A Personal History

A Career in Medical Imaging: Large and Small Companies

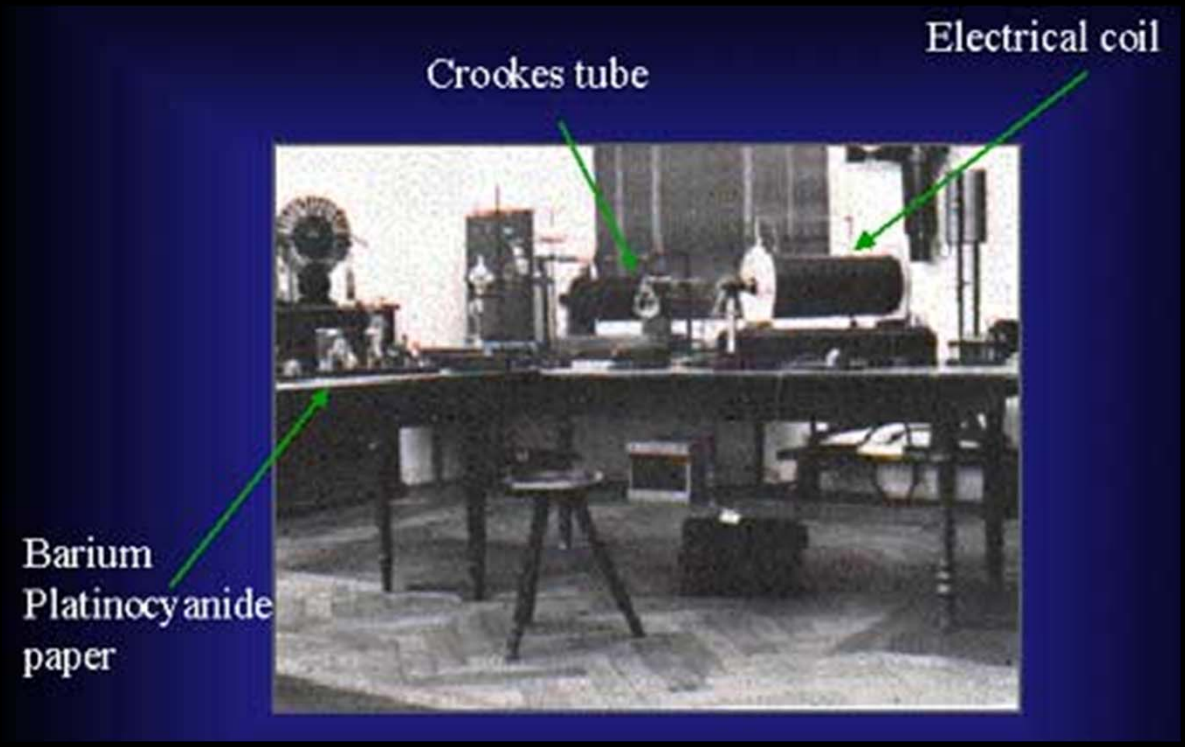
Lonnie Edelheit
Senior Vice President
Research & Development
General Electric Co. – Retired

University of Illinois April 4, 2014

Objectives

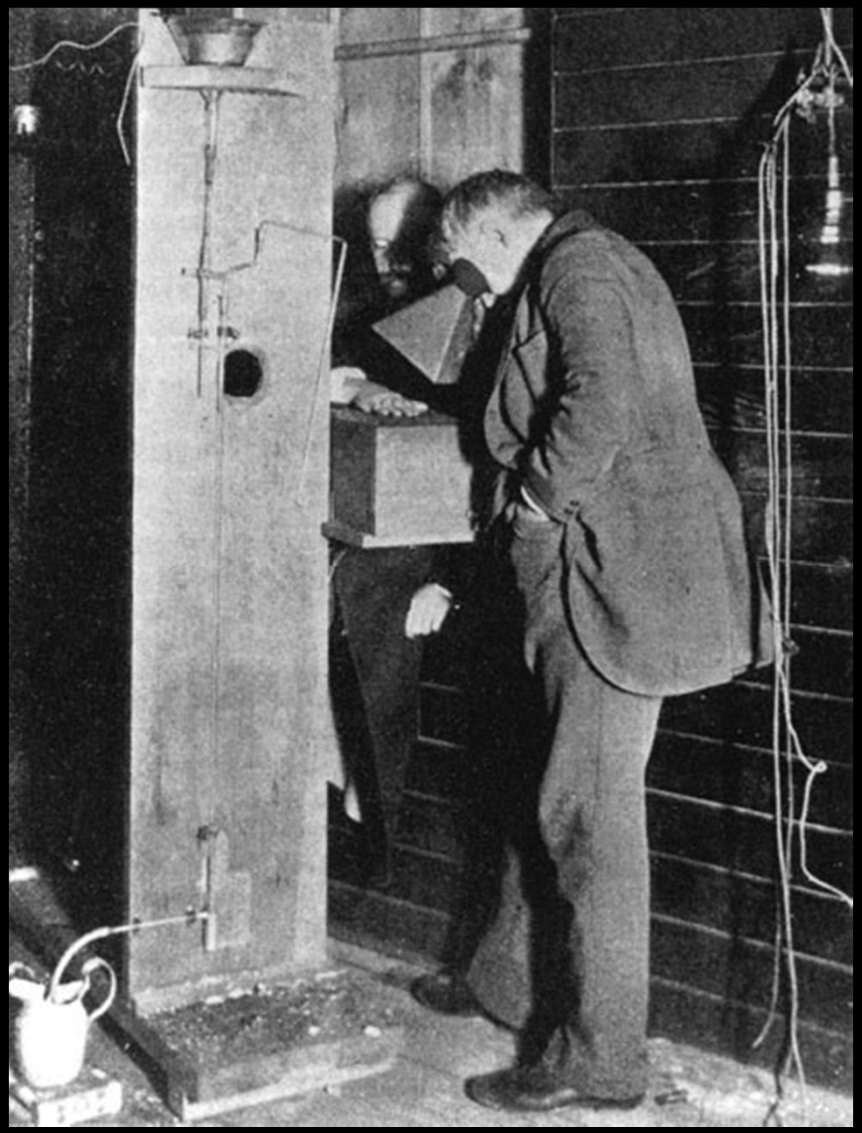
1. Summarize medical imaging technology
2. Describe personal experiences in commercialization of technology
3. Discuss lessons learned and values
4. Answer questions

Roentgen Discovers the X-Ray – 1895



Roentgen's Wife's Hand – 1895

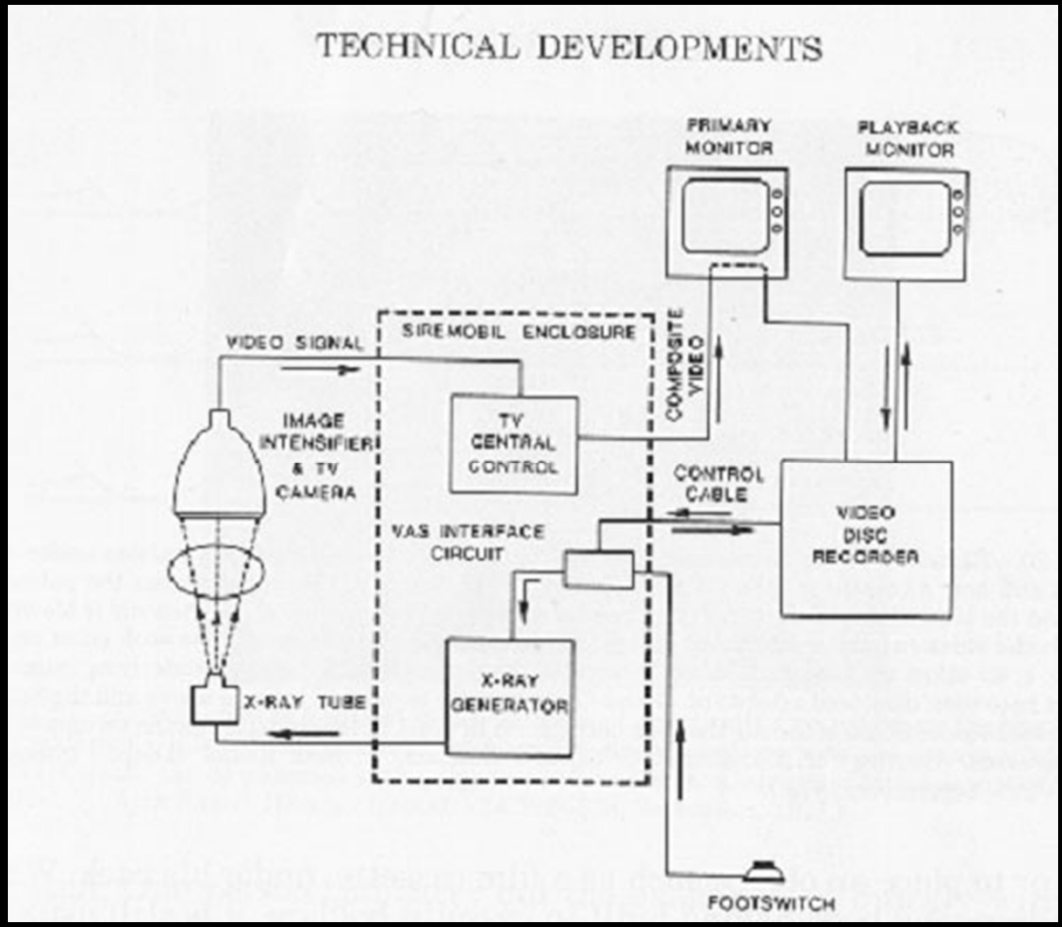
Edison Examines Hand With Fluoroscope



Coolidge Handles First Modern X-Ray Tube

1970's X-Ray Room

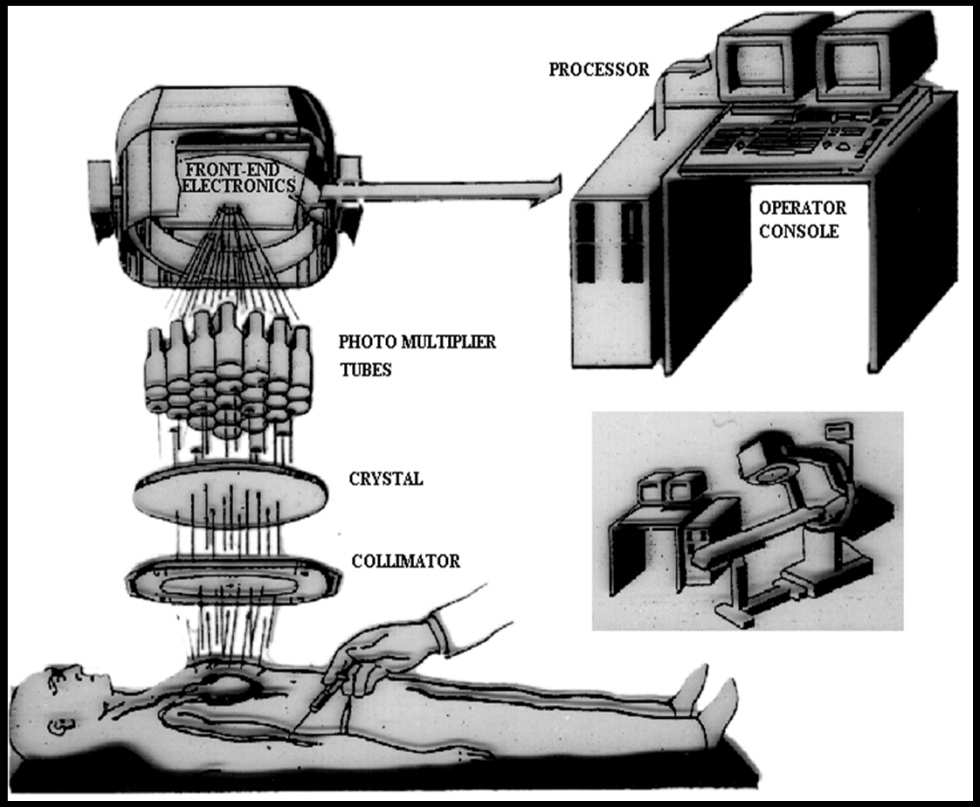
- Video and image intensifiers replace phosphor screens and dark glasses
- Better X-Ray Tubes
- Safer, but . . .



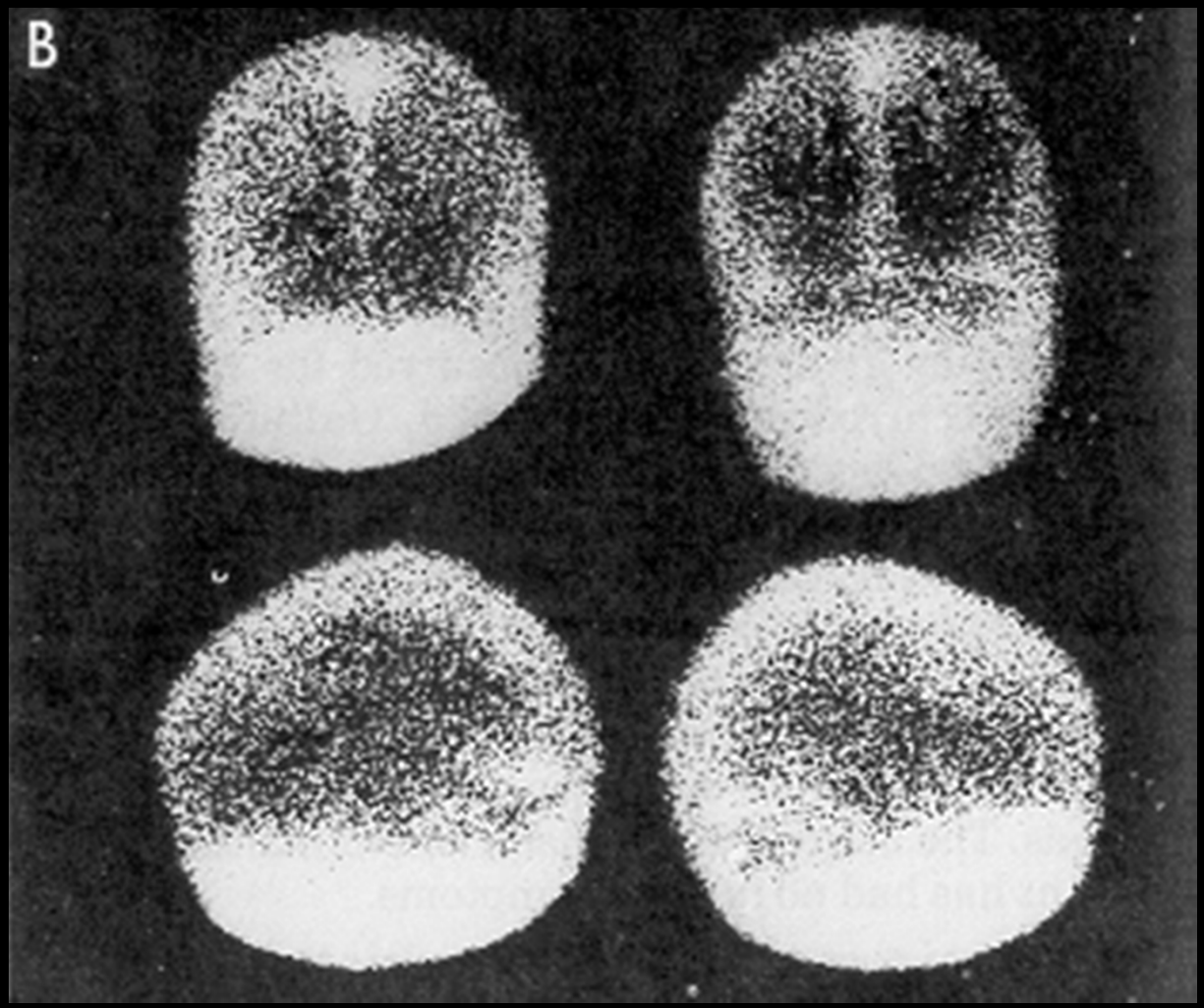
Roentgen would recognize images

Nuclear Pioneers

- *Lawrence: First medical isotopes, 1935*
- *Sokoloff: Cat brains, 1955*
- *Gamma camera, 1968*



Early Nuclear Image: ^{99m}Tc of Brain – 1976



Early Ultrasound

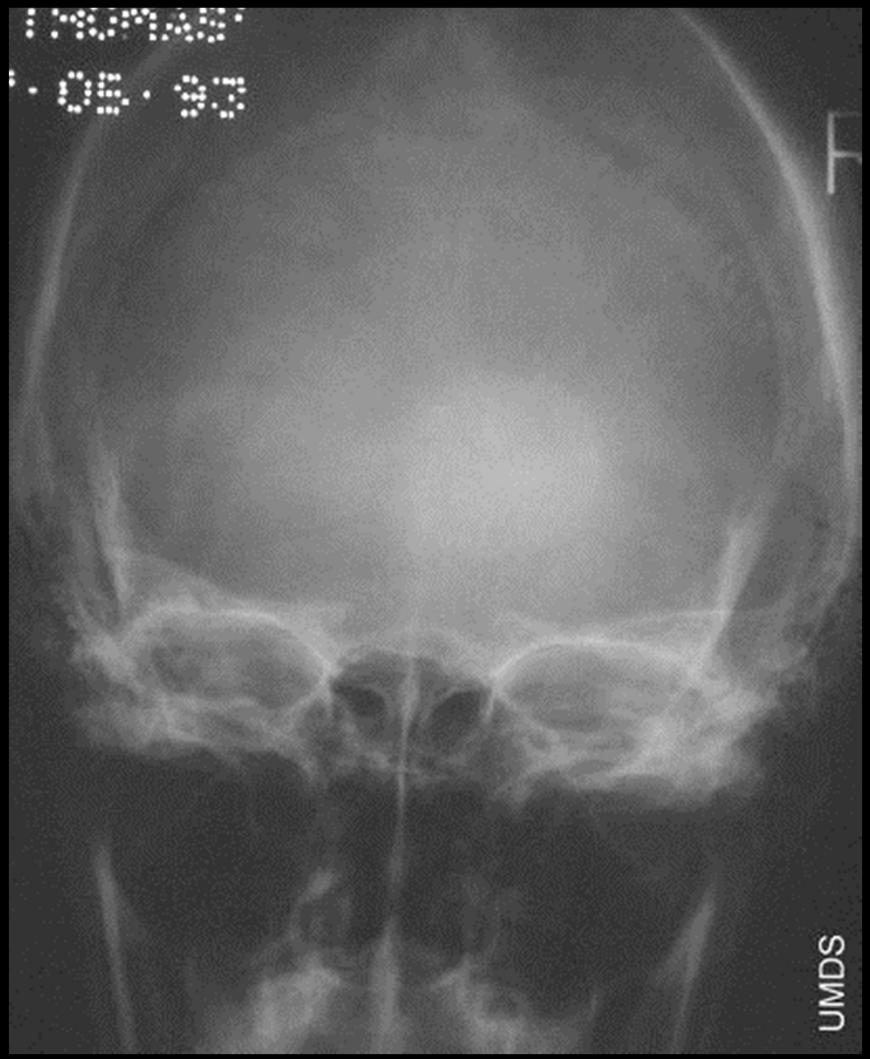
Breakthroughs made using WWII sonar technologies

Image of Neck – 1975

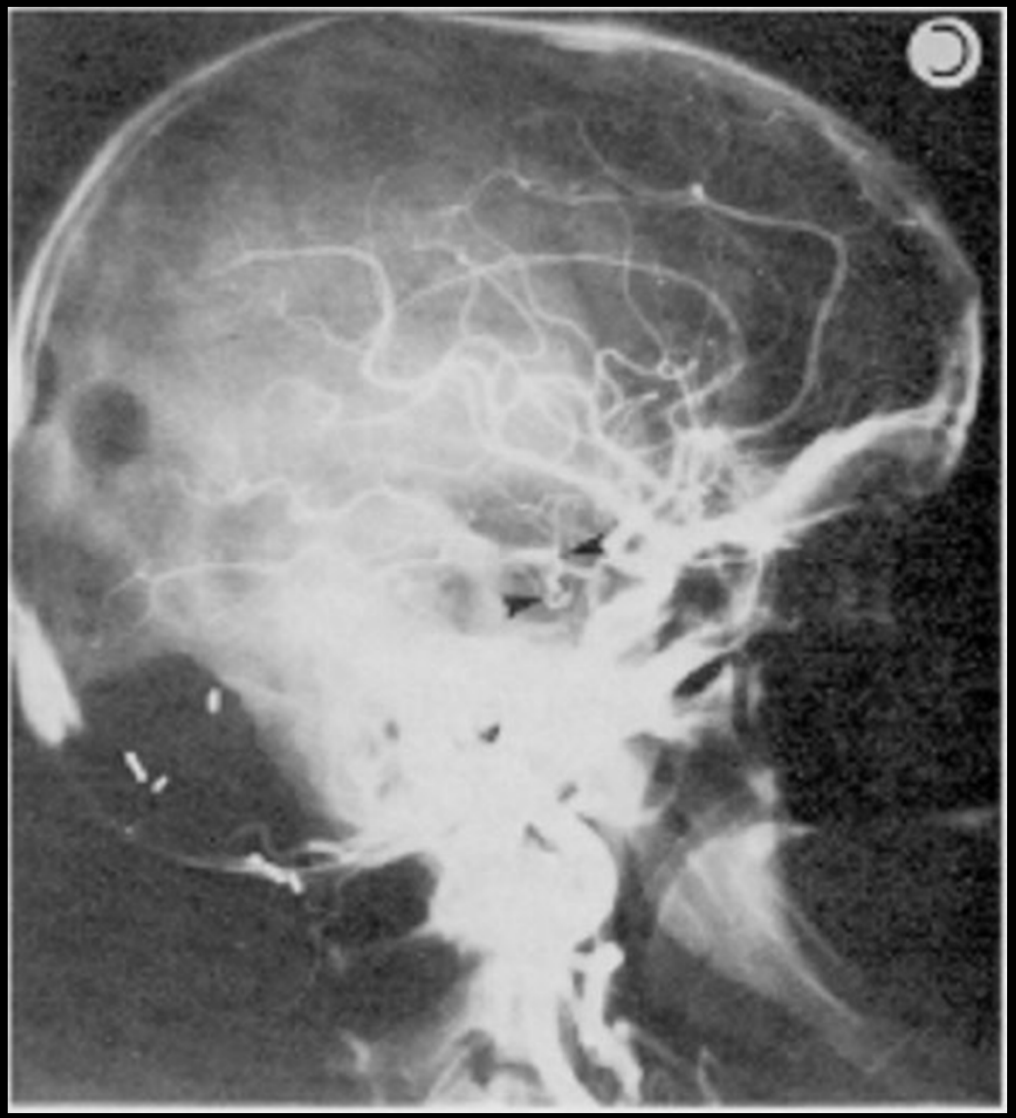
Personal Experience from 4 Game Changers

1. CT
2. MRI
3. Color-Flow Ultrasound
4. Digital X-Ray

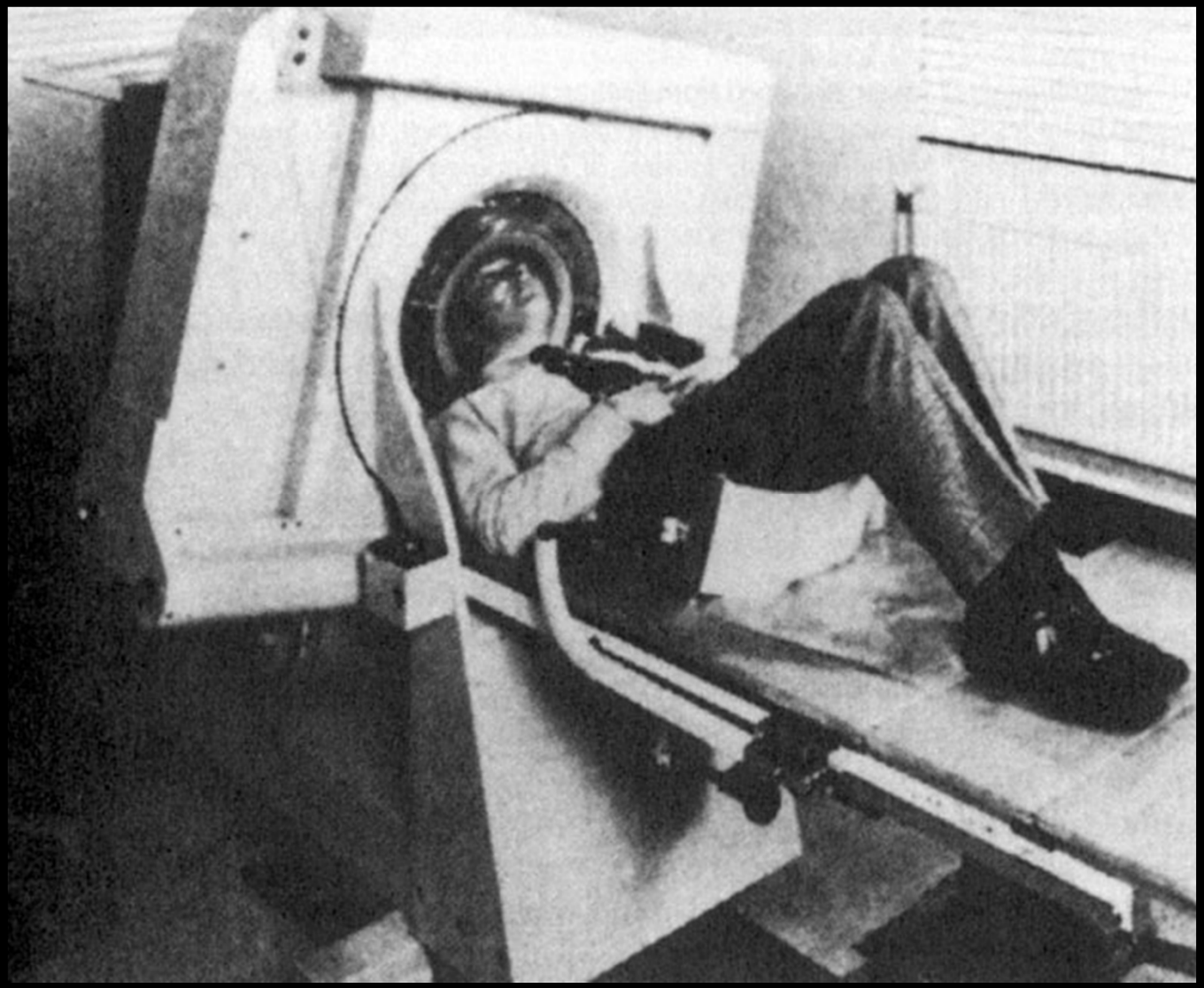
X-Ray Image of Skull

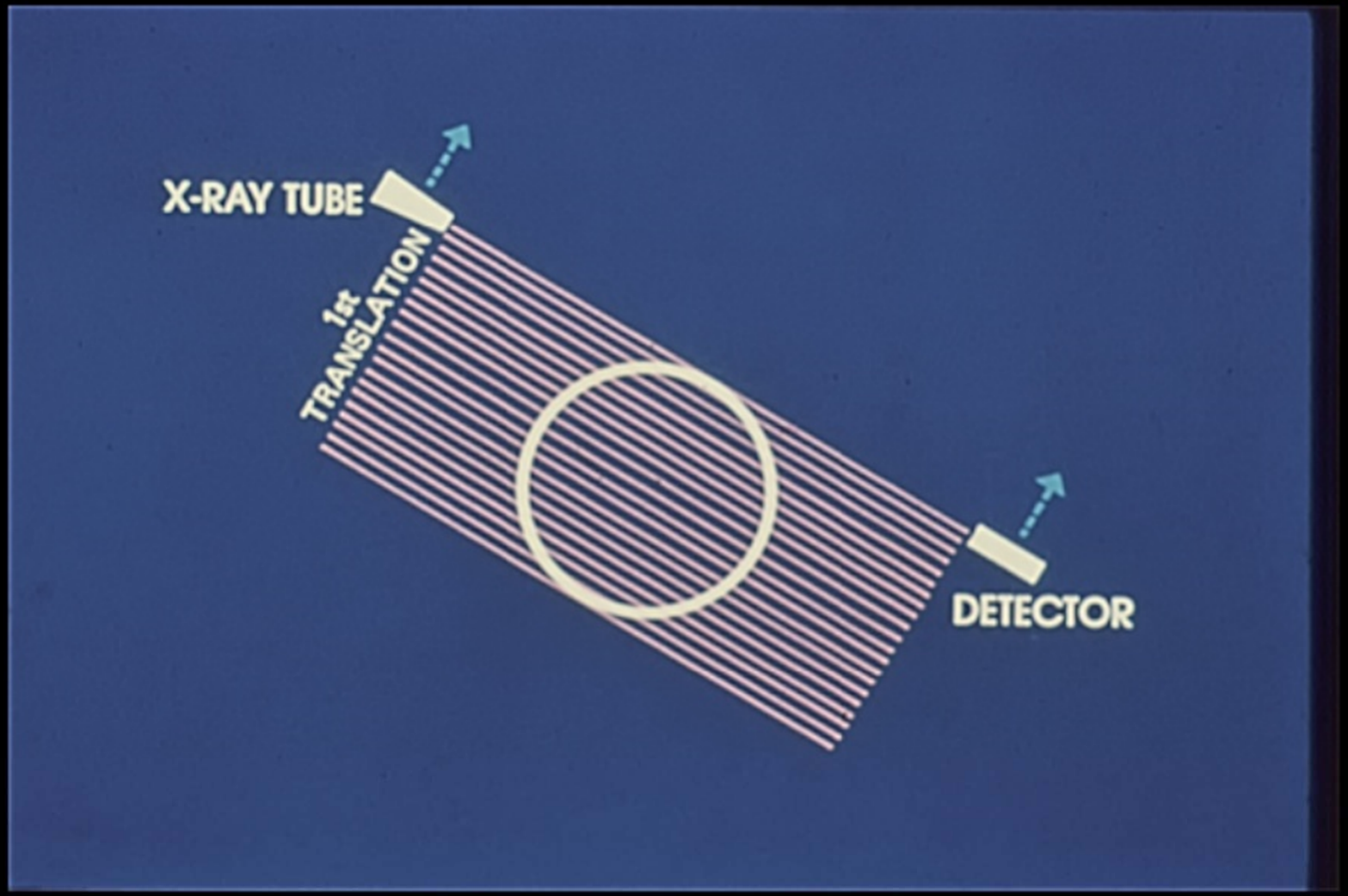


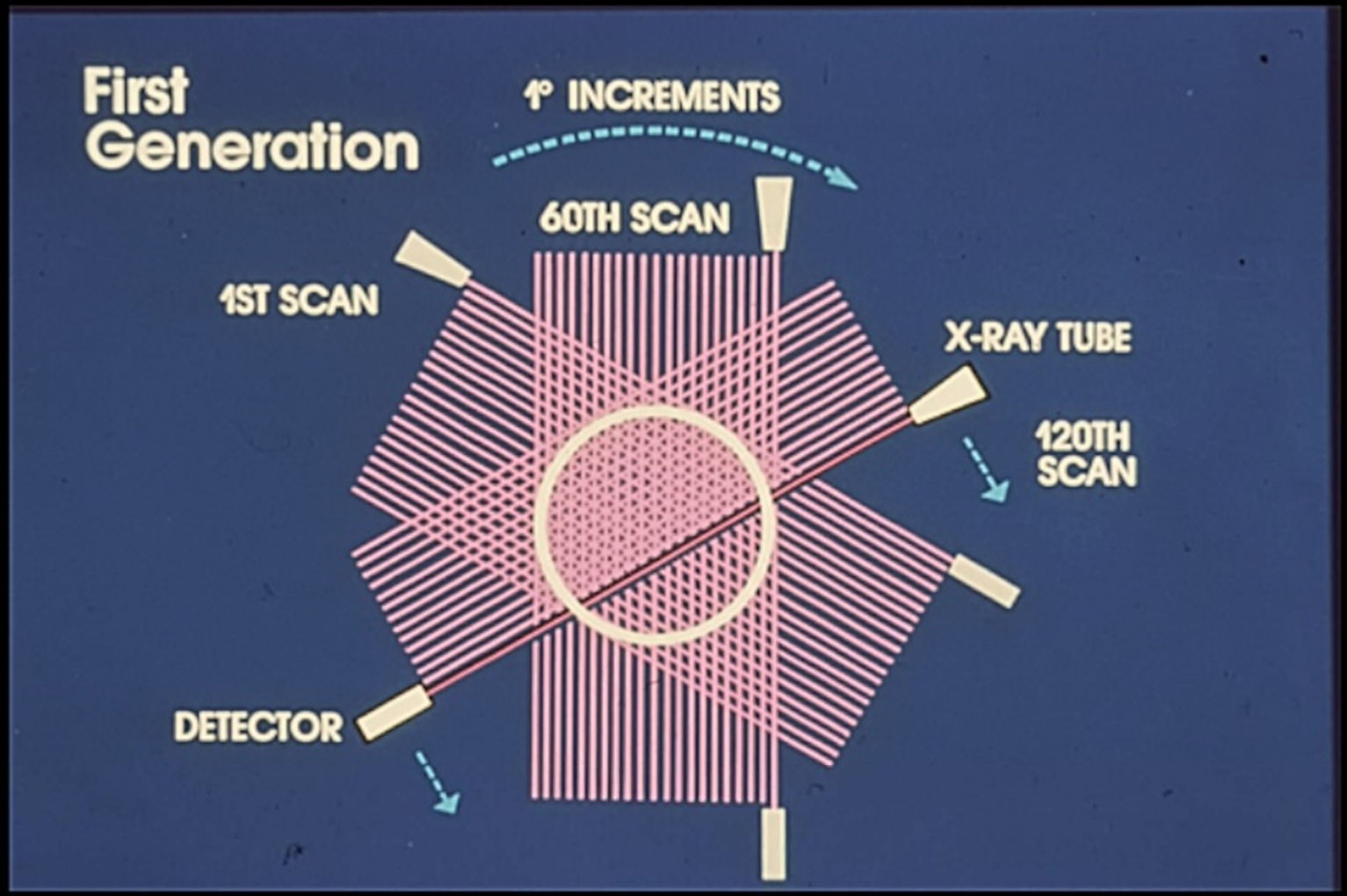
Neuro Angiogram



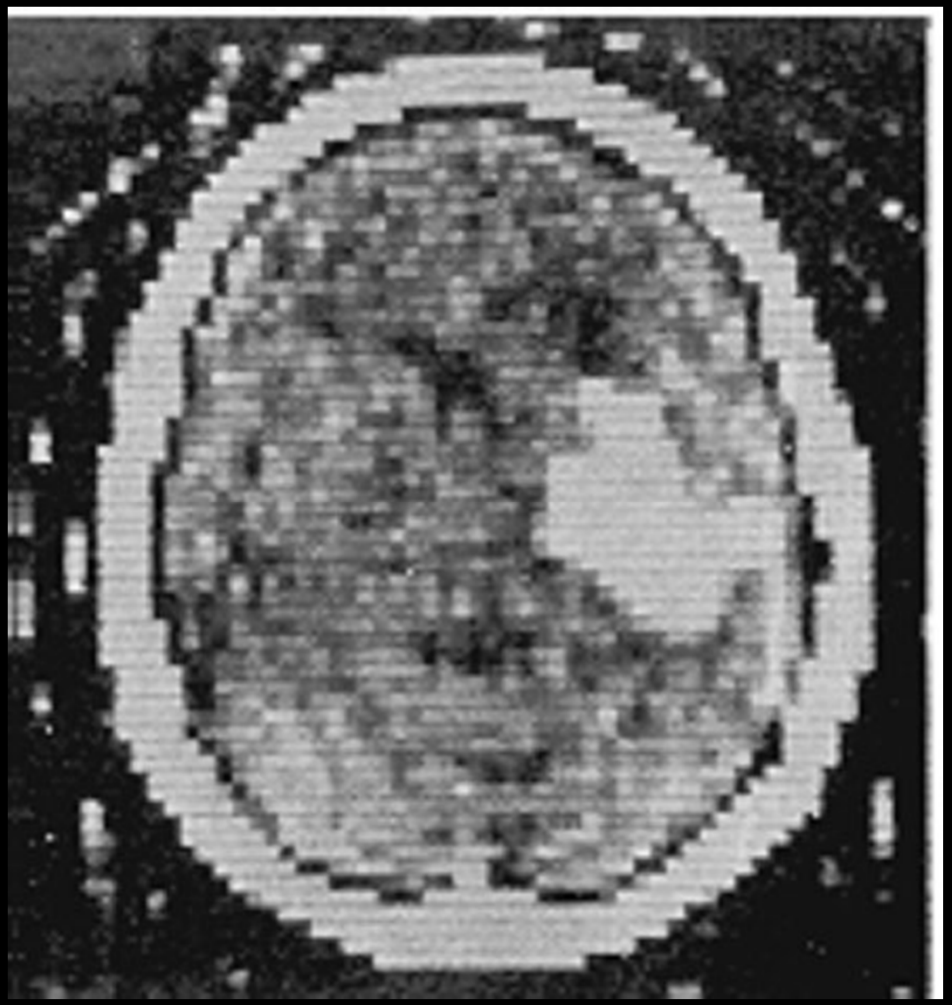
Hounsfield Invents the CAT Scan – 1971




X-RAY TUBE
1st TRANSLATION
DETECTOR

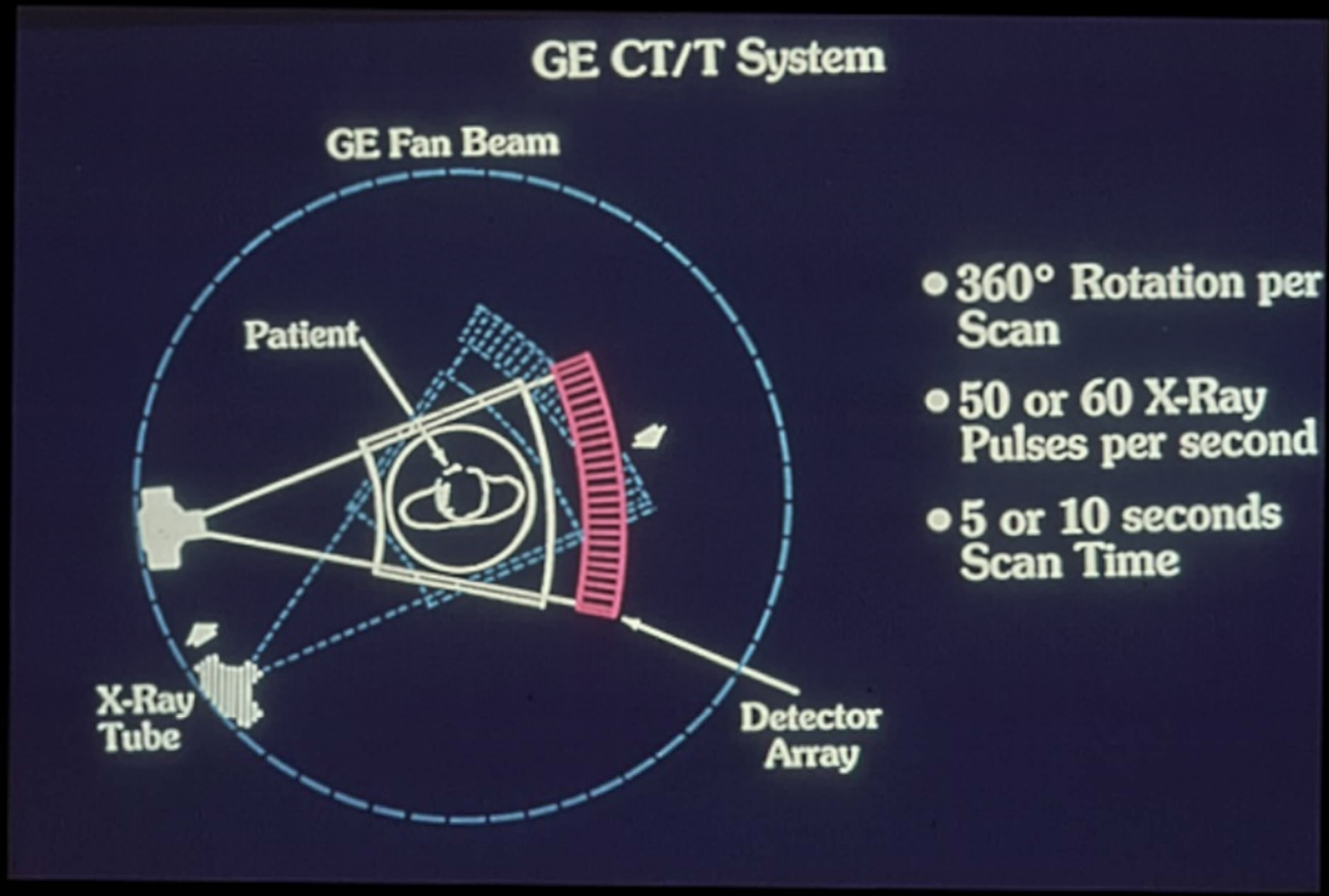

First Generation
1° INCREMENTS
60TH SCAN
1ST SCAN
X-RAY TUBE
120TH SCAN
DETECTOR

Early CT Brain Image – 80x80 Pixels

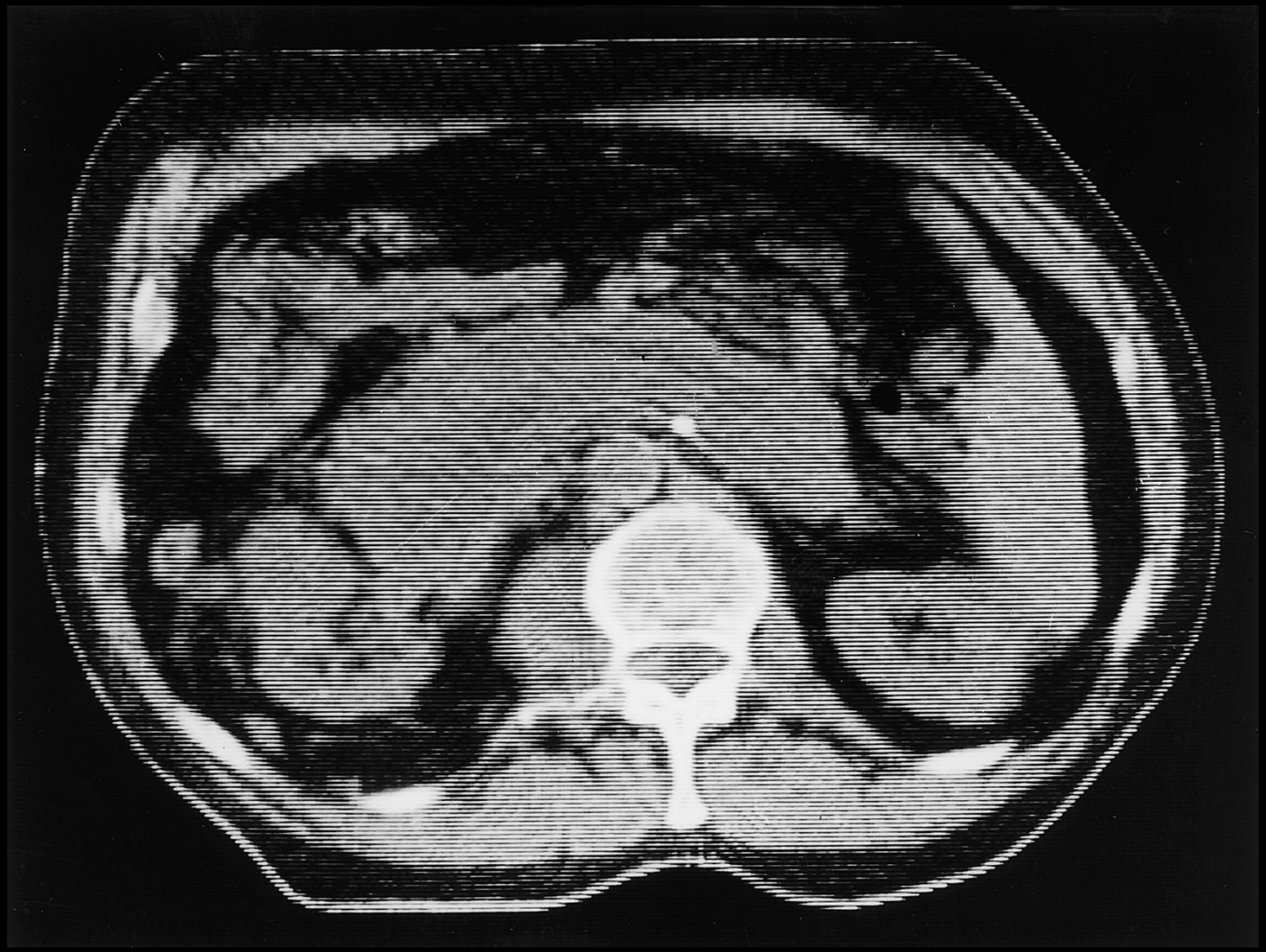


The First “Magic” Picture of the Digital Age

Fan Beam CT


GE CT/T System
GE Fan Beam
Patient
X-Ray Tube
Detector Array
• 360° Rotation per Scan
• 50 or 60 X-Ray Pulses per second
• 5 or 10 seconds Scan Time

10-Second CT Image of Abdomen – 1976

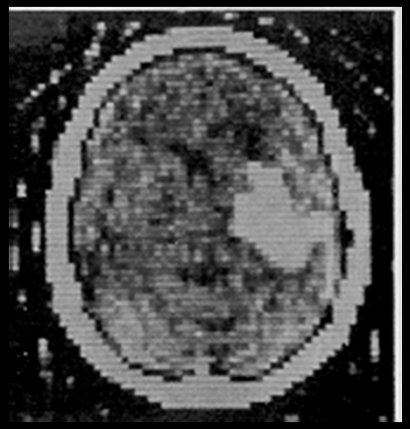


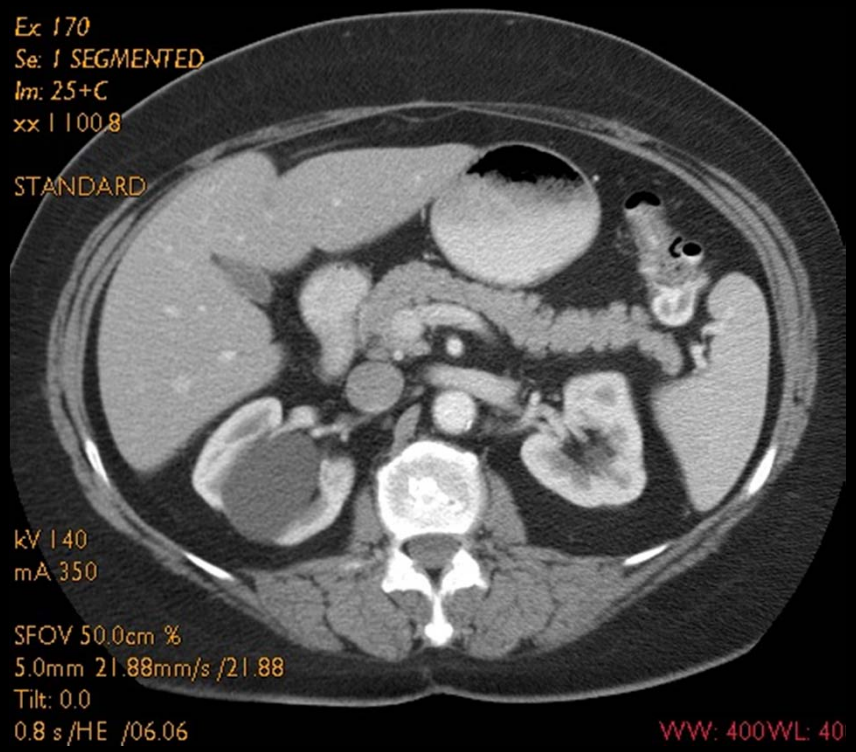
Lonnie Edelheit's Role

- **Position**: Individual contributor scientist at Corporate Research Lab in barely related field
- **Role**:
  - Technical project manager at Corporate Research Lab
  - Technical evangelist
  - Engineering leader in business
  - CT business leader

Now a Multi-Billion Dollar Business

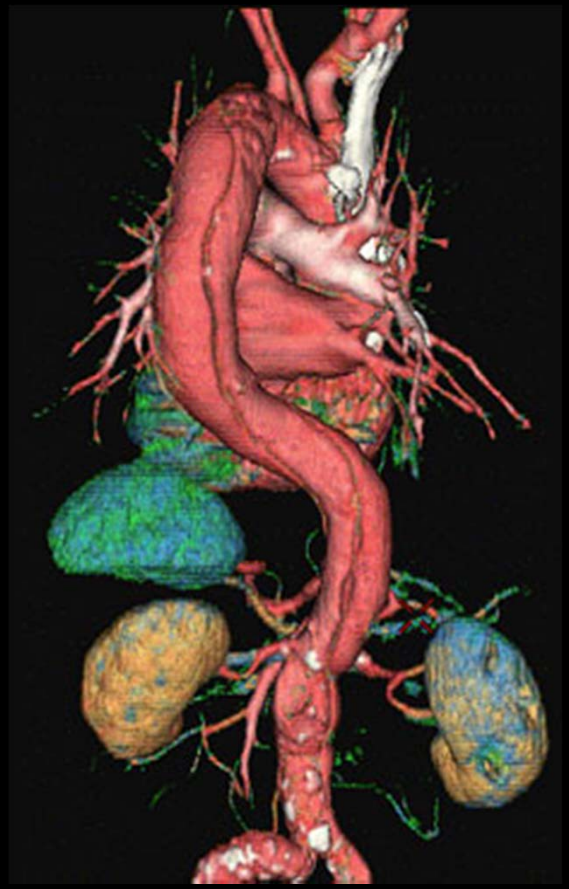
Progression of CT Computer Power





Moore's Law at Work

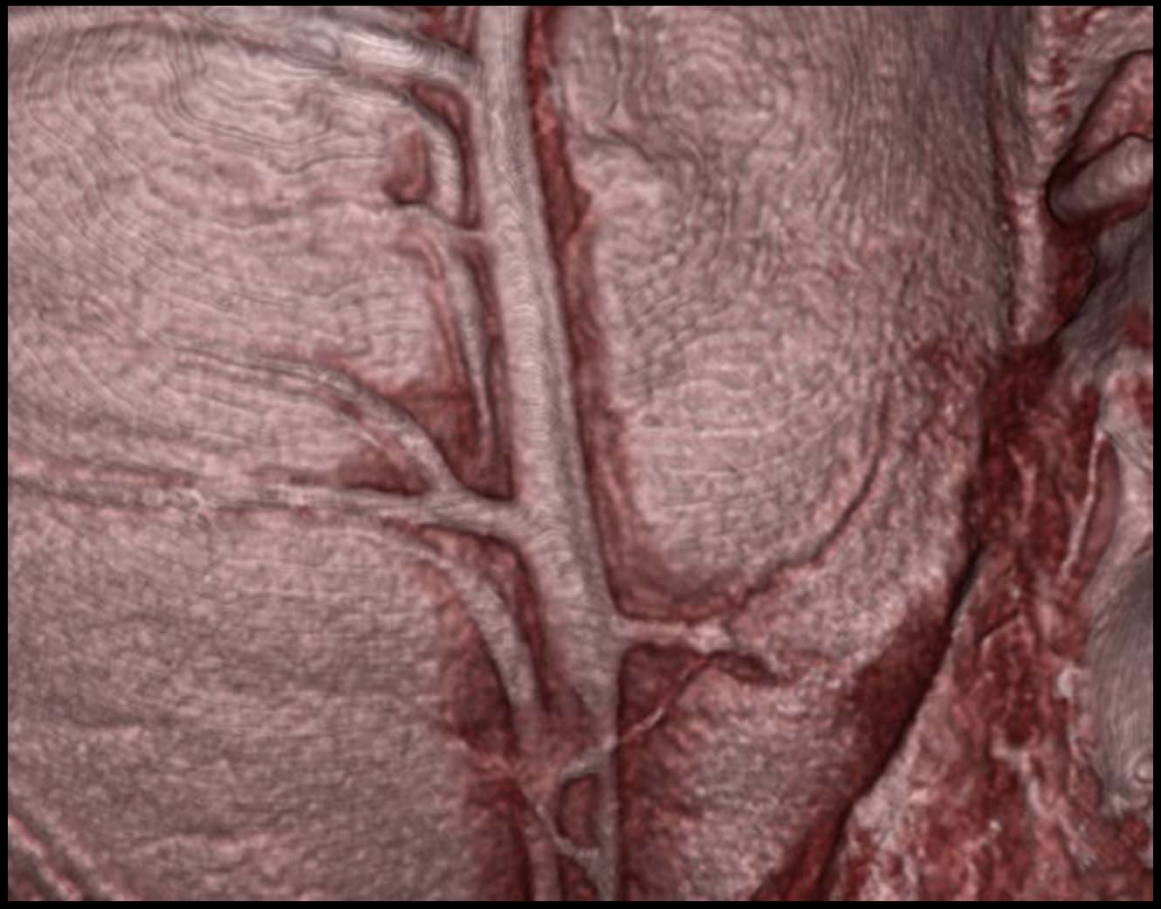
Modern CT



MultiSlice CT

Future CT – Potential for Cardiac CT

Canine Heart (not beating)



100 um resolution

Still A Long Way to Go, But a Huge Payoff

Cardiac exam 0.9 mSv[1]

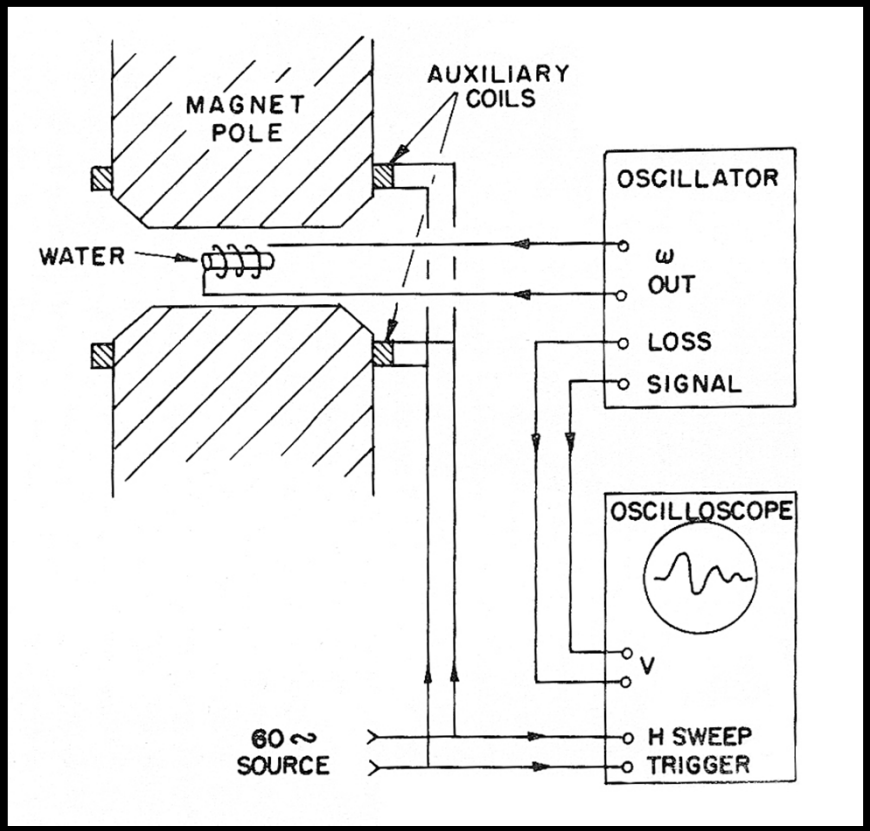
1. Obtained using a chest factor of 0.014*DLP

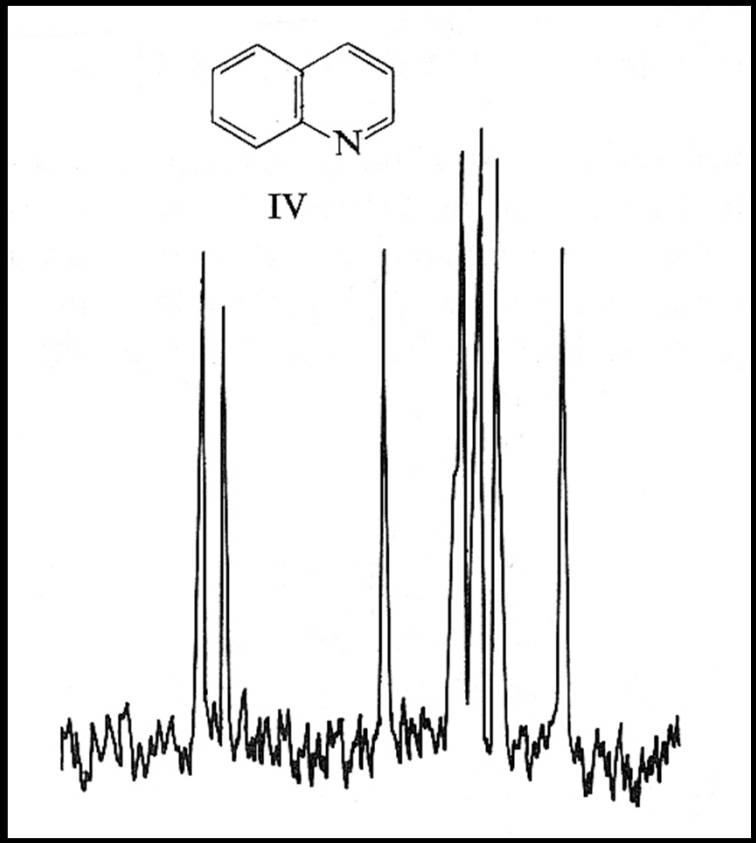
imagination at work

Personal Experience from 4 Game Changers

1. CT
2. MRI
3. Color-Flow Ultrasound
4. Digital X-Ray

NMR Lab and Spectra





Purcell (Harvard) and Bloch (Stanford) measure NMR in matter – 1946

Brilliant Forecasting

GE Internal Memo

September 1, 1977

To: **JC Truscott**
From: **L.S. Edelheit**
Subject: **ZEUGMATOGRAPHY**

I have just spent a couple of days . . . discussing Zeugmatography. To be honest, the results are not very encouraging.

Imaging mouse lungs is not very important medically.

. . . I see no major hope for this as a product.

Lonnie

Now a $3+ Billion Market

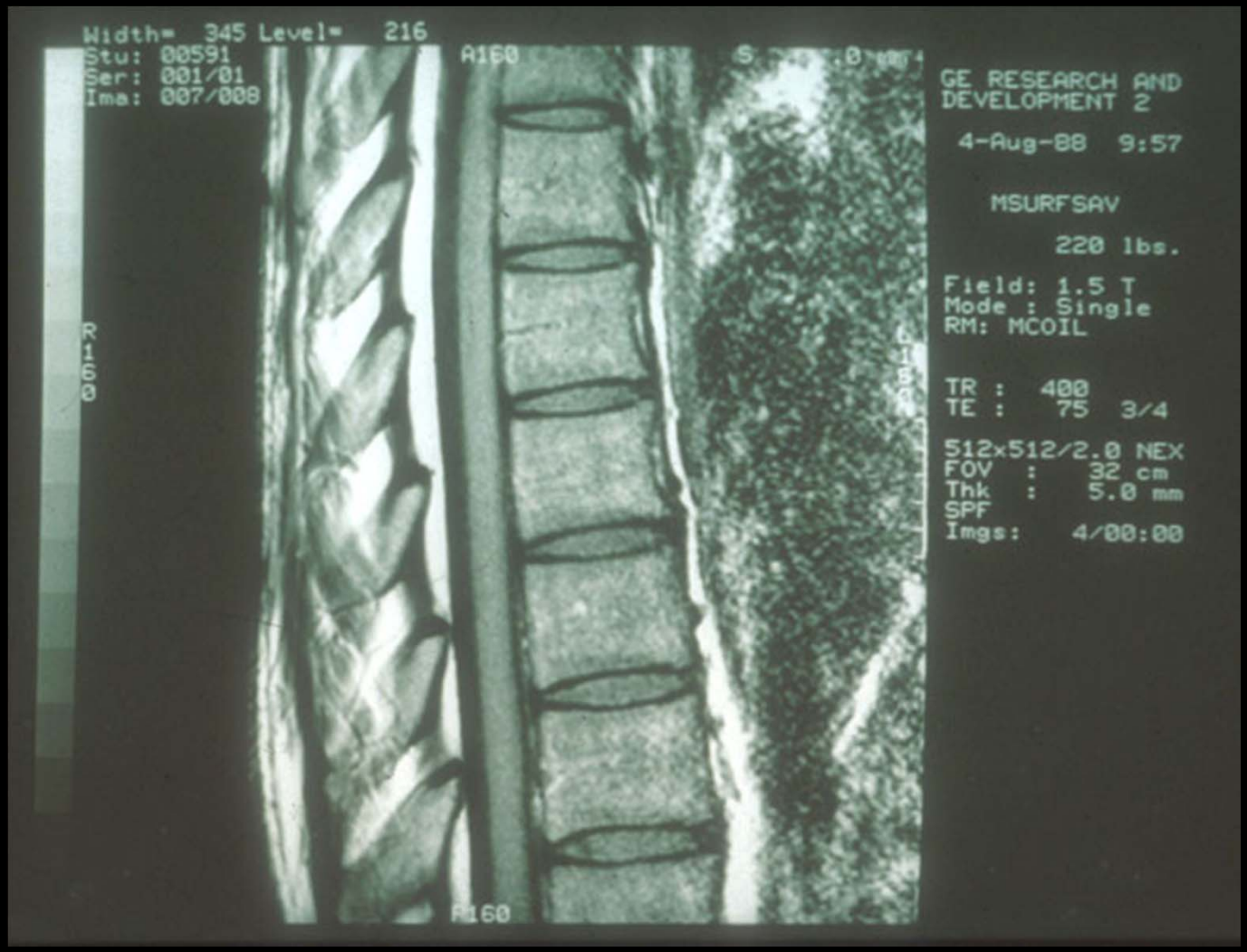
Early MR/NMR of Chest – 1980

Lonnie Edelheit's Role

- **Position**: Leading CT Technical Development Worldwide
- **Role**:
  - Developing worldwide product plan
  - Driving rapidly changing evolutionary business with vicious competition
  - About to be made business leader
  - Growing career in core business

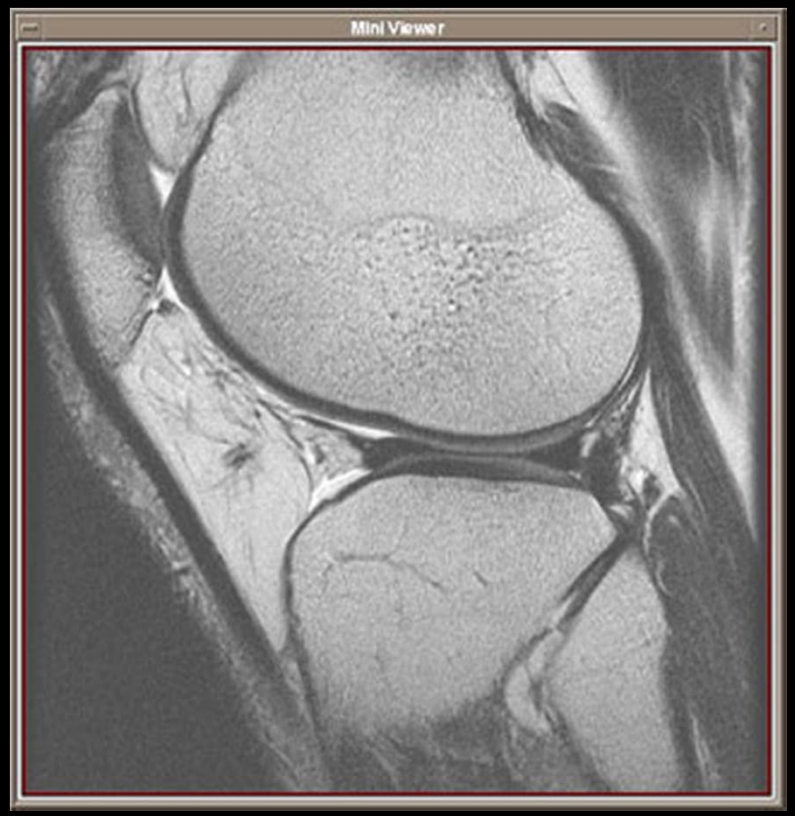
Very Competitive and Very Focused

Modern MRI



Spine Image with 10 Element Phased Array

Future MRI – High Field MRI (3 Tesla)



Knee

Spine

Even Higher Magnetic Field May Add Value

Additional Imaging Modalities

- *Positron Emission Tomography (PET)*
- *Thermography*
- *Magnetic Field Imaging*
- *Electric Field Imaging*
- *Optical Imaging*
- *Very Fast CT*
- *Thermo-Acoustic Imaging*
- *Microwave Imaging*
- *etc.*

Still Waiting for “Magic” Picture

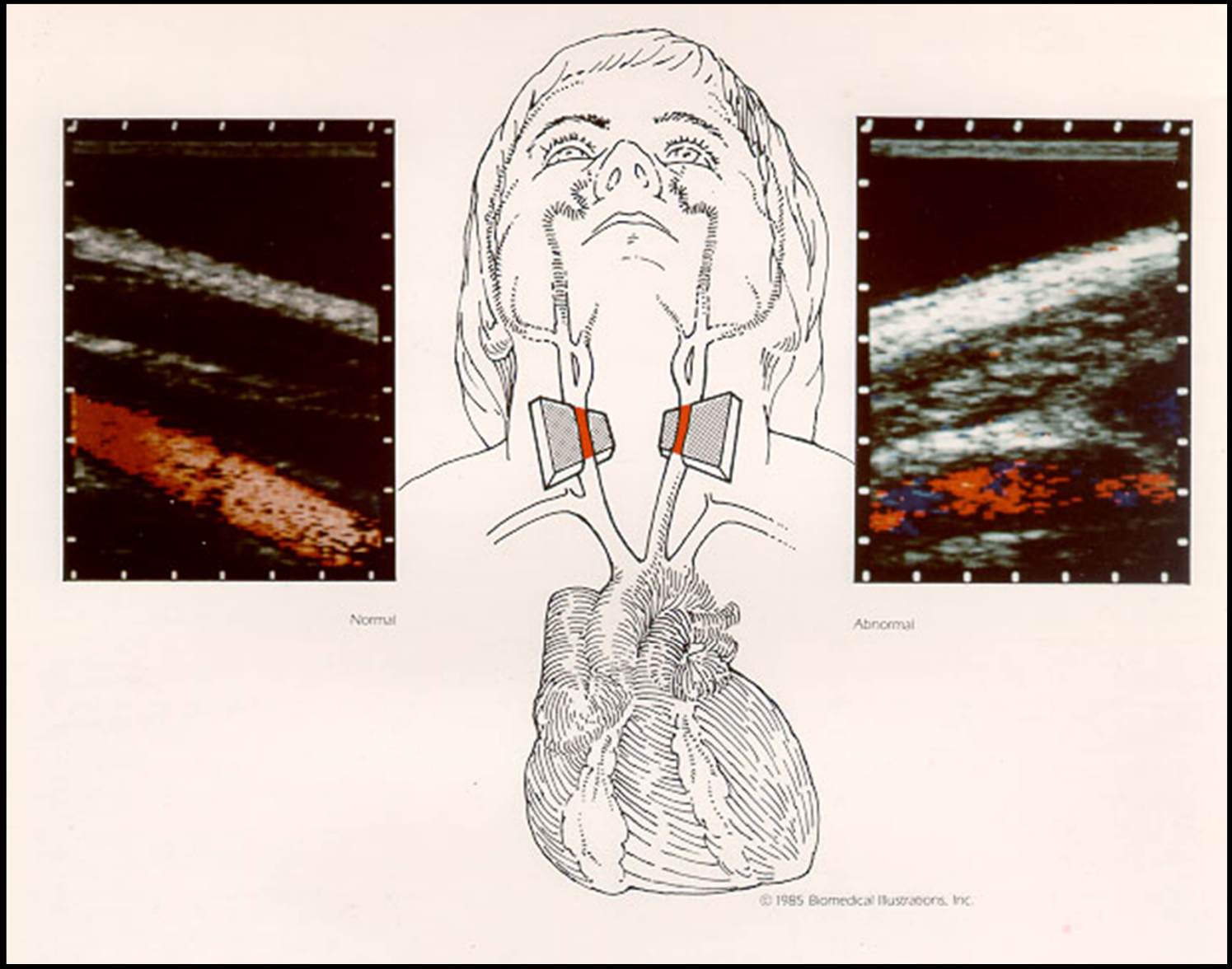
Personal Experience from 4 Game Changers

1. CT
2. MRI
3. Color-Flow Ultrasound
4. Digital X-Ray

Modern Ultrasound

3-D Ultrasound View – Improved Surface Rendering

Quantum



Lonnie Edelheit's Role

- **Position**: CEO, Quantum Medical Systems
- **Role**:
  - Raise venture capital
  - Be first to market
  - Stay away from the big guys
  - Create a new market and technology

Very Competitive and Very Focused

Personal Experience from 4 Game Changers

1. CT
2. MRI
3. Color-Flow Ultrasound
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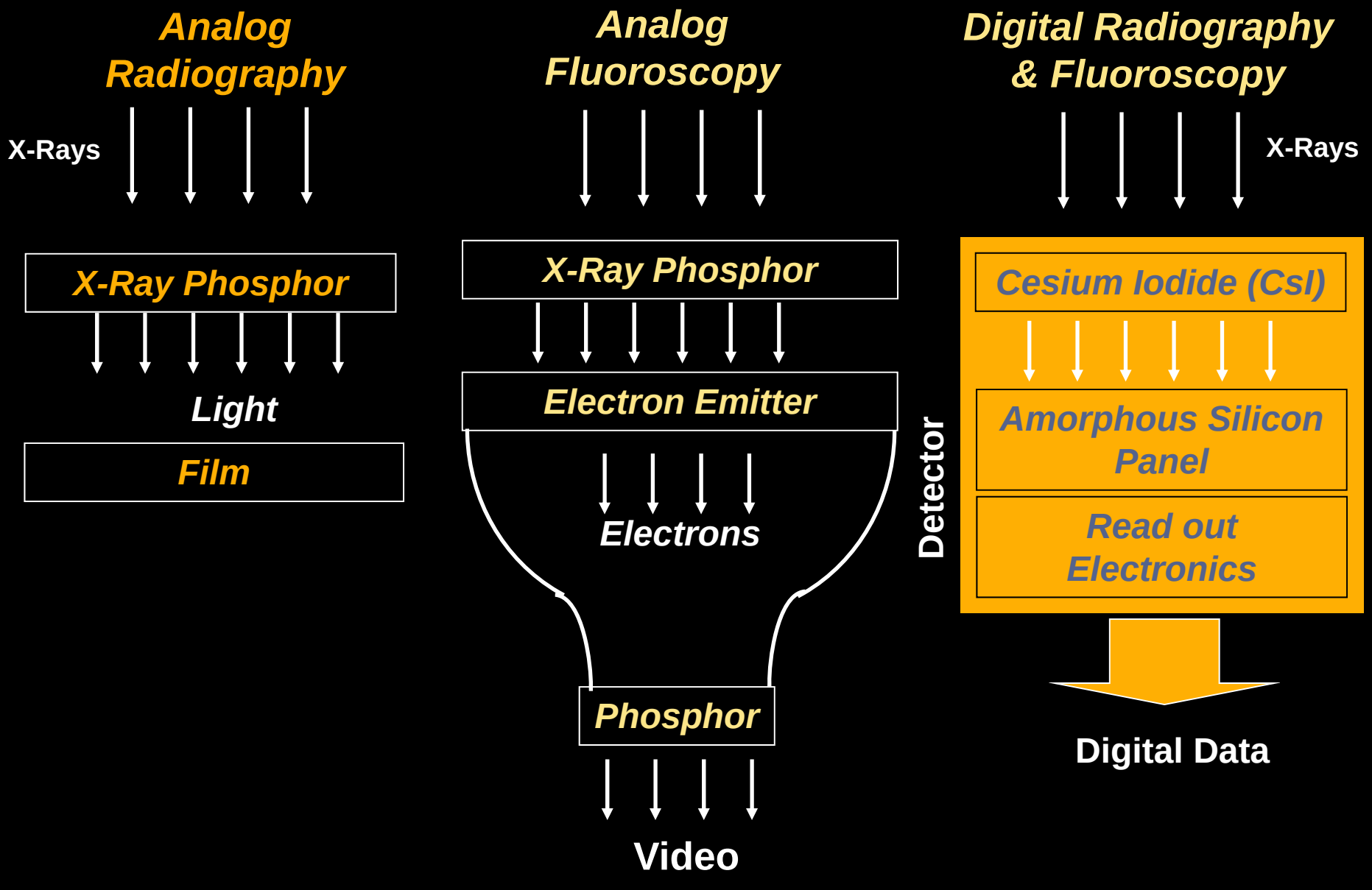
Modern Medical Imaging

- Before 1972: All medical imaging (x-ray, ultrasound, nuclear) is analog
- 1972-1980: CT, MRI, PET invented, fundamentally digital Ultrasound, nuclear become digital
- 1980-2000+: ALL modalities are digital; Moore's Law has dramatic impact

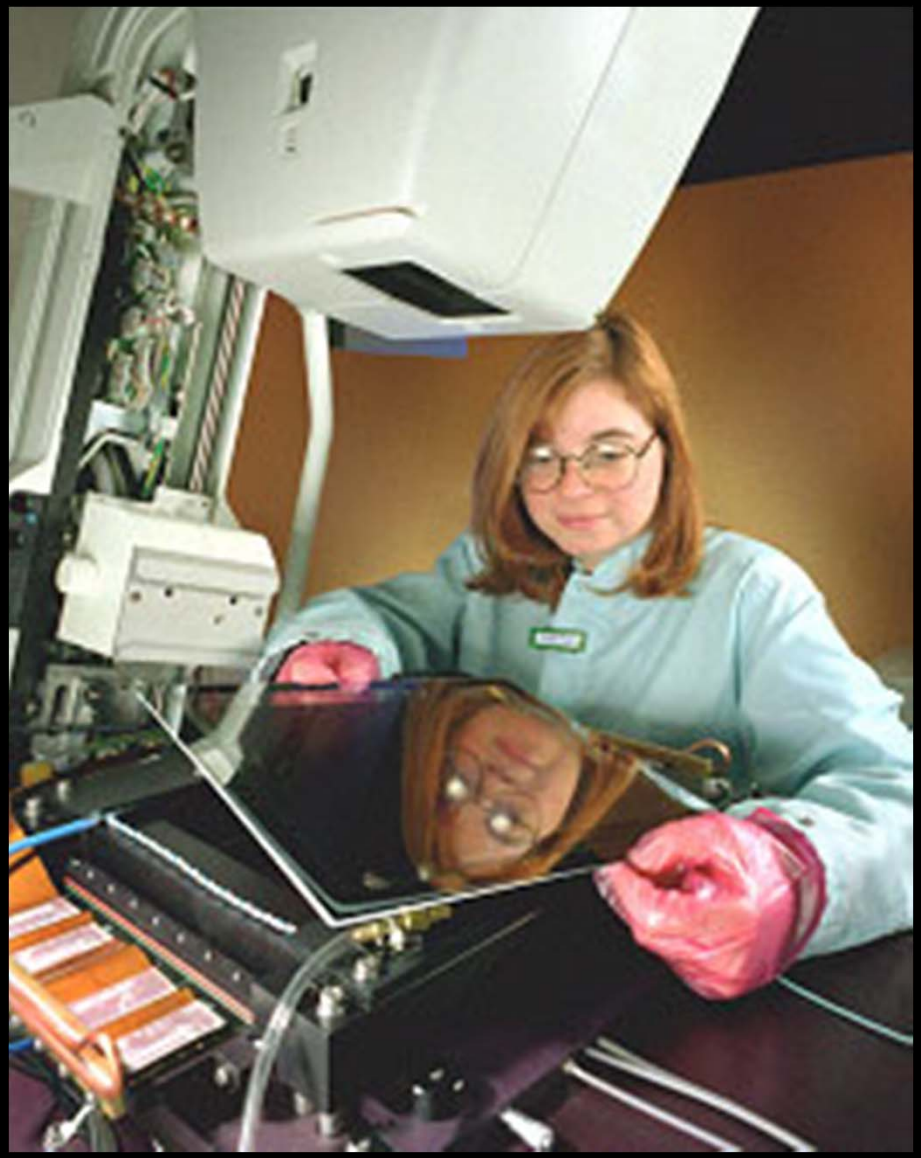
Medical Imaging Explodes

- But, in 2000: One half of all images still analog
  - Radiographs—Film
  - Fluoroscopy—video

Finally: Digital X-Ray

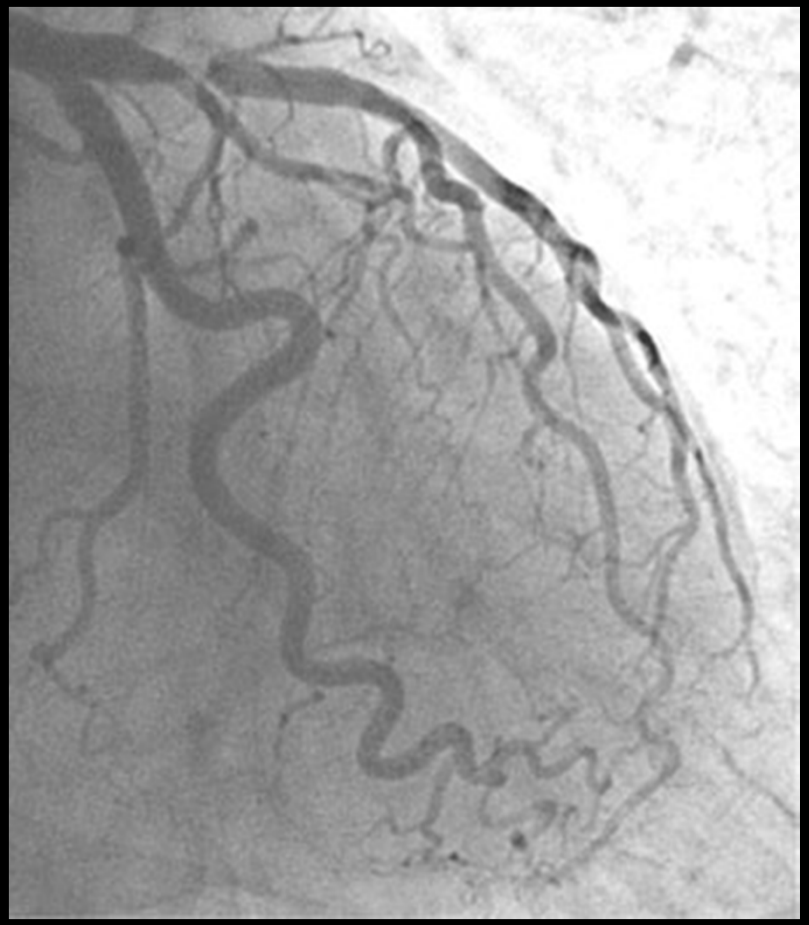


Digital X-Ray



Digital Mammography

Digital Coronary Artery Angiograph



Lonnie Edelheit's Role

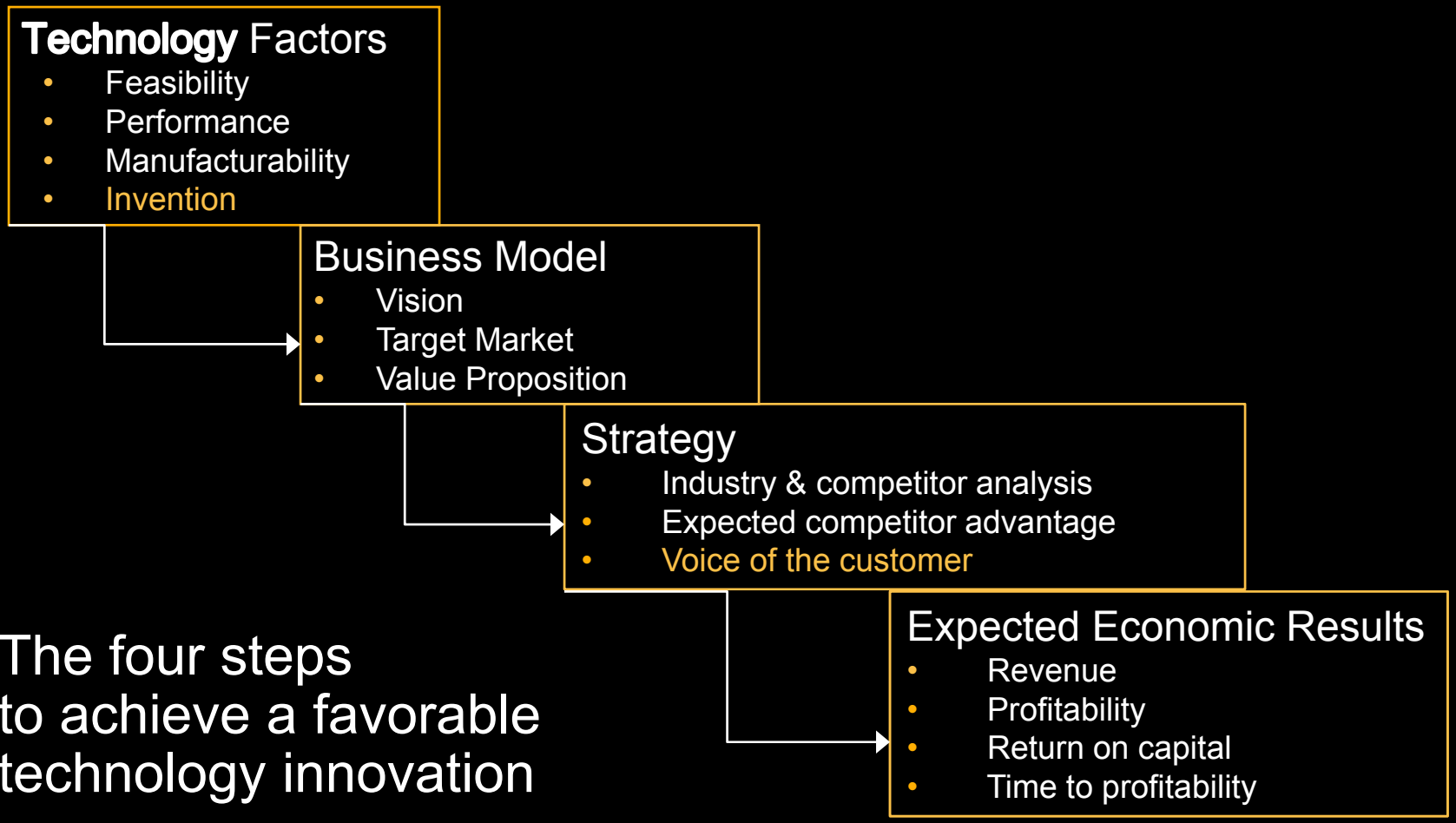
- **Position**: Senior Vice President, Research & Development – Head of CRD
- **Role**:
  - Business champion
  - Cheerleader
  - Evangelist
  - Fight political battles

Digital X-Ray: A Billion Dollar Business

Invention to Profit

- Big companies vs. Startups
- Entrepreneur vs. Intrepreneur

Innovation Strategies



The four steps to achieve a favorable technology innovation

Game Changing Innovation Needs in Companies

Big Companies

- Big market under change
- Technical Champion
- Business champion
- Strategic focus
- Much Capital Required

Small Companies

- New growing markets or new technology in existing markets
- Inventor
- Entreprenuers & investors
- Liquidity focus
- Little Capital Required

Technology Revolution

The World of Innovation Has Changed in the Past Decade

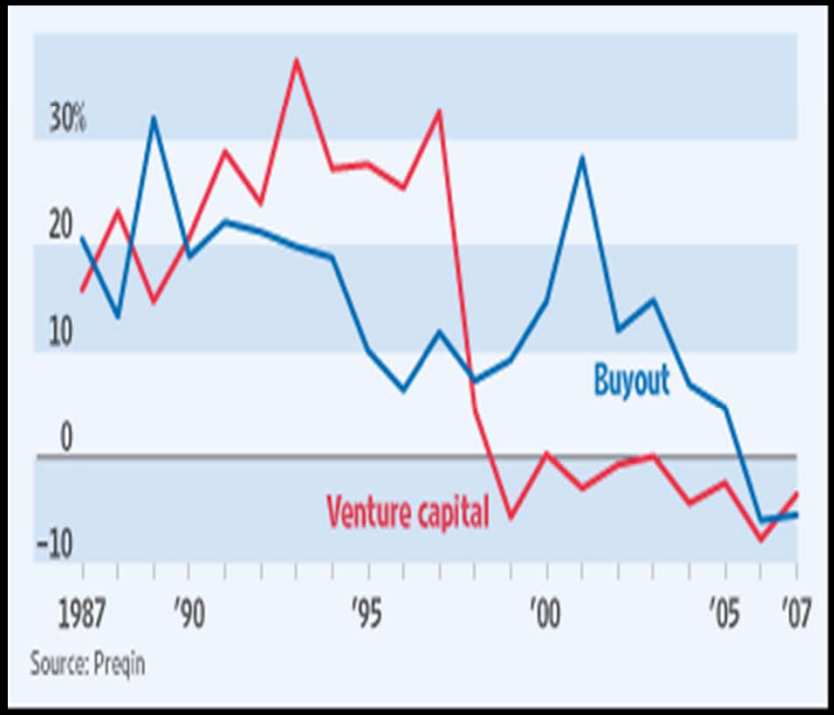
- Big companies facing global competition have gotten much faster
- Venture capital has grown much larger but profits lacking for a decade
- Speed of product development & availability of technology globally have changed all the rules
- From performance only to performance, speed, cost & quality

Technology Revolution, cont.

- Global sourcing results in lower cost & global markets
- Partnerships with suppliers, vendors, competitors, customers, etc.
- Capital tough to get

Tougher for small companies to compete

Median Annualized Return by Year of Origination



Future of health care

- New Technology
- New Paradigm
- New innovations
- New Careers

1. CT

2. MRI

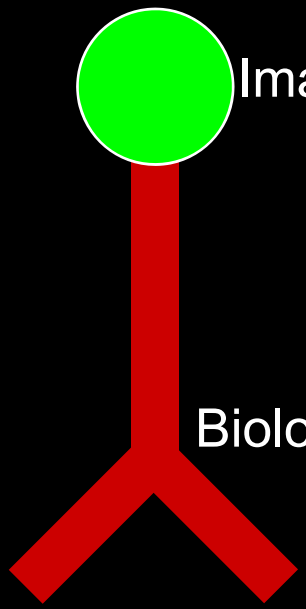
3. Color-Flow Ultrasound

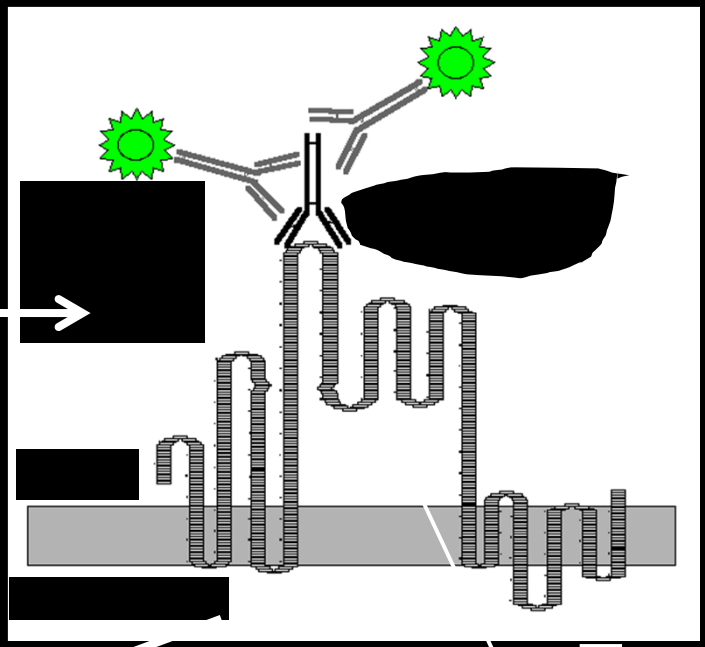
4. Digital X-Ray

5. A Potential 5th Game Changer

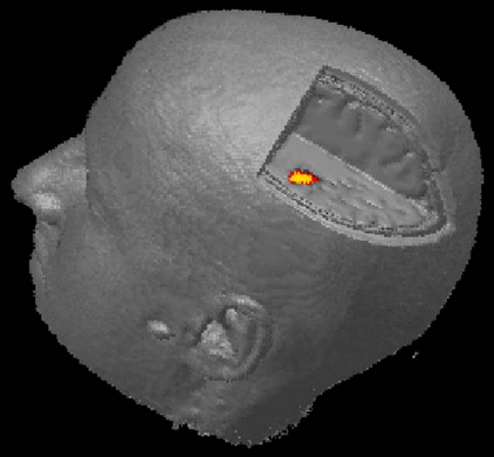
Molecular Imaging – Biomarker Localization

Molecular Contrast Agent





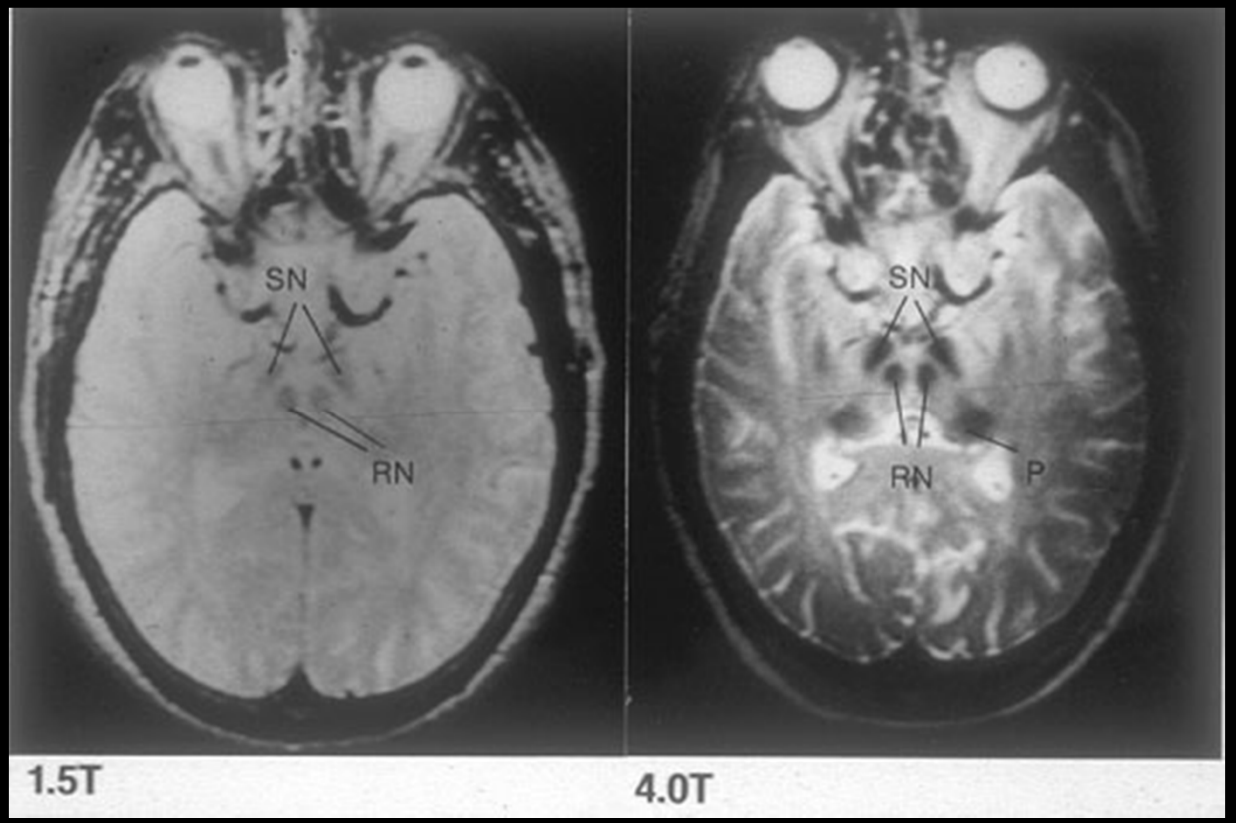
Molecular Image
showing concentration
of target protein



Future Molecular Imaging

Prognostic and Predictive Imaging Marker(s) for Alzheimer's

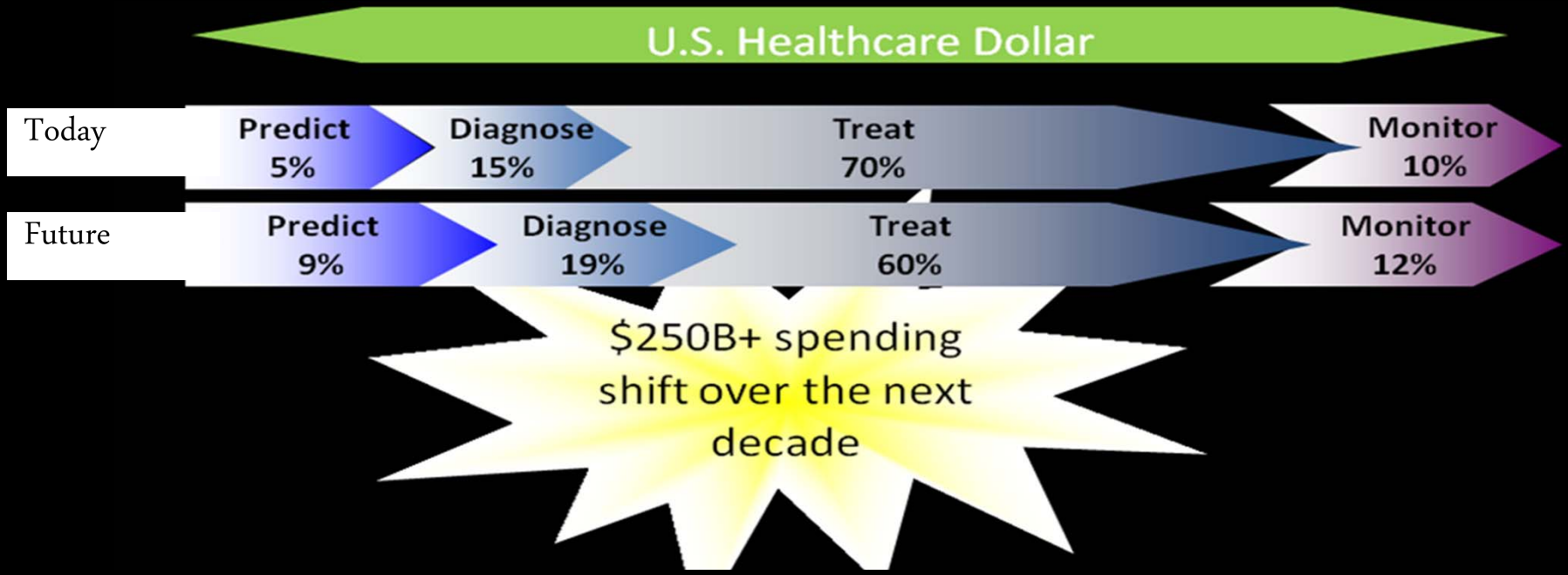
- MRI imaging of iron deposits in brain tissue
- PET imaging of b-amyloid plaque



Early Diagnosis of Alzheimer's Disease

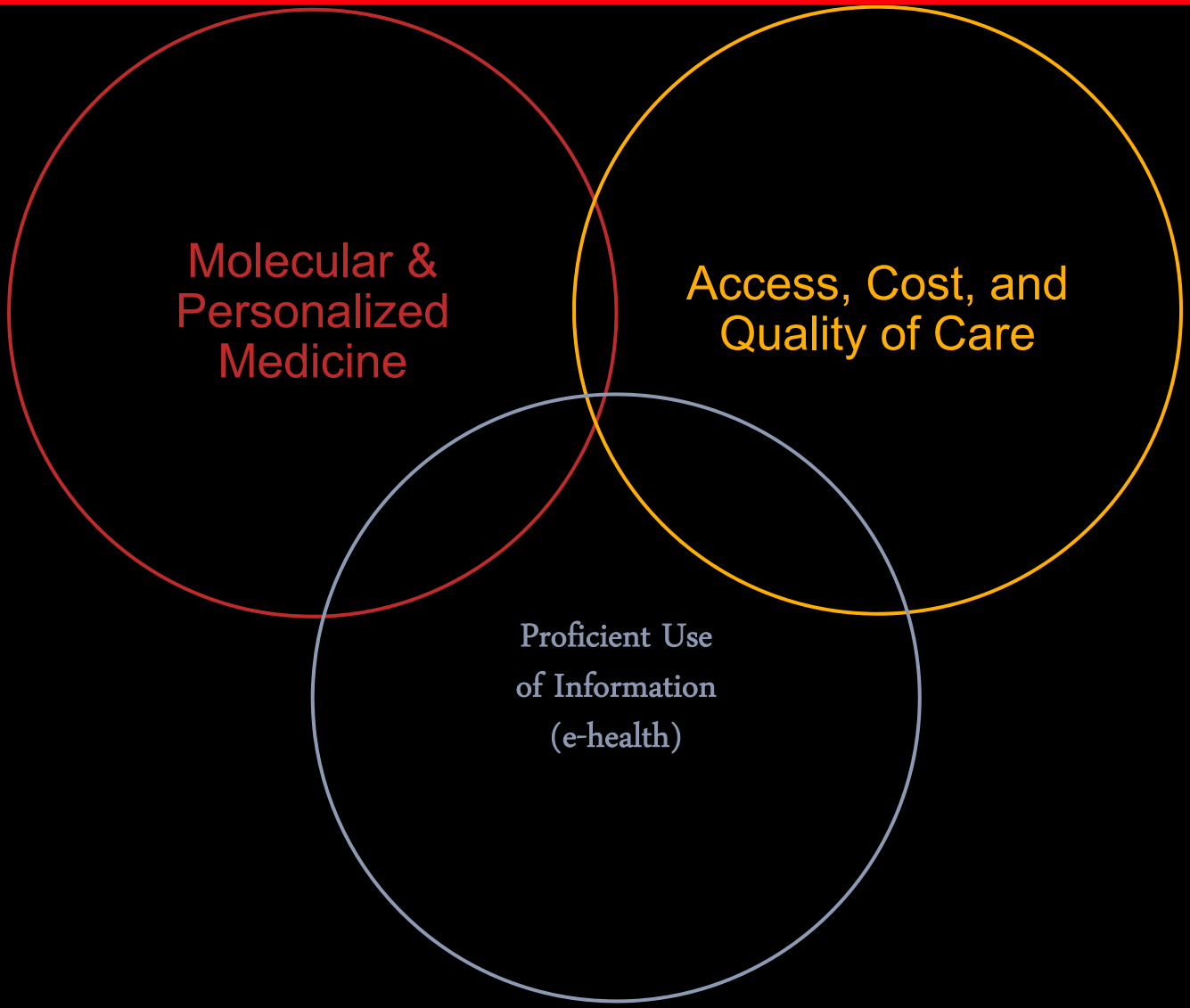
Healthcare Costs Are Unsustainable

Washington State Healthcare costs in 2004 = $31.6 Billion
growing at 7.2% (Statehealthfacts.org)



The challenge: How to improve outcomes **and** reduce cost

Future Drivers of Healthcare



From: George Poste – Burrill & Company

Values

- Integrity
- Boundary-less
- Hates bureaucracy
- Relishes change
- Passion for customer
- Meritocracy
- Global brains
- Speed

Needed for Big AND Small Companies

Lion and Gazelle

Every morning in Africa a gazelle wakes up and knows that it will have to outrun the fastest lion or it will be killed.

And, every morning in Africa a lion wakes up and knows that it will have to outrun the slowest gazelle or it will starve to death.

So, in Africa, it doesn't matter if you are the lion or the gazelle. When that sun comes up, you had better be running.