IEEE P1858 CPIQ Overview

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What is CPIQ?

- CPIQ = Camera Phone Image Quality
- Image quality standards organization for mobile cameras (not just phones anymore)
- Launched 2006 under International Imaging Industry Association (I3A)
- Transitioned in 2012 to IEEE standards development as Work Group P1858

Who is CPIQ?

- Participating companies
  - Mobile carriers, OS vendors, handset manufactures, chipset vendors, component vendors, test labs, test software and equipment vendors, and others
  - Google, Intel, Microsoft, Huawei, LG, nVidia, AT&T, OVT, Imatest, DxO, Image Engineering, Apkudo, ...

- Relationship to ISO
  - Liaison relationship with ISO
  - Maintain consistency across imaging standards from different organizations

Why CPIQ?

- Reviewers and consumers starting to understand that megapixels ≠ image quality
- Need alternative way to assess & communicate image quality
- CPIQ goals are to:
  - **Standardize** image quality test metrics and methodologies across the industry
  - **Correlate** objective results with human perception
  - **Combine** the data into a meaningful consumer rating system

IEEE P1858 CPIQ Standard

- Standardizing means everyone measures the same way
- Version 1 of *CPIQ Standard for Image Quality Testing* is planned to be published in 2016
- Will include seven metrics:
  - Spatial frequency response
  - Visual noise
  - Texture blur
  - Lateral chromatic displacement
  - Chroma level
  - Color uniformity
  - Local geometric distortion

CPIQ Objective Metric Development Methodology

AE Metric Development - EI16

Real-world Scenes Used in the Study

- People and landscape scenes
- Outdoor and indoor scenes
- Landscape and portrait formats

AE Metric Development - EI16

Target Capture

- For each scene capture a second capture was taken with test charts to characterize the lighting condition for the specific scene
- Target image went through the same image processing path as the scene image

AE Metric Development - EI16

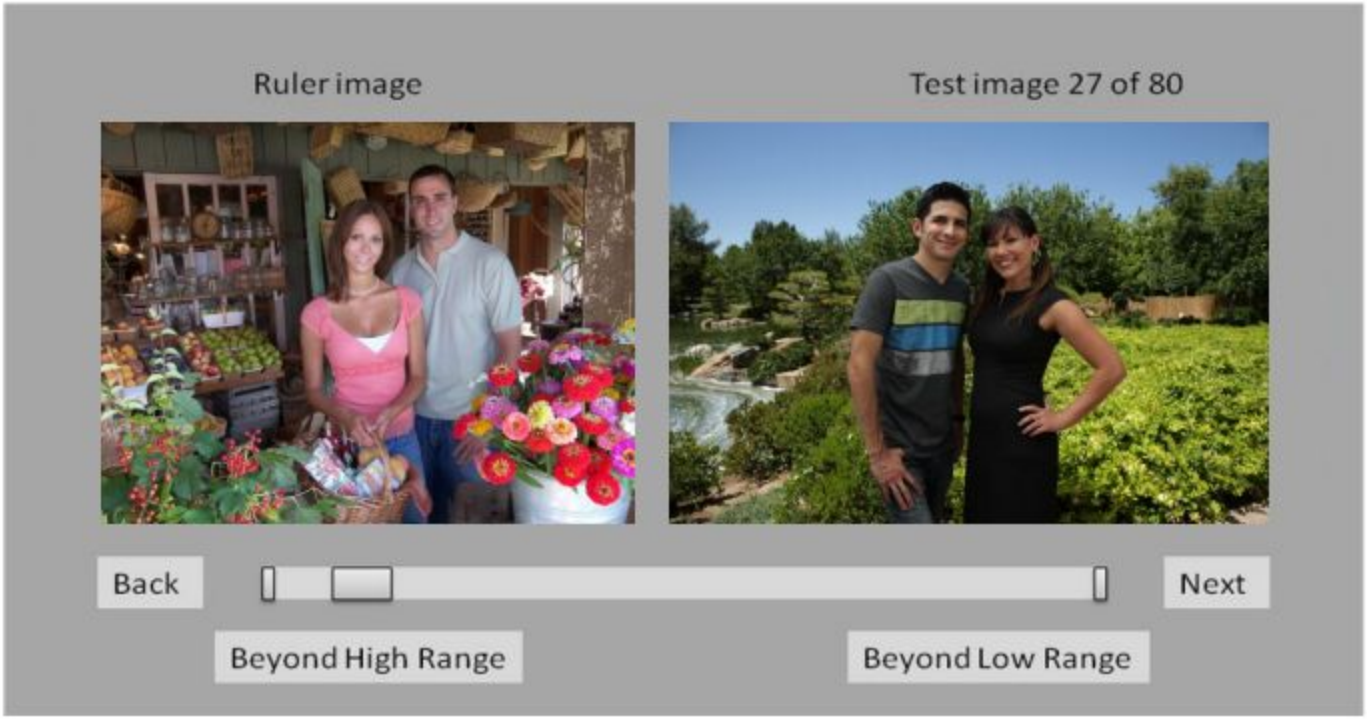
Softcopy Quality Ruler Method

ISO 20462 - Photography – Psychophysical experimental methods for estimating image quality – Part 3: Quality ruler method

- An absolute quality scale in units of JNDs on overall quality (not appearance)
- A set of reference stimuli in hardcopy format
- A method for generating quality ruler images of known JND values

AE Metric Development - EI16

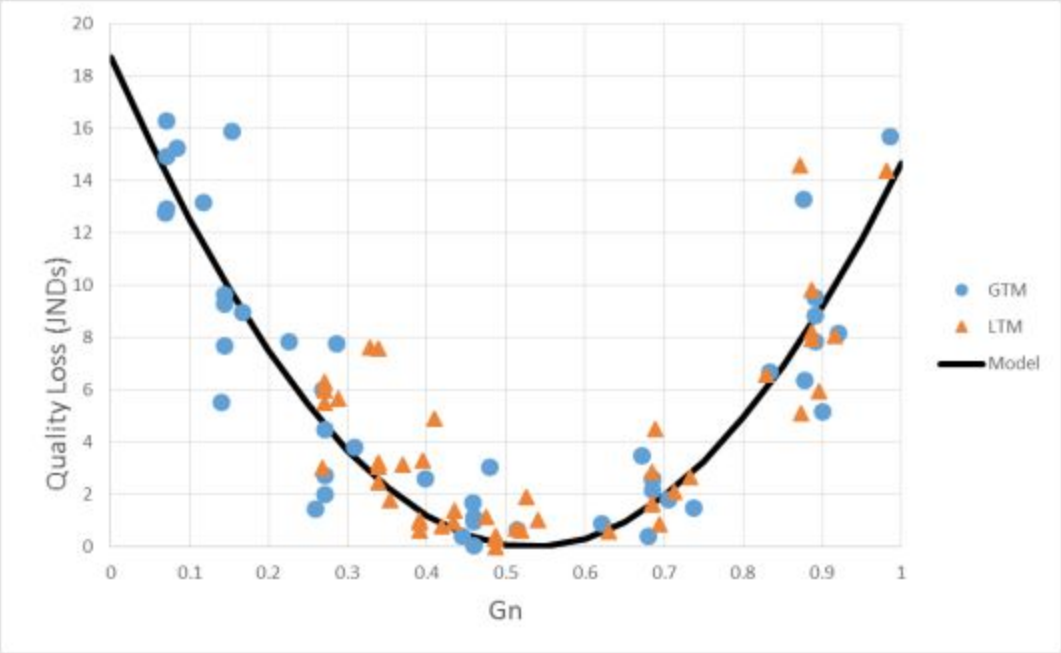
Softcopy Quality Ruler GUI



Ruler image sharpness (quality) can be adjusted using the slider bar. Subjects were instructed to match quality of the test image to that of the ruler image.

AE Metric Development - EI16

AE Quality Loss Function



$QL = d * (1 - \exp(b*|OM - a|^c))$

a = 0.537
b = 0.416
c = 1.739
d = 250

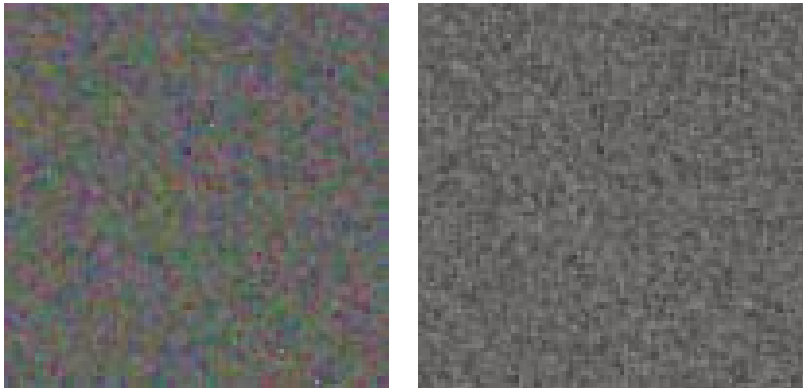
13

Spatial Frequency Response (SFR)

- Measure of resolution, sharpening, acutance and image sharpness
- Derived from ISO 12233 – *Photography Electronic Still Picture Imaging – Resolution and Spatial Frequency Response Measurements*
- Adds a method for calculating a visually correlated global sharpness measure (acutance)
- Measured on a low-contrast slanted edge
- Current version only calculates SFR of image center
  - Continuing work planned to add corner/edge sharpness

Visual Noise

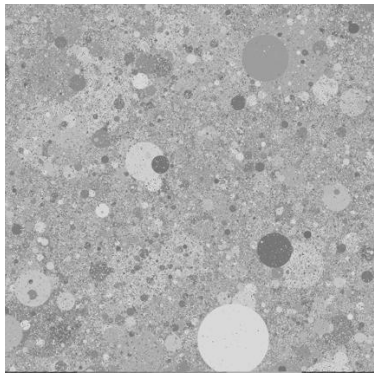
- Derived from ISO 15739:2013 – *Noise measurements*
- Shows better correlation with visual perception of noise than ISO 15739.
- Measured on a ISO 14524:2009 compliant OECF chart
- Reported as base 10 logarithm of the weighted sum of the L*, a*, b* variances and L*a* covariance
- Rewards for noise in blue-yellow axis due to –b* term
- This & other aspects of metric planned to be refined for V2



Texture Blur

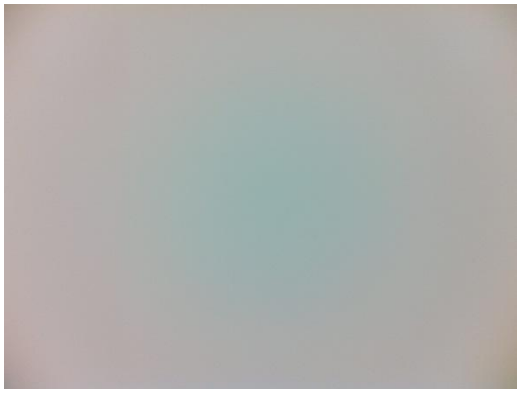
- Strong noise reduction can preserve edges (and hence give good SFR results) but destroy texture
- Measured on “dead leaves” target
- Reported as a ratio between the power spectral density (PSD) of the captured dead leaves patch minus the PSD of a flat field patch (in order to compensate for the noise), and the PSD of the ideal (reference) dead leaves target.
- V1 may not provide accurate results for NR algorithms that apply localized NR strength based on image content





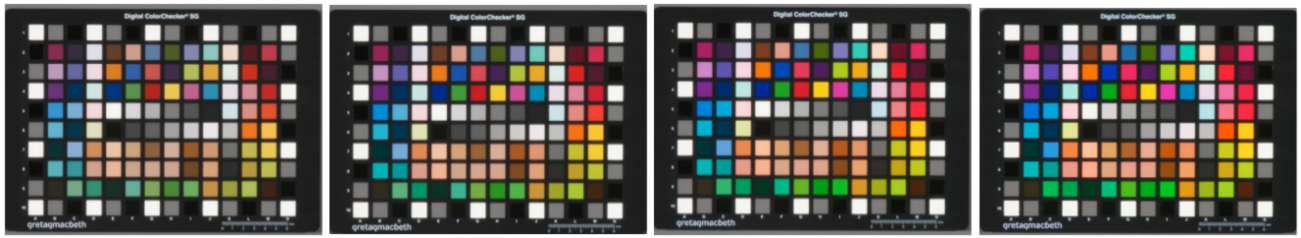
Color Uniformity

- Typically seen as radial color variation across an image
- Can be caused by
  - optical mismatch between sensor and lens
  - spatially varying spectral transmittance differences from the IR filter
  - spectral sensitivity differences across the sensor
- Measured on neutral flat-field (uniform) target
- Reported as the maximum color deviation from the scene average
- Adopted by ISO as International Standard 17957



Chroma Level

- Measures average scene colorfulness and links it to end users preference.
- Chroma is often used to indicate color *intensity* and is used in this standard as an approximation of saturation.
- Saturation measures deviation from accurate colorimetric reproduction, whereas Chroma Level is derived from user studies.
- Measured on a 140 patch color target
- Reported as percentage of the ratio of mean chroma between captured image and reference data

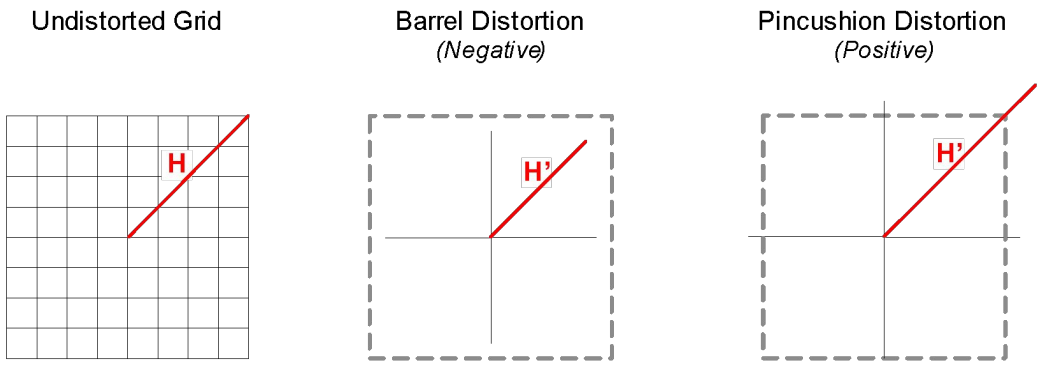


Lateral Chromatic Displacement

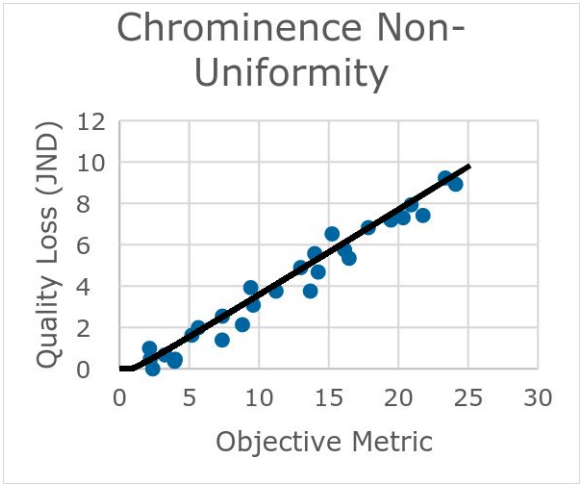
- Caused by different wavelengths of light being focused at different positions in the focal plane
- Measured on a target of black dots over a uniform white background
- Reported as the worst case shift of color planes over the whole image as a proportion of the image height.
- Adopted by ISO as International Standard 19084

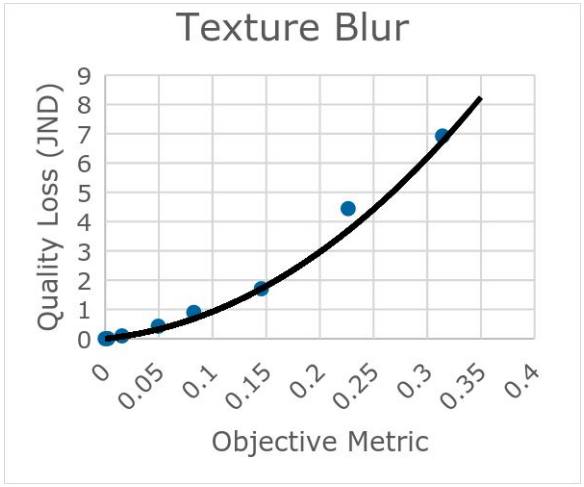
Local Geometric Distortion

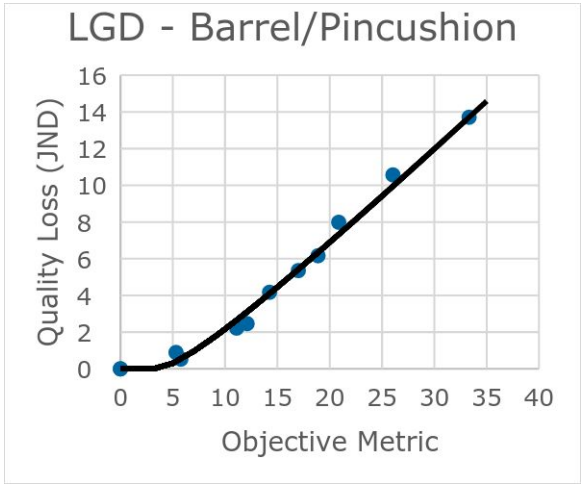
- Defined as the variation of magnification in the image field. (The most well known effect of distortion is that straight lines appear warped.)
- Measured on a target of black dots over a uniform white background
- Reported as the largest absolute value of the distortion in the image field
- Adopted by ISO as International Standard 17850

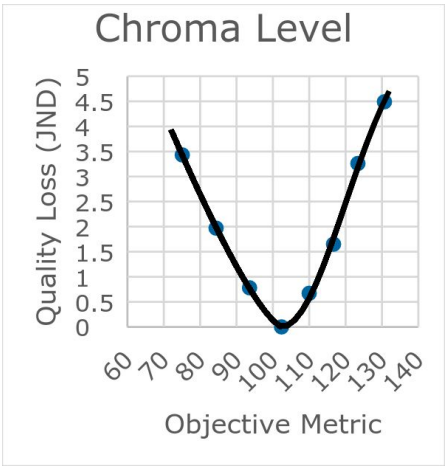


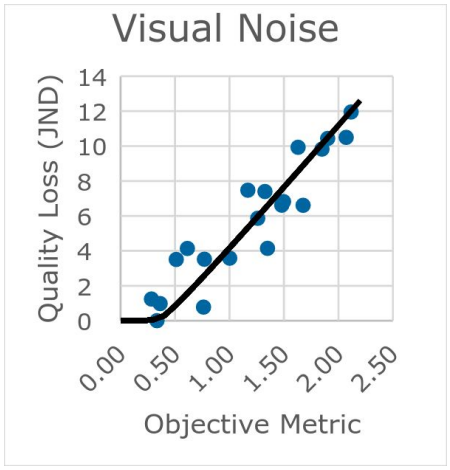
JNDs for Published Standards

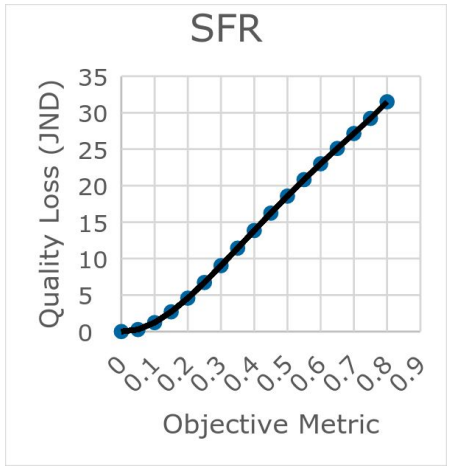


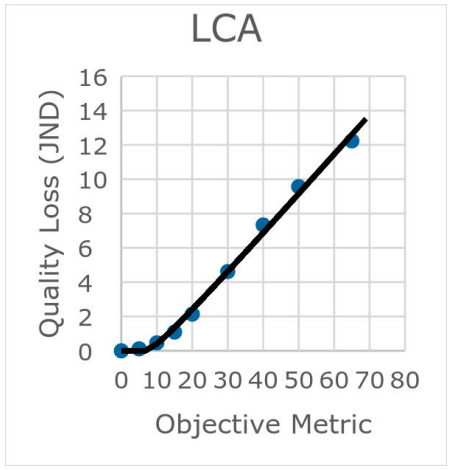








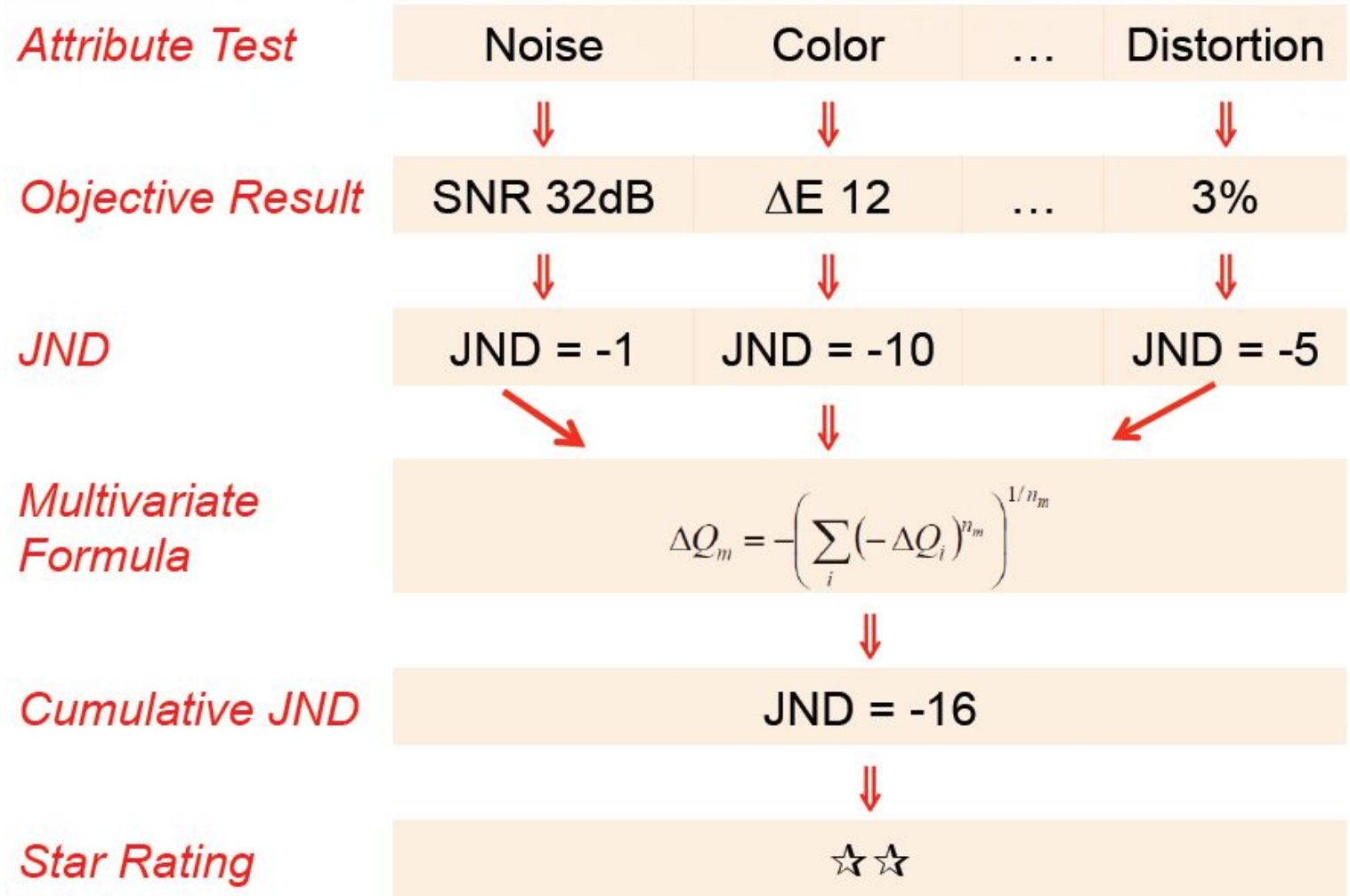




ICAP - IEEE Conformity Assessment Program

- CPIQ Conformity Assessment Steering Committee (CASC)
  - Formed 2014, 13 member companies
- CPIQ CASC Objectives:
  - Create a meaningful, easy to understand **consumer rating system** (CRS) for mobile cameras
  - Create and manage a mobile camera **certification program** to award ratings

From Specs to Stars



CPIQ Next Steps

- Version 2 of *CPIQ Standard for Image Quality Testing* targeted for 2017 publication
- Will include:
  - Auto White Balance
  - Auto Exposure
  - AF Consistency
  - Video
  - Revised Texture Metric
  - Updates to Visual Noise
  - Updates to SFR Metric

CPIQ Next Steps

- Many more metrics remain:
  - HDR
  - Local tone mapping
  - Visible Dynamic Range Capability
  - Spatial non-uniformity (vignetting)
  - Veiling Glare
  - Image Stabilization
  - Video Stabilization
  - Memory Color
  - Extended color gamut
  - Flash
  - Horizontal and vertical edge measurements
  - AF Speed
  - Latency
  - Artifacts
  - Panorama

ICAP Next Steps

- Develop the Consumer Rating System formula
- Conduct Consumer Rating System validation study
- Prepare test spec and documentation
- Develop certification program guidelines
- Administer certification programs
- Market the Consumer Rating system to build brand awareness

CRS validation study (Feb 2016 - Oct 2016)

- Model prediction: CPIQ and VIQET
- Subjective evaluation: Ruler method and paired comparison