Electronic Portal Imaging Devices

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DISCLAIMER:

I am not affiliated with any vendor and did not receive any financial support from any vendor.

I am not recommending any particular product.

Role of Portal Imaging

- Patient positioning
- Block/MLC verification
- Field matching
- Gap verification

Port Films vs. EPID

- Image quality, window/level, resolution, and noise
- Image scaling and distortion
- Efficiency and convenience
- Storage and accessibility
- Image size, SSD range, off-axis location
- Device sensitivity and the patient dose
- Computer monitors and image quality
- Image labeling, annotating, and editing

Image Guidance: Elekta Volume View

Misalignment found

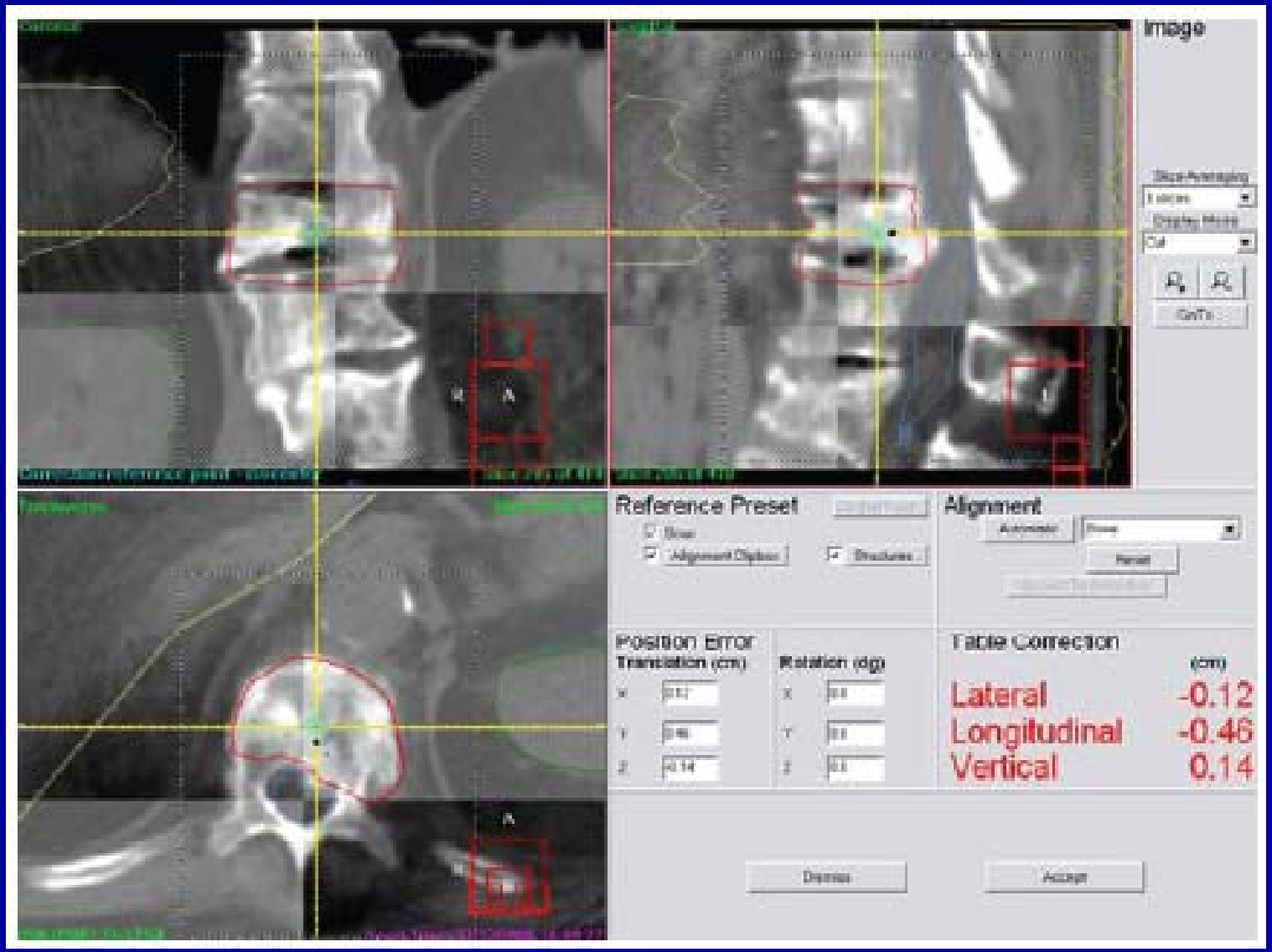
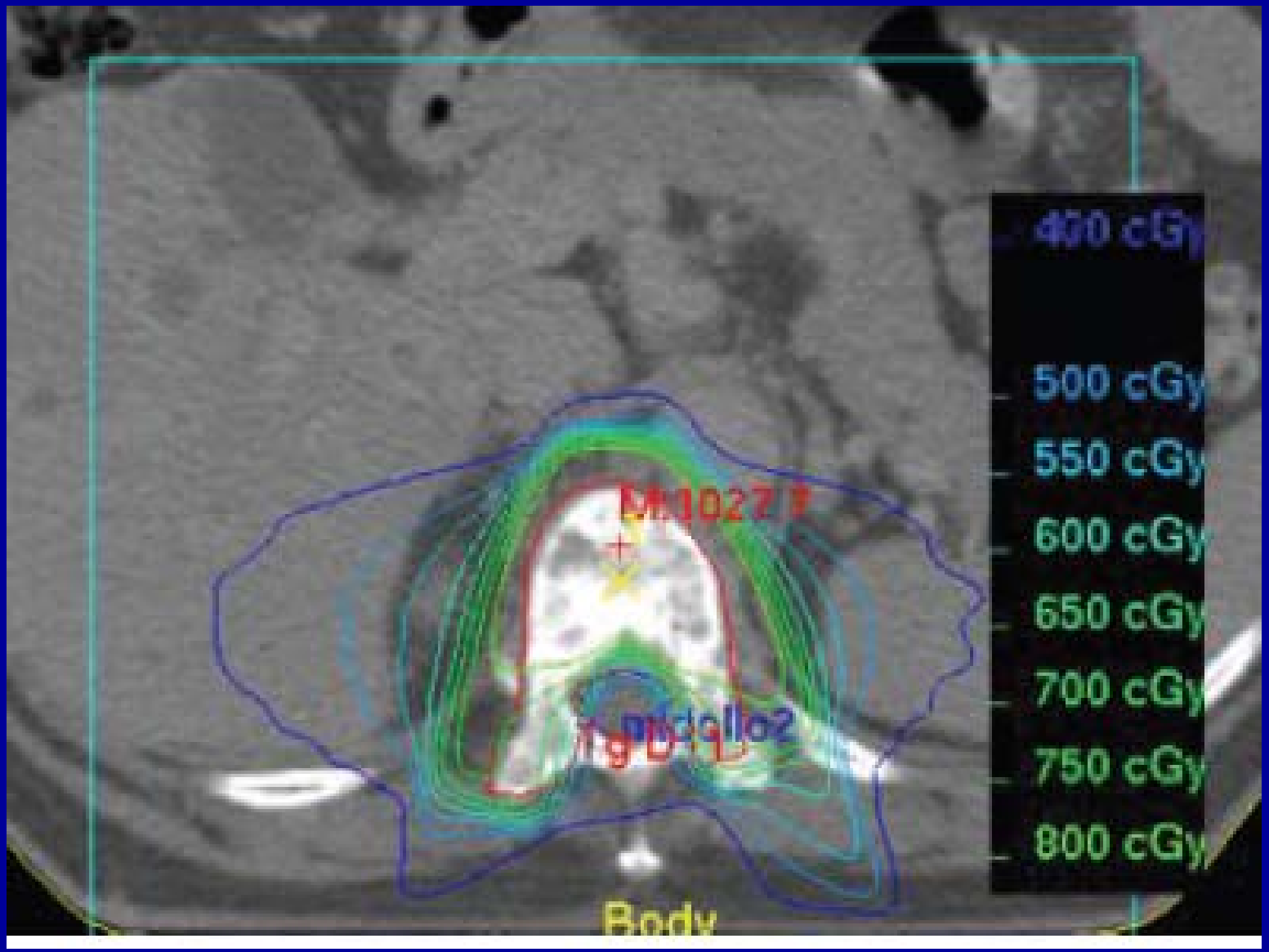


Image Guidance: Elekta Volume View

Acceptable Alignment achieved

Image Guidance: Elekta Volume View

Dose Distribution Very Critical to Positioning



Delivery Verification

Results

Ion chamber measurements with respect to the treatment planning system calculated dose, show a mean deviation of 1.2% (max. 3.2 %). Analyzing the γ values distributions for plan to film comparison, the percentage of points satisfying $\gamma < 1$ for IMAT plans ranges between 87% and 98% (mean 93%).

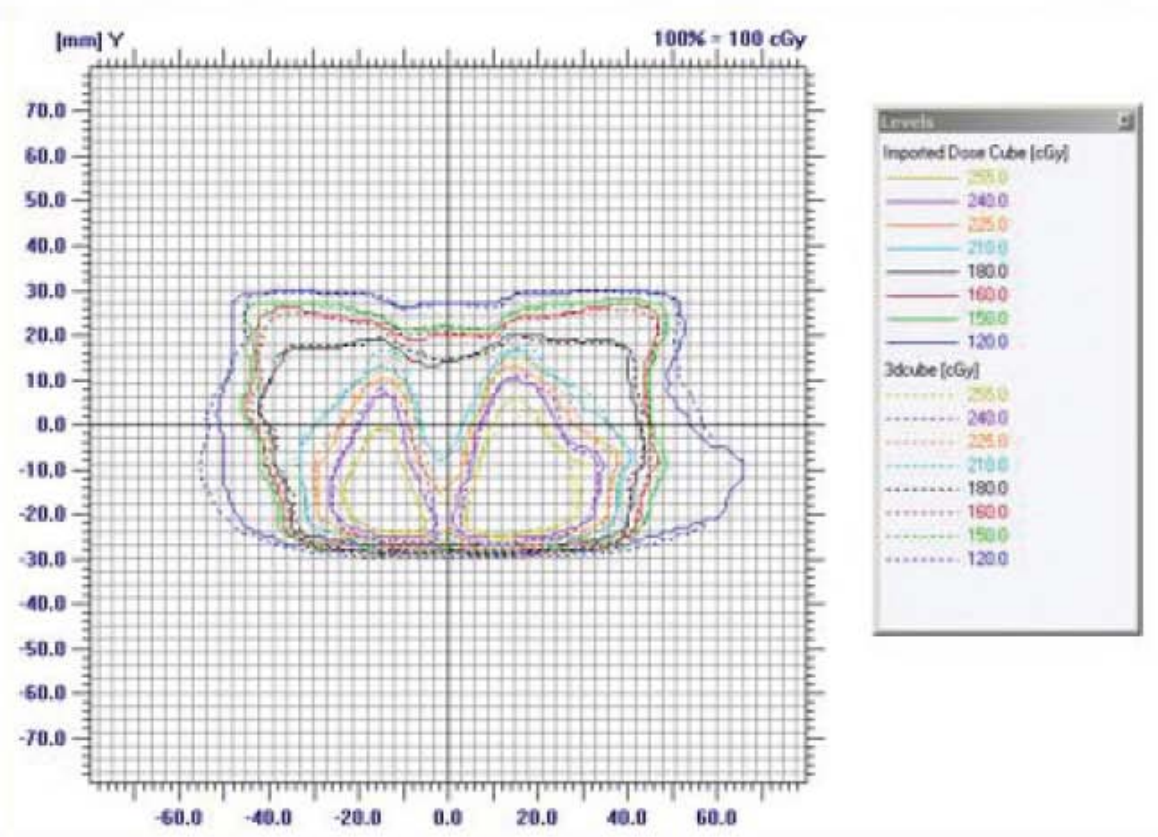


Figure 3:
IMAT-AMOA pre-treatment dosimetric verifications, plan to film comparison in a coronal plane including the cord.

(left) comparison of calculated (plan) and measured (film) isodoses
(below) γ values distribution for the same case.

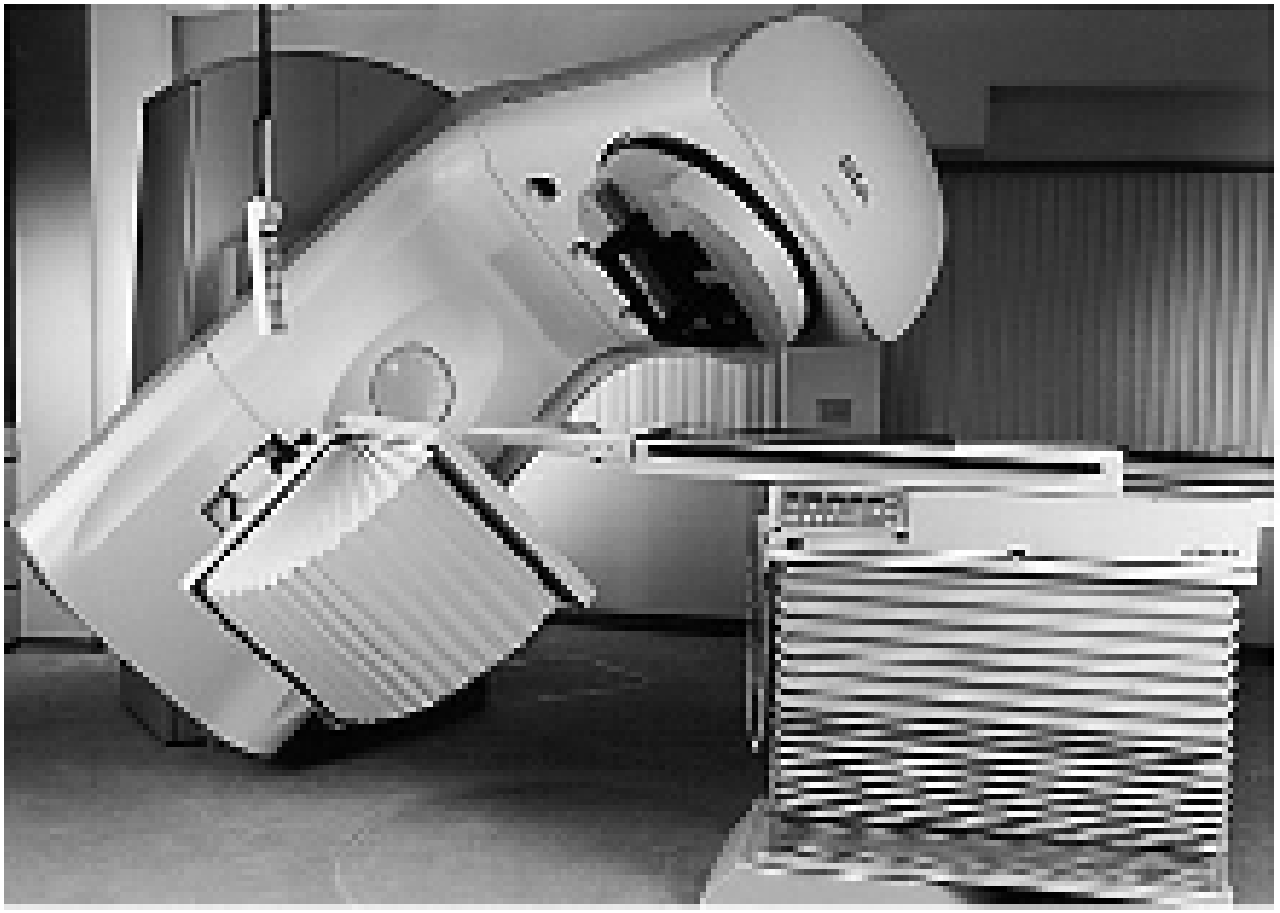
Automation tasks of portal imaging

- Block identification and delineation
- Detection of fiducial markers and patient position adjustment
- Image-based MLC adjustment
- MLC calibration
- IGRT – next talk

Type of Portal Imaging

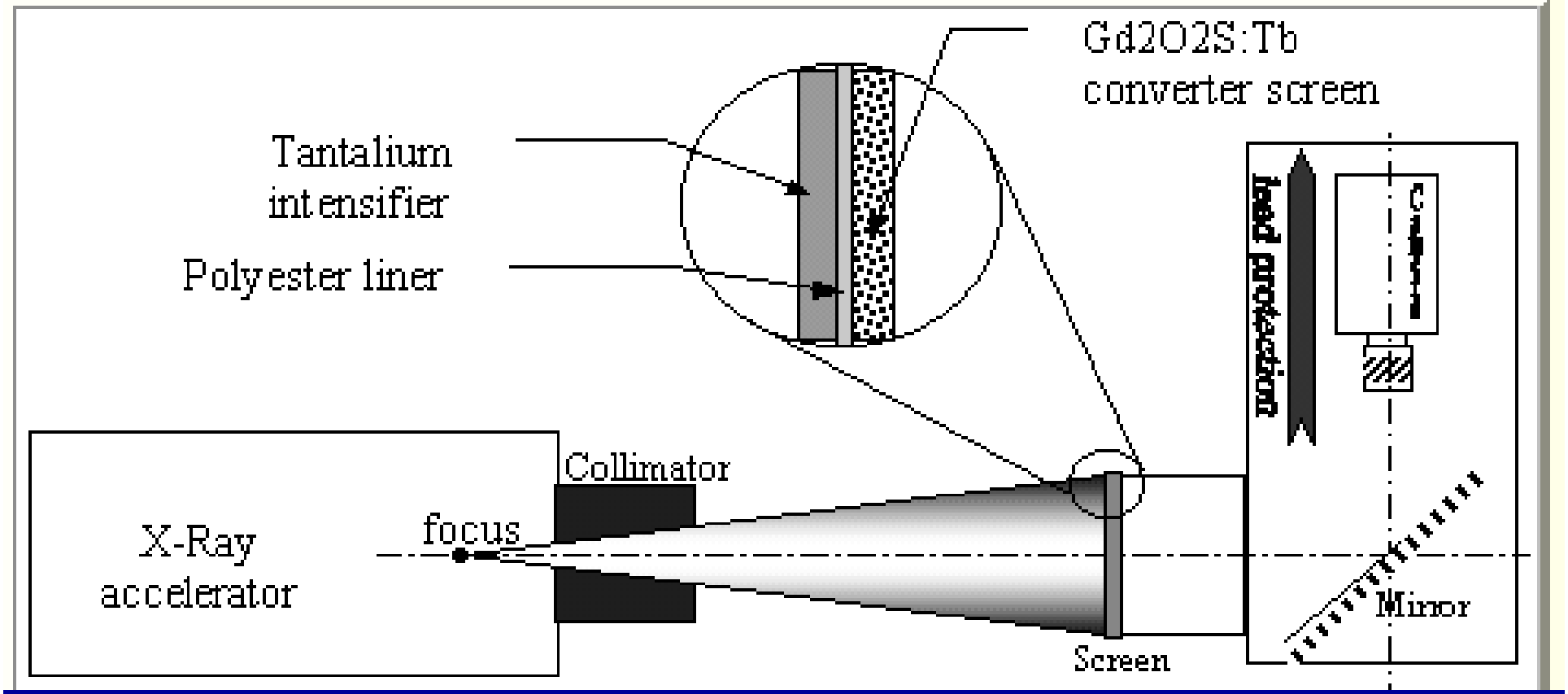
- Fluorescent screen, mirror, and CCD camera-based imaging.
- Liquid ion chamber imaging
- Amorpho-silicon portal imagers
- Fluoroscopic portal imaging
- Kodak CR reader
- Other types of portal imaging devices

Fluorescent screen, mirror, and CCD camera – industrial prototype

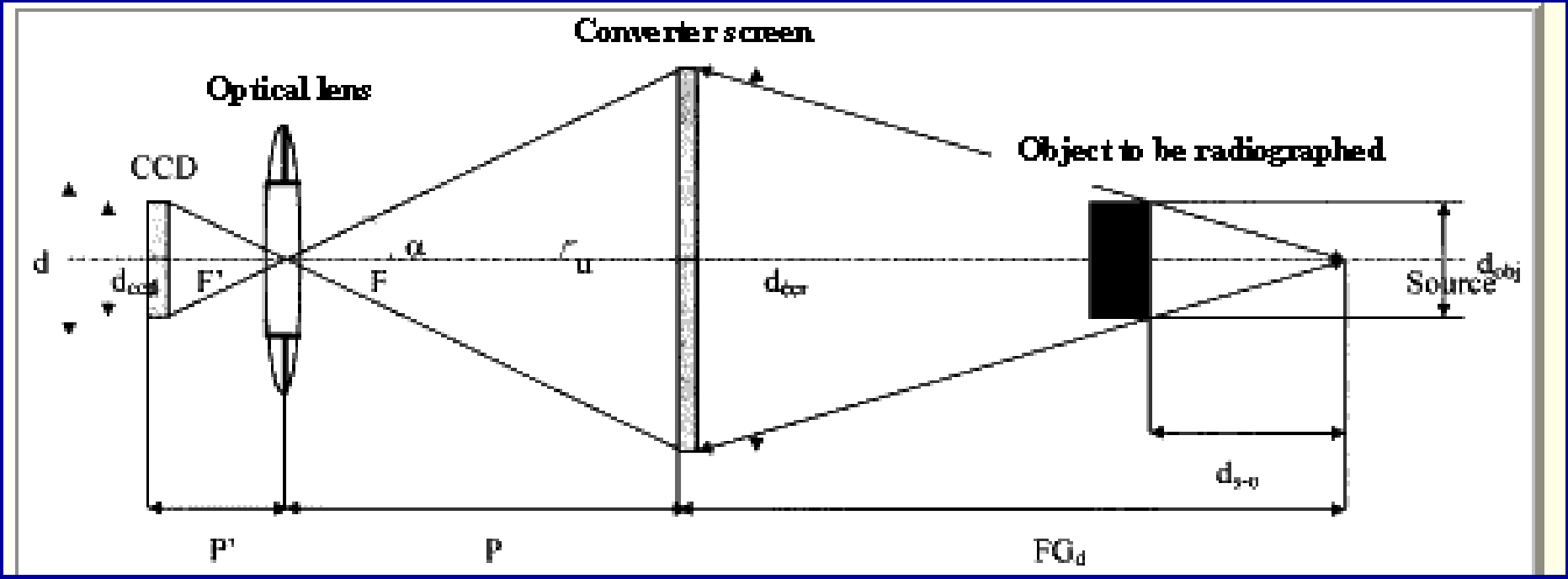


Siemens BeamView

Principle of CCD EPID

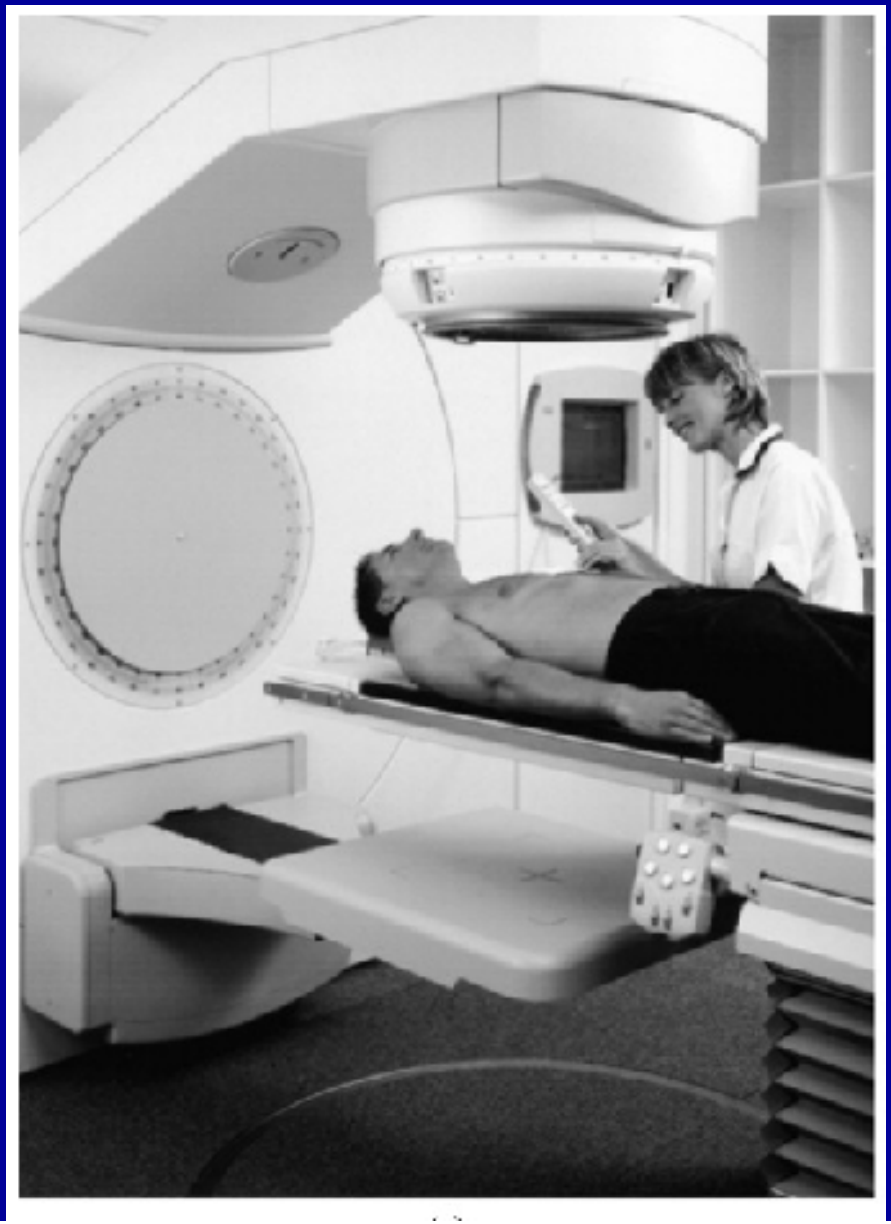


Magnification and Resolution of CCD EPID

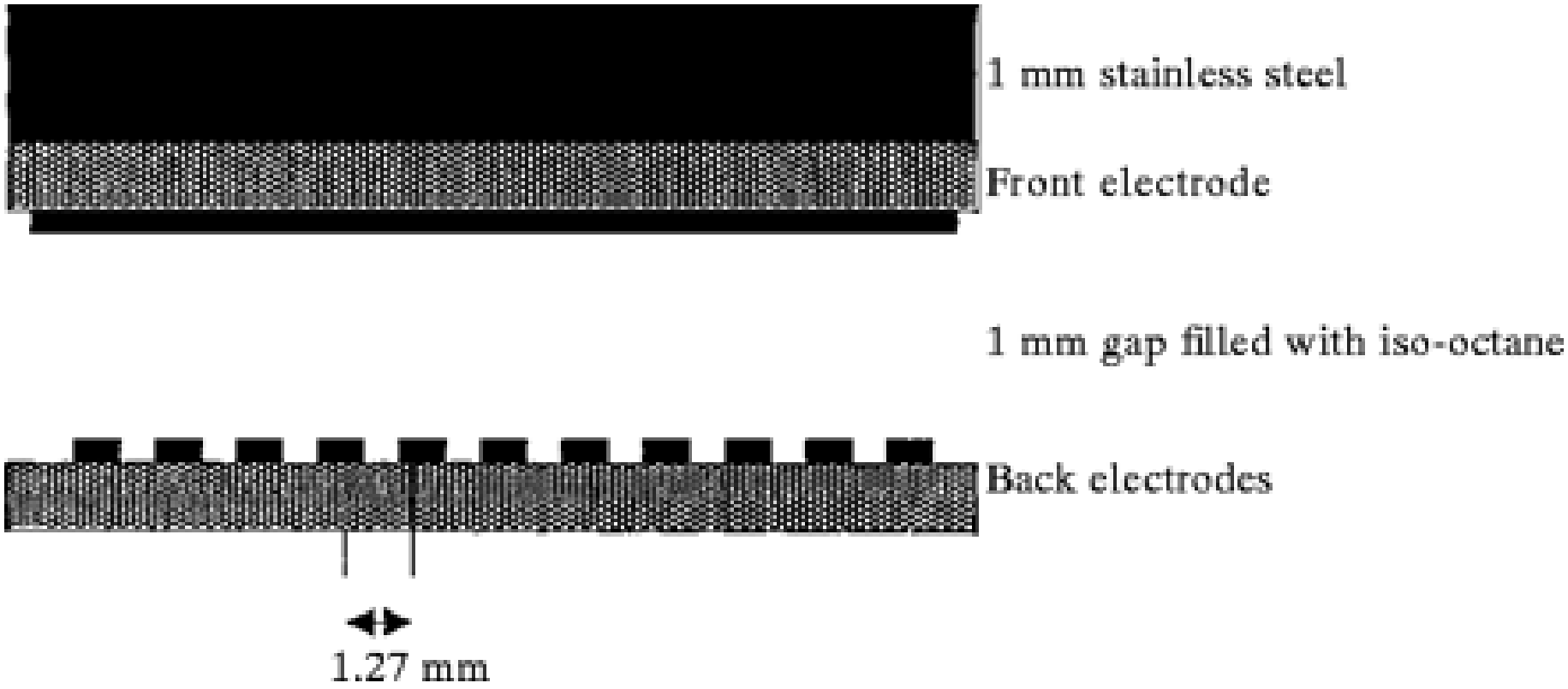


Liquid Ion Chamber Imaging

Elekta iView



Liquid Ion Chamber Array
256*256 pixels

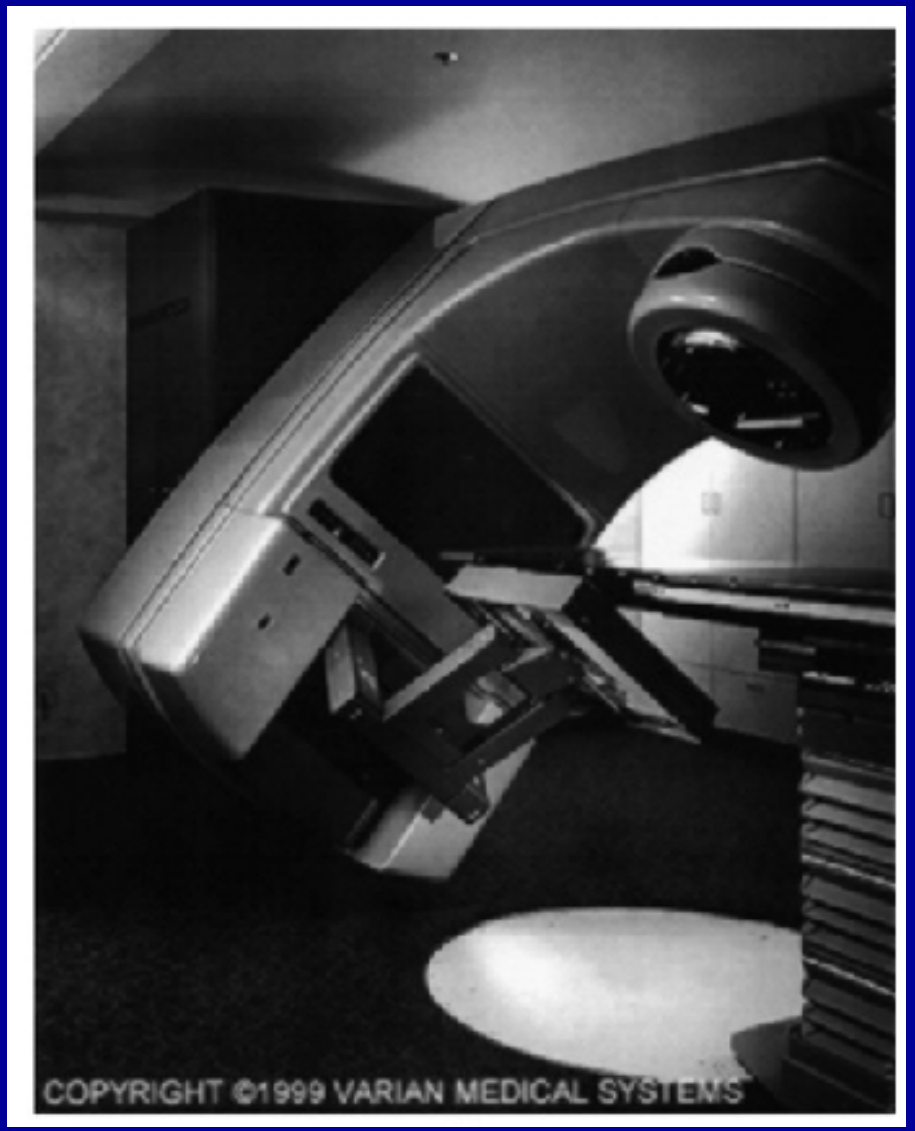


Pluses and Minuses of Liquid Ion Chamber Portal Imaging

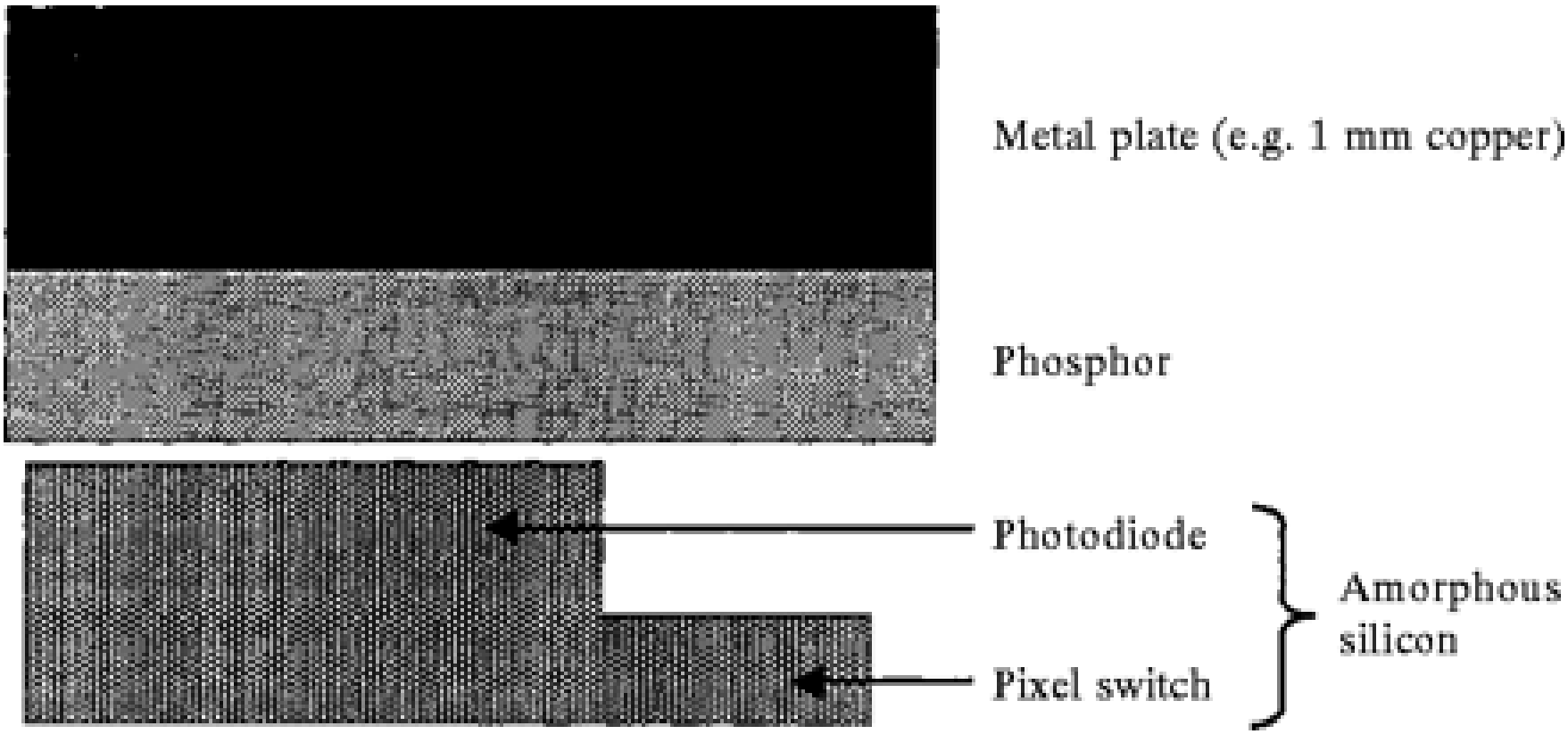
- Simple and reliable device
- The maximum spatial resolution is 2.3 mm x 2.9 mm, increasing to 2.3 mm x 4.5 mm depending on acquisition mode (256*256 pix)
- Noise levels vary from 0.13% to 0.28 %
- The characteristic curve of the system show that the response varies substantially with acquisition mode
- Detector contrast increases at low dose rates
- Should be synchronized with linac pulses (difficult for IMRT verification)

Amorpho-Silicon Imaging

Varian PortalVision



Amorphous Silicone Imaging (1 pixel shown)



Pluses and Minuses

- Best resolution (up to a 1024*1024)
- Lower pixel noise ratio
- Removal of dead pixels
- Required a fixed pulse repetition frequency from the linac-no dynamic fields.
- Saturated at unattenuated dose of 3 MU: for acquisition speeds 1.31–6.20 s, dose rates should be <400 MU/min
- Time penalties of 3–4 s for data transmission and image display processing, which slows down image display.

Commercially Available Systems

	Electa		Siemens	Varian		InfiMed	Eliav	BioScan
	SRI100[a]	iViewGT	BeamView	PortalVision	PortalVision aS500	Theraview	PORTpro	IRIS[b]
Type of detector	Camera	a-Si	Camera	Liquid ion chamber array	a-Si	Camera	Camera	a-Si
Linac mounted	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Detector size (cm^2)	30×38	41×41	35×44	32.5×32.5	40×30	40×40	43×32	10×10 20×20 41×41

MVision from Siemens

Cone-beam CT


Tx RefPts
List
Plan Strs
List
Plan RefPts
List
Acquisition
IEC Table
Position
Adjusted
IEC Table
Position
IEC
Table
Offset
Lat
cm
Long
cm
Vert
cm
accept
print

Eliav PortPro Independent System

QA of EPID

- Dark Image
- Flood Image
- Various Doserates
- Test Image: Pixel Noise Ratio
- Test Low-Contrast Phantom

Electronic Portal Dosimetry

- Principles of operation
- Clinical implementation
- IMRT QA: fluence verification
- Delivery verification in patient treatment

Other Portal Imaging Devices *Storage phosphors: Digital Radiography and Fluoroscopy*

- A phosphor plate replaces film
- Laser scanning of the irradiated phosphor induces luminescence
- Detection of the luminescence is used to form a digital image
- The quality is at least as good as portal films
- Can be used for verification of dynamic treatments
- Like film, require developing before an image can be obtained.
- Digital Fluoroscopy

Other Portal Imaging Devices:

- Amorphous selenium:
  - When irradiated it conducts electricity and an electrostatic image can be formed.
  - Combine a metal plate/amorphous selenium detector with a flat panel amorphous silicon TFT for direct-detecting imaging
- A variety of scanned linear arrays of radiation detectors:
  - scintillation crystals coupled to photodiodes
  - silicon diodes

Portal Dosimetry

- Allows compare in-vivo measurements with TPS calculations
- Allows IMRT QA
- Can be used with all types of EPID or film
- Requires calibration (field-size dependent)
- Variability due to the patient position, gas, etc.

Conclusion:

Electronic Portal Imaging is a great clinical tool allowing IGRT