# BIOR informatics tools relevant to ATC efforts

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Radiological Physics Center

# Tools [1/2]

- Web-based automated plan reporting
- Outcomes quality assurance database
- Monte Carlo dose recalculations
- QA tool for RPC
- Ca-BIG enabled version of CERR

# Tools [2/2]

- Extensions of CERR
  - PLUNC importing
  - Old GammaKnife inporting
- Near-term efforts
  - CERR V4
    - Deformable imaging tools built-in
    - Mesh-based representations
    - New data type: geometric transform (includes deformable/DICOM friendly)

# Web-based plan reporting and review

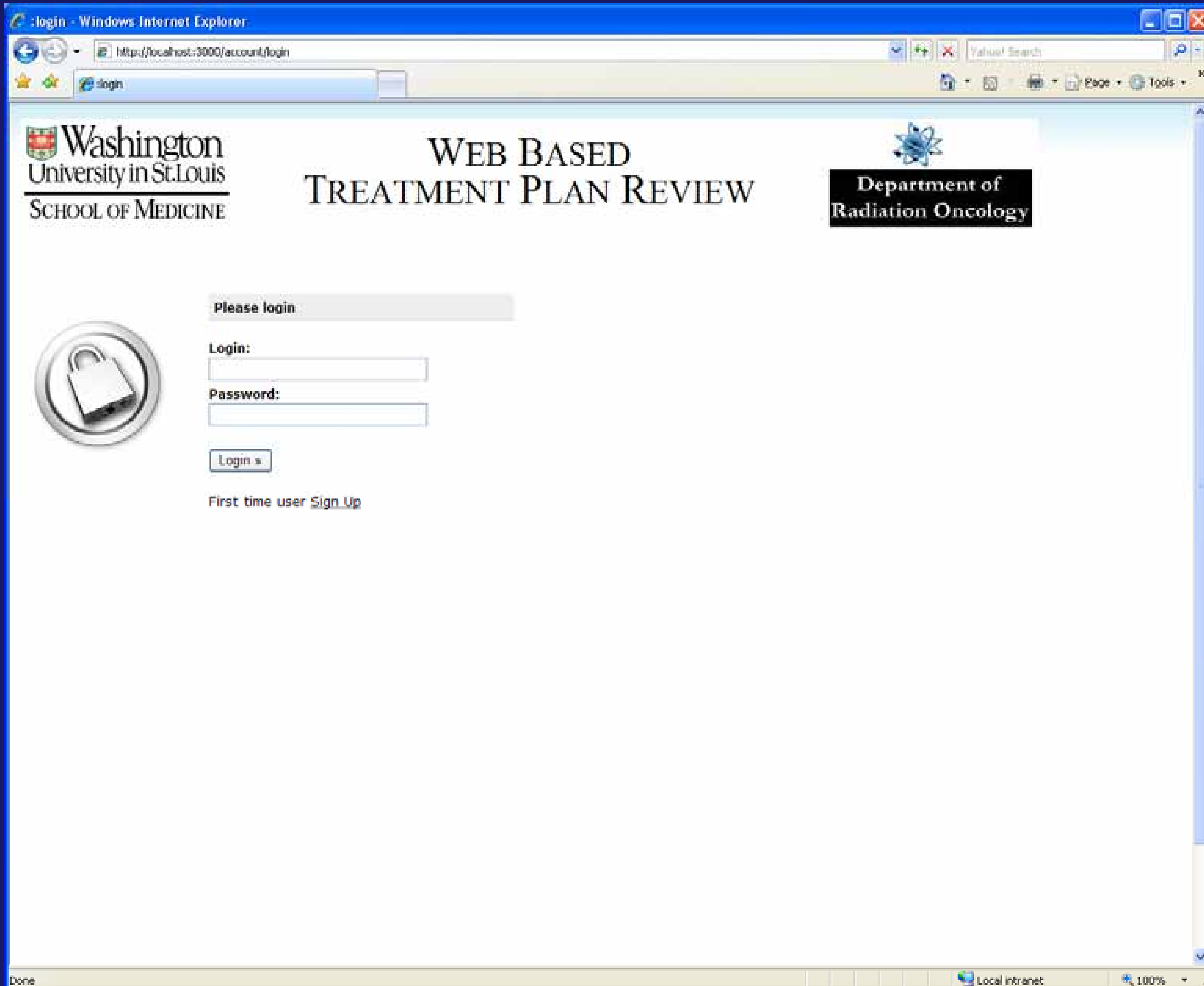
- Goal is to provide detailed reporting on treatment plan quality in convenient manner
- Analysis by CERR and CERR scripts
- Database-centric
- Workflow/review management
- MySQL/Ruby/Ruby on Rails/AJAX

# Treatment planning at a cross-roads:

Visual review of data is inadequate,

but

Detailed plan reporting tools are not available in planning systems.


:login - Windows Internet Explorer
http://localhost:3000/account/login
Yahoo! Search
:login
Page
Tools
Washington University in St.Louis
School of Medicine
Web Based
Treatment Plan Review
Department of
Radiation Oncology
Please login
Login:
Password:
Login »
First time user Sign Up
Done
Local intranet
100%

WebTREV - Windows Internet Explorer

http://localhost:3000/plans/unapproved

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# Web Based Treatment Plan Review

Department of Radiation Oncology

Setting / Log Out

- Approved List
- Unapproved List
- List All
- Contact

**Unapproved Plans**

**Filter on Last Name:**

Number of Plans found : **3**

| Plan ID | Last Name | First Name | Date Created | Date Approved | Planner | Planning System | Status |
|---|---|---|---|---|---|---|---|
| plan11 Approve | Apte | Aditya | Fri Apr 20 12:00:00 Central Daylight Time 2007 | | Divya | Tommo | unapproved |
| plan12 Approve | Mullen | Dan | Fri Apr 20 12:30:00 Central Daylight Time 2007 | | Jing | Pinnacle | unapproved |
| Plan16 Approve | Mast | Anand | Tue Mar 27 12:30:00 Central Daylight Time 2007 | | JD | Pinnacle | unapproved |

Done Local intranet 100%

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# Web Based Treatment Plan Review

Department of Radiation Oncology

Setting / Log Out

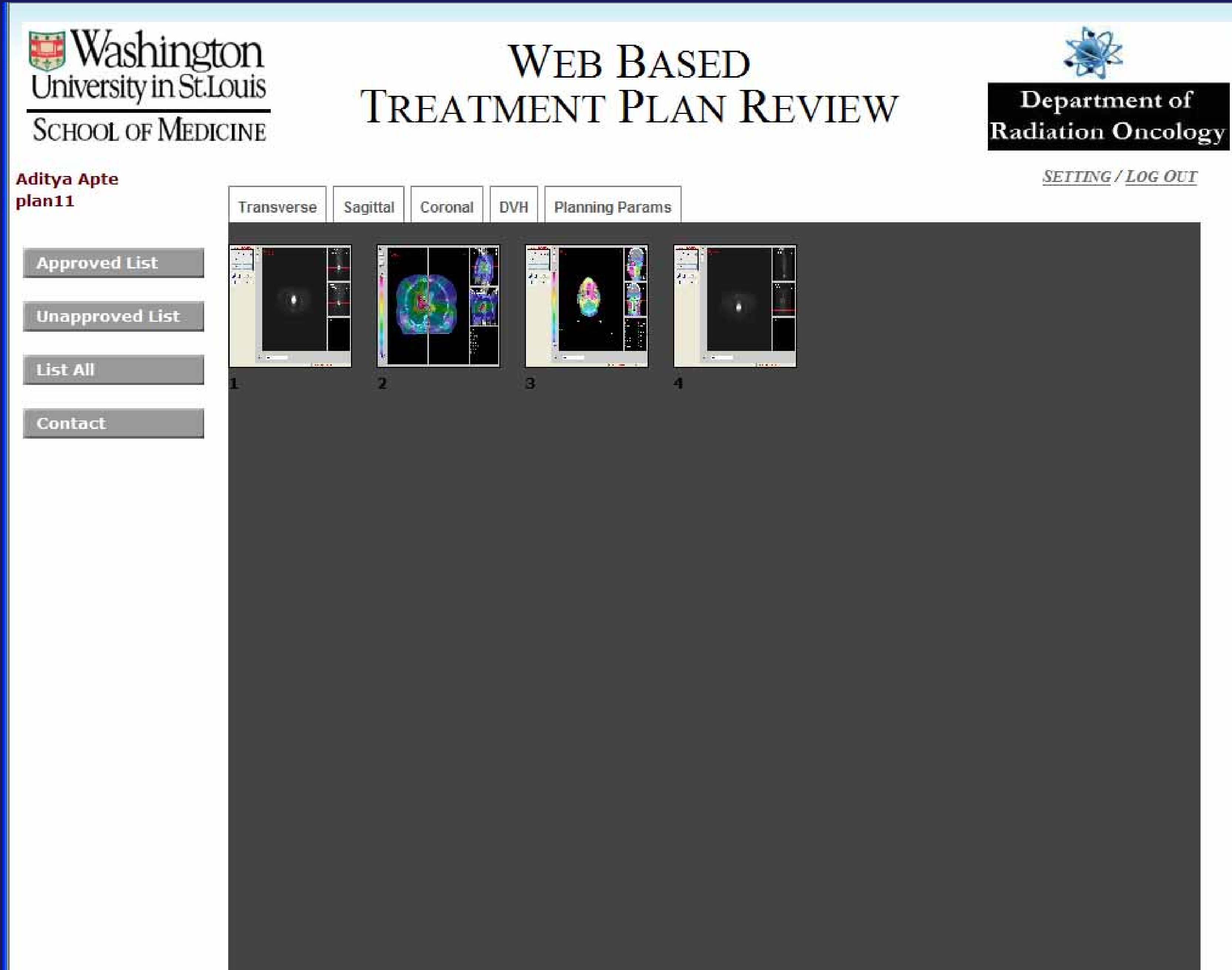
- Approved List
- Unapproved List
- List All
- Contact

**Unapproved Plans**

**Filter on Last Name:** apt

Number of Plans found : **1**

| Plan ID | Last Name | First Name | Date Created | Date Approved | Planner | Planning System | Status |
|---|---|---|---|---|---|---|---|
| plan11 Approve | Apte | Aditya | Fri Apr 20 12:00:00 Central Daylight Time 2007 | | Divya | Tommo | unapproved |


Washington University in St.Louis
SCHOOL OF MEDICINE
WEB BASED TREATMENT PLAN REVIEW
Department of Radiation Oncology
Aditya Apte
plan11
SETTING / LOG OUT
Transverse
Sagittal
Coronal
DVH
Planning Params
Approved List
Unapproved List
List All
Contact
1
2
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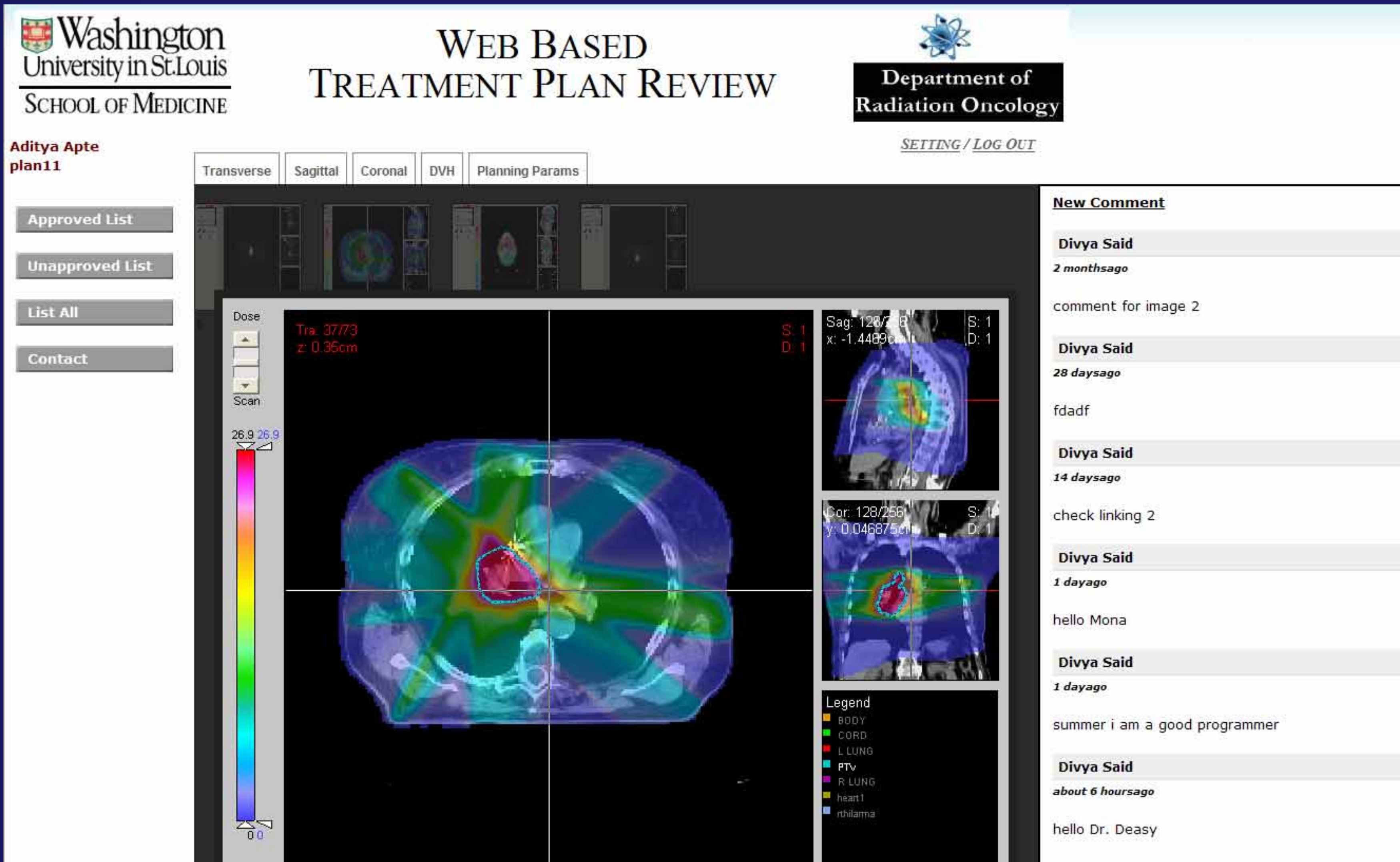
4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Coronal
DVH
Planning Params
Approved List
Unapproved List
List All
Contact
Dose
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26.9 26.9
Tra: 37/73
z: 0.35cm
S: 1
D: 1
Legend
BODY
CORD
L LUNG
PTV
R LUNG
heart1
rthilarma
0 0
New Comment
Divya Said
2 monthsago
comment for image 2
Divya Said
28 daysago
fdadf
Divya Said
14 daysago
check linking 2
Divya Said
1 dayago
hello Mona
Divya Said
1 dayago
summer i am a good programmer
Divya Said
about 6 hoursago
hello Dr. Deasy

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# WEB BASED TREATMENT PLAN REVIEW

Department of Radiation Oncology

Aditya Apte
plan11

SETTING / LOG OUT

Approved List
Unapproved List
List All
Contact

Transverse | Sagittal | Coronal | DVH | Planning Params

## WASHINGTON UNIVERSITY IMRT DOSE QA TABLE

### Head and Neck Target Volume Goals for Protocol 06-0001

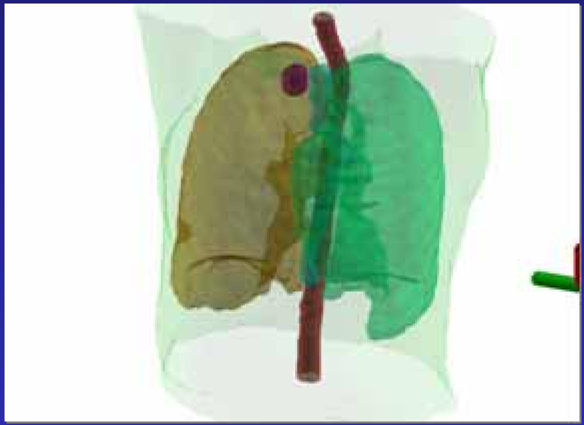
| ROI | Vol (cc) □ | Goal | Meet Goal | | | | | |
|---|---|---|---|---|---|---|---|---|
| **PTV Coverage Goals** | | | | | | | | |
| PTV 66 | 46 | 99% Vol > 93% Rx (65.1 Gy) | Yes | 93% Rx= | 99.50% | 6243 | Gy | PTV 6 |
| | | 20% Vol ≤ 110% Rx (77 Gy) | Yes | % Vol ≥ 102% Rx= | 5% | 6937 | Gy | |
| | | | | % Vol ≥ 110% Rx= | 1% | 7260 | Gy | |
| | | | | % Vol ≥ 120% Rx= | 0% | N/A | Gy | |
| PTV 63 | 75 | 99% Vol > 93% Rx (63 Gy) | Yes | 99% Vol= | 99.2% Rx | 6249 | Gy | PTV 6 |
| | | 20% Vol ≤ 110% Rx (63 Gy) | Yes | 20% Vol= | 32.4% Rx | 6526 | Gy | |
| | | | | 10% Vol= | 12.5% Rx | 6728 | Gy | |
| | | | | 2% Vol= | 6.5% Rx | 7234 | Gy | |
| PTV 56 | 104 | 99% Vol > 93% Rx (56 Gy) | Yes | 99% Vol= | 99.9% Rx | 6229 | Gy | PTV 5 |
| | | 20% Vol ≤ 110% Rx (56 Gy) | Yes | 20% Vol= | 34.5% Rx | 6500 | Gy | |
| | | | | 10% Vol= | 13% Rx | 6721 | Gy | |
| | | | | 2% Vol= | 4.5% Rx | 7002 | Gy | |
| **Critical Structure Constraints** | | | | | | | | |
| Cord | | 0.1 cc Vol ≤ 45 Gy | Yes | 0.1 cc = | 3700 cGy | | | |
| | | | | Max = | 3894 cGy | | | |
| Brainstem | | 0.1 cc Vol ≤ 60 Gy | Yes | 0.1 cc = | 5834 cGy | | | |
| | | 1% ≤ 60 Gy | | Max =□ | 5994 cGy | | | |
| Brain | | 1% ≤ 60 Gy | No | 60 Gy Volume= | 1.50% | | | |
| | | 5 cc ≤ 65 Gy | Yes | 5 cc Max = | 6137 cGy | | | |

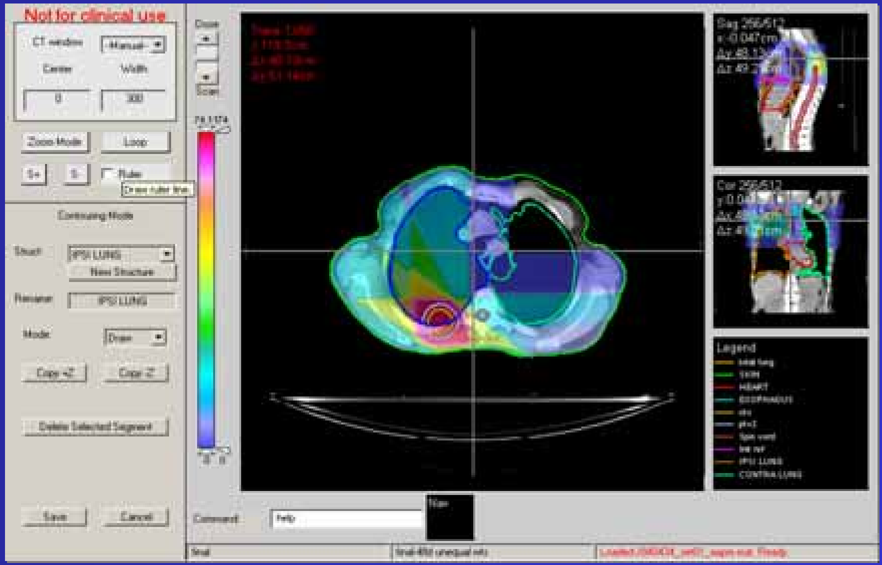
# The Computational Environment for Radiotherapy Research: New Tools and Present Status

Aditya Apte, Issam El Naqa, Gita Suneja, Andres Hope, Patricia Lindsay, James Alaly, Yi Mu, J. Deasy

# Computational Environment for Radiotherapy Research (CERR)

- Matlab-based
- 3-D plans exported from planning systems, archived, and converted to CERR format
- Converts plans from
  - DICOM
  - RTOG format
  - PLUNC (in beta test)
- Exports to DICOM
- Freely available from http://radium.wustl.edu/cerr



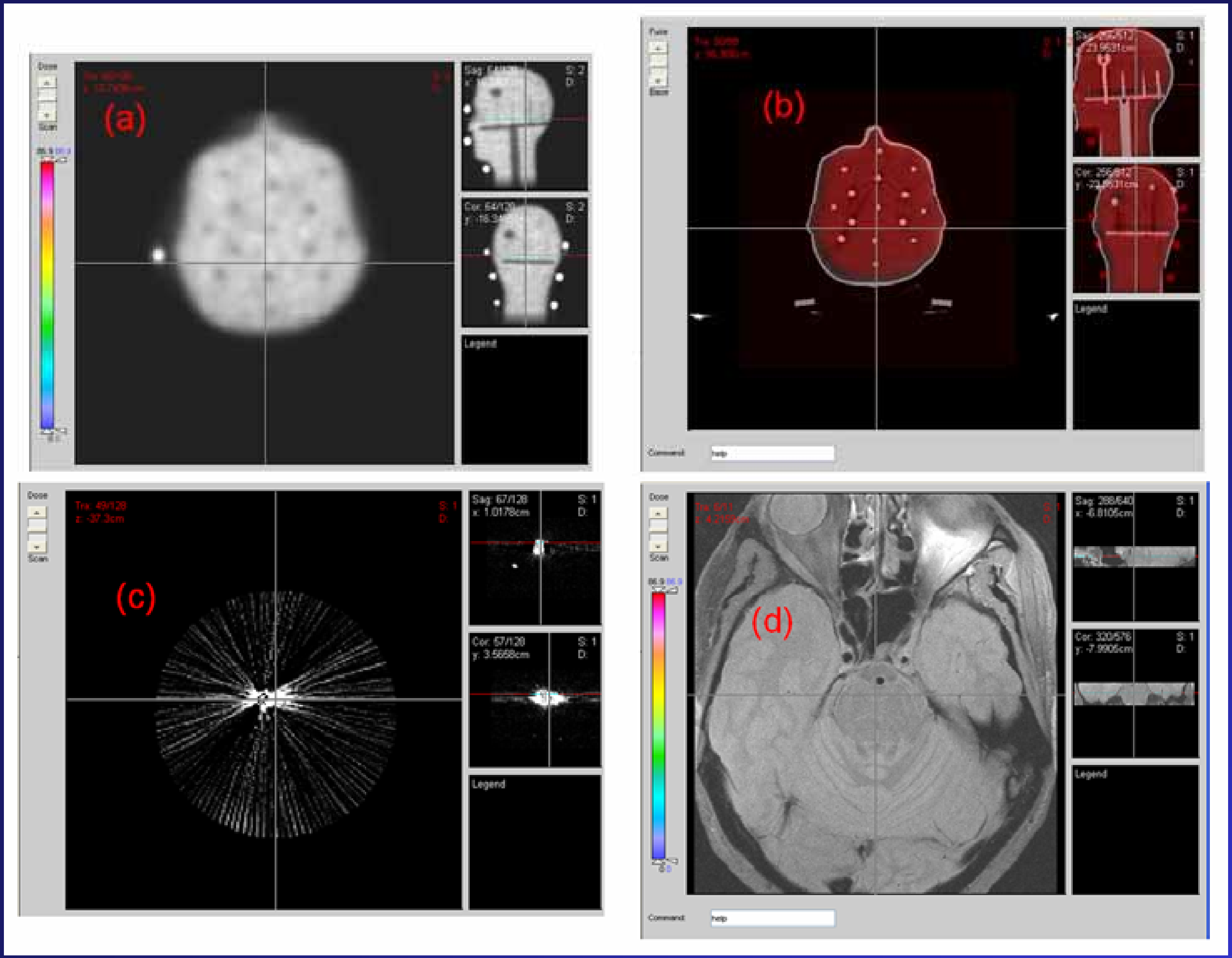



*Support is provided through a 'Google Group': CERR-Forum*

Currently there are 101 members

# CERR can automatically extract…

- GTV volumes
- DVHs
- DVH-based parameters
- Dose surface histograms
- Positional information (e.g., structure center of mass)
- Anything that can be programmed in Matlab…




*New multimodality image review capabilities within CERR:  (a) PET import into CERR, (b) fused/overlaid PET-CT image, (c) SPECT head and neck scan, and (d) MRI import.*

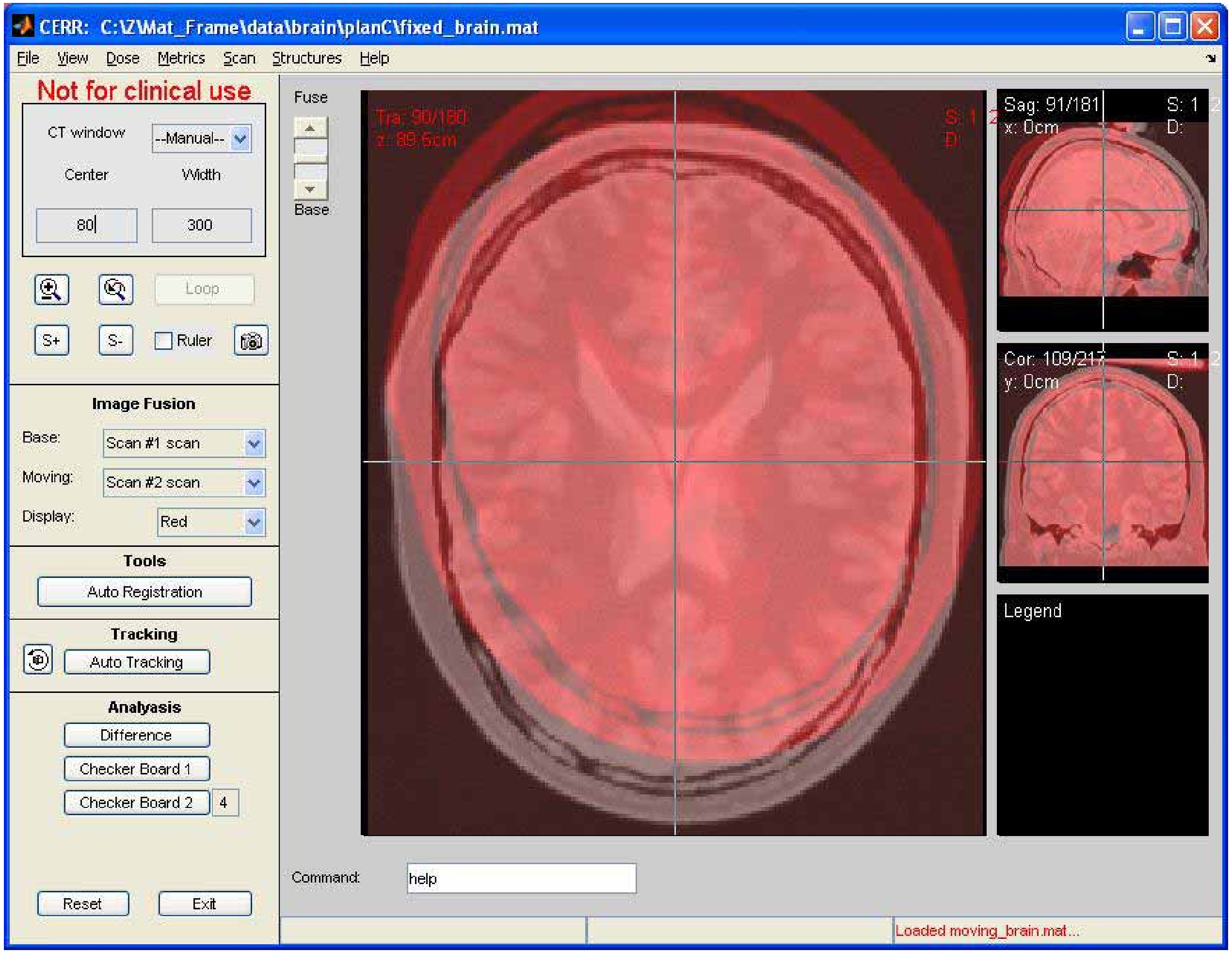
# Development of phantom dosimetry/planning comparison tool w/RPC

# CERR Registration Introduction (minutes of software review)

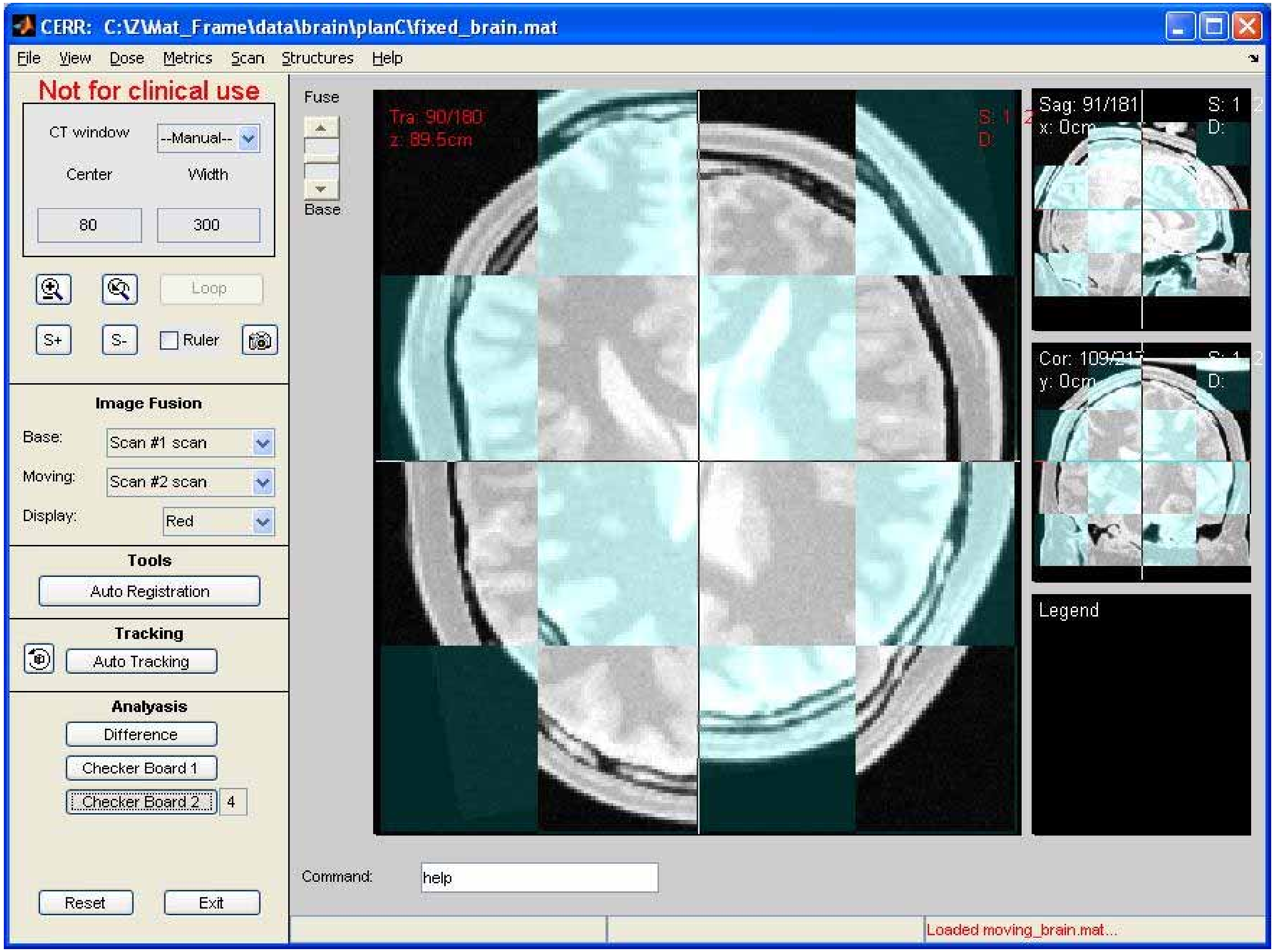
Yu Wu

# Image Fusion Frame

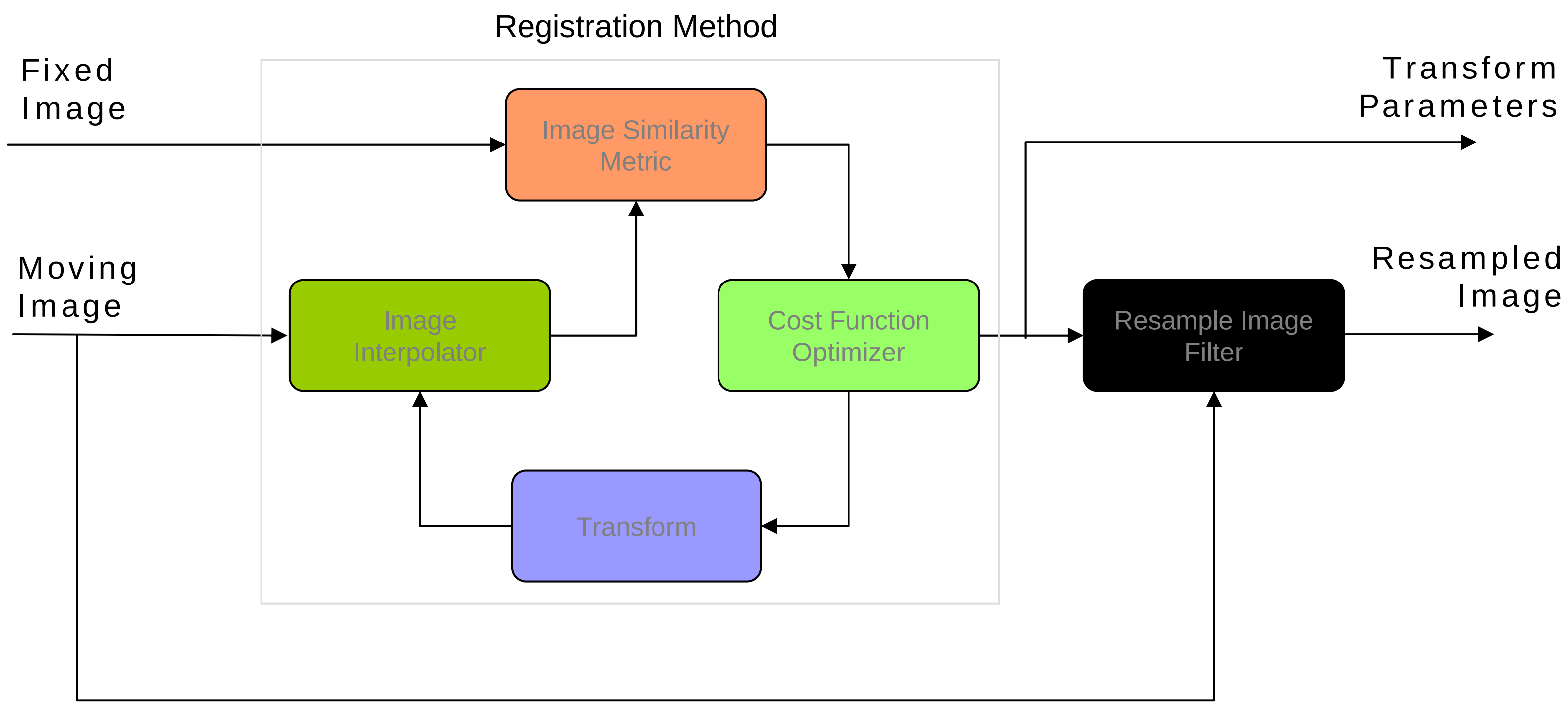
- Moving image overlapped onto the Base image.



# CheckerBoard View before Registration



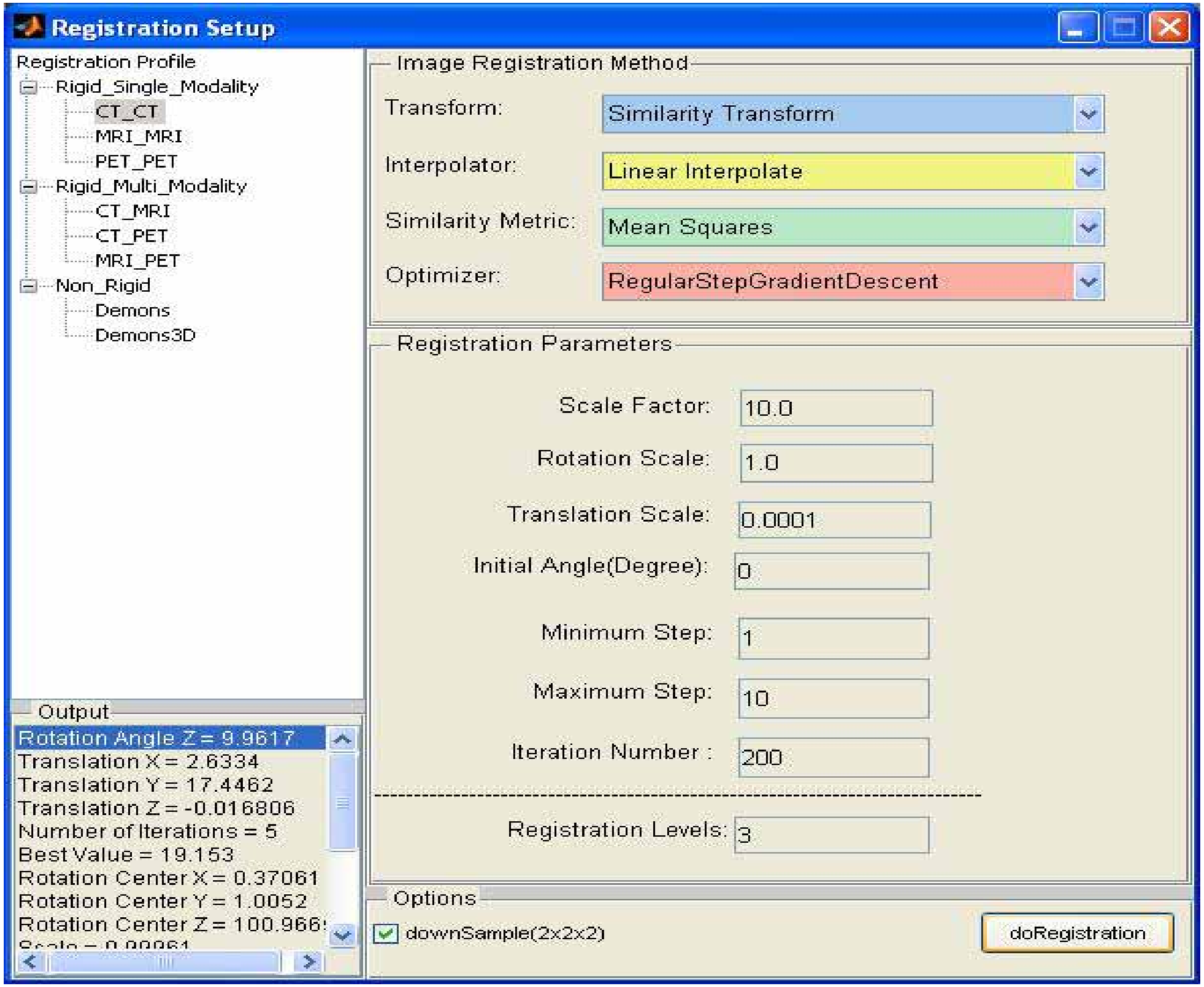
# Registration Framework




- The *transform* component represents the spatial mapping of points from the fixed image space to points in the moving image space.
- The *interpolator* is used to evaluate moving image intensities at non-grid positions.
- The *metric* component provides a measure of how well the fixed image is matched by the transformed moving image.
- The *optimizer* is used to optimize the metric over the searching space defined by the transform parameters.

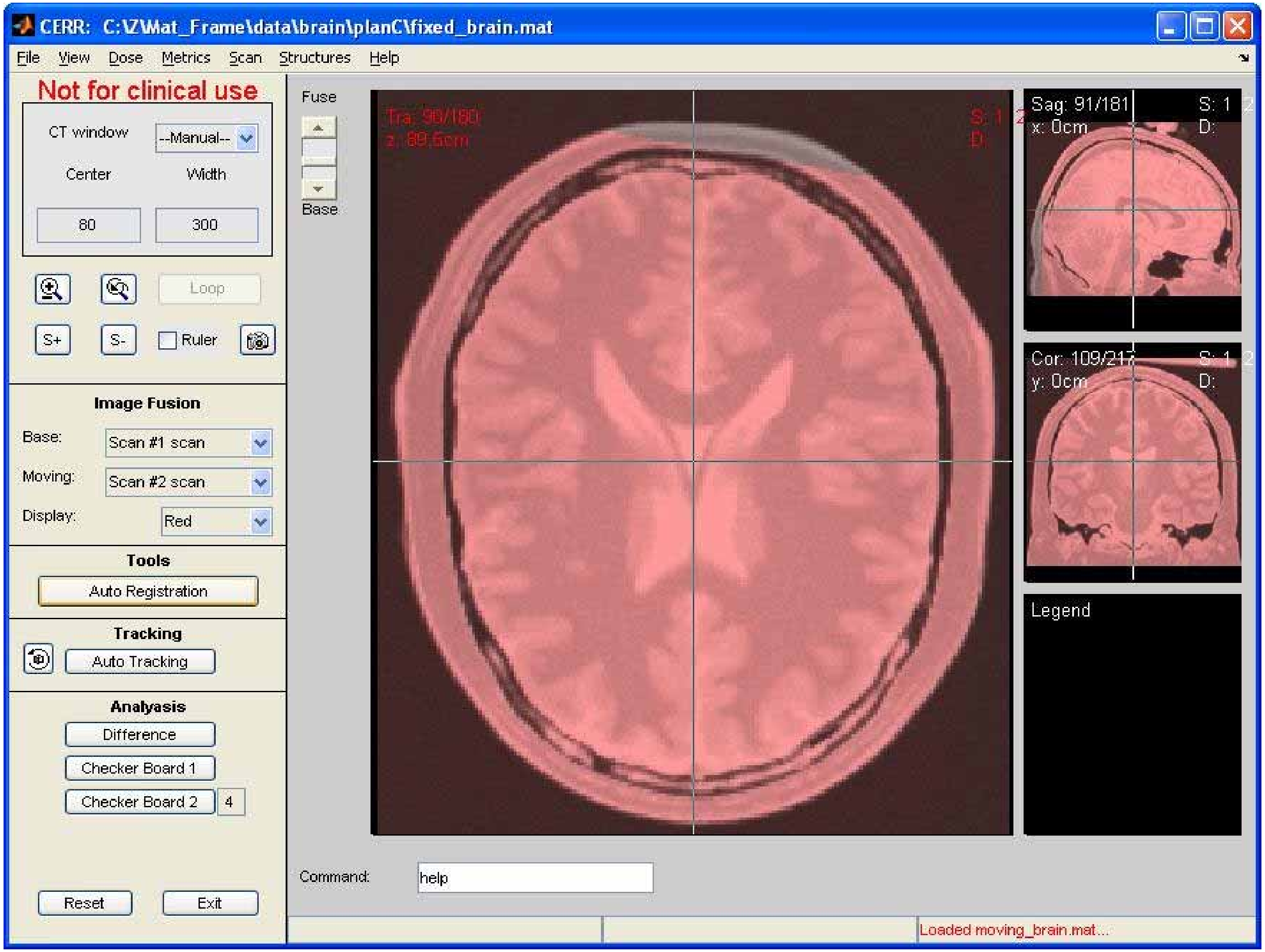
# Registration Setup Form

- This form provides users some options for selecting particular registration profile, composing registration method with different components, and tuning registration parameters according to the output information.



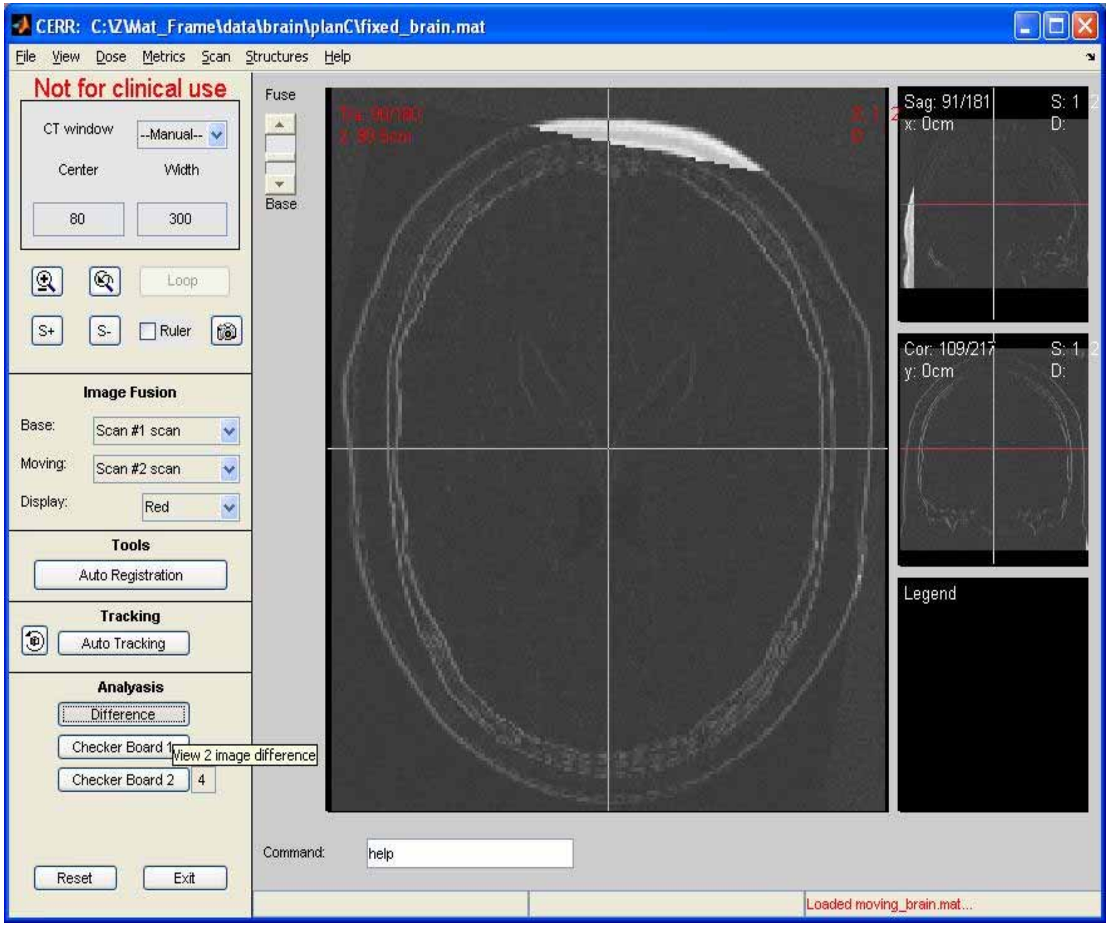
# Image Fusion after registration

- Fusion of base dataset and transformed moving dataset.

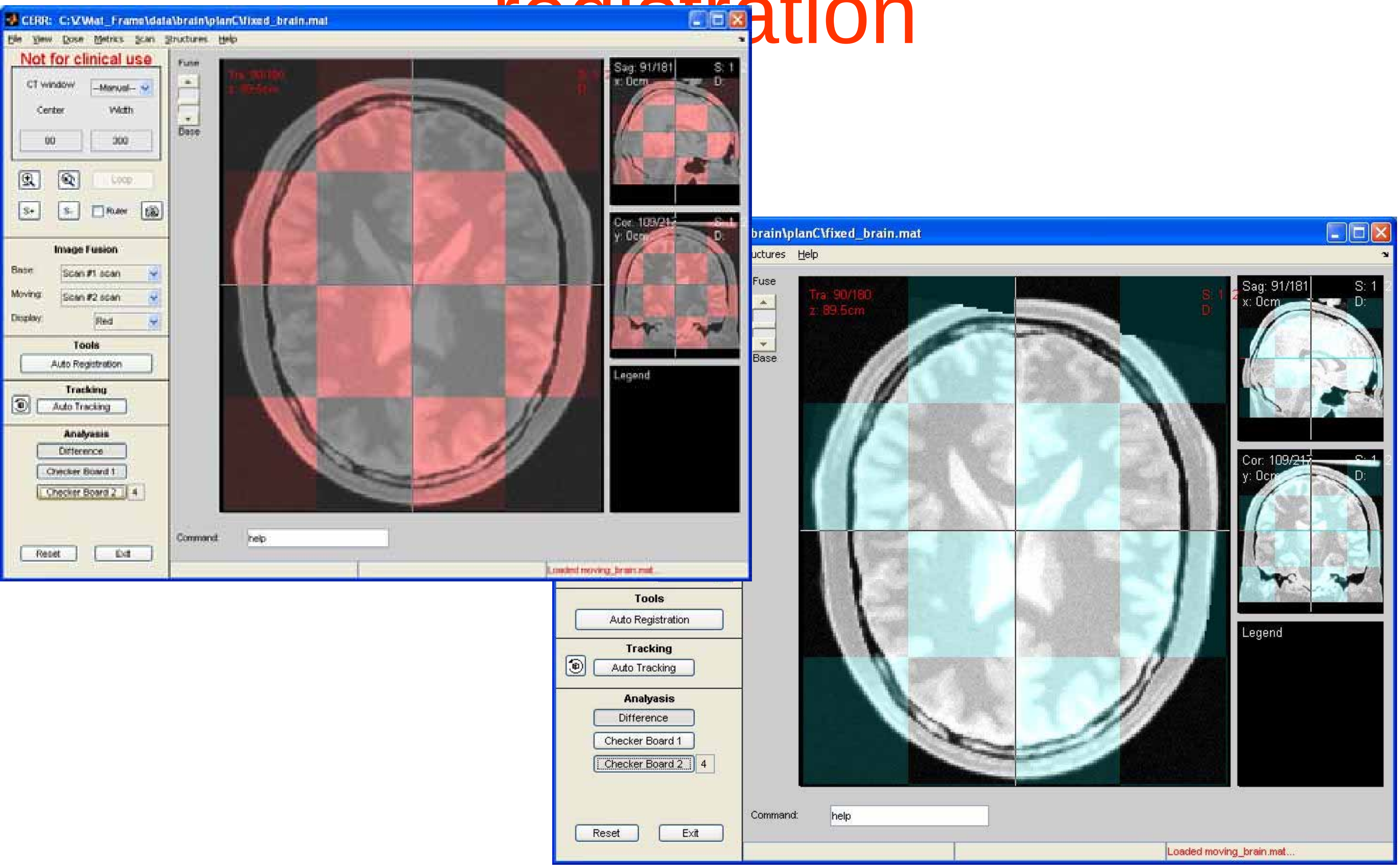


# Registration result analysis

- Difference view between based image and registered moving image.



# Checkerboard view after registration



# A Versatile Source Model for Monte Carlo Dose Calculations of External Radiotherapy

J Cui[1], S Davidson[2], K Zakaryan[3], I El Naqa[1], V Willcut[1], M Wiesmeyer[4], D Followill[2], J Deasy[1]

(1)Washington University School of Medicine; (2) UT MD Anderson Cancer Center; (3) Sun Nuclear Corporation; (4) Virginia Commonwealth University

# Components of the Source Model

**Fast Monte Carlo Dose Engine:**

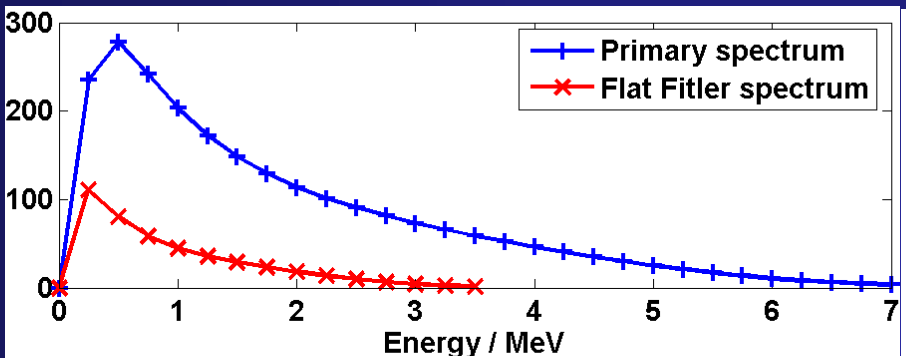
**Dose Planning Method (DPM,** *Sempau, 2000* **)**

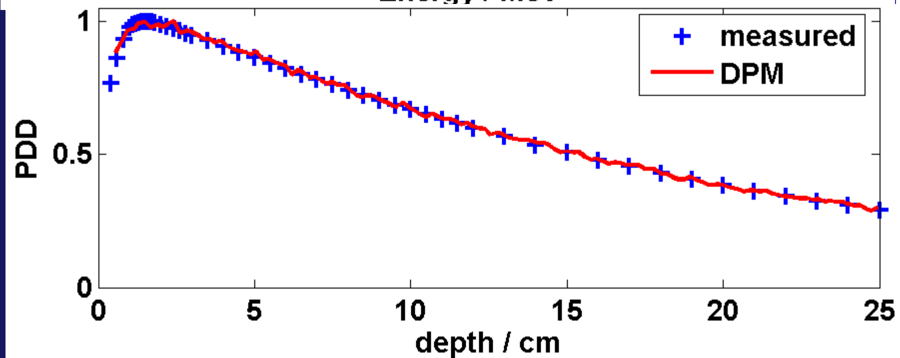
- Primary source: point source
  - Energy spectrum (Fatigue-Fermi)
  - Off-axis softening (*Tailor, 1998*)
  - Horn effect (piecewise linear)
- Flattening filter
  - Exponential spatial distribution (*Liu, 1997*)
  - Energy spectrum (Fatigue-Fermi)
- Electron contaminations (*Fippel, 2002*)
- Ion chamber size effect (Gaussian convolution)

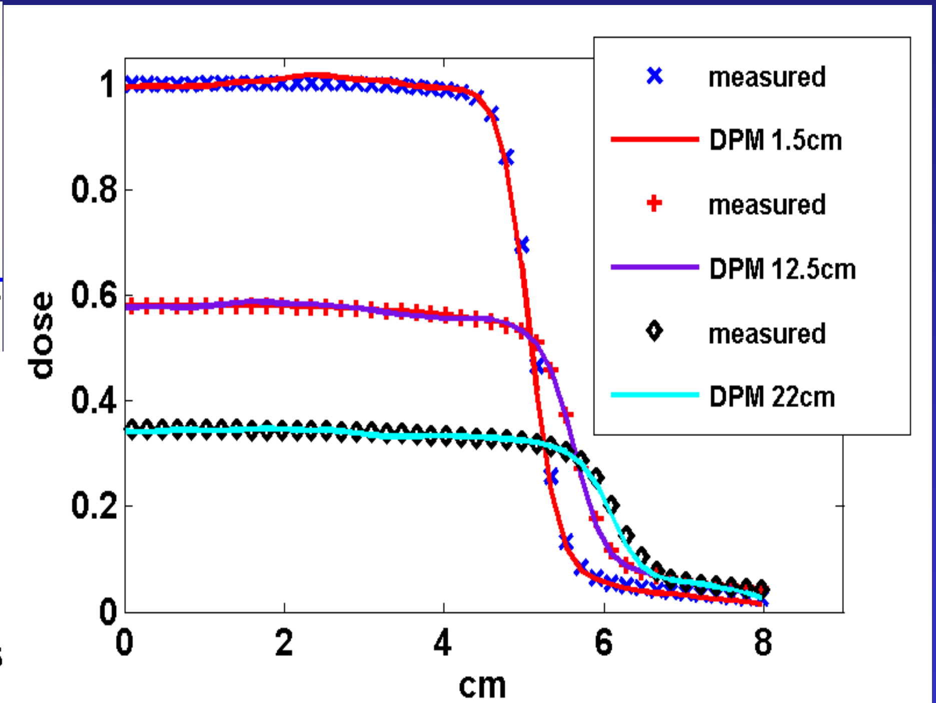
# Commissioned Results for Varian 6MV

DPM vs. IC measured in water phantom

Field size: 10 x10 $cm^2$



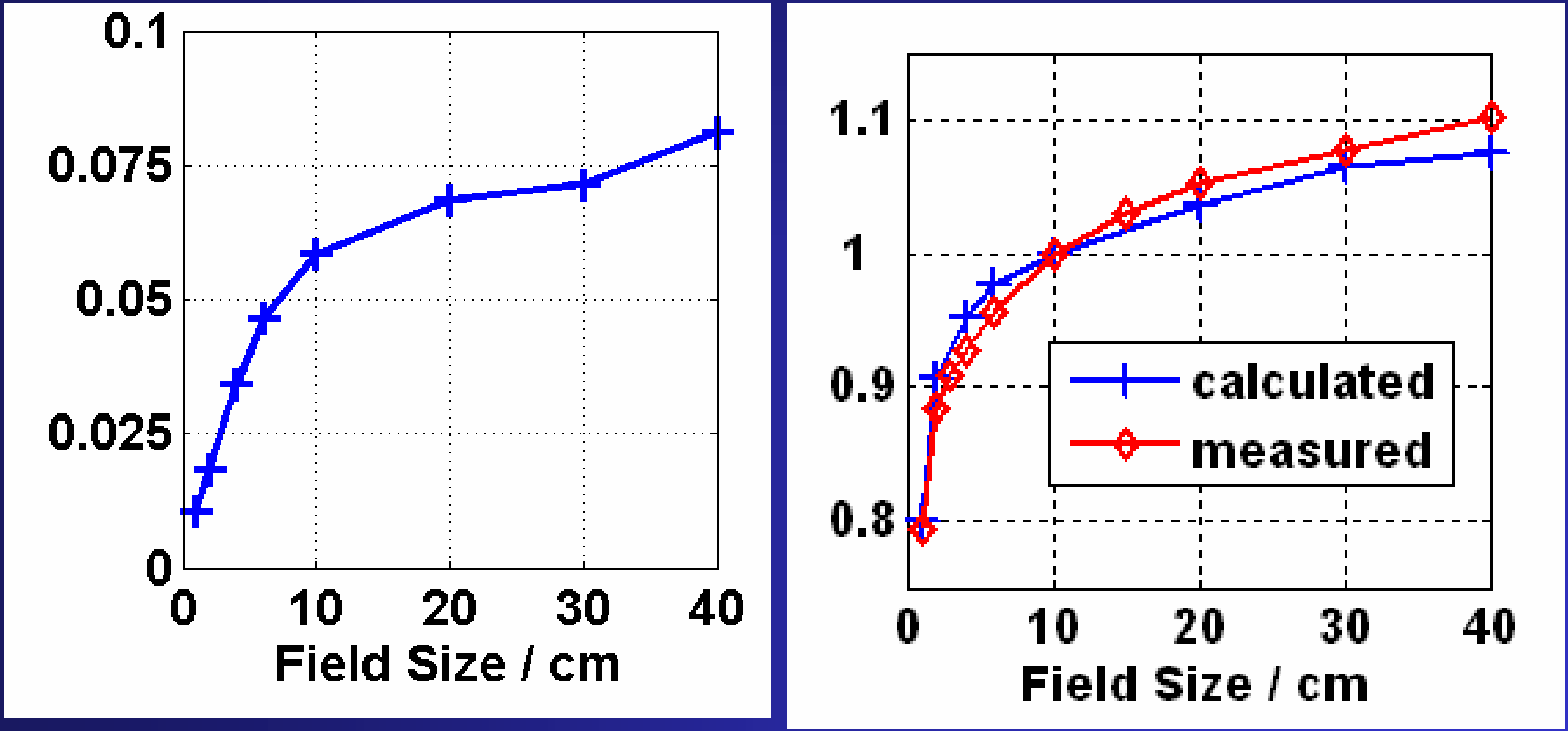




- Upper Left: Spectra for primary source and flattening filter
- Lower Left: PDD;  Right: Lateral dose profiles at various depths

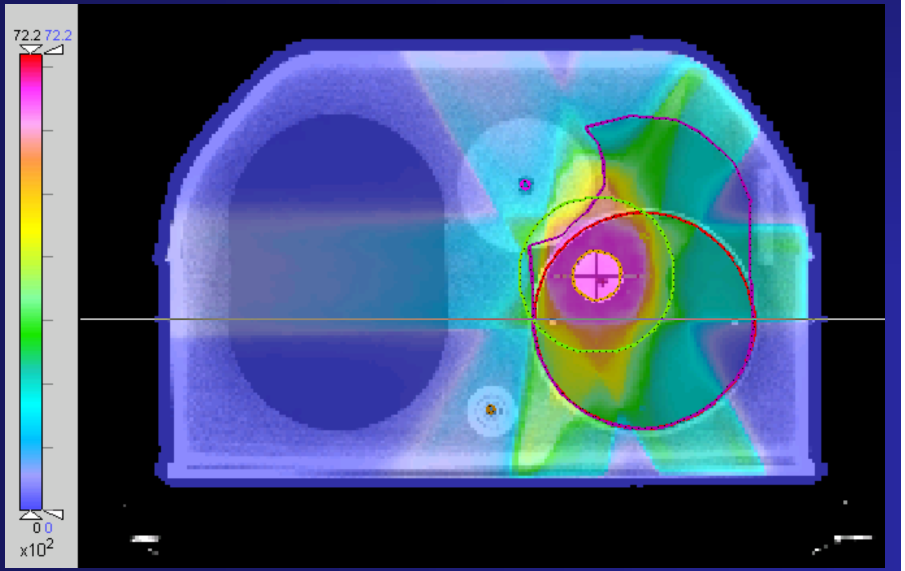
# **Commissioned Results for Varian 6MV**

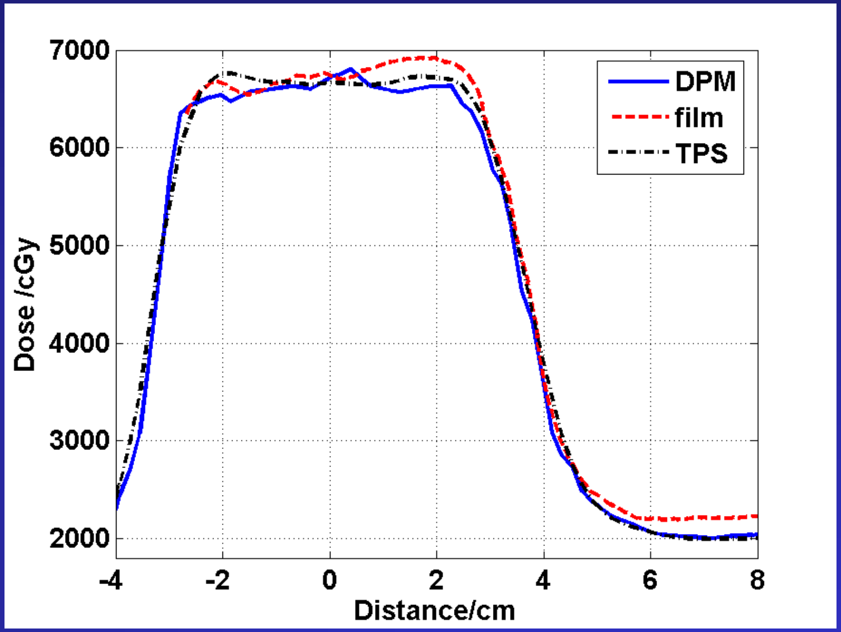
# output factors in various field sizes: 1 x1 cm$^2$ up to 40x40 cm$^2$




- Left: Dose contribution from the flattening filter relative to the primary dose at $d_{max}$=1.5 cm
- Right: output factor at $d_{max}$=1.5 cm; calculated vs. IC measurement

# Model Validation: an IMRT plan in an Anthropomorphic Lung Phantom




- Left: IMRT lung plan, calculated using the source model
- Right: Lateral dose profile across the isocenter, obtained using the source model with DPM, radiochromic film measurement, and Pinnacle Treatment Planning System (TPS)

# RTOG Bioinformatics Committee

- Focusing on enabling investigations of mixed data, i.e., dose, images, biomarkers
- Near-term agenda:
  - Development of RTOG Data Survey
    - What patients do we have all of data types A, B, C?
    - For a given set of patients, what data types do we have?
    - ACRIN (PET, MRI, CT), ITC (RT-Objects), Tissue Data Bank
  - Demonstrate the ability to analyze biomarkers and dose outcome determinants within the same framework
- 8-9 AM, Tomorrow

# Tools [1/2]

- Web-based automated plan reporting
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- Ca-BIG enabled version of CERR