

Chromatic Stimuli and Instrumentation in Vision Science and Testing

International Commission on
Illumination

Balázs Vince Nagy

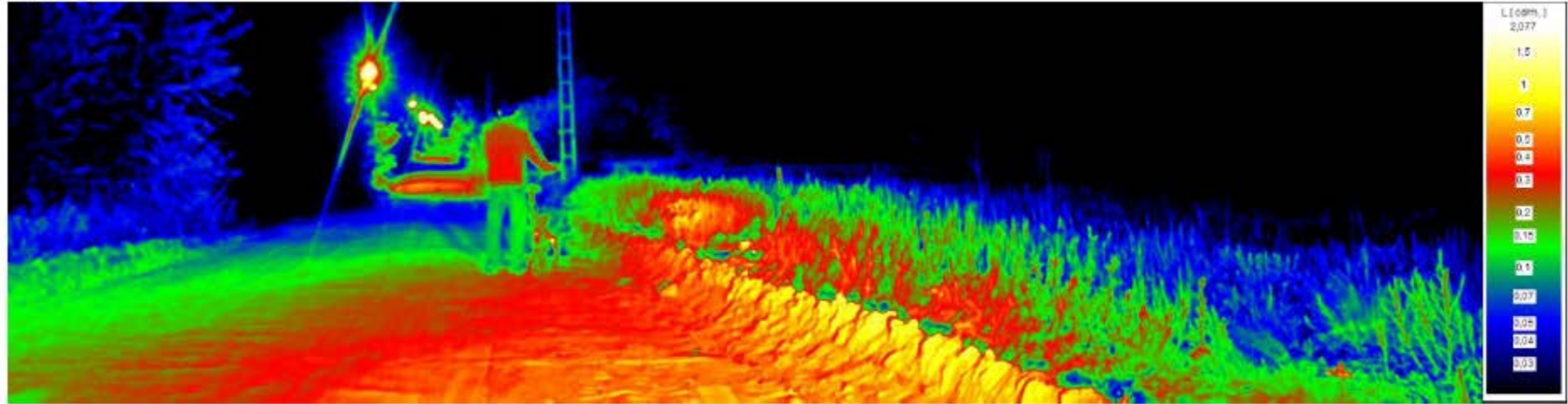
BR/HU

Outline

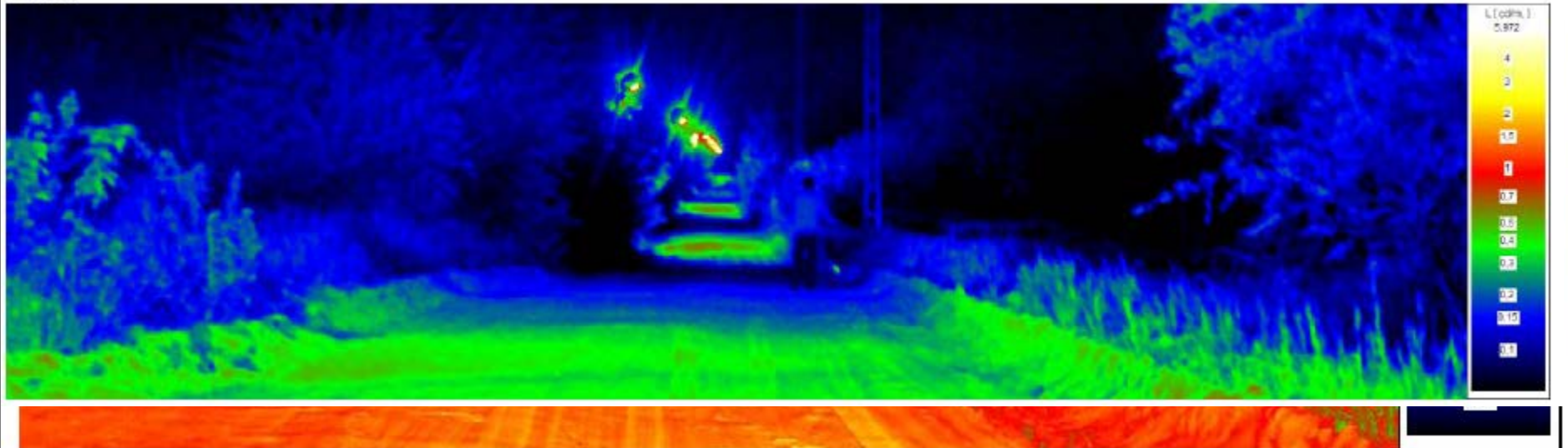
- Vision
 - Introduction on color vision
 - Instrumentation, calibration
 - Chromatic stimulation
 - Psychophysics and visual electrophysiology
- CIE
 - Introduction and basic structure
 - Medical related topics
 - ICC liasions

Introduction

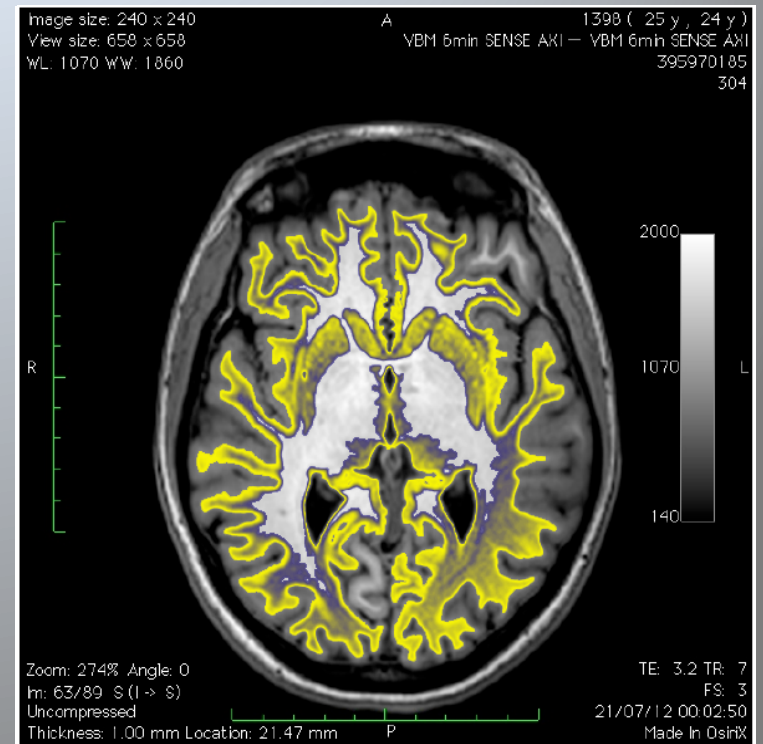
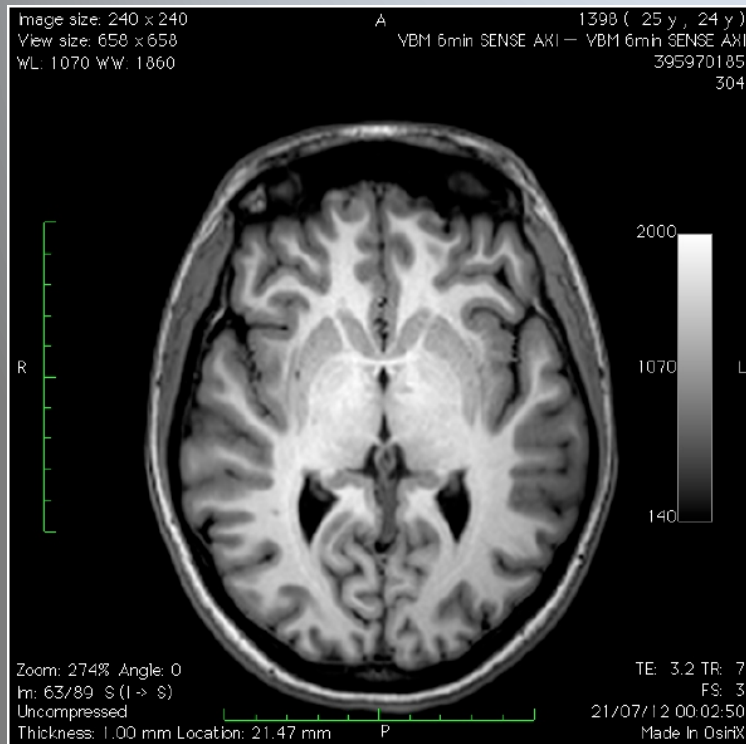
12m



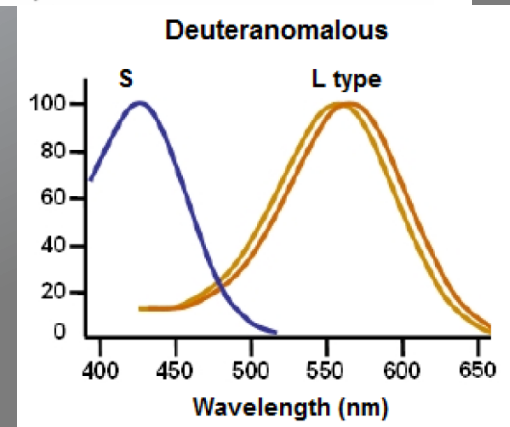
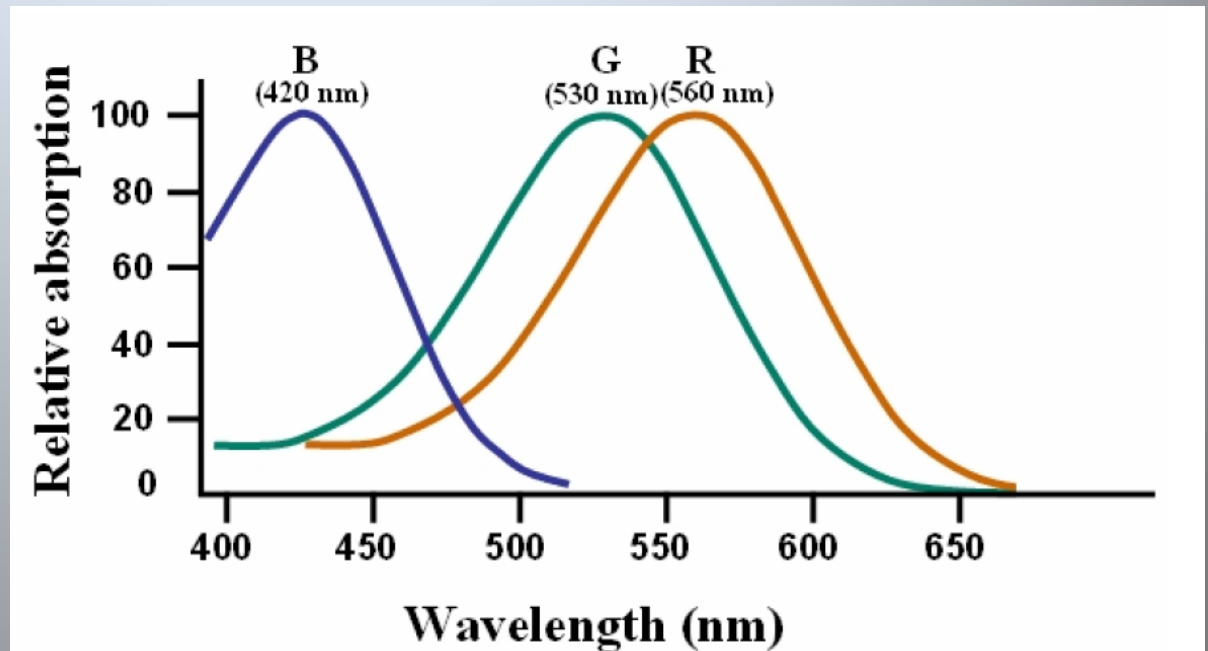
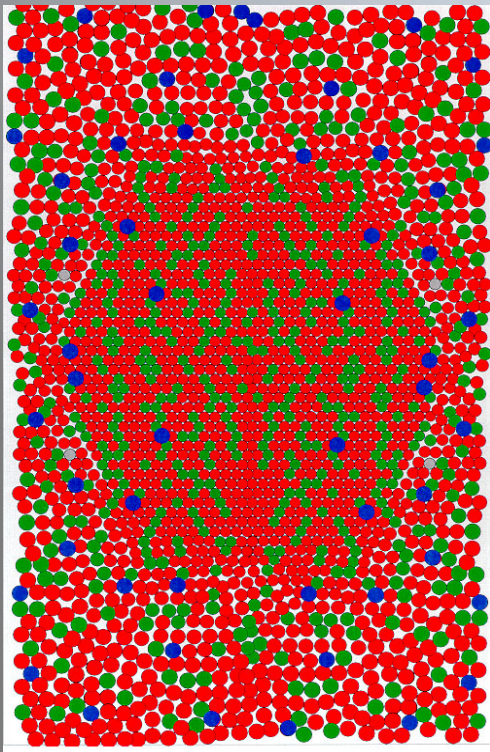
30m
42m



Introduction

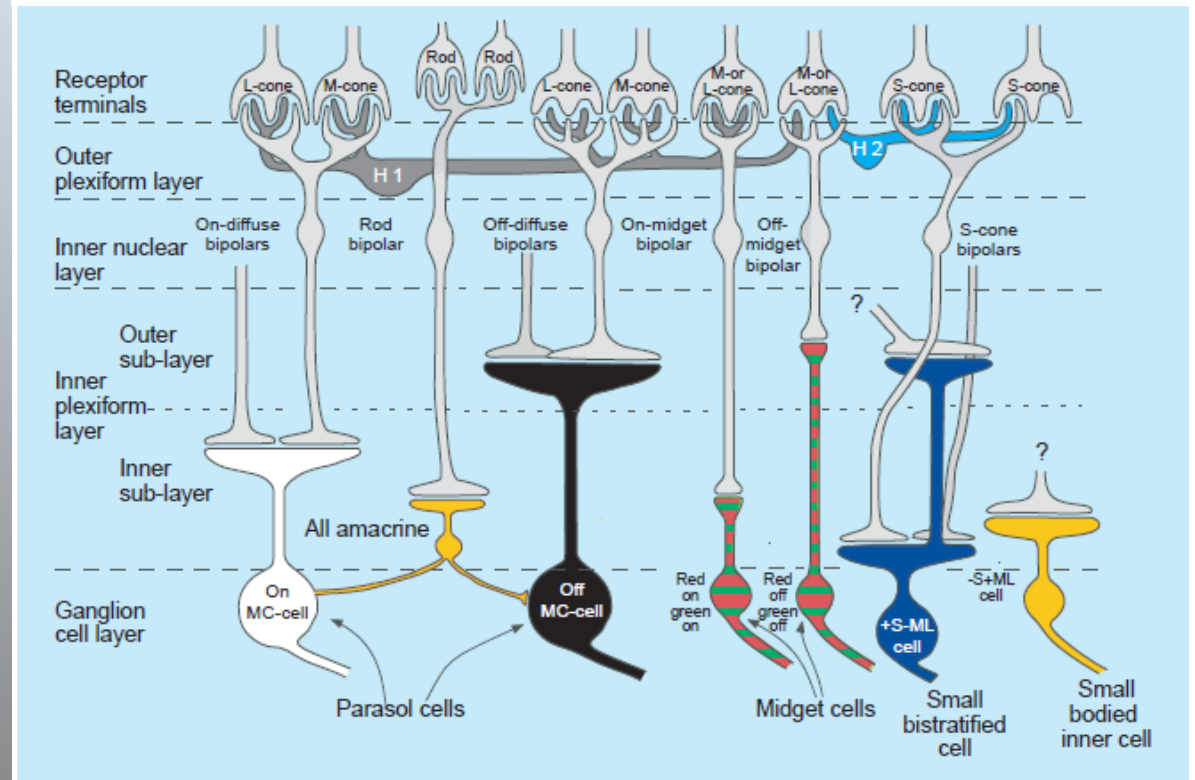


Introduction – Human color vision

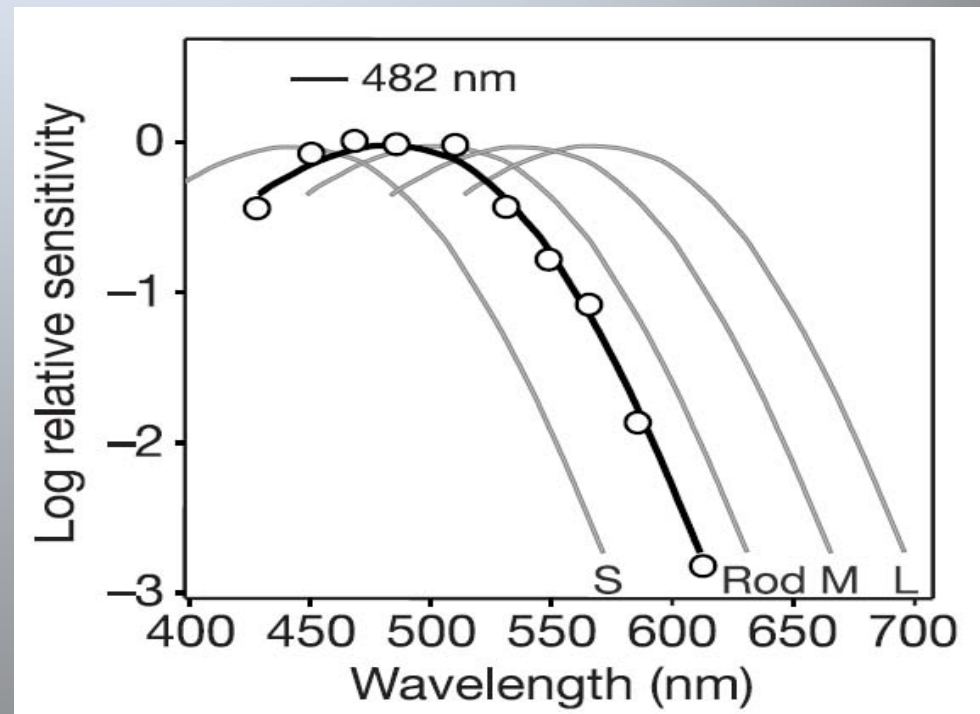
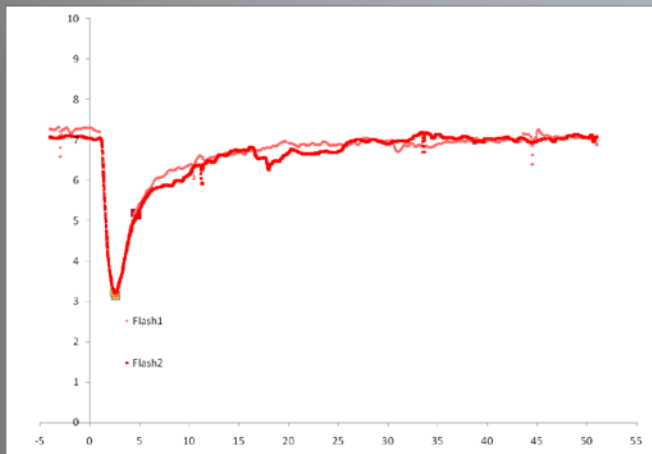
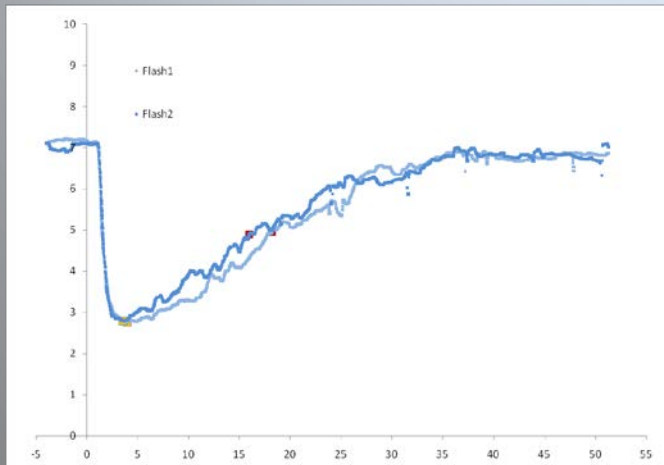


Introduction – Human color vision

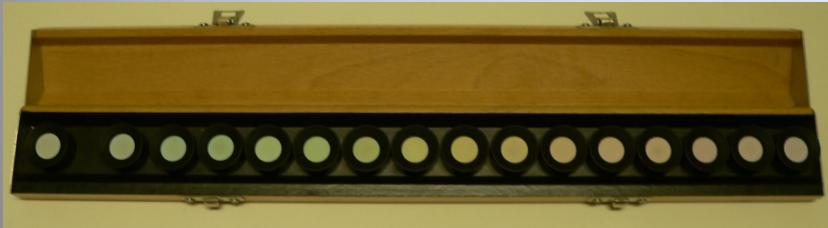
- ON-, OFF-
- Opponency
- Magno
- Parvo
- Gonio



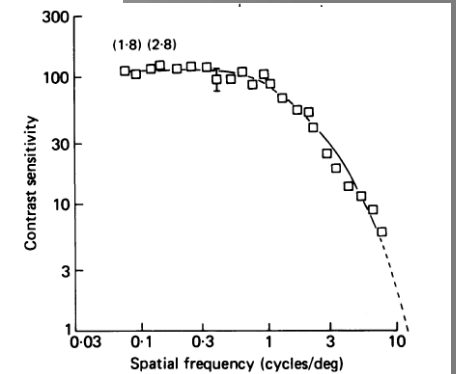
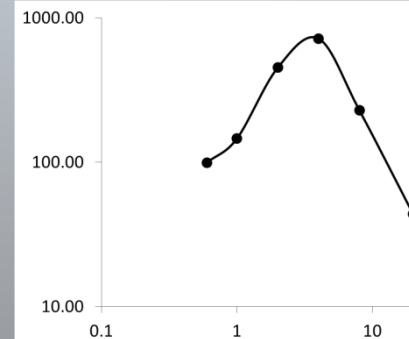
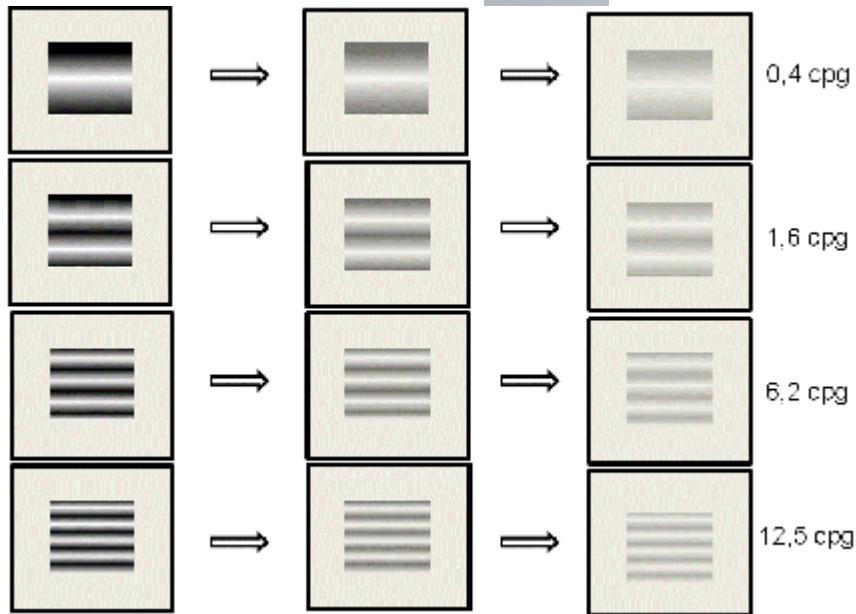
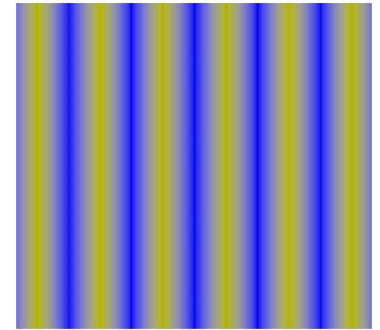
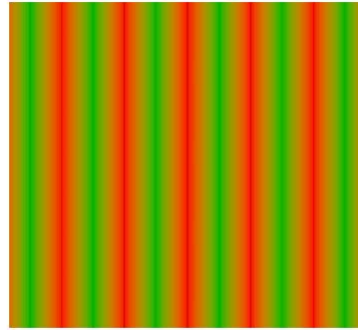
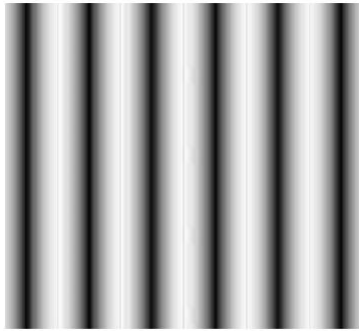
Introduction – Human color vision



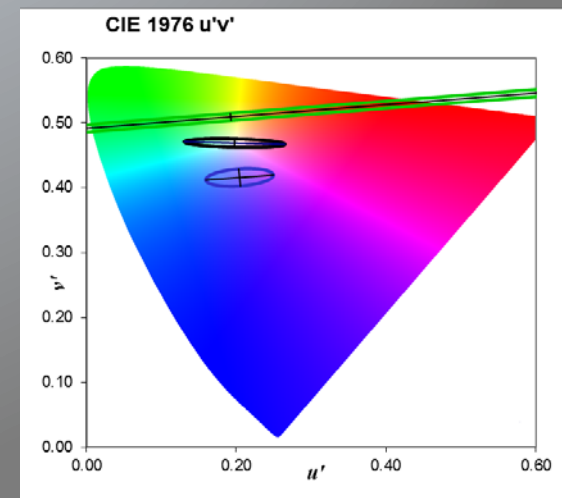
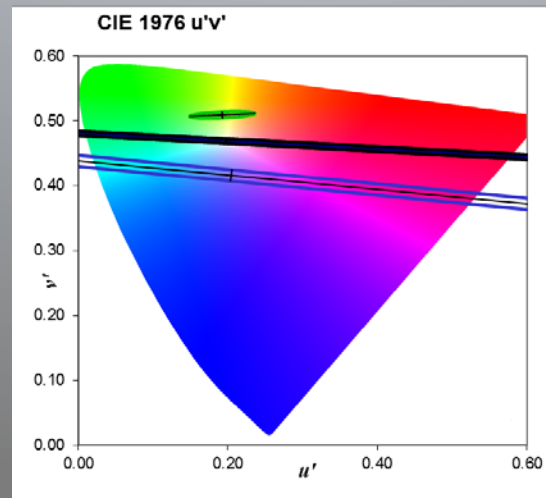
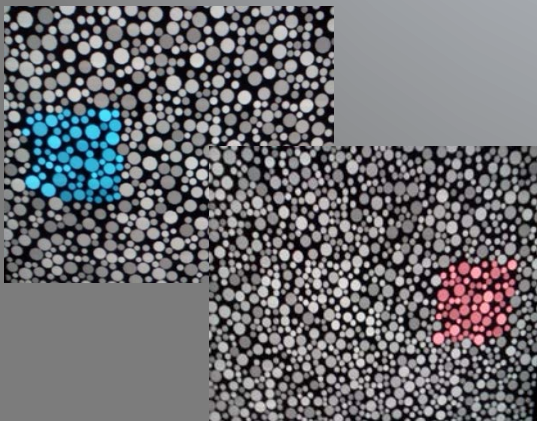
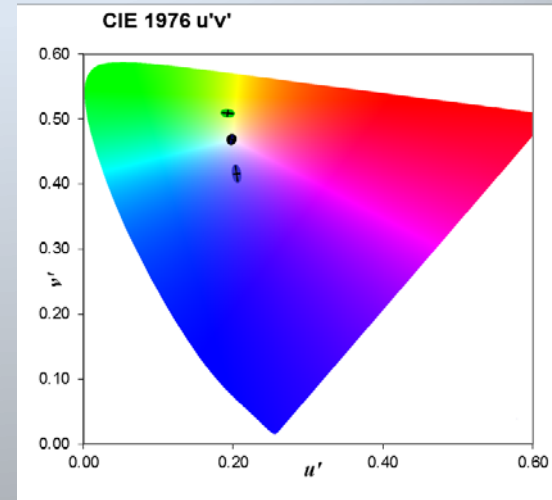
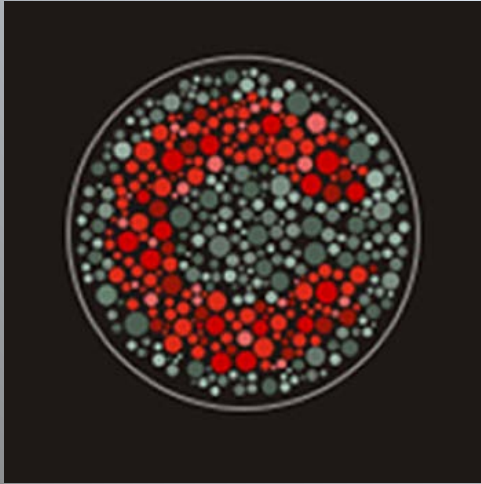
Psychophysical testing



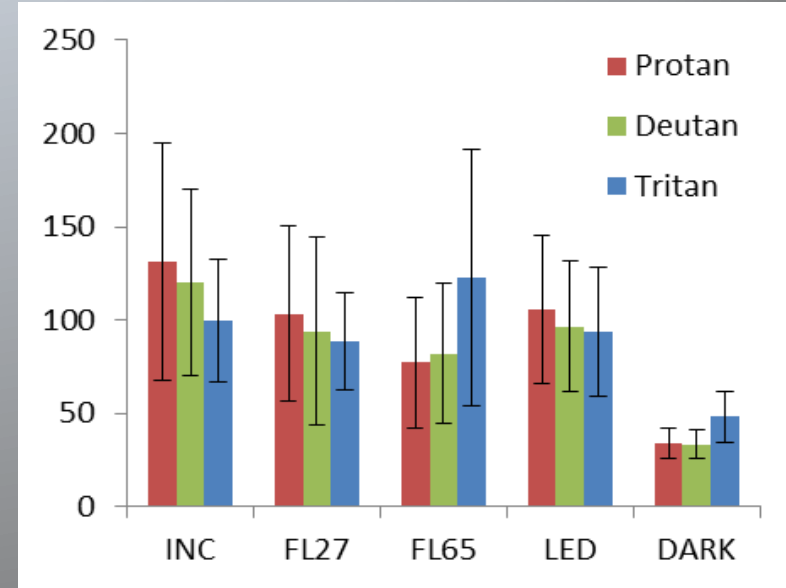
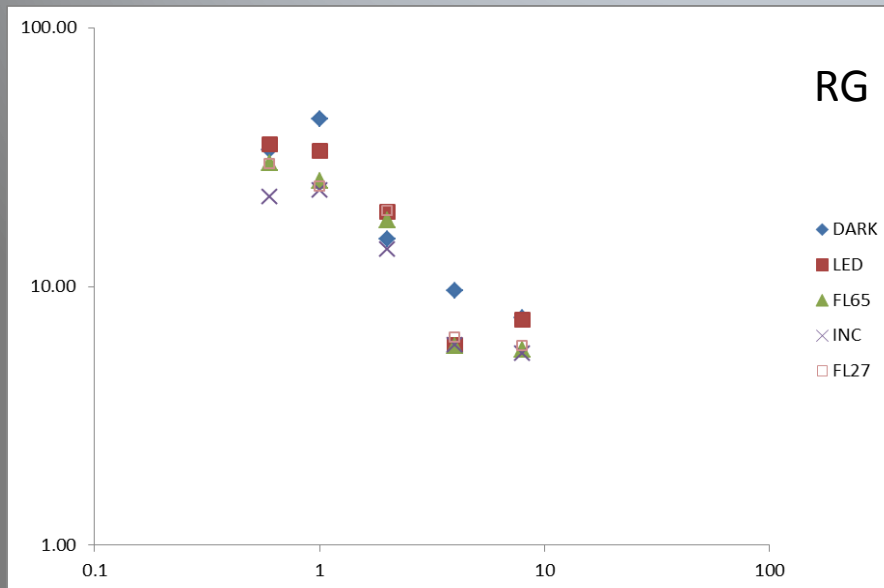
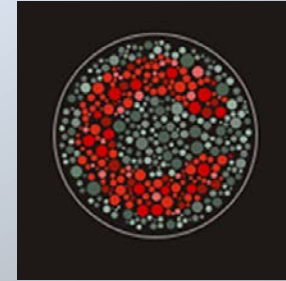
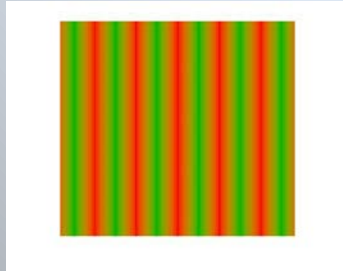
Computer displays - CSF



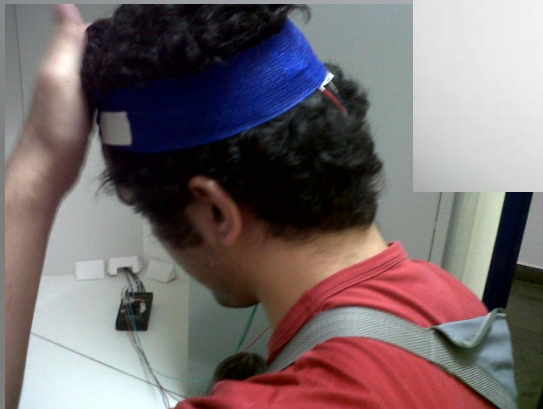
Computer displays – Chromatic discrimination



Ambient illumination effects



Visual Electrophysiology



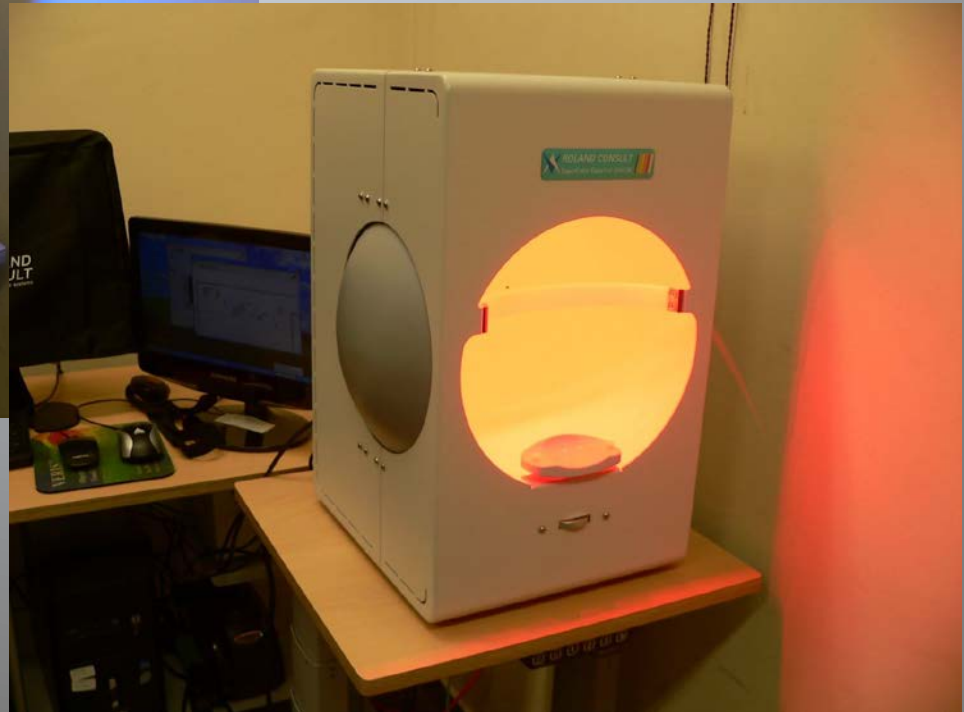
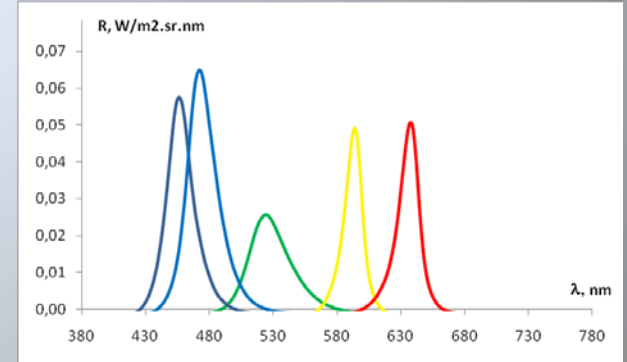
International Society for Clinical Electrophysiology of Vision

Current ISCEV Standards

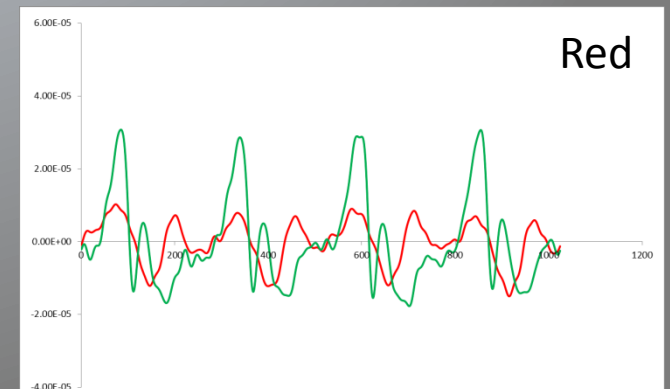
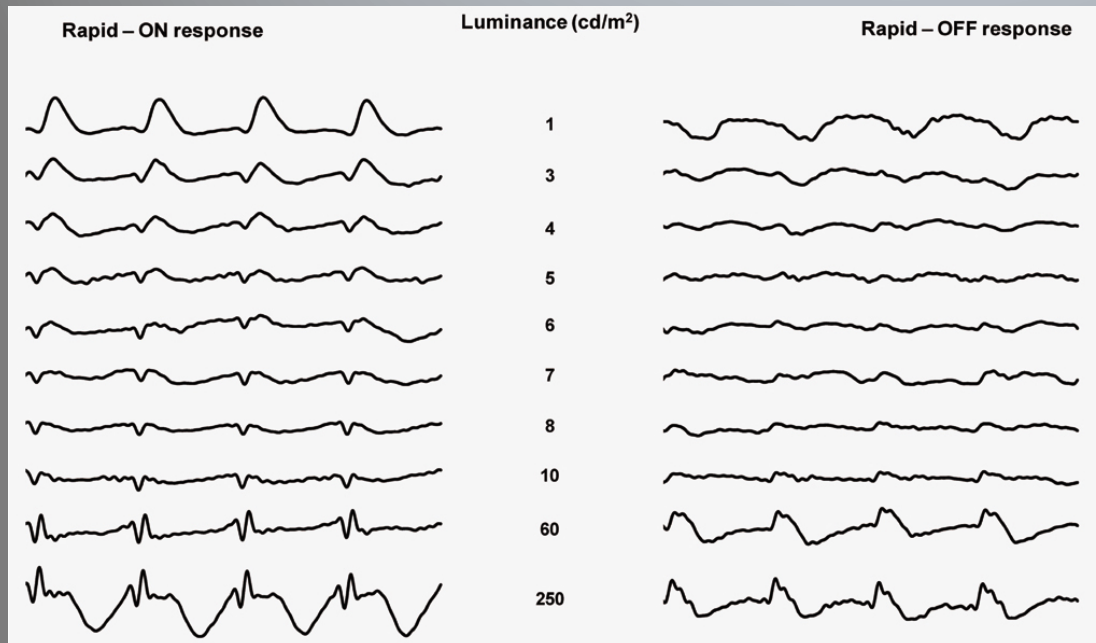
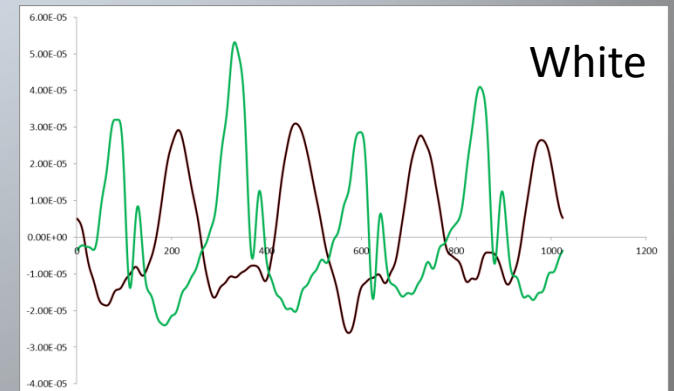
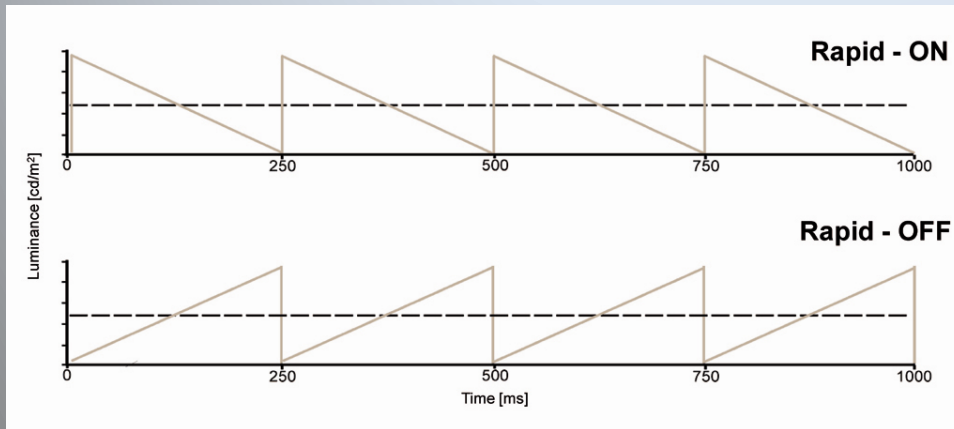
- mfERG (= multifocal ERG)
- ERG
- EOG
- PERG (= Pattern ERG)
- VEP
- Calibration and Recording
- Extended Protocols



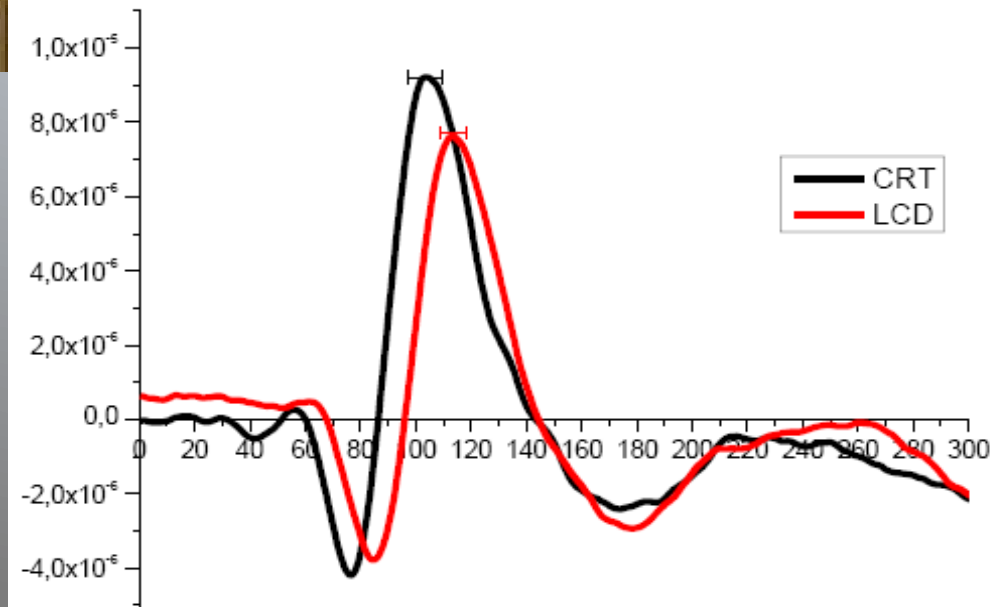
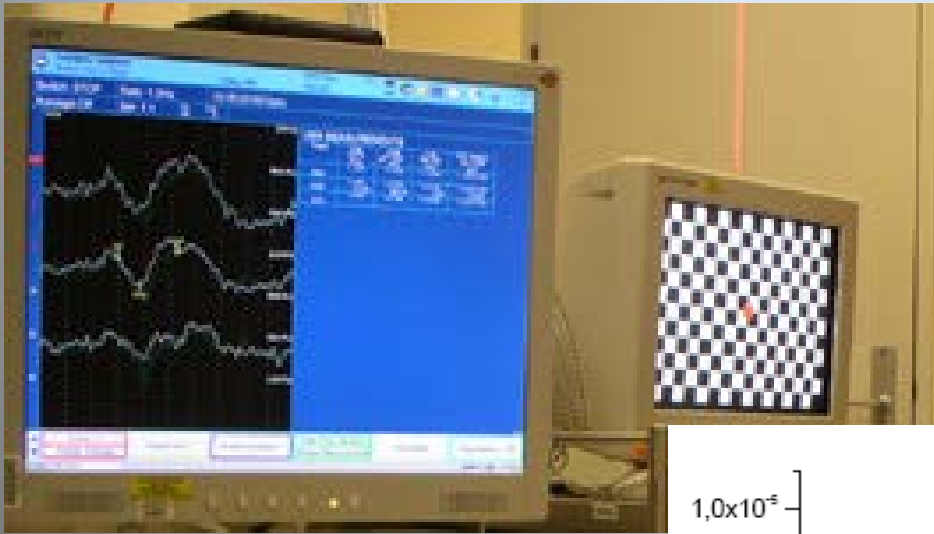
Ganzfeld



Visual Electrophysiology



Visual Electrophysiology



Calibration

- General metric: CIE xyY (Luminance in cd/m^2)
- Contrast – relative
- Uniformity (L)
- Angular (L)
- Temporal (L)
- Some specific stimulators:
 - CIE $u'v'$
 - Spectral
 - Gamma curves
 - Gamut area (mapped stimuli)
- More appropriate metric?
 - L, M, S or L-M, S-(L+M), L+M
 - Trolands

CIE

International Commission on Illumination



COMMISSION INTERNATIONALE DE L'ECLAIRAGE
INTERNATIONAL COMMISSION ON ILLUMINATION
INTERNATIONALE BELEUCHTUNGSKOMMISSION

Introduction

- Member countries (NCs)
- 7 Divisions
- Reporterships
- Technical Committees
- Joint TCs
- Liaisons
- Standards, Reports
- Meetings

Complex systems example

Remote diagnostics

- Illumination characteristics and conditions (CRI, geometry, SPD)
- Spectral sensitivity of camera (deviation from CIE CMFs)
- Camera calibration (optical, radiometric, FLAT, MTF)
- Display calibration (angle, uniformity, chromatic)
- Ambient conditions where the display is located (illumination level, SPD, glare)
- Observer's vision (VA, CSF, color)

Division 1: Vision and Colour

- CIE S 014-6/E:2013 Colorimetry - Part 6: CIEDE2000 Colour-Difference Formula
- CIE 200:2011 CIE Supplementary System of Photometry
- **CIE S 017/E:2011 ILV: International Lighting Vocabulary**
- ISO 11664-3:2012(E)/CIE S 014-3/E:2011 Colorimetry - Part 3: CIE Tristimulus Values
- **CIE 195:2011 Specification of Colour Appearance for Reflective Media and Self-Luminous Display Comparisons**
- ISO 11664-5:2009(E)/CIE S 014-5/E:2009 Colorimetry - Part 5: CIE 1976 $L^*u^*v^*$ Colour Space and u',v' Uniform Chromaticity Scale Diagram
- CIE 185-2009 Reappraisal of Colour Matching and Grassmann's Laws
- ISO 11664-1:2008(E)/CIE S 014-1/E:2006 Colorimetry - Part 1: CIE Standard Colorimetric Observers
- CIE 170-1:2006 Fundamental Chromaticity Diagram with Physiological Axes - Part 1
- CIE 167:2005 Recommended Practice for Tabulating Spectral Data for Use in Colour Computations
- CIE 166:2005 Cognitive Colour
- CIE 165:2005 CIE 10 Degree Photopic Photometric Observer
- CIE 015:2004 Colorimetry, 3rd Edition
- CIE 160:2004 A Review of Chromatic Adaptation Transforms
- CIE 116-1995 Industrial Colour-Difference Evaluation
- CIE 101-1993 Parametric Effects in Colour-Difference Evaluation
- CIE 095-1992 Contrast and Visibility
- **CIE 087-1990 Colorimetry of Self-Luminous Displays, A Bibliography**
- CIE 086-1990 CIE 1988 2° Spectral Luminous Efficiency Function for Photopic Vision
- CIE 075-1988 Spectral Luminous Efficiency Functions Based upon Brightness Matching for Monochromatic Point Sources 2° and 10° Fields

Division 2: Physical Measurement of Light and Radiation

- DS 023/E:2012 Characterization of the Performance of Illuminance Meters and Luminance Meters
- CIE 198:2011 Determination of Measurement Uncertainties in Photometry
- CIE 179:2007 Methods for characterising tristimulus colorimeters for measuring the colour of light
- ISO 23539:2005(E) / CIE S010/E:2004 Photometry - The CIE System of Physical Photometry
- CIE 130-1998 Practical Methods for the Measurement of Reflectance and Transmittance
- CIE 105-1993 Spectroradiometric Measurement of Pulsed Optical Radiation
- **CIE 122-1996 The Relationship Between Digital and Colorimetric Data for Computer-Controlled CRT Displays**

Division 6: Photobiology and Photochemistry

- IEC 62471/CIE S009/E&F:2002 Photobiological Safety of Lamps and Lamp Systems
- CIE 139-2001 The Influence of Daylight and Artificial Light on Diurnal and Seasonal Variations in Humans - a Bibliography
- CIE x016-1998 Measurements of Optical Radiation Hazards
- CIE 186:2010 UV-A Protection and Sunscreens
- CIE 181:2007 Hand Protection by Disposable Gloves against Occupational UV Exposure

Division 8: Image Technology

- CIE 199:2011 Methods for Evaluating Colour Differences in Images
- CIE 162:2010 (including Erratum 1) Chromatic Adaptation under Mixed Illumination Condition when Comparing Softcopy and Hardcopy Images
- CIE 159:2004 A Colour Appearance Model for Colour Management Systems: CIECAM02
- CIE 168-2005 Criteria for the Evaluation of Extended-Gamut Colour Encodings
- CIE 163:2004 The Effects of Fluorescence in the Characterization of Imaging Media
- CIE 156:2004 Guidelines for the Evaluation of Gamut Mapping Algorithms
- CIE x010-1996 Proceedings of the CIE Symposium '96 on "Colour Standards for Image Technology"
- CIE x021:2001 Proceedings of the CIE Expert Symposium 2000 "Extended Range Colour Spaces"

Current CIE TCs on medical related areas

- [Ambient illumination in hospital/clinic]

TC 1-90 , TC 1-91: Color Rendering Index (CRI) to assess color quality of light

TC 8-10, Office lighting for Imaging

- [Endoscopy]

TC 8-07 Multispectral Imaging

- [Human color vision]

TC 1-89 Enhancement of Images for Colour Defective Observers

- [Microscope slide scanning – histopathology]

TC 8-07: Multispectral Imaging

- [Pseudo coloring]

TC 1-61: Categorical Colour Identification

TC 1-36: Fundamental Chromaticity Diagram with Physiologically Significant Axes

- [Image transmission, archives]

TC 8-12: Image and Video Compression Assessment

TC 8-09: Archival Colour Imaging

CIE – ICC liaisons

- Marc Mahy (BE)
- Fumio Nakaya (JP)

CIE relations and possible input to ICC medical initiative

- Allocate existing standards and reports to ICC medical
- ICC to define specific needs for international debate from the CIE side which is particular for medical areas (or general but not existing)
- Possible formation of CIE R/TC/JTCs in case of well defined projects to involve international experts

Special thanks to
Dora Fix Ventura & Mirella Barboni - USP
Ronnier Luo & Po-Chieh Hung - CIE

**THANK YOU FOR YOUR KIND
ATTENTION!**