Advance Technology in Vascular Imaging

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Application Specialist CT/MR

GE Healthcare

Some history….

- The first angiogram was performed only months after Roentgen's discovery
- Which was when?
- Two physicians injected chalk or mercury salts into an amputated hand
- and created an

image of the arteries

- Post-mortem injection of mercury compounds, January 1896

Modailities

which demonstrate the vasculature to a greater or less degree

- CT
- MRI (MRA)
- Ultrasound (particularly Doppler)
- Nuclear Medicine
- are all used to image vessels and each has its advantages and disadvantages
- Vessel imaging is a constantly evolving area.

Refresher (basic concept)

- Contrast Administration

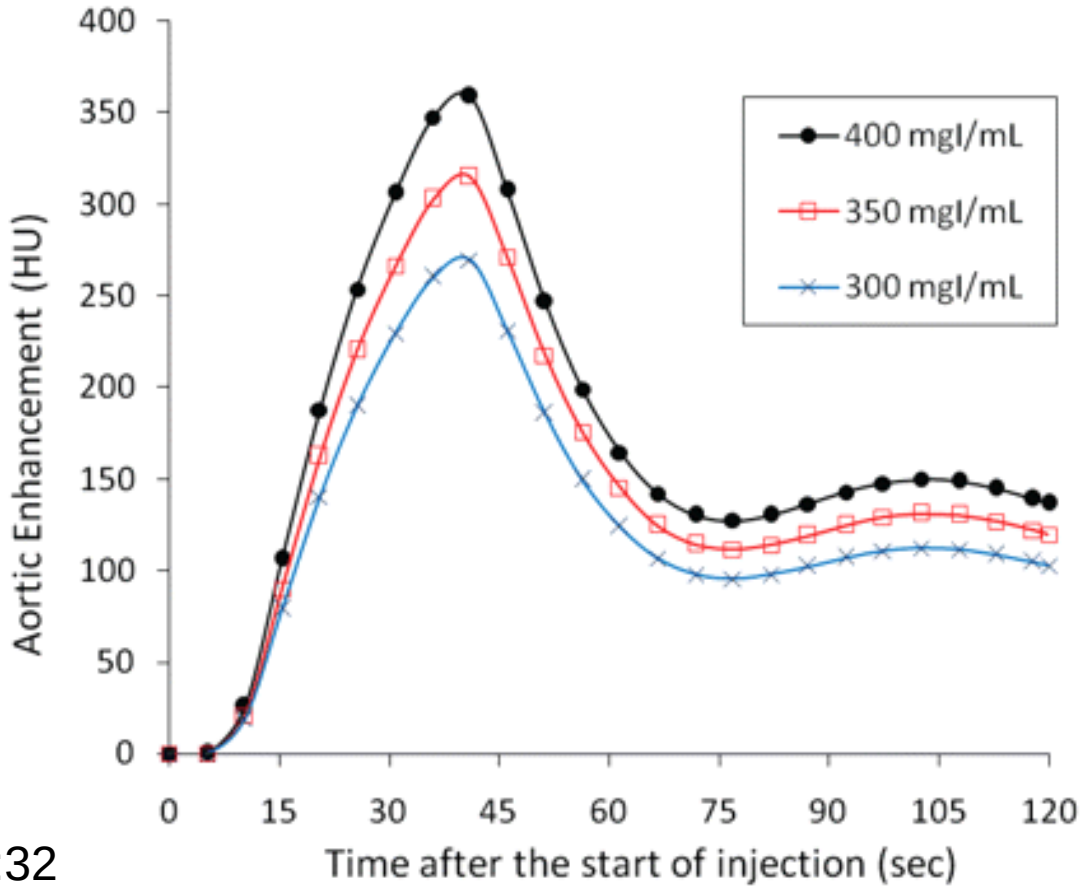
To achieve arterial enhancement generally it is proportional to the iodine administration rate i.e:

1. Iodine concentration
2. Flow rate (mL/s)
3. Longer injection duration (larger volume)

- Time of scan

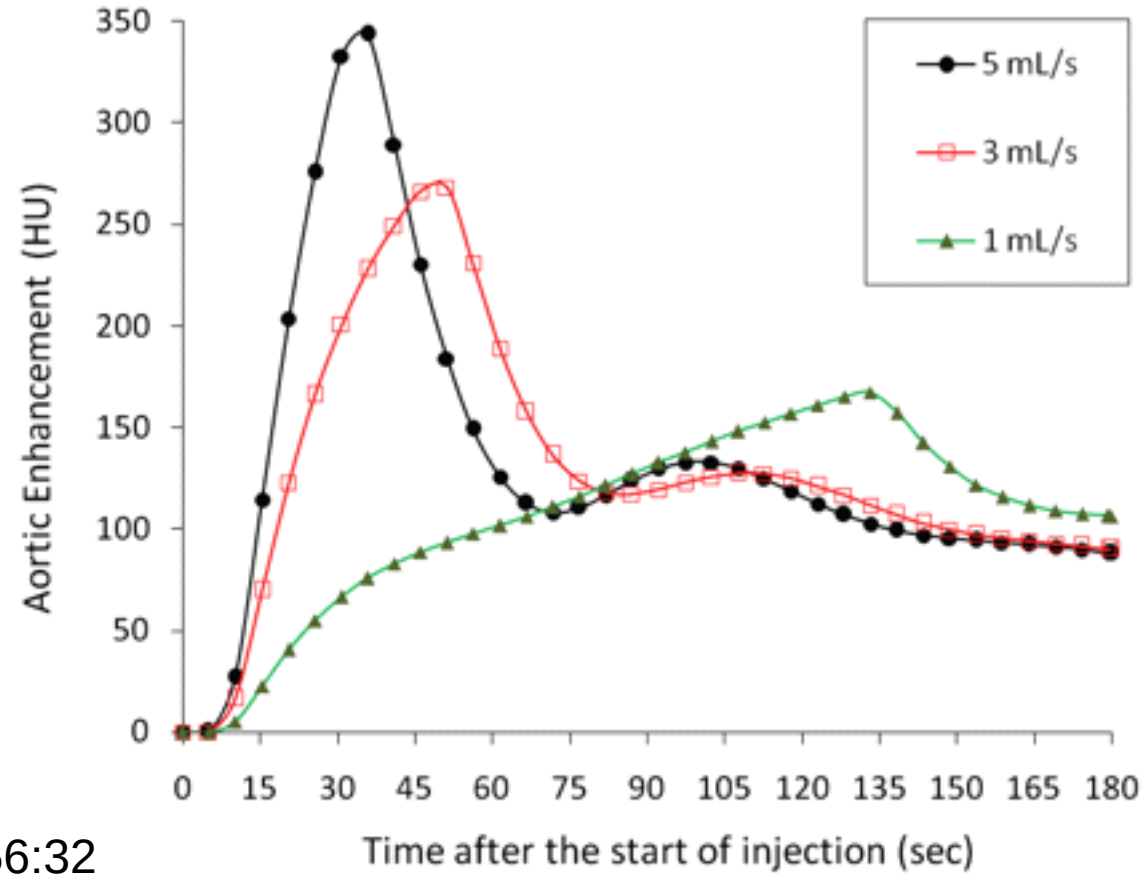
1. Timing bolus
2. Smart prep
3. Fixed delay

Iodine Concentration



Bae KT. Radiology 2010;256:32

Flow rate



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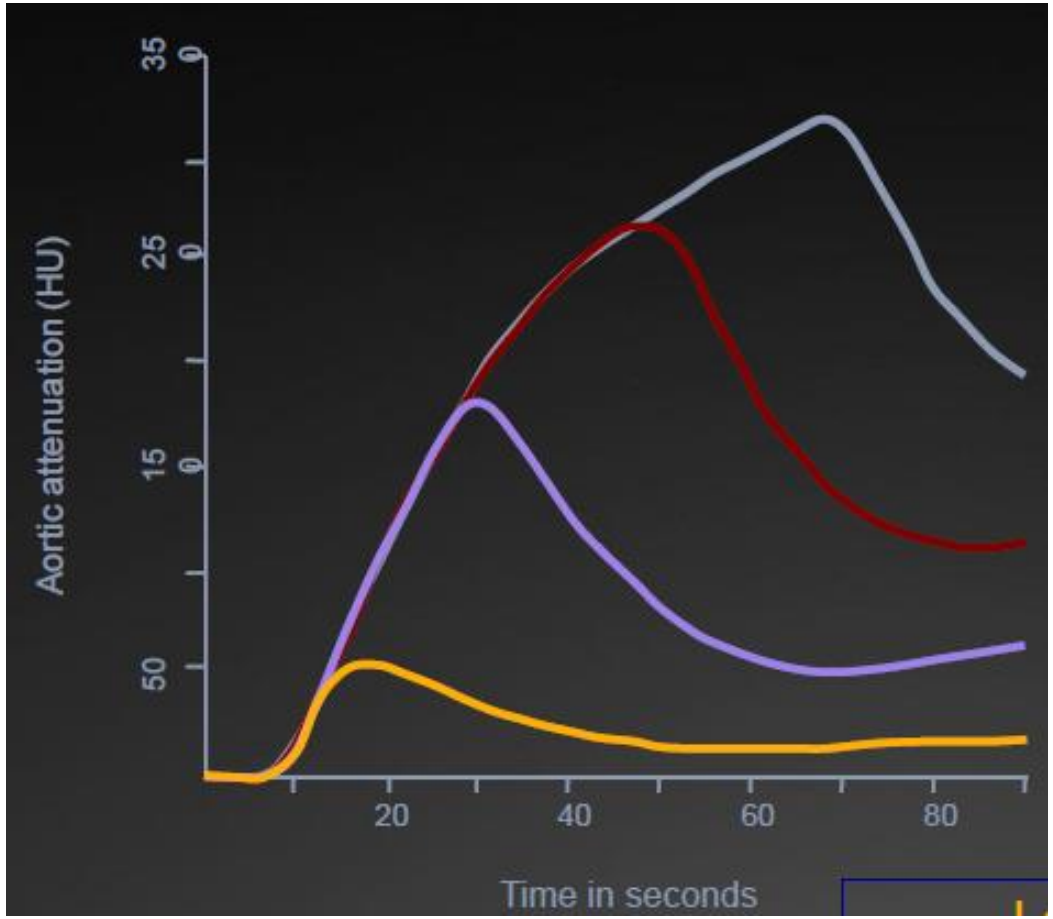
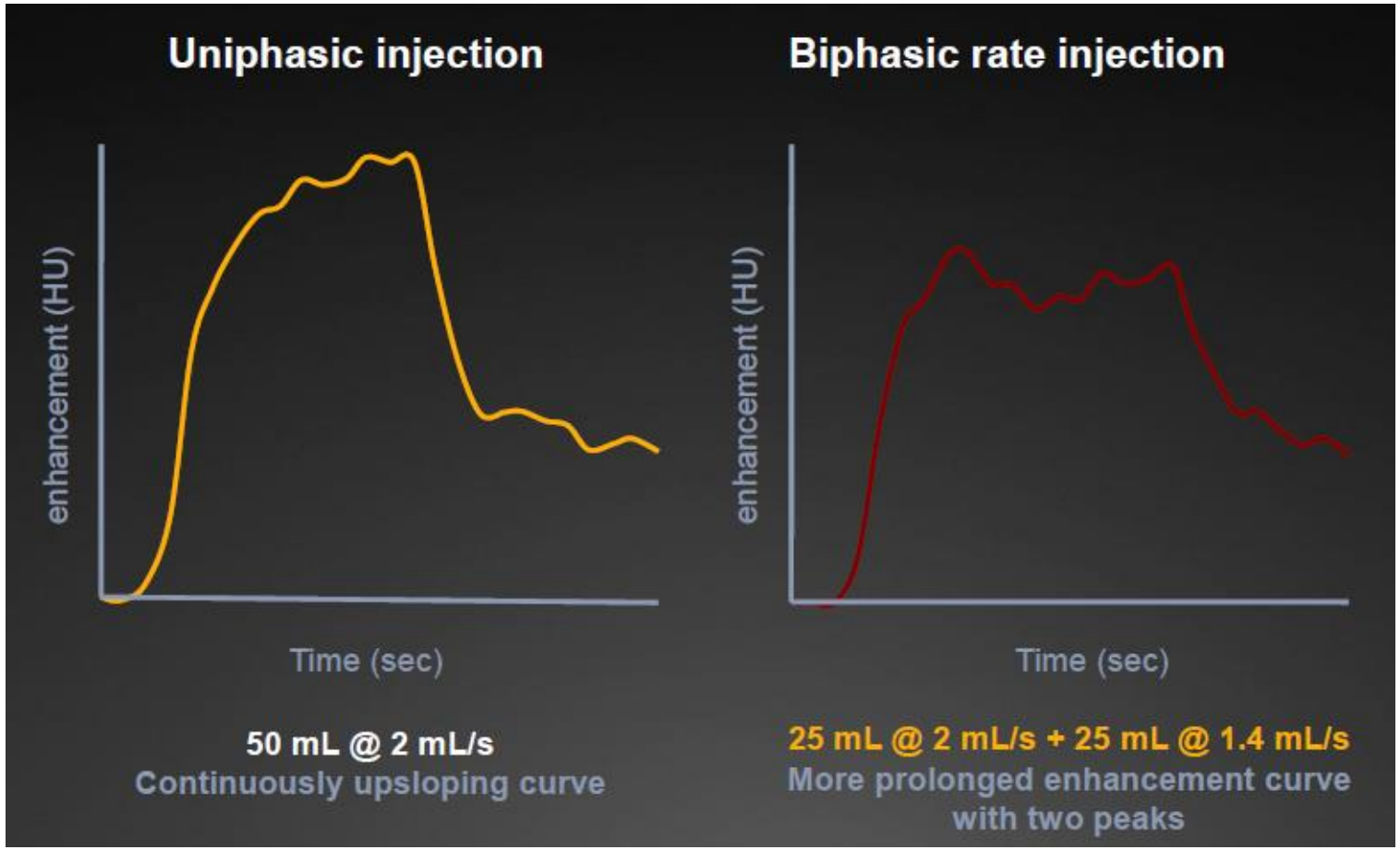
Injetion duration = contrast volume



Varying injection duration of 350ml/mg @ 3cc/s

5 sec = 15 cc
20 sec = 60 cc
40 sec = 120 cc
60 sec = 180 cc

Bae KT. Radiology 2010;256:32



Bae KT. Radiology 2010;256:32

Example


3D
Ex05906111
Se:302
HD MIP No cut
DFOV58.4cm
STND/SS40
S:1171
Runoff demo
AW18468035526.109.1464196876
ExFeb 05 2017
No calc.
R
L
Gantry OFF
No VOI
kV 100
mAMod.
Rot 1.00s/HE+ 35.0mm/rot
1.2mm 1.75:1 0.62sp
Tilt:0.0
11:38:31 AM
W =700 L =200
S:3
0 L0LAO0CRA


3D
Ex05906111
Se:302
Volume Rendering No cut
DFOV58.4cm
STND/SS40
S:1171
Runoff demo
AW18468035526.109.1464196876
ExFeb 05 2017
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Gantry OFF
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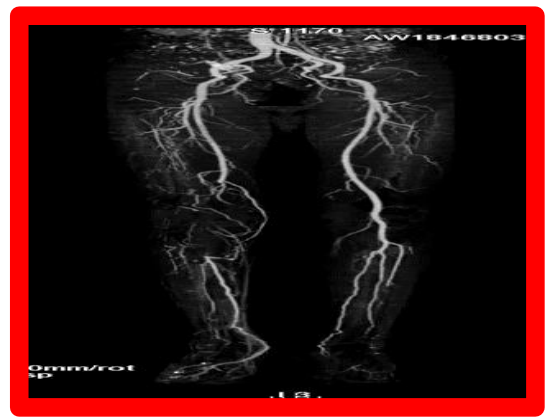
S:1170
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Runof
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cut
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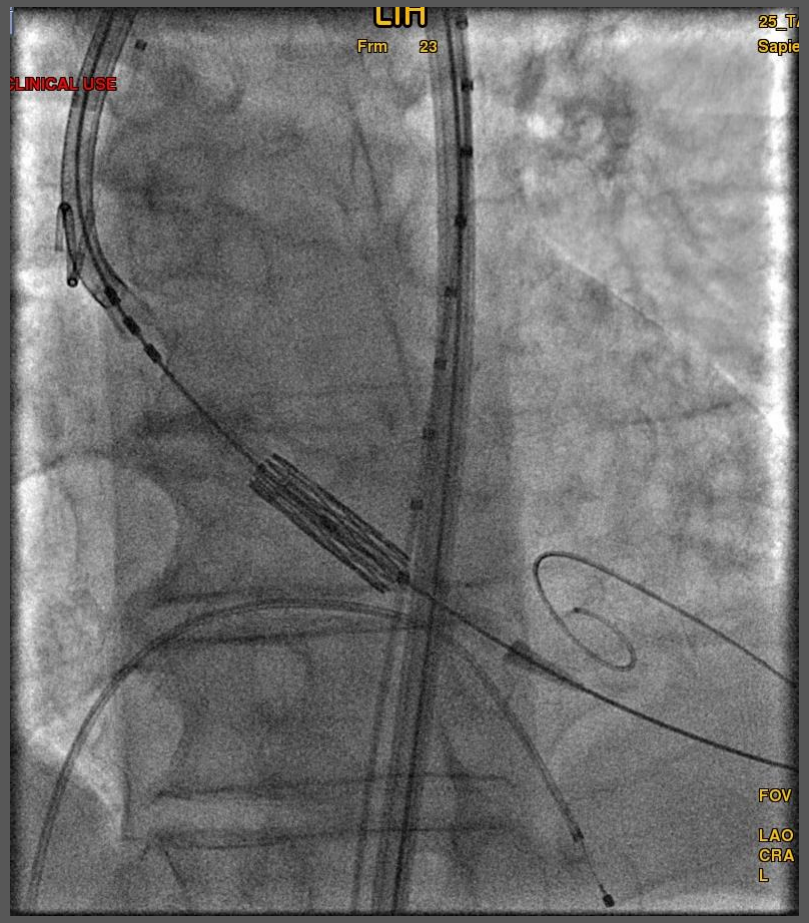
General Vast Areas of Improvement

- Hardware
- Slices
- Detector
- Tube
- Rotation
- Dose

- Software
- Faster processing
- Smarter
- User friendliness

A new visualization mode for your TAVI procedures



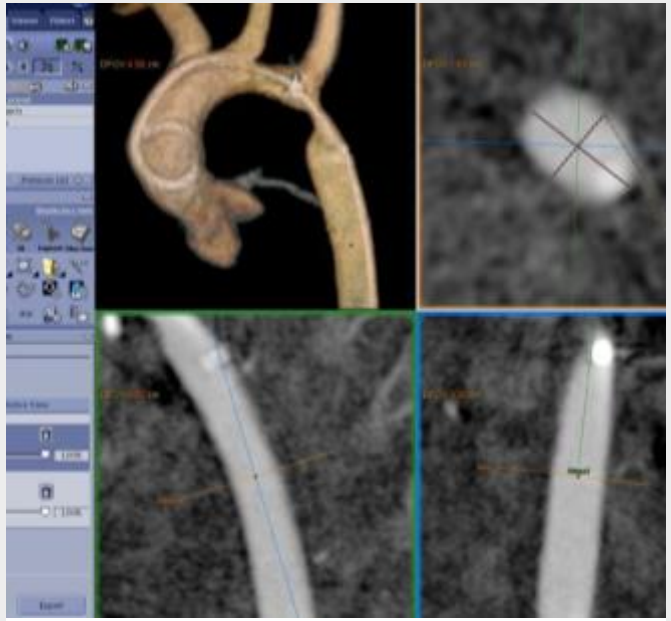
Without Valve ASSIST 2[1]

With Valve ASSIST 2[1]

1 Cannot be placed on the market or put into service until it has been made to comply with all required regulatory authorizations including the Medical Device Directive requirements for CE marking.

Our Solution for Aortic Coarctation

with Innova 3D & Valve ASSIST 2

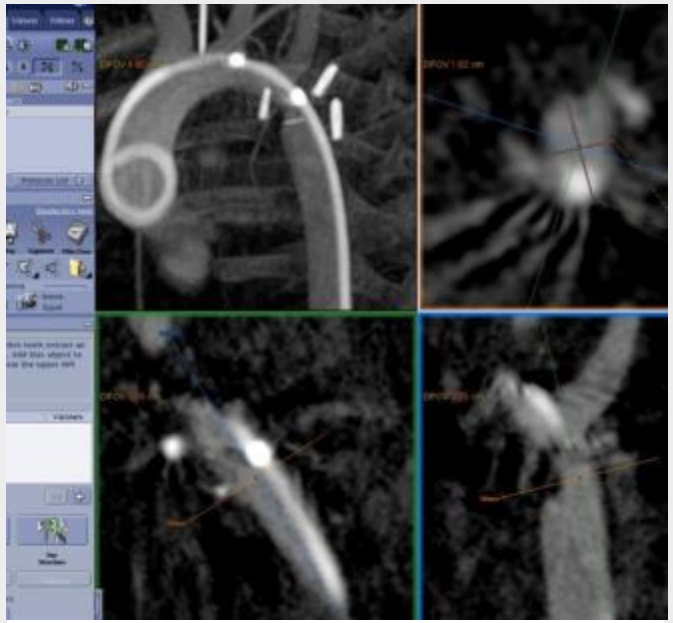


- Plan

Innova 3D helps physicians in diagnosis, surgical planning, interventional procedures, and treatment follow-up, and helps clinician find the optimal C-arm angulation.

- Guide

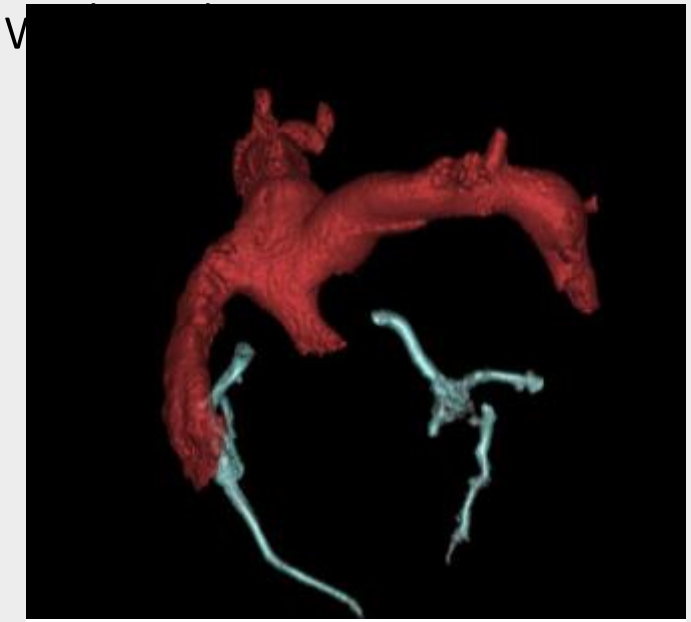
Helps to perform a serial angioplasty on the aortic coarctation using Innova HeartVision to fuse the 3D image on the live fluoroscopy.



- Assess

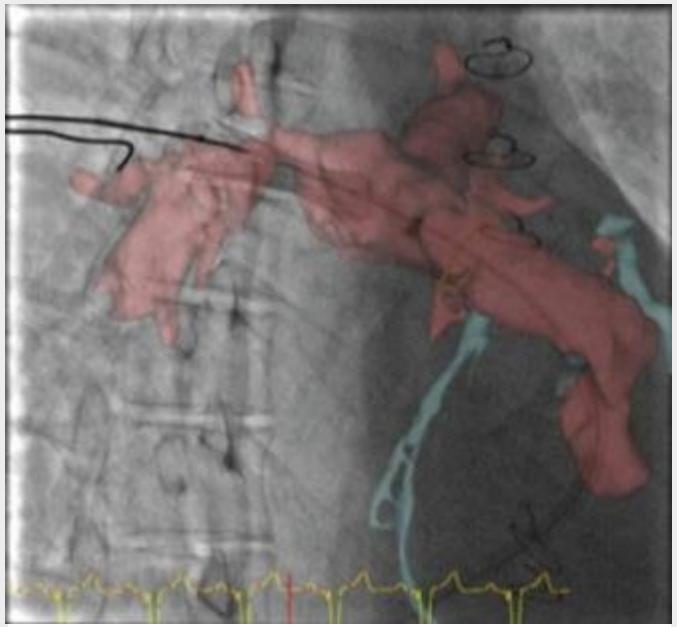
3DRA helps you compare pre-post angioplasty vessel size.

Our Solution for Pulmonary Artery Valve Replacement



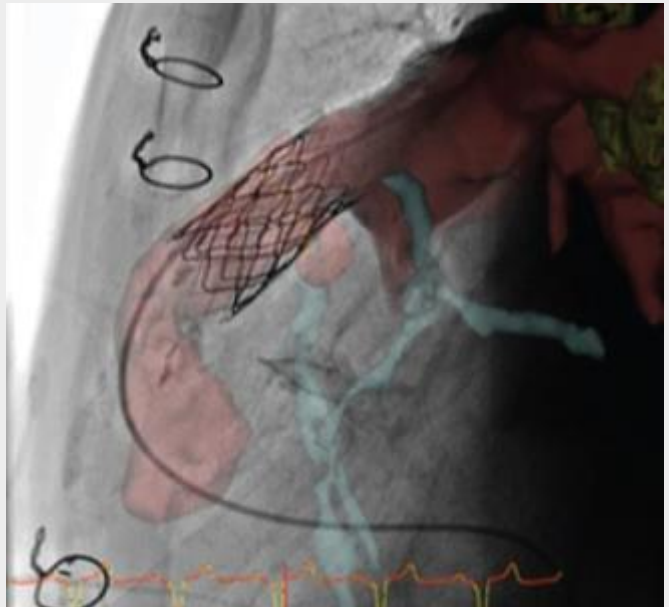
- Plan

Gives the optimal C-arm angulation for valve deployment with CT, MR or Innova 3D. Pulmonary artery conduit quantitative sizing and calcification visualization.



- Guide

HeartVision helps navigating into complex, unusual anatomies with confidence. It helps clinician avoid coronaries compression during angioplasty and valve deployment with HeartVision or Innova 3D



Assess

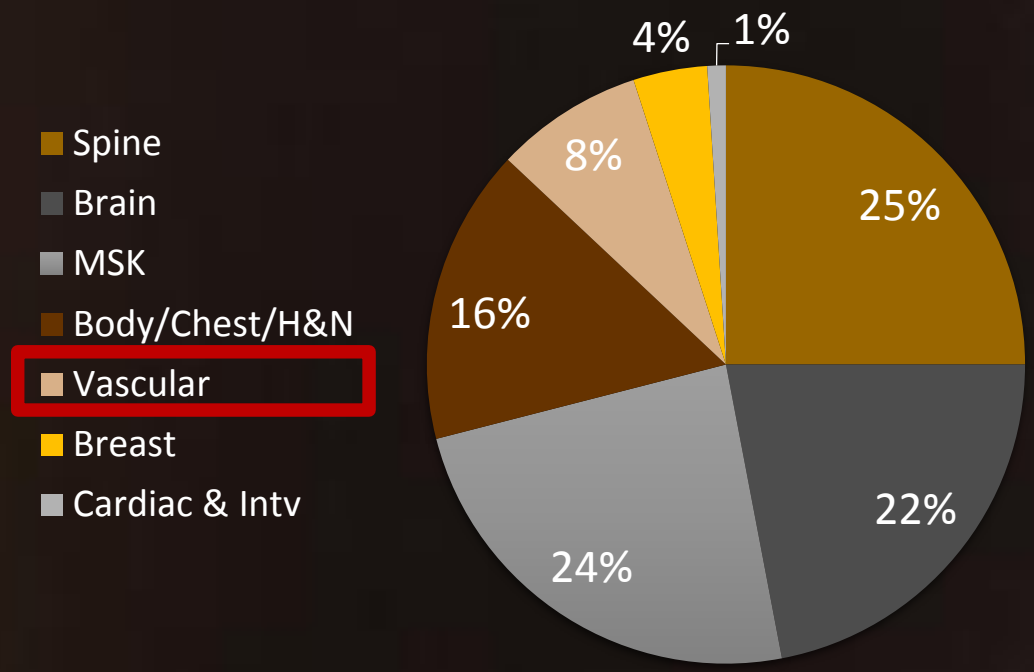
- Immediately determine the success of treatment delivery
- Exceptional contrast visualization for assessment of potential regurgitation
- Real time benefits of Ultrasound imaging or angiography

PAVR Melody valve: Humanitarian Device. Authorized by Federal law (USA) for use in pediatric and adult patients with a regurgitant or stenotic Right Ventricular Outflow Tract (RVOT) conduit (≥ 16 mm in diameter when originally implanted). The effectiveness of this device for this use has not been demonstrated.

MR Procedures – US

Total 30.2M in 2010[1]

Everyday Routine



Fastest Growth

2010 vs. 2007

83% Breast

35% MSK

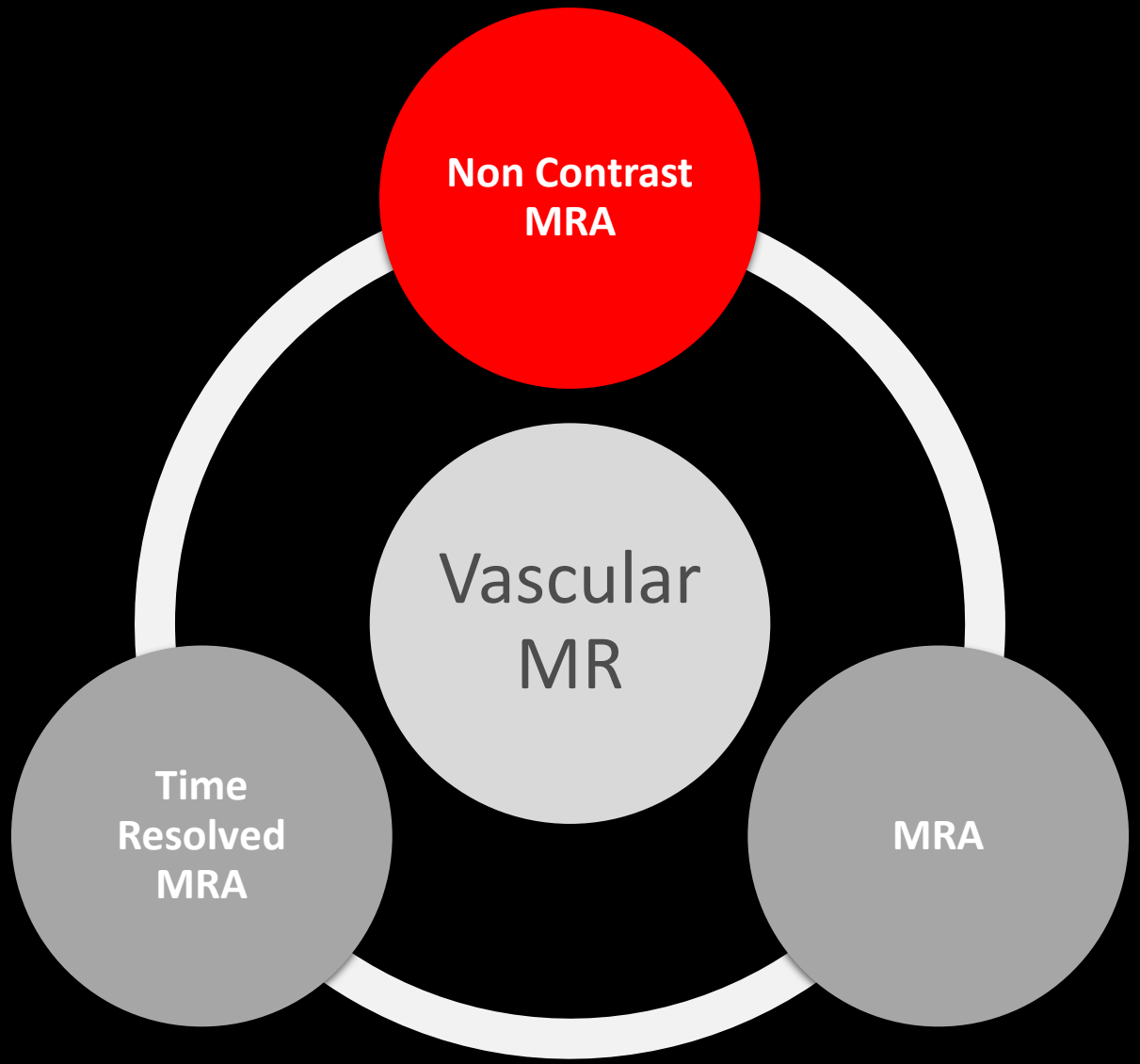
16% Body

8% Vascular

87% Cardiac[2]

Source:
[1] 2010 IMV MR Medical Market Outlook Report
[2] 2010 Arlington Medical Records

Vascular MR



Non Contrast MRA

- Optimized tools for each anatomy
- Robust in diverse diseases

MRA

- Improved workflow
- Fast multi-station movement

Time Resolved MRA

- High spatial resolution
- High temporal resolution

Vascular MRI

TRICKS : Time Resolved Imaging of Contrast Kinetics

Target :

- To provide high temporal resolution without sacrificing spatial resolution

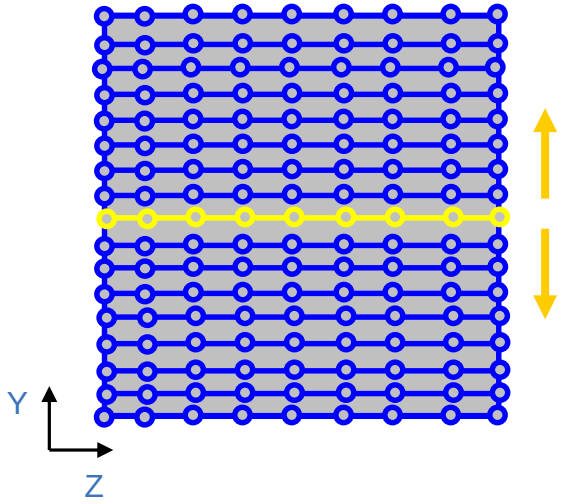
Characteristics :

- Elliptic centric-TRICKS
- 3D k-space : segmentation in 4 regions from the center to the periphery
- The central region is sampled more frequently compared to the other regions
- 3D FGRE sequence

Vascular MRI

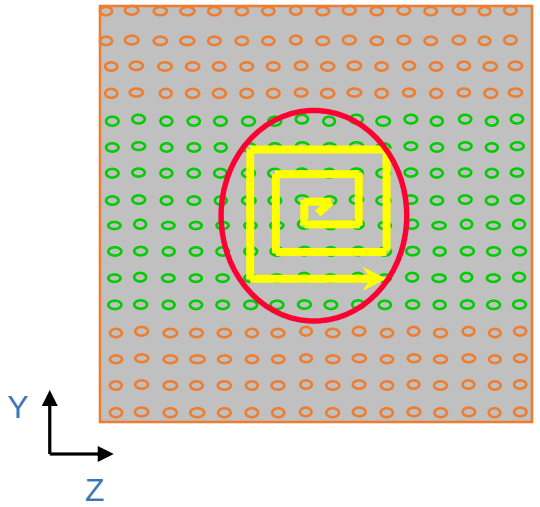
Characteristics :

Centric



- The sequence acquires first the central lines along the Ky axis
- Not only the contrast sensitive data are acquired

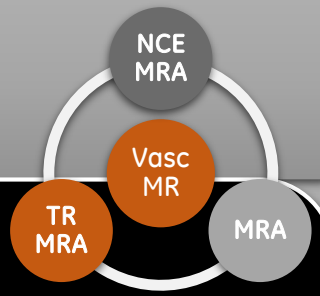
Elliptic centric



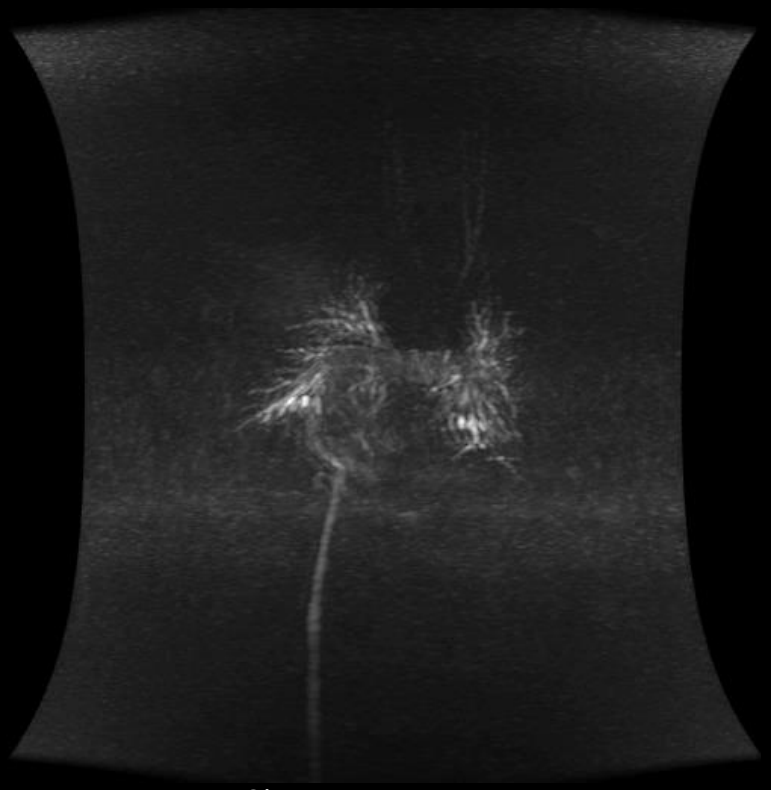
- The sequence acquires first the contrast sensitive data in both Ky and Kz axes simultaneously

Elliptic-Centric encoding accomplishes the optimal capture of central k-space for very high resolution and strong arterial weighting

TRICKS

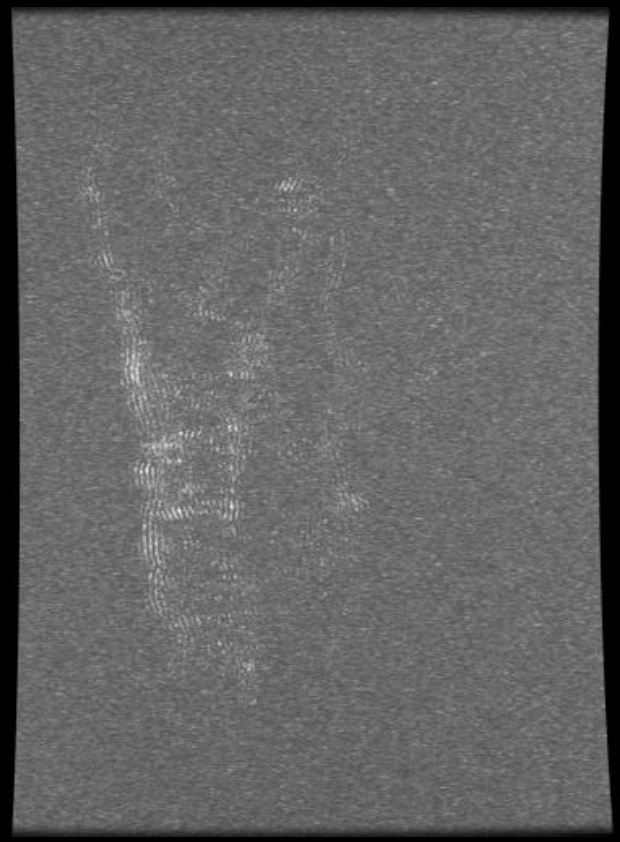


Thoracic

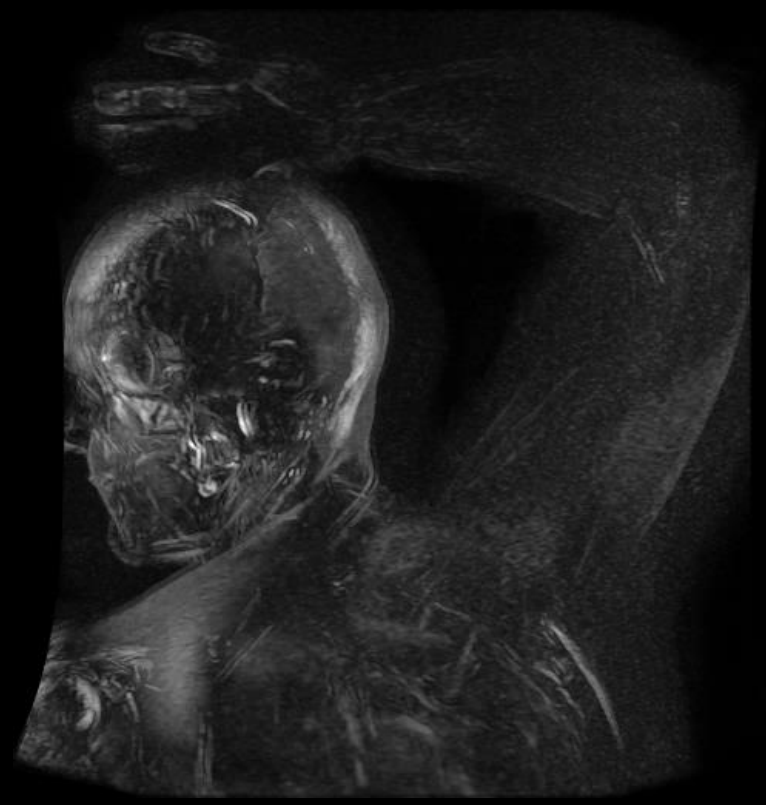


Signa HDxt 1.5T
Classic Fontan
20 yo male

Fingers



Upper Extremity



Discovery MR750 3.0T

Back

Courtesy: OSF Healthcare, Peoria, USA, Policlinico Umberto, Rome, Italy

Background on NCE-MRA

- Linked with NSF, adverse event of Gd contrast agent.
- FDA warnings in 2006-2007
- Risk to high dose of Gd contrast agent for patients with renal insufficiency
- Renewed interest

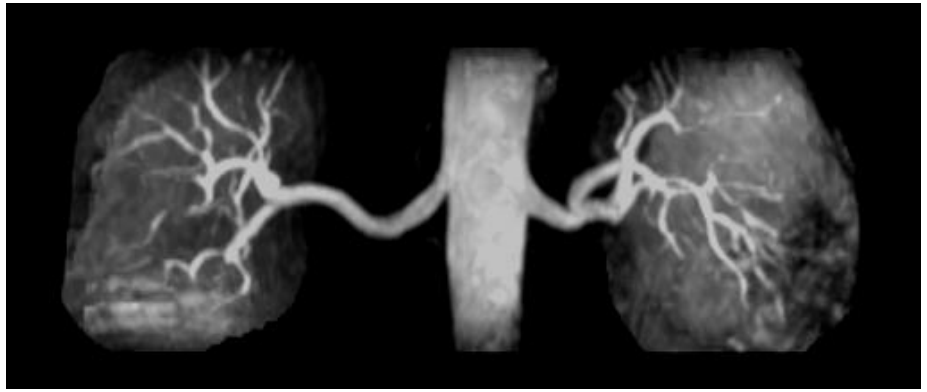
NSF(Nephrogenic systemic fibrosis)

Inhance Family

- **Inhance IFIR (Inflow IR)**
- Inhance Delta Flow
- Inhance Velocity

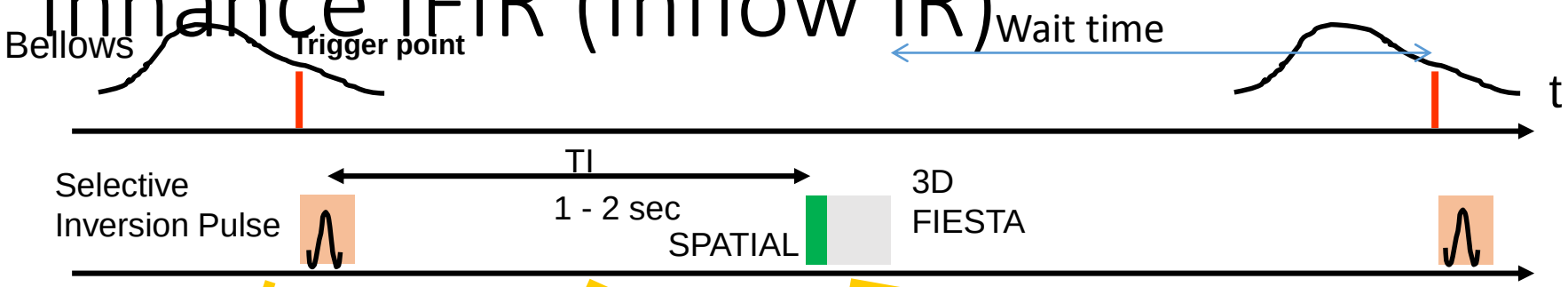
Inhance means “non contrast”, inherent enhancement.

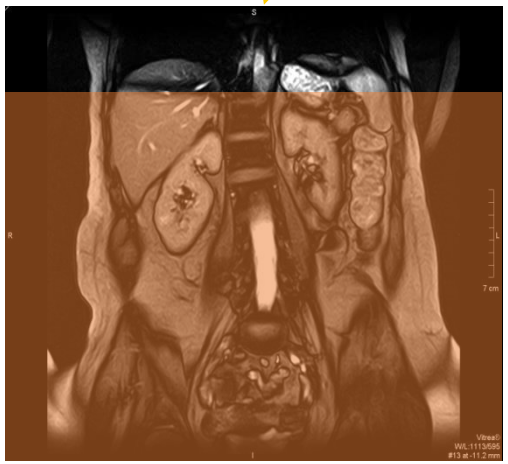
Inhance IFIR (Inflow IR)

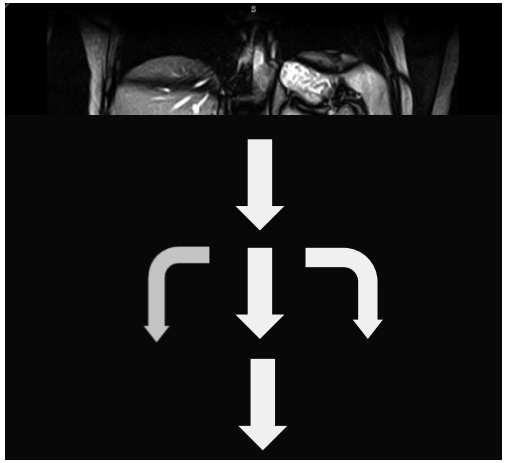


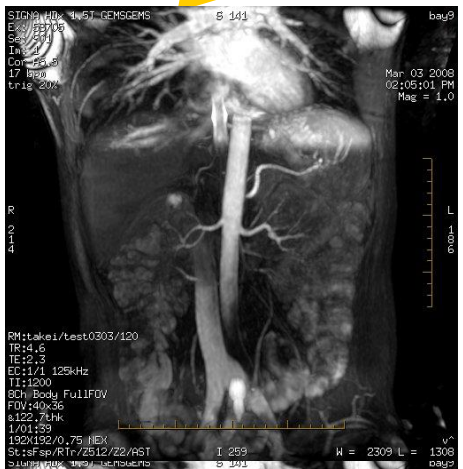
- Stenosis in renal and aorta and renal transplant for preoperational planning
- Excellent separation of arteries from veins
- No image subtraction to make robustness to respiratory motion

Inhance IFIR (Inflow IR)

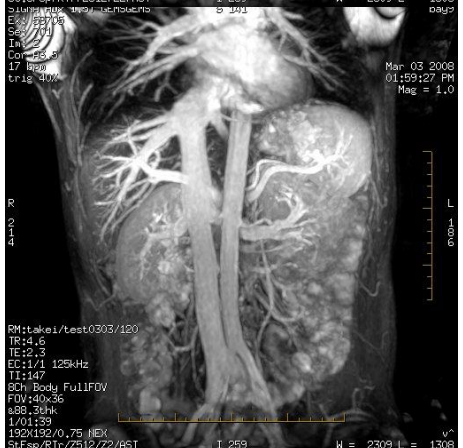








IR off

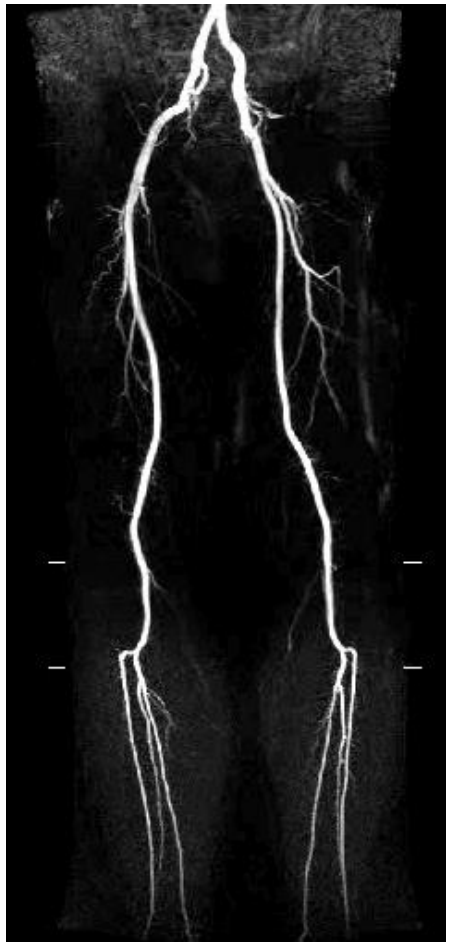


Inhance Family

- Inhance IFIR (Inflow IR)
- **Inhance Delta Flow**
- Inhance Velocity

Inhance means “non contrast”, inherent enhancement.

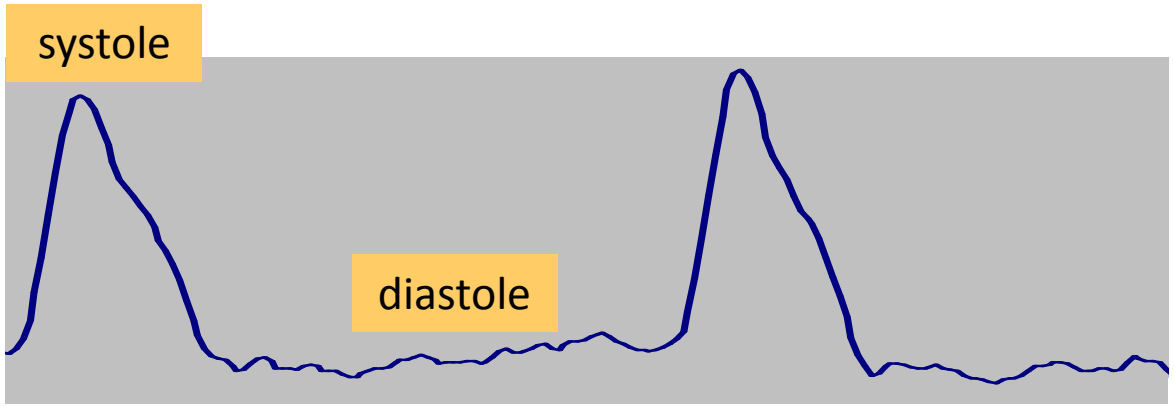
Inhance Delta Flow

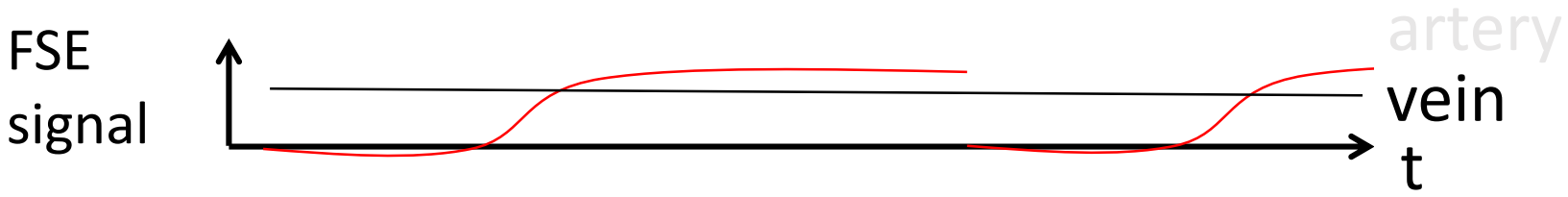


Peripheral MRA, 3 stations

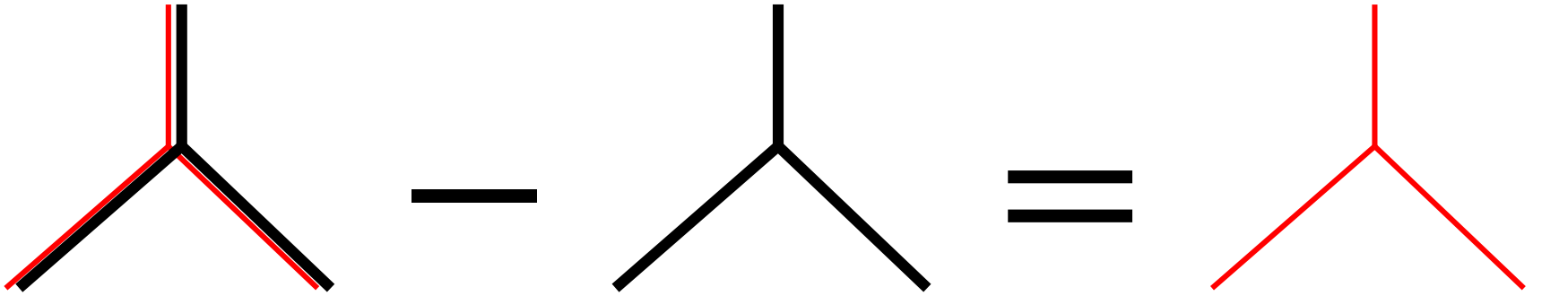
- Flow difference images at systole and diastole
- 3D FSE acquisition with coronal scan plane to scan faster
- Scan time 3-4 min/station

Peripheral wave





- faster arterial blood ⇒ faster signal decay in FSE ⇒ darker
- slower arterial blood ⇒ slower signal decay in FSE ⇒ brighter
- slow vein blood ⇒ slow signal decay in FSE ⇒ bright

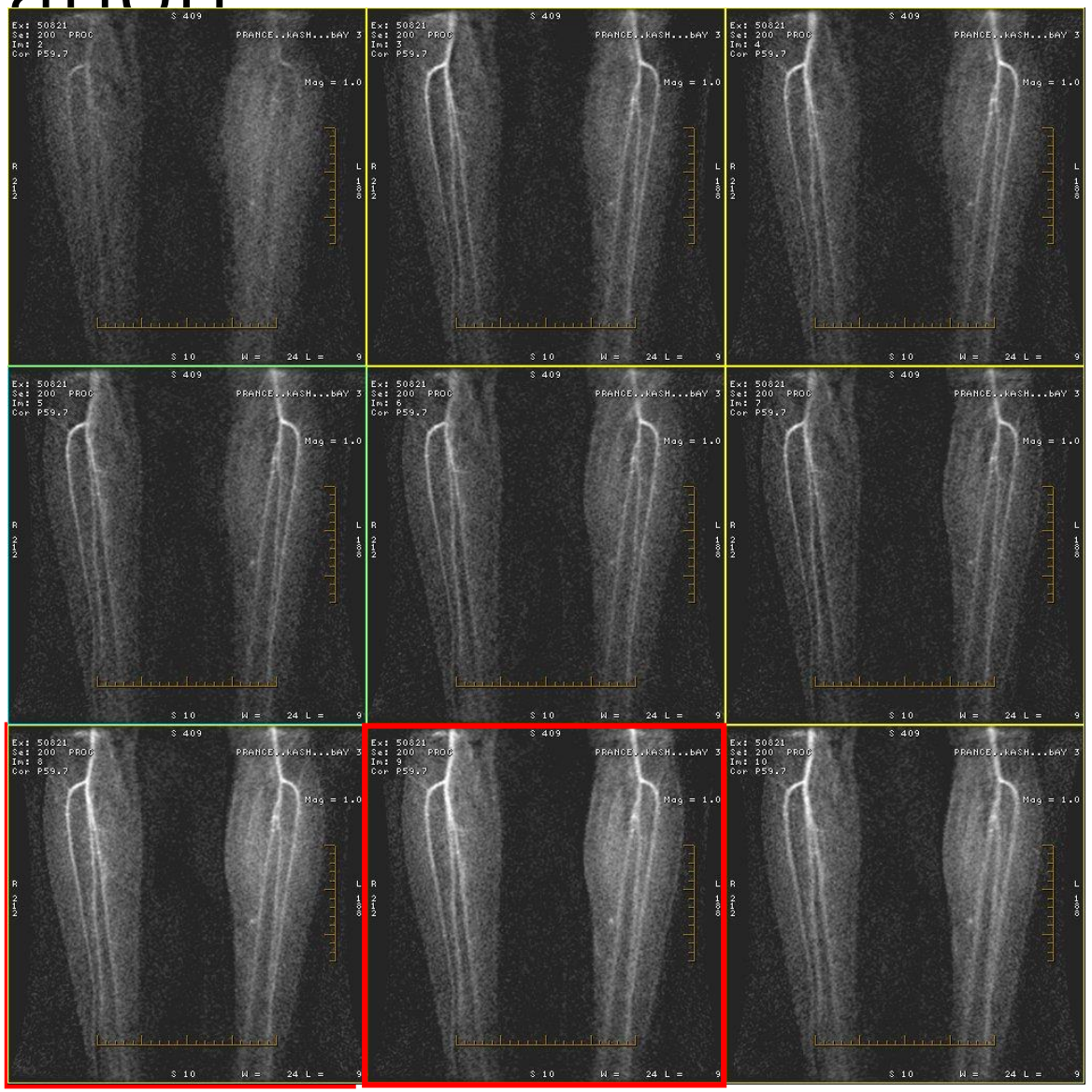


diastole — systole = arterial image

Trigger delay calculation

- Multi-phase coronal 2D sequence (75ms step)
- Use Minimum TD with PG or 200 ms with ECG for systolic timing
- Subtract the minimum TD image from each images. Create arterial only image
- Diastolic TD - image with the best visualization of superior (faster flow) arteries.
- Less than a minute

☐ Intuitive TD selection



Inhance Family

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- **Inhance Velocity**

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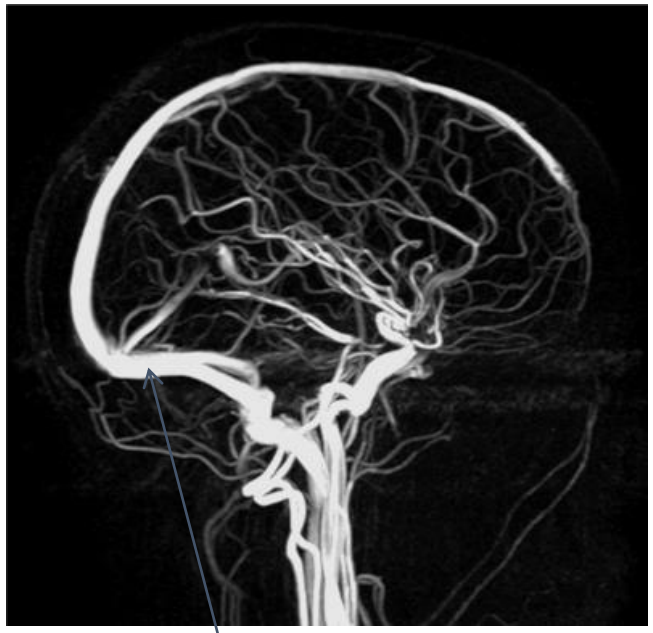
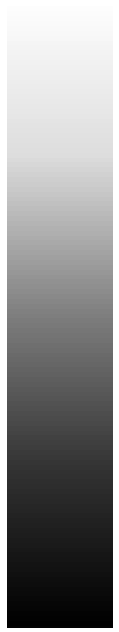
Inhance Velocity :
phase contrast imaging

- -Visualization and quantification of blood flow

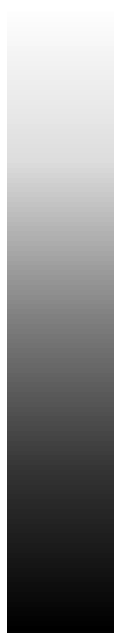




|velocity| (cm/s)

0 (cm/s)

Magnitude image



+velocity (cm/s)

-velocity (cm/s)

Phase image

For example
Velocity 30 cm/s or – 30 cm/s

CVWorks: Cardiovascular Signature Applications

- Function & Flow

VIosWorks*

Mapping

T1/T2 Mapping*

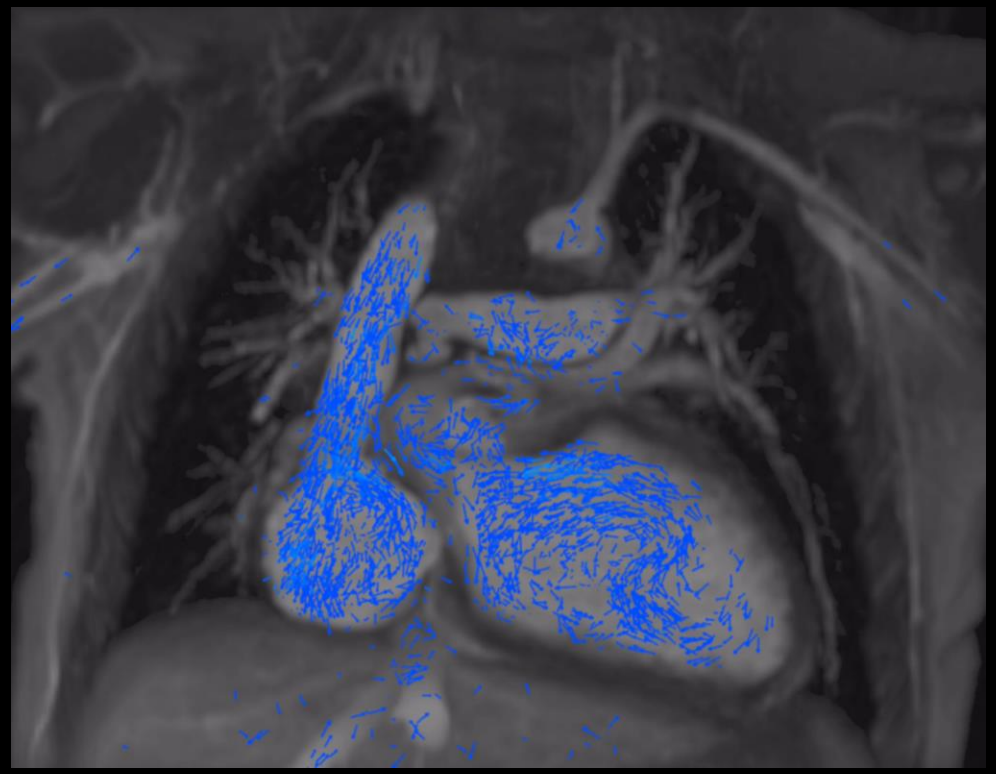
Post Processing

CMR42

*Not yet commercially available

ViosWorks

3D cardiac anatomy, function, and flow in 1 free-breathing, 8 min scan



What is the ViosWorks Solution?

- 3D Cine PC (eFGRE)- “Vios 3D”
  - Whole ventricular coverage in a single BH
- 4D Flow – “Vios 7D”
  - Capture data in 7 dimensions
    - 3 in space, 1 in time, and 3 in velocity direction
- GPU Cloud Post Processing – Arterys™

Benefits

- Free-breathing, non-invasive
- Unsupervised cardiac imaging – enable every technologist to scan cardiac
- Faster cardiac exams help to shorten backlog scheduling times

ViosWorks not commercially available.
Expected availability 2016

Overall Benefits

	Conventional	ViosWorks
Acquisition Time *More exams per hour*	**60- 90 min**	**10-20 min**
Slice positioning *Cardiac MR as easy as a brain*	**Complicated** *Multiple slices*	**Simple** *One 3D Volume*
Exam Complexity *One requirement: Find the chest*	**Physician** *Required to be at scanner during acquisition*	**Technologist** *Empowers every technologist to scan cardiac MR*
Breath-holds *100% free-breathing*	**Breath-holds** *leads to image quality issues*	**Free-Breathing**
Blood flow measurements *1st technology to offer blood flow in 7D*	**Flow only at 2 or 3 slices**	**Flow everywhere in 7D** *3 in space, 1 in time, 3 in direction*
Processing Time *Leveraging machine learning to accelerate case processing*	**1 hour** *With multiple, complex steps*	**10 min** *With artificial intelligence platform support*

ViosWorks

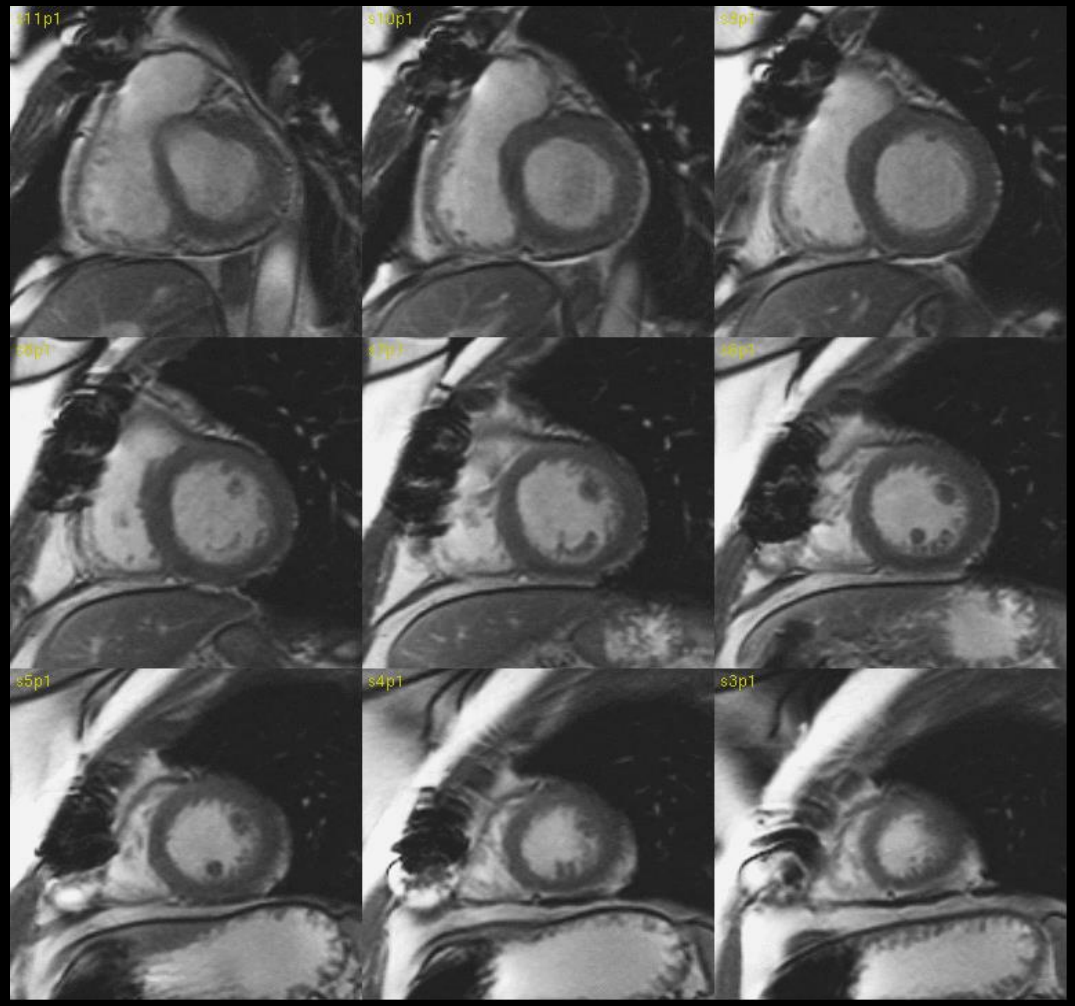
Vios 7D

42cm FOV
256 x192
7:55 min

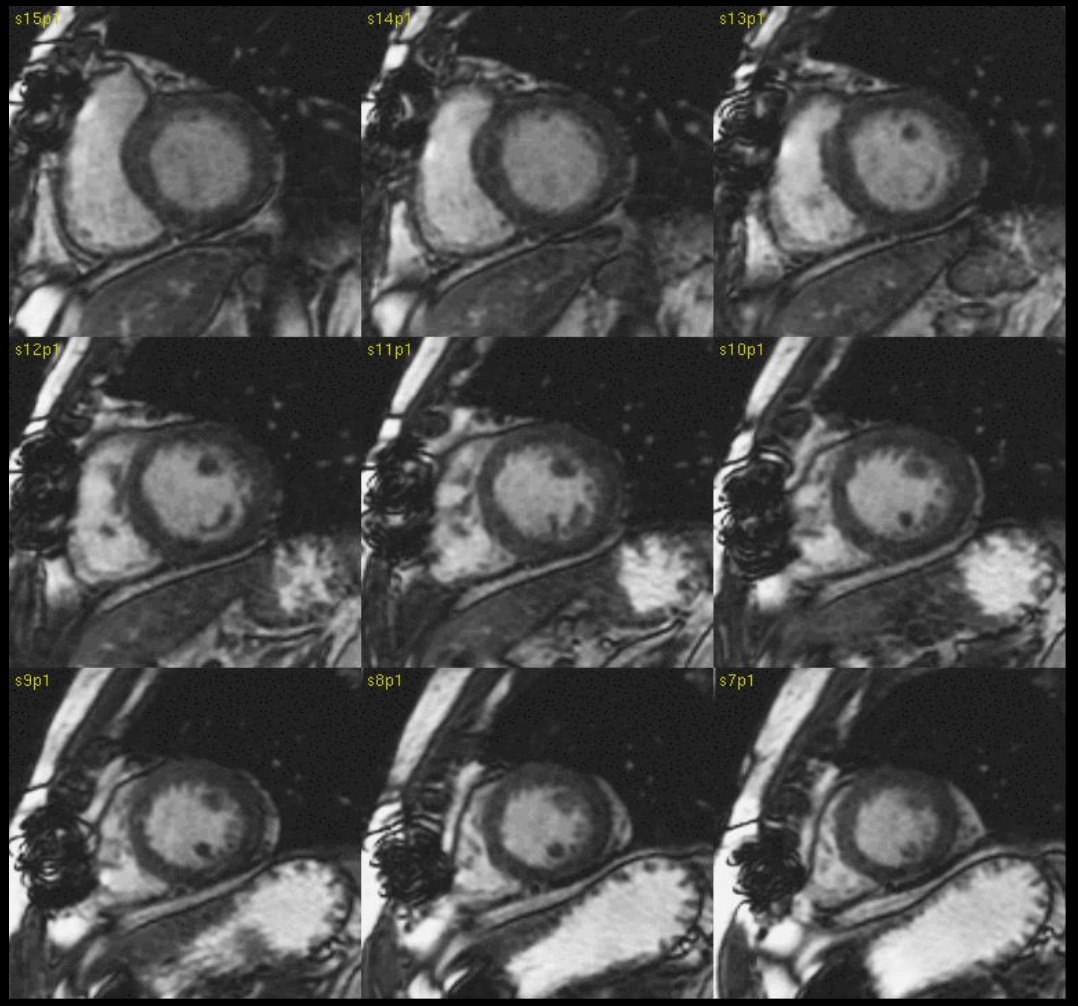
3D cardiac anatomy, function, and flow in 1 free-breathing, 8 min scan

VIosWorks

Vios 3D

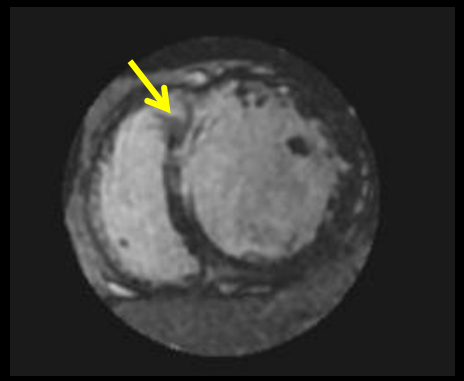


2D Cine = 9 Breath-holds

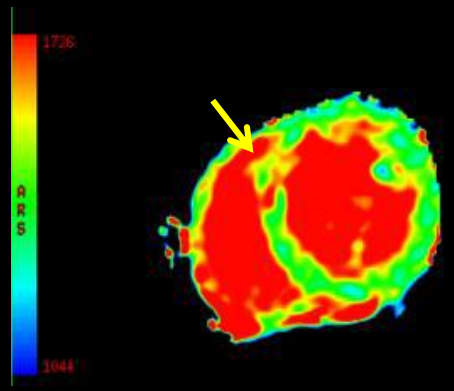


Vios 3D= 1 Breath-hold

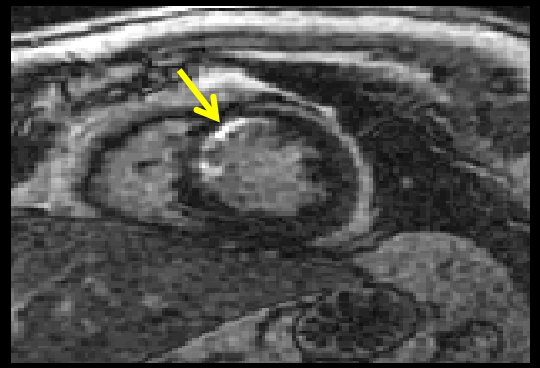
T1/T2 Mapping
Quantitative Myocardial Measurements



2D MDE



T1 Mapping



2D MDE

T2 Mapping

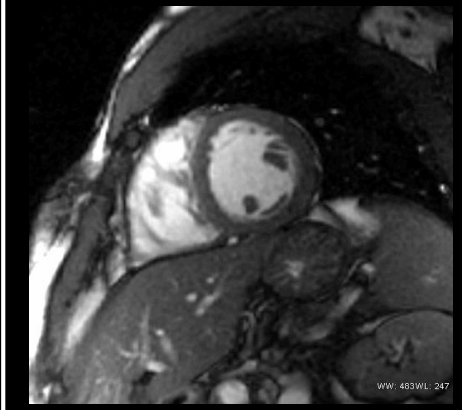
<u>What is it?</u>

- T1 Mapping
  - FIESTA based with IR pulse (MOLLI)
    - Measurement of apparent T1, with motion correction
  - FIESTA based with SR pulse (SMART1 Map)
    - Measurement of true T1, with motion correction
    - Used in comparison studies from other systems, sites
- T2 Mapping
  - DIR-FSE based

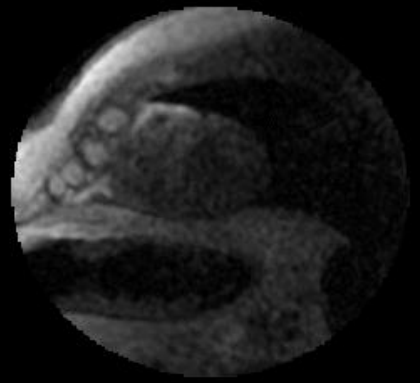
<u>Benefits</u>

- T1- assessment of diffuse fibrosis (non-detectable with MDE)
- T2- assessment of edema, myocarditis, iron concentration

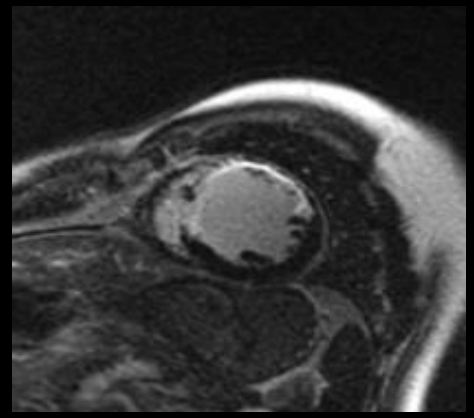
GE Cardiovascular MR Applications



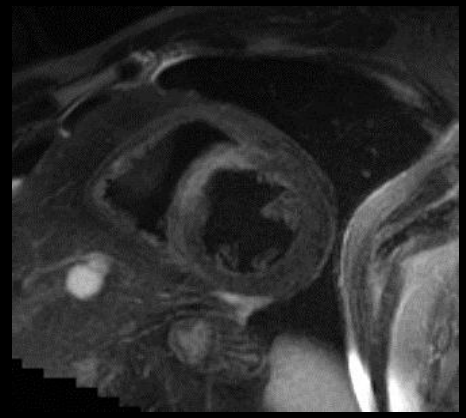
Function
High Resolution Wall motion & EF
With FIESTA Cine



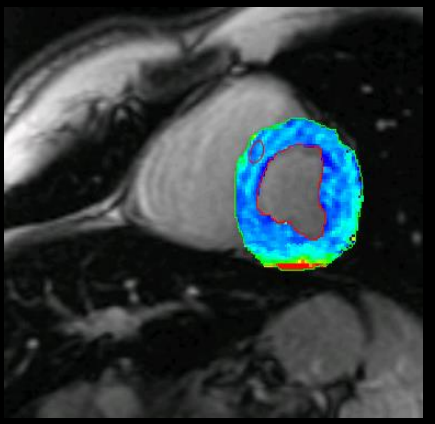
Time course
High Resolution SR FGRE/FIESTA
Stress/Rest tim eourse exam



Viability
Delayed enhancement (IR FGRE)
for scar tissue assessment

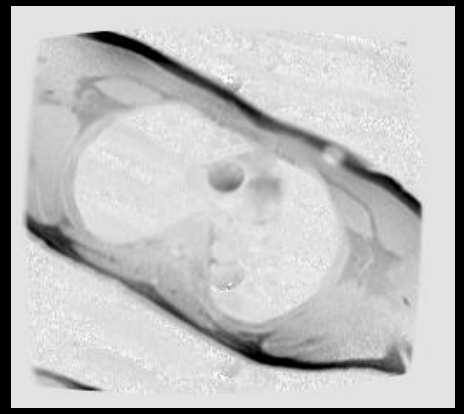


Tissue Characterization/Morphology
T1/T2w black-blood imaging for tissue
char. in myocarditis and acute MI



T2* mapping
Iron overload assessment

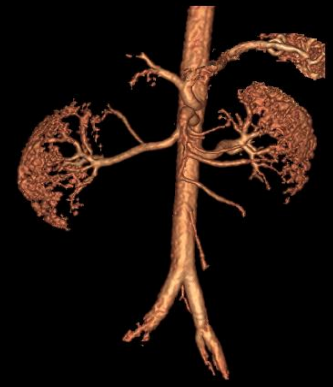
Coronary
NCE Free breathing approach for
anomalous coronaries &
cardiac structure assessment



Flow
Quantify flow, no limitation on scan plane.
Routinely use for Qp/Qs, AI/MR evaluation.

Angiography
MRA with TOF & SPGR

Time Resolved MRA
TRICKS provides dynamic
filling information



Non-Contrast MRA
Inhance Application Suite, 3D Inflow IR,
3D Velocity, 3D Deltaffow