

# Importance of shooting, scene and visualization parameters for subjective tests purpose

Orange Labs, Networks and Carriers  
Research & Development

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# Context and objective



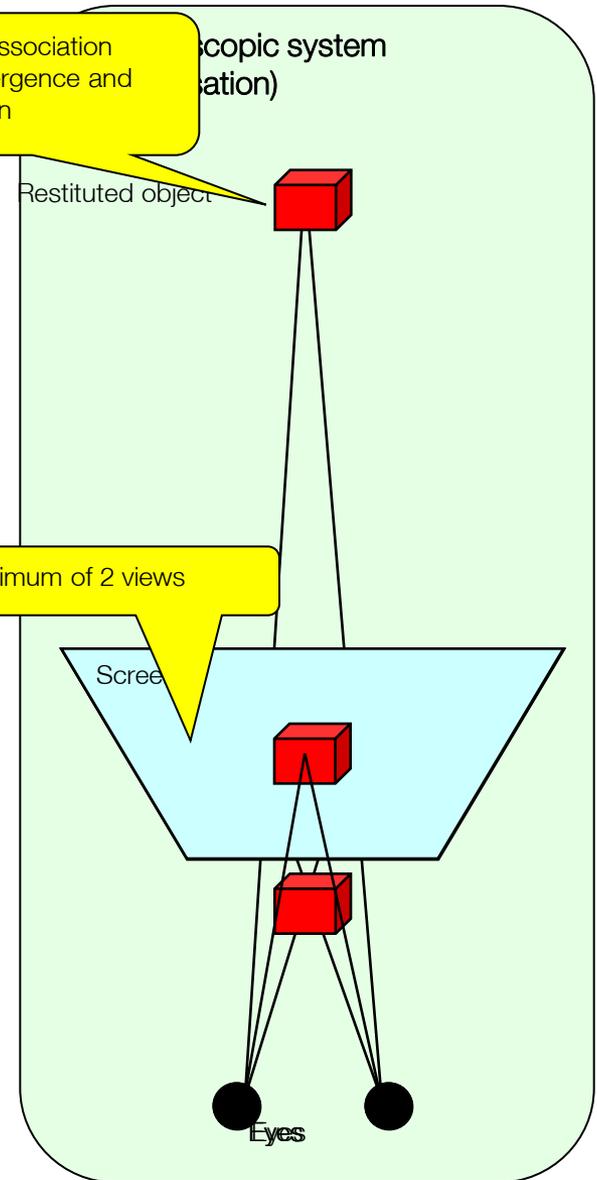
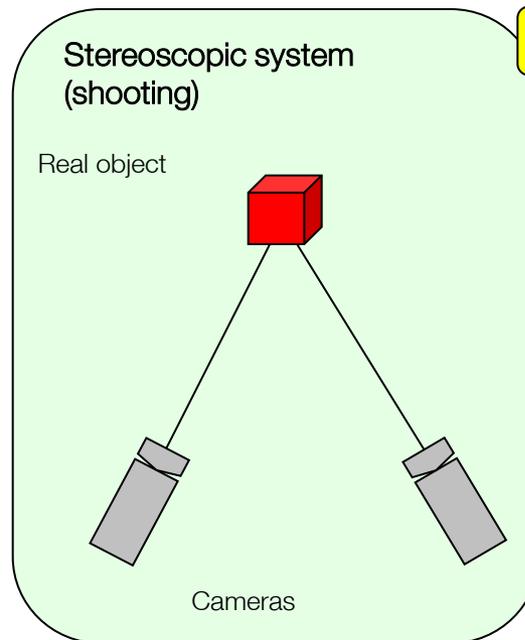
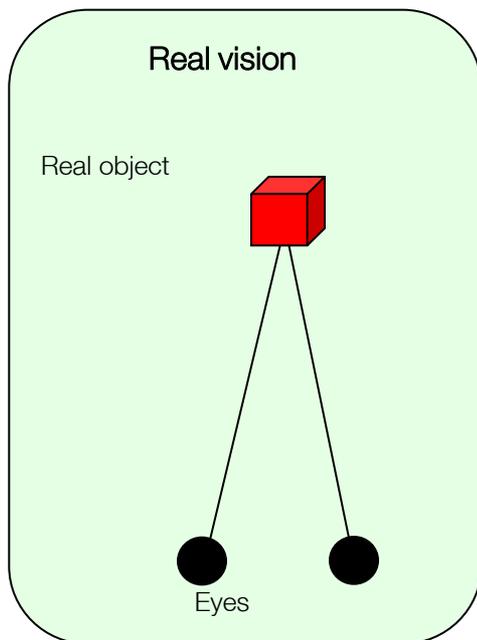
restricted



# Context

## S-3D systems principle

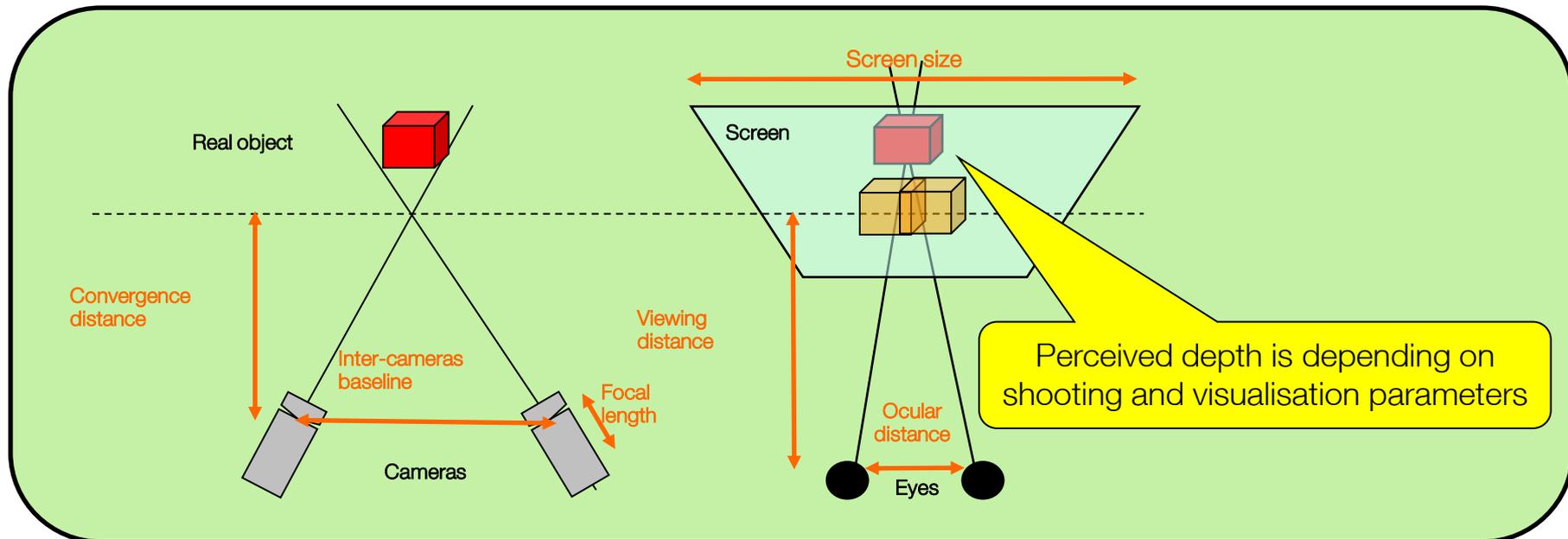
- Multiple solutions dedicated to 3D visualization
  - Anaglyph, active shutters, polarized glasses, etc.
- Current industrial solutions based on plane images
  - Conventiional 2D images (cameras, screen)



# Objective

To control the perceived depth for testing purpose

- Strong relation between shooting parameters and viewing configuration
    - Shooting parameters : focal length ( $f$ ), inter-camera baseline ( $b$ ), convergence distance ( $d$ )
    - Visualisation parameters : screen distance ( $D$ ), screen size ( $M$ ), inter-ocular distance ( $B$ )
- Restituted space =  $f(\text{shooting and scene parameters, visualisation parameters})$
- It is essential to model and control the perceived depth to better understand end-users' opinion about the overall visual experience and related perceptual components



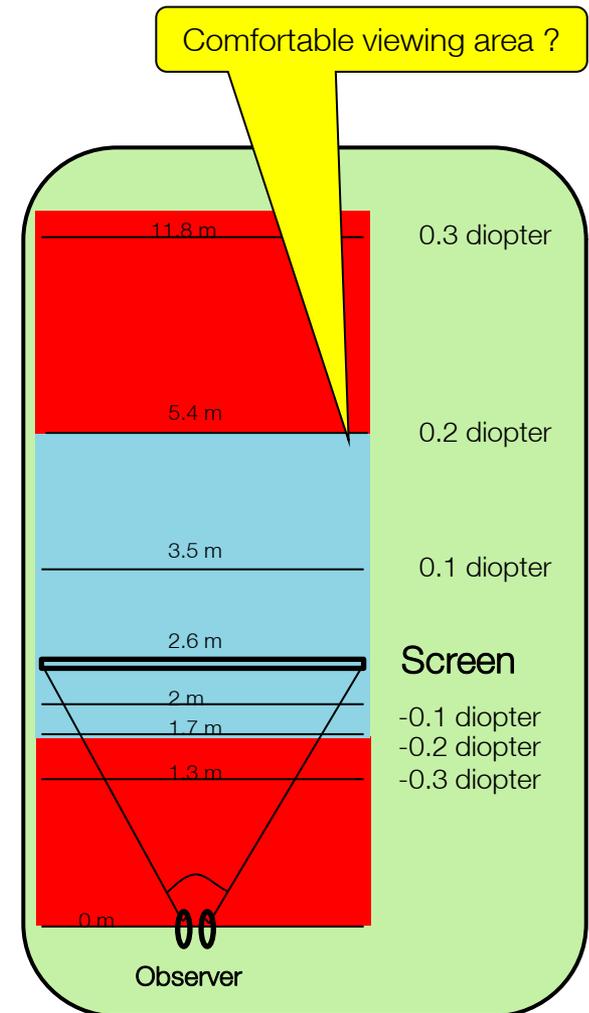
# Tools to model and control the perceived depth



# Perceived depth

## Key concepts

- **Real space**
  - Scene parameters
    - Foreground, background and ROI distances
  - Shooting parameters
    - Baseline, focal length and convergence distance
- **Restituted space**
  - Visualisation environment
    - Viewing distance, screen size and ocular distance
  - Depth parameters
    - Foreground, background and ROI distances
    - Dimensions: local depth variations ( $D_x$ ,  $D_y$ ,  $D_z$ )
    - Shape: roundness of objects ( $D_s = D_x/D_z$ )
  - **Comfortable viewing area**
    - Maximum crossed and uncrossed disparities
    - DoF



# Stereo calculator software

To control depth rendering and to minimize Visual Discomfort

The screenshot displays the StereoCalcApp interface with several key components and callouts:

- Parameter graphical view:** Shows a 3D scene configuration with a viewer, a region of interest (ROI) of 3.0000 m, a background of 5.0000 m, a foreground of 2.0000 m, and a convergence distance of 2.6000 m. The focal length is 22.5000 mm and the inter-camera baseline is 35.0000 mm.
- Warnings graphical view:** Displays graphical bars for Depth, Perceived depth (rendering), Horizontal disparity, and Vertical disparity. It includes values for foreground (fg), background (bkg), ROI, and convergence distance (dCov).
- Distortions at ROI distance:** Lists Dx: 93.51%, Dy: 93.51%, Dz: 47.02%, and Ds: 50.28%.
- Chart view:** A line graph showing depth and shape distortion curves for different parameters.
- 3D view:** A 3D rendering of a tiger, labeled 'Original' and 'Perceived ROI view', showing the effect of the software's adjustments.
- Suggestions:** A list of optimization proposals, such as 'Suggestion 0: Automatic' and 'Suggestion 1: Optimize view'.

Callouts highlight specific features:

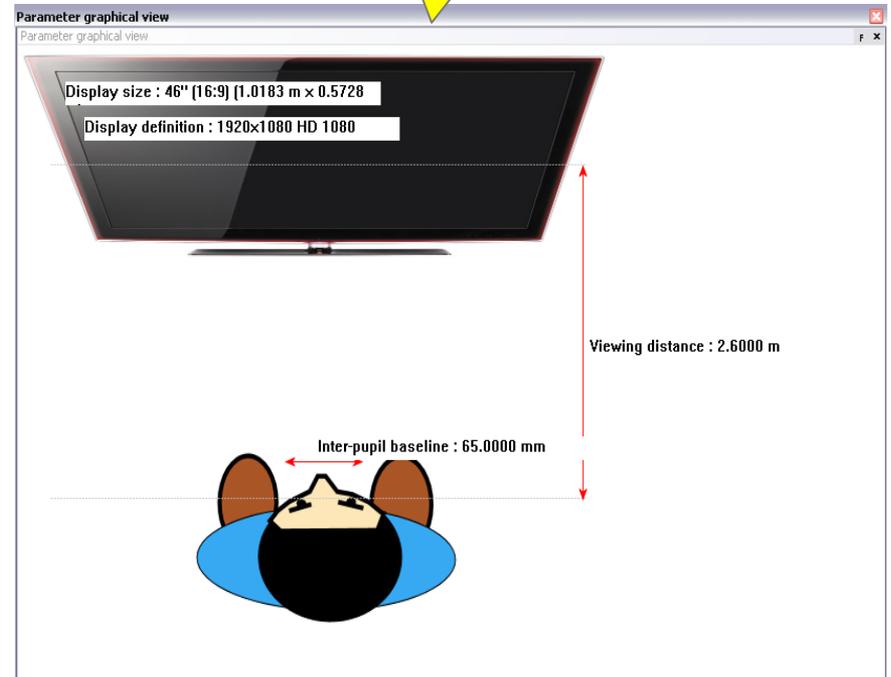
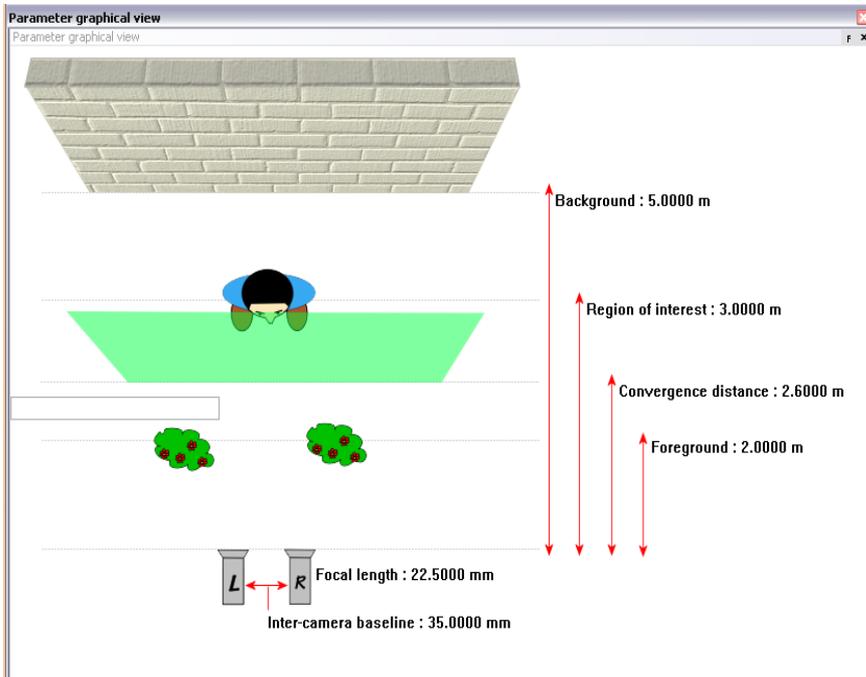
- Scene configuration Shooting parameters Viewing environment:** Points to the 3D scene view.
- Graphical view of warnings considering HVS features:** Points to the warnings graphical view.
- ROI depth and shape distortions visualization:** Points to the chart view.
- Depth and shape distortion curves:** Points to the chart view.
- Optimization proposals:** Points to the suggestions panel.

# Stereo calculator software

To control depth rendering and to minimize visual discomfort

Scene configuration  
Shooting parameters

Visualization environment



# Impact of shooting parameters on perceived depth (camera baseline case)



# To model and control the depth rendering

## Impact of shooting parameters on the final perceived depth

The screenshot displays the StereoCalcApp interface with the following components:

- Input parameters:**
  - Rig type: ToedIn
  - Current baseline: 65.0000
  - Minimum baseline: 0.0000
  - Maximum baseline: 110.0000
- Andrew Woods view:** A 3D grid visualization showing the viewing frustum. Parameters include Grid size (0.1), Min view Z (0), and Max view Z (6.500000). A yellow callout bubble indicates:
  - Baseline = 65 mm
  - Viewing distance = 4.5 H
- Depth and Disparity Metrics:**
  - Depth:** fg: 2.000 m, dCov: 2.600 m, roi: 3.000 m, bkg: 5.000 m
  - Perceived depth (rendering):** fg: 1.999 m, dCov: 2.600 m, roi: 3.001 m, bkg: 5.006 m
  - Horizontal disparity:** fg: -19.524 mm, dCov: 0.000 mm, roi: 8.678 mm, bkg: 31.242 mm
  - Vertical disparity:** bkg: 1.805 mm, fg: 1.835 mm, dCov: 1.862 mm, roi: 1.846 mm
- Distortions at ROI distance:**
  - Dx: 100.15%
  - Dy: 100.16%
  - Dz: 100.17%
  - Ds: 100.02%
- 3D view:** Shows two tiger models side-by-side, labeled 'Original' and 'Perceived'. The 'Perceived' model appears slightly more compressed. Controls include 'Perceived ROI view', 'Tiger', 'Toggle full screen', 'Toggle REF (F3)', 'Change device (F2)', and 'Take screenshot (F4)'. Camera position is (x=0.00, y=0.00).

# To model and control the depth rendering

## Impact of shooting parameters on the final perceived depth

The screenshot displays the StereoCalcApp interface with the following components:

- Input parameters:**
  - Rig type: Toedin
  - Current baseline: 35.0000
  - Minimum baseline: 0.0000
  - Maximum baseline: 110.0000
- Andrew Woods view:** A diagram showing the camera's field of view and depth rendering parameters.
  - Grid size: 0.1
  - Min view Z: 0
  - Max view Z: 6.500000
  - Focus Max and Focus Dof buttons are visible.
- Depth rendering diagrams:**
  - Depth:** fg: 2.000 m, dCov: 2.600 m, roi: 3.000 m, bkg: 5.000 m
  - Perceived depth (rendering):** fg: 2.238 m, dCov: 2.600 m, roi: 2.801 m, bkg: 3.508 m
  - Horizontal disparity:** fg: -10.514 mm, dCov: 0.000 mm, roi: 4.673 mm, bkg: 16.824 mm
  - Vertical disparity:** bkg: 0.987 mm, fg: 0.996 mm, roi: 0.999 mm, dCov: 1.004 mm
- Distortions at ROI distance:**
  - Dx: 93.51 %
  - Dy: 93.51 %
  - Dz: 47.02 %
  - Ds: 50.28 %
- 3D view:** Shows a tiger model in two states: 'Original' and 'Perceived'. The perceived view shows a tiger that appears closer and more distorted.
  - Camera position: (x=0.00, y=0.00)
  - Buttons: Toggle full screen, Toggle REF (F3), Change device (F2), Take screenshot (F4)

A yellow callout box highlights the input parameters: **Baseline = 35 mm** and **Viewing distance = 4.5 H**.

# To model and control the depth rendering

## Impact of shooting parameters on the final perceived depth

The screenshot displays the StereoCalc application window with the following components:

- Input parameters:**
  - Rig type: ToedIn
  - Current baseline: 85.0000
  - Minimum baseline: 0.0000
  - Maximum baseline: 110.0000
- Warnings graphical view:**
  - Depth:** fg: 2.000 m, dCov: 2.600 m, roi: 3.000 m, bkg: 5.000 m
  - Perceived depth (rendering):** fg: 1.867 m, dCov: 2.600 m, roi: 3.150 m, bkg: 6.999 m
  - Horizontal disparity:** fg: -25.528 mm, dCov: 0.000 mm, roi: 11.347 mm, bkg: 40.853 mm
  - Vertical disparity:** bkg: 2.336 mm, fg: 2.387 mm, dCov: 2.433 mm, roi: 2.406 mm
  - Distortions at ROI distance:**
    - Dx: 105.13 %
    - Dy: 105.14 %
    - Dz: 144.34 %
    - Ds: 137.30 %
- Andrew Woods view:**
  - Grid size: 0.1
  - Min view Z: 0
  - Max view Z: 8.398526 [x:1.31 z:-0.36]
  - Buttons: Focus Max, Focus Def
- 3D view:**
  - Perceived ROI view: Tiger
  - Buttons: Toggle full screen, Toggle REF (F3), Change device (F2), Take screenshot (F4)
  - Identify objects: [x] Identify objects
  - Camera position: (x=0.00 y=0.00)
  - Visuals: Original (left), Perceived (right)

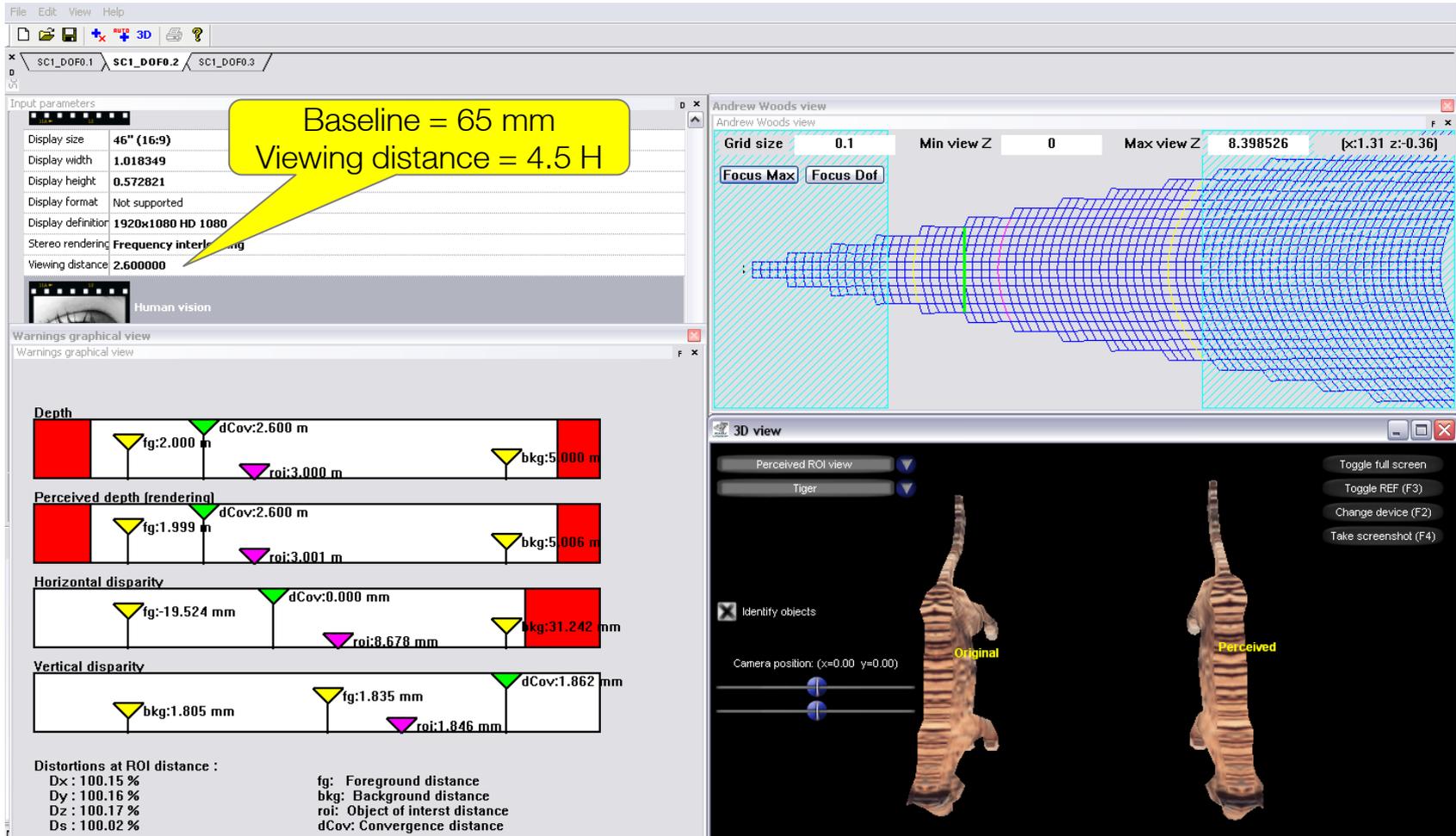
A yellow callout bubble points to the 'Current baseline' value, containing the text: **Baseline = 85 mm**  
**Viewing distance = 4.5 H**

# Impact of viewing parameters on perceived depth (viewing distance case)



# To model and control the depth rendering

## Impact of visualisation parameters on the final perceived depth



# To model and control the depth rendering

## Impact of visualisation parameters on the final perceived depth

**Input parameters**

Input parameters

Display size: 46" (16:9)  
 Display width: 1.018349  
 Display height: 0.572821  
 Display format: Not supported  
 Display definition: 1920x1080 HD 1080  
 Stereo rendering: Frequency interleaved  
 Viewing distance: 1.700000

**Human vision**

Viewing distance (m):

**Andrew Woods view**

Grid size: 0.1    Min view Z: 0    Max view Z: 6.500000 [x:1.00 z:0.45]  
 Focus Max    Focus Dof

**3D view**

Perceived ROI view: Tiger  
 Toggle full screen  
 Toggle REF (F3)  
 Change device (F2)  
 Take screenshot (F4)

Identify objects  
 Camera position: (x=0.00 y=0.00)

Original    Perceived

**Depth**

fg:2.000 m    dCov:2.600 m    roi:3.000 m    bkg:5.000 m

**Perceived depth (rendering)**

fg:1.307 m    dCov:1.700 m    roi:1.962 m    bkg:3.273 m

**Horizontal disparity**

fg:-19.524 mm    dCov:0.000 mm    roi:8.678 mm    bkg:31.242 mm

**Vertical disparity**

bkg:1.805 mm    fg:1.835 mm    roi:1.846 mm    dCov:1.862 mm

**Distortions at ROI distance :**

Dx: 100.15 %    fg: Foreground distance  
 Dy: 100.16 %    bkg: Background distance  
 Dz: 65.50 %    roi: Object of interest distance  
 Ds: 65.40 %    dCov: Convergence distance

**Callout:** Baseline = 65 mm  
Viewing distance = 3 H

# To model and control the depth rendering

## Impact of visualisation parameters on the final perceived depth

The screenshot displays the StereoCalcApp interface with the following components:

- Input parameters:**
  - Display size: 46" (16:9)
  - Display width: 1.018349
  - Display height: 0.572821
  - Display format: Not supported
  - Display definitor: 1920x1080 HD 1080
  - Stereo rendering: Frequency interleaving
  - Viewing distance: 3.400000
- Andrew Woods view:** A 3D wireframe grid showing a perspective view of a cylinder. Parameters include Grid size: 0.1, Min view Z: 0, Max view Z: 6.500000, and a coordinate system [x:0.86 z:-0.28].
- Warnings graphical view:**
  - Depth:** fg:2.000 m, dCov:2.600 m, roi:3.000 m, bkg:5.000 m
  - Perceived depth (rendering):** fg:2.615 m, dCov:3.400 m, roi:3.924 m, bkg:6.547 m
  - Horizontal disparity:** fg:-19.524 mm, dCov:0.000 mm, roi:8.678 mm, bkg:31.242 mm
  - Vertical disparity:** bkg:1.805 mm, fg:1.835 mm, dCov:1.862 mm, roi:1.846 mm
- Distortions at ROI distance:**
  - Dx: 100.15 %
  - Dy: 100.16 %
  - Dz: 130.99 %
  - Ds: 130.80 %
- 3D view:** Shows two tiger models side-by-side, labeled 'Original' and 'Perceived'. The 'Perceived' model appears more compressed. Controls include 'Perceived ROI view', 'Tiger', 'Toggle full screen', 'Toggle REF (F3)', 'Change device (F2)', 'Take screenshot (F4)', and 'Identify objects'. Camera position is (x=0.00 y=0.00).

Baseline = 65 mm  
Viewing distance = 6 H

# Conclusion

## Importance of scene, shooting and visualization parameters

- **Perceived depth as well as depth distortions are depending on:**
  - Scene parameters: foreground, background and ROI distances
  - Shooting parameters: camera baseline, focal length and convergence distance
  - Visualization parameters: display size, interocular distance and viewing distance
- **Exemple: 1mn of arc criteria used in 2D to define the viewing distance will impact depth perception and visual comfort of viewers**
  - 6H viewing distance in case of Line Interleave 3D displays (HD screen)
  - 3H viewing distance in case of active shutters (HD screen)
- **Proposal: it is essential to provide scene, shooting and visualization parameters**
  - To better understand and to analyse viewers' opinion about the 3D video QoE
  - To compare subjective test results from different studies and/or laboratories

Thank you! Question?



restricted

