

# New Technology in Radiation Oncology

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# Technology's everywhere

- From the imaging chain...
- To the planning system...
- To the linac...
- To QA.....it's everywhere

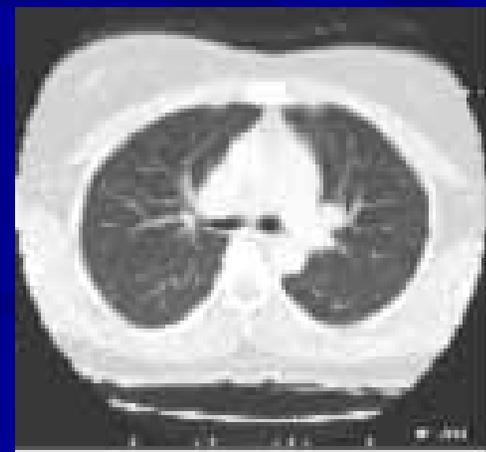
# Imaging 101

- First there was X-ray  
(back in the day....)



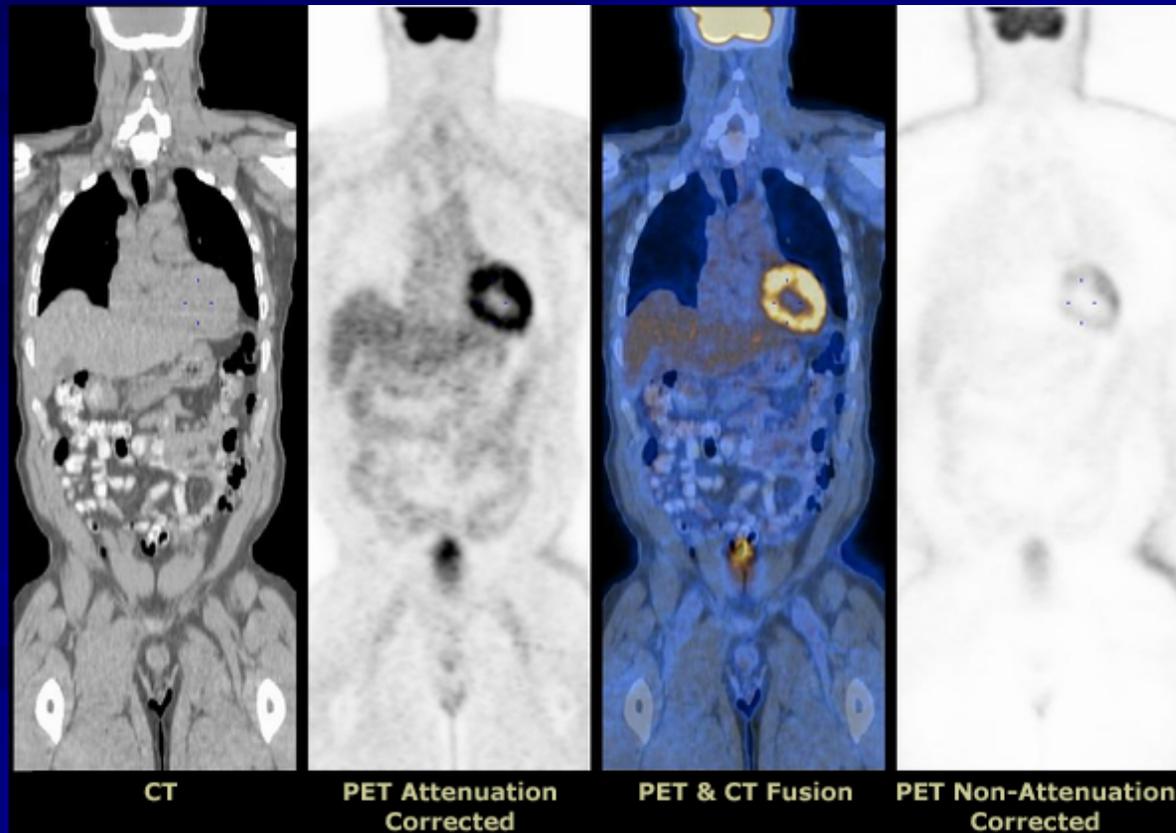
# Imaging 102

- Then there was CT



# Imaging 103

- Now there's PET-CT



# Linac 101

- The linac has been the backbone of therapy since the mid 80's.
- First they were analog
- Then digital...

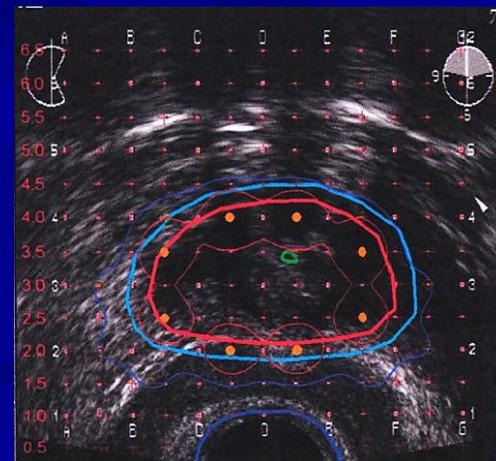
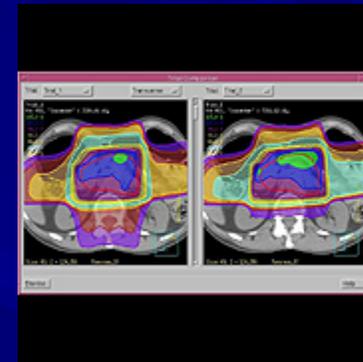
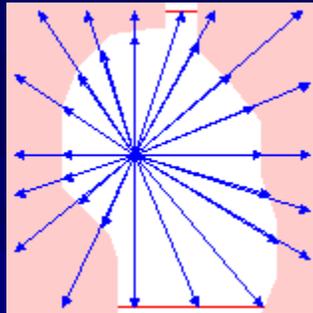


# Linac 102

- Now they're robotic



# Planning systems



# Targeting

- Intensity Modulated Radiation Therapy (IMRT) has been with us for about 7 years. Conformality is one thing....hitting the target is another...
- Image Guided Radiation Therapy (IGRT) is the new paradigm. IGRT has been here for 7 or more years as well, it's just that we can do it right now.

# Imaging on the linac

- The X-ray tubes and flat panel imagers are now attached to the linac....or...



# Imaging near the linac

- Mounted about the linac in a known geometry, allowing for unparalleled precision in targeting the tumor.



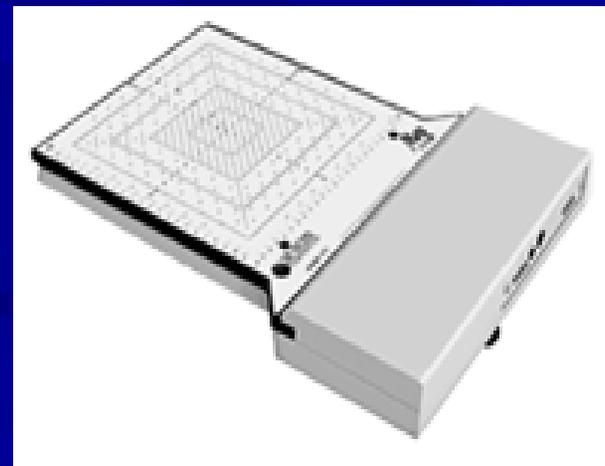


# Technology in QA

- Some things don't even need a battery



- Others require power supplies, computers and software



# Imaging

- Plane films (actually plane images) are used either on (or in conjunction with) the linac on a daily basis. This calls for substantial investment in image acquisition and storage.
- X-ray tube and flat panel imagers provide stereo images for target localization in 3D space. You need to use digital techniques (instead of film) due to patient motion.

# Gantry Mounted

- The imaging system has to have positional encoders that update continuously, due to gravity, as the gantry rotates.  $\pm 1$  mm reproducibility is the minimum requirement.



# Gantry Mounted

- The imaging system can also generate cone beam CT data, for comparison with planning CT dataset.
- Can be useful in soft tissue situations, as tumor volumes or nodal volumes change during treatment.



# Gantry Mounted

- The mechanical isocenter is the limiting factor in determining the CT quality.
- A 'tight' isocenter results in a better image quality.



# Room mounted

- Geometry is well known and stable.
- Oblique images – a visualization issue.
- Uses IR reflective spheres to get you close ( $\pm 2$  mm).
- Limited to plane images.



# Both technologies

- Use robotic couches to move patient's target to isocenter.
- Room mounted uses IR spheres to monitor patient motion during treatment.
- Linac can be sync'd to patient breathing cycle, if desired.



# Imaging for planning

- Scanners are now faster and better than even 2-3 years ago.
- 64 slice scanners are the state of the art, but not for long.
- Radiation Oncology departments typically have their own 4 slice scanner.



# Imaging for planning

- Even the little things like the table tops are standard across all machines...and they're indexed, so patient setup reproducibility is now better than ever.



# Planning systems

- Algorithms that were previously CPU bound can now be implemented, as processors are now fast enough to allow timely calculations. Convolution style algorithms are now standard fare for all commercial systems. Photon pencil beam algorithms are still used for some “small” fields (radiosurgery)
- “Shortcuts” that had been used previously can now be eliminated (e.g. - larger grid size, with interpolation)
- Monte Carlo algorithms are commercially available for electrons, photons will hit the shelves this year.

# Linacs

- Fully computer controlled, multiple embedded processors and a variety of OS's and platforms.
- Up to 7 dedicated CPUs are required to run some vendors machines.



# Linacs

- Let's keep this in perspective though... we went to the moon on 4k of RAM and 32k of ROM.
- Remember, more isn't always better.



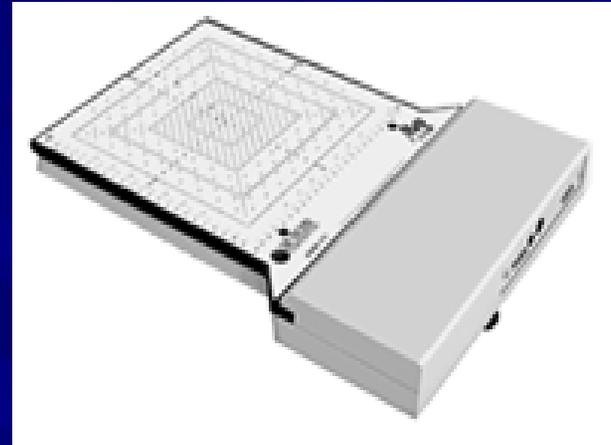
# Linacs

- Failure of any one of the computers can render the accelerator non-functional, resulting in suboptimal treatment for the patient.
- The days of treating without a R&V are pretty much over.



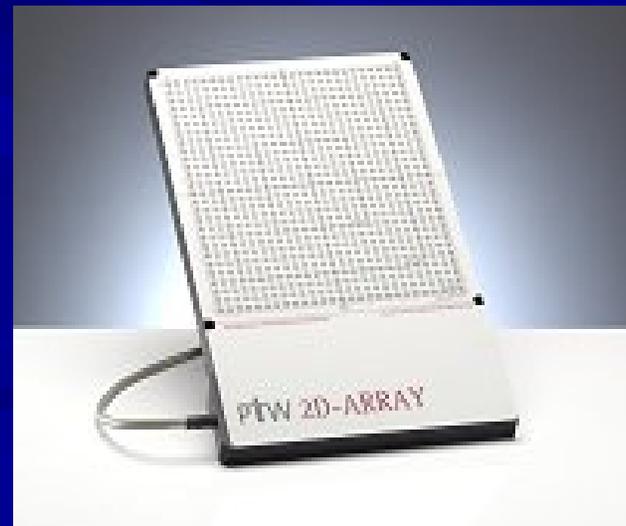
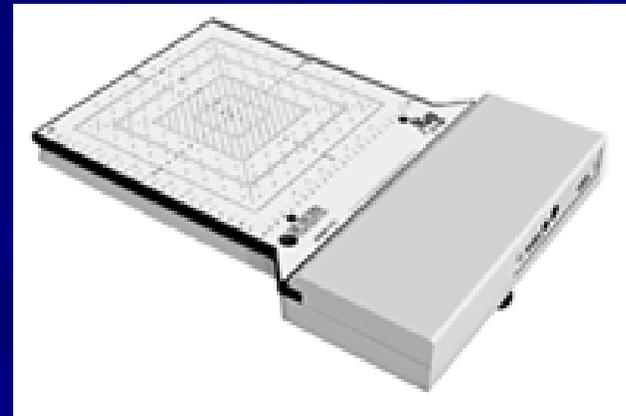
# Technology in QA

- IMRT QA, both fluence maps and point doses can now be measured without the use of film or ion chamber.
- Darkrooms are becoming a thing of the past, just like my old friend...(sigh)



# Multiple detector arrays

- Several vendors offer either diode or ion chamber arrays.
- Useful for both IMRT QA, as well as “standard” QA, light-rad shots, FS, flatness and symmetry



# Materials

- Composite materials have increased in strength, with minimal attenuation to the x-rays used in therapy.
- New uses for thermoplastics continue to be found in the clinic. We now can do frameless SRS with sub-millimeter accuracy.
- Some vendors take it to the extreme, layers of composites that are stronger, yet they result in increased attenuation and increased skin dose...both not good.

# Summary

- New computer technology has allowed us to do things in the clinic we only dreamed about 10 years ago.
- New computer technology has maddened us as well, because application and operating system stability has not kept up with the demands of the field.
- Material technology has allowed us to increase patient positioning accuracy, but at a price.