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MINUTES

DICOM WORKING GROUP SEVEN (RADIOTHERAPY)

Meeting Location	Online Meeting	
Dates and Times	Monday, June 10, 2024	8:30 – 17:00 EDT
	Tuesday, June 11, 2024	8:30 – 17:00 EDT
	Wednesday, June 12, 2024	8:30 – 17:00 EDT
	Thursday, June 13, 2024	8:30 – 17:00 EDT
	Friday, June 14, 2024	08:30 – 12:00 EDT
Presiding Officers	Christof Schadt, Co-Chair	
	Jim Percy, Co-Chair	
Secretary	Shayna Knazik, MITA	

Participants

Company/Organization	Represented by	6/10	6/11	6/12	6/13	6/14
AAPM	Walter Bosch	X	X	X	X	X
AAPM	Bruce Curran	T	T		T	T
AAPM	Yulong Yan	X	X	X	X	X
Accuray	Bob Pekarek	X	X	X	X	X
Brainlab	Christof Schadt	X	X	X	X	X
Elekta	Jim Percy	X	X	X	X	X
IBA	David Wikler	X	X	X	X	X
Mevion	Bruce Rakes	X	X	X	X	X
RaySearch Labs	David Holst	T	T		T	
RaySearch Labs	Stina Svensson		T			
Reflexion	Michael Owens	T			T	
Varian/Siemens	Kari Jyrkkälä	X	X	X	X	X
Varian/Siemens	Thomas Schwere				T	
Varian/Siemens	Martin von Siebenthal					T
Lombardy Region RT Network, DICOM WG-28	Alberto Torresin			T		
Lombardy Region RT Network	Stefano Arcangeli			T		
Lombardy Region RT Network	Carlo De Meglio			T		
Lombardy Region RT Network	Federica Dessi			T		
Lombardy Region RT Network	Laura Fariselli			T		
Lombardy Region RT Network	Giorgia Marola			T		
Lombardy Region RT Network	Angelo Monti			T		

X = In person, T = via Teams

Week Overview

ACTUAL topics discussed are shown in the table below.

	Monday	Tuesday	Wednesday	Thursday	Friday
Session 1 08:30-10:15	Setup, Administrative, Opening	Assertions (with D. Holst)	Placeholder: Lombardy Region RT network call-in (with A. Torresin)	Setup Beams (with T. Schwere)	FHIR (with M. von Siebenthal)
Session 2 10:30-12:00	Review CP State, WG-07 Projects	Assertions	CBCT CP, IHE codes in DICOM	Setup Beams	Dedicated subject meetings; Review minutes
12:00-13:00	Lunch				Adjournment
Session 3 13:00-14:45	WG-07 Projects Future Scope	Nifti presentation, Treatment site	Supplement 177 RT Dose	Boutique Machines (with M. Owens)	
Session 4 15:00-17:00	WG-07 Projects Future Scope	Structure Overlap	Supplement 177 RT Dose	FHIR Background information	
Evening			Group Dinner		

For details on the topics, see the sections below.

Details

Administrative

- The meeting was called to order at 8:35 am EDT
- Introductions, identify participants.
- The group was reminded of NEMA anti-trust rules and DICOM Patent Disclosure Policy
- Review the agenda and revise as needed.
 - Except as relevant to F2F meeting topics, work on CPs will be carried out on teleconferences.
 - The emphasis of this F2F meeting is to define the future scope and focus of WG-07.
 - Review of discussion topics for the week. Additional topics to be addressed as time permits:
 - Dose-related concepts
 - Structure overlap / segmentation approval
 - Conversion to NIFTI
 - Coding schemes for workflow
- Review of meeting minutes from the last meeting(s) was postponed to the next teleconference.

Meeting Schedule

- The decision (June 2023 in Stockholm) to meet in person once a year and schedule focused teleconferences to address single topics was reviewed. Consensus that this approach is working well.

CP Status

- The status of WG-07 CPs was reviewed.
 - CP_RT214 – 4D Imaging Support was reviewed. The current practice of using (proprietary) Series Descriptions is problematic. There is strong interest in creating a better solution. Decision to continue work on this CP in WG-07 after the 2024 summer vacation.
 - ACTION: Christof to add to CP session in October.
 - CP_RT255 – Extending Beam Limiting Device Description to Support Binary Leaves. This CP relaxes the semantics of the Tomotherapeutic Leaf Initial Closed Duration. This Attribute, already defined in a 2nd Gen Macro, must be included to the Control Point Sequence of the RT Beams Module with a new Section defining the relaxed semantics.
 - ACTION: Bob to update CP and present at July CP session

Project Review

- The status of projects identified at the June 2023 WG-07 Meeting in Stockholm was reviewed and updated in WG7_RatingOfHybridTopics_2024.xlsx. Decision to continue discussion/work on the topics listed below. The WG-07 members indicated for each project will review options for further development of that topic.
 - **CP_RT237 Rename RT Prescription to Dose Reference Module in RT (Ion) Plan** (Christof)

- The Module was initially intended as the prescription, but (most) vendors no longer use it for this purpose. The Dose Reference Module has been adapted for dose tracking.
 - Decision to continue work on this
 - ACTION: Christof to prepare CP-RT237 for July CP session
- **Use of Equipment Mapping Matrix in RT (Ion) Plan** (Bruce/Bob)
 - Proposal to move the generic mapping of patient to machine coordinate systems from 2nd Gen to 1st Gen Plan. This is a breaking change, since it replaces isocenter and table parameters for patient positioning. Conversion between matrix and machine/table parameters must specify the order of application of rotations and translations.
 - Continued monitoring of IEC 61217 edition 3 is warranted.
 - This topic to be discussed further at upcoming focus session.
 - ACTION: Bruce and Bob to prepare a new CP
- **Support of non-Standard devices in RT (Ion) Plan** (Jim)
 - Creating a new IOD for “boutique” machines has been ruled out. Alternative approaches using DICOM for non-Standard machine plans were discussed.
 - Complete plan with proprietary plan parameters as private tags
 - “Compatibility plan” with limited information and dummy values for mandatory attributes
 - Encapsulated proprietary plan data as raw data.
 - This topic to be discussed further at upcoming focus session.
 - ACTION: Jim to prepare a new CP
- **Use of Patient Treatment Preparation instead of Setup Beams** (David)
 - This topic to be discussed further at upcoming focus session.
- **Enhance RT Dose with 2nd Gen Dose Parameters (incl. multi-instance)** (Christof/Yulong)
 - Metadata to describe derivation of a dose instance. Includes information on dose calculation, combination, and radiobiological modeling
 - Overlap with plan summary information (currently in RT Dose) should be reviewed.
 - Identify dose metadata from Sup 177 for inclusion in RT Dose IOD.
 - An alternative is adding dose annotation information to Parametric Map
 - Christof will extract Sup 177 features for discussion later in the week.
 - This topic to be discussed further at upcoming focus session.
- **DVH Data Representation** (Kari)
 - Discuss further
 - ACTION: Kari to prepare a CP for October session
- **LET maps/Dose Rate maps/Dose ensembles** (Walter)
 - Discuss further
 - Topic to be discussed further at Hybrid RT Dose focus session.
- **Additional RT Assertions** (Christof)
 - ACTION: Christof to prepare two CPs for August session

[Adjourn for the day 6/10/24 at 5:10pm EDT]

[Resume meeting 6/11/24 at 8:35am EDT]

Assertions

RT Assertions

In the context of CP RT 247, the additional need for assertions was discussed, for ROI level and Registration Approval. C. Schadt will provide a supplementary approach in the Structure Set Module (for Registration) and the Referenced RT Structure Set Sequence of the RT Plan (for ROI level approval).

- Several use cases were discussed, including
 - Approval of images
 - Approval of spatial/deformable registrations
 - Approval of ROI contours
 - Approval of ROI observations
- Approval is the result of review. Approval for a specific purpose.
- Review of CP RT247 draft
 - The group discussed addition of an Anatomy Model Content (Type 3) Attribute in the RT Structure Set Module to act as a switch for ROI defining Sequences within the RT Structure Set IOD:
 - ACQUIRED_DATA – Input Data for contouring (images, registrations, segmentations)
 - PATIENT_ANATOMY – ROIs derived from acquired data
 - Other states (CONTOUR_DATA, TEMPLATE) were considered, but found to be inconsistent with internal requirements of the RT Structure Set IOD.
 - This is a breaking change (like dual-layer MLC definition). It uses an “empty” structure set to assert approval for input objects (images, registrations) and provides approval for ROIs, including deformed/transformed ROIs.
 - ROI-level approvals are represented in the structure set RT ROI Sequence.
 - RT Assertions Sequence in RT Plan can represent approval of structure sets at the instance level or ROI level.
 - When Anatomy Model Content is ACQUIRED_DATA, input data images are referenced in the Referenced Frame of Reference Sequence and Referenced Image Sequence (in General Reference Module).
- ACTION: Christof will draft two CPs: one for Anatomy Model Content and one for Assertions for discussions

Assertion Collection

This topic depends on the outcome of the related assertion CP RT247 and it needs to be decided how to proceed with the Assertion Collection Supplement 238.

WG-07 decided to cancel Sup 238 because three CPs (RT Plan Approval, Anatomy Model Content, and Assertions) provide facilities for the major of RT use cases involving approval. Additionally, assertion management may be implemented using other technologies, e.g., FHIR.

ACTION: Christof to report to WG-06 that Supplements 238 and 177 have been cancelled.

NiftI conversion to DICOM

Yulong Yan presented an overview of the NiftI neuroimaging format (<https://nifti.nimh.nih.gov>)

- Coordinate conversions between DICOM (LPS+) and NiftI (RAS+) coordinate systems
- Yulong's slides have been saved to the Presentation folder in Teams.

Treatment Site

From D. Wikler: The Treatment Site Code Sequence in the General Plan module allow inclusion of codes from BCID 4 "Anatomic Region". Checking BCID 4 "Anatomic Region" list of codes, I feel it lacks a lot of anatomical regions commonly used in RT. BCID 4031 Common Anatomic Region (used in General Image" seems to contain more relevant anatomic region for RT.

After a review of nested codes in DICOM Part 16, it appears to contain the needed codes for anatomic regions (see CID 4031).

Support of non-Standard devices in RT (Ion) Plan

- Attributes in the RT Ion Beams Treatment Record and RT Radiation Salvage Record were reviewed to see how the progress in delivering treatments can be captured.
 - How to track and indicate progress toward completion of a treatment?
 - How is Meterset defined?
 - What is stopping criterion? I.e., what is 100% progress?
- Attributes of a "Boutique Beams Sequence" were discussed.
- Further discussion is planned with Michael Owens

Structure Overlap

- The 2nd Gen Segment Characteristics Precedence (3010,0029) attribute (Type 2) in the Segment Annotation. This (unsigned) value indicates precedence for density (or characteristic) overrides. Lowest non-NULL values have highest priority.
- ACTION: Jim Percy to draft CP to include the Segment Characteristics Precedence in the RT ROI Observations Sequence (revising description to "ROI").

Future Scope of WG-07

With quitting the task of developing 2nd Generation RT and the overall very little ability to perform further substantial changes to the DICOM Standard for RT, the vendors have to discuss how to proceed with DICOM WG-07 and what the general tasks should be.

This discussion may also cover/overlap with the topic of the application of FHIR in RT. Of course, there is a dedicated subgroup on FHIR by the IHE-RO TC, still it may be worth discussing transferring the use cases and issues that were initially intended to be solved by DICOM to "some kind of RT FHIR Working Group". Maybe one solution could be to reduce the overall workload of WG-07 to a pure maintenance mode and re-group (e.g. under IHE-RO) to work on a different protocol, as the demands in additional communication between systems will not go away. Current examples at hand are:

- Prescription
- Setup imaging (instruction)

Outstanding topics

Support for adaptive RT
Predecessor plan relationship

Other ideas for the RT DICOM community

Example data for dose-related concepts: LET, dose-rate, Temp, SAR, ...
Open-source tooling
Adoption of DICOM-web
Dose Upgrader: Dose+Plan --> Dose_w_PlanOverview
DICOM object troubleshooting and repair

Motivation for Open-Source Effort

Maintain cross-vendor, cooperative engagement
Encourage application and extension of DICOM in RT
Tools for translational research/implementation
Knowledge Base for DICOM RT

[Adjourned for the day 6/11/24 at 5:10pm EDT]

[Resume meeting 6/12/24 at 8:35am EDT]

WG-02/28 RT Treatment Planning Result SR

Alberto Torresin (Secretary of WG-28) made contact that he is looking into a "Treatment Planning Summary/Result" based on a Structured Report. This is primarily a local initiative in Italy/Lombardy, but we agreed that it might be good that he presents the ideas they have and whether there maybe is more interest from a DICOM WG-07 perspective.

Alberto Torresin, Stefano Arcangeli and members of the Lombardy Region RT Collaborative presented a discussion of a means to capture clinical data along with DICOM images. This group is investigating the use of DICOM SR to convey clinical data and references to DICOM instances.

The IHE-RO XRTS and ROTH Profiles were described by members of WG-07 as they address similar use cases. Links to IHE-RO Profiles in Box were shared with the Lombardy group. The group was invited to participate in IHE-RO XRTS and ROTH subgroup discussions.

ACTION: Christof to send invitation to participate in IHE-RO. (Sent)

CBCT

The group revised CP 2220. The CP requires re-work before presentation to WG-02 and WG-21. The previous revision was rejected by WG-06 following LB.

- A new Optional RT Cone-Beam Imaging Macro with CBCT parameters must be created. The attributes are used both at the top level in a Functional Group and at the root level of the CT Image IOD. They must be Type 3.
- TODO: Need to decide which cone-beam imaging parameters are needed by RT applications.

- Bob Pekarek to check on requirements for parameters.
- Can the required parameters be encoded in Scan Options (0018,0022)? Could be used encode an indicator that CBCT is adequate for planning.
- ACTION: Christof to clean up CP2220, present to WG-21 and forward to WG-06.

Coding Schemes for IHE-RO

Discussion of Coding Schemes used in IHE-RO Profiles

- Existing DICOM coding schemes are listed in DICOM Part 16, Section 8. What is required to include a coding scheme in this list?
- An Equivalent Code Sequence is present in the Code Sequence Macro.
- Advice to IHE-RO TC to mandate use and recognition of Equivalent Code Sequence in IHE-RO Profiles. Encourage IHE-RO to request DCM codes early in the development of Profiles (even if they are ultimately not used).
- No further action at this time.

Supplement 177: 2G RT – Dose Image

WG-06 wants to know whether this Supplement will be continued or should be cancelled.

WG-07 reviewed Supp 177 to see if work on this supplement should continue. Features introduced in Supp 177 for 2nd Gen Dose (listed below) were discussed. (see file 1st Gen Hybrid Extension/01_RT Dose/**NewDoseFeatures.xlsx** in Teams)

- Dose Context ?
 - Dose Constituents - Yes
- Dose Representative Value - Yes
- Dose Value Origin - Yes
 - Mark recalculated doses
- Radiobiological Interpretation - Yes
- Dose Calculation Method – Yes*
 - ~~Material Composition Information Source~~
 - Pixel Conversion process identification ?
 - Dose Calculation Algorithm - Yes
 - Dose Calculation Algorithm Parameters ?
- Commissioning Key - Yes
- Dose Reporting Material - Yes
- Dose Measurement Device ?
- ~~Related Conceptual Volume~~

Group members worked on incorporating 2nd Gen Dose features in the hybrid RT Dose IOD. Results to be saved in the 1st Gen Hybrid Extension/01_RT Dose folder in Teams.

Sequence of CPs to incorporate new RT Dose features:

1 Extend CP RT250 with Dose Calculation Algorithm Parameter Sequence, commissioning keys and Dose Reporting Material Code Sequence	Now	
2 CP for radiobiological stuff: create new RB macro from existing 2nd gen macro: all type 3, remove Y/N flag	Now	
3 CP for dose characteristics (= origin)	Now	
4 CP with rest of Dose Calculation Parameters and creating a macro with changes from CP RT250	when 1-3 are done	
5 CP for constituents (use codes for dose units on constituent level for fancy new stuff)	when 1-3 are done	
6 dose rate/LET	when 1-3 are done	
7 Dose Context	Maybe	

ACTION: Christof to prepare overview of new RT Dose structure

[Adjourned for the day 6/12/24 at 5:20pm EDT]

[Resume meeting 6/13/24 at 8:45am EDT]

Future Meeting Dates, Agenda for the Next Meeting and other Administrative Topics

Schedule

The list should be reviewed again, whether any adaptations are required since the last meeting.

[Teams Meeting List](#)

WG-06/WG-07 Meeting Schedule

Tentative meeting dates and times were scheduled for the coming year. WG-07 Teams meeting dates are available to prepare CPs for presentation to WG-06 and may be cancelled or shortened if not needed.

- WG-07: 2024-08-07, 9:00-13:00 ET (Teams)
- WG-06: 2024-08-19
- WG-07: 2024-10-31, 9:00-13:00 ET (Teams)
- WG-06: 2024-11-04
- WG-07: 2025-01-08, 9:00-13:00 ET (Teams)
- WG-06: 2025-01-13
- WG-07: 2025-03-19, 9:00-13:00 ET (Teams)
- WG-06: 2025-03-24
- WG-07: 2025-05-12 to 2025-05-16, F2F tentatively, in Europe (Brainlab or other venue)
- WG-06: 2025-06-16

ACTION: Christof to notify Shayna of meetings

Setup Beams

CP RT252 “Add Imaging to Patient Setup Sequence” is not just another CP, but would introduce the base for a fundamental change, as it was foreseen in 2nd Gen RT Objects: to no longer have a need for “Setup Beams”.

With the introduction of the RT Treatment Preparation Macro to the RT Patient Setup Module in CP 2344, it would now be possible to use this generic mechanism to extend it also for imaging. Additional codes to reflect the required information would be missing and would need to be added.

As this was a request by T. Schwere from Varian, the group discussed the general use case and whether this endeavor should be taken on for 1st Gen RT. The proposed approach was discussed, its feasibility was evaluated, and missing pieces identified.

Review CP2344 (cp2344_dft2_Update RT PatientSetupModule.docx).

Discussion points:

- Setup specifies device and procedure codes. Could extend procedure codes to cover imaging, surface scanning, etc. Additional parameters for procedures may be needed.
 - Request: can we replace setup beams with information in the Setup Module? There may be benefits to not representing setup as beams, but setup beams are deeply embedded in treatment planning and delivery workflow.
 - Grouping of beams: which beams are related to a setup? which setups are related?
 - Care is needed to avoid over-specification in the Standard, as this may raise barriers to implementation.
 - Including the Treatment Preparation Module in the Setup Sequence
 - Also need to include treatment preparation information in the Treatment Record.
 - Treatment “preparation” steps can be identified by Start Datetime and Stop Datetime.
 - The treatment record may require a different representation, e.g., event log.
 - Comment from Thomas S.: Consider using something like the Scheduled Protocol Code Sequence (in Modality WL).
1. ACTION: David to prepare CP modifying RT Plan to include procedure and potentially missing device parameter codes for imaging
 2. ACTION: Christof to prepare CP modifying the Treatment Record to incorporate an Event Log

Boutique/Alternate Machines Discussion

Michael Owens joined the group to discuss topics related to boutique treatment machines. Currently, the RT Plan contains either a Beam Sequence or a Brachy Applicator Sequence. A proposal to extend the RT Plan by adding a Boutique Beams Sequence. This Sequence has basic beam identification, contains two control points, and encapsulates detailed, proprietary plan information.

- Treatment progress is tracked using “Accumulated Fluence” (computed from number of pulses * number of open binary MLC leaf stations) and is expressed without units. The Primary Dosimeter Unit attribute would need to support this quantity.
- “Portion” data is a combination of PET image, filter parameters, and plan data.
- The number of control points depends on the PET data.
- Treatment proceeds in bi-directional passes across “firing positions” within multiple “beam stations”.
- 0-6 pulses per control point
- Large volume of beam data could be stored as a BLOB in a DICOM Raw IOD.

Could use “Alternate”, rather than “Boutique” to describe this representation of treatment plans and treatment records.

Further discussion in focused session.

HL7 FHIR Standard

David Wikler presented an overview of the HL7 FHIR Standard to the WG.

- Adaptation of FHIR to a context is referred to as profiling
- Profiles are specified in an Implementation Guide (IG)
- IGs are published in a hierarchy of community projects (organized by authority, country, category, content)
- Each IG is a JIRA project
- mCode (minimal Common Oncology Data elements) is a FHIR community project
- CodeX is HL7 FHIR Accelerator created for the community developing mCode as a FHIR IG (also manages CardX and GenomiX projects)
- CodeX Radiation Therapy Treatment Data (RTTD) Project
- IG proposal is reviewed/approved by Cross-Group Projects work group
- IHE-RAD has published the IMR Profile (developed as a FHIR IG) as an IHE Profile
- CodeX Radiation Therapy is the standard that is published by the RTTD Project

Presentation has been saved in the Teams meeting folder (6/10/2024)

DICOM WG-20 – Integration of Imaging and Information Systems is addressing DICOM/HL7 connectivity

Discussion of how to motivate implementation of FHIR and DICOMweb

ACTION: Walter to load Orthanc PACS (supports DICOMweb) on the AAPM Test Server.

[Adjourned for the day 6/13/24 at 5:00pm EDT]

[Resume meeting 6/14/24 at 8:30am EDT]

FHIR in Radiotherapy

Martin von Siebenthal joined the group

- Application of FHIR to Radiotherapy is use-case dependent. FHIR has a broad base; extensions may be needed to support new use cases. FHIR ties in well with general patient management in EHR.
- Broad representation of stakeholders is important to have wide applicability of the standard. CodeX is technically within the US Realm.
- RTTD Resources provide a summary of prescription, planning, and delivery of RT courses, phases. Plan and session summaries have been added. Details of these objects are not currently represented in the data model.
- Consider use cases that may be well supported by FHIR solutions.

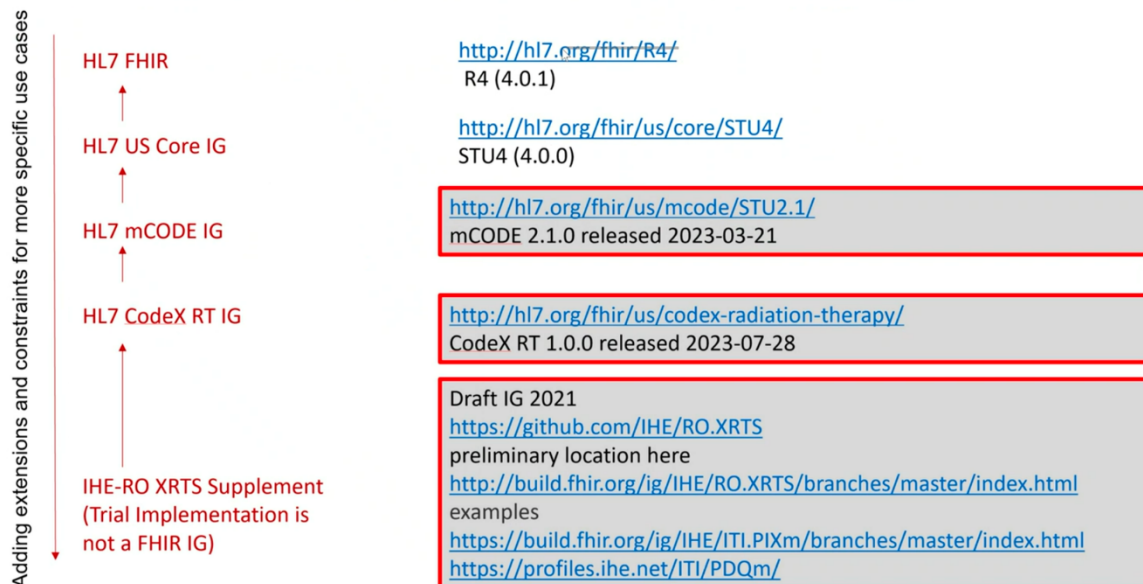
- CodeX has brought together oncology data stakeholders. The accelerator has helped to establish the needed SNOMED codes.
- Application of FHIR to control and document workflows. FHIR has concepts of Procedures, Requests, Tasks, and Events for managing workflows. FHIR Resources for medications are a useful example for such workflows. Issues of logging and cybersecurity are addressed.
- Participation in FHIR and CodeX is open, but voting requires membership in HL7 and CodeX, respectively.
- Linking between DICOM and FHIR documents is needed for some aspects of RT workflow, e.g., Plan reference to Prescription.

Relationships among HL7 FHIR and extensions for IHE-RO XRTS IG are shown below:

ACTION: David, Jim, Walter to draft white paper outlining DICOM limitations for possible use of FHIR as an alternative.

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Profile Dependencies (potential IHE/RO.XRTS IG)



Single Topic Meetings

Schedule 2-hour meetings for each topic

1. Boutique Machines in RT (Ion) Plan - Name? Review (2 h): 2024-07-17, 11am-1pm ET
2. Hybrid RT Dose - Update/summary for 7 CPs with overview: 2024-07-31, 9-11am ET
3. Event-based Recording: 2024-09-26, 10am-12pm ET
4. Equipment Mapping for Imaging – review Enhanced RT Image: 2024-10-10, 9-11am ET
5. Setup Beams vs Treatment Preparation: 2024-11-27, 9-11am ET
6. White Paper on DICOM Limitations – small group preliminary discussion: TBD (Jim, David, Walter)

Review of Minutes

Draft minutes were reviewed by WG-07. Members to review in detail.

Adjournment

Meeting was adjourned at 11:28am EDT.

Appendix: General Information

I. Project List

The list of major projects pursued by WG-07 can be found [here](#).