3D Dosimetry of the Amersham 6711 and AgX100 Iodine-125 Brachytherapy sources with PRESAGE®

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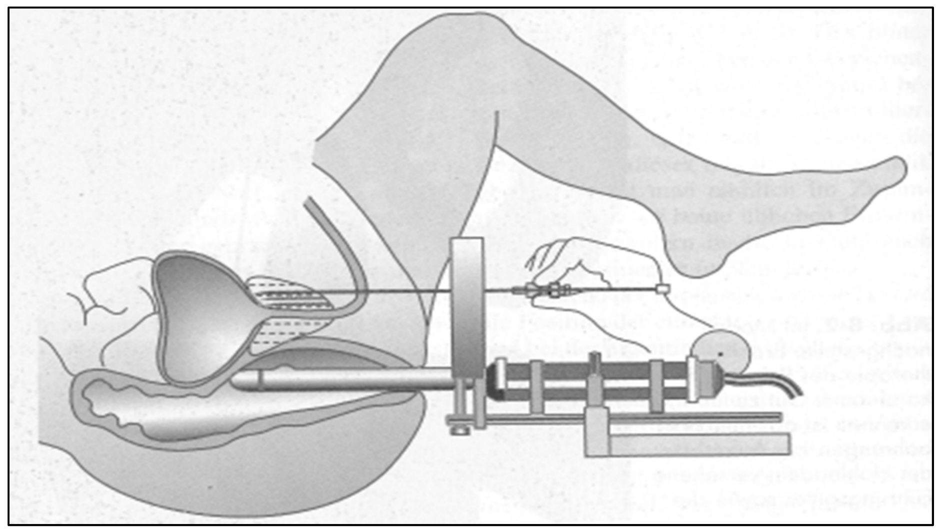
Presentation Outline

1. Overview of Brachytherapy
2. Introduction to PRESAGE® dosimeters
3. Research goals
   - Establish PRESAGE® as accurate dosimeter
   - Characterize the new AgX100 I-125 seed with PRESAGE®

WHAT IS BRACHYTHERAPY?

Brachytherapy

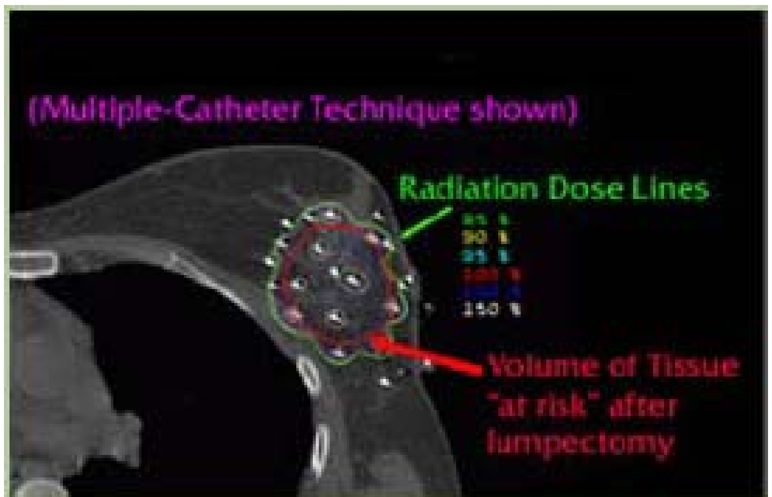
- Commonly used method of radiation therapy
- Sealed radioactive sources or “seeds” may be inserted directly into the treatment area

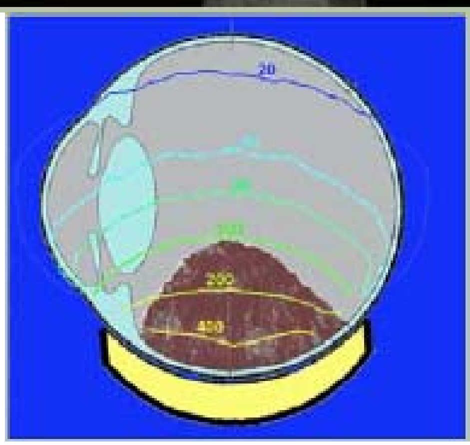


R Popert, P Acher, N Nichol, S Morris, Ron Beaney. “Brachytherapy vs. Surgery” presentation.

Brachytherapy

- Commonly used for prostate, breast, cervical, head & neck, and eye cancers





Gifford, Kent. "Brachytherapy Lecture 1".

Clinically used radionuclides:

Nuclide	Energy (MeV)	Half-life
Radium-226	0.24-2.2	1600 years
Cobalt-60	1.25	5.26 years
Radon-222	0.78	3.83 days
Cesium-137	0.66	30 years
Palladium-103	0.021	17 days
Iodine-125	**0.028**	**59.4 days**
Gold-198	0.42	2.7 days
Iridium-192	0.47	73.83 days
Yttrium-90	Beta 2.3 gamma 1.74	64 hours
Strontium-90	Beta 0.55	28 years

INTRODUCTION TO TOPIC OF RESEARCH:

PRESAGE®

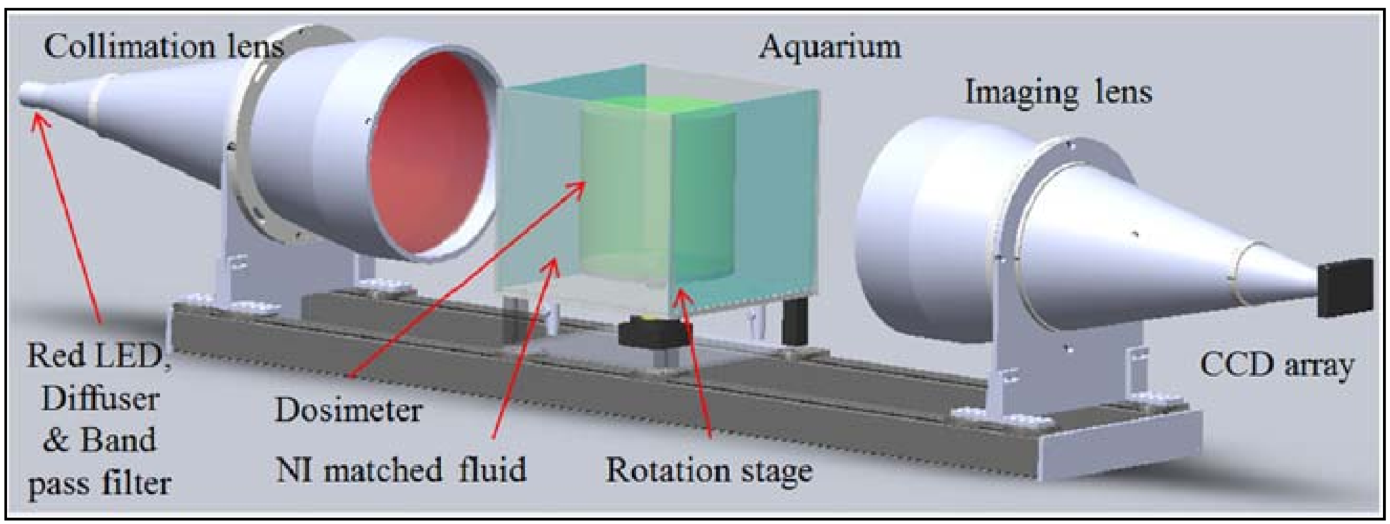
What is PRESAGE®?

- Optically clear polyurethane-based dosimeter
- Linear OD response to dose
- Tissue equivalent: effective Z about 7.6
- Temp. and light dependency
- Insensitive to red light

M. Oldham. "3D Dosimetry, and Clinically Meaningful QA" presentation. (accessed Aug 2012)

Duke **M**edium FOV **O**ptical-CT **S**canner

- Light emitted from red LED source
- Parallel light projection images formed by telecentric imaging lens



A. Thomas , J. Newton , M. Oldham. “A method to correct for stray light in telecentric optical-CT imaging of radiochromic dosimeters”. (accessed Aug 2012)

RESEARCH PROJECT

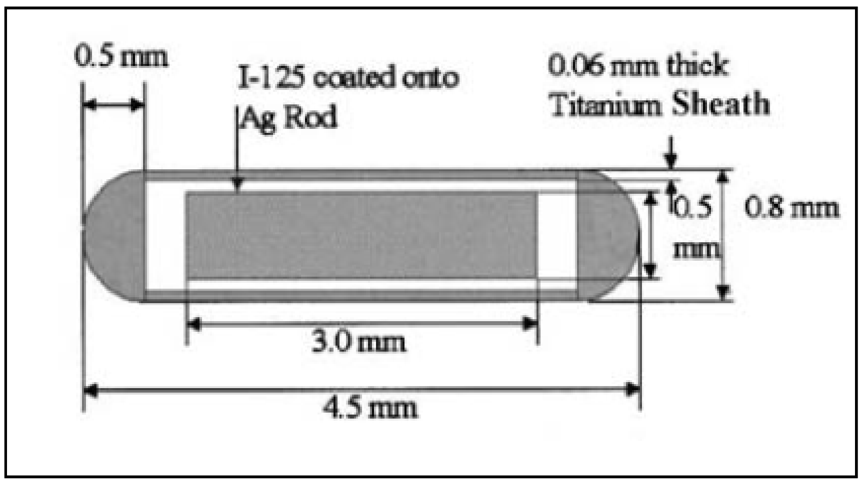
3D dosimetry of I-125 seeds with PRESAGE®

Motivations

- Accuracy in dose profile measurements allows for optimal patient treatment planning
- Reliable 3D method necessary for accurate dose measurements
- New AgX100 model: characterization by experimental measurements is necessary

Amersham 6711

- Dosimetric parameters extensively evaluated
- General consensus data published in AAPM Report: TG-43U1
- Measure parameters of 6711 seeds and compare with published values
- Goal: Characterize Presage as a 3D dosimeter for brachytherapy sources



P. Wai, N. Krstajic, J. Adamovics, et al. "Dosimetry of the Amersham 6711 Oncoseed using PRESAGE and optical CT". (accessed Aug 2012)

Methods: Amersham 6711 in PRESAGE®

- Manufacture PRESAGE® with a channel in center
- Irradiate with two types of sources to evaluate dynamic range
- Ir-192 source positioned in center with afterloading device
- I-125 seed positioned in center through hole for irradiation

Figure 1. PRESAGE® dosimeter connected to remote afterloading device to expose Ir-192 source at end of catheter

Figure 2. Presage® dosimeter with channel in center for I-125 seed placement

P. Wai, J. Adamovics, et al. "Dosimetry of the microSelectron-HDR IR-192 source using PRESAGE and optical CT". (accessed Aug 2012)

Dosimetry in PRESAGE®

AAPM Brachytherapy Dosimetry Formalism:

Radial dose function:

$$g_X(r) = \frac{\dot{D}(r,\theta_0)}{\dot{D}(r_0,\theta_0)} \frac{G_X(r_0\theta_0)}{G_X(r,\theta_0)}.$$

Anisotropy Function:

$$F(r,\theta) = \frac{\dot{D}(r,\theta)}{\dot{D}(r,\theta_0)} \frac{G_L(r,\theta_0)}{G_L(r,\theta)}$$

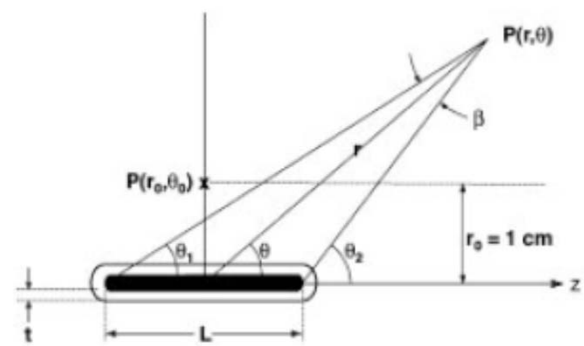


FIG. 1. Coordinate system used for brachytherapy dosimetry calculations.

$\dot{D}(r,\theta_0)$ = Dose rate at given radius and angle from center of source

$G_X(r_0\theta_0)$ = Geometry function at given radius and angle from center of source

Preliminary Results

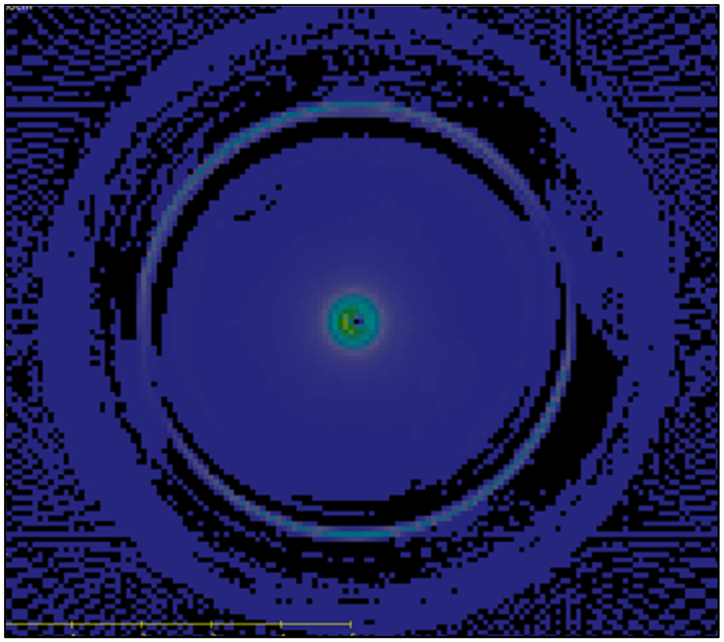


Figure 1. Reconstructed image for dose profile measurement in the Computational Environment for Radiothreapy Research (CERR)

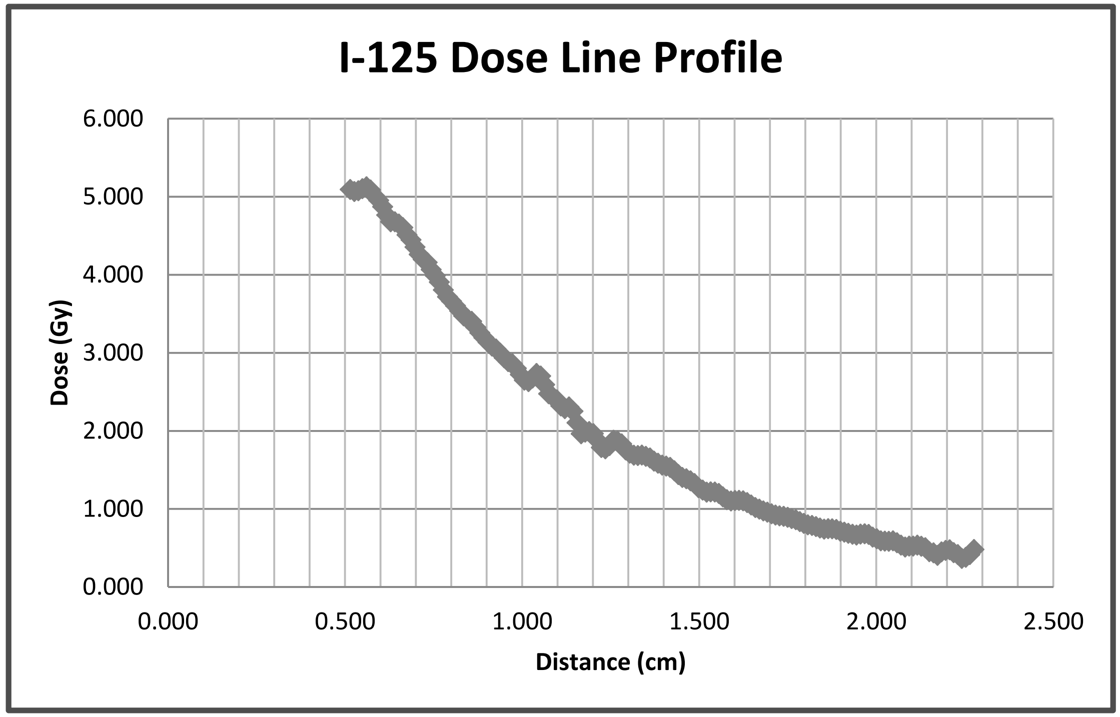
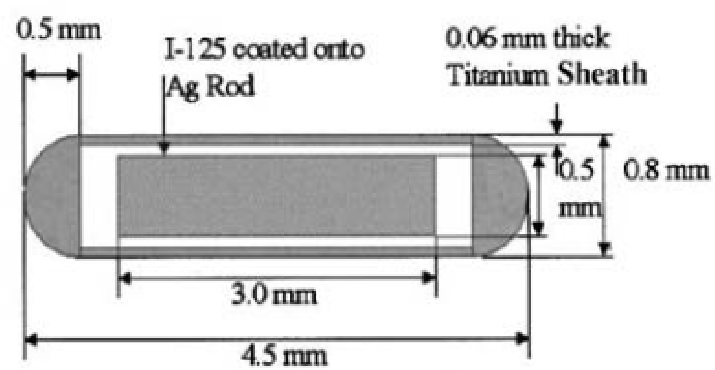


Figure 2. Dose line profile from r= 0.5 cm to r= 2.3 cm

Preliminary studies show average differences of 5.3% and 9.8% between measured and published dose rate values for Ir-192 and I-125 sources respectively.

New I-125 source: AgX100

- New seed models need to be thoroughly characterized for optimal patient treatment planning
- Use verified method from the Amersham 6711 study to find dosimetric parameters



Amersham 6711

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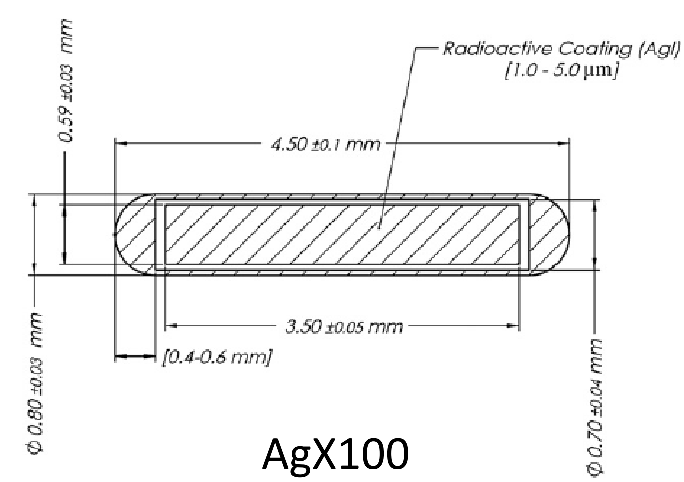

AgX100

F. Mourtada, J. Mikell, G. Ibbott. "MC calculations of AAPM TG-43 dosimetry paramters for the I-125 I-seed AgX100 source model". (access Aug 2012)

Thank you for listening!

References

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2. M. J. Rivard, *et al.* “Update of AAPM Task Group No. 43: A revised AAPM protocol for brachytherapy dose calculations”. Med Phys. Vol. 31, Issue 3, p. 633-674. (2004)
3. F. Mourtada, J. Mikell, G. Ibbott. “MC calculations of AAPM TG-43 dosimetry paramters for the I-125 I-seed AgX100 source model”. (access Aug 2012)
4. P. Wai, N. Krstajic, J. Adamovics, et al. “Dosimetry of the Amersham 6711 Oncoseed using PRESAGE and optical CT”. (accessed Aug 2012)
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8. R Popert, P Acher, N Nichol, S Morris, Ron Beaney. “Brachytherapy vs. Surgery” presentation. (accessed Aug 2012)
9. K. Gifford. “Brachytherapy Lecture 1” presentation (accessed Aug 2012)