
# Visibility Performance Under New Lighting Technologies

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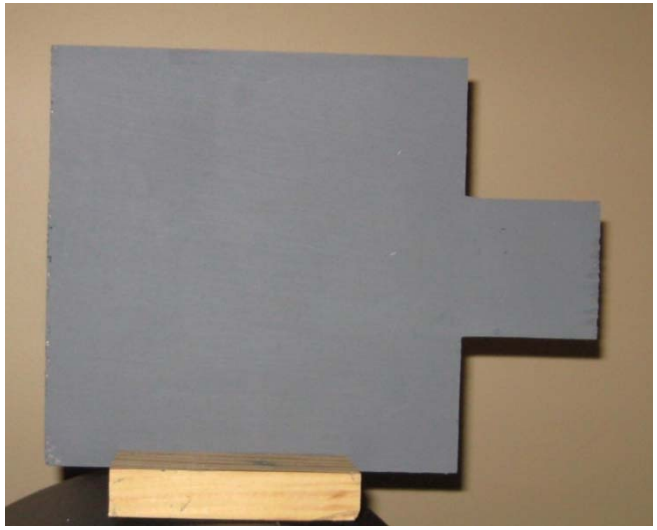
# Anchorage Alternative Lighting

- This project was the investigation of the impact of broad spectrum light sources on driver visibility.
  - Visibility was rated based on the detection distance of a small target on the side of the road
- Luminance and Illuminance was measured in-vehicle during the experiment



# Experimental Design

| Variable | Description |
|---|---|
| Lighting | five alternative light sources (Dimming HPS, Beta LED, Kim Induction, Lumecon LED, Kim LED), one group of the existing condition (HPS 400W Non-Dimming) |
| Lighting Level | High and Low (Dimmed) *Except existing condition |

- 6 different lighting systems were tested along an urban street in Anchorage
  - HPS, LED, Induction
- 2 Dimming Levels
  - Attempting to investigate adaptive lighting

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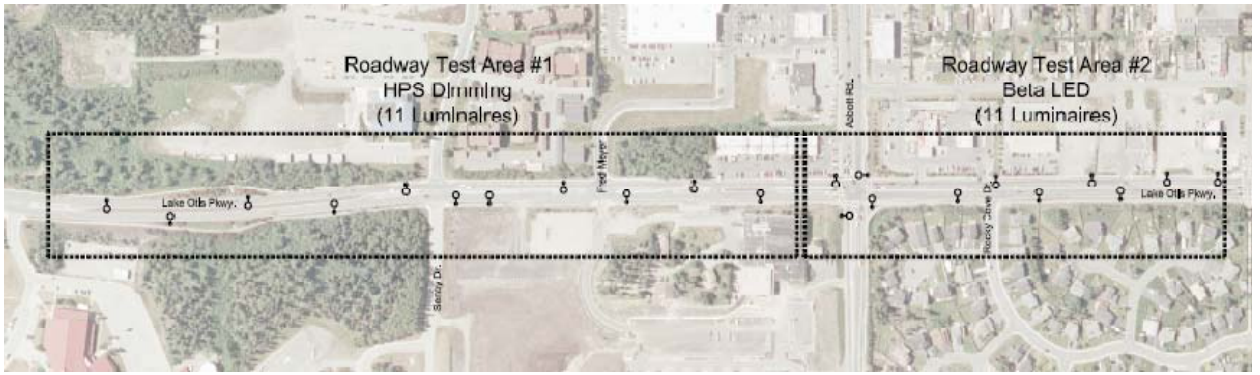
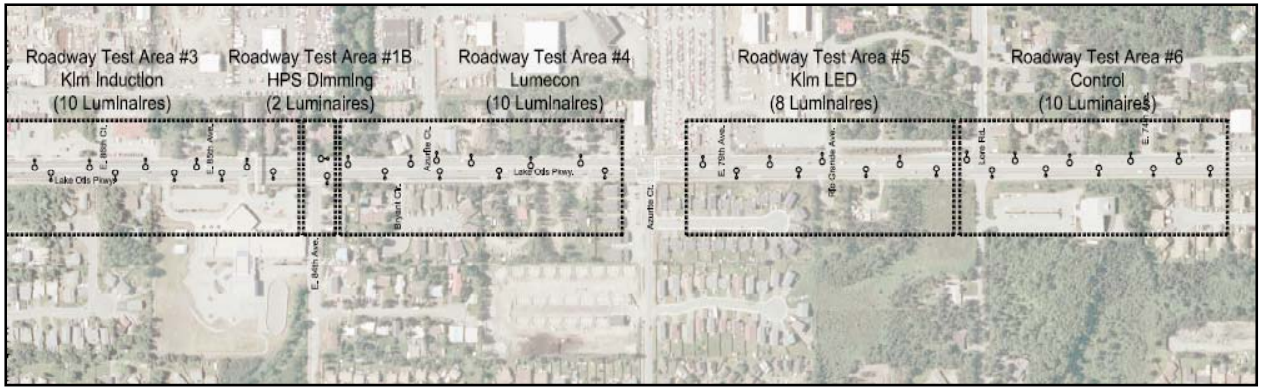
# Lighting Layouts



# Participants

- 27 Participants from the public were tested for object detection and public opinion
  - The participants were invited by the Anchorage Mayors office to take part in a survey
  - After a briefing at the Public Library, participants were taken to the test area in buses where they were allowed to rate the installations
  - During the subjective rating sessions, 3 participants were drawn at random from the group.

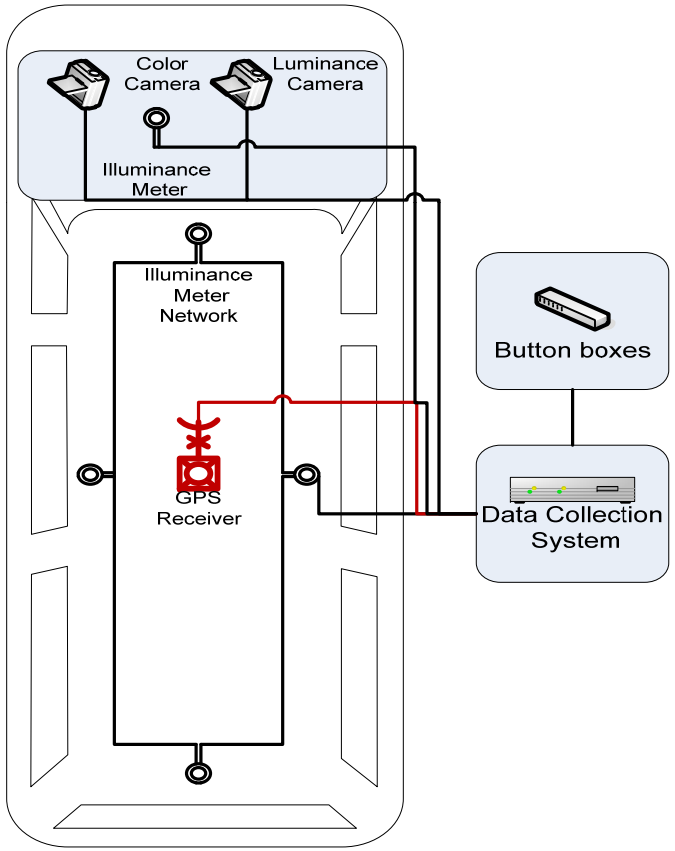
# Methods

- After Pickup, the Participants were then driven to the beginning of the test area and instructed on the task
- Each participant was given a button to press when they were sure that they could see the target on the side of the road.
  - Two targets were located in each test area
- The button presses were recorded in the data file

# Equipment

- The VTTI RLMMS was installed on a rental vehicle and used during the data collection
  - The measurement system utilizing GPS, a Luminance camera and illuminance meters records photometric and visual information at 10 Hertz.
    - The system, also measures:
      - Spectroradiometer
      - Button Presses
      - Color Video Camera
      - Vertical Illuminance
      - Linking to Automobile J1850 interface for Speed and Throttle information

# System Layout

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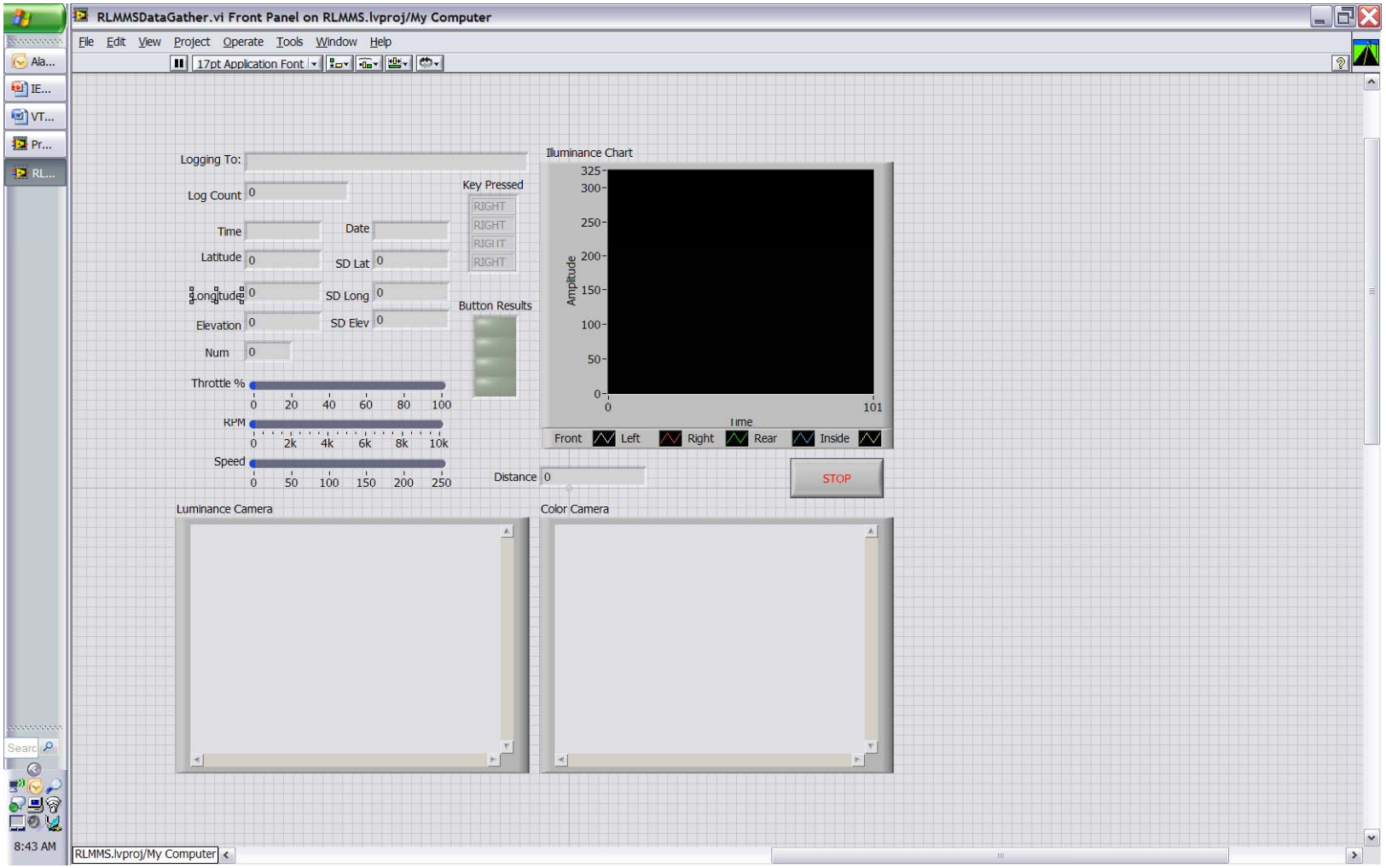
# Data Collection

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# Luminance Camera

- 12 bit Point Grey Digital Firewire camera.
  - Calibrated against a Prometric Still Luminance Camera
- Varying shutter and gain values determine the range of luminance measured
  - 2 cameras can be coupled to increase dynamic response
- Individual images are stored for later analysis

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# Luminance Camera

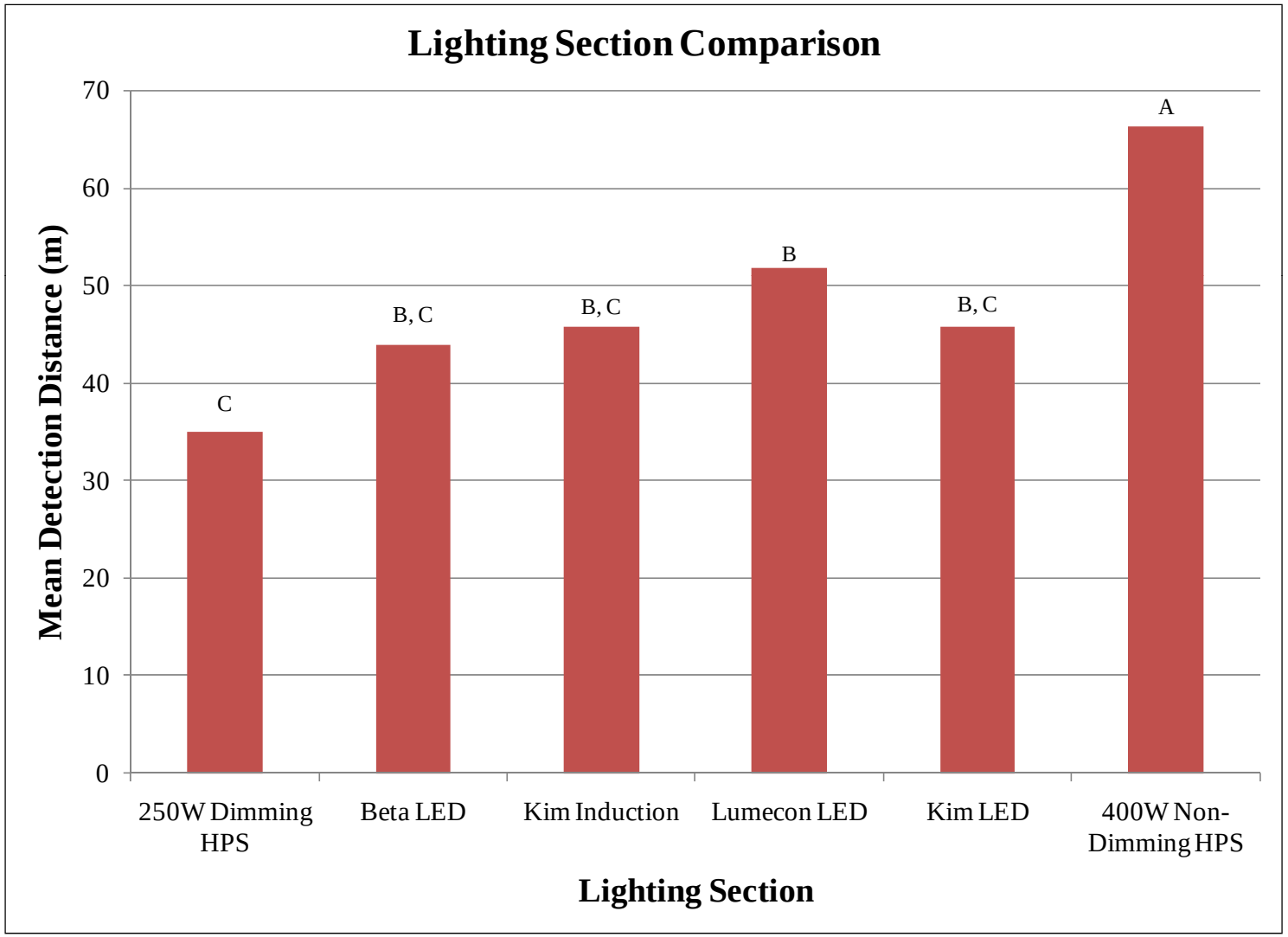
# Results

- The results were analyze using ANOVA techniques

| Source | F value | P value | Significant |
|---|---|---|---|
| Lighting Type | 5.00 | 0.0011 | * |
| Lighting Level | 10.24 | 0.0037 | * |
| Lighting Type* Lighting Level | 3.00 | 0.0225 | * |
| Lighting Class | 4.06 | 0.0004 | * |

All factors and their interaction were significant

# Lighting Level Comparison

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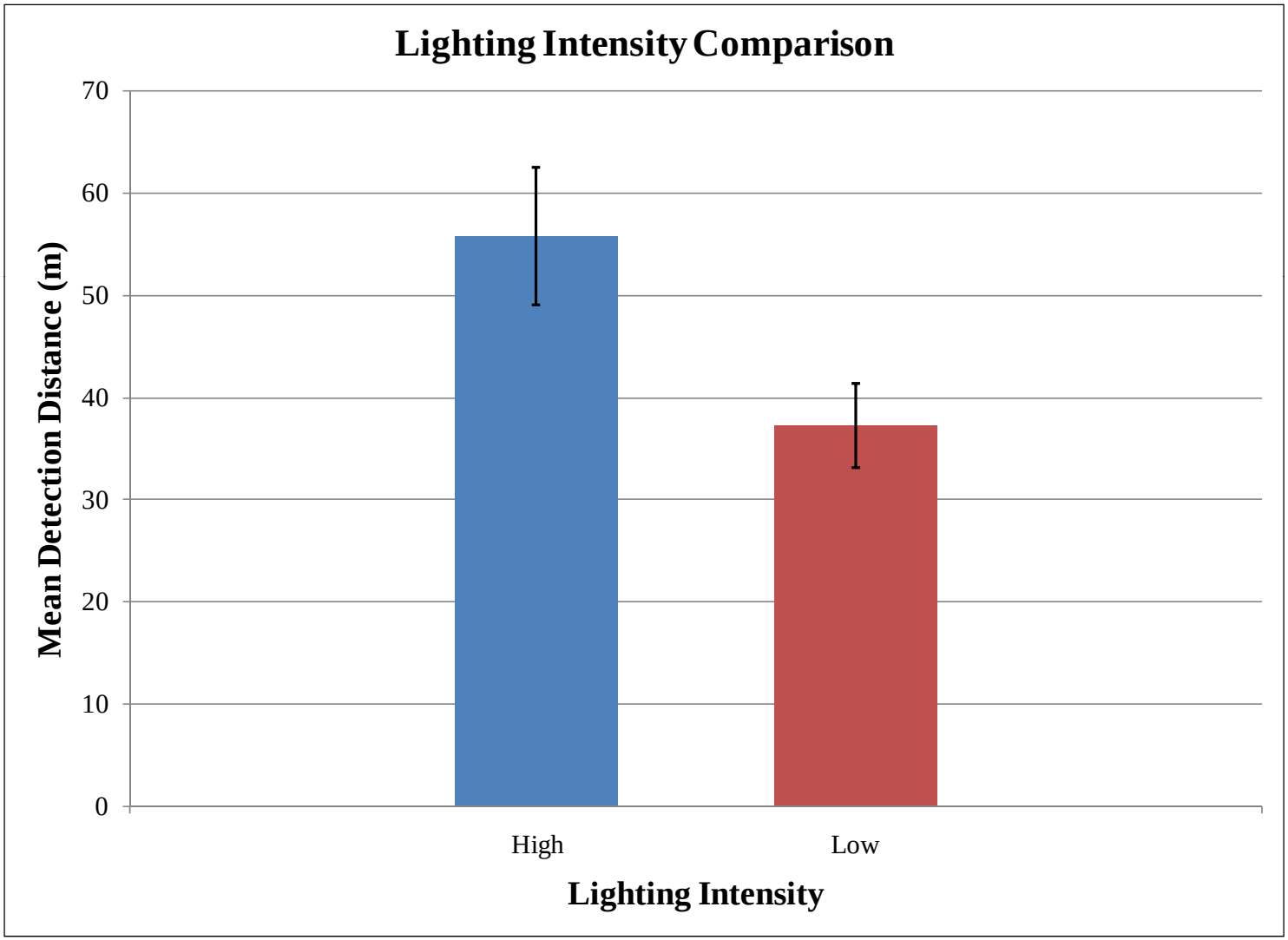
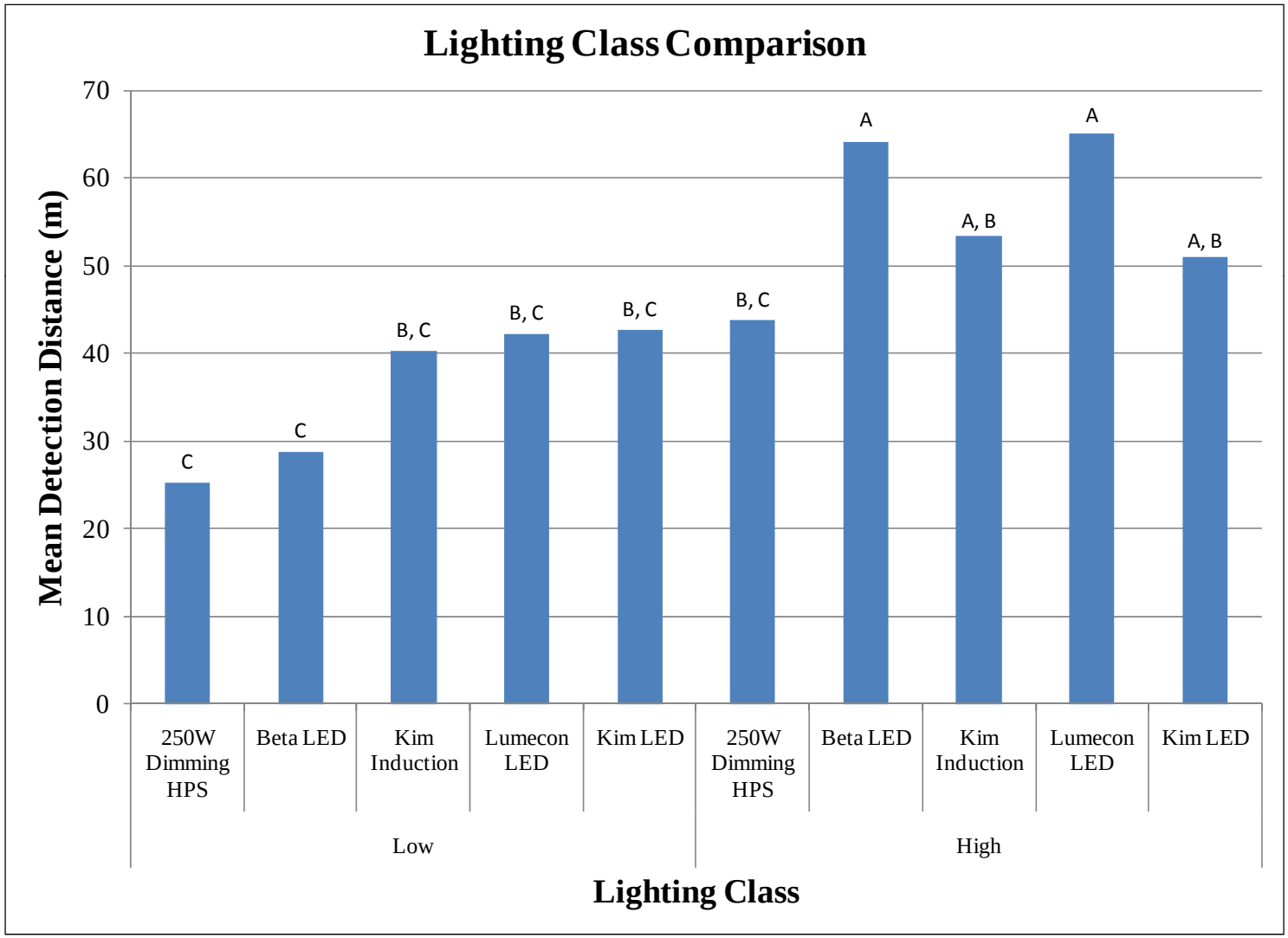
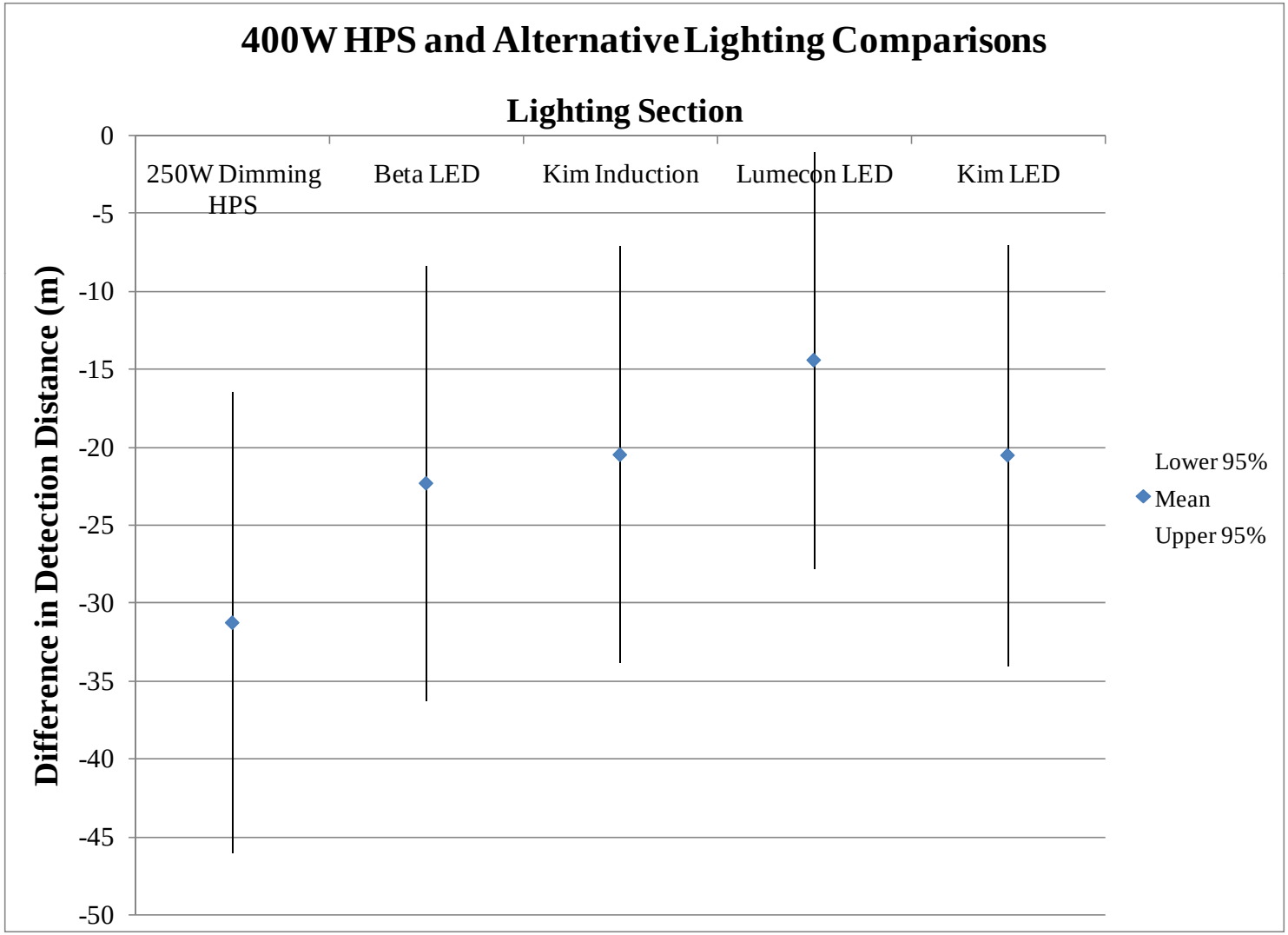
# Lighting Level



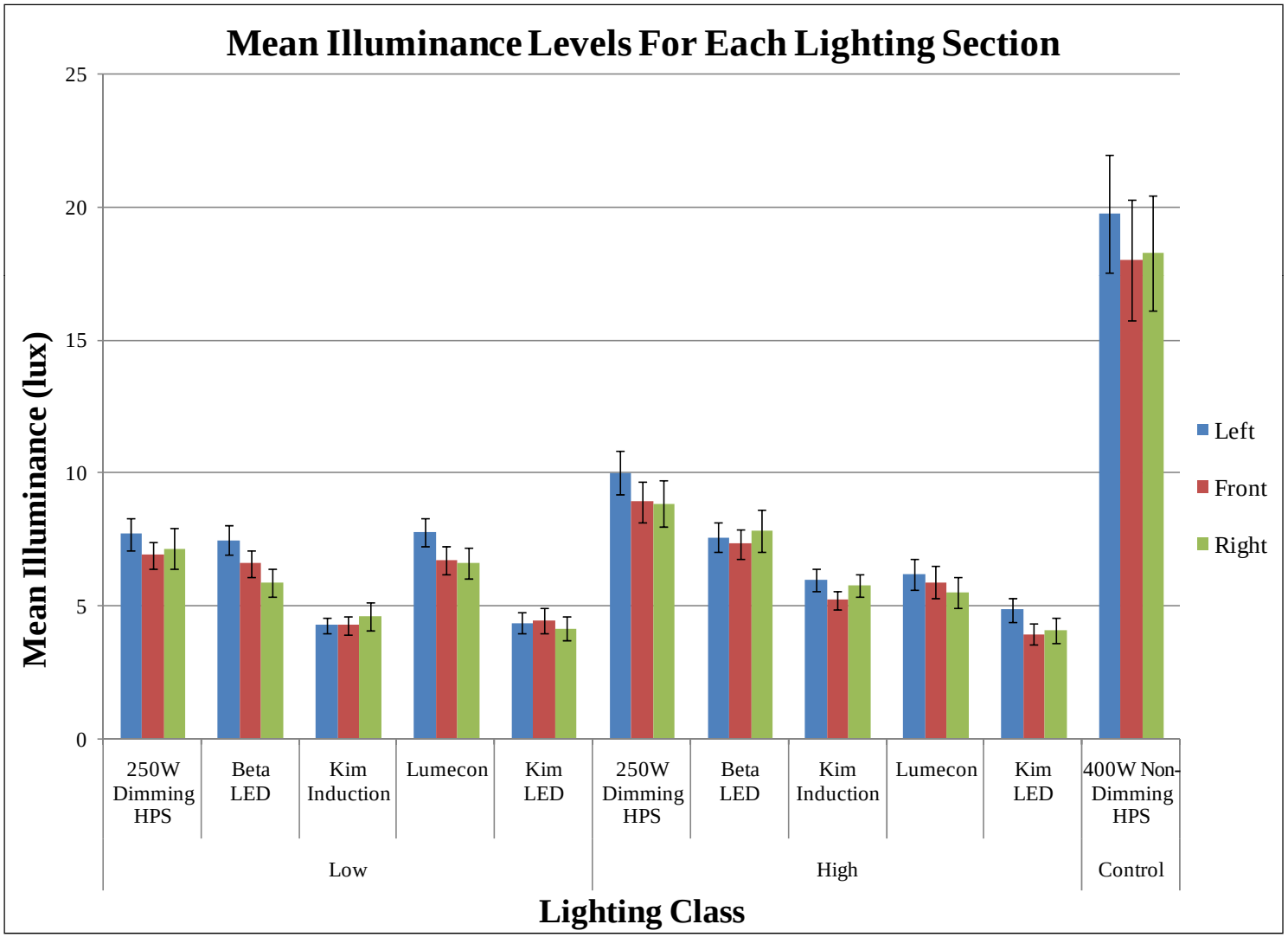
# Lighting Type and Level



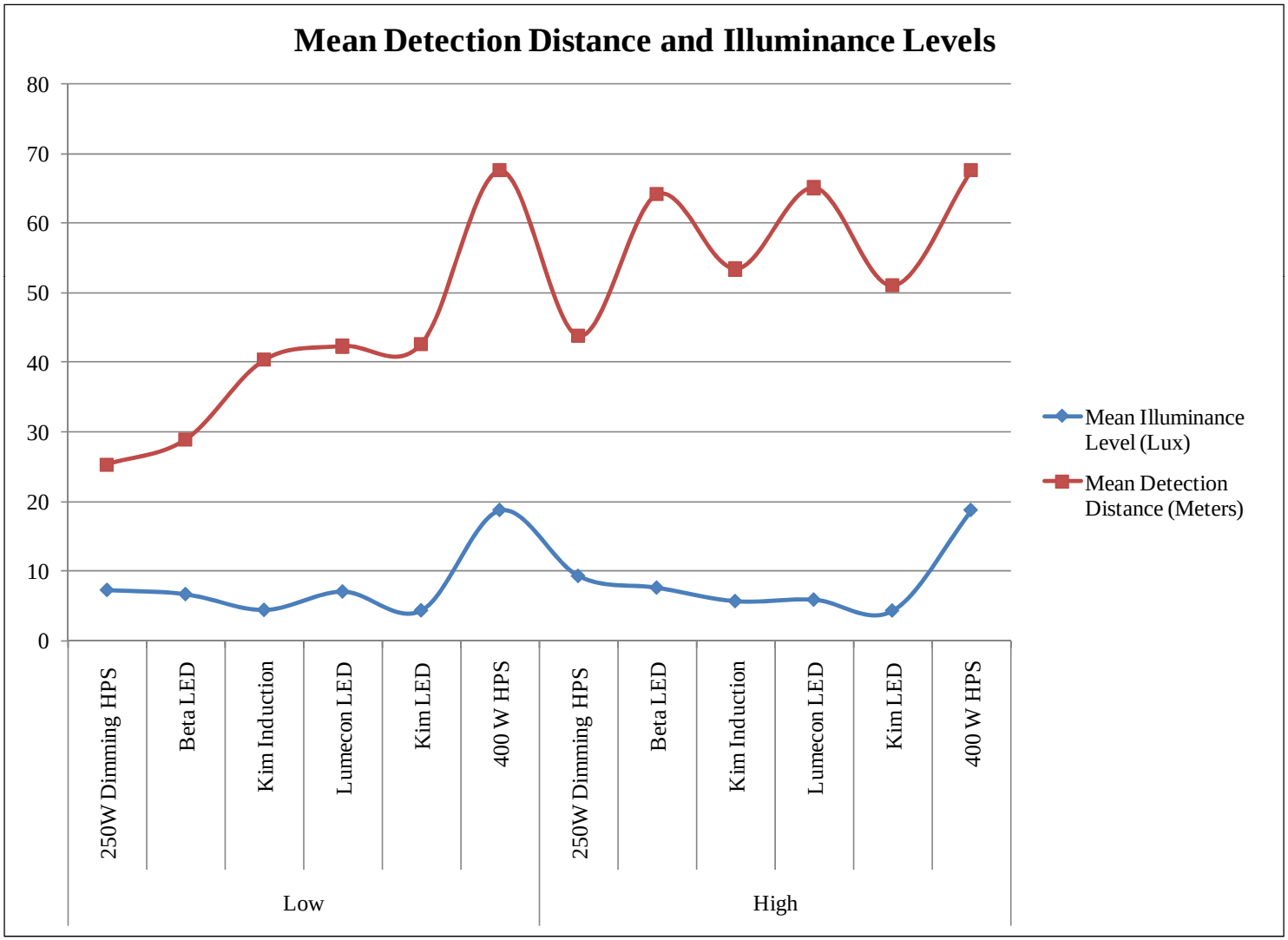
# Practical Differences



# Illuminance Results



# Relationship to Illuminance



# Anchorage Observations

- 400 Watt HPS provided the longest detection distance
- 250 Watt HPS was the shortest detection distance
- The Broader Spectrum sources provided an improved visibility at a average lower horizontal illuminance level.
- The lighting level significantly impacted Detection

# Lighting Considerations

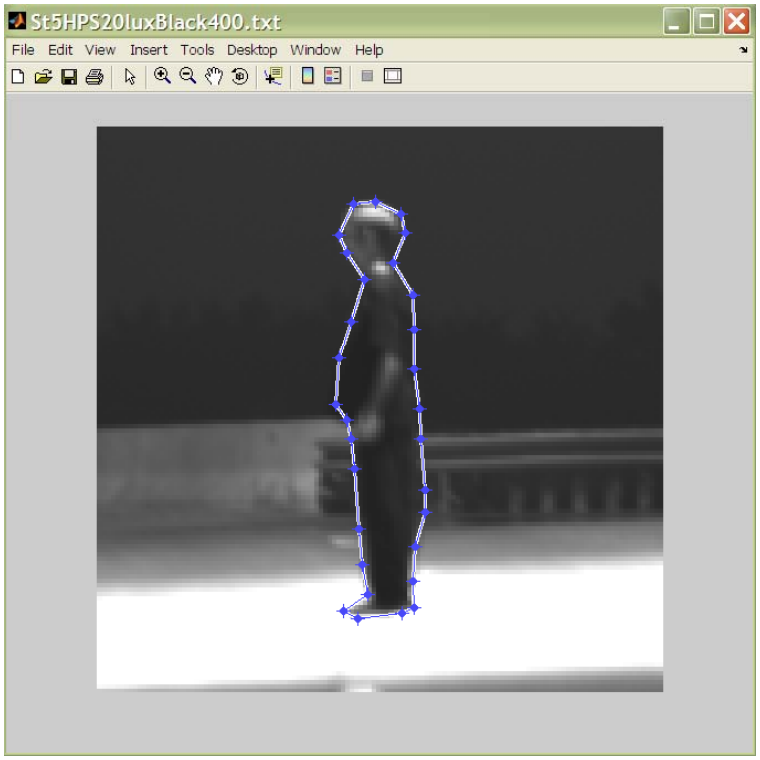
- Mesopic Effect
  - The eye is more sensitive to blue spectrum light sources at low luminance levels
- Is the improvement based on the broader spectrum sources a result of Light Sensitivity or more available information in the visual environment?
  - Further investigation is required

# Further Analysis

- We will be looking at the distances of detection for both the pedestrians and the objects
- The luminance, illuminance and contrast will all be assessed based on the measured results of the system
- Glare will be attempted to be measured using the interior illuminance meter

# Luminance Metrics

- Applying multiple contrast metrics to images
- Semi-automated process
  1. Accesses database of images for analysis
  2. User selects target
  3. Automatically calculates contrast metrics



# Luminance Metrics

- Results in luminance and contrast information

| | | |
|---|---|---|
| Mean Luminance of Target | 0.677cd/$m^2$ | 0.961cd/$m^2$ |
| Mean Luminance of Background | 1.579cd/$m^2$ | 1.492cd/$m^2$ |
| Weber Contrast | -0.571 | -0.356 |
| Simple Contrast | 2.331031 | 1.552046 |
| Michelson Contrast | 0.399585 | 0.216315 |