## Interactive segmentation

Prior to treatment planning, the target and critical structures are delineated in CT. The current state of the art is manual segmentation in axial view. A line tool is used delineate the boundary, rather than a paintbrush tool that fills pixels. Commercial products generally support some but not all of the following tools to assist the operator.

      1 contour interpolation between slices
      2 boundary editing
      3 mixed axial/coronal/sagittal drawing
      4 livewire or intelligent scissors
      5 drawing constraints (e.g. constraints on volume overlap/distance)
      6 post-processing tools to nudge or smooth the boundary

An ideal tool would also contain the following list. I've never seen these features in commercial RT tools, but maybe they exist for surgery.

      1 tilted-plane drawing
      2 intelligent contour interpolation

Interactive segmentation is important for both research and patient care. An open source tool for segmentation would be widely used.

## Deformable registration in thorax

Accurate assessment of radiation dose to the thorax & abdomen during respiration requires simulation of a static beam that irradiates a moving and deforming target. Patient images are acquired using 4D-CT, and radiation dose is computed for 3D volumes at each breathing phase. The volumes are aligned using deformable registration, and radiation dose deposited in each phase are accumulated in a reference tissue coordinate system. Ideally this procedure is repeated to perform 4D treatment plan optimization.

However, deformable registration is still not as reliable as it should be. The sliding of the lungs against the chest wall is difficult to model. Image acquisition has residual artifacts which cause unrealistic deformations. Registration algorithms are not always robust, and require experimentation and tuning. Validation of registration results is not easy, since there are inadequate tools. Temporal regularization is generally not done, because of slow algorithms and large memory footprints. And so on.

# Thoracic segmentation for Tx planning
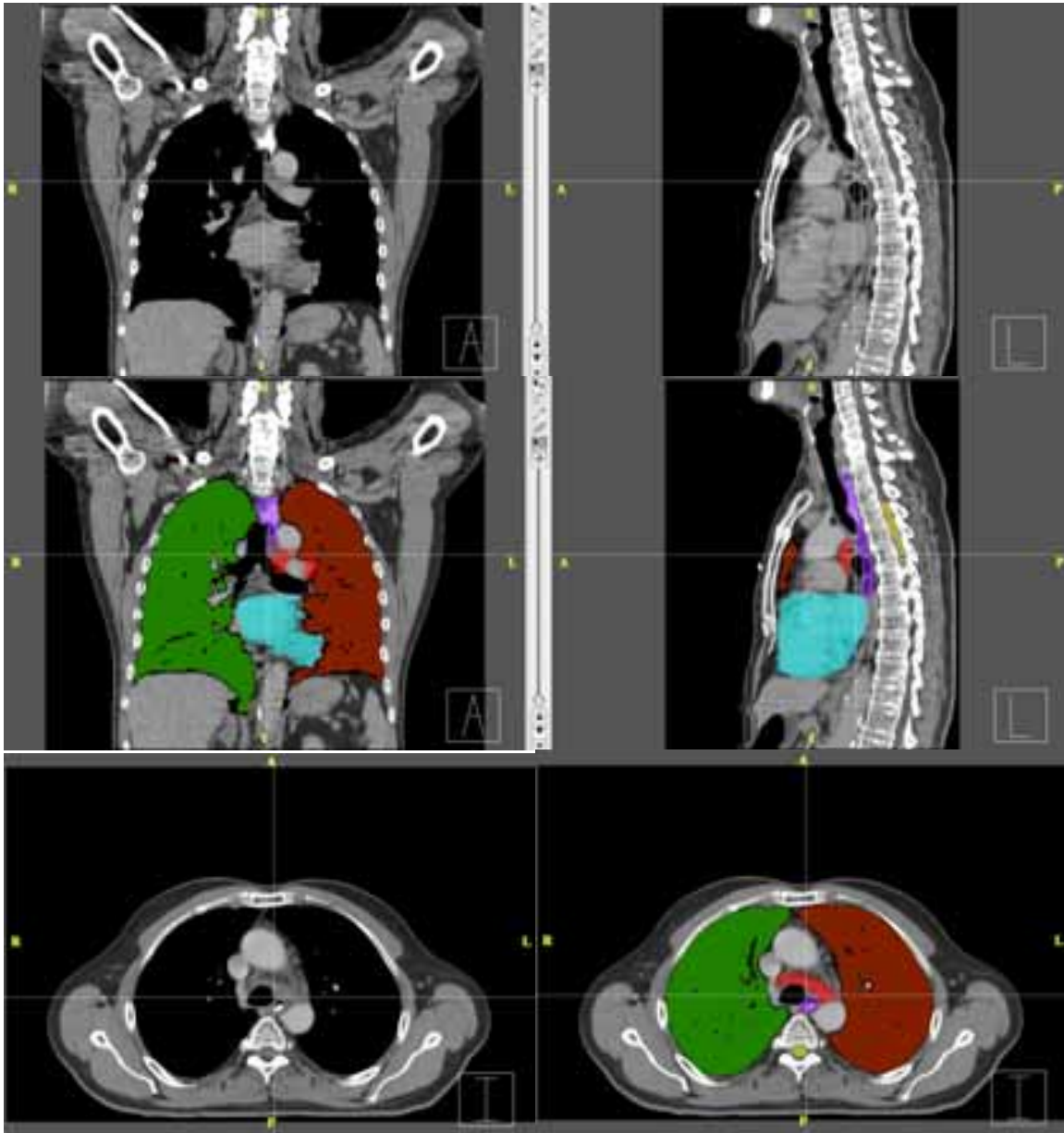
# Thorax segmentation for deformable registration

For deformable registration, we sometimes segment the images at the pleural boundary. This allows us to separate the moving set of organs from the non-moving set. Ideally we would always do this, but segmentation is manual and therefore we usually skip this step.
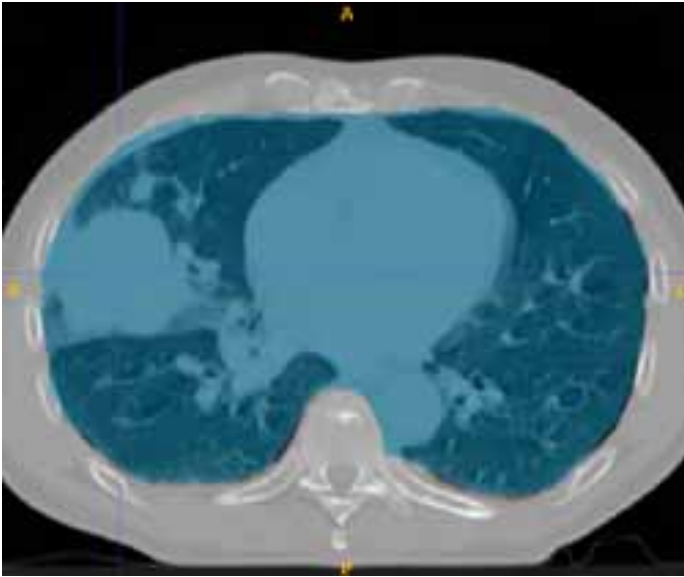
# Prostate segmentation for Tx planning
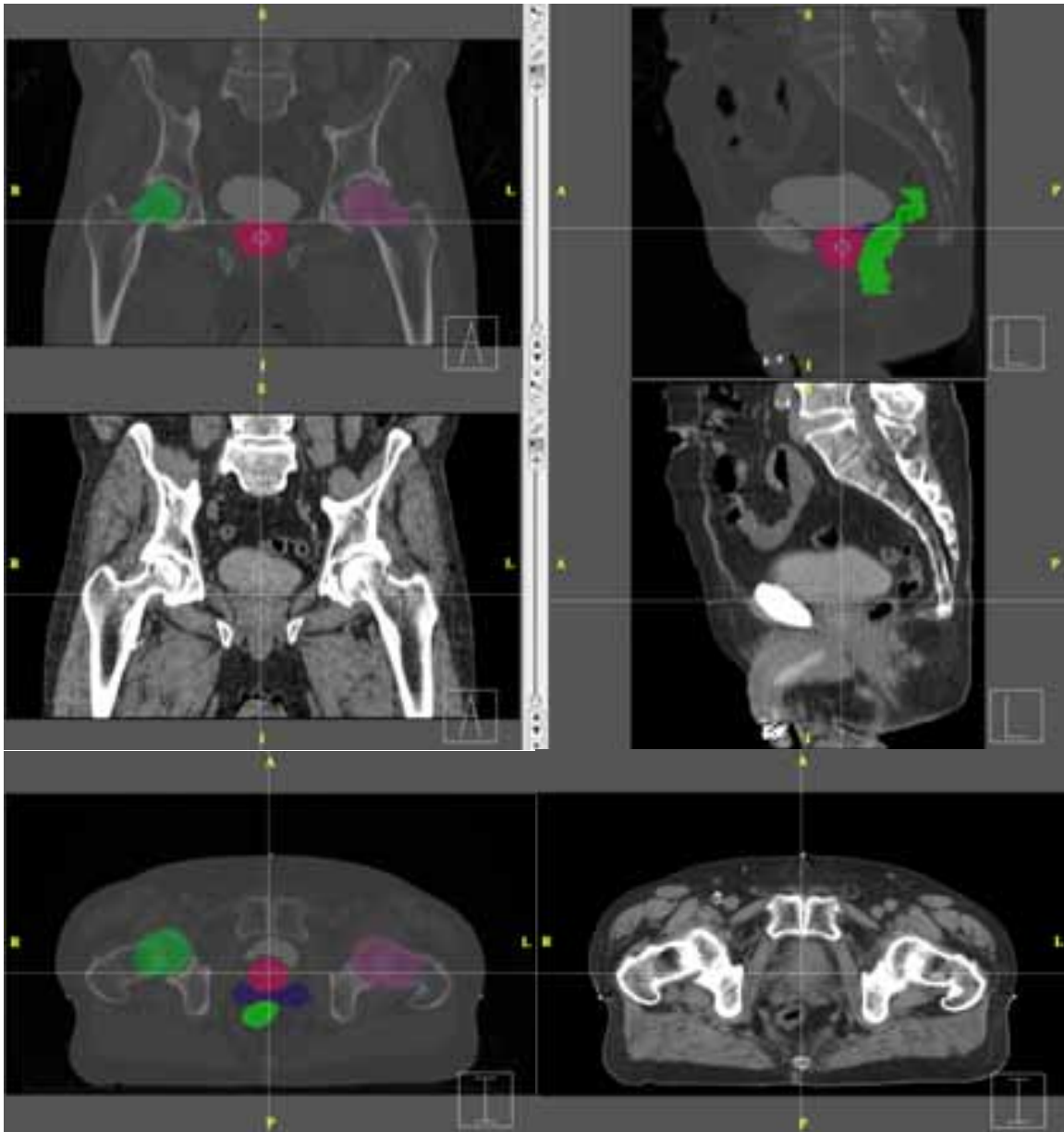
# Head and neck segmentation

# Key

Thoracic:

| left lung | dark red |
|-----------|----------|
| right lung | green |
| esophagus | violet |
| heart | cyan |
| cord | yellow |
| (target) | light red |

Prostate:

| left femoral head | violet |
|-------------------|--------|
| right femoral head | dim green |
| prostate | red |
| seminal vesicles | purple |
| bladder | gray |
| rectum | bright green |

Head and neck:

| optic chiasm | med green |
|--------------|-----------|
| brain stem | dim green |
| spinal cord | bright green |
| left parotid | violet |
| right parotid | dim blue |
| oral cavity | cyan |
| mandible | pink |
| larynx | bright blue |
| esophagus | orange |
| (target) | red |
| (target) | yellow |