ATC/NEMA/AAPM DICOM Demonstration

Walter R. Bosch, D.Sc.

Two-Phase Strategy for DICOM Demonstration

1. Demonstrate export of ATC-Compliant DICOM RT objects (or as large a subset as possible)
2. Demonstrate import of RT objects exported in Phase 1.

DICOM Demonstration Strategy
Step 1: DICOM Export

1. Distribute a modest test suite as a starting point for manufacturers:
   a. CT Image Series (DICOM)
   b. RT Structure Set (DICOM)
   c. Instructions for creating treatment plans
2. Manufacturers
   a. Import images, structures
   b. Create plans
   c. Export CT images, RT Structure Set; RT Plan, RT Dose, RT Image
3. Display and compare data submitted by manufacturers
   - ATC web-based review tools (RRT, NetSys)
   - Computation Environment for Radiotherapy Research (CERR)

DICOM Demonstration Strategy
Step 2: DICOM Import

1. Provide a library of manufacturers' DICOM objects for off-line testing:
   a. Includes as much as possible, CT Images, RT Structure Set, RT Plan, RT Dose, RT Image from Step 1.
   b. ATC web-based review tools provide displays of what data should look like.
2. Demonstrate exchange using
   a. Manufacturer-to-manufacturer network exchange
   b. Central Test Node (ATC, AAPM, Merge, ???)
   c. Media exchange

DICOM Test Data

- Starting point for treatment planning
- De-identified
  - Remove “hidden” identifiers
  - New instance UIDs
- Minimize obstacles for importing into treatment planning systems
  - Remove private tags
  - Structure Sets contour Z positions coincide with those of CT slices
  - Available both as LittleEndian/ImplicitVR Datasets, and as Part-10 Filesets

DICOM "Pushset" Script

```
.\pushset.bat <DCMDIR> <APP_TITLE> <HOST> <PORT_#>
```

Where:

DCMDIR is the DICOM file directory one level below this scripts directory on the CD

APP_TITLE is the AE_TITLE of the DICOM receiver host

HOST is the host name (or IP address of the DICOM receiver)

PORT_# is the port number (usually 104) of the DICOM receiver

Example:

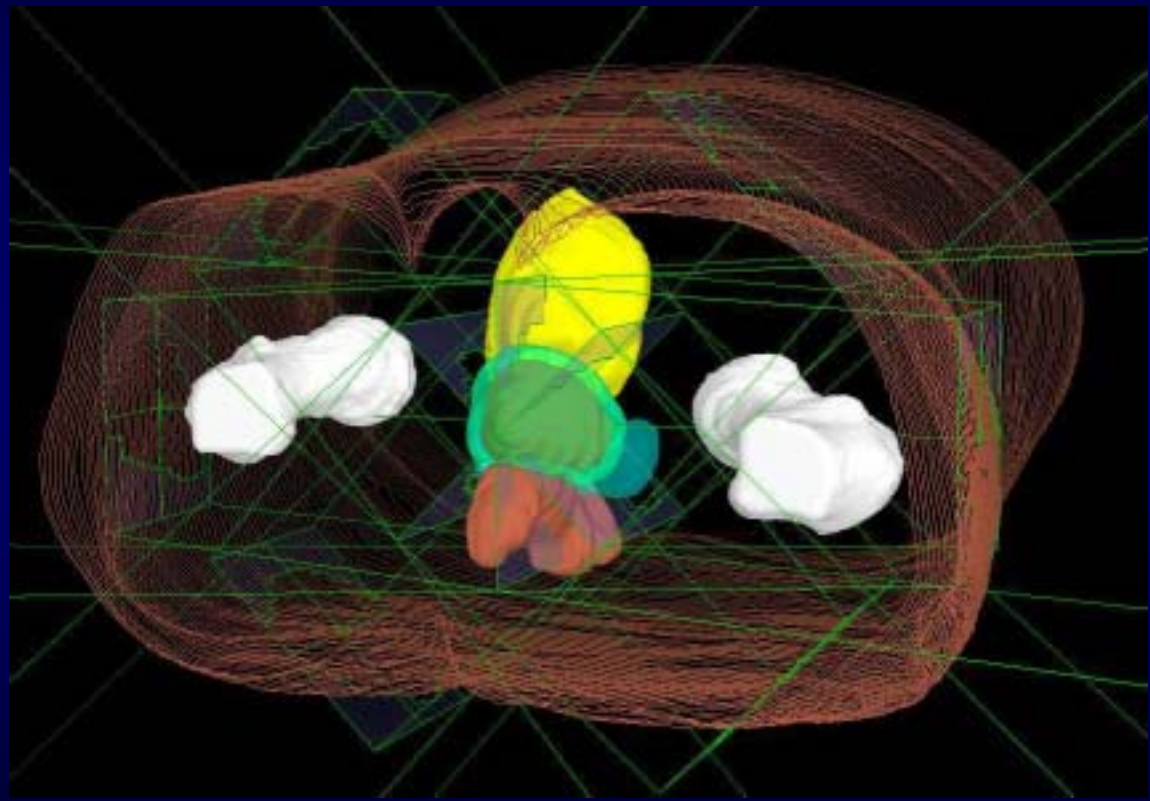
```
.\pushset.bat ATC04PR02 STORESCP rtp1.mydomain 104
```

DICOM Test Data Sets

1. ATC04PR02
   - 3D-Conformal Prostate
   - Conforms to RTOG protocol 0126
2. ATC04HN02
   - IMRT Head/Neck
   - Conforms to RTOG protocol 0225

Case 1 (ATC04PR02) Data

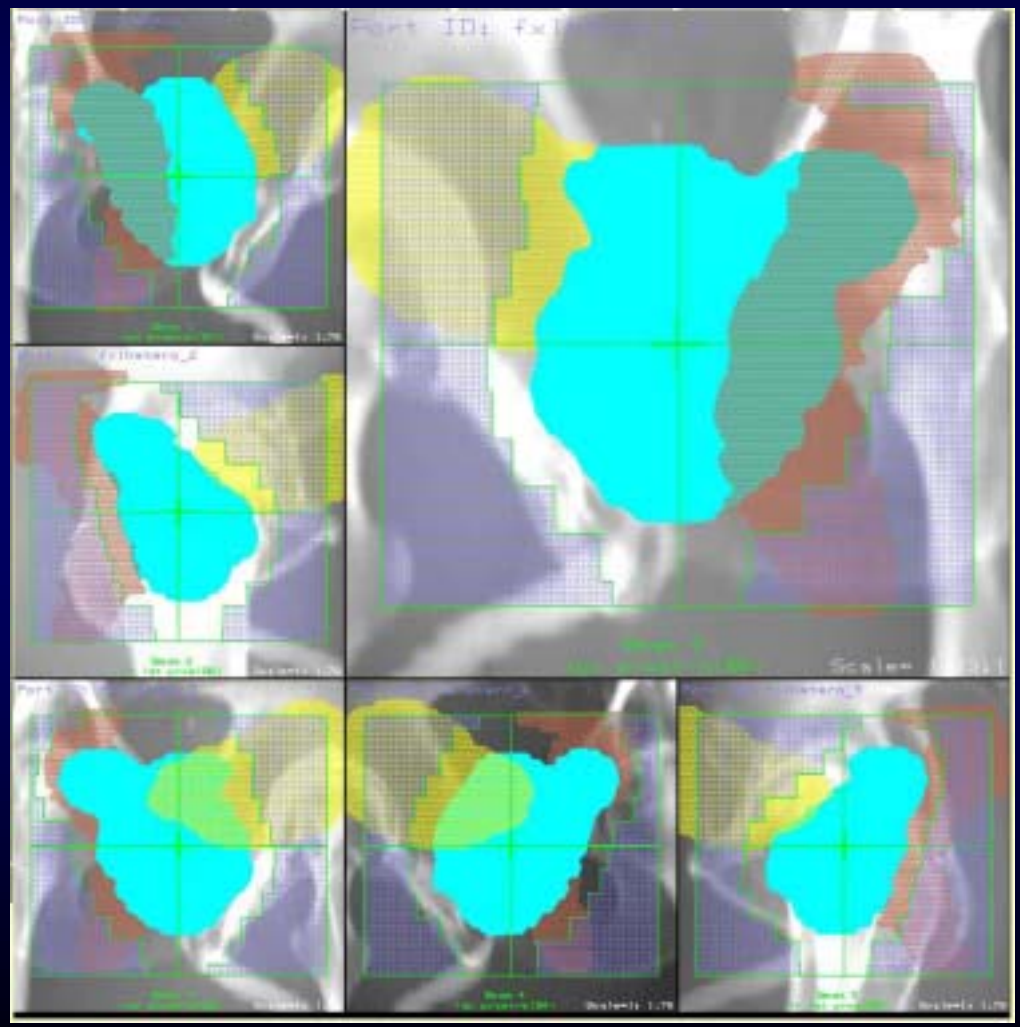
- 97 CT slices
- 10 Structures:
  - PTV2 (high-dose)
  - PTV1 (low-dose)
  - Prostate/SV [CTV1]
  - CTV2
  - Bladder
  - Rcctum
  - RT Femur
  - Lt Femur
  - Penile bulb
  - Skin



Case 1 (ATC04PR02) Plan Specifications

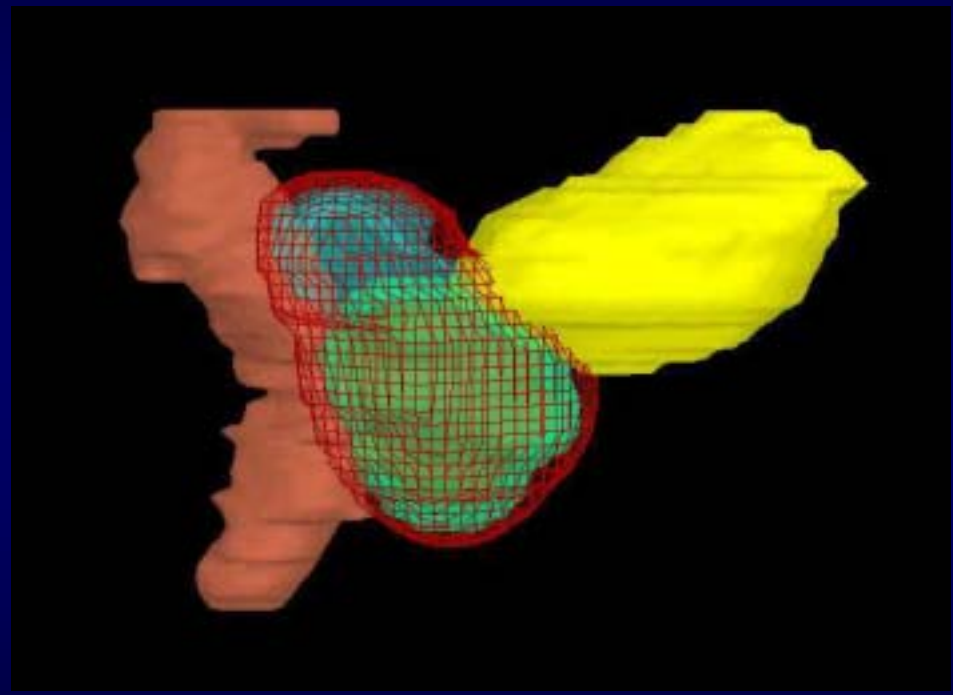
- 2 fraction groups (sub-plans) with 6 beams each

	Gantry	ICRU Ref Point Dose (cGy) Initial	Boost
RPO	315	837	351
RLat	270	1224	514
RAO	225	837	351
LAO	135	837	351
Llat	90	1224	514
LPO	45	837	351
Total		5796	2432



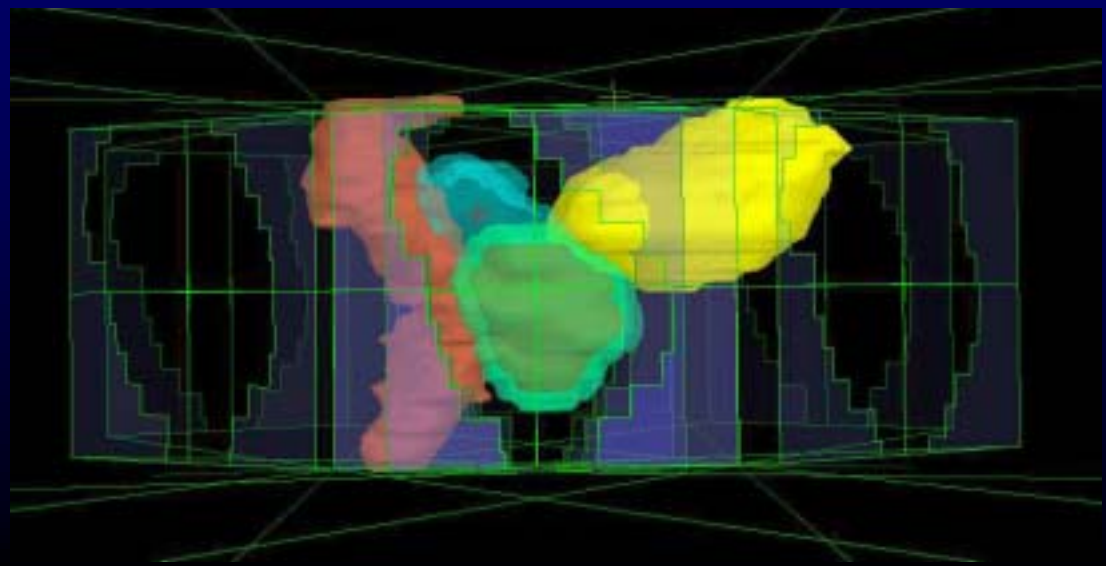
Case 1 (ATC04PR02) Target Volume Prescription

- Prescription (ICRU Ref Dose)
  PTV1: 57.97 Gy
  PTV2: 82.28 Gy (44 fractions)
- Minimum dose
  PTV1: 95% RxD = **55 Gy**
  PTV2: 95% RxD = **78 Gy**
- Coverage score (minimum dose)
  - 100% = no variation
  - ≥ 95% = minor variation
  - < 95% = major variation
- Maximum dose to PTV2
  - ≤ 107% RxD = no variation
  - ≤ 110% RxD = minor variation
  - > 110% RxD = major variation



Case 1 (ATC04PR02) Normal Tissue Guidelines

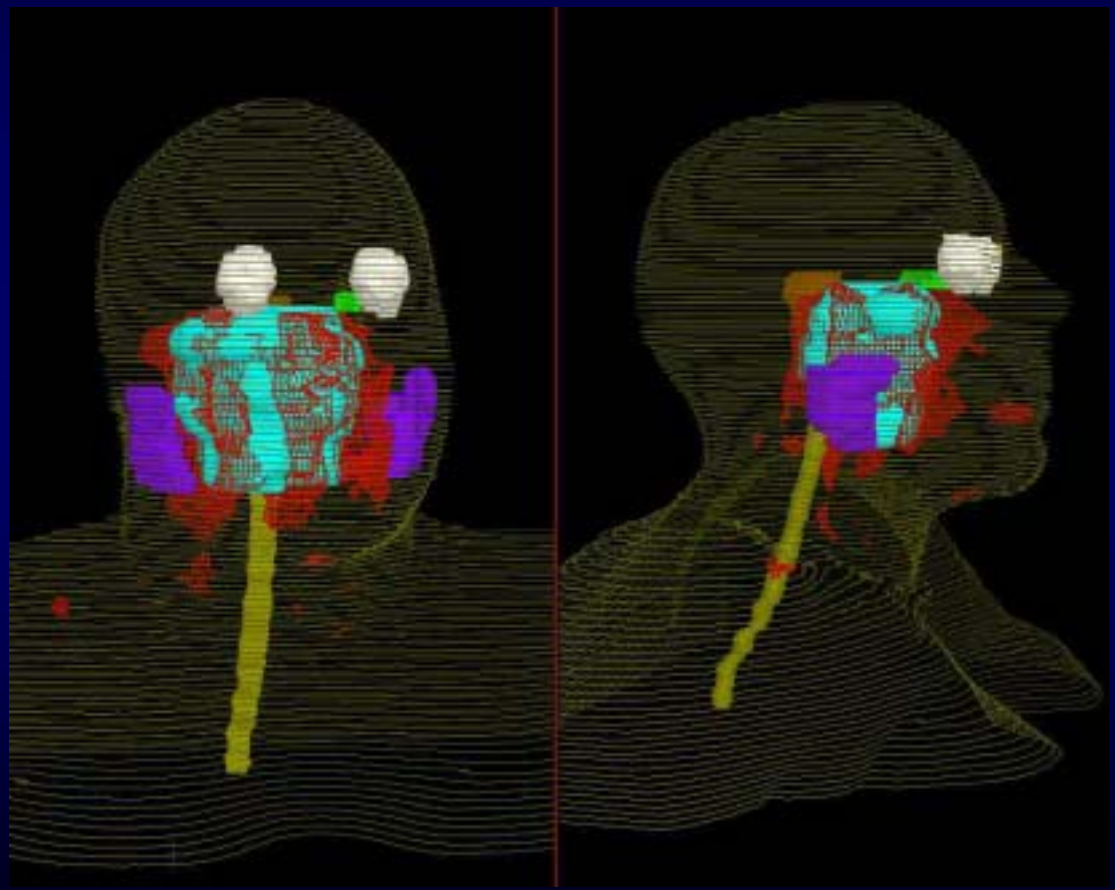
	Maximum Dose to Percent of Volume			
	15%	25%	35%	50%
Bladder	80 Gy	75 Gy	70 Gy	65 Gy
Rectum	75 Gy	70 Gy	65 Gy	60 Gy



Case 2 (ATC04HN02) Data

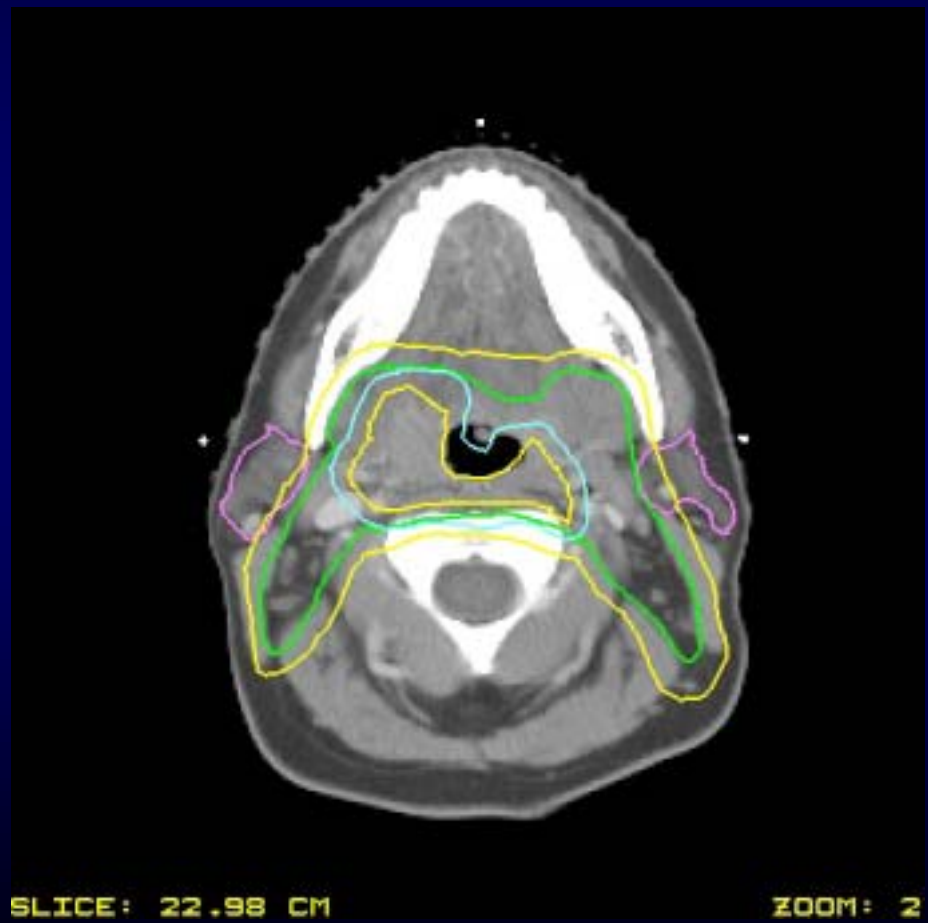
- 107 CT slices
- 28 structures

Brain	RT Parotid
CTV 59.4	Rt Parotid-PTV
CTV 70	Shoulder 2
Cord	Skin
INITIALREF	TMJ
LT Parotid	avoidance
LT Parotid-PTV	brainstem
Larynx	cord+8mm
Mandible	gross vol
Optic Chiasm	inf avoidance
Oral Cavity	lt eye
PTV 59.4	lt optic nerve
PTV 70	rt eye
Pituitary	rt optic nerve



Case 2 (ATC04HN02) Target Volumes

- Target volumes
  - CTV70 = GTV + microscopic extensions
  - PTV70 = CTV70 + 0.5 cm
  - CTV59.4 = cervical lymph nodes at high risk
  - PTV59.4 = CTV59.4 + 0.5 cm

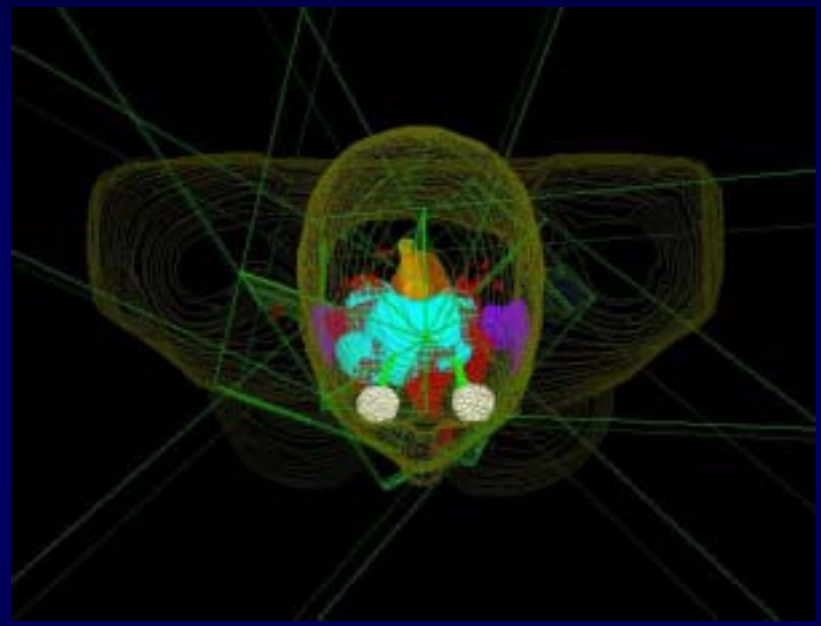


Case 2 (ATC04HN02) Prescription

- 33 Fractions, 5 fractions per week, all fields treated once daily
- Rx Dose: 70Gy (PTV70), 59.4Gy (PTV59.4)
  - No variation: ≥ 95% of PTV at or above RxD *or* ≥ 99% of PTV at or above 93% of RxD
  - Minor variation: ≥ 95% of PTV at or above 93% of RxD
  - Major variation: < 95 % of PTV at or above 93% of RxD
- Dose heterogeneity
  - No variation: no more than 20% of either PTV is at or above 77Gy
  - Minor variation: nor more than 5% of either PTV is at or above 80.5 Gy

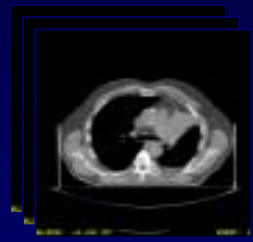
Case 2 (ATC04HN02) Normal Tissue Constraints

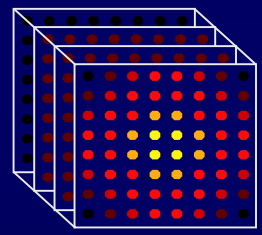
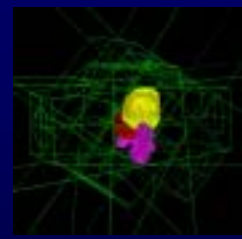
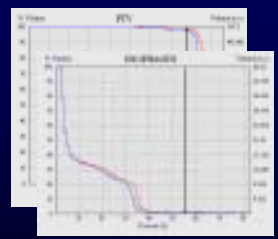
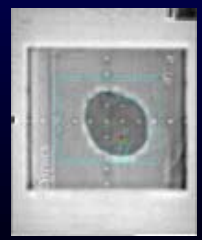
Organ at Risk	Dose Limit and Criteria
Temporal lobes	60 Gy or 1% of Vol. > 65 Gy
Brainstem, optic nerves, chiasm	54 Gy or 1% of Vol. > 60 Gy
Spinal cord	45 Gy or 1 cc > 50 Gy
Mandible, TMJ	70 Gy or 1cc > 75 Gy
Parotid glands	Mean dose to either gland < 26 Gy, *or* 50% of either gland receives < 30 Gy, *or* 20cc of combined glands receives < 20 Gy *Minor variation:* 40% of either gland receives < 30 Gy



DICOM Objects to Be Submitted to ATC

- CT Image
- RT Structure Set
- RT Dose (3D dose distribution) for each fraction group
- RT Plan
- RT Dose (DVH) for total dose plan
- RT Image (DRRs)



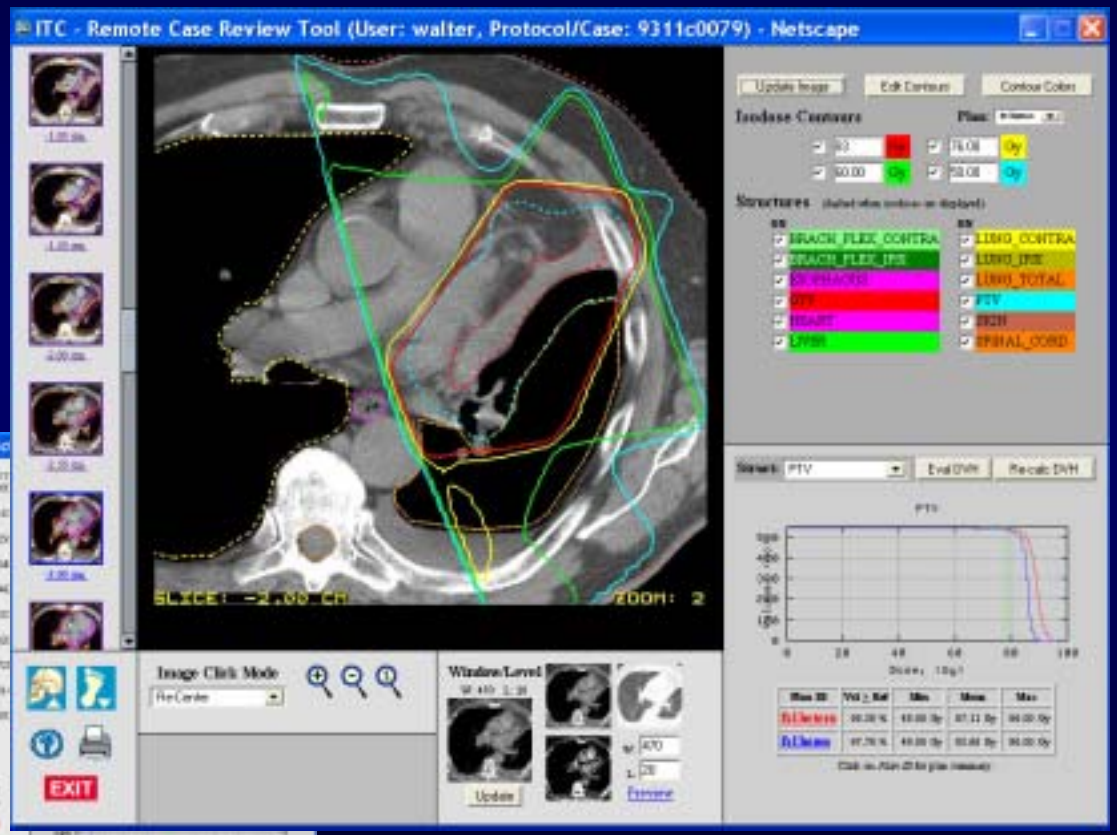





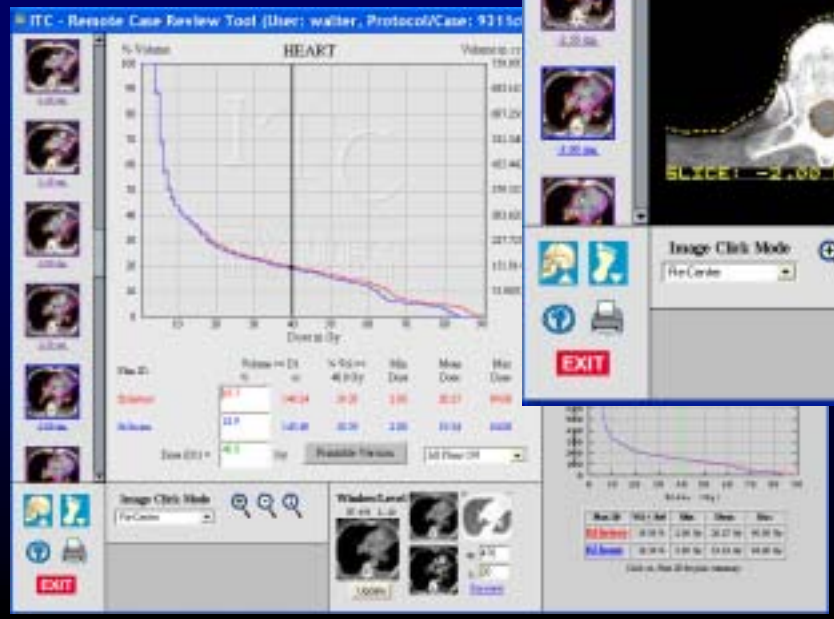
Review Tools for Display of Data

- ITC Remote Review Tool
- RCET NetSys Client
- CERR

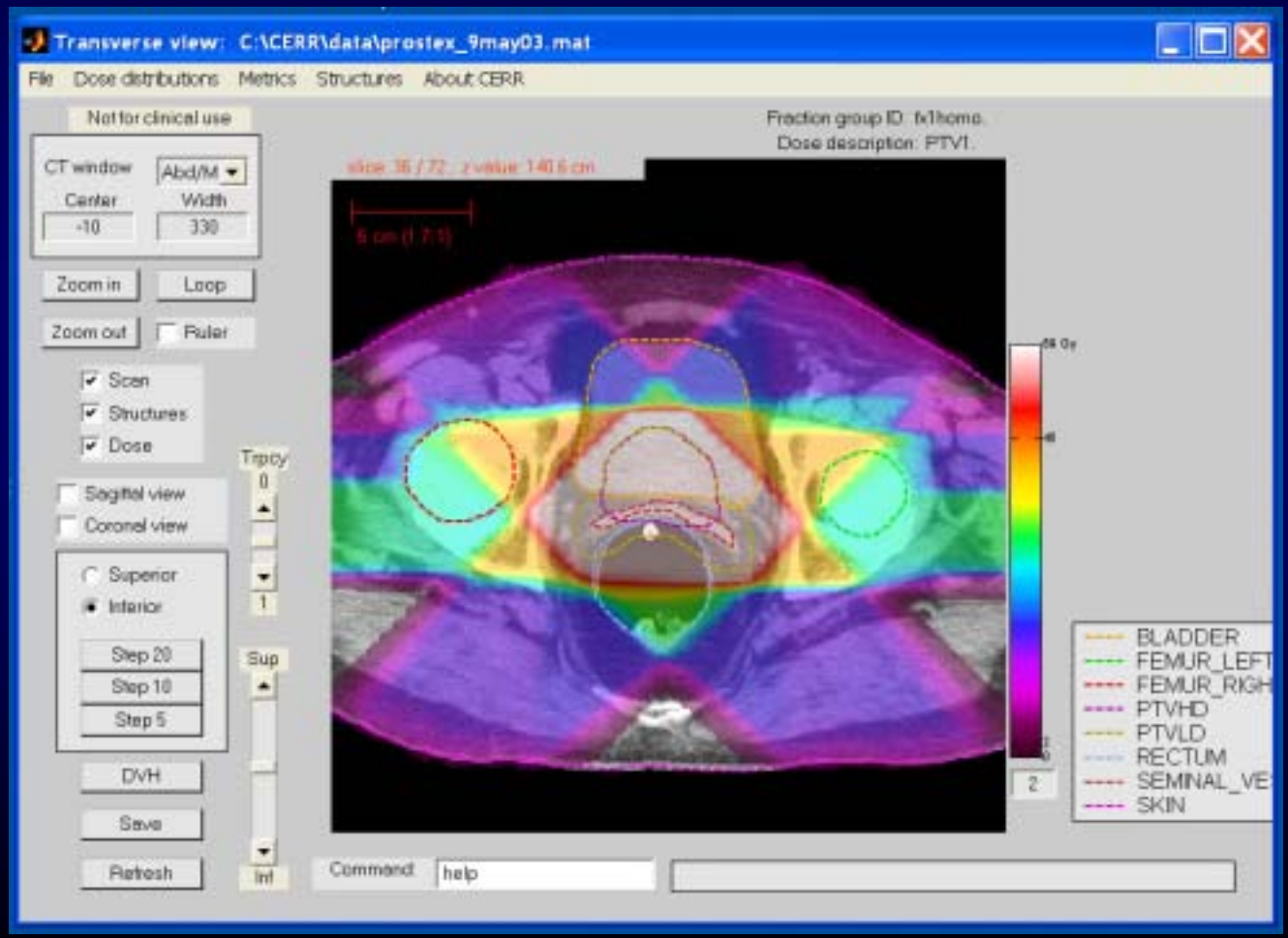
Remote Review Tool

- CT Images (zoom, window/level)
- Structure contours (review, editing)
- Iso-dose contours
- Interactive DVH
- Point-dose display





Computational Environment for Radiotherapy Research (CERR) – J. Deasy, Washington Univ.



Submission Timeline

- Vendors submit DICOM data to ITC until June 25, 2004
  - FTP to castor.wustl.edu
  - CD-R
  - WebSys (contact Walter Bosch, itc@castor.wustl.edu for account)
- AAPM 46th meeting July 25-29, 2004
  - Network
  - CD-R
  - USB drive

Email from Dwight Simon 2/14/04

Walter/et al,

I've tried to keep track of all the things that go on in WG7 over the years, but I certainly haven't done an adequate job. However, I am aware of the great amount of energy and effort that has been put into developing the RT portion of DICOM over the years and I would like to applaud your diligence and accomplishments. I believe, that you have the **most complex set of DICOM objects in the standard** and, this is where the difficulty has come in for getting it all to work in a fully interoperable environment.

I wish you the best of luck in this latest demonstration endeavor and would like to **encourage everyone to participate to there fullest extent**. I think you are on the verge of really making it happen - if you get full and in depth participation.

Best Regards,
Dwight