

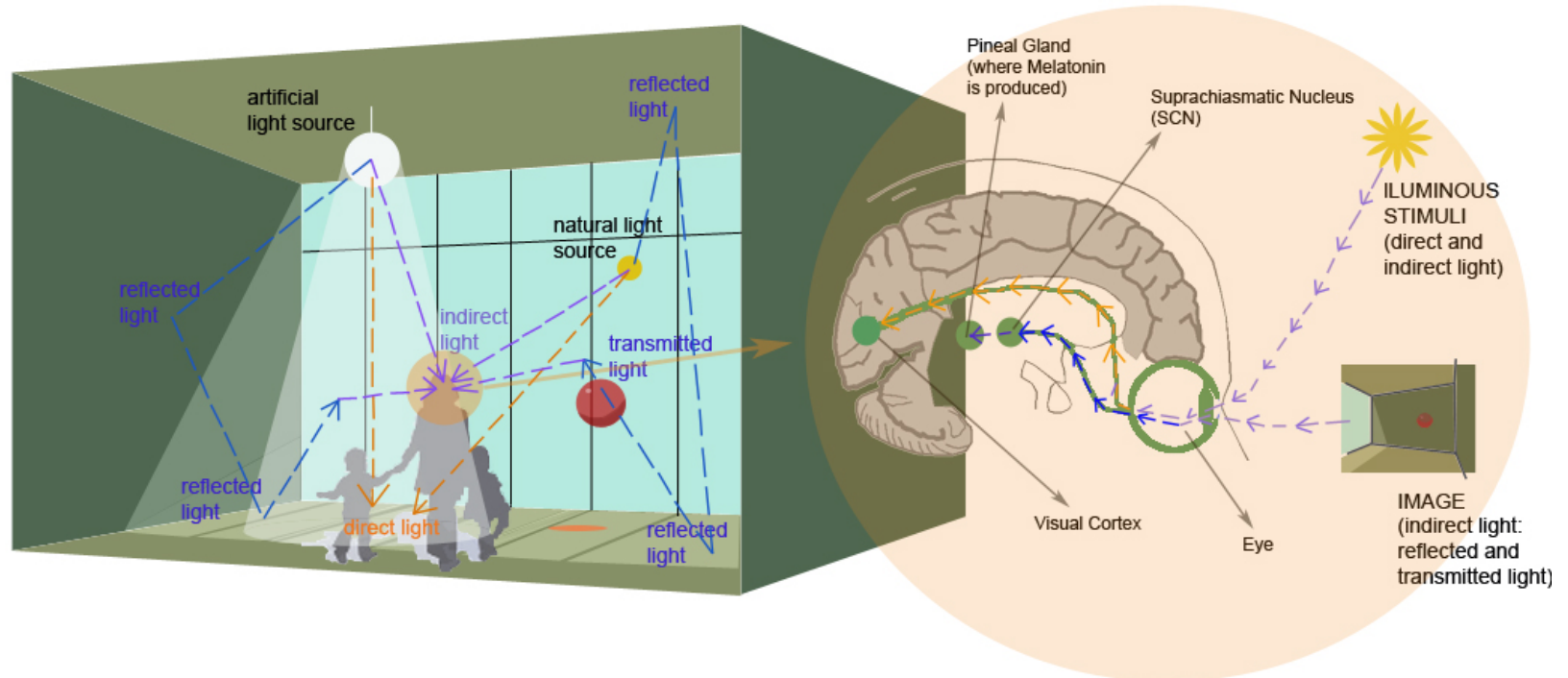
# What is the Circadian System?

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- Endogenous **pacemaker**
- It is entrained (synchronized) by **the 24-hour day/night cycle**; in other words: the alternation of light and darkness conditions, which describes the circadian contrast
- The **EYE** is the organ that transduces the information coded in light characteristics to the endogenous pacemaker (Suprachiasmatic Nucleus)

# Circadian and Visual system

- Intensity of Light
- Spectral characteristics
- WATTS



# Factors in Resetting the Circadian System

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## Light Characteristics

**INTENSITY:** Bright light resets the clock (however bright light evenly distributed in a room is not the solution, because we need to save energy.)

**TIMING:** light directed to the eye is only effective when applied at a specific time.

**DURATION:** Bright light has to be applied during a certain amount of time depending on the intensity.

**WAVELENGTH:** It is the use of white and/or blue light that has an effect in melatonin suppression. Still, the most effective spectrum is under study, but it is close to 460nm-480nm.

**SPATIAL DISTRIBUTION:** the angle with which light is projected towards the eye is very important. The more the retina is covered by the light, the better.

# What is an Illumination System?

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**Light sources**

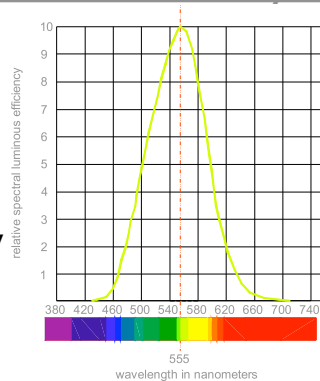
**Reflective and/or absorptive surfaces**

The interaction of these two and the light that is the product is the one the reaches the eye.



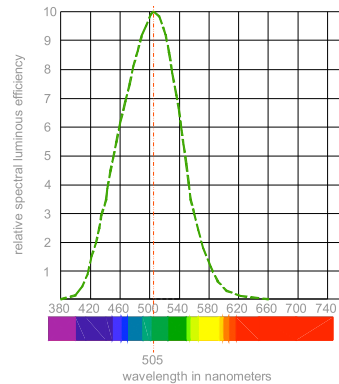
# Photopic, Scotopic and Circadian Sensitivity Curve

photopic → high light intensity



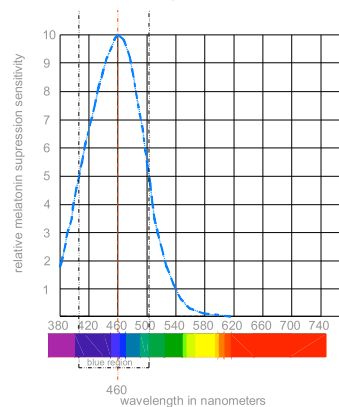
$V(\lambda)$  – CIE standard observer

scotopic → low light intensity



$V'(\lambda)$  – CIE standard observer

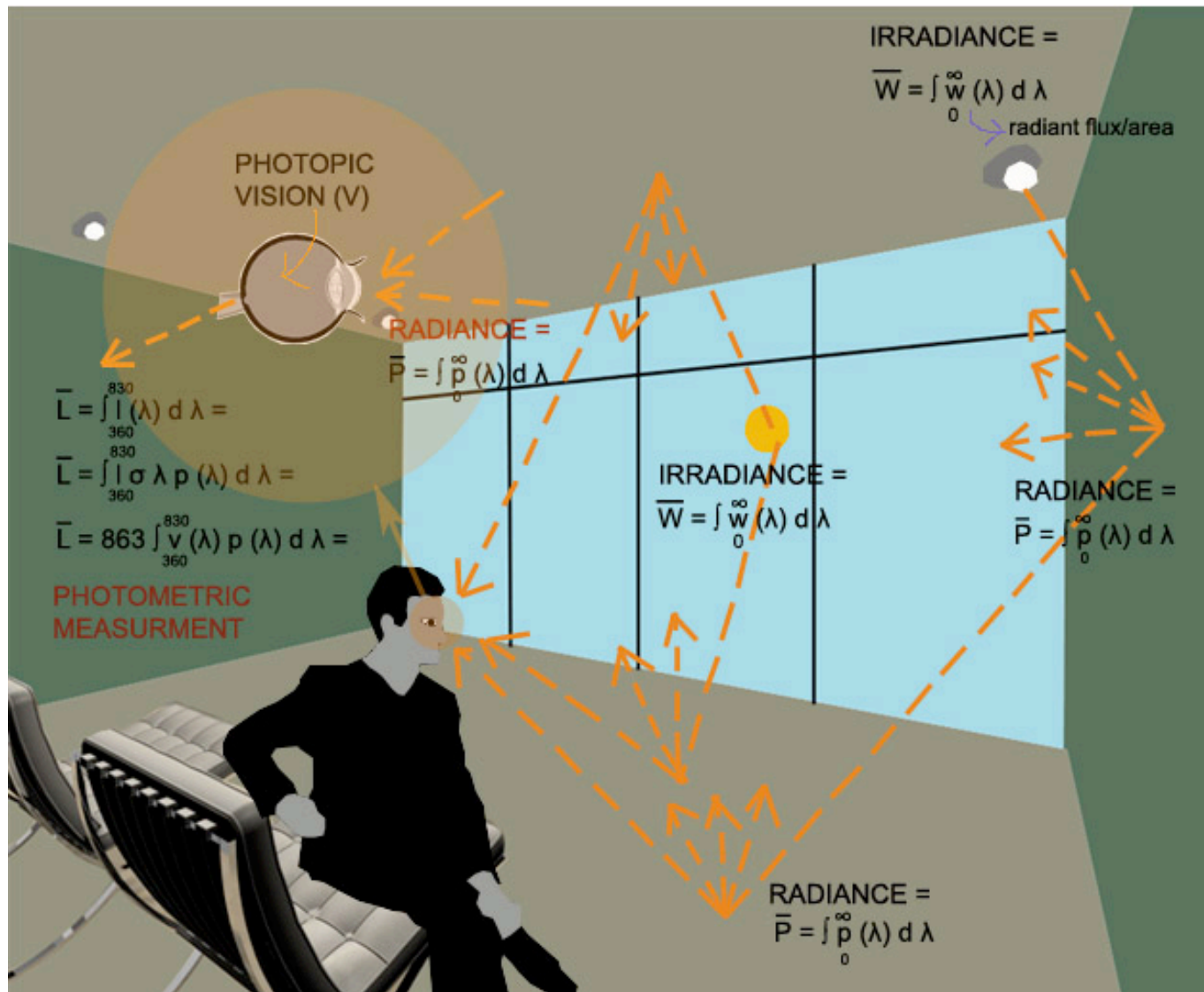
circadian →



Melatonin suppression sensitivity

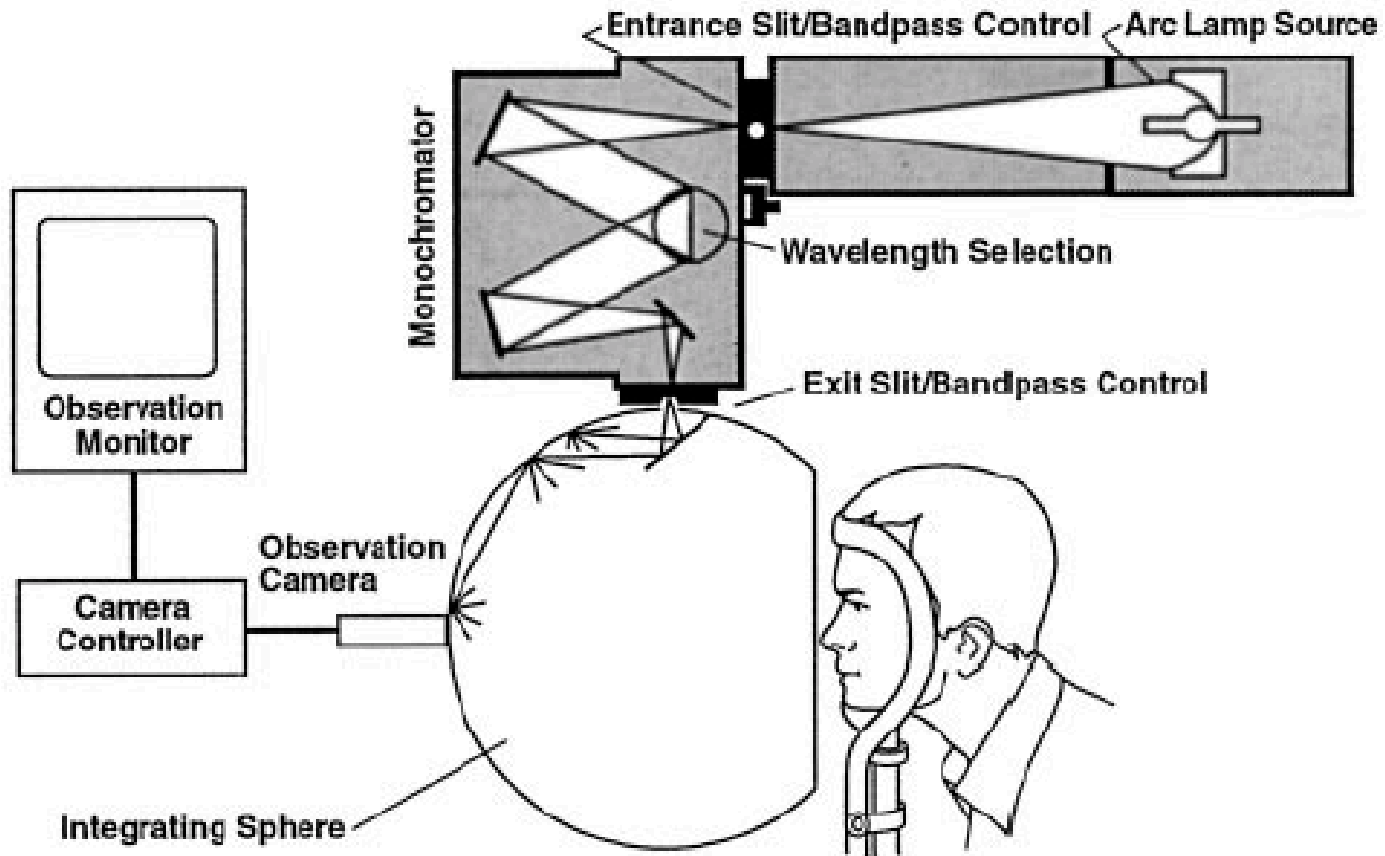
Neurology studies (Brainard, 2001)

# Light Interior Distribution



## Brainard's Experiment

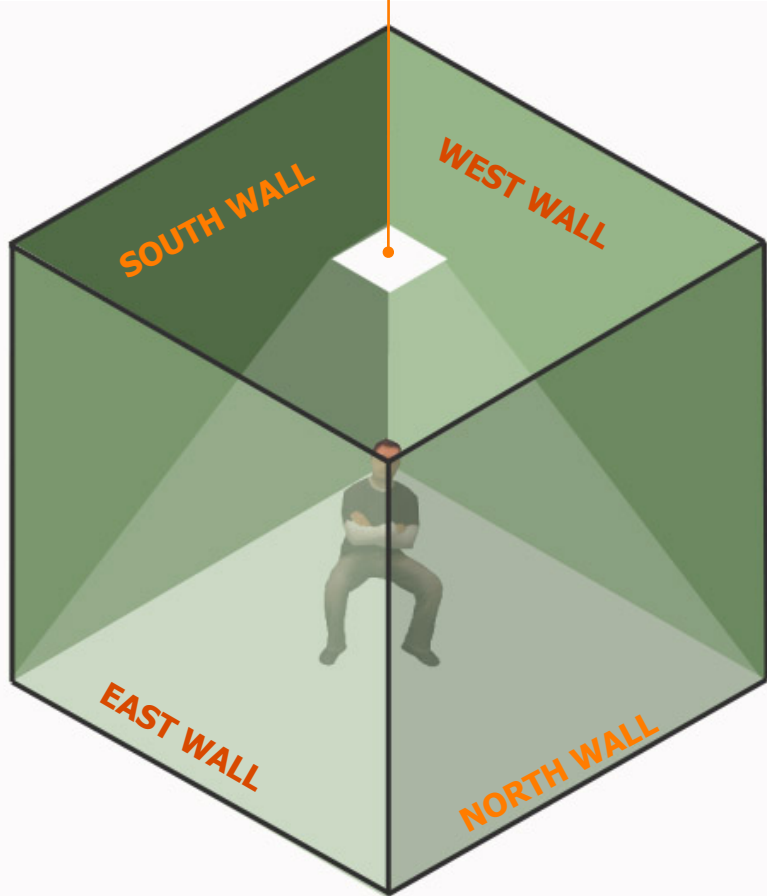
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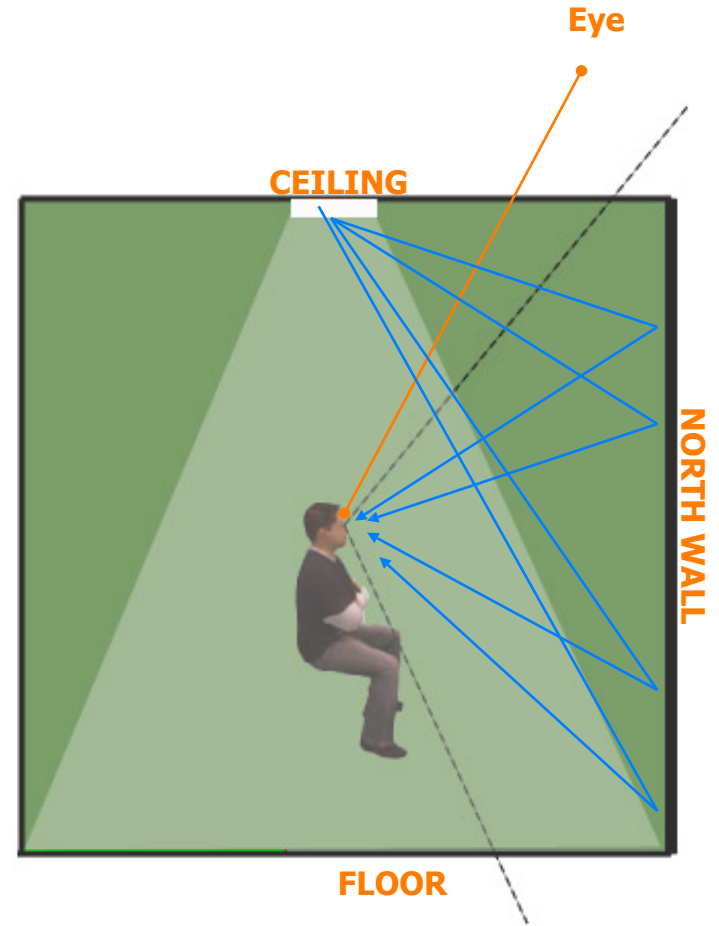
# The Experiment: 3 X 3 X 3 M CUBE

Perspective

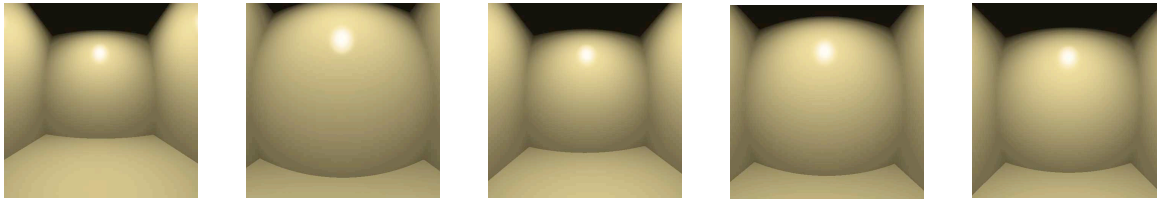
**Light source:** .25 m x .25 m  
Diffused light



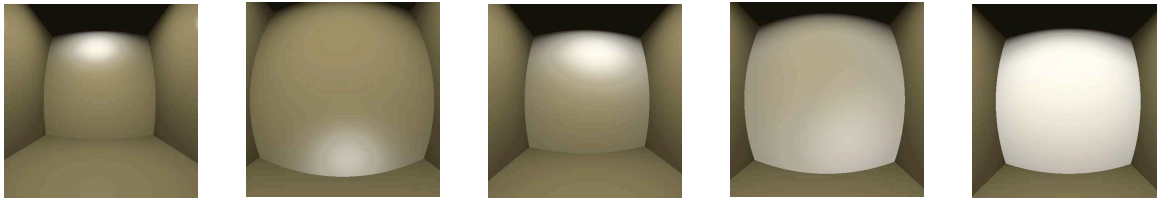
Section



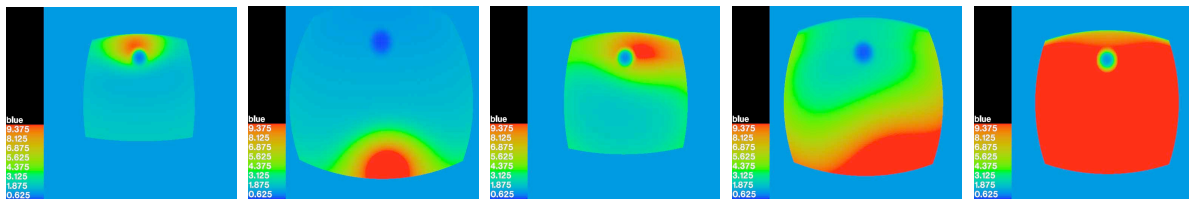
## The Experiment: 3 X 3 X 3 M CUBE



Room with the north wall completely flat



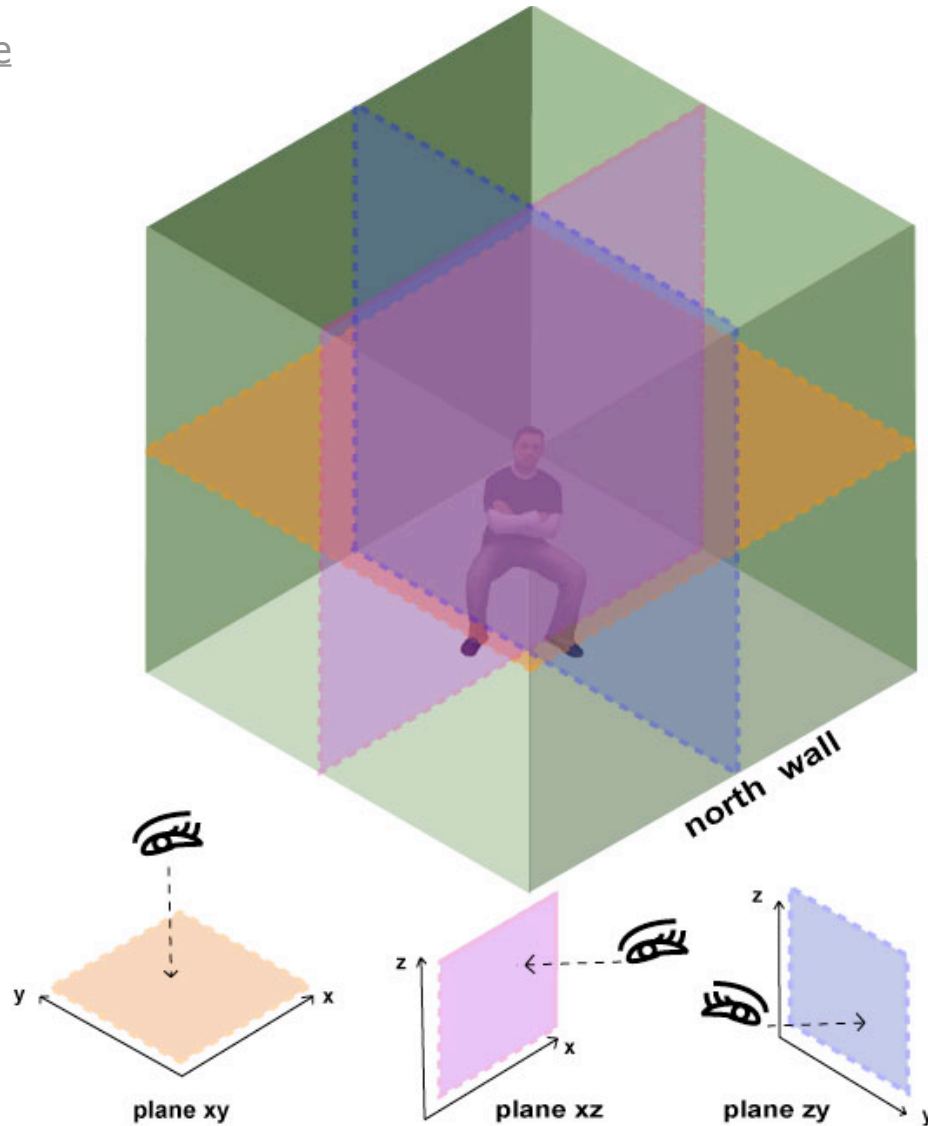
Room with a texture on the north wall that redirects the rays of the light source towards the geometrical Center of the room



Combination of two images using PCOMB and FALSECOLOR in order to calculate the ratio of how much of the Blue component of the light source is getting towards the center of the room.

# The Experiment: 3 X 3 X 3 M CUBE

Perspective



condition 5

light

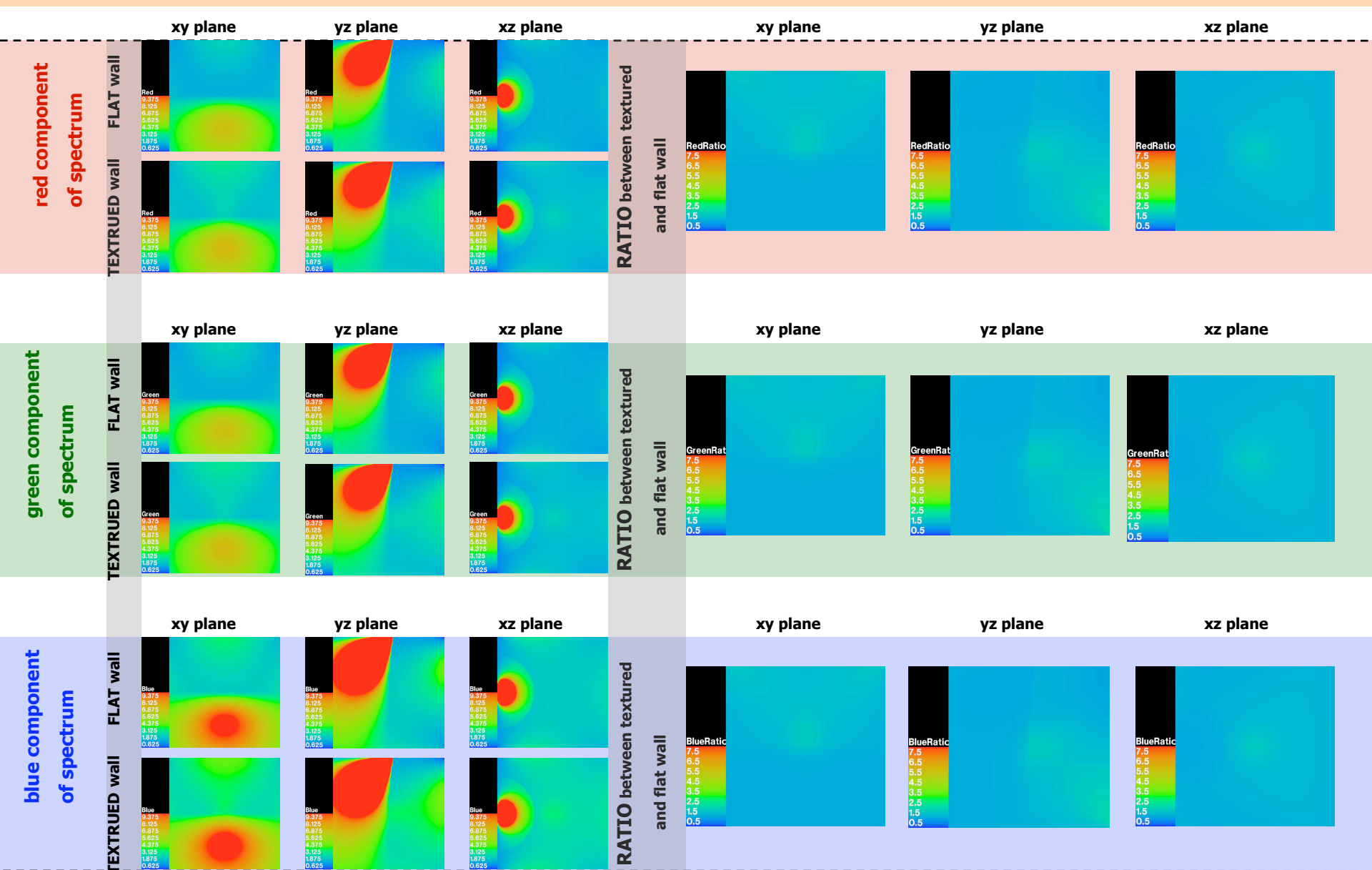
material

R 1000 G 1000 B 1500

R .5 G .5 B .5

specularity .01

roughness .1



Light Spectrum and Internal Variation by Changing a Wall Texture

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condition 39

light

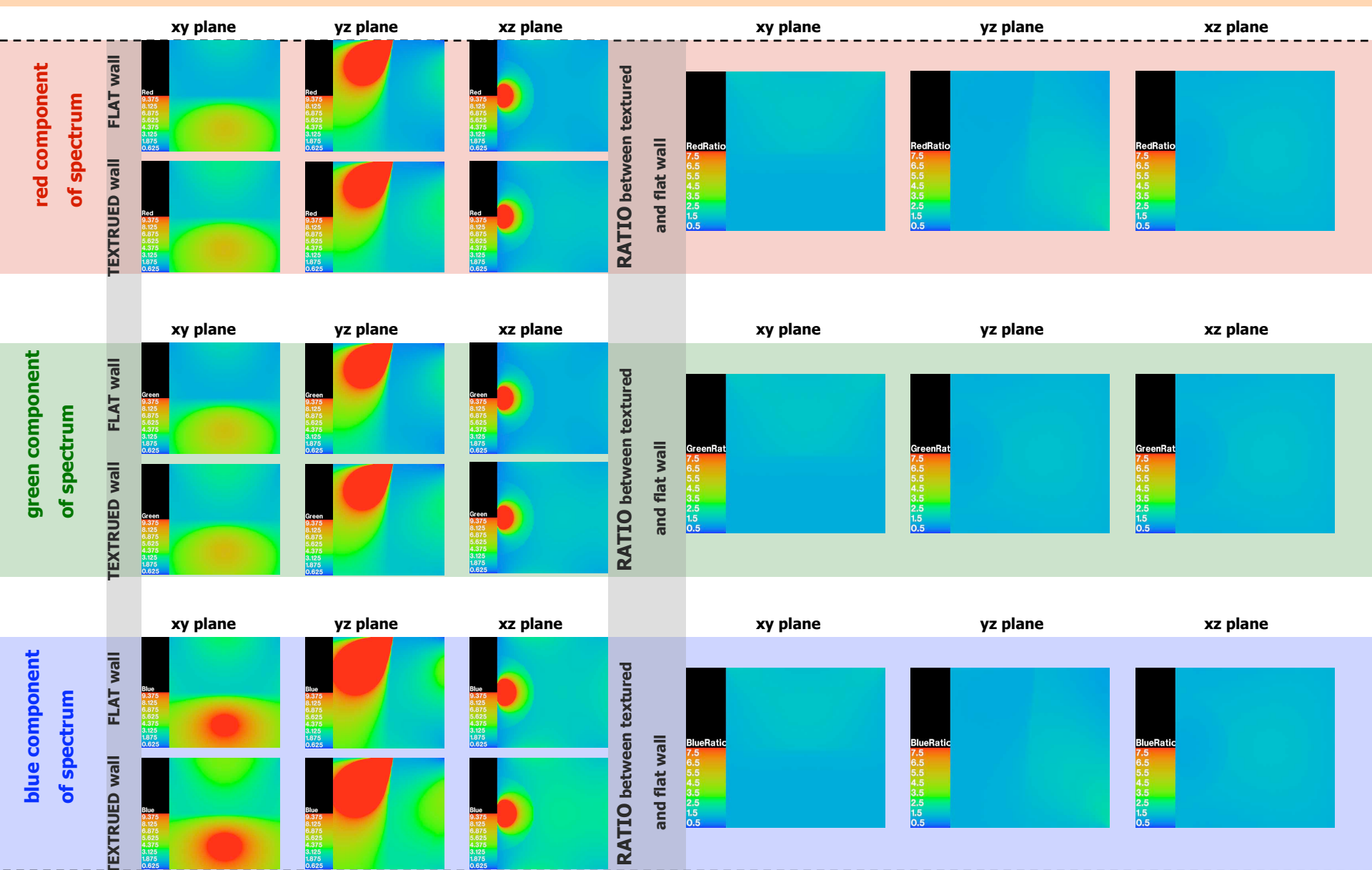
material

R 1000 G 1000 B 1500

R .5 G .5 B .5

specularity .09

roughness .4



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condition 40

light

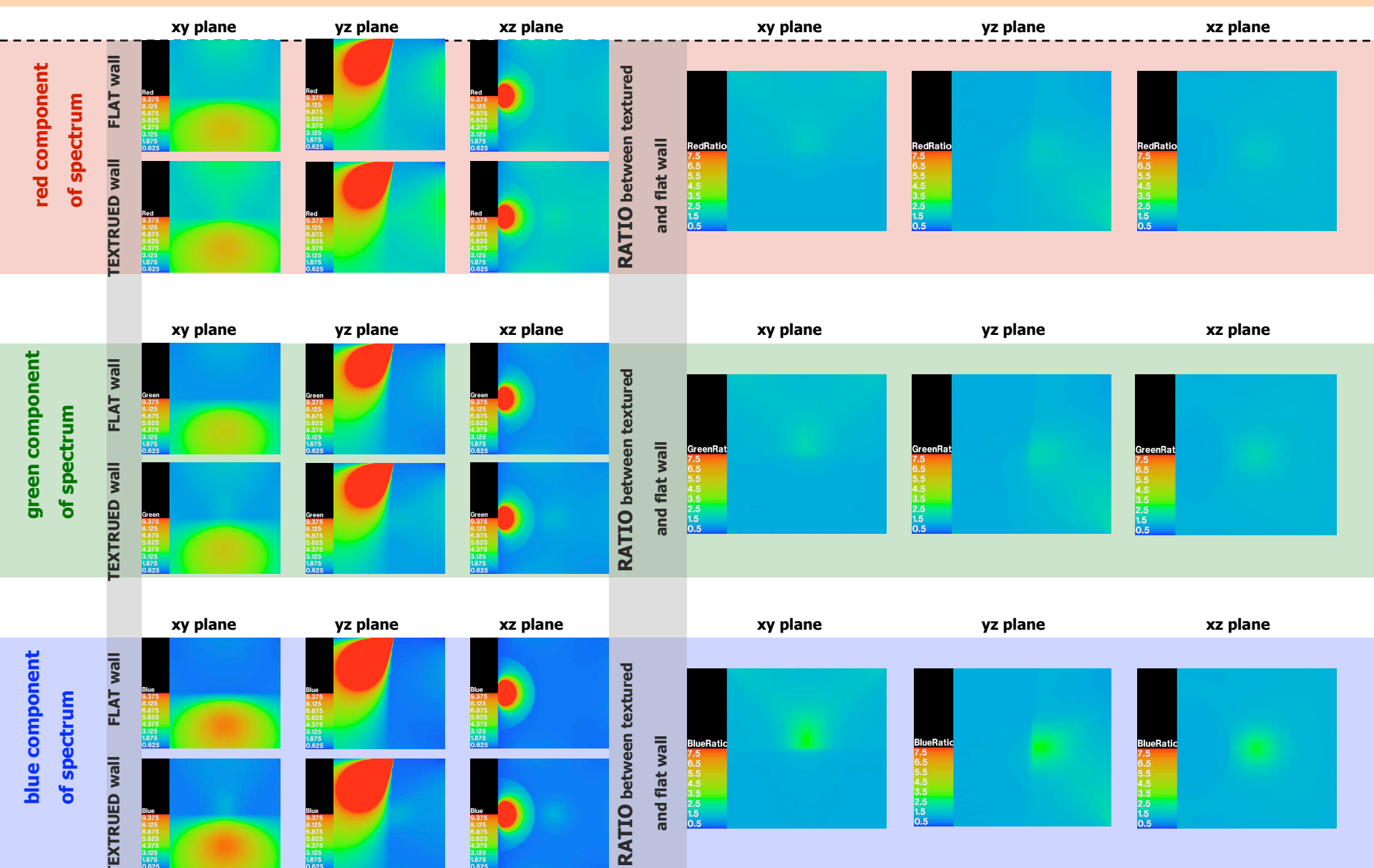
material

R 1000 G 1000 B 1500

R .6 G .3 B .1

specularity .01

roughness .1



Light Spectrum and Internal Variation by Changing a Wall Texture

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condition 74

light

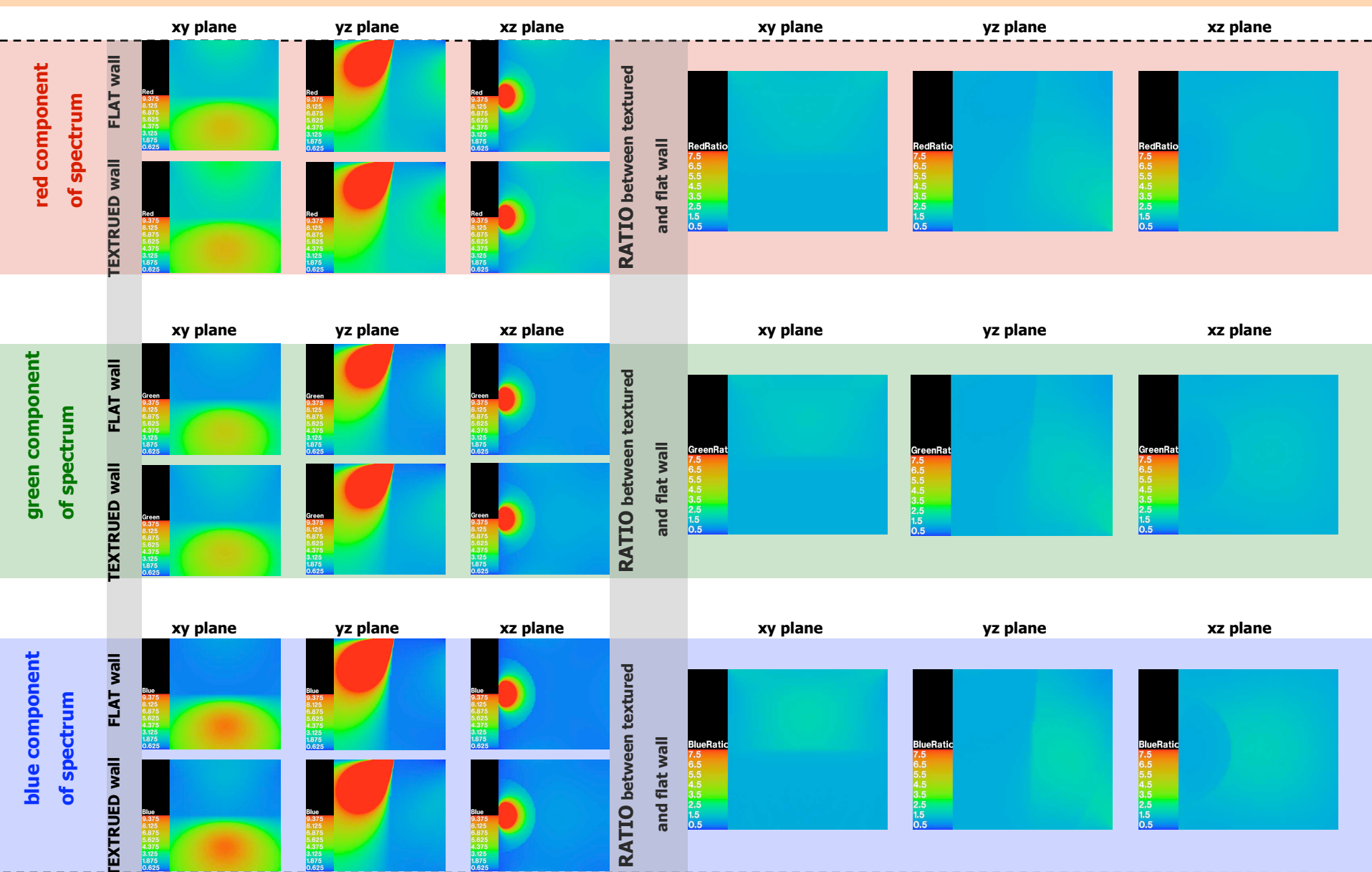
material

R 1000 G 1000 B 1500

R .6 G .3 B .1

specularity .09

roughness .4



Light Spectrum and Internal Variation by Changing a Wall Texture

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condition 75

light

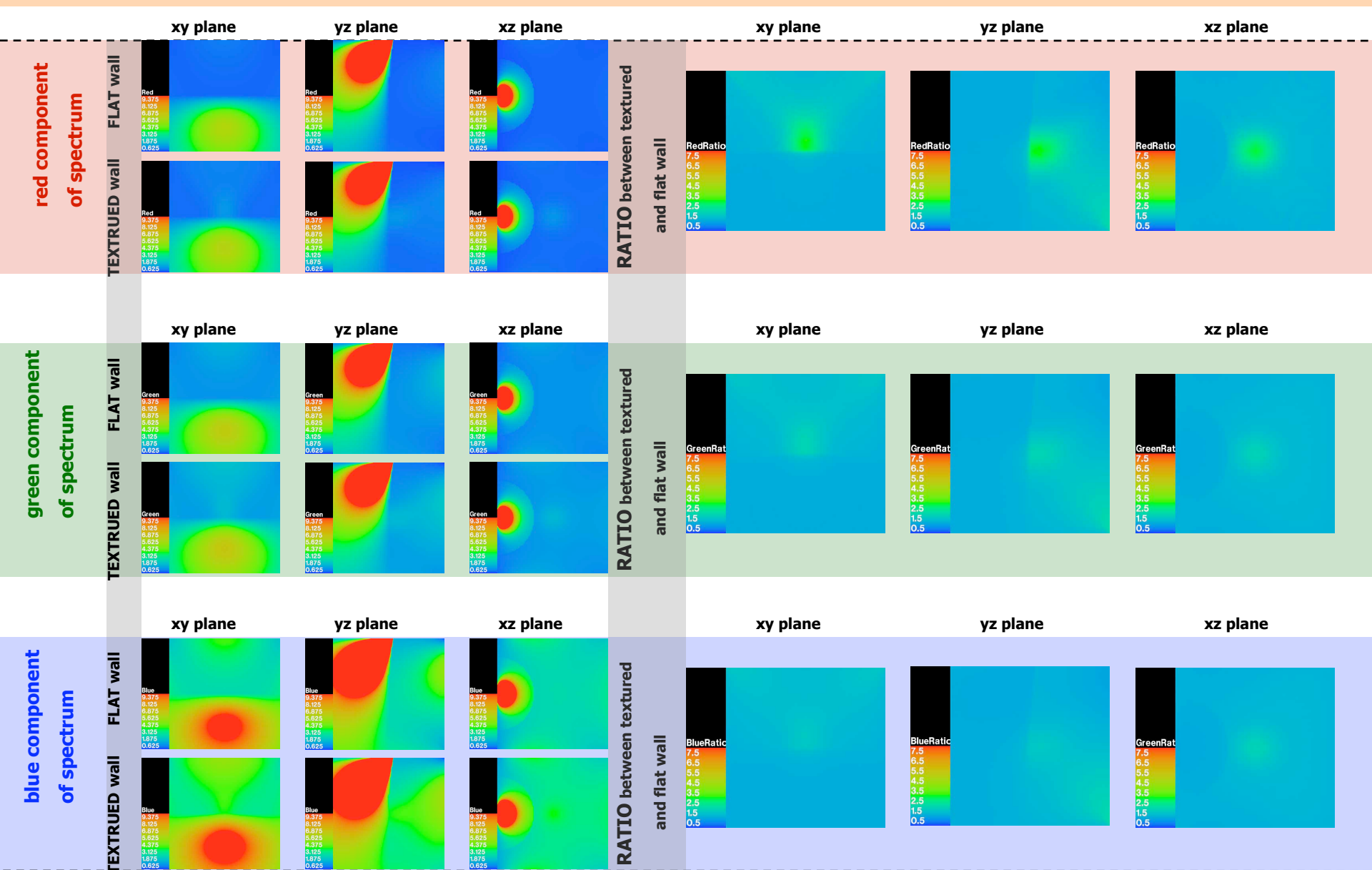
material

R 1000 G 1000 B 1500

R .1 G .3 B .6

specularity .01

roughness .1



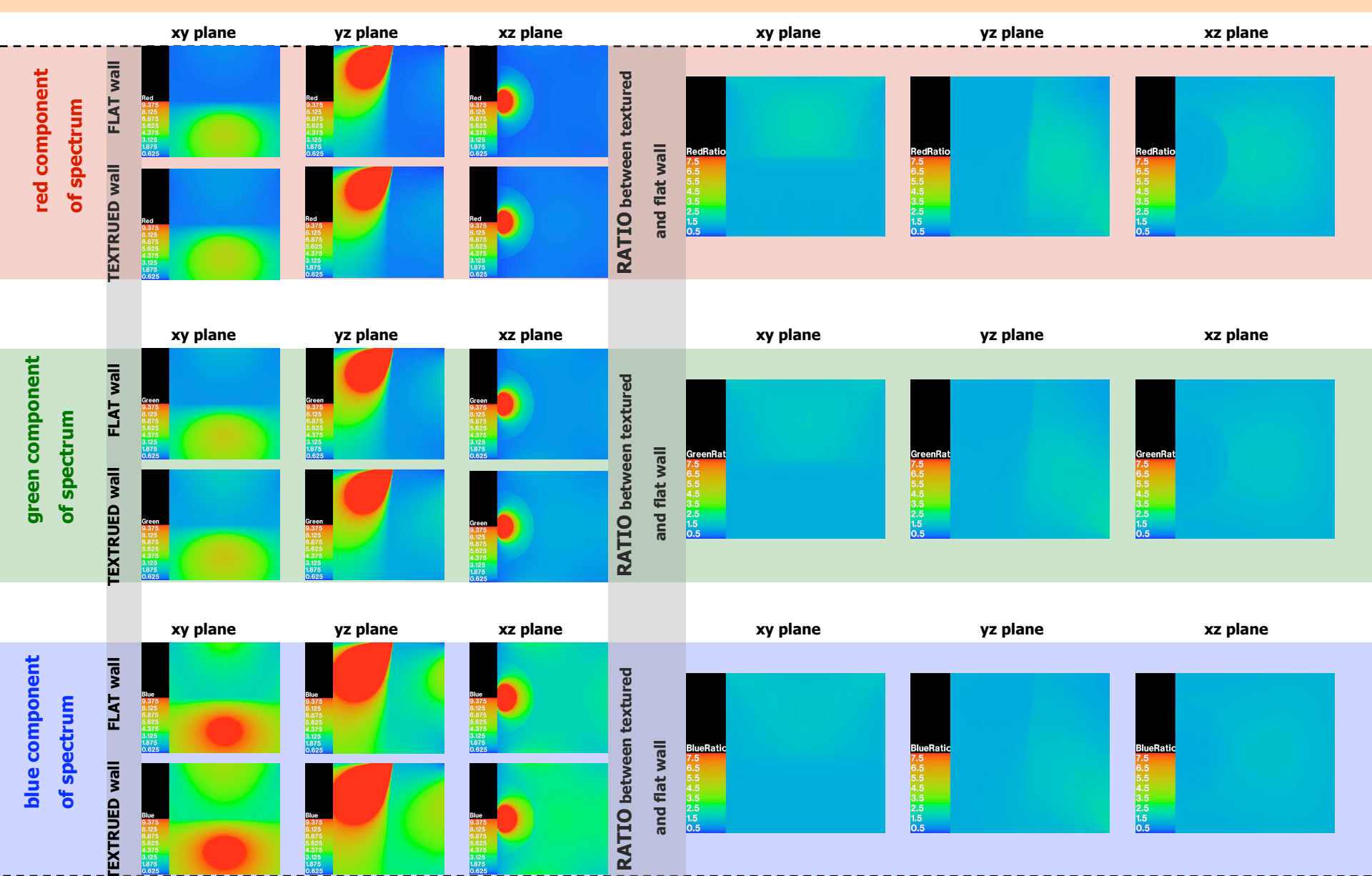
Light Spectrum and Internal Variation by Changing a Wall Texture

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condition 110

light material  
R 1000 G 1000 B 1500 R .1 G .3 B .6 specularity .09 roughness .4



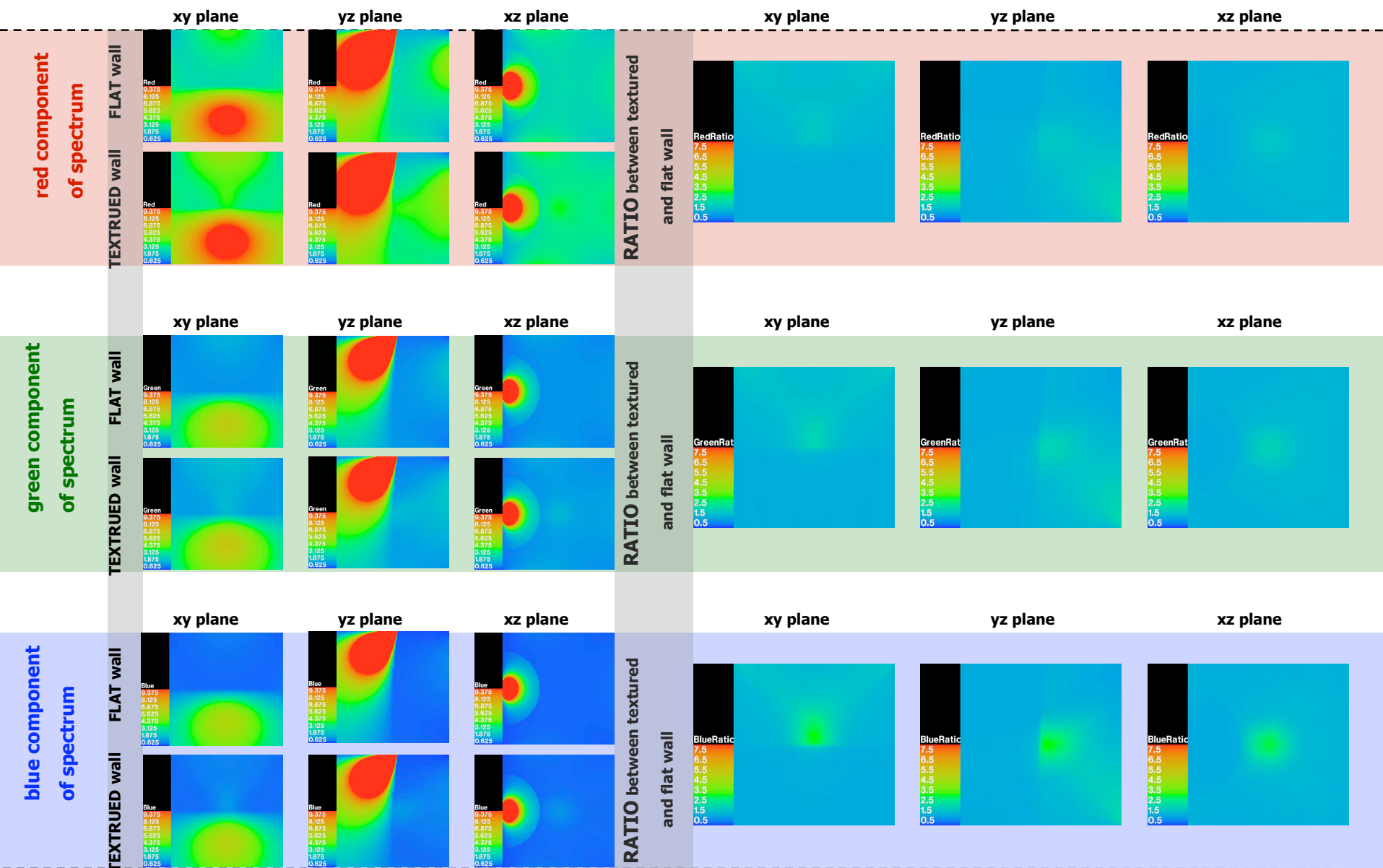
Light Spectrum and Internal Variation by Changing a Wall Texture

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condition 111

light material  
R 1500 G 1000 B 1000 R .6 G .3 B .1  
specularity .01 roughness .1



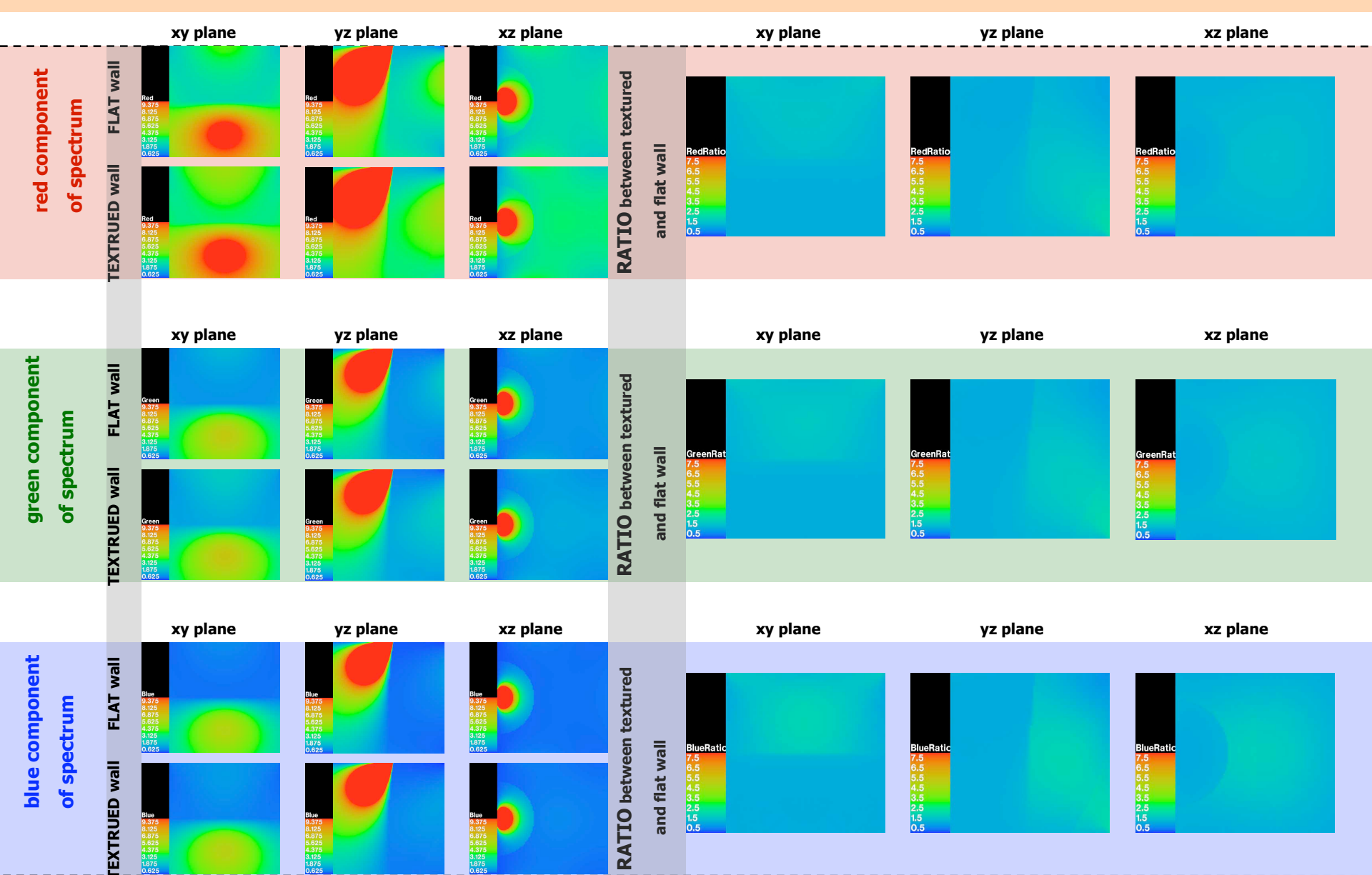
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condition 146

light material  
R 1500 G 1000 B 1000 R .6 G .3 B .1 specularity .09 roughness .4





condition 147

light

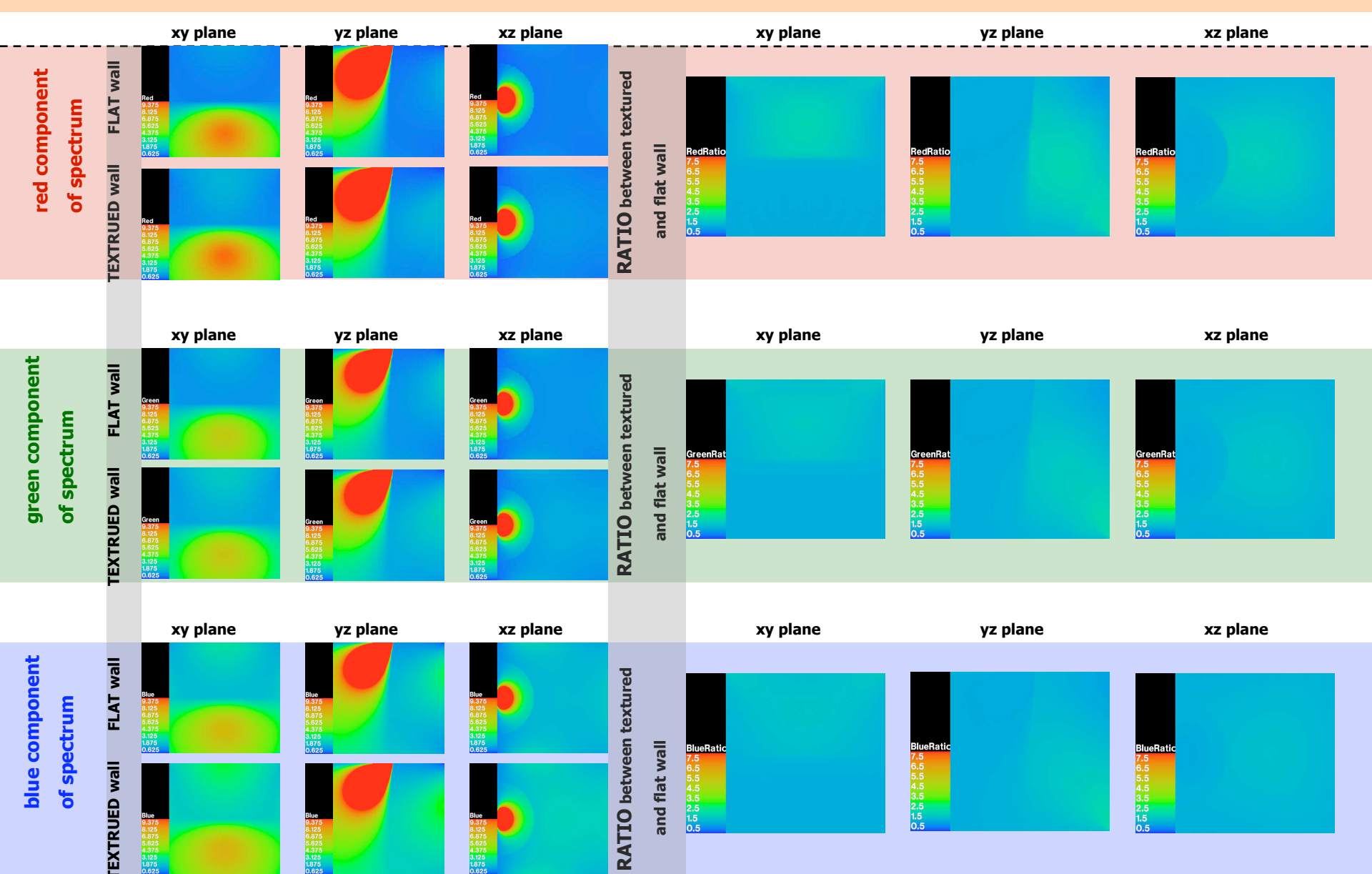
material

R 1500 G 1000 B 1000

R .1 G .3 B .6

specularity .01

roughness .1



Light Spectrum and Internal Variation by Changing a Wall Texture

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condition182

light

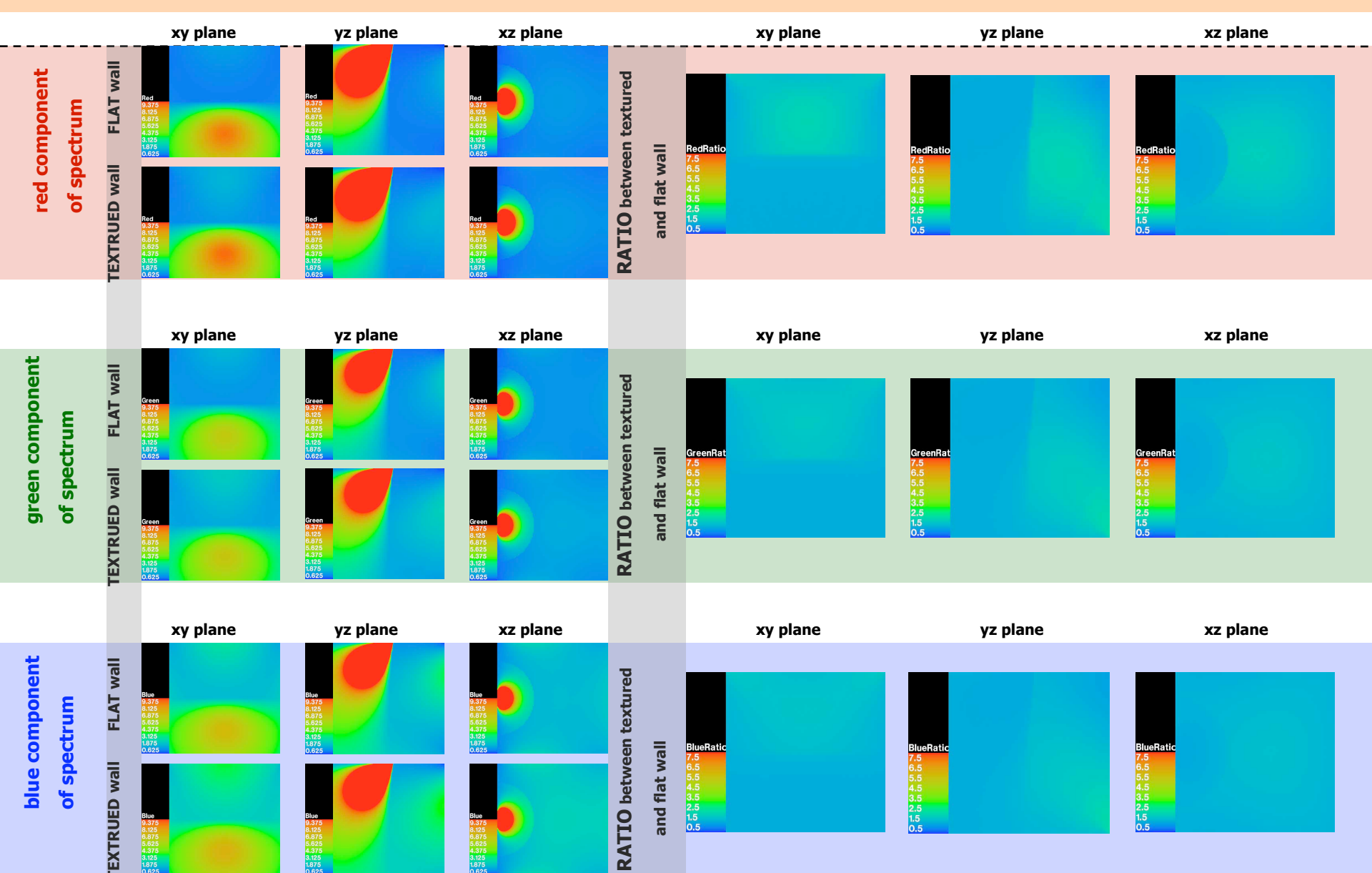
material

R 1500 G 1000 B 1000

R .1 G .3 B .6

specularity .09

roughness .4



Light Spectrum and Internal Variation by Changing a Wall Texture

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# “Playing” with the light spectrum by playing with the “specularity”

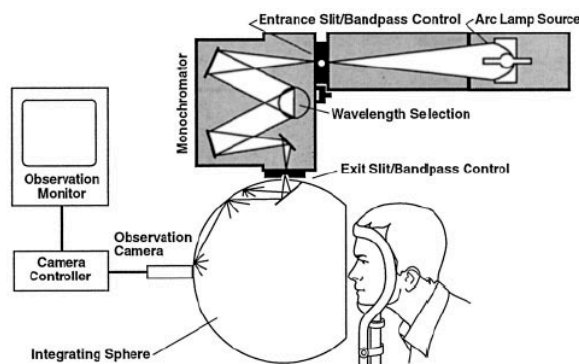
## Non-light materials:

- **Plastic:** It is a material with **uncolored highlights**

**Therefore, specular highlights are modified by the light source.**

- **Metal:** .- It is similar to plastic, **but specular highlights are modified by the material color.**

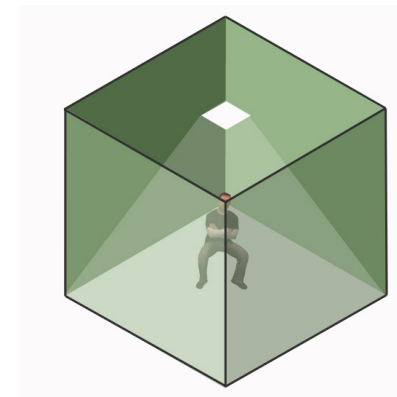
### Laboratory experiment



The right combination  
of **material  
properties + light  
characteristics +  
texture**

in order to deliver the  
right spectrum in a  
right quantity for the  
right stimulation  
of the circadian  
system.

### architecture



## Acknowledgements

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I want to thank the many contributors to the **www.radiance-online.org** listserv message board who helped me to get handle on the Radiance lighting simulation program  
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