Accelerating Market Adoption: e.g., Daylighting The New York Times

- Automated roller shades and daylighting controls available for past 20-30 years with < 1% market share

- 3-year NYSERDA-DOE-CEC PIER R&D project
  - 9-month full-scale field test in 4000 sf daylighting mockup → findings applicable to 1.2 Msf headquarters building
  - Measured data: energy, comfort, human factors
  - Controls engineering: Test, redesign, then retest
  - Developed supporting infrastructure:
    - Publicly-available procurement specifications
    - Commissioning and verification tools for use in the final building

http://windows.lbl.gov/comm_perf/newyorktimes/

Outcomes

- Largest single procurement of automated shades and daylighting controls in US
- Tremendous industry response (established product demand): significant change in product offerings, features and capabilities at lower cost
  - Dimmable lighting controls:
    - From: hard-wired, fixed topology 0-10 V systems
    - To: DALI open protocol systems with individual fixture control capability -- enables zone reconfiguration, photosensor tuning, demand response, setpoint tuning all via software
  - Shading controls:
    - From direct sun control
    - To direct sun control, glare control, view/ daylight control
- Competitive pricing for both material costs and installation costs. Worked out details for factory pre-assembly and wiring to reduce install costs. Demystified new technology.
- Other A/E teams now considering use of smart shading & daylighting controls for two new buildings in NYC totalling ~4 Msf.

Issues

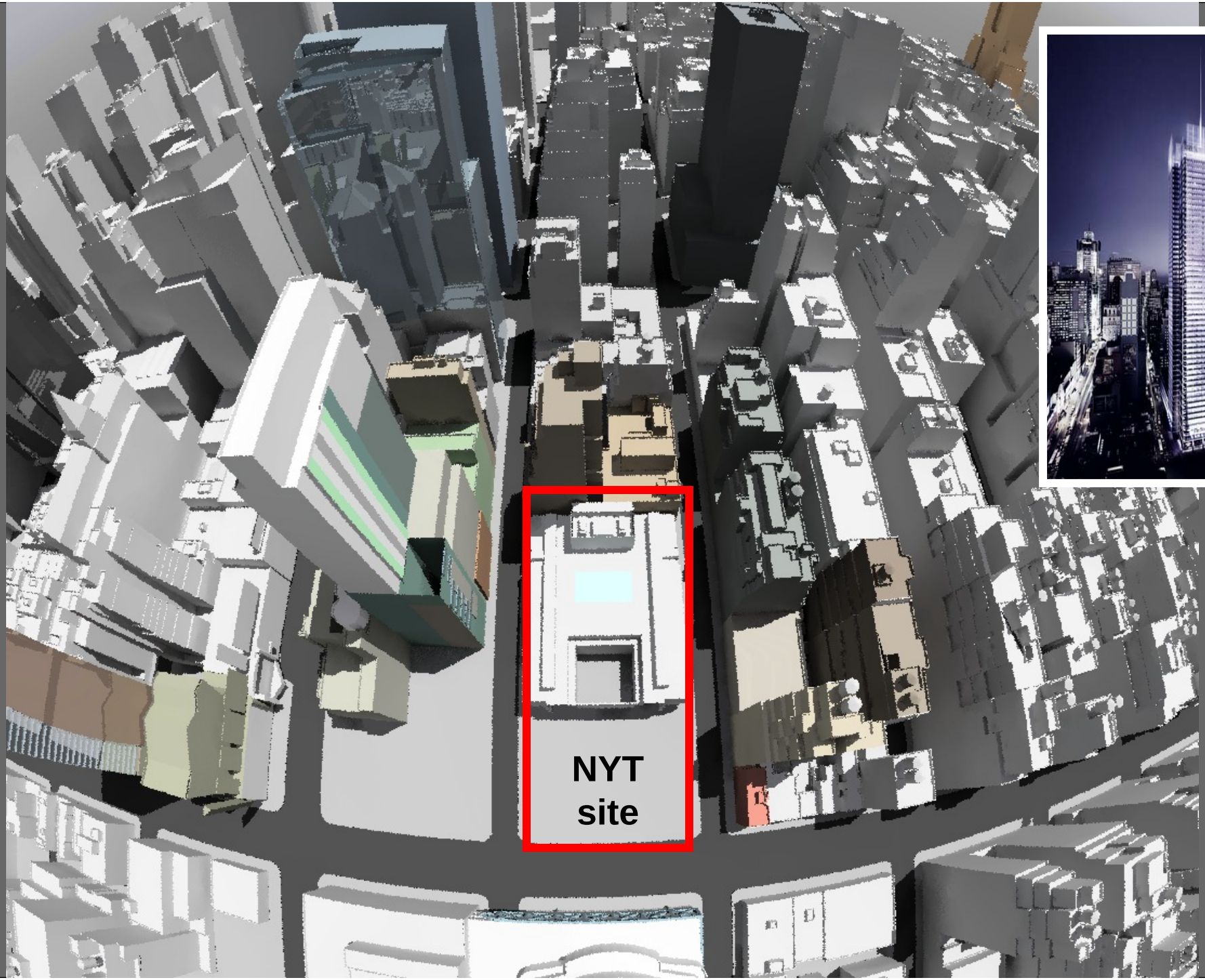
- Floor to ceiling, clear, water white, low-iron, spectrally-selective glass
  - Tv=0.75, SHGC=0.39
  - Horizontal ceramic tubes
- Manual control of interior shades
  - Too busy to adjust shades -- once down, stays down
- Trade-offs with automated shading control + fabric selection:
  - Direct sun control (PPD and visual comfort)
  - Absence of glare (disability, discomfort, luminance ratios, VDT visibility)
  - Reduced peak solar load (depending on fabric choice and control)
    - Versus ----------
  - Maximize daylight (lighting energy savings, peak demand reduction)
  - Maximize interior brightness, combat gloom
  - Maximize view out (meaningful stimuli, reduction of stress)
  - Preserve design aesthetic of a “transparent” façade

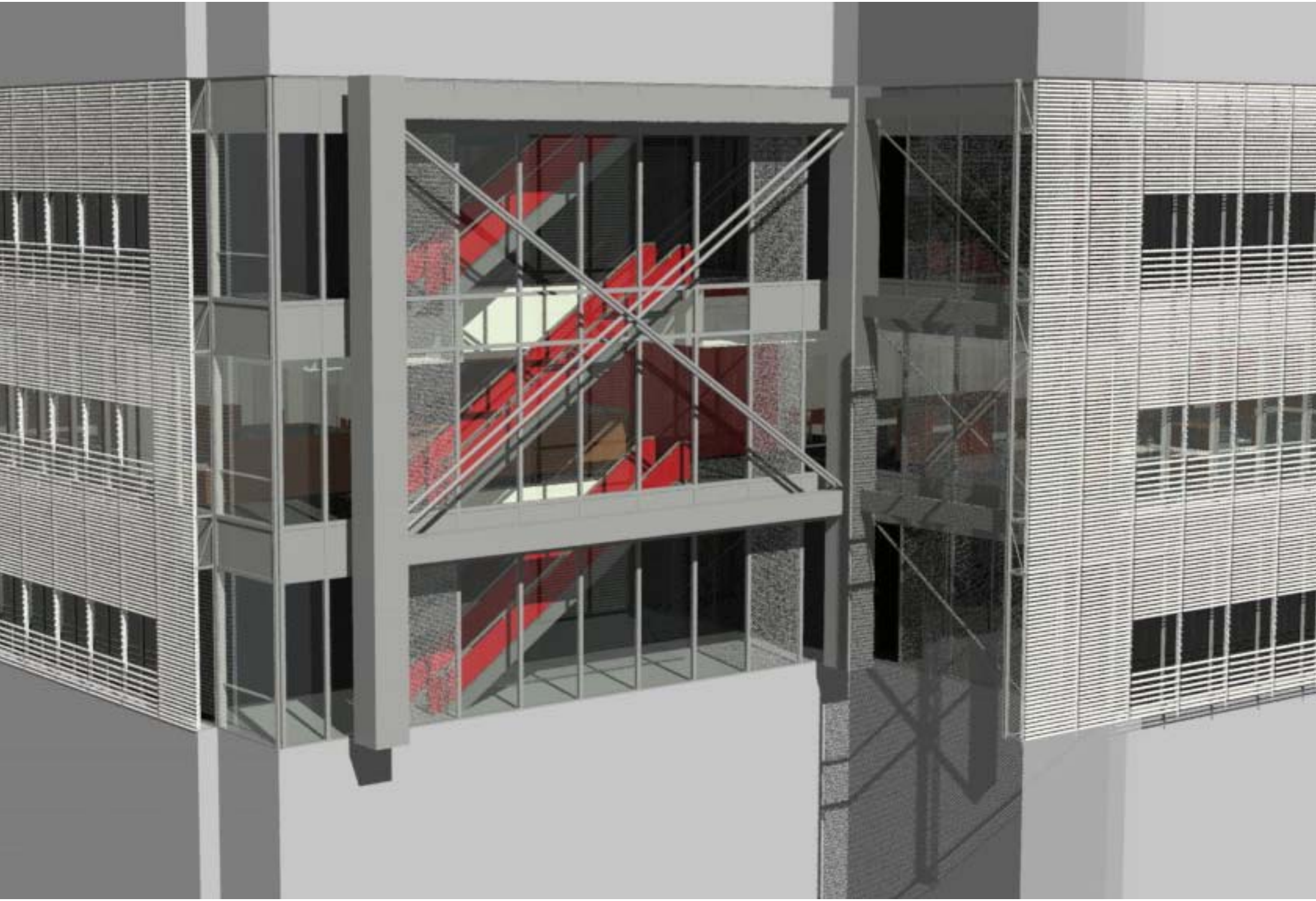
Mock-up Instrumentation

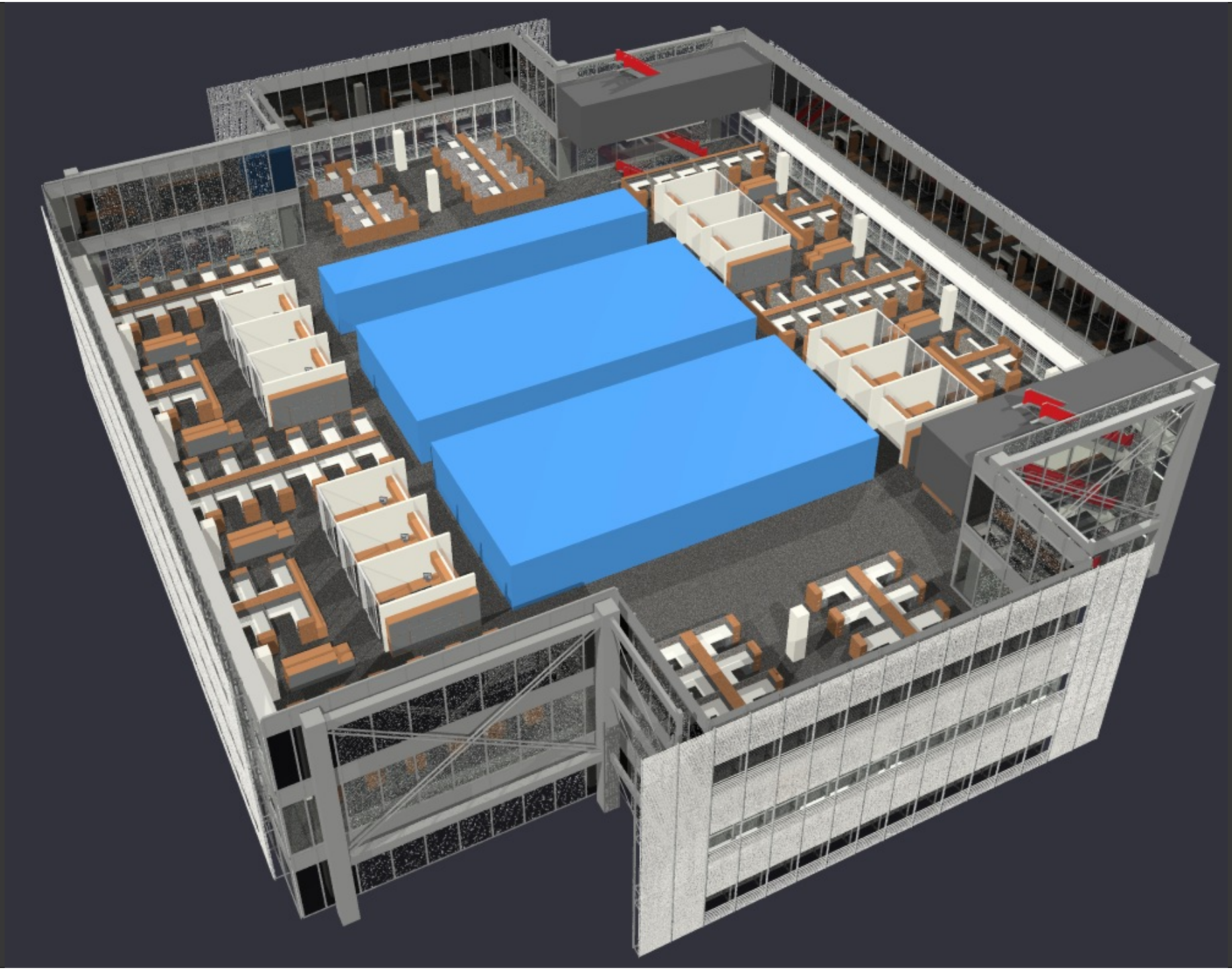
illuminance sensors

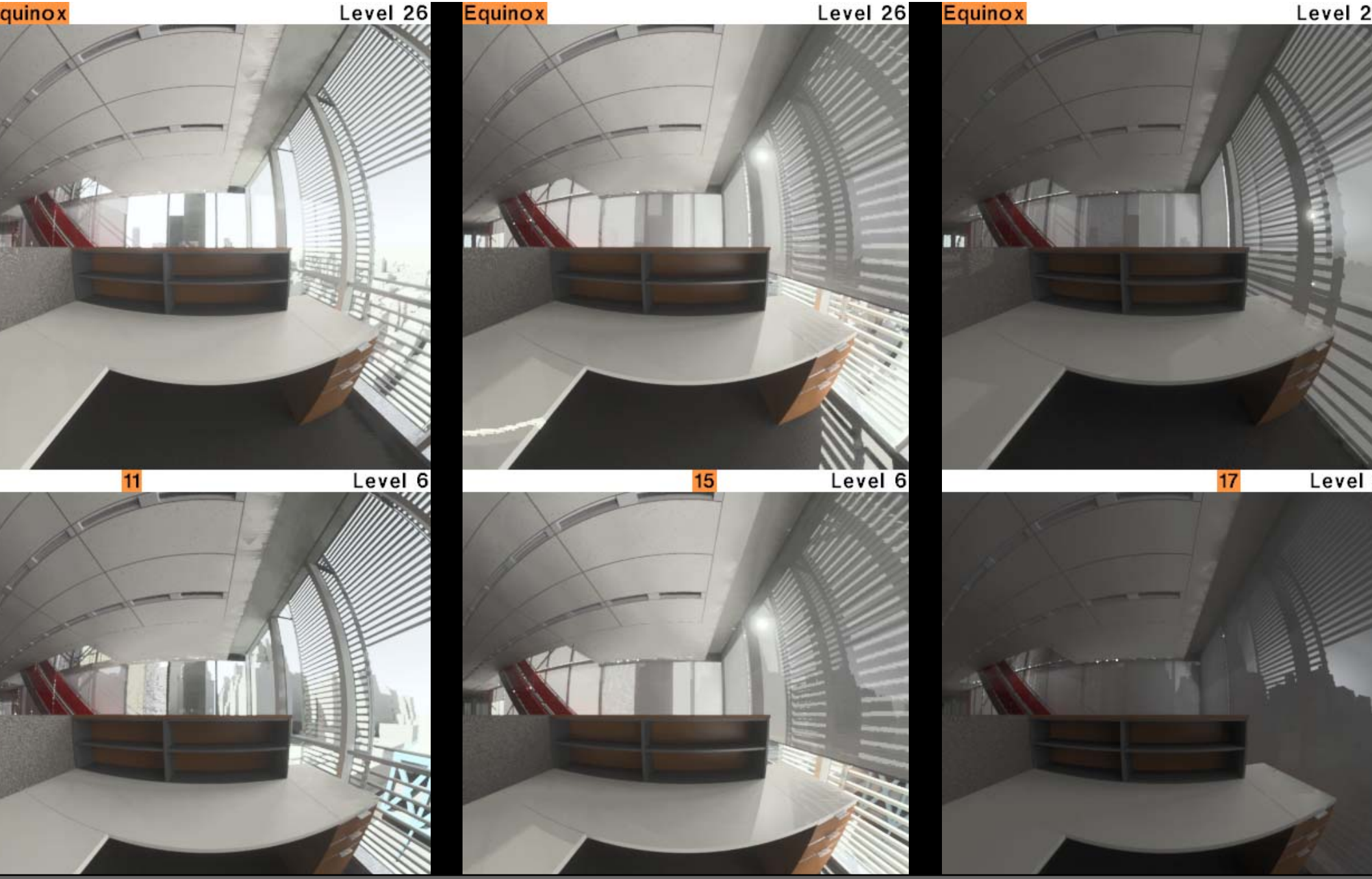
Workstation instrumentation at occupant position with LCD screen

- Luminance and illuminance sensors
- Webcams (10-min time lapse throughout the day)


NYT
site

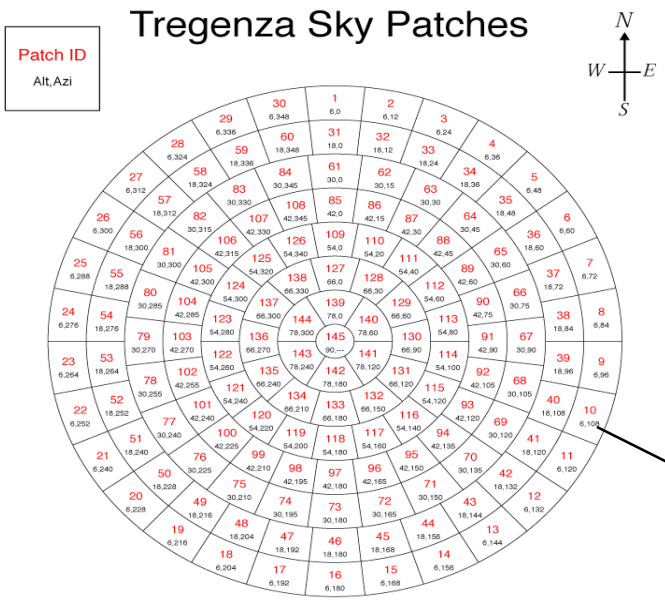




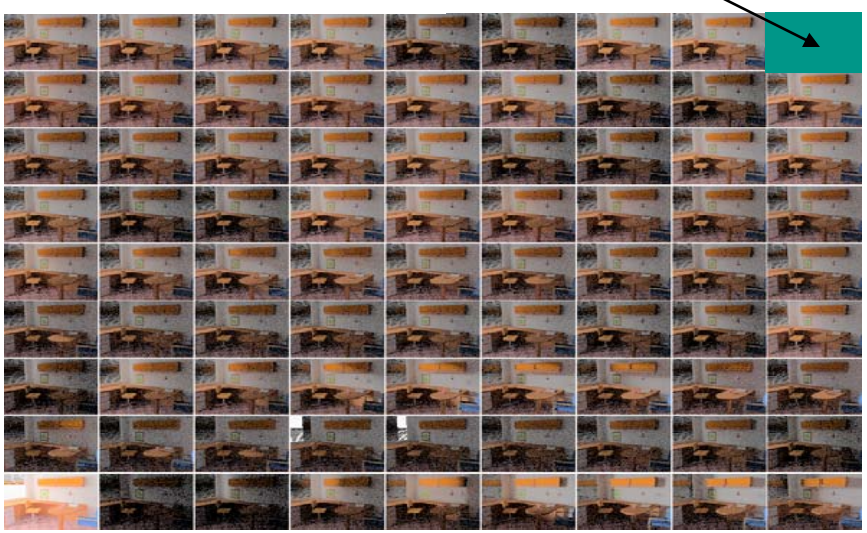


If sun orb in view, window luminance > 2000 cd/m² for < 30 min/day

Annualized Radiance Calculations



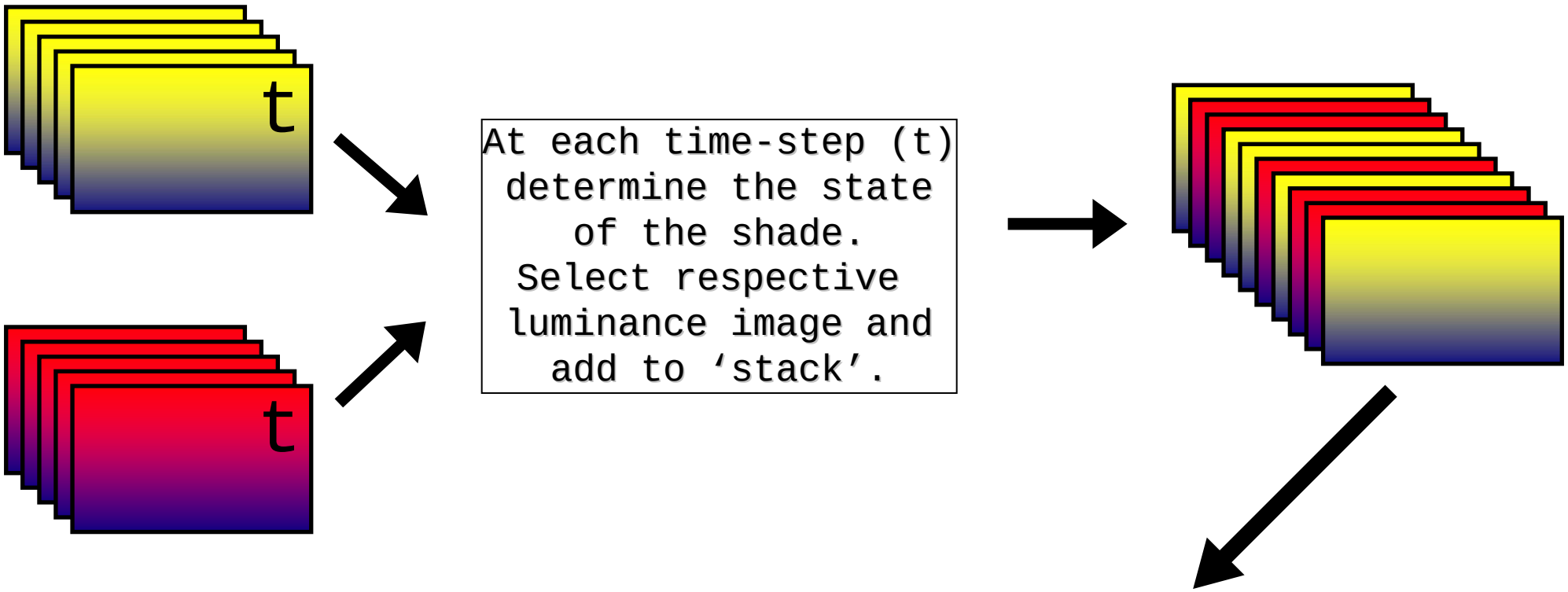
Sky patch contributions



Tregenza's Daylight Coefficient Method:

Sky is divided into roughly equal-sized patches, and the relative contribution of each patch is calculated for a given geometry

Operation of shades

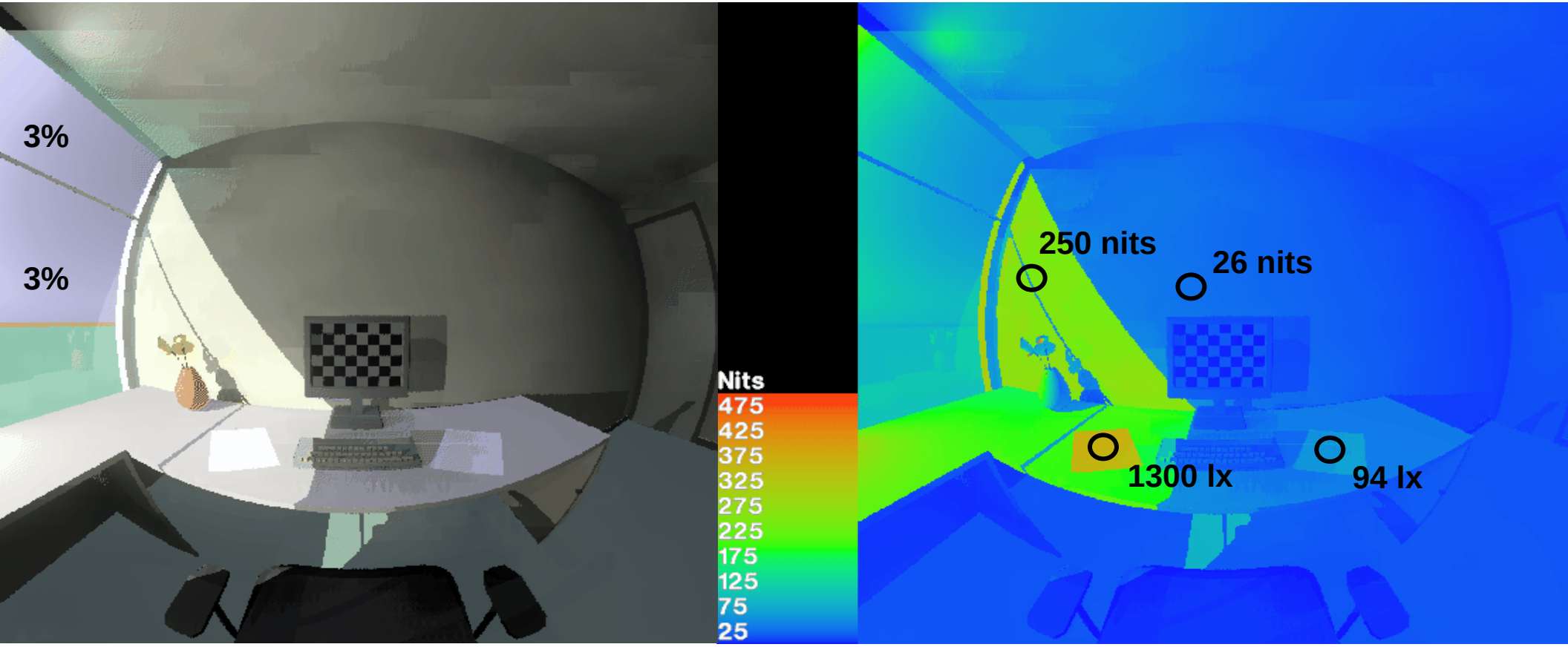


At each time-step (t) determine the state of the shade. Select respective luminance image and add to ‘stack’.

Process ‘stack’ to determine annual occurrence of high luminance for various control algorithms.

Result: optimum transmittance for each window pane

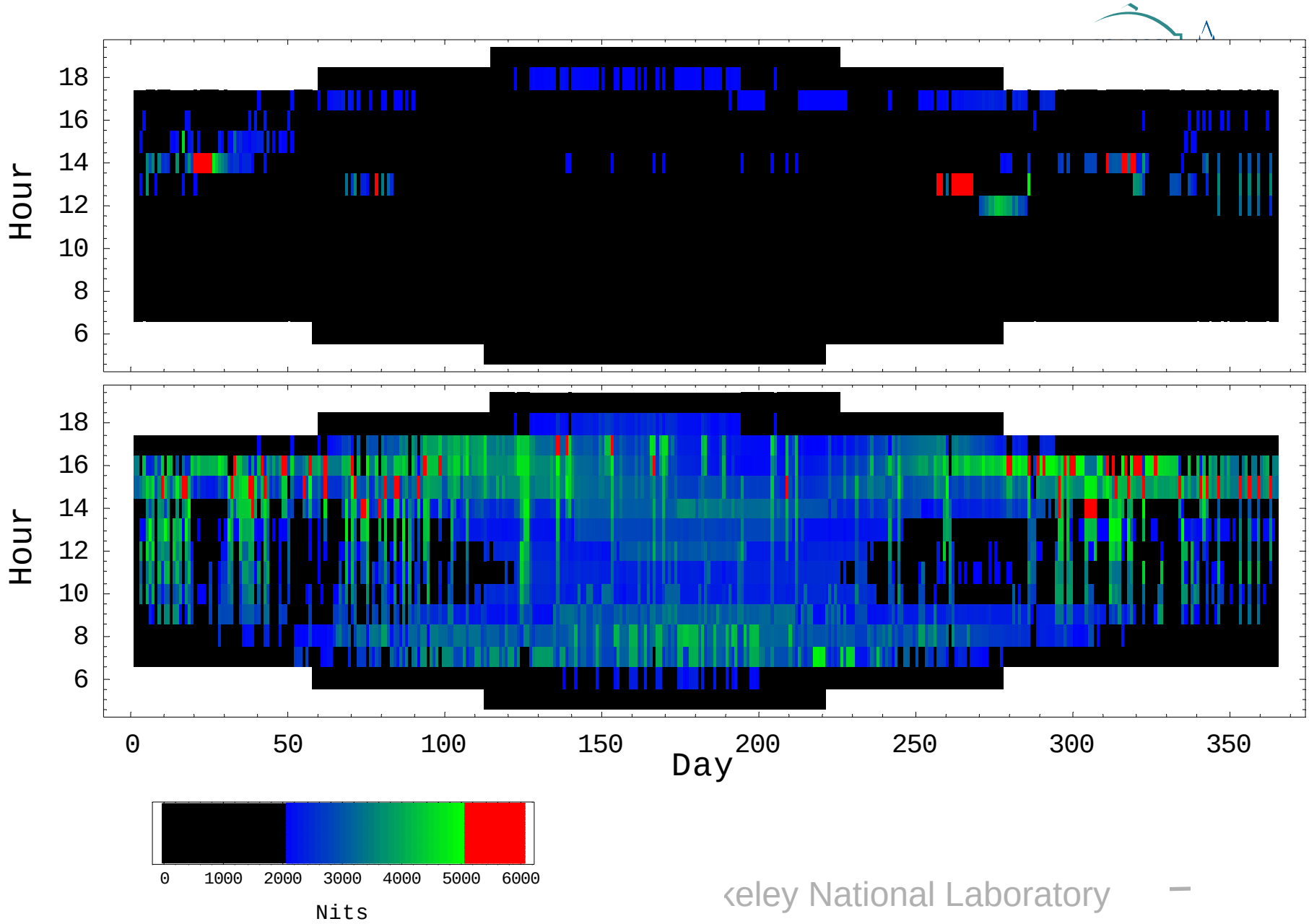
Just glass / Equinox



Max window luminance – NO overhang

EC

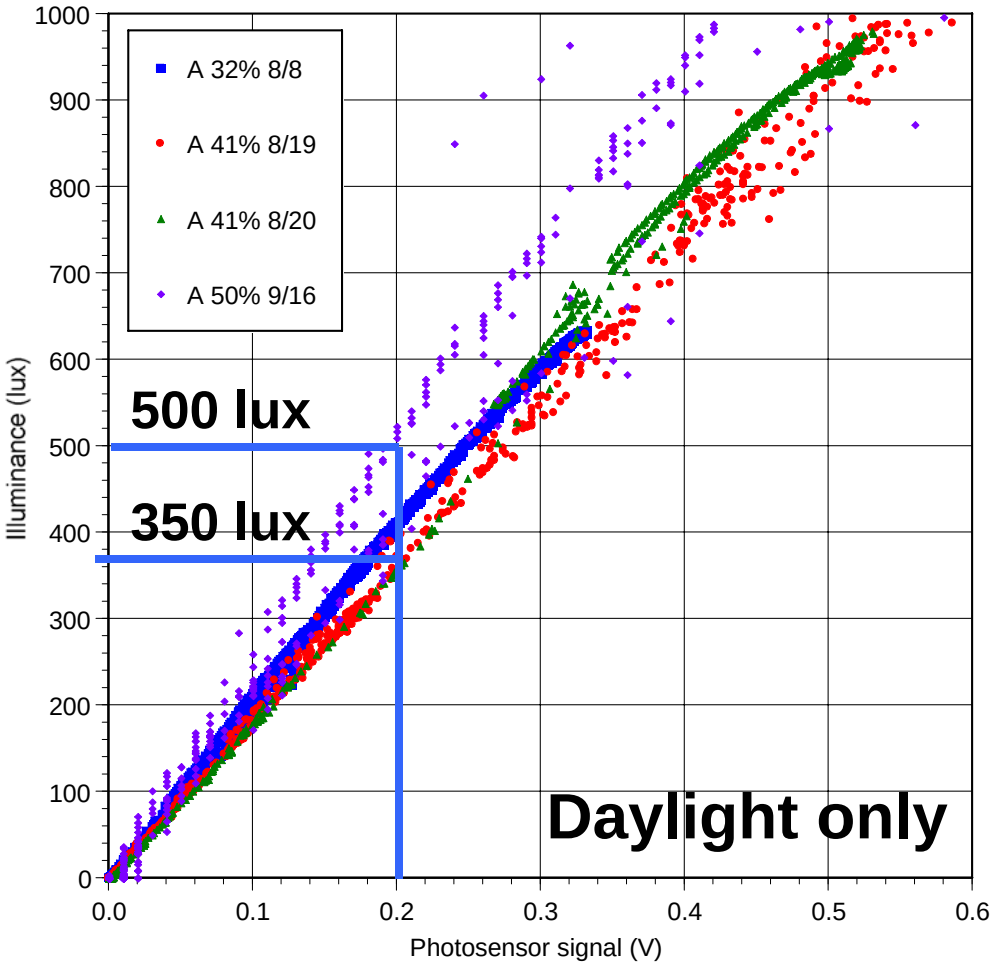
Ref

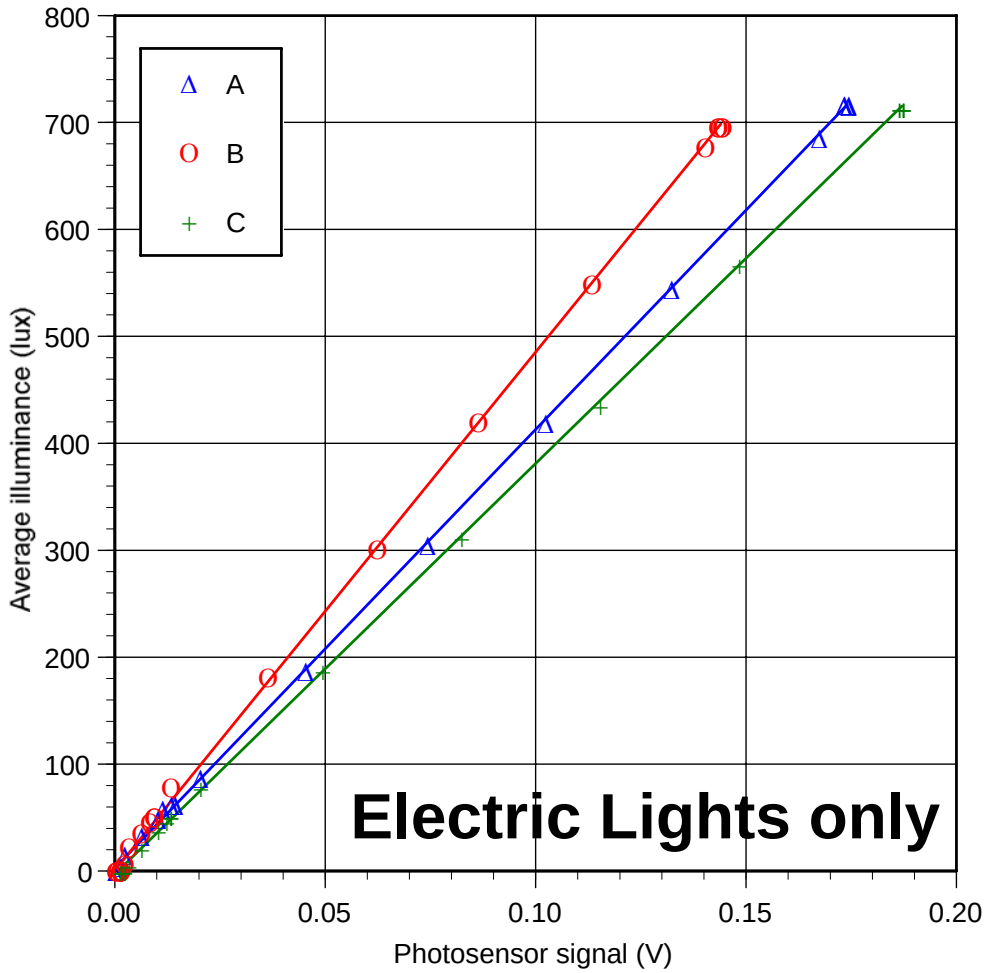


Photosensor correlation to work plane illuminance

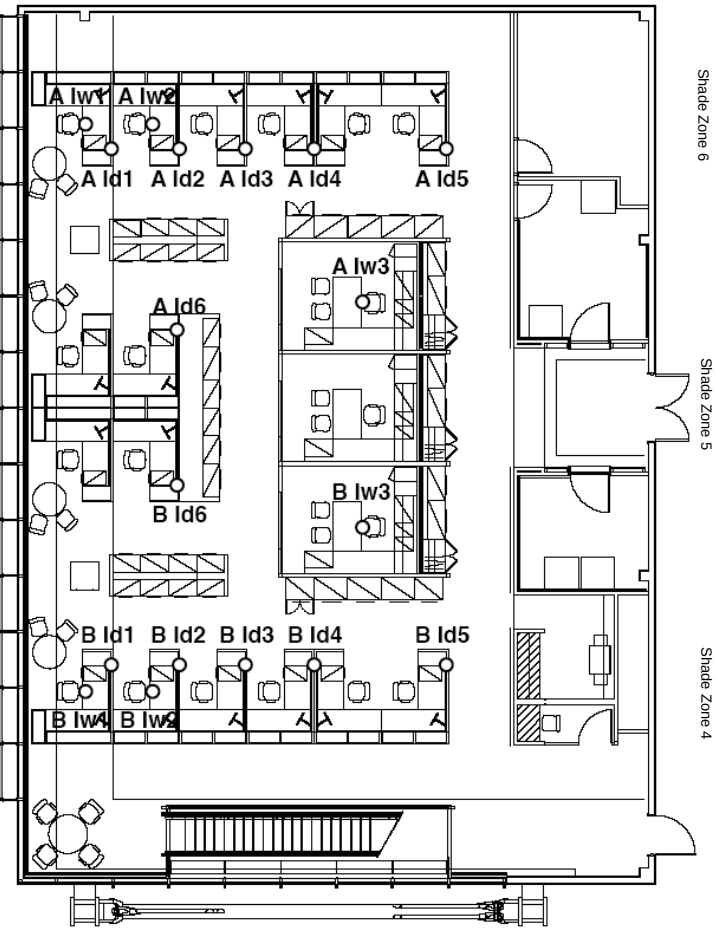
f(x)=?

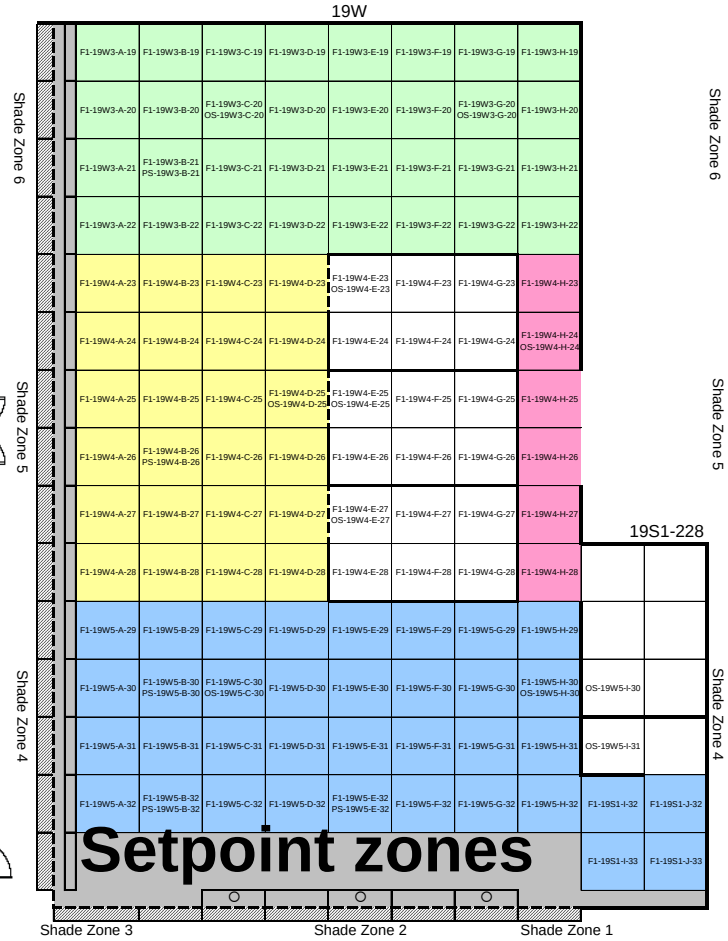
Origin of daylight control system unreliability

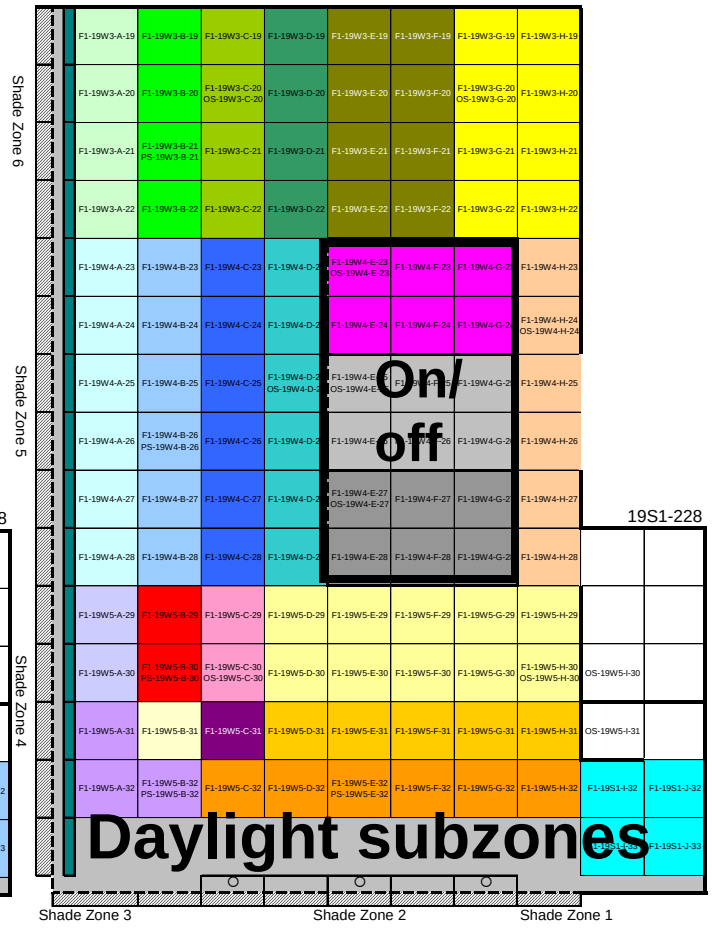




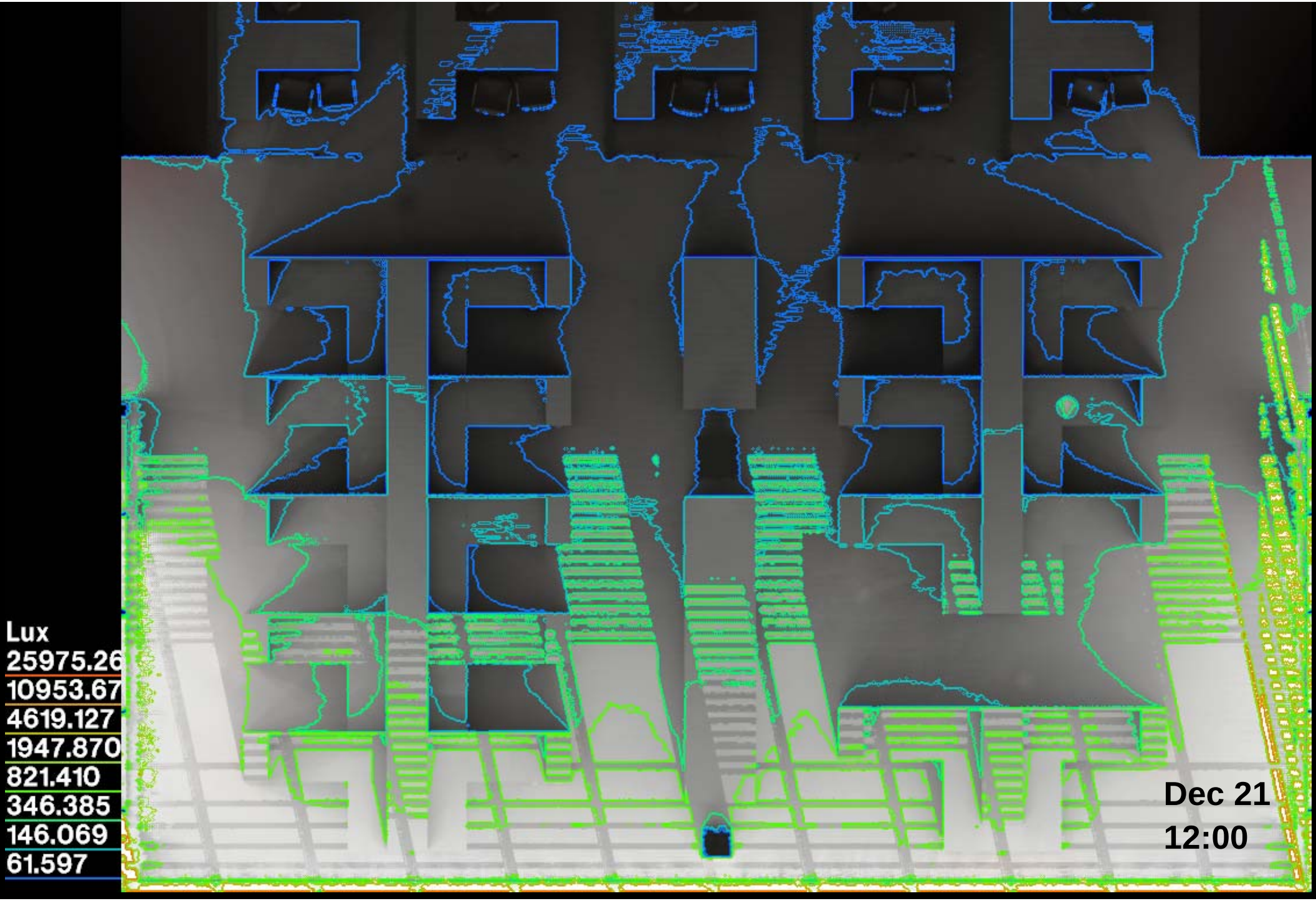
Daylight control zones with DALI ballasts







The Times daylighting mockup floor plan


Lux
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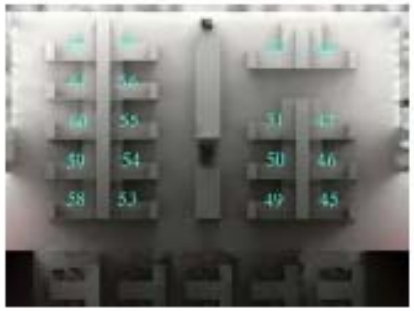
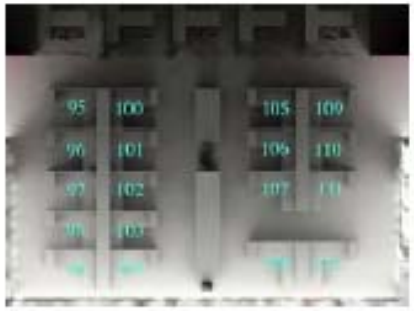
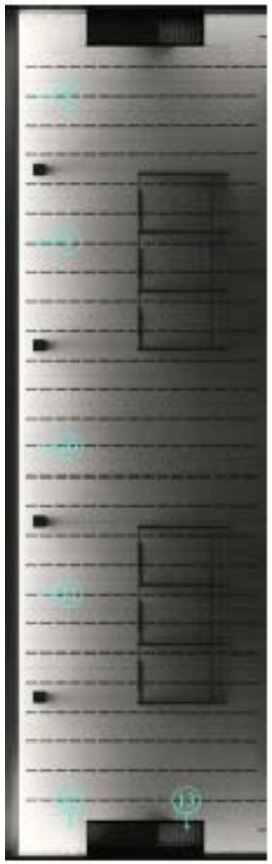
10953.67
4619.127
1947.870
821.410
346.385
146.069
61.597
Dec 21
12:00



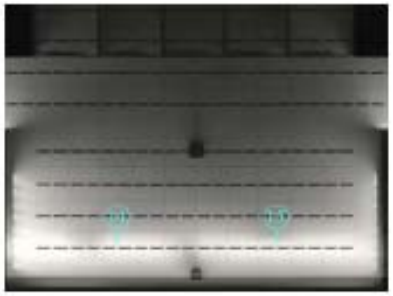
Radiance data:

Correlate desk illuminance for





to signal of a unique photo-sensor design



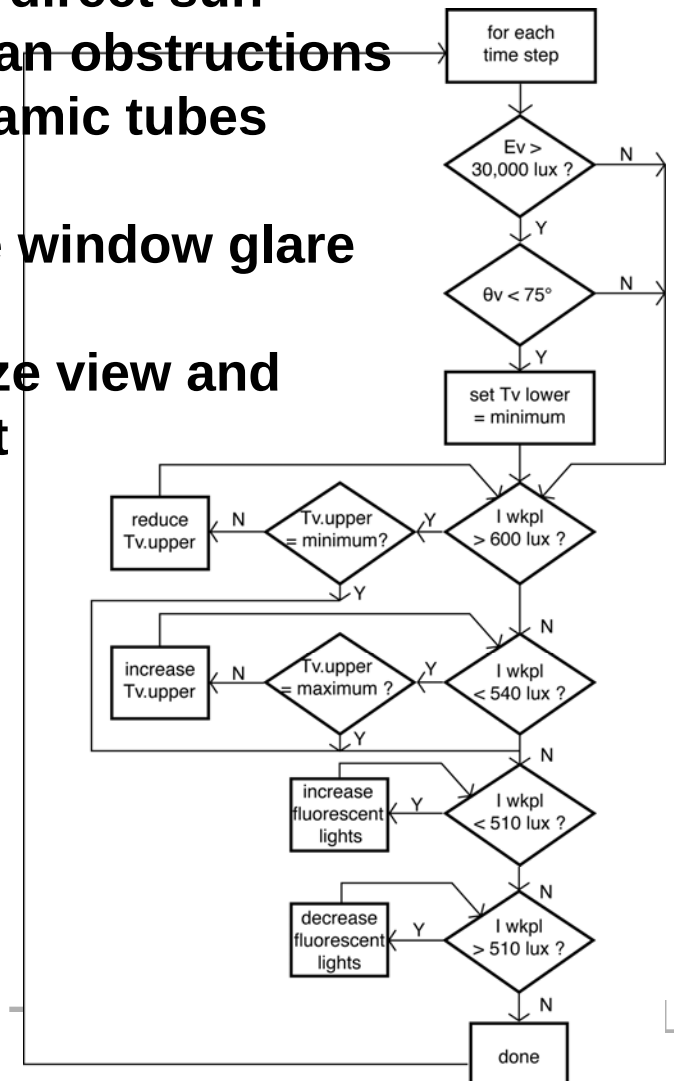
Field commissioning tools: Goal – meet specs before occupancy

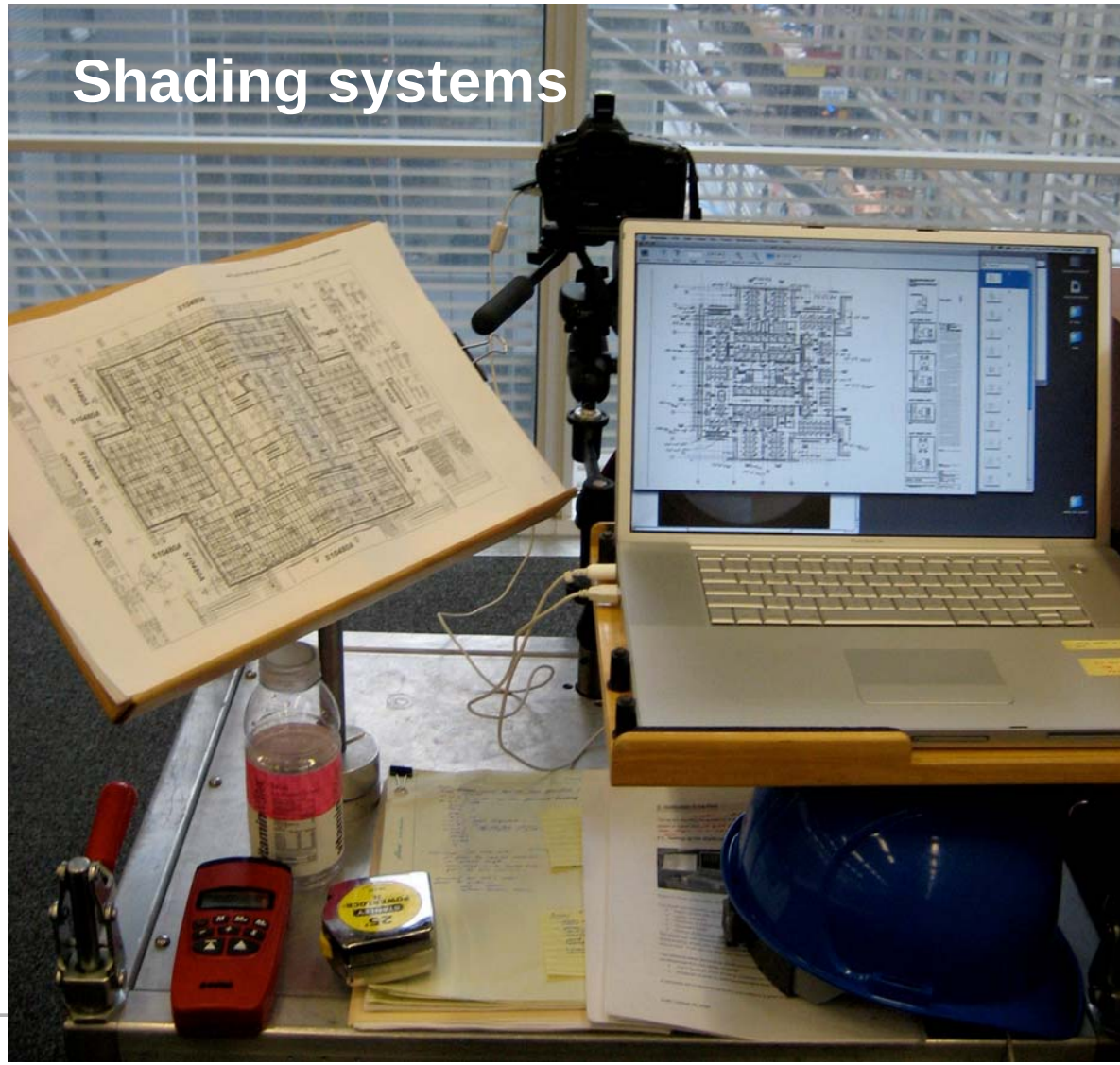
Control direct sun

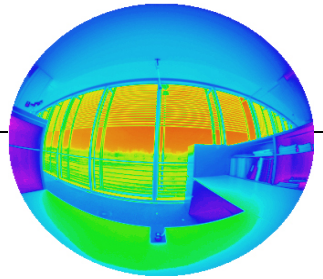
- **Urban obstructions**
- **Ceramic tubes**

Manage window glare

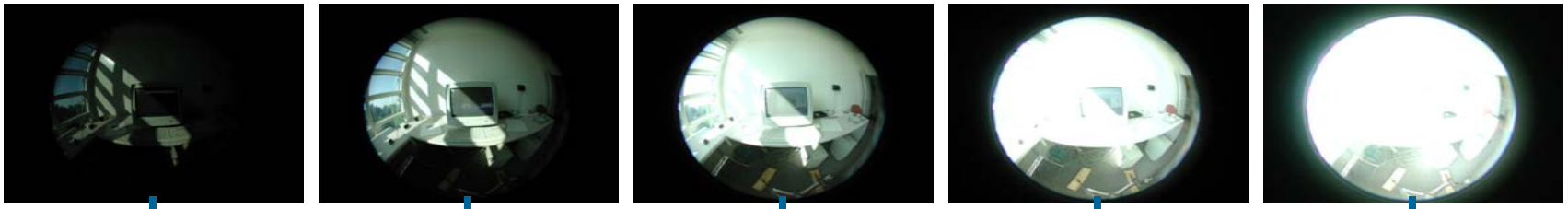
Maximize view and daylight

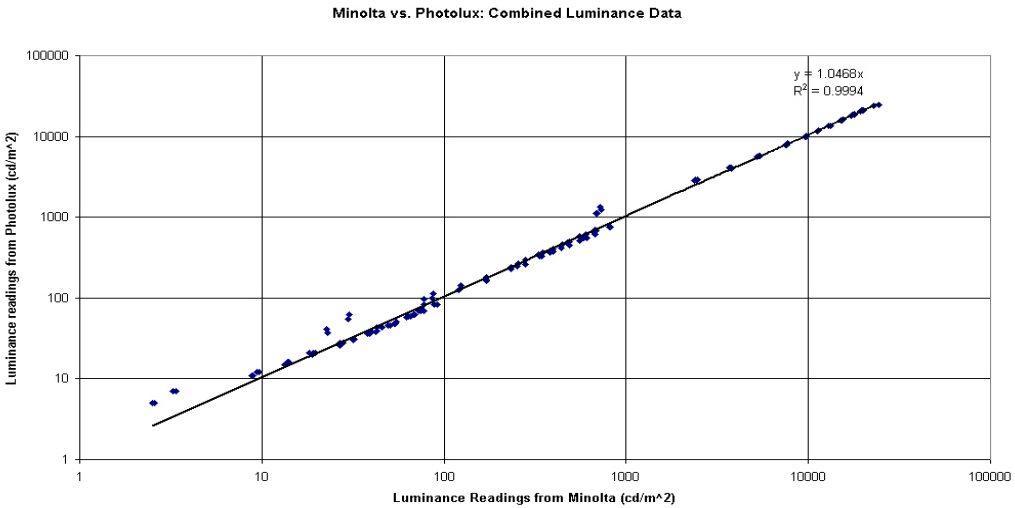


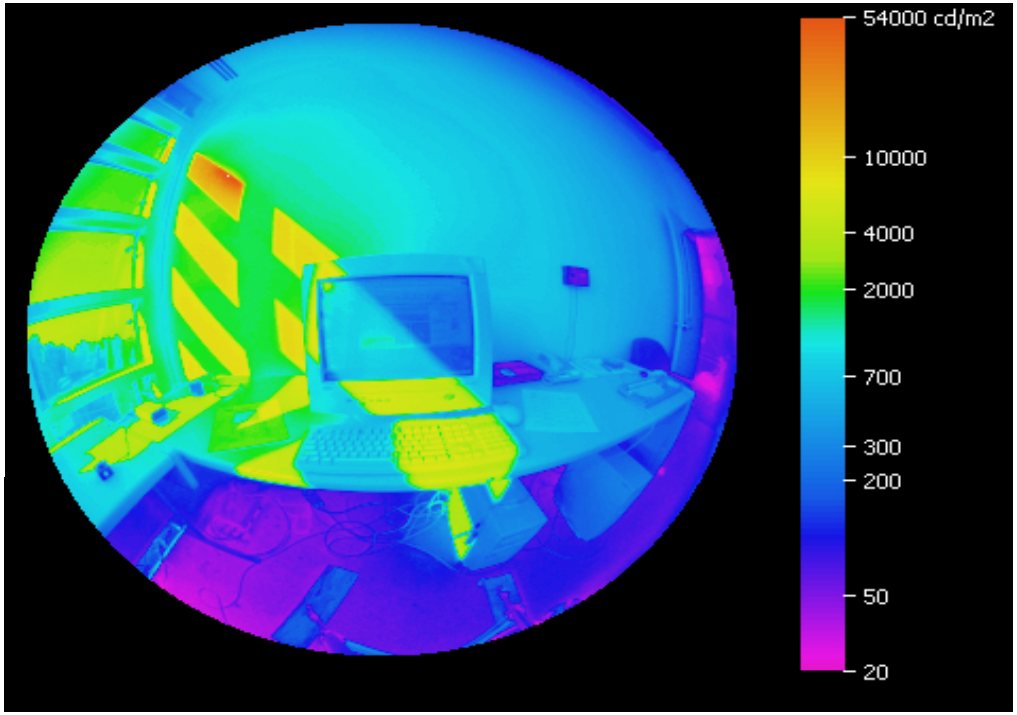




Luminance Data using High Dynamic Range (HDR) photography



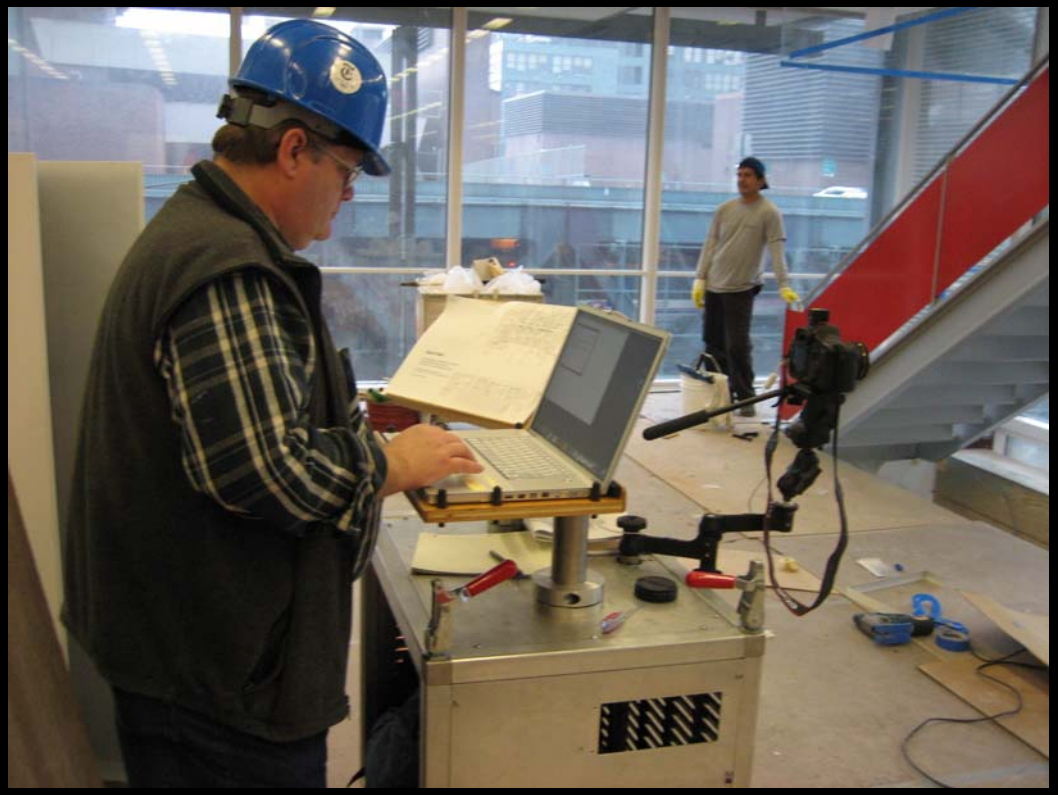




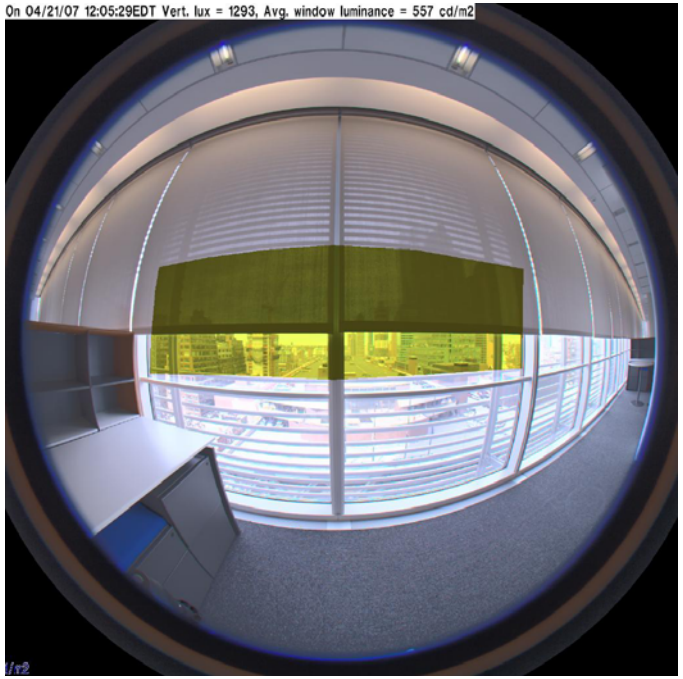
Accuracy of +/- 10%

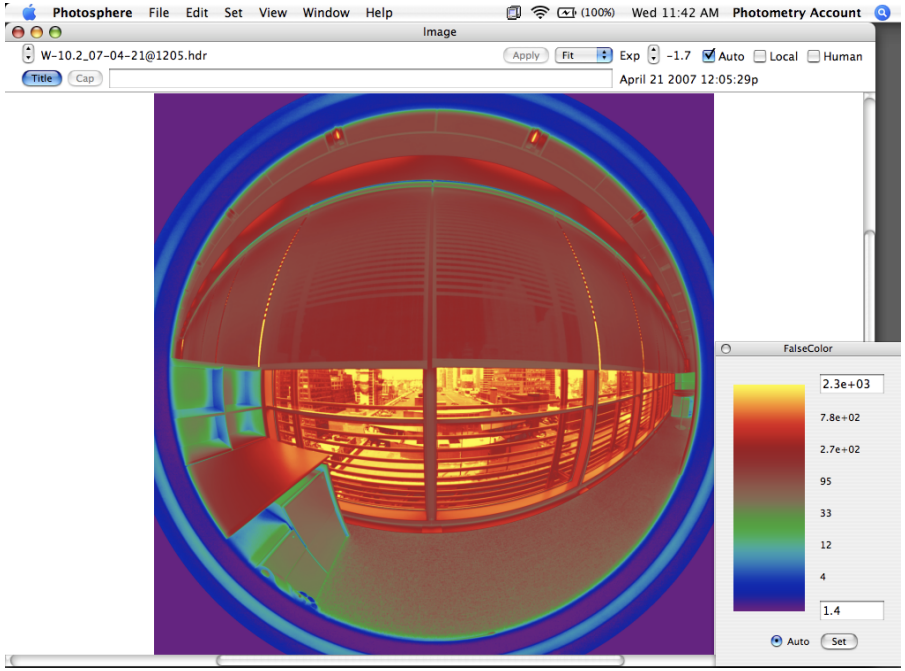
L_{min} = 4 cd/m^2, L_{max} = 53,280 cd/m^2

LBNL shade commissioning cart at The New York Times Headquarters Building

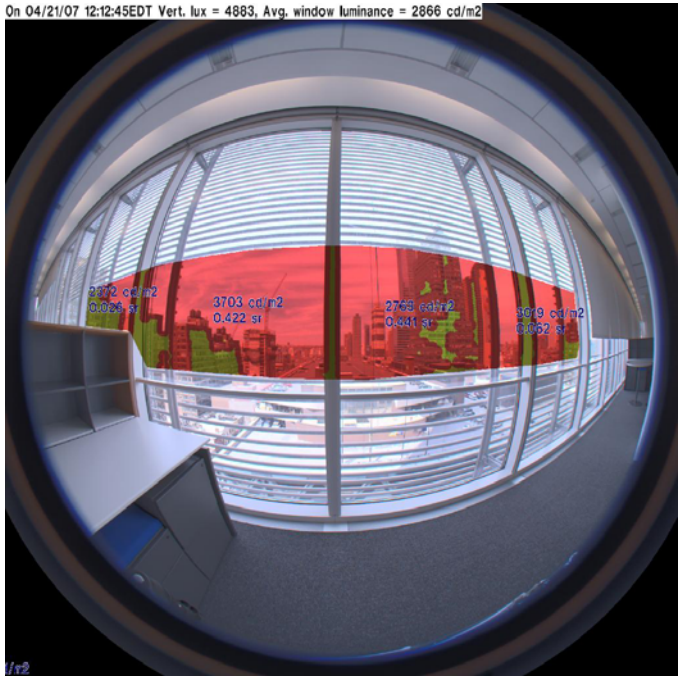


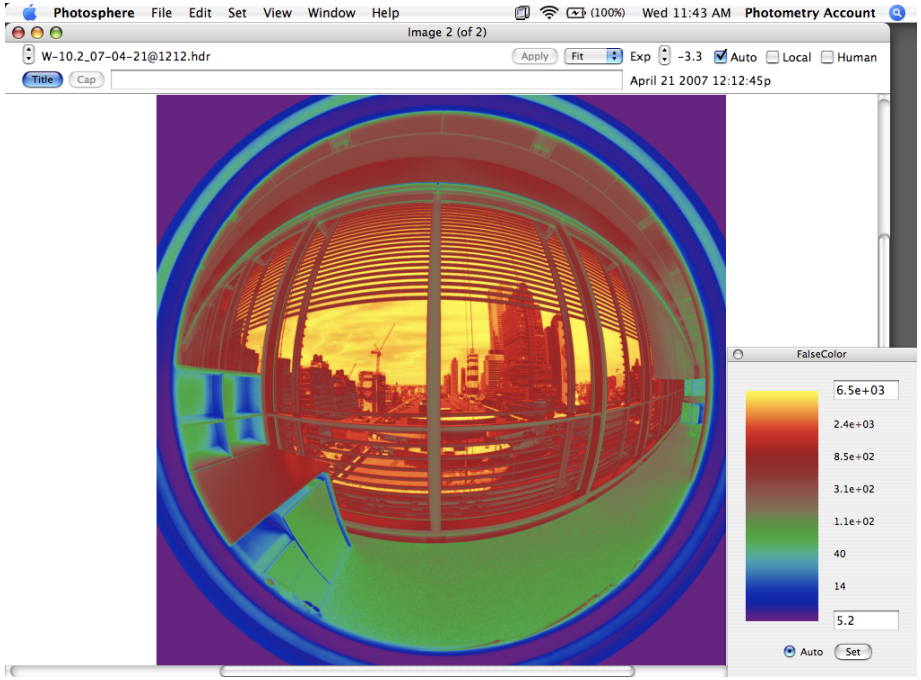
Auto mode:





Override mode:

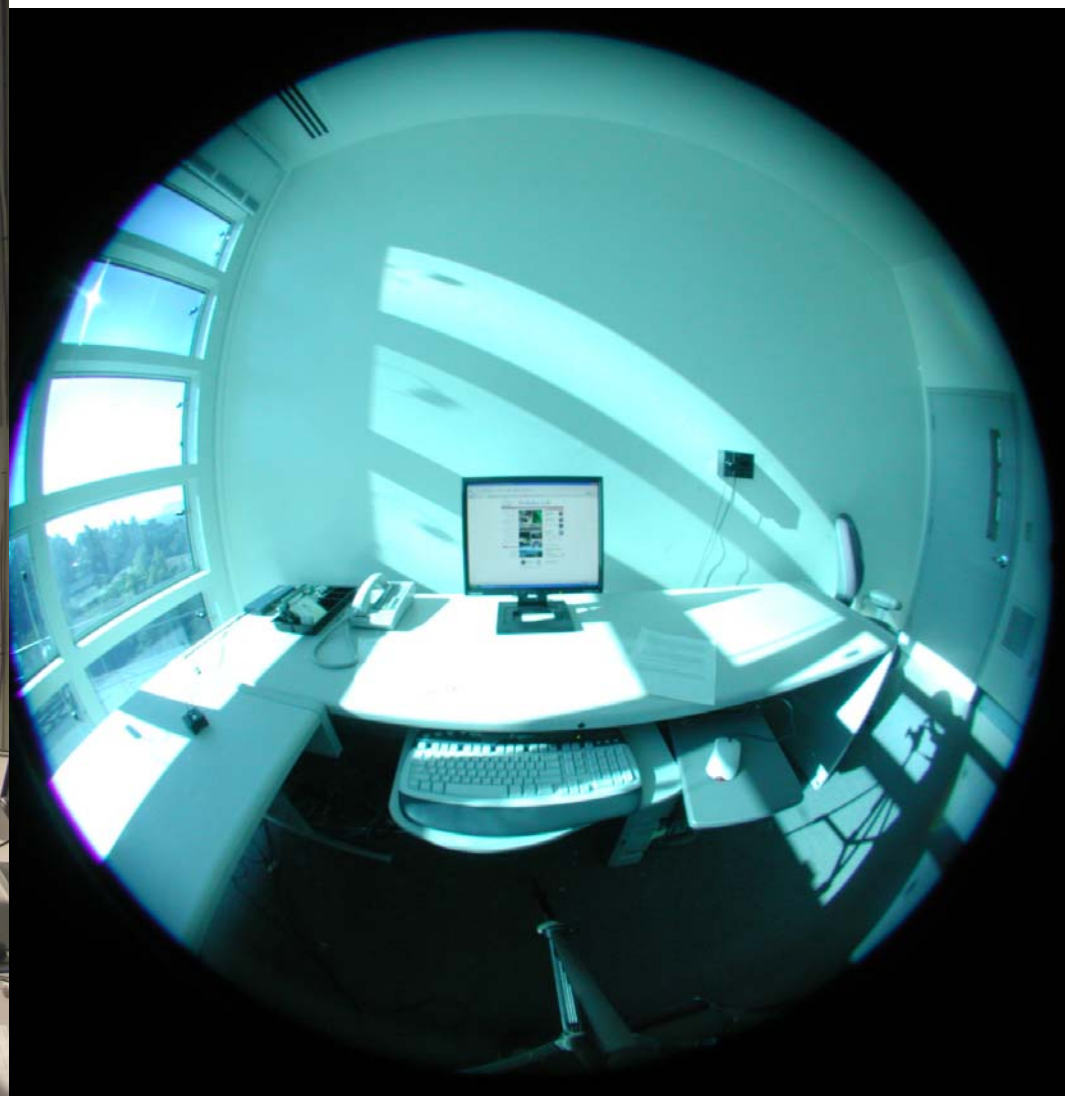




Verification data enables productive discussions

- Owner able to hold productive discussions with manufacturer during commissioning and verification phases of project:
  - Verification activities time synch'd with manufacturer's control computer
  - Real-time diagnostics using measured data to troubleshoot and fine-tune control response
  - Modification of control system required to meet performance specifications

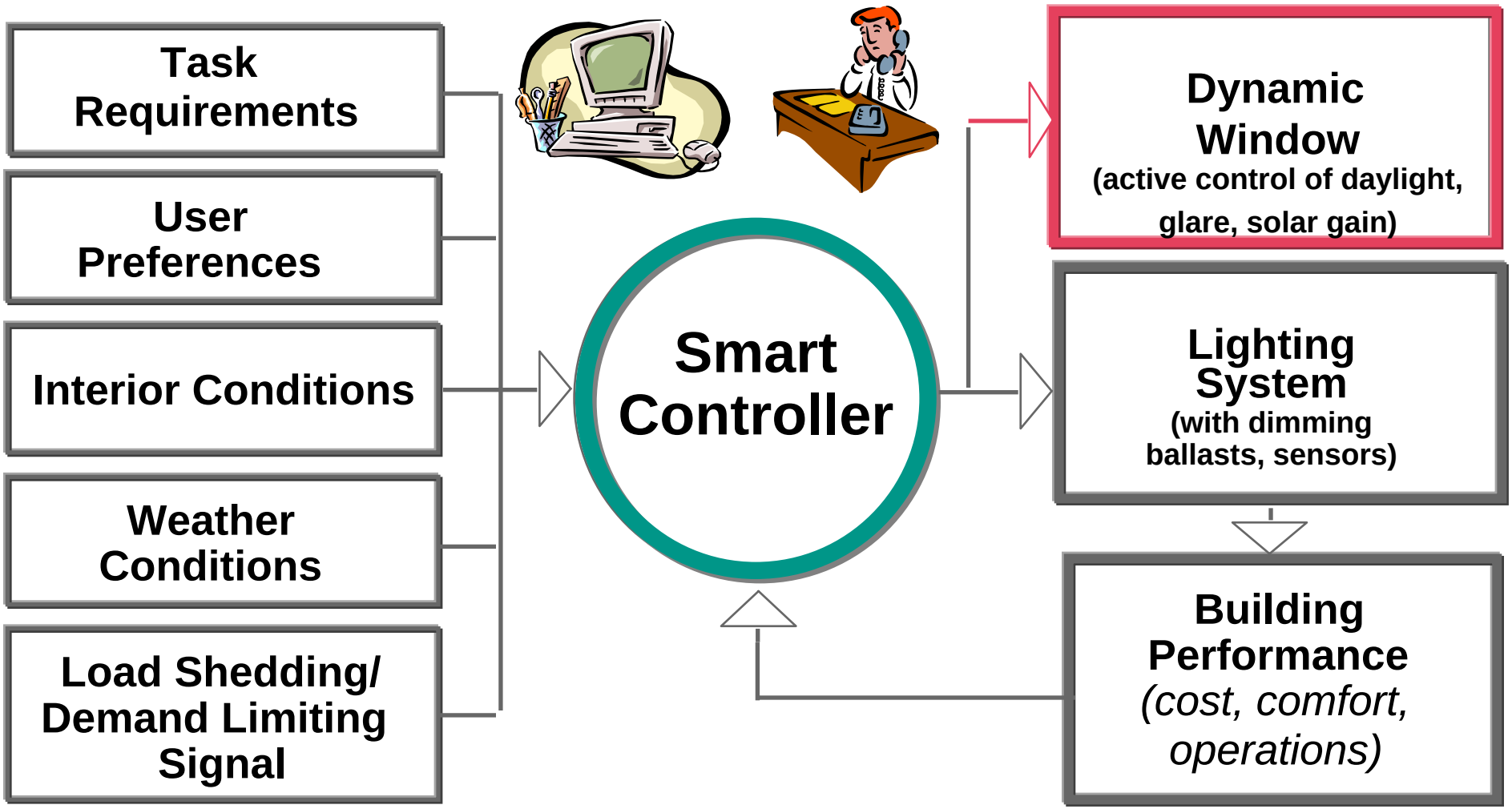
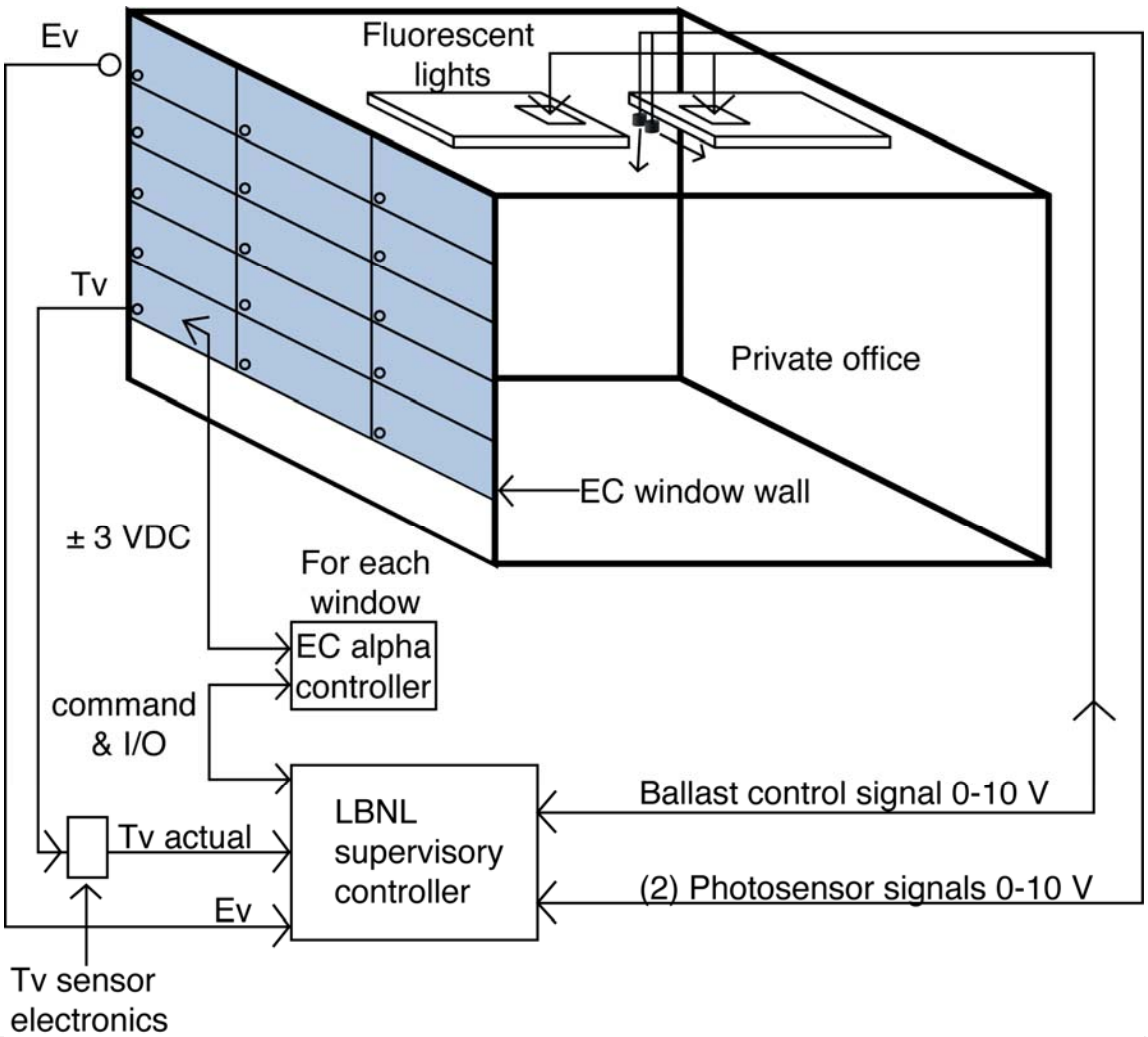
LBNL windows testbed facility with electrochromic windows below (prior field test)



Field test capabilities

- 1000 sf full-scale test facility measures thermal, daylighting, and control system performance in realistic office environment under variable sun and sky conditions
  - Between-room daily cooling/ heating load measurements to within 3-5%
  - Between-room hourly cooling/ heating loads to within 5-7%
  - Minute-to-minute lighting energy measurements to within 1-3%
- Can contribute to a gross understanding of how window heat transfer models and lighting control system models can be improved
- Monitor dynamic window operations sufficiently to characterize the system design and operations
- Monitor electric lighting control system response, operation, and reliability under realistic building conditions.
- Measure statistically representative user response on satisfaction and acceptance within a conventional office-like setting.

Intelligent Control of Dynamic Systems



Systems Engineering