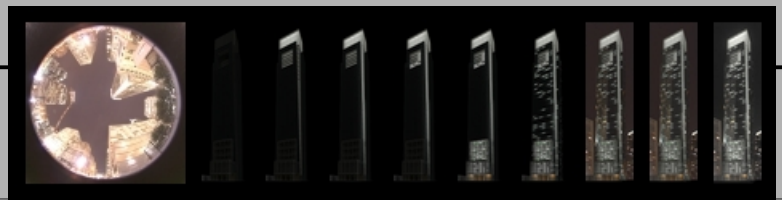
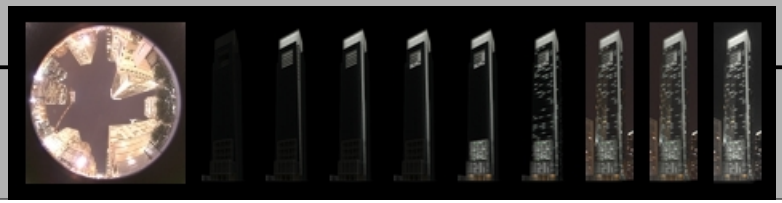
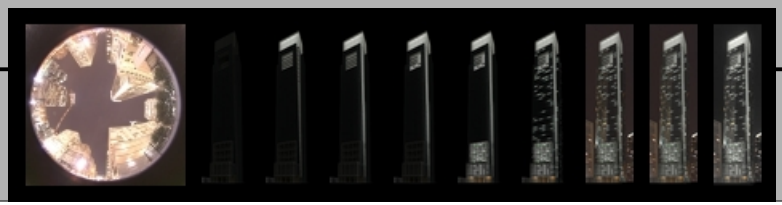


Night Lighting Simulation:
Design Evaluation with *Radiance rtcontrib* and m*ksource*

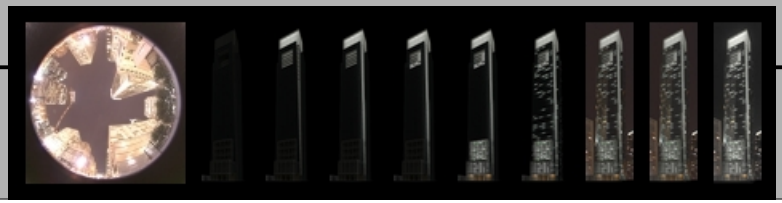


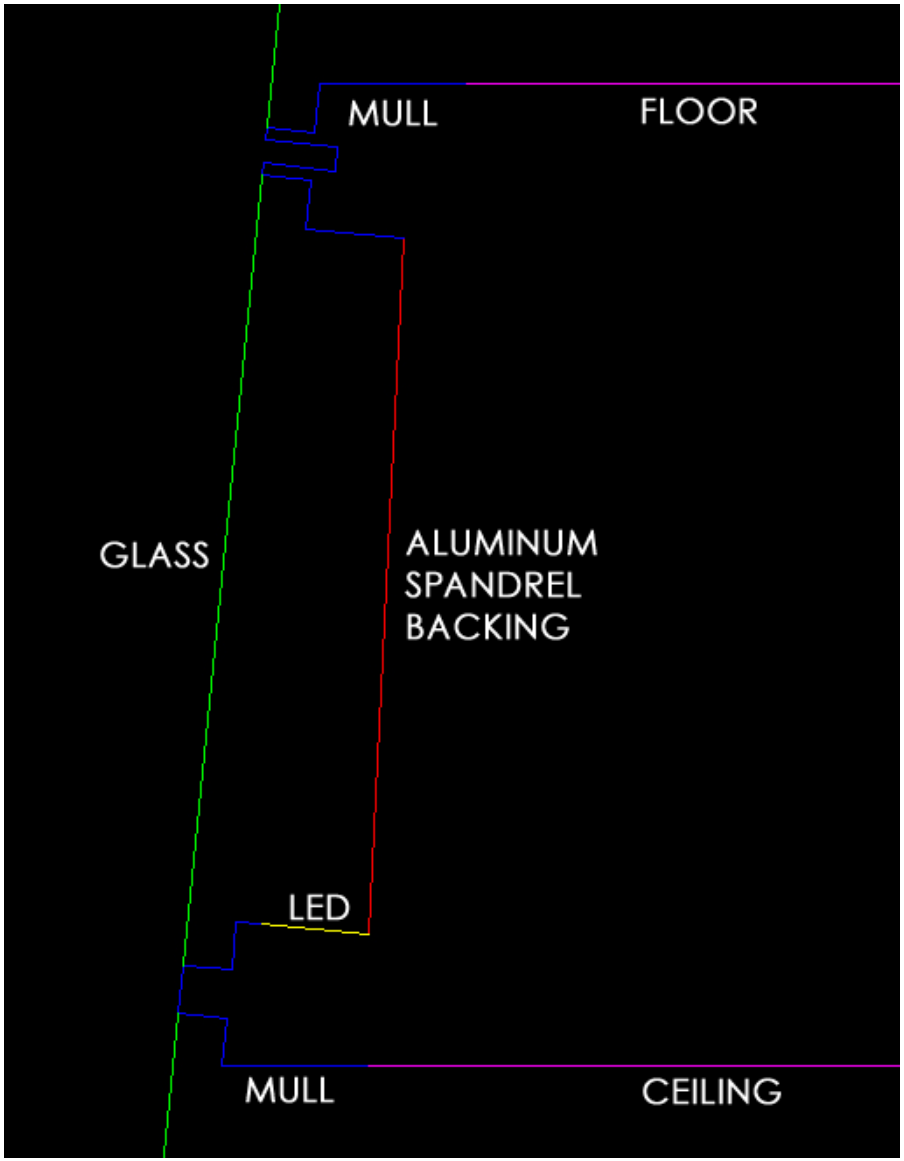
SUMMARY

This presentation discusses issues relating to a night lighting simulation of a 60 story office tower set in an urban context. The purpose of the study was to assist the design team in evaluating and presenting the proposed lighting design to the owner. Due to the complexity of the design and high potential for variable design options, the *Radiance* programs *rtcontrib* and *mksource* were used to provide the greatest flexibility and control over the simulation process.

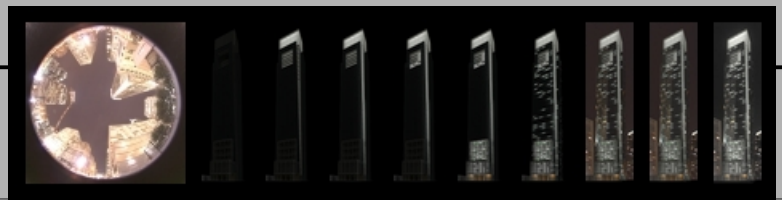


- Key Building Design Features
  - Glass building composed of two types of insulating vision glass make-ups
    - Viracon VRE-138 (low-e) at most of building facade
      - Tvis = 36%, Rout = 44%, Rin = 21%
    - PPG Solarban 60 (low-iron) at corners, mechanical level, large punch and atrium/lobby
      - Tvis = 73%, Rout = 12%, Rin = 12%
  - Spandrel condition is made up of vision glass and solid backing panel to form a “shadow box”
  - Selected spandrel conditions include “built-in” linear LED fixtures placed at top of bottom mullion to uplight backing panel
    - LED's by Winona Lighting (lensed with ~30 degree spread)
  - Mechanical level is also illuminated by linear LED fixtures
    - LED's by Winona Lighting (lensed with ~60 degree spread)

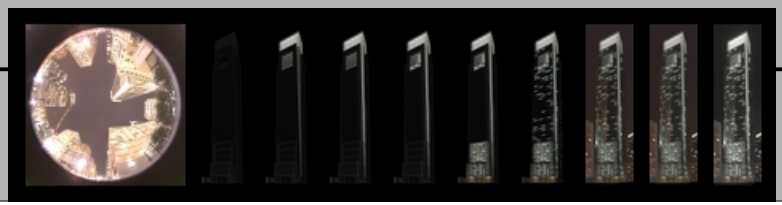




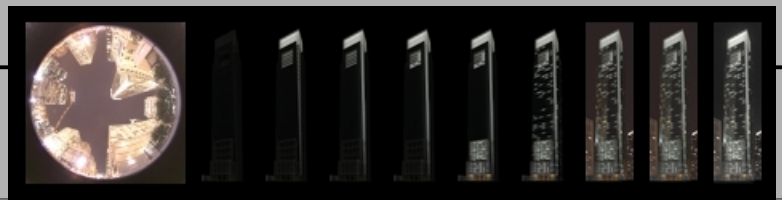
- Spandrel Makeup Notes
  - Diagram NOT to scale
  - Portions of curtain-wall at corners are indeed out of the perpendicular plane
  - Backing panel slopes towards glazing from top to bottom
  - LED strip runs length of spandrel unit



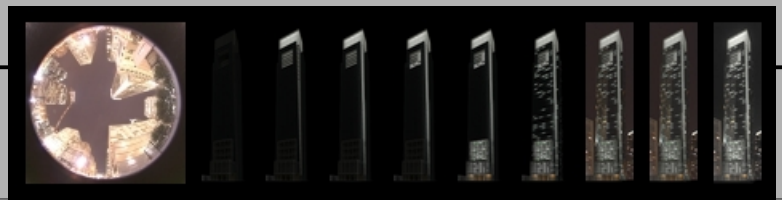
- Core Issue
  - Lighting design uses LED fixtures in spandrel to create accent lighting on building exterior
  - Traditional method of simulation had already been employed via the creation of a 2 story full scale mock-up of “typical” corner condition
  - So what does this look like at the scale of the whole building under nighttime conditions?



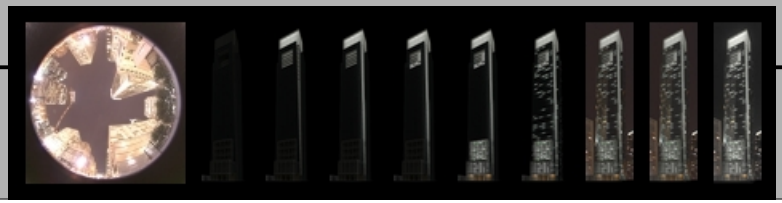
- Production issues
  - Client wants to see effects not only of LED's at spandrels (at corner and punch) and mechanical level, but also factor in appearance of “random” office lighting turned on inside the building as well as local environment.
  - There are a lot of lights! (~2160 for purposes of this simulation)
  - There are aspects of the design that are unresolved, such as interior office lighting (since the interiors will be designed and built out to satisfy tenant needs).



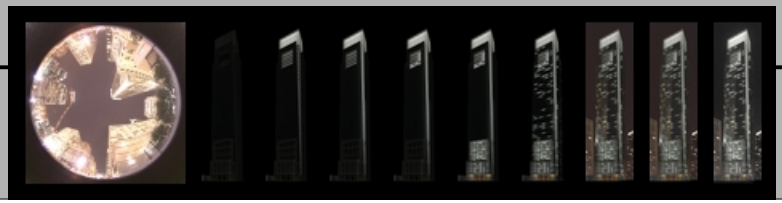
- How do we make this manageable?
  - Rtcontrib – enables finer control over simulation process
  - Mksource – enables the reacquisition of local lighting from an HDRI



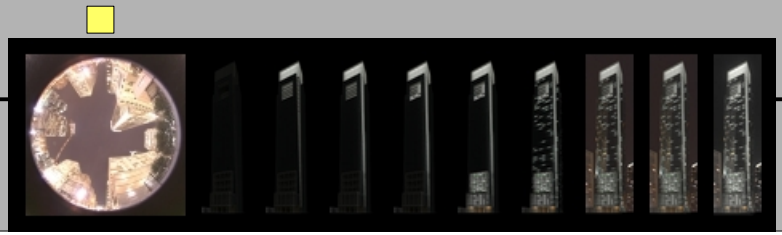
- rtcontrib
  - Completed “images” are generated by combining resulting output from rtcontrib as input to pcomb. Thus, if we want to see what one specific set of lighting looks like we can “turn off” lights as a function of the -s or -c multiplier in pcomb. We do not have to re-run a simulation with a long run time!
    - This requires that we think very carefully about how lights are named and specified in radiance prep. For example, how should lights be grouped together (even if they are the same fixture type and use) to enable control to turn things on/off in a useful way.
    - Simulation is still long (relative to more typical productions). However, since rtcontrib sets -aa 0, a view can be subdivided and distributed over multiple nodes without concerns of ambient data sharing!
    - Since there are so many light sources using photometric data, glows with limiting radii where used to help speed things up

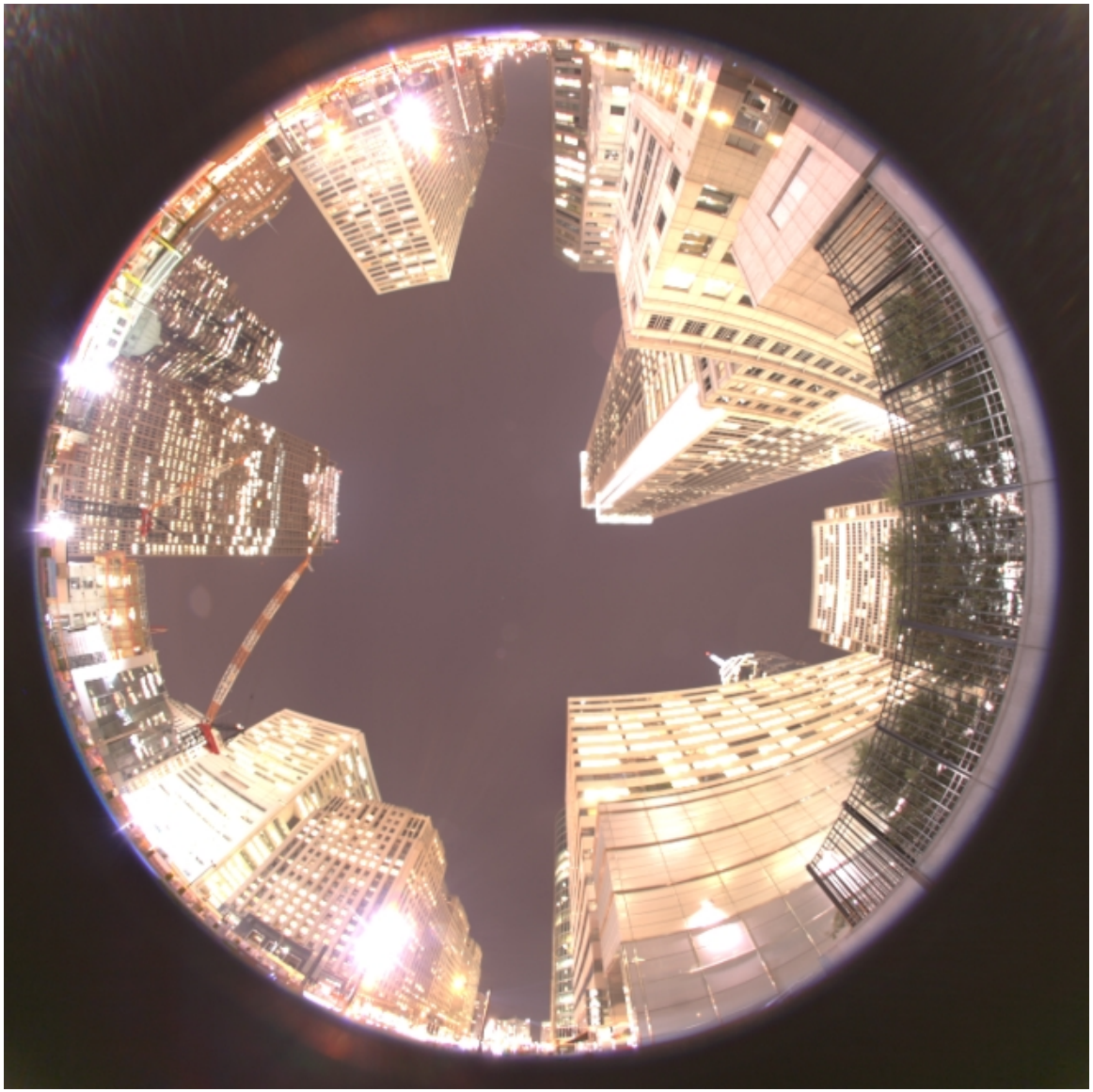


- mksource
  - using HDRI we can capture and reacquire the local lighting from the surrounding environment.
    - Nighttime conditions are challenging to shoot!
    - There is a LOT of light noise due to moving vehicle headlights
    - Additional light noise due to lighting of construction site
    - Could not actually be “on-site” as the building is already in construction, so location of actual HDRI was best compromise available
    - Attempting to capture a full sphere by shooting multiple shots around the z axis was problematic largely due to light noise from moving cars. The best shot turned out to be pointing directly up into the sky.
  - Default mksource settings resulted in over 100 illum sources, so first simulations where extra slow.
  - With input from Greg, this was narrowed down to ~10 illum sources

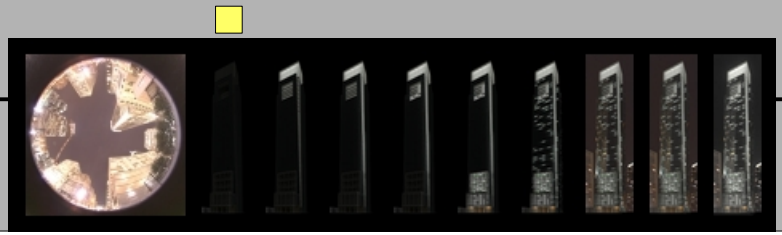


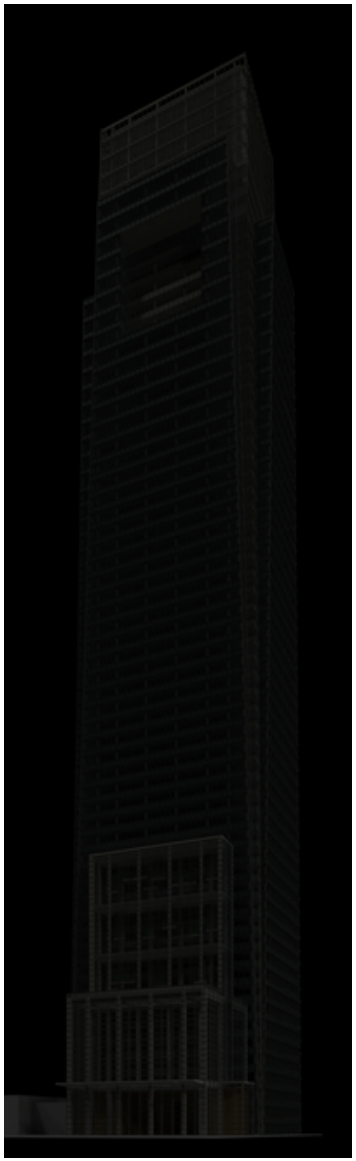
OK, enough talk!
Let's look at some pictures!



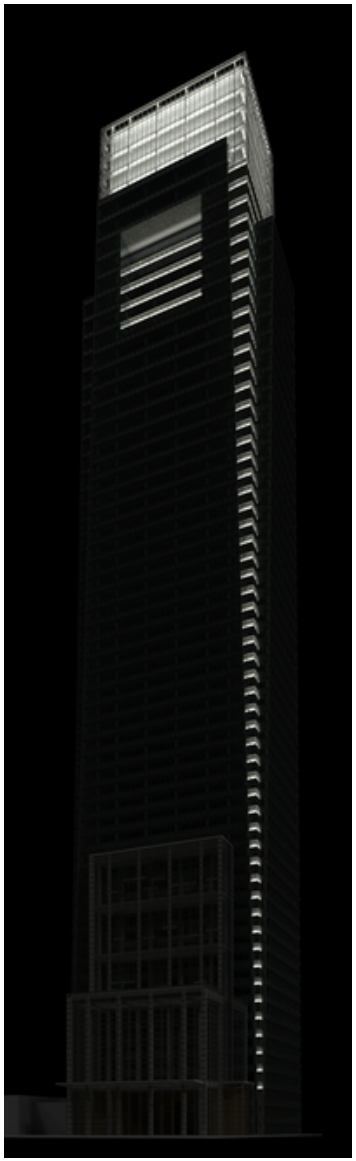


- HDRI capture of local environment
  - Sigma 8mm EX/DG Fisheye on Cannon EOS 5D
  - Average illuminance estimated at ~15 lux based on field measurements
- Now, let's look at what happens when we use the results from rtcontrib and mksource to build up to a fully illuminated scene

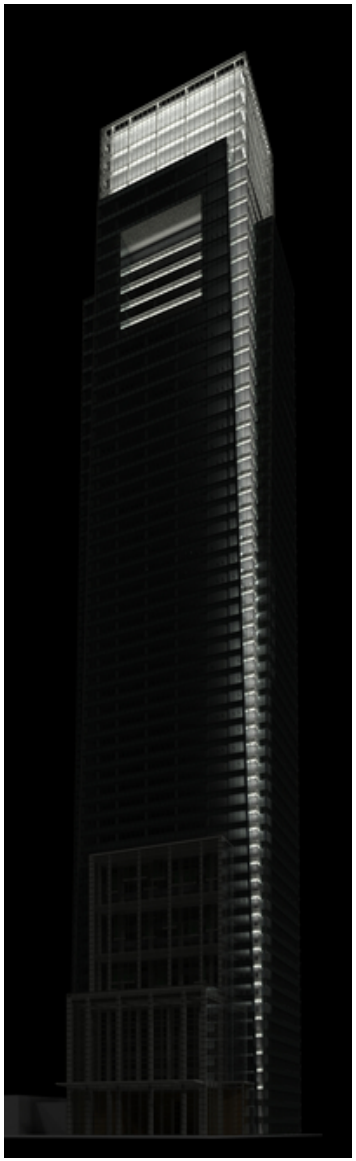




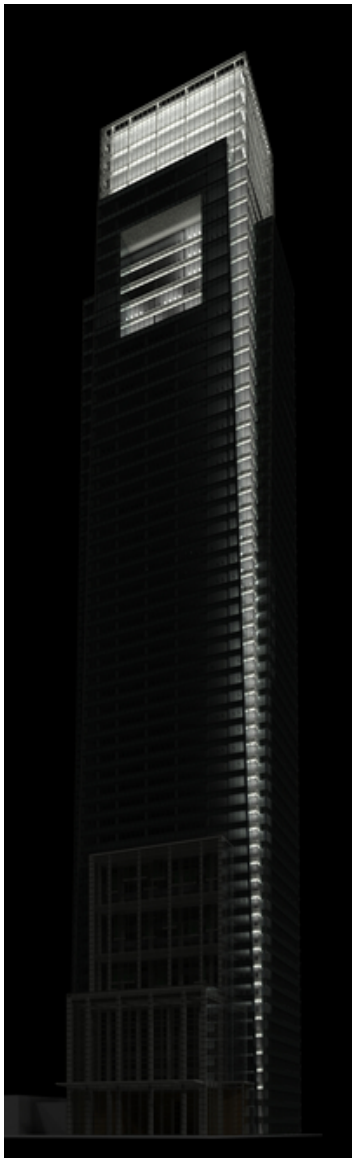
- IBL sources



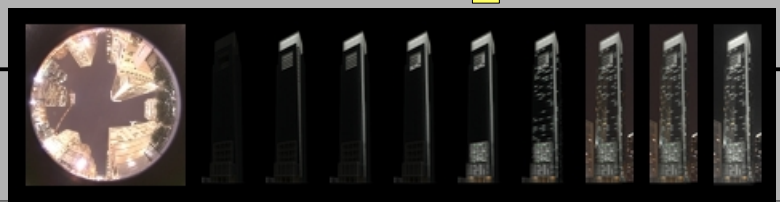
- IBL sources
- LED sources at selected spandrel conditions

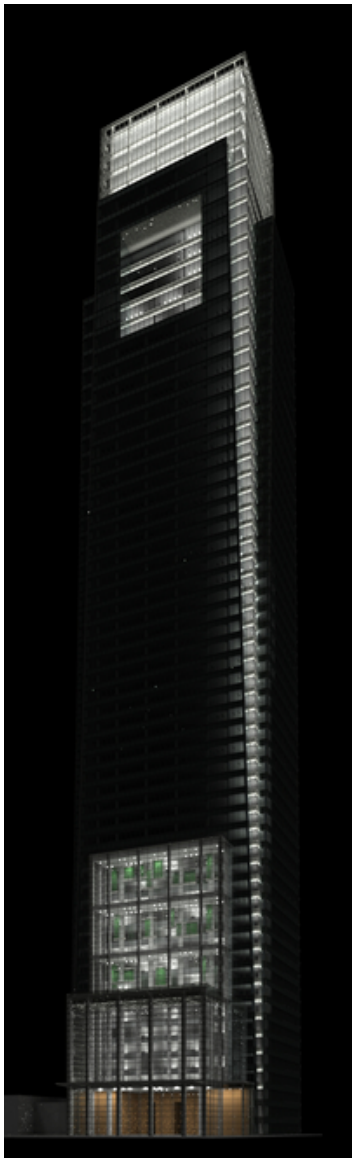


- IBL sources
- LED sources at selected spandrel conditions
- Interior downlights at corner condition

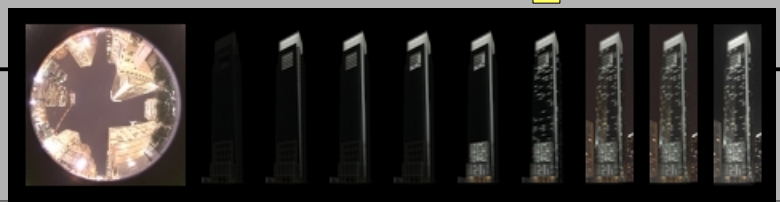


- IBL sources
- LED sources at selected spandrel conditions
- Interior downlights at corner condition
- Office lights (randomized) at “punched” condition

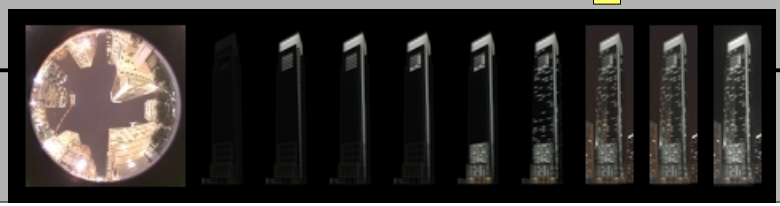


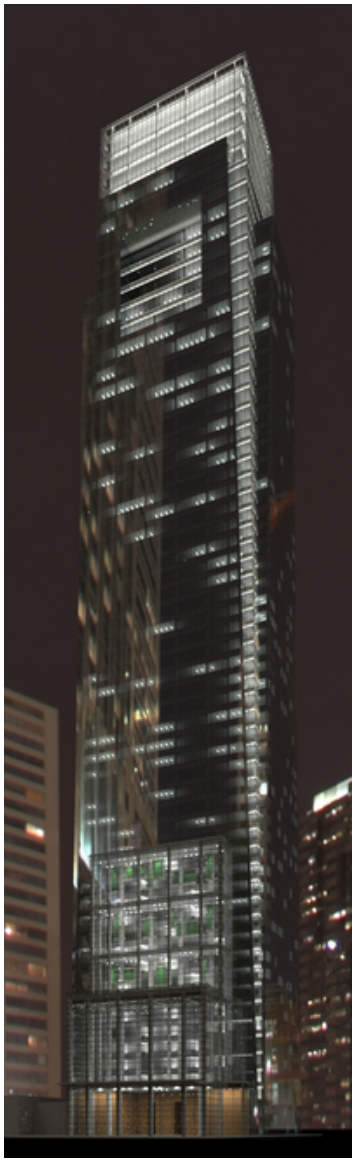


- IBL sources
- LED sources at selected spandrel conditions
- Interior downlights at corner condition
- Office lights (randomized) at “punched” condition
- Lighting at atrium/lobby condition

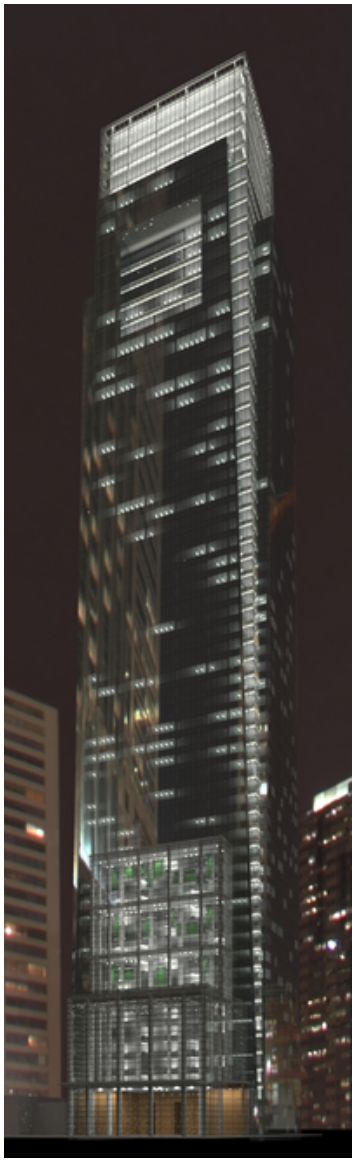


- IBL sources
- LED sources at selected spandrel conditions
- Interior downlights at corner condition
- Office lights (randomized) at “punched” condition
- Lighting at atrium/lobby condition
- office lighting (randomized) at typical conditions

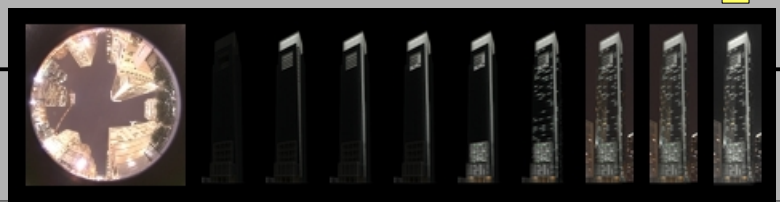


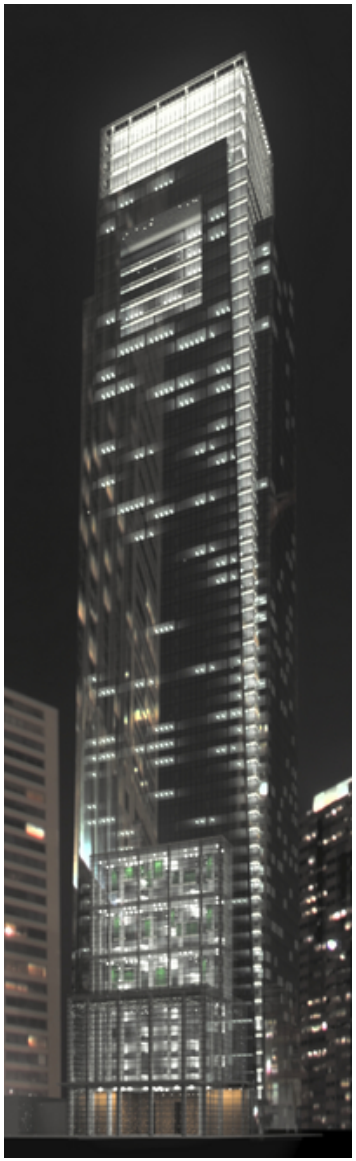


- IBL sources
- LED sources at selected spandrel conditions
- Interior downlights at corner condition
- Office lights (randomized) at “punched” condition
- Lighting at atrium/lobby condition
- Randomized office lighting at typical conditions
- “background” HDRI

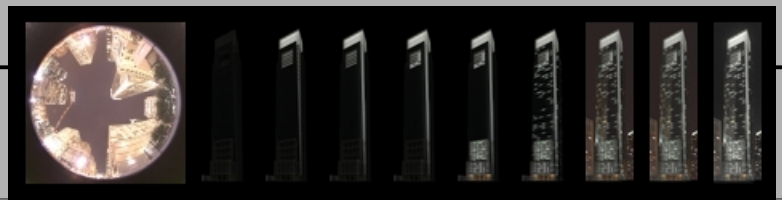


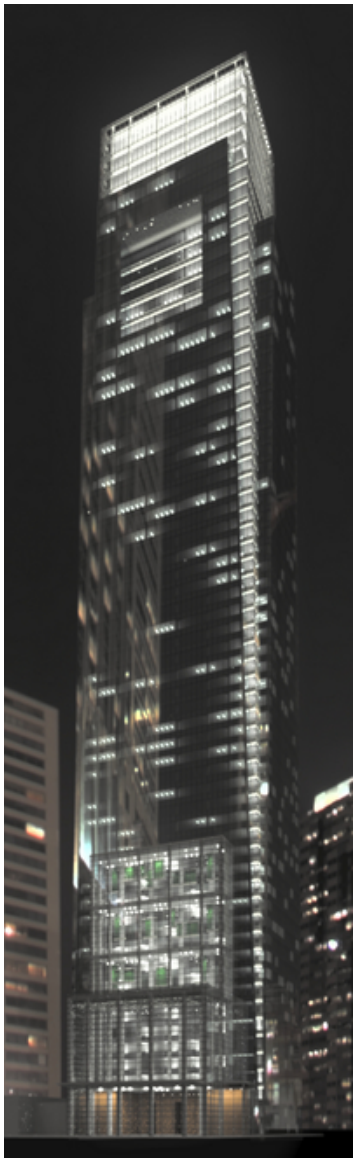
- IBL sources
- LED sources at selected spandrel conditions
- Interior downlights at corner condition
- Office lights (randomized) at “punched” condition
- Lighting at atrium/lobby condition
- Randomized office lighting at typical conditions
- “background” HDRI
- Ambient term



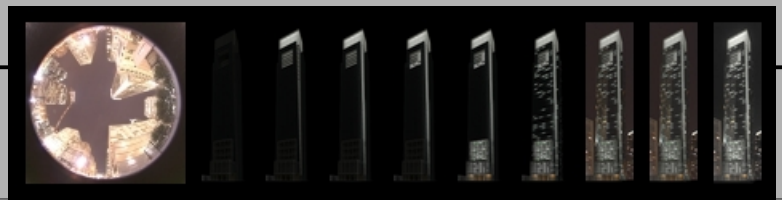


- IBL sources
- LED sources at selected spandrel conditions
- Interior downlights at corner condition
- Office lights (randomized) at “punched” condition
- Lighting at atrium/lobby condition
- Randomized office lighting at typical conditions
- “background” HDRI
- Ambient term
- Tone mapping -h+





- Some final food for thought
  - There is more noise in the results (note speckles of light at underside of punch and in atrium/lobby space). This seems in part a function of how rtcontrib works so it is not clear if there are ways to mitigate the effect. However, some of this may in fact also be a result of using glows vs. lights/illums.
  - For a job with lots of lights such as this it is very important to subdivide the view and have multiple nodes to run on in order to get timely results.
- Special Thanks!
  - As always Greg Ward was very generous in helping to work through some of the intricacies of rtcontrib and mksource. He additionally provided very useful input on the best photography equipment for the HDRI capture.



Credits

Project: Comcast Center
Owner: Liberty/Commerz 1701 JFK Boulevard LP
Architect: Robert A. M. Stern Architects, LLP
Simulation: Visarc Inc
(production by Jack de Valpine and Tara Wike)