Content Creation for Dome Displays

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iVEC @UWA

Outcomes

- An appreciation of the dome industry - dome types, applications.
- An understanding of the options available for content creation.
- An understanding of the issues, difficulties.
- Will not cover details of the projection hardware - cameras - software.
  Left to later workshop.

Rio Tinto dome control centre

Qualifications

- Inventor of the spherical mirror projection system, now the most widely used projection system for small (and some large) domes.
- Co-developer of the iDome with iCinema, UNSW.
- Travel internationally assisting with fulldome installations and training.
  2014: NTU, Singapore a few weeks ago.
  2013: India (4), Malaysia (2), Qatar, Hong Kong.
- Travel extensively capturing fulldome images and video.
- Producer of Dark: a fulldome movie that explains and explores the nature of Dark Matter, the missing 80% of the mass of the Universe. Showing in over 20 countries, 4 language translations.
- Various dome installations in museums and art galleries.
  Current:
  - Gascoyne Aboriginal Heritage and Culture Centre
  - South Australia Museum and Art gallery
  - Wollongong Science Centre
  - Lawrence Wilson Gallery
- Regularly present dome seminars and workshops such as this one.
  - DomeLab

Contents

- A little history, types of domes, iDome, motivation, applications
- Projections: perspective, fisheye, spherical, cylindrical and cubic
- Content creation options
  - Photography
  - Digital video
  - Computer graphics prerendered
  - Realtime
- Considerations
  - Viewing position
  - Zooming
  - Image processing
  - Content sharing and dome orientations
- Questions / discussion
- Demonstration in the HIVE dome

Turkey national orchestra

Cyclorama

- In 1787 Robert Baker was awarded the patent for “La Nature a Coup d’Oeil”. (Nature at a Glance)
- What we now call the cyclorama, large paintings often presented on architecture matching the place represented in the painting. Heightens the suspension of belief, the sensation of “being there”.

“to make observers,
on whatever situation he may choose they should imagine themselves,
feel as if really on the very spot”

Panorama 1453 - Istanbul

Panorama 1453: Capture of Istanbul by the Turks

Panorama 1453 - Istanbul

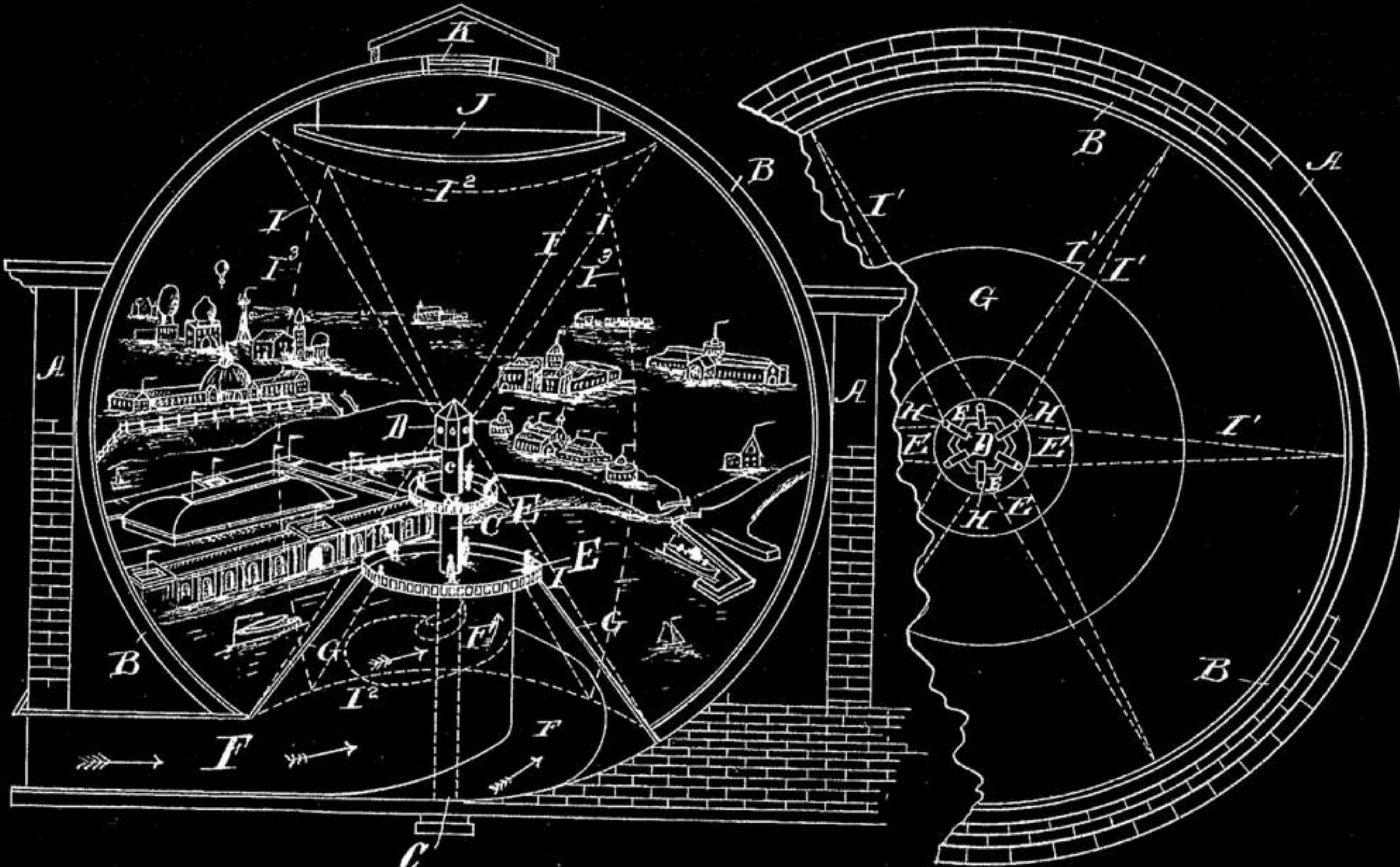
Charles Chase

- In 1896 Charles Chase employed recent advances in photography to create more literal panoramic experiences.

"everything in view from the point where the photograph is taken will be reproduced exactly as it appears when seen from such point"

- Targeted virtual tourism

"By this manner of reproducing views a person can get a better idea of the different parts of the world without actually going there than in any other manner heretofore devised. In fact he may see such views exactly as they would appear if seen on the ground"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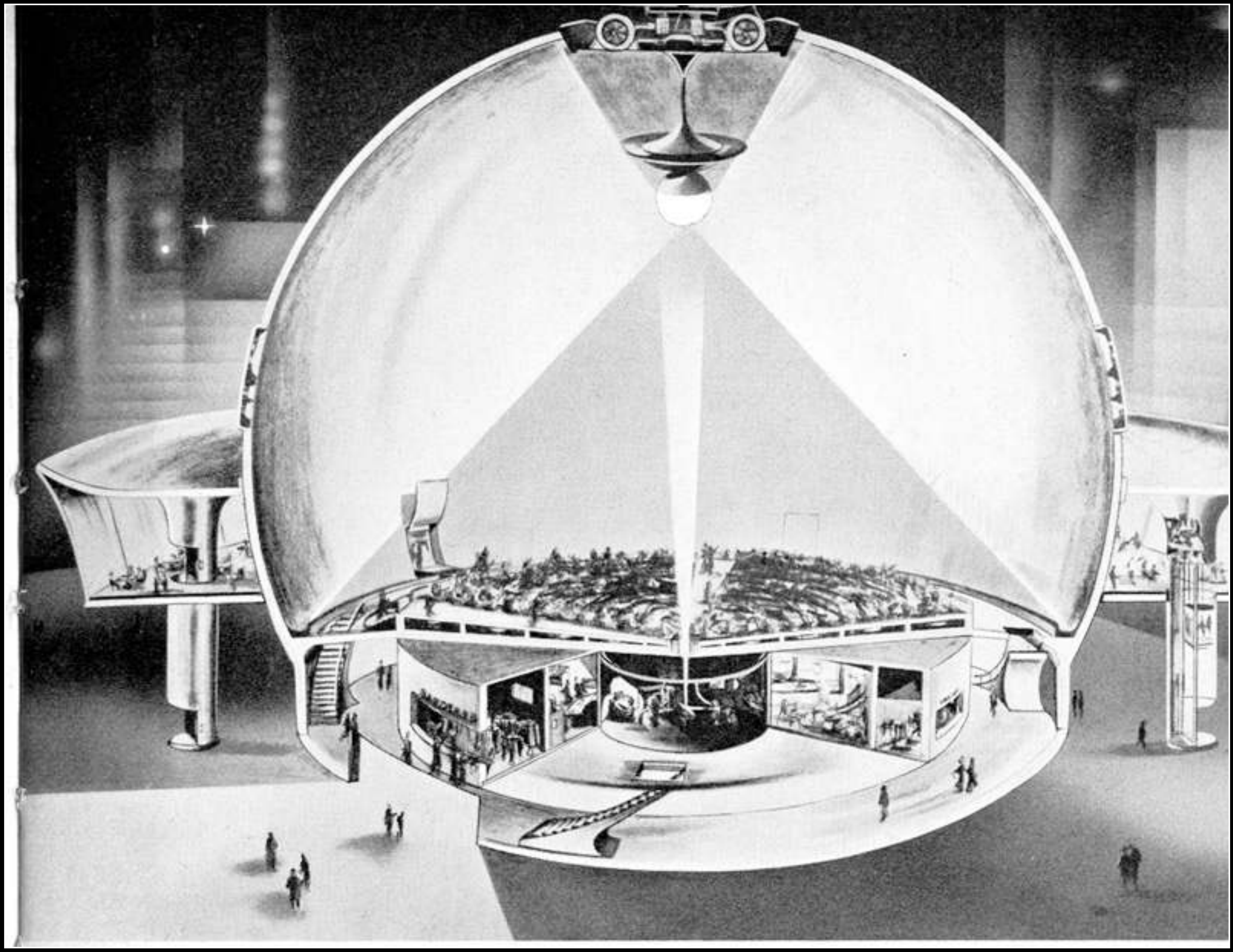
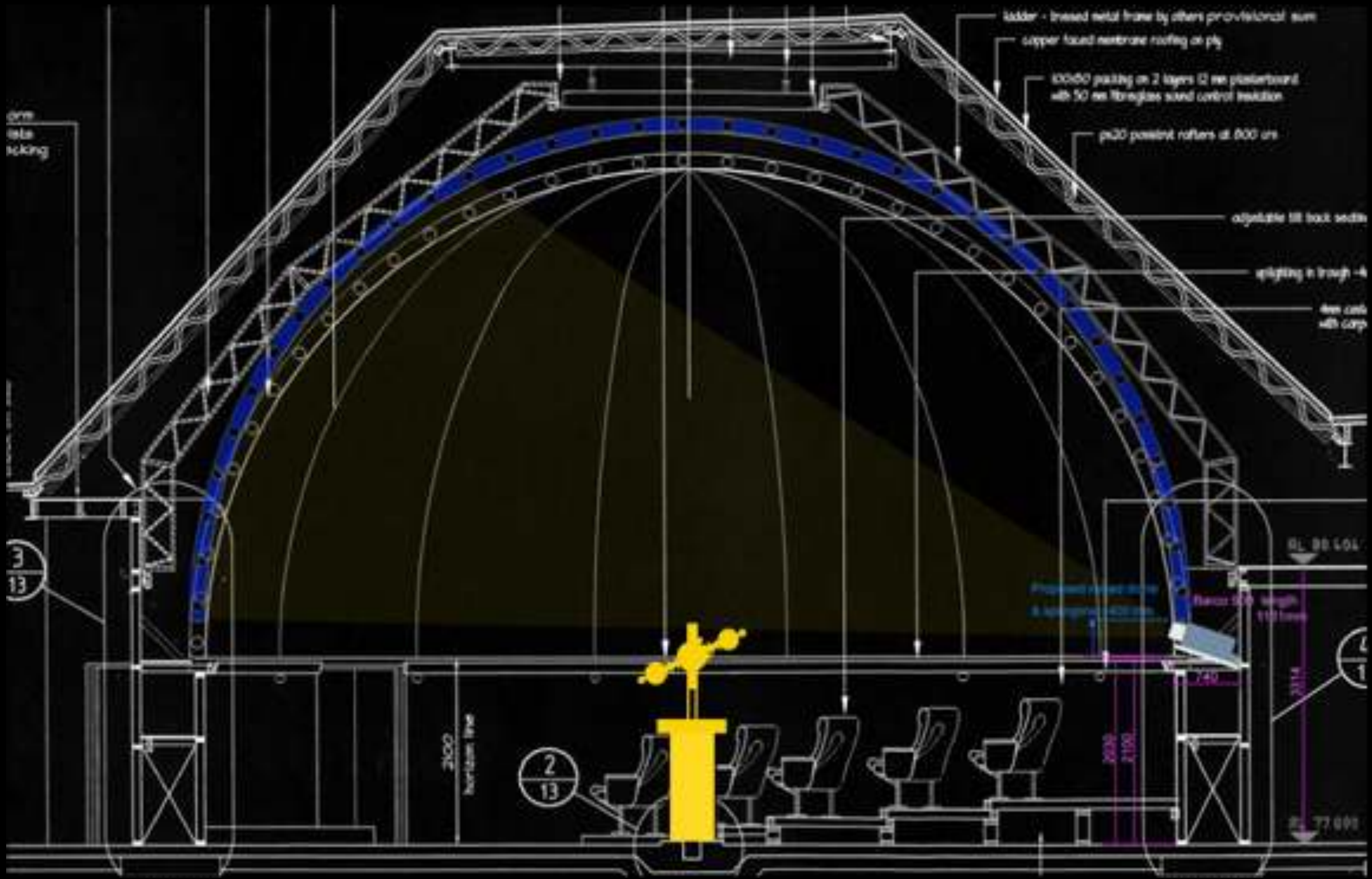
Hamburg planetarium, 1957



Dome types

- Planetariums: Historically employed to convey astronomy, the night sky.
- Over the last 15 years there has been a steady move towards digital upgrades.
  That is, a digital image/video that covers the whole hemispherical surface.
  For example, Horizon planetarium in Perth.
- Allows planetariums to educate in other areas of science, but also entertainment.
- A digital planetarium is now better described as an immersive digital theatre.
- While some domes may be tilted (eg: OmniMax), the orientation of the planetarium dome makes it awkward for other experiences.



Planetarium dome History

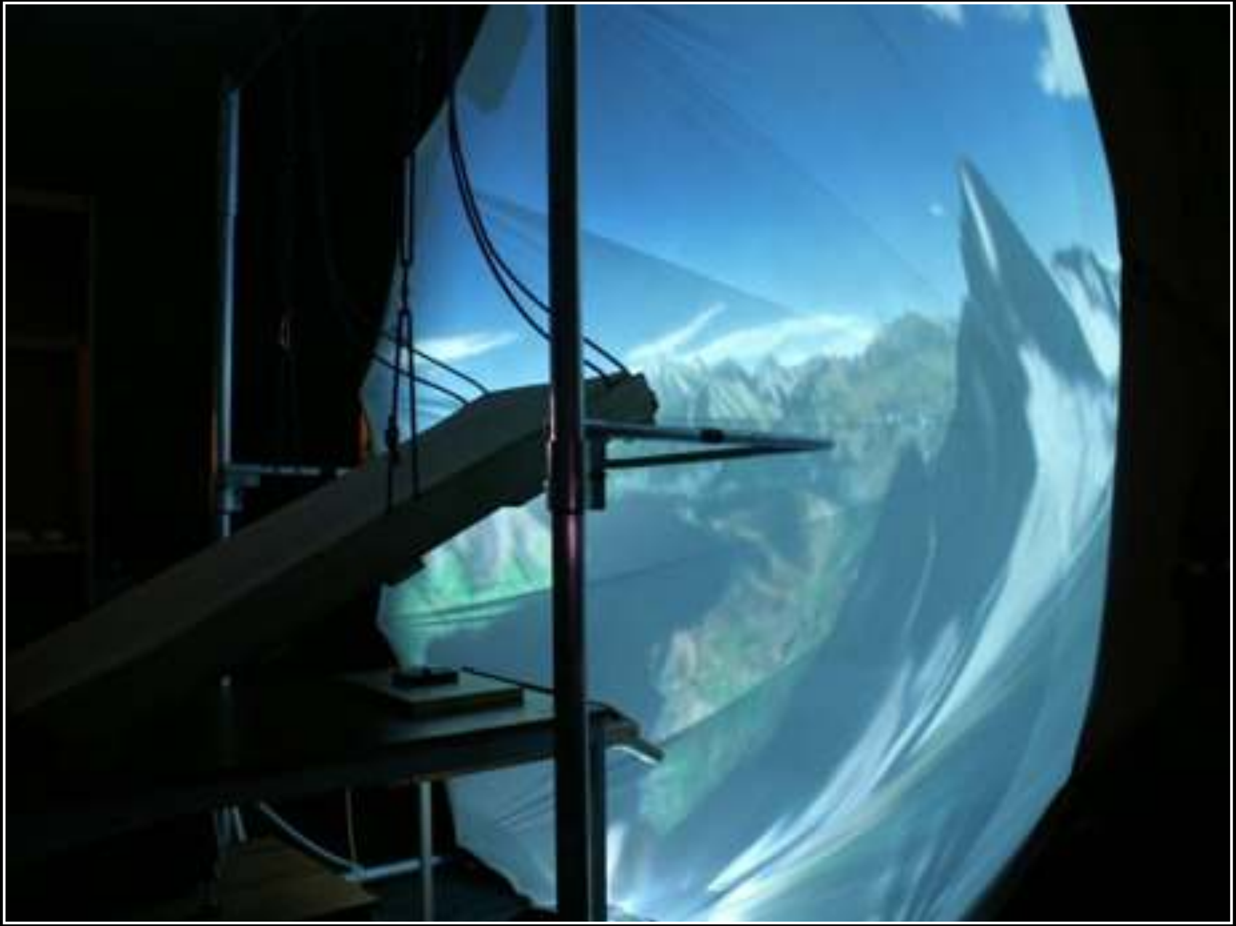
- 1500BC: Earliest known depiction of the night sky on Egyptian tomb of Senenmut.
- 500BC: First known domed building, called the The Dome of Heaven.
- 1923: First planetarium built in Munich, Germany. Projection using the Zeiss Mark 1 star projector.
- 1949: Spitz demonstrated their first star projector at Harvard College in the USA.
- 1959: First planetarium and star projector by GOTO of Japan.
- 1965: First star projector by Minolta of Japan.
- 1973: First OmniMax (iMAX) opened in Reuben Fleet Science Centre, based upon 70mm film.
- 1983: Evans and Sutherland develop a vector graphics style projector capable of creating points and lines at the Virginia Science Museum.
- 1997: Spitz install the first ElectricSky system in Canada comprising of 4 CRT projectors and edge blending.
- 2002: First laser projection system by Zeiss demonstrated in the largest digital dome at the time, 24m diameter.
- 2005: GOTO of Japan create the first full sphere projection system.
- 2008: SkySkan installs the first 8Kx8K projection system in the Beijing planetarium.
  2010: SkySkan installs first stereoscopic 4Kx4K planetarium in Macau

Personal domes

- Inflatables are the most prevalent small domes.
- Also geared towards astronomy education
- Usually run as outreach programs for science centres but also lots of independent operators
- Elumenati a pioneer of personal domes, ex Elumens.

Personal domes

- Early example of a digital “front facing” or “upright” dome was the VisionStation.
- 1.5m diameter dome used largely for flight simulators by the US airforce.
- Employed a fisheye lens that needed to be located near the centre of the dome where it competed with space with the viewer.
- Particularly problematic for larger higher resolution brighter projectors.
- Price prohibitive.



Hang glider - Adelaide University

Visionstation, circa 2002

iDome

- Developed at iCinema, UNSW around 2002 for an exhibition called “glasshouse” at the Powerhouse museum.
- Main expense was the 3m and 4m fibreglass mold.
  3m - sitting down (simulators)
  4m - standing up
- Projection system developed by the author soon afterwards, 2003.
- Main advantage was the projection hardware is not in the way.
- Significantly lower cost than fisheye solutions.
- Requires an image warping to correct for optical arrangement.
- Spherical mirror projection now overtaken fisheye for the single projector low cost planetarium market.

Ankor Wat

iDome

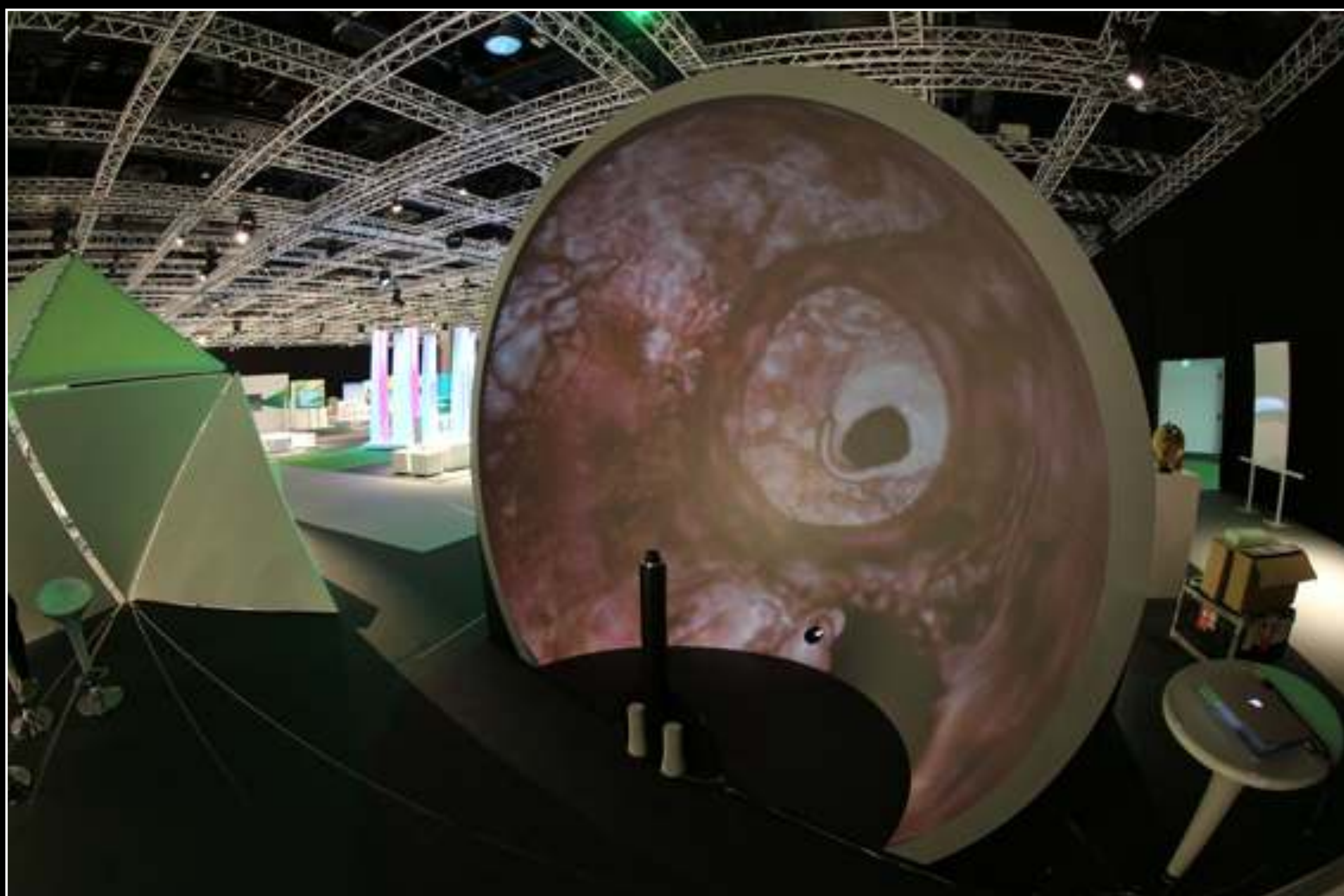
- 2005: Used as truck driving simulator at Centre for Mining at UNSW.
- 2007: iDome installed at iVEC@UWA.
- 2007: Treehuggers.
- 2009: iDome installed at Science Centre University of Wollongong in conjunction with ARC Centre of Excellence for Electromaterials Science
- 2010: Remote operations Rio Tinto.
- 2012: Running room.
- 2013: iKnife virtual surgery, Imperial College London.

Treehuggers

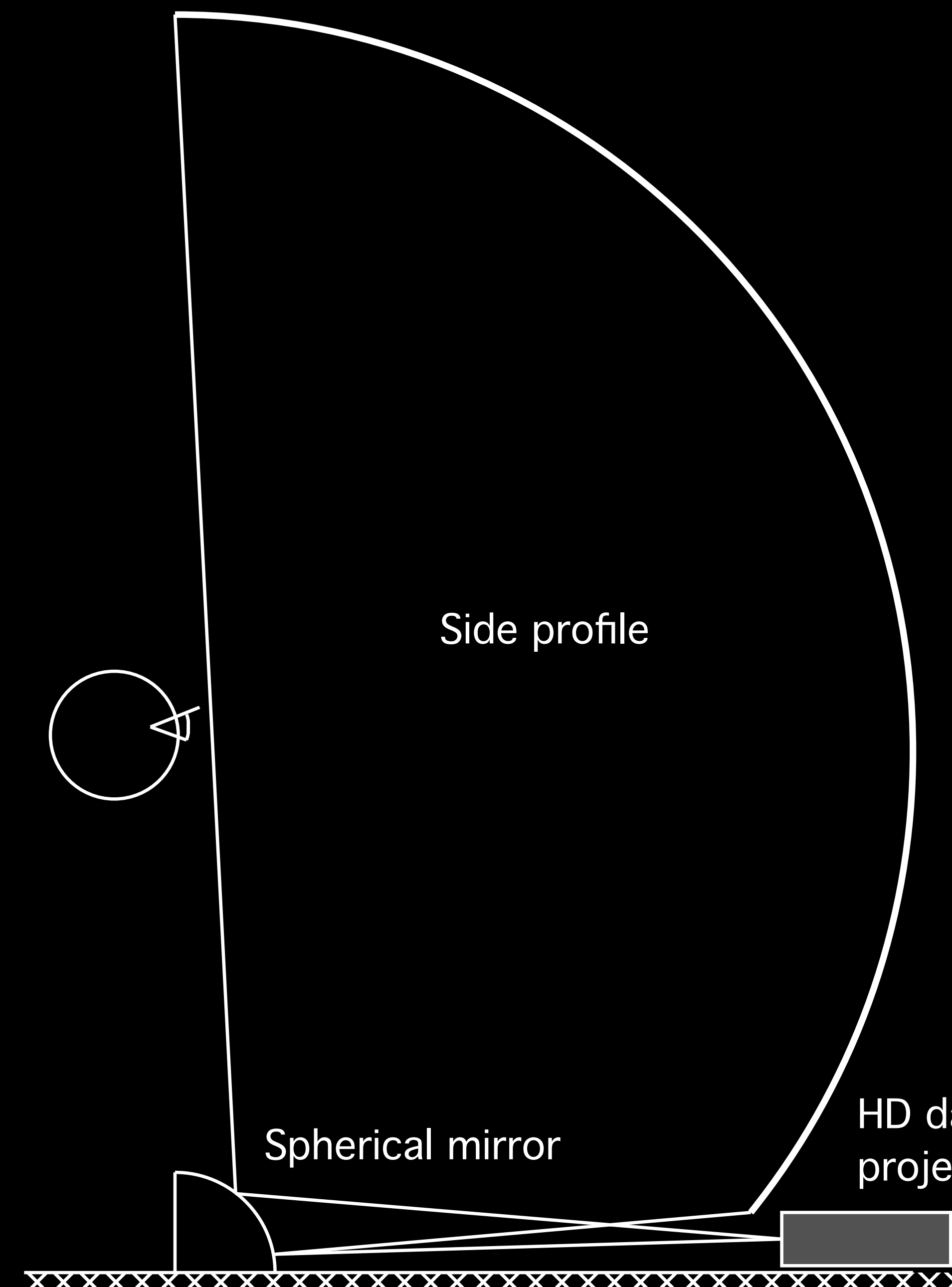
Wollongong science centre

Running room: sports science

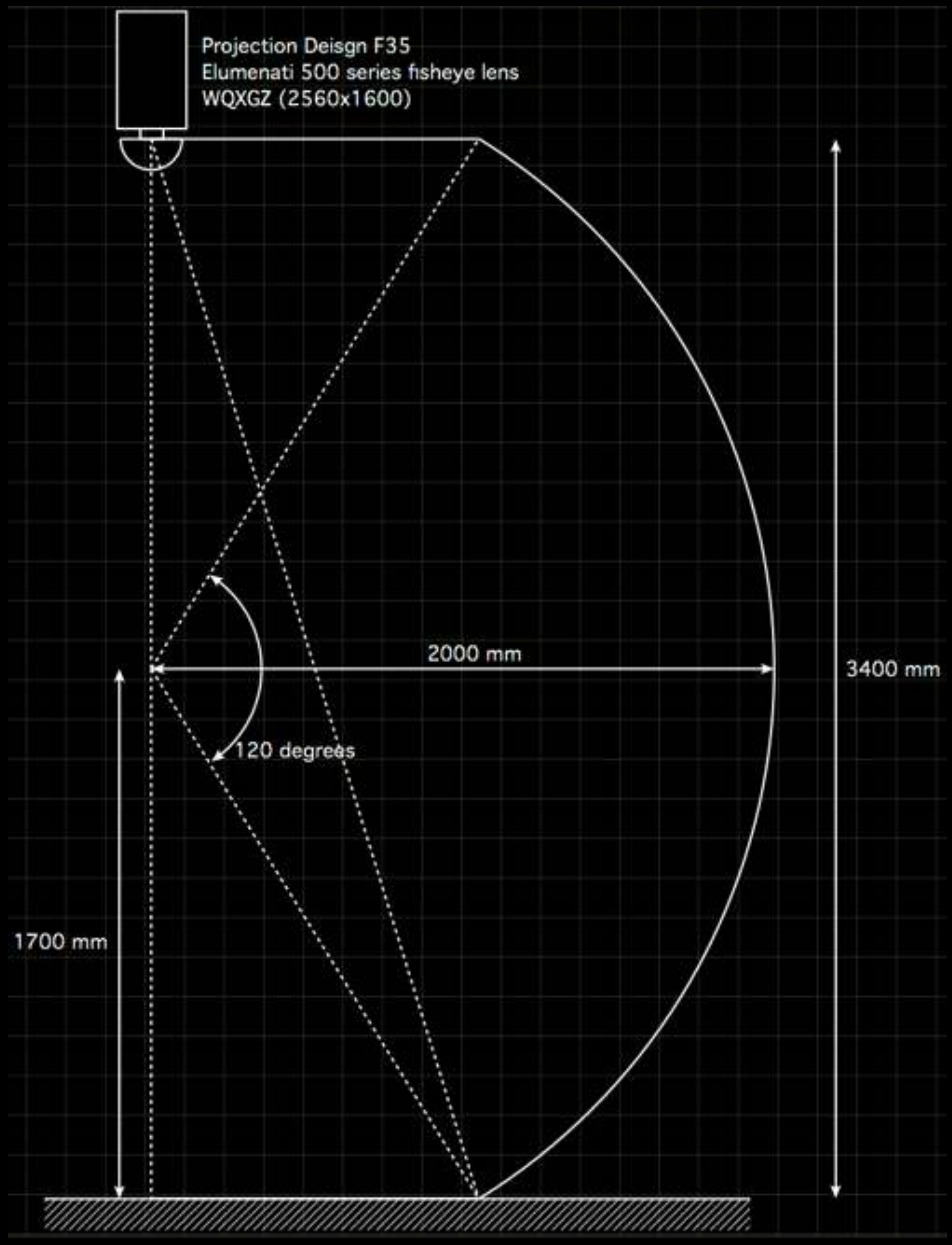
iDome: Projection optics



World Innovation Summit for Health (WISH), Qatar.

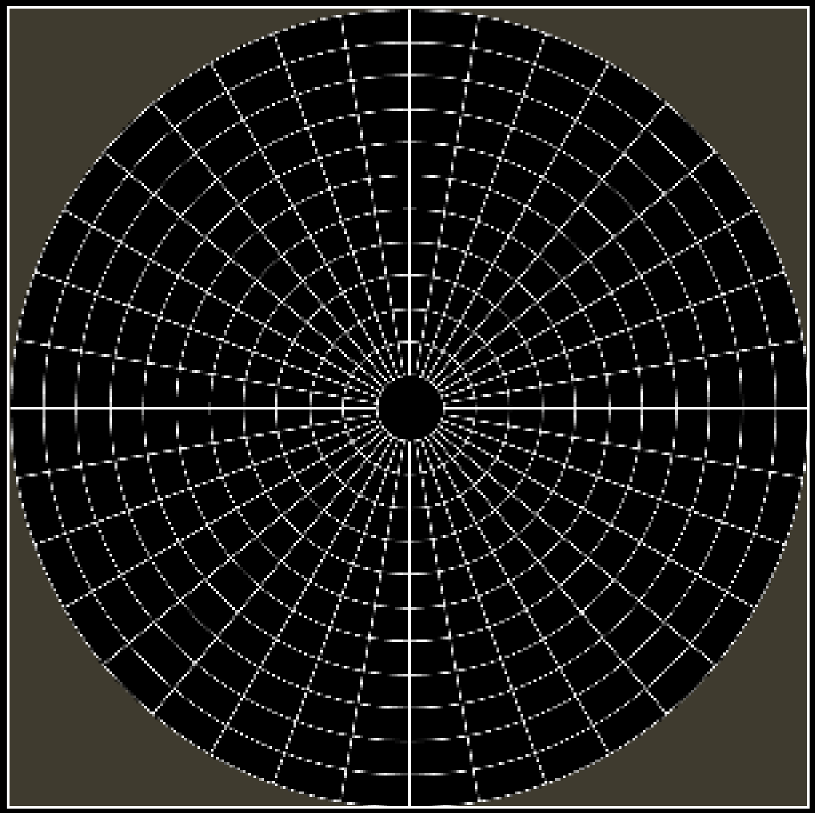


Curtin dome: Projection optics

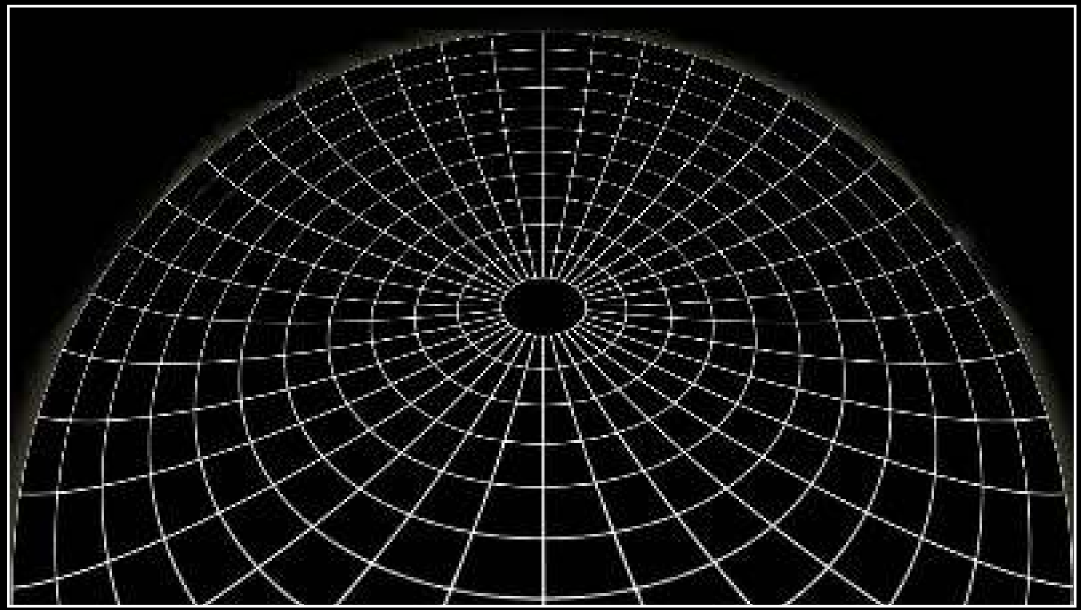


Fisheye warping: iDome

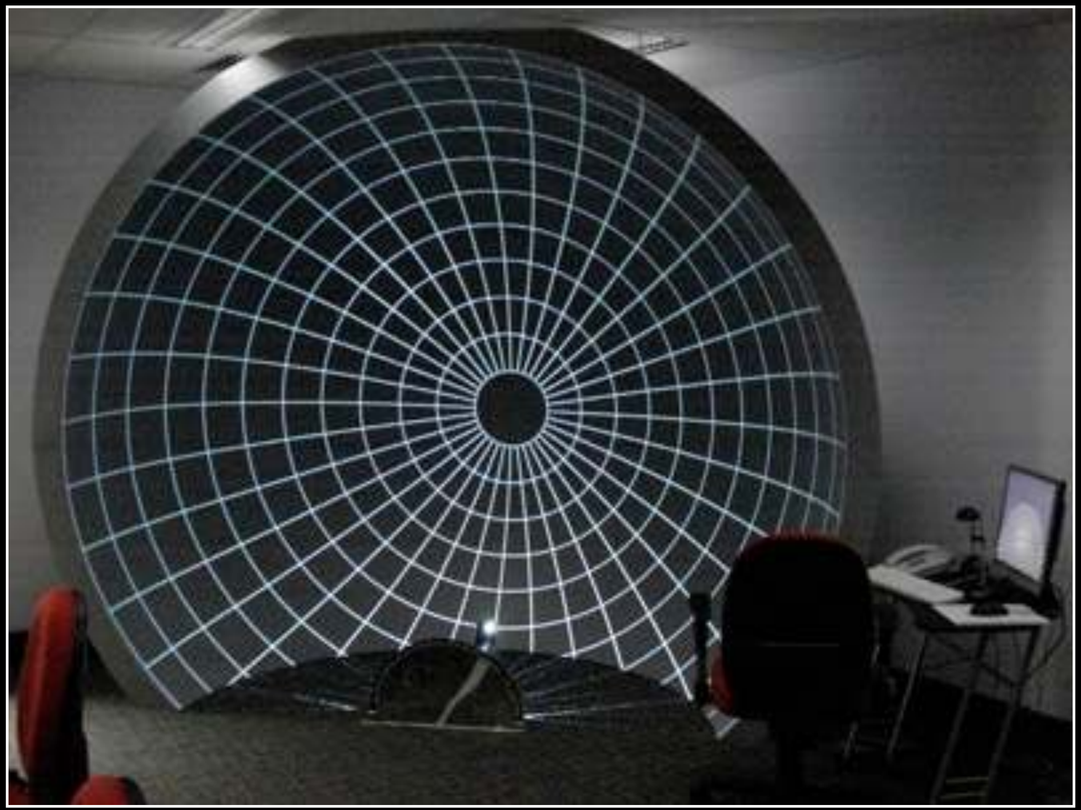
- Image warping needs to be performed to correct for the optics - variation in light path from projector frame, off mirror, and onto dome.
- Strict mathematical formulation is difficult, simulation used instead.
- Usual calibration image are lines of latitude and longitude, a polar grid.
- The lines of longitude should be straight.
- The lines of latitude should be circular rings.



Fisheye polar grid



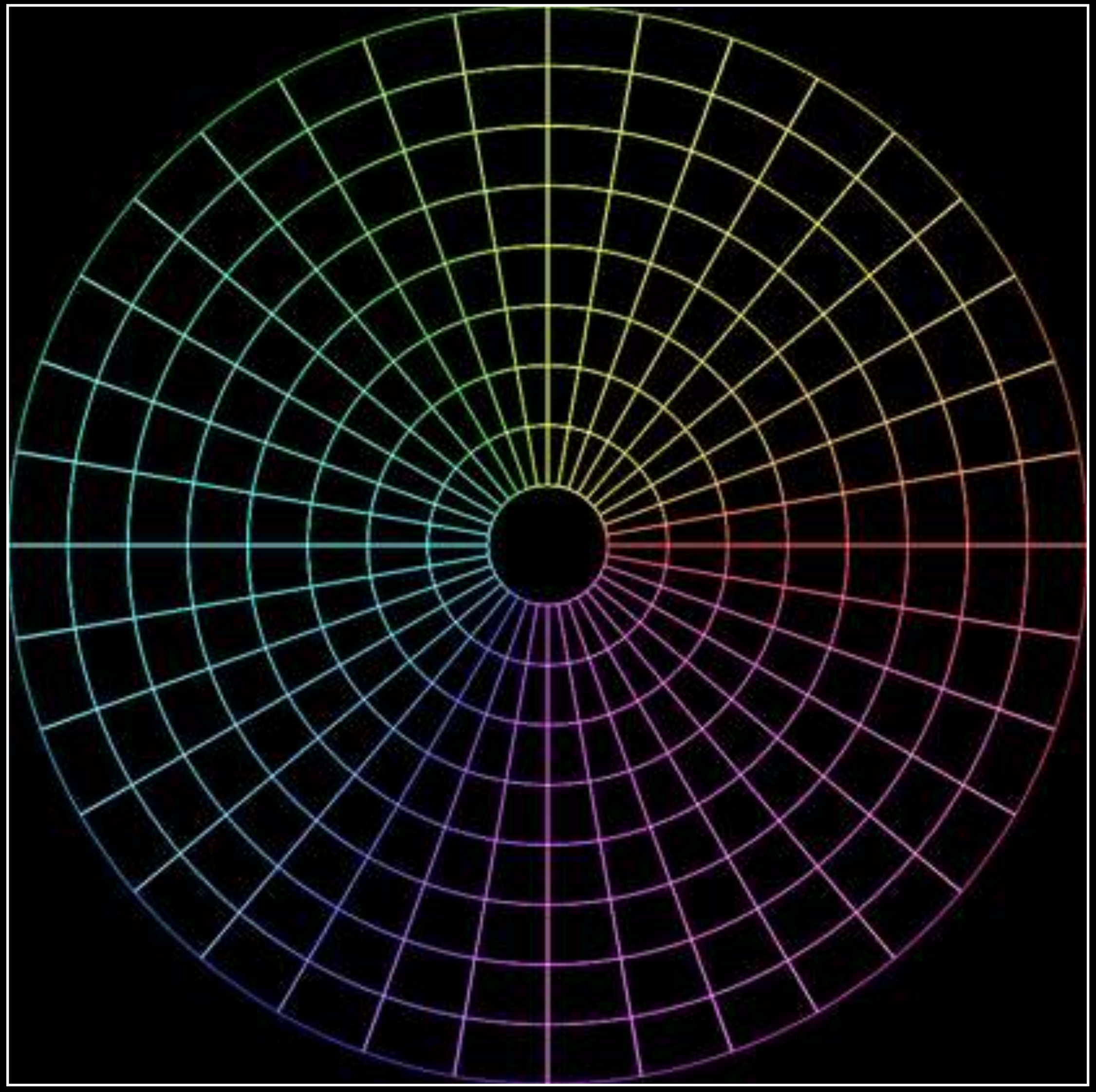
Warped fisheye

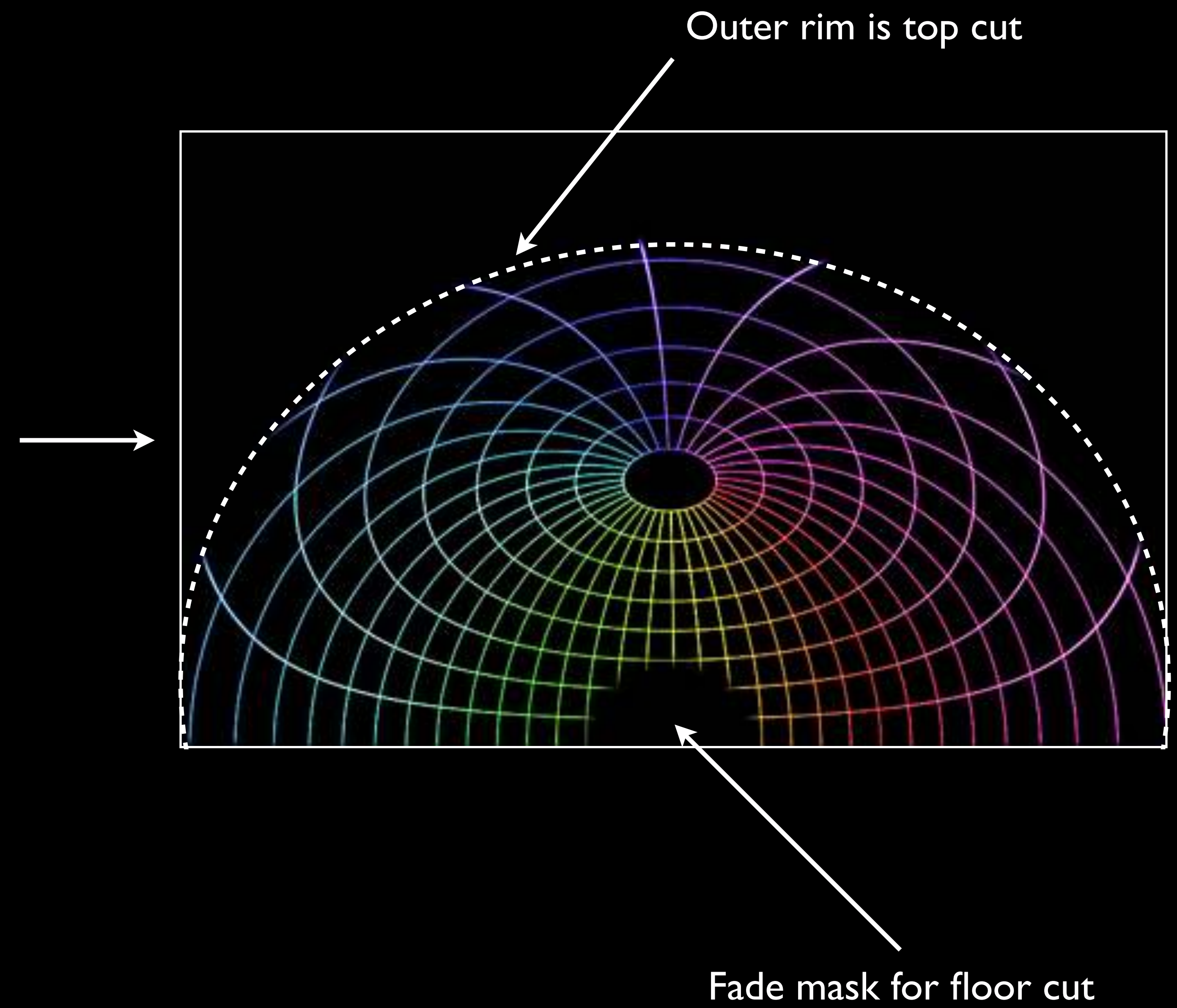


Result in iDome

Fisheye warping: HIVE dome

- Warping may not be needed if the projector and fisheye lens were at the center of the dome.
- Of course this completes with where the viewer should be.
- Note: uneven pixel size across dome, same as iDome.





Motivation

- Visualisation largely about conveying information to the brain through our sense of sight.
- Might as well leverage the characteristics of our visual system.
- Stereopsis - visual fidelity - peripheral vision.
- Peripheral vision attributed to our sense of “being there”, “presence”.
- Evolutionary reasons for peripheral vision, detecting predators in our far visual field.
- Easy to imagine that this could also be an advantage in game play. Interesting to note that gaming has partially adopted stereopsis which I claim has little game play advantage and lots of disadvantages.
- Sense of depth one often gets from a dome experience is from motion cues.
- The dome is one of a number of mechanisms for filling the human field of view with a virtual world.
- “Removing the frame” such that everything visible is synthetic is accepted as enabling immersion, suspension of belief, of “being there”.

Application examples

Science education: Wollongong science centre

Remote operations (mining)

Application areas

Art gallery installations

South Australia Museum: indigenous storytelling

Application areas

Science visualisation: Astronomy

Science visualisation: Chemistry

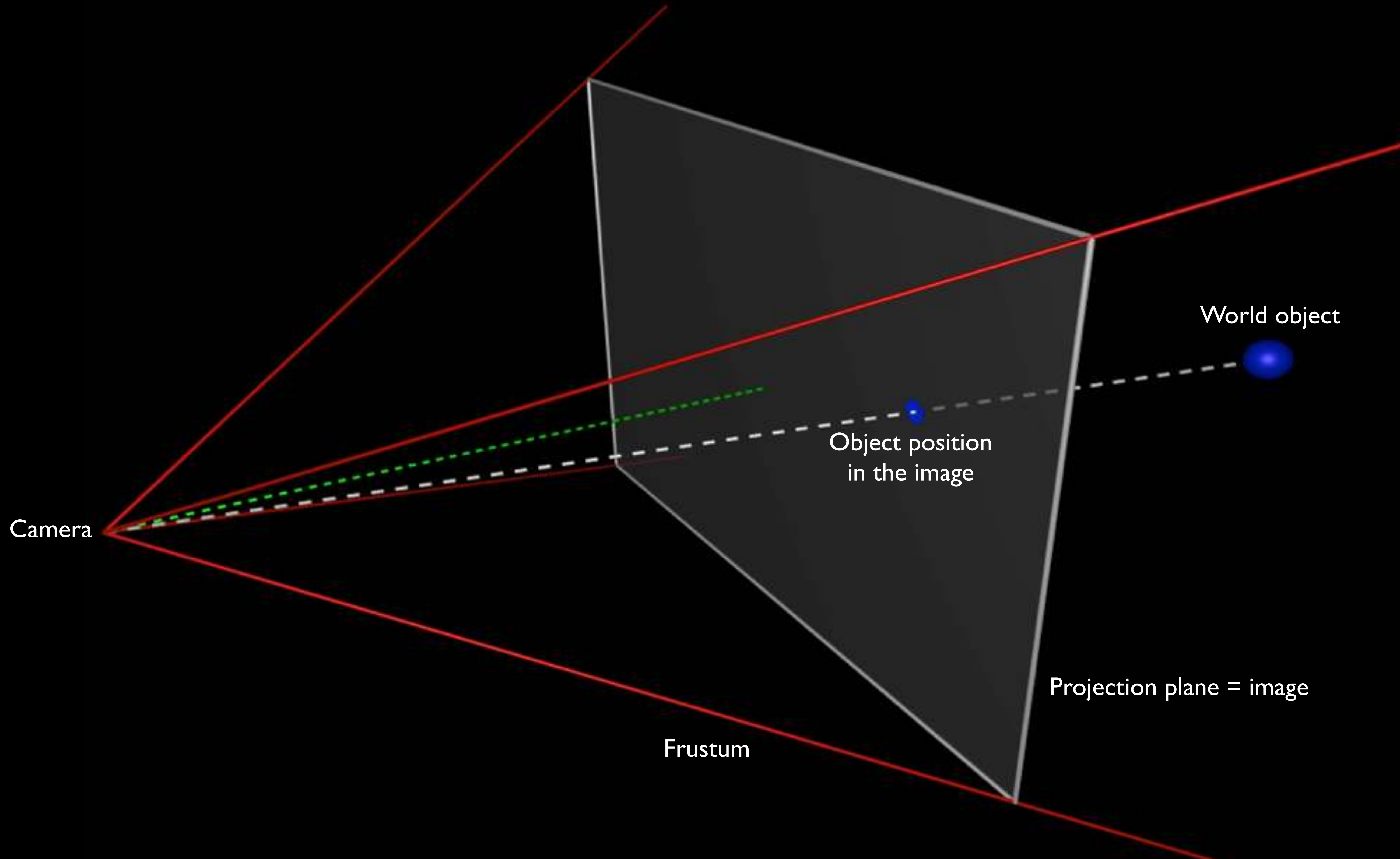
Application areas

Virtual and cultural heritage

Perspective projections in computer graphics

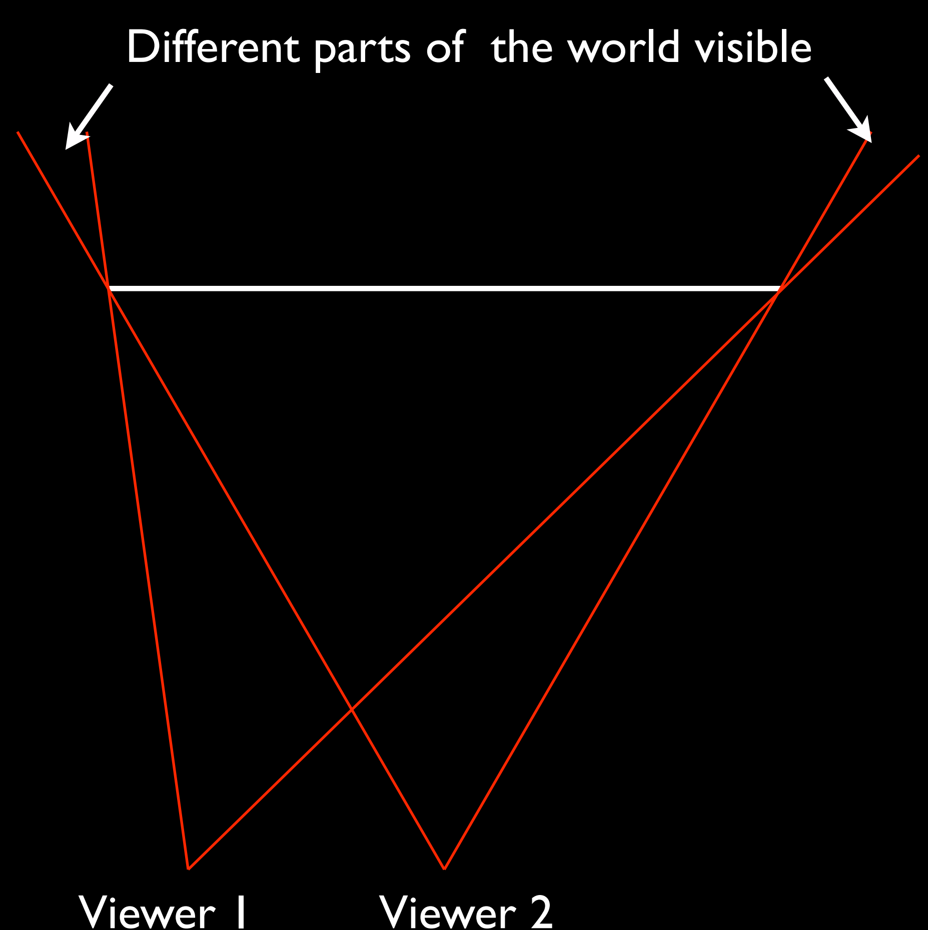
- By projection I am referring to how objects in a scene are mapped onto the image plane.
- Most familiar with perspective projections, the position in the image plane is where a line from the camera to the object intersects the image plane. Applies to all other projection geometries.
- Assume a pinhole camera model.
- Correct model is to imagine a window on the world, the frustum is the rectangular pyramid formed from lines from the camera to each corner of the image plane rectangle.
- This correct model is required in order to answer questions for more exotic displays, stereo and immersive displays.
- For example, explains the benefits of head tracking in stereoscopic displays.
- Camera = Observer.
Projection plane = Screen surface.

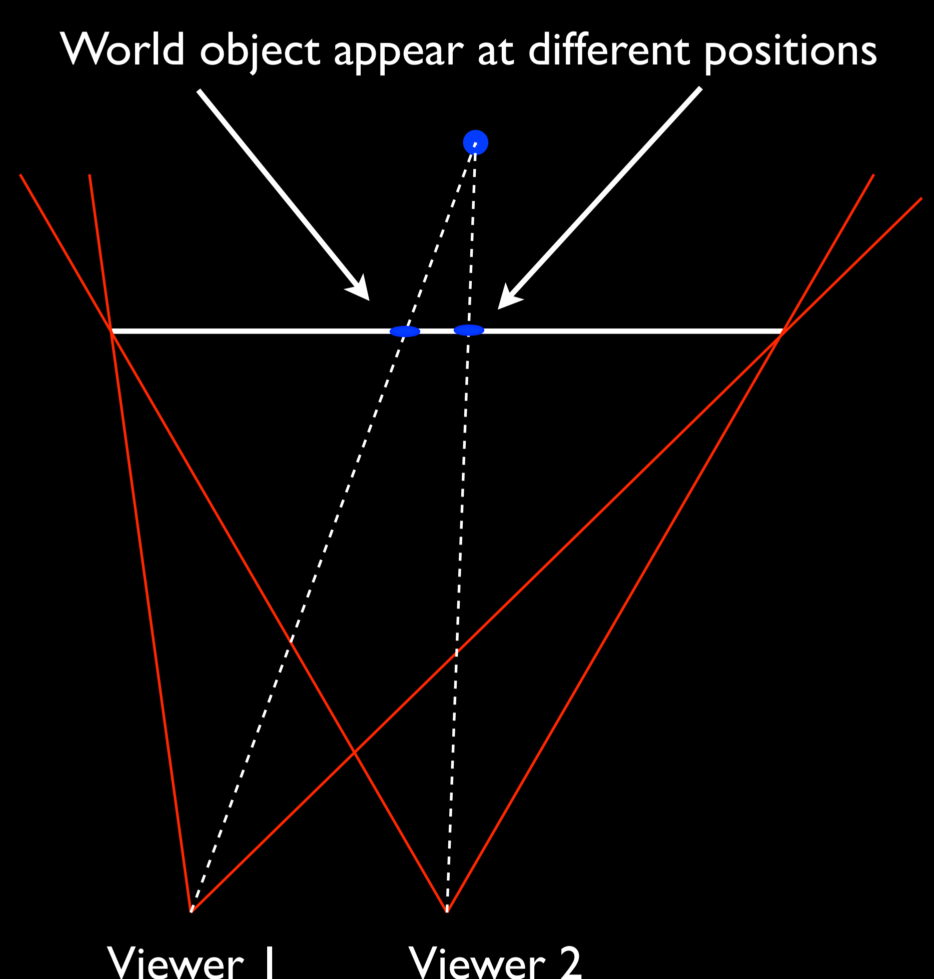
Perspective projections



Consequences explained by this model

- Implication is that all observers get a distorted view of the imagery except the one observer located at the camera position.
- We are tolerant of this for flat imagery, becomes more important for stereoscopic 3D and immersive environments such as domes.
- For example, in a dome straight lines will only appear exactly straight for observers located in the spot of the camera (sweet spot), generally the center of the dome.
- It is possible to place the sweet spot anywhere, but still the imagery is only strictly correct for an observer at that position.





Fisheye projections

- While a standard perspective projection (rectangular frustum) is the natural projection for a flat rectangular image frame, the field of view cannot be widened to 180 degrees to capture the imagery required for a hemispherical dome.
- Same principle as for a flat screen, the dome surface acts as the window to the world. The intersection on the dome surface of a line from the camera/viewer to an object is where that object appears on the dome and consequently on the fisheye image.
- A fisheye projection is the natural way to represent the imagery for a hemispherical display, captures half the world.
- A fisheye projection is not limited to 180 degree FOV, it is defined for all angles.

90 degrees up

90 degrees left

90 degrees right

90 degrees down

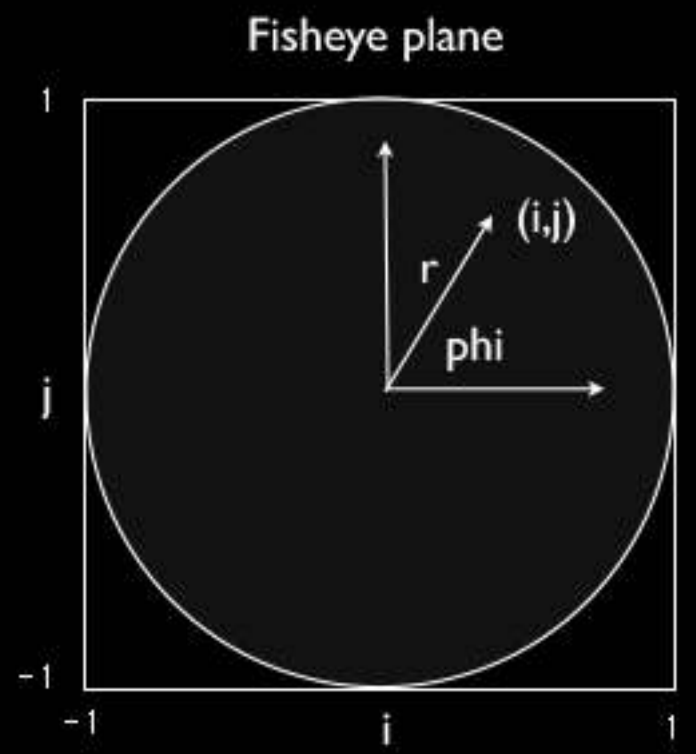
Fisheye projections

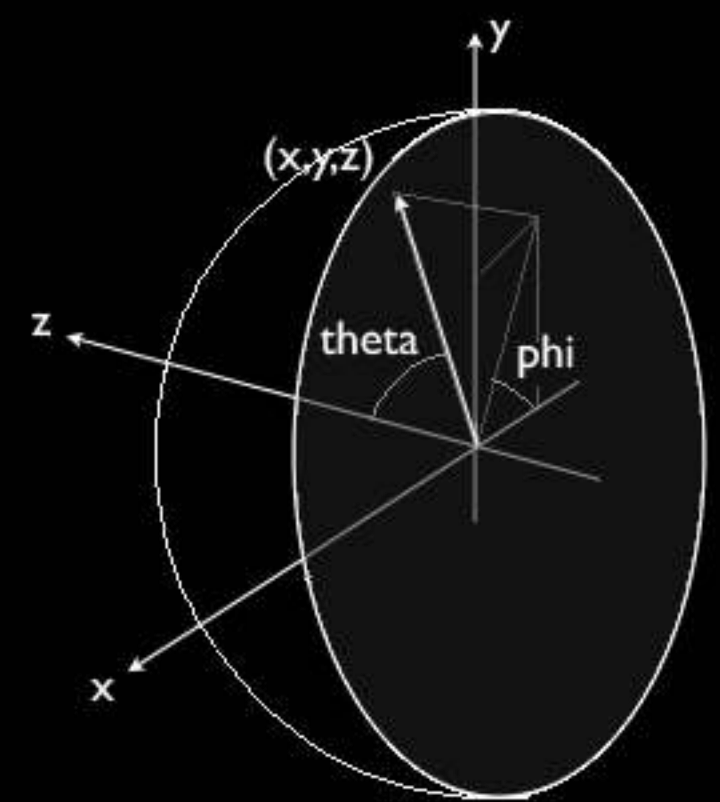
- Typically need to relate the mapping to/from fisheye image coordinates (2D) to a world vector (3D).

- 1. Given a point (i,j) on the fisheye image (in normalised image coordinates), what is the vector (x,y,z) into the scene?
  r = sqrt(i^2 + j^2)
  phi = atan2(j,i)
  theta = r pi / 2
  x = sin(theta) cos(phi)
  y = sin(theta) sin(phi)
  z = cos(theta)

- 2. Given a point (x,y,z) in world coordinates what is the position (i,j) on the fisheye image?
  L = sqrt(x^2 + y^2 + z^2)
  x' = x / L , y' = y / L , z' = z / L
  theta = atan2(sqrt(x'^2 + y'^2), z')
  phi = atan2(y', x')
  r = theta / (pi / 2)
  i = r cos(phi)
  j = r sin(phi)

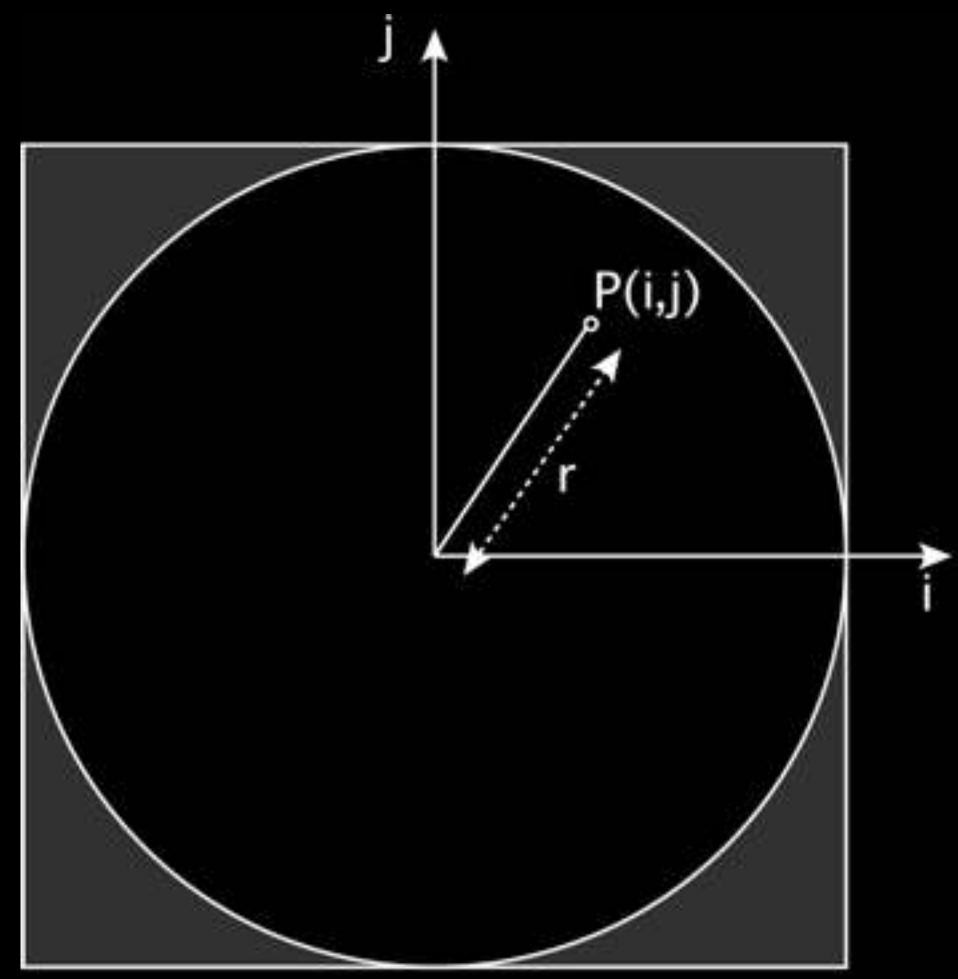
  Traditional to limit the fisheye image to a circle but it is defined outside the circle.

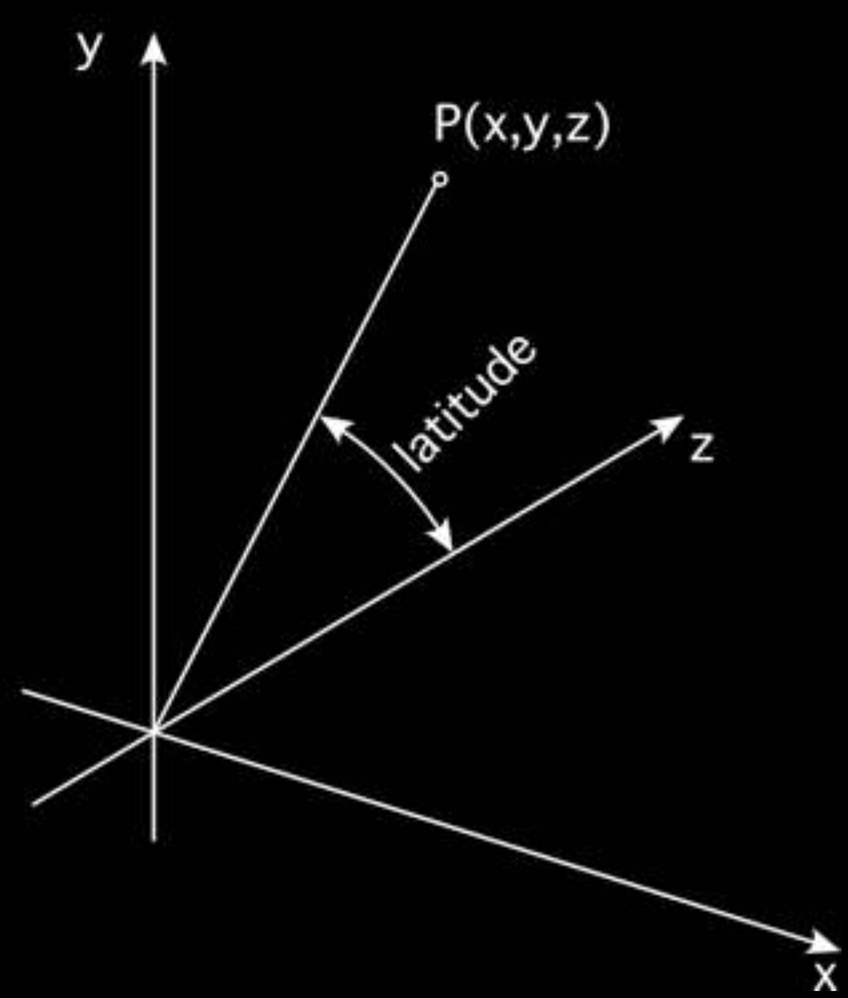




Equal-angle (idealised) fisheye

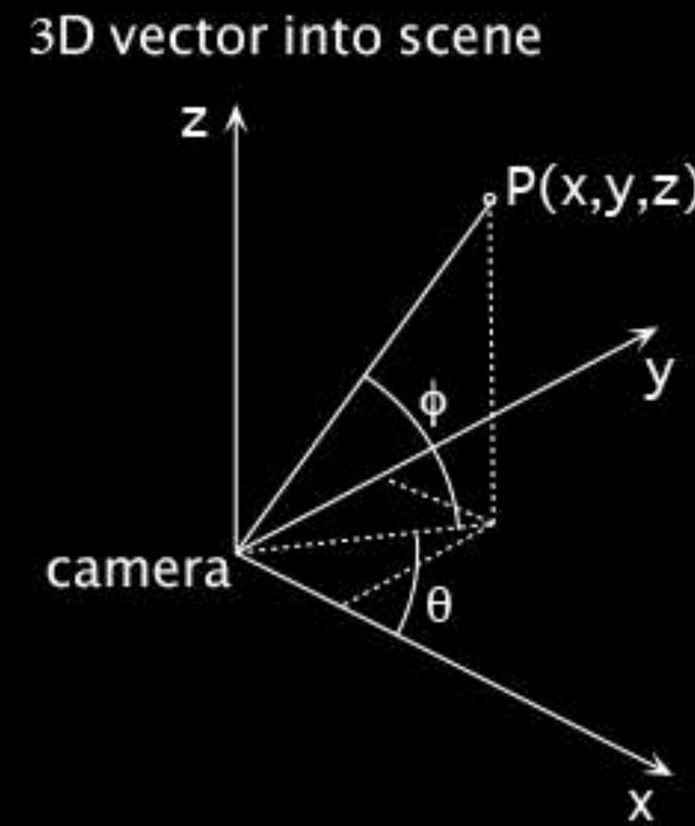
- The radial distance from the centre of the image is proportional to latitude.
- This may not be the case with physical fisheye lenses where there is generally a compression towards the rim of the fisheye image.
- Non-ideal fisheyes can be corrected in the same way as barrel distortion can be correct for normal lenses to give an ideal pinhole camera view.
- We will not talk about fisheye projections being “distorted”, they are no more distorted than any other projection.

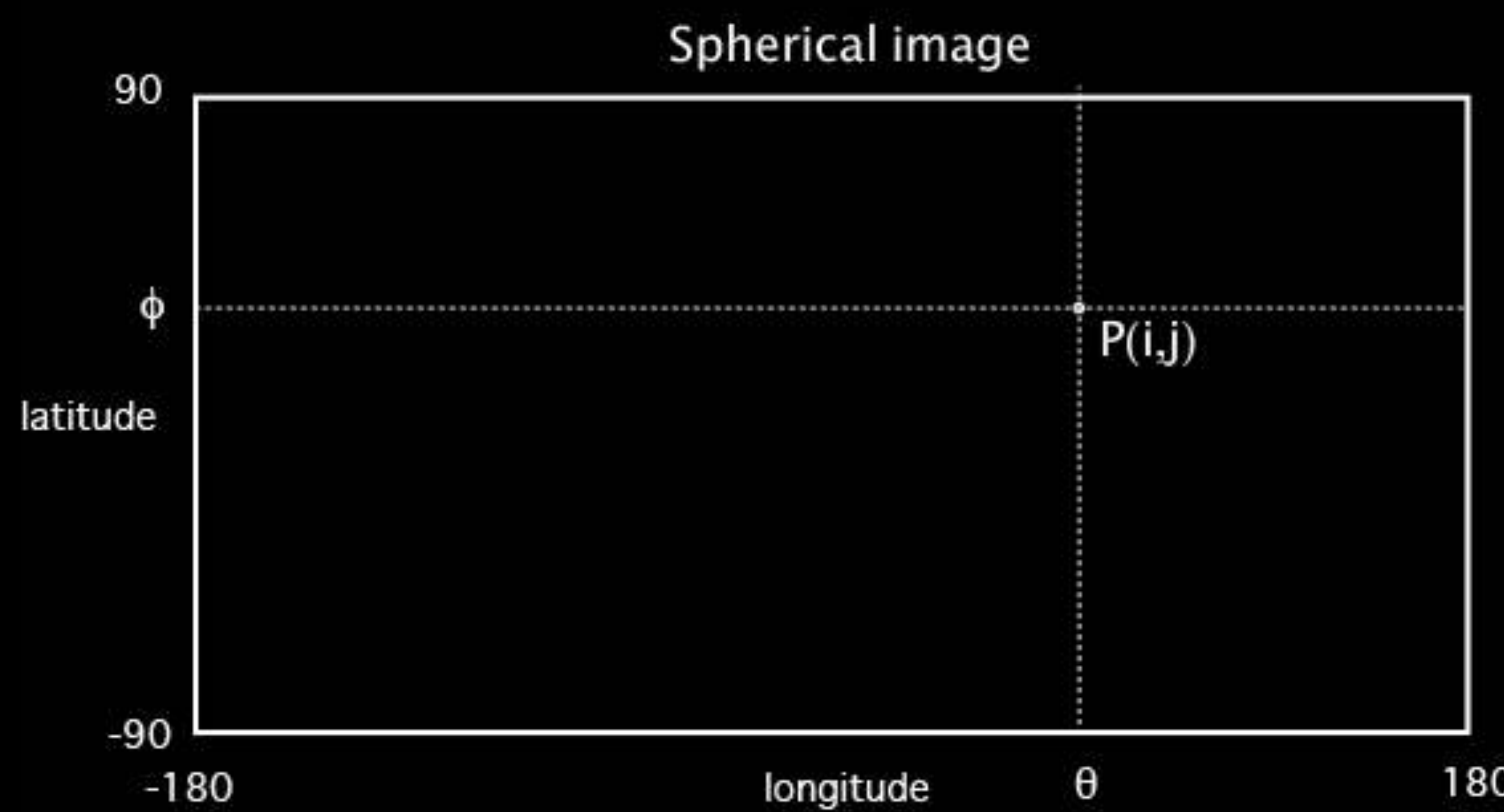




Spherical projections

- Contains sufficient visual information for a presentation into a hemisphere, actually captures more than required.
- 1. Given P(i,j) in spherical projection, what is the 3D vector into into the scene P(x,y,z)
  $Px = \cos(\Phi) \cos(\theta)$
  $Py = \cos(\Phi) \sin(\theta)$
  $Pz = \sin(\Phi)$
- 2. Given 3D vector P(x,y,z) what is the corresponding point on the spherical projection.
  $\Phi = \text{atan2}(Pz,\text{sqrt}(Px2 + Py2))$
  $\theta = \text{atan2}(Py,Px)$





Spherical projection

- A spherical projection captures the whole environment, everything visible from the camera.
- Unwrapping of a sphere. “Distortion” at north and south pole just due to mapping of two different topologies, sphere to plane.
- This allows for navigation within the dome, the creation of any other projection.
- Playback software for a dome will at some stage extract a fisheye from the spherical projection.
- There are an infinite number of possible fisheye views, one can generate the fisheye in any direction.
- Movies provide a means of a semi-interactive experience, one is constrained to the camera path but when travelling along that path one can look around.

Beacon Island fisherman hut

Cylindrical projections

- Objects projected onto a cylinder surrounding the viewer.
- Of less use since the limited vertical field of view is more obvious than one might intuitively expect.
- For the HIVE dome one would need to capture from -60 degrees to +60 degrees in latitude.
  The iDome requires -45 to 90 degrees, the later impossible for a cylindrical projection.
- The HIVE includes a cylindrical display for which the image projection of choice would be a cylindrical projection..
- Vertical distortion increases as the vertical FOV increases so less useful/efficient for domes.

Turkey

Cube Map projections

- Projection of the scene onto the surface of a cube. Each face a 90 degree FOV vertically and horizontally.
- Often shown with the cube folded out.
- Can generate any fisheye we like. Can also generate the matching spherical projection, just pixel reshuffling.

Bangalore

Content creation options

- Photography
  - fisheye
  - spherical images
- Video
  - fisheye
  - spherical video
- Computer generated
  - rendering fisheye, spherical
  - cubemaps converted to fisheye or spherical
- Compositing
- Realtime
  - generating fisheye projections
  - Unity3D and Blender

Fisheye photography

- Distinction between “wide angle fisheye” lens and circular fisheye lens.
  The former is what photographers refer to as fisheye.

- For the HIVE dome and iDome we only need 180 degrees vertical FOV, there are 185 degree and even as high as 220 degree fisheye lenses.

- Main issues with real lenses are
  - non-linear fisheye mapping (radius on image not proportional to latitude)
  - chromatic error towards the rim
  - poorer focus towards the rim

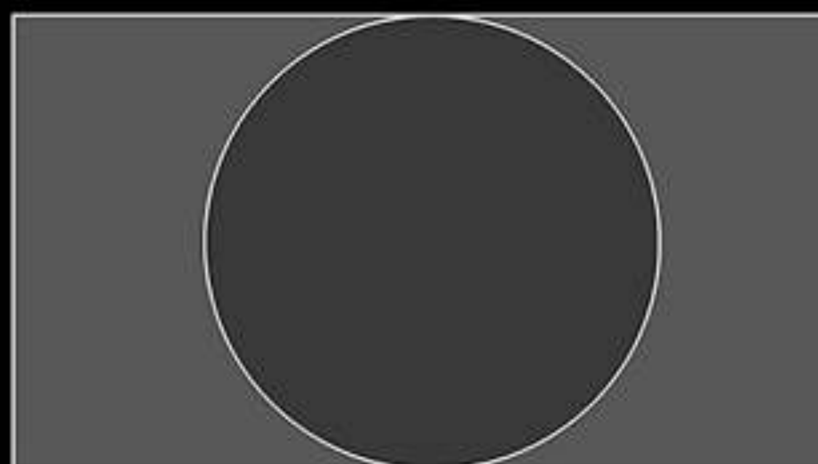
170 degree wide angle fisheye

Circular fisheye

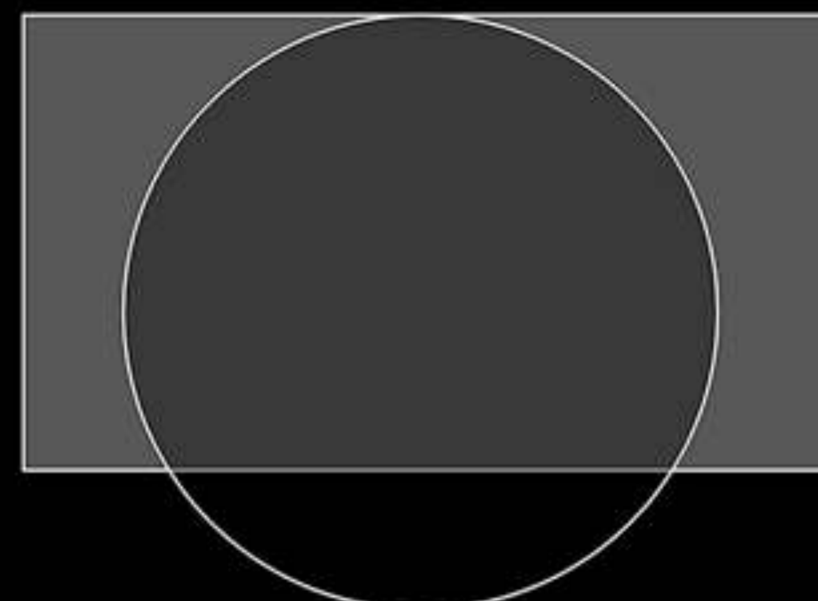
Fisheye photography: Sensors + Fisheye

- Need to consider the location and size of the fisheye circle on the camera sensor.
- Generally a match between sensor size (eg: full frame, APS-C, etc) and the lens.
- These same comments will apply later to video.

16x9 aspect sensor examples

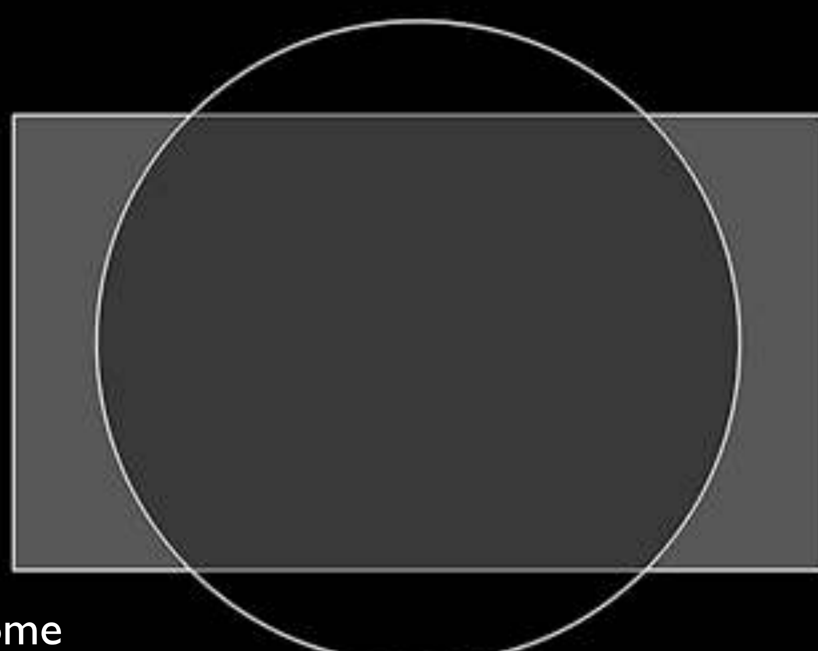


Optimal for general domes

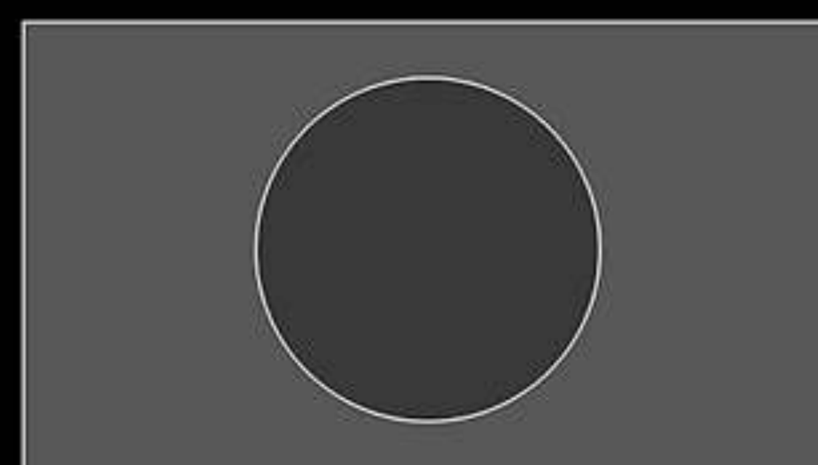


Offset lens, rare

Optimal for iDome



Optimal for HIVE dome



Too small (Inefficient)

Fisheye photography: Sensors + Fisheye

Example of a full frame fisheye on a 2/3 sensor

Example of a 2/3 fisheye on a full frame sensor

Ideal, 2/3 fisheye on a 2/3 sensor,
or full frame fisheye on full frame sensor

Fisheye photography for the HIVE dome

- HIVE dome is truncated on the top and bottom +-30 degrees.
  One can get higher resolution by using full width of the sensor.
- The fisheye can be zoomed in to use more of the sensor horizontally than vertically.
- BUT it reduces the ability to use the imagery on other domes. Recommend against this since resolution is rarely an issue for stills.
- Even though only part of the sensor is used, material would still be prepared as a full fisheye frame.

Optimal use of the camera sensor for HIVE fisheye

Still prepare the frames in a square format

Spherical images

- Otherwise known as “Equirectangular projections”, or just “Bubbles”.
- Very straightforward using a camera and fisheye lens.
- Just requires 3 or 4 shots and suitable stitching software.

Beacon Island

Spherical images

- Can get higher resolution with 4 shots and the camera in portrait mode.





Weld - Indigenous rock shelters

Higher resolution spherical images

- Arbitrarily high resolution spherical images can be captured by taking larger number of shots.
- Usually done with a motorised rig.
- Otherwise known as gigapixel (spherical) images, useful capture as a record of the place but wasted on the dome.

Wanmanna

Wanmanna 220 photographs 80,000 pixels x 20,000 pixels

Fisheye video

- Much more difficult to achieve sufficient resolution.
- Truncated fisheye may be the best option.
- Note that pixel resolution is not the only story, most video cameras have limited bandwidth to storage so apply lossy compression to the video.
- Full frame fisheye on a HD camera is only a 1K fisheye circle.
Truncated options for the HIVE dome a necessary evil.

Canon video camera

Fisheye video

- Cost effective solution is the Canon 5D Mk III and zoomable 8-15mm fisheye lens.

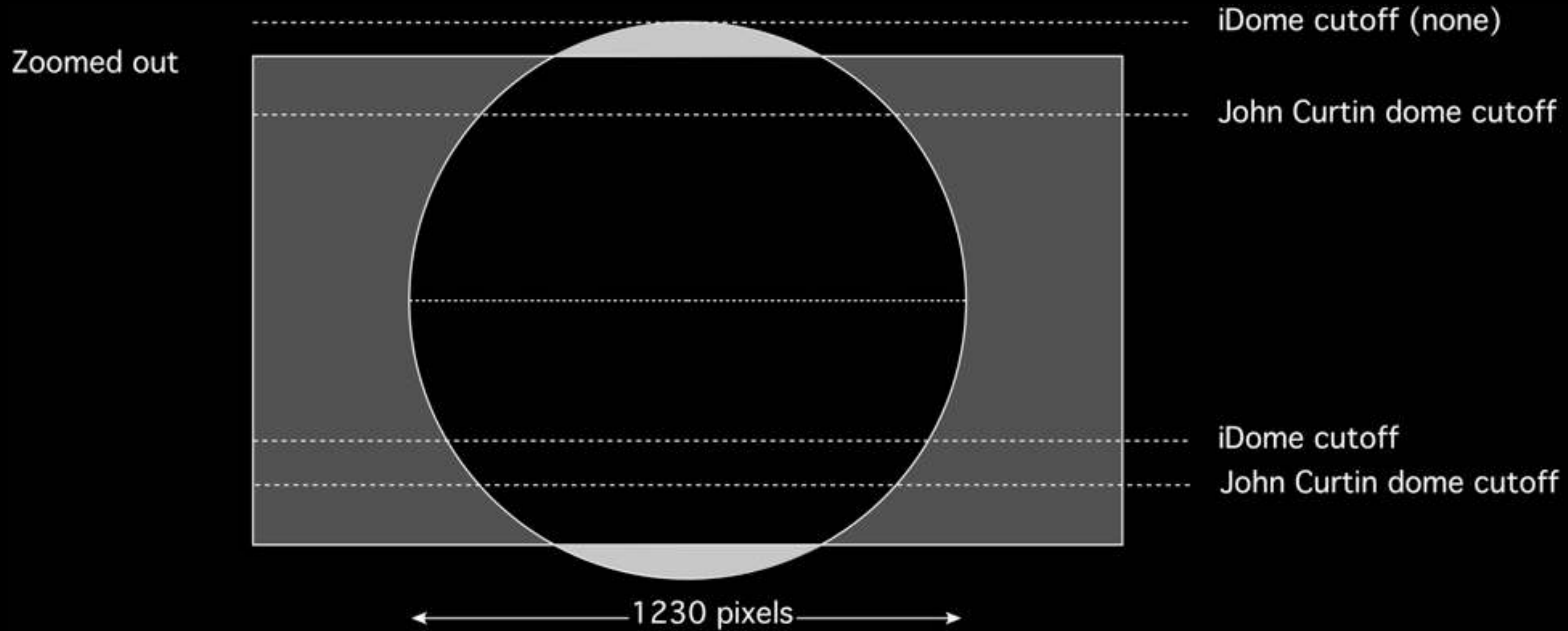
Zoomed out

Still images (4x3)

Zoomed in

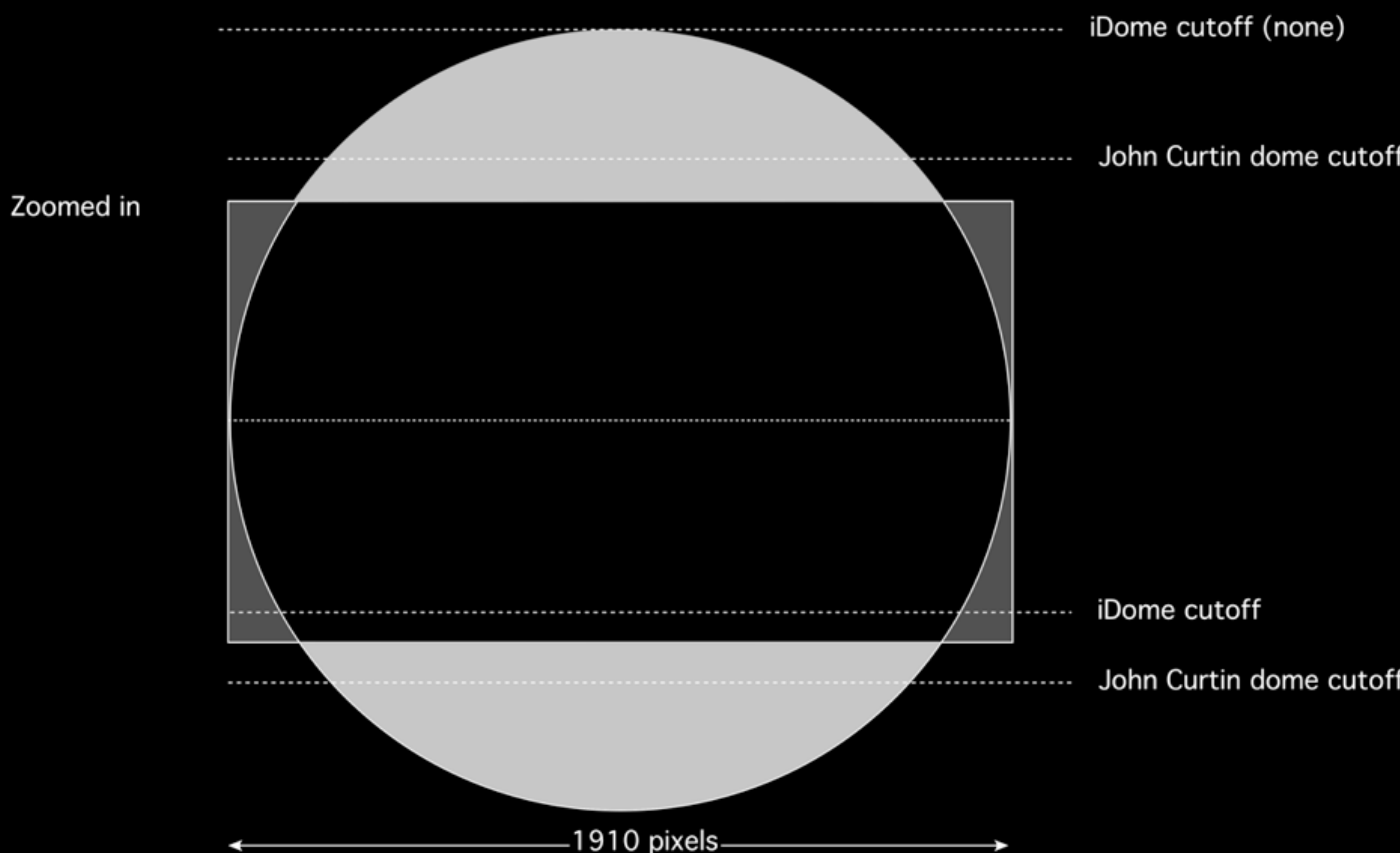
Canon 5D Mk III and 8-15mm zoom fisheye

- In video mode the fisheye extends past the sensor vertically even when zoomed out.
- Ok for the HIVE.



Canon 5D Mk III and 8-15mm zoom fisheye

- When zoomed in all the way the truncation is less than the HIVE cut-off.



Fisheye video

- Next step up is a 4K video camera and fisheye lens.
- Have used the Red Scarlet and Red Epic for a number of projects. APS-C sensor.
- A fully inset fisheye would only be a 2K circle.
- Also investigating a number of more square machine vision cameras.
The 16x9 aspect of modern video is not helpful for dome filming.

Fisheye and Red cameras

- Despite fisheye truncation, all content should be processed to lie within a square fisheye image.
- The industry standard and sites will only generally know how to project full fisheye frames.

UWA English

Red Epic + 4.5mm sigma fisheye lens
2300 pixel circle

Red Scarlet + 4.88mm coastal optics fisheye lens
2800 pixel circle

My favourite shot

Spherical video

- A number of options for capturing spherical video.
- With single camera options hard to capture sufficient resolution.
- Lots of attempts over the years including more modern version based upon the GoPro cameras.

UNSW

UNSW

Kolor

Spherical video

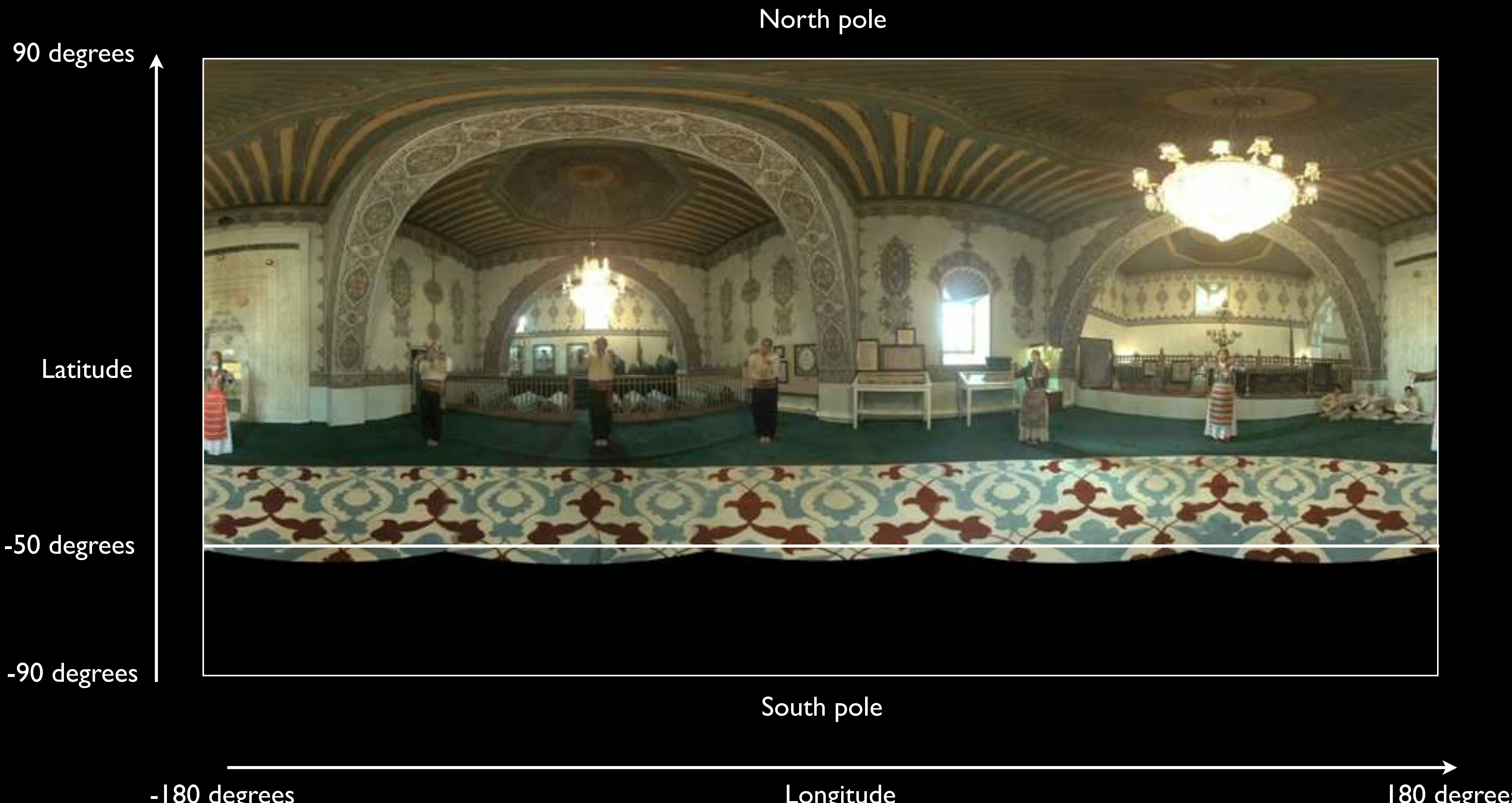
- We have a LadyBug-3 and 5 camera.
- LadyBug-3 records 5400x2700 pixel spherical projection.
- Some interesting options now involving multiple GoPro cameras in cluster arrangement. But GoPro dynamic range and compression is pretty ordinary.

Perth

Ladybug video

- Captures 360 degrees horizontally (longitude).
- Captures from the north pole to approximately -50 degrees vertically (latitude).
- Cut-off at the bottom suited the lower truncation of the iDome.

Ladybug video



Hashibektashi performance, Turkiye

Hashbecktashi Dancers

Kardeslik Semahi & Aliyar Semahi (Hacibektas Veli Museum)
Bektasi Semahi (Hacibektas Veli Museum performers)

Ladybug video

Mah Meri tribal healing ritual, West Malaysia

Mah Meri

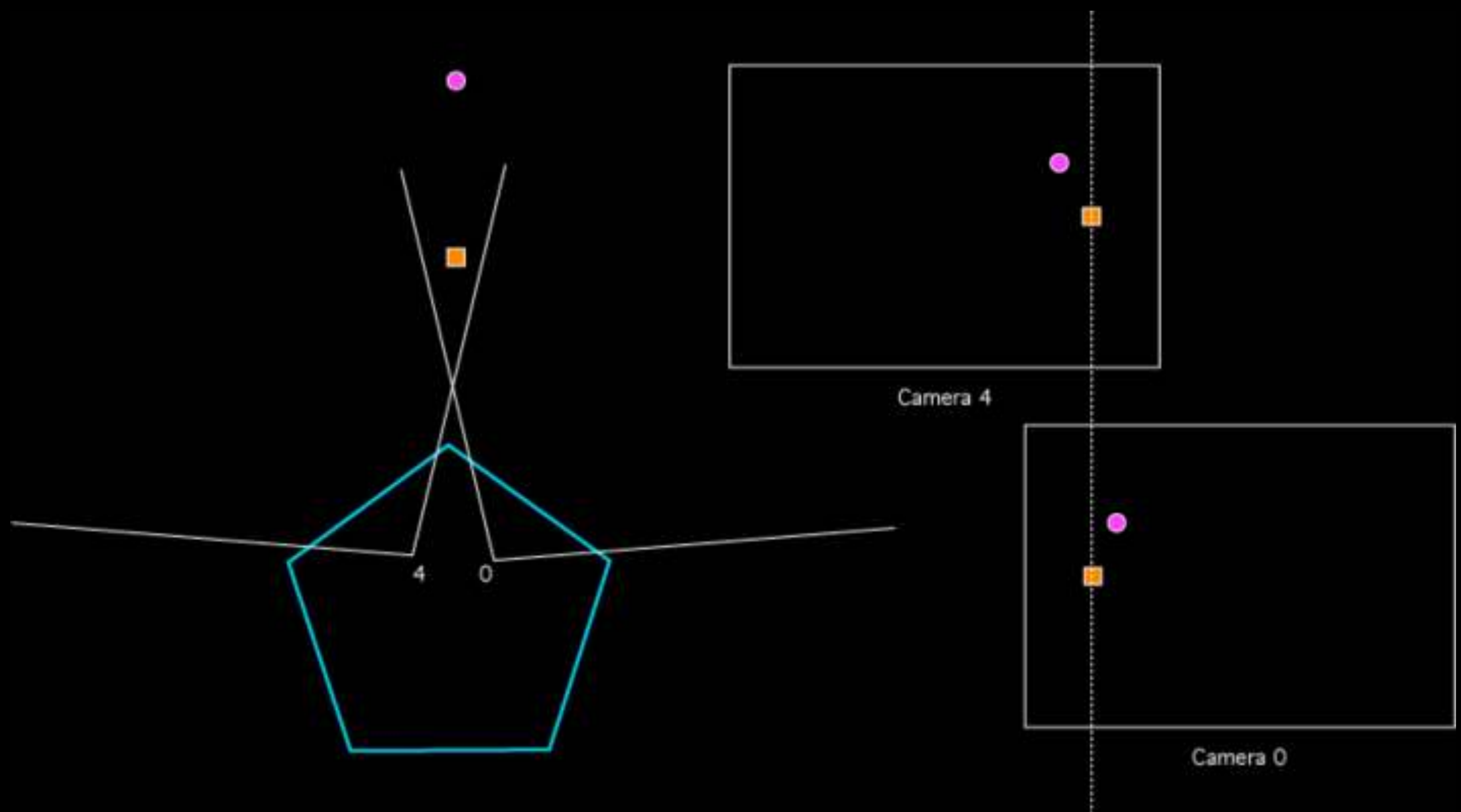
Mah Meri tribal dance, West Malaysia

Ngintaka

Ngintaka story

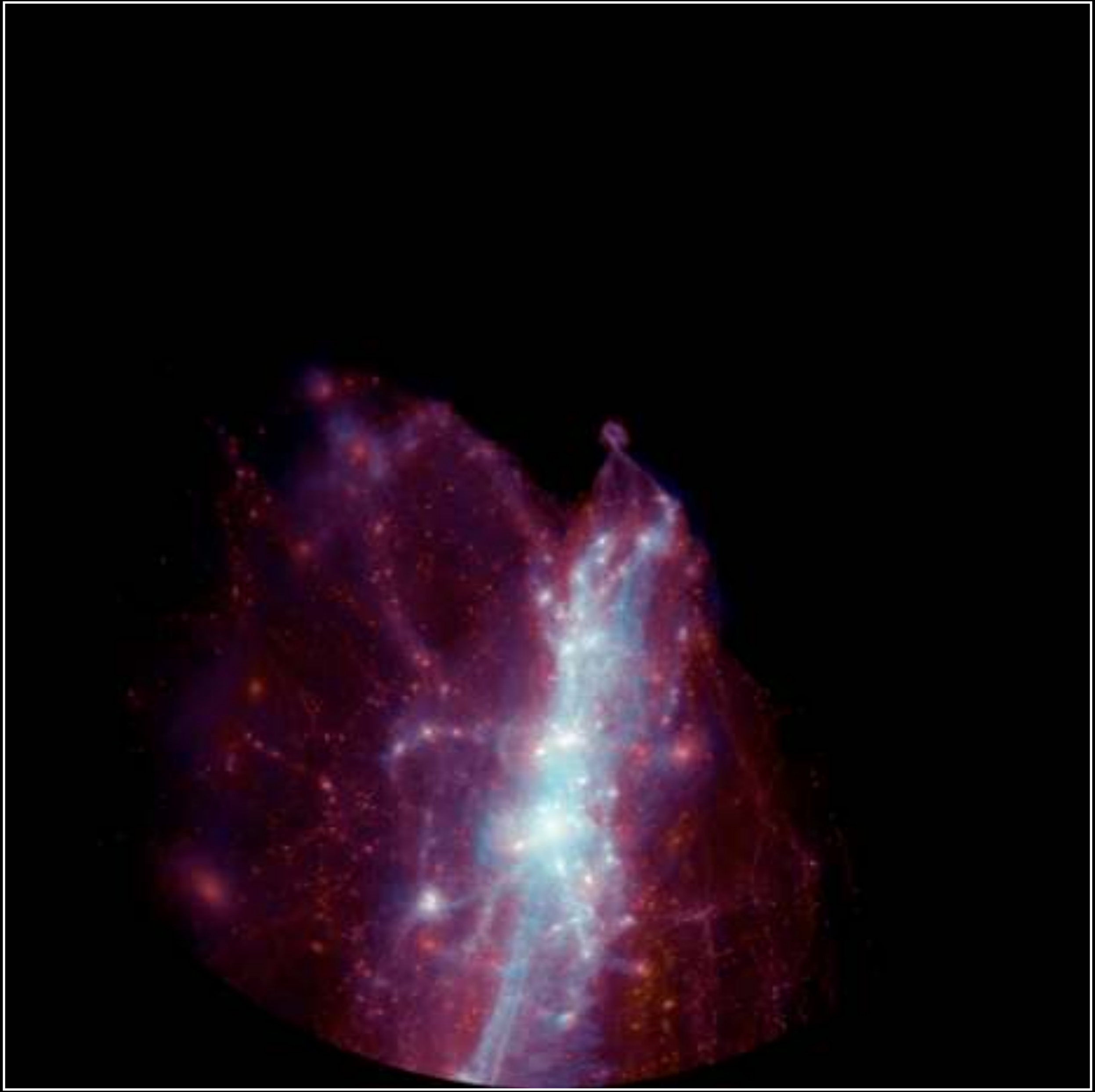
Spherical video and multiple camera problem

- Fundamental issue with multiple camera rigs is that it is not possible to achieve a perfect blend for all depths.
- There will always be blend zones.



Computer generated

- Require a virtual camera that supports the desired projection type.
- In theory any projection can be created, for example for a raytracer just need to know the ray into the scene from the camera for any position on the image frame.
- The maths is quite straightforward for custom rendering solutions developed inhouse.



Sequence from Dark, custom rendering from my own code.

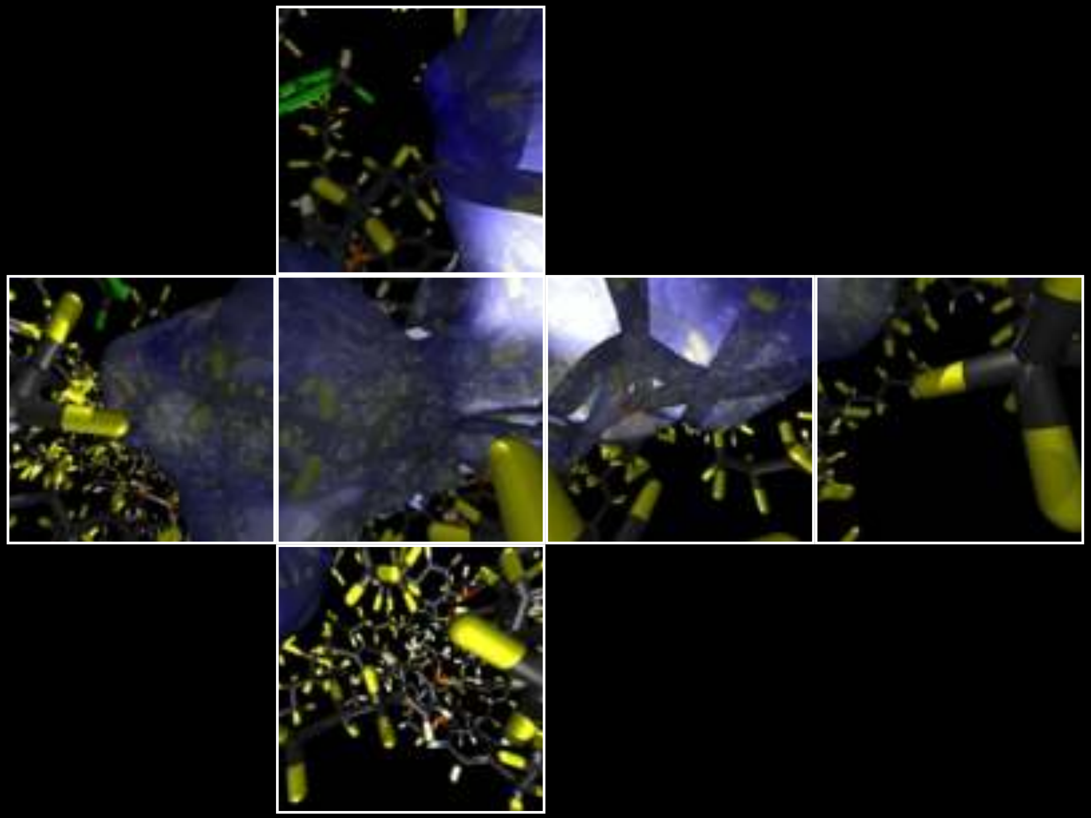
Cube maps

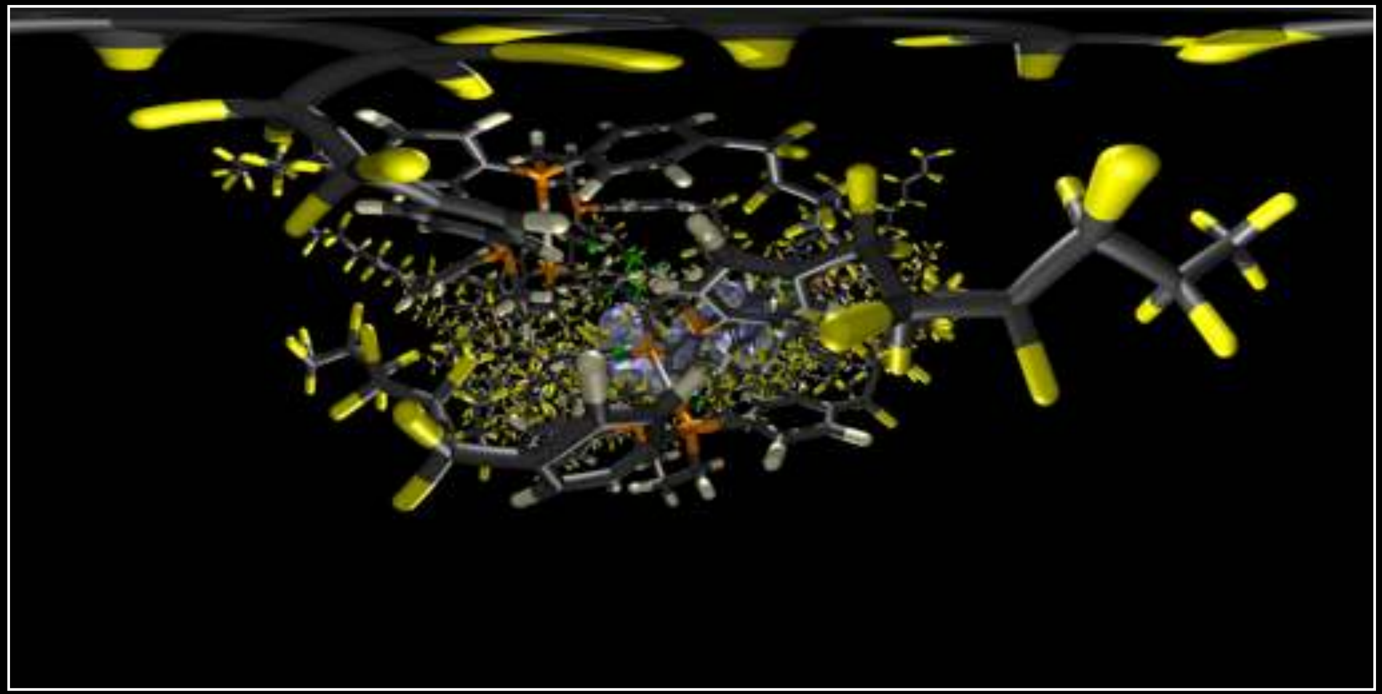
- Many/most rendering engines now support angular fisheye.
- For others there is generally an externally available plugin.
- Fallback position is rendering so called cubemaps.
- Fisheye assembly: cube2dome (my software), there are others.
- Can create a fisheye in any direction with 6 cube maps or one can choose to only render 4, minimum required for a 180 degree fisheye.

Sydney law chambers

Cube maps to spherical projections

- Can obviously create more than a fisheye since whole field of view is represented in the cubemap.
- Just pixel shuffling.
- Generally use a 3:1 ratio for cube map faces, that is, cube faces 1 third the horizontal pixels of the spherical projection width.
- The most common (or only) approach for closed software without fisheye support.
- Care needs to be taken with antialising at edges.





Crystal explorer

Spherical movies

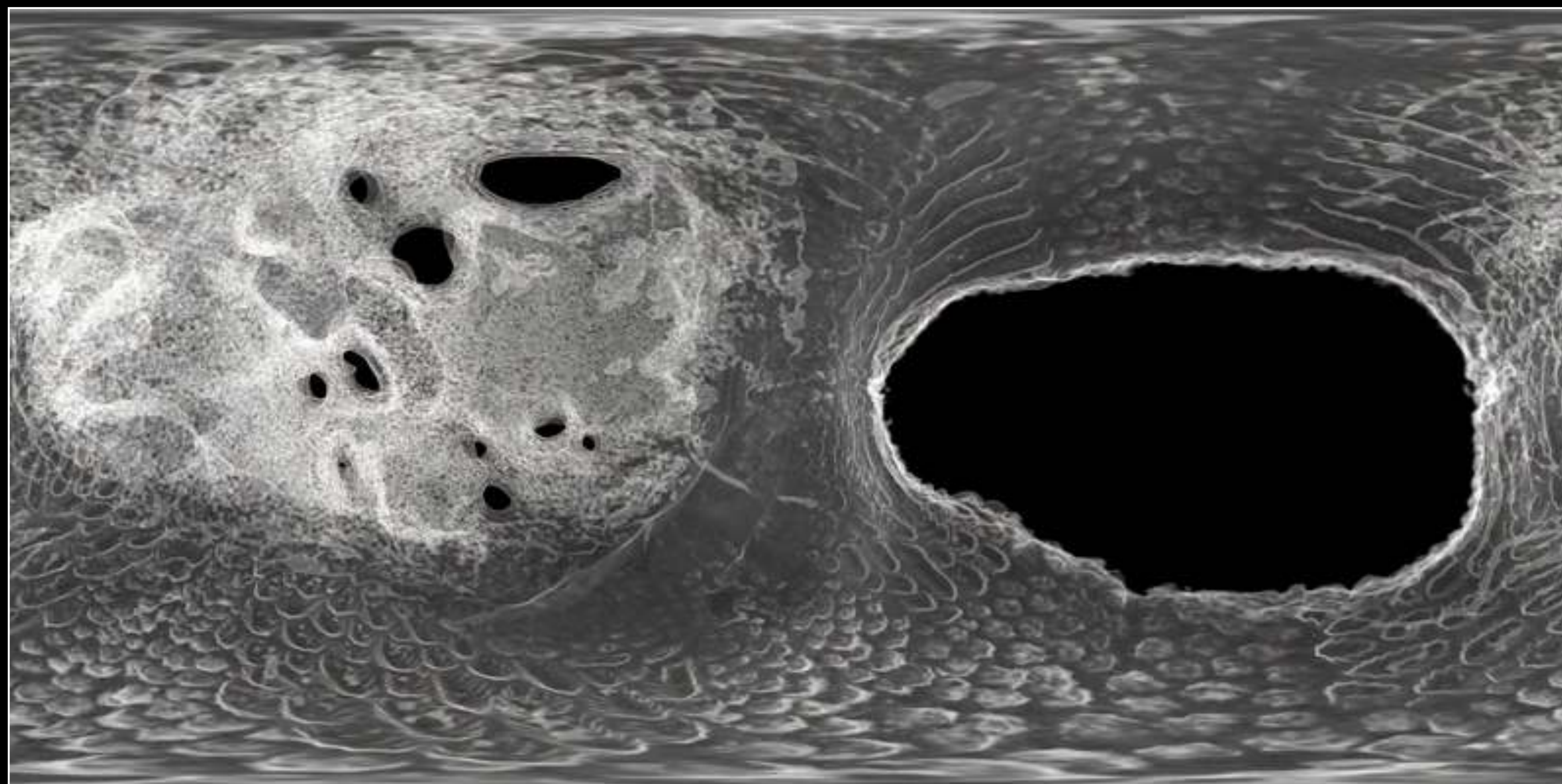
Drishti

North pole

90 degrees

Latitude

-90 degrees



South pole

-180 degrees

Longitude

180 degrees

Inside the eyeball of a placoderm fish, circa 400 million years old

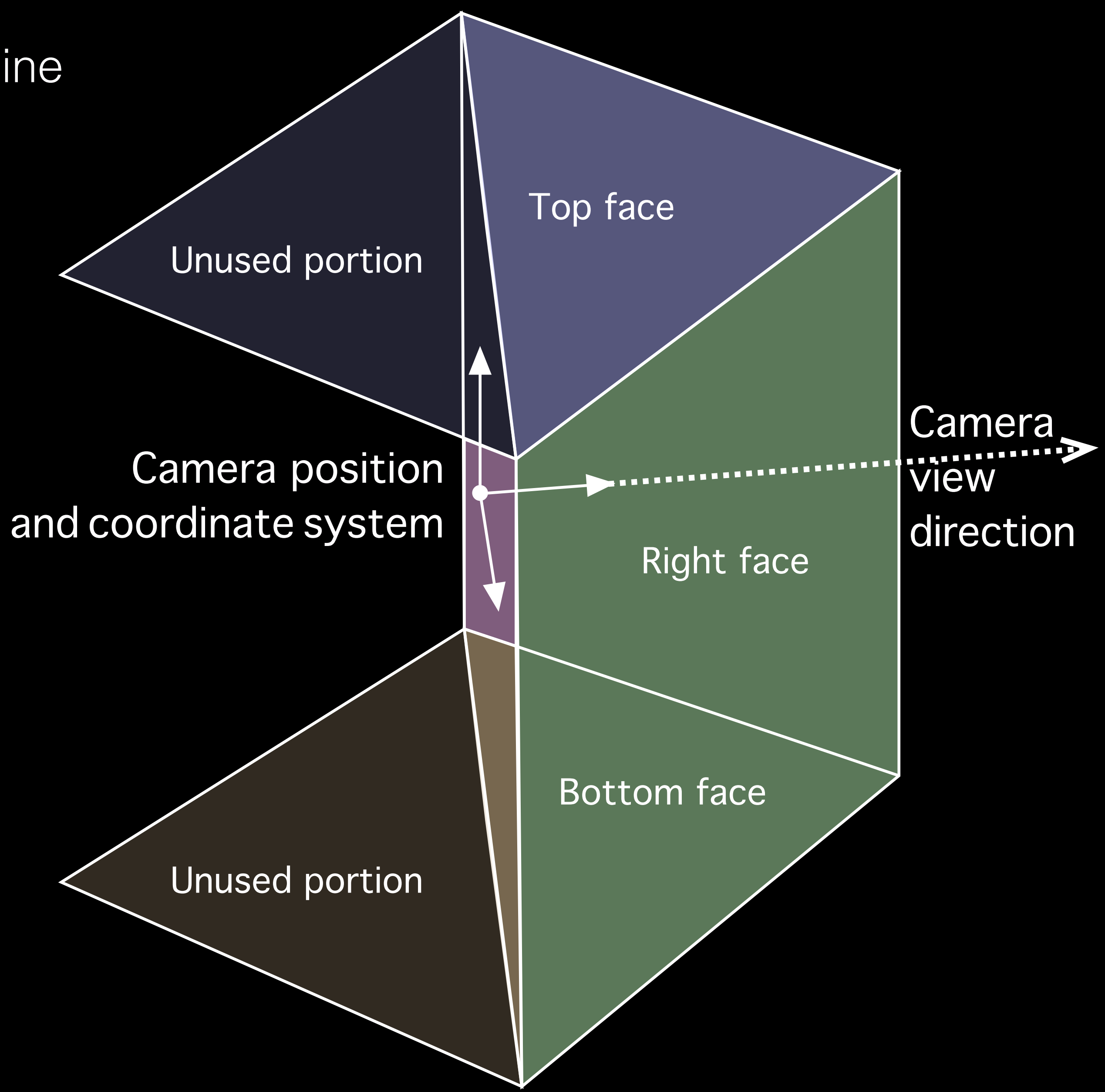
Compositing

- Can’t often use standard packages because of non-rectilinearity of a fisheye projection.
- “Straight lines” in a fisheye image is not a straight line in fisheye space.
  Rectangular regions vary in shape depending on the location in the image,
- There are plug-ins for various packages to support fisheye coordinates.
- We use “Fulldome” plugin from Navegar for After Effects.

Dragon Gardens, Hong Kong

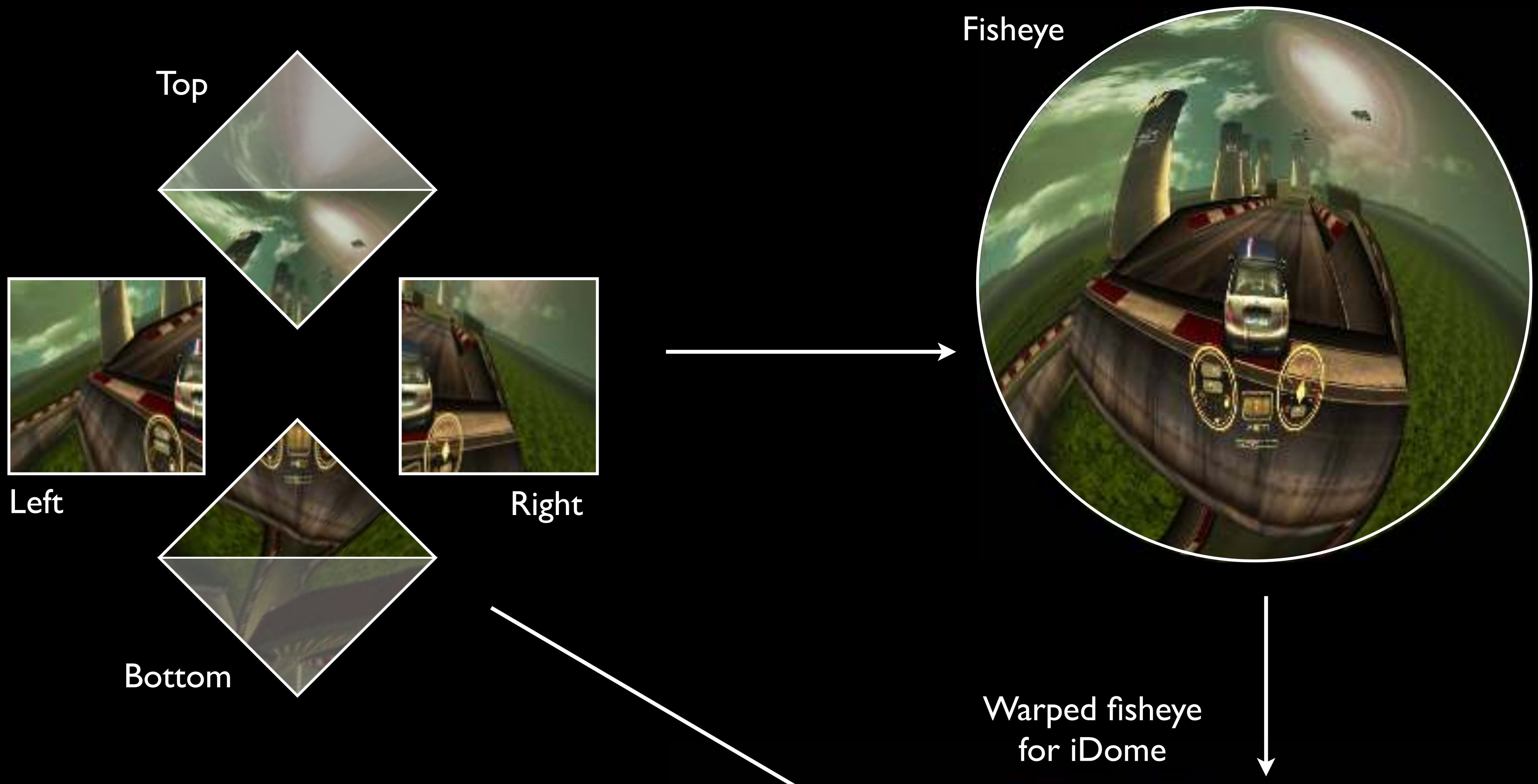
Realtime

- Realtime APIs don't support fisheye projections: only perspective and orthographic.
- Two approaches, typically use multipass generation of cube maps.
- Approach used here is to render 4 views, frustums through the vertices of 4 faces of a cube centred at the camera. Special case of cubemaps.
- Note this is one less face than required than if the camera looks at the center of the front cube face.
- This is the approach used in Blender Game Engine and Unity3D implementations.
- Also tested Crystal Quest ....
  sure others are possible.
- Use the full left and right faces, only use half the top and bottom faces.



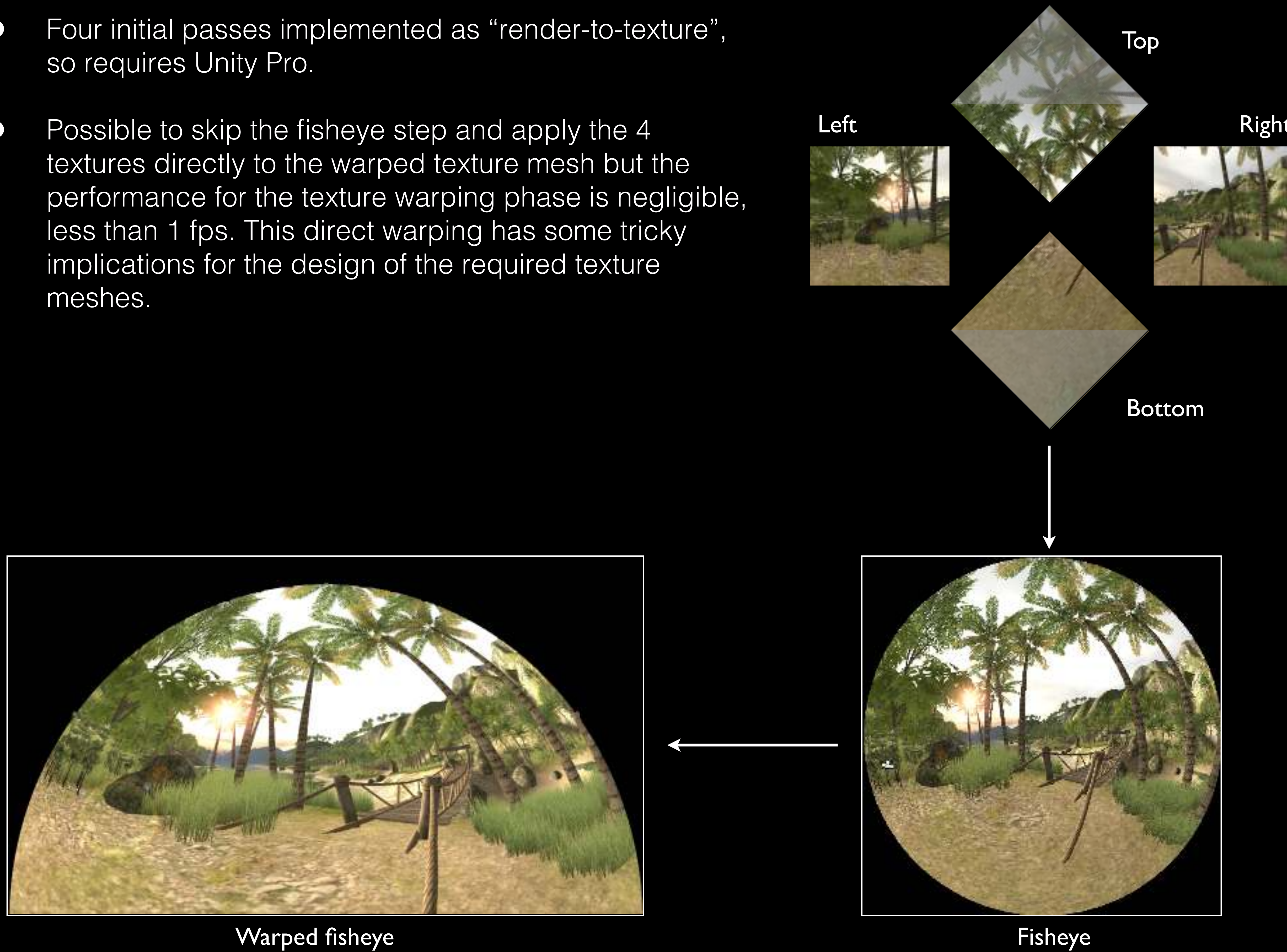
Blender Game Engine

- Supported in the current release.



Unity3D

- Four initial passes implemented as “render-to-texture”, so requires Unity Pro.
- Possible to skip the fisheye step and apply the 4 textures directly to the warped texture mesh but the performance for the texture warping phase is negligible, less than 1 fps. This direct warping has some tricky implications for the design of the required texture meshes.

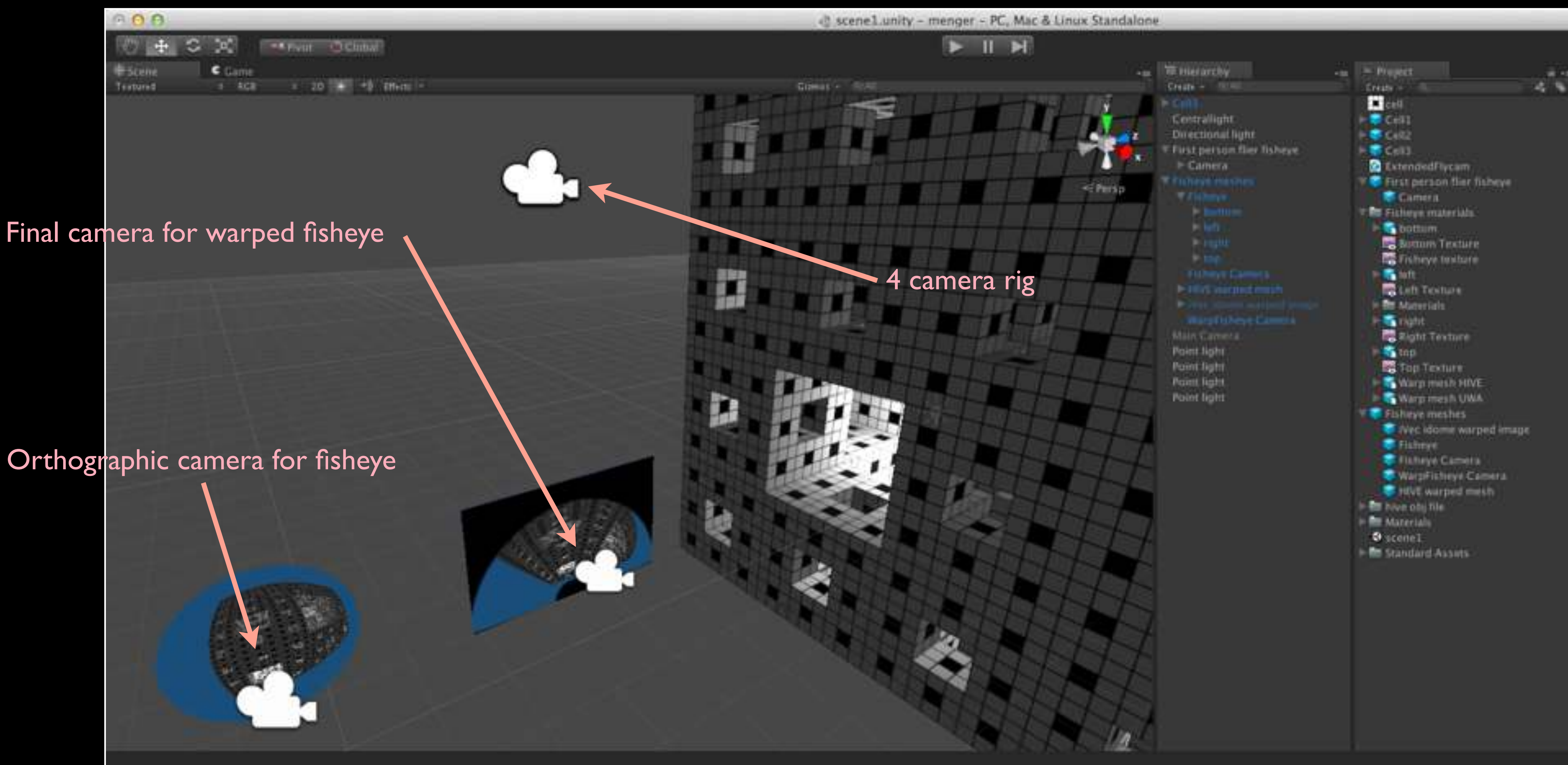


Performance

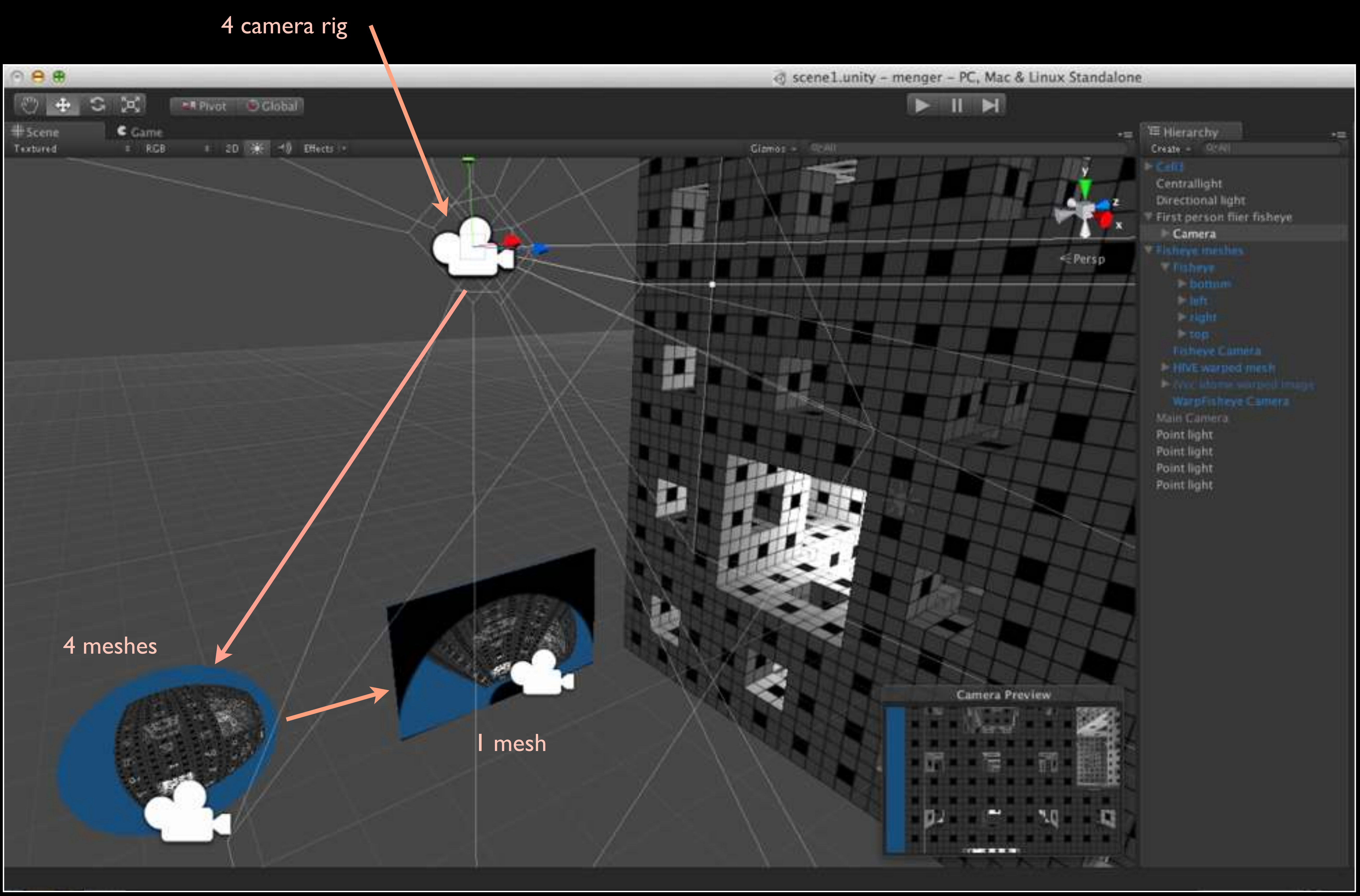
- Performance hit is approximately a factor of 2.5
- On current graphics cards the texture passes are negligible.
- Important to match the resolution of the 4 rendered textures to the final fisheye and/or warped fisheye resolution.
- Care must be taken at every stage of the pipeline to optimise image quality.

Unity3D example

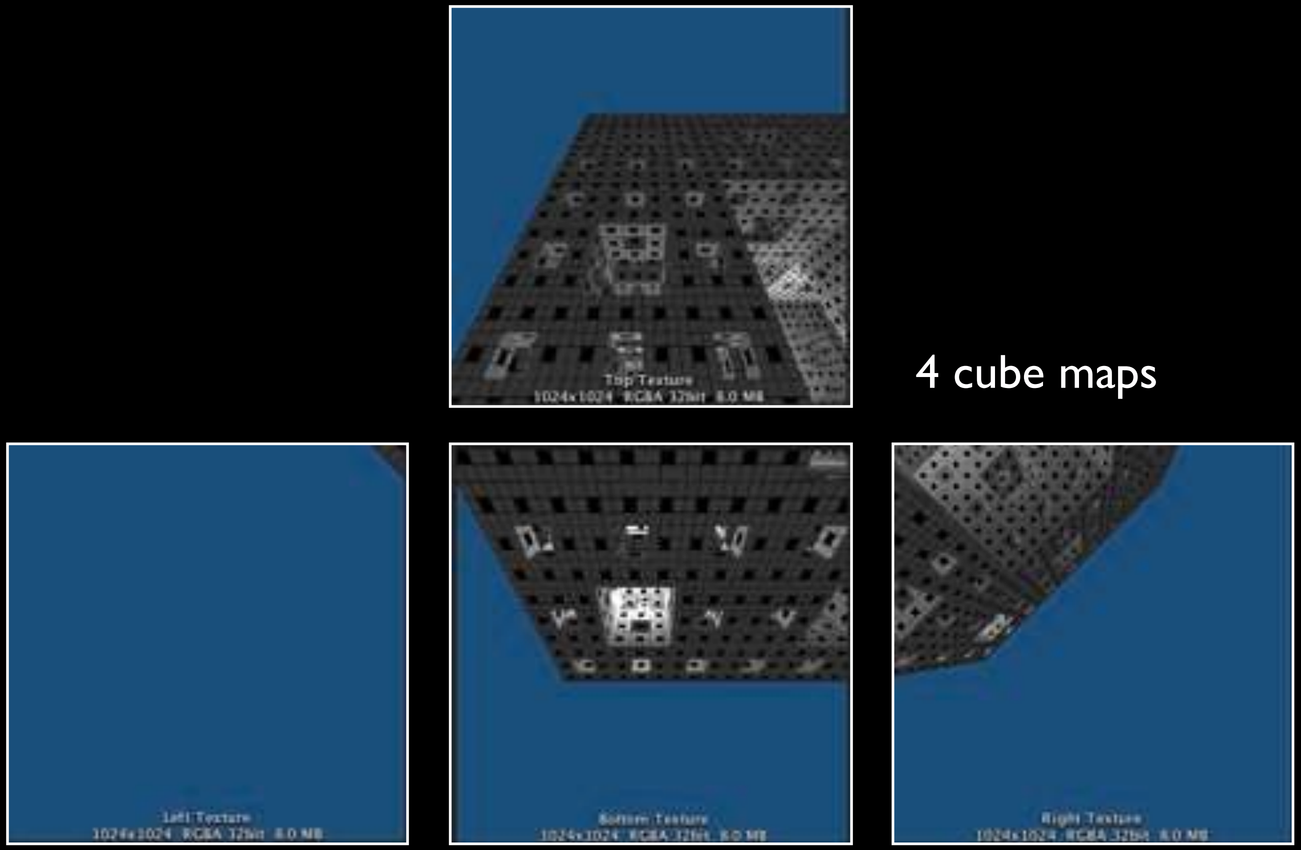
- What size textures to use in each stage?
  Two high and there are performance and aliasing effects.
  Too low and the full resolution of the iDome isn't being exploited.
- Cube face textures: 1024 pixels square. Fisheye texture is 2048 pixels square.
- Texture maps and extra camera placed on their own layers so invisible in game play.



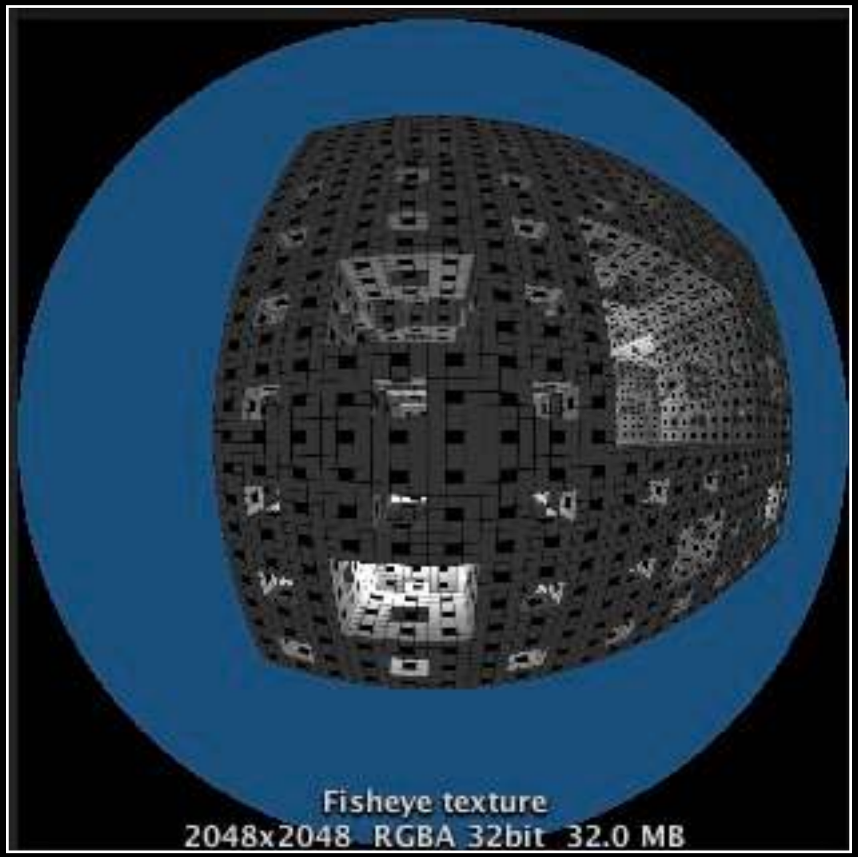
Unity3D example



Unity3D example

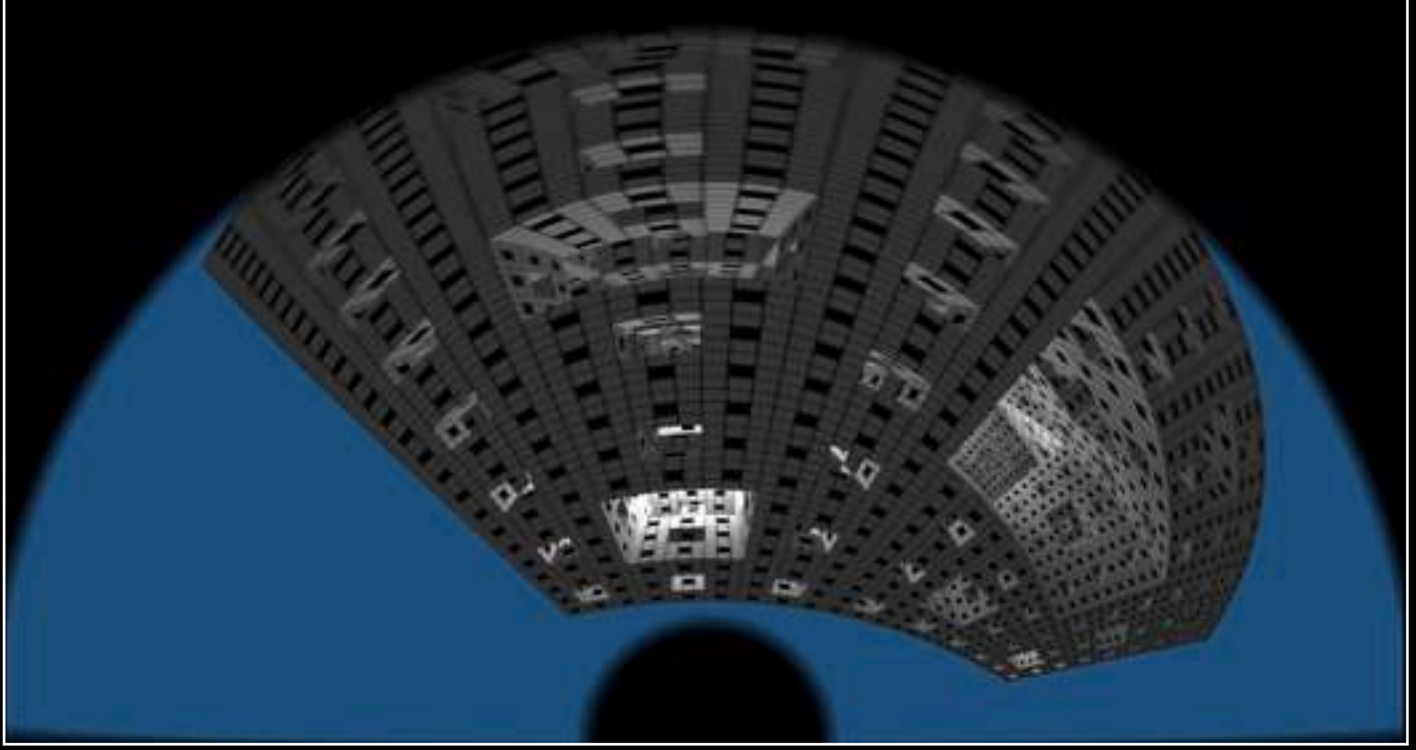


4 cube maps



Fisheye

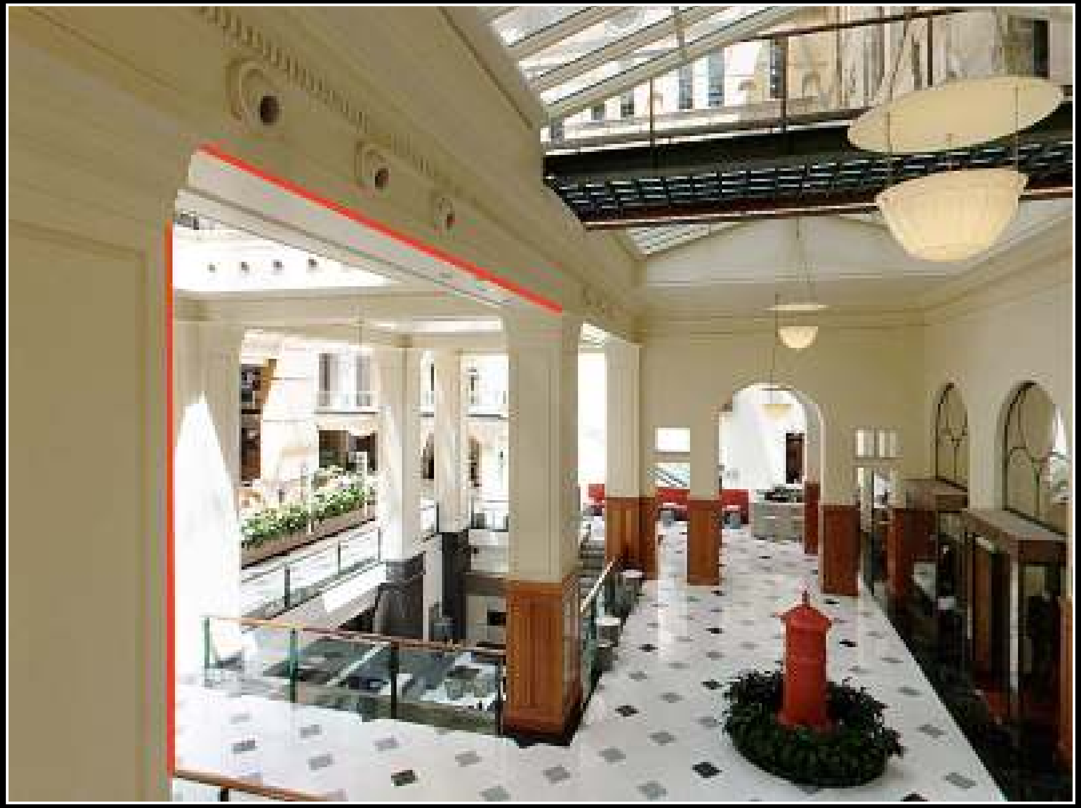
View for HIVE projector



Menger sponge

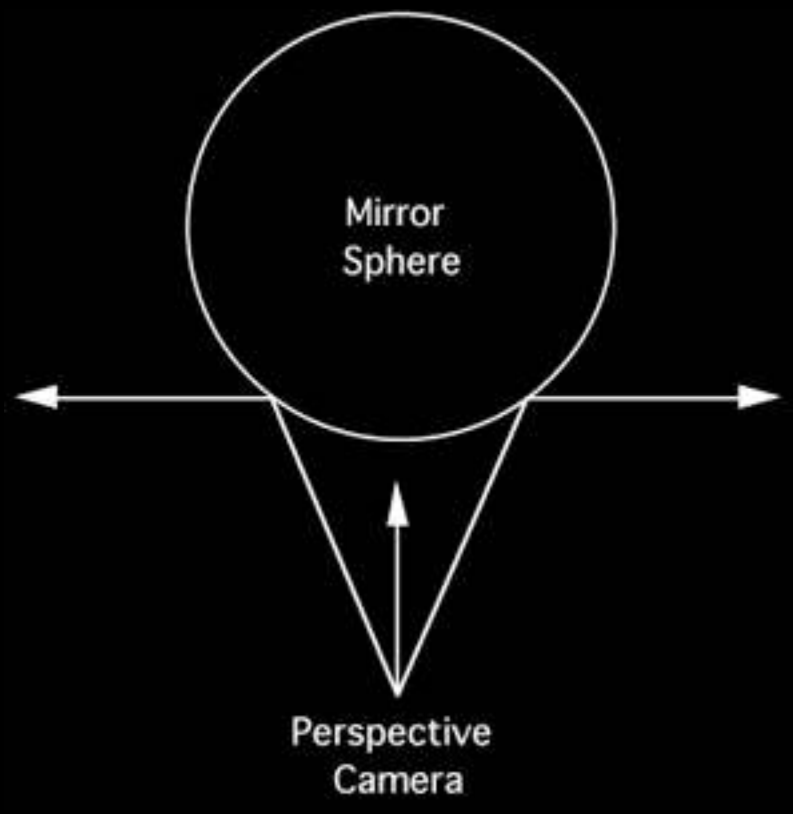
Vertex shaders

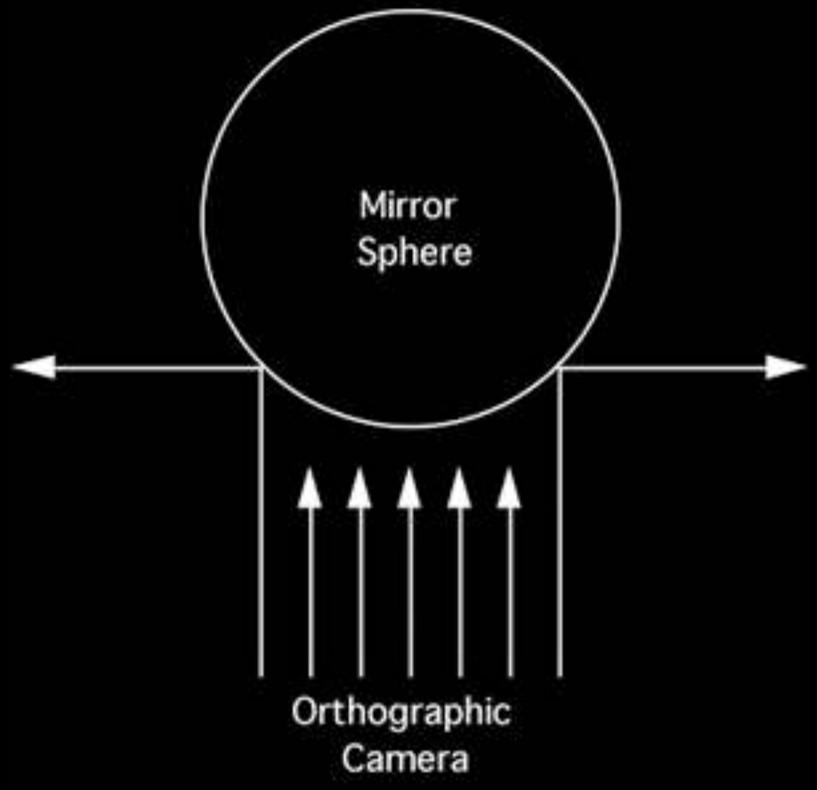
- Other approach is single pass (followed by warping) using vertex shader.
- A cunning trick: modify the position of each vertex such that the result when viewer with an orthographic camera is a fisheye image.
- Simple in concept but involves geometry tessellation which can be expensive.
- A straight line in a standard perspective projection only requires knowledge of the two end points. A straight line is not “straight” in a fisheye projection.
- The solution is to tessellate all the 3D geometry being drawn. The optimal algorithm to do this is not at all trivial, inefficient tessellation results in a high geometry load on the graphics card.



Cheats

- Approximations to fisheye projections by pointing a camera at a reflective sphere.
- This has been used by animators when there isn't a native fisheye lens supported. Can be a messy approach.
- For CG need to pay attention to the sphere being visible in the scene. eg: shadows and objects passing through the sphere.
- Not very common or necessary today due to limitations and availability of other methods.



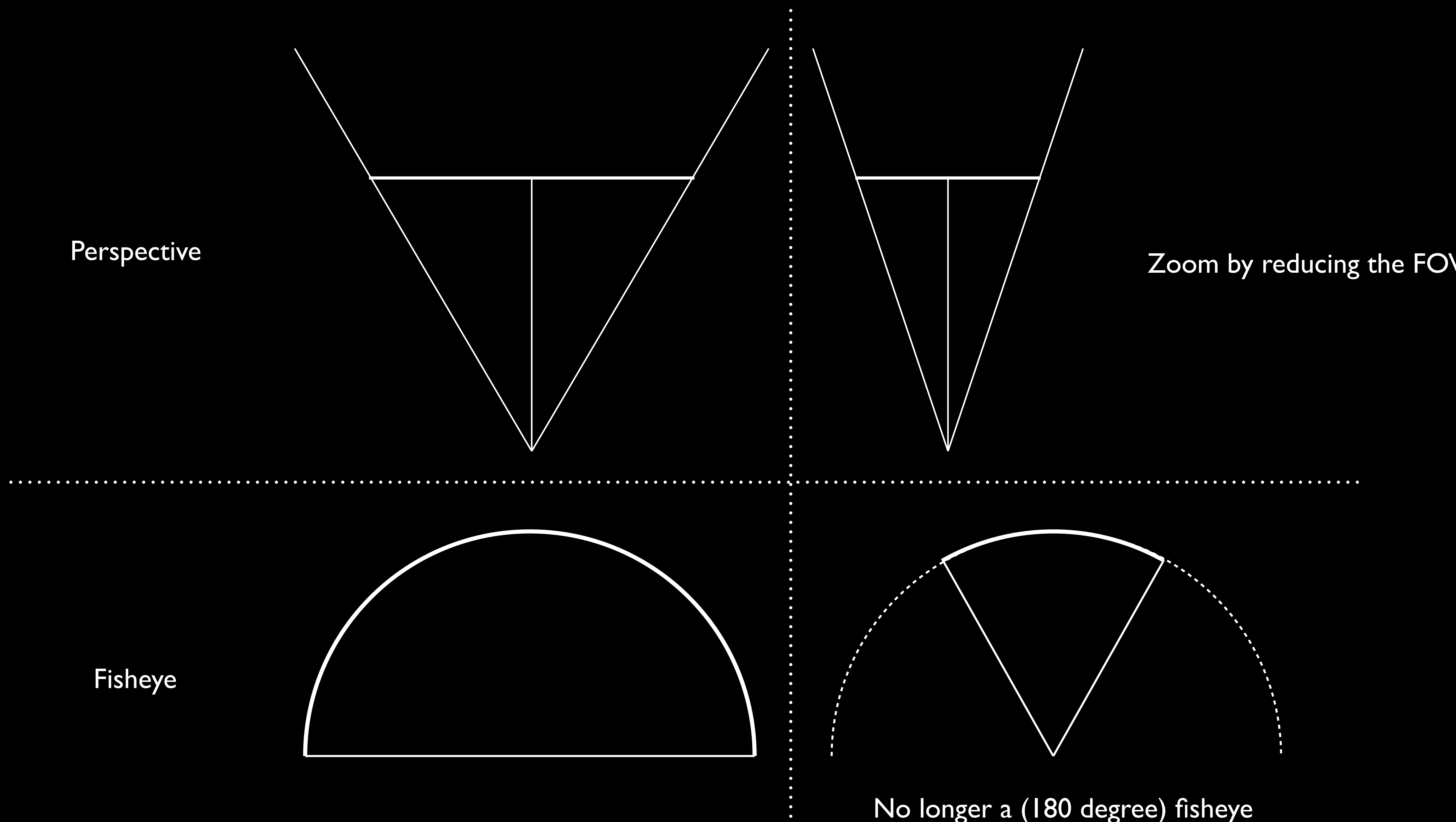


Considerations: viewing position

- Geometry only strictly correct for a single position, the camera position.
- Can be any position (called offset fisheye projections), but only one at a time.
- Nothing to do with the projector position, it’s job is only to place an image on the dome.
- Straight lines will only look straight from this one position, characteristic of seeing photographs of dome content.
- More tolerant of offaxis viewing in a dome than rectangular surround displays where a straight line crossing a “corner” bends.

Considerations: zooming

- No such thing as a zoom for fisheye or spherical projections.
- Same for all immersive displays.
- The effect of zoom is achieved by moving closer, as in real life.



Considerations: image enhancement

- Avoid lossy codecs until the end of processing pipeline ... not just limited to dome production.
- Pay attention to large bright areas, will wash out and reduce contrast due to interreflections.
- Generally increase colour vibrance as a means of compensating for interreflections.
- Know the colour space and perform colour calibration.

Beacon Island

Vibrance adjustment

Considerations

- Motion is good, conveys depth through relative velocity cues.
  Generally use slower motion than traditionally used, consider distances travelled.

- Use inertia for starting / stopping camera ... should be doing this anyway.

- Place camera generating fisheye at the height of the intended viewer.
  Imagine the dome around the camera, applies to filming as well as CG.

- The above principle means that the further one gets away from the position where the content was designed for, the greater the distortion.

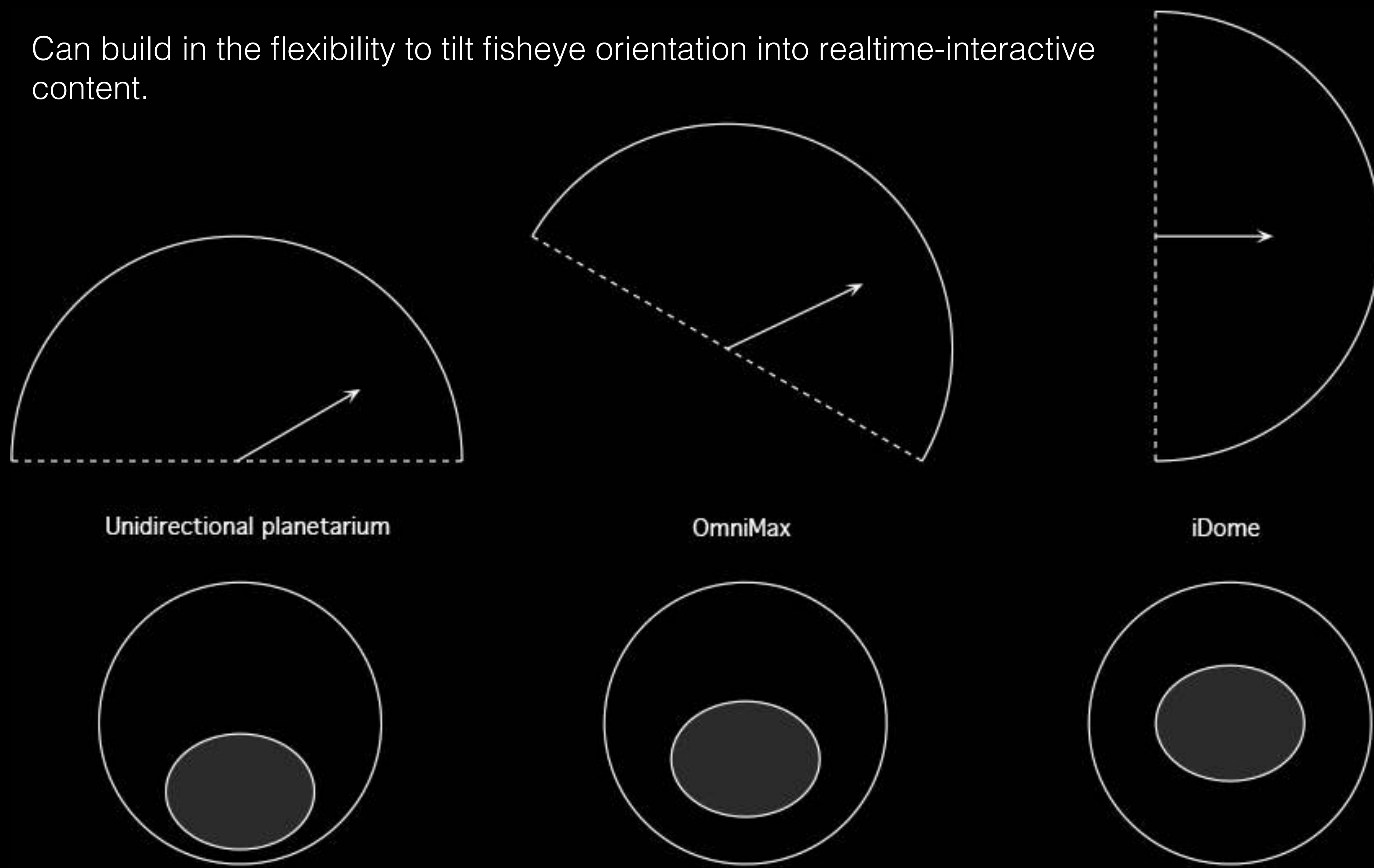
Traditional planetarium

30 degree tilt: OmniMax

90 degree tilt: upright dome

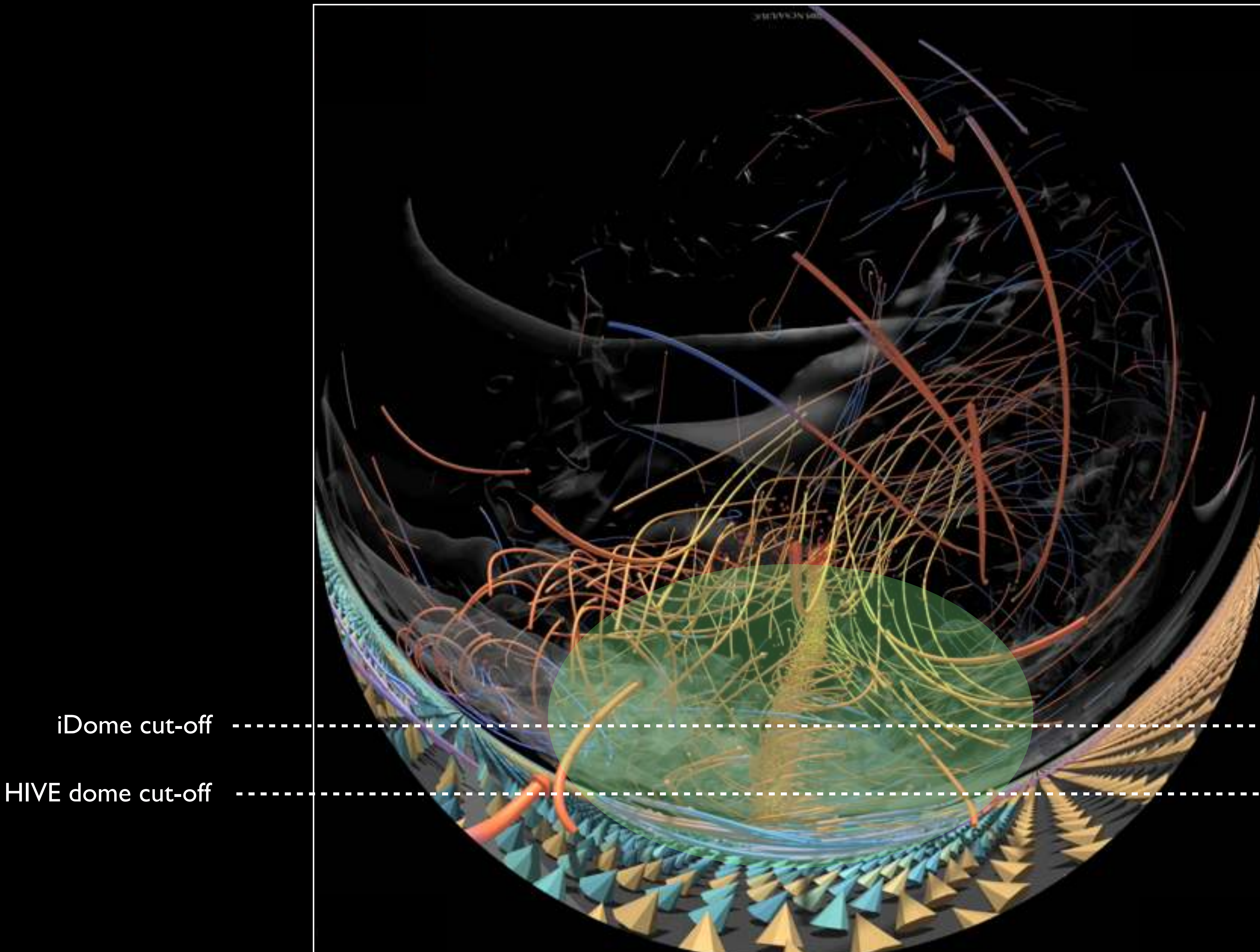
Dome orientation and “front”.

- The natural “front” direction depends on the dome orientation, and the seating arrangement.
- Upright dome viewing is not suitable (generally) for planetarium style dome content and visa-versa.
- Can build in the flexibility to tilt fisheye orientation into realtime-interactive content.

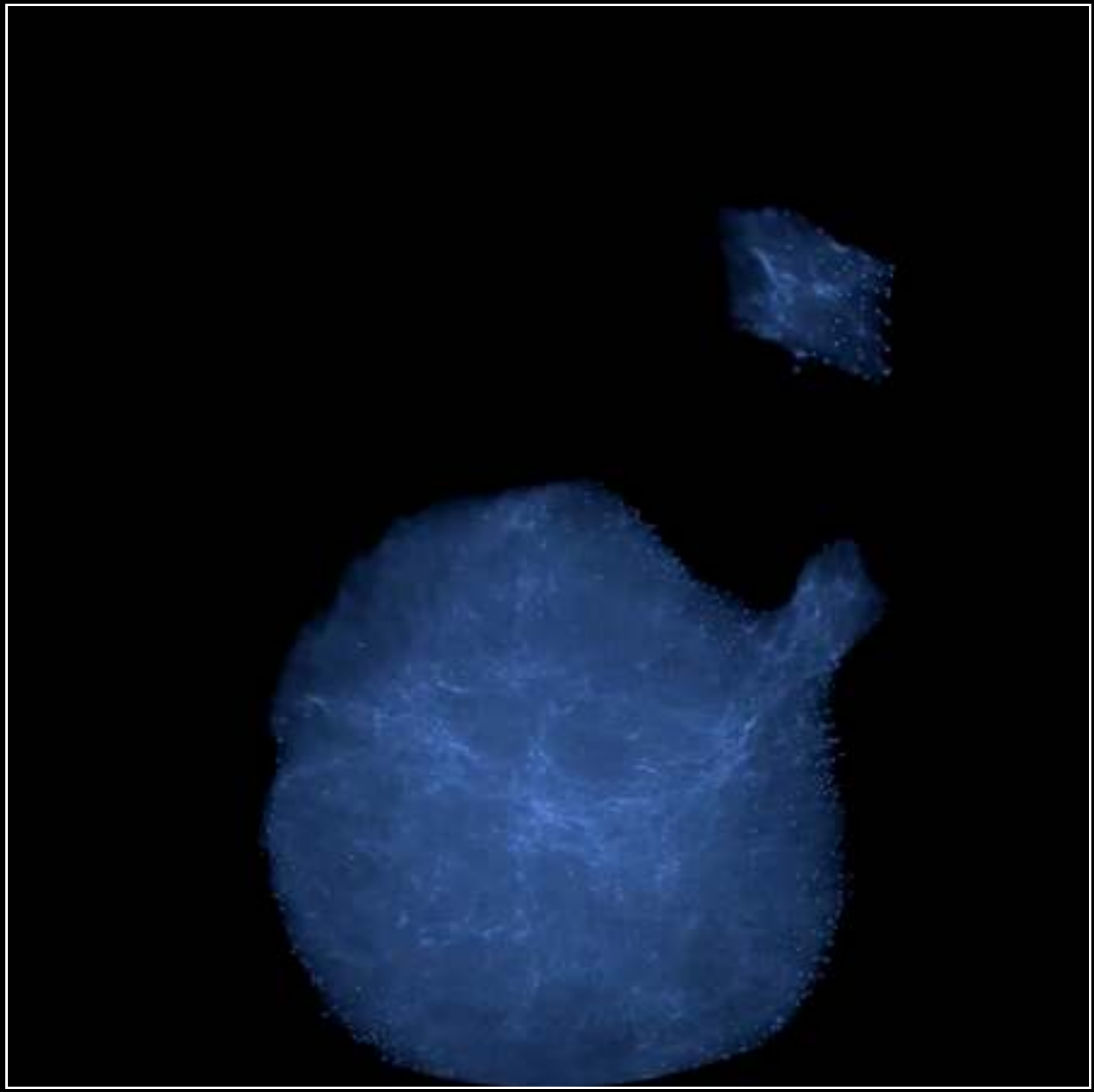


Typical planetarium content

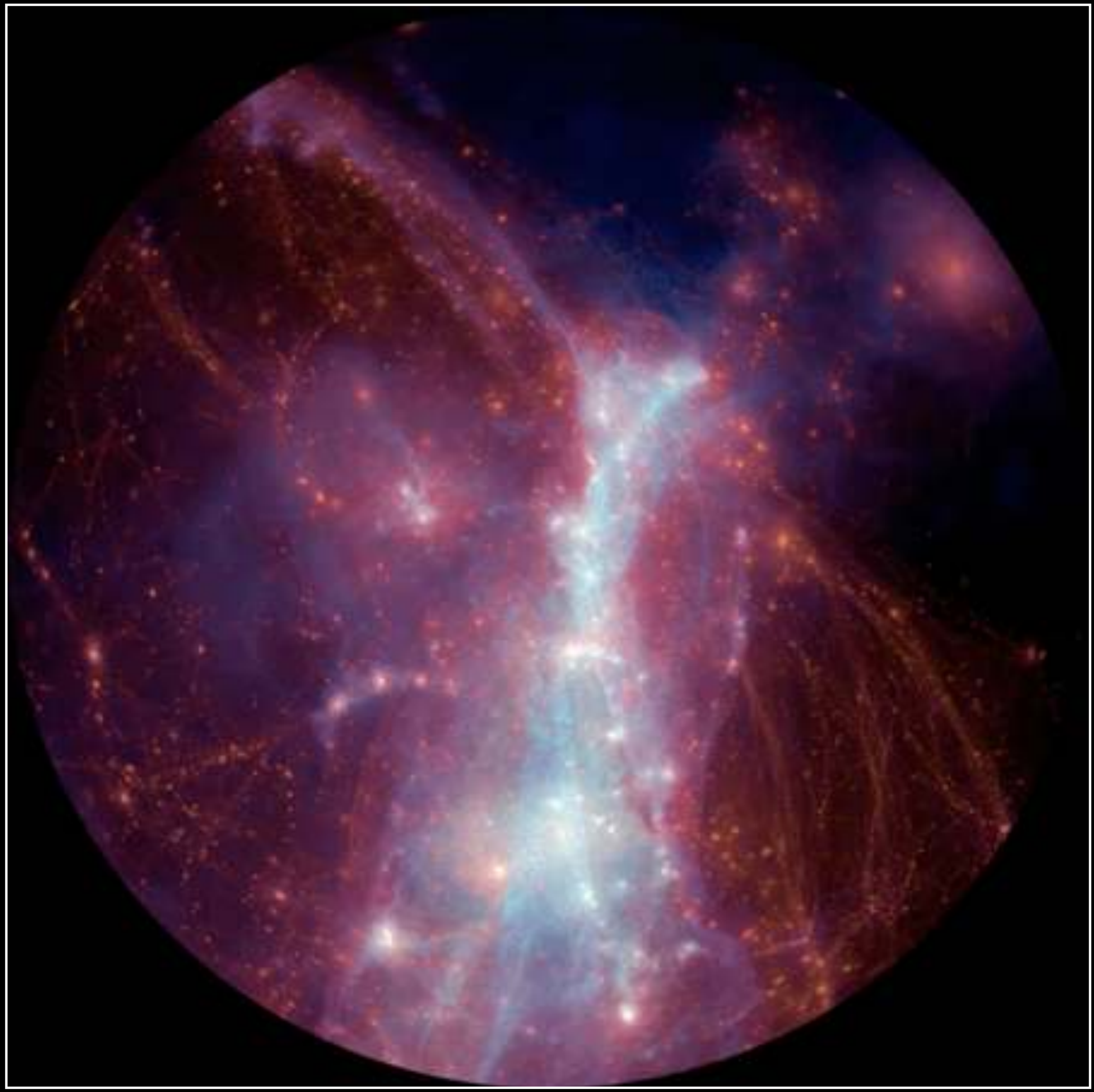
Tornado simulation



Comparison



Intended for planetarium

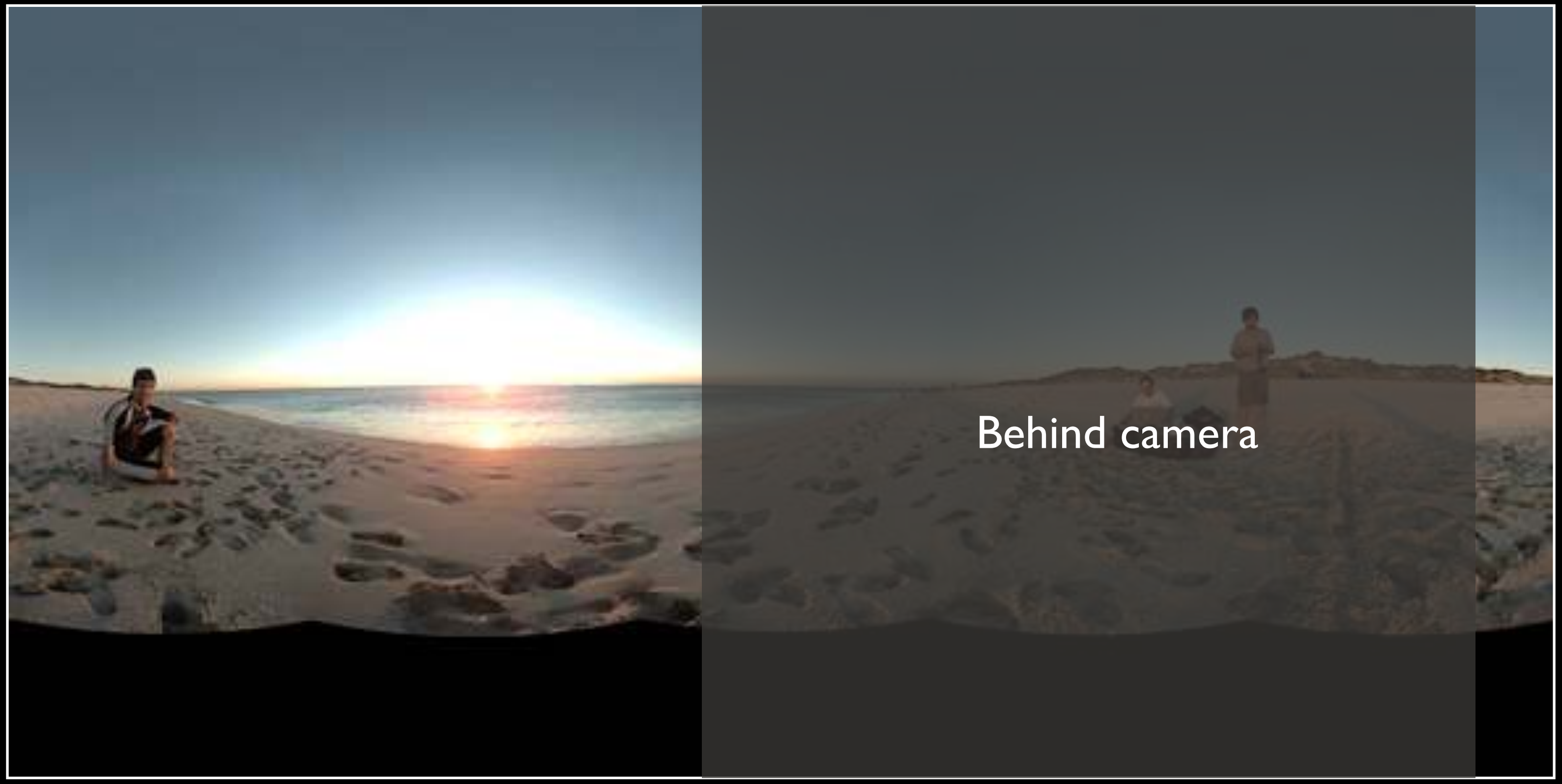


Intended for upright dome

Dark

Attractive approach

- An attractive approach is to render everything as spherical.
- Different fisheye orientations can be created for different domes.
- Dark was rendered and filmed in spherical.
  Adjust all camera shots (direction and tilt) in post production.



Dark

iDome

Horizon

Further reading

- Authors web site
  - Blender and Immersive Gaming in a Hemispherical Dome. Proceedings of the Computer Games & Allied Technology 10 [http://paulbourke.net/papers/blender10/]
  - iDome: Immersive gaming with the Unity game engine. Proceedings of the Computer Games & Allied Technology 09 [http://paulbourke.net/papers/cgat09b/]
  - Low Cost Projection Environment for Immersive Gaming. JMM (Journal of MultiMedia) [http://paulbourke.net/papers/jmm/]
  - Digital Fulldome - Techniques and Technologies. Graphite (ACM Siggraph) [http://paulbourke.net/papers/graphite2007/]
  - Introduction to digital fulldome technology. DomeLab (Australia Network for Art and Technology) [http://paulbourke.net/papers/domelab2010/]
  - Immersion: The Challenge for Commodity Gaming. Proceedings of the 5th Annual International Conference on Computer Games Multimedia & Allied Technology [http://paulbourke.net/papers/cgat2012/]
  - Digital fulldome technology for content developers. Jawaharlal Nehru Planetarium. [http://paulbourke.net/papers/bangalore2012/]

- Online forums and organisations
  - Yahoo group: small_planetarium [http://tech.groups.yahoo.com/group/small_planetarium/]
  - Yahoo group: fulldome [http://groups.yahoo.com/group/fulldome/]
  - International Planetarium Society [http://www.ips-planetarium.org/]
  - Australiasian Planetarium Society [http://apsplanetarium.com]

Questions / Discussion

Will show examples on the dome for each of the topics discussed.