

# BTDF Compression

Based on Wavelet Transforms

Yujie Wu, J. H. Kämpf, J.-L. Scartezzini

Solar Energy and Building Physics Laboratory (LESO-PB)  
École Polytechnique Fédérale de Lausanne (EPFL)  
Switzerland



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- ④ Daylight factor
- ⑤ Glare risk



01

## BTDF data

Measurement-Compression-Rendering



# BTDF Measurement

**BTDF** (Bidirectional Transmission Distribution Function) is defined:

$$BTDF(\theta_1, \varphi_1, \theta_2, \varphi_2) = \frac{L_2(\theta_1, \varphi_1, \theta_2, \varphi_2)}{E_1(\theta_1)}$$

- $\theta_1, \varphi_1$  and  $\theta_2, \varphi_2$  are the polar **coordinates** of the incoming and emerging light
- $L_2$  is the **luminance** of the emerging light flux
- $E_1$  is the **illuminance** on the window plane by the incident light flux

# BTDF Measurement



Gonio-photometer based on CCD imaging, installed in **LESO-PB**

## Source of BTDF

- Simulated, like with genBSDF
- Measured, like by gonio-photometer



# BTDF Measurement

## Source of BTDF

- Simulated, like with genBSDF
- Measured, like by gonio-photometer



Gonio-photometer based on CCD imaging, installed in **LESO-PB**

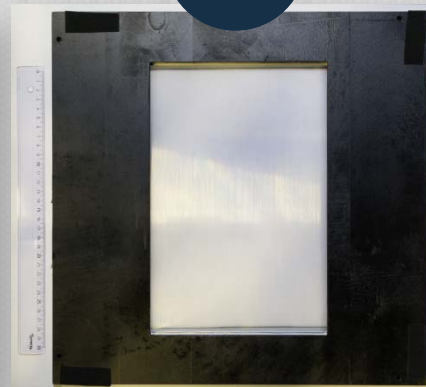
# BTDF Measurement

1



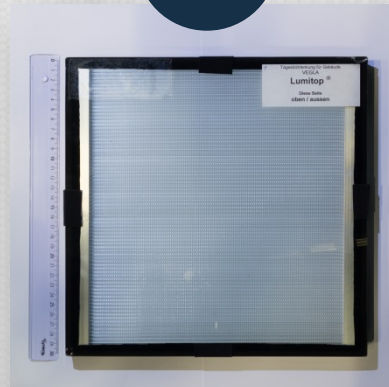
Opalescent  
Plexiglas

2



CFS3

3



Lumitop

4



Metallic  
Slats

5



Dolan Duo  
Color Model



# BTDF Measurement

1



Opalescent  
Plexiglas

1. Diffusing  
Material

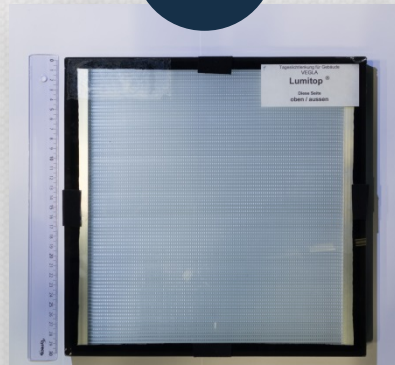
2



CFS3

2. Sunlight  
Redirecting

3



Lumitop

3. Prismatic  
Panels

4



Metallic  
Slats

4. Venetian  
Blinds

5



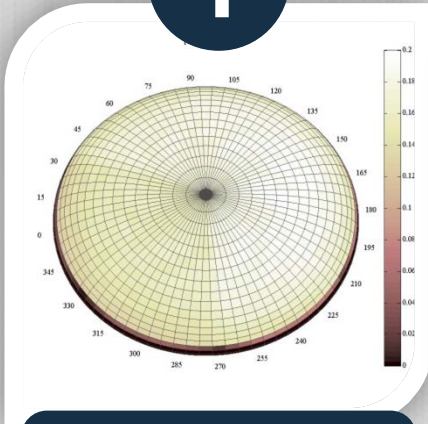
Dolan Duo  
Color Model

5. Fabric  
Blinds



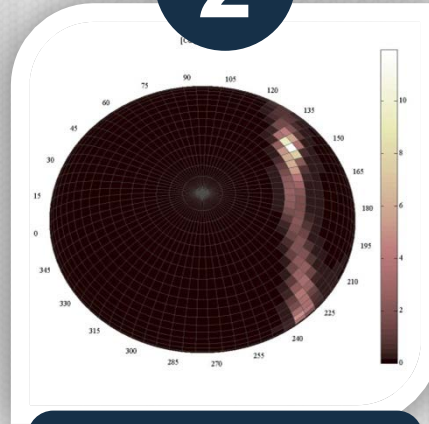
# BTDF Measurement

1



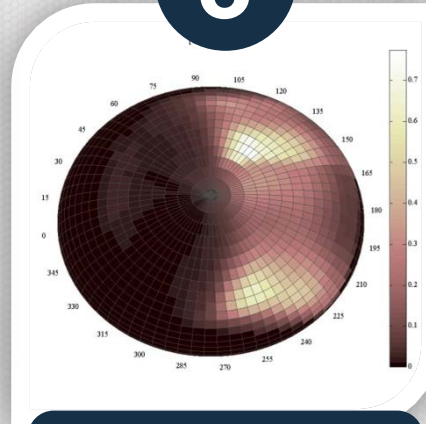
Opalescent  
Plexiglas

2



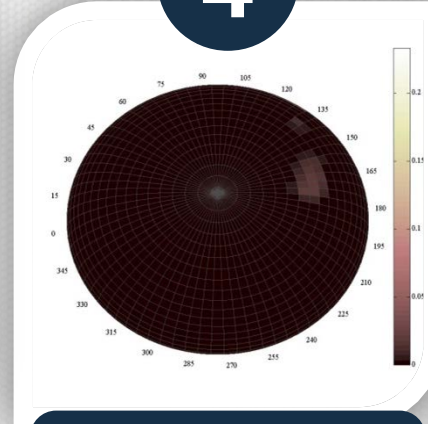
CFS3

3



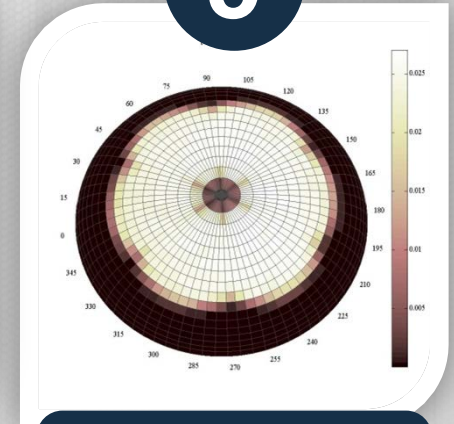
Lumitop

4

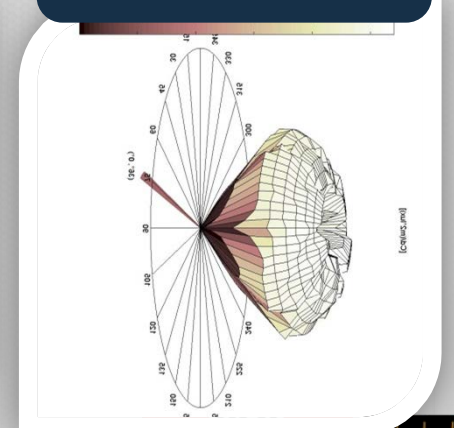
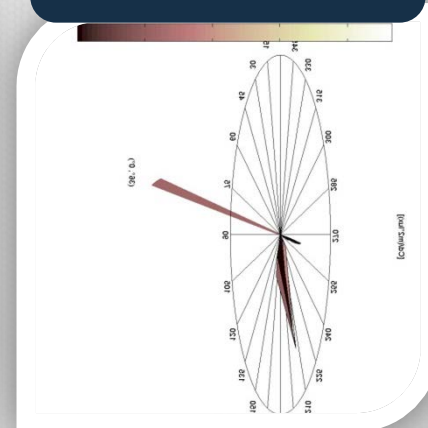
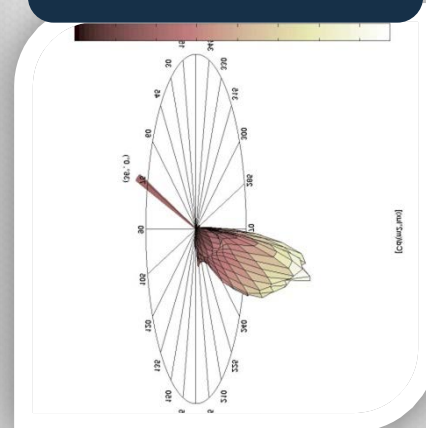
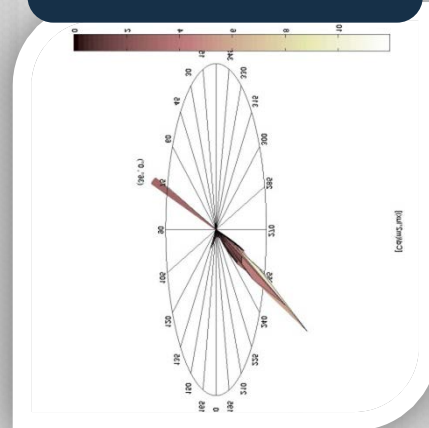
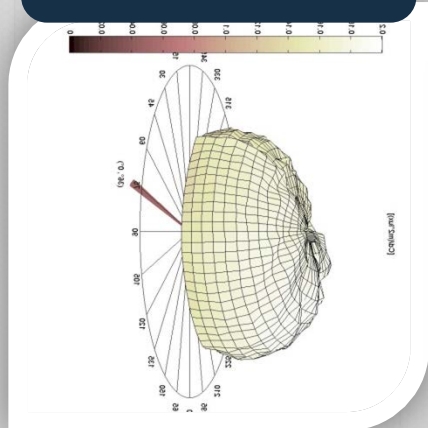


Metallic  
Slats

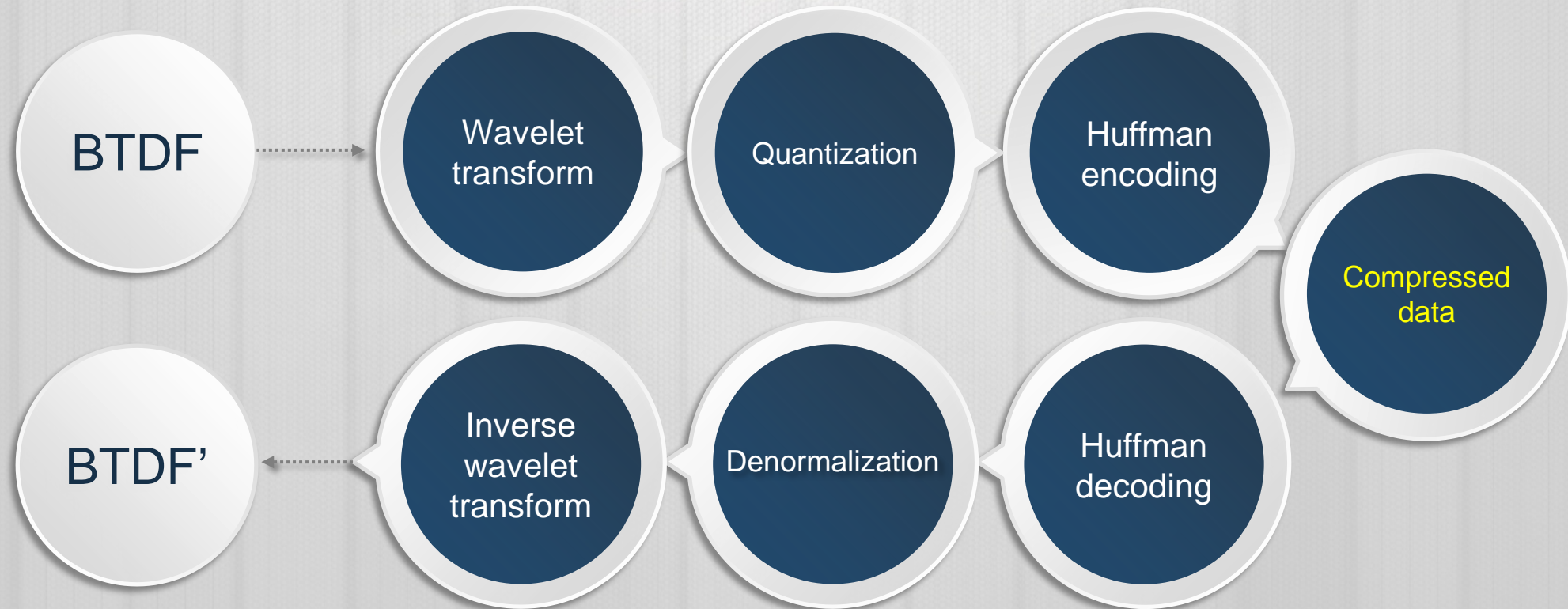
5



Dolan Duo  
Color Model



# Compression Routine





# Window Panels

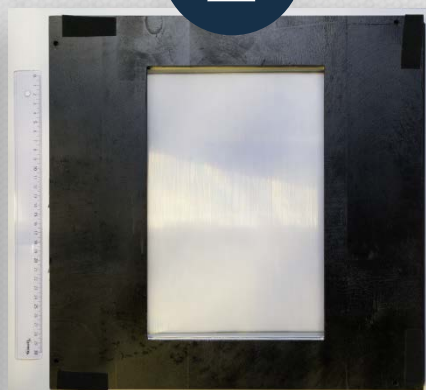
1



Opalescent  
Plexiglas

1. Diffusing  
Material

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CFS3

2. Sunlight  
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Lumitop

3. Prismatic  
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Dolan Duo  
Color Model

5. Fabric  
Blinds

# Radiance Rendering

Compression Rate

CDF9.7

1



Lumitop

20



TE: 1.06%  
RMSE: 3.55%

45



TE: 3.72%  
RMSE: 9.73%

70

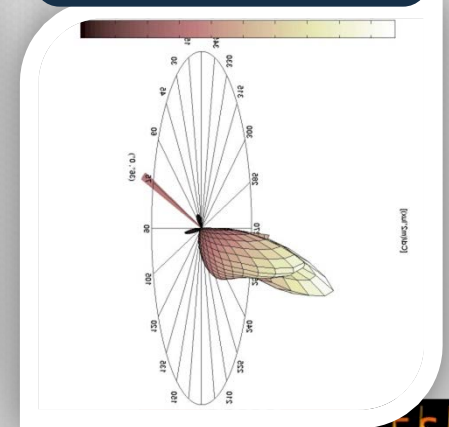
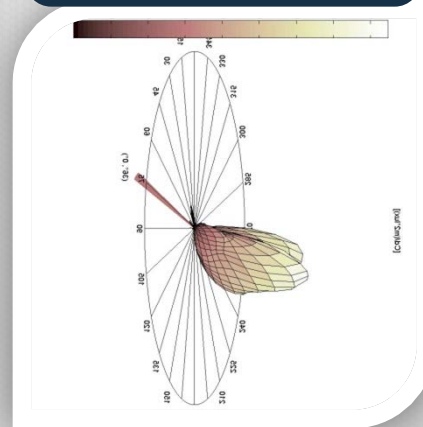
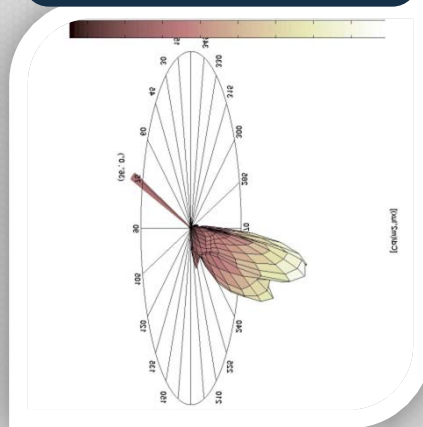
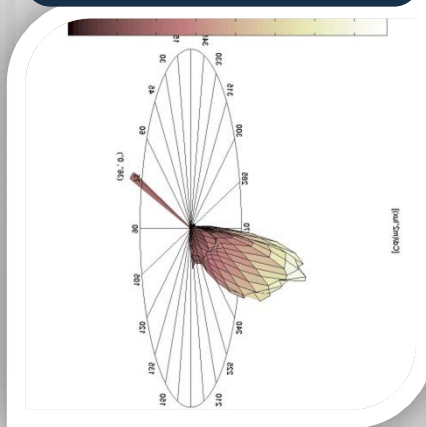
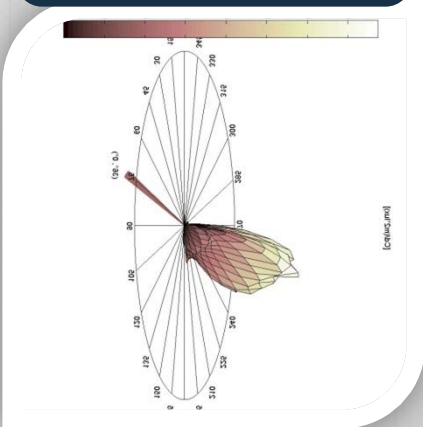


TE: 6.02%  
RMSE: 15.6%

220



TE: 13.2%  
RMSE: 40.5%





# Jpeg2000 Quantization

Quantization

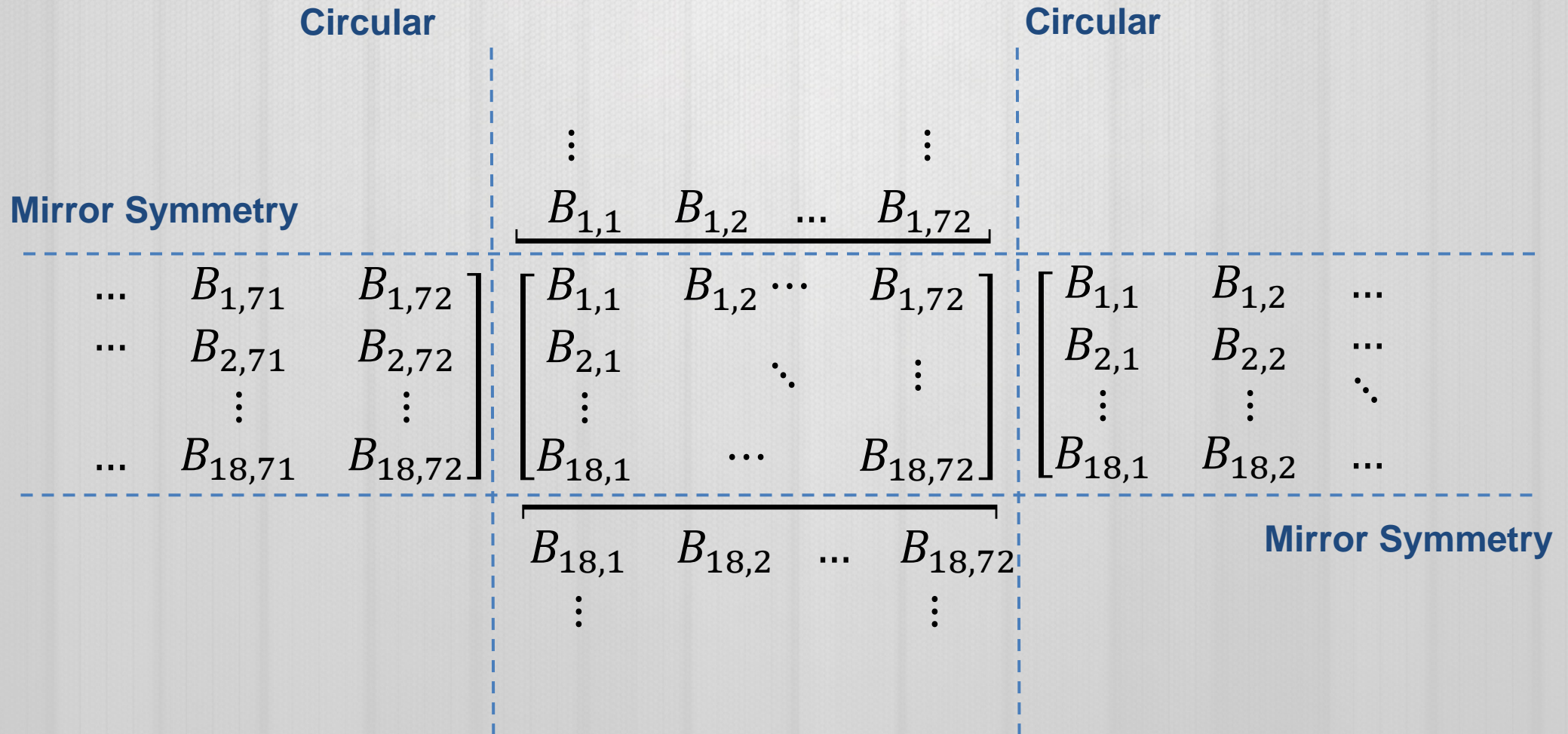
$$New\_C = \frac{C}{\max(C)} \cdot 2^v \cdot \frac{1}{1 + u/2^{11}}$$

WT  
Coefficient

$\downarrow$   
 $Floor(New\_C)$

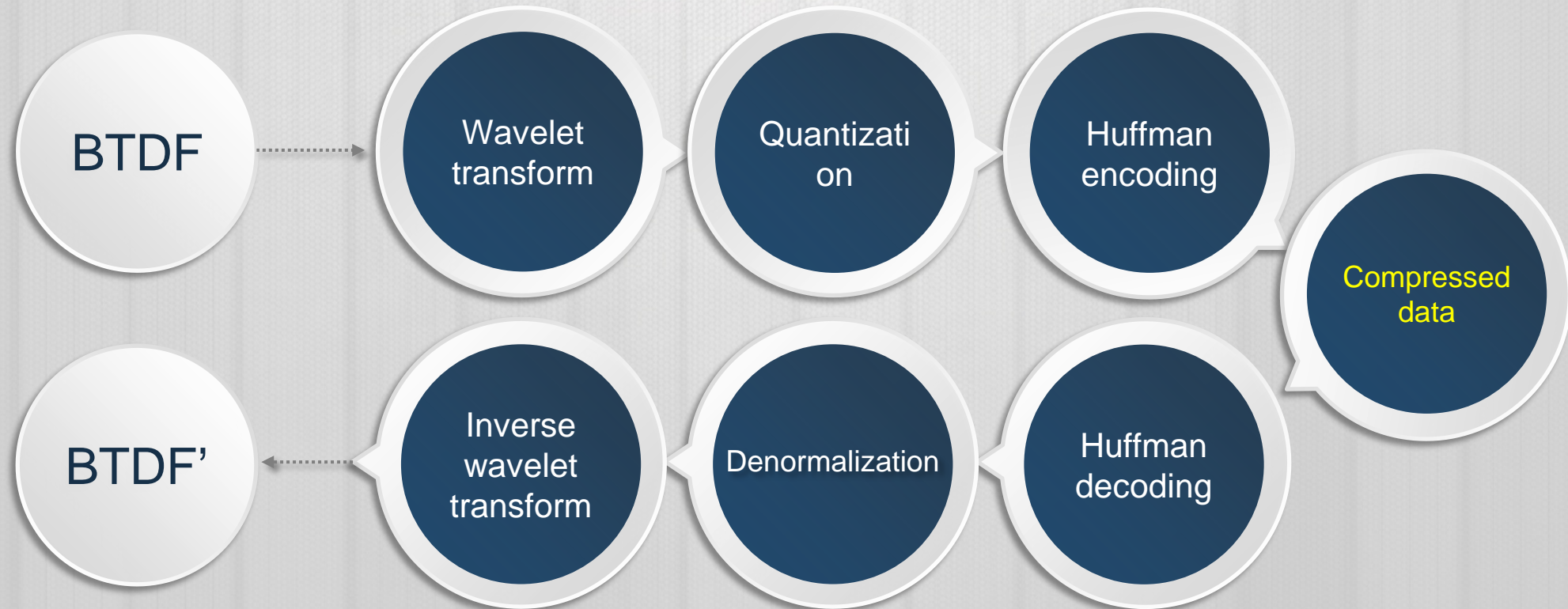
Note:  $v, u$  are parameters

# Wavelet Process





# Compression Routine



# Symbol Redundancy

Huffman  
encoding

$$\begin{bmatrix} 16 & 17 & 18 \\ 16 & 16 & 16 \\ 17 & 16 & 17 \end{bmatrix}$$

UINT8: 9 bytes

Num	P	Code
16	0.56	1
17	0.34	01
18	0.13	00

UINT8: 2 bytes



# Symbol Redundancy

Huffman  
encoding

## Merits and drawbacks

- Variable length symbol coding
- Simply based on probability sequence
- Compact and close to entropy
- Time consumption of recursive calculation



02

## Compression Comparison

Comparison before and after compression



# Window Panels

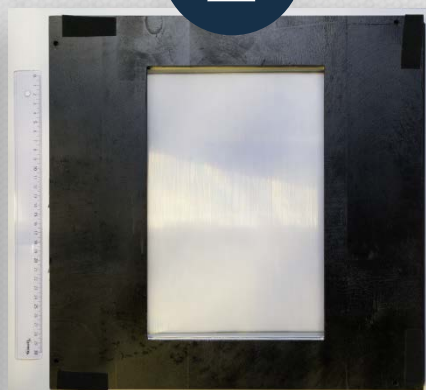
1



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Plexiglas

1. Diffusing  
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Dolan Duo  
Color Model

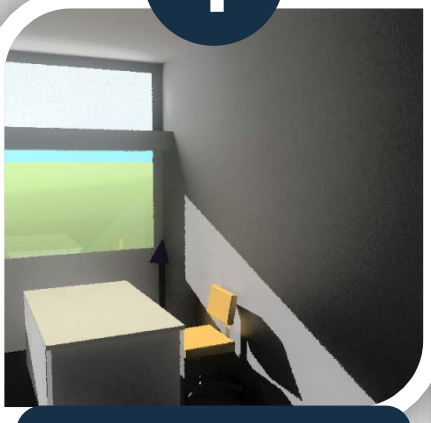
5. Fabric  
Blinds

# Compression Rate: 70

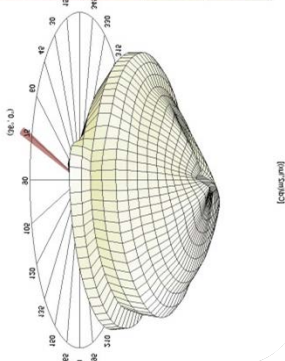
Panel No. →

Compressed

1



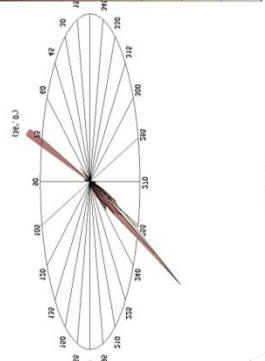
TE: 5.6%  
RMSE: 13.4%



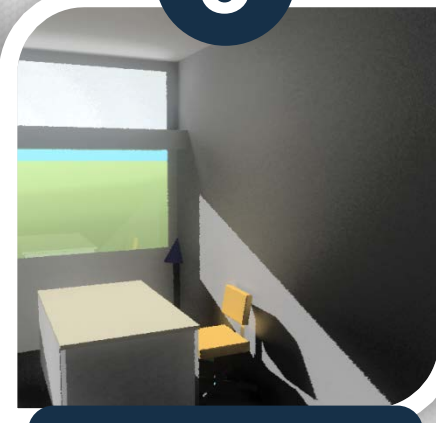
2



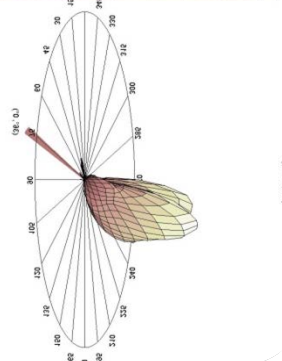
TE: 12.3%  
RMSE: 34.2%



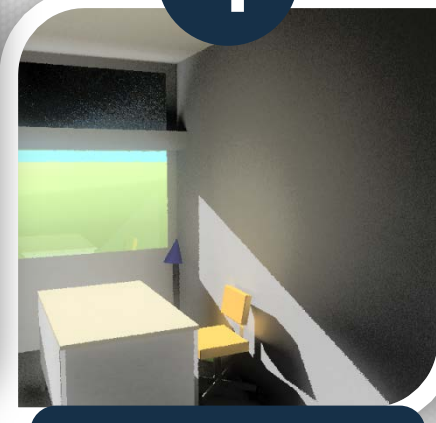
3



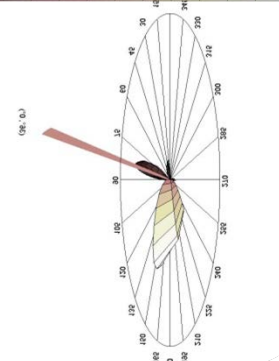
TE: 6.02%  
RMSE: 15.6%



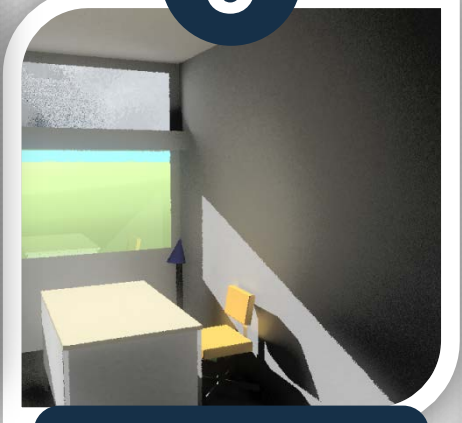
4



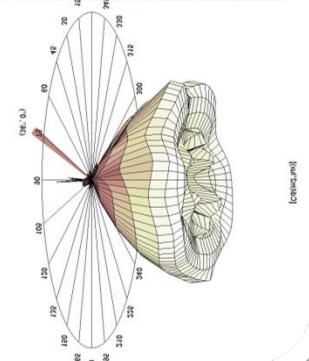
TE: 3.05%  
RMSE: 2.34%



5



TE: 5.18%  
RMSE: 15.1%



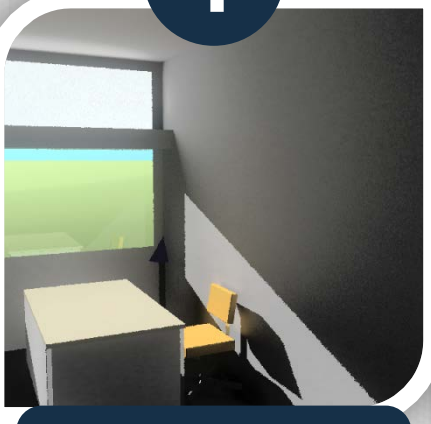


# Compression Rate: 20

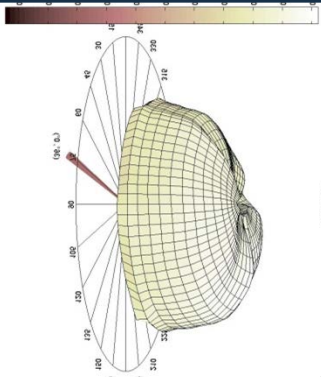
Panel No.

Compressed

1



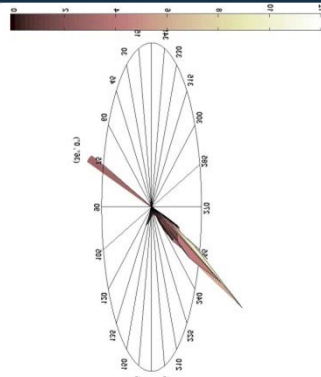
TE: 0.69%  
RMSE: 3.04%



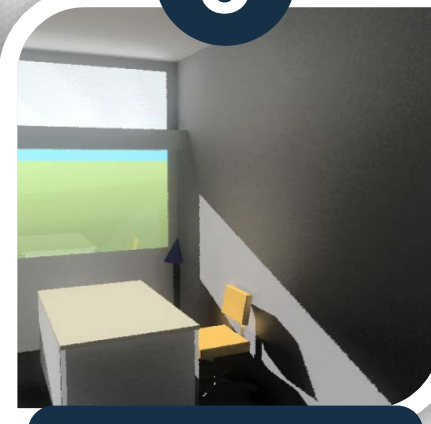
2



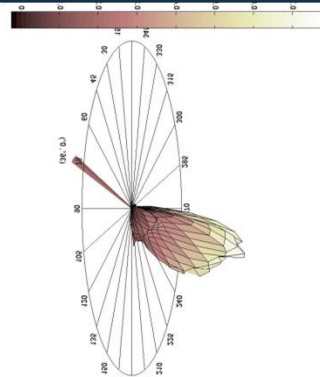
TE: 1.65%  
RMSE: 5.47%



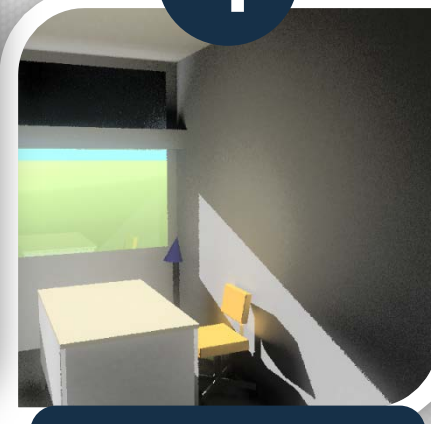
3



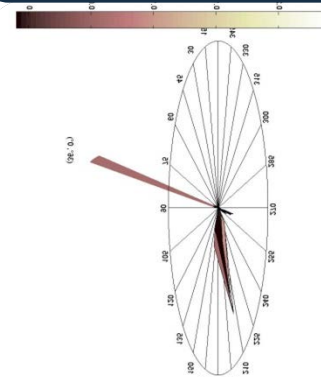
TE: 1.06%  
RMSE: 3.55%



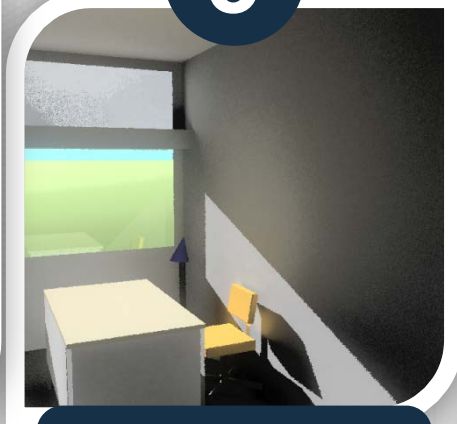
4



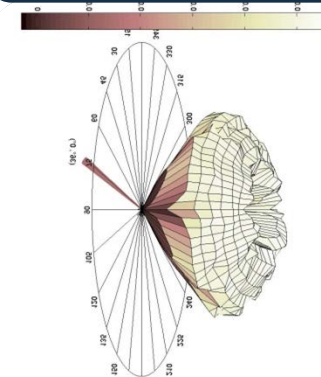
TE: 0.18%  
RMSE: 0.16%



5



TE: 0.54%  
RMSE: 2.73%

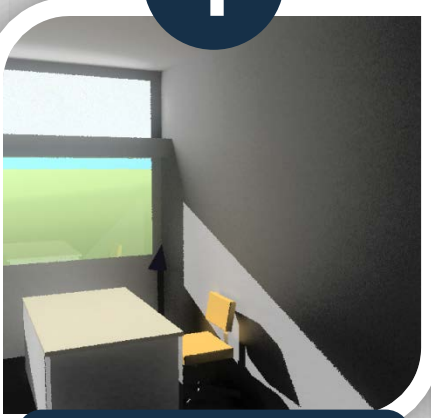


# Compression Rate: 1

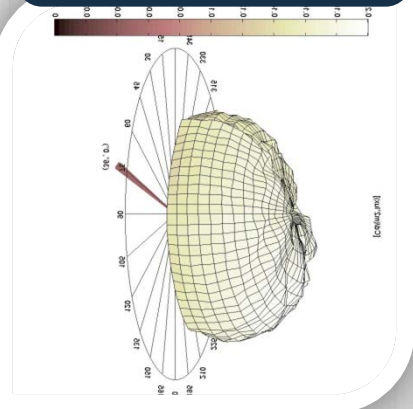
Panel No.

Original

1



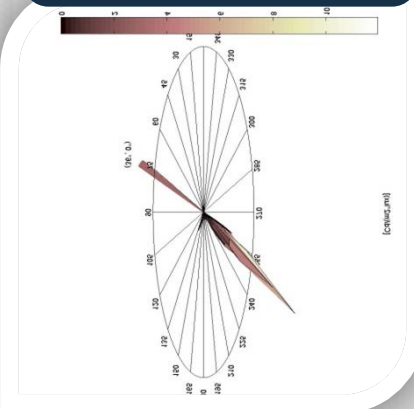
Opalescent  
Plexiglas



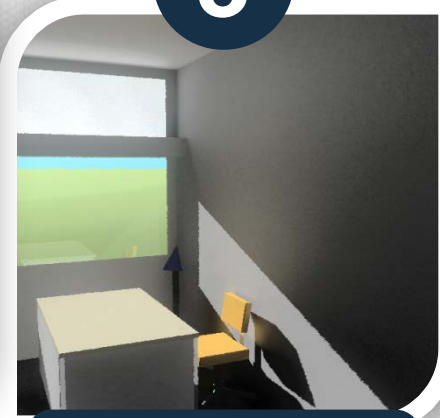
2



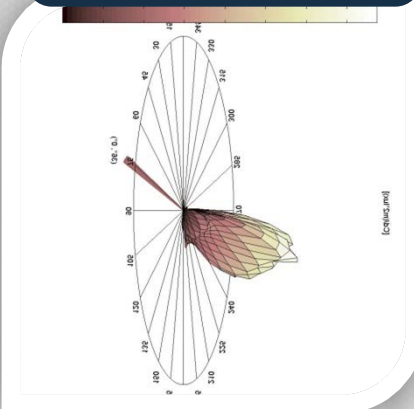
CF3



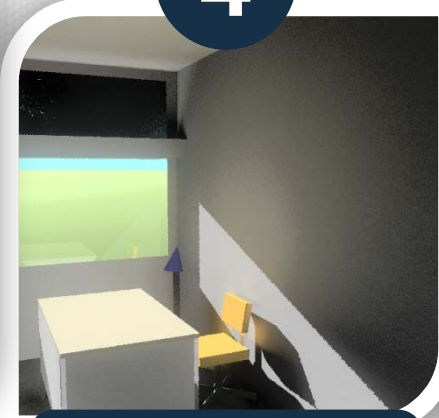
3



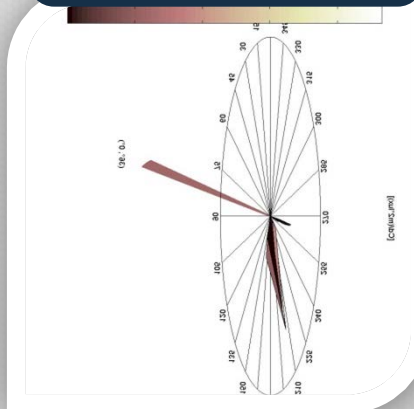
Lumitop



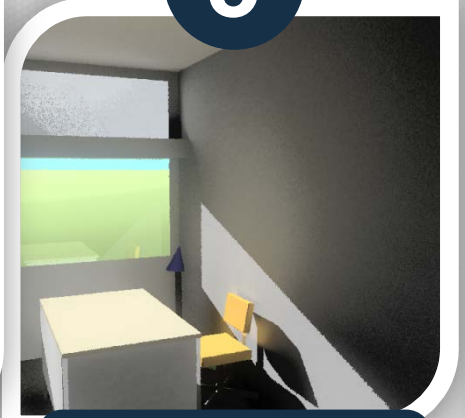
4



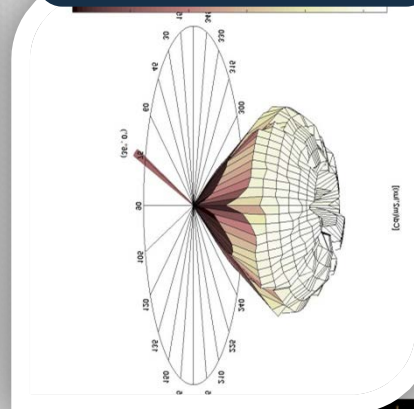
Metallic  
Slats



5

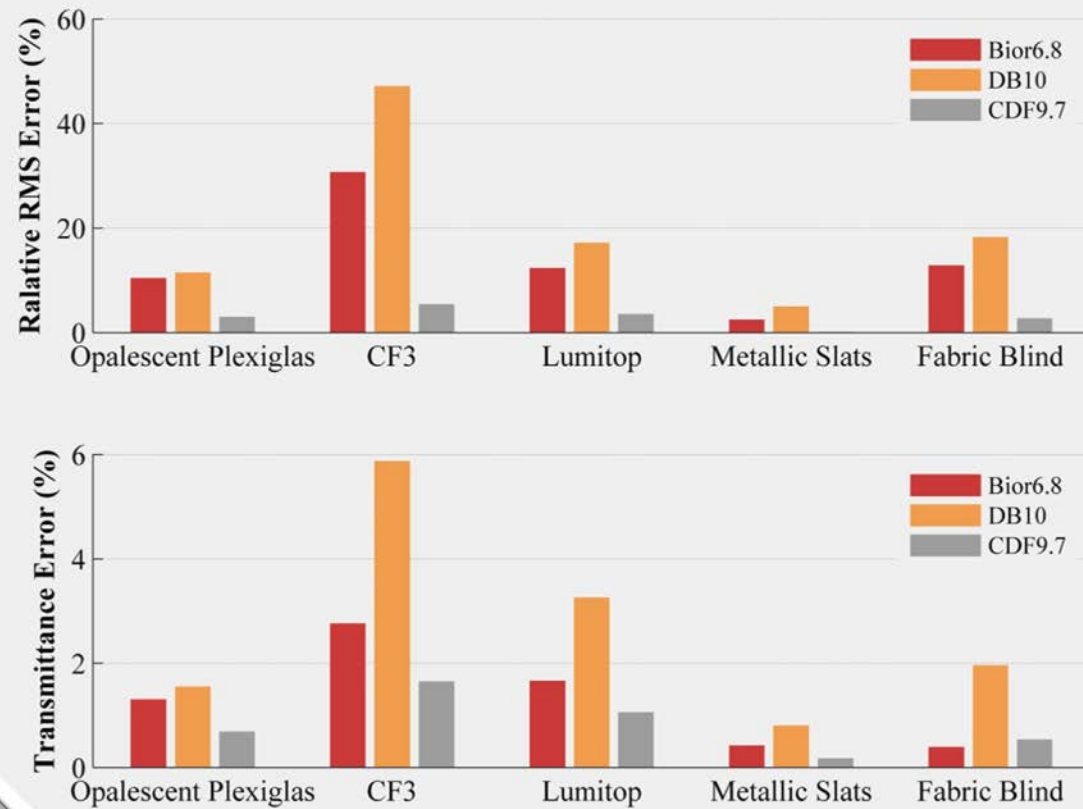


Dolan Duo  
Color Model





# Compression Rate: 20



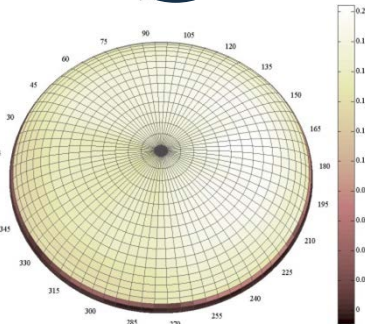
## Wavelet basis comparison

- Biorthogonal 6-8
- Daubechies 10
- Cohen-Daubechies-Feauveau 9-7

# Compression Rate: 20

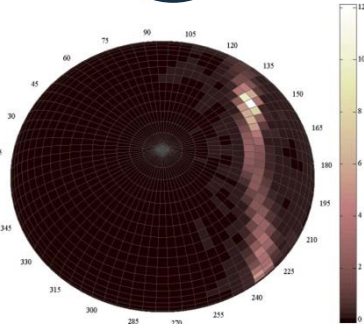
Panel No.

1



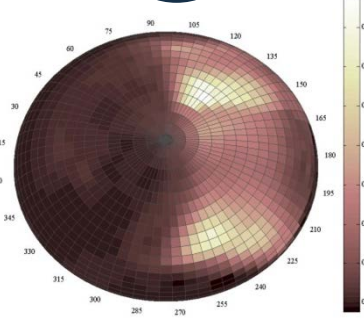
TE: 0.69%  
RMSE: 3.04%

2



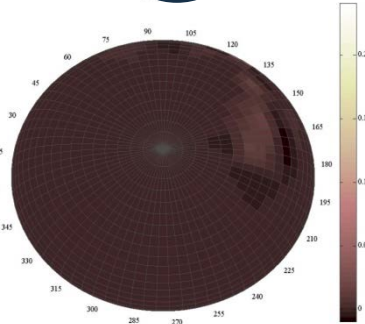
TE: 1.65%  
RMSE: 5.47%

3



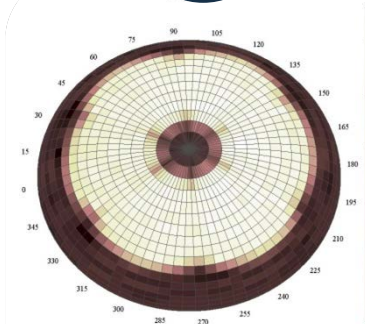
TE: 1.06%  
RMSE: 3.55%

4



TE: 0.18%  
RMSE: 0.16%

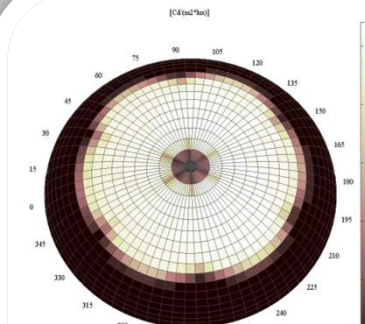
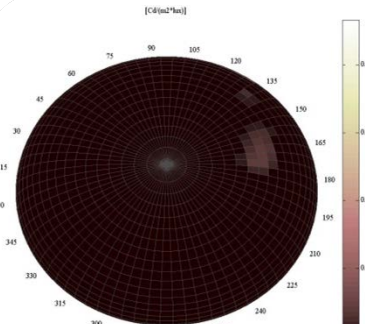
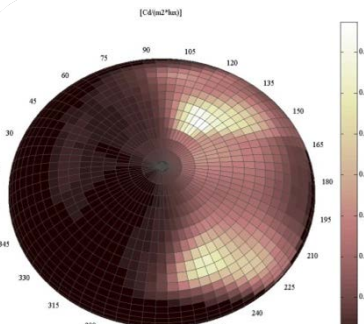
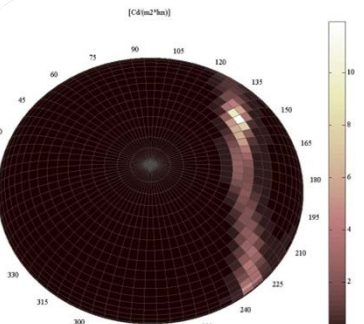
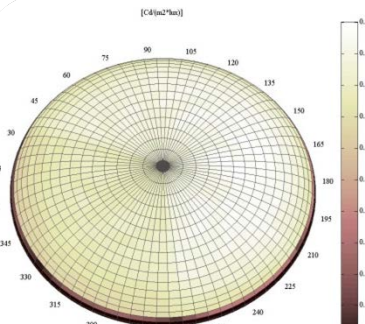
5



TE: 0.54%  
RMSE: 2.73%

Compressed-CDF9.7

Original

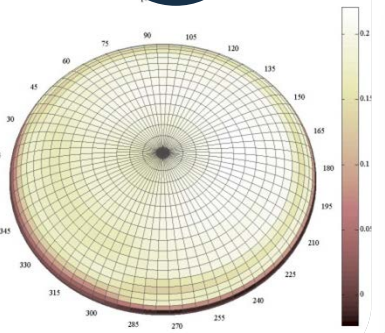




# Compression Rate: 20

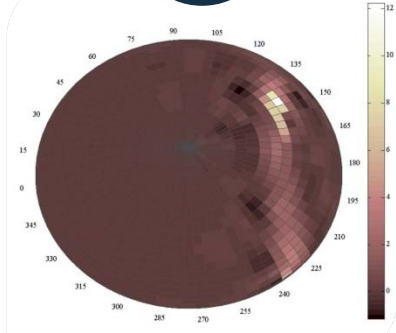
Panel No.

1



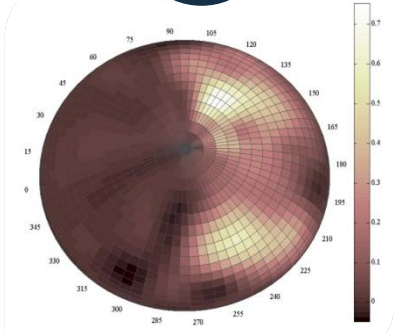
TE: 1.31%  
RMSE: 10.4%

2



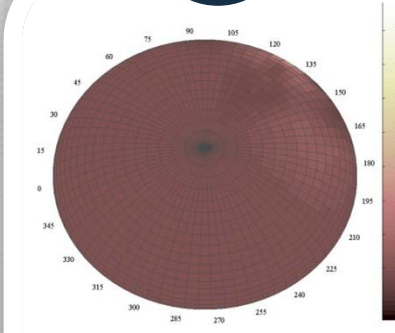
TE: 2.77%  
RMSE: 30.7%

3



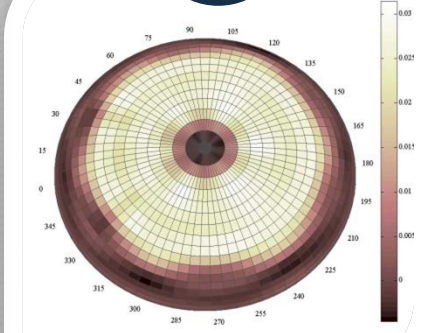
TE: 1.67%  
RMSE: 12.4%

4



TE: 0.42%  
RMSE: 2.50%

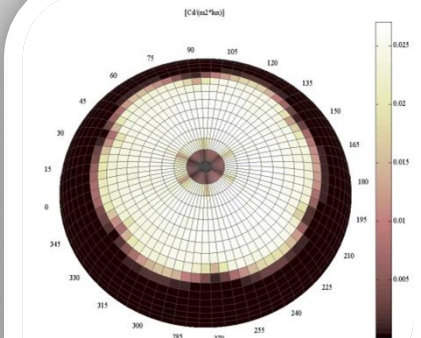
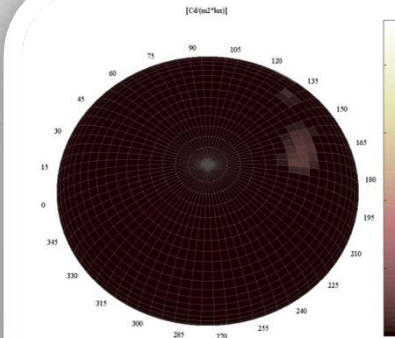
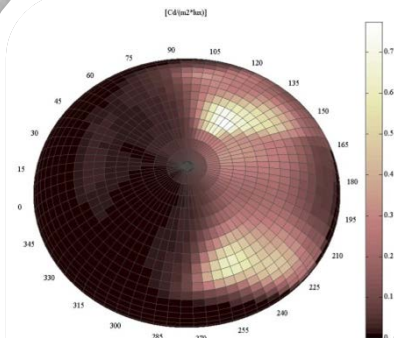
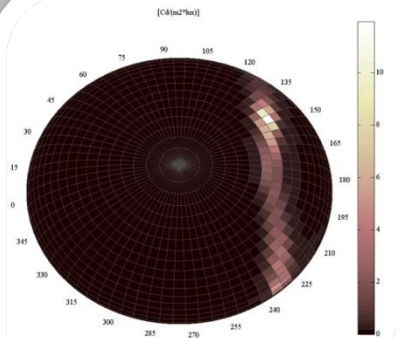
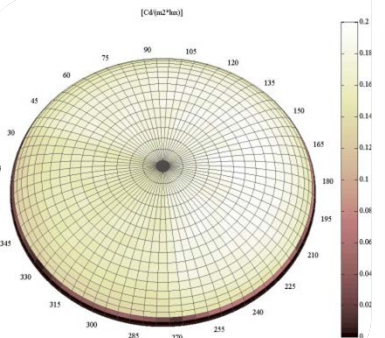
5



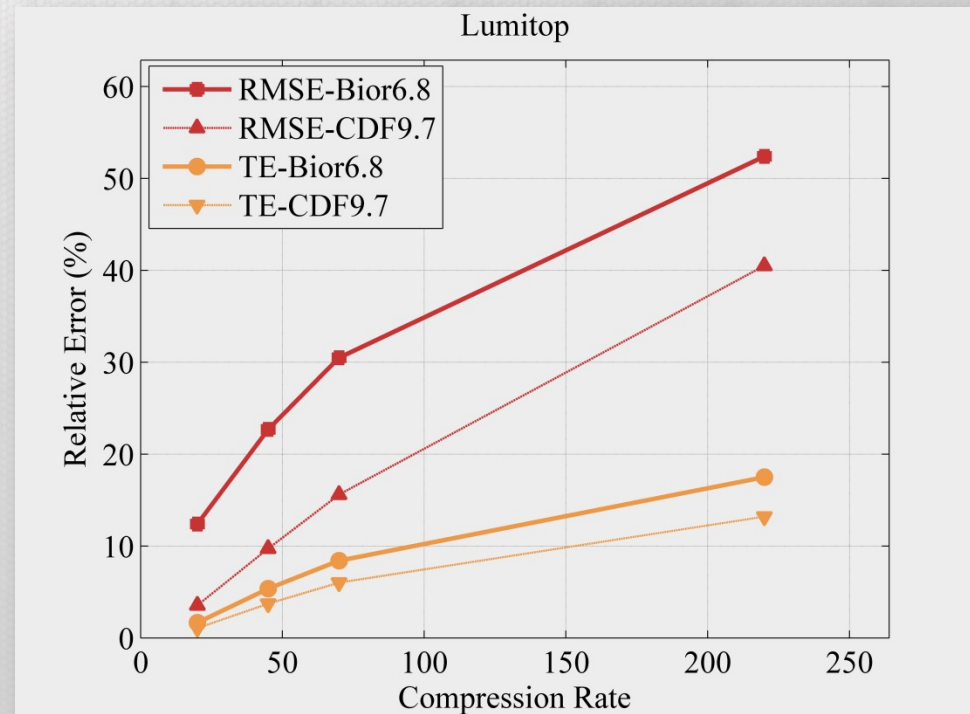
TE: 0.39%  
RMSE: 12.9%

Compressed-Bior6.8

Original



# Error Trend





# Radiance Rendering

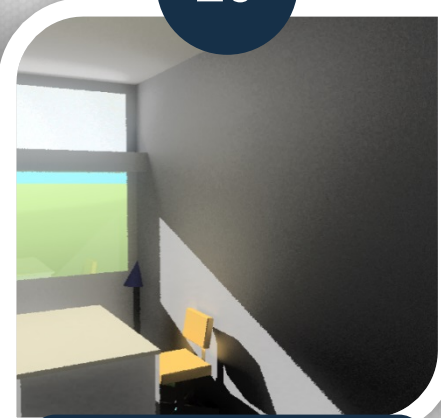
Compression Rate

1



Original

20



TE: 1.06%  
RMSE: 3.55%

45



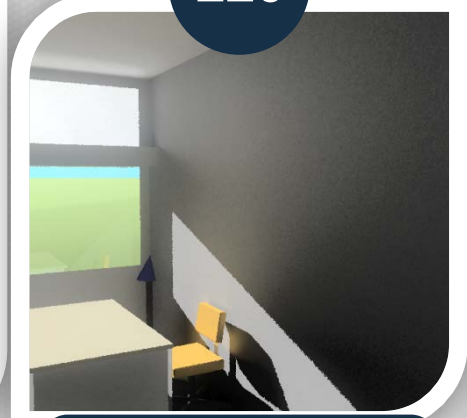
TE: 3.72%  
RMSE: 9.73%

70



TE: 6.02%  
RMSE: 15.6%

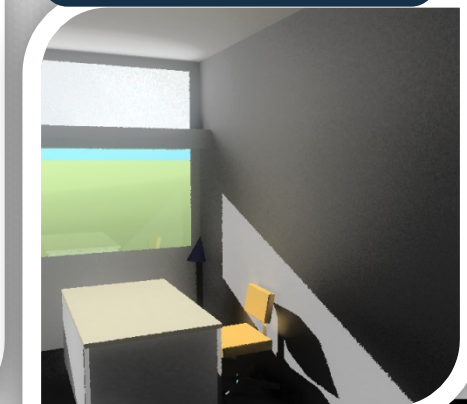
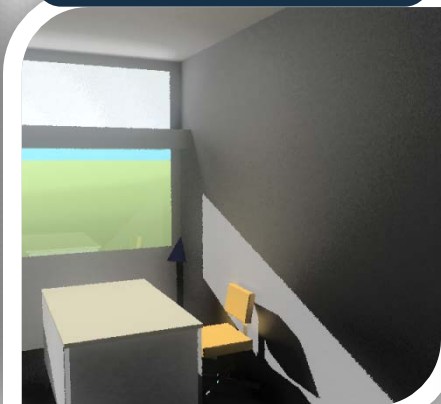
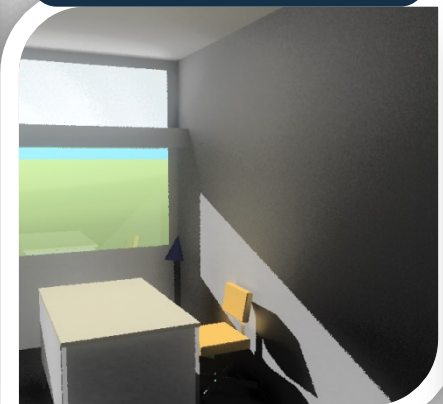
220



TE: 13.2%  
RMSE: 40.5%

Bior6.8

CDF9.7



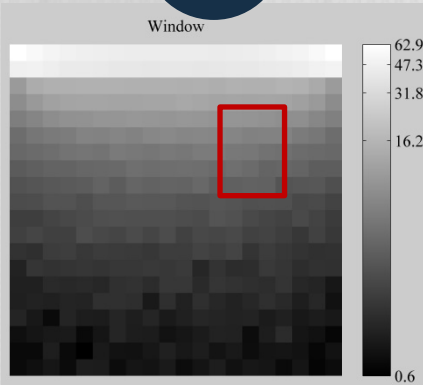
# Daylighting Factor

EN 12464-1 standard  
Min g1 : 0.6  
Min Eav: 500  
( $g1 = E_{min}/E_{av}$ )

Desk\_1

Compression Rate

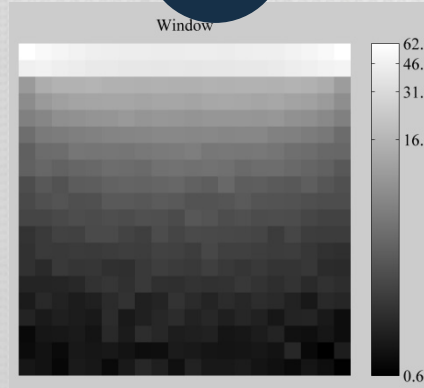
1



g1: 0.531  
Eav: 502



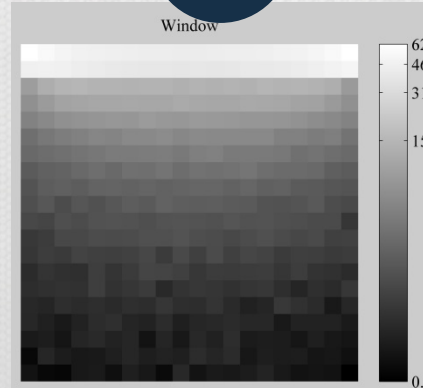
20



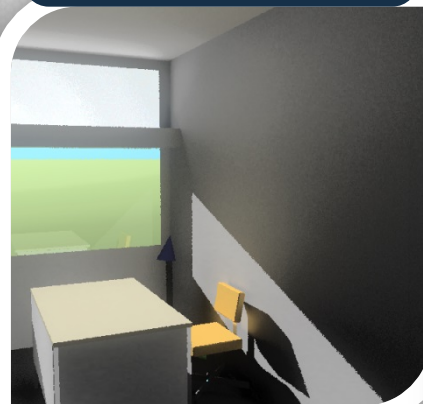
g1: 0.542  
Eav: 504



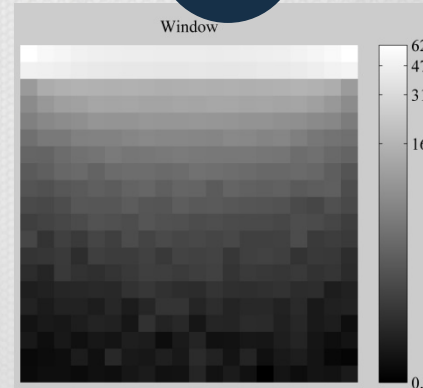
45



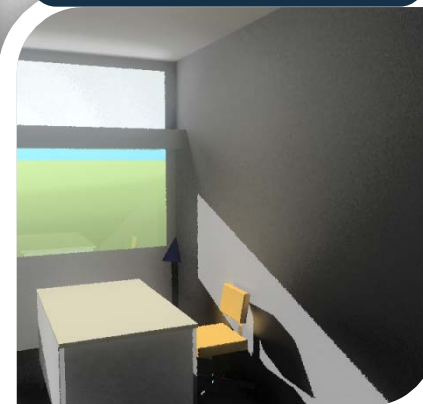
g1: 0.510  
Eav: 504



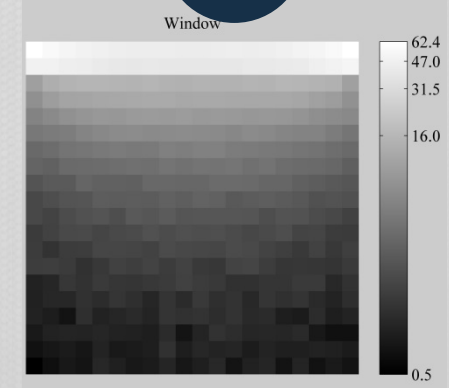
70



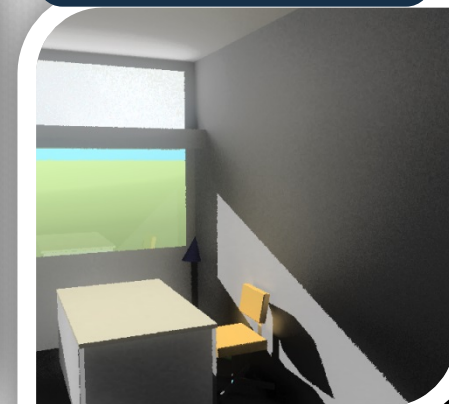
g1: 0.549  
Eav: 509



220



g1: 0.532  
Eav: 511





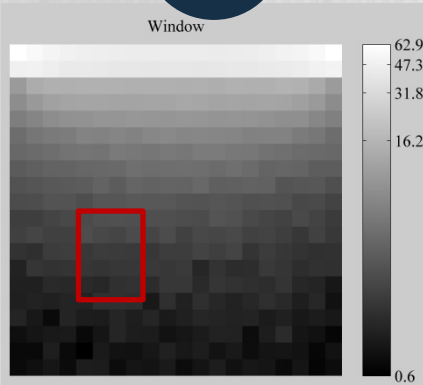
# Daylighting Factor

EN 12464-1 standard  
Min g1 : 0.6  
Min Eav: 500  
(g1=Emin/Eav)

Desk\_2

Compression Rate

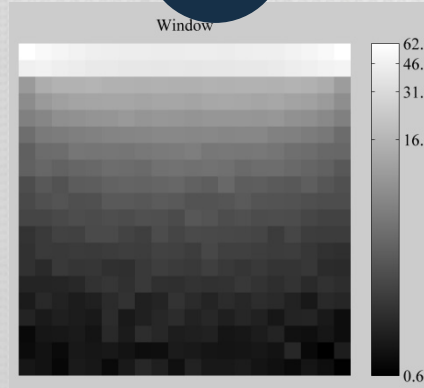
1



g1: 0.757  
Eav: 95



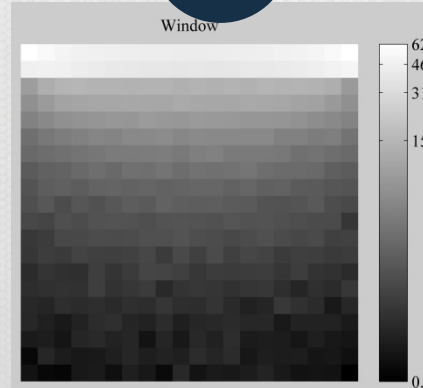
20



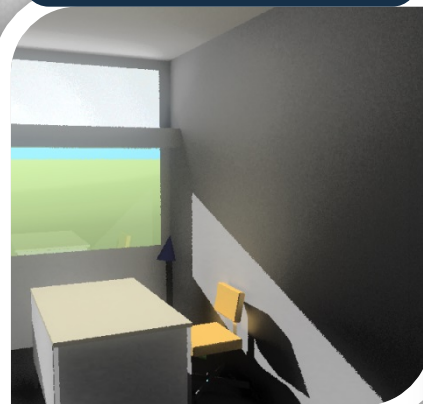
g1: 0.688  
Eav: 99



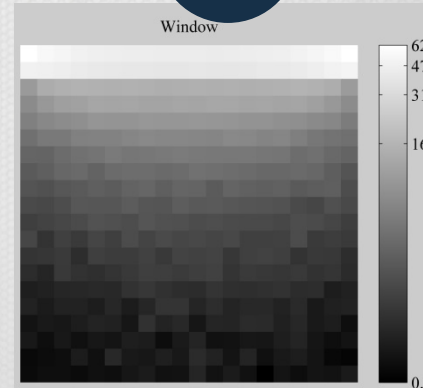
45



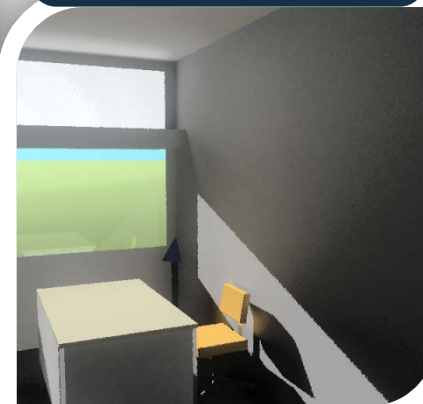
g1: 0.685  
Eav: 98



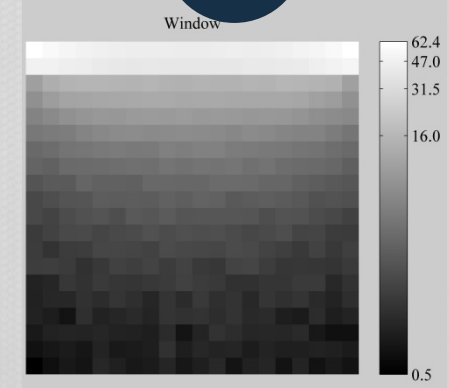
70



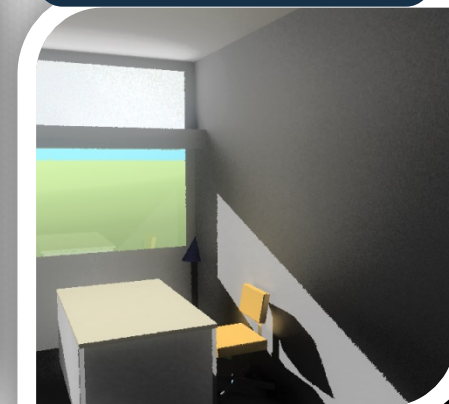
g1: 0.599  
Eav: 101



220



g1: 0.724  
Eav: 101

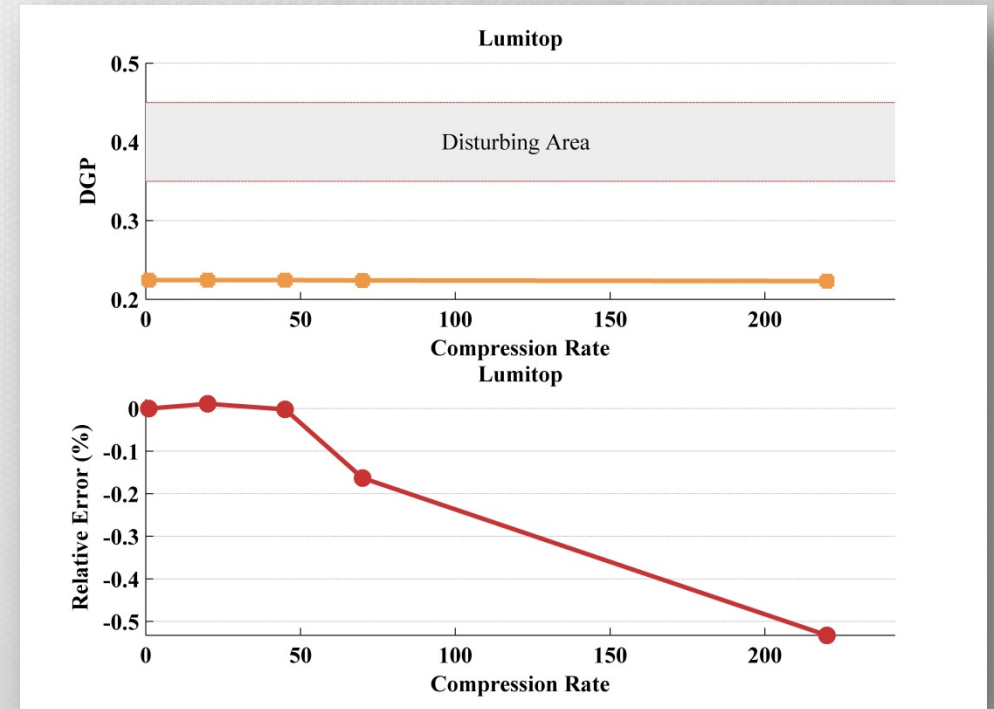
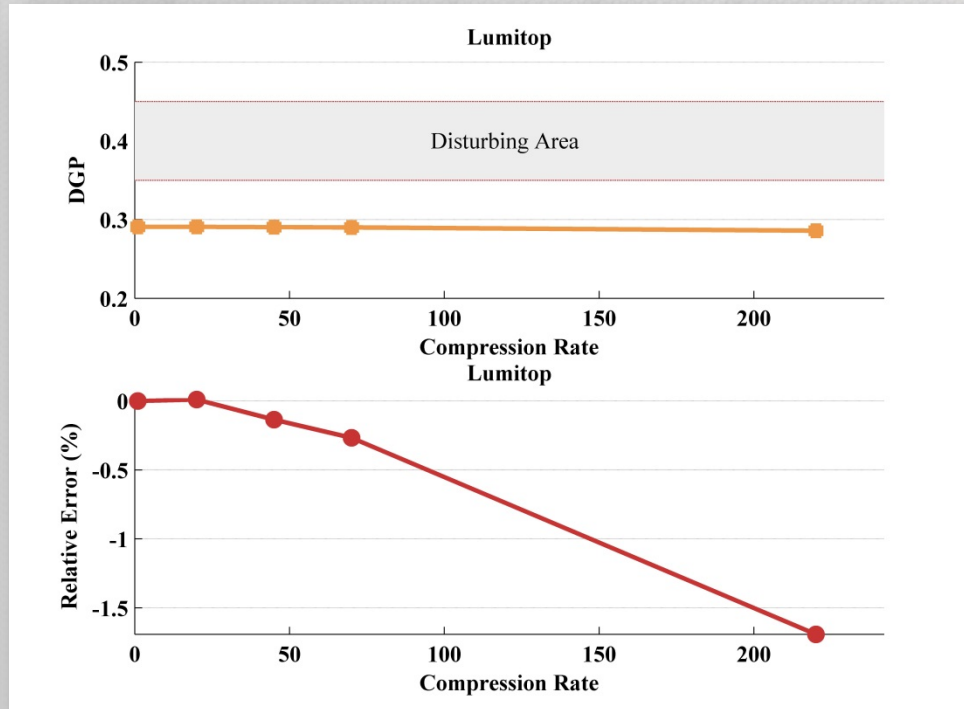


# Glare Risk

Desk\_1

Desk\_2

Daylight Glare Probability (DGP)





# Glare Risk

Compression Rate

1

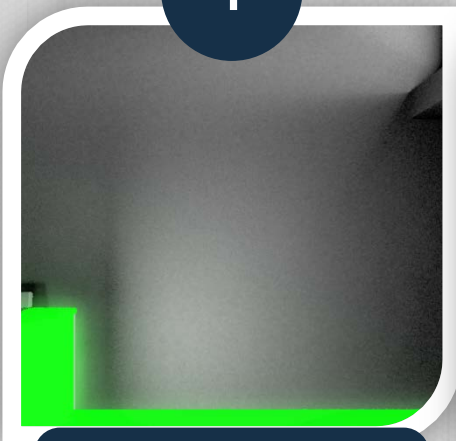
20

45

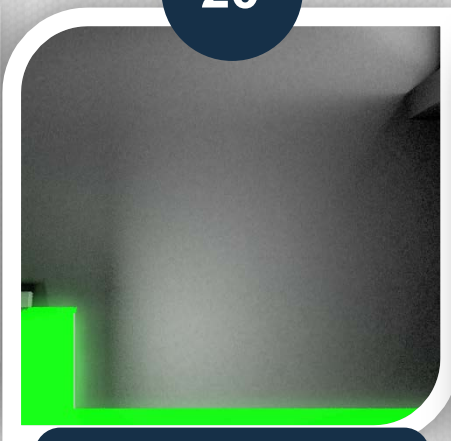
70

220

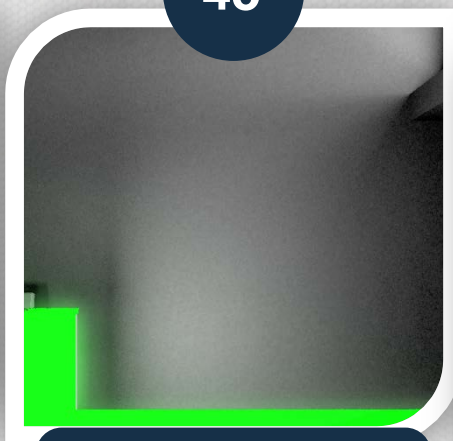
Desk\_1



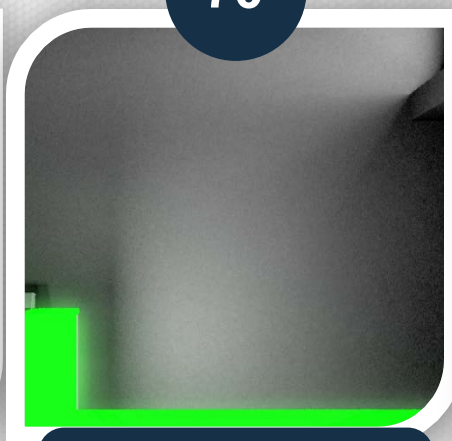
DGP\_1: 0.291  
DGP\_2: 0.224



DGP\_1: 0.291  
DGP\_2: 0.224



DGP\_1: 0.290  
DGP\_2: 0.224

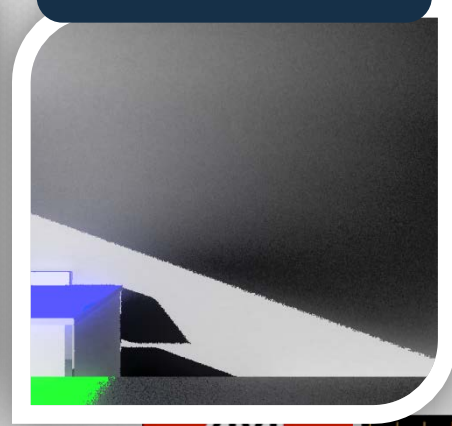
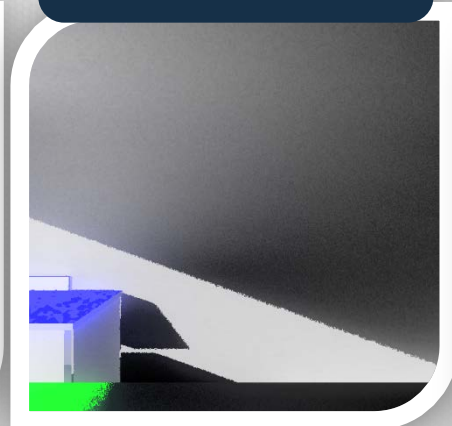
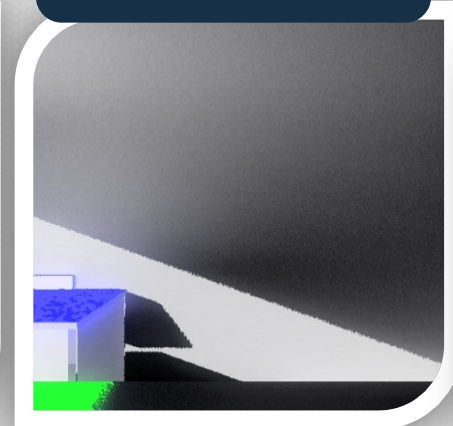
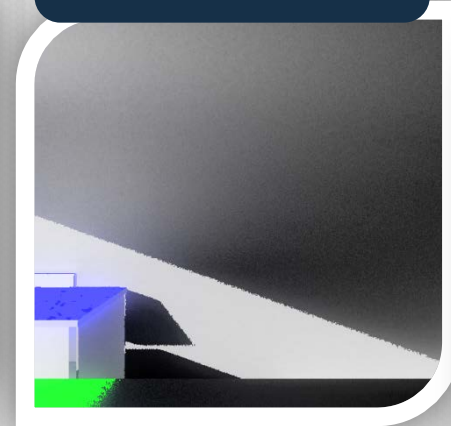
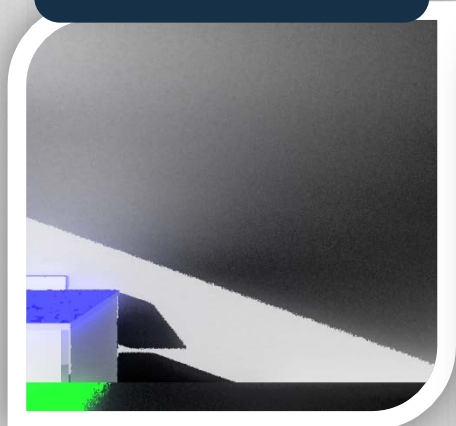


DGP\_1: 0.290  
DGP\_2: 0.224



DGP\_1: 0.286  
DGP\_2: 0.223

Desk\_2



# Conclusion

## Compression

Integrated compression and reconstruction routine

1

2

## Radiance rendering

Radiance rendering of a lesso office with CFS.

## Daylight factor and glare risk

Safe compression rate threshold 45-70

4

3

## Wavelet basis

Compression performance of 3 different wavelet basis.



# Thanks



Thanks for watching