

DICOM 3.0 RT Dose IOD for Multi-Institutional Clinical Trials

Advanced Technology Consortium

for Clinical Trials Quality Assurance

John W. Matthews, D.Sc.

Dose Matrices and DVHs Share Same IOD

- While each may be present in the same IOD, discussion will separate them a bit
- If both present in a single file, *must* represent the same dose matrix
- While Fraction Group dose matrices are needed, only total dose DVHs are required
- As of Jan 2004, DVH plots (hard copy, screen capture, etc.) may be submitted in lieu of digital DVHs.

What Dose IOD Can Represent in DICOM 3.0

- Beam dose
- Fraction group dose (or sequence of brachytherapy application setups)
- Plan dose (sum of all fraction groups)
- Other things (error, etc.)
- Absolute physical, biological or relative dose
- Points, planes, volumes, isodose curves
- DVHs for logical combinations of structures for any listed doses (e.g. beam, fx group, plan, etc.)

What Dose IOD Must Represent for Multi-Institutional Trials

- Fraction group dose (or sequence of brachytherapy application setups) for **all treatments of a fraction group**. (See Number of Fractions Planned (300A,0018) for clarification of fraction group.)
- 3D absolute physical dose matrices in Gy (i.e., multi-frame)
- DVHs for logical combinations of structures in absolute dose and absolute volume for total dose plan (sum of fraction groups and/or brachytherapy applicaton setups)

How Dose Matrices Are Used in Multi-institutional Trials

- Total dose planned to be delivered (per fraction group) to critical structures and target volumes
- Together with treatment record, provides adequate data for modeling of tissue response based on temporal pattern of dose delivery
- Multiple fraction group doses are combined by ITC to produce total plan doses.
- Total (combined) plan doses and resulting DVHs are compared to institutional data.

Why Are Dose Matrices Required to Be in Absolute Dose Units?

- Normalization other than absolute dose is:
 - Frequently ambiguous
 - Subject to appropriate scaling to convert to absolute dose
- Absolute dose is necessary for any biological modeling

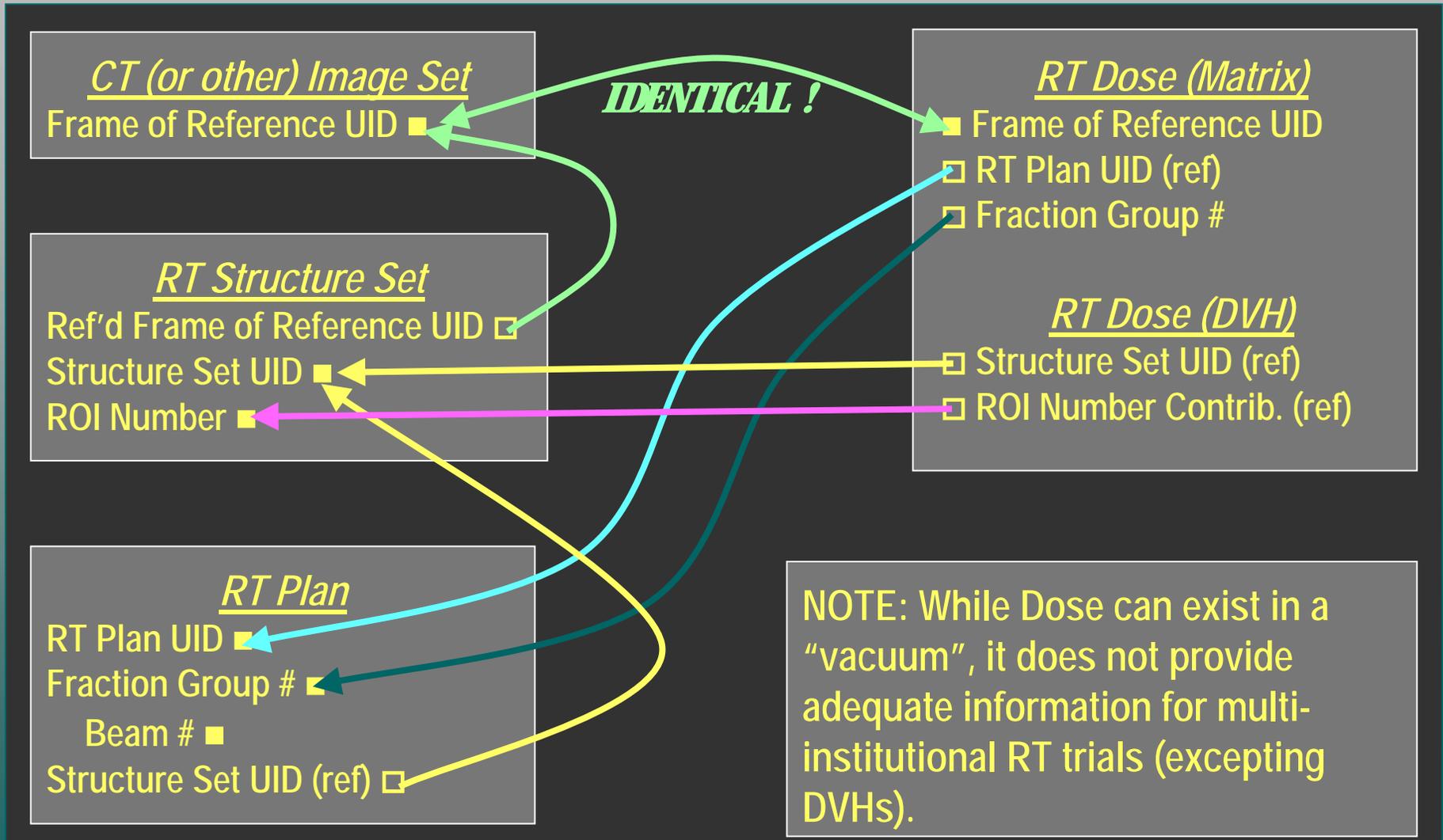
Dose Summation Type

- Fraction Group dose (i.e., Dose Summation Type (3004,000A) = “FRACTION”) represents the summation of all treatments for a fraction group.
- Treatment record (communicated separately) provides fractionation information.

Specific DVH Requirements

- Only required for total dose plan (not fraction group or any smaller delivery increment)
- Must be absolute dose
- Must represent absolute volumes
- May represent logical combination (inclusion or exclusion) of structures and target volumes

ITC Required Linkages for Dose IODs



RT Dose Module ITC Attribute Constraints

Field	Tag	Type	Comment
Samples per Pixel	(0028,0002)	1C	1
Photometric Interpretation	(0028,0004)	1C	MONOCHROME2
Bits Allocated	(0028,0100)	1C	16 or 32
Bits Stored	(0028,0101)	1C	16 or 32
High Bit	(0028,0102)	1C	= Bits Stored – 1
Pixel Representation	(0028,0103)	1C	Unsigned Integer
Dose Units	(3004,0002)	1	Only GY supported by ITC
Dose Type	(3004,0004)	1	Only PHYSICAL, PHYSICAL_HOMO or PHYSICAL_HETERO supported by ITC (See CP 442.)

RT Dose Module ITC Attribute Constraints

Field	Tag	Type	Comment
Dose Summation Type	(3004,000A)	1	FRACTION, TOTALHOMO or TOTALHETERO (See CP442.)
Referenced RT Plan Sequence	(300C,0002)	1C	Dose may reference either FRACTION or PLAN. (excluded for TOTALHOMO or TOTALHETERO) (See CP442.)
>Referenced SOP Class UID	(0008,1150)	1C	
>Referenced SOP Instance UID	(0008,1155)	1C	
>Referenced Fraction Group Sequence	(300C,0020)	1C	
>>Referenced Fraction Group Number	(300C,0022)	1C	

Grid Frame Offset Vector

- Only monotonic offsets are supported.
- The values in the vector are considered relative to “Image Position (Patient)” (0020,0032)
- However, if “Image Orientation (Patient)” is $[1,0,0, 0,1,0]$ (non-rotated) **AND** the first value in the vector is **NOT** zero (0.0), then the Z-values are considered to be Z coordinate values in patient space (for compatibility with prior implementations).

RT Dose Module ITC Attribute Constraints

Field	Tag	Type	Comment
>>Referenced Beam Sequence	(300C,0004)	1C	
>>>Referenced Beam Number	(300C,0006)	1C	
>>Referenced Brachy Application Setup Sequence	(300C,000A)	1C	
>>>Reference Brachy Application Setup Number	(300C,000C)	1C	
Grid Frame Offset Vector	(3004,000C)	1C	
Dose Grid Scaling	(3004,000E)	1	Must convert to GY.

RT DVH Module ITC Attribute Constraints

Field	Tag	Type	Comment
>DVH Type	(3004,0001)	1	
>Dose Units	(3004,0002)	1	Must be GY.
>Dose Type	(3004,0004)	1	Must be PHYSICAL, PHYSICAL_HOMO or PHYSICAL_HETERO (See CP442.)
>DVH Dose Scaling	(3004,0052)	1	Must convert to GY.
>DVH Volume Units	(3004,0054)	1	Must be CM3 (PERCENT not supported by ITC).
>Number of Bins	(3004,0056)	1	
>DVH Data	(3004,0058)	1	BIN WIDTH and ABSOLUTE VOLUME