Target Volumes for Anal Carcinoma
For RTOG 0529

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Clinical Target Volumes for Anal Cancer (11 figures)

Images are displayed from a fixed, circumferential cT4N3 anal cancer with palpable bilateral groin nodes and radiographic evidence of involvement of peri-rectal nodes. The primary tumor extends into the peri-anal skin on the patient's right side. At the level of the low rectum it extends into the right ischio-rectal space. The anal clinical target volume (CTVA) is displayed in green contour. It includes the primary tumor with a 2.5 cm margin, the infiltrated peri-rectal mesentery, and involved skin (marked by radio-opaque wire) with bolus. The multiple bilateral involved inguinal nodes are less than 3 cm and, therefore, are treated to 50.4 Gy (CTV50). CTV50 is contoured in red. The external iliac, pre-sacral, and internal iliac nodal regions are covered electively, in CTV45, contoured in dark blue. If the groins had not been involved, they would have been in CTV45.

The cephalad and caudad extent of disease is often better defined by the physical findings and other radiographic imaging studies (e.g. FDG PET) than a diagnostic CT scan. Physical findings can be incorporated into the simulation process by careful placement of flexible tubes within the rectum and/or radio-opaque skin markers.

Nodal CTV

The nodal target volume (elective or involved) should include peri-rectal, inguinal, external and internal iliac, and pre sacral regions.

Note that anal cancer, like rectal cancer (but unlike gynecologic or GU cancer), has a first echelon drainage to the peri-rectal lymph nodes. Therefore it is NOT sufficient to generate target volumes by a simple expansion about vessels and the rectum. The case displayed demonstrates infestation throughout the pelvis posterior to the bladder. In cases with no clinical evidence of peri-rectal nodal involvement, this same region still should be included in the low dose CTV (CTV45 for T3,T4 N0 tumors or CTV42 for T2 N0 tumors).

If there are no positive nodes in the inguinal/femoral nodal region, the caudad extent of elective CTV groin coverage should be at the level of

the takeoff of the profunda femoris vessels (~bottom of the obturator foramina).

In the lower pelvis, the nodal CTV breaks into three structures: the two inguinal regions and the peri-rectal nodal region. To adequatly cover the peri-rectal nodal region, the nodal CTV should extend posteriorly and laterally to the bones of the pelvic sidewall, the levators at the floor of the pelvis and the posterior-lateral pelvic fascia cephalad to the levators. Anteriorly, the peri-rectal region abuts the GU structures (anterior border discussed in more detail below).

In the mid pelvis, the nodal CTV should include the peri-rectal, external iliac, and internal iliac regions as a continuous structure, rather than three disjoint areas. The peri-rectal region extends cephalad to the rectosigmoid junction. In the mid pelvis the nodal target volume should be somewhat round in the posterior pelvis, with extensions anteriorly along each pelvic sidewall to cover the iliac nodal regions.

In the upper pelvis, coverage of the pre-sacral region mandates that the nodal CTV include at least 1 cm anterior to the sacrum up to the level of the sacral promentory. Even if a loop of small bowel is abutting the sacrum at the time of the simulation image, the pre-sacral region must be included in the nodal CTV. If the patient's diagnostic CT scan shows bowel abutting the sacrum when the patient is supine, it is strongly recommended that the patient be simulated prone with bowel exclusion techniques.

Adequate coverage of the internal and external iliacs means that, in the upper pelvis the nodal CTV will be shaped like a somewhat stubby "U", extending continuously from the left iliac vessels through the pre-sacral region to the right iliac region. The cephalad extent of the external and internal iliac CTV is where the common iliac vessels bifurcate into the external and internal iliacs. This is usually at or slightly below the sacral promontory.

PTV margin

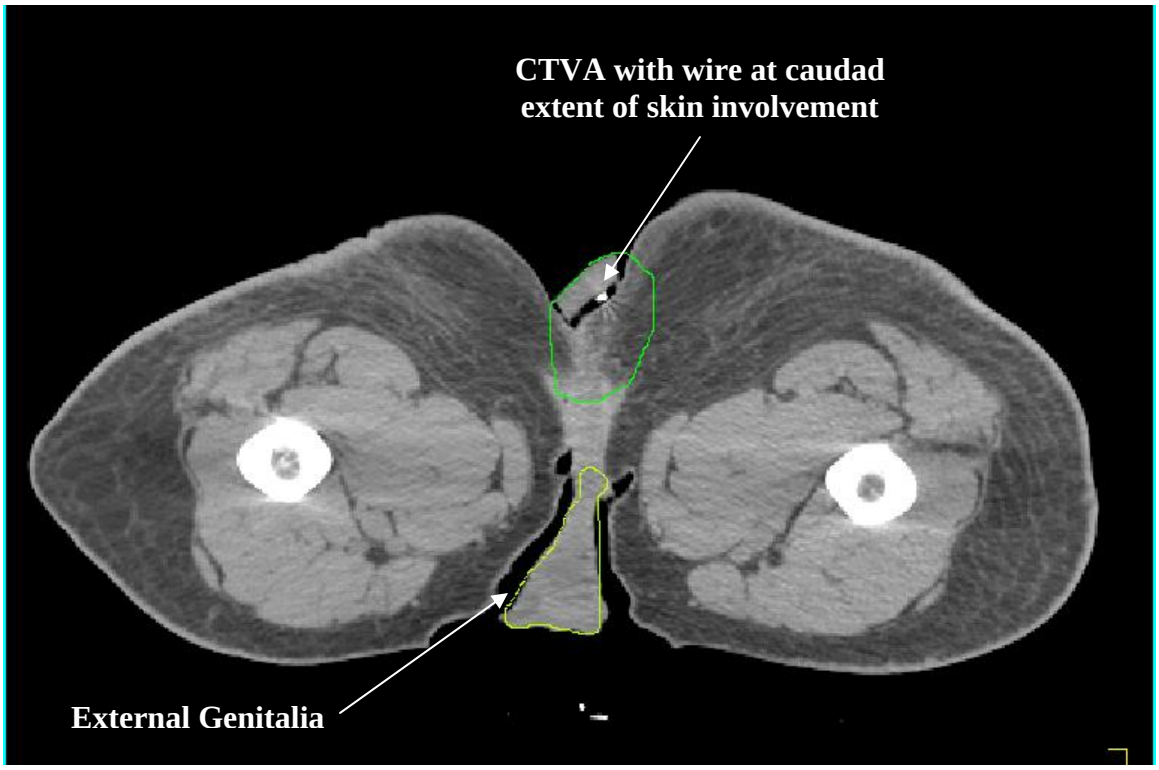
The PTV margin should account, in general, for setup reproducibility and for physiologic movement of the clinical target volume. Studies

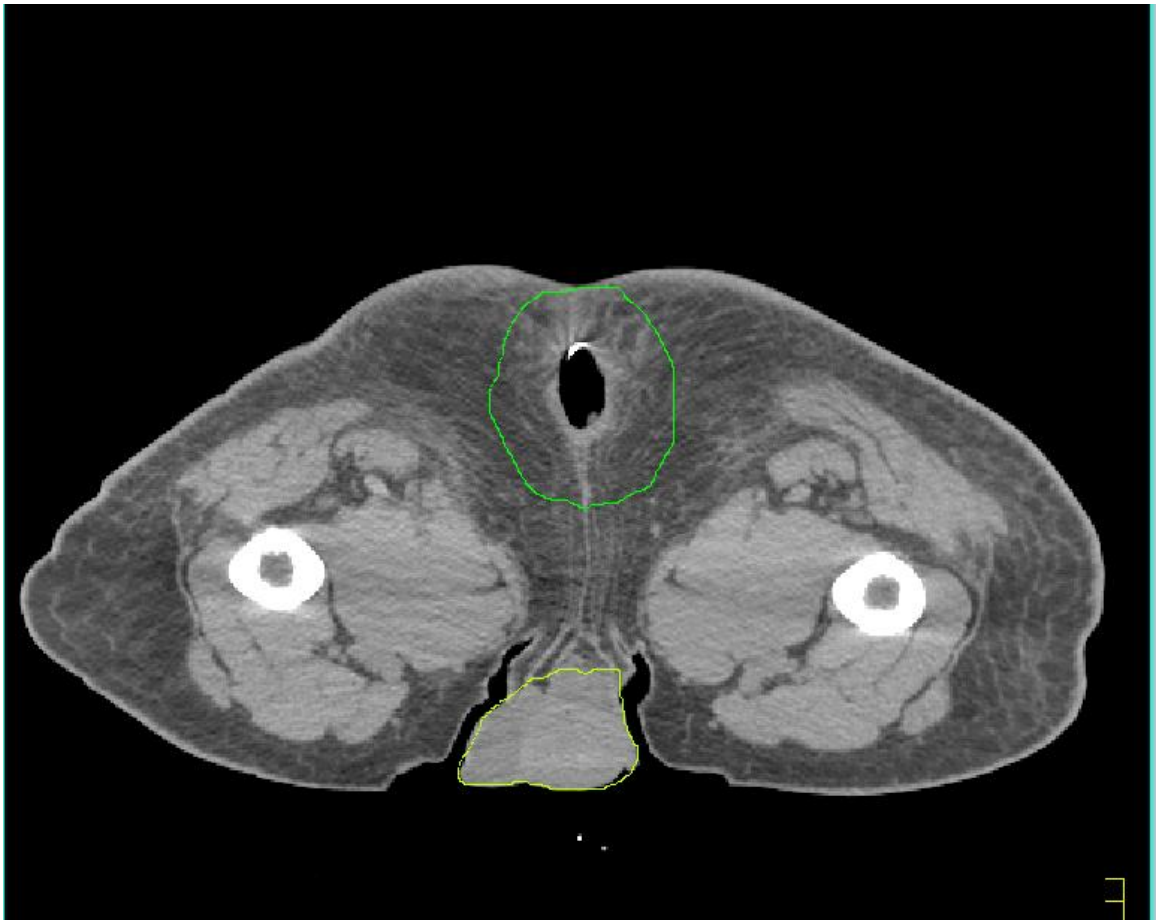
have shown that physiologic movement of the rectum can be ~1 cm. Planning with a distended rectum (~50 cc air put in the rectum at the time of simulation, if the patient can tolerate it) is recommended because it accounts for the maximum extent of rectal excursion. The use of an alpha cradle also helps to reduce setup variability. Nonetheless, setup variations can occur and a PTV margin of about 1 cm is appropriate.

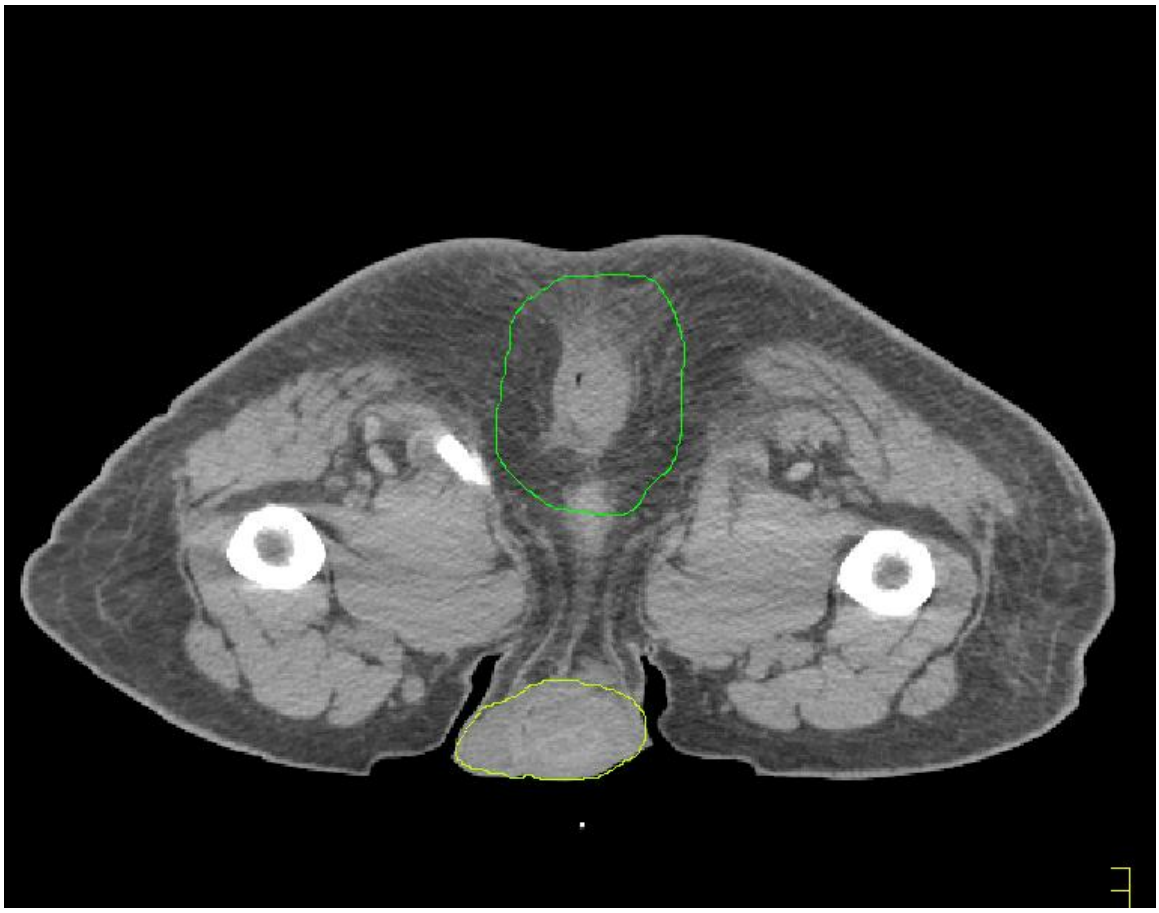
The bladder and/or uterus define the anterior extent of the peri-rectal nodal CTV at the level of the mid rectum. Since organ movement for both structures can also be on the order of 1 cm, it is recommended that the CTV extend ~1-2 cm into the bladder or uterus. Often the 2.5 cm margin around the involved anorectum will place it there anyway. Technically this allowance for organ movement should be incorporated into the PTV margin, but it is more practical to place it in the CTV margin and then generate an automatic uniform margin (for setup errors) around the CTV to define the PTV.

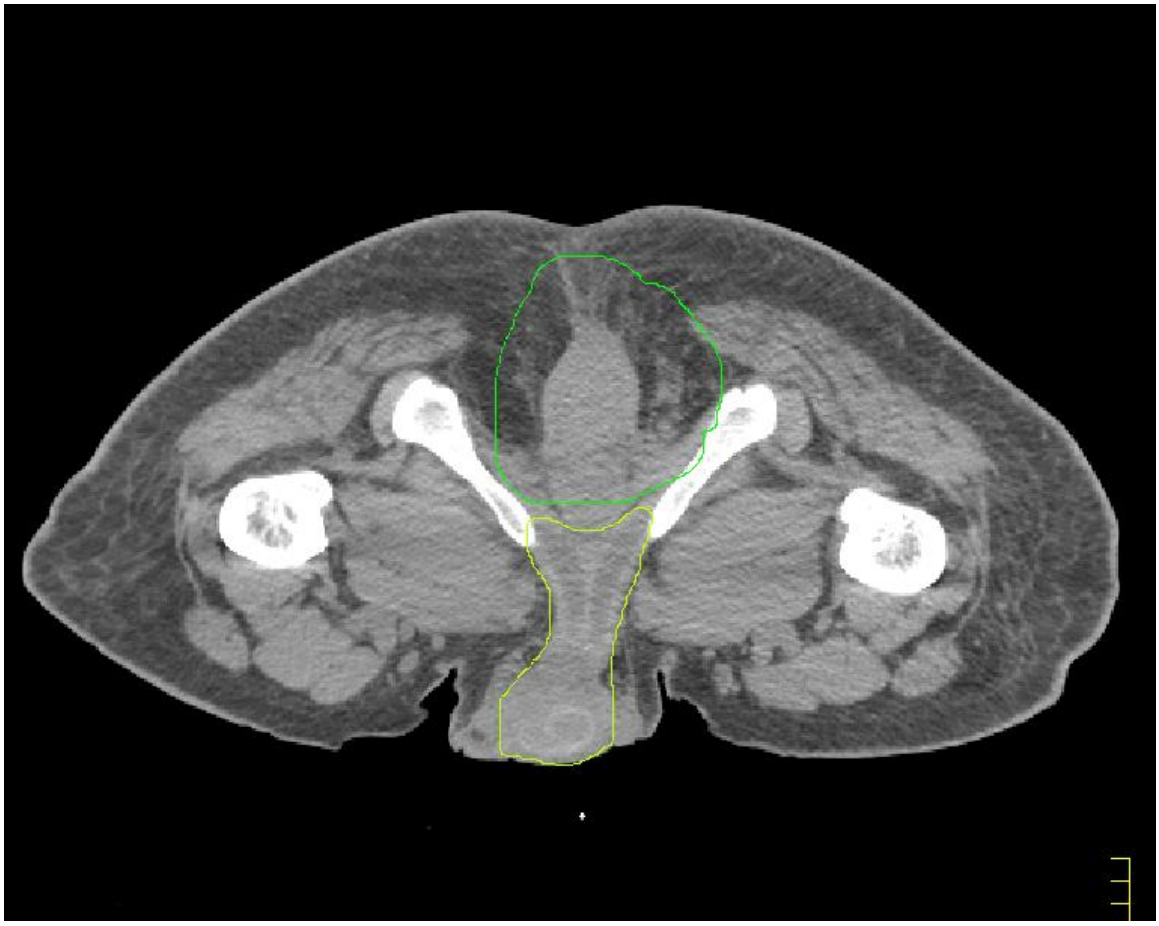
Normal Tissues

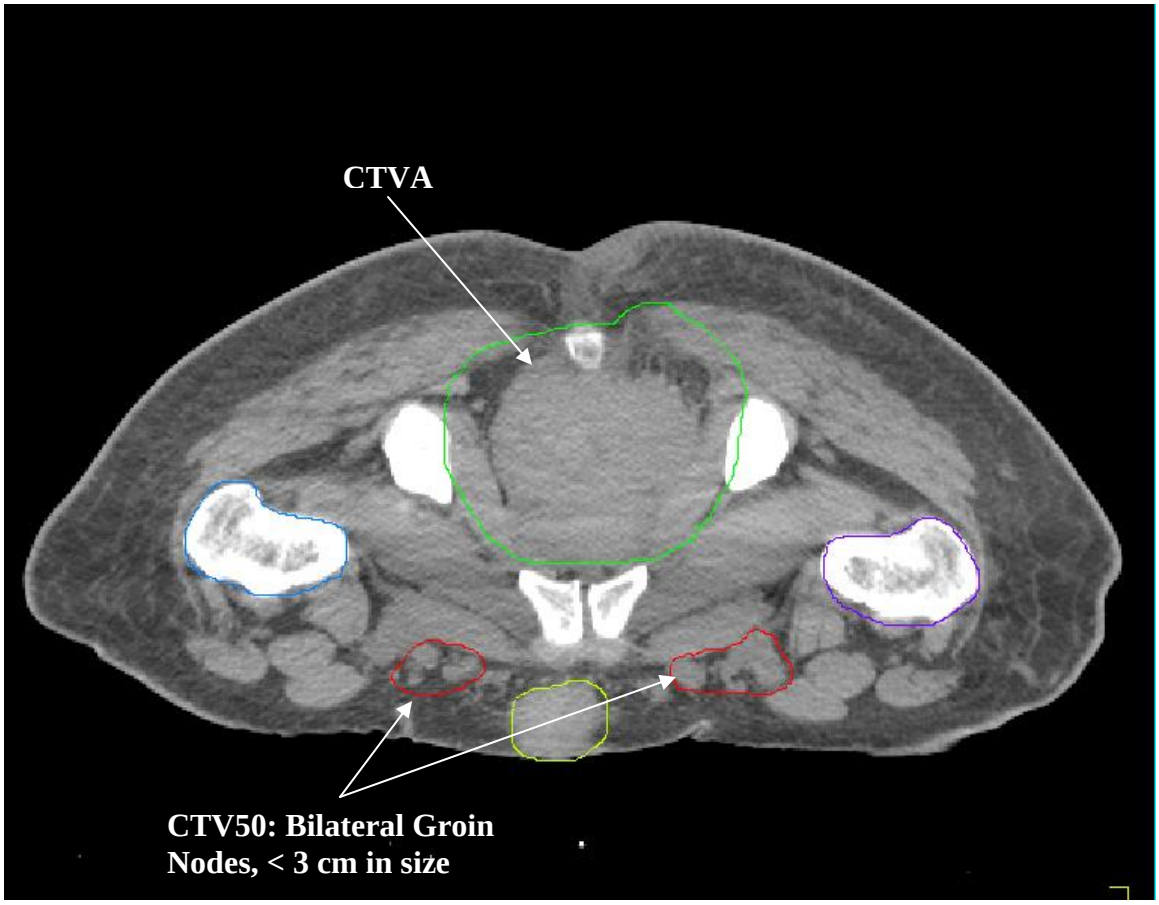
Contoured normal tissues include small bowel in yellow, uninvolved large bowel (defined to be large bowel outside CTVA) in magenta, femoral heads in blue and violet, iliac crests in green, external genitalia in yellow, and bladder in light blue. The small and large bowel are contoured closely, rather than with a large margin, in order to provide operator independent DVHs. The femoral heads include the greater and lesser trochanters. The caudad extent of the iliac crests contours is just above the cephalad extent of the femoral heads.

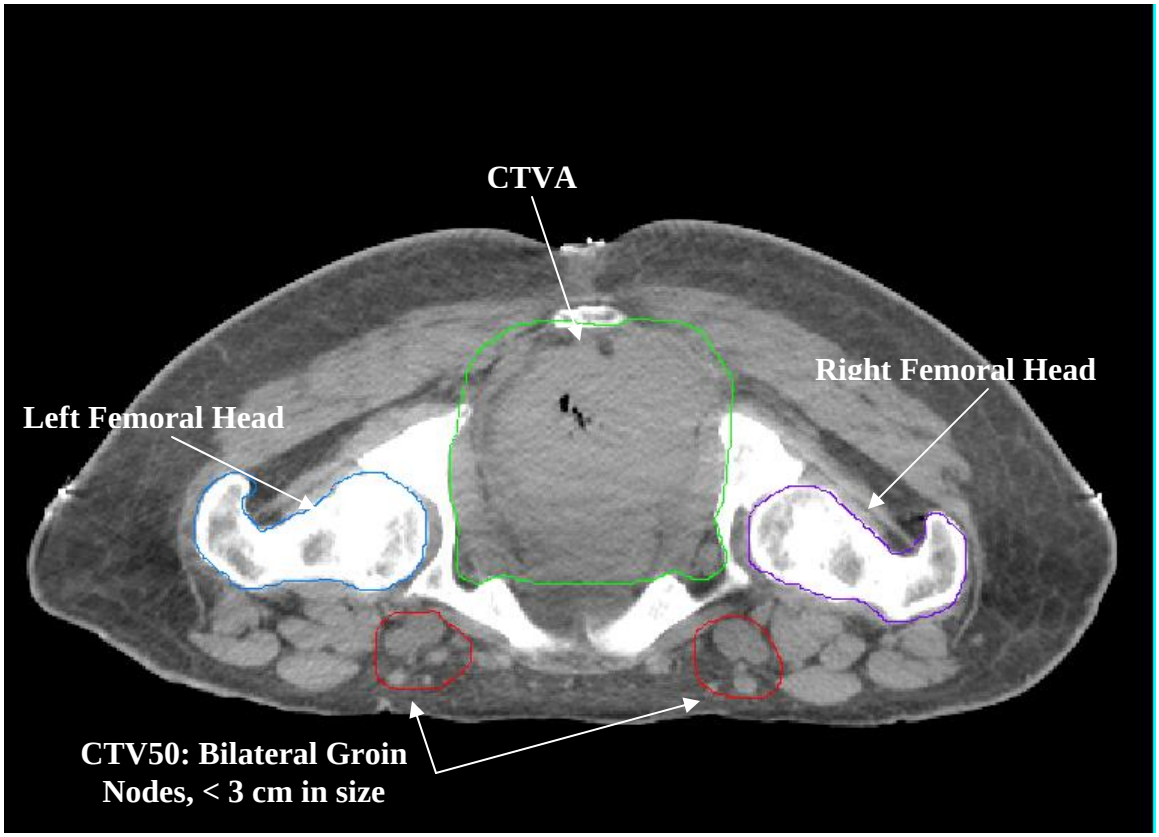

CTVA with wire at caudad
extent of skin involvement
External Genitalia

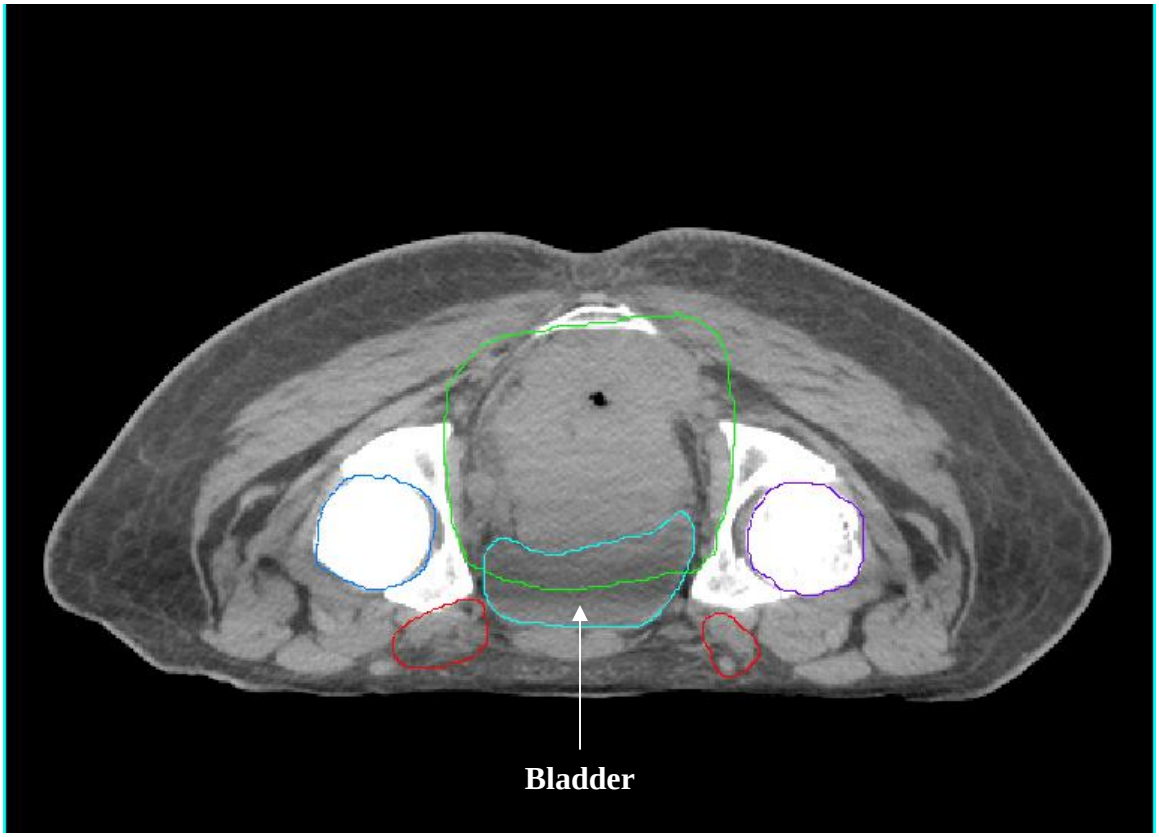


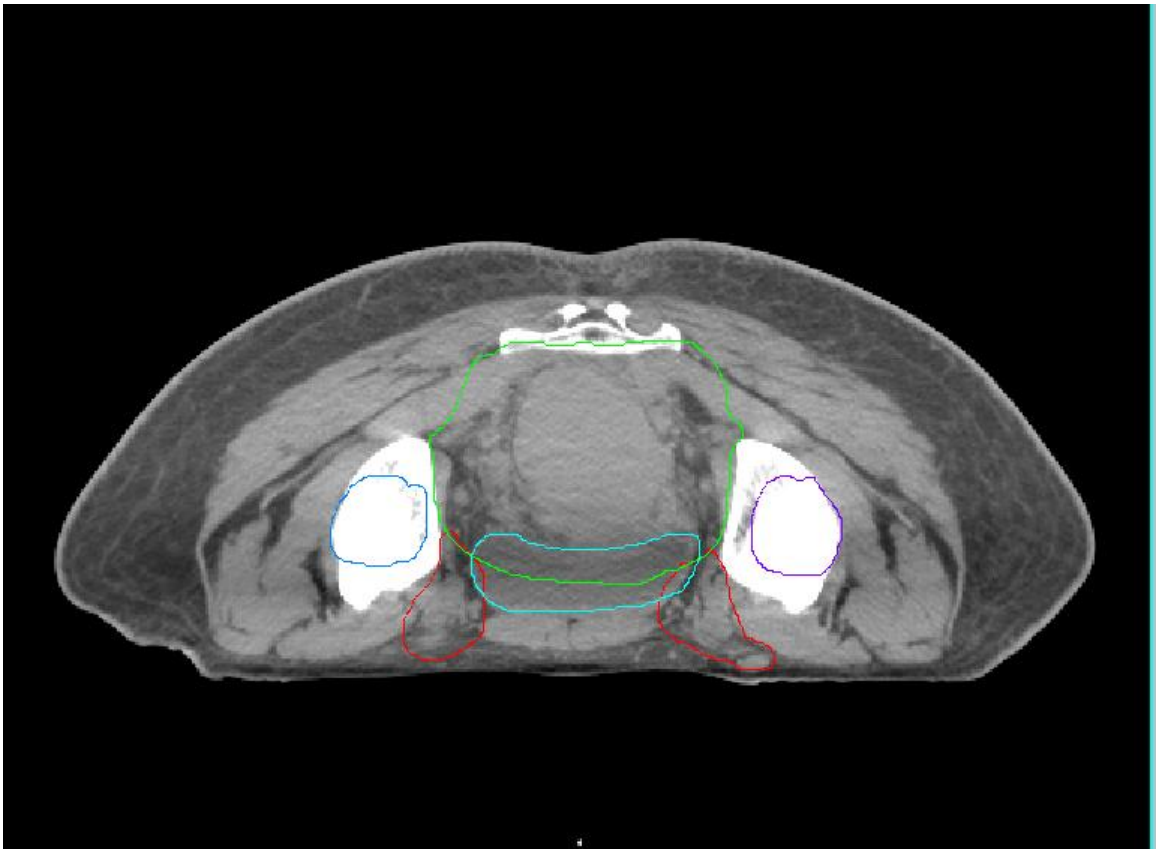


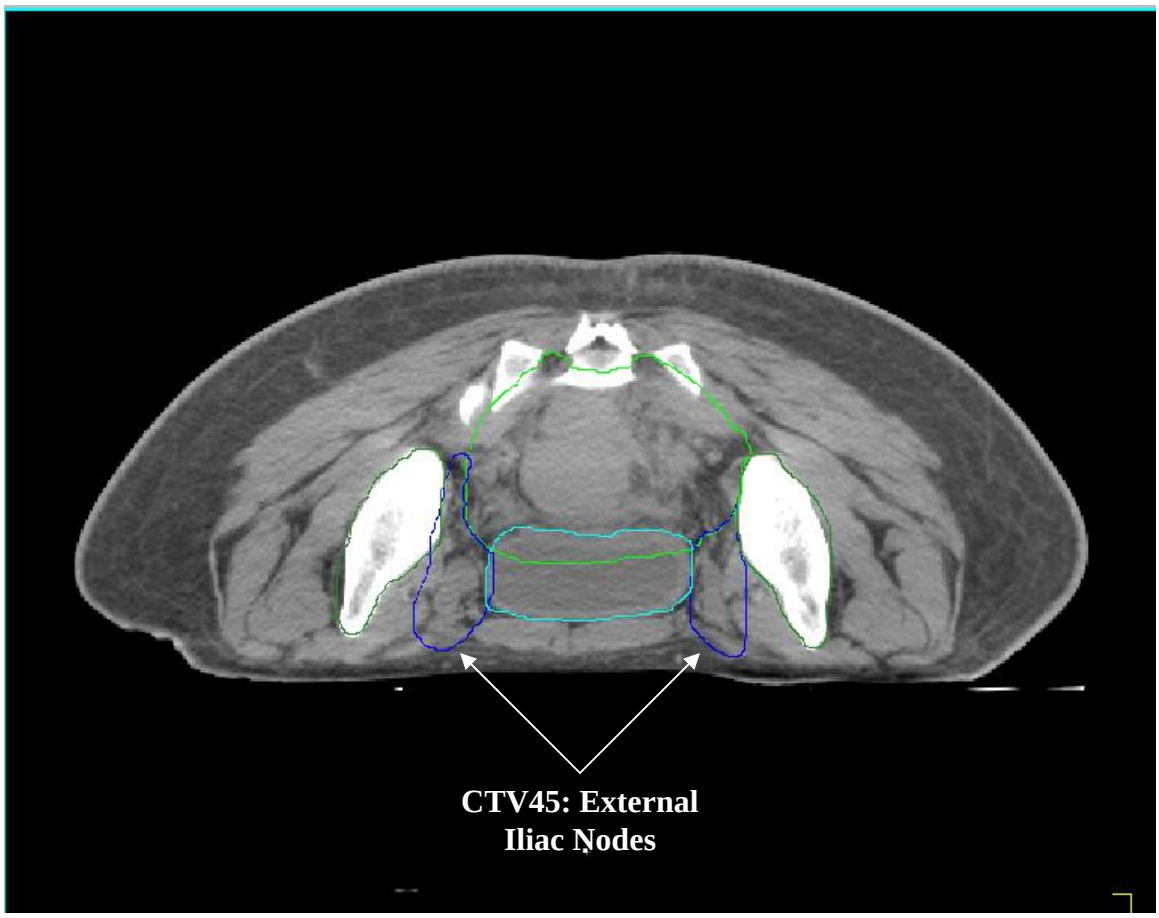


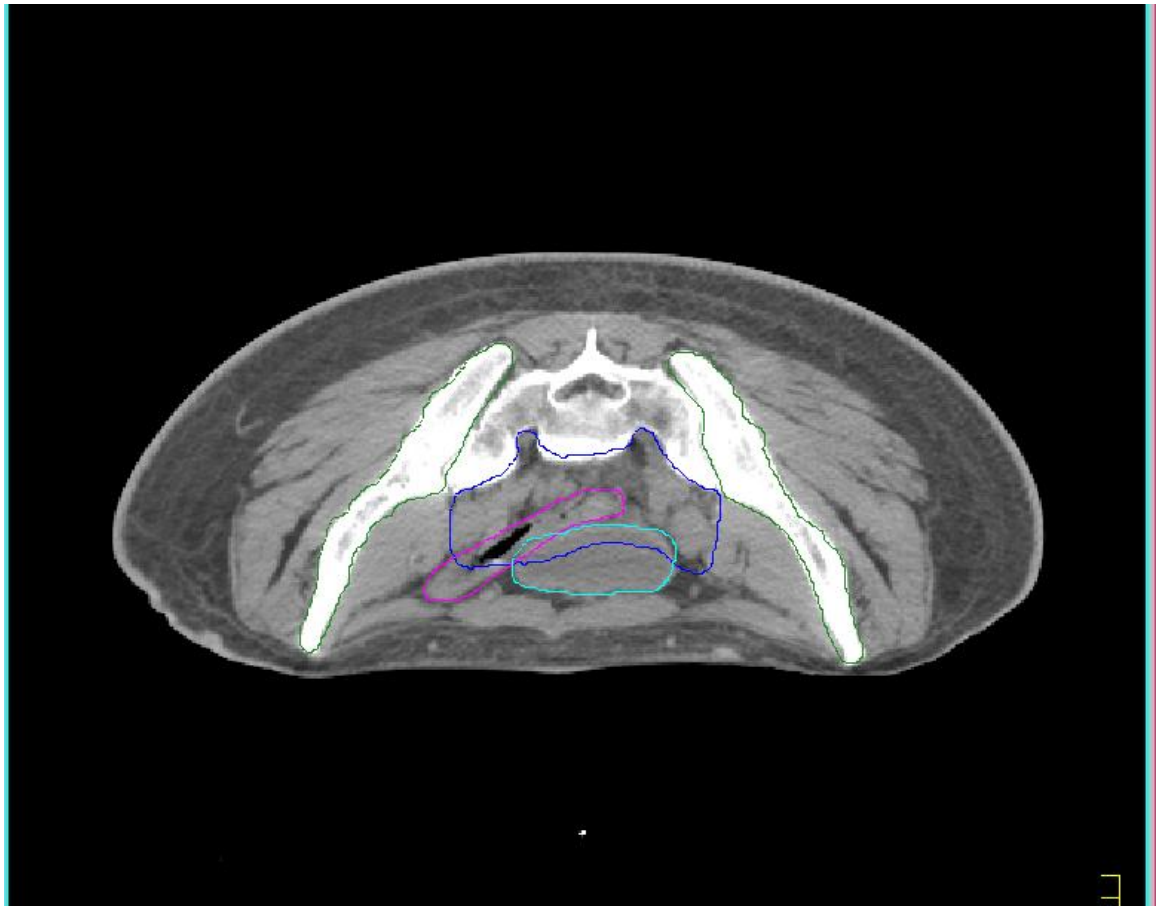

CTVA
CTV50: Bilateral Groin Nodes, < 3 cm in size

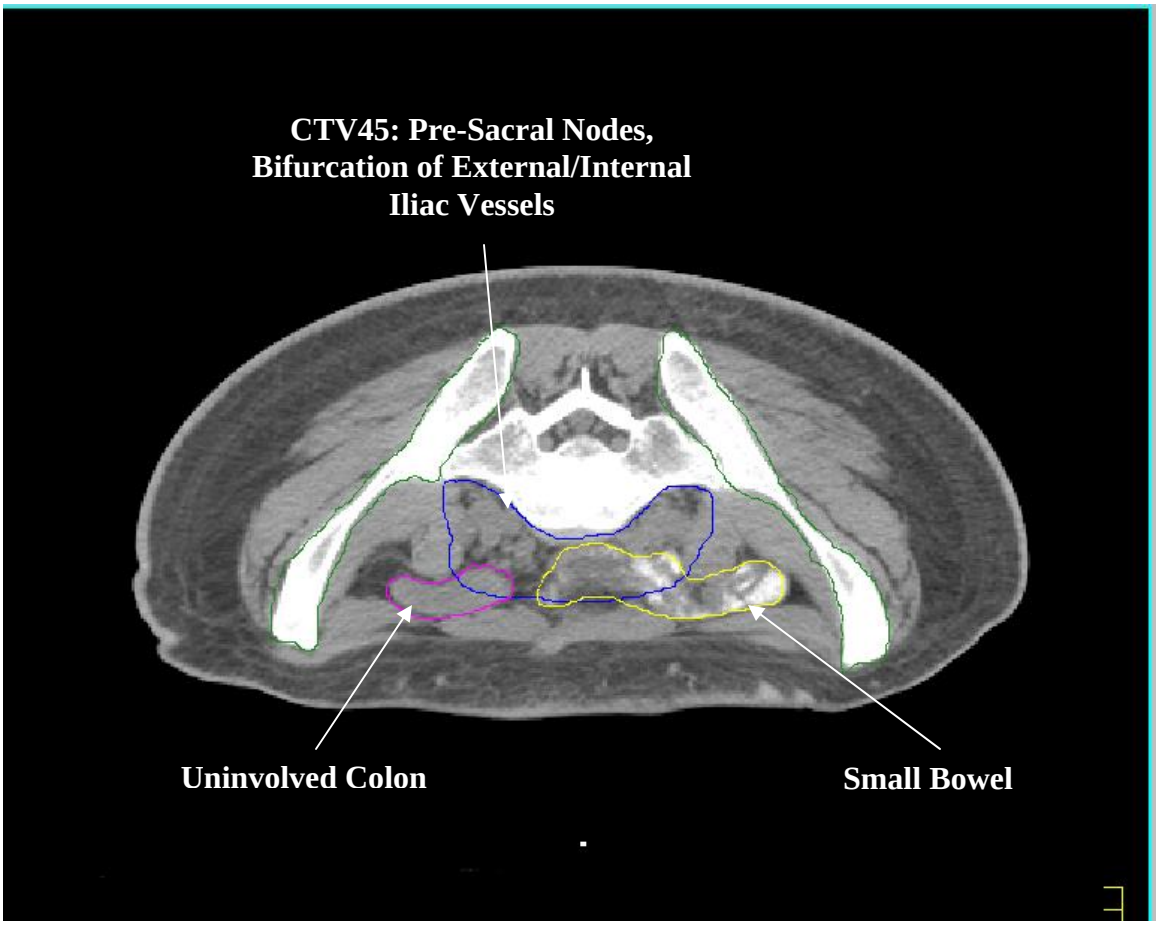

CTVA
Right Femoral Head
Left Femoral Head
CTV50: Bilateral Groin
Nodes, < 3 cm in size


Bladder




CTV45: External
Iliac Nodes




CTV45: Pre-Sacral Nodes,
Bifurcation of External/Internal
Iliac Vessels
Uninvolved Colon
Small Bowel

Considerations when CTVs involve skin or are close to the skin (3 figures)

It is important to have skin bolus in place at the time of simulation. The peri-anal skin must be included, at a minimum 2.5 cm circumferentially about the verge plus involved skin if the cancer involves peri-anal skin. The bolus technique must be very conformable, with reliable coverage within a few mm of the targeted skin areas. Probably the most straightforward way to reliably bolus the peri-anal skin is to "auto bolus" the patient by taping the buttocks together at the time of simulation and for treatment. Placement of TLDs in this area is suggested as a way to confirm target dosimetry.

Radio-opaque markers, placed at simulation to define the targeted skin, should be as small as possible, to avoid significantly disrupting the bolus technique. If the skin is not clinicically involved, it is still necessary to extend the CTVA 2.5 cm about the anal verge in all directions—and, therefore, a marker identifying the verge is needed at the time of simulation. This could be in the form of a small marker or, alternatively, a rectal tube (provided the insertion length is measured at simulation). When there is skin involvement, radio-opaque wire demarcating the involved skin should be placed at simulation.

In IMRT cases where the CTV does not involve the skin, but comes within 1 cm of the skin surface (most often in the groins and/or near the coccyx) bolus is NOT recommended. However, it will be important to provide adequate photon fluence in the air near the skin in these areas, to account for set-up variations. The problem is that, at locations where a CTV approaches skin, the treatment planning system will require that the PTV margin be retracted. This could potentially lead to an inadequate margin of photon fluence in the air overlying locations where CTVS approach skin. There are two ways to determine if this is the case, discussed below. Neither is mandatory, although one or the other is strongly recommended.

Method 1 (appropriate for "Step and Shoot" IMRT systems). Examination of the beam's eye view projection of the extracted portion of PTV

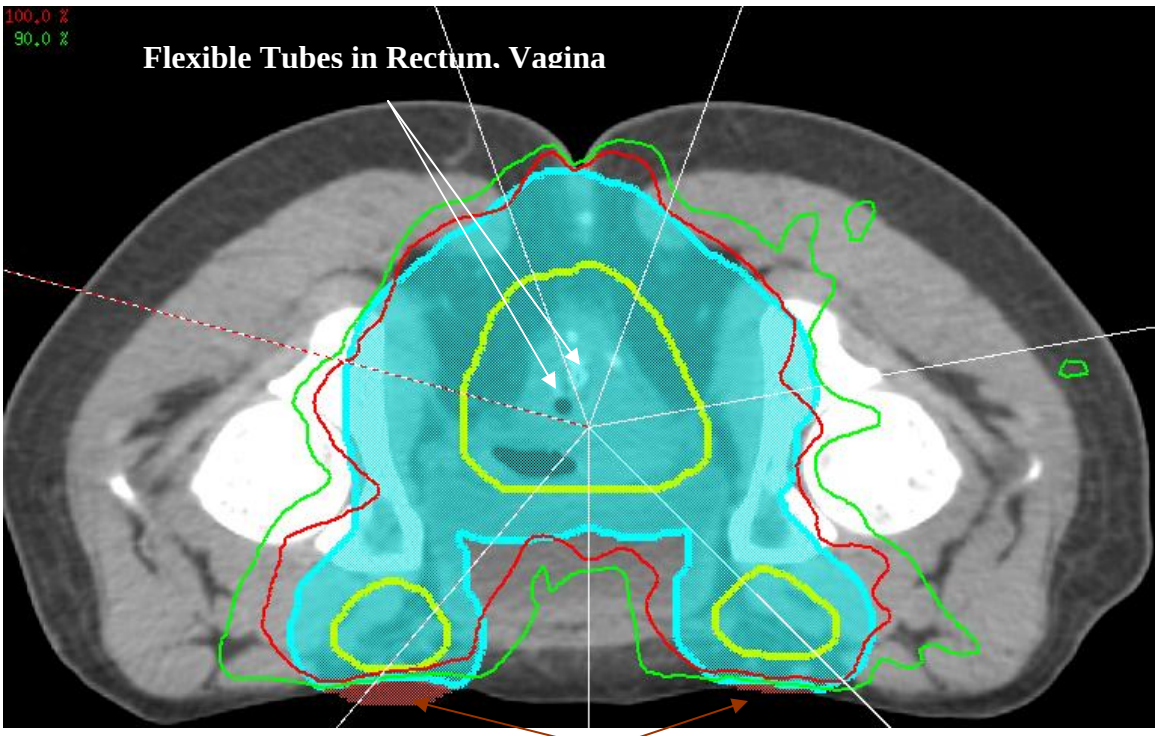
The most common location where the PTV margin will be pulled back is in the groins, as the next set of figures illustrate. In the first figure, the low dose CTV is displayed in thick solid yellow and the PTV is displayed in light blue color wash. The PTV margin was 1 cm in 3 dimensions in all locations, EXCEPT in the groins, where the dosimetrist had to pull the PTV contour inside the skin. The extracted portions are displayed in orange colorwash. Also displayed in the first figure are the 100% isodose (thin red line) and 90% isodose (thin green line).

In this case, for the seven beam directions selected, the extracted portion of the PTV (orange colorwash) never projected beyond the remaining PTV (light blue contour) (see second figure below). The CTV is also displayed, in yellow contour. In this situation, no plan modification was necessary.

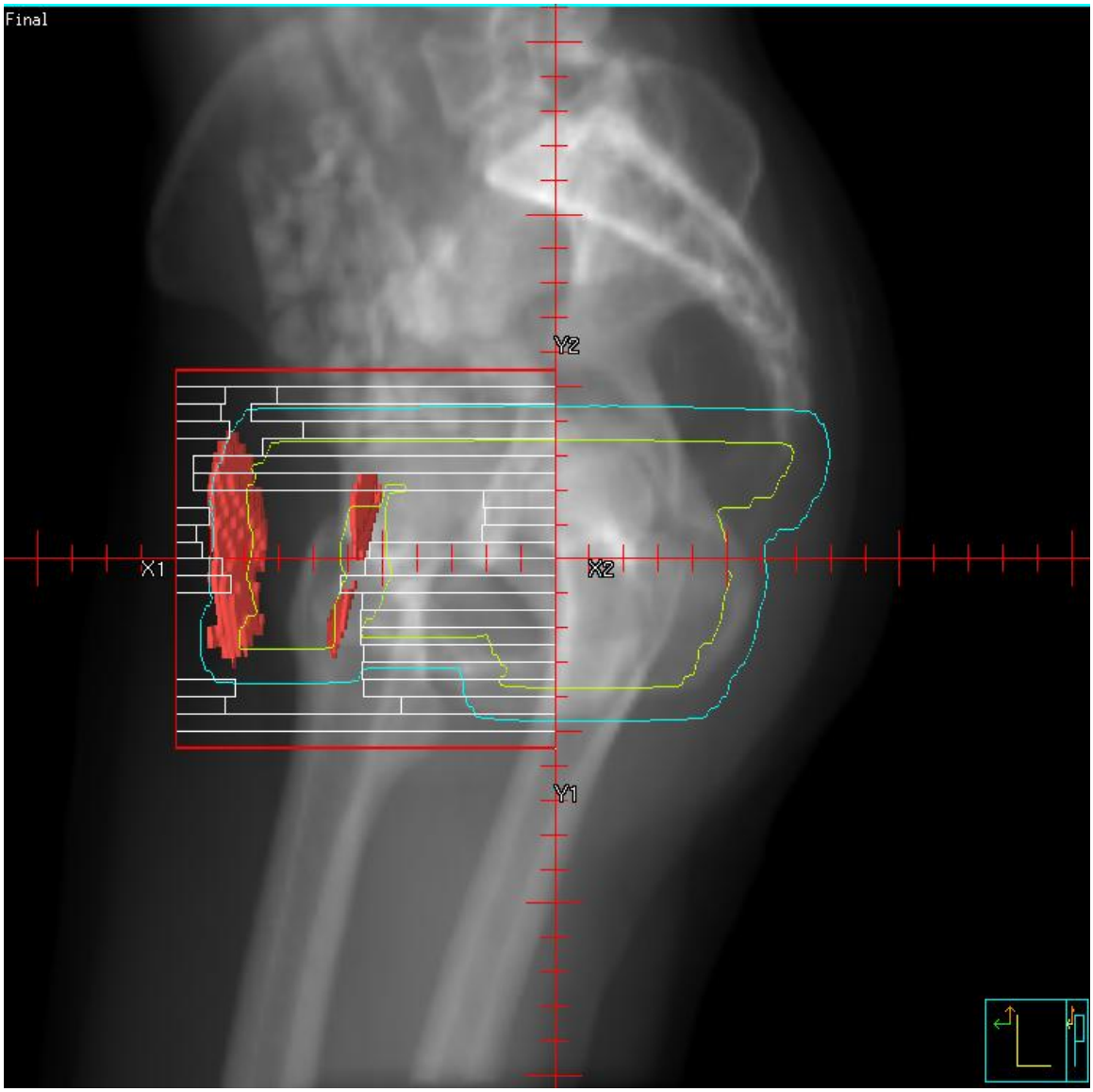
If there had been beam directions where the extracted PTV projected beyond the remaining PTV, a treatment planning tool, called the flash tool, could have been used to modify collimator leafs to ensure that incident beamlets include the extracted volume. This tool would be used at locations where both the extracted portion of the PTV (orange colorwash) projects beyond the remaining (light blue) PTV <u>and</u> planning called for collimator leafs extending beyond the light blue PTV.

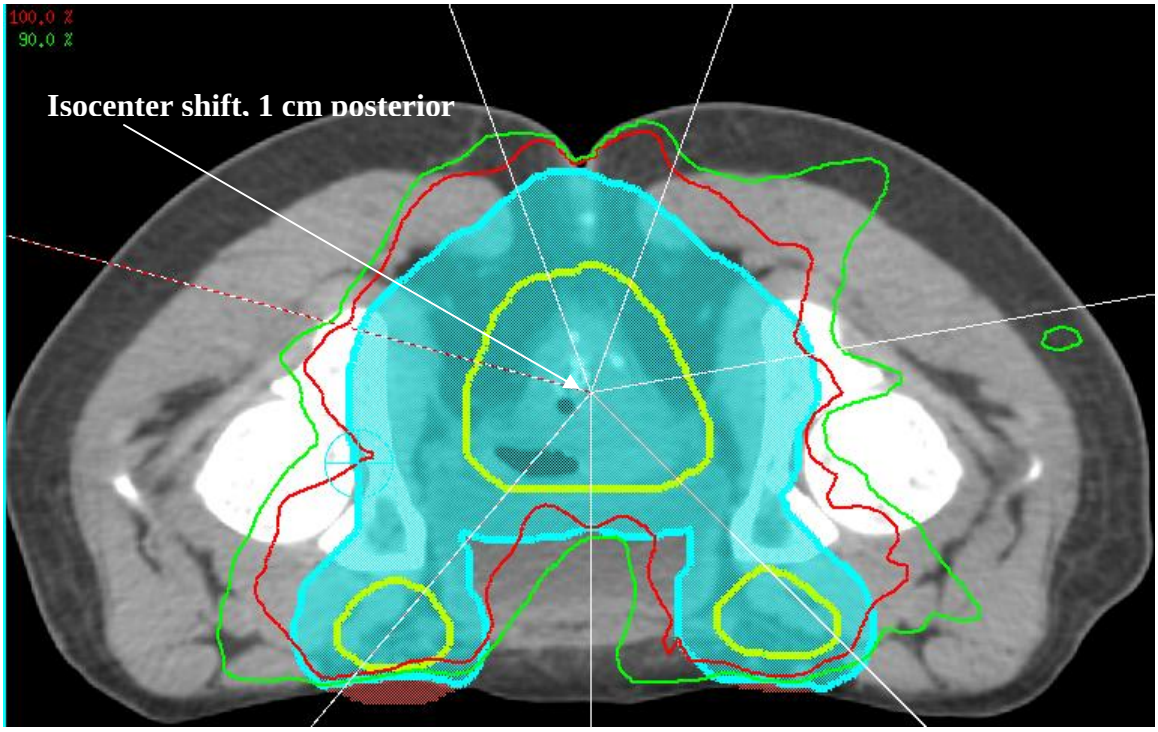
<u>Method 2</u>. Evaluate isodose distribution with tissues displaced.

The third figure verifies that, using beamlet fluences planned in the first figure, isodose coverage of the CTV—including in the groins—remained stable, even when all tissue was shifted 1 cm anterior (i.e. relative to tissue, isocenter shifted 1 cm posterior). The 100% isodose covered both groins prior to the shift. With the 1 cm shift, the coverage in the left groin degraded slightly but the 90% isodose still covered the CTV.



Extracted Portion of PTV (Orange Colorwash)


Final
Y2
X1
X2
Y1


100.0 %
90.0 %
Isocenter shift. 1 cm posterior