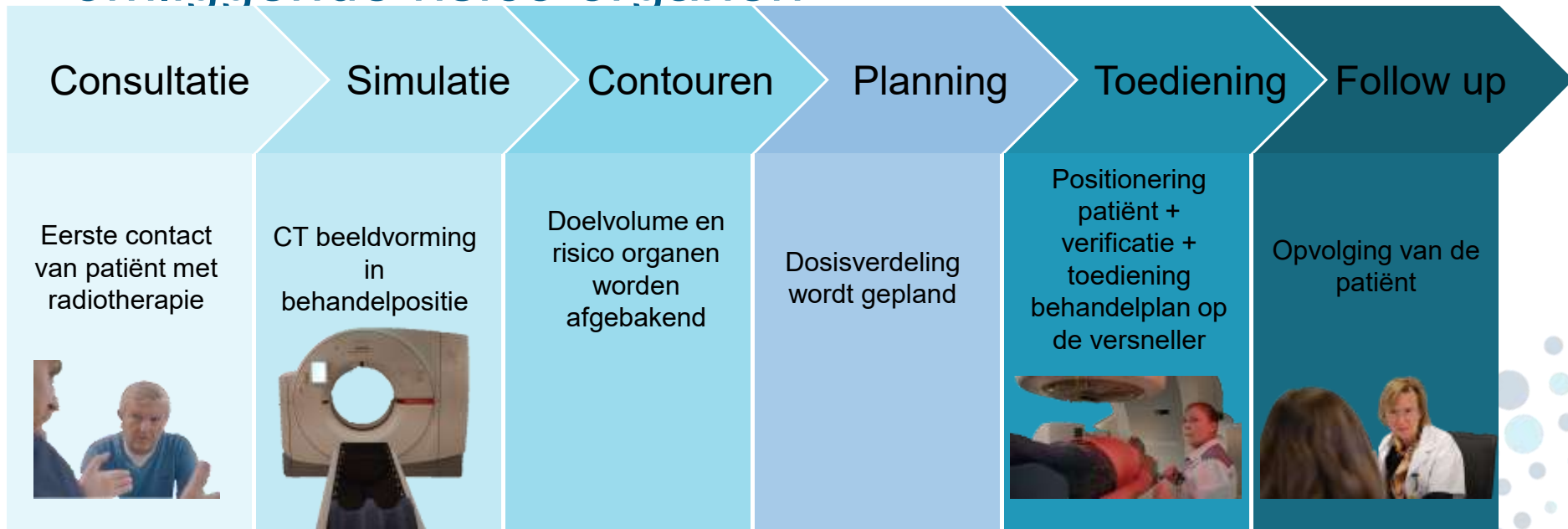


Innovaties rond surface scanning in radiotherapie

KARVA symposium 18 maart 2023

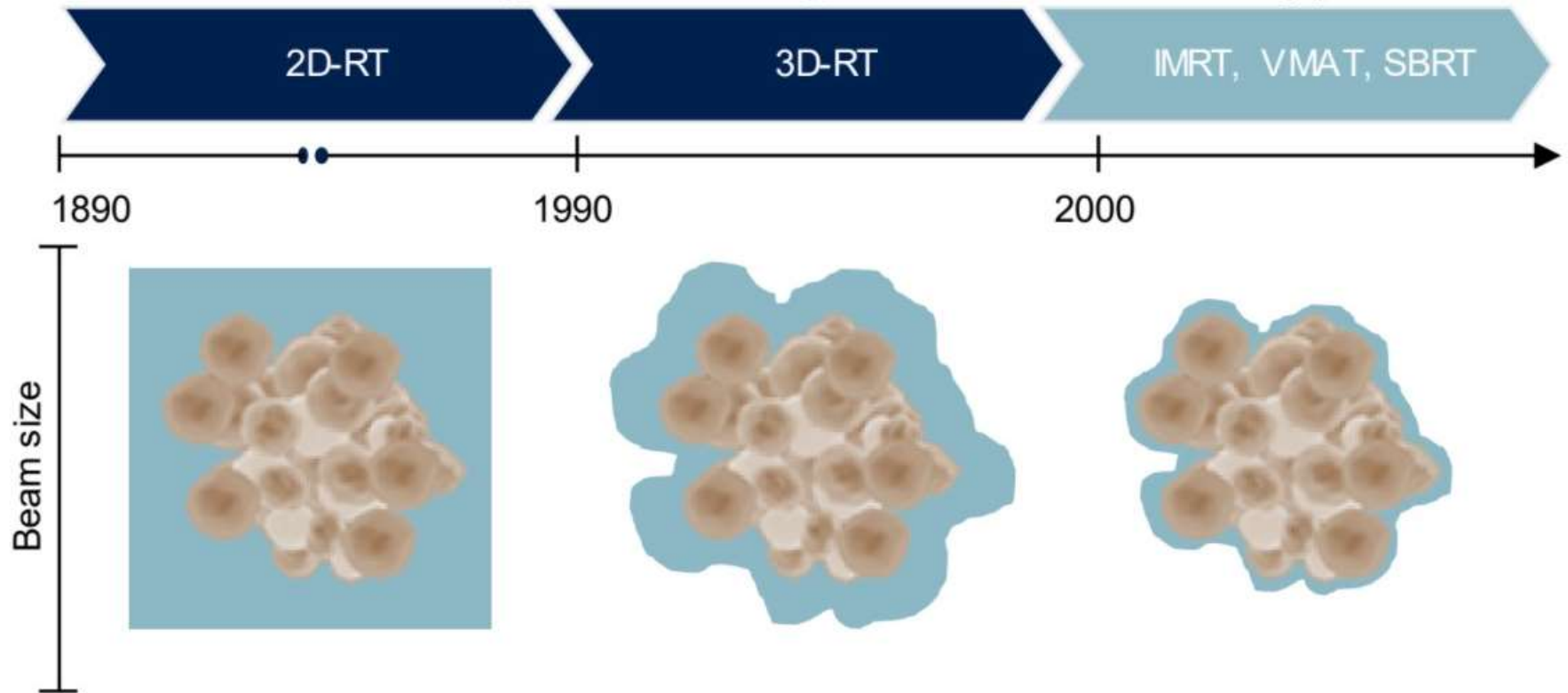
- AZ Klina
- AZ Monica
- AZ Rivierenland
- AZ Voorkempen
- GZA Ziekenhuizen
- UZA
- Vitaz
- ZNA

Doel radiotherapie : maximale gewenste dosis aan de tumorplaats met maximale vrijwaring van omliggende risico organen



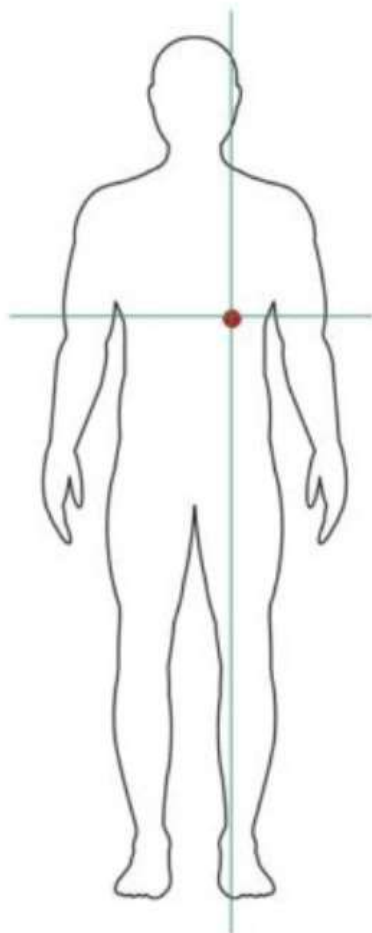
Hoe ervoor zorgen dat de patiënt na enige tijd exact hetzelfde ligt ?

Radiotherapie contouring/planning wordt steeds meer accuraat

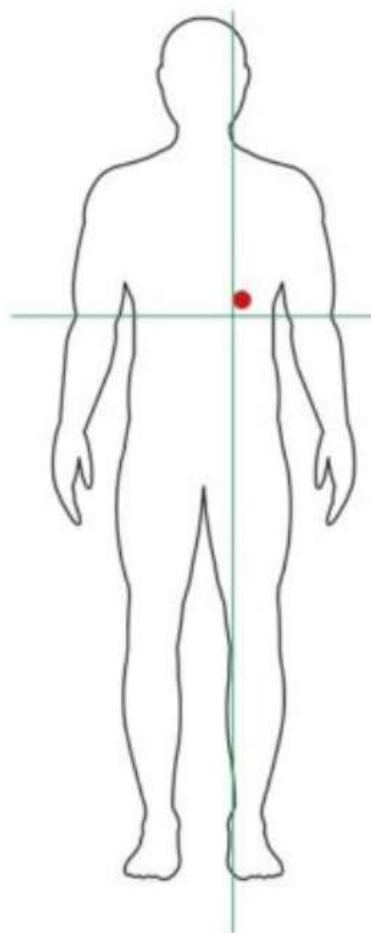


Note: Illustrative example of how the technological advancements in radiation therapy has developed. Modern technology allows for highly conformal dose deliveries which spares more healthy tissue (blue) surrounding the tumour

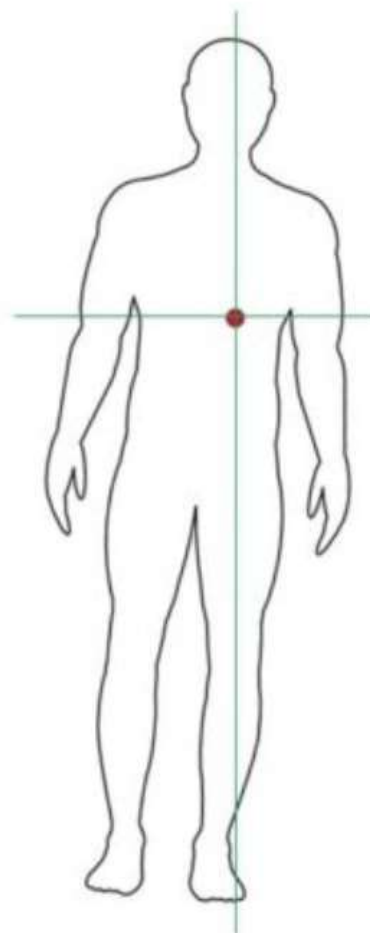
Both rigid and non-rigid algorithms can correct for these situations.



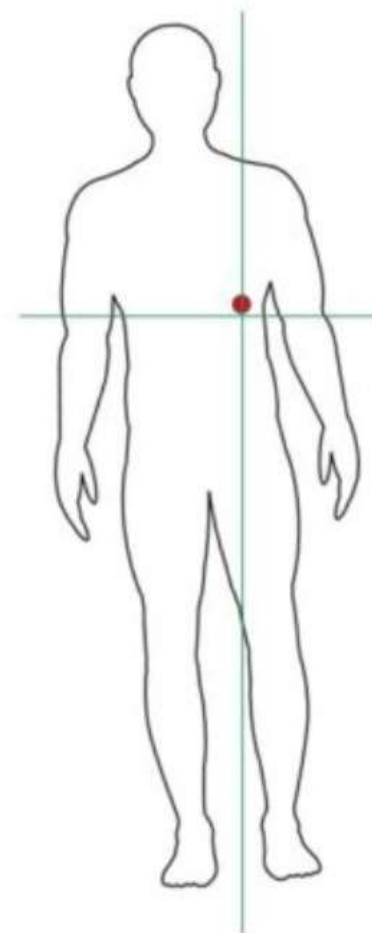
Patient reference image.



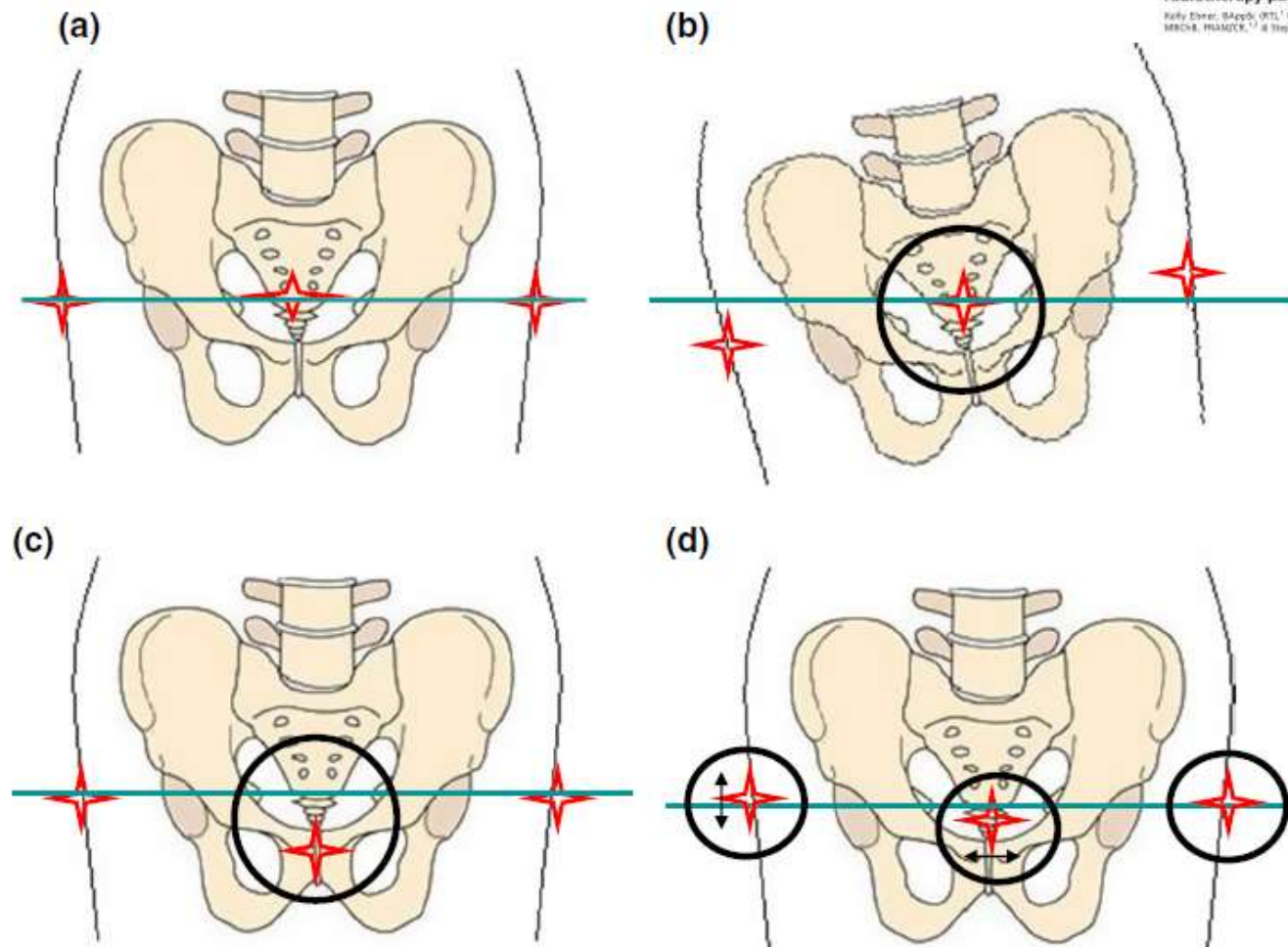
Patient position is shifted.



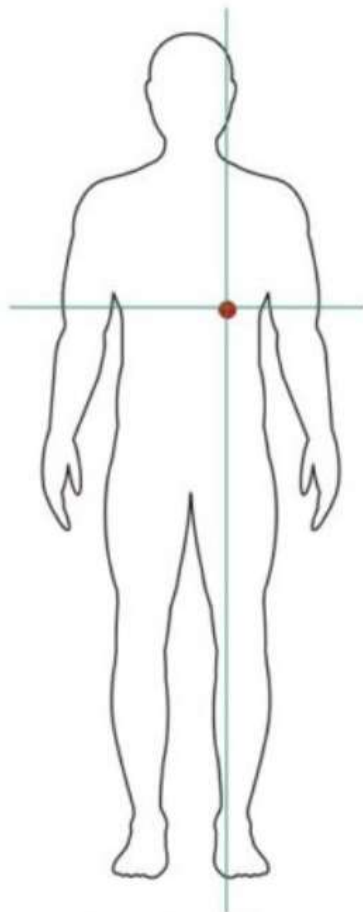
Patient position is rotated.



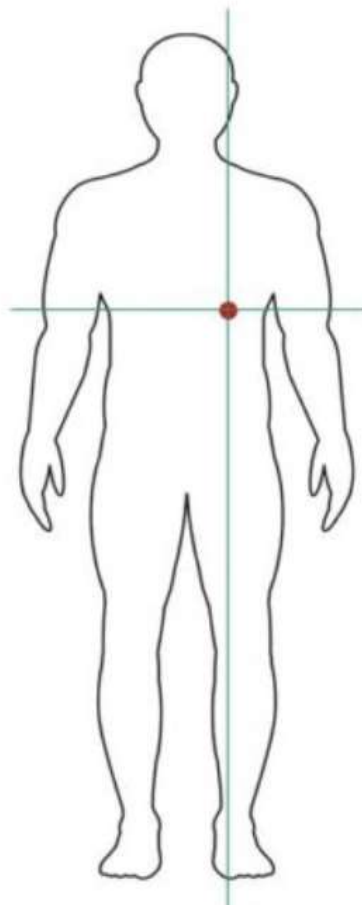
Patient position is shifted and rotated.



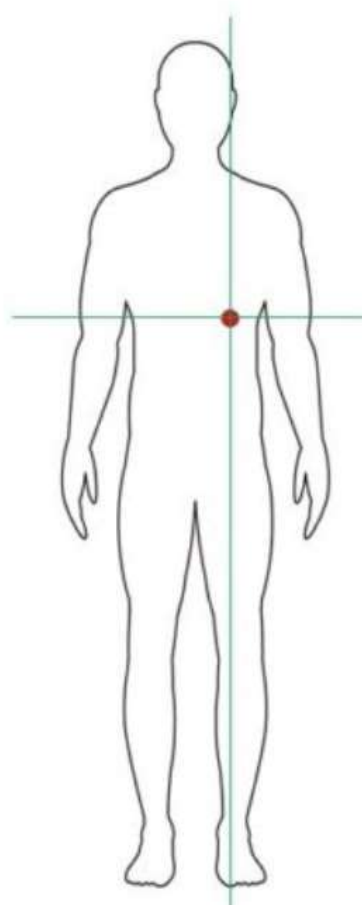
Only non-rigid algorithms can correct for these situations.



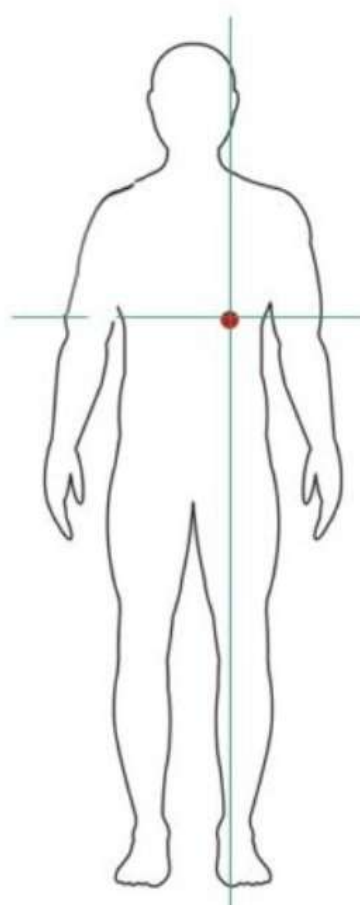
Patient reference image.



Patient has gained weight.



Patient has lost weight.



Patient posture has changed (shoulder slouch).

Wat is surface scanning

Wanneer een optisch verificatie systeem is gekoppeld aan een lineaire versneller om patiënten te positioneren en te verifiëren noemt men dit SGRT (surface guided radiotherapie).

Het is een niet ioniserend en niet invasief beeldvormingssysteem dat toelaat de positie van de patiënt continue te verifiëren tijdens zijn/haar behandeling door de verkregen 3D informatie te vergelijken met een referentiebeeld.

Het SGRT systeem heeft dus 2 functies:

- patiënt positionering
- patiëntpositie monitoring tijdens de behandeling



Tijdslijn surface scanning

2021 alle behandelingen binnen Iridum dmv surface scanning

2017 start SBRT/SRS toestel
Uranus met surface scanning



In 1979 presenteerden Velkey et al

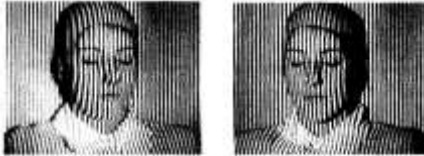


FIG. 3. Stereo-pair of photographs of subject's head with the projected pattern. A small piece of black tape has been added above each of three fiducial points on each side of the subject to make the points more recognizable.





Patiënt immobilisatie, positionering en verificatie





Immobilisatiemateriaal
op vaste positie op
behandeltafel





Tafelparameters
worden
berekend vanuit
isocentrum van
het
behandelplan





The BHPA Congress had a surprising ending. Many thanks to BHPA and to all my colleagues at the Iridium Network.

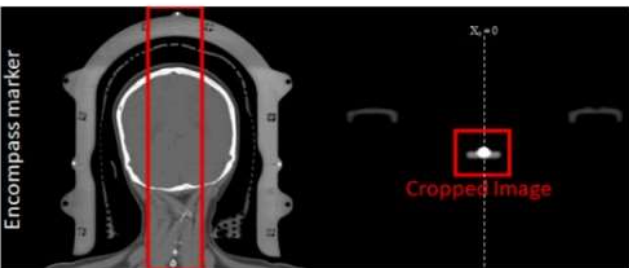
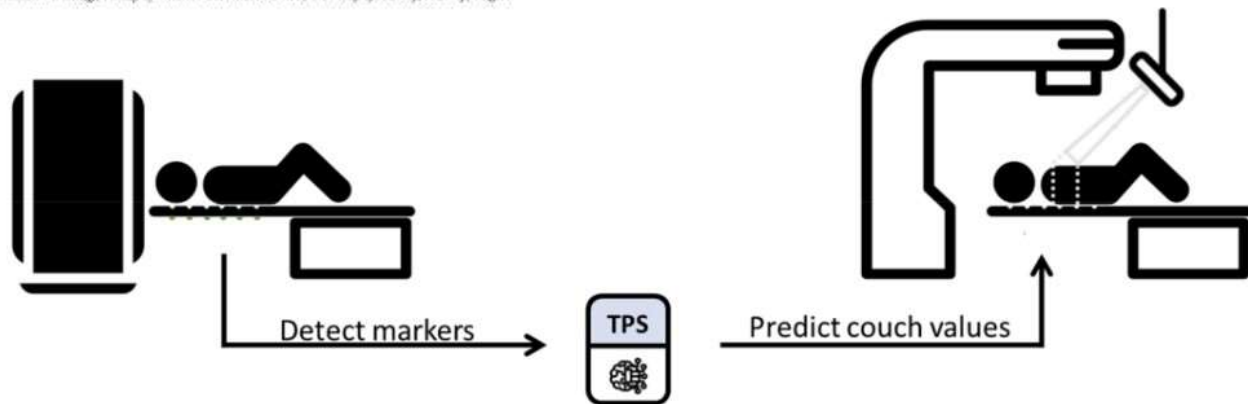


Machine learning-based treatment couch parameter prediction in support of surface guided radiation therapy

Geert De Kerf^{a,*}, Michaël Claessens^{a,b}, Isabelle Mollaert^a, Wim Vingerhoed^a, Dirk Verellen^{a,b}

^a Iridium Network, Antwerp, Belgium

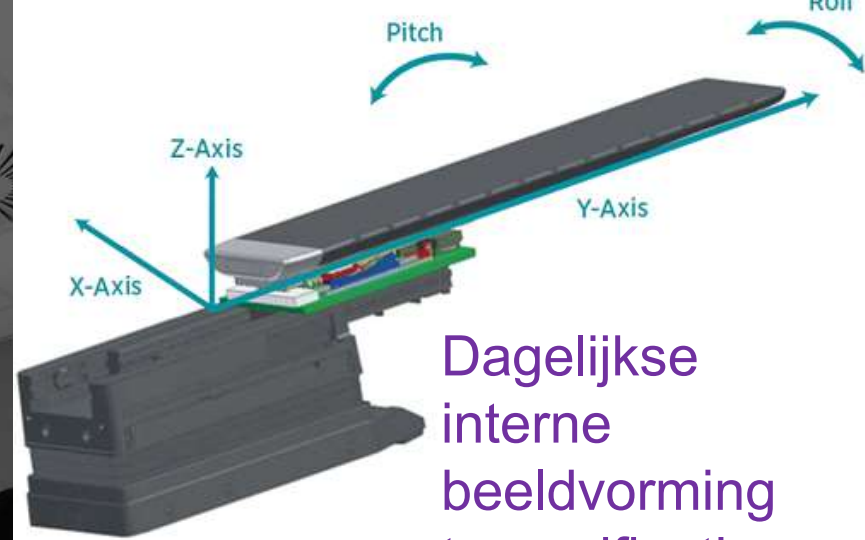
^b Department of Radiation Oncology, Faculty of Medicine and Health Sciences, University of Antwerp, Antwerp, Belgium





Surface
scanning om
de patiënt
juist te
positioneren
tov
isocentrum.





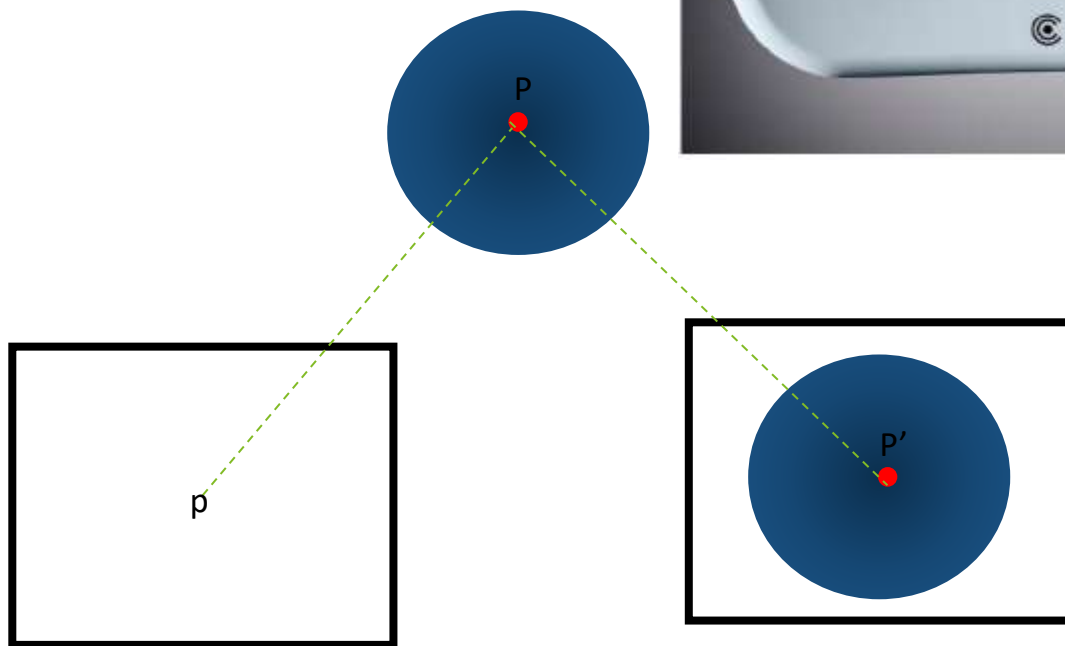
Dagelijkse
interne
beeldvorming
ter verificatie
(Cone Beam
CT of
conventionele
RX)

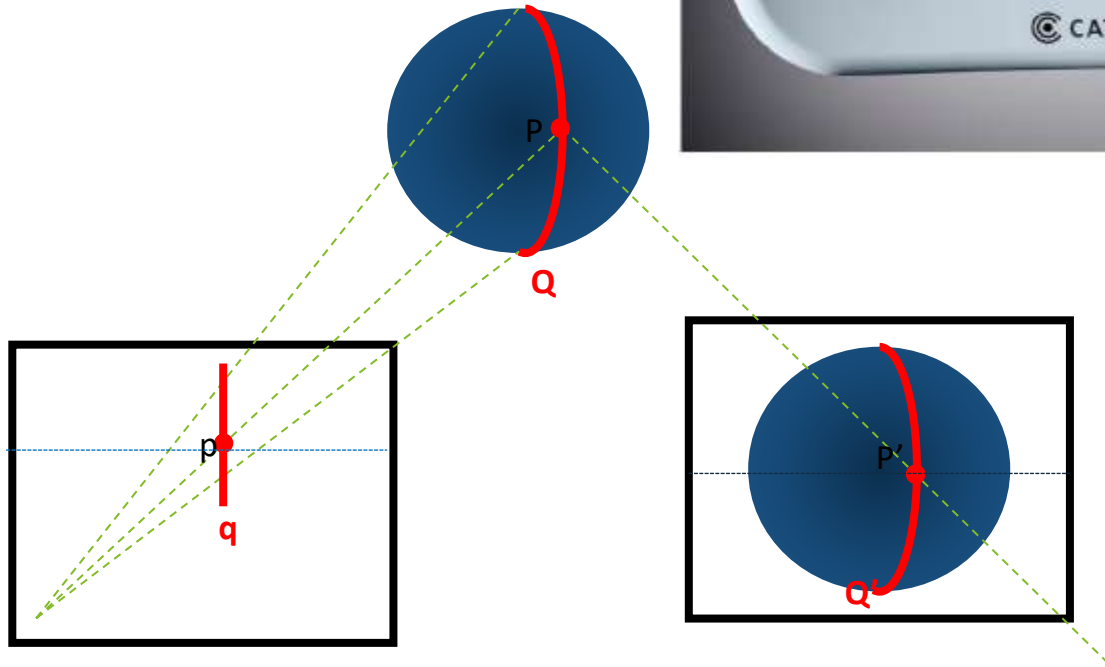


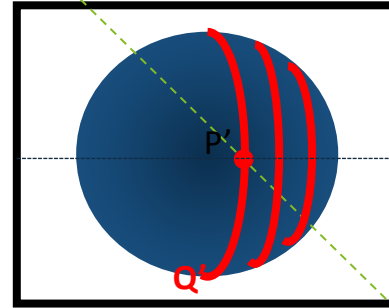
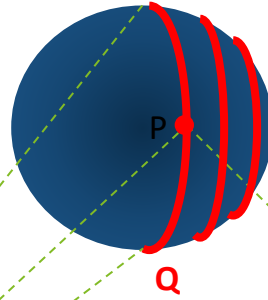


Surface scanning blijft patiënt heel de tijd in de gaten houden. Patiënt gaat buiten tolerantie-> automatische stop bestraling.



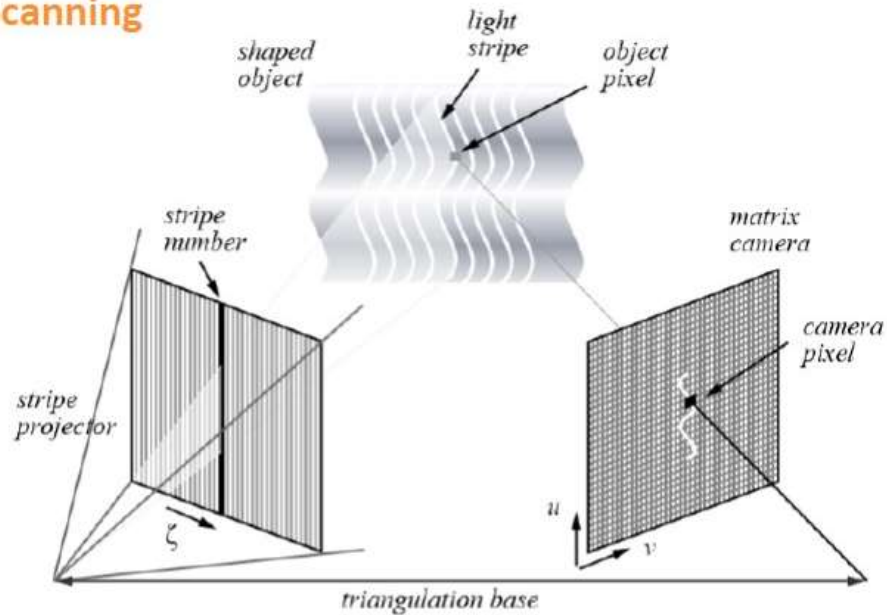






Structured light

Structured Light Scanning



Each camera works separately and collects its own 3D data point cloud in real-time



Left Slave

LINAC

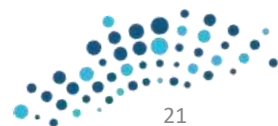
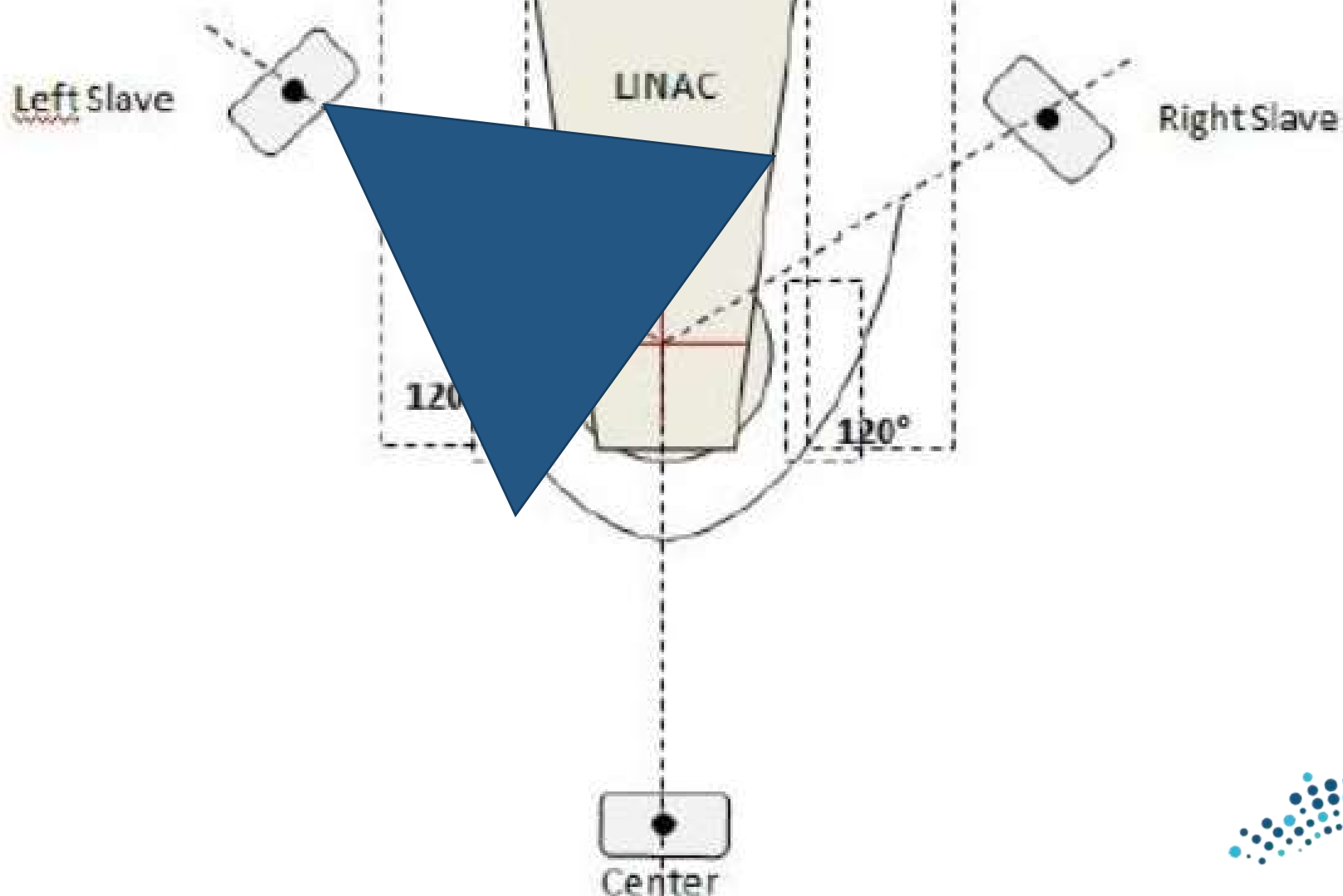
Right Slave

120°

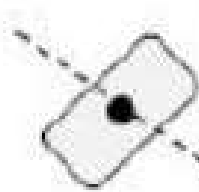
120°

Center





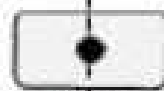
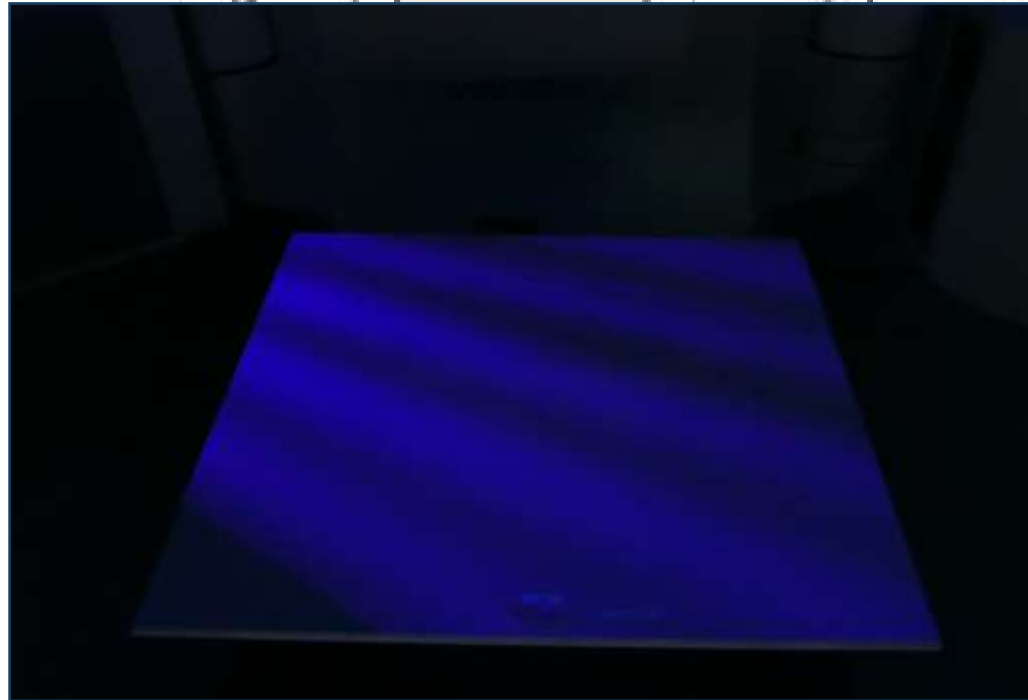
Left Slave



LINAC



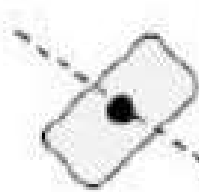
Right Slave



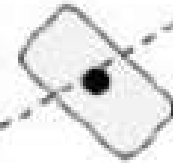
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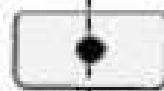
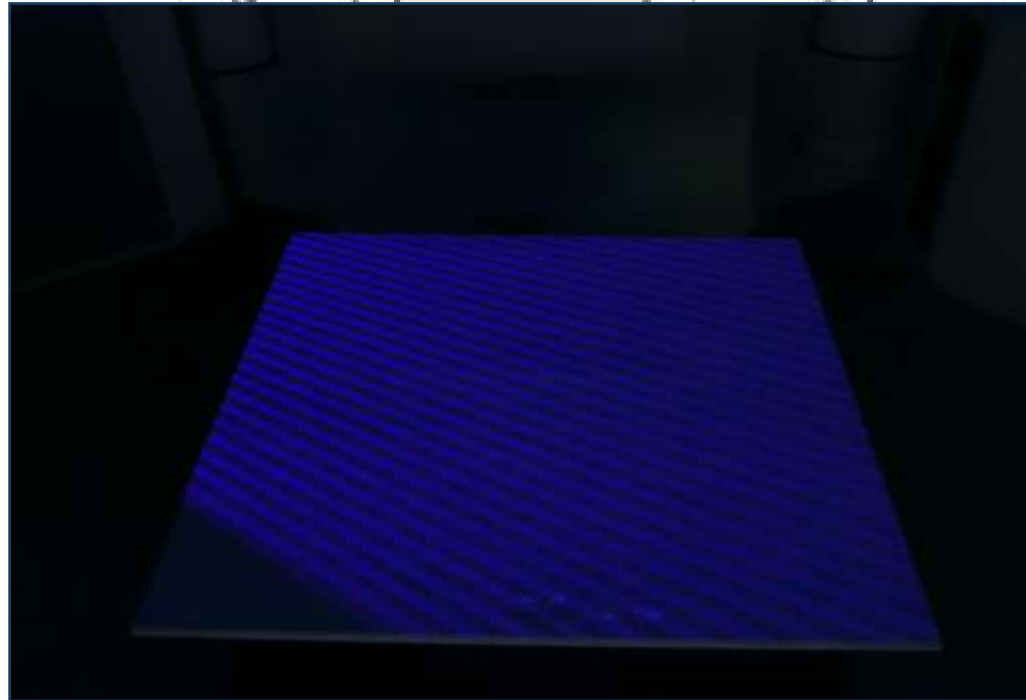
Left Slave



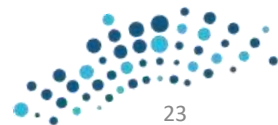
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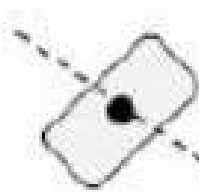
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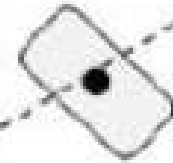
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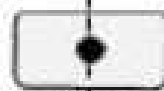
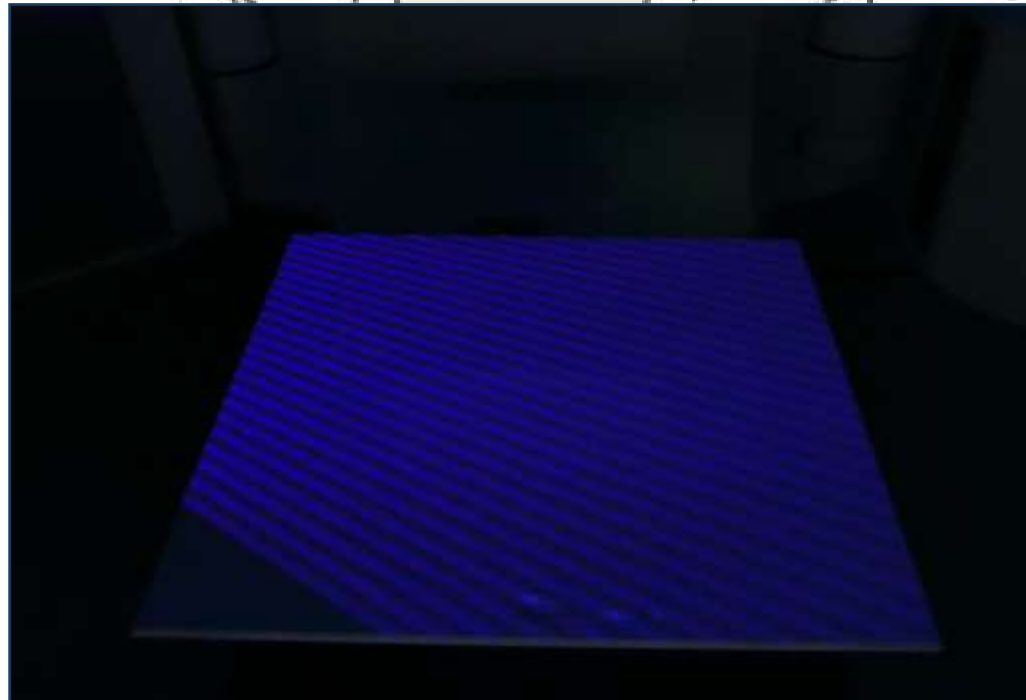
Left Slave



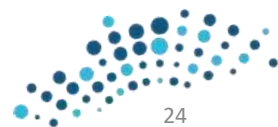
LINAC



Right Slave



Center



Left Slave

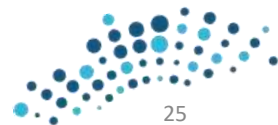
LINAC

Right Slave

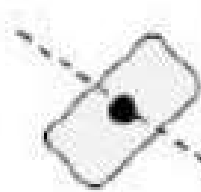
120°

120°

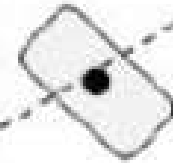
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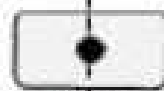
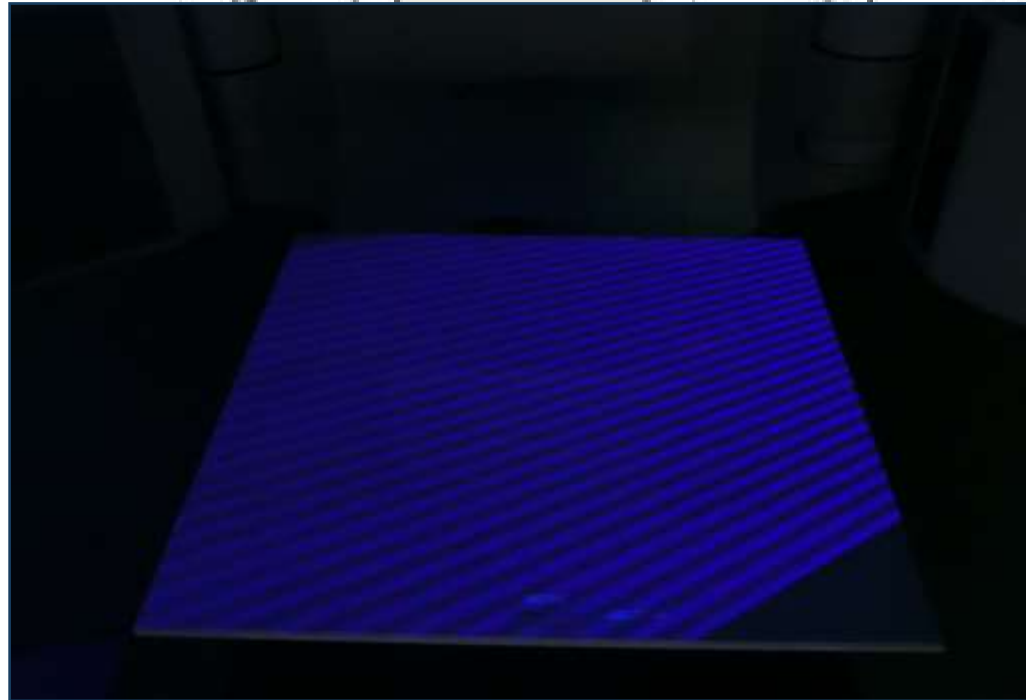
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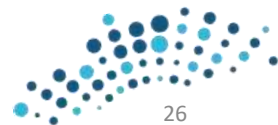
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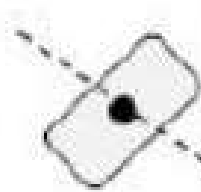
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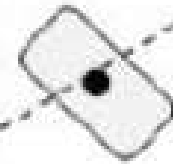
Center



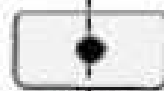
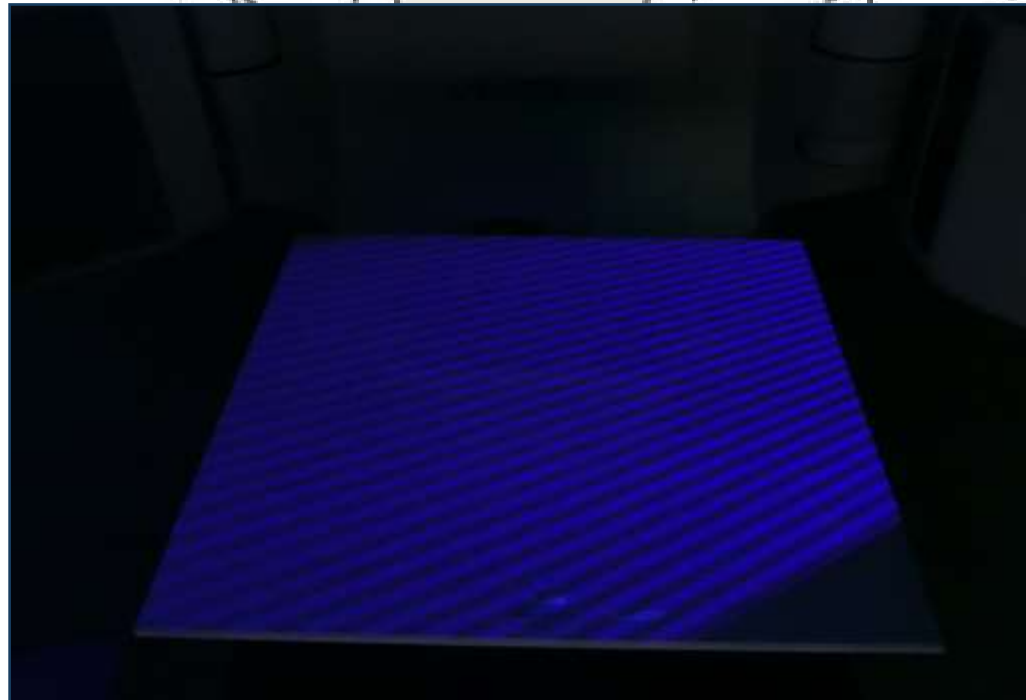
Left Slave



LINAC



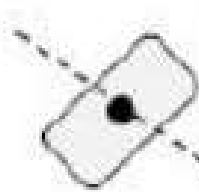
Right Slave



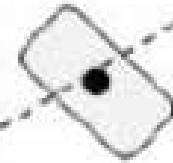
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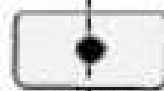
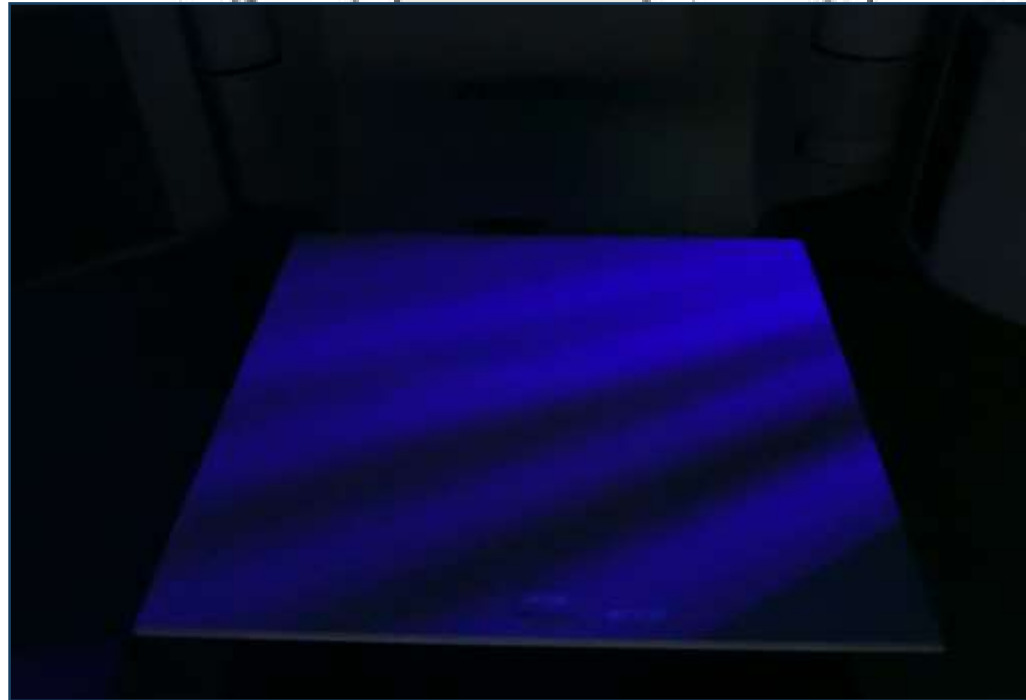
Left Slave



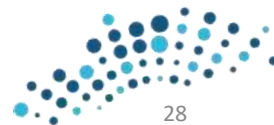
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Right Slave



Center



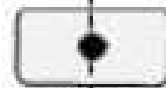
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LINAC

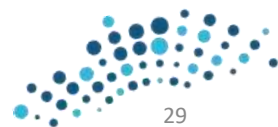
Right Slave

120°

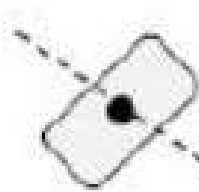
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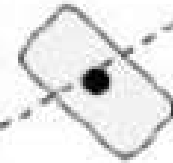
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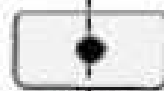
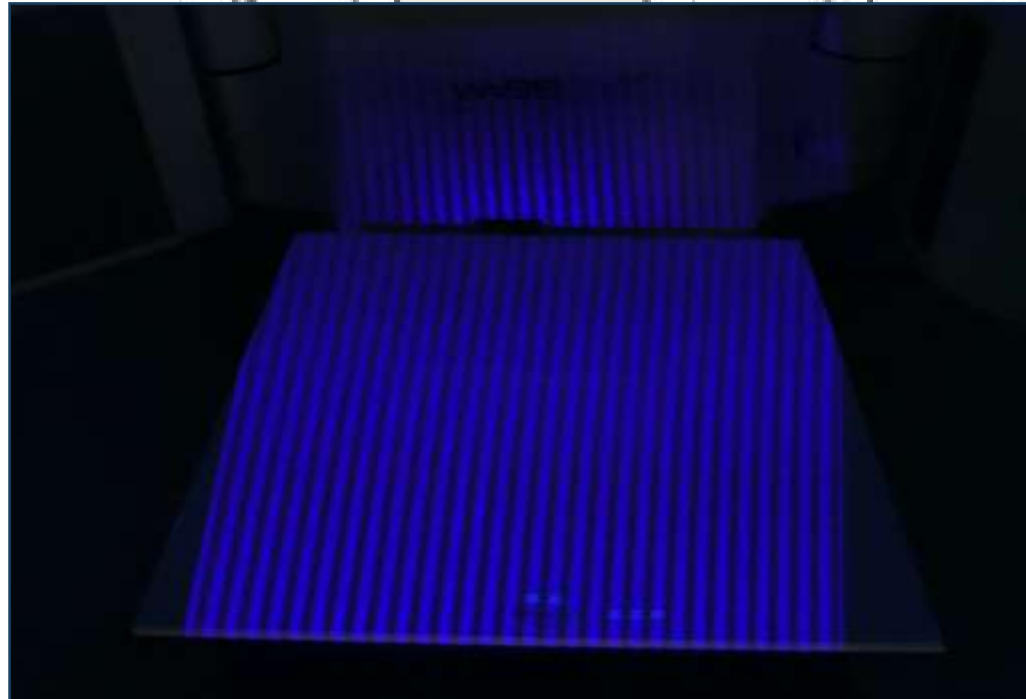
Left Slave



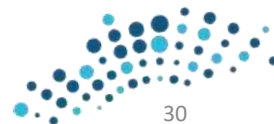
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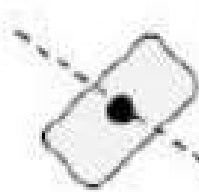
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Center



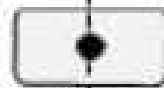
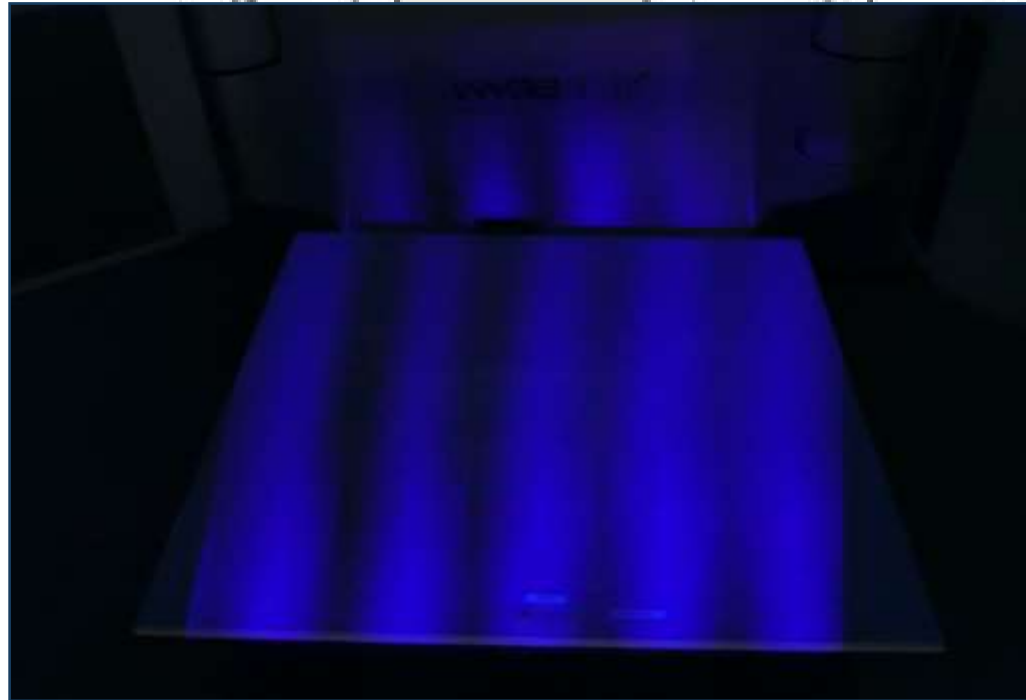
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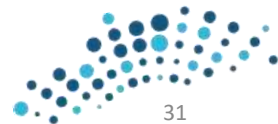
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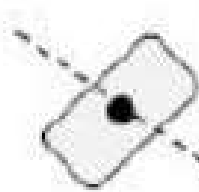
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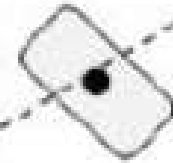
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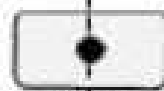
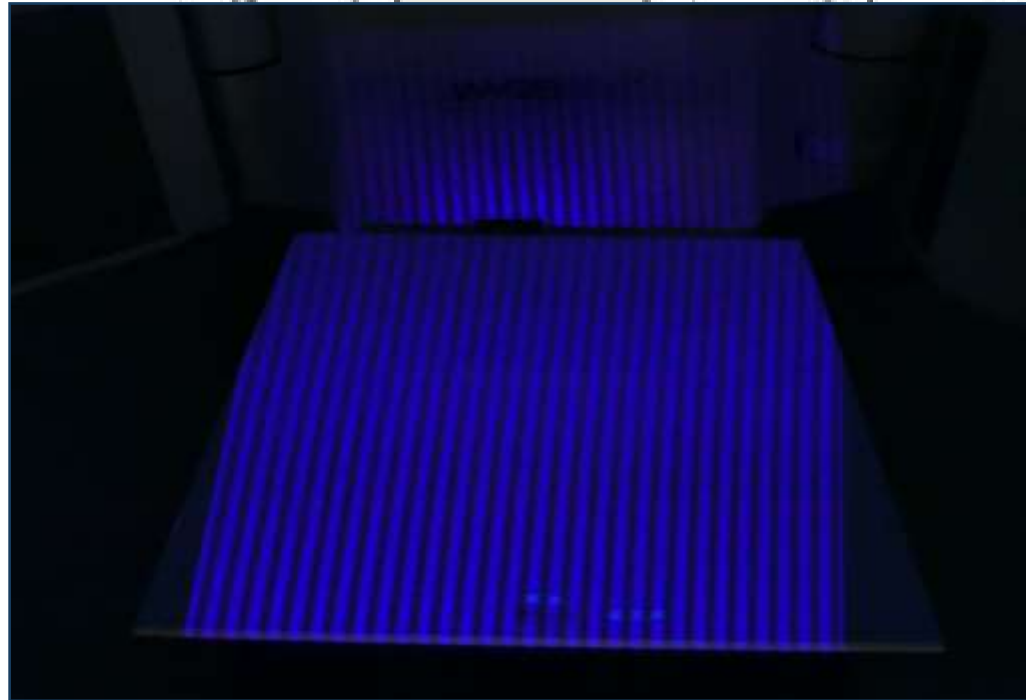
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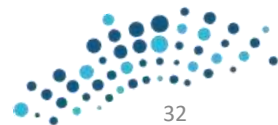
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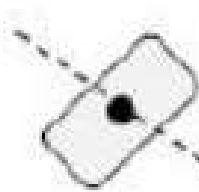
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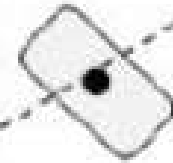
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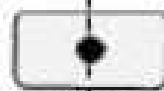
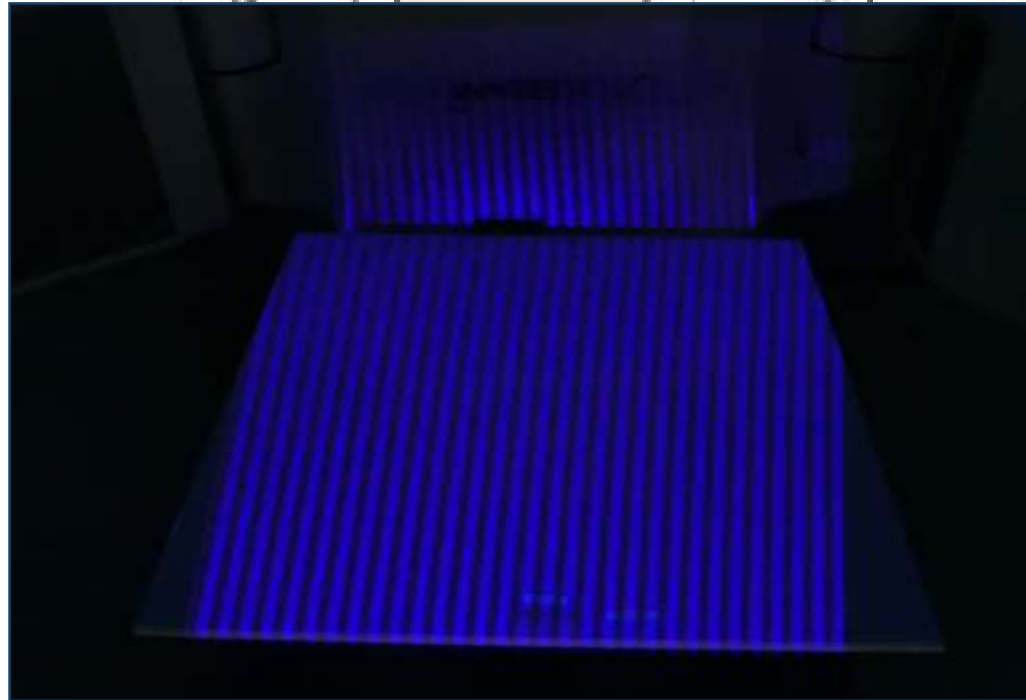
Left Slave



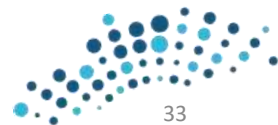
LINAC



Right Slave



Center



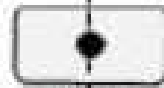
Left Slave

LINAC

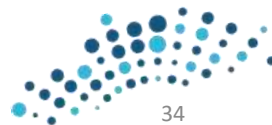
Right Slave

120°

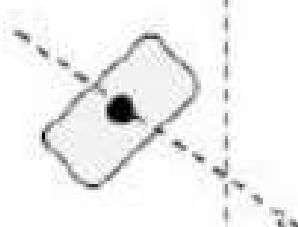
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Center



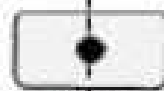
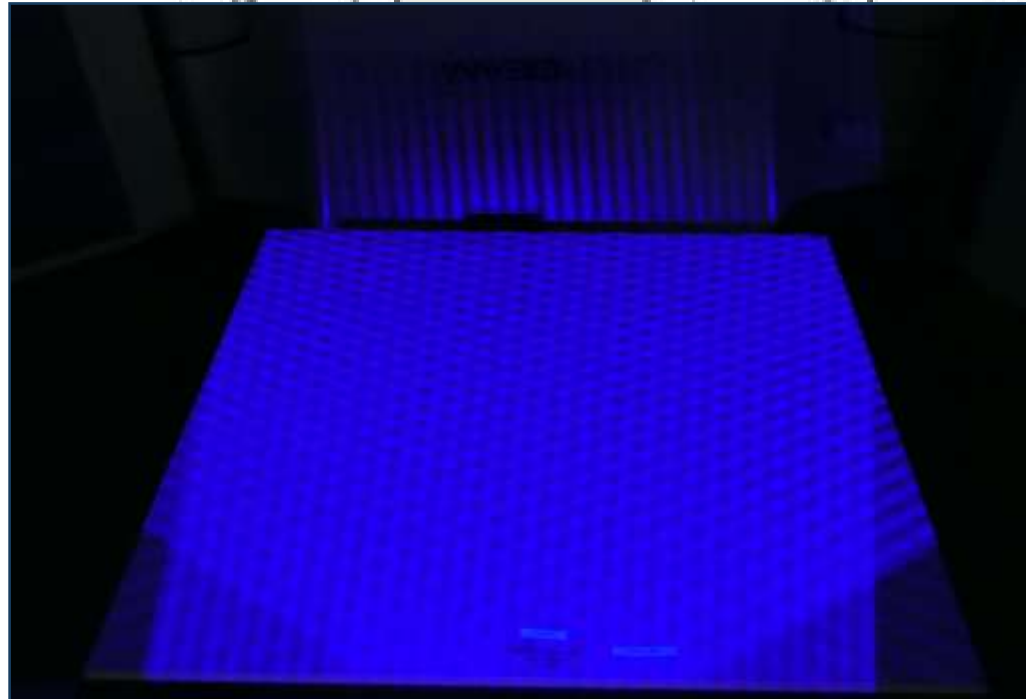
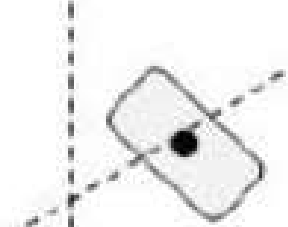
Left Slave



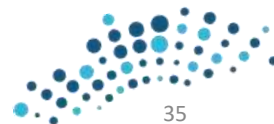
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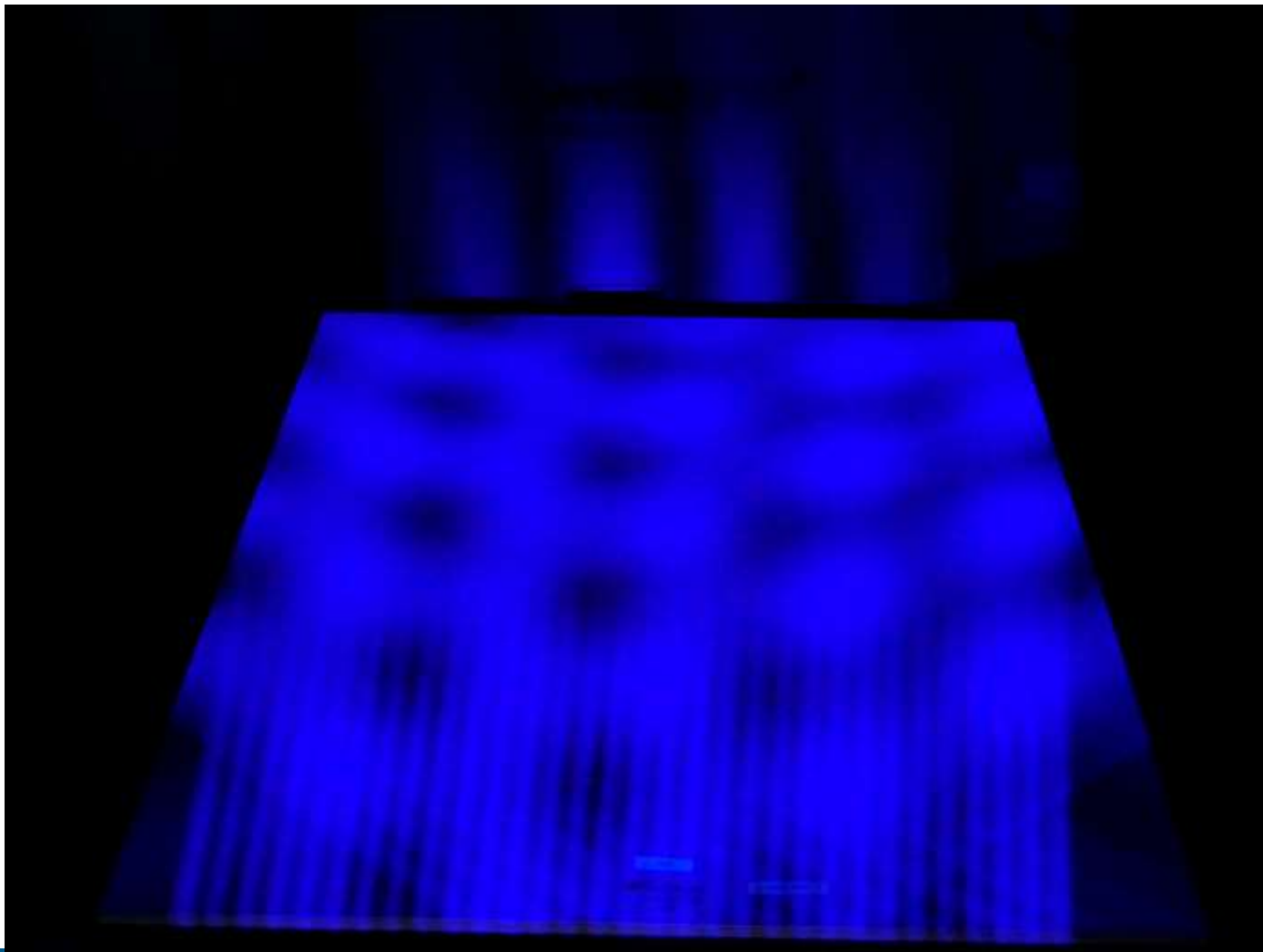


Right Slave

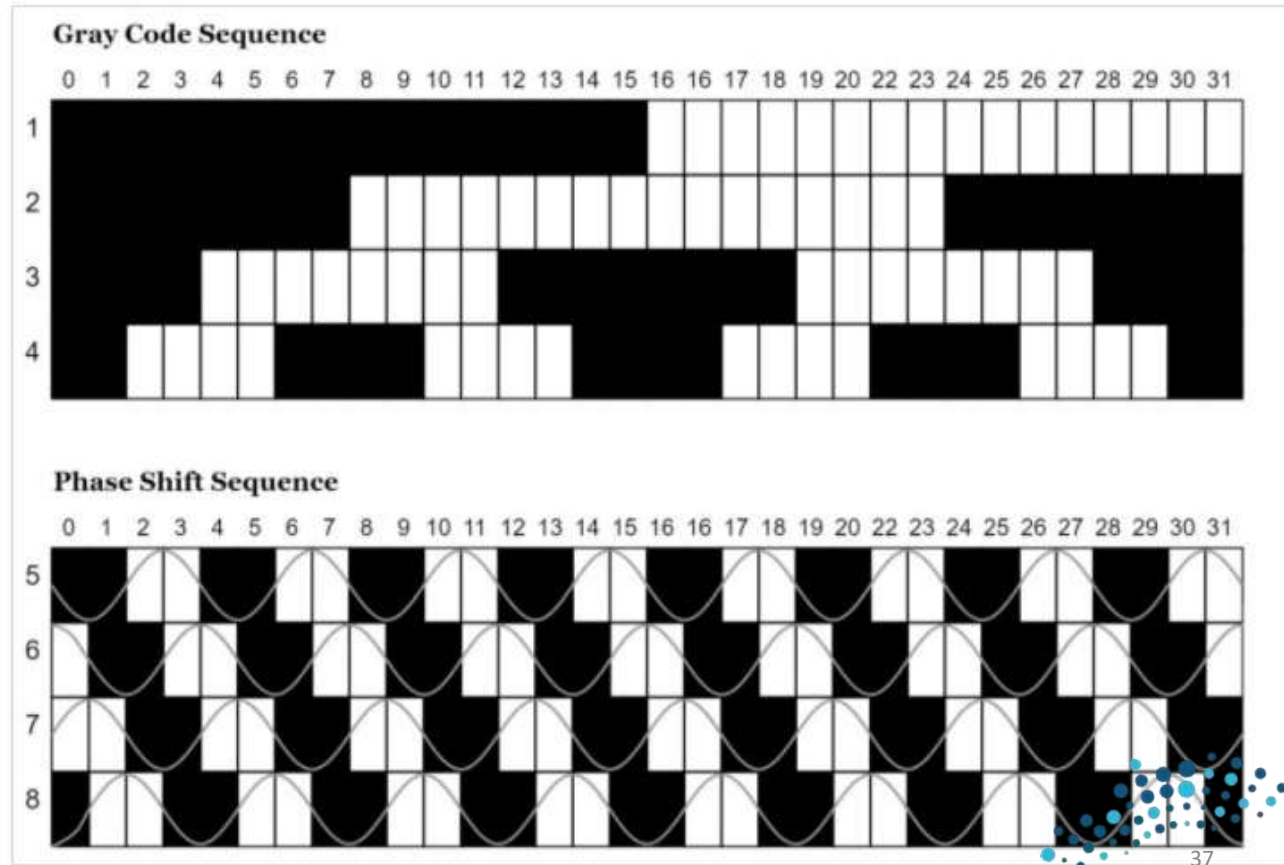


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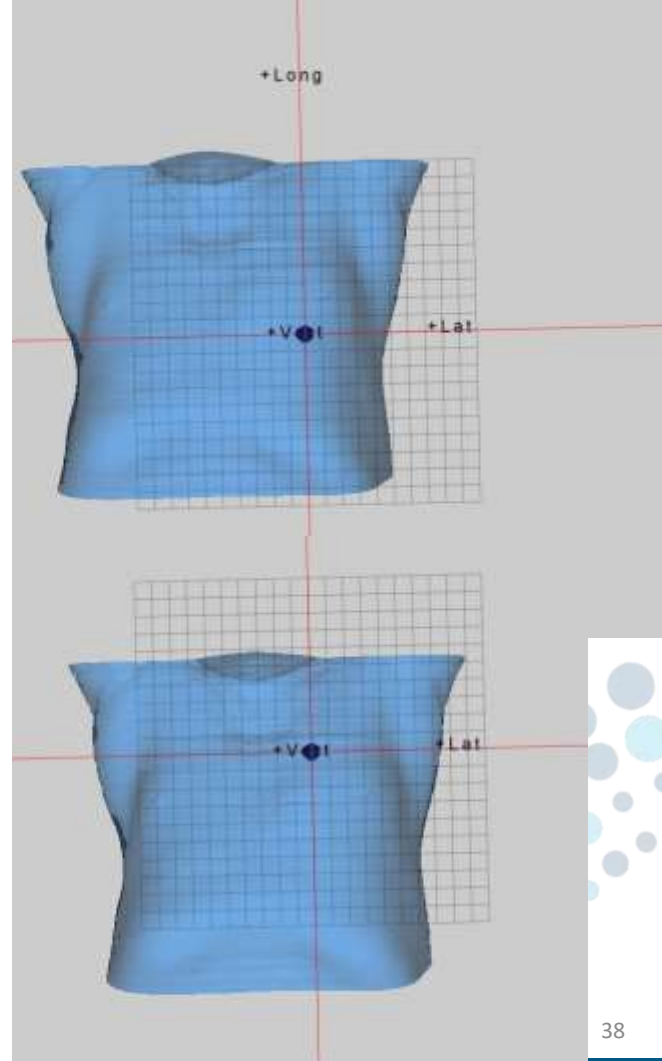


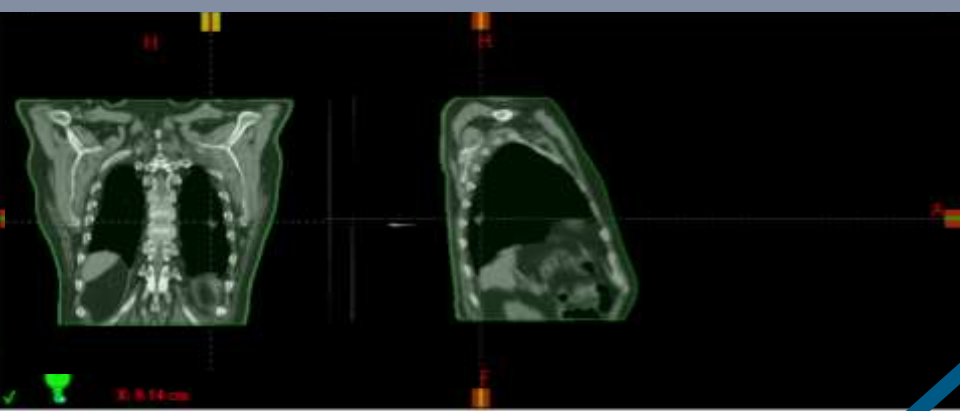
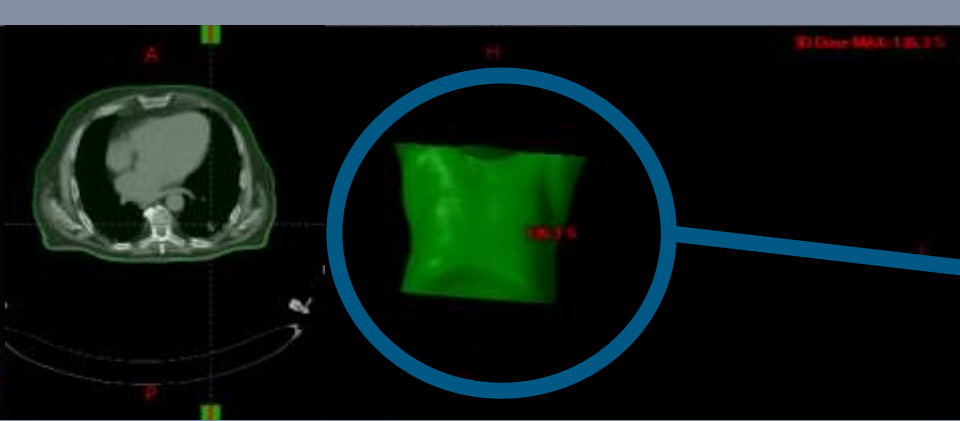
Binaire code en fase shift = gestructureerd lichtpatroon



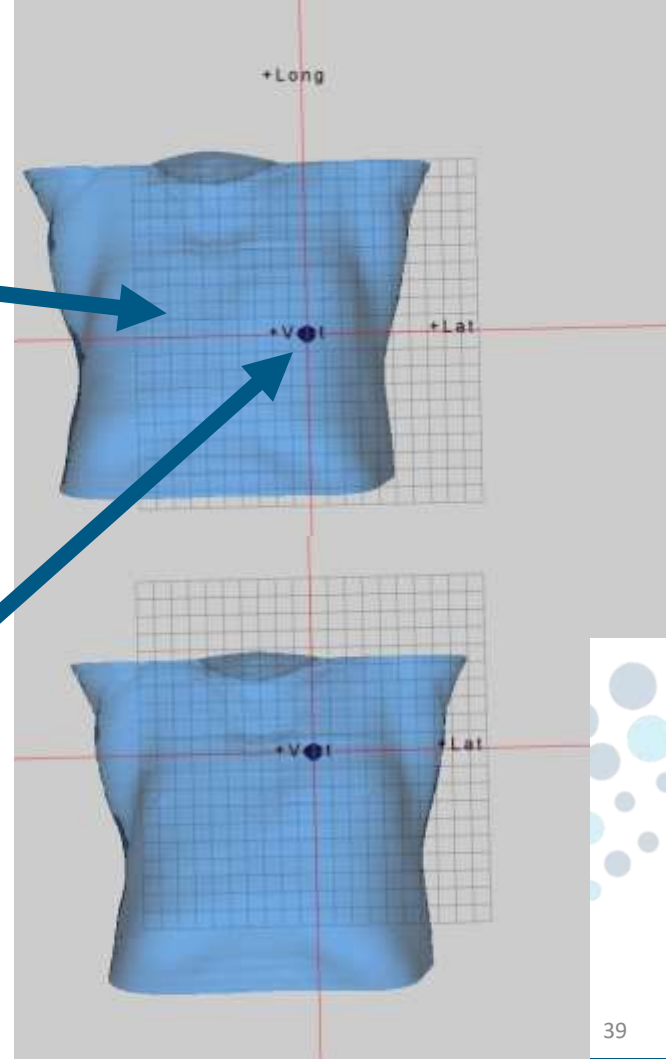


Field # [cm]	X1 [cm]	X2 [cm]	Field # [cm]	X1 [cm]	X2 [cm]	Y [cm]	Y [cm]	Z [cm]	Calculated SSD [cm]	MU	Set. D [cm]
4.0	+2.0	+1.9	5.3	+2.7	+2.6	9.14	-19.70	34.32	79.8		
4.0	+2.0	+1.9	5.3	+2.7	+2.6	9.14	-19.70	34.32	79.8		
4.0	+2.0	+1.9	5.3	+2.7	+2.6	9.14	-19.70	34.32	95.1	1448.4	
5.3	+2.7	+2.6	4.0	+2.0	+2.0	9.14	-19.70	34.32	78.2	1279.1	
4.0	+2.0	+1.9	5.3	+2.7	+2.6	9.14	-19.70	34.32	79.8		

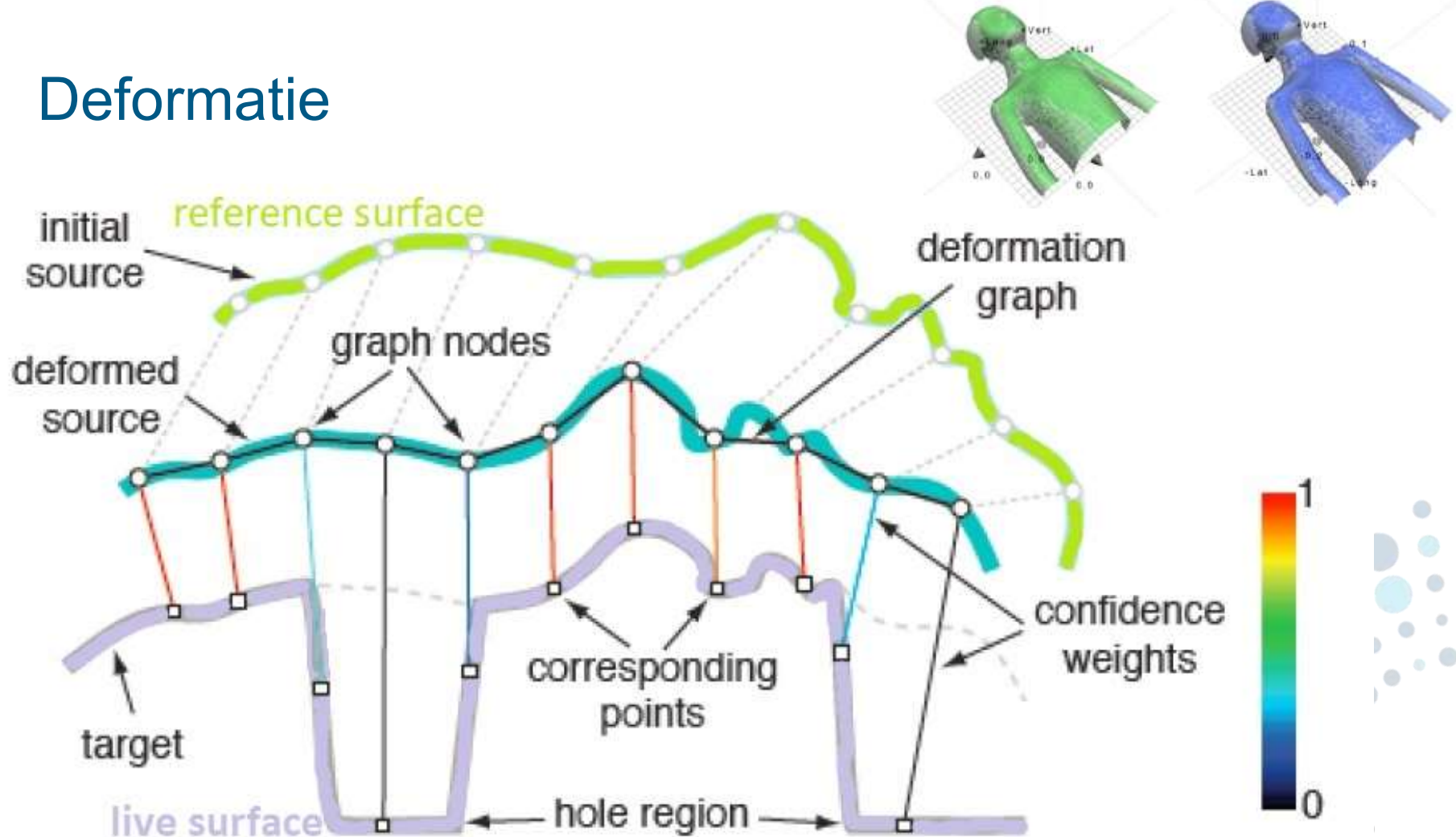




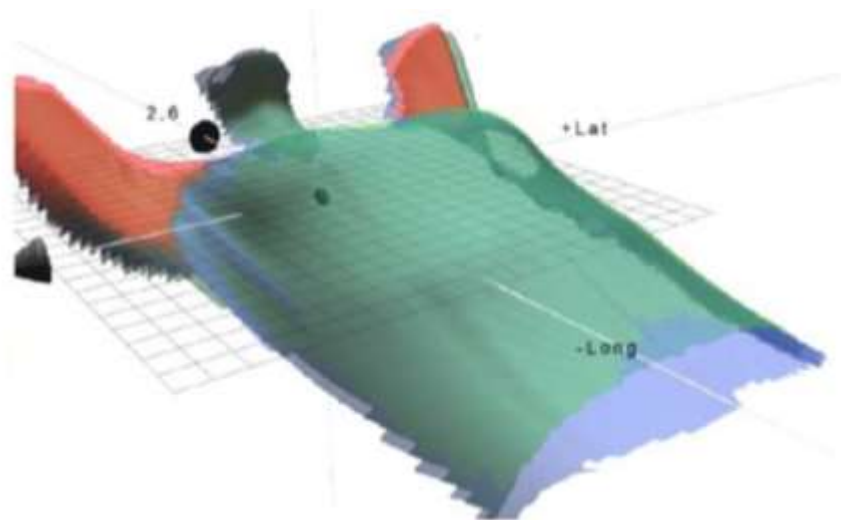
Field # (cm)	X1 (cm)	X2 (cm)	Field # (cm)	X1 (cm)	X2 (cm)	X1 (cm)	X2 (cm)	Z (cm)	Cent. Lat. (cm)	Cent. Lat. (cm)	Cent. D (cm)
4.0	+2.0	+1.9	5.3	+2.7	+2.6	9.14	-19.70	34.32	7.8		
4.0	+2.0	+1.9	5.3	+2.7	+2.6	9.14	-19.70	34.32	7.8		
4.0	+2.0	+1.9	5.3	+2.7	+2.6	9.14	-19.70	34.32	7.8	1448.4	
5.3	+2.7	+2.6	4.0	+2.0	+1.9	9.14	-19.70	34.32	7.8	1279.1	
4.0	+2.0	+1.9	5.3	+2.7	+2.6	9.14	-19.70	34.32	7.8		

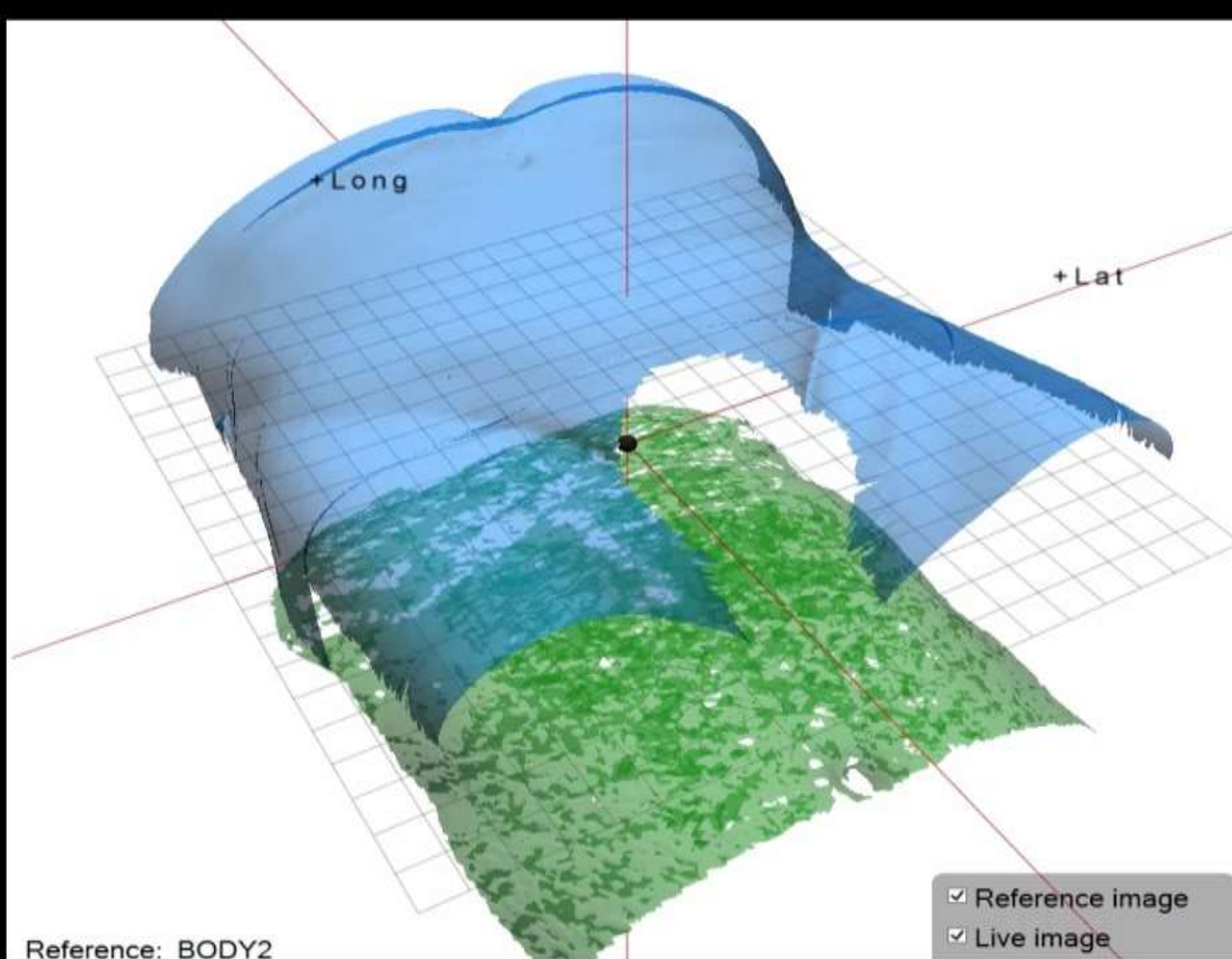


Deformatie



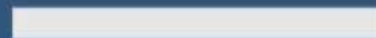
Het kan een visualisatie van houdingsonnauwkeurigheden creëren door middel van augmented reality (kleurprojecties rechtstreeks op de patiënten), waardoor een snellere workflow mogelijk wordt





COUCH

	<i>Absolute</i>	<i>Relative</i>
Lat	- mm	- mm
Long	- mm	- mm
Vert	- mm	- mm
Rot	- °	- °



POSTURE

	<i>Relative</i>
Roll	- °
Pitch	- °

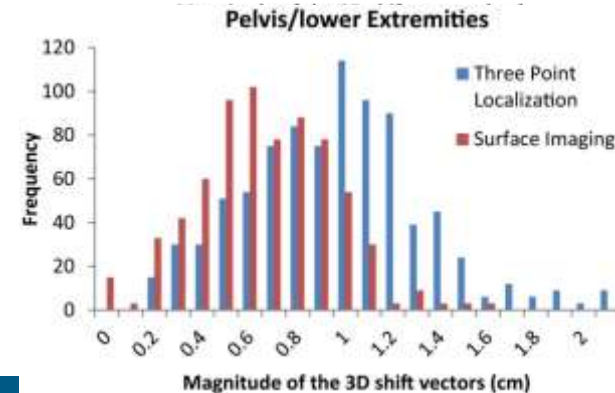
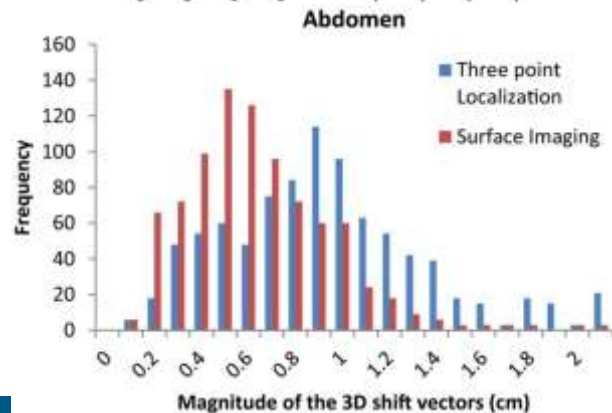
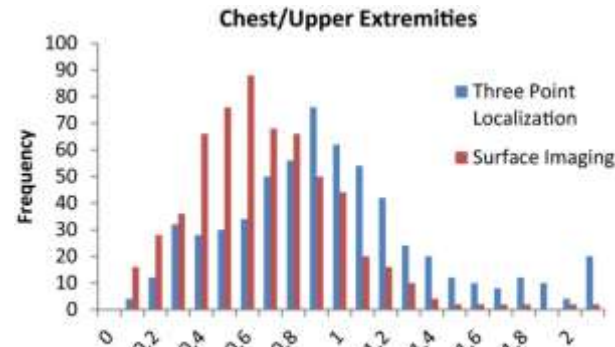
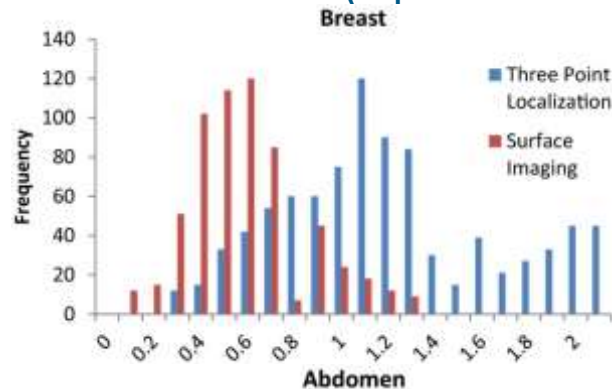
- ☒ Reference image
- ☒ Live image



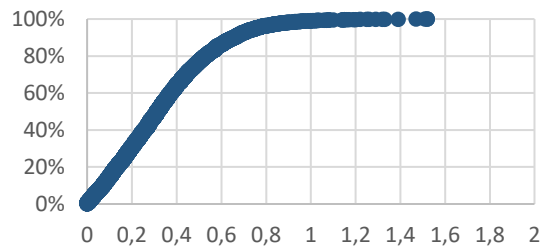
Reference: BODY2

Voordelen surface scanning

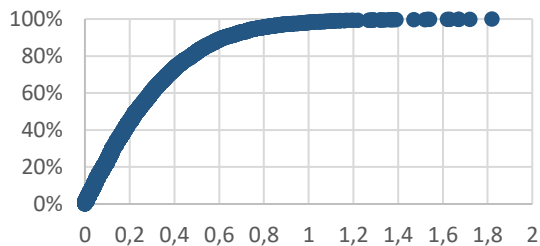
Significant verschil in restfouten tussen oppervlaktescanning en positionering met in-room lasers (3 punts lokalisatie).



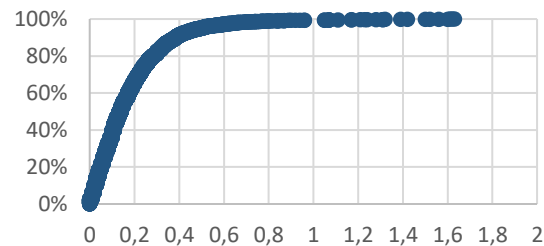
LONG VRT



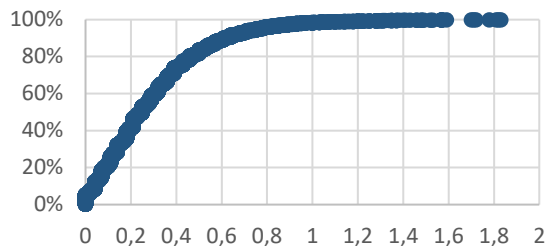
LONG LNG



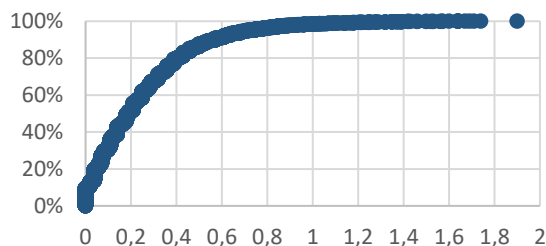
LONG LAT



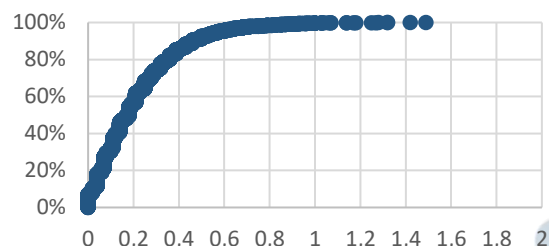
BORST VRT



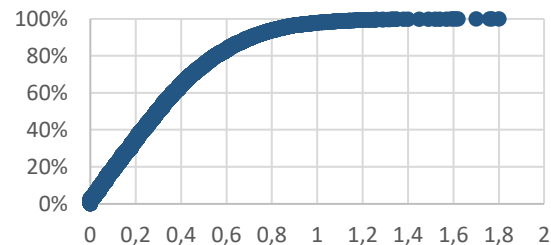
BORST LNG



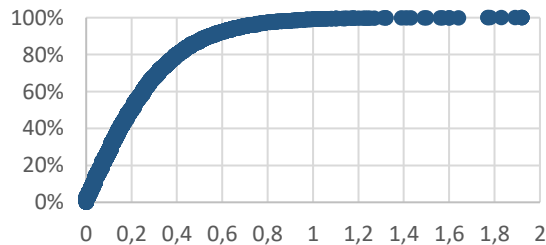
BORST LAT



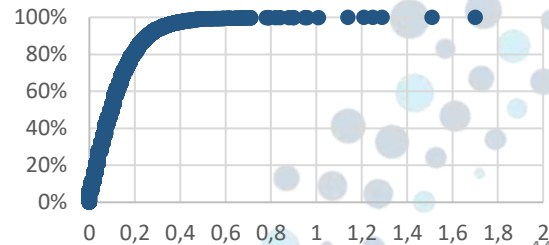
PROSTAAT VRT



PROSTAAT LNG

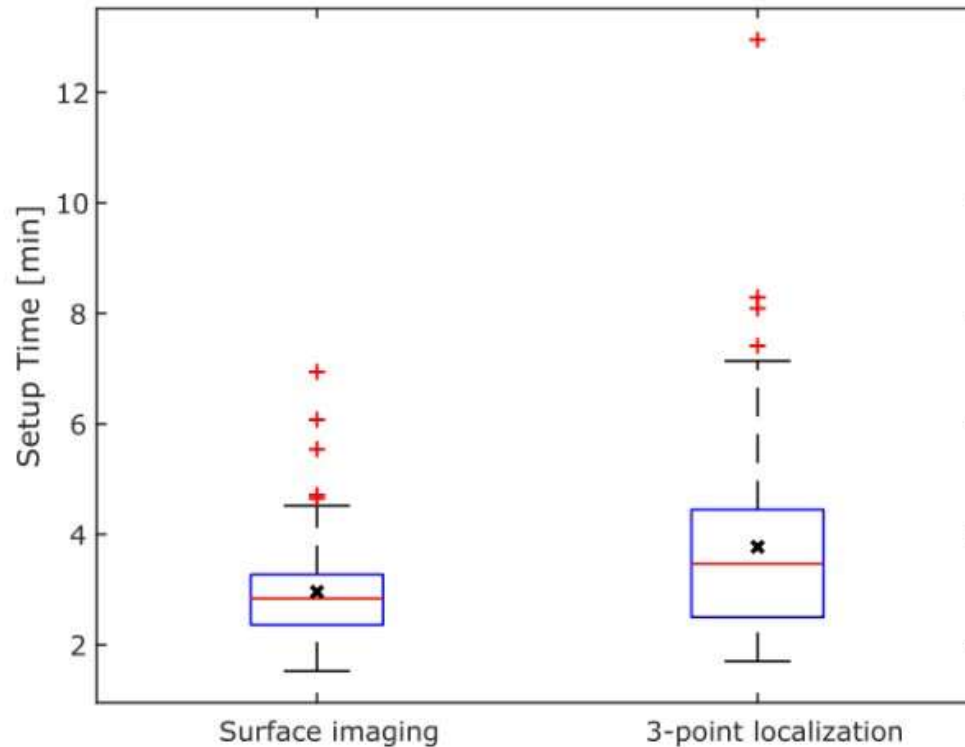


PROSTAAT LAT



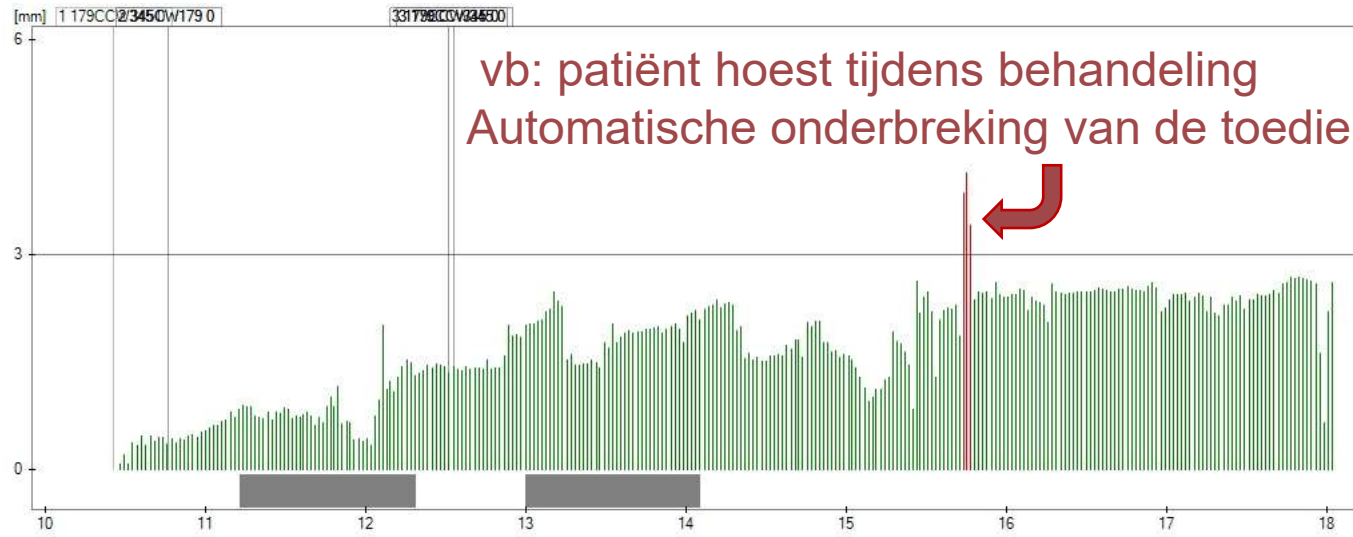
Voordelen surface scanning

SGRT zorgde voor een snellere en nauwkeurigere positionering



Voordelen surface scanning

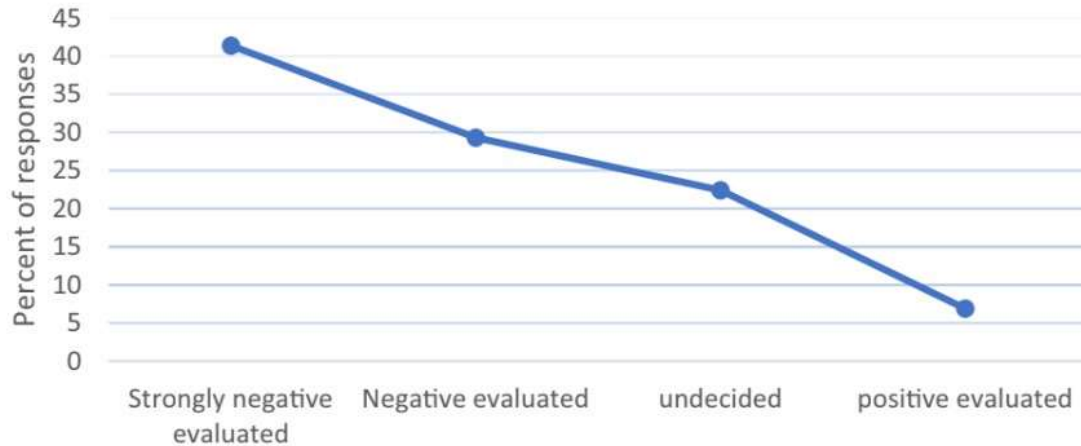
Naast een vlottere workflow, verbetering van functionaliteit en efficiëntie wint het aan veiligheid (SGRT als een vier ogen principe of als "onafhankelijke waarnemer" in de kamer)



Voordelen surface scanning

Welzijn van patiënten verbeteren -> geen tatoeages/uitwendige markeringen op patiënt meer nodig.

What were your feelings about your skin marks during your radiation therapy treatment?



n=58



Take home surface scanning

SGRT tilt de positionering van de patiënt naar een hoger niveau heeft grote invloed hebben op verbetering van de kwaliteit en de veiligheid van bestralingsbehandelingen, maar IGRT is nog steeds de gouden standaard voor positieverificatie.

SGRT vult andere beeldvormingsmodaliteiten aan zonder toevoeging van extra stralingsdosis.



