



# 2020 AAPM/COMP Partners In Solutions

## Use of Xoft Cervical Applicators

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# Disclosure / Conflict of Interest

I am an employee of Xoft, a subsidiary of iCAD

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# Xoft AXXENT® HDR Electronic Brachytherapy System



Controller



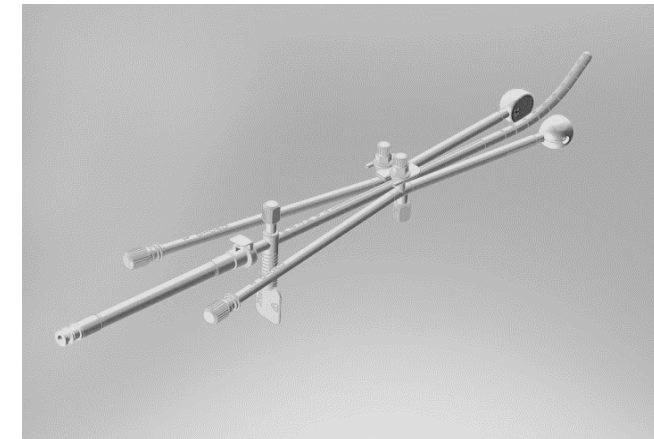
Disposable Balloon Applicators



Vaginal Applicators



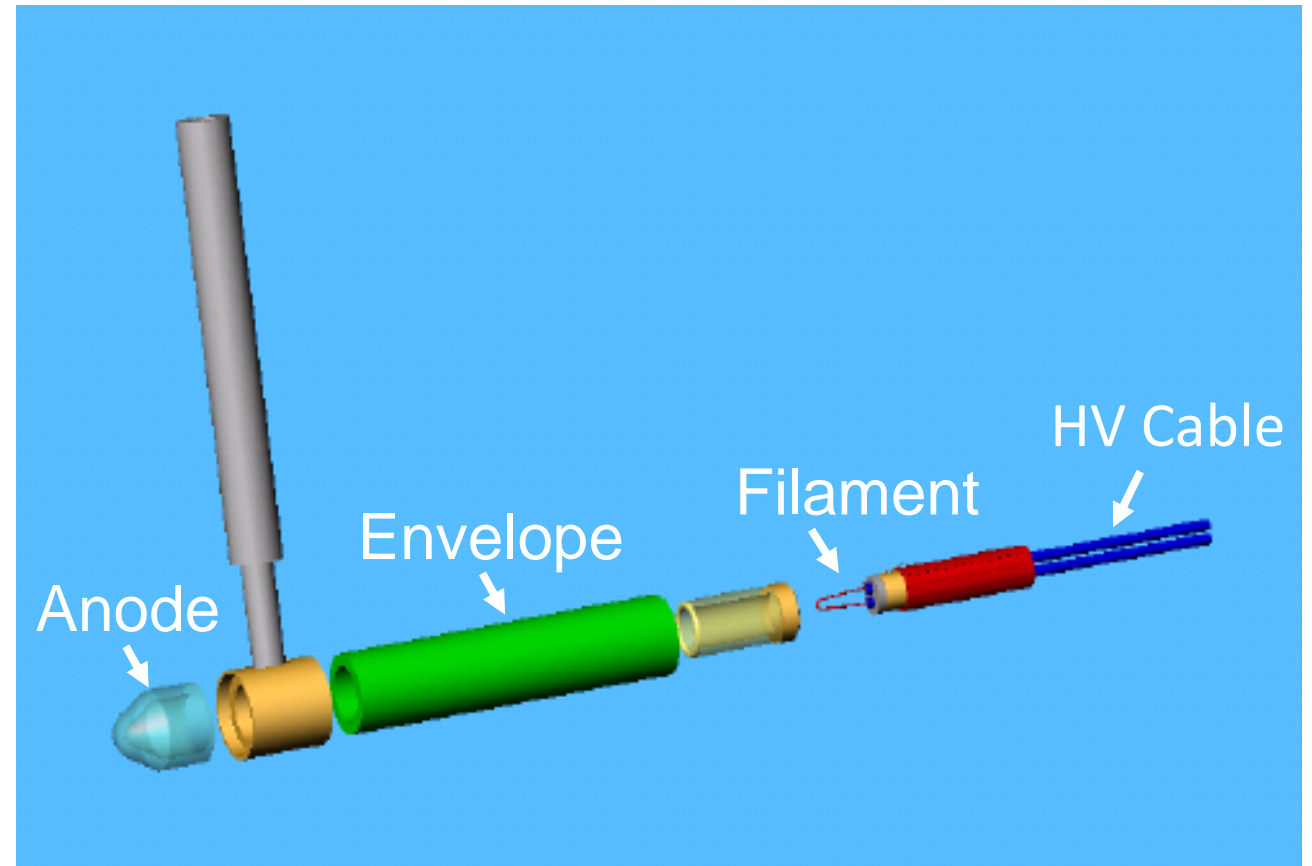
Surface Applicators



Cervical Applicator

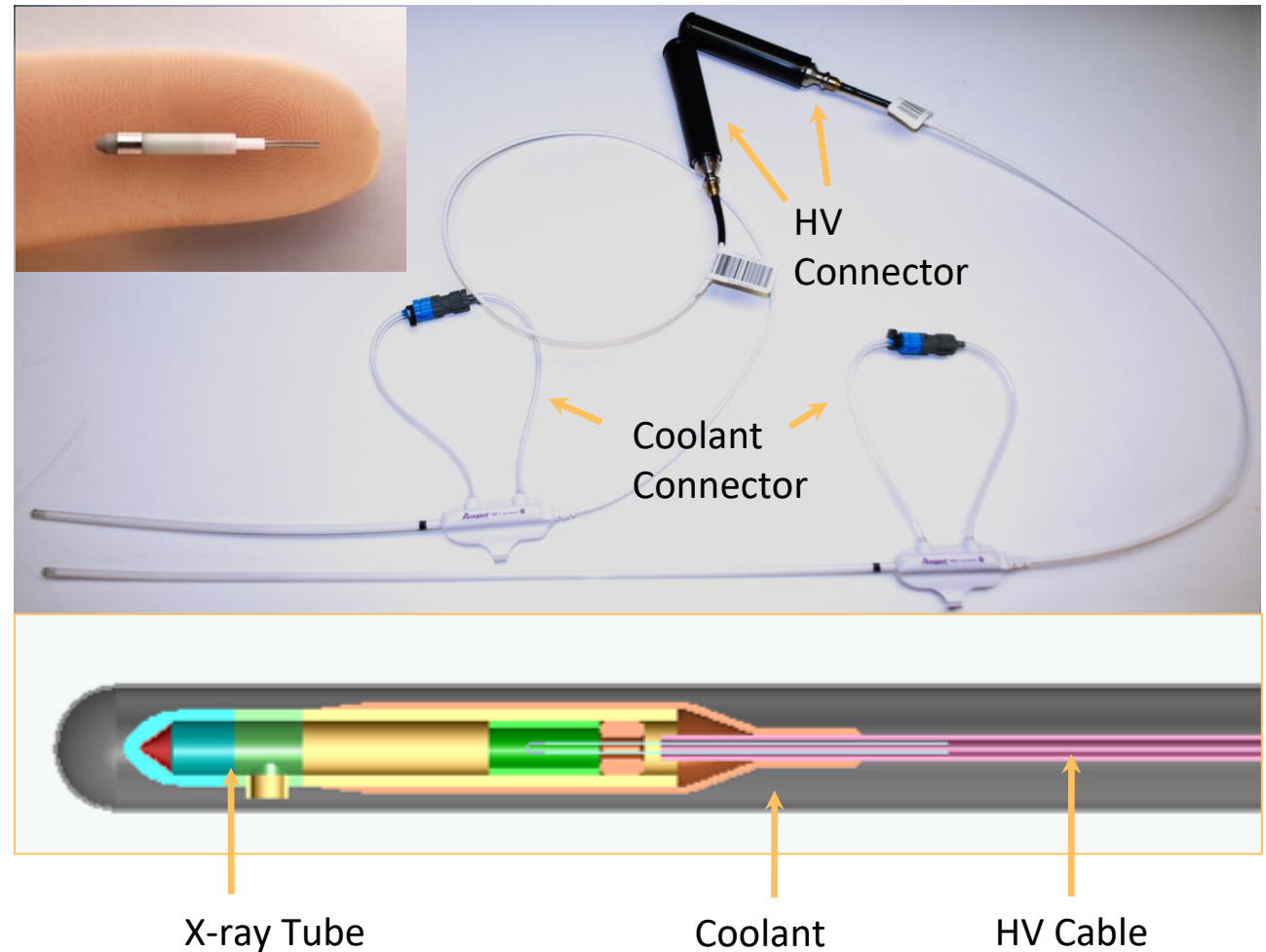
# Xoft AXXENT<sup>®</sup> HDR X-ray Source

- 2.3 mm diameter
- 15 mm length
- Standard high vacuum x-ray tube technology
- Operates at 50 kV and 300  $\mu$ A (15 Watts)
- Avg energy:  $\sim$ 28 kV
- Doserate in water: 14 Gy / min @ 1 cm



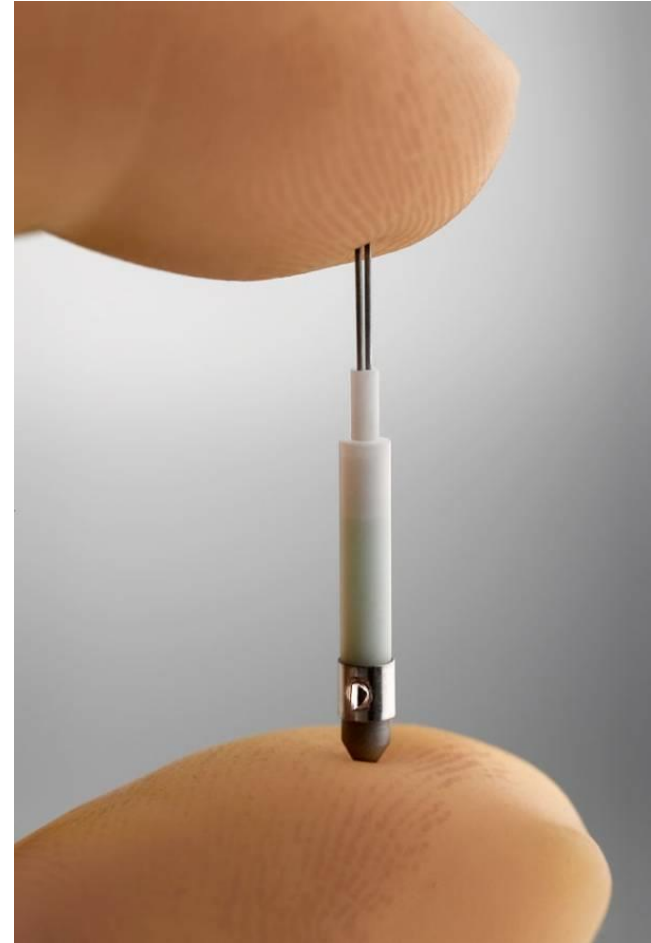
# Xoft AXXENT® HDR Source Catheter

- X-ray source embedded in tip of a flexible cooling catheter
- Available in 2 lengths
  - 25 cm (standard)
  - 50 cm (cervical)
- Up to 1500 min beam-on time
- Fully disposable



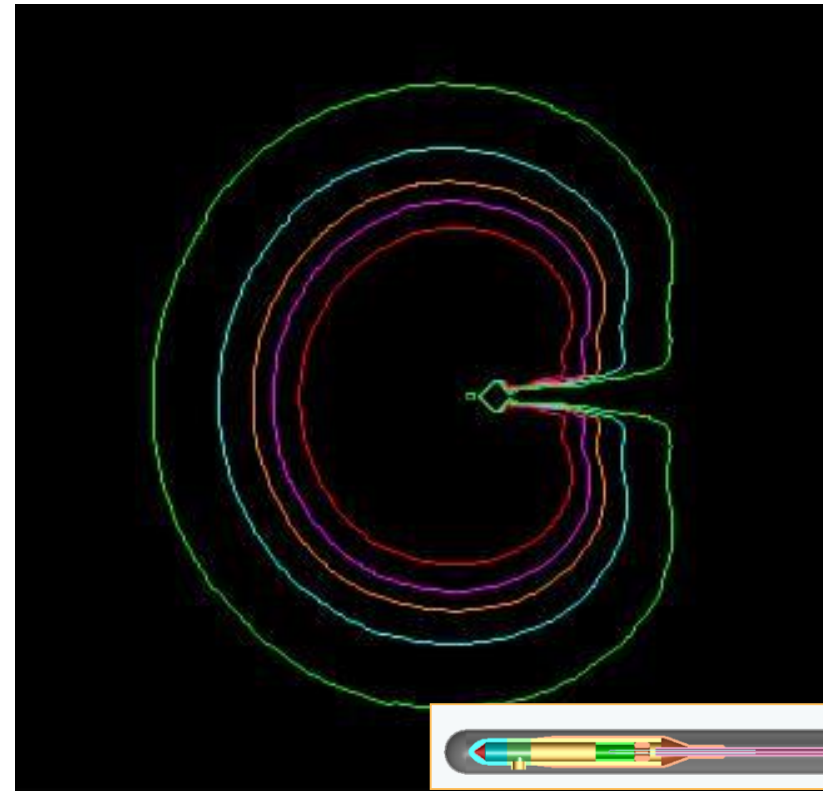
# Xoft AXXENT® HDR X-ray Source Dosimetry

- In-water dosimetry data were measured and MC calculated following AAPM TG-43 UI dosimetry protocol
- Data published by Rivard, et al, in Medical Physics 33 (11) November 2006
- NIST calibration standard in 2014



# Xoft AXXENT<sup>®</sup> HDR X-ray Source Dosimetry

- Sample dose distribution from Xoft x-ray source
- Green dot denotes location of source anode
  - Can be treated as a point source due to 1 mm effective length\*
- Essentially a point source with 2D anisotropy

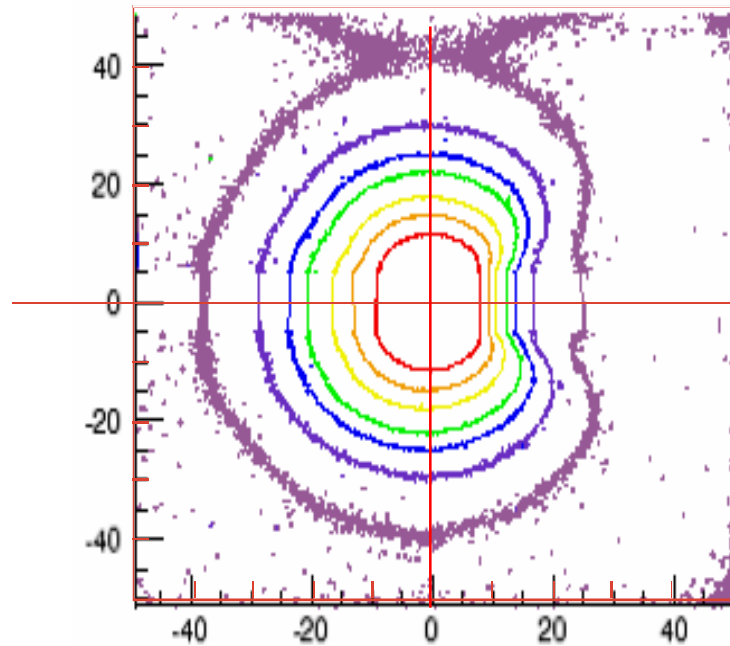


Source Catheter

\* Rivard, et al: Medical Physics 33(11) "Calculated and measured brachytherapy dosimetry parameters in water for the Xoft Axxent X-Ray Source"



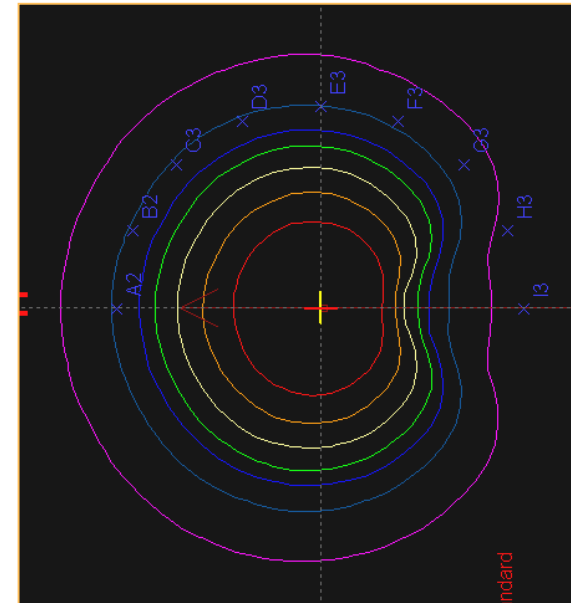
# Xoft AXXENT<sup>®</sup> HDR X-ray Source Dosimetry



Delivered Dose Distribution On Film

Film 40A01

D (Gy)	Color
34	Red
17	Orange
10.2	Yellow
6.8	Green
5.1	Blue
3.4	Dark Blue
1.7	Magenta



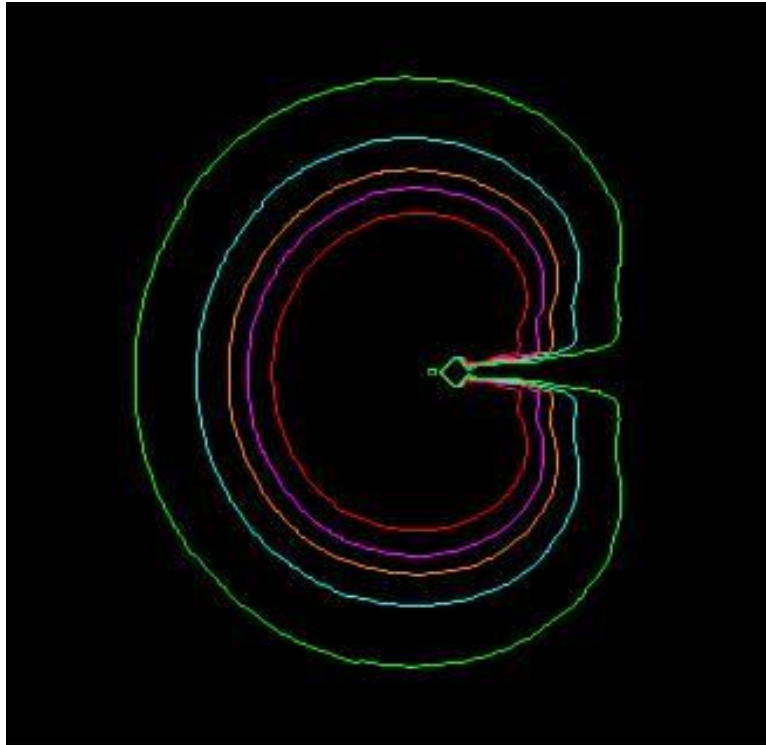
Dose Distribution From TPS

40 kV Probe in BrachyVision<sup>®</sup>

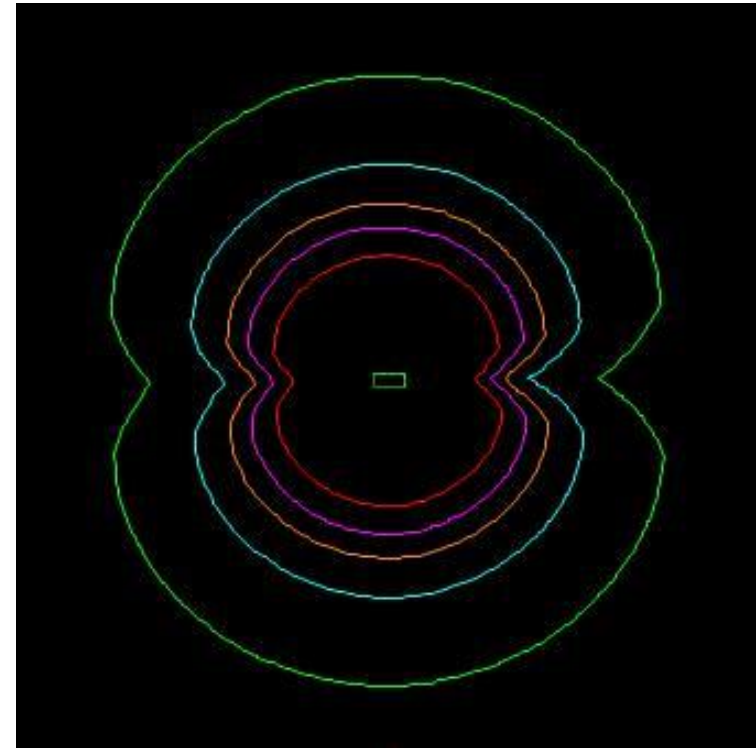
D (Gy)	Color
34	Red
17	Orange
10.2	Yellow
6.8	Green
5.1	Blue
3.4	Dark Blue
1.7	Magenta

TG43 formalism accurately represent the source characteristics

# Xoft AXXENT<sup>®</sup> HDR X-ray Source Dosimetry



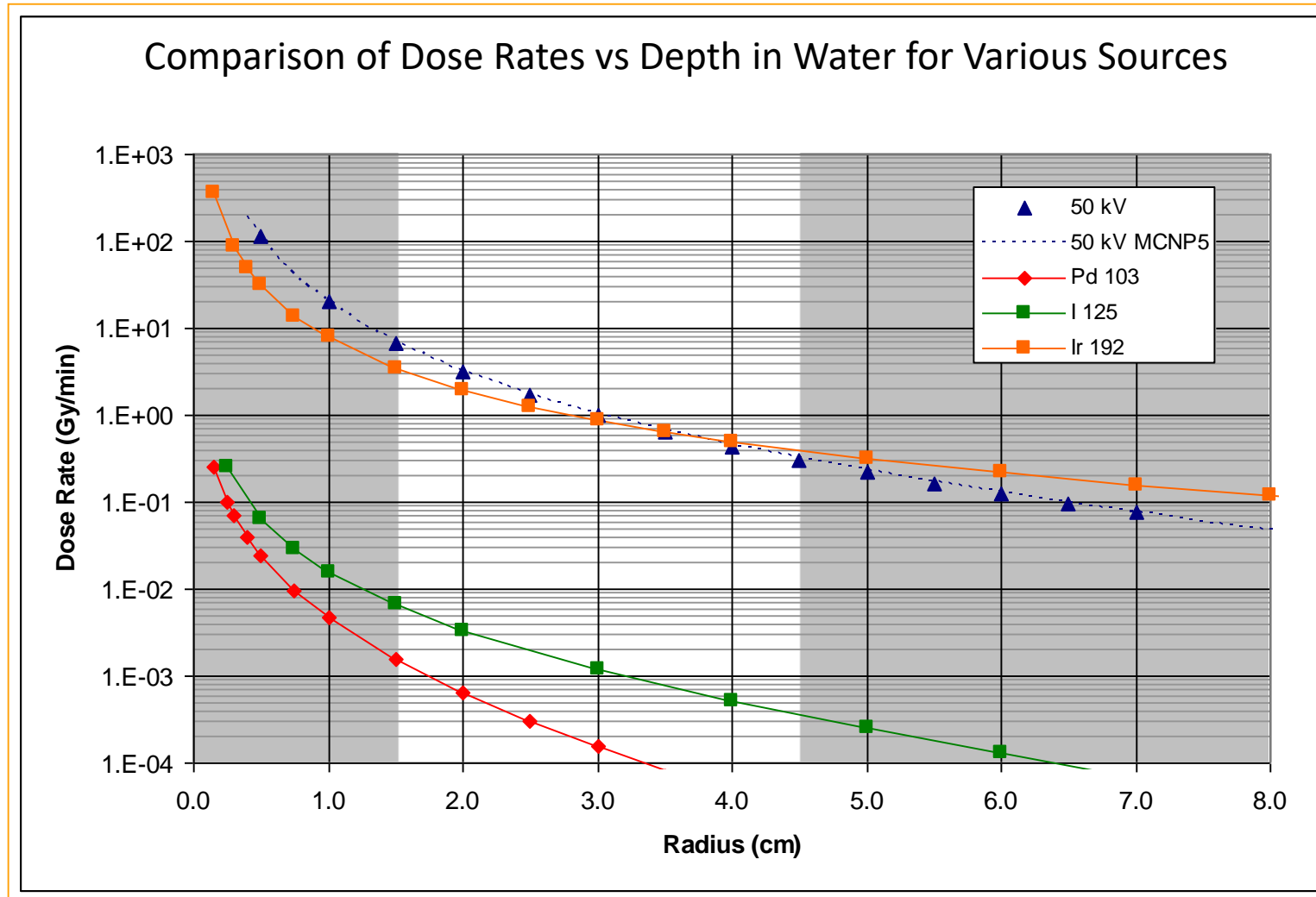
Xoft x-ray source



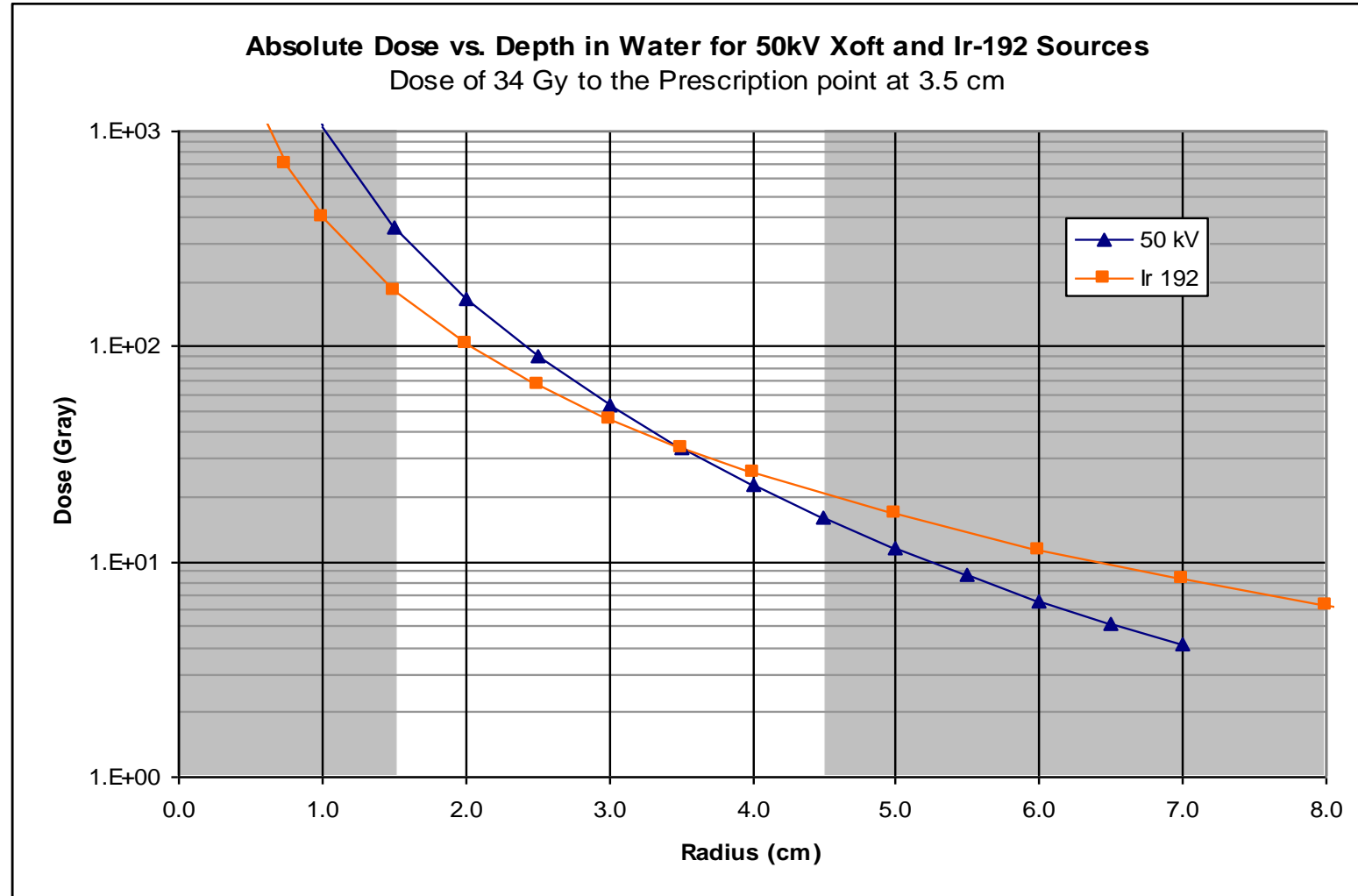
Ir-192 source

Dose distribution comparison between x-ray and Ir-192 source

# Xoft AXXENT® HDR X-ray Source Dosimetry



# Xoft AXXENT<sup>®</sup> HDR X-ray Source Dosimetry

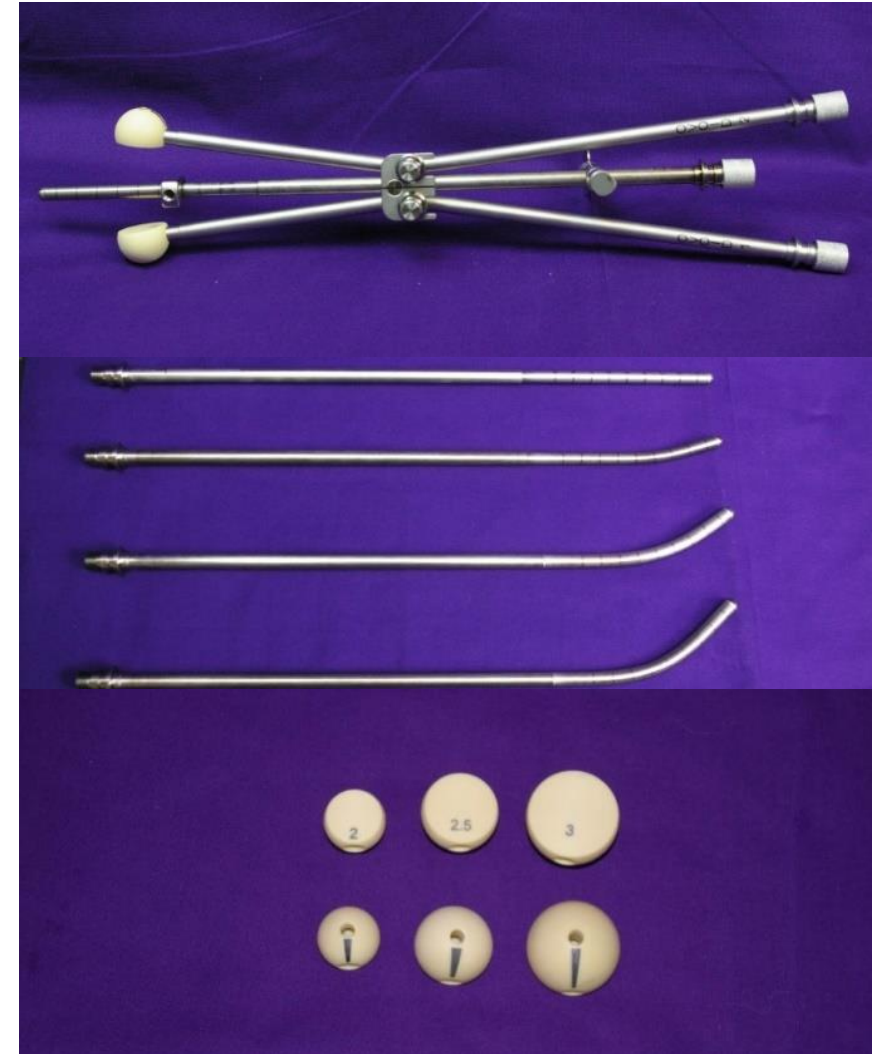


# Xoft AXXENT® Cervical Applicator



# Xoft AXXENT<sup>®</sup> Cervical Applicator

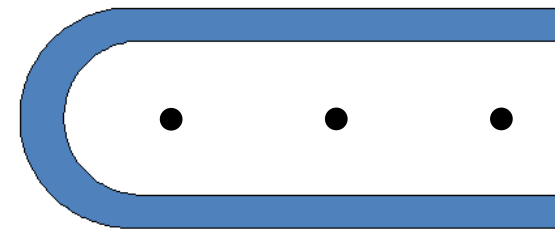
- Henschke type applicator
- Thin wall Ti design
  - CT compatible
  - MR conditional
- Multiple tandem angles
  - 0° , 15° , 30° and 45°
- Multiple ovoid diameters (unshielded)
  - 2.0 cm, 2.5 cm and 3.0 cm
- Use with 50 cm source



# Modified TG-43 Dosimetry For Cervical Applicator

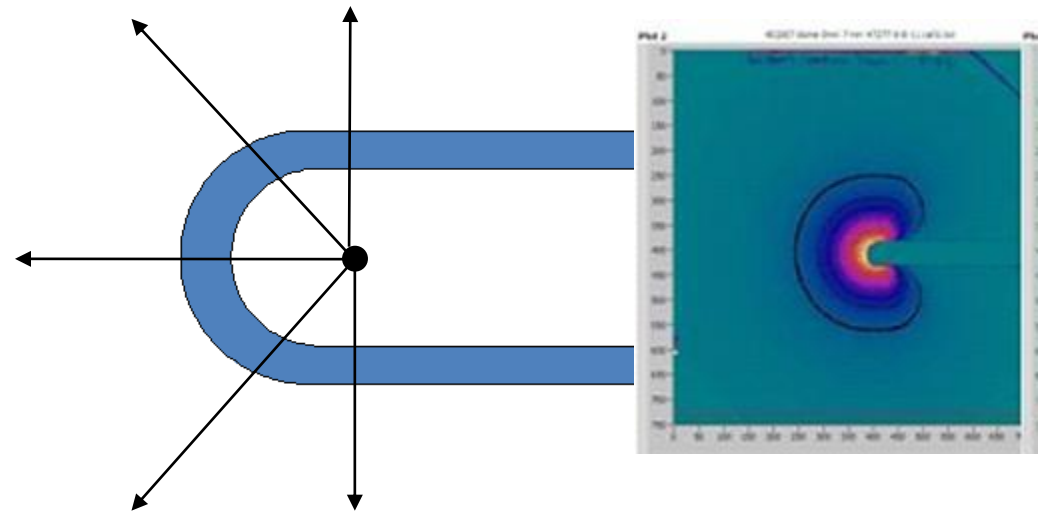
Due to the 50 kV energy

- Filtration effects from the Ti material must be accounted for
- Amount of filtration depends on position of source within the applicator
- Modification of water-based TG-43 source data is required



# Modified TG-43 Dosimetry For Cervical Applicator

- The source at first dwell position near the tip of the applicator will “see” a fairly uniform wall thickness
- Forward directed dose will attenuate uniformly through the Titanium
- Beam will also harden in a relatively uniform manner

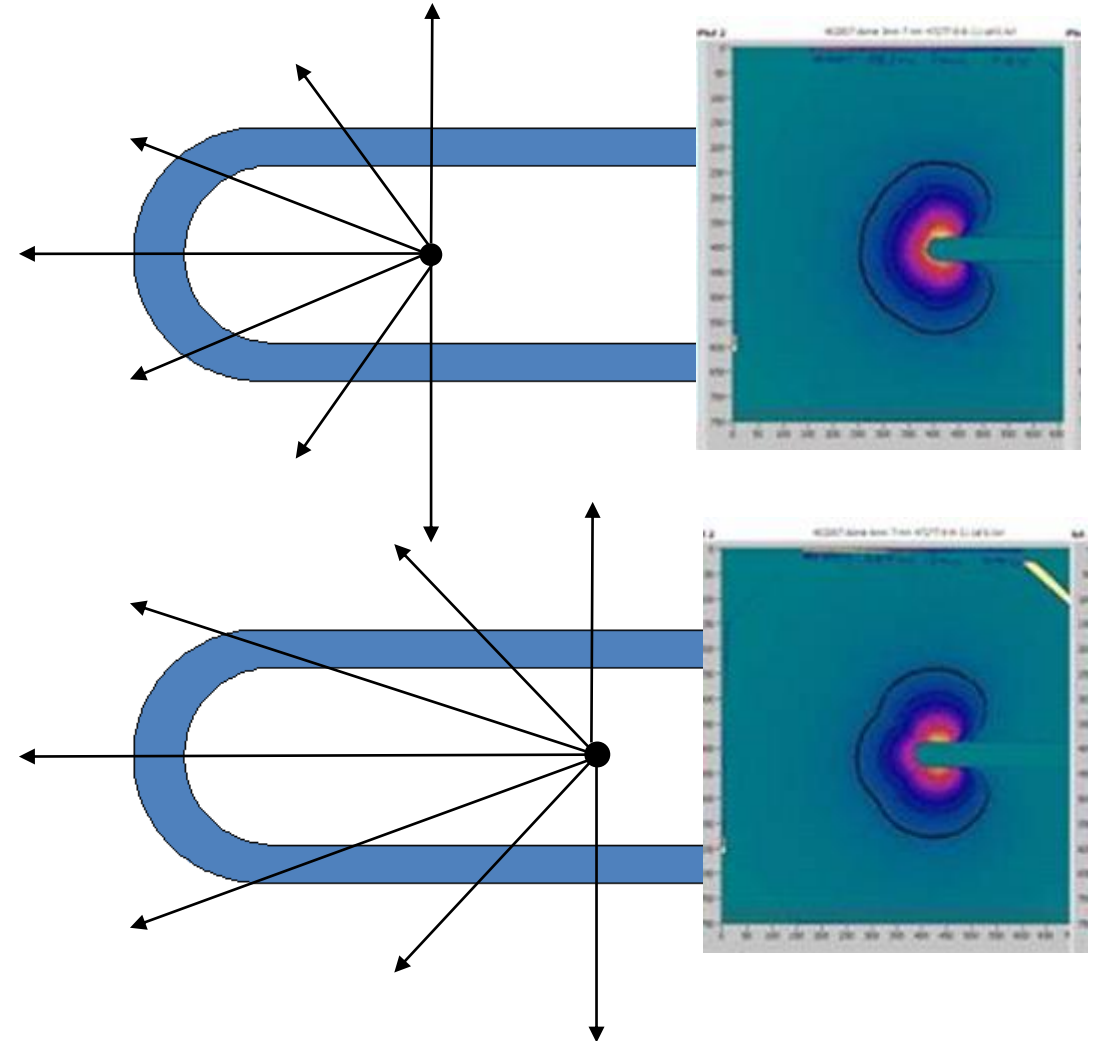




# Modified TG-43 Dosimetry For Cervical Applicator

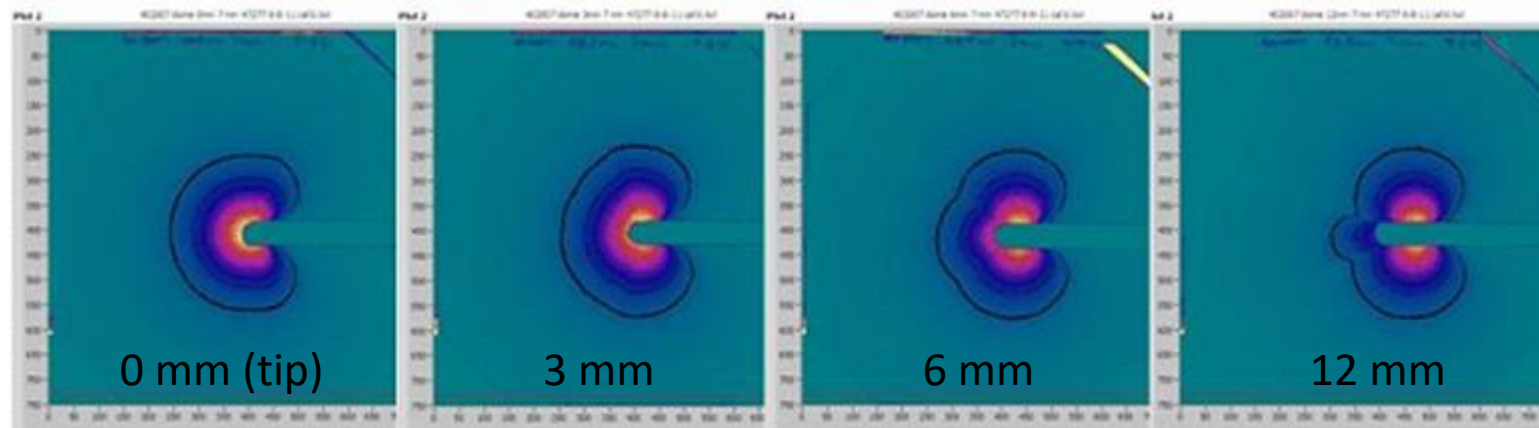
When source is stepped back

- Some x-rays become oblique to the applicator wall
- Amount of wall material traversed increases for those rays
- Filtration will vary depending on obliqueness of the x-rays



# Modified TG-43 Dosimetry For Cervical Applicator

- Current Xoft water-based TG-43 source dataset does not correct for dose heterogeneities caused by the Titanium cervical applicator
- Must have new TG-43 source dataset to correctly model the Ti-filtration
  - One dataset for each position between 0 mm and 12 mm
  - Positions beyond 12 mm can use the 12 mm dataset
- Xoft provides Ti-filtered source datasets for dwell positions at 0 mm, 3 mm, 6 mm and 12 mm



# Xoft Cervical Applicator Treatment Planning

The screenshot displays the Xoft Cervical Applicator Treatment Planning software interface. The main window shows a CT scan of a cervical applicator with isodose lines overlaid. The isodose lines are labeled with dose values: 17.500, 14.000, 10.500, 7.000, 3.500, and 1.500 Gy. The applicator is labeled with 'RIB', 'RIA', 'LIA', 'LOB', 'RO', and 'LO'. A green robot icon is visible in the bottom left corner, and the text 'Head First-Supine' is at the bottom center.

The left sidebar shows the treatment plan details for 'Plan: Compare Xoft'. The 'Image: CT\_1' section includes 'Registered Images' (CT\_1, MR\_1session Ax), 'Structure Set: CT\_1', and 'User Origin'. The 'Reference Points' section includes 'Dose Matrix: Dose', 'Fields', and 'Fields' (T 0mm, Channel 1; T 3mm, Channel 2; T 6mm, Channel 3; T 12mm, Channel 4; RO 0mm, Channel 5; RO 6mm, Channel 6; RO 12mm, Channel 7; LO 0mm, Channel 8; LO 6mm, Channel 9; LO 12mm, Channel 10). The 'Radiographs' section is also visible.

The bottom table shows the 'Dose Prescription' and 'Dose Statistics' for the treatment plan.

Fractionation Id	Dose / Fraction [Gy]	Number of Fractions	Total Dose [Gy]	Primary Reference Point	Total Dose at Primary [Gy]	Relative Dose at Primary [%]	Prescribed Percentage [%]	Plan Normalization Mode	Plan Normalization Value [%]
F1	7.000	1	7.000				100.0	Plan Normalization Value: 100.00	100.0

The bottom navigation bar includes 'Contouring', 'Brachytherapy Planning', and 'Plan Evaluation'.

# Xoft Cervical Applicator Treatment Planning

The screenshot displays the Xoft Cervical Applicator Treatment Planning software interface. The main window shows a CT scan of a cervical applicator with isodose lines overlaid. The isodose lines are color-coded and labeled with their respective dose values in Gy: 17.500 (red), 14.000 (orange), 10.500 (yellow), 7.000 (green), 3.500 (light green), 2.500 (cyan), 1.500 (blue), and 0.000 (purple). The applicator is positioned in the center of the patient's head, with the cervical canal and surrounding structures visible. The patient's head is oriented in a supine position, as indicated by the 'Head First-Supine' label and the green robot icon in the bottom left corner. The software interface includes a menu bar at the top, a toolbar, and a left-hand panel with a tree view showing the patient information, course, and plan details. The bottom of the interface features a 'Dose Prescription' and 'Dose Statistics' table, and a navigation bar with tabs for 'Contouring', 'Brachytherapy Planning', and 'Plan Evaluation'.

**Plan: Compare Ir-192**

- Image: CT\_1
  - Registered Images
    - Image: CT\_1
    - Image: MR\_1sesion Ax
  - Structure Set: CT\_1
    - User Origin
  - Reference Points
    - Dose Matrix: Dose
    - Fields
      - T, Channel 1
      - RO, Channel 2
      - LO, Channel 3
    - Radiographs

Fractionation Id	Dose / Fraction [Gy]	Number of Fractions	Total Dose [Gy]	Primary Reference Point	Total Dose at Primary [Gy]	Relative Dose at Primary [%]	Prescribed Percentage [%]	Plan Normalization Mode	Plan Normalization Value [%]
F1	7.000	1	7.000				100.0	Plan Normalization Value: 100.00	100.0



Thank You!

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