

# SBRT of Lung & Liver lesions using Novalis® IGRT System

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It could be worse !!!



# Acknowledgements

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# Disclosure Statement

- No Business Affiliation or Financial Interest with:
  - BrainLab, Inc.
  - Philips Medical Systems
  - Varian Medical Systems



# Goals

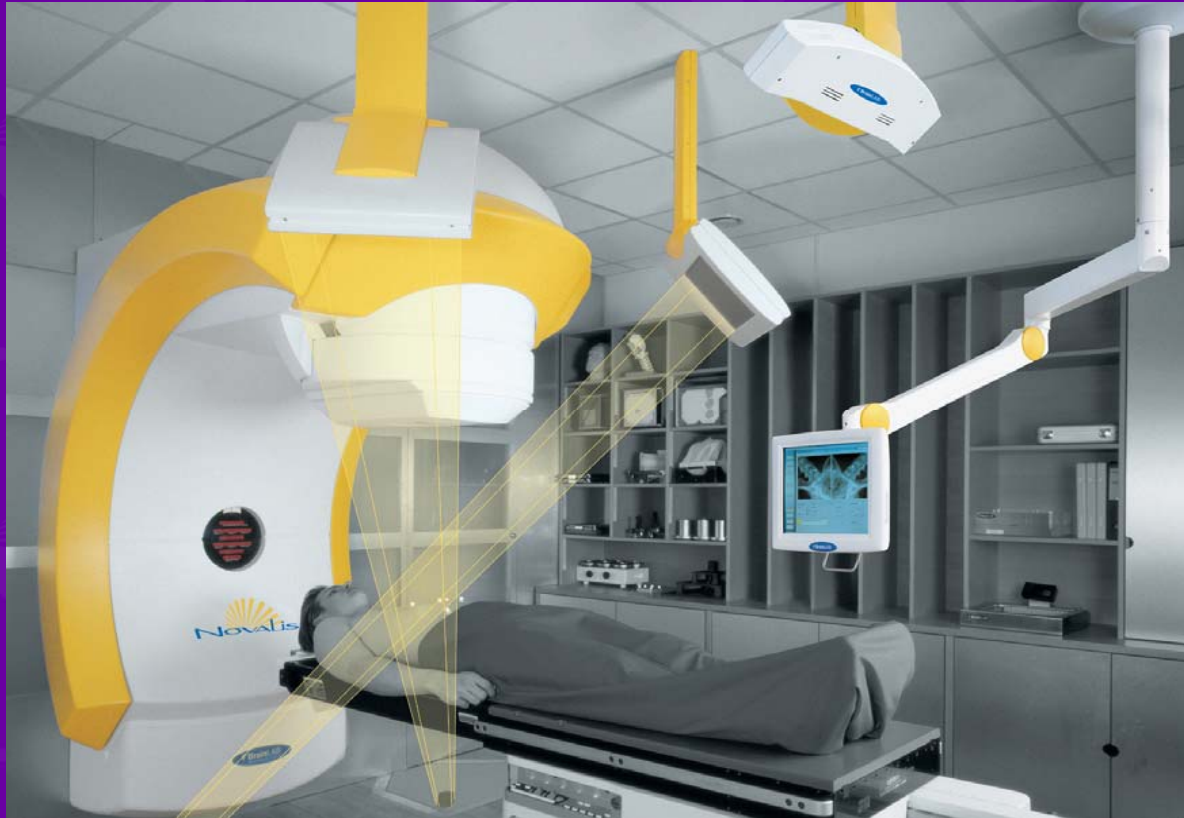
- Provide a “brief” summary of the Novalis IGRT system
- Provide examples of our clinical experience using Novalis IGRT for SBRT Lung & Liver treatments



# Novalis® IGRT



# Exactrac®



# Daily QA

- Linac Output
- Winston Lutz
- Isocenter Calibration
- X-ray calibration
- Isocenter & X-ray Calibration Verification



# Philips Big Bore Brilliance CT

- 85 cm bore
- 4D imaging capability



# Practical Aspects of SBRT

- Extend stereotactic radio-surgery techniques to targets in the body
- Patient Position Verification
  - Compare in room images, prior to Tx, to CT images (DRRs)
- Intra-fraction Movement



# 4D CT

- Patient positioned in *Medical Intelligence* Blue Bag using Body Fix Immobilization system
- Bellows belt used for respiratory monitoring
- Un-coached breathing with 2mm slices thickness



# Blue Bag & Body Fix



# Bellows belt

- measures lung volume changes via expansion and contraction;
  - Inhalation → belt expands;
  - Exhalation → belt contracts,
- generates breathing signal based on lung volume;



# Phase Reconstruction

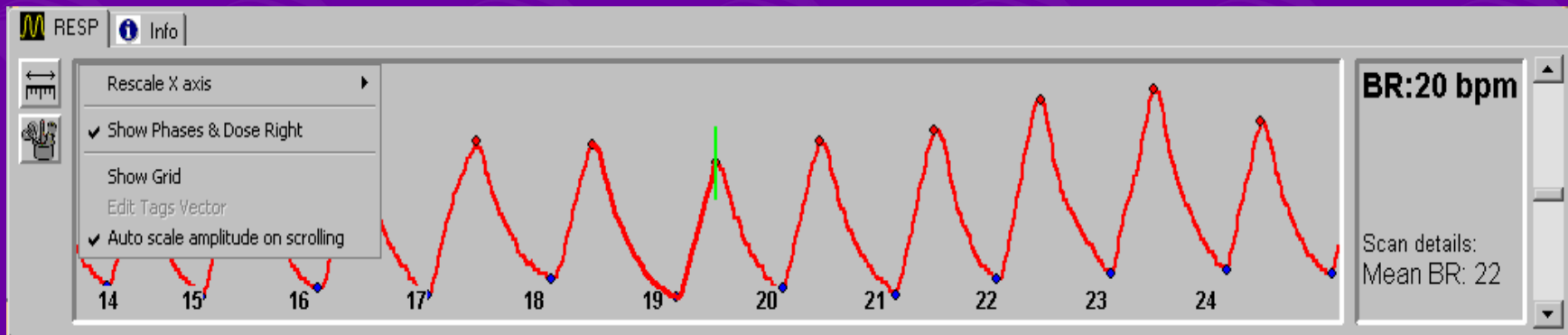


Image Courtesy of Philips Medical Systems



# Phases → MIP

- Phases
  - based on breathing pattern during scan.
  - 0%, 10%, 20%, ... 90%
- MIP
  - Maximum Intensity Projection



# MIP, MinIP, Avg.

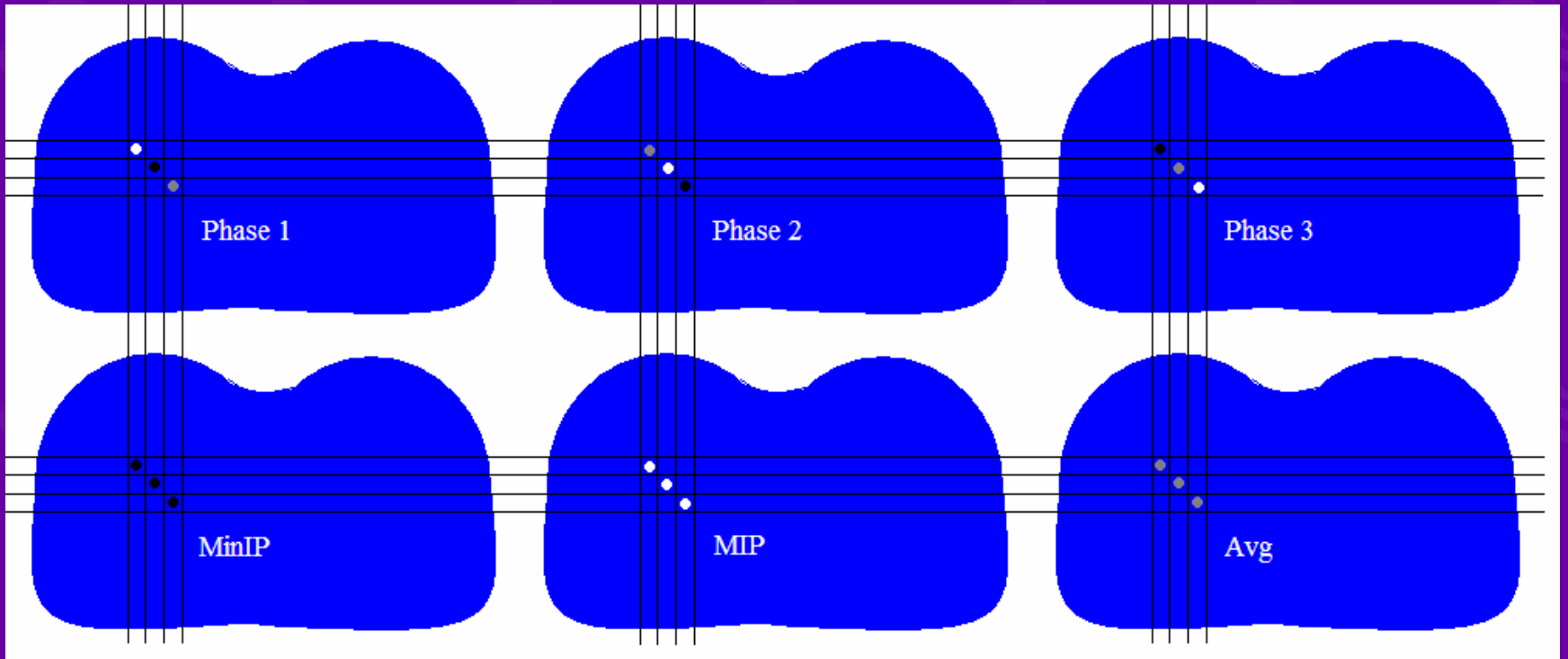
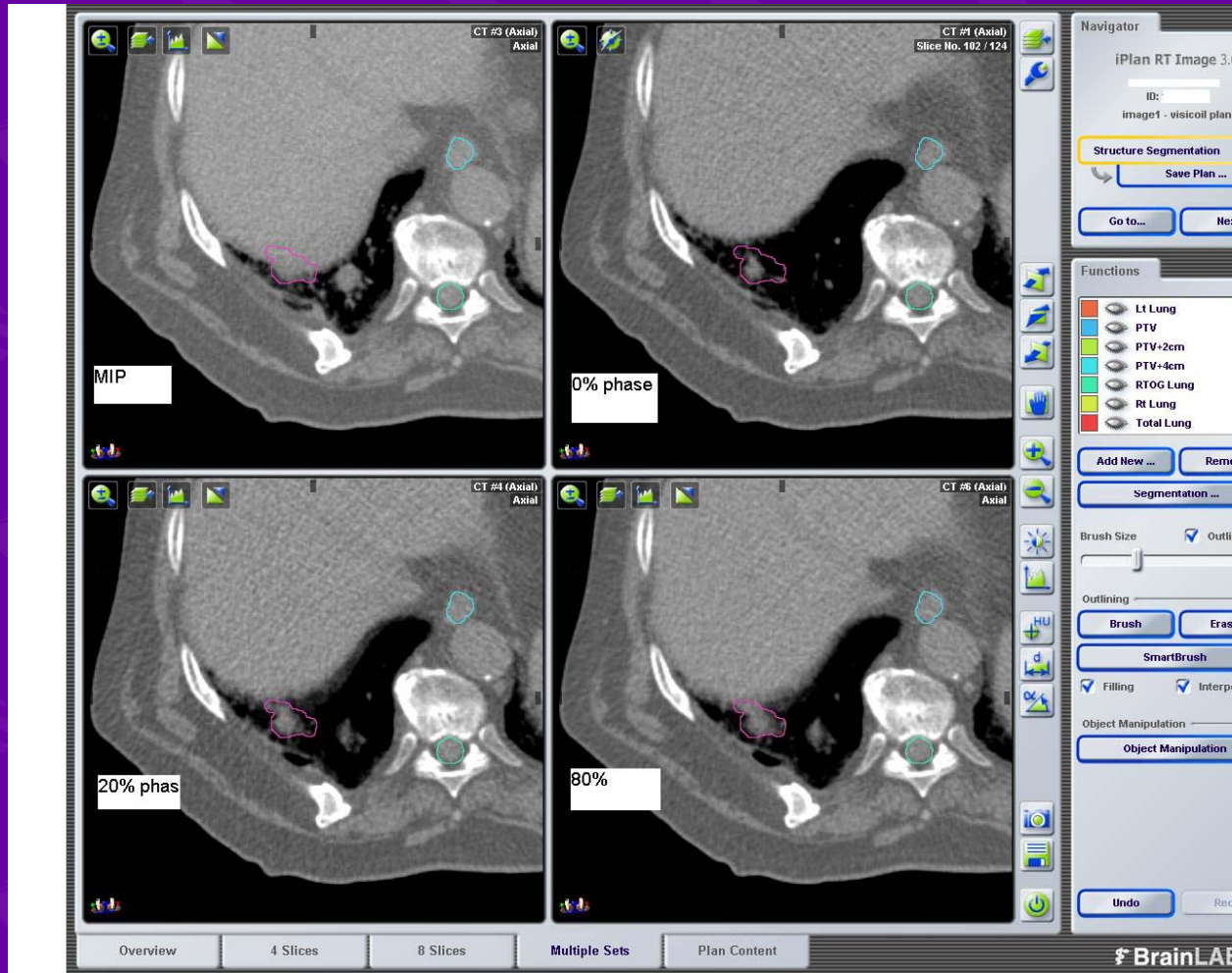


Image Courtesy of Philips Medical Systems



# Multiple Image Sets



# Case 1: Lung lesion without x-ray marker

The image displays a medical software interface for CT scan localization and visualization. The interface is divided into several panels:

- Localization Panel (Left):** Contains controls for organ definition, visualization, and protocols. The 'Lung' protocol is selected. It includes a 'Time Cine' slider and various navigation icons.
- Top Left Panel:** Shows a cross-sectional CT scan of the chest with a yellow dashed box highlighting a region of interest in the lung.
- Top Right Panel:** Shows a magnified view of the region of interest from the top left panel, with a yellow circle highlighting a specific area.
- Bottom Left Panel:** Shows a 'Beam's Eye View' (IRR) for the 'B1I50\_1' phase. It displays a skeletal view of the chest with a yellow box and coordinate axes (X1, X2, Y1, Y2).
- Bottom Right Panel:** Shows a 'Beam's Eye View' (IRR) for the 'B2I50\_1' phase. It displays a skeletal view of the chest with a yellow box and coordinate axes (X1, X2, Y1, Y2).

Technical data for the scans is provided below the images:

Top Left: Slice 54: Z = 94,500 Cooper~Karol PHASE: 0,0%

Top Right: Slice 295: Y = 4,409 (5) Cooper~Karol PHASE: 40,0%

Bottom Left: Name: Cooper~Karol AP Coll: 0,0 Lat Coll: 0,0  
SSD(cm) X1: -5,0 X2: 5,0  
A/P: 89,04 Y1: -5,0 Y2: 5,0  
P/A: 89,62 Y1: -5,0 Y2: 5,0

Bottom Right: Name: Cooper~Karol AP Coll: 0,0 Lat Coll: 0,0  
SSD(cm) X1: -5,0 X2: 5,0  
R/L: 72,88 Y1: -5,0 Y2: 5,0  
L/R: 84,21 Y1: -5,0 Y2: 5,0

Status:



# Treatment Plan

- iPlan software;
- 3D and 4D CT image sets fused;
- Tumor volume contoured on 4D image set;
  - $PTV = GTV + \text{margin}$
- Prescription
  - 1200 cGy/Tx \* 5 Treatments



# RTOG 0236 Protocol

- Normal tissues contoured:
  - Cord, trachea, whole lung, esophagus, heart
- Conformal beam arrangement
- High/Low Dose Spillage
- V20% whole lung

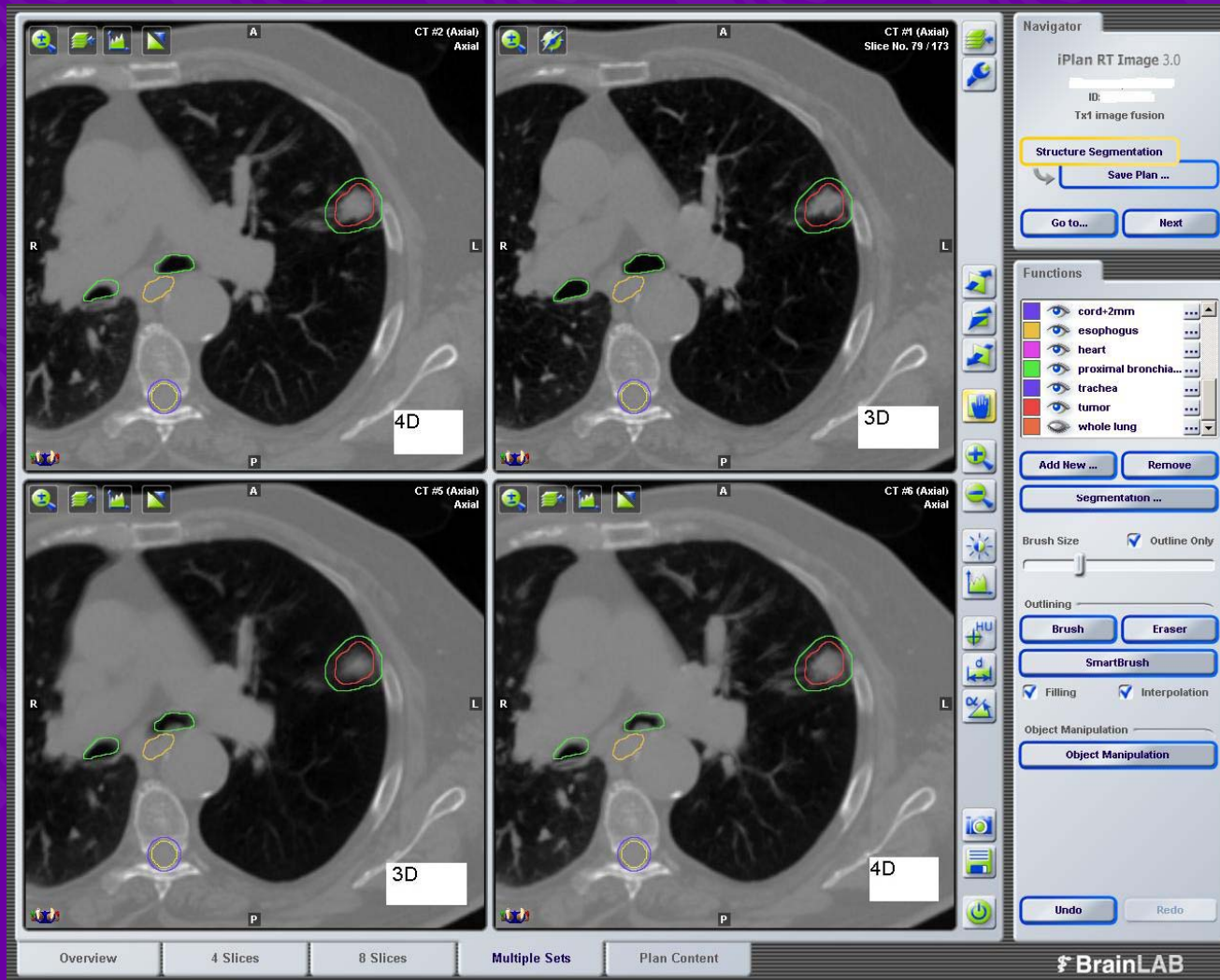


# Verification Simulation & Tx #1

- 3D & 4D CT
- Image sets fused to initial planning CT sets
  - bony fusion
- tumor volume reviewed on all image sets;
- Exactrac® Imaging in treatment room
  - Image fusion via bony fusion



# Multiple Image Sets viewed



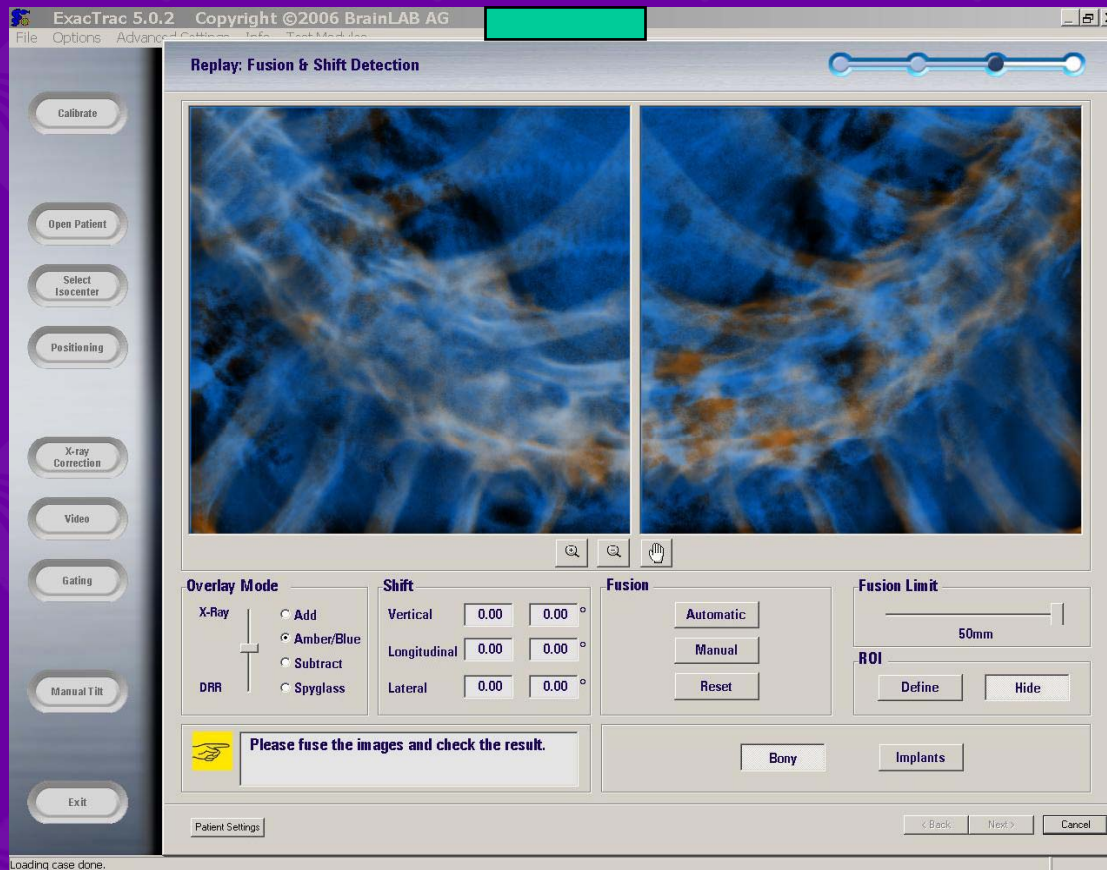
# Alignment X-ray Tube1



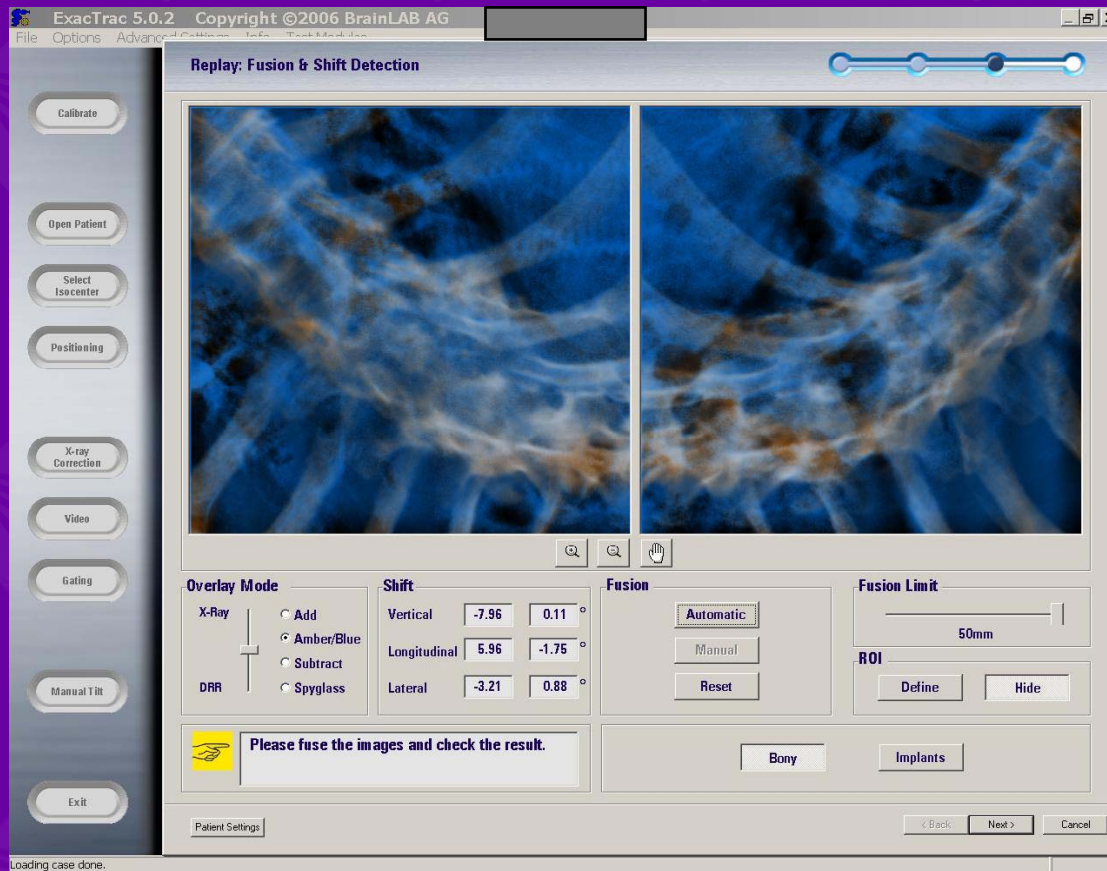
# Alignment X-ray Tube2



# DRR/X-ray pre fusion



# DRR/X-ray post fusion



## Case 2: Lung lesion w/ x-ray marker

- Coil placed in Radiology after CT imaging;
- Pre-Plan created w/ Pre-Coil CT
- Patient returns 7-10 days after coil insertion
  - 3D & 4D CT imaging
    - Image fusion in TPS
    - tumor volume reviewed on all image sets
    - Coil contoured on 4D image set
  - Exactrac Imaging and verification of plan



# Day of Treatment

- Exactrac Imaging
  - Bony fusion
  - Criteria for Treatment
    - coil on x-ray must fall on or within the coil contour projection.
- Treatment



# Exactrac Image Fusion



# Case 3: Liver lesion w/out x-ray marker

- Simulation
  - 3D & 4D CT sets in Blue Bag & Body Fix;
  - 3-Phase CT scan with contrast in Radiology;
- Image sets sent to TPS
  - 3D Tx. Planning CT;
  - diagnostic scans w/contrast;
  - 0% - 90% phase scans from 4D scan;



# Plan details

- Image Fusion based on soft tissue alignment near & around tumor;
- Tumor defined on diagnostic image set;
- Individual phases used to determine max. movement of liver near the tumor;
  - 5.3 mm Ant-Post;
  - 2 mm sup-inf
  - 1 mm right-left



# RTOG 0438 Protocol

- 10 fractions
- IMRT Not allowed
- GTV determined on CT w/ IV contrast;
- DVH analysis
  - Liver & Kidneys;
- Max dose values for:
  - spinal cord, small bowel, stomach



# PTV margin

- 9 mm ant-post
- 5 mm sup-inf
- 3 mm right-left



# Daily Pre-Tx. Imaging

- 4D CT obtained prior to each treatment;
- 30% phase reconstructed and sent to TPS;
  - Approximates middle of breathing cycle;
  - Fused to initial 30% phase
- Patient kept in Medical Intelligence Blue Bag during fusion & planning process.



# Daily Treatment Plan

- Image sets fused
  - Diagnostic, 30% phase, 3D
- New plan each day
  - SSD variations, patient position, etc.
- 3D image set sent to Exac trac for bony fusion.



# Questions



April, 2008



April, 2009

