

# QA-related informatics issues

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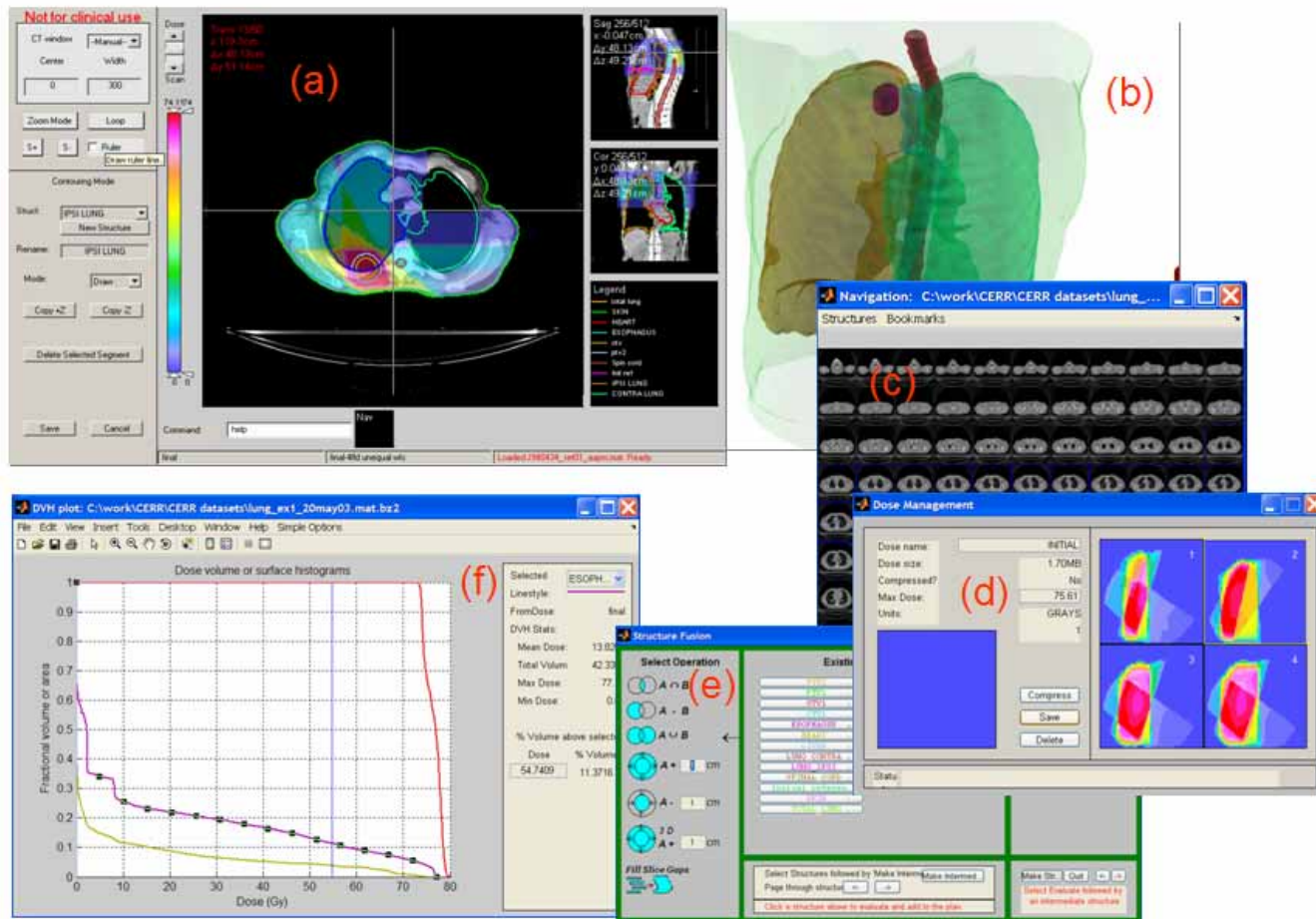
# CERR: Computational Environment for Radiotherapy Research

- Under development for 10+ yrs.
- Based on high-level visualization and data analysis system (Matlab)
- Probably several hundred users worldwide
- Approx 2-3 downloads a day
- About 40K lines of code

# CERR: basic tools

- Dose calculation research
- Margin calculations
- Outcomes analysis
- IMRT optimization research
- Comparing planning systems
- Functional imaging research
- Quality assurance
- Anything where someone needs to analyze radiotherapy data...

# CERR: a flexible platform for radiotherapy research



# Plan comparisons

**Not for clinical use**

CT window: Lung  
Center: -500, Width: 1500

Zoom Mode: Loop  
S+ S- Ruler

Dose: 86.9 86.9  
Scan: 0 0

Trans 53/106  
z:130.35cm  
S: 1  
D: 1

Trans 53/106  
z:130.35cm  
S: 1  
D: 2

Trans 53/106  
z:130.35cm  
S: 1  
D: 3

Legend

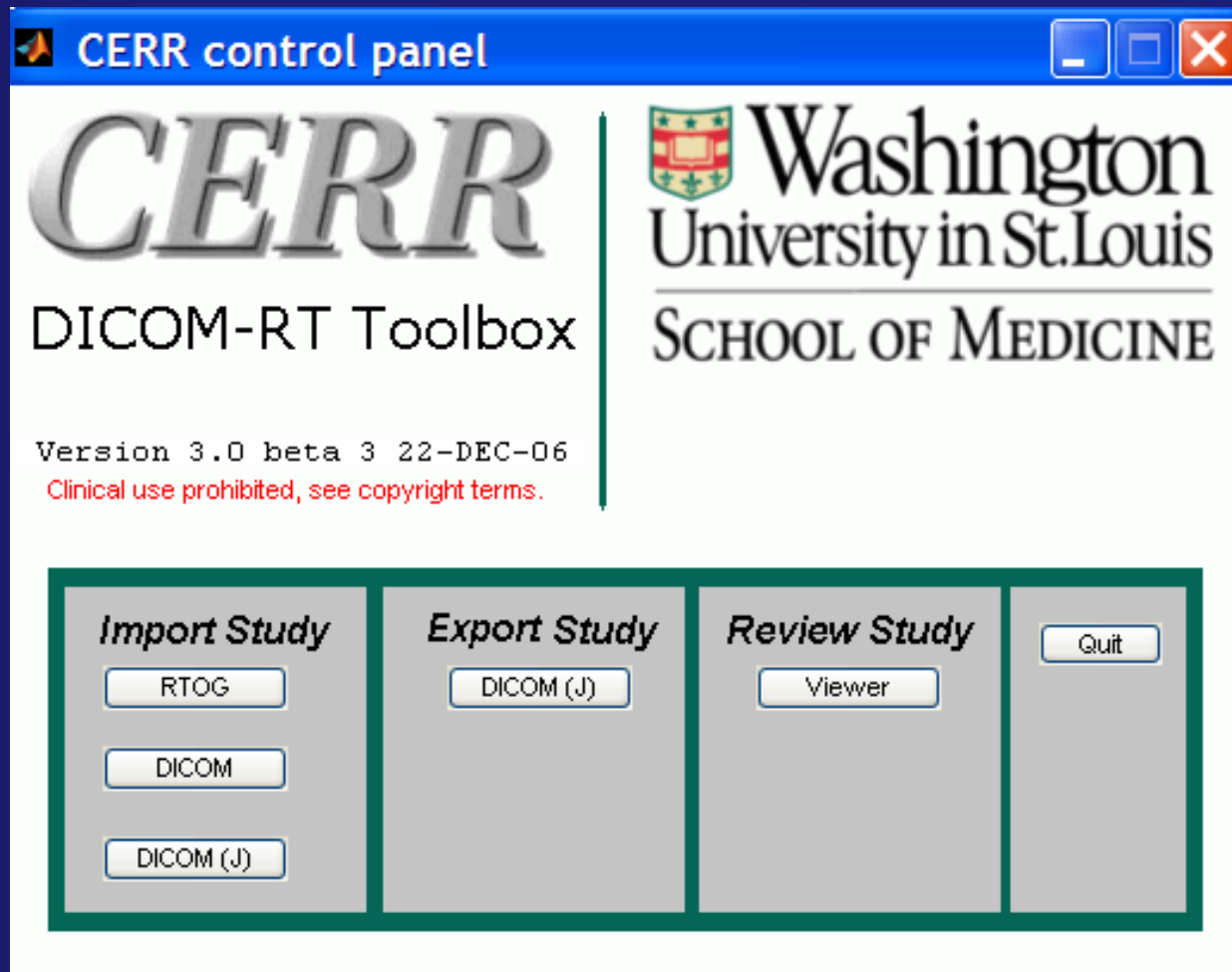
- PTV2
- PTV1
- GTV1
- CTV1
- ESOPHAGUS
- HEART
- LIVER
- LUNG\_CONTRA
- LUNG\_IPSI
- SPINAL\_CORD
- Initial reference
- SKIN
- TOTAL\_LUNG

Command: help

Nav

FINALHETERO FINALHETERO MLG APPROVED

# Open format I/O



# Key value-added of CERR/Matlab

- Customization
- Widely-used
- Low-cost development
- Responsive development group
- Compiled version available

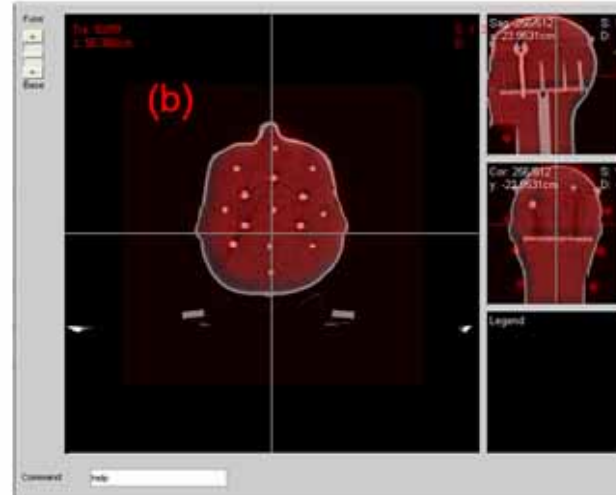
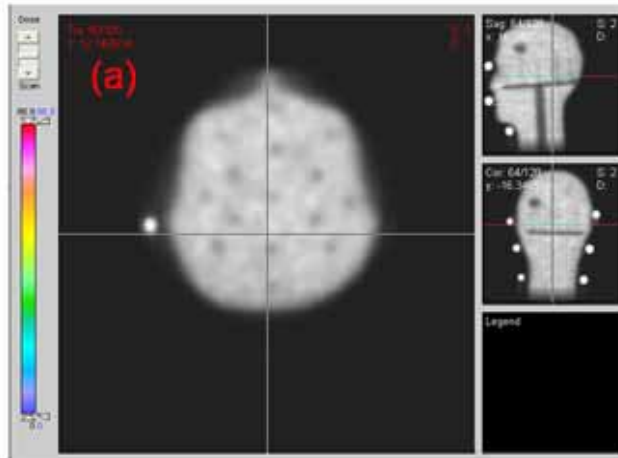


# Some application areas

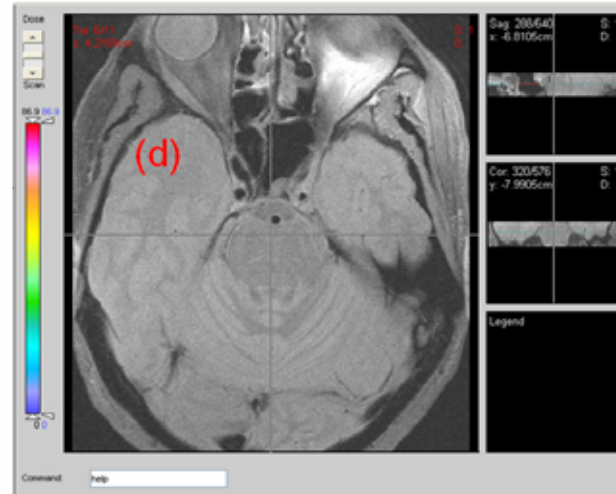
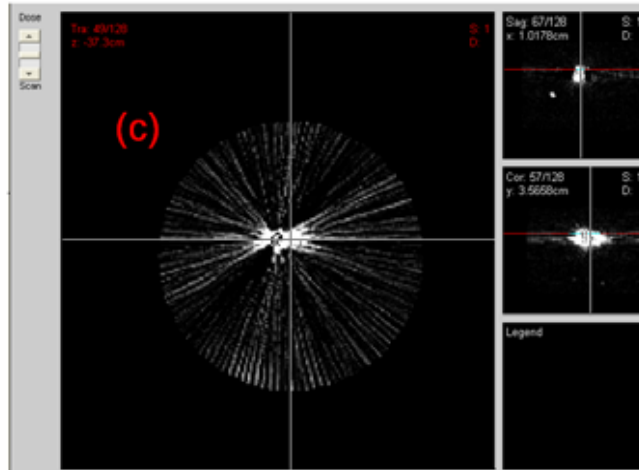
- Image registration: Estimating image shifts (rigid)
- PET registration: platform for open code
- PET image analysis: intensity value histograms
- Extraction of image-dose-based parameters which may correlate with outcomes
- 4-D planning
- Data viewer
- DICOM import/export

# CERR: Functional imaging

PET

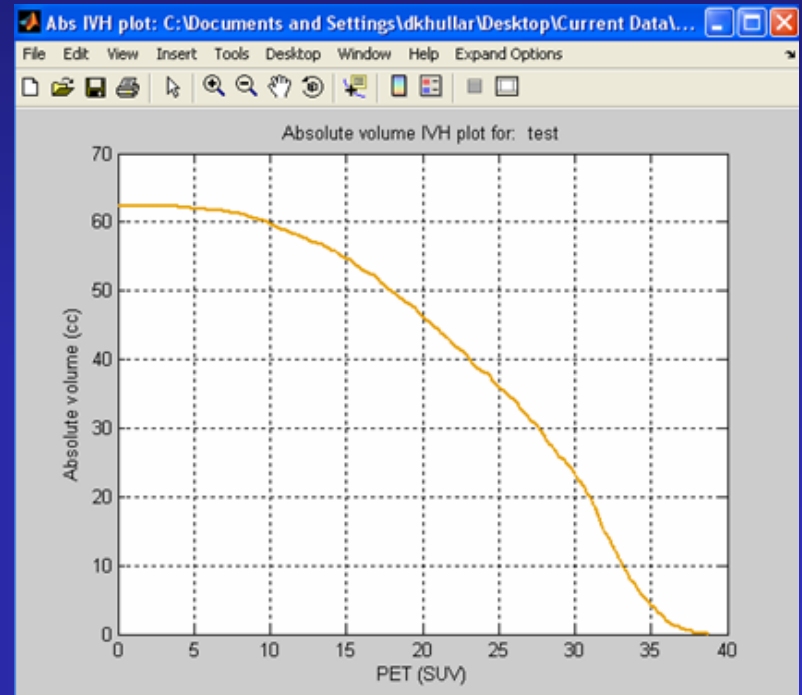


SPECT



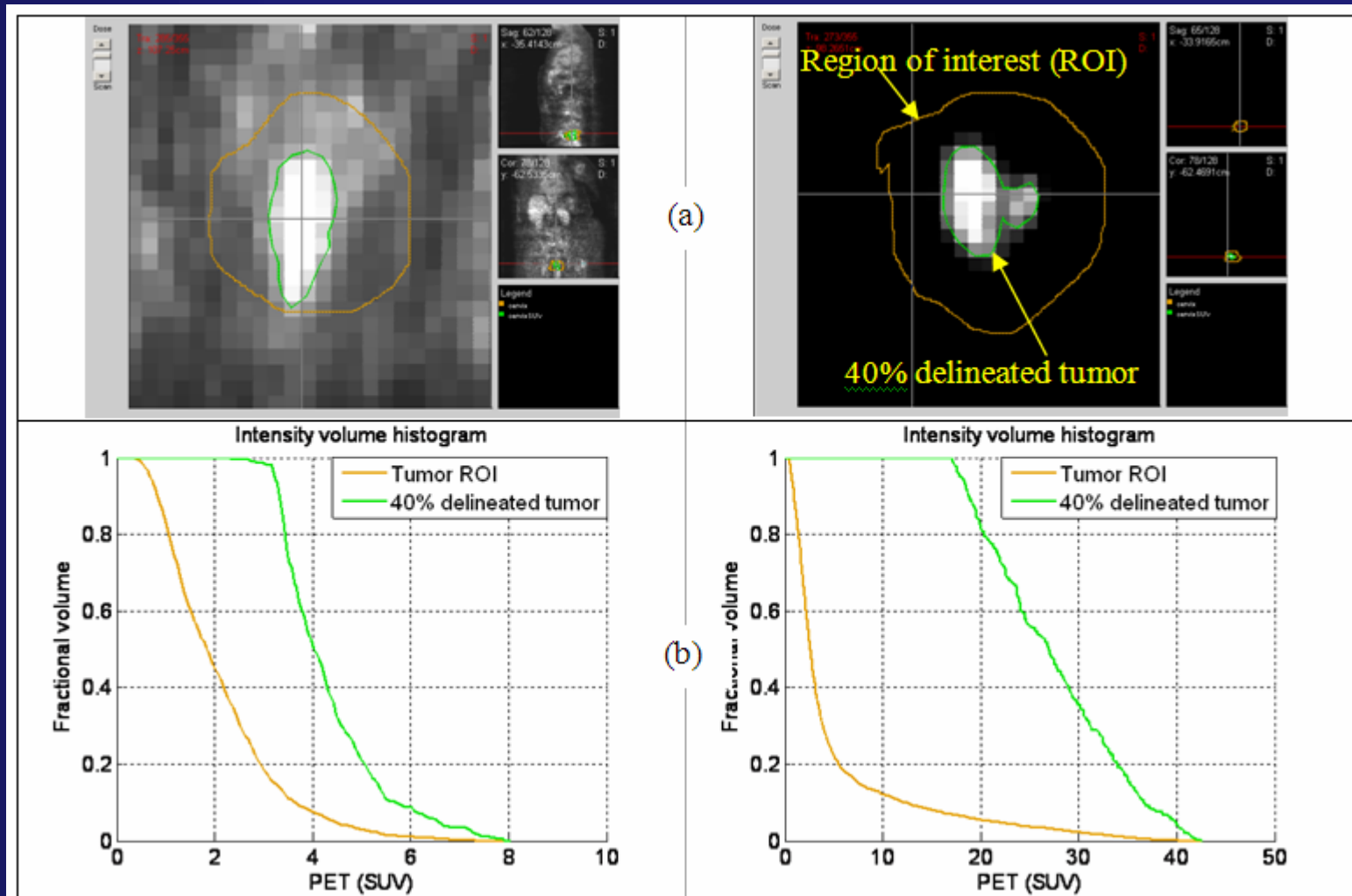
MRI

# PET image analysis beyond max SUV: intensity value histograms

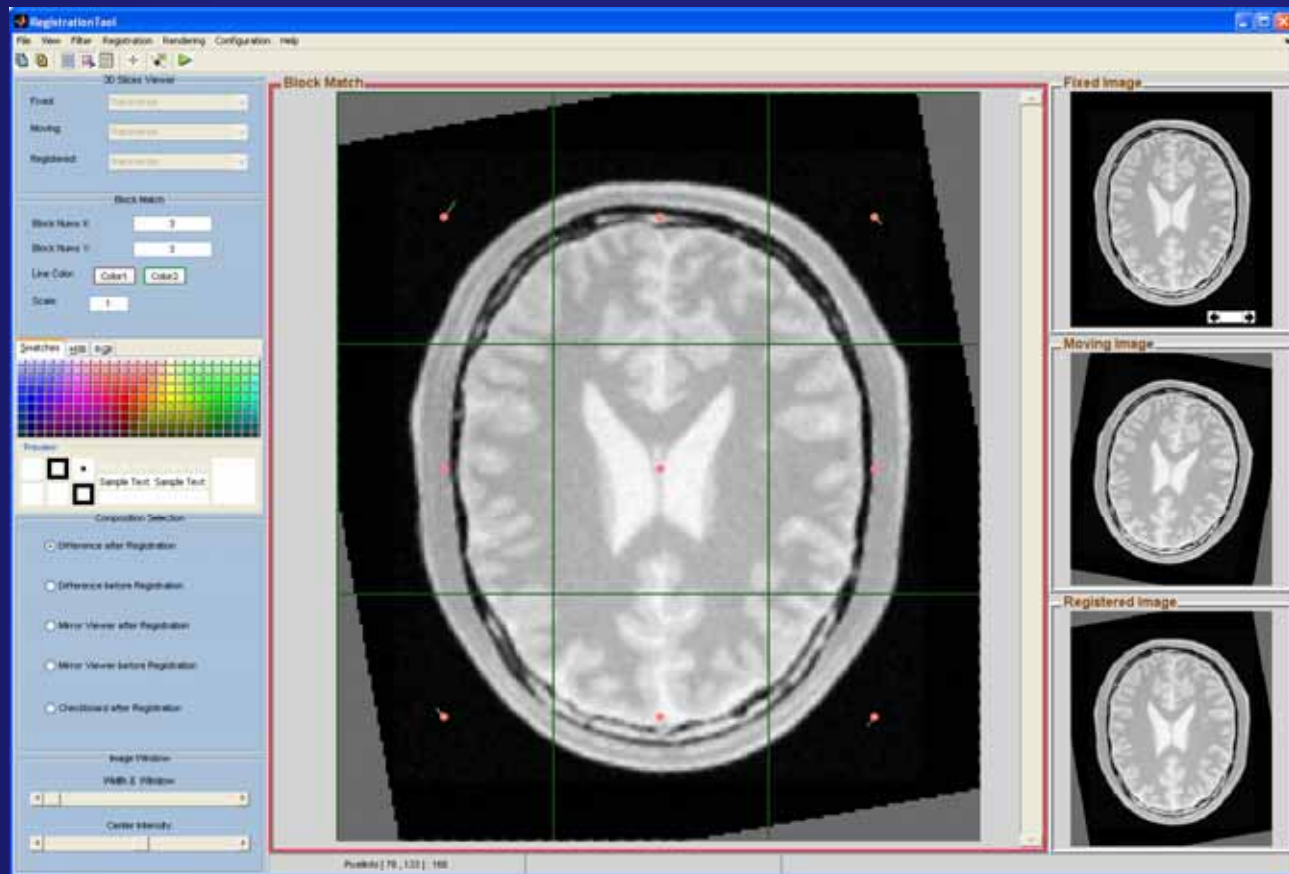


IVH always with reference to threshold  
level, e.g., IVH40

# ICCR submission (El Naqa et al.)



# Image Registration Quality Assurance



## CERR projects in collaboration with the RPC

- Open source Monte Carlo head model
  - Will allow MC recalculation using standard field input
  - Dose-calc QA
  - Delivery QA
- Open source QA phantom data analysis tool

# Monte Carlo head model

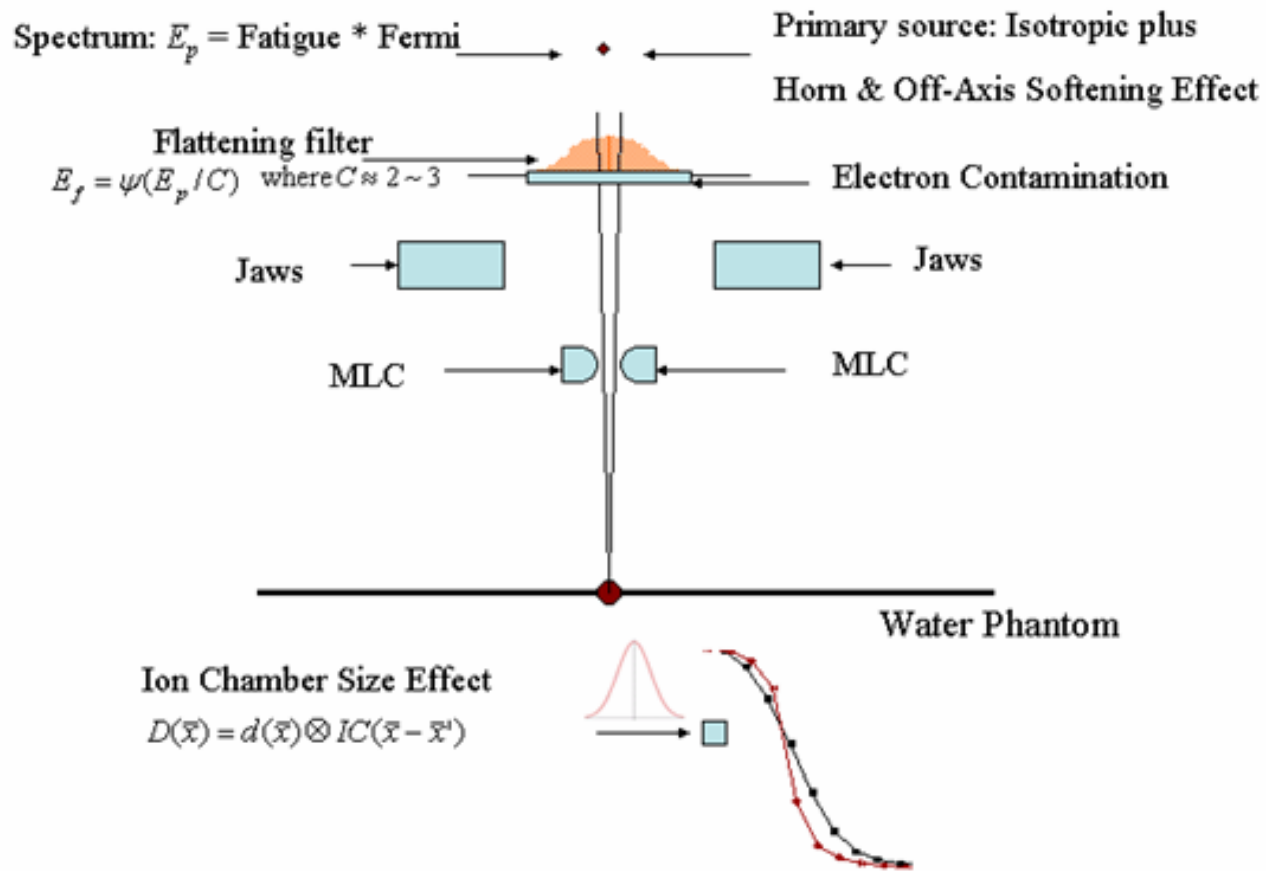
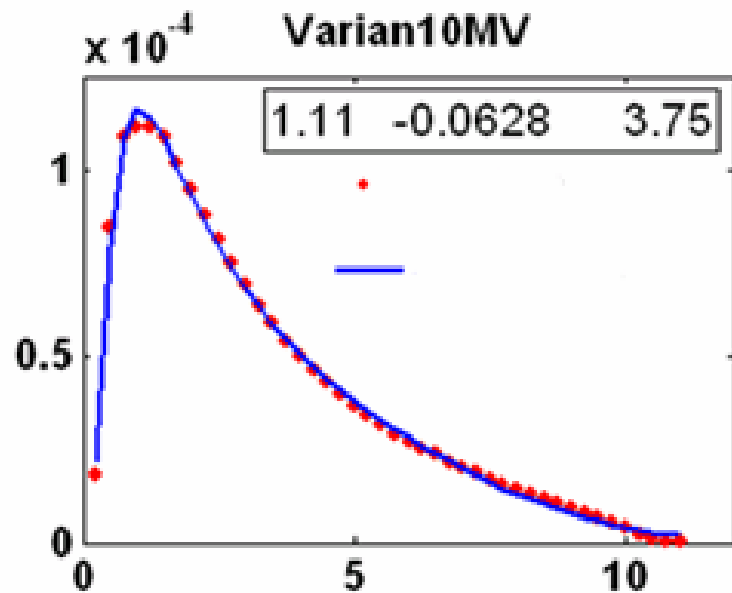
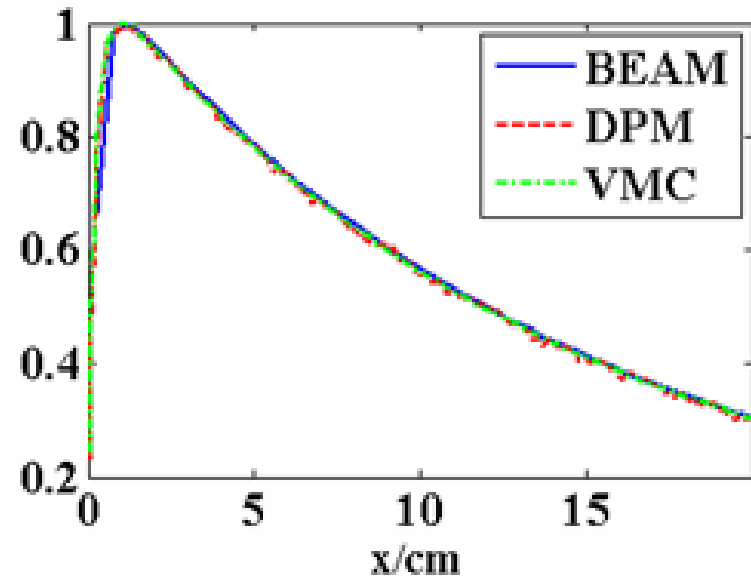


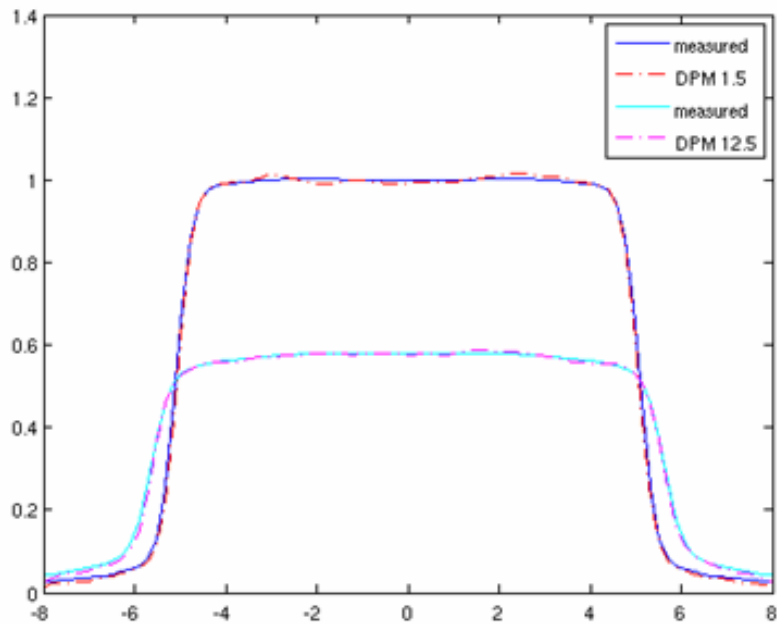
Figure 1. The source model diagram (not proportional)



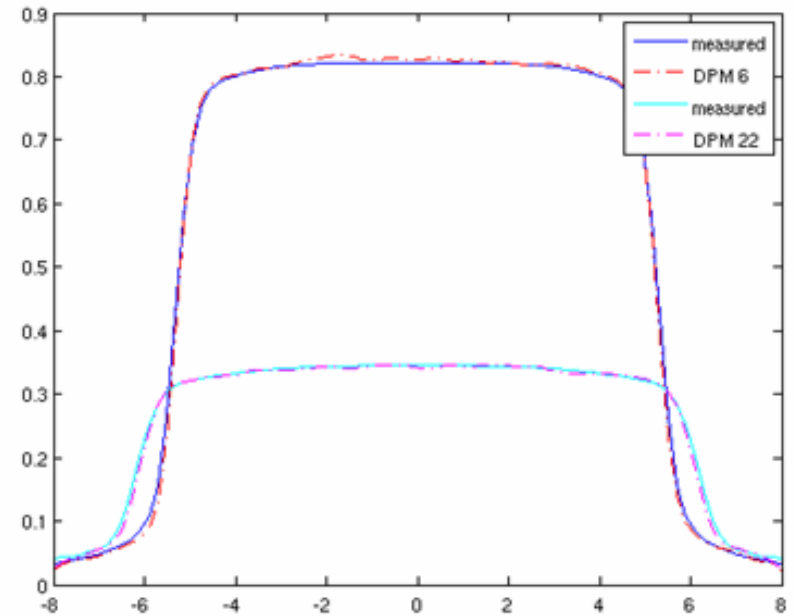
Comparison with  
CAX DD



# Comparison with commissioning data

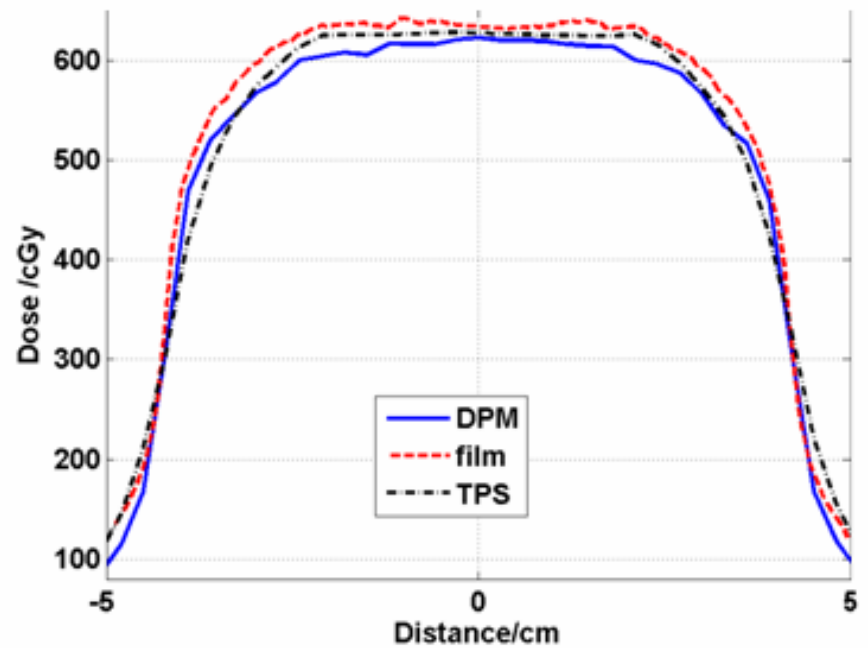
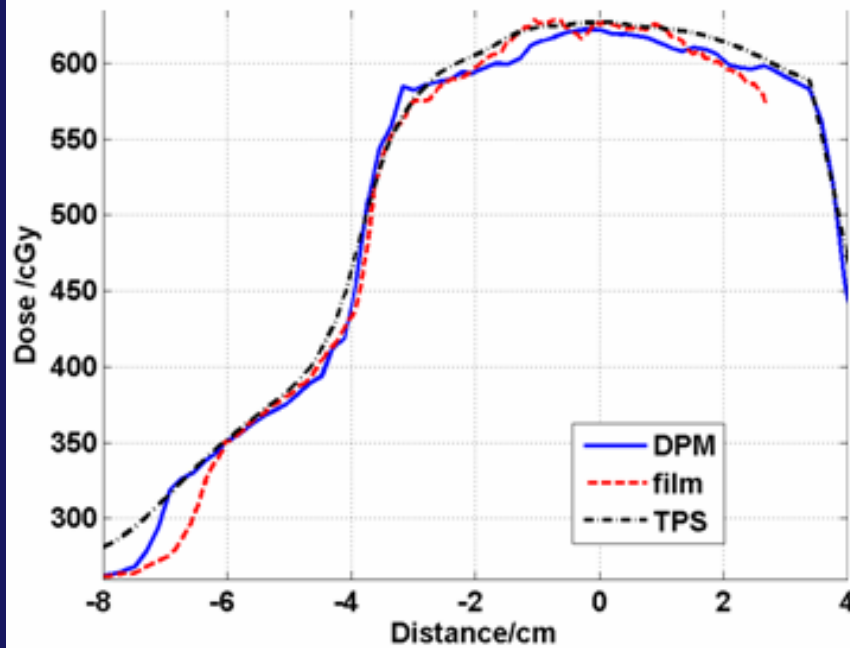


(b) Profiles at depth 1.5cm and 12.5cm



(c) Profiles at depth 5cm and 22cm

# Comparison with phantom data



# WebTrev

- Allows us to build any type of plan reporting into the plan review process
- Built on high-level objective oriented language (Ruby and Ruby-on-Rails)
- Uses open-source database: MySQL
- Very productive system

# Workflow tool: Web-based treatment review (WebTrev)

The screenshot shows a web browser window titled "Plan Review - Mozilla Firefox" with the address bar displaying "http://localhost:3000/plan\_items/transverse". The page header features the Washington University in St. Louis School of Medicine logo and the title "WEB BASED TREATMENT PLAN REVIEW".

On the left side, the user information is displayed: "Name: aditya Apte", "Plan ID: plan123", and "View: Transverse". Below this is a vertical menu of buttons: "Transverse", "Coronal", "Sagittal", "DVH", "Approved List", "Unapproved List", "List All", and "Contact". At the bottom of this menu are "Report" and "Log Out" buttons.

The main content area is a large 3D visualization of a patient's chest and head region. A central transverse slice is shown with a color-coded dose distribution. To the left of this slice is a vertical color scale legend ranging from 0.0 to 26.9, with a "Scan" label and a "Dose" label. To the right of the main slice are two smaller 3D views: a sagittal view (labeled "Sag 12/7" and "x: -1.4485") and a coronal view (labeled "Cor: 128/259" and "0.04507"). A legend at the bottom right of these views lists: "ROD1", "CORD", "LUNG", "PTV", "R LUNG", "Heart", and "intensity".

At the bottom of the main visualization area are two circular navigation buttons with left and right arrows, and a central "Update" button.

The browser's status bar at the bottom left shows "Done" and the bottom right shows "1.17ts".

# Platform for comparing target definitions: Michalski et al. comparison of prostate target volumes

CERR: C:\Documents and Settings\jdeasy\Desktop\sand b on SHARE\mergedPlans\NODAL\_1.mat

File View Dose Metrics Scan Structures Help

**Not for clinical use**

CT window: --Manual--  
Center: 0 Width: 300

Dose  
Scan

Loop  
S+ S- Ruler

Tra: 82/164  
z: -32.5cm  
S: 1  
D:

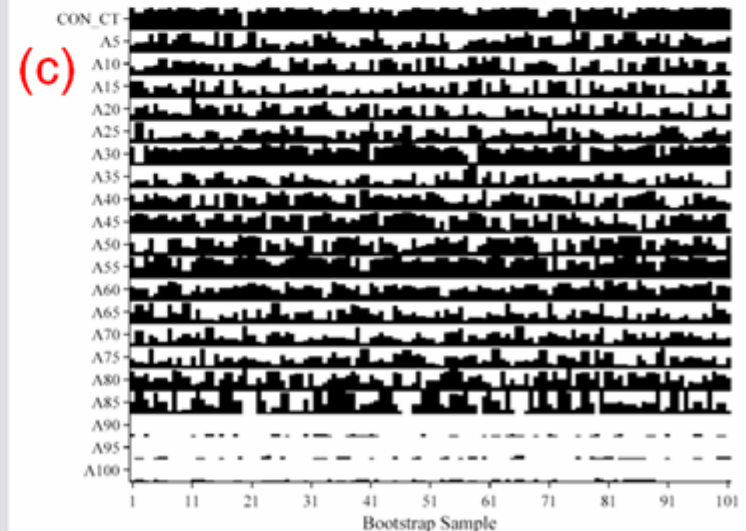
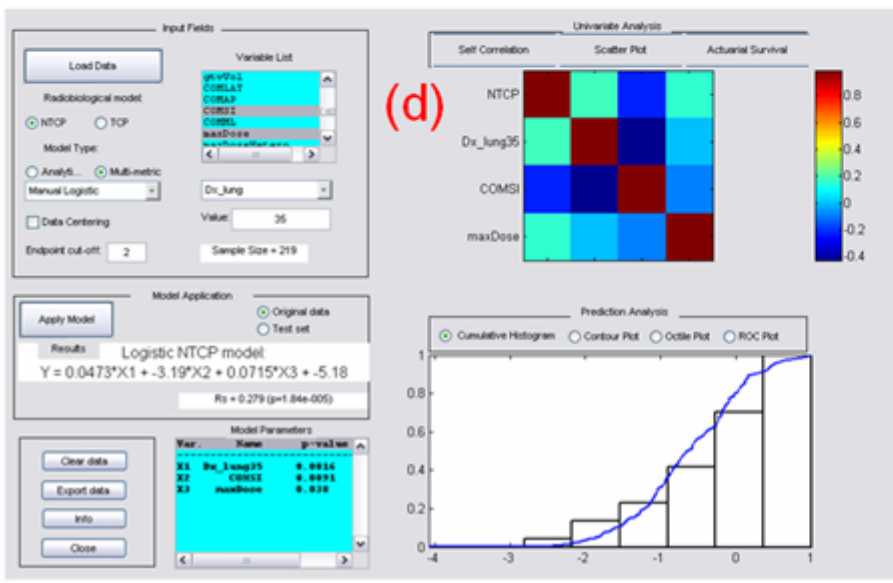
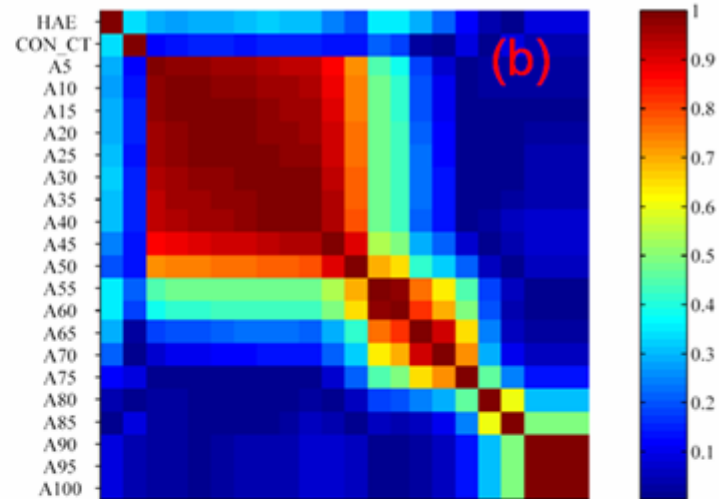
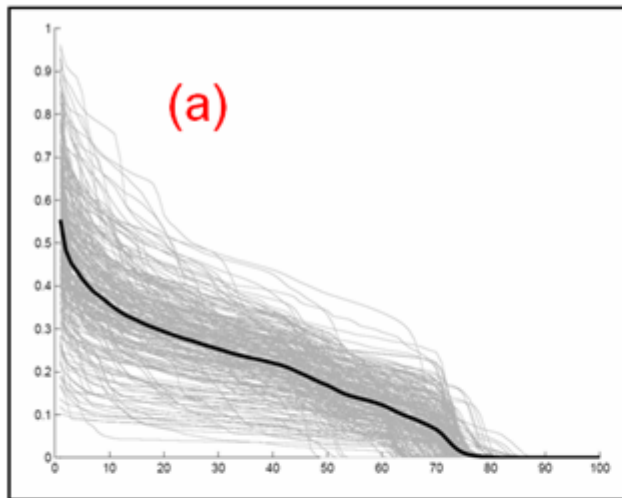
Sag: 256/512  
x: -0.058595cm  
S: 1  
D:

Cor: 256/512  
y: -9.9414cm  
S: 1  
D:

**Legend**

- CTV-iliac
- presacral
- 2 - ctv-iliac a
- 3 - CTV-iliac a
- 4 - CTV-iliac a
- 2 - ctv-ps asoc
- 3 - CTV-PS asoc
- 4 - CTV-PS asoc

# Dose response explorer/data-mining system



# Potential new tool: cohort review

- A physician (or physicist) will be able to authoritatively review treatment plans and outcomes for a given cohort of patients to understand
  - Trends and differences
  - How technique has changed
  - Adequacy of the technique
  - How the patient cohort has changed
  - How outcomes have changed



# Bioinformatics committee (1/2)

- New RTOG committee
- Meeting Friday morning 8-9, Meeting room 2.
- Key area of interest: combining physical and biological markers in outcomes to better understand both factors
- Expansion to QOL, socio-economic factors
- These types of analyses currently not done routinely for RTOG studies

# Bioinformatics committee (2/2)

- Funding?
  - Line item money in RTOG budget unlikely
  - Apply for umbrella grant?
    - Theme could be data-mining, non-linear modeling, modeling of disparate factors.
  - Or focus individual R21's on individual RTOG Phase III trials

# Long-term goals

- Continued customization of CERR
- Publicly available databases
- CaBig accessible
- CaBig I/O format compliant
- Multi-modality analysis tools
- Image registration quality assurance
- Data-mining/exploration/modeling tools
- Open source software
- Accurate dose recalculation available