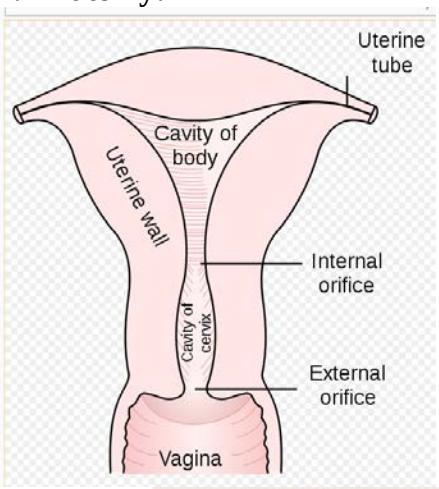
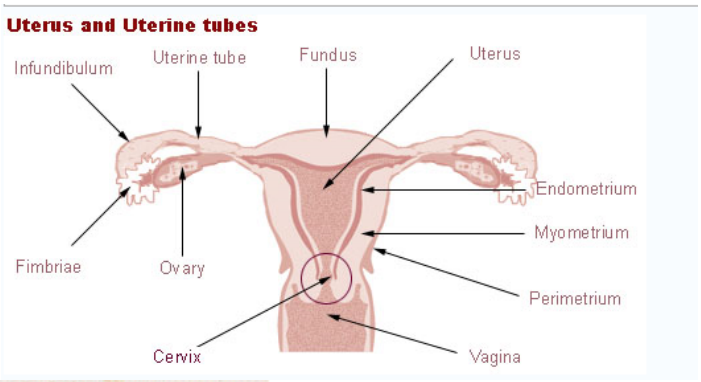
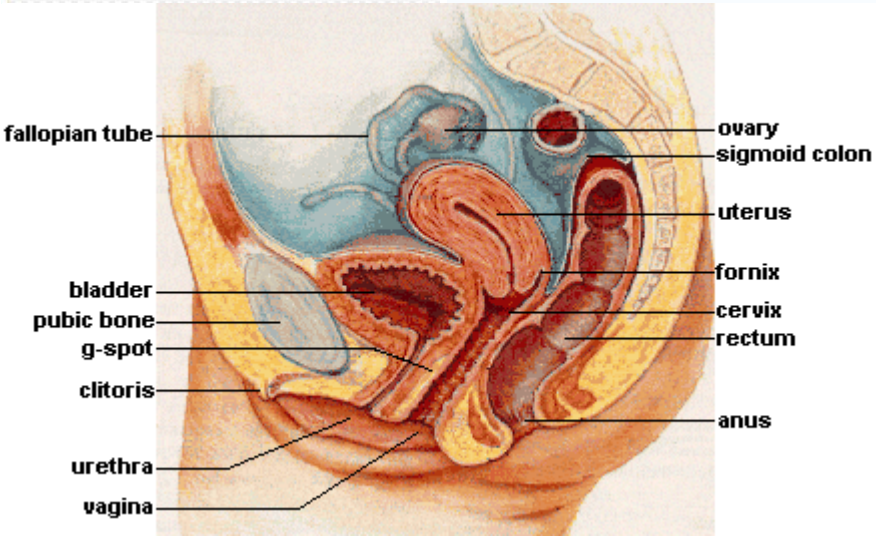
1. Anatomy:







2. Dose Reference Points

Point A: 2 cm superior to the mucous membrane of lateral fornix (level with the external orifice) in the plane of the uterine tube and 2cm lateral to the center of uterine canal.
(On X-ray image, the origin is defined as middle point of a line connecting the tops of the source to the ovoids, the bottom of the most inferior tandem source. For afterload system, the origin was defined as the position of the flange abutting the external cervical OS.)

Two reasons of the choice of A:

- treatment was thought to be limited by tissue tolerance of paracervical trianagle. Cervix, upper vagina, and uterus are remarkably tolerant to radiation, but tissues in paracervical region including uterine artery and ureters are more vulnerable.
- dose rate at this point is not too sensitive to small variations in applicator position. (This is contradicting to statement “the general location of A lies near a steep gradient in dose rate. Hence small changes in the definition of point A can produce variations in the delivered dose”). In another book, “a point rather than a volume is defined because the dose distribution is very inhomogenous and the dose gradient is very steep.”

According to AAPM review course: Pt A simultaneously represents two treatment limiting conditions. 1) the lateral aspect of the target organ (cervix) that must receive at least the min target dose; 2) the location of dose-sensitive normal tissues (ureter and uterine artery) that limits the max dose tolerated.

Point B: 5cm lateral to midline at the same level as A and represent dose to the pelvic wall. The position of pt B mark the location of the first set of lymph nodes to which the disease spreads. The dose at B is about 20-25% of the dose at point A and is of importance when calculating the total dose when combined with EBRT.

Rectum ref pt: On the lateral film, draw a AP line from the middle of ovoid sources. The Rect point is located on this line 5mm behind the posterior vaginal wall. The posterior vaginal wall can be visualized by radio-opaque gauze or packing in vaginal cavity. On AP film, this point is at the middle of the ovoid sources or lower end of the tandem sources.

Bladder ref Pt: On lateral film, draw a AP line through the center of balloon to the posterior surface of balloon. On AP film, the point is at the center of balloon

Pelvic wall point: On AP film, intersected by the horizontal and vertical lines tangential to the highest point and inner aspect of acetabulum. On LAT film, the highest points of R and L acetbulum in the cranio-caudal direction are jointed and the lateral projection of the point is located at the mid-distance of these points.
Represent dose at distal part of parametrium and at the obturator lymph nodes

Lymphatic trapezoid: On Lat film, a line is drawn from junction of S1-S2 to the top of symphysis. Then a line is drawn from the middle of that line to the middle of anterior aspect of L4.

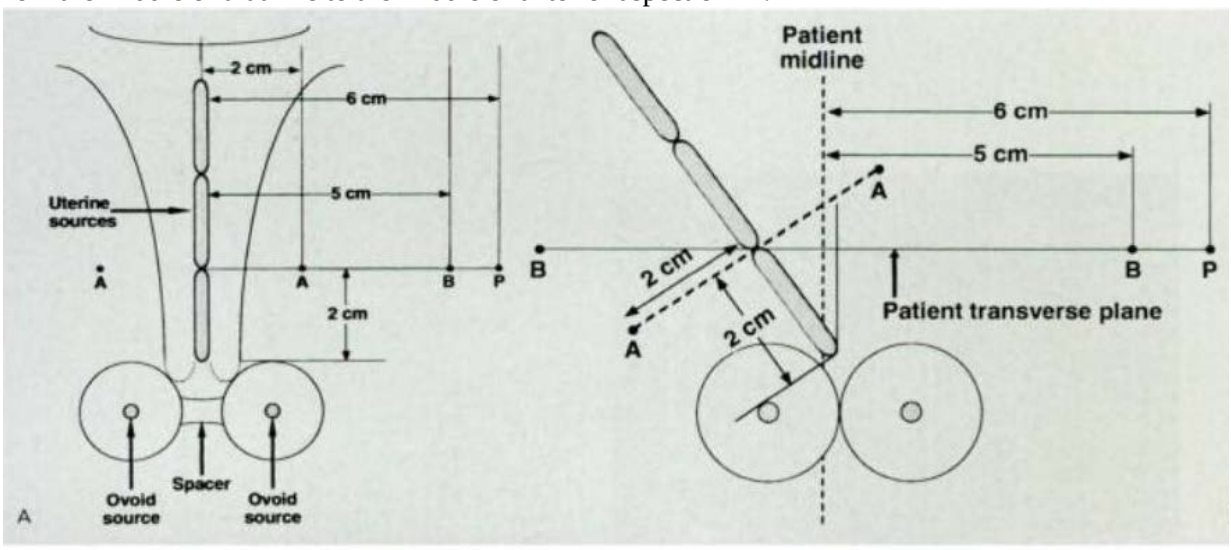


FIGURE 19.26. Definition of points A and B in an ideal application **(A)** and a distorted application **(B)**, which is displaced to the left of the patient's midline, and a uterus, which is tilted toward the right. Note that point A is carried with the uterus, whereas points B and P are defined to be 5 and 6 cm, respectively, to the right and left of patient midline. Point P is used by the Mallinckrodt Institute of Radiology System to specify minimum dose to the pelvic lymph nodes. (Adapted from Meredith WJ. Dosage for cancer of cervix uteri. In: Meredith WJ, eds. *Radium Dosage: The Manchester System*, 2nd ed. Edinburgh: E. & S, Livingston, Ltd, 1967;42–50, with permission.)

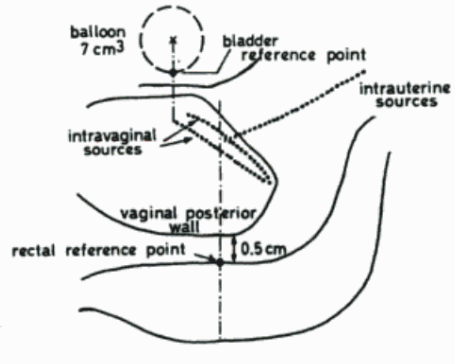


FIGURE 19.31. Reference points for bladder and rectal brachytherapy doses proposed by International Commission on Radiation Units and Measurements Report 38. (From ICRU. *Dose and volume specification for reporting intracavitary therapy in gynecology: Report 38.* International Commission of Radiation Units and Measurements, 1985, with permission.)

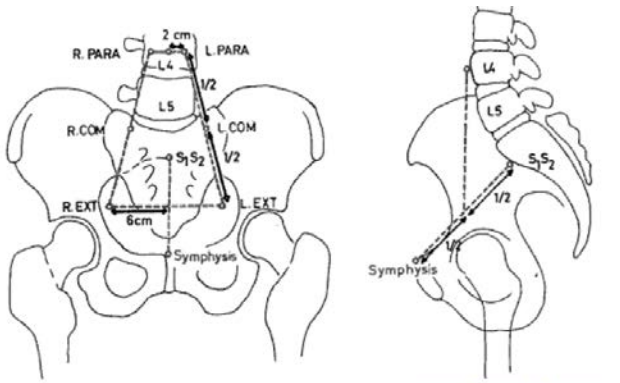


Figure 15.28. Determination of reference points corresponding to the lymphatic trapezoid of Fletcher. (From International Commission on Radiation Units and Measurements [ICRU]. *Dose and Volume Specification for Reporting Intracavitary Therapy in Gynecology.* ICRU Report No. 38. Bethesda, MD: International Commission on Radiation Units and Measurements; 1985, with permission.)

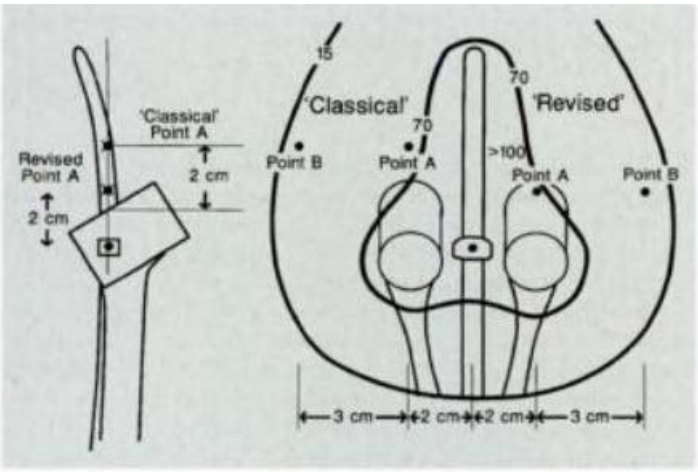


FIGURE 19.29. Radiographic definition of classical point A (2 cm above the cephalic-most aspect of the colpostat in the tilted coronal plane) and the revised point A (2 cm above the cervical collar top or center). Because the distance from caudal-most intrauterine source tip to colpostat center (tandem-to-colpostat displacement) varies from patient to patient, the vaginal contribution to revised point A is highly variable. (From Potish RA, Gerbi BJ. Role of point A in the era of computerized dosimetry. *Radiology* 1986;158:827–831, with permission.) The revised definition was suggested in Tod M, Meredith WJ. Treatment of cancer of the cervix uteri: A revised Manchester method. *Br J Radiol* 1953;26:252–257.

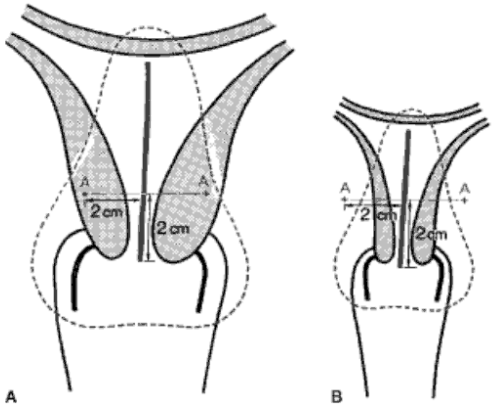


Figure 15.24. Variation of point *A* relative to anatomy. **A:** Point *A* inside large cervix, resulting in underdosage. **B:** Point *A* outside small cervix, resulting in overdosage. (From Pierquin B, Wilson JF, Chassagne D, eds. *Modern Brachytherapy*. New York: Masson; 1987, with permission.)

3. LDR Brachytherapy:

1) Small volume disease:
   Brachytherapy alone: 6500cGy (Cs) or 7500cGy (Ra) to point A in 2 fx (7-10days apart)
   EBRT + brachytherapy: AP+PA parallel pair with wedge (give 50% dose to point A and 100% dose to point B), 3250cGy in 16fx, then followed by *brachytherapy*: 2 insertion fx 7-10 days apart, giving 6000cGy to point A.
2) Enlarged pelvic lymph nodes:
   EBRT: 4-field box, 4000cGy in 20fx
   Brachytherapy: single fraction of 3250cGy to point A
3) Bulk central disease and no evidence of nodes:
   EBRT: 4-field box, 4000-4500cGy
   Brachytherapy: single insertion giving 2000-2500cGy to point A

LDR TX Techniques:

- Intrauterine tube: 4-6cm in length with a flange, angle at 40 degree to the vagina. The Fletcher type tube have varying degrees of curvature which allows to draw uterus into a central position in the pelvis away from the pouch of Douglas, the sigmoid colon, and the anterior rectal wall.
- Dose rate checked at rectal wall: can be measured by chamber in contact with the arterial rectal wall. The dose should be kept below 2/3 (or 60%) of the dose to point A (80% from Eric). In IU manual, the rectum total dose needs to be less 65Gy and bladder less than 70Gy. Gauze can be re-packed to adjust dose to rectal wall. For Selectron LDR, the source position in ovoid can be adjusted (position 1, 5 to 2, 6) to reduce rectum dose.
- Rectum is more radio-sensitive than bladder.
- Dose rate: manually loaded radium/cesium Manchester (53cGy/hr) vs. Selectron LDR (140-180cGy/hr) (50-60cGy per Eric. Higher dose rate may cause more complications. Low dose rate (about 40cGy) is used if protection of OAR has high priority). DR is also considered based on total time of treatment.
- Larger ovoids result in a lower bladder and rectal dose but higher point B does; longer uterine tandems produce a lower rectal dose and higher point B dose. [Per Eric, tandems usually have the same length, but different curvature radius. Basic ovoid size is 2cm in diameter and 3cm length. There are different caps to make the ovoid diameter of 2.5, 3cm. With different caps added, the position of point A also changes if it is measured from the top surface of ovoid.]
- Per Eric, two sessions of implants sometimes are used for bulky diseases. It is expected that the first fraction will help reduce tumor mass and improve the geometry for second implant.
- Foley catheter balloon filled with 7cc contrast used for bladder localization.

Complications:

- Acute reactions: bowel symptoms, menopause, vaginal fusion
- Late effects: bowel and rectal complications (6m to 10y) , hemorrhagic and necrotic, fibrotic, stenotic

4. HDR brachytherapy:

- Significant difference btw LDR/HDR: LDR is not necessarily combined with EBRT, particularly for early-stage disease, where HDR is, because using HDR alone entailed an impractical number of fractions.
  Early disease: the emphasis is usually on intra-cavitary irradiation; EBRT being used to boost the dose to pelvic lymph nodes to what is considered to be a max level
  Advanced and bulky stage IB disease: EBRT used to shrink the primary tumor to a size that can be adequately covered by intra-cavity brachytherapy.

- Optimal dose regime: Per ABS survey, median EBRT 48Gy and 50Gy + the median HDR dose is 6Gy x 5fx.
  Median EBRT 45Gy and 50Gy + median LDR dose of 42Gy and 45Gy for early and advanced cancer.

- Advantages:
  Out-patient, high throughput; less radiation dose to staff; short tx time makes it easy to retain tx applicator position; DR comparable to EBRT; better patient comfort and minimal risk of ischemia of vaginal vault epithelium
- Disadvantages:
  Increase fx number; increase in OR work load
- Special considerations:
  - Any change of distance between the ovoids and flange from one TX to another will have a greater effect on the point A dose when referenced from the flange.
  - It is not recommended that combined EBRT and HDR should be given on the same day
  - Rectal dose: <60% of point A dose
    Rectal retractor of different thickness can be used
    CT based planning, max rectal dose value obtained from a transverse CT slice near the top of vagina
  - Bladder dose:

Ref:

[1] ABS recommendations for low-dose-rate brachytherapy for carcinoma of cervix. Int. J Radiat Oncol, Biol Phys 52(1):33-48
[2] ICRU report 38

5. **Workflow for HDR Selectron Tandem-Ovoid implant (IU)**

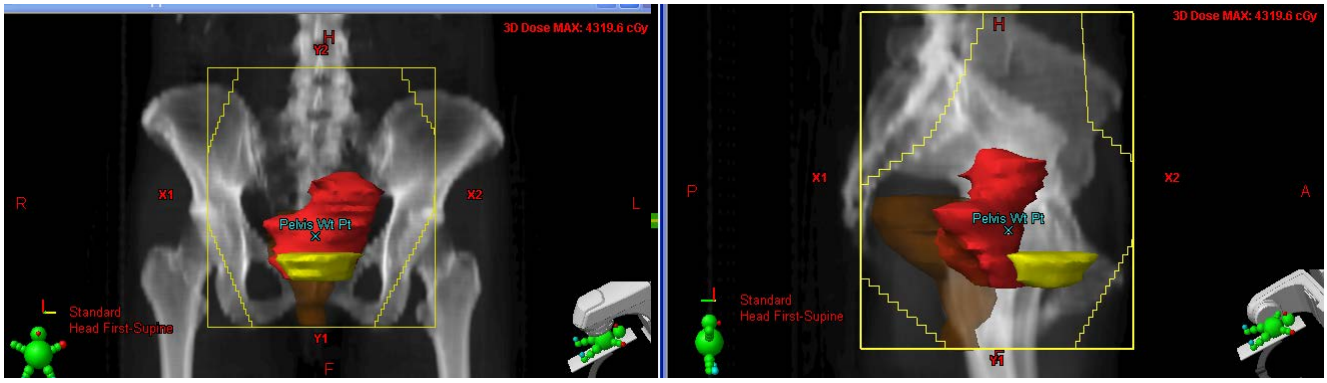
1) Applicator loaded with dummy and film acquisition
   (AP 85kVp, 40mAs, LAT 120-135kVp, 100mAs); communicate with physician for prescription; size of ovoid (caps), position of point A eta.
2) Film localization:
   a. Align two film with x-axis; check magnification; check top position of tandem, bladder balloon on both films to make sure no patient motion between two films.
   b. Localize ovoid:
   c. Localize tandem:
   d. Localize anatomic points:

3) Planning
   a. Login as user “plato”, no password needed

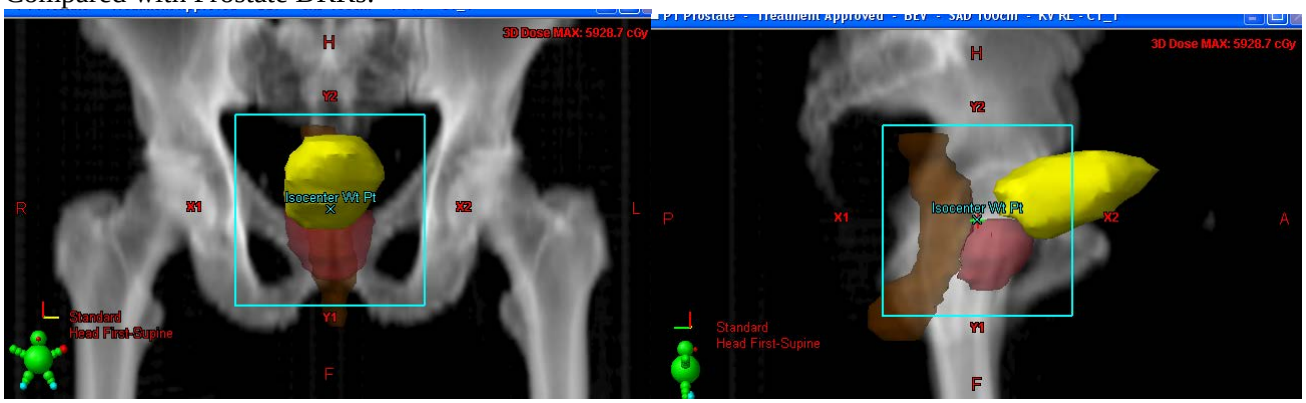
b. Click planning
c. Click new case -> input patient info, case info, study info, apply changes
d. File -> load machine customization file
e. “setup” -> film setup
f. calibrate digitizer and film
g. recon catheter
h. recon anatomic points
i. assign source position
j. prescribe to pt A.
k. output check

4) Loading
   a. Turn on air supplier
   b. Key on power of machine
   c. Programming machine for QA
   d. Expose film
   e. Programming machine according to plan
   f. Connect tubes
   g. Start treatment, area survey, documentation

DRRs for 4 field box EBRT treatment



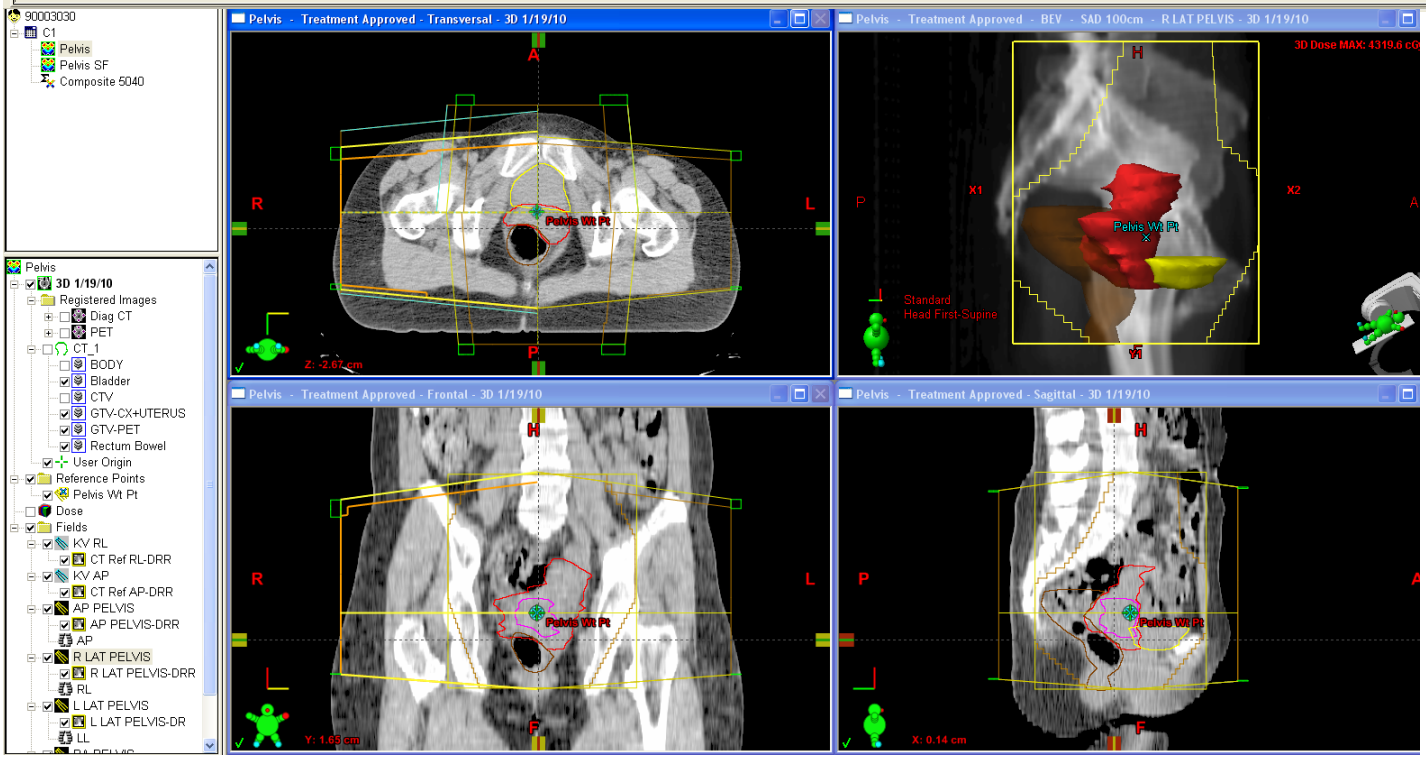
Compared with Prostate DRRs:

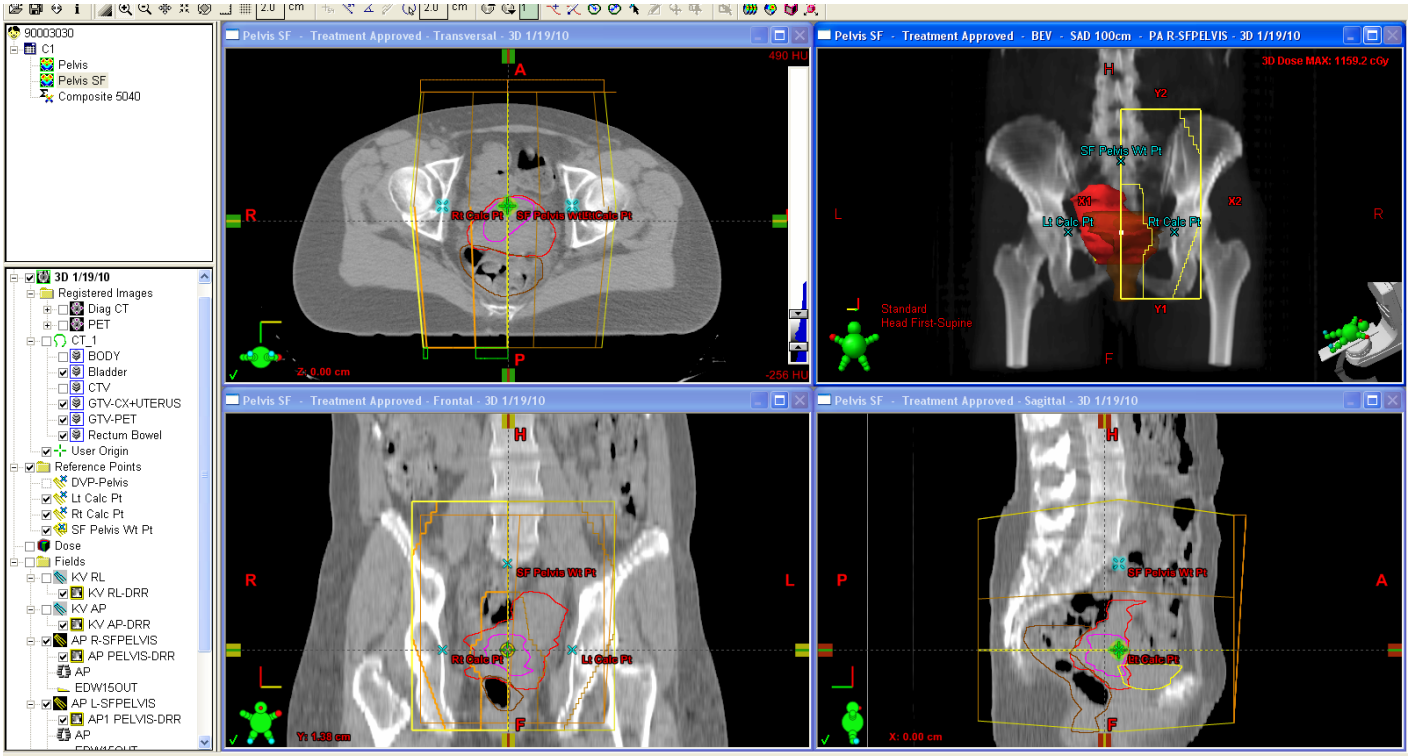


Selection | Registration | Contouring | Field Setup | Plan Evaluation

Fields | Dose Prescription | Field Alignments | Plan Objectives | Optimization Objectives | Dose Statistics | Calculation Models | Plan Sum

Group	Field ID	Technique	Machine/Energy	MLC	Field Weight	Scale	Gantry Rtn [deg]	Coll Rtn [deg]	Couch Rtn [deg]	Wedge	Field X [cm]	X1 [cm]	X2 [cm]	Field Y [cm]	Y1 [cm]	Y2 [cm]	X [cm]	Y [cm]	Z [cm]	SSD [cm]	MU	Ref. D [cGy]
☑	KV RL	STATIC-I	IUTRILOGY1 - 6X		0.00	Varian IEC	270.0	0.0	0.0	None	20.0	+10.0	+10.0	21.5	+7.5	+14.0	0.0	0.0	0.0	81.5		
☑	KV AP	STATIC-I	IUTRILOGY1 - 6X		0.00	Varian IEC	0.0	0.0	0.0	None	20.0	+10.0	+10.0	21.5	+7.5	+14.0	0.0	0.0	0.0	90.4		
☑	AP PELVIS	STATIC-I	IUTRILOGY1 - 16X	Static	1.00	Varian IEC	0.0	0.0	0.0	None	19.0	+9.0	+10.0	21.5	+7.5	+14.0	0.0	0.0	0.0	90.4	39	52.7
☑	R LAT PELVIS	STATIC-I	IUTRILOGY1 - 16X	Static	1.00	Varian IEC	270.0	0.0	0.0	None	17.5	+9.5	+8.0	21.5	+7.5	+14.0	0.0	0.0	0.0	81.5	51	84.2
☑	L LAT PELVIS	STATIC-I	IUTRILOGY1 - 16X	Static	1.00	Varian IEC	90.0	0.0	0.0	None	17.0	+7.5	+9.5	21.5	+7.5	+14.0	0.0	0.0	0.0	81.8	50	82.8
☑	PA PELVIS	STATIC-I	IUTRILOGY1 - 16X	Static	1.35	Varian IEC	180.0	0.0	0.0	None	19.0	+10.0	+9.0	21.5	+7.5	+14.0	0.0	0.0	0.0	87.9	56	81.1





Group	Field ID	Technique	Machine/Energy	MLC	Field Weight	Scale	Gantry Rtn [deg]	Coll Rtn [deg]	Couch Rtn [deg]	Wedge	Field X [cm]	X1 [cm]	X2 [cm]	Field Y [cm]	Y1 [cm]	Y2 [cm]	X [cm]	Y [cm]	Z [cm]	SSD [cm]	MU	Ref. D [cGy]
☑	KV RL	STATIC-I	IUTRILOGY1 - 6X		0.00	Varian IEC	270.0	0.0	0.0	None	20.0	+10.0	+10.0	21.5	+7.5	+14.0	0.0	0.0	0.0	81.5		
☑	KV AP	STATIC-I	IUTRILOGY1 - 6X		0.00	Varian IEC	0.0	0.0	0.0	None	20.0	+10.0	+10.0	21.5	+7.5	+14.0	0.0	0.0	0.0	90.4		
☑	AP R-SFPELVIS	STATIC-I	IUTRILOGY1 - 16X	Static	1.20	Varian IEC	0.0	0.0	0.0	EDW15OUT	9.0	+9.0	+0.0	21.5	+7.5	+14.0	0.0	0.0	0.0	90.4	101	
☑	AP L-SFPELVIS	STATIC-I	IUTRILOGY1 - 16X	Static	1.20	Varian IEC	0.0	0.0	0.0	EDW15OUT	10.0	-0.0	+10.0	21.5	+7.5	+14.0	0.0	0.0	0.0	90.4	103	
☑	PA L SFPELVIS	STATIC-I	IUTRILOGY1 - 16X	Static	0.99	Varian IEC	180.0	0.0	0.0	None	10.0	+10.0	+0.0	21.5	+7.5	+14.0	0.0	0.0	0.0	87.9	85	
☑	PA R-SFPELVIS	STATIC-I	IUTRILOGY1 - 16X	Static	1.01	Varian IEC	180.0	0.0	0.0	None	9.0	-0.0	+9.0	21.5	+7.5	+14.0	0.0	0.0	0.0	87.9	87	