



Field-evaluations of upper-room and whole-room germicidal ultraviolet installations

Eduardo Rodriguez-Feo Bermudez
Belal Abboushi
Jason Tuenge



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Background of Germicidal Ultraviolet Systems

Upper-Room (UR-GUV)



- Space can be occupied
- UV radiation must stay in the upper space of the room
- Low pressure mercury (LPM) emits 254nm peak radiation
- LED emission peak vary, (e.g., 270nm)

Whole-Room (WR-GUV)



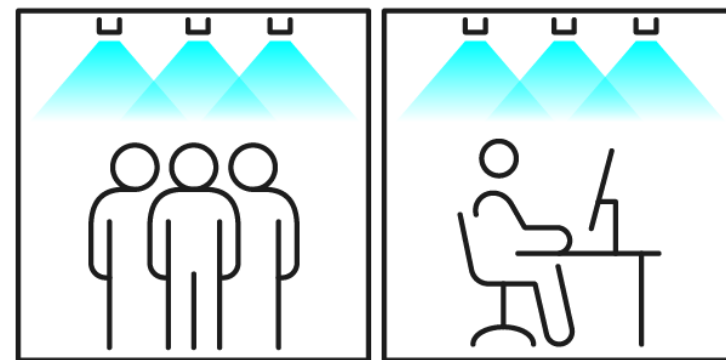
- Space can be occupied
- UV radiation aims downwards towards the occupied space
- Excimer emits 222nm peak radiation

Objective of Field Evaluations

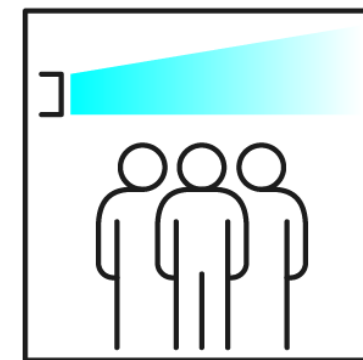
- Sample for both Upper-Room (254nm for LPM or 270nm for some LED) and Whole Room (222nm, Excimer) systems
- Evaluate the systems from three perspectives
 - Safety
 - Effectiveness
 - Occupant and facility manager's experience
- Primary measurements
 - Irradiance with 80° and 180° Field of View (FoV)
 - Spectral Irradiance Distribution
- Other Measurements
 - Ozone Concentration
 - Energy Consumption

Benefits of Field-Evaluations

- Examining the effectiveness and safety of in-situ GUV system installations
- Develop methods that can be applied on-site
- Identify installation practices that are safe and effective or unsafe and ineffective

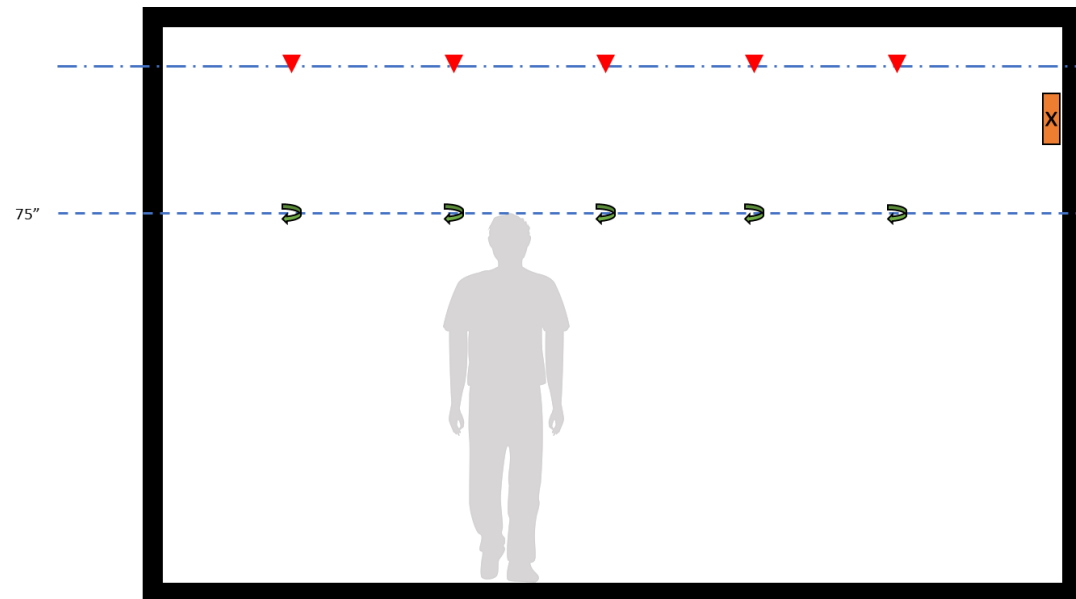
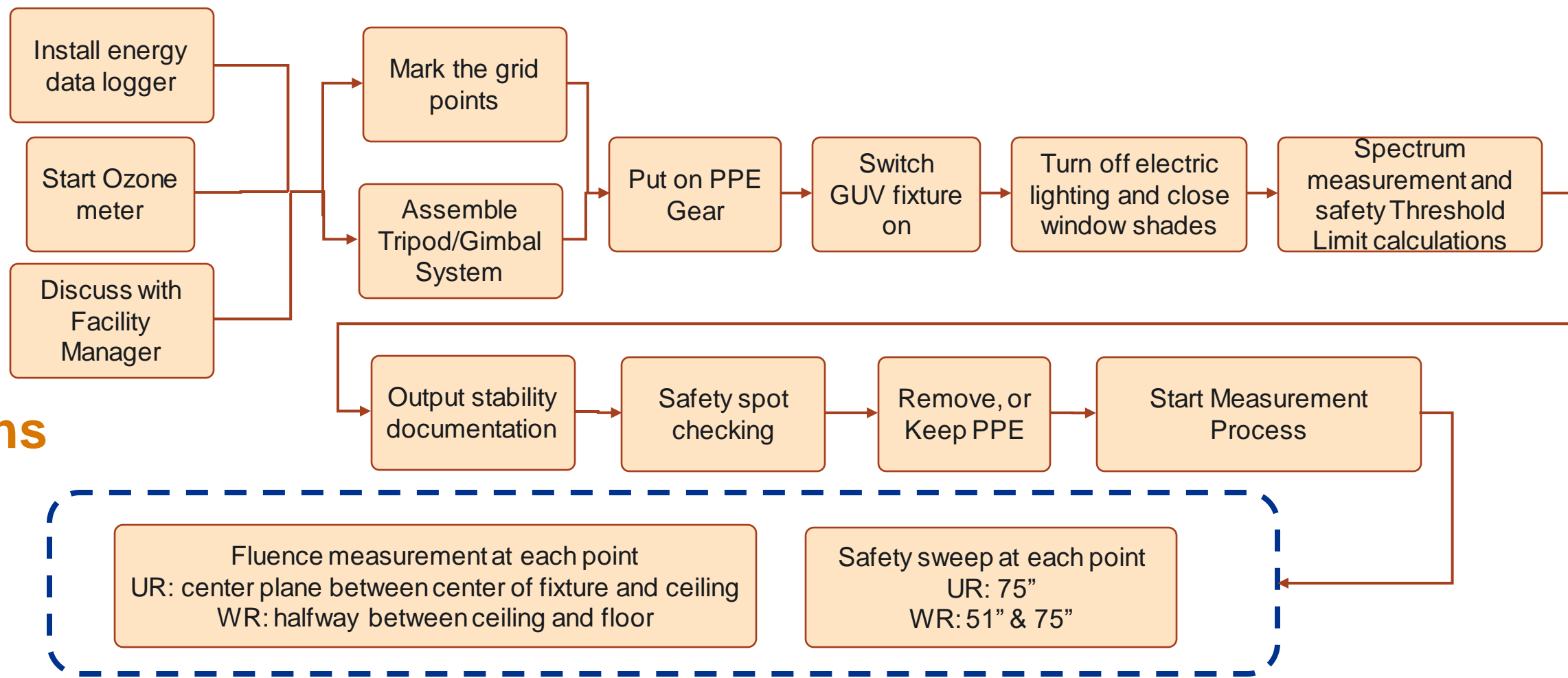


Whole-Room GUV

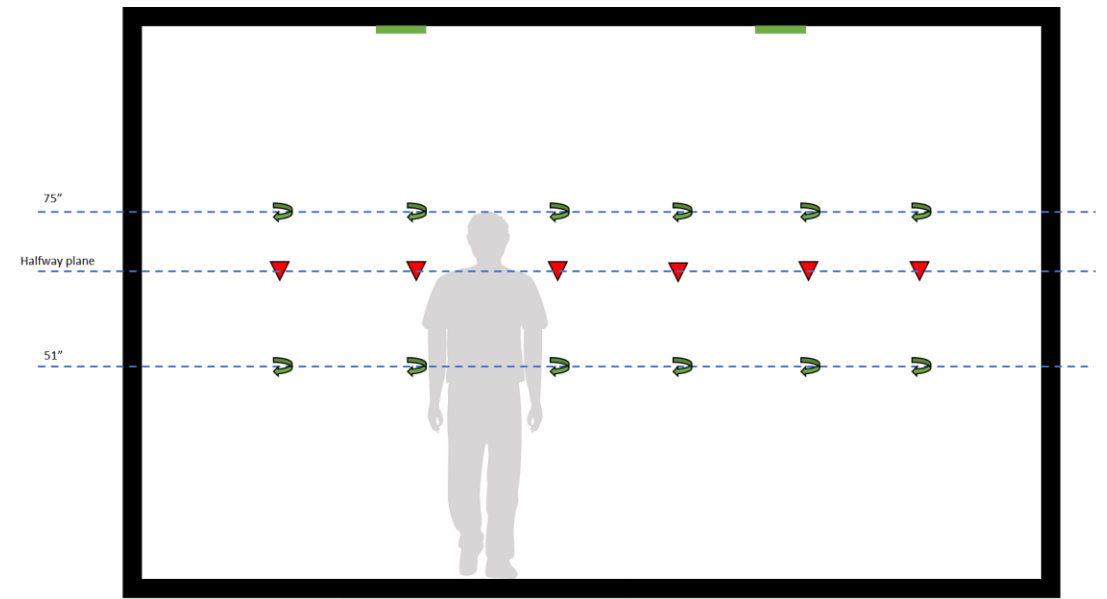


Upper-Room GUV

Field-Evaluations Flow



UR-GUV



WR-GUV

Measurement Tools

- Irradiance meter
- Spectroradiometer
- Tripod system
- Gimbal system
- Ozone concentration meter
- Energy and occupancy data logger

Safety Gear

- UV rated goggles (ANSI Z87.1+U6)
- UV rated face shield (ANSI Z87.1+U6)
- Nitrile gloves
- Long sleeves and pants



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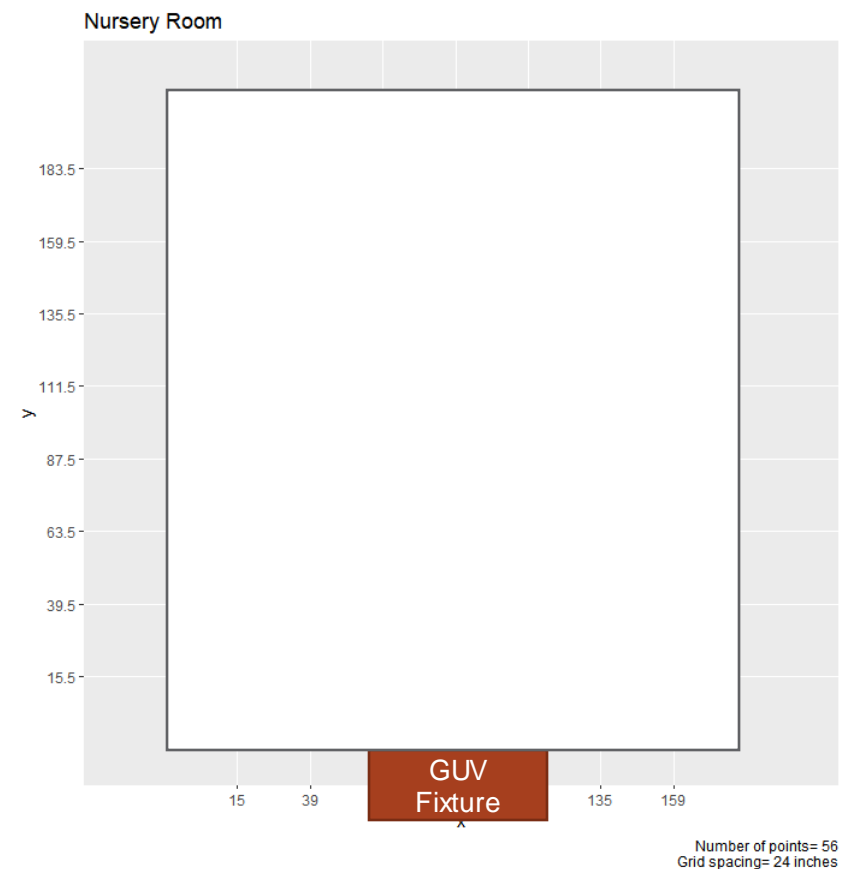
Creating the Grid

Determine...

- The space to be evaluated
- Dimensions of the space/room
- Grid spacing (e.g., 24", 36", 48")
- The height of horizontal planes to be tested

Nursery Room Details

- Occupants: 6-7 babies and 3-4 adults
- 2-hour blocks
- Ceiling height is 9' 9"
- The space is approximately 17' x 17'



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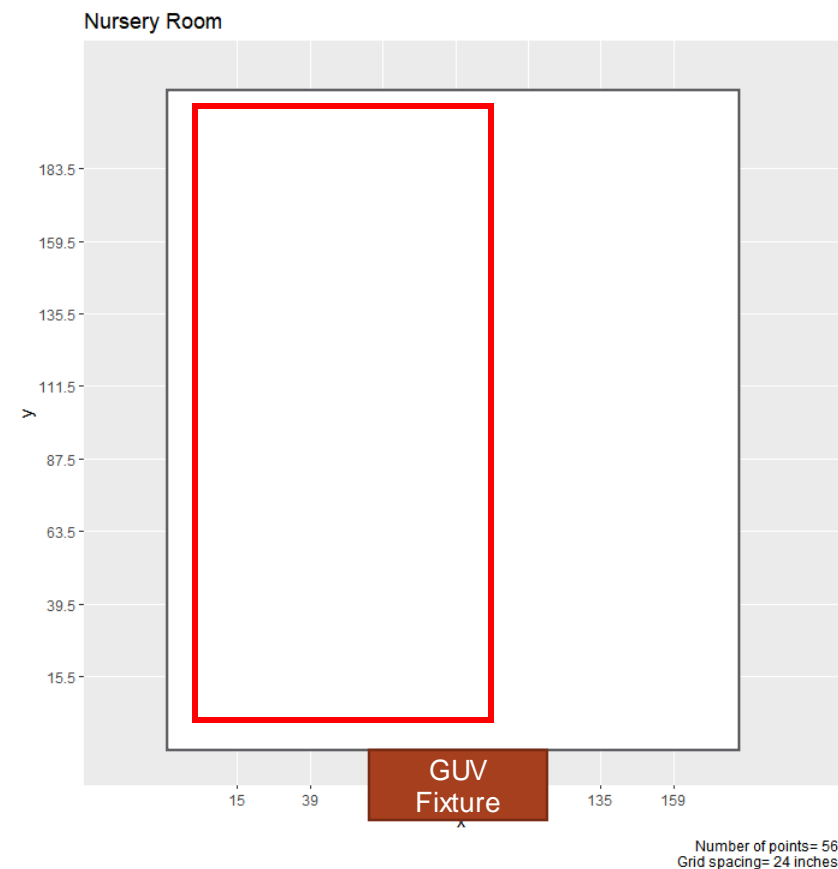
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Identify...

- Symmetry that can be used to reduce total number of measurement locations
- Potential obstructions

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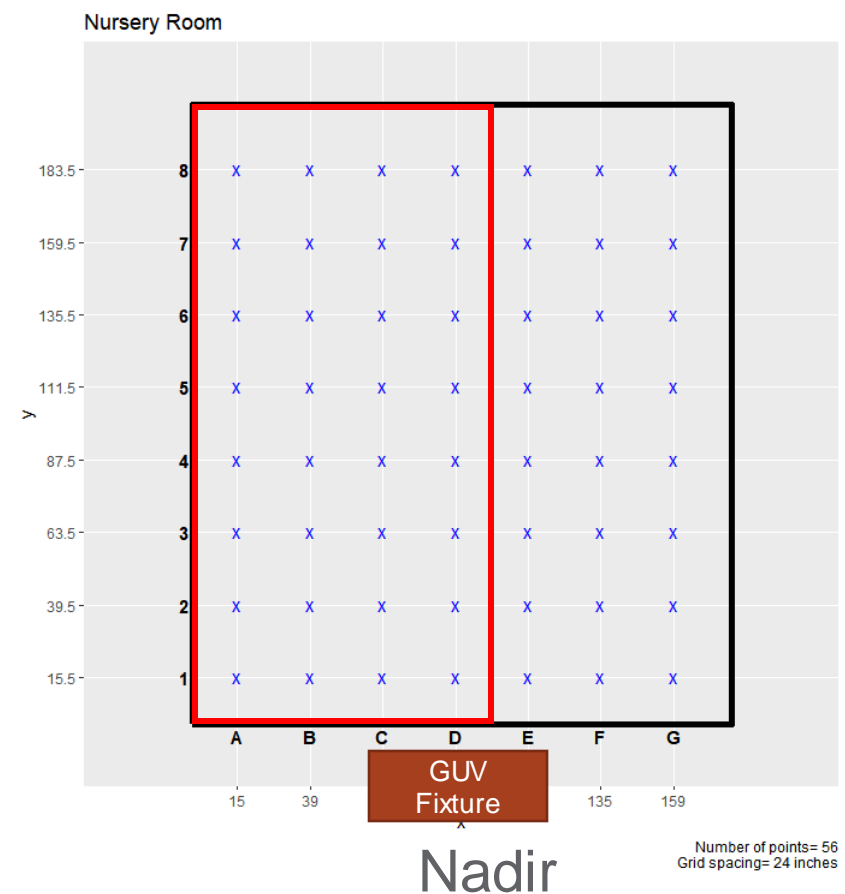
Create...

- The grid by marking the space
- The naming conventions for the grid points (A1, A2, B1 ...)
- Identify which wall or direction will be considered the 0 Deg direction

Then take the measurements

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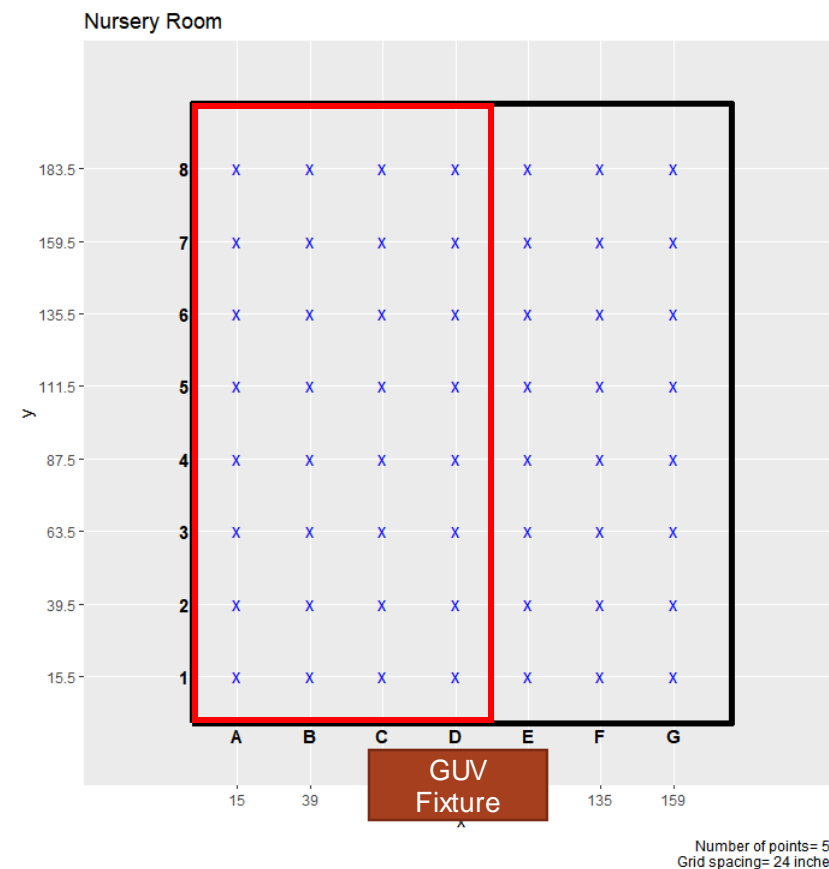


Creating the Grid



Nursery Room Details

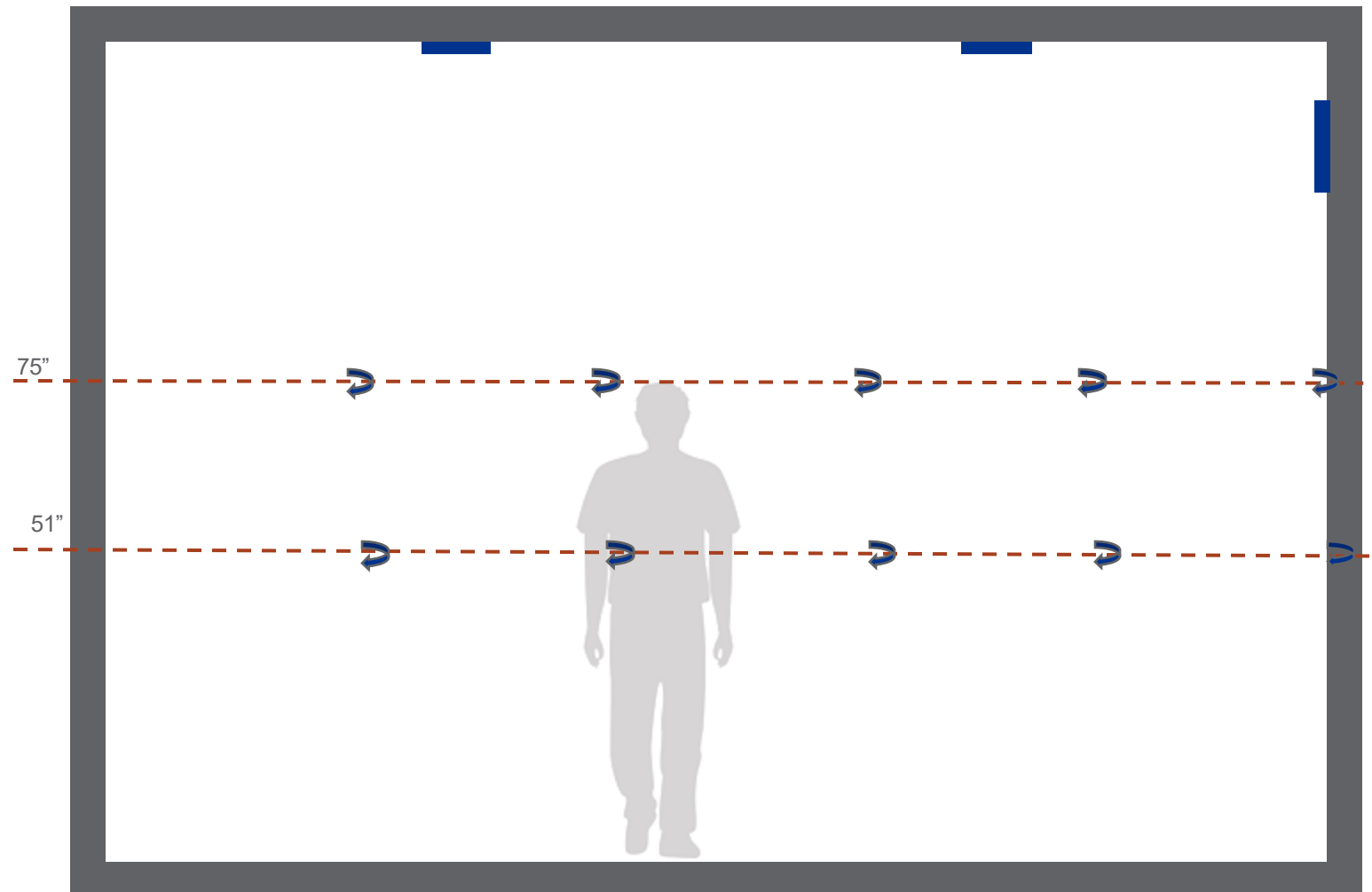
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Measurements - Safety

Safety

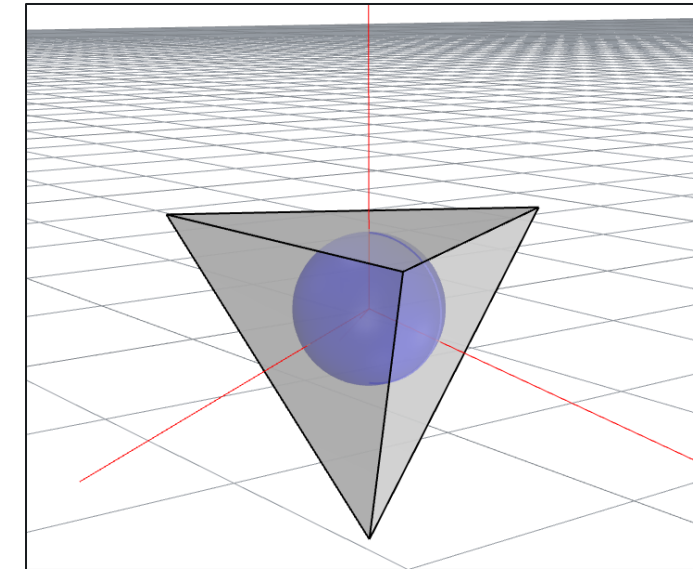
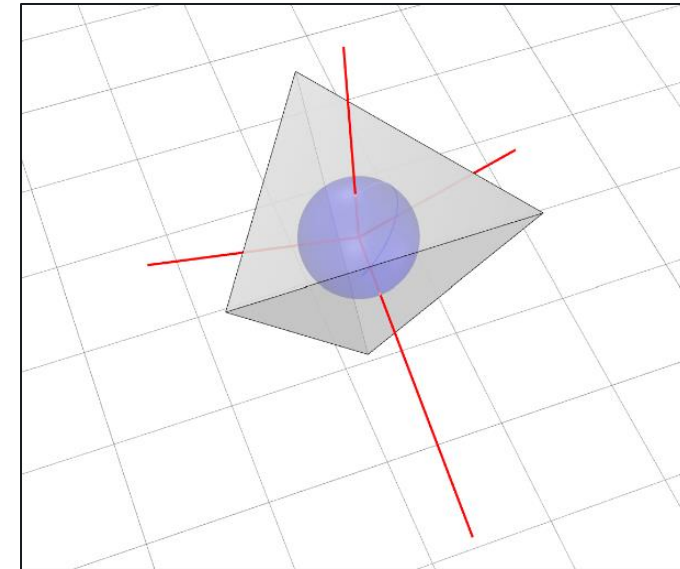
- 80° Field of View
- 360° scan with detector aimed at horizon
- Two Planes
 - 75" for standing height
 - 51" for sitting height
- Vertical peak radiation spot checking



Measurements - Effectiveness

Effectiveness

- 180° Field of View
- 19.5° below horizontal 360° scan
 - From the scanning, 6 points that are 60° apart are used.
- Vertical measurement taken with detector aimed at zenith
- One plane
 - For UR-GUV, midpoint between fixture and ceiling
 - For WR-GUV, midpoint between ceiling and floor.

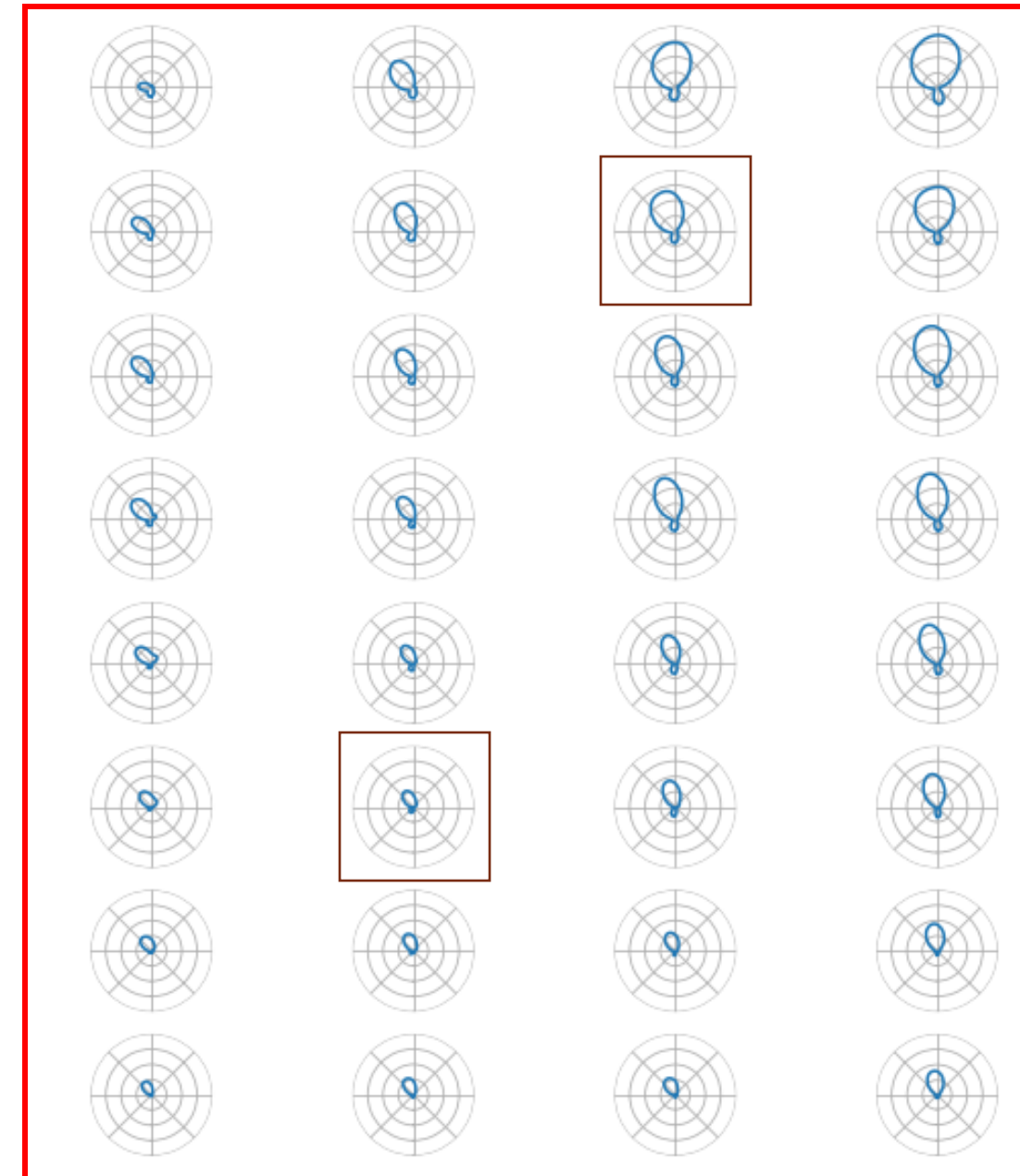
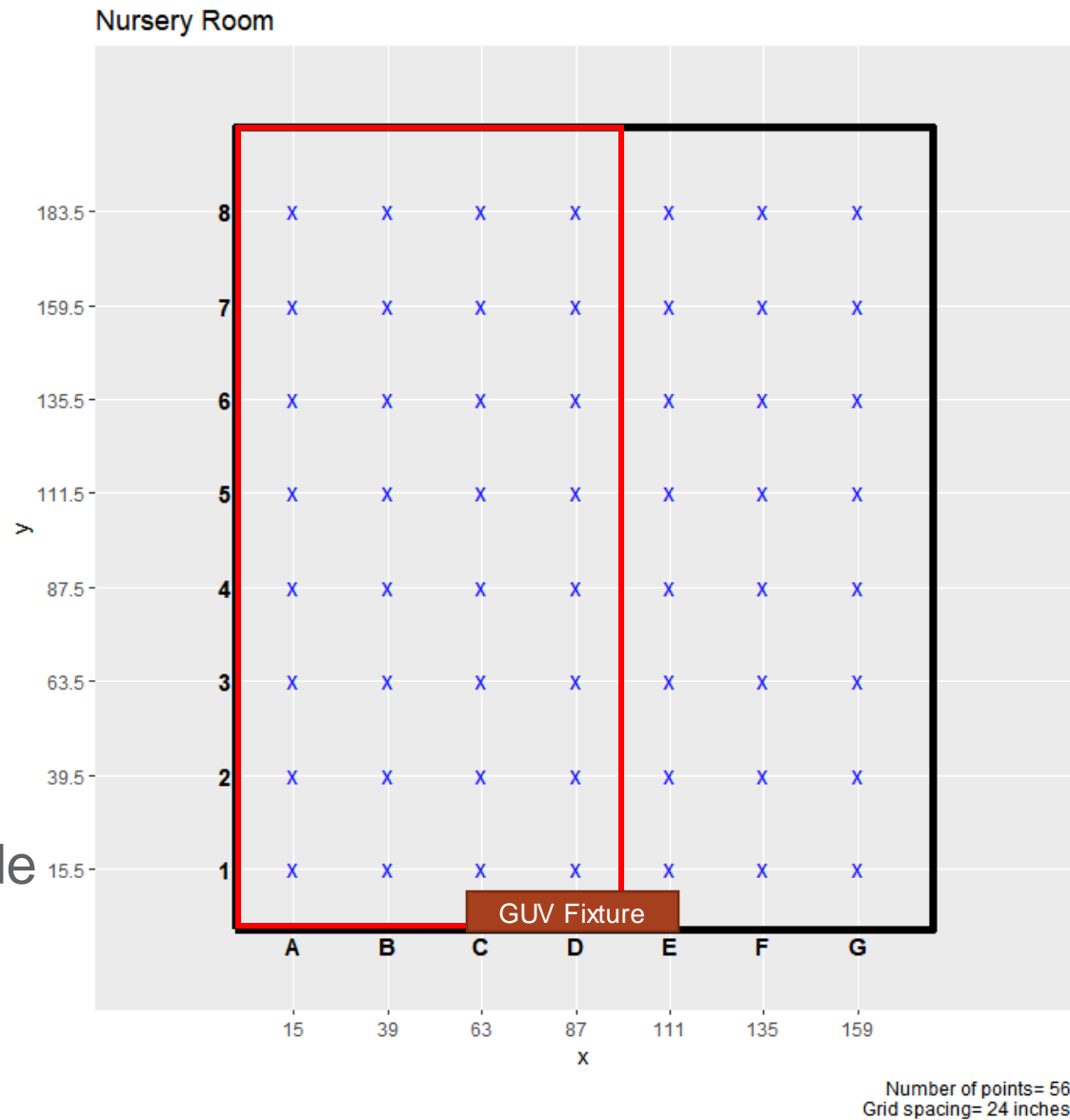


Fluence rate will be estimated by summing the 6 tilted measurements, dividing by 2, and then adding the result to the zenith measurement. Note that we're averaging two sets of tilted measurements ($0^\circ+120^\circ+240^\circ$ and $60^\circ+180^\circ+300^\circ$) to reduce variability per Bjorn (1995)

Björn LO. Estimation of fluence rate from irradiance measurements with a cosine-corrected sensor. *J Photochem Photobiol B Biol.* 1995;29(2):179–83.

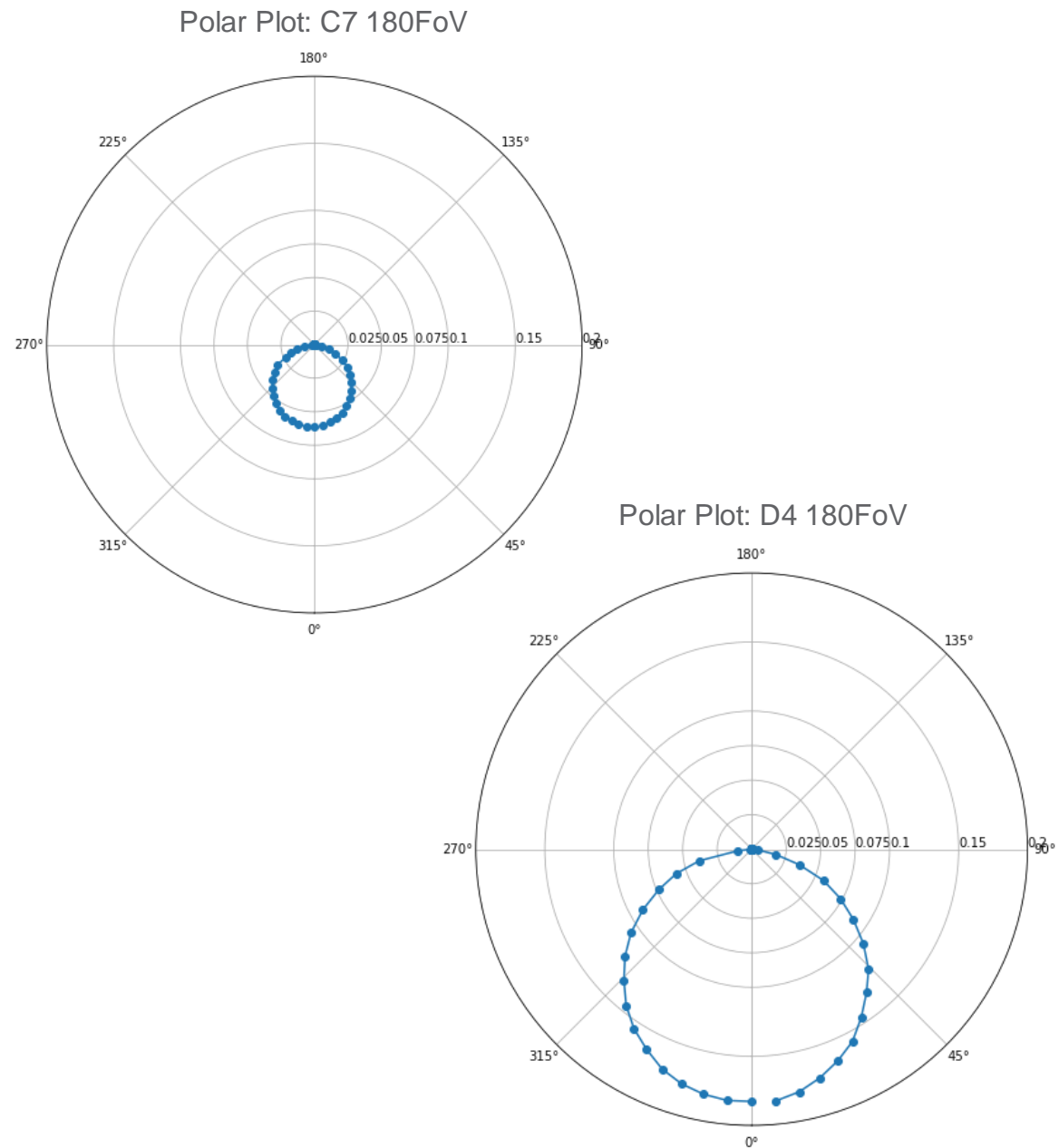
Measurements - Safety Polar Plots

- Taking measurements at each grid point location to characterize the space
- Close up look in the polar in the next slide

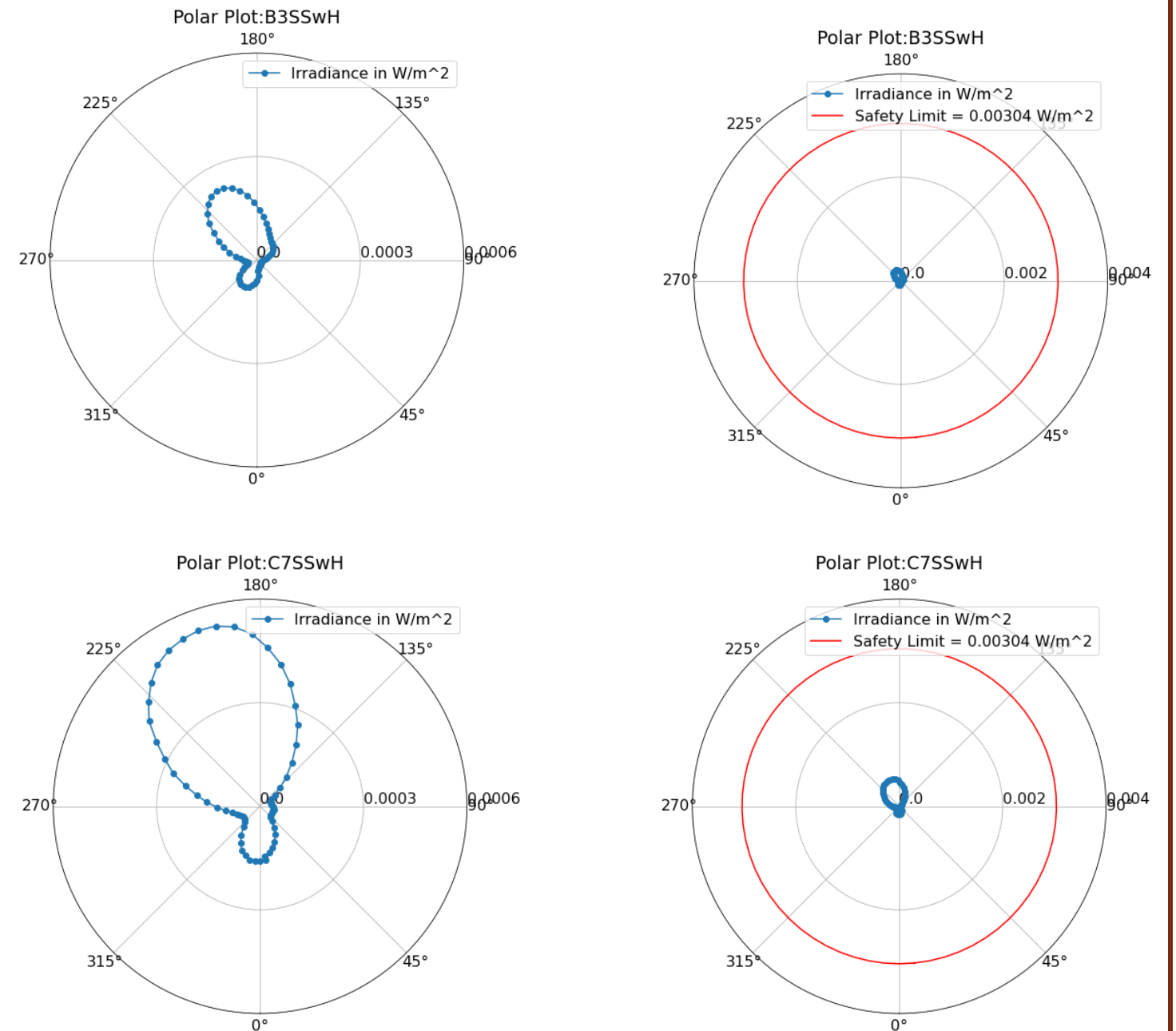


Horizontal Sweeps (360°)

Effectiveness Measurements



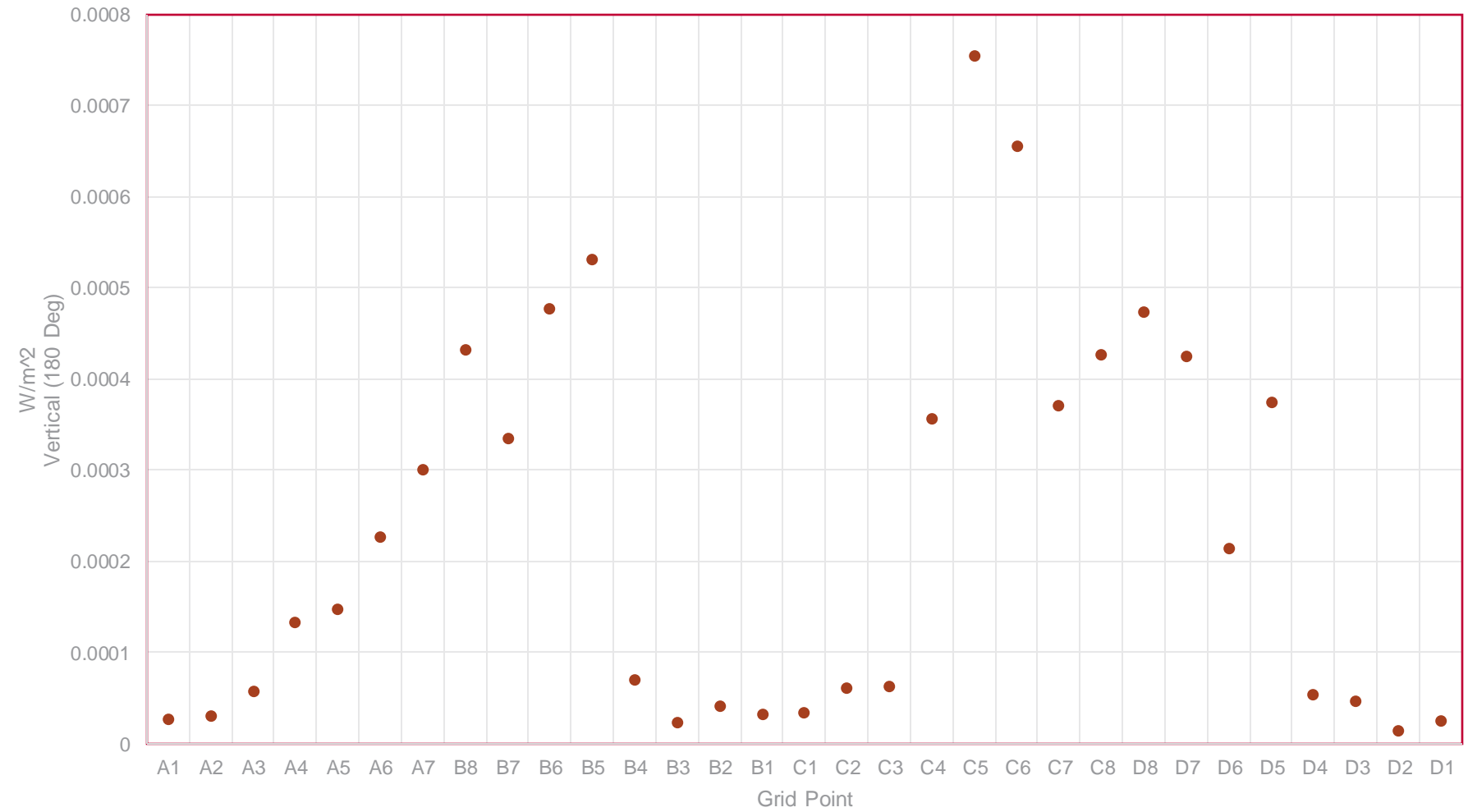
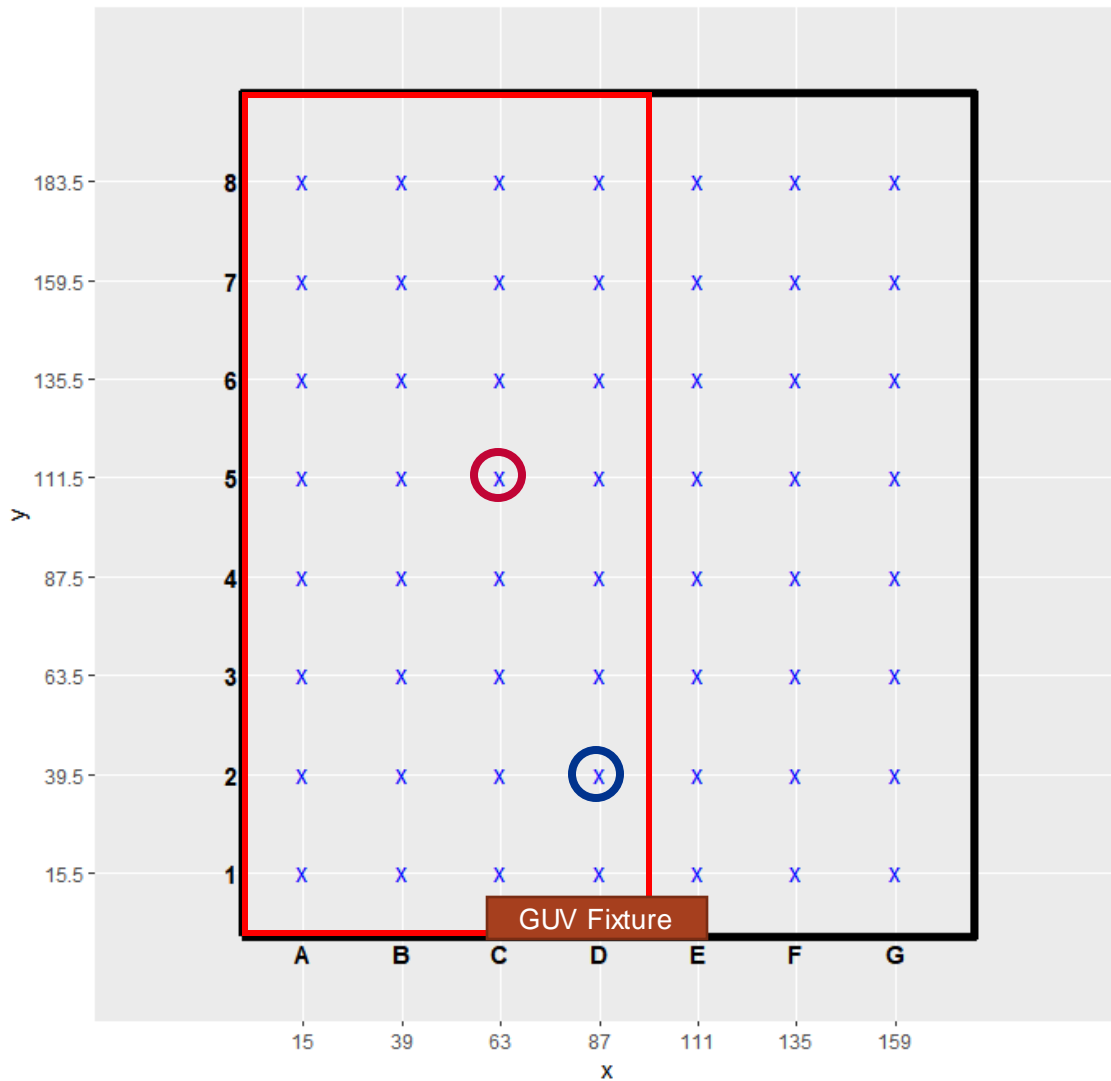
Safety Measurements



Detector aimed at zenith measurements

Vertical (Zenith) Measurements for Effectiveness

Nursery Room



- Highest value : C5
- Lowest value : D2

Upcoming Full Scope of Field Evaluations Plans

- Plan to visit a total of 11 sites
 - Multiple rooms in some of the sites
 - As of today, 7 have been completed.
- Even mix of UR-GUV and WR-GUV
- Mix of high impact spaces (Schools, Dentistry, Church, Airport, Conference rooms, etc.)

Thank you