

Advanced Technology QA Consortium

**caBIG™ In Vivo Imaging Workspace
Face-to-Face Meeting
Rockville, MD
July 20-21, 2006**

James A. Purdy, Ph.D.

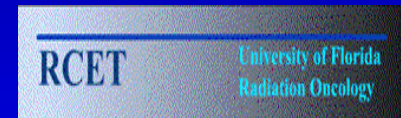
**Supported by NIH U24 grant CA81647,
“Advanced Technology QA Center”**

- ATC dates from April 1992 when 3DQA Center was established at WU-St. Louis to provide QA for RTOG 3DCRT trials (digital data submissions).
- Now functions as QA Consortium capitalizing on existing infrastructure and strengths of national QA programs

- Image-Guided Therapy Center (ITC – Washington University in St. Louis and UC Davis)



- Resource Center for Emerging Technologies (RCET – Univ. Florida Gainesville)



- Radiological Physics Center (RPC, M.D. Anderson Cancer Center)



- Radiation Therapy Oncology Group (RTOG)



- Quality Assurance Resource Center (QARC)



ATC'S OVERALL GOALS

- To facilitate the conduct of NCI sponsored advanced technology radiation therapy clinical trials that require digital data submissions.
- Effort includes coordination of QA activities, image/RT digital data management, RT QA, and clinical trials research & developmental efforts.
- We strongly believe that advanced medical informatics can facilitate education, collaboration, and peer review, as well as provide an environment in which clinical investigators can receive, share, and analyze volumetric, multimodality treatment planning and verification (TPV) digital data.
- Our ultimate goal is to improve the standards of care in the management of cancer by improving the quality of clinical trials medicine.

ATC's MISSION

- **Developmental efforts:**

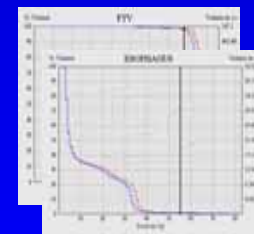
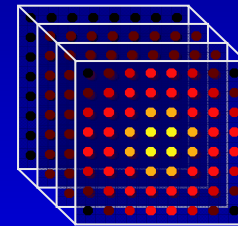
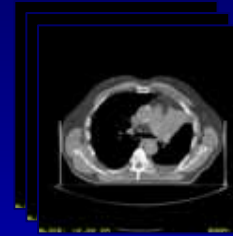
- electronic data exchange of digital planning data between ATC QA Centers and protocol participating institutions.
- web-based software tools to facilitate protocol digital data submissions and QA reviews.
- archival treatment planning & QA databases that can be linked with the cooperative group's clinical outcomes database.

- **Service efforts:**

- assist Cooperative Group's in protocol development, particularly credentialing requirements.
- manage/facilitate protocol digital data submissions, credentialing, QA review, and data analysis.

Data Objects for 3DCRT/IMRT Clinical Trials

- **Data Objects**
 - Volumetric, digital images
 - Contours
 - 3-D dose distributions
 - Treatment plan
 - Treatment verification images
 - DVHs
- **Challenges**
 - Heterogeneous treatment planning systems
 - Proprietary data formats



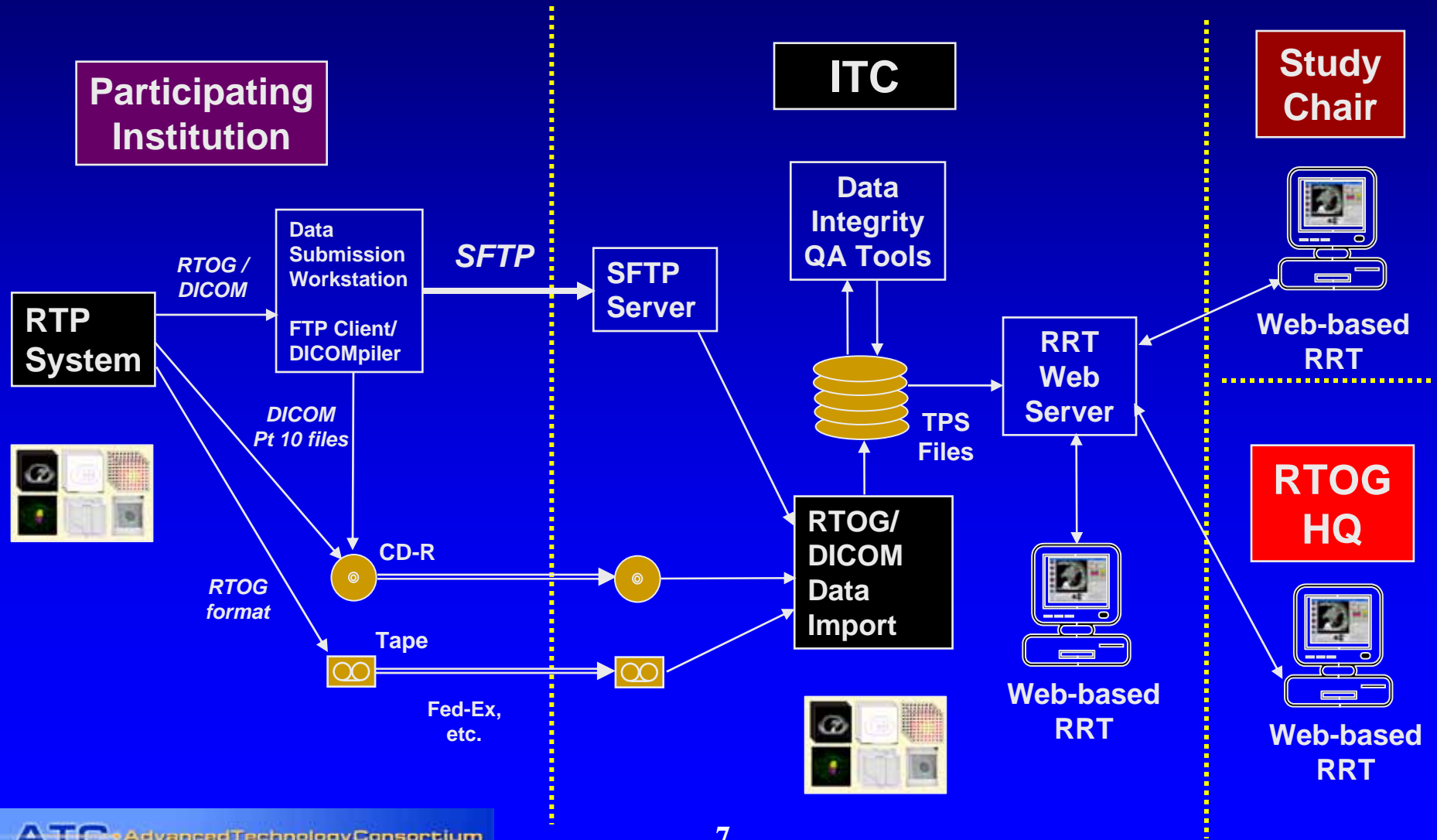
Typical Data Set per Patient ~ 100 MB

ATC Compliant Treatment Planning Systems (as of July 2006)

- ITC provides direct and ongoing assistance to TPS vendors for their DICOM implementation
 - Vendors submit DICOM datasets to ITC via FTP or media
 - ITC imports datasets into TP review system
 - Vendors evaluate correctness of data transfer using ITC's (RRT)
 - For RT Plan validation, screen captures are sent back to vendor

Treatment Planning Systems				Treatment Modality				
Vendor	System	Version *	Exchange Format	3DCRT	IMRT	Seed Brachy	HDR Brachy	Protons
CMS	Focus/XiO	3.1	R	✓	✓	✓		
Elekta	RenderPlan 3D		R	✓				
	PrecisePlan	2.01	D	✓	✓			
Nomos	Corvus		R		++			
Nucletron	Helax TMS		R	✓	✓			
	TheraPlan Plus		R	✓				
	PLATO RTS	2.62	D	✓				
	PLATO BPS	14.2.6	D				✓	
Philips	Pinnacle ³		R	✓	✓			
	AcqPlan	4.9	R	✓				
Rosses Medical	Strata Suite CTPlan	4.0	R			✓		
RTek	PIPER	2.1.2	R			✓		
Varian	BrachyVision	6.5 (Build 7.1.67)	D				✓	
	Eclipse	7.1	D	✓	✓			
	VariSeed	7.1	D			✓		

ATC Method 1: Digital Data Submissions to ATC (Currently in use for all ATC-supported protocols.)



ITC Remote Review Tool

- Secure web server (ITCreview.wustl.edu)
- Uses standard web browser

The screenshot displays the ITC Remote Review Tool interface. The main window shows a CT scan slice at -146.59 cm with various contours overlaid. The interface includes a sidebar with image thumbnails, a central image viewer, and a right-hand control panel. The control panel features buttons for 'Update Image', 'Edit Contours', and 'Contour Colors'. Below these are sections for 'Isodose Contours' (with checkboxes for 51, 30.6, and 68 Gy) and 'Structures' (with checkboxes for BREAST IPSI, PTV_EVAL, GTV, and SKIN). A DVH (Dose-Volume Histogram) plot is shown for 'PTV_EVAL' with a 'Recalc DVH' button. The DVH plot shows Volume (%) on the y-axis (0 to 200) and Dose (Gy) on the x-axis (0 to 300). Below the plot, a table provides summary statistics:

Plan ID	Vol ≥ Ref	Max	Min	Mean
Ex1	98.30 %	300.10 Gy	21.30 Gy	45.70 Gy

Additional statistics shown include Total Volume: 157.52 cc, DVH Data File, and Conformity Index: 0.607. The interface also includes a 'Window/Level' section with 'Preset: Default (soft tissue)', 'Window: 470', and 'Level: 20'. An 'EXIT' button is located at the bottom left.

The screenshot shows the 'Remote Review Tool' selection screen. It features two columns of lists: '1. Select Protocol ...' and '2. Select Case ...'. The '1. Select Protocol ...' list includes various protocols such as 'ACOG 0403 - Lung Ph II SBRT', 'NSABP B-39 RT0G 0413 - Breast Ph II (PBI)', 'RT0G 0019 - Prostate Ph II 3DCRT, TRPB', 'RT0G 0022 - Oropharynx Ph II 3DCRT, IMRT', 'RT0G 0027 - Head/neck phantom data for credentialing', 'RT0G 0117 - Lung Ph II Dose Intensification', 'RT0G 0126 - Prostate Ph II 3DCRT, IMRT', 'RT0G 0120 - Prostate phantom data for credentialing', 'RT0G 0225 - Nasopharynx Ph II IMRT +/- Chemo', 'RT0G 0232 - Prostate Ph II Ext Beams, TRPB', 'RT0G 0236 - Lung Ph II SBRT', 'RT0G 0236 - Immobilization test data', 'RT0G 0236 - Lung phantom data for credentialing', 'RT0G 0319 - Breast Ph II PBI 3DCRT', 'RT0G 0321 - Prostate Ph II HDR Brachy', 'RT0G 0421 - Head/Neck Phase II Recurrent', 'RT0G 0438 - Liver Phase II Highly conformal', and 'RT0G 0438 - Liver phantom data for credentialing'. The '2. Select Case ...' list contains case numbers from 0001 to 0017. An 'Exit Tool' button is located at the bottom.

- CT images
 - Structure contours
 - Iso-dose curves
- Contour editor
- Measurement tool
- Dose statistics
- Plan summary

Current ATC (RTOG – ITC) Methodology

- **The Participating Institution**
 - Identifies a patient that is appropriate to a particular clinical trial protocol.
 - Obtains informed consent from patient if patient is willing to participate.
 - Registers patient with clinical trial group.
 - Plans patient treatment according to protocol requirements
 - Sets up SFTP account with the ITC if submitting data via internet.
 - Submits planning CTs, RT-structures, RT-plan, and RT-dose to the ITC either using SFTP or using media via express mail.

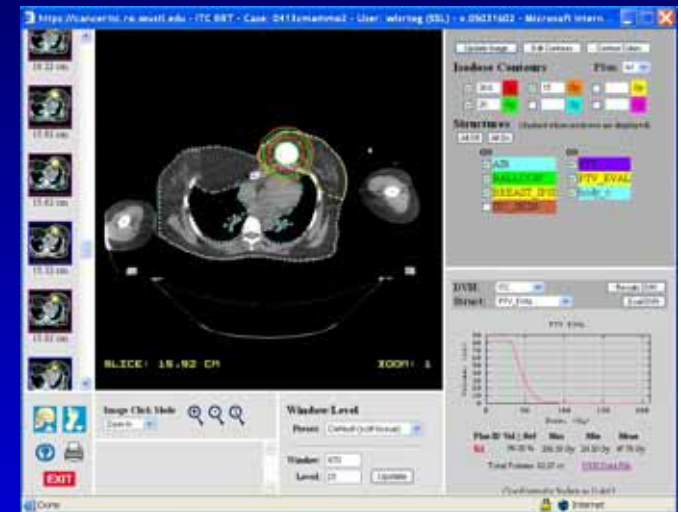
Current ATC (RTOG – ITC) Methodology

- The ITC

- Performs “Data Integrity QA” (Checks that the submission is protocol compliant in terms of objects submitted, makes sure data can be extracted for later review, prepares data for QA review, including renaming structures, sum fraction groups for total dose distribution, calculate DVHs)
- Forwards the case for QA review of contours by the study chair.
- Collects QA scores from study chair and logs them into a QA scoring database.
- Imports reviewer edited structures if necessary.
- Refers the case to a dosimetrist reviewer (dose prescription/heterogeneity protocol compliance).
- Collects the QA score from the dosimetrist reviewer.
- Notifies institution if any feedback is necessary.

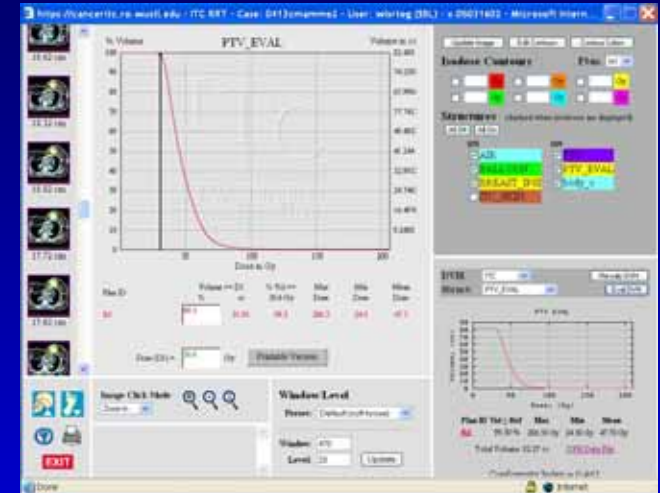
Current ATC (RTOG – ITC) Methodology

- **The Study Chair**
 - Receives notification from ITC that the case is ready for QA review of contours.
 - Reviews the appropriateness of the structures as drawn by the institution utilizing the Remote Review Tool.
 - Forwards the QA review scores for the contours and any edits, suggestions or requests for resubmission to the institution or the ITC.

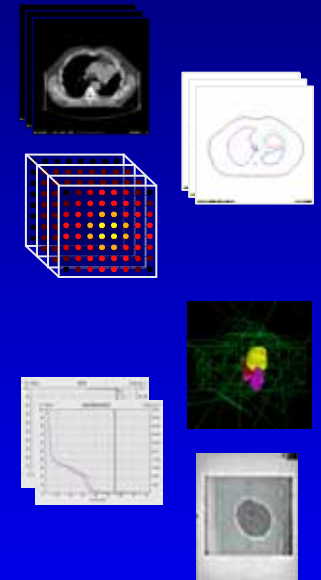
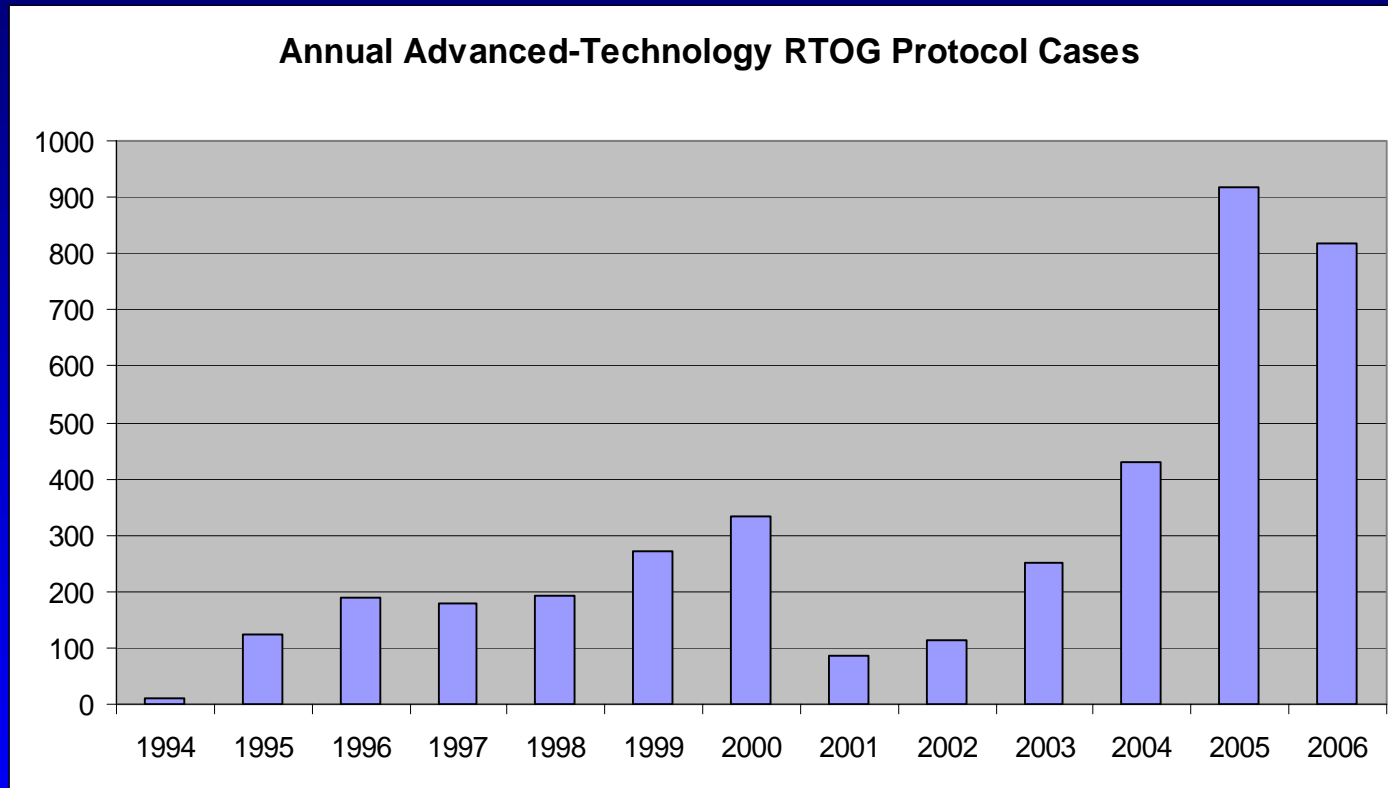


Current ATC (RTOG – ITC) Methodology

- **The Dosimetrist Reviewer**
 - Receives notification from ITC that the case is ready for dosimetry review.
 - Reviews the protocol compliance of the case with respect to the dose constraints as outlined in the protocol.
 - Forwards the QA review scores to the ITC.

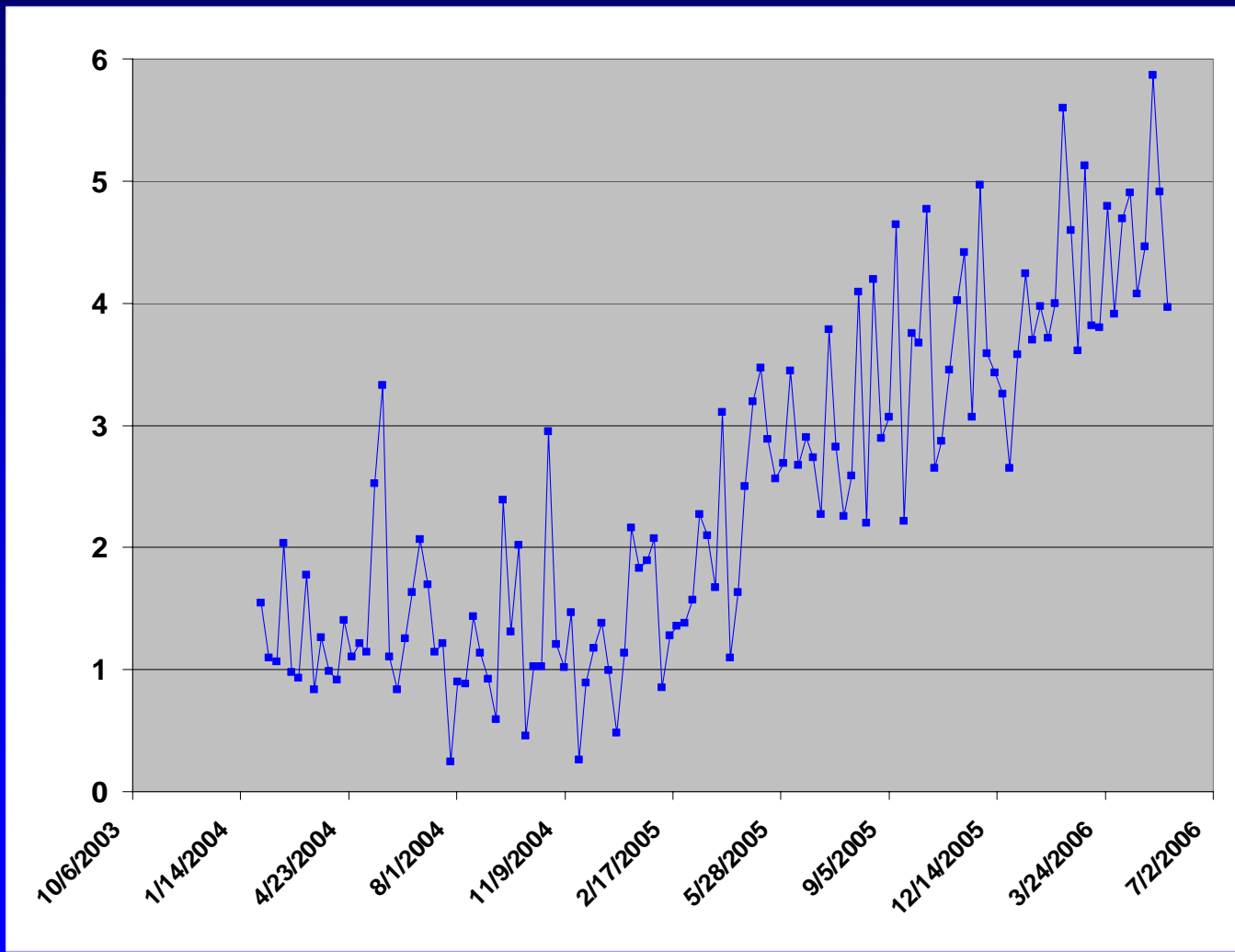


- June 22 2006 ATC Mtg: **3913** Complete, Protocol-Case, Digital Data Sets Submitted Over 12 Year Period using ATC Method 1*



- 15 commercial TPS vendors have implemented export capability
- 418 institutions able to submit data to ITC in St. Louis

ITC Data Submission Rate (Gbytes/week)



COORDINATION - SERVICE

Credentialing of Institutions

- Facility Questionnaire
- Knowledge Assessment Form (RPC)
- Benchmark / “Dry-run” Tests (ITC)
- Phantom IMRT Dosimetry Test (RPC) or QARC IMRT Benchmark
- Repositioning reproducibility Test for SBRT
- Rapid review of initial cases

IMRT Facility Questionnaire

- **Formats**

- Online web form, or
- Microsoft Word, or
- Adobe Acrobat (PDF)

- **Identifies**

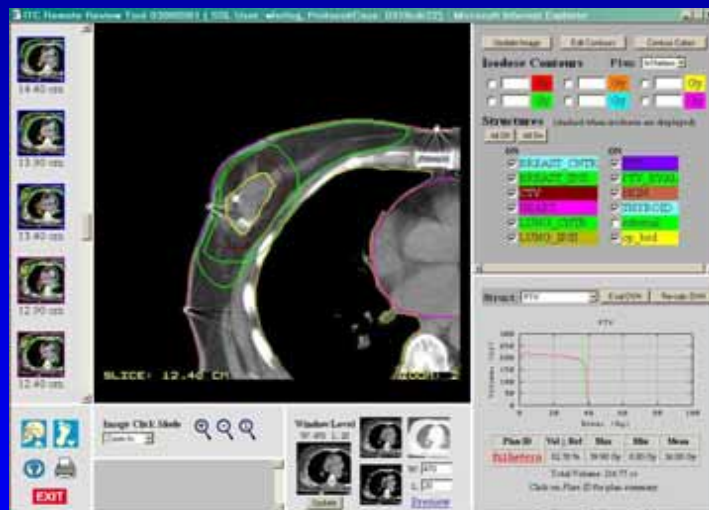
- Institution
- Key personnel (physician, physicist, dosimetrist, RA)
- Information on IMRT treatment planning and delivery systems
- IMRT Experience
- QA procedures

- **Current version on ATC web site**

The screenshot shows a web browser window titled "IMRT Form - Microsoft Internet Explorer". The address bar displays "https://cancer.vumc.edu/FORMS/IMRT/IMRT.cgi". The main content area is titled "IMRT Facility Questionnaire (For Protocols Requiring Digital Data Submission)". Below the title, there is a paragraph of text: "Before entering cases in IMRT protocols supported by the Advanced Technology Consortium (ATC), institutions must". This is followed by a numbered list of three requirements: 1. Submit this completed Facility Questionnaire for the IMRT Protocol, 2. Contact the ITC and request an FTP account for Digital Data Submission, and 3. Submit and successfully complete a protocol specific Dry-Run Test. Below the list, the section "I. INSTITUTION" is followed by a form with several input fields: "Institution Name", "If Affiliate, Name of Member Institution", "Address" (with a scroll bar), "RTOG Institution No (if applicable)", "NCI Number (if applicable)", and "RTF Number(s)".

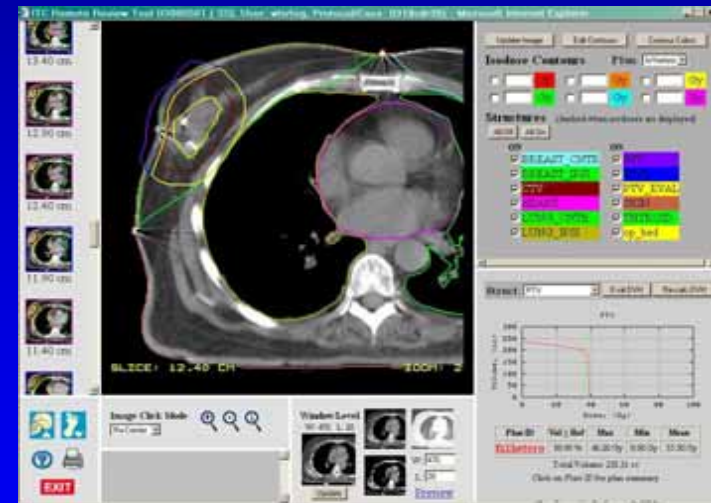
ITC Benchmark (“Dry Run”) Test

- Intended to demonstrate...
 - Understanding of protocol requirements (Tumor/target volumes, Organs at Risk, Dose prescription)
 - Digital data exchange capability



Incorrect Contouring for RTOG 0319

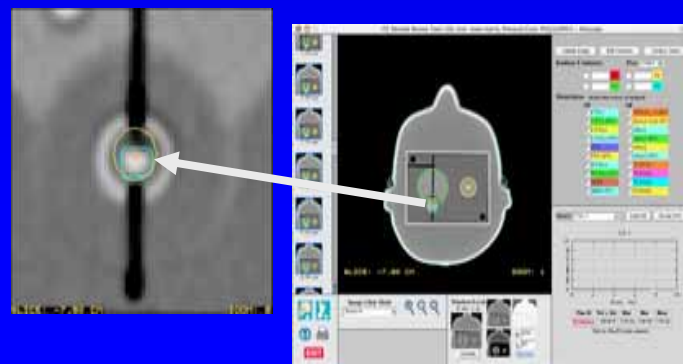
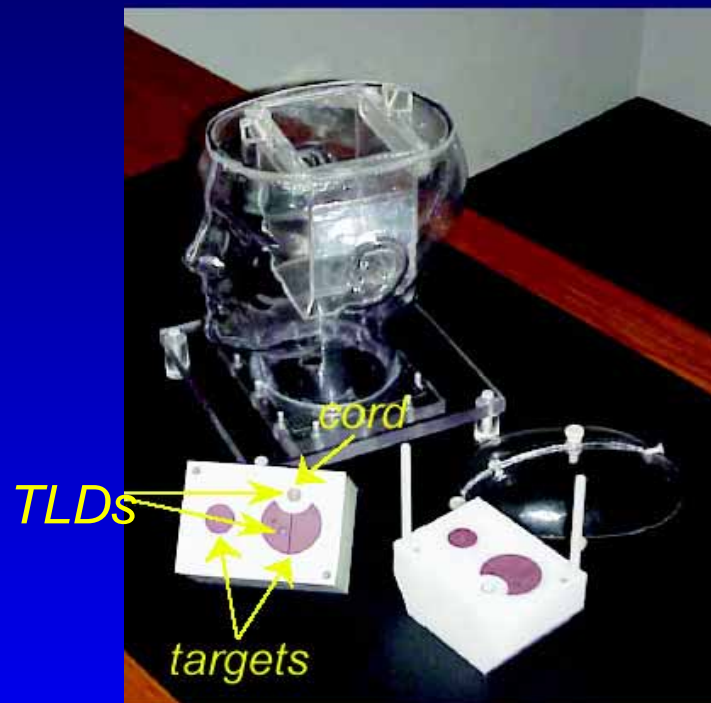
- Breast incorrect
- PTV incorrect



Corrected contouring after feedback from ITC

RPC IMRT Phantom Test

- RPC tests ability of each RTOG institution to deliver IMRT by asking facility to
 - Scan RPC phantom (CT)
 - Generate an IMRT plan according to protocol
 - Deliver treatment to phantom
 - Return phantom and dosimeters to RPC for evaluation
 - Submit digital treatment planning data to ITC for online review using Remote Review Tool



Repositioning Reproducibility Test for SBRT

ITC RRT - Case: I0236c002 - User: www-jgalvin (SSL) - v.05011101 - Microsoft Internet Explorer ITC RRT - Case: I0236c002b - User: www-jgalvin (SSL) - v.05011101 - Microsoft Internet Explorer

Left Window (Case I0236c002):
SLICE: 10.60 CM ZOOM: 1
Window/Level: Preset: Default (soft tissue), Window: 470, Level: 20

Right Window (Case I0236c002b):
SLICE: 10.57 CM ZOOM: 1
Window/Level: Preset: Lung, Window: 1500, Level: -700

RTOG ATC Closed Protocols

Protocol	Description	Institutions Credentialed	Cases Accrued
9406	Ph I/II 3DCRT Prostate Dose Escalation	54	1084
9311	Ph I/II 3DCRT Lung Dose Escalation	27	180
9803	Ph I/II 3DCRT GBM Dose Escalation	46	210
0022	Ph I/II 3DCRT/IMRT Oropharynx	35	69
0225	Ph I/II 3DCRT/IMRT Nasopharynx	36	68
0319	Ph I/II 3DCRT Partial Breast	31	58
0321	Ph I/II HDR/Ext Beam Prostate	18	129

RTOG ATC Open Protocols (June 7, 2006)

Prot.	Description	Institutions Credentialed	Cases Accrued
0117	Ph I/II 3DCRT/chemo Lung (73 goal)	48	40
0126	Ph III 3DCRT/IMRT Prostate (1520 goal)	135 (62 IMRT)	921 (208 IMRT)
0232	Ph III Ext Beam/TIPPB Prostate (1520 goal)	65	210
0234	Phase II Randomized Trial of Surgery Followed by Chemoradiotherapy Plus C225 (Cetuximab) for Advanced Squamous Cell Carcinoma of H&N (230 goal)	46 IMRT only	165
0236	Ph II SBRT Lung (52 goal)	7	46
00415	Phase II Advanced H&N Randomized Trial of Surgery Followed by Chemoradiotherapy (706 goal)	0	0

RTOG ATC Open Protocols (June 7, 2006)

Prot.	Description	Institutions Credentialed	Cases Accrued
0418	Phase II IMRT +/- Chemotherapy for post-op Endometrial or Cervical Ca (92 goal)	55	0
0421	Phase III 3DCRT/IMRT Locally Recurrent, Previously Irradiated H&N Cancer (240 goal)	40	13
0438	Phase III localized High Risk Prostate (ITC collects IMRT data only) (18 goal)	1	1
0515	Phase II NSCLC Volume definition +/- PET (48 goal)	0	0
0521	Phase III localized High Risk Prostate Cancer: Androgen Suppression with Radiation vs. Radiation with Chemotherapy and Prednisone (600 goal)	55 IMRT only	16
0522	Phase III Trial Comparing Radiation and Cisplatin with/without Cetuximab for Advanced Head and Neck Cancer (720 goal)	46	17

NSABP/RTOG ATC Supported Open Protocols (1)

(June 7, 2006)

Protocol	Description	Institutions Credentialed	Cases Accrued	Accrual Goals
NSABP B39 RTOG 0413	Phase III Partial Breast Irradiation	322(264/189/32)	1446 (488/158/62)	3000

COG/CALGB/ACOSOG/ECOG

QARC ATC Supported Open Protocols (5)

(July 20, 2006)

Cooperative Group	Protocol	Cases Accrued
COG	ACNS0121	10
COG	ACNS0126	5
COG	ACNS0331	16
CALGB	80101	1
ACOSOG	Z5031	1
	Miscellaneous Studies	8

JCOG ATC Supported Open Protocols (1)

(June 7, 2006)

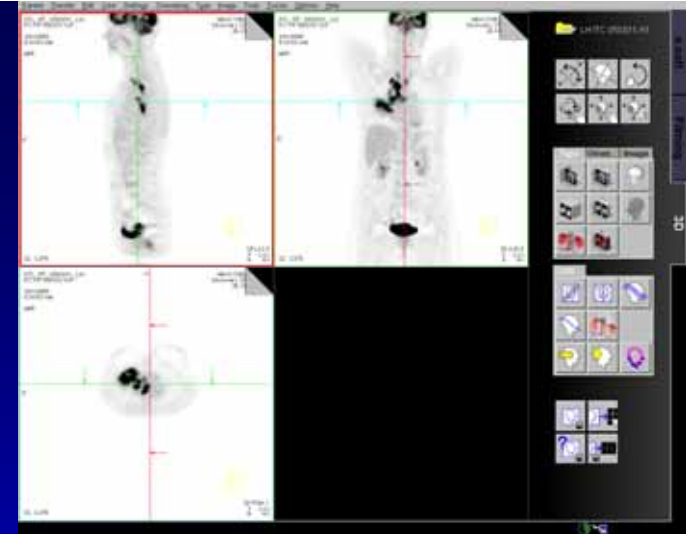
Protocol	Description	Institutions Credentialed	Cases Accrued	Accrual Goals
JCOG 0403	Phase II Study of SBRT in Patients with T1N0M0 Non-Small Cell Lung Cancer	13	67	165

Status of ATC PET QA Capability for Advanced Technology Protocols RTOG 0515 Credentialing / QA

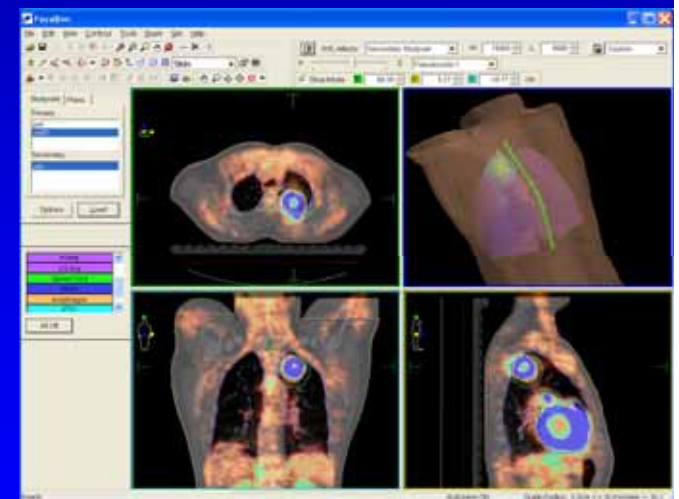
- **Credentialing Requirements (see ATC web site)**
 - Be credentialed for RTOG S-0132/ACRIN 6665 or RTOG 0235/ACRIN 6668
 - Demonstrate ability to submit 3DCRT Digital Data to the ITC
 - Credentialed for another ATC supported 3DCRT study
 - Submit FQ with digital data (CT, Structs, Plan, Dose)
 - Demonstrate digital submission of PET or PET/CT images to ITC
- **Collect Data for Developing QA Procedures**
 - Screen captures of fused PET/CT images in T/S/C planes

PET Image Review for RTOG 0515

1. Institution submits PET DICOM Images and TP data to ITC using FTP or media.
2. ITC places (anonymized) PET data on ATC secure web server for download by Nuc Med radiologist
3. PET studies read (qualitatively) using eFilm or Syngo
4. PET/CT image registration checked at ITC using CMS FOCAL (Bosch, Forster)
5. TV contours evaluated using CMC FOCAL with/without PET (Bradley)



PET scan (GE) downloaded and displayed on MIR NM Siemens Syngo software

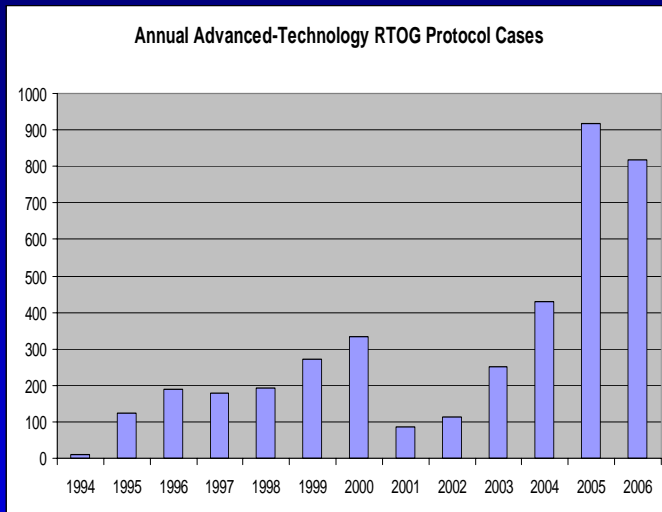


PET and CT images registered on FOCAL workstation; displayed with TV/OAR contours

Status of ATC PET QA Capability for Advanced Technology Protocols RTOG 0522

- Quantitative PET (PET/CT) images submitted to ACRIN, forwarded to NCI Archive
- CT, Structures, Doses submitted to ITC (DICOM or RTOG Data Exchange), forwarded to NCI Archive (DICOM)
 - ITC has forwarded one DICOM dataset to NCI Archive for testing. (Nine of remaining ten cases are in RTOG format.)
 - RTOG-to-DICOM conversion (for data sets submitted in RTOG Data Exchange format) is in development (Deasy). One converted dataset has been forwarded to NCI Archive.
 - Current transfer of data to NCI Archive is via SFTP.
 - ITC plans to use specially-configured MIRC Field Center software for future transfers of DICOM (RT) data to NCIA.
- Subset of clinical data from RTOG to NCI Archive

ATC Supports Secondary Analysis of Multi-Institutional Clinical Trials Data



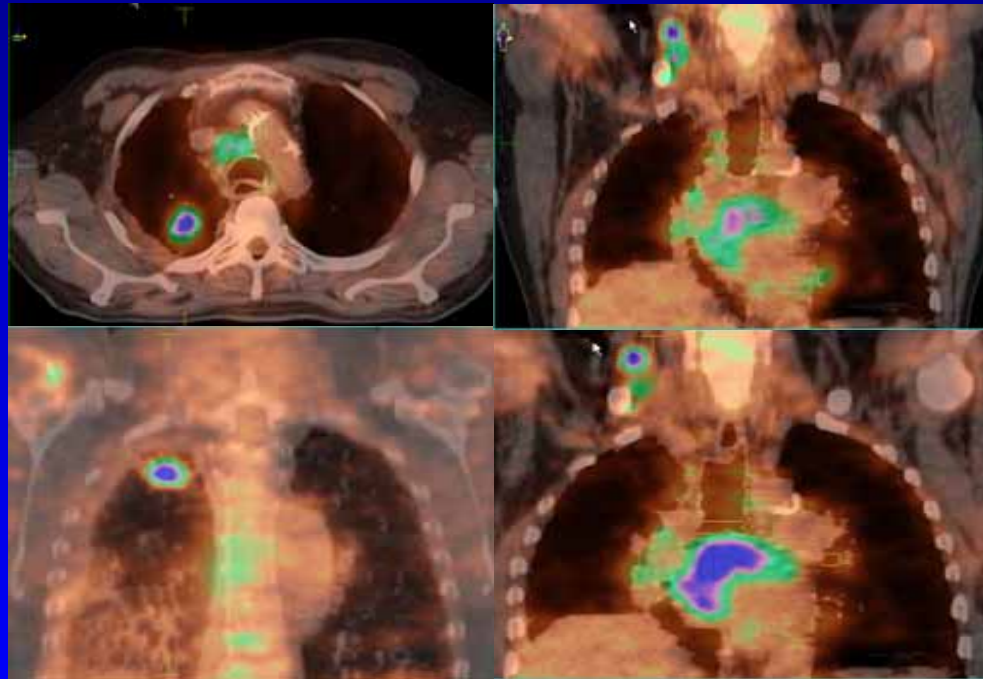
- **RTOG 9406** – NIH R01 Grant: Tucker/Thames (M.D. Anderson)
- **RTOG 9311** – NIH R01 Grant: Bradley/Deasy (Washington Univ.)
- **RTOG 9406** – Publication: Roach, M., et al., Penile bulb dose and impotence after 3DCRT for prostate cancer on RTOG 9406: Findings from a prospective, multi-institutional, phase I/II dose-escalation study. *Int. J. Radiation Oncology Biol. Phys.*, 60(5): 1351–1356, 2004.

caBIG In Vivo Imaging Workspace

- **ATC is one of the funded participants in the caBIG In Vivo Imaging Workspace.**
- **ATC members are participating in the following IVI SIGs Teleconferences:**
 - Testbed SIG (ITC, QARC, RTOG)
 - Software SIG (QARC)

Challenges: ATC Supported Clinical Trials

- PET (Quantitative) and image fusion QA



Challenges: ATC Supported Clinical Trials

- 4-D CT (several 100 MB)

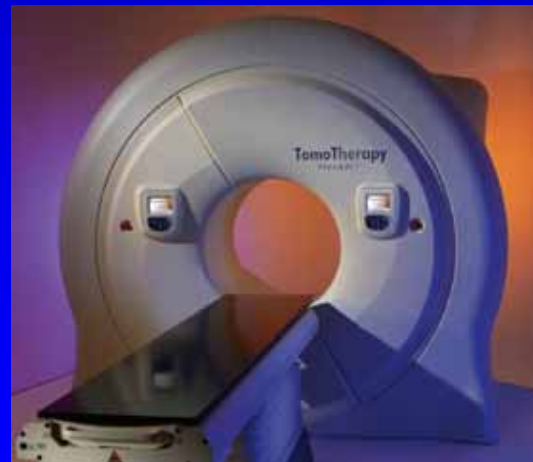


Challenges: ATC Supported Clinical Trials

- **Image-Guided RT (kV Cone beam CT)**
 - 185 MB for one 200° scan
 - 330 MB for one 360° scan
- **Image-Guided RT (Helical Tomotherapy MV CT)**
 - 13 MB for one localization scan
- **Adaptive Radiotherapy (Daily Confirmation and Adjustment using On-Board Imaging)**



Elekta Synergy System



TomoTherapy HI-ART System

SUMMARY AND CONCLUSIONS

- **ATC has pioneered the ability to conduct fully digital 3DCRT, IMRT, SBRT, HDR, and prostate brachytherapy multi-institutional clinical trials in which volumetric 3D treatment planning digital data are collected, reviewed, analyzed, and linked to clinical outcomes. (Nearly 4000 data sets have been successfully submitted).**
- **A methodology for developing uniform institutional credentialing process and QA criteria for advanced technology clinical trials has been developed.**
- **Treatment planning and QA databases (that can be linked to outcomes) have been developed.**
- **Participating in caBIG IVI Workspace**

ATC Web Site

<http://atc.wustl.edu>

ATC Advanced Technology Consortium
Providing support in quality assurance and data management for radiation therapy clinical trials

MEMBERS CREDENTIALING PROTOCOLS PUBLICATIONS RESOURCES HOME

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Radiation Therapy
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(RTOG)
Radiological Physics
Center (RPC)
Resource Center for
Emerging
Technologies (RCET)

Supported by the
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RADIATION THERAPY ONCOLOGY GROUP

[RTOG 0022](#) PHASE I/II STUDY OF CONFORMAL AND INTENSITY MODULATED IRRADIATION FOR OROPHARYNGEAL CANCER

[RTOG 0117](#) PHASE I/II DOSE INTENSIFICATION STUDY USING THREE DIMENSIONAL CONFORMAL RADIATION THERAPY AND CONCURRENT CHEMOTHERAPY FOR PATIENTS WITH INOPERABLE, NON-SMALL CELL LUNG CANCER

[RTOG 0126](#) A PHASE III RANDOMIZED STUDY OF HIGH DOSE 3D-CRT VERSUS STANDARD DOSE 3D-CRT FOR PATIENTS WITH INOPERABLE, NON-SMALL CELL LUNG CANCER

[RTOG 0225](#) A PHASE III RANDOMIZED STUDY OF HIGH DOSE 3D-CRT VERSUS STANDARD DOSE 3D-CRT FOR PATIENTS WITH INOPERABLE, NON-SMALL CELL LUNG CANCER

[RTOG 0232](#) A PHASE III RANDOMIZED STUDY OF HIGH DOSE 3D-CRT VERSUS STANDARD DOSE 3D-CRT FOR PATIENTS WITH INOPERABLE, NON-SMALL CELL LUNG CANCER

[RTOG 0236](#) A PHASE III RANDOMIZED STUDY OF HIGH DOSE 3D-CRT VERSUS STANDARD DOSE 3D-CRT FOR PATIENTS WITH INOPERABLE, NON-SMALL CELL LUNG CANCER

[RTOG 0319](#) A PHASE III RANDOMIZED STUDY OF HIGH DOSE 3D-CRT VERSUS STANDARD DOSE 3D-CRT FOR PATIENTS WITH INOPERABLE, NON-SMALL CELL LUNG CANCER

Protocols in Development

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RADIATION THERAPY ONCOLOGY GROUP

RTOG 0022

PHASE I/II STUDY OF CONFORMAL AND INTENSITY MODULATED IRRADIATION FOR OROPHARYNGEAL CANCER

[Protocol Participation Information](#)

- **Credentialing**
 - [Credentialing Requirements](#)
 - [Dry Run Guidelines](#)
 - [Facility Questionnaire](#)
- **How to Participate**
 - [Digital Data Submission Procedures](#)
 - [T2 Form](#)
 - [Submission Check list](#)
 - [ATC Compliant Treatment Planning Systems](#)
- [Instructions for Corvus Users](#)
- [QA Guidelines \(IMRT\)](#)
- [QA Scoring Criteria](#)
- [Structure Names](#)
- [Neck Node Atlas](#)
- [Protocol Text \(http://www.rtog.org/\)](#)

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Supported by the
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Washington University in St. Louis
School of Medicine

- ATC Steering Committee
- Protocols
 - Facility Questionnaires
 - Dry Run Test Guides
 - Data submission Forms
 - Data submission checklists
 - QA Guidelines (by protocol)
 - Protocol text
- Publications
- Resources