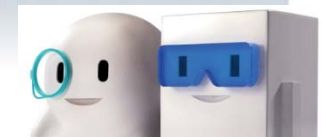# Non-invasive & Non-radioactive Optical Image Capturing and Management System for Skin Disorder Diagnosis

26 Mar 2018

Ms Carol LIU
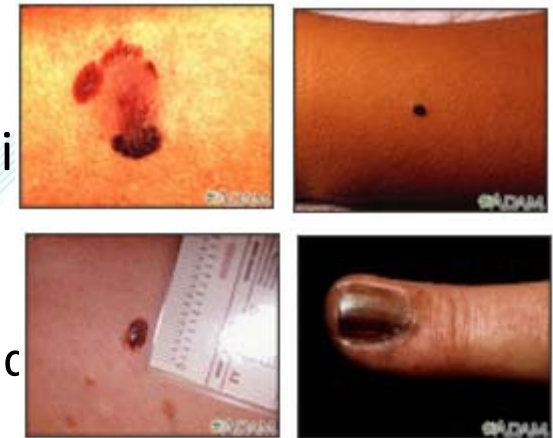Smart Healthcare, MedTech & Optics, Automotive and Electronics

HKPC

Background

- ## What is Melanoma
  - Melanoma is a malignant tumor of melanocytes, which are cells that produce the dark pigment, melanin, which is responsible for the color of skin.

  wiki

  - Melanoma is the most dangerous type of skin cancer. It is the leading cause of death from skin disease.
    - Less common than other skin cancers.
    - However much more dangerous if it is not found early.
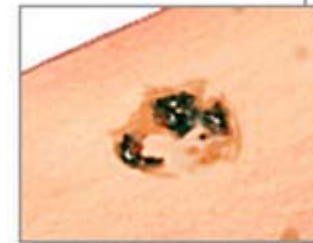   - Causes the majority (75%) of deaths related to skin cancer*.

  PubMed Health

* Jerant AF, Johnson JT, Sheridan CD, Caffrey TJ (July 2000). "Early detection and treatment of skin cancer". *Am Fam Physician* **62** (2): 357–68, 375–6, 381–2.

Background (Cont.)

- The risk of melanoma increases with age, but frequently effects young, otherwise healthy people.

- Melanoma is an aggressive type of cancer that can spread very rapidly.

- It is more common in women than in men. In women, the most common site is the legs and melanomas in men are most common on the back*.

Superficial spreading melanoma

✤A.D.A.M.

星島副刊 FEATURES
SingTao Daily

皮 膚癌是香港十大常見的癌症之一，可分為惡性黑色素瘤及非黑色素瘤兩大類。最近一位知名男藝人懷疑患上惡性黑色素瘤，因而喚起不少港人對此病的關注。本地專家指出，此病雖然罕見，惟死亡率相當高，須小心防護。

文：Esther 部分圖片：星島圖片庫

罕見癌症
黑色素瘤防治大全

成報：謝霆鋒爆患皮膚癌及時切除

2012-10-24 08:47:23 來源：大公網

■謝霆鋒（左）亮相黎芝珊節目，大談自己患皮膚癌一事。

謝霆鋒亮相黎芝珊節目，大談自己患皮膚癌一事

MOTIVATION

Start from a problem

頭條日報 📈財經 📗Blog 💬論壇
新聞 娛樂 潮流時尚 數碼

其它癌症資訊

患惡性黑色素瘤 半數致命 暴曬過久長黑痣須及早求醫

Quick facts for skin cancer

Globally:
- One in every three cancers diagnosed is a skin cancer
- Up to 3 million non-melanoma skin cancers & 132,000 melanoma new cases each year
- One in every five Americans will develop skin cancer in their lifetime

t3/5/14   WHO | Skin cancers

World Health Organization

Ultraviolet radiation and the INTERSUN Programme

Skin cancers   Share   Print

How common is skin cancer?

The incidence of both non-melanoma and melanoma skin cancers has been increasing over the past decades. Currently, between 2 and 3 million non-melanoma skin cancers and 132,000 melanoma skin cancers occur globally each year. One in every three cancers diagnosed is a skin cancer and, according to Skin Cancer Foundation Statistics, one in every five Americans will develop skin cancer in their lifetime.
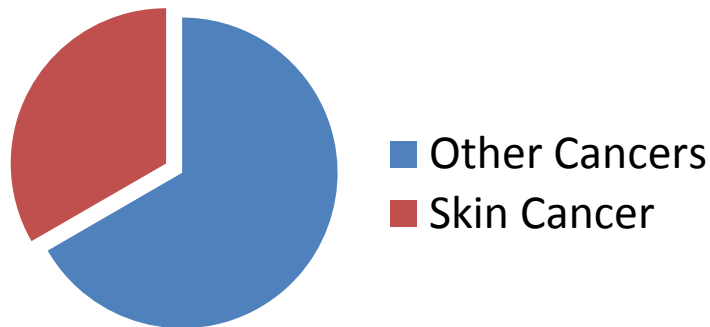
Questions
1. What are the different types of skin cancer?
2. How common is skin cancer?
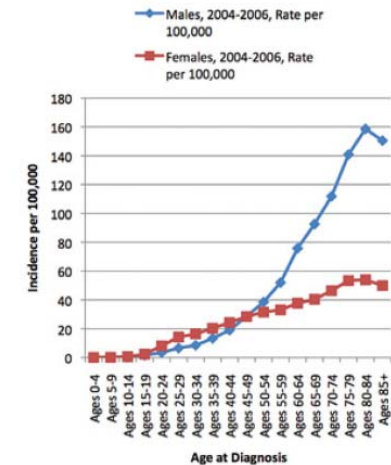3. Who is most at risk of getting skin cancer?

In HK:
- Top 10 cancers in HK since 02'
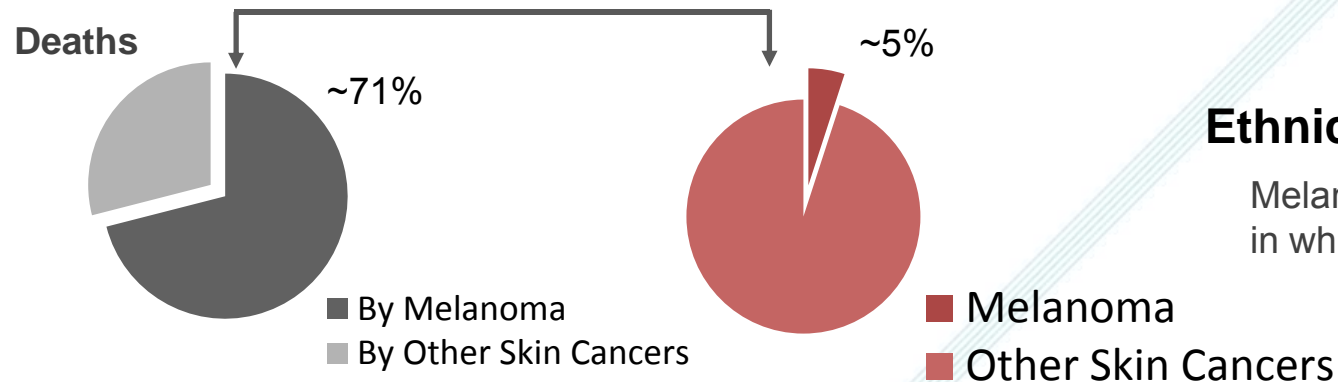
HKPC©

How Common is Skin Cancer

- Other Cancers
- Skin Cancer

Gender

Melanoma affects both men and women

Males, 2004-2006, Rate per 100,000
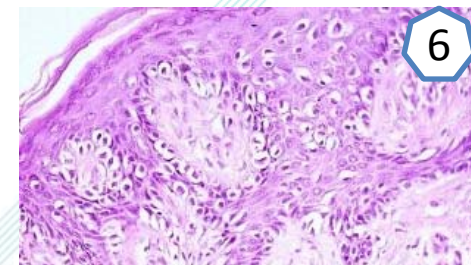Females, 2004-2006, Rate per 100,000

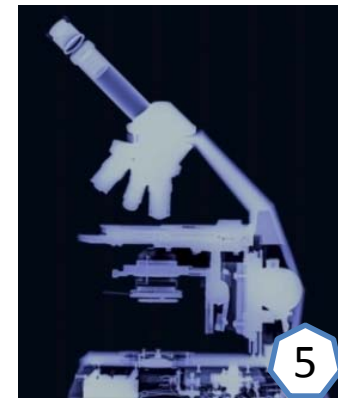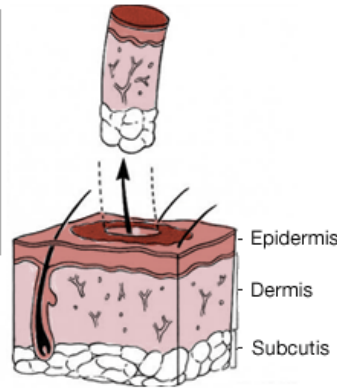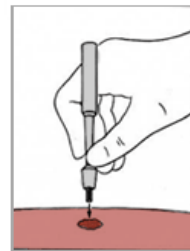## Age

- Average age of diagnosis: 52
- However, melanoma is the 2nd most common cancer in people aged 25-29.

## How Serious is Melanoma

Deaths

~71%

~5%

- By Melanoma
- By Other Skin Cancers

- Melanoma
- Other Skin Cancers

Ethnic Group

Melanoma is 20 times more common in whites than in African Americans.

References:
WHO: http://www.who.int/uv/faq/skincancer/en/index1.html
American Cancer Society: http://www.cancer.org/cancer/skincancer-melanoma/detailedguide/melanoma-skin-cancer-key-statistics
Bradley Bloom, David Polsky, "Melanoma in Women Under Age 50: Can Genetics Work with Estrogen to Boost Risk?", The Melanoma Letter, Vol. 28, No. 1, 2010.

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Current Medical Procedures

- (1) (2) Naked eye examination / with amplifiers is with lower sensitivity and specify / not convenient for long-term monitoring

- (3)~(6) Skin biopsy and histopathology can confirm clinical diagnosis but is invasive and with more complex procedures

- (7) Dermoscopy helps reduce the needs for biopsy and is especially helpful for melanoma diagnosis. However, large scan systems / camera mounted dermoscopy require lengthy set up and are not convenient in busy clinics.
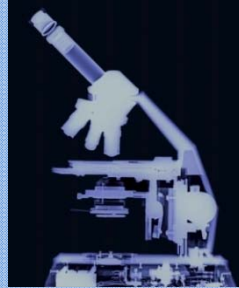
Daily medical Services
- Diagnosis
- Therapy
- Intervention
- Outcome evaluation
- Operation procedures
- Resources management
- Safety issue
- Cost-effective
- Practice
- …
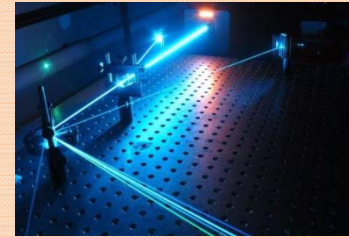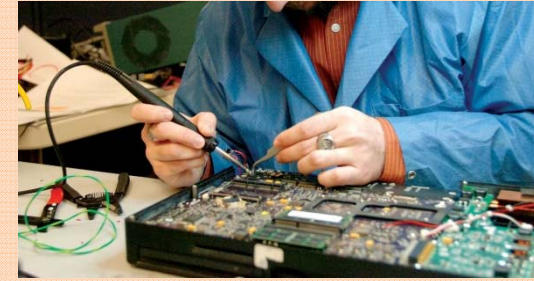
Biomedical Engineering
- R&D
- Functional prototype
- Clinical evaluation
- Manufacturing
- Marketing
- Regulatory requirements

Knowledge-based Interpretation

Our Solution: A Non-invasive & Non-radioactive
Optical Image Capturing System for Skin Applications
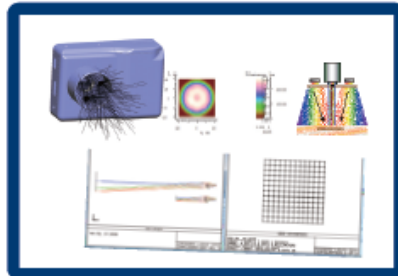
Hardware Development

Schematic diagram of hardware device

Polarizing Unit
& Illumination Unit

Camera

Magnifying Unit
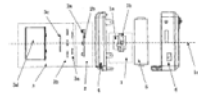
<u>Patented</u> Design
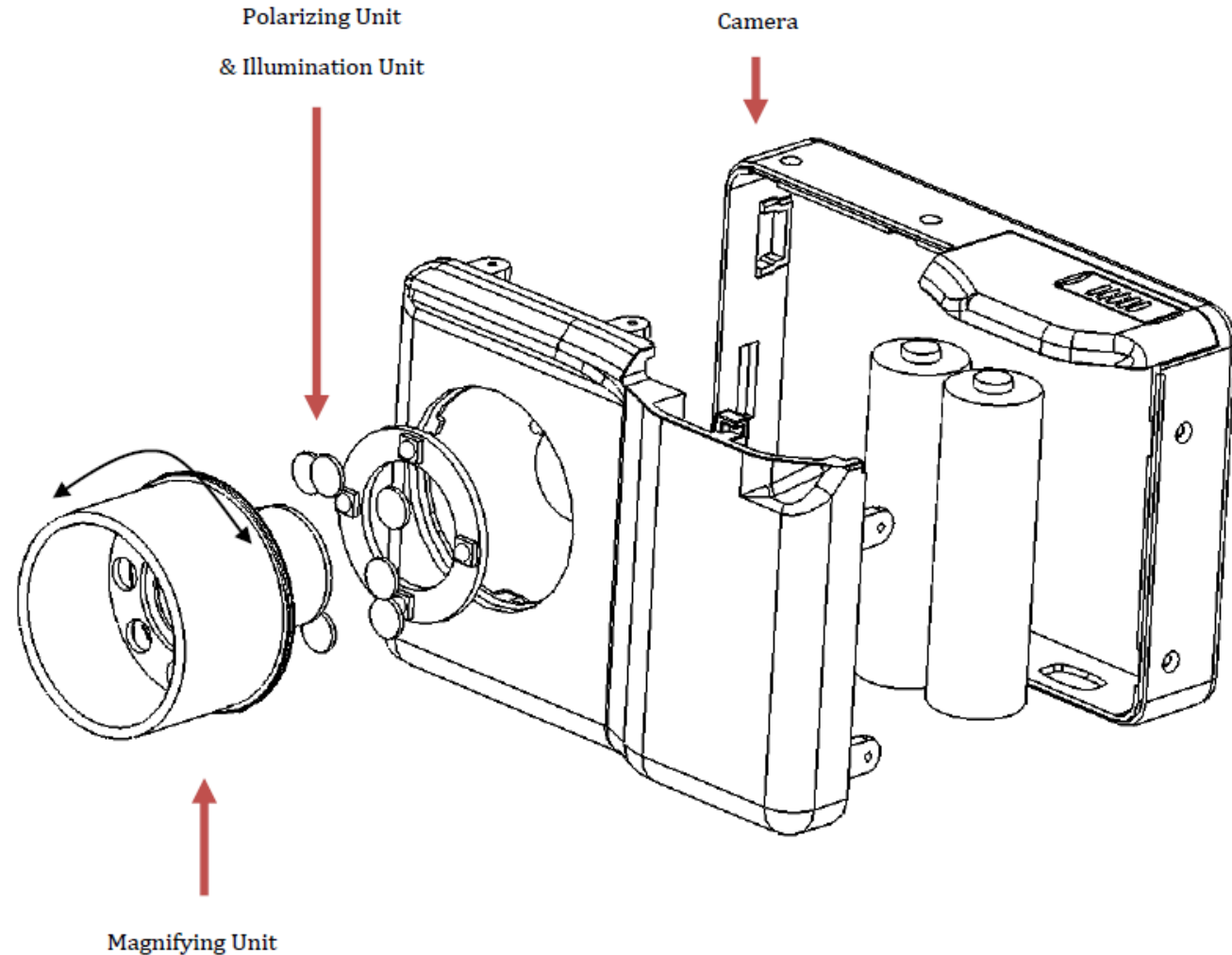
Hardware Development

Polarizer Unit Development – Linear Polarizer
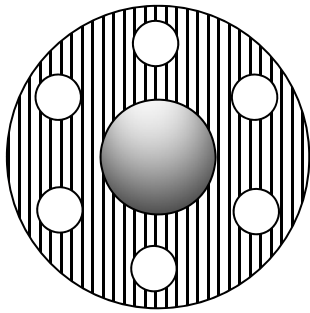
Linear Polarizer for first light source
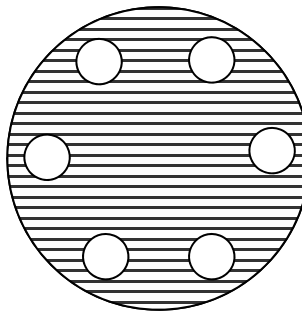
Overlapped cross polarizer for polarization function
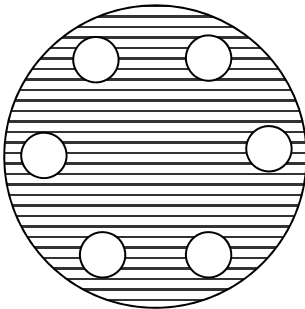
Linear polarizer for second light source and camera lens
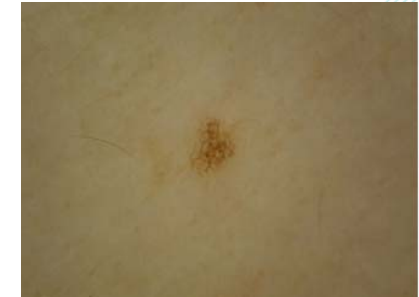
Skin lesion image without vs. with polarization

•Every other LED on ring fixture operates as first and second light sources. As shown in the left upper figure, the even LEDs are filtered by a first polarization ring. As shown in the left lower figure, the odd LEDs and camera lens are filtered by a second polarization ring, which is crossed-polarized relative to the first polarization ring.

•Above mentioned two polarizer rings were overlapped together for polarization function of the hardware (right figure).

Hardware Development

Image Capturing Unit - Lenses
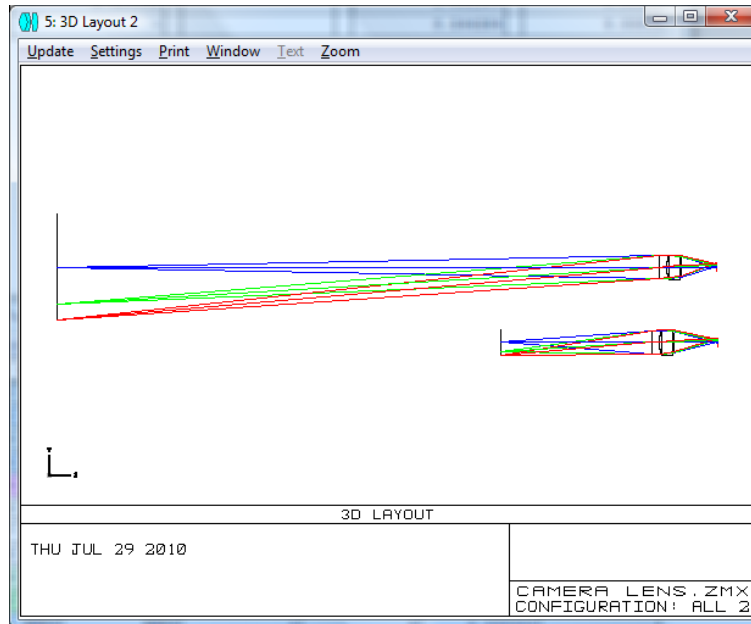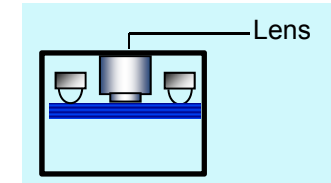
Lens

Camera lens design by ZEMAX
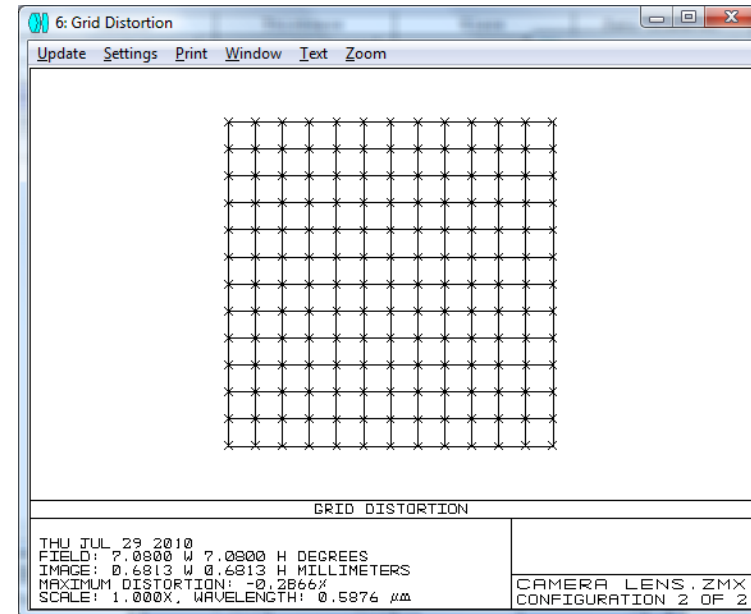
Grid distortion of proposed imaging system

- Through computer aided simulation and optimization, as shown in the left figure, camera lens was designed by ZEMAX to realize general and 10x magnify mode for 2D pigmented skin lesion images capturing.
- Aspherical achromatic lens was used as the magnifying lens to achieve less dispersion, better chromatic correction and smaller RMS spot size. The image distortion can be controlled below 1%.

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Hardware Development

Image Capturing Unit - Lenses

Factors that affected the image quality in design v1.0 - Optical aberrations & Chromatic aberrations

Improvements in v2.0:
• Aspheric Achromatic Lenses (amplifying lens)
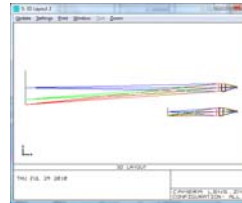
Camera lens design by ZEMAX

✓ Correction of spherical aberration
✓ Better chromatic correction than traditional achromatic lenses
✓ Less dispersion in optical glass (than optical plastics with the same refractive index)
✓ Smaller RMS spot size

• Effective focal length (amplifying lens)
  ✓ Allow better positioning of illumination unit
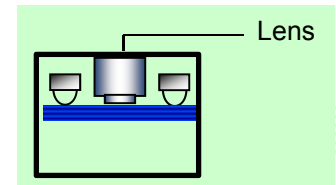
Aspherized Achromatic Lenses
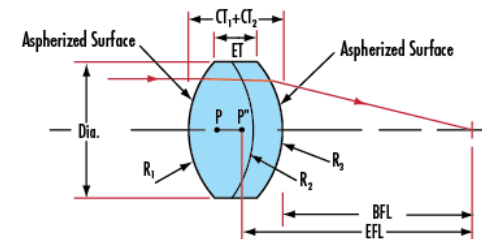
Spot Size

Aspheric
Achromatic
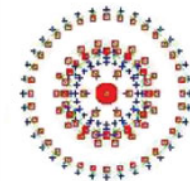
Traditional
Achromatic

- Chromatic aberration (色差)
  - Because lenses have a different refractive index for different wavelengths of light.

  - Chromatic aberration manifests itself as "fringes" of color along boundaries that separate dark and bright parts of the image, because each color in the optical spectrum cannot be focused at a single common point.
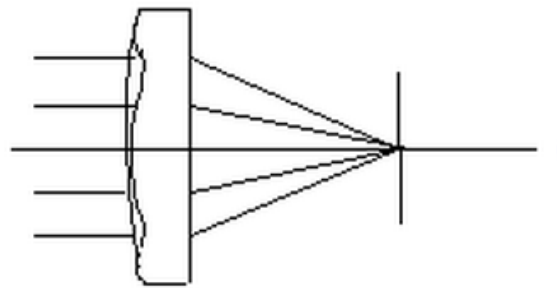
wiki

Chromatic aberration

Crown — Flint

Achromatic doublet

HKPC©
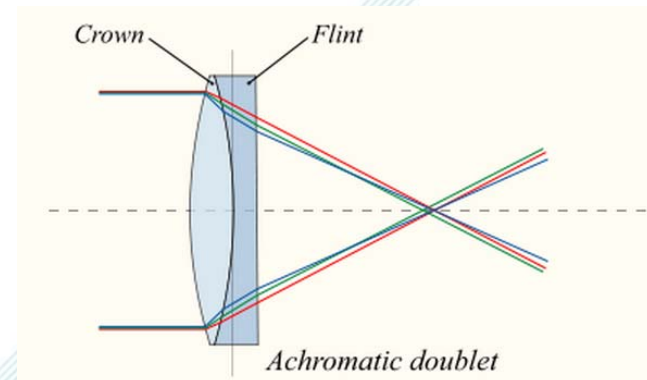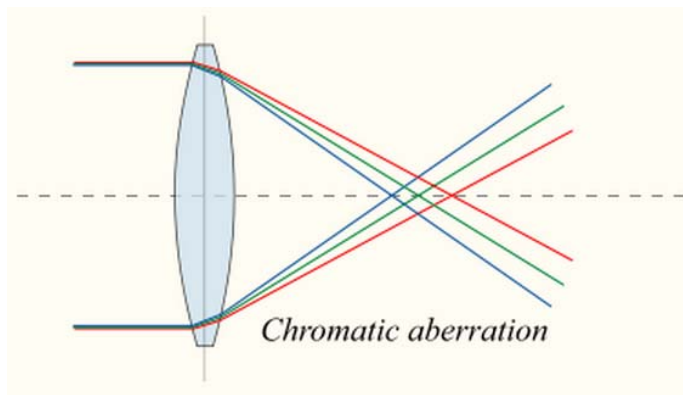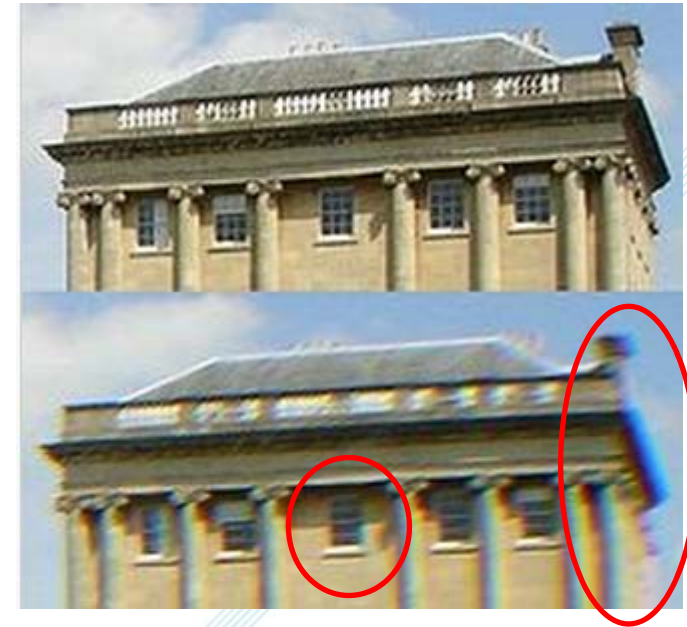
- Spherical aberration (球差)
  - Due to the increased refraction of light rays when they strike a lens or a reflection of light rays when they strike a mirror near its edge, in comparison with those that strike nearer the centre.

WiKi
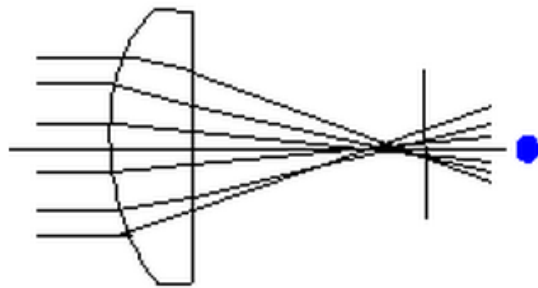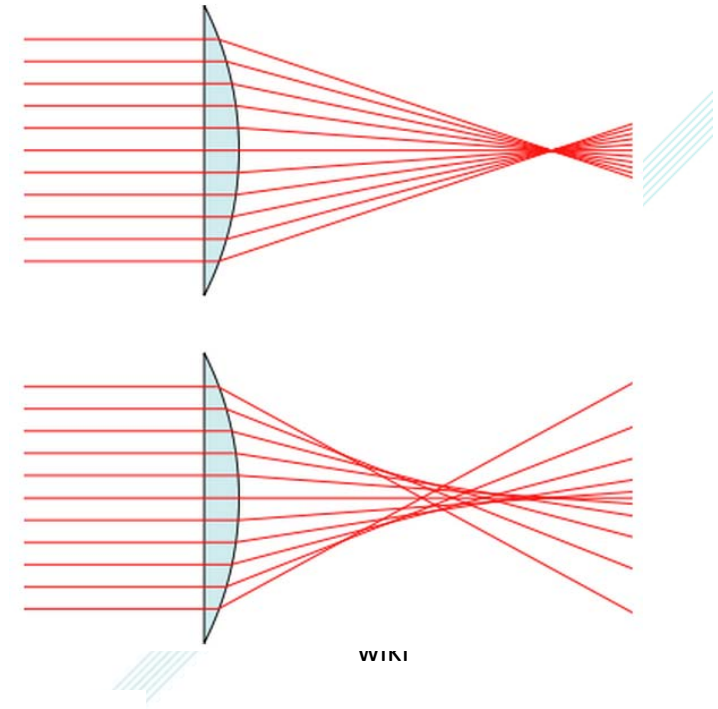
Spherical Lens

Aspherical Lens

Hardware Development

Illumination Unit

illumination

General information of selected White LED

No. of LED	6
LED	Cree XPEWHT-L1-WD0-Q4
Color	Cool White
CCT Range (k)	5,000 - 10,000
Luminous Flux (lm)	100
Viewing Angle (deg)	115
DC Forward Current (mA)	700
Forward Voltage (@700 mA) (V)	3.4
LED Junction Temperature (°C)	150
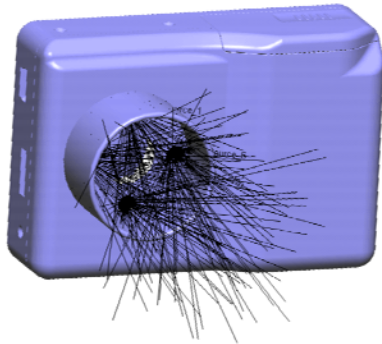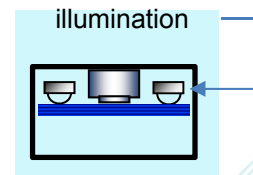
Illumination Simulation by LightTools
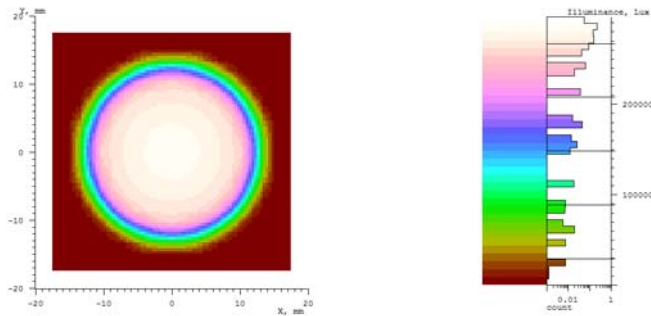
Illuminance distribution at amplifying mode

PCB ring with LED array
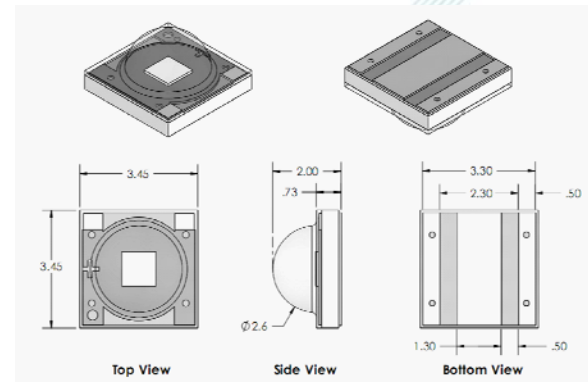
Light source: white LED

Hardware Development

Other Feature

"Can you make it more easy to use and to check the images?"

Functional Prototype
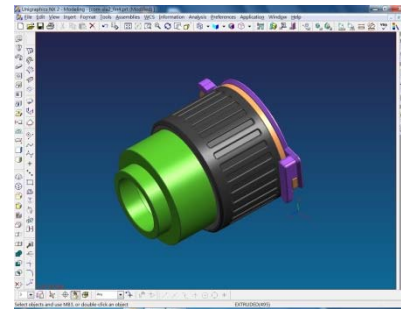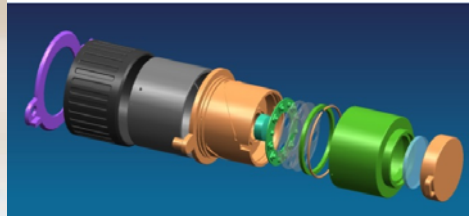
3D CAD Design of the Barrel
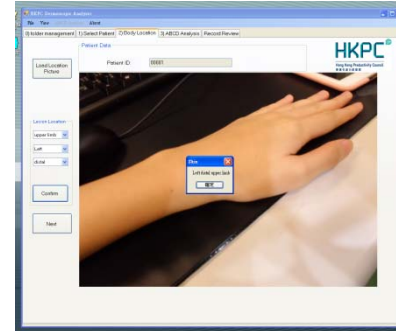
General mode
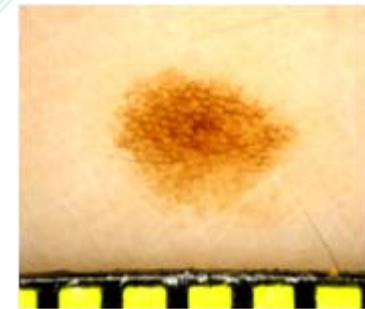
10x mode

Bi-mode image capture:

✠General Mode: enabling the acquisition of skin lesion location and patient identification information

✠Amplified Mode: providing amplified dermoscopic images of the skin lesion
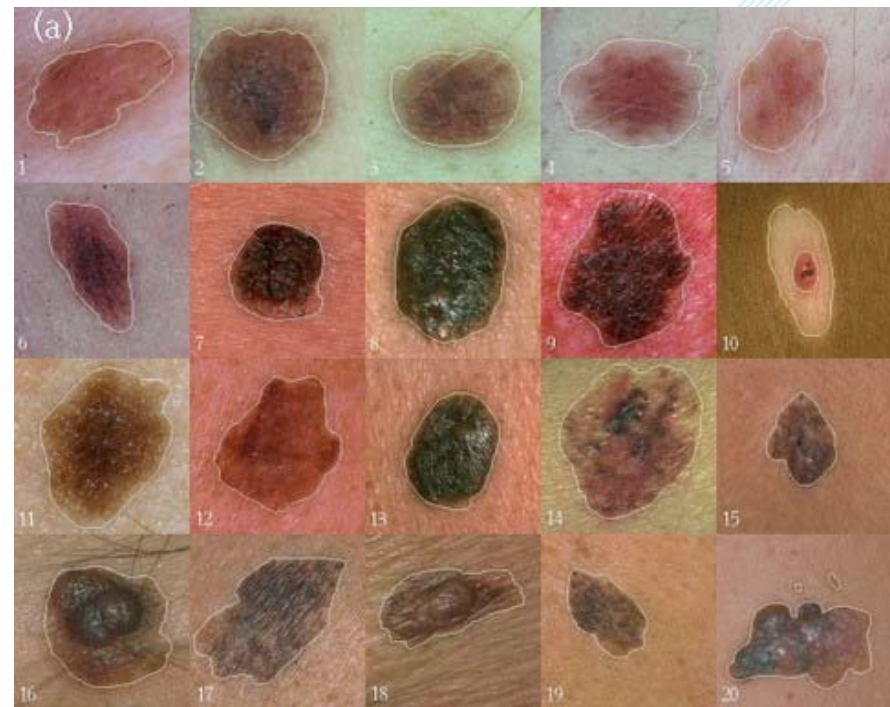
Software Development

Enabled Long Term Monitoring after both Hardware and Software Upgrade
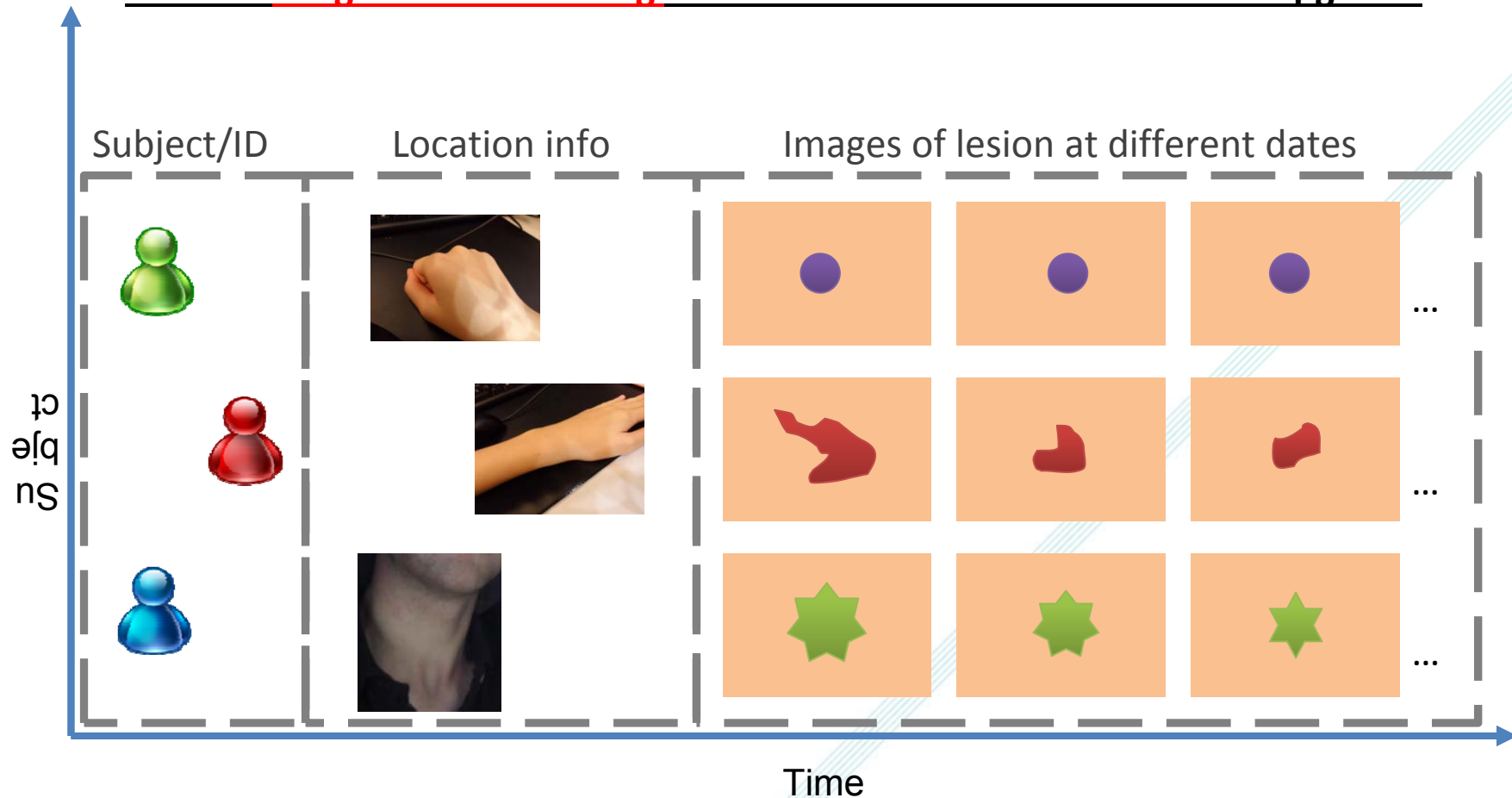
Software Development

ABCD Rules

- The ABCD rule has been proven to be a reliable method providing a more objective and reproducible diagnosis of **melanoma**.
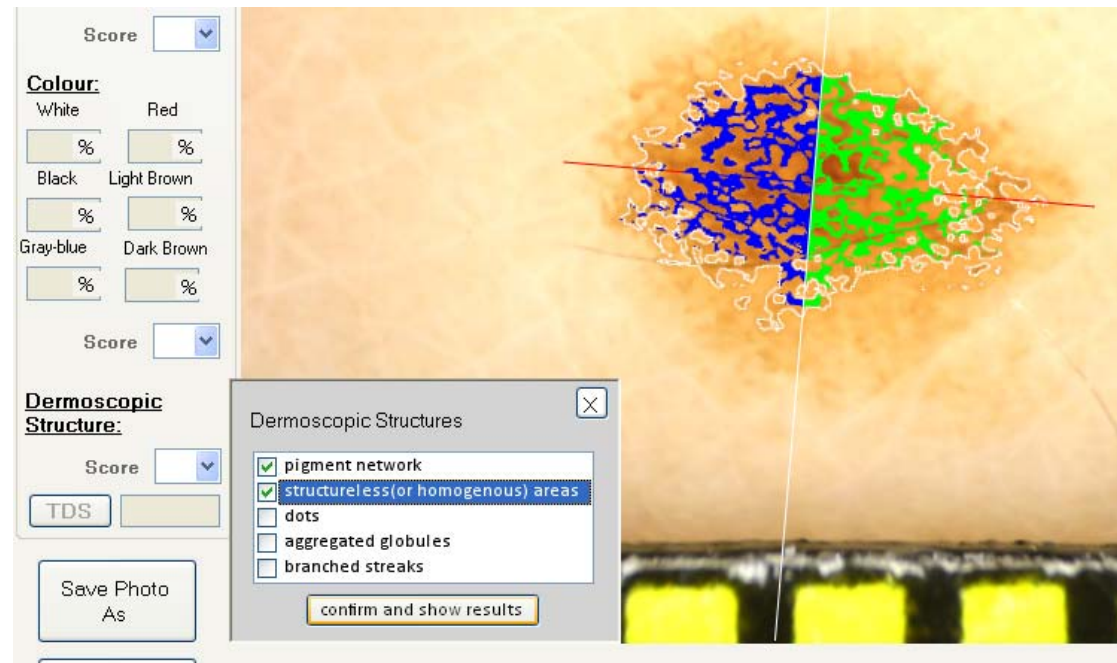
Software Development

ABCD Rules

✕ The ABCD rule, which has been proven to be a reliable method providing a more objective and reproducible diagnosis of **melanoma**.

A – Asymmetry
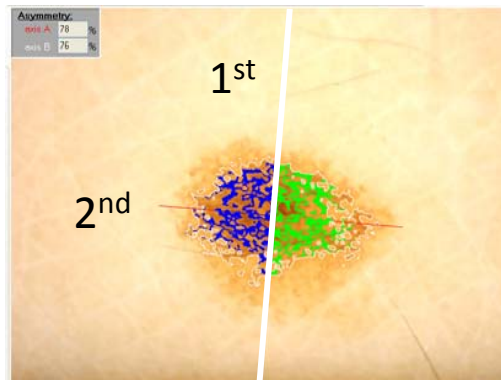
B – Border
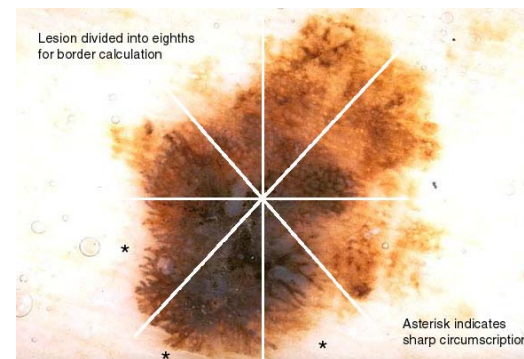
C – Color

Presence of 6 colors: white, red, light brown, dark brown, blue-gray and black, will be calculated

D – Dermoscopic Structures

Presence of network, structureless or homogeneous areas, branched streaks, dots, and globules

http://www.dermoscopy.org/consensus/2b.asp

Software Development

Snapshot of determing the Dermoscopic Structure

Software Development

Interface Overview
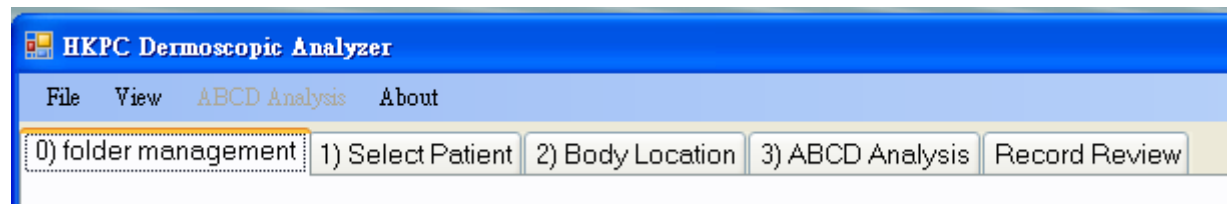
Software Development

Deliverables

Version 2.0 (v2.0)

Pre-trial Study

Example Cases:

cancerous cases:
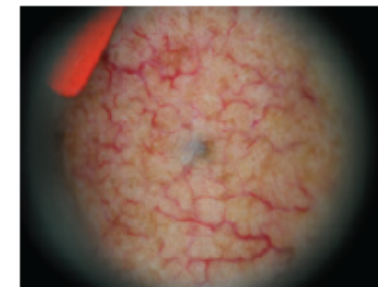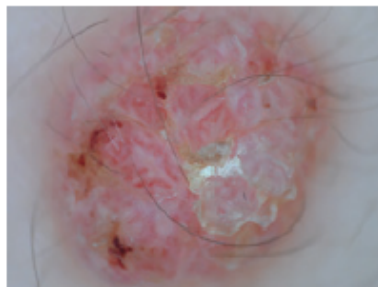
Pre-trial Study (cont.)

— Examples of lesion photos captured from subjects:
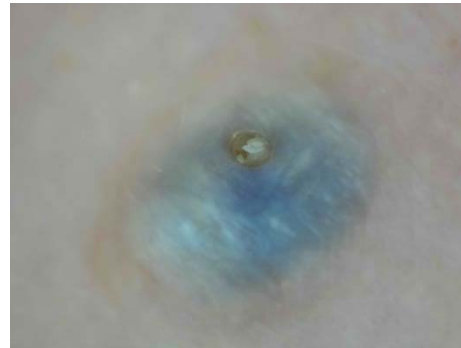
Diagnosis remark: non-suspicious (epidermoid cyst)

Pre-trial Study (Cont.)

– Examples of lesion photos captured from subjects:
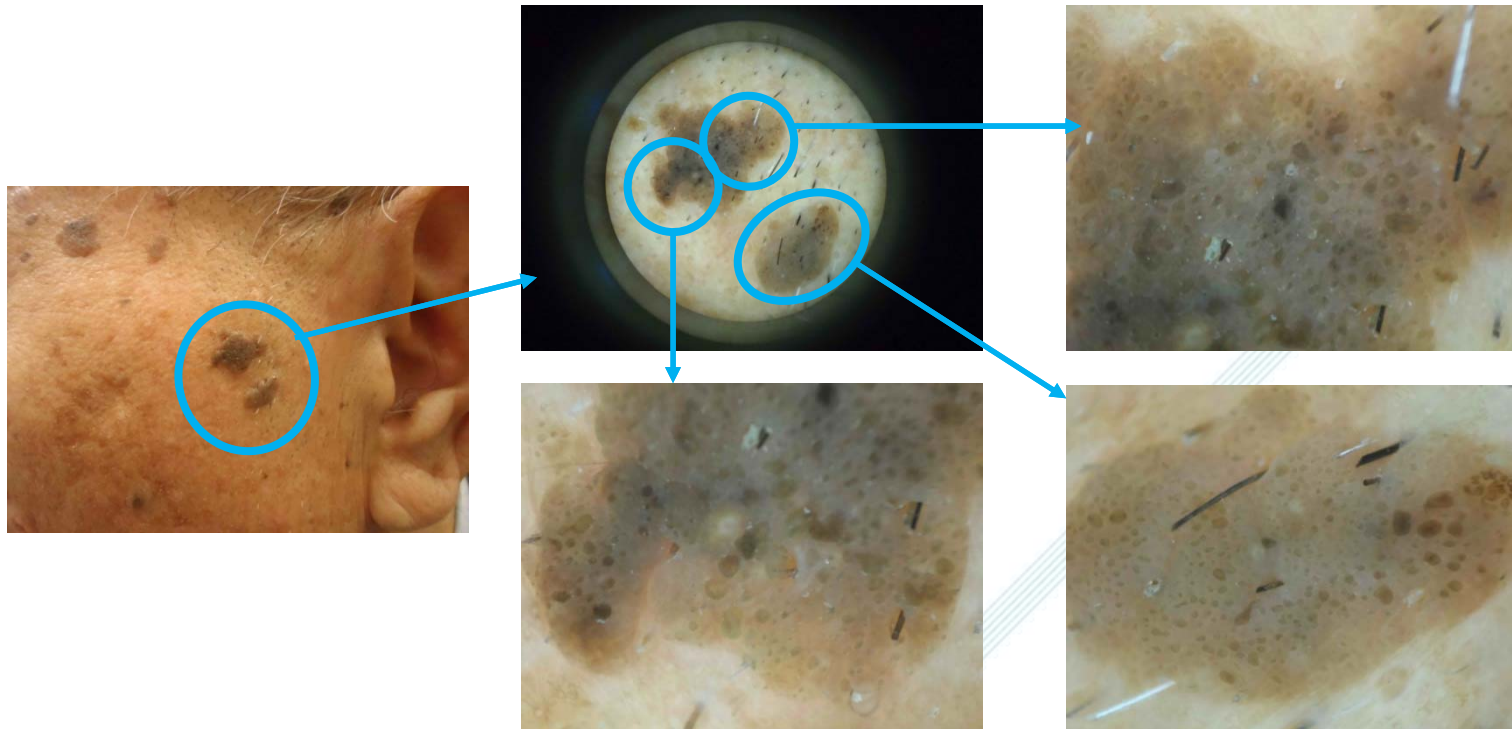
Diagnosis remark: suspicious (seborrheic keratosis in a cancer patient)

Pre-trial Study (Cont.)

— Examples of lesion photos captured from subjects:
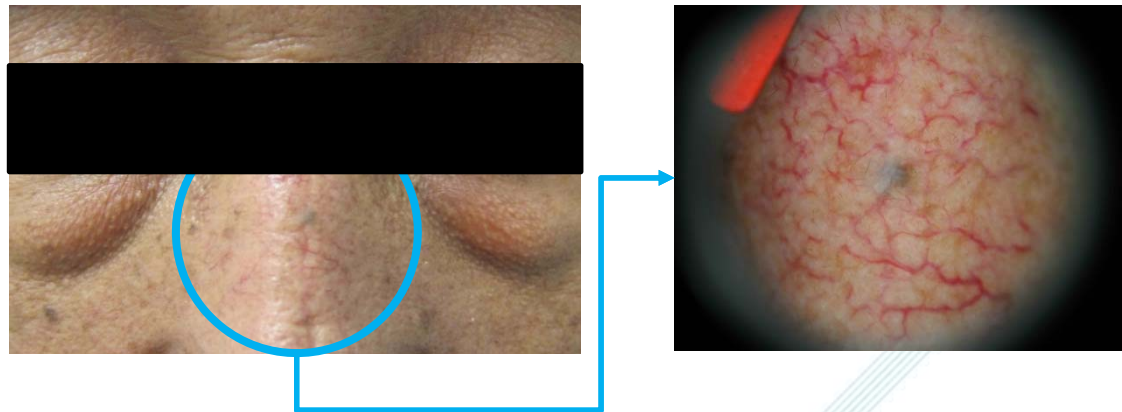
Diagnosis remark: suspicious (non-melanoma skin cancer)

Pre-trial Study (Cont.)

– Examples of lesion photos captured from subjects:

Diagnosis remark: suspicious (non-melanoma skin cancer)

Trial Study

– Objective:

- To evaluate the dermoscopic features of common skin problems in Chinese children using the developed dermoscope functional prototype

– Participants:

- 185 Chinese children aged 0 to 18 yrs (mean: 5.2 yrs), 86 boys vs. 99 girls

– Operators:

- Paediatricians trained in dermoscopy

– Location:

- UCH
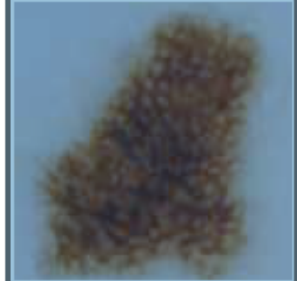
Clinical Significance

TABLE 2. Clinical significance of dermoscopic examination in children with skin lesions

Diagnosis	Clinical significance
Melanocytic naevi	Detection of melanoma Serial follow-up
Café-au-lait macule	Early differentiation from congenital melanocytic naevi
Port-wine stain	Early differentiation from haemangioma Prognosis on response to laser
Haemangioma	Timely initiation of appropriate monitoring and treatment Early planning of treatment
Viral wart	Easy and accurate diagnosis Differentiation from callus and corn Prevent missing a melanoma Monitor treatment progress Confirm treatment success
Molluscum contagiosum	Confirm clinical diagnosis
Scabies	Rapid confirmation of diagnosis Early initiation of treatment
Sebaceous naevus	Early diagnosis Monitoring for tumourous change
Alopecia areata	Support clinical diagnosis Assess disease activity Identify signs of early clinical response and adverse effects to treatment
Cutis aplasia	Differentiate from sebaceous naevus Avoid unnecessary treatment and follow-up
Atopic dermatitis	Support clinical diagnosis Monitor disease severity
Psoriasis	Aid clinical diagnosis Evaluation of treatment outcome

n = 41
n = 15
n = 42
n = 30
n = 7
n = 3
n = 3
n = 8
n = 5
n = 5
n = 6
n = 4

☞ Top twelve diagnosis reported

☞ Grouped under four main categories:
- Pigmentary and vascular birthmarks
- Infections
- Hair problems
- Inflammatory dermatoses

☞ Forty two dermoscopic features identified

Examples of Dermoscopic Features Identified

	Diagnosis (No. of patients)	Dermoscopic features (No. of patients)			
Pigmentary birthmark	Melanocytic naevus (41)	Mixed (26)	Globular (13)	Homogeneous (6)	Reticular (6)
	Café-au-lait macule (15)	Perifollicular hypopigmentation (10)	Reticular (5)		

Reproduced with permission from the Hong Kong Medical Journal (Luk DC, Lam SY, Cheung PC, Chan BH. Dermoscopy for common skin problems in Chinese children using a novel Hong Kong–made dermoscope. Hong Kong Med J 2014;20:Epub 12 Sep 2014), 2014, Hong Kong Academy of Medicine.

Non-invasive and Non-radioactive Opto-mechatronic System for Skin Applications

- Total Solution for assisting medical doctors for melanoma and skin disorder early diagnosis

- Small size & User friendly

- Reduce the usage of biopsy

- The bi-mode image capturing method helps facilitate the ease of management on image data

- Patented design integrating opto-mechatronics technologies, 3D printing technology, precision engineering, image processing, software engineering, etc.

- Enabling technology for knowledge-base system towards dermoscopic database & AI
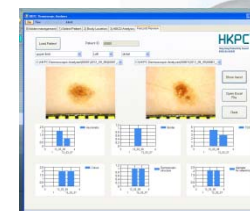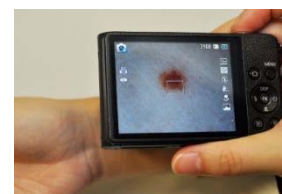
Medical Advisors:
Dr. David Luk & Dr. Maria Gonzalez (Cardiff University)
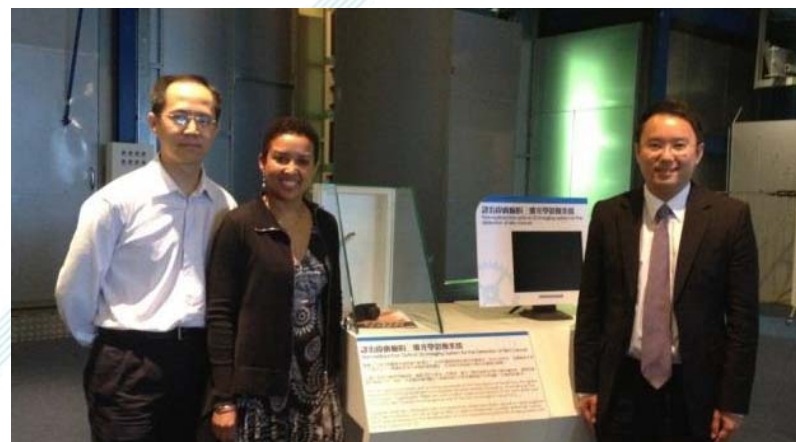
![SPIE. PHOTONICS WEST BIOS]

The Moscone Center
San Francisco, California, USA
7 – 12 Feb 2015

R&D work* presented at:
SPIE Photonics West 2015 - BiOS:
"Advanced Biomedical and Clinical Diagnostic and Surgical Guidance Systems XIII" track
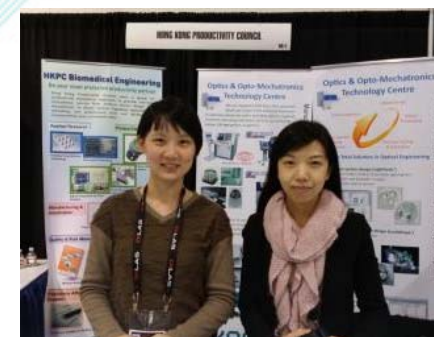
Workshop on "Dermoscopy"

Organizer: The Hong Kong Paediatric and Adolescent Dermatology Society
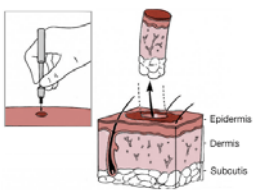
Practice for biopsy tissue acquisition

Functional prototype developed by HKPC

HKPC Smart Healthcare & MedTech
Expertise in Converting Clinical & Healthcare Challenges into Solutions

Core Competence

R&D	Prototypes	Compliance
Opto-Mechatronics	Medical 3D Printing	Clinical Trial Protocol
Sensors & Acquisition Technologies	Precision Engineering	Testing & Compliance
Image Recognitions & Application Software Programming	Design for Manufacturing & Small Batch Production	Regulatory

Funding opportunities

Innovation and Technology Commission (ITC)

1. ITSP*

Tier 2**

90% (Gov.) + 10% (Sponsor) = Plat-form — IP owned by research institutes

50% (Gov.) + 50% (Sponsor) = Co-llab — IP owned by collaborative organization

Tier 3

100% ≤ 1.4 mil
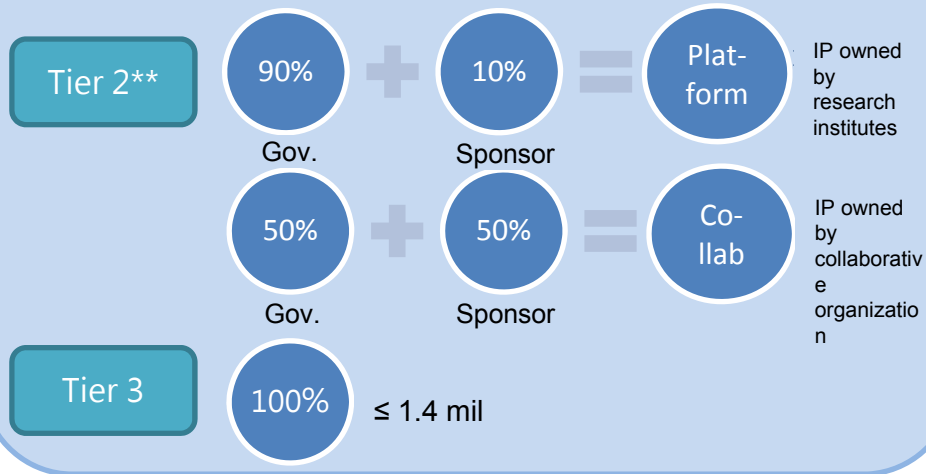
2. R&D Cash Rebate Scheme (CRS)*

40% (Gov.) + 60% (Industrial partner) = CRS — IP owned by industrial partner

3. ITF/ R&D Centres (e.g. APAS)*

90% (Gov.) + 10% (Sponsor) = Plat-form — IP owned by research institutes (except R&D centres)
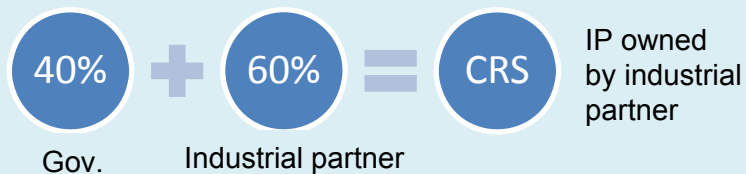
50% (Gov.) + 50% (Sponsor) = Co-llab — IP owned by collaborative organization (except R&D centres)
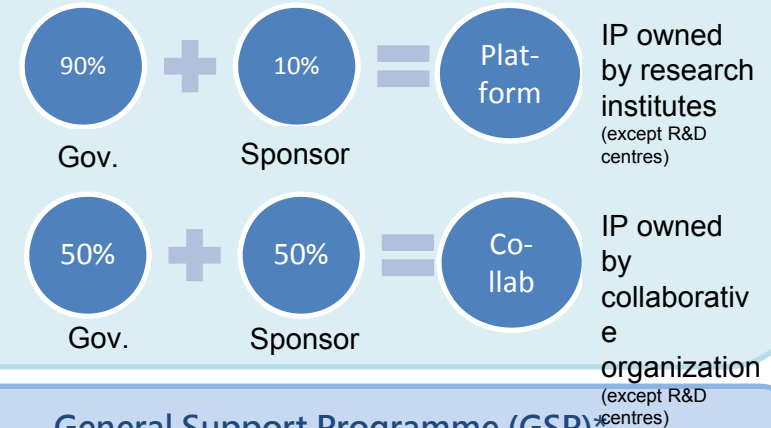
4. General Support Programme (GSP)*

90% (Gov.) + 10% (Sponsor) = GSP

5. Technology Voucher Programme (TVP)*

66% (Gov.) + 34% (Sponsor) = TVP ≤ 200k
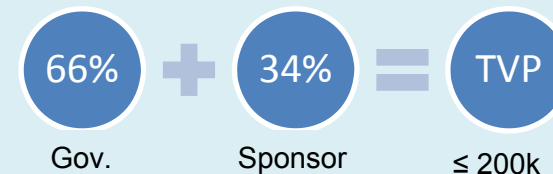
Funding opportunities
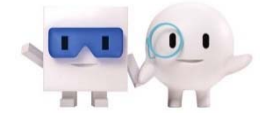
Trade and Industry Department (TID)

6. Fund on Branding, Upgrading and Domestic Sales (BUD) *

Enter-prise			
≤ 500k	**50%** Gov.	**+** **50%** Industrial partner	**=** **BUD**

Organ-ization			
≤ 5 mil	**90%** Gov.	**+** **10%** Industrial partner	**=** **BUD**
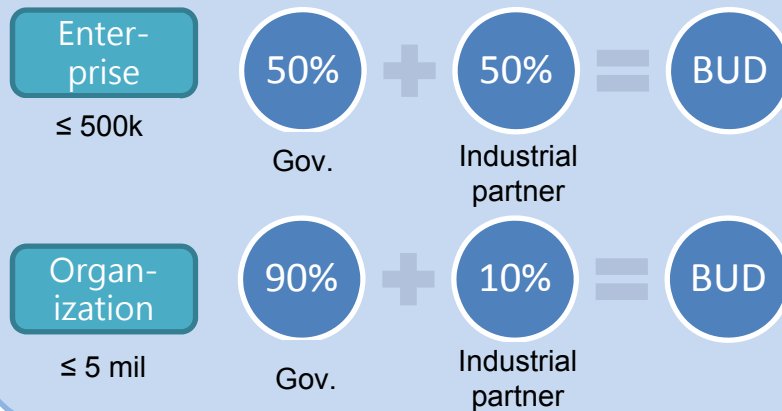
7. SME Development Fund (SDF) *

90% Gov. **+** **10%** Industrial partner **=** **SDF**

元)
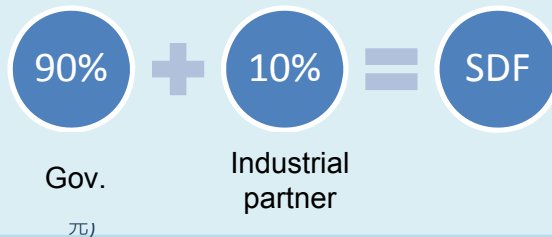
Innovation and Technology Bureau (ITB)

8. Innovation and Technology Fund for Better Living, (FBL) *

90% Gov. **+** **10%** Industrial partner **=** **FBL** ≤ 5 mil
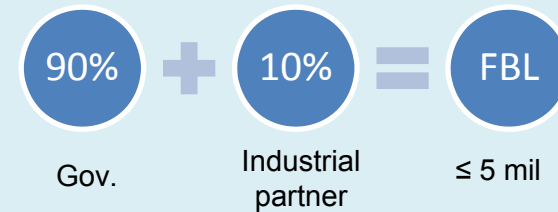
Eligible organization for FBL
- Non-governmental organisations (receiving subvention from the Social Welfare Dept)
- Public bodies (e.g. HKPC)
- Professional bodies
- Trade associations

HKPC Smart Healthcare & MedTech
Our Advantage

Integrated

Professional Services

Trustworthy

Partnership

Funding

Facilitation

Carol LIU 劉音博
Consultant
Smart Healthcare, MedTech & Optics Unit
Automotive & Electronics Division
Hong Kong Productivity Council
香港生產力促進局汽車及電子部
智能保健，醫療科技及光學組 顧問
carolliu@hkpc.org / (852) 2788 5550

HKPC Hong Kong Productivity Council 香港生產力促進局

AHWP
ASIAN HARMONIZATION WORKING PARTY

Carol LIU
Secretariat
Asian Harmonization Working Party
secretariat@ahwp.info

Other Capacities 其他公職:-

O Secretary, Asian Harmonization Working Party (AHWP)
 亞洲醫療器械法規協調組織 秘書處
O Co-opted Member, Biomedical Division, The Hong Kong Institution of Engineers (HKIE)
 香港工程師學會-生物醫學分部 委員
O Executive Committee, Engineering in Medical & Biology Society HK-Macau Joint Chapter,
 Institute of Electrical & Electronics Engineers (IEEE-EMBS)
 電機及電子工程師學會-生物醫學工程學會-香港澳門分會 委員

Responsible for:

O Biomedical Engineering R&D and
 Medical Technology Development

O Consultancy on Medical Device
 Regulatory Affairs (Pre-market, GCP,
 CSV)

O Medical Professional and Technology
 Upgrade Services

HKPC

INNOVATION

PARTNERSHIP

INTEGRATION

Thank You

Licensing Arrangement

- Licensing arrangement:

- 2014 – 2020: European Union, PRC, Australia, New Zealand

HKPC©

Hardware Development

Specification of the prototype for the current image capturing system

| Imaging Unit		
Camera Lens		Doublet magnifying lens with effective focal length = 25mm
Focus		TTL Auto Focus
Image Distortion		<0.4% (Pincushion), < 1% (Barrel)
Illumination Unit		
Light Source	White LED	Cree High Power LEDs (XPEWHT-L1-WD0-Q4) x 12pcs
Polarizer Unit		
Linear Polarizer		Cross polarized high contrast Viewing polarizer & LED polarizer with alternative LED polarizer
Others:		
Image Sensor		16M 1/2.3"- CCD Sensor
LCD Display		3" Color LCD 460K dots
Storage		Internal flash memory: 16MB External memory: supporting SD Card Digital output connector: USB2.0/WIFI
Power Source		Li-ion battery
Operation Modes:		
Mode I:		General capture mode
Mode IIa:		Amplifying Mode (White LEDs)
Mode IIb:		Amplifying Mode (White LEDs + Polarizer)

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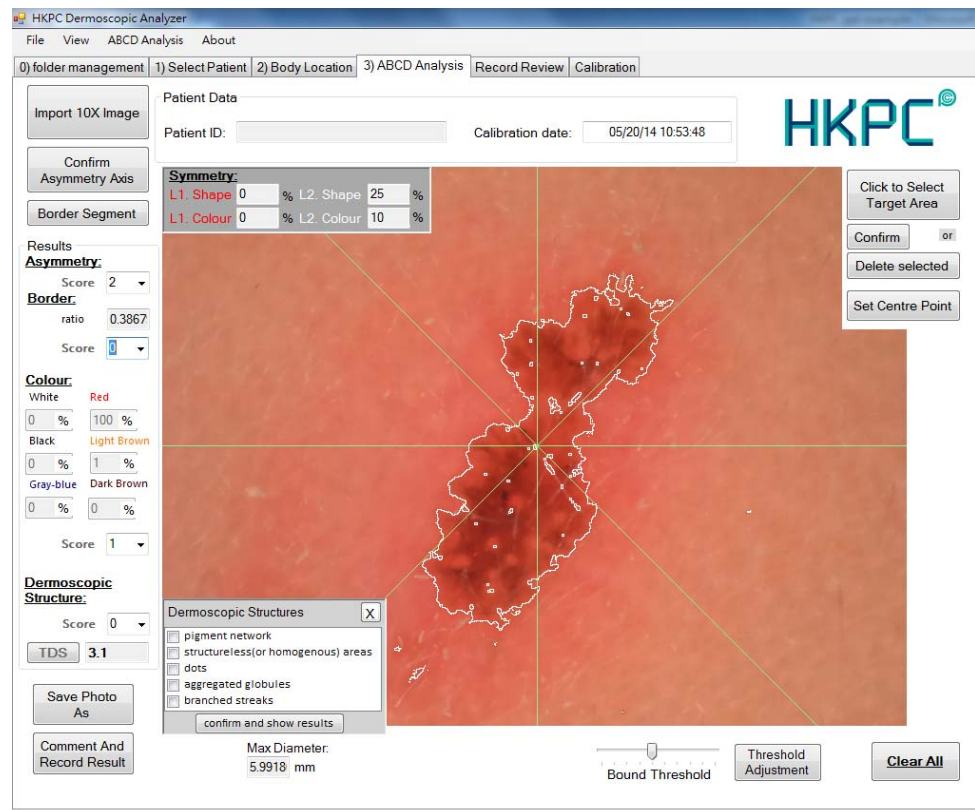# Blue Naevus - wlh

TDS:3.6
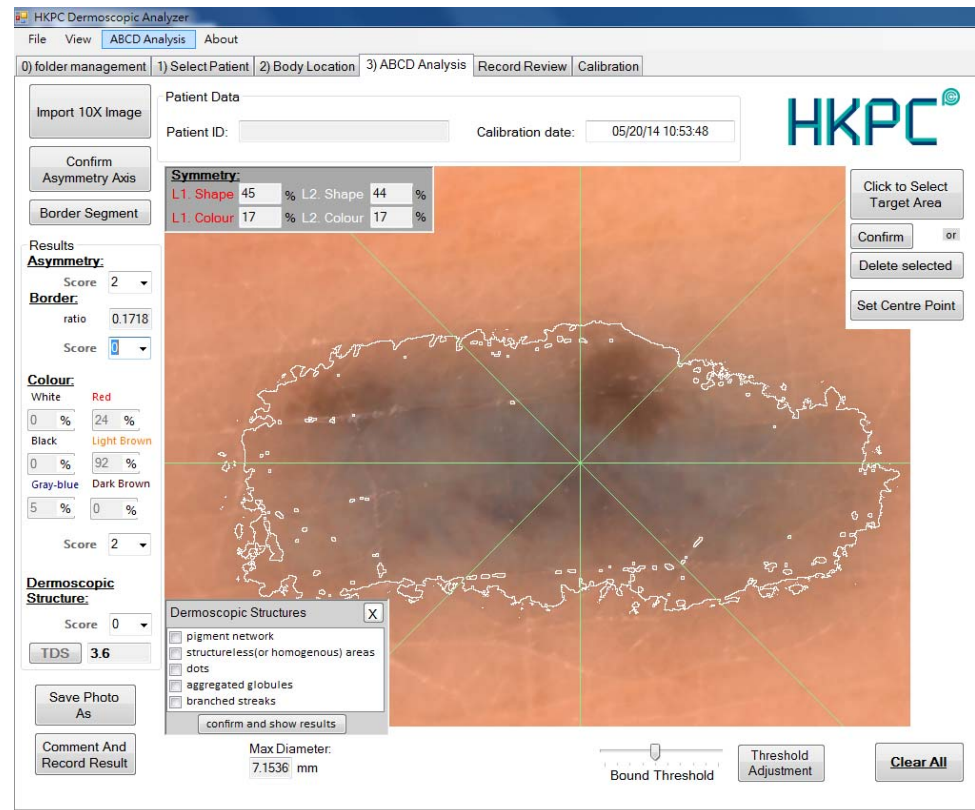
Nevus compound – yly 103530q

TDS:3.1
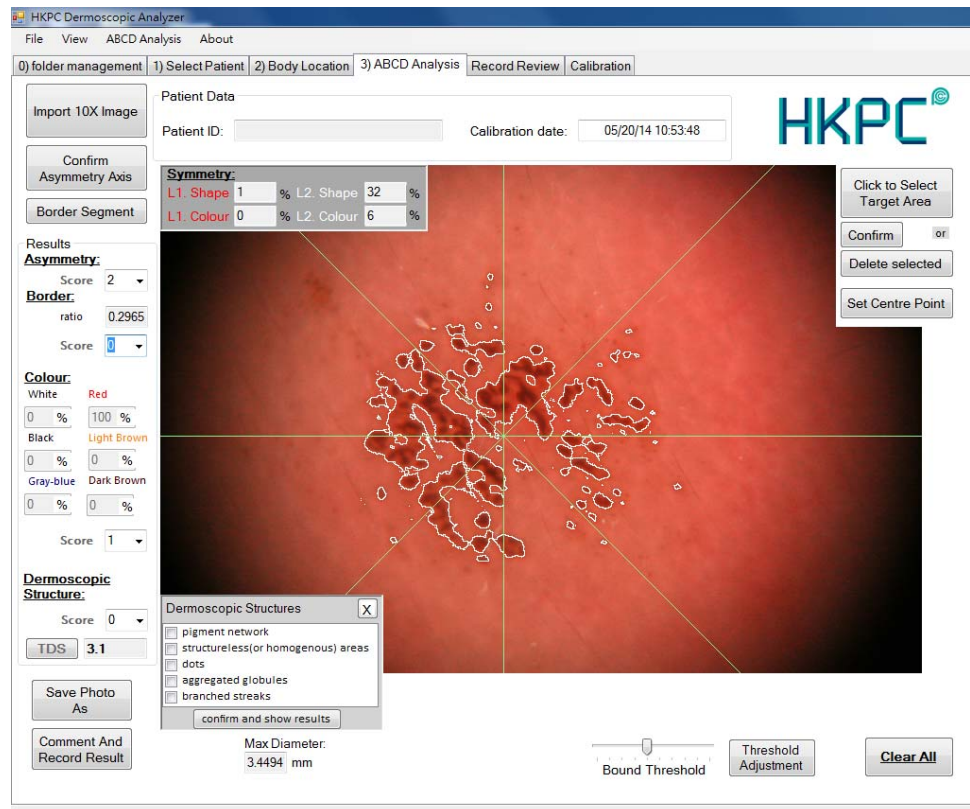
Nevus face - naevus face akhi vember pharmacist
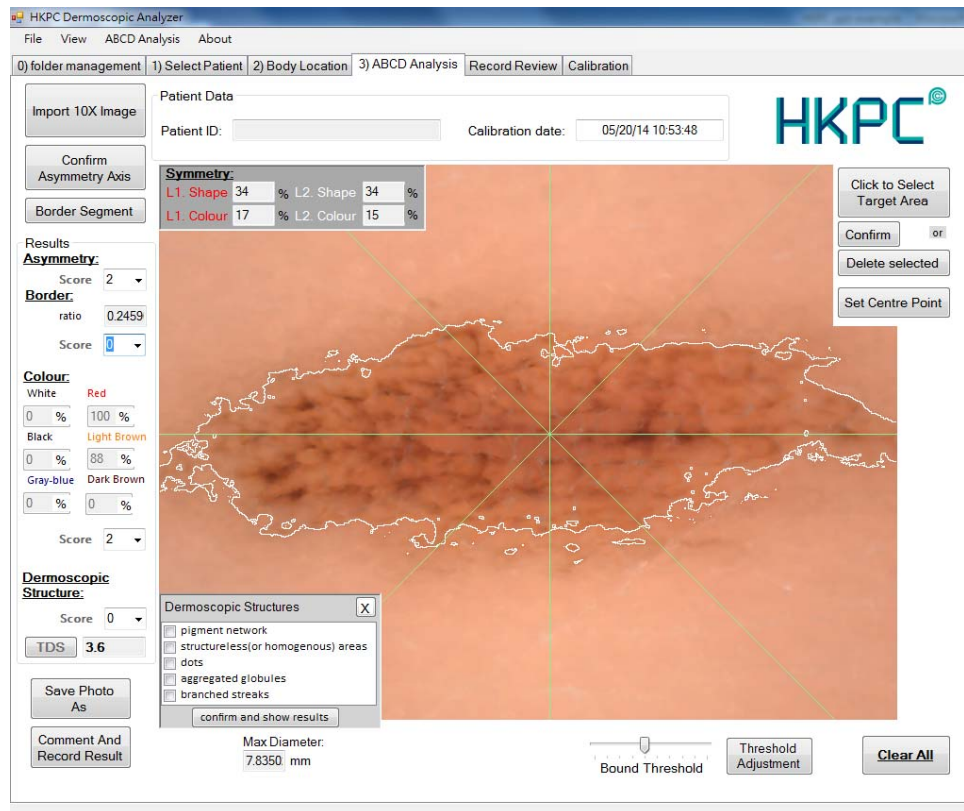
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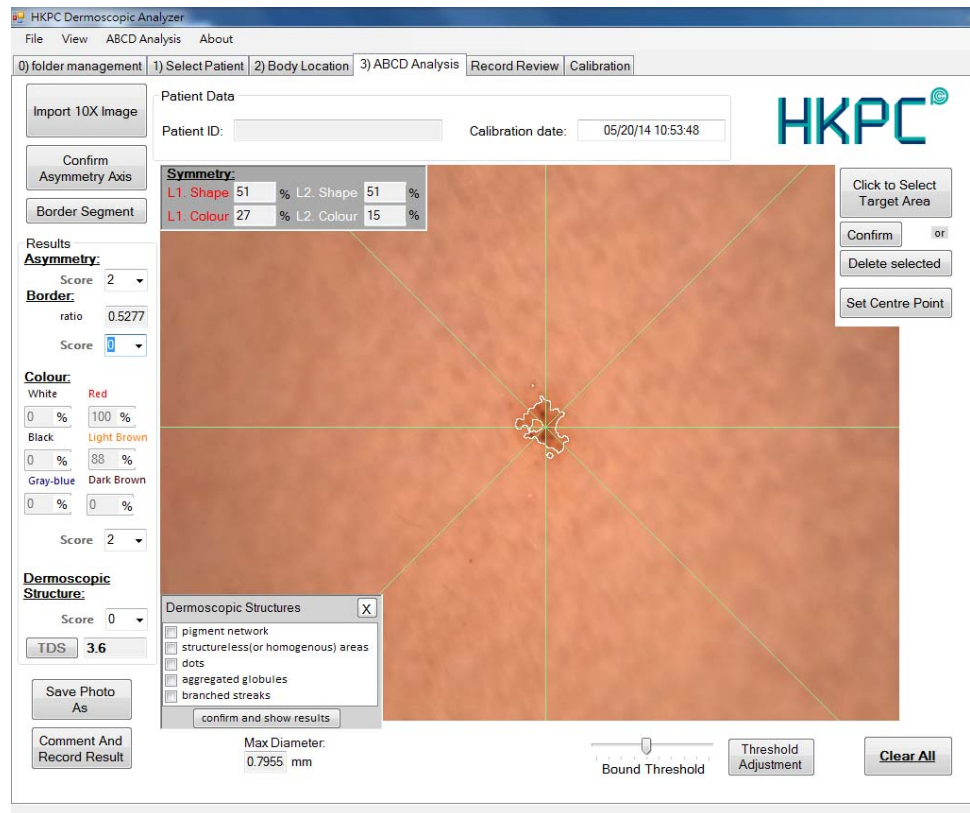
Nevus face - yhd

TDS:3.1

Nevus foot – shn 17 yo

TDS:3.6

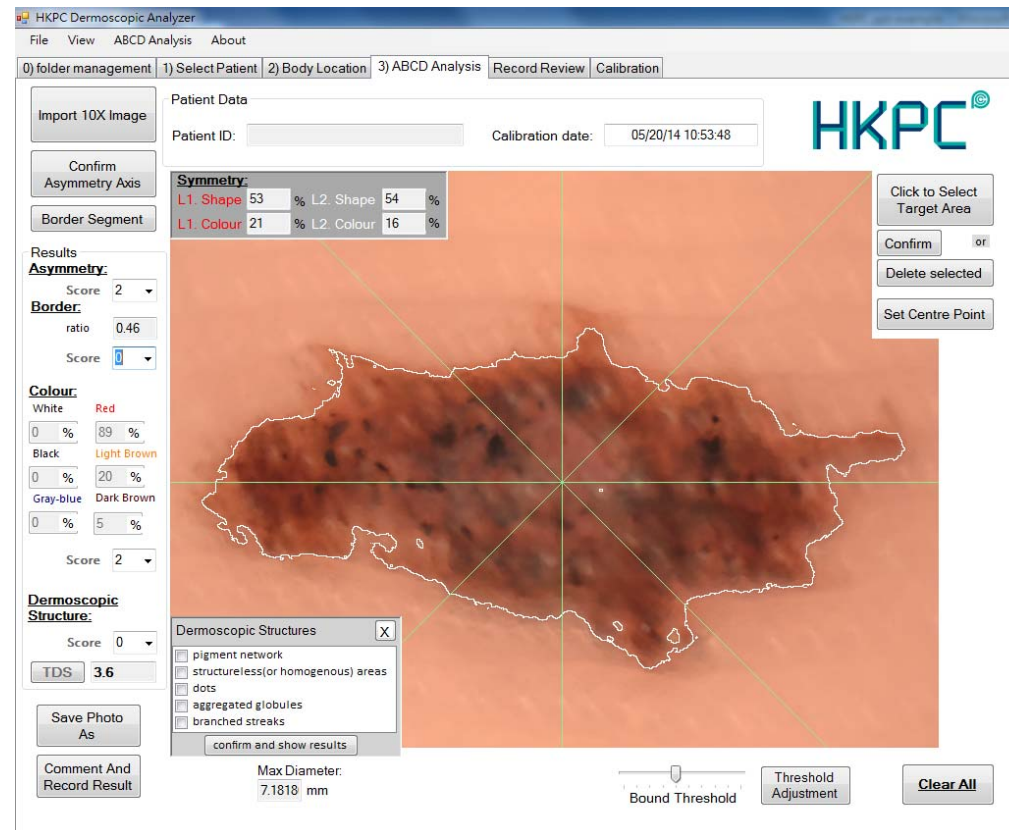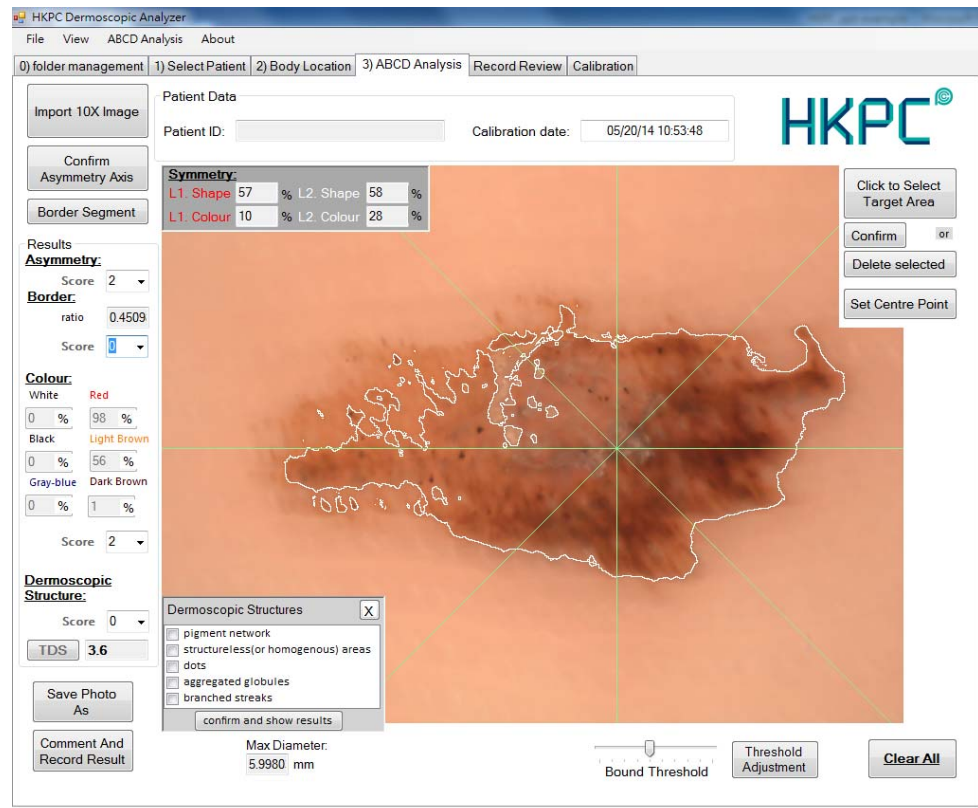# Nevus foot – ty, SAM_0246

TDS:3.6

Nevus foot – ty, SAM_4150

TDS:3.6

Nevus reticular - Adolescent

TDS:3.6