

# Assessing in vivo 2D image analysis sensitivity in breast cancer treatments using PerFRACTION

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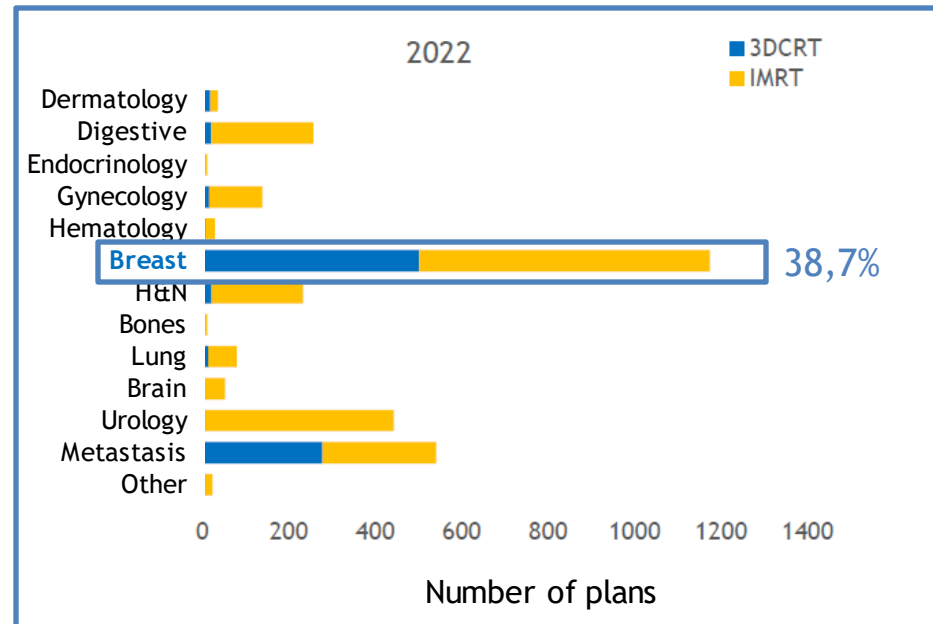
Patient

**Sun Nuclear supported my participation in QADS14**

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**DISCLOSURE**

1. Anthropomorphic phantom study – sensitivity to positional and anatomical errors
2. Retrospective study on 30 **breast** cancer treatments – 3DCRT and VMAT plans



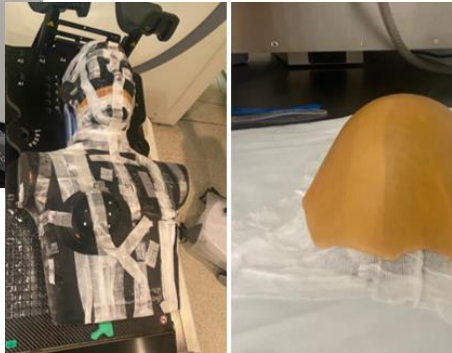
Patient

**OUTLINE**



## LINAC

TrueBeam® STx linac (Varian Medical Systems, Inc.)



## PHANTOM

Alderson-Rando anthropomorphic phantom – sensitivity study:

- Inducing positioning errors
- Bolus to simulate anatomical changes



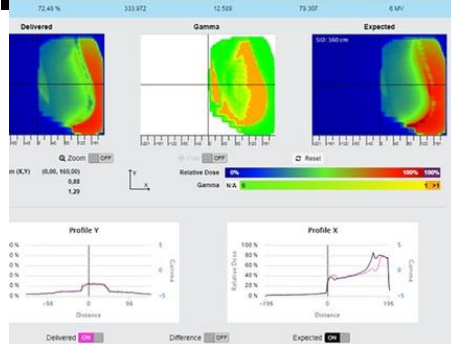
## PATIENTS SAMPLE

30 breast cancer patients – retrospective study:

- 70 plans in total,
- 319 images (148 3DCRT and 171 VMAT)

## SOFTWARE

- SunCHECK™ Patient PerFRACTION (Fraction n) - 2D Analysis (Absolute Dose)
- Offline Review (Varian Medical Systems, Inc.)
- Portal Dosimetry (Varian Medical Systems, Inc.)

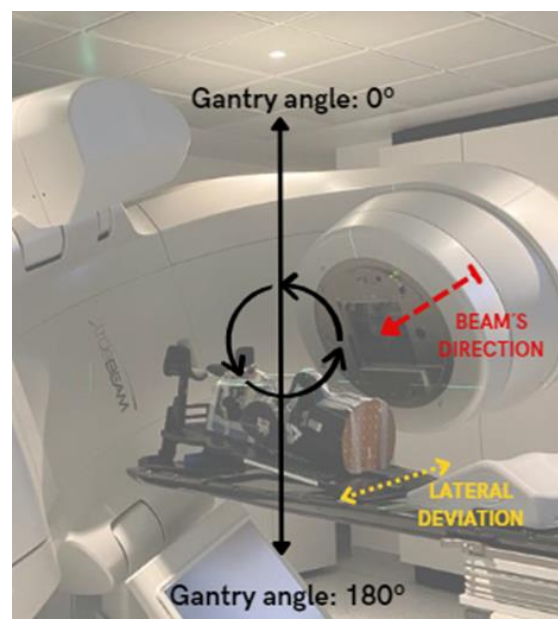


Number of Fractions per technique and treatment region			
TREATMENT PLAN	3DCRT	VMAT	TOTAL
Boost	-	51	51
Breast	59	-	59
Breast - Axilla-supraclavicular ganglionic region	31	55	86
Breast - Supraclavicular ganglionic region	4	4	8
Chest wall - Axilla-supraclavicular ganglionic region	15	14	29
Chest wall with bolus	3	-	3
Chest wall with bolus - supraclavicular ganglionic region	23	-	23
Chest wall - supraclavicular ganglionic region	13	47	60
<b>TOTAL</b>	<b>148</b>	<b>171</b>	<b>319</b>

# MATERIALS and METHODS

# 3DCRT technique:

A priori gamma criteria established:  
5%/3mm, global normalization, GPL $\geq$ 90% and TH=20%



Detected translational deviations:

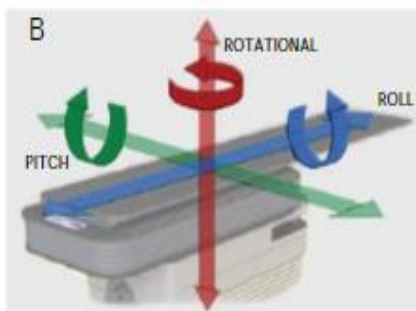
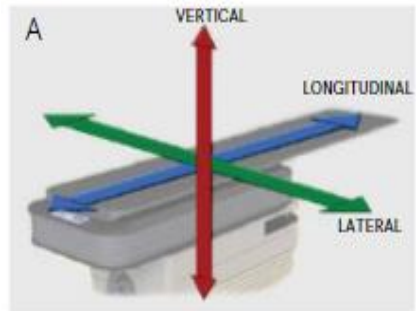
- Lateral: 20 mm
- Vertical: 10 mm
- Longitudinal: 10 mm

Detected rotational deviations:

- None up to 4°

Detected anatomical deformation:

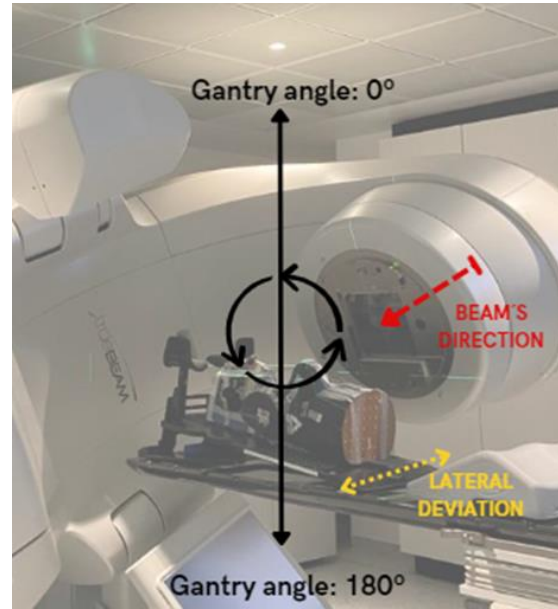
- Bolus: 5 mm



		GAMMA PASSING LEVEL - 3DCRT						
CONTROL	Fraction 1 Fraction 2	Field 1: MEXT			Field 2: MINT			
			99,58			99,66		
		99,43			99,45			
TRANSLATIONAL DEVIATION		LATERAL		VERTICAL		LONGITUDINAL		
		Field 1: MEXT	Field 2: MINT	Field 1: MEXT	Field 2: MINT	Field 1: MEXT	Field 2: MINT	
		+20 mm	84,28	90,58	60,74	57,49	63,98	64,2
		+15 mm	90,68	94,5	72,86	69,43	72,49	72,58
		+10 mm	97,5	98,67	84,77	82,77	78,74	79,3
+5 mm	98,25	98,46	95,41	94,7	92,87	93,44		
ROTATIONAL DEVIATION		RTN		PITCH		ROLL		
		Field 1: MEXT	Field 2: MINT	Field 1: MEXT	Field 2: MINT	Field 1: MEXT	Field 2: MINT	
		+4°	99,34	99,64				
		+3°	99,17	99,38			99,67	99,8
		+2,8°			99,08	99,42		
+2°	99,47	99,67	99,52	99,73	99,56	99,73		
ANATOMICAL DEVIATION	10 mm 5 mm	BOLUS						
		Field 1: MEXT			Field 2: MINT			
		86,32			89,11			
70,93			71,26					

# Phantom study - RESULTS

# VMAT technique:



## Detected translational deviations:

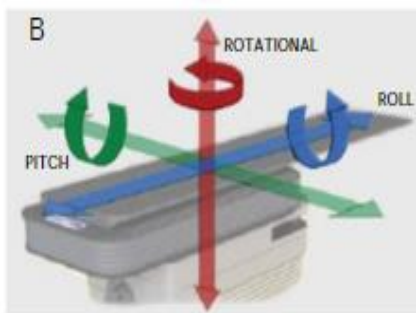
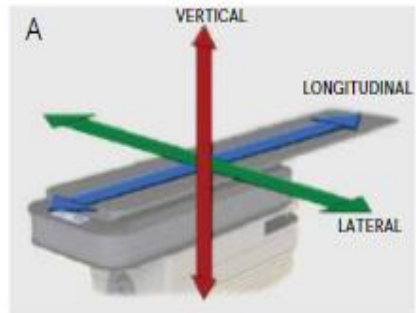
- Lateral: 15 mm
- Vertical: none up to 30 mm
- Longitudinal: 35 mm

## Detected rotational deviations:

- None up to 5°

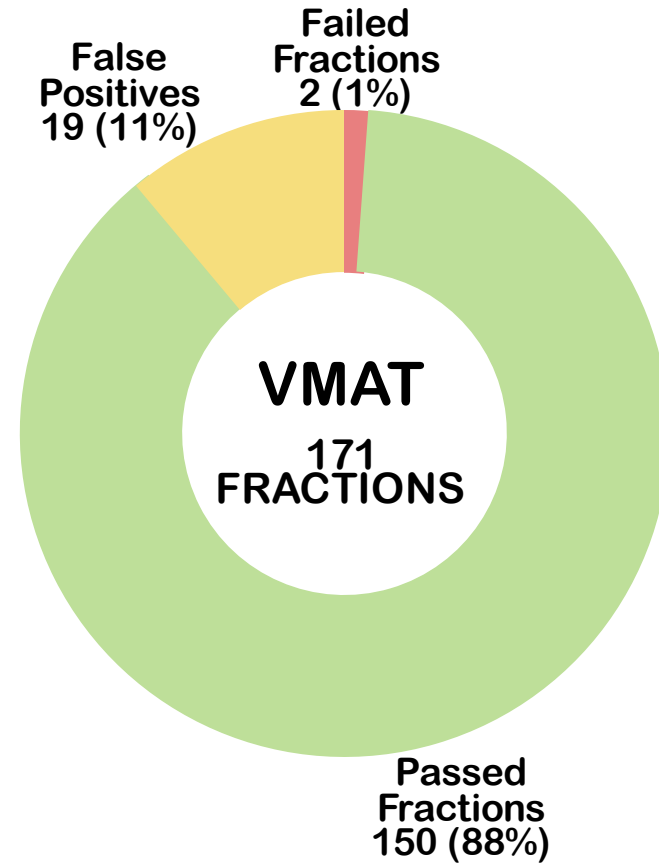
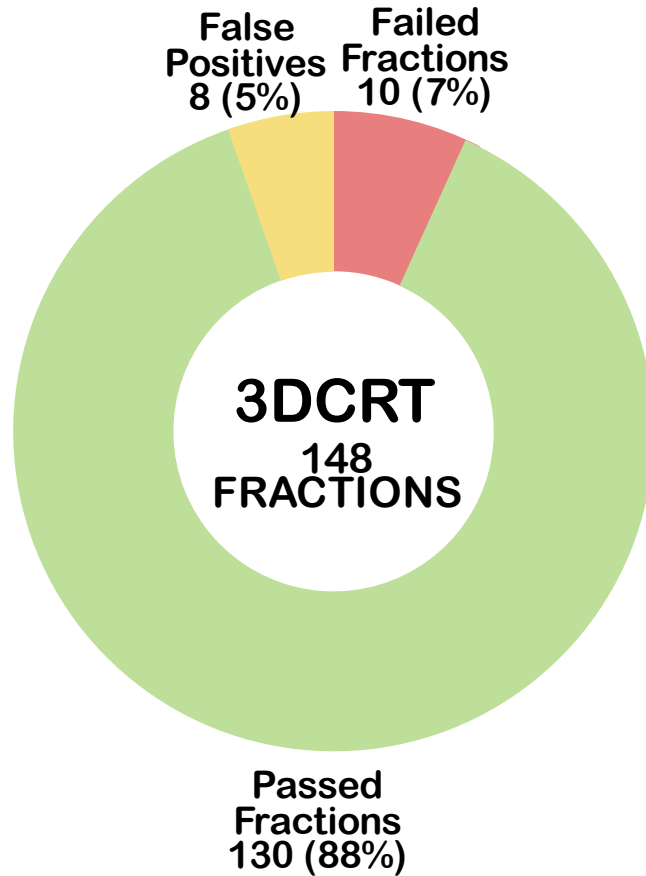
## Detected anatomical deformation:

- No bolus detected



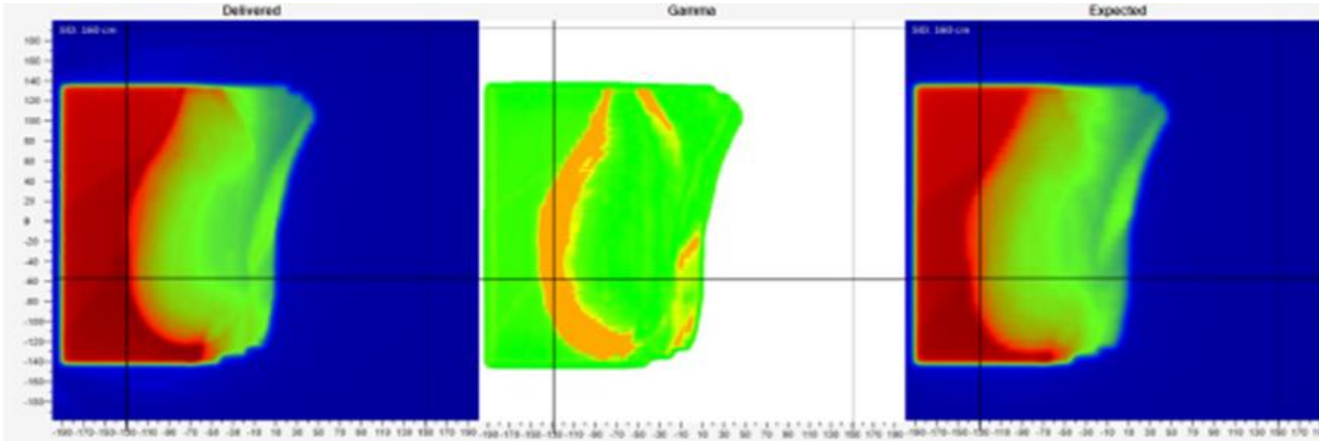
GAMMA PASSING LEVEL - VMAT								
CONTROL	Fraction 1 Fraction 2	Field 1: ARC 1		Field 2: ARC 2				
		99,51	99,77	99,75	99,97			
TRANSLATIONAL DEVIATION	+40 mm +35 mm +30 mm +25 mm +20 mm +15 mm +10 mm	LATERAL		VERTICAL		LONGITUDINAL		
		Field 1: ARC 1	Field 2: ARC 2	Field 1: ARC 1	Field 2: ARC 2	Field 1: ARC 1	Field 2: ARC 2	
						84,81	87,23	
						89,17	91,14	
				98,16	95,01	92,06	93,31	
				99,02	96,96			
		80,69	66,61	98,96	98,89	98,62	98,31	
92,58	75,85	99,56	100	98,79	98,66			
98,5	95,21	99,97	99,79					
ROTATIONAL DEVIATION	+5° +4° +3° -3° +2,8° +2,5°	ROTATIONAL		PITCH		ROLL		
		Field 1: ARC 1	Field 2: ARC 2	Field 1: ARC 1	Field 2: ARC 2	Field 1: ARC 1	Field 2: ARC 2	
		99,11	99,79					
		99,29	99,9					
		99,19	99,85					
				99,67	99,8			
				97,91	97,52			
ANATOMICAL DEVIATION	10 mm 5 mm	BOLUS						
		Field 1: ARC 1		Field 2: ARC 2				
		100	98,92	99,92	99,92			

# Phantom study - RESULTS

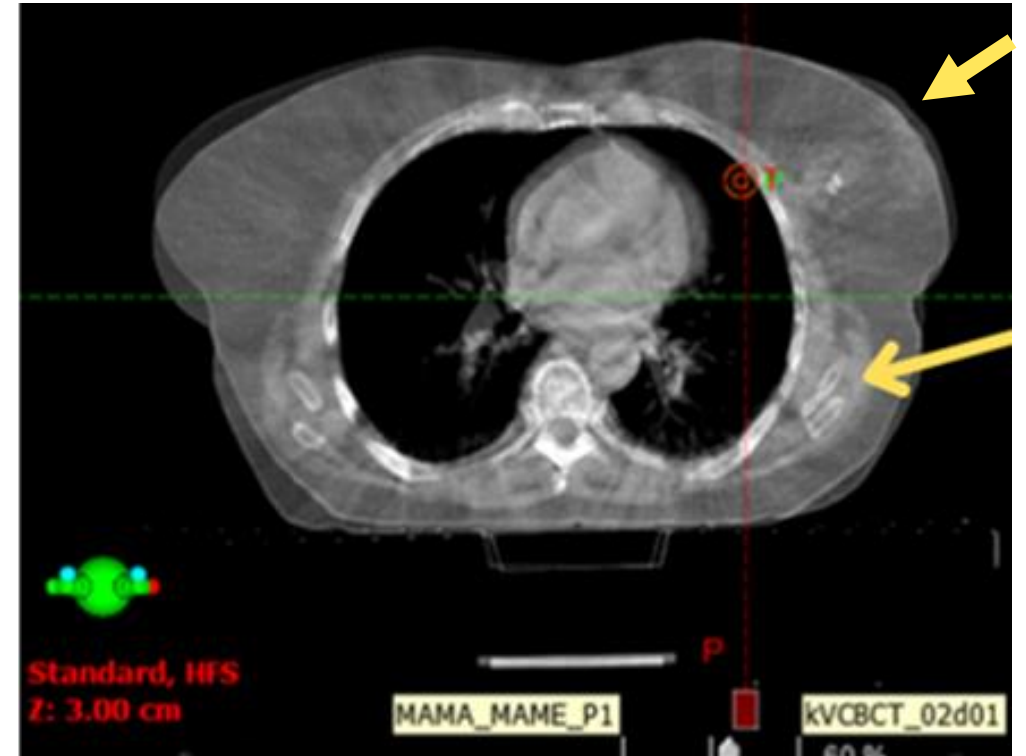
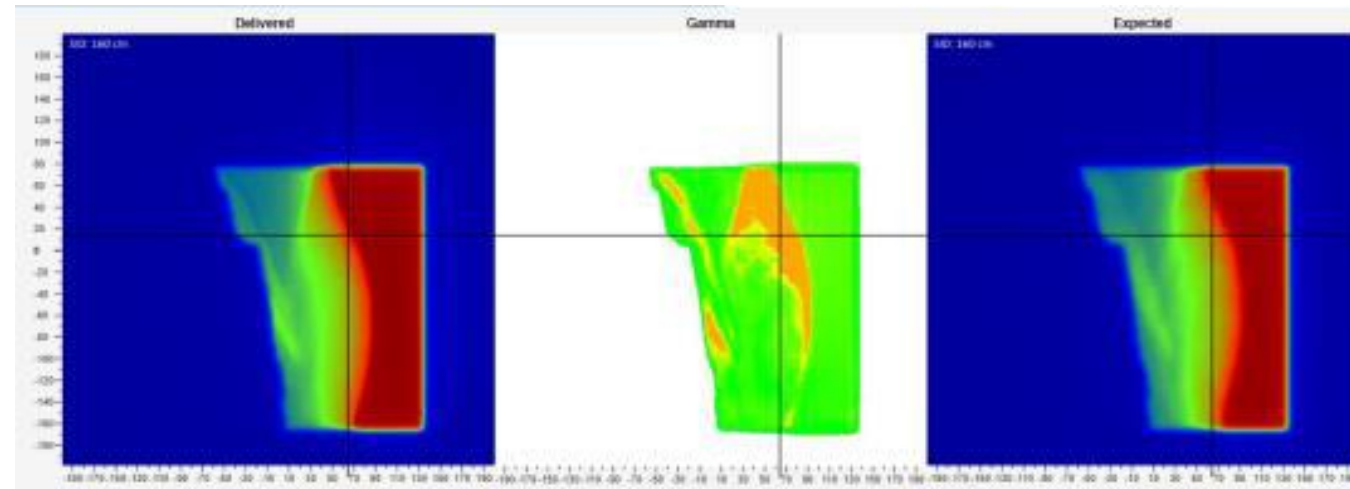


# Patients study - RESULTS

**FAILED FRACTIONS EXAMPLES:**  
**1. Positioning errors**



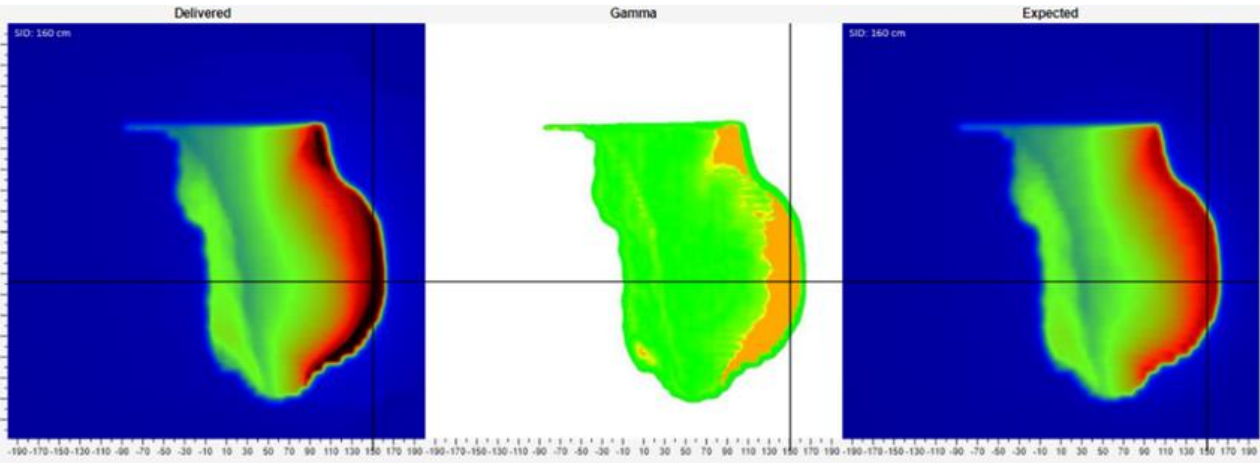
Examples of failed Fraction detected for 3DCRT breast plans



Transversal view in Offline Review:  
comparing kVCBCT with planning CT

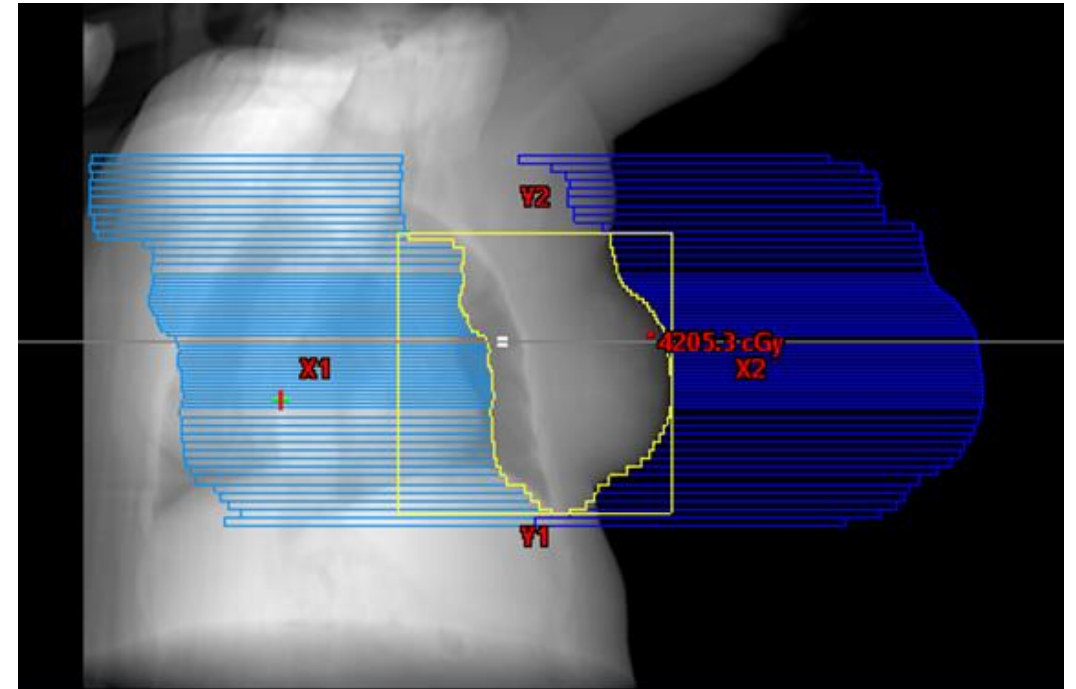
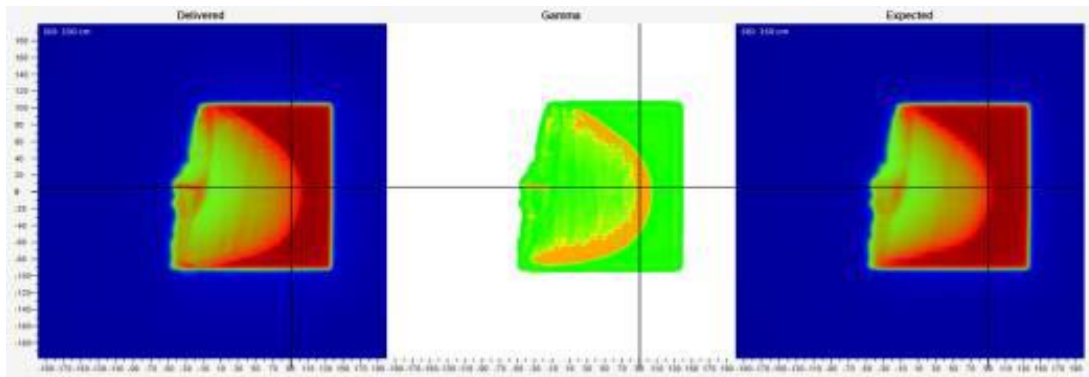
# Patients study - RESULTS

### FAILED FRACTIONS EXAMPLES: 2. Planning error



Failed Fraction detected in an hybrid plan

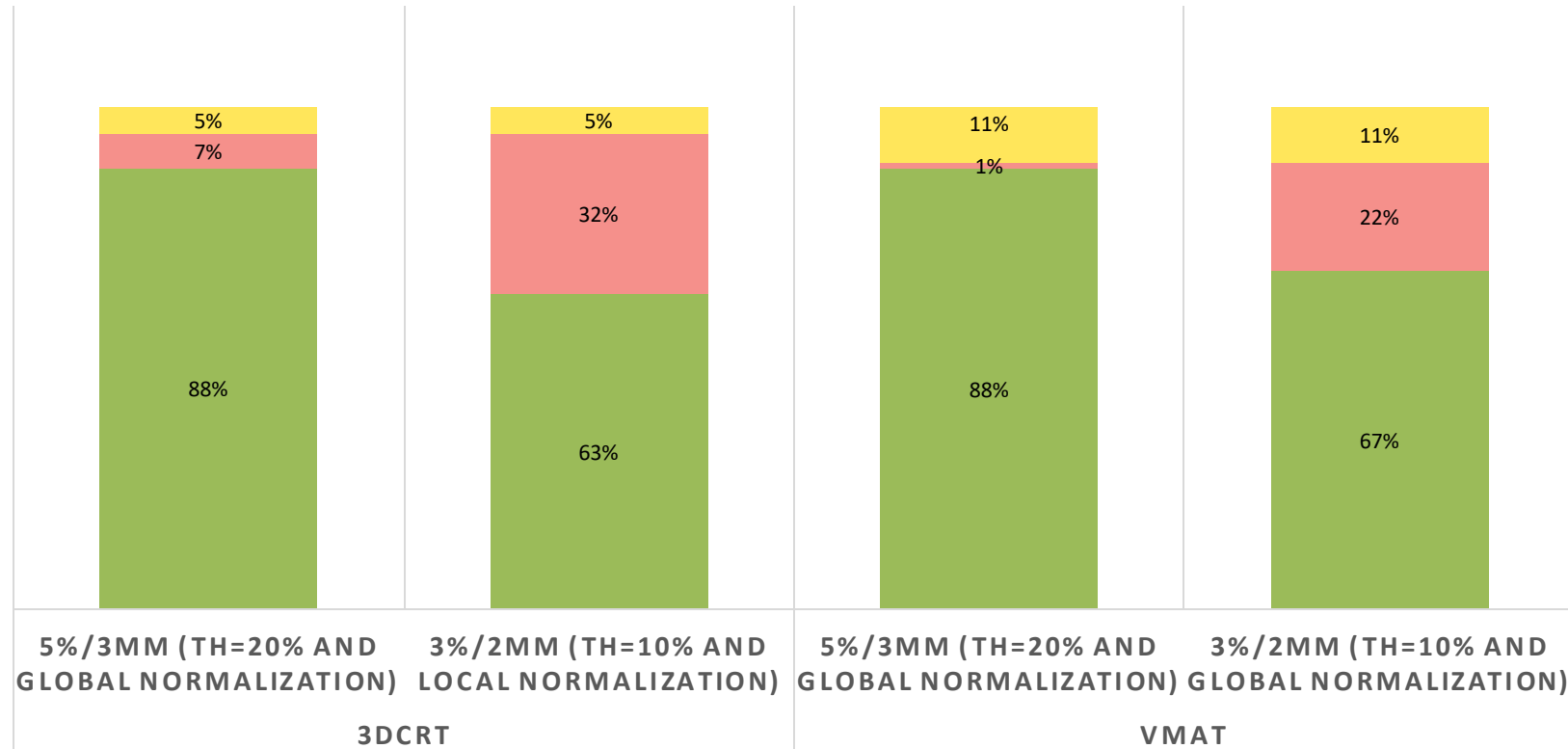
### FAILED FRACTIONS EXAMPLES: 3. Bolus missing



Beam's eye view highlighting the lack of the recommended 3 cm falloff from skin

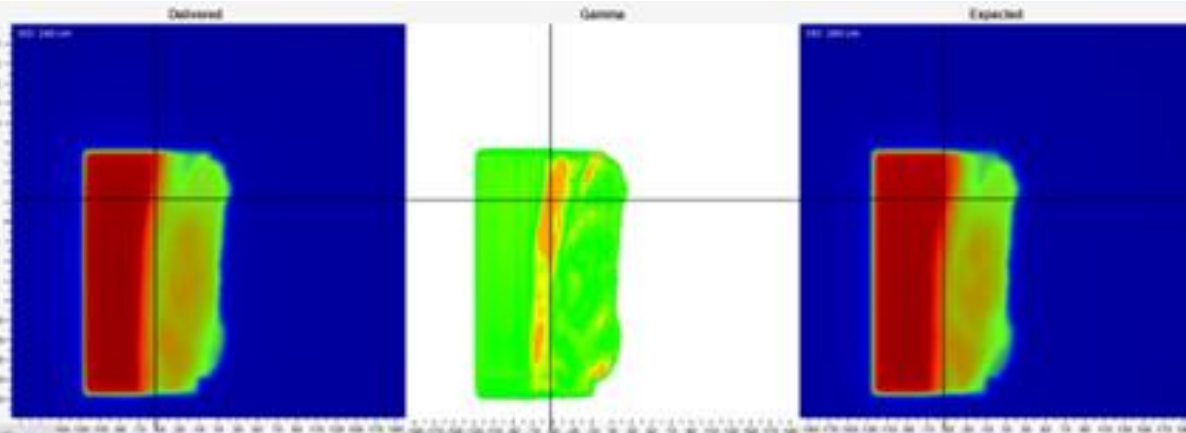
### CHANGING GAMMA CRITERIA

■ Passed Fractions   ■ Failed Fractions   ■ False Positives



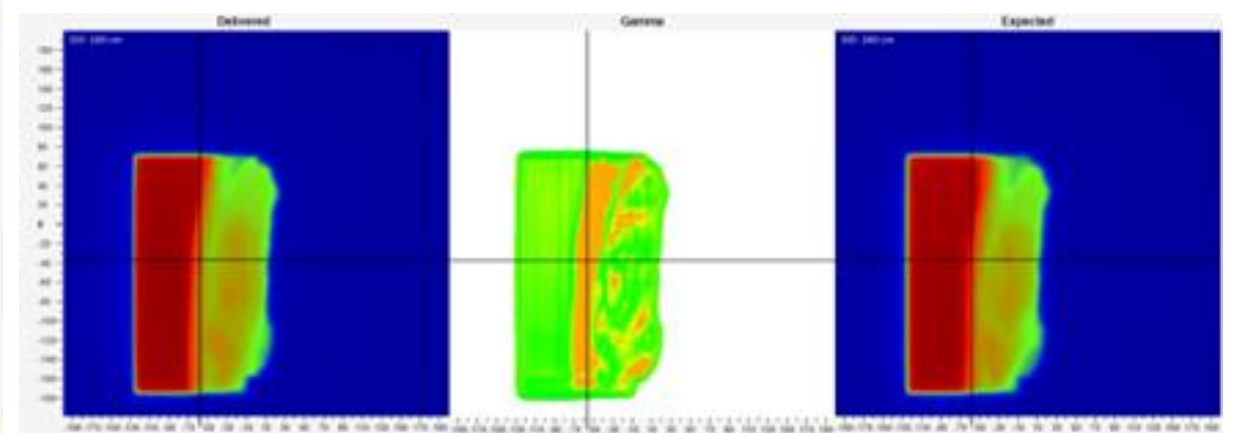
**Patients study - RESULTS**

### Comparing PerFRACTION images for a chest wall 3DCRT plan with different gamma criteria



**GAMMA PASSING LEVEL=93,36%**

5%/3mm, GPL $\geq$ 90%, TH=20% and global normalization

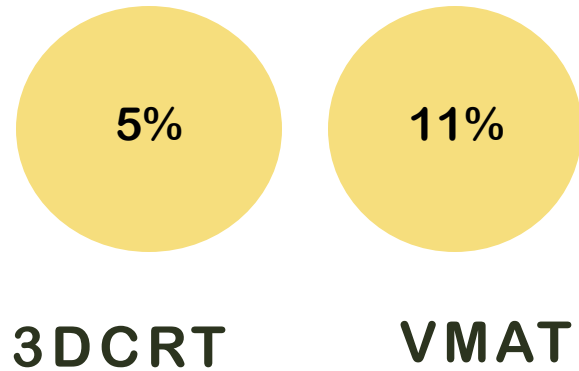


**GAMMA PASSING LEVEL=81,81%**

3%/2mm, GPL $\geq$ 90%, TH=10% and local normalization

**Patients study - RESULTS**

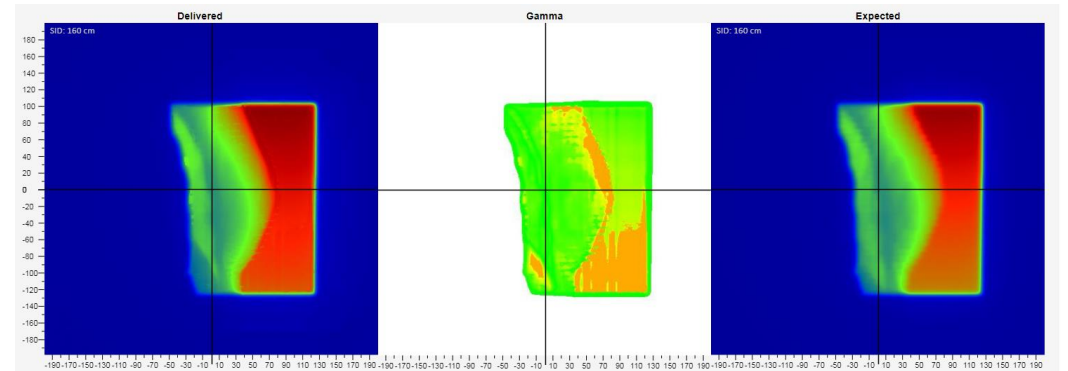
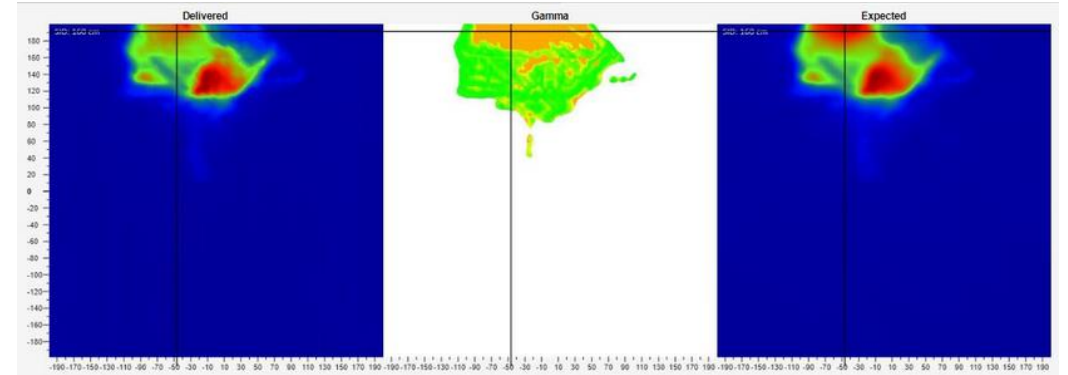
## Types of False Positive Results



treatment plans in regions where the EPID panel cannot fully detect the entire treatment area

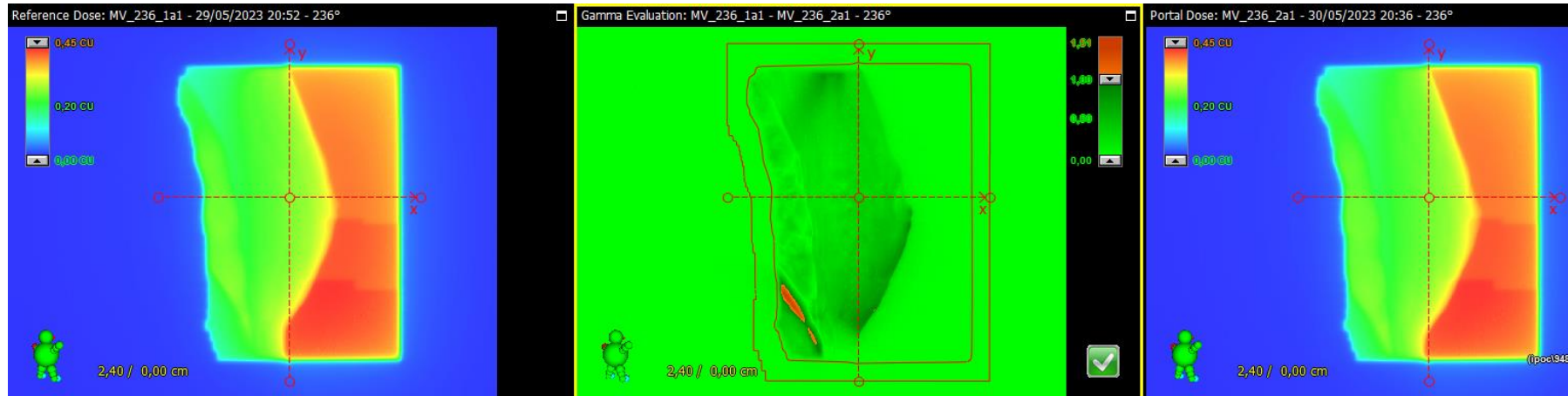
low MU fields with EDW (in the FiF technique) show large in-air areas of orange pixels

and also...  
Delivery interruptions that lead to partial images

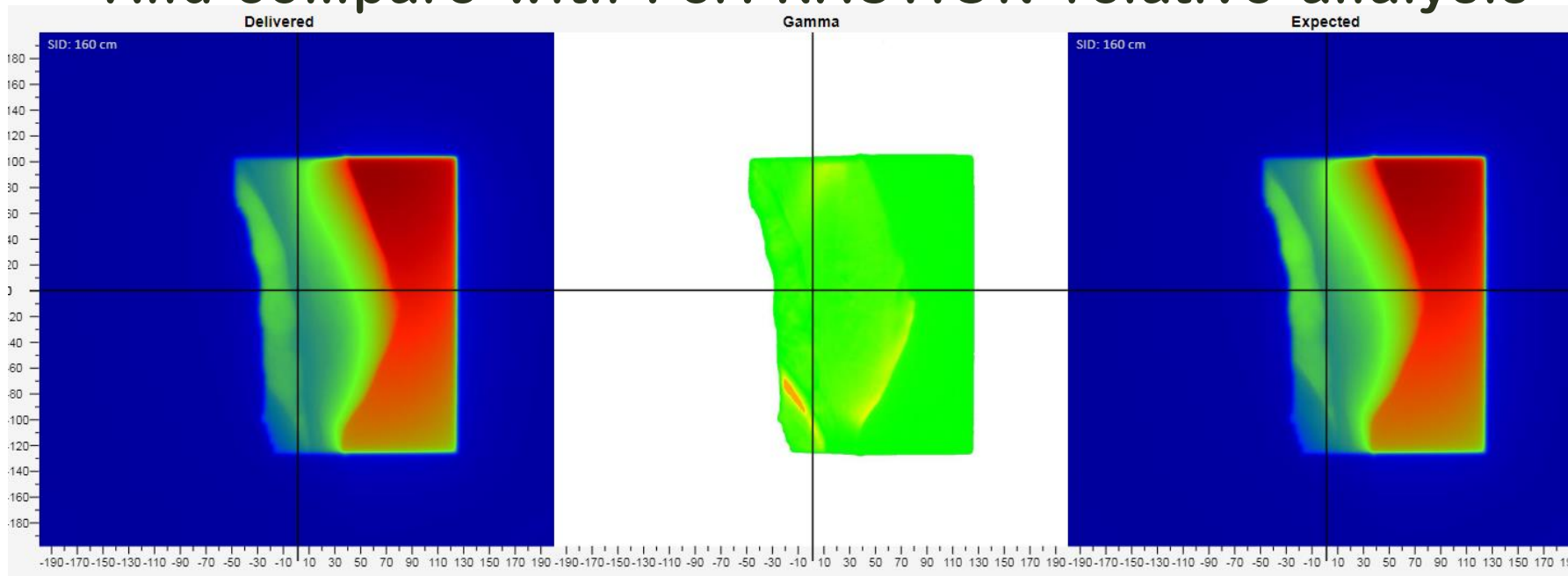


# Patients study - RESULTS

# Using Portal Dosimetry to double check false positives



## And compare with PerFRACTION relative analysis



**RESULTS**

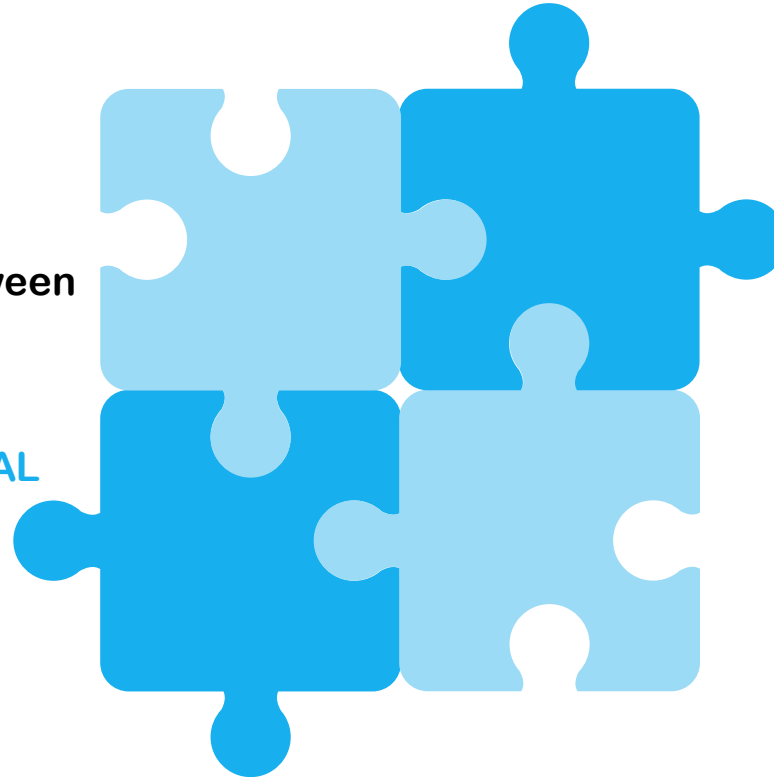
**KEEP THE A PRIORI GAMMA CRITERIA\* ESTABLISHED**

\*the most used (TG-307)

Good balance detection between true and false positives.

**OFFLINE REVIEW AND PORTAL DOSIMETRY**

Excellent tools to complement SunCHECK™.



**IVD FREQUENCY**

Ideally in all treatment fractions\*; at least in the 5 first fractions and once a week thereafter.C

**EXCEPTION**

For plans with bolus, IVD should be used in all fractions

\* Preventing the automation of the sequence of fields, IVD implies 35s more on average of treatment time per patient what constituted a factor of resistance to the introduction of in-vivo dosimetry by the treatment unit RTTs

**Already in clinical practice!**

**IVD implementation - recommendations**

**THANK YOU FOR YOUR ATTENTION**

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**QUESTIONS?**