4D Dynamic Contrast-Enhanced Breast CT: Evaluation of quantitative accuracy

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x-ray
tomographic
imaging

Radboudumc

Disclosures

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Ref.: Arnold M, Morgan E, Rumgay H, et al. Current and future burden of breast cancer: Global statistics for 2020 and 2040. Breast. 2022;66:15-23. doi:10.1016/j.breast.2022.08.010

BREAST4D

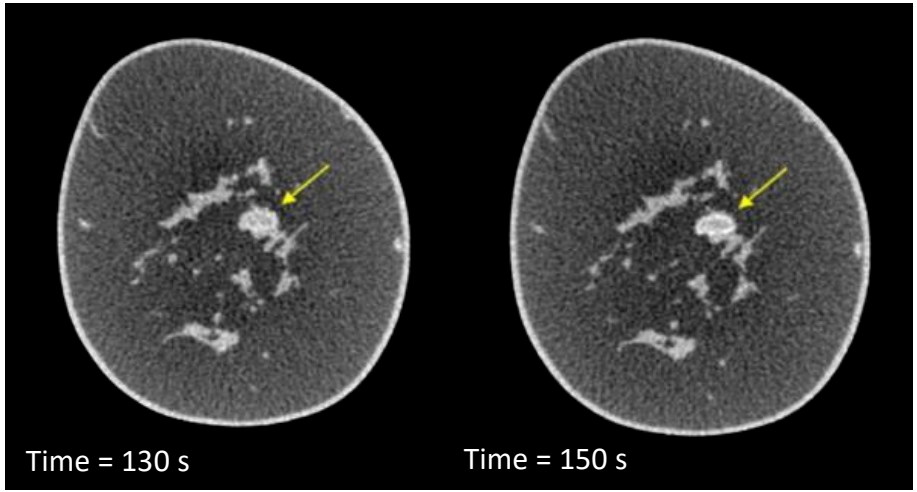
European Research Council

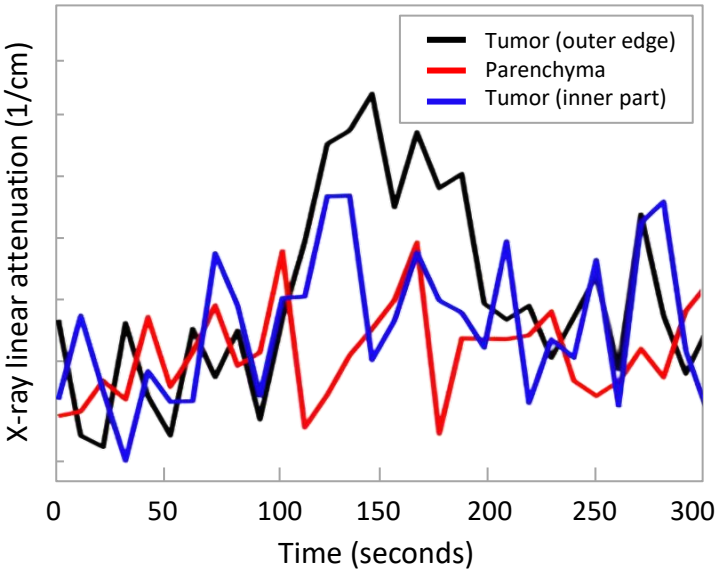
Established by the European Commission


?
Treatment

Breast cancer heterogeneity

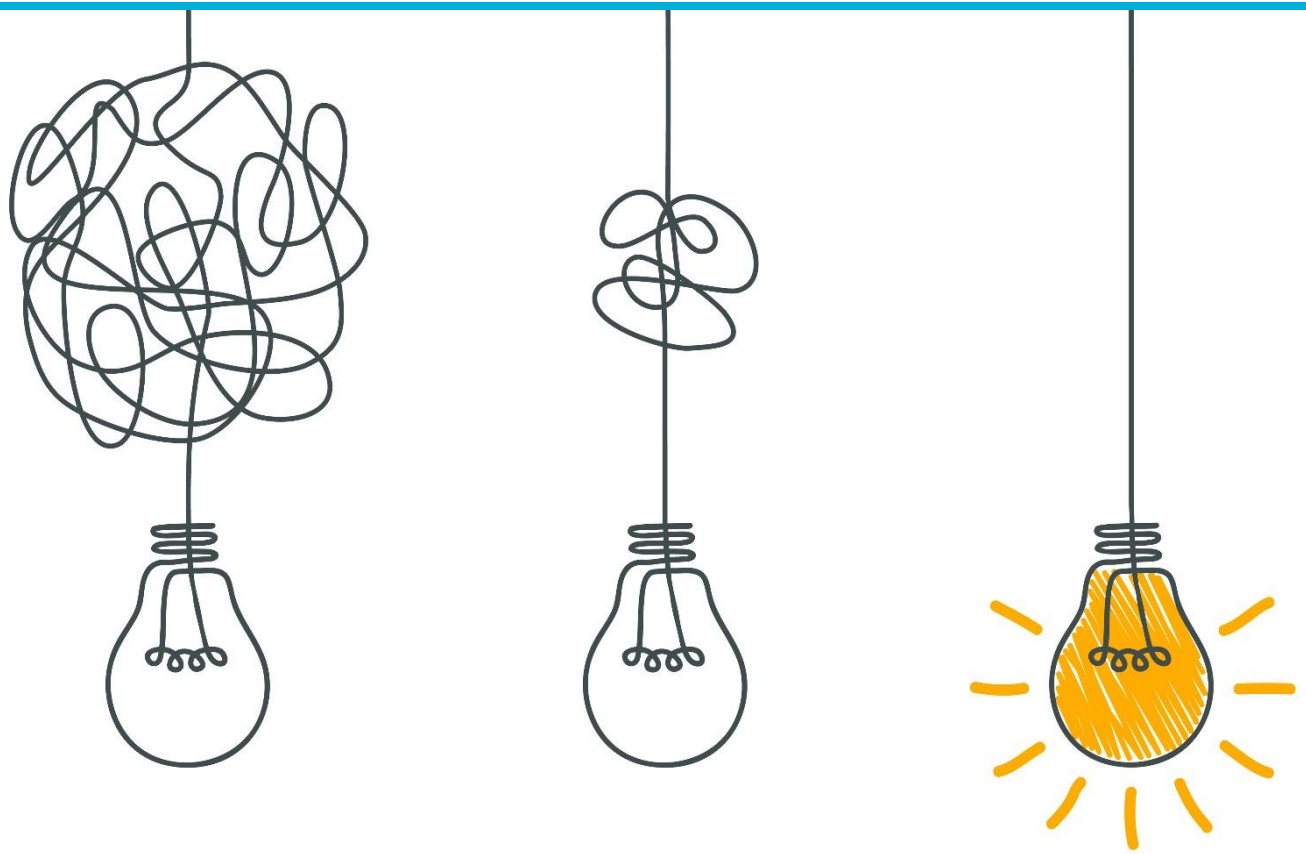
Ref.: Guo L, Kong D, Liu J, et al. Breast cancer heterogeneity and its implication in personalized precision therapy. *Exp Hematol Oncol*. 2023;12(1):3. Published 2023 Jan 9. doi:10.1186/s40164-022-00363-1





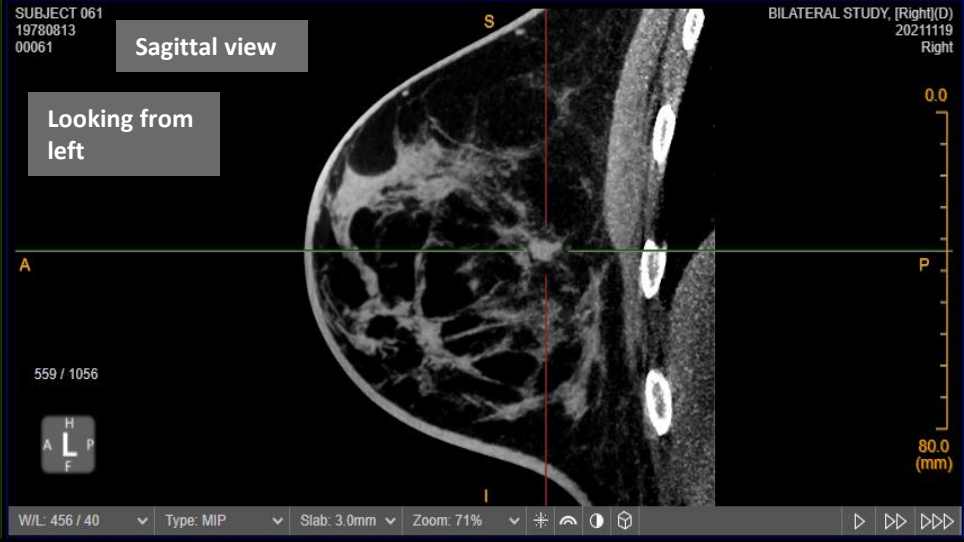
Ref.: Caballo, M., Michielsen, K., Fedon, C. and Sechopoulos, I., 2019. Towards 4D dedicated breast CT perfusion imaging of cancer: development and validation of computer simulated images.

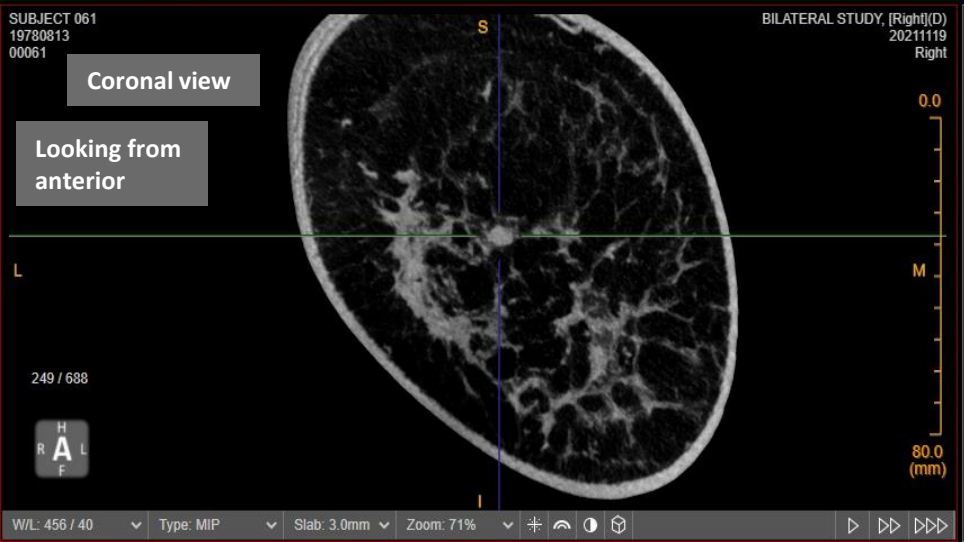
4-dimensional dynamic contrast-enhanced dedicated breast computed tomography

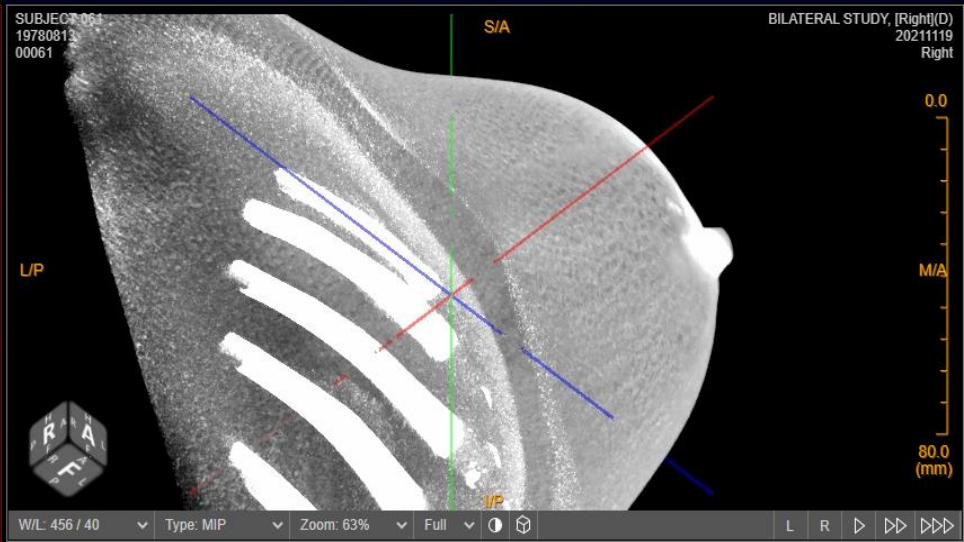


4-dimensional dynamic contrast-enhanced dedicated breast computed tomography


SUBJECT 061
19780813
00061
BILATERAL STUDY, [Right](D)
20211119
Right
Transverse view
Looking down from head
L
A
P
M
0.0
80.0
(mm)
704 / 1301
W/L: 456 / 40
Type: MIP
Slab: 3.0mm
Zoom: 71%


SUBJECT 061
19780813
00061
BILATERAL STUDY, [Right](D)
20211119
Right
Sagittal view
Looking from left
S
A
P
I
0.0
80.0
(mm)
559 / 1056
W/L: 456 / 40
Type: MIP
Slab: 3.0mm
Zoom: 71%


SUBJECT 061
19780813
00061
BILATERAL STUDY, [Right](D)
20211119
Right
Coronal view
Looking from anterior
S
L
M
I
0.0
80.0
(mm)
249 / 688
W/L: 456 / 40
Type: MIP
Slab: 3.0mm
Zoom: 71%


SUBJECT 061
19780813
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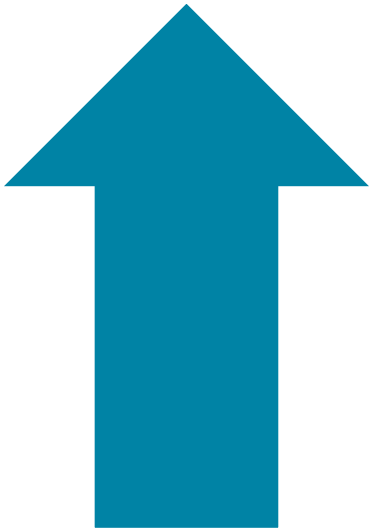
BILATERAL STUDY, [Right](D)
20211119
Right
S/A
L/P
M/A
I/P
0.0
80.0
(mm)
W/L: 456 / 40
Type: MIP
Zoom: 63%
Full

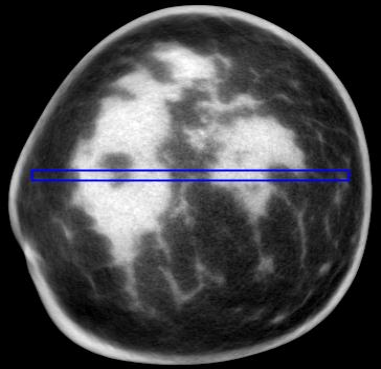


X-ray scatter

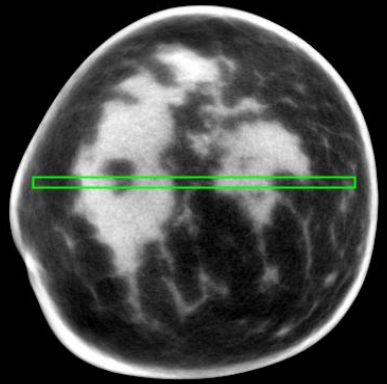
Image quality

(quantitative information)

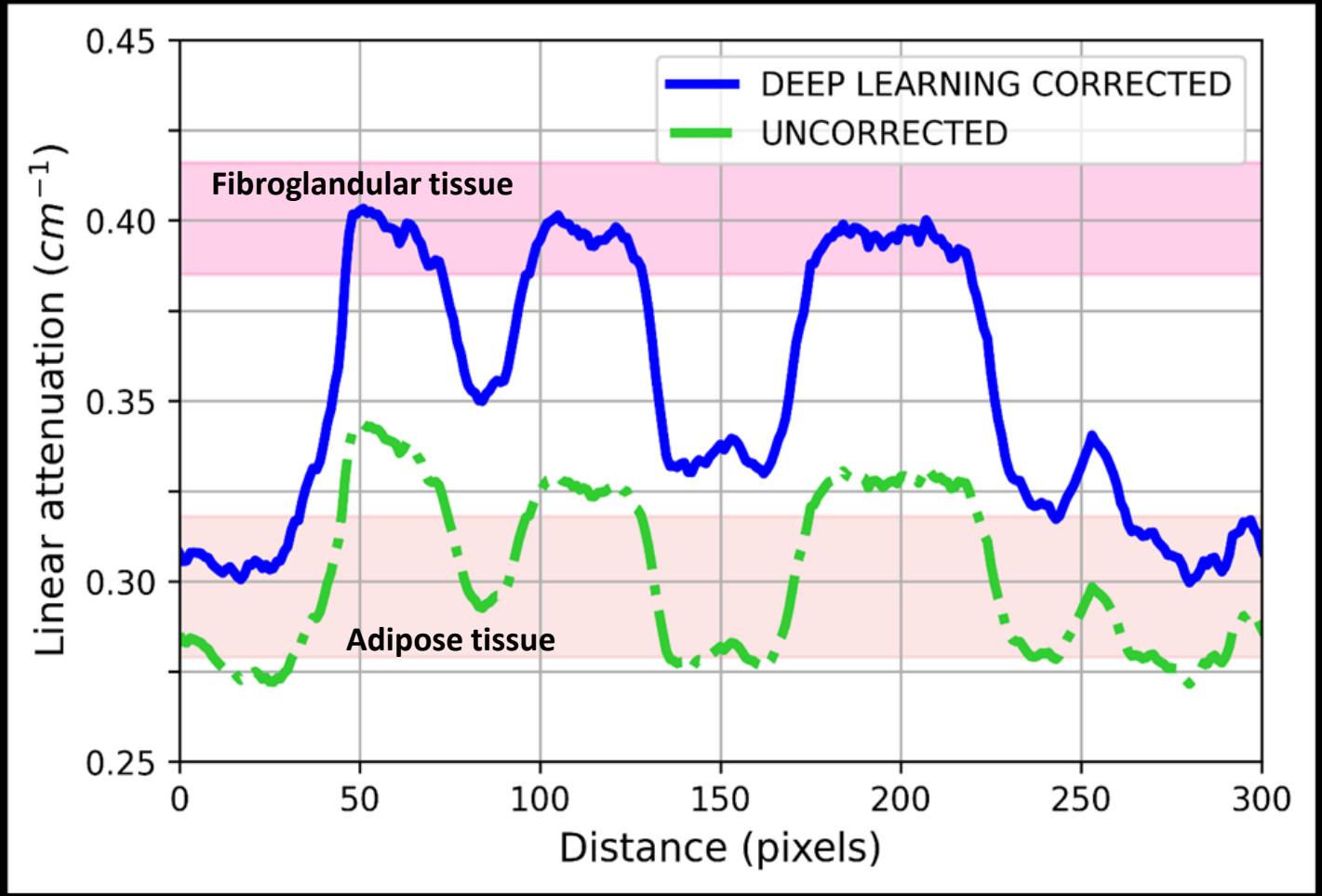
DEEP LEARNING CORRECTED



UNCORRECTED



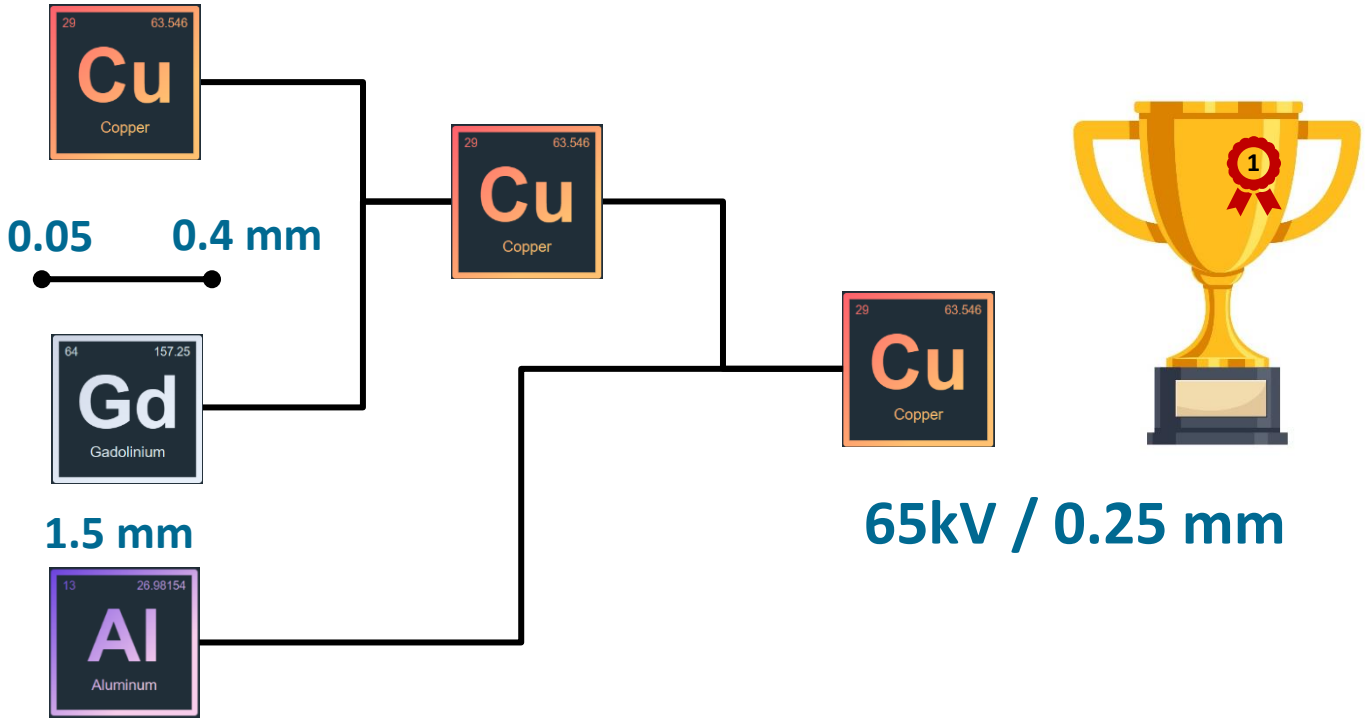
WW/WL: 0.01/0.03 mm^{-1}



Ref.: Pautasso, J. J., Caballo, M., Mikerov, M., Boone, J. M., Michielsen, K., & Sechopoulos, I. (2023). Deep learning for x-ray scatter correction in dedicated breast CT. *Medical physics*, *50*(4), 2022-2036.

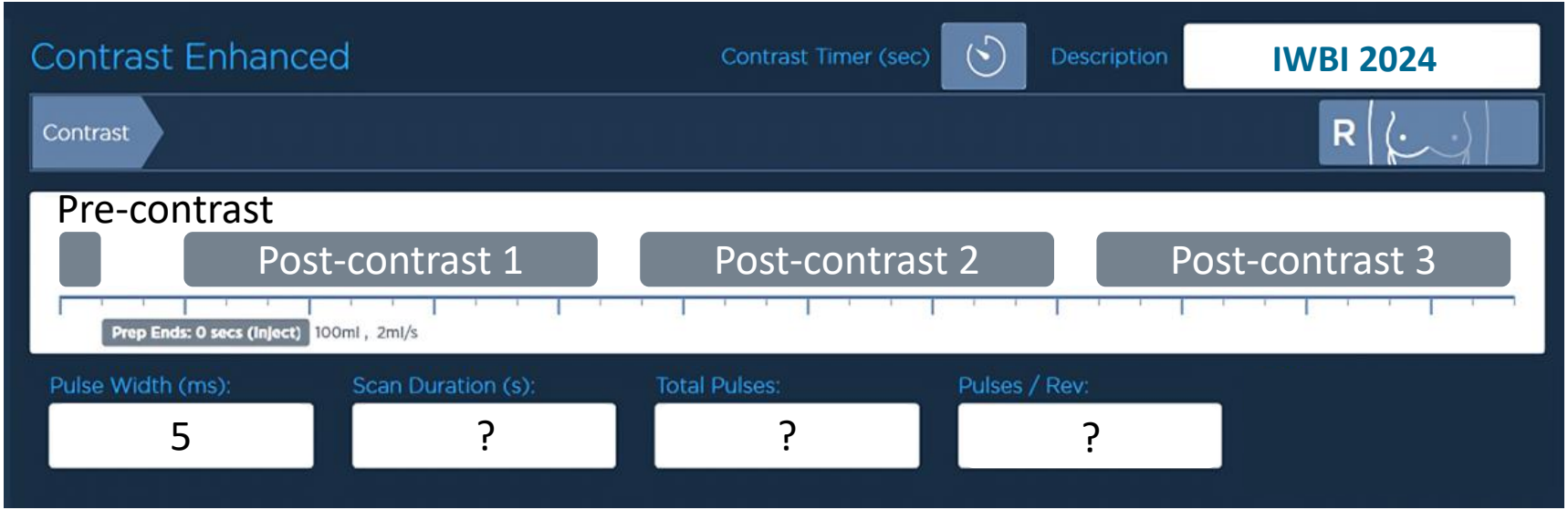
4-dimensional dynamic **contrast-enhanced** dedicated breast computed tomography

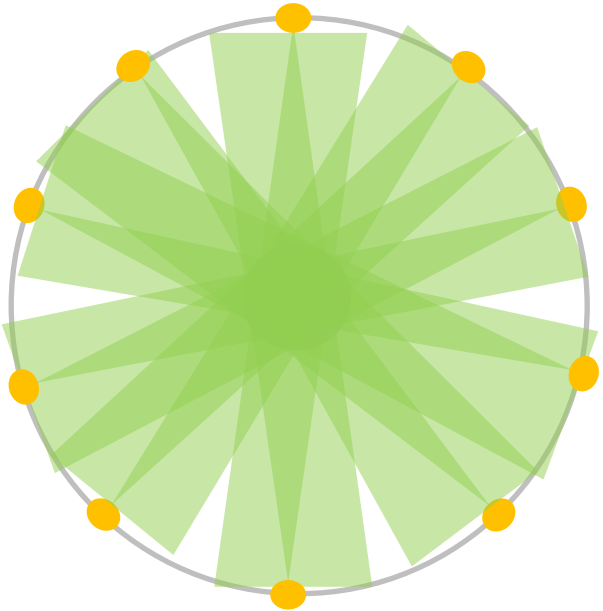
Optimal settings for imaging



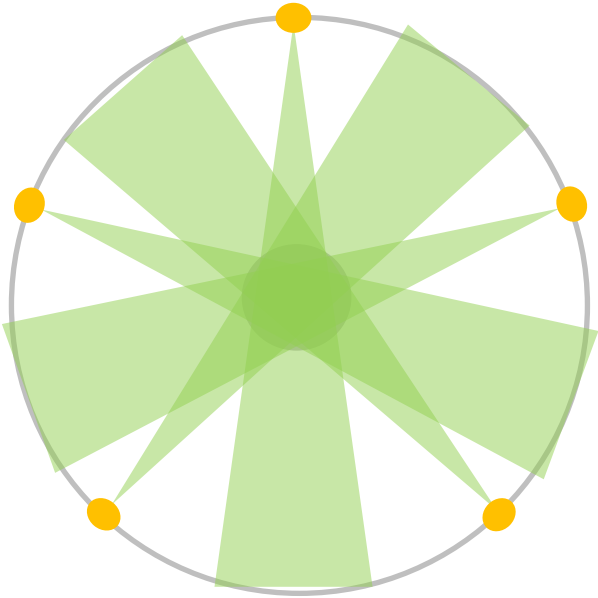
4-dimensional dynamic contrast-enhanced dedicated breast computed tomography

4D DCE-bCT protocol



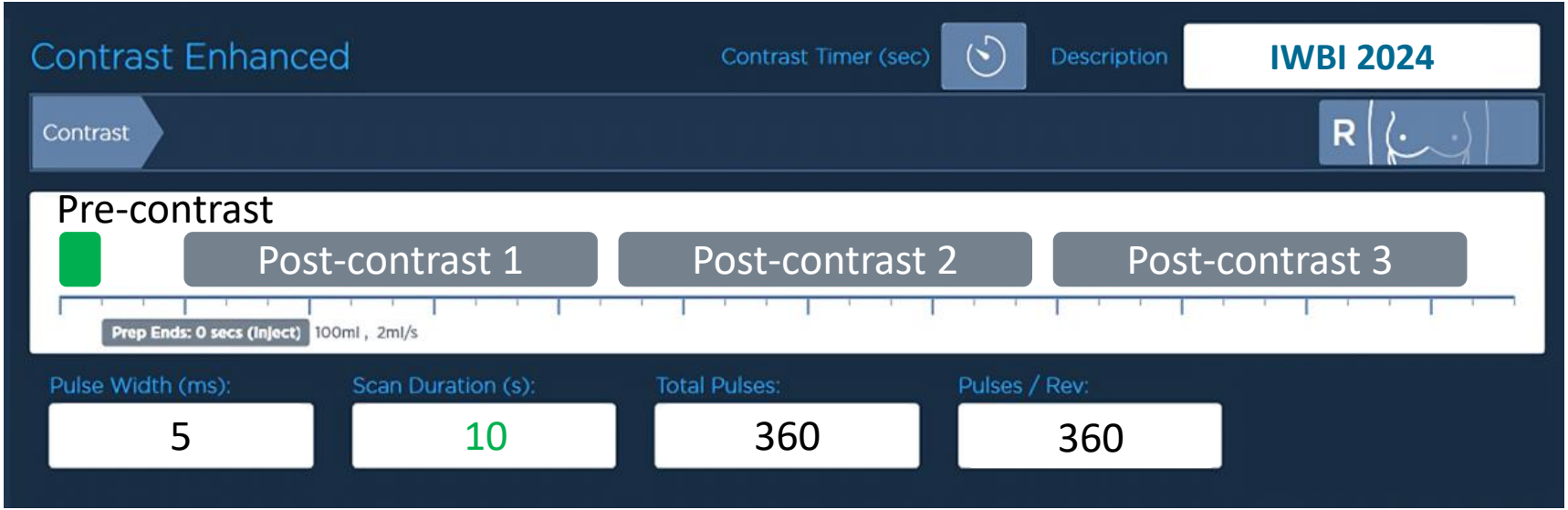


Pre-contrast

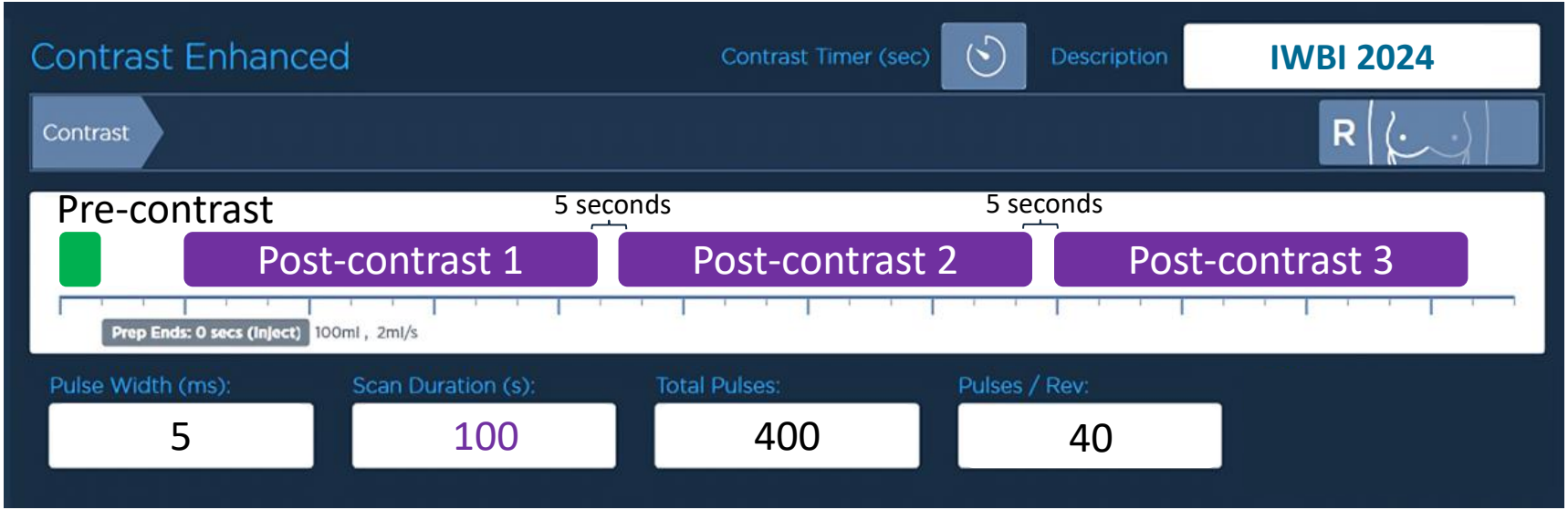


Post-contrast

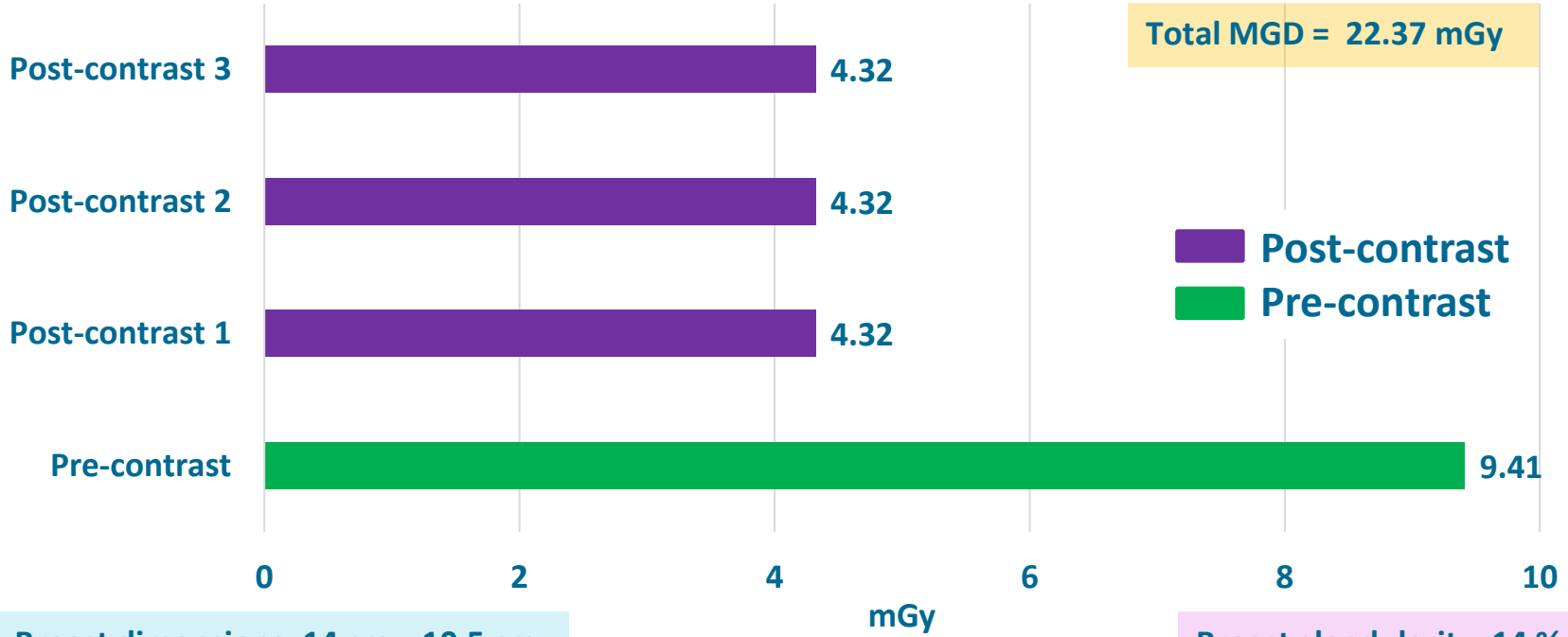
4D DCE-bCT protocol



4D DCE-bCT protocol

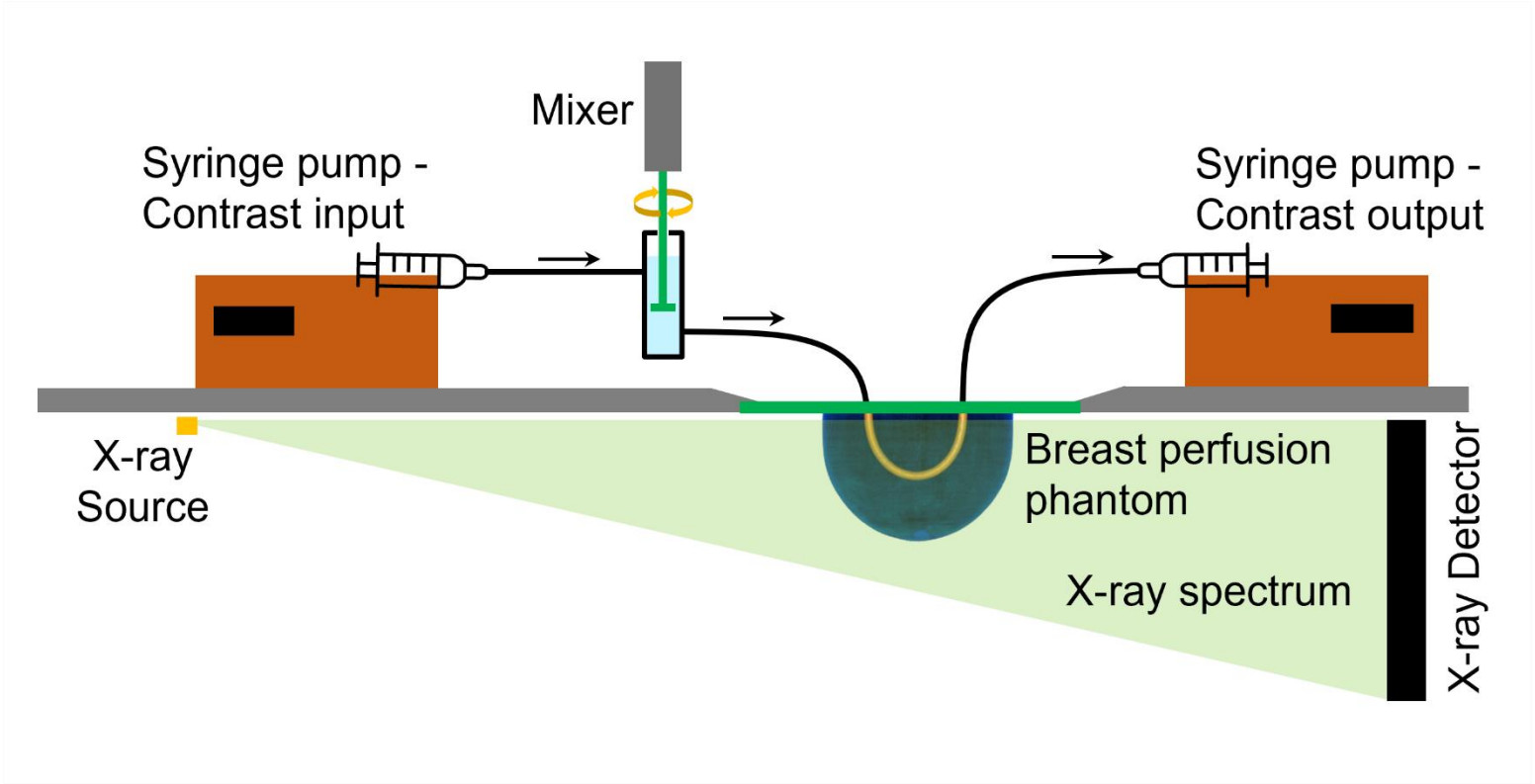


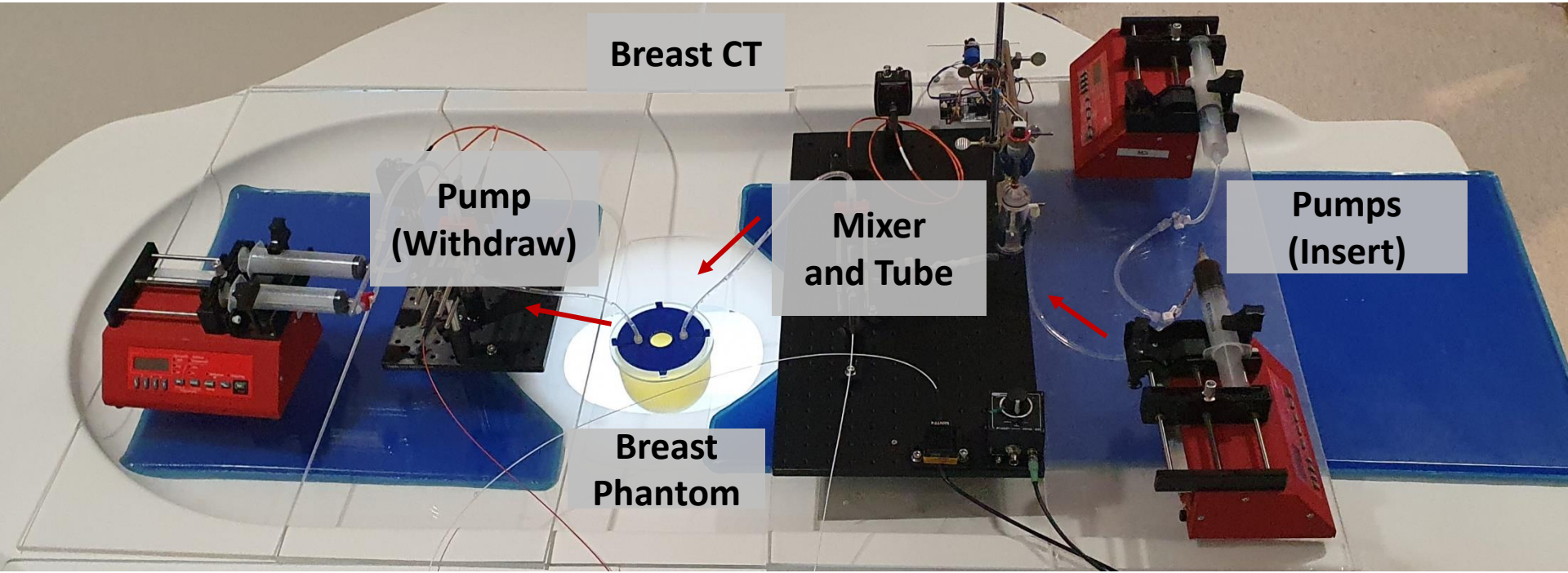
Mean glandular dose in 4D DCE-bCT protocol

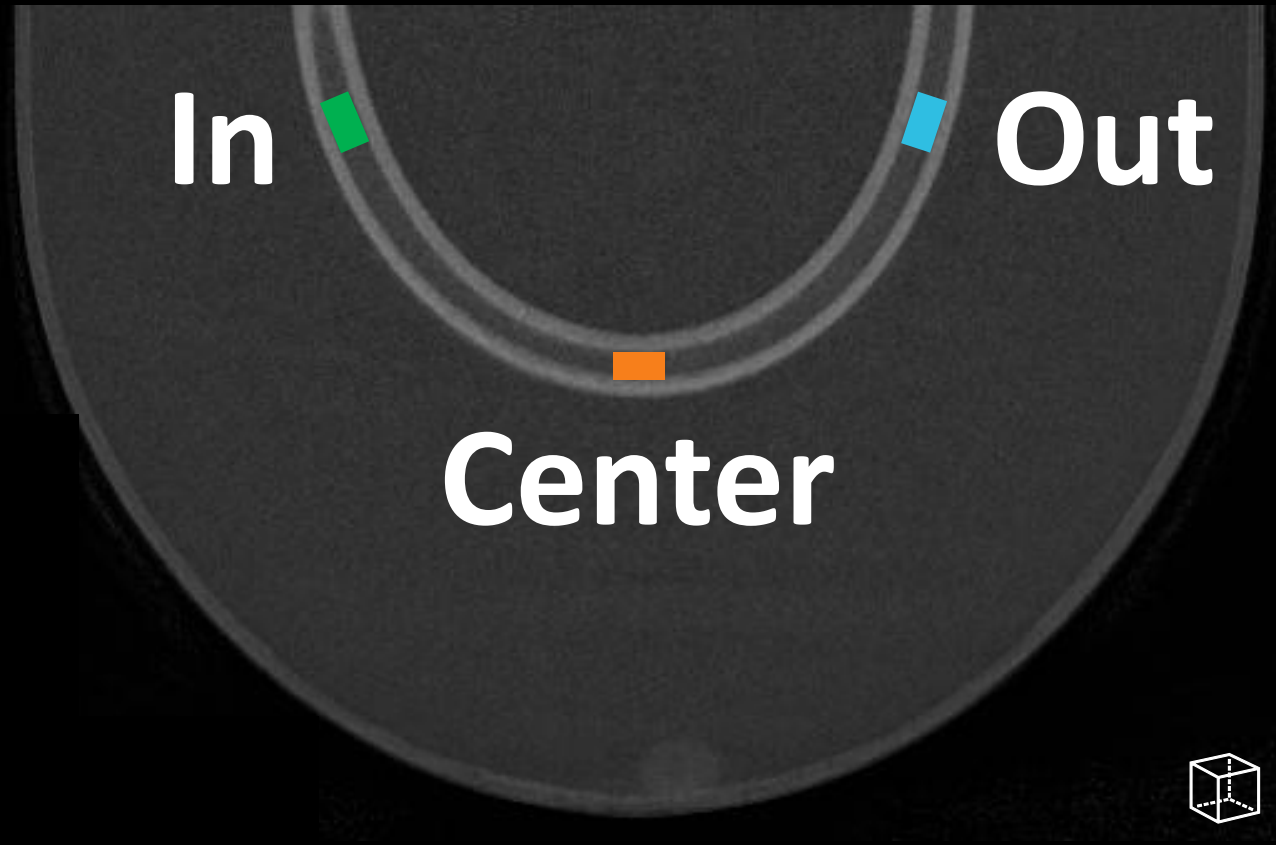


Breast dimensions: 14 cm x 10.5 cm

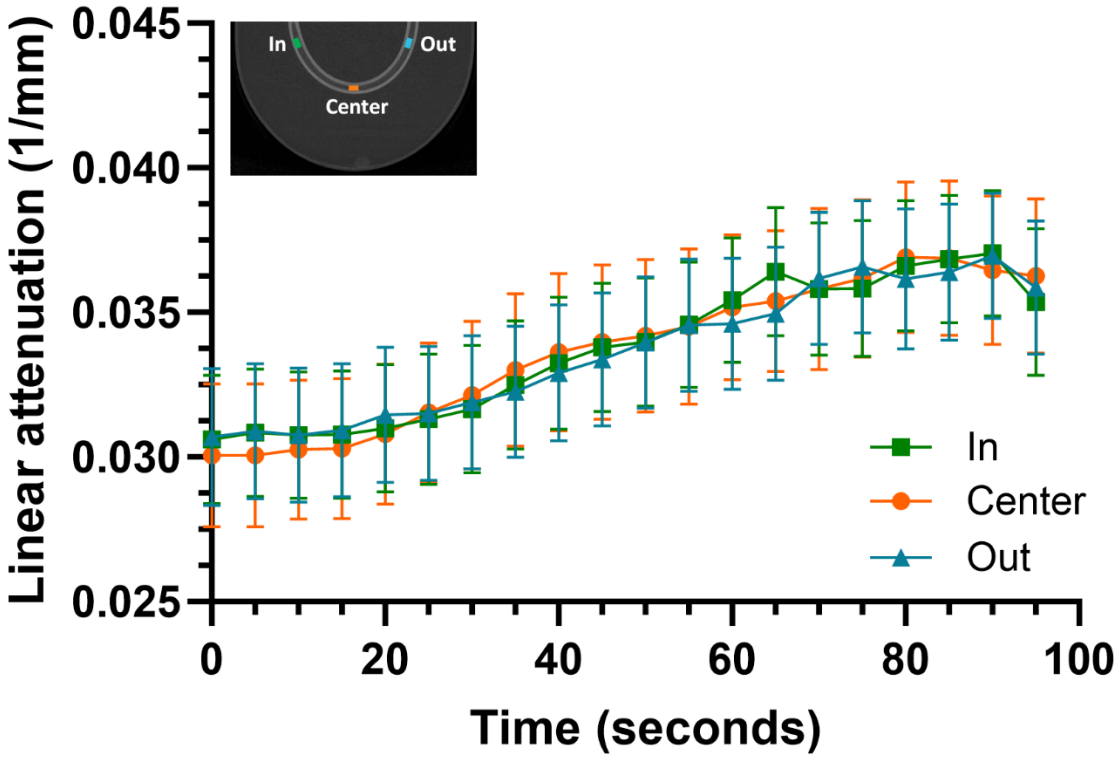
Breast glandularity: 14 %

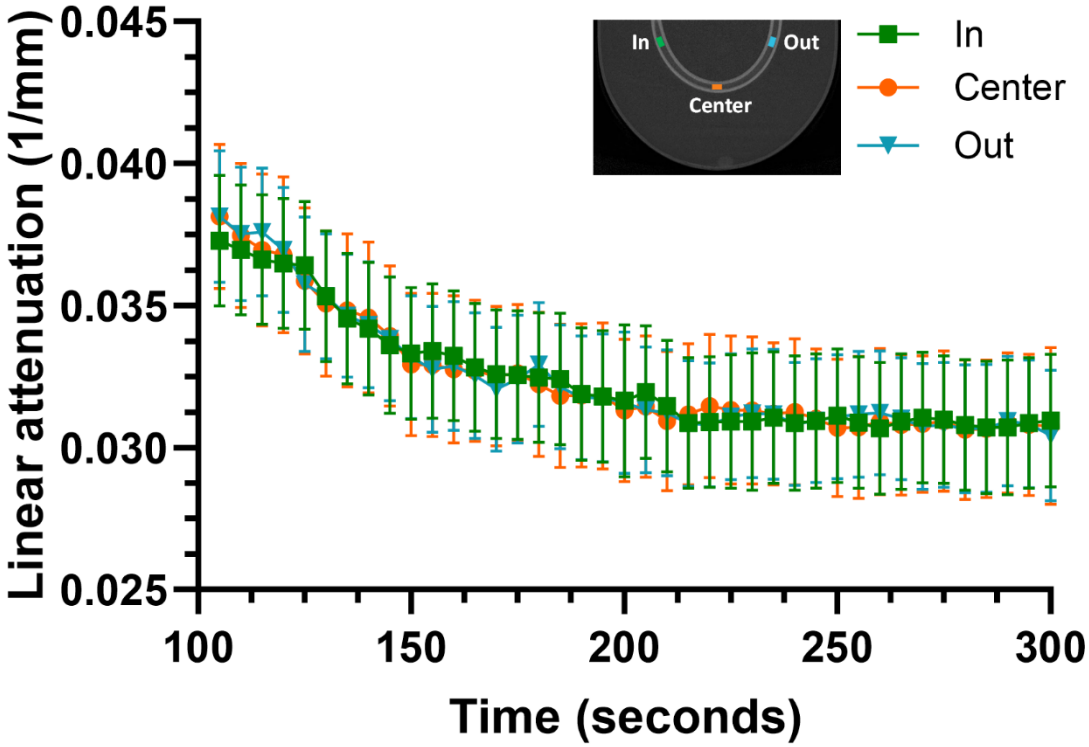

Mixer
Syringe pump -
Contrast input
Syringe pump -
Contrast output
X-ray
Source
Breast perfusion
phantom
X-ray spectrum
X-ray Detector

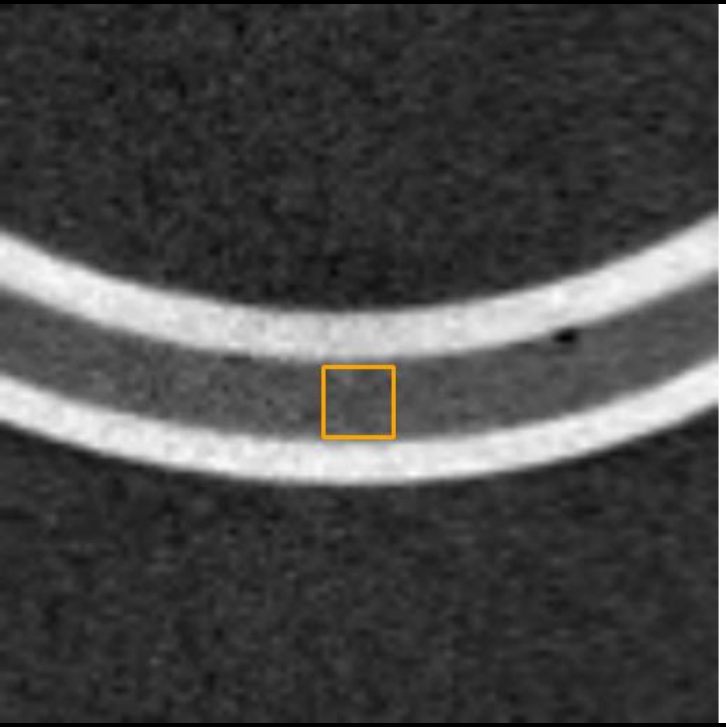

Breast CT
Pump
(Withdraw)
Mixer
and Tube
Pumps
(Insert)
Breast
Phantom

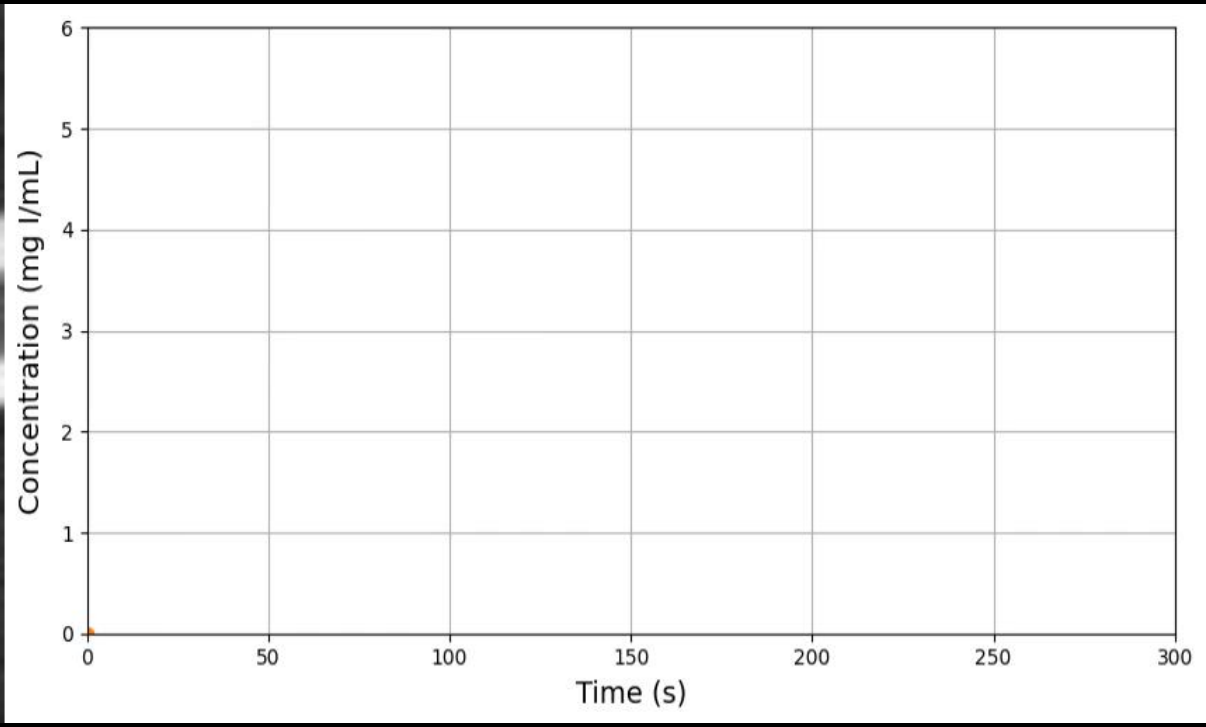


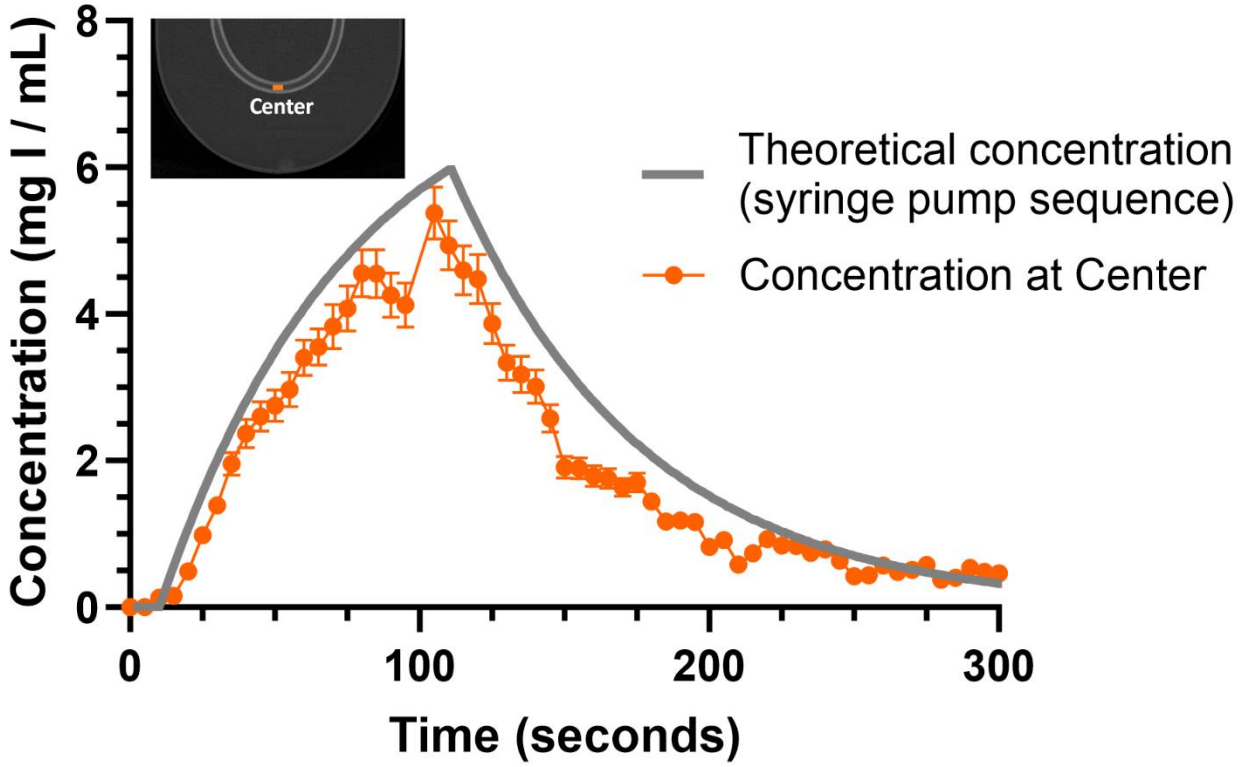
= 0.25 mm


In
Out
Center
Linear attenuation (1/mm)
0.045
0.040
0.035
0.030
0.025
0
20
40
60
80
100
Time (seconds)
In
Center
Out

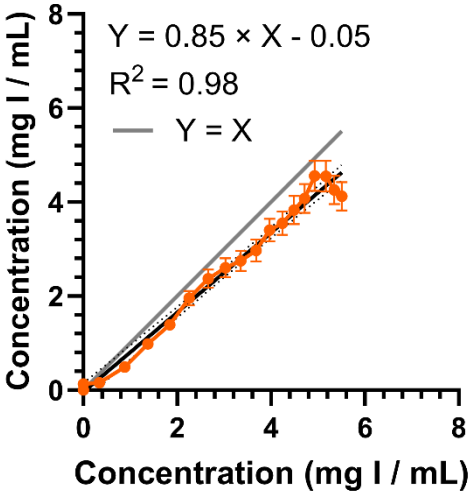

0.045
0.040
0.035
0.030
0.025
Linear attenuation (1/mm)
100
150
200
250
300
Time (seconds)
In
Out
Center
In
Center
Out



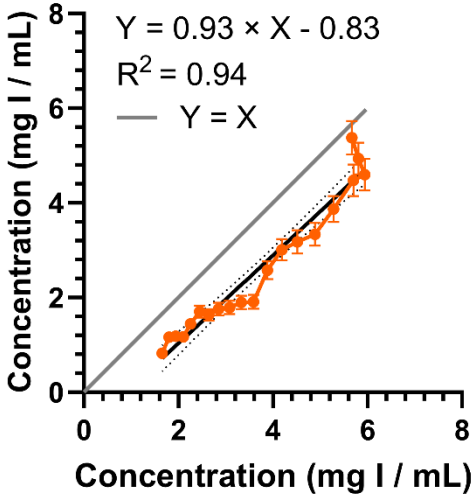

Concentration (mg I/mL)
Time (s)
0
1
2
3
4
5
6
0
50
100
150
200
250
300


Center
Concentration (mg I / mL)
0
2
4
6
8
0
100
200
300
Time (seconds)
Theoretical concentration
(syringe pump sequence)
Concentration at Center

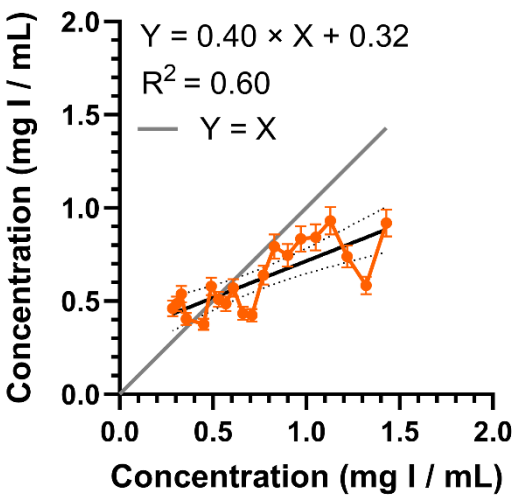
Post-contrast analysis (100-second Intervals)



Post-contrast 1

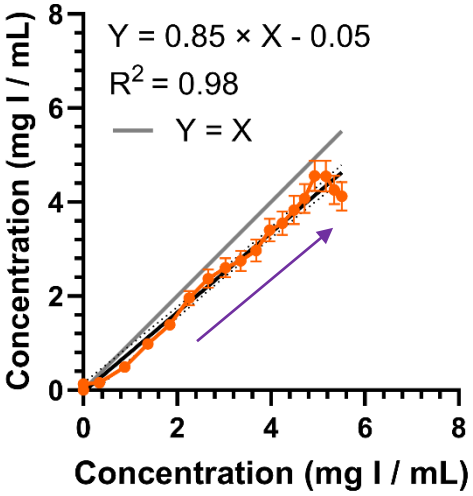


Post-contrast 2

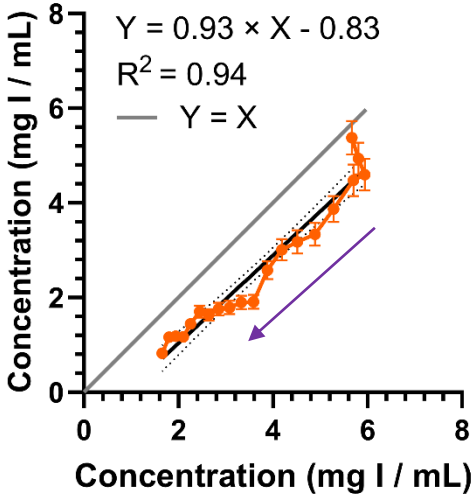


Post-contrast 3

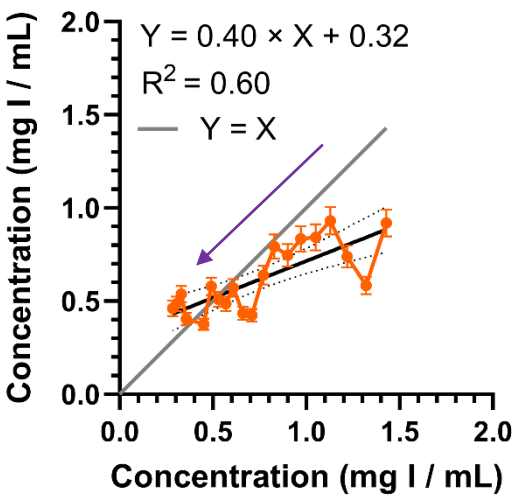
Post-contrast analysis (100-second Intervals)



Post-contrast 1

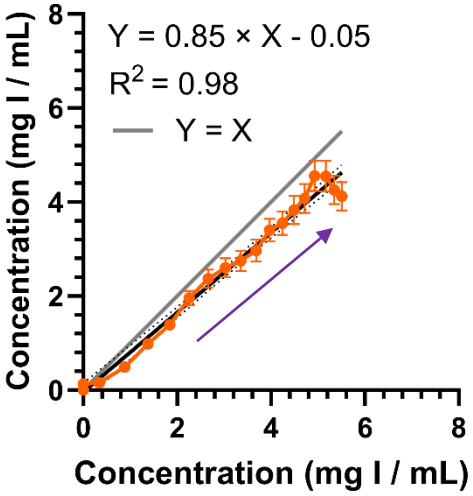


Post-contrast 2

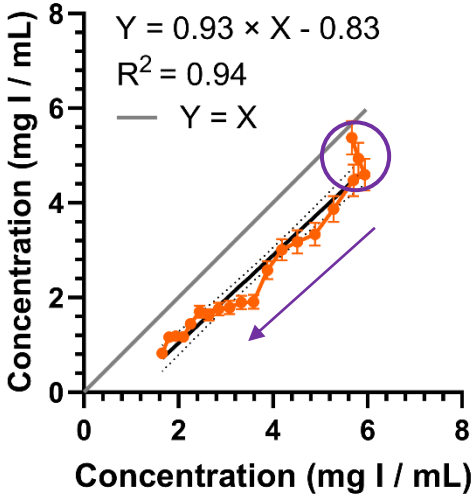


Post-contrast 3

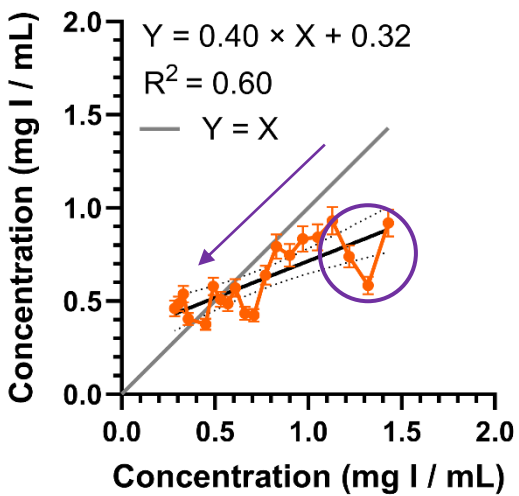
Post-contrast analysis (100-second Intervals)



Post-contrast 1



Post-contrast 2



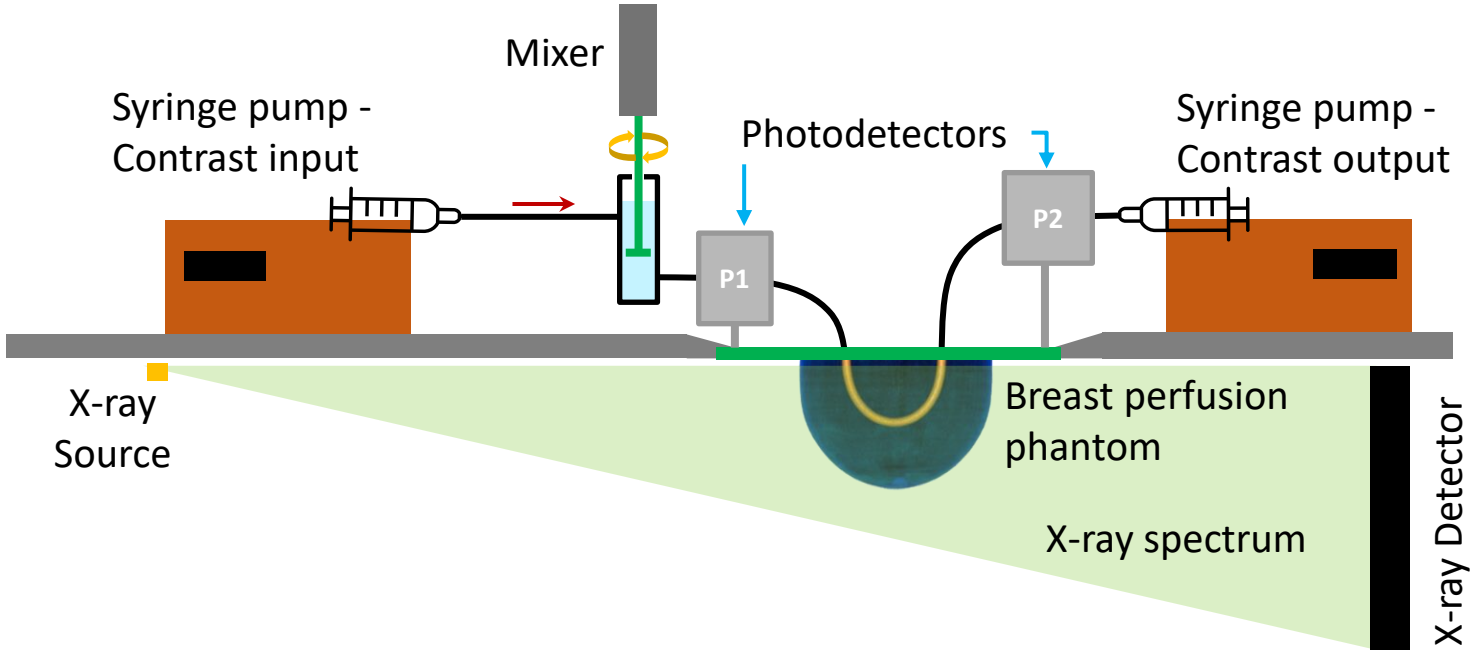
Post-contrast 3

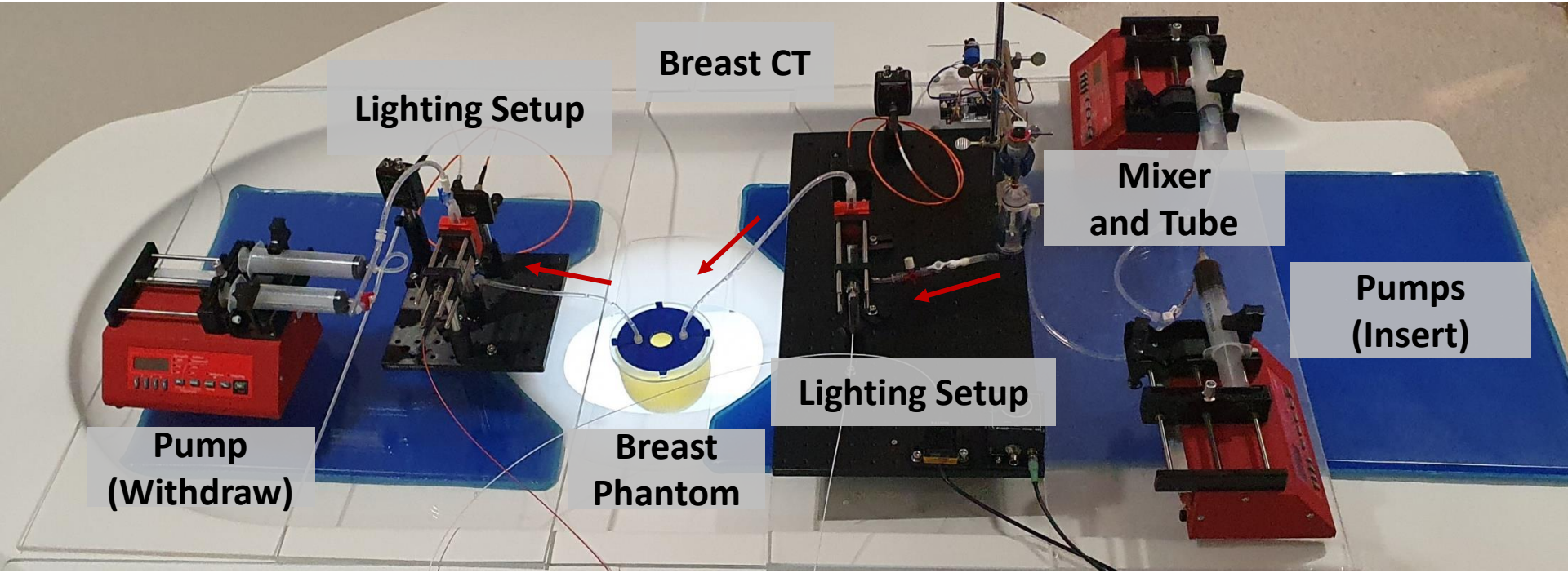
How to go with that flow?

Perfusion phantom for the optimization of dynamic contrast-enhanced dedicated breast CT: Iodide contrast curves in a simplified breast phantom

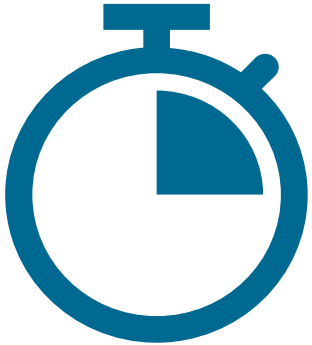
Liselot Goris[1,2], Juan J. Pautasso[2], Mikhail Mikerov[2], Koen Michielsen[2], Ioannis Sechopoulos[1,2,3]

[1] Technical Medicine Center, University of Twente, Enschede, The Netherlands.
[2] Dept. of Medical Imaging, Radboud University Medical Center, Nijmegen, The Netherlands.
[3] Dutch Expert Center for Screening (LRCB), Nijmegen, The Netherlands.

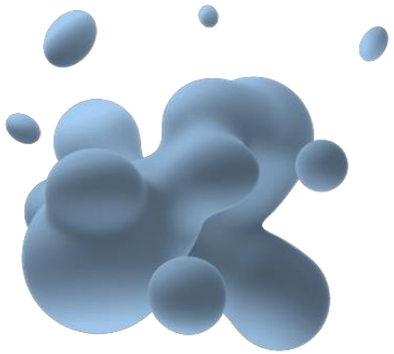

Mixer
Syringe pump -
Contrast input
Photodetectors
Syringe pump -
Contrast output
P1
P2
X-ray
Source
Breast perfusion
phantom
X-ray spectrum
X-ray Detector


Breast CT
Lighting Setup
Mixer
and Tube
Pumps
(Insert)
Lighting Setup
Pump
(Withdraw)
Breast
Phantom

Limitations

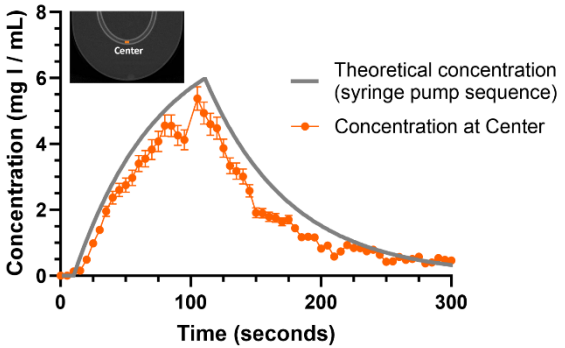


Timing of peak capture



Fluid bolus behavior

Conclusion



4D DCE-bCT has the potential to provide quantitatively accurate estimates of iodine concentration

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@AxtiLab

AxtiLab

Thank you for your attention!

AXTI advanced x-ray tomographic imaging

Radboudumc