



RUSH UNIVERSITY
MEDICAL CENTER

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Balloon-Based IORT using Xoft Source

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IT'S HOW MEDICINE SHOULD BE®

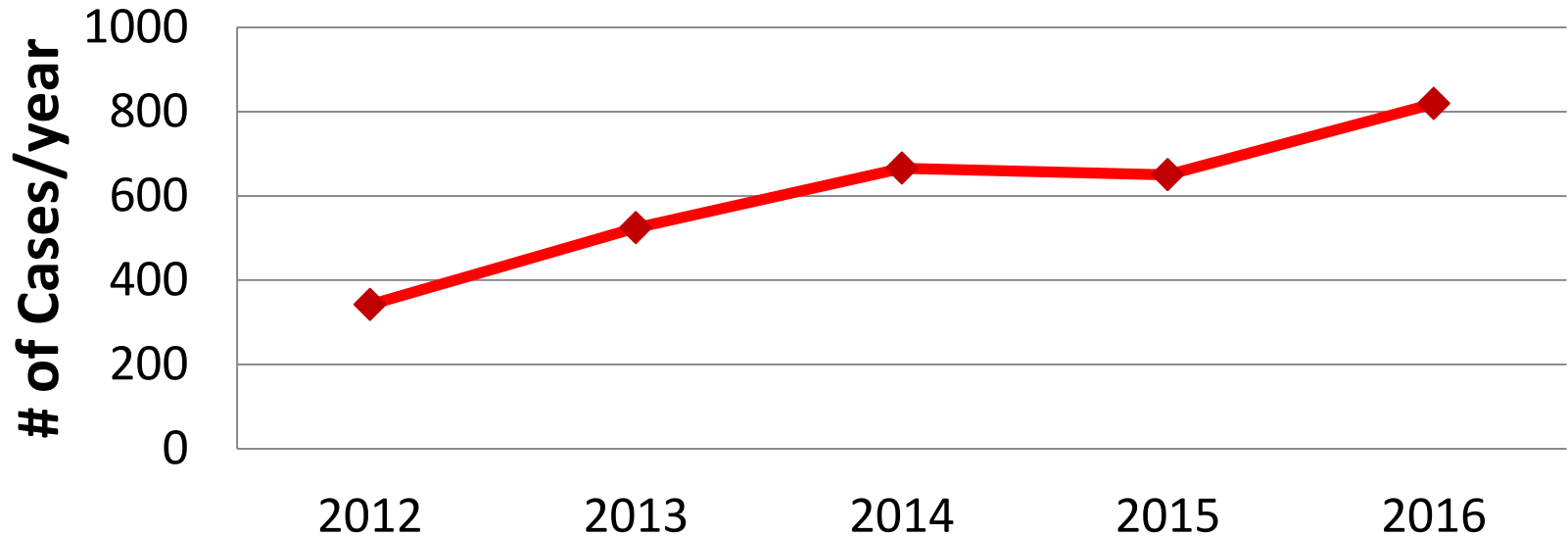


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Disclosures

- No conflict of interest

Xoft eBx system based IORT



- Number of cases/year has been doubled over the past 4 years (2012 – 2016)

Treatment Unit (Front)

Emergency Button



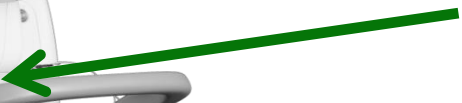
Control Console



Barcode Scanner



USB Reader



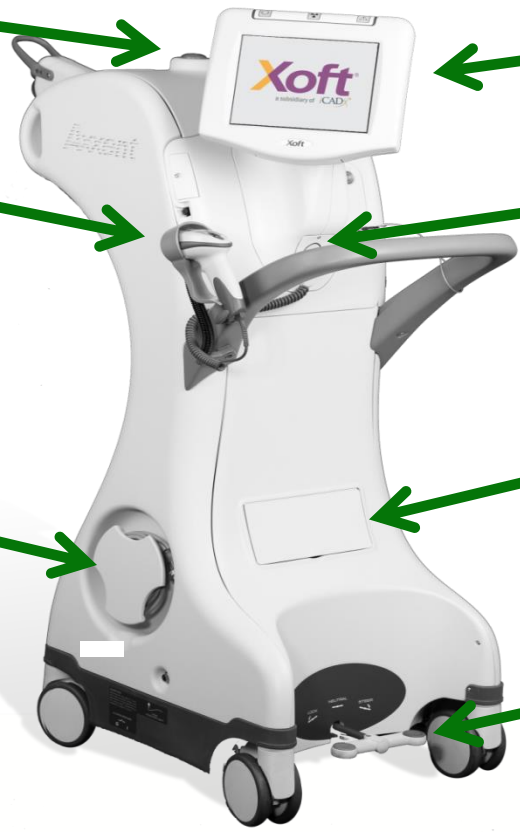
Power Cord



Electrometer

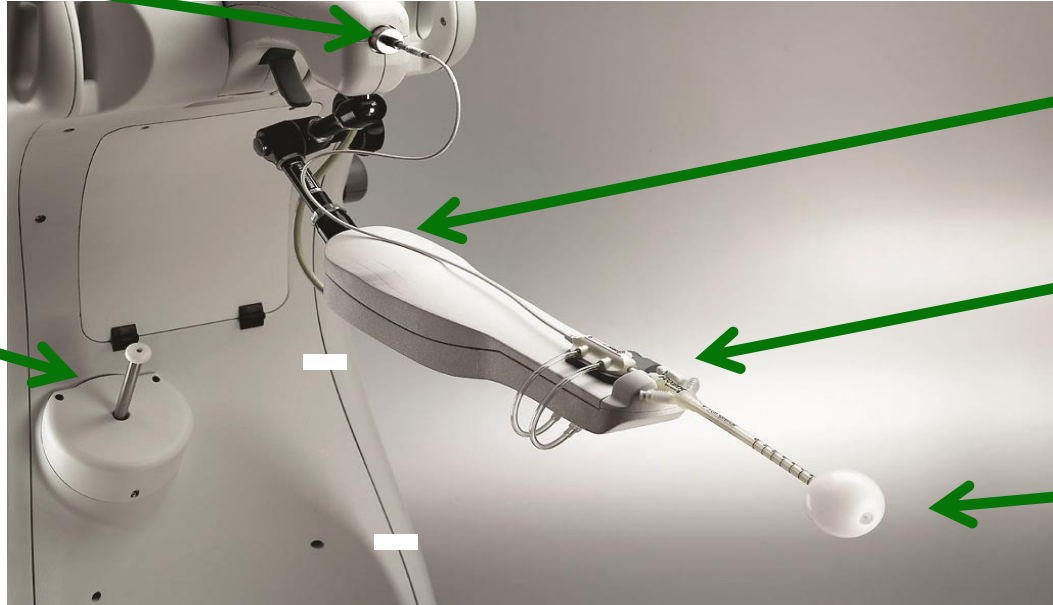


Brake



Treatment Unit (Back)

High Voltage Plug



Treatment Arm

Pullback nest

Shielded Well Chamber

Balloon Applicator

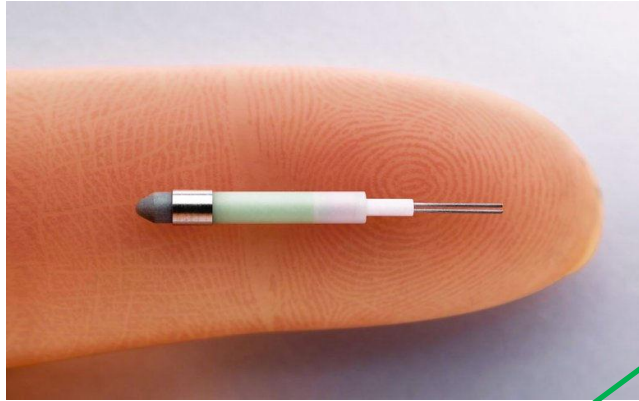
Applicators



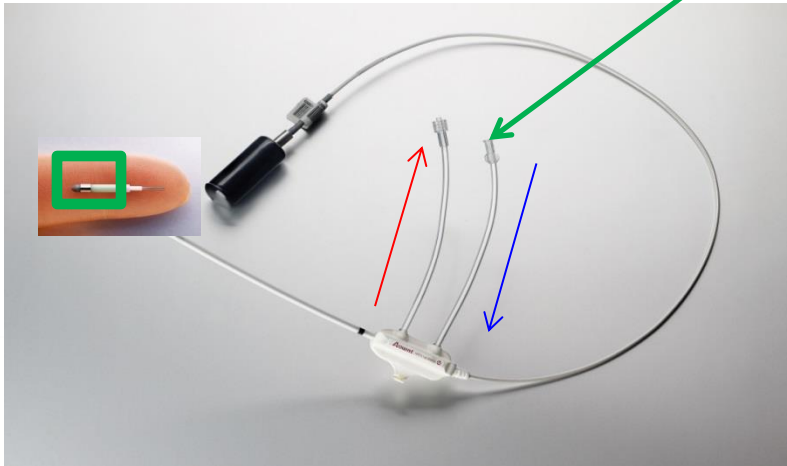
- Silicone w/ barium sulfate
 - Latex free
 - No need for contrast
 - ~6% attenuation
- Three sizes:
 - Small (3 – 4 cm) spherical:
 - 30 – 45 cc
 - Medium (4 – 5 cm) spherical:
 - 45 – 75 cc
 - Large (5 – 6 cm) spherical:
 - 65 – 130 cc
- Filled with Saline

Photo Credit: Xoft, a subsidiary of iCAD, Inc

Xoft Source



- Miniature X-ray source
- Water **cooled**
- Operates at 50 kVp
 - Average Energy
~ 28keV
- Source strength:
 - Nominal: 110000 U
 - Actual: 120000-140000 U
 - 3X Ir-192 HDR: ~ 40000 U
 - New NIST calibration standard
 - Air Kerma Strength → Air Kerma Rate



Xoft Source Spec.

- Ramp up time (0 → 50 kVp):
 - 20 seconds
 - Equivalent to ~2 seconds treatment time
- Source Travel:
 - 0.7 seconds per 5mm
 - Vs. Nucletron MicroSelectron: 35 mm in 0.1 second
 - 7.5 cm source travel limitation



IORT Prescription

IORT

- Single fraction
- 20 Gy to tumor bed / surface of balloon
- Heart: V5% ~ 10%

EBRT

- 25 fractions
- 40-50 Gy
- Heart: V5%
~ up to 50% or higher

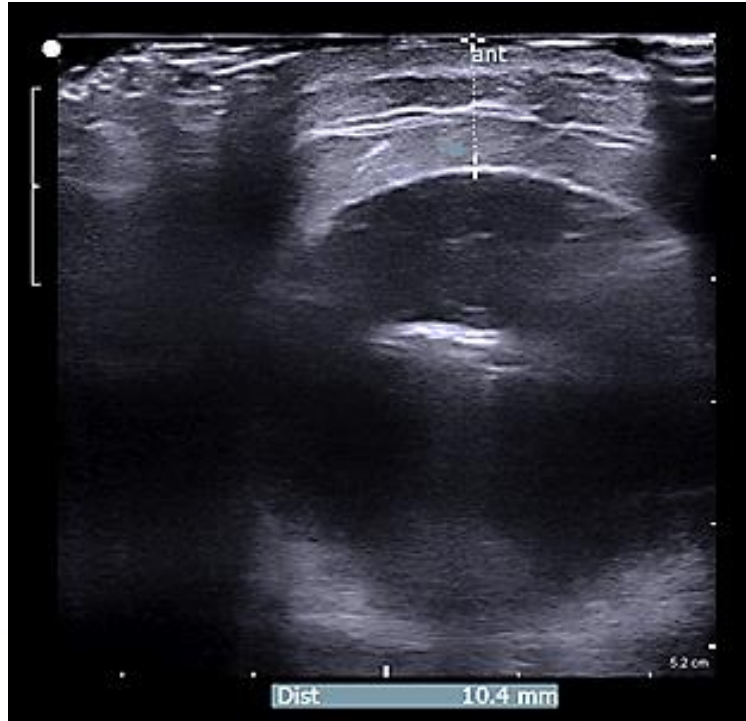
Xoft Protocol

- Safety and efficacy study
- 1200 subjects (~100 to go)
- Up to 10-year follow-up
- Evaluate:
 - Primary: Ipsilateral breast tumor recurrence (IBTR)
 - Secondary: Regional Recurrence, Safety, DFS, OS, Cosmetic Outcome, and Quality of Life

IORT Patient Selection (Xoft Protocol)

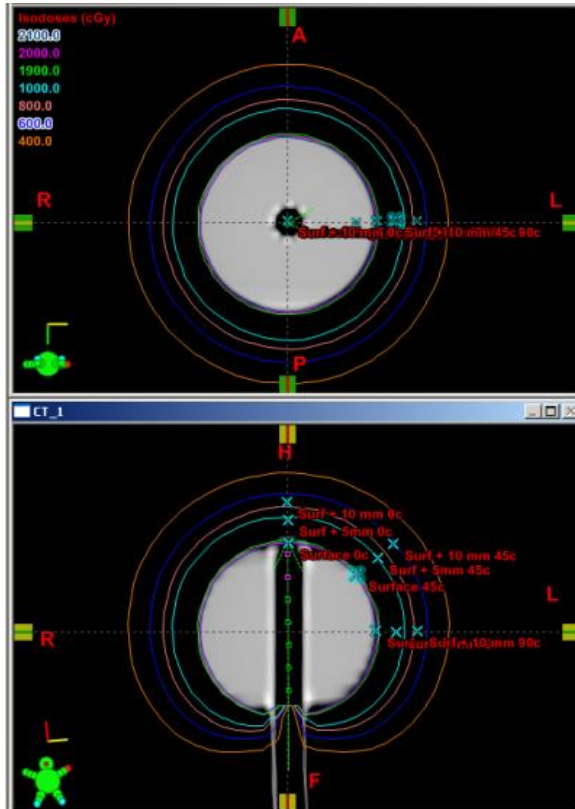
- General inclusion criteria:
 - Invasive ductal carcinoma or DCIS
 - Female > 40 yr (TARGIT: 45yr)
 - Tumor < 3 cm
 - Tis, T1 or T2 (< 3cm), N0, M0
 - Negative pregnancy test within 1 wk
- Intra-Operative Inclusion:
 - Balloon surface-to-skin distance \geq 1cm
 - Satisfactory balloon conformance
- General exclusion criteria:
 - Pregnant or nursing
 - Pacemaker in the field
 - Significant auto-immune disease
 - Multi-focal > 3cm
 - Multi-centric
 - Known lympho-vascular invasion
 - Invasive lobular cancer
 - Neo-adjuvant chemo/endocrine
 - Previous radiation
 - Etc.
- Intra-Operative Exclusion:
 - Positive sentinel node
 - Positive surgical margins

Imaging - Ultrasound



- Conformance
- Surface to skin distance
 - Multiple directions
 - > 1 cm
- Decide the filling volume of the balloon
- Done twice:
 - First with foley balloon / Cavity Evaluation Balloon
 - Second with the applicator balloon

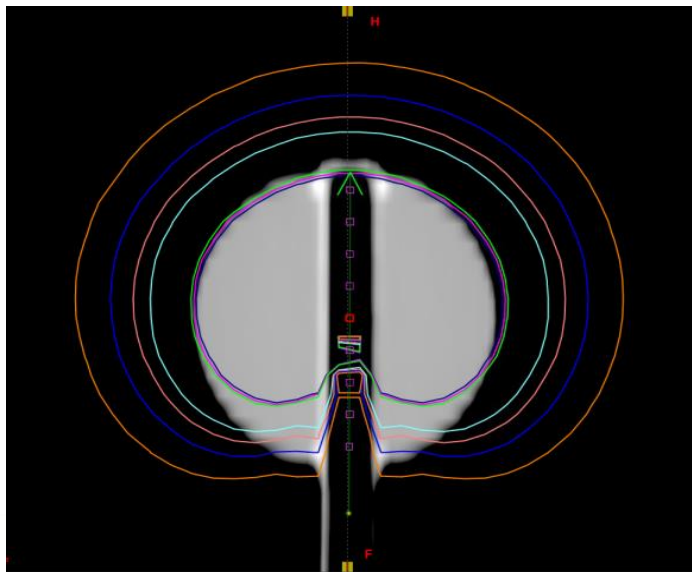
Atlas Plan



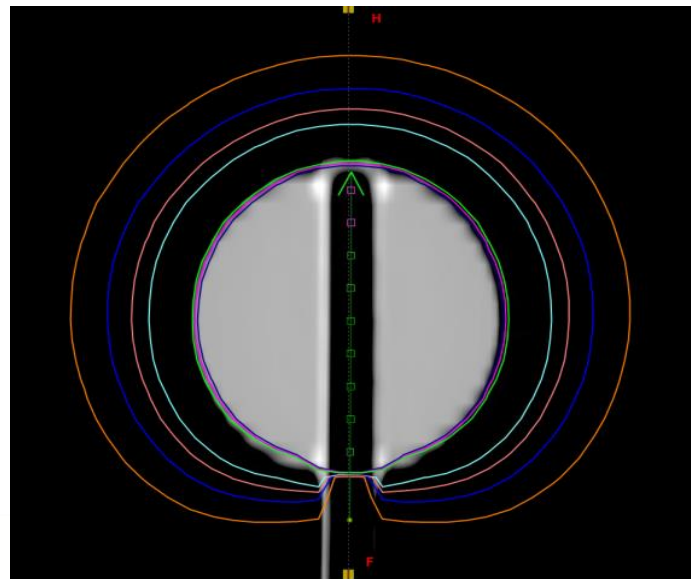
- 33 plans
 - 30 – 130 cc
 - in 5 cc increments
 - Preplanned in Eclipse (TG43): assuming water
 - Based on nominal source strength
 - Loaded on USB

Dwell Positions

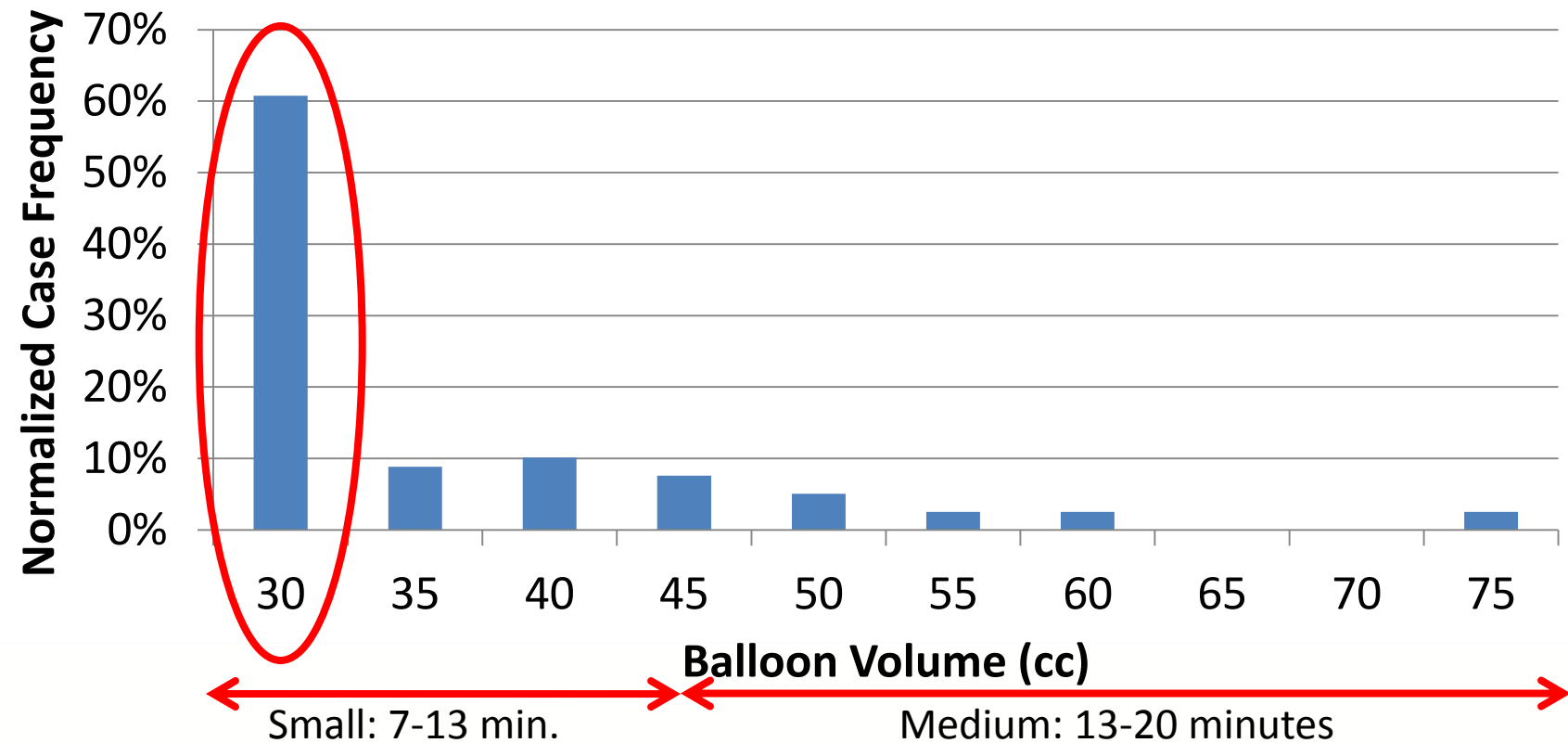
Single Dwell



Multiple Dwell

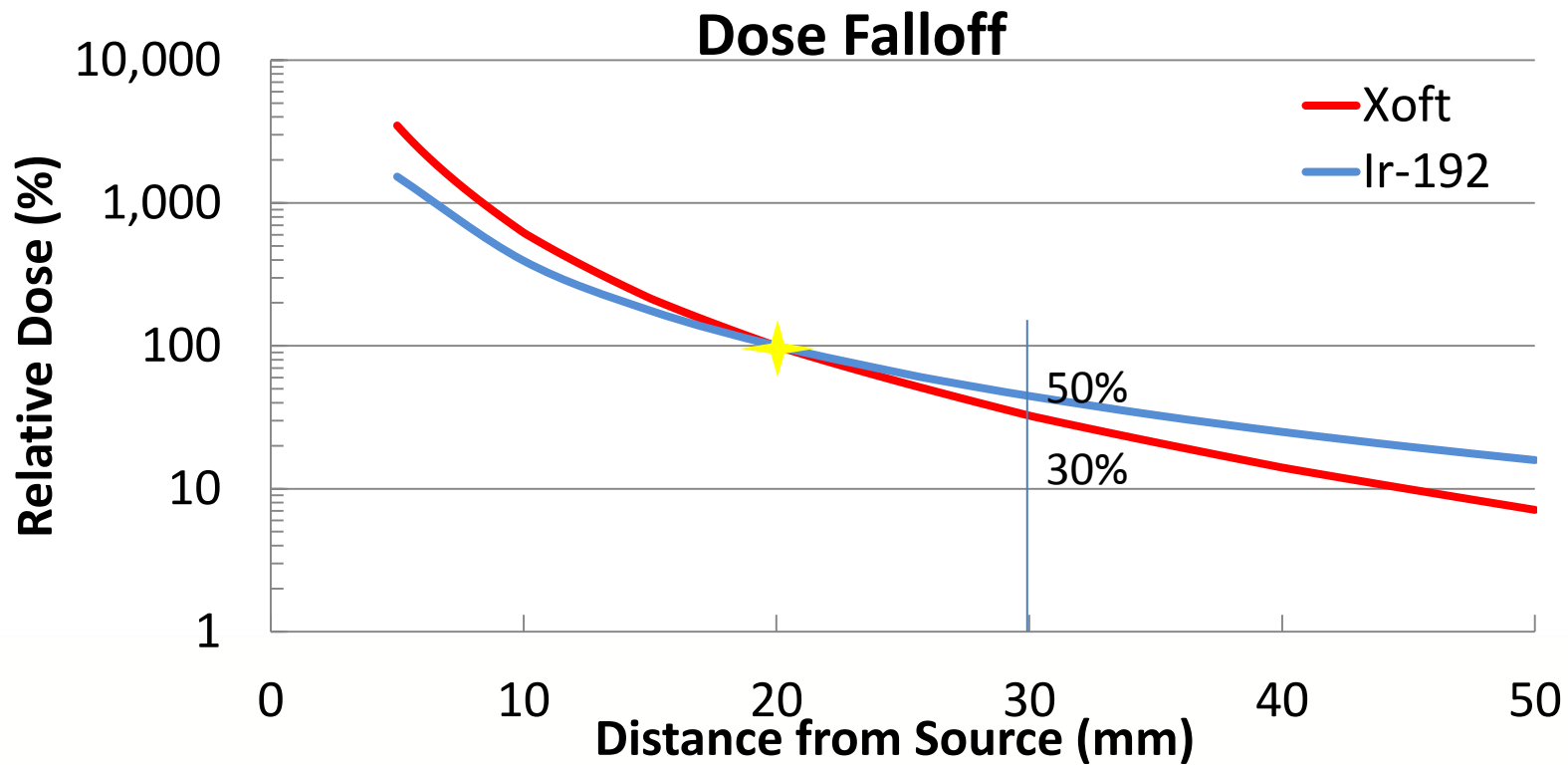


Case vs. Volume Distribution

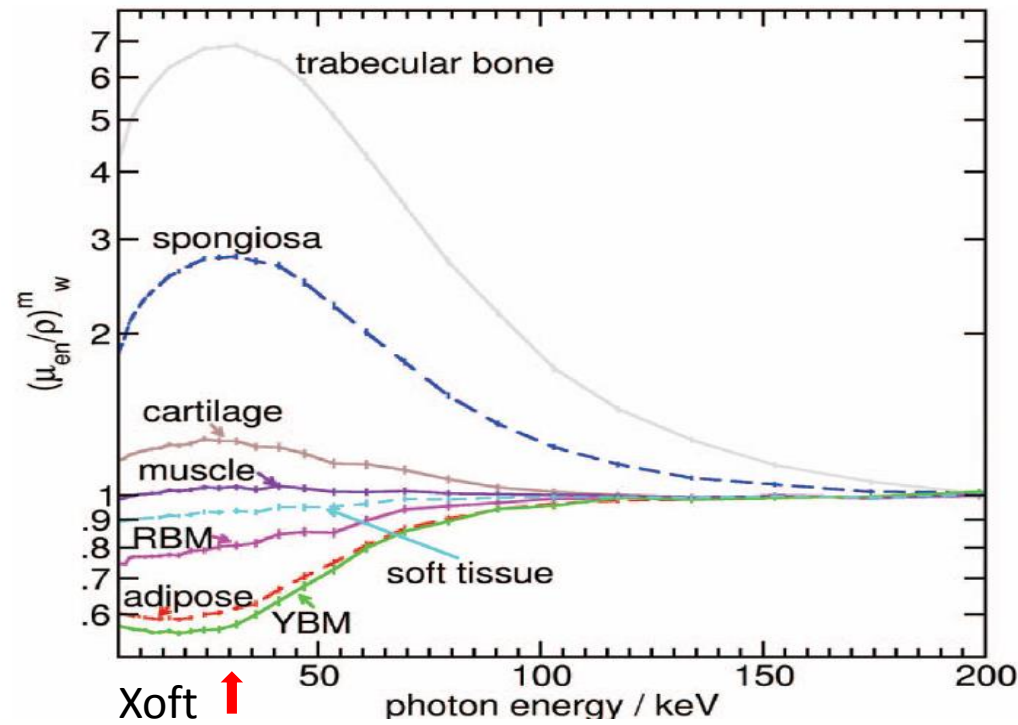


DOSIMETRY DISCUSSION

Dose Falloff Comparison



Tissue Heterogeneity

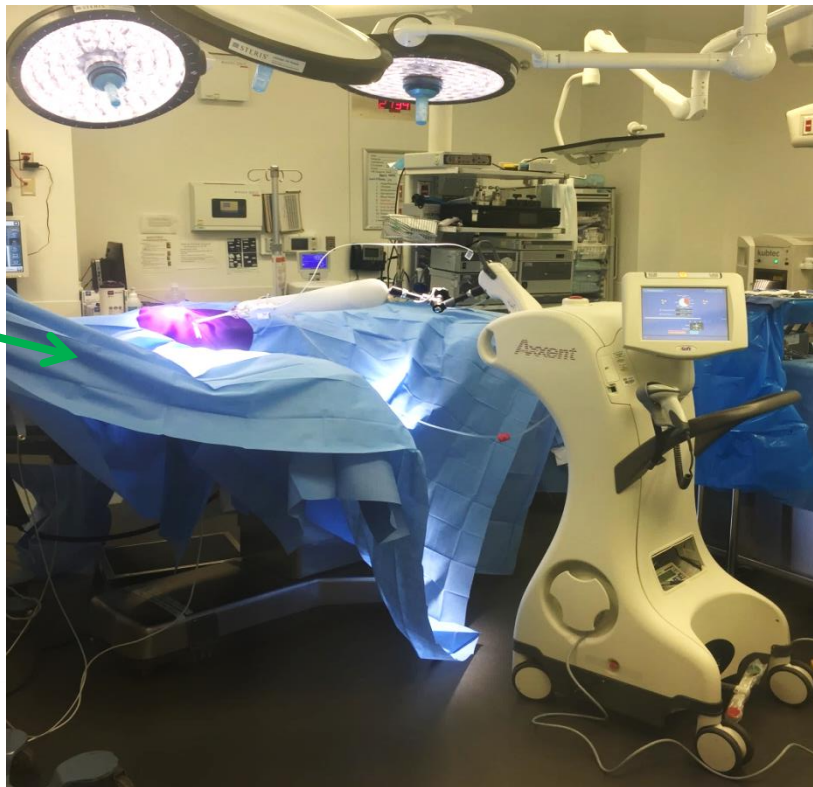


Studies of Dosimetric Effect

- R. Holt & J DeMarco (UCLA), 2010:
 - Air bubbles (5mm x 10mm): Dose **increase** 23% at surface
- S. White et. al. Med. Phys. 41 (6), June 2014:
 - Skin dose **reduction** ~ 0.5 – 24%
 - Rib dose **increase** ~ 300%
- Rush study:
 - Saline effect: ~ 5% **reduction** compared to atlas plans

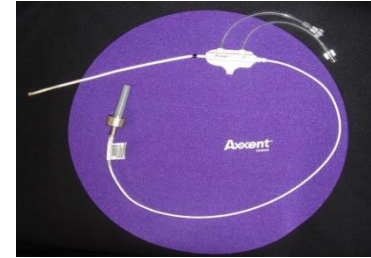
IORT @ RUMC

Additional Drape



Shielding and Radiation Protection

- HVL of 50 kVp = 0.06 mm Pb
- Patient
- FlexiShield:
 - Tungsten drape, 0.45 mm Pb equivalent thickness
 - ~ 200X reduction
- Portable Shield
 - 100X – 1000X reduction
- Lead apron
 - ~ 100X reduction
- Rigid shield:
 - 0.2 mm Pb equivalent thickness
 - 10X reduction
- ~ 40 μ R/hr behind portable shield



QA

- Daily QA
 - Water level/cooling tubes
 - Mechanical interlocks:
 - Wheel locks
 - Applicator connection
 - Source connection
 - Pullback obstruction
 - Position

QA

- Monthly QA
 - Daily QA
 - Electrometer test
 - Emergency stop test
 - Timer test
- Annual QA
 - Monthly QA
 - FlexiShield integrity

Thank you!

