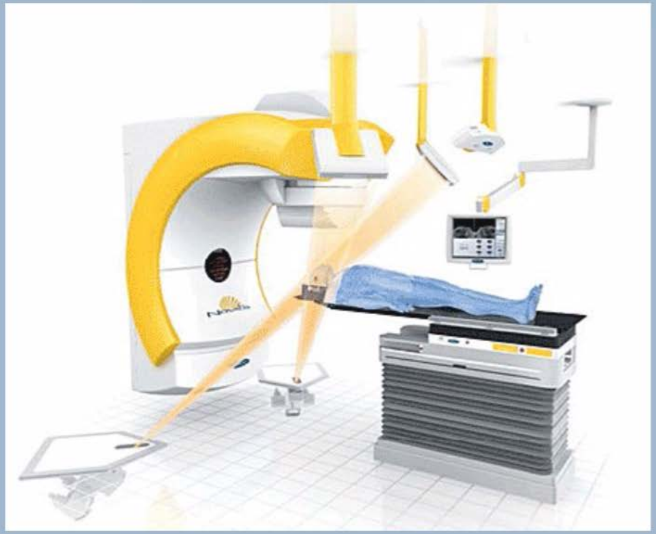
Compare/contrast the advantages of the two image guidance systems shown.



Follow Up

- *Describe* the key aspects of the *QA* program you would employ to monitor any IGRT system.
- *Are* portal images even needed if one has these patient positioning systems?
- What is the difference in patient dose for a single kV versus *MV* image?

What is the difference in patient dose for a single kV versus MV image?

Room-mounted	CyberKnife and Novalis	kV	0.25 – 0.5 mGy
Gantry-mounted	OBI and Synergy	kV	1 – 3 mGy
EPID	Multiple vendors	MV	10 – 50 mGy
Film	All vendors	MV	50 – 100 mGy

TG-75

TG142;

- What are the tolerances for Daily QA of imaging devices?
- What are the QA procedures recommended by 142 for;
  1. Monthly
  2. Annual QA?

Imaging QA Procedure (Daily)	Tolerance	
Planar kV and MV (EPID) Imaging		
Collision interlocks		
Positioning/Repositioning		
Imaging and treatment coordinate coincidence (single Gantry Angle)		
Cone-beam CT (kV and MV)		
Collision Interlocks		
Imaging and treatment coordinate coincidence		
Positioning/Repositioning		

Imaging QA Procedure (Monthly)	Tolerance	
	Non-SRS/SBRT	SRS/SBRT
Planar MV imaging (EPID)		
Planar kV Imaging		
Cone Beam CT (kV and MV)		

Imaging QA Procedure (Annual)	Tolerance	
	Non-SRS/SBRT	SRS/SBRT
Planar MV imaging (EPID)		
Planar kV Imaging		
Cone Beam CT (kV and MV)		

TG142;

- What are the tolerances for Daily QA of imaging devices?
- What are the QA procedures recommended by 142 for;
  1. Monthly
  2. Annual QA?

Imaging QA Procedure (Daily)	Tolerance	
	Non-SRS/SBRT	SRS/SBRT
Planar kV and MV (EPID) Imaging		
Collision interlocks	Functional	Functional
Positioning/Repositioning	2 mm	1 mm
Imaging and treatment coordinate coincidence (single Gantry Angle)	2 mm	1 mm
Cone-beam CT (kV and MV)		
Collision Interlocks	Functional	Functional
Imaging and treatment coordinate coincidence	2 mm	1 mm
Positioning/Repositioning	1 mm	1 mm

Imaging QA Procedure (Monthly)	Tolerance	
	Non-SRS/SBRT	SRS/SBRT
Planar MV imaging (EPID)		
Imaging and treatment coordinate coincidence (4 card.)	2 mm	1 mm
Scaling	2 mm	
Spatial Resolution	Baseline	
Contrast	Baseline	
Uniformity and Noise	Baseline	
Planar kV Imaging		
Imaging and treatment coordinate coincidence (4 card.)	2 mm	1 mm
Scaling	2 mm	1 mm
Spatial Resolution	Baseline	
Contrast	Baseline	
Uniformity and Noise	Baseline	
Cone Beam CT (kV and MV)		
Geometric distortion	2 mm	1 mm
Spatial resolution	Baseline	
Contrast	Baseline	
HU constancy	Baseline	
Uniformity and Noise	Baseline	

Imaging QA Procedure (Annual)	Tolerance	
	Non-SRS/SBRT	SRS/SBRT
Planar MV imaging (EPID)		
Full range of travel SDD	5 mm	
Imaging Dose	Baseline	
Planar kV Imaging		
Beam quality/energy	Baseline	
Imaging dose	Baseline	
Cone Beam CT (kV and MV)		
Imaging dose	Baseline	

Describe key aspects of the QA program you would employ to monitor an IGRT system.

- Daily QA
  - safety feature checks (collision, etc), positioning and repositioning accuracy tests, verification of imaging and treatment coordinate coincidence.
- Monthly QA
  - more thorough tests of the coincidence of imaging and treatment coordinates, image quality including noise, resolution, and contrast, Hounsfield unit (HU) consistency, and the scaling factor.
- Annual QA
  - a full range of mechanical traveling accuracy, imaging dose, kV beam energies, tube current, etc.

TG-142

What kind of images are these? What is image registration and why is it needed in radiation therapy?

Follow Up

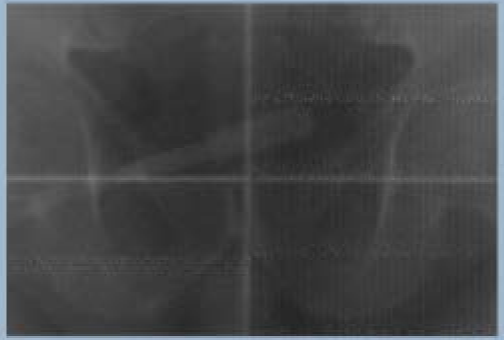
- What kind of images do you use for treatment planning? Why? What images for what site?
- What is image registration? Is it the same as image fusion? How does your TPS do image registration?

Is image registration the same as image fusion?

- Image registration is the <u>mathematical transformation</u> of different sets of image into one coordinate system (using translation and rotation)
- Registration can be rigid (commonly used for brain, for example) or non-rigid. Non-rigid registration is sometimes called “deformable registration”. This could be used, for example, for lung image sets.

- Image fusion is the process of combining two different images into a single image. So it is for <u>display purposes</u>. Usually done by overlaying one image over another.

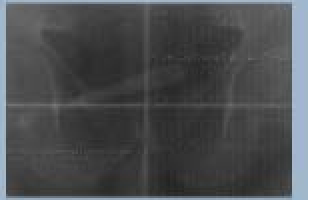
Both of these images were made by X-rays, why are they so different?



Follow Up

- *Is X-ray scatter more of a problem for kV or MV EPID performance?*
- *In terms of spatial resolution, is it better to increase magnification by placing the imager farther from the source?*

Both of these images were made by X-rays, why are they so different?



- The image on the left was generated with kV X-rays.
  - Low kV energy X-rays predominantly interact via the photoelectric effect which is dependent upon the cube of the atomic number (Z^3) of the tissue. High Z bone attenuates these low energy X-rays much more e, ciently than fat or muscle.
- The image on the right was generated with MV X-rays.
  - The Compton effect dominates interactions in the MV X-ray energy range. Compton interactions are independent of Zttherefore contrast between bone and soft tissue is much lower.

Is X-ray scatter more of a problem for kV or MV EPID performance?

- The effect of X-ray scatter is much more of a problem for kV EPID imaging.
  - As the energy of the X-ray beam increasesttthe scatter fraction (fraction of 5uence reaching the imager that is due to scatter) decreases.
  - HowevertJaffray et al. have shown that the signal to noise ration would improve by less than 10% if all x-ray scatter were eliminated within a moderately thick patient.