



Radiation Dose Structured Report

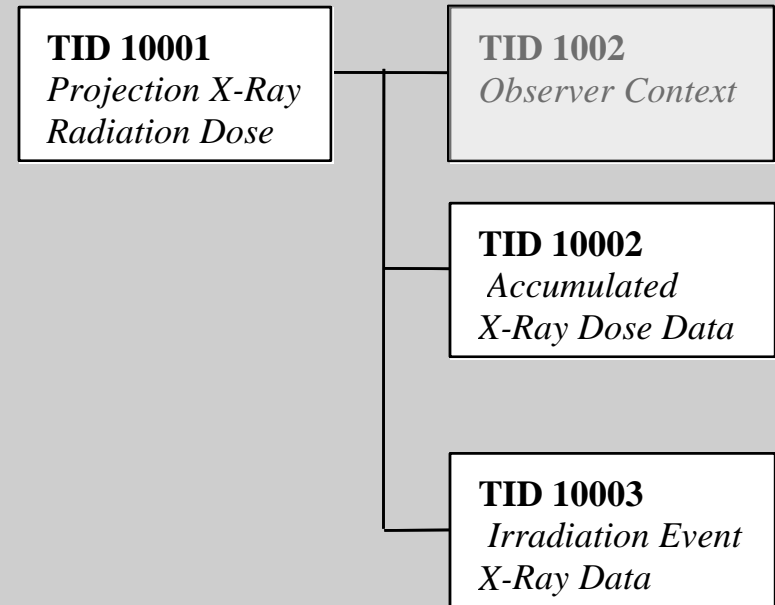
Current and Future

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Radiation Dose SR

- Original developed in 2005 for Projection Radiography
 - Added 3 new template ID's (TID)
- Used to convey exposure characteristics and dose generated by imaging devices
 - Therapeutic dose is reported in RT Dose IOD
- Records “radiation output” information, not patient dose



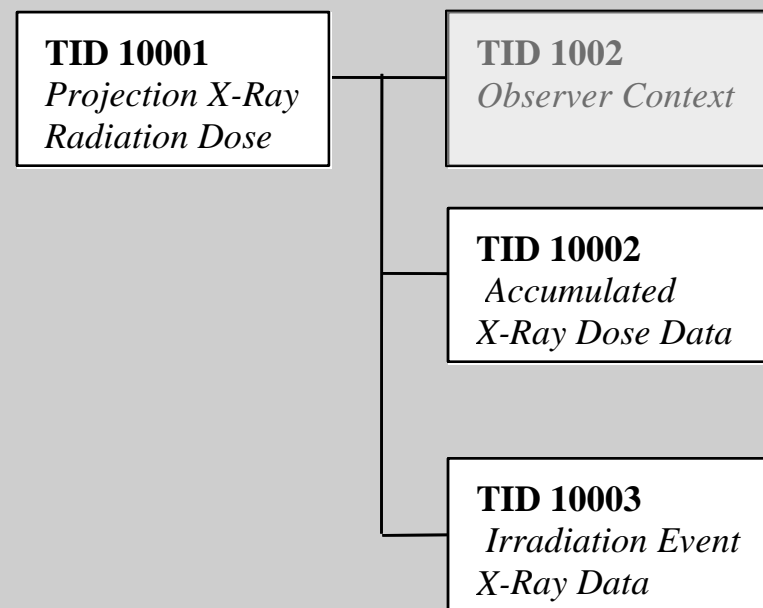


Radiation Dose SR – Projection Radiography

- TID 10001
 - Defines a container with subordinate content items for a single projection or single-plane x-ray irradiation dose
 - A bi-plane system would record events and accumulations separately for each plane

- TID 10002
 - Container for accumulated x-ray dose for all irradiation events

- TID 10003
 - Dose and equipment parameters from each irradiation event





Radiation Dose SR – Projection Radiography

- Mammography Dose SR was developed in 2007
 - Allows templates for different modalities or different modality configurations to be included

This change (i.e. CP687) removed the original projection radiography accumulated dose information from TID 10002

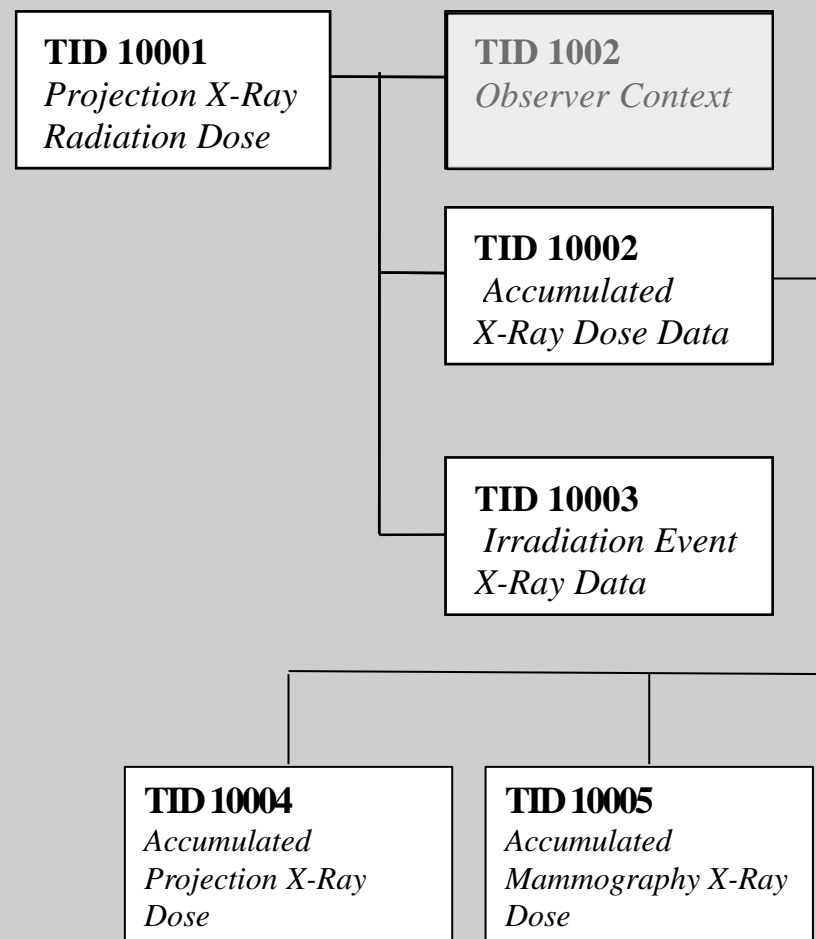
TID 10002 ACCUMULATED X-RAY DOSE

NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1		CONTAINER	EV (113702, DCM, "Accumulated X-Ray Dose Data")	1	M		
2	> HAS CONCEPT MOD	CODE	EV (113764, DCM, "Acquisition Plane")	1	M		\$Plane
3	> CONTAINS	TEXT	EV (113780, DCM, "Reference Point Definition")	1	U		
4	> CONTAINS	CONTAINER	EV (122505, DCM, "Calibration")	1	M		
5	>> HAS CONCEPT MOD	CODE	EV (113794, DCM, "Dose Measurement Device")	1-n	M		DCID (10010) Dose Measurement Devices
6	>> CONTAINS	DATETIME	EV (113723, DCM, "Calibration Date")	1	M		
7	>> CONTAINS	NUM	EV (122322, DCM, "Calibration Factor")	1	M		Units = EV (1, UCUM, "no units")
8	>> CONTAINS	NUM	EV (113763, DCM, "Calibration Uncertainty")	1	M		Units = EV (% , UCUM, "Percent")
9	>> CONTAINS	TEXT	EV (113724, DCM, "Calibration Responsible Party")	1	M		
10	> CONTAINS	INCLUDE	DTID (10004) Accumulated Projection X-Ray Dose	1	MC	XOR row 11, IFF TID (10001) Row 2 = (113704, DCM, "Projection X-Ray")	
11	> CONTAINS	INCLUDE	DTID (10005) Accumulated Mammography X-Ray Dose	1	MC	XOR row 10, IFF TID (10001) Row 2 = (P5-40010, SRT, "Mammography")	
10	> CONTAINS	NUM	EV (113722, DCM, "Dose-Area-Product Total")	±	M		Units = EV (Gym2, UCUM, "Gym2")
11	> CONTAINS	NUM	EV (113725, DCM, "Dose (RP) Total")	±	M		Units = EV (Gy, UCUM, "Gy")
12	> CONTAINS	NUM	EV (113726, DCM, "Fluoro-Dose-Area-Product Total")	±	MG	IFF TID(10003) Row 3 value = (P5-06000, SRT, "Fluorescopy") for at least one irradiation event	Units = EV (Gym2, UCUM, "Gym2")
13	> CONTAINS	NUM	EV (113728, DCM, "Fluoro-Dose (RP) Total")	±	MG	IFF TID(10003) Row 3 value = (P5-06000, SRT, "Fluorescopy") for at least one irradiation event	Units = EV (Gy, UCUM, "Gy")
14	> CONTAINS	NUM	EV (113730, DCM, "Total Fluoro-Time")	±	MG	IFF TID(10003) Row 3 value = (P5-06000, SRT, "Fluorescopy") for at least one irradiation event	Units = EV (s, UCUM, "s")
15	> CONTAINS	NUM	EV (113727, DCM, "Acquisition Dose-Area-Product Total")	±	M		Units = EV (Gym2, UCUM, "Gym2")
16	> CONTAINS	NUM	EV (113729, DCM, "Acquisition Dose (RP) Total")	±	M		Units = EV (Gy, UCUM, "Gy")
17	> CONTAINS	NUM	EV (113731, DCM, "Total Number of Radiographic Frames")	±	U		Units = EV (1, UCUM, "no units")



Radiation Dose SR – Projection Radiography

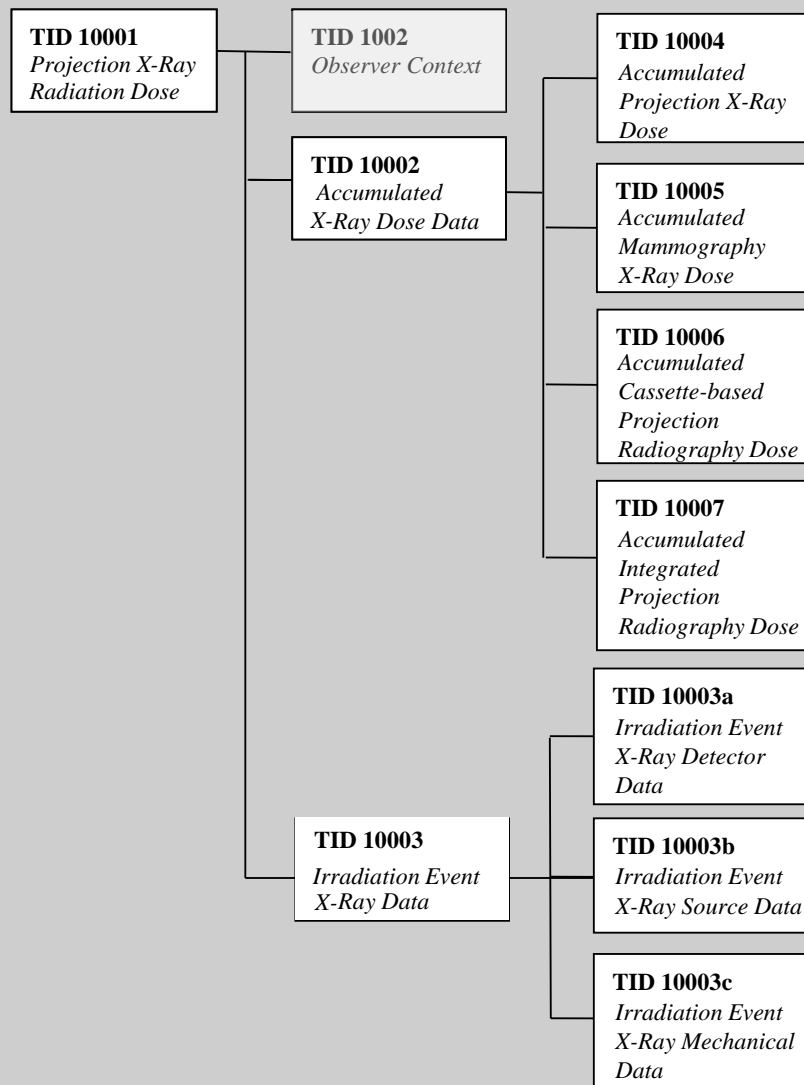
- TID 10004
 - Accumulated dose information that was in TID 10002 for projection radiography systems
- TID 10005
 - Mammography Dose
 - Accumulated average glandular dose and laterality





Recent RDSR changes for Projection X-Ray

- Include dose information relative to different types of digital detector systems
- TID 10004 only includes dose from fluoroscopy-guided projection radiography systems
- Adds integration options:
 - X-ray detector data
 - X-ray source data
 - X-ray mechanical data
- CP1077 approved April 2012





Radiation Dose SR –TID 10003a

- Irradiation Event X-Ray Detector Data
 - 2008 AAPM TG116 and IEC 62494-1 exposure indicator values

	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1	NUM	EV (113845, DCM, "Exposure Index")	1	MC	IF the value is displayable to the X-ray system operator.	Units = (1,UCUM, "no units")
2	NUM	EV (113846, DCM, "Target Exposure Index")	1	MC	IF the value is displayable to the X-ray system operator.	Units = (1,UCUM, "no units")
3	NUM	EV (113847, DCM, "Deviation Index")	1	MC	IF the value is displayable to the X-ray system operator.	Units = (1,UCUM, "no units")
4	INCLUDE	DTID (1021) Device Participant	1	U		\$DeviceProcedureRole = EV (113942, DCM, "X-Ray Reading Device")
5	IMAGE	EV (113795, DCM, "Acquired Image")	1-n	MC	IFF Image Object is created for this irradiation event	

Reference to image instances created during each event



Radiation Dose SR – TID 10003b

- Irradiation Event X-Ray Source Data
 - kVp, mA, exposure time, focal spot, filter material etc.
 - Reference point location where dose is determined

CID 10025 Radiation Dose Reference Points

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
DCM	113860	15cm from Isocenter toward Source
DCM	113861	30cm in Front of Image Input Surface
DCM	113862	1cm above Tabletop
DCM	113863	30cm above Tabletop
DCM	113864	15cm from Table Centerline
DCM	113865	Entrance exposure to a 4.2 cm breast thickness
DCM	113941	In Detector Plane



Radiation Dose SR – TID 10003c

- Irradiation Event X-Ray Mechanical Data
 - Gantry angle, beam geometry, etc
 - Detector configuration

CID 10031 CR/DR Mechanical Configuration

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
DCM	113953	Unmounted Detector
DCM	113952	Table Mount
DCM	113954	Upright Stand Mount
DCM	113955	C-Arm Mount



Radiation Dose SR – TID 10006

- Accumulated Cassette-Based Projection Radiography Dose
 - Count of the number of radiographic frames (i.e. images) recorded for a study or the number of exposures
 - Whichever is “known” to be greater
 - Provides a method to determine if more exposures were produced than images stored (retake analysis?)
 - Detector type specified

CID 10030 Detector Types

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
DCM	113948	Direct Detector
DCM	113949	Indirect Detector
DCM	113950	Storage Detector
DCM	113951	Film

Stores a signal which is later transformed by a reader into pixel values (e.g. storage phosphor)



Radiation Dose SR – TID 10007

- Accumulated Integrated Projection Radiography Dose
 - Accumulated dose and dose area product

	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1	NUM	EV (113722, DCM, "Dose Area Product Total")	1	M		Units = EV (Gy.m2, UCUM, "Gy.m2")
2	NUM	EV (113725, DCM, "Dose (RP) Total")	1	M		Units = EV (Gy, UCUM, "Gy")
3	NUM	EV (113731, DCM, "Total Number of Radiographic Frames")	1	U		Units = EV (1, UCUM, "no units")
4	CODE	EV (113780, DCM, "Reference Point Definition")	1	MC	IF Row 5 is not present.	DCID (10025) Radiation Dose Reference Points
5	TEXT	EV (113780, DCM, "Reference Point Definition")	1	MC	IF Row 4 is not present.	

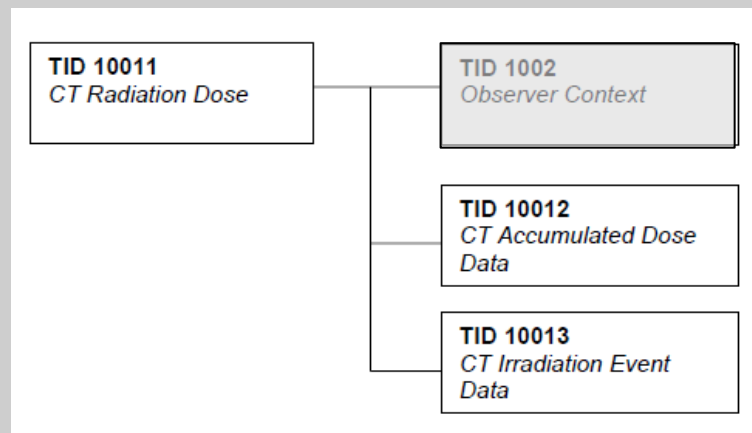
Includes count of exposures taken (retake analysis?)

Includes reference point



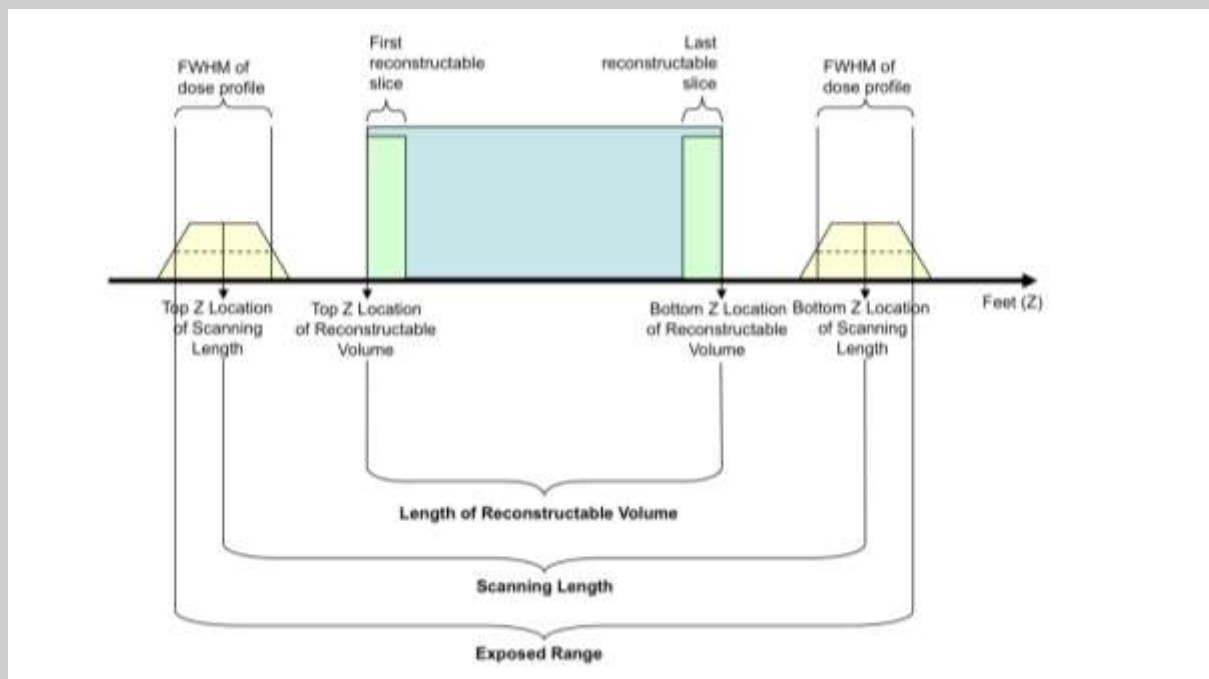
Radiation Dose SR – CT Radiation Dose

- Originally approved in 2007
- TID 10012
 - Detailed accumulated CT dose for all irradiation events
- TID 10013
 - Dose and equipment parameters from each irradiation event
 - SSDE and reference to iterative reconstruction methods added in 2011



Radiation Dose SR – TID 10014 Scanning Length

- Added in 2009
- Defines detail relative to the scanning length for spiral acquisitions due to the additional rotations at the beginning and end of the scan
 - so-called “overranging”





Radiation Dose SR – TID 10015 Dose check values

- Records details related to the use of the NEMA Dose Check Standard (NEMA XR-25-2010)
 - see <http://www.aapm.org/pubs/CTProtocols/>

	VT	Concept Name	VM	Req Type	Condition
1	CONTAINER	EV (113900, DCM, "Dose Check Alert Details")	1	MC	IF the scanning device has implemented dose alerts
⋮					
4	NUM	EV (113903, DCM, "DLP Alert Value")	1	MC	IFF value of Row 2 is (R-0038D,SRT, "Yes")
5	NUM	EV (113904, DCM, "CTDIvol Alert Value")	1	MC	IFF value of Row 3 is (R-0038D,SRT, "Yes")
6	NUM	EV (113905, DCM, "Accumulated DLP Forward Estimate")	1	MC	IF Accumulated DLP Forward Estimate (Row 6) exceeds DLP Alert Value (Row 4)
7	NUM	EV (113906, DCM, "Accumulated CTDIvol Forward Estimate")	1	MC	IF Accumulated CTDIvol Forward Estimate (Row 7) exceeds CTDIvol Alert Value (Row 5)
8	TEXT	EV (113907, DCM, "Reason for Proceeding")	1	UC	IFF Accumulated DLP Forward Estimate (Row 6) exceeds DLP Alert Value (Row 4) or Accumulated CTDIvol Forward Estimate (Row 7) exceeds CTDIvol Alert Value (Row 5)

⋮



Radiation Dose SR – Projection Radiography

7 stationary acquisitions and 9 fluoroscopy runs (total time 13 seconds)

```
test DoseSR_DICOMdump.txt - WordPad
File Edit View Insert Format Help

#DcmDump -L +E +Un

# Dicom-File-Format

# Dicom-Meta-Information-Header
# Used TransferSyntax: Little Endian Explicit
(0002,0000) UL 204 # 4, 1 FileMetaInformationGroupLength
(0002,0001) OB 00\01 # 2, 1 FileMetaInformationVersion
(0002,0002) UI =XRayRadiationDoseSRStorage # 30, 1 MediaStorageSOPClassUID
(0002,0003) UI [1.3.12.2.1107.5.4.5.139985.30000013031313140169400000052] # 56, 1 MediaStorageSOPInstanceUID
(0002,0010) UI =LittleEndianExplicit # 20, 1 TransferSyntaxUID
(0002,0012) UI [1.2.276.0.7230010.3.0.3.5.4] # 28, 1 ImplementationClassUID
(0002,0013) SH [OFFIS_DCMBF_354] # 16, 1 ImplementationVersionName

# Dicom-Data-Set
# Used TransferSyntax: Little Endian Explicit
(0008,0005) CS [ISO_IR 100] # 10, 1 SpecificCharacterSet
(0008,0016) UI =XRayRadiationDoseSRStorage # 30, 1 SOPClassUID
(0008,0018) UI [1.3.12.2.1107.5.4.5.139985.30000013031313140169400000052] # 56, 1 SOPInstanceUID
(0008,0020) DA [20130313] # 8, 1 StudyDate
(0008,0021) DA [20130313] # 8, 1 SeriesDate
(0008,0023) DA [20130313] # 8, 1 ContentDate
(0008,0030) TM [143538.314000] # 14, 1 StudyTime
(0008,0031) TM [143538.000000] # 14, 1 SeriesTime
(0008,0033) TM [143538.000000] # 14, 1 ContentTime
(0008,0050) SH [a123] # 4, 1 AccessionNumber
(0008,0060) CS [SR] # 2, 1 Modality
(0008,0070) LO [Siemens] # 8, 1 Manufacturer
(0008,0080) LO [AX FLM-E IC K07A] # 18, 1 InstitutionName
(0008,0081) ST [1 Siemensstrasse~/FA948E/^Frankonia^91301^DE] # 44, 1 InstitutionAddress
(0008,0090) PN (no value available) # 0, 0 ReferringPhysicianName
(0008,1010) SH [ISK07A] # 6, 1 StationName
(0008,1030) LO [3D Head] # 8, 1 StudyDescription
(0008,103e) LO [Exam Protocol SR] # 16, 1 SeriesDescription
(0008,1050) PN (no value available) # 0, 0 PerformingPhysicianName
(0008,1090) LO [AXIOM-Artis] # 12, 1 ManufacturerModelName
(0008,1111) SQ (Sequence with explicit length #=0) # 0, 1 ReferencedPerformedProcedureStepSequence
(ffff,e0dd) na (SequenceDelimitationItem for re-encod.) # 0, 0 SequenceDelimitationItem
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Radiation Dose SR – Projection Radiography

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test DoseSR_DICOMdump - highlighted.rtf - WordPad
File Edit View Insert Format Help

(fffe,e000) na (Item with explicit length #=3) # 58, 1 Item
  (0008,0100) SH [113722] # 6, 1 CodeValue
  (0008,0102) SH [DCM] # 4, 1 CodingSchemeDesignator
  (0008,0104) LO [Dose Area Product Total] # 24, 1 CodeMeaning
(fffe,e00d) na (ItemDelimitationItem for re-encoding) # 0, 0 ItemDelimitationItem
(fffe,e0dd) na (SequenceDelimitationItem for re-encod.) # 0, 0 SequenceDelimitationItem
(0040,a300) SQ (Sequence with explicit length #=1) # 86, 1 MeasuredValueSequence
  (fffe,e000) na (Item with explicit length #=2) # 78, 1 Item
    (0040,08ea) SQ (Sequence with explicit length #=1) # 48, 1 MeasurementUnitsCodeSequence
      (fffe,e000) na (Item with explicit length #=3) # 40, 1 Item
        (0008,0100) SH [Gy.m2] # 6, 1 CodeValue
        (0008,0102) SH [UCUM] # 4, 1 CodingSchemeDesignator
        (0008,0104) LO [Gy.m2] # 6, 1 CodeMeaning
      (fffe,e00d) na (ItemDelimitationItem for re-encoding) # 0, 0 ItemDelimitationItem
      (fffe,e0dd) na (SequenceDelimitationItem for re-encod.) # 0, 0 SequenceDelimitationItem
      (0040,a30a) DS [0.00318572] # 10, 1 NumericValue
    (fffe,e00d) na (ItemDelimitationItem for re-encoding) # 0, 0 ItemDelimitationItem
    (fffe,e0dd) na (SequenceDelimitationItem for re-encod.) # 0, 0 SequenceDelimitationItem
    (fffe,e00d) na (ItemDelimitationItem for re-encoding) # 0, 0 ItemDelimitationItem
    (fffe,e000) na (Item with explicit length #=4) # 186, 1 Item
      (0040,a010) CS [CONTAINS] # 8, 1 RelationshipType
      (0040,a040) CS [NUM] # 4, 1 ValueType
      (0040,a043) SQ (Sequence with explicit length #=1) # 58, 1 ConceptNameCodeSequence
        (fffe,e000) na (Item with explicit length #=3) # 50, 1 Item
          (0008,0100) SH [113725] # 6, 1 CodeValue
          (0008,0102) SH [DCM] # 4, 1 CodingSchemeDesignator
          (0008,0104) LO [Dose (RP) Total] # 16, 1 CodeMeaning
        (fffe,e00d) na (ItemDelimitationItem for re-encoding) # 0, 0 ItemDelimitationItem
        (fffe,e0dd) na (SequenceDelimitationItem for re-encod.) # 0, 0 SequenceDelimitationItem
        (0040,a300) SQ (Sequence with explicit length #=1) # 76, 1 MeasuredValueSequence
          (fffe,e000) na (Item with explicit length #=2) # 68, 1 Item
            (0040,08ea) SQ (Sequence with explicit length #=1) # 40, 1 MeasurementUnitsCodeSequence
              (fffe,e000) na (Item with explicit length #=3) # 32, 1 Item
                (0008,0100) SH [Gy] # 2, 1 CodeValue
                (0008,0102) SH [UCUM] # 4, 1 CodingSchemeDesignator
                (0008,0104) LO [Gy] # 2, 1 CodeMeaning
              (fffe,e00d) na (ItemDelimitationItem for re-encoding) # 0, 0 ItemDelimitationItem
              (fffe,e0dd) na (SequenceDelimitationItem for re-encod.) # 0, 0 SequenceDelimitationItem
              (0040,a30a) DS [0.57922] # 8, 1 NumericValue
            (fffe,e00d) na (ItemDelimitationItem for re-encoding) # 0, 0 ItemDelimitationItem
```

Data element tag ID values are the same



Radiation Dose Information in Radiology Reports SR

- Approved August 2011
- TID 2006 Imaging Report with Conditional Radiation exposure and Protection Information
 - Template used for general imaging reports
 - Specialization of TID 2000 Basic Diagnostic Imaging Report
- TID 2007 Imaging Procedure Description
- TID 2008 Radiation Exposure and Protection Information

Radiation Dose Summary Information in Radiology Reports



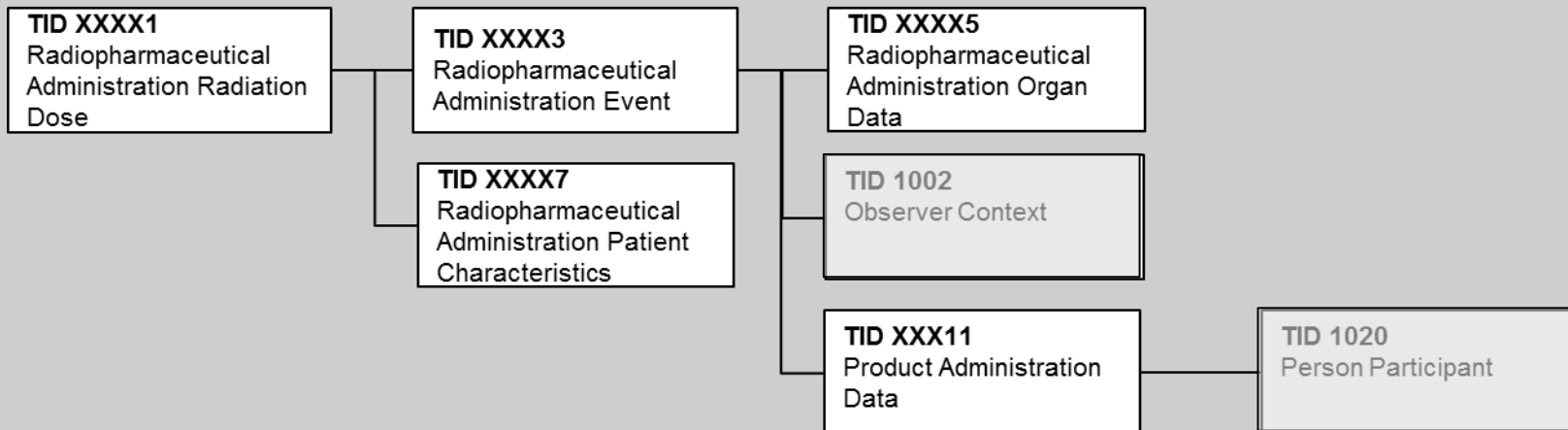
- TID 2008 Radiation Exposure and Protection Information

	VT	Concept Name	VM	Req Type	Condition
1	CONTAINER	EV (113923, DCM, "Radiation Exposure and Protection Information")	1	M	
2	INCLUDE	DTID (1001) Observation Context	1	U	
3	CODE	EV (111532, DCM, "Pregnancy Status")	1	MC	IF female patient of child-bearing age
4	TEXT	EV (121109, DCM, "Indications for Procedure")	1	M	
5	PNAME	EV (113850, DCM, "Irradiation Authorizing ")	1	M	
6	TEXT	EV (113921, DCM, "Radiation Exposure")	1	MC	IFF ionizing radiation is applied in the context of the current procedure
7	TEXT	EV (113922, DCM, "Radioactive Substance Administered")	1	MC	IFF radioactive substance is administered in the context of the current procedure



NM RDSR Supplement 159

- Reporting of radiation dose due to administration of radiopharmaceuticals, as in NM or PET imaging
 - Introduces 5 new templates
- Version out for public comment in April 2013
 - AAPM argued to *not* make ‘effective dose’ mandatory and SNMMI commented to *not* include either ‘effective’ or ‘organ absorbed’ dose and if included it should be optional
 - Revisions underway responding to all comments





AAPM and DICOM Efforts

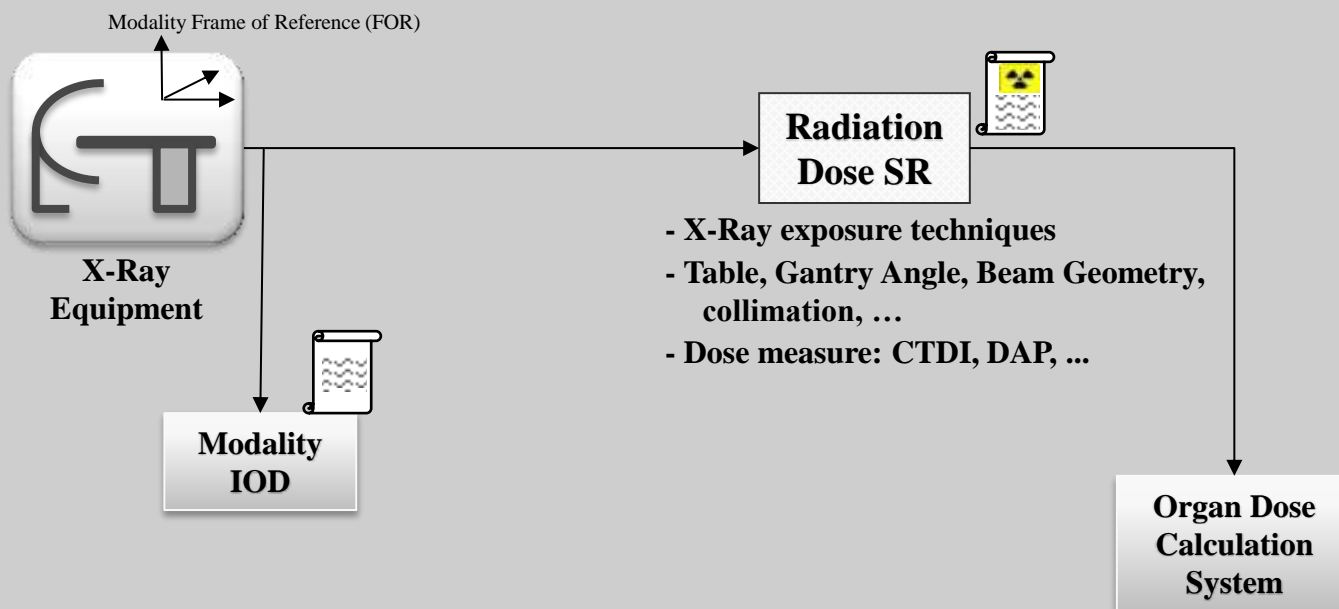
- WG28 Physics
 - Formed by DICOM Standards Committee (DSC) at RSNA 2011
 - Work Item to create Patient Radiation Dose Structured Report approved by DSC at RSNA 2012



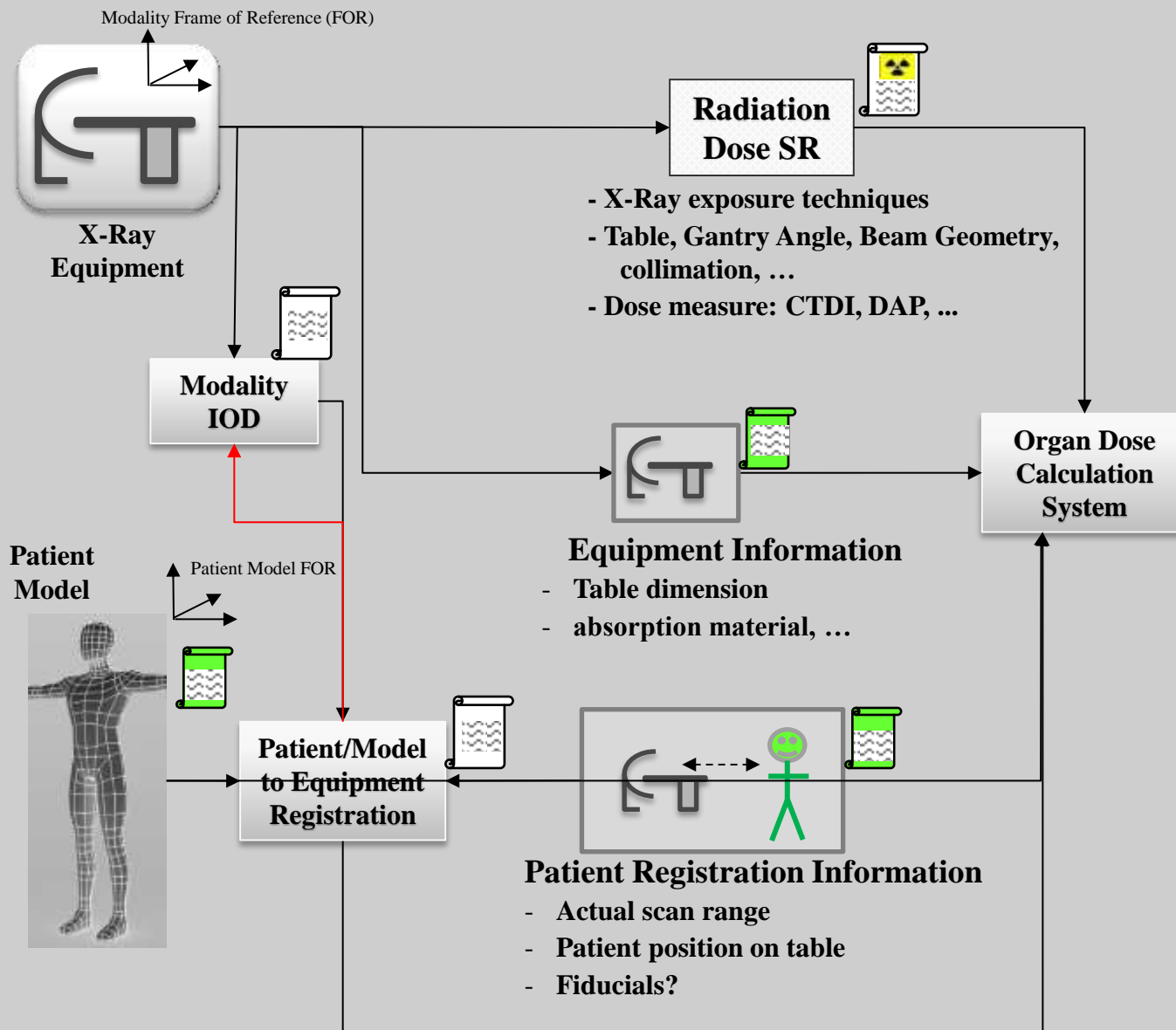
Development of Patient Radiation Dose SR Work Item

- Current Radiation Dose SR contains only information about the x-ray system or information the x-ray system can determine, e.g.:
 - radiation output, geometry, x-ray source, detector system, etc.
- Estimation of patient or organ dose requires:
 - Models of radiation beam characteristics
 - Models of the patient/organs
 - Models of radiation interaction within the patient
- Methods to do patient dose estimations are being developed and improved continuously
 - storage of these estimations in a different object would allow more versatile utilization of the data

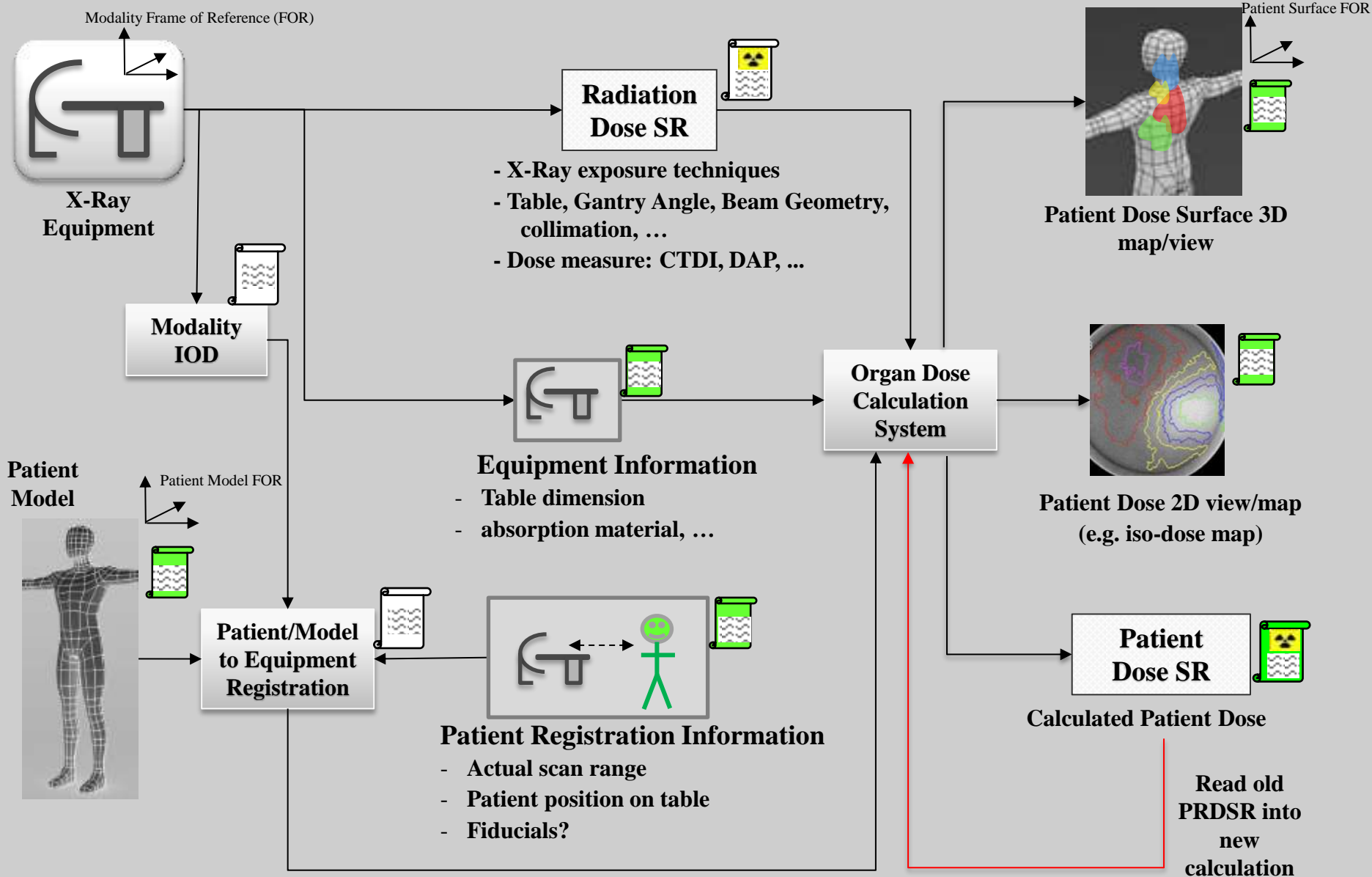
Patient Dose SR: Data Flow/Requirements



Patient Dose SR: Data Flow/Requirements



Patient Dose SR: Data Flow/Requirements



Patient Dose SR: Requirements for Organ Dose



- Calculation Information
 - Algorithm details
 - Assumptions of calculation model
 - table attenuation, backscatter model, ...
- Interpretation of Results
 - Accuracy/Uncertainty model
- Referenced Objects (UID's)
 - Irradiation context: Radiation Dose SR – one or more?
 - Patient model: skin surface, organs, ...
 - Patient location and orientation: registration, fiducials, ...
 - 2D map or 3D dose map: Iso-dose image, ...
- Calculated Data for Documentation
 - Peak Dose locations
 - Iso-dose lines
 - Registry data



AAPM and DICOM Efforts

- AAPM TG 246 Patient Dose from Diagnostic Radiation
 - Charge: summarize the current state of the art and outline a roadmap for standardized estimation of organ doses from medical imaging
 - Chair: William Pavlicek, PhD
 - International effort with European Federation of Medical Physicists (EFOMP)
 - DICOM WG28 will use the results of this work to determine elements in the Patient Radiation Dose Structured Report