

# NEW PERFORMANCE STANDARD: GAFCHROMIC FILM BASED DOSIMETRY SYSTEM

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Ashland Specialty Ingredients



# IDEAL DOSIMETRY FOR IMRT/SRS

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- ✘ Absolute dose measurement
- ✘ Precise and accurate
  - + Better level than the delivery
- ✘ Wide dynamic range
- ✘ Energy and dose rate independent
- ✘ Flexible positioning
  - + Any depth and angle

# NEW THERAPY MODALITIES

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- ✘ Trends in radiation therapy/surgery
  - + Less fractions
  - + Higher doses per fraction
  - + Tighter conformity
  
- ✘ Trending to a higher value on
  - + Spatial resolution
  - + Dynamic range

# PATIENT SPECIFIC DOSE VERIFICATION

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- ✘ Individual field

- + Fixed and rotating angles
- + Composite calculation

- ✘ Composite field

- + Like patient receiving the radiation
- + True end-to-end test

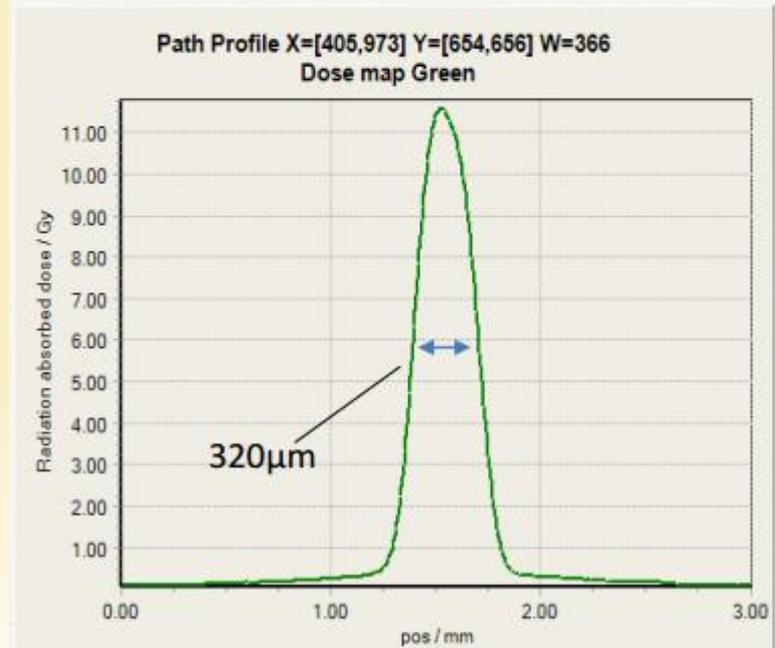
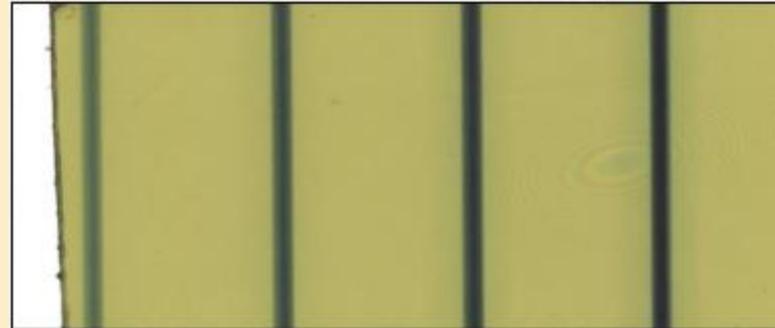
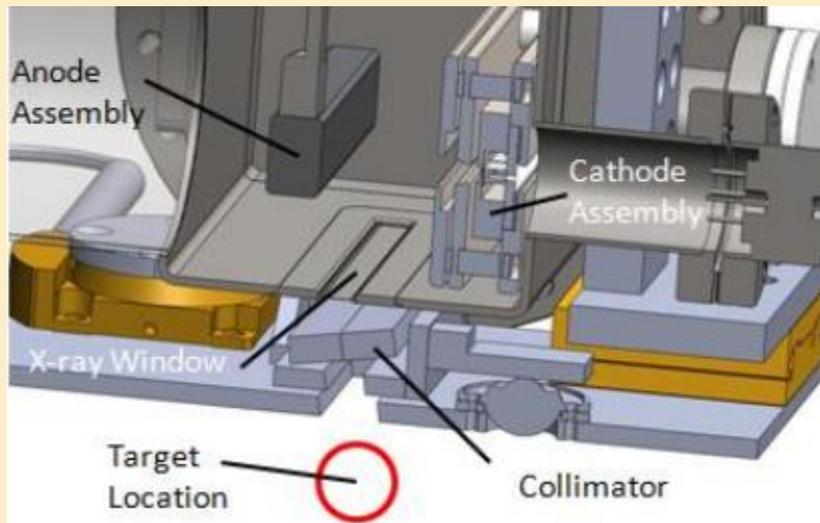
# GAFCHROMIC FILMS

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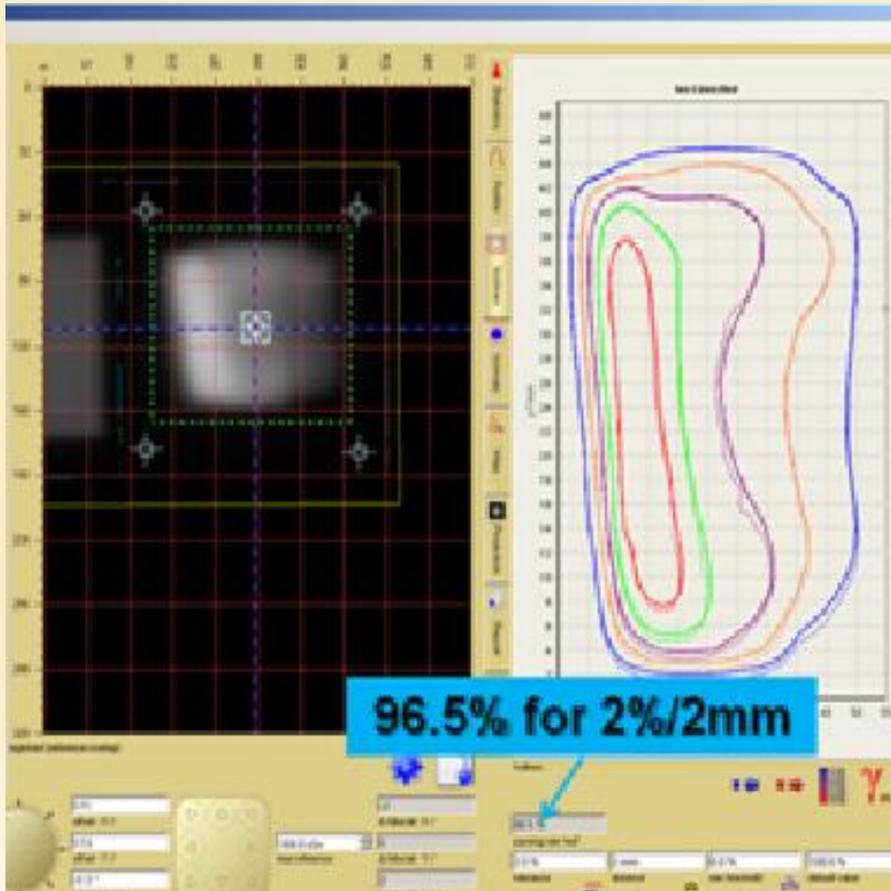
- ✗ Not your old wet film
  - + No processing
  - + Handle in light
  - + Cut to size
  - + Bend to shape
  - + Immerse in water
- ✗ Wide dynamic range
- ✗ High spatial resolution

New Software and Protocol make film use much more accurate and friendly

# SMALL FIELD – HIGH SPATIAL RESOLUTION

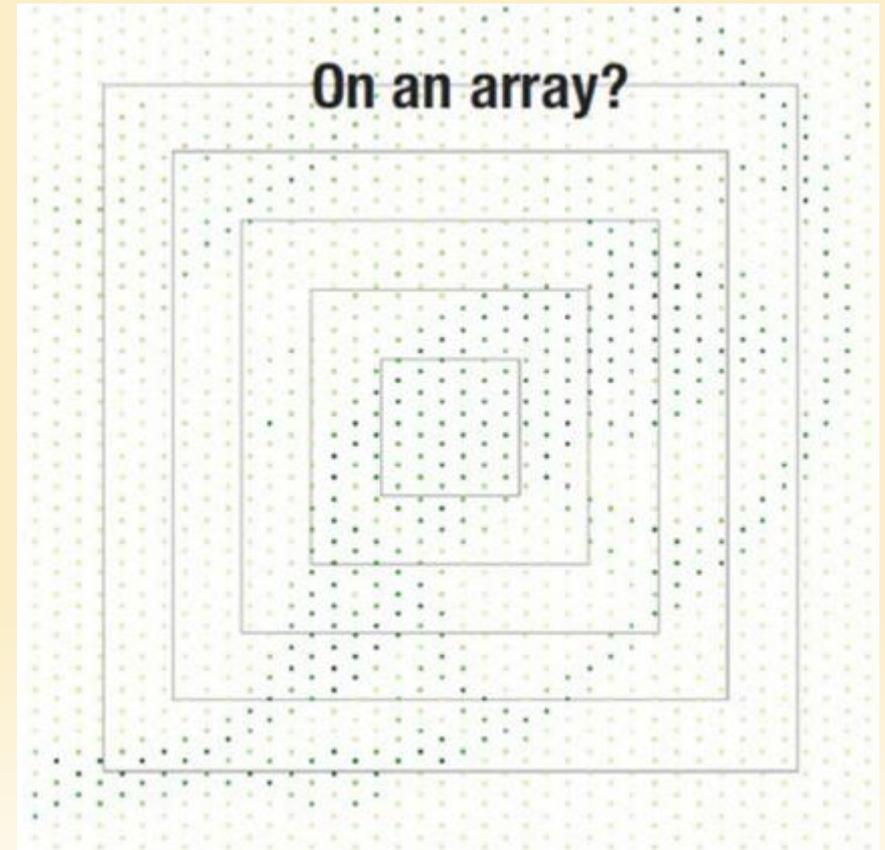


# SMALL FIELD DOSIMETRY CHALLENGES

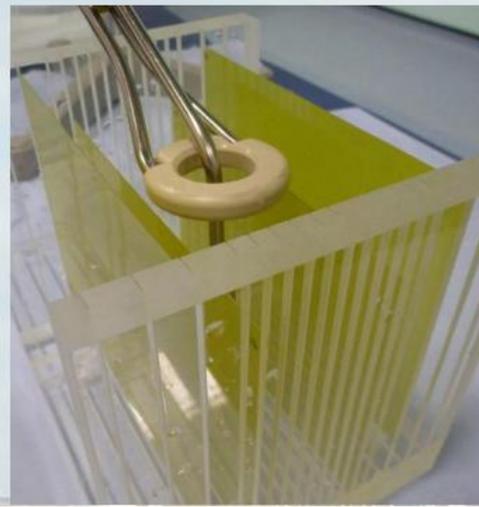
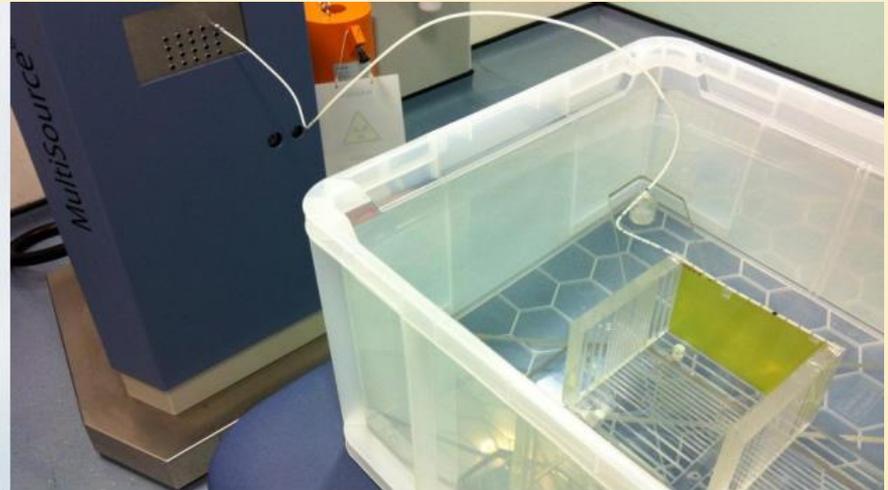
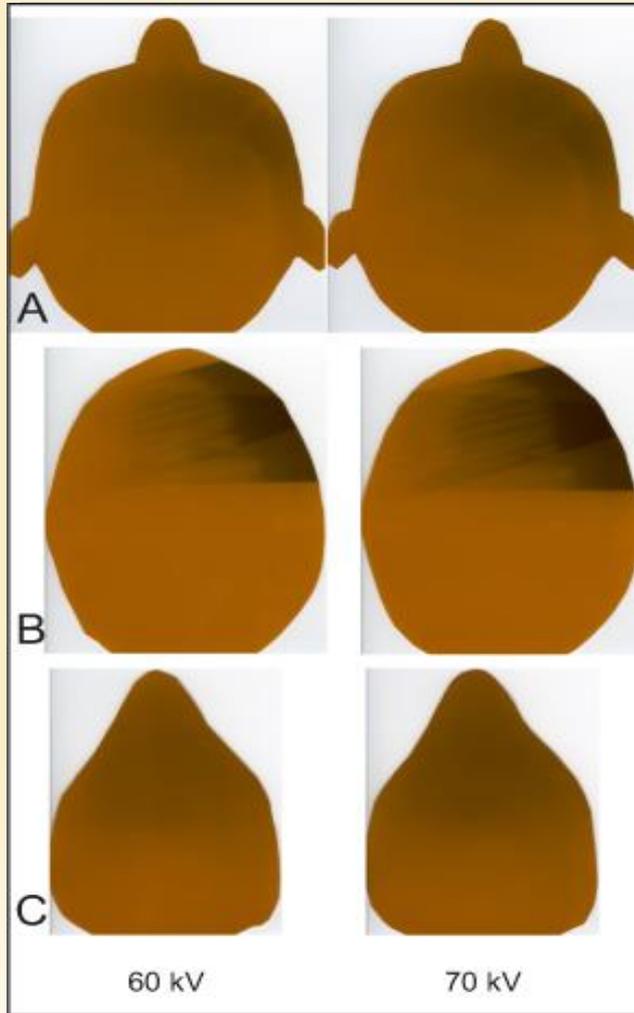


- ✘ In the first try
  - + Low passing rate with film
  - + Good passing rate with MapCheck
- ✘ Wrong beam profile
- ✘ Second try after corrected beam profile
  - + High 90% gamma at 2%/2mm with film
  - + No difference with MapCheck

# HOW DO YOU CAPTURE CHAMELEON

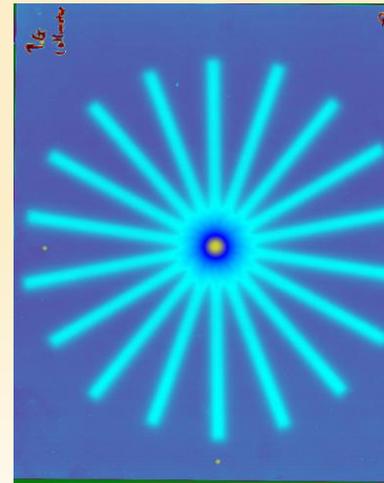
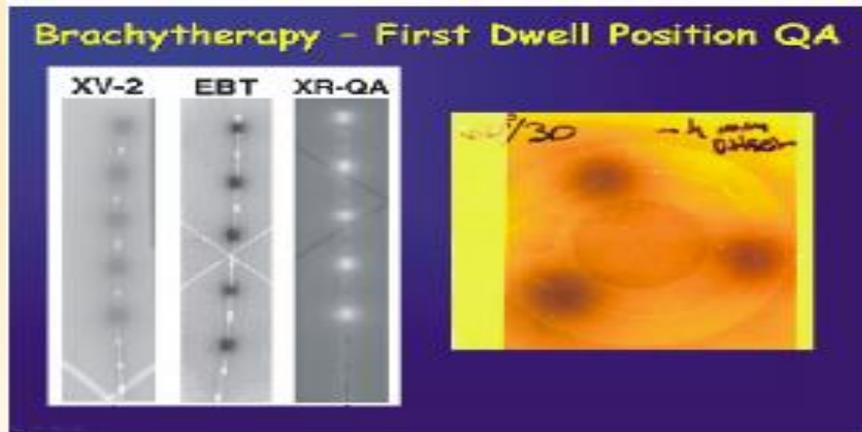
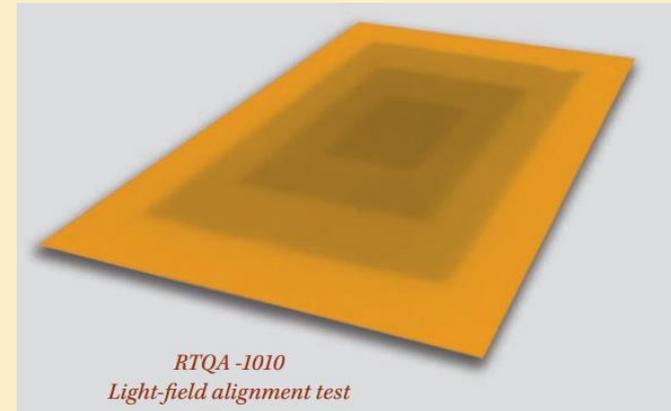


# MANY USES OF THE FILMS



# WHAT FOR BEAM LOCATION?

- Radiotherapy (MV photons, electrons, protons)
  - RTQA2 - 2 cGy to 8 Gy
- Radiology (kV photons)
  - XRQA2 - 1 mGy to 20 cGy
  - XRCT2 - 1 mGy to 20 cGy
  - XRM2 - 1 mGy to 20 cGy



# PRODUCT OFFERINGS - RADIOLOGY



**GAFCHROMIC<sup>®</sup>**  
**XR**

**NEW SOFTWARE!**  
**ISP FILM QA-XR<sup>™</sup>**  
See Inside!

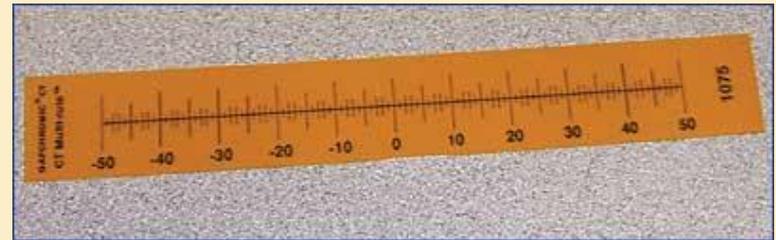
State of the art scanning software and processor-less film products *that save you time and money.*

CONVENIENT, ACCURATE AND COST-EFFICIENT TOOLS FOR RADIOLOGY AND DIAGNOSTIC APPLICATIONS

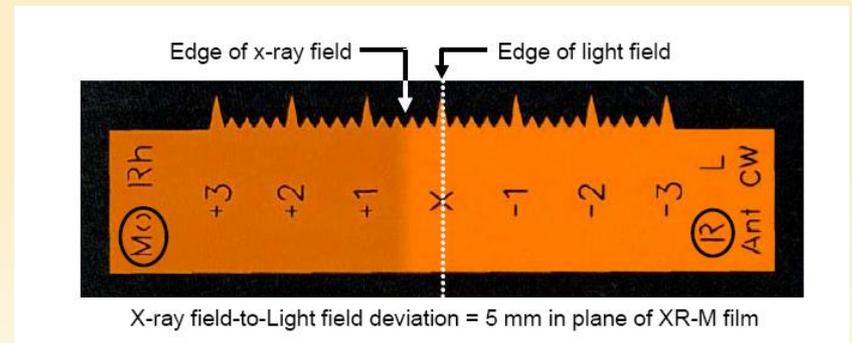
- XR QA2** FOR FILM QUALITY CONTROL
- XR CT2** FOR QUALITY CONTROL OF CT FILM
- XR M2** FOR FILM QUALITY CONTROL
- XR RV3** FOR FILM QUALITY CONTROL

**ISP**  
INTERNATIONAL SPECIALTY PRODUCTS

+ XR-CT

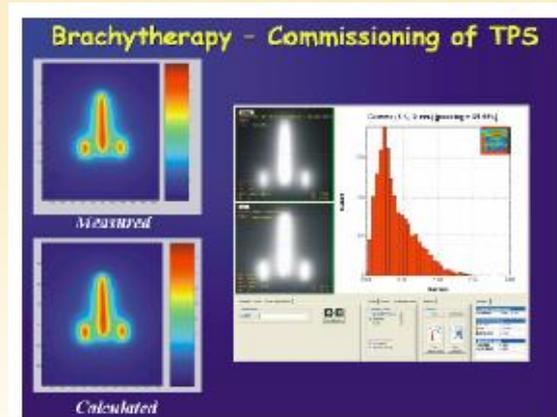
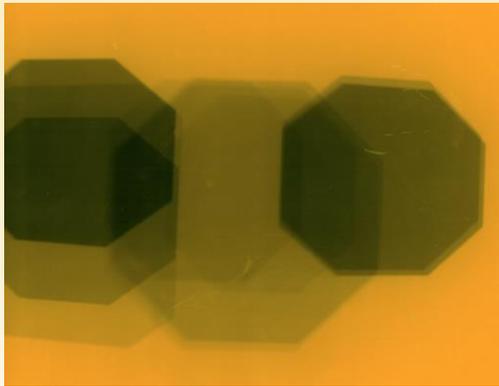


+ XR-M

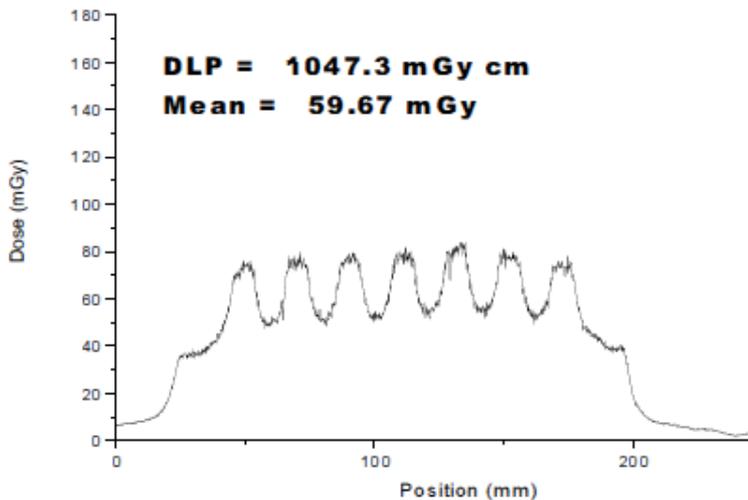
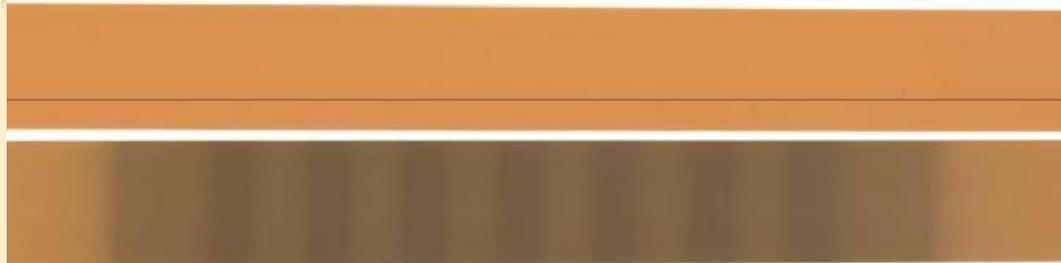


# WHAT FOR DOSE MEASUREMENT?

- Radiotherapy (MV photons/electrons/protons)
  - EBT2, EBT3 and EBT3+ - 1 cGy to >40 Gy
  - MD-V3 - 2 Gy to 100 Gy
  - HD-V2 - 10 Gy to 400 Gy
- Radiology (kV photons)
  - XR-RV3 - 5 cGy to 15 Gy
  - XRQA2 - 1 mGy to 20 cGy



# CT DOSE MEASUREMENT WITH XR-QA2



Pelvis Phantom

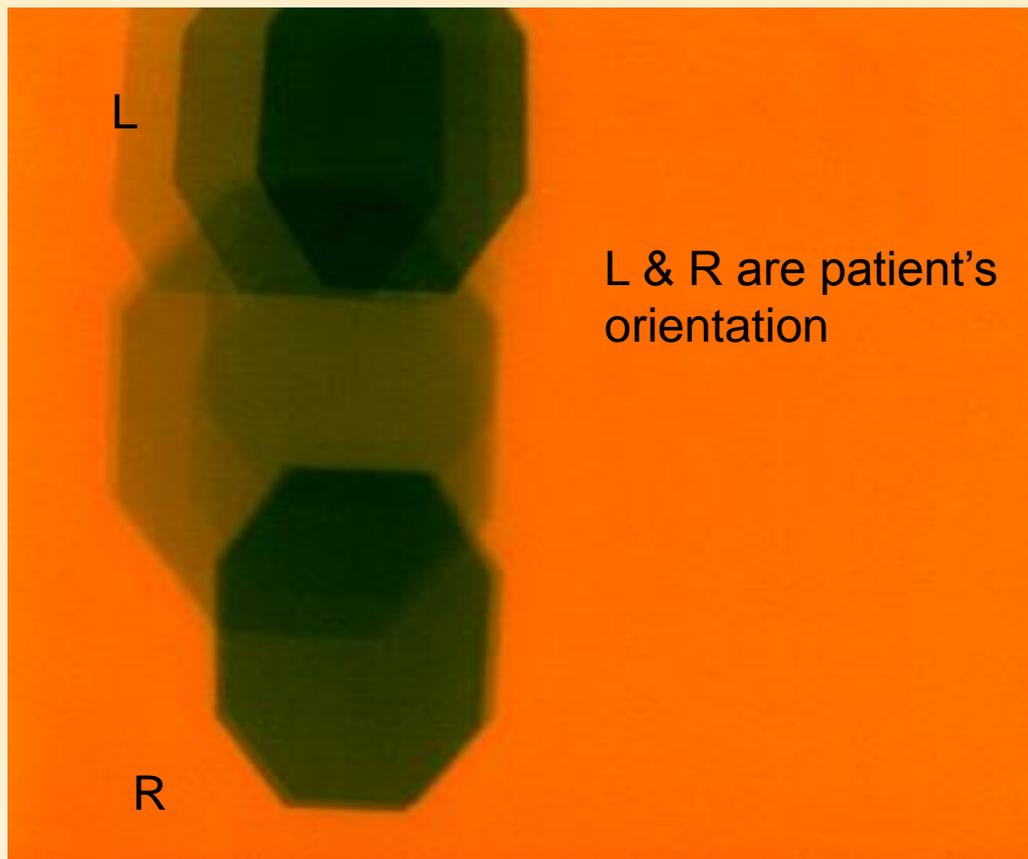
120 kVp  
Wedge L – 120 mm  
200 mA – 313 mAs  
PITCH 0.641

Toshiba Aquilion 64

Queensway Carleton Hospital January 2009

Nagi Sharoubim, Engineer  
Slobodan Devic, Ph.D., MCCPM

# DOSE MONITORING WITH GAFCHROMIC XR-R



- Immediate visualization of patient exposure – magnitude and location
- Detailed dose distribution

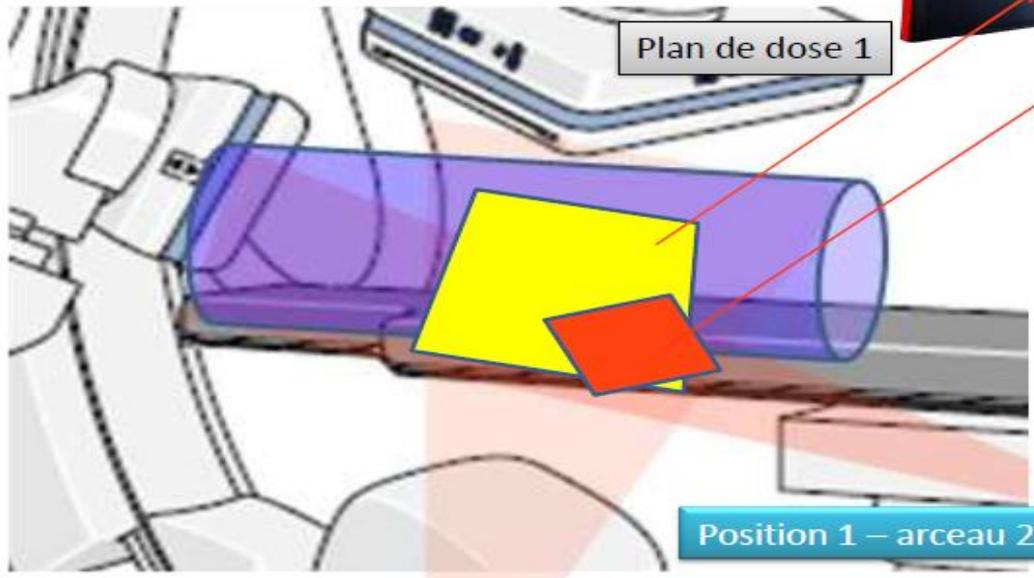
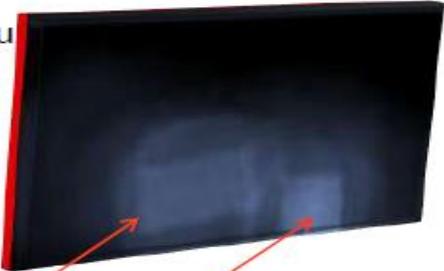
# PEAK SKIN DOSE WITH GAFCHROMIC XR-R

6

Dosimétrie in vivo



Cumul à la peau du patient

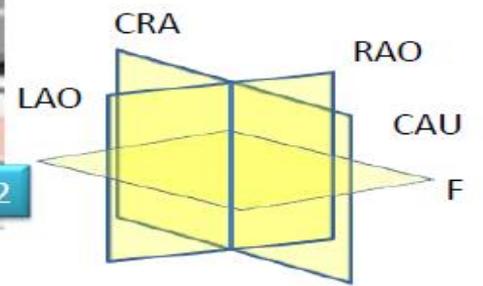


Plan de dose 1

Plan de dose 2

Position 1 – arceau 2

Position 1 – arceau 1



\*Provided by Les Hopitaux Universitaires de Strasbourg, used with permission



# COMPARISON OF GAFCHROMIC XR-R VS. DIODES

6

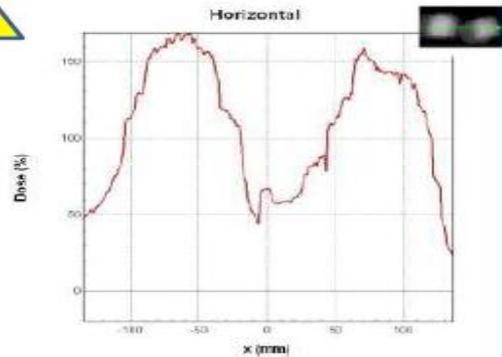
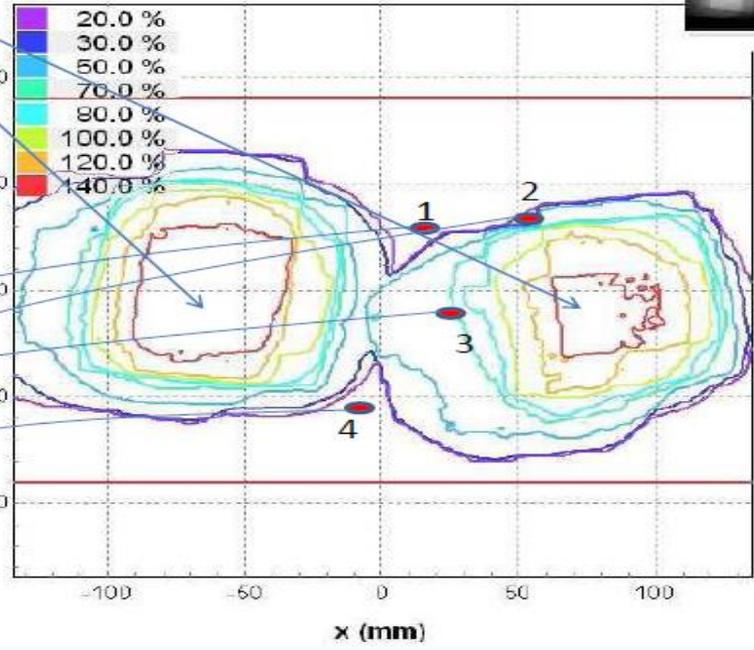
Dosimétrie in vivo

- Diode 1 : 1 % du max
- Diode 2 : 2 % du max
- Diode 3 : 5 % du max
- Diode 4 : 1 % du max

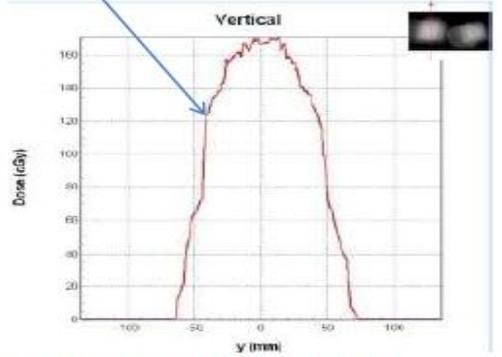


Dose max

Isodoses



Gradient de dose



**Les diodes (MOSFET) ne permettent pas de garantir la mesure de la dose max !**

\*Data provide by Les Hopitaux Universitaires de Strasbourg, used with permission



# PRESENT/FUTURE OF FILM DOSIMETRY

Film is  
~~a hassle~~  
*snap*

GafChromic

ASHLAND

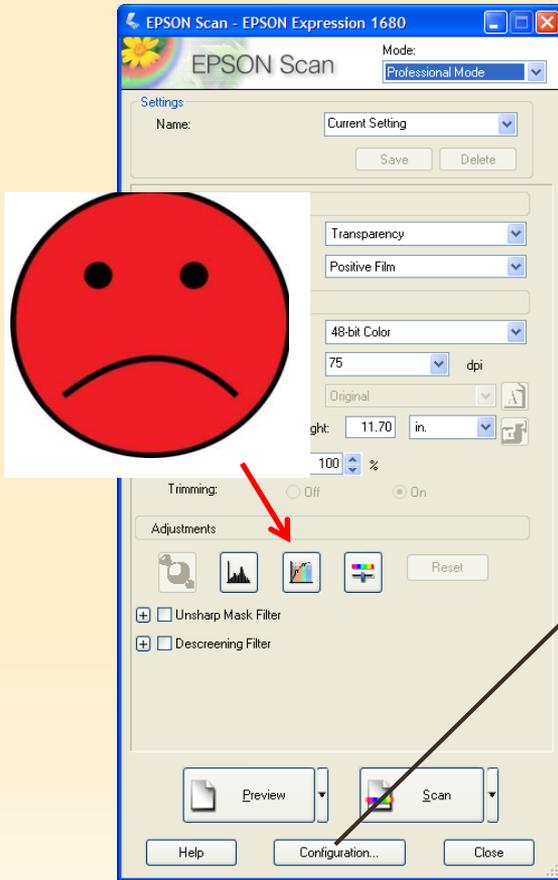
- × Post-exposure waiting
- × Film artifacts
- × Scanner artifacts
- × Environmental

How we turn film use from a hassle to a snap?

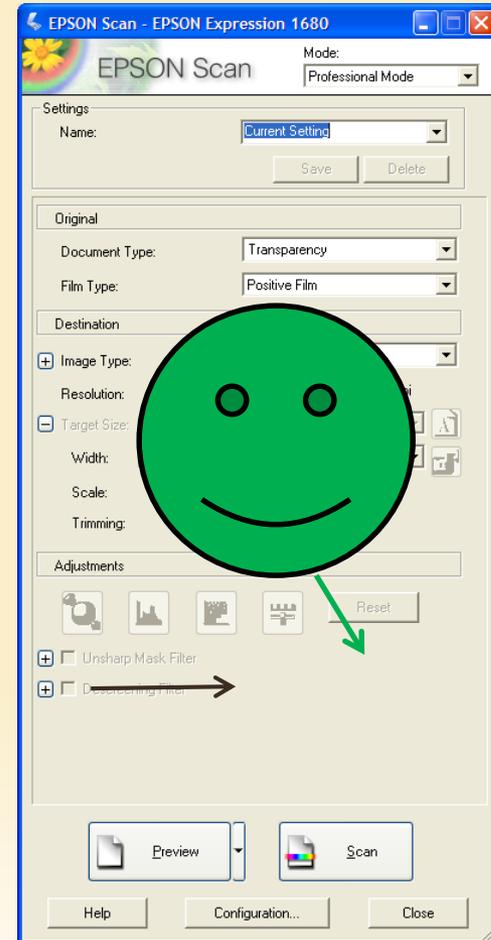
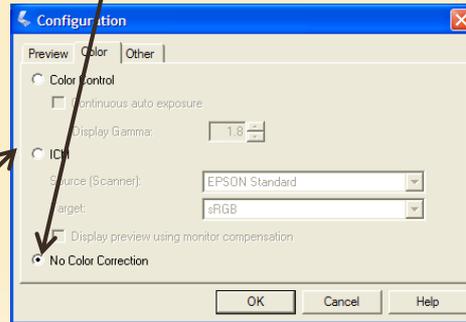
GafChromic

ASHLAND

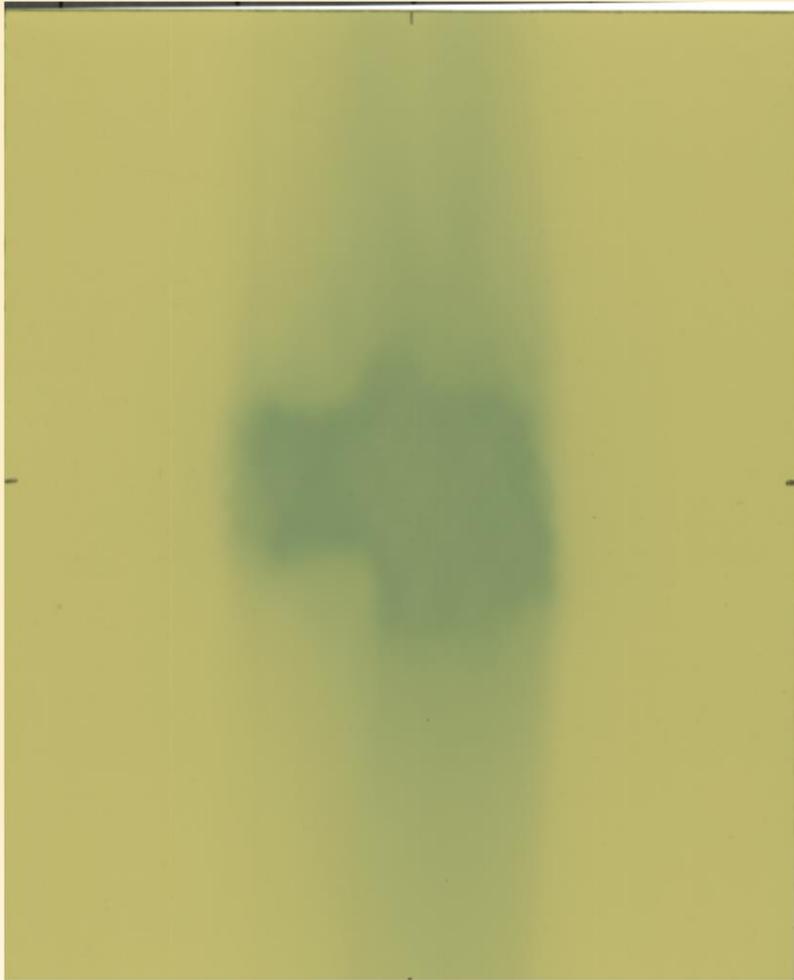
# WHAT DO I NEED TO KNOW ABOUT SCANNING? DISABLE ALL THE IMAGE ADJUSTMENT FEATURES



Check  
"No Color Correction"



# IMAGE COLOR CORRECTION

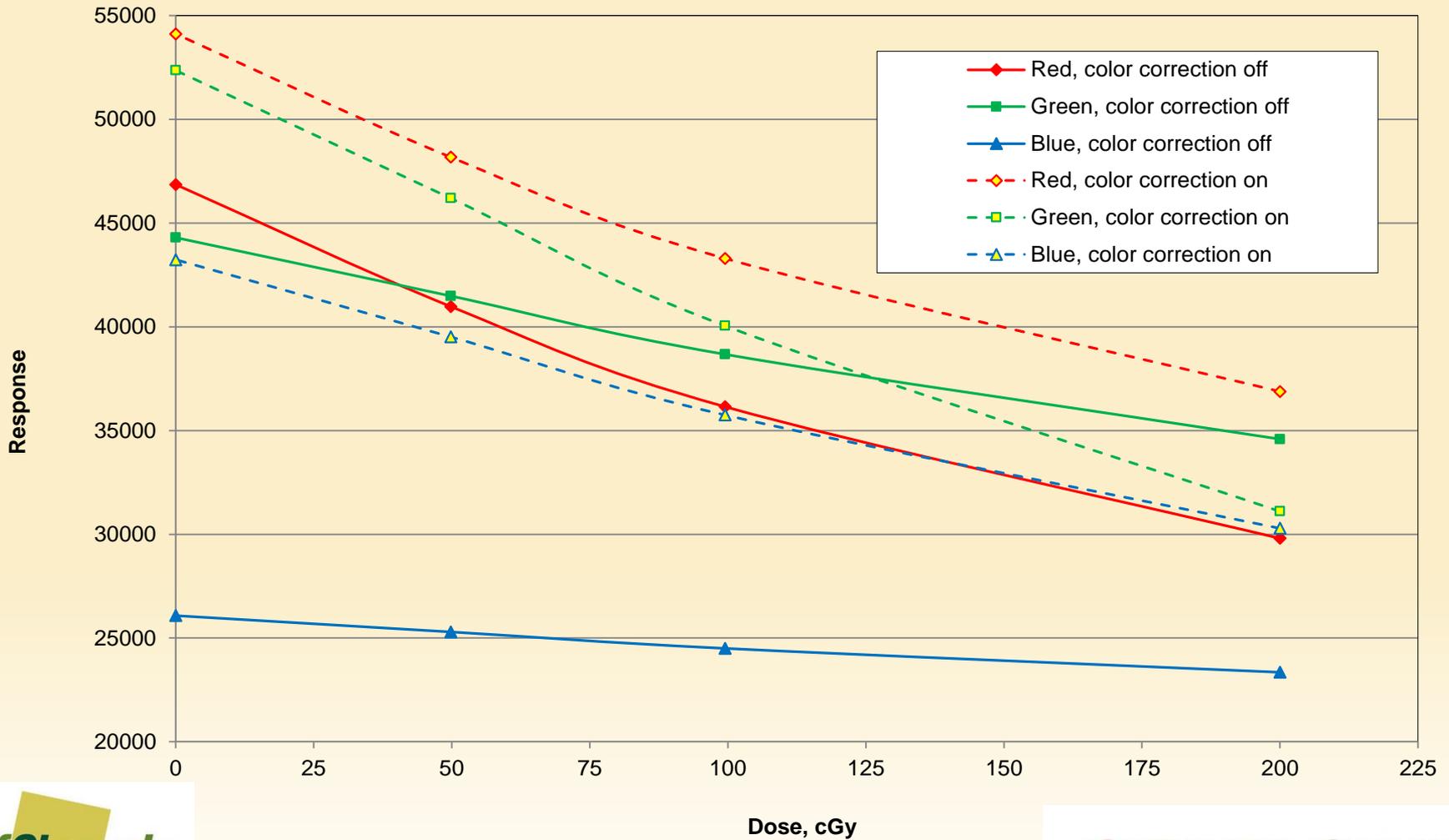


No color correction

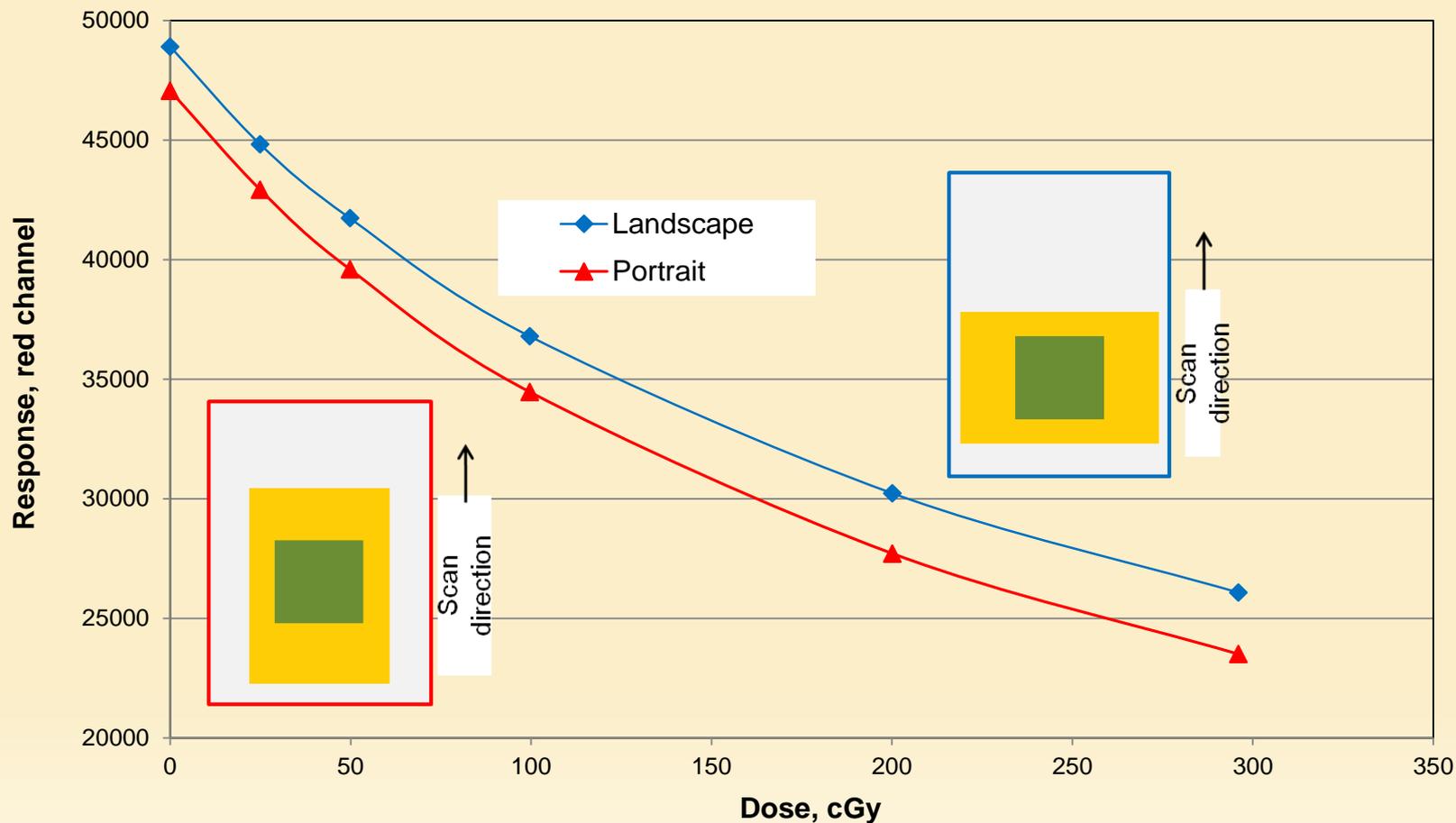


Color correction active

# CALIBRATION – EFFECT OF COLOR CORRECTION



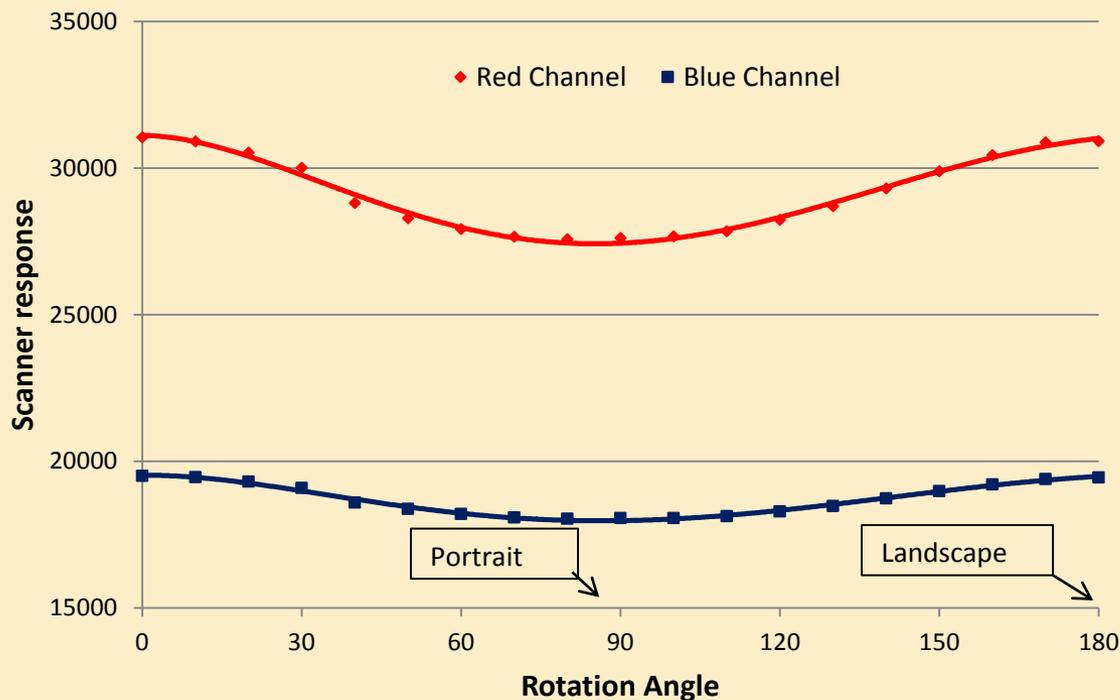
# ORIENTATION DEPENDENCE



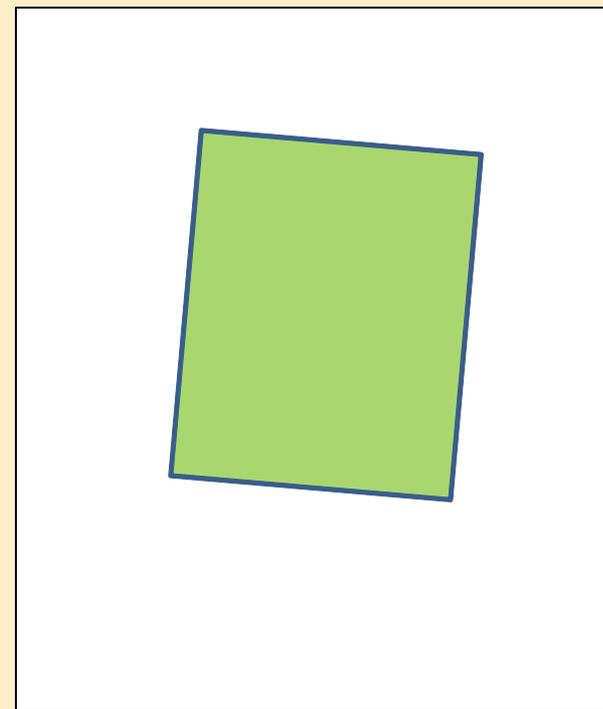
- Either orientation is usable
- But don't mix orientations!

# ORIENTATION DEPENDENCE

## Angular Dependence of EBT2



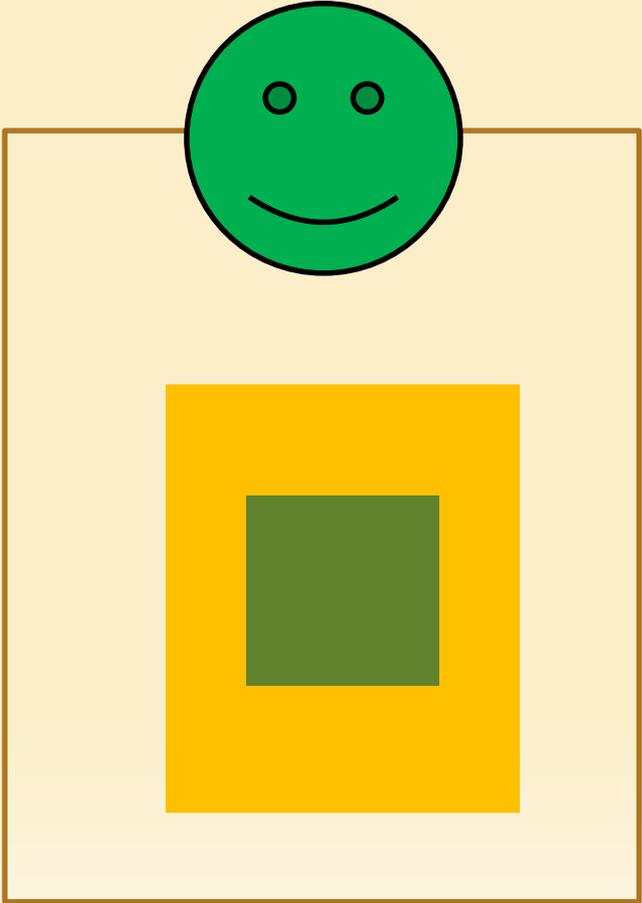
Response error is  $\sim 0.05\%$  per degree  
Dose error  $\sim 0.15\%$  per degree



5° misalignment on scanner

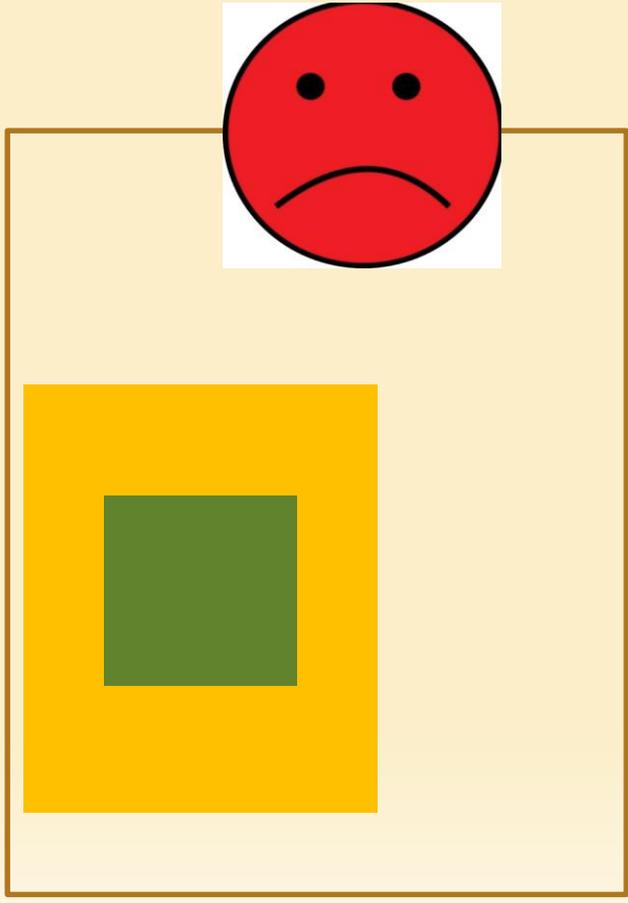
Conclusion: Misalignment is unlikely to cause significant error

# FILM PLACEMENT ON THE SCANNER



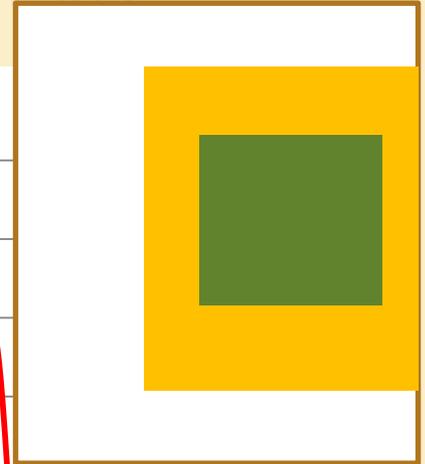
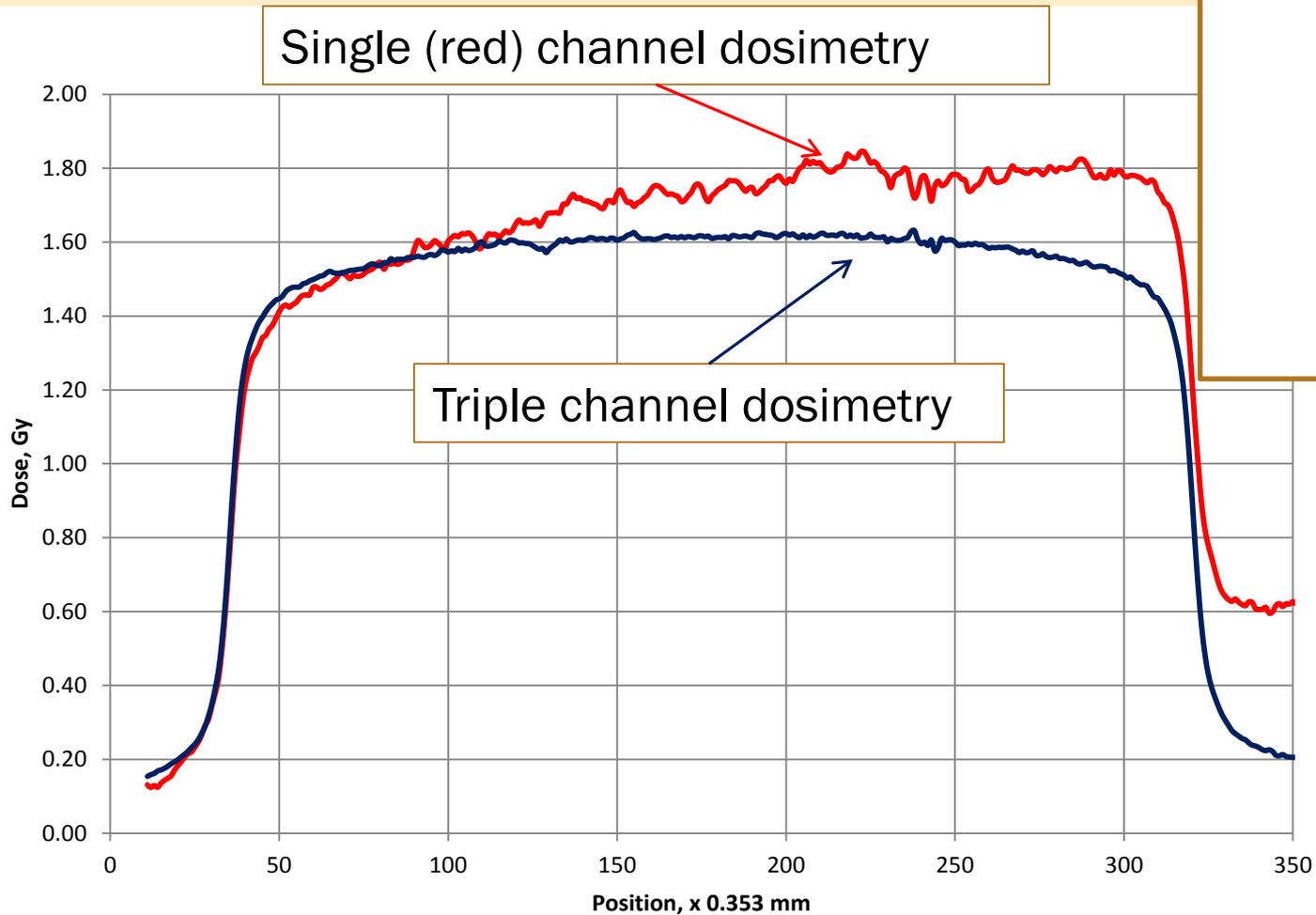
Central placement

↑  
Scan direction

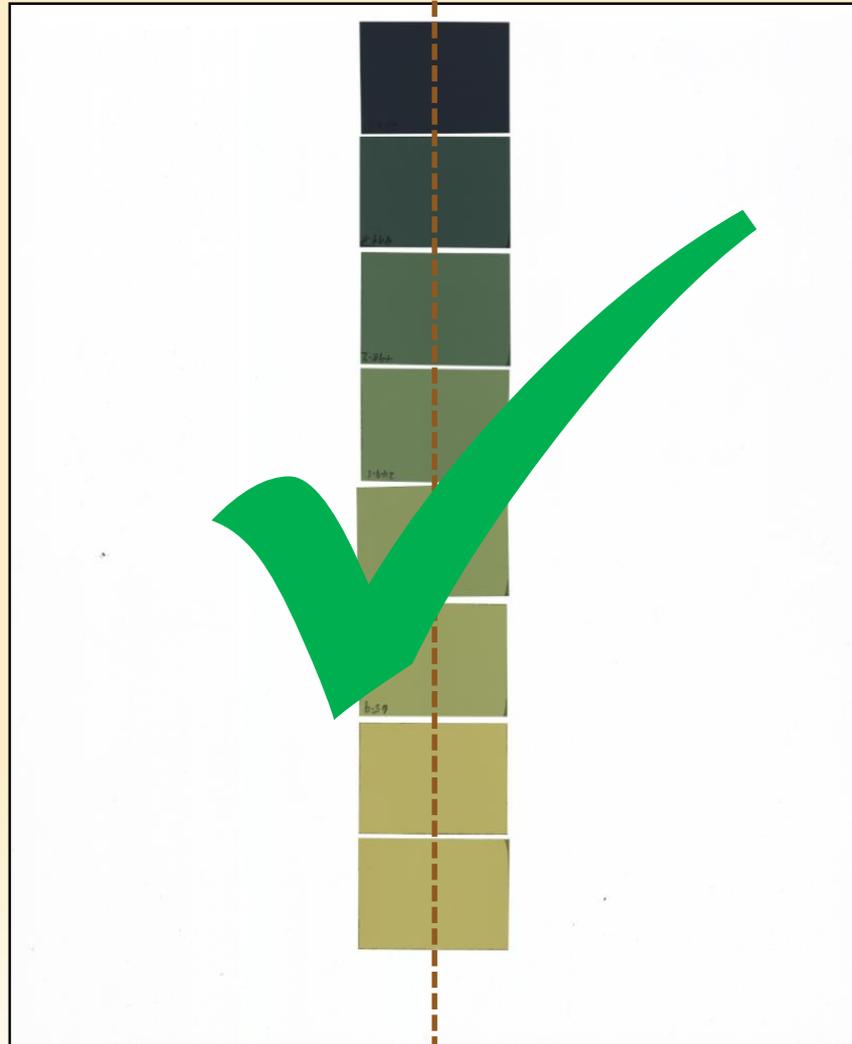


Lateral placement

# EFFECT OF FILM LATERAL DISPLACEMENT



# CORRECT PLACEMENT FOR SCANNING

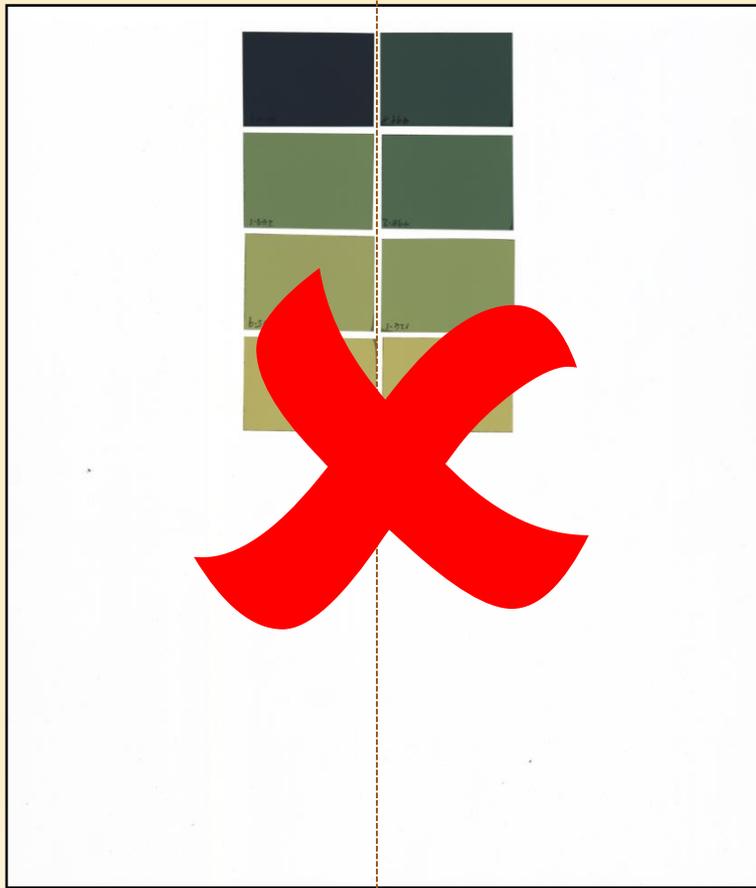


Scan  
direction



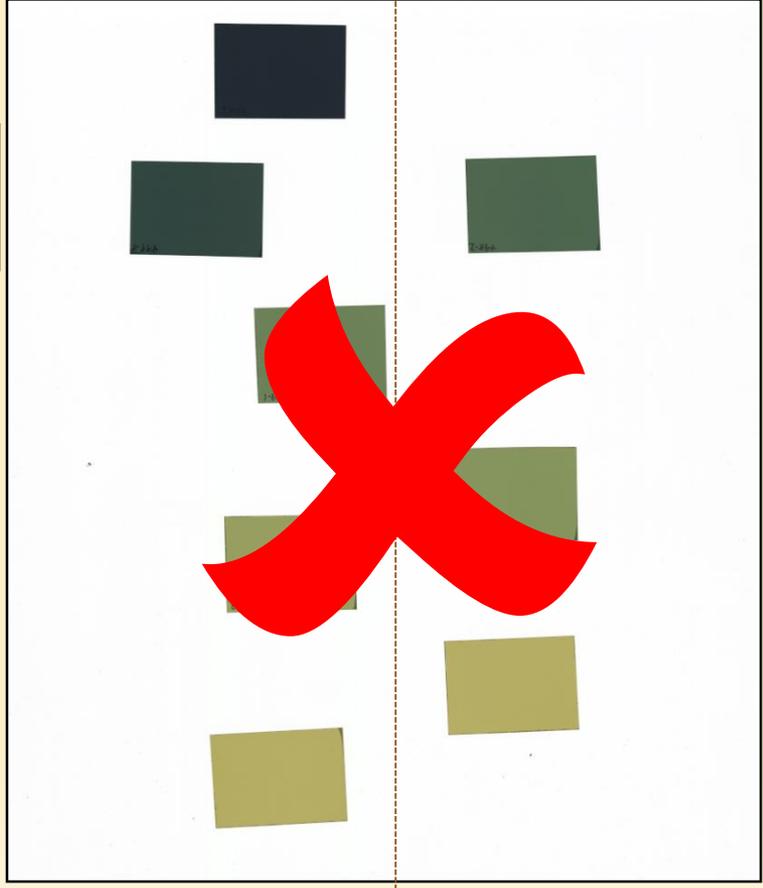
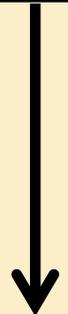
Center

# INCORRECT PLACEMENT FOR SCANNING



Center

Scan direction



Center

# PERCEIVED DIFFICULTIES OF USING FILMS

- ✘ Waiting time after exposure
  - + Post-exposure film density change
- ✘ Scanning variations
  - + Inter-scan variation
  - + Ambient temperature/moisture change
- ✘ Multiple calibrations
  - + Film aging
  - + Photon energy

SOLUTION:  
ONE SCAN PROTOCOL

# ONE SCAN DOSIMETRY: DOSE RESCALING

The screenshot displays the ISF FilmQA Pro software interface. The main window shows a film scan with a grid overlay. Two reference regions are highlighted with dashed green boxes and labeled: "reference 0.0 cGy" and "reference 313.0 cGy". The histogram on the right shows the distribution of the red color channel, with a peak around 44000. The histogram is titled "Histogram 'dose film'" and "Color channel: Red". The region for the histogram is a rectangle [326, 494] x [89 x 168] = (W=158, H=80). The histogram shows a probability distribution of the color channel values, with a peak around 44000. The histogram is titled "Histogram 'dose film'" and "Color channel: Red". The region for the histogram is a rectangle [326, 494] x [89 x 168] = (W=158, H=80). The histogram shows a probability distribution of the color channel values, with a peak around 44000.

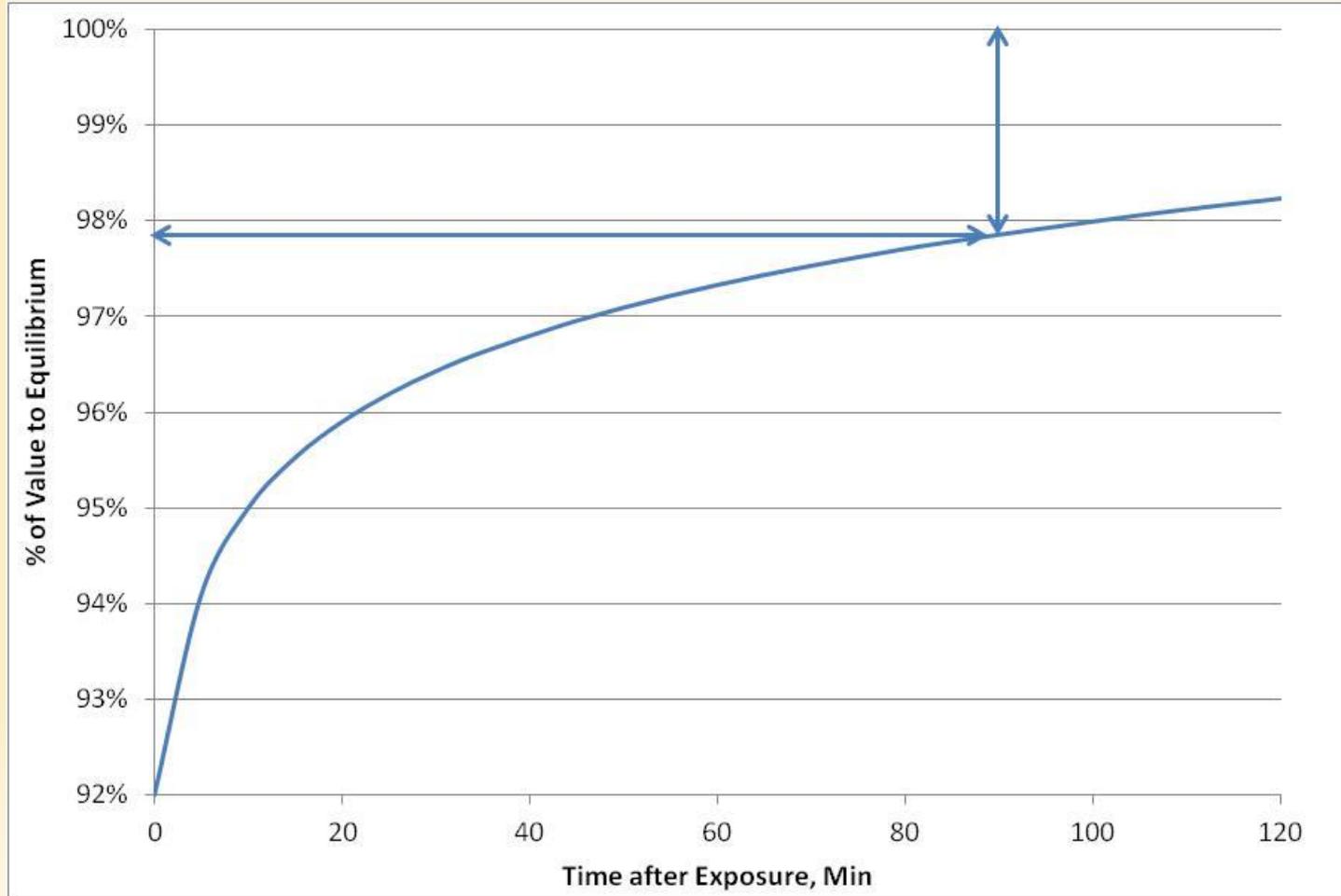
	Cursor region <(16 bpch)>	Full image <(16 bpch)>	Union of all frames <(16 bpch)>
R average	43302	47384	33636
R std deviation	65	14824	10646
R min	43183	3646	23228
R max	43401	65533	44993
G average	41832	48239	35445
G std deviation	127	13623	7086
G min	41612	4289	27659
G max	42003	65534	43407
B average	23915	38965	22143
B std deviation	54	20390	2140

Pixel statistics (631, 319)

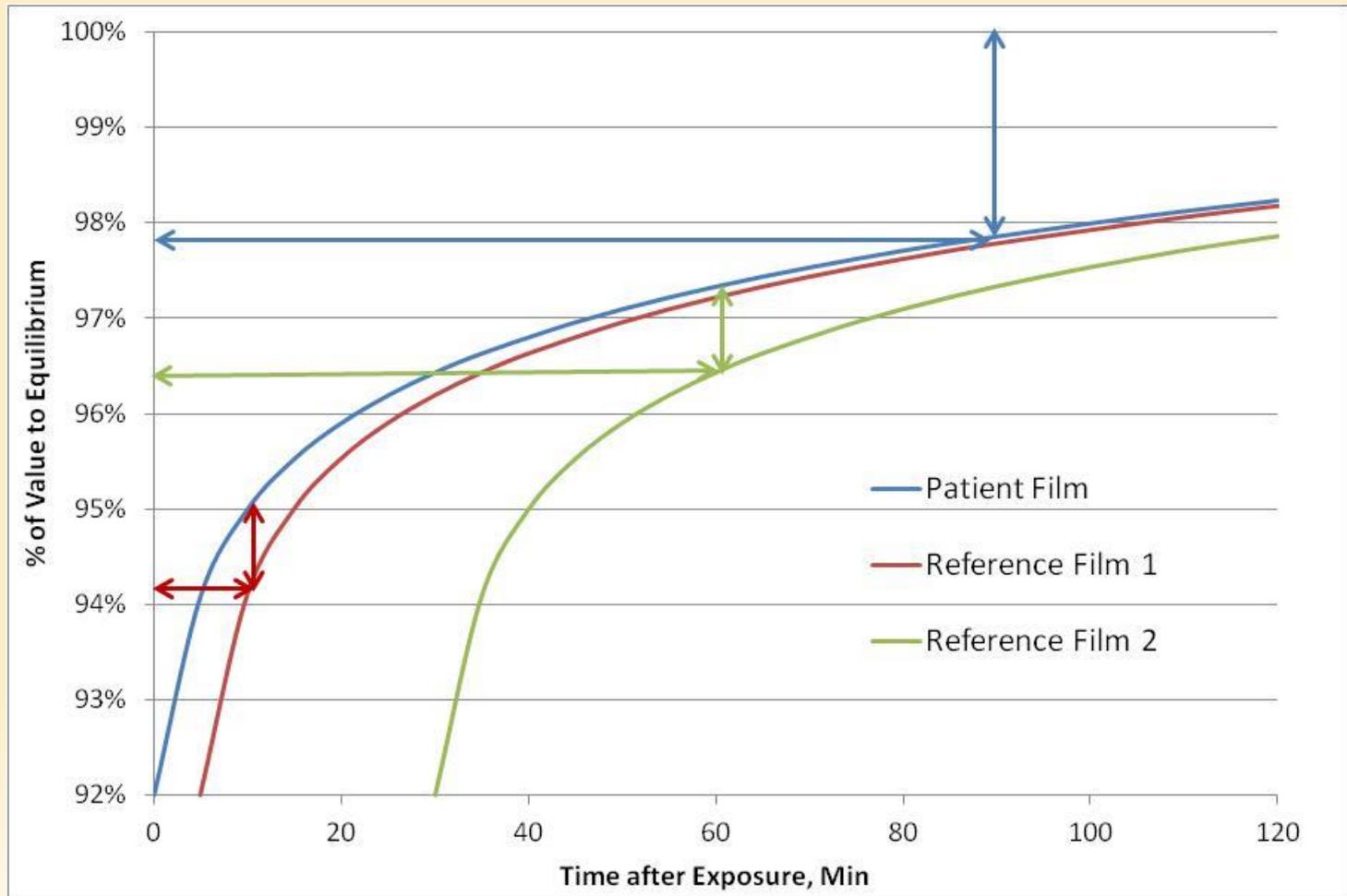
Image 'dose film' - 78 %



# DEALING WITH POST EXPOSURE DENSITY GROWTH



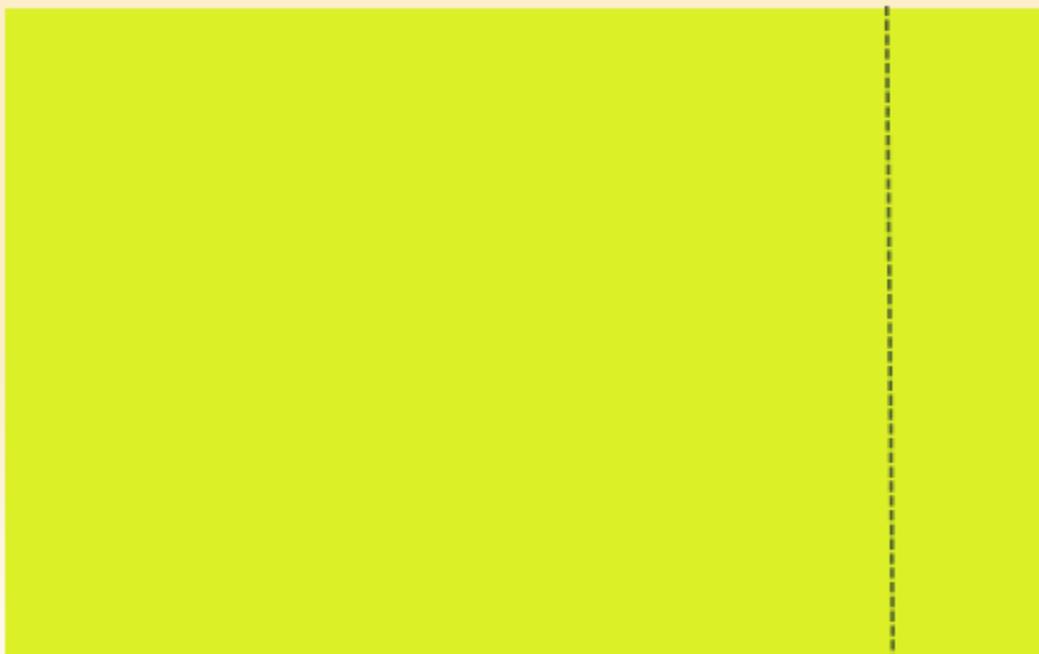
# REDUCE POST-EXPOSURE WAIT WITH ONE SCAN



# WHAT IS EBT3+?

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- × EBT3 film in a special format
  - + Matched application film and reference strip
  - + 20.3 x 24.1 cm<sup>2</sup> sheet and 3.8 x 20.3 cm<sup>2</sup> strip
  - + Provided for “One-scan” dosimetry protocol



# NEW PERFORMANCE STANDARD

Film is  
~~time-consuming.~~  
quick

GafChromic

ASHLAND

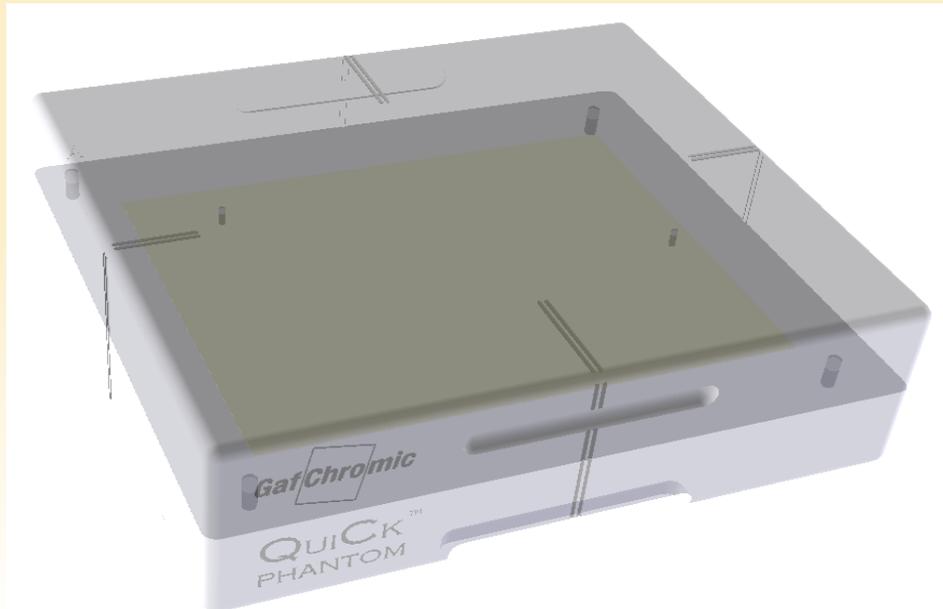
## Why One-scan dosimetry?

- Fast – results in minutes
  - Less exposures and scanning
- Uncomplicated
  - Easy use
- Economical
  - Less film consumption
- Reliable and Accurate
  - Multi-Channel Dosimetry

GafChromic

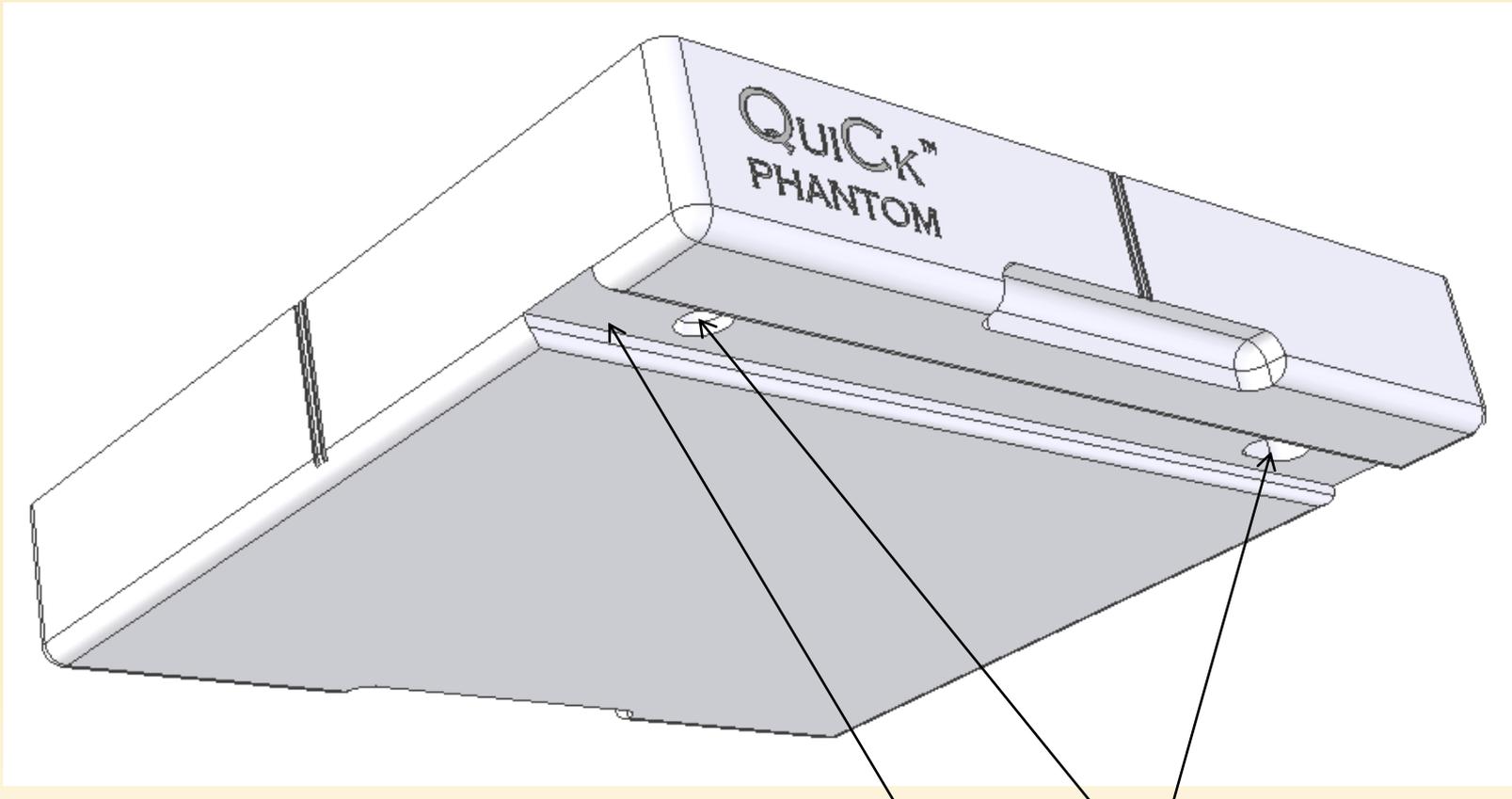
ASHLAND

# NEW GAFCHROMIC QUICK PHANTOM



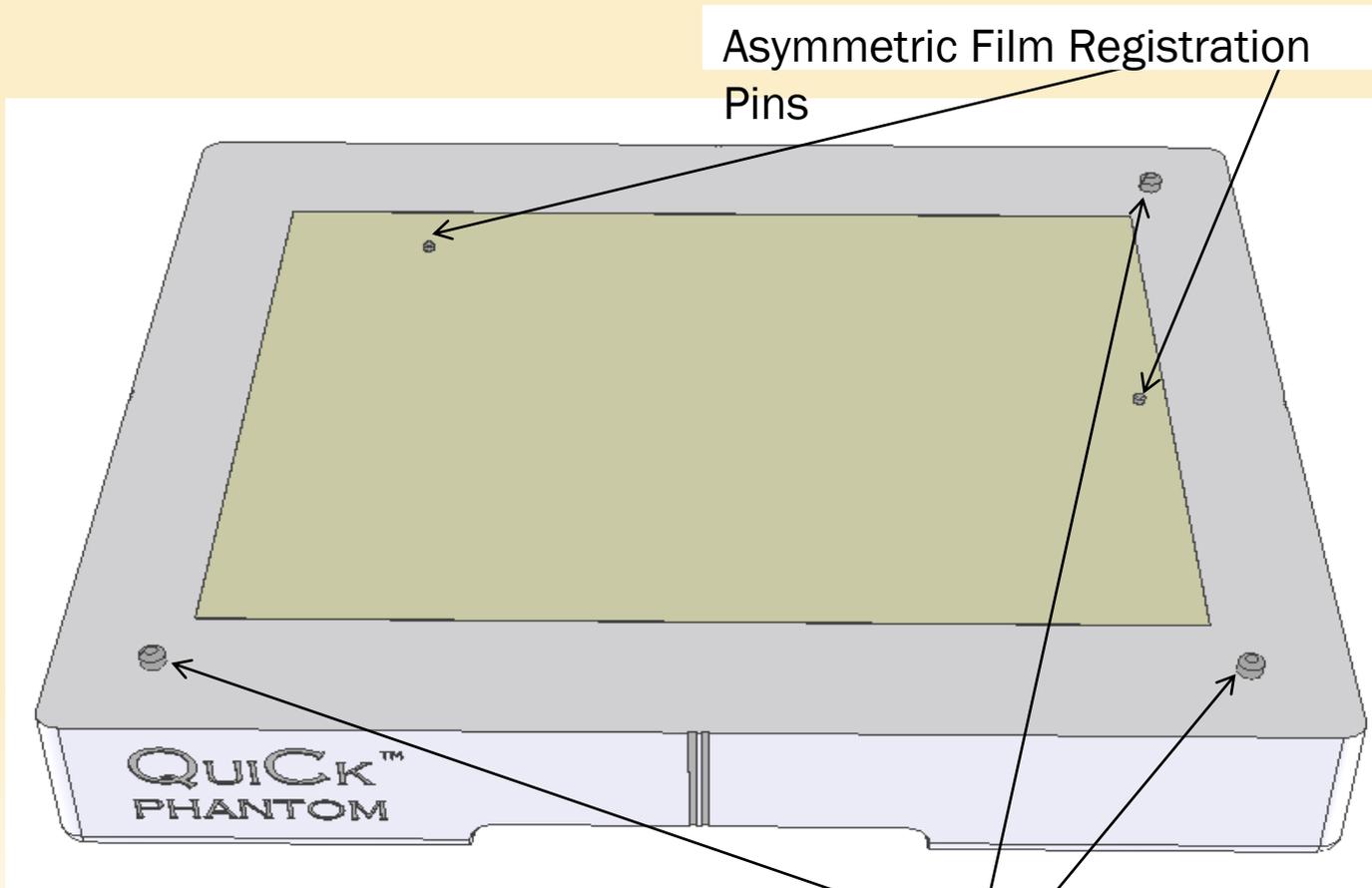
**ASHLAND.**

# NEW GAFCHROMIC QUICK PHANTOM



Groove and two holes to fit standard two Pin patient positioning index bar

# NEW GAFCHROMIC QUICK PHANTOM



# NEW GAFCHROMIC FILM DOSIMETRY

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- ✘ Multi-channel dosimetry corrects/mitigates film and scanner artifacts
- ✘ One scan protocol
  - + Inter-scan variability/environmental effects are avoided
  - + Post-exposure timing rules are relaxed
  - + No concern whether a calibration is still valid
- ✘ Quick Phantom for quick and accurate film positioning and easy analysis flow
- ✘ Simpler, Faster, and More Accurate

# FUTHER QUESTIONS?

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- ✘ For more information

- + [www.gafchromic.com](http://www.gafchromic.com)

- + [www.FilmQAPro.com](http://www.FilmQAPro.com)

- + [www.FilmQAXR.com](http://www.FilmQAXR.com)

- ✘ Contact us

- + [amicke@ashland.com](mailto:amicke@ashland.com)

- + [xiangyu@ashland.com](mailto:xiangyu@ashland.com)

WITH THE NEW PROTOCOL AND OUR EFFORTS



**Film is the**  
~~**PAST**~~

**FUTURE**

**GafChromic**

**ASHLAND**