



School of Computing
Armstrong Atlantic State University
Department of Computer Science

X3D in Radiation Therapy Procedure Planning

Felix G. Hamza-Lup, Ph.D.

Computer Science
Armstrong Atlantic State University
Savannah, Georgia USA

MD ANDERSON
CANCER CENTER
ORLANDO

Outline

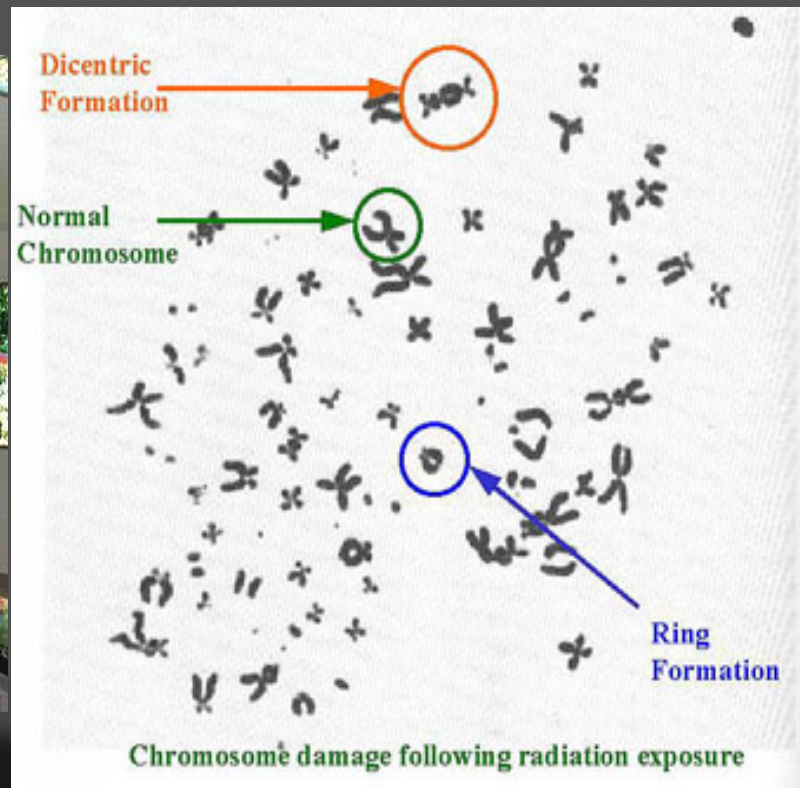
1. What is radiation therapy ?
2. Treatment planning issues
3. Web-3D & the treatment plan
4. The 3DRTT web-based simulator
5. Assessment plan
6. Near future

What is Radiation Therapy ?

- Radiation therapy is the careful use of high-energy radiation to treat cancer.
- “About 50-60% of cancer patients are treated with radiation at some time during their disease” (www.radiologyinfo.org)
- A radiation oncologist may use:
 - radiation generated by a machine outside a patient's body ([external beam radiation therapy](#)) **EBRT**
 - radioactive sources that are put inside the patient ([brachytherapy](#))

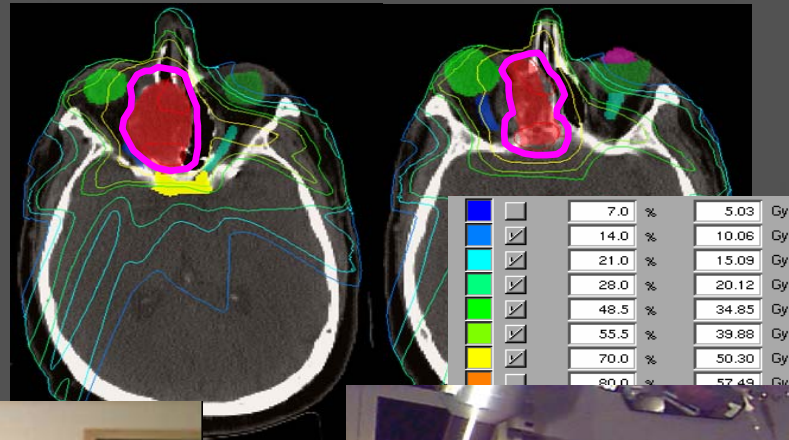
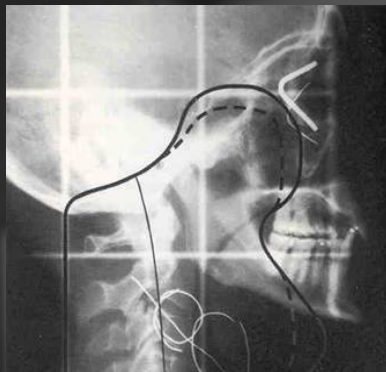
Cell Killing By Ionizing Radiation

Radiation destroys the cancer cells' ability to reproduce and the body naturally gets rid of these cells.



Planning

- Calibration of radiation sources
- Planning of patient procedures
- Calculation of patient dose (dosimetrists)



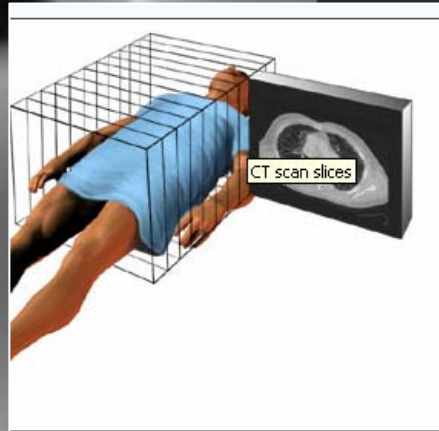
General Flow of External Radiation Therapy Treatments



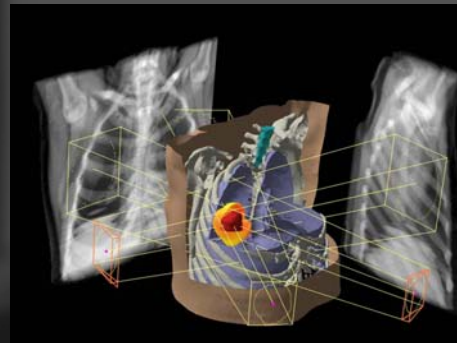
CT scanner



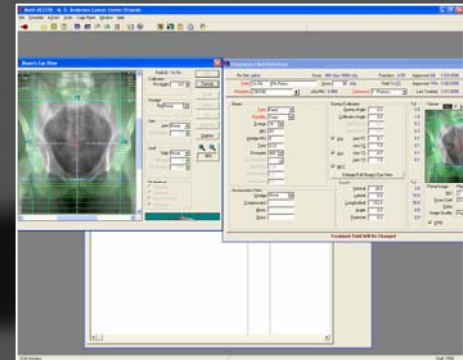
Linac:
external beam
treatment



CT Slices +
Radiation Therapy (RT) info



Treatment Planning System (TPS):
dose calculation and visualization

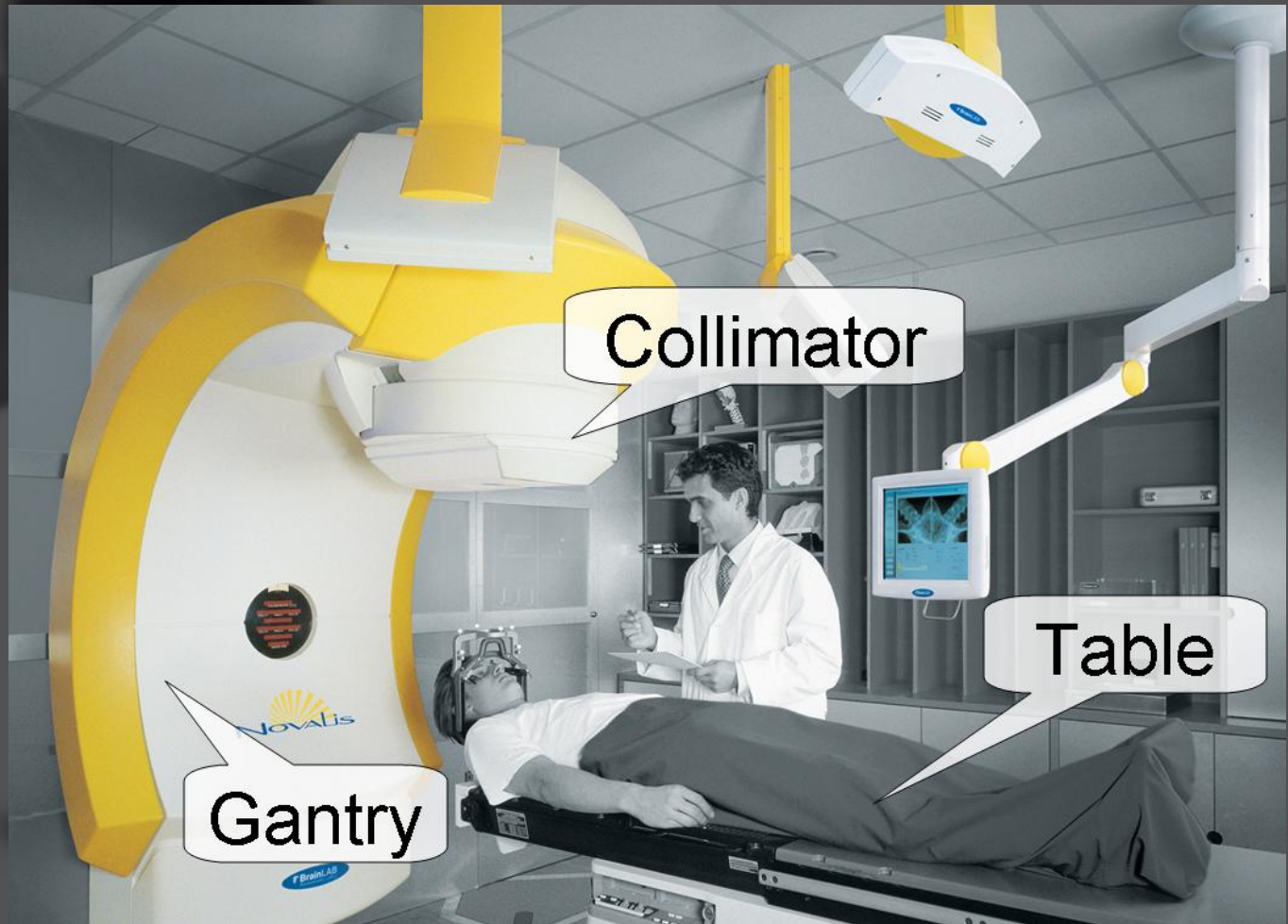


Record and Verify System (RV):
makes sure all parameters are
properly transferred to/from linac

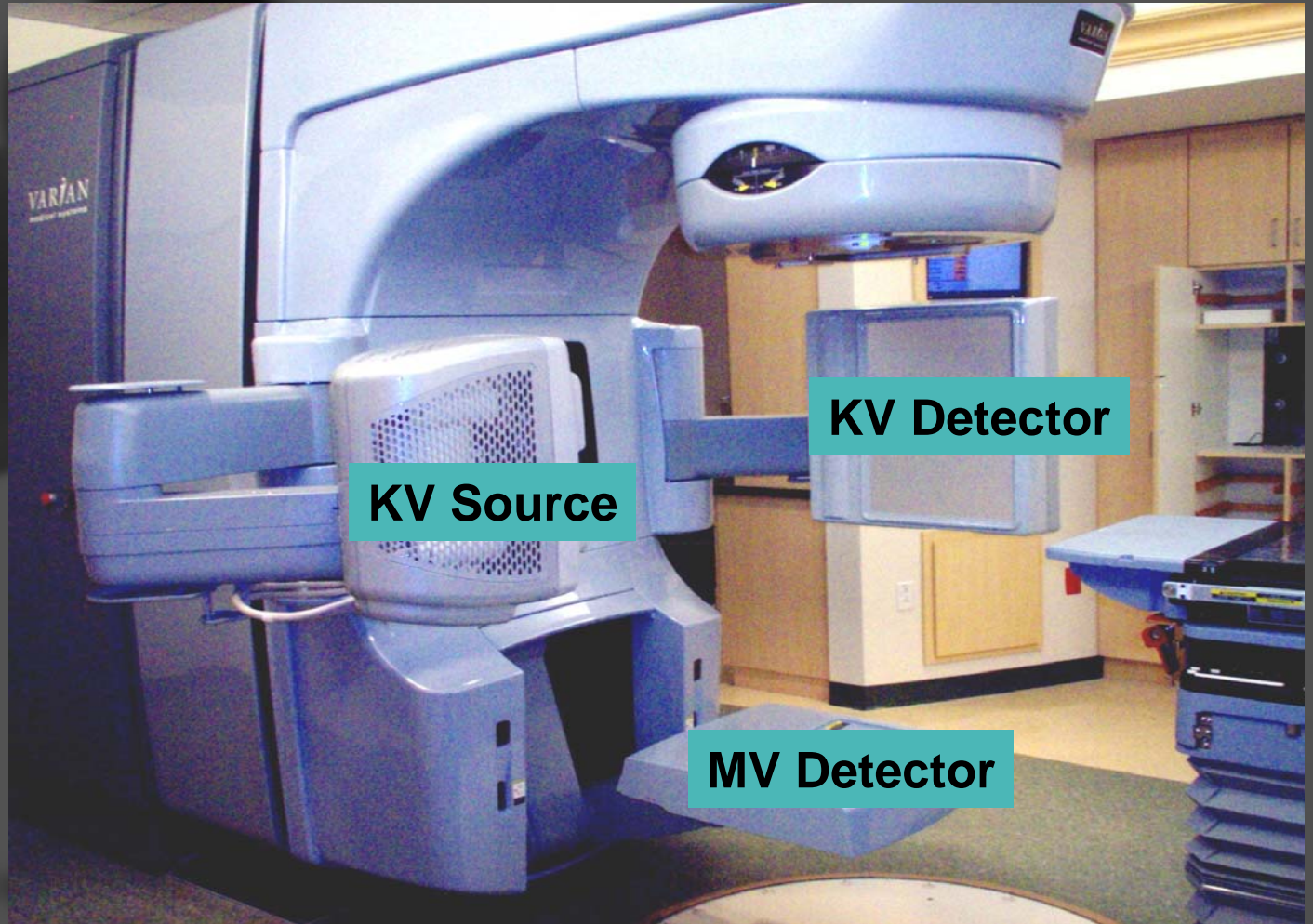


LINACS (Novalis™)

- LINear ACcelerator main components

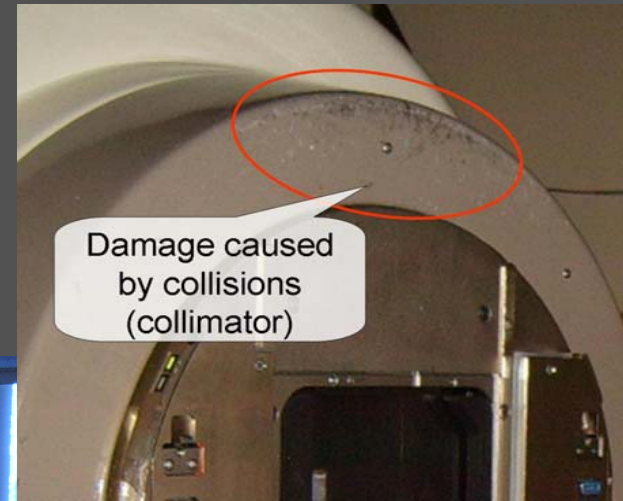


LINACS (*Varian Trilogy™*)



Planning issues

- Hardware Collisions
- Beam intersection with external objects



"A typical situation from our clinic" – MD
Anderson Cancer Center Orlando
Novalis 7-field H&N RT



needs a new
paint job!

Beam Parameters:

Gantry = 245°
Couch = 350°
Collimator = 0°
VRT = 10.0
LAT = 0.0
LNG = 60

In many cases the collimator is touching the couch, and re-planning is required

There are many add-ons we need to keep track of and avoid collision with



stereotactic head frames



wing boards



head extensions



wing boards

Motivation

- Most of the currently available treatment planning systems offer little or no information for the treatment planner on possible collision scenarios during the planning process
- Most collision scenarios are found by RTTs during visual treatment verification checks
- Computer Controlled Radiation Therapy (CCRT) requires precise knowledge of the relative positions of all linac components with respect to the patient and to each other. All motions must be verified before use

Motivation

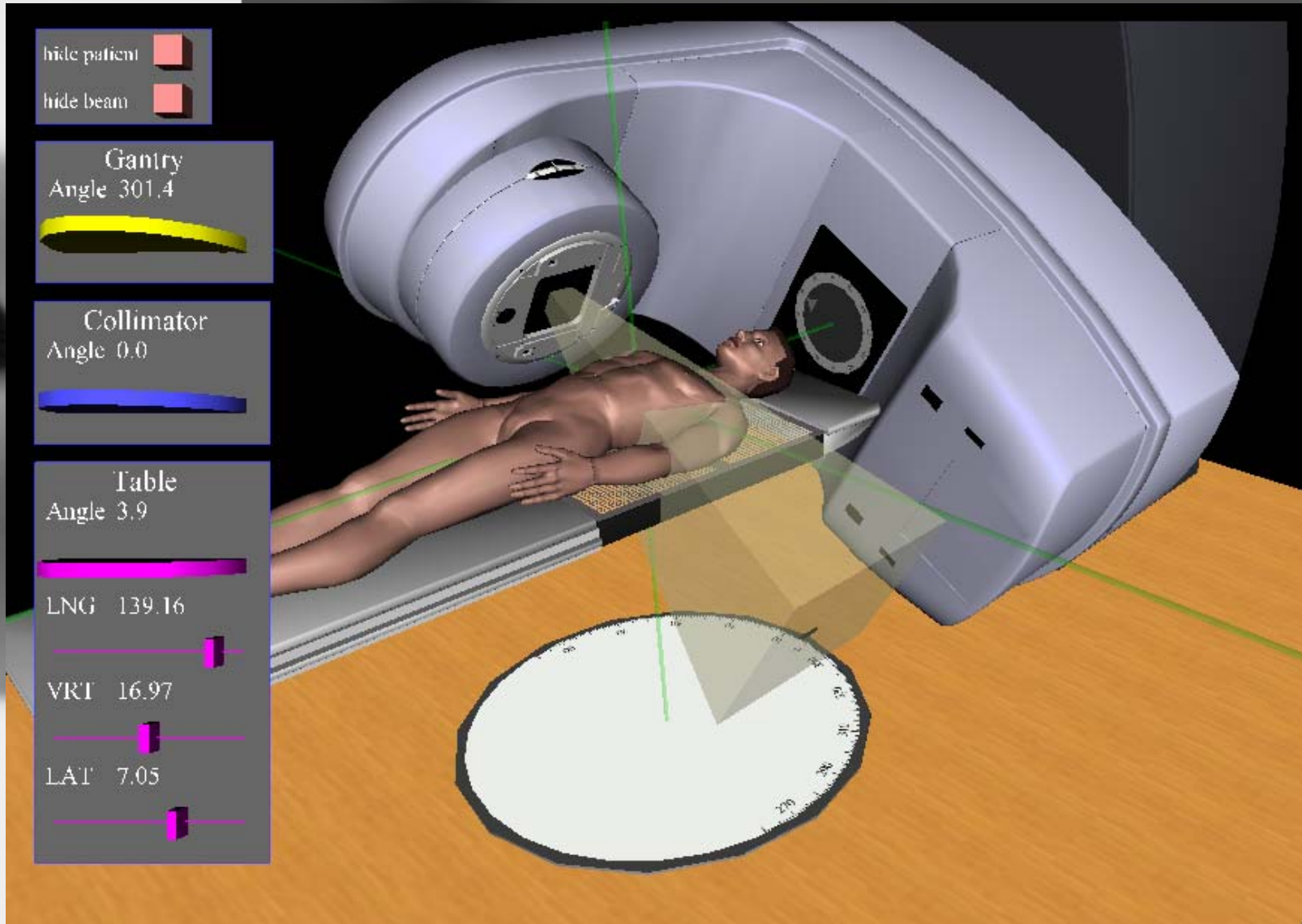
We would like to:

1. Generate a realistic 3D simulation of the treatment room with as much detail and resolution as possible?
2. Virtually move different linac components gantry, table, collimator, ..etc as if you were in the room using a hand pendant?
3. Visualize the beam path, the lasers, and the actual patient external geometries/surfaces on the couch together with add-on/immobilization devices?

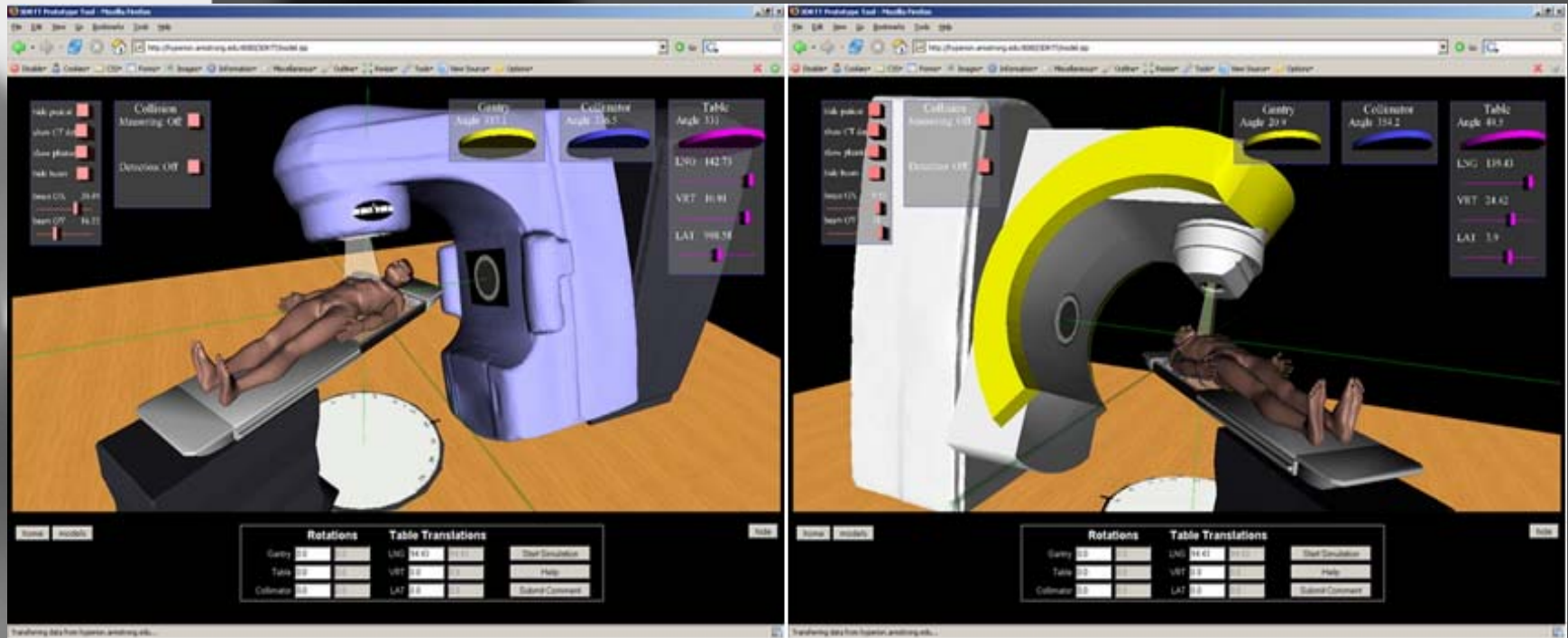
If we can, then we have a tool that provides simulation of patient-specific external beam plans.

3DRTT Simulator

- 3D Radiation Therapy Treatment: Varian Trilogy 23ix

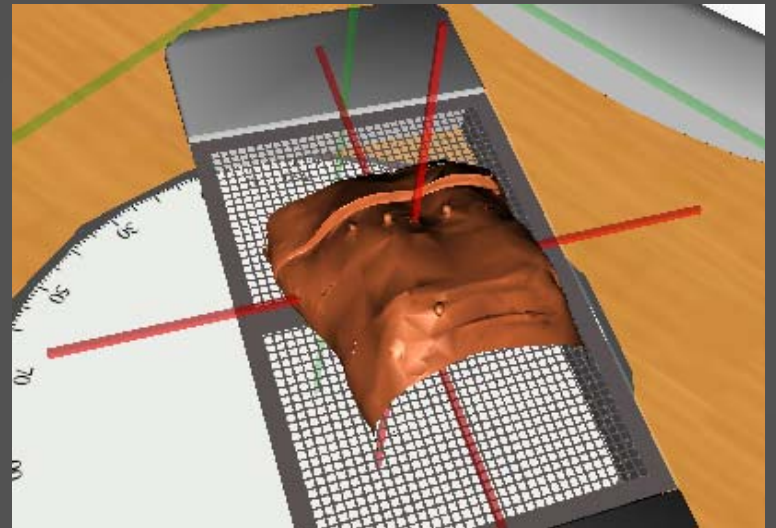


Varian Trilogy™ & Novalis™ (BrainLab™)



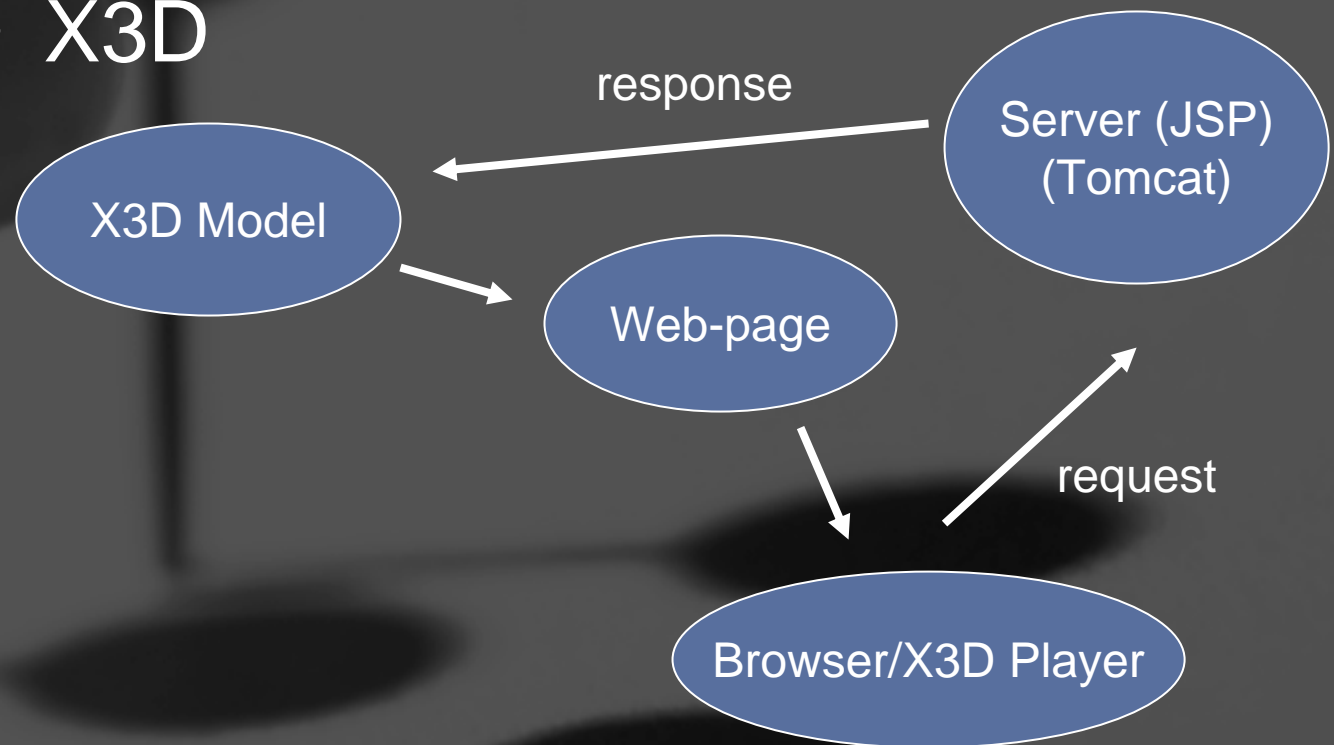
Patient specific data

- Patient specific CT data in the simulator



Implementation

- EcmaScript
- Java (JSP/servlet)
- X3D





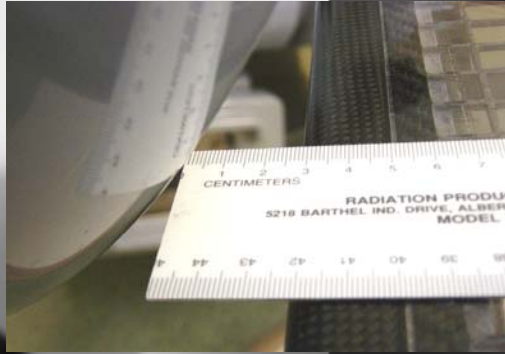
3DRTT Simulator



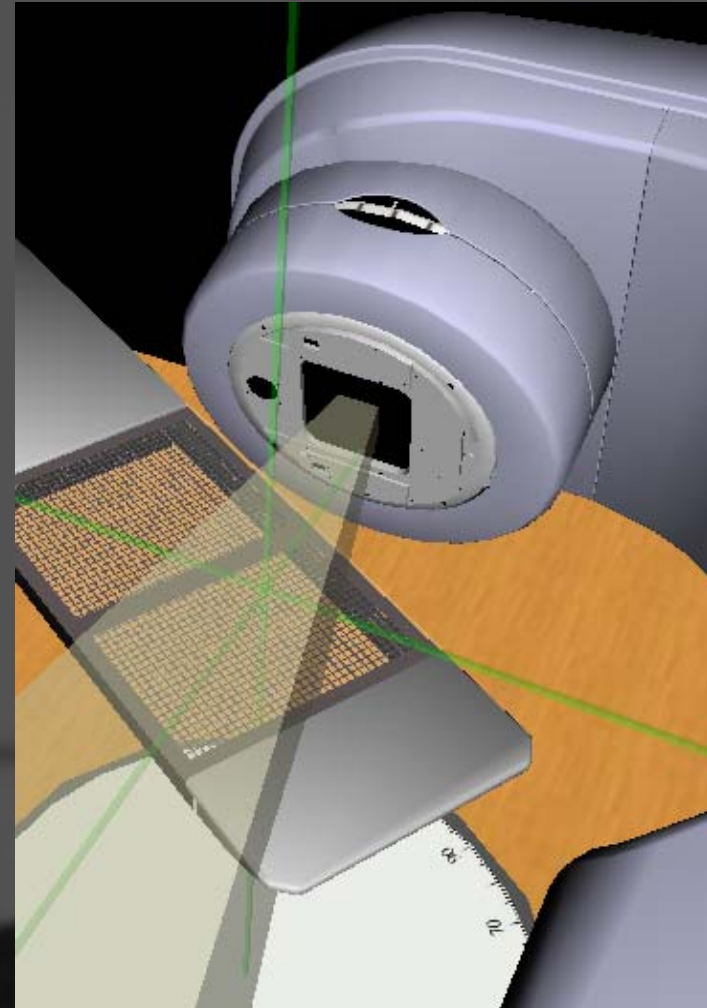
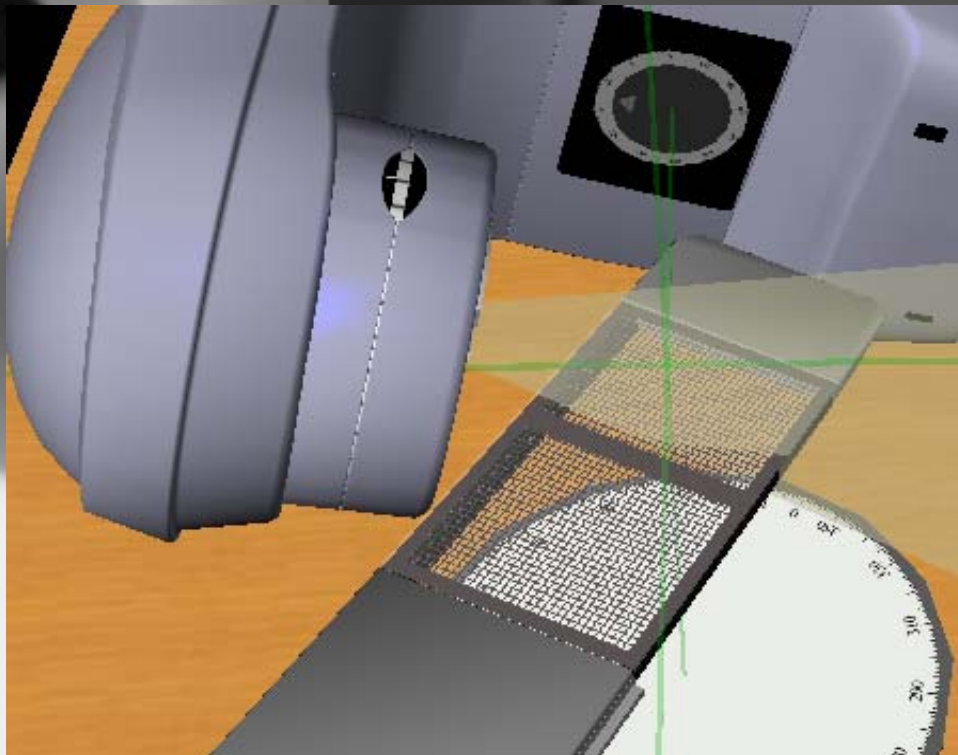
- **Features:**

1. **Web-based** simulator (using latest X3D technology standards)
2. Friendly GUI (Graphical User Interface)
3. **Easy setup** and is platform independent
4. Uses **freely available software components** (web browser, x3d player)
5. To experience **immersive 3D visualization** use red/blue glass pair or shutter glasses

3DRTT Simulator - Assessment

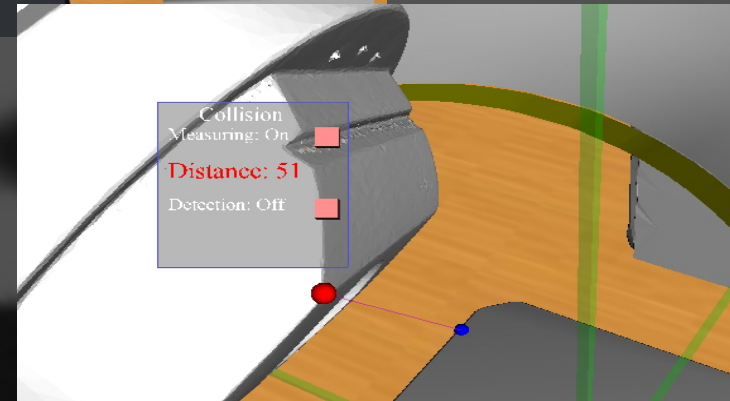
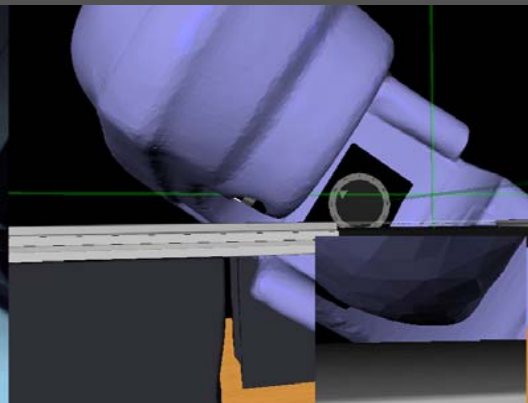


Coll Rtn	90.0
Gantry Rtn	285.2
Couch Vrt	12.0
Couch Lng	118.7
Couch Lat	0.0
Couch Rtn	30.3



More on accuracy ...

- Measurements (~ 1.5 cm)
 - in the real environment
 - in the virtual environment (simulator)



Conclusions

- The simulation tool allows for accurate 3D representation of the all linac components and allows the user to perform virtual 3D simulation of the delivery.
- The current version allows for visual detection of collision scenarios to within a few centimeters average accuracy
- With increased model resolution including add-on devices and patient-specific external contour volumetric data, the tool may serve as a verification check for CCRT deliveries.
- The tool can be used as a training tool for RTTs, dosimetrists, and physics residents

Acknowledgments

- Ivan Sopin, Dan Lipsa, Omar Zeidan
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Thank you

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3DRTT

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What is 3DRTT? **Development** **Terms of Use** **Contact Info**

3DRTT (Background/Problem)

With the advent of complex 3D treatment planning, there is an increasing use of oblique/nonaxial fields. In combinations with machine head-mounted add-ons and patient immobilization devices and on-board image components, treatment planners are finding it increasingly difficult to generate combinations of beam parameters that would prevent potential collisions between different linac components and with the patient. This is especially prevalent in stereotactic radiosurgery treatments or hypofractionated extracranial treatments with complex beam arrangements. Therefore, planners generally resort to "traditional" combinations of gantry-couch-collimator sets that are known to be "safe" from routine clinical experience. However, due to the lack of knowledge of the actual collision space, the planner will not be able to always generate the most "optimal" collision-free treatment plan. Current treatment planning systems lack the ability to accurately model the geometry of the various LINAC (Linear Accelerators) components to present a realistic "room-eye-view" in combination with actual patient geometries on the treatment table. For example, laterally displaced lung tumors may require couch top shifts that would give rise to potential gantry-collimator collisions with the couch that would not occur if the treatment isocenter was closer to the patient medial plane. Hence, the need for an exact representation of patient-specific setups combined with machine geometry is an essential requirement for the planner to produce an "optimal" plan that is free of collision scenarios between the different LINAC components.



Project Goal

The purpose of this project is to create a real-time 3D graphical simulator for an advanced radiation therapy/surgery medical systems that significantly improves the radiation planning process.

Important Links

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[registration](#)

News:

Monday, July 31, 2006:
[49th AAPM Annual Meeting](#), Orange County Convention Center, Orlando, FL. The project is represented with a title "A 3D Collision Avoidance Tool for External Beam Radiation Therapy Treatment Planning." F. Hamza-Lup, L. Davis, S. Meeks, D. Zeidan. Visit the [abstract information](#) page for details.

Friday, April 28, 2006:
[TECH FEST 2006](#), Savannah State University, Savannah, GA. The poster is entitled "Advanced Training Tools for Medical Procedures." Ivan Sopin, Felix Hamza-Lup, Ph.D.

Internet