COMPUTER GRAPHICS

COMPUTER GRAPHICS

- A picture is nothing but a combination of thousands words.
- It is using in teaching, learning, communicating and sharing ideas.
- We will refer to any sketch, drawing, special art work etc. using graphics.
- It also includes text in various sizes and shapes.

Classification of Computer Graphics

- Business graphics e.g. Bar charts, pie charts, pictograms, x-y charts etc.
- Scientific graphics e.g. X-y plots, curve fitting, contour plots, flow charts.
- Scaled drawings e.g. Architectural, buildings, machines, bridges etc.
- Cartoons and art work.
- Graphical user interface e.g. Images on screen.

Features of Computer Graphics

Functions of Computer Graphics

- Creation of an object with data from input coordinates/free hand or specific input/scanning.
- Manipulation
- Production

Characteristics of Computer Graphics

- Interactive nature and preview capabilities.
- Create drawing and look at various angles.
- User friendly.
- Ease of production of high quality graphics.
- Logic of mistakes does not exist.

Applications of Computer Graphics

- Computer Aided Design and Drafting
- Geographical information systems
- Presentation and business graphics
- Scientific & engg. Graphics
- Computer Aided Learning
- Medical applications
- Desktop publishing
- Computer art
- Computer games & entertainment

Continue

- Simulation & virtual reality
- Graphical user interface
- Internet
- Multimedia
- Pre processors and post processors

Continue

Miscellaneous applications

- Image processing
- Image superposition and enhancement(Morphing)
- Fractals
- Forward and backward extrapolation
- Shrinking and directing time

Display Devices & Display Controllers

- The purpose of display device is to convert electrical signal into a visible image.
- Display controller sits between computer and the display device.

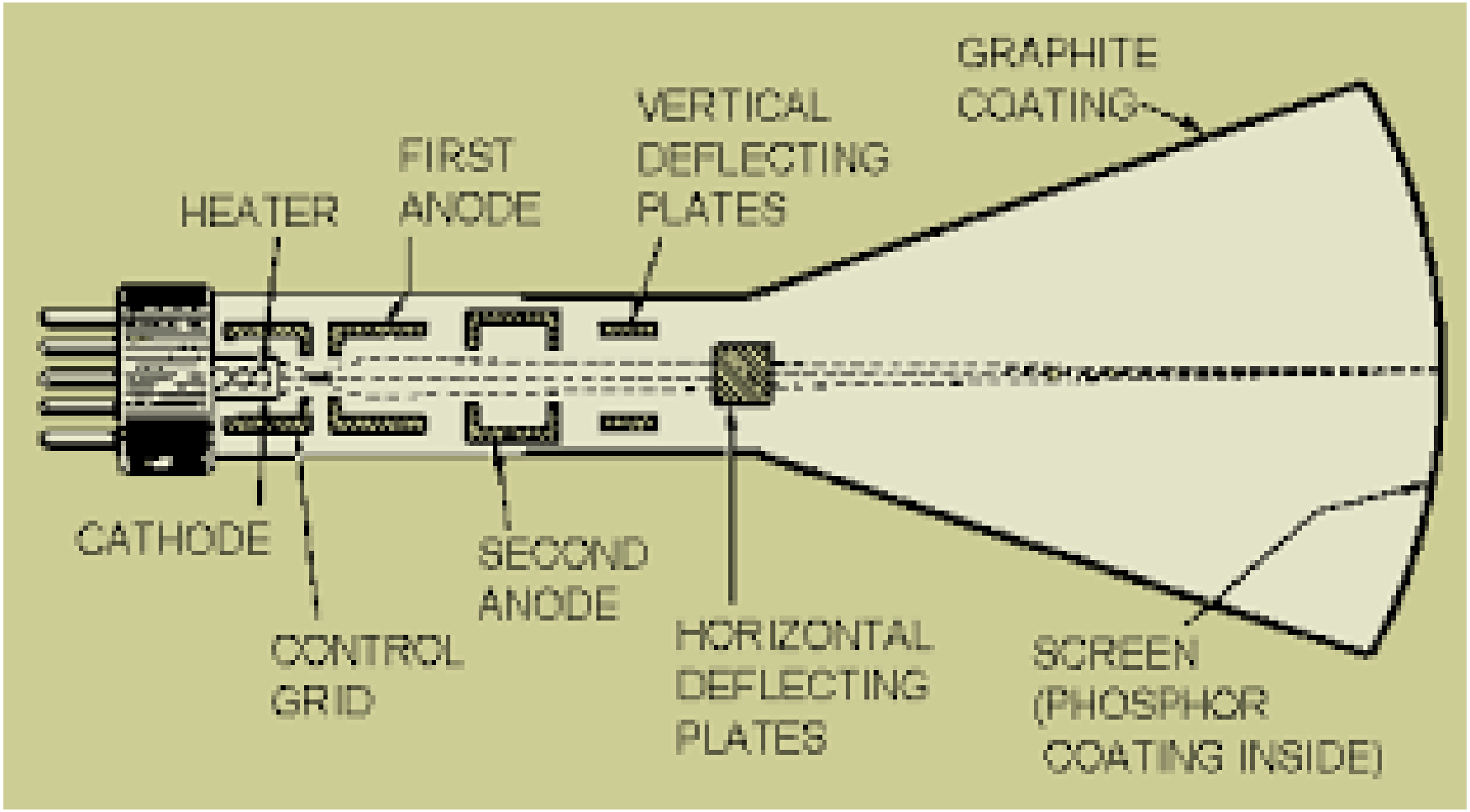
CRT

- Small, dim and inexpensive.
- High speed
- Reliable and display distortion free images

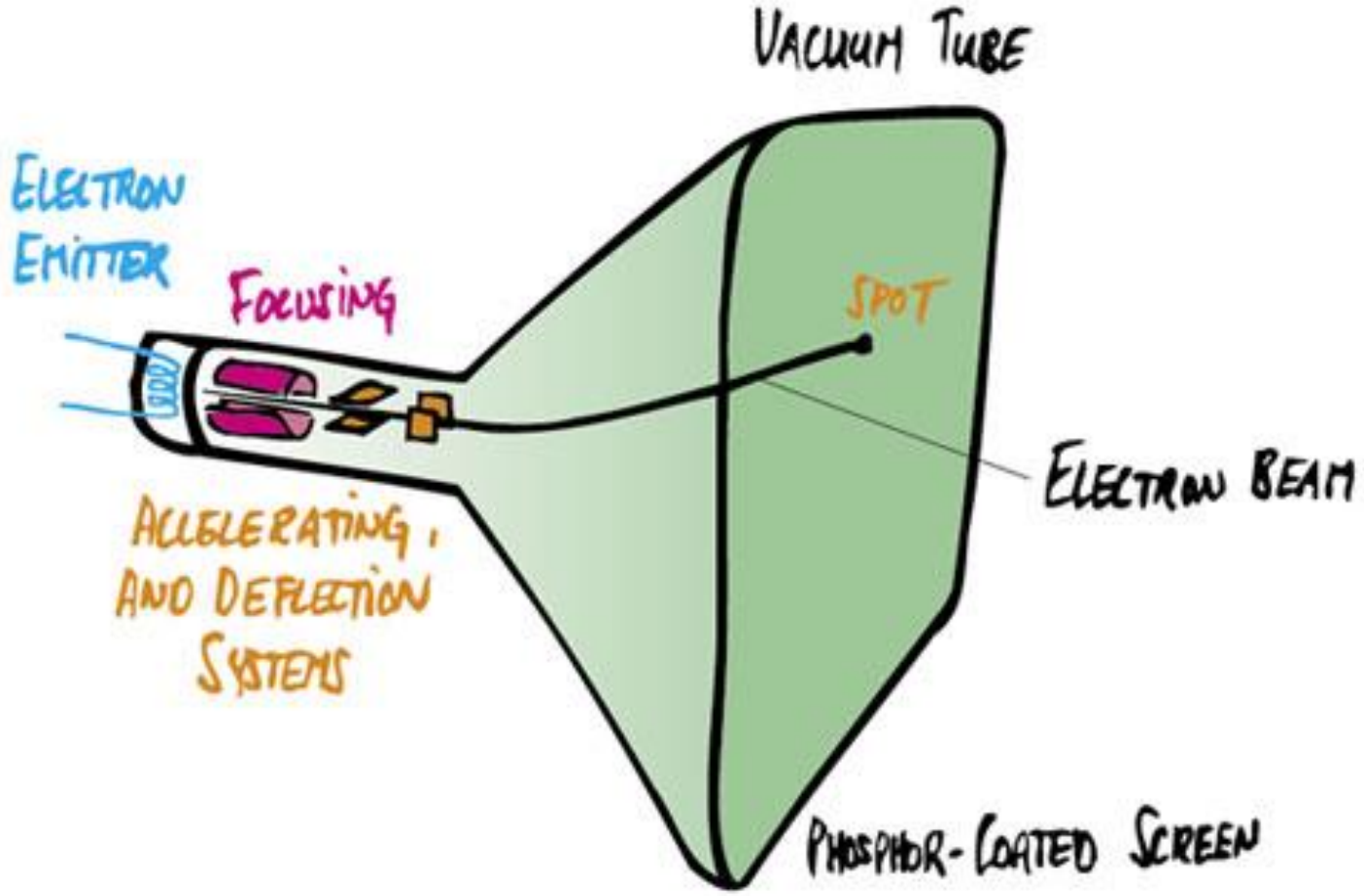
Cathode-ray tube (CRT) Monitors

- **Primary output device – Video monitors**
  - **Standard design of video monitor: Cathode-ray tube (CRT)**

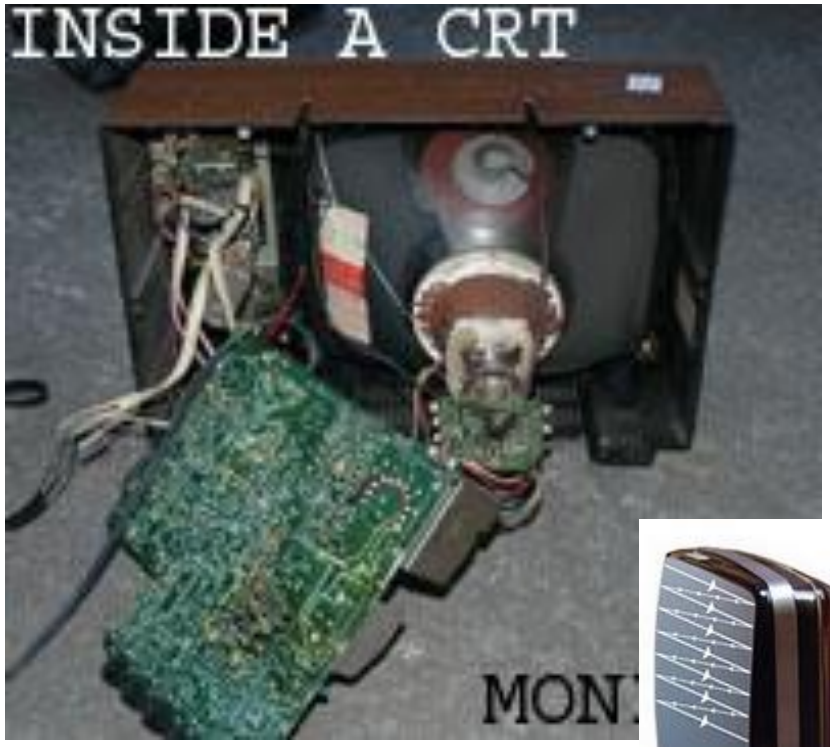
CRT


GRAPHITE COATING
VERTICAL DEFLECTING PLATES
FIRST ANODE
HEATER
CATHODE
CONTROL GRID
SECOND ANODE
HORIZONTAL DEFLECTING PLATES
SCREEN (PHOSPHOR COATING INSIDE)

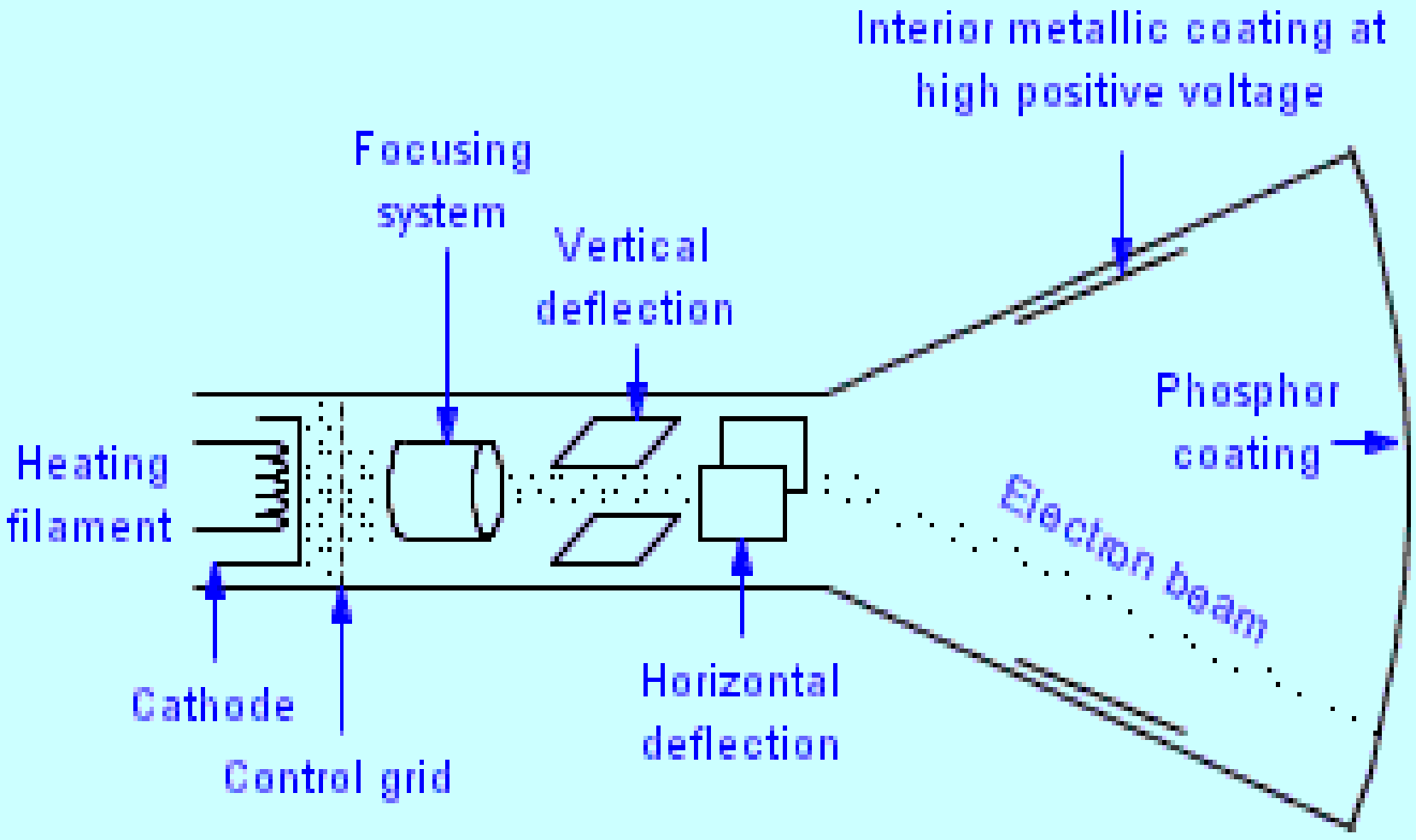
Display Technologies



Cathode-ray tube (CRT) Monitors



Basic Design of a CRT Tube



CRT

- A cathode ray tube (**CRT**) is a specialized vacuum tube in which images are produced when an electron beam strikes a phosphorescent surface. Most desktop **computer** displays make use of **CRTs**. The **CRT** in a **computer** display is similar to the "picture tube" in a television receiver.

Parts of CRT

- Electron gun: it produces electron beam strikes with phosphor. It has high velocity . some mechanism is used to control the flow of electrons. So the intensity of beam can be controlled.
- Deflection system: set of coils to control the horizontal and vertical deflection.
- Screen : phosphor is used in graphic display.

Cathode-ray tube (CRT) Monitors

– Refresh CRT

- **Beam of electrons hit phosphor-coated screen, light emitted by phosphor**
- **Direct electron beam to the same screen repeatedly, keeping phosphor activated**
- **The frequency at which a picture is redrawn on the screen is referred to as the "refresh rate"**
- **The maximum number of points that can be displayed on a CRT is referred to as the "resolution"**
- **Display principle**
  - **Raster Scan Display Principle**
  - **Random Scan Display Principle**

Persistence

- Time required for the brightness of the spot to drop 1/10^{th} of its initial value. It is less than 100 ms or less.

Properties of Phosphor Material

- Persistence
- Colour
- Grain size

Series of Phosphor in market

- P1, P4, P7, P31
- P4- for black and white T.V. has low persistence
- P7-blue phosphor emits green-black light has long persistence
- P-31-emits blue light has short persistence

Grain size

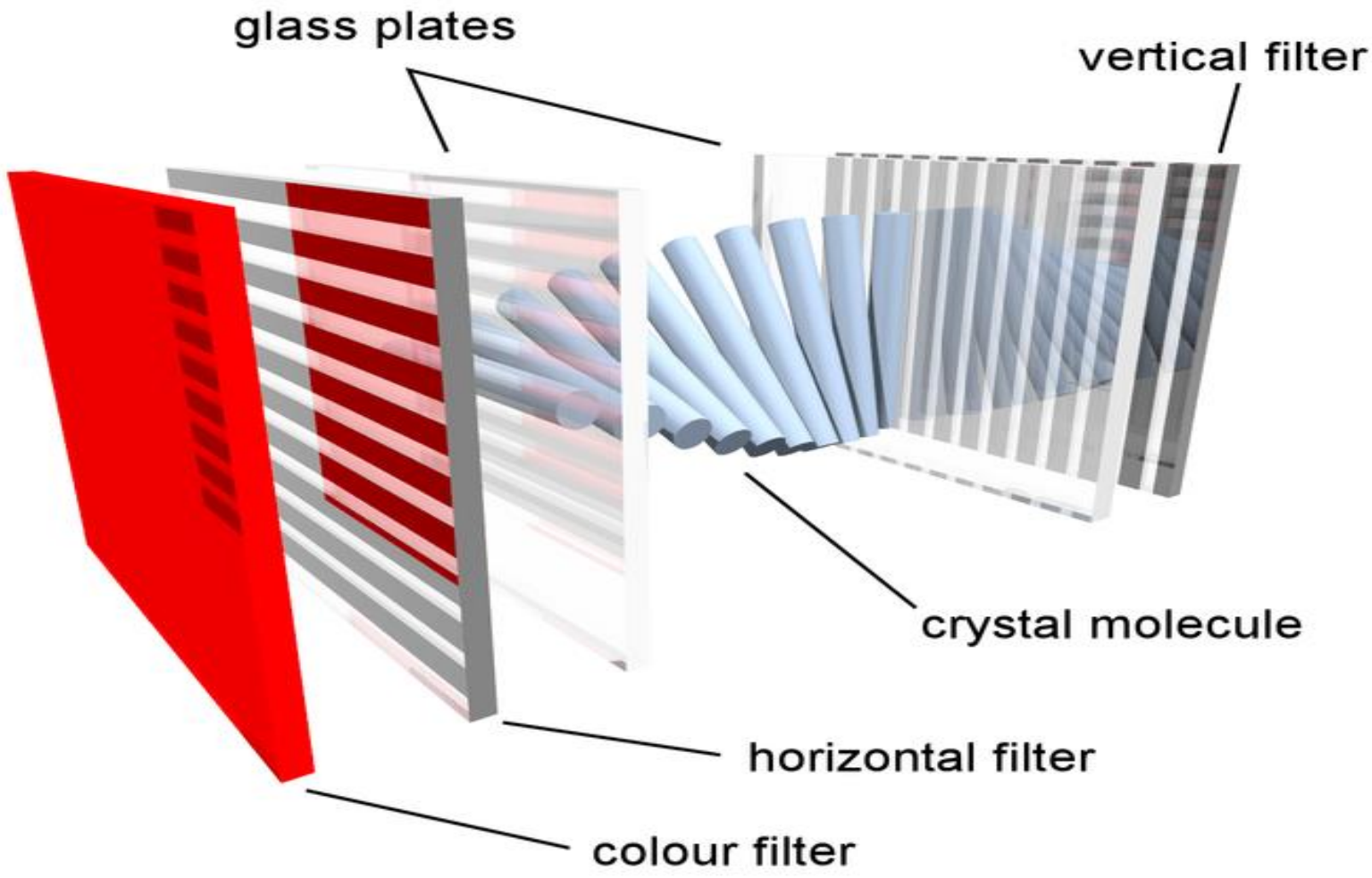
- It controls the resolution of screen
- Grain is fine resolution is high
- Pixel is made of three grains (Red, Blue, Green)

  Conversion efficiency
- Intensity provided per unit of kinetic energy

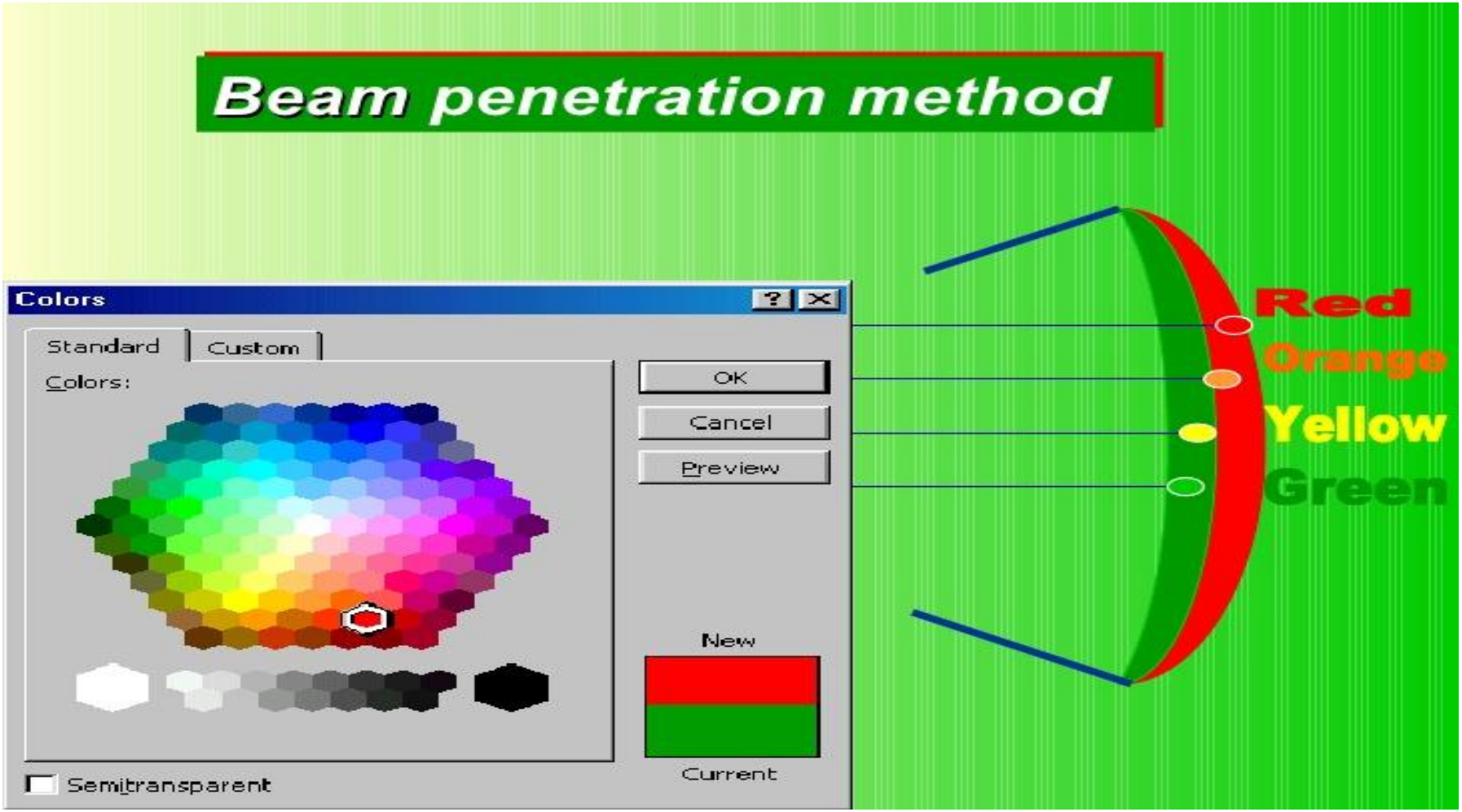
Colour CRT

- Beam penetration CRT
- Shadow Mask CRT

Beam Penetration CRT



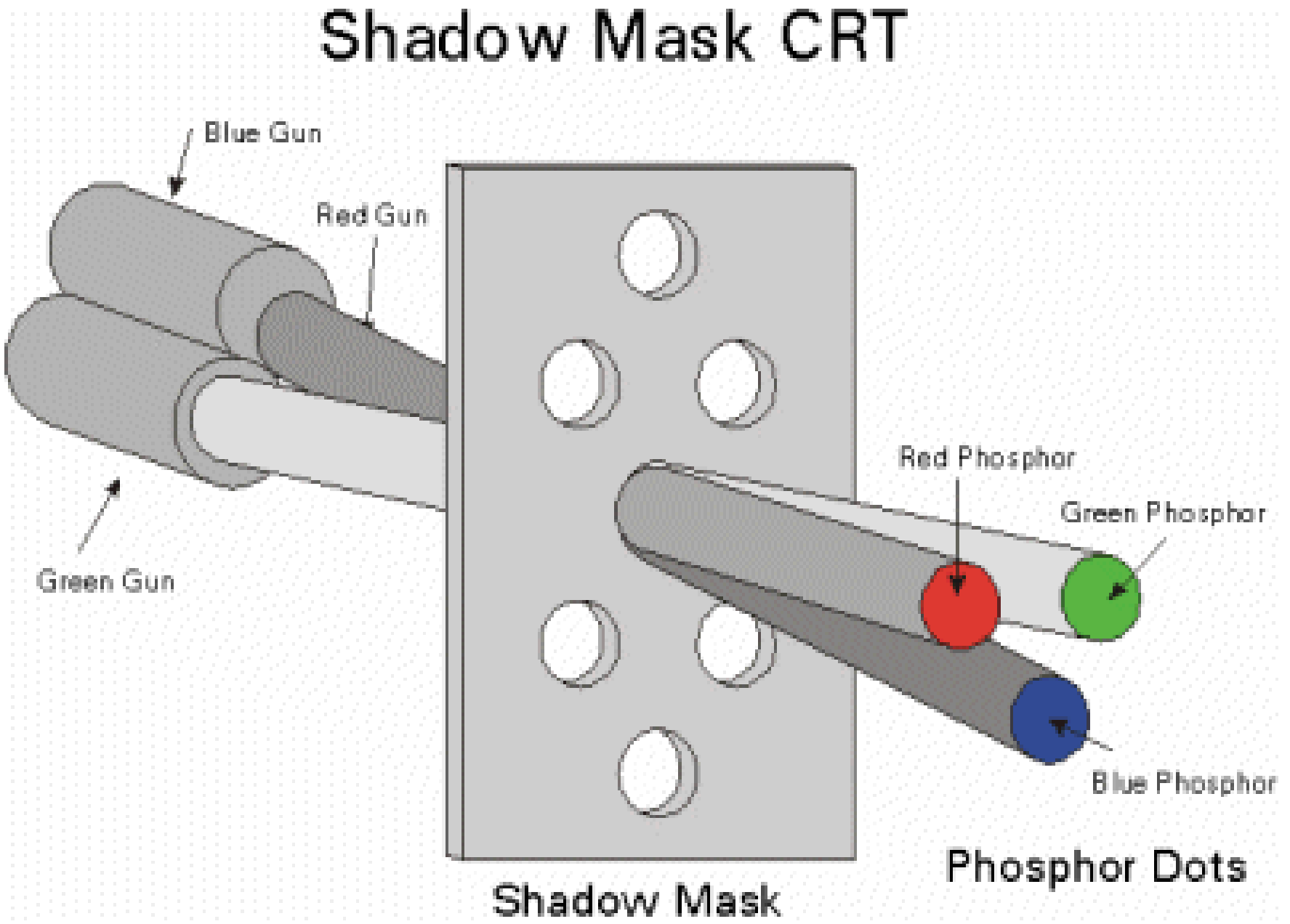
Beam Penetration CRT



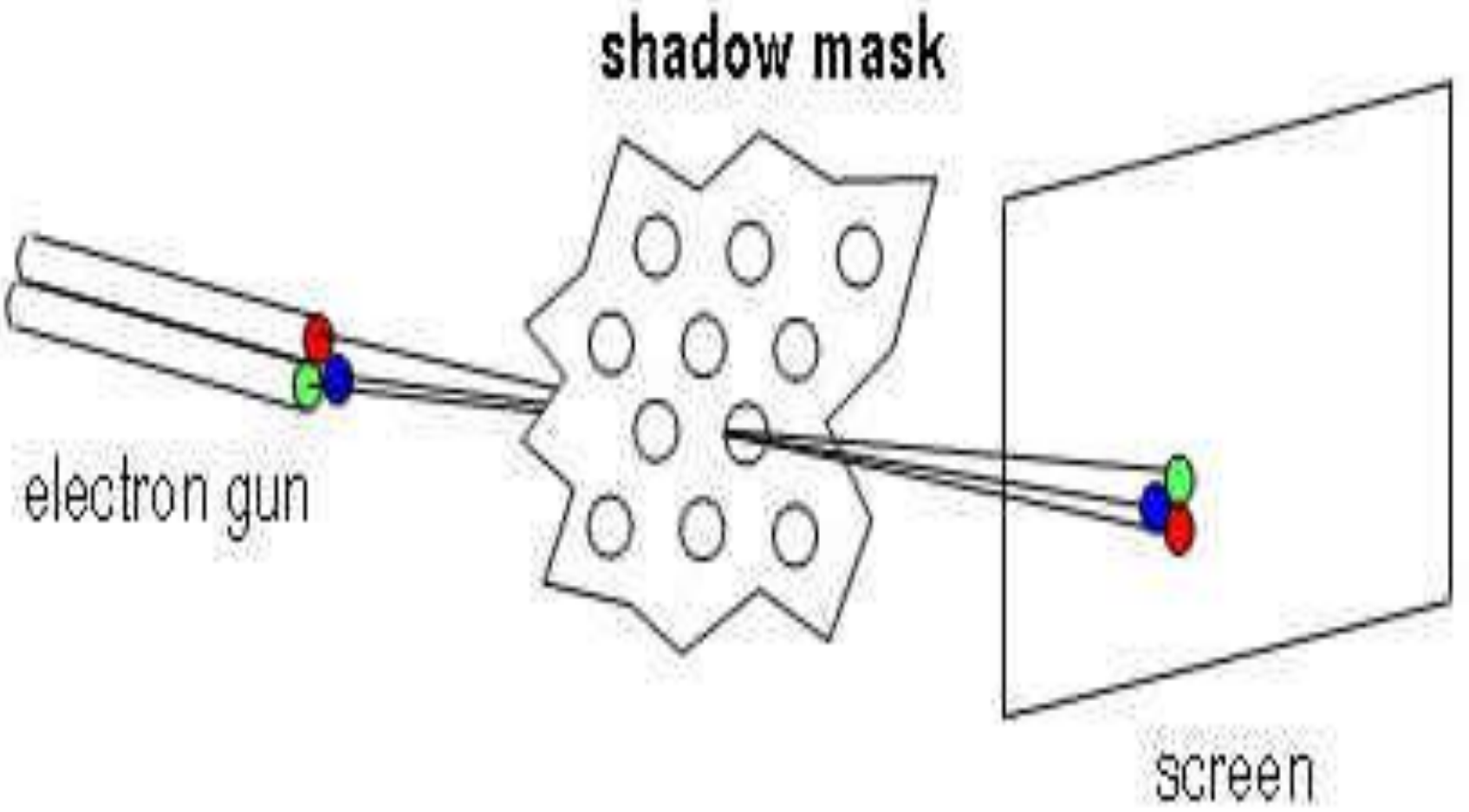
Continue

Beam-penetration method:

- In this method the red, green and blue phosphorus are coated in layers - one behind the other.
- If a low speed beam strikes the CRT, only the red colored phosphorus is activated, a slightly accelerated beam would activate both red and green (because it can penetrate deeper) and a much more activated one would add the blue component also.


Shadow Mask CRT
Blue Gun
Red Gun
Green Gun
Red Phosphor
Green Phosphor
Blue Phosphor
Shadow Mask
Phosphor Dots

Shadow Mask CRT



CRT Display Principles

- **Raster-Scan Displays**
  - **Based on TV technology**
    - **Electron beam swept across screen one row at a time from top to bottom**
    - **Each row is referred to as a scan line**

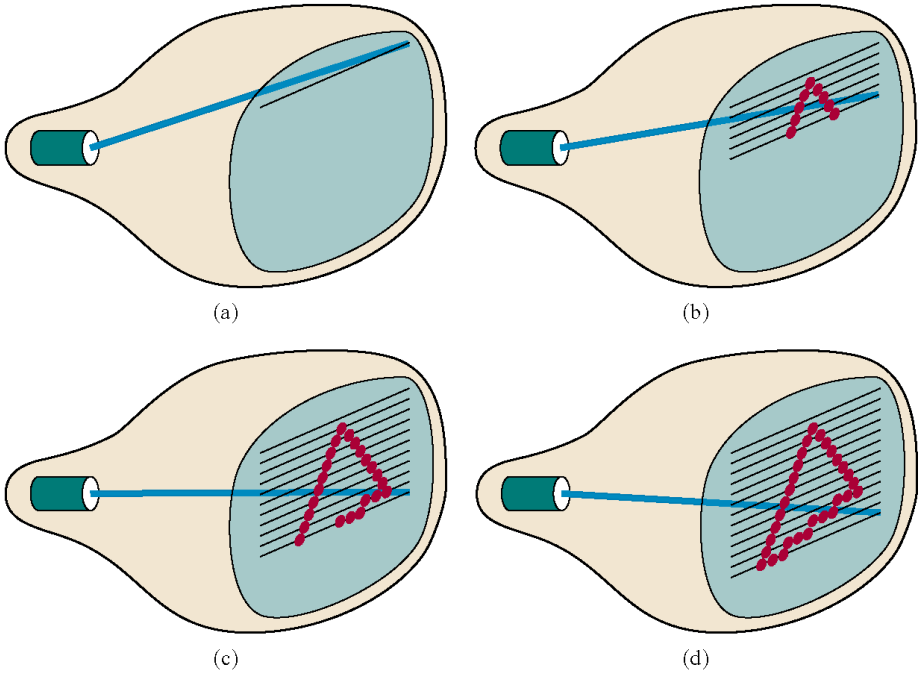
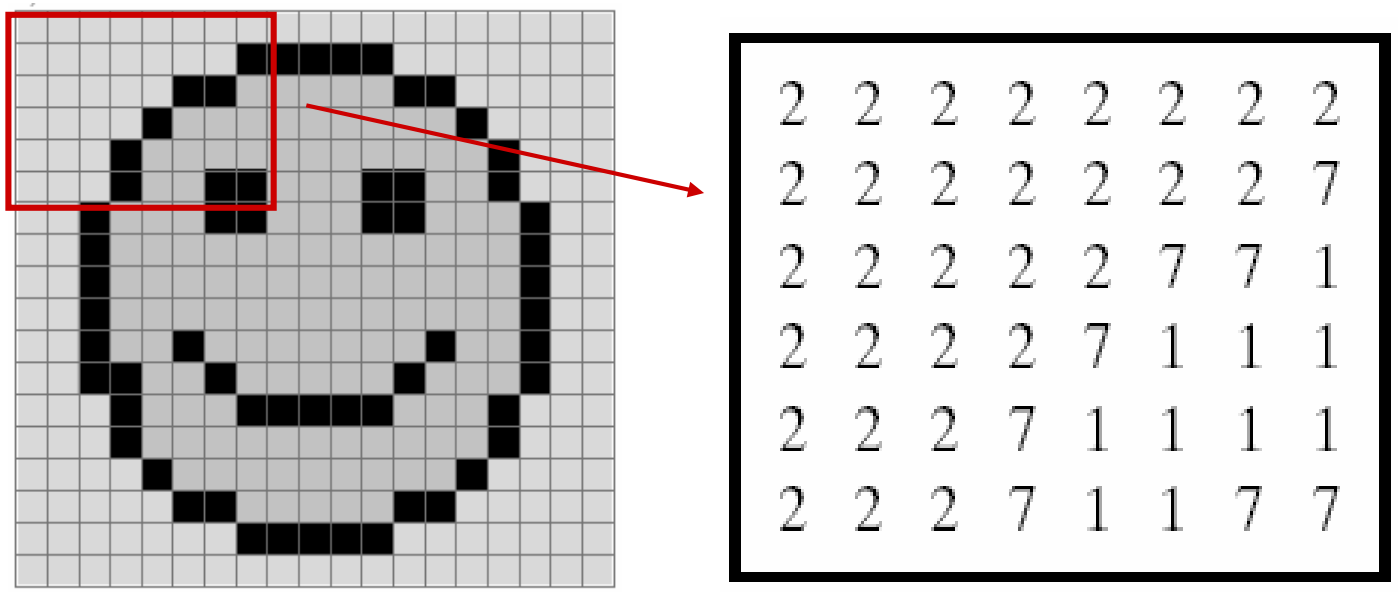


Figure 2-7
A raster-scan system displays an object as a set of discrete points across each scan line.

CRT Display Principles

- **Raster-Scan Displays**
  - **Picture elements: screen point referred as “Pixel”**
  - **Picture information stored in refresh (frame) buffer**

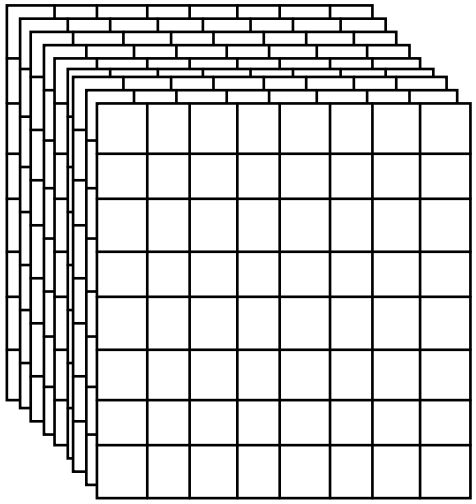


CRT Display Principles

- **Raster-Scan Displays**
  - **Picture information stored in refresh (frame) buffer**
    - **The number of bits per pixel in the frame buffer is called depth or bit planes**
    - **Buffer with 1 bit per pixel – Bitmap**
    - **Buffer with multiple bits per pixel – Pixmap**
  - **Interlaced refresh procedure**
    - **Beams sweeps across every other scan line**

Frame Buffer

- A frame buffer is characterized by size, x, y, and pixel depth.
- the **resolution** of a frame buffer is the number of pixels in the display. e.g. 1024x1024 pixels.
- Bit Planes or Bit Depth is the number of bits corresponding to each pixel. This determines the **color resolution** of the buffer.



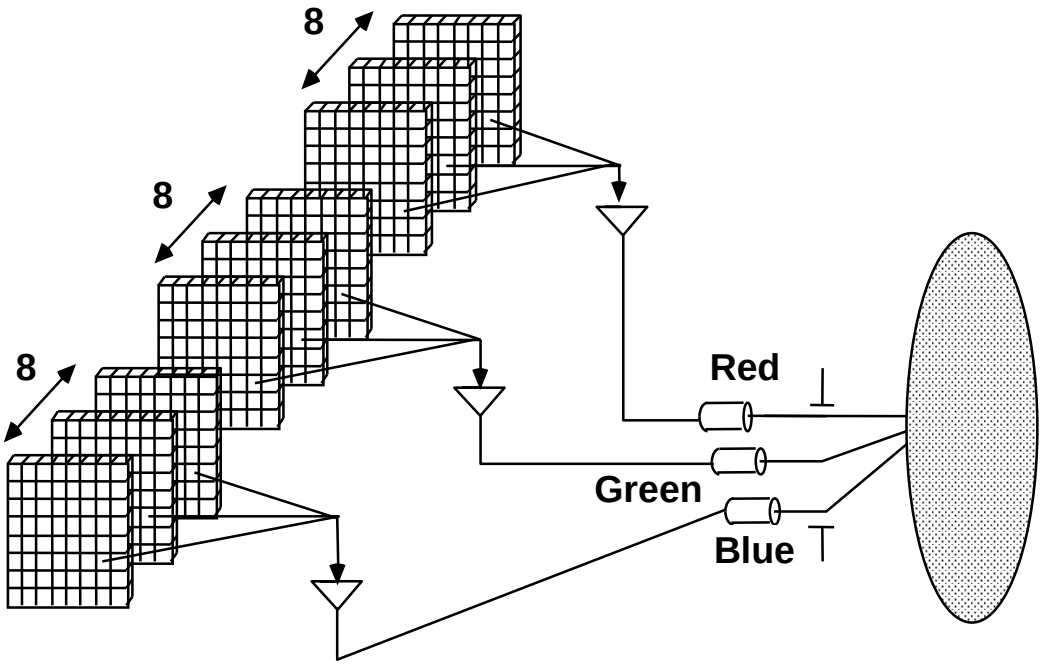
Bilevel or **monochrome** displays have 1 bit/pixel

8bits/pixel -> 256 simultaneous colors

24bits/pixel -> 16 million simultaneous colors

Specifying Color

- direct color :
  - each pixel directly specifies a color value
    - e.g., 24bit : 8bits(R) + 8bits(G) + 8 bits(B)
- palette-based color : indirect specification
  - use palette (CLUT)
    - e.g., 8 bits pixel can represent 256 colors

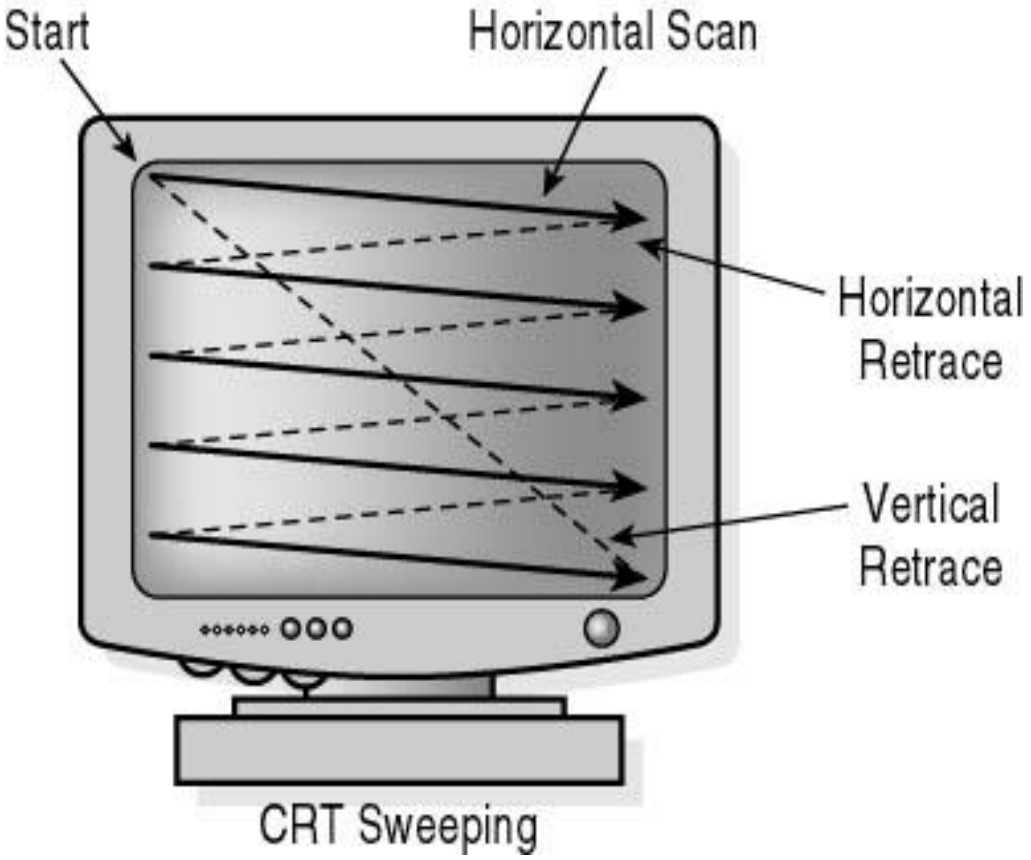


24 bits plane, 8 bits per color gun.

2^{24} = 16,777,216

Refresh Rates and Bandwidth

- Frames per second (FPS)



Interlaced Scanning

- Scan frame 30 times per second
- To reduce flicker, divide frame into two fields—one consisting of the even scan lines and the other of the odd scan lines.
- Even and odd fields are scanned out alternately to produce an interlaced image.

Interlaced

Odd lines
Field 1

Even lines
Field 2

Field 1 + Field 2 = Frame (complete image)

Display Rate: 60 fields per second (North America)

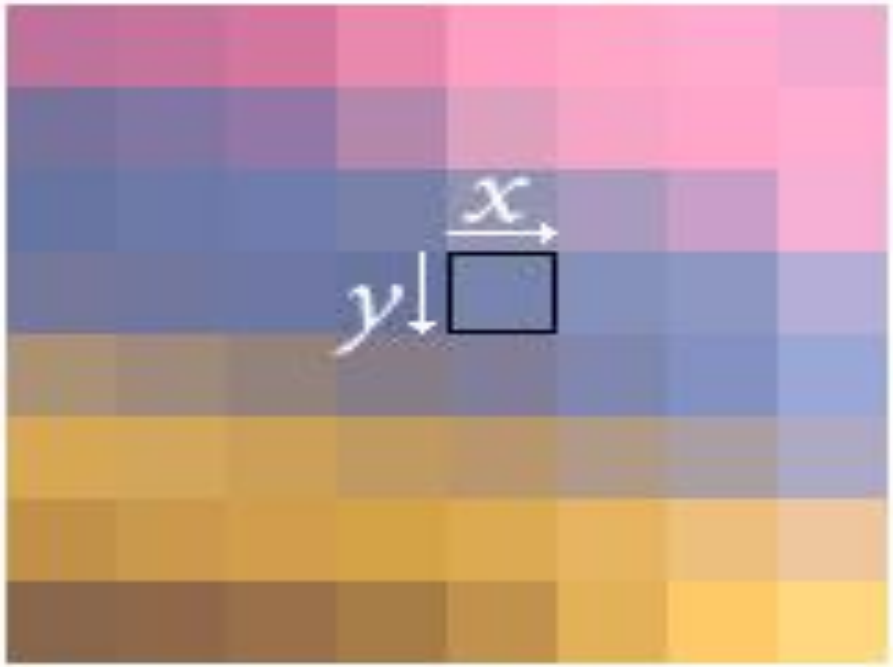
Aspect Ratio

Frame aspect ratio (FAR) = horizontal/vertical size

TV	4:3
HDTV	16:9
Page	8.5:11 ~ 3/4

Pixel aspect ratio (PAR) = FAR vres/hres

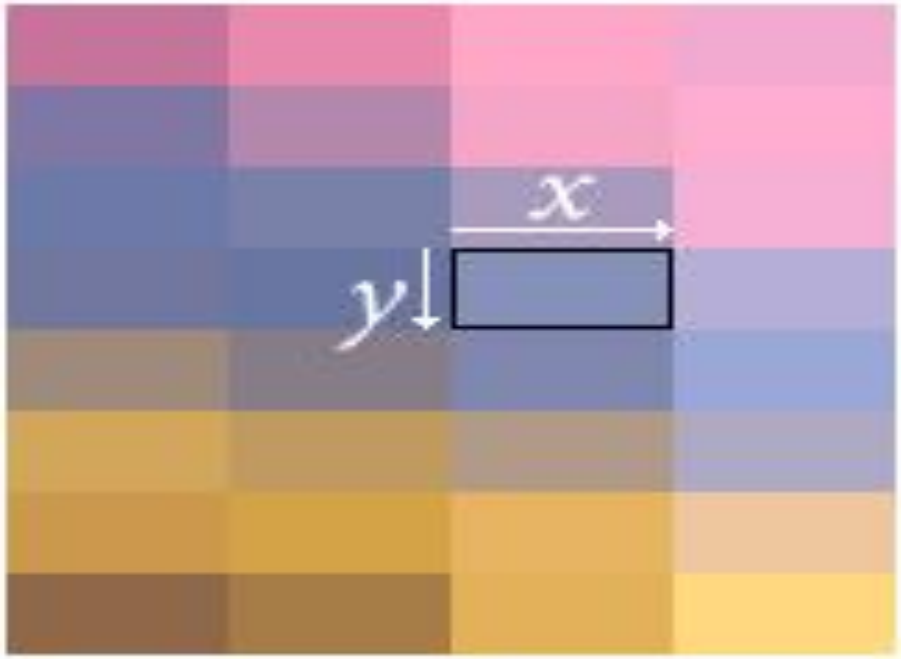
Nuisance in graphics if not 1



Pixel Aspect Ratio

PAR = x/y = 1:1

x = pixel width
y = pixel height



Pixel Aspect Ratio

PAR = x/y = 2:1

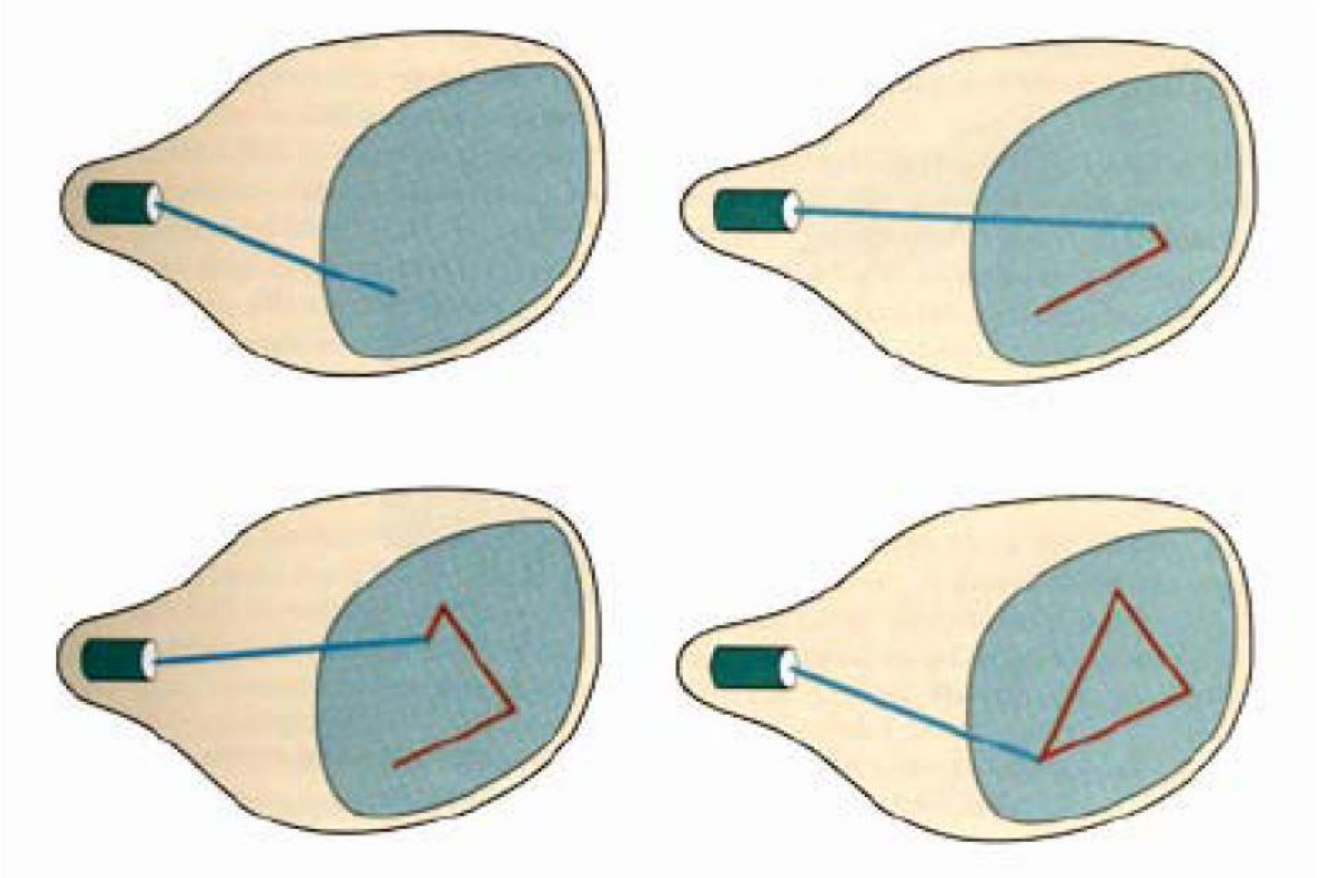
x = pixel width
y = pixel height

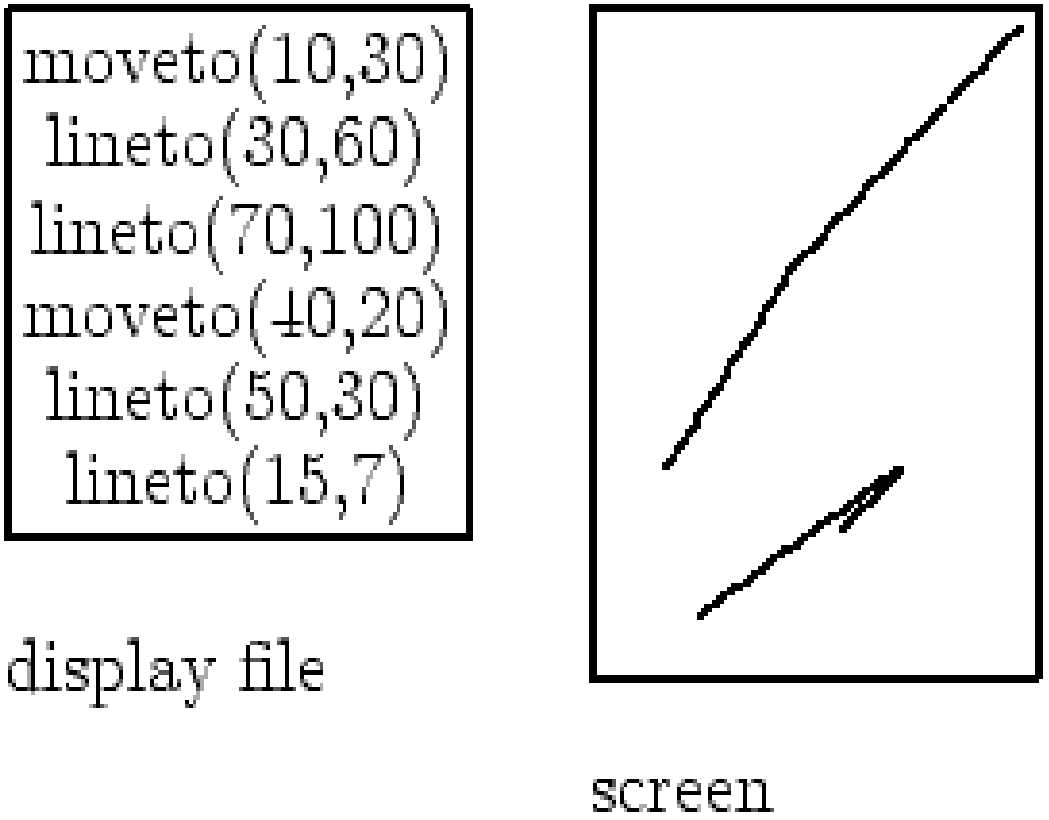
CRT Display Principles

- Random-Scan Display Principles
  - Calligraphic Displays also called vector, stroke or line drawing graphics
  - Electron beam directed only to the points of picture to be displayed.
  - Vector displays, electron beams trace out lines to generate pictures
  - Picture stores as a set of line-drawing commands
    - Storage referred as display list, refresh display file, vector file or display program
  - http://groups.csail.mit.edu/graphics/classes/6.837/F98/Lecture1/Slide11.html

CRT Display Principles

- Sample of Random-Scan displays principles

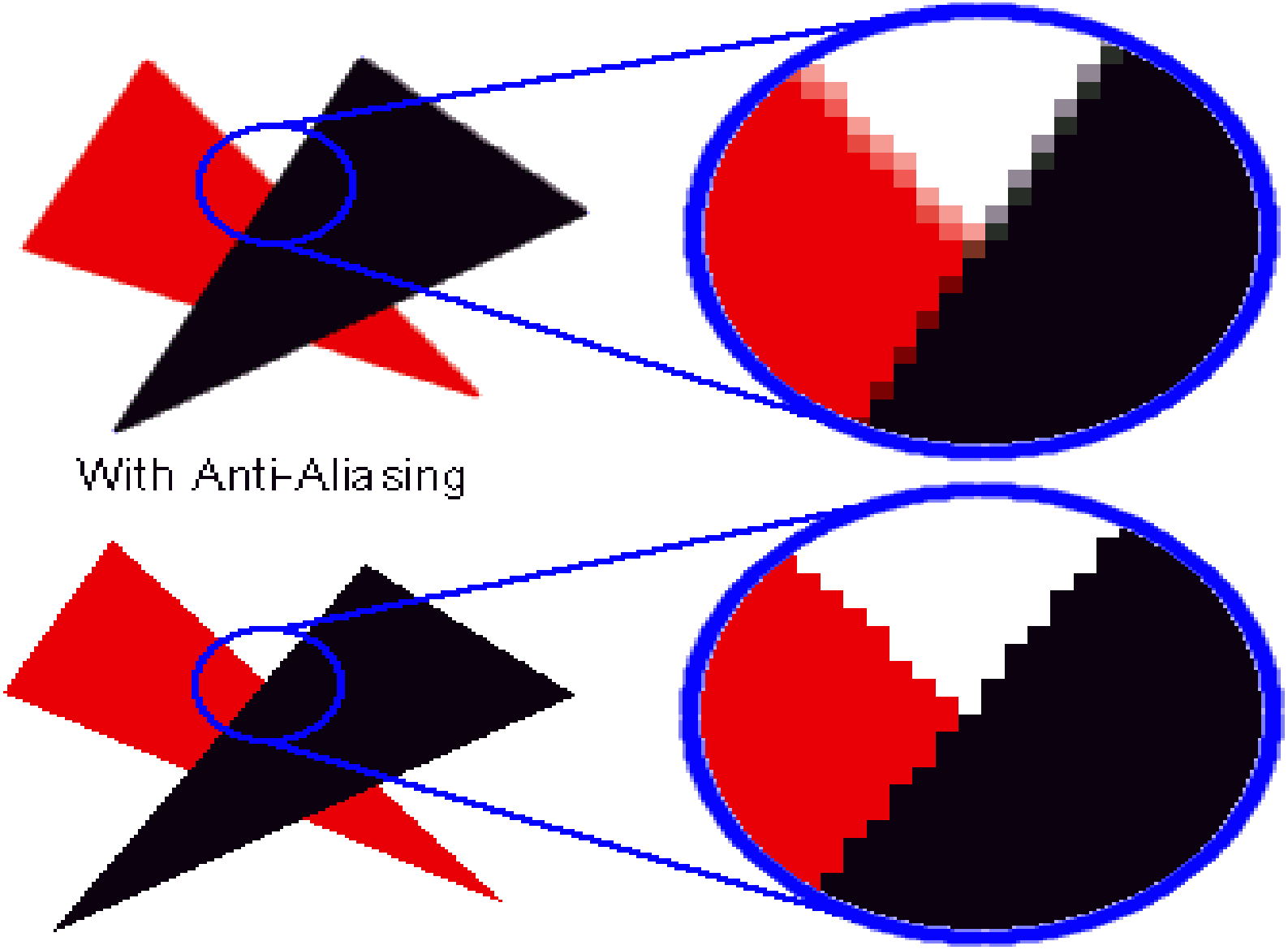




- Images are described in terms of line segments rather than pixels
- Display processor cycles through the commands

Pros and Cons

- Advantages to Raster Displays
  - lower cost
  - filled regions/shaded images
- Disadvantages to Raster Displays
  - a discrete representation, continuous primitives must be **scan-converted** (i.e. fill in the appropriate scan lines)
  - **Aliasing** or "**jaggies**" Arises due to sampling error when converting from a continuous to a discrete representation


With Anti-Aliasing
Without Anti-Aliasing

Comparing Raster and Vector (1/2)

- advantages of vector:
  - very fine detail of line drawings (sometimes curves), whereas raster suffers from jagged edge problem due to pixels (aliasing, quantization errors)
  - geometry objects (lines) whereas raster only handles pixels
  - eg. 1000 line plot: vector disply computes 2000 endpoints
  - raster display computes all pixels on each line

Comparing Raster and Vector (2/2)

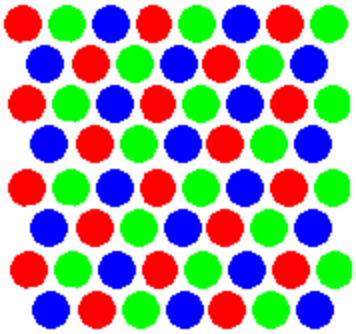
- advantages of raster:
  - cheaper
  - colours, textures, realism
  - unlimited complexity of picture: whatever you put in refresh buffer, whereas vector complexity limited by refresh rate

Color CRT Monitors

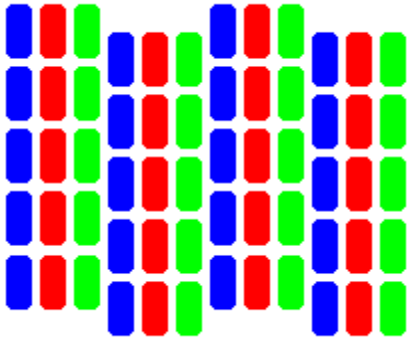
- **Using a combination of phosphors that emit different-colored light**
- **Beam-penetration**
  - **Used in random-scan monitors**
  - **Use red and green phosphors layers**
  - **Color depends on the penetrated length of electrons**
- **Shadow mask**
  - **Used in raster-scan systems**
  - **Produce wide range of color with RGB color model**

Color CRT Monitors

- Color CRTs are *much* more complicated
  - Requires manufacturing very precise geometry
  - Uses a pattern of color phosphors on the screen:



Delta electron gun arrangement

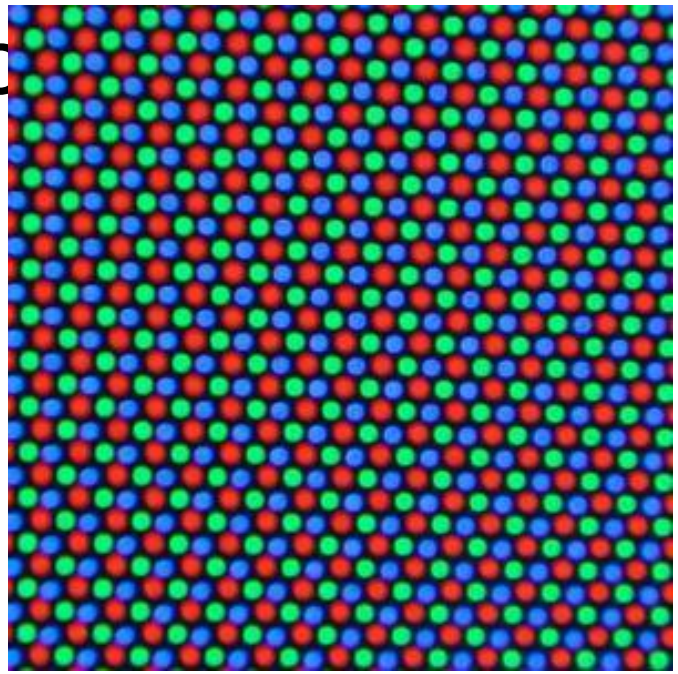


In-line electron gun arrangement

http://www.udayton.edu/~cps/cps460/notes/displays/

Color CRT Monito

- Operation of delta-delta, shadow mask CRT



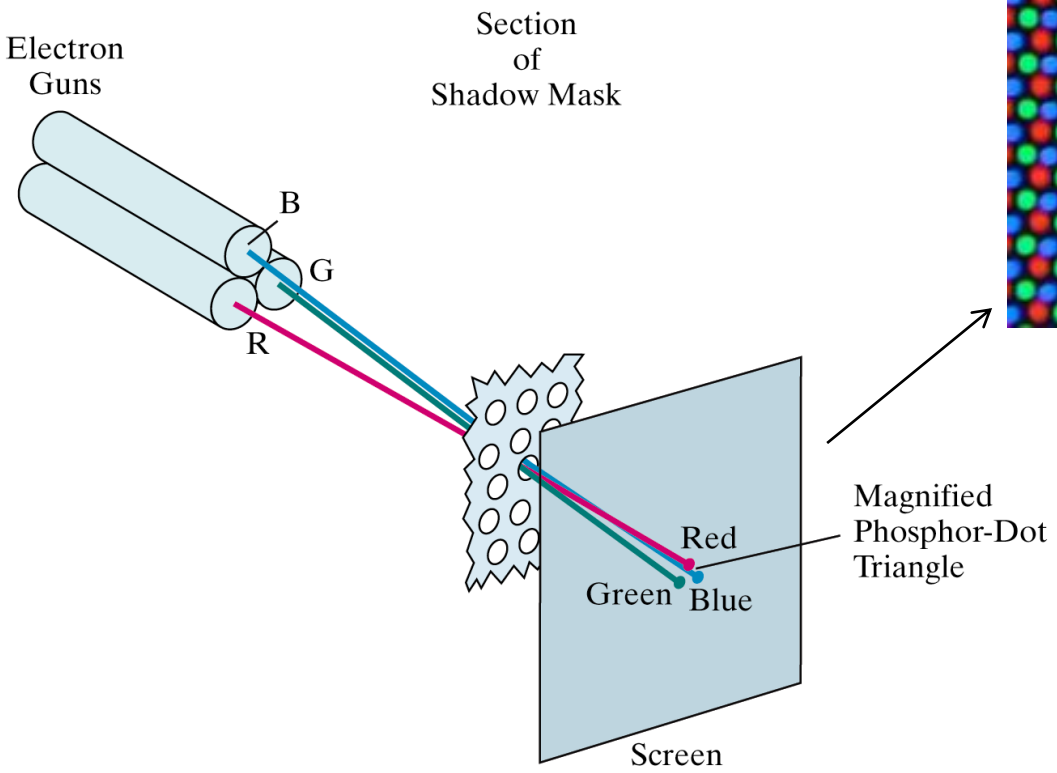


Figure 2-10

Inherent Memory Devices

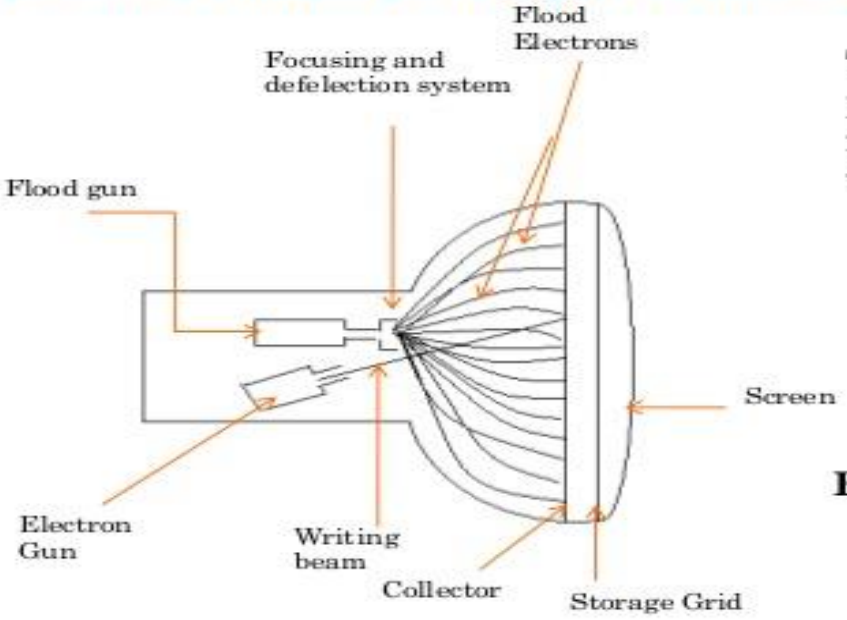
- DVST (Direct View Storage Tube)
- Plasma Panel Displays
- Laser Scan Displays

DVST

•Direct view storage tube(DVST) :- It Consist of two electron guns as writing gun & flood gun. Writing gun stores picture pattern as a positive charge on storage grid.

•This picture pattern is transferred to phosphor by continuous flood of electron generated from flood gun.

•Flood electrons passes through collector which smoothes out flow of electrons. Electrons passes through collector at low speed and are attracted by positively charged picture pattern on storage grid and are repelled by rest.



The attracted electrons by positive picture pattern pass right through it and strike on phosphor making it visible screen.

Fig. DVST

Direct-View Storage Tubes

This is the method for maintaining a screen image by storing the picture information inside the CRT. Similar to the standard CRT, except that it does not need to be refreshed because its stores picture information as a charged distribution just behind the screen.

Flat-Panel Displays

- **A class of video devices that have reduced volume, weight and power requirement compared with CRT**
- **Two main categories**
  - **Emissive Displays**
    - **Convert electrical energy to light energy**
    - **e.g. Plasma panels**
  - **Non-emissive Displays**
    - **Use optical effects to convert light from other sources into graphics patterns**
    - **e.g. LCD monitors**

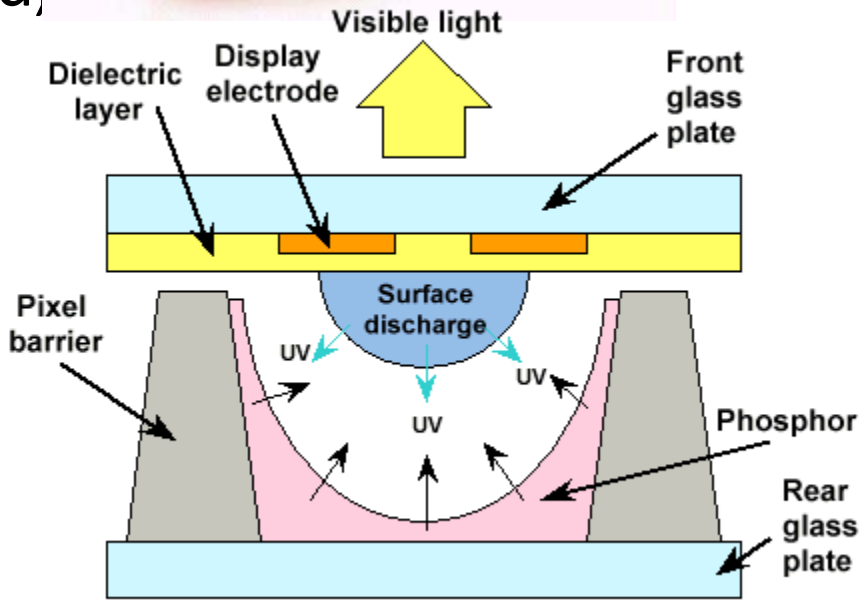
Plasma Panel Display

- **Plasma panels (gas-discharge display)**
  - **Contracted by filling the region between two glass plates with a mixture of gases**
  - **Refresh buffer used to store picture information**
  - **Firing voltages applied to refresh the pixel positions**

Plasma Panel

Plasma display panels

- Similar in principle to fluorescent light tubes
- Small gas-filled capsules are excited by electric field, emits UV light
- UV excites phosphor
- Phosphor relaxes, emits some other color



Plasma Panel (2)

Plasma Display Panel Pros

- Large viewing angle
- Good for large-format displays
- Fairly bright

Cons

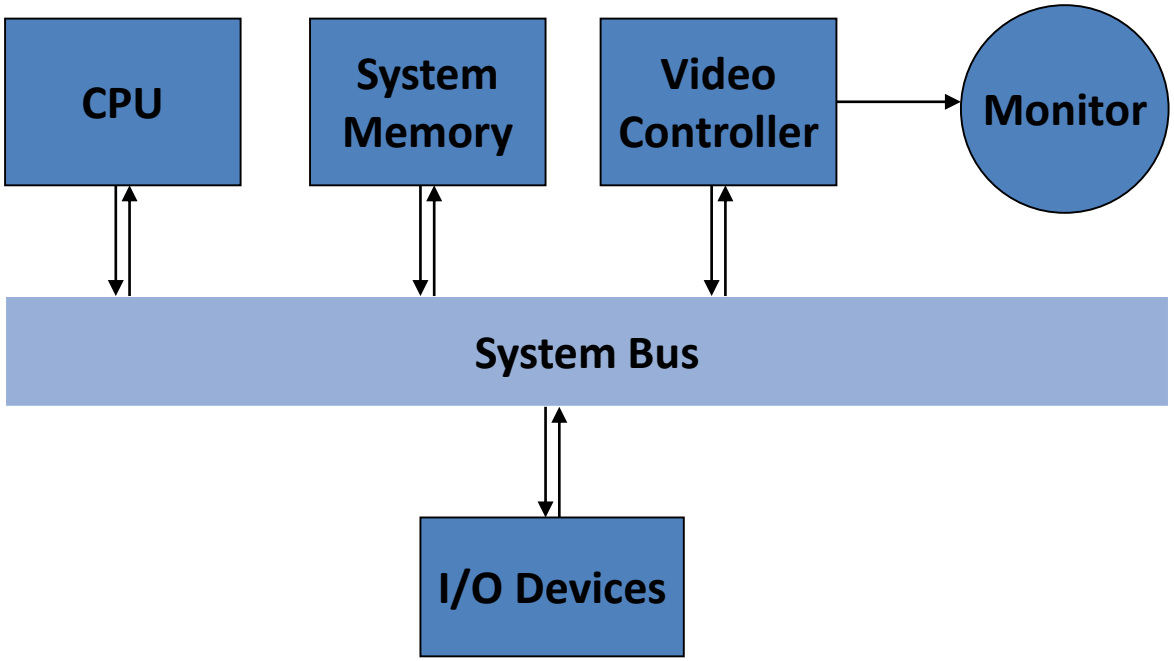
- Expensive
- Large pixels (~1 mm versus ~0.2 mm)
- Phosphors gradually deplete
- Less bright than CRTs, using more power to some extent in order to make up for the less illumination.

Liquid-crystal Displays

- **Liquid-crystal displays (LCD) commonly used in small systems**
  - **Liquid crystal, compounds have a crystalline arrangement of molecules, flow like a liquid**
  - **Passive-matrix LCD To control light twisting, voltage applied to intersecting conductors to align the molecules**
  - **Active-matrix LCD Using thin-film transistor technology, place a transistor at each pixel location**

Raster-Scan systems

- **Organization of raster system**
  - **Fixed area of system memory reserved for frame buffer which can be directly accessed by video controller**

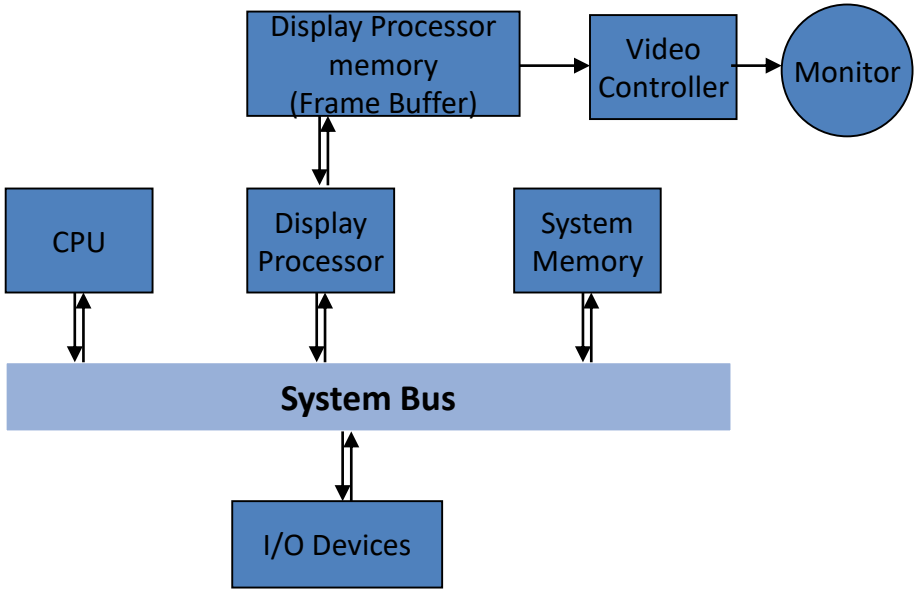


Raster-Scan systems

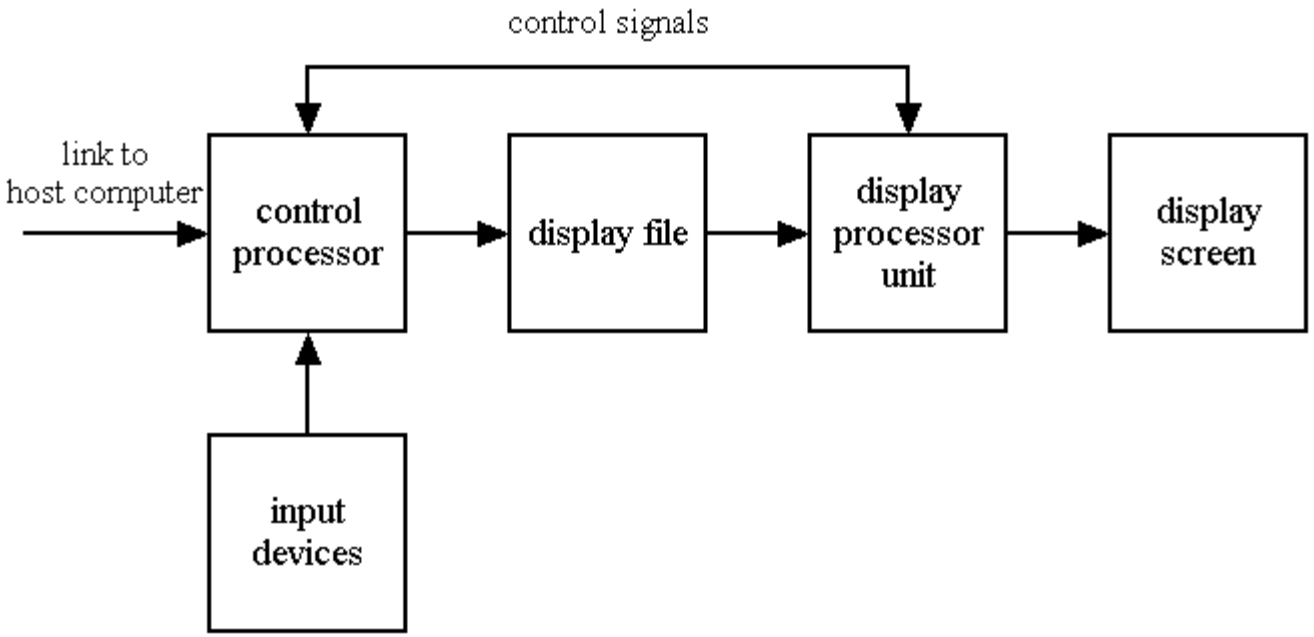
- **Video Controller**
  - **Refresh operations**
    - **X, Y register used to indicate pixel position**
    - **Fix Y register and increment X register to generate scan line**
  - **Double buffering**
    - **Pixel value can be loaded in buffer while**
    - **Provide a fast mechanism for real-time animation generation**

Raster-Scan Systems

- **Raster-Scan Display Processor**
  - **Free the CPU from the graphics chores**
  - **Provide separate display-processor memory**
  - **Fig. Architecture of raster-scan display system with display processor**

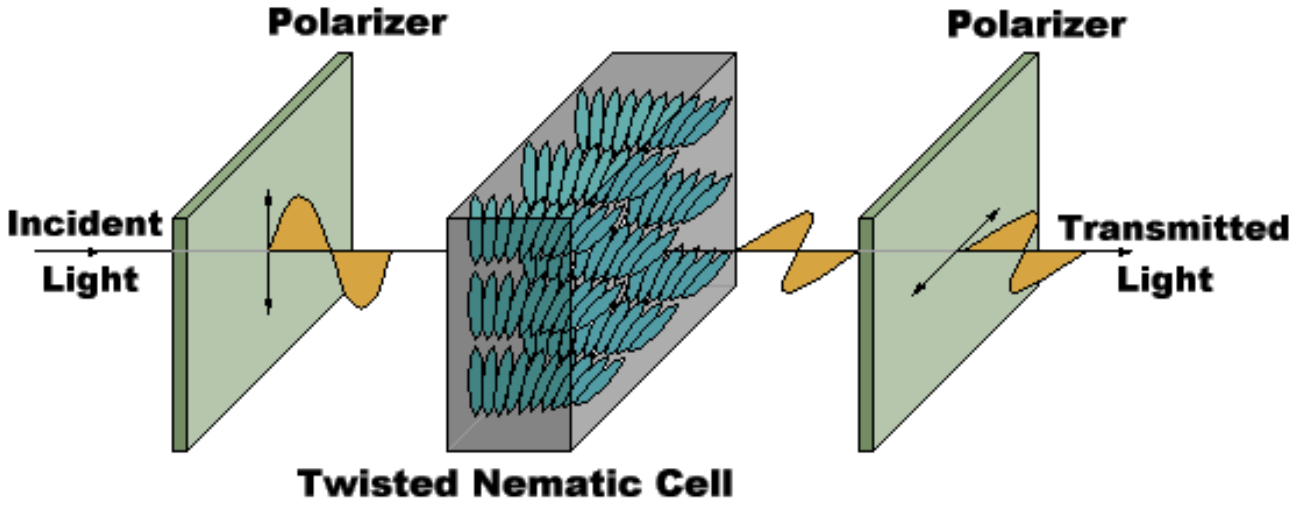


Block diagram of line drawing display/Random Scan Display



Liquid Crystal Displays (LCDs)

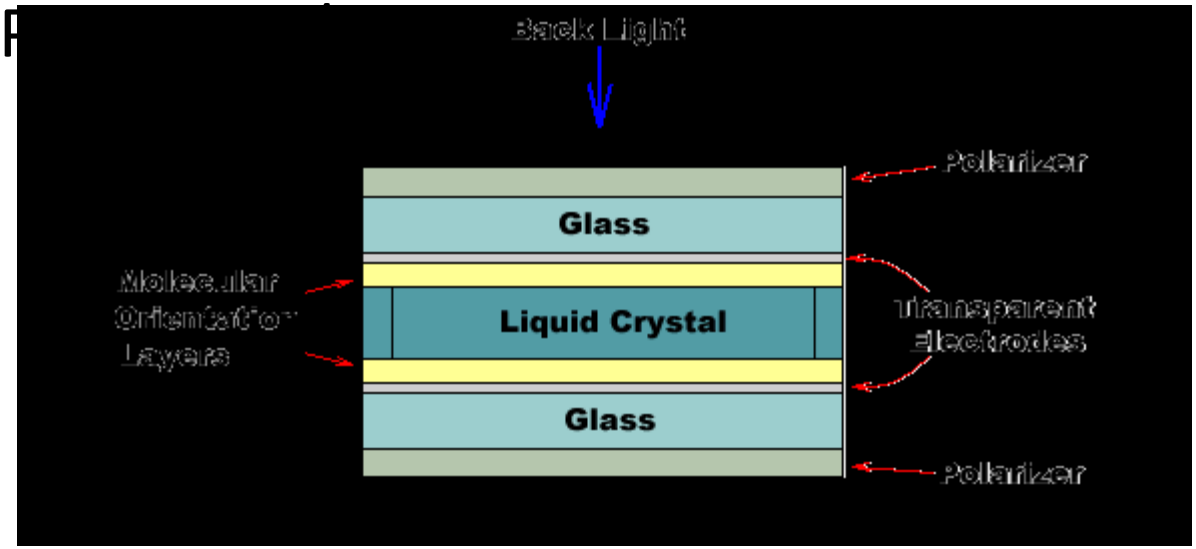
– LCDs: organic molecules, naturally in crystalline state, that liquefy when excited by heat or E field
– Crystalline state twists polarized light 90º.



Display Technology: LCDs

Transmissive & reflective LCDs:

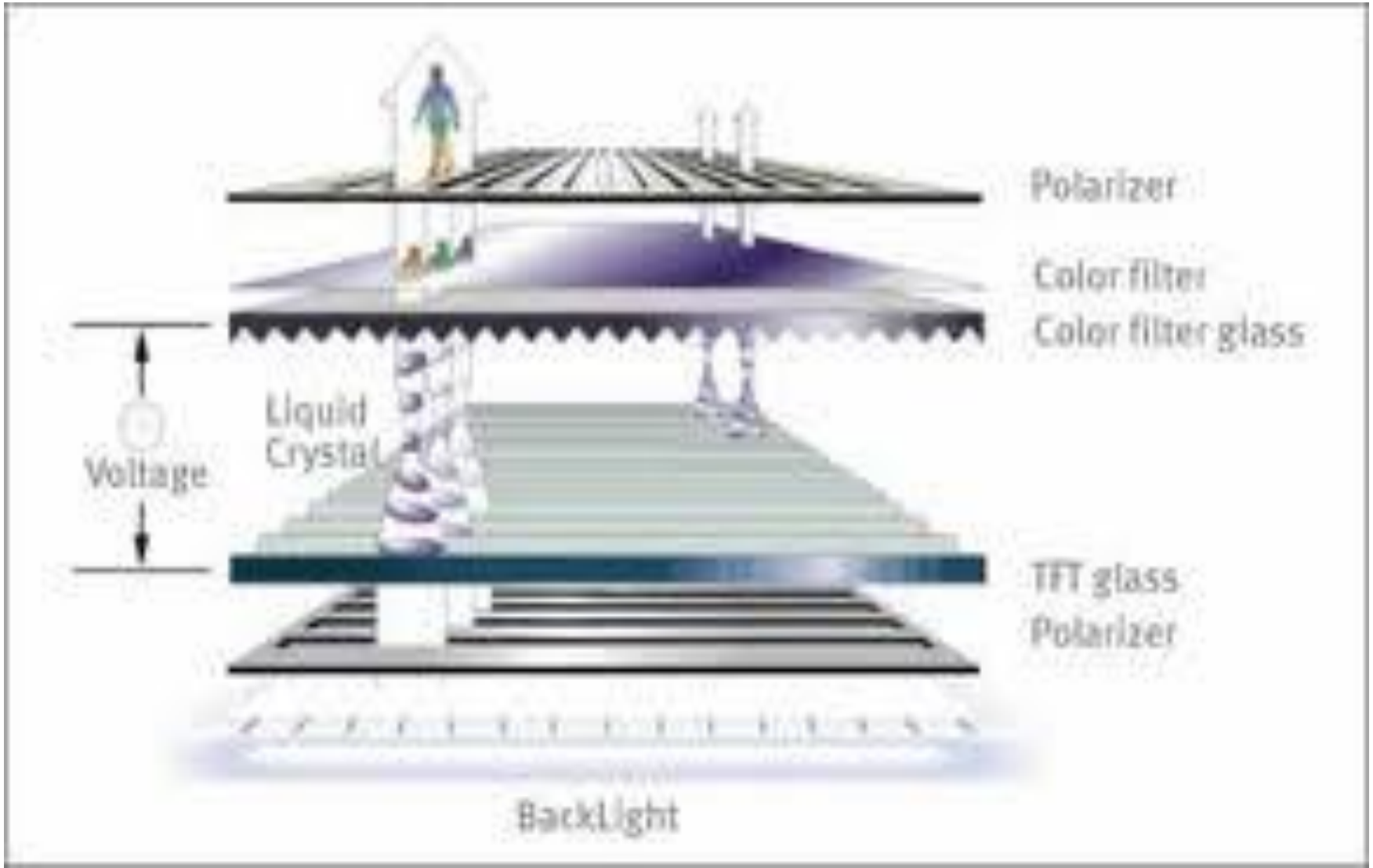
- LCDs act as light valves, not light emitters, and thus rely on an external light source.
- Laptop screen: backlit, *transmissive display*
- R



Working of LCD

- An LCD works entirely differently compared to Plasma Panel.
- An active matrix LCD's light source is generated by small fluorescent bulbs. The white light from these bulbs is diffused to create a uniform light source by shining it through a polarizer located in the back of the display, which allows light to go through in only one direction.
- Individual LCD cells in the panel are then turned "on" and "off" by applying a small electric charge to the thin film transistors (TFT), located in each sub-pixel.
- This charge causes the liquid crystals to twist, allowing white light to be passed through red, green and blue color filters and a front polarizer in front of the LCD cells. The image is formed according to which crystals twist to let light through or block it.

Working of LCD (pic)



Thank you