Lenox Hill
Heart and Vascular
Institute
Of New York

Summit TCT Asia Pacific 2009

April 22-24, 2009

The Convention Center of Sheraton Grande Walkerhill Hotel, Seoul, Korea

3D/4D CTA Reconstruction

Interventions in Structural Heart Disease

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Fluoroscopic Angiography

- **Reserved for resolution of specific anatomical and physiological questions, and for interventions**
- **Still considered the gold standard**
  - Fine focal spot < 0.6 mm - sharp definition (0.3 mm)
  - Exposure (temporal resolution) 4 msec.
  - High kV and low mA - for maximal penetration and wide grade scale
  - Lower kV and higher mA - for sharper contrast and edge definition
- **X-Ray Projections**
  - Bi-plane eases access to depth perception
  - Common views

VIEWS	PA TUBE	LATERAL TUBE
PA-Lat	90°	0°
RAO, LAO	30-60° RAO	30-60° LAO
Long Axis	30-60° RAO	30-45° LAO + 30-45° Caudocranial
4-Chamber	60° LAO + 20-30° Caudocranial	30° LAO
Sitting-up "cranial"	30-40° Caudocranial	0°
Ao orifice (down-the-barrel)	90°	10-20° LPO + 20-30° Craniocaudal
Ao orifice (down-the-barrel) - TGA	45-60° Craniocaudal + 0-20° LAO	0°
LV down-the-barrel	90°	20° LPO + 30° Craniocaudal

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Cath/Angiography Risks

	Frequency (%)
Mortality	0,11
MI	0,06
Cerebro-vascular complications	0,07
Arrythmia	0,38
Vascular complications	0,43
Contrast media complications	0,37
Hemodynamic complications	0,26
Perforation	0,03
Total number of severe complications	1,70

Guidelines AHA/ACC 2003, www.americanheart.org

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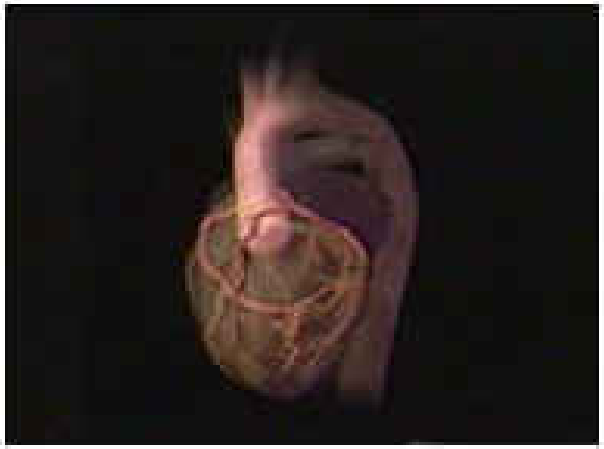
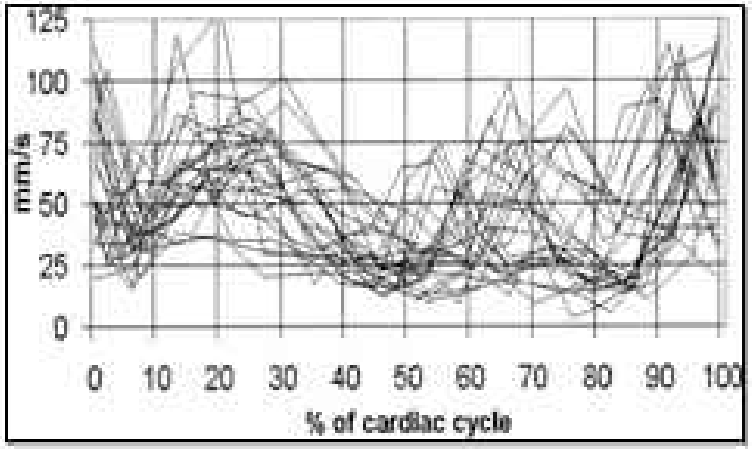
CT Cardiac Angiography

- **Rapidly moving cardiac structures**
  - Different for the 3 coronaries and cardiac valves
  - Not predictable motion location
  - Breathing
- **Complex anatomical structures (course)**





® **High temporal resolution required !!**

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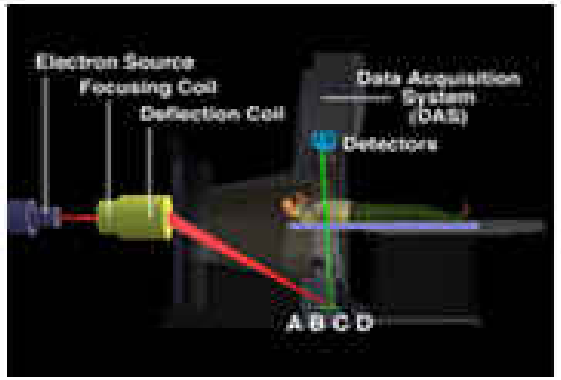
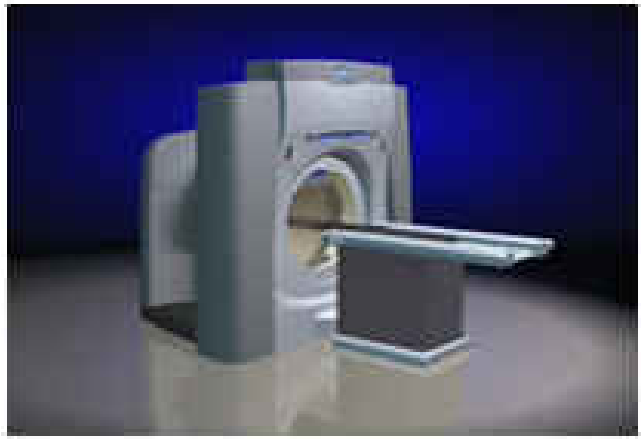
EBCT

- Produces x-ray by focusing an electron beam onto 4 tungsten target rings positioned beneath the patient
- Acquires 1 scan at a time using prospective ECG-triggering in which radiation is produced only during predetermined instant of the cardiac cycle
- Increases in acquisition speed are possible by magnetically sweeping the electron beam faster
- There are no moving parts
- Free from the limitations of centrifugal force, thus faster speed (10 times faster than 16-MSCT)
- 33, 50 or 100 ms true temporal resolution images at 30 f/s
- ECG triggered (60<HR<180) - up to 8 trigger points R-to-R
- Reduced radiation exposure (1/10 dose than the fastest spiral 16 – MSCT)





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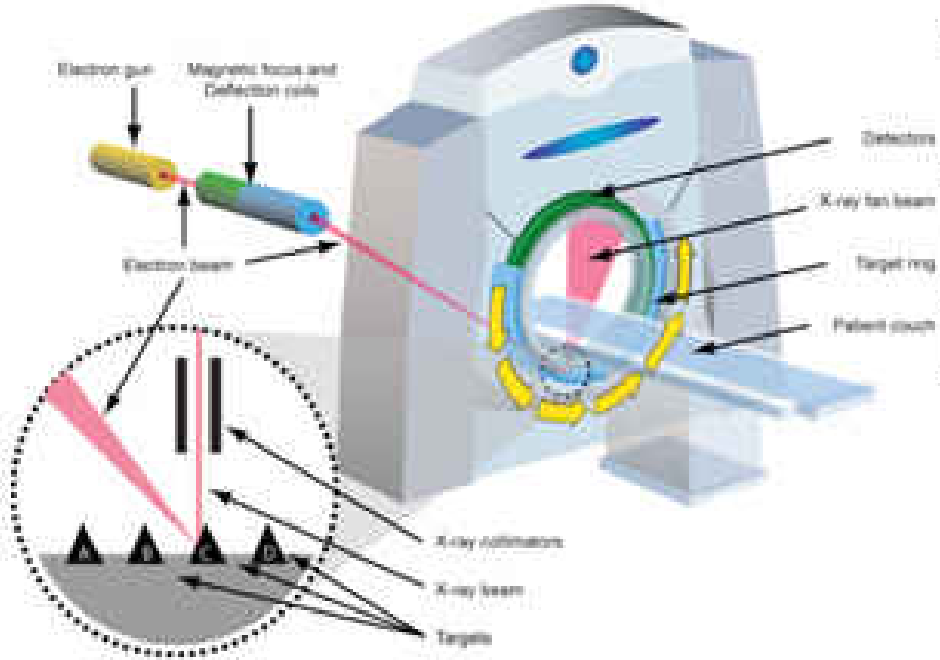
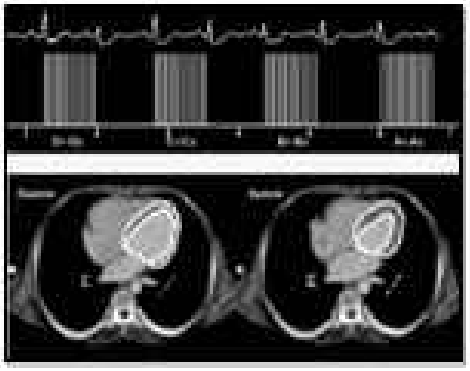
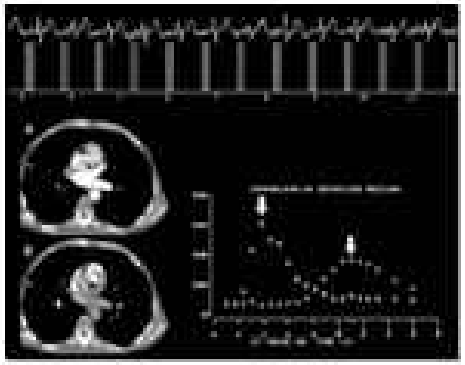
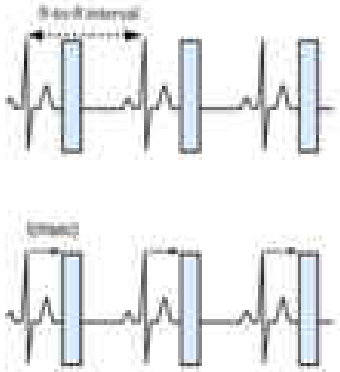
ECG – Gating

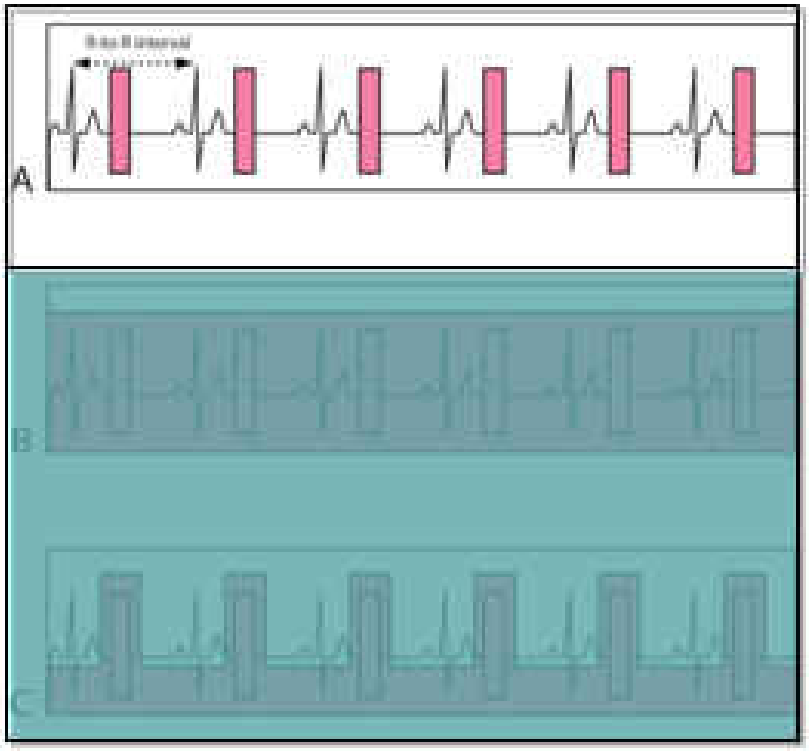




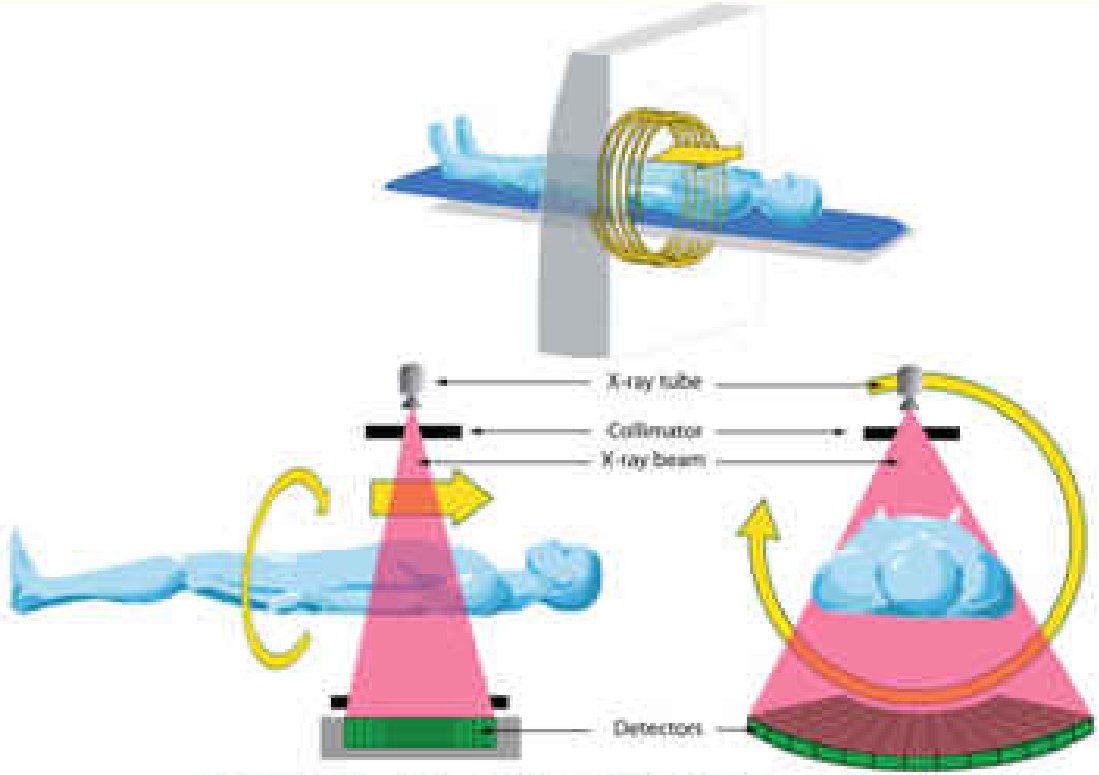


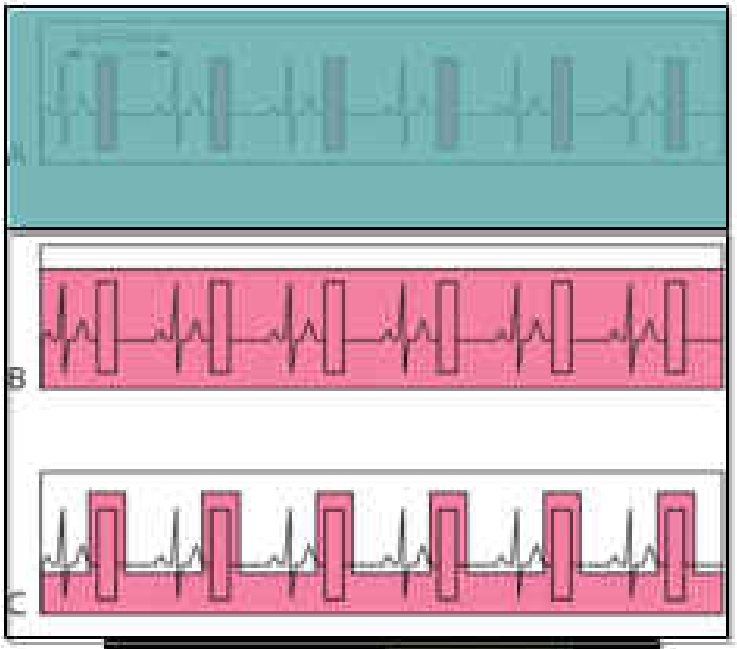


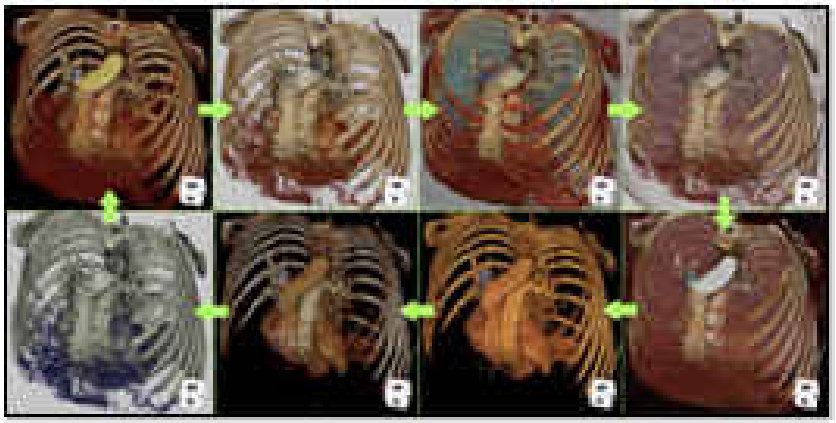
Heart Rate (bpm)	Trigger Rate (msec)
<40	410
41-50	359
51-60	338
61-70	314
71-80	304
81-90	289
91-100	283
101-110	274
>110	269

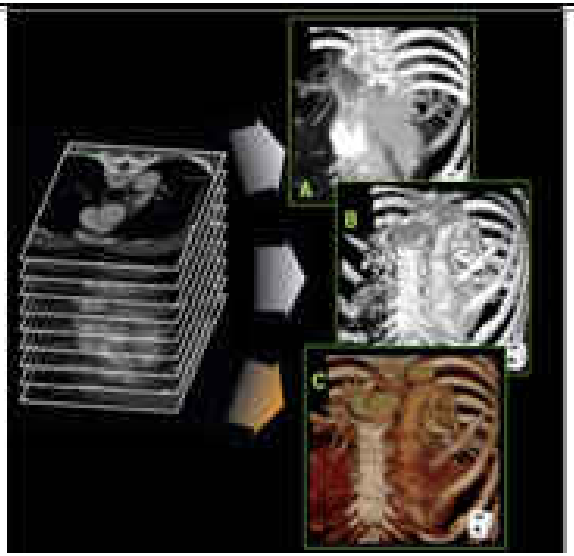


MDCT









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Conventional CT's

- Acquire several parallel scans simultaneously using either:
- Prospective ECG-triggering: radiation (attenuation) and data acquisition is produced only during a predetermined instant of the cardiac cycle
- Retrospective gating - radiation and data acquisition is produced throughout the entire cardiac cycle (images are reconstructed only during diastole) - higher radiation dose at an equivalent image noise

4-8-16-32-64-128-256...Detectors

Increase speed
Decrease in slice thickness

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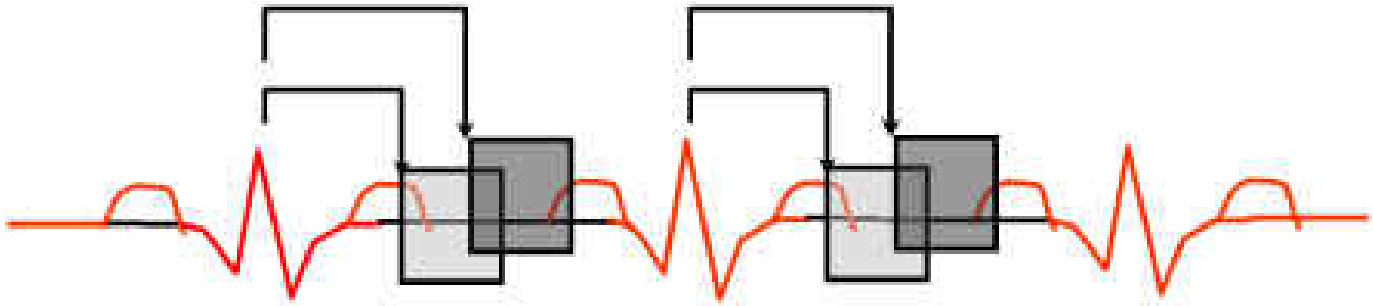
EBCT vs. MDCT

	EBCT		MDCT	
Acquisition	ECG gated	Continuous	ECG gated	Continuous
Reconstruction	Prospective	(Non-Cardiac)	Prospective ("Pulsed")	Retrospective
Temporal Resolution	33 msec		>200msec	
Spatial Resolution	1.5 mm		<0.5 mm	
Optimal Heart Rate	60-150 bpm		≤60 bpm	≤60 bpm



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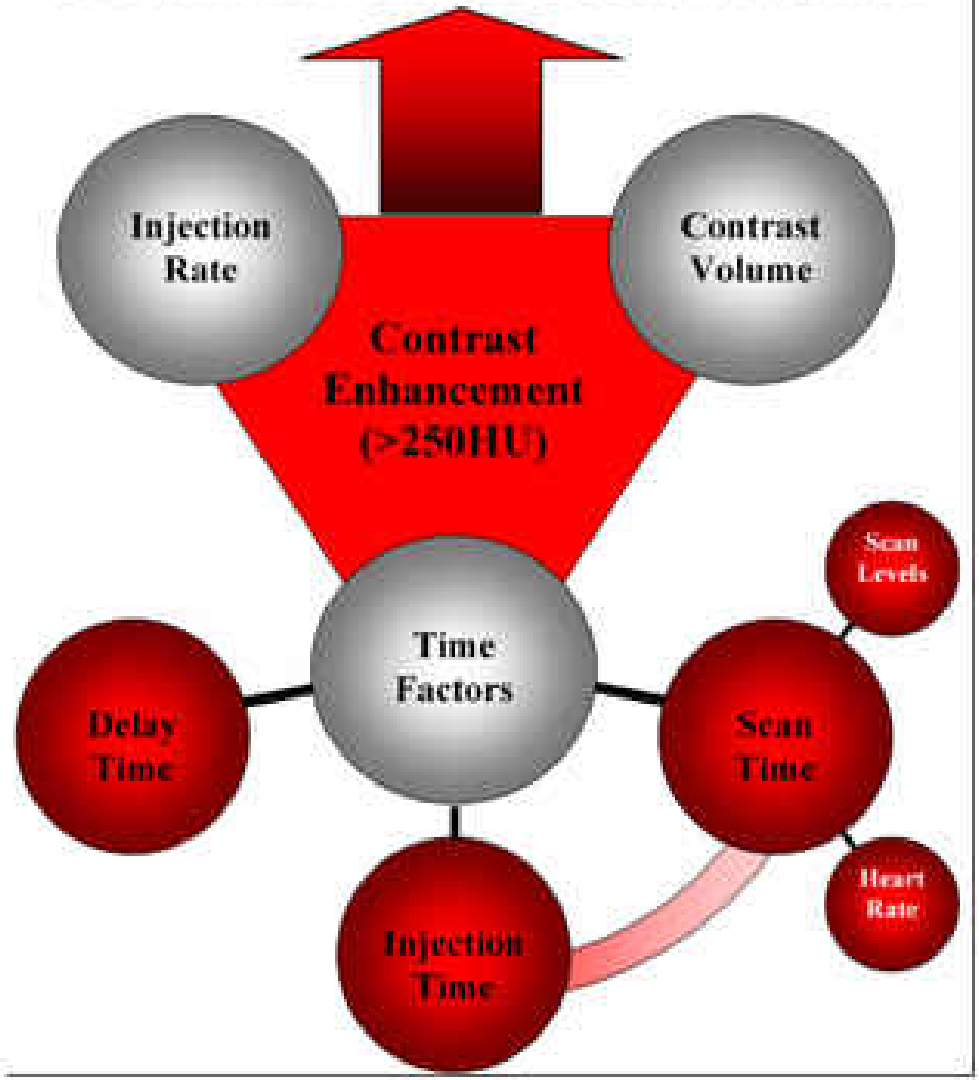
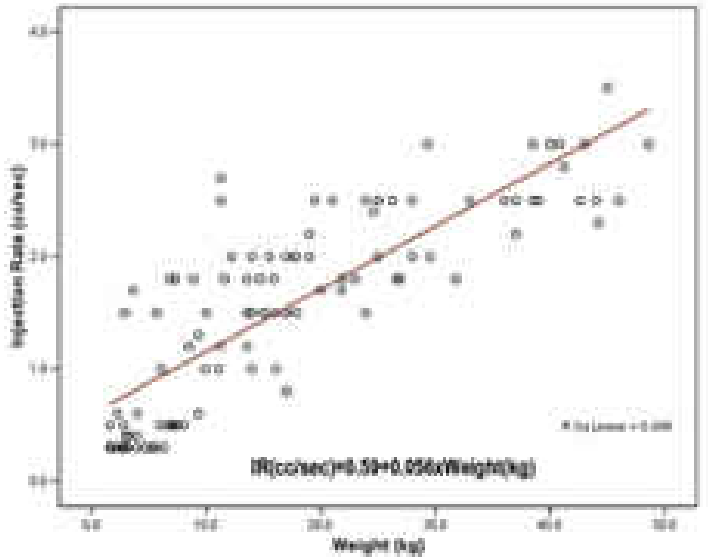
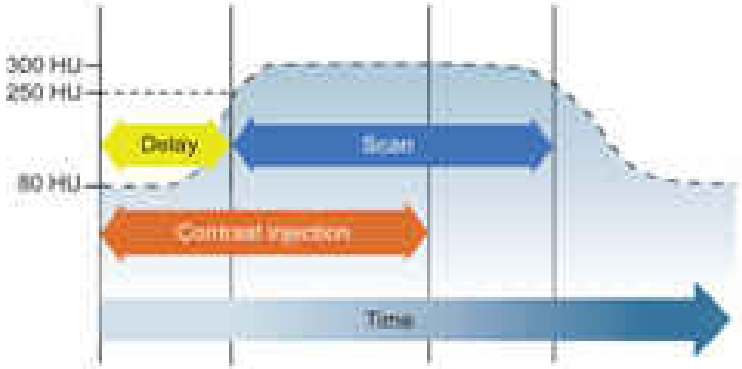
Technique

3 Dimentional Reconstruction







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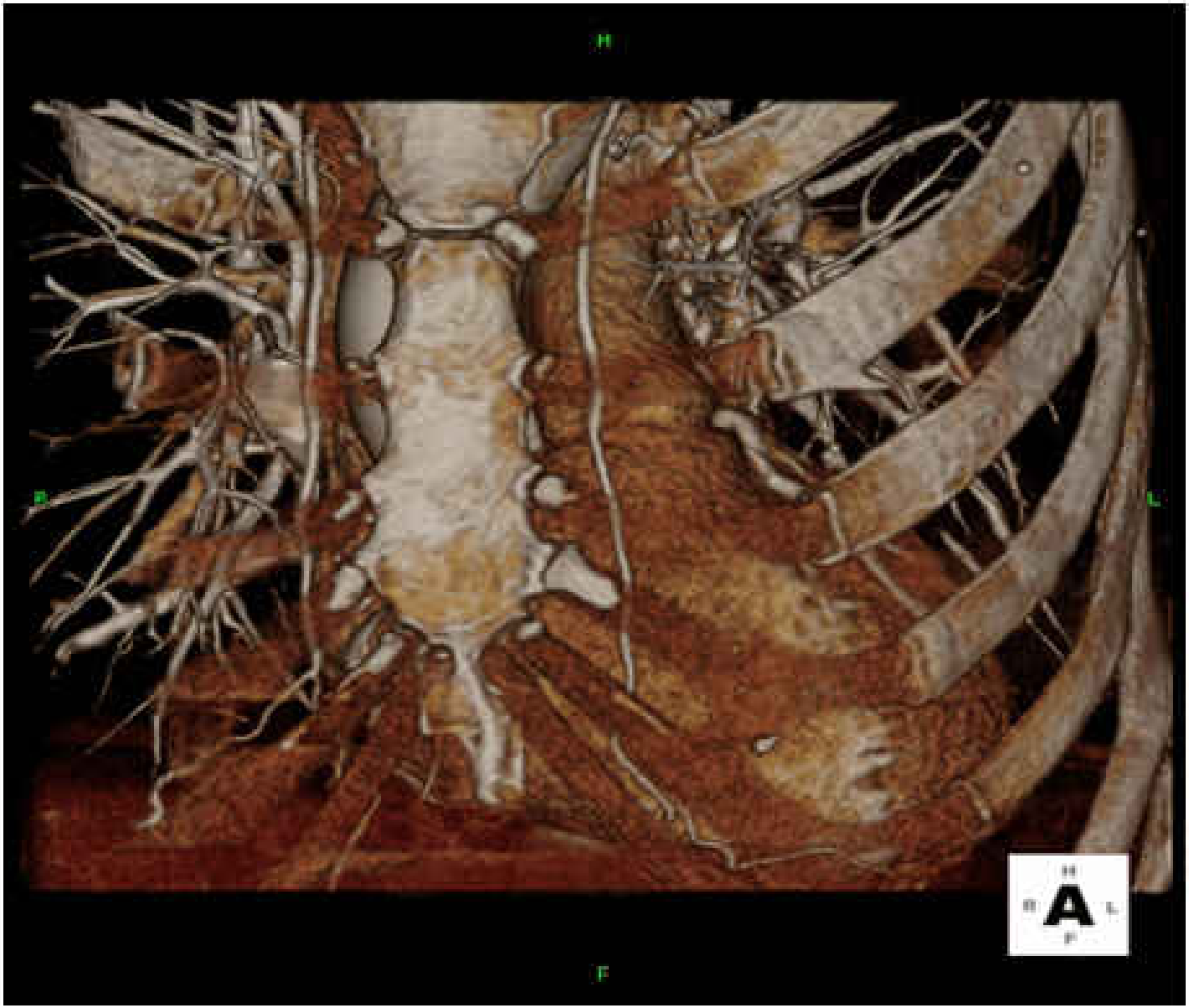
Defining Cardiac Structures



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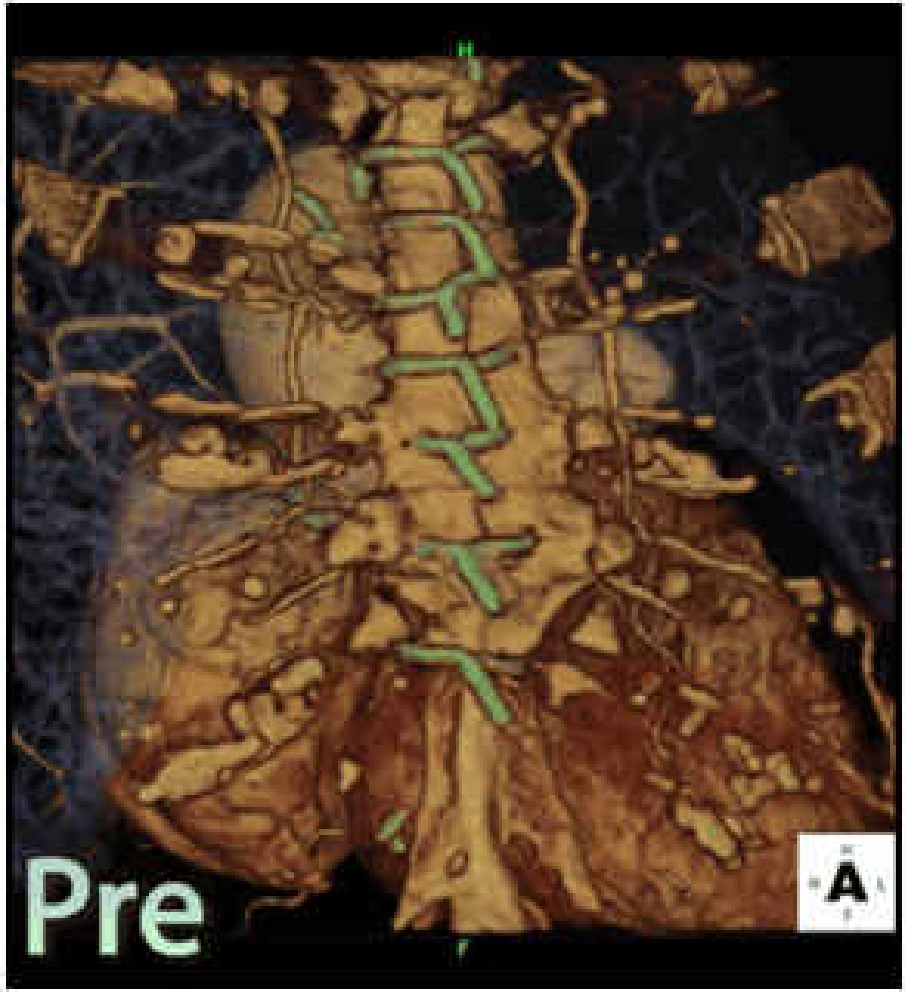
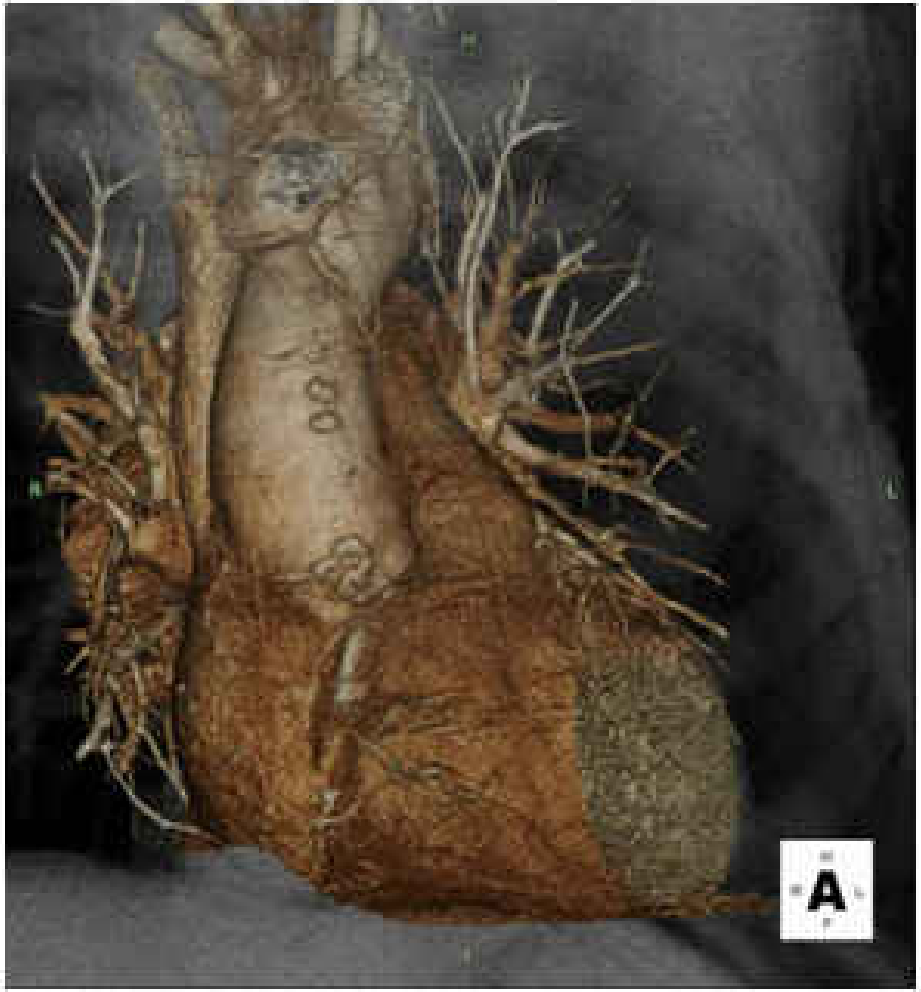
Guiding Complex Interventions

Paravalvular Leaks

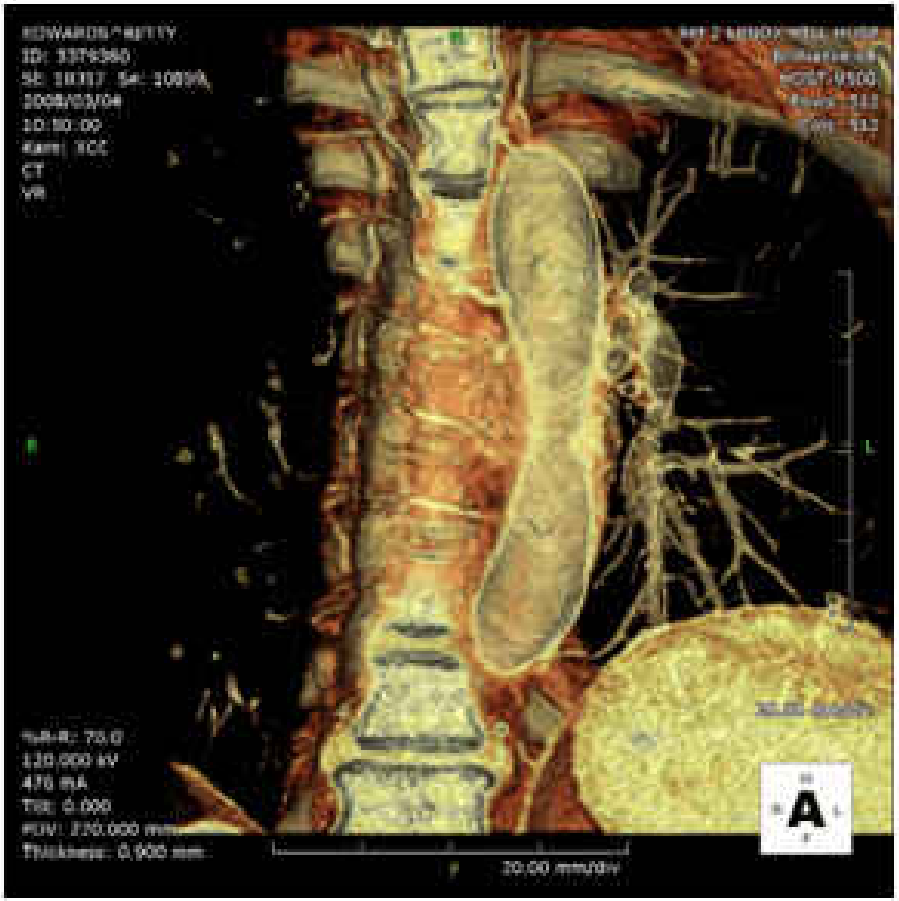


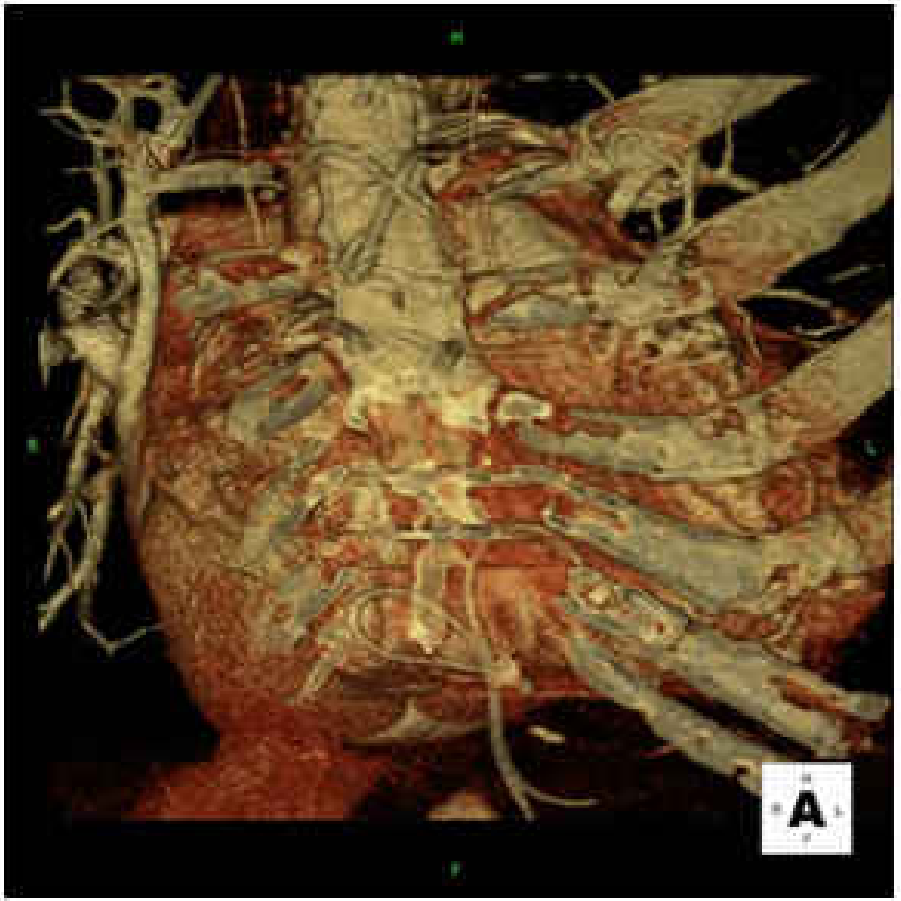


Guiding Complex Interventions

Paravalvular Leaks

TRANSAPICAL APPROACH





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Integrated Fluoro-CT

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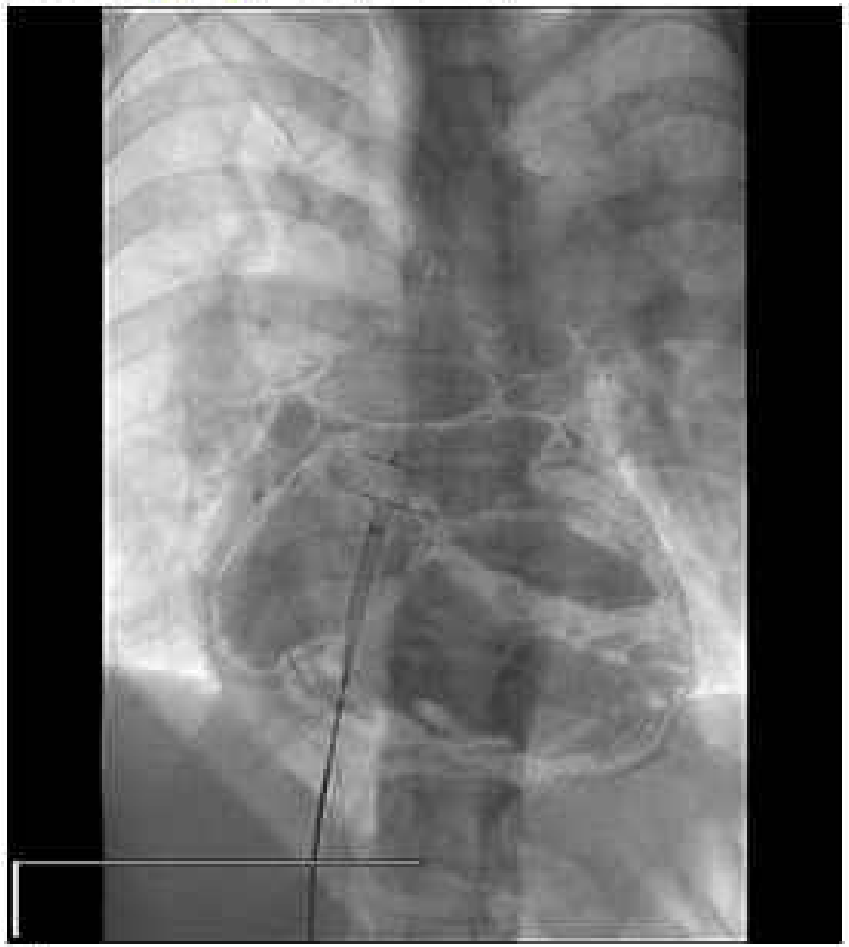
New Advances

Overlay of Live Fluoroscopy on CT

- **Registration**
  - Challenges:
    - Cardiac, pulmonary, and patient motion
    - Deformation of structures
- **CT Segmentation**
  - Highlighting versus exclusion of specific objects



AHA 2006 Presentation: Cardiac Computed Tomographic Angiography Pre-procedural Planning for Percutaneous Atrial Septal Defect Closure. Marcus Y. Chen, Robert A. Quaife, John D. Carroll

(Courtesy of Dr. John D. Carroll)

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New Advances

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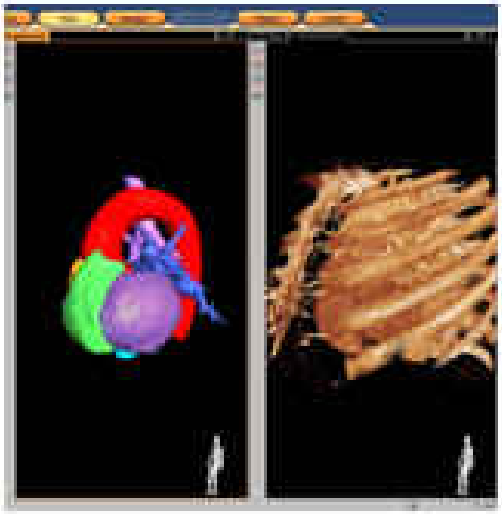

New Advances

Imaging Continues to Improve

- CT Reconstruction imperative for planning and execution
- Complementary imaging with 3D echo also imperative

Thank You