

# Tracking Radiation Exposure From Medical Diagnostic Procedures: Siemens Perspectives

**Gilbert W. Beebe Symposium**  
**The National Academies**

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# Dose Measures and Standardization



## General

- Dose related measures and standards (e.g.  $CTDI_{vol}$  and DLP, DICOM SR) are typically defined by IEC, FDA and/or other country specific governing bodies.
  - Further standard/recommendations are given by organizations such as ACR or AAPM
- Siemens complies with standards
- Vendors contribute constructively to dose awareness efforts/campaigns via MITA (e.g. MITA CT DOSE CHECK INITIATIVE)

# Dose Measures and Standardization

## Example I: DICOM SR (Dose Report)



**Patient Browser**

Intervention  
ida, oberstein  
Local Database  
Scheduler  
DVD-RW

haudslkj, xyz  
Head Dental (v...)  
{502} Dose Report

feuerlein, emil  
ExtrMultiPhase\_VAr  
carla, columna

Patient name haudslkj, xyz  
Study description Head Dental (Adult)

Date of birth 18-Sep-1910  
Study date 18-Sep-2009

Patient ID 1234  
Modality SR

1  
18-Sep-20...

Current Filter: Off

haudslkj, xyz - X-ray Radiation Dose Report - Microsoft Office InfoPath 2003

File Edit Help

Note: Some parts of this DICOM SR Document cannot be displayed with the current stylesheet. They will not be lost or modified while editing, saving or exporting the DICOM SR Document.

### X-ray Radiation Dose Report

Procedure reported, Has Intent: Diagnostic Intent: Computed Tomography X-ray

Patient's Name haudslkj, xyz

Patient ID 1234  
Day of Birth 18.09.1910  
Sex M

Referring Physicians Name

Content Date 18.09.2009  
Content Time 14:43:06

Completion Flag COMPLETE  
Verification Flag UNVERIFIED

Go To Detailed View

Observer Type

Device

Device Observer UID

74998

Device Observer Name

Form ID: urn:GenericReport:SiemensMEDSW

# Dose Measures and Standardization

## Example IIa: Dose Check MITA XR-25

01\_AbdMultiPhase (Adult) 10.10.19-15:18:21-DST-Specials PolyTraum 10.10.19-15:18:21-DST- Total mAs: 184

Topogram  
Non Contrast RT 1  
Pause  
PreMonitoring  2  
Contrast  
Monitoring  3  
Arterial Phase RT  4  
Venous Phase RT  5

Load Hold Recon Recon

Eff. mAs 197 CARE Dose4D  
kV 140 CTDIvol (32cm): 19.43 mGy DLP: 459.3 mGy\*cm  
Scan time 5.62 s configured ref. value: 10.00 mGy  
Delay 2 s  
Slice 5.0 mm Acq. 128 x 0.6 mm  
No. of images 45  
Comments

Dose Notification

Arterial Phase: DLP (38.8 mGy\*cm) exceeds the notification value (12.0 mGy\*cm).  
Venous Phase: CTDIvol (17.79 mGy) exceeds the notification value (10.00 mGy).  
Venous Phase: DLP (420.6 mGy\*cm) exceeds the notification value (12.0 mGy\*cm).

Diagnostic reason

Load Cancel

3D Simulation

# Dose Measures and Standardization

## Example IIb: Dose Check MITA XR-25

**Examination Configuration**

Patient | **Dose** | Workflow | Topogram | Processing | Contrast

Display Options

Dose Notification    Dose profile     Exposed range

Dose Report

Activate Dose Report     Auto transfer     Additional transfer: None

Dose Alert

Adult  mGy    Child  mGy

DLP  mGy\*cm     mGy\*cm


OK    Apply    Default Settings

CARE Dose4D configuration: mAs adaptation to patient size

<input type="checkbox"/> Organ characteristics	Child	Adult slim	Adult obese
<input type="checkbox"/> Brain	Average	Average	Average
<input type="checkbox"/> Neck	Very weak	Average	Average
<input type="checkbox"/> Shoulder	Very weak	Average	Average
<input type="checkbox"/> Thorax	Very weak	Average	Average
<input type="checkbox"/> Abdomen	Very weak	Average	Average
<input type="checkbox"/> Pelvis	Very weak	Average	Average

**Dose Alert**

A dose value will be exceeded!

 The accumulated CTDIvol (767.47 mGy) will locally exceed the alert value (700 mGy for Adult). Please reconsider the current examination procedure.

Hint: The currently used scan protocol can not be saved!

User name (mandatory) |

Diagnostic reason

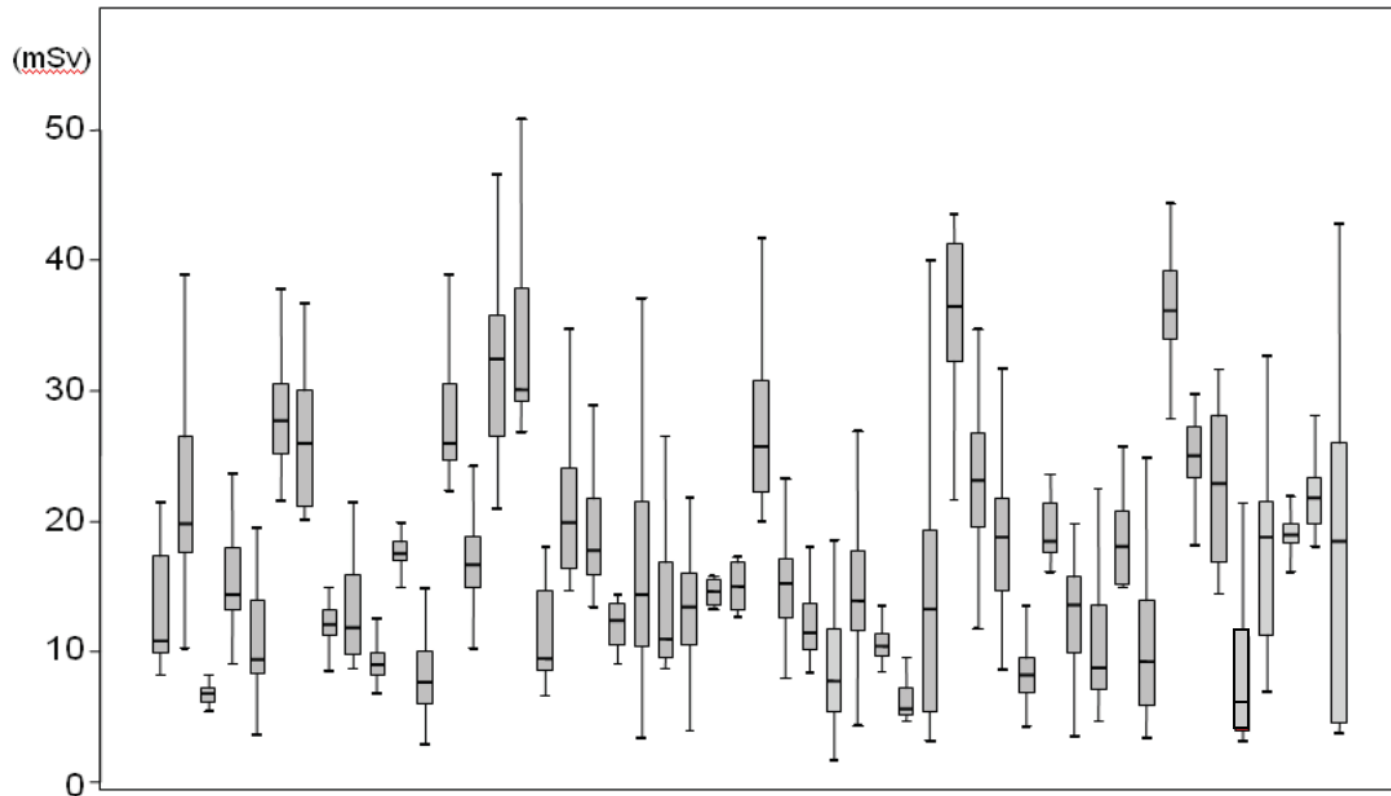
Load    Cancel

# Variations in Reported Dose for Same Exam

Example: Cardiac CTA

## The Protection1 Study\*

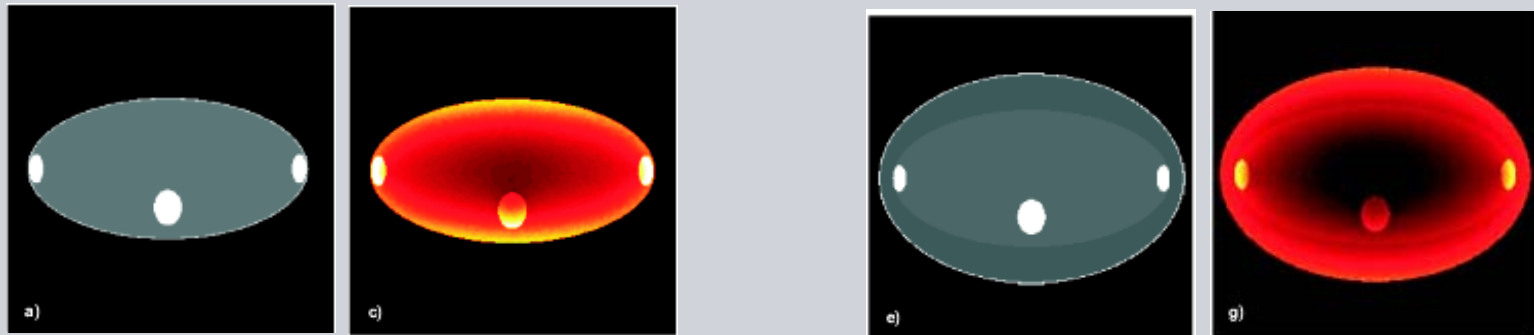
- Multi-center multi-vendor trial, 50 sites, 1965 coronary CTAs
- Mean radiation dose: 5.7 mSv – 36.5 mSv



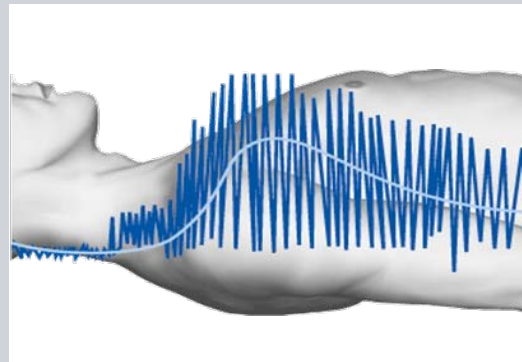


# Variations in Reported Dose for Same Protocols BUT ....

- Impact on patient individual dose at SAME parameters (equivalent CTDIvol for small and large patients) is not considered



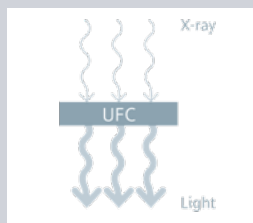
- Impact of dose reduction tools is considered (e.g. CAREDOSE4D) via CTDIvol and DLP



# Equipment Features to Reduce Exposures

## Overview

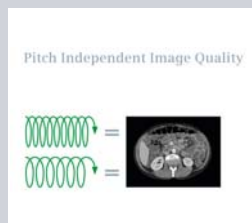
**SIEMENS**



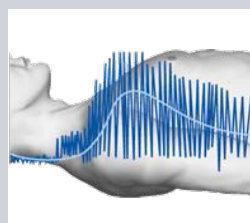
UFC



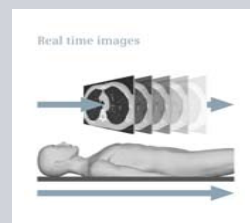
DICOM SR



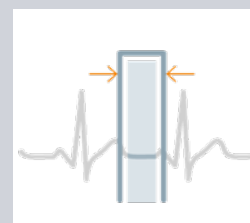
SureView



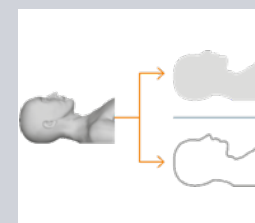
CARE Dose4D



Real-time Imaging



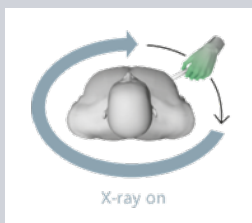
Adaptive ECG-Pulsing



4D Noise Reduction



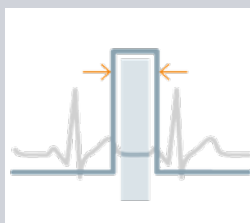
Dose Alert & Notification



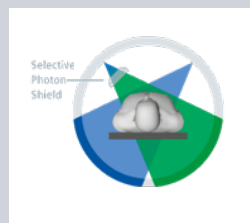
Hand CARE



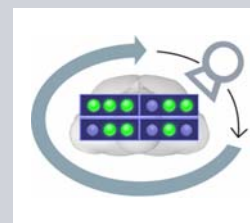
CARE Analytics



Adaptive Cardio Sequence



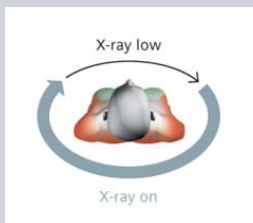
Selective Photon Shield



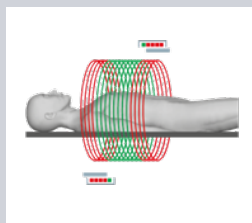
CARE Dashboard



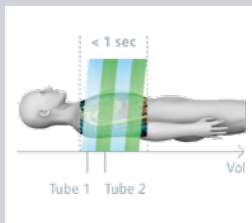
IRIS



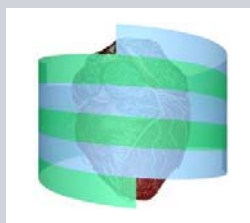
X-CARE



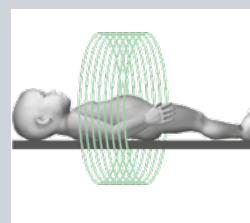
Adaptive Dose Shield



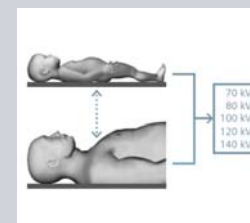
Flash Spiral



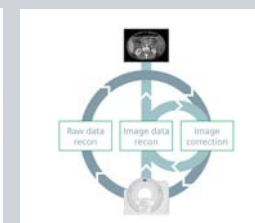
Sub-mSv heart



Pediatric 70 kV Protocols



CARE kV



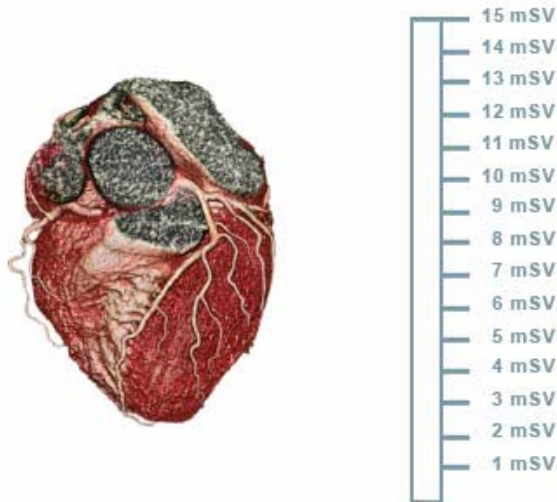
SAFIRE\*

# Equipment Features to Reduce Exposures

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## High-Pitch Spiral on DSCT Systems for Cardiac Scanning

### Conventional CTA



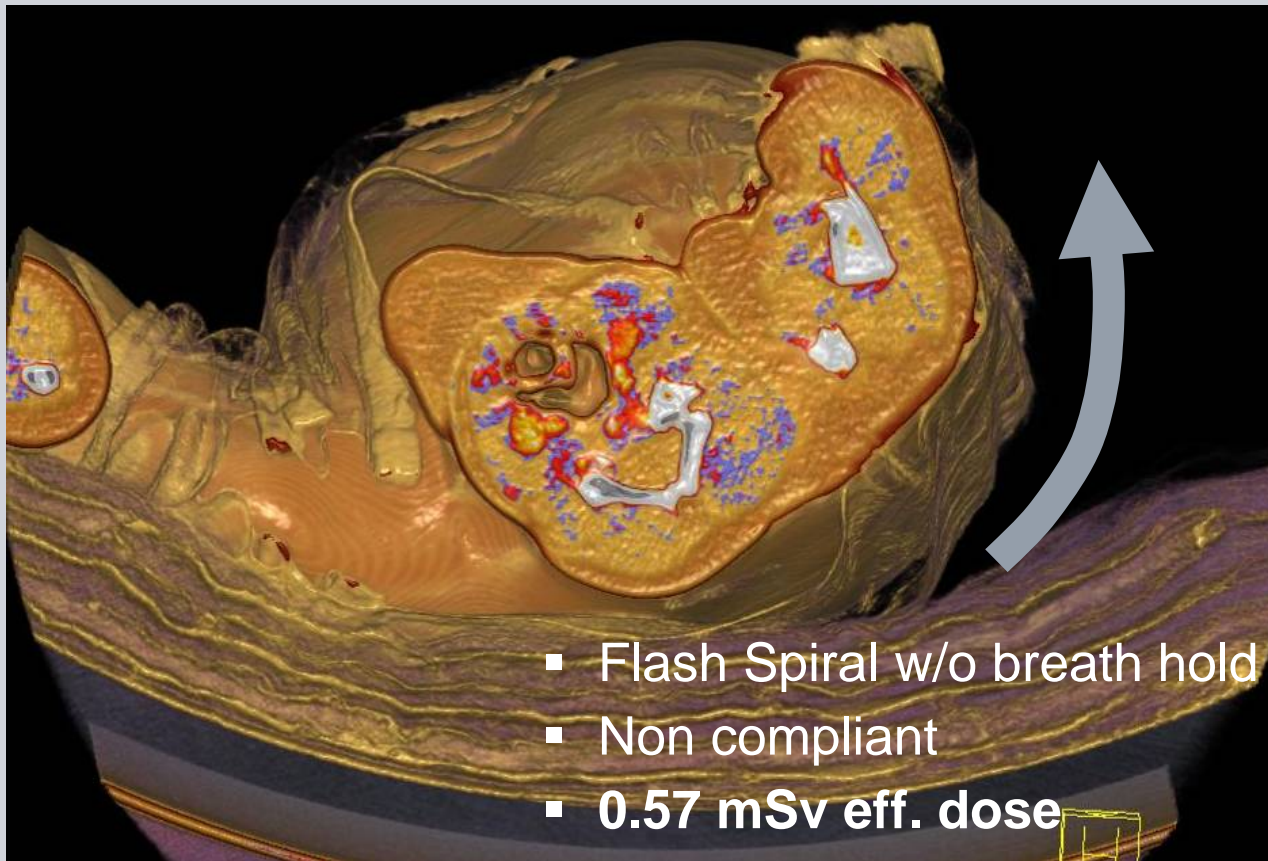
- 135 - 175 ms temporal resolution
- 2-10 s scan time
- Low Pitch + Overlap = Robustness
- Up to 30 mSv dose<sup>1</sup>

# Equipment Features to Reduce Exposures

SIEMENS

## High-Pitch Spiral on DSCT Systems for Pediatric Scanning

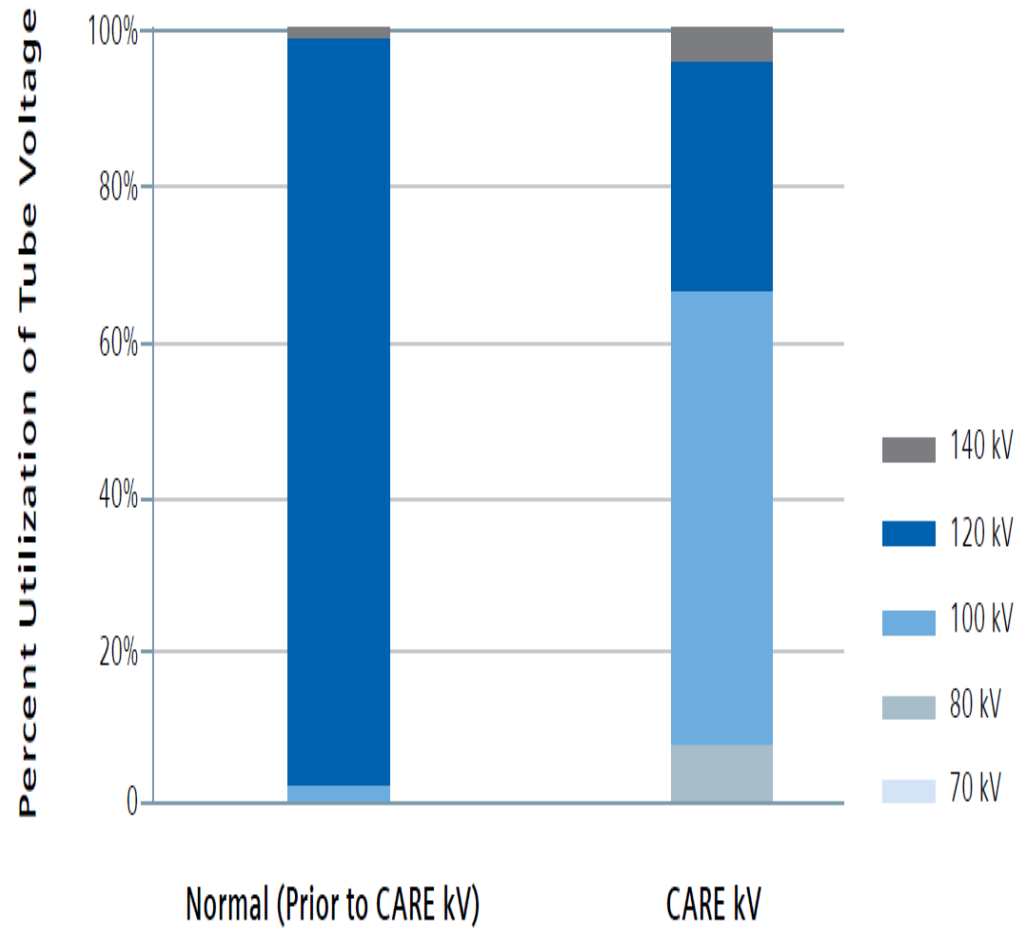
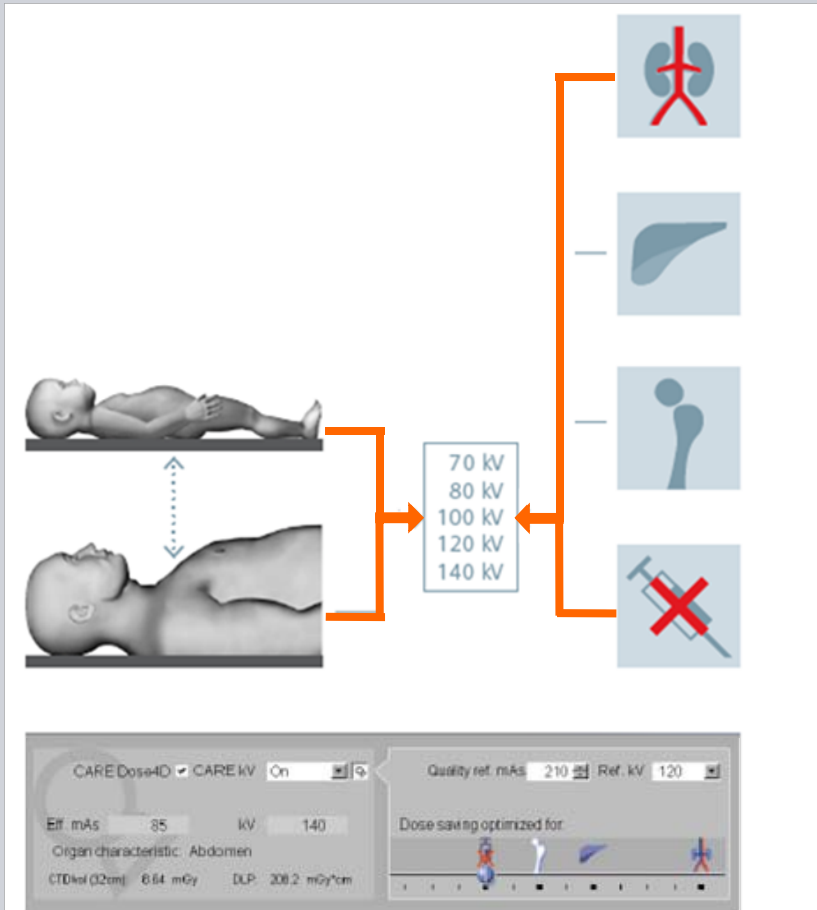
- 13 month old boy, NO SEDATION
- Suspected congenital heart defect
- Tried to get up during scan



# Equipment Features to Reduce Exposures

## CARE kV: Automated, exam-specific kV setting

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Source: Internal data evaluation based on anonymous assessment on SRS connected scanners.

# Equipment Features to Reduce Exposures

SAFIRE: Up to 60% Dose Reduction\*

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**Without SAFIRE**  
**CTDI<sub>vol</sub> = 12.30 mGy**



**With SAFIRE**  
**CTDI<sub>vol</sub> = 4.07 mGy**

\* In clinical practice, the use of SAFIRE may reduce CT patient dose depending on the clinical task, patient size, anatomical location, and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task. The following test method was used to determine a 54 to 60% dose reduction when using the SAFIRE reconstruction software. Noise, CT numbers, homogeneity, low-contrast resolution and high contrast resolution were assessed in a Gammex 438 phantom. Low dose data reconstructed with SAFIRE showed the same image quality compared to full dose data based on this test. Data on file.

## Training for Users

- **Scanner Specific Training:**
  - 48h On-site Applications Training
  - Application-specific default protocols using dose reduction feature (e.g. SAFIRE, CAREkV, 70kV)
  - Workflow assistant: Practical tips, default protocols incl. dose values for the different body parts
  
- **Additional Material:**
  - Education PPT's that describe dose reduction features
  - CARE Dose 4D Training CD's for customers
  - Siemens Medical Academy – e-learning 5 dose presentations
  - 4 class room courses at Siemens Training Center (dose is one of the major focus of each of the courses)
  - Training presentation developed for Image Gently
  - Siemens Innovation Meeting – Dose main focus of meeting (90%)
  - “How to...” Flyers
  - Scientific White Papers

# Training for Users

## Training outline – user specific

Life Training Guideline - Data Selection

Scanner
  Workplace

SOMATOM Definition Flash

Update Training
  System Training

syngo CT 2010A

**Select The Engines:**

Acute CARE CT  
 Adaptive Interventional Suite  
 Cardiac CT  
 Neuro CT  
 Oncology CT  
 syngo Dual Energy Advanced

**Select The Options:**

4D Adaptive Spiral  
 Adaptive 3D Intervention


Life Training Guideline - SOMATOM Definition Flash

	Initial	Follow Up
<b>Introduction to Siemens MSCT Technology</b>	1	0
CT Basics MSCT Technology Sure View Concept		
<b>Introduction to Dual Source CT</b>	1	0
Two Detectors and Two Tubes Size of the Two Detectors Up to 75 mSec Temporal Resolution Through Dual Source CT Double Tube Output Through Dual Source CT for Obese Patient Scanning Introduction to Dual Energy Technique Advantages over Single Source CT		
<b>System Hardware</b>	0.2	0
Scan Unit		

# Training for Users

“How to...” Flyers for optimizing dose reduction & White Papers

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**How to scan children with FAST CARE**

For all SOMATOM Scanners equipped with FAST CARE syngo CT 2011  
By C. Leidecker and T. Flohr

[www.siemens.com/healthcare](http://www.siemens.com/healthcare)

**SIEMENS**



**How to scan with CARE kV**

For all SOMATOM Scanners equipped with FAST CARE syngo CT 2011  
By B. Schmidt, R. Raupach and T. Flohr

[www.siemens.com/healthcare](http://www.siemens.com/healthcare)

**SIEMENS**



**How to scan with CARE Dose4D**

For all SOMATOM Scanners equipped with FAST CARE syngo CT 2011  
By T. Altmendinger, R. Raupach and T. Flohr

[www.siemens.com/healthcare](http://www.siemens.com/healthcare)

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# Training for Users

## Teaching Website about Dose and Dose Reduction

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Dose saving in Computed Tomography - Dedication to Low Dose - Siemens Healthcare

http://www.medical.siemens.com/webapp/wcs/stores/servlet/LandingPage?storeId=10001&langId=-11&catalogId=-11&catTree=100010,1007660,12752&page

File Edit View Favorites Tools Help

★ Favorites Web Slice Gallery

Dose saving in Computed Tomography - Dedication to...

SIEMENS

Dose saving in Computed Tomography

Discover more

Siemens Global Website Site Explorer Contact

Home > Healthcare > Diagnostic Imaging & Therapy > Detection & Diagnosis > Computed Tomography

### Dose saving in Computed Tomography

Dedication to Low Dose Example: Dose Shield Example: SAFIRE Example: IRIS Example: SIERRA

Text Size

Related Links

- > Expert tips on low dose CT techniques on DSCT.com
- > Download Clinical Low Dose Protocols

**Easy Guide to Low dose**  
The Guide brings you up-to-date on what is new and developing in the field of diagnostic imaging.  
Read Now [1.47 MB]

**SOMATOM Definition Flash**  
Flash speed. Lowest dose.  
> more

**CT Image Contest**  
International CT Image Contest – highest image quality at lowest dose  
> more

**Worldwide Dose Counter**  
SOMATOM Definition Flash  
> View LIVE Statistics

**Reduce radiation dose with CARE.**

**General Information on low dose**  
Read more about Siemens' CARE standard to reduce radiation  
> more

With SOMATOM cameras, seeing dose starts right at the point where image data is acquired – the Ultra-Fast Ceramic, DPC detectors enable...

The tube current is switched off within a certain range of projections, minimizing direct exposure to the patient. Siemens CT system components...

An Dual-Source CT means the heart beats as fast, the dose necessary for excellent cardiac imaging can be avoided as long as that's the case...

Its ability to dynamically block clinically irrelevant gas and joint spinal dose significantly reduces the possibility of over-radiation, saves...

Enables dose-reduced Dual Energy imaging by blocking unnecessary portions of the X-ray energy spectrum...

Reduced dose sensitive body regions exposure up to 40% by actually switching the X-ray tube off for a certain sector of projections...

Internet 100%

## Which Dose Values Need to be Reported

### Differentiate between System Specific and Patient Specific Dose Values

- $CTDI_{vol}$ , phantom size and DLP per IEC
- Additional measure about the patient might be helpful to extract specific dose information (e.g. to assess differences between sites)
  - weight / attenuation
  - Size Specific Dose Equivalent (SSDE)
- Organ dose values desired, but
  - no agreement on method how to derive values
  - no consensus yet on a practical, routine approach
  - amount of information might overwhelm physicians
- Effective dose values
  - physics community mixed feelings reg. individual values per patient (aim of effective dose)
  - DICOM SR prepared for effective dose values (can be filled by users)
  - Further discussion required between MITA, AAPM, ACR, FDA ...

## Integration of Radiation Dose into Reports

- Radiation dose automatically becomes part of radiology reports and EMR → We currently send Patient Protocol to PACS
- Most Siemens scanners currently generate DICOMSR
  - DICOMSR can be sent to PACS and/or DICOM node
- Unfortunately the DICOM committee has removed dose information from the Modality Performed Procedure Step (MPPS) standard.
  - We do not deviate from this standard: we send dose information in the comment field of the MPPS data for most software versions

Data format Example: (found in Dose Log also)

RangeName: kV=120 mAs=430 CTDIvol=7.20 DLP=48

PhantomType=16cm

- Partnership with a third party vendor to get dose information from the PACS to the EMR