Supplement 214:
Cone Beam CT RDSR

Supplement is developed by DICOM Working Groups 02 and 28
(WG-02 Projection Radiography and Angiography)
(WG-28 Physics)

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Create a CBCT RDSR

- **Combination of the CT and X-ray Projection RDSRs (?)**
  - Neither RDSR could completely describe CBCT radiation output
  - CBCT requires a new template RDSR
- **Current RDSRs missing certain necessary components**
  - No beam geometry
    - Complete description of shape and size of the x-ray beam
    - Description is self-contained, outside of detector or reconstruction characteristics
  - Incomplete beam characteristics
    - Modulation of technique factors
    - Partial beam filters, wedge filters, bowtie filters are not handled correctly
  - Non-standardized output values
    - CT uses CTDI, XA uses reference point dose
      - CBCT dosimetry is not standardized
  - No details beyond the “irradiation event” time frame
    - Per-pulse or per-projection information

Motivation (cont.)

A new CBCT RDSR is required

- **Option 1: Use same root template as CT RDSR**
  - Doses described as CTDI or DLP
    - Neither appropriate for CBCT
  - Irradiation event period in CT does a poor job at describing sub-event changes in beam characteristics and geometry

Motivation (cont.)

A new CBCT RDSR is required

- **Option 2: Use same root template as x-ray projection RDSR**
- **Use rotational XA irradiation event information**
  - No sub-event radiation dose information
    - Per-pulse information creates “events” that may be large and redundant
    - Medical community now demands a more detailed assessment of patient dosimetry
      - Requires information that is more detailed than a single output value for an entire CBCT spin

Challenges to Options 1 & 2

- **Maintaining backward compatibility becomes increasingly challenging**
  - X-ray projection RDSR has many conditions for compliance
  - The templates become unreadable or unmanageable

Motivation (cont.)

- **Option 3: Create a new root template to accommodate the requirements of CBCT**
  - Define complete beam geometry
    - Include a FOR
    - Complete description of shape and size of the x-ray beam
  - Provide complete beam characteristics
    - Modulation of technique factors
    - Partial beam filters, wedge filters, bowtie filters
  - Standardize output values
    - Define a value that allows for easy derivation for other values (e.g., CTDI, reference point output)
  - Provide descriptions of characteristics beyond the “irradiation event” time frame (e.g., per-projection or per-pulse)
    - Define temporal construct that provides the above information when it changes or is needed (i.e., exclude redundant pulse information)

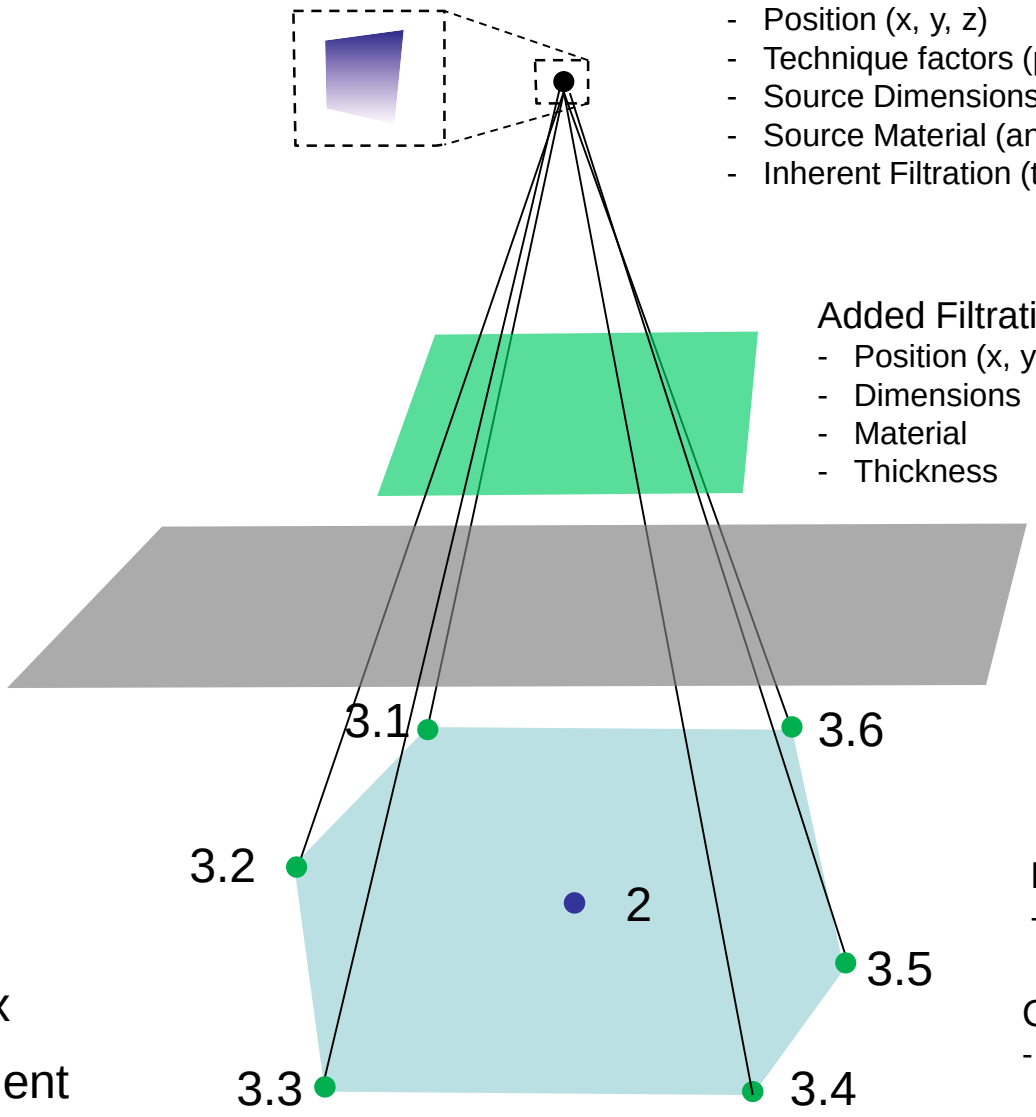
Proposal

- **Option 3 provides a solution that will allow for a more complete description of CBCT radiation**
- **In addition, much of the irradiation information is universal for all modalities**
  - The generation of radiation, filtration, and beam restriction of x-ray systems use similar, and in many instances, identical methods
- **Therefore, the proposal is to create an RDSR that does not require the modality to be defined, and include existing modality-specific information when needed**
  - Modalities are evolving, and new hybrid systems may be created
  - Making a modality-agnostic RDSR will reduce or eliminate the need for CPs to accommodate new technology or uses
  - Legacy, regulatory, and other dose information from existing RDSRs can still be included

Proposal

- **Define geometry**
  - Use FOR for complete beam description
- **Define Time Window concept**
  - Removes requirement to define characteristics by Irradiation Event

Geometry



Source
- Position (x, y, z)
- Technique factors (potential, current, time)
- Source Dimensions (of focal spot)
- Source Material (anode material)
- Inherent Filtration (thickness, material, etc.)

Added Filtration (spectral filters, attenuating filters)
- Position (x, y, z)
- Dimensions
- Material
- Thickness

Added attenuators (e.g., patient support, compression paddle)
- Position (x, y, z)
- Dimensions
- Material
- Thickness

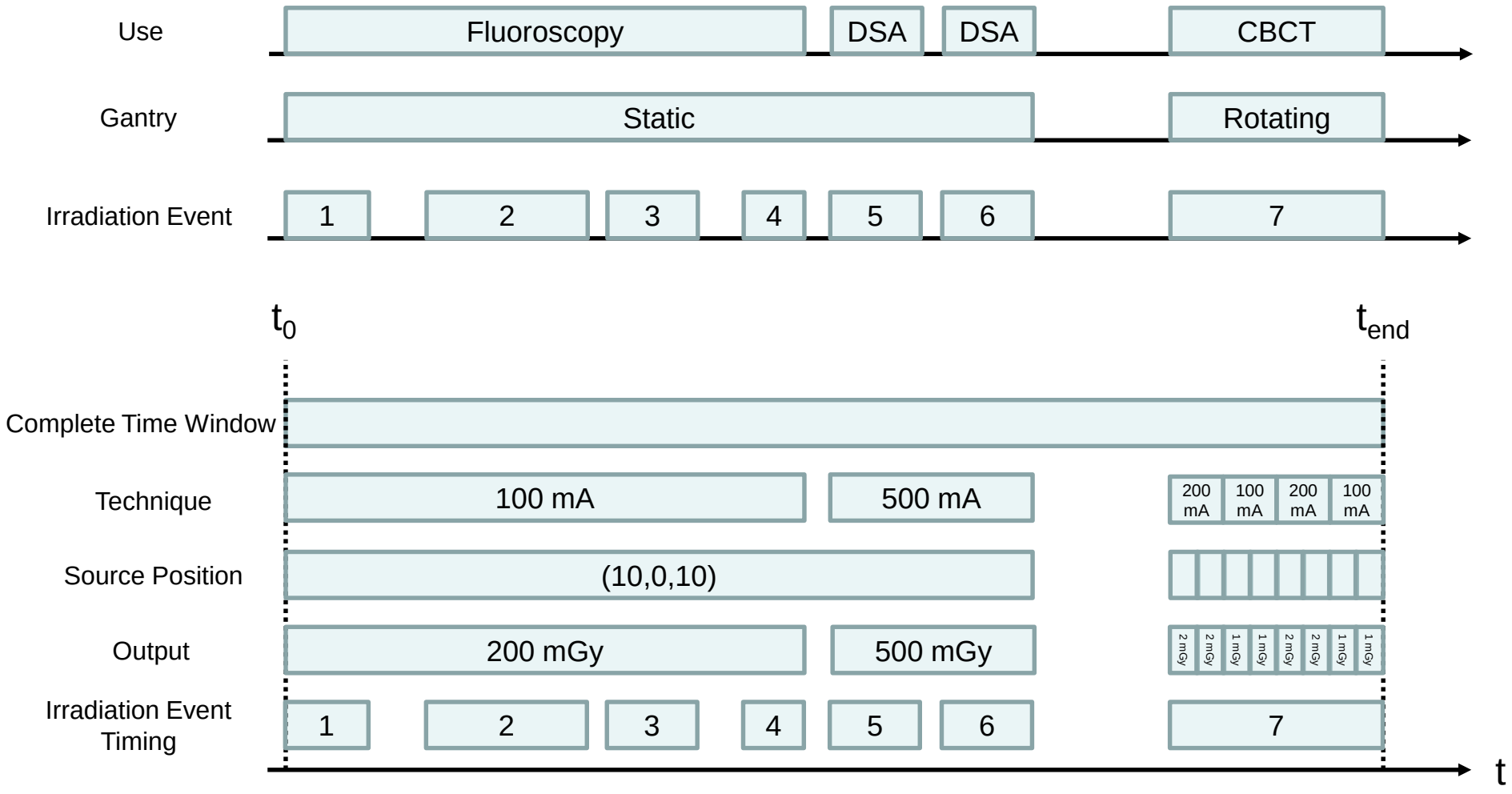
Radiation Output Information
- iAK at Point 2 (x, y, z)

Collimated field
- Shape (x, y, z) (Points 3.1-6)

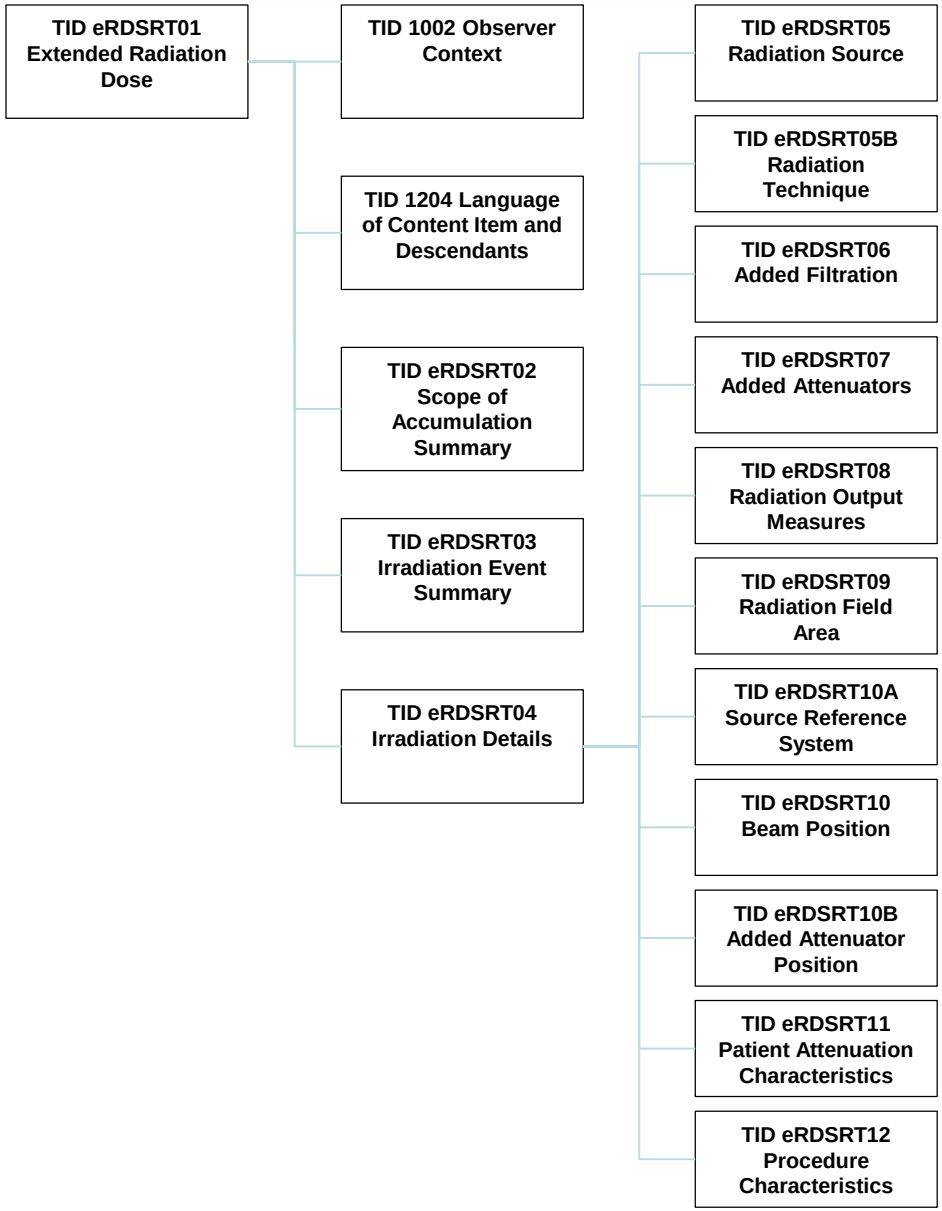
z
y
x

Equipment FOR

Time Window


Use
Fluoroscopy
DSA
DSA
CBCT
Gantry
Static
Rotating
Irradiation Event
1
2
3
4
5
6
7
t_0
t_{end}
Complete Time Window
Technique
100 mA
500 mA
200 mA
100 mA
200 mA
100 mA
Source Position
(10,0,10)
Output
200 mGy
500 mGy
2 mGy
2 mGy
1 mGy
1 mGy
2 mGy
2 mGy
1 mGy
1 mGy
Irradiation Event Timing
1
2
3
4
5
6
7
t

Structure


TID eRDSRT01 Extended Radiation Dose
TID 1002 Observer Context
TID 1204 Language of Content Item and Descendants
TID eRDSRT02 Scope of Accumulation Summary
TID eRDSRT03 Irradiation Event Summary
TID eRDSRT04 Irradiation Details
TID eRDSRT05 Radiation Source
TID eRDSRT05B Radiation Technique
TID eRDSRT06 Added Filtration
TID eRDSRT07 Added Attenuators
TID eRDSRT08 Radiation Output Measures
TID eRDSRT09 Radiation Field Area
TID eRDSRT10A Source Reference System
TID eRDSRT10 Beam Position
TID eRDSRT10B Added Attenuator Position
TID eRDSRT11 Patient Attenuation Characteristics
TID eRDSRT12 Procedure Characteristics

Structure

TID eRDSRT02 Scope of Accumulation Summary

- Modality specific exam-level information
- Accumulated MGD, DAP, Fluoro time, RAK, alerts, etc.
- Definition of Reference Point for eRDSRT10

TID eRDSRT03 Irradiation Event Summary

- Irradiation Event UID
  - Time window (t_1-t_2)
  - Source index
  - Modality specific dosimetry information (MGD, CTDI, DLP, DAP, alerts, irradiation duration, etc.)

TID eRDSRT04 Irradiation Details

- Complete time window (t_0-t_{end})
- Equipment FOR UID

TID eRDSRT05 Radiation Source

- Time window (t_1-t_2)
- Source index
- Source Dimensions (of focal spot)
- Source Material (anode material)
- Inherent Filtration (thickness, material, etc.)

TID eRDSRT05B Radiation Technique

- Time window (t_1-t_2)
- Source index
- Technique factors (potential, current, time)
- HVL
- Pulse width, rate

TID eRDSRT06 Added Filtration

- Time window (t_1-t_2)
- Source index
- Dimensions
- Material
- Thickness

TID eRDSRT07 Added Attenuators

- Time window (t_1-t_2)
- Dimensions
- Material
- Thickness

TID eRDSRT08 Radiation Output Measures

- Time window (t_1-t_2)
- Source index
- Air Kerma

TID eRDSRT09 Radiation Field Area

- Time window (t_1-t_2)
- Source index
- Beam shape (x_s, y_s, z_s) (Points 3.1-n)

TID eRDSRT10A Source Reference System

- Time window (t_1-t_2)
- Source index
- Source position (x, y, z)
- Source coordinate system rotation matrix (4x4)

TID eRDSRT10B Beam Position

- Time window (t_1-t_2)
- Source index
- Added filtration position (x_s, y_s, z_s)
- Output measure position (x_s, y_s, z_s) (Point 2)
- RP position (if in summary) (x_s, y_s, z_s)

TID eRDSRT10C Added Attenuator Position

- Time window (t_1-t_2)
- Added attenuator position (x, y, z)

TID eRDSRT11 Patient Attenuation Characteristics

- Time window (t_1-t_2)
- Source index
- Equivalent Patient Thickness
- CT size metrics (WED, Effective Diameter)

TID eRDSRT12 Procedure Characteristics

- Time window (t_1-t_2)
- Source index
- Anatomy (body part, laterality)
- Acquisition Protocol
- Patient Table Relationship
- Patient Orientation

Rationale

- **Promote mandatory technical information that allows the precise definition of needed features of the system, e.g. the whole geometry and characteristics of the X-Ray beam, that are related to dose.**

- **Reduce constraints of mandatory "summary" radiation information.**
  - It is the role of regulators, not DICOM, to mandate of the presence of dose information
  - These regulations are evolving (IEC…), country-dependent, and they may mandate different information depending on the "category" or "classification" of products within the same modality. Therefore, the manufacturers shall fill the information in the RDSR based on their applicable regulations, case by case.