

Dome Projection

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Motivation

Dome as an immersive environment for astronomy visualisation, science education, and entertainment.

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Introduction to planetarium projection

- Traditionally use specialised star generation hardware: eg: Digistar-2, Zeiss star projector.
- Large numbers of slide projectors for full dome images.
- Individual CRT for portions of the dome.
- New trend is towards full dome video.
- Boils down to creating fisheye images.

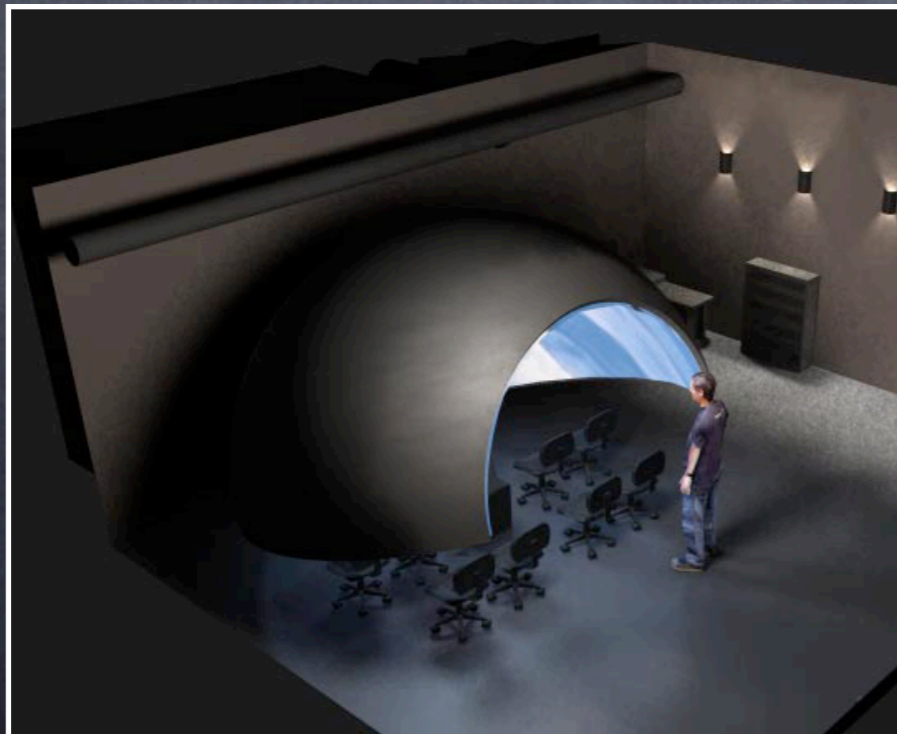
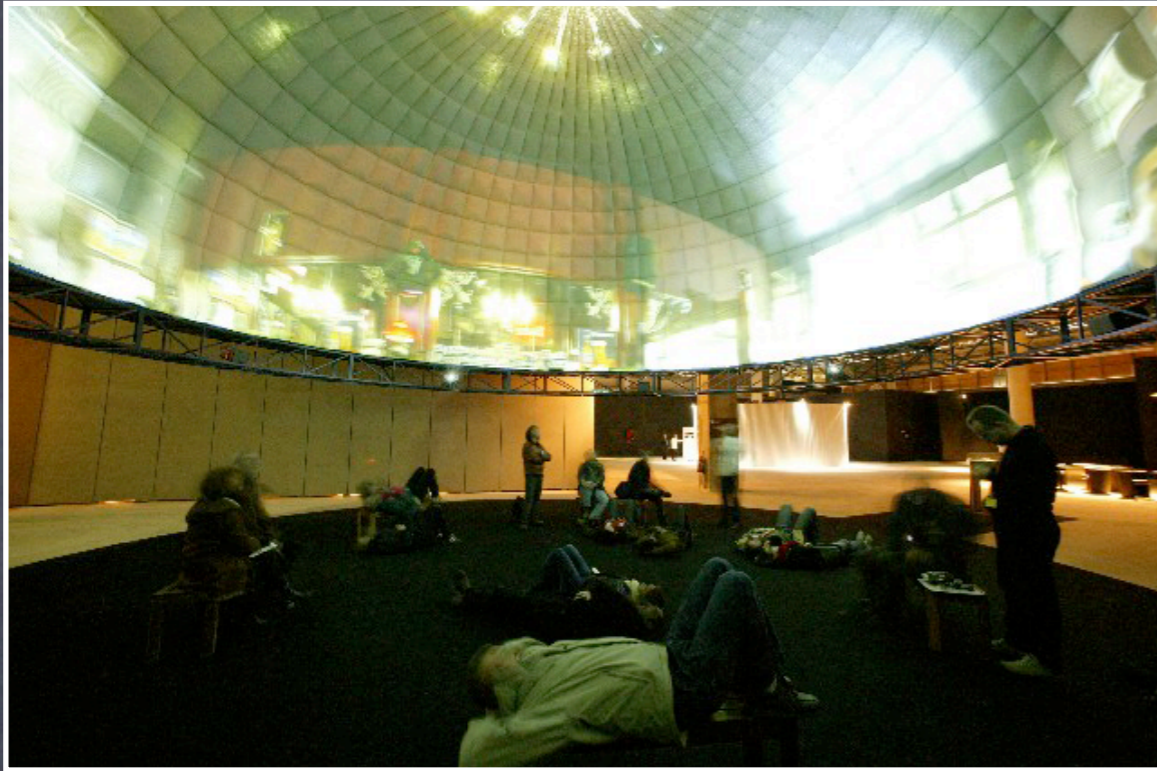
“Downgrading to digital projection”

Complications

- Incomplete fisheye longitude range.
- Truncated domes.
- Sloping domes.
- Different seating angles.
- Offaxis seating positions.
- Edge blending.

Any projection system needs to cope with these.

Installation Examples



Current full dome projection options

- Multiple tiled (edge blended) CRT projectors.
- Multiple tiled (edge blended) digital projectors.
- Single fisheye lens and digital projector, partial or full dome options (pixel efficiency).
- Dual fisheye/wideangle lens and digital projector.

Relative merits

- CRT – good black, high cost of ownership, calibration/alignment time, poor brightness.
- Digital – poor black, poor colour space, high quality image, bright.
- Single fisheye – simple, low resolution, locked to a narrow range of projectors.

Cost is prohibitive for most smaller planetariums!

Mirror projection

- Mirror instead of a fisheye lens.
- Projector focus constraint.
- Not projector specific.
- Scalable to 2,3,4 projectors/mirrors.
- Releases the center of the dome.
- Warp the content, movies and interactive.

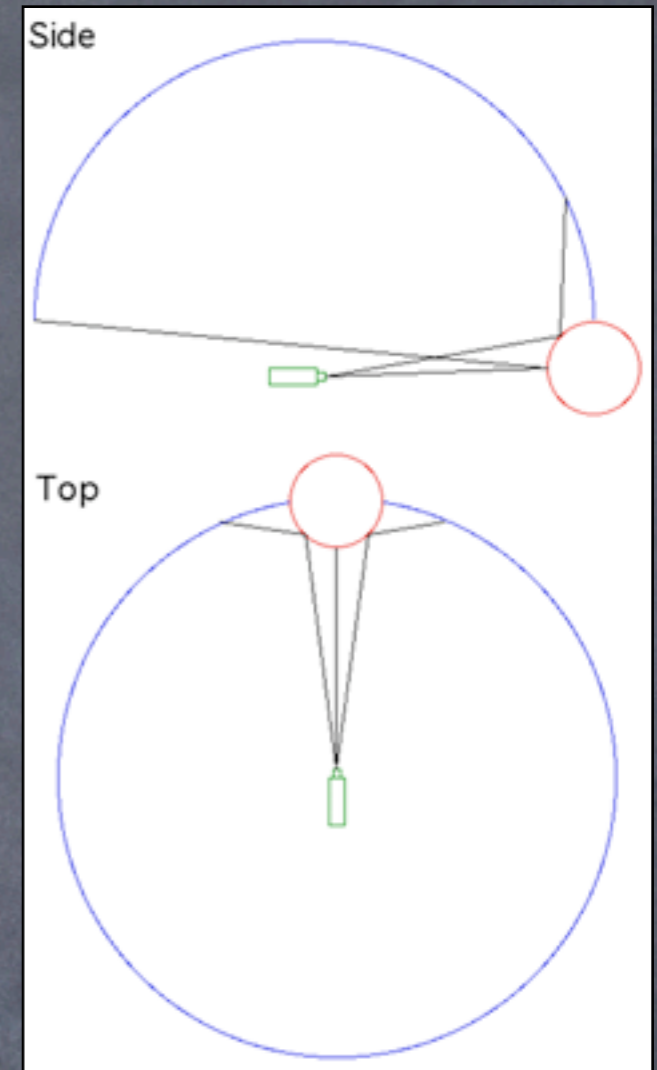
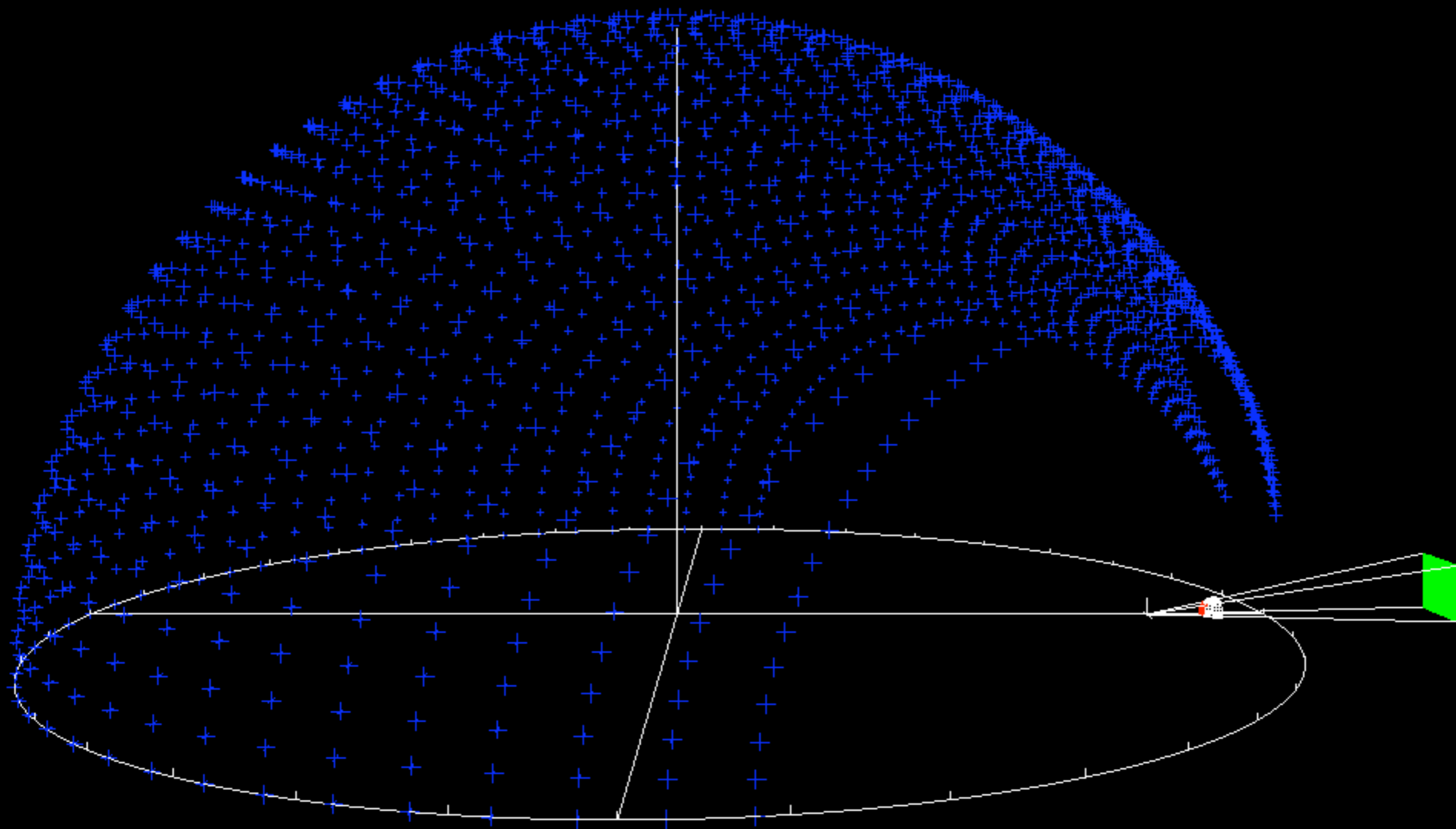


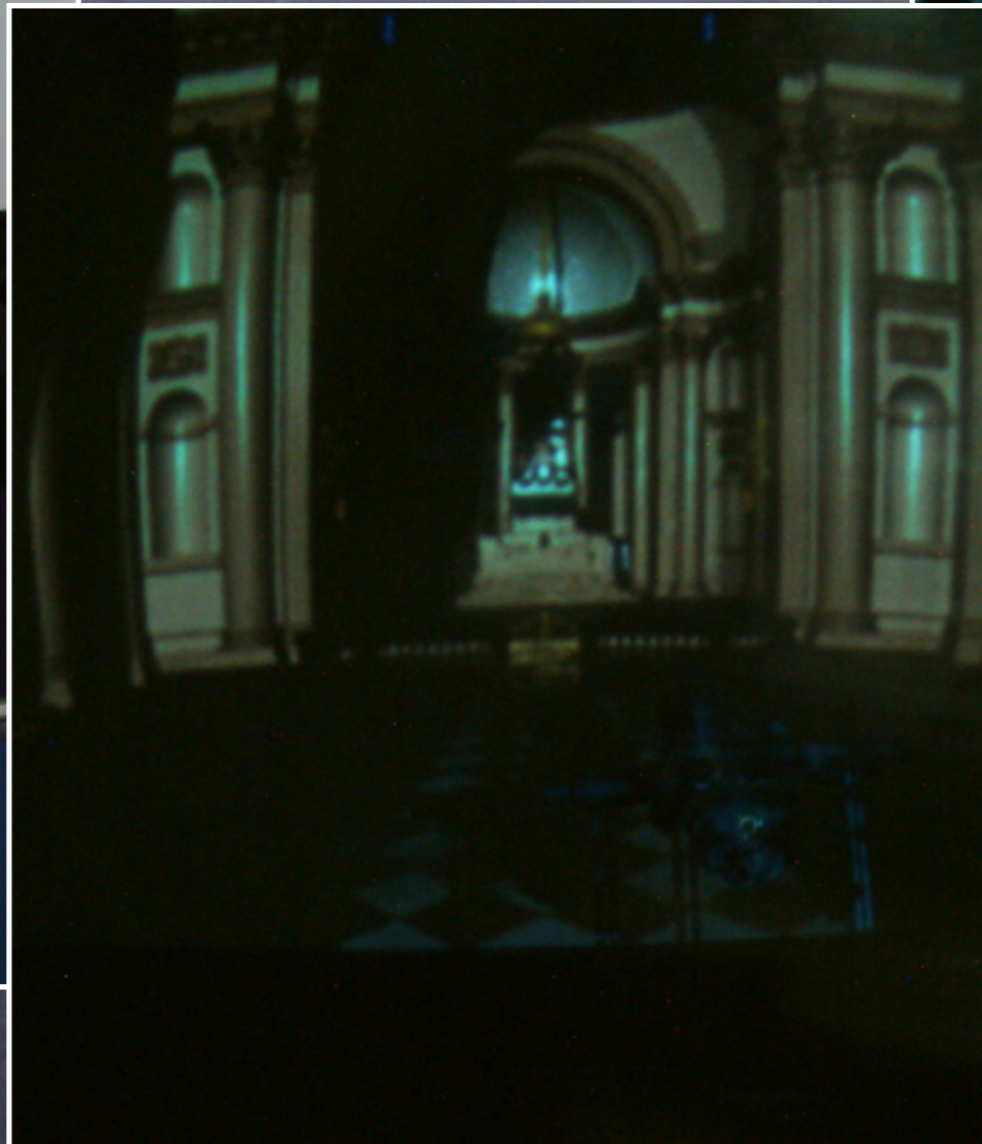
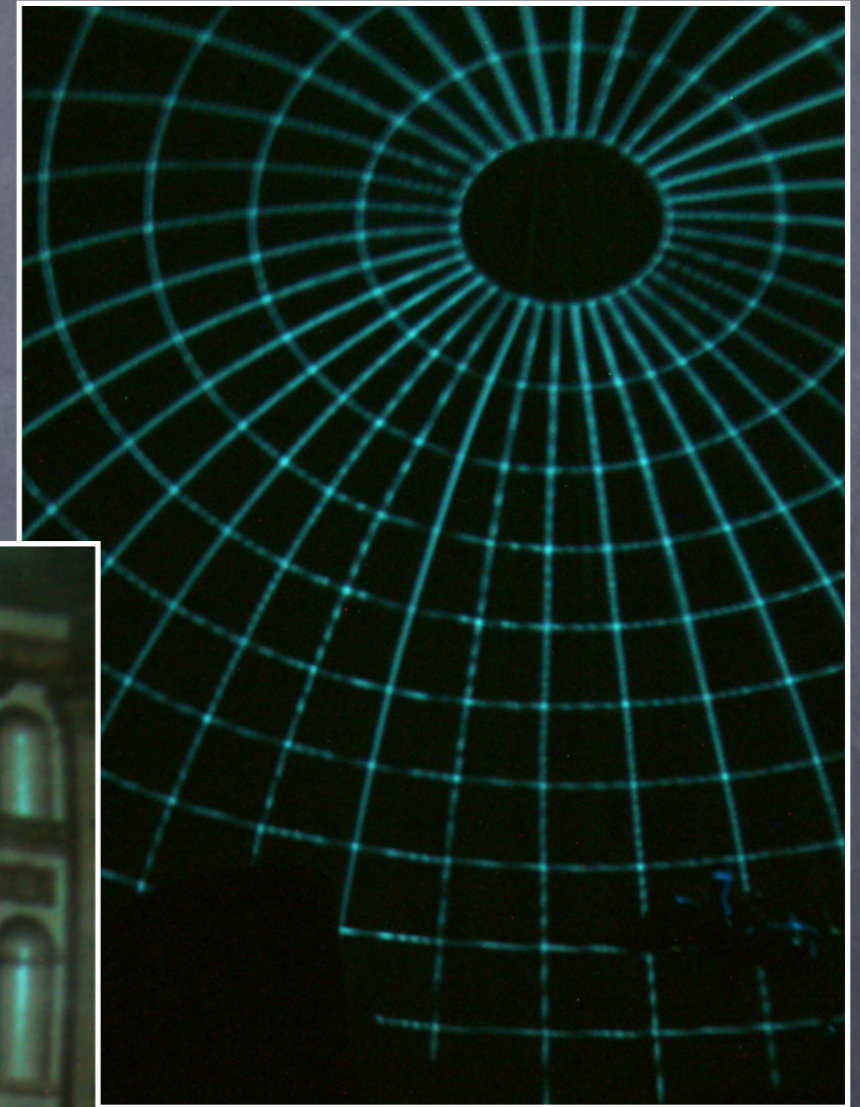
Image Warping

- Derive the transform that warps an image in such a way that the projected output looks undistorted.
- (u,v) , (x,y) , i map generator.
- Derive analytically, manually, simulation.
- Ray tracer, projector-lens-mirror-surface.

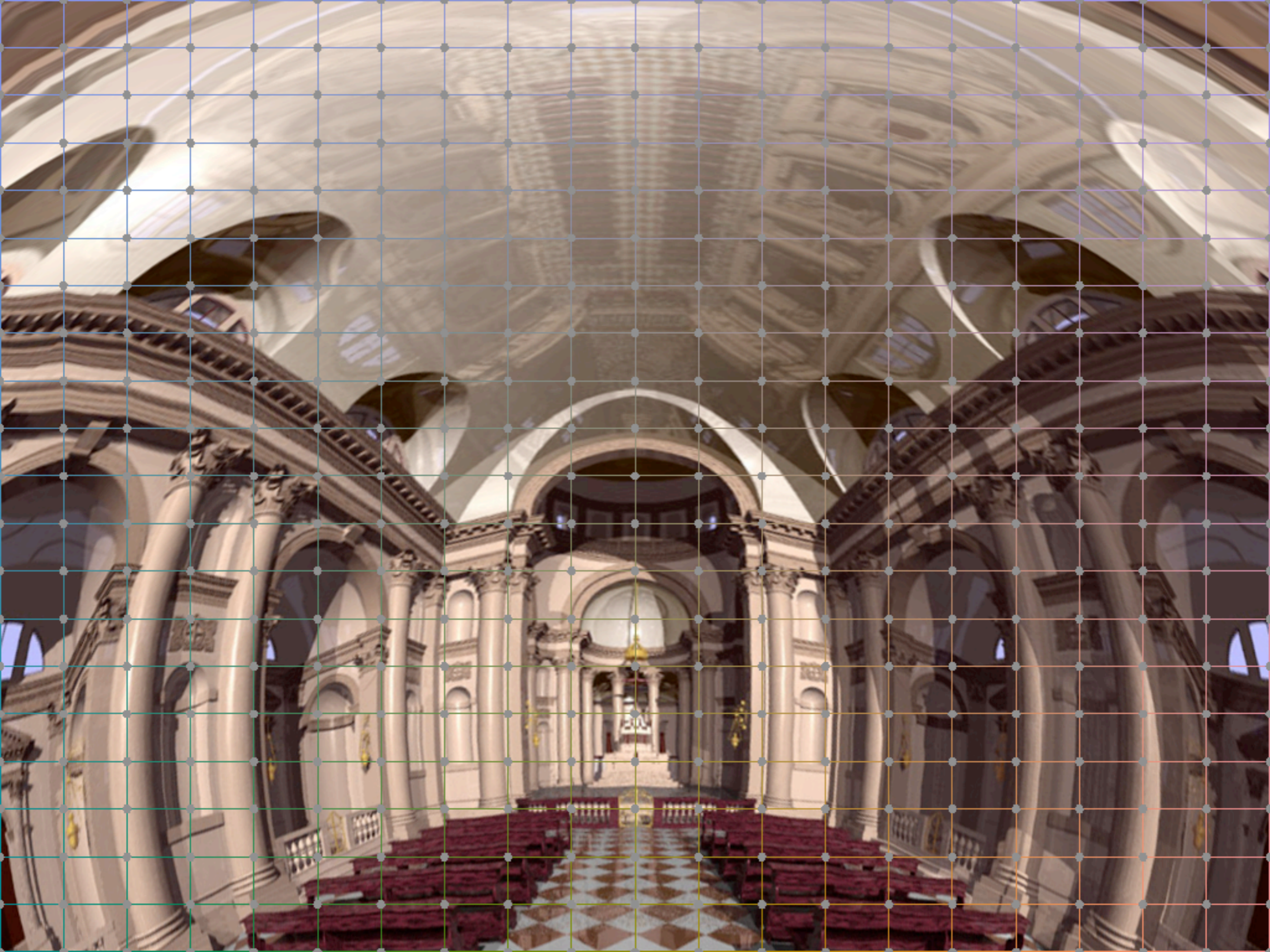
Demo



Wollongong planetarium tests



Demo



Creating fisheye movie content

- Fisheye projection native to many animation software packages.
- Render to cubic maps and resample to fisheye.
- High resolution: 3kx3k@30fps typical.
- Movie player reads a fisheye movie and displays the frames on a textured surface with the (u,v) , (x,y) , i mapping.

Interactive fisheye content

Multipass cubic texture algorithm.

- 4 texture passes for a full fisheye image, looking into an edge of the cube.
- Generally better for colour rich, textured applications.
- Usually easier to retrofit to existing applications.

Demo

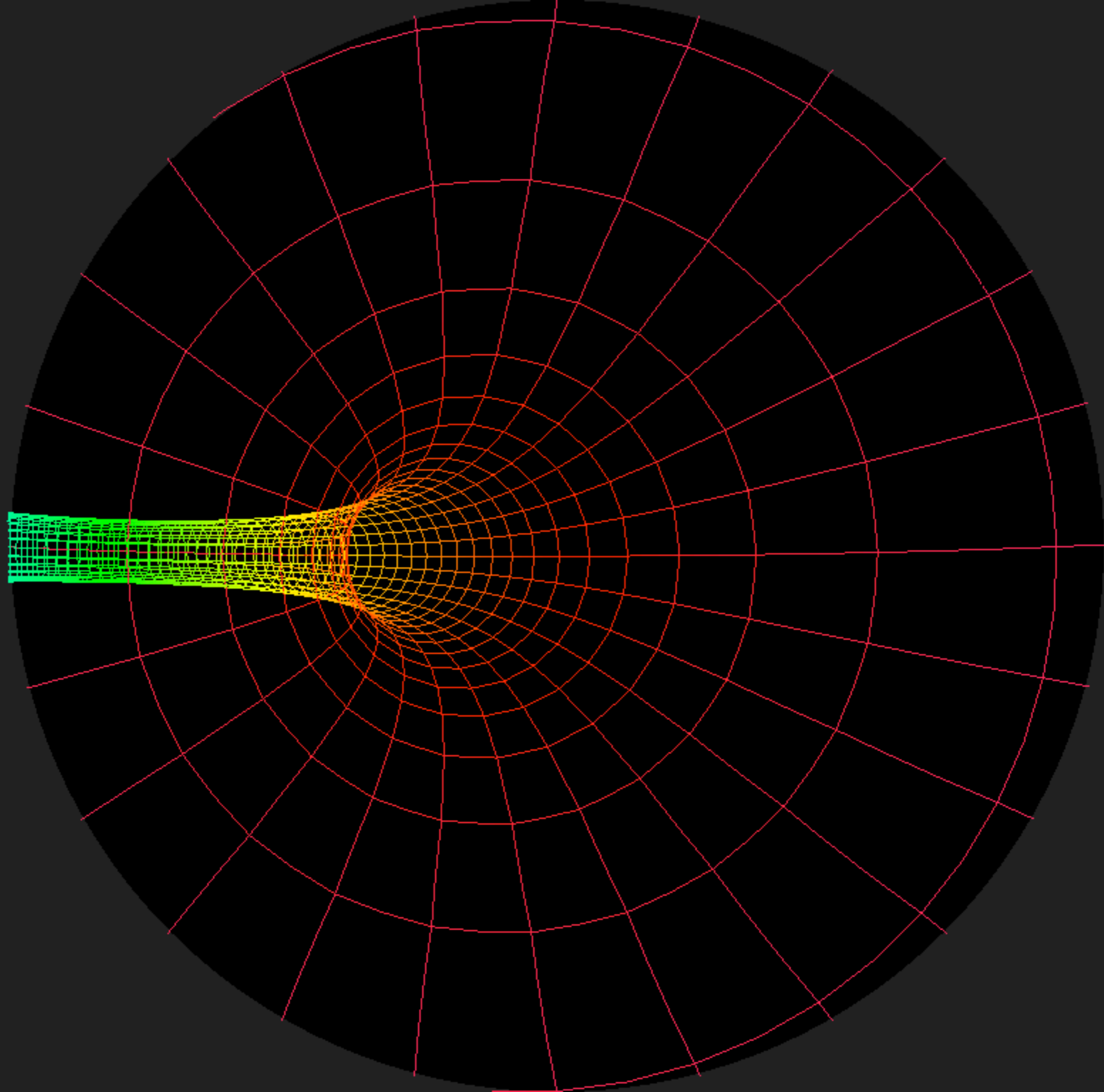


Interactive fisheye content

Geometric prewarping algorithm.

- Modify the geometry so that when viewed with a parallel projection, a fisheye view results.
- Requires “smart” geometry tessellation.
- Better for data visualisation and simple crisp high resolution graphics.
- Can be implemented as a vertex shader on GPU.

Demo



Application: PanoDome

QTVR in steroids

- Input is a panoramic image (cylindrical or spherical), or cubic map.
- QT VR (and others) render to perspective frustum. PanoDome is functionally the same but renders to a fisheye projection.
- Uses multipass texture algorithm.
- Commissioned by elumenati for Burning Man.

Burning Man



- Black Rock City, USA, Sept 2004.
- <http://www.burningman.com>
- 2004 art theme: "Vault of Heaven".
- PanoDome running in Bok-Globule.

Bok-Globule



Propylaea example

Contributions by panoramic photographers

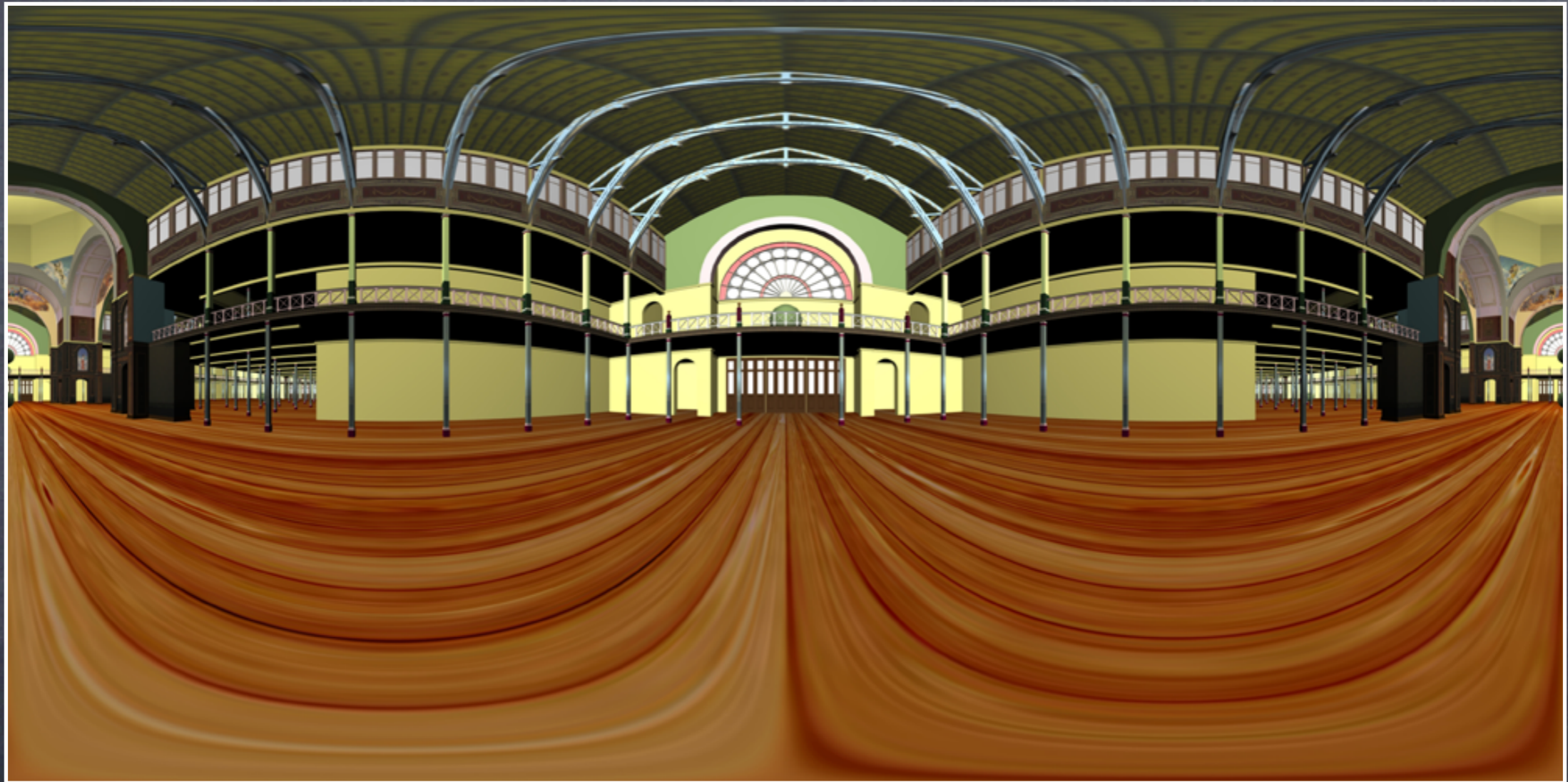


The gateway from the land of the humans, to the land of the gods.

Example



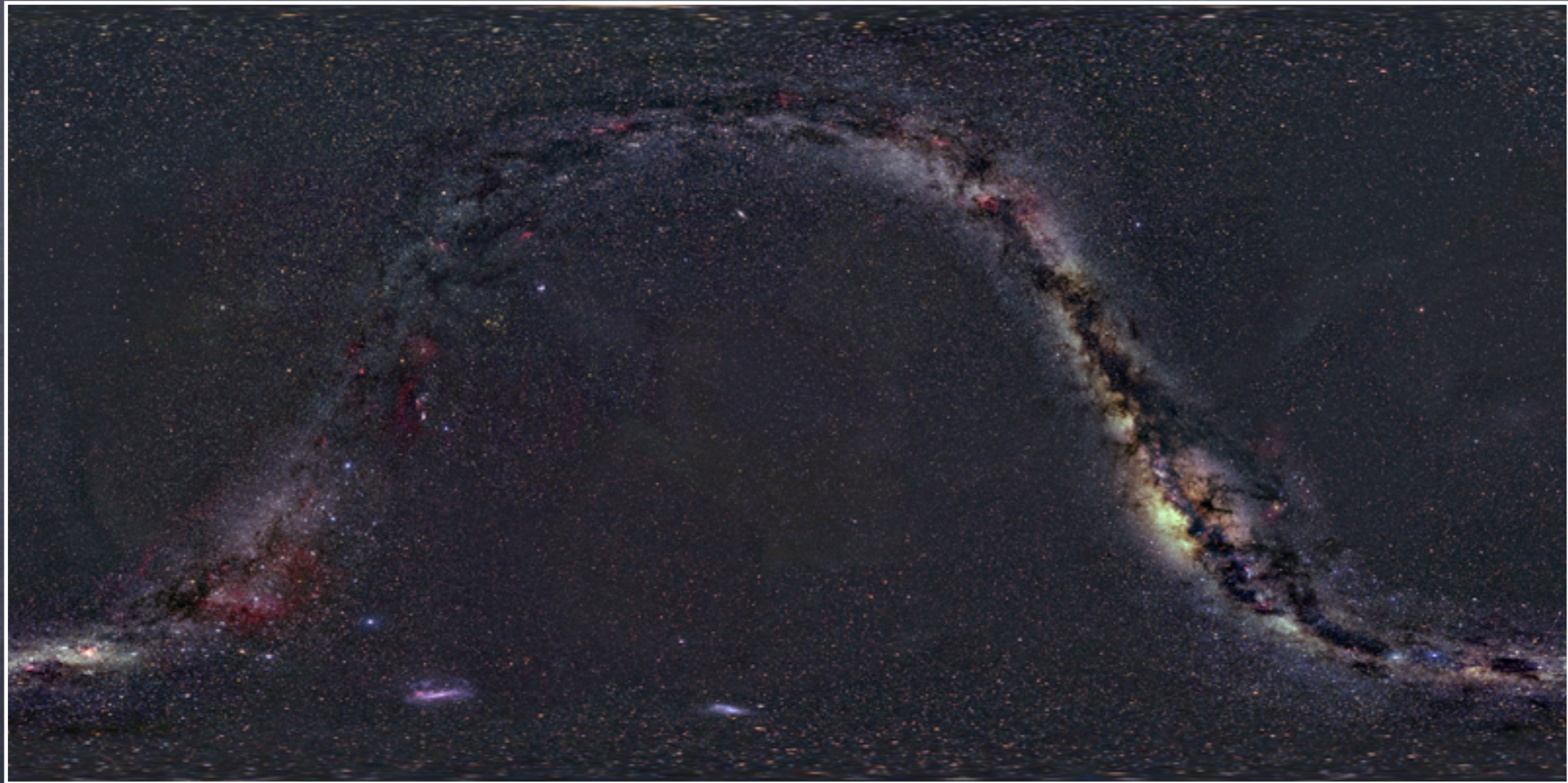
Royal Exhibition Building



World Heritage Listed,
Melbourne.

Example

Astronomy visualisation



View from Earth, without the solar system.

Example

The Burning!



The End

- Visit the Brisbane planetarium, second full dome digital planetarium in Australia.
- Shameless self promotion: see the 3D animations by myself in the current "Infinity Express" show.
- Current projects: portable (inflatable dome) for education, planetarium installation, dome for astrophysics visualisation.
- Questions?