PAUL SCHERRER INSTITUT

PSI

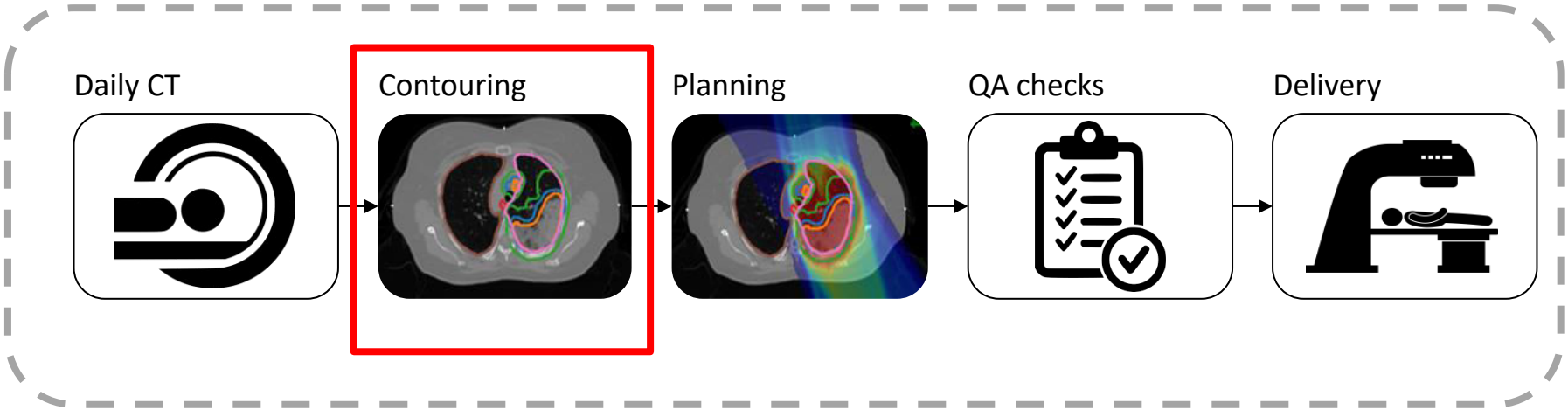
Andreas Smolders :: Paul Scherrer Institute

Patient specific neural networks for contour propagation in online adaptive radiotherapy

SASRO 2022 :: Baden, Switzerland

Daily contours are necessary for re-optimization in adaptive therapy

Daily patient appointment



Needs to be automatic

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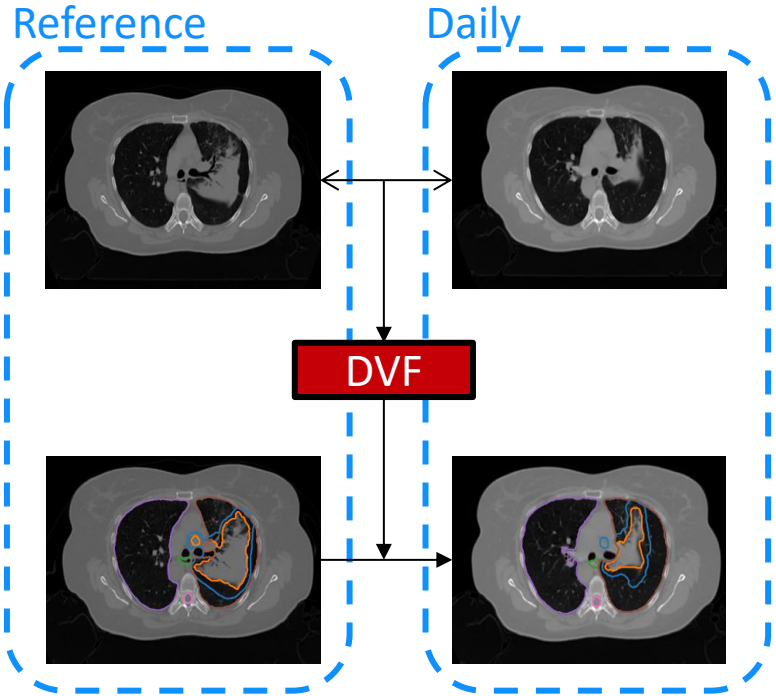
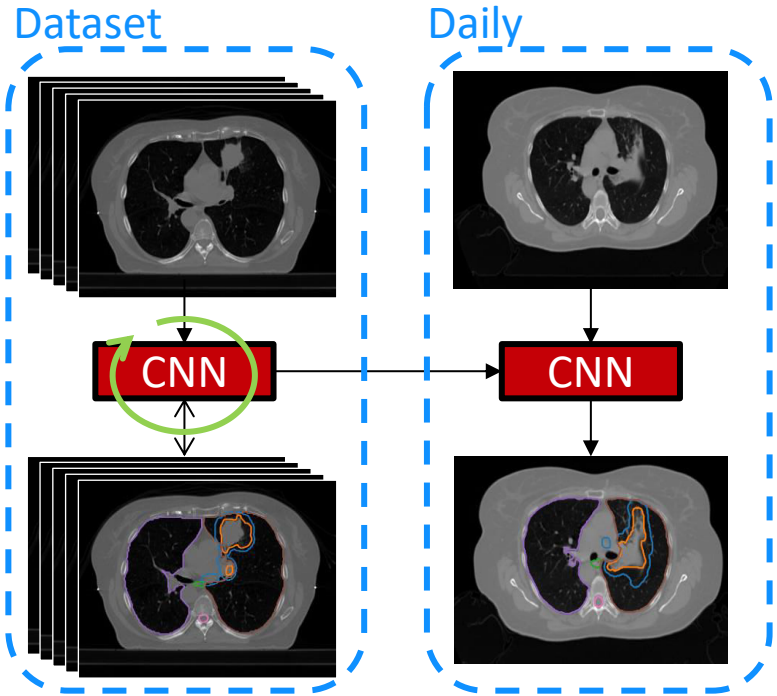
Registration and segmentation can be used to obtain daily contours

Registration



No general knowledge

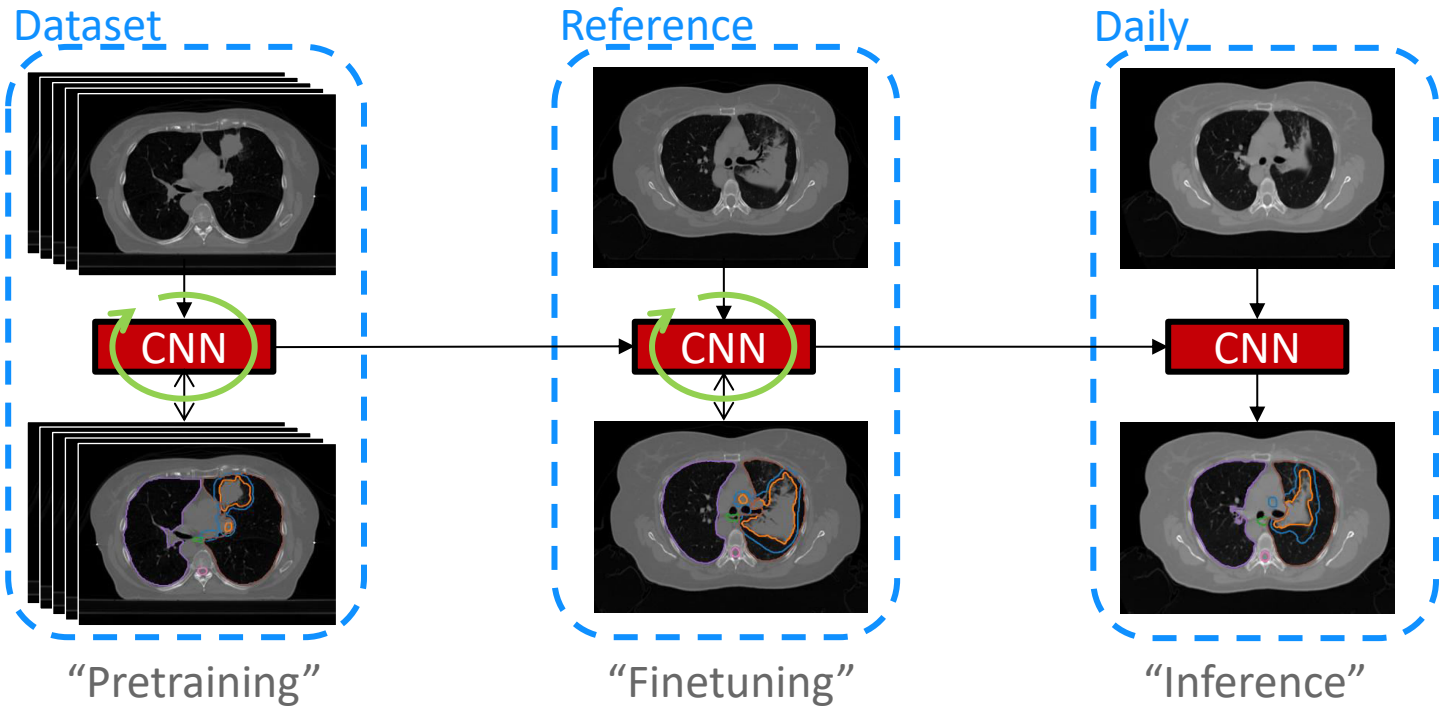
Segmentation



No patient specific knowledge

Patient specific knowledge is incorporated in CNN by fine tuning on reference CT

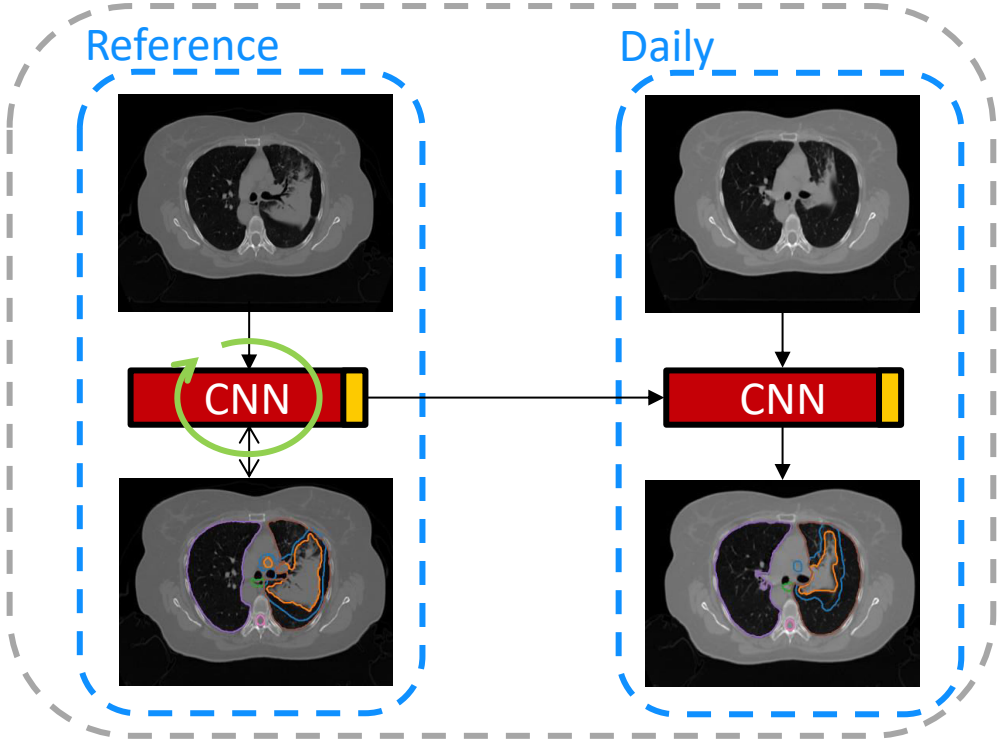
Patient specific CNN



Dataset for CTV not so representative for new CTV

In case no prior dataset exists, we use transfer learning for One-Shot segmentation

One-shot segmentation



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Research questions

1. Does patient specific fine tuning improve segmentation accuracy?
2. Which method is suitable/optimal for contouring in adaptive therapy?

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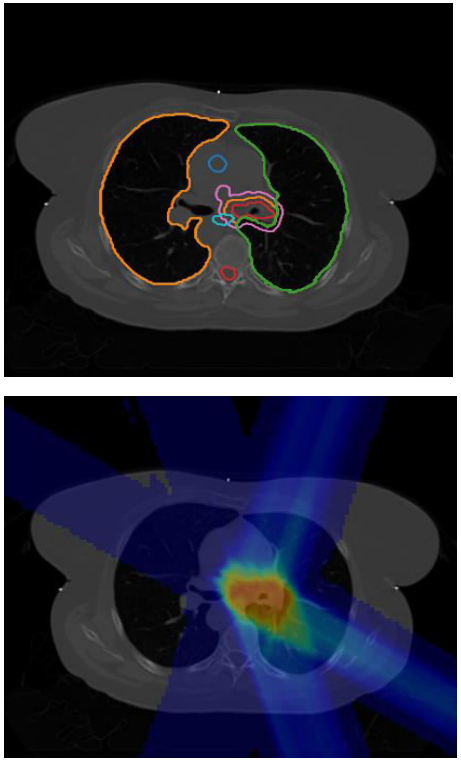
The dataset has manual contours for daily CTs

NSCLC dataset

- 5 patients, retrospective proton therapy plan
- Reference + 9 daily CTs
- All manually contoured
- OARs:
  - Lungs
  - Esophagus
  - Spinal cord
  - Heart



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Registration and segmentation can be used to obtain daily contours

Registration

- Rigid
- Deformable:
  - B-spline

Segmentation

- OARs:
  - Pretrained
  - Commercial system (Limbus AI)
  - Fine tuned (patient specific)
- Target volumes:
  - One shot (patient specific)

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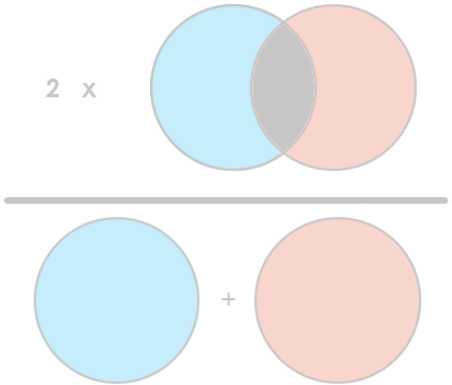
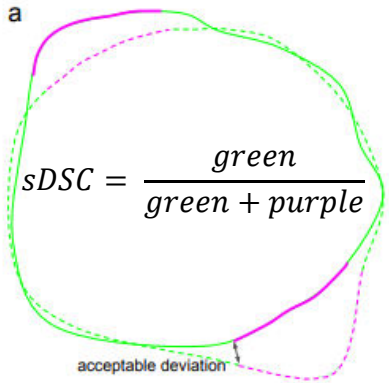
We use dice and surface dice to evaluate performance

Dice coefficient



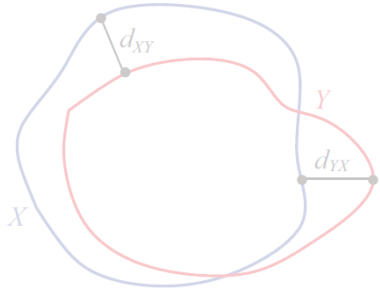
Surface Dice coefficient (2 mm)



$$sDSC = \frac{green}{green + purple}$$

Advantage: less dependent on magnitude of structure

Hausdorff 95% distance



95th percentile instead of maximum

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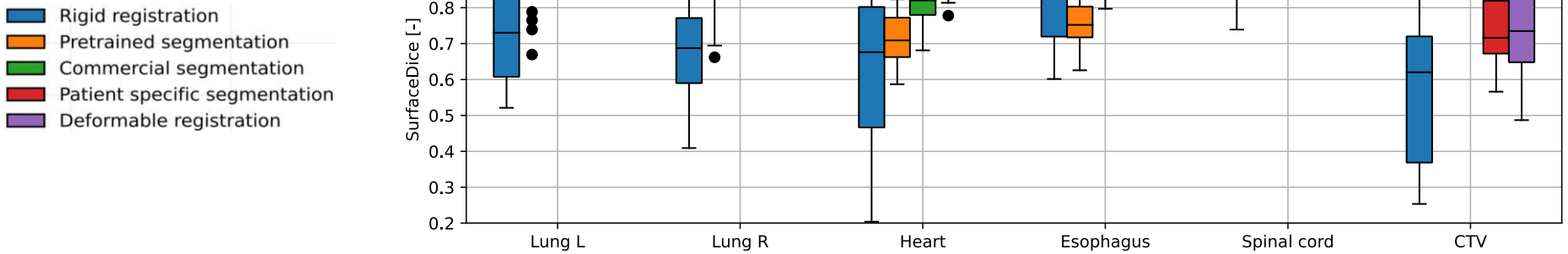
Fine tuning improves segmentation quality



BUT: Does it matter?

➔ We need to look at dose

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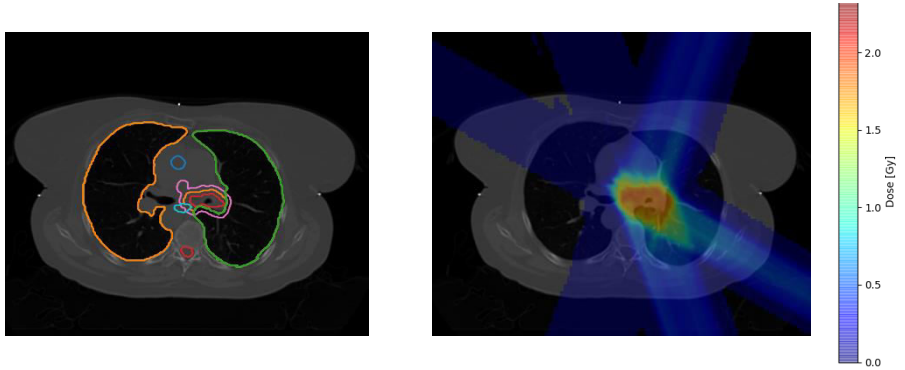
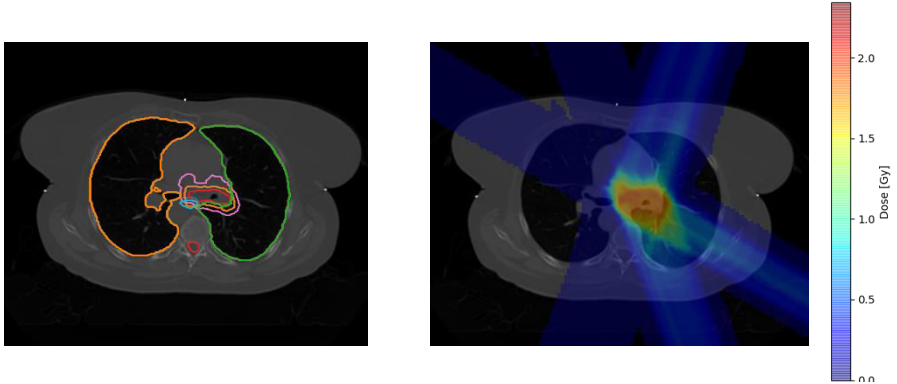
We optimize a plan on the manual contours and compare it to a plan optimized on auto contours

Optimized on **manual** contours



Optimized on **automatic** contours



Dose difference metrics

1. DD2: 98% of the volume receives a dose difference smaller than this value
2. CTV V95, D98

We split the analysis for OAR and TV segmentation

1 Influence of OAR contours

- Optimization on **manual target**
- Constraints on **propagated contours**

2 Influence of CTV contours

- Optimization on **propagated target**
- Constraints on **propagated contours**

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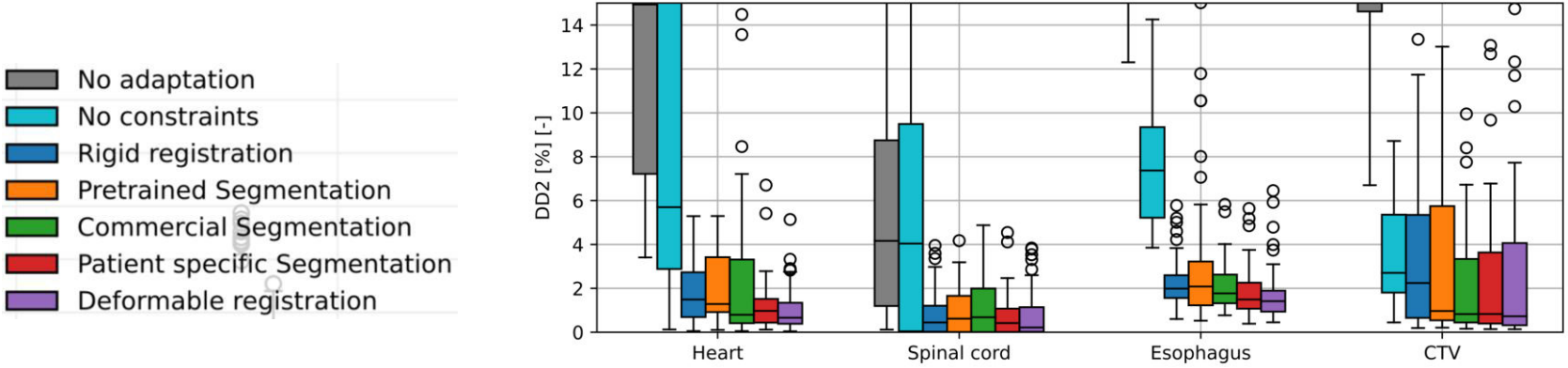
1 All techniques lead to very small dosimetric differences



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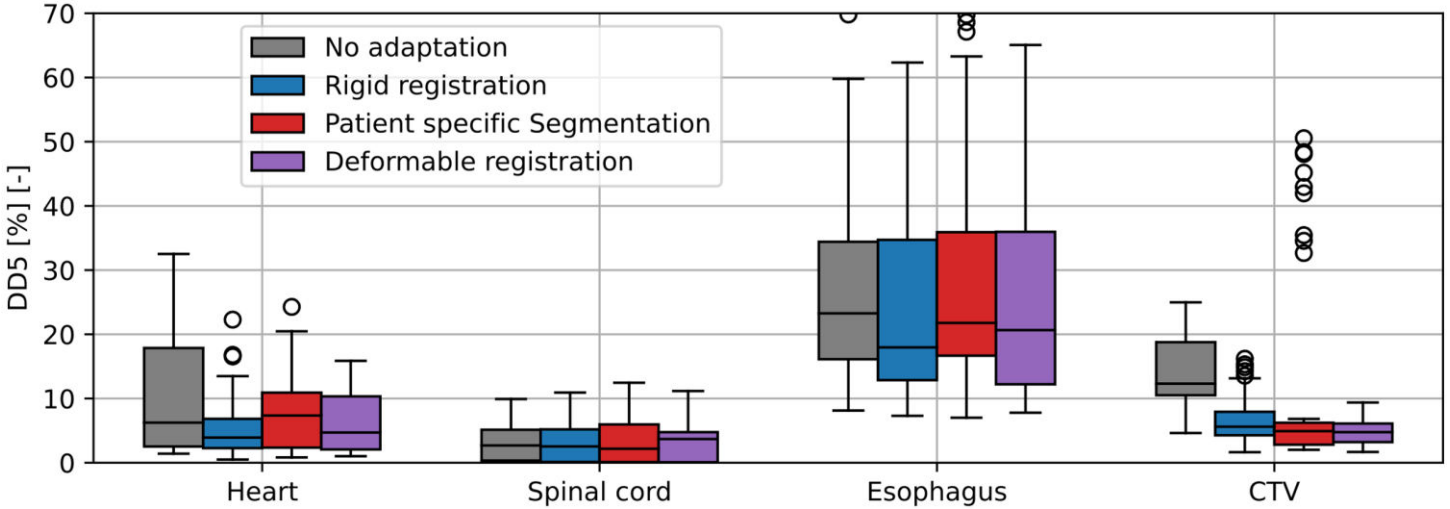
2 Propagating also the target does influence the results



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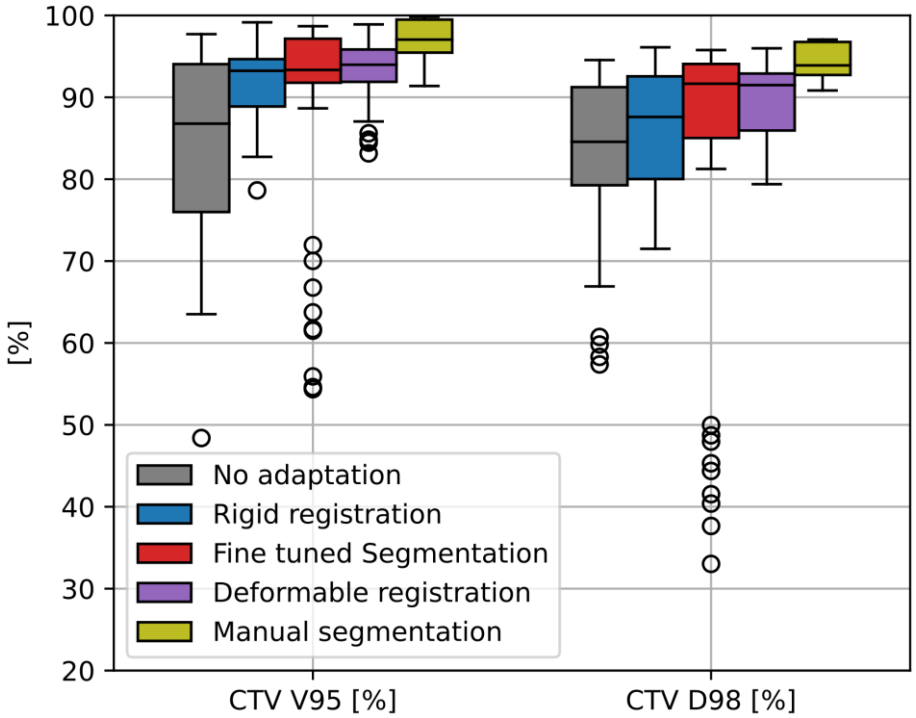
2 Methods do not achieve full target coverage



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Conclusions

- Using propagated OARs has negligible influence on dose, even for rigid registration
  - DIR still best, PSNN similar and faster

Manual adjustment of OAR contours is NOT necessary for adaptive therapy

- Using propagated target does influence dose
  - Target coverage best with DIR and PSNN
  - Dose to OARs can always change

Manual adjustment of target contours might be necessary for adaptive therapy

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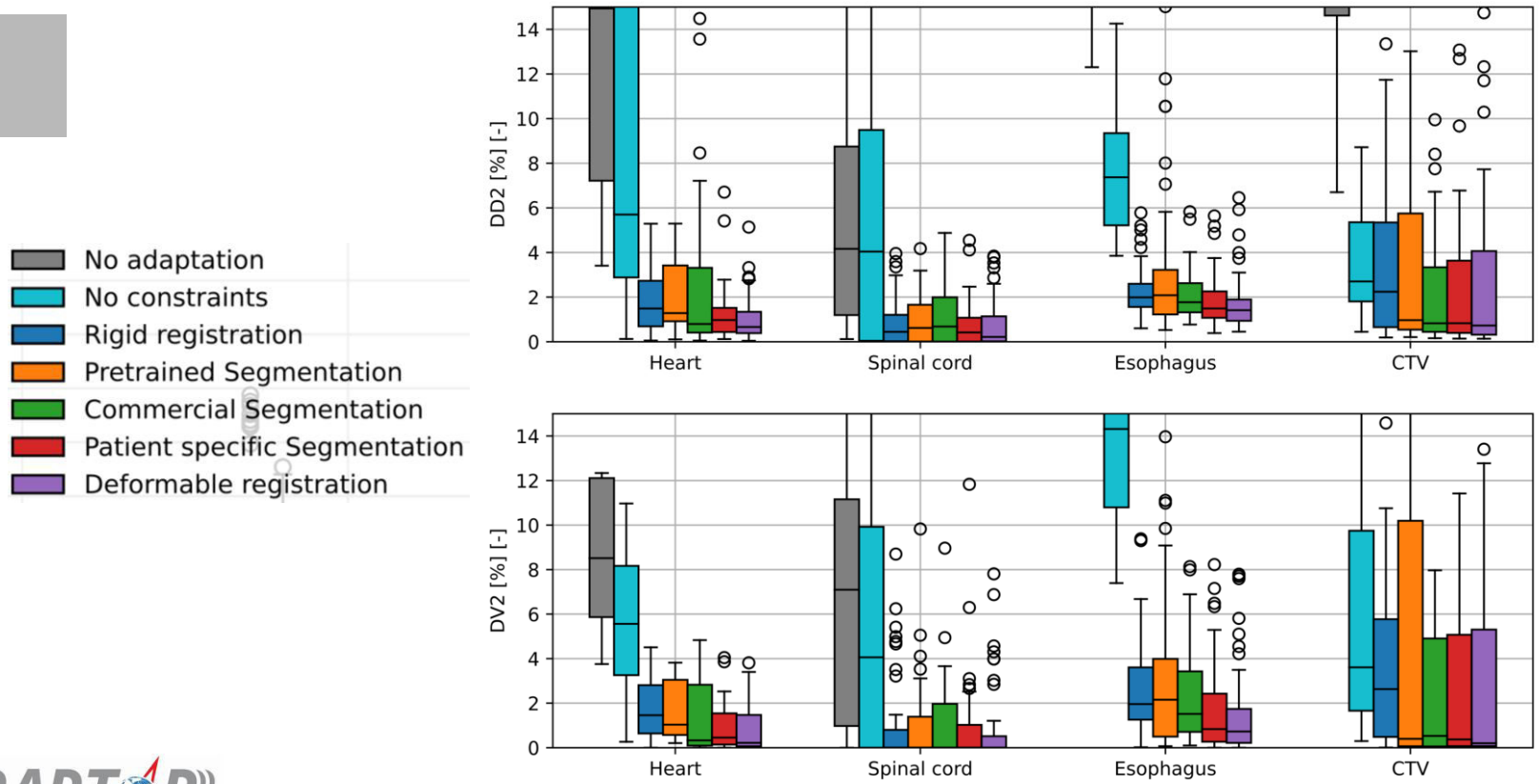
Backup slices

1 All techniques lead to very small dosimetric differences



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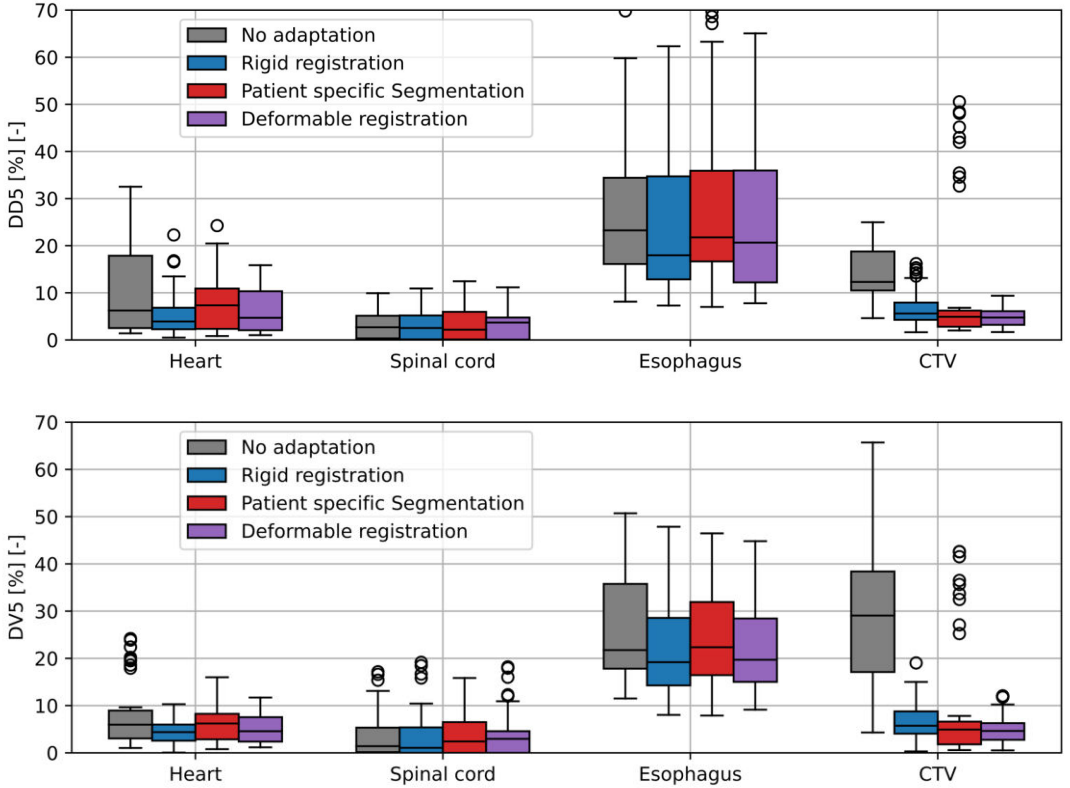

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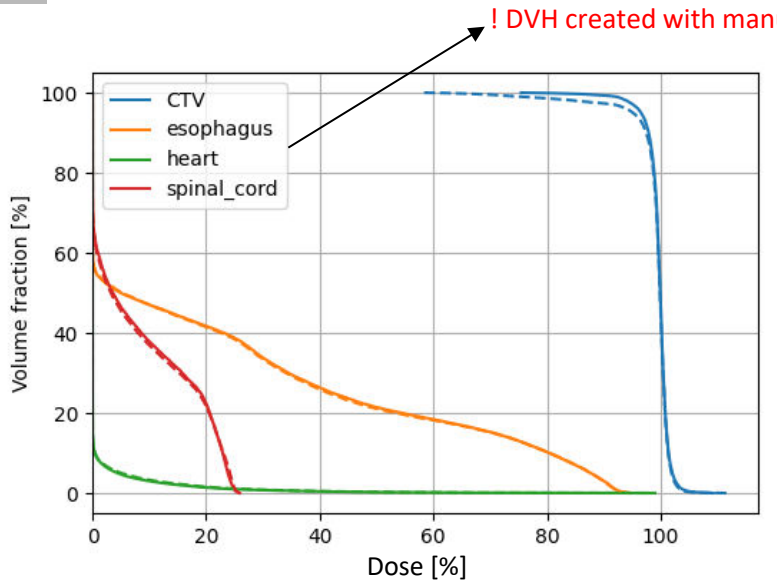
A DVH can be used to visualize the results

Dose Volume Histogram (DVH)



Optimized on manual contours

Optimized on DIR contours

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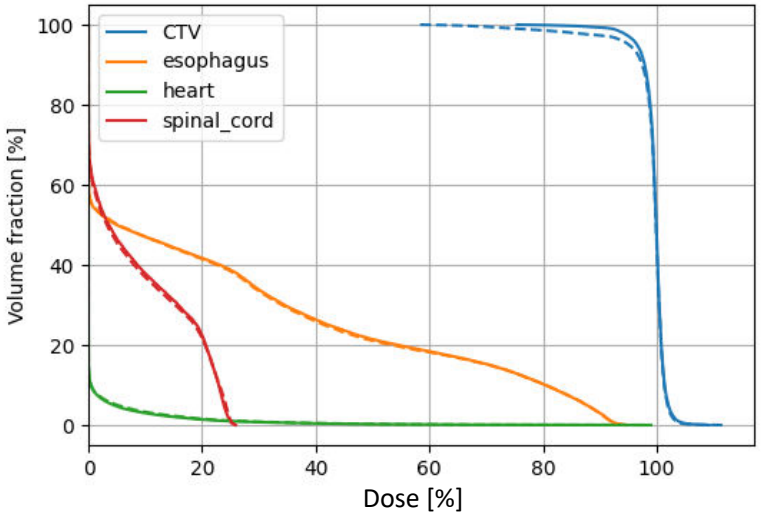
Dose difference is plotted in DDVH and quantified with DV2 and DD2

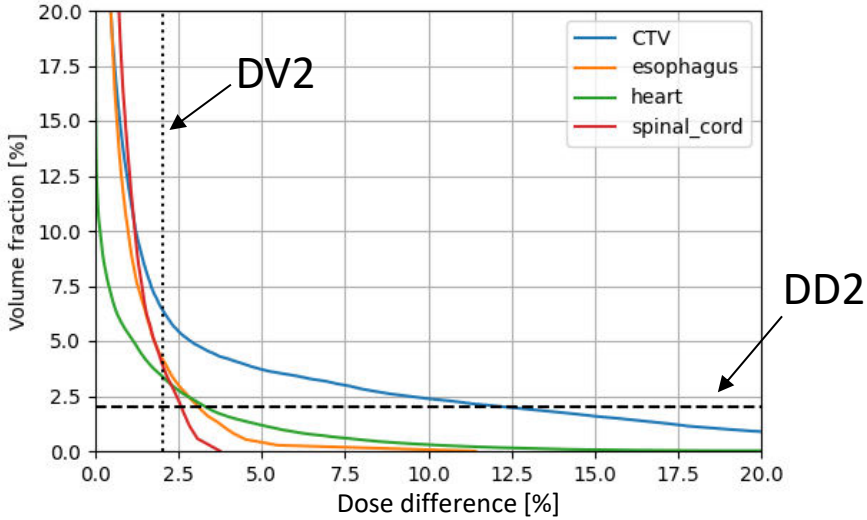
Dose Volume Histogram (DVH)



Optimized on manual contours

Optimized on DIR contours

Dose Difference Volume Histogram (DDVH)



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