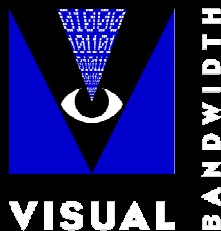


IFSV 2009

Challenges of Immersive Scientific Visualization in the World:

Immersive Scientific Visualization in Education, Storytelling and Art

**Tokyo, Japan
March 23, 2009**



Ed Lantz

IMERSA

Spherical Media Group

Visual Bandwidth, Inc.

Ed@visualbandwidth.com

www.spherical-media.com

www.visualbandwidth.com

www.imersa.org



Challenges in Scientific Visualization

- Many challenges are being effectively met:
 - Moore's Law accelerating CPU and GPU computational capacity
 - Software tools improving in usability, compatibility, multi-threading support
 - Computational models advancing in complexity and accuracy
 - Displays and user interfaces improving in interaction, immersion, presence
- Challenges are greatest in dissemination of SciVis in education, storytelling and art

Scientific Visualization

"the use of computer graphics to create visual images which aid in understanding of complex, often massive numerical representation of scientific concepts or results." – McCormick (1987)

- Most commonly used as tool for scientists
- Vital applications outside of science as well:
 - Education
 - Storytelling & Entertainment
 - Art & Culture

Scientific Visualization

Scientific Visualization provides windows into understanding the known universe

- Physics, chemistry, biology, materials science, earth science, astrophysics, cosmology
- Much of the known universe can only be fully understood through Scientific Visualization
- Scientists have responsibility to share expanding knowledge of universe with non-scientists
- Need solid infrastructure for dissemination to non-scientists

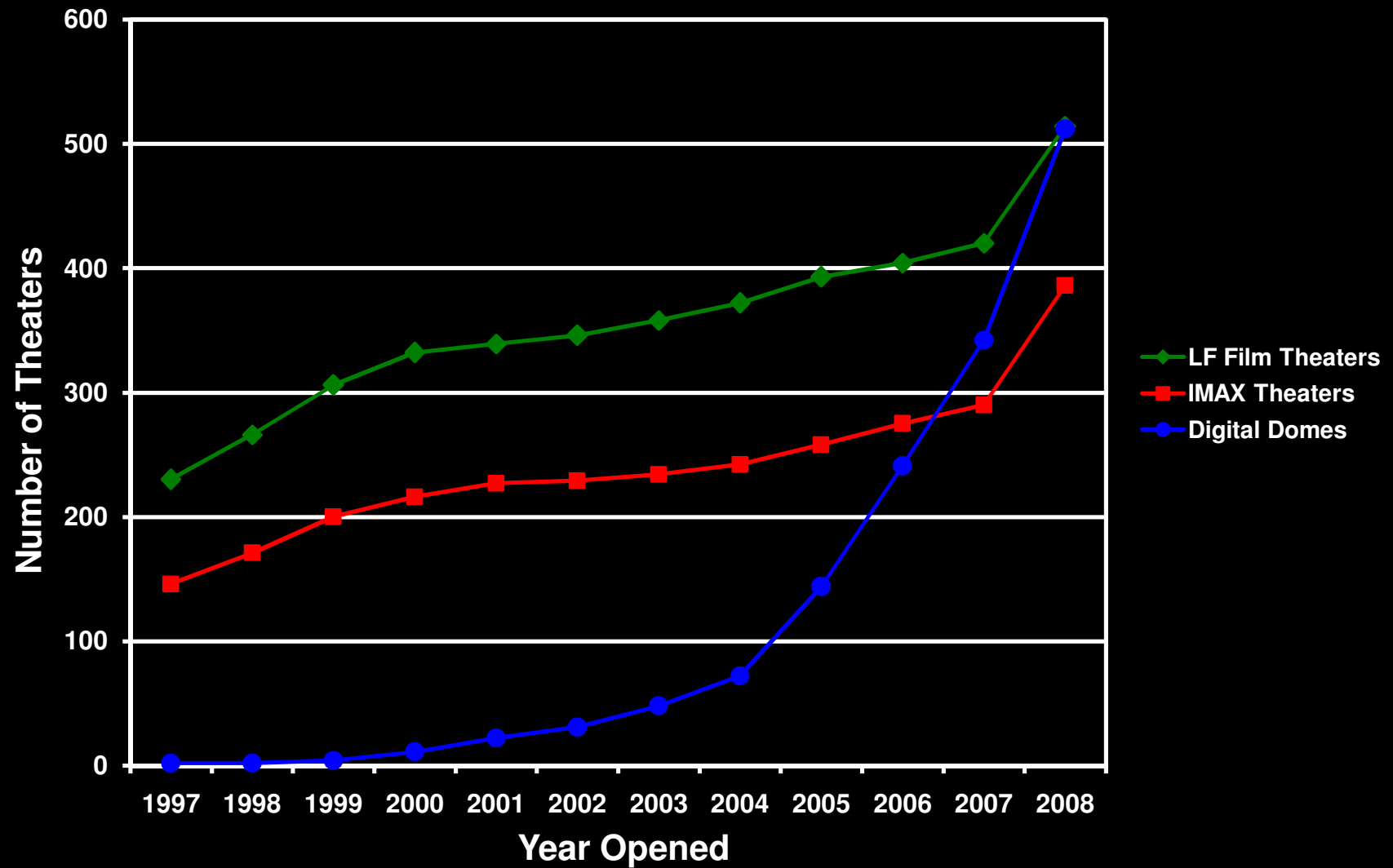
Digital Dome or “Fulldome” Theatre



Large-scale, real-time interactive
group immersive environments

- Large-format immersive cinema
- Real-time digital planetarium & visualization
- Multi-use auditorium and performance space

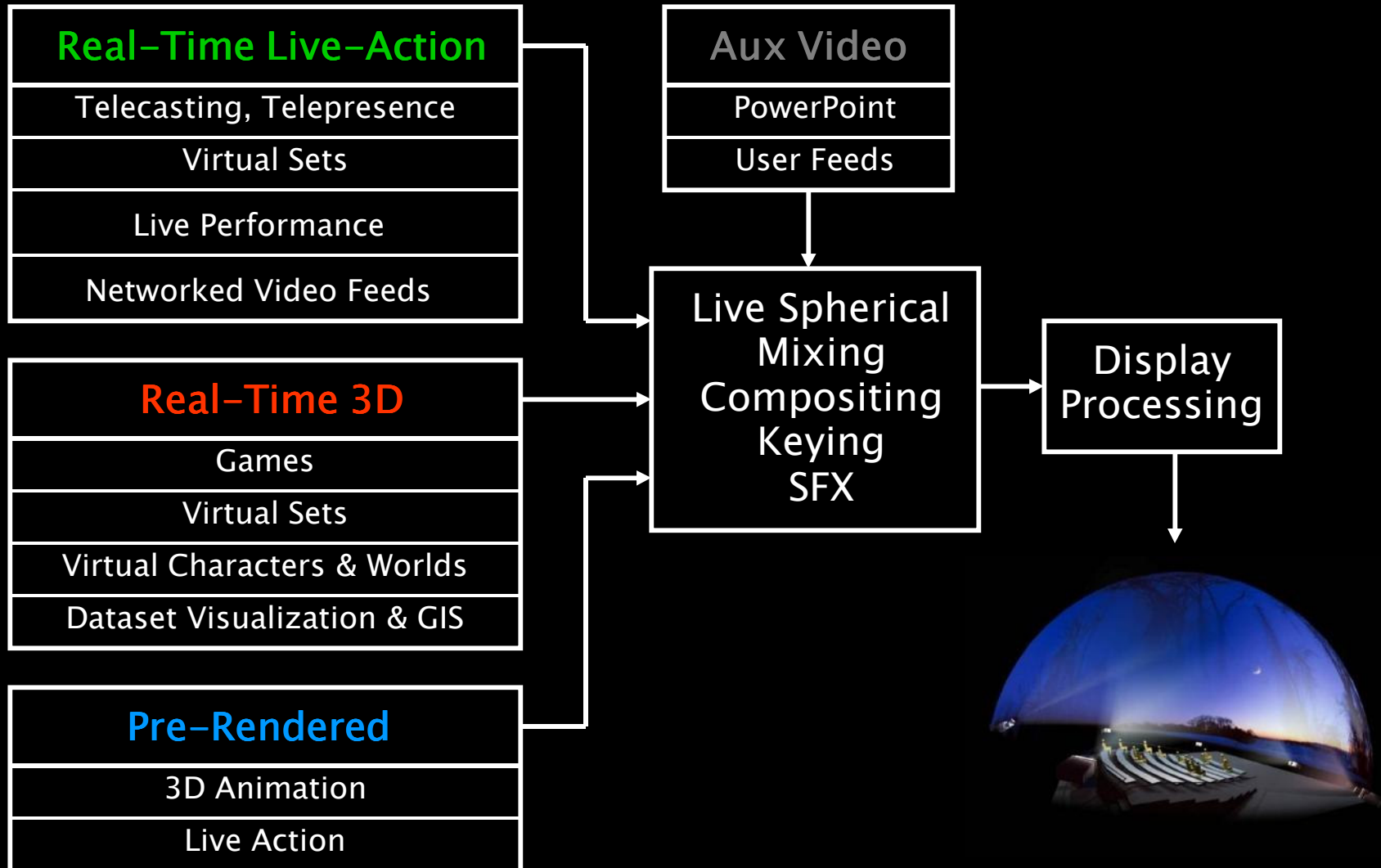
Fulldome Theaters Worldwide



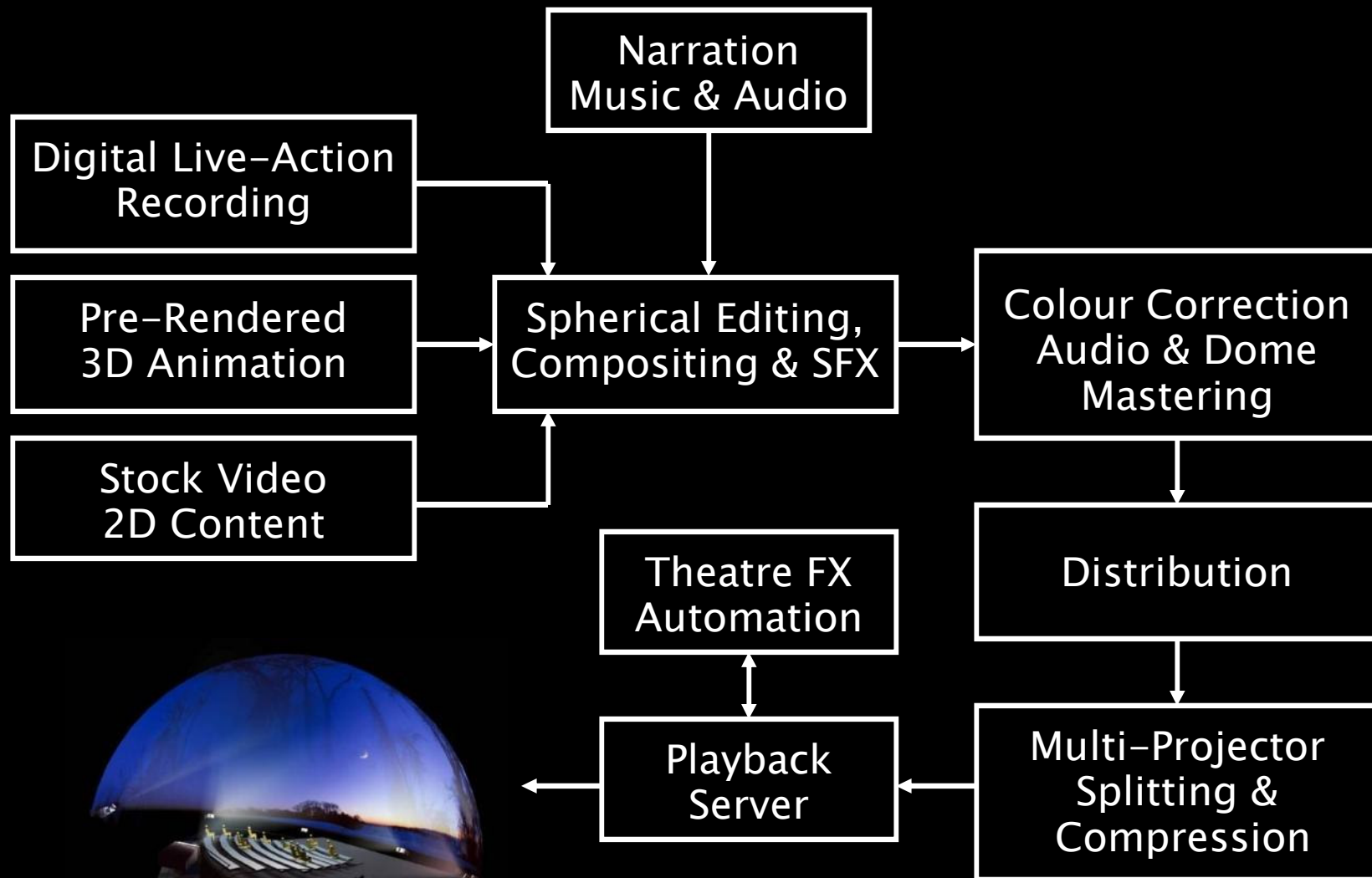
Full dome Theater Breakdown

- 527 Theaters Worldwide (Mar. 22, 2009)
 - Half in U.S., 10% in Japan
 - 36% are in Museums & Science Centers (US)
 - 21% are in Universities & Colleges
 - 15% are in School Districts
 - 26 million annual attendance
 - 58% are Single-Lens Fisheye Systems
- Over 3000 Planetariums Worldwide
 - 110 million annual attendance
- Over 80 Show Titles

Advanced Fulldome Theater



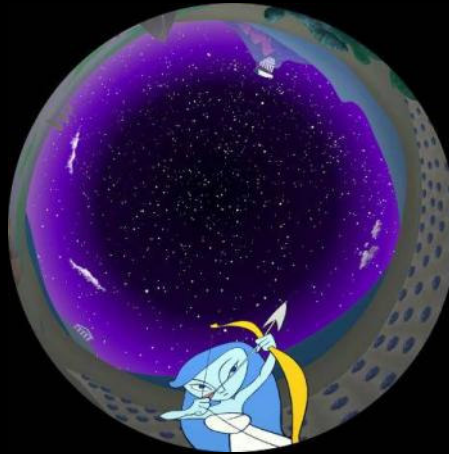
Pre-Rendered Workflow



Pre-Rendered Fulldome Productions



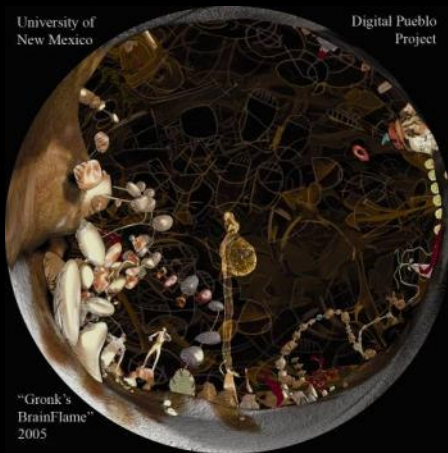
Stars of the Pharaohs
Evans & Sutherland



*Legends of the
Night Sky: Orion*
AVI/Spitz



Sonic Vision
AMNH

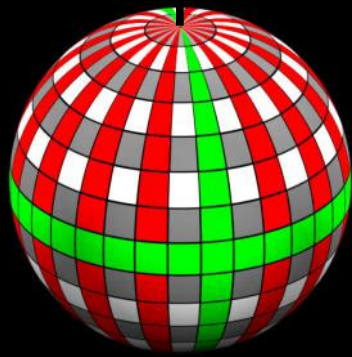


Brain Flame
GRONK/UNM

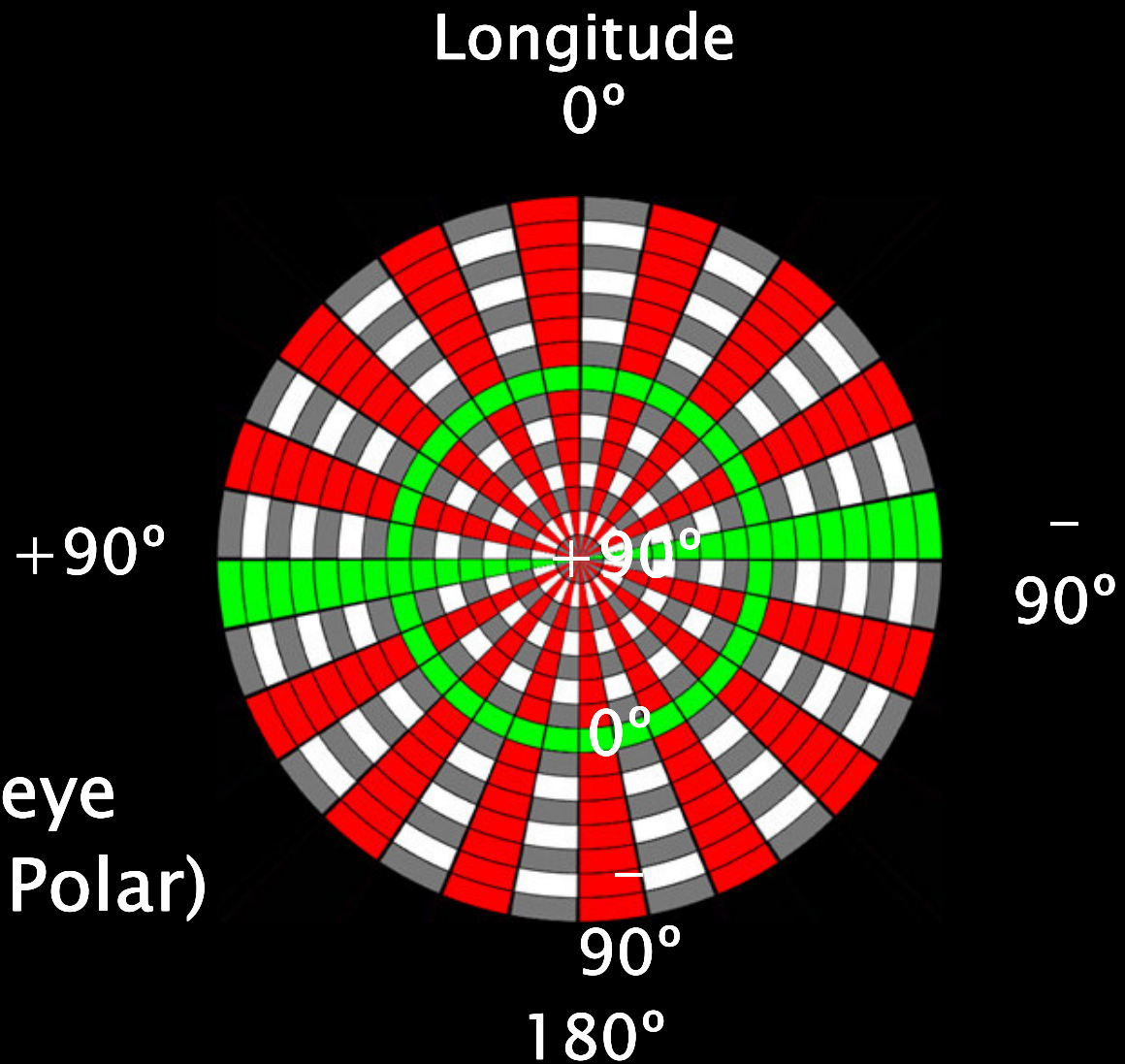
Kaluoka'Hina
Softmachine



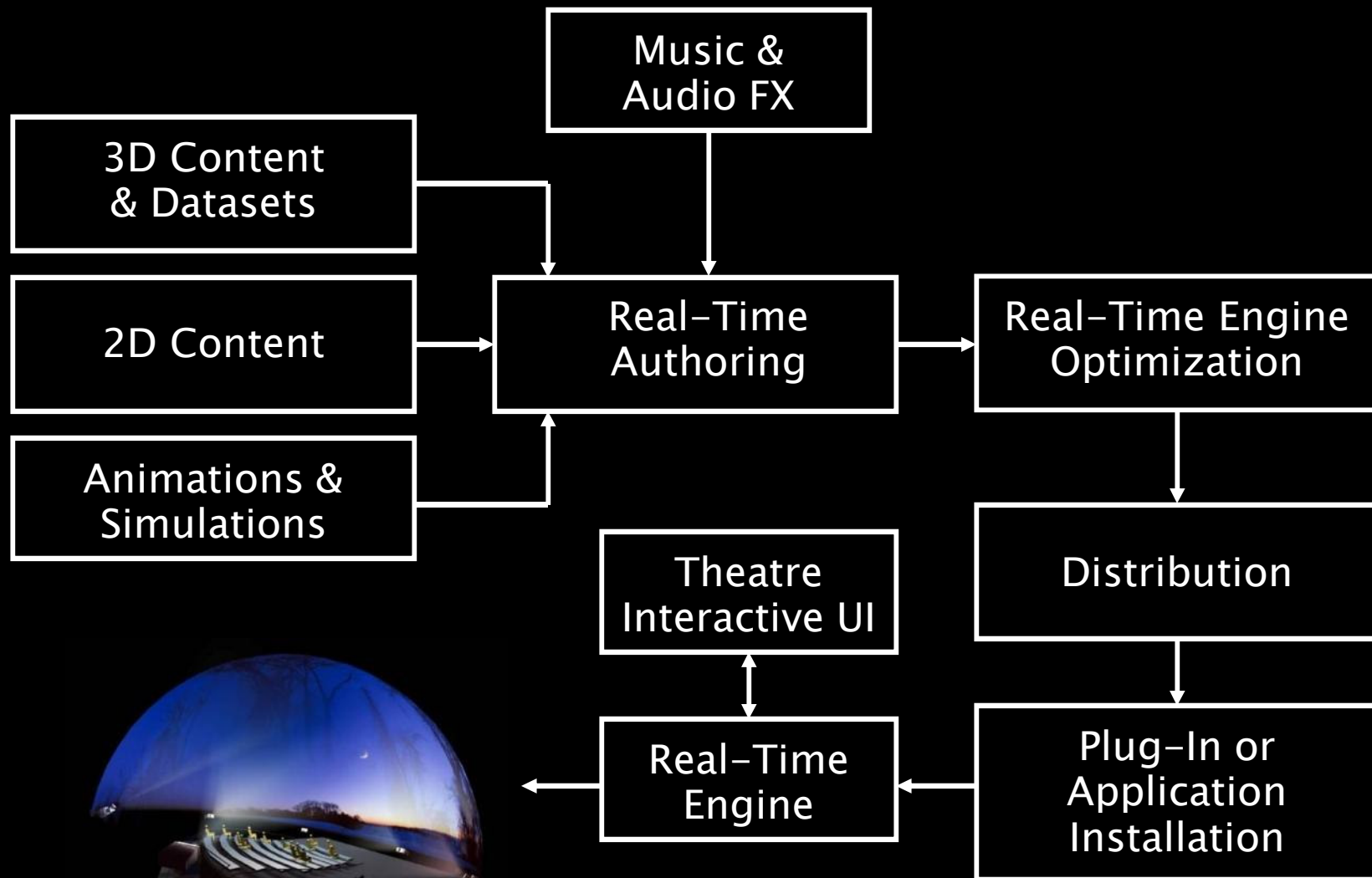
Dome Master Format



Polar Fisheye
(Equidistant Polar)

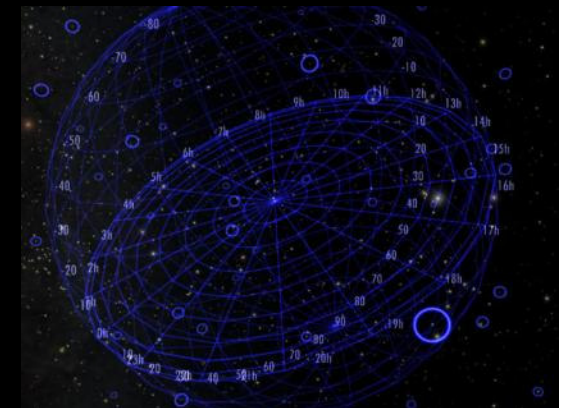
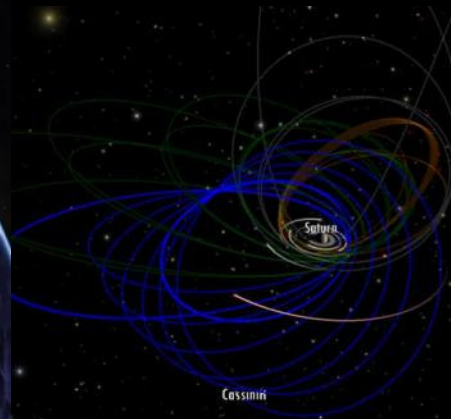


Real-Time 3D Workflow



Digital Planetariums

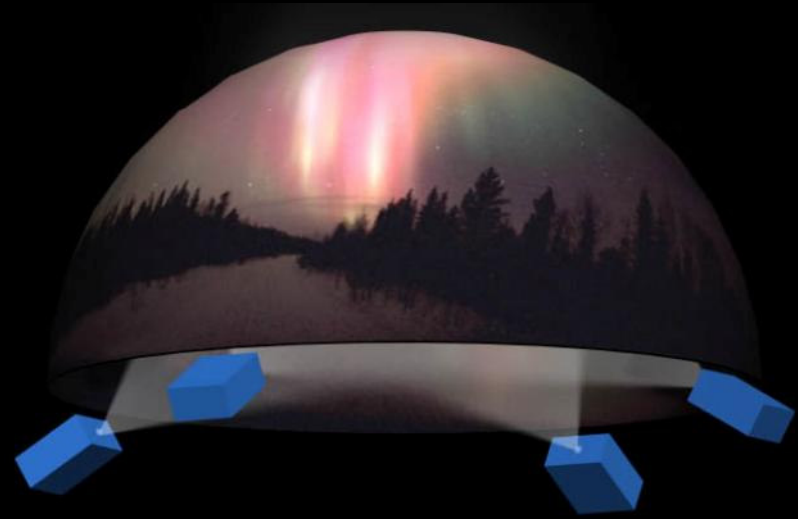
Real-Time Navigable, Scientifically Accurate
Astronomical and Astrophysical Datasets



Spherical Projection Formats

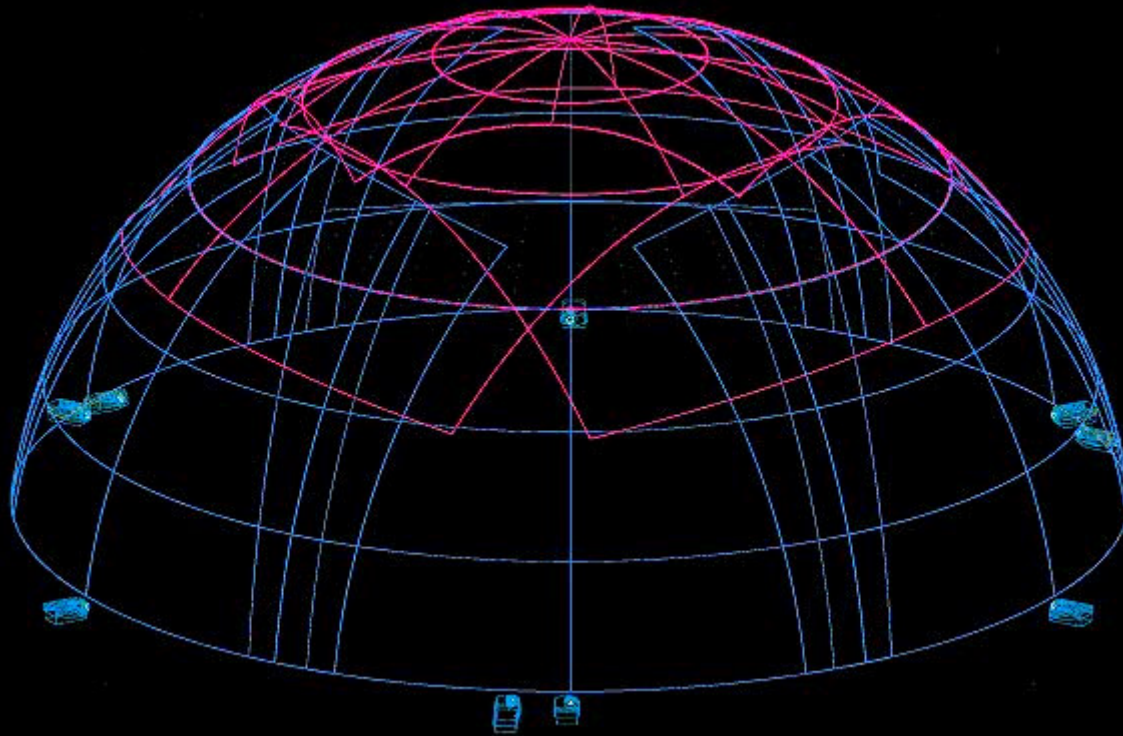


Single Projector
(Fisheye)



Multi-Projector
Edge Blended

A Sampling of Fulldome Displays



From small fisheyes to 4k stereoscopic theaters...

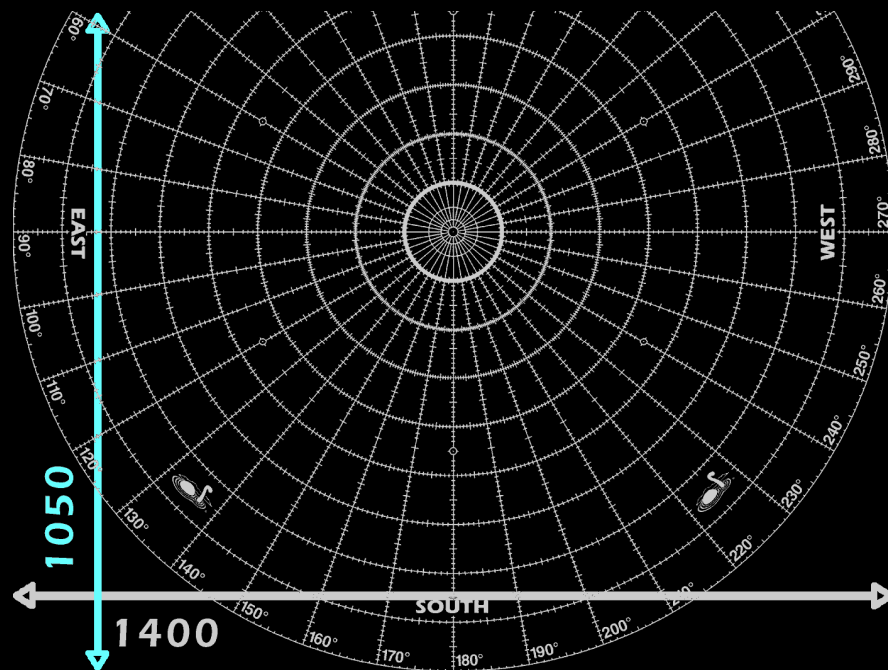
Adapted from: *A Planetarian's Primer For Fulldome*
Loch Ness Productions (www.lochnessproductions.com)

Truncated Hemisphere

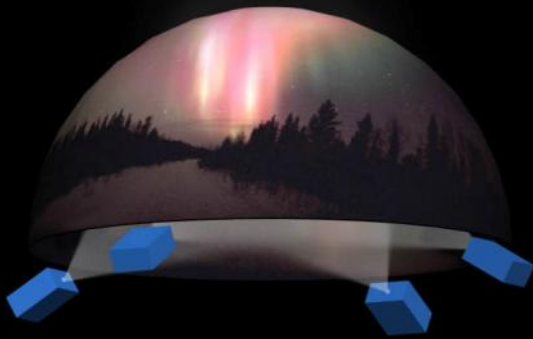


**SXGA+
Fisheye System**

1400 x 1400 Dome Master (t)
1.2M pixels on dome
7.8 pixels/degree
Up tp 16,800 lumens
>1500:1 contrast
1 projector (DLP)
1 channel @ 1400 x 1050

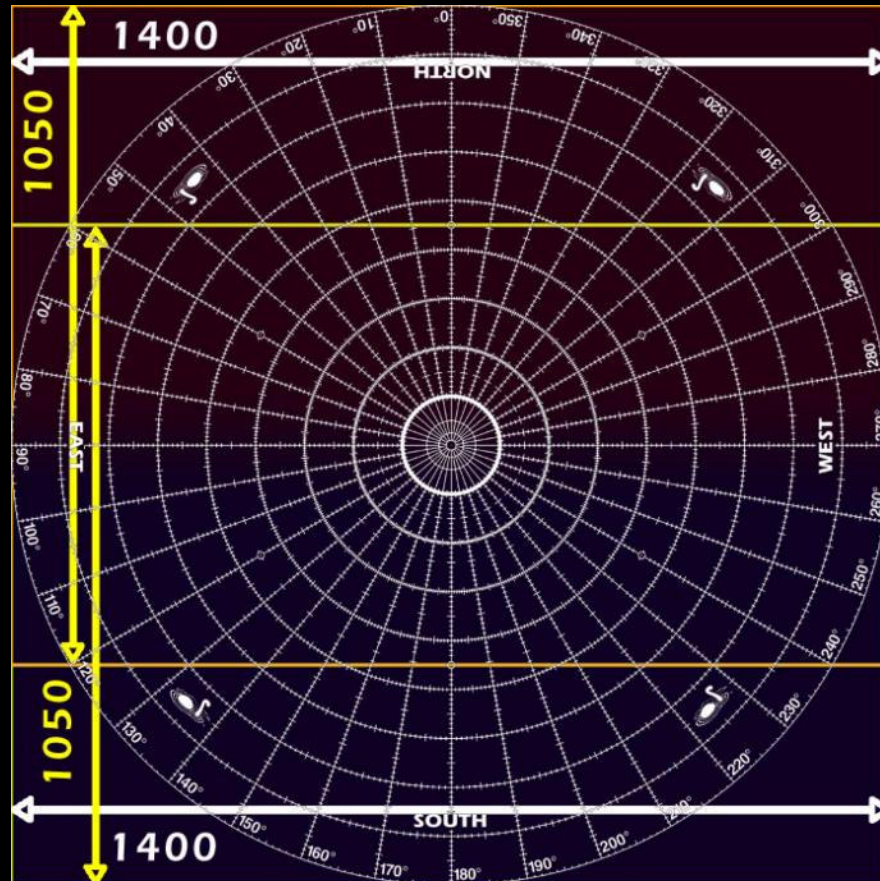


Dual Fisheye with Edge-Blend

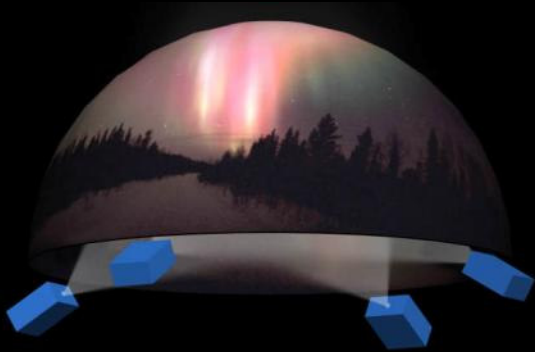


Dual SXGA+ Fisheye System

1400 x 1400 Dome Master
1.5M pixels on dome
7.8 pixels/degree
Up tp 21,000 lumens
>1500:1 contrast
2 projectors (DLP)
2 channels @ 1400 x 1050

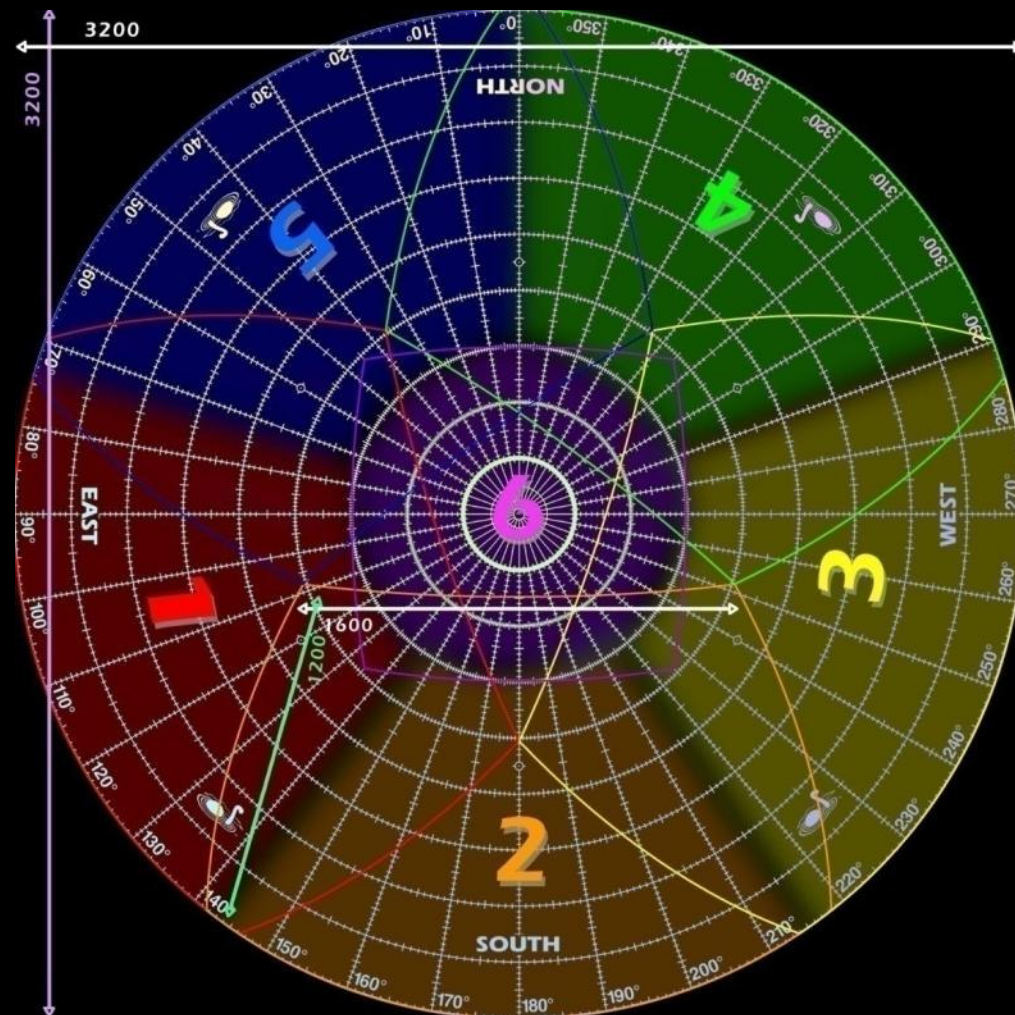


DLP Projector Edge-Blend

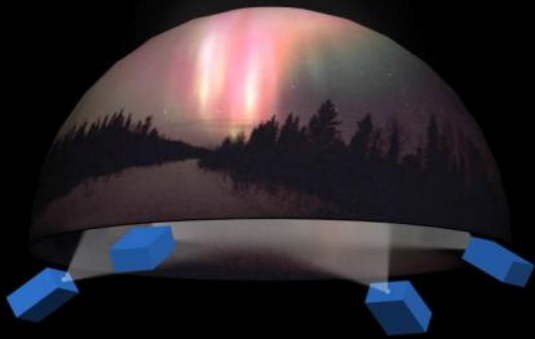


6-Projector Edge-Blend (DLP)

2880 x 2880 Dome Master
6.5M pixels on dome
16 pixels/degree
29,250 lumens
>1800:1 contrast
6 projectors (DLP)
6 channels @ 1400 x 1050

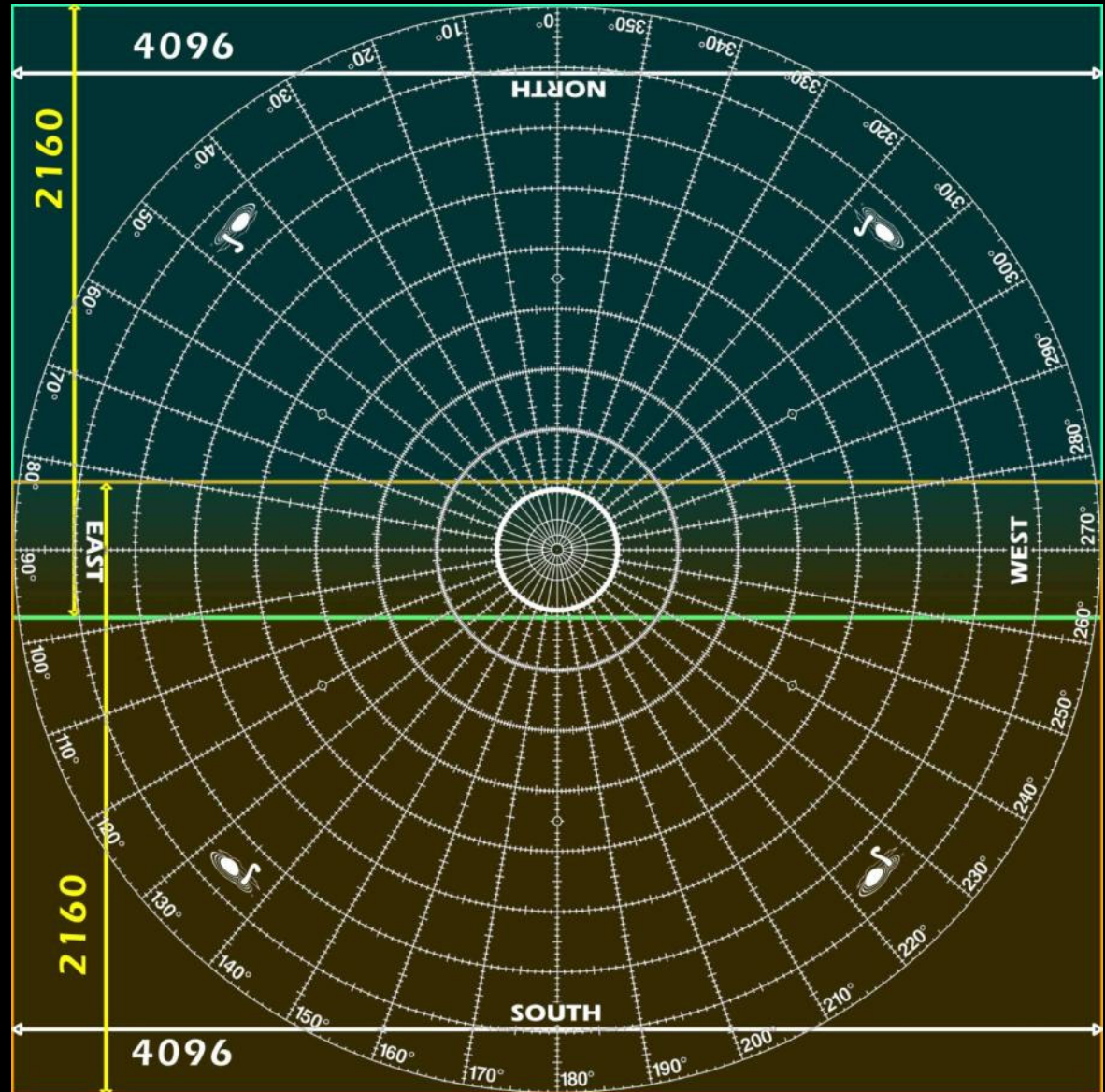


Dual 4k Fisheye with Edge-Blend

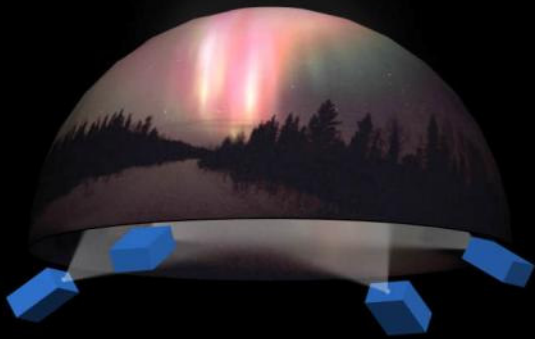


Dual Fisheye System

4096 x 4096 Dome Master
13M pixels on dome
22.7 pixels/degree
14,900 lumens
1800:1 contrast
2 projectors (Sony SXRD 4k)
8 channels @ 2k x 1k

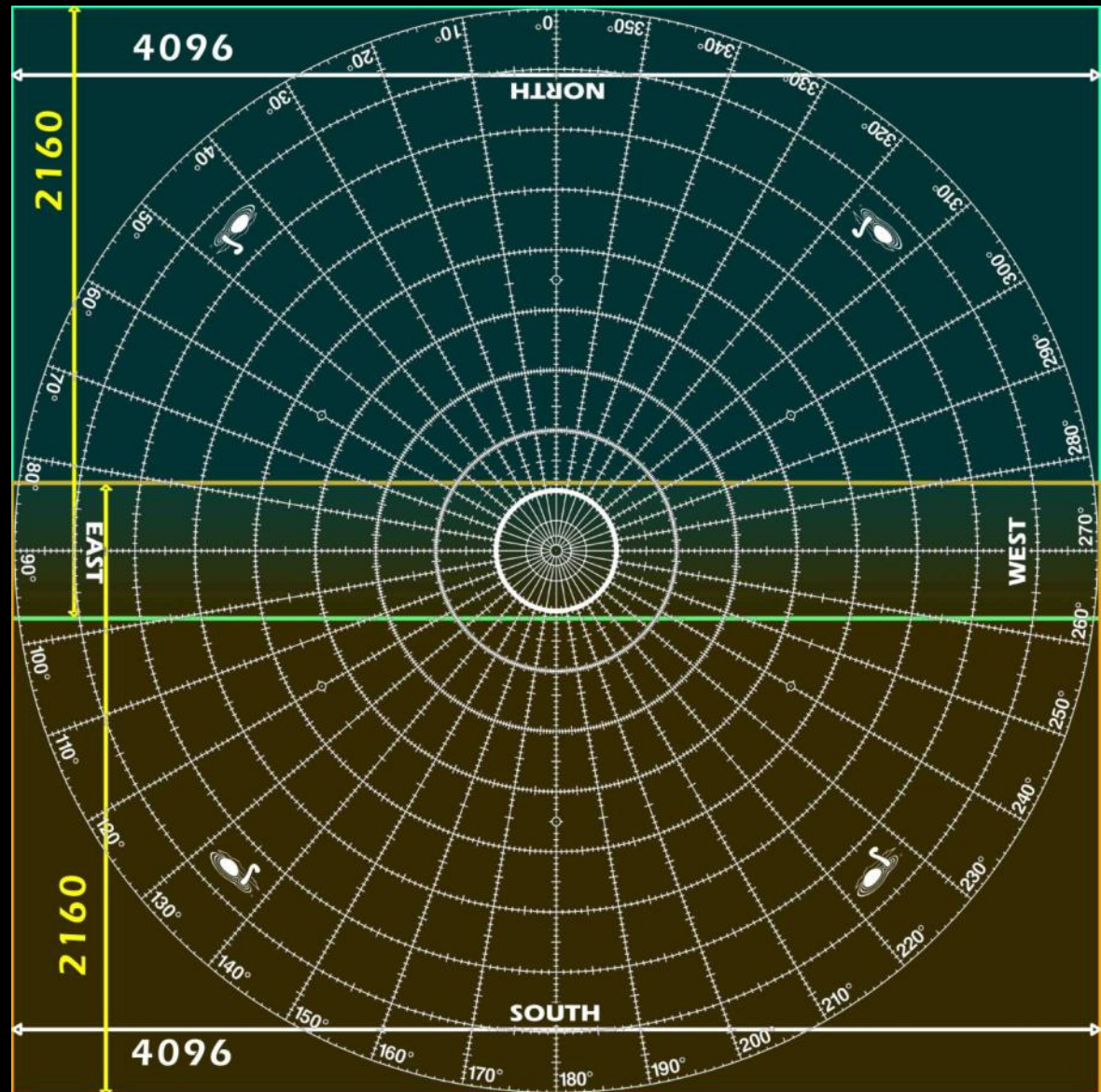


Stereoscopic 4k Dual Fisheye



Dual Fisheye System

4096 x 4096 Dome Master
13M pixels on dome
22.7 pixels/degree
4,500 lumens
1800:1 contrast
4 projectors (Sony SXR4 4k)
16 channels @ 2k x 1k



Sampling of Fulldome Theaters



Boeing CyberDome Theater
Exploration Place
Wichita, Kansas



Volkswagen Autostadt
Wolfsburg, Germany



Papalote Museo del Niño
Mexico City



Bibliotheca Alexandrina
Alexandria, Egypt

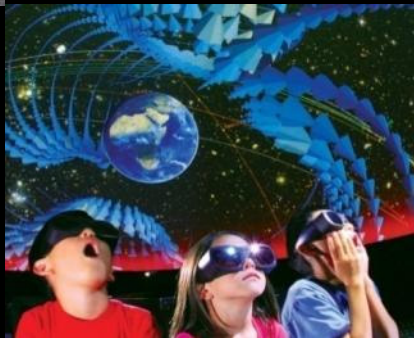


Hayden Planetarium
Rose Center for Earth and Space
American Museum of Natural History
New York, NY

Stereoscopic 3D Digital Domes



Images Courtesy Sky-Skan

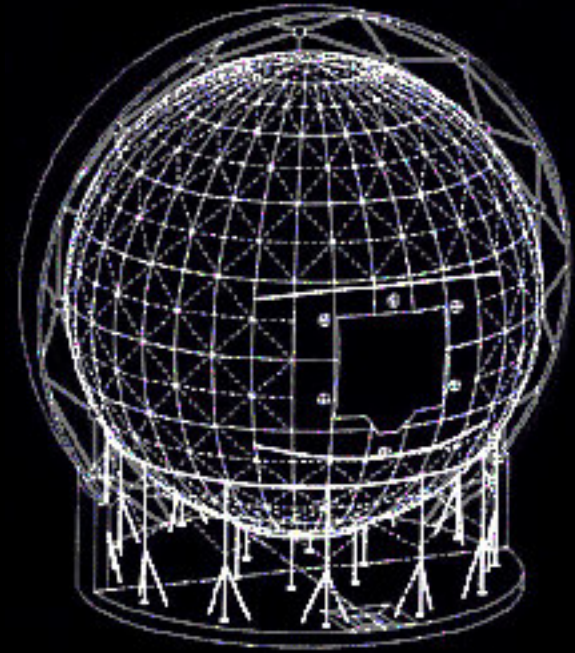
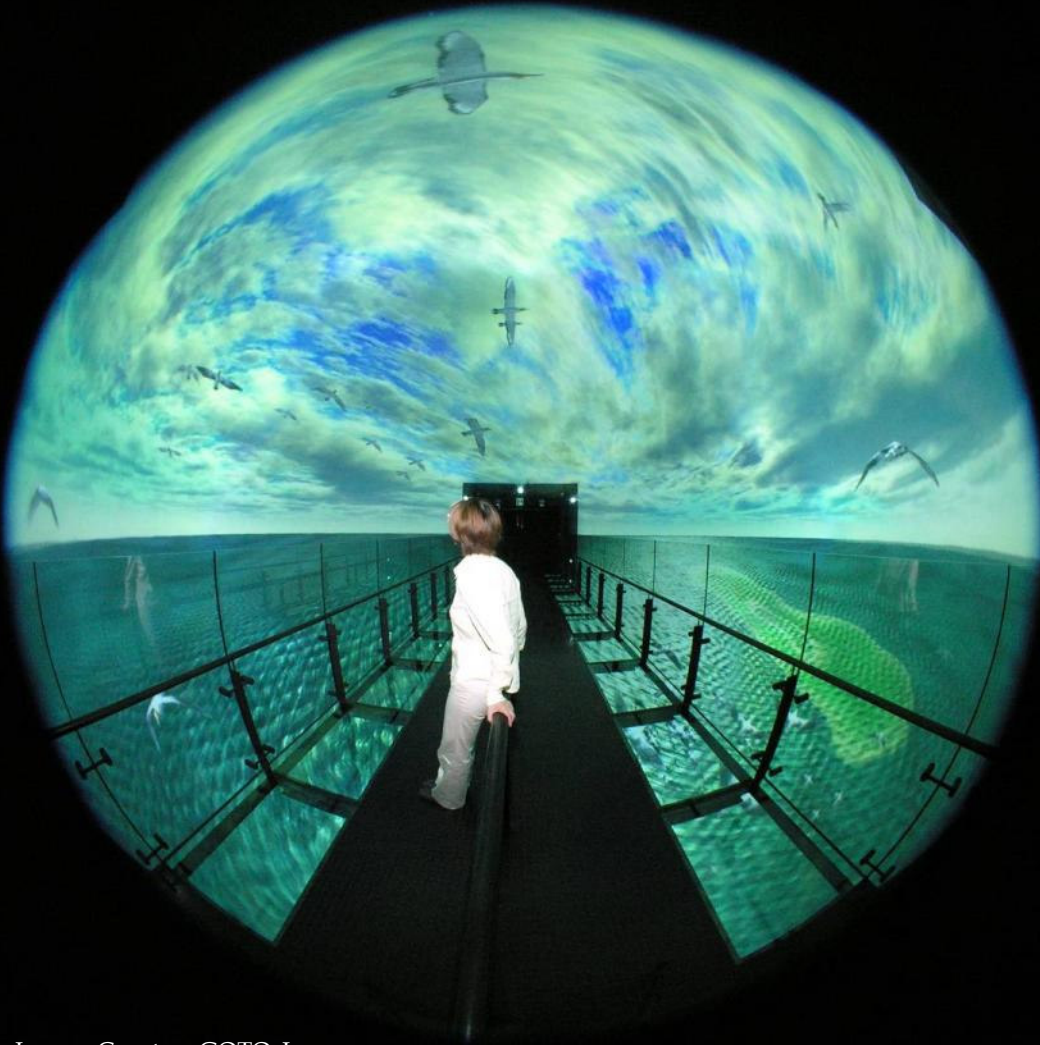


- 'Imiloa Astronomy Center: Hilo, Hawai'i
- Infitec 3D Stereo
- Opened Jan. 2008
- Integrated by Sky-Skan

- Foundation for the Hellenic World: Athens, Greece
- Infitec 3D Stereo
- Opened 2007
- Integrated by SEOS

THEATER 360

National Museum of Nature and Science, Japan



12.8m, 360° spherical display
(Courtesy GOTO, Inc.)

Portable Domes



VORTEX Mobile Dome



SciDome™

- Dome Production Environments
- Educational Planetariums, Portables, Art Exhibits
- Tradeshows, Nightclubs, Special Venues

Fulldome Theater Summary

- Powerful Immersive Medium
- Capable of Real-Time Simulations
- Widespread Adoption
- Profitable Shows
- Wide Range of Programming is Possible
- Focused on “Meaningful Media”
- Convergence with Large-Format Film?

SciVis Dissemination to Non-Scientists

Three primary areas of importance:

- Education
- Entertainment & Storytelling
- Art & Culture

*These are not areas of expertise for scientists,
however scientists must play key role in
dissemination of SciVis to non-scientists*

Cosmology

Cosmology is the study of the universe in its totality, including humankind's place in the universe. We each have a personal cosmology or "world view."

Much of the known universe lies beyond our everyday experience.



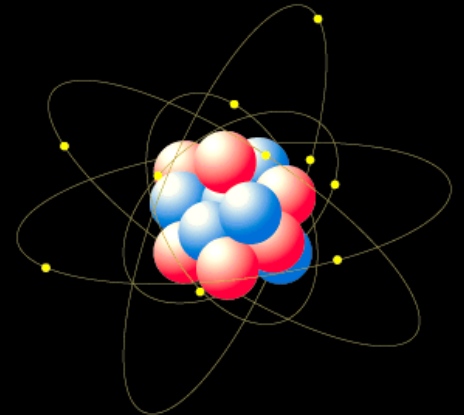
Ancient Cosmologies

Awe-inspiring cathedrals, temples and mosques immersed their subjects a religious world view. Reinforced by art, music, literature, architecture and storytelling, they forged a religious cosmology that remains deeply infused in our world cultures even today.



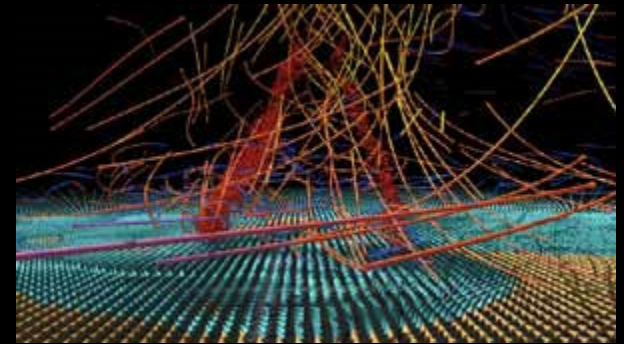
Fostering a New Cosmology

Through education, storytelling and deeply engaging art, non-scientists assist in the assimilation of scientific knowledge into deeper personal and cultural meanings – fueling new cosmologies or "world views" – in ways that scientists cannot.



Education

- Formal Science Education
 - Classroom teaching tools
- Informal science education
 - Television documentaries
 - Giant screen theaters (i.e. IMAX)
 - Digital planetariums



NCSA's Tornado
Simulation

Convey basic understanding of scientific concepts through visualization of the known universe

Storytelling & Entertainment

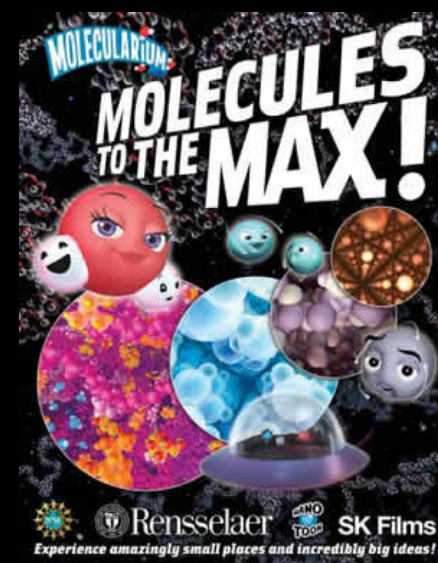
- Docudramas and fact-based storytelling
- Films, television and immersive media
 - Drama, SciFi, fantasy, etc.
- Video games, virtual worlds



Infinity: The Quest for
Earth (MMO)



Universe Online
(MMO)



The universe is made of stories, not of atoms.

- Muriel Rukeyser

Lunar Racing Championship

- Students/players build their own racers
 - Physics-based simulations
 - Accurate moon terrain, starfields
 - Apollo landing sites
- Digital dome tournaments
 - Regional, national, international
- Audiences are spectators
 - Audience can collaborate to support their team



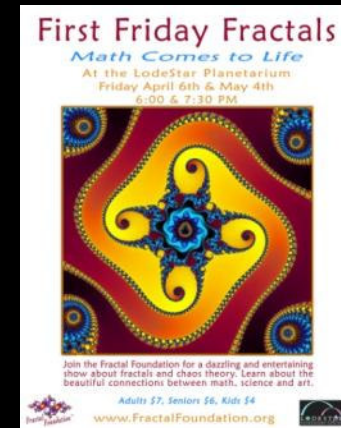
Art and Culture

- Opera, theater, live performance
- Art & music festivals
- Immersive media programming
- Internet, virtual worlds, pop culture
- SciArt (ArtScience)



Earthrise over the lunar
horizon, Apollo 8,
December 1968

Fractal Foundation's
First Friday Fractals



Art does not reproduce what we see; rather, it makes us see.

- Paul Klee

Bella Gaia



REMEDY ARTS™

Audio Visual Remedies

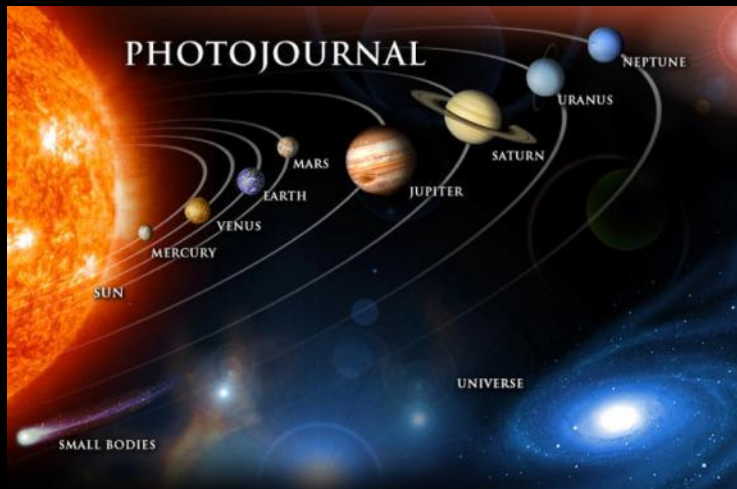


- An Immersive SciArt Experience
 - Classically trained violinist, Kenji Williams
 - Earth and space visualization by UNIVIEW
 - World tour of planetariums in 2009/2010
- Cognitive goals include understanding of:
 - Power of STEM tools to change the earth and improve lives
 - The many world cultures, their geography and sacred sites
 - The power of space science to better understand the world
- Affective goals include appreciation of
 - The Earth itself as a heritage site
 - Global culture, music and environment
 - Inspiration to use STEM tools wisely for benefit of humanity
- Seeking support from NASA, UNESCO, Smithsonian



Turning Raw Data into Visualization

- Spatial and Temporal Continuity
 - Missing data must be extrapolated, interpolated, or guessed
 - Motions must be smooth inertia
- Aesthetics, Understanding Trump Accuracy
 - Exaggeration, distortion, artistic license
 - Ordinarily coupled variables are separated



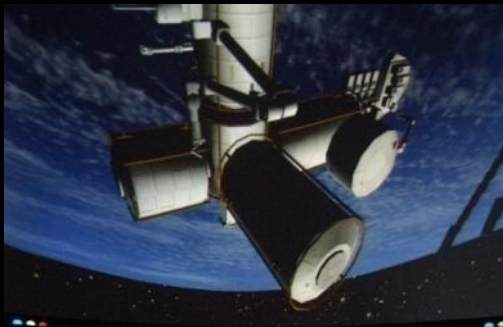
NASA Website



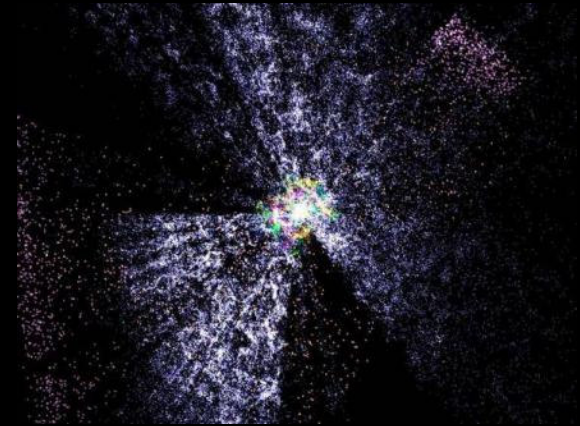
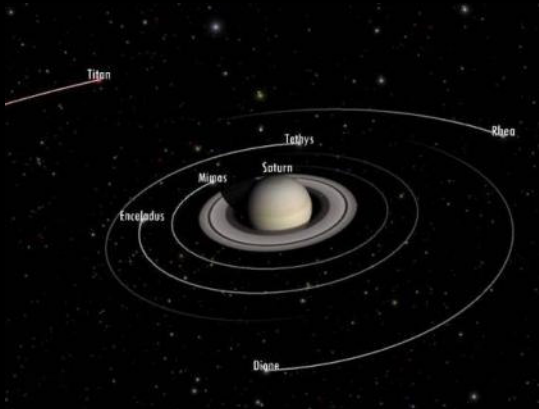
Will Wright's SPORE

AMNH's Digital Universe Atlas

Curated datasets for digital planetariums



Carter Emmart, Director of
Astrovisualization at the American Museum
of Natural History's Rose Center for Earth
and Space



AMNH's Digital Universe Atlas



- Started in 1998 with NASA Funding
 - Originally the “Digital Galaxy Project” – Dennis Davidson
- Curated Package of 3D Astrophysical Datasets
 - Nearby Stars (Hipparcos/Tycho star catalogs)
 - Milky way galaxy
 - Star clusters, nebulae, extrasolar planets
 - Extragalactic galaxies, quasars, etc.
 - Tully Galaxy Catalog
 - Sloan Digital Sky Survey and others...
 - Multispectral Sky, WMAP, etc.
- Used by Multiple Digital Planetarium Vendors
 - Sky-Skan's DigitalSky, Uniview, E&S's D3/D4

Model of the Known Universe

- Proposed Collaboration of Leading Institutions
 - Universities, science centers, data curation programs
 - Multi-agency funding: NASA, NSF, UNESCO, ESA, etc.
- Curation of Scientific Datasets and Simulations
 - Geospatial, planetary, galactic, extragalactic
 - Biological, biomedical
 - Microscopic, particle/quantum physics
 - World heritage sites
 - Participation could be mandated by funding agencies
- Standard Licensing Templates
- Dissemination through Vendor Partners, i.e.
 - Web: Google, Microsoft, Second Life
 - Digital Dome Software: E&S, Spitz, Sky-Skan, Uniview
 - Academia: OptIPortals
 - Television and Cinema: Film studios

Networked Domes



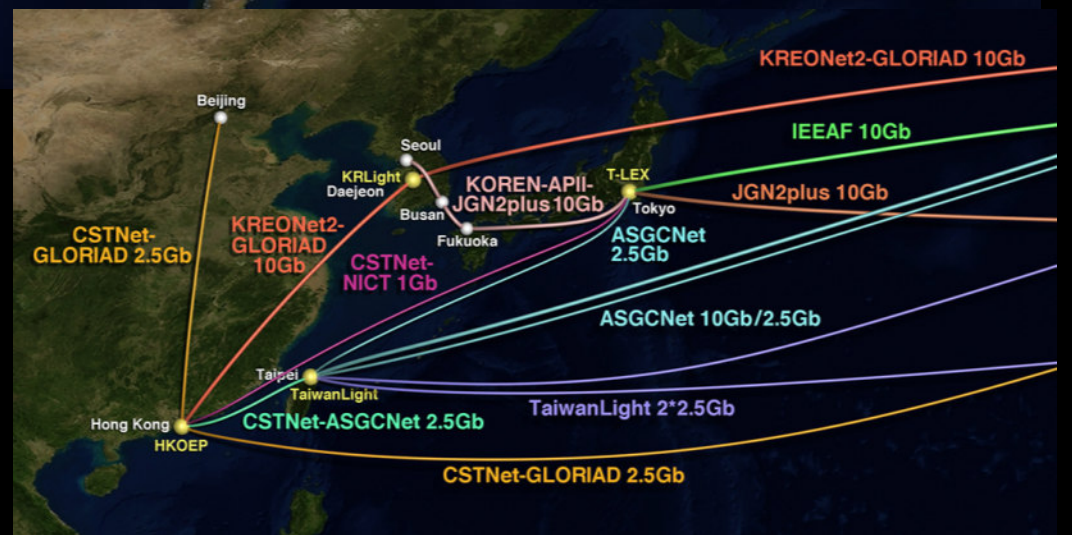
SciVis Distribution

The Global Lambda Integrated Facility

Visualization by Robert Patterson, NCSA/University of Illinois
at Urbana-Champaign

Compilation by Maxine Brown,
University of Illinois

Earth Texture, visibleearth.nasa.gov



IMERSA



Immersive Media Entertainment, Research, Science and Art association

IMERSA is a professional association founded to advance and promote the art and science of large-scale digital immersive media and immersive group experiences including (but not limited to) surround digital theaters and digital (fulldome) planetariums.

www.IMERSA.org

IMERSA



- **Industry standards**, guidelines and recommended practices.
- **Program and fund development** for research, arts & show production consortia.
- **Professional development** education, certifications, awards.
- **Professional communication and collaboration** via events, online networking and an annual conference.
- **Industry research** including market and industry statistics, historical records, product evaluations.
- **Outreach** to the media, the public and other trade organizations.

Fulldome Standards & Guidelines



- **Specifications for digital systems**
 - Brightness, contrast resolution, bit depth...
- **Cross-vendor pre-rendered show distribution**
 - Dome master, audio files, metadata
- **Digital planetarium performance**
 - Educational, Public, LF Film
- **Theater design recommendations**
- **Real-time application distribution**

IMERSA Fulldome Summit 2009

- First Fulldome Summit Held in Valencia in 2004
 - Special session of IPS 2004
 - 13 papers presented and published on fulldome standards, panel and standards roundtable
- Fulldome Summit in Chicago on July 3rd, 2008
 - Special session of IPS 2008
 - 14 Papers, panel and keynote by Walt Ordway (DCI)
 - Standards roundtable
 - Integrated with DomeFest 2008
- DomeFest & IMERSA Fulldome Summit
July 16–19, 2009, Albuquerque, NM
 - Call for Papers
 - Producing, editing & evaluating fulldome programming

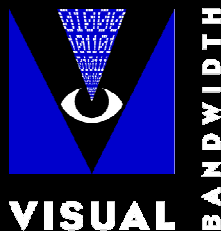
Preparatory Event 2009
featuring Full Dome & Stereoscopic Movies
for the International Festival of Scientific Visualization

ドーム&立体プレイベント2009

国際科学映像祭

IFSV 2009

Thank You!



Ed Lantz

IMERSA

Spherical Media Group

Visual Bandwidth, Inc.

Ed@visualbandwidth.com

www.spherical-media.com

www.visualbandwidth.com

www.imersa.org

