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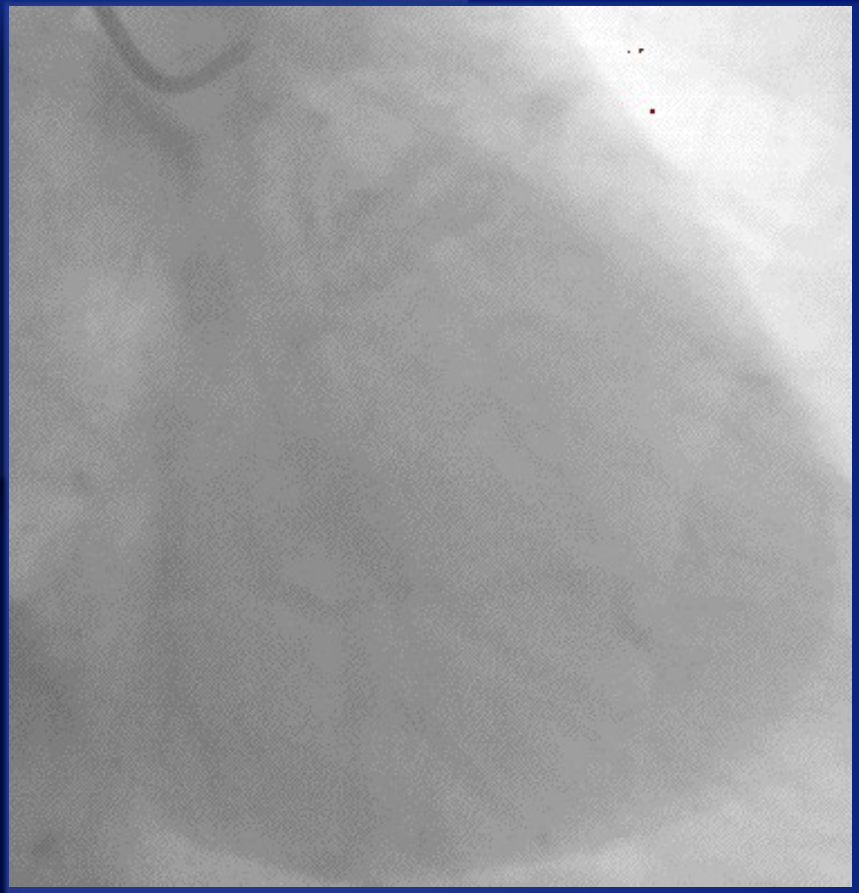
Advanced interventional imaging

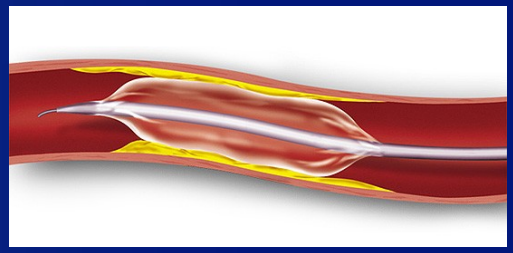
Cardiac fluoroscopy



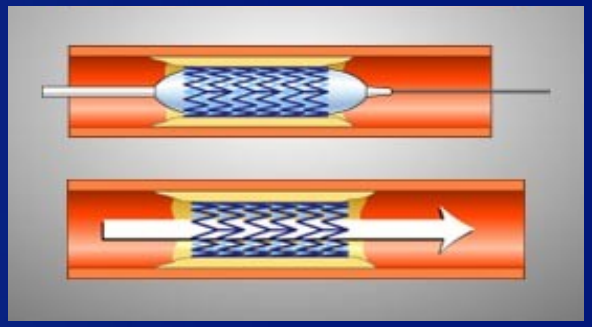
X-ray angiogram
Diagnostic gold standard

Cardiac fluoroscopy

X-ray angiogram
Diagnostic gold standard



Balloon angioplasty



Stents

Guide all interventions

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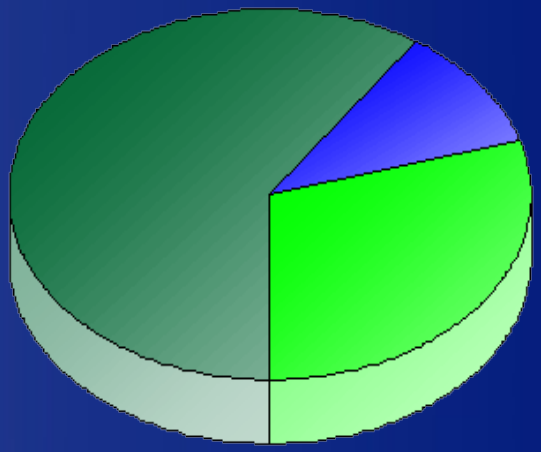
$1.8B interventional imaging market

Cardiac
Catheterization Systems
$1.1B



Neurovascular
Catheterization Systems
$0.1B

Abdominal & Peripheral Vascular
Catheterization Systems
$0.6B

Cardiac Catheterization Systems

- Average price: $1M
- Service life: 8 years

Source: Frost & Sullivan

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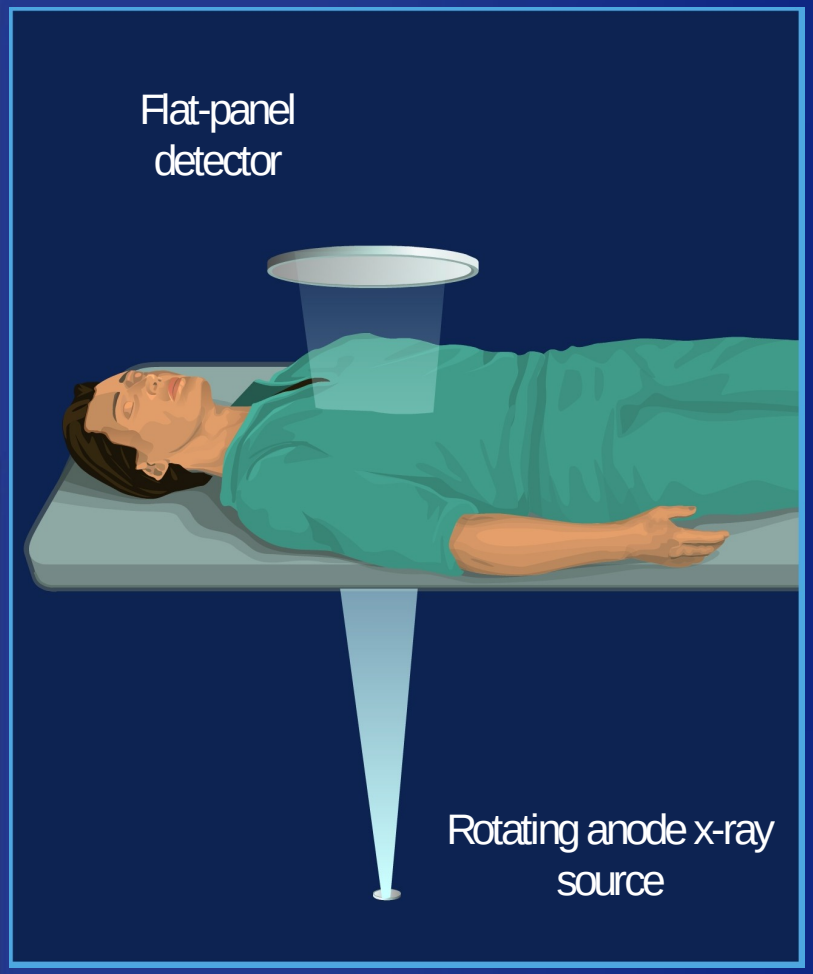
Conventional fluoroscopy system



- Point x-ray source
- Large-area detector
- Shadowgram image

Conventional fluoroscopy limitations

- Excessive radiation
- Poor image quality in large patients / steep angles
- Anatomical clutter
- Cumbersome quantitative vessel sizing
- Obstructed access to patient

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NovaRay solution

Entirely new

fluoroscopy technology

- Dramatically reduced radiation
- Enhanced imaging
  - Continuous diagnostic quality
  - Superior quality in large patients
- Unique real-time 3D multi-slice tomography
  - Enhanced visualization
  - Simple accurate vessel sizing
- Open patient access

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NovaRay fluoroscopy technology

New architecture

and subsystems

- Inverse geometry
- Scanning x-ray source
- High-efficiency detector array
- Image-reconstruction computer

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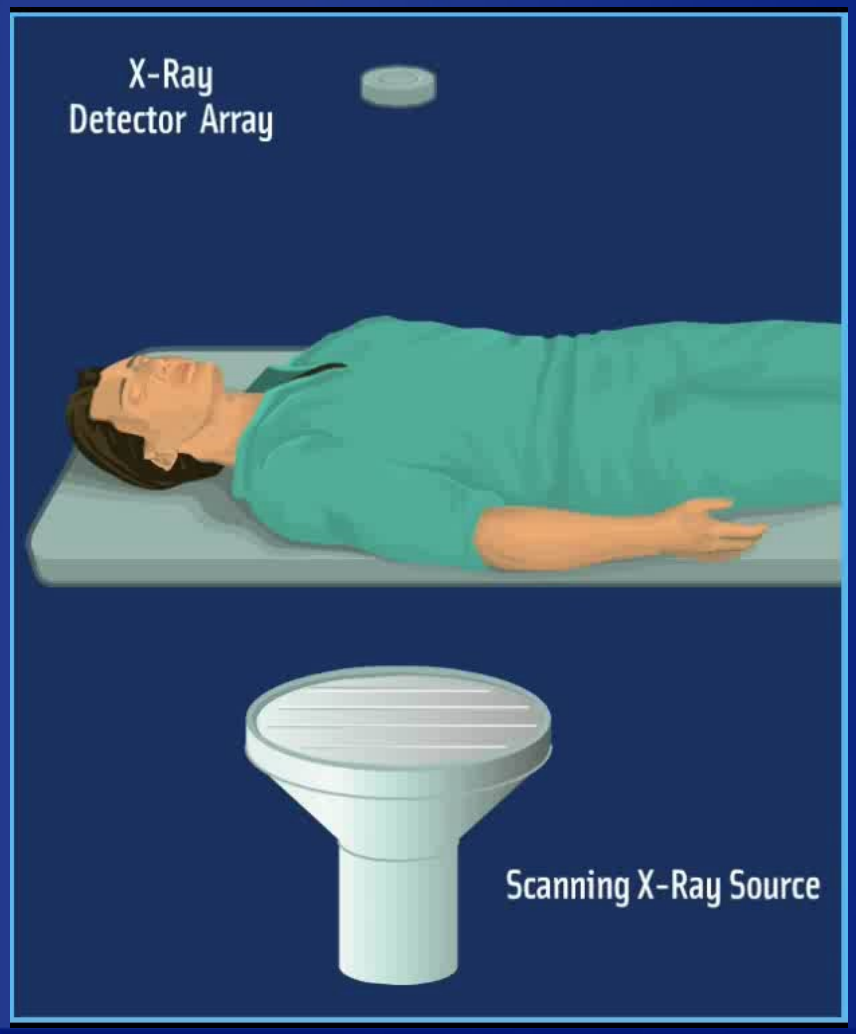
NovaRay system



- Inverse geometry
- Scanning x-ray source
- Small-area detector
- Collect many small overlapping images
- Scan entire field of view 30 times / second
- Reconstruct full images in real time

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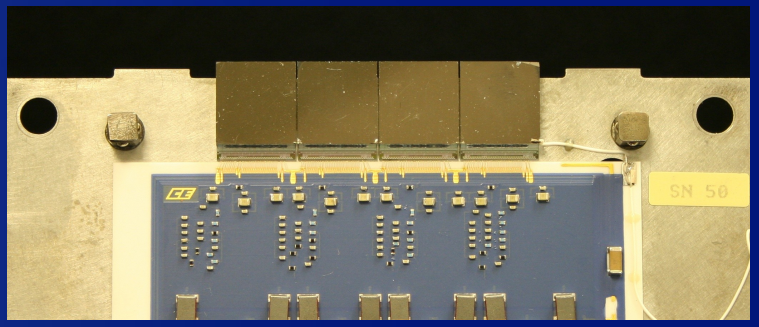
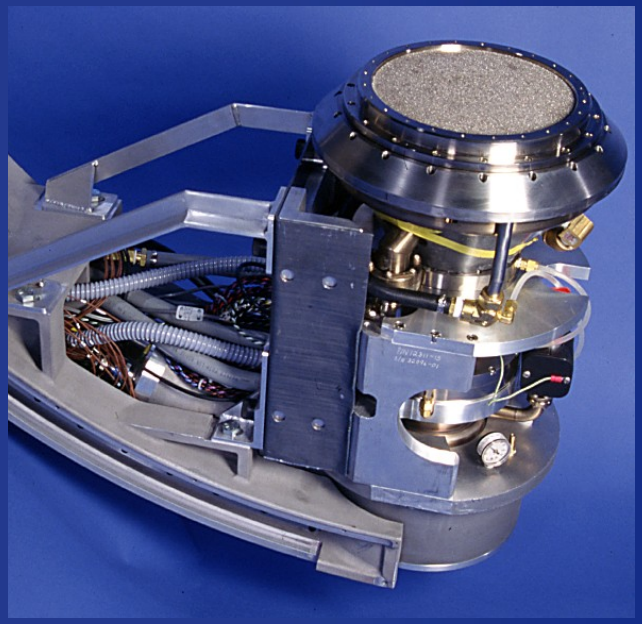
NovaRay proprietary imaging chain

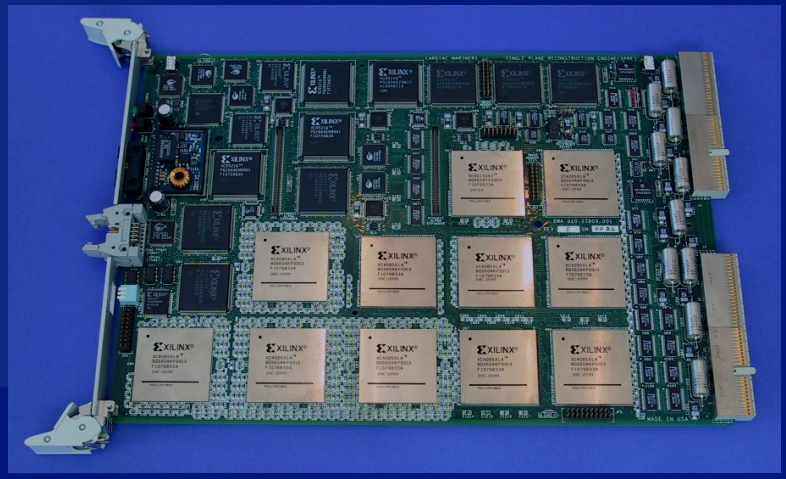
High-efficiency photon-counting x-ray detector arrays



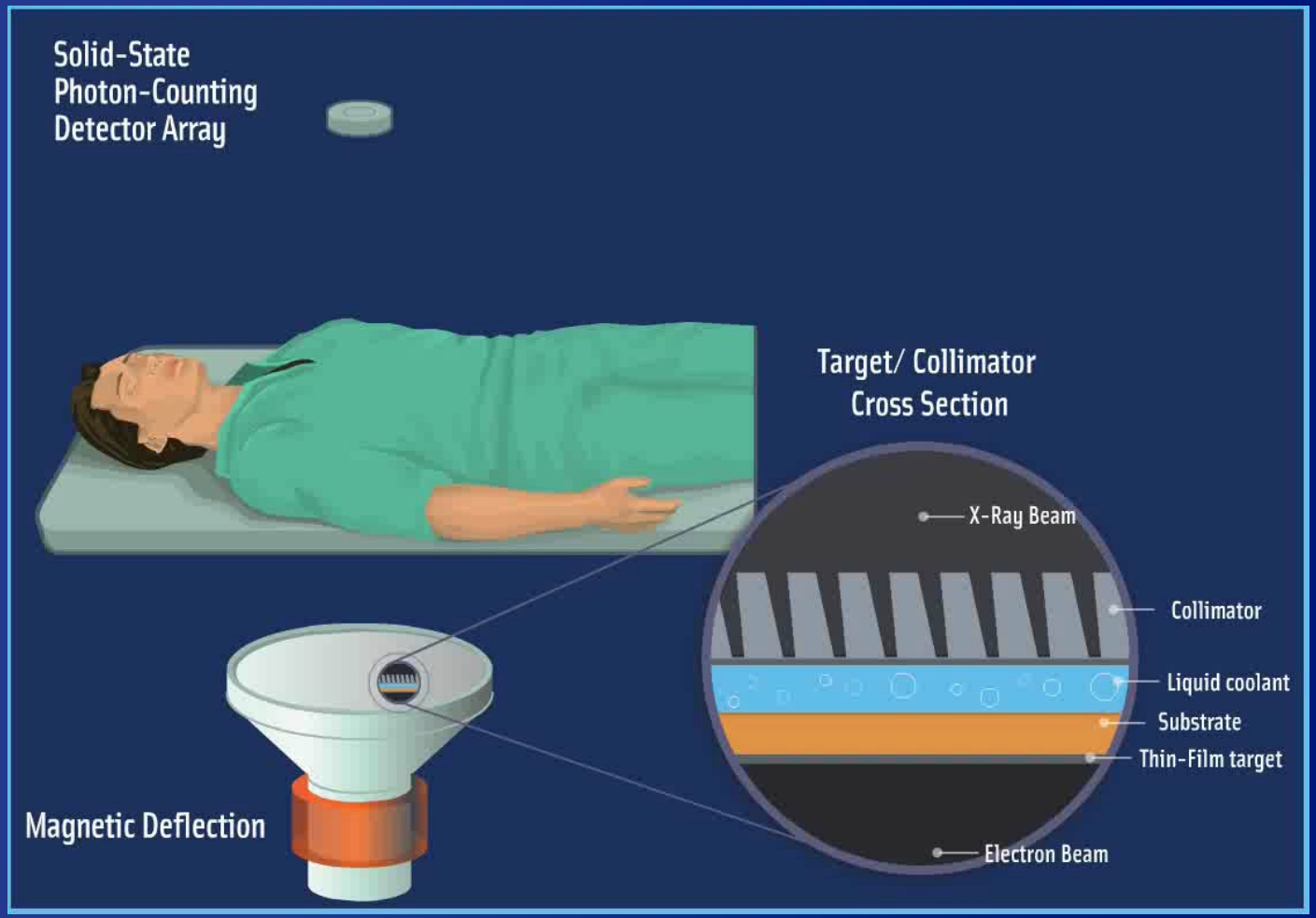
High-power scanning x-ray source



High-speed multi-slice tomosynthesis reconstruction



NovaRay technology



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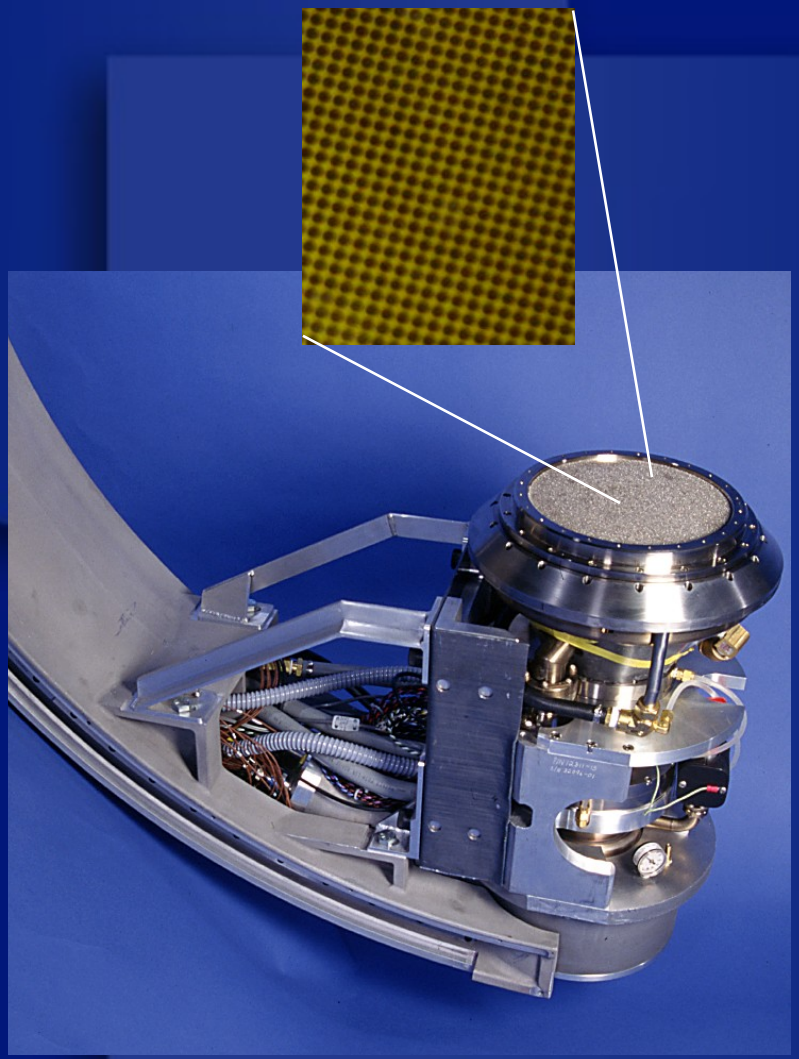
Scanning x-ray source



- 25 kW continuous operation
- 70 kVp - 120 kVp
- 0.4 mm beam spot
- ~100 kW / mm^2
- 23 cm x 23 cm
- 100 x 100 collimator holes
- 1 µs dwell, 0.25 µs move time
- 30 frames per second
- No moving parts in vacuum
- No output decline over time

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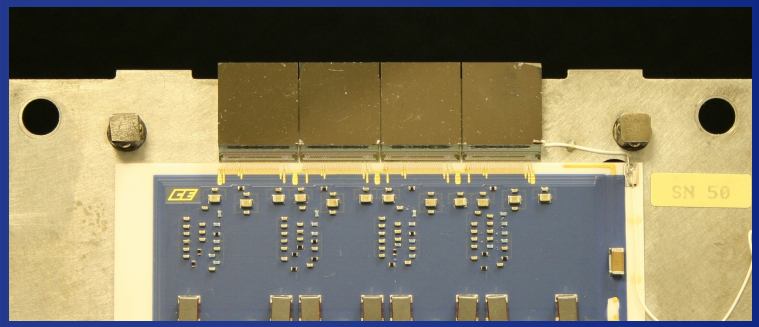
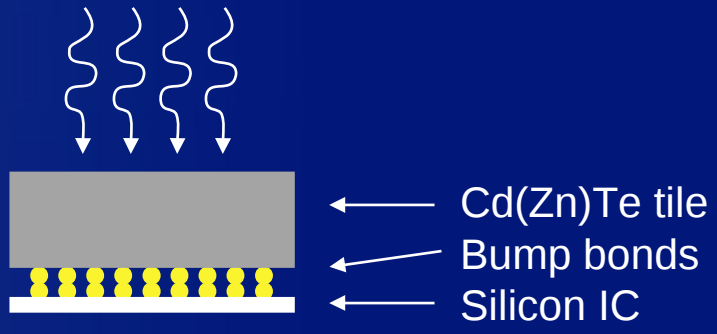
Photon-counting detector





Detector hybrid cross-section

- Solid state, room temperature detector
- Photon counting
  5×10^6 photons / sec / mm^2
- 1.25 µs cycle time
- High-efficiency 90% DQE(0)

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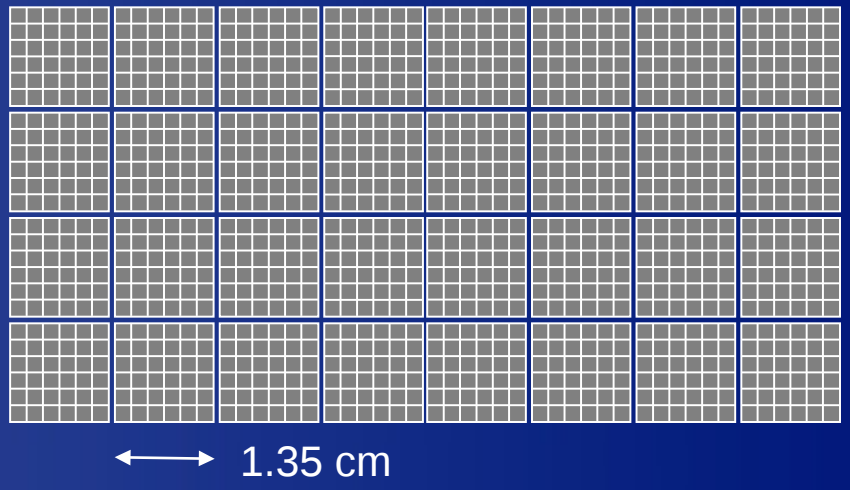
Photon-counting detector array

4 x 8 array of detector hybrids



- 5.4 x 10.8 cm active area
- 0.33 mm pixel
- 160 x 320 (51,200) detector elements
- 100x100x160x320 = 5×10^8 “rays”

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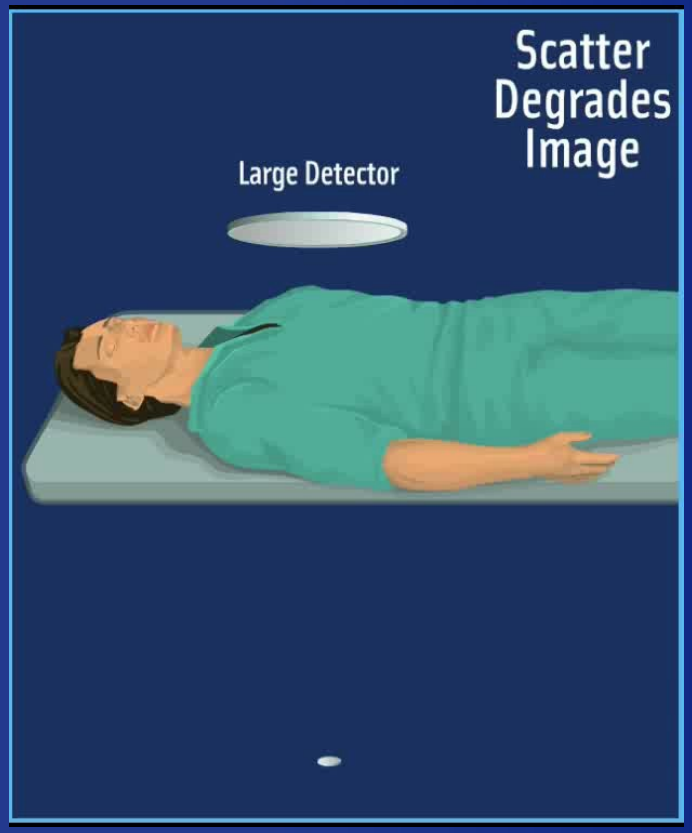
Image-Reconstruction Requirements

- Back projection reconstruction algorithm
- 40 Gbit / sec input from 640 x 320 sensor array
  - Condensed to 10 Gbps for our case
- 1 Gpixel / sec image reconstruction
  Multiple 1,000 x 1,000-pixel focal planes at 30 fps
- 1M pixel “best-focus” image (SIFT) at 30 fps
- ~1.4 TOPS (for 32 planes)

Low x-ray scatter

Conventional



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Higher signal-to-noise ratio = improved image quality

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Exposure reduction factors

- Five factors contribute to exposure reduction
  - Low x-ray scatter
  - No anti-scatter grid
  - Higher detector efficiency
  - Adaptive scanning (new)
  - Larger entrance area

Unique multi-slice tomography

Conventional

Shadowgram

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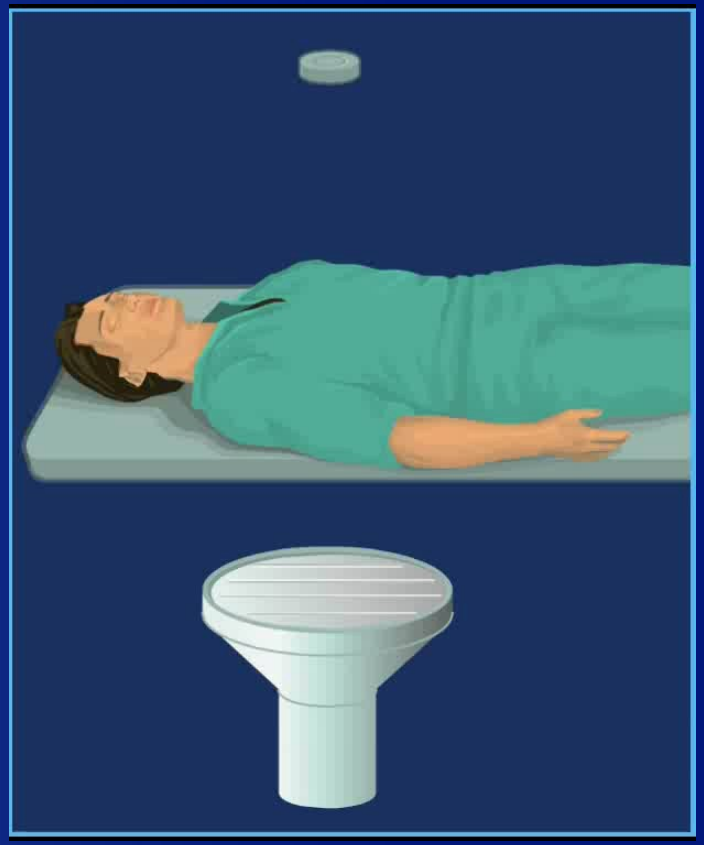
Reconstruct multiple slices



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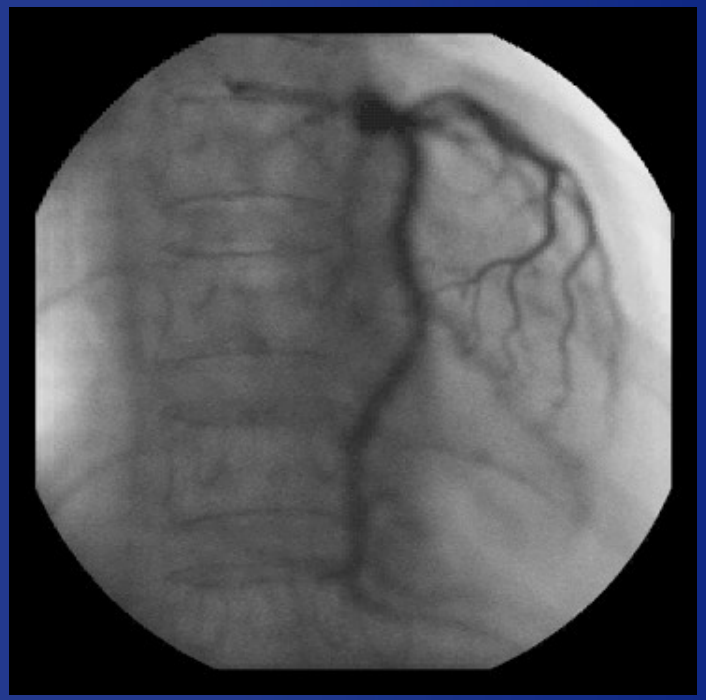
Single-slice imaging



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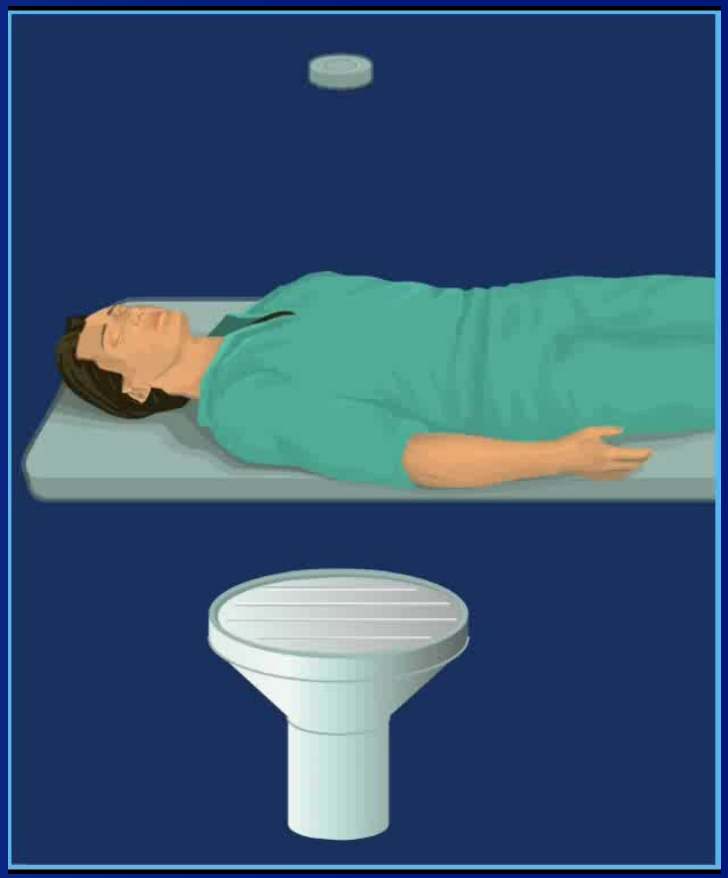

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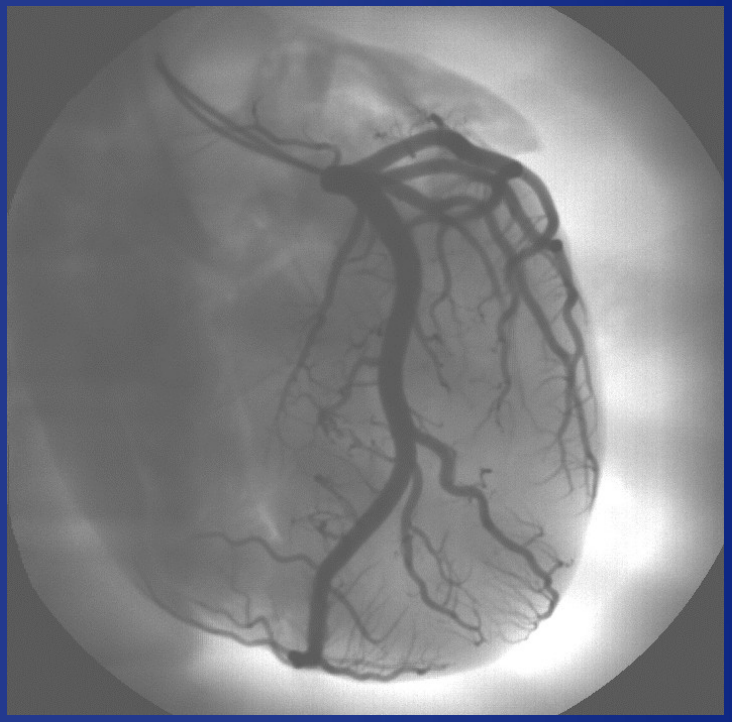
Volume imaging



Anatomical clutter removed

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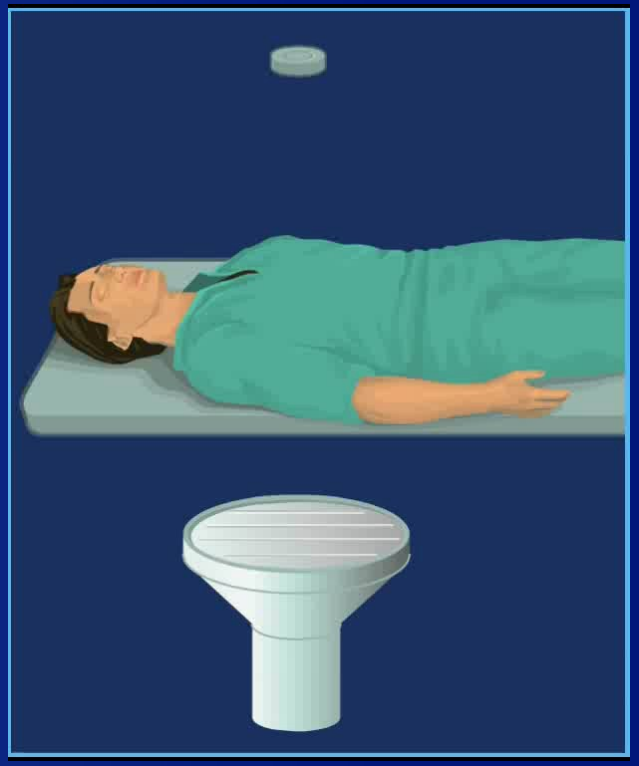

Selectable slices

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