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)

1/23/2020

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Background

- Provide a framework 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
  - CBCT as a modality with specific requirements remains poorly defined
  - 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
- This CBCT RDSR may allow for other modalities to take advantage of this generalizability

Requirements

- Define Time Window concept
  - Removes requirement to define characteristics by Irradiation Event
- Define geometry
  - Use frame of reference (FOR) for complete beam description

Time Window

- Time windows describe a begin and end time of machine characteristics
- Time window allows for describing radiation-dose-related characteristics of a system in two ways:
  - Dependent solely on irradiation event
    - For each irradiation event, describe the time window and all template content for each irradiation event individually
  - Independent of irradiation events
    - **Parameter is characterized by a single value during time window**
    - For characteristics that remain constant (or within some tolerance), create larger time windows that span several irradiation events.
      - For example, if the same technique is used across several irradiation events, the template can encode a single template that indicates a constant technique across events
    - For characteristics that change within an irradiation event, create smaller time windows that describe the changes during the irradiation event
      - For example, a rotating gantry during a CBCT run in XA can have many time windows that describe the position of the gantry.

Time Window

- The methodology for beginning/ending time window is implementation dependent
  - Wait for a change in the characteristic to meet some threshold
    - Percent change
    - Absolute change
    - Time dependent (every X seconds)
    - By irradiation events
- All mandatory characteristics must be described completely for the entire time window described by each irradiation event
- There may be gaps between time windows
  - The information between irradiation events is not relevant for radiation dose purposes.
    - Characteristics may or may not be populated between irradiation events

Time Window

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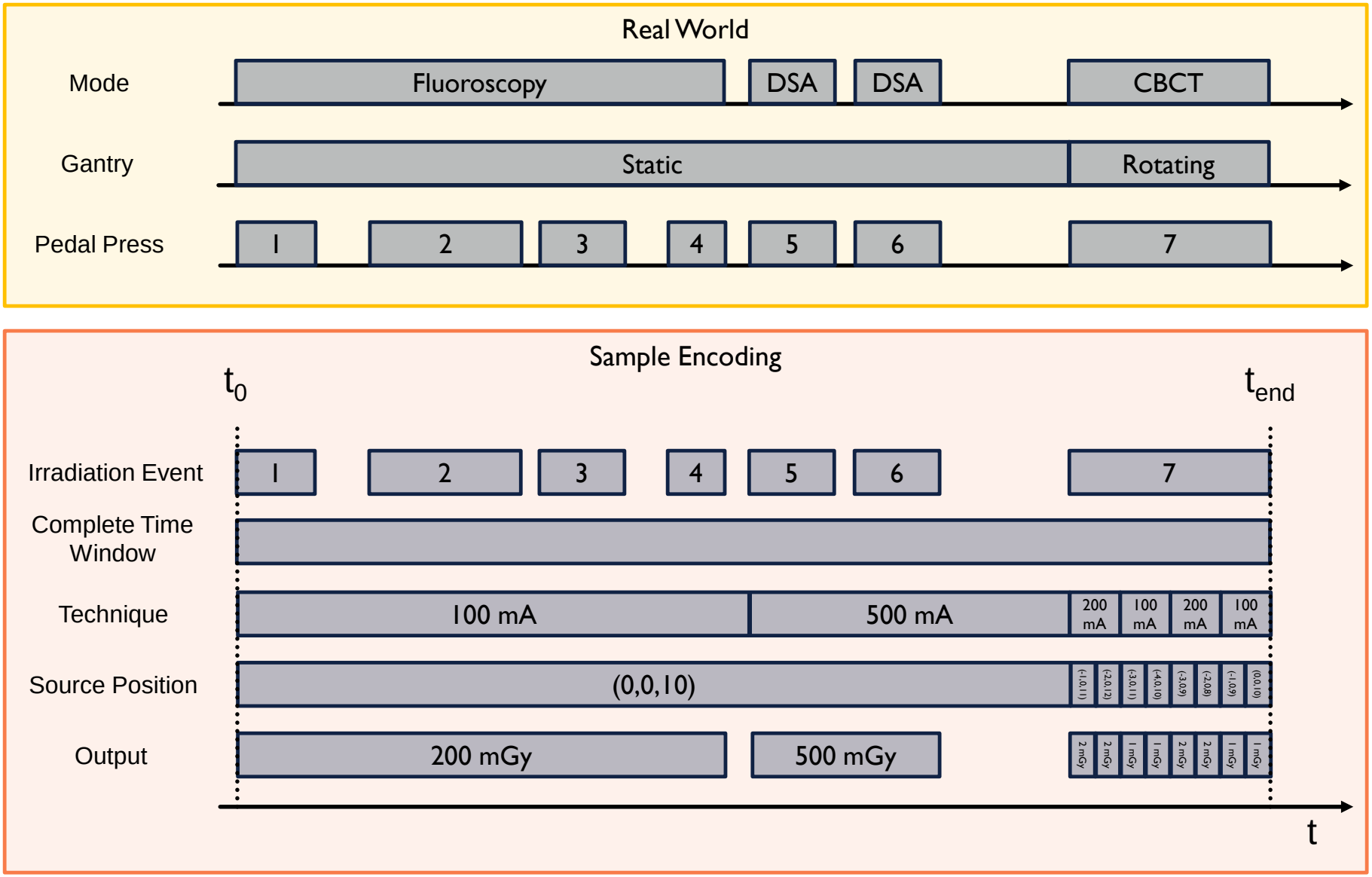
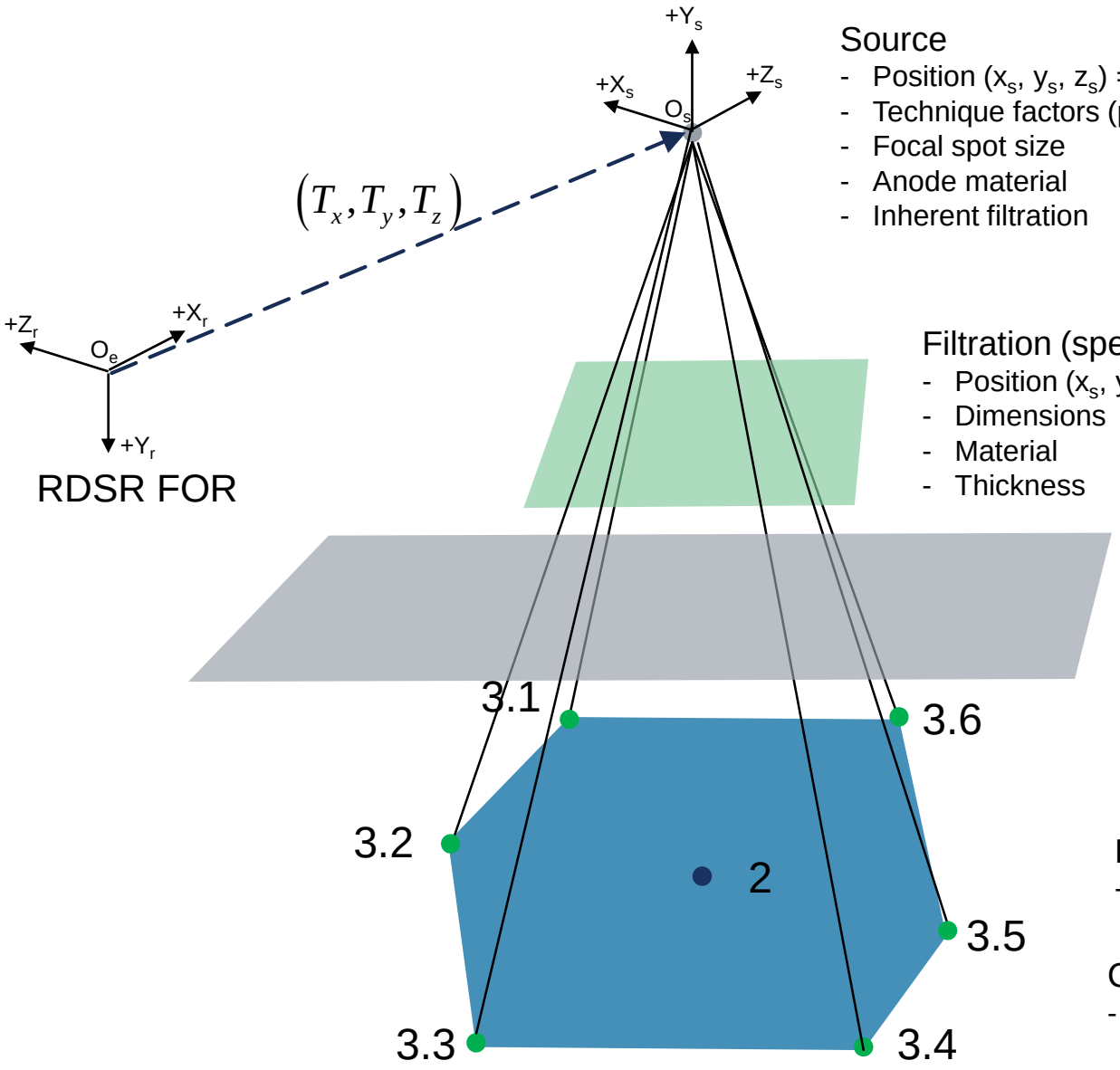


Geometry



Source

- Position (x_s, y_s, z_s) = (0, 0, 0)
- Technique factors (potential, current, time)
- Focal spot size
- Anode material
- Inherent filtration

Filtration (spectral filters, attenuating filters)

- Position (x_s, y_s, z_s)
- Dimensions
- Material
- Thickness

Attenuators (e.g., patient support, compression paddle)

- Position (x_r, y_r, z_r)
- Dimensions
- Material
- Thickness

Radiation Output Information

- iAK at Point 2 (x_s, y_s, z_s)

Collimated field

- Shape (x_s, y_s, z_s) (Points 3.1-6)

Transformation Matrix

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X-Ray Source Transformation Matrix

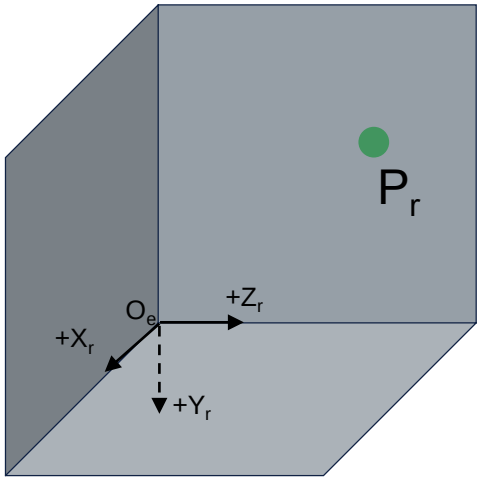
RDSR Coordinate System

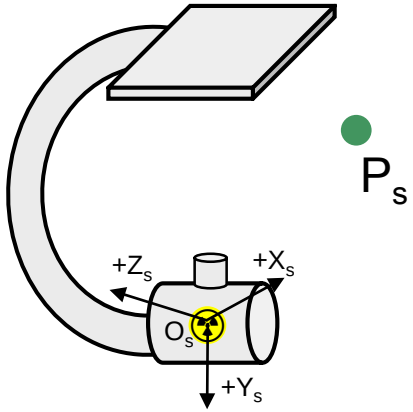
$$P_r = (x_r, y_r, z_r)$$

$$\begin{bmatrix} x_r \\ y_r \\ z_r \\ 1 \end{bmatrix} = \begin{bmatrix} M_{11} & M_{12} & M_{13} & T_x \\ M_{12} & M_{22} & M_{23} & T_y \\ M_{31} & M_{32} & M_{33} & T_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_s \\ y_s \\ z_s \\ 1 \end{bmatrix}$$

Source Coordinate System

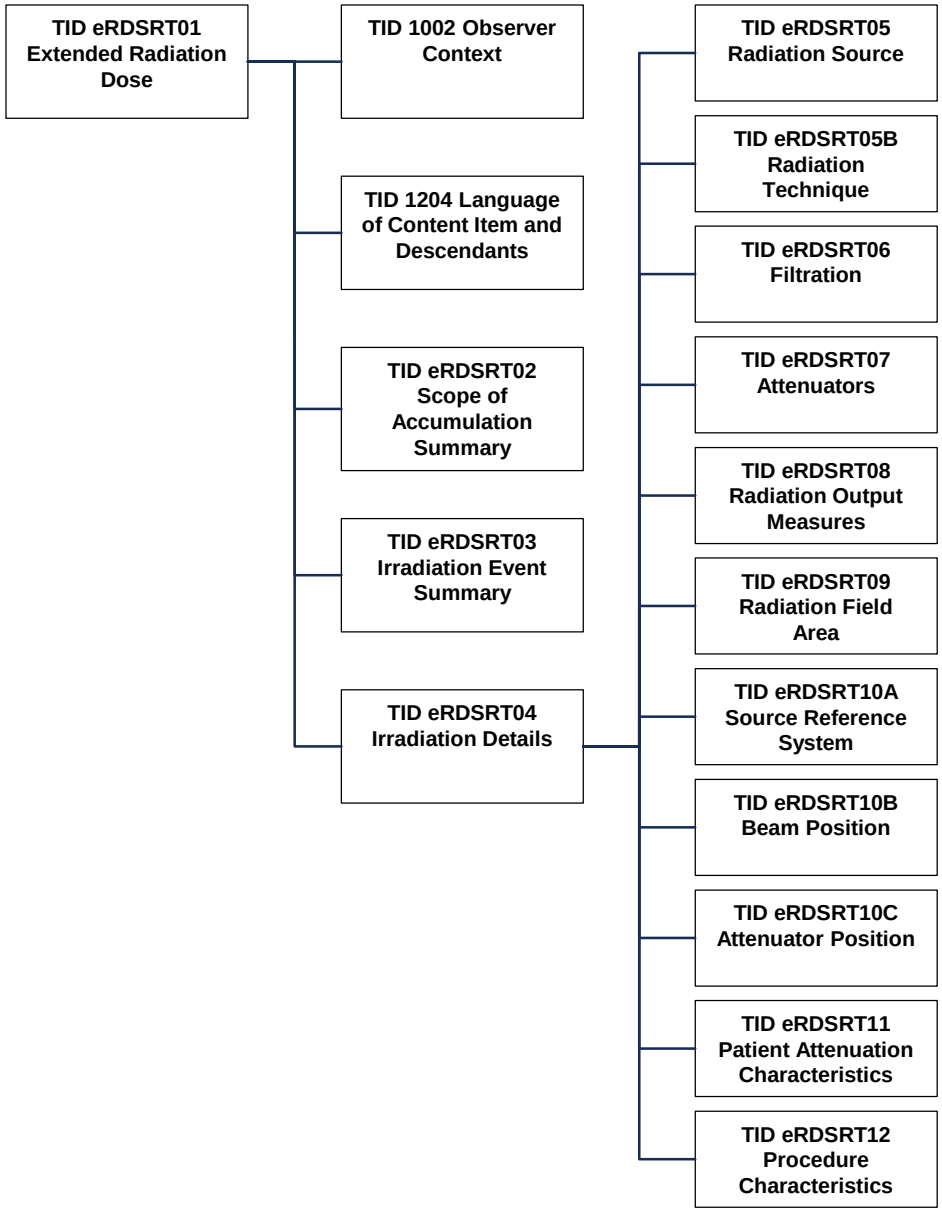
$$P_s = (x_s, y_s, z_s)$$





RDSR FOR

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 Filtration
TID eRDSRT07 Attenuators
TID eRDSRT08 Radiation Output Measures
TID eRDSRT09 Radiation Field Area
TID eRDSRT10A Source Reference System
TID eRDSRT10B Beam Position
TID eRDSRT10C Attenuator Position
TID eRDSRT11 Patient Attenuation Characteristics
TID eRDSRT12 Procedure Characteristics

Structure

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TID eRDSRT02 Scope of Accumulation Summary

- Modality specific exam-level information
- Accumulated MGD, DAP, Fluoro time, RAK, alerts, etc.
- Definition of Reference Point for eRDSRT10B

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
- Focal spot size
- 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 Filtration

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

TID eRDSRT07 Attenuators

- Time window (t_1-t_2)
- 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 transformation matrix (4x4)

TID eRDSRT10B Beam Position

- Time window (t_1-t_2)
- Source index
- Filtration position & dimensions (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 Attenuator Position

- Time window (t_1-t_2)
- Attenuator position and dimensions (x_e, y_e, z_e)

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)
- Anatomy (body part, laterality)
- Acquisition Protocol
- Patient Table Relationship
- Patient Orientation

Notes

- 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, etc.), 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.