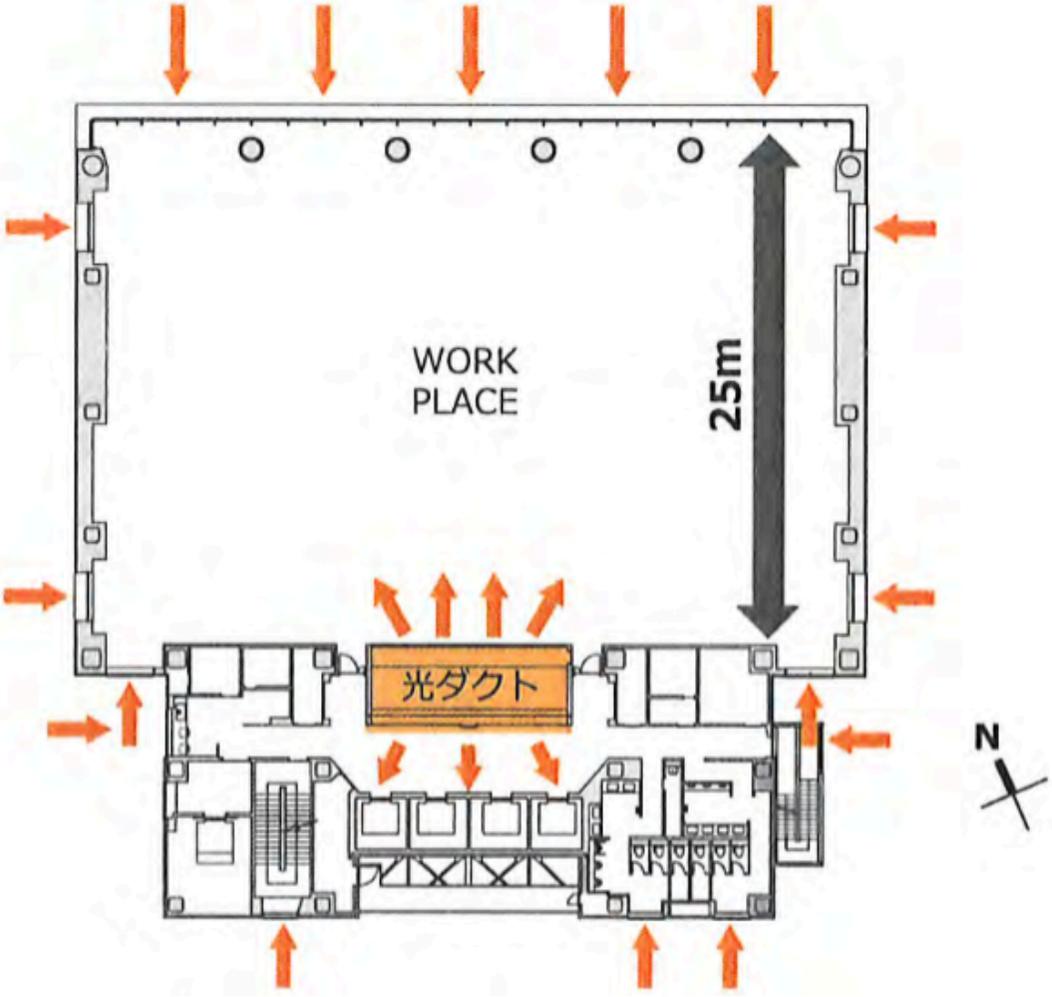


# Mirrored light duct:

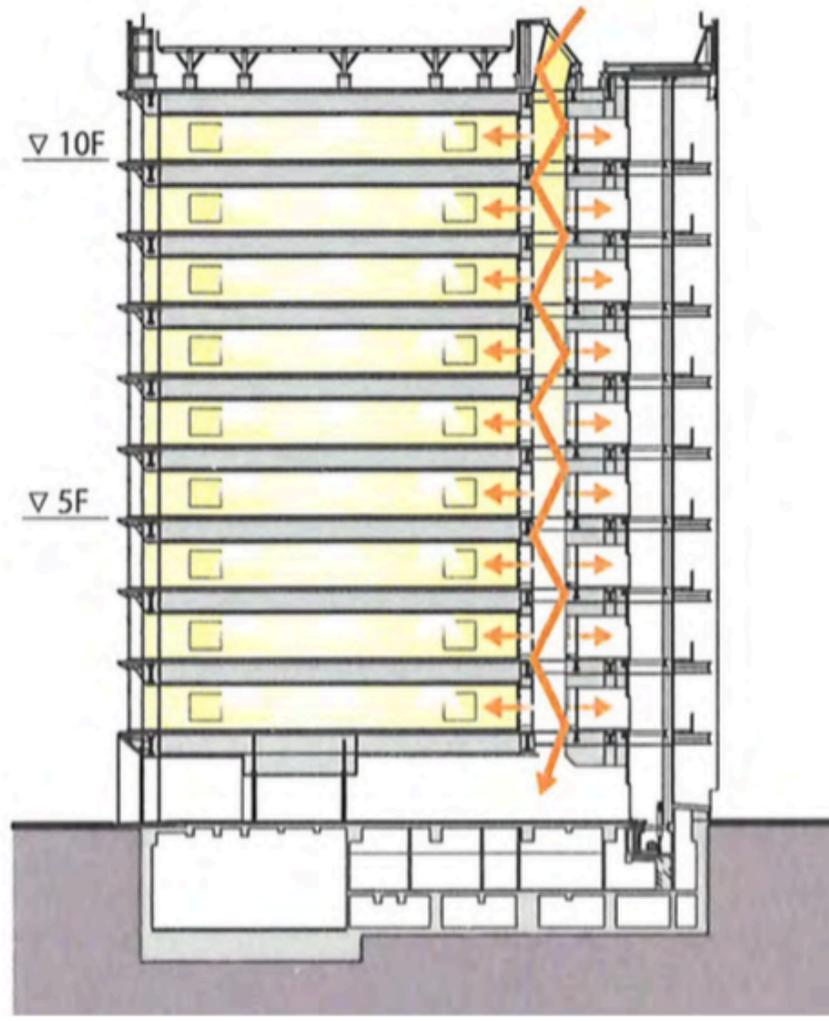
Santiago Torres

15<sup>th</sup> IRW – Padua, August 2016

# The building

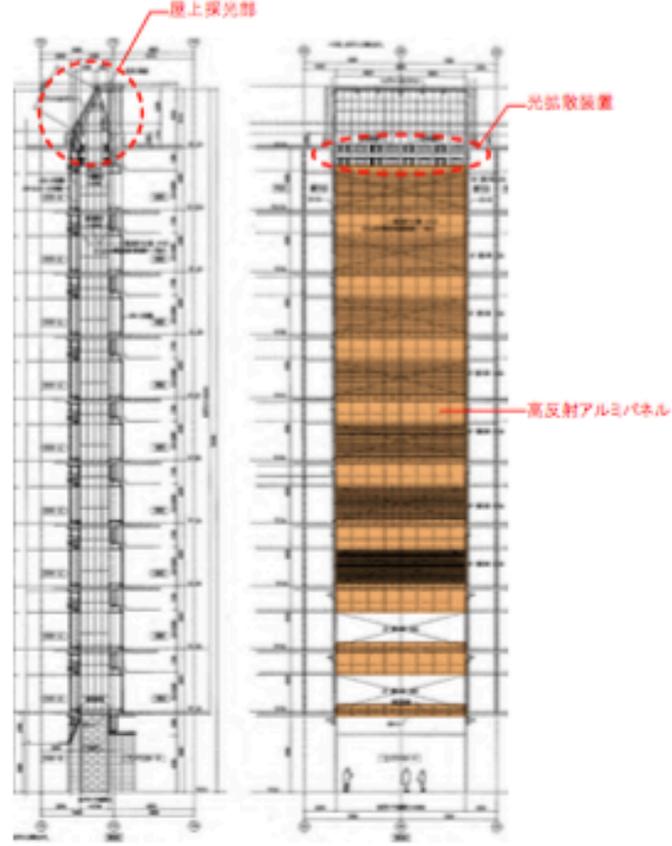
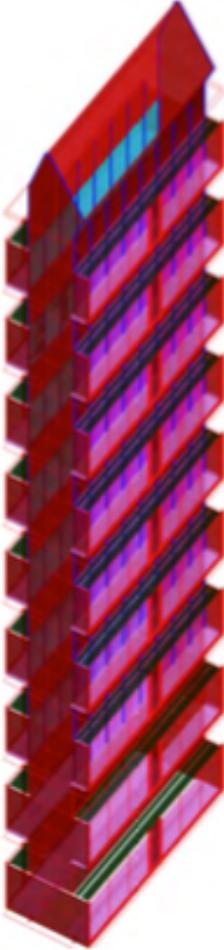


基準階平面図

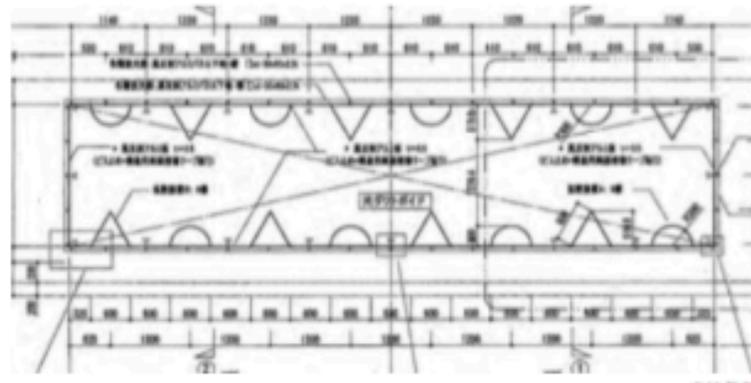


断面図

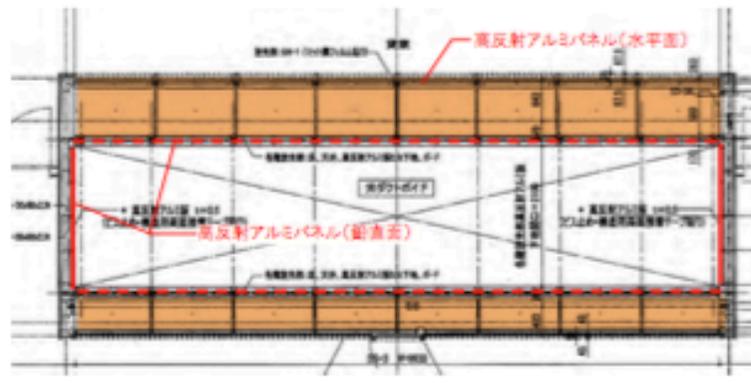
# The building



光ダクト断面図



光拡散部



基準階ダクト



屋上採光部

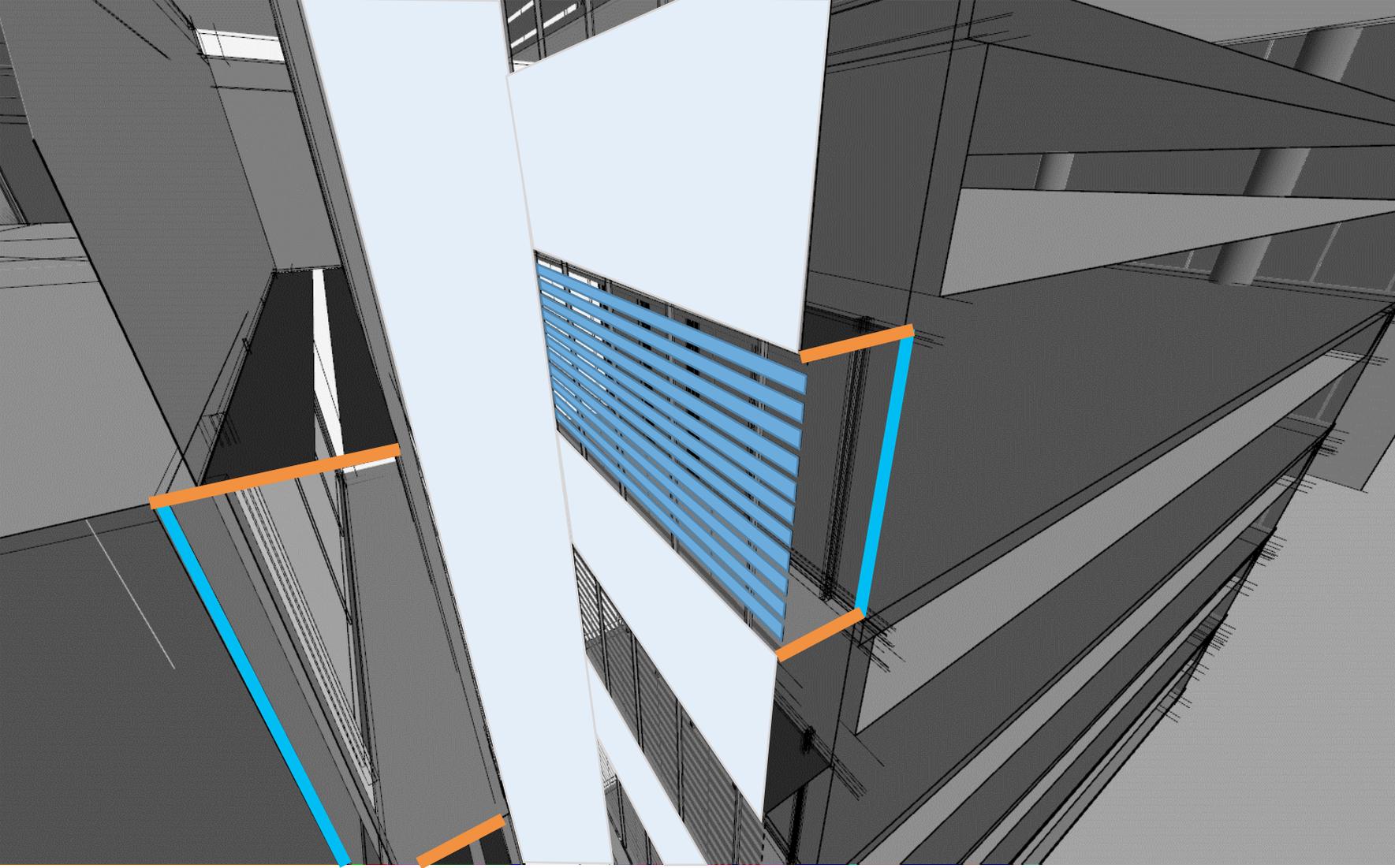


EVホール側放光部



1階放光部

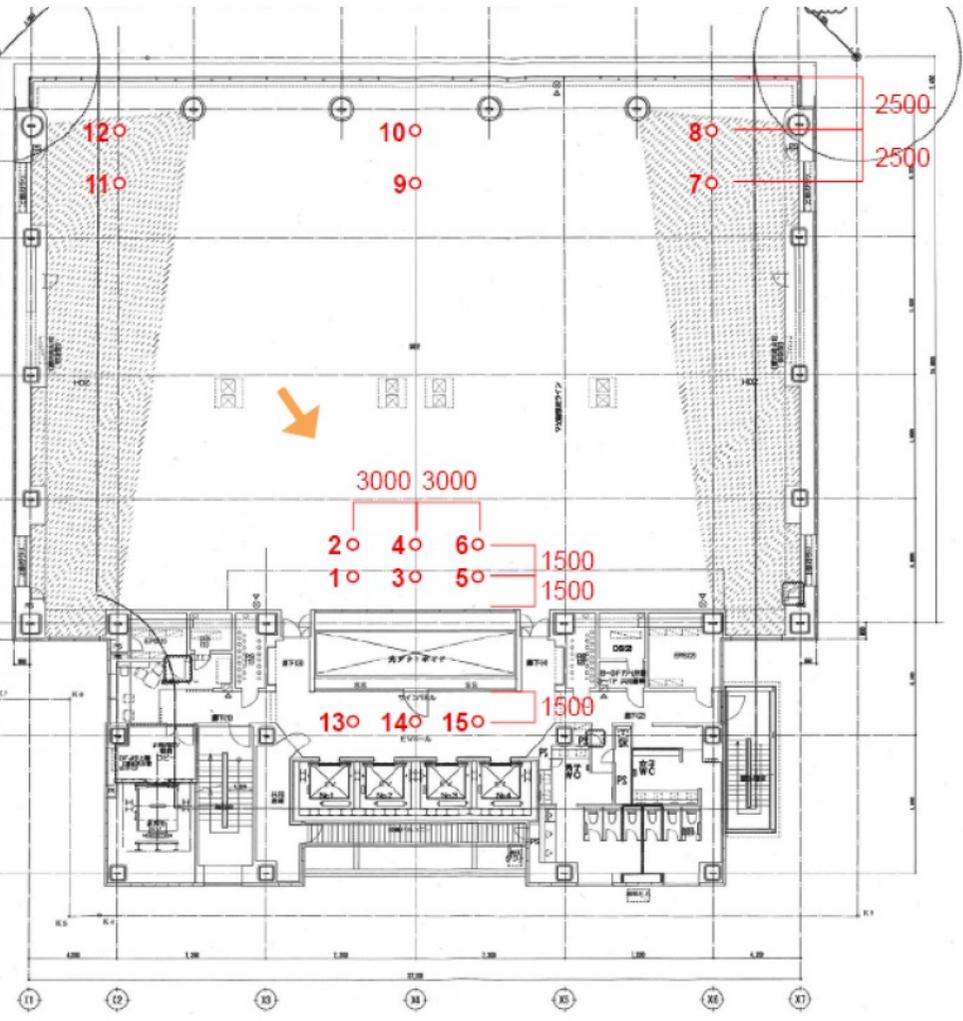
# The building



# The building



# Horizontal illuminance measurements



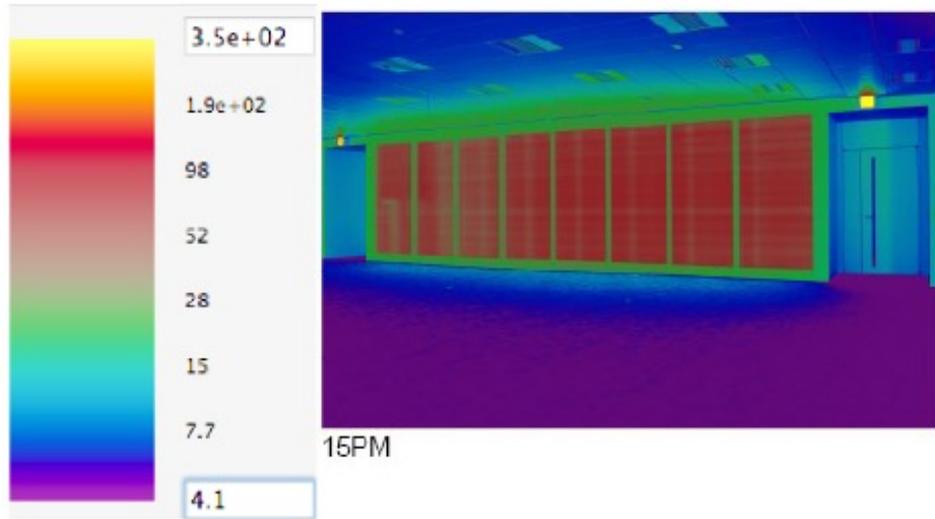
9F Measurement

| Measurement     |       |                   |                |       |
|-----------------|-------|-------------------|----------------|-------|
| Floor           | Point | Illuminance [lux] | Exterior [lux] | DF(%) |
| Work place side | 1     | 62.6              | 26,082         | 0.2   |
|                 | 2     | 40.6              | 25,947         | 0.2   |
|                 | 3     | 68.1              | 25,713         | 0.3   |
|                 | 4     | 44.1              | 25,906         | 0.2   |
|                 | 5     | 66.5              | 25,503         | 0.3   |
|                 | 6     | 42.3              | 25,411         | 0.2   |
|                 | 7     | 405               | 25,411         | 1.6   |
|                 | 8     | 1596              | 25,242         | 6.3   |
|                 | 9     | 380               | 25,254         | 1.5   |
|                 | 10    | 1587              | 25,599         | 6.2   |
|                 | 11    | 523               | 25,643         | 2.0   |
|                 | 12    | 1706              | 25,828         | 6.6   |
| EV hall side    | 13    | 35.1              | 25,746         | 0.1   |
|                 | 14    | 32.5              | 26,089         | 0.1   |
|                 | 15    | 39.6              | 26,132         | 0.2   |

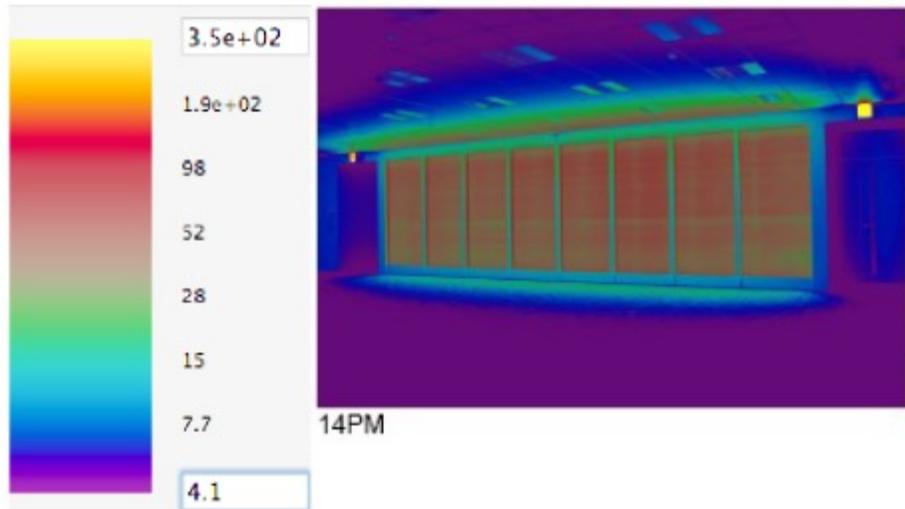
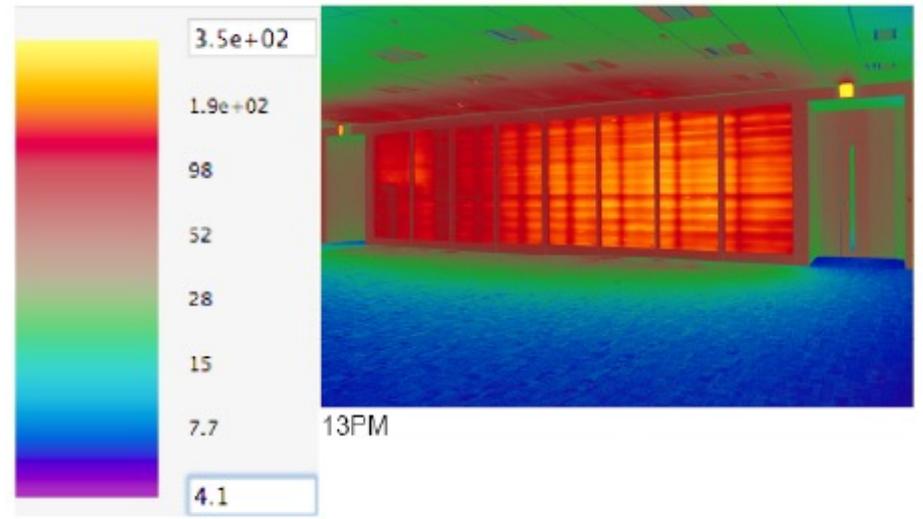
4F Measurement

| Measurement     |       |                   |                |       |
|-----------------|-------|-------------------|----------------|-------|
| Floor           | Point | Illuminance [lux] | Exterior [lux] | DF(%) |
| Work place side | 1     | 92.5              | 28,956         |       |
|                 | 2     | 37.1              | 29,072         |       |
|                 | 3     | 102.3             | 29,016         |       |
|                 | 4     | 44.3              | 28,729         |       |
|                 | 5     | 92.6              | 28,524         |       |
|                 | 6     | 38.5              | 28,360         |       |
|                 | 7     | 165.4             | 28,249         |       |
|                 | 8     | 526               | 28,123         |       |
|                 | 9     | 168.6             | 28,138         |       |
|                 | 10    | 680               | 28,063         |       |
|                 | 11    | 230.9             | 27,969         |       |
|                 | 12    | 819               | 27,740         |       |
| EV hall side    | 13    | 64.5              | 27,624         |       |
|                 | 14    | 54.9              | 27,554         |       |
|                 | 15    | 65.3              | 27,556         |       |

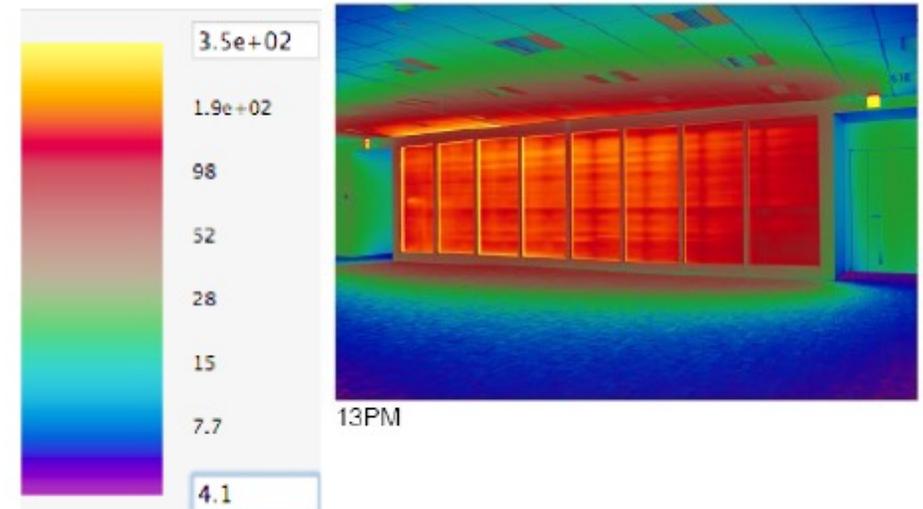
# Calibrated HDR images



9F



4F

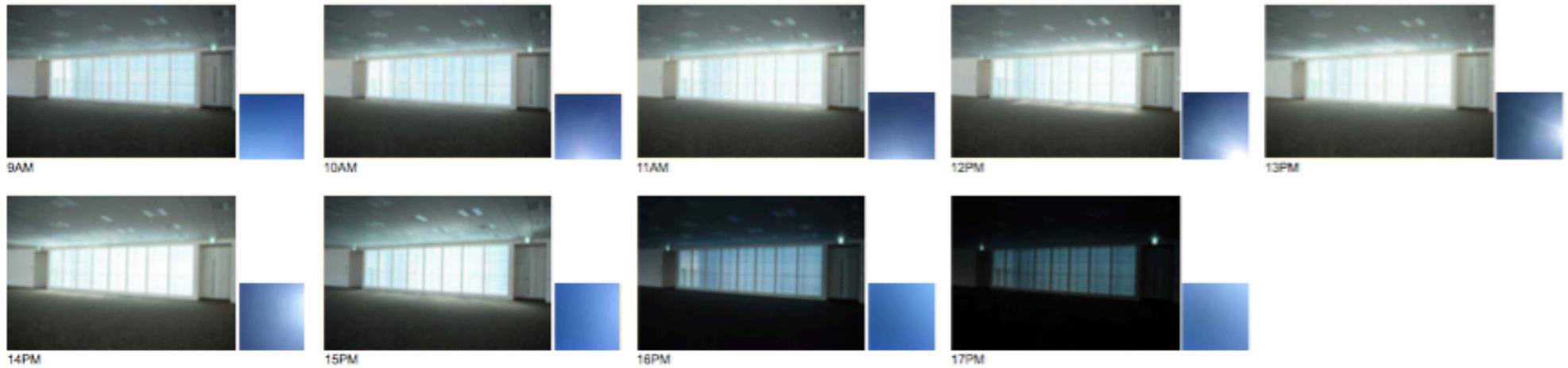
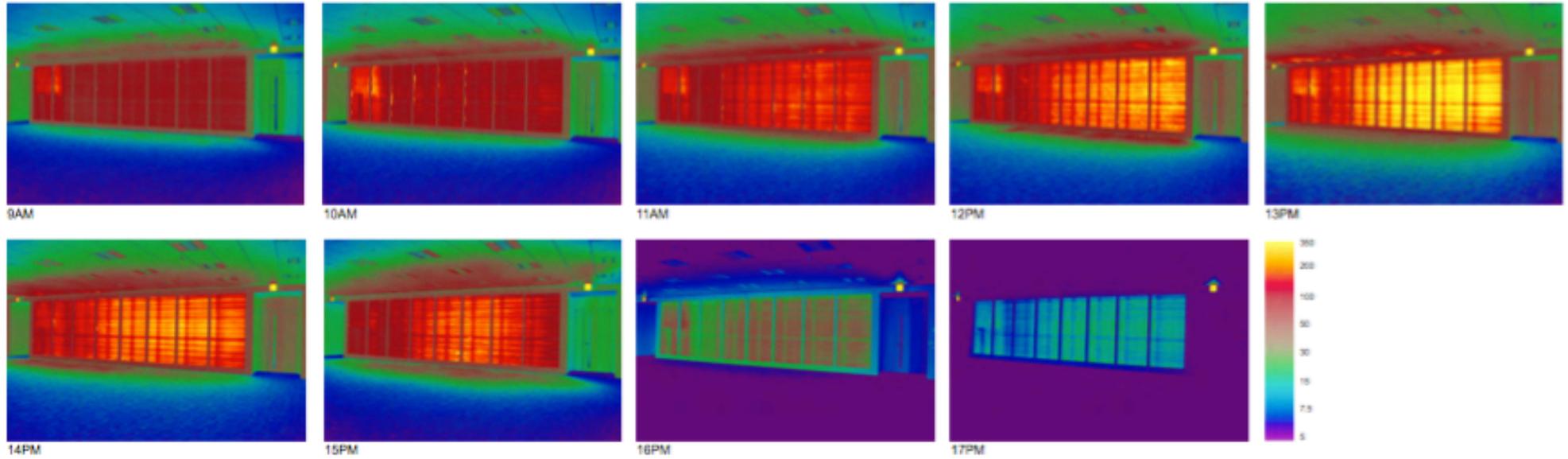


OVERCAST

CLEAR

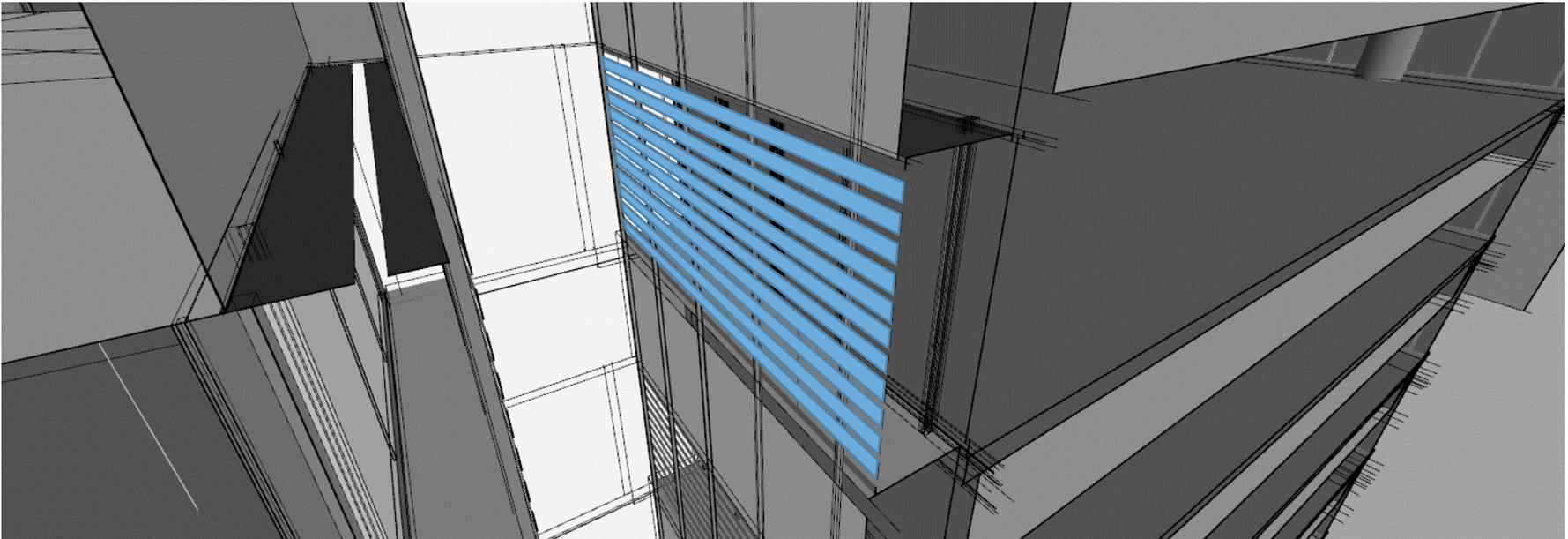
# Calibrated HDR images

图4.7 续 (3月17日)



First try: Just push -dr

- Run rtrace calculation with `-dr 12`
- Need to limit the number of virtual sources / mirror polygons



# Mirror cut-out

```
#metal

stripes metal metal
00
5 .8 .8 .8 0.001 0

#mix the metal with void to create holes

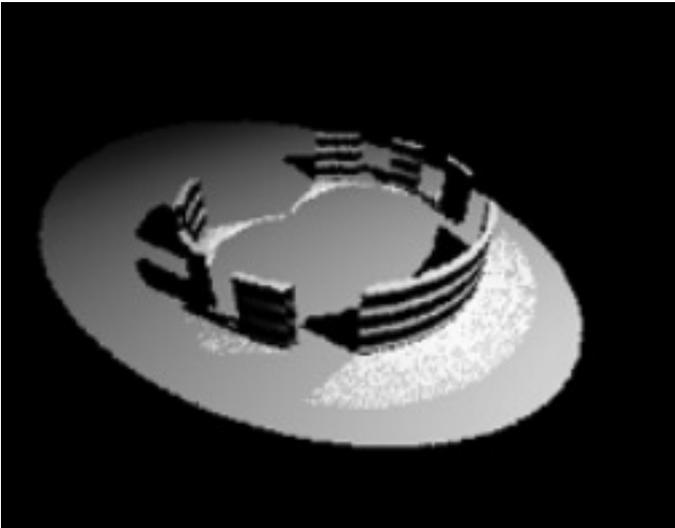
void mixfunc strip
4 metal void 'if(sin(A1*Py),0,1)' .
0
1 .2

#alterate the reflectance of mirror, reflectance is 0% for holes

void brightfunc band
2 'if(sin(A1*Py),0,1)' .
0
1 .2

#mirror attached to the metal surface, with holes

band mirror mix
1 strip
0
3 1 1 1
```



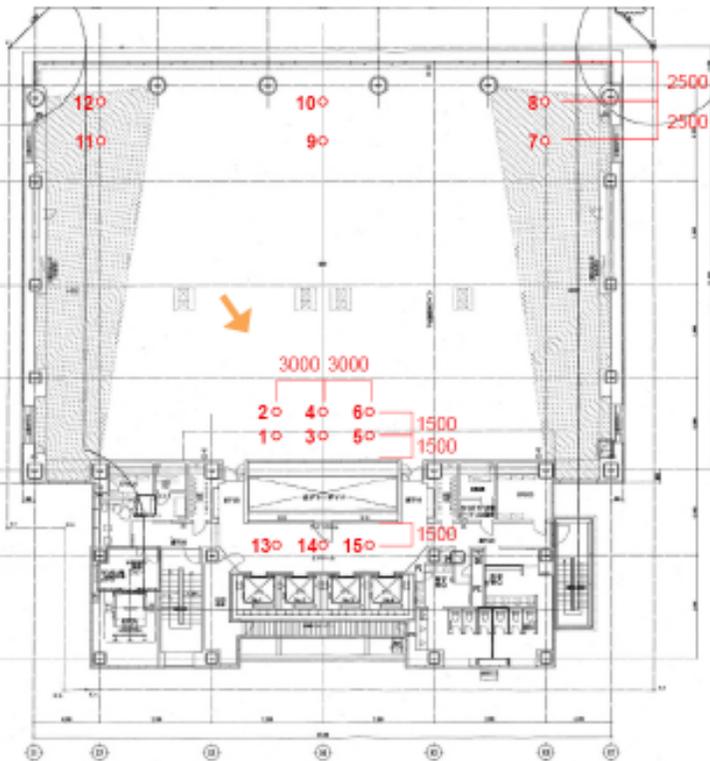
# First try: results

## Test simulation setting

```
ops="-dp 1024 -ds .25 -dt .08 -dc .75 -dr 4 -st .01 -ab 2 -ad 512 -ar 256 -as 512 -av 0 0 0 -lr 12 -lw .000001"
```

Opening ratio: 60% (report setting)

Measurement plan



9F Measurement

| Measurement     |       |                   |                |
|-----------------|-------|-------------------|----------------|
| Floor           | Point | Illuminance [lux] | Exterior [lux] |
| Work place side | 1     | 145.8             | 46,683         |
|                 | 2     | 82.7              | 44,456         |
|                 | 3     | 138.1             | 41,027         |
|                 | 4     | 76.8              | 38,934         |
|                 | 5     | 123.7             | 37,991         |
|                 | 6     | 73.6              | 38,821         |
|                 | 7     | 578               | 39,938         |
|                 | 8     | 2068              | 42,573         |
|                 | 9     | 555               | 46,485         |
|                 | 10    | 2186              | 62,687         |
|                 | 11    | 844               | 77,323         |
|                 | 12    | 2549              | 82,415         |
| EV hall side    | 13    | 190               | 87,198         |
|                 | 14    | 169.4             | 90,673         |
|                 | 15    | 235.2             | 92,488         |

| Simulation      |       |                   |                |
|-----------------|-------|-------------------|----------------|
| Floor           | Point | Illuminance [lux] | Exterior [lux] |
| 4F              |       |                   |                |
| Work place side | 1     | 11.6              | 6367           |
|                 | 2     | 6.7               | 6367           |
|                 | 3     | 18.1              | 6367           |
|                 | 4     | 9.2               | 6367           |
|                 | 5     | 11.4              | 6367           |
|                 | 6     | 6.6               | 6367           |
|                 | 7     | 0.1               | 6367           |
|                 | 8     | 0.1               | 6367           |
|                 | 9     | 0.3               | 6367           |
|                 | 10    | 0.2               | 6367           |
|                 | 11    | 0.1               | 6367           |
|                 | 12    | 0.1               | 6367           |
| EV hall side    | 13    | 7.8               | 6367           |
|                 | 14    | 4.8               | 6367           |
|                 | 15    | 6.1               | 6367           |

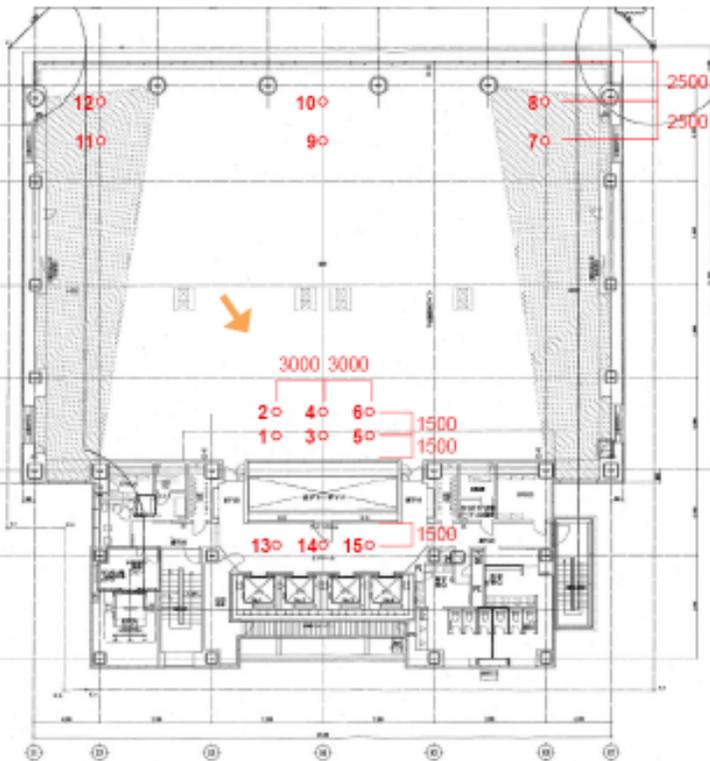
# First try: results

## Test simulation setting

```
ops="-dp 1024 -ds .25 -dt .08 -dc .75 -dr 4 -st .01 -ab 2 -ad 512 -ar 256 -as 512 -av 0 0 0 -lr 12 -lw .000001"
```

Opening ratio: 60% (report setting)

Measurement plan

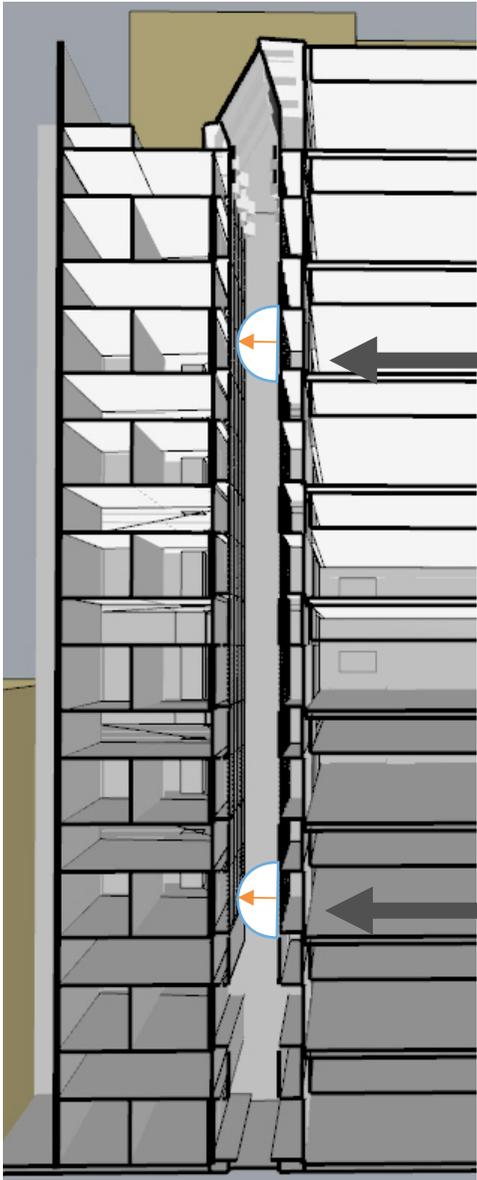


4F Measurement

| Measurement     |       |                   |                |
|-----------------|-------|-------------------|----------------|
| Floor           | Point | Illuminance [lux] | Exterior [lux] |
| Work place side | 1     | 404               | 81,911         |
|                 | 2     | 170.6             | 80,497         |
|                 | 3     | 662               | 78,766         |
|                 | 4     | 257.2             | 79,206         |
|                 | 5     | 824               | 80,161         |
|                 | 6     | 284               | 80,241         |
|                 | 7     | 438               | 79,963         |
|                 | 8     | 1160              | 81,952         |
|                 | 9     | 341               | 80,545         |
|                 | 10    | 1078              | 79,860         |
|                 | 11    | 428               | 80,762         |
|                 | 12    | 1221              | 81,086         |
| EV hall side    | 13    | 283.9             | 80,989         |
|                 | 14    | 323               | 76,583         |
|                 | 15    | 486               | 75,523         |

| Simulation      |       |                   |                |
|-----------------|-------|-------------------|----------------|
| Floor           | Point | Illuminance [lux] | Exterior [lux] |
| 4F              |       |                   |                |
| Work place side | 1     | 23.5              | 6367           |
|                 | 2     | 12.9              | 6367           |
|                 | 3     | 28.5              | 6367           |
|                 | 4     | 15.9              | 6367           |
|                 | 5     | 26.0              | 6367           |
|                 | 6     | 14.0              | 6367           |
|                 | 7     | 0.2               | 6367           |
|                 | 8     | 0.3               | 6367           |
|                 | 9     | 0.4               | 6367           |
|                 | 10    | 0.4               | 6367           |
|                 | 11    | 0.2               | 6367           |
|                 | 12    | 0.2               | 6367           |
| EV hall side    | 13    | 17.0              | 6367           |
|                 | 14    | 10.9              | 6367           |
|                 | 15    | 17.1              | 6367           |

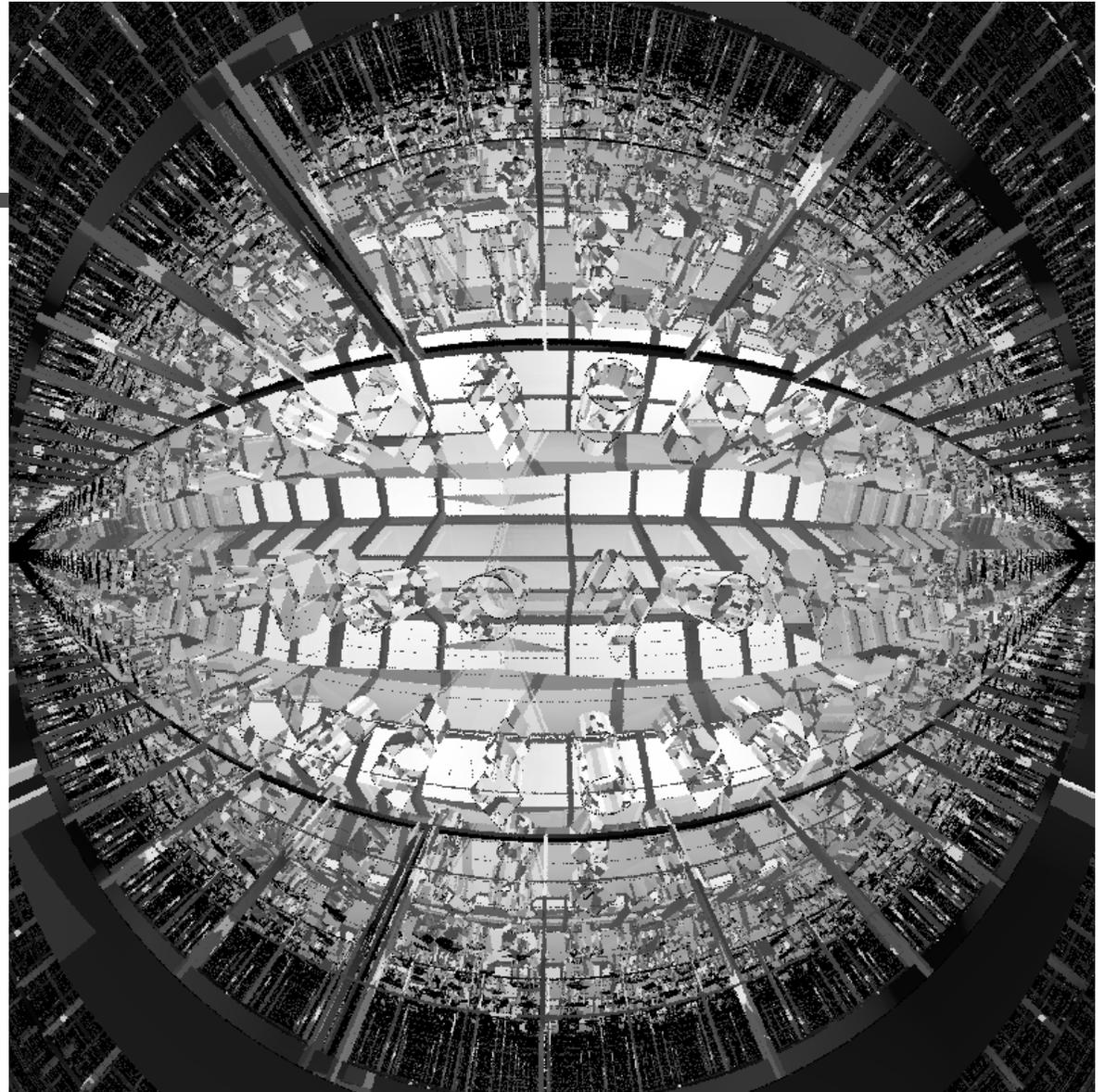
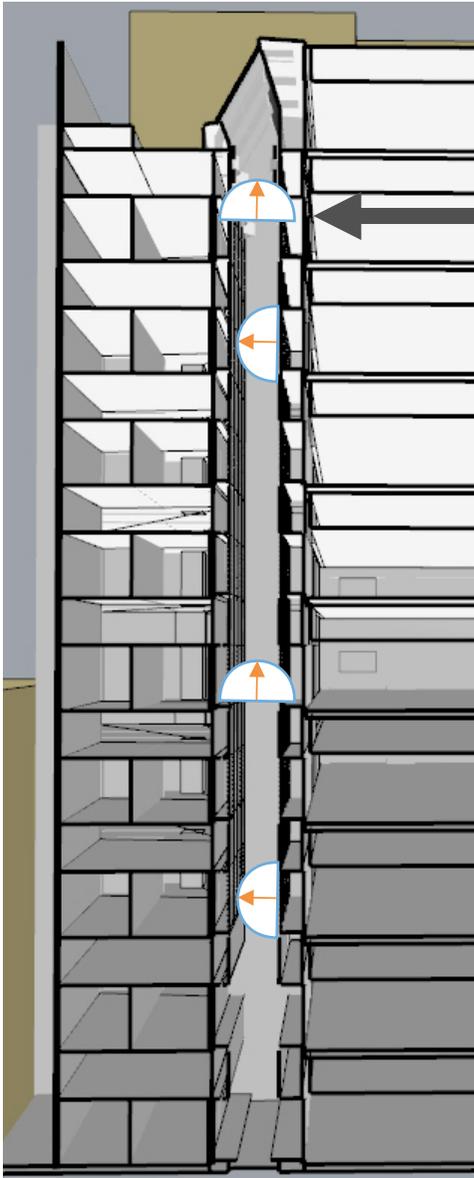
# Second try: use renderings instead



- Use `-dr 0 -lr 12`
- Map images to polygons



Second try: use renderings instead



Side note: mkpmap

- Run quick test with “lots” of photons (100,000 to 1,000,000!)
- Soon run out of memory
- Results were  $1/10^{\text{th}}$  to  $1/100^{\text{th}}$  of expected values
- Finally we managed to prove conclusively that

Side note: mkpmap

we need more tests before we can use it reliably

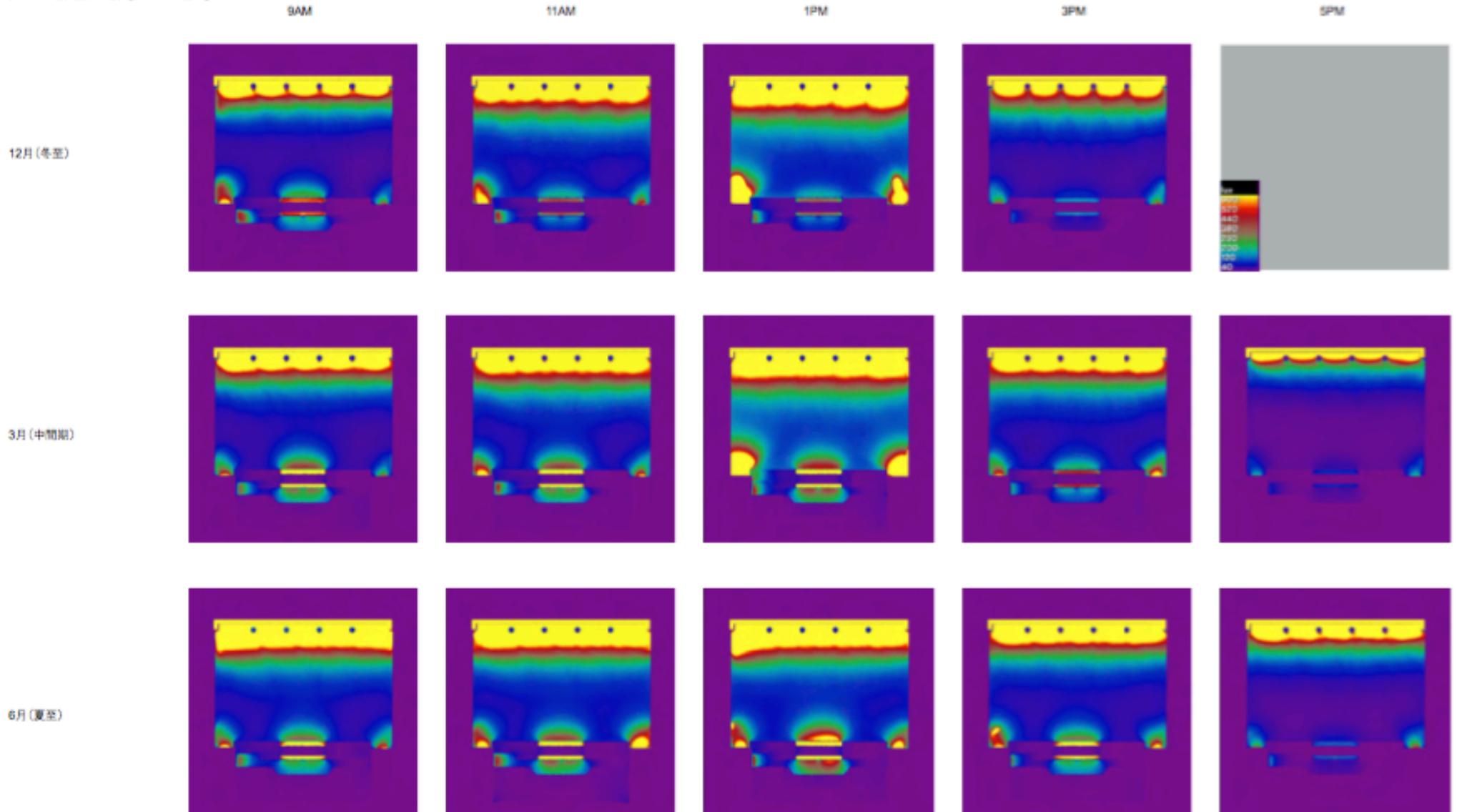
- Especially try ooC pm

Third try: rfluxmtx

- Escalate to SF!
- `rfluxmtx -n 40 -faa -l+ -ab 12 -lr -20 -ad 400000 -lw 1e-12 -st 0 -ss 1 -y 200 < grid/grid2a.grd - sendreceive/glass05.rad mat/mat.rad scene.rad > matrices/top2portgrid.mtx`
- `#@rfluxmtx u=+Z h=kf o=matrices/sensor2m4n.mtx`

# Third try: rfluxmtx

図5.5 4層 昼光照度【光ダクト有り】



# Third try: rfluxmtx

図5.7 4階 星光照度【光ダクト無し】

