

# CSE 190: Virtual Reality Technologies

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LECTURE #6: DISPLAYS

# Upcoming Deadlines

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Sunday April 18: Project 1 due

Monday April 19: Discussion Project 2

Sunday April 25: Project 1 late deadline

Monday April 26: Discussion Project 2

Sunday May 2: Project 2 due

# App Presentations

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Jeffrey Ha

Emily Zhuang:

- Supernatural

# Display Characteristics

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# Definition of Display

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- *Display*: a device which presents **perceptual information**
- In most cases the term “display” is used for “**visual display**”
- Goal for VR: to use display devices which accurately represent **visual perception** in a **simulated world**

# Visual Display Characteristics

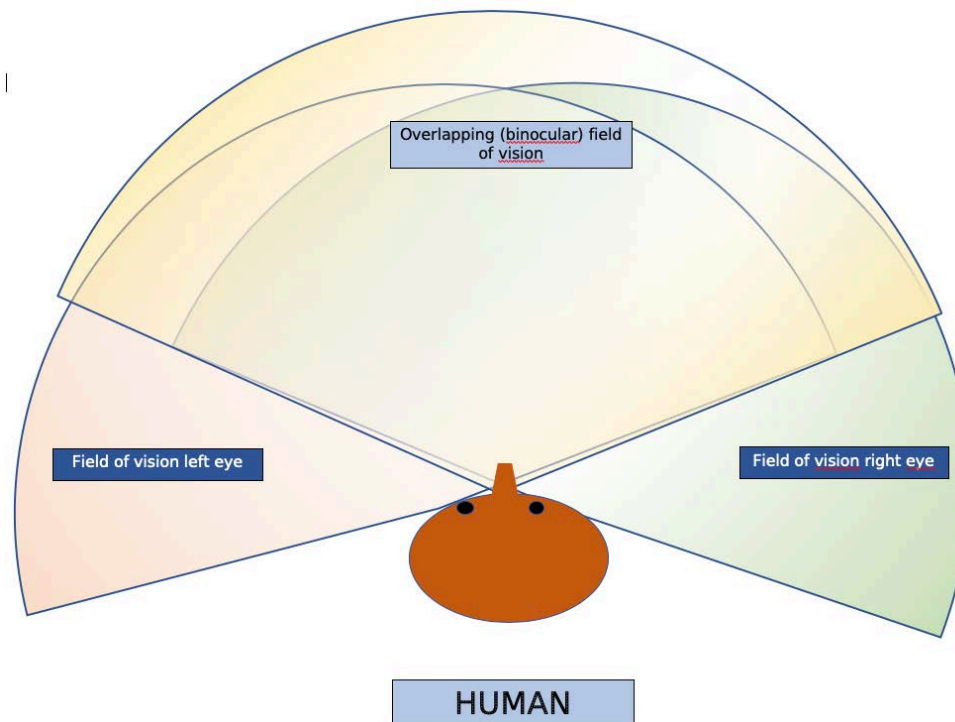
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- Field of View
- Field of Regard
- Spatial Resolution
- Screen Geometry
- Light Transfer Mechanism
- Refresh Rate
- Ergonomics

# Field of View (FOV)

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FOV = The total area in which VR images can be seen by a viewer **at a particular time instant**.



# Field of Regard (FOR)

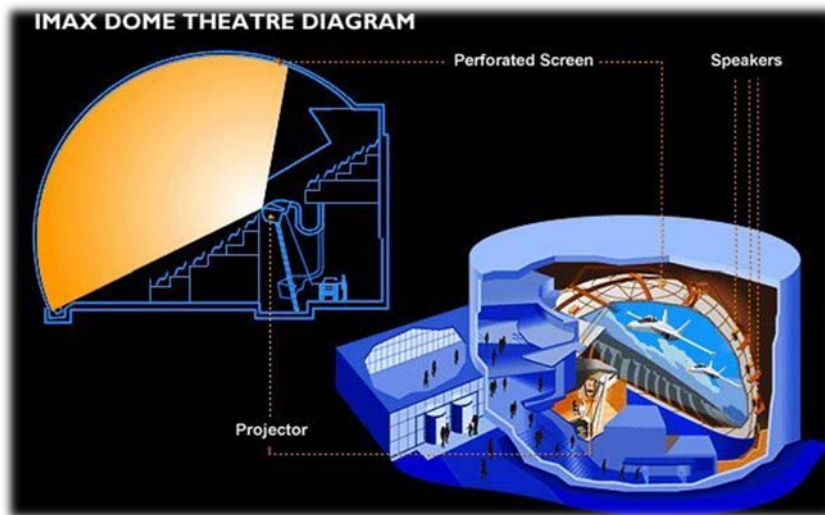
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FOR = The total area in which VR images can be seen by a viewer **when allowed to move their head.**

Example: IMAX Dome

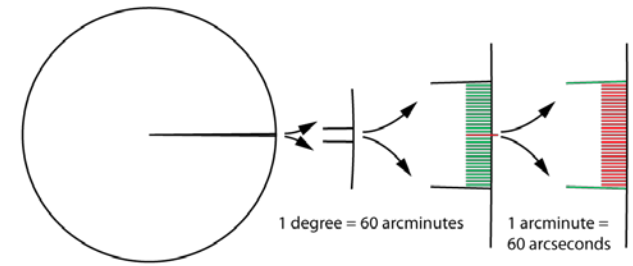
The first permanent IMAX Dome installation, the Eugene Heikoff and Marilyn Jacobs Heikoff Dome Theatre at the **Reuben H. Fleet Science Center**, opened in San Diego's Balboa Park in 1973.

It was initially called “Omnimax” and wraps 180° horizontally, 100° above the horizon and 22° below the horizon for a viewer at the center of the dome for a total of 180° x 122° FOR.





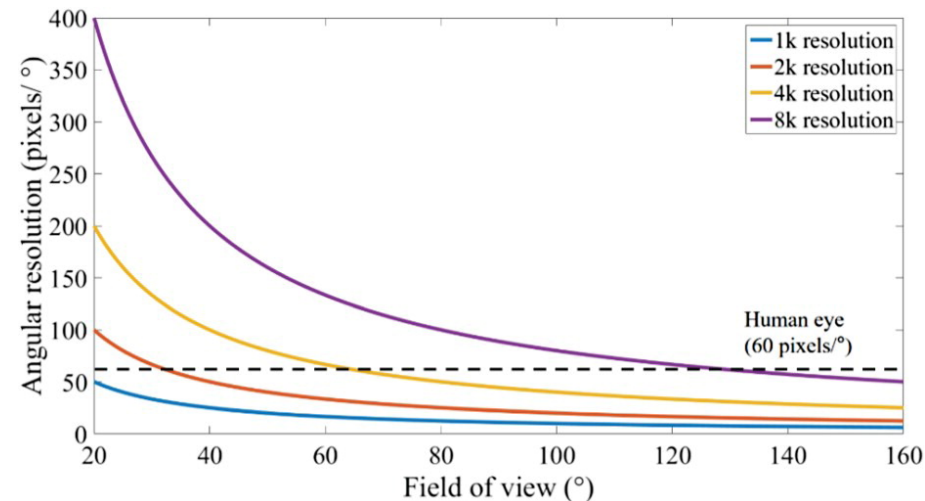
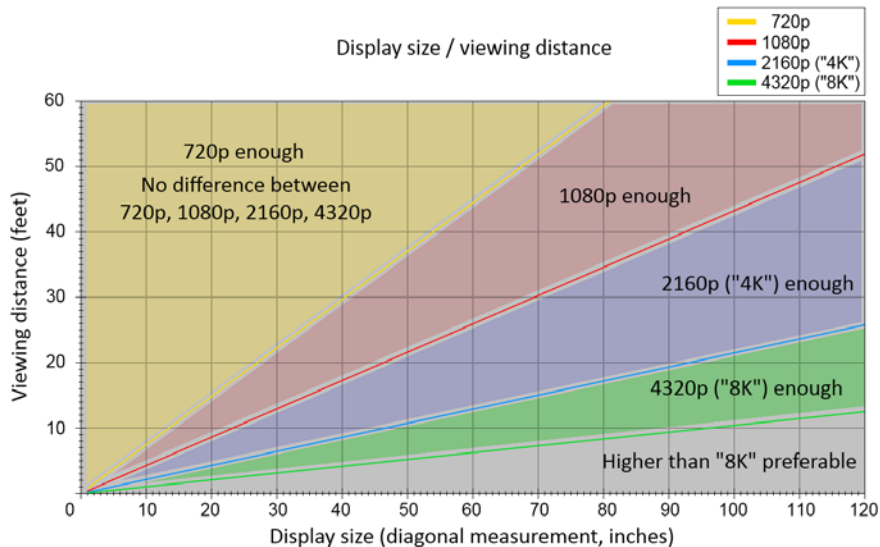
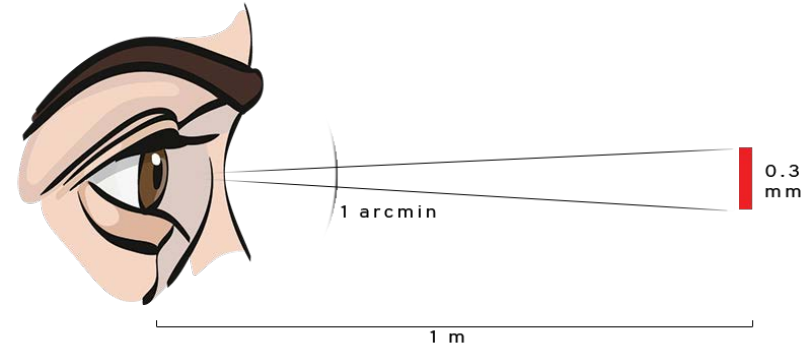
# Spatial Resolution



Ratio of pixels per screen area (=pixel density) or pixels per degree of the FOV (=angular resolution).

This is different than screen resolution, which is the absolute number of pixels a screen can display, for example 1920 x 1080 pixels.

Human eye: 150 pixels/degree in center of FOV, diminishes towards edge



# Screen Geometry

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The geometric shape of the surface the image is displayed on.

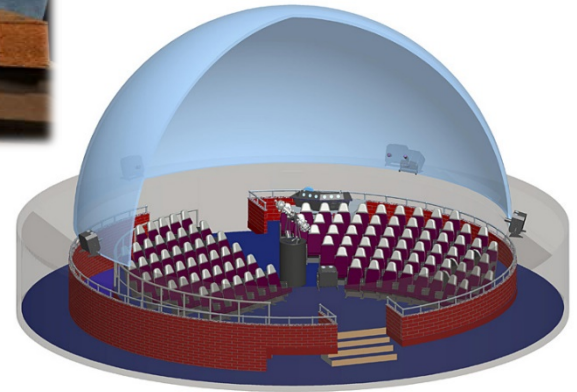
Examples: rectangular, curved, hemispherical



*Rectangular*



*Curved*



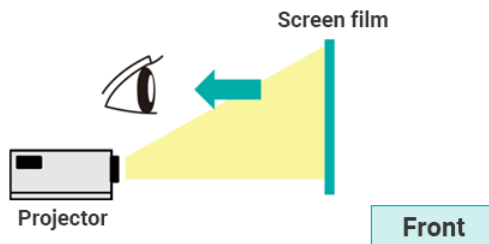
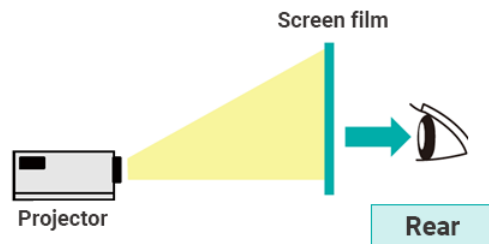
*Hemispherical*

# Light Transfer Mechanism

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How is the image generated?

Examples: LCD, front projection, rear projection, laser projection



*Rear vs. Front Projection*

The planetarium at Griffith Observatory (Los Angeles) has one of the first **digital laser projection** systems

- Two laser projectors are used
- System features: high resolution, brightness, color contrast, saturation
- Reduced image distortion on curved planetarium dome surface
  - With lasers, depth of focus is unlimited
- Low maintenance costs

# Refresh Rate

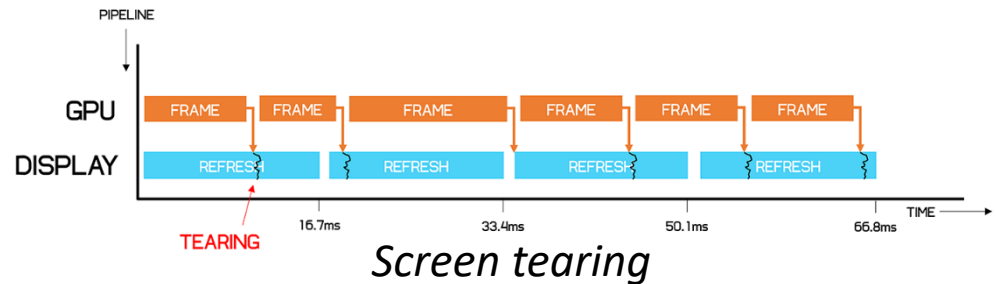
Independent of frame rate

Higher refresh rate is better

Goal: frame rate = refresh rate (e.g., 90 Hz)

At minimum: frame rate = integer fraction of refresh rate (e.g., 45 Hz, 30 Hz)

Otherwise: screen tearing



*Screen tearing example*

# Ergonomics

How is the system used?

- Seated
- Standing
- Hands on a surface
- Hands in the air

