Wobbling nature of gamma passing rate as a function of calibration field sizes in patient specific quality assurance

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Origin of the study?

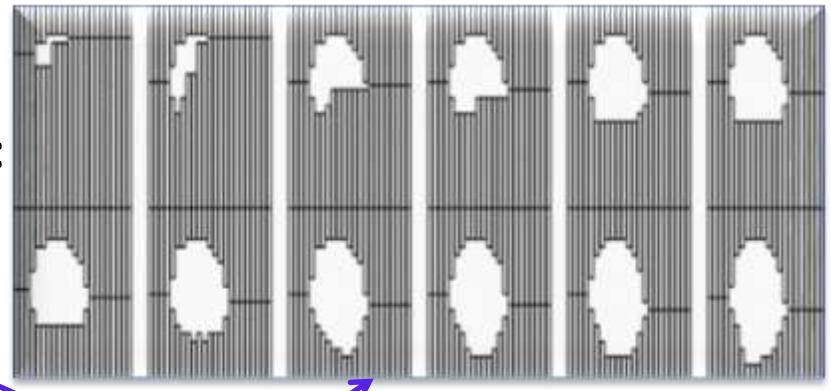
Calibration field size		Plan field size	Delivery
5x5 cm^2	=	5x5cm^2	
10x10 cm^2	=	10x10 cm^2	

Source of errors in IMRT delivery (TG218):

- MLC position errors (Random and systematic)
- MLC speed
- Gantry rotation stability &
- Beam stability

Hypothesis: ***Calibration field size also may introduce an uncertainty in IMRT QA***

10x10 or 5x5 ≠



How a simple reference field (10x10) can be a represent group of irregular segments in the IMRT plan?

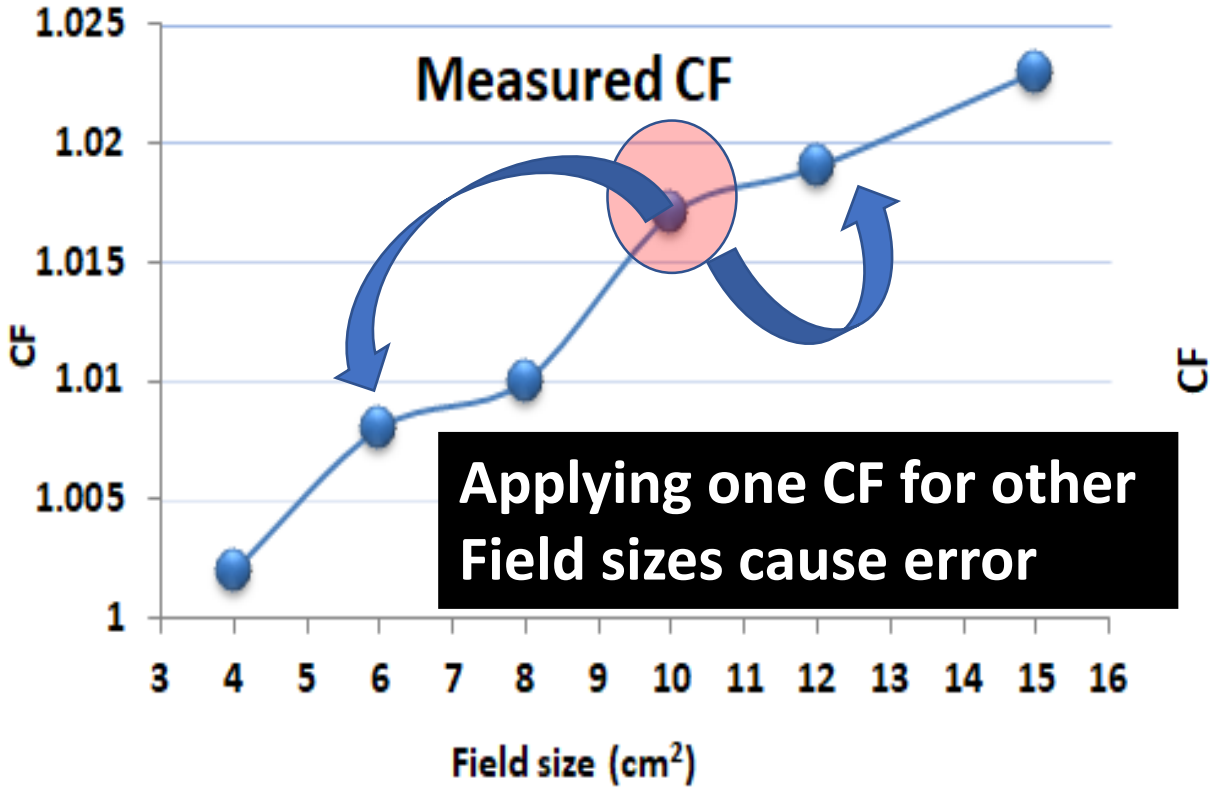
Calibration field size not same as segments in the modulated beam

Calibration Factor using Ocatavious

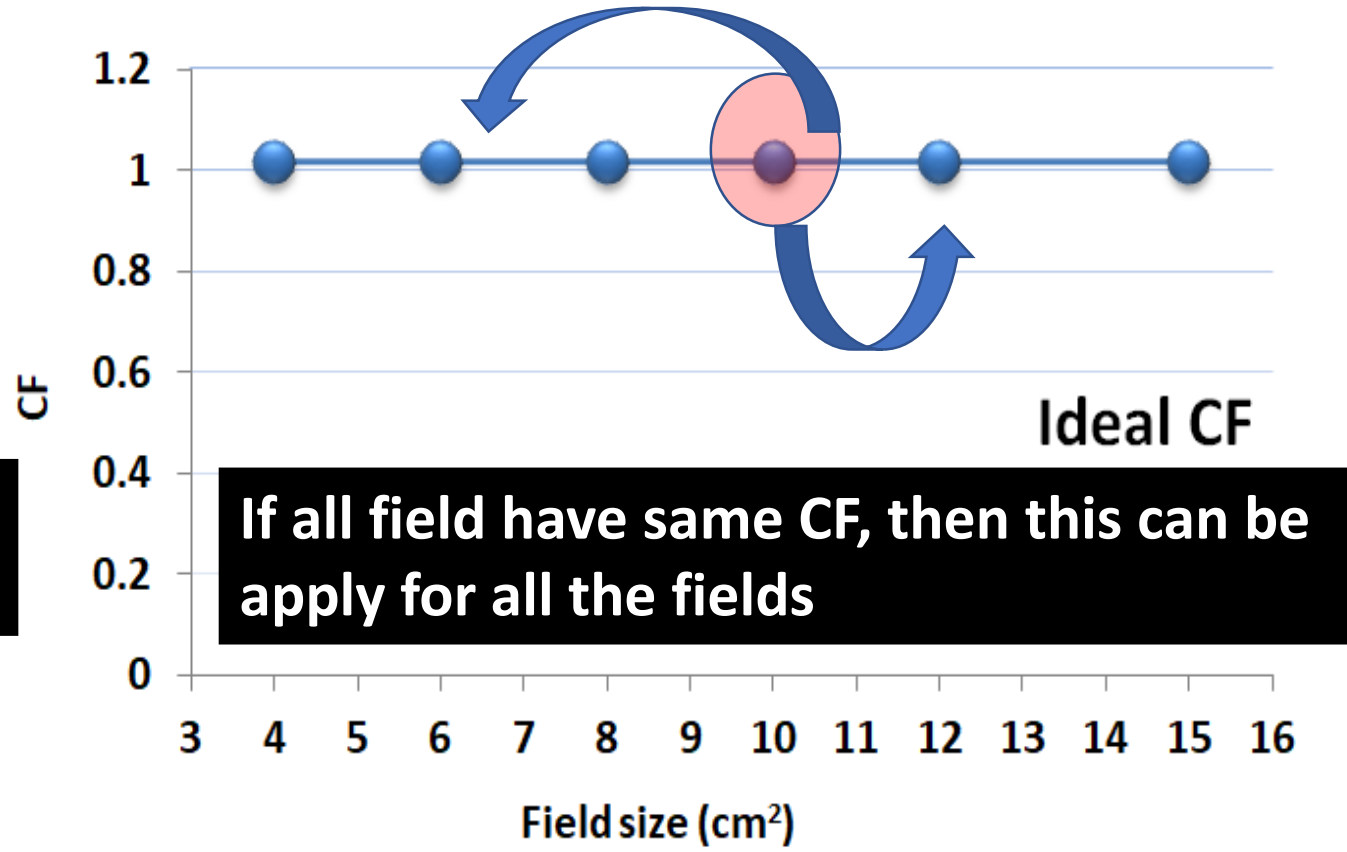
- PTW recommends a cross calibration procedure using a 10×10 cm^2 field
- MU for known dose for simple field (10x10 cm^2) calculated in TPS
- Delivered the calculated MU in the machine to obtain the dose
- Ratio of the TPS dose and measured dose gives the calibration factor called (K_{cross})

Validity of Reference Calibration Factor(CF)-*(Evidence)*

Measured CF in reality



Not happen in reality



Calibration factor obtained in different filed sizes are not same, so one calibration factor not applicable to all the fields of the IMRT/VMAT beam

Materials and Methods(included only 4DOCT study)

Sample size (n) :12

Plan : Rapid Arc

Planning system : Eclipse

Plan delivery : Varian Unique

Dosimetry : 4D Ocatavious phantom with 2d array-729 detectors

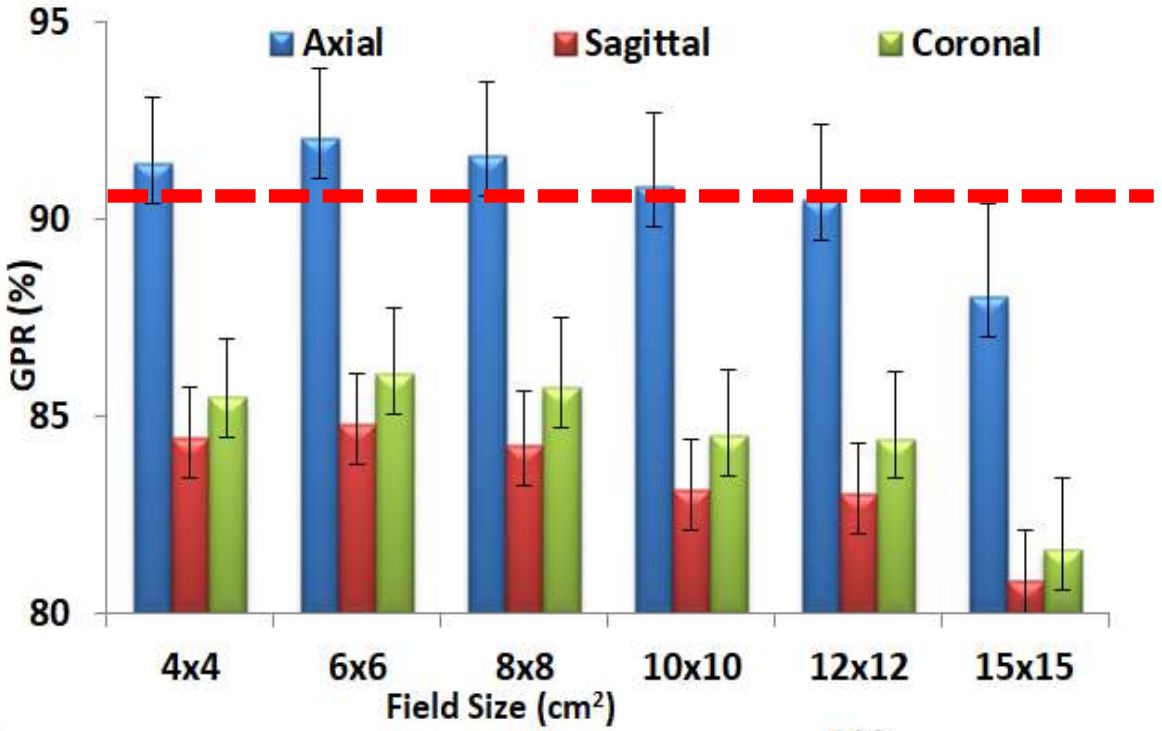
Delivery mode : Perpendicular Composite

QA analysis tool : Gamma index (***10%low dose threshold, global normalization for 2%2mm, 2%3mm and 3%3mm***)

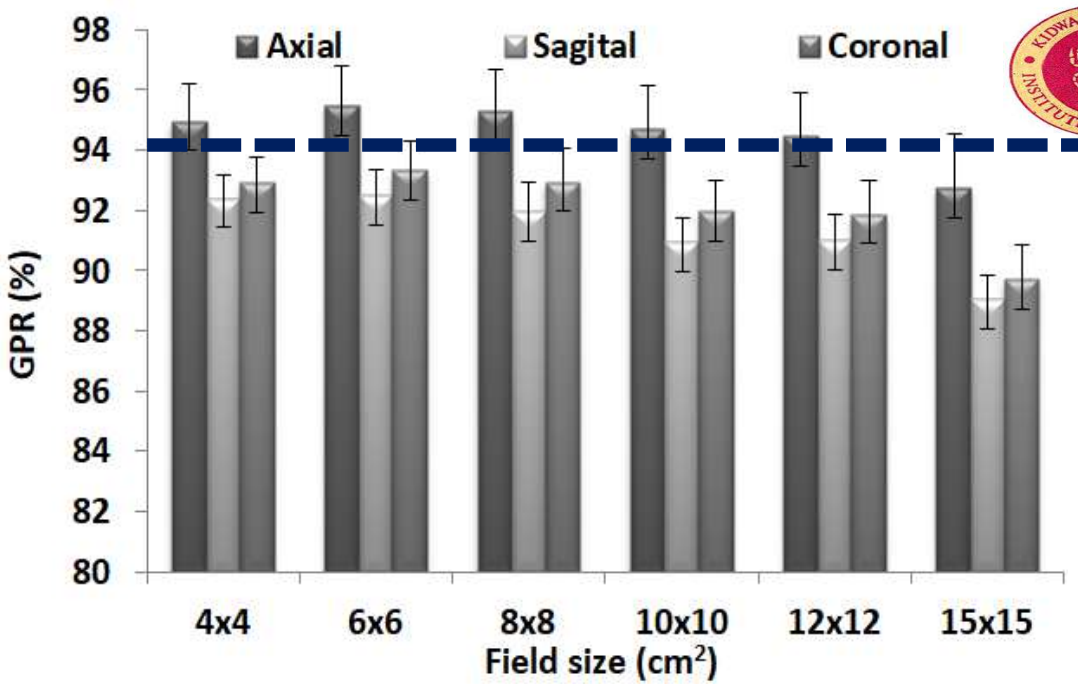
Calibration:

- Calibration factor obtained for **4x4, 6x6, 8x8, 10x10, 12x12 and 15x15 cm^2**
- Each plan delivered using 6 different calibration factors **(12 plan x 6 calibration factors =72 deliveries)**

Results

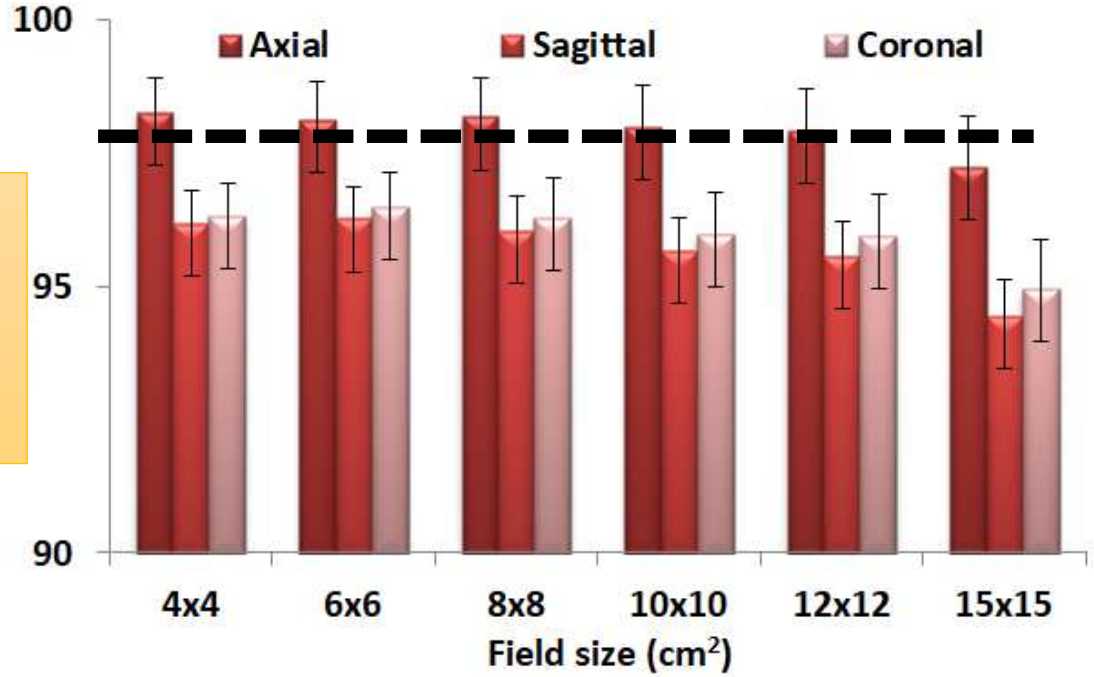


2%2mm



2%3mm

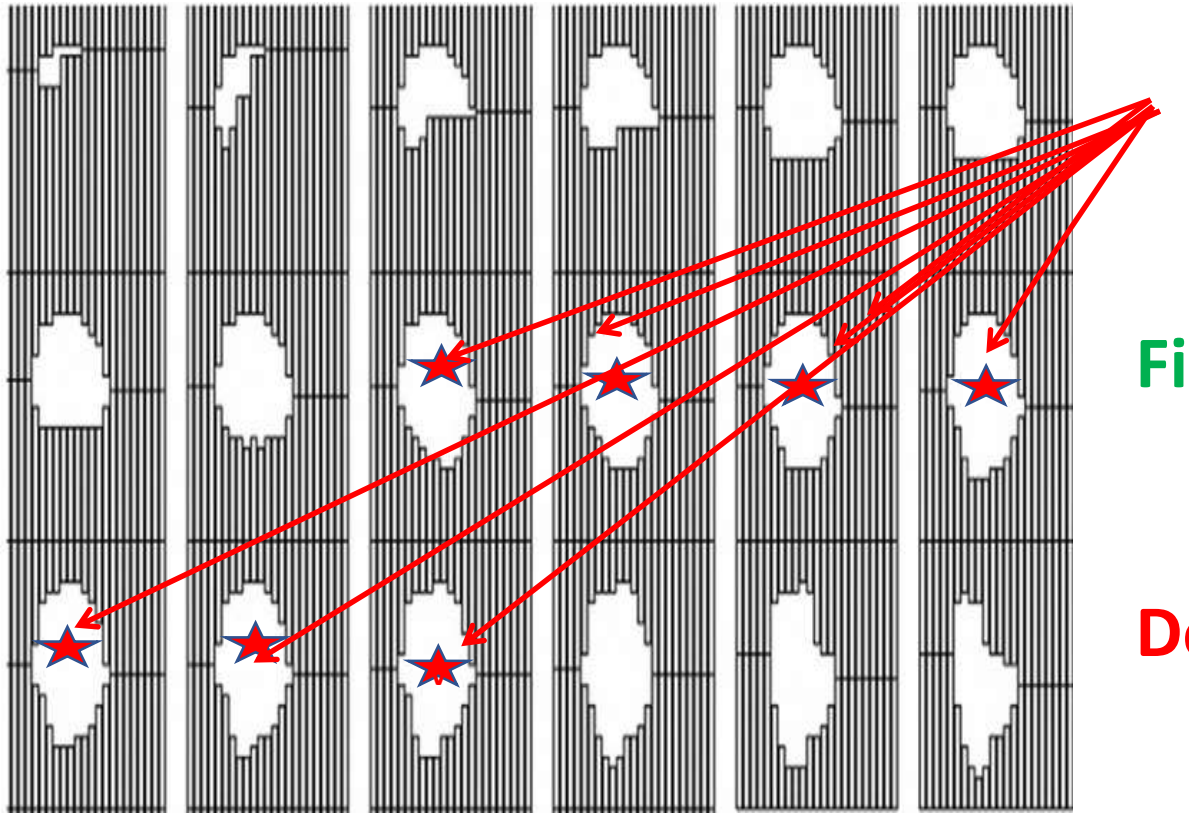
Gamma passing rate (GPR) is not same for all the calibration fields!!



3%3mm

Interpretation

Any plan can have better GPR, if the 2d array calibrate using field size which is equal to the maximum number of repeated segments in the given plan



Identify the repeated segments

Find the equivalent square field size

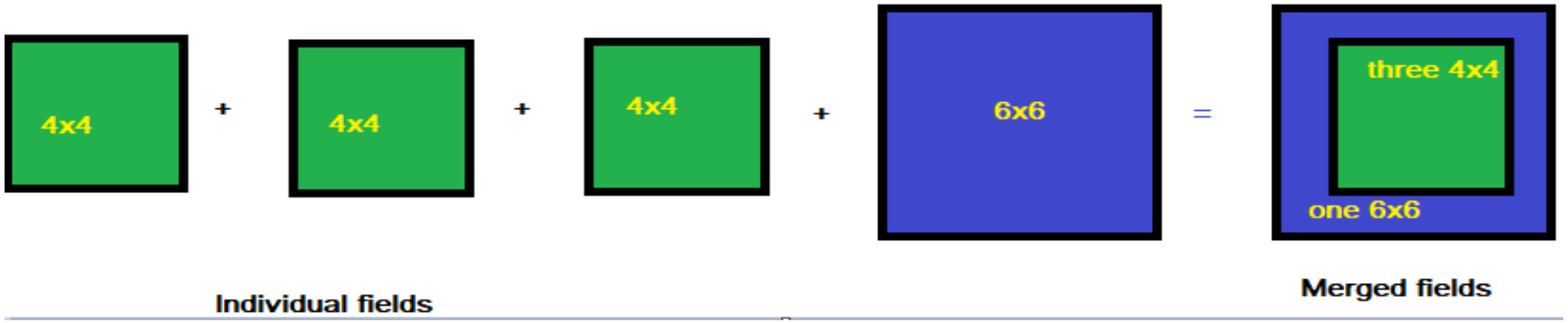
Do the calibration for better QA results

Proof for Interpretation

We justified the results……

How to do this?

- A simple composite field plan has been created by merging ,three same fields (ex: 4x4) and one different filed (ex: 6x6)



- Measured dose is close to TPS when the 2d array was calibrated by repeated field in the plan

Proof for Interpretation

Calibration F.S	TPS dose (ref)	Measured dose (4x4)	Different F.S		%diff from 4x4	%diff from diff F.S	
3_4x4, 1_6x6	1.05	1.054	6X6	1.060	-0.380	6X6	-0.95
3_4x4, 1_8x8	1.067	1.0720	8X8	1.080	-0.416	8X8	-1.22
3_4x4, 1_10x10	1.082	1.087	10X10	1.100	-0.460	10X10	-1.66
Calibration F.S	TPS dose (ref)	(6X6)	Different F.S		(6x6)	%diff from diff F.S	
3_6X6, 1_4X4	1.092	1.1	4X4	1.112	-0.7	4X4	-1.8
3_6X6, 1_8X8	1.13	1.135	8X8	1.140	-0.44	8X8	-0.44
3_6X6, 1_10x10	1.145	1.15	10X10	1.156	-0.44	10X10	-0.96

Findings

- Conventional calibration may mask the superior results of patient specific QA

- Repeated segment's equivalent field size may appropriate for calibration

- GPR is higher in transfers plane
  - Reason is unknown