"Pre-treatment verification with film" oh no.

Elfried Kok, Reinier de Graaf Groep, Delft

6 december 2012, Wijchen

Content

- Situation RdGG
- Film and scanner tests
- Pre-treatment verification
  - One scan methode
- Results
- Time table
- Physics QA
- Conclusion
- Questions

Reinier de Graaf Groep

- 2 Varian Linacs 2100CD, with ExacTrac systems
- TPS: OMP and iPlan → IMRT / Stereotactic
- R&V: Mosaiq

<u>Pre-treatment</u>

- Stereotactic brain metastase (10-15 p.a.)
- IMRT prostate (± 60 p.a.) since may 2012 clinically

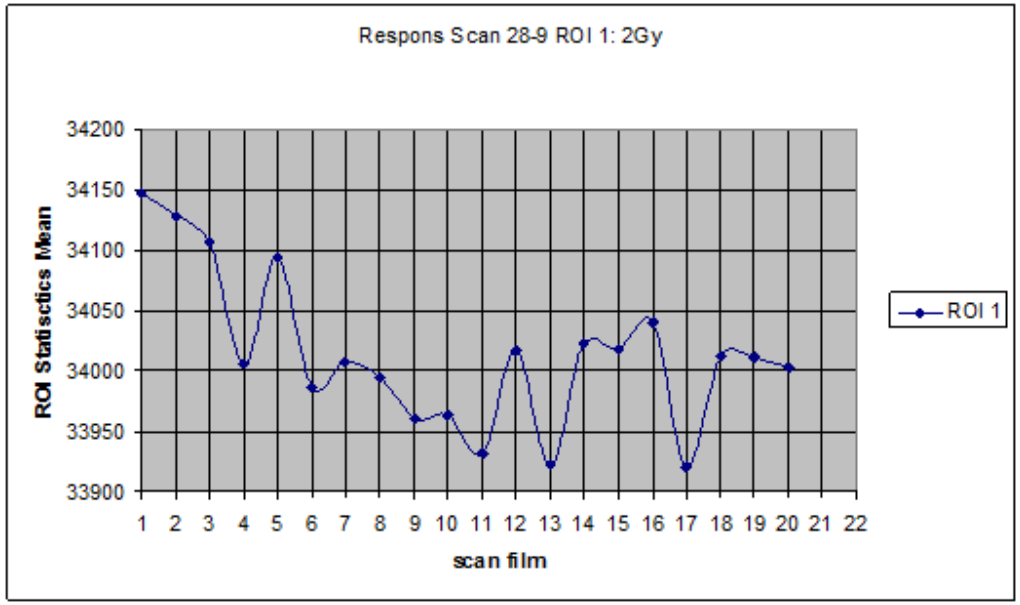
Film and scanner tests

- Start 2010
- Test scanner and film
  - FilmQA ⟹ FilmQA Pro
  - Epson V750 ⟹ Epson10000XL
  - EBT 2 ⟹ EBT 3
    - Scanner effects; warm-up and irregularities
    - Lateral correction
    - Homogeneity of the film
    - Filmbadges
- Test IMRT plan

Film and scanner tests

- Scanner warm-up effects

  Dose 100, 200 and 300 cGy

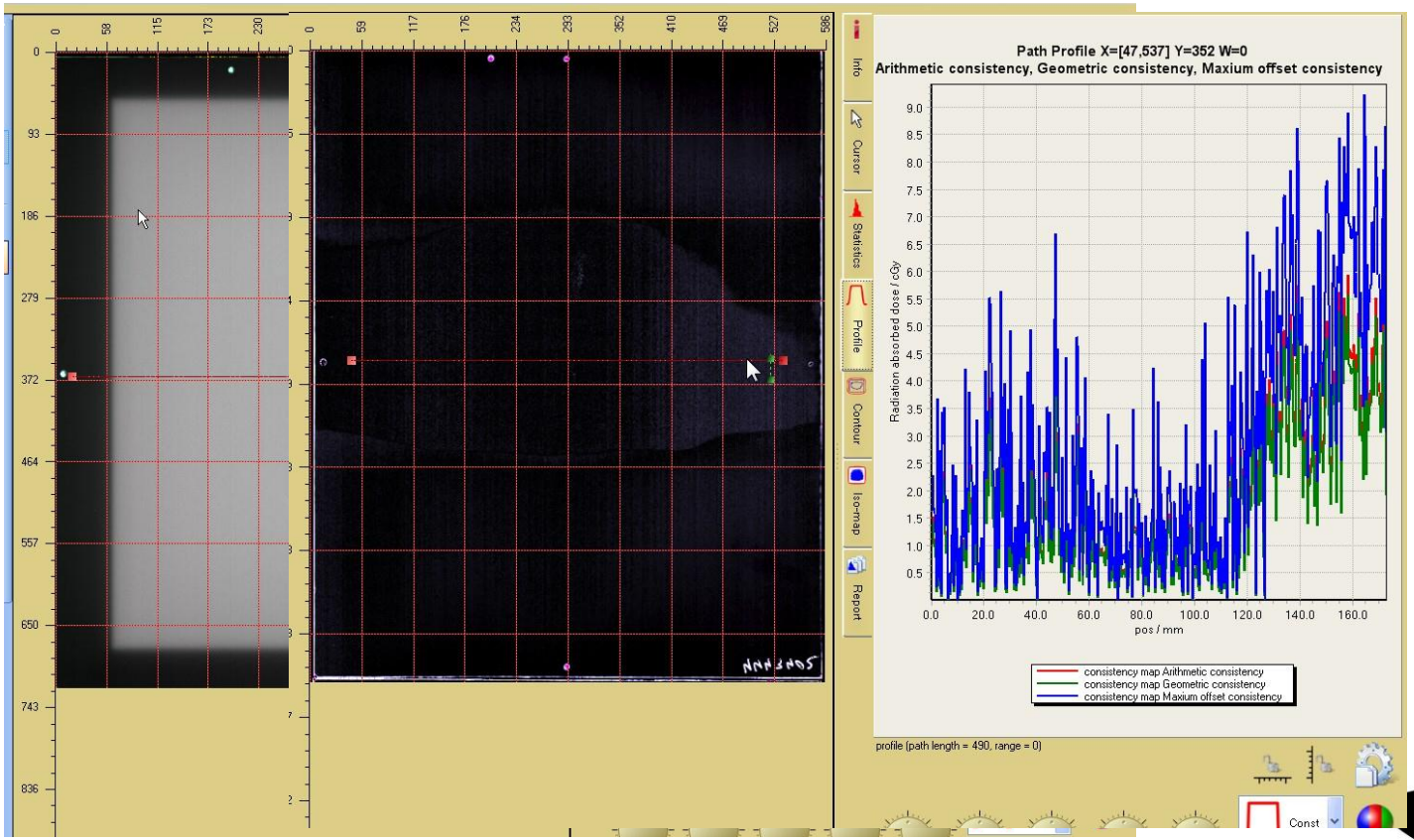


Deviation < 0,2%

RdGG protocol 3 warm-up scans

Film and scanner tests

- Scanner effects irregularities



Film and scanner tests

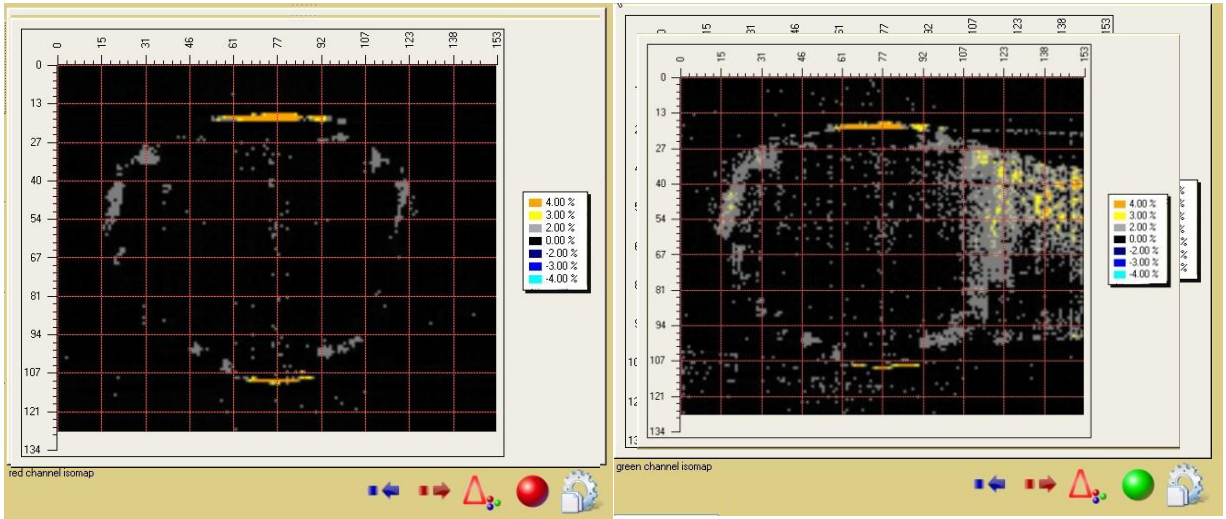
- Scanner effects, irregularities

The color shift on the left side is caused bij the scanner and is present in every scan. ➡ Not caused by the film.

Is this a major problem?

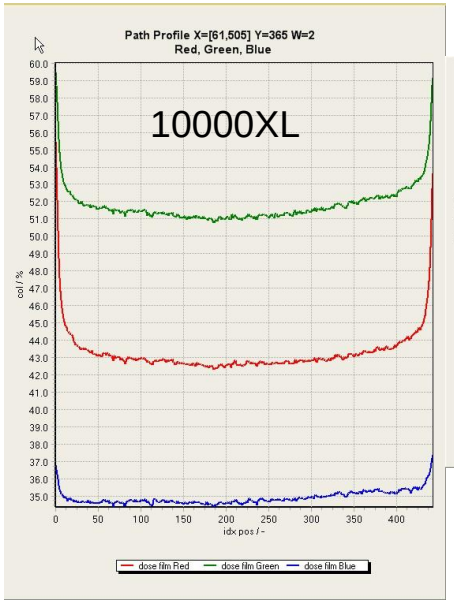
For analyses with the red color channel no problem (<300 cGy)

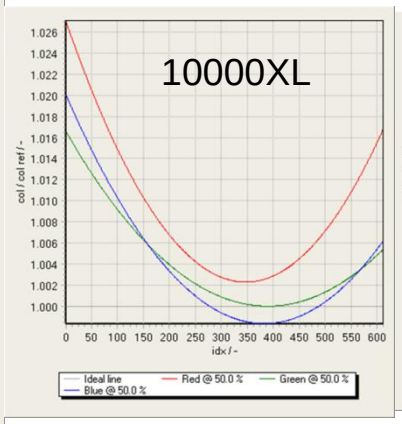
Take care with analyses; We know where the deviation is and that this is caused by the scanner.

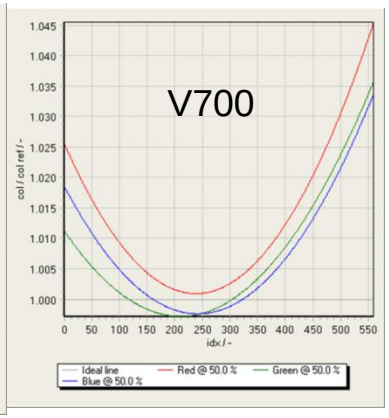


Film and scanner tests

- Lateral correction
  - Yes there is a lateral effect
  - Is this a major problem?
  - No because we have the triple color correction.
  - Choose for a large scanner



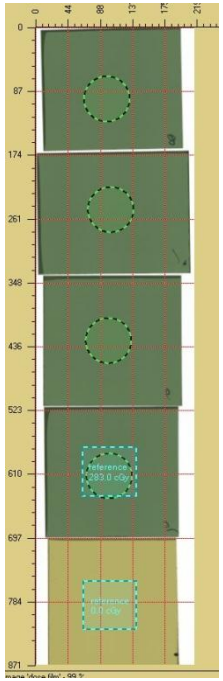


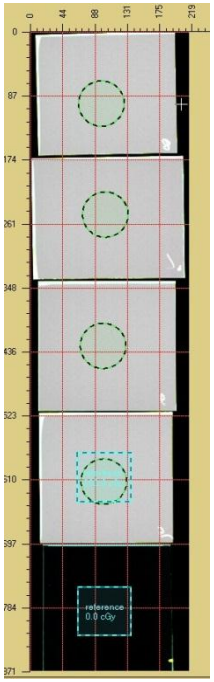


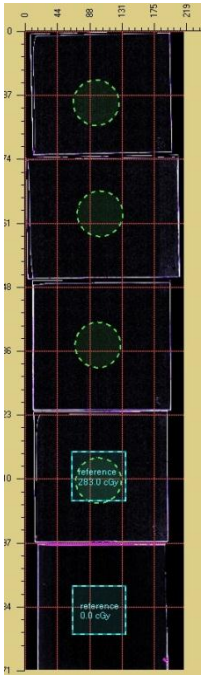
Film and scanner tests

- Homogeneity of the film
  - Cut the film
  - Irradiate each piece of film with ± 100, 200, 300 cGy
  - Scan the films
  - Measure the color values, dose values and check consistency map

3	2	1
6	5	4
9	8	7
12	11	10







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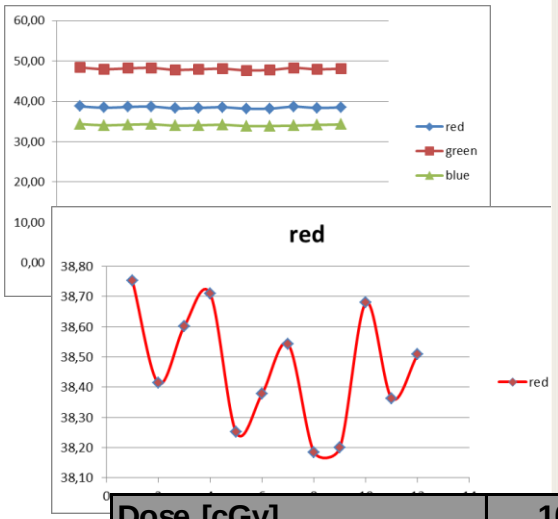
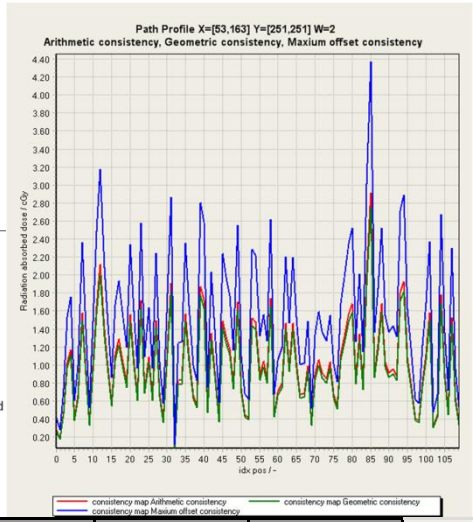
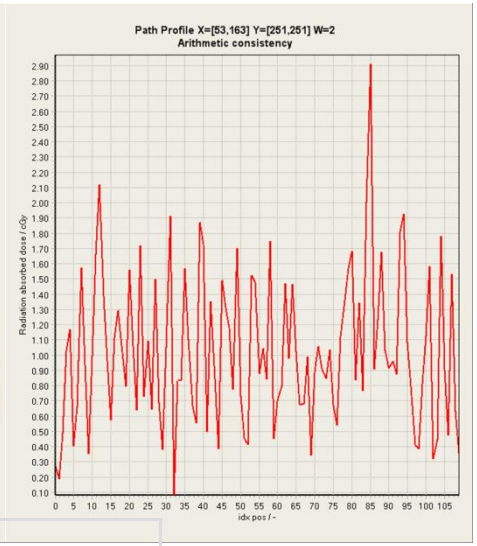




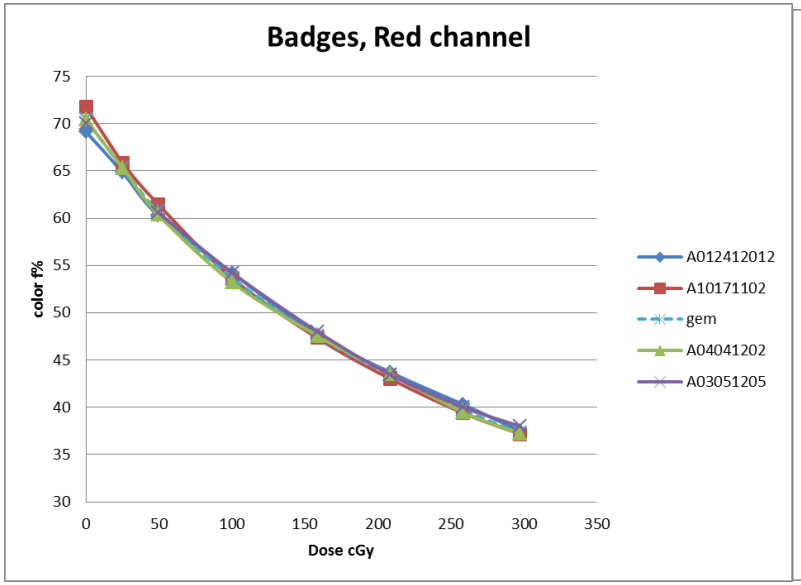


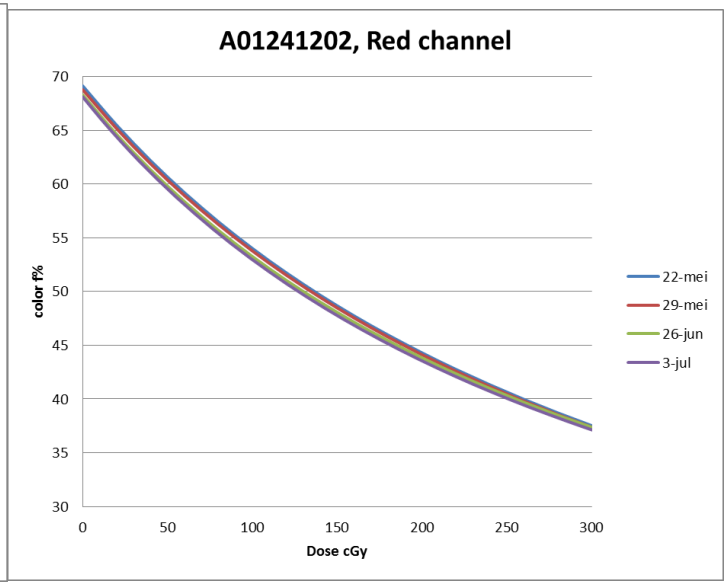
Dose [cGy]	100	200	300	
Color channel	0,30%	0,36%	0,51%	(STDEV/mean)
Dose	0,44%	0,24%	0,28%	
Dose consistency map	0,65%	0,47%	0,41%	(mean/dose)

Film and scanner tests

- Film badges

  Shape of the calibration curve for different badges of film is comparable.

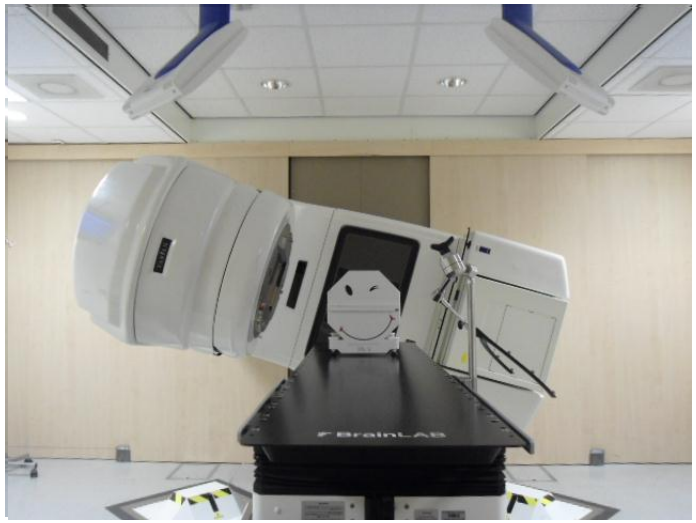




Pre-treatment verification

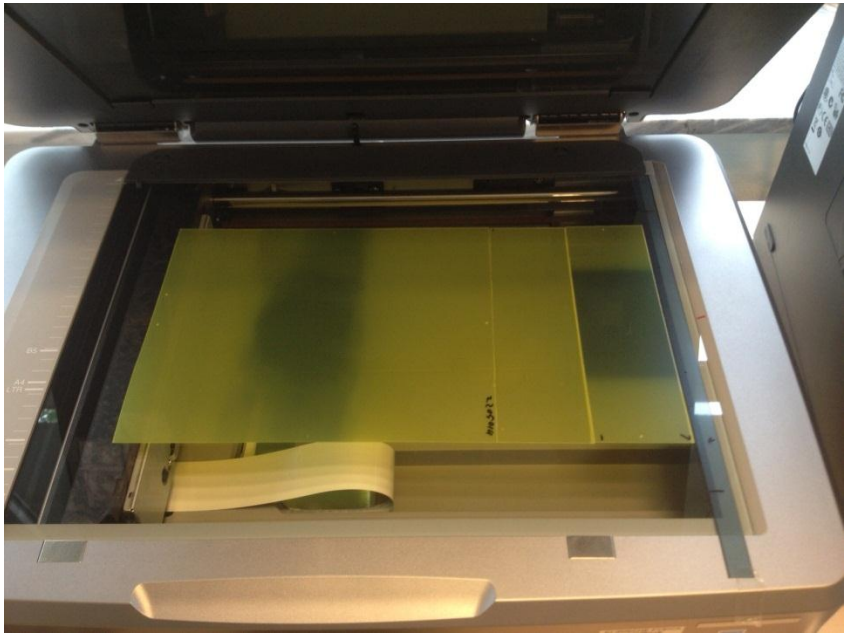
- Prostate
  - Regular calibration methode (scan time > 6 hours after irradiation)
  - One scan calibration methode (scan time ± 1 hour after irradiation)

- Stereotactic brain metastase
  - Regular calibration method

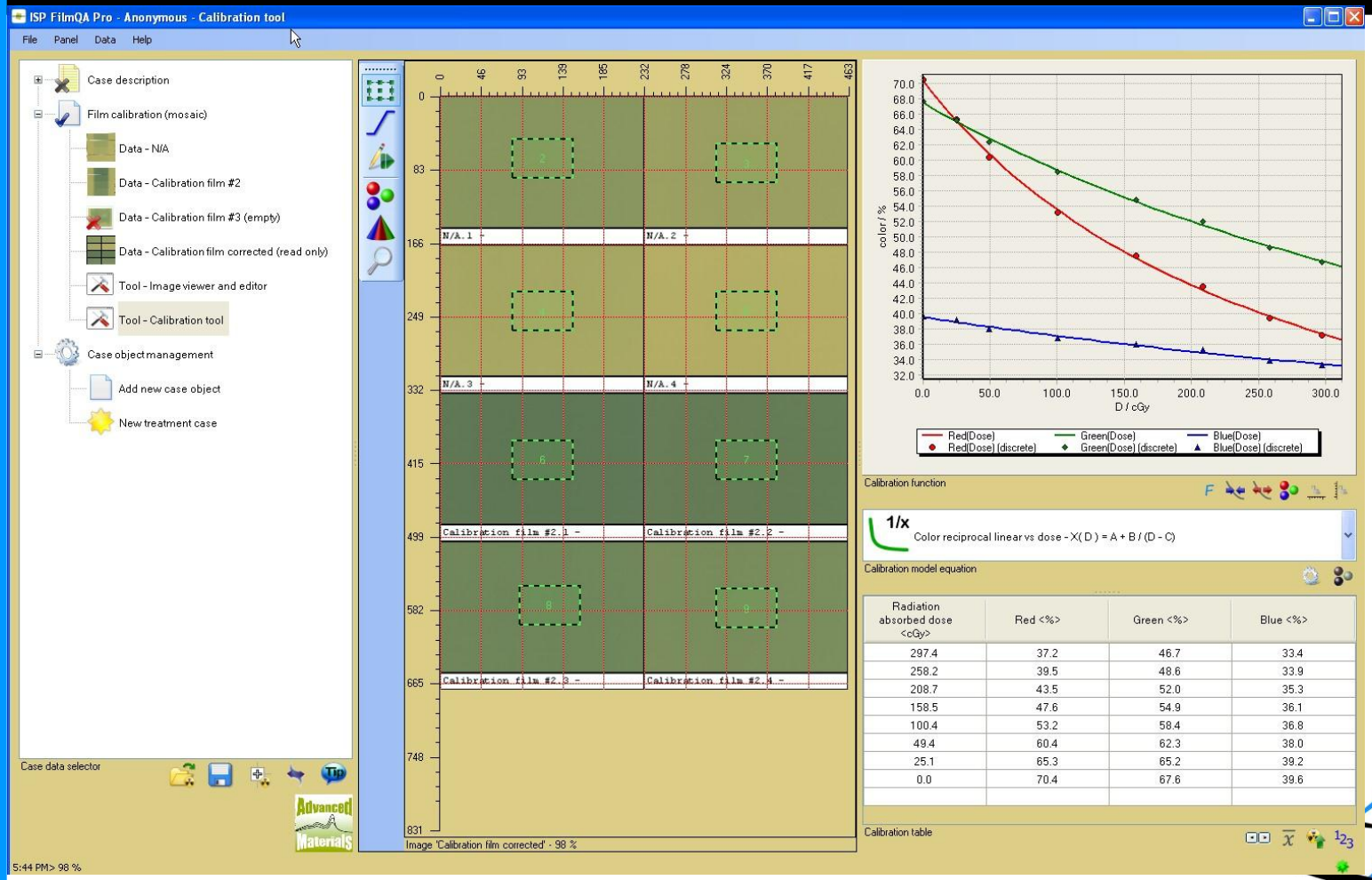


Pre-treatment verification

- One scan method
  - Irradiate calibration patch
  - Irradiate treatment plan in QA mode Mosaiq
  - Wait about 50-60 minutes
  - Scan films
  - Analyse

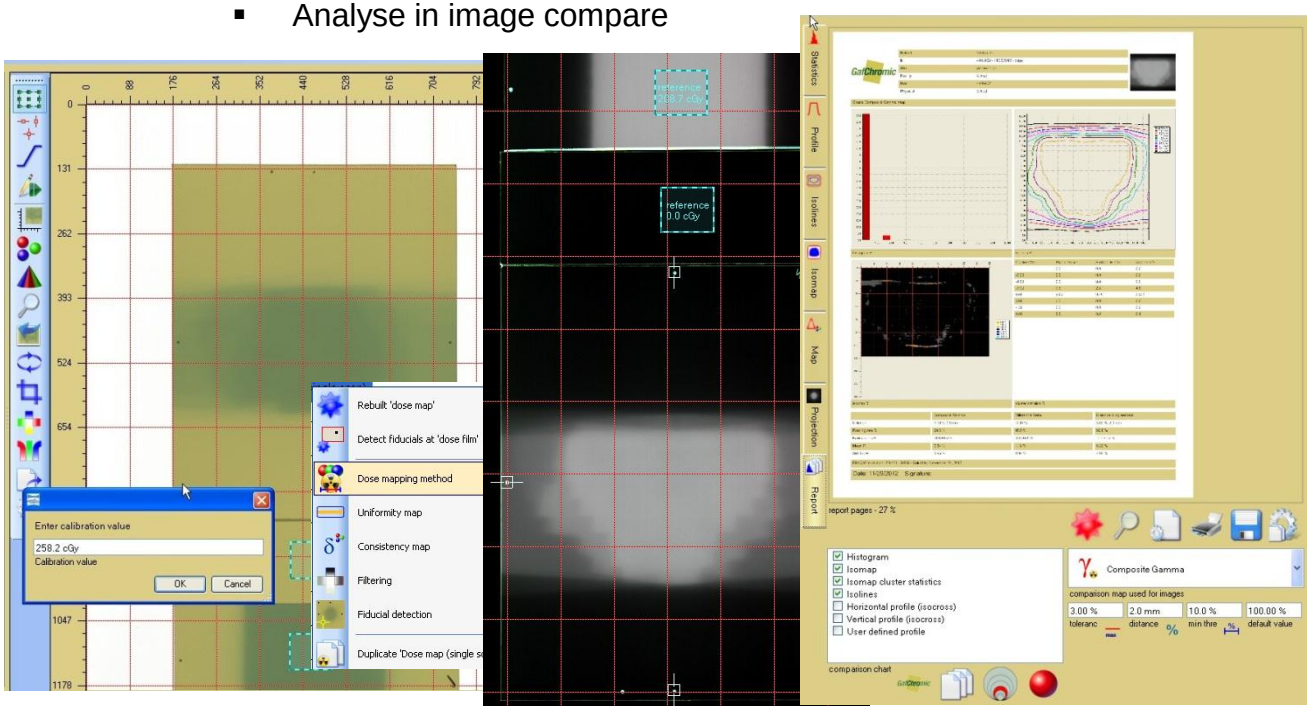


Pre-treatment verification



Pre-treatment verification

- Analysing
  - Open the box calibration file
  - Place calibration regions on calibration patches (0 cGy and 209/258 cGy)
  - Recalculate with triple color and Dose linear scaling
  - Place fiducials
  - Import 2D dose map (TPS)
  - Analyse in image compare



Pre-treatment verification

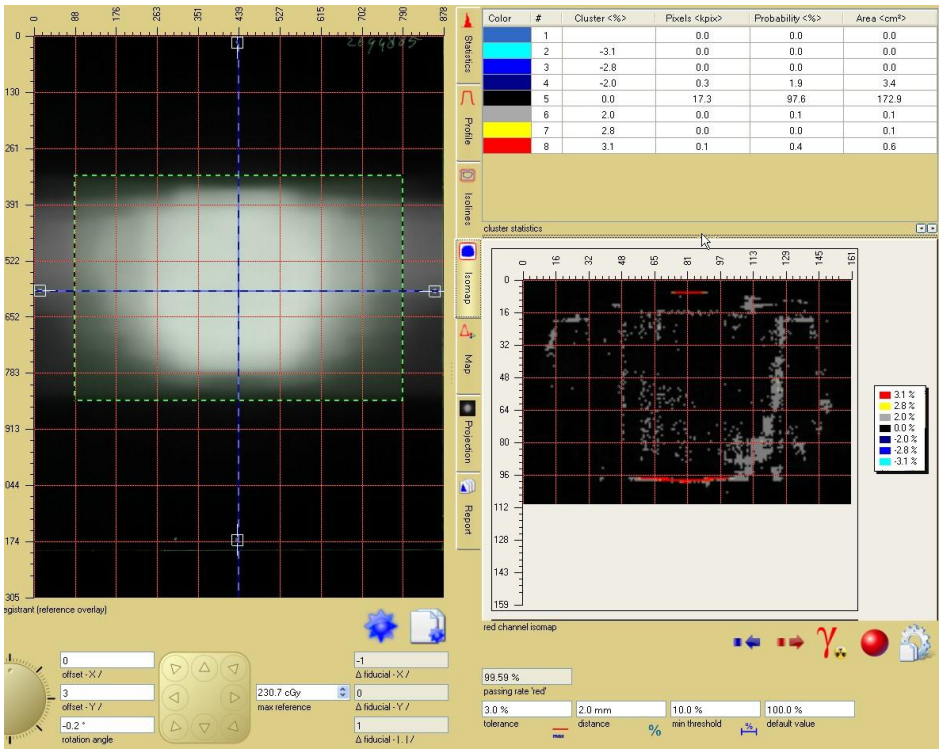
- Results
  - Regular calibration methode
  - One scan calibration methode

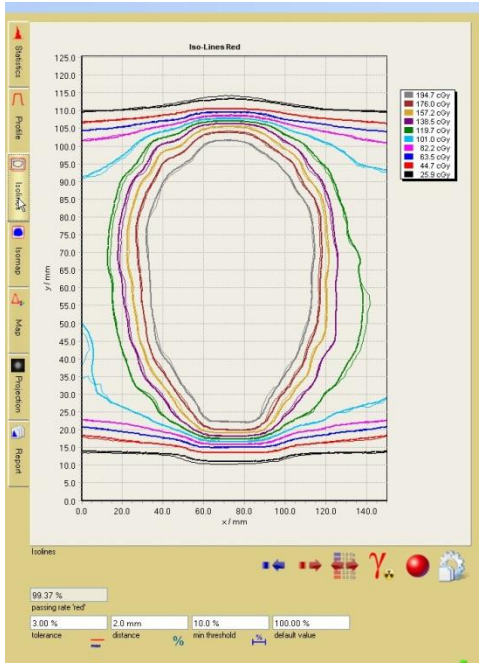
Measurement	Point dosimetrie [% dev. In ISO to TPS]	Scan Oriantation	Gamma [3%, 2 mm]	Differential Delta [3%]
IMRT Prostate 1	0.2%	Portrait	99.8%	95.0%
		Landscape	99.6%	89.0%
IMRT Prostate 2	-1.2%	Portrait	99.2%	87.2%
		Landscape	96.7%	80.3%
IMRT Prostate 3	0,6%	Portrait	99,5%	90,9%
		Landscape	99,6%	87,1%
IMRT Prostate 4	0,2%	Portrait	99,6%	96,2%
		Landscape	97,6%	85,0%

Patient ID	Datum	Standaard Kalibratie			One scan				Opmerking
		Gamma	Differential Delta	Cluster oppervlak [cm]	Gamma	Differential Delta	Cluster oppervlak [cm]	Cal film	
IMRT A	4-sep	99,4%	96,3%	0,7	99,5%	96,8%	0,8	4-sep	
IMRT B	4-sep	99,8%	96,8%	0,2	99,6%	93,3%	0,4	4-sep	
IMRT C	11-sep	97,1%	72,3%	2,3	97,6%	77,3%	2,4	4-sep	2 Gy plan Prostate low risk
IMRT D	11-sep	99,8%	91,7%	0,1	99,8%	86,4%	0,2	4-sep	
IMRT E	17-sep				99,6%	93,1%	0,4	4-sep	21 min. between cal and composite, scan after 50 min
		99,6%	94,6%	0,5	99,6%	95,7%	0,5	4-sep	after 18 hour
IMRT F	17-sep				99,7%	93,6%	0,3	4-sep	12 min. between cal and composite, scan after 50 min
		99,6%	94,7%	0,5	99,8%	95,9%	0,2	4-sep	after 18 hour
IMRT G	25-sep				99,3%	95,8%	0,9	4-sep	scan after 1 hour
		99,4%	96,6%	0,9	99,4%	96,5%	0,9	4-sep	after 16 hour
IMRT H	25-sep				99,5%	95,7%	0,6	4-sep	scan after 1 hour
		99,7%	96,9%	0,4	99,7%	96,2%	0,4	4-sep	after 16 hour

Pre-treatment verification

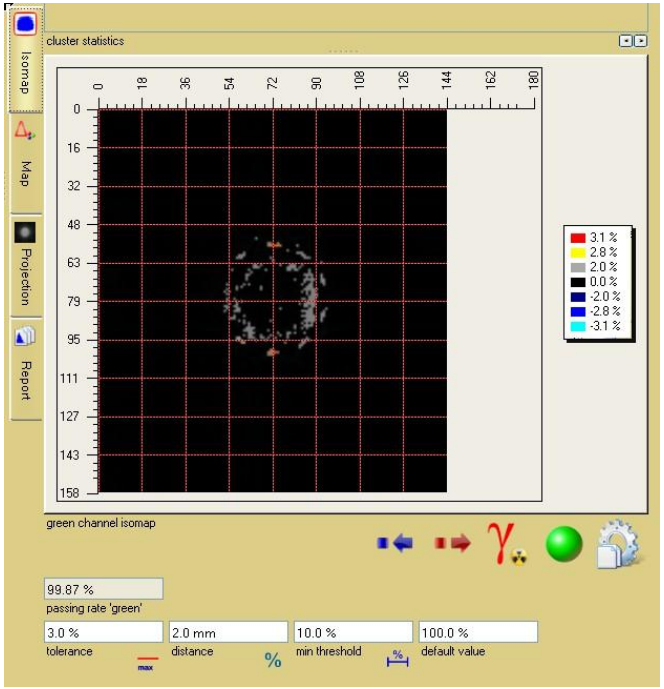
IMRT Prostate
Gamma map (3% 2 mm)



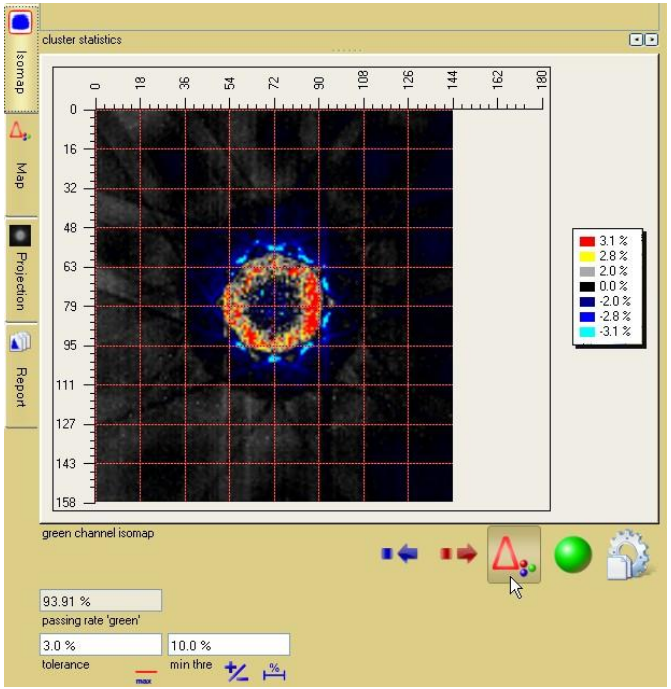


Pre-treatment verification

Stereoctatic
Gamma map (3% 2 mm)



Dose map (3%)



Pre-treatment verificatie

Reinier de Graaf Groep

Uitgevoerd op:	12-11-2012
Door:	Elfried
Toestel:	Clinac

Patient naam:	PEO test
Patient ID:	123123
Plan naam:	1 IMRT prostaatloge
Energie	X15

Electrometer	PTW Unidos Webline, sn. 000255
Ionisatiekamer	PTW 31010 (slangenkamer)
Serienummer	0118

$$k_{T,P} = \frac{(T + 273{,}15)P_0}{(T_0 + 273{,}15)P}$$

T_0 = 20,0 °C

P_0 = 1013,25 hPa

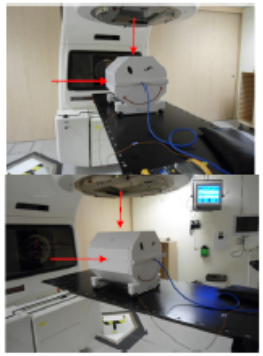
Temperatuur fantoom	21,4	°C
Luchtdruk	1023,9	hPa
$k_{T,P}$	0,994	
Calibratiefactor ionisatiekamer:	311,713	mGy/nC
Fantoom correctiefactor Octavius:	-2,4%	
K_{tot}	319,194	mGy/nC

Standaard veld (MLC 10×10 cm)	Kcehc CAL4 128MU	
Dosis TPS	100,44 cGy	
Gemeten output [pC]	3157	3157
	3157,00	
Berekende dosis	100,20 cGy	
Correctie dosimetrie	-0,24%	

Film dosimetrie	JA, one scan methode		Kal. strook 6
Badge nummer:	A04041202	Doos nr.:	21

Verschuiving ISO:	NEE		

Meetopstelling:ISO; laser lijnen



Resultaten puntdosimetrie

Bundel	ME planning	Dosis uit Iplan TPS [cGy]	Metingen [pC]	Gemeten [cGy]	Afwijking t.o.v. berekend	Gemeten corr.dosime [cGy]	Afwijking t.o.v. berekend
Bundel 1	144	37,70	1174	37,26	-1,2%	37,35	-0,9%
Bundel 2	123	41,71	1267	40,21	-3,6%	40,31	-3,4%
Bundel 3	129	38,15	1208	38,34	0,5%	38,43	0,7%
Bundel 4	135	39,11	1240	39,36	0,6%	39,45	0,9%
Bundel 5	129	41,57	1271	40,34	-3,0%	40,44	-2,7%
Totaal	660	198,24	6160	195,51	-1,4%	195,98	-1,1%
Criteria voldaan							JA

Resultaten Filmdosimetrie

Film ID	Kleurkanaal	Gamma [3%, 2 mm]	Dosis match	Cluster opp. Gamma >3%, 2 mm [cm²]	Criteria voldaan
4443402	Rood	99,6%	95,8%	0,5	JA

Resultaten RadCalc

	Plan	Maximale afwijking bundels	Criteria voldaan
Afwijking RadCalc vs TPS	-0,1%	-2,3%	JA

Nader onderzoek plan door Klinisch Fysica RT	NEE

Plan akkoord:	Elfried Kok
Datum	12-11-2012

Opmerking:

- Report Physics, Radiation therapy RdGG

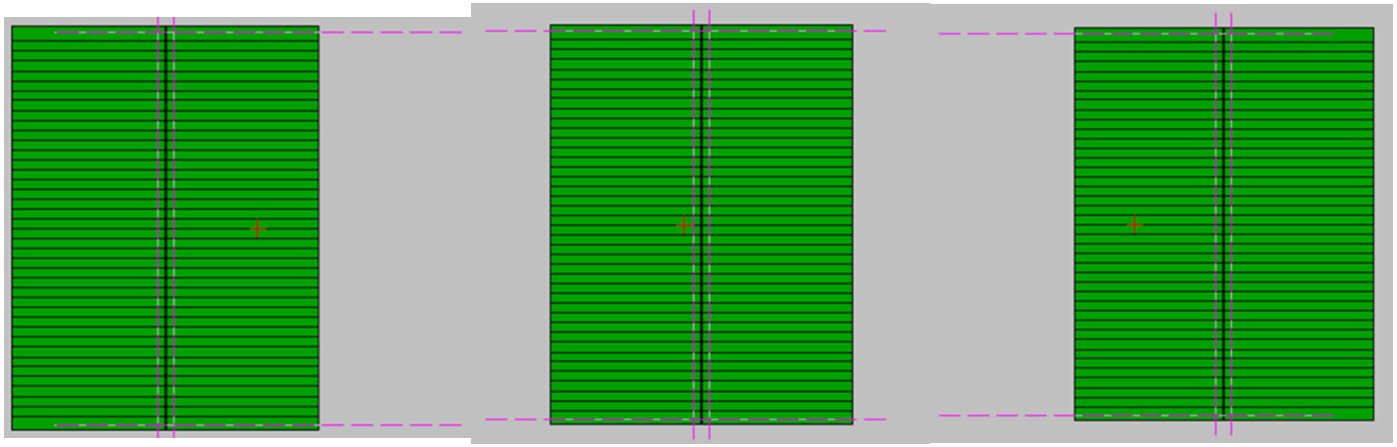
Pre-treatment verification

- Time table

Controle	Regular calibration	One scan calibration
preparation	30 minutes	30 minutes
Linac time	30-45 minutes	20 minutes
FilmQA Pro	20 minutes	10 minutes
Administration	10 minutes	10 minutes
Total	**90-105 minutes**	**70 minutes**

Physics QA

- Picket fence
  - Slit 2 mm with MLC
  - 11 slit positions with distance from 2 cm
  - 100 MU/ slit position
  - Film in collimator adapter (67,5 cm)



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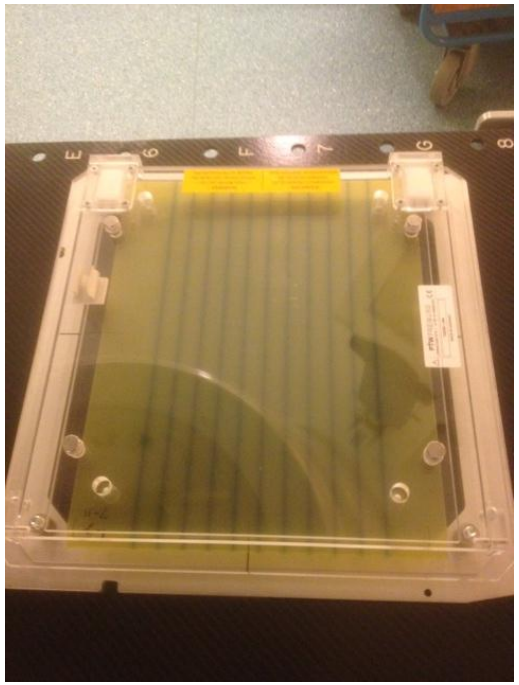
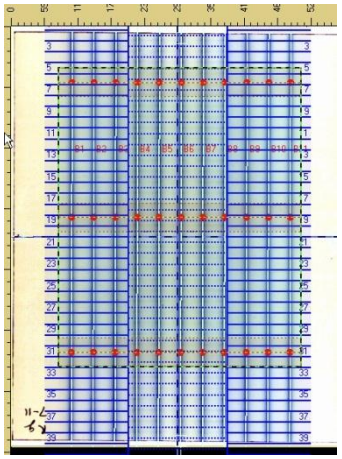
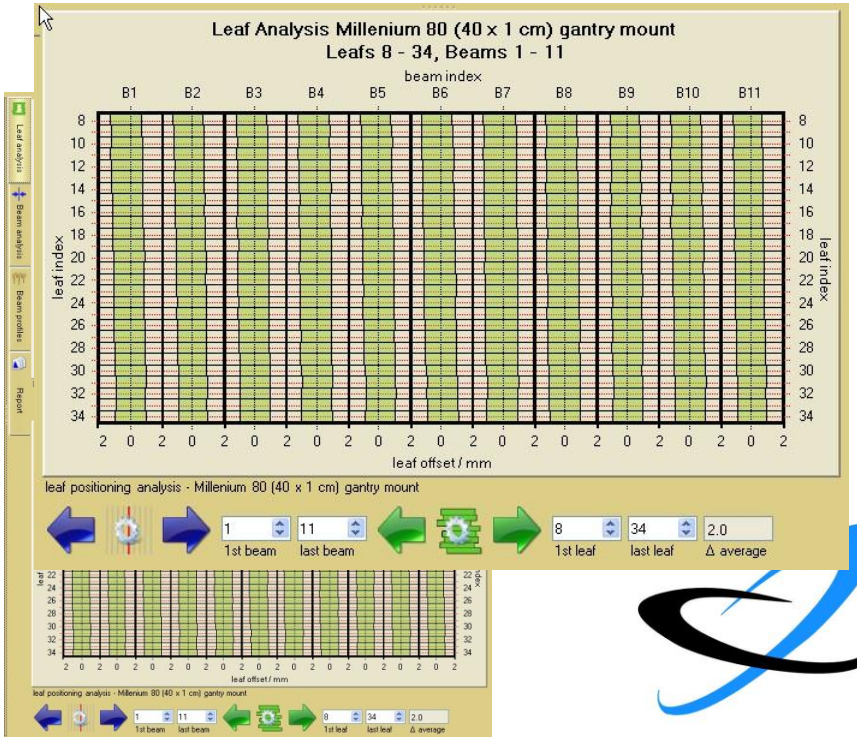


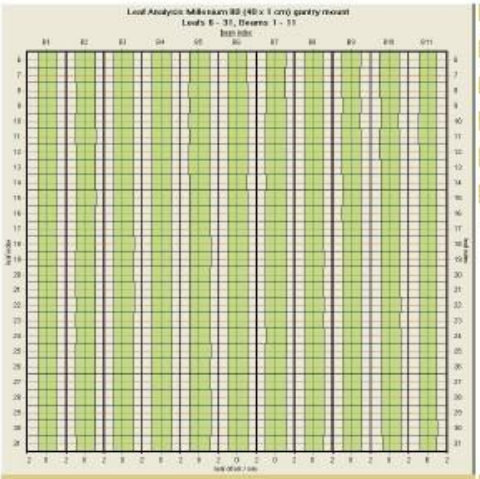
Physics QA

- Picket fence
  - Slit 2 mm with MLC
  - 11 slit positions with distance of 2 cm
  - 100 MU / slit position
  - Film in collimator adapter (67,5 cm)
  - Scan film
  - Analyse
    - Set the MLC design
    - Set Δ avarge 2,0 mm
    - Leafopening 2,3 mm
    - Bias 0,3 mm
  - report





Images	Picket fence #Clinac houder
Source	
Resolution	72 dpi
Analysis color	Red (dk)



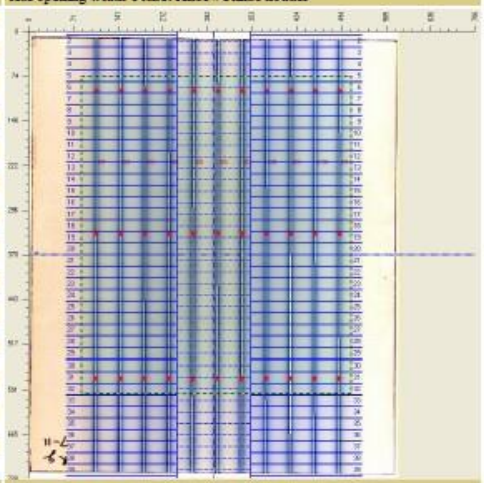
	min / mm	ave / mm	max / mm
Beam 1	1.9	1.9	2.0
Beam 2	1.9	2.0	2.1
Beam 3	2.0	2.1	2.2
Beam 4	2.0	2.1	2.2
Beam 5	2.1	2.2	2.3
Beam 6	2.1	2.1	2.2
Beam 7	2.0	2.1	2.2
Beam 8	1.9	2.0	2.1
Beam 9	1.9	2.0	2.1
Beam 10	1.9	2.0	2.1
Beam 11	1.7	1.8	1.9

leaf analyis 'Picket fence #Clinac houder'

	min / mm	ave / mm	max / mm
Leaf 6	1.9	2.0	2.1
Leaf 7	1.8	2.0	2.1
Leaf 8	1.8	2.0	2.1
Leaf 9	1.8	2.0	2.1
Leaf 10	1.8	2.0	2.1
Leaf 11	1.9	2.1	2.1
Leaf 12	1.8	2.1	2.2
Leaf 13	1.8	2.0	2.2
Leaf 14	1.7	2.0	2.1
Leaf 15	1.8	2.0	2.2
Leaf 16	1.8	2.0	2.2
Leaf 17	1.8	2.0	2.2
Leaf 18	1.8	2.1	2.2
Leaf 19	1.8	2.1	2.3
Leaf 20	1.8	2.0	2.2
Leaf 21	1.8	2.1	2.2
Leaf 22	1.8	2.1	2.2
Leaf 23	1.8	2.0	2.2
Leaf 24	1.7	2.0	2.2
Leaf 25	1.8	2.1	2.2
Leaf 26	1.8	2.1	2.2
Leaf 27	1.8	2.0	2.2
Leaf 28	1.8	2.1	2.2
Leaf 29	1.8	2.1	2.2
Leaf 30	1.8	2.1	2.2
Leaf 31	1.8	2.0	2.1

leaf opening width 'Picket fence #Clinac houder'

leaf opening width 'Picket fence #Clinac houder'



picket fence image 'Picket fence #Clinac houder'

FilmQaPro version: 2.0.4711.31868 - Saturday, November 24, 2012

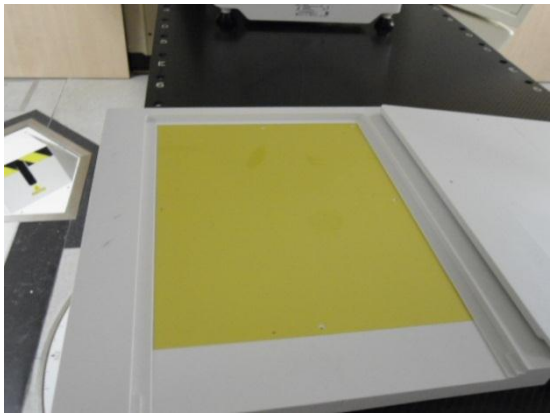
Date: 11/29/2012 Signature:

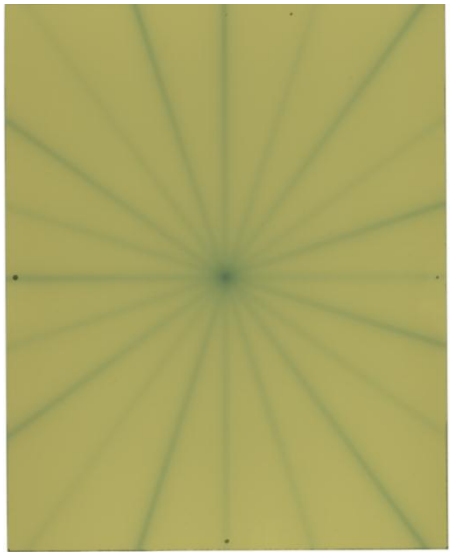
- Picket fence

Physics QA

- Starshot
  - Slit 1 mm with MLC in centre
  - 120 MU / slit position
  - Collimator, gantry and table
  - Film in Octavius adapter

Veld	Collimator hoek
1	198°
2	234°
3	270°
4	306°
5	342°
6	0°
7	36°
8	72°
9	108°
10	144°



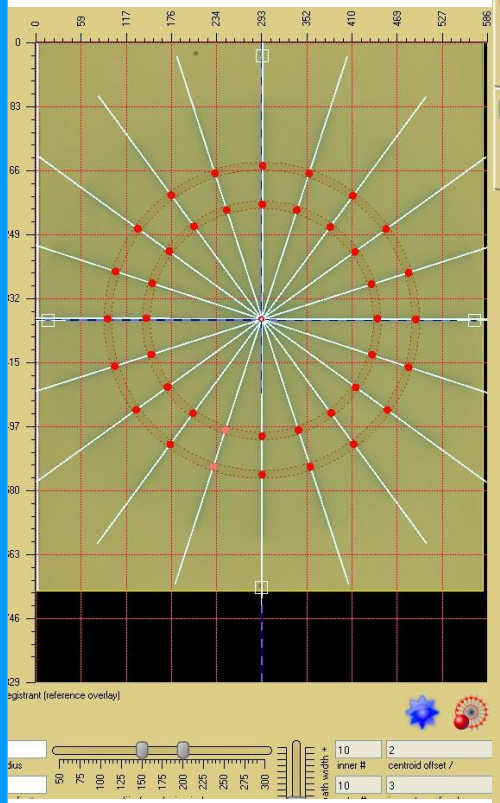


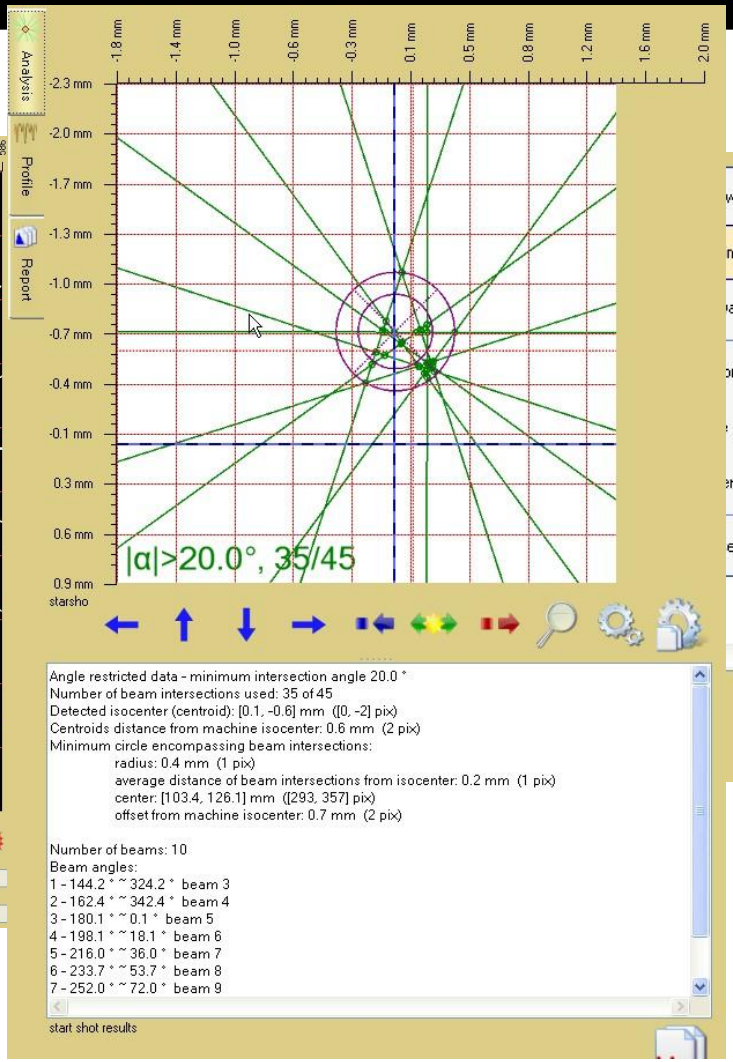
Physics QA

- Starshot (spaken film)
  - Slit 1 mm with MLC in centre
  - 120 MU / slit position
  - Collimator, gantry and table
  - Film in Octavius adapter
  - Set fiducials
  - Analyse
    - tool
    - Adjust alignment
  - report

Physics QA

- Starshot





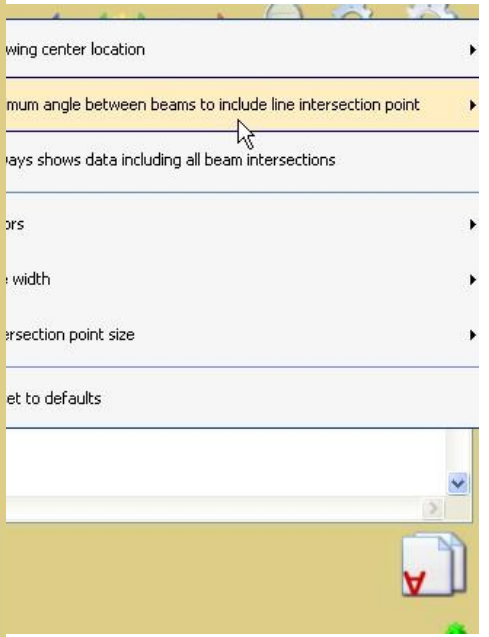
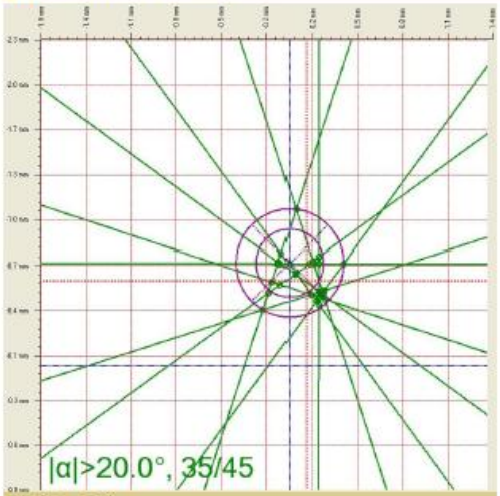
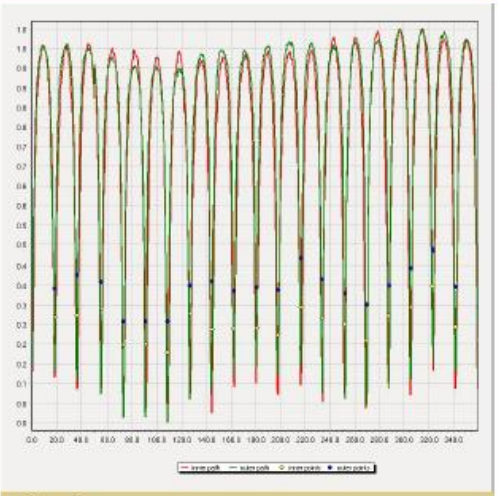


Image	Start shot #1
Source	EPSON Expression 10000XL
Size	{W= 586, H= 719} pix = {W= 206.7, H= 253.6} mm
Resolution	72 dpi
Origin	RDGG\koke 6-11-2012 14:48:21
Analysis color	Red (beam darker)

Charts 'Dose film' star shot analysis

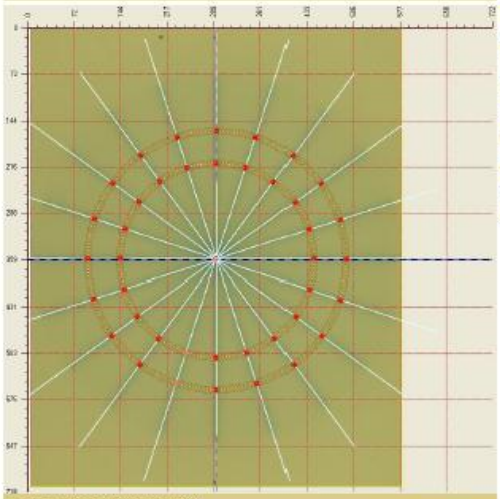


star shot analysis



profiles red

isocenter (centroid, 35 o	(X=103.5, Y=126.2) mm	(X=293, Y=358) pix
dist from machine isocer	0.7 mm	2 pix
center of outer circle, 35	(X=103.4, Y=126.1) mm	(X=293, Y=357) pix
radius outer circle, 35 of	0.4 mm	1 pix
offset circle center, 35 o	0.7 mm	2 pix
ave dist to circle center,	0.2 mm	1 pix
angles 1+	144.2 °	162.4 °
angles 3+	180.1 °	198.1 °
angles 5+	216.0 °	233.7 °
angles 7+	252.0 °	270.1 °
angles 9+	288.1 °	306.4 °



star shot image 'Start shot #1'

star shot statistics (red)

FilmQaPro version: 2.0.4711.31868 - Saturday, November 24, 2012

Date: 11/29/2012 Signature:

Wish list

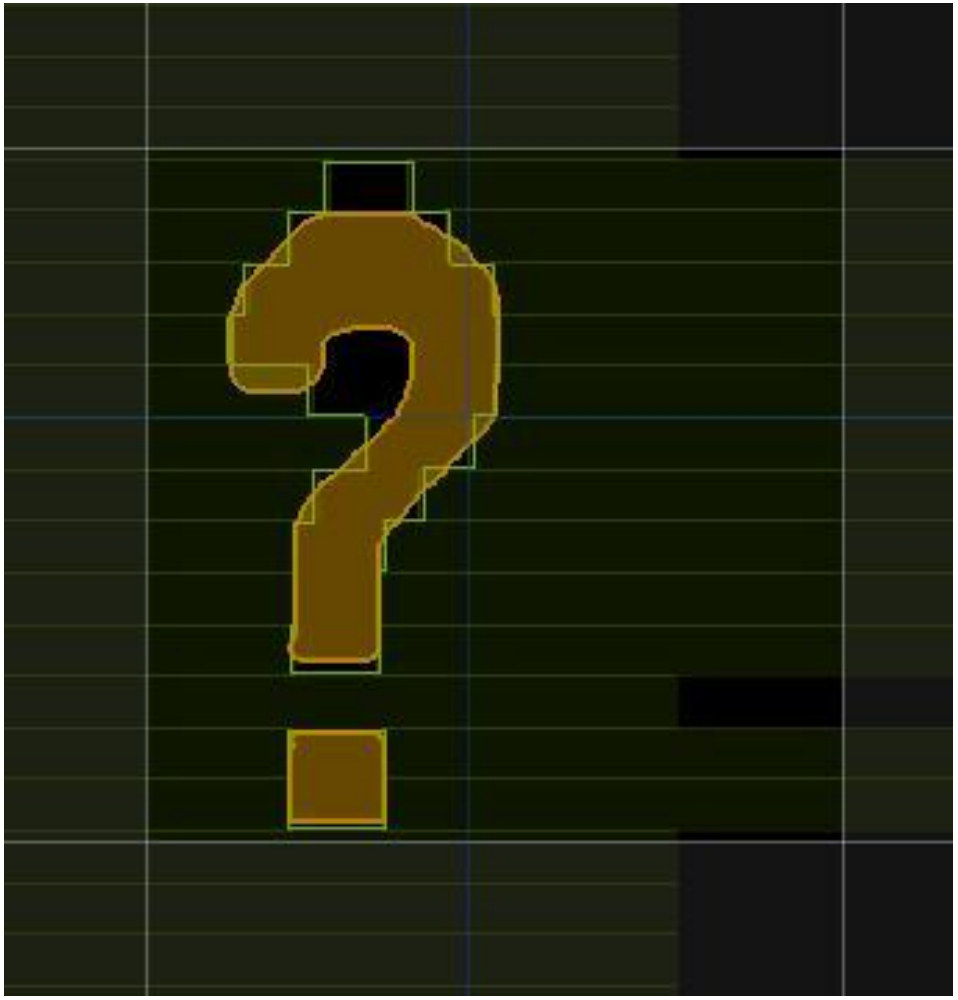
- Correction for scanner irregularities
- Winston Lutz analyses
- Extensive manual

Conclusion

The question:

"Pre-treatment verification with film"

Questions?



Thanks

Special thanks:
Andre Micke

for all the answers to our questions and for the tools built in the software, to make our (filmdosimetry) work easier.

thanks for the invitation