

Advancements in  
Stereoscopic 3D LCoS  
Projection Systems  
For Digital Cinema

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Sony Electronics, Inc

42,000

lumens

...of Powerpoint

## Today's Topics

SPATIAL  
Media

- **The Basics**
  - Digital Cinema 101
  - Overview of the Projection System
  - Mercado Test theater
- **SXRD (LCoS) Projection System**
  - Understanding 4K
  - LCoS and Optical system
  - Market acceptance
- **Configuration for 3D**
  - Single projector (for smaller screens)
  - Dual projector (for larger screens)

Sony Digital Cinema 4K

## Thank You!!!

SPATIAL  
Media

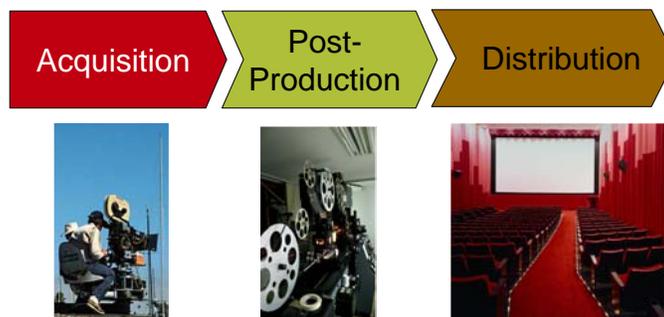
- **Keith Graham**     **Alan Bourke**     SMPTE
- **Geoff Walker**     SID
- **Dan Huerta**     AMC
- **Masaki Nakayama, Marie Nixon**     Sony Pictures
- **Tim Mundorff**     Sony
- **Dale Resalsingh, Kyle Lindgren, Vanessa Duran**     AMC

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## The Basics

## Digital Cinema Semantics

*Three phases of content creation process*



## Digital Cinema Semantics

*Three phases of content creation process*



## Digital Projection booth



## Motivation for the Digital Conversion

### *Previous Process:*

- **35mm film can distribution**
  - Expensive (\$1,200 per screen)
  - Slow
  - Inflexible
  - Manual process for assembling shows
- Studios spend **\$2 - \$3 billion per year** on release prints



## Motivation for the Digital Conversion

### *Digital Cinema Process:*

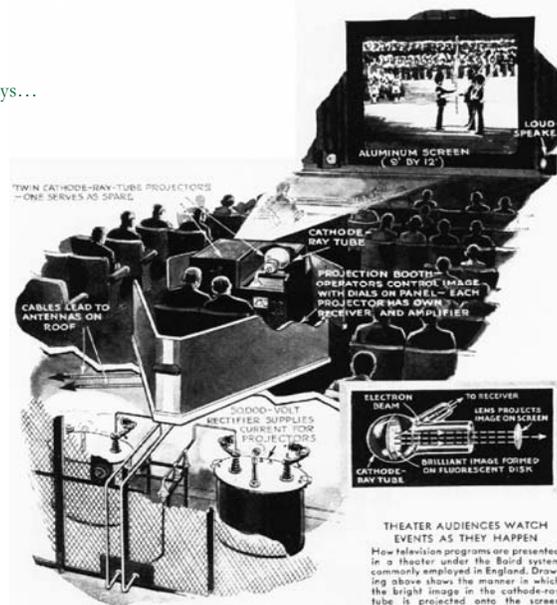
- **File distribution**
  - Economical (< \$250)
  - Fast: Satellite or transportable drive
- **Excellent picture quality**
  - High resolution
  - Controlled color gamut
  - Security
  - Consistency



## Why Now?

## Television Shown in Theaters

The really early days...



## History

**1999**

Disney / Texas Instruments /  
Technicolor

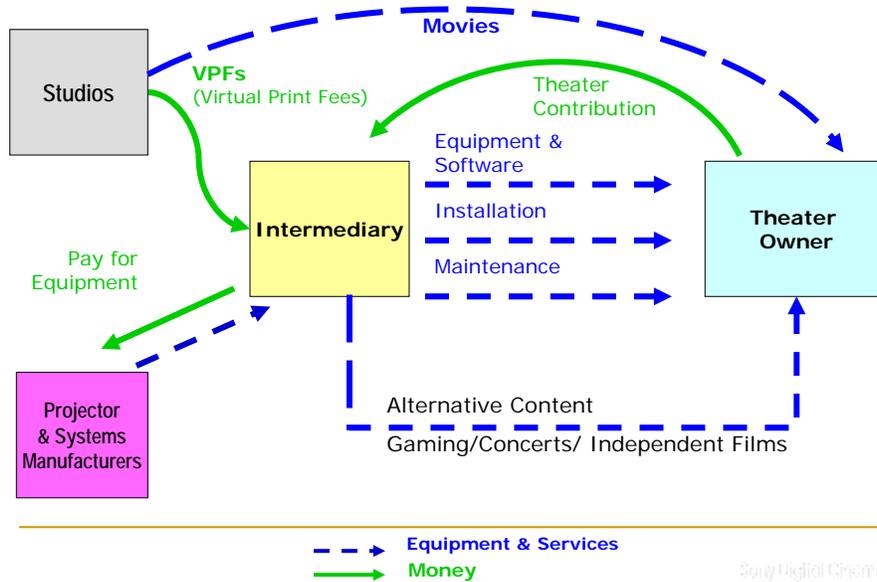
Science Fair Projects  
(about 40 screens)



## Early findings:

- Technology worked pretty well...
- But, two obstacles became clear
- There was no agreement on standards
  - Studios
  - ASC (American Society of Cinematographers)
  - Manufacturers
  - Exhibitors
- Business model was needed
  - D-Cinema mostly helped Studios
    - Savings in Release prints (up to \$3 billion/year!)
    - Easier to support day and date release worldwide
  - So why should theaters spend the money?
    - 35mm projectors "are working fine"

## Digital Cinema Business Model



## Typical Business terms

- **VPF concept**
  - VPF 7 to 10 year deal
  - Studio pays one VPF per screen per movie
    - 12-15 titles per screen per year
  - Price Structure
    - VPF level is \$800 to \$1,000/movie
    - Studio pays DCP transport \$250
- **Exhibitor pays for...**
  - Portion of equipment
  - Maintenance
  - Software

## Specifications and Standards

SMPT  
2008

- **SMPTE DC-28 Formed (2000)**

- Steering
- Mastering
- Audio
- Compression
- Encryption
- Packaging
- Transport
- Theater Systems

[www.smpte.org](http://www.smpte.org)

- **Digital Cinema Initiative- DCI (2002)**

- Disney
- Fox
- MGM
- Paramount
- Sony Pictures
- Universal
- Warner Bros.

[www.dcimovies.com](http://www.dcimovies.com)

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## What is DCI?

SMPT  
2008

- Digital Cinema Initiatives, LLC (DCI)
- Founded March, 2002
- Joint venture of
  - Disney
  - Fox
  - Paramount
  - Sony Pictures Entertainment
  - Universal
  - Warner Bros. Studios
- Primary purpose:
  - *Establish and document voluntary specifications for an open architecture for digital cinema that ensures a uniform and high level of technical performance, reliability and quality control*
- Published DCI System Specification - July 2005
- Certification Program launched in 2008
  - Re-launched in 2009
  - First Full system received compliance in February 2011



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## During the Ice Age

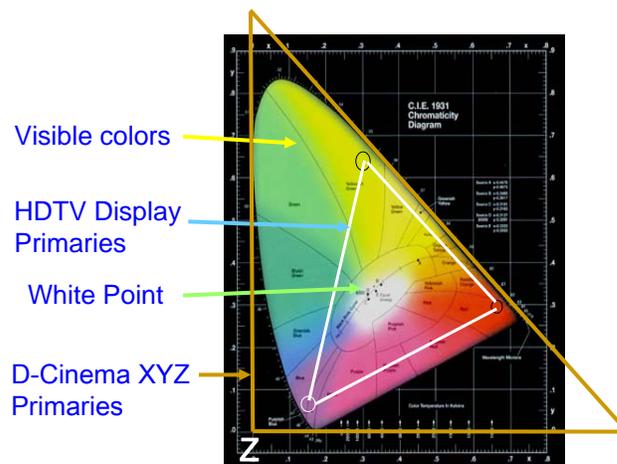


- Decisions were made
- Testing of 2K/4K Layered compression and JPEG2000
- Finalized the audio - including 96K
- The spec publishing adventure
- StEM (Standard Test Evaluation Material)
- Some early companies withdraw, new companies enter



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## Wide color gamut: XYZ Color space



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## DCDM numbers game

(Digital Cinema Distribution Master)

- V6.0      4928 x 2048
- V5.5      3680 x 1536
- V2.5      2464 x 1024
- Others:    1920 x 1080; 3840 x 2160; 4096 x 2048

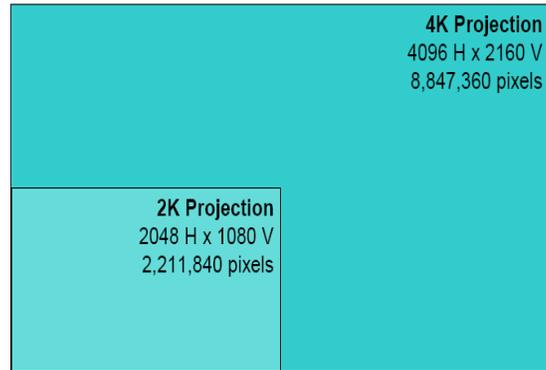
Today it's **4096 x 2160** (4K)  
or **2048 x 1080** (2K)

## Why 4K?

- Optical Considerations
  - Visual Acuity
- Theater viewing environment

## 4K has four times the resolution of 2K

4K  
Resolution



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## Resolution vs. Sharpness

4K  
Resolution

Higher Resolution  
(Twice as many pixels)

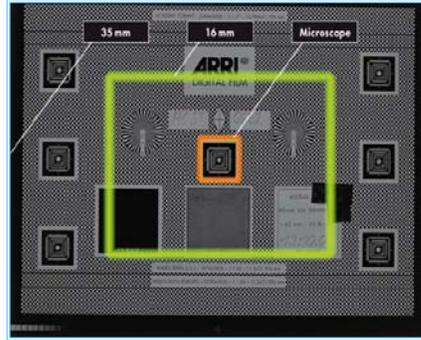
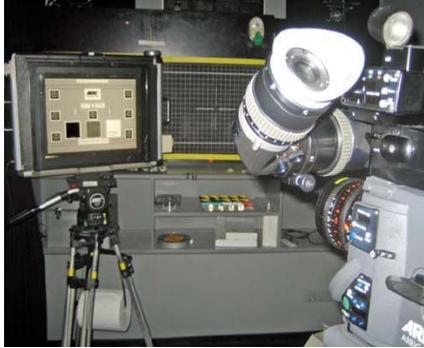


Higher Sharpness  
(Contrast in course details)

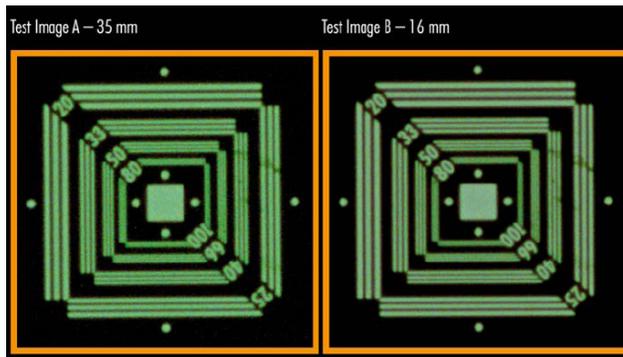


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## Investigation of film resolution



## Calculating film resolution



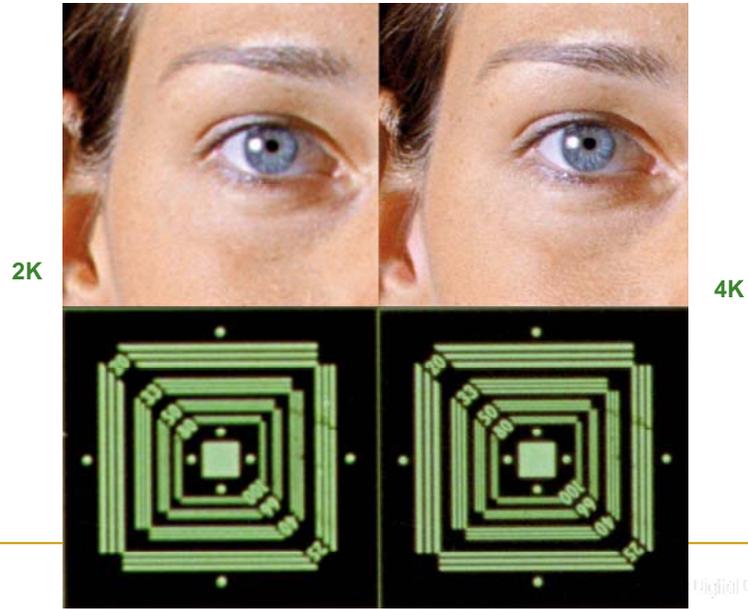
Smallest Resolvable  
Detail = 0.006mm

$$\begin{aligned} &35\text{mm} \\ 25.576\text{mm} / 0.006\text{mm} &= \\ &4096 \end{aligned}$$

$$\begin{aligned} &16\text{mm} \\ 12.35\text{mm} / 0.006\text{mm} &= \\ &2048 \end{aligned}$$

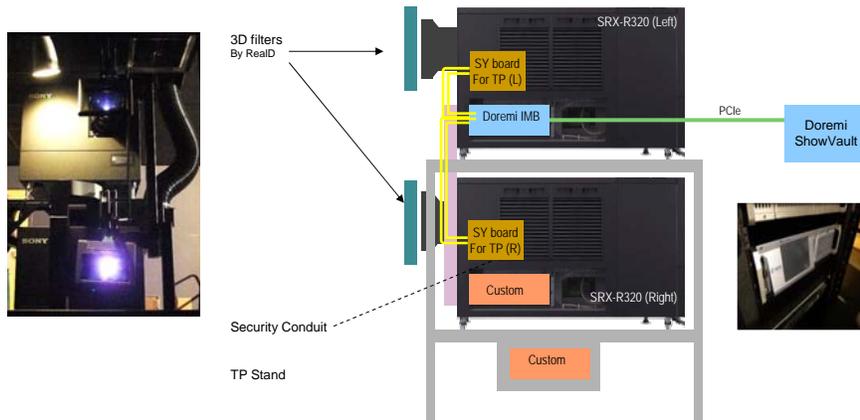
## Visible difference in DI Process

4K  
Master



## Sony Double Stack System overview

4K  
Master



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## Mercado AMC features...

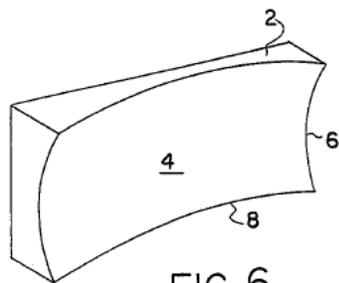


FIG. 6

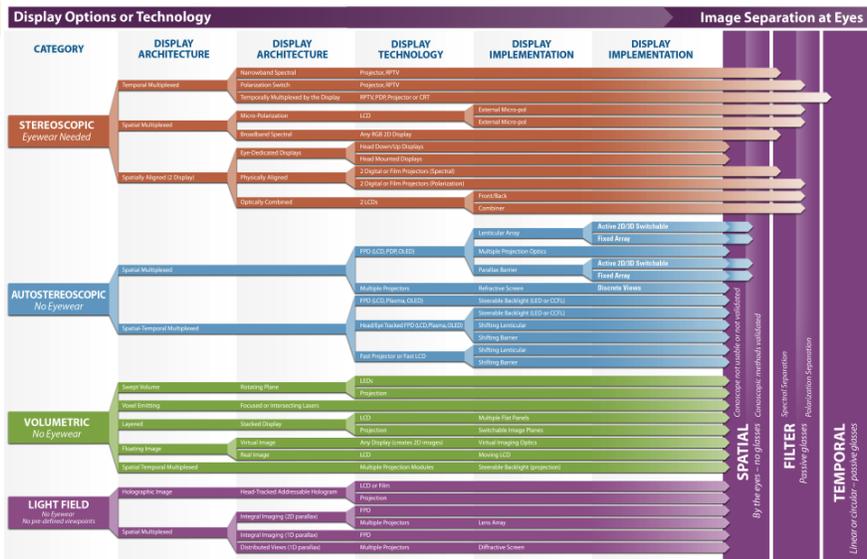
- Taurus Screen
- Patent 4,750,808
  - June 1988
  - Gerald Nash, Glenn Berggren, Robert Wetmore, Donald Steward



A break for questions?

Stereoscopic 3D Projection

# 3D Display Technology Family Tree



3D @ Home Consortium

Sony Digital Chemicals

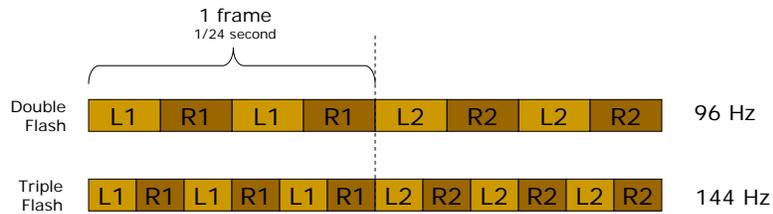
# Single Projector

Sony Digital Chemicals

## Single Projector System: Display rate



- This is an issue on any single-projector system
  - Dual Chromatic, Polarized or sequential frame
- 24 fps left and right are interleaved and flashed several times



- Motion can be confusing at lower flash rates
  - Triple flash provides better motion than double

## Concept of “3D on 4K” projector

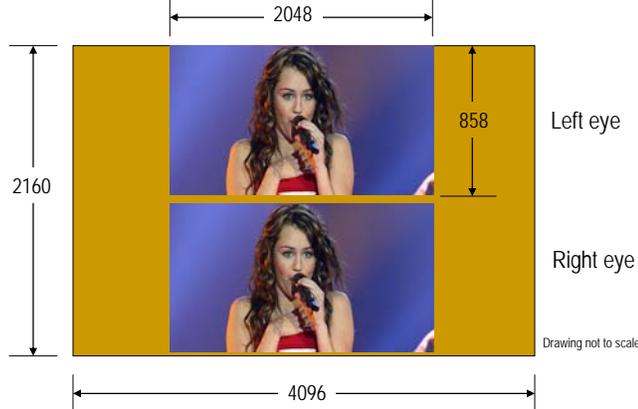


- Images are stretched horizontally (anamorphic)
- This method preserves full screen brightness (no unused light from SXRD panel)



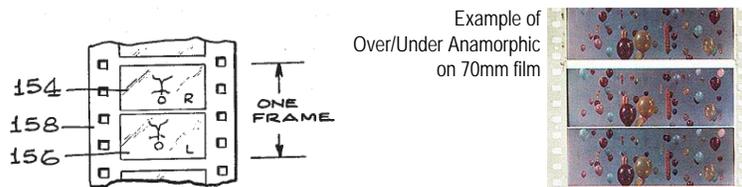
## Concept

- Stereoscopic 3D Movies are only available in 2K (not 4K) according to DCI and SMPTE specifications
- Therefore two images (left eye + right eye) can easily fit within 4K image

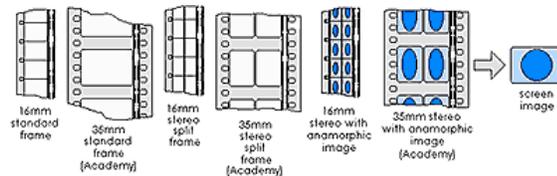


Note: Cinemascope is 2048 x 858 container, 1:2.39 aspect ratio

## Same idea was used on film in 1970's – 1980's



From Aug 1984 Stereovision Patent (Condon) No. 4,464,028

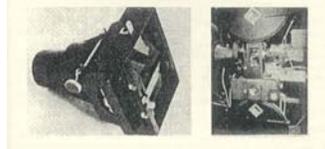


Anamorphic images could either be top/bottom or side/side

## 1980's systems for 3D film



Dimension 3000 Projection Mirror box  
(circa 1981)

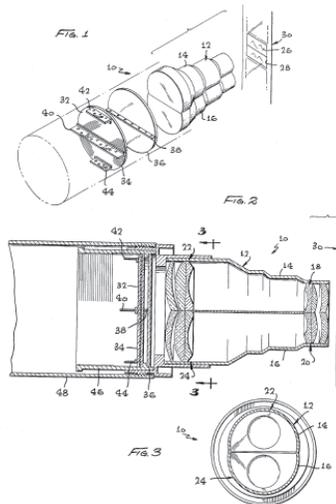


Marks 3-Depix Polarator prismatic device  
(Used for "Friday the Thirteenth III" 1982)

## 1980's systems for 3D film

Dual anamorphic  
Projection lens

Condon patent 4,235,503

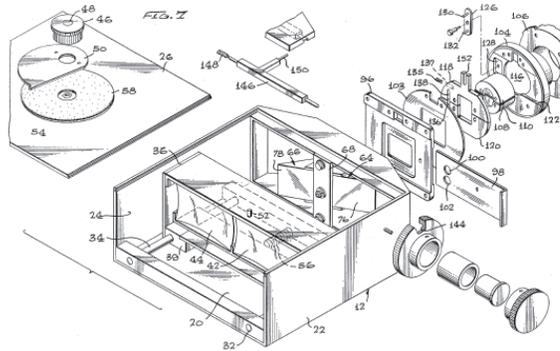


## 1980's systems for 3D film



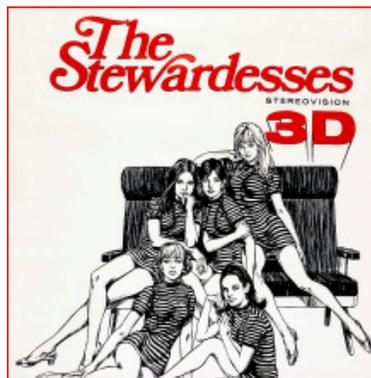
Stereovision 3D projection beam splitter (1982)

Chris Condon Patent No. 4,464,028 (August 1984)



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## Highest Grossing 3D film (before Avatar)



1972

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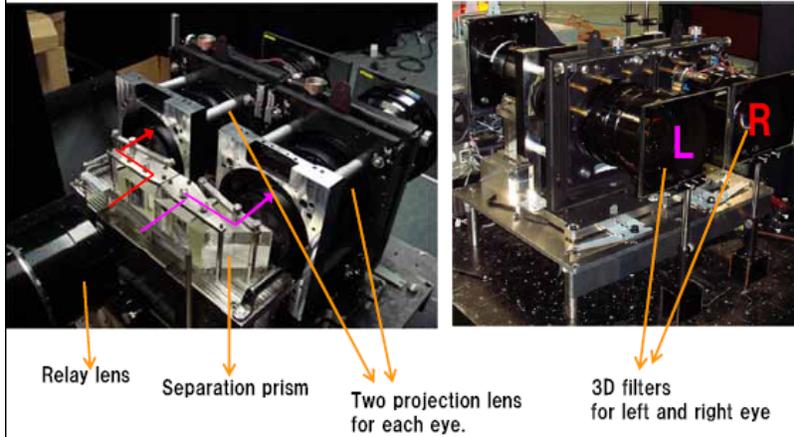
## Early tests



Steve Schklair with "Stereovision" Beam Splitter



# Prototype Dual-lens system

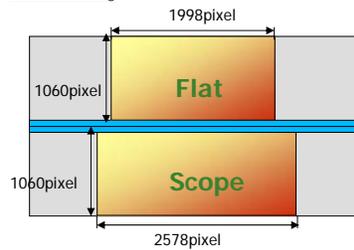


## Features

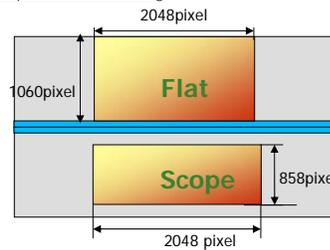
### Throw ratio & zoom range

To keep L/R image convergence, electrical zoom function is applied with R220 3D mode for scope and flat operation. Following image shows how Scope and Flat images are mapped in 4096x2160 device which is differ with masking system.

#### Side Masking

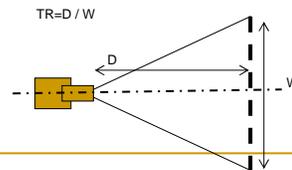


#### Top-Bottom Masking

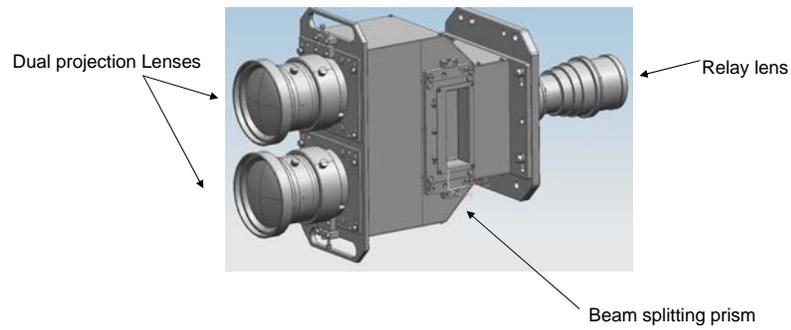


Because of these, throw ratio coverage of A002 and A003 are different with masking type.

Throw ratio	Side masking	A002 1.1 - 1.9 A003 1.9 - 4.0
	Top masking	A002 1.4 - 2.466 A003 2.466 - 5.0



## Mechanical design of dual lens 3D system



## Dual Stack System

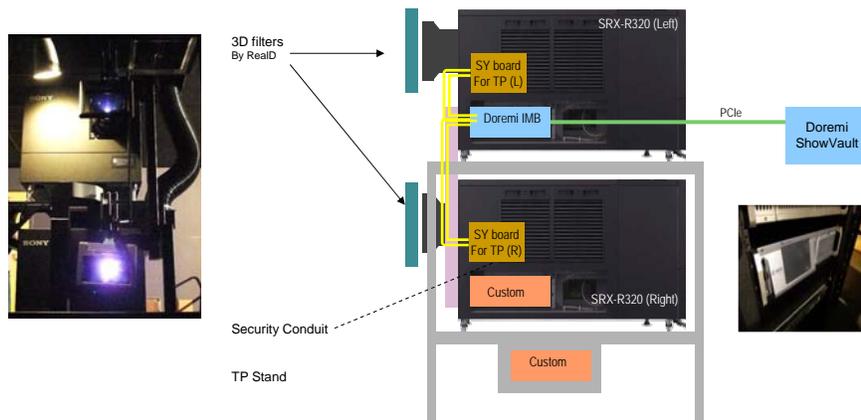
## Sony Double Stack System Overview



- The system uses 2 Sony SRX-R320 Projectors
  - One each dedicated to LE and RE images
  - Standard units with specific software for double stack
- Doremi “Integrated Media Block” (IMB)
  - Standard Doremi product, but in new chassis to accommodate
    - Signal conversion to Sony LVDS
    - Power supply, and other interfaces (Audio, GPIO)
- Uses RealD fixed Color-Select polarizing filters
  - Same as Sony single-projector 3D system
- DCI Compliant - 2K 3D, 2K 2D and 4K 2D (with lens adjustment)
- FIPS-140 Compliant
- Being tested under DCI Compliance Test Plan (CTP)
  - As “Integrated Projector/Media Block”

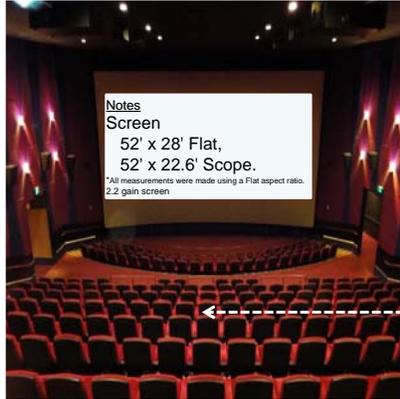
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## Sony Double Stack System overview



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## Specification



	Side Masking	Top / Bottom Masked
	FLAT	FLAT
3D 4.5ft.L	95.1	92.1
2D 14ft.L	100.5	97.3

### Condition

- Lamp power 100%
- Screen Gain 2.2 (Silver)
- No port glass
- RealD Filter & Glasses

## Discriminator filters

- 3D Filters are the same as on Sony single projector 3D system
  - Fixed, for LE and RE
  - No Z-screen needed
- RealD GhostBusting are fully supported by Doremi Server
- Uses standard RealD Circularly polarized eyewear



## Content Security

SRX-R320  
Digital Cinema System

- Basically, the same as on single projector / integrated media block system
- SPB1 (Secure Processing Block level 1) is in Doremi IMB
- SPB2 boundary is SRX-320 projectors
  - Plus FIPS Security Cable Duct between the top and bottom projectors
- Both projectors have appropriate tamper detection function
  - according to FIPS and DCI specs
- FIPS Lab (InfoGard) has reviewed and tested FIPS Security Cable Duct (Security Conduit)

*FIPS 140-2 Physical Security Test Report  
SRX-R320 Digital Cinema System*

### Summary

The physical security characteristics of the Sony 3D Dual Stack Projector System cable conduit are sufficient to meet the current DCI Physical Security requirements, based on the test results described in this document.

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4/29/2010

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## Looking Forward...

SRX-R320  
Digital Cinema System

Sony Digital Cinema 

## High Frame Rate Considerations

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- **24 fps Cinema**
  - Legacy from early days of sound
  - Understood to be lacking temporal fidelity
  - However, widely accepted in Hollywood on creative merit
- **48 – 60 fps**
  - Currently driven by S3D
- **Beyond 60 fps**
  - 72, 120, 240, 300
  - Suggested for downward compatibility
  - Selectable on scene-by-scene basis?

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## James Cameron 'Fully Intends' to Make 'Avatar 2 and 3' at Higher Frame Rates

6:18 PM 3/30/2011 by Carolyn Giardina



James Cameron

UPDATED: He says at CinemaCon that he is looking seriously at 48 and 60 frames per second.

LAS VEGAS -- Championing the digital 3D movie revolution at a joint appearance at the CinemaCon exhibitors convention Wednesday, the high-powered trio of James Cameron, Jeffrey Katzenberg and George

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Media

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Now in production...



Peter Jackson



Sony Digital Cinema 4K

Thanks!

Pete Ludé  
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Sony Electronics (USA)

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Twitter [@Lude3D](https://twitter.com/Lude3D)  
3D FunFact of the Day

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