TG-43U measurements of a miniature x-ray source for high dose rate brachytherapy

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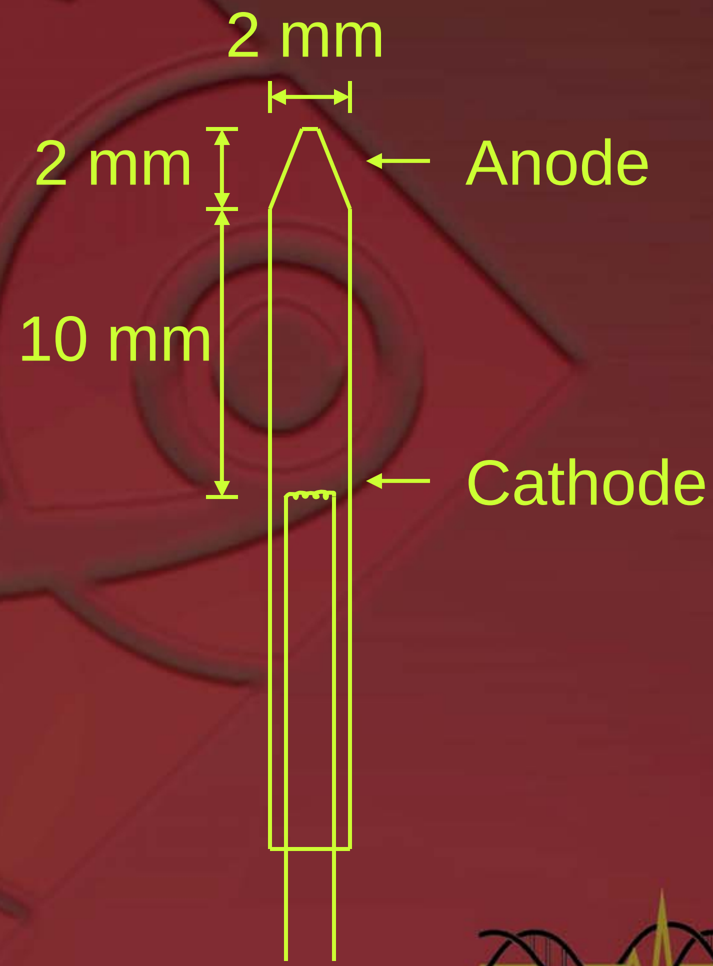
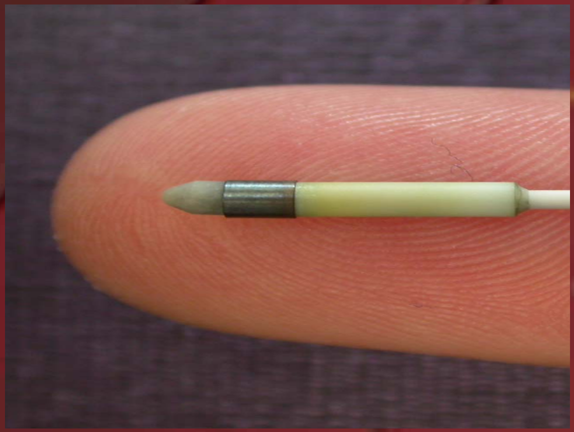
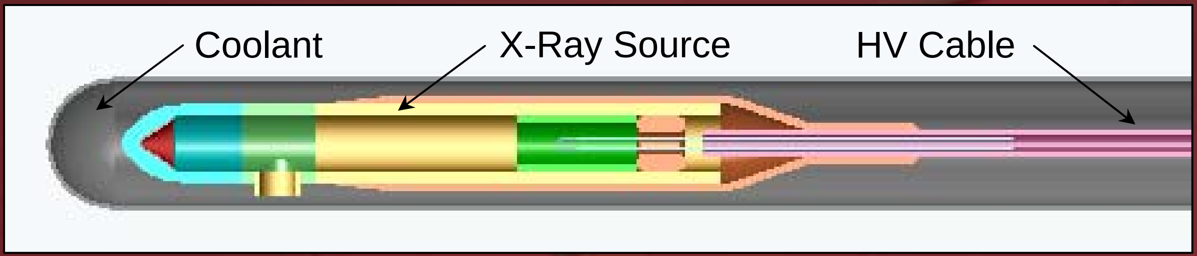
Source design

- X-ray source is ~ 2 mm diameter
- Placed in flexible water-cooled catheter of ~ 5 mm diameter
- Tube voltages from 40 kV to 50 kV
- Air kerma rates comparable to 370 GBq (10 Ci) HDR ^{192}Ir



Source design (cont.)





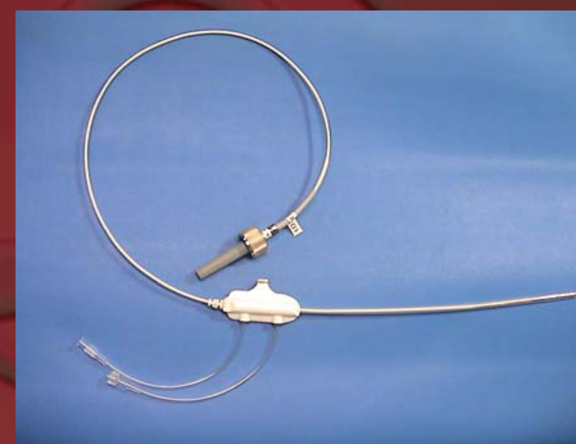
X-Ray Probe Tip Detail

Xoft system components

Balloon applicator

Power supply

Flexible x-ray probe



Project goals

- Full TG-43U characterization independent of manufacturer's in-house measurements
- Monte Carlo modeling of the source
- Development of standard for NIST-traceable calibration of sources
- Comparison to TG-61 protocol (external kilovoltage x-ray beams)

TG-43U measurements

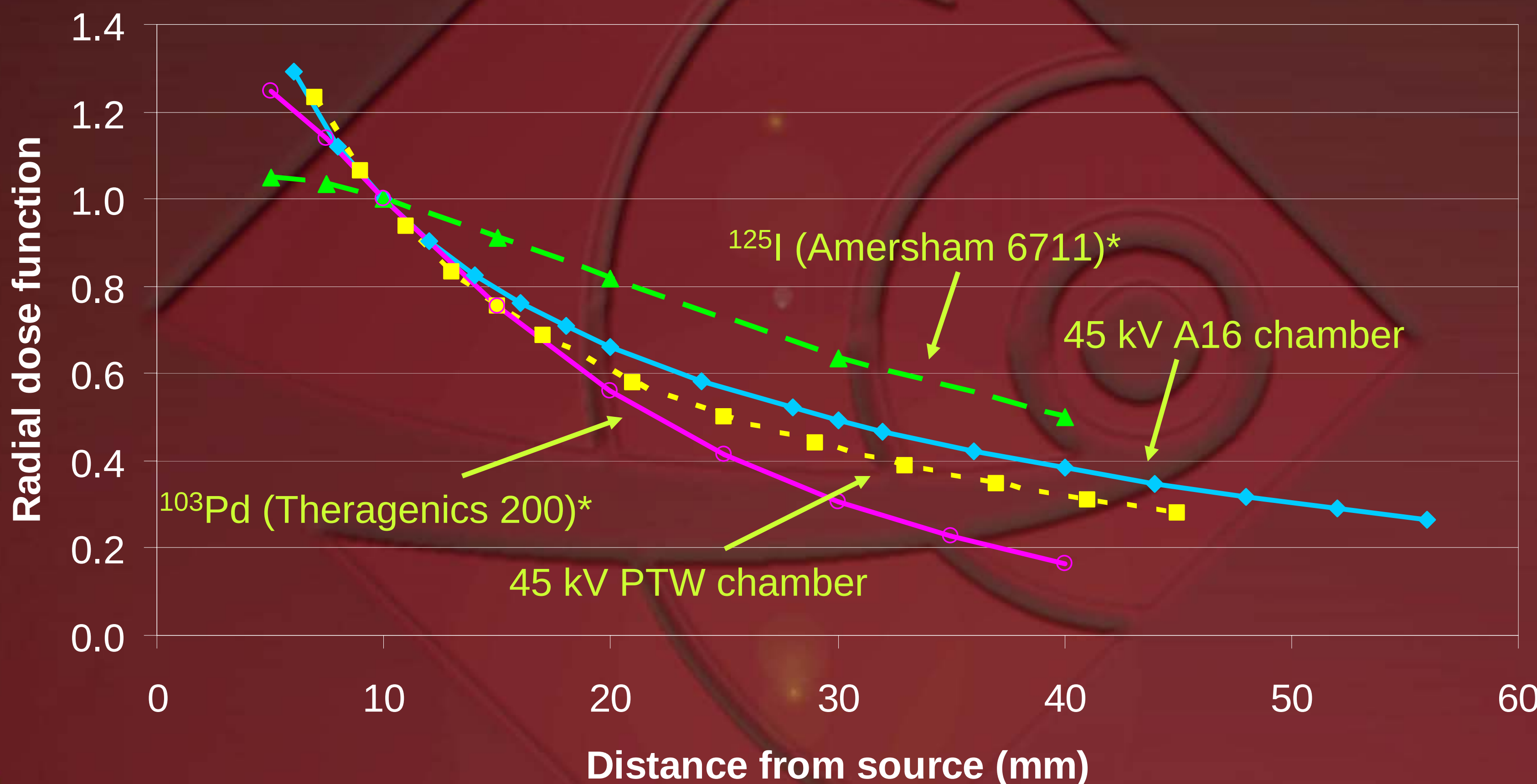
$$\dot{D}(r,\theta) = S_K \cdot \Lambda \cdot \left(\frac{G_P(r,\theta)}{G_P(r_0,\theta_0)} \right) \cdot g_P(r) \cdot F(r,\theta)$$

- Measurements of S_K using UW Attix free-air chamber (FAC), NIST Attix FAC, NIST Ritz FAC
- Standard Imaging HDR1000Plus well chamber with customized insert used as transfer standard
- Air kerma rates achievable that are equivalent to a brachytherapy source with S_K of ~135,000 U

Dose rate constant

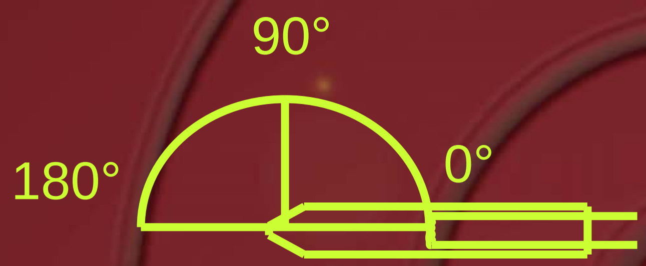
- Dose rates in liquid water measured using Exradin A16 microchamber (0.007 cm^3 nominal collecting volume) and PTW 34013 pinpoint chamber (0.005 cm^3 nominal collecting volume)
  - Determination of applicable calibration factors for chambers is an issue
- Future measurements will use TLD-100 μcubes (1 x 1 x 1 mm^3) and possibly newly developed microchips (~0.4 x 1 x 1 mm^3)
  - Energy response correction for TLD-100 may be a problem

Radial dose function, $g_P(r)$



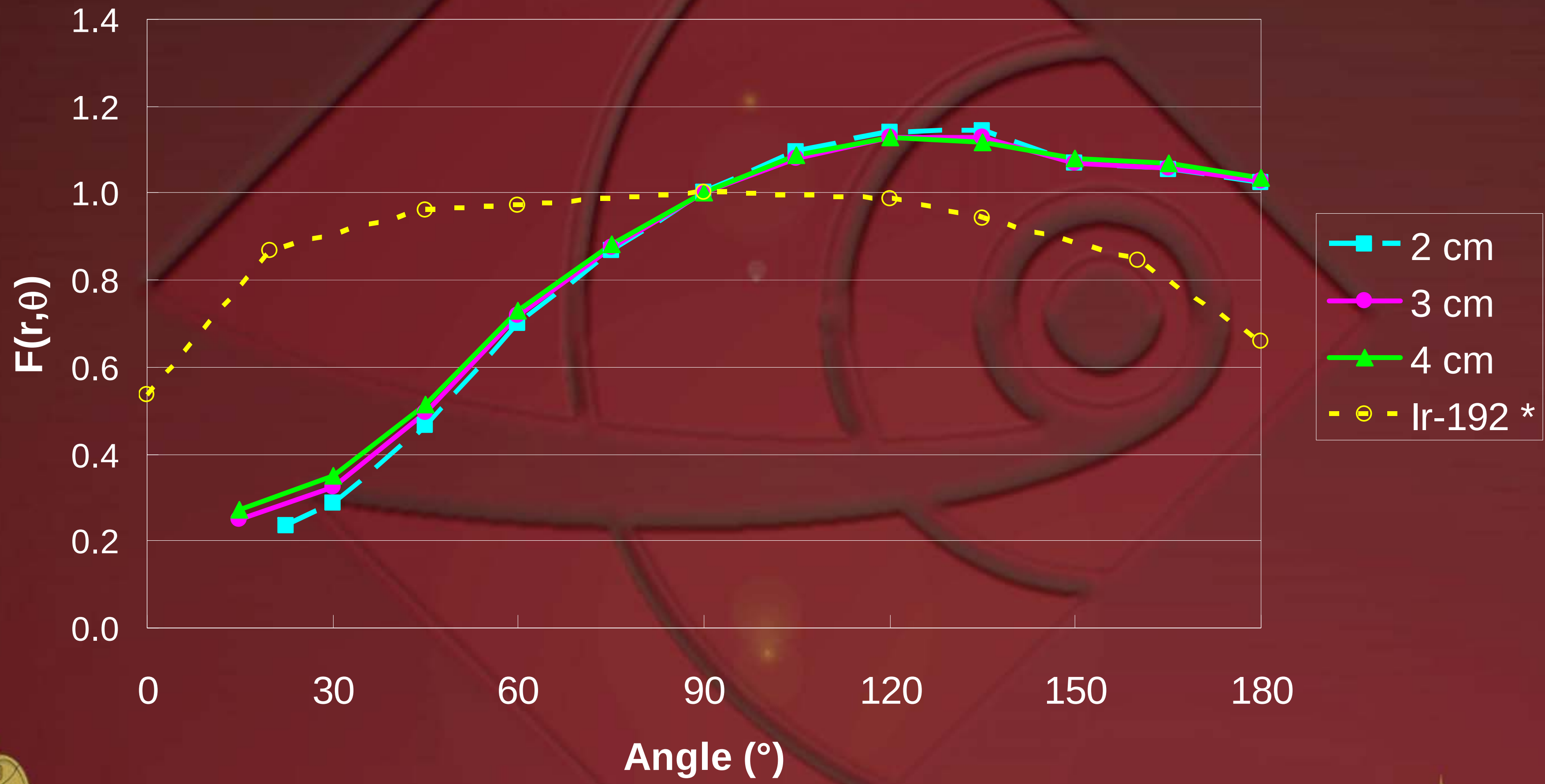
* Rivard *et al*, AAPM TG-43 update (2004)

2-D anisotropy function, $F(r,\theta)$



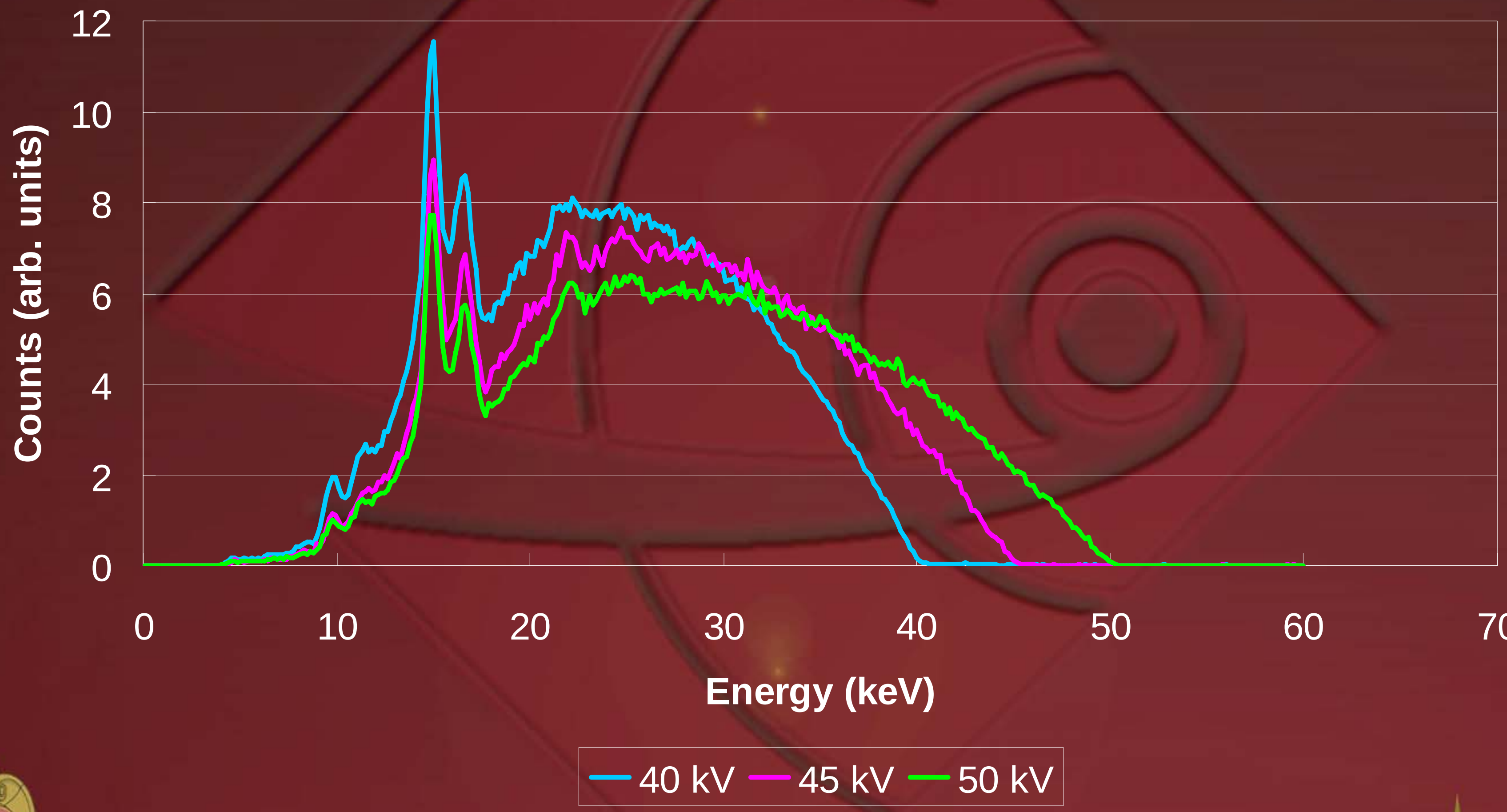
- Measured in water tank using A16 microchamber
- Future TLD measurements as well

2-D anisotropy function, F(r,θ)



* Kirov *et al* (1995)

Photon spectra



Future work

- Determine optimal method for measuring air kerma rate using Ritz and Attix free-air chambers at NIST
- Examine effects of energy response with Exradin A16 microchamber
- Monte Carlo simulations of Xoft probe

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