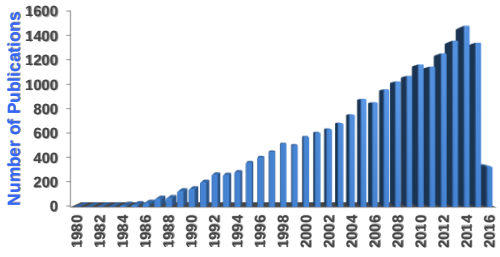
GE Healthcare
Integrating MR into Radiation Therapy

Dennis V Savitskij,
Product Manager, MR in Radiation Oncology
Aug 1st, 2016

Pubmed search of: *'MRI radiation therapy'*



Dr Kiaran McGee, PhD - Mayo clinic, Rochester MN

Diagnostic vs. Radiation Planning MRI

Diagnostic MRI:
- What is the problem?
- High conspicuity
- Dedicated/customized RF coils
- Multiple sequences:
  - –Varying contrast
  - –Functional information
  - –Often qualitative

≠

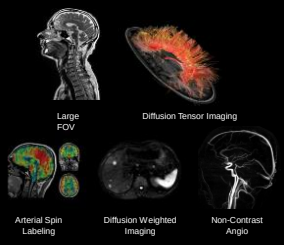
Radiation Planning MRI:
- What is the spatial extent of the problem?
- Where are the adjacent radiosensitive organs?
- High resolution 3D
- Image in treatment position
- Non ideal (surface coils)
- Relatively limited imaging sequences
- Requires large FOV data

Dr Kiaran McGee, PhD - Mayo clinic, Rochester MN

MR Advantages in Oncology

- Excellent soft tissue contrast helps provide confidence in tumor delineation
- Multi-parametric imaging, anatomical, functional, metabolic, dynamic
- Vascular imaging with and without contrast media
- No ionizing radiation

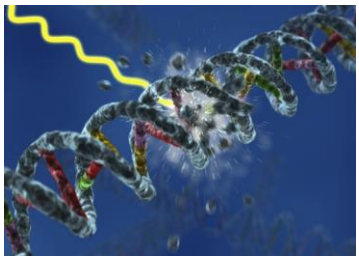
Prostate, GYN, Brain/Head & Neck, Spine, Liver, Sarcoma and Breast



Normal Volunteer Images 4

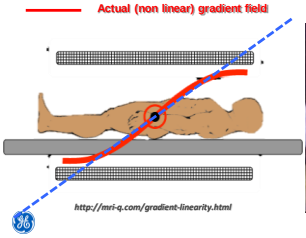
Outline

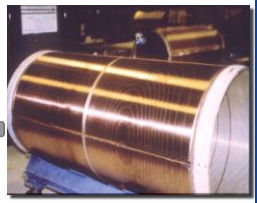
High Quality image generation
RT Applications
MRI patient positioning devices
RT software



Spatial Accuracy

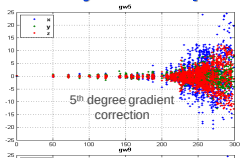
Ideal (linear) gradient field
Actual (non linear) gradient field



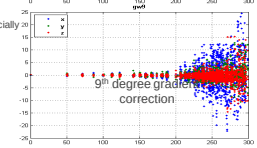


Spatial Accuracy: *'Grad Warp'*

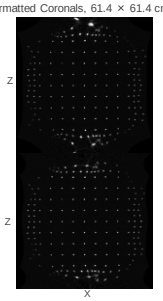
MR450W
BW = 31.25kHz



Impact especially on z-axis



Reformatted Coronals, 61.4 × 61.4 cm,



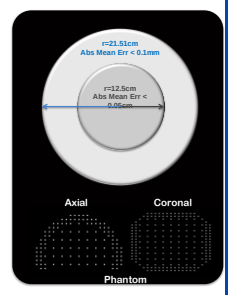
High Spatial Integrity

Mean abs error ≤ 0.1cm at 43.0 cm diameter

Max abs error ≤ 1.6% at 43.0 cm diameter

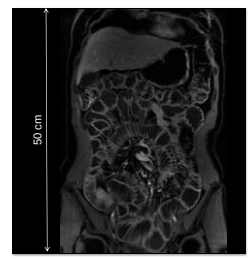
- High magnet homogeneity
- Excellent gradient linearity over a LFOV
- 3D gradient distortion correction software reduces distortion in the MR image

Measurements based on NEMA MS-12 "Quantification and Mapping of Geometric Distortion for Special Applications", using a Large Field of View phantom with a 3D FGRE acquisition

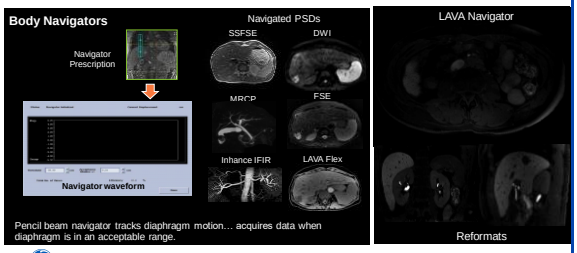


Field of View for Radiation Treatment Planning

- Exceptional magnet homogeneity and Field of View
  - 50x50x50 FOV
  - 45cm DSV @<0.7ppm typical



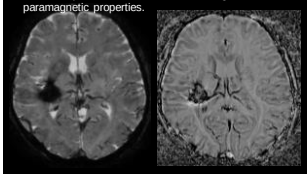
Navigators... Motion Insensitive Body Imaging



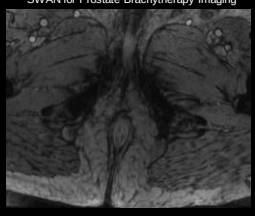
Courtesy: UW Madison, USA & Seirei Hamamatsu, Japan

SUSCEPTIBILITY WEIGHTED 3D IMAGING - SWAN

- SWAN is a multi-echo 3D T2* susceptibility weighted imaging technique
- SWAN provides a magnitude image and phase maps
- Phase map allows visualization of diamagnetic and paramagnetic properties.



SWAN for Prostate Brachytherapy Imaging

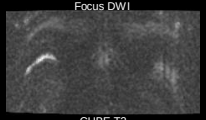


Courtesy: Dr Cornelis from CHU Bordeaux , France – MR750w

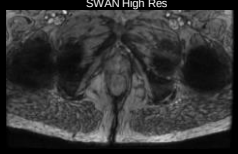
Fast Brachytheraphy Protocol

- eSSFE for Lymph Node assessment FOCUS Diffusion
- CUBE volumetric T2
- SWAN High-Res

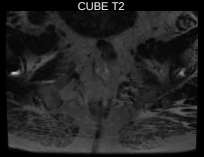
Focus DWI



SWAN High Res



CUBE T2

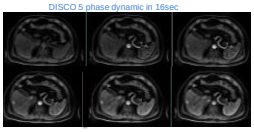


Courtesy: Dr Cornelis from CHU Bordeaux , France – MR750w

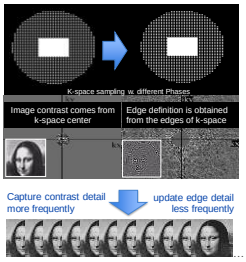
DISCO: 4D time resolved imaging

- High spatial and temporal resolution
  - By treating DCE as a 4D data vs series of 3D sets
- Flexible matrix size & FOV
  - By using Cartesian k-space sampling
- Maximizes contrast uptake
  - By always sampling full central region
- Reduces blurring/motion artifacts
  - By "random -iterative" subsample of outer k-space

DISCO 5 phase dynamic in 16sec



ARC=2x2 Acceleration DISCO Time Undersampling

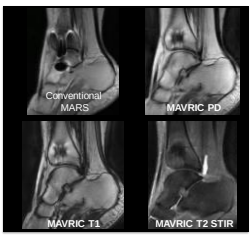


Sananathan , J Magn Reson Imaging. 2012 June ; 35(6): 1484–1492

Imaging Around Metal Implants - MAVRIC

MAVRIC– Volume imaging at multi-frequency offsets to reduce distortions

- Composite image created from spectral offset images
- PD, STIR and T1 contrast is possible



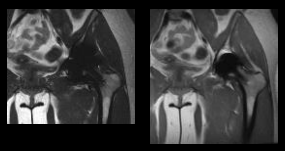
Courtesy of MVZ, Fürth, Germany

Imaging Around Metal Implants MAVRIC SL

Images courtesy of Hospital for Special Surgery, New York Hospital Marmston, UK

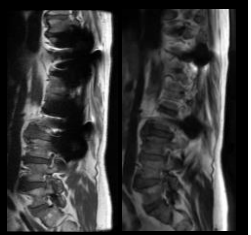
Designed for imaging soft tissue and bone near MR Conditional metal implants

2D PD FSE (MARS) MAVRIC SL



Conventional MRI of patient with MR Conditional metal-on-metal hip implant

MAVRIC SL image showing peri-prosthetic bone



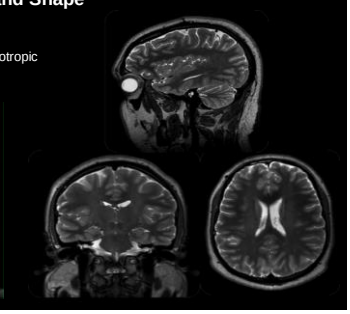
These images were generated using the MAVRIC SL software feature and are representative of the quality of images that users should expect to generate. However, GE Healthcare is not always able to confirm whether the images are of MR Conditional implants or whether scanning was in accordance with the implant's instructions for use. MAVRIC SL should only be used with MR Conditional implants and within the MR conditions specified for those implants.

Voxels of the Right Size and Shape

3D Cube

Scan once and reformat the sub-mm isotropic dataset into any plane

T1, T2, FLAIR, DIR, and PD contrasts



Voxels of the Right Size and Shape
Pre-Loaded Radiation Oncology Protocols

High resolution

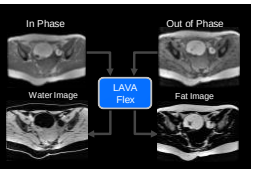
Thin-slice, zero skip

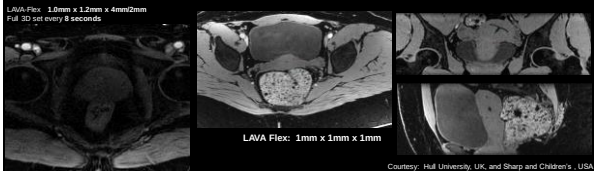
High contrast

Brain, Head & Neck, Pelvis

LAVA Flex

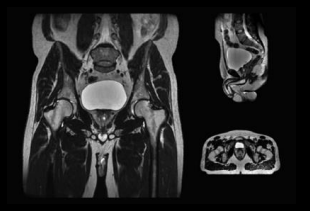
- Volumetric T1 sequence for DCEMRI
- Four image contrasts in one scan with perfect registration: Segmentation
- Excellent fat suppression
- High SNR allows high-resolution images





For Prostate Treatments
GEM AA & PA Coils with CIVCO Positioning Devices

High quality images in the treatment position.



Normal Volunteer Images – Optima 450w GEM 19

Pelvic positioning Setup

GEM posterior Array

Anterior Array Supports

For Head & Neck Treatments
GEM RT Open Head & Neck Suite

GEM RT
Open Array

Open Design. Patient Comfort.

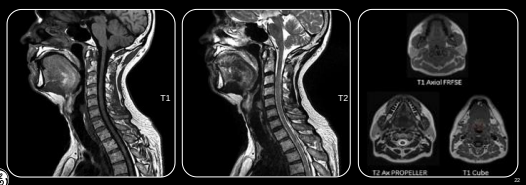
Combined with 16 ch GEM Large Flex coil and 6 ch Neuro Flex coil to obtain high quality H&N images in the treatment position.

21

For Head & Neck Treatments
RT Open Head & Neck Suite

RT Open Array + 6 Channel Flex coil + Large Flex coil with coil supports

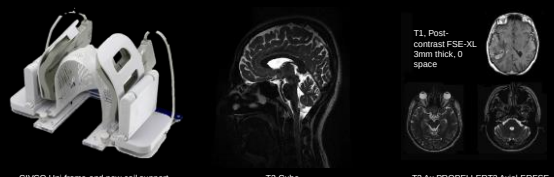
- Excellent image quality
- High resolution, full FOV images in the treatment position



22

For Brain Treatments
6 Channel Flex Coil + RT Open Array

High quality images in the treatment position. 10 channels of imaging.

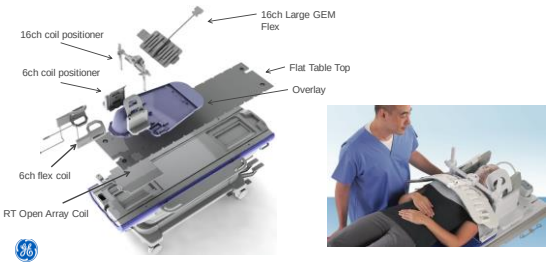


CIVCO Uni-frame and new coil support | T2 Cube | T2 Ax PROPELLERT2 Axial FRFSE

Normal Volunteer Images. Image courtesy of Al Amal Hospital

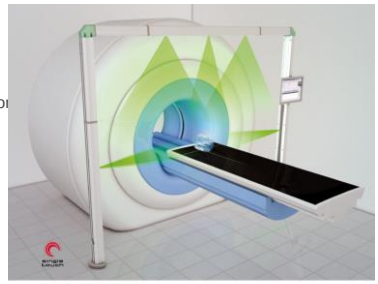
23

For Head & Neck Treatments
GEM RT Open Head & Neck Suite



Laser Marking

Laser bridge system specifically designed for radiation therapy laser marking in MR



THE LAP DORADO MRT BRIDGE SYSTEM,
ESPACIALLY DESIGNED TO WORK WITH HIGHEST MAGNETICAL SYSTEMS CERTIFIED UP TO 3 TESLA FIELD INTENSITY

25

MR Compatible Positioning Devices
A Comprehensive Set of Options

Designed to properly position the patient

MR compatible positioning packages, developed in collaboration with CIVCO, provide reassurance

Brain Package

CIVCO Uni-frame™

Head & Neck

CIVCO PosiFix® and Type-S™

Prostate & GYN

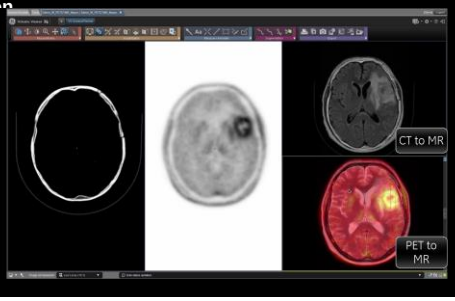
CIVCO HipFix®

CIVCO Vac-Lok bags

CIVCO Feetfix™
CIVCO Kneefix™

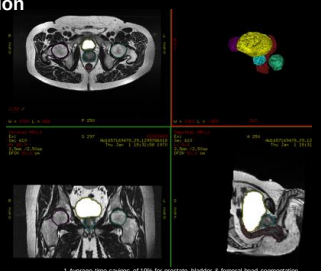
•Lok-bar, Uni-frame, Posifix, Type-S, Feetfix, Hip-Fix, Kneefix are all trademarks of CIVCO 20

Integrated Registration –MR to MR and Multi-Modality Fusion



MR pelvic Organ Segmentation Advantage Sim9

- Semi-automatic segmentation
- Registered to CT
- Designed to support:
  - Prostate
  - Bladder
  - Femoral
  - Heads
  - Rectum
- Designed to help speed up time consuming manual contouring of Organs-at-Risk on MR images[1]
- Designed to improve consistency of inter-operator countouring[2]



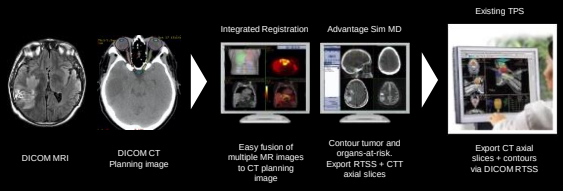
1 Average time savings of 19% for prostate, bladder & femoral head segmentation

2 Decreases inter-observer variability by an average of 14% for prostate, bladder and femoral head segmentation

28

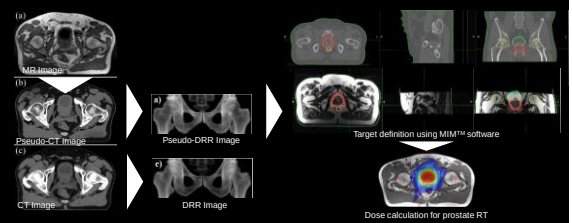
Easy Integration into RTx Workflow

GE Oncology Workstation (AW) / MD Connect (AW Server)



29

Planning RT with MR images only Workflow



J. Korhonen, M. Kapanen, J. Keyriläinen, T. Seppälä, and M. Tenhunen; "A dual model HU conversion from MRI intensity values within and outside of bone segment for MR-based radiotherapy treatment planning of prostate cancer," Med. Phys. 41(011704), 1-13 (2014).

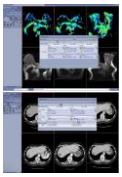
30

Treatment Monitoring… OncoQuant

- OncoQuant AW application is designed to help organize and display multi-modality/ multi-time point oncology data to facilitate quick review.

Highlights

- Automatic multi-modality image registration at loading for two or more exams.[1]
- Adaptable workflow supports standard criteria such as RECIST[2] and WHO.[3]
- Dedicated automatic review protocols to identify and load like series.
- Single-click display up to four dates including Baseline, Nadir, Prior, and Current exams.



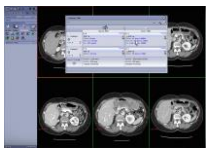
1. Integrated Registration Multi-Modality option required. 2. RECIST http://www.eortc.be/Recist/Default.htm.
3. Measures of Response: RECIST, WHO, and New Alternatives, J Clin Oncol 24:3245-3251.

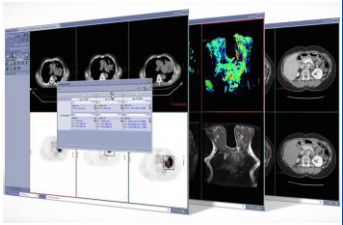
Case study by Dr. Boulay

ASSESSING DRUG RESPONSE WITH MULTIPLE MODALITIES USING ONCOQUANT

Treatment Monitoring… OncoQuant

CT/MR/PET
Autoregistration





Automatic Tumor segmentation
Fx to Fx Statistics

Takeaways

- GE has a solution for MR in RT
- RT needs a definition of MR Sim analogous to AAPM TG 66
- Have a great AAPM 2016
- Visit the GE booth if you have any questions

GE Healthcare

Thank you!