

# **Dosimetry parameters of the Xoft AXXENT™ X-ray Source:**

## **A New High Dose Rate Electronic Brachytherapy Source**

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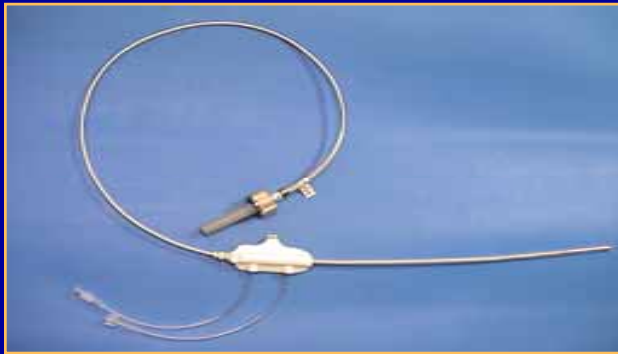
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# Source Overview

- ❖ New miniature x-ray source with a flexible HV cable
  - ❖ Actively cooled with circulating water
  - ❖ Retractable like a standard HDR  $^{192}\text{Ir}$  source
  - ❖ Characterized using TG-43U1 dosimetry protocol with
  - ❖ Measurements on at least 10 sources
  - ❖ Monte Carlo modeling using MCNP5
- 
- ❖ System presented here is for investigational use only:  
FDA approval is pending.

# Electronic Brachytherapy System Components



## Disposable HDR X-Ray Source

- Emulates BT radionuclides



## Disposable Applicators

- Multiple Shapes & Sizes



## Controller

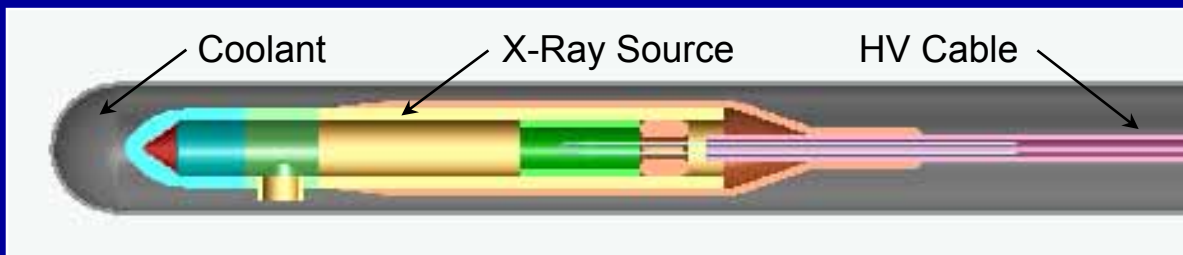
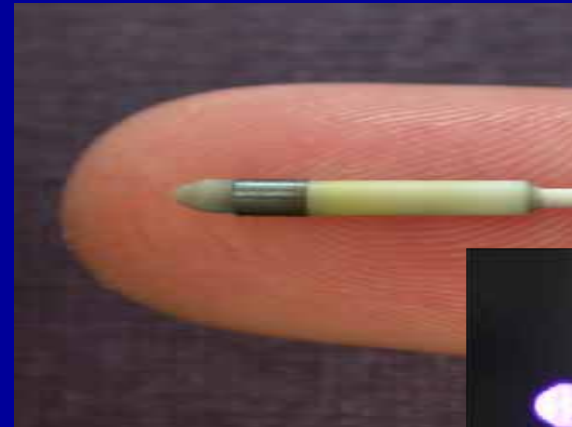
- Source output and position

For Investigational Use Only

# Miniature X-Ray Source

Miniature X-ray source with a flexible high voltage cable in a cooling catheter

- ❖ High vacuum x-ray tube technology
- ❖ 50 kVp operating potential
- ❖ Output:  $\sim 10$  Gy/min at 1cm in water
- ❖ Water-cooled
- ❖ Fully disposable device



X-Ray Source Tip Detail

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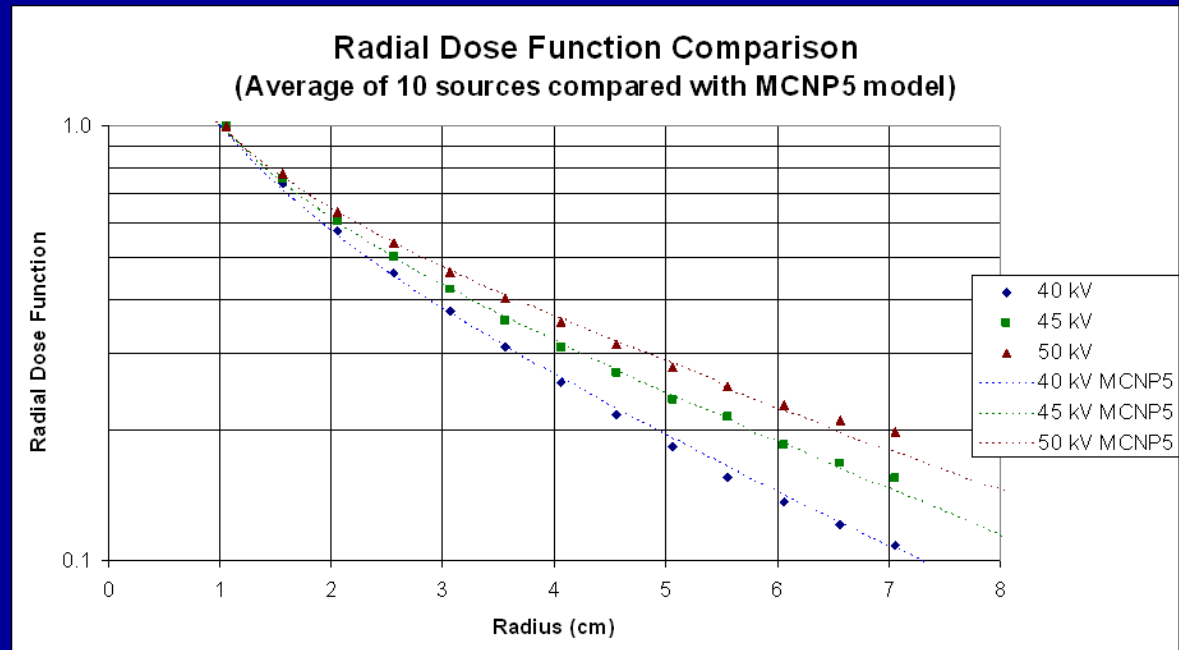
# Air Kerma Strength & Dose Rate Constant

- ❖  $S_k$  was measured with Standard Imaging HDR 1000 Plus calibrated with a 6711  $^{125}\text{I}$  seed (preliminary calibration)
- ❖ Interim calibration measurements are underway using the University of Wisconsin Medical Radiation Research Center Attix free air chamber
- ❖ Calibration studies have started using the NIST Attix free air chamber

<b>Air kerma strength (cGy*cm<sup>2</sup>*h<sup>-1</sup>) and Dose Rate Constant (cm<sup>-2</sup>)</b>			
	<b>40 kV</b>	<b>45 kV</b>	<b>50 kV</b>
<b>Air Kerma Strength</b>	32,600	51,200	74,500
<b>Dose Rate Constant</b>	1.19	1.12	1.07
<b>Std Deviation of DRC</b>	11%	6.9%	8.0%

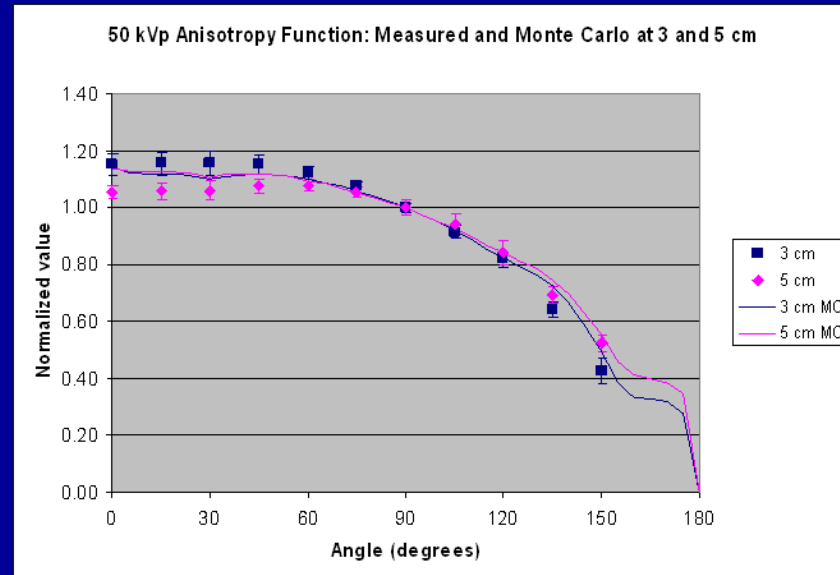
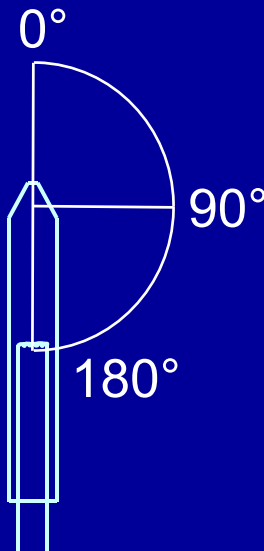
# Radial Dose Function, $g(r)$

- ❖ PTW 34013 soft x-ray ion chamber in water on a precision XYZ stage
- ❖ Measurements have  $SD \leq 5\%$  at each operating voltage
- ❖ Monte Carlo model using MCNP5 with EPDL97-based mcplib04 cross-section library
- ❖ Model included all source components
- ❖ Monoenergetic electron beam incident on anode
- ❖ Point source approximation
- ❖ Measurements and model agree to within  $\pm 6\%$



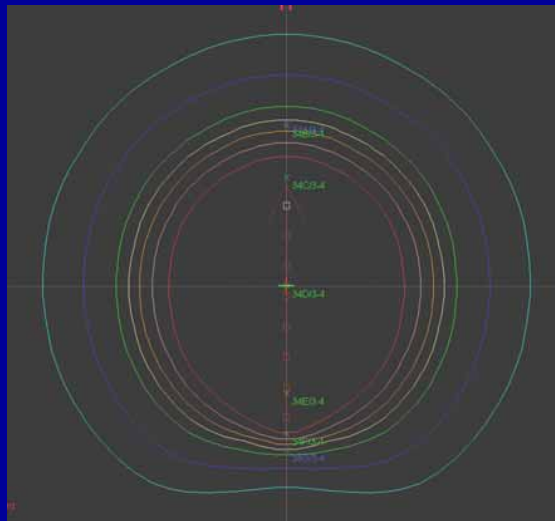
# 2-D Anisotropy Function, $F(r,\theta)$

- ❖ PTW 34013 soft x-ray ion chamber in solid water phantom
- ❖ Measured and calculated distributions agree within  $\pm 4\%$  at 5 cm
- ❖ Measured and calculated distributions agree within  $\pm 3\%$  at 3 cm to  $120^\circ$  and agree within  $\pm 7\%$  at  $135^\circ$  and  $150^\circ$
- ❖  $F(r,\theta)$  varies slowly with depth for  $r > 2$  cm

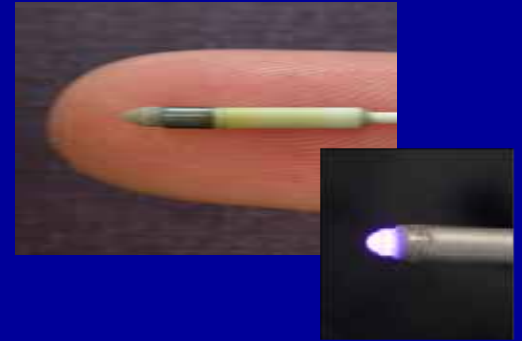


# Treatment Planning

- ❖ Source parameters  $g(r)$ ,  $F(r, \theta)$ ,  $SK$  and  $\Lambda$  were used in BrachyVision™ for animal trial dose plans with spherical and ellipsoidal balloons
- ❖ Plan isodose distributions were compared quantitatively with GAFCHROMIC® EBT film exposed in a water phantom
- ❖ Standard deviations from plan for prescription dose contours at 40 kV and 50 kV were  $7.5 \pm 2.5\%$



# Summary



- ❖ New miniature x-ray source for electronic brachytherapy was characterized experimentally and with Monte Carlo modeling
- ❖ TG-43U1 parameters have been determined using the point source approximation
- ❖ BrachyVision™ has been used for treatment planning with this new source

# Acknowledgements

- ❖ Prof. Larry DeWerd, Steven Davis, John Micka, Ben Palmer, Steve Beach and Dr. Tim Bohm, University of Wisconsin, Madison
- ❖ Dr. Sou-Tung Chiu-Tsao, Beth Israel Medical Center
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