IMRT Dose Verification using One Scan Radiochromic Film Dosimetry

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Memorial Sloan-Kettering Cancer Center

@ Basking Ridge

EBT3+FilmQAPro™ Professional Users Meeting
54th Annual Meeting of AAPM
July 30th, 2012, Charlotte, NC

Acknowledgements

Advanced Materials Group, Ashland Inc.

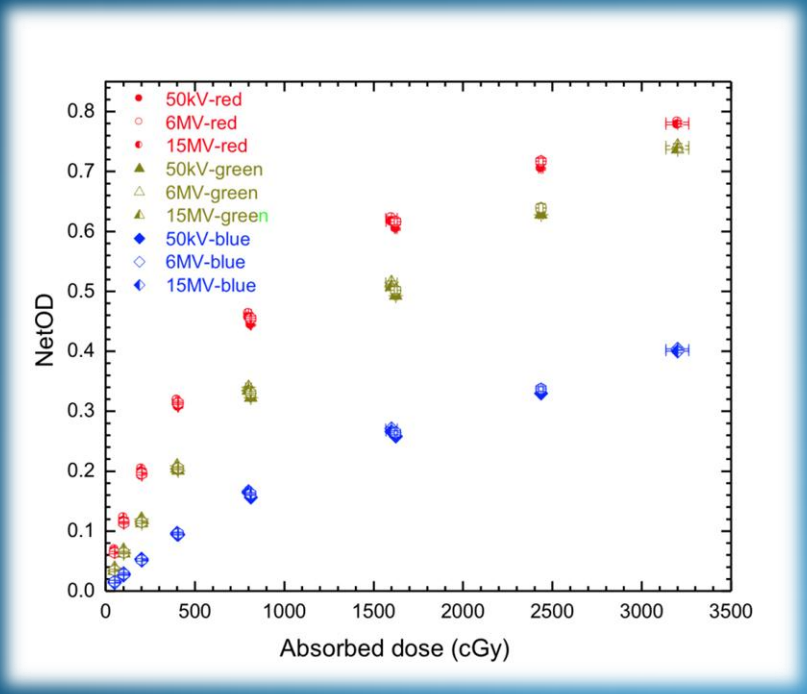
1361 Alps Road, Wayne. NJ 07470

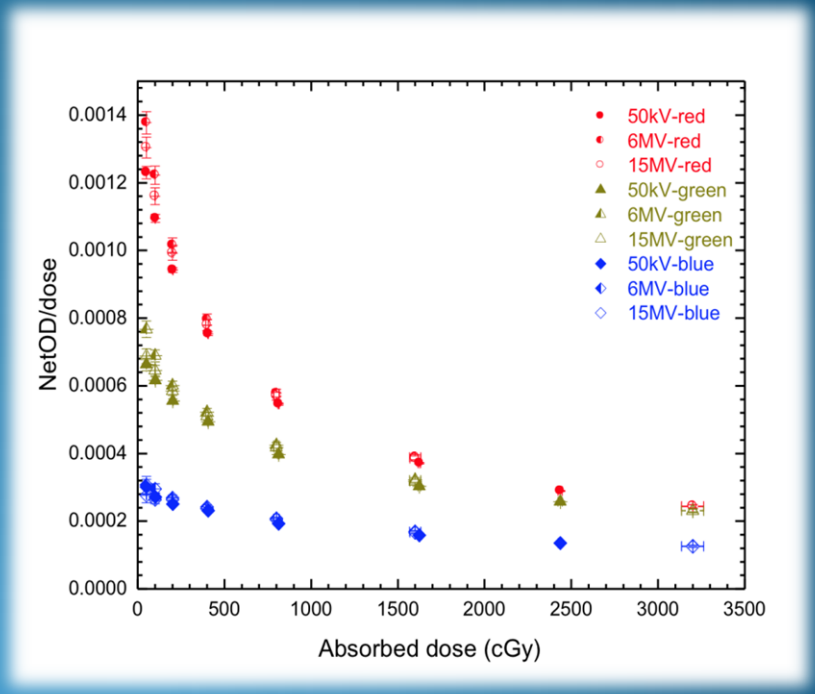
Providing the EBT3 and FilmQAPro 3.0

Equipment and Tools

- Varian Trilogy Linac
- Memorial Sloan-Kettering IMRT/VMAT TPS
- EBT3 films (lots # A101711, A012412)
- FilmQAPro 3.0
- Epson 10000XL flatbed scanner
- Four 5-cm thickness polystyrene phantoms

Energy Dependence of the New EBT3 Film's Dose-response Curve





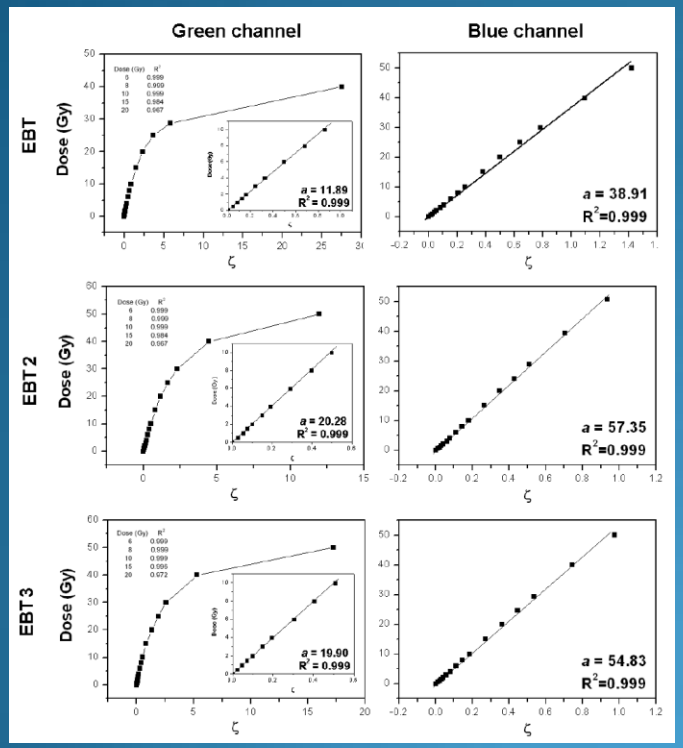
Chiu-Tsao ST, Massillon-JL G, Domingo-Muñoz I, Chan MF.
SU-E-T-96, 54th annual meeting of AAPM, Charlotte, NC, July 28-August 2, 2012

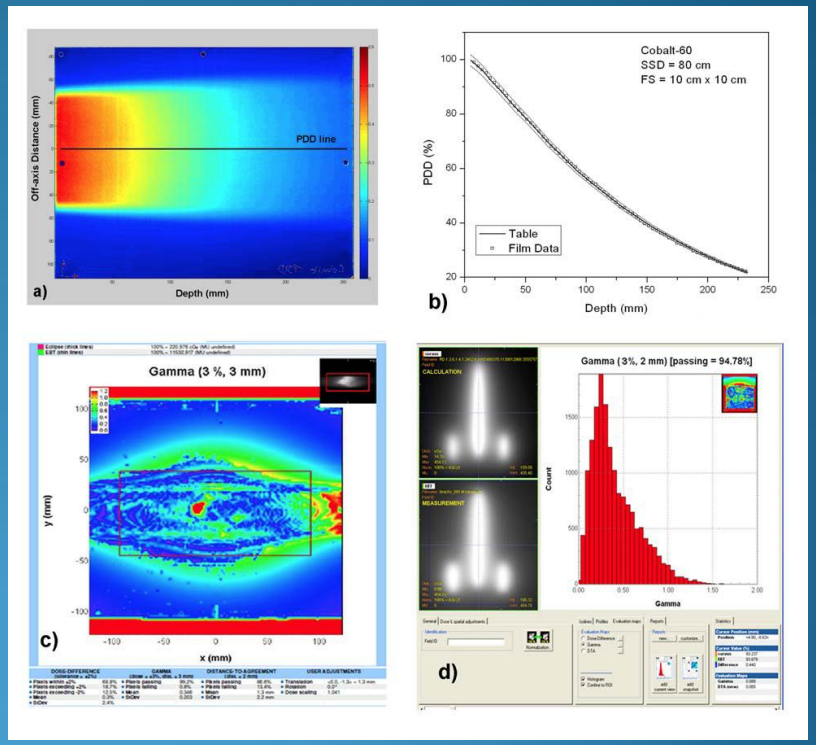
Benefits and Limitations of EBT2/EBT3 Film Dosimetry

Time	Spatial Resolution	Dynamic Range	Energy Independence	Tissue Equivalence	Absolute Dose
					

M.F. Chan, EBT3+Film QA™ Professional Users Meeting,
53rd annual meeting of AAPM, Vancouver, Canada, July 30-August 4, 2011

Linearization of Dose Response Curve of the Radiochromic Film Dosimetry System





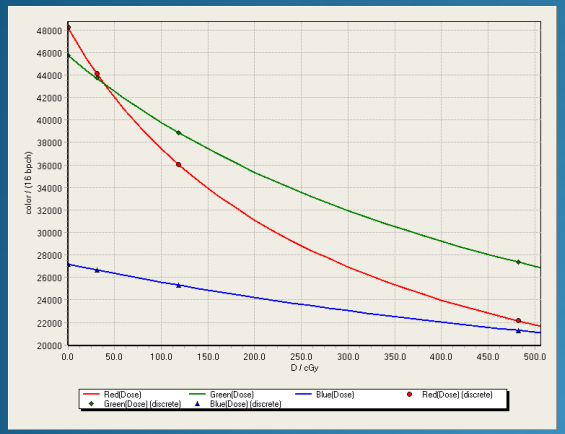
Devic S, Tomic N, Aldelaijan S, DeBlois F, Seuntjens J, Chan MF., Lewis D. In Press, Med Phys, 2012

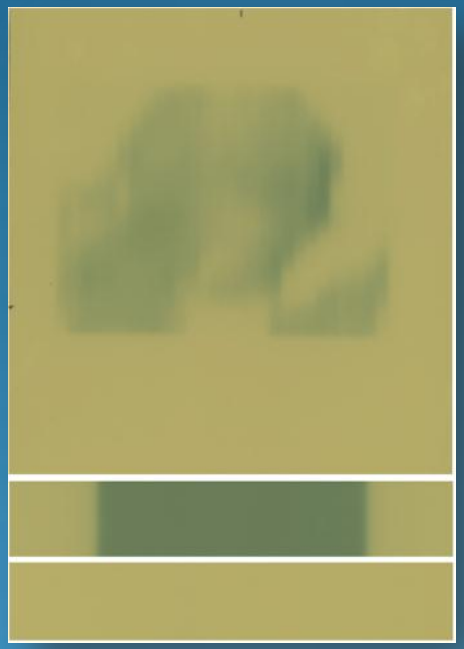
What is “One Scan” Radiochromic Film Dosimetry?

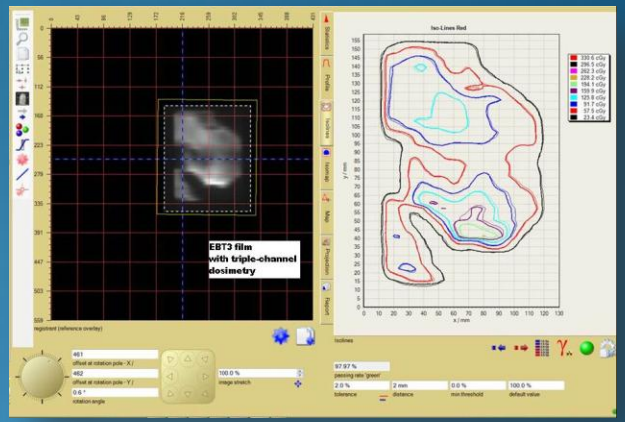
One Scan Protocol

- Simplifying calibration
  - Simple rational function fitting
  - Less number of points required
  - Master calibration curve per film lot
- Combining calibration and measurement in a single scan
  - One known dose and one background to rebuild the master calibration curve

One Scan Film Dosimetry Method

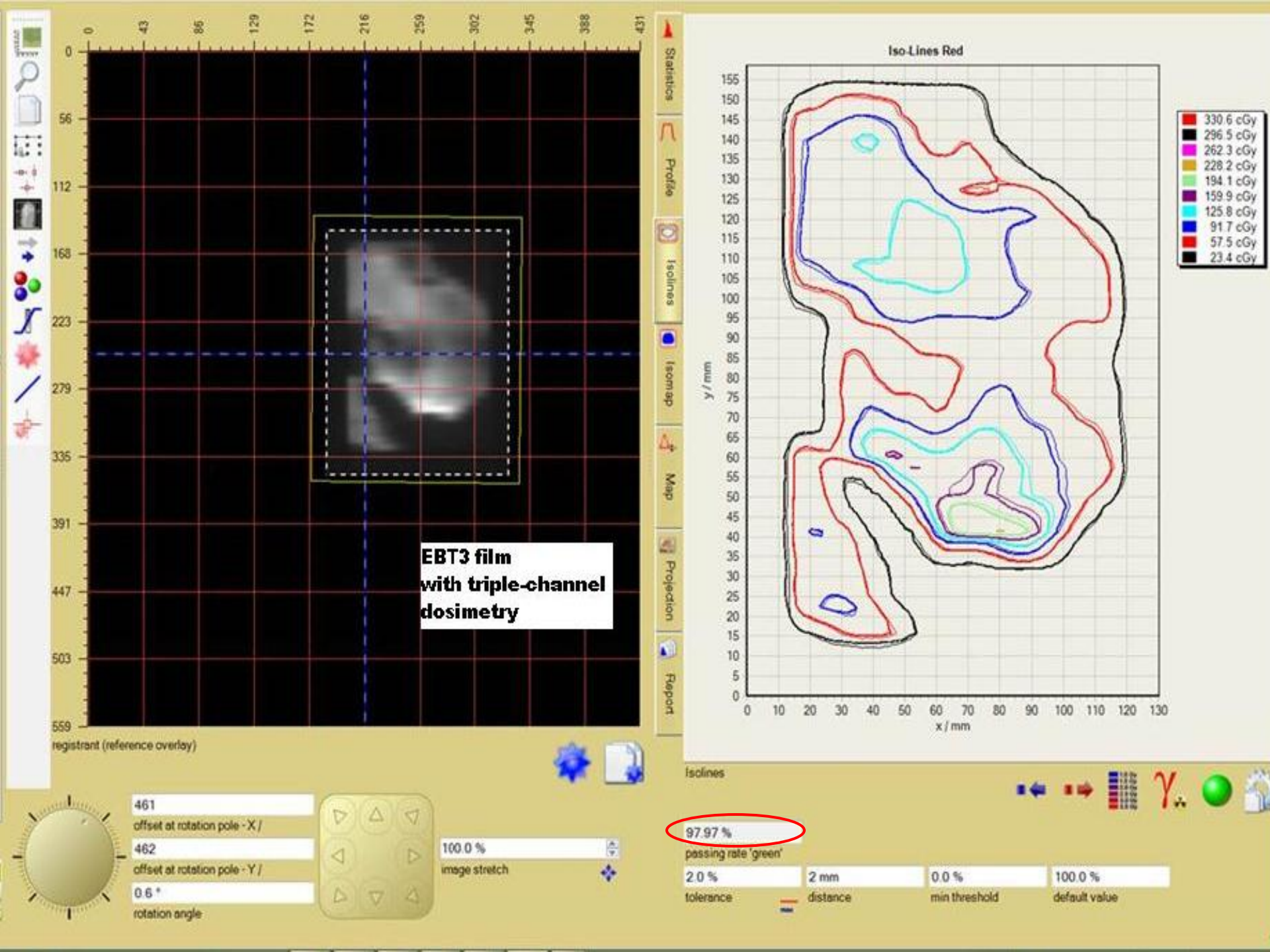




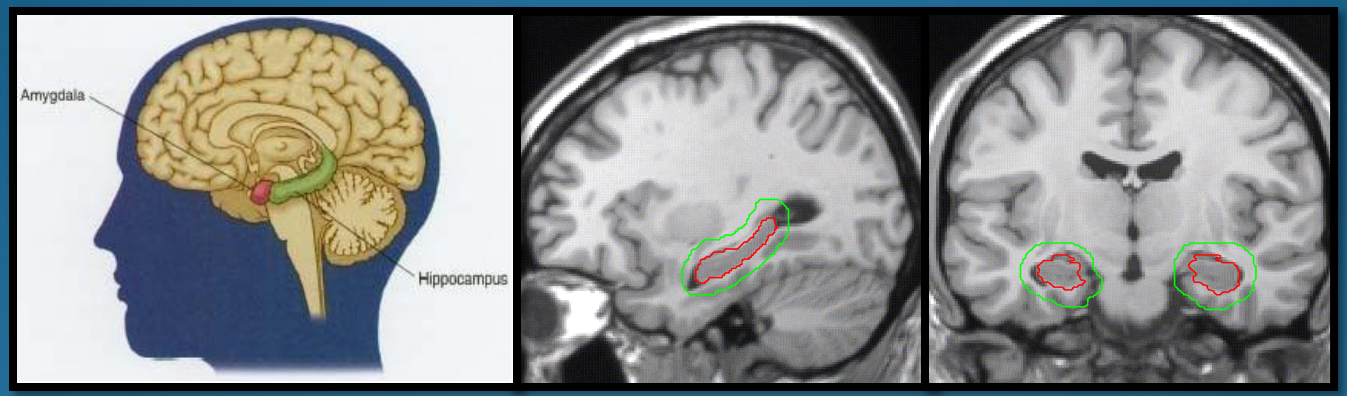


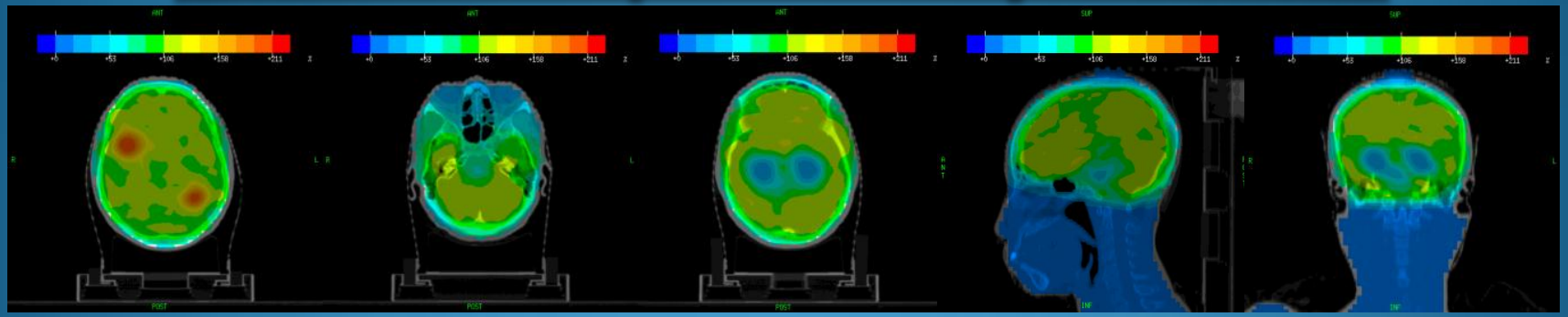
Step 1 *Master Curve* → ***Step 2*** *One-Scan Digitization* → ***Step 3*** *Overlay & Analysis*

(Lot-dependent) *(4t, Cal. dose=80-100%*D_m)* *(DD, DTA, Gamma)*


Iso-Lines Red
330.6 cGy
296.5 cGy
262.3 cGy
228.2 cGy
194.1 cGy
159.9 cGy
125.8 cGy
91.7 cGy
57.5 cGy
23.4 cGy
y / mm
x / mm
EBT3 film
with triple-channel
dosimetry
registrant (reference overlay)
Statistics
Profile
Isolines
Isomap
Map
Projection
Report
461
offset at rotation pole - X /
462
offset at rotation pole - Y /
0.6 °
rotation angle
100.0 %
image stretch
97.97 %
passing rate 'green'
2.0 %
tolerance
2 mm
distance
0.0 %
min threshold
100.0 %
default value

Hippocampus Sparing Dose Painting VMAT





Lesions: 195% (63Gy) **WB: 100% (32.25Gy)** **Hippocampi: 18% (< 6Gy)**

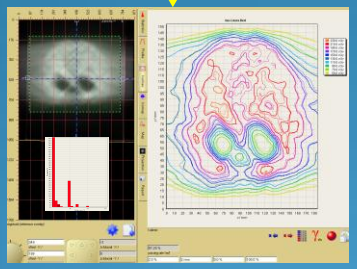
Whole Brain 32.25 Gy/2.15 Gy daily

Concurrent boost to lesions 63 Gy/4.2 Gy daily

Radiochromic Film Dosimetry Procedure

Import Plan via DICOM

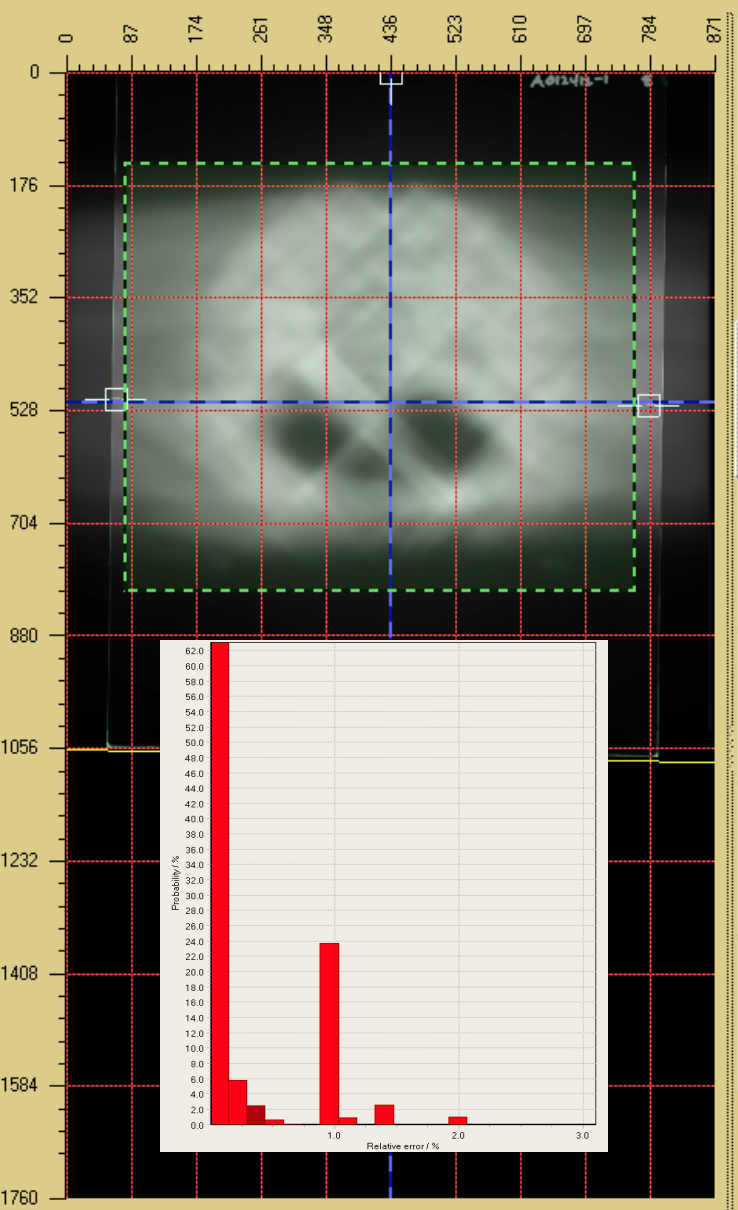
Flatbed Scanner



Plan vs. Measurement

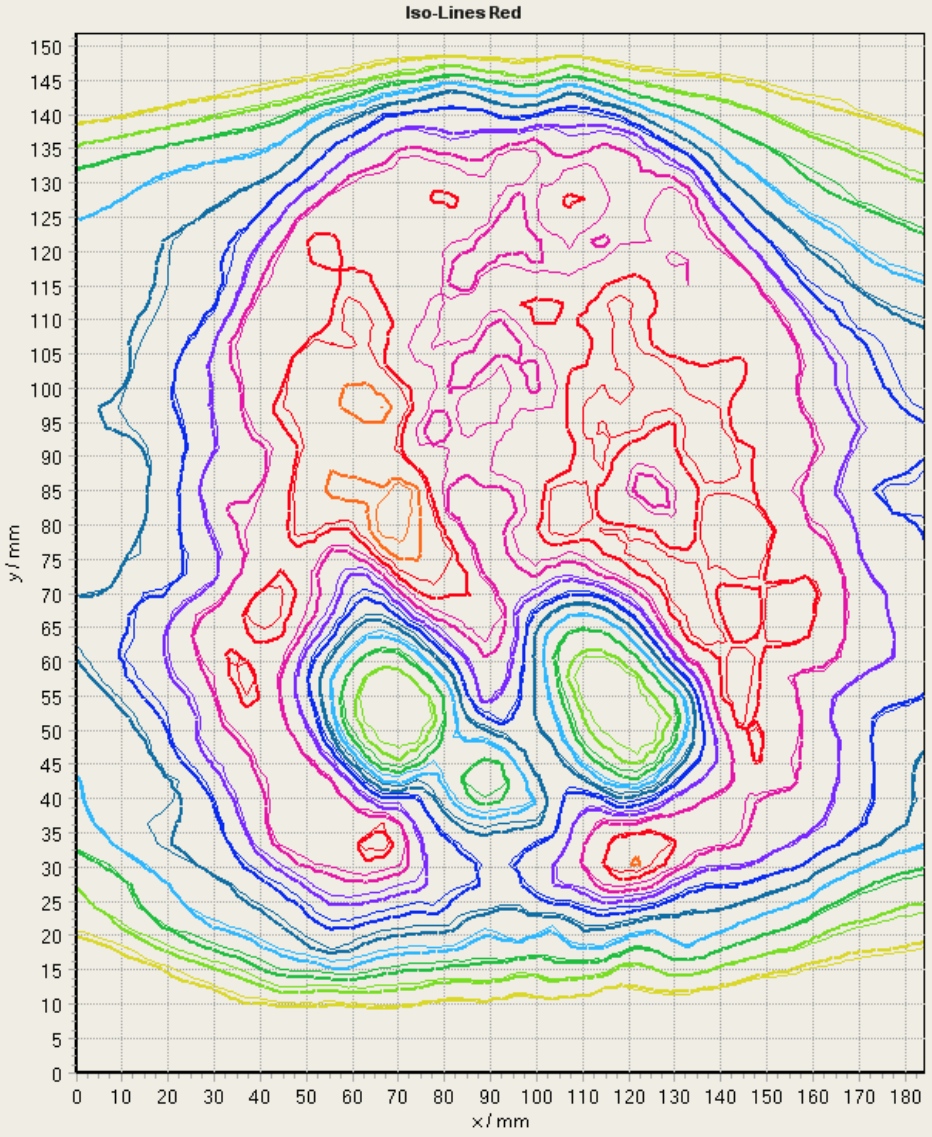
Export via R&V System

Expose Phantom



registrant (reference overlay)

Statistics
Profile
Isolines
Isomap
Map
Projection
Report



Isolines

349
offset - X /

189
offset - Y /

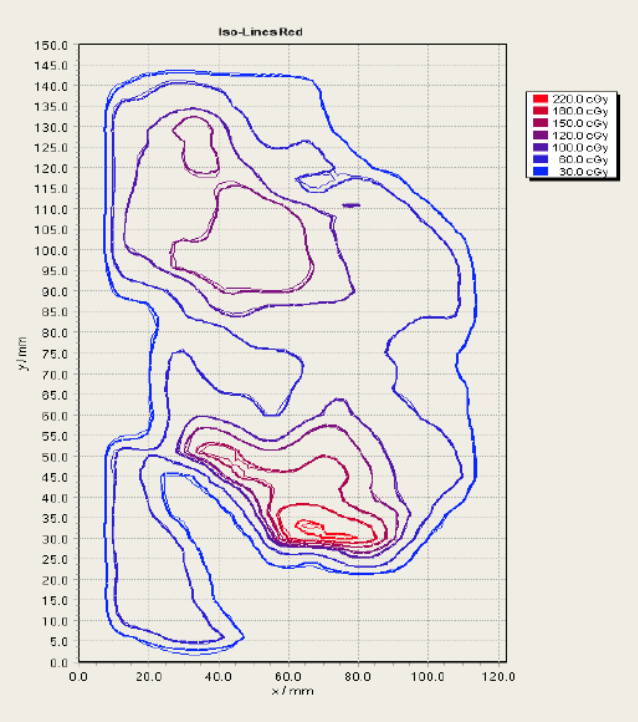
-3
Δ fiducial - X /

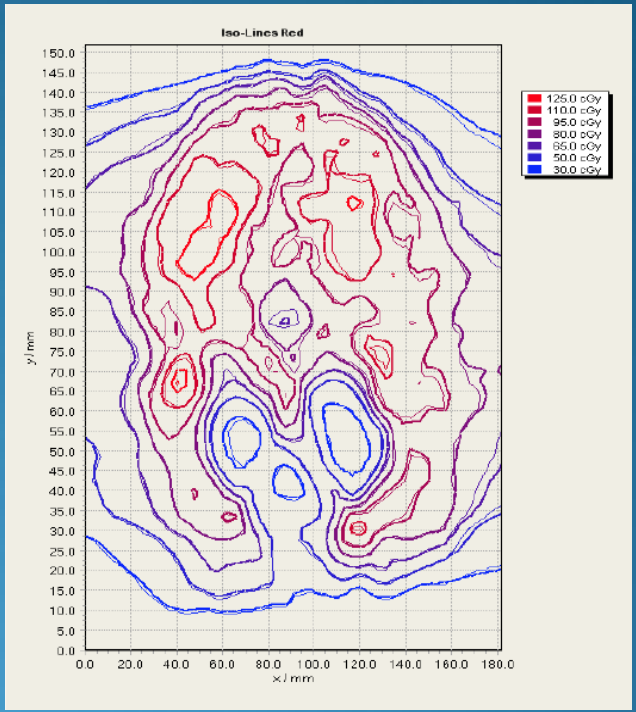
0
Δ fiducial - Y /

97.29 %
passing rate 'red'

2.0 %
2 mm
0.0 %
100.0 %

Validation of One Scan Protocol (1)

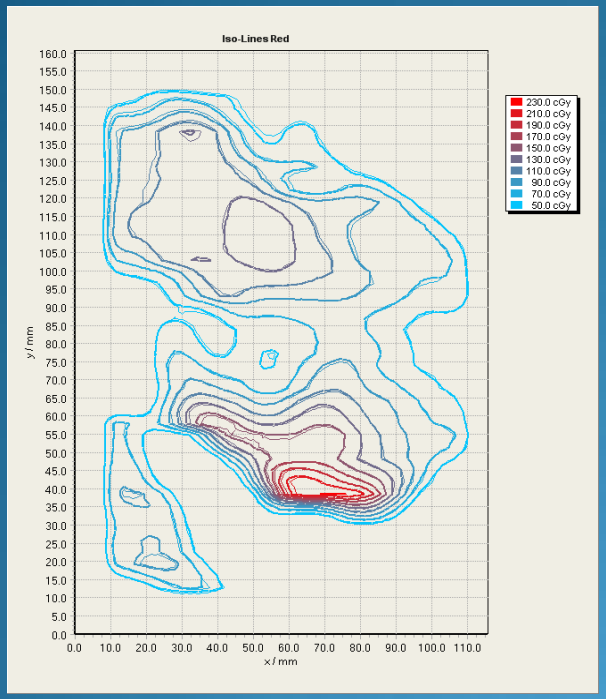


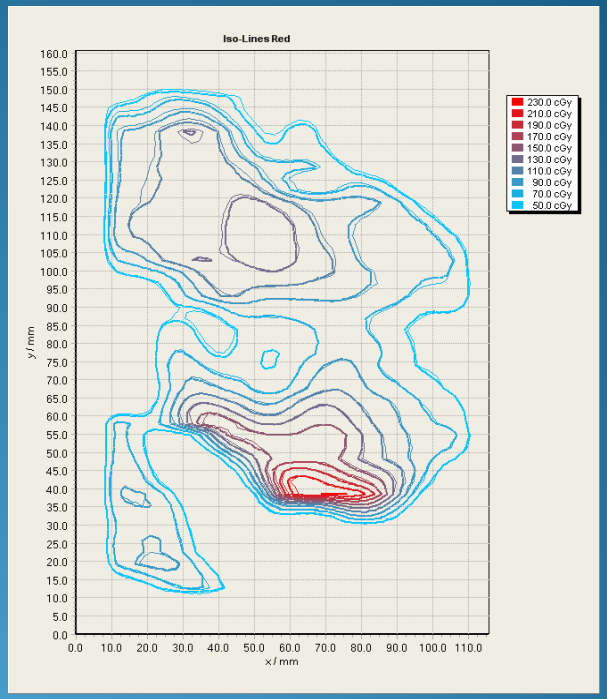


IMRT: 30 min vs. 72 hr Post-exposure

VMAT: Portrait vs. Landscape Orientations

Validation of One Scan Protocol (2)

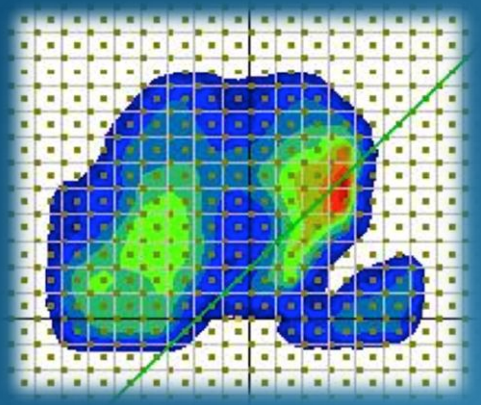




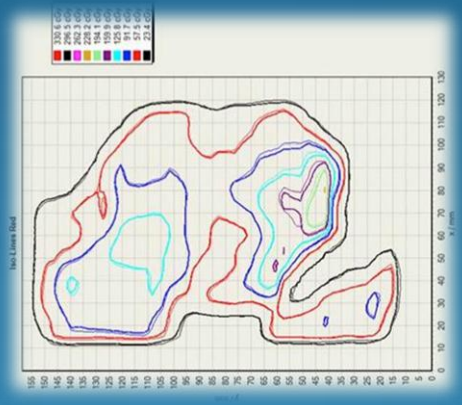
4-point calibration: 98.0% (2%/2mm)

7-point calibration: 98.1% (2%/2mm)

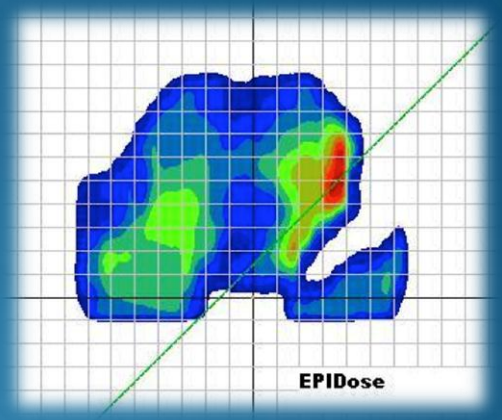
Validation of One Scan Protocol (3)



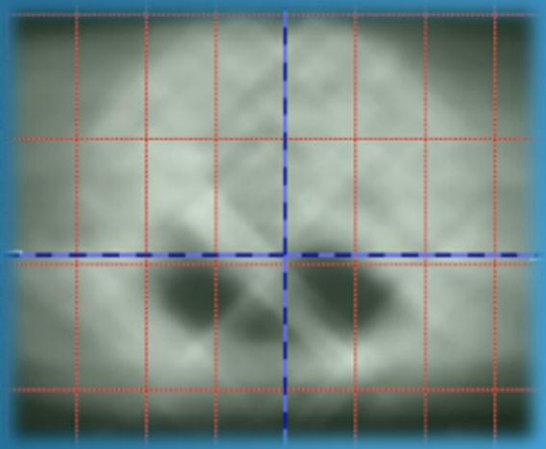
MapCHECK2: 99% (2%/2mm)



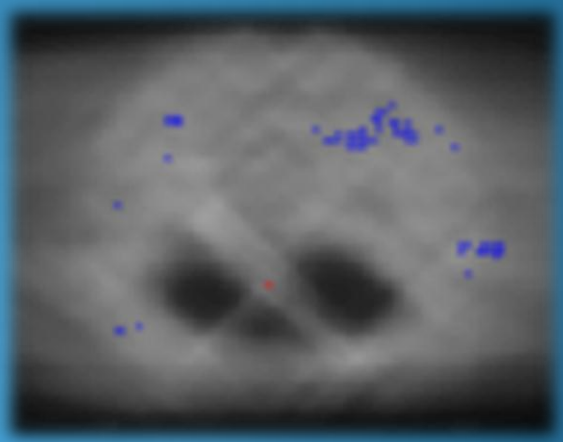
EBT3 Film: 98% (2%/2mm)



EPIDose: 97% (2%/2mm)



VMAT: EBT3 Film (97%:2%/2mm)



VMAT: AC-3DVH (99%:2%/2mm)

Benefits of One Scan Protocol

- Fitting function matched to behavior of the film
- Fewer exposures and less film required
- One scan to eliminate scan-to-scan variability
- Ability to obtain accurate results in minutes

Time	Spatial Resolution	Dynamic Range	Energy Independence	Tissue Equivalence	Absolute Dose
					

Conclusions

One Scan Radiochromic Film Dosimetry provides a practical solution for routine IMRT/VMAT QA without sacrificing spatial resolution for convenience.