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Chest X-ray Taking Procedures Training for X-ray Technicians/ Radiographer

"Digital Radiography"

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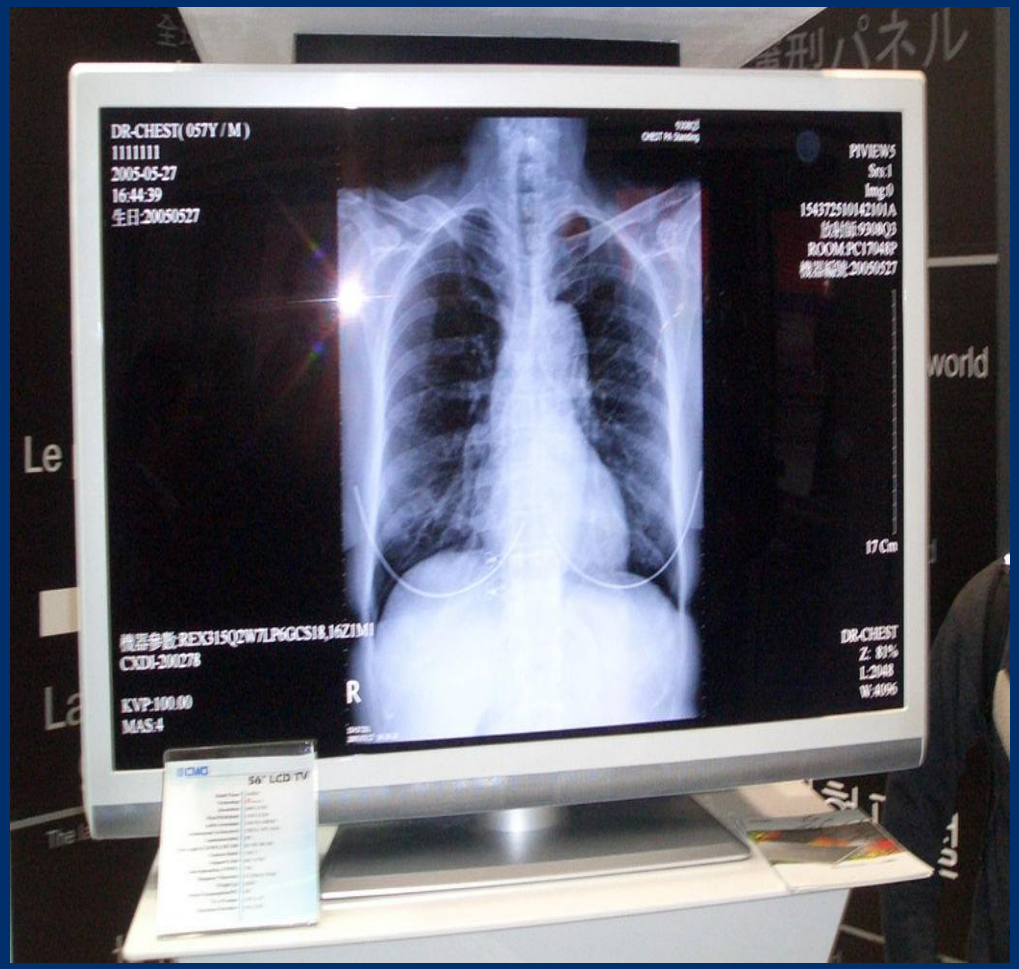
Content

Digital Radiography (DR)

The DR image is produced directly from the image detector and is displayed on the screen.



Digital radiography Display

Photo reference: Author, Andreas -horn- Hornig
Access for free at (https://commons.wikimedia.org/wiki/File:CeBIT_2006_Chi_Mei_Optoelectronics_56LCD_QuadHDTV_digital_radiography_Digitalroentgen_by_HDTVTotalDOTcom.jpg)

Digital Radiography (DR)

The most common DR Detectors

Based on

- Thin-film Transistor (TFT) arrays
- Direct conversion photoconductors

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014

Thin film transistors (TFT)

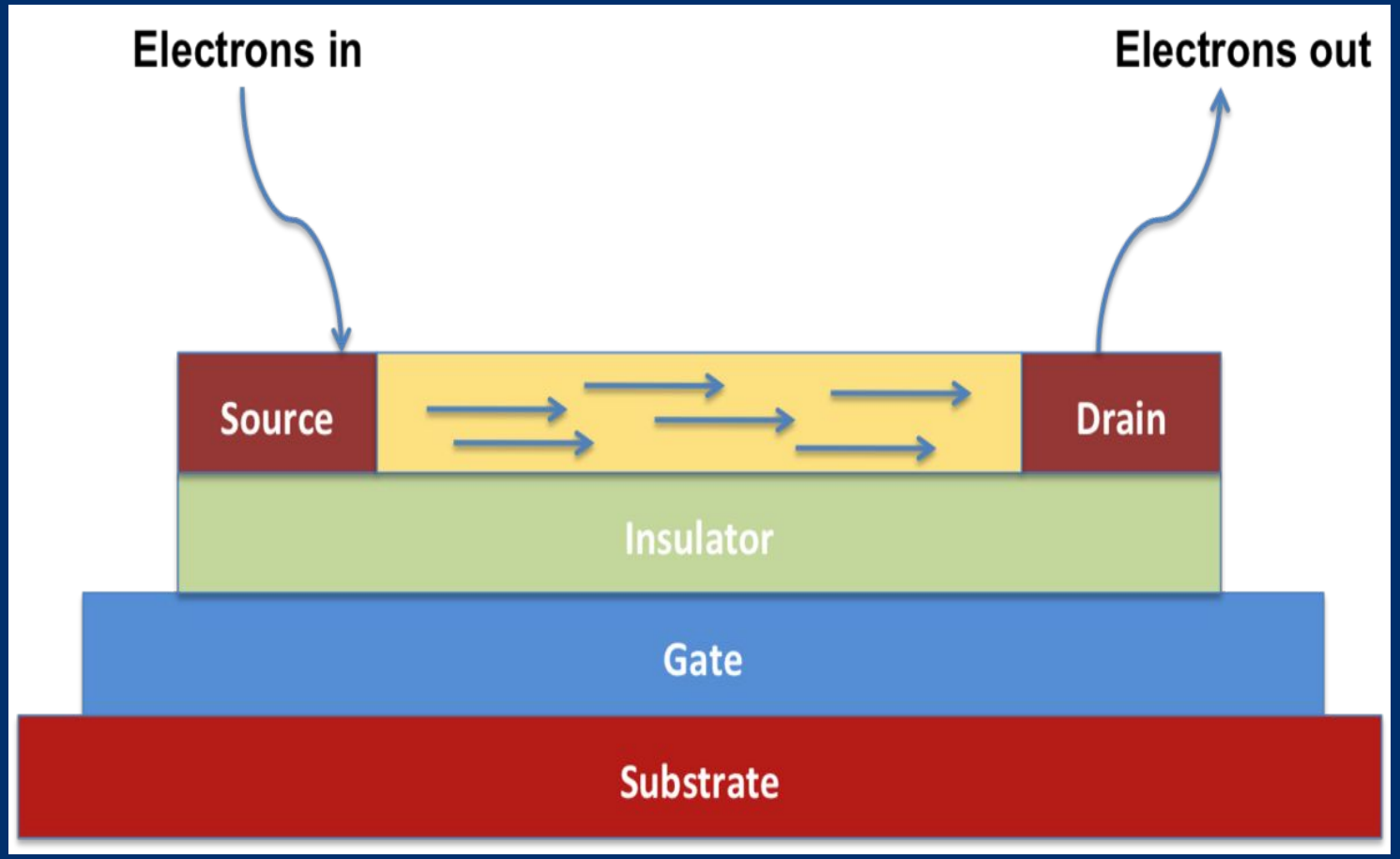
- Used in both direct and indirect conversion

Structure:

- Deposited in multiple layers on glass substrate
- Higher layer has charged collectors X ray elements
- Light sensitive elements are deposited on the top layer
- Lowest layer has readout electronics
- Encased in a protective layer for insulation connected to computers through wire for image reconstruction

Reference: Christi E. Carter, Beth L.Vealé, Digital Radiography and PACS, 2nd Edition, 2014

Thin film transistors (TFT) – Cont.



Thin film transistor

Photo reference: Author, Myxiao
Access for free at (https://commons.wikimedia.org/wiki/File:Tft.png)

Direct conversion photoconductors

- Used amorphous selenium and lead iodide
- Most commonly selenium is used
- Selenium drum or flat panel detector can be used

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014

Types of Digital Radiography

Indirect conversion type

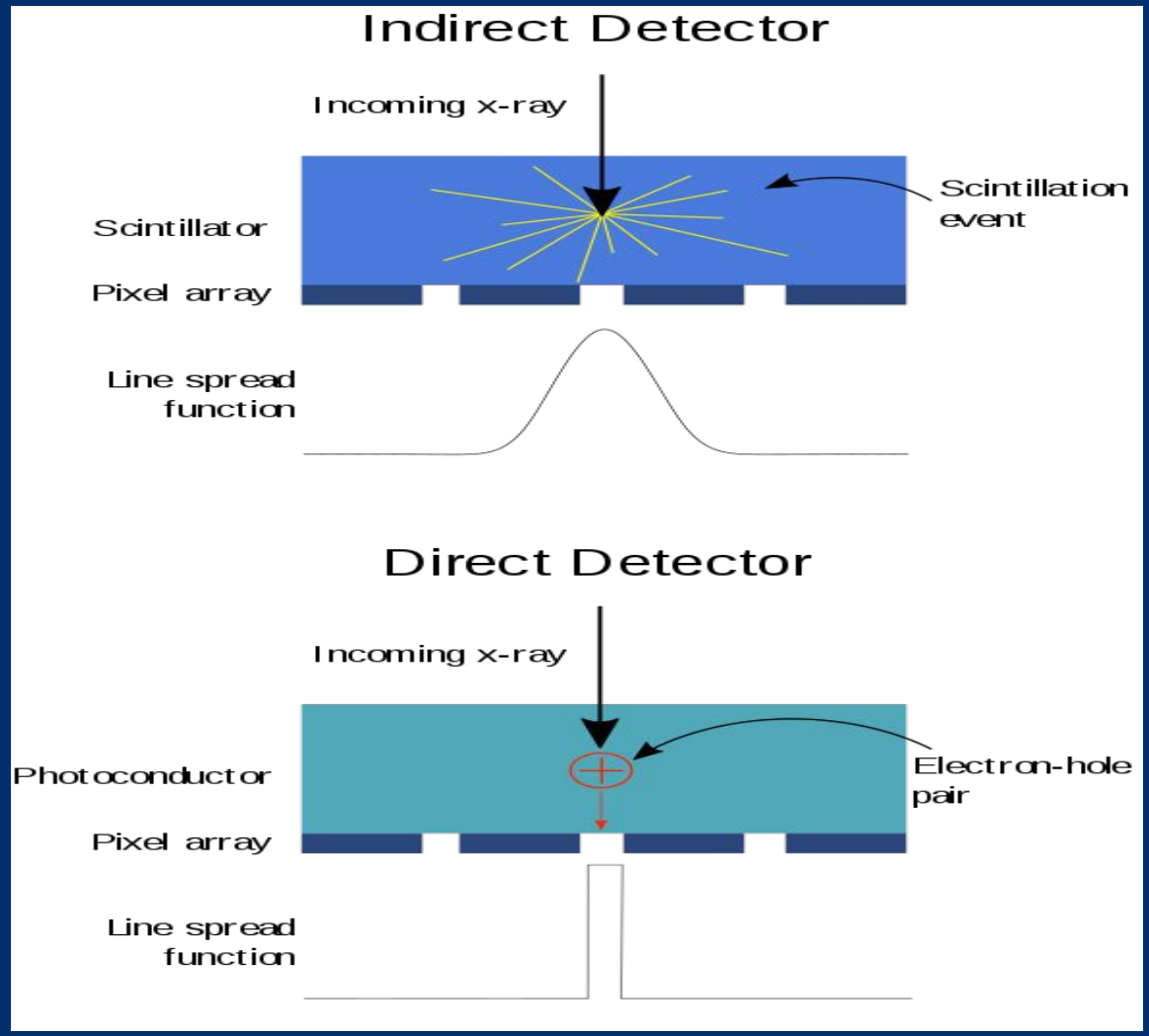
- X ray to visible light by scintillator
- Visible light to electrical charges by photo detectors

Direct conversion type

- Photoconductors like amorphous selenium directly

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014

Types of Digital Radiography – Cont.



Resolution in Indirect and Direct x-ray Detectors

Photo reference: Author, Beevil
Access for free at (https://commons.wikimedia.org/wiki/File:Resolution_in_direct_and_indirect_x-ray_detectors.svg)

1. Image formation steps by indirect conversion type

Consists of scintillator
(thallium doped cesium iodide to convert x-rays into light)

TFT arrays (CsI:Tl) and charge coupled device CCD system

- **CCD system – light sensitive sensor*

CsI:Tl absorbs x-ray photons and releases light photons

Light photons are then absorbed in the photodiodes

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014

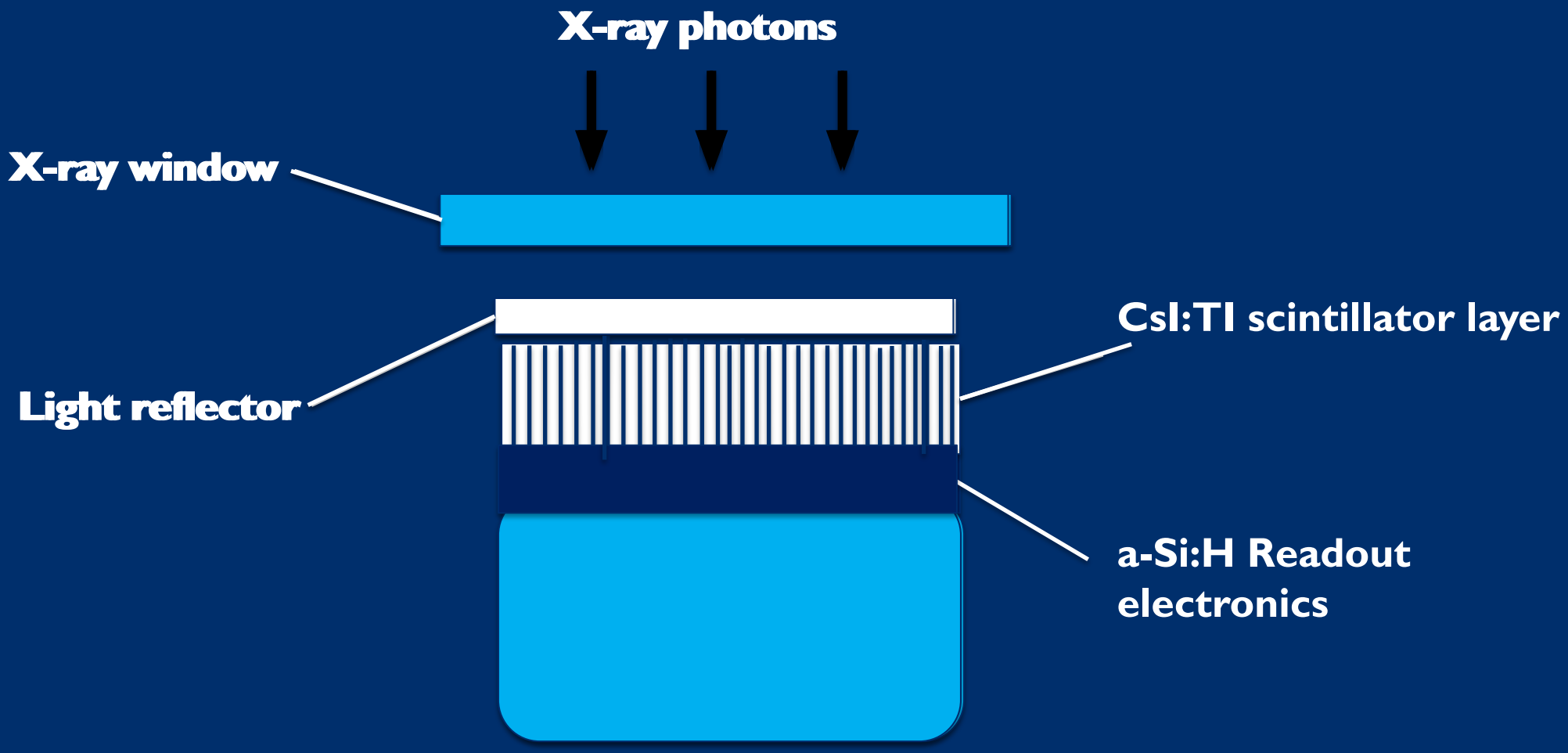
1. Image formation steps by indirect conversion type – Cont.

Electrical charges stored in the charge storage capacitor at each pixel location

The latent image is read out by TFT array

The resulting voltage signal is then digitised and transferred to the system computer where the DR image is built up

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014



Indirect conversion type

Indirect conversion type

Active Matrix:

- Formed by a layer of a-Si:H and forms the readout electronics
- Consists of a high resolution array of electronic components

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014

Indirect conversion type

Active matrix composed of:

1. Photodiode (a light sensor)	2. Charge storage capacitor	3. Thin-film transistor (or TFT switch)
• Amplifies signal from incident light photons	• Stores signal of latent images	• Latent images are read out and transferred to TFT switches that produce a voltage signal that is digitised and converted into the image

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014

2. Image formation steps by direct conversion type

X-ray photon absorbed by a-Se photoconductor

Electrical charge carriers (negative electrons and positive holes are created in the a-Se (Selenium)

A surface electrode at positive potential attracts all the electrons

Reference: Christi E. Carter, Beth L.Vealé, Digital Radiography and PACS, 2nd Edition, 2014

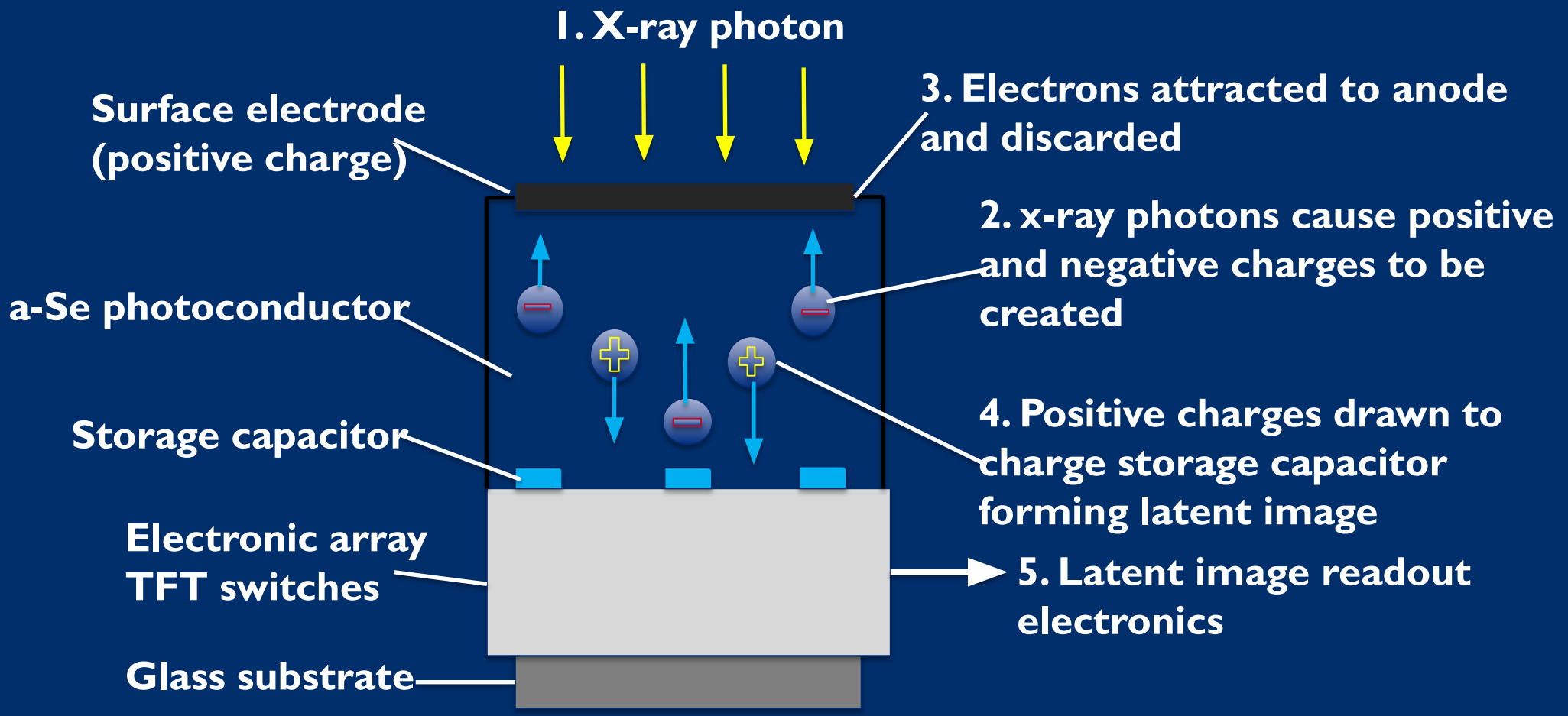
2. Image formation steps by direct conversion type – Cont.

The positive charges are drawn to the charge storage capacitor forming the latent image

The latent image is read out by TFT array

The resulting voltage signal is then digitised and transferred to the system computer where the DR image is built up

Reference: Christi E. Carter, Beth L.Vealé, Digital Radiography and PACS, 2nd Edition, 2014



Direct conversion type

Post Processing

1. Correction of artifacts:
   - Pixel-calibration uses values of neighbouring pixels to correct defects in pixel array
2. Auto-ranging:
   - Analysis of histogram of image grey-scale data to reject very high and low value that contain no clinical information

Reference: Christi E. Carter, Beth L.Vealé, Digital Radiography and PACS, 2nd Edition, 2014

Post Processing – Cont.

3. Digital image enhancement:

- Grey-scale modification - look-up-table (LUT) to remap grey- scale values and improve displayed images
- Spatial feature enhancement to produce enhanced composite images

Reference: Christi E. Carter, Beth L.Vealé, Digital Radiography and PACS, 2nd Edition, 2014

Artifacts

Artifacts related to the image receptor

Artifacts related to software

Artifacts related to technical errors

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014

1. Artifacts related to the image receptor

	Causes
Light area on the image	• Any object on the surface of the image receptor (e.g., hair, dust, adhesive) • Dust on the CR plate reader rollers
Areas of dead pixels or a row of dead pixels **dead pixels are unable to display the information deposited in their region of the image*	• Mishandling of the image receptor • Caused by bending or cracks in the plate
"Ghosting" or "Image lag" (the appearance of anatomy image on the previous exposure)	• Inadequate erasure of an image receptor, or incorrect erasure settings

Dead pixel correction software may provide some correction

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014

2. Artifacts related to software

Causes

Loss of information of the image
(Artifacts related to software)

- Overprocessing the digital image
- Over compression of the image

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014

3. Artifacts related to technical errors

Causes

Too light, too dark, or too noisy

(Artifacts related to technical errors)

- Improper collimation
- Misalignment of the exposure field

Reference: Christi E. Carter, Beth L. Vealé, Digital Radiography and PACS, 2nd Edition, 2014

Quality Control of Digital Equipment

No	Equipment	Methods
1	All equipment	i. Initial acceptance testing ii. Verify equipment matches specifications
2	CR plate maintenance	i. Inspect and clean IP regularly ii. Plate erasure at least every 48 hours
3	CR reader	Calibrate annually

Reference: Christi E. Carter, Beth L.Vealé, Digital Radiography and PACS, 2nd Edition, 2014

Quality Control of Digital Equipment – Cont.

No	Equipment	Methods
4	DR plate maintenance	Inspect and clean regularly
5	Monitors	i. Clean as needed ii. Use QC monitor test pattern to verify image quality, resolution, presence of geometric distortion iii. Measure luminance with a luminance meter iv. Determine presence of reflections and their sources

THANK YOU !