

# ITC Assists Developers of ATC Compliant DICOM Export for Clinical Trials

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## Abstract

**Purpose:** The Image-guided Therapy QA Center (ITC) as part of the Advanced Technology QA Consortium (ATC) has played a key role in assisting treatment planning system (TPS) developers in verifying that their DICOM implementations (CT, RT Structure Set, RT Dose, RT Plan, and RT Image) match ATC's conformance statement. This presentation will review lessons learned in this important effort.

**Methods and Materials:** ITC hosted a series of DICOM Implementers' Workshops to assist TPS vendors in implementing RT objects needed for clinical trials. A system of software ("ATC Method 1") developed at ITC to receive, process, and review volumetric treatment planning data for advanced technology clinical trials was used to assist vendors in their implementation of DICOM export. ATC's DICOM conformance statement specifies requirements for using DICOM RT objects in these clinical trials. ITC's DICOM fileset reader converts incoming data to an internal format for efficient display and review using the ITC web-based Remote Review Tool (RRT). The RRT was used by TPS developers to visualize/compare submitted images, structure sets, and dose distributions, thus greatly facilitating their DICOM implementations.

**Results:** Interactions with developers have exposed several problems in interpretation and implementation of the DICOM standard resulting from the complexity of DICOM RT objects and differences in design/capabilities of TPSs. Examples of problems seen include CT/Structure/Dose miss-registration and DVH-calculation discrepancies. To date, 6 TPSs have released ATC-compliant DICOM export software. ITC has received DICOM data matching the ATC conformance statement from a total of 15 TPSs. ITC has worked with 8 additional TPS developers.

**Conclusions:** The ITC web-based Remote Review Tool has proven to be of great help to vendors in developing and verifying implementations. More effort is needed by vendors to make digital data submission for clinical trials a simpler process.

Besides the DICOM ATC-compliant TPSs indicated in Figure 2, four other TPSs vendors have submitted complete ATC-compliant DICOM data sets to the ITC and are classified as "vendor complete". The ITC is awaiting release of these TPSs versions to permit evaluation by clinical users. The table also shows 9 TPSs that have compliant "RTOG Data Exchange Format" digital data export.

Figures 3 and 4 show examples of Vendor submission problems that were quickly diagnosed.

Vendor	Treatment Planning System		Exchange Format	Treatment Modality		
	System	Version		IDCRT	IMRT	Seed Brachy HDR Proton
CMS	FusionGO	3.1	R	✓	✓	✓
Delta	RadioPlan 3D		R	✓		
	PrecisPlan	2.01	D	✓	✓	
Nomen	Corvus		R		✓	
Nucletron	Helix TMS		R	✓	✓	
	TheraPlan Plus		R	✓	✓	
PLATO	PLATO RIS	2.62	D	✓	✓	
	PLATO BPS	14.2.6	D			✓
Philips	Pinnacle <sup>3</sup>		R	✓	✓	
	AcqPlan	4.9	R	✓	✓	
Raycast Medical	Stratix Suite CTDPlan	4.0	R		✓	
RTek	PIPEE	2.1.2	R		✓	
Varian	BrachyVision	6.5 (200710)	D			✓
	Eclipse	7.1	D	✓	✓	
	VarSeed	7.1	D			✓

Fig. 2. ATC-Compliant Treatment Planning Systems by Modality (as of 7/1/06). In the "Exchange Format" column, D means DICOM and R means "RTOG Data Exchange Format".

Over the years, ITC has conducted a series of Data Exchange Technical Workshops For TPS Vendors:

- Mar 10, 1995, St. Louis: Implementation of RTOG Data Exchange standard.
- Sep 10-11, 1999, St. Louis: Implementation of RTOG Data Exchange standard (prostate brachy).
- Mar 16-17, 2001, St. Louis: Implementation of DICOM 3.0 standard.
- Mar 16, 2002, St. Louis: Implementation of DICOM 3.0 standard.
- May 3, 2003, St. Louis: Implementation of DICOM 3.0 standard.
- April 14, 2004, St. Louis: Implementation of DICOM 3.0 standard. (followed by a WG7 meeting)

The slides for the most recent workshop are available at: [http://atc.wustl.edu/home/news/2004\\_dicom\\_workshop/2004\\_atc\\_dicom\\_wkshp\\_040505.htm](http://atc.wustl.edu/home/news/2004_dicom_workshop/2004_atc_dicom_wkshp_040505.htm)

In addition ITC hosted and participated in the Apr 24-28, 2006 meeting of the JHE-RO Technical Committee in St. Louis, MO. This IHE-RO meeting was to set constraints on the RT objects that will be used in a demonstration of DICOM interoperability that is to take place at this year's ASTRO meeting (Philadelphia, November 5-9, 2006).

The proportion of data submitted to the ITC for ATC-supported protocols using DICOM continues to rise. Currently, half of all submitted data sets are sent as DICOM RT objects, with the other half in RTOG Data Exchange format.

Efforts to facilitate the export of ATC-compliant DICOM RT data from commercial TPS have established the collection and evaluation of volumetric imaging and treatment planning data as an essential tool for QA of advanced technology clinical trials. The ITC is now contributing its experience to the ASTRO IHE-RO initiative (Integrating the Healthcare Environment - Radiation Oncology). This cooperative effort involving both clinicians and equipment vendors is expected to further benefit clinical trials by increasing the interoperability of TPS components and the uniformity of DICOM RT objects they produce.

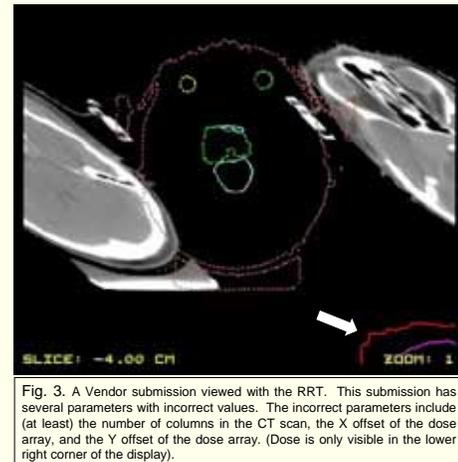


Fig. 3. A Vendor submission viewed with the RRT. This submission has several parameters with incorrect values. The incorrect parameters include (at least) the number of columns in the CT scan, the X offset of the dose array, and the Y offset of the dose array. (Dose is only visible in the lower right corner of the display).

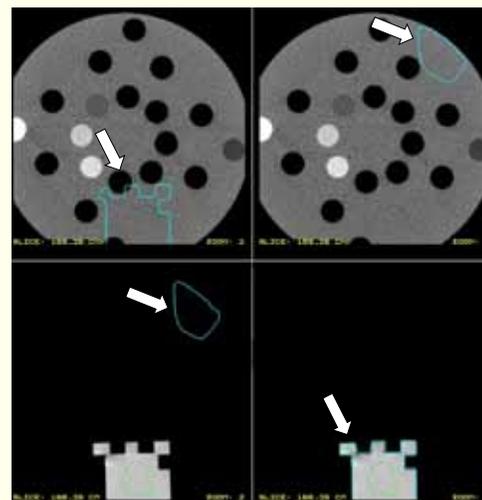


Fig. 4. Two Vendor submissions viewed with the RRT. The two panels on the left are from one submission; the two on the right are from a second submission the next day after the vendor corrected a problem in the Z coordinates of the dose array. Green represents a "structure" and cyan represents an isodose line. The two top panels are at the same Z offset while the two bottom panels are at a different Z offset.

The purpose of this work has been to facilitate the development of DICOM export capabilities in commercial treatment planning systems (TPS) appropriate to the collection and QA of digital data for advanced technology clinical trials.

A DICOM conformance statement was developed to specify requirements for DICOM RT objects and attributes used in representing TPS data in ATC-supported clinical trials. Communication with TPS vendors has taken place through technical workshops, individual correspondence, verbal communication, exchange of data, and participation in DICOM Working Group 7 (RT Objects).

A test process was established to evaluate ATC conformance of data submitted by vendors and their customers. Vendors have submitted sample DICOM data sets to the Image guided Therapy QA Center (ITC) for evaluation of their compliance with the ATC DICOM conformance statement. Evaluation of vendor DICOM RT data by the ITC and evaluation using the web-based ITC Remote Review Tool have been useful in testing initial ATC-compliance of TPS software, as well as verifying continuing compliance of succeeding software versions.

A screen capture image showing the comparison of RT Structures and isodose curves displayed by the RRT (left) and those displayed by a vendor's TPS (right) appears in Figure 1.

To date, 6 TPSs have released ATC-compliant DICOM export software. ITC has received DICOM data matching the ATC conformance statement from a total of 15 TPSs and has worked with 8 additional TPS developers. Figure 2 shows a table of TPSs that have successfully submitted digital data to the ITC. The ITC has also received compliant DICOM data from clinical users using two other TPSs not shown on this table. The vendors of these systems, however, have declined to be listed due to limited distribution arrangements for their software.

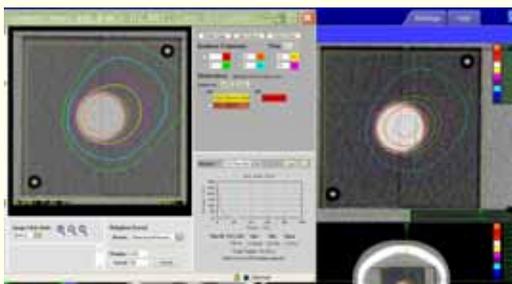


Fig. 1 Comparison of structure and isodose displays on RRT (left) and commercial TPS (right) as part of the evaluation of ATC-compliance in exported data.

## Conclusions

- ITC has been a pioneer in the design of DICOM RT objects.
- We feel that ITC's efforts have moved DICOM forward in the field of Radiation Therapy digital data exchange.
- ITC is committed to continue to help vendors with their DICOM implementations.
- DICOM is rapidly becoming the most common format for digital exchange of treatment planning data in ATC-supported clinical trials.