California Law: Dose Tracking Software

2013 ICTP/IAEA Training Course on Radiation Protection of Patients • Trieste

California Law: Dose Tracking Software

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Professor of Biomedical Engineering
University of California Davis Medical Center
Sacramento, California

This talk is not a discussion of California, *per se*. The California law has provoked several other U.S. states into developing their own laws (Ct, Tx, etc.). More importantly, the software described in this talk was developed in response to the Ca Law, and it is now available world-wide. It is this RESPONSE to the California law that is the topic of this presentation.

California Law: Dose Tracking Software
(new technology for managing CT dose)

DISCLOSURE: I have worked with several companies working on Dose-Tracking software so that they get it right, but have received no money, gifts, or stock in return for this participation. Nothing presented herein is intended to be an endorsement for any specific company.

California Law: Dose Tracking Software
(new technology for managing CT dose)

- What got us here (review)
- California Senate Bill 1237 (review)
- Actual Requirements of the Law
- Unintended (positive) Results of the Law
- Summary

Mad river hospital, No. Calif

Humboldt Online

Get the News... Not the Paper

Radiation Overdoses Point Up Dangers of CT Scans

Written by Humboldt Online Editor on 16 October 2009

New York Times Raven Knickerbocker, then an X-ray technologist at Mad River Community Hospital in Arcata, Calif., activated a CT scan 151 times on the same area of the head of 2 ½-year-old Jacoby Roth, investigators concluded.

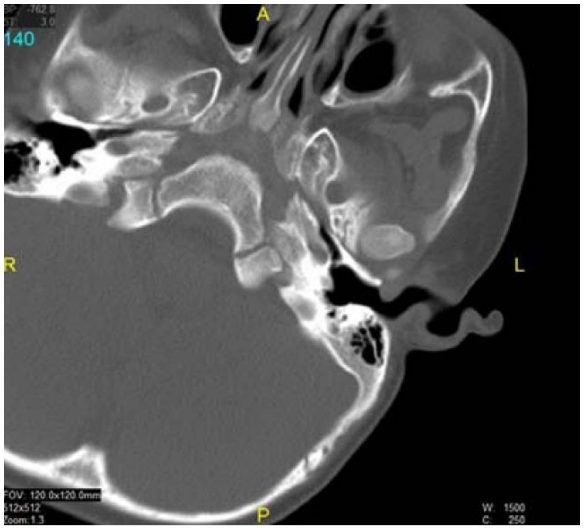
California hospital fined $25,000 for pediatric CT radiation overdose

By Cynthia E. Keen
AuntMinnie.com staff writer
March 24, 2009

Parents sue California hospital over pediatric CT radiation overdose

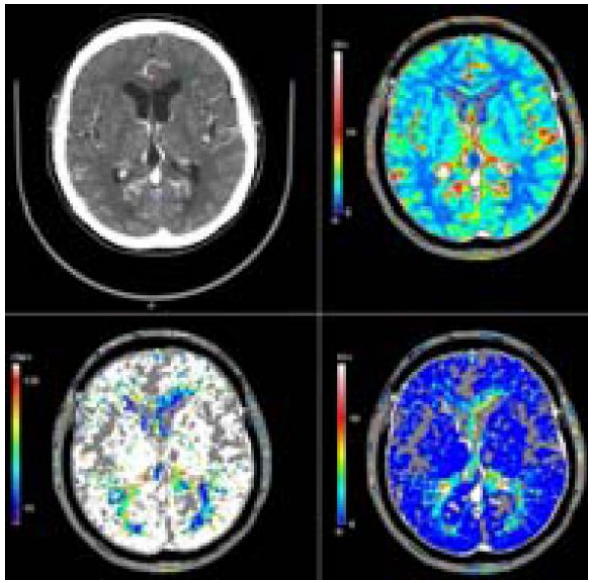
By Cynthia E. Keen
AuntMinnie.com staff writer
November 20, 2008

A rural California hospital is being sued by parents of a child who underwent a CT exam during an emergency department visit for a neck injury. The parents allege that their 23-month-old boy received radiation burns and has permanent chromosomal damage due to excessive radiation exposure from the CT scan, which took over an hour to perform.



Roth family

Cedars-Sinai, Los Angeles



U.S. Department of Health & Human Services www.hhs.gov

FDA U.S. Food and Drug Administration A-Z Index Search go

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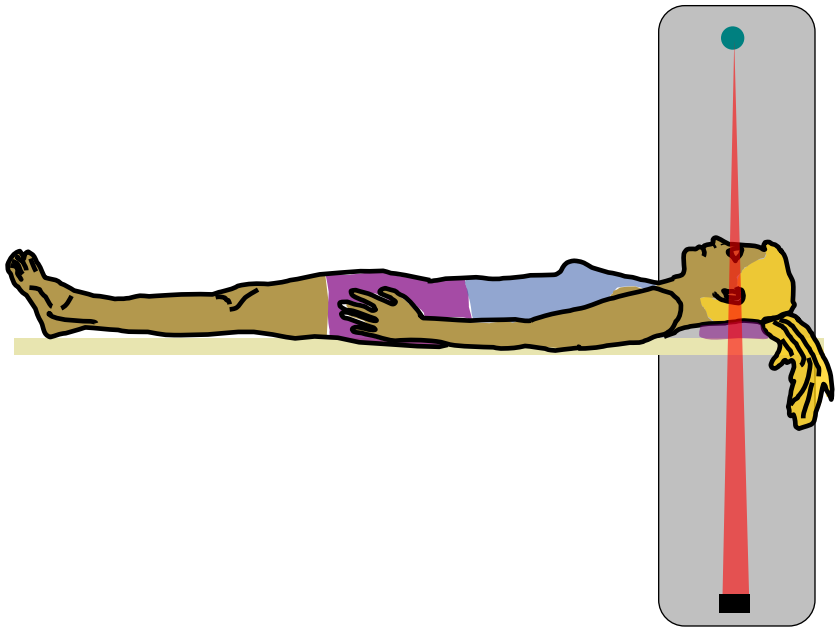
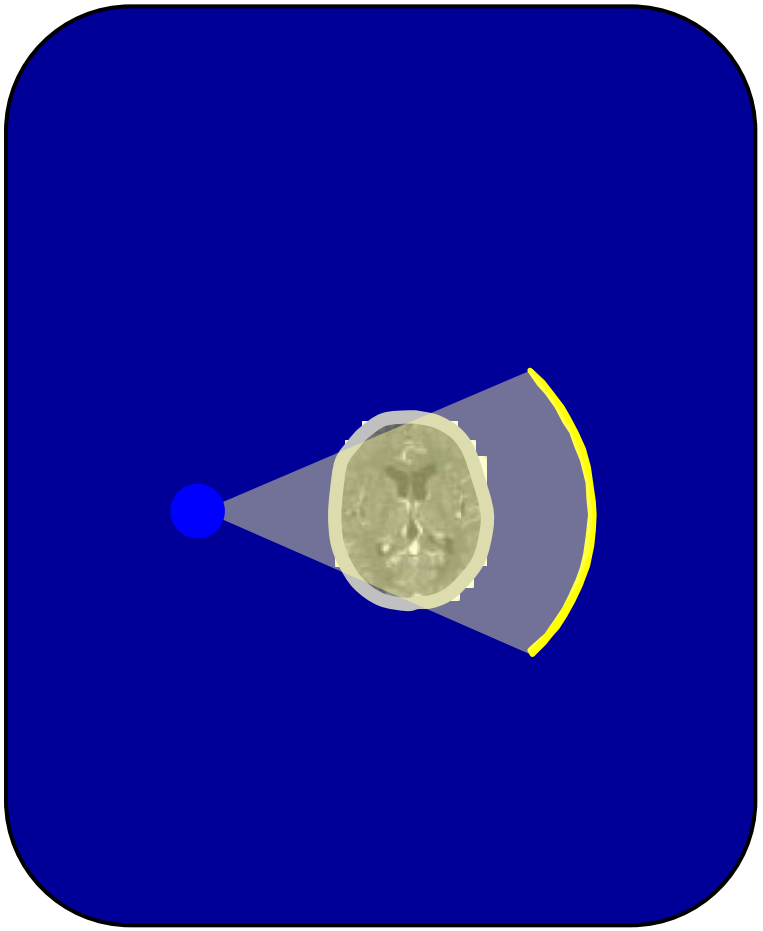
Medical Devices

Home > Medical Devices > Medical Device Safety > Alerts and Notices (Medical Devices)

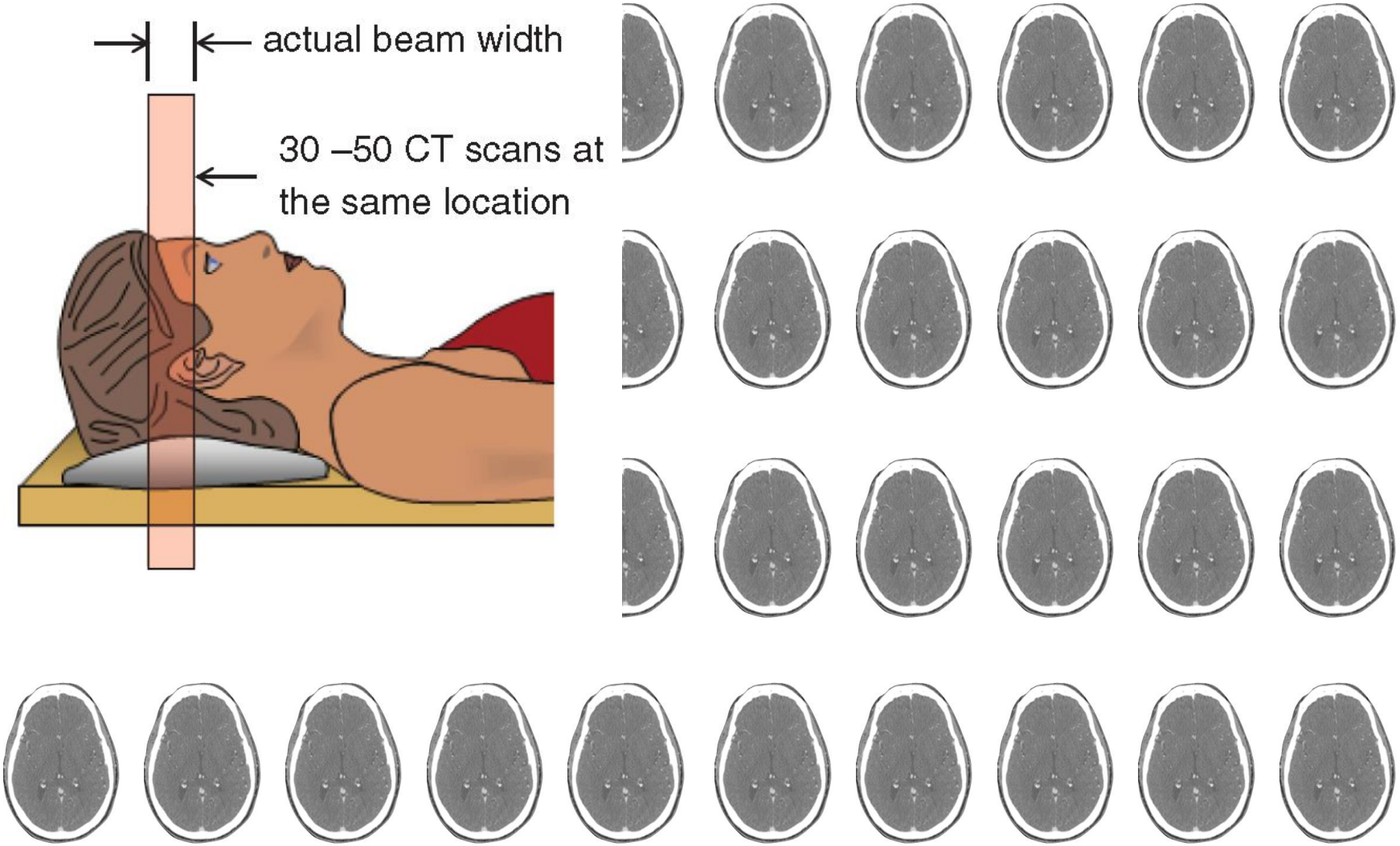
Safety Investigation of CT Brain Perfusion Scans: Update 12/8/2009

CT perfusion imaging

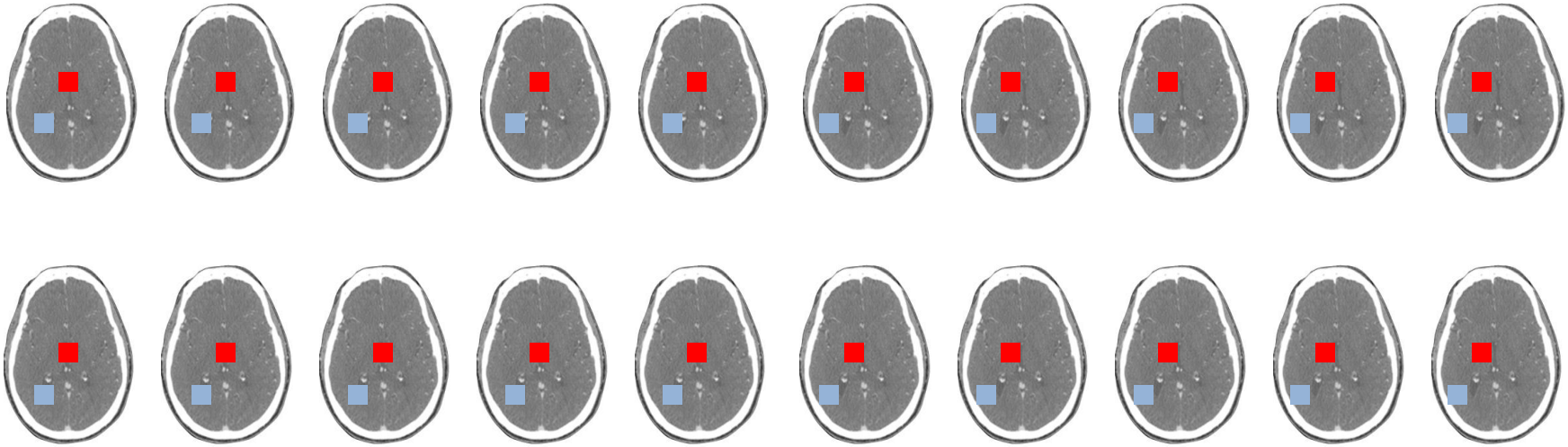


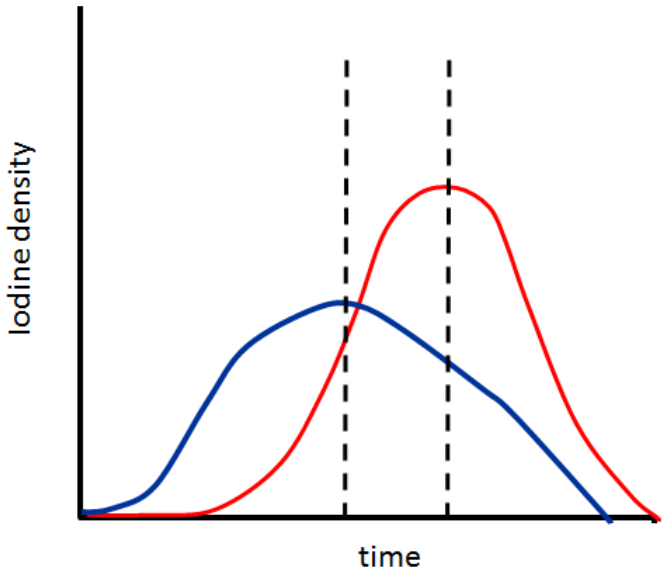


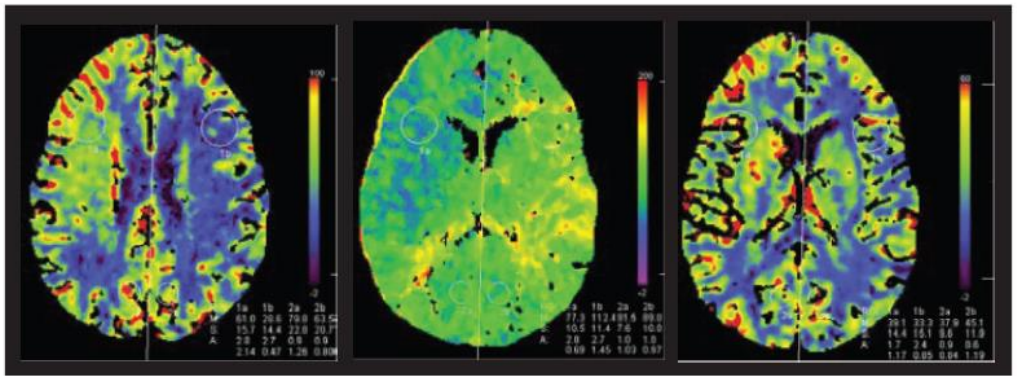
CT perfusion: 40 CT scans of the head



CT perfusion: functional information about brain perfusion and viability

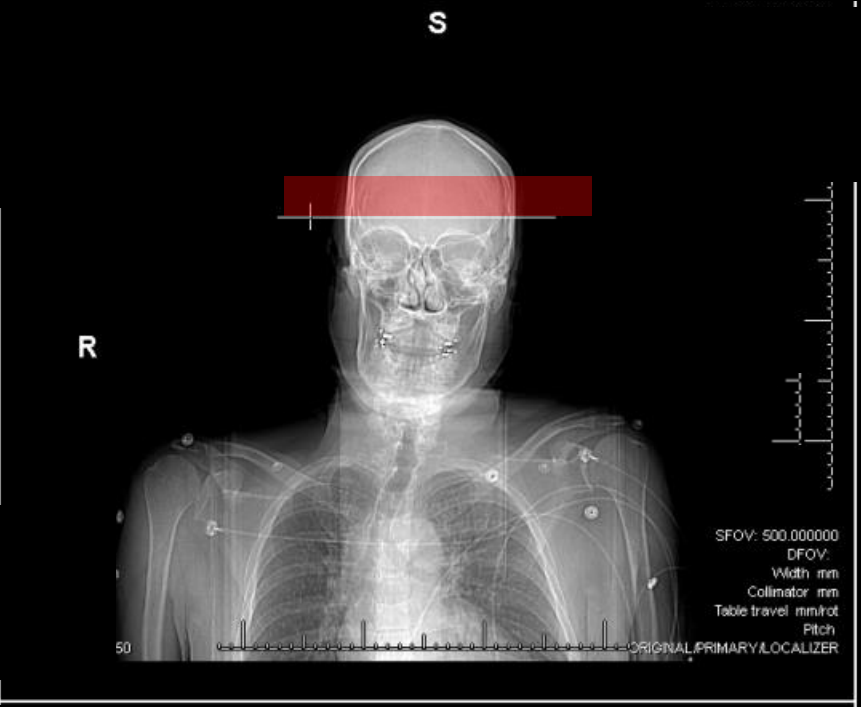




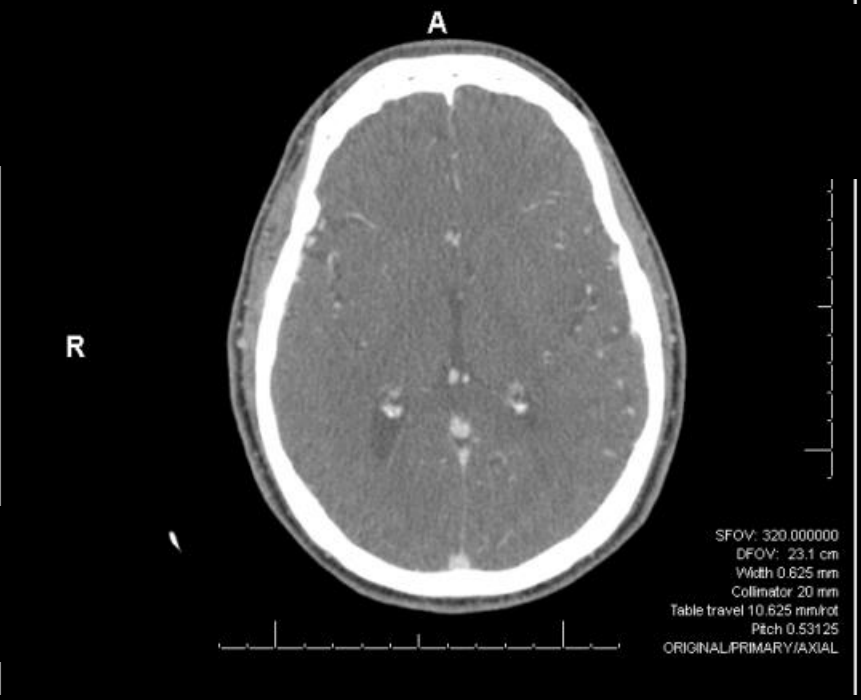


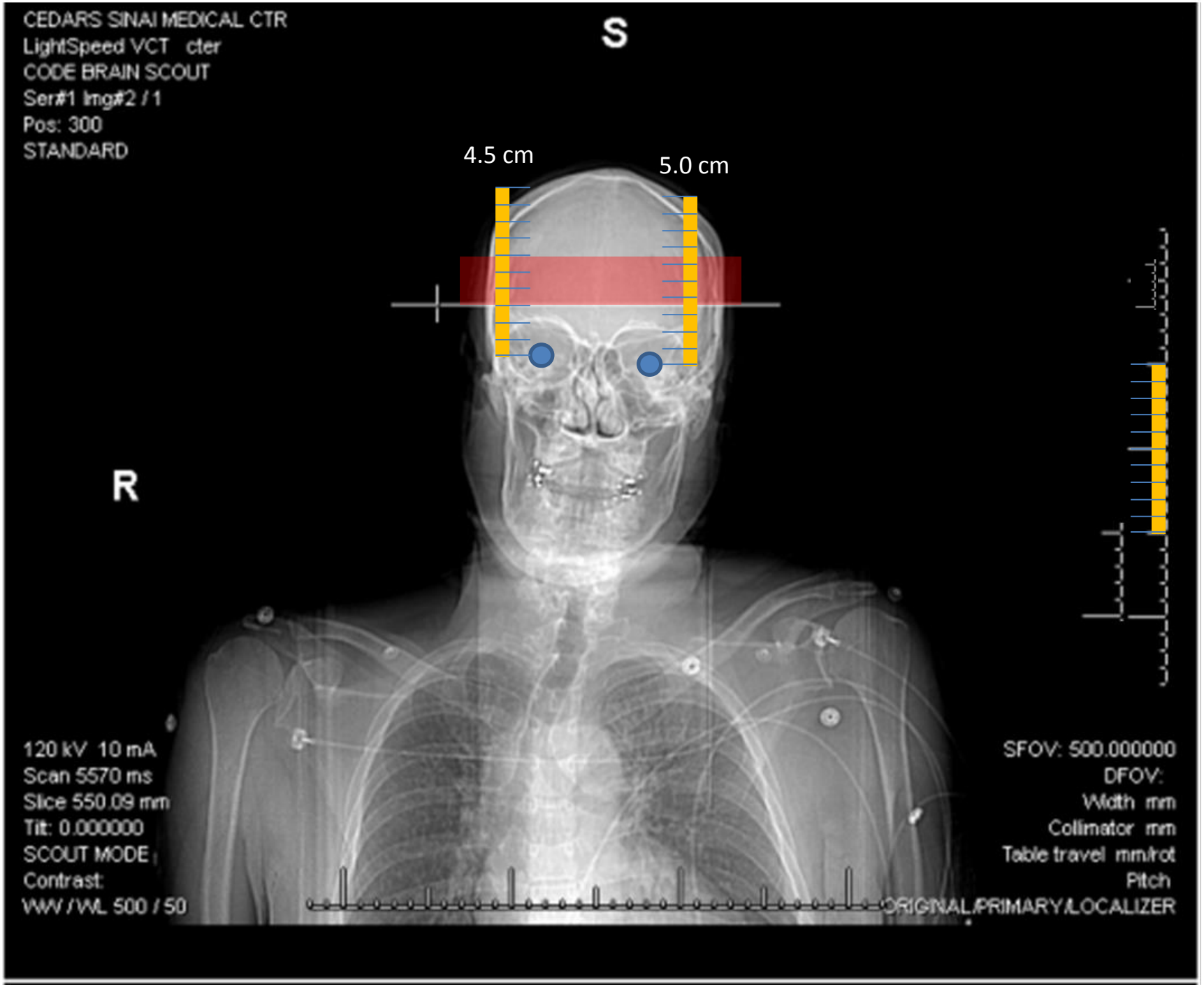
perfusion | time to peak enhancement | blood volume


S
P
120 kV 20 mA
Scan 4070 ms
Slice 400.00 mm
Tilt: 0.000000
SCOUT MODE
Contrast:
WW/WL 1193 / 130
ORIGINAL


S
R
SFOV: 500.000000
DFOV:
Width mm
Collimator mm
Table travel mm/rot
Pitch
50
ORIGINAL/PRIMARY/LOCALIZER


A
R


A
R
SFOV: 320.000000
DFOV: 23.1 cm
Width 0.625 mm
Collimator 20 mm
Table travel 10.625 mm/rot
Pitch 0.53125
ORIGINAL/PRIMARY/AXIAL


CEDARS SINAI MEDICAL CTR
LightSpeed VCT cter
CODE BRAIN SCOUT
Ser#1 Img#2 / 1
Pos: 300
STANDARD
S
4.5 cm
5.0 cm
R
120 kV 10 mA
Scan 5570 ms
Slice 550.09 mm
Tilt: 0.000000
SCOUT MODE
Contrast:
WW / WL 500 / 50
SFOV: 500.000000
DFOV:
Width mm
Collimator mm
Table travel mm/rot
Pitch
ORIGINAL/PRIMARY/LOCALIZER

Dose report from CT Head Perfusion Study

LightSpeed VCT

Exam Description: BRAIN ANGIO/PERFUSION

Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Axial	I39.000-I1.500	60.57	242.29	Head 16
2	Axial	I2.000-S133.000	60.57	848.00	Head 16
202	Axial	I231.250-I231.250	114.40	57.19	Head 16
3	Helical	I253.000-S121.375	156.71	6198.51	Head 16
4	Axial	I37.000-S0.500	60.57	242.29	Head 16
4	Axial	S-0.000-S135.000	60.57	848.00	Head 16
5	Cine	S35.000-S70.000	4371.42	17485.70	Head 16
			Total Exam DLP:	25921.98	

$CTDI_{vol}$ of 4371 mGy

$CTDI_{vol}$ of 4371 mGy

Scanner Group	kVp	Sub-group	Scanner	CTDI (Head, mGy/100mAs) Air	Centre	Perip
GE.o	80	GE.o.080	GE LightSpeed VCT	14.8	8.3	10.0
GE.o	100	GE.o.100	GE LightSpeed VCT	24.2	15.3	17.4
GE.o	120	GE.o.120	GE LightSpeed VCT	35.0	23.7	26.1
GE.o	140	GE.o.140	GE LightSpeed VCT	46.9	33.1	35.5

25.3 mGy /100 mAs

4371 / 25.3 = 172 times

35 x 172 = 6046 mGy $CTDI_{air}$

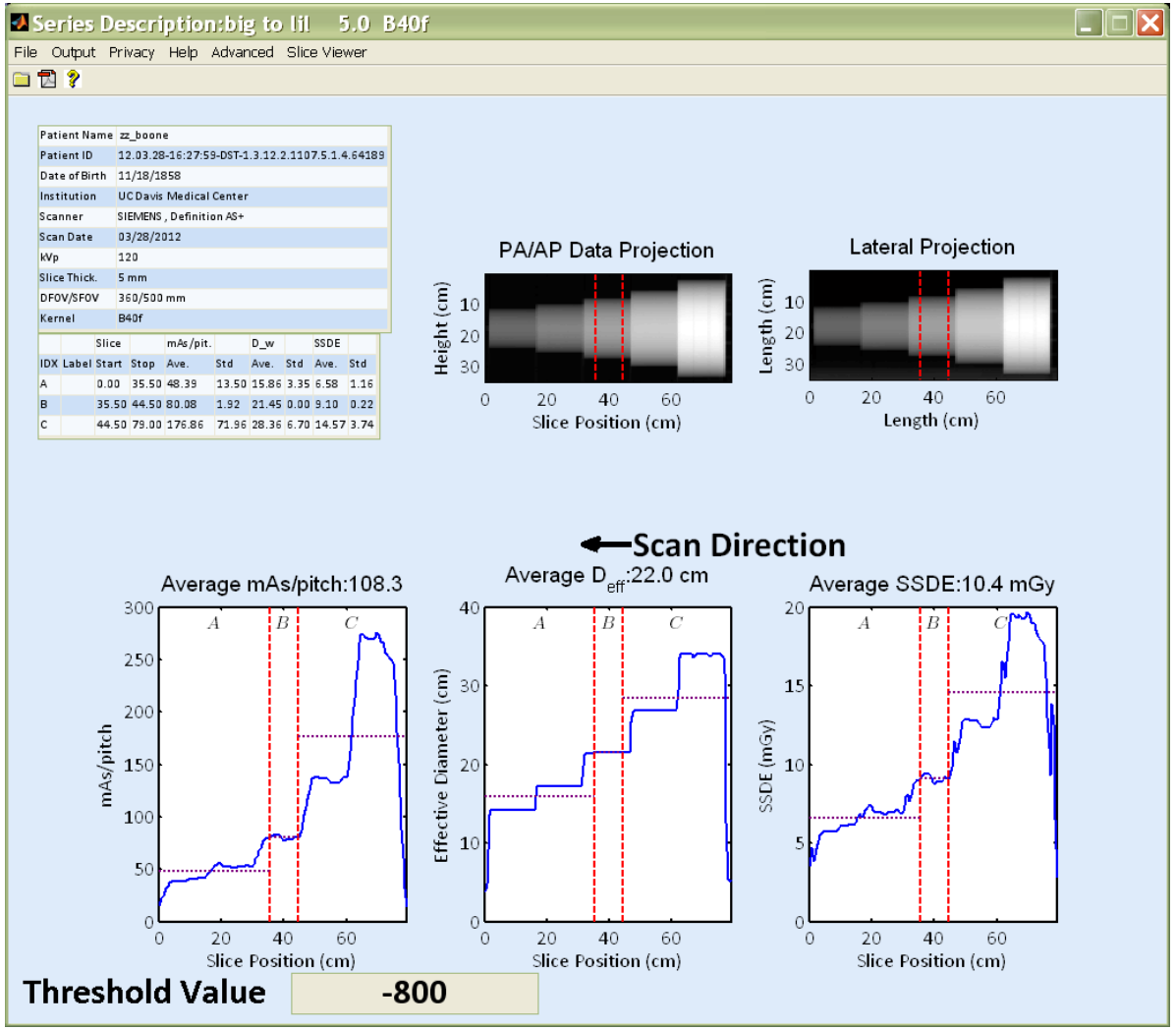
6046 x 1.386 (ISL) = 8,381 mGy = 8.3 Gy

8.3 x ½ ≈ 4.1 Gy

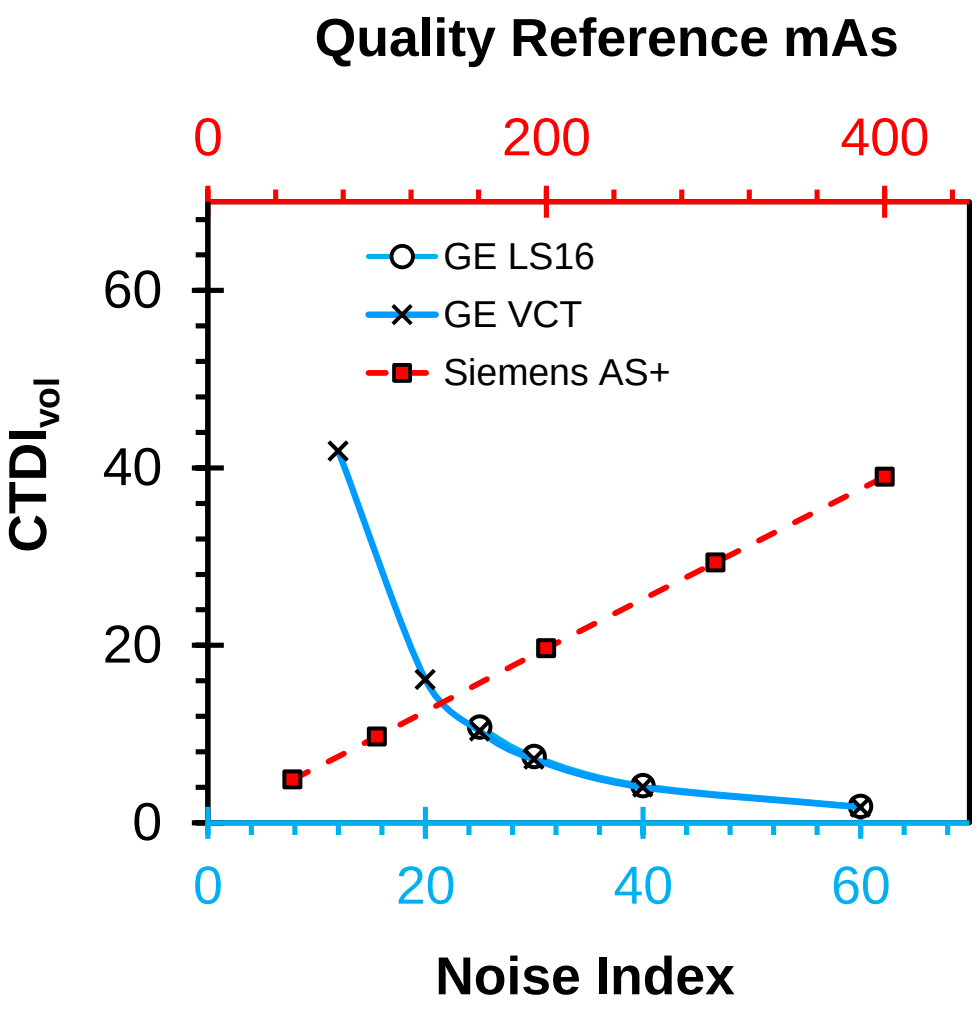
What went wrong?

Automatic Exposure Control

A short treatise on Automatic Exposure Control in CT



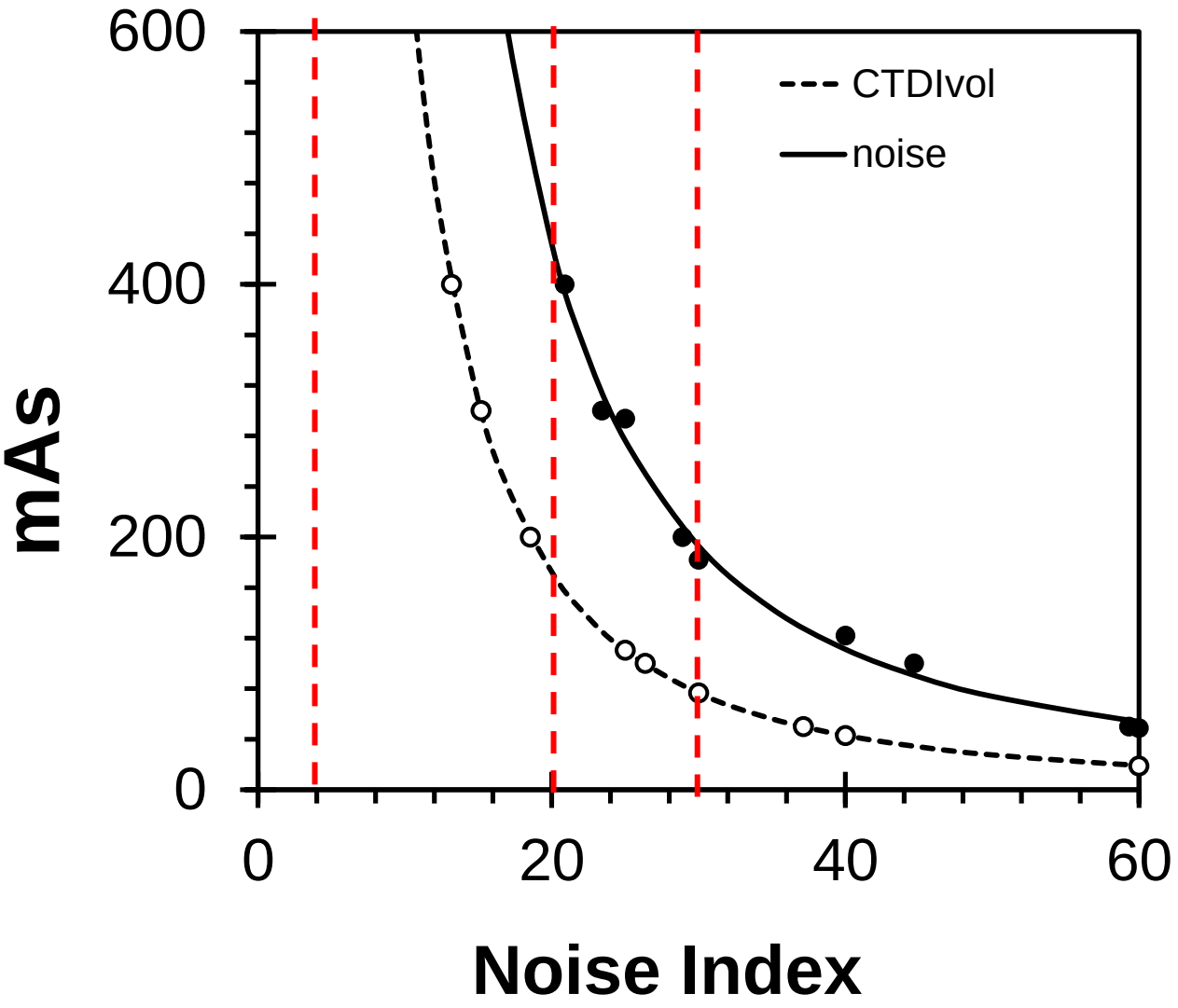
A short treatise on Automatic Exposure Control in CT



Siemens' CT scanners

General Electric VCT

A short treatise on Automatic Exposure Control in CT



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- Actual Requirements of the Law
- Unintended (positive) Results of the Law
- Summary


University of California Davis Medical Center
Sacramento
San Francisco
Oakland
San Jose
Fresno
Bakersfield
Los Angeles
Long Beach
Anaheim
Santa Ana
Riverside
San Diego
California

CA Legislative Activities

- **Sen. Padilla introduced SB 1237 in Feb 2010**
  - **Radiation Control: Health Facilities and Clinics**
- **Governor signed SB 1237 on September 29, 2010**

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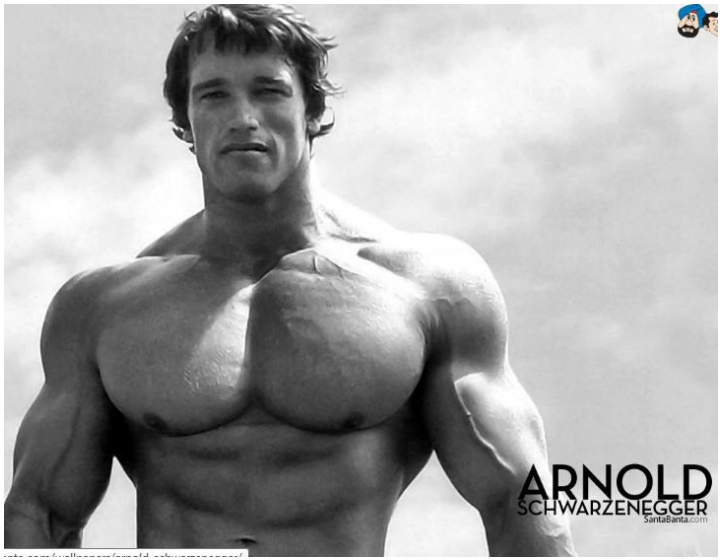

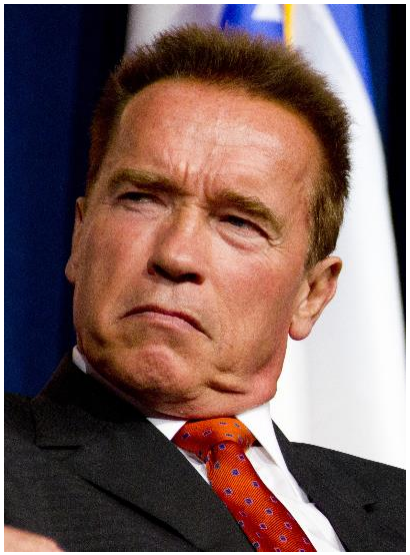

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SB 1237/ SB 38

The most important provision of the law:

Commencing July 1, 2012

- Must record the radiation dose ($CTDI_{vol}$ and DLP) of CT studies in the radiology report

Most radiologists use digital dictation to generate their clinical interpretation

UC DAVIS MEDICAL CENTER
LightSpeed16 cti1
Dose Report
Ser: 999 Img: 1 / 1
Table Pos

Patient Name:
Accession Number:

Exam no:
Apr 2009
LightSpeed16

Exam Description: CT CHEST WITH CONTRAST

Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Helical	I510.250-I700.250	15.55	349.79	Body 32
4	Helical	I50.000-I395.000	17.48	661.77	Body 32
4	Helical	I230.750-I715.750	16.09	834.64	Body 32
4	Helical	I230.750-I725.750	7.98	421.68	Body 32
			Total Exam DLP:	2267.88	

1/1

$$$

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- What got us here (review)
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Legislators Make the Laws

Staff at the California Radiological Health Branch have to enforce the laws

Jerry Helmsley

C-CAMP* contributors

- *John Boone: University of California Davis*
- *Christopher Cagnon: UC Los Angeles*
- *Melissa Martin: Therapy Physics, Inc. Gardena, CA.*
- *Michael McNitt-Gray: UC Los Angeles*
- *Thomas R. Nelson, UC San Diego*
- *J. Anthony Seibert: University of California Davis*

*California Clinical and Academic Medical Physicists

Frequently Asked Questions (FAQs)

H&S Code Section 115113(a)(1) Repeating of a CT examination, unless otherwise ordered by a physician or a radiologist, if the following dose values are exceeded:
(A) 0.05 Sv (5 rem) effective dose equivalent.
(B) 0.5 Sv (50 rem) to an organ or tissue.
(C) 0.5 Sv (50 rem) shallow dose equivalent to the skin.

2. **What does "repeating a CT examination unless otherwise ordered by a physician or radiologist" mean?**

   This means that a technologist must repeat an examination due to instrument malfunction, wrong technical factors, incorrect positioning, or miscommunication, which render the image non-diagnostic.

3. **After reviewing H&S Code Section 115113(a)(1), it appears that all the dose values referenced in this Section have to be exceeded, to trigger the reporting requirement for a repeat CT examination. Is this true?**

   If the CT examination is repeated, all dose values listed in this subsection would need to be exceeded before mandatory reporting is required.

4. **Assume that a CT scanner breaks during a procedure and the technical factors are high enough to exceed the dose values referenced in this subsection. The actual patient exposure time is unknown. How do we calculate radiation doses?**

Frequently Asked Questions (FAQs)

H&S Code Section 115113(a)(3) CT or therapeutic exposure that results in unanticipated permanent functional damage to an organ or a physiological system, hair loss, or erythema, as determined by a qualified physician.

7. **What defines "unanticipated" in Section 115113(a)(3)?**

   If the patient received instructions concerning the risks and potential consequences of a procedure, and has given consent prior to the procedure being performed, then the facility has met the definition of an anticipated event.

   Due to age, health status, or confounding medical conditions the radiation exposure(s) can cause organs or physiological system to fail. If this unanticipated event occurs, then it must be reported.

8. **Hair loss or erythema is usually a transient event. Do we report all unanticipated events or just permanent events?**

   Report all unanticipated hair loss or erythema episodes.

9. **Section 115113(a)(3) references unanticipated permanent functional damage. Is a facility required to report radiation-induced cataracts, if they are repaired?**

   Yes, if the cataracts are found by a qualified physician to have been an unanticipated consequence of the procedure.

Computed Tomography Dose Limit Reporting Guidelines for Section 3 – 115113

California Dose Reporting Law

Three sections to the Health and Safety Code:
(115111, 115112, 115113)
Senate Bill SB 1237, enacted November, 2010
Section 3 in force January 1, 2011

Recommendations of the California Clinical and Academic Medical Physicists (C-CAMP)

(ver. 5.0/2010-Dec-06)

Patient Effective Dose Threshold: 50 mSv

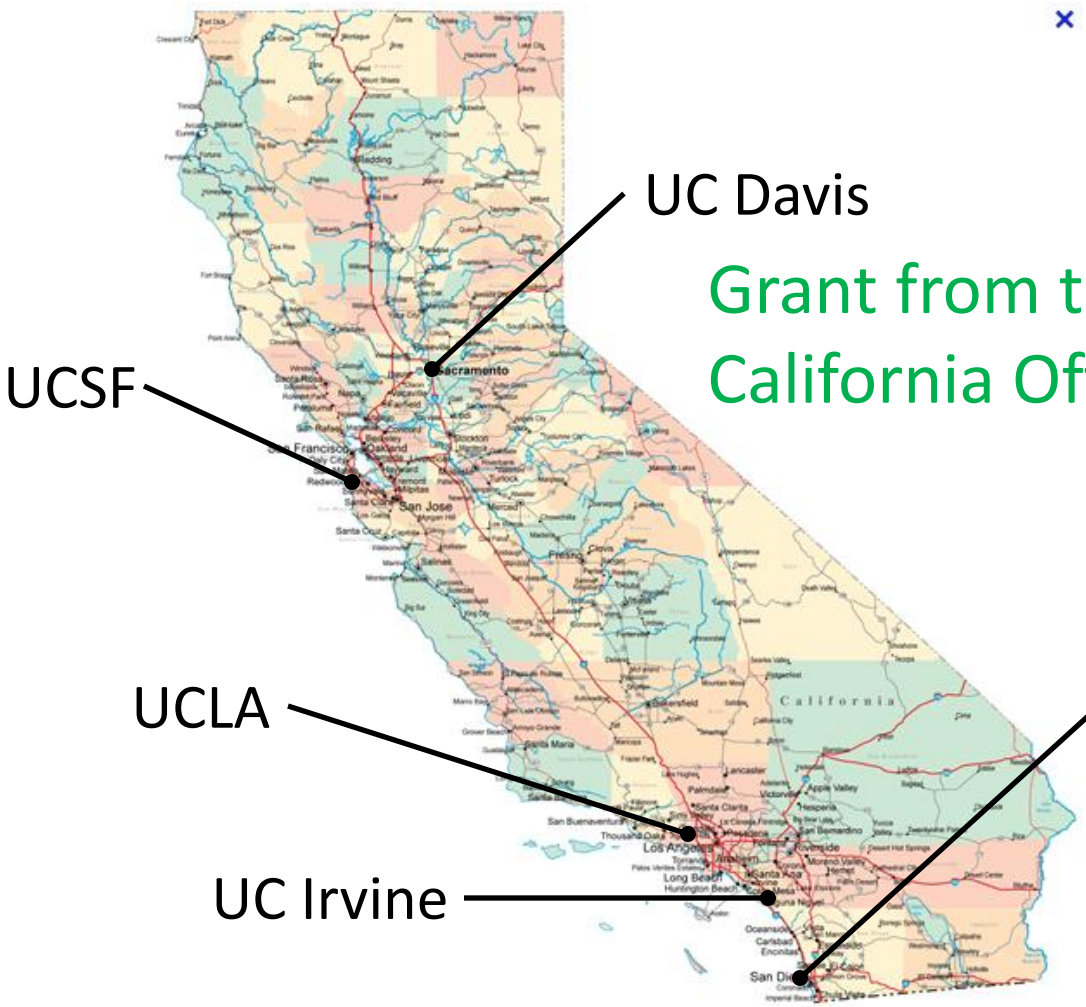
$$E = DLP \times k$$

DLP Triggers for Effective Dose for Reporting Incorrect/Repeated Exams (Siemens scanners only)

DLP in mGy*cm

	0 yr old	1 yr old	5 yr old	10 yr old	adult
head and neck	3840	5880	8770	11900	16120
head and neck	4540	7460	12500	15620	23800
neck	2940	4160	4540	6320	8470
chest	550	830	1200	3840	3570
abd/pelvis	440	720	1080	3330	3330
trunk (C/A/P)	490	770	1140	3570	3330

UC Dose Optimization and Standardization Endeavor



Grant from the University of California Office of the President

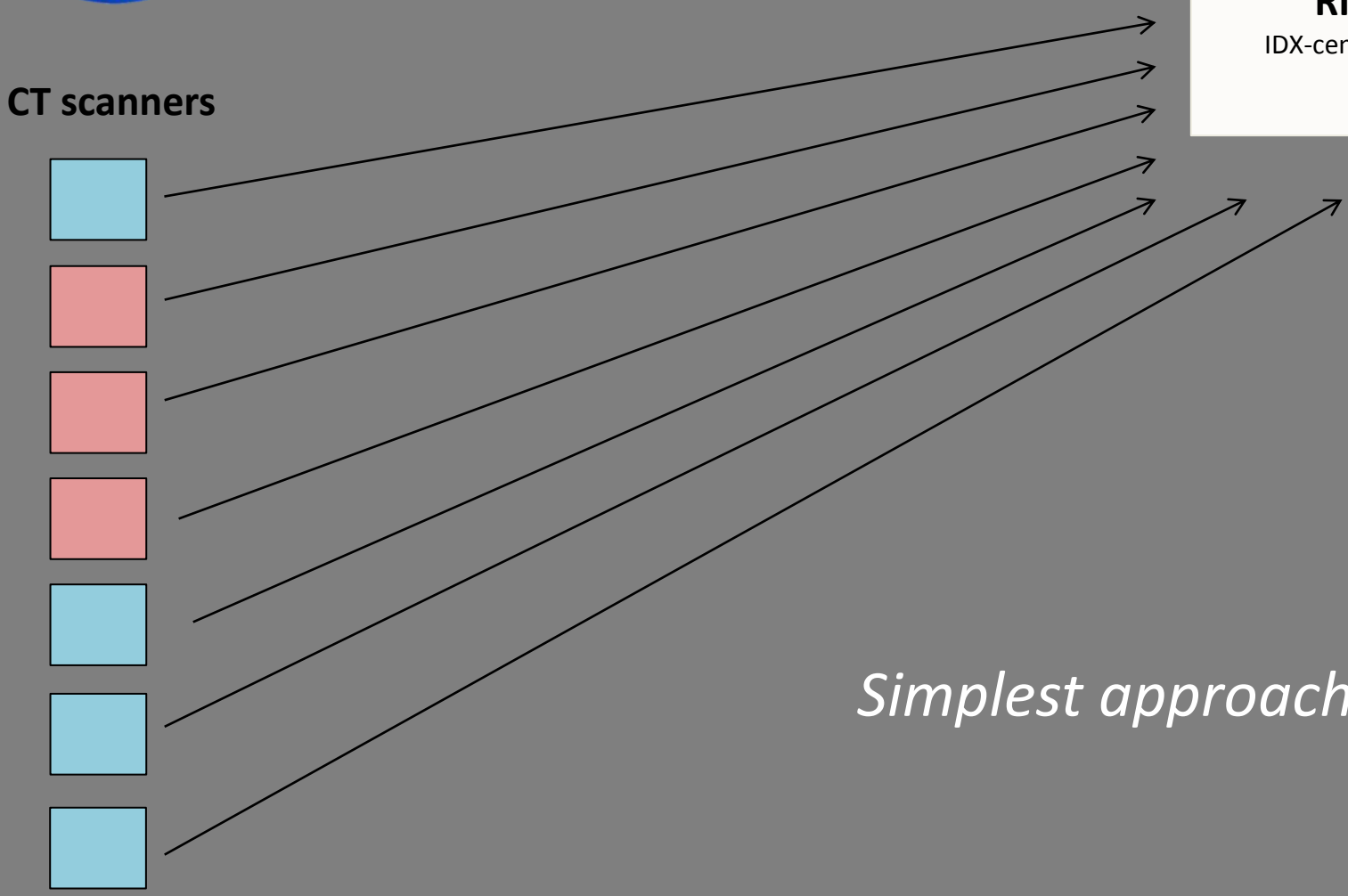
UC DOSE

UC DOSE researchers interviewed 4 different DOSE REPORTING software companies, and finally went with one.

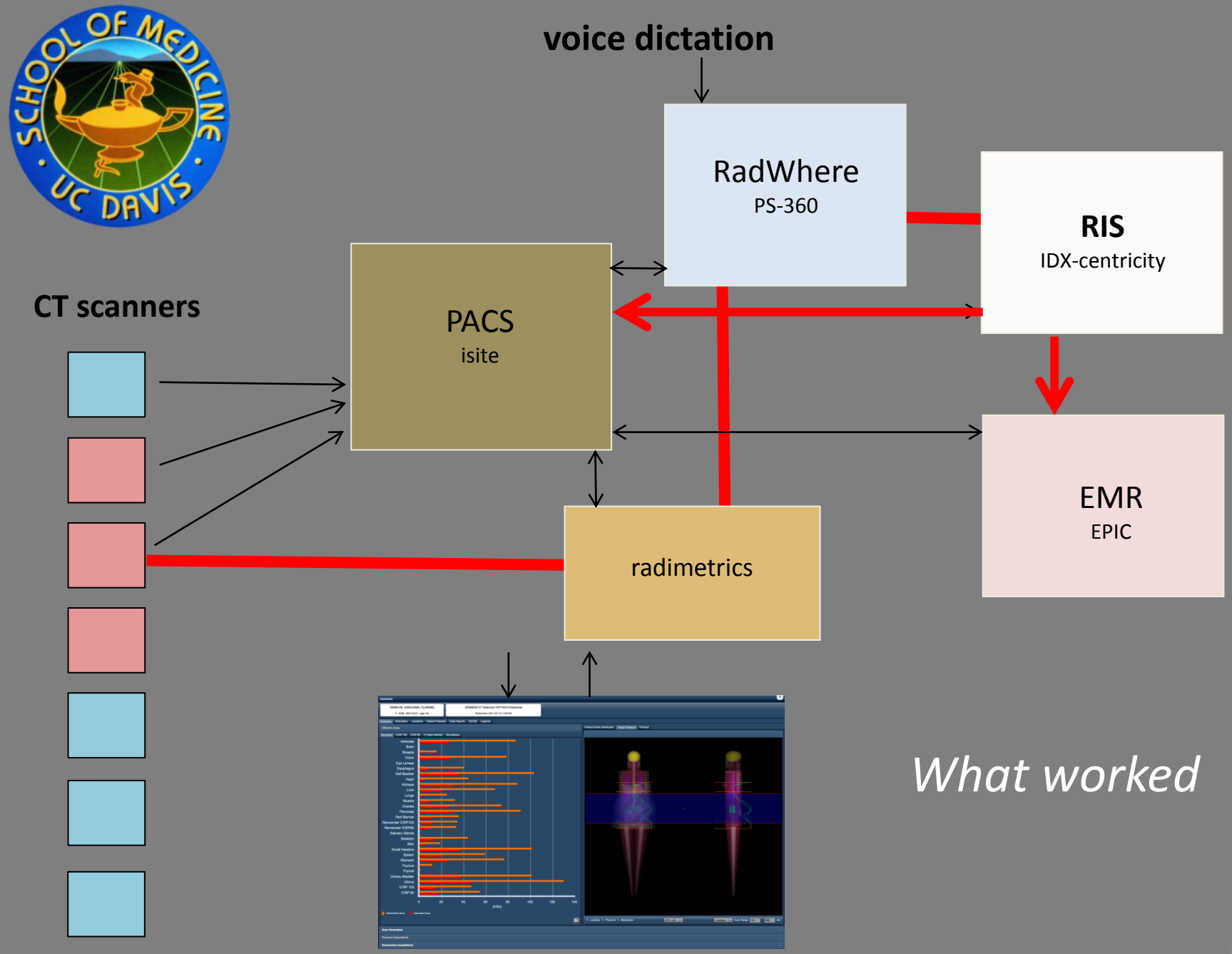
We negotiated that all 5 medical centers would receive this software FREE for 18 months, and we would work with the vendor to make it robust and useful.

Radiology Information System

where all of the radiology dictation is stored



Simplest approach


voice dictation
RadWhere
PS-360
RIS
IDX-centricity
CT scanners
PACS
isite
EMR
EPIC
radimetrics

What worked

The Structured Dose Report with Radimetrics Feed

Report: Gaga, Lady – MRN: 1234567

EXAM DATE [5/24/2012 12:35 pm]

INDICATION:
[]

DOSE:
[This was an abdomen-pelvis CT examination with two series, one with and one without contrast. Estimates of the radiation dose metrics that you received are:

Series 1: (no contrast)
CTDIvol = 12.4 mGy
DLP = 496 mGy-cm

Series 2: (with contrast)
CTDIvol = 13.2 mGy
DLP = 577 mGy-cm

These doses are {lower} {typical} {higher} than other patients having this same CT study]

FINDINGS:
[]

IMPRESSION:

[]

text and format are up for discussion

The Structured Dose Report with Radimetrics Feed

Report: Gaga, Lady – MRN: 1234567

EXAM DATE [5/24/2012 12:35 pm]

INDICATION:
[]

DOSE:
[Dose information for this CT examination:

Series 1: (no contrast)
CTDIvol = 12.4 mGy
DLP = 496 mGy-cm

Series 2: (with contrast)
CTDIvol = 13.2 mGy
DLP = 577 mGy-cm

UC Davis Health System CT scanners are accredited by the American Board of Radiology, and employ modern techniques for CT dose reduction, including protocol review, automatic exposure control, and iterative reconstruction techniques. These features assure that radiation dose levels in CT are optimized and are consistent with state of the art CT practice.]

FINDINGS:
[]

IMPRESSION:

[]

text and format are up for discussion

The Structured Dose Report with Radimetrics Feed

Report: Gaga, Lady – MRN: 1234567

EXAM DATE [5/24/2012 12:35 pm]

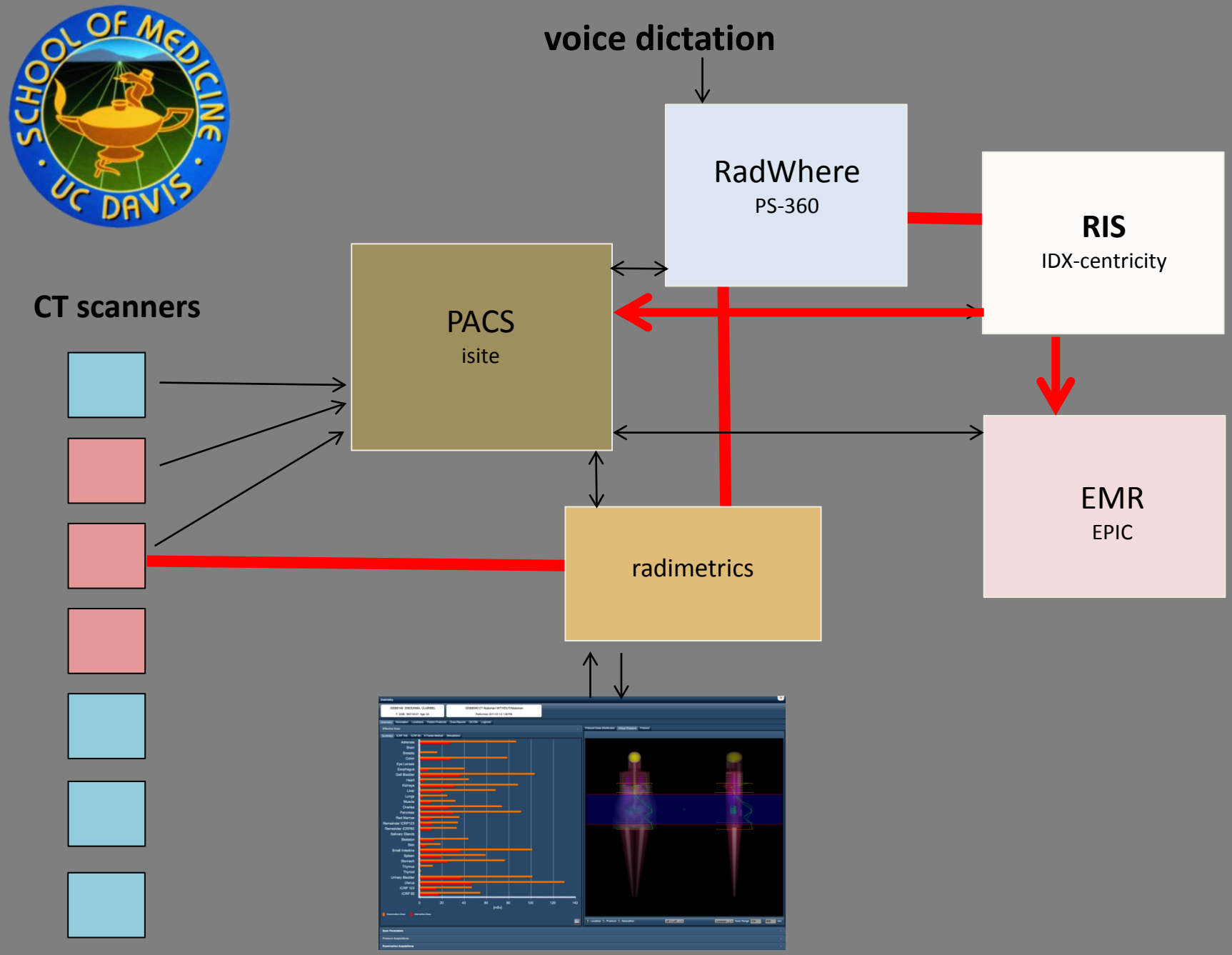
INDICATION:
[]

DOSE:
[There were two exposure events in this study:
Series 1: CTDI=12.4, DLP=496, 32 cm
Series 2: CTDI=13.2, DLP=577, 32 cm
See www.ucdavis.edu/CTdose for further information.]

FINDINGS:
[]

IMPRESSION:

[]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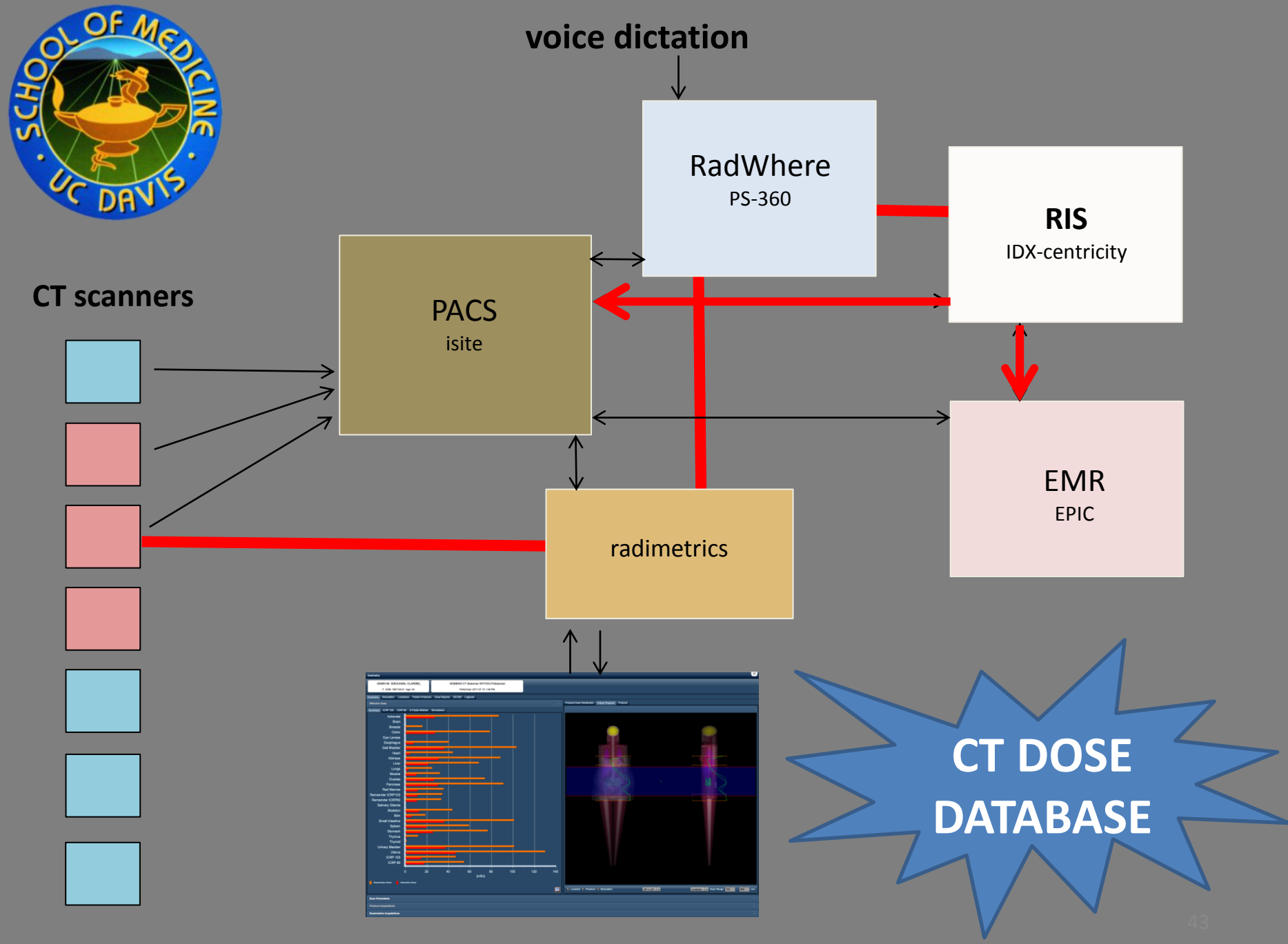
voice dictation
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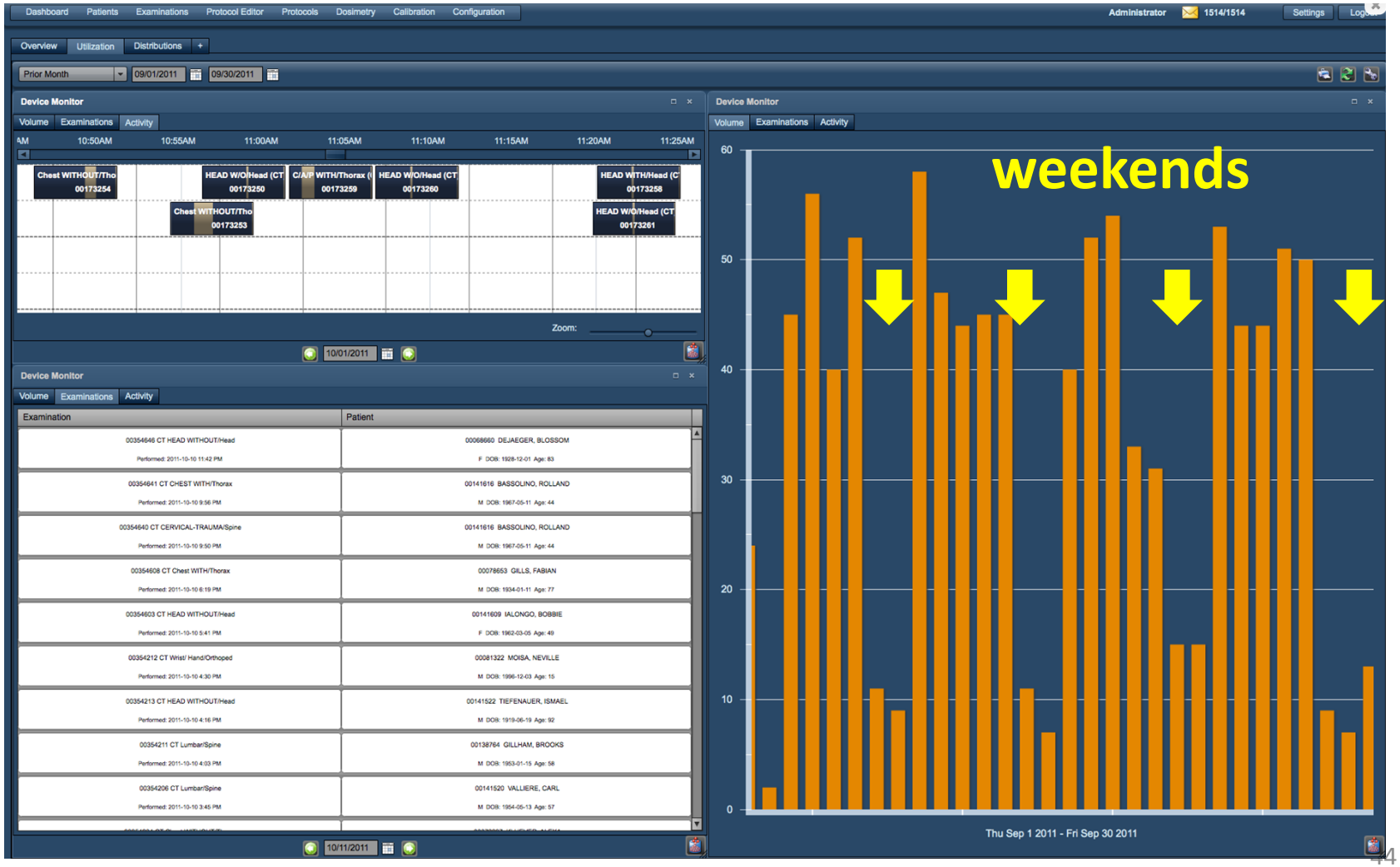
CT DOSE
DATABASE

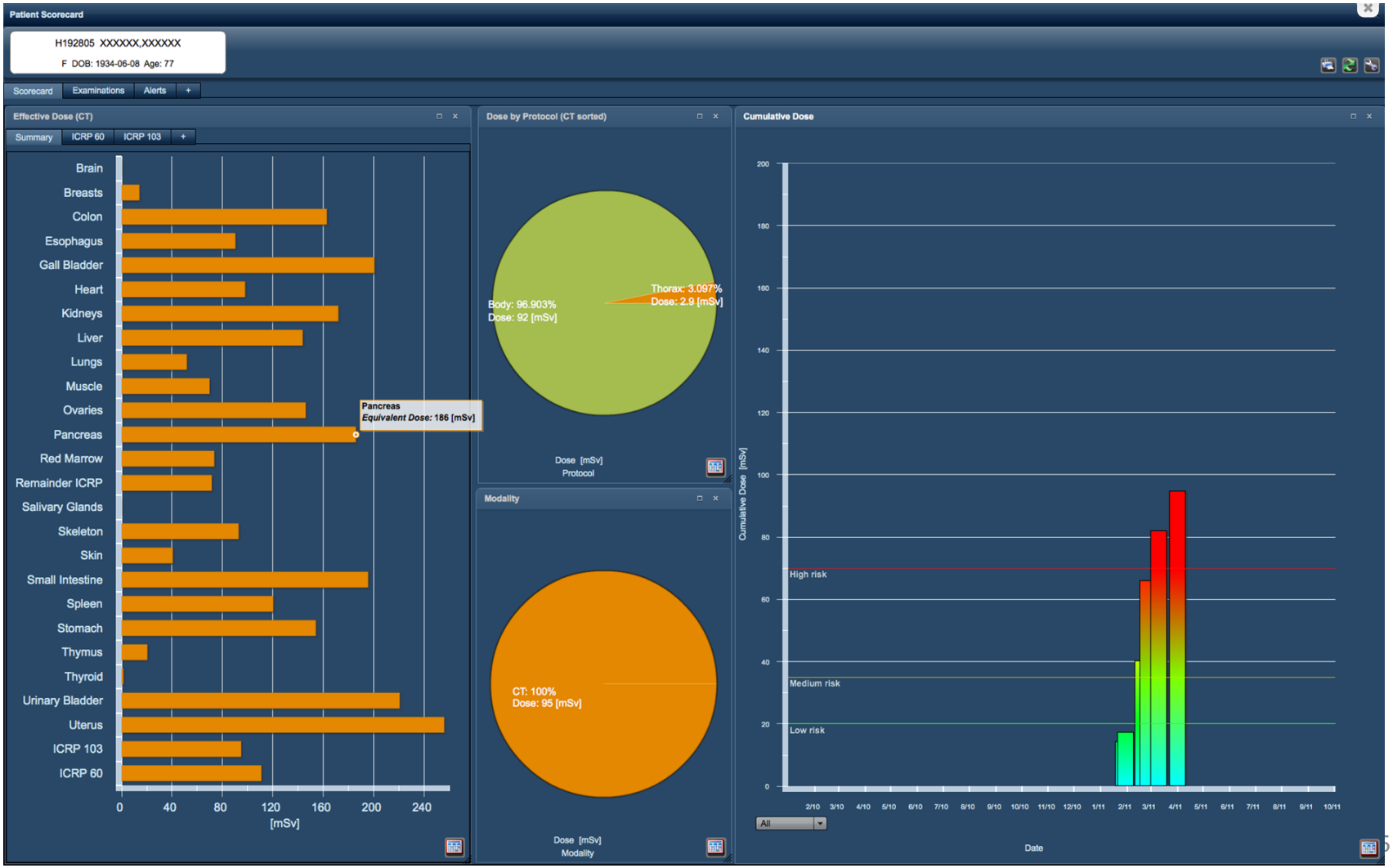
Software based analysis of CT doses

CT scans per day



Software based analysis of CT doses

Individual patient's cumulative effective dose by organ



Software based analysis of CT doses

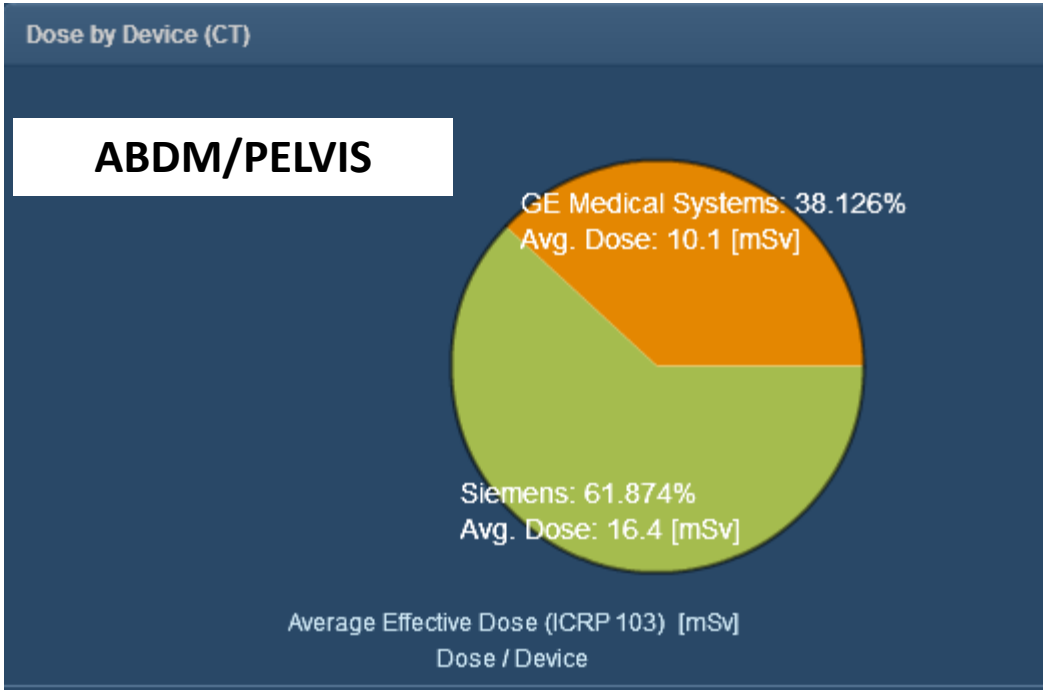
Break-down of CT procedures for different CT scanners

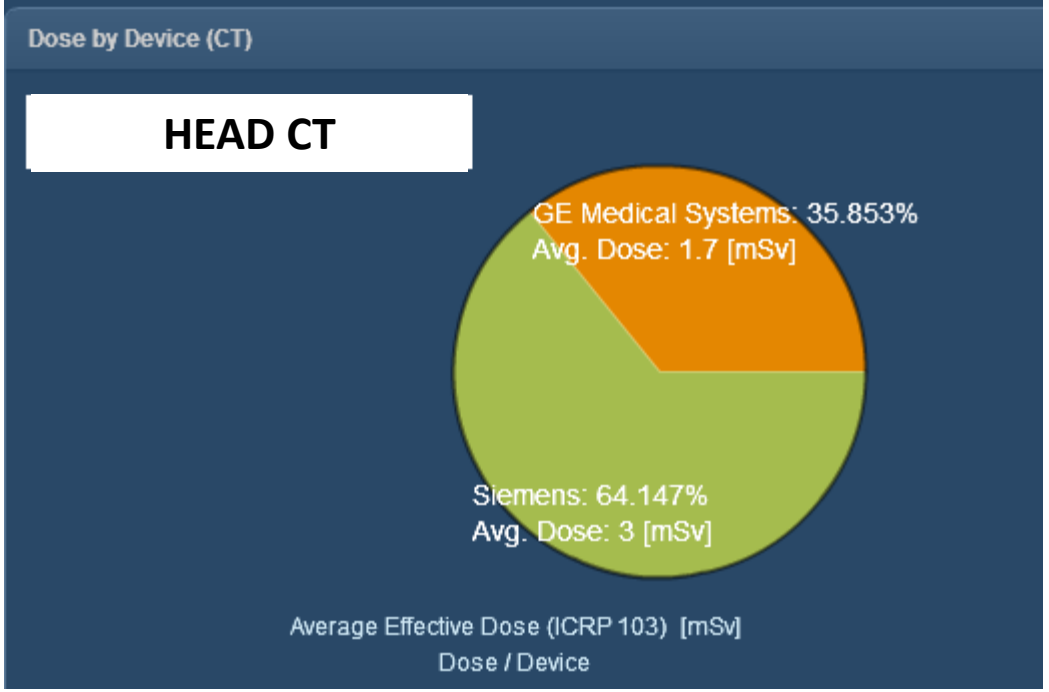
Dose by scanner

Software based analysis of CT doses

Dose by scanner type

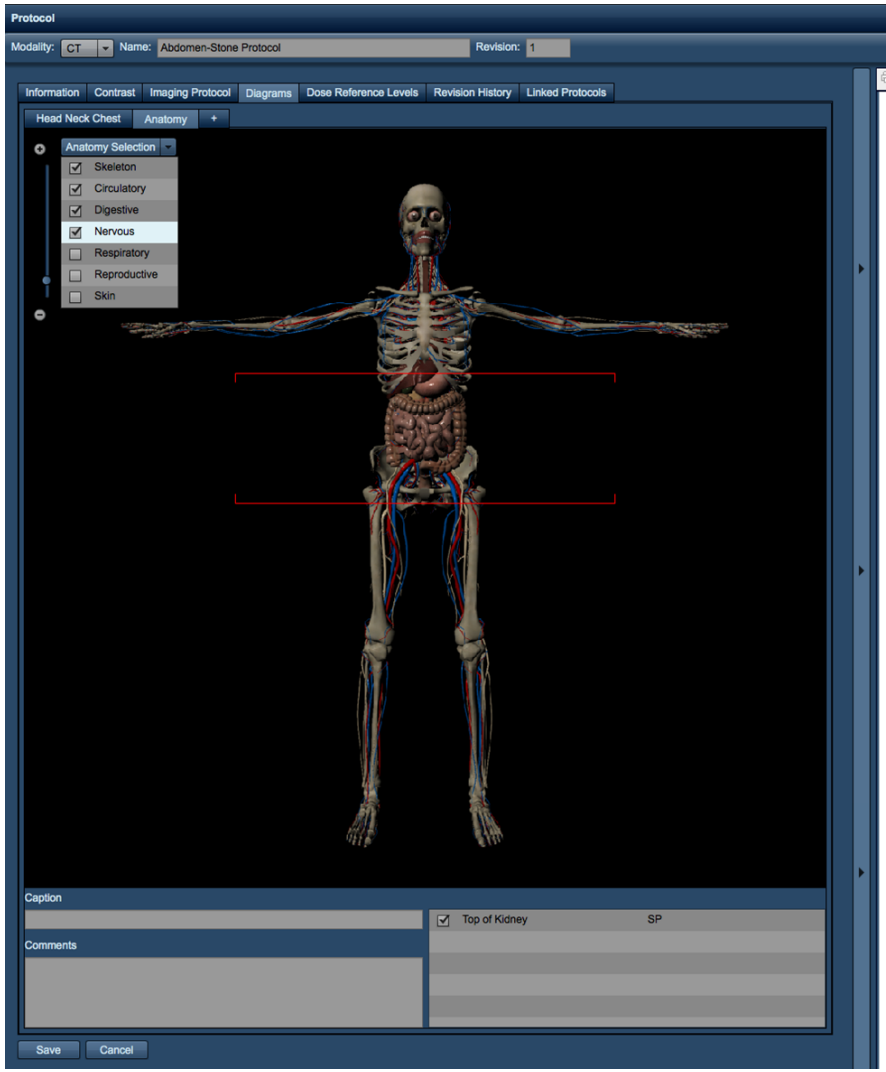
Software based analysis of CT doses

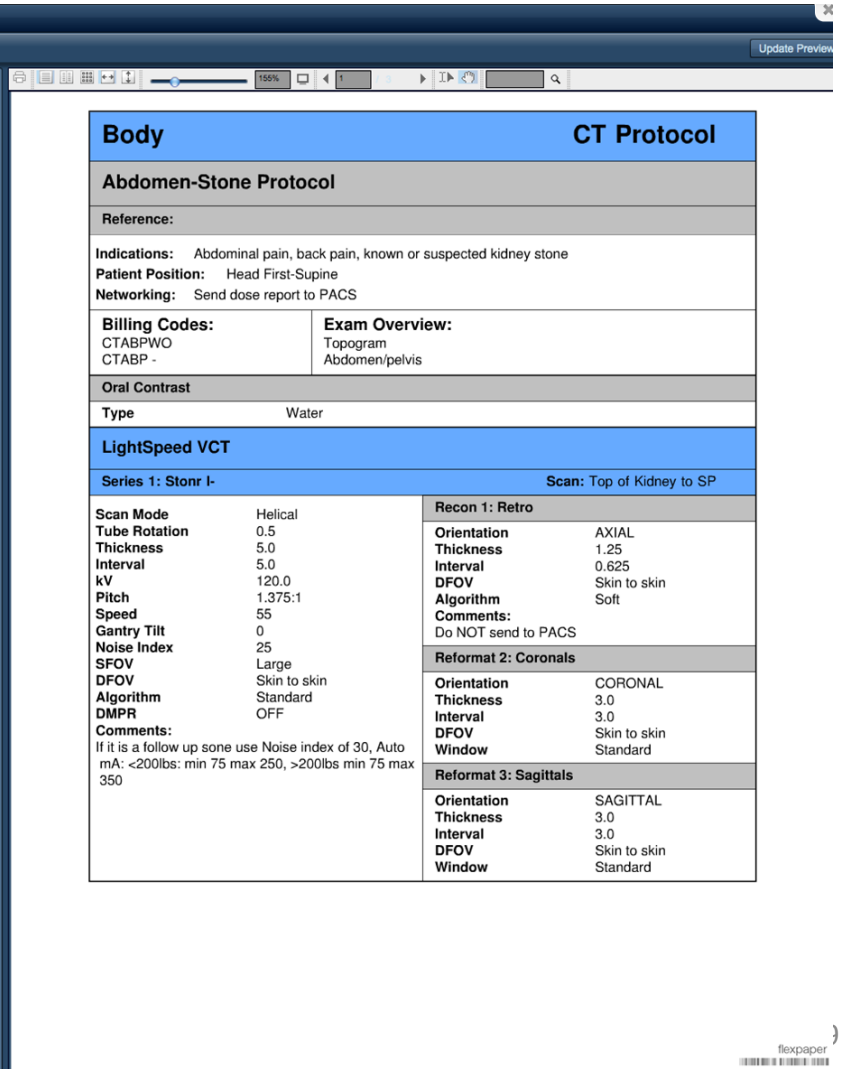




Software based analysis of CT doses

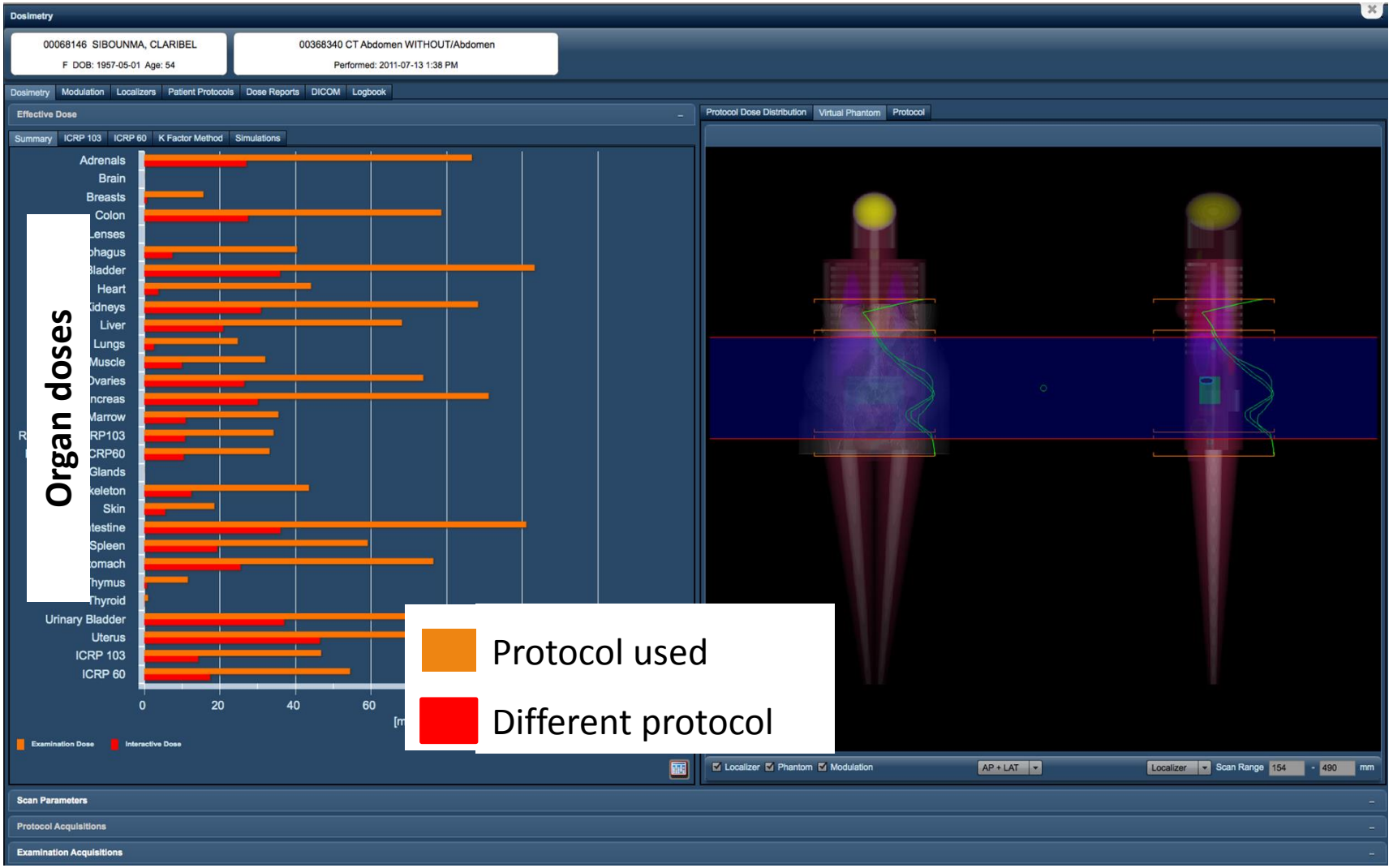
CT protocol review



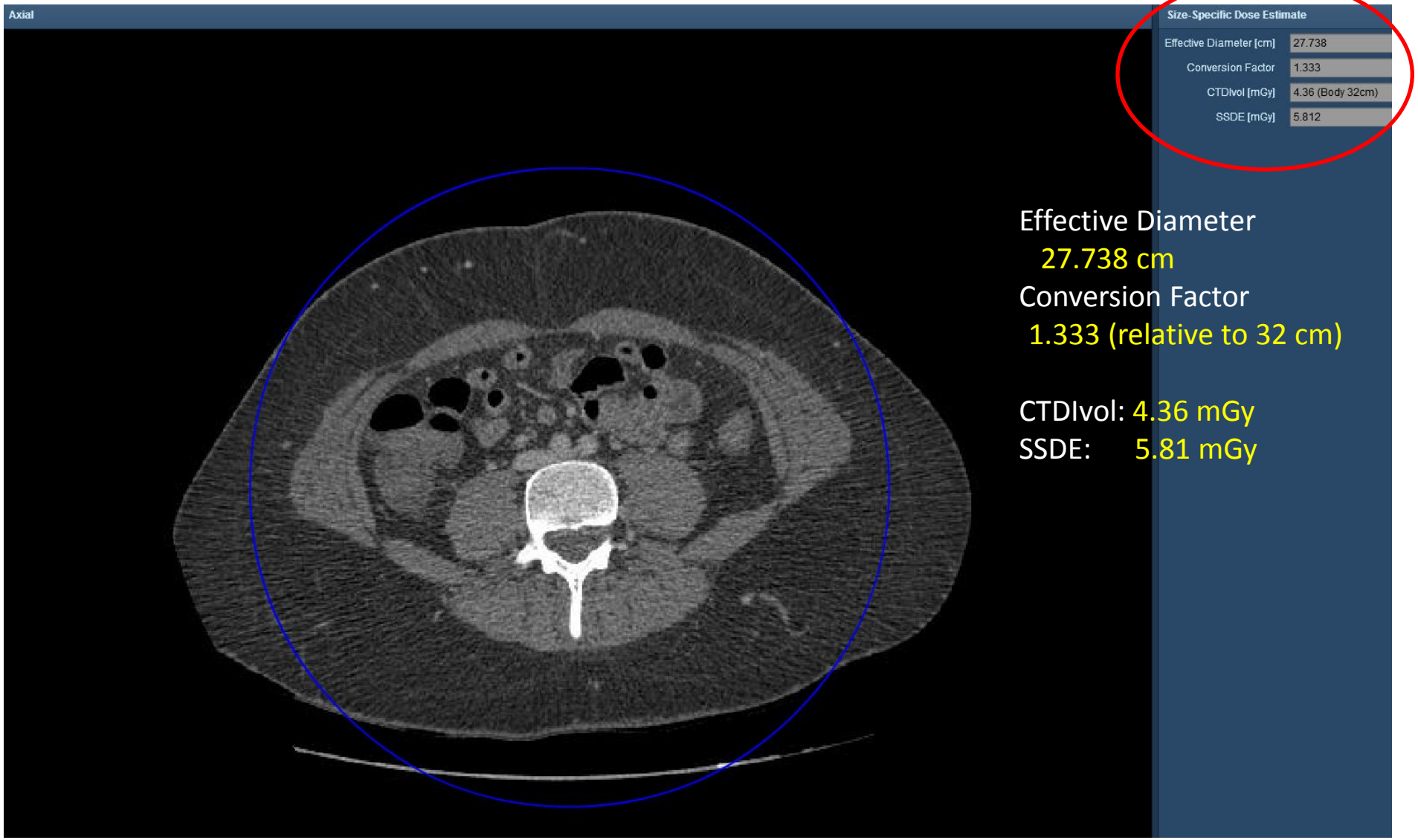


Software based analysis of CT doses

Protocol review: “What IF” scenarios



SSDE modification to CTDIvol

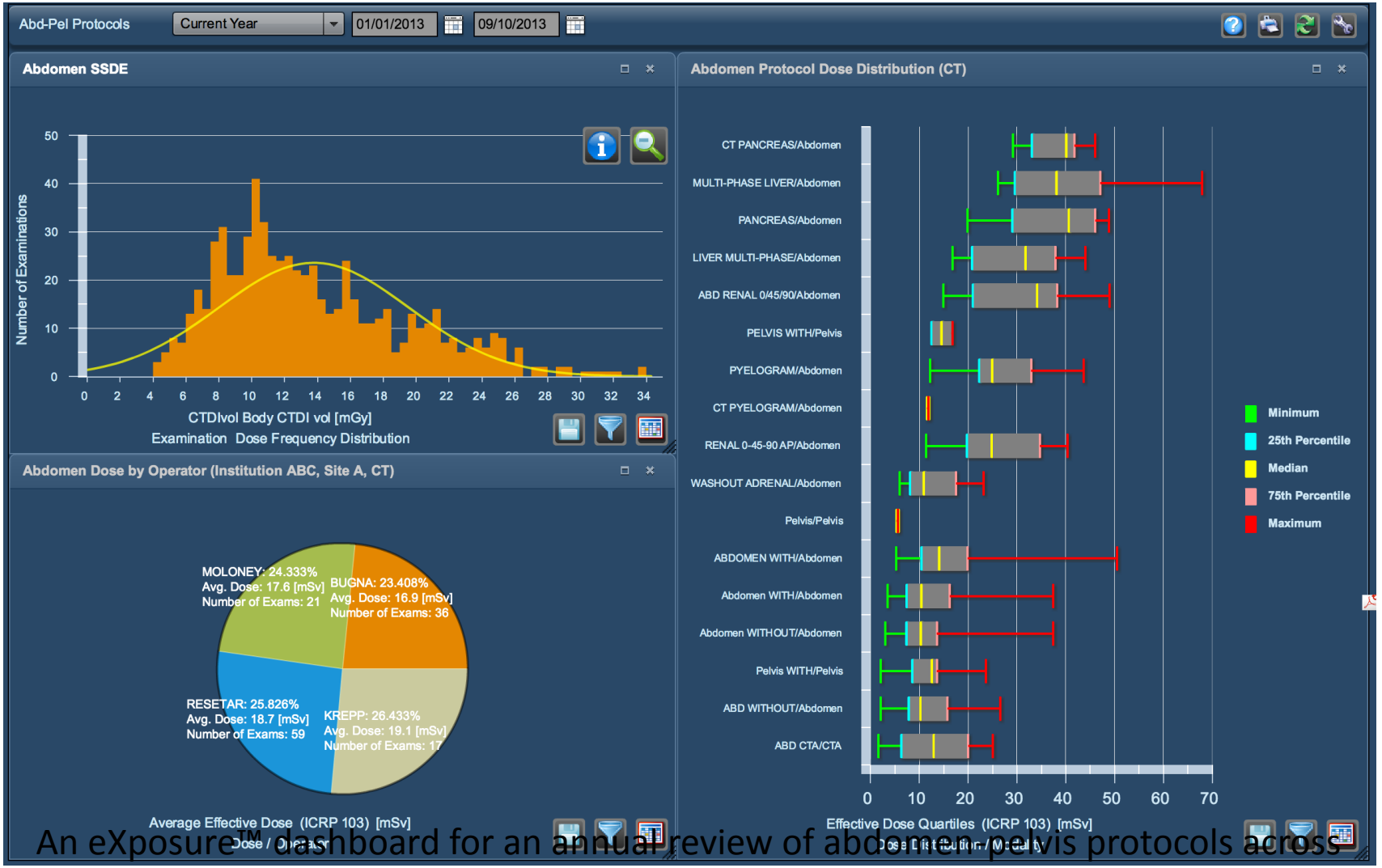


Effective Diameter
27.738 cm
Conversion Factor
1.333 (relative to 32 cm)

CTDIvol: 4.36 mGy
SSDE: 5.81 mGy

Software based analysis of CT doses

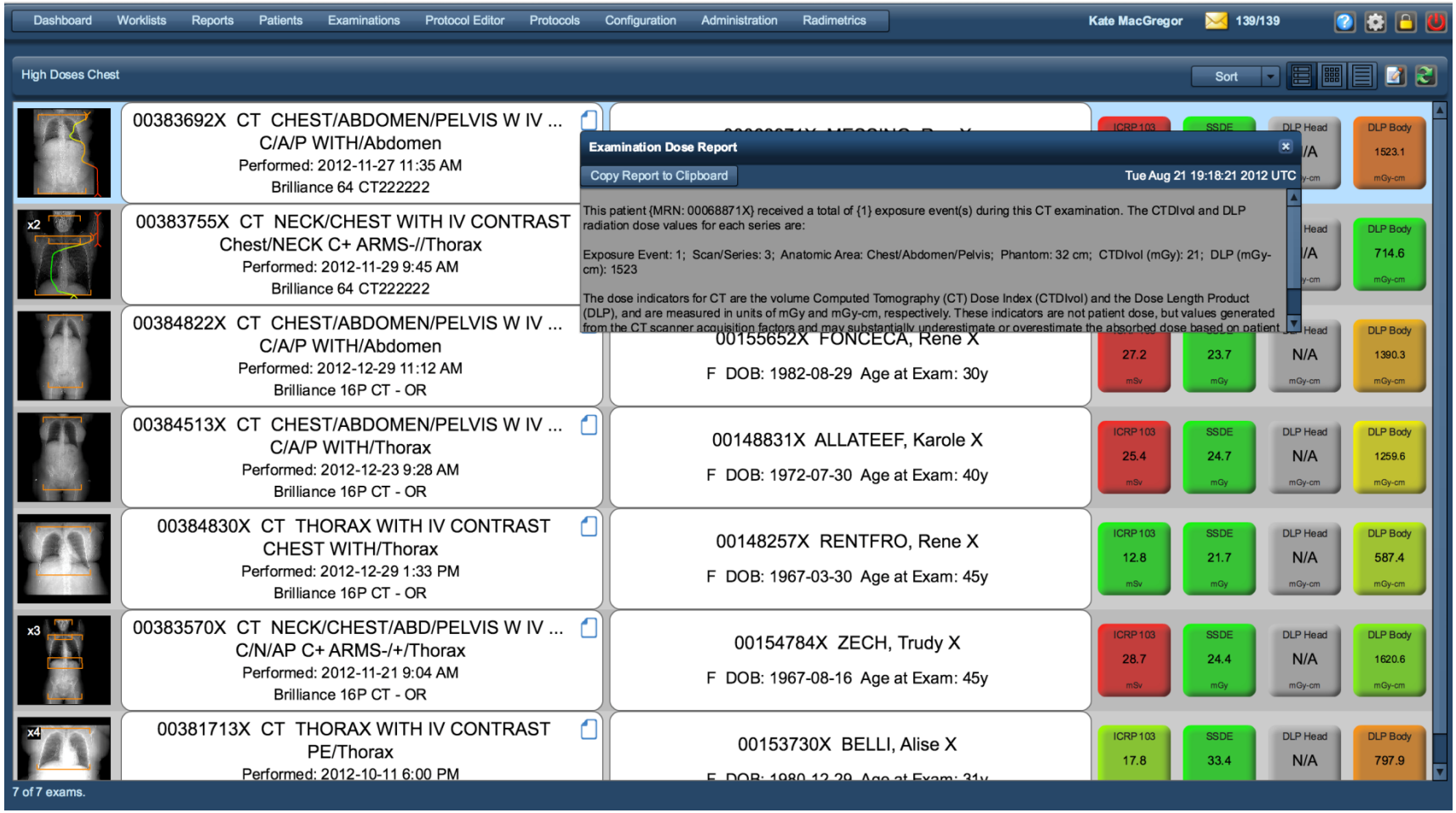
Protocol review across sites (abd-pelvis)



An eXposure™ dashboard for an annual review of abdomen-pelvis protocols across multiple sites.

Software based analysis of CT doses

Rapid review of dose reports by patient



Software based analysis of CT doses

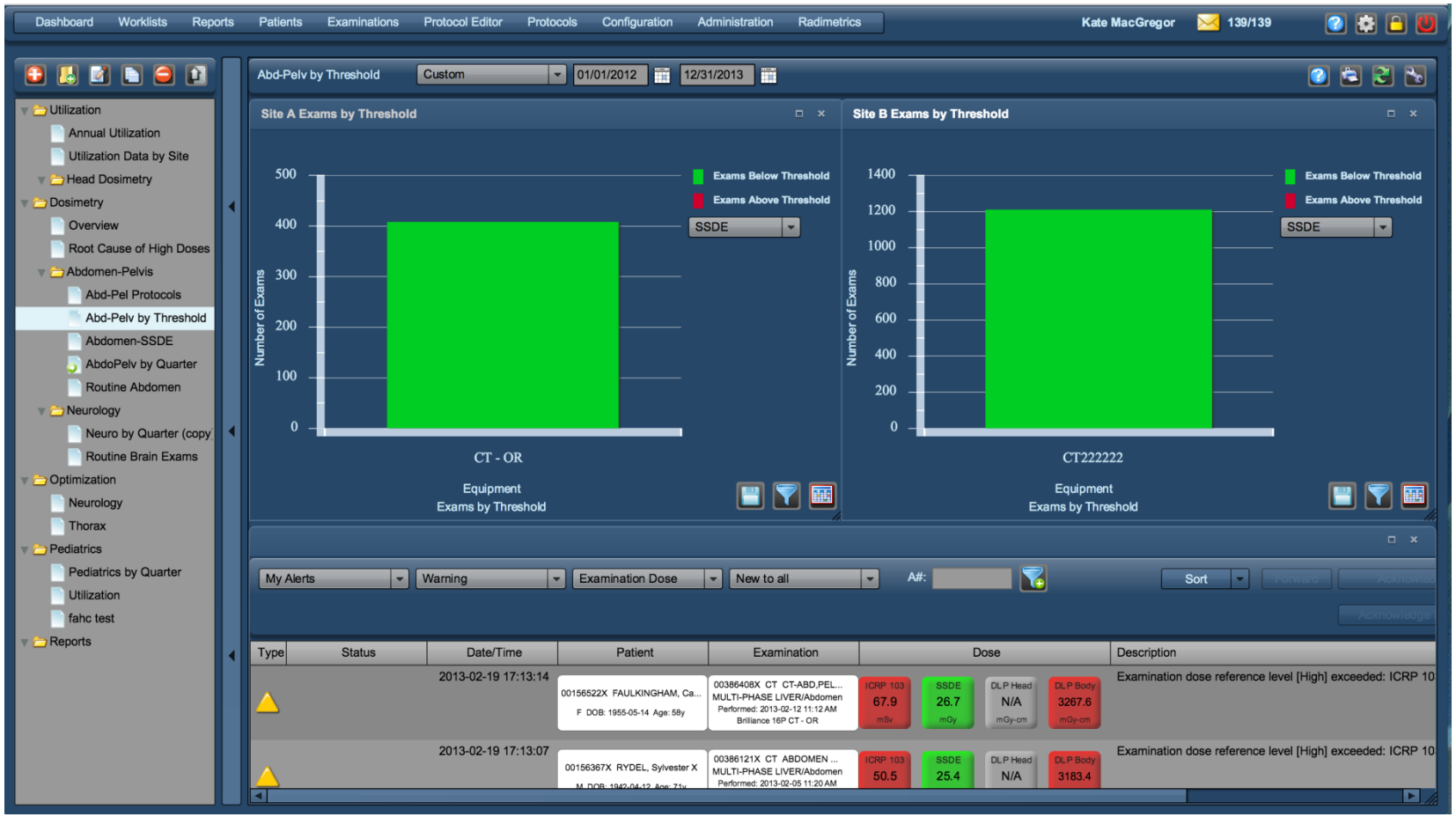
Dose Alerts for patients with high doses

Software based analysis of CT doses

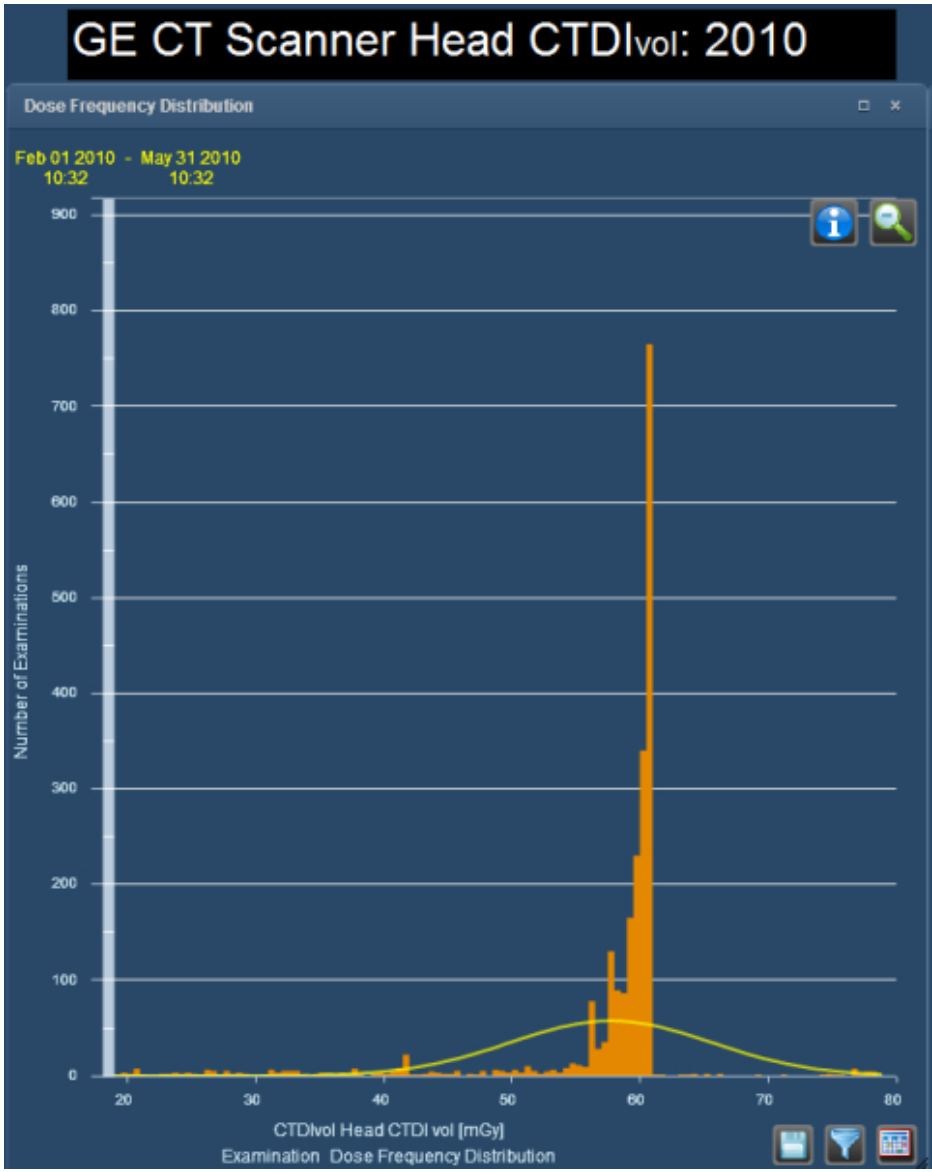
$CTDI_{vol}$ based Dose Alerts by CT protocol (red=alert)

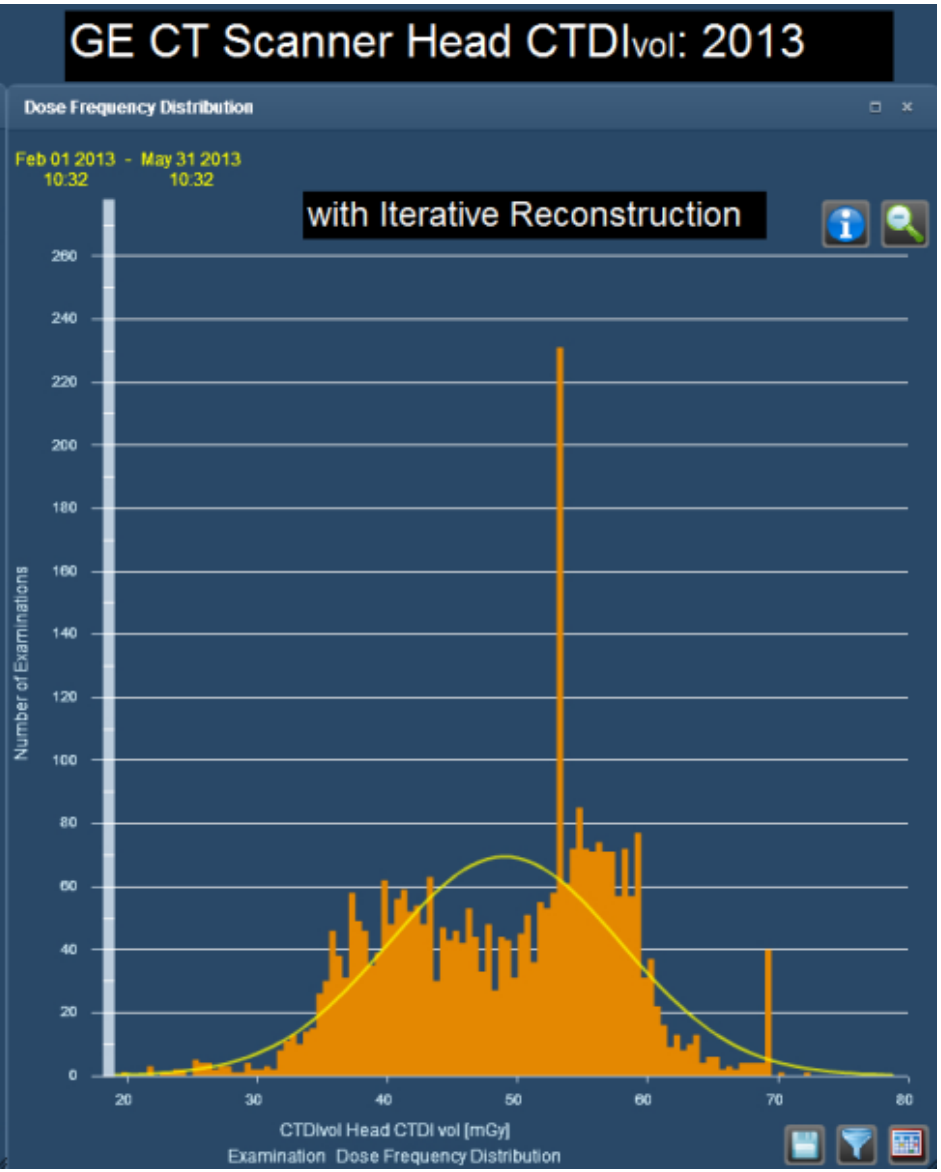
Software based analysis of CT doses

SSDE based Dose Alerts by CT protocol (alerts gone)

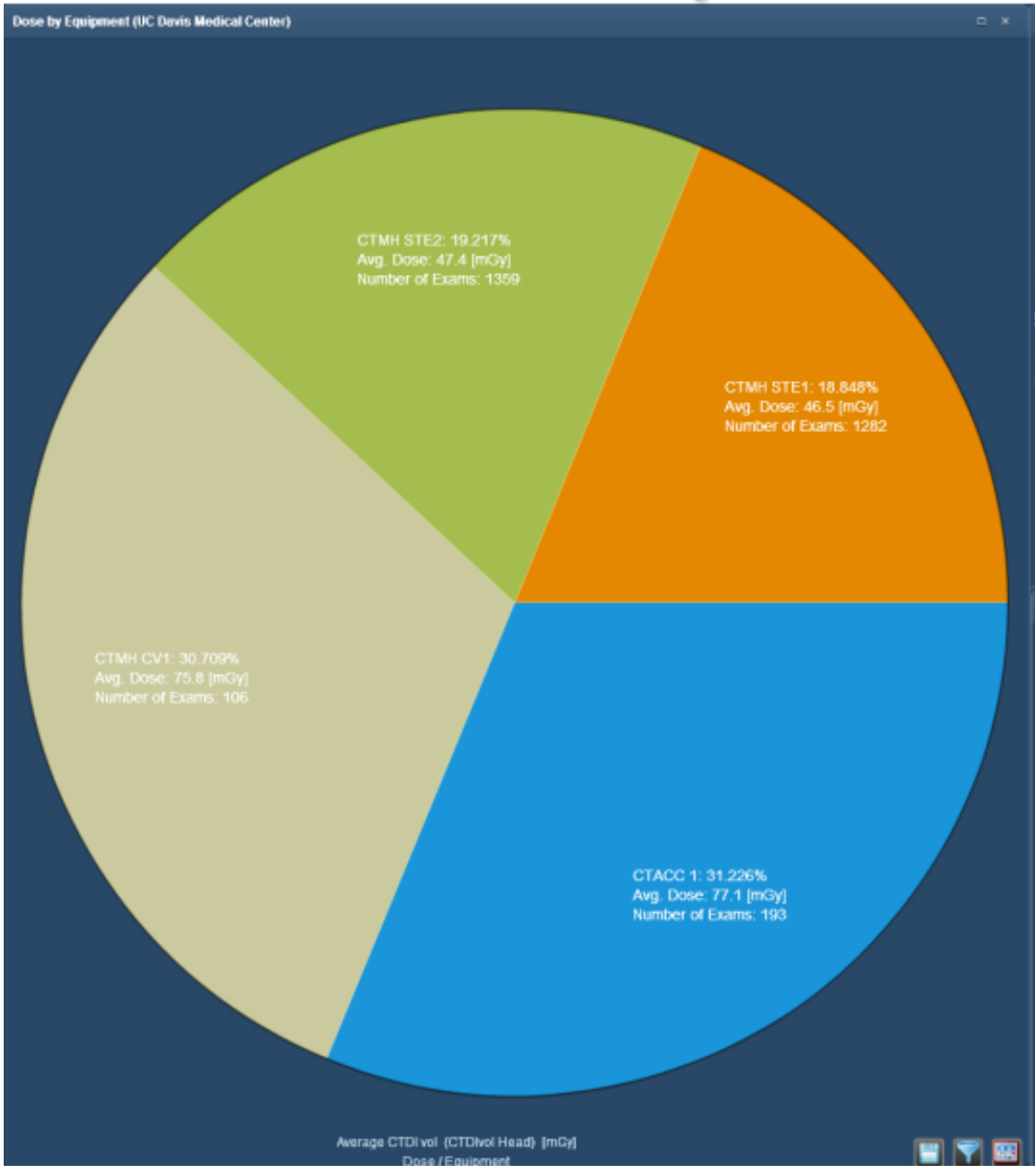


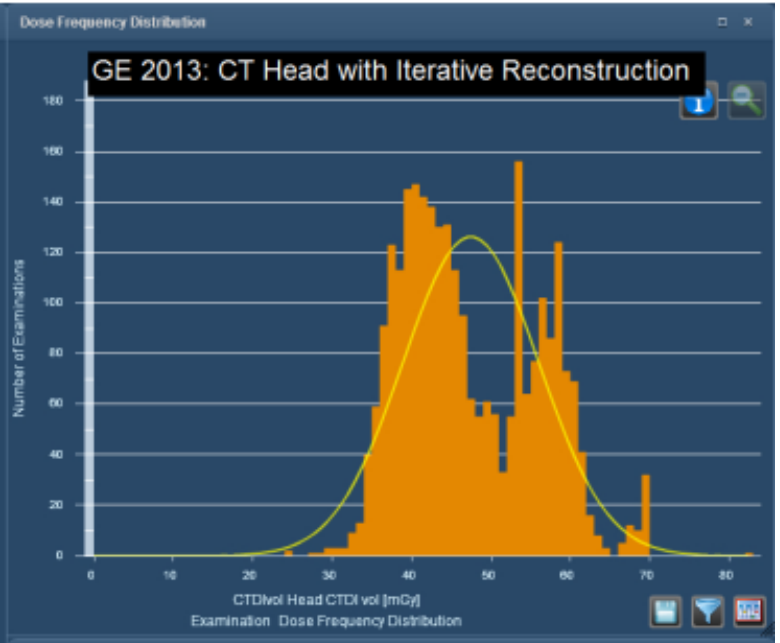
Before & After implementation of IR Software

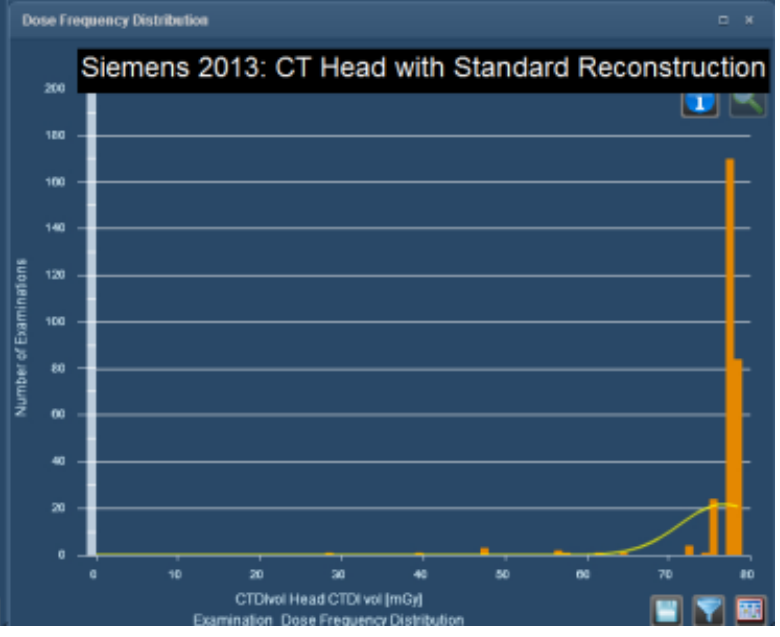




Before & After implementation of IR Software







California Law: Dose Tracking Software
(new technology for managing CT dose)

- What got us here (review)
- California Senate Bill 1237 (review)
- Actual Requirements of the Law
- Unintended (positive) Results of the Law
- Summary

California Law: Dose Tracking Software

Summary

- Several CT accidents happened in California
- A CT DOSE law was passed
- Software to address the law has been developed
- It provides excellent CT protocol evaluation
- Medical Physicists should become more involved in CT protocol evaluation

California Law: Dose Tracking Software
(new technology for managing CT dose)

What got us here (review)

California Senate Bill 1237 (review)

Actual Requirements of the Law

Unintended (positive) Results of the Law

Summary

Introduction