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X3D in Radiation Therapy Procedure Planning

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MD ANDERSON CANCER CENTER ORLANDO

Outline

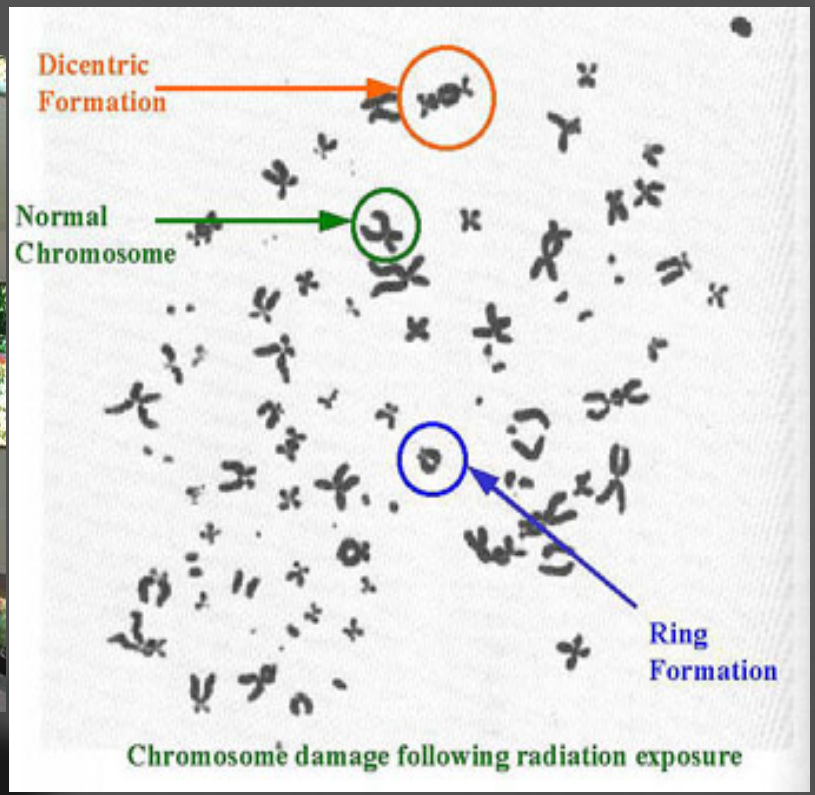
1. What is radiation therapy ?
2. Treatment planning issues
3. Web-3D & the treatment plan
4. The 3DRTT web-based simulator
5. Assessment plan
6. Near future

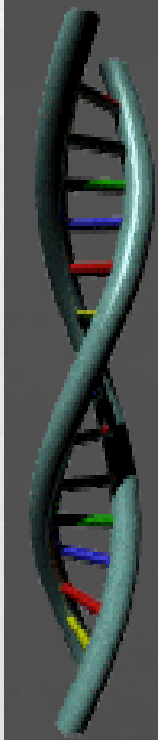
What is Radiation Therapy ?

- 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

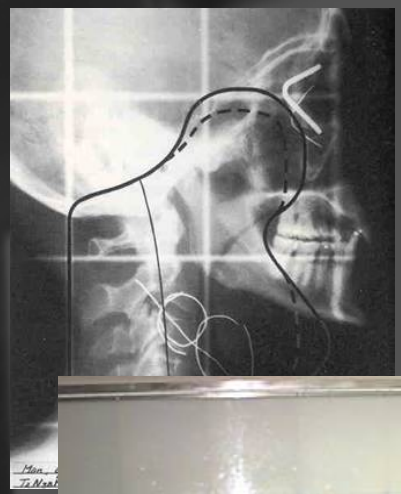
Radiation destroys the cancer cells' ability to reproduce and the body naturally gets rid of these cells.

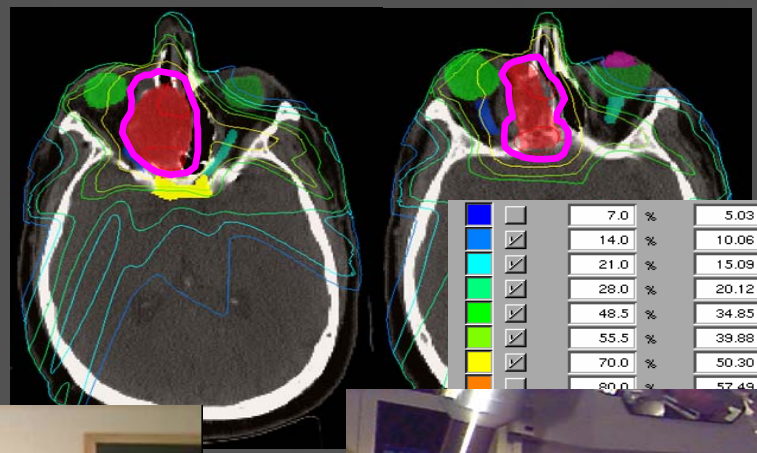




Planning

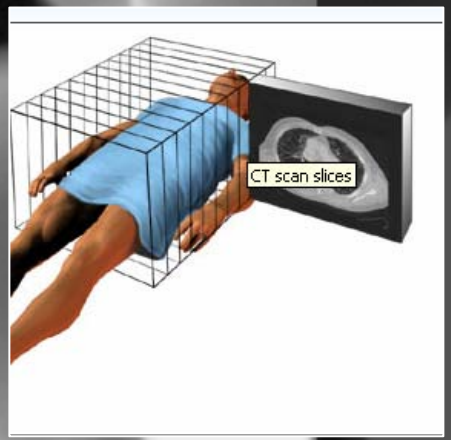
- Calibration of radiation sources
- Planning of patient procedures
- Calculation of patient dose (dosimetrists)



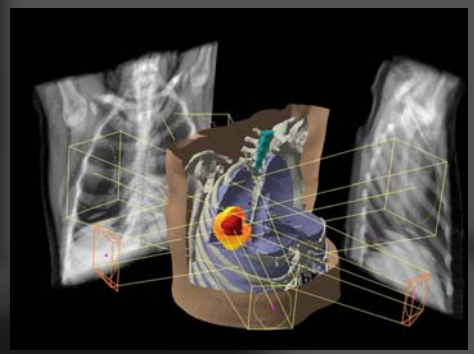


General Flow of External Radiation Therapy Treatments

CT scanner

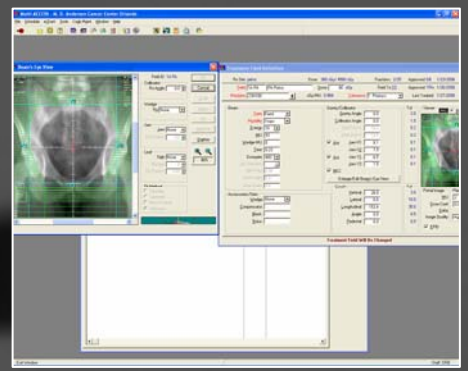


CT Slices +
Radiation Therapy (RT) info



Treatment Planning System (TPS):
dose calculation and visualization

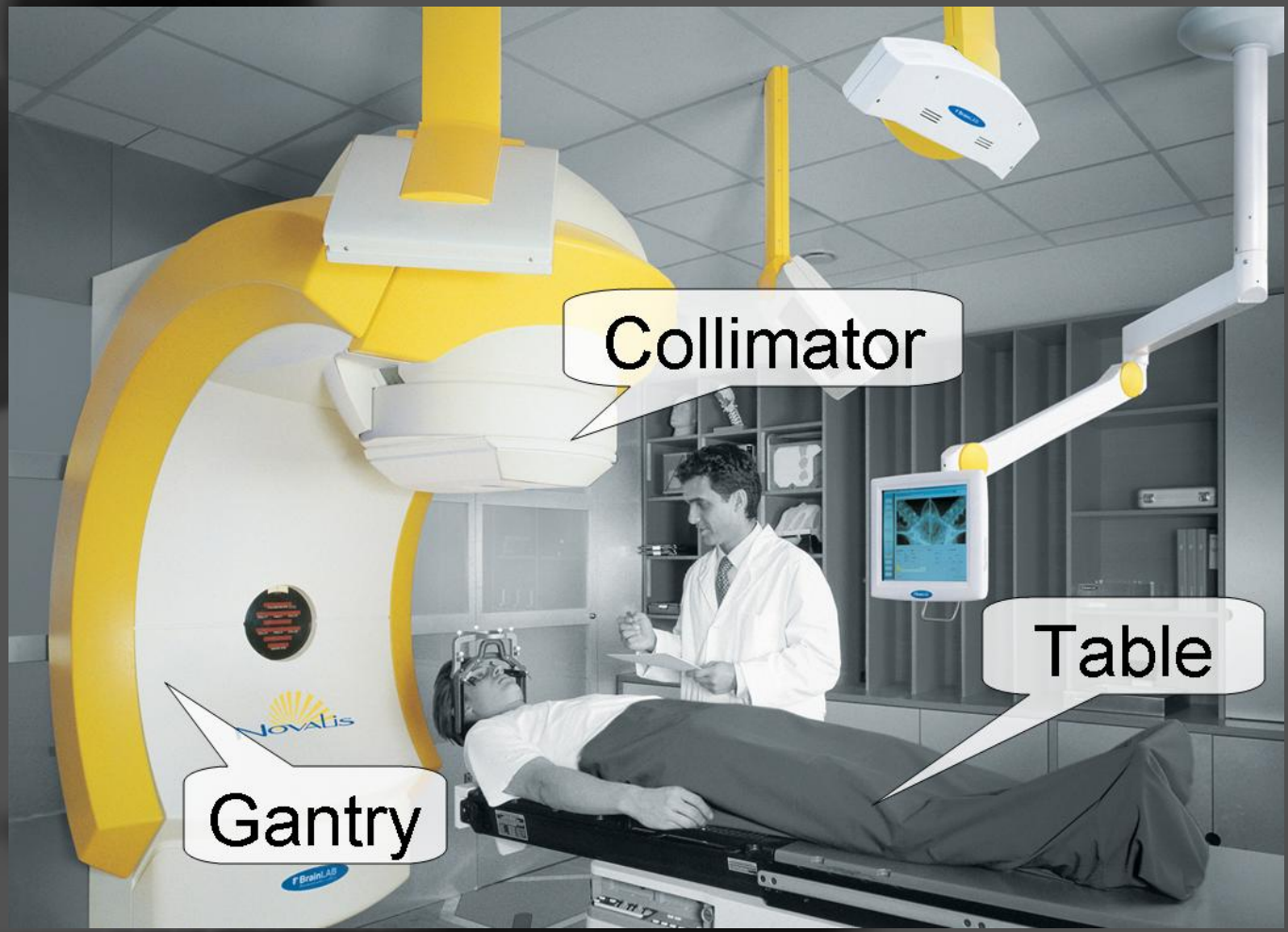
Linac:
external beam
treatment



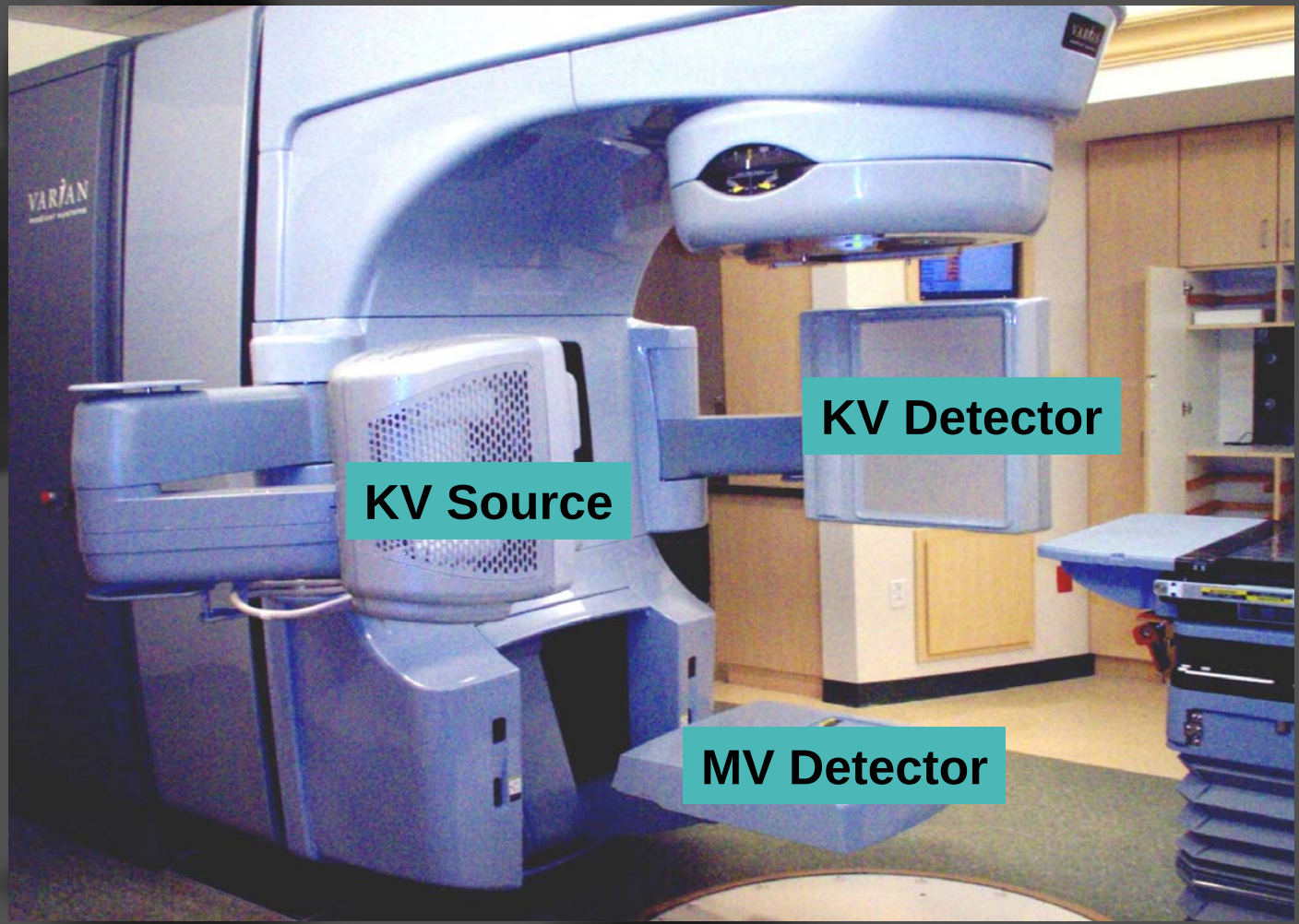
Record and Verify System (RV):
makes sure all parameters are
properly transferred to/from linac

LINACS *(Novalis ™)*

- LINear ACcelerator main components

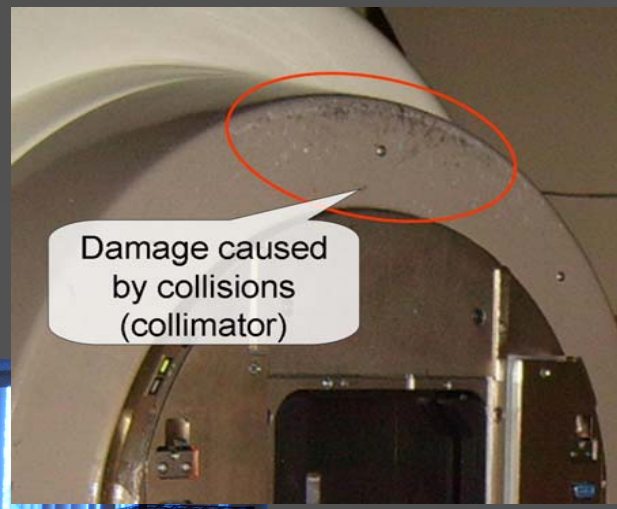


LINACS *(Varian Trilogy™)*



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 off and avoid collision with

stereotactic head frames

t 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?

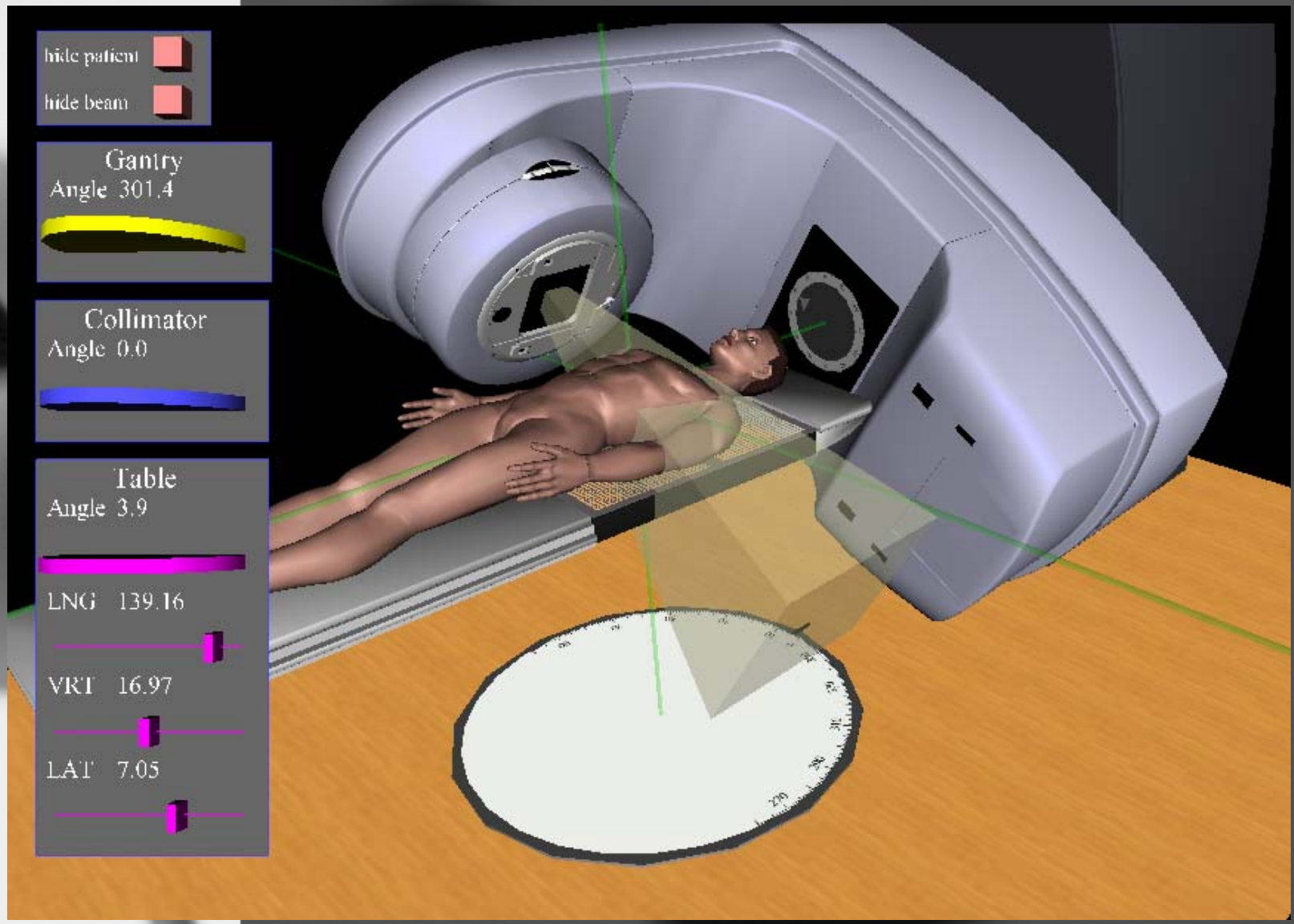
2. Virtually move different linac components gantry, table, collimator, ..etc as if you were in the room using a hand pendant?

3. Visualize the beam path, the lasers, and the actual patient external geometries/surfaces on the couch together with add-on/immobilization devices?

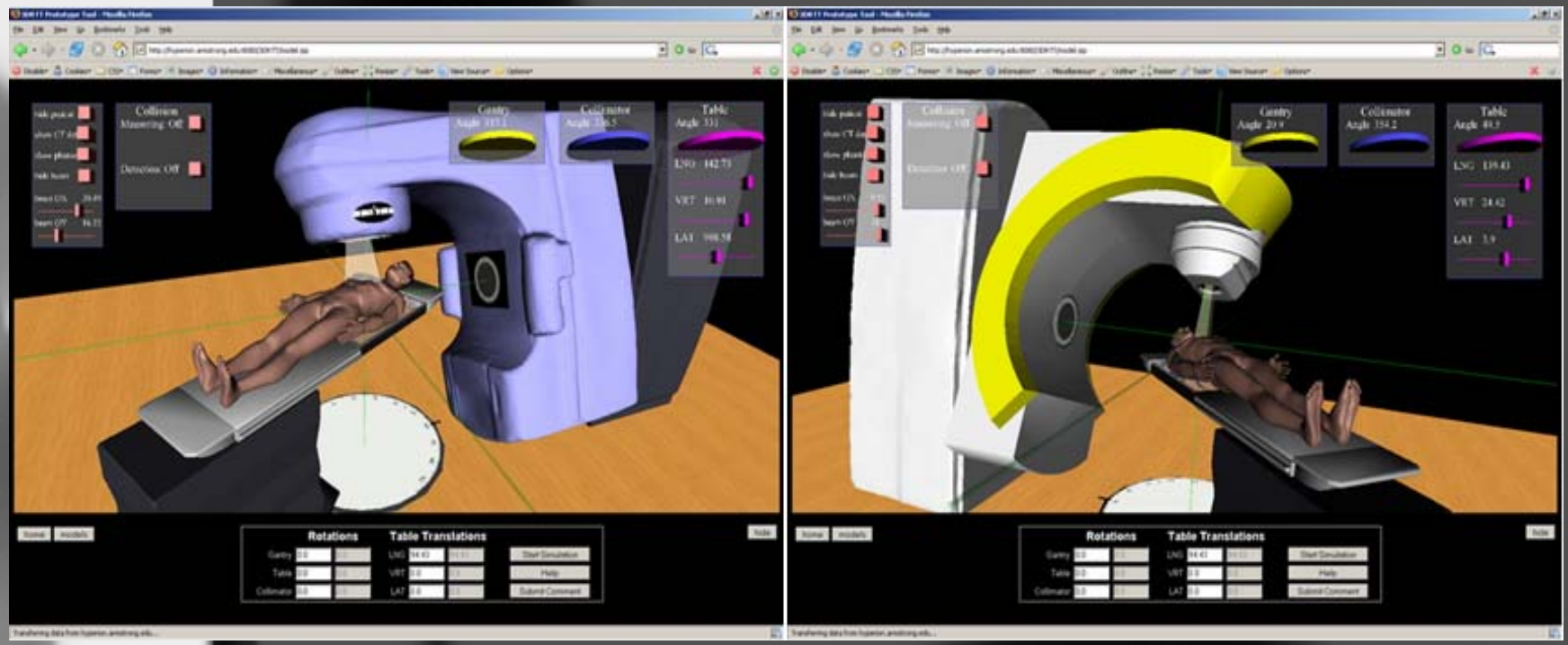
If we can, then we have a tool that provides simulation of patient-specific external beam plans.

3DRTT Simulator

- 3D Radiation Therapy Treatment: Varian Trilogy 23ix

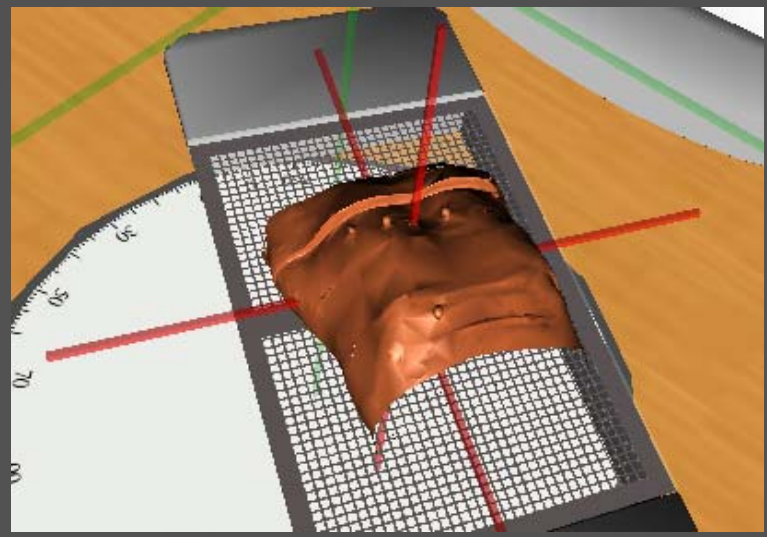


Varian Trilogy™ & Novalis™ (BrainLab™)



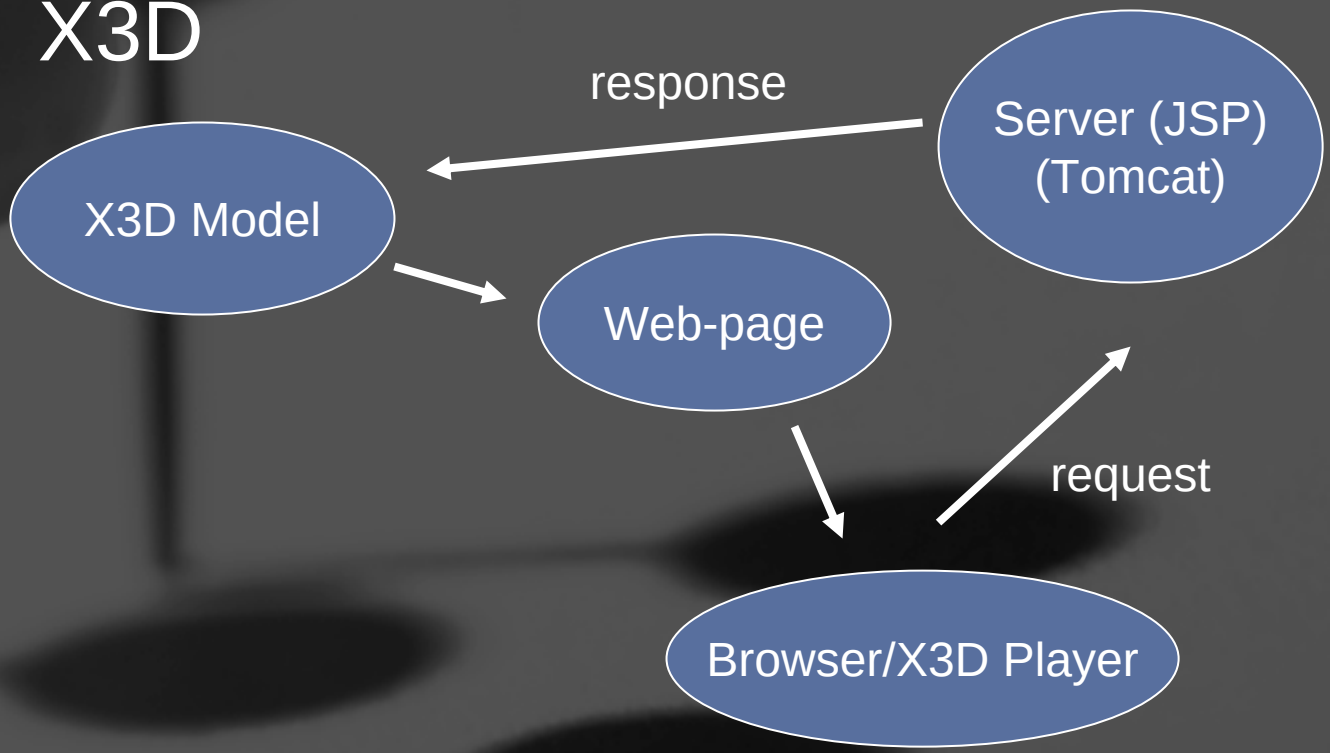
Patient specific data

- Patient specific CT data in the simulator



Implementation

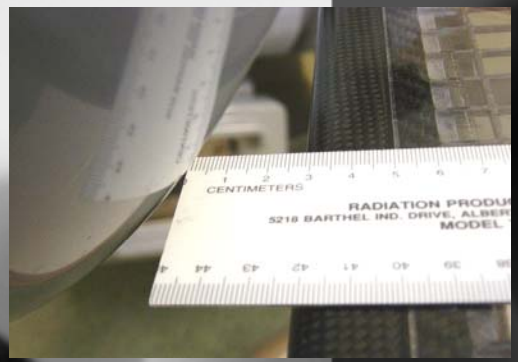
- EcmaScript
- Java (JSP/servlet)
- X3D



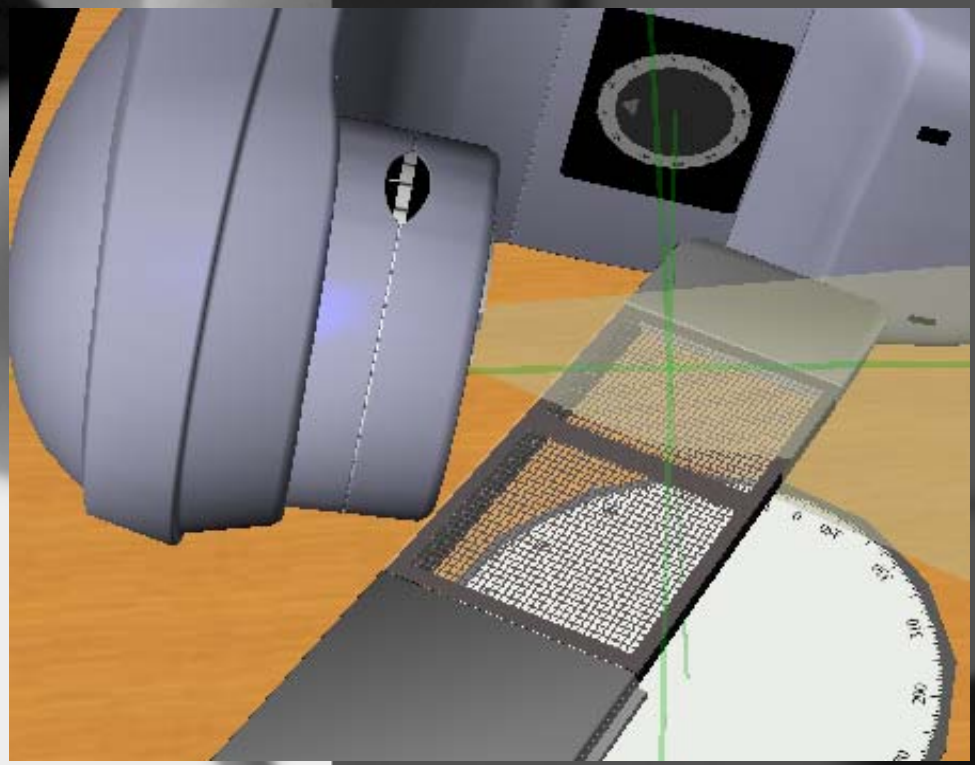
3DRTT Simulator

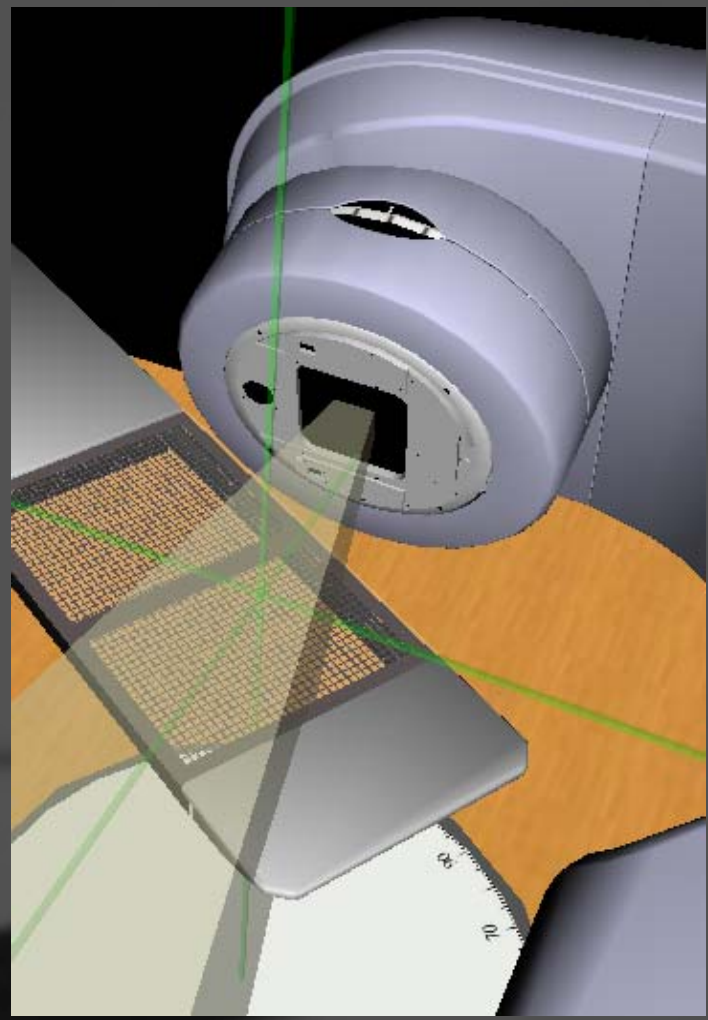
- **Features**:
  1. **Web-based** simulator (using latest X3D technology standards)
  2. Friendly GUI (Graphical User Interface)
  3. **Easy setup** and is platform independent
  4. Uses **freely available software components** (web browser, x3d player)
  5. To experience **immersive 3D visualization**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

3DRTT Simulator - Assessment



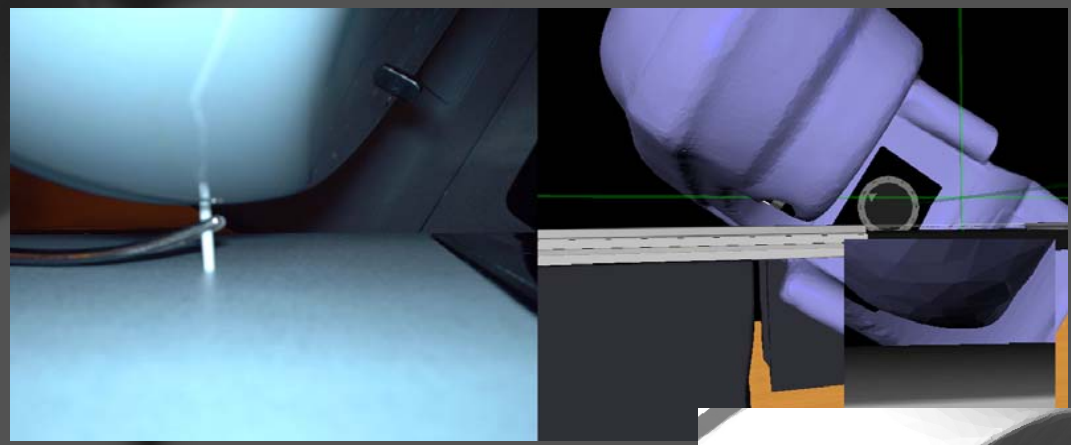
Coll Rtn	90.0
Gantry Rtn	285.2
Couch Vrt	12.0
Couch Lng	118.7
Couch Lat	0.0
Couch Rtn	30.3

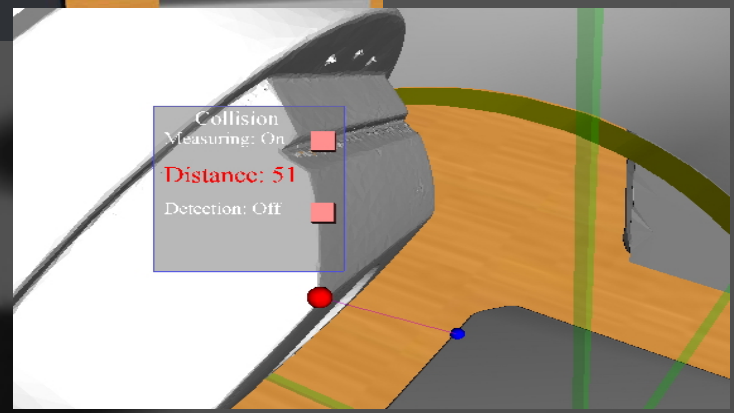




More on accuracy ...

- 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
- M.D. Anderson Cancer Center Orlando, Florida.

Thank you

hyperion.armstrong.edu:8080/3DRTT