



UNIVERSITY OF COLORADO  
AT DENVER AND HEALTH SCIENCES CENTER  
DOWNTOWN DENVER CAMPUS



MUSIC & ENTERTAINMENT INDUSTRY STUDIES

College of Arts & Media, University of Colorado at Denver and Health Sciences Center

# Methods for Sharing Stereo and Multichannel Recordings among Planetariums

Presented by:  
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## Methods for Sharing Stereo and Multichannel Recordings among Planetariums

Areas of concern:

- Acoustics
- Production
- Delivery
- Equipment
- Seating Arrangements

...plus a survey of over  
100 Planetariums  
worldwide.



*What is a planetarium?*

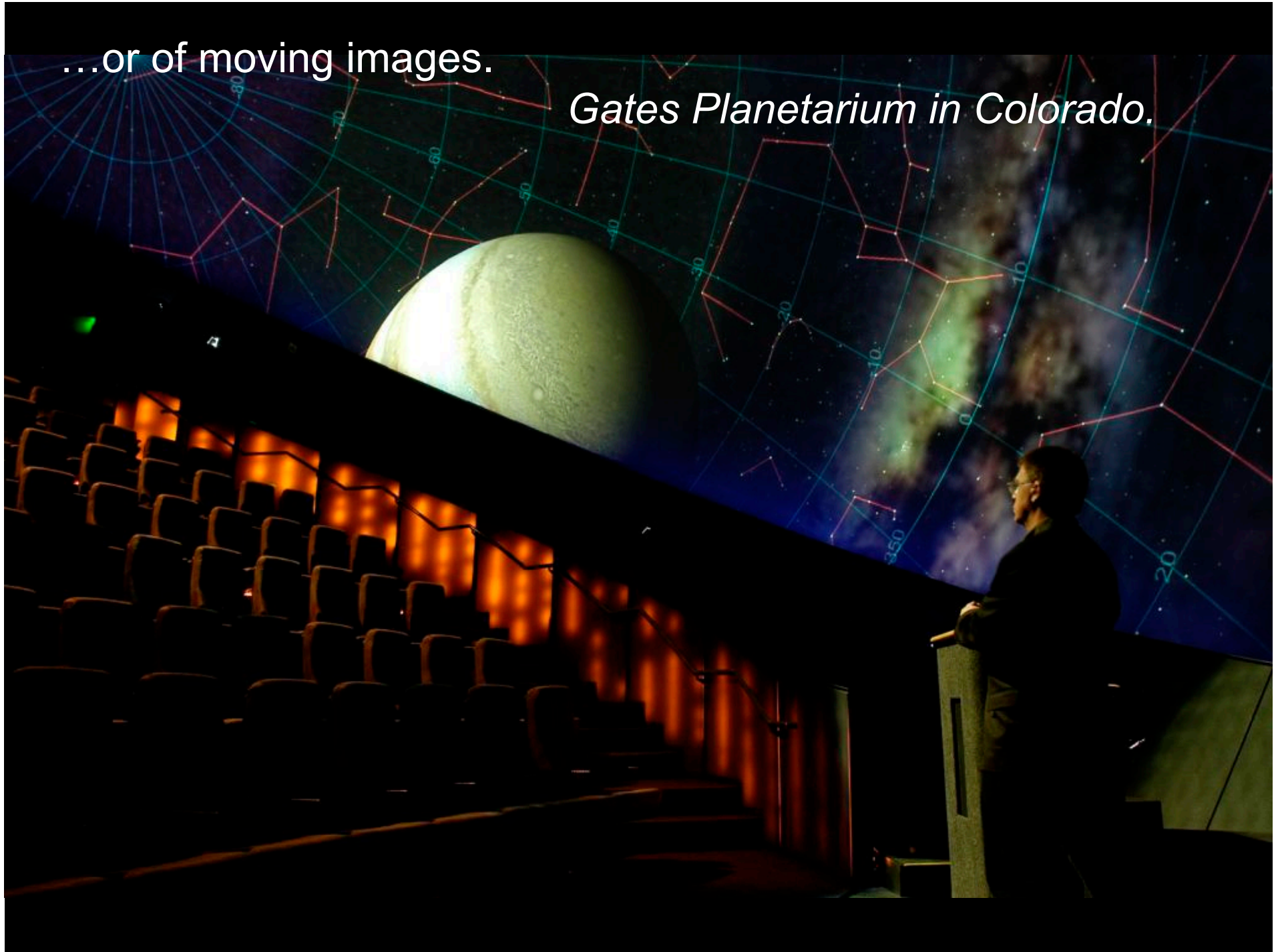
Planetariums (or planetaria) provide information to the general public about astronomy and the night sky. Planetariums have domed ceilings, and project images of stars...

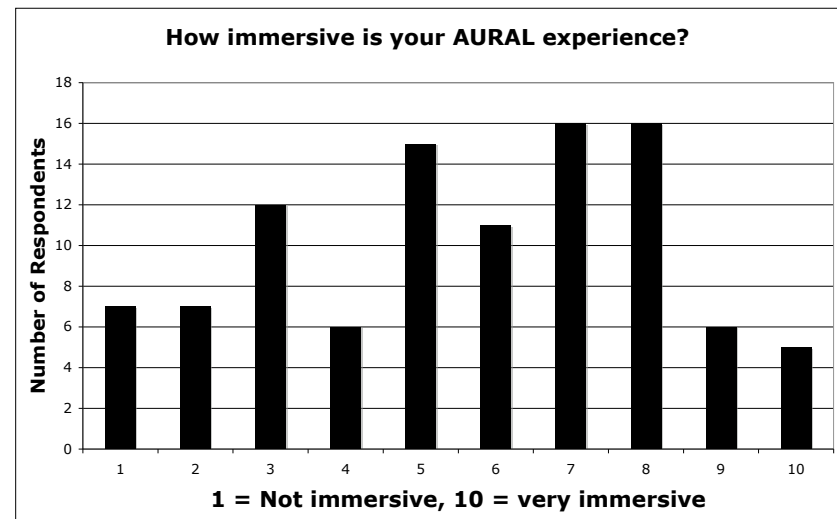
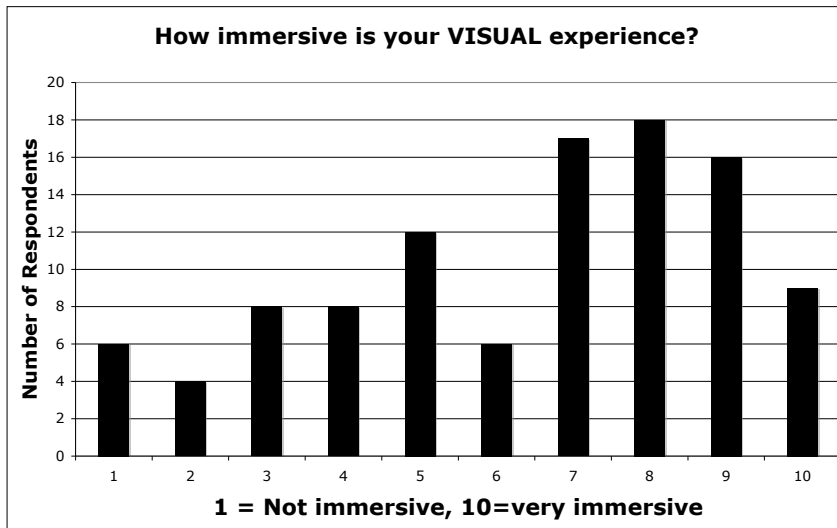
*Star ball at  
Seymour  
Planetarium in  
Massachusetts*



...or of moving images.

*Gates Planetarium in Colorado.*







## Audio in Planetariums

“Star Shows” with a single announcer

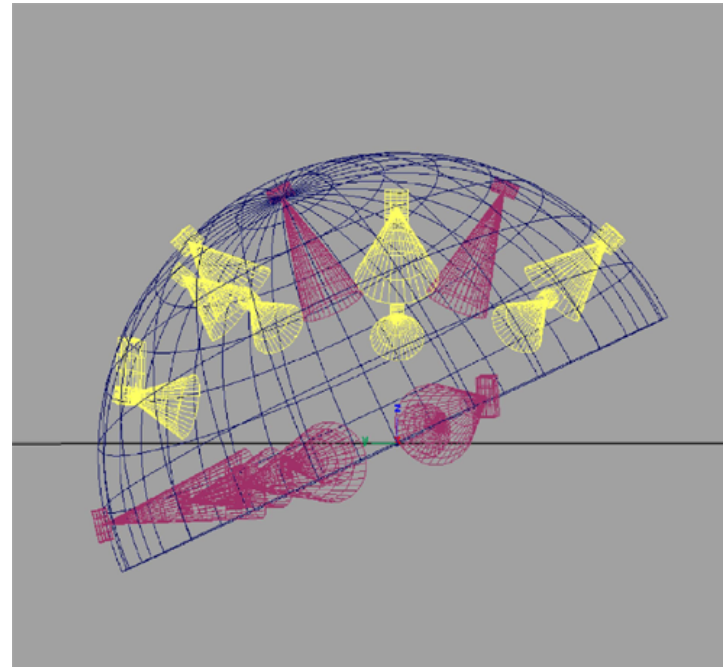
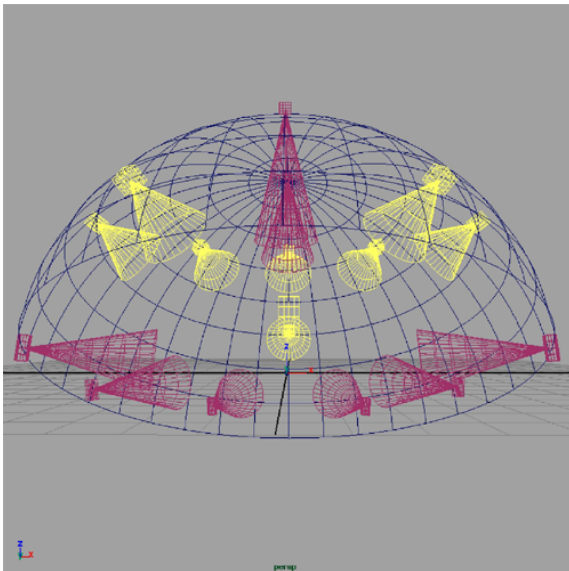
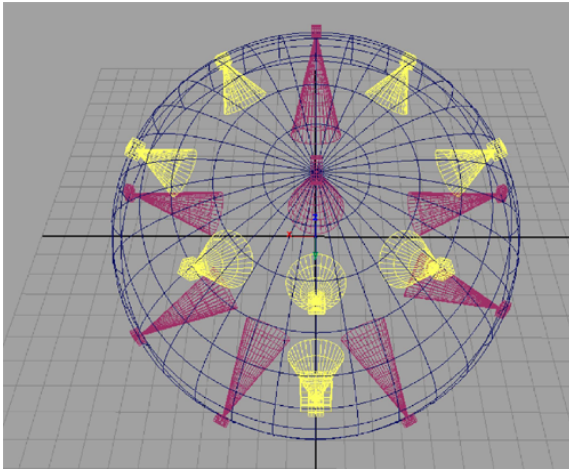
Prerecorded shows

Live music



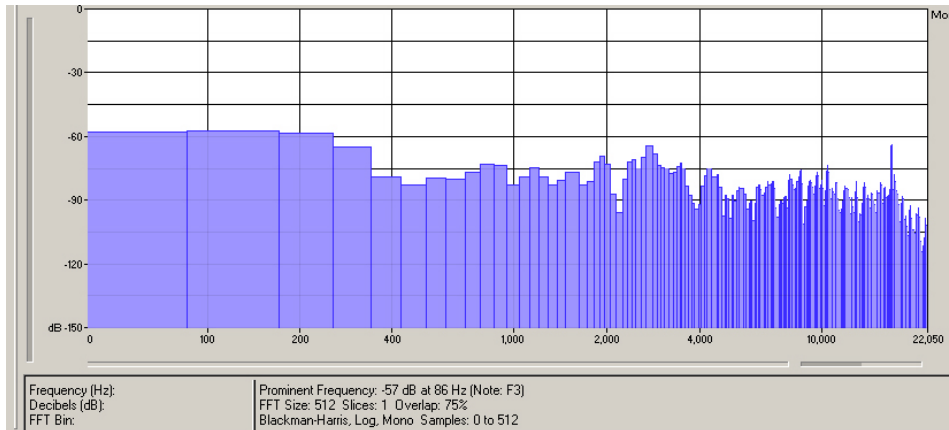
## Audio in Planetariums

**Prerecorded shows** are produced at one planetarium, and shared with others, *despite a lack of standardization of speaker placement and seating arrangements.*

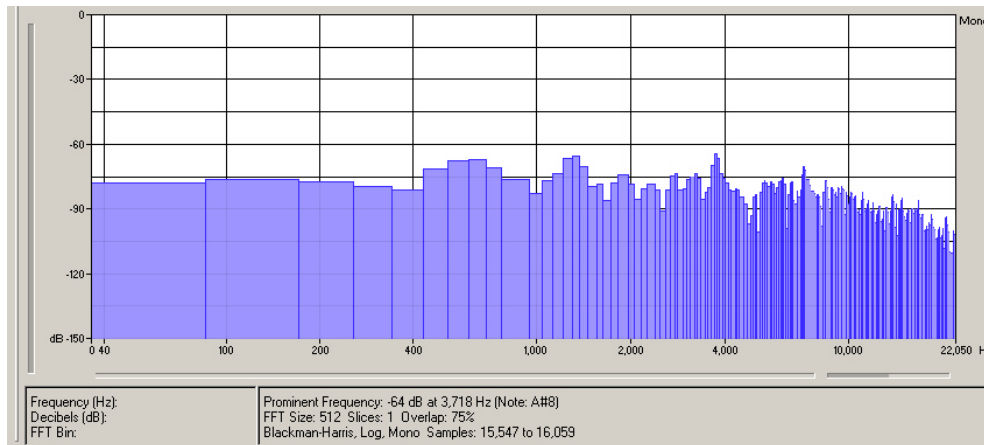


Gates Planetarium Speaker  
Arrangement: 16 loudspeakers





Back Speaker, mic position A



Back Speaker, mic position B

Gates' "Back Speaker"  
measured at two  
positions

Gates does not use any  
loudspeaker correction



## Survey Question #17. Do you use any loudspeaker correction or equalization?

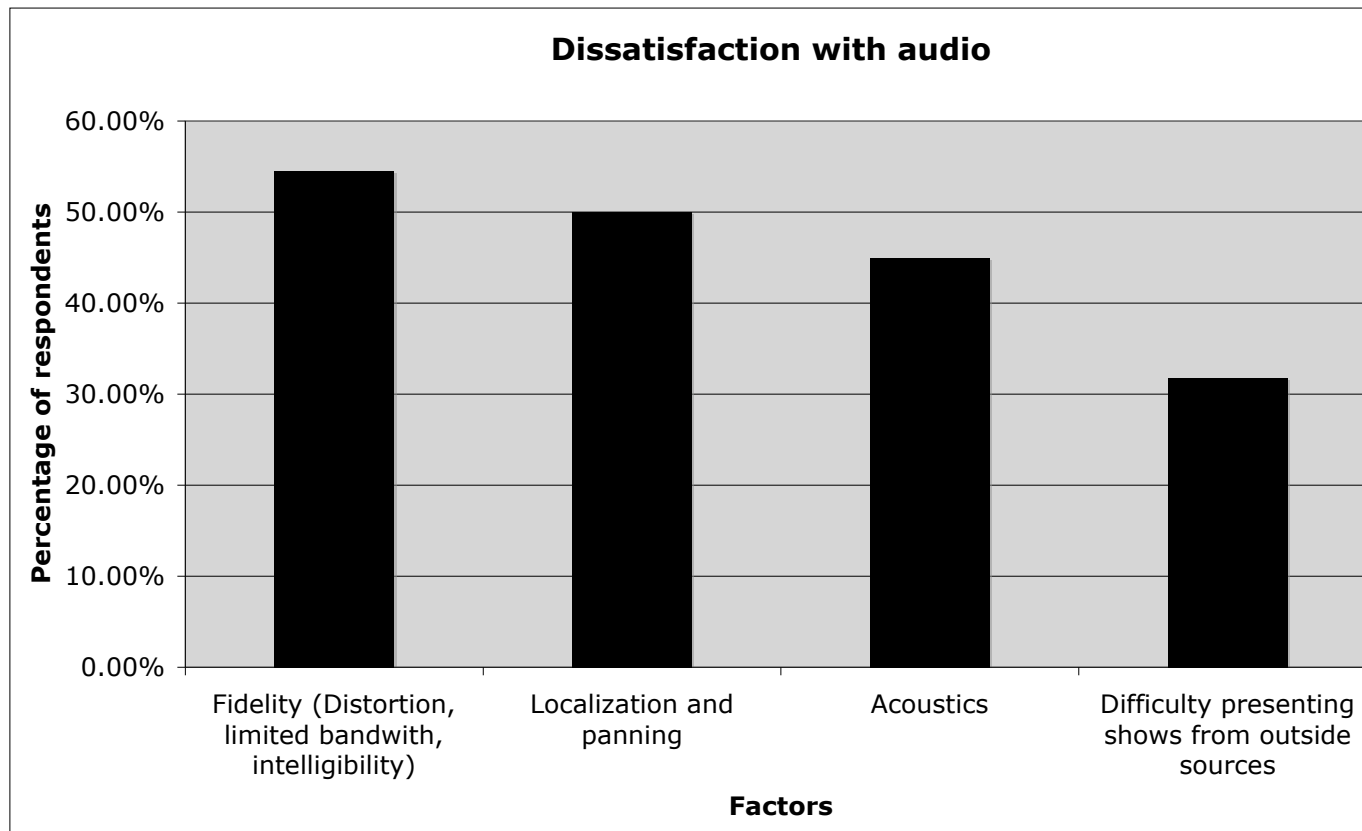
47.9% (45) answered yes.

52.1% (49) answered **no**.

*six survey respondents skipped this question*



*Not suprisingly... when asked, “Are you satisfied with the audio in your Planetarium?” Forty-six percent (46%) of the 103 surveyed are **not** satisfied with the audio in their venue.*



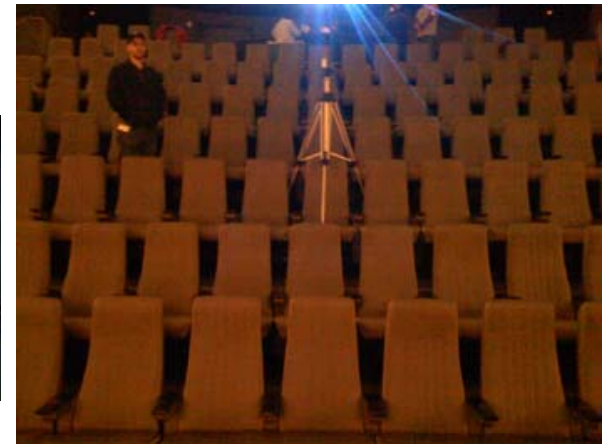
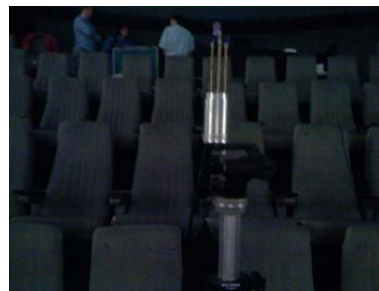
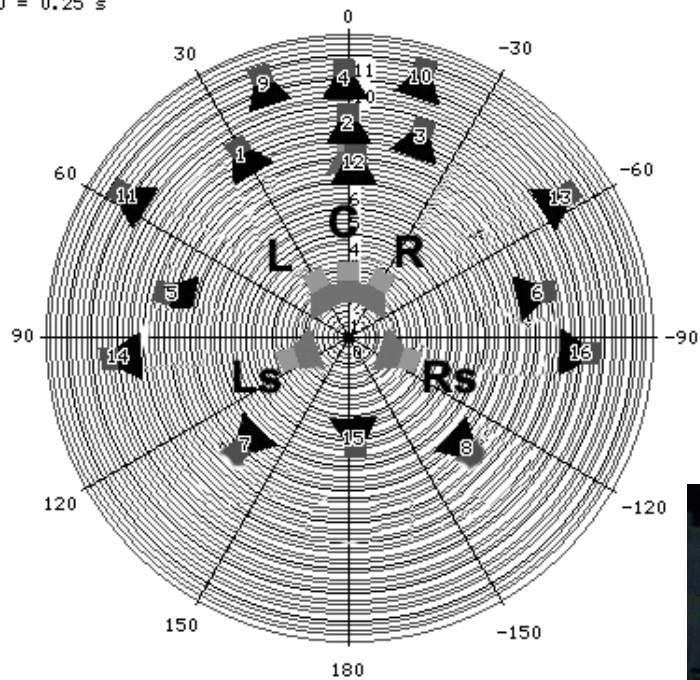


Based on these findings, **loudspeaker correction** should be considered the first step towards achieving the goal of transferability of content between planetariums.



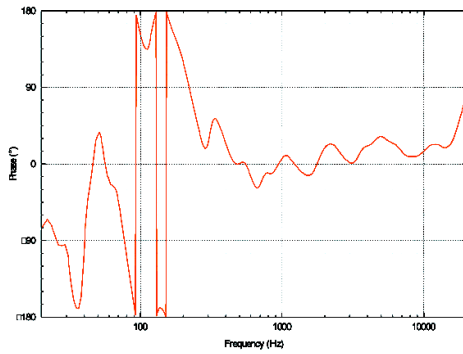
## Work with Trinnov Optimizer

RT60 = 0.25 s

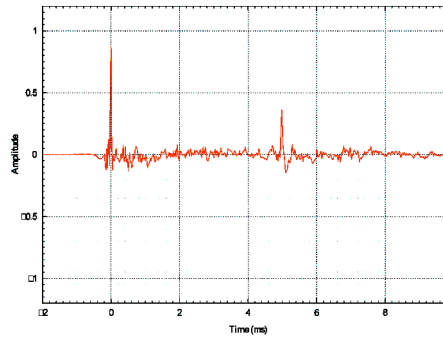




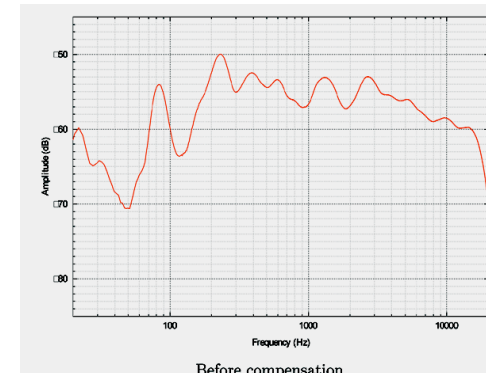
## Work with Trinnov Optimizer: phase, impulse and frequency response



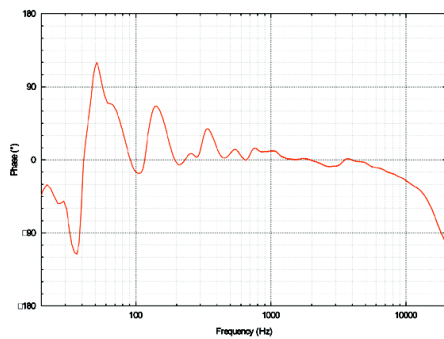
Before compensation



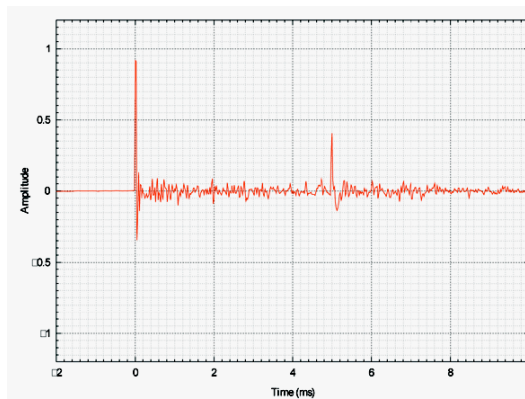
Before compensation



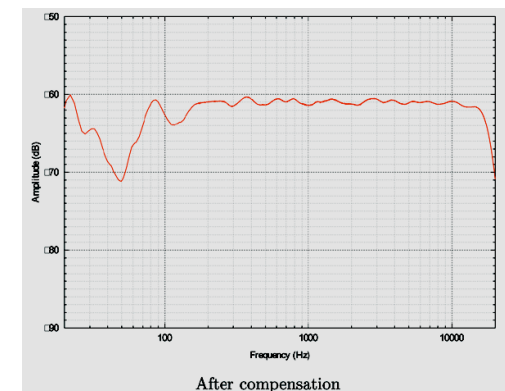
Before compensation



After compensation



After compensation



After compensation



## Informal Listening Tests:

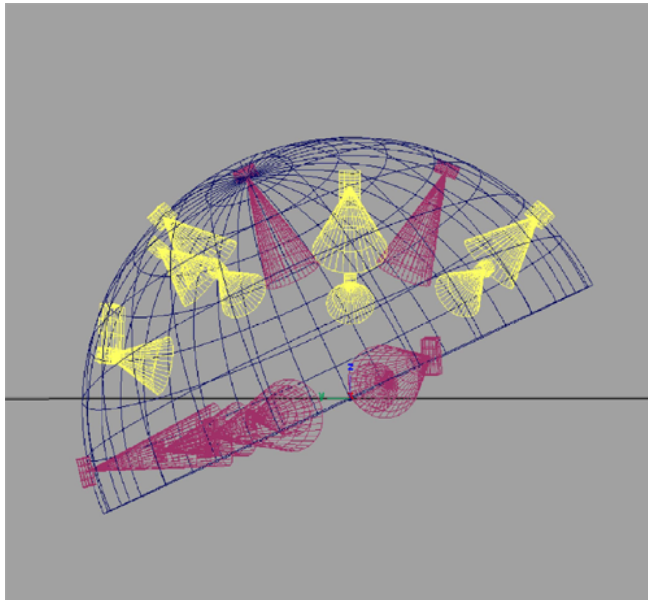
“Solo’ed” right channel reproduced from multiple loudspeakers.

**Without correction:** multiple locations perceived based on precedence effect, based on listener position.

**With correction:** single location perceived, independent of listener position.



## Gates Informal Listening Session



- No loudspeakers behind listeners,
- Viewers turn their heads and bodies to see images (impacting HRTF's),
- All speakers are above, except for forward speakers.





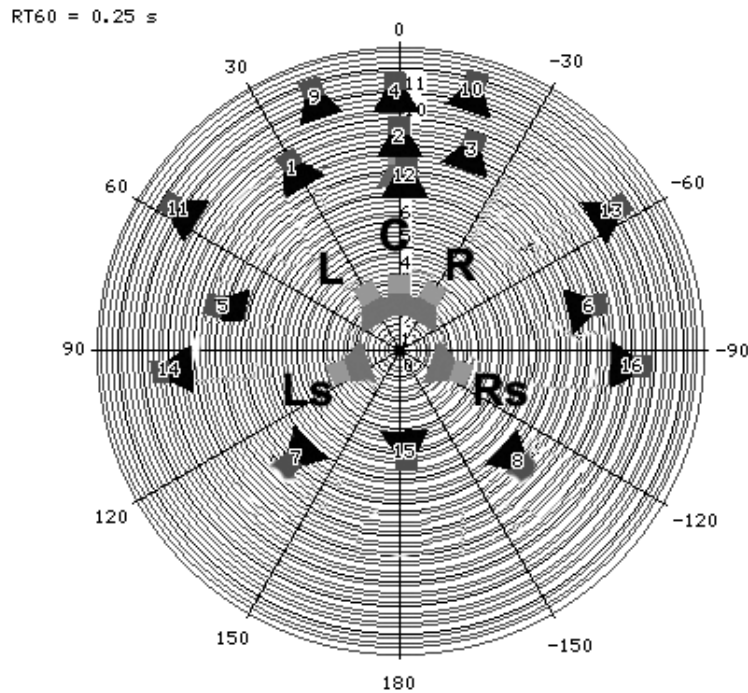
## Informal Listening Tests:

“Black Holes” and “Sonic Vision” shows at Chabot

**Without correction:** missing instruments, bass problems, indistinct narration, distortion (in layman’s terms)

**With correction:** “more compelling” narration, less dominant bass, increase of clarity in “missing” instruments.

*Formal listening tests to follow...*



## Production:

## Loudspeaker Remapping

“Traditional 5.1” is remapped to the 16 loudspeakers in the dome.

Spatialization can be done with Trinnov Optimizer, Lake Huron 3D system, and potentially Max/MSP (such as the Vector Based Amplitude Panner by Ville Pulkki)

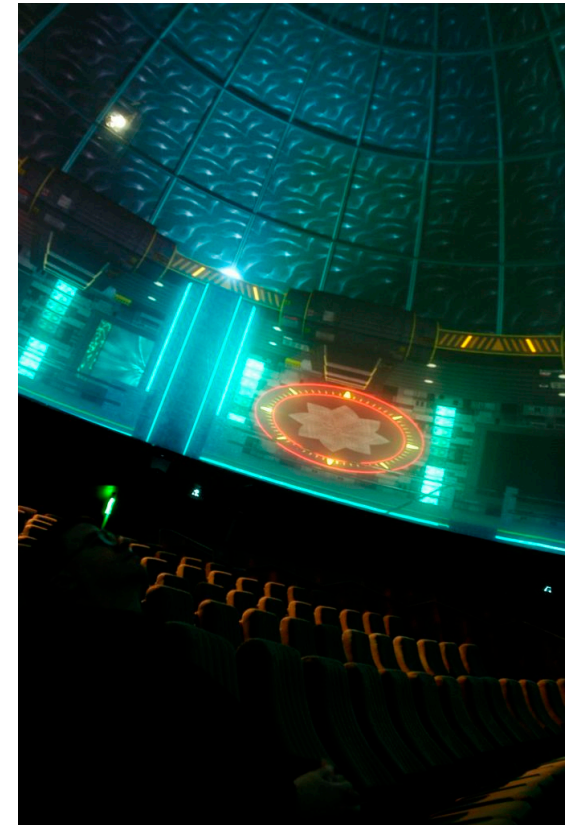
what to do with traditional center channel content...



...given different **Seating Arrangements**



Chabot: narration = “voice of God”



Gates: front narration channel



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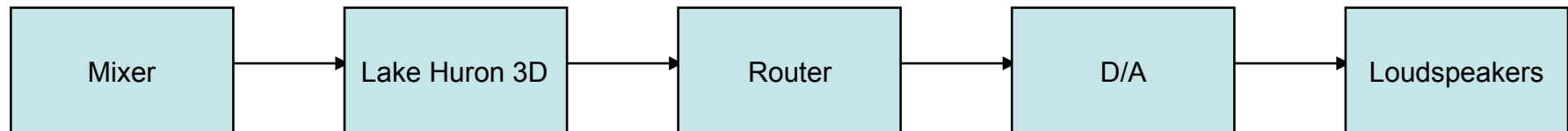
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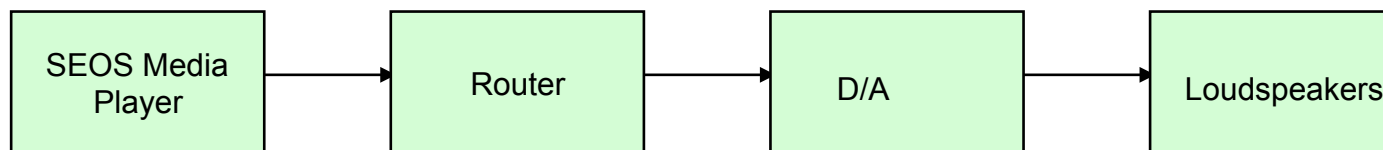
Live shows in  
“spatialized 5.1”



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## Live production



## Prerecorded shows



### Media:

- DVD-ROM
- DVD-Video
- DVD-Audio
- DTRS tapes
- Laser Disc
- VHS
- hard drives
- Betacam
- DAT
- CD

### Stems:

As in feature-length films, some planetariums replace the main dialog track with another language, so they need a mix separated into “stems”, with the dialog on one set of tracks (mono or stereo) and the music and effects on another (mono, stereo, cube, 5.1, etc.). Not only does this allow replacement of the dialog track, it allows the show to be remixed to create a more intelligible mix.

### Track Layout:

In addition to the “usual” 5.1 channels of Left, Right, Center, Left Surround, Right Surround, and LFE, **show producers sometimes use a “top” channel.**

Formats such as 6.1 and 7.1 are not as common, but are being used. A variety of channel orders were given in the survey, which could be another item to consider for standardization.



**There is a widespread sentiment among planetarium operators that some sort of standardization should be implemented to promote ease of sharing (92.5% in favor) and audio quality (91.1% in favor).**

## Recommendations:

- Standards: the IPS has **none** for audio.
- Loudspeaker correction for complex, domed systems.
- Standards for speaker placement
- Creating “audio fingerprints” for venues, and “mastering houses”
- Experiments with height recording, B-Format, amplitude-based panning...?



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*Thank you*

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