

REACHING NEW
HEIGHTS WITH
SGRT



MEDICAL PHYSICS TRACK



Cross-vendor comparison of beam hold duration (latency)



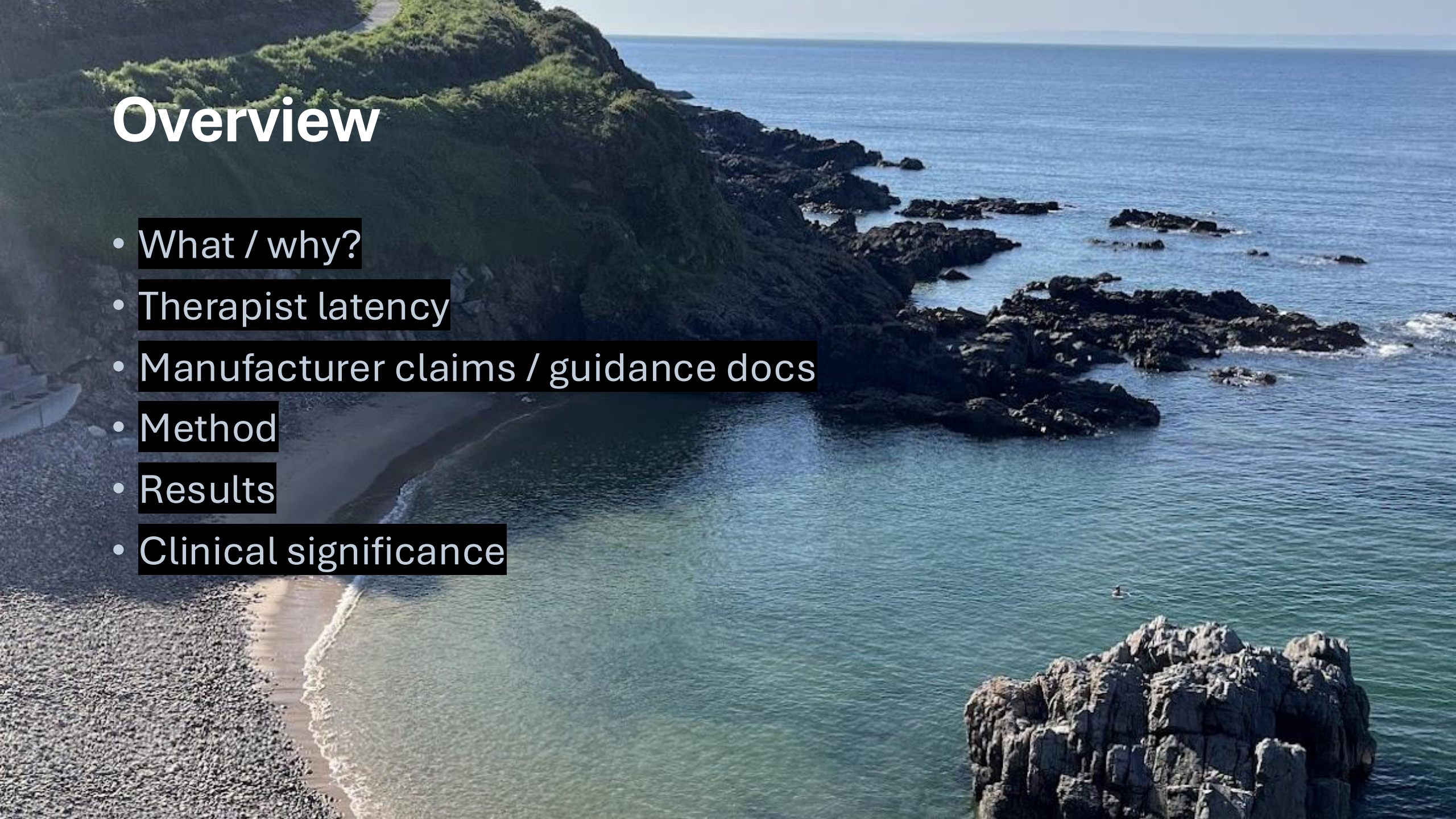
Josh Naylor
Physicist



AKA!
Cymhariaeth traws-
werthwr o hwyrni

Overview

- What / why?
- Therapist latency
- Manufacturer claims / guidance docs
- Method
- Results
- Clinical significance



- Latency
- Lag time
- Temporal accuracy for dynamic radiation delivery
- Beam hold performance
- Latency threshold
- Trigger performance
- Beam off

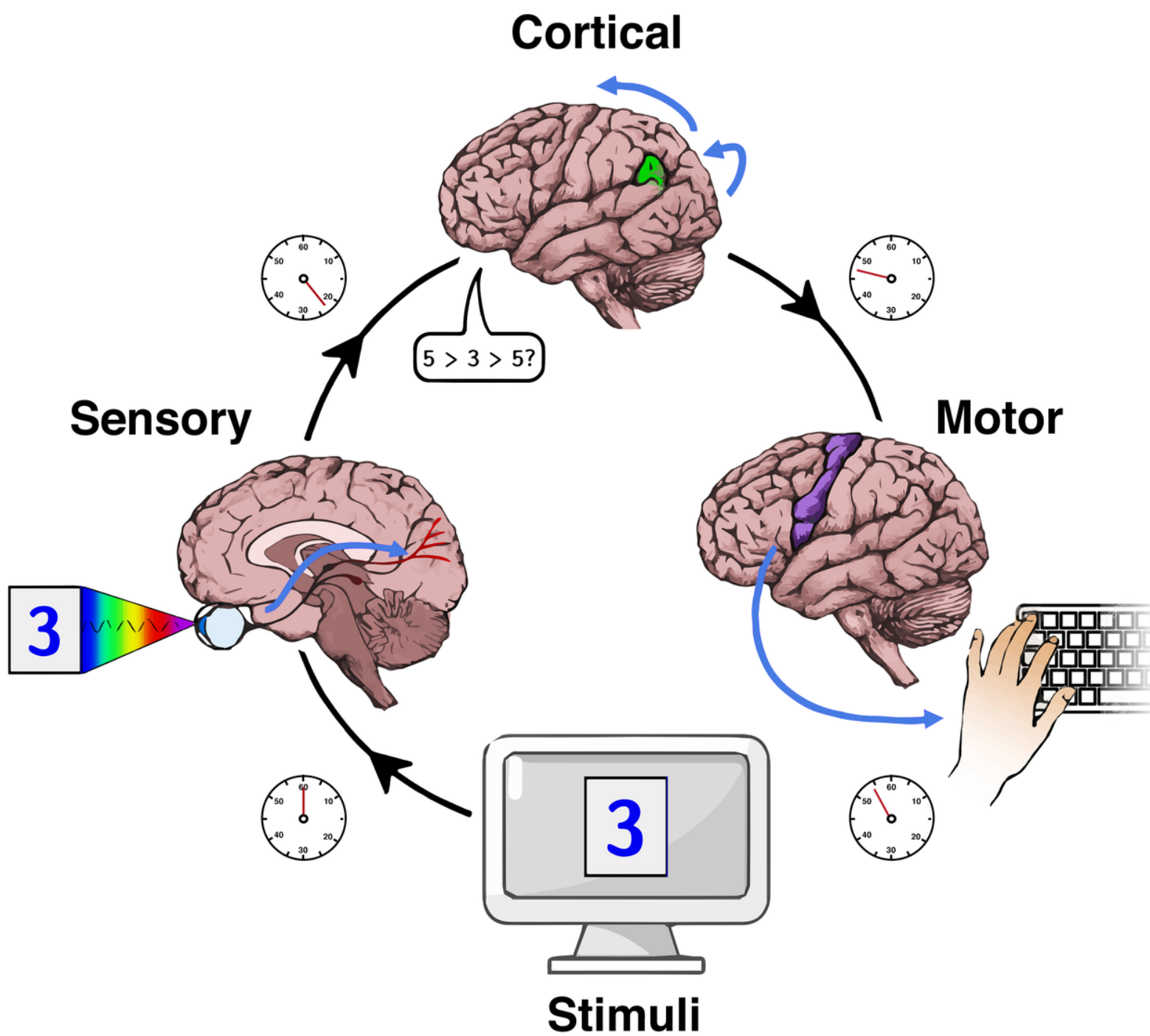
==Patient moves...
radiation goes off!



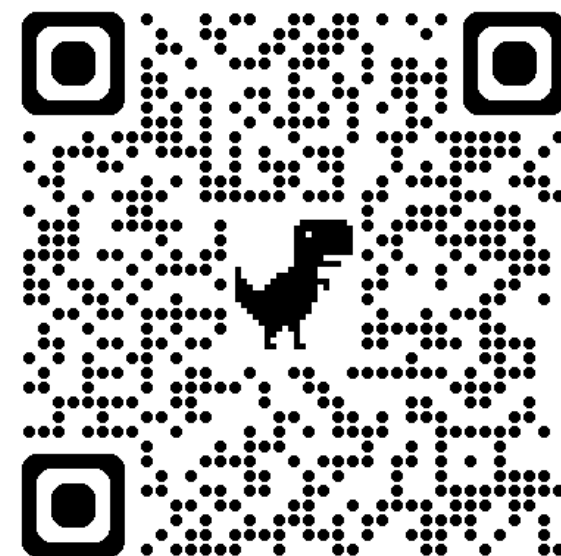
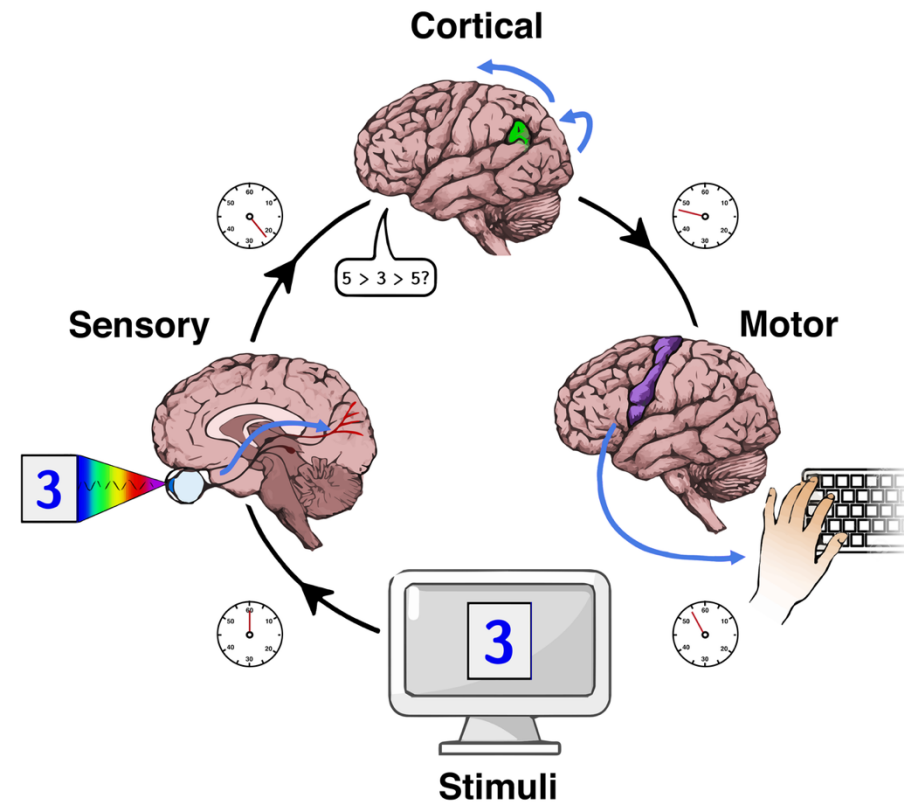
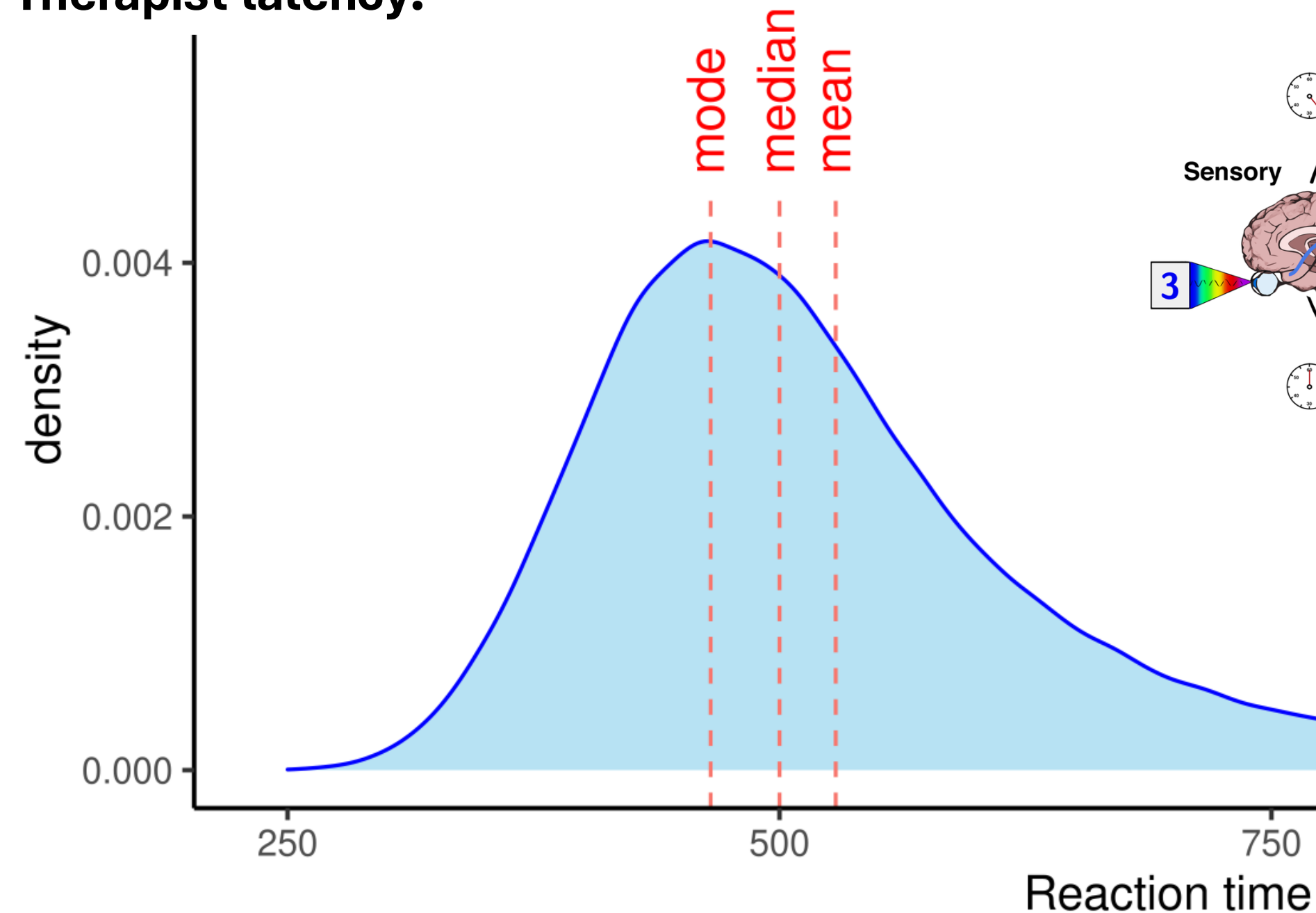


Why does latency matter?

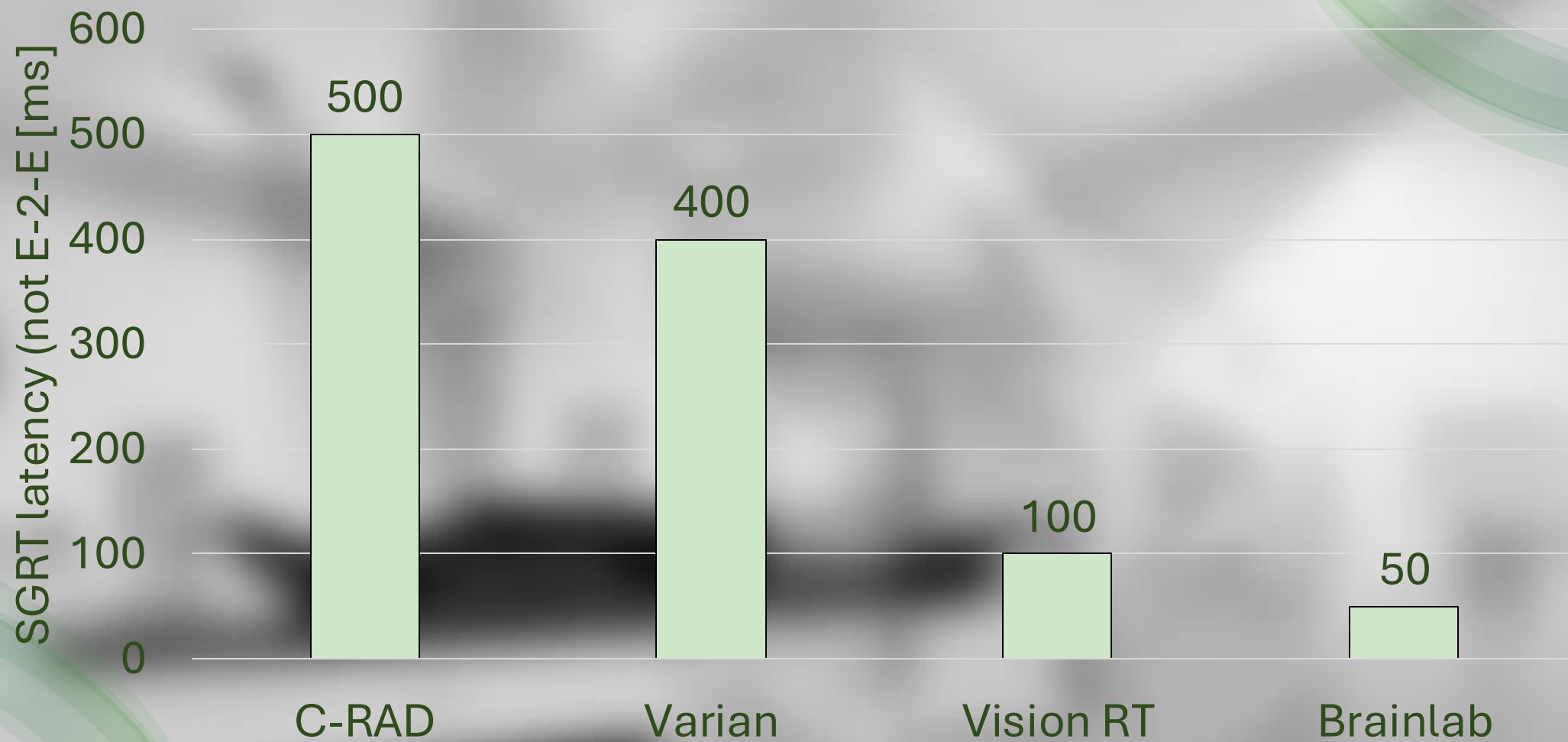
Therapist latency!



Therapist latency!



Manufacturer specifications



end-to-end



End-to-end latency includes linac component

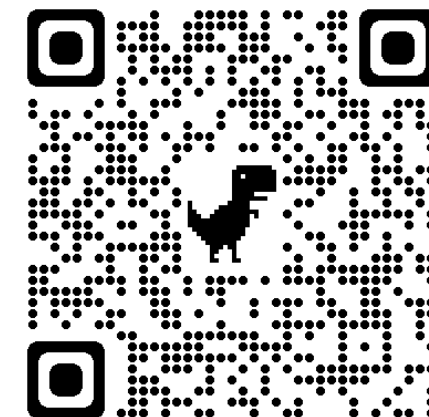
- RPM aka RGSC represents the linac component
- Measured w/ MV panel method

=38 ms



GUIDANCE DOCUMENTS

TG142



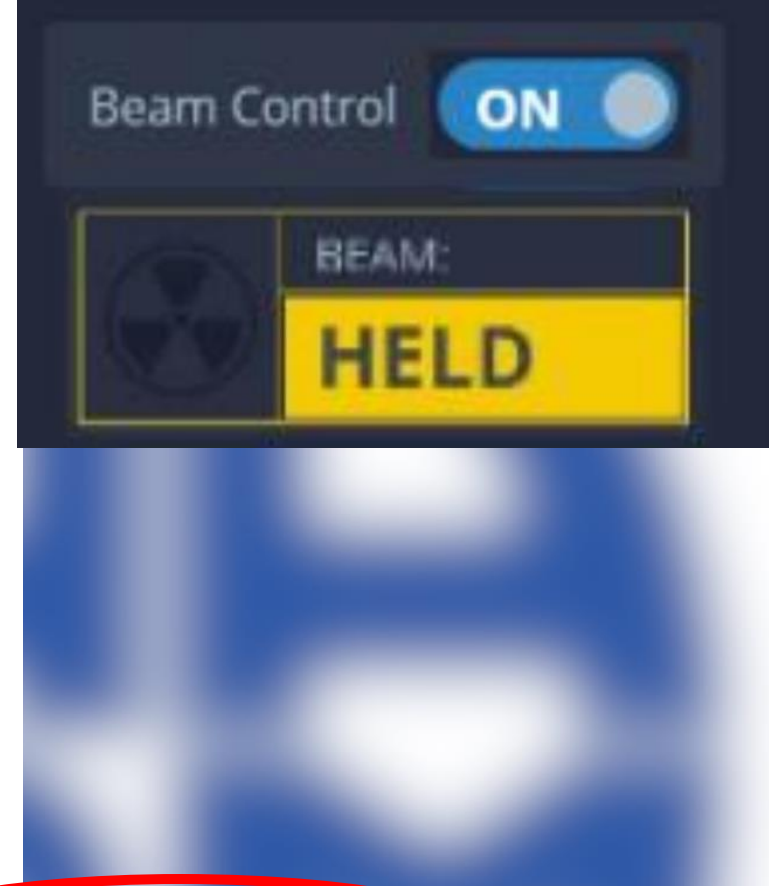
Temporal accuracy of phase/amplitude gate on 100 ms of expected

Calibration of surrogate for respiratory phase/amplitude 100 ms of expected

phase/amplitude

3.3.2 | Implications of temporal accuracy/latency for dynamic radiation delivery

The temporal accuracy/latency for dynamic radiation delivery (i.e., beam hold) and integration with the treatment unit, when available, may affect dosimetric accuracy.³⁶ Per TG-142, the SGRT system delay should be evaluated for the specific application and deemed appropriate before treatment. While direct measure-



TG302

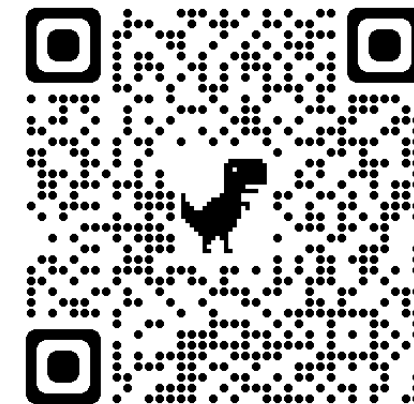


ment of the latency time may be challenging,³⁷ SGRT latency time should be confirmed to be below a clinically appropriate threshold (e.g., <1 s for breast DIBH treatment). For free-breathing (FB) gated treatment, TG-76 recommends that the total time latency be as short as possible, and not to exceed 0.5 s in any case, as prediction models cannot perform well above this

GUIDANCE DOCUMENTS



www.elsevier.com/locate/ro



Radiotherapy & Oncology

Journal of the European Society for
Radiotherapy and Oncology

ESTRO-ACROP guideline on surface guided radiation therapy

[P. Freisleder](#)  ¹  • [V. Batista](#) • [M. Öllers](#) • ... [D. Nguyen](#) • [C. Bert](#) • [J. Lehmann](#) • [Show all authors](#) •

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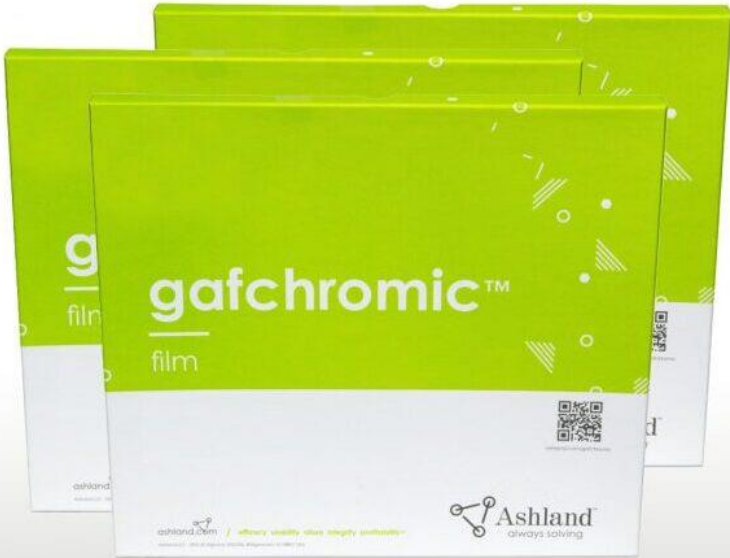
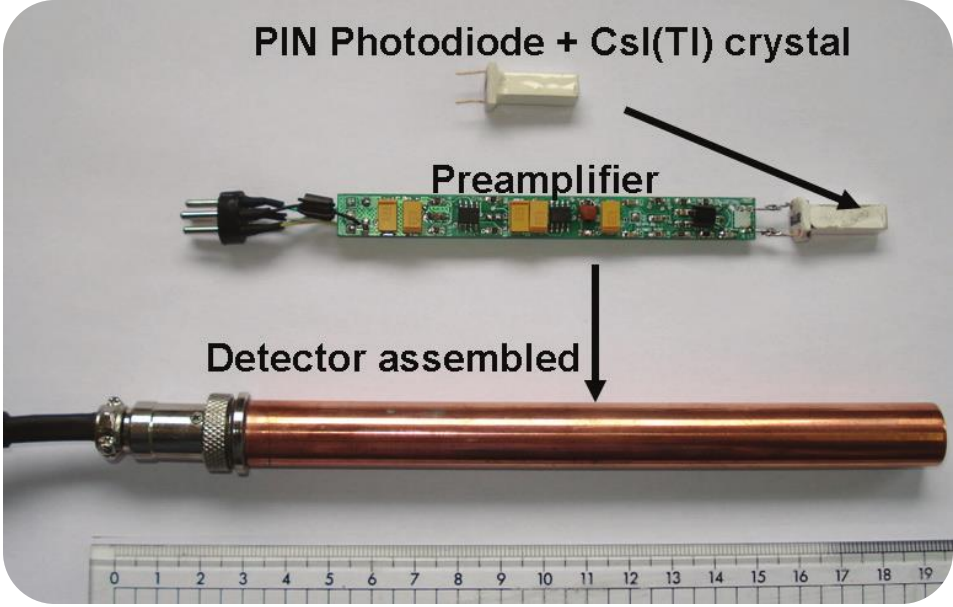
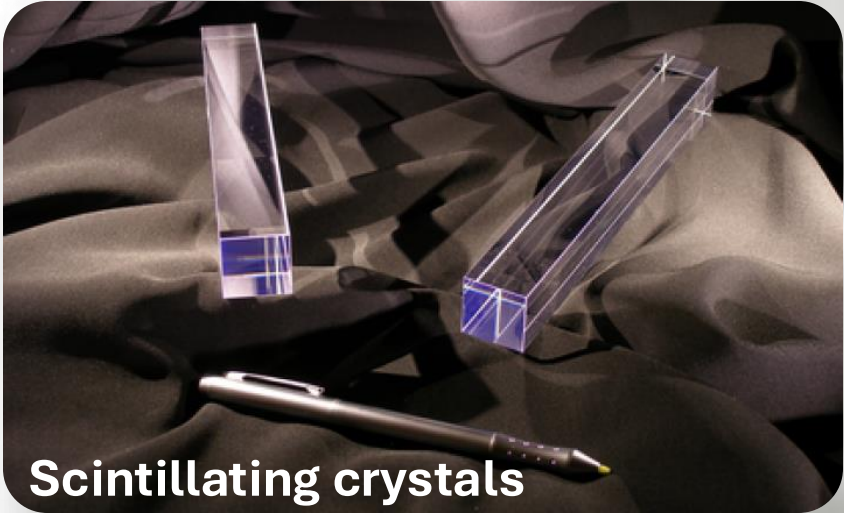
[Open Access](#) • Published: May 30, 2022 • DOI: <https://doi.org/10.1016/j.radonc.2022.05.026> •



**Tracking Performance – Free
Breathing-Gating Check,
Lag Time 200 ms**



METHODS



2023

US SGRT ANNUAL MEETING

The next stop on

YOUR SGRT JOURNEY



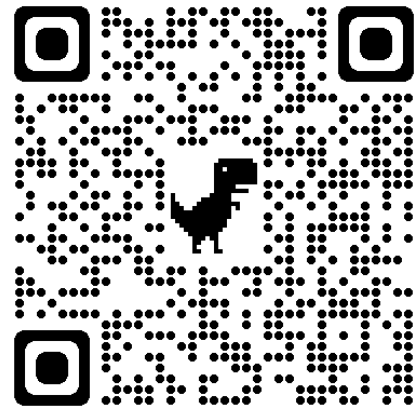
May 11 - 12, 2023



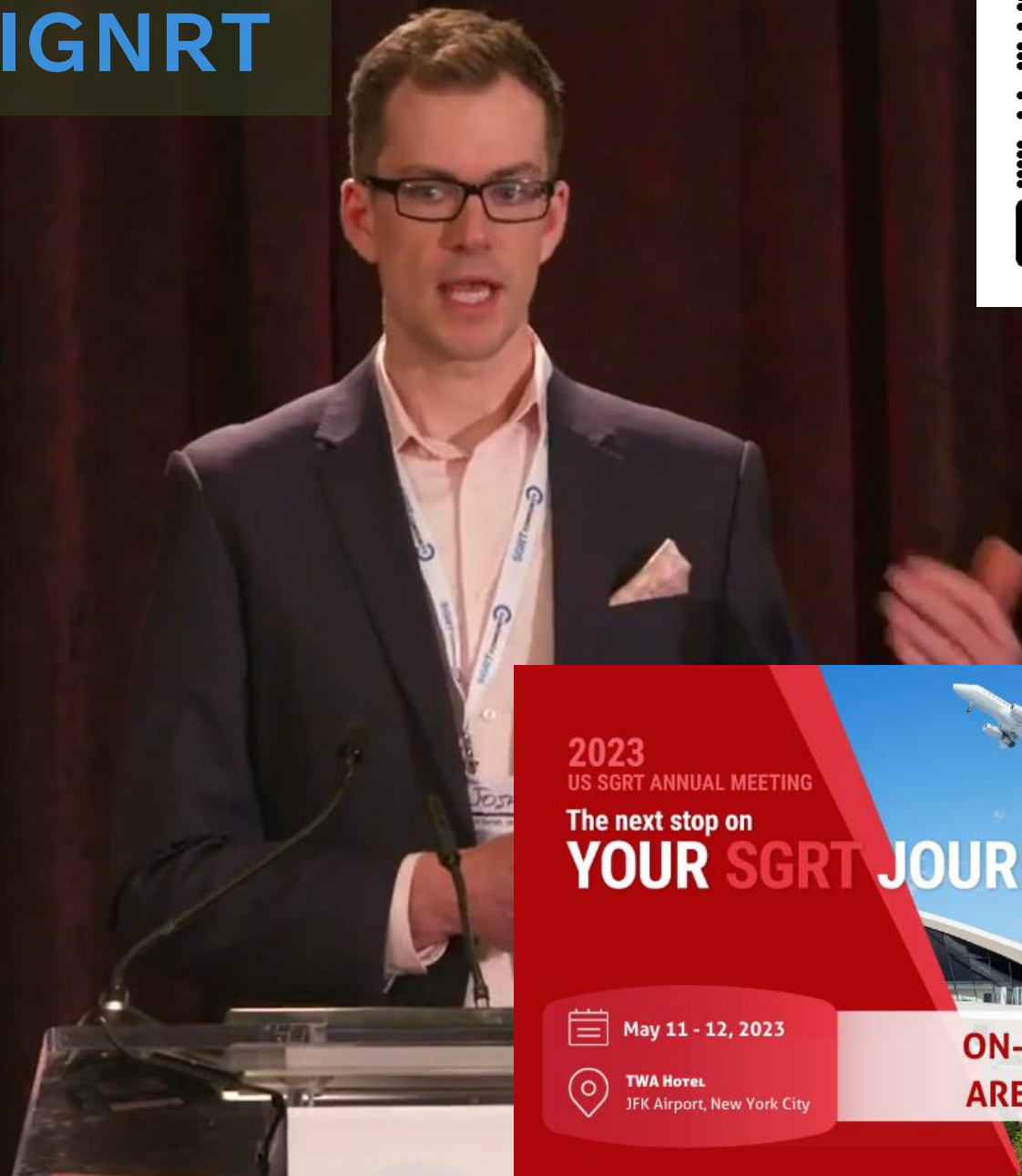
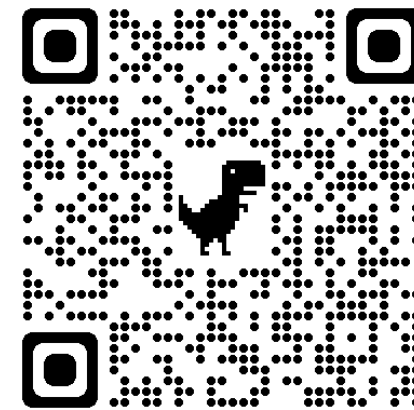
TWA Hotel

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QUANTIFICATION OF BEAM LATENCY USING ALIGNRT



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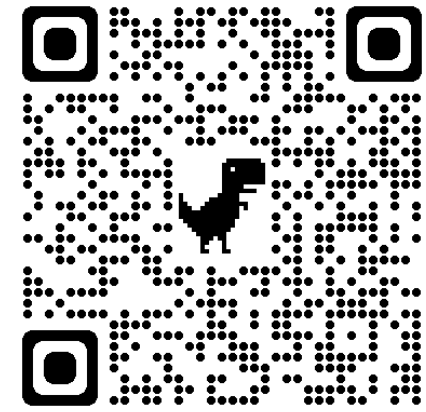
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JFK Airport, New York City

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QUANTIFICATION OF BEAM LATENCY USING ALIGNRT



Method...



MV panel

2023
US SGRT ANNUAL MEETING

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May 11 - 12, 2023

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RESULTS



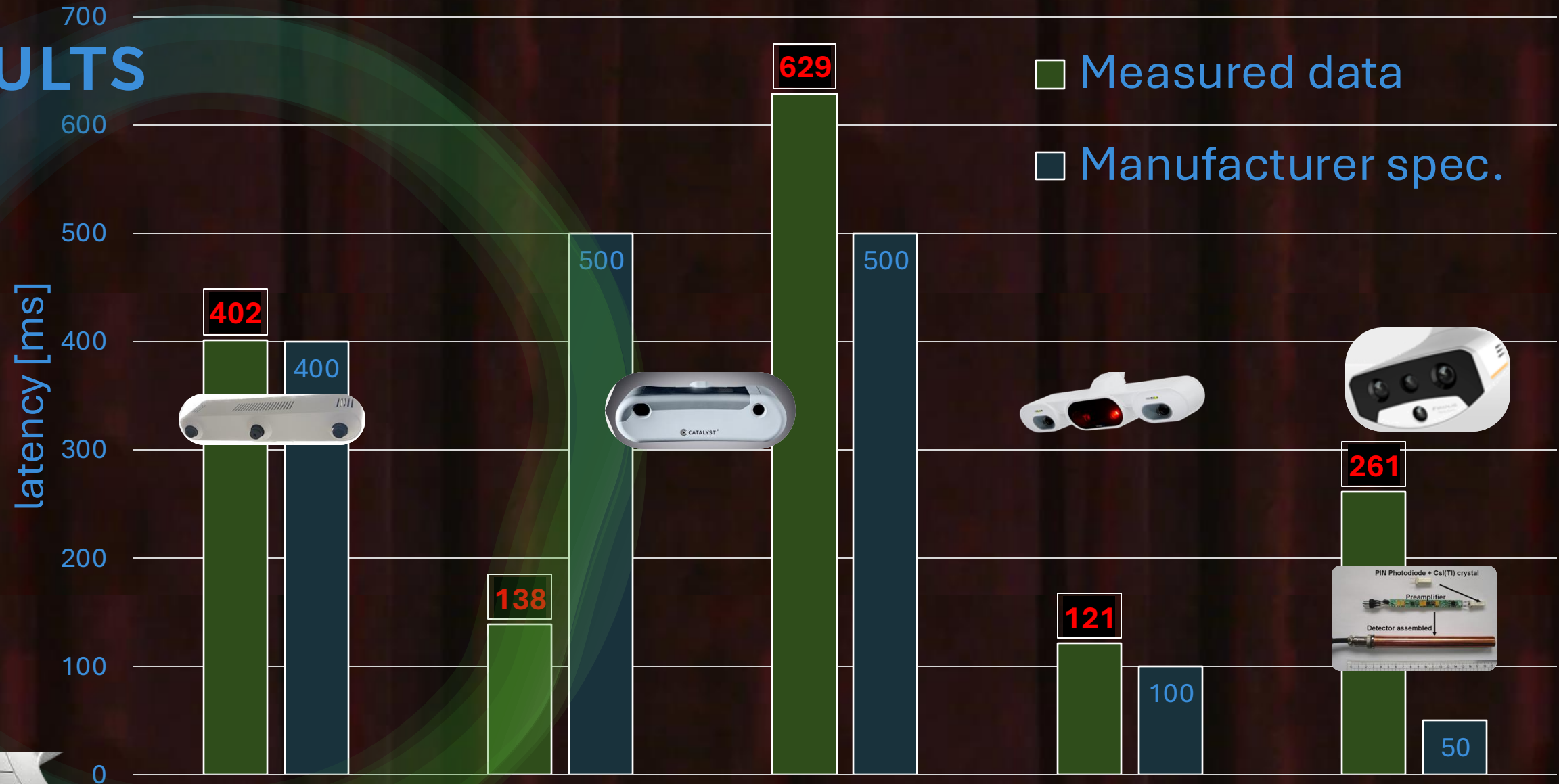
- Elekta and Varian

RESULTS



- Elekta and Varian
- AlignRT v6 & v7 / ROI & patch (Vision RT)
- Identify (Varian)
- Catalyst (C-RAD)
- ExacTrac Dynamic Surface (Brainlab)

RESULTS



MV panel
(except
BrainLab)

Varian: Identify
V TRUEBEAM, n=2



C-RAD: Catalyst
E VERSA, n=1



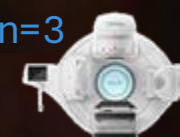
C-RAD: Catalyst
V TRUEBEAM, n=1



Vision RT: AlignRT
V TRUEBEAM, n=4



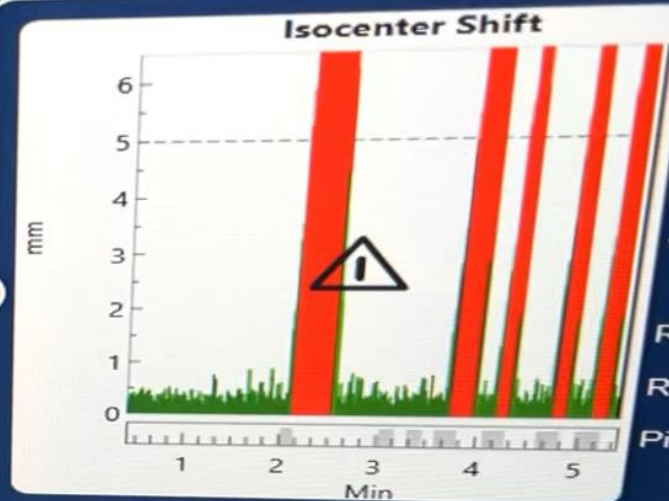
Brainlab (diode not
panel)
E VERSA, n=3



© CATALYST⁺

1-- Rot: (0)

+Lat



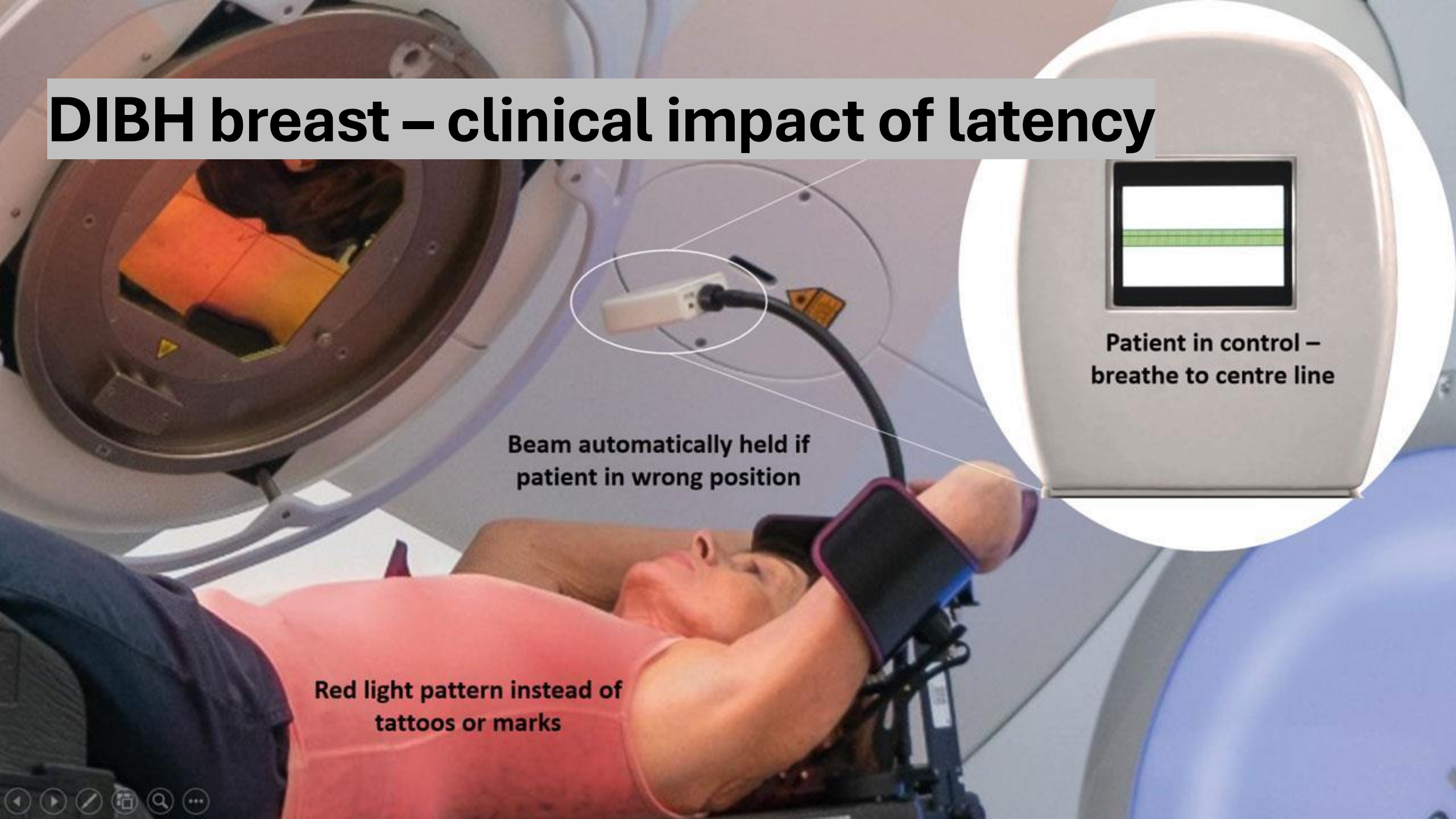
- ☒ cMotion Ref
- ☒ Live image
- ☐ cRespiration Ref

Free-breathe / DIBH latency threshold <200 ms?
(for 2%)

SBRT lung – clinical
impact of latency

		2400 MU/min		
		40 MU /s		
		8 MU delivered in	→	200 ms
1000 MU /#		0.8%		
		2.0%	(TG142 threshold)	2.5 Beam holds

DIBH breast – clinical impact of latency



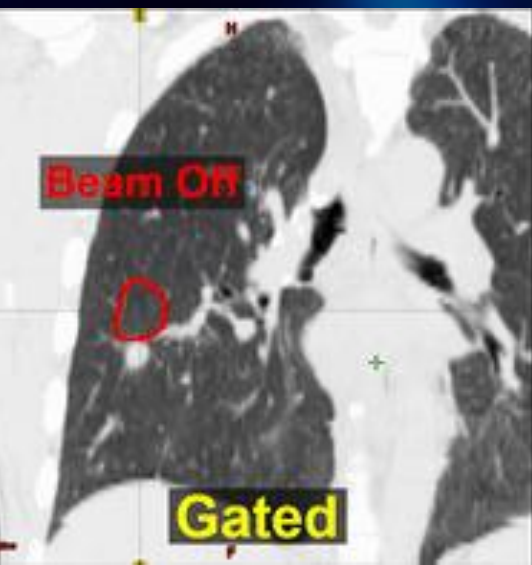
Beam automatically held if
patient in wrong position

Red light pattern instead of
tattoos or marks

Patient in control –
breathe to centre line

DIBH breast – clinical impact of latency

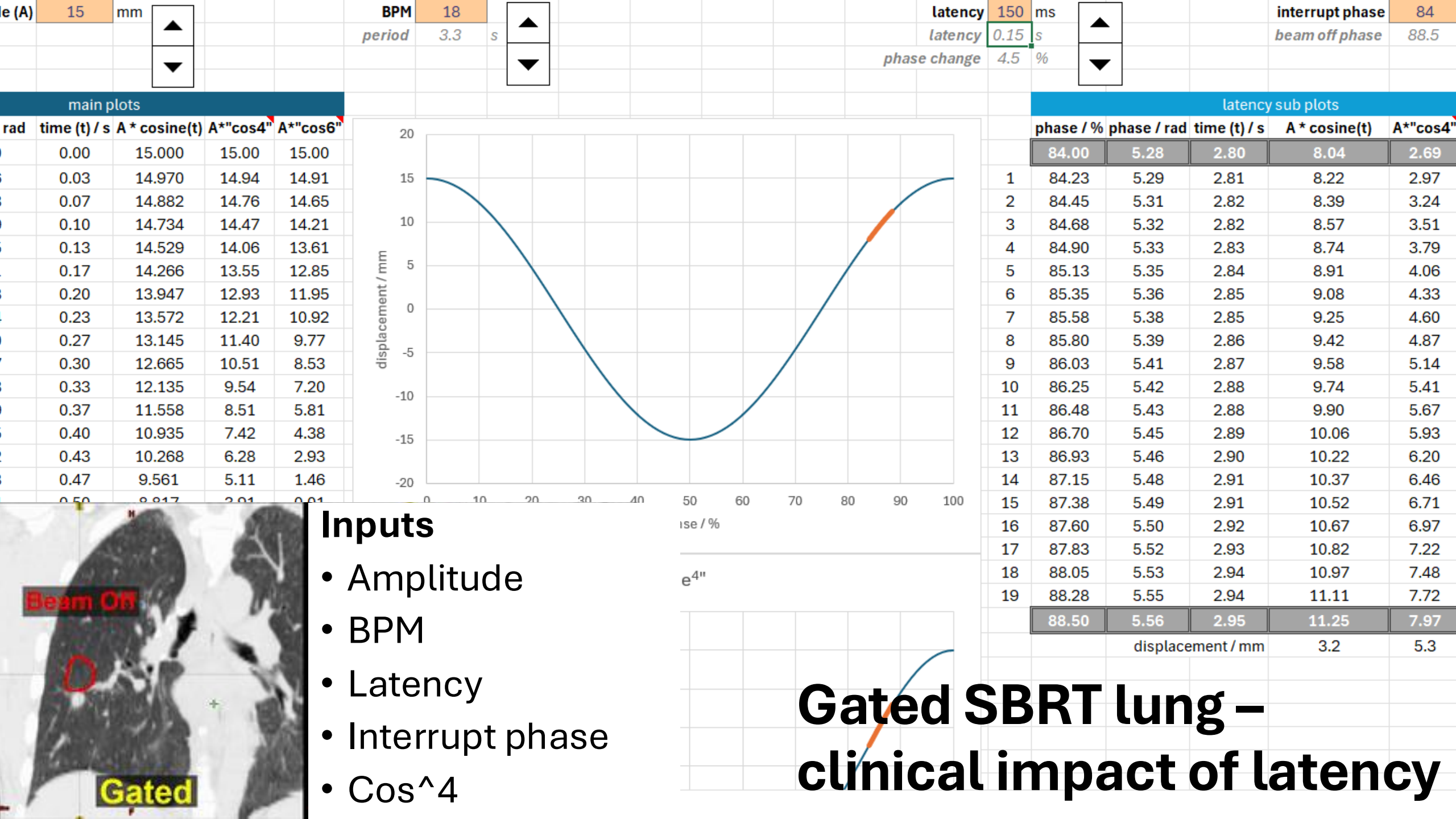
- Based on SimRT data: 4 mm/s “breath velocity”
- 500 ms == 2 mm (TG142 threshold)
- @600 MU/min: 5 MU incorrectly delivered
- For 2.6 Gy /beam/day, patient with poor compliance
- ~9% incorrectly delivered
- *200 ms latency tolerance allows 13 beam holds for 2% dose impact* (TG142 threshold)
- Whole breast PTV lower significance than boost or nodal involvement



Inputs

- Amplitude
- BPM
- Latency
- Interrupt phase
- $\cos^4$

**Gated SBRT lung –
clinical impact of latency**



Inputs

- Amplitude
- BPM
- Latency
- Interrupt phase
- Cos^4

**Gated SBRT lung –
clinical impact of latency**

[illegible]

Inputs

- Amplitude
- BPM

Gated SBRT lung – clinical impact of latency

Inputs

- Amplitude
- BPM

amplitude

8 mm

▲

▼

BPM

19

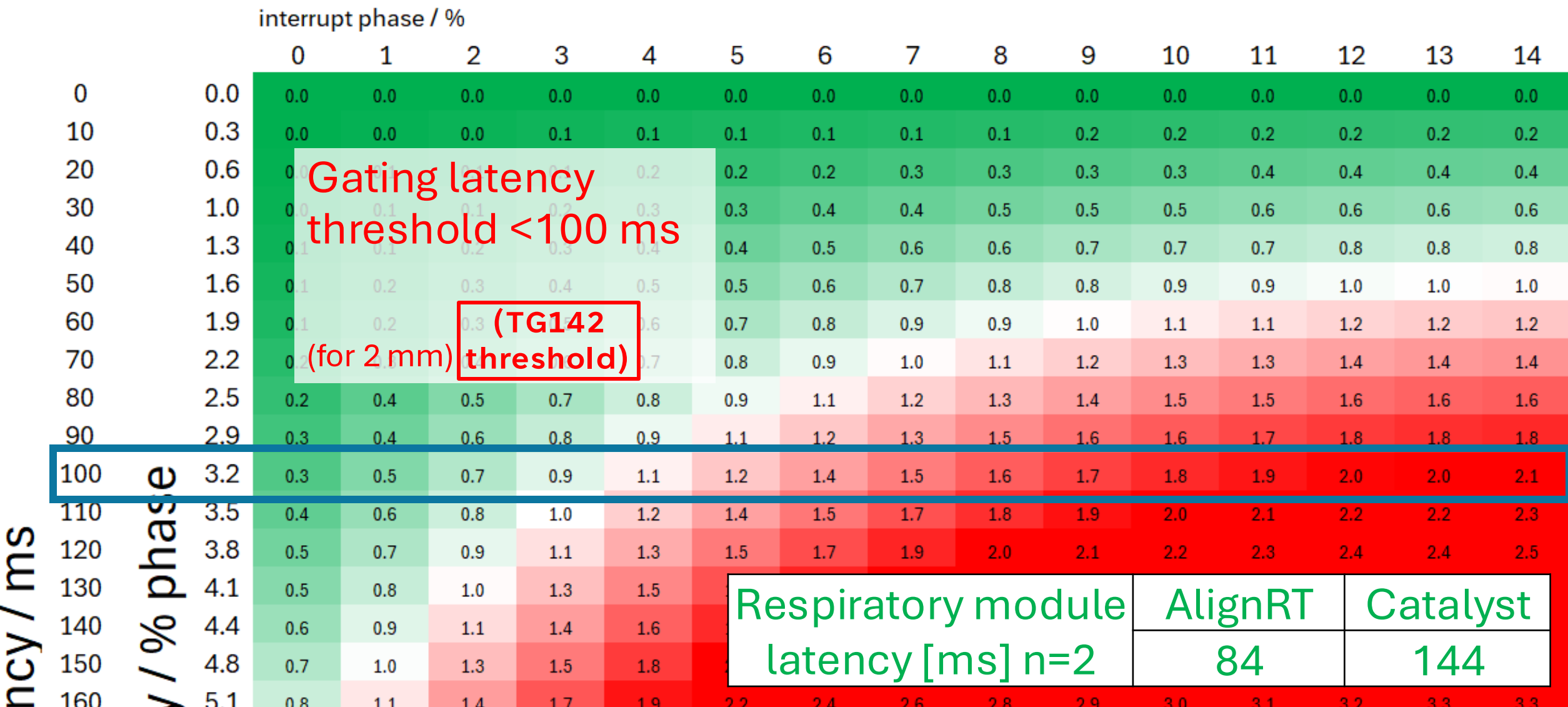
▲

▼

period

3.2

SBRT lung – clinical impact of latency



“Best case”

Amplitude = 5 mm

BPM = 12

Gating latency
threshold **<250 ms**

“Worst case”

(90% patients)

Gating latency
threshold <100 ms

(for 2 mm) **(TG142
threshold)**

Respiratory module latency [ms] n=2	AlignRT	Catalyst
	84	144

- Gating required >5mm
- 95% patients have 3d mag motion <15mm
- 90% people 11.8-19.2 bpm

Conclusions / summary

- Latency matters:
 - Measure it
 - Tolerances – DIY, but <100 ms for gating, else <200 ms for compliant patients
 - For latency commissioning / annual QA
 - & for real-time delta SGRT thresholds
 - Lower is always better
- Vision RT has lowest latency of any SGRT vendor (*and only one to meet thresholds above*)
- Use auto beam hold (not therapist beam off)

Thanks to!: Steve Moloney (latency spreadsheet), RT teams @ Velindre (Cardiff) / Singleton (Swansea) / Glan Clwyd (N Wales), Alex Papangelou (code)

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HEIGHTS WITH
SGRT



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