

## ADA Professional Product Review Intraoral Cameras: Laboratory Testing Methods

### Scope

This protocol for the laboratory testing of *intraoral cameras* was developed to provide relevant laboratory information that will be used as part of a report on this dental equipment in the Summer 2008 issue of the [ADA Professional Product Report](#). The tests described in this protocol are meant to provide the dental practitioner with appropriate comparative scientific information to assist in the purchase of intraoral cameras.

### List of Tests in this Protocol:

- A. [Weight](#)
- B. [White Balance](#)
- C. [Field of View](#)
- D. [Contrast Transfer Response](#)

#### A. Weight

##### Materials:

**Scale**, accurate to at least 0.01 g.

##### Procedure:

- 1) Weigh the intraoral camera handpiece, with the USB cable or fiber optics attached if applicable, and record the results to the nearest 0.01 g.
- 2) Report the average weight and range for each handpiece manufacturer.

#### B. White Balance

##### Materials:

**Test Environment.** Darkroom

**White Balance Reflectance Test Target**, which offers 99% reflectivity throughout the UV-VIS-NIR wavelengths.

**Positioning/loading apparatus.** The apparatus shall be used as a means to secure the intraoral camera handpiece such that the optical axis of the handpiece will be perpendicular to the object plane of the test target. The apparatus shall allow movement in the x, y, z direction while maintaining the orientation of the optical axis.



**Image capture.** All the images will be exported in uncompressed TIFF format with the manufacturer supplied software.

**Disposable barrier sheaths.** The manufacturer supplied barrier sheaths will be used for the tests.

##### Procedure:

- 1) Position the handpiece such that the optical axis is parallel to the object plane of the test target and the center of the target fills the field of view of the imaging system.
- 2) For auto-focus systems: Acquire images of the test target at 0-50 mm distance with 1mm increment.

- 3) For manual-focus systems: Acquire images of the test target, manually focusing the system at each position from 0-50 mm, with 1mm increment.
- 4) For manual-focus systems with pre-set focusing positions: Acquire images of the test target at these 3 preset positions at 0-50 mm distance with 1mm increment.
- 5) Analyze the RGB components of each pixel in the image for its perpendicular deviation from the white/black axis in RGB space that corresponds to a line drawn from (0, 0, 0) to (255, 255, 255).
- 6) Average the deviation for each pixel over the entire image.
- 7) The average deviation is the deviation from white of the imaging system and can give an indication of white balance. The larger the deviation, the poorer the ability of the system to render proper color values

### C. Field of View

**Test Environment.** Darkroom

**0.5 mm Grid Test Target**, which offers black grid rulings on white paper, 1 mm in size. The substrate for the target shall be high quality paper.

**Positioning/loading apparatus.** The apparatus shall be used as a means to secure the intraoral camera handpiece such that the optical axis of the handpiece will be perpendicular to the object plane of the test target. The apparatus shall allow movement in the x,y,z direction while maintaining the orientation of the optical axis.

**Image capture.** All the images will be exported in uncompressed TIFF format.

**Image analysis software.** The software shall be used as a means to quantify RGB values of the images taken. It will allow for plot profiles, color analysis, histograms, and dimensional analysis such as ImageJ.

**Disposable barrier sheaths.** The manufacturer supplied barrier sheaths will be used for the tests.

#### Procedure:

1. Position the handpiece such that the optical axis is parallel to the object plane of the test target and the lens face is 0mm away from the test target, or as close as the handpiece configuration will allow.
2. Acquire images:
  - a. For auto-focus systems: Acquire images of the test target at 0-50 mm distance in 5 mm increments.
  - b. For manual-focus systems: Acquire images of the test target manually focusing the camera at each position from 0-50 mm distance in 5 mm increments
  - c. For manual-focus systems with pre set positions: Acquire images of the test target from 0-50 mm distance in 5 mm increments.
3. Measure the field of view by counting the total number of complete squares visible in the field for each image.  
Report the field of view at each distance from the test target

### D. Contrast Transfer Response and Visual Assessment of Resolution Materials

**Test Environment.** Darkroom

**Single Frequency Ronchi Rulings** on semi-matte photopaper offering rulings at 2, 4, 8, 10, 12, 14, 16, 18, 20 lp/mm

**Positioning/loading apparatus.** The apparatus shall be used as a means to secure the intraoral camera handpiece such that the optical axis of the handpiece will be perpendicular to the object plane of the test target. The apparatus shall allow movement in the x,y,z direction while maintaining the orientation of the optical axis.

**Image capture.** All the images will be exported in uncompressed TIFF format.

**Image analysis software.** The software shall be used as a means to quantify contrast response values of the images taken. It will allow for plot profiles, color analysis, histograms, and dimensional analysis such as ImageJ.

**Disposable barrier sheaths.** The manufacturer supplied barrier sheaths will be used for the tests.

### Procedure:

- 1) Position the handpiece such that the optical axis is perpendicular to the object plane of the test target and the lens face is 0mm away from the test target, or as close as the handpiece configuration will allow.
- 2) Acquire images:
  - a. For steps b-d the lines of the Ronchi Rules shall be positioned horizontally with respect to the long axis of the handpiece configuration.
  - b. For auto-focus systems: Acquire images of the test target at 0-50 mm distance in 1mm increments for each test target listed in the Materials section.
  - c. For manual-focus systems: Acquire images of the test target manually focusing the camera at each position from 0-50 mm distance in 1mm increments for each test target listed in the Materials section.
  - d. For manual-focus systems with pre set positions: Acquire images of the test target at each of the 3 preset positions from 0-50 mm distance in 1mm increments for the 2 and 4 lp/mm targets. Following this acquire images of the rest of the test targets by manually focusing the camera at each position from 0-50 mm distance with 1mm increments.
- 3) Export images into the analysis software which shall perform the following steps:
  - a. Crop the image in half along the vertical axis.
  - b. Average the RGB grayscale values along the length of the Ronchi Rulings (Figure 1a) for each row of pixels (Figure 1b).
  - c. Calculate the differences between local peaks and valleys for the entire profile plot.
  - d. Average all the calculated differences and divide the average by 255 (the largest possible difference). This value is the percent contrast response.
- 4) For each camera report results as percent contrast response VS distance at each resolution.

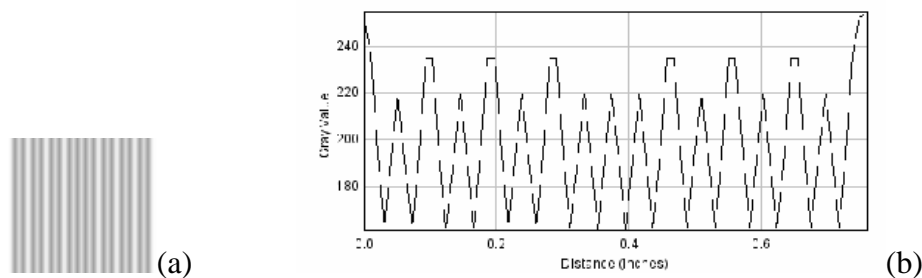


Figure 1. (a) Image of Ronchi Ruling, (b) Horizontal Profile Plot of Ronchi Ruling