Medical Imaging Working Group

FOGRA
Einsteinring 1a
85609 Ascheim
Munich, Germany
26 February 2018

Craig Revie, MIWG chair, opened the meeting at 08:45 and introduced the agenda as follows:

1. Introductions
2. Electro-Optical Requirements for Medical Display
3. Medical imaging projects at NTNU
4. Medical display calibration using remote clients
5. Identification of possible future projects for MIWG
6. Action items review

1. Introductions

Mr Revie performed a sound check and participants introduced themselves. He reminded the participants of the ICC MIWG web site http://www.color.org/groups/medical/medical_imaging_wg.xalter, which contains pages for all the activity areas as well as minutes, presentations and recordings of the meetings.

2. Electro-Optical Requirements for Medical Display

Wonseon Song of LG Display was unable to attend the meeting so this item was deferred to the next meeting.

3. Medical imaging projects at NTNU

Phil Green presented a summary of work undertaken by students taking his Colour in Medical Imaging course at NTNU [see attached]. This is a 7.5 ECTS course which is part of the Applied Colour Science semester at NTNU, in the Colour in Science and Industry programme offered jointly with other European universities. The projects were mostly novel imaging applications directed at non-contact monitoring of vital signs, with joint supervision by Professor Ruud Verdaasdonk of the Amsterdam Free University Hospital. A number of projects will be submitted to relevant conferences or journals for publication. Dr Green stated that collaborations from medical specialists and vendors for the next course session in the August-December 2018 semester were welcome.

4. Medical display calibration using remote clients

Tom Lianza of Portrait Displays introduced the CalMed software for medical display calibration [see attached]. This has a client-server architecture with a relatively low seat cost. The software manages direct digital control of the display hardware, and meets medical standards for calibration frequency. The main applications were DICOM and medical video. The software checks conformance and generates a report.

Mr Lianza undertook to provide links to industry recommendations on medical display calibration for the minutes.

5. Identification of possible future projects for MIWG

There was no further update on the projects discussed at the previous meeting [see attached]. Craig Revie undertook to contact MIWG members and ICC honorary members to invite suggestions.

6. Action item review

The meeting discussed open action items [see attached] as follows:

MIWG-15-30: Dr Kimpe had provided the calibration targets and they were available on the MIWG web site.
MIWG-16-01 and 16-20: Dr Pescatore had changed roles at BioMerieux and was unable to work on these actions, and hence it was decided to close them.

MIWG-16-12: The ICS for GSDF was on hold pending finalising the ICS template.

There being no other business, the meeting closed at 10:30.

Action items

The following action item was agreed at the meeting:

MIWG 2018-01 Provide links to industry recommendations on medical display calibration (Lianza).

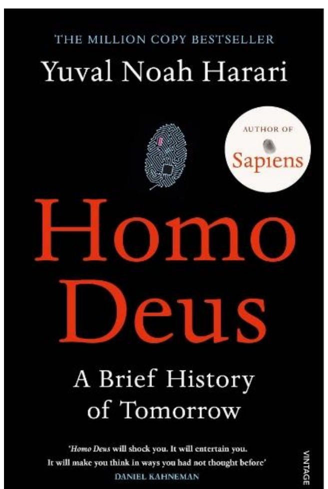
ICC Medical Imaging Working Group

Fogra

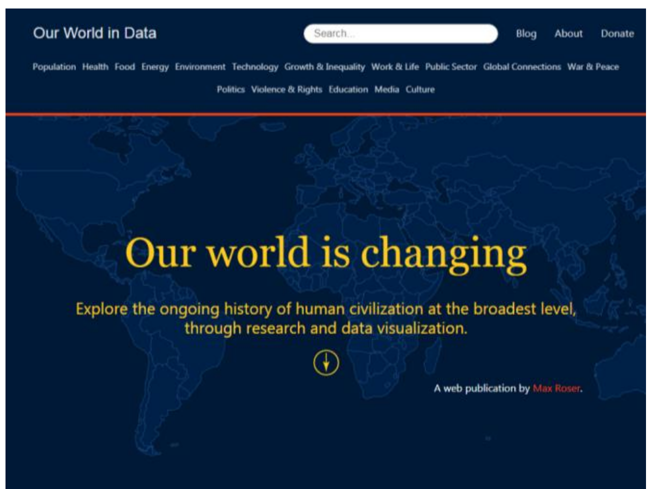
26th February 2018 (08:30-11:00)

This is the first century in history where Homo sapiens are more likely to die from…

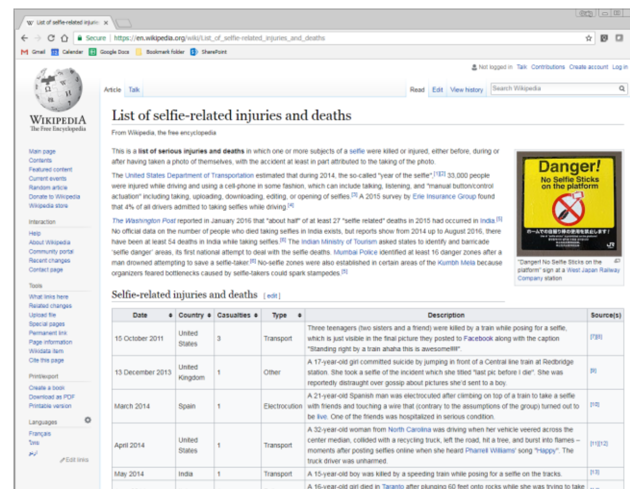
- **eating too much than from eating too little**
- **old age than from a communicable disease**
- **suicide than from war**
- **taking selfies than being killed by sharks**



www.ynharari.com/book/homo-deus/

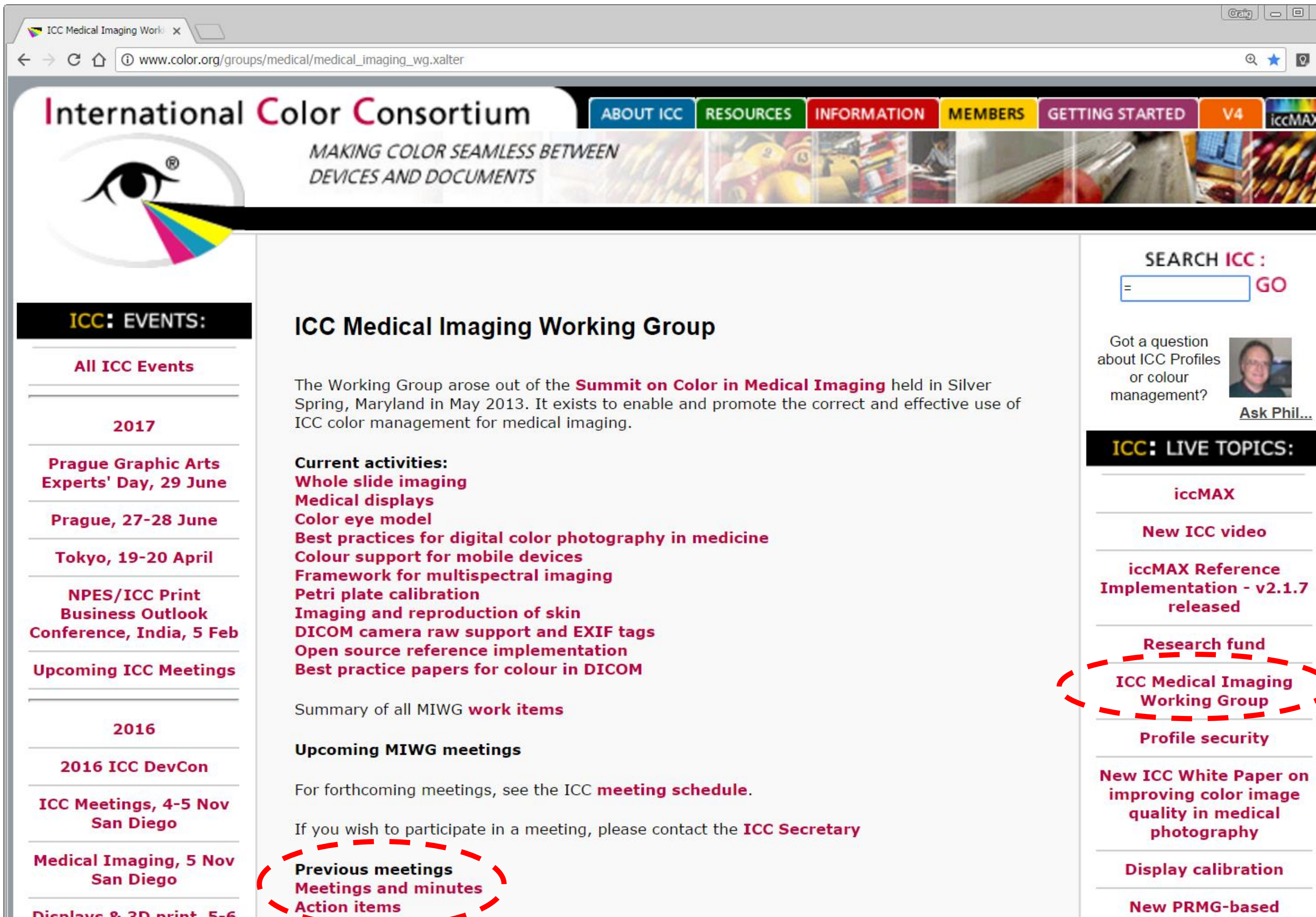


https://ourworldindata.org/



https://en.wikipedia.org/wiki/List_of_selfie-related_injuries_and_deaths

ICC MIWG web page at www.color.org



ICC MIWG Working group meeting

February 2018

- Introductions
- Electro-Optical Requirements for Medical Display — Wonseon Song
- Medical imaging projects at NTNU — Phil Green
- Medical display calibration using remote clients — Tom Lianza, Portrait Displays
- Identification of possible future projects for MIWG — Craig Revie
- Action items review — Craig Revie

Possible future projects for MIWG

- Guidelines for digital pathology viewing environment (check telemedicine guidelines)
- Recommendation for colour vision testing and development of tools to aid practitioners with colour deficiency
  - Daltonisation to improve diagnostic ability
- Algorithms for analysis of medical images (we need to determine what the ICC could do to help this)
- LG medical display/application assessment
- Others? Call to MIWG + Honorary Members [CR]

International Color Consortium

Action items review

MIWG-15-30	Displays	Make assessment targets available to group	13-10-2015	Kimpe	Done
MIWG-16-01	Petri plate	Send Petri plate imaging guidelines for review by MIWG	16-02-2016	Pescatore	Close
MIWG-16-12	Displays	Discuss ICS for GSDF and report back to MIWG	04-05-2016	Bai, Derhak, Nagashima-san, Kimpe	Open
MIWG-16-20	Petri plate calibration	Distribute draft primer on Petri plate system calibration by December 2016	05-11-2016	Pescatore	Close
MIWG-17-03	General	Develop activity proposals on Viewing Environment in Pathology Imaging; Automation of Detecting Anomalous Features; and Electro-Optical Requirements for Medical Displays	20-05-2017	Revie; Lianza; Wonseon	Open

The Norwegian
Colour and Visual Computing
Laboratory

NTNU

Colour in Medical Imaging

Coursework projects Fall 2017

The Norwegian Colour and Visual Computing Laboratory
Faculty of Computer Science and Media Technology
Norwegian University of Science and Technology
Gjøvik, Norway
http://www.colourlab.no

Colour Science and Industry

- 2-year Master degree
- EU Erasmus+ joint Master degree offered by 4 European universities + 15 industrial partners
- Consortium partners include Barbieri, FFEI, HP, Technicolor
- https://master-colorscience.eu/cosi-master-degree/
- Applied Colour Science semester in Norway

Colour in Medical Imaging

- 7.5 ECTS course
- Students undertake a coursework project on a medical imaging topic
- Co-supervision by Prof. Ruud Verdaasdonk, Amsterdam Free University Hospital
- Lab supervision at NTNU by Dr. Peter Nussbaum
- Support for oxyhemoglobin concentration project by Jacob Bauer

Colour in Medical Imaging

- Most projects involve an experimental set-up based on a novel imaging application and low-cost imaging devices
- Steps include building a suitable phantom, setting up imaging system and recoding and analyzing results
- Imaging devices were a mix of those at the Colorlab and lent for the project by Prof. Verdaasdonk
- Most projects used hyperspectral or multi-spectral imaging modes

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The effectiveness of sunscreen protection for UV light using an UV imaging setup

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Motivation

- UV radiation can result in acute and chronic harmful effects on the eye's dioptric system and retina.
- Overexposure to UVB radiation not only can cause sunburn but also some forms of skin cancer.
- 132000 melanoma skin cancers occur globally each year
- Most people only apply 25-50 percent of the recommended amount of sunscreen.

UV imaging system setup

- **Setup-I:** PIXELTEQ’s SpectroCam Multispectral Camera with 8 rotating wheel filters from UV to IR range.

Figure-1. Setup-I utilizing PIXELTEQ’s SpectroCam Multispectral Camera

UV imaging system setup

- **Setup-II:** full spectral converted camera – Sony NEXT 5T, with VIS cut-off filter and high UV transmitting filter.

Figure-2. Camera system for the Setup-II. (A) converter ring, (B) extension ring, (C) lens (D) filters and UV imaging Setup-II

Transmission measurement setup

- UV–Vis Ocean Optics USB2000+XR1 spectrometer with UV irradiating black-light

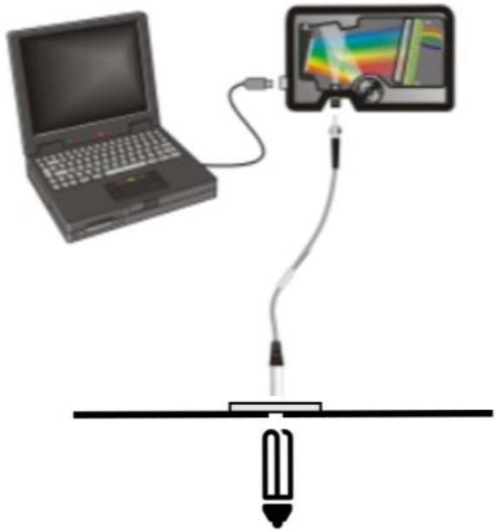


Figure-3. Setup employed to measure the UV transmission through sunscreen applied to a substrate sample holder. Positioned in the bottom UV light from a 365 nm black-light light source enters the setup through a fibre on the top.

Difference in SPF using UV imaging

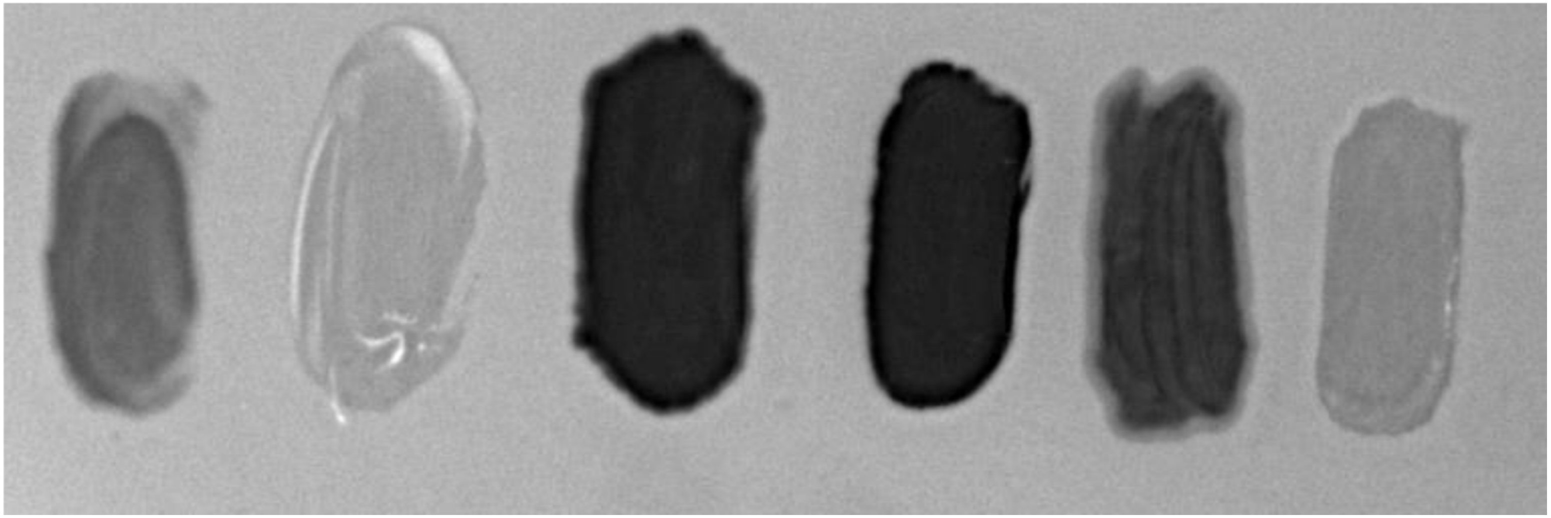


Figure-7. Image of Sunscreens applied on rough plastic film surface from Pixelteq camera.

Setup II images from Sony

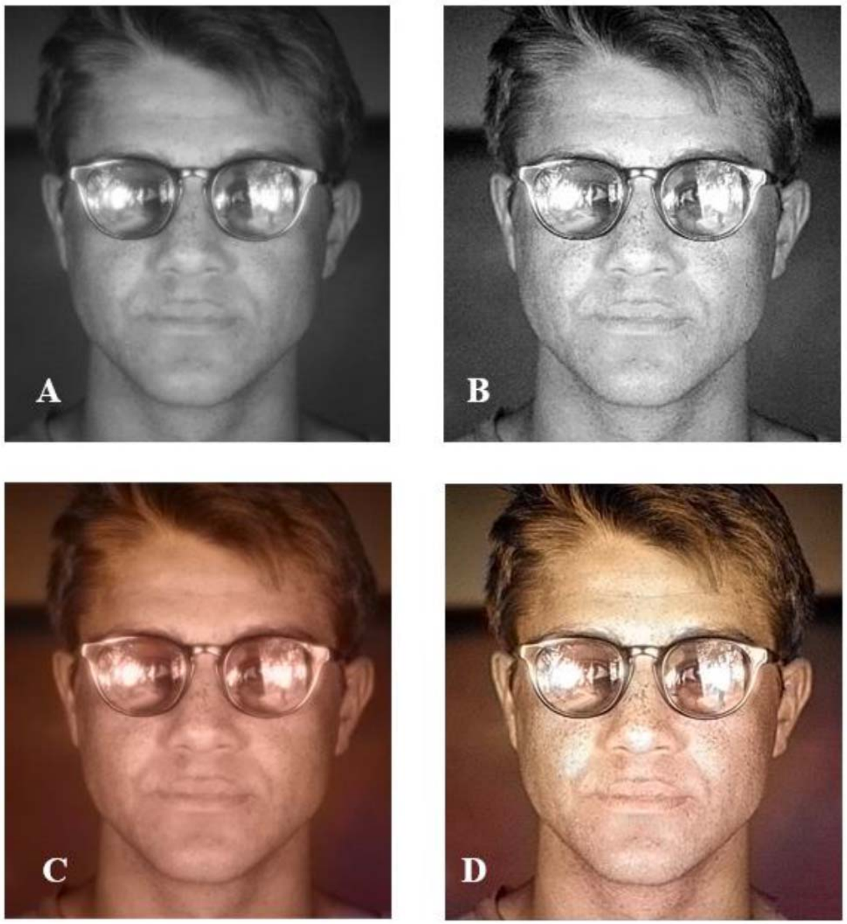


Figure-10. (A) Original image, (B) enhanced image, (C) CNN based Colorized original image, (D) CNN based Colorized enhanced image (with glassess)

Setup I images before and after Sunscreen applied

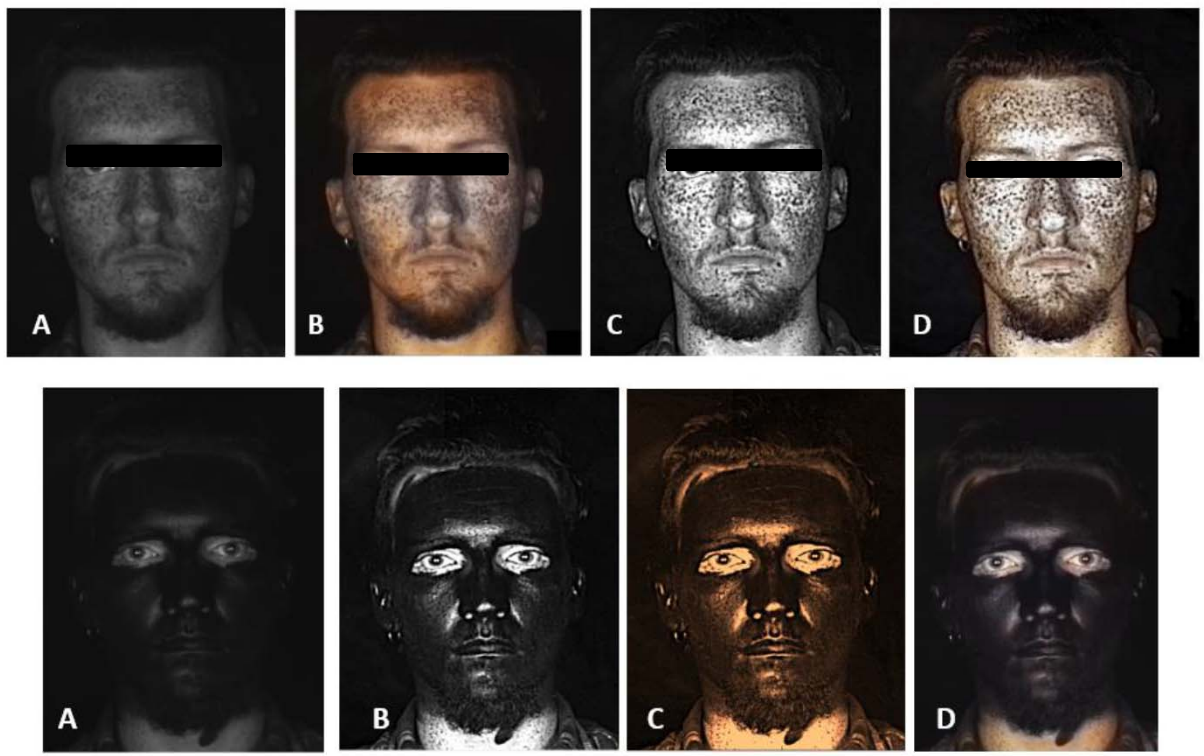
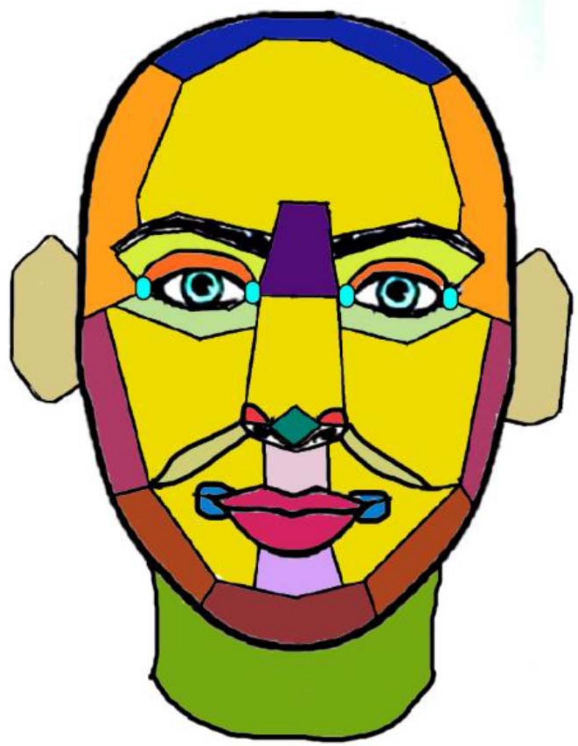


Figure-11. (A) Original image, (B) CNN based Colorized original image, (C) enhanced image, (D) CNN based Colorized enhanced image

Face regions that are missed during sunscreen application



Chin		95.8%
Maxilla		93.75%
Nose tip		89.6%
Nasolabial folds		91.7%
Mandibular		91.7%
Nose wings		87.5%
Temple		75%
Under eyebrows		75%
Under lips		68.8%
Lips corners		72.9%
Above the lips		70.8%
Between eyebrows		70.8%
Top of forehead		64.6%
Lips		60.4%
Eye corners		41.7%
Eyelids		43.8%
Under eyes		39.6%
Ears		14.6%
Neck		8%
Other regions		100%

Figure-15. Facial map showing the areas and how many percent of subjects applied a sunscreen on them. Regions with yellow tagged as other regions were covered by all participants.

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Monitoring of Respiration Rate using the FLIR ONE thermal camera

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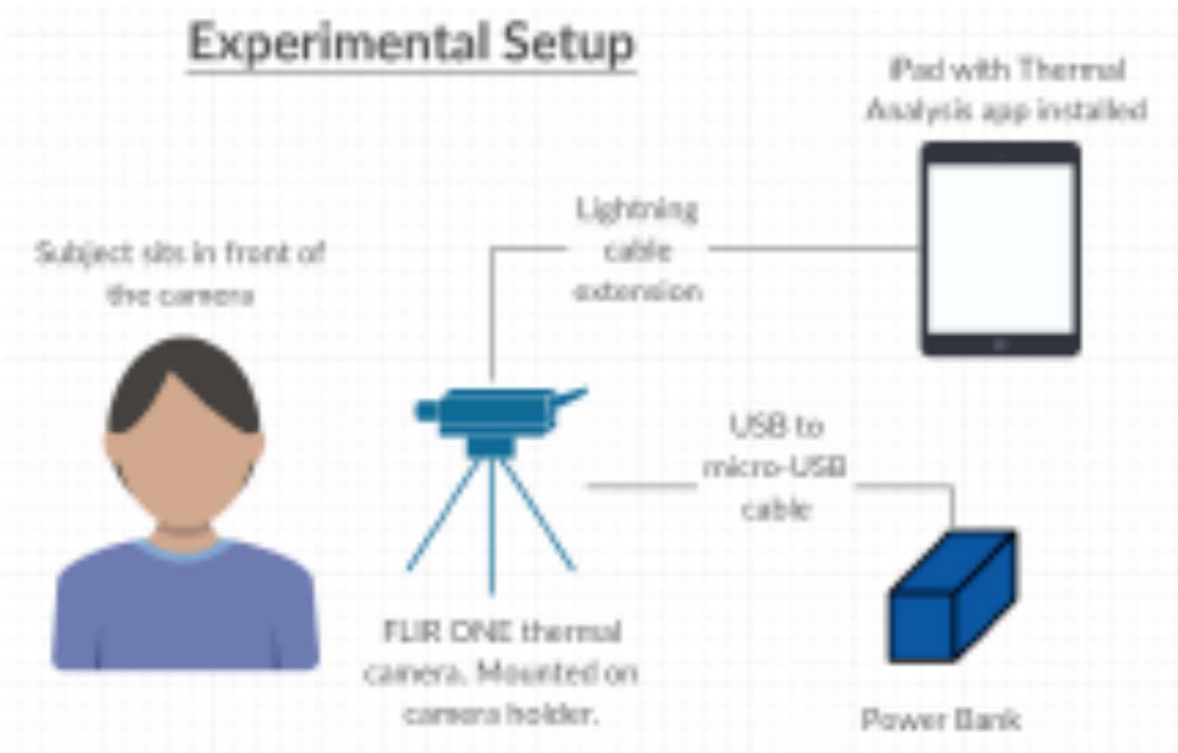
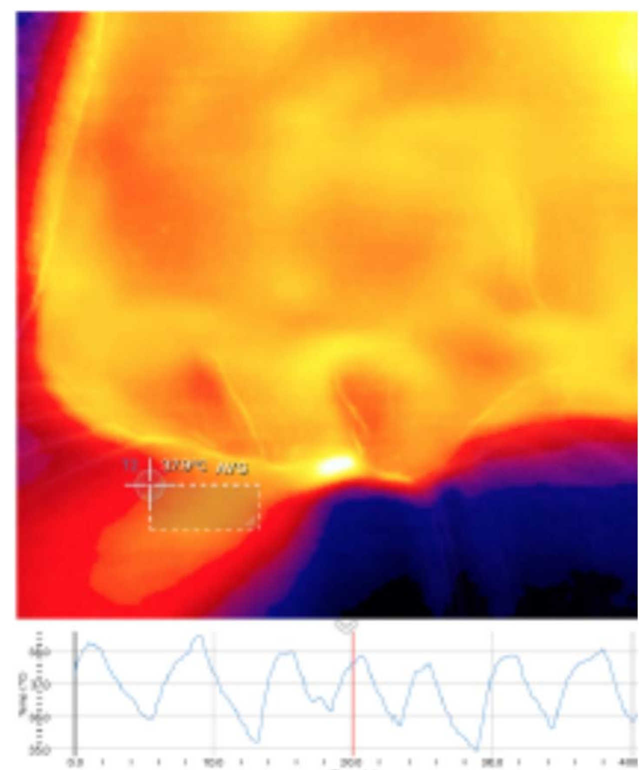
http://www.colourlab.no

Thermal imaging system setup





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Multispectral Imaging in Tracking Psoriasis

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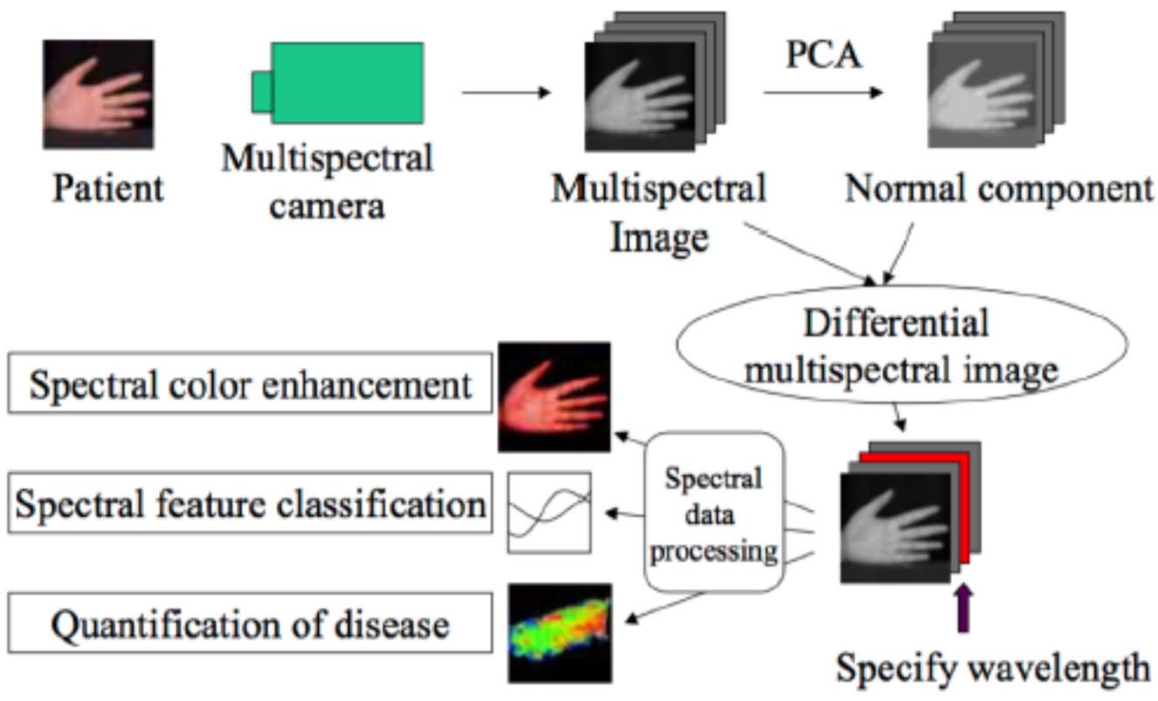
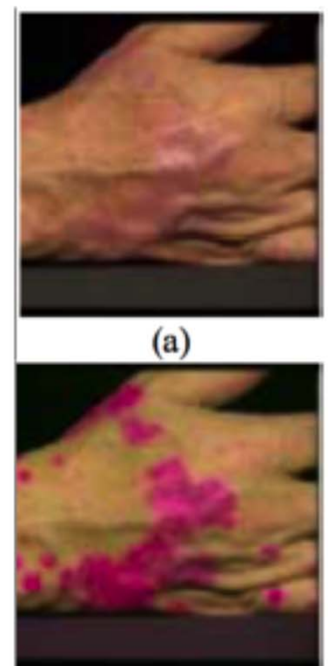
http://www.colourlab.no

Multispectral imaging of psoriasis

- Goal is to find an automatic way to quantitatively evaluate and track psoriasis from multispectral images





(a) (b)

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Real-time heart rate monitoring using a HD webcam

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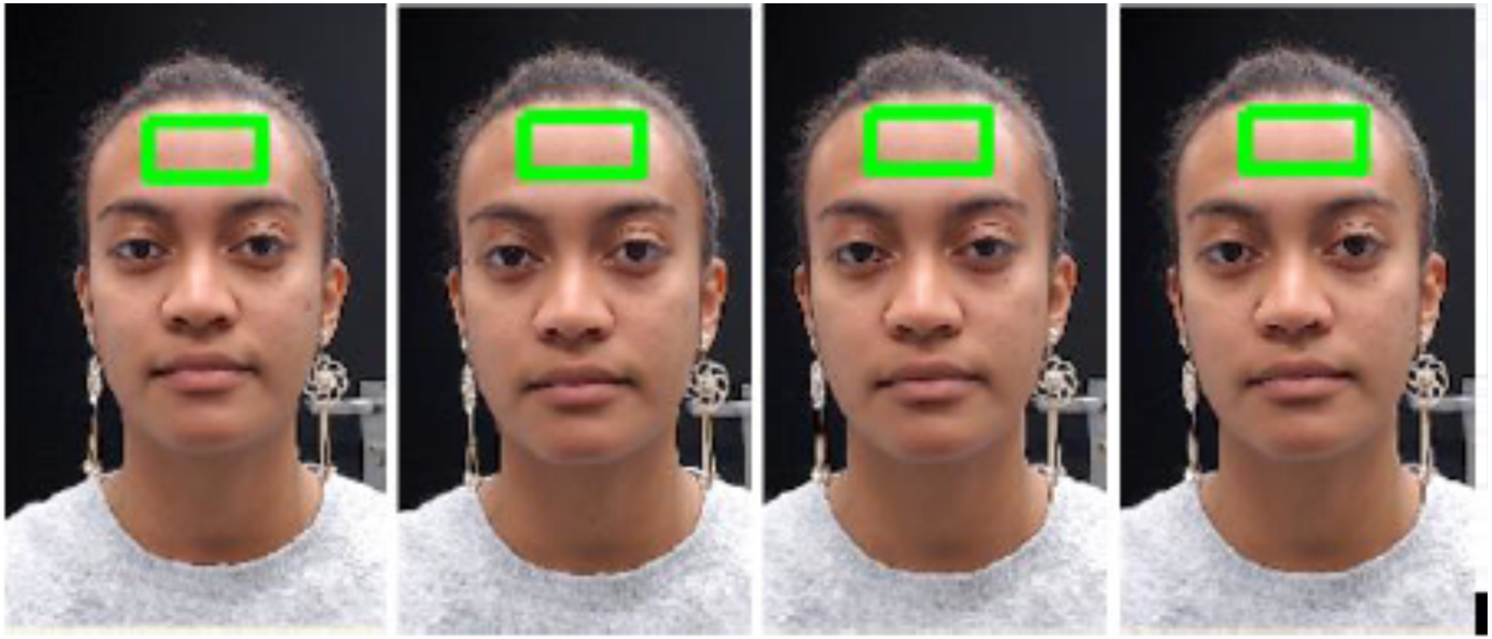
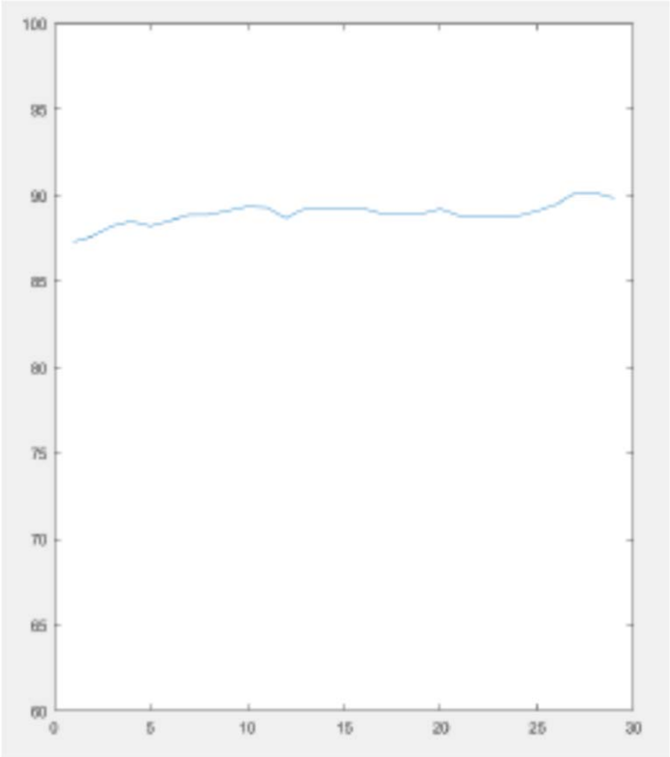
http://www.colourlab.no

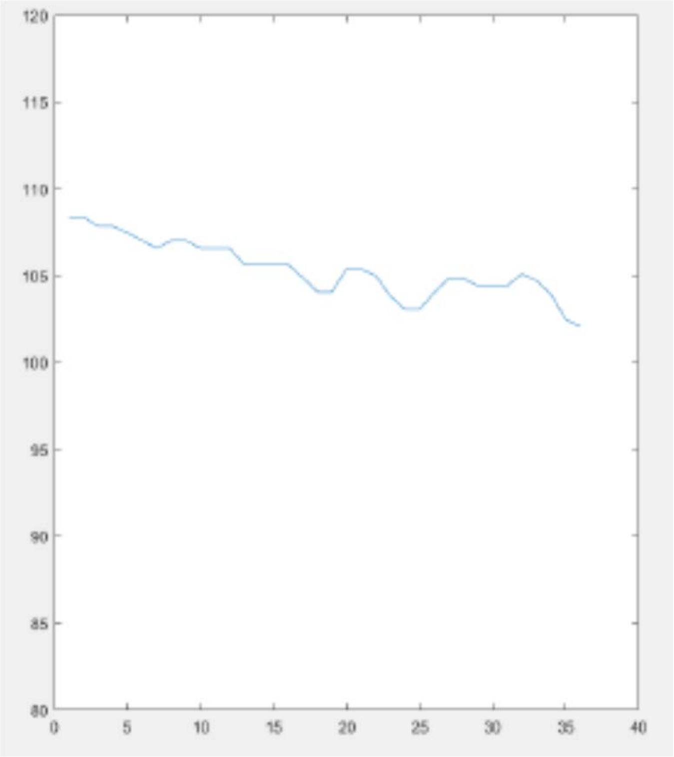
Webcam setup

- Goal is to use a non-contact method of monitoring heart rate
- Challenge is to establish stable consistent ROI on patient
- Developed algorithm for real-time processing of video stream



Results

- 



Measured heart rate for rest and elevated states

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Thermal detection of pigment lesions

NADILE NUNES DE LIMA
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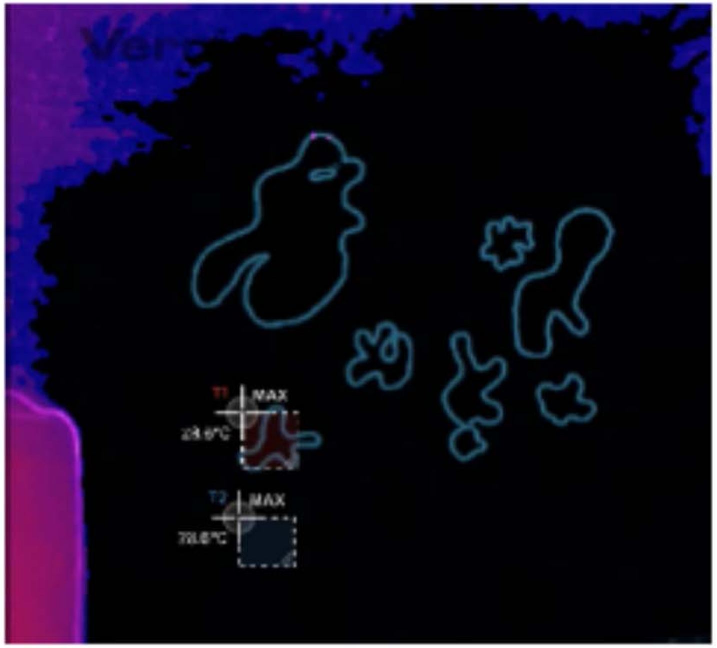
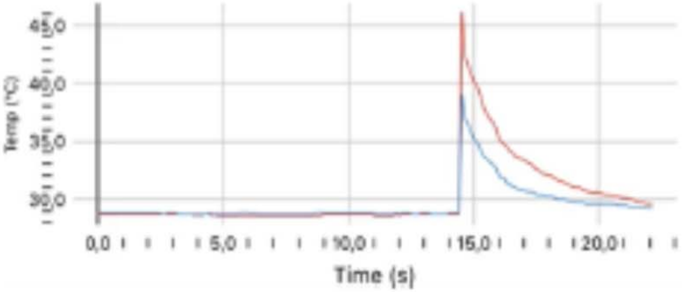
Faculty of Computer Science and Media Technology
Norwegian University of Science and Technology
Gjøvik, Norway
http://www.colourlab.no

- Used intense flash light for quantification of concentration, depth and layer thickness of melanin
- Lesions are believed to cool differently after heating by flash light



(c) Experiment 2



(d) Time x Temp for experiment 2

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Contrast enhancement of oxyhemoglobin concentration using multispectral imaging

Cristian da Costa Rocha

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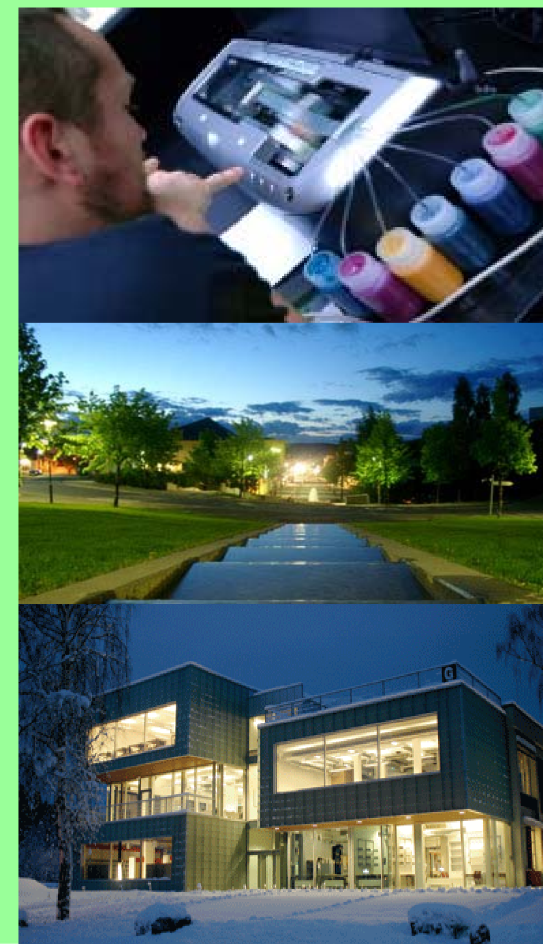
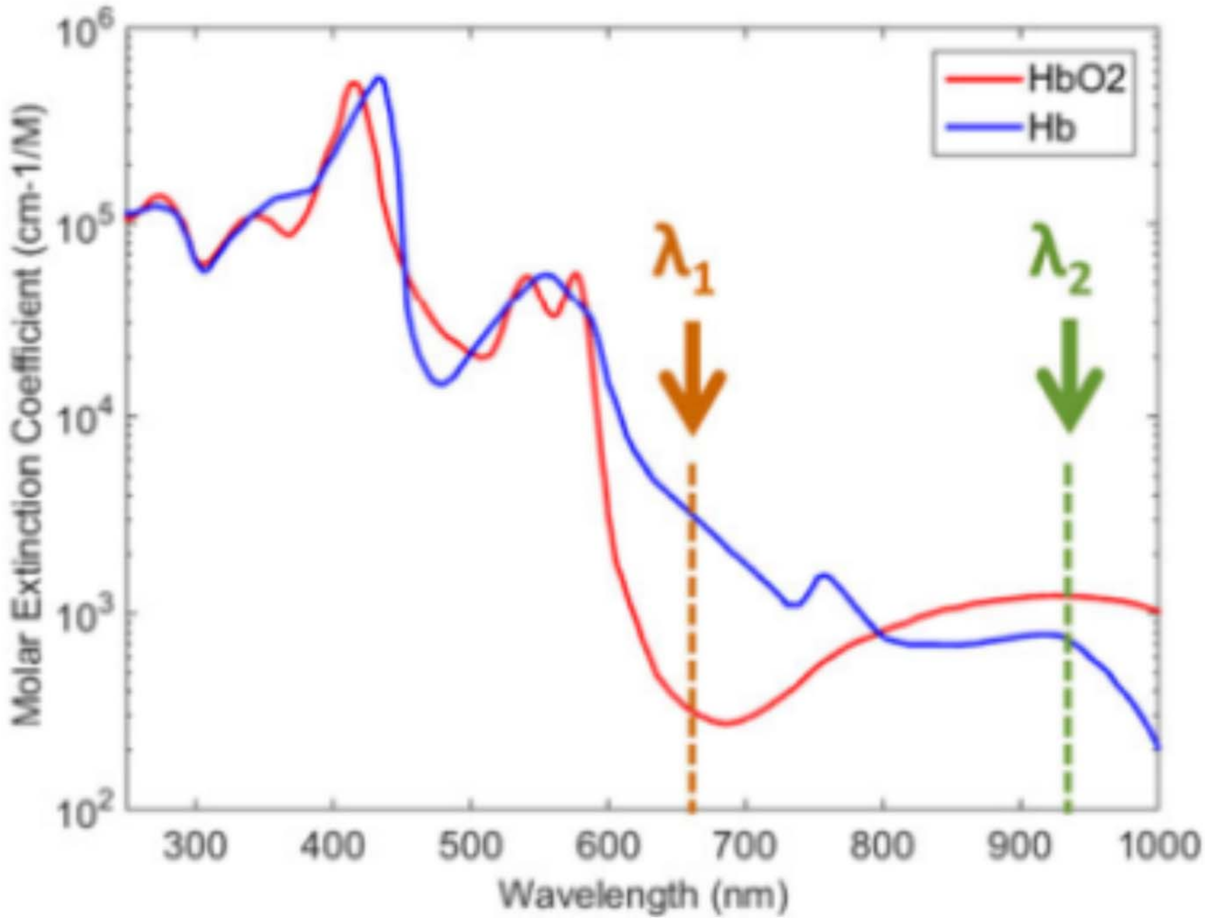
http://www.colourlab.no

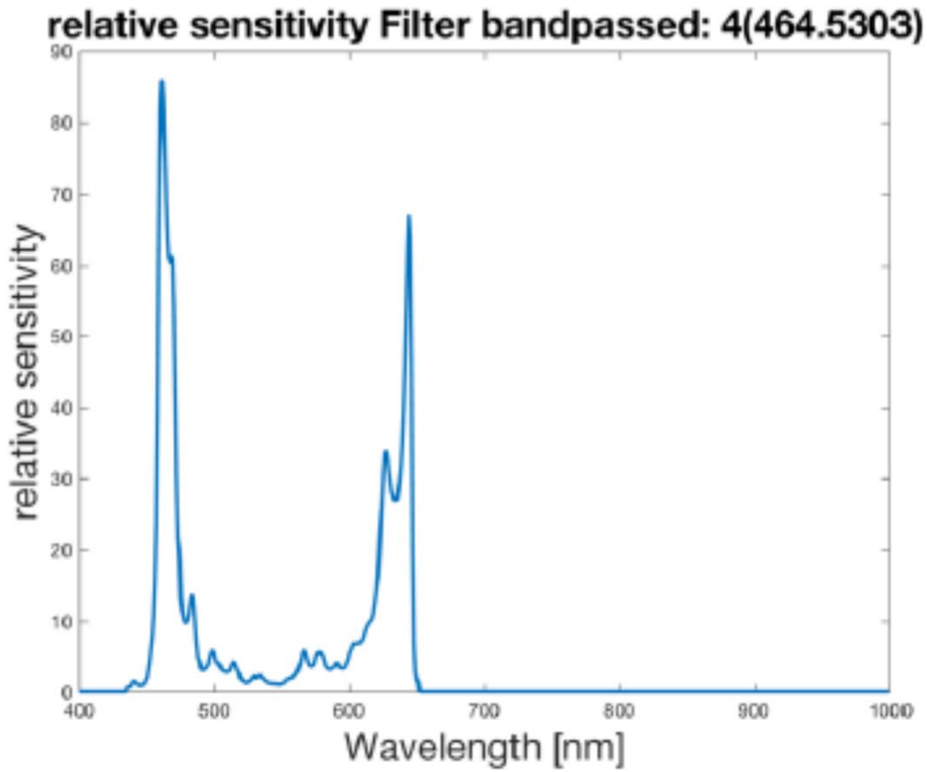


Goal is to enhance contrast between oxyhemoglobin and deoxyhemoglobin

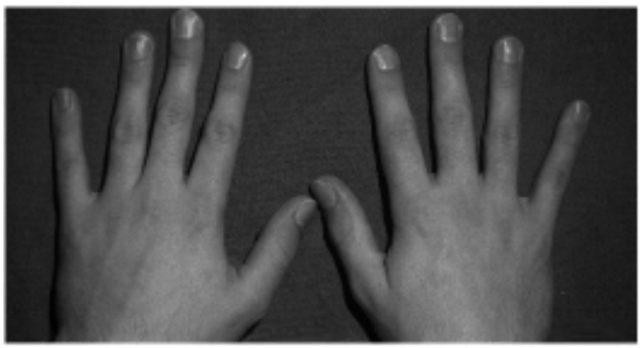


Ximea SFA multispectral camera with dual sensitivity peak

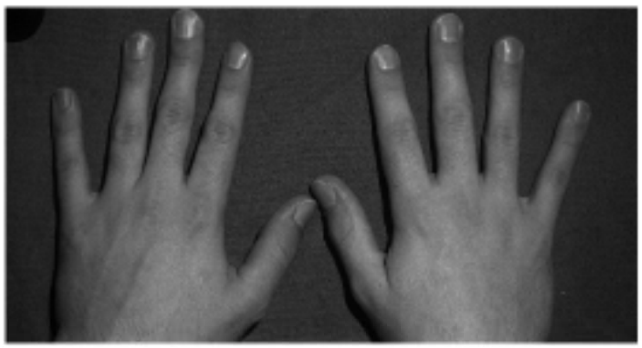
- Spectral correction required to give 601nm image
- Used PCA to difference between normoxic and hypoxic states



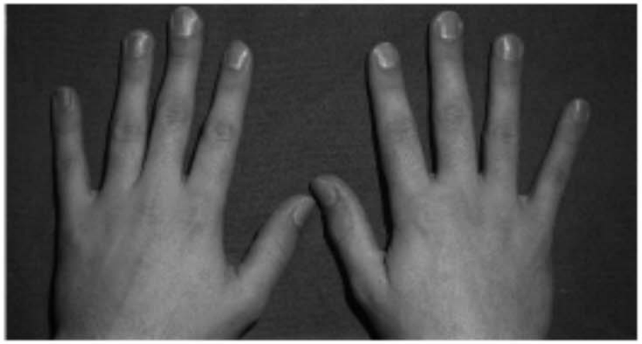
Images at 601nm



(a) Normoxic

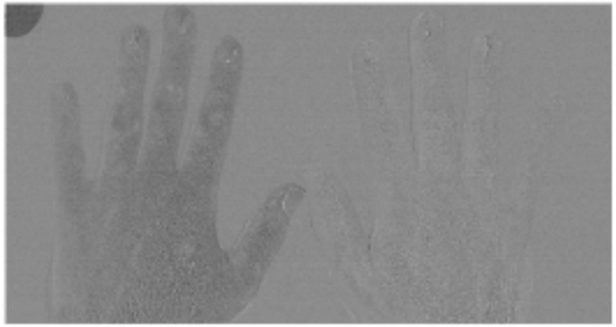


(b) Hypoxic

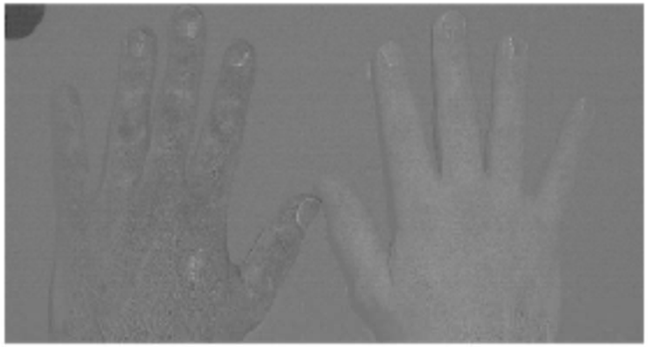


(c) Reperfusion

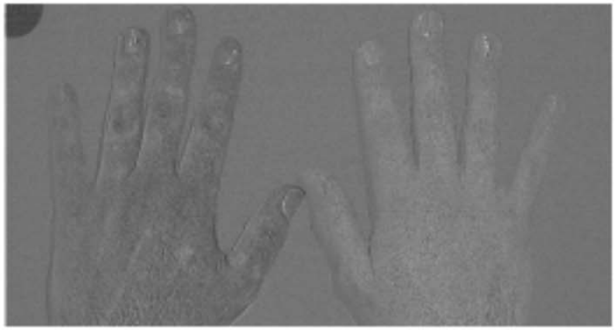
Hypoxic – normoxic state using different configurations



(a) PCA on the whole cube



(b) PCA on the last 3 bands



(c) Wavelength band 601nm

- Some projects to be submitted for publication at SPIE Medical Imaging, 2019 and Colour & Visual Computing Symposium, 2018
- Projects for 2018 cohort in development – collaborators welcome

Medical Display Calibration using Active Clients

A description of the SpectraCal CalMED application

Portrait Displays – SpectraCal

SpectraCal

- **Portrait Displays**
  - An application software provider and middleware developer for monitors, notebooks, all-in-one computers, tablets, and smartphones
  - For over 25 years, a proven and trusted software outsource supplier to the leading OEM manufacturers throughout the world
- **SpectraCal**
  - World's leading provider of video display calibration software for both professional and consumer needs
  - For 10 years, CalMAN software has been critically acclaimed for broadcast, video production, post production, commercial A/V, home theater, medical imaging, and geospatial intelligence

PORTRAIT DISPLAYS

The Components of a typical stand alone calibration system

- Calibrated Video Generator
- Calibrated Light Meter or Spectral Device
- The Target Display and Target Display Controller

Calibration Software

SpectraCal CalMED

Medical Workstation Calibration Software

SpectraCal

PORTRAIT DISPLAYS

What is a Client architecture and what are the advantages?

SpectraCal

- The client architecture treats the display and the connected computer as the video generator / target display combination.
- The client monitors the physical setup continuously and loads the proper look up tables and Virtual Control Panel Settings that were determined during initial calibration.
- The client monitor shut down events, screen saving events, and manual adjustments made outside of calibration.
- The client software saves considerable dollars and licensing issues. One application can be configured to work with many clients.
- Client cost per seat is under $50 dollars for 10 seats.

PORTRAIT DISPLAYS

What functions does CalMED provide?

SpectraCal

Two Imaging Workflows:

Radiology Imaging

Scanner-sourced, non-visible energy

X-ray, CT, nuclear, PET/SPECT, ultrasound, MRI, etc.

Medical Video

Camera-sourced, visible light

Endoscopy, surgical, ophthalmology, dermatology, microscopy, etc.

Basic Functionality:

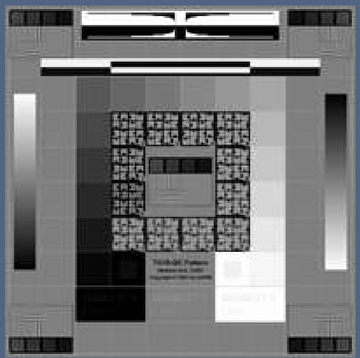
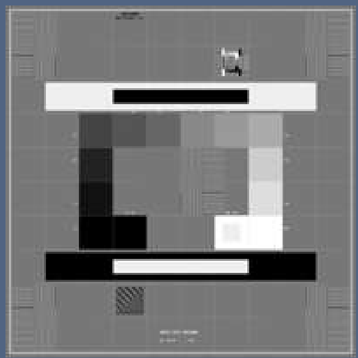
- Visual Assessment
- Certification
- Calibration
- Reporting

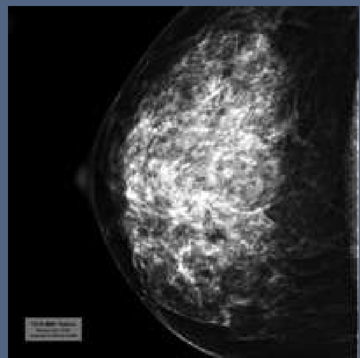
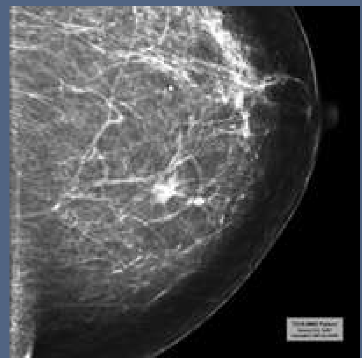
PORTRAIT DISPLAYS

Qualitative Visual Tests

Visual assessment of overall clinical image quality

(TG18-QC, SMPTE, AAPM Anatomical)

Certification

Runs from the Host Server

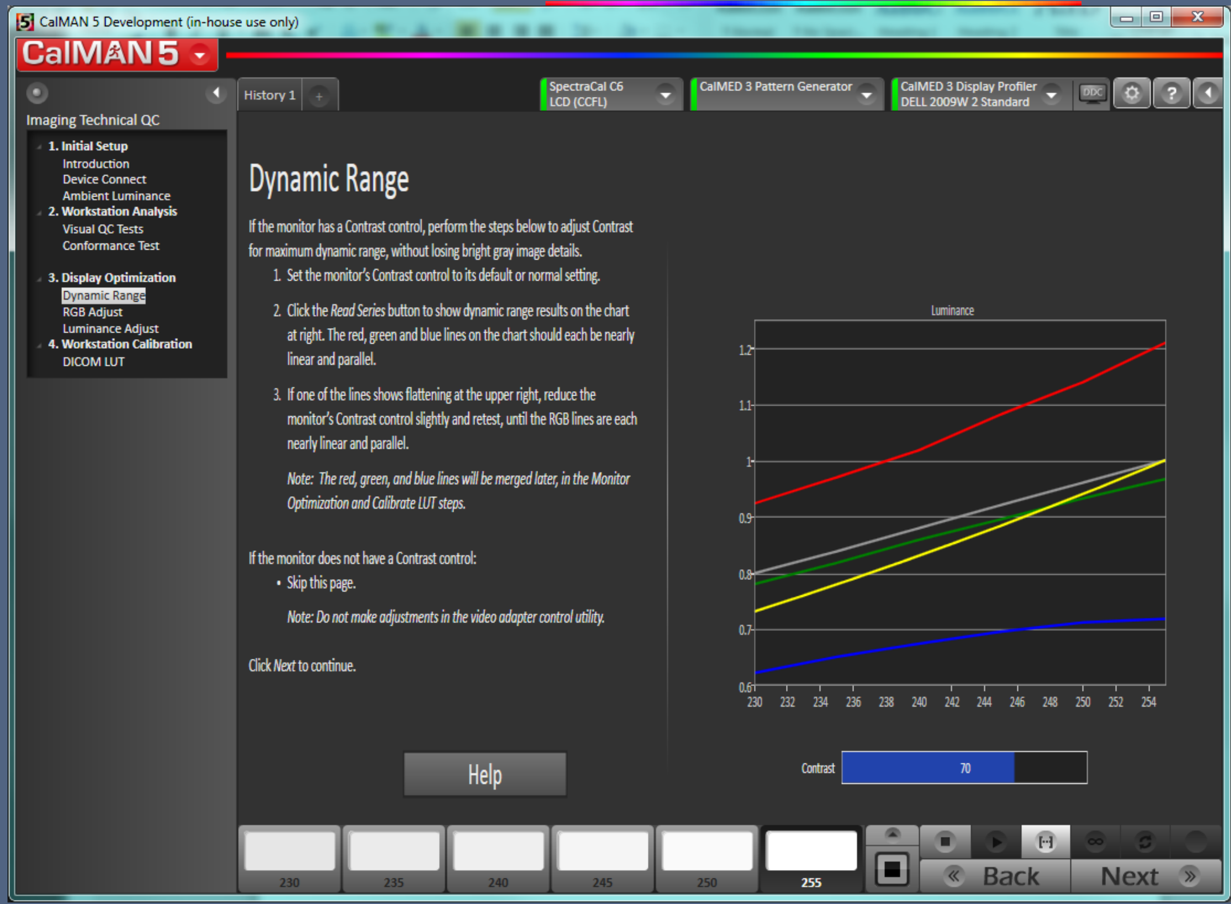
Radiology Imaging Calibration Workflow

Optimize Display Controls

Dynamic Range;
Contrast control

If the display manages DDC/VCP commands, this can be automated

Note that ambient luminance and display reflection can also be measured.



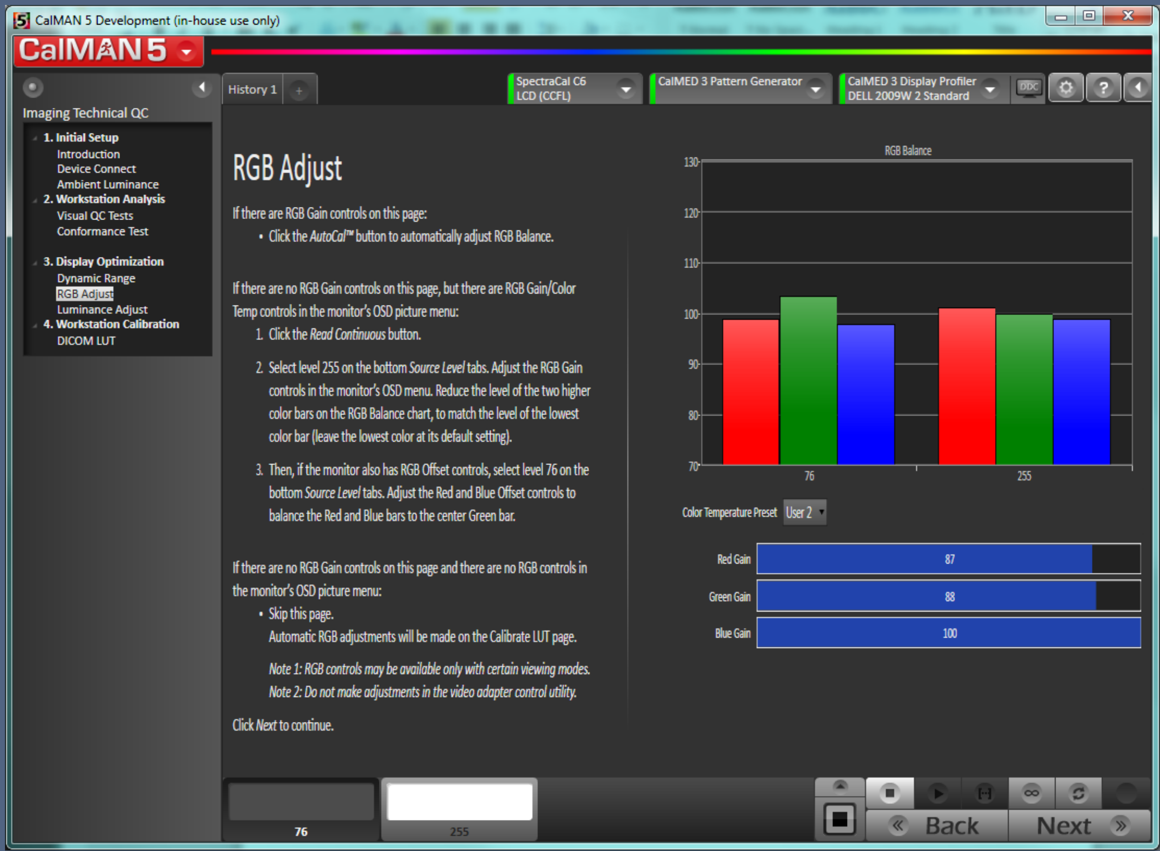
Radiology Imaging Calibration Workflow

SpectraCal

Optimize Display Controls

- White Point;
- RGB Gain controls

If the display manages DDC/VCP commands, this can be automated



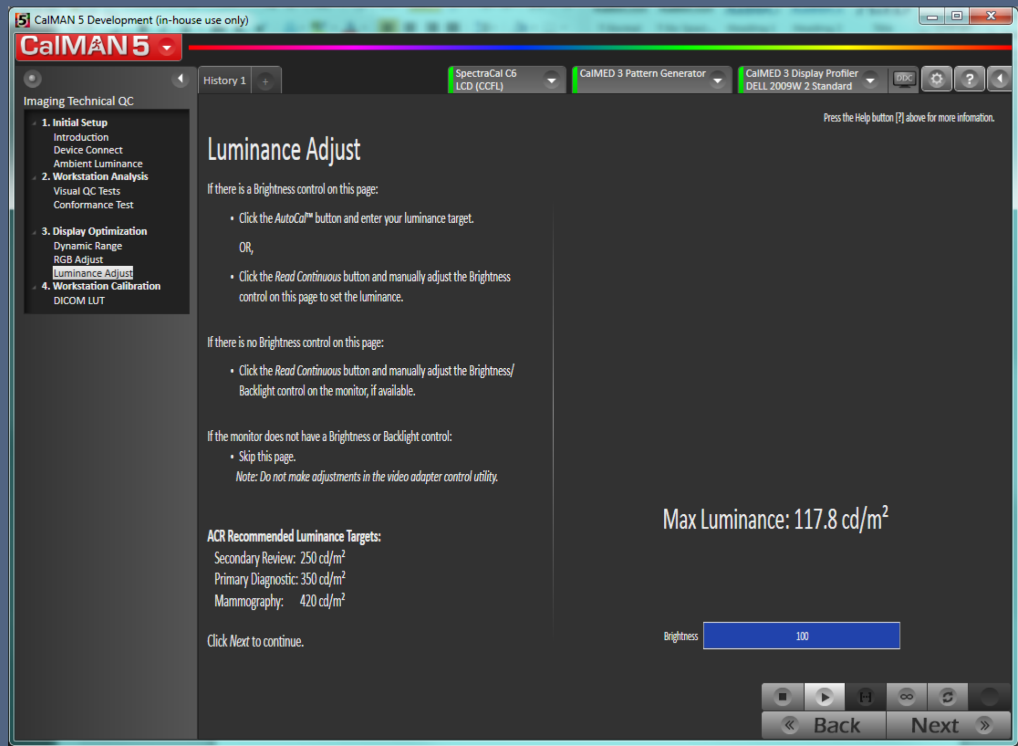
PORTRAIT DISPLAYS

Radiology Imaging Calibration Workflow

SpectraCal

Maximum Luminance
Adjust Display
Contrast Control

If the display manages DDC/VCP commands, this can be automated



PORTRAIT DISPLAYS

SpectraCal

Radiology Imaging Calibration Workflow

Calibrate the LUT

Process takes about 1 minute

Calibration is based upon absolute luminance

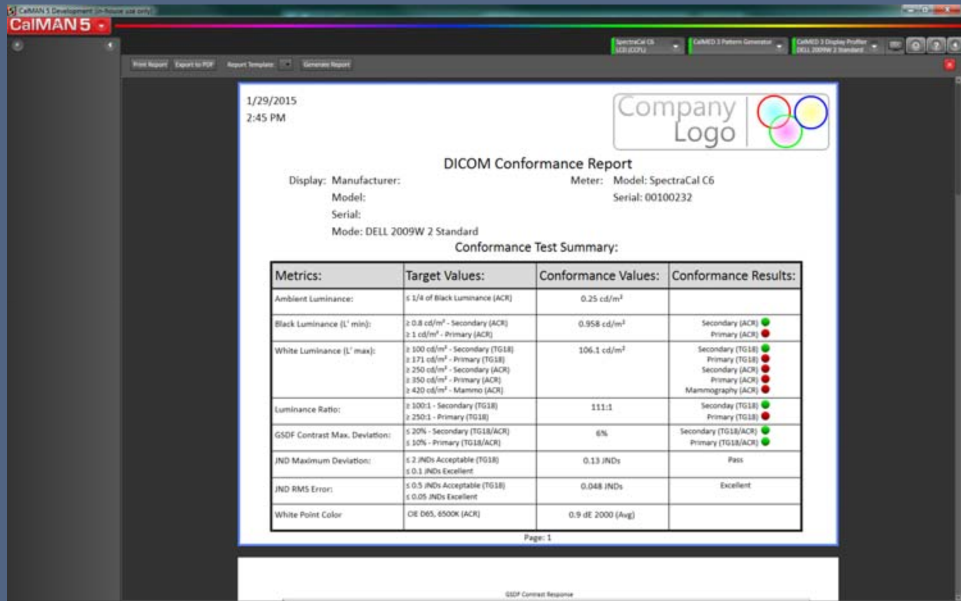
PORTRAIT DISPLAYS

Radiology Imaging Calibration Workflow

SpectraCal

Check Conformance

Generate and save report



Metrics:	Target Values:	Conformance Values:	Conformance Results:
Ambient Luminance:	≤ 1/4 of Black Luminance (ACR)	0.25 cd/m²	
Black Luminance (L' min):	≥ 0.8 cd/m² - Secondary (ACR) ≥ 1 cd/m² - Primary (ACR)	0.958 cd/m²	Secondary (ACR) Primary (ACR)
White Luminance (L' max):	≥ 100 cd/m² - Secondary (TG18) ≥ 171 cd/m² - Primary (TG18) ≥ 250 cd/m² - Secondary (ACR) ≥ 350 cd/m² - Primary (ACR) ≥ 420 cd/m² - Mammo (ACR)	106.1 cd/m²	Secondary (TG18) Primary (TG18) Secondary (ACR) Primary (ACR) Mammography (ACR)
Luminance Ratio:	≥ 100:1 - Secondary (TG18) ≥ 250:1 - Primary (TG18)	111:1	Seconday (TG18) Primary (TG18)
GSDF Contrast Max. Deviation:	≤ 20% - Secondary (TG18/ACR) ≤ 10% - Primary (TG18/ACR)	6%	Secondary (TG18/ACR) Primary (TG18/ACR)
JND Maximum Deviation:	≤ 2 JNDs Acceptable (TG18) ≤ 0.1 JNDs Excellent	0.13 JNDs	Pass
JND RMS Error:	≤ 0.5 JNDs Acceptable (TG18) ≤ 0.05 JNDs Excellent	0.048 JNDs	Excellent
White Point Color	CIE D65, 6500K (ACR)	0.9 dE 2000 (Avg)	

Page: 1

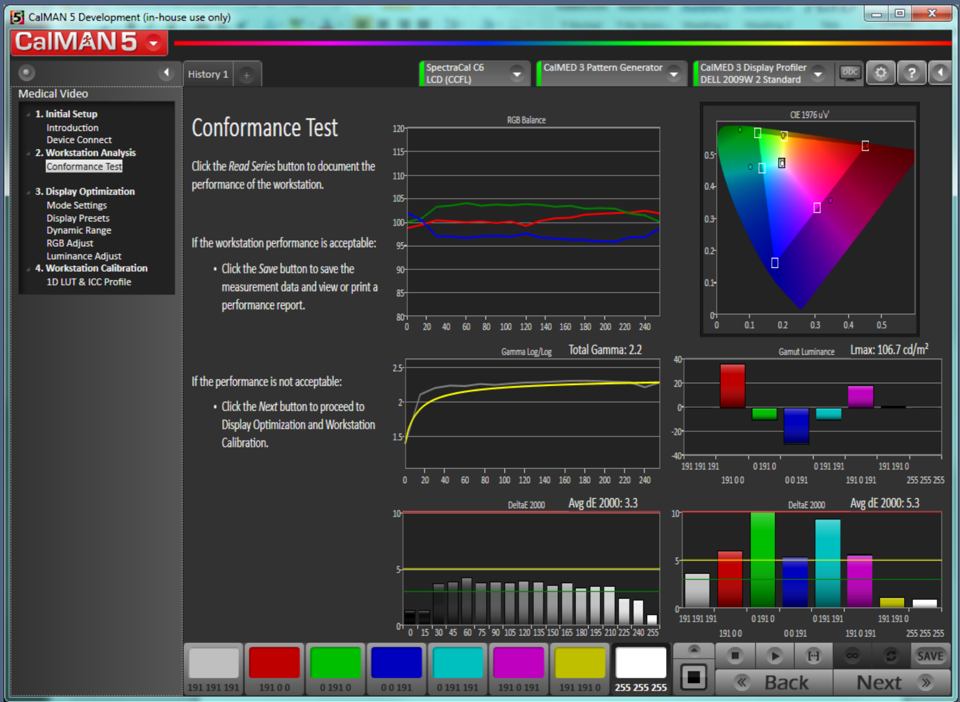
PORTRAIT DISPLAYS

Medical Video Workstation Calibration

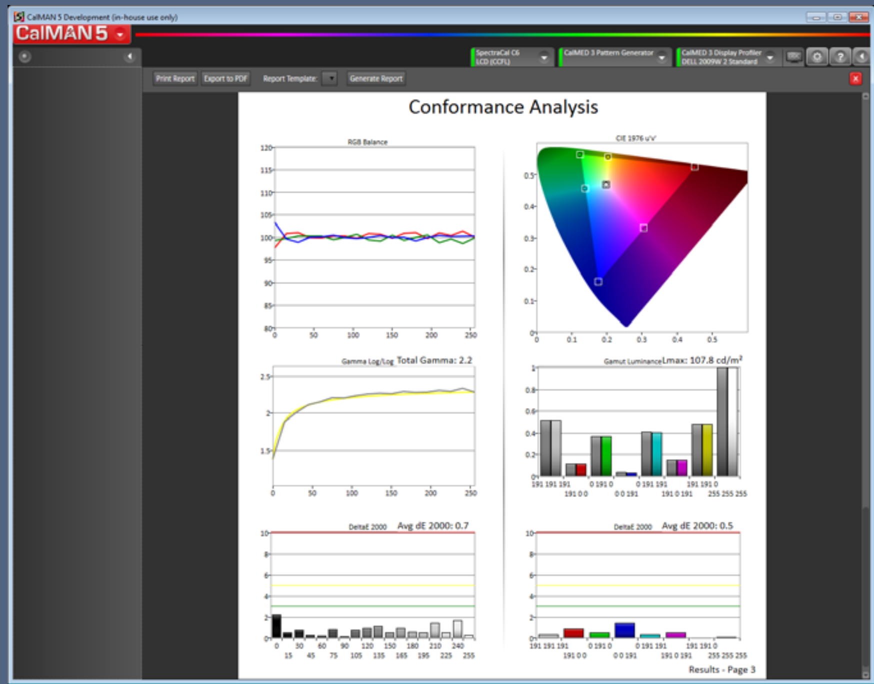
SpectraCal

Analyze Conformance

Luminance gamma, Lmax, DeltaE;
Chromaticity, DeltaE



Save and Print report



PORTRAIT DISPLAYS