IMMERSIVE VIRTUAL REALITY SCENES USING RADIANCE
COMPARISON OF REAL AND VIRTUAL ENVIRONMENTS

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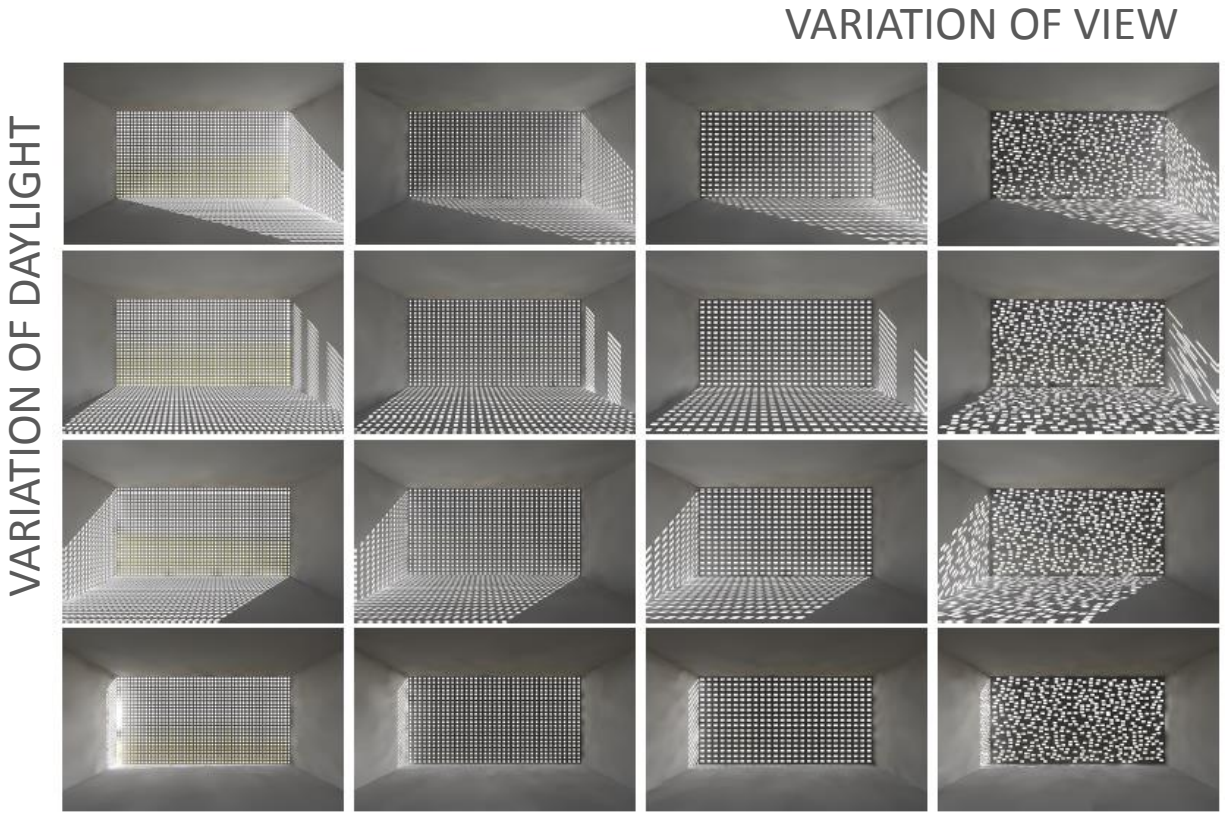
LIPID
Interdisciplinary Laboratory of Performance-Integrated Design

INTRODUCTION

MOTIVATION: KYNTHIA'S DOCTORAL RESEARCH

subjective experiments



Which **pattern factors** (if any) lead to changes in the **perceived spatial ambience***?*

MOTIVATION: KYNTHIA'S DOCTORAL RESEARCH

challenges in real space experiments

- change of façade pattern
- variation of luminous conditions

2D rendering?

- limited luminance range
- lacking immersion

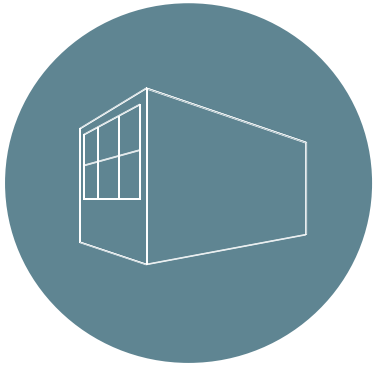
problematic for evaluation of
- pleasantness[1]
- distribution of light[1]

[Cauwerts, 2013[1]]

MOTIVATION: KYNTHIA'S DOCTORAL RESEARCH

Oculus Rift
Virtual Reality Headset

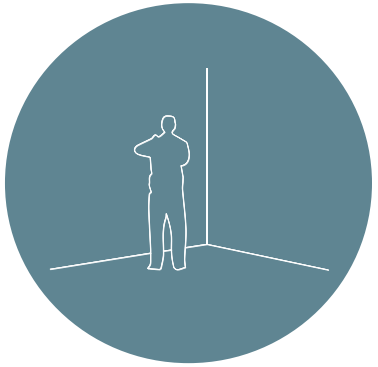
MOTIVATION: KYNTHIA'S DOCTORAL RESEARCH



feasibility study

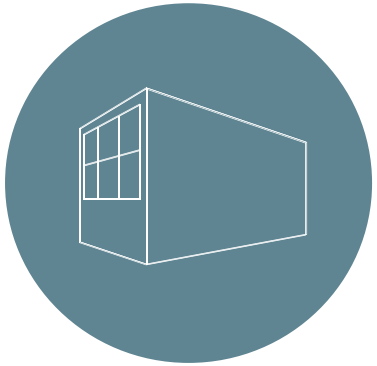
virtual space experiments

statistical model



real space experiments

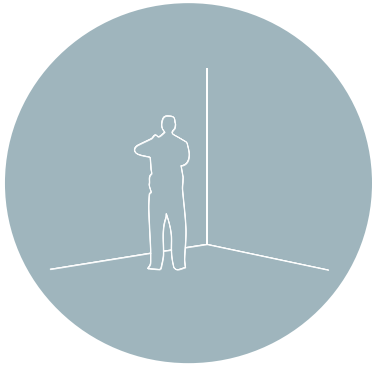
MOTIVATION: KYNTHIA'S DOCTORAL RESEARCH



feasibility study

virtual space experiments

statistical model

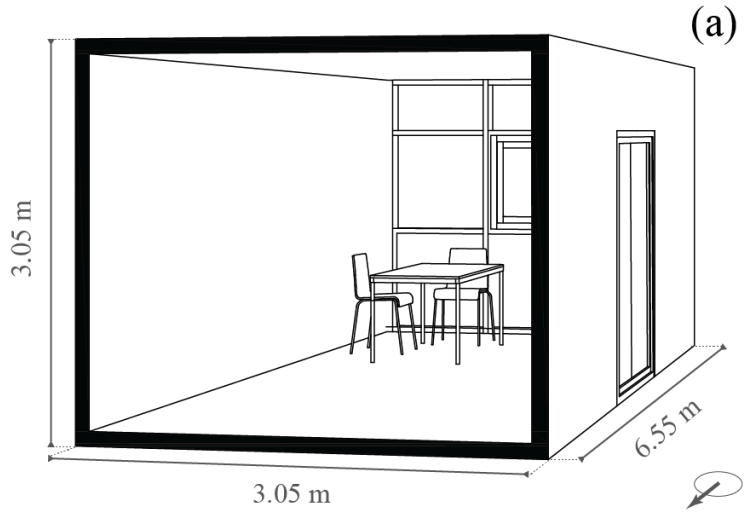


real space experiments

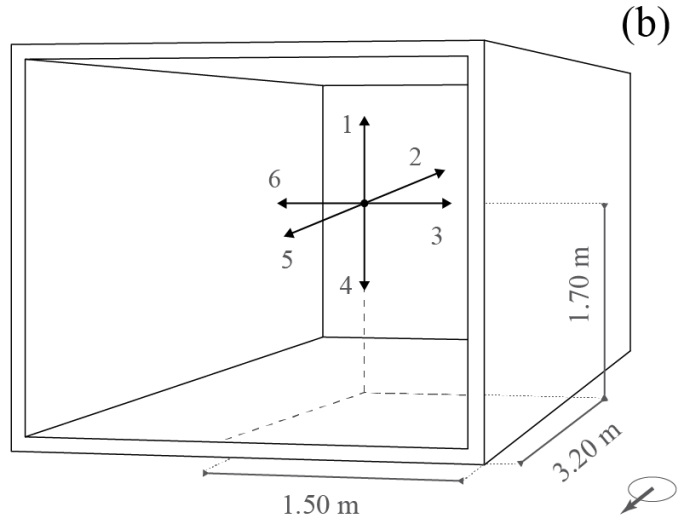
FEASIBILITY STUDY: GENERATION OF VIRTUAL SCENES

Immersive virtual representation
of the DEMONA **test room**

DEMONA test room,
EPFL



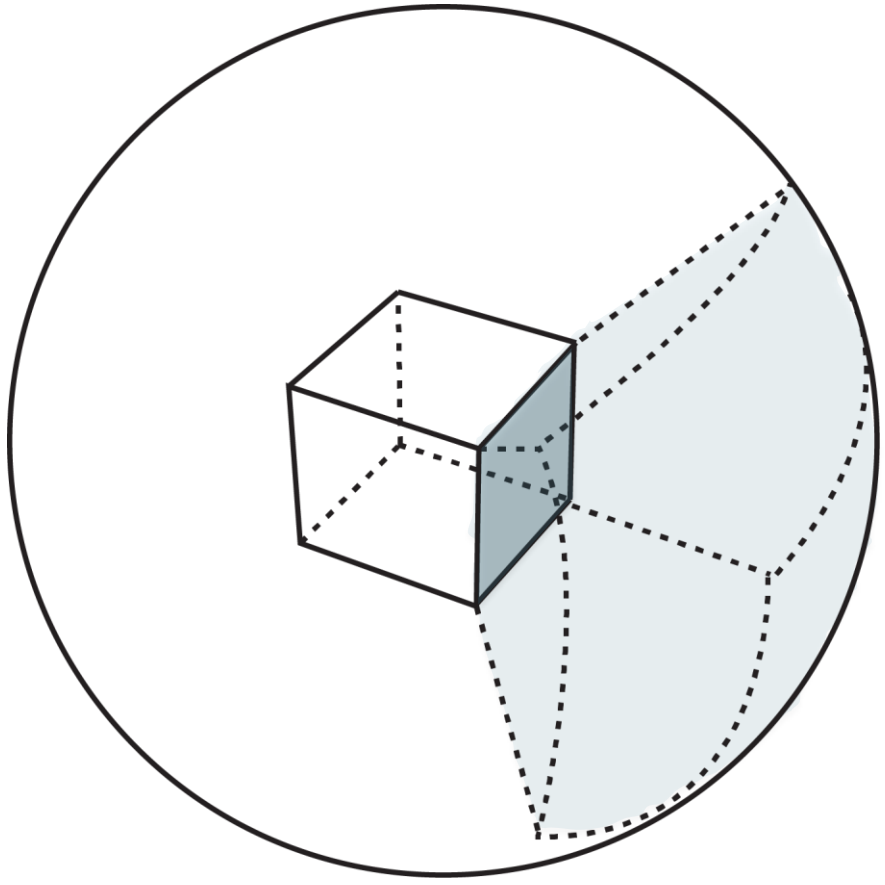
3D model of the test room

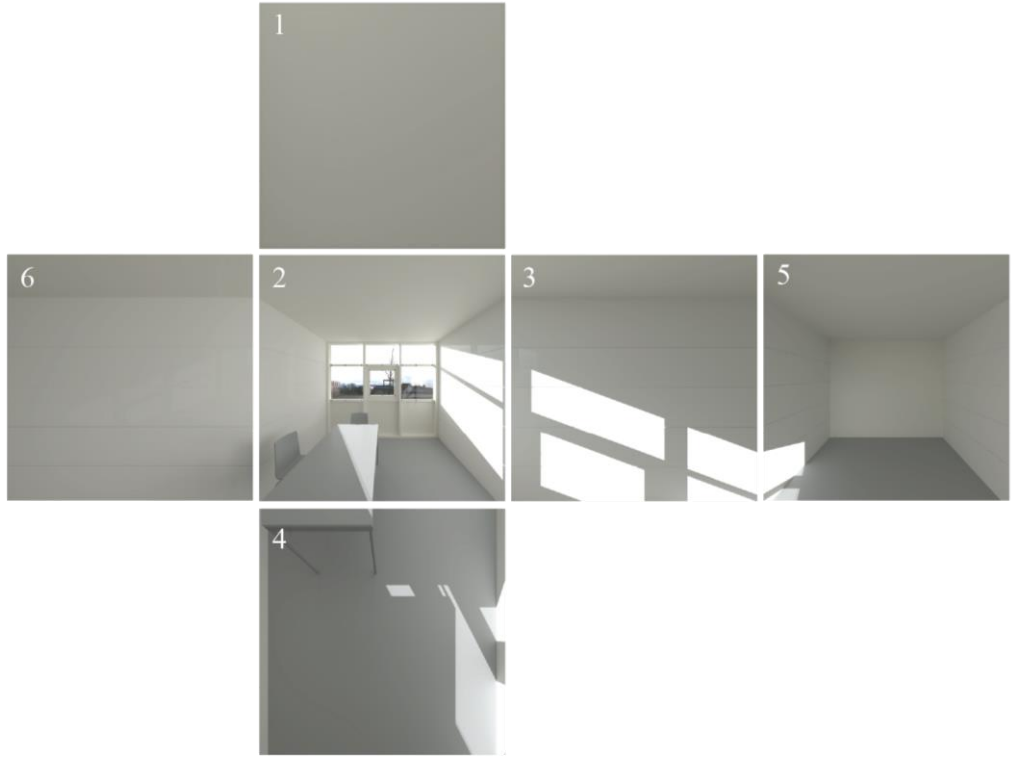


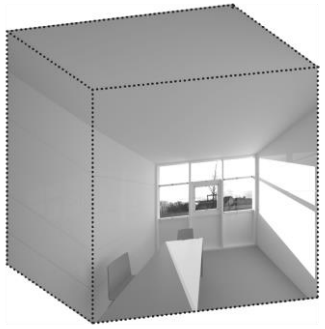
viewpoint set
in the center of the room

FEASIBILITY STUDY: GENERATION OF VIRTUAL SCENES

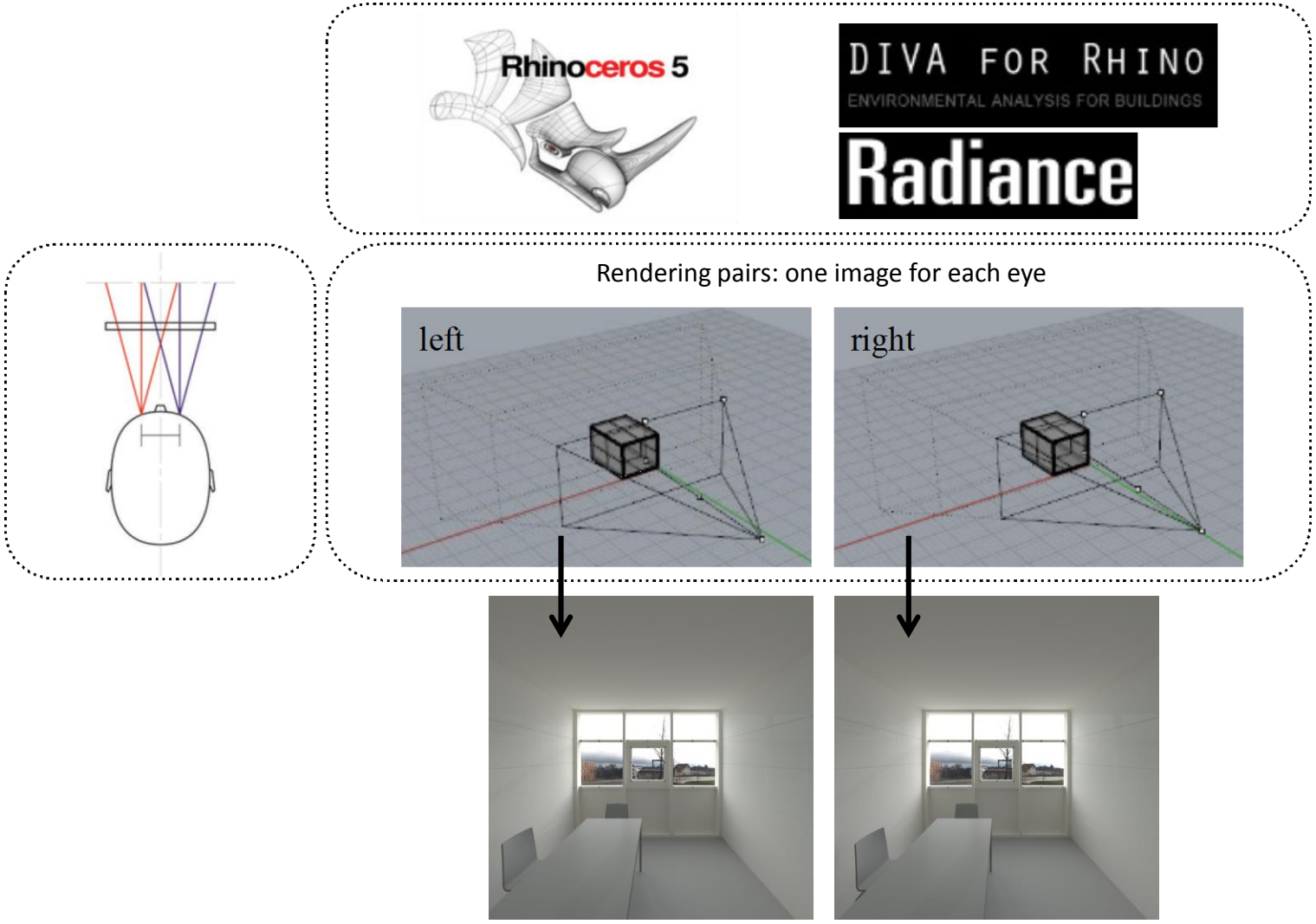
Immersive virtual representation
of the DEMONA **test room**



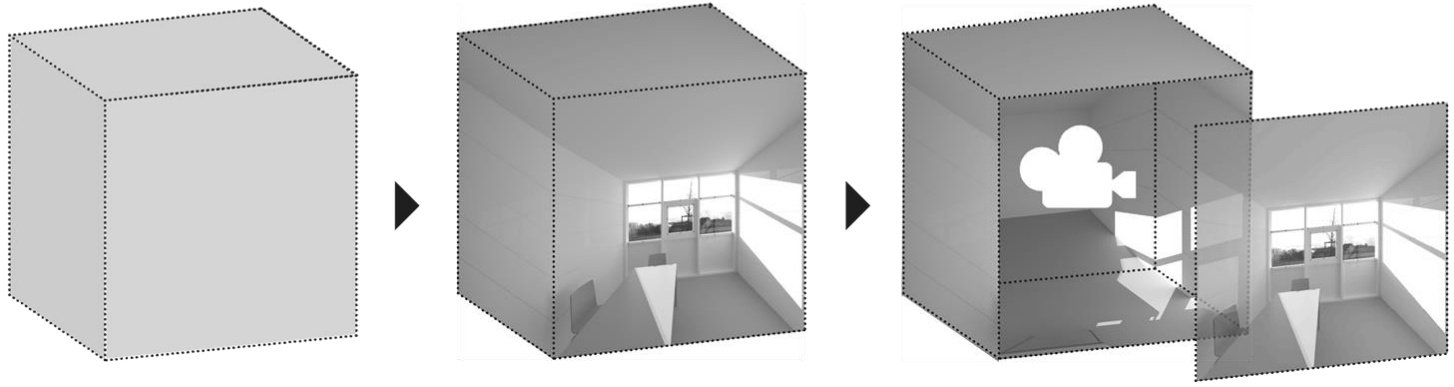




FEASIBILITY STUDY: GENERATION OF VIRTUAL SCENES



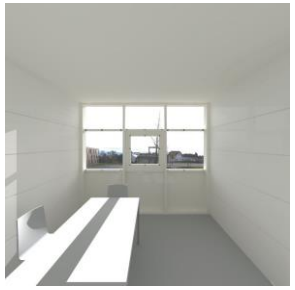
FEASIBILITY STUDY: GENERATION OF VIRTUAL SCENES

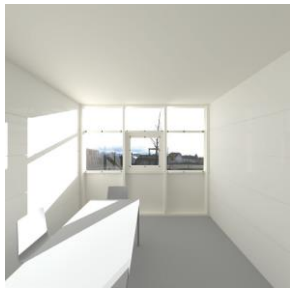


EXPERIMENTAL RESULTS

FEASIBILITY STUDY: REAL VERSUS VIRTUAL SPACE







9:30 10:30 11:30 12:30 13:30 14:30 15:30

10 immersive
virtual scenes

7 with **clear** sky

hourly time steps
from 9:30-15:30

3 with **overcast** sky

different
view out conditions

presented according
*to **similarity***
with conditions
in real space

limited similarity
due to time constraints

FEASIBILITY STUDY: REAL VERSUS VIRTUAL SPACE

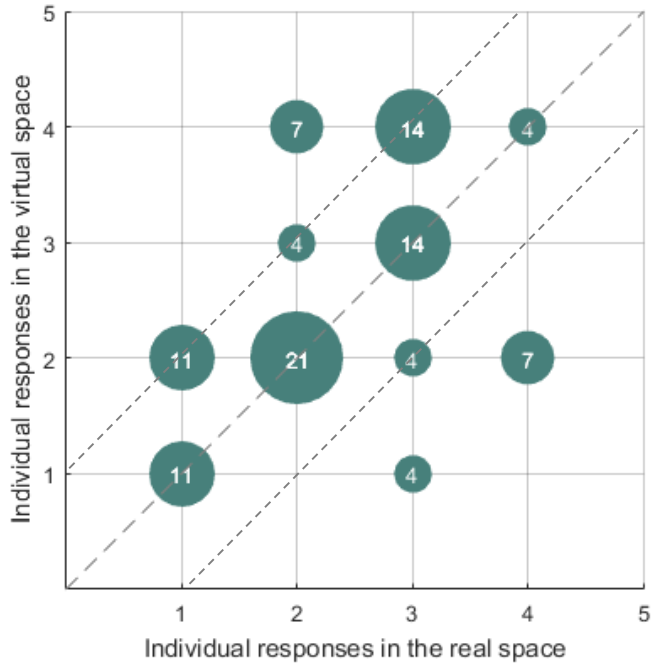
subject exploring
the **virtual** space

subject exploring
the **real** space

- *ambience* questionnaire for each space
- physical symptoms *before* and *after* the session
- perceived presence in the virtual environment

RESULTS: EVALUATION OF REAL VERSUS VIRTUAL SPACE

How **pleasant** do you find this space?

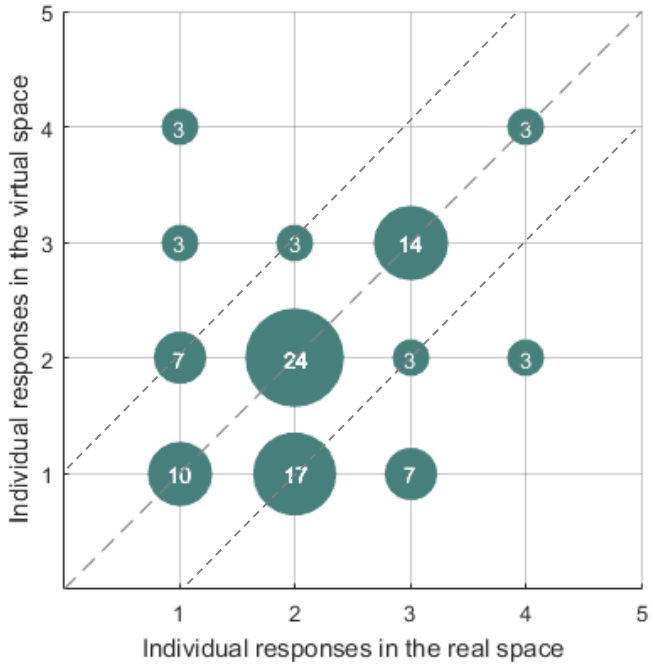


scatter plot mark text = frequency of responses (%)

	N subjects	*Percentage of pairs with absolute difference (%)*		
		0	*1*	*0 and 1*
pleasant	28	**50**	32	**82**
interesting	29	**52**	31	**83**
complex	29	**76**	24	**100**
exciting	28	43	47	**90**
satisfied with amount of view	29	**52**	45	**97**

RESULTS: EVALUATION OF REAL VERSUS VIRTUAL SPACE

How **interesting** do you find this space?



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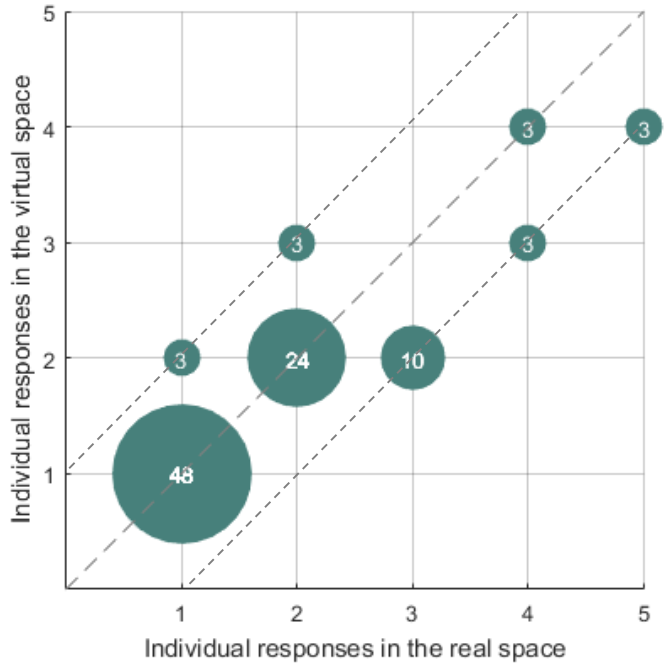
RESULTS: EVALUATION OF REAL VERSUS VIRTUAL SPACE

How **complex** do you find this space?



scatter plot mark text =
frequency of responses (%)

	N subjects	*Percentage of pairs with absolute difference (%)* *0*	*1*	*0 and 1*
pleasant	28	**50**	32	**82**
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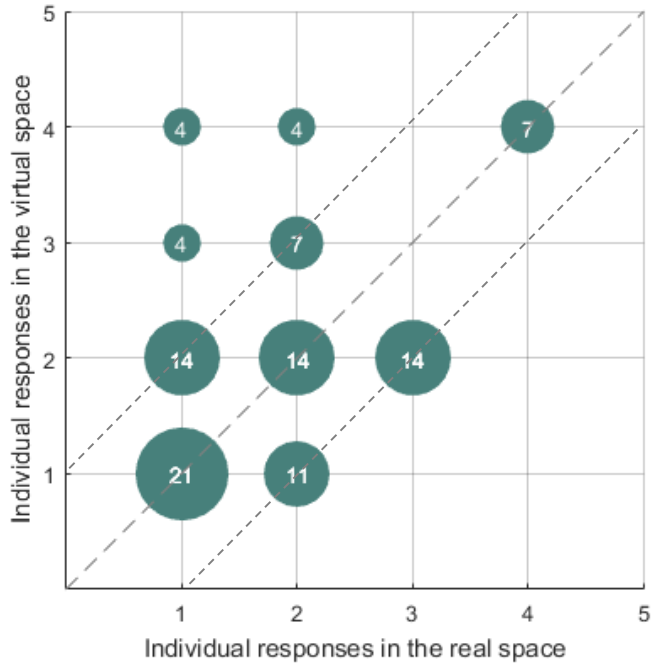
RESULTS: EVALUATION OF REAL VERSUS VIRTUAL SPACE

How **exciting** do you find this space?



scatter plot mark text =
frequency of responses (%)

	N subjects	Percentage of pairs with absolute difference (%) 0	1	0 and 1
pleasant	28	**50**	32	**82**
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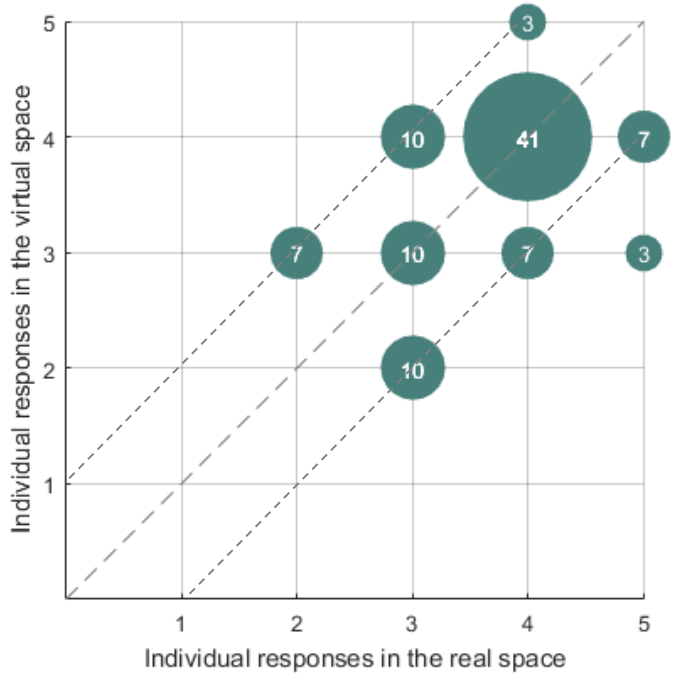
RESULTS: EVALUATION OF REAL VERSUS VIRTUAL SPACE

How **satisfied** are you with the **amount of view** in this space?



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	N subjects	*Percentage of pairs with absolute difference (%)* *0*	*1*	*0 and 1*
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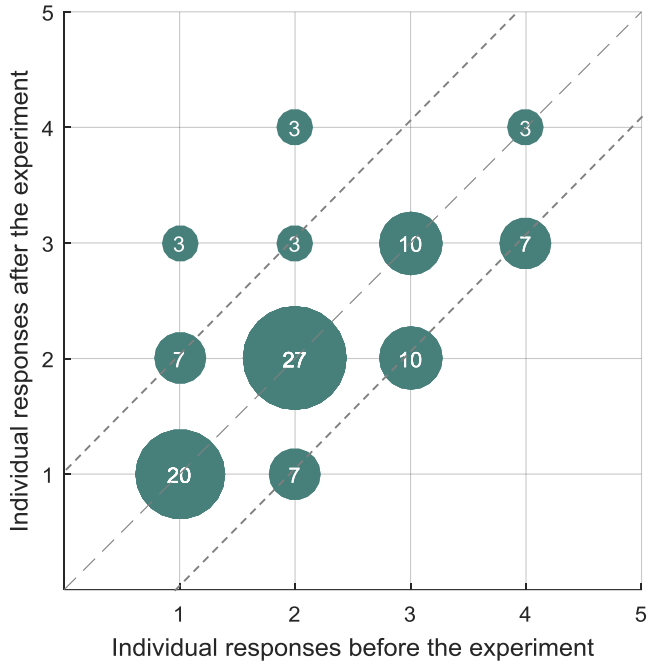
RESULTS: EVALUATION OF REAL VERSUS VIRTUAL SPACE

marked attributes:
adequate perceptual accuracy in the virtual space

	N subjects	*Percentage of pairs with absolute difference (%)*				
		0	*1*	*2*	*3*	*0 and 1*
pleasant	28	**50**	32	18	0	**82**
interesting	29	**52**	31	14	3	**83**
complex	29	**76**	24	0	0	**100**
exciting	28	43	47	7	3	**90**
satisfied with amount of view	29	**52**	45	3	0	**97**

RESULTS: PHYSICAL SYMPTOMS BEFORE AND AFTER THE USE OF VR

How **fatigued** do you feel?

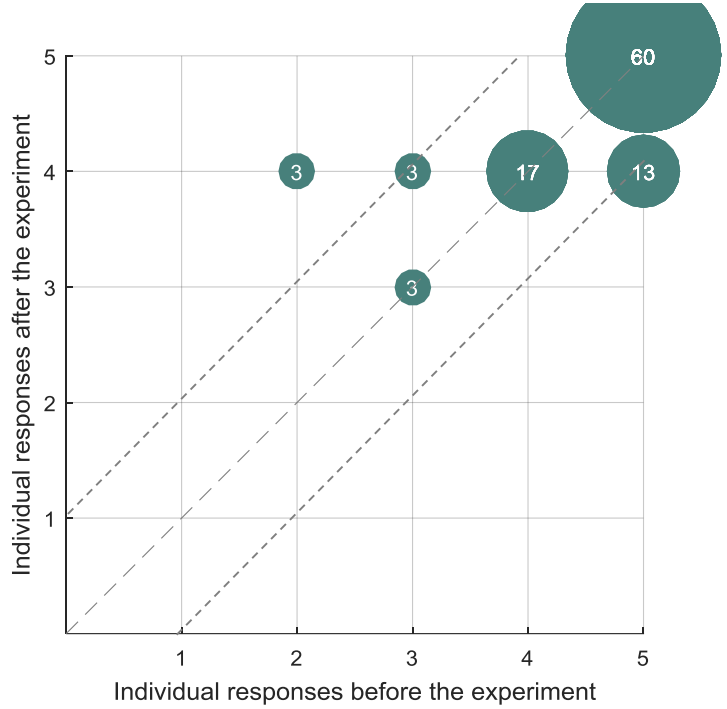


scatter plot mark text =
frequency of responses (%)

	N subjects	Percentage of pairs with absolute difference (%) 0	1	0 and 1
fatigue	30	**60**	34	**94**
clear vision	30	**80**	16	**96**
fresh head	30	44	43	**87**
sore eyes	30	**66**	22	**88**

RESULTS: PHYSICAL SYMPTOMS BEFORE AND AFTER THE USE OF VR

How **clear** is your vision?



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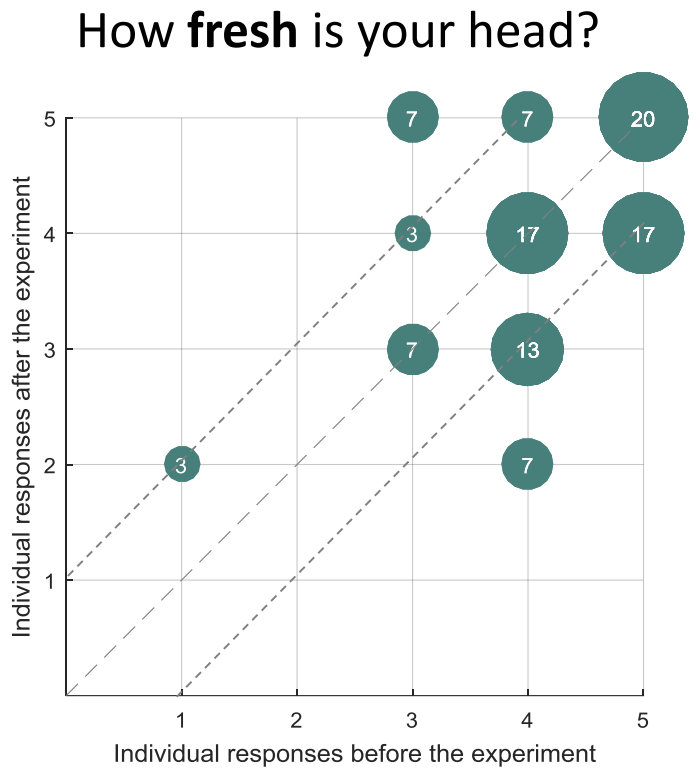

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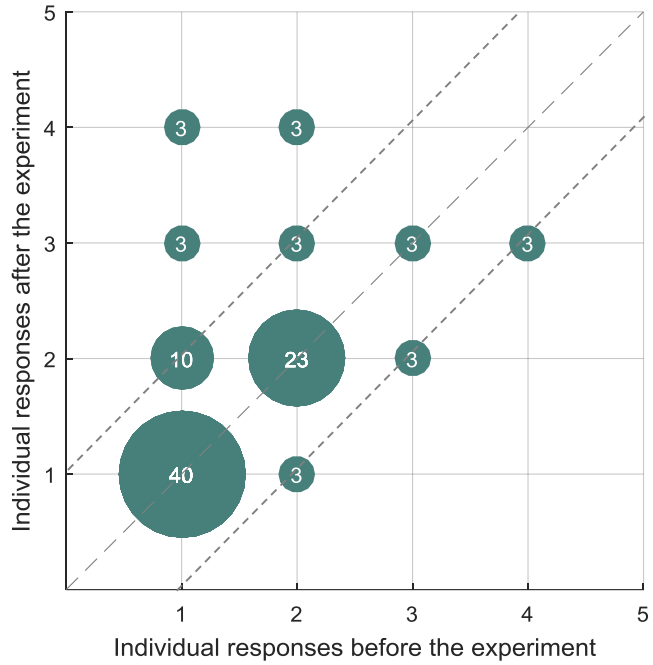
RESULTS: PHYSICAL SYMPTOMS BEFORE AND AFTER THE USE OF VR

How **sore** are your eyes?



scatter plot mark text = frequency of responses (%)

	N subjects	*Percentage of pairs with absolute difference (%)*		
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fatigue	30	**60**	34	**94**
clear vision	30	**80**	16	**96**
fresh head	30	44	43	**87**
sore eyes	30	**66**	22	**88**

Results: Evaluation of Real versus Virtual Space

marked attributes:
negligible physical symptoms after the use of the VR headset

	N subjects	*Percentage of pairs with absolute difference (%)*		
		0	*1*	*0 and 1*
fatigue	30	**60**	34	**94**
clear vision	30	**80**	16	**96**
fresh head	30	44	43	**87**
sore eyes	30	**66**	22	**88**

Questionnaire based on Shibata et al., 2011.

RESULTS: PRECEIVED PRESENCE IN THE VIRTUAL SPACE

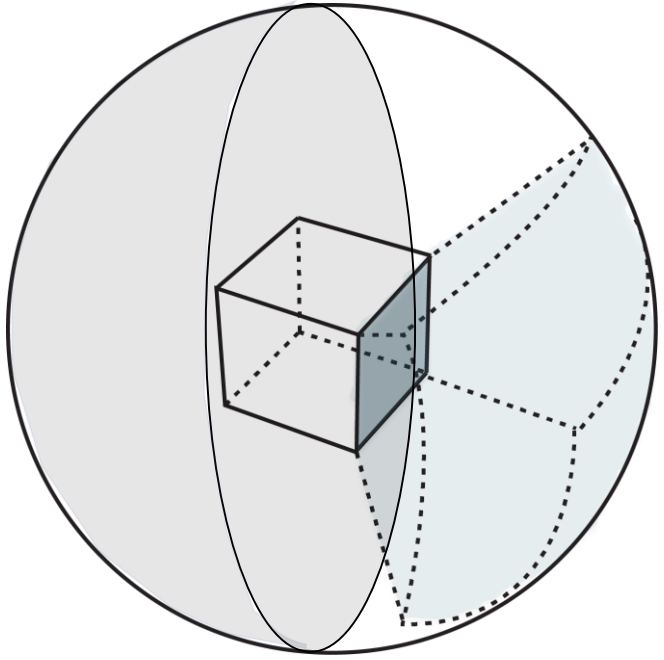
[PR1] How much did you feel like "**being there**" in the **virtual space**?

Questionnaire based on Witmer and Singer, 1994.

ONGOING & FUTURE WORK

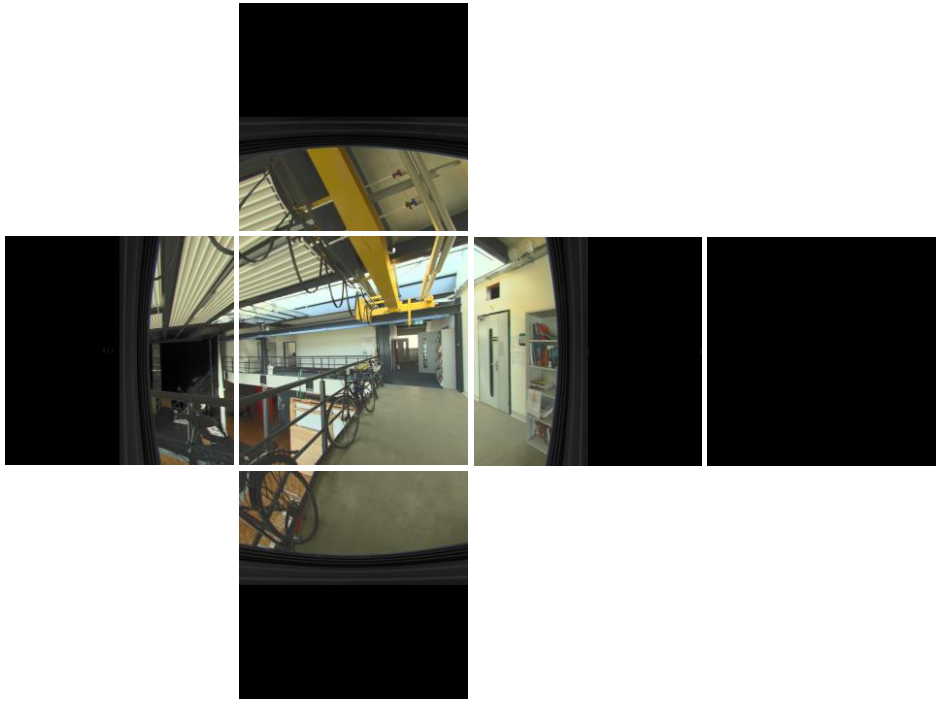
ONGOING AND FUTURE WORK

Immersive **hemispherical scene** from **HDR photograph**



immersive
hemisphere

180° fisheye image
with a SIGMA 4.5mm F2.8 lens



cube mapping using *pinterp*
(monoscopic projection)

ONGOING AND FUTURE WORK

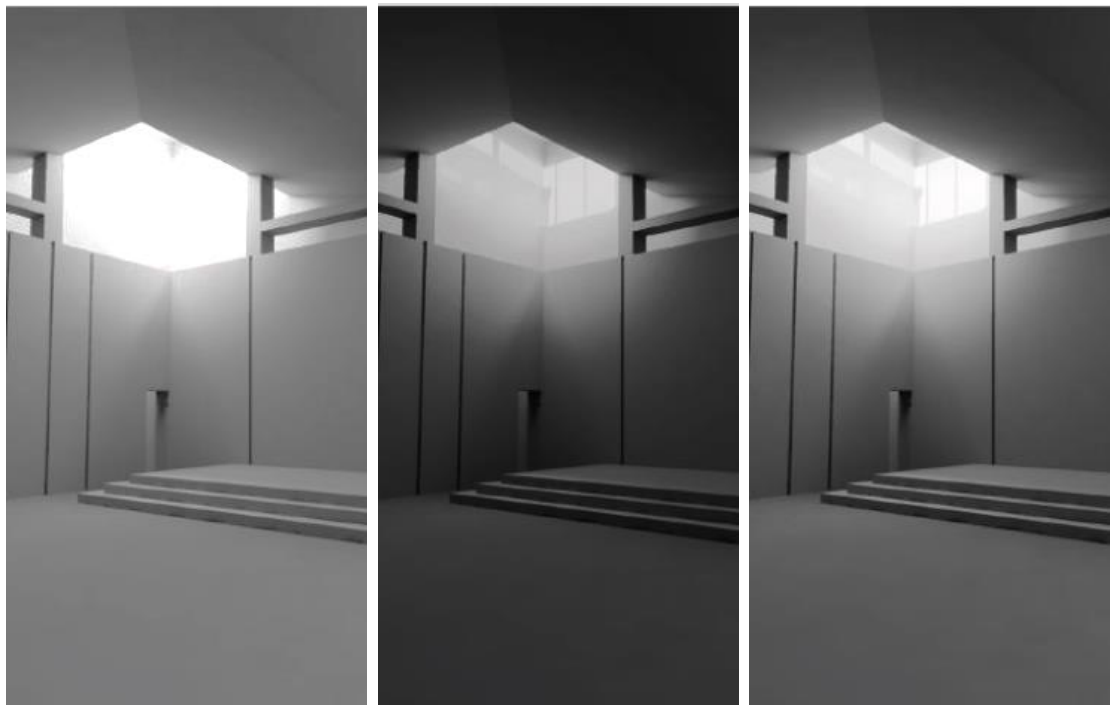
180° fisheye HDR
with a SIGMA 4.5mm F2.8 lens

adequacy of tonemapping algorithms
in immersive virtual environments

perceptual accuracy of device (Oculus Rift CV1)
in photographic immersive scenes

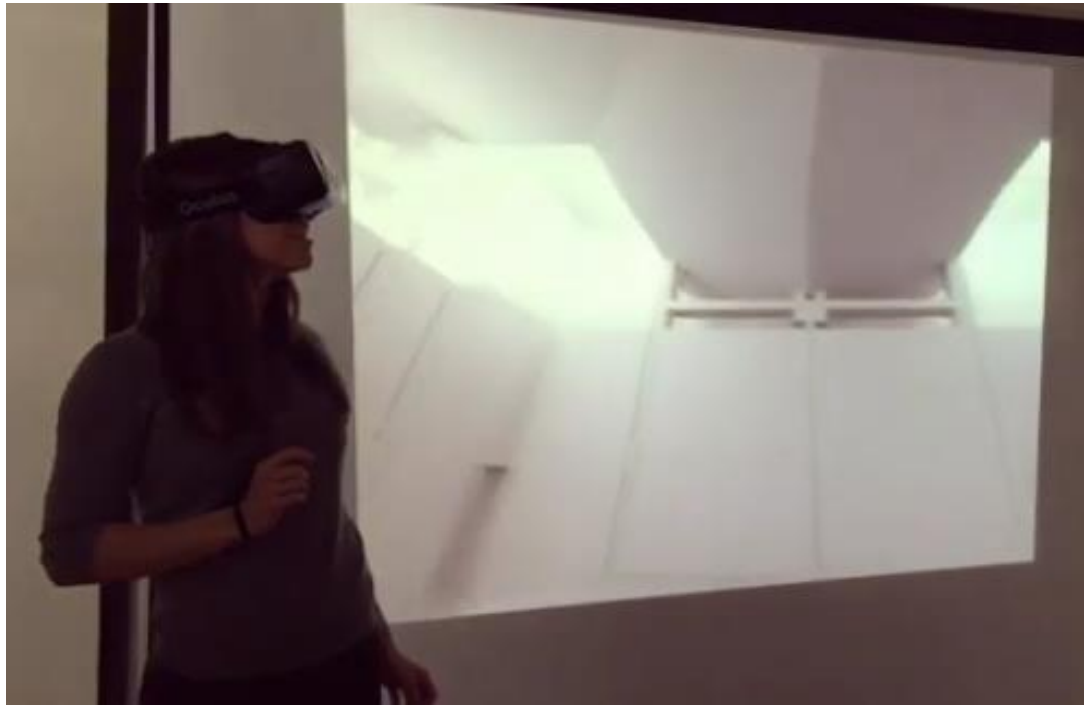
ONGOING AND FUTURE WORK

improvement of **perceptual accuracy** of the **virtual scene**



tone-mapping algorithm,
new VR headset,
scene details & view out

VR **immersion** in **architectural spaces**



upcoming experiment
with Siobhan Rockcastle

Thank you! ☺

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