



RESPIRATORY MODULE

Dr. Torsten Moser
SGRT Meeting Darmstadt

TAKING MOTION INTO ACCOUNT



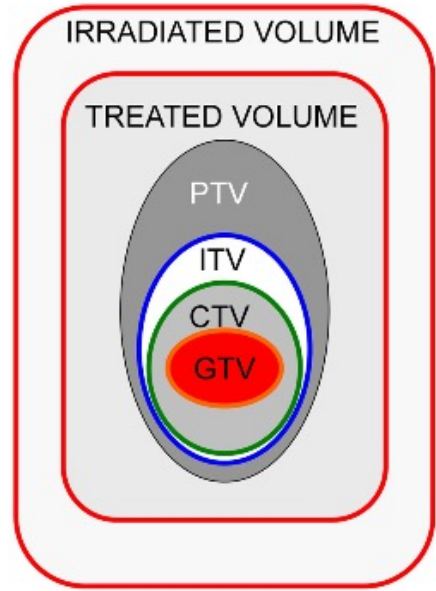
INTEGRAL DOSE AND THE IMPACT OF MARGINS



Figure 2: Orange and its peel representing a target volume and its margin. A 6.5 mm thick margin (peel) consists of the same volume as a 5 cm diameter target (orange), taken from Verellen et al. 2007.



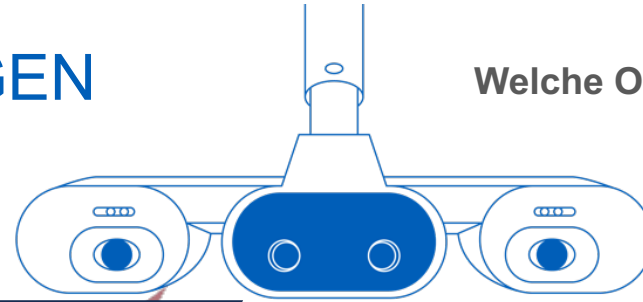
ICRU 50/62/83



- **Gross tumor volume (GTV):** Tumor visible on (CT, MRI, PET, clinical etc.)

KLINISCHE ANFORDERUNGEN

Welche Optionen für Atembewegungsmanagement gibt es?



**Passe den Patienten der
Behandlung an**

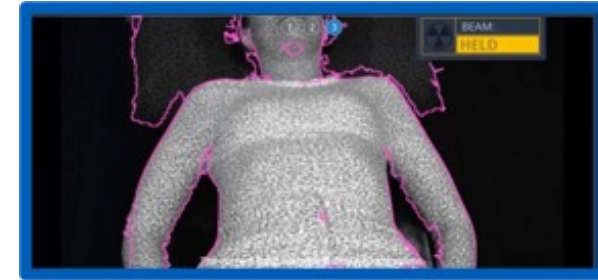
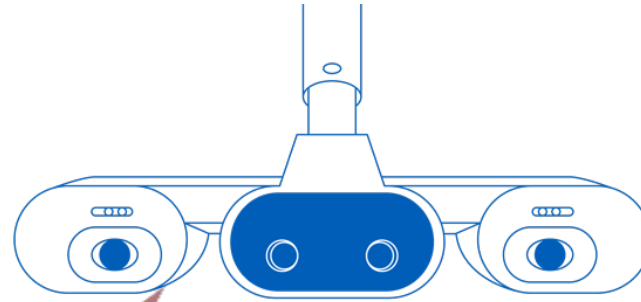
- *Atemanhaltetechniken*

1

DIBH

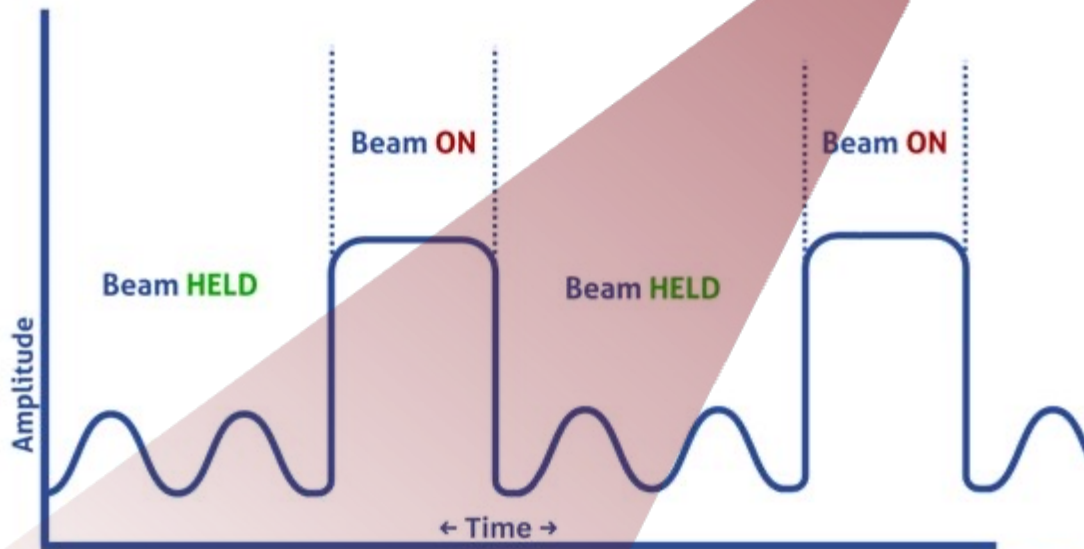
2

EEBH



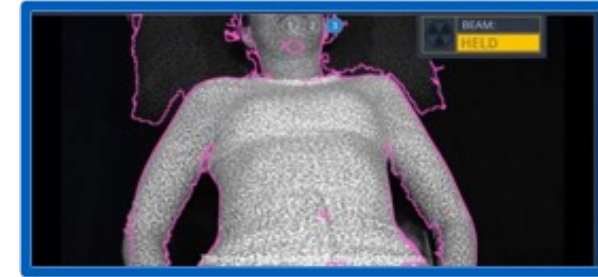
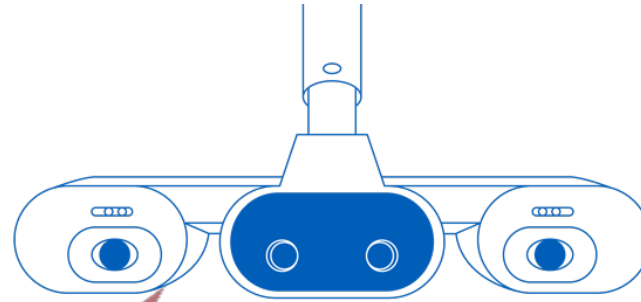
DIBH

Deep Inspiration Breath Hold (DIBH) a well-recognized technique used in radiotherapy treatments for the breast, thorax and abdomen. The patient takes a deep breath in and holds whilst the radiation is delivered.



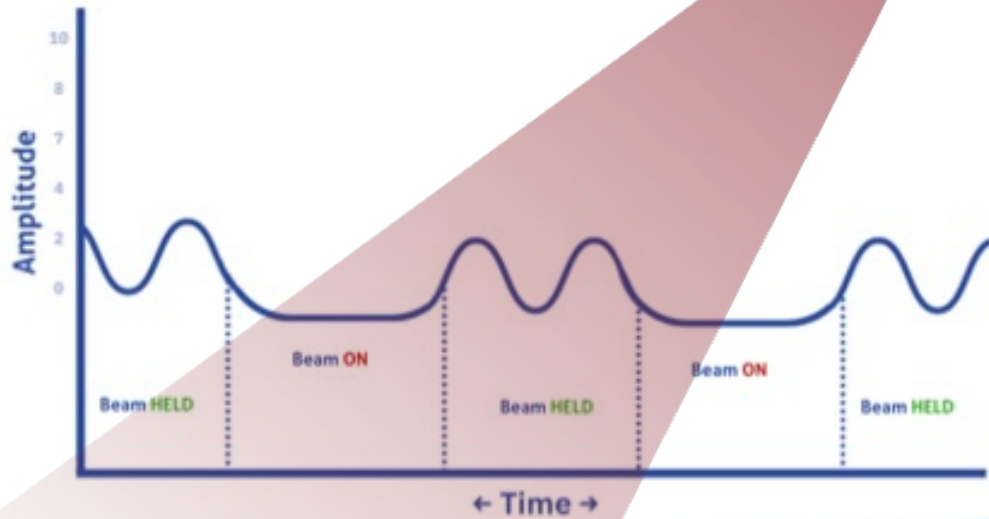
- Atemanhalt in tiefer Einatmung
- Effektive und unkomplizierte Methode die Bewegung zu reduzieren
- Für viele Brustbestrahlungen bereits state-of-the-art.
- Nicht von allen Patienten gut toleriert.

VRT _{cm}	0.04	
LNG _{cm}	0.07	
LAT _{cm}	0.04	
MAG _{cm}	0.09	
YAW [°]	-0.2	
ROLL [°]	0.0	
PITCH [°]	-0.3	



EEBH

End Expiration Breath Hold (EEBH) a technique sometimes used in SBRT treatments to the abdomen. The patient will hold their breath at the end point of their expiration cycle whilst the radiation is delivered.

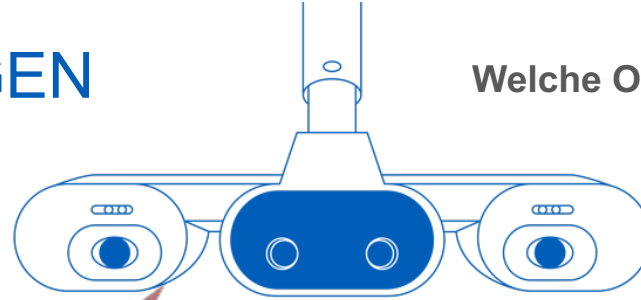


- Viele Kliniker glauben, dass EEBH besser toleriert wird als DIBH.
- End-expiration repräsentiert die längste statische Phase im Atemzyklus und kann für Atemanhaltetechniken geeigneter sein.

VRT _{cm}	0.04	
LNG _{cm}	0.07	
LAT _{cm}	0.04	
MAG _{cm}	0.09	
YAW [°]	-0.2	
ROLL [°]	0.0	
PITCH [°]	-0.3	

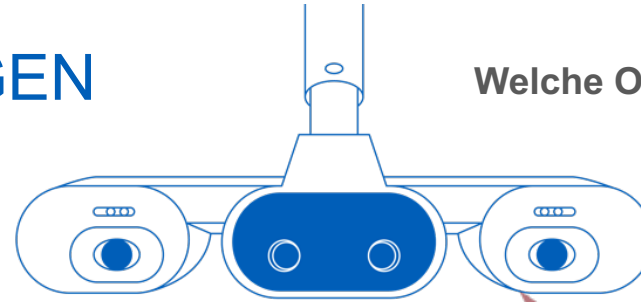
KLINISCHE ANFORDERUNGEN

Welche Optionen für Atembewegungsmanagement gibt es?



KLINISCHE ANFORDERUNGEN

Welche Optionen für Atembewegungsmanagement gibt es?



**Passe Behandlung
dem Patienten an**

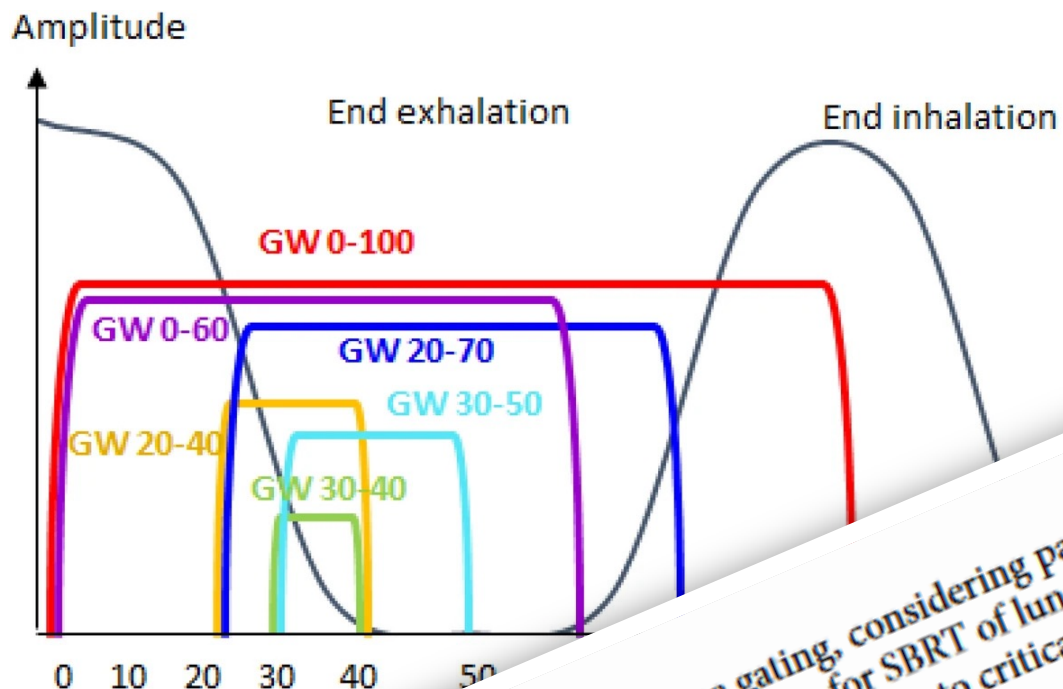
- *Rx in freier Atmung*

3

Phase

4

Amplitude

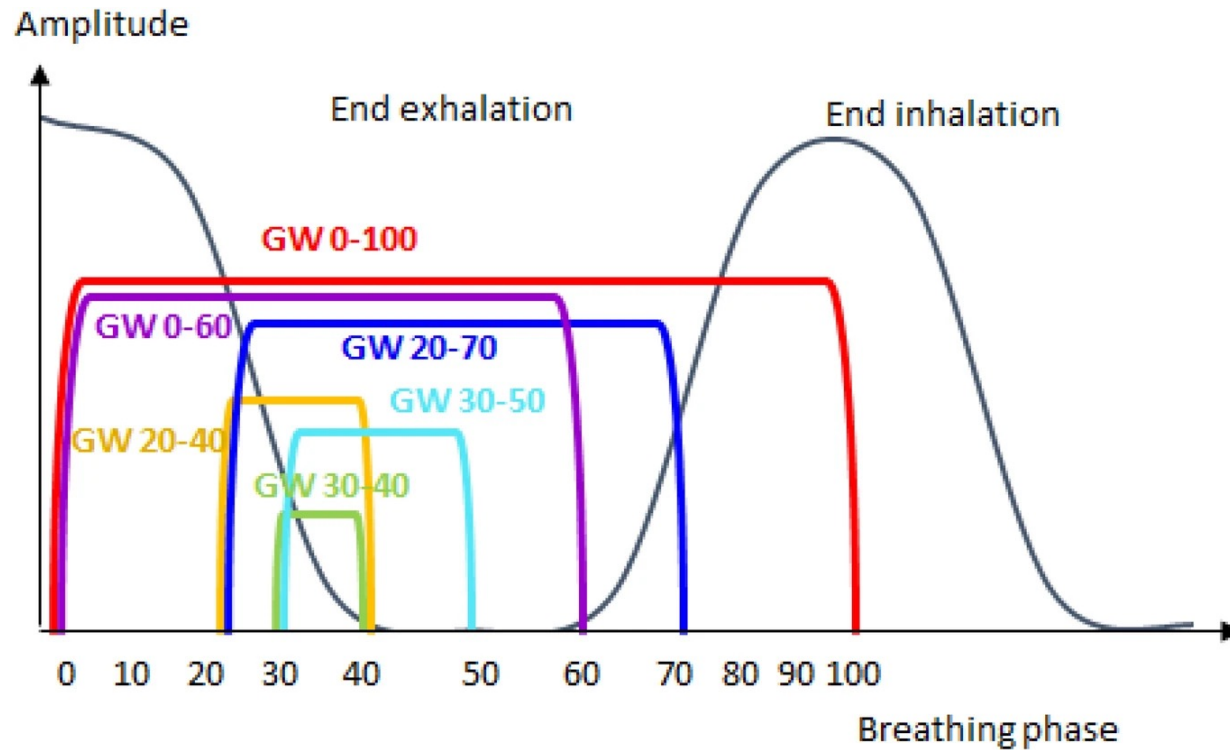


Conclusion
 Patient individual phase gating, considering patient individual tumor position and location, can considerably improve the dose distribution for SBRT of lung tumors. This can be of particular importance for the treatment of central tumors in close proximity to critical organs with high radiation doses.

Schematic drawing of inspiration) to 50 (end

Kraus, K.M., Oechsner, M., Wilkens, et al. Patient individual phase gating for stereotactic radiation therapy of early stage non-small cell lung cancer (NSCLC). Sci Rep

Case number and case location peripheral	GW (phase)	PTV (cm ³)	PTV reduction		Max GTV motion (mm)	PTV		V _{20Gy} [lung] (%)	V _{20Gy} [lung] red. (%)	D _{mean} [lung] (Gy)	
			(%)	(cm ³)		D _{50%} (Gy)	D _{95%} (Gy)				
1 RLL	30-50	44.7	-	-	-	2	46.7	7.5	11.8	6.6	
						47.7	8.5	-	7.0		
						68.4	55.6	42.8	5.5	3.5	4.4
						70.3	56.1	45.3	5.7	-	4.6
	30-50	22.1	35.5	12.2	5.8. Ir	58.8	50.6	40.5	4.6	33.8	4.1
	0-100	34.3	-	-	-	59.2	50.5	39.0	7.1	-	5.5
4 RLL	30	40.7	38.4	39.1	17.8. cc	71.1	56.8	45.6	6.0	68.3	5.7
	20-40	61	18.2	18.8	-	69.1	55.8	42.5	8.0	20.8	7.1
	0-60	69.6	9.9	10.2	-	70.6	52.8	35.2	8.5	15.8	7.4
	0-100	79.8	-	-	-	69.6	56.4	42.9	10.1	-	8.2



Schematic drawing of a breathing cycle. Breathing phases are defined from 0 (end inspiration) to 50 (end exhalation) and to 100 (end inhalation).

Kraus, K.M., Oechsner, M., Wilkens, J.J. et al. Patient individual phase gating for stereotactic radiation therapy of early stage non-small cell lung cancer (NSCLC). Sci Rep

Reduktion der Lungendosis bei stereotaktischer Bestrahlung von Lungentumoren durch Atemgating

Andreas Sebastian Hofmeister

Vollständiger Abdruck der von der Fakultät für Medizin der Technischen Universität München zur Erlangung des akademischen Grades eines Doktors der Medizin genehmigten Dissertation.

Bewegungstrajektorien

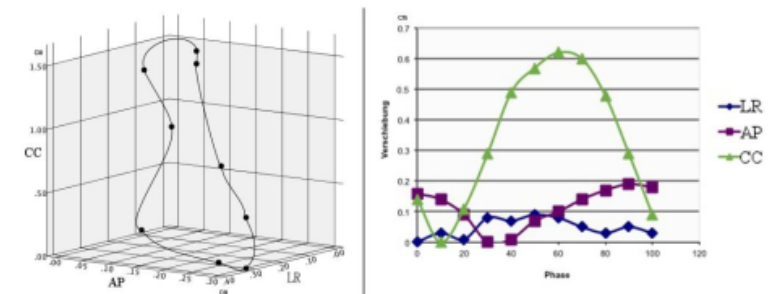
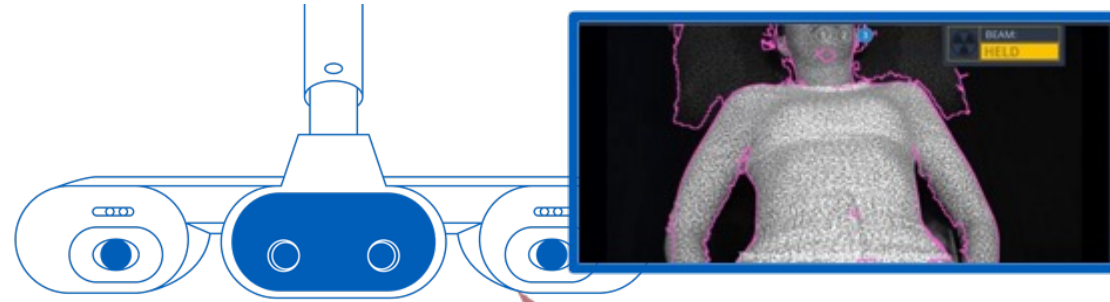
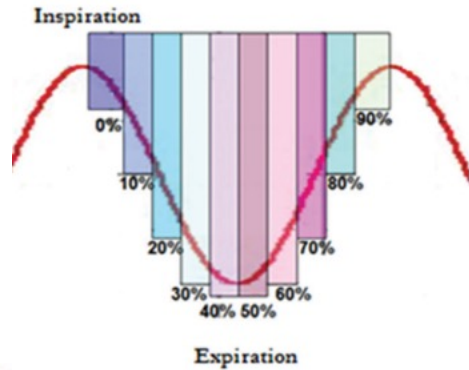
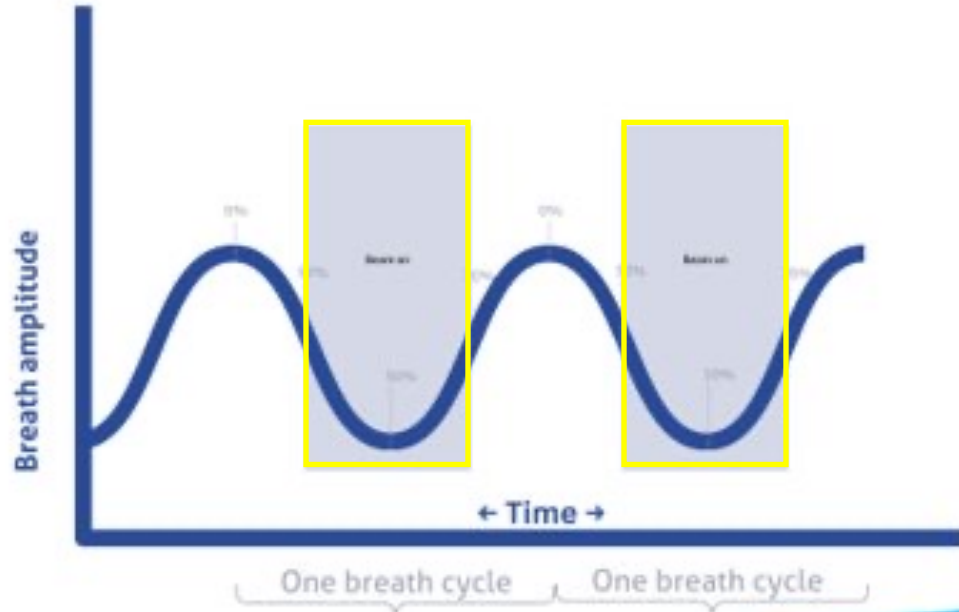


Abbildung 16: Exemplarische Bewegungstrajektorien. Die Punkte entsprechen den COM Koordinaten Links: Tumorbewegung eines Patienten im dreidimensionalen Koordinatensystem in LR-, AP- und CC-Richtung. Rechts: Zweidimensionale Bewegungsdarstellung.

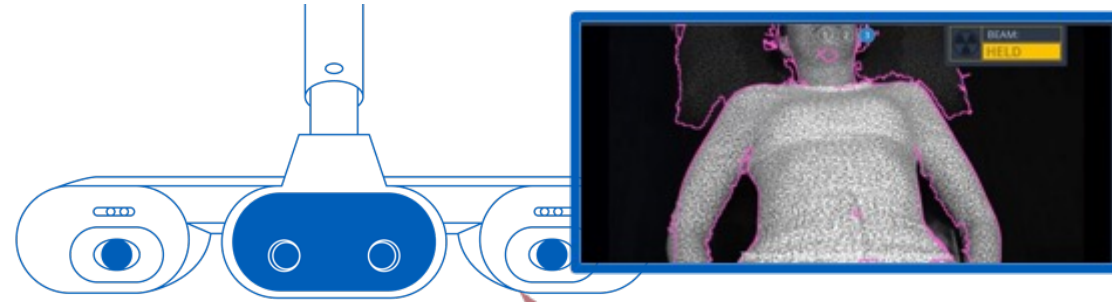


In **PHASE-based gating**, the beam is on during a prescribed phase of the breathing cycle. The timing of the cycle is the trigger.



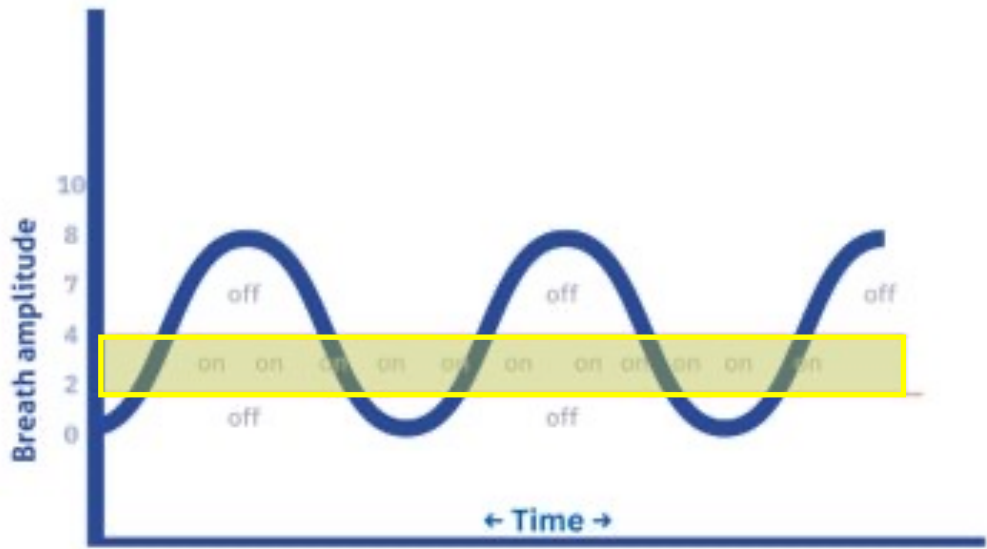
- Behandlungsstrahl nur während der gewählten **Phase**
- Niedriger Duty Cycle

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LNG _{cm}	0.07		
LAT _{cm}	0.04		
MAG _{cm}	0.09		
YAW°	-0.2		
ROLL°	0.0		
PITCH°	-0.3		



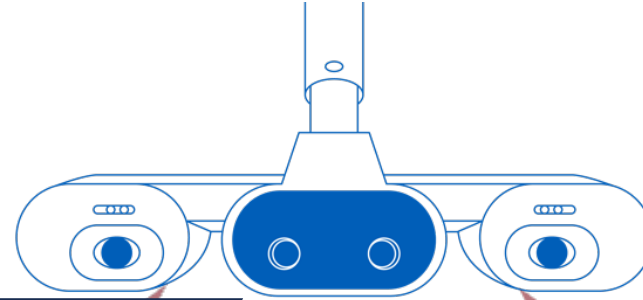
In **AMPLITUDE**-based gating, the beam is on during a specific amplitude, regardless of where the patient is in the breathing cycle.

- Behandlungsstrahl nur während einer bestimmten **Amplitude**
- Üblicherweise höherer Duty Cycle als phasenbasiert
- Niedrigere Konformität



VRT _{cm}	0.04	
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Phase based treatments



**Passe den Patienten der
Behandlung an**

- *Atemanhaltetechniken*

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DIBH

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EEBH

**Passe Behandlung
dem Patienten an**

- *Rx in freier Atmung*

3

Phase

4

Amplitude

**Respiratory Module
in AlignRT
erfüllt alle**

Klinische Anforderungen

Questions and Discussion
