

# 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

Disc Averaging  
1 slices  
Display Mode  
Col  
Get To

Reference Preset  
 Bone  
 Alignment Option  
 Structures

Alignment  
Automatic  
None  
Reset

Position Error		Table Correction	
Translation (cm)		(cm)	
x	0.17	Lateral	-0.12
y	0.16	Longitudinal	-0.46
z	0.14	Vertical	0.14

Rotation (deg)

x	0.1
y	0.1
z	0.1

Dismiss Accept

# Image Guidance: Elekta Volume View

Acceptable  
Alignment  
achieved

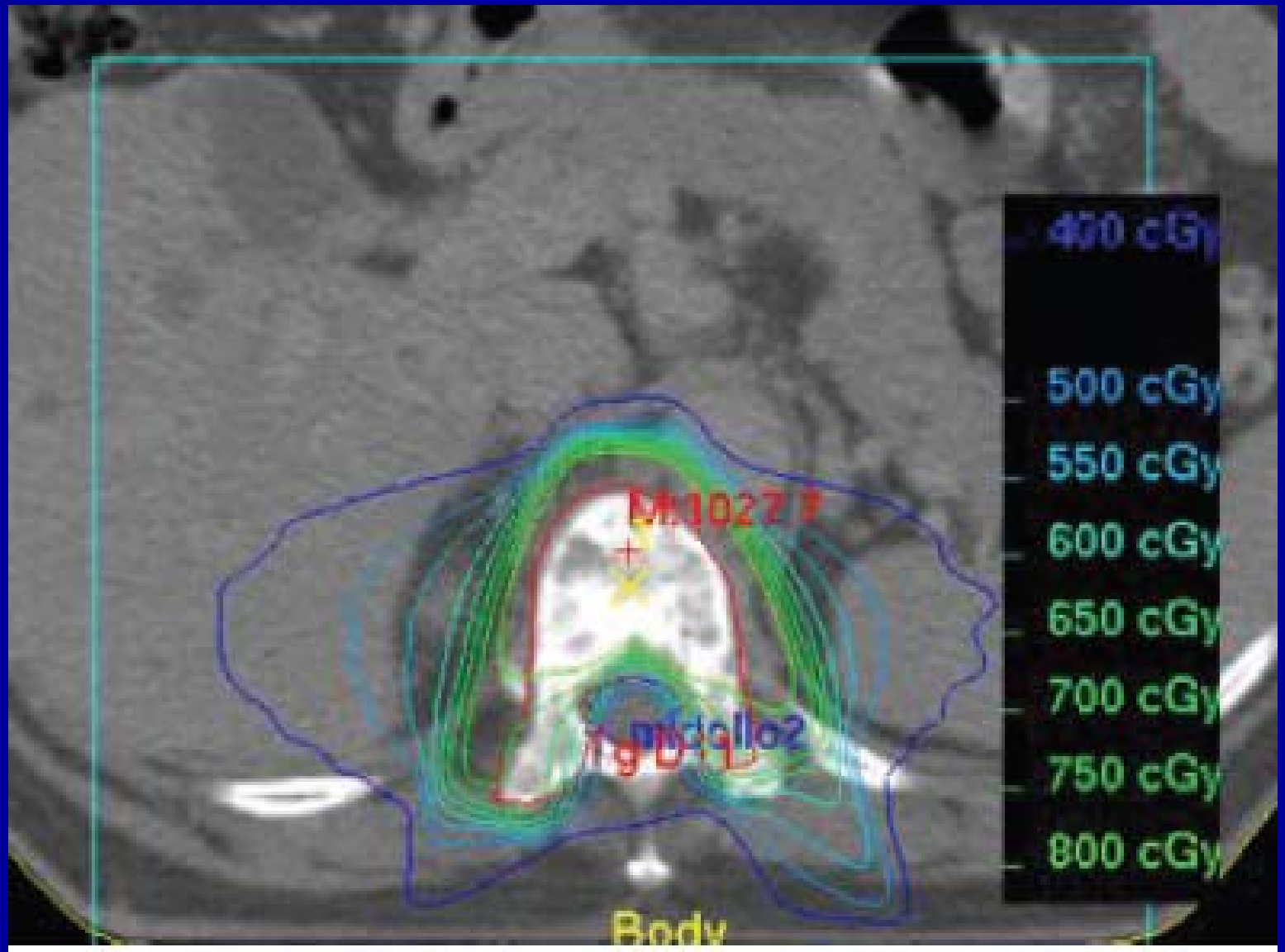
The screenshot displays the Elekta Volume View software interface. It features three main image windows: Coronal (top left), Sagittal (top right), and Axial (bottom left). Each window shows a CT scan of a vertebra with a red outline indicating the target volume. The Coronal view shows the vertebra from the front, the Sagittal view from the side, and the Axial view from above. The interface includes several control panels: 'Image' (top right) with 'Slice Averaging' and 'Display/Hide' options; 'Reference Preset' (middle right) with 'Alignment Criteria' and 'Structure' checkboxes; 'Position Error' (bottom middle) with input fields for Translation (mm) and Rotation (deg) in X, Y, and Z directions; 'Alignment' (middle right) with a 'Preset' button; and 'Table Correction' (bottom right) with a table showing lateral, longitudinal, and vertical corrections in centimeters. At the bottom, there are 'Done' and 'Accept' buttons.

Position Error	
Translation (mm)	Rotation (deg)
X: 0.0	X: 0.0
Y: 0.1	Y: 0.0
Z: 0.0	Z: 0.0

Table Correction	
	(cm)
Lateral	0.47
Longitudinal	0.11
Vertical	-0.06

# 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  $\gamma$  values distributions for plan to film comparison, the percentage of points satisfying  $\gamma < 1$  for IMAT plans ranges between 87% and 98% (mean 93%).

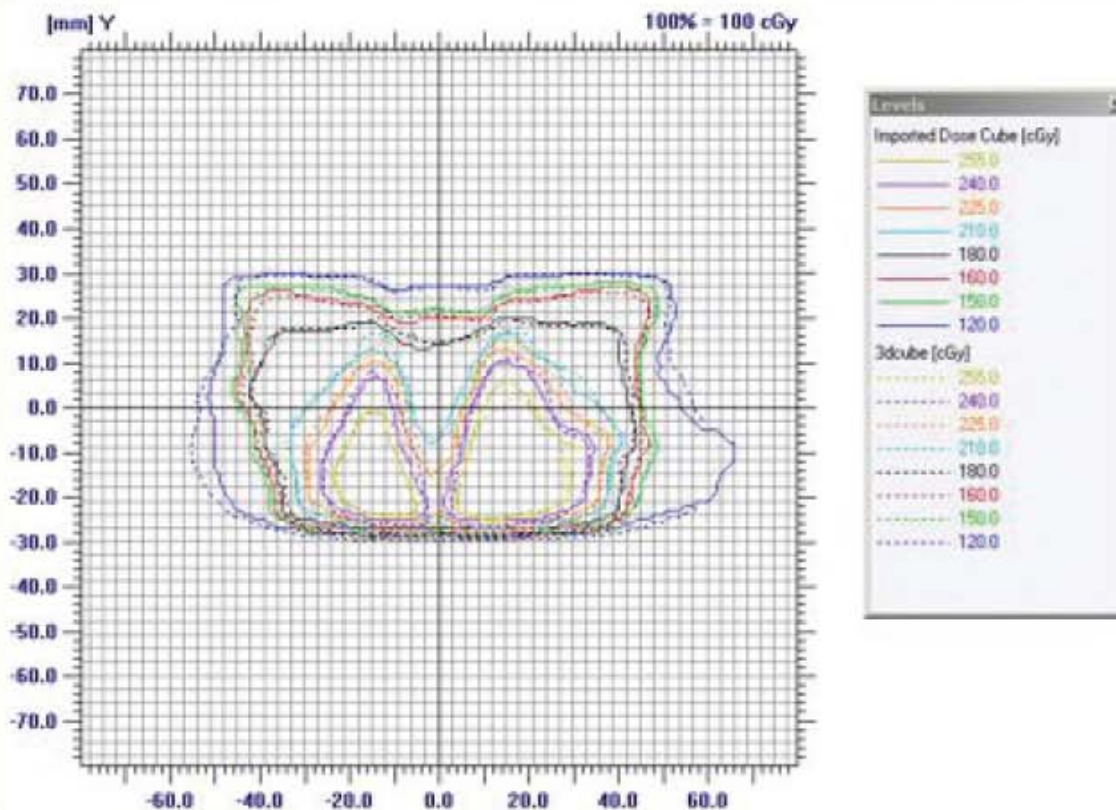


Figure 3:  
IMAT-AMOA pre-treatment dosimetric verifications, plan to film comparison in a coronal plane including the cord.

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

# Automation tasks of portal imaging

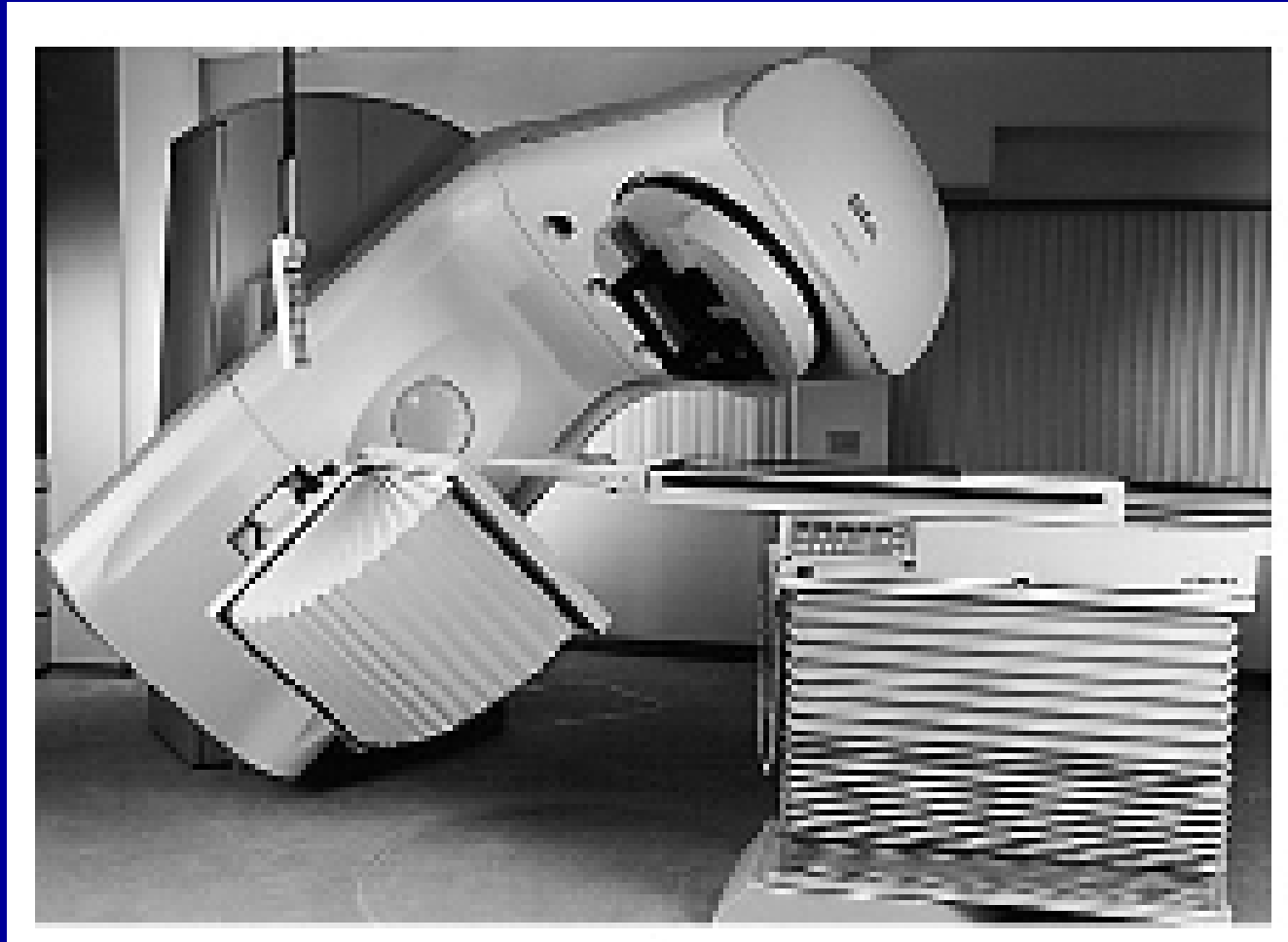
- Block identification and delineation
- Detection of fiducial markers and patient position adjustment
- Image-based MLC adjustment
- MLC calibration
- IGRT – next talk



# Type of Portal Imaging

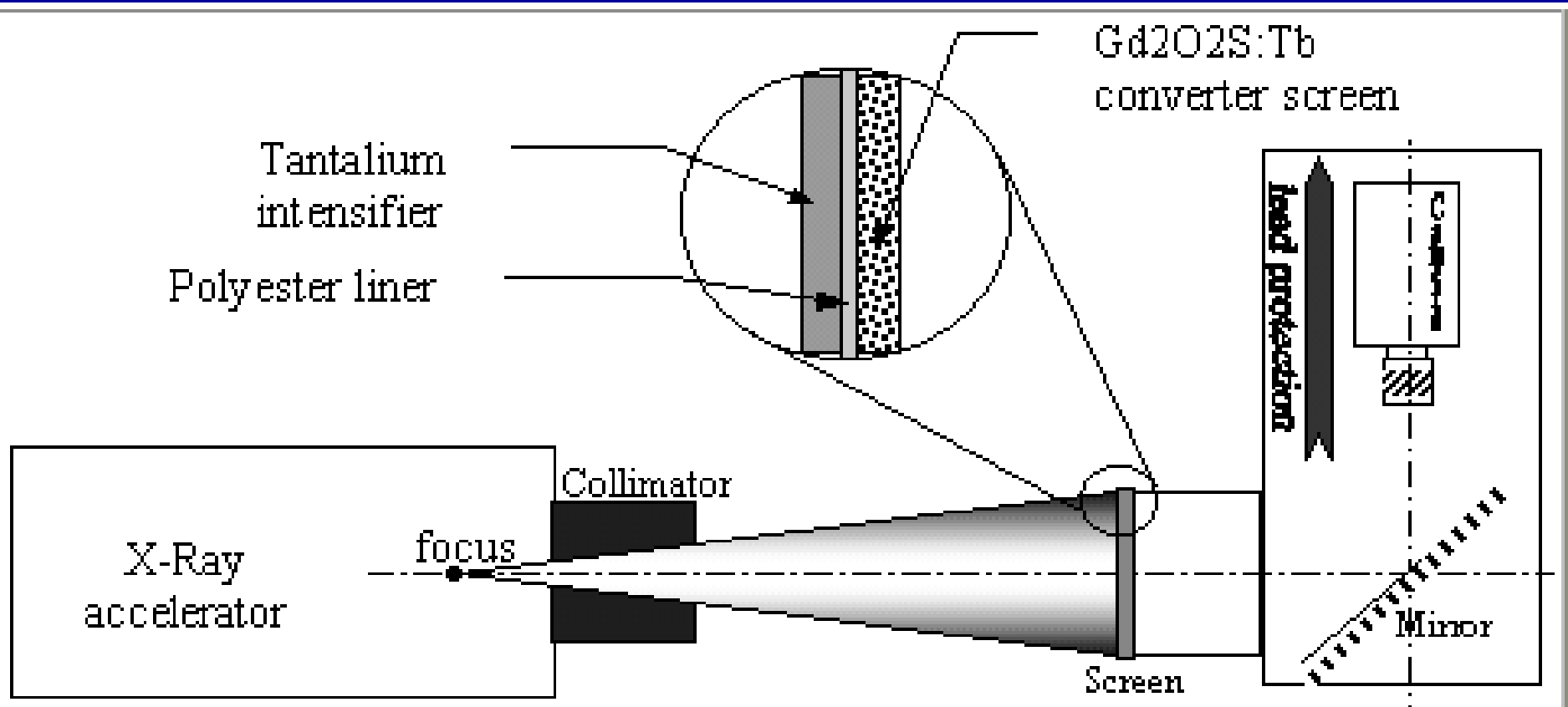
- Fluorescent screen, mirror, and CCD camera-based imaging.
- Liquid ion chamber imaging
- Amorpho-silicon portal imagers
- Fluoroscopic portal imaging
- Kodak CR reader
- Other types of portal imaging devices

# Fluorescent screen, mirror, and CCD camera – industrial prototype

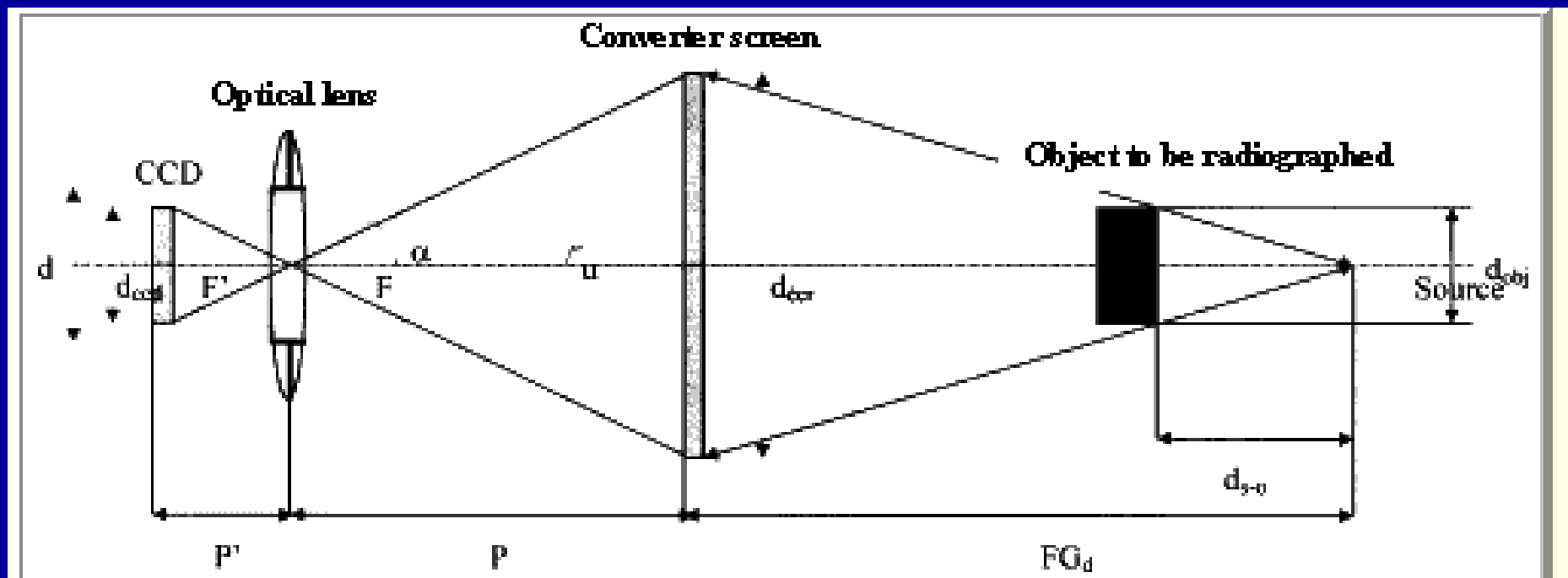


Siemens BeamView

# Principle of CCD EPID

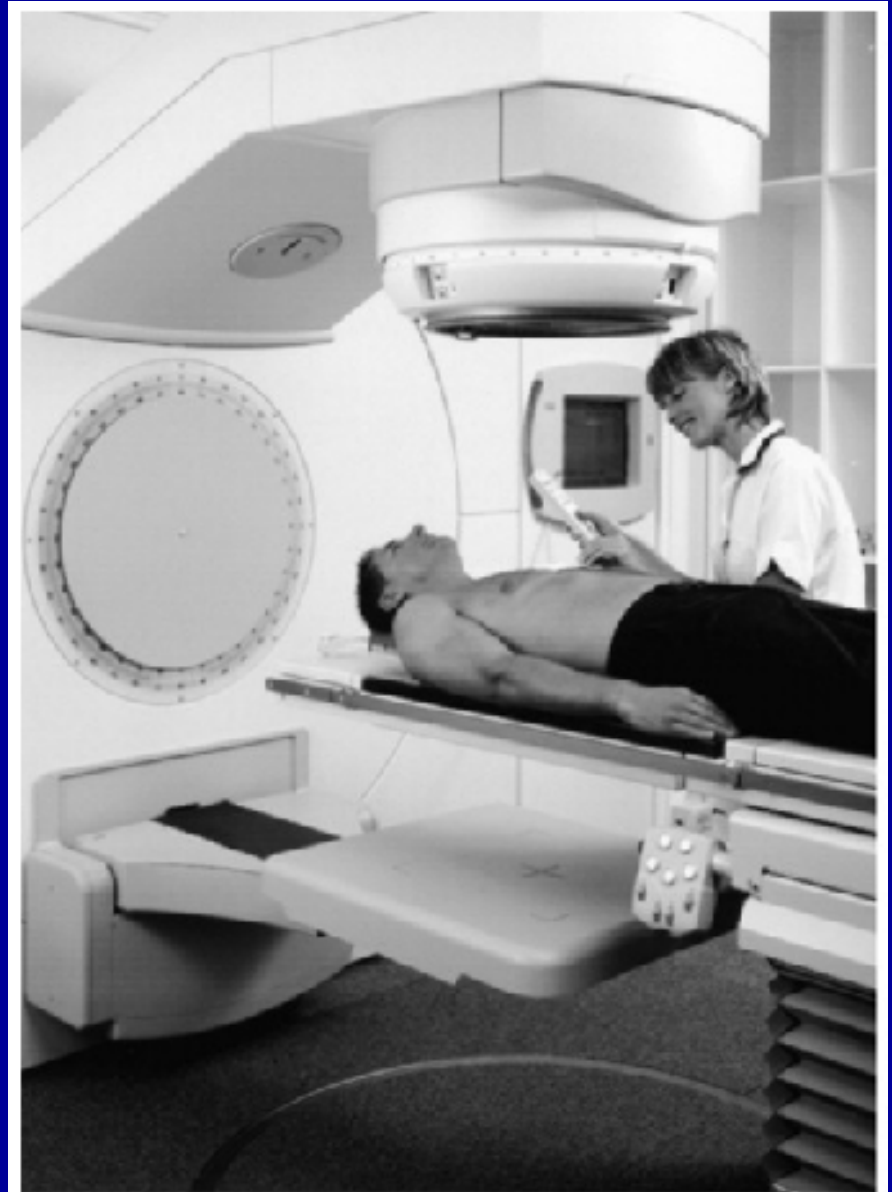


# Magnification and Resolution of CCD EPID



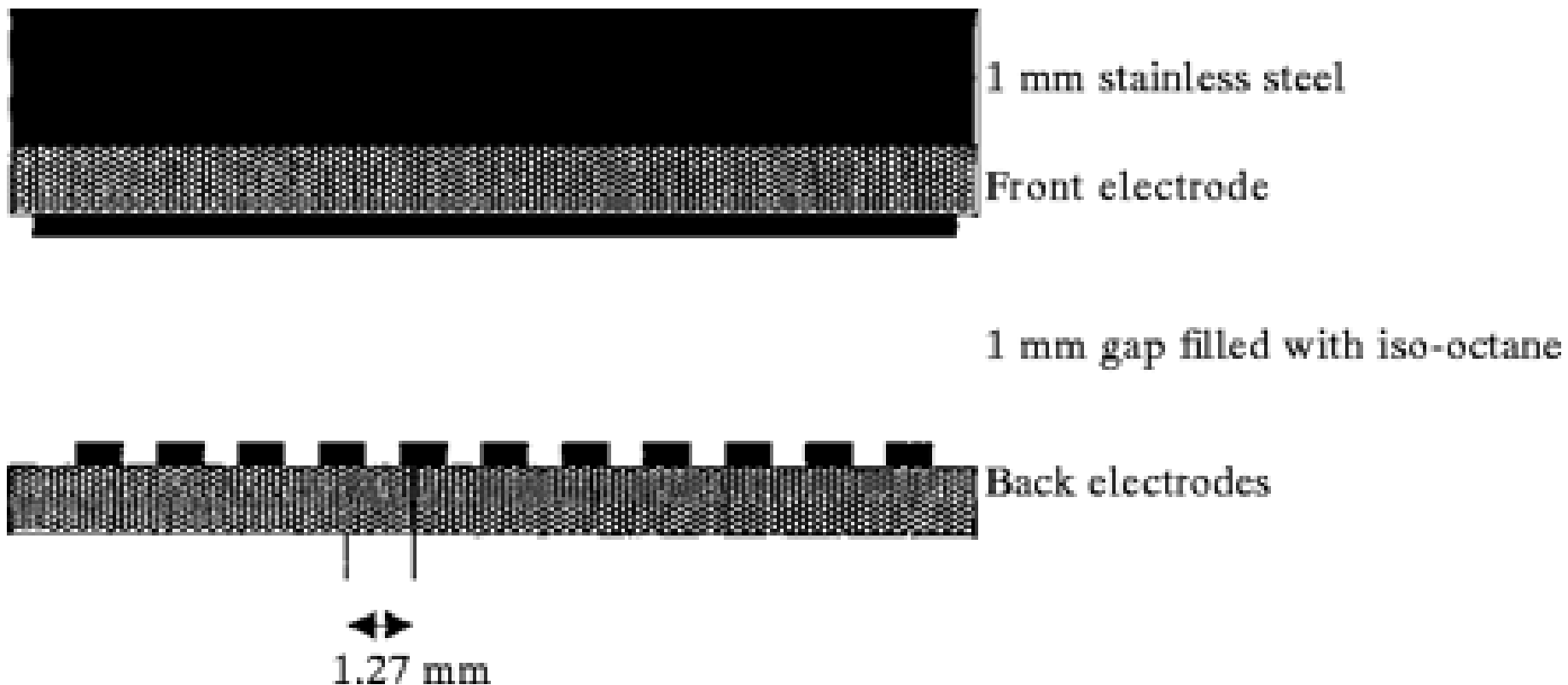
# Liquid Ion Chamber Imaging

Elekta iView



# Liquid Ion Chamber Array

## 256\*256 pixels

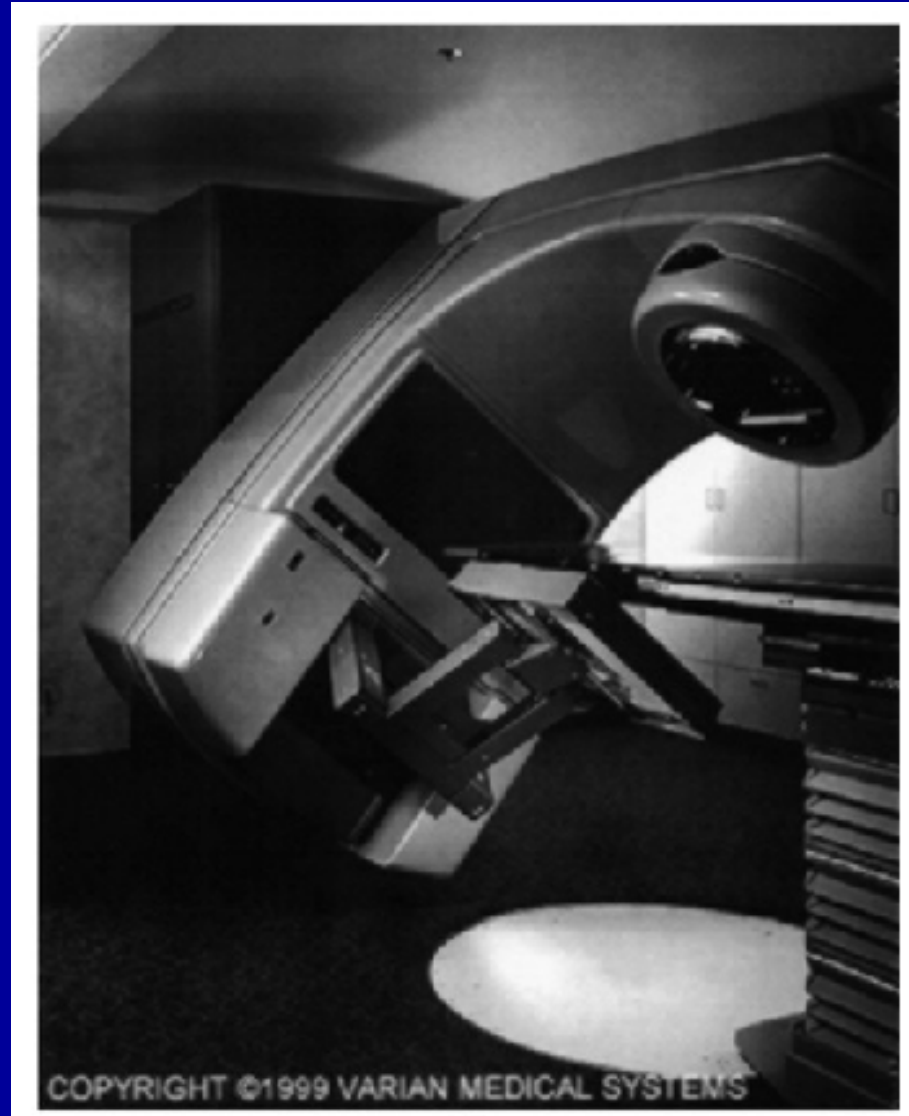


# Pluses and Minuses of Liquid Ion Chamber Portal Imaging

- 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)

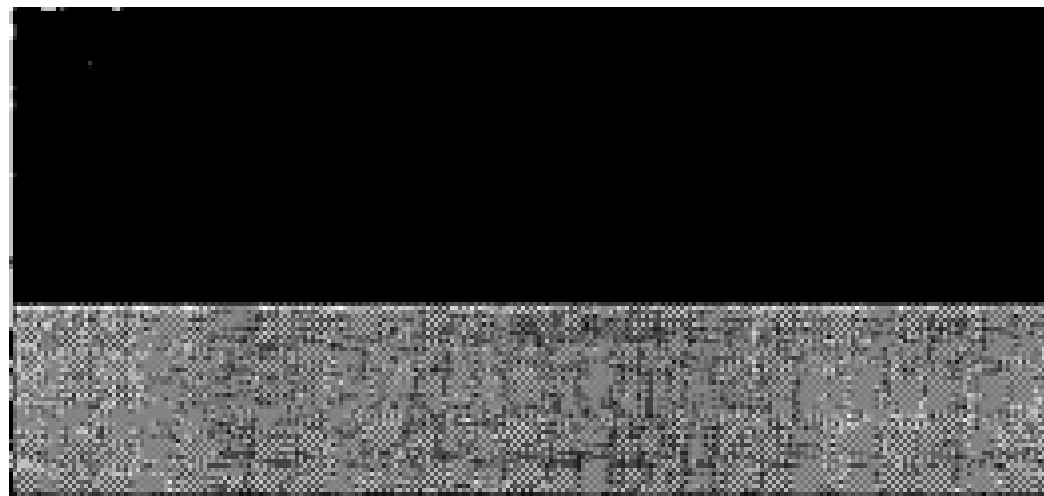
# Amorpho-Silicon Imaging

Varian PortalVision



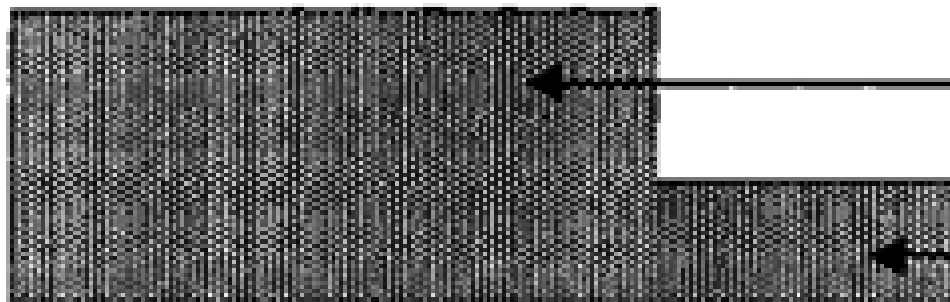


# Amorphous Silicon Imaging (1 pixel shown)



Metal plate (e.g. 1 mm copper)

Phosphor



Photodiode

Pixel switch

} Amorphous silicon

# 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 <sup>a</sup>	iViewG1	BeamView	PortalVision	PortalVision aS500	Theraview	PORTpro	IRIS <sup>b</sup>
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 <sup>2</sup> )	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

File Edit Application View Structure Balance Points Registration Control Help

TC RofPts List  
Plan Strs List  
Plan RofPts List

Registration Views

Registration Control Panel:

	Registration EC Table Position	Adjusted EC Table Position	EC Table Offset
Lat	<input type="text"/> cm	<input type="text"/> cm	<input type="text"/> cm
Long	<input type="text"/> cm	<input type="text"/> cm	<input type="text"/> cm
Vert	<input type="text"/> cm	<input type="text"/> cm	<input type="text"/> cm

Accepted 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