Lucerne University of
Applied Sciences and Arts

HOCHSCHULE
LUZERN

Engineering & Architecture

Simulation of reflected sunlight from building façade to the neighbourhood

- Work in progress

Competence Centre Envelopes and Solar Energy
Xiaoming Yang
wissenschaftlicher Mitarbeiter

T direct +41 41 349 39 70
xiaoming.yang@hslu.ch

Horw 9/13/12

11th International Radiance Workshop Copenhagen

Overview

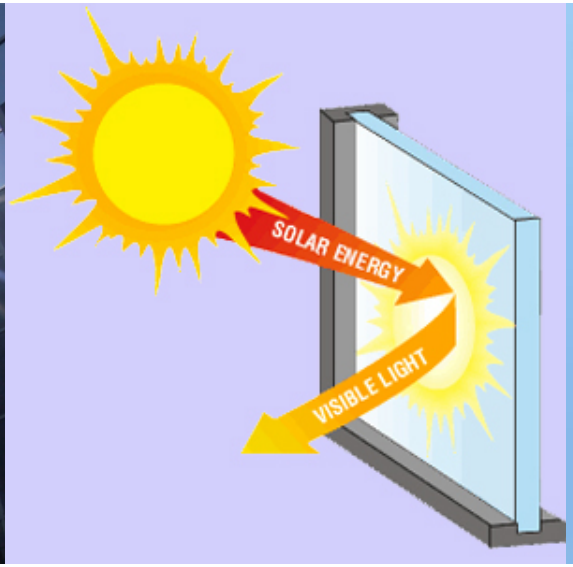
- Background
- Objective
- Method
- Discussion

Background

- Outdoor glare result of sunlight reflection from building envelope is getting worse and more frequent.

- *More high rise building with curtain walls*
- *Application of energy efficient material with high reflectance*
- *Free formed façade with concave surfaces*

curtain walls



high reflectance material

Free formed façade

Background

- Current approaches to eliminate the problem

- Regulations:control the use of building materials based on reflectivity alone
- Academic: A study on Walt Disney Concert Hall, fixed view simulation followed by digital process of photographs
- Industry: Glare protractor method based on solar chart and plan view of the assessed building

Objective

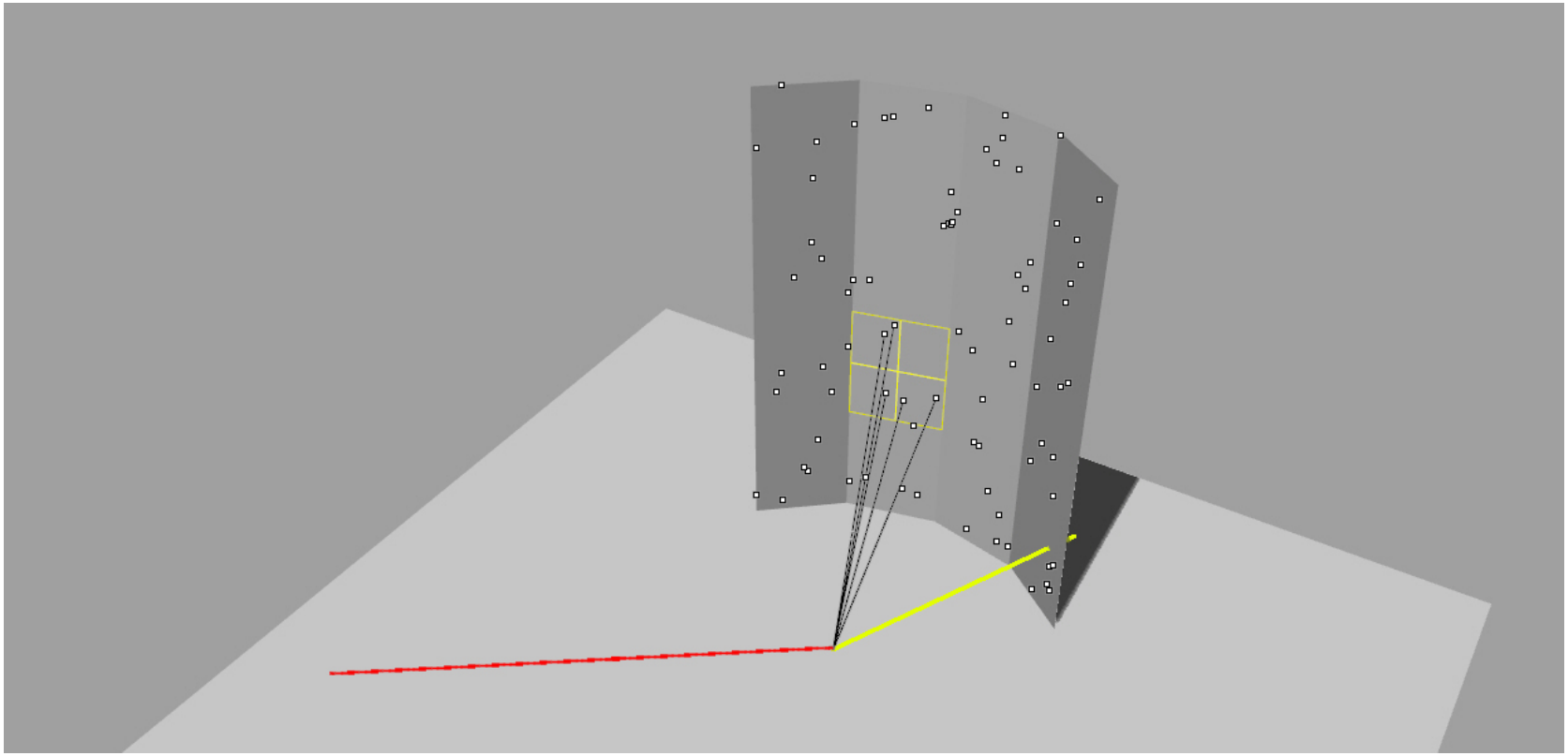
- A prediction method for outdoor glare caused by sunlight reflection from building envelope to neighbourhood

- *How is the neighbourhood affected*
- *How does the assessed building envelope generate the effect*
- *Assist designers to optimize the form of the envelope and make façade material selection*

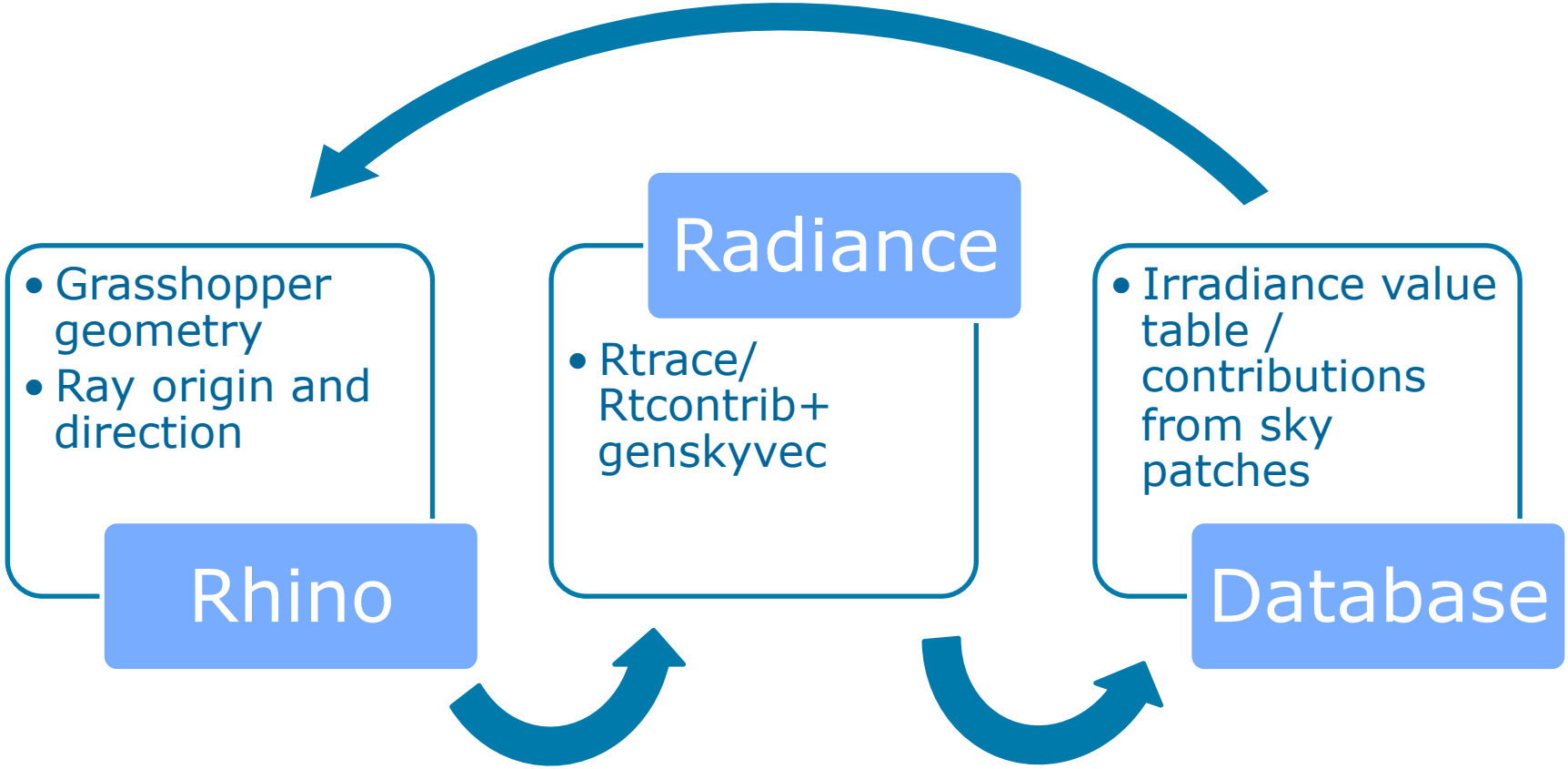
Method

- Calculate contribution of irradiance from each mesh face of the assessed building envelope to testing points around.
- Annual simulation to find worst scenario and overall performance
- Platform: Rhino+Grasshopper for geometry manipulation and optimization

  DIVA is lovely but $rtrace\ -I$ only



Method


• Grasshopper geometry
• Ray origin and direction
Rhino
Radiance
• Rtrace/ Rtcontrib+ genskyvec
• Irradiance value table / contributions from sky patches
Database

Method

- Approach 1:rtrace

- Find mesh faces which could directly reflect sun into test point
- Send random rays to these mesh faces until the running mean stabilized
- Send random rays to the rest of the mesh faces

Method

- Approach 2:rtcontrib+sky patches

- Send random rays to each mesh face
- Calculate contribution from each sky patch to each random ray
- Efficient for annual simulation

Method

- Approach 3:three phase method?

- i = VTDs => i = VRDs

  (Transmission matrix=>Reflection matrix)

- Less computational cost for changing materials

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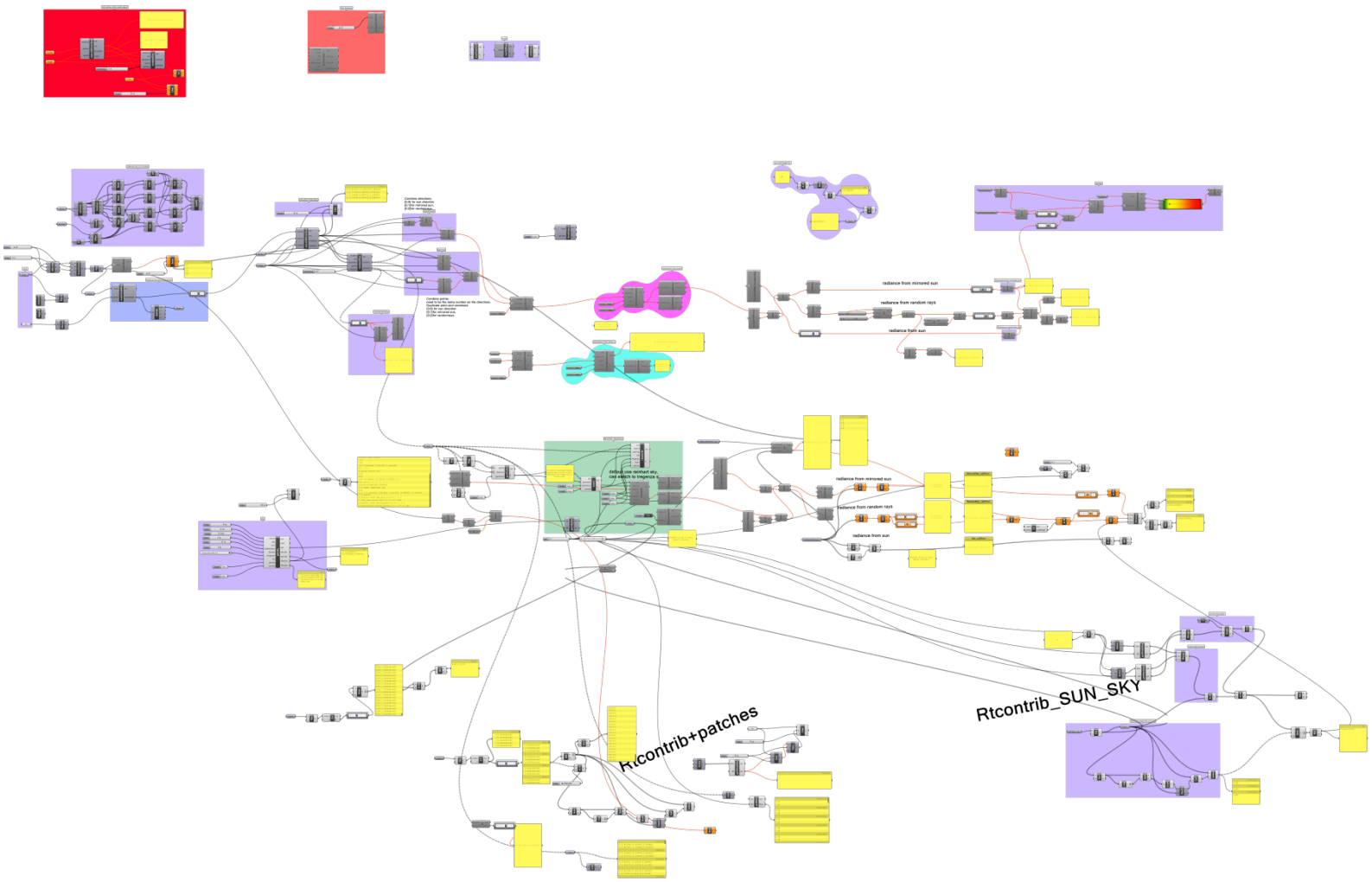
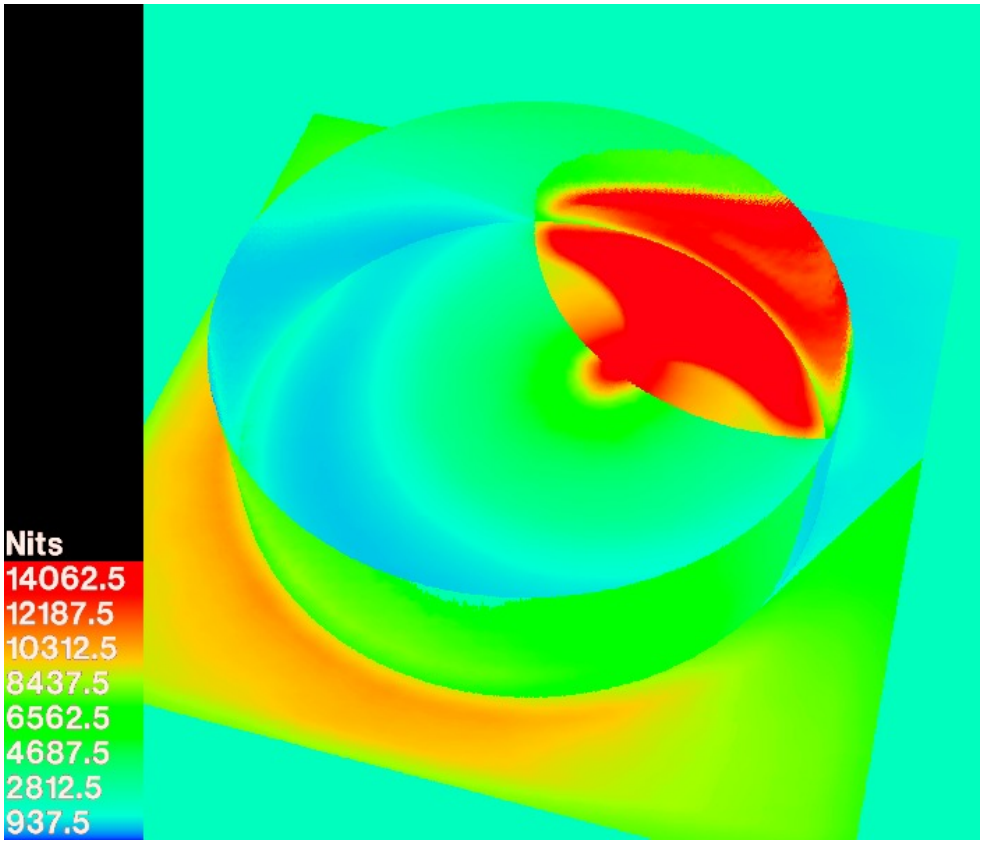
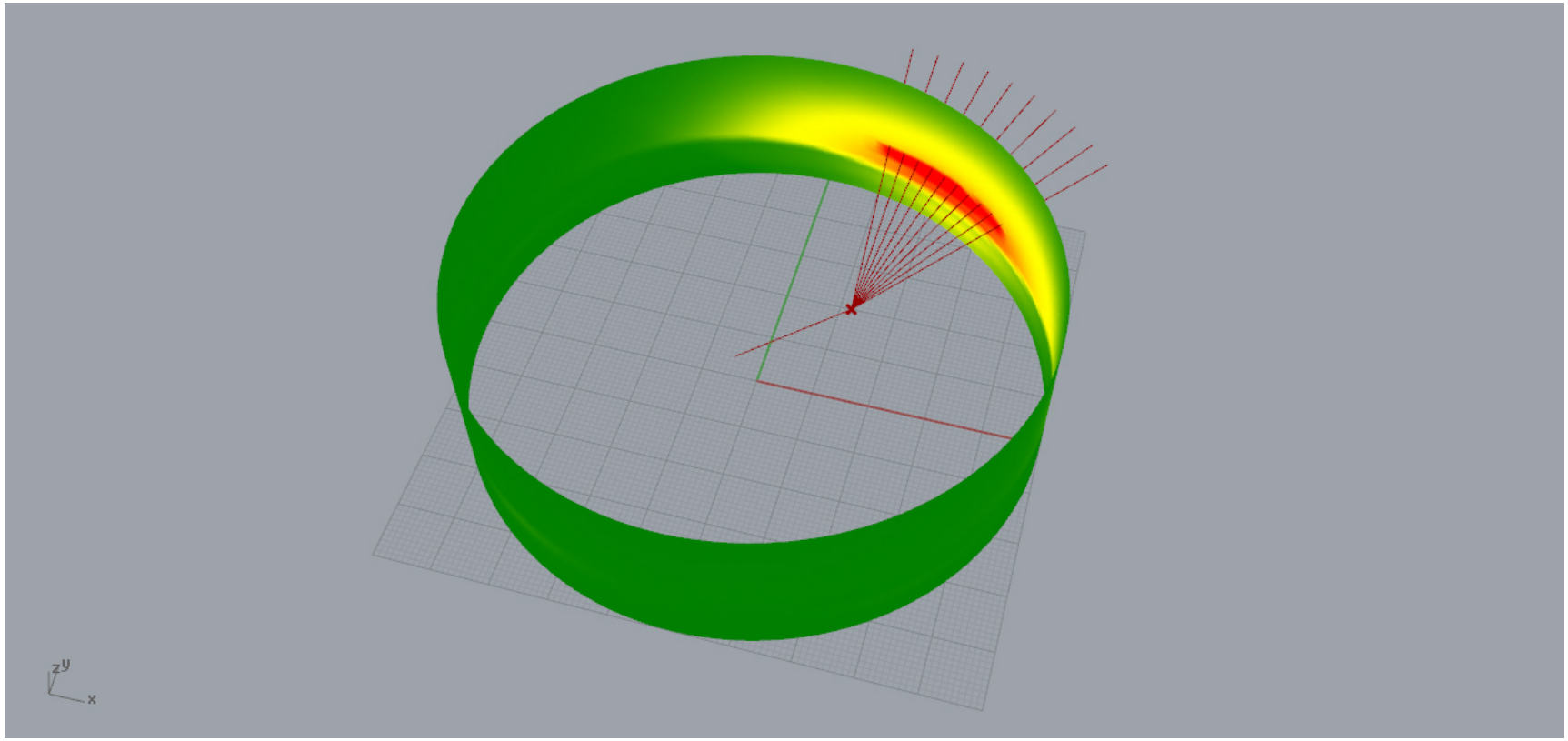

Rtcontrib+patches
Rtcontrib_SUN_SKY

Test case: A specular ring



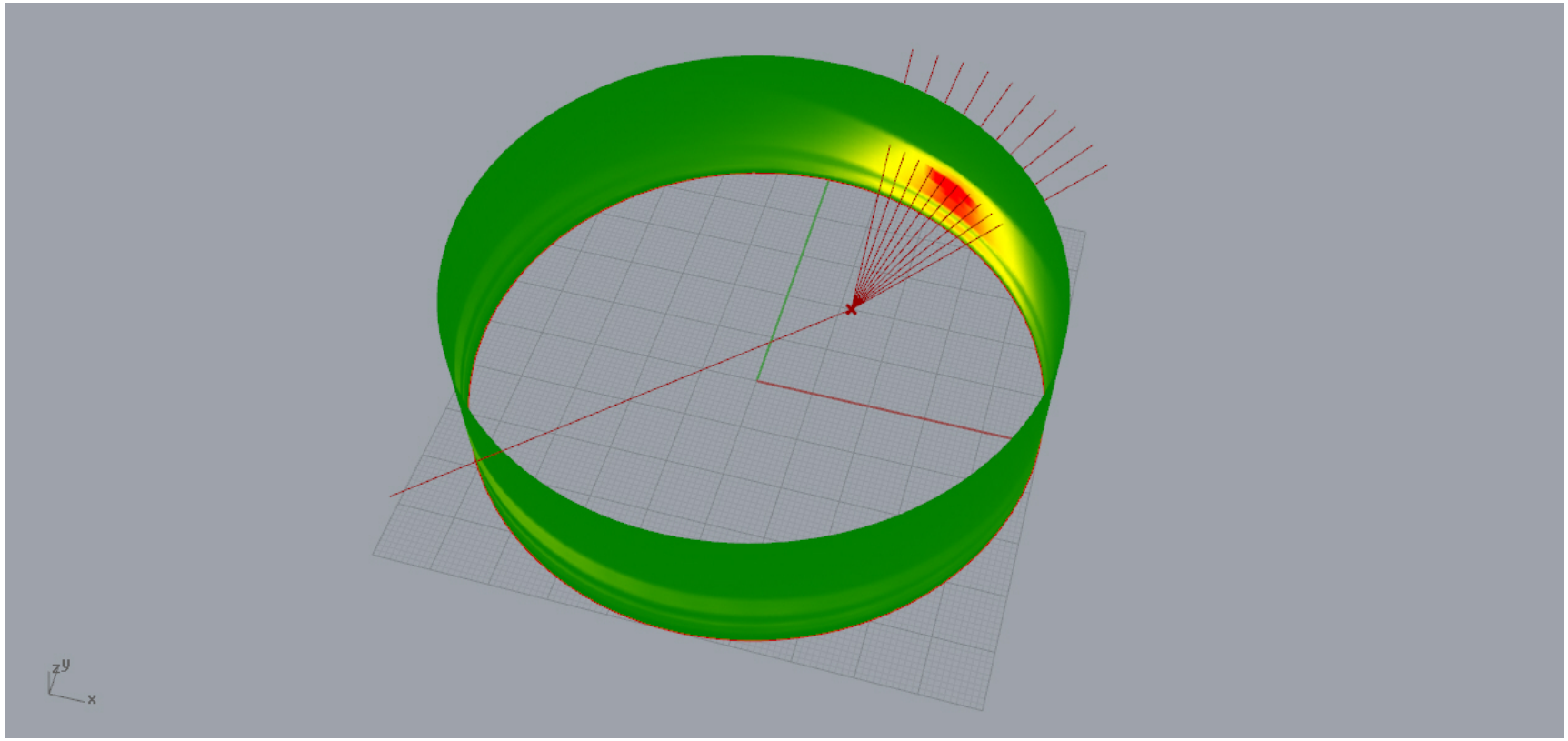
Rendering using Pmap

Approach 1:rtrace

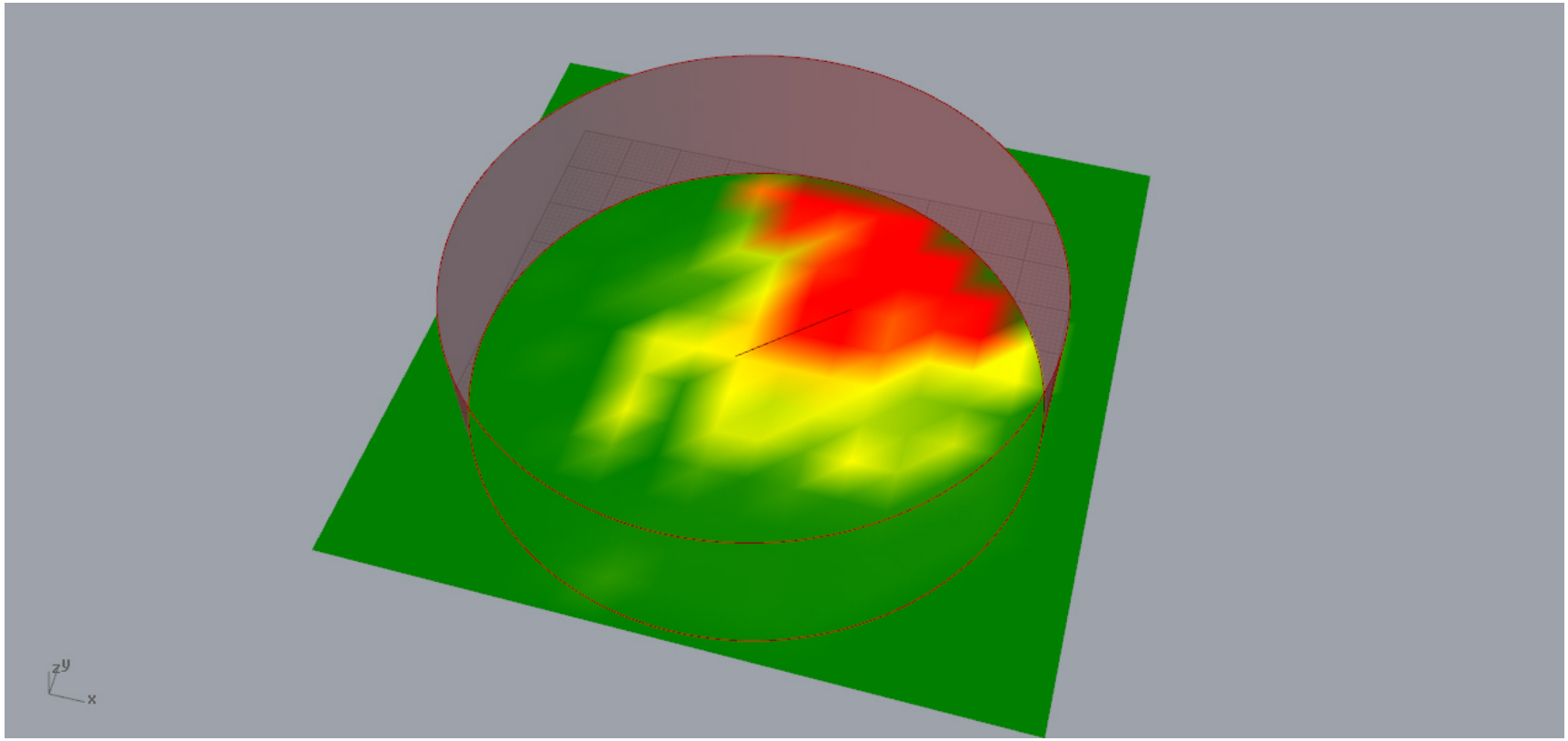


Contribution from mesh to irradiance at testing point

Approach 2:rtcontrib+sky patches



Contribution from mesh to irradiance at testing point



Irradiance at testing points

Discussion

	Approach 1	Approach 2
Difference to Pmap result	-1.4%	-46.1%

What is wrong?

echo 0 0 0 0 0 1| rtcontrib -faa -h -e MF:2 -f reinhart.cal -bn 578 -b rbin -ab 1 -ad 8192 -lw 0.0001 -ar 256 -V- -m sky_glow sceneRtcontrib.oct

References

- www.eclipsetints.com
- www.ladowntownnews.com
- www.lasvegassun.com
- www.vidracariasantacatarina.com.br

Questions & Suggestions?