CT-X-ray angiography hybrid systems

Innovation to keep pace with a changing world

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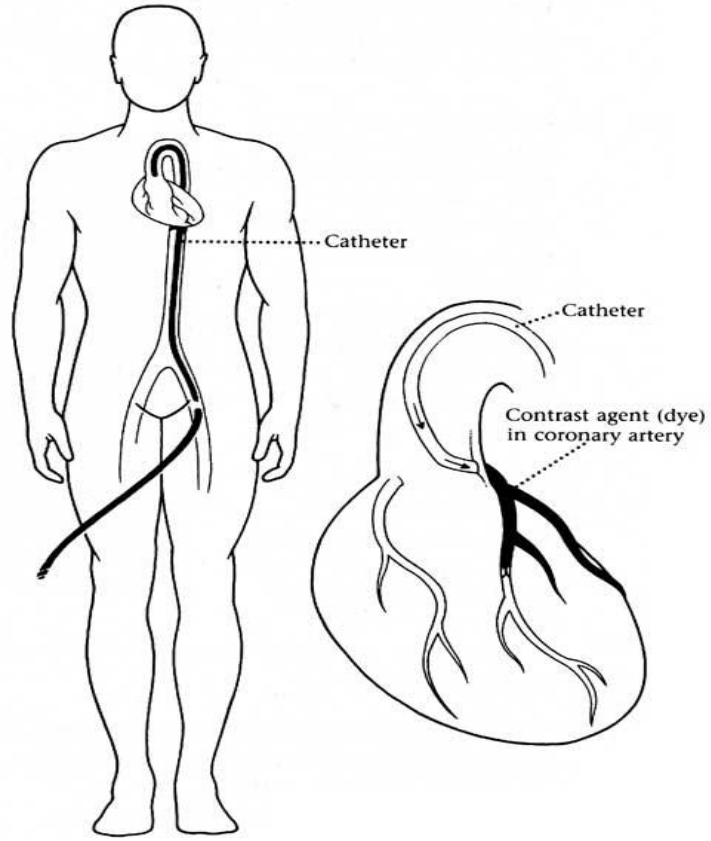
Catheter Angiography

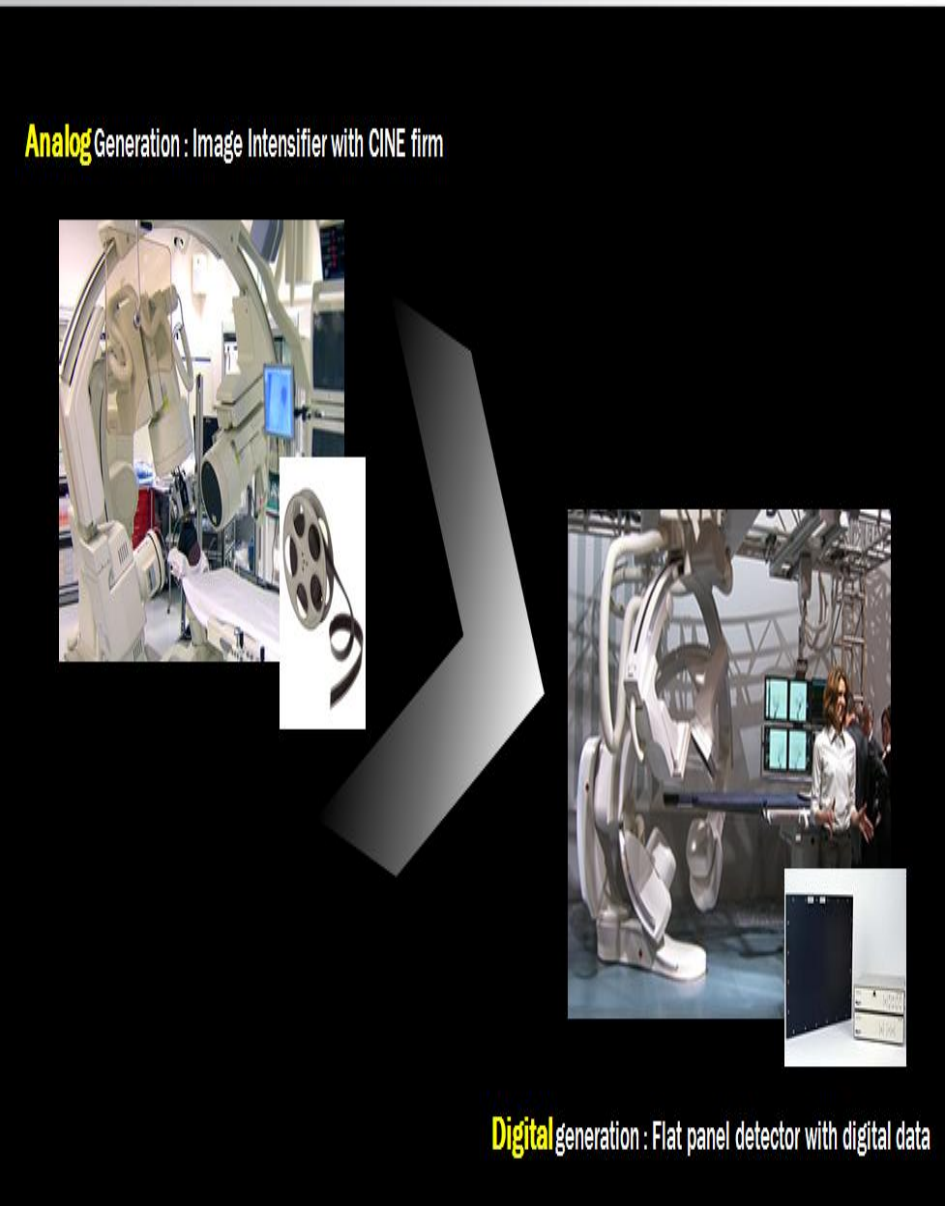
CTA

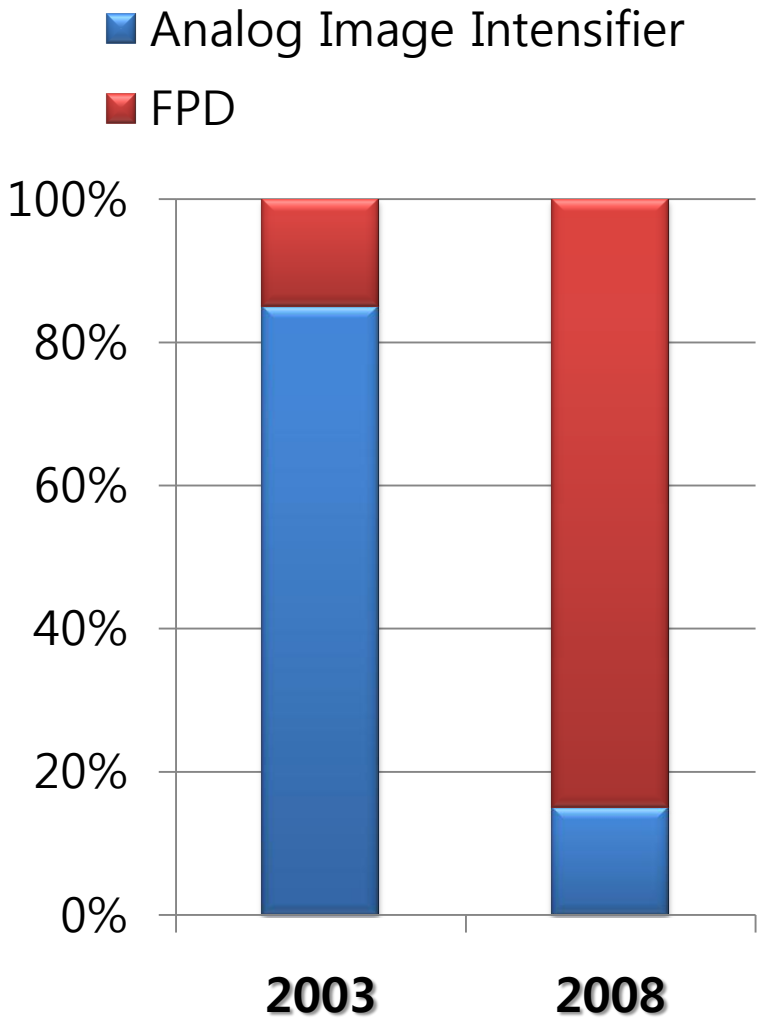
MRA



The average replacement time for angio technology to be 12 years, longer than other imaging modalities. Typically, CT or MR replacement is 7~8 years.

Angiography Technology



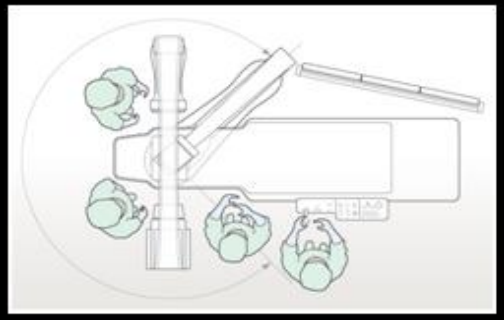


The switch from AIIs to FPDs accounts for most of the growth in the angio market.

Hardware Technology

Lateral Movement for Radial Approach

Vertical movement of FPD and Tube



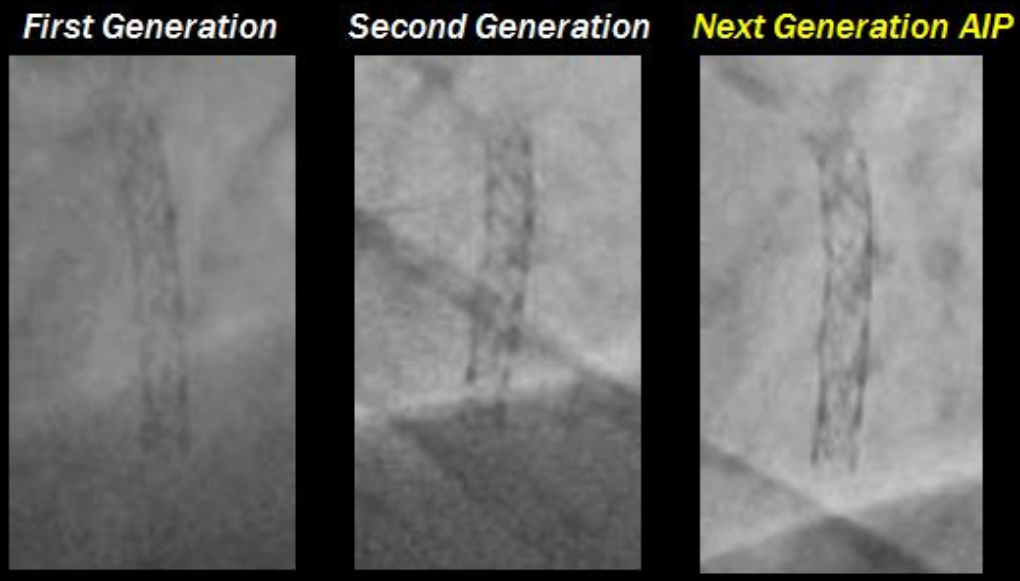
Unparalleled Patient Access

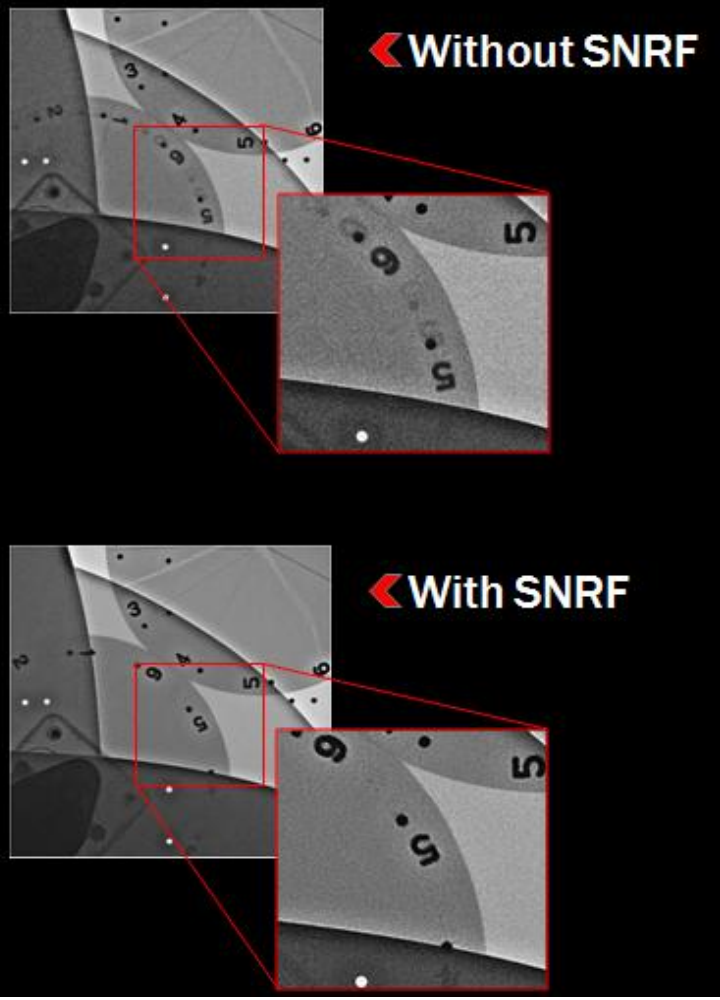
New display monitor system

“Modification for user friendly interface”

Advancement of Post-processing

- Improves Moving Wire Contrast and Device Contrast and Visability
- Reduces Noise
- Eliminates Image Lag

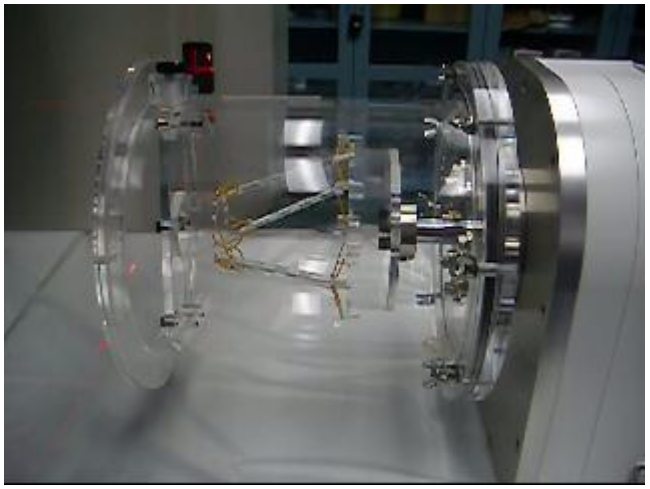


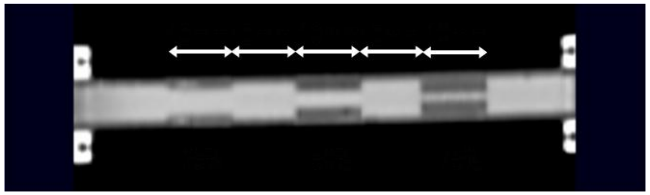


Limitations of Fluoroscopy

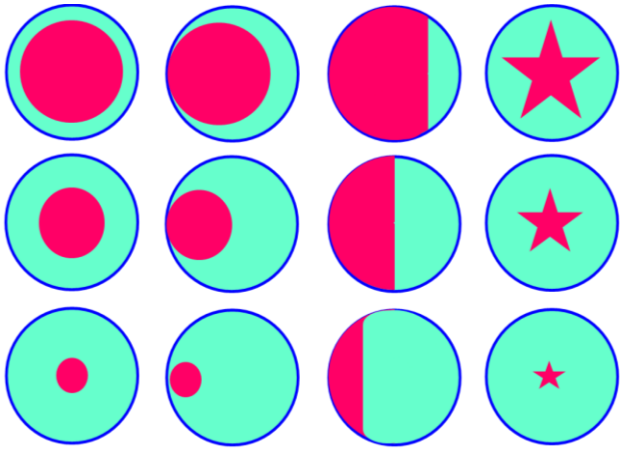
- Prolonged radiation exposure
- Adverse effects of contrast dye utilization
- Inability to image soft-tissue
- 2-D representation of 3-D structures

Accuracy Of Stenosis Quantification By 64-Slice Computed Tomography And Quantitative Angiography Compared To Known Dimensions

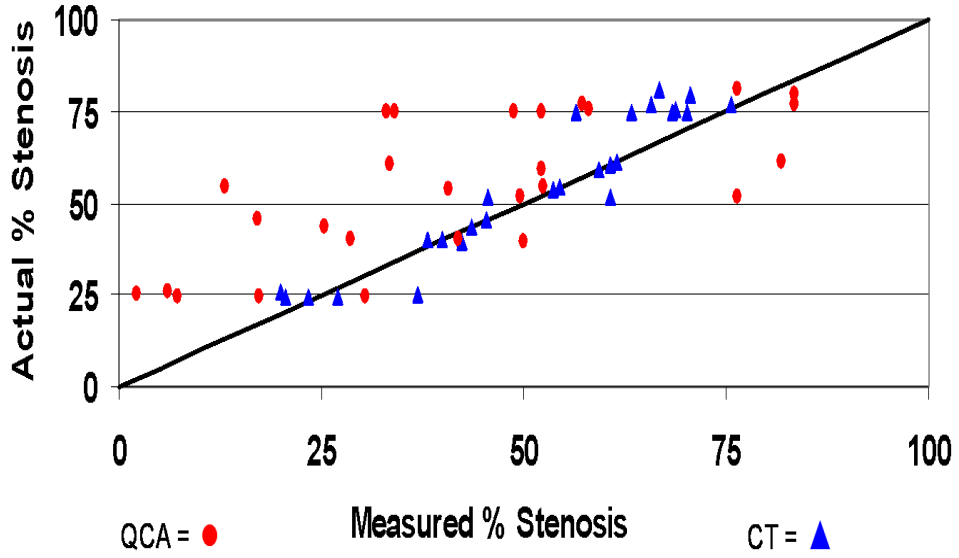




57 Stenoses (measurement accuracy ≤ 0.01 mm)



Non-Circular lesions



Mean Error ± SD: 18.5 ± 11.6 Mean Error ± SD: 6.8 ± 4.7 p<0.001

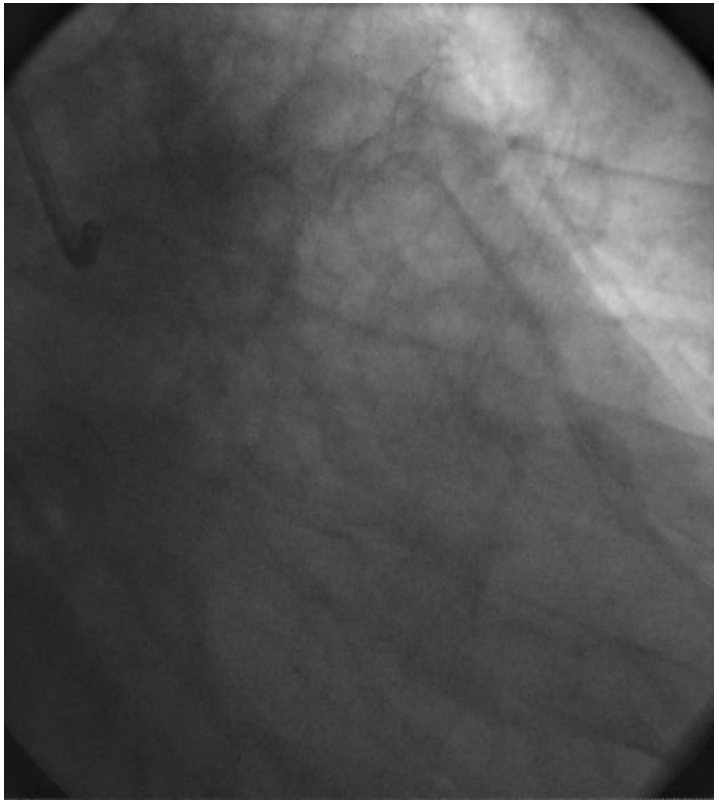
Arbab-Zadeh A, EHJ 2010

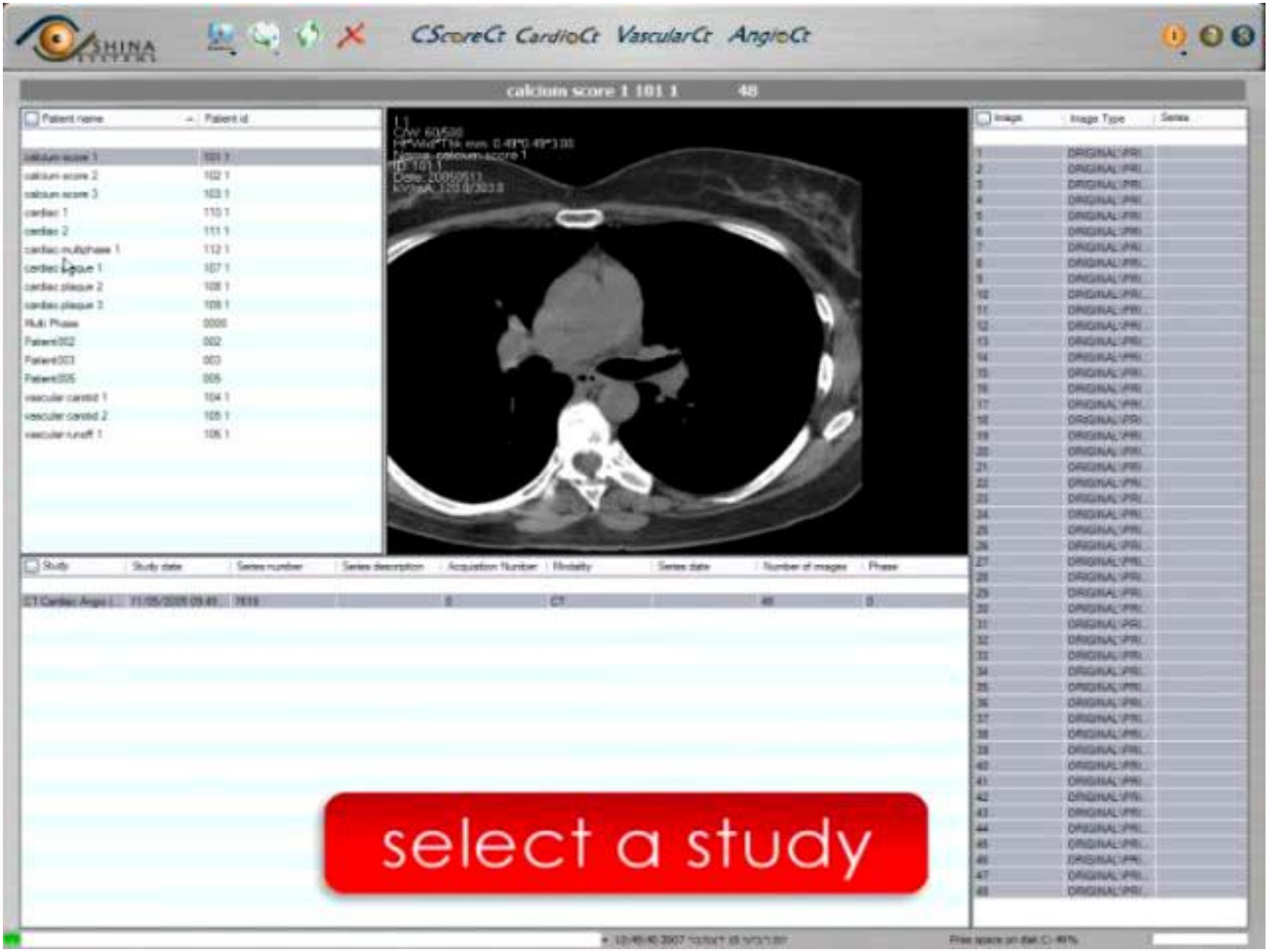
Computed Tomography

- Detailed anatomic assessment
- 3-D dataset which can be reconstructed and analyzed in multiple views
- Used often in procedural planning for cardiac catheterization and structural interventions

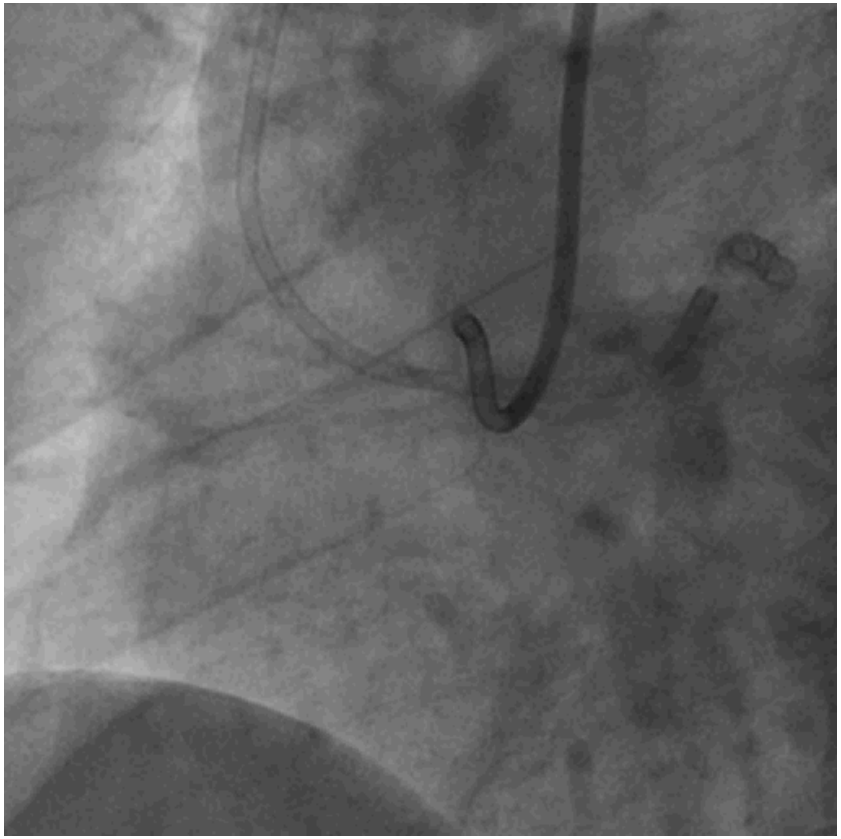
Case: Intervention-Success

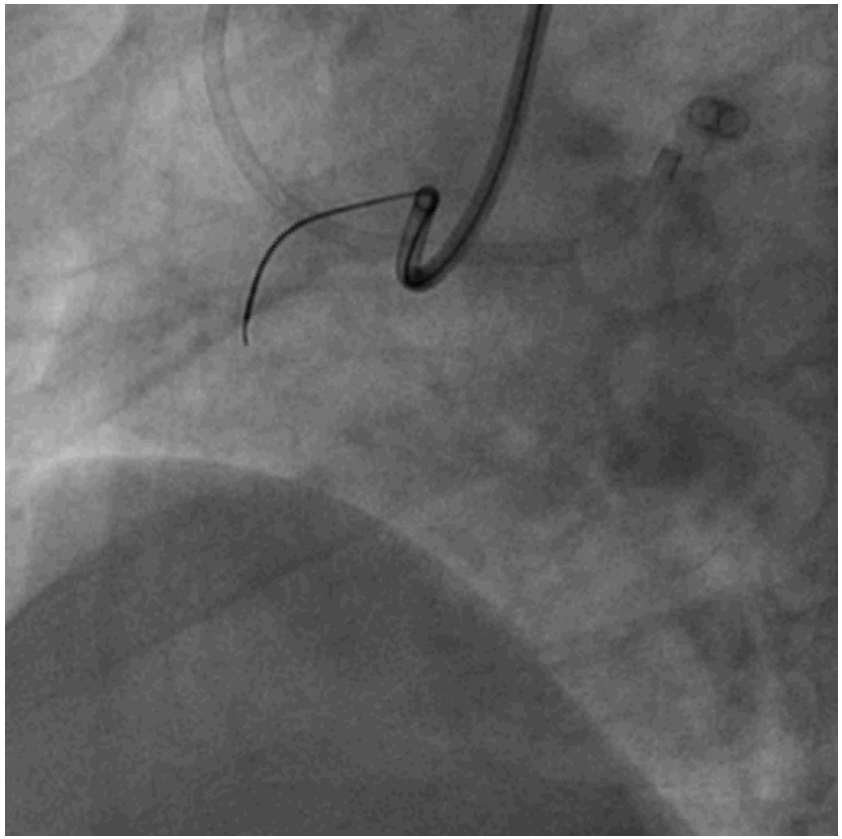
M/48, Chest Pain 6M




CScoreCt CardioCt VascularCt AngioCt
calcium score 1 101 1 48
select a study

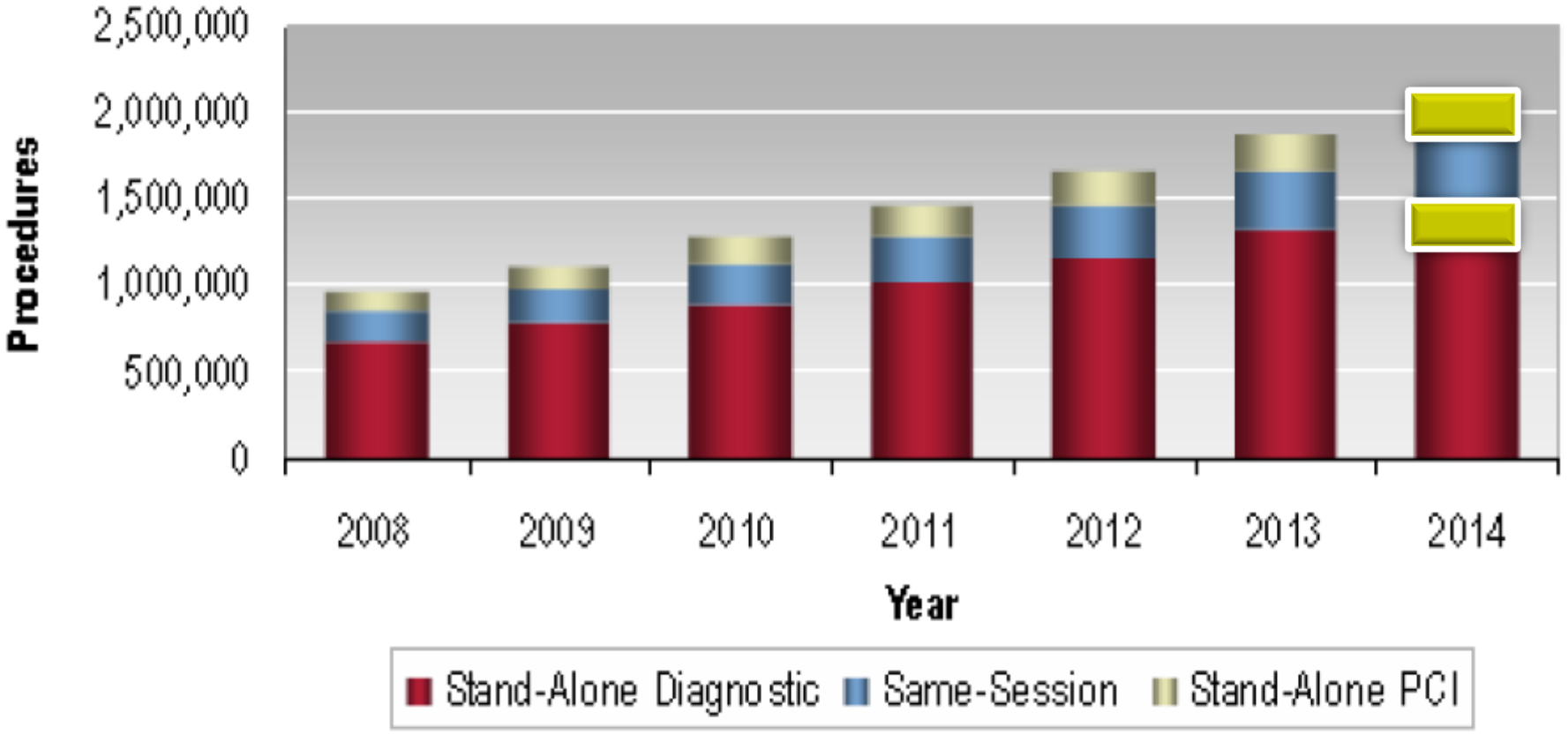
CTO (Chronic Total Occlusion) Intervention





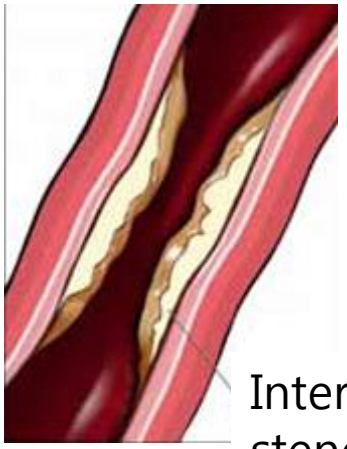
Procedure Type

Asia Pacific. 2008-14

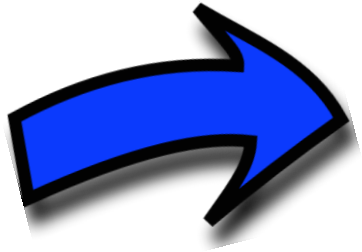


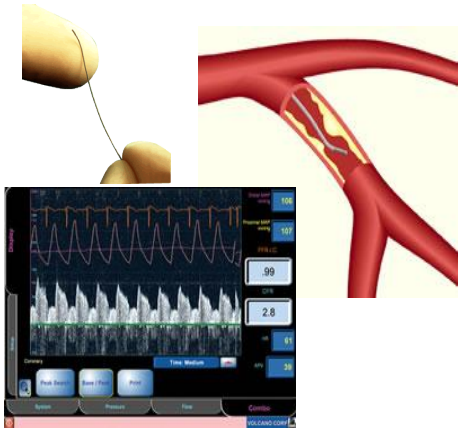
Millenium Research Group

Expected Workflow of “Intermediate”



Intermediate stenosis





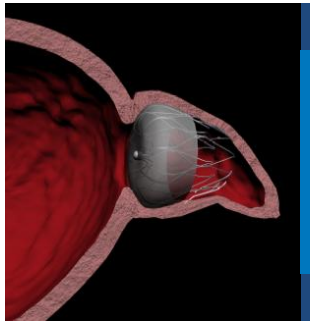
‘**On site**’ invasive work-up:
high cost and invasiveness

‘**Off-site**’ non-invasive work-up:
Extra-day work-up and procedure

New growth markets in Cardiology

Procedures become more aggressive!

+15%/year Electrophysiology



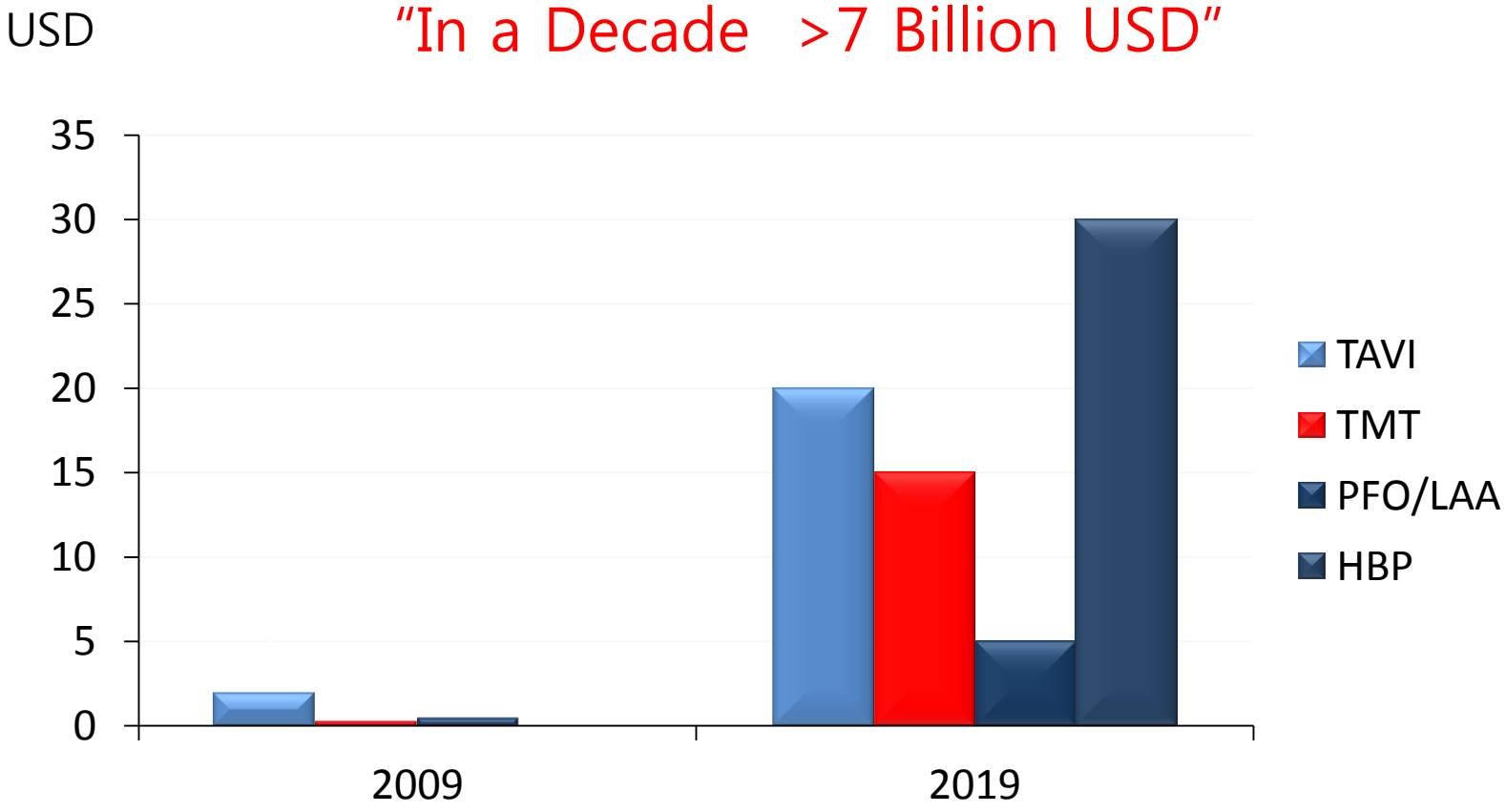
+200%/year Structural heart disease

+20%/year Endovascular procedures

STRUCTURAL HEART DISEASE

Market Potential

"In a Decade >7 Billion USD"



CT Aids for X-ray angiography

Angiographic CT

- Siemens: DynaCT® 05′
- GE: Innova® 04′
- Philips: XperCT® 04′
- Toshiba: LCI® 07′

CT-angio

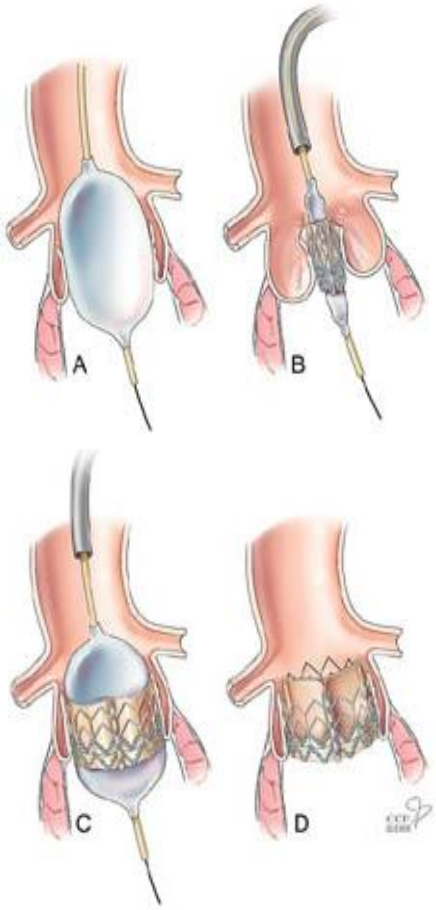
- Siemens: Miyabi®
- GE: Angio-CT®
- Philips: -
- Toshiba: IVR-CT®

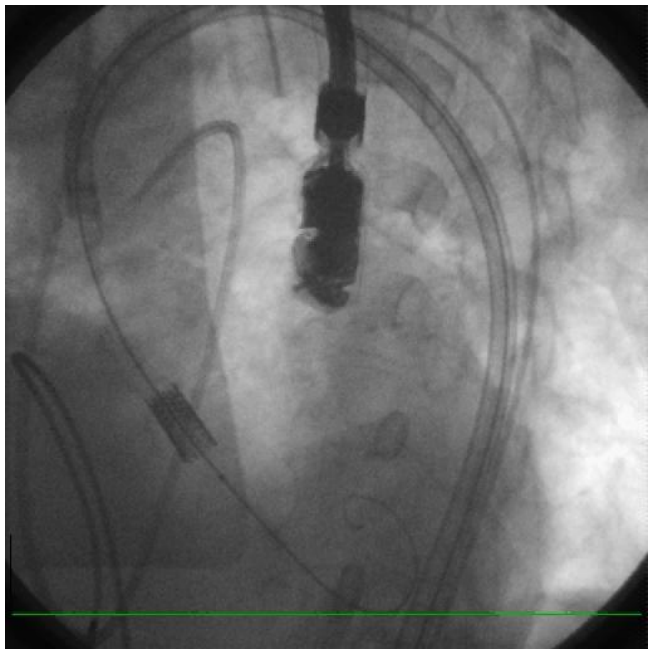
DynaCT® Cardiac protocol

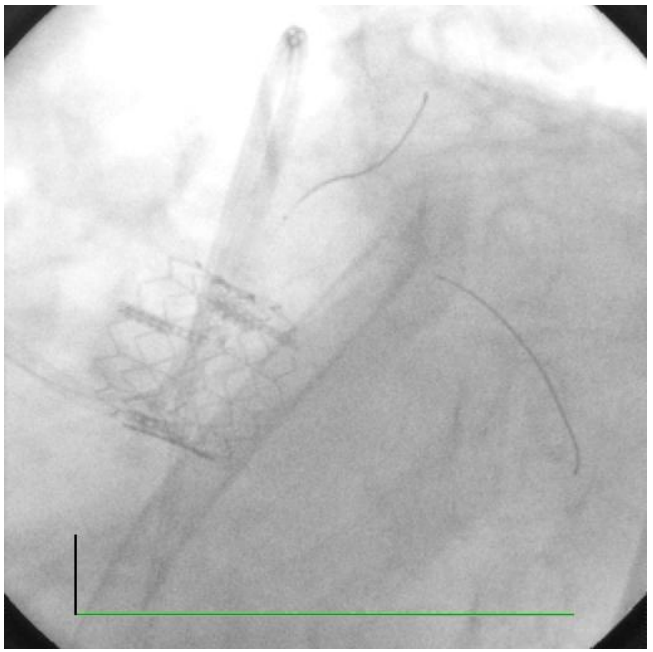
	Non-gated (20x20 or 30x40)	Gated (30x40 FD only)
Technical differentiation	Un-gated 4 - 5 sec/run 30 frames/sec during run Recon ≈ 30 sec	ECG-triggered acquisition Retrospective ECG-gating 25 sec/4runs 60 frames/sec during runs Recon ≈ 2.5 min
Clinical differentiation	Limited temp resolution Good enough for LA segmentation* Breath for only 5 sec	Breath hold for 25 sec
Contrast agent	≈ 100 ml Test bolus required Injector (synchronization with acquisition system) required No dilution Acquisition Delay :4 - 10 sec**	≈ 100 - 150 ml " " " Acquisition Delay: 10 sec**

*With 20x20 FD, exact positioning of LA in iso-center needed
**Patients specific

Transcatheter AV Implantation

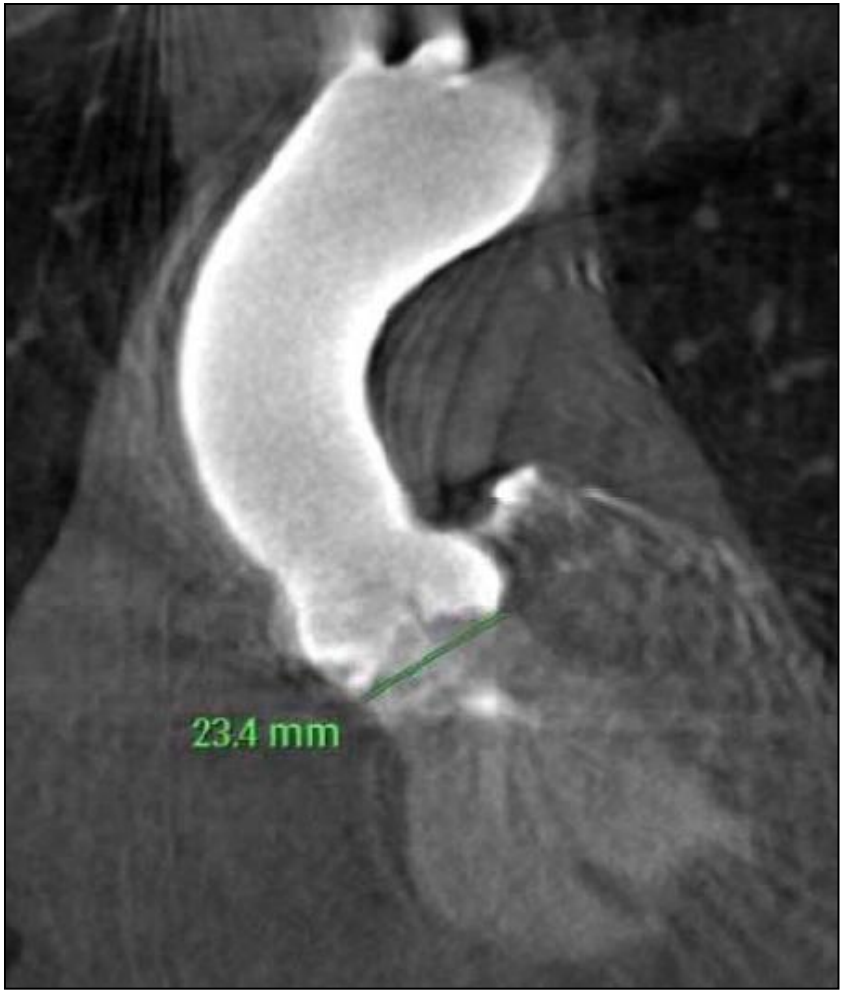






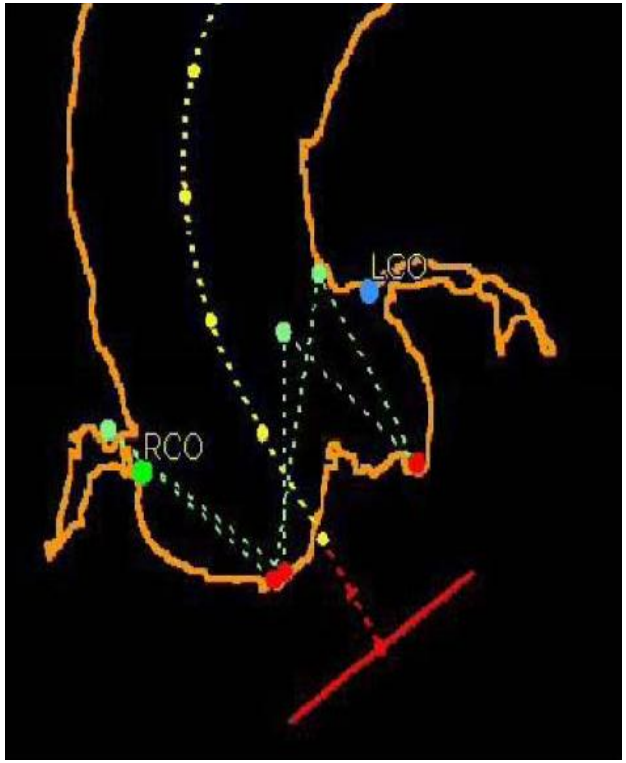
Conventional CT

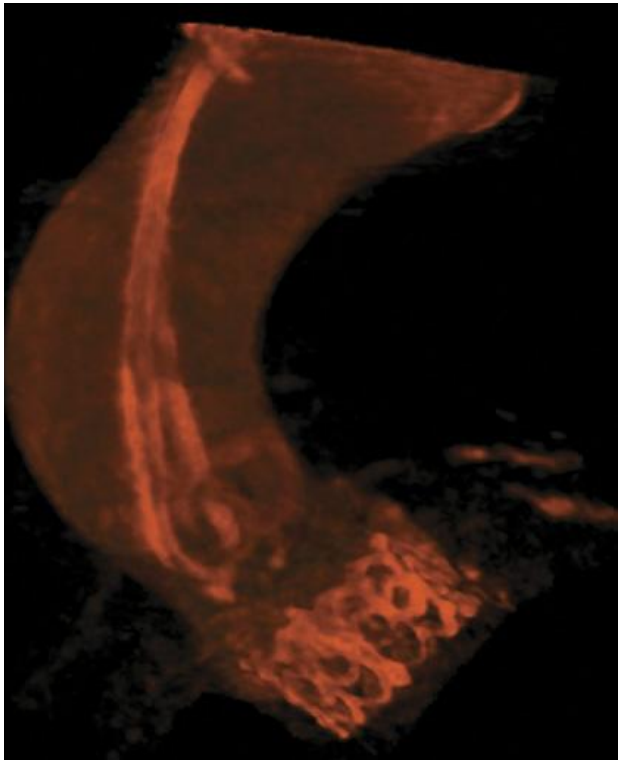
DynaCT



Walther et al., Heartcenter Univ of Leipzig, Germany

DYNA CT during TAVI

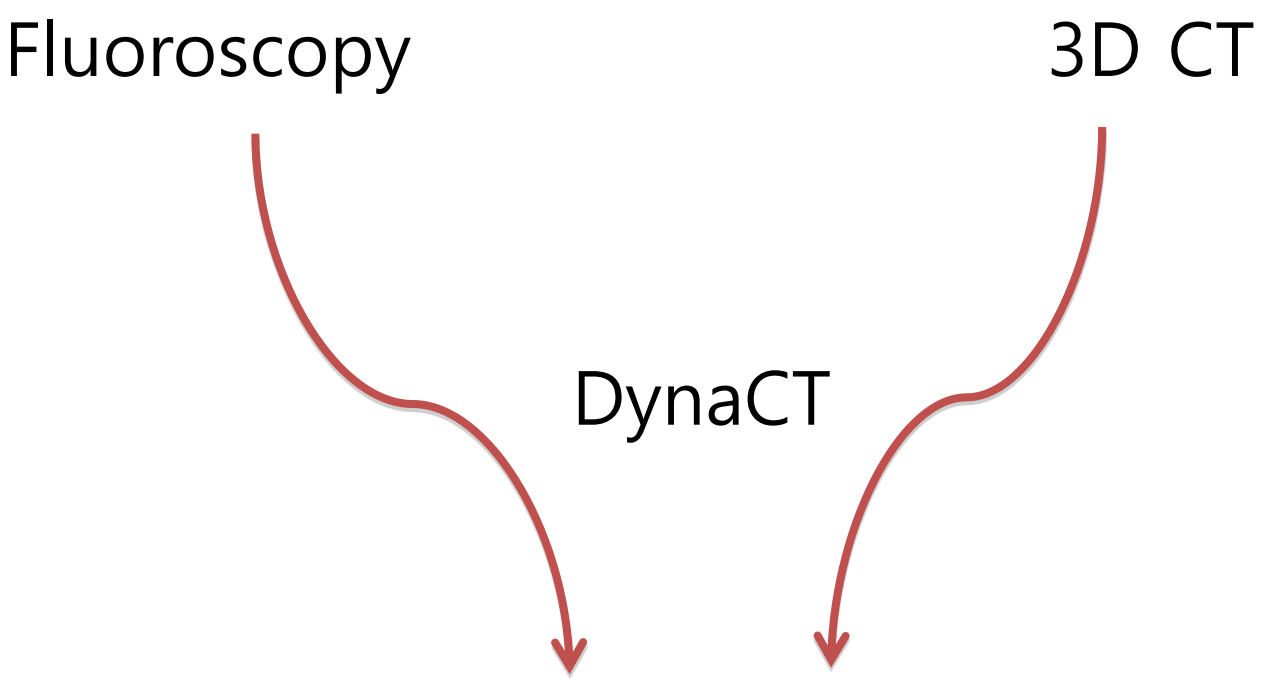




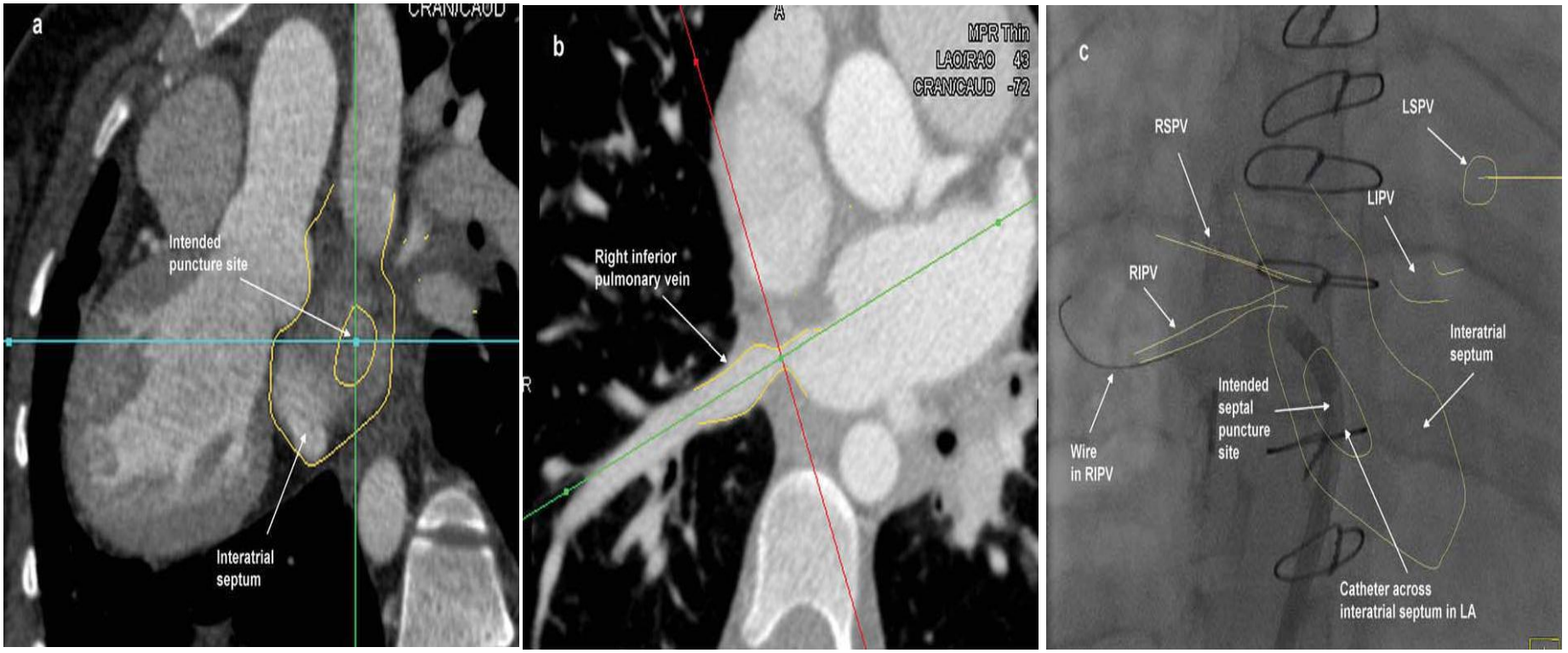
Walther et al., Heartcenter Univ of Leipzig, Germany

Kempfert et al., Ann Thorac Surg 2009

Fusion of old CT, Dyna CT and Flouroscopy

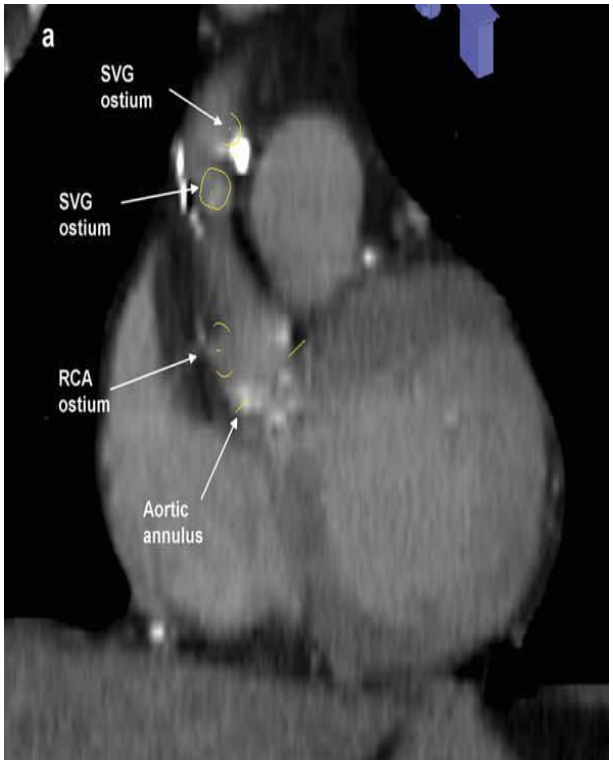


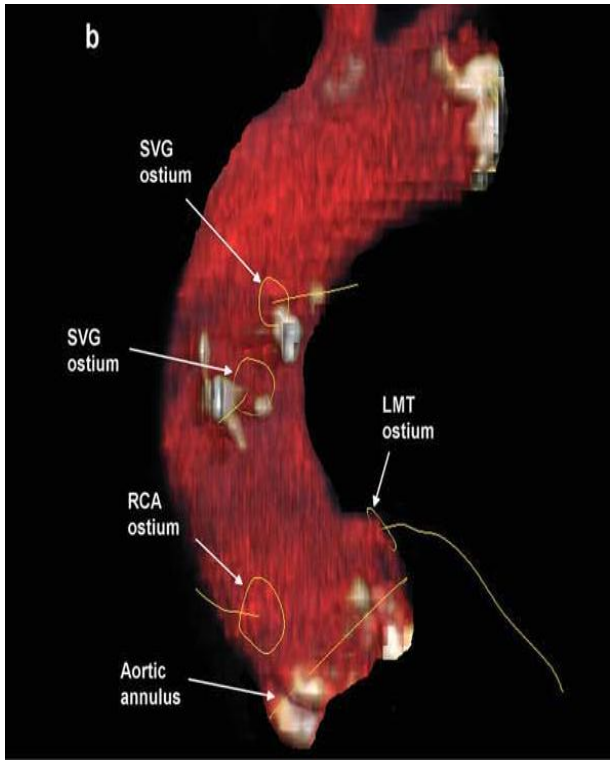
Pulmonary Vein Stenting

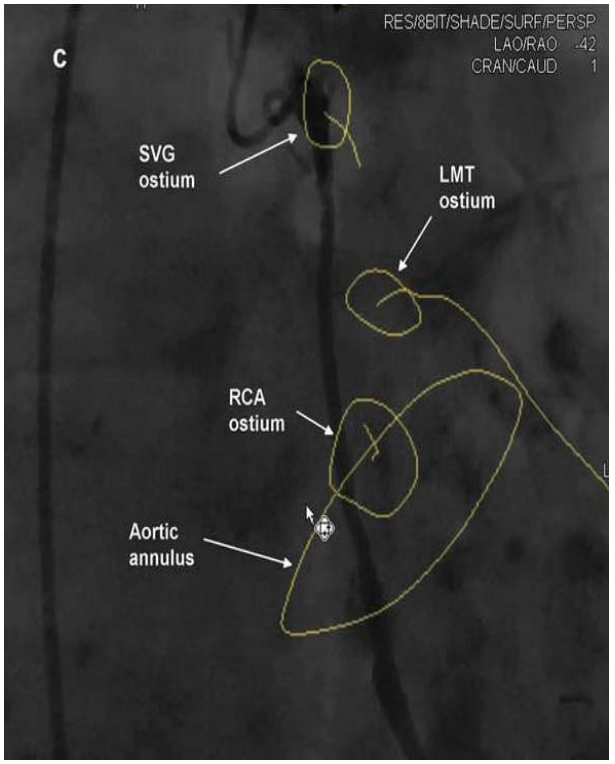


Krishnaswamy et al., Cath and Cardiovasc Intervention 2011

Bypass Graft Cannulation







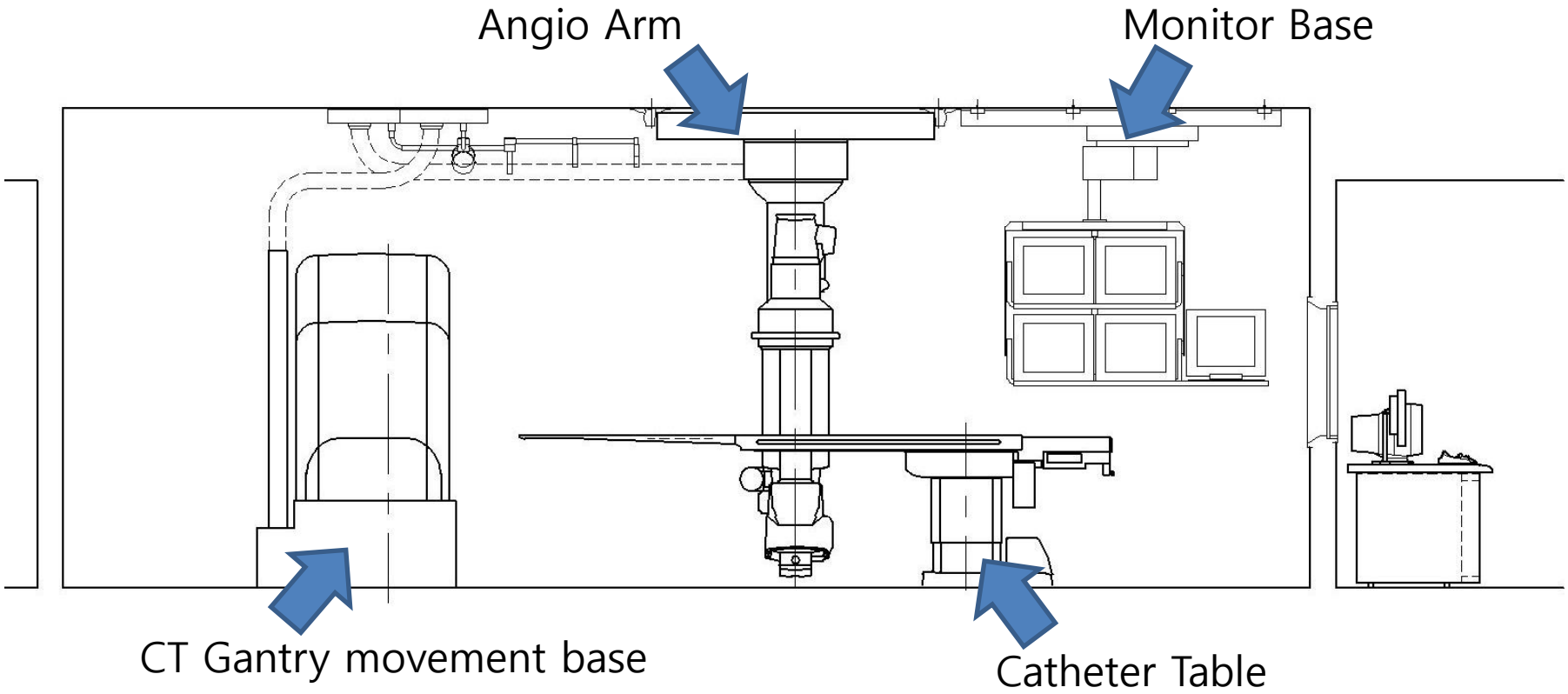
Limitations of DynaCT

- Image resolution of non-contrast DynaCT:
  - Faster spin to allow minimal contrast utilization and decrease motion during the scan
- Radiation exposure

  Effective Dose: 5.5 – 6.5 mSv
  - Routine angiography: 5 mSv
  - Cardiac CT angiography: 1~12 mSv
  - Nuclear perfusion imaging: 22 mSv
- Movement of the patient on the table: “misalignment”
  - Interactive breath hold system
  - Software upgrade for easier image manipulation

CT-Angiography Hybrid System Configuration

CT-Angiography Hybrid System Configuration

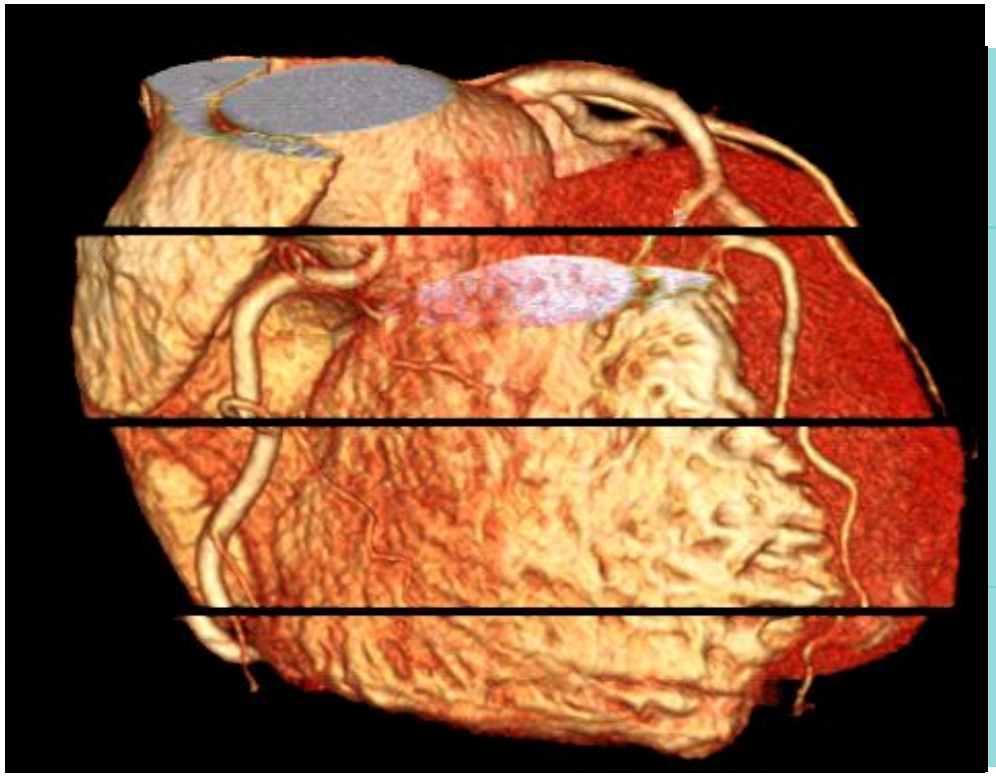


Side View

Development of CT-Angiography Hybrid System

	Siemens	GE	Philips	Toshiba
Single			-	1992
4 slice	2004		-	2000
16 slice	2004		-	2003
64 slice	2004		-	2007
128 slice		2008	-	2010
640 slice			-	

Advantages of Volume CT



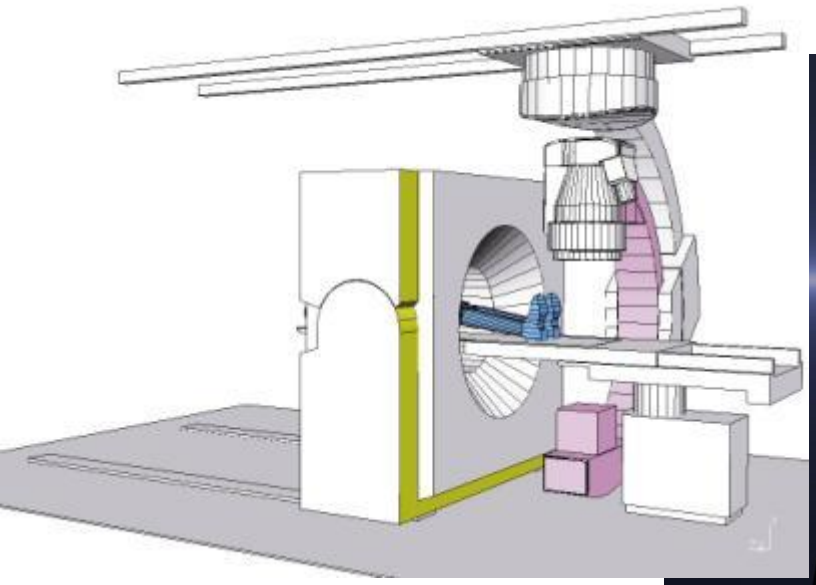
- Detector coverage
- Radiation and

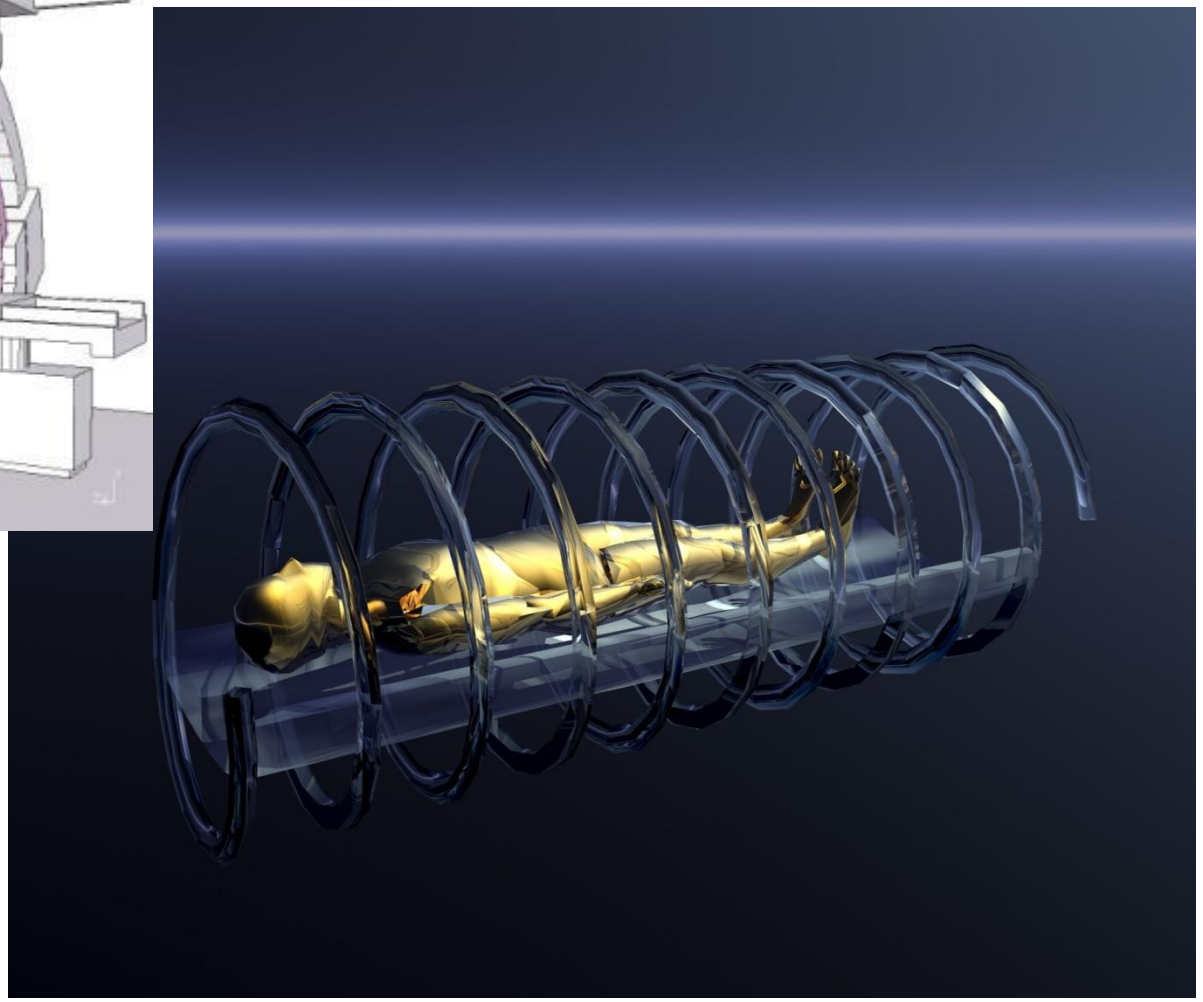
Contrast dose

- Temporal resolution

/uniformity

- …

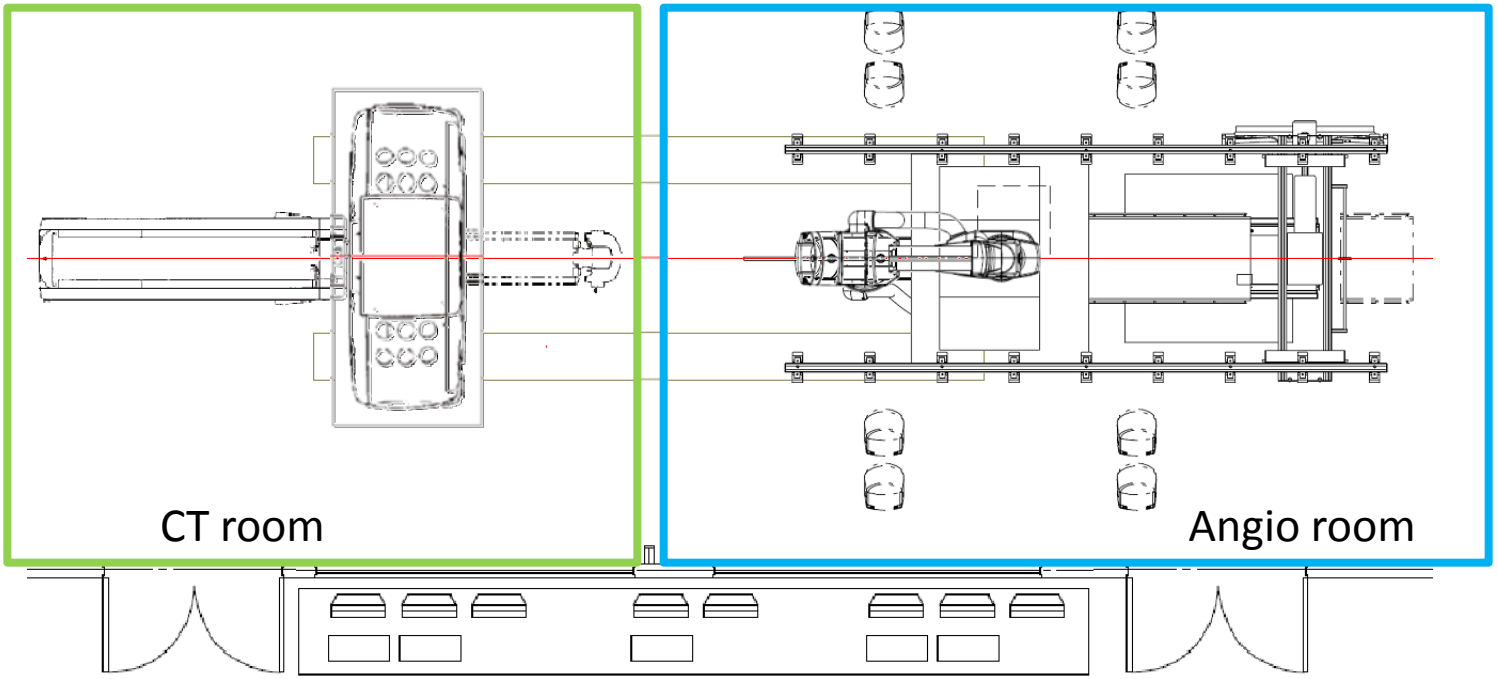




Spiral CT technology has an limitation
to apply to heart with Angio unit table.
Therefore, gantry moves in stepwise manner.

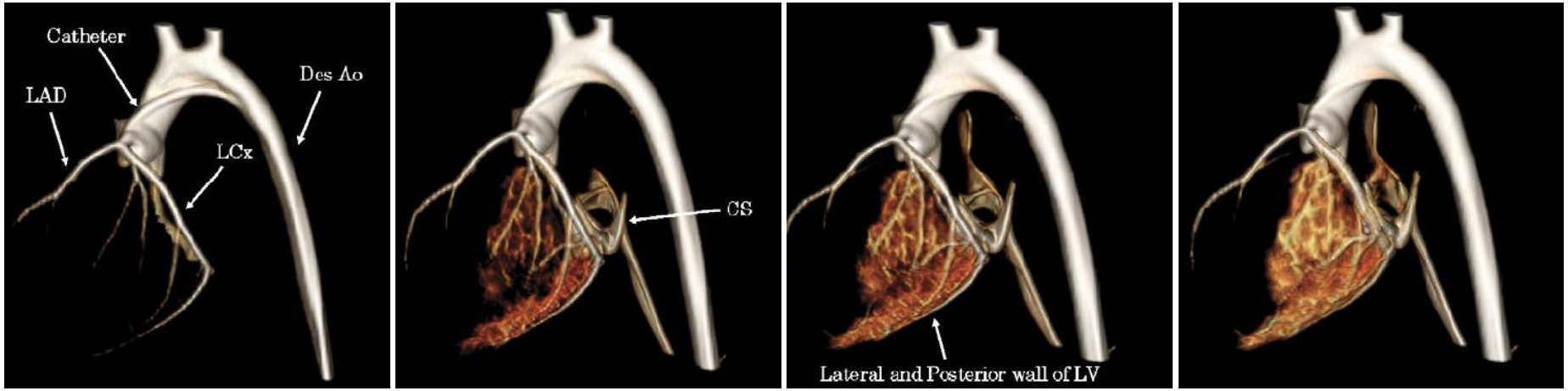
640 slice CT-Angiography Hybrid System

slide
shielding
door



Time series of volumetric measurement of porcine 3D segmented myocardial perfusion by selective contrast injection using 256-slice cone beam CT

1 sec 3 sec 6 sec 12 sec



120 kV, 200 mA, 1.0 s gantry rotation time and 256X0.5 mm slice collimation. 10 ml iodinated contrast material (300 mg/ml) diluted in 40 ml of saline, 3 ml/s for 20 s,

Funabashi N, et al. Int J Cardiol 2006;111: 455-6

	Recon Image N° (Vitrea)	series number	SBP/DBP/ MeanBP	Heart rate (bpm)	Route (IV/IA)	CT parameters						Contrast parameters				
						CFA/ CTA	Dose mod (+/-)	KeV	mA	N°of Acquisition Beats	dilution (contrast: saline), ml	ml/sec	sec	Total amount (contrast/ saline)	ratio (contrast/ saline)	real ratio (contrast/ saline)
#4		11	99/77/85	70	IA	CFA		120	550	1~10	1:14	4.0ml/sec	10	40ml		

2.6 sec

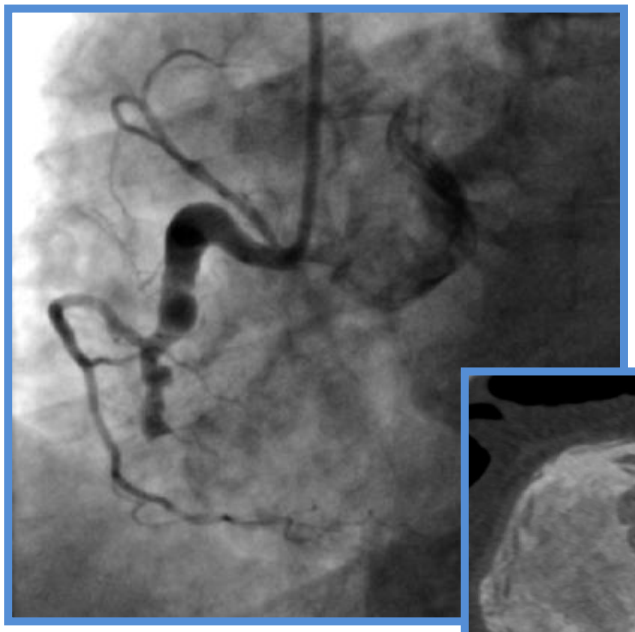
3.5 sec

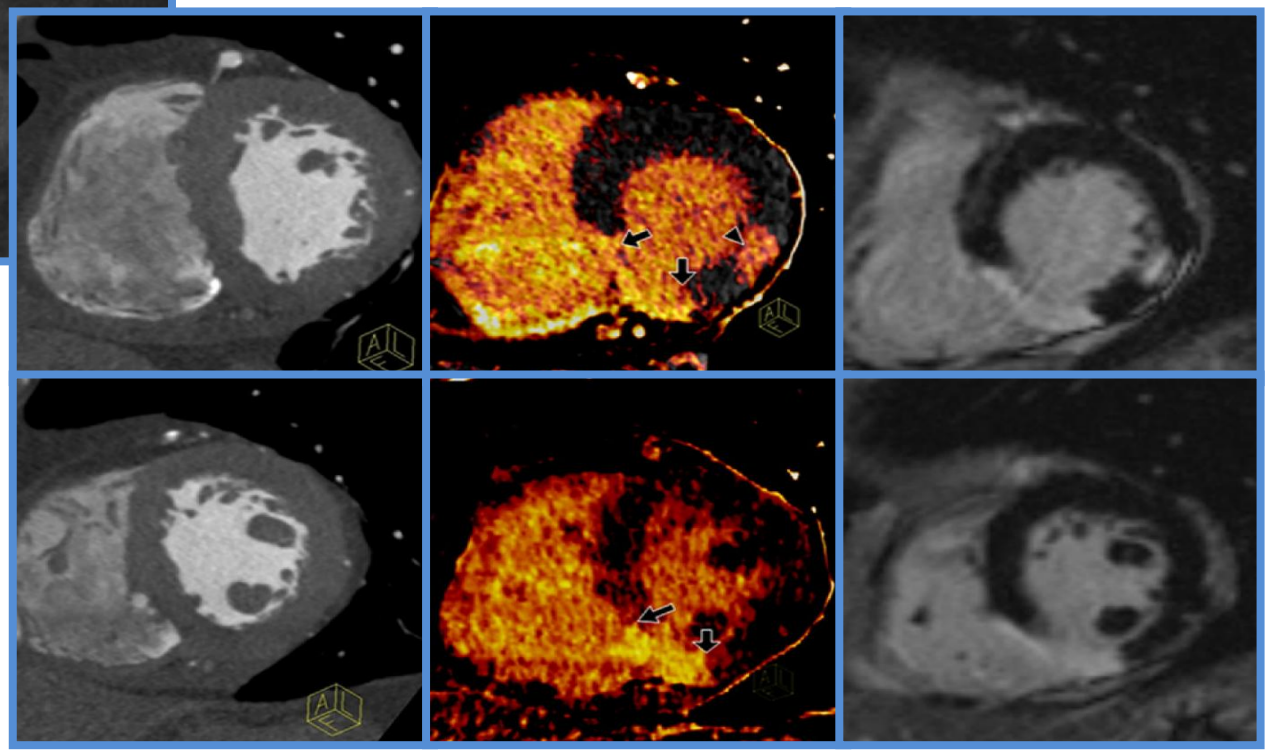
4.4 sec

- Best timing range : 3.5sec ± 0.90sec

Myocardial Viability by Dual-Energy DE-CT

JACC CV imaging 2011





Day #4
128-slice
dual source CT

contrast: 100cc
overall radiation
dose: 4.8mSv

100kV

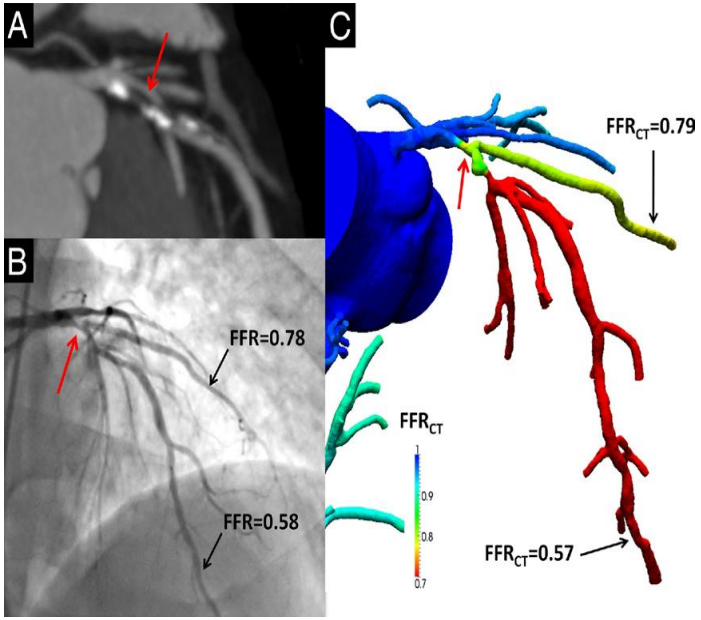
12 min after
100-140kV

CMR (Day #5)

Computational Flow Dynamics

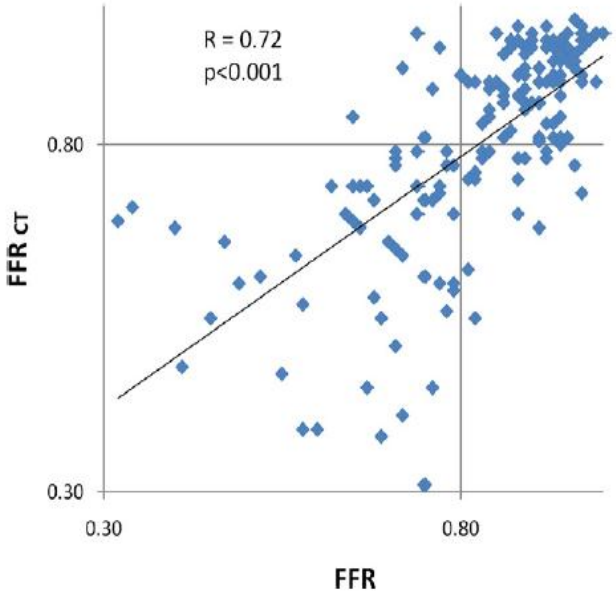
Results from DISCOVER-flow

Anatomically obstructive stenosis with a lesion of casual ischemia



HeartFlow®

Correlation of FFR_{CT} to FFR

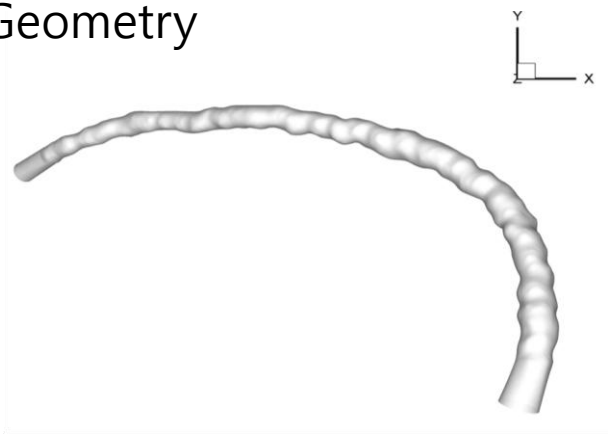


Koo BK, et al. JACC 2011

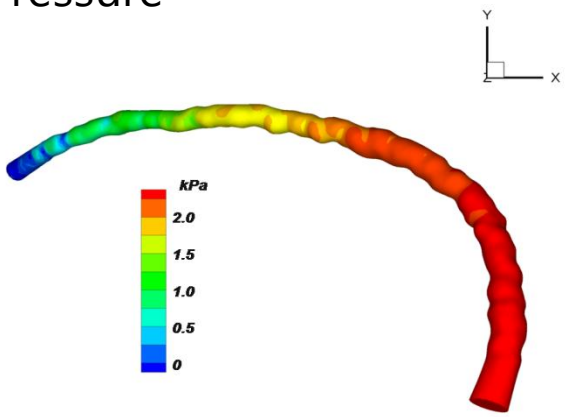
CFD in Selective CTA

Pig #5
RCA

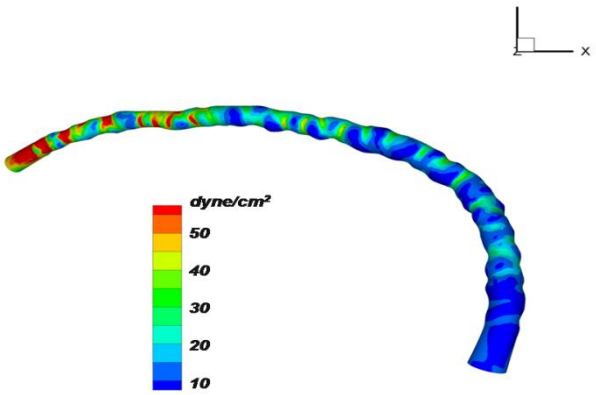
Geometry



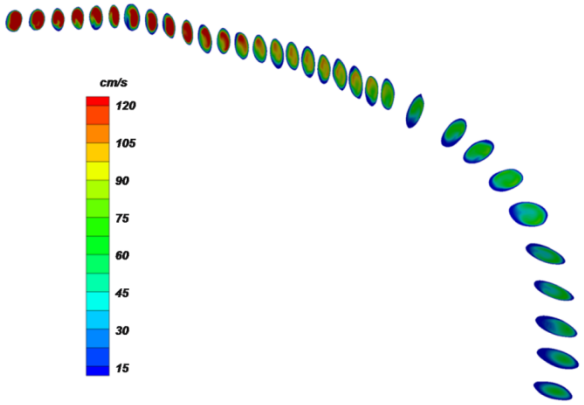
Pressure



Time averaged WSS

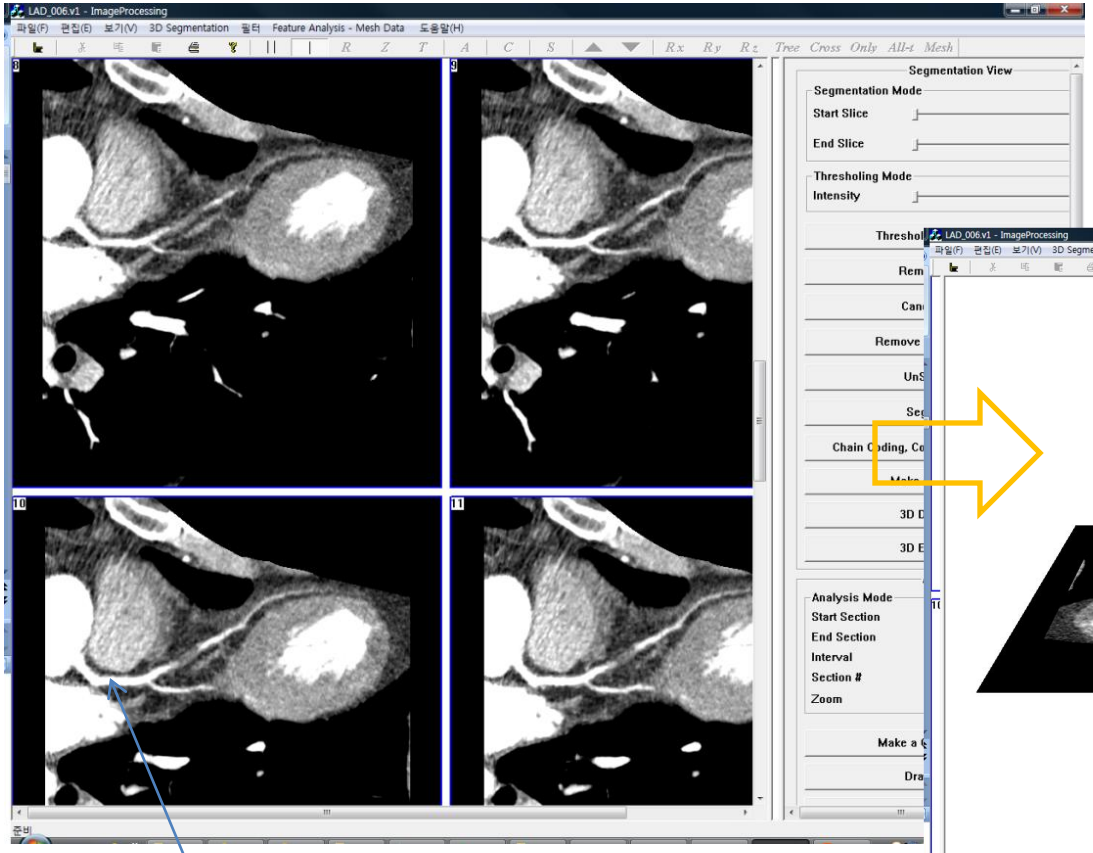


Velocity

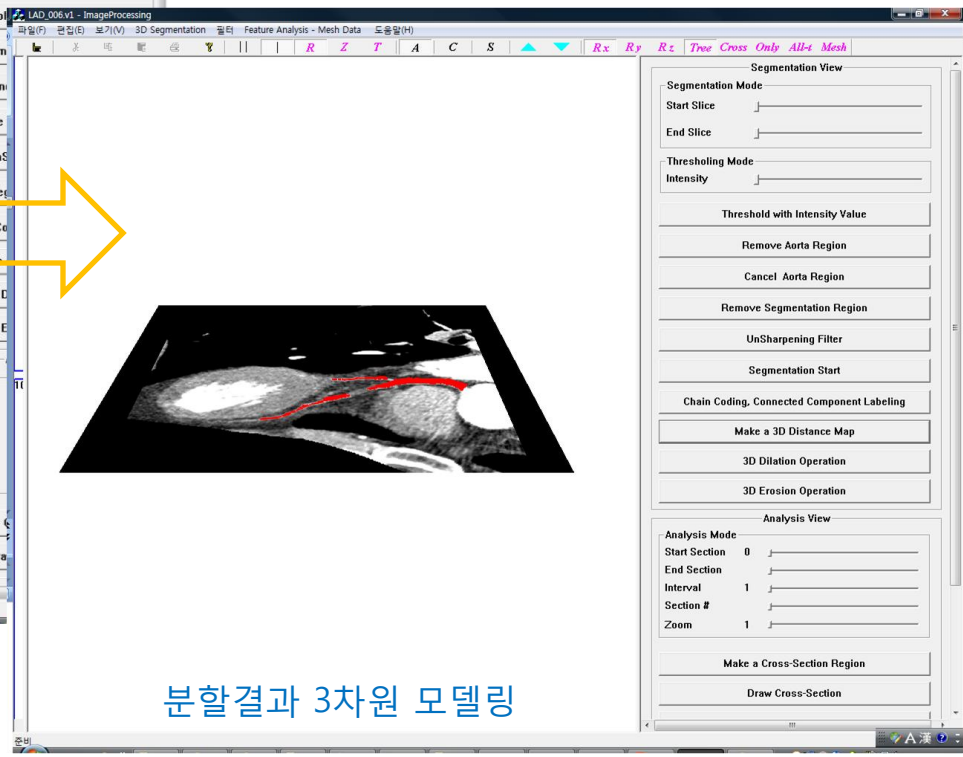


<4 hour! with conventional computer system

혈관모델 (CT Angiography)



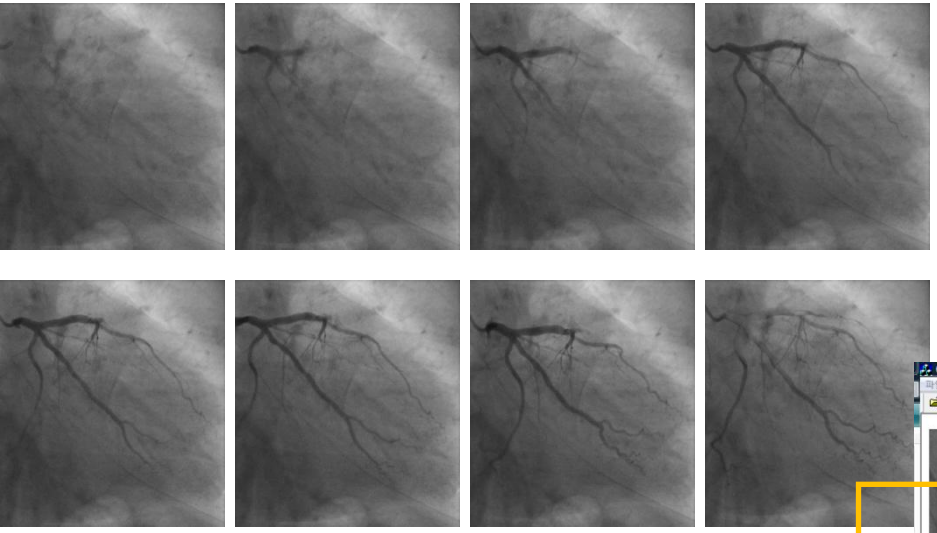
사용자 seed point 입력



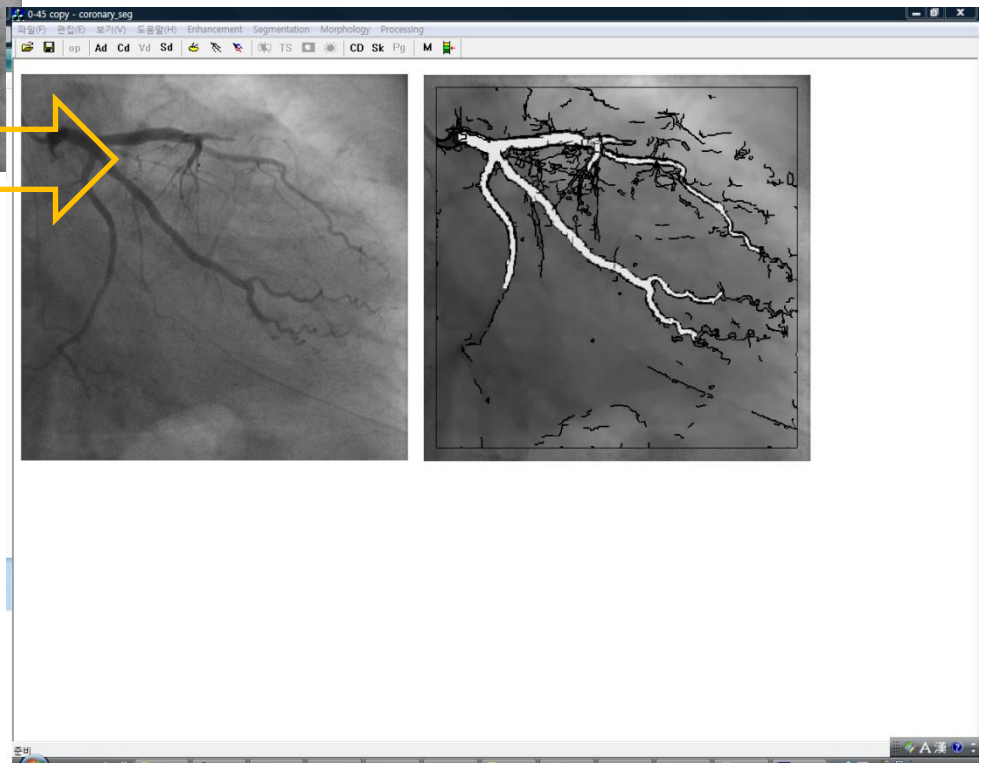
분할결과 3차원 모델링

Spatial resolution: 512x512x96

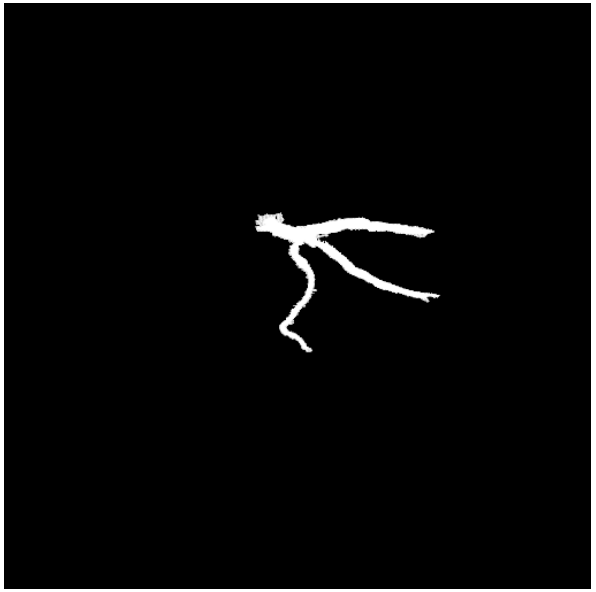
혈관모델 (X-ray Fluoroscopy)



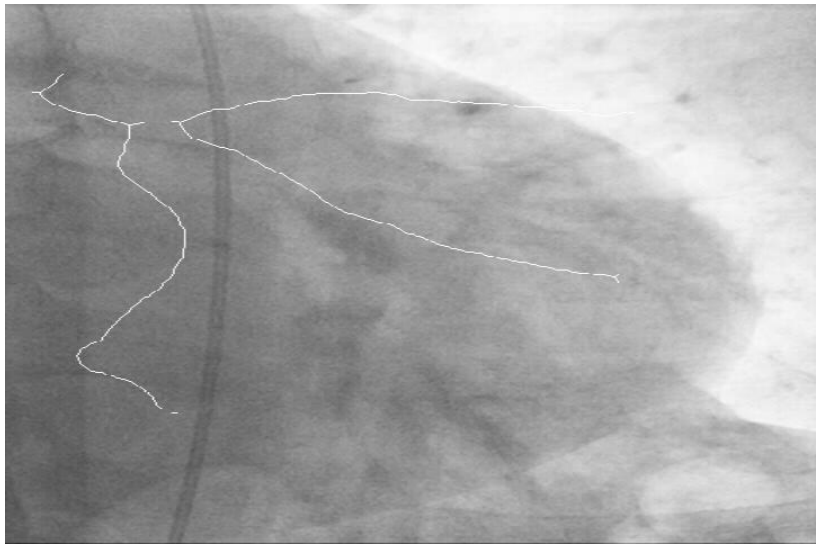
Spatial resolution: 512x512 x 93 frames



영상 오버레이 및 가이드라인 제공



CTA 혈관모델을
X-ray 촬영각도에 맞춰
투영한 결과한 예
(RAO18 CRAN28)



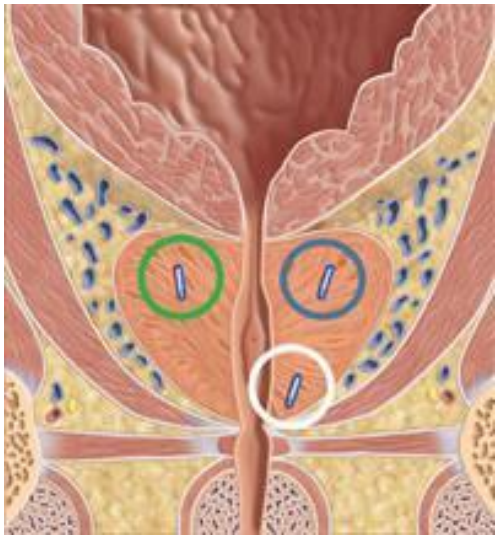
Motions on Spot

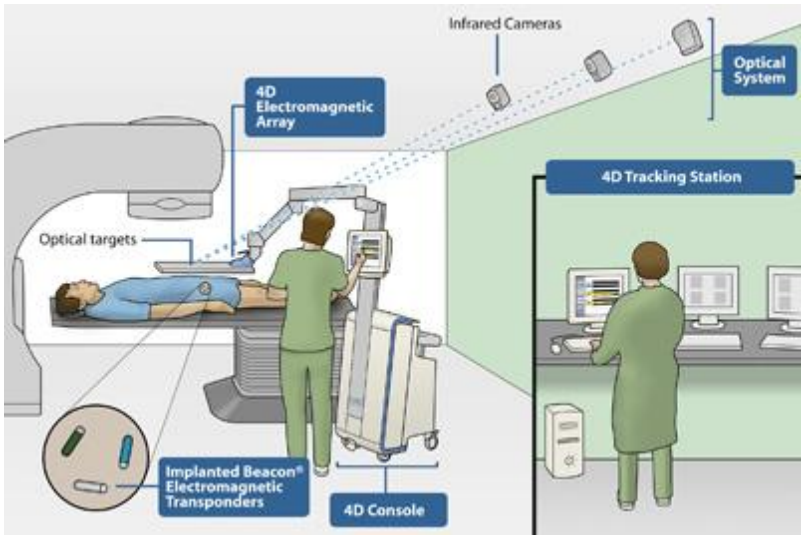
- Cardiac Motion
- Extracardiac Motion
- Respiratory Motion
- Patient Motion

GPS for the Body®

Calypso® 4D Localization System

: Prostate Cancer





Wireless miniature Beacon® electromagnetic transponders work with the Calypso® 4D Localization System™ to provide guidance to the clinician on the position and movement of the prostate during radiotherapy.

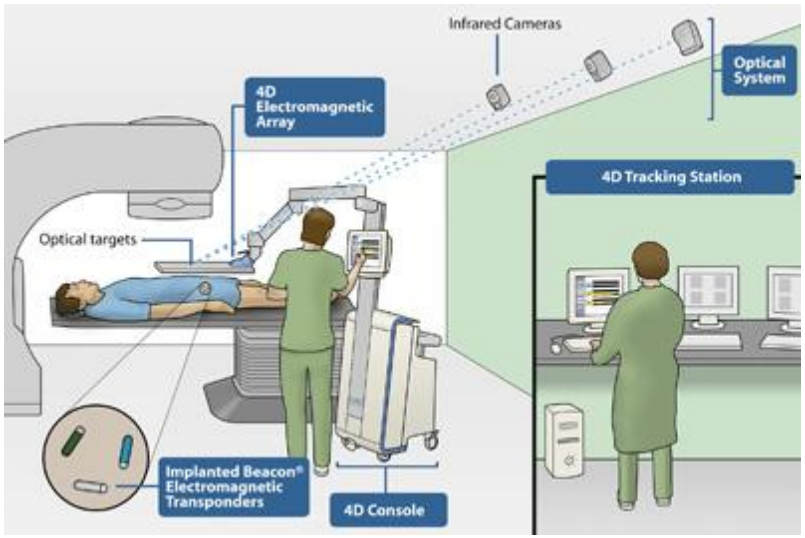
Calypso Medical Technologies Inc.

http://www.calypsomedical.com/

GPS for the Body®

Calypso® 4D Localization System

: Prostate Cancer



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What is our goal?

Past

2D

Present

3D

Upcoming,

and

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