Improving Fundus Camera Quality

Paul Galsworthy
Joint Programme Manager

My Background

- 2003 – BA Hons Photography Degree
- 2008 – City & Guilds Diploma – Diabetic Retinopathy
- 2013 – PGDip Diabetes

- 2006-2007 MI/EMIS/Northgate – Trainee Screener/Grader
- 2007-Present – Joint Programme & Grading Centre Manager
  I also undertake weekly clinics and do Primary – ROG Grading

- Visiting Lecturer – Aston University – School of Life Sciences (Optometry)

- Clinical Professional Group – DES – Camera Assessment Panel
- Clinical Professional Group – DES - Grading
- EQA Peer reviewer for PHE

Financial Disclosures

Kowa Cameras (Sense Medical) - Product development (Current)

Public Health England - Peer review/EQA Visits (Current)

Global Diagnostics - ROG Grader for ROI DESP (Current)

Zeiss Cameras - Product development

Health Intelligence - Software evaluation project

Public Health England - Tender evaluation/award panels

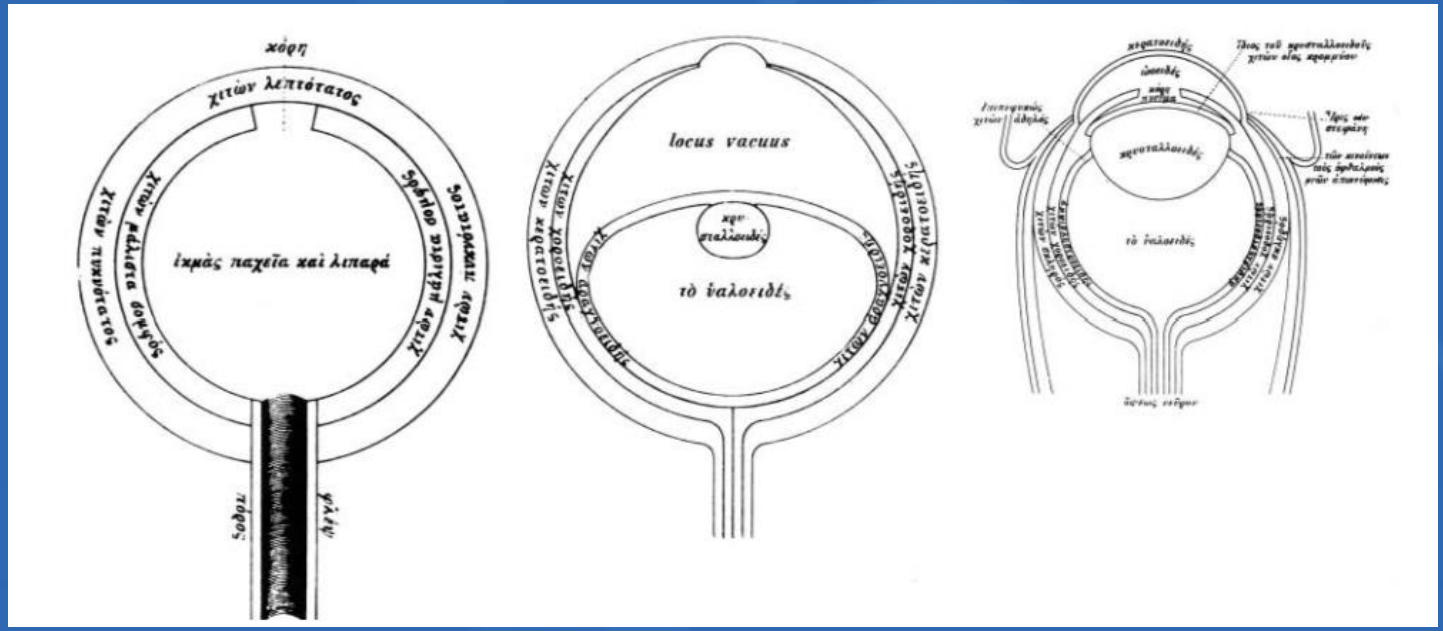
Disclaimers

The content and opinions within this presentation are that of my own and my programme from my/our experience of using and testing cameras for our day to day activities as a service

I am currently undertaking some paid work with Sense Medical (Kowa Cameras) advising on improvements to current cameras and future models – so I will talk a little about that!

It is NOT the opinion of NDESP, PHE or that of BARS

History of fundus Imaging



Democritus 400 BC - Celsus 400 years later - Galen's eye, from about 150 AD

History of fundus Imaging

c1851 - Ophthalmoscope was invented

C1860 - First attempt of fundus photography was attempted on animals

c1886 - Jackman & Webster captured first human fundus photograph (2.5 minute exposure)

c1888 - Howe & Barr refined the process

1921 - Dimmer published first “reliable photographs” using a complicated research camera

1926 - Nordenson & the Zeiss Camera Co. marketed a commercial device

1959 - First fluorescein angiography (FFA) performed

1991 - OCT Imaging introduced

1999 - Optos Ultra Wide Field Imaging

2014 - OCT Angiography imaging

More recently wide field OCT

1886 - First fundus images

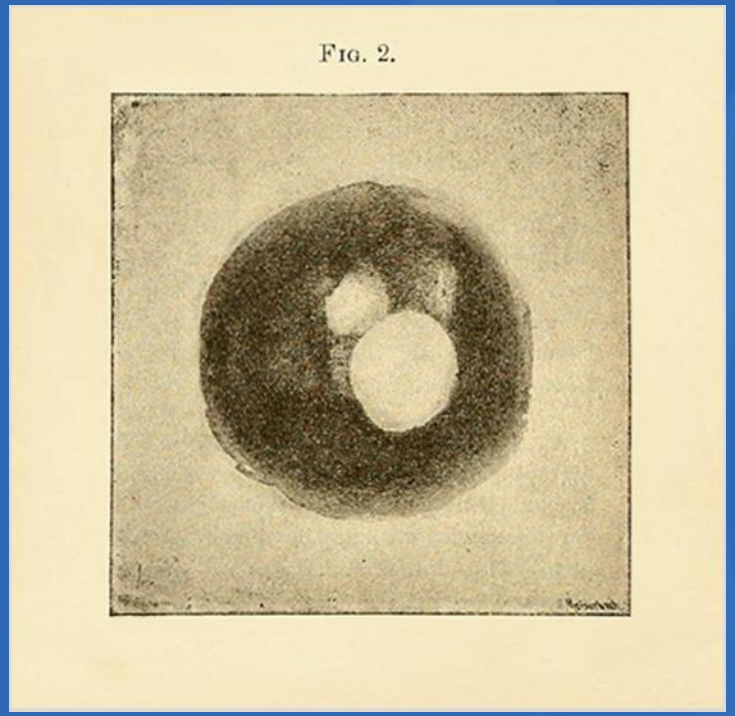


Fig. 2.

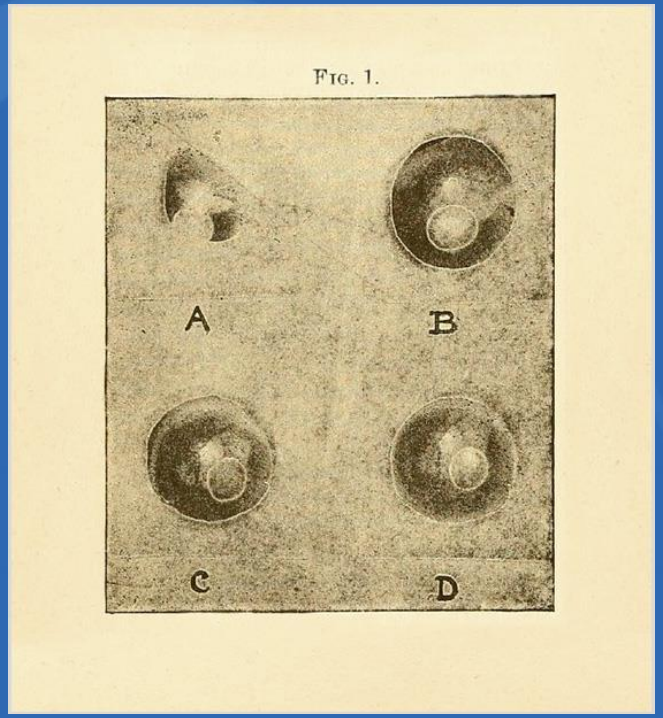
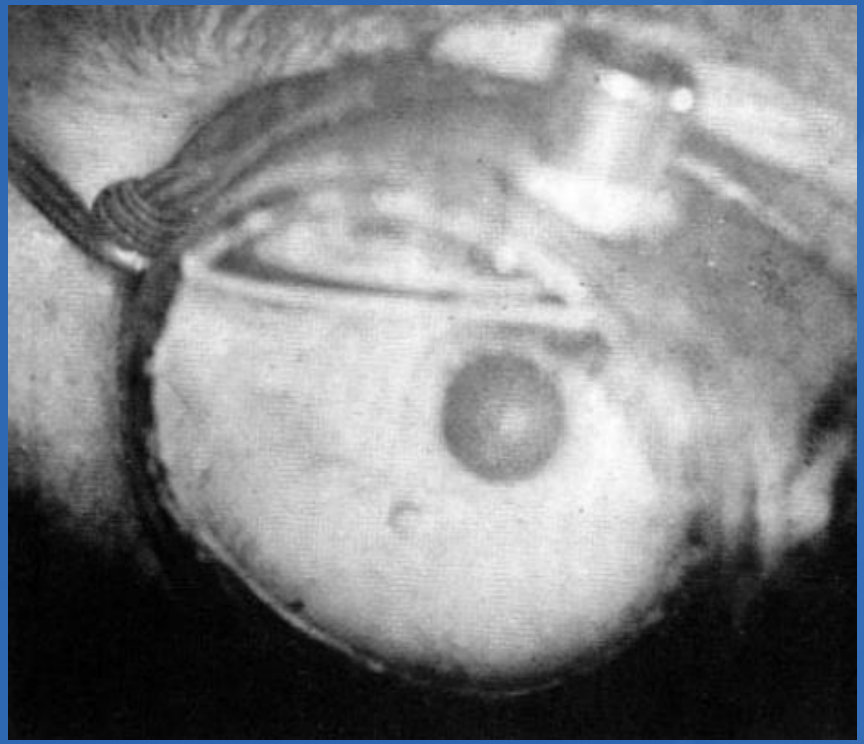
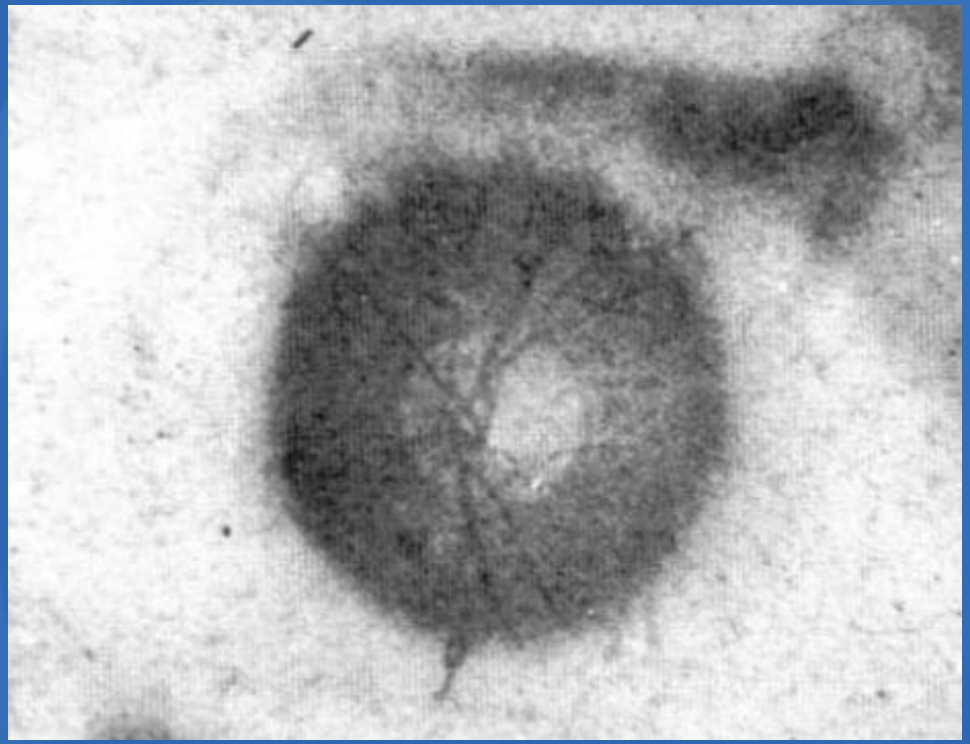


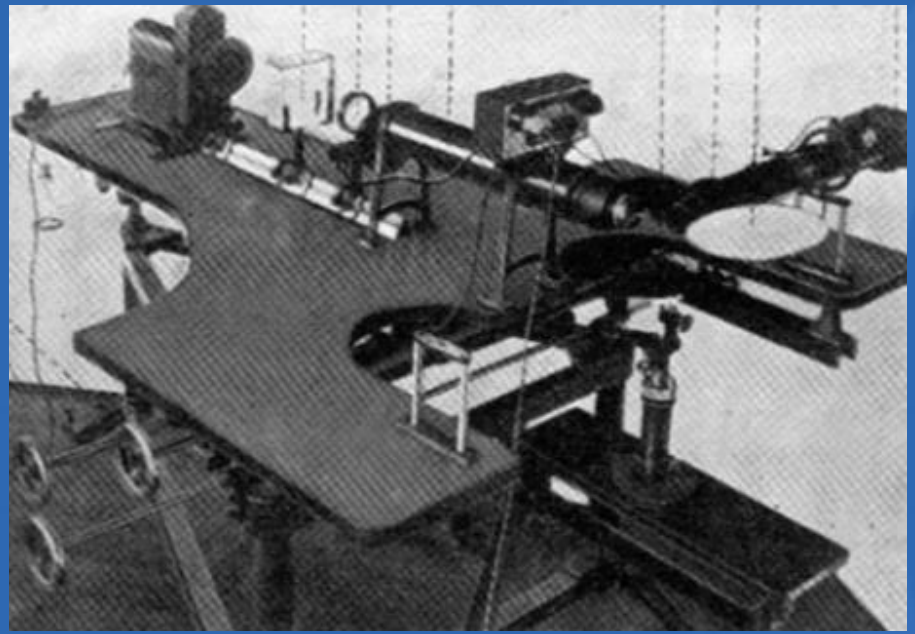
Fig. 1.

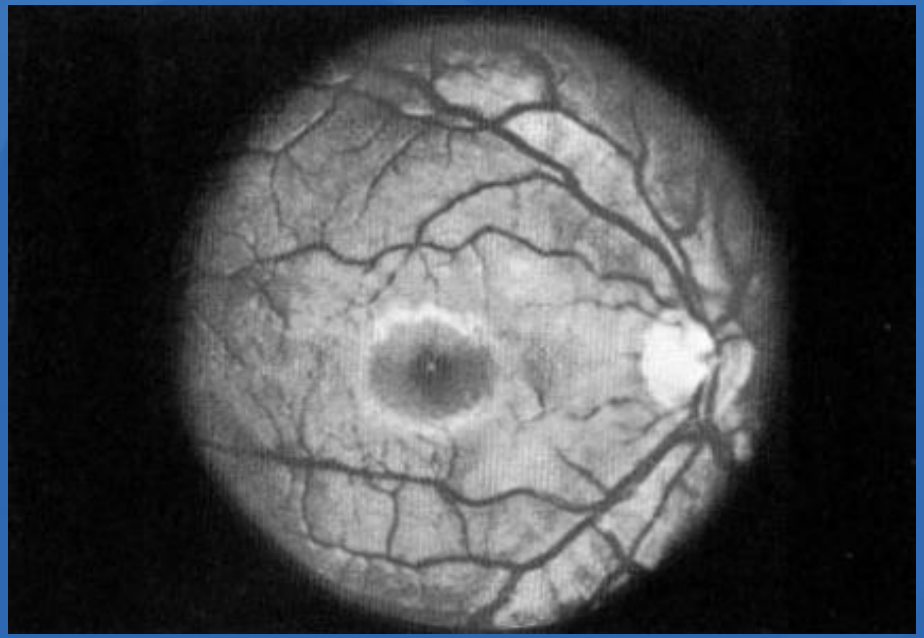
Early Electronic Flash 1891





1900s Camera





1932 – Advert of the first commercial camera available

ZEISS

Reflex free
RETINAL CAMERA after NORDENSON

AN instrument of simple construction which can be used in any hospital or private office without special training in photographic technique. To obtain a satisfactory record of fundus condition is a matter of minutes only.

Price $768 f.o.b. N.Y.

CARL ZEISS, Inc., 485 Fifth Ave., New York
Pacific Coast Branch: 728 South Hill Street, Los Angeles, Calif.

Rational for this talk...

One of my PHE/DES roles is that of the camera assessment team

I have tested every camera approved on the DES approved list with Optometrist & AOP legal advisor Trevor Warburton. As screener & graders we understand the devices better than PHE/DES

Phil Gardner and Patrick Rankin currently oversee the camera assessment process and are present on camera assessment days from a PHE/DES point of view who understand the legal, contractual NHS supply chain side of things better than we do

Current assessment Process

- Manufacturers are informed of a planned camera assessment date
- Manufacturers apply to submit a camera for testing
- They are sent an application pack including the current camera specifications to ensure the camera is fit for purpose and appropriate for testing
- If the camera meets camera specification its added to the list of cameras to be tested
- We often will test about 4 cameras on a given assessment day, and do 1 or 2 a year

Current Specification

Huge list of criteria however some key points:

- Camera must take 45 degree fields of view (All studies on screening/grading are based on this)
- Camera must have internal and external fixation targets
- Must incorporate a viewing screening to aid, focus and capture
- Must be able to be operated manually if has automated functions
- Must be able to take the 4 DES standard colour images within 2 minutes
- Must be capable of taking an anterior chamber image plus additional wider field fundus images
- Must come mounted and have a chin/head rest
- Must meet a minimum resolution (30 pixels per degree)
- Must be portable/manoeuvrable (e.g. GP practice Screening)
- Must meet EU/CE quality standards and medical devices regulations

Current assessment Process

On the day.....

•A PHE/DES member of staff eyes are dilated

•Each manufacturer sets up their camera, table and software

•The manufacturer takes the best 4 DES images they can

•Assessment team may wish to have a go using the product if it appears “unconventional” e.g. No joystick to operate

•Following the physical test of the devices, Trevor and I discuss the operation of the camera and image quality i.e. even exposure, noise/grain/ fine vessel detail at fovea and OD

•Images from current tested cameras can be benchmarked against one another

Real life (Programme clinic testing)

There are limitations of only photographing one person , although it gives a good reference for all devices tested it does not take into consideration real life scenarios such as:

- Age
- Ethnicity
- Patients mobility
- Head shape, size, pupil distances
- Poor pupil dilation
- Language – being able to follow instructions and comply with test
- How easy it is to use internal/external fixation targets or fingers
- Can the patient still see you when positioned on the camera
- How does device link with screening software (Optomize/Vector/Spectra)

My Programme

Birmingham programme has 128 cameras, by 5 Manufacturers, range of 11 different models

80% Topcon - NW6, NW8, NW400, OCT 2000
10% **Nidek** - AFC 210 & AFC 330

10% mix of:

Canon - DGi, CR2

Zeiss - Visucam 200
Kowa - Non-Myd7 and 8

So our screener/graders are used to seeing varying results from different cameras and we all have our own favourites to use and ones we prefer grading the images of

Real life (Programme clinic testing)

Following my own experiences within my programme and having received a few concerns from other screening programmes about “approved cameras” image quality

I have been trying to undertake independent “real life” camera assessments within our clinics

Testing an approved camera for a couple of weeks on “real patients” and feeding back findings to manufacturers to improve/develop their current & future products

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Zeiss, Canon, Topcon, Kowa and Nidek have all made some efforts to or in process of trying to improve some of the issues we have pointed out

Findings

Many manufacturers new devices have gone backwards in regards image quality

A shift towards poor quality internal sensors instead of good quality Nikon/Canon SLR backs – Less SLRs are being produced due to smart phone popularity

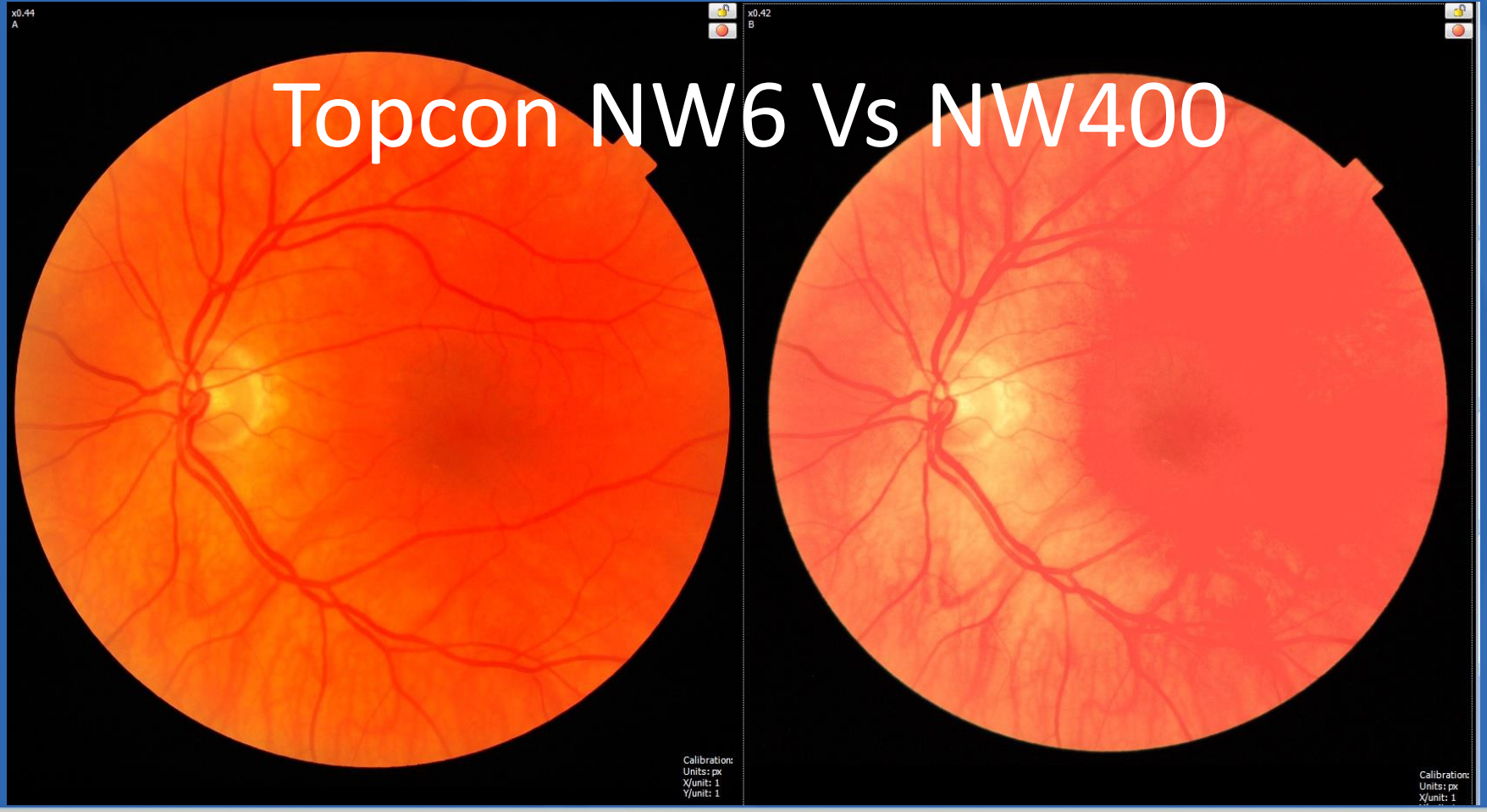
Cameras are too clever for their own good (Auto focus, tracking, shooting)

Multiple functions in one device (Fundus/OCT/FFA)

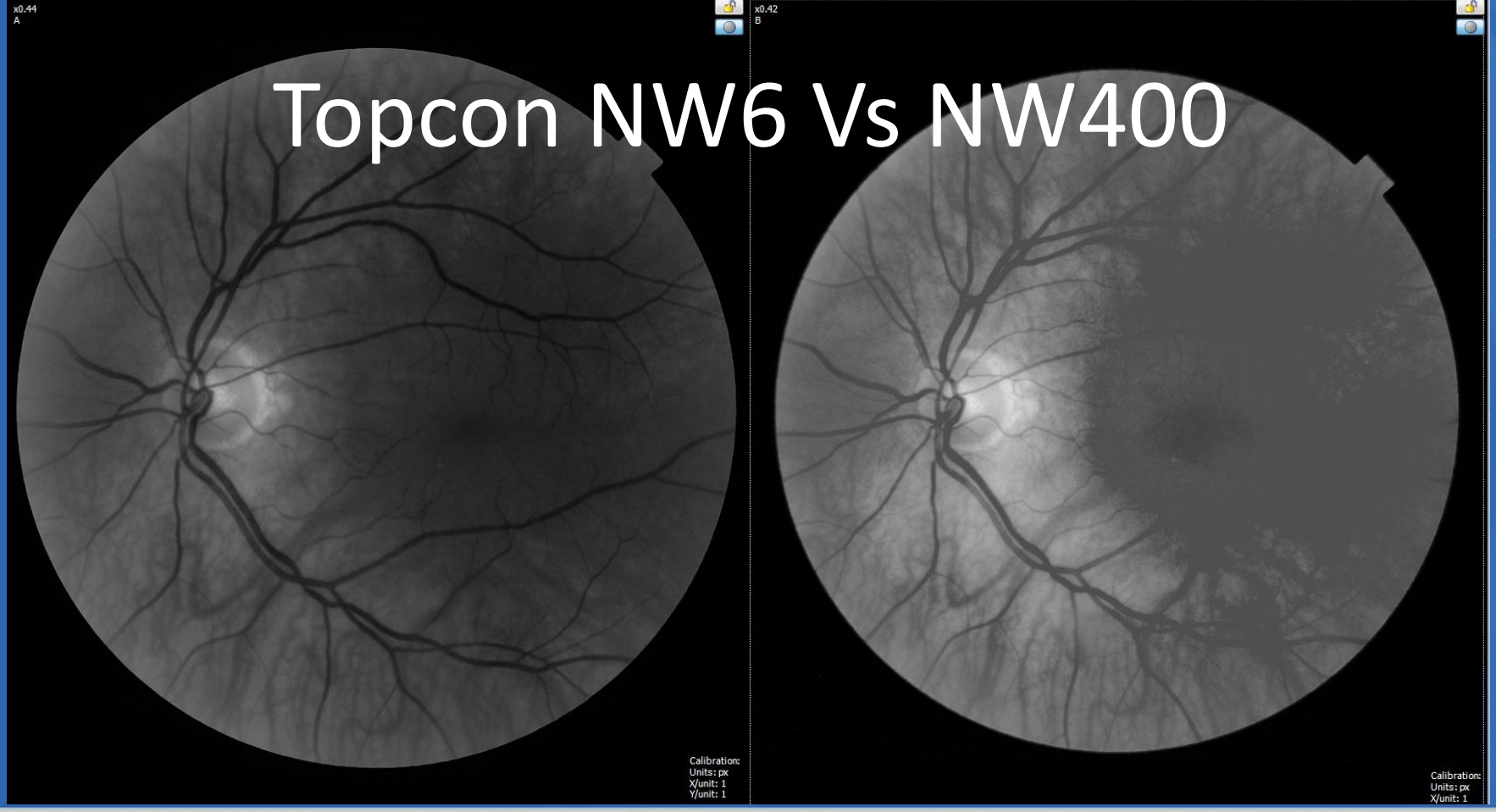
Less manual/conventional joystick control - move towards touch screen controls

Dependent upon use of device own software (GDPR issues &not plug and play)

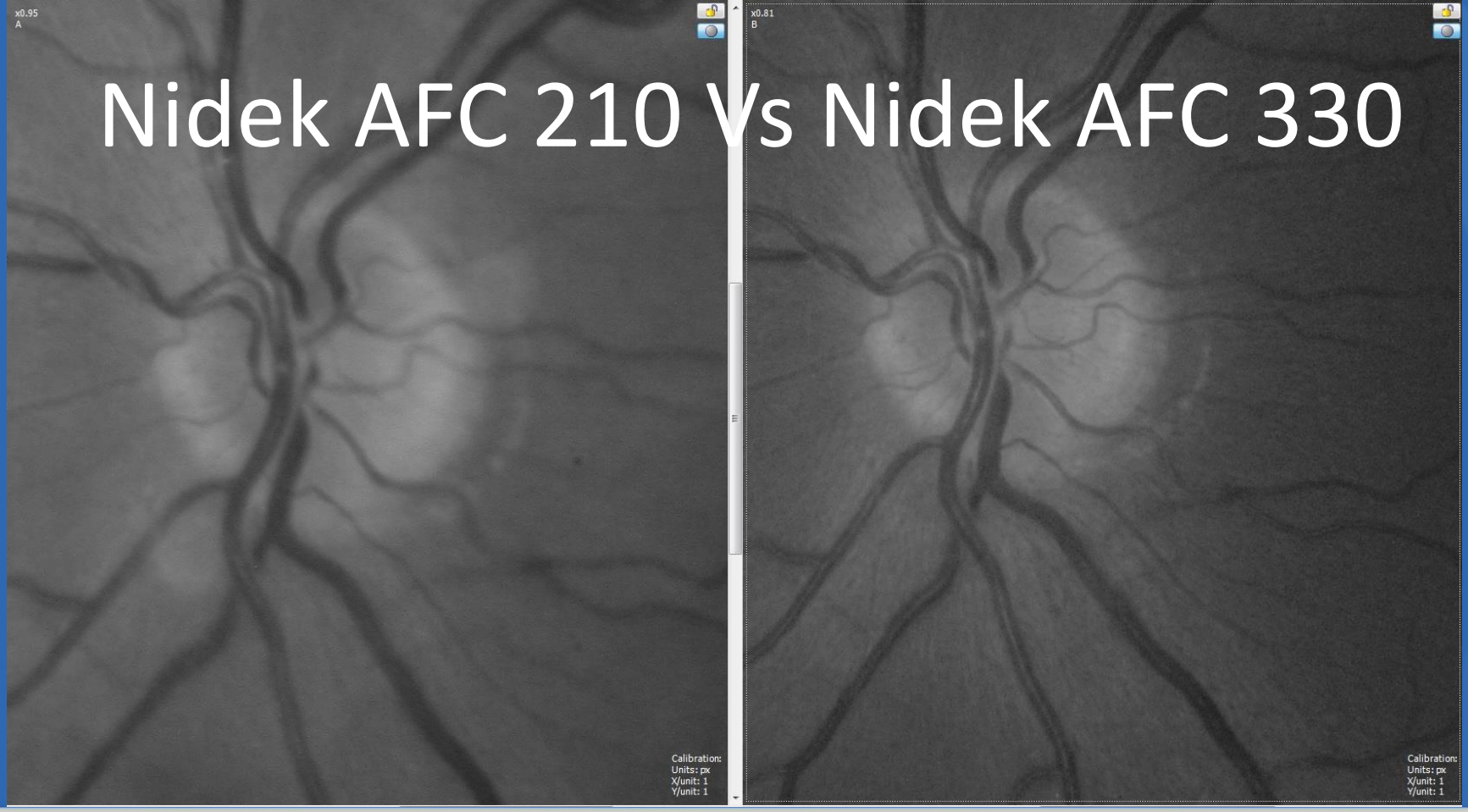
Topcon NW6 Vs NW400



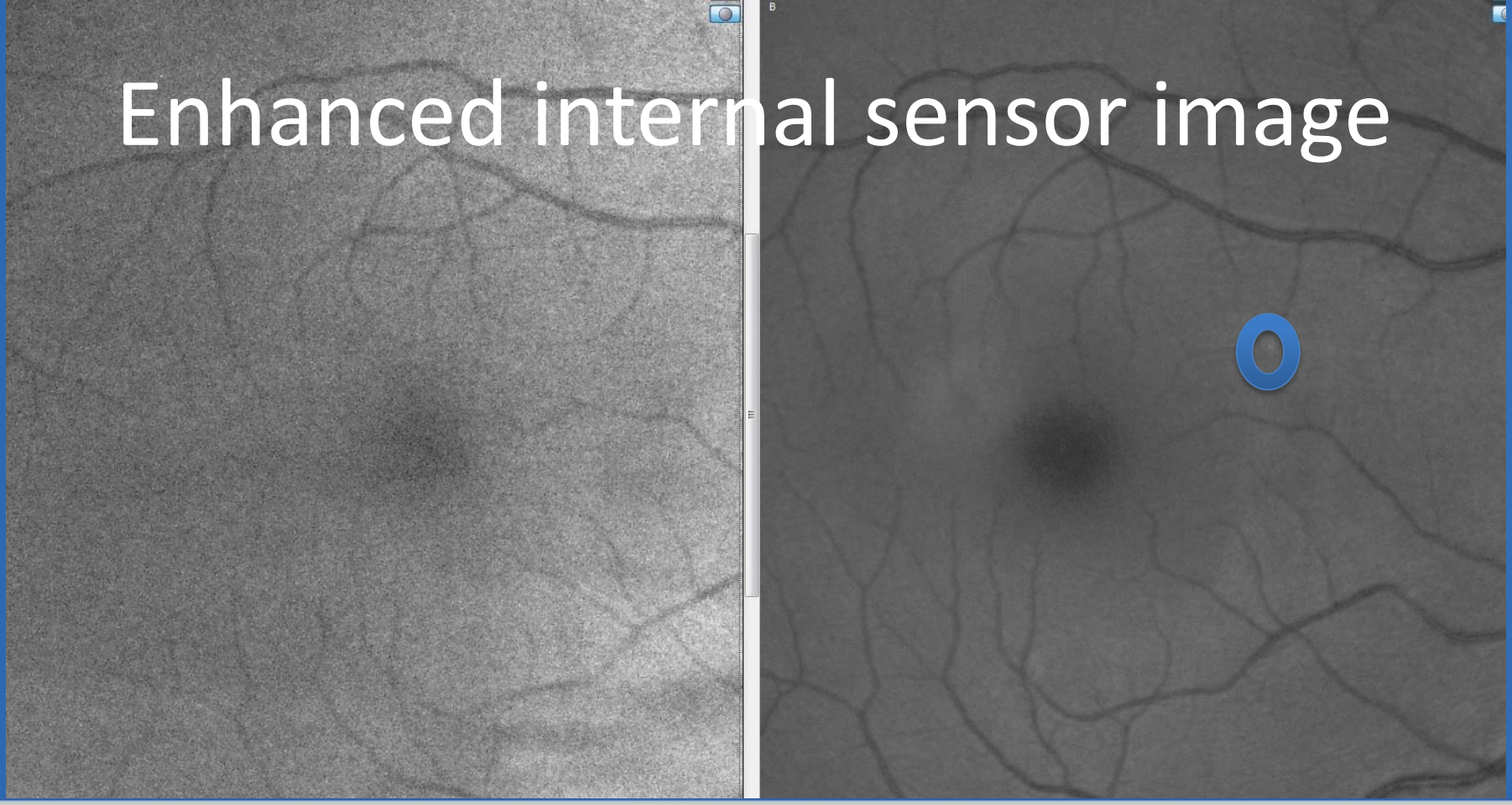
Topcon NW6 Vs NW400



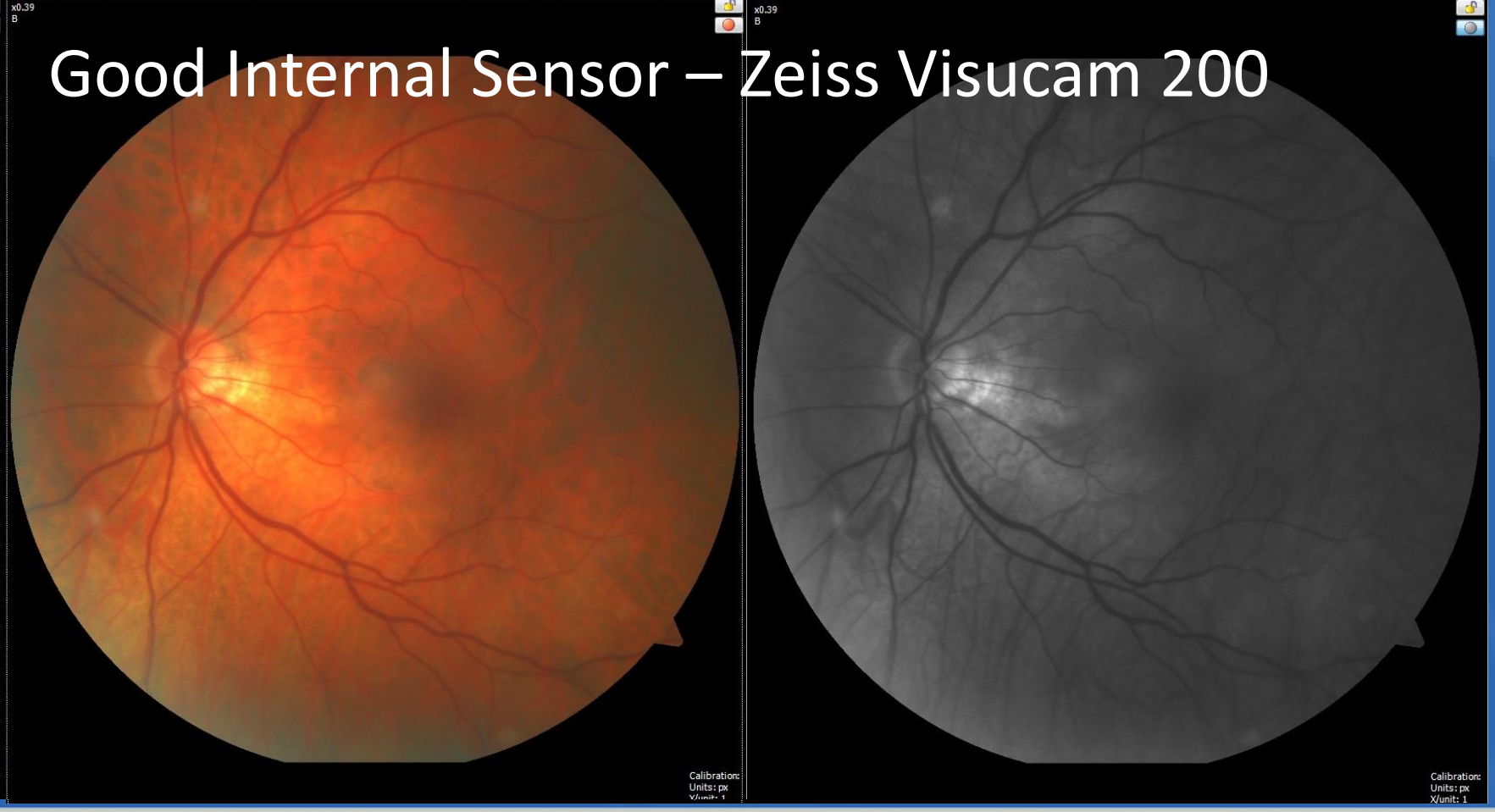
Nidek AFC 210 Vs Nidek AFC 330



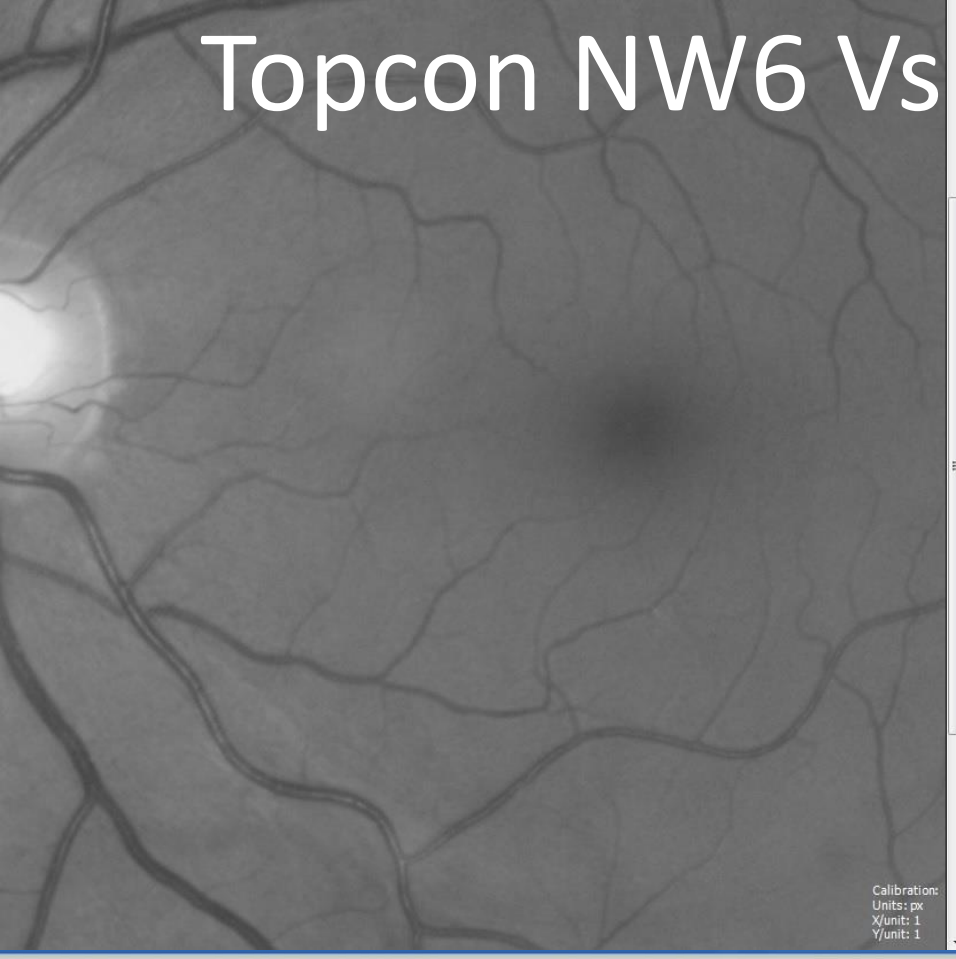
Enhanced internal sensor image

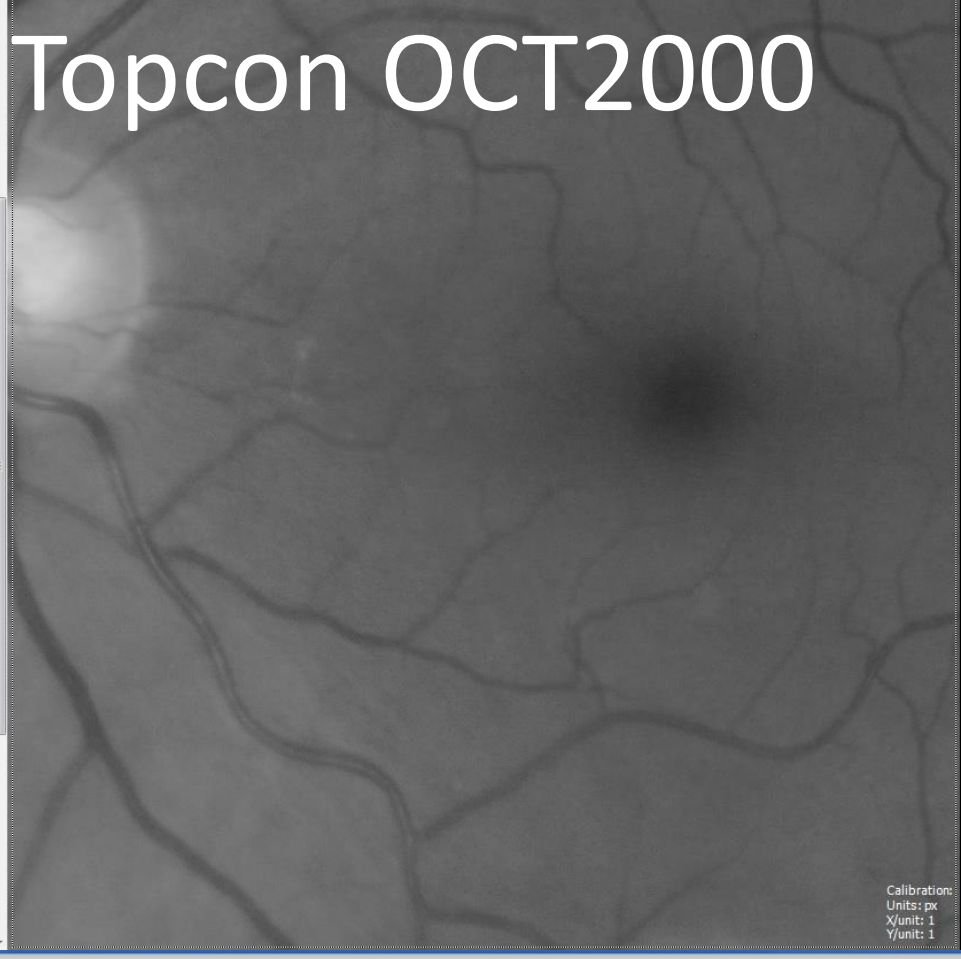


Good Internal Sensor – Zeiss Visucam 200

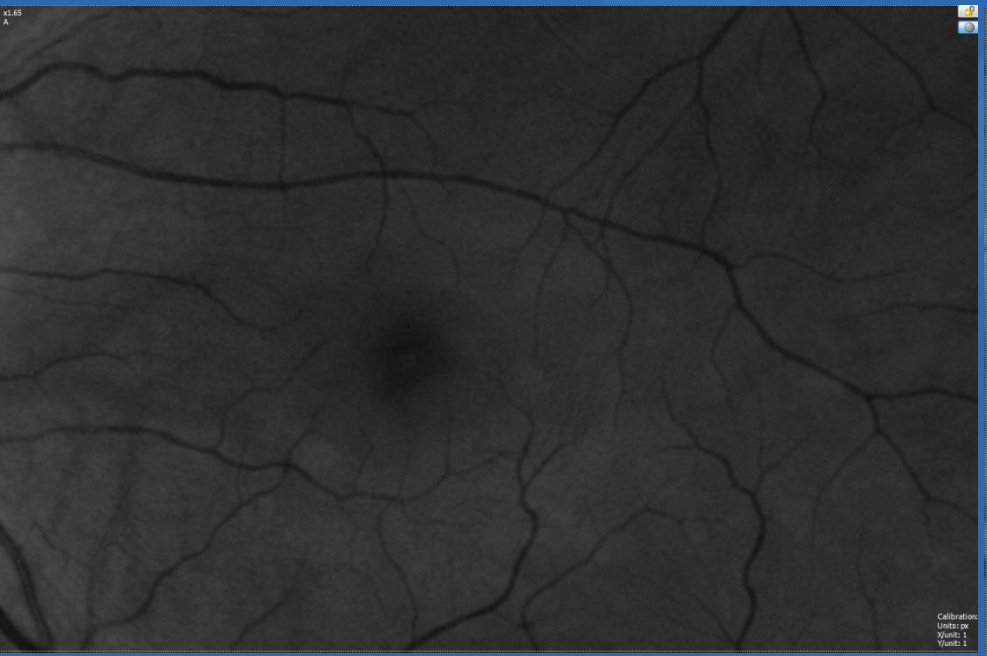


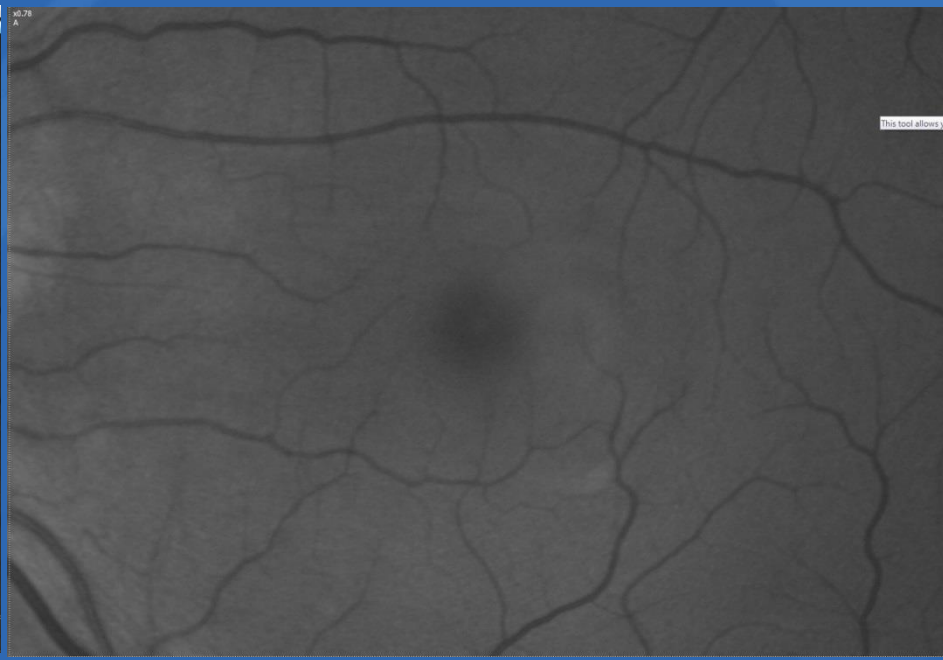
Topcon NW6 Vs Topcon OCT2000



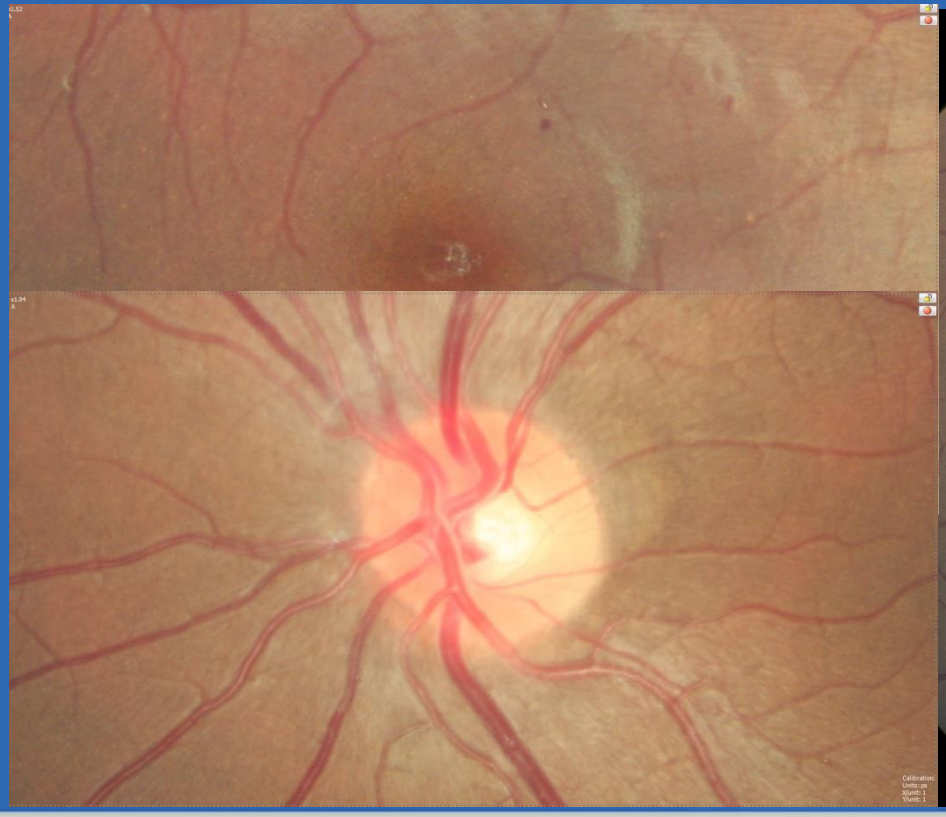


Topcon NW6 Vs Canon CR2





18 Yr old Canon CR6



The Future

New/Updated 2019 camera specification/assessment process to include:

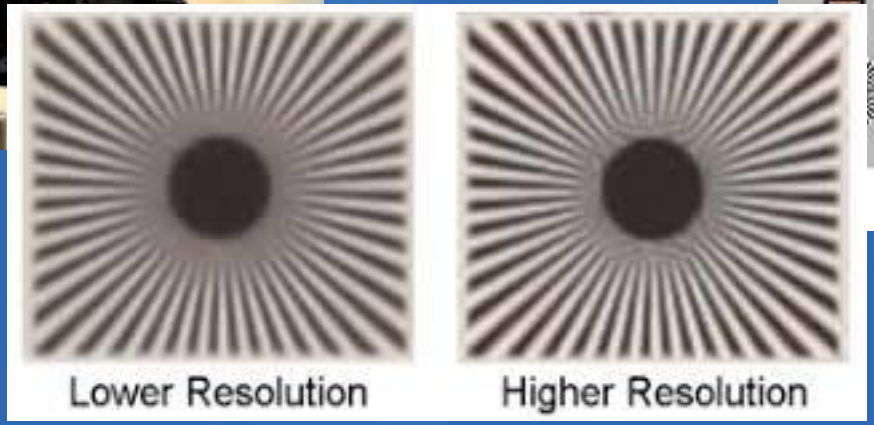
- Direct connectivity to screening software (Optomize/Vector/Spectra)
- Capture, transfer and save 4 DES images within 2 minutes
- 2 year warranty

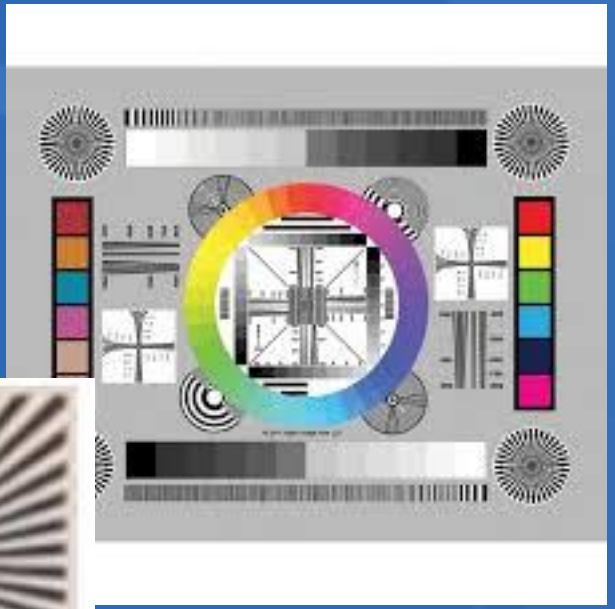
Large scale real life testing of wide field imaging:

- Do we pick up more disease
- If so does it affect grade & outcome Vs current 45 degree images

An objective, measurable method of testing lens & image quality

Such as....





Or....

New Fundus Cameras

PHE/DES have already received interest from the following to test new screening cameras:

- Topcon
- Nikon/Optos
- Kowa

All will be likely to face the new camera specification/assessment criteria and as a result changes may need to be made to meet screening standards.

New Fundus Cameras

We cannot continue to carry on with substandard image quality or usability

The specification/assessment process must be more robust for both users & patients

Image quality and ability to accurately detect a single MA/haem is more important than ever:

extended screening intervals (correct recall date for disease/no disease presence)

diabetes management (risk factors of development to STDR)

New Kowa coming soon...

All new Optics – superior to current/past models

Internal CCD sensor - Can be replaced like an SLR

Direct connectivity (plug and play)

Optional Auto focusing, shoot, flash compensation modes

If it passes the PHE/DES specification/assessment !

So what would I recommend?

So what would I recommend?

No. 1 for Image Quality

Canon CR2

Pros – Excellent image quality, Plug and play, less that £10k

Cons – Cheap build, small screen, worry about transporting

So what would I recommend?

Topcon NW8

Pros – Good Image & build Quality

Cons – Not at sharp as NW6
Requires Top connect & USB Dongle
Not cheap c£16k

So what would I recommend?

My Choice

Kowa Non Myd 8

Pros – Good Image & build Quality, Plug and play

Cons – Small halo on some macula images

So what would I avoid (at present)?

Nidek AFC 330 - Poor Image quality, clunky to use
Topcon NW400 - Poor image quality, too automatous, no Joystick
Zeiss Visucam 224 or 524 - Good Image quality, poor connectivity with screening software
Haag-Streit DRS - Slow, too autonomous, no Joystick

All combined fundus/OCT machines - Topcon OCT Maestro – Poor Image quality
- Nidek Duo – Poor Image quality & connectivity

Best OCT models - Topcon OCT 2000 – Not great images
Zeiss Cirrus 600 or 800 – Good images however poor connectivity

Summary

Huge technological, medical & optical advancements in the world

Huge advancements in OCT imaging

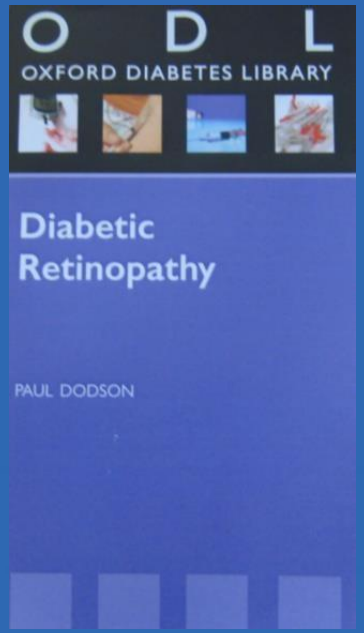
Positive advancements in wide field & scanning imaging - this needs large study to see measure image quality and outcomes for patients

Current 45 degree fundus photography image quality is getting worse - manufactures are generally trying to produce one device that will do lots of things and the fundus photograph appears to be the least important

Move to extended screening intervals whereby a single MA is more important than ever before

A robust specification and assessment resulting in greater image quality and therefore detection of disease in vital for patients

Coming Soon...



Second Edition due early 2020

Revised/new chapters

Thank you for listening

Does anybody know of a good lawyer ?