / 4mm 3:40 min



T2 PROPELLER  
320 x 320 2:48 min



[> case study A](#)

[> case study B](#)

OncoWorks

## Standard Applications

# Case Study: Assessment of Tumor Infiltration with PROPELLER

### Protocols used

Sagittal T2 PROPELLER, Axial T2 PROPELLER, Coronal T2 PROPELLER, Axial DWI, Sagittal FOCUS, Sagittal ADC Map, 3D Turbo LAVA

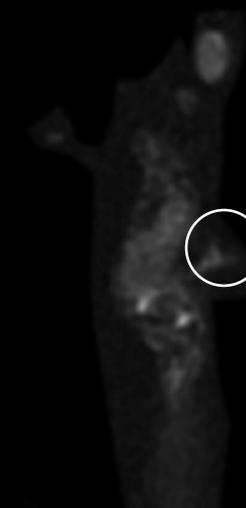
### Patient history

A patient was referred to MR to determine the primary staging level of semi-circular, extramural rectum carcinoma.

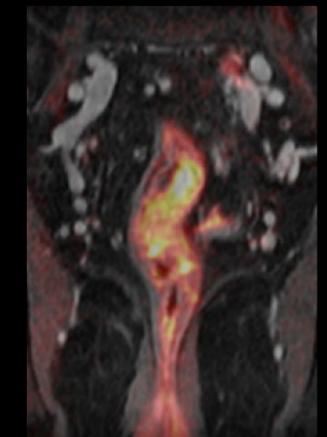
### Procedure

T2 PROPELLER and DWI shows a mesorectal tumor infiltration. PROPELLER compared to standard FSE shows higher CNR/SNR and provides better in-plane resolution for enhanced wall assessment. FOCUS and LAVA Flex high-res isotropic with Turbo mode show potential improvement in the assessment of the tumor infiltration.

Coronal FOCUS b1000



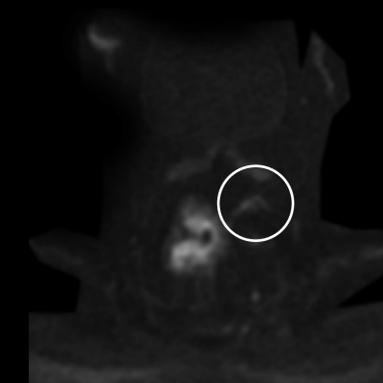
Fusion to LAVA Flex



Axial T2 PROPELLER



Axial DWI b1000



Coronal T2 PROPELLER



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## Standard Applications

# Case Study: Primary Staging Assessment with PROPELLER

### Protocols used

T2 PROPELLER, Axial DWI, Coronal FOCUS, Sagittal FOCUS, Sagittal ADC Map, Sagittal 3D LAVA, Axial 3D LAVA

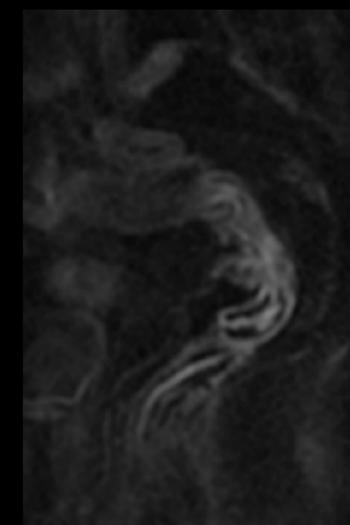
### Patient history

A patient was referred to MR to assess primary staging and re-staging after RCT for rectum adenocarcinoma.

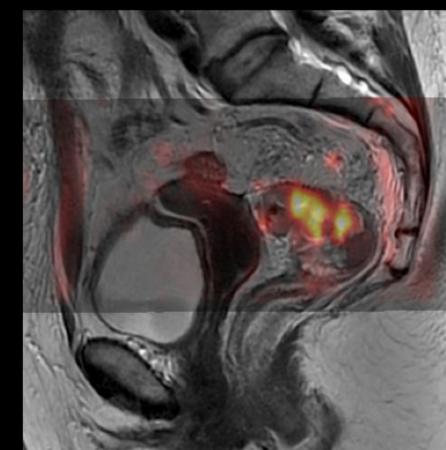
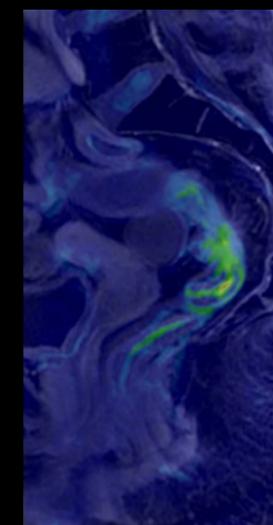
### Procedure

PROPELLER shows high CNR/SNR and a possible in-plane resolution for enhanced wall assessment. FOCUS DWI demonstrates a high potential to improve the assessment of partial or complete tumor regression. High-res LAVA Flex with Turbo mode improves visualization of residual tumor and lymph nodes in a short scan time.

Sagittal FOCUS b1000



Fusion of FOCUS DWI & LAVA post contrast



Fusion of FOCUS DWI & PROPELLER



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## Standard Applications

# Cube

Cube is our 3D volumetric imaging technique that can easily be reformatted into any plane. The SNR-rich submillimeter slices can provide partial volume averaging effect which helps to visualize even small and subtle abnormalities.

### Clinical benefits:

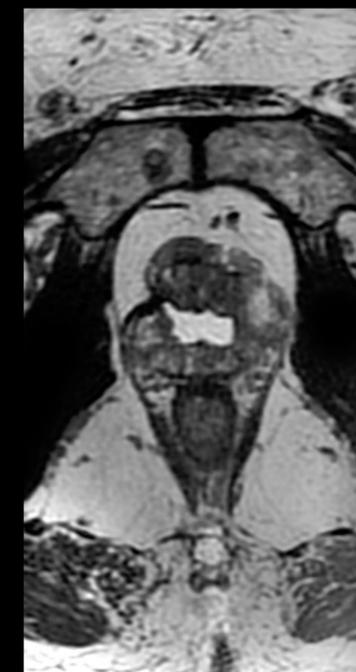
- Scan once, then reformat to any plane with high sub-millimeter resolution
- Spatial anatomical localization for abnormalities
- Higher slice resolution compared to 2D imaging
- Can decrease flow artifacts
- Combines with ARC acceleration to reduce scan times

Sagittal T2 Cube acquisition with Axial and Coronal reformats

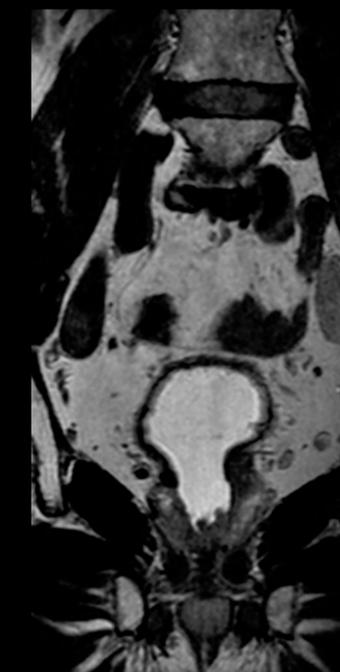
Sagittal Cube



Axial Cube



Coronal Cube



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**Standard Applications****eDWI**

Diffusion Weighted imaging (DWI) is used to image diffusivity of water molecules (Brownian motion). This enhanced Diffusion Weighted Imaging (eDWI) technique enables high signal-to-noise-ratio (SNR) diffusion images, with short-acquisition time and shortest possible Echo Time (TE). Its multi-b feature is designed to measure apparent diffusion coefficient (ADC) map with reduced effect of perfusion.

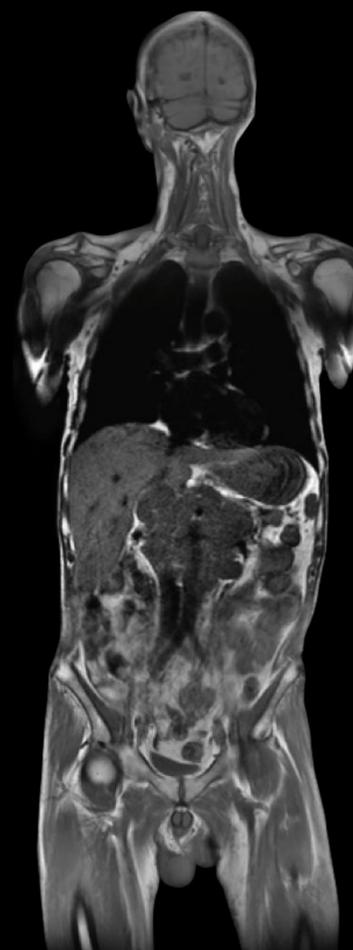
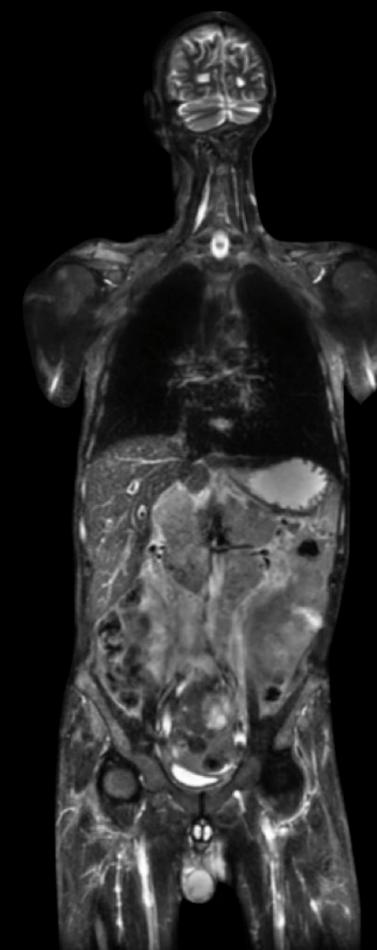
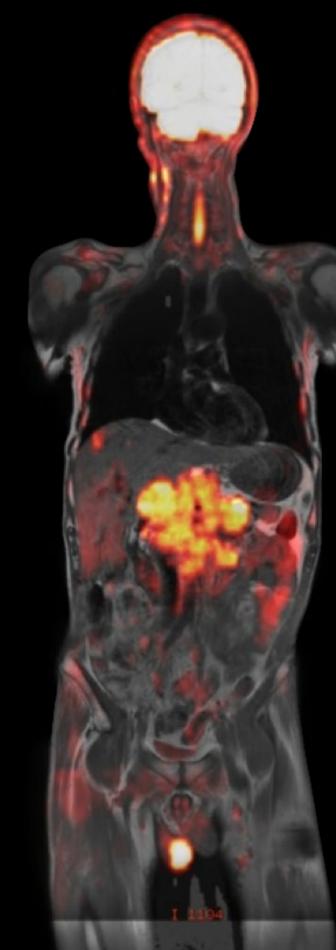
**Clinical benefits:**

- Increases sensitivity and specificity of lesions
- Decreases overall exam sequences and time
- For body imaging, helps to improve patient tolerance with shortened breath-hold time or free-breathing Navigator

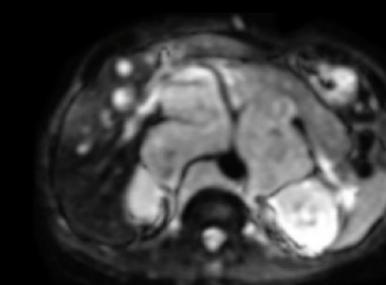
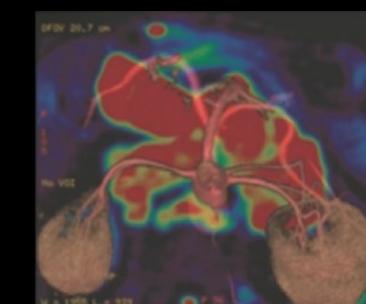


case study

Whole body diffusion on patient with Lymphoma

Coronal T1, 3 Stations  
2:17 minCoronal STIR, 3 Stations  
2:48 minAxial DWI, 6 Stations  
T1 with DWI Fused  
9:54 min

Axial DWI

Enhance Inflow IR  
fused to DWI

OncoWorks

## Standard Applications

# Case Study: Whole Body eDWI with MAGiC DWI

### Clinical solutions

System: Optima™ MR450w

### Protocols used

Coronal T1, Coronal T2, DWI, MAGiC DWI

### Patient history

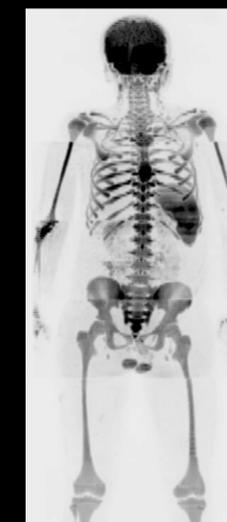
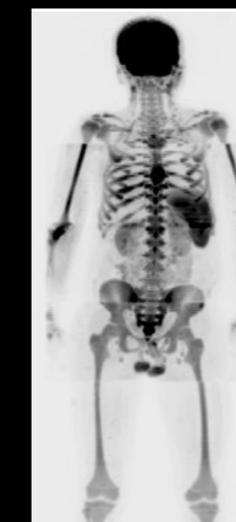
Patient presented with persistent erythrocytosis with high Erythropoietin (EPO) and weight loss.

### MR findings

Diffuse whole body bone marrow T1w and higher T2w signal intensity was consistent with a known hematological disorder. Patient was confirmed with splenomegaly and a large left kidney, but there was no evidence of malignancy.



DWI  
—  
b800



Synthetic DWI  
—  
(left) b600  
—  
(right) b1200



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## Standard Applications

# LAVA

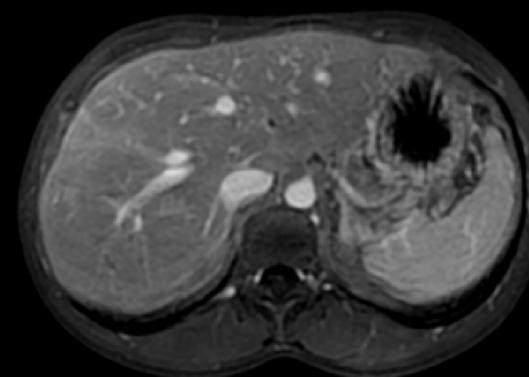
Liver Acquisition with Volume Acceleration (LAVA) is a rapidly, accelerated 3D T1 dynamic (DCE) body imaging technique that uses a unique PSD waveform to allow for a reduction of scan time needed for dynamic imaging.

### Clinical benefits:

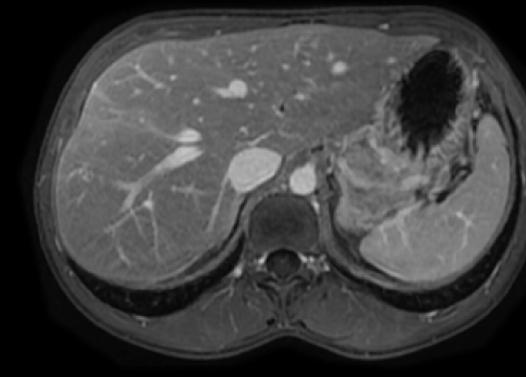
- Produces 2D ARC parallel imaging for short scans
- Turbo mode further reduces scan time up to 50%
- Achieve higher spatial resolution scans within the same scan time (compared to conventional LAVA/LAVA Flex imaging)
- Provides adiabatic special fat suppression for robust imaging

40% increase in resolution

LAVA 21s



Turbo LAVA 20s



33% reduction in scan time  
1.14 x 1.14 x 2mm

LAVA 2:45 min



Turbo LAVA 1:50 min



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**Standard Applications**

# Navigator

Navigator uses a tracker to detect the motion of the diaphragm which enables free-breathing body imaging acquisition. The tracker is automatically placed over the right hemidiaphragm so the acquisition synchronizes the patient's breathing pattern and minimizes ghosting artifacts.

**Clinical benefits:**

- Enhances workflow
- Eliminates need to use respiratory bellows
- Allows for adjustment of threshold and acceptance window in real time as the patient's respiration changes

Coronal T2 SSFSE  
FOV 44cm  
2:14 min



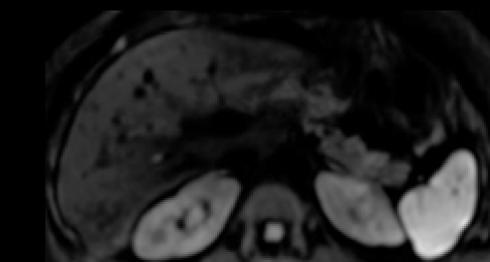
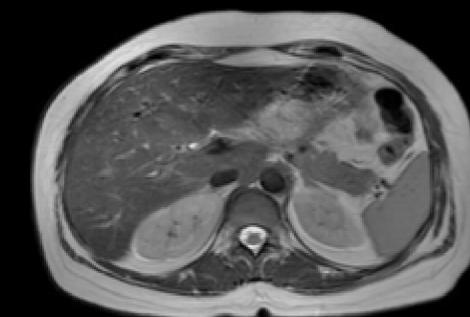
Axial T2 PROPELLER  
3:18 min



Axial eDWI, b800  
3:13 min



Coronal Turbo LAVA  
FOV 42cm  
0:59 min



OncoWorks  
Standard Applications

# Navigator

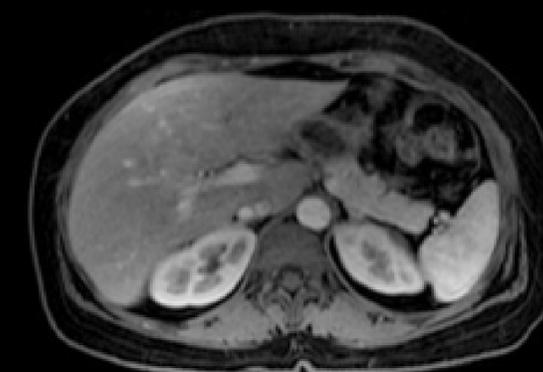
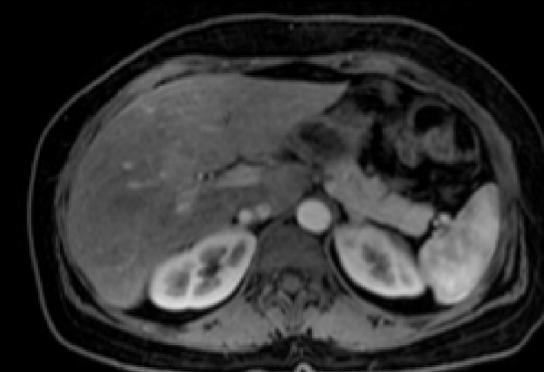
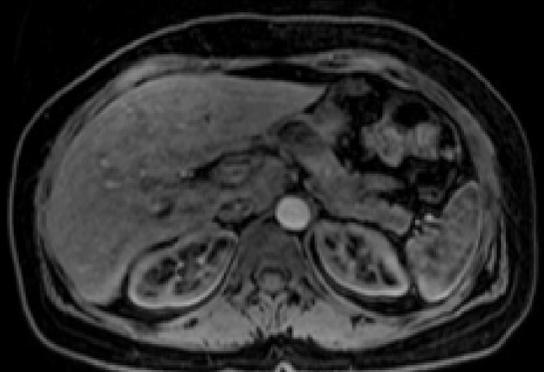
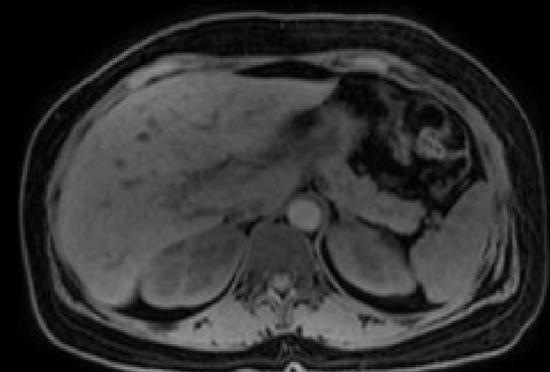
Free-breathing Dynamic Turbo LAVA, 288 x 192 20s / phase

Pre

Arterial

Portal

Delayed



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**Elective Applications**

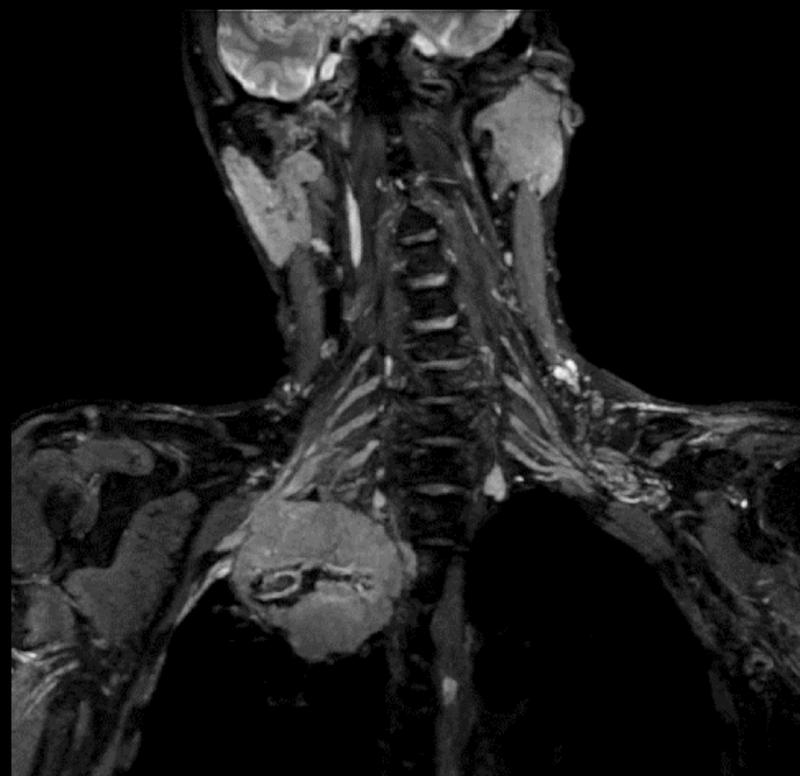
## Cube Flex

Cube Flex combines 3D FSE acquisition and a 2-point Dixon separation technique that provides robust, uniform fat suppression to obtain high-resolution 3D images.

### Clinical benefits:

- Can shorten scan times by eliminating separate sequences
- Can be combined with HyperCube and HyperSense to further reduce scan time
- Highly useful in difficult-to-scan anatomies where chemical FatSat can fail in the neck, hip, spine and feet
- Scan once, then reformat to any plane with high sub-millimeter resolution

Coronal T2 IDEAL  
1.4 x 1.4 x 1.2mm, pFOV 1  
4:50 min



Coronal 3D T2 Flex with HyperCube  
and HyperSense factor = 1.2  
1.2mm<sup>3</sup>, pFOV 0.85  
4:58 min



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## Elective Applications

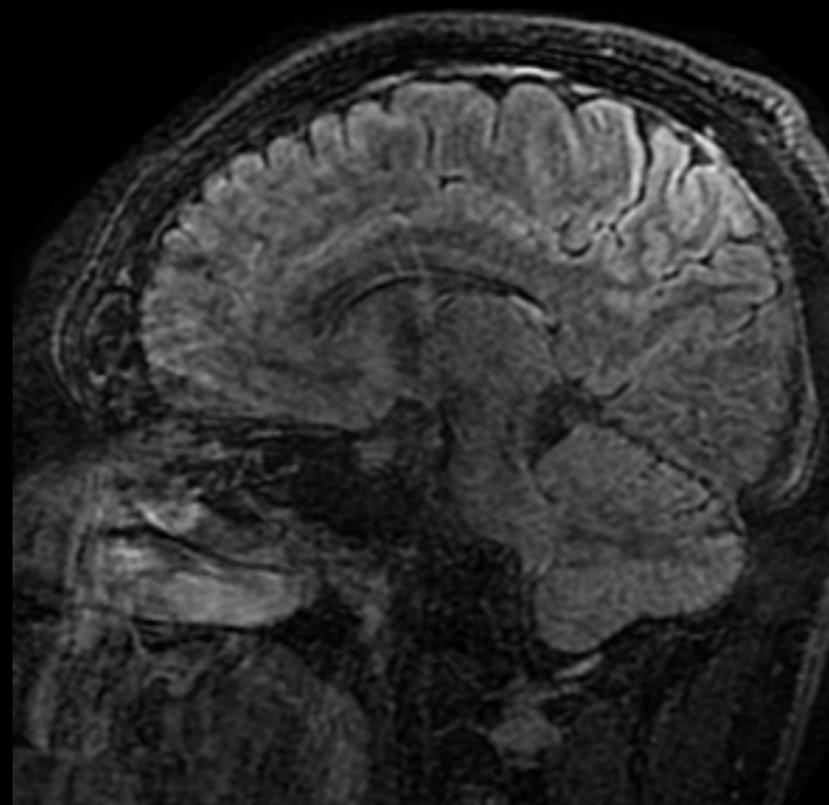
# PROMO

PROspective Motion correction (PROMO) is an imaging technique that delivers prospective motion correction for rigid 3D brain imaging.

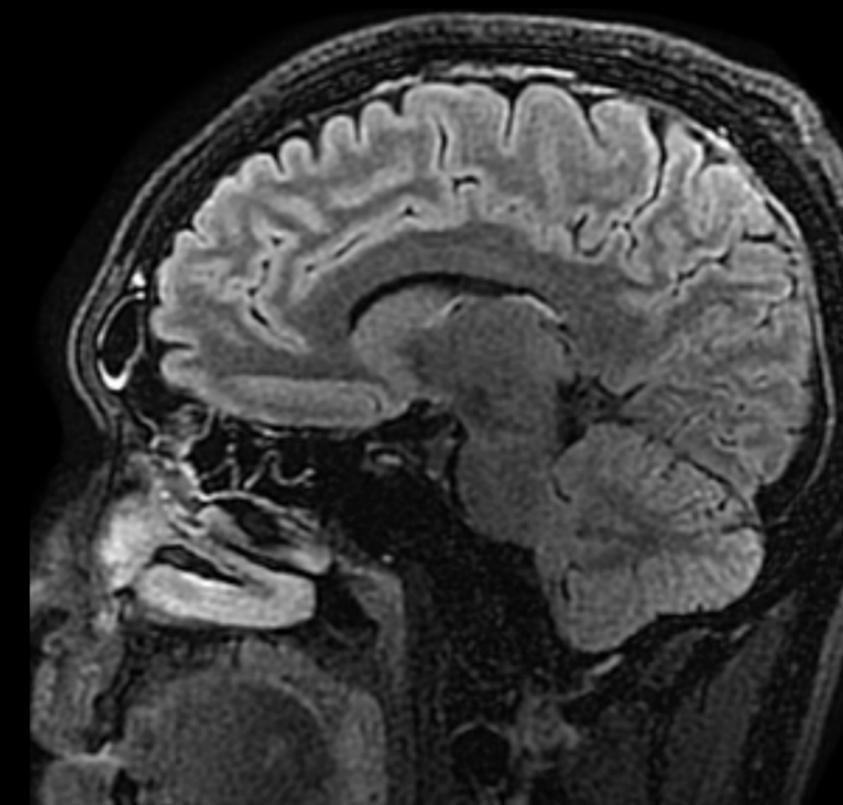
### Clinical benefits:

- Produces motion-free images in patients with involuntary movements or non-sedated pediatrics
- Increases productivity by reducing the series of scans and repeats
- Can assist with spatial anatomical localization for tumor evaluation

Sagittal T2 FLAIR Cube, 240 x 220, FOV 24cm  
4:29 min



T2 FLAIR Cube with PROMO, 240 x 220, FOV 24cm  
4:35 min



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## Elective Applications

# FSE Flex

Fast Spin Echo (FSE) Flex uses a 2-point Dixon technique that provides homogenous fat separation with water, fat, in-phase and out-of-phase images in a single scan. It provides robust imaging where chemical FatSat can fail when detecting cancerous lesions, even in difficult-to-scan anatomies such as the abdomen, neck, hips, spine and feet.

### Clinical benefits:

- Acquires multiple contrasts in a single scan, reducing need for multiple acquisitions
- Compatible with 2D and 3D imaging, which is helpful in challenging off-isocenter anatomies or larger fields of view
- Can be combined with ARC acceleration to reduce scan times



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## Elective Applications

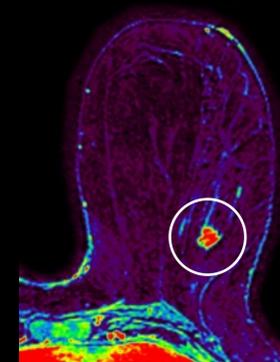
# DISCO

Dynamic Scan Optimization (DISCO) combines 3D DCEMRI + 2 pt Dixon + Parallel Imaging + Temporal Acceleration to reduce scan time. It uses a pseudo random Cartesian trajectory to disperse motion and view sharing to improve temporal resolution.

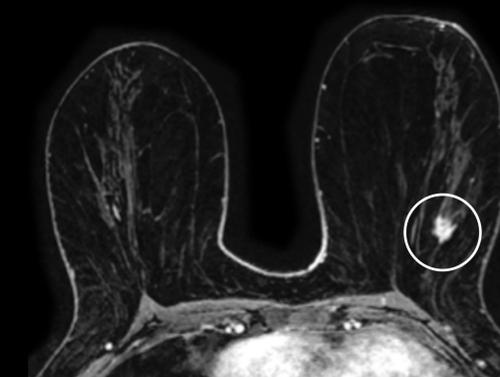
### Clinical benefits:

- Generates extreme, high resolution for 3D dynamic imaging
- Detects smaller lesions with higher spatial resolution and less blurring
- Allows for shorter patient breath-holds
- Compatible with Navigator for free-breathing dynamic scans
- Has the potential to eliminate bolus timing

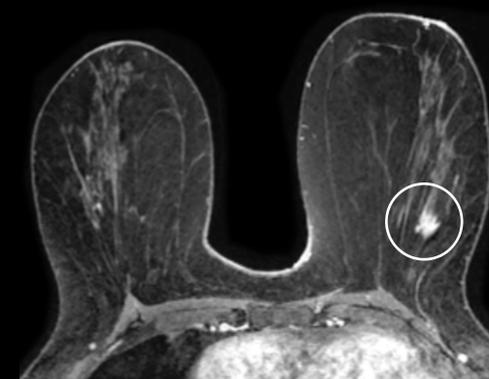
READYView PEI color map of DISCO Flex



DISCO Flex 512 x 512  
1.2mm / 0.6mm 1:06 min / phase



DISCO Single Echo 512 x 512  
1.2mm / 0.6mm 1:24 min / phase



MIP of DISCO Flex phase 5



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Elective Applications

# DISCO

Hepatocellular Carcinoma  
FOV 44cm, 300 x 200, 4mm / 2mm, 16s

Pre

Art<sub>1</sub>

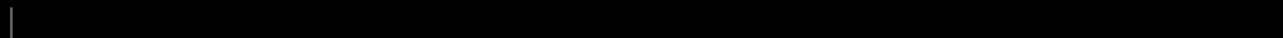
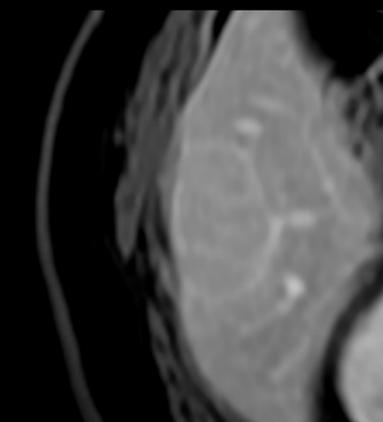
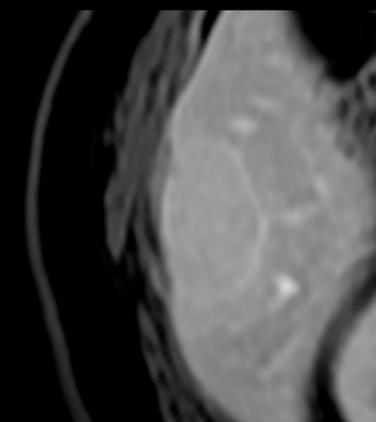
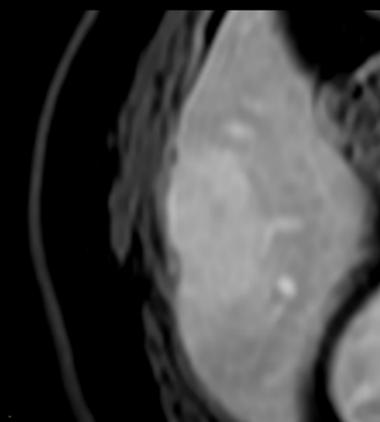
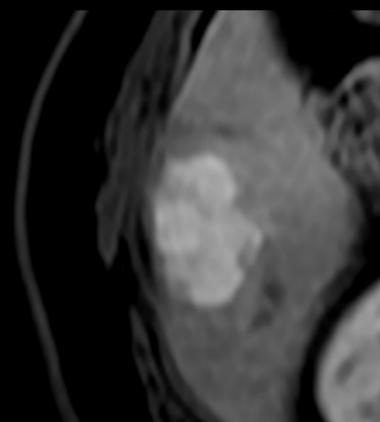
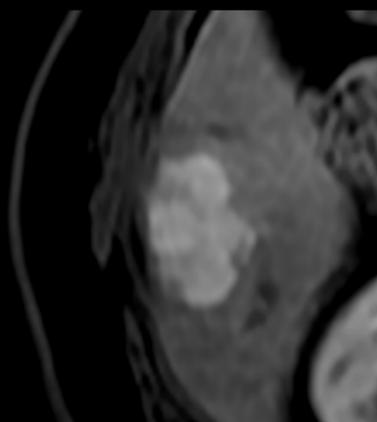
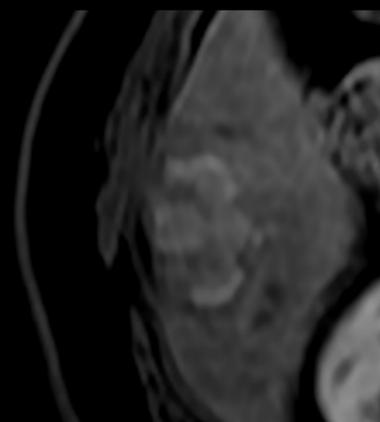
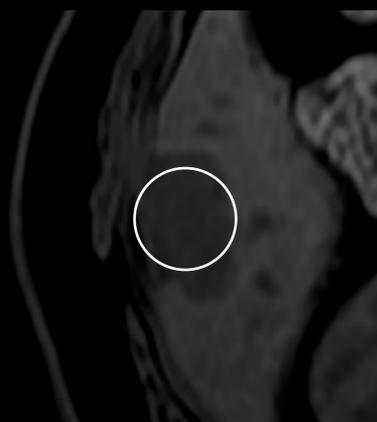
Art<sub>2</sub>

Art<sub>3</sub>

Portal

Equilibrium

3:00 min



Wash in phases in 16s breath-hold



case study

OncoWorks

**Elective Applications**

# Case Study: High Resolution Breast Imaging with DISCO

**Clinical solutions**

System: Optima™ MR450w GEM 1.5T

**Protocols used**

T2w PROPELLER, DISCO Flex, DISCO Single Echo, 3D MIP of DISCO

**Patient history**

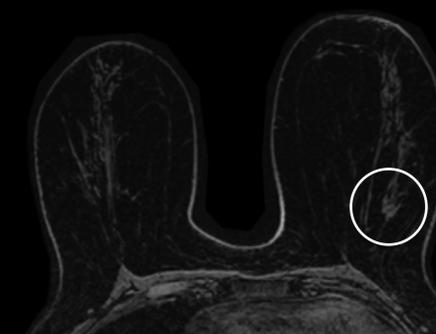
An elderly patient was referred for an MR exam of a left breast lesion after mammography and ultrasound. The lesion appeared to be markedly hypoechoic on the ultrasound exam.

**Procedure**

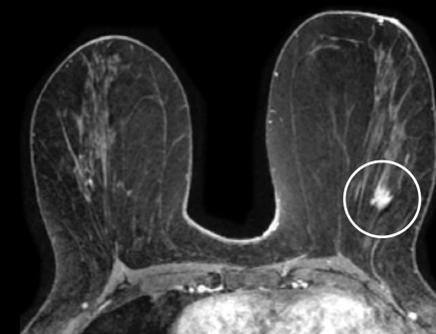
The DISCO sequence improved spatial resolution compared to standard DCE imaging. The DISCO Flex or Single Echo options provided tailored CNR.

**MR findings**

A 9mm spiculated lesion was noticed in the infero external quadrant of the left breast, corresponding to the lesion seen at mammography and ultrasound. Suspect a high grade ductal carcinoma. Also noticed two additional small lesions, located in the upper breast, at the junction of external quadrants. Ultrasound-guided biopsy confirmed three locations of invasive ductal carcinoma.



DISCO Flex  
512 x 512  
1.2mm / 0.6mm  
1:06 min / phase



DISCO Single Echo  
512 x 512  
1.2mm / 0.6mm  
1:24 min / phase



T2w PROPELLER  
352 x 352  
2mm  
4:07 min / phase



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**Elective Applications**

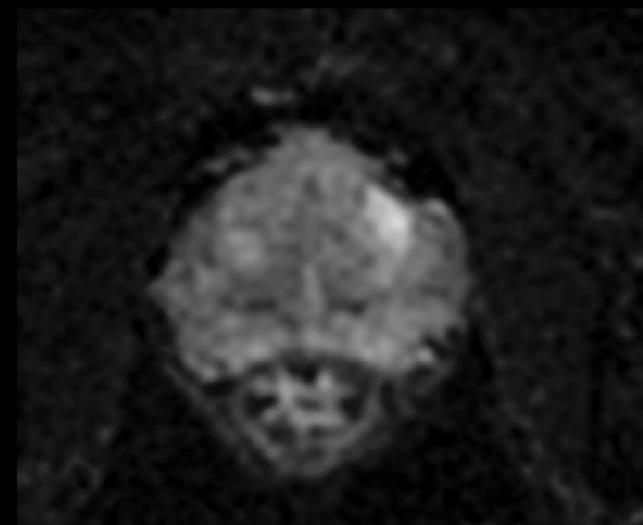
# FOCUS DWI

FOV Optimized & Constrained Undistorted Single-shot (FOCUS) is a 2D Spatially Selective RF Excitation method for DW-EPI and DTI that reduces the FOV in the phase encode direction, to reduce geometric distortion, eliminate phase wrap artifacts and increase image sharpness. It provides high resolution DWI scans, especially useful when the region of interest is small in the phase encode direction.

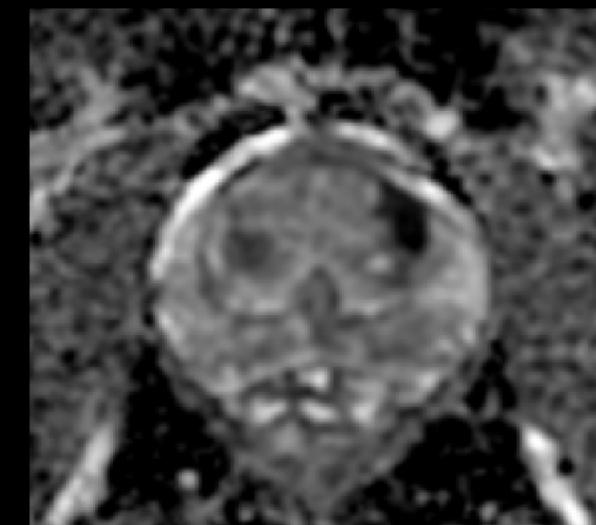
## Clinical benefits:

- Helps reduce distortion around air/tissue interfaces, e.g., bowel
- Provides a higher spatial resolution diffusion when compared to conventional EPI diffusion techniques
- Helps detect and evaluate small lesions that may be obscured by distortion

Axial FOCUS DWI b1000  
3:23 min



FOCUS ADC



OncoWorks

**Elective Applications**

# Case Study: Assessing Hepatocellular Carcinoma with FOCUS and DWI

“The combination of DISCO and FOCUS DWI adds a few more steps to getting closer to one-stop-shop imaging of abdominopelvic diseases with MRI.”

*Yasemin Gündüz, MD, Sakarya University, Research and Training Hospital*

**Protocols used**

T2 FatSat frFSE, T1 3D LAVA Flex, eDWI, FOCUS DWI, DISCO

**Patient history**

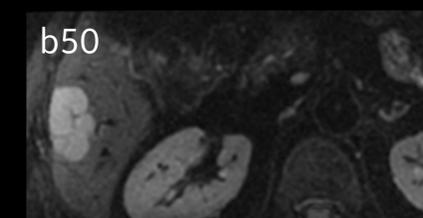
A 61-year-old patient had a liver mass detected during an ultrasound checkup. AFP results were normal and patient had no prior history of chronic liver disease. Underwent a previous splenectomy.

**Procedure**

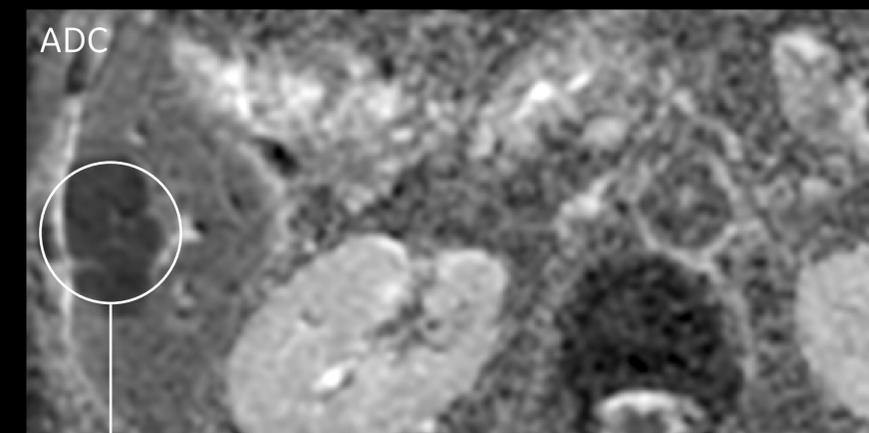
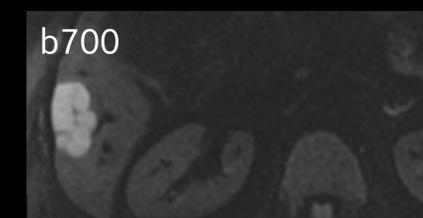
FOCUS DWI significantly improved the resolution and quality of DWI imaging. ADC added accuracy to lead to a differential diagnosis. DISCO helped overcome the difficulty of delivering both spatial and temporal resolution and provided the fastest multiple-wash-in phases in a single breath-hold.

**MR findings**

Hepatocellular carcinoma was suspected and the MR scan clearly depicted early arterial enhancement and fast wash-out and capsular contract enhancement. There was also an increased diffusion restriction pattern and moderate hyper-intensity on T2-weighted images.



FOV 24cm  
150 x 74  
5mm / 0.5mm  
03:35 min



677.4 x10<sup>-6</sup>



OncoWorks

**Elective Applications**

# OncoQuant

A cross-modality software platform for the AW or AW Server that provides innovative analysis and reporting tools to streamline clinical capabilities and simplify exam reading workflow.

## Benefits:

- Can help to increase diagnostic confidence for tracking measurements
- Manages cases across multiple modalities with no limit on the number of exams
- Provides automatic multi-modality image registration when loading two or more exams



OncoWorks

**Innovative Applications**

# HyperSense

HyperSense is an acceleration technique based on sparse data sampling and iterative reconstruction that delivers high image resolution or reduced scan time, without the typical penalties of conventional parallel imaging. It can be combined with other acceleration methods (ARC) to achieve high SNR with shorter acquisition times.

## Clinical benefits:

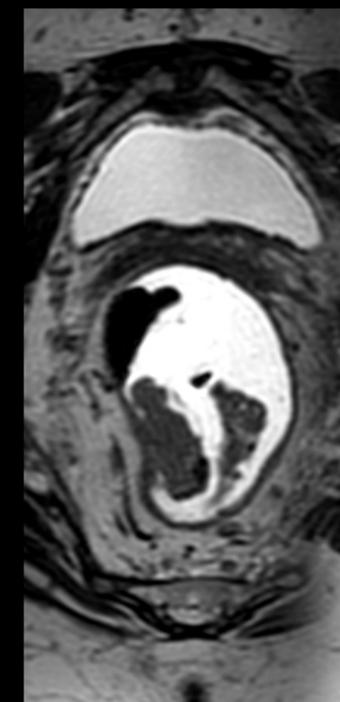
- Lowers scan time, without reducing SNR
- Helps achieve outstanding resolution in the same amount of time
- Provides faster 3D imaging acquisitions
- Combines with ARC for higher acceleration

Rectal carcinoma

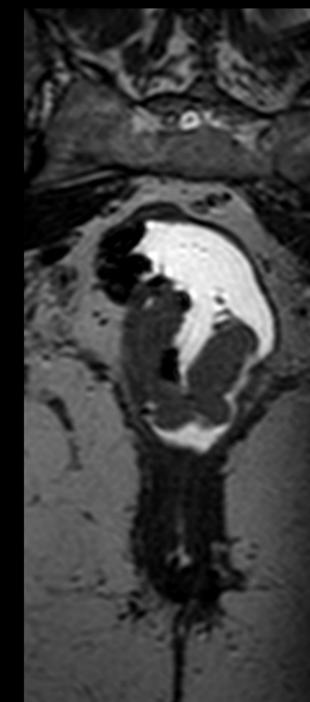
T2 Cube  
with HyperSense



Axial MP  
with HyperSense



Coronal MPR  
with HyperSense

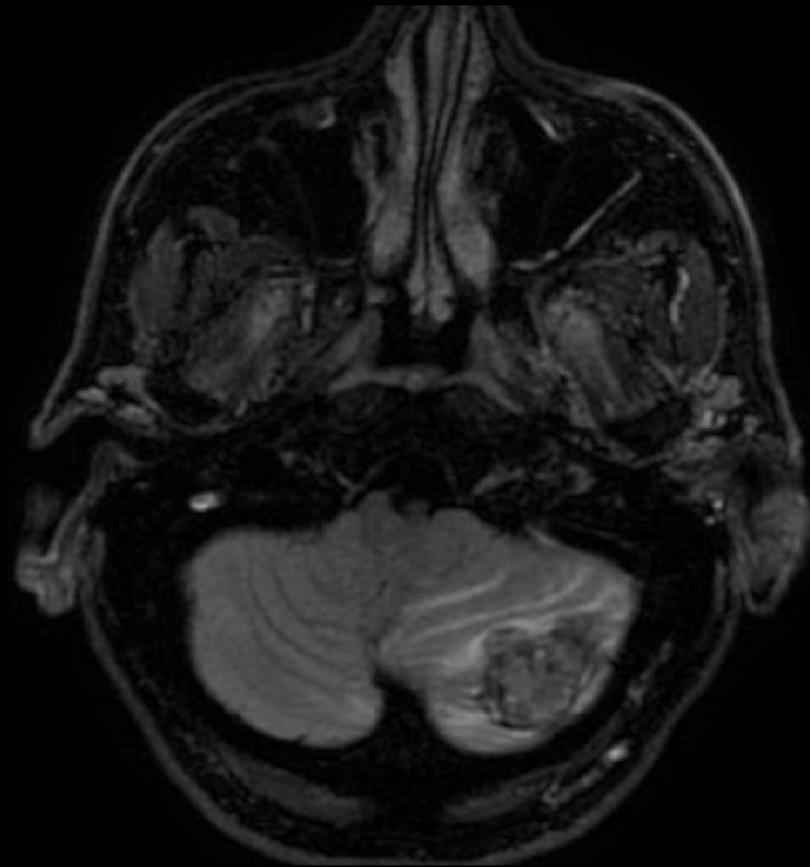


OncoWorks  
Innovative Applications

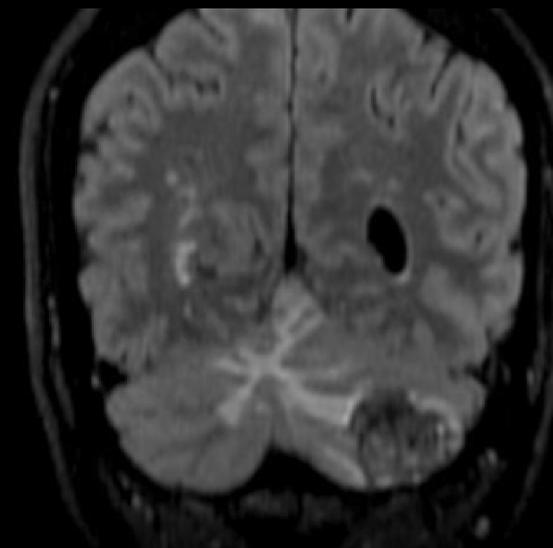
# HyperSense

Axial T2 FLAIR Cube with HyperSense factor = 1.4, ARC 2 x 2

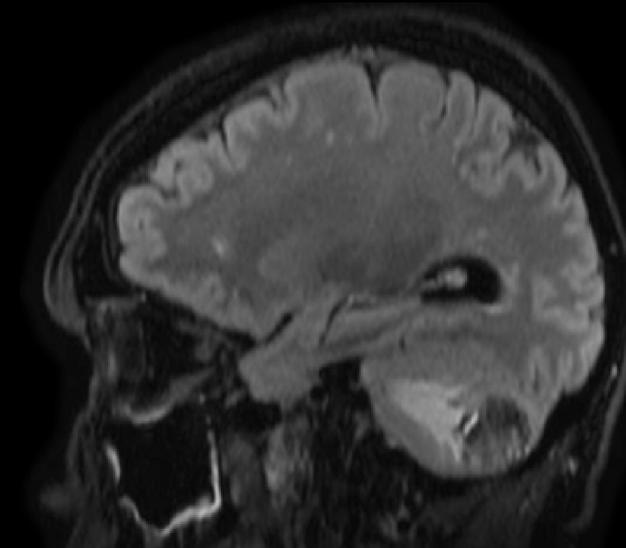
Axial acquisition  
0.94 x 0.94 x 1.6mm



Coronal reformat



Sagittal reformat



OncoWorks

**Innovative Applications**

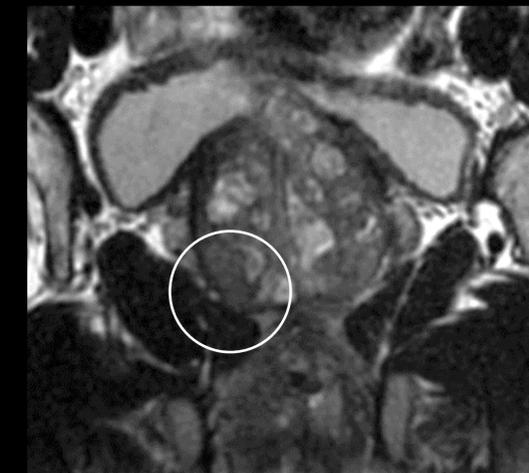
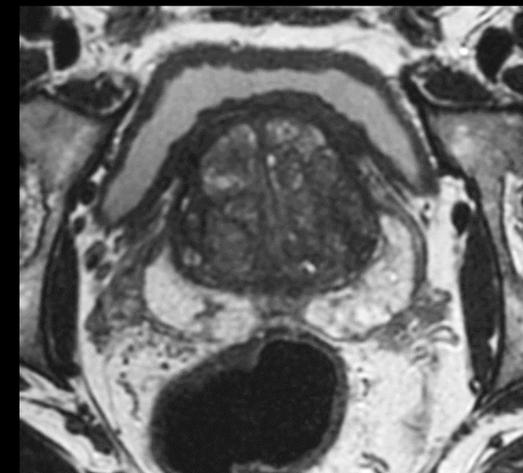
# HyperCube

HyperCube reduces scan time and limits artifacts such as motion and aliasing by reducing the phase FOV. It can be applied with or without fat suppression and significantly lowers imaging time without sacrificing contrast quality. It allows focus on the area of interest, can be used on the entire body and is compatible with HyperSense.

## Clinical benefits:

- Lowers scan time, without SNR loss, allowing less potential for patient motion and less repeats
- Eliminates time-consuming parameters
- Provides high-resolution small FOV imaging
- Helps with large FOV robust fat suppression when combined with FSE Flex

Axial T2 with HyperCube



OncoWorks

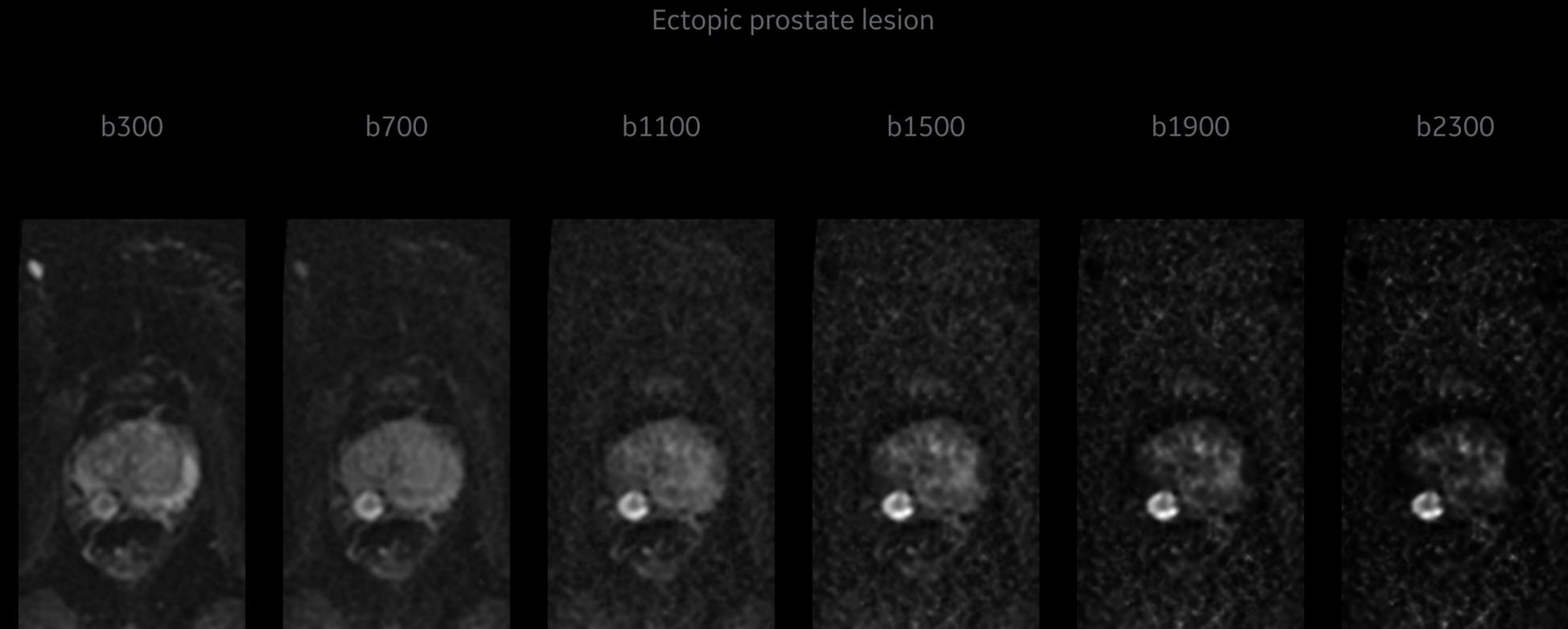
**Innovative Applications**

# MAGiC DWI

MAGnetic resonance image Compilation Diffusion Weighted Imaging (MAGiC DWI) generates multiple synthetic b-values from one DWI scanned series so you can view diffusion contrast changes in real time after acquisition. It delivers high b-values without stressing protocol parameters, and shorter scan times without sacrificing contrast or anatomy coverage. It also allows shorter TE, improving SNR and sharpness.

## Clinical benefits:

- Produces multiple synthetic b-values from a single DWI scan
- Increases productivity by enabling higher b-values in shorter scan times
- Calculates high b-value as recommended by PIRADS for prostate
- Compatible with FOCUS diffusion



Images courtesy of: Triemli Hospital, Zurich, Switzerland; Sakarya University Research and Training Hospital, Sakarya Province, Turkey; GIE IRM, Creil, France; Tenon Hospital, Paris, France; Fairfax MRI Center, Fairfax, VA, US; Necker Hospital, Paris, France; Addenbrooke's Hospital, Cambridge, UK; radiomed, Germany; Keio University, Japan; Clinique Charcot, Lyon, France; Levanger Hospital, Levanger, Norway



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