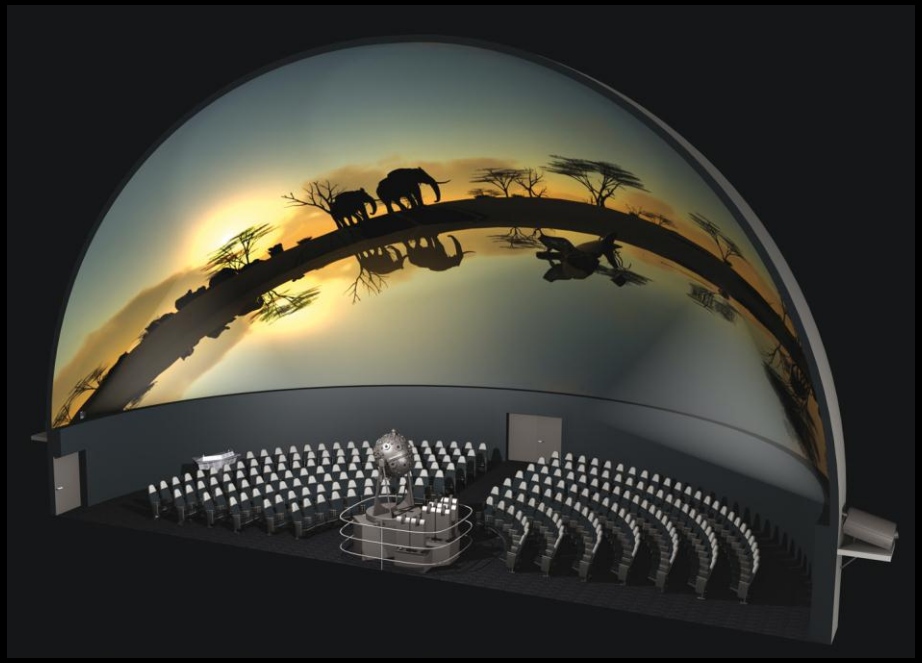
Fulldome: Medium and Technique

(Introduction)



Introduction to fulldome
What‘s fulldome?

Term:

- simply put together “full” and “dome”
- less common, but synonym: alldome
- spelling – linguistically correct: full-dome / actual in use: fulldome
- Jena FullDome Festival

Meaning:

- digital images spread on the dome by means of projection (spherical surface: 360° x 180°)
- “immersive” imaging
- real-time applications (interactive) and playback (linear)
- mostly computer animated content – live footage in development (inserts or fisheye images)

→ no content limitations – astronomy most common
→ pure digital work flow from production to projection
→ potential of standardization and networking
→ content is challenging: what topics in a “planetarium”?

Definition:

Fulldome oder Ganzkuppelprojektion bezeichnet die Videoprojektion von vorausberechneten (linearen) oder interaktiv in Echtzeit visualisierten Computerdaten sowie Realaufnahmen, oder eine Komposition aus diesen, mit einer Anzahl Projektoren an eine sphärisch gekrümmte Projektionsfläche, die Kuppel, die sowohl horizontal, als auch im Winkel bis zu 90 Grad geneigt aufgebaut sein kann. Die Videoprojektion umgibt den Betrachter mit einem halbkugelförmigen Bildwinkel. Fulldome stellt ein noch sehr junges, bildgewaltiges, audio-visuelles Medium dar, für das es technologisch keine applikativen Grenzen gibt, dessen Portfolio Wissenschaft, Bildung, Unterhaltung, Kunst, Wellness, Interaktion und Spiel einschließt.

ZEISS

Definition:

Fulldome projection refers to video projection onto a dome, i.e. a spherical projection surface, which may be arranged horizontally or inclined by an angle up to 90 degrees. Projection is by a single projector with a fish-eye lens or a number of projectors arranged for multi-channel displays. The contents projected may be computer data, whether (linearly) pre-rendered or visualized interactively in real time, real video footage or a composition of both. The viewer is surrounded by the video projection in a hemispherical angle of view. As a novel audio-visual medium, fulldome is distinguished by the exceptional vividness of the imagery projected, the embedded sound and by a technically limitless scope of applications, including science, education, entertainment, art, wellness, interaction and games.

Fulldome erweitert Horizonte

Fulldome verknüpft komplexe Themen zu einem Teppich mit durchschaubaren Mustern, einem Teppich, der unser Verständnis von der Welt trägt, mit dem Urknall beginnend bis zum Umgang miteinander. Wie sein fliegender Vorgänger nimmt er uns auf Reisen in Räume mit, die wir in persona nie betreten werden, Räume, die unserer Phantasie, unserer Wissenschaft, unserer Kreativität, unseren Träumen entspringen. Fulldome verschiebt Grenzen, Grenzen im Sehen, Grenzen im Wissen, Grenzen im Handeln.

Fulldome broadens horizons

Fulldome ties complex topics into a carpet of transparent patterns, the carpet, carrying our understanding of the world, from the Big Bang in the beginning to human relationships at the end. As its flying predecessor it enables us to travel to spaces, which we in persona never can enter, spaces, originated from imagination, from sciences, from childhood, from dreams... Fulldome is pushing boundaries, boundaries in perception, boundaries in knowledge, boundaries in acting.

Introduction to fulldome
Short History

Developments:

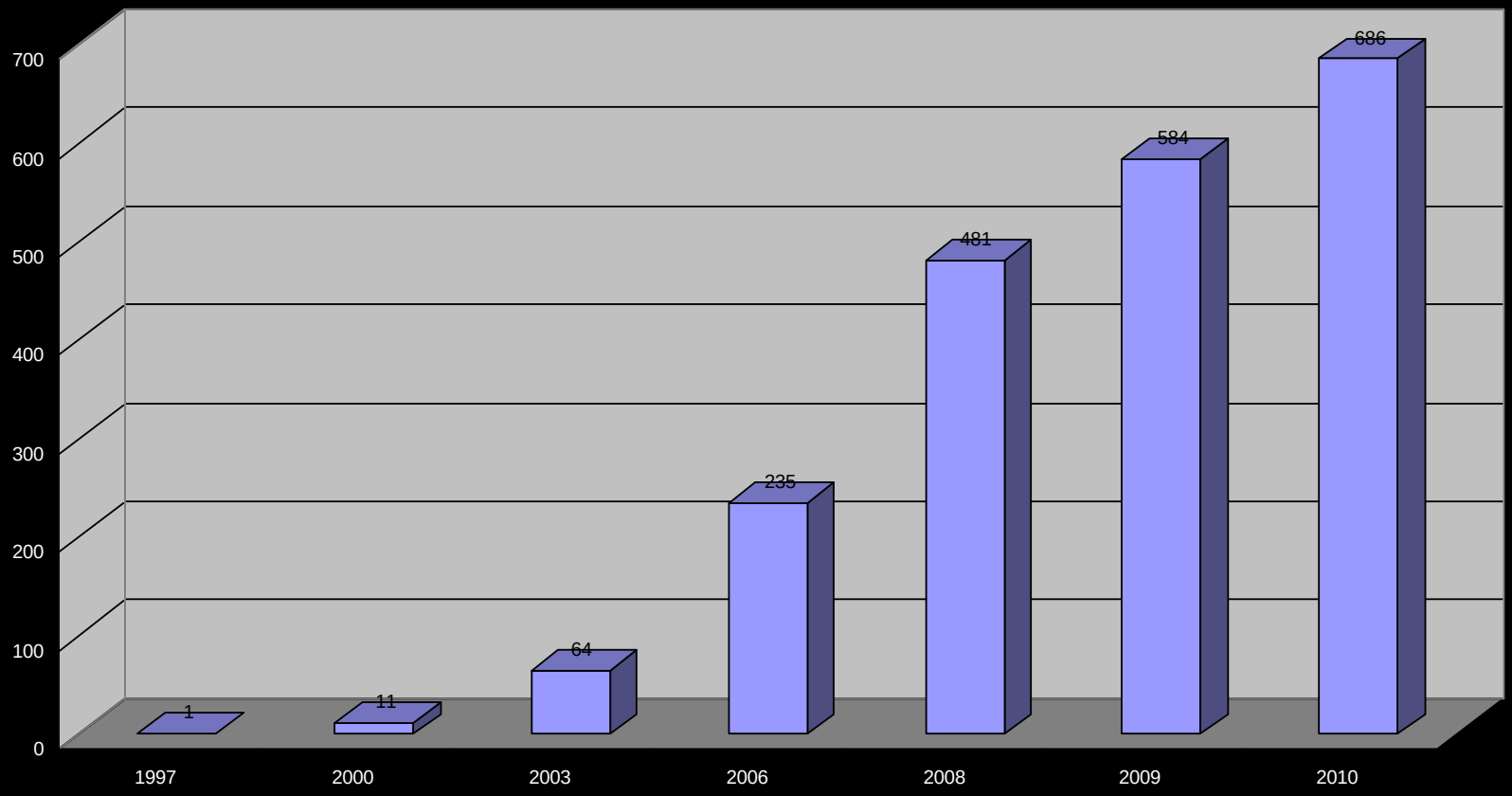
- Introduction in 1996 (USA and Japan)
- first systems featured CRT projectors and high-end computer (i.e. Silicon Graphics)
- only planetariums as users
- only big domes in the beginning (budgets!)
- only multi-channel systems in the beginning

  now: majority of small and fisheye systems (more than 65%)
- enormous growth rate
- 2008: > 20M visitors (world)

  → 2012: approx. 50M visitors expected

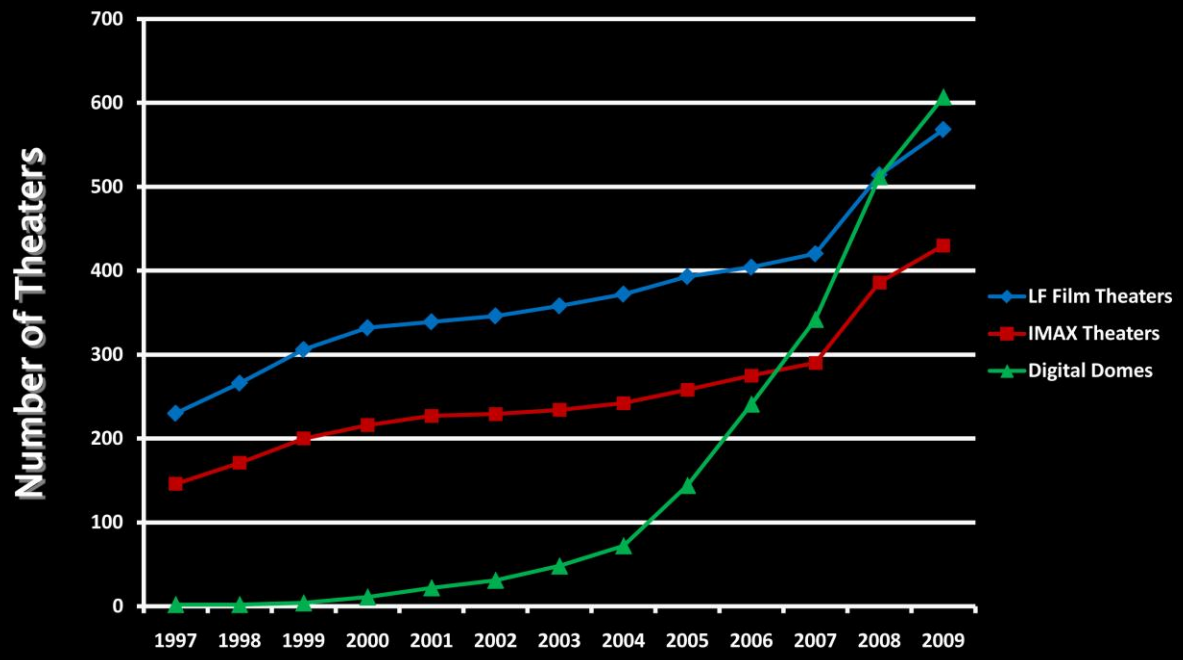
Introduction to fulldome
Short History

- nearly 700 digital fulldome systems in 13 years
- > 65% mobile and small planetariums (dome diameters up to approx. 10 m
- > 90% Planetarium related



Introduction to fulldome
Short History

Number of large format film theaters vs. fulldome theater since 1997 [1]:

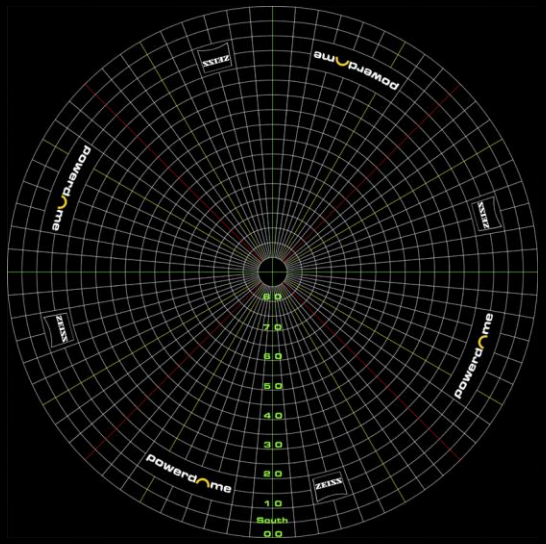


[1] Lantz, Ed: Fulldome Digital Dome Production and Market Overview,San Diego 2010 (GSCA Film Expo – Dome Day).

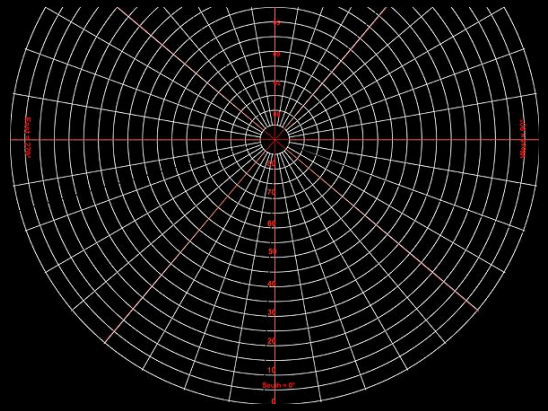
Introduction to fulldome
Fulldome Systems

Methods of projection:

- dome projection (360° x 180°) – multi-channel, fisheye
- truncated projection – only fisheye systems
- panorama projection (ca. 220° x 120°) – only multi-channel – less important



fulldome



truncated

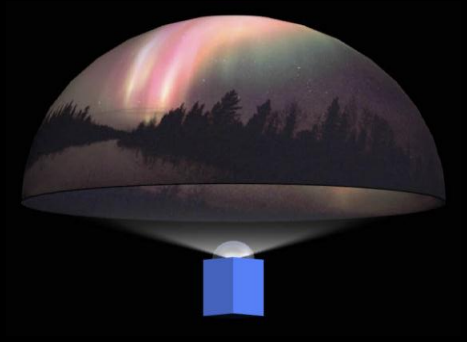
Introduction to fulldome
Fulldome Systems

Methods of projection:

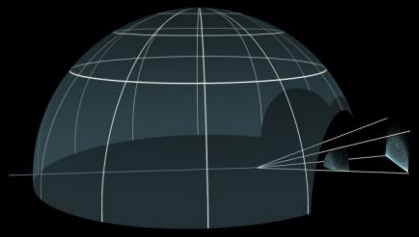
- multi-channel
  edge blending
  high to best resolution

- fisheye
  low to medium
  resolution

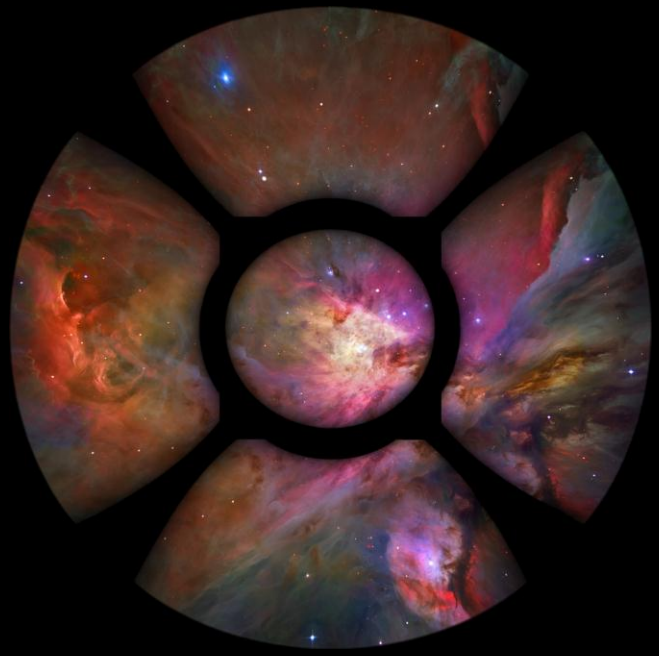
- mirror projection
  low resolution
  weakest image quality



fisheye dome projection*



mirror dome projection*

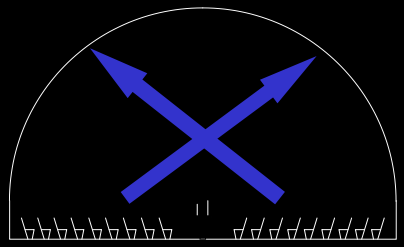


five image channels edge blended with SPACEGATE Quinto (channels separated)

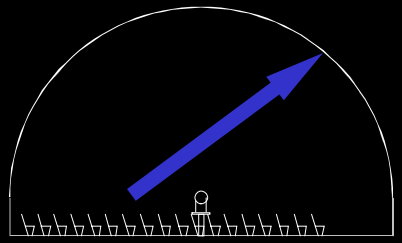
* image courtesy: Ed Lantz (**Computer Graphics for Large-Scale Immersive Theaters**)

Introduction to fulldome
Fulldome Systems

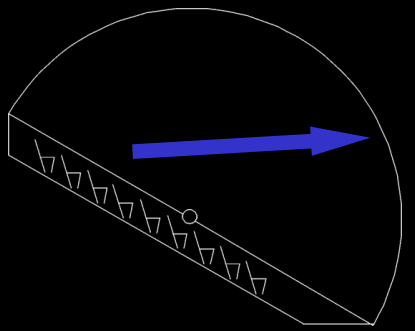
Orientation:



concentric



unidirectional



tilted

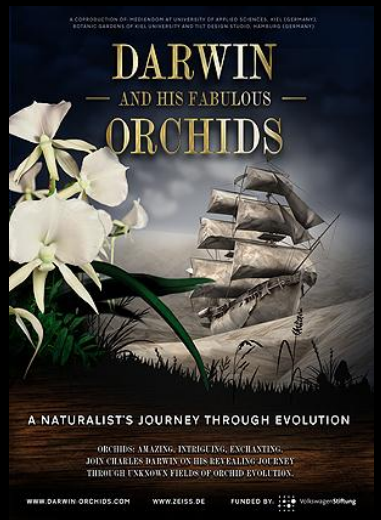
Introduction to fulldome
Fulldome Content

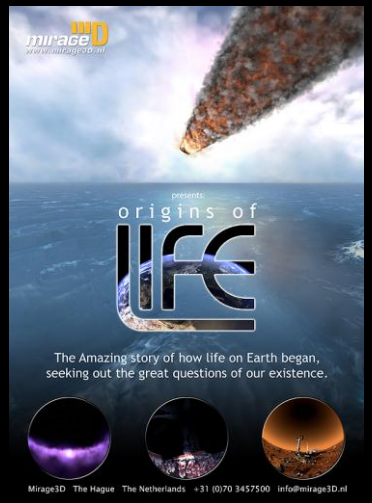
Fulldome content:

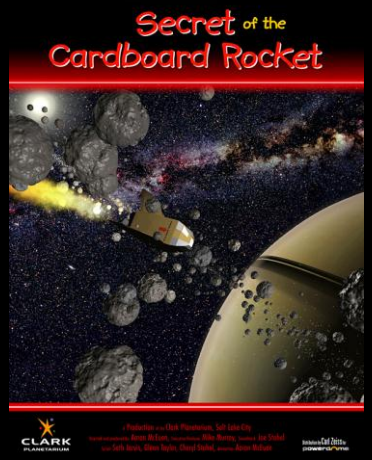
Majority:

Playback prerendered visuals

- linear or interactive playback
- fulldome video or sequences/clips





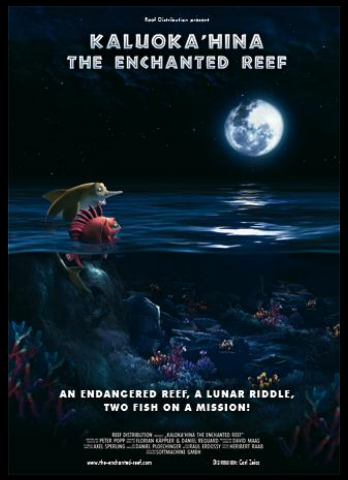


81% *astronomical topics*
7% *earth sciences*
7% *entertainment, music shows*
4% *human sciences, biology, chemistry*
1% *Fine Arts*

Introduction to fulldome
Fulldome Content – few Milestones (selection)

Infinity Express
Sky-Skan

First investigation
in 2D and 3D
attractive effects



Kaluoka‘hina -
The Enchanted Reef
Softmachine

First fulldome movie with story and characters

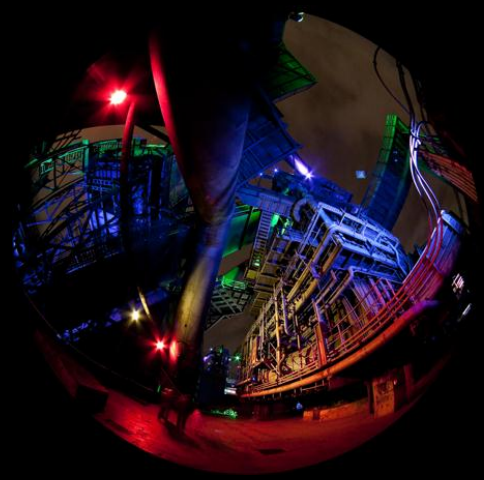
R+J
LivinGlobe

First real fulldome footage,
shot on film with ARRI and
8-mm-lens

Alien Action
Ralph Heinsohn et al.
First digital art show
in fulldome

tempus.ruhr
Rocco Helmchen

First full-length time-laps
fulldome show



Introduction to fulldome
Fulldome Content – few Milestones (selection)

combining analog-digital

greatly customized for target group

top visual design

best use of humor

dramatic music visualization

Introduction to fulldome
Fulldome Content – Fulldome Festivals

Fulldome Festivals:

Domefest
(USA, Albuquerque)
since 2004

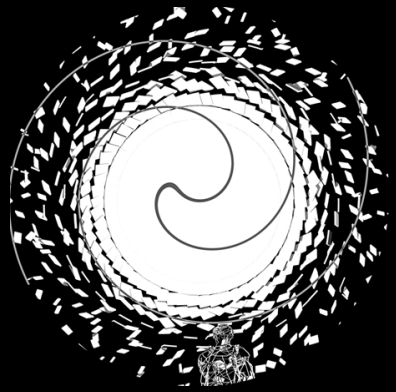
FullDome Festival
(Jena)
yearly since 2007

Immersive Film Festival
(Espinho, Portugal)
biannual since 2009

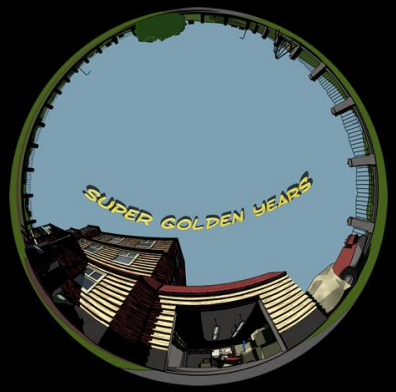
in addition:
Fulldome Festival UK (UK, since 2010)
Imiloa Fulldome Film Festival (Hilo, Hawaii, in 2010 only)
International Planetarium Movie Festival (South Korea, in 2010 only)
TOWERdome Festival (Judenburg, A, first time in 2011)

Introduction to fulldome
Fulldome Content – few Milestones

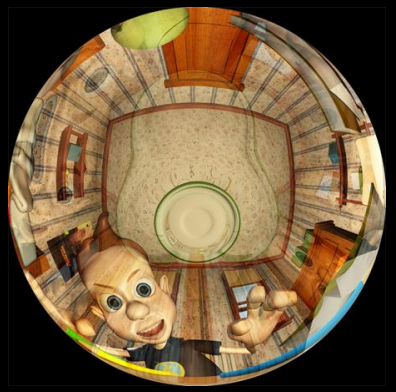
FullDome Festival Experiments



Above
Florian Meyer



Super Golden Years
Hannes Wagner et al.



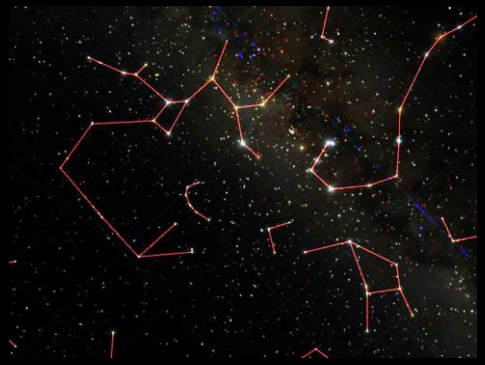
Petty Tyrant
Alexander Schumann

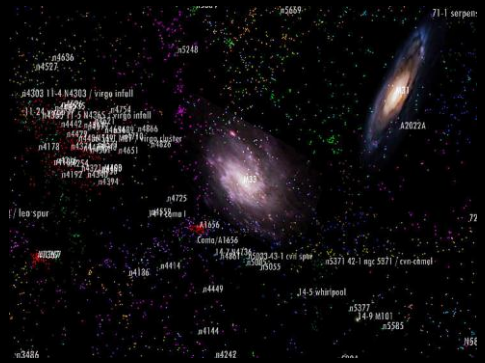
Chroma Elements
Alexander Stephan

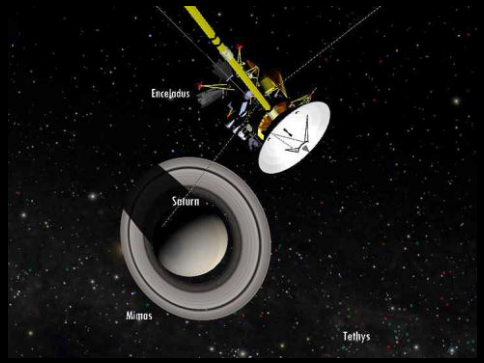
Introduction to fulldome
Fulldome Content

Live presentations

- Visualizing software (e.g. “digital planetarium”)
- Interaction by operator or visitor
- Online data access (Internet)





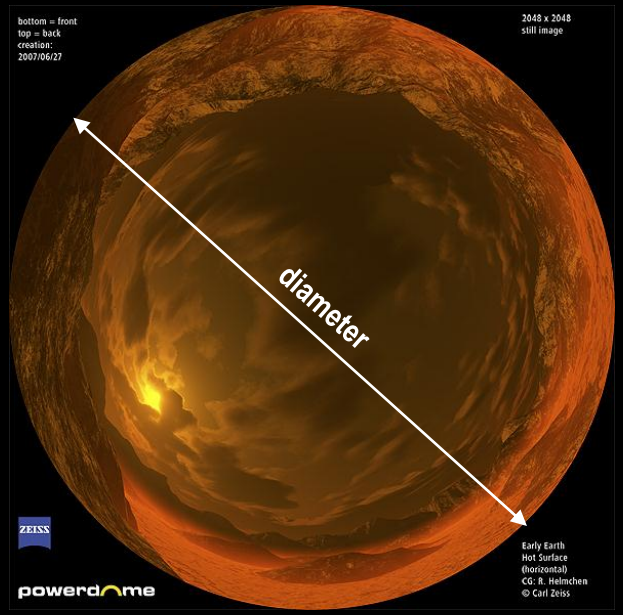


Introduction to fulldome
Fulldome Format

Fulldome Formats:

- dome master
  - circular sector of square frame
  - same radii correspond to the same elevation angles
  - “frame-edges” available for additional information: title, credits, frame number, etc.

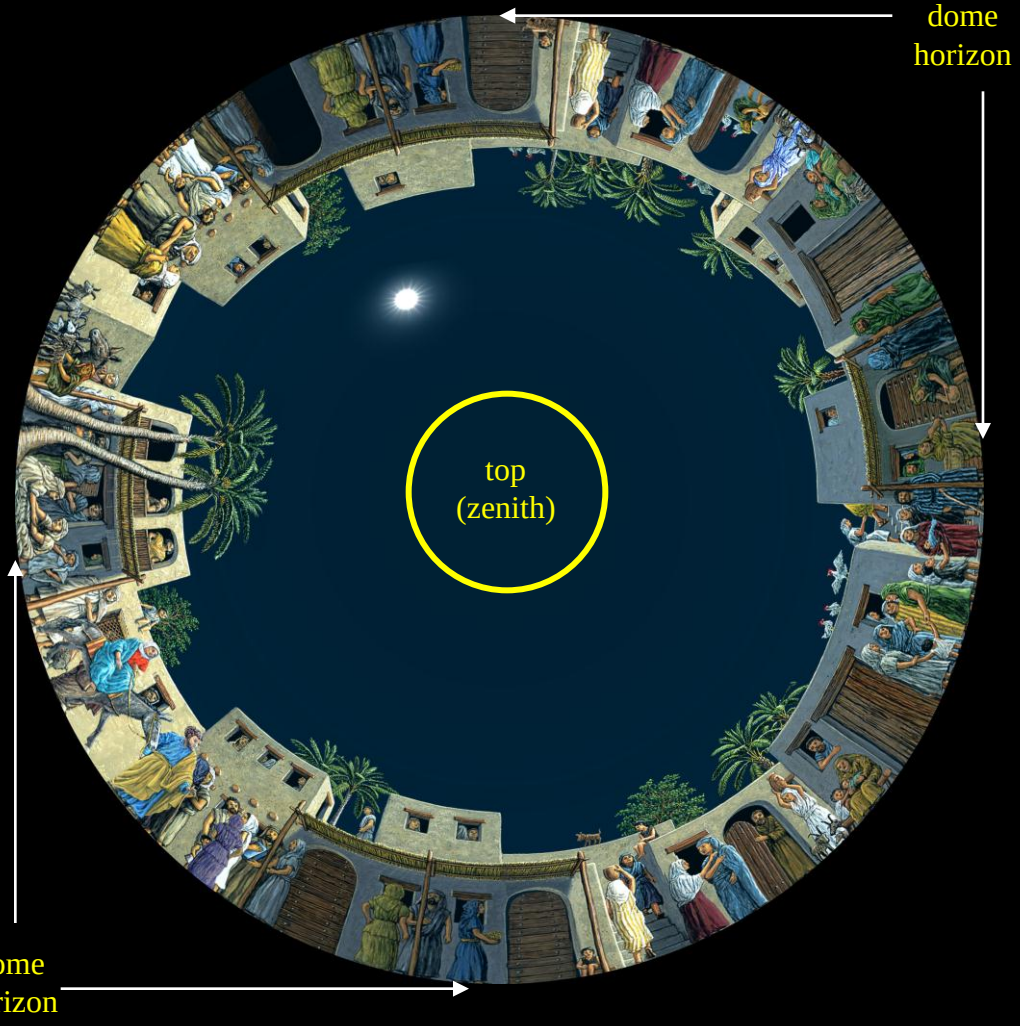
- resolution
  - designated by the number of pixels on the diameter
    2k = 2.048 x 2.048 px 3k = 3.072 x 3.072
    4k = 4.096 x 4.096 px
  - general: the bigger the dome, the higher the resolution needed
    Jena Planetarium: 3k and 4k
  - powerdome: 1.5k / 2k / 3k / 4k



Introduction to fulldome
Fulldome Format

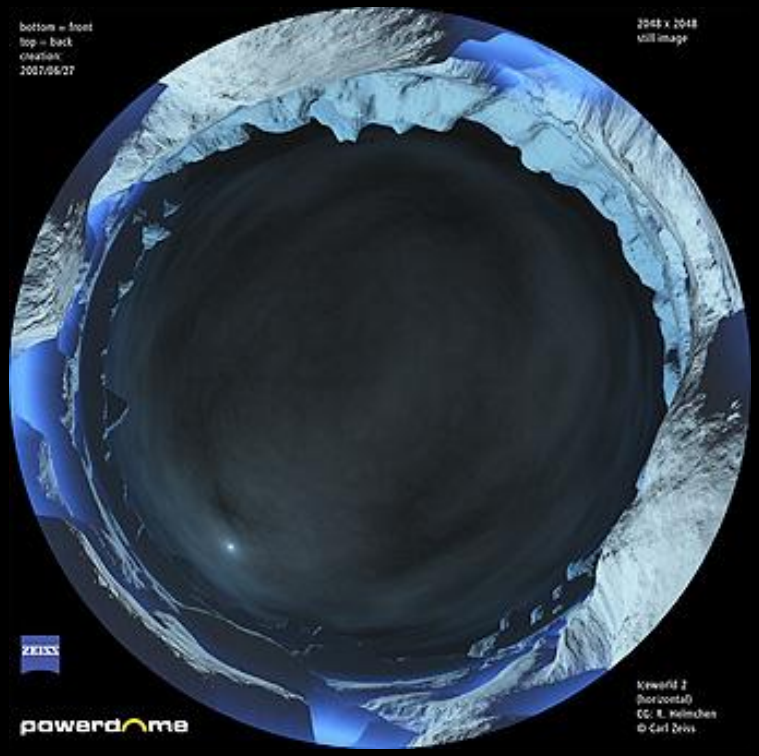
Fulldome Format:

- Orientation
  - “bottom” = front (south)
  - “top” = back (north)
  - left (east), right (west)

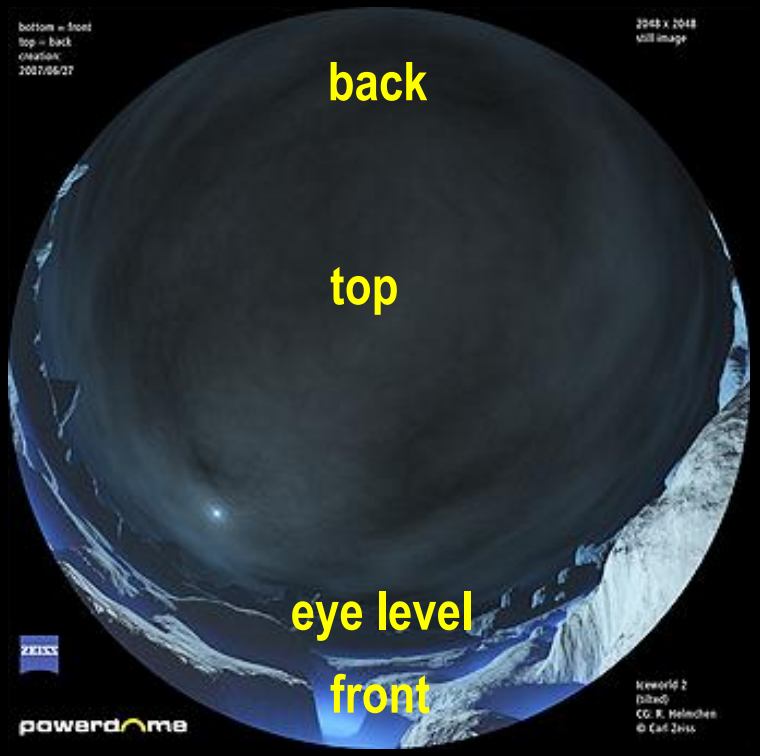


Introduction to fulldome
Fulldome Format

Fulldome Format: location of horizon



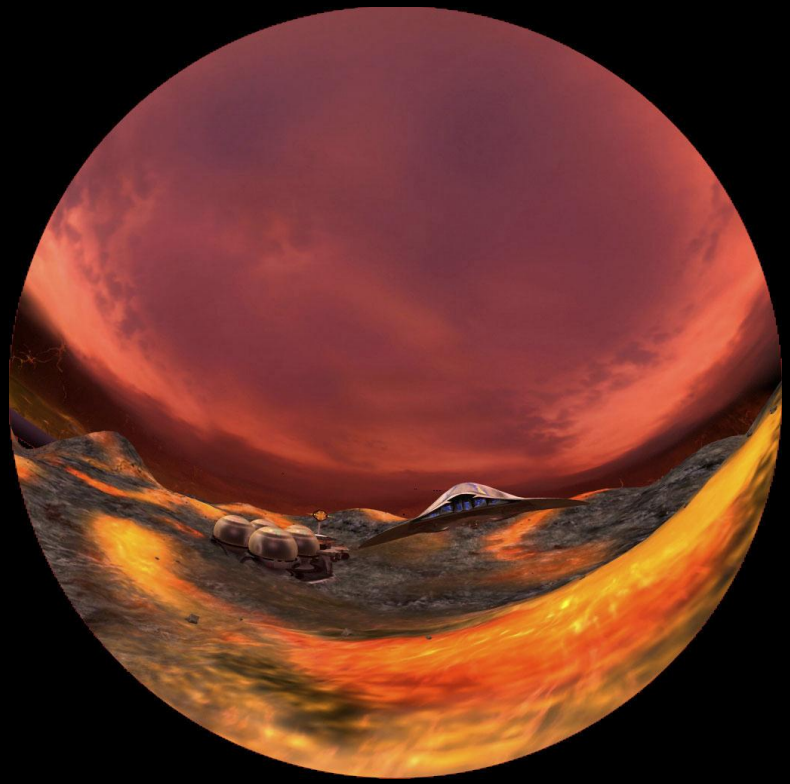
"flat"



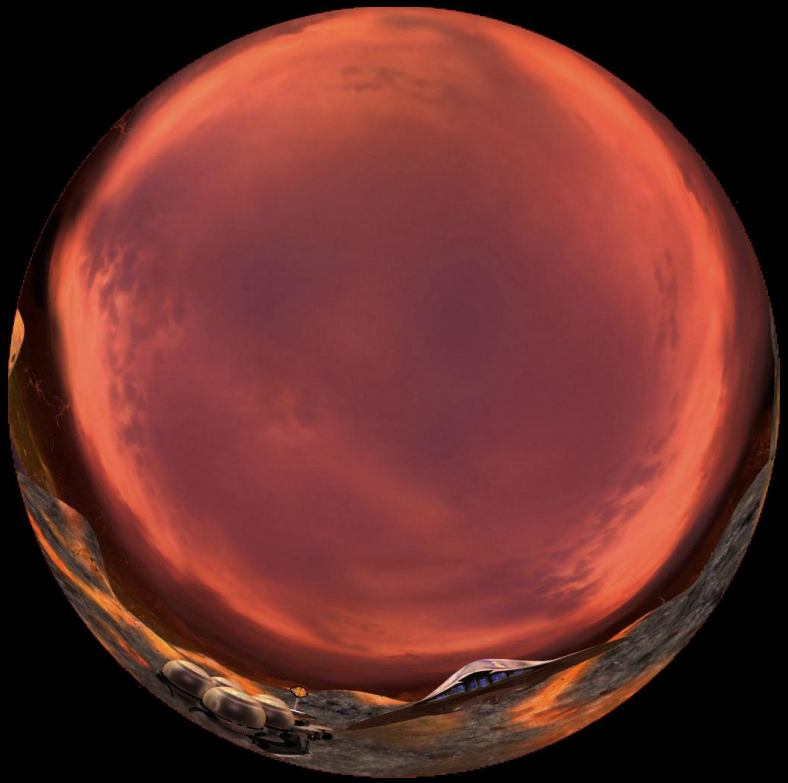
tilted

Fulldome Format: location of horizon

Tilt: up to 30° in use, Jena = 0°
15° - “compromise” for show distribution



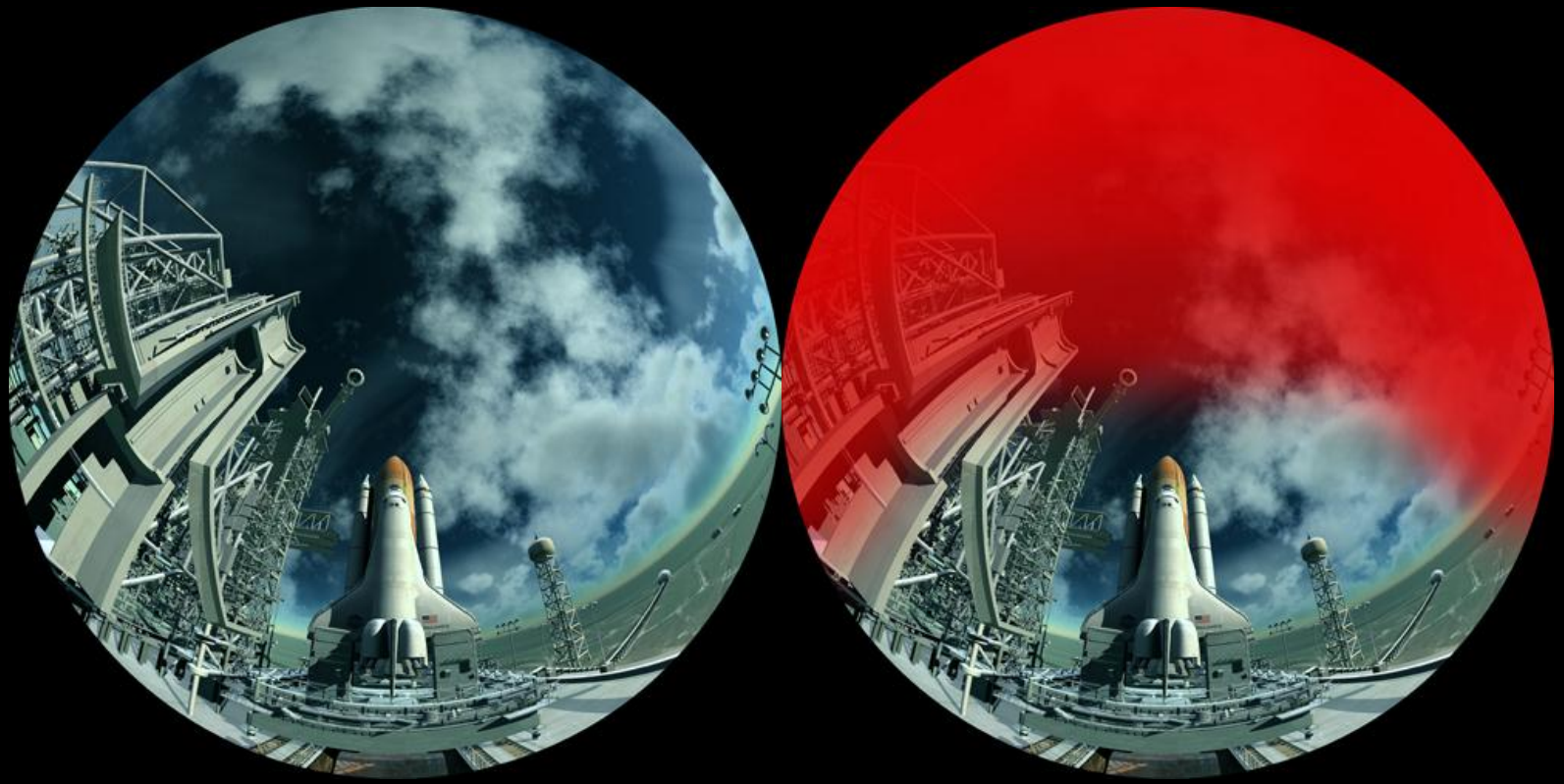
to high



comfortable

* image courtesy: Spitz Creative Media

Fulldome Format: Field of View (unidirectional seatings)



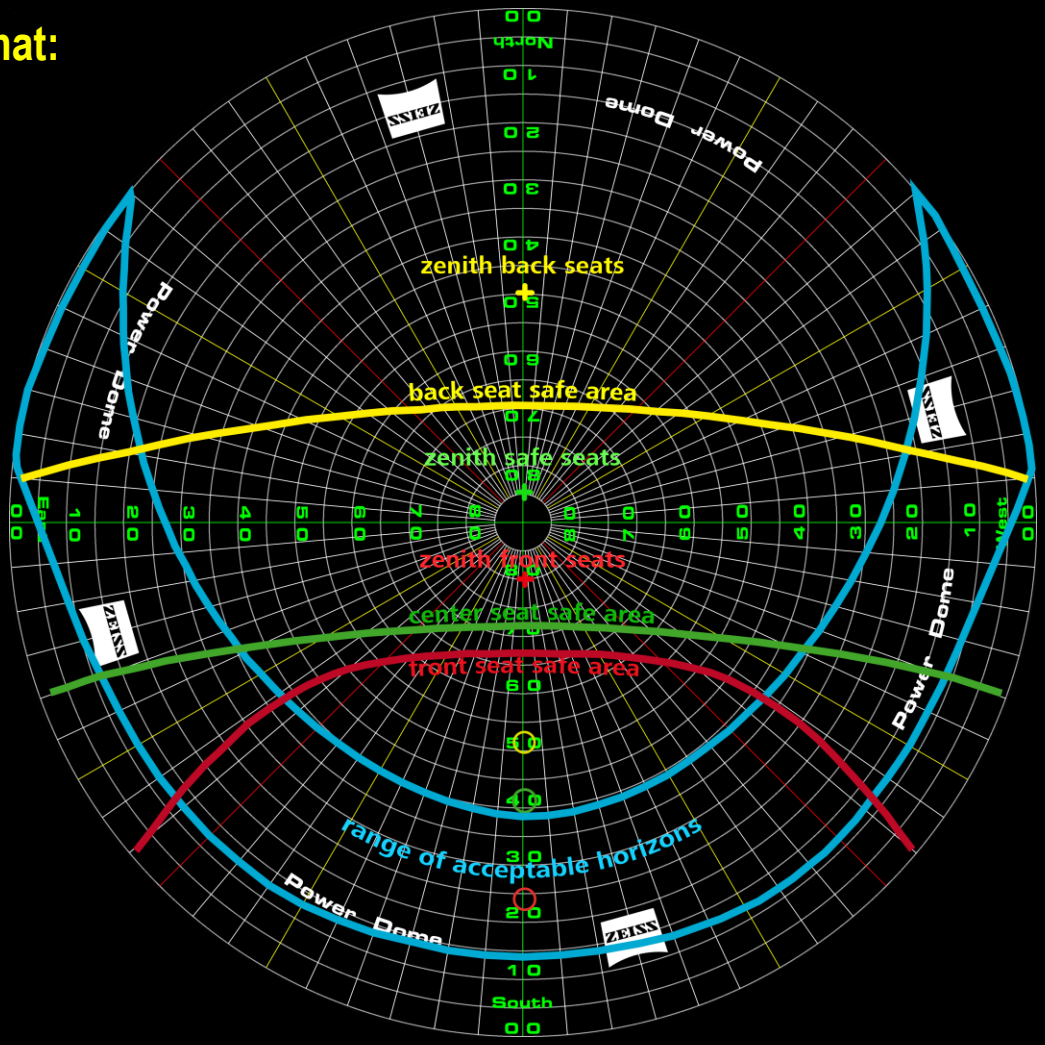
projection

red: imperceptible

* image courtesy: Mirage3D

Introduction to fulldome
Fulldome Format

Fulldome-Format:
Field of View



ZEISS

Fulldome hints:

- consider Black as your most friendly color (background, contrast enhancement)

- consider White for highlighting only

- avoid larger areas with smooth colors, make colors high saturated

- shorten scenes with bright colors as much as possible

- distribute bright objects across the dome (as far as applicable)

- think about twilight instead of daylight scenes

Fulldome Motions

- noticeable motion blur at faster motions (double images – stars!)
- dome: reduce motion speed by factor of 4 to 5 compared with computer screen
- spinning images: risk of motion sickness (“cybersickness”)

typical motion blur
(turning image)

Fulldome cuts

- be careful with cuts: blend scenes, where possible
- abrupt cuts are risky, use them carefully
- keep sequences as long as meaningful – avoid short cuts for a longer time

ZEISS

Fulldome Format: Specs

- dome master colors: 24bit RGB
- frame designations
  - scheme: MyFrames_00000.png, consecutively numbered
- frame rate
  - 30 fps (preferred)
  - 29.97 fps (US productions, not recommended)
- frame file formats
  - png (preferred)
  - jpg (select best quality / lossless compression)
  - tga RLE (lossless compression, yet memory consuming)
- sound
  - surround 5.1 (preferred, ac3 create from uncompressed wav)
  - stereo (wav)

Fulldome storage capacities (uncompressed)

- per frame
  - 8 bit color depth, 3k resolution: 28 MB
- per second
  - 840 MB
- per minute
  - 50 GB

- use lossless compressions!
- calculate at least twice the capacity for back-ups!

Introduction to fulldome Projection Technology

VELVET (Jena Planetarium)

True Black Projection Technology

standard contrast

high contrast

black*

*simulation

Dome contrast

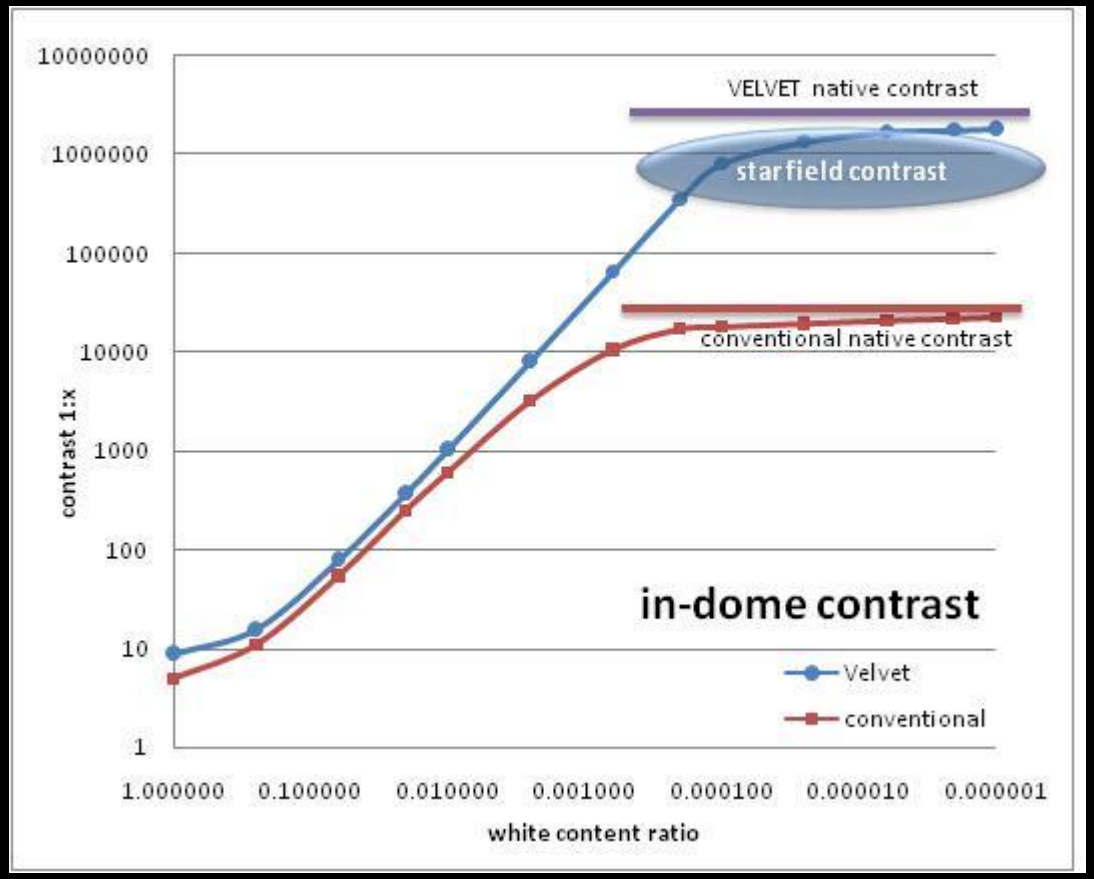


Image Quality

Influences

1. Brightness
2. Contrast
3. Resolution




low color saturation



Brightness

Influences	brighter dome images, if:	darker dome images, if:
1. Projector (lumen) - given -	bright	dim
2. Dome reflectivity - given, Jena = high -	white	grey
3. Adaption time of eyes - take into account! -	long	short

Eyes can adapt to low brightness.

ZEISS

Kontrast

Influences	hight contrast, if	low contrast, if
1. sequ. contrast of projectors = - given, Jena = highest -	high	low
2. Dome reflectivity = - given, Jena = high -	low (grey)	high (white)
3. Adaption time of eyes:	no influence	no influence

Eyes can not adapt to low contrast.

Contrast: projector vs. dome

Biggest influence results from **dome**.

Cross reflection causes a general drop of contrast.

to distinguish:
projector contrast = on/off (full white / full black) < > dome contrast = checkerboard

	Standard projector	VELVET
on-off contrast	3.000 : 1	2.500.000 : 1
dome contrast	7 : 1	15 : 1

Resolution

Defined by projector resolution and system configuration (number of projectors, blending areas, horizon cut-off).

Perception of images „being sharp“ starts with 4k resolution (high contrast provided).
Bad contrast „reduces“ resolution.

VELVET: approx. 4k resolution

Thanks.