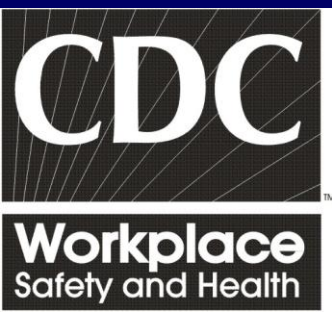


# **“Taxicab Security Camera System Evaluation Study” Project Progress Report**

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# **Objectives of Camera Evaluation Study**

- **Develop minimum requirements for taxicab camera system evaluation**
- **Evaluate technological advantages and limitations of sample taxicab cameras in use**
- **Determine research needed to improve taxicab cameras to maximize effect**
- **Develop technical guidance for taxicab security camera selection and use**

# Status of Evaluation Study (1)

- **Completed head-shaking speed human subject tests and calculations to determine head movement speed**
- **Re-measured field taxicab light conditions**
- **Modified taxicab lighting equipment setup**
- **Modified the methods of reference camera parameter measurements**

# Status of Evaluation Study (2)

- **Modified the photo test charts**
- **Reference camera tests to determine thresholds of photo parameters are underway**
- **Completed recording media waterproof tests.**
- **Completed recording media fireproof computer simulations.**

# **Status of Evaluation Study (3)**

- **Will complete reference camera tests to determine thresholds of photo motion blur, resolution, dynamic range and distortion in late Sep. 2011**
- **Will send test photo sets to photo quality evaluators for threshold determination in late Sep. 2011**
- **Will complete sample camera system tests in Dec. 2011**
- **Will complete test report/guidelines in Mar. 2012**

# Head Moving Speed Determination (1)

- **Videoed human subjects shaking heads right/left with normal speed**
- **Measured head shaking speed by counting the number of image frames in 30 degrees of head shaking**
- **Average head-shaking speed determined: 0.312 rotation per second**
- **A round face photo board will rotate at this speed to determine minimum shutter speed for avoiding photo motion blur**

# Head Moving Speed Determination (2)

- Counting number of frames in 30 degrees of head shaking

Frame No. 8



Frame No. 16



Frame No. 24



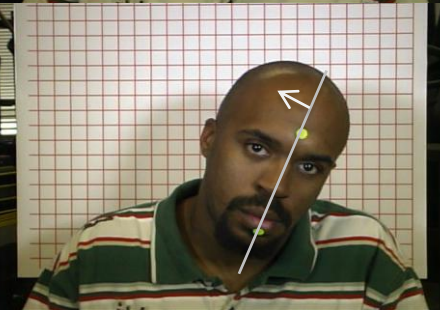
Frame No. 32



Frame No. 40



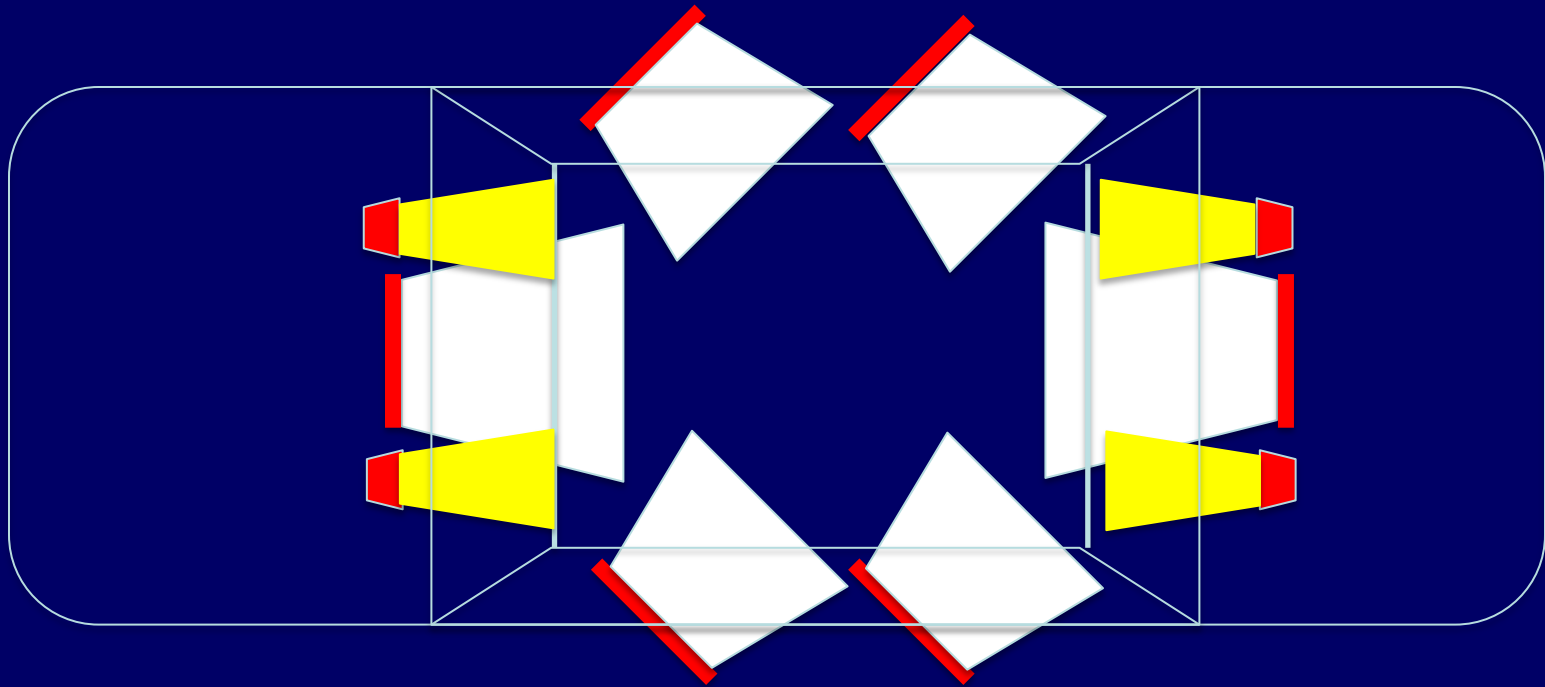
Frame No. 45



# Simulate Taxicab Light Conditions (1)

- Use LED light panels and incandescent lights to simulate 4 field taxicab light conditions:
- Daylight: 7.4k Lux (Lux = Lumen per square meter) max.
- Dark: 0.4 Lux max.
- Dark + Backlit: 108 Lux max.
- Sunset via Rear Window : 8.1k Lux max.

# Simulate Taxicab Light Conditions (2)

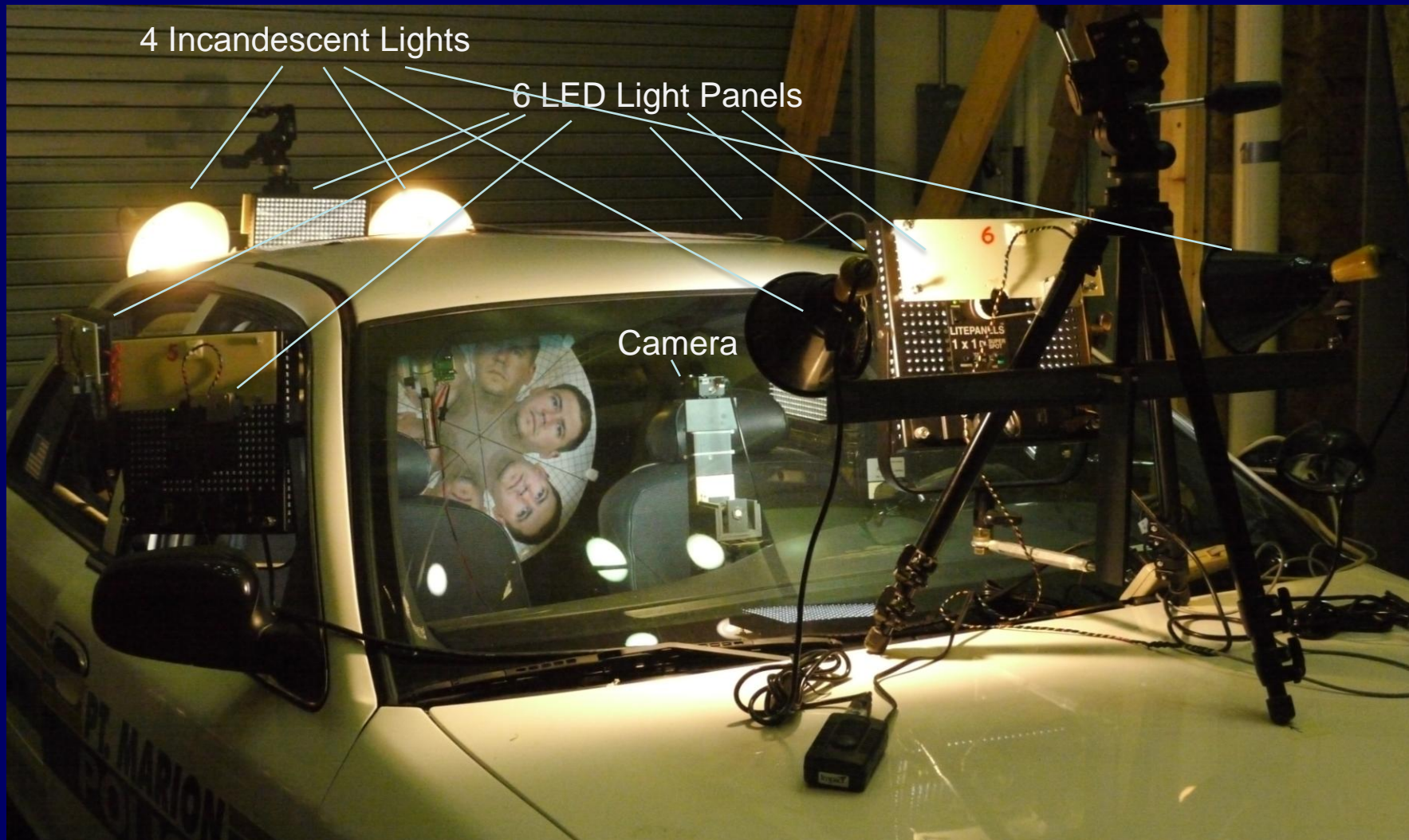


1' x 1' LED light panel (2200 Lux @ 4 ft)  
Light Color 5400 K

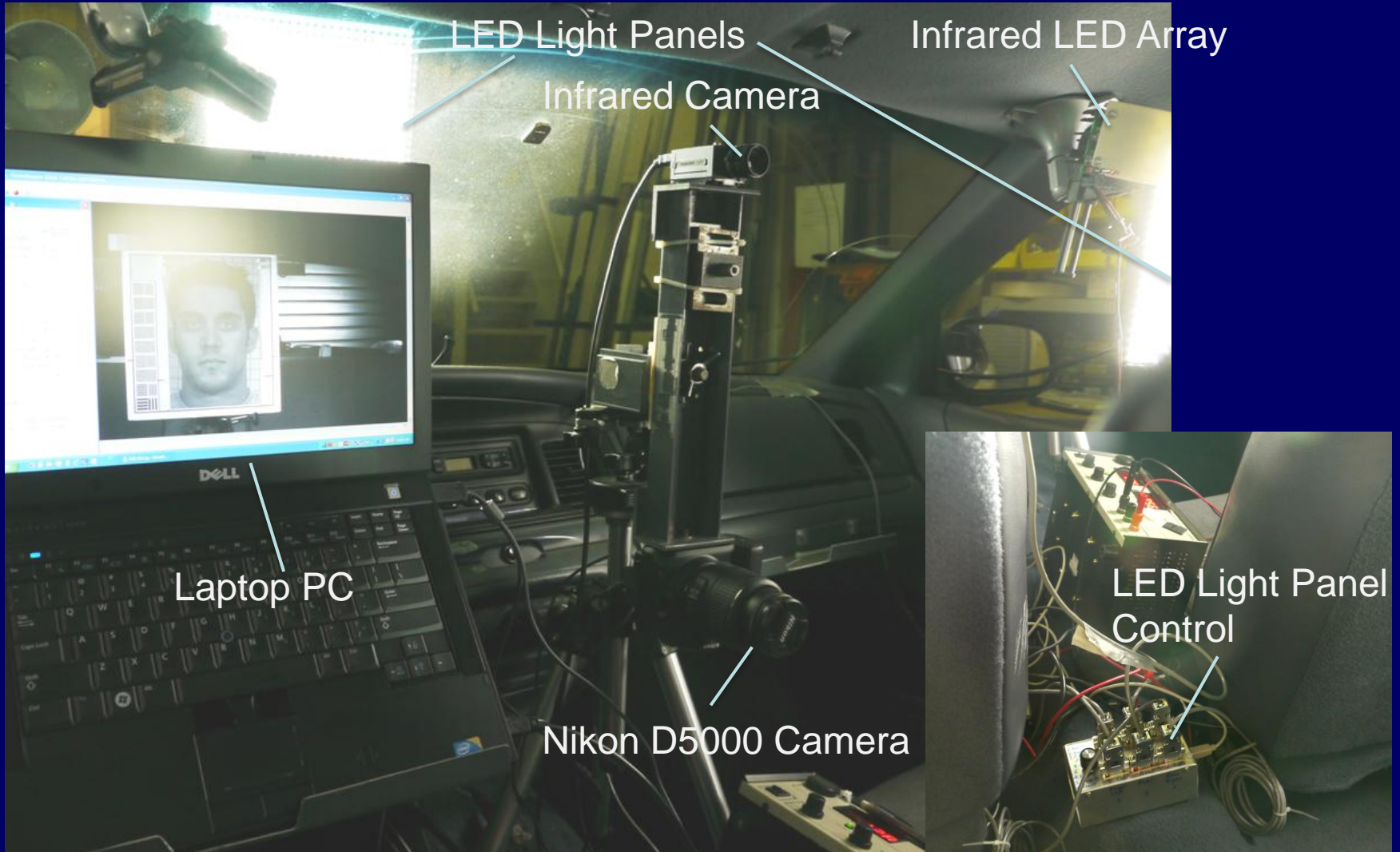


500 W incandescent bulb  
Light Color 3200 K

# Simulate Taxicab Light Conditions (3)



# Taxicab Camera Setup

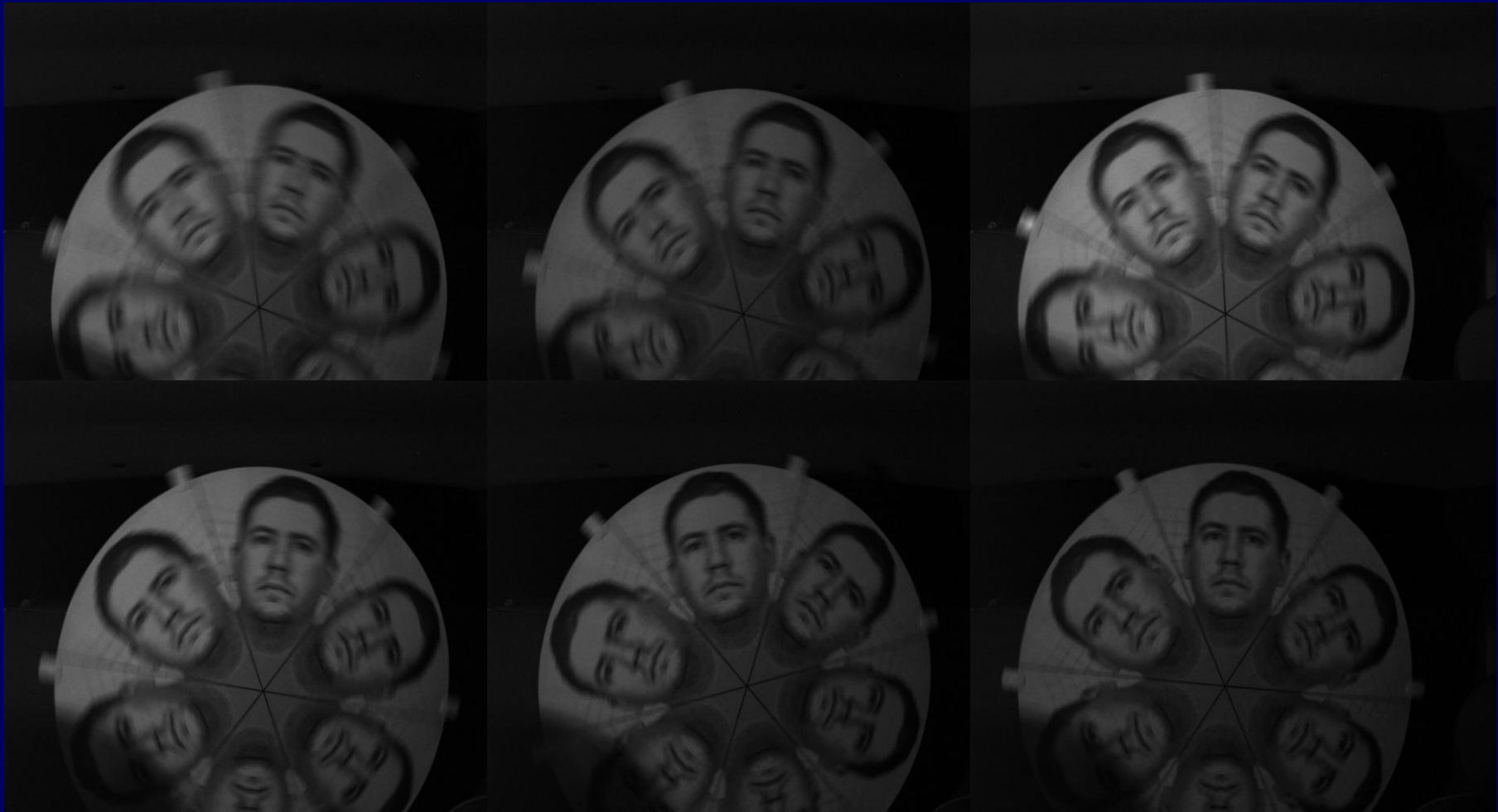


# Photo Motion Blur Threshold Determination (1)

- Face photo board is 60cm in diameter and there are 6 identical subject's face photo on board
- Face photo board rotates at 18.73 rpm (determined by head shaking tests)
- Reference cameras photograph rotating board with 6 different shutter speeds
- Photo evaluators determine the shutter speed thresholds in each of 4 light conditions and 5 seat positions

# Photo Motion Blur Threshold Determination (2)

- Infrared photos taken in dark light condition with 6 different shutter speeds (infrared LED array illuminated the taxicab)



# Photo Resolution Threshold Determination (1)

- **Subjects' face photos and a slant-square are photographed by reference cameras with 5 different resolutions by out-focusing the camera lenses**
- **Slant-square photos are used to measure face photo resolutions**
- **Photo evaluators determine minimum resolution thresholds in each of 4 light conditions and 5 seat positions**

# Photo Resolution Threshold Determination (2)

- 5 face photos taken in taxicab with difference resolutions, measured in Line-Width per Head Height (LW/HH). Head height = 30 cm



1232 LW/HH

166 LW/HH

95 LW/HH

68.5 LW/HH

60 LW/HH

# Photo Dynamic Range Threshold Determination (1)

- **Subjects' face photos and gray-scale step charts are photographed by reference cameras with different dynamic ranges by adjusting the camera aperture and shutter speed**
- **Highlight dynamic range measures the degree that a photo is washed out**
- **Shadow dynamic range measures the degree that a photo is darkened**
- **Photo evaluators determine minimum shadow/highlight dynamic range thresholds in each of 4 light conditions and 5 seat positions**

# Photo Dynamic Range Threshold Determination (2)

- Face photo dynamic ranges are measured in Exposure Value

Medium-High: 4.77 EV

4.31 EV

3.47 EV

2.57 EV



High: 4.61 EV

4.32 EV

3.60 EV

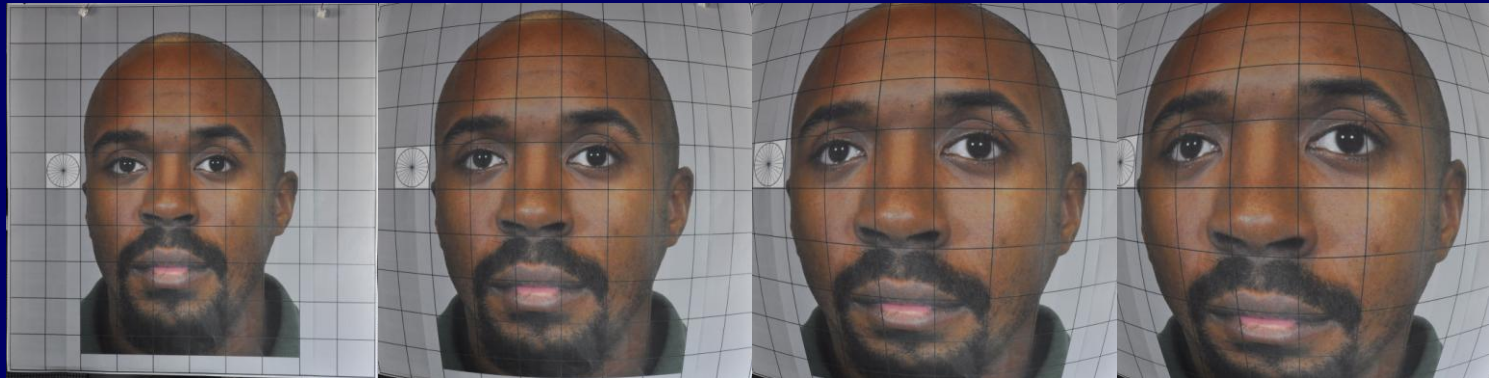
2.90 EV

# Photo Distortion Threshold Determination (1)

- **Subjects' face photos and a square-grid chart are photographed by reference cameras**
- **The face and grid chart photos are geometrically distorted with 5 different degrees of distortion by PhotoShop software**
- **Photo evaluators determine maximum distortion thresholds in each of 4 light conditions and 5 seat positions**

# Photo Distortion Threshold Determination (2)

- Distorted taxicab face photos. The degrees of distortion are measured using SMIA (Standard Mobile Imaging Architecture) TV Distortion method



No Distortion

-6.46% Barrel

-9.99% Barrel

-14.4% Barrel

## **Recording Media Waterproof Tests (1)**

- **3 Secure-Digital and 3 Compact-Flash flash memory cards, loaded with ~4 GB of video files, were placed on the bottom of 5-meter water pipe for 72 hours**
- **After the memory cards were dried, they were tested by playing the preloaded video files on the cards**
- **The video files on all cards are intact and playable.**

# Recording Media Waterproof Tests (2)

- Waterproof test setup



# Recording Media Fireproof Simulations (1)

- **Flash memory card fireproof simulations were conducted using ANSYS finite-element analysis software**
- **Temperature rise inside two types of thermal insulation materials with different physical dimensions were simulated with typical gasoline caused car fire temperature-profile.**
- **Simulation results show that “Microtherm” thermal insulation material with 2.5 inches of wall thickness may protect a flash memory card from a typical car fire**

# Recording Media Fireproof Simulations (2)

- Flash memory card fireproof simulation using “Gemcolite” and “Microtherm” insulation materials. Insulation chamber walls are 2.5” thick on each side

