

Devices displaying 3D image

RNDr. Róbert Bohdal, PhD.

Types of devices displaying 3D image

- Stereoscopic
- Re-imaging
- Volumetric
- Autostereoscopic
- Holograms
- Head mounted displays, optical head-worn displays
- Pseudo 3D displays

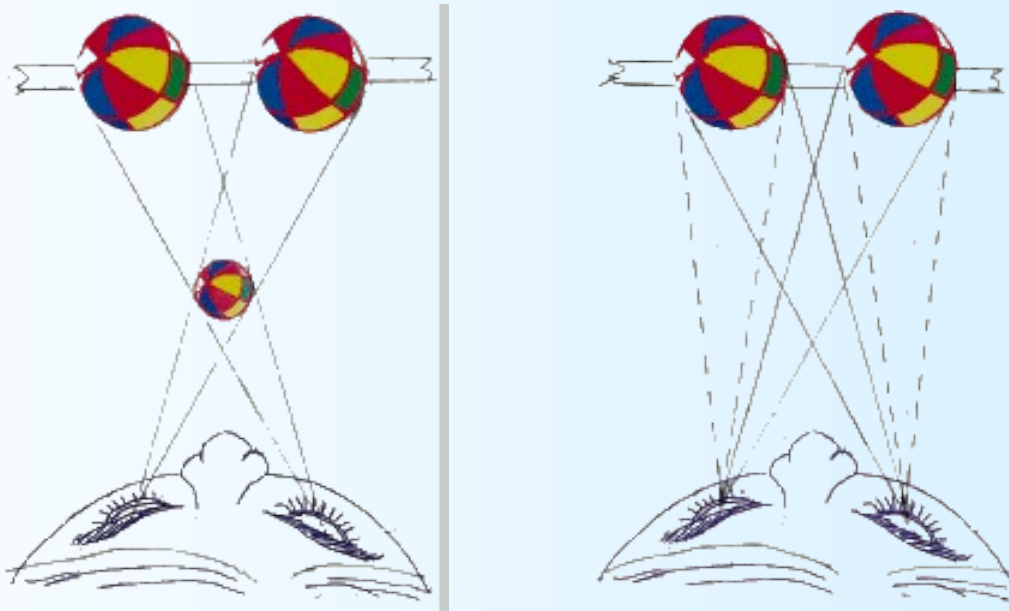
Stereoscopy

- Technique for creating the illusion of depth in an image by means of stereopsis.
- Stereoscope was created by British inventor Charles Wheatstone in 1838.
- In 1849 David Brewster used two lenses to separate two images shown next to each other.



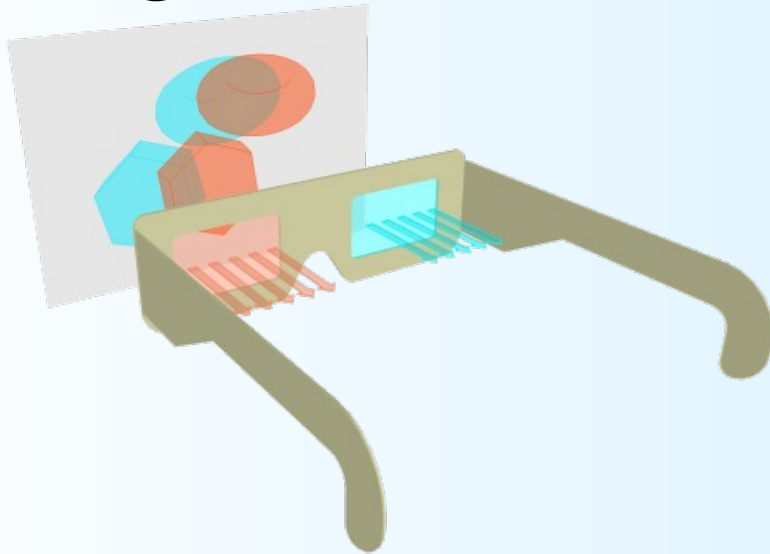
Stereoscopy

- The observer sees the two balls on the screen and therefore does not rise a stereoscopic effect.
- To create it, we must find a way to eliminate viewing cones represented by dashed lines.



Stereoscopy...

- The image is shown in duplicate, one for the left eye and the other for the right.
- Images are not identical, each is from a different point of view.
- The parts of the image that must not be visible are filtered out using glasses with colour or polarizing filters.



Anaglyph 3D

- Anaglyph is stereoscopic 3D effect achieved by using filters of different (usually chromatically opposite) colours.

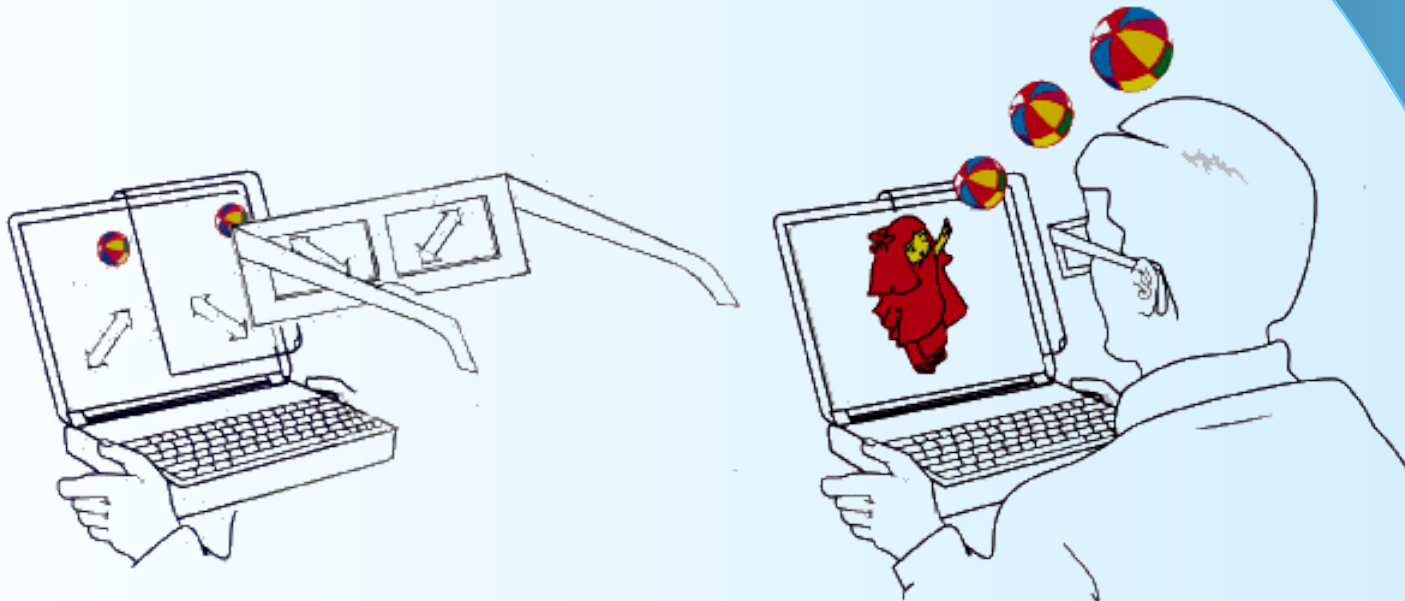
Name	Left eye	Right eye	Colour rendering
red-green	red	green	monochrome
red-blue	red	blue	monochrome
red-cyan	red	cyan	color (poor reds, good greens)
ColorCode 3-D	amber	dark blue	color (almost full-color perception)

Stereoscopy in the 3D cinemas

- Passive glasses are used especially in 3D cinemas.
- RealD 3D cinemas use the circular polarizing to achieve 3D which allows viewers a clear image even when turning or tilting their heads. RealD 3D projectors use a special lens to project 3D four times the resolution of full-HD 1080p.
- Imax 3D movies are less tolerant of head movements. Imax screens are curved to fill a viewer's field-of-view, which enhances immersion. Imax3D projectors are only full-HD.

Stereoscopy DIY

- Half of the LCD display is covered with a special cellophane that rotates the plane of polarized light by 90 degrees.
- The parts of the image that are not to be seen are eliminated by polarizing glasses.



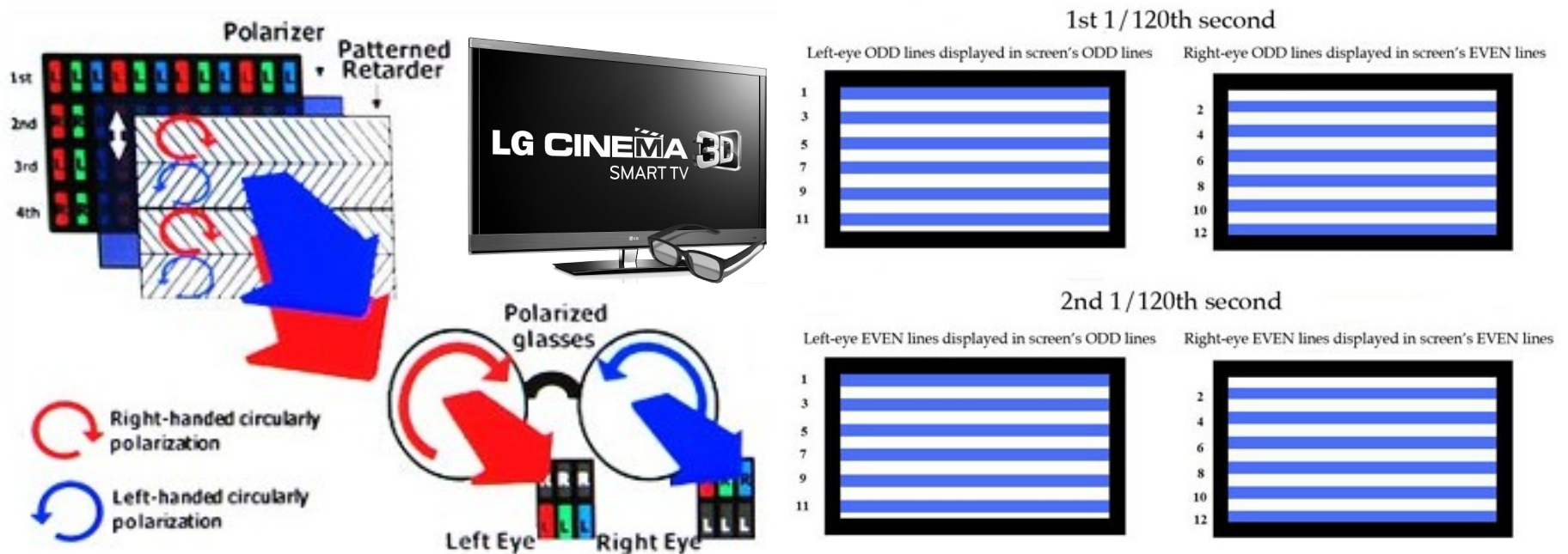
3D TV

- Two different technologies are used - with active or passive glasses.
- Each lens of the active glasses is a small LCD filter that is switched by the electronics to a state when it is transmitting or not transmitting light in synchronization with the image displayed on the TV.
- Passive technology displays two images at a time, but each with another polarization.



LG Cinema 3D TV

- Uses passive technology and left- and right-handed circular polarization.
- TV displays odd lines with right- and even lines with left-handed polarization.
- Uses interlaced method of image displaying.

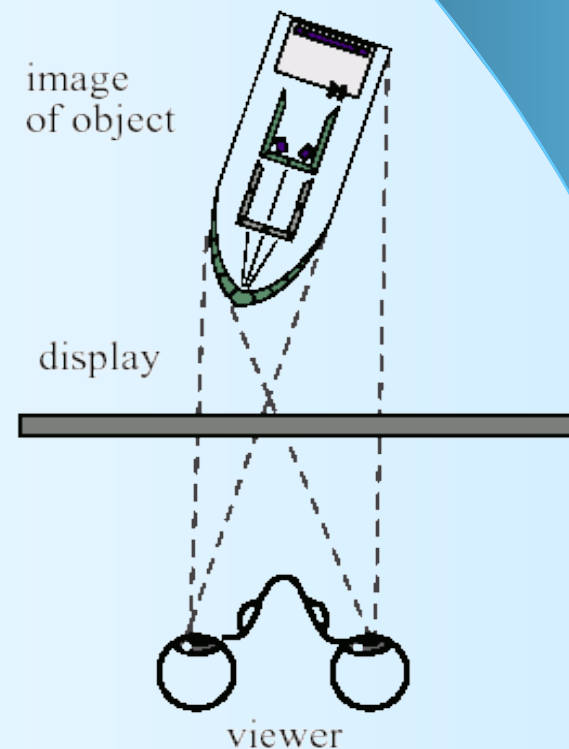
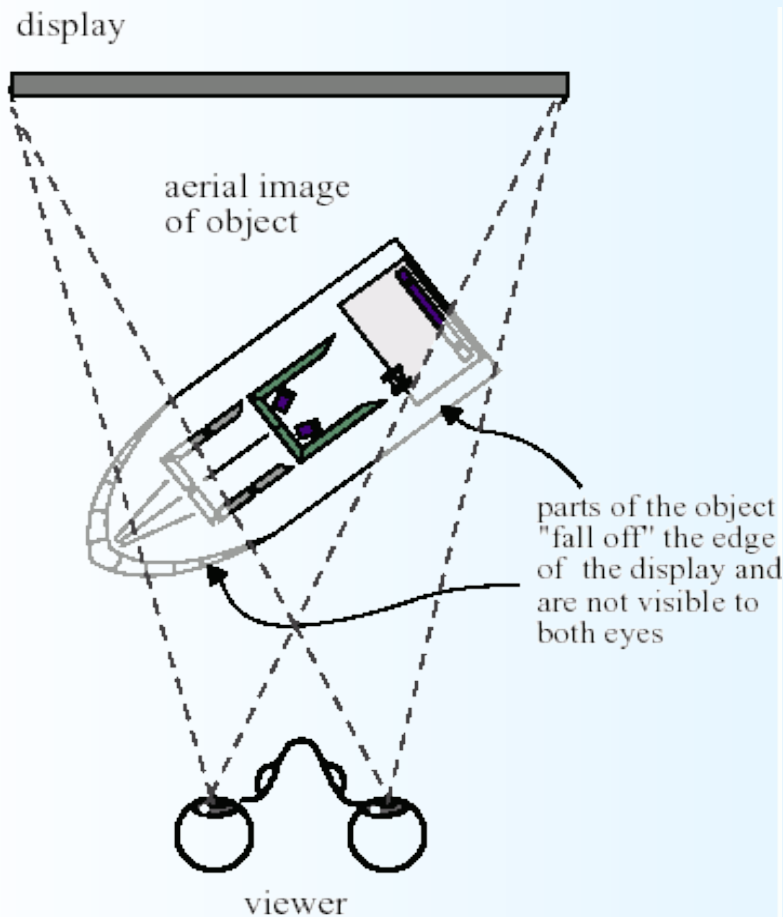


Re-imaging

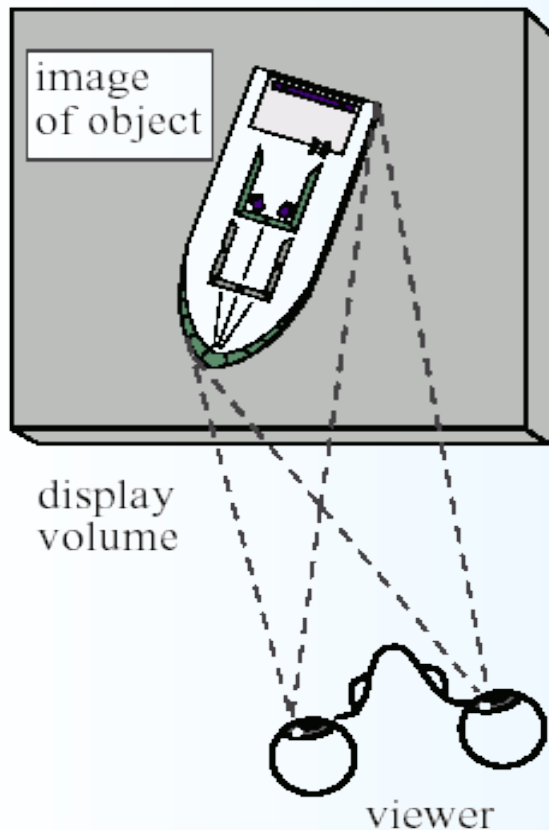
- They do not create an image, they only transmit it to a new display point with the optical system.
- The simplest example is a mirror.
- More complex devices (using lenses, ordinary or semi-transparent mirrors) can also change the depth or shape of the displayed object.

3D displays and displayed image

- Object image is displayed in front or behind of the display surface.

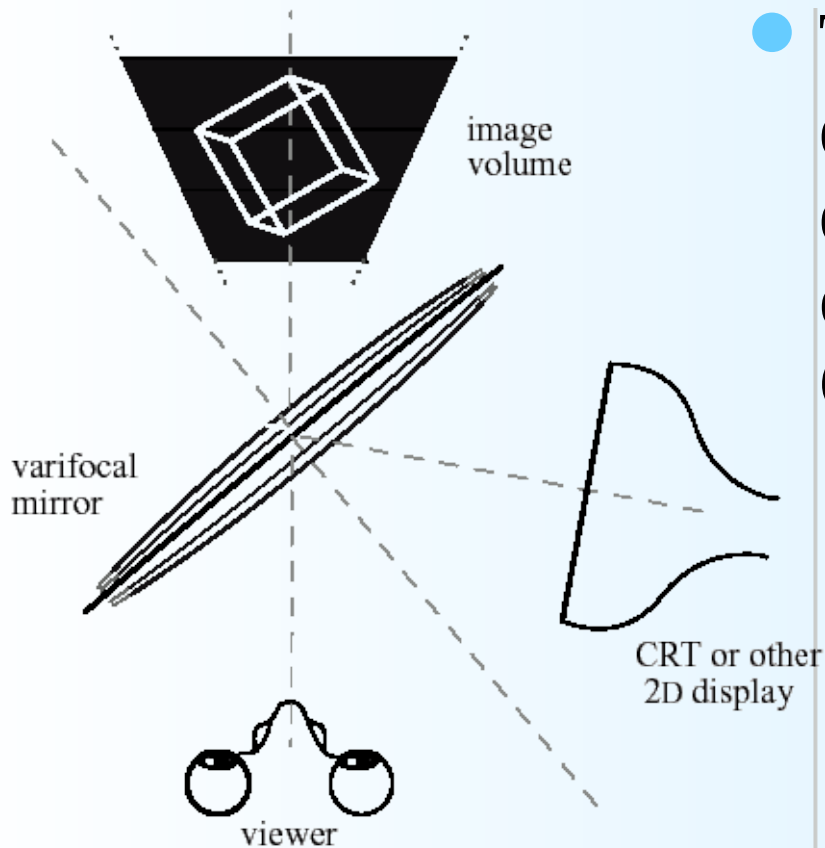


Volumetric displays



- Image is created by swiping the display space quickly or displays create an image without moving parts in the whole volume of the display.
- Object image is displayed inside the display volume.

Volumetric displays

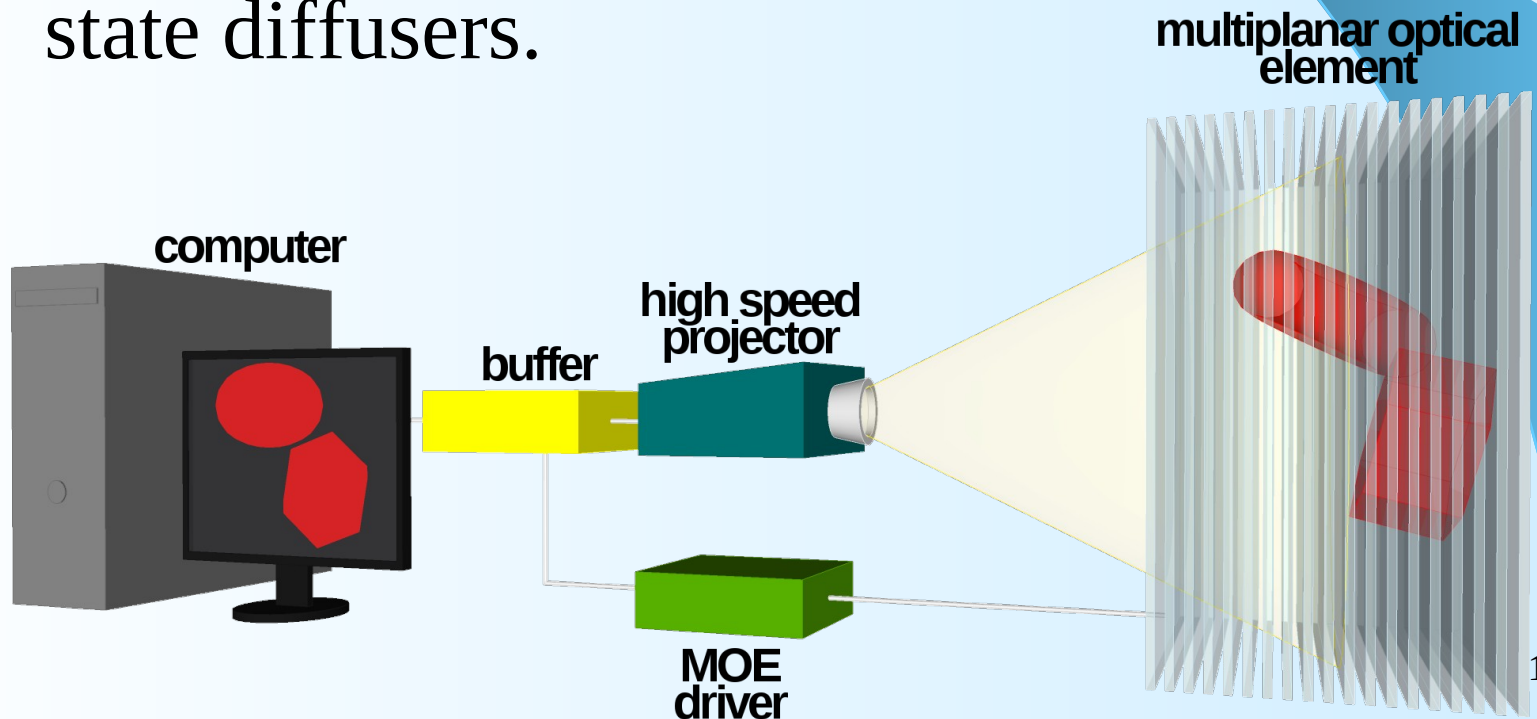


- The varifocal mirror creates depth by gradually displaying cut planes (slots) of the 3D image on the CRT.

Varifocal mirror

Volumetric displays with static screen

- Uses several layers of panels that display three-dimensional image sections.
- Active types use transparent OLED panels, passive types, use LC panels acting as two-state diffusers.

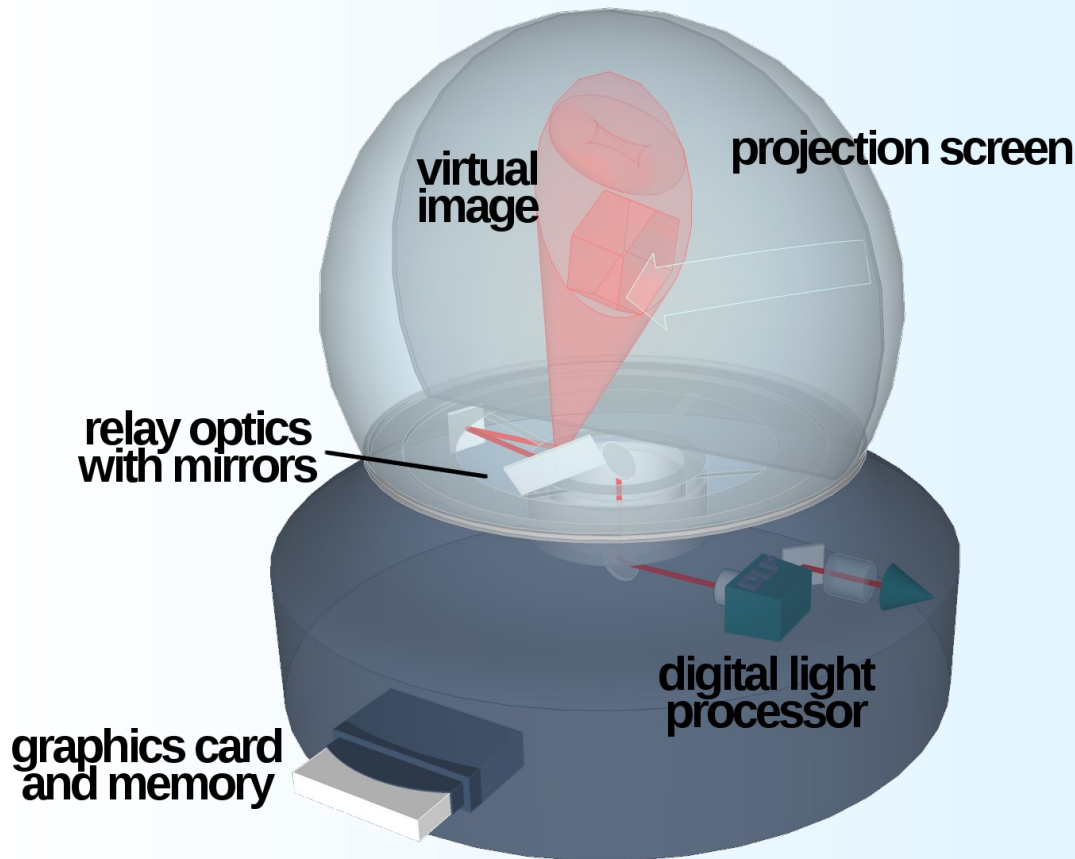


Volumetric displays with rotating screen

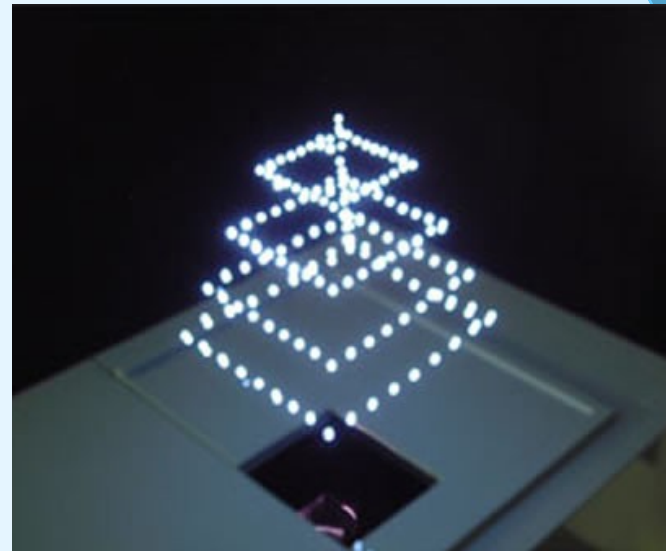
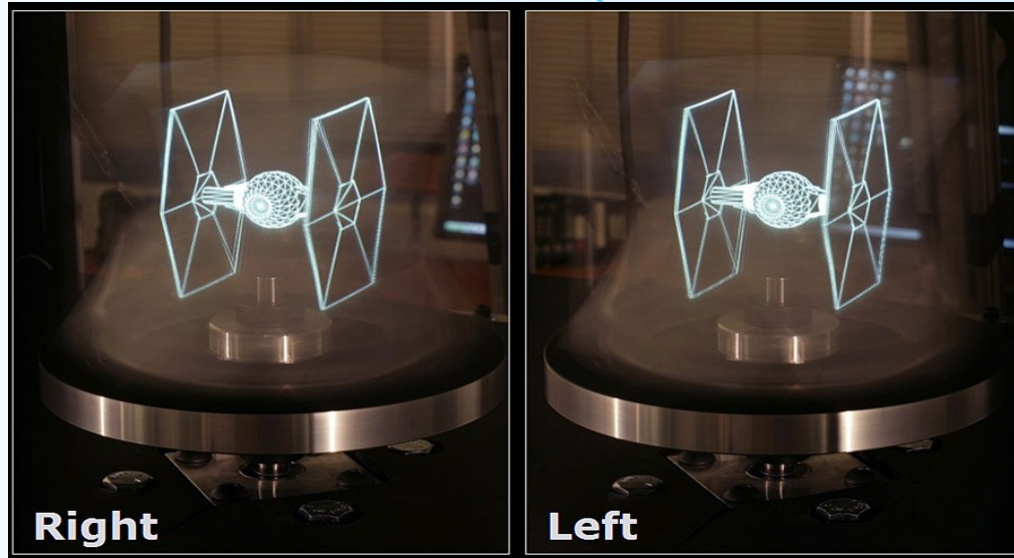
- The rotating element may be a circle, a rectangle, or a helix.
- The light points on the rotating element are either located on it (light diodes), or they may be formed by a beam incident on the rotating surface.
- The displayed object is visible in a wide field of view.
- They do not allow that one part of the object hides another - they are only suitable for vector objects.

Volumetric displays with rotating screen

- The image is displayed in a certain volume, usually on a rotating surface.



Examples of volumetric displays

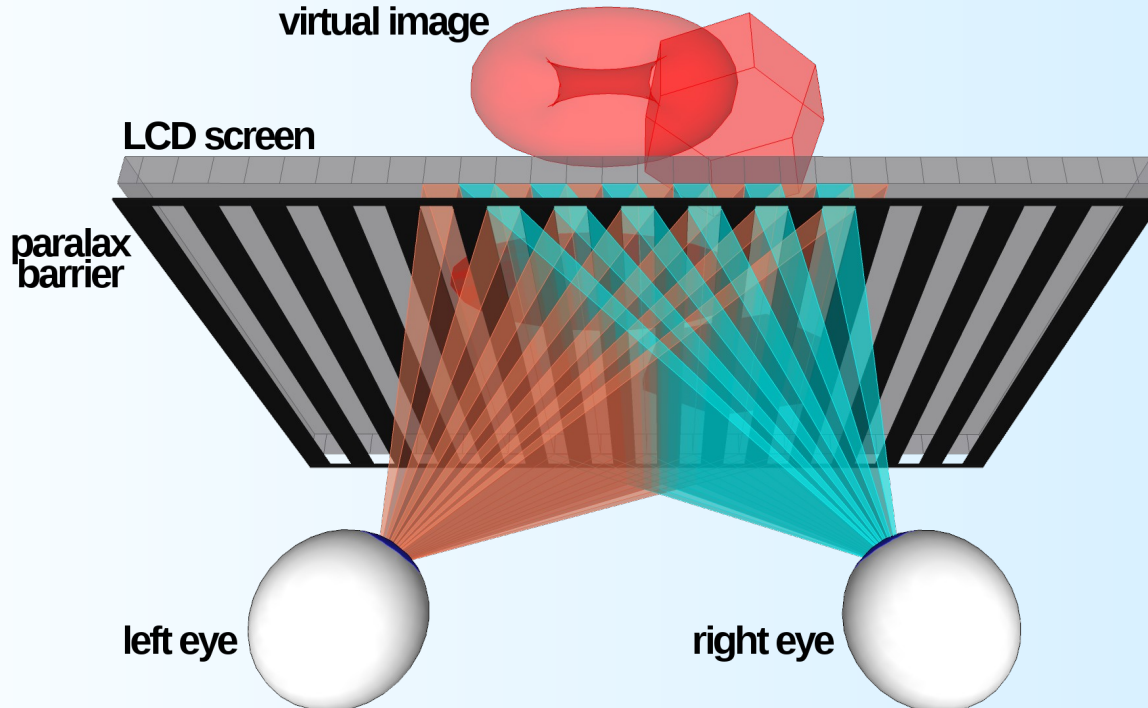


Autostereoscopic displays

- Parallax barrier displays
 - ✓ Parallax stereogram (panoramagram)
- Lenticular sheet displays
 - ✓ Lenticular panoramagram
 - ✓ Spherical integram
- Displays using time aperture
- Holographic stereograms

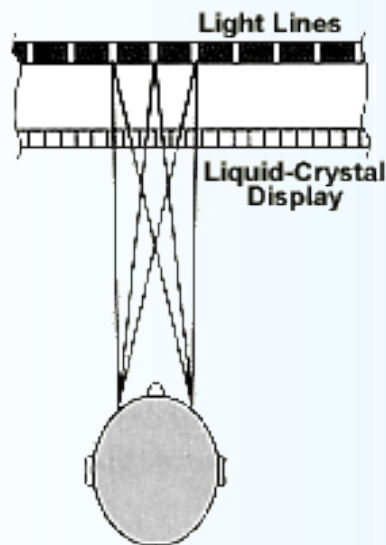
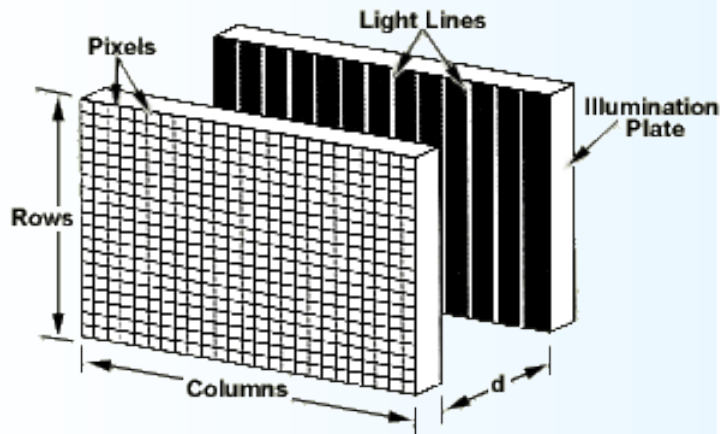
Parallax barrier displays

- Use a vertical mask in the shape of stripes placed at a specified distance in front of the display.
- Each eye of the observer sees different vertical stripes of the image on the display because each second stripe is shaded by mask stripes.



Parallax barrier displays...

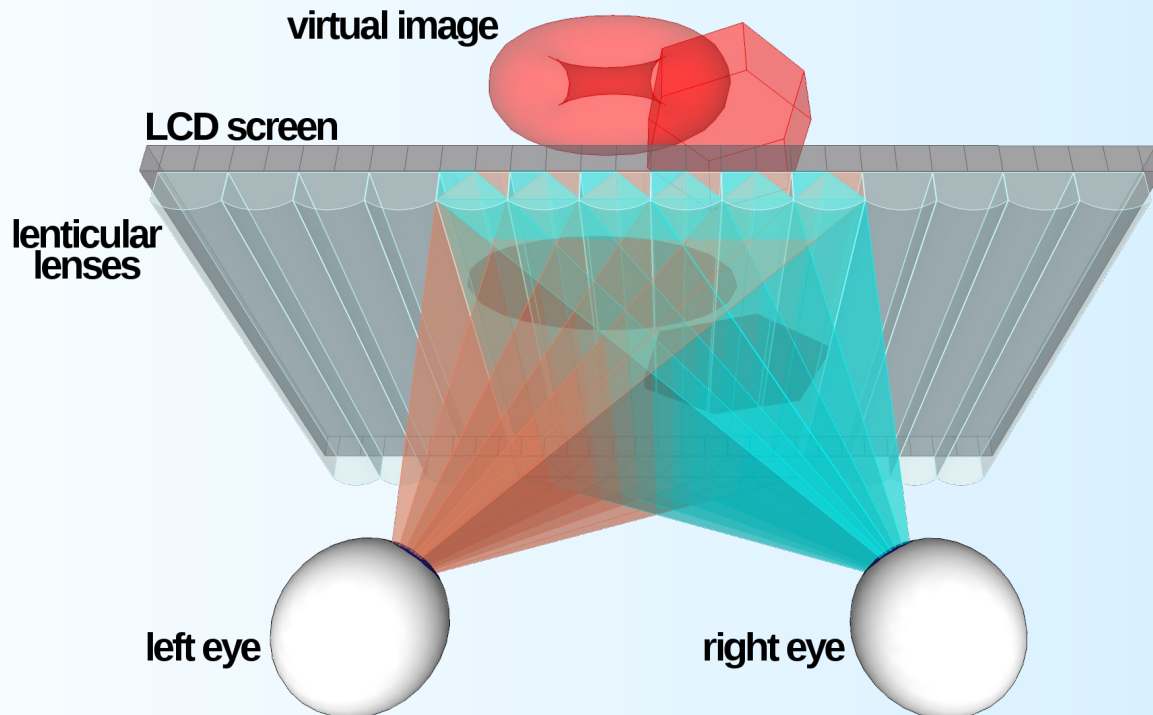
Dimension Technologies



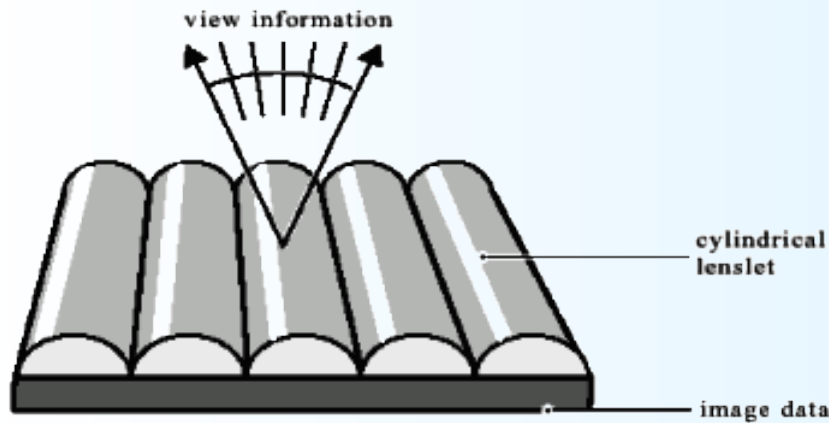
- As a parallax barrier, a separate translucent LCD panel can also be used to dynamically create vertical black bars so that the mask matches the current observer's position.
- In the DT technology „bars“ are located beyond the LCD display media.
- The most important drawback is reduction of the brightness and resolution in half.

Lenticular sheet display

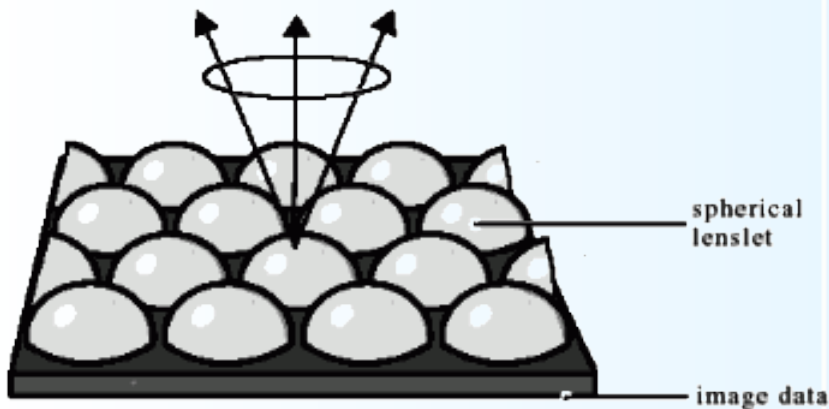
- Panel consisting of vertical stripes of cylindrical lenses – lenticulars.
- Lenses play the same role as the parallax barrier, and as they are translucent, there is no loss of brightness.
- Are aligned with vertical pixel columns on the LCD panel located in the focal plane of the lenses.



Panoramagram and Integram



Lenticular panoramagram

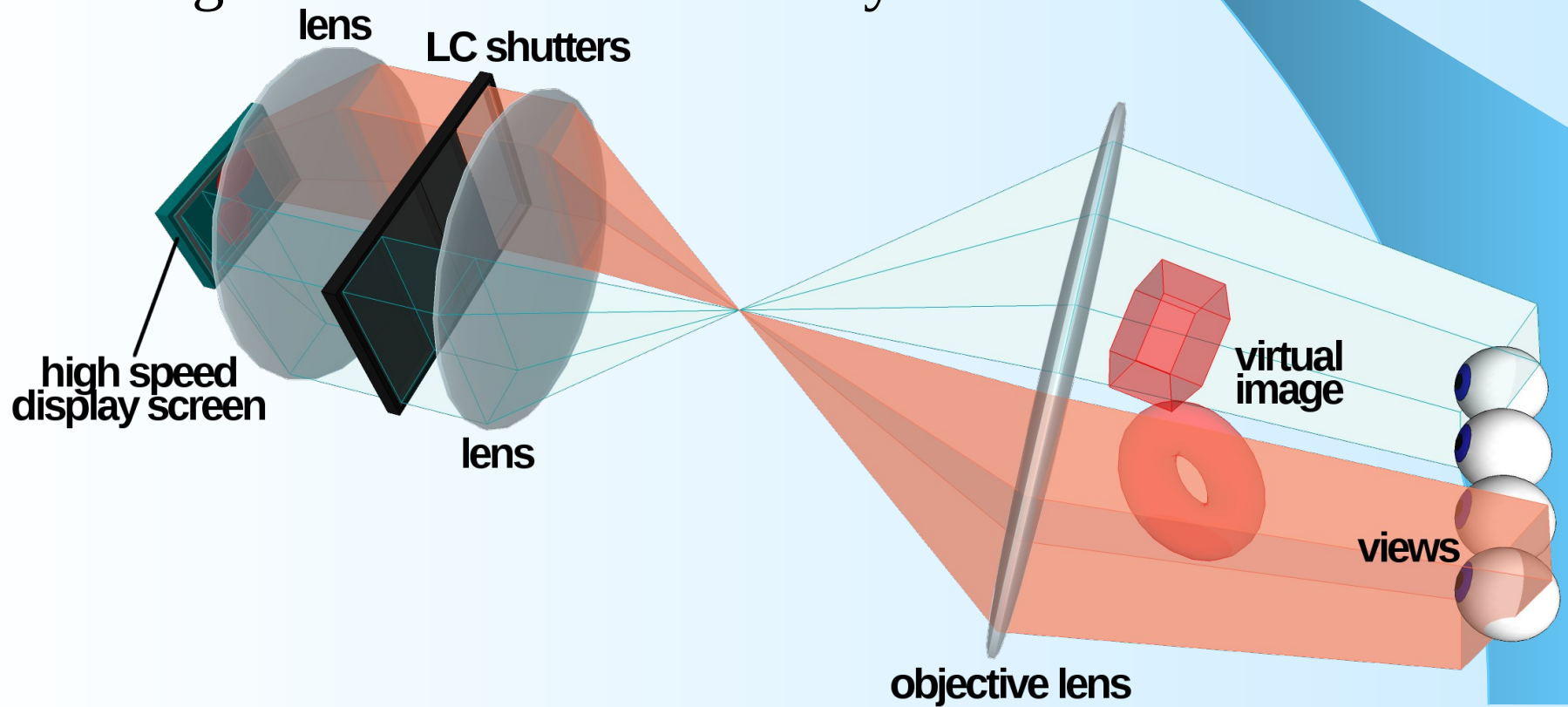


Integram

- Stereograms display 3D images only when viewers' eyes are in the horizontal direction (HPO).
- Panoramagram provides more than one angle of view.
- Integram provide a complete, 3D view independent of the point of view.
- Each type reduces the resolution multiple times.

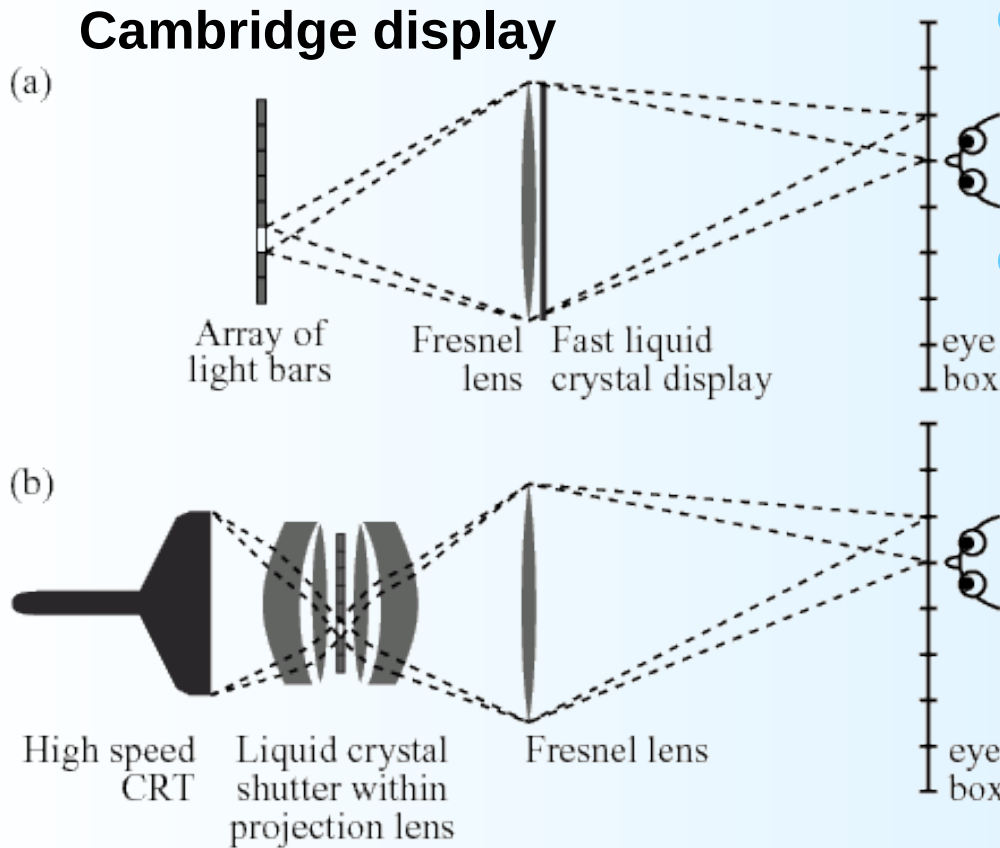
Displays using time aperture

- 1990s, the University of Cambridge presented a multi-view autostereoscopic display based on high-speed CRT display and ferroelectric panel of liquid crystals.
- The CRT display showed images at high speed, each image for one view and one eye.



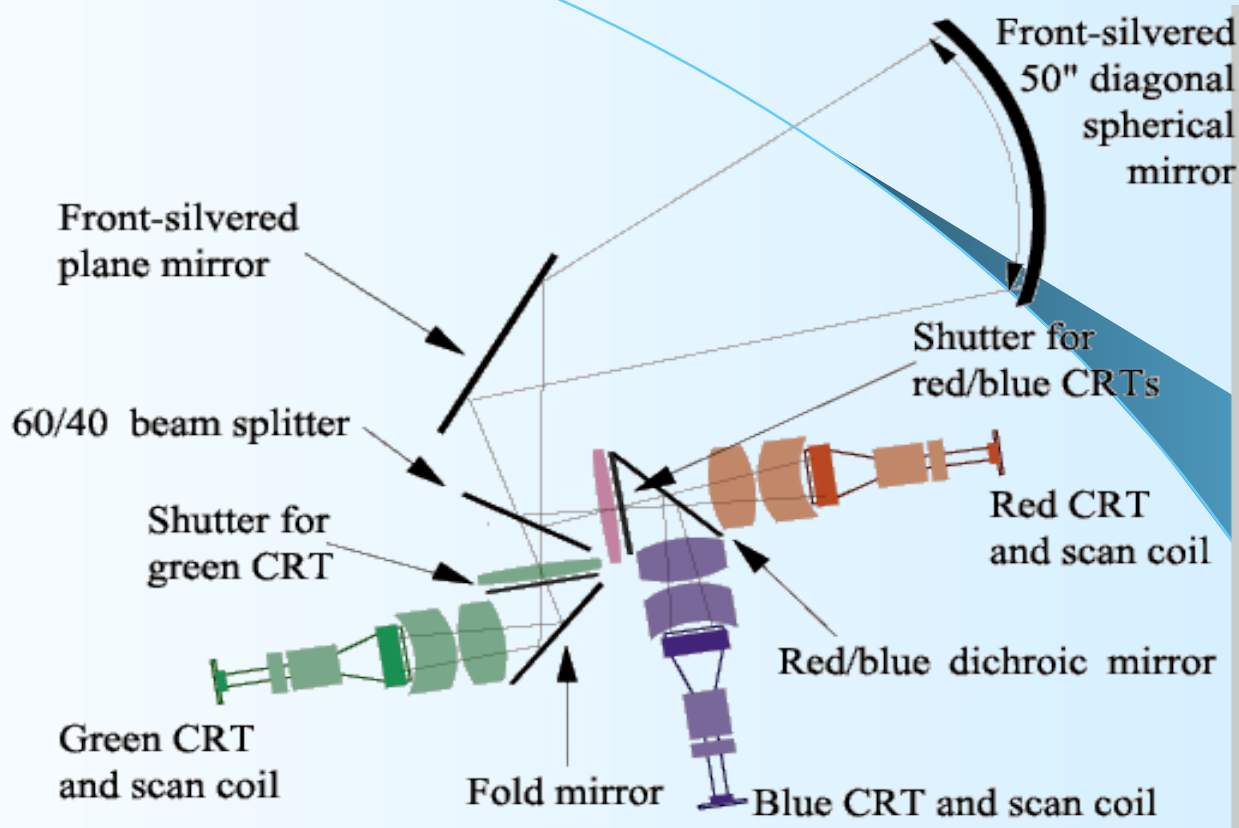
Multiplexed autostereoscopic

- The light strip passes through the lens and illuminates the image on the LCD. This image is only visible in the corresponding eyebox. (a).



- By successively lighting up the light strips, we get up to 8 views.
- In Cambridge Display (b), CRT is used instead of LCD. The Liquid crystal shutter is used to direct the light beam to the corresponding view

Multiplexed autostereoscopic



- High brightness and resolution are achieved by using three monochrome CRTs. Their images are merged into one beam, which is projected onto a spherical mirror.

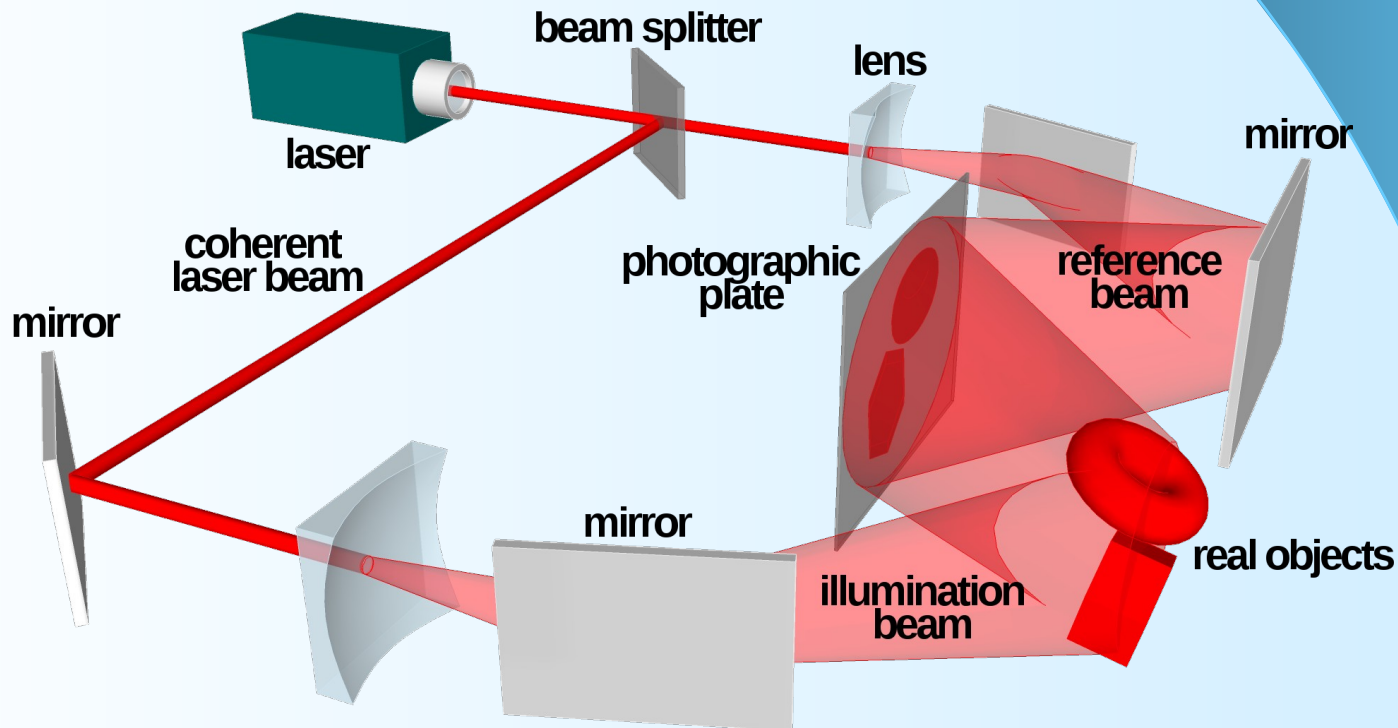
Professional 3D displays

- These displays use the principle of stereoscopy with passive or active glasses or autostereoscopic technology.



Hologram

- Light from a laser is split into two beams. A beam that illuminates an object interferes with the reference beam and creates an interference pattern on the film. This pattern (hologram) contains information about the object, which is then used to reconstruct the 3D image of the object.



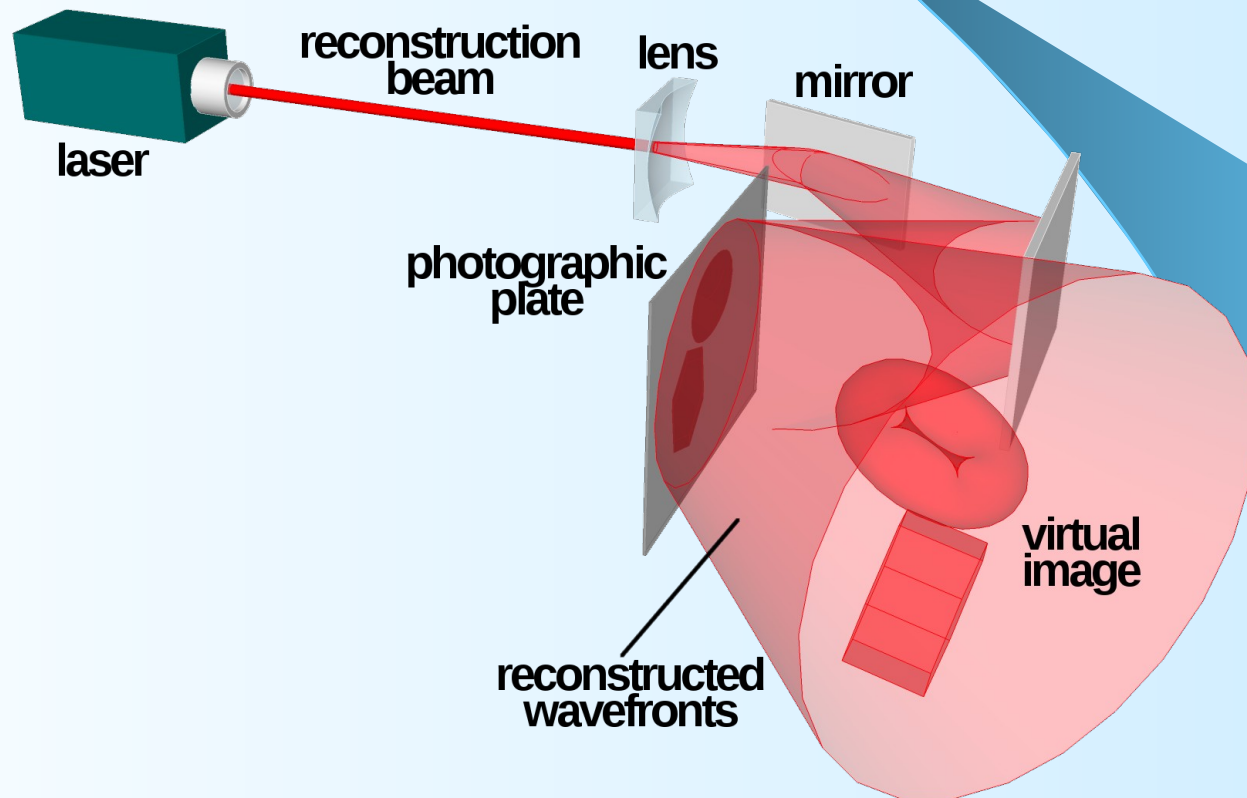
Hologram...



- Interference patterns look like water waves that are created when throwing stones into the lake.
- When displaying the 3D image stored in the hologram, we must place the laser into the same position as the reference beam. Then we will see the object image in the same place as the original object. It is as if the light from the object "froze" in the photographic plate and continued into the eye when reconstructing 3D image using the laser beam.

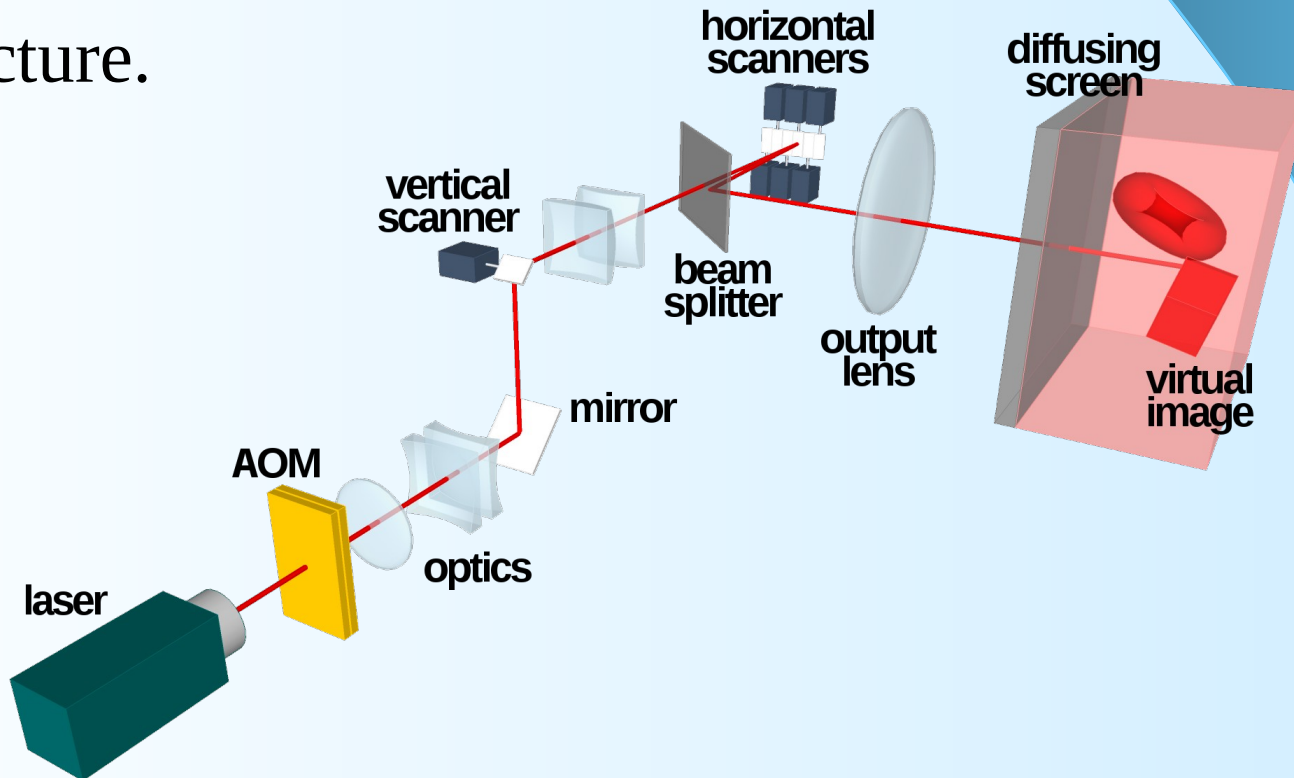
Hologram...

Image reconstruction creates virtual 3D object.



Electro-Holography

- A holographic image is created using acousto-optic modulator (AOM). The calculated interference pattern is sent to the AOM where it modulates the light wave.
- The beam uses a horizontal scanner (mirror) to draw individual points in a line. The horizontal "scanning" mirror deflects the beam to draw the individual lines of the picture.



Pseudo 3D displays

- Many devices displaying the virtual image often have the name “holographic”:
 - “Hologram” of Jessica Yellin, broadcast on CNN during US presidential elections in 2008.
 - Image projected onto fog or an image that creates graphic patterns on drops of flowing water.
 - Projected image on glass surface or semi-transparent film that uses the technique known as Pepper’s ghost.
- Some of them have become an interesting commercial product:
 - Kono-mo Hypervsn™ uses fast-moving arms with miniature colour LEDs.

Examples of pseudo 3D displays

