CARDIAC PET PERFUSION IMAGING with RUBIDIUM-82

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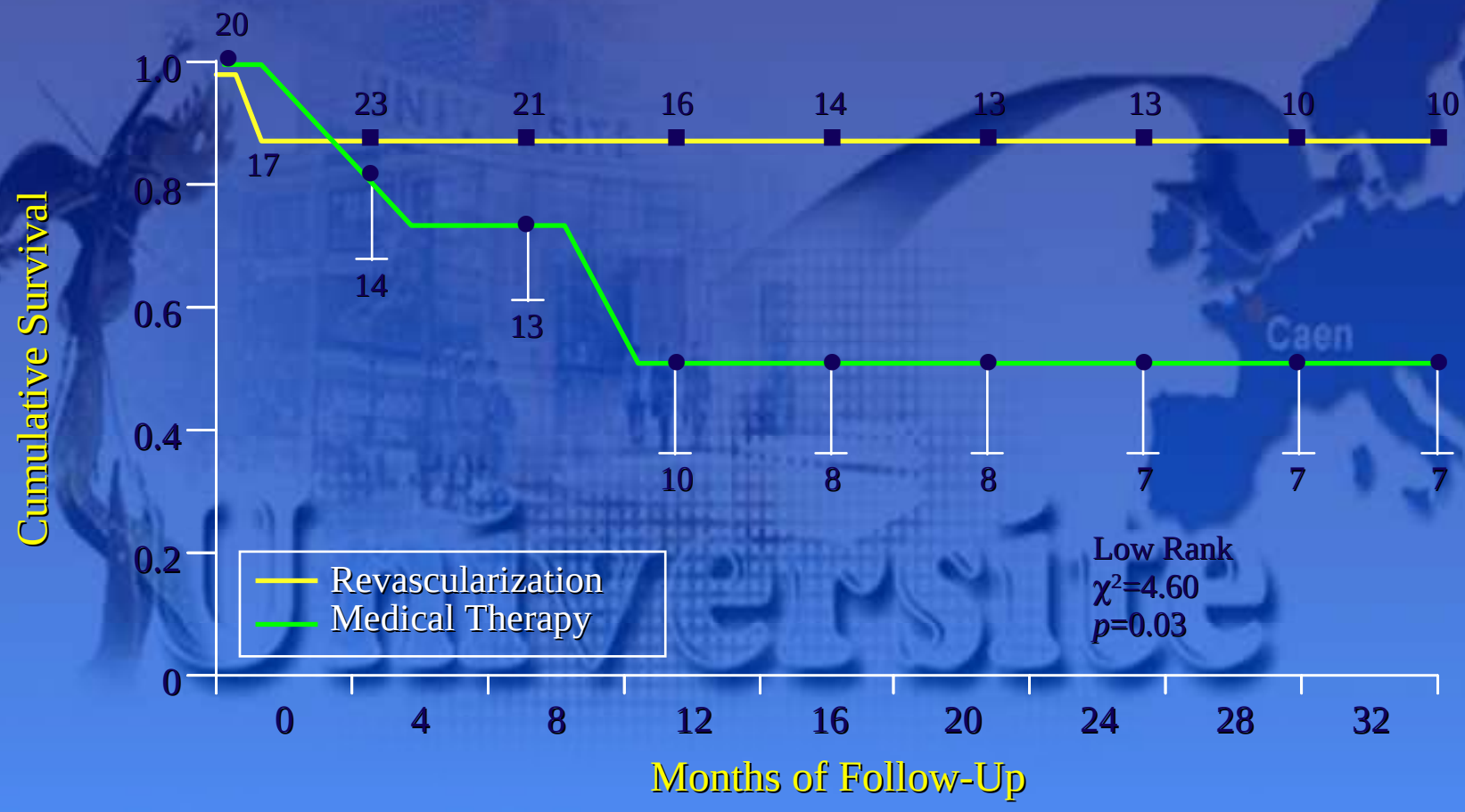
Cardiac Perfusion-Metabolism Mismatch with PET



Objectives

- **Background of cardiac PET**
- **Understand advantages of cardiac PET perfusion imaging**
- **Discuss cardiac PET and PET/CT imaging**
- **Quantification of coronary reserve : dream or reality ?**

Diagnostic Accuracy of PET Myocardial Perfusion Imaging for CAD

Sensitivity (%)	Specificity (%)	No. Patients	Agent	Author
95	100	50	NH_3, ^{82}**Rb**	Gould et al
94	95	193	^{82}**Rb**	Demer et al
93	78	202	^{82}**Rb**	Go et al
97	100	45	NH_3	Schelbert et al
93	100	49	NH_3	Yonekura et al
98	93	146	^{82}**Rb**	Williams et al
84	88	81	^{82}**Rb**	Stewart et al
95	95	25	NH_3	Tamaki et al
93	92	791		Average

Advantages of Cardiac PET Perfusion Imaging

- **Improved efficiency[1]**
- **Lower radiation exposure[1]**
- **Fewer attenuation artifacts[1]**
- **Improved resolution[1]**

1. Bateman TM. PET Myocardial Perfusion Imaging: Making the Transition to a Clinical Routine. *Appl Imaging: Applications Nucl Cardiol. 2002;* 3(1): 1-6

Commercially Available Cardiac PET Agents in US

- **Perfusion Imaging**
  - **Rubidium Rb 82**
  - **N-13 Ammonia**
- **Viability Imaging**
  - **F-18 Fluorodeoxyglucose (FDG)**

Sensitivity & Specificity[2]

Author	Sensitivity	Specificity	Patients
Gould	95%	100%	50
Demer	94%	95%	193
Go	93%	78%	202
Schelbert	97%	100%	45
Yonekura	93%	100%	49
Williams	98%	93%	146
Stewart	84%	88%	319
Weighted Avg.	**93% +/- 8**	**92% +/- 5**	**766**

2. Nuclear Medicine Self-Study Program III: Nuclear Medicine Cardiology. Botvinik, EH, Ed. 1998: SNM, Reston, VA.

Cardiac PET Tracers

Agent	Physical Half-life	Mean Positron range (mm)	Production	Extraction
$^{13}N\ NH_3$	10.0 min	0.7	Cyclotron	80 %
^{82}Rb	78 s	2.6	Generator	50-60 %
$^{15}O\ H_2O$	2.0 min	1.1	Cyclotron	Diffusible
^{18}F FDG	110 min	0.2	Cyclotron	1-3 %

CardioGen-82®
(Rubidium Rb 82 Generator)

- Indication in US :

Useful in distinguishing normal from abnormal myocardium in patients with suspected myocardial infarction.

CardioGen-82®
(Rubidium Rb 82 Generator)

- **Rubidium-82 (Rb-82) is produced by decay of Strontium-82 (Sr-82)**
- **75 second T½**
- **Kinetics:**
  - **Potassium analog**
  - **High extraction fraction at high flow rates**
- **Defects visualized 2-7 minutes after injection**
- **Same sized dose at stress & rest due to short T½**
- **New generator every 28 days**
- **Dose available 24 hours per day, 7 days per week**
- **Pharmacologic stress studies ONLY**

Cardiac Pet Tracer Dosimetry

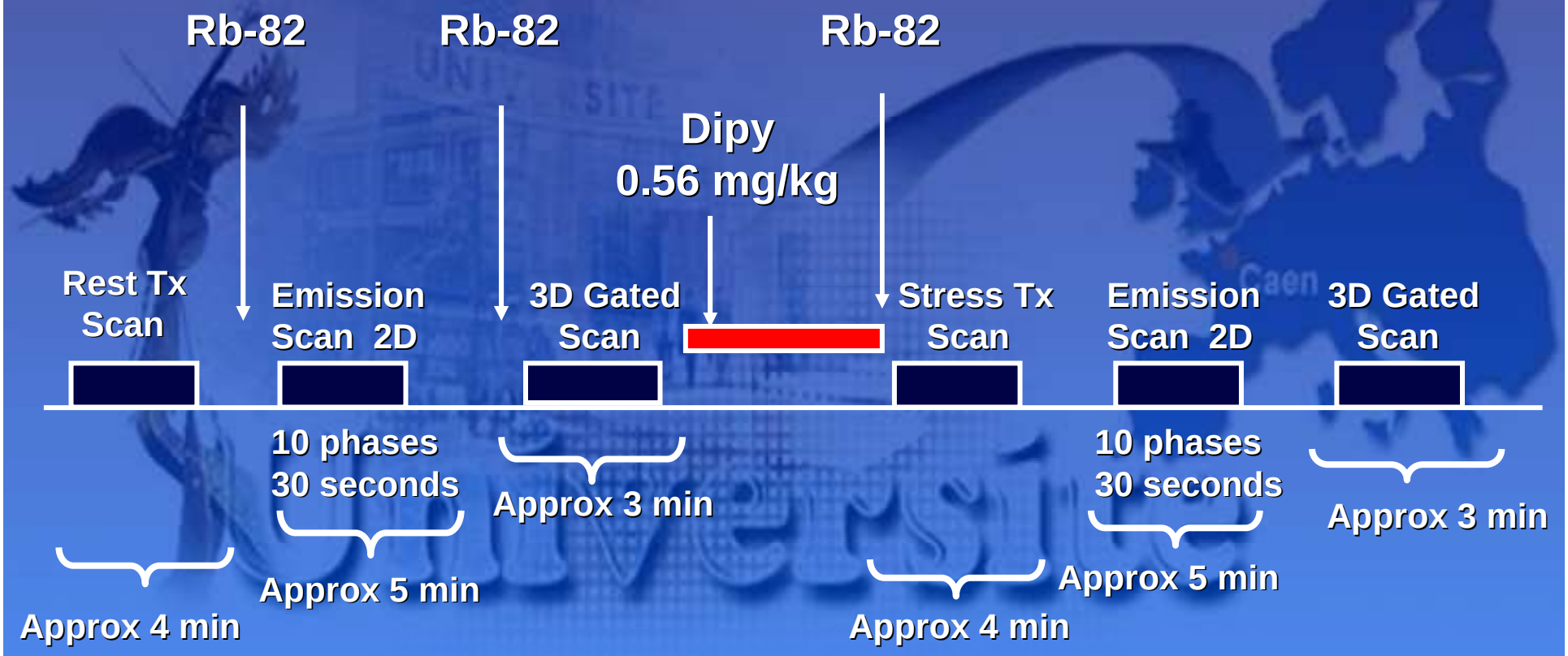
Agent	Activity (mCi)		Critical Organ	Organe Dose (rem)
$^{13}N\ NH_3$	20		Bladder	0.52
^{82}Rb	60		Kidneys	1.98
$^{15}O\ H_2O$	60		Heart	0.49
^{18}F FDG	10		Bladder	7.00

Less irradiation with Rb82 than technetium agents for technicians (MYOVIEW) (J Nucl Cardiol 2006)

Comparison of PET and SPECT Myocardial Perfusion Imaging for Detection of CAD in the Same Patients

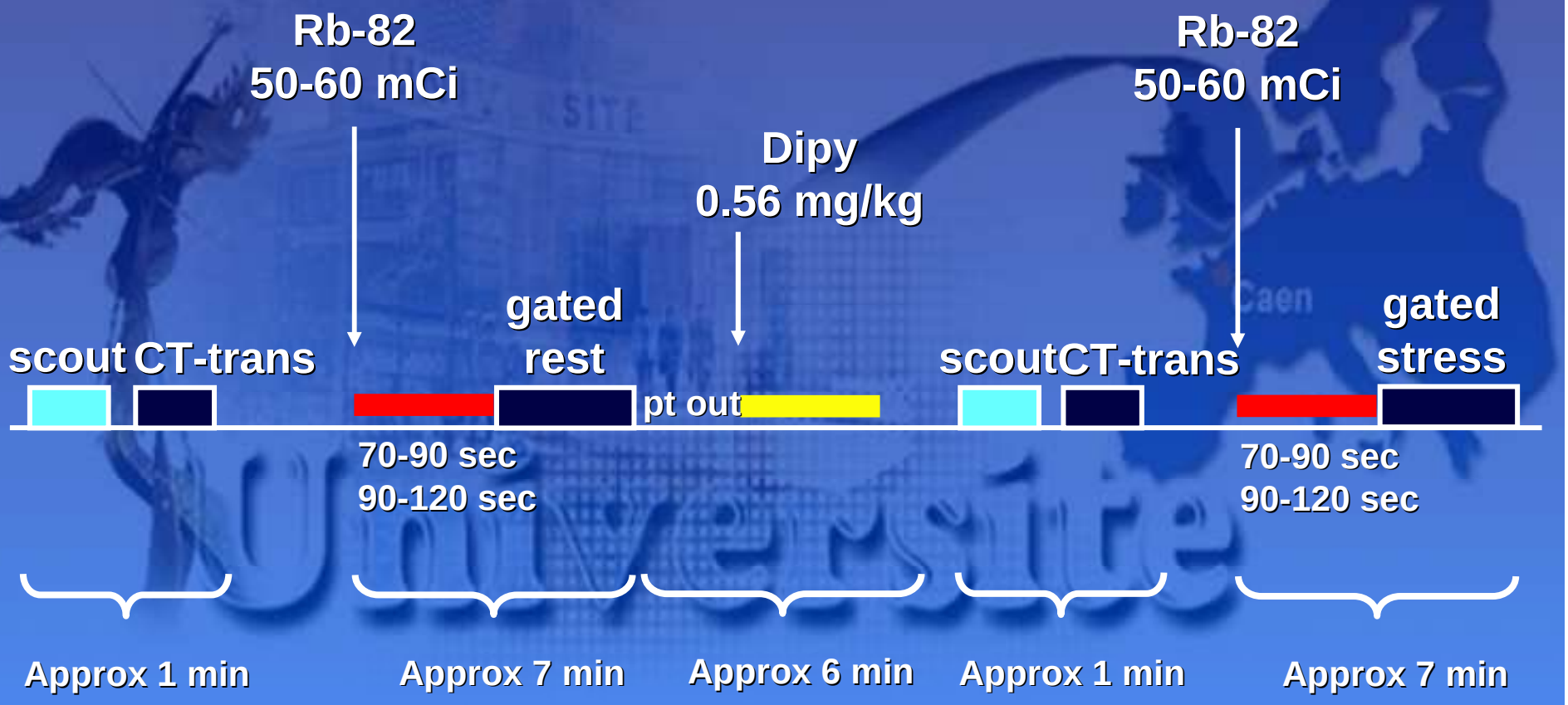
Author	Tracer	Accuracy (%)	Sensitivity (%)	Specificity (%)
Go et al	Rb-82	92	95	82
(n = 132)	Tl-201	78	79	76
Stewart et al	Rb-82	85	87	82
(n = 81)	Tl-201	78	87	52
Tamaki et al	NH3	98	98	100
(n = 51)	Tl-201	98	96	100
Total	**PET**	**91**	**93**	**82**
	SPECT	**81**	**85**	**67**

Sample Dedicated PET Protocol (35 min)



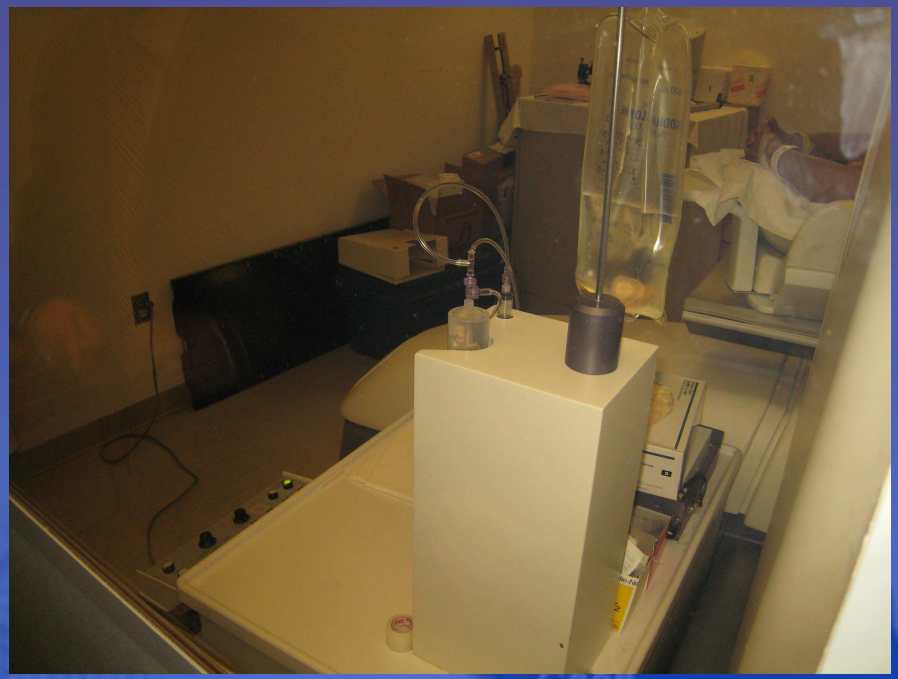
Protocol courtesy of Timothy Bateman, MD
Approximately 35 minutes

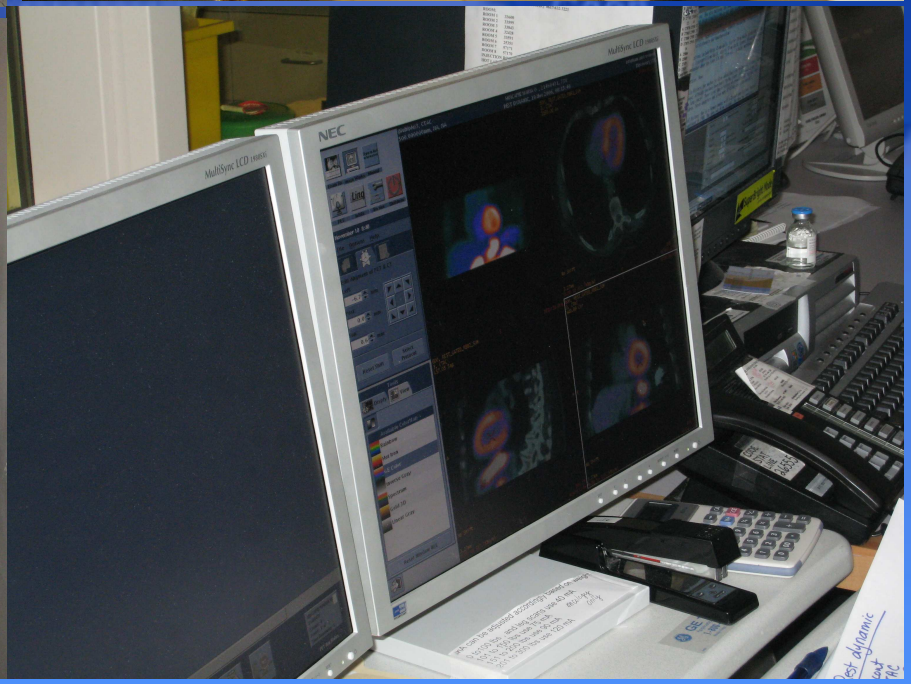
PET/CT Protocol (30 min)



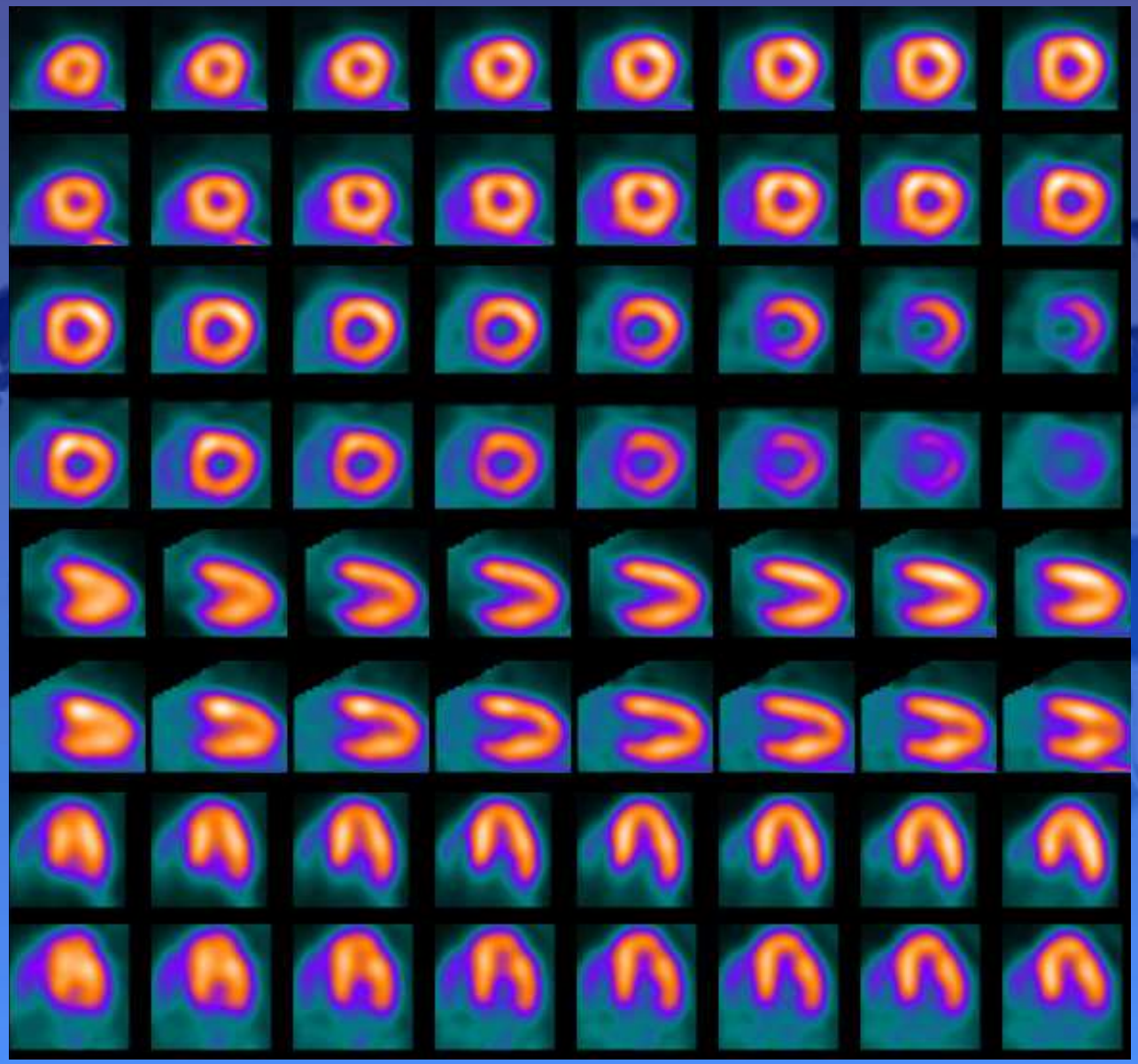
Protocol courtesy of Marcelo DiCarli, MD
Approximately 30 minutes


73
Fragile
Medical Supplies
Handle With Care




NEC
MultiSync LCD

CASE 1



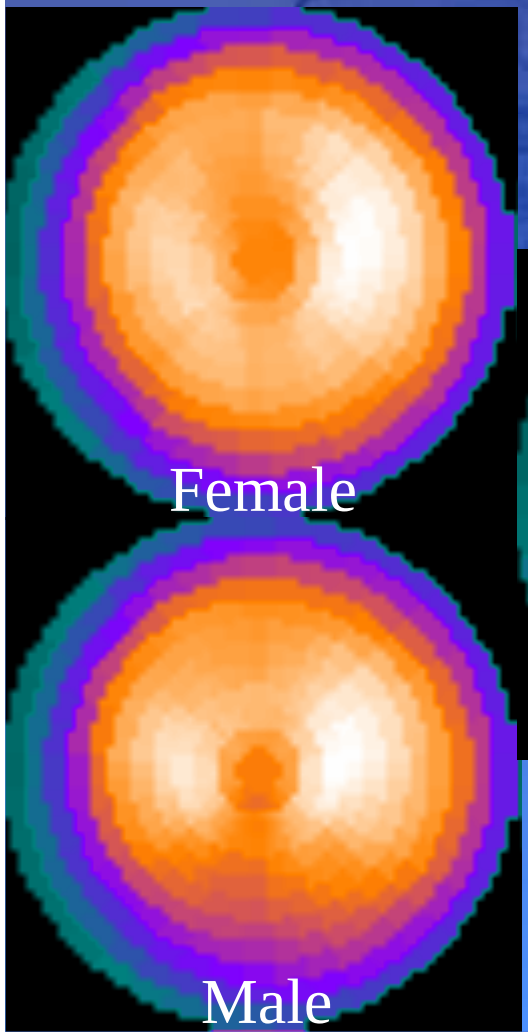
STRESS

Normal Database Comparison: PET vs. SPECT/ Rb-82 vs ammonia

Stress Uncorrected
Gender-matched

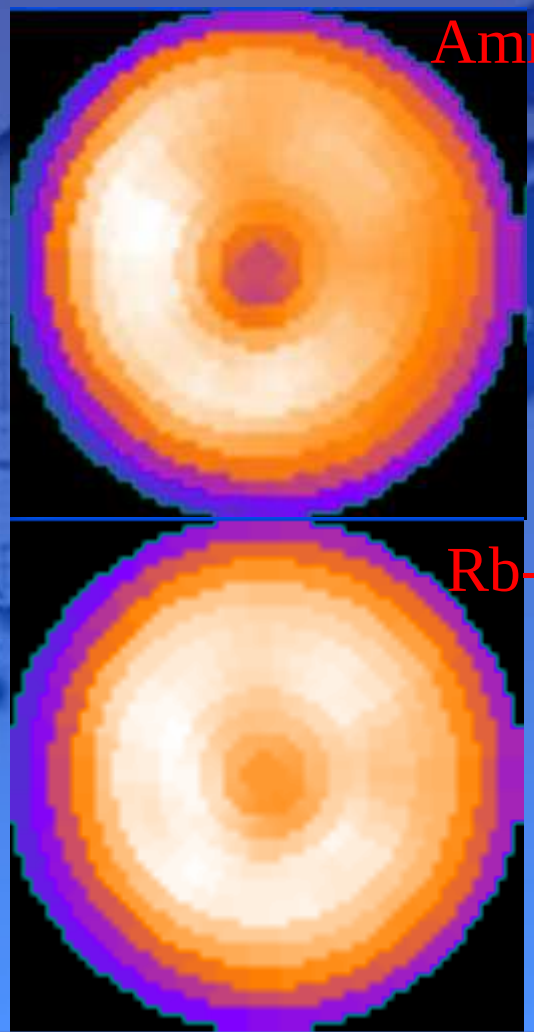
Stress corrected
Gender-combined

PET Stress
Gender-combined



SPECT

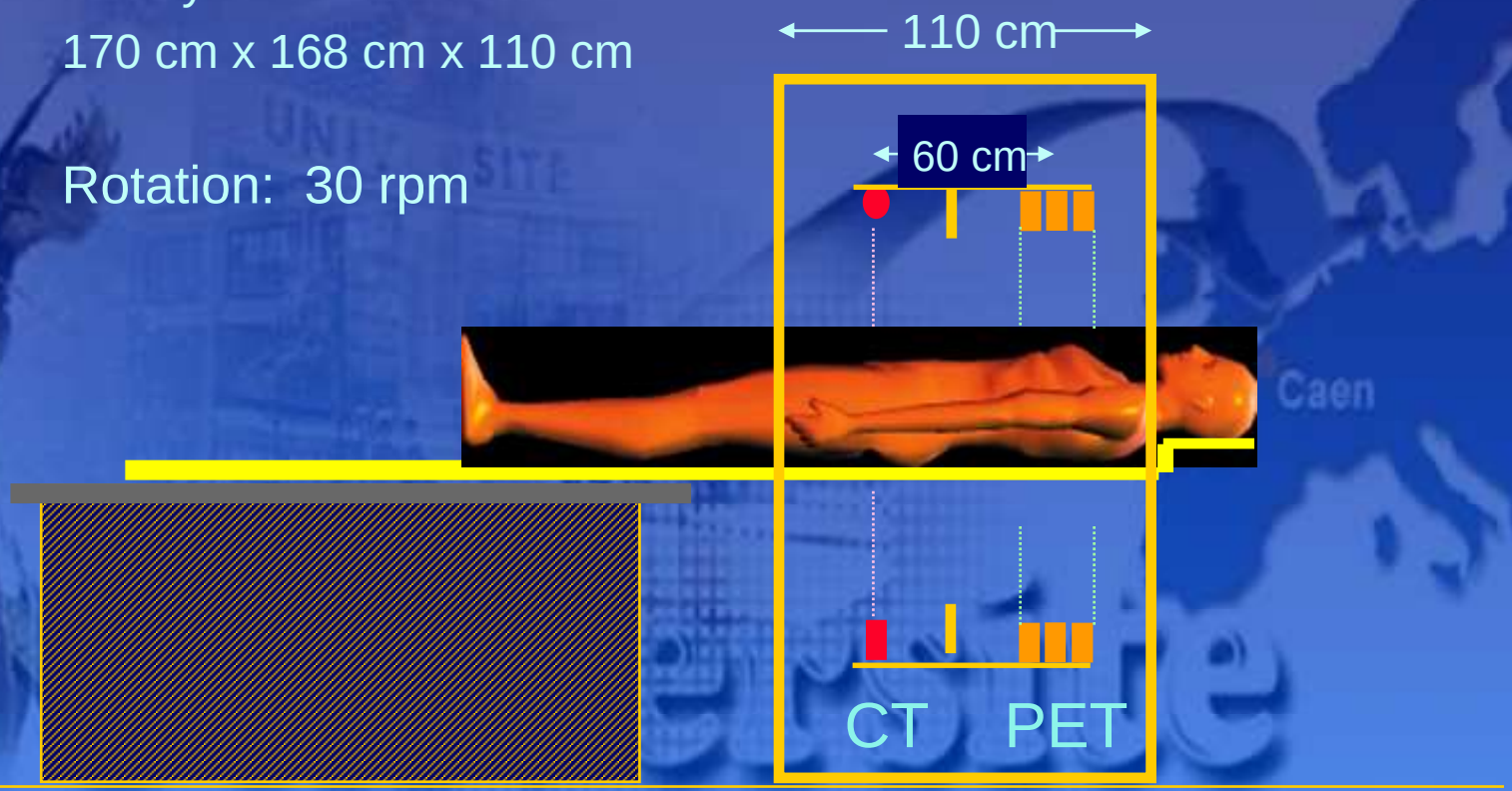
1-day rest/stress
sestamibi protocol



The PET/CT design

Gantry dimensions:
170 cm x 168 cm x 110 cm

Rotation: 30 rpm

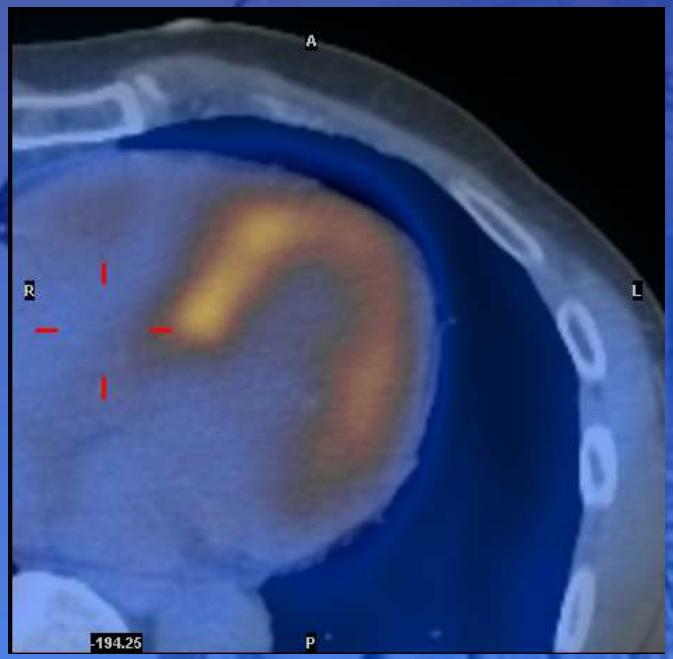


Dual-modality imaging range

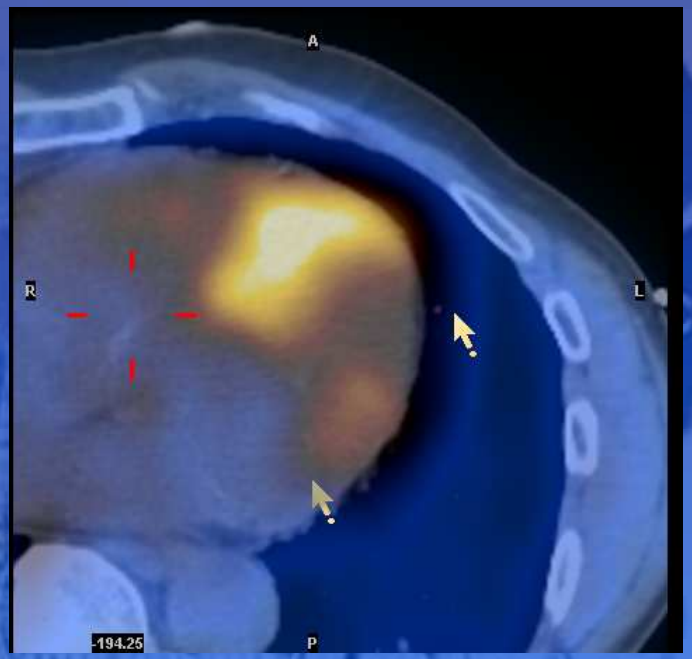
QC Issues: Table sag, patient motion, organ motion (ave. vs. instant)

* Avoid Misalignment between Emission & Transmission Sequential Scans

Rest



Stress



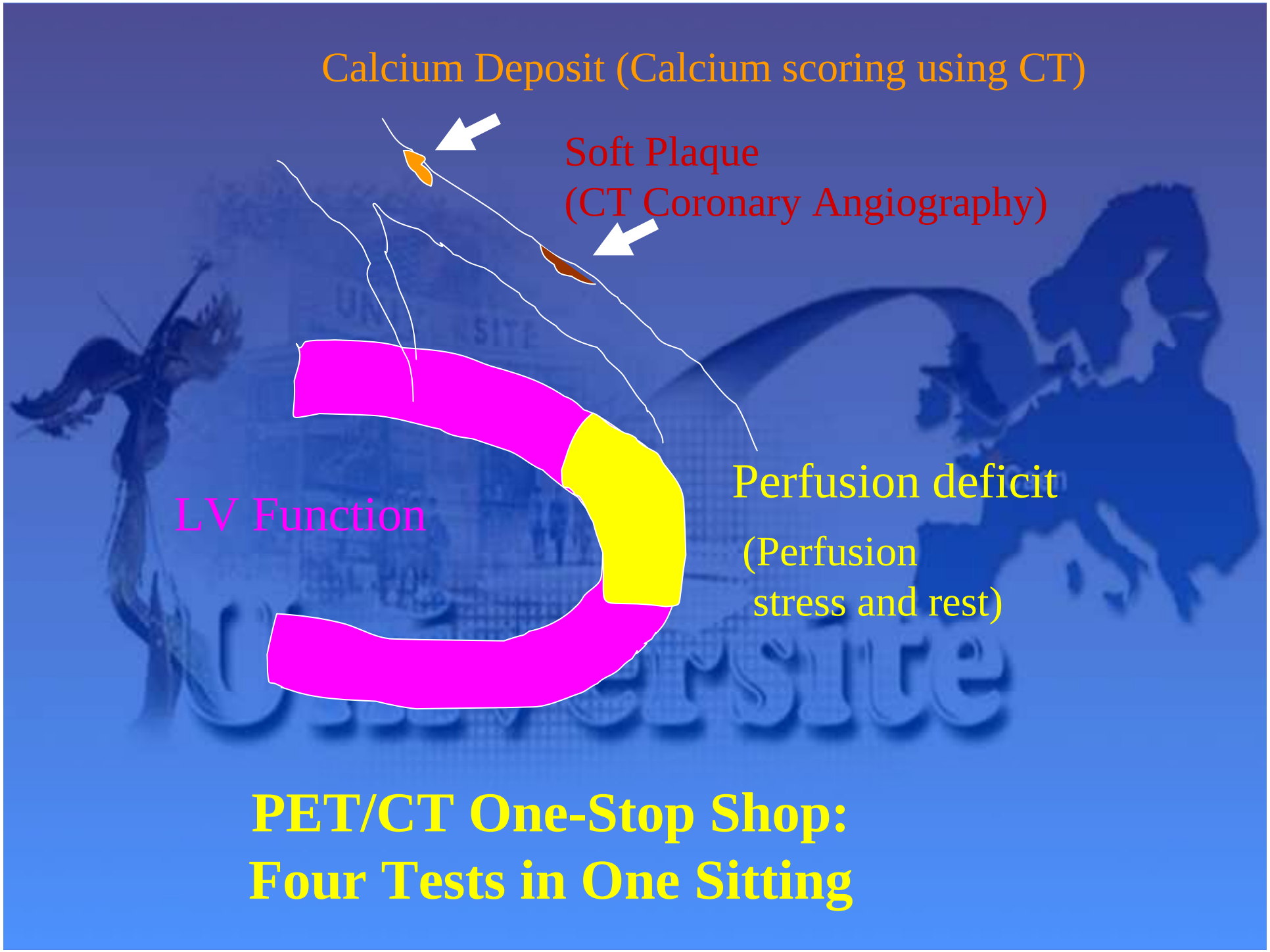
Cardiac motion artifact:

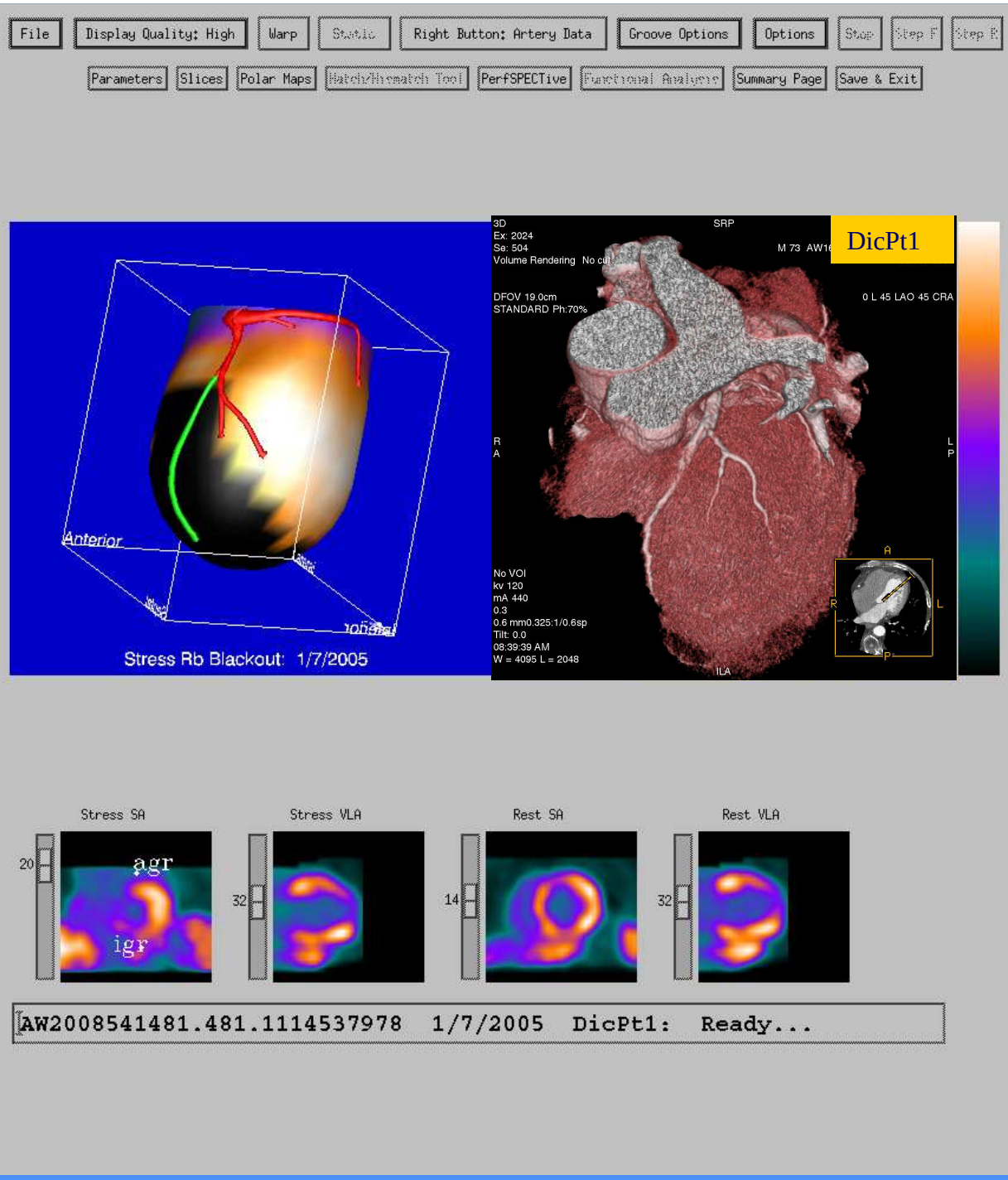
Heart moved during pharmacological stress

John Votaw, Ph.D., 2003

PET/CT

1. CT used for attenuation correction (obeses patients)
   - CT vs. Radioactive sources
2. CT used for fusion of coronary anatomy and calcium deposits with perfusion distribution (risk stratification for CAD patients) .


Calcium Deposit (Calcium scoring using CT)
Soft Plaque
(CT Coronary Angiography)
LV Function
Perfusion deficit
(Perfusion
stress and rest)
PET/CT One-Stop Shop:
Four Tests in One Sitting


File
Display Quality: High
Warp
Static
Right Button: Artery Data
Groove Options
Options
Stop
Step F
Step R
Parameters
Slices
Polar Maps
Match/Mismatch Tool
PerfSPECTive
Functional Analysis
Summary Page
Save & Exit
Anterior
Stress Rb Blackout: 1/7/2005
3D
Ex: 2024
Se: 504
Volume Rendering No cut
DFOV 19.0cm
STANDARD Ph:70%
SRP
M 73 AW16
DicPt1
0 L 45 LAO 45 CRA
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No VOI
kv 120
mA 440
0.3
0.6 mm0.325:1/0.6sp
Tilt: 0.0
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W = 4095 L = 2048
ILA
Stress SA
Stress VLA
Rest SA
Rest VLA
20
agr
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32
14
32
AW2008541481.481.1114537978 1/7/2005 DicPt1: Ready...

Clinical Applications of Coronary Flow Reserve Quantification

1 - Verification of efficacy of pharmacological vasodilation

2 - Detection of global/diffuse disease

3 - Evaluation of extent of multivessel disease

4 - Evaluation of significance of individual vessel lesions

5 - Detection of coronary steal syndrome-collaterals

6 - Evaluation of endothelial function

7 - Monitoring therapy

Conclusions

- Rb-82 is currently the best PET myocardial perfusion tracer available for clinical work.
- Rb-82 provides the most homogeneous normal distribution of myocardial perfusion.
- PET AC works better than SPECT and can be performed using either CT,
- Emission and transmission misregistrations due to patient motion or breathing can cause artifacts. QC should be routinely performed.
- Image fusion of CT angiography and PET perfusion is a promising clinical tool.

Prospective in France

- 1st site in Europe (UK 2006) from US
- Cyclotron (Arronax) in Nantes 2009 to produce Rb82 generators in France and Europe
- The best "parc" of PET-CT in the world (today : 55 and 100 in the next 5 years)
- Compromise between oncology and cardiology in the nuclear department
- Selection of patients :
  - obesity
  - women and
  - triple vessels disease

THE END

(thanks to Bertrand Merino for your invitation in the Wine's Country)

REUNIONS DE LA SOCIETE FRANCAISE DE CARDIOLOGIE MARS-OCTOBRE-DECEMBRE

Prochaine réunion SFC:
le 15 DECEMBRE
18h – 20h
MERIDIEN ETOILE
– PARIS -