

Oral Abstract

Dosimetric characterization and calculation of the INTRABEAM® system with a needle applicator in heterogeneous tissues

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First U.S. INTRABEAM User Meeting

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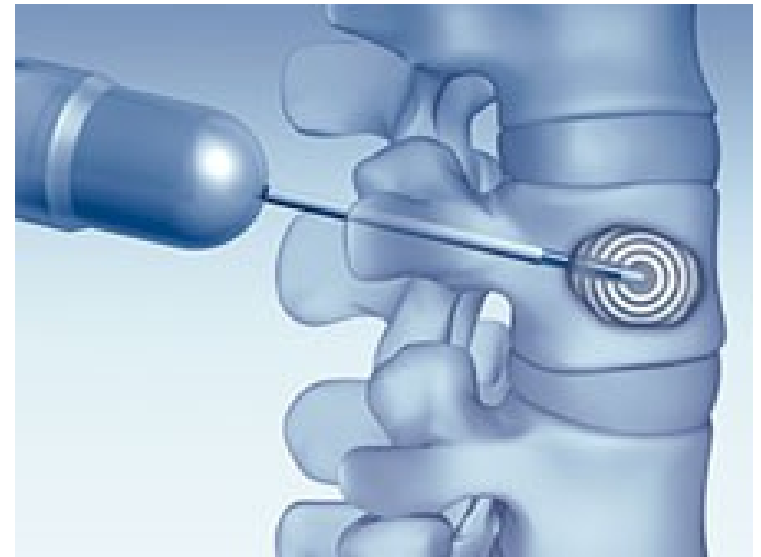
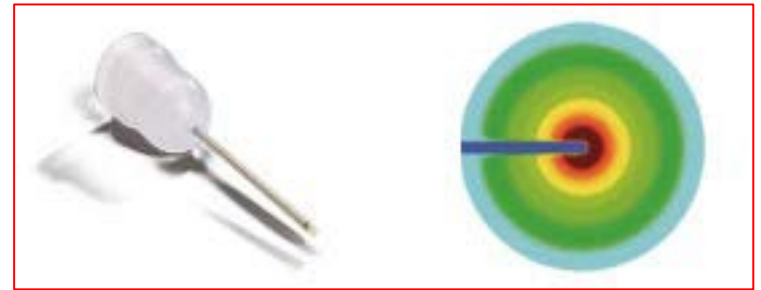
Objectives

- The current practice in determination of dose at depths for intraoperative radiotherapy (IORT) using the INTRABEAM system is based on depth dose measurements in **water**.
DD (for source) * TF (for associated applicator)
- There is a necessity in more accurately determining depth dose when **heterogeneous tissues** need to be taken into account.
- For example, in a procedure to deliver IORT to vertebral metastases during kyphoplasty (Kypho-IORT), nearby organ at risk (OAR) - spinal cord dose is desired besides prescribed dose to the region of metastases.

Kypho-IORT Using INTREBEAM

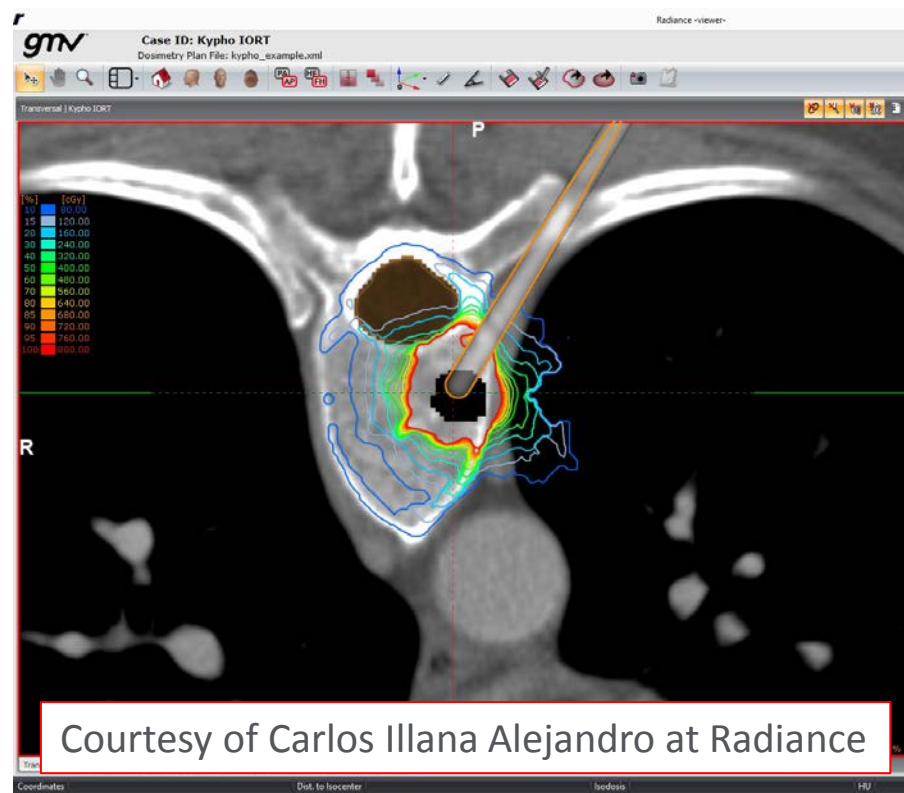
Needle Applicator:

- Nearly isotropic dose distribution in water
- Single use
- Stainless steel and plastic
- Small in dimensions:
 - ✓ 4.4 mm in diameter
 - ✓ 0.5 mm from tip surface to source iso



Clinical Considerations in Kypho-IORT

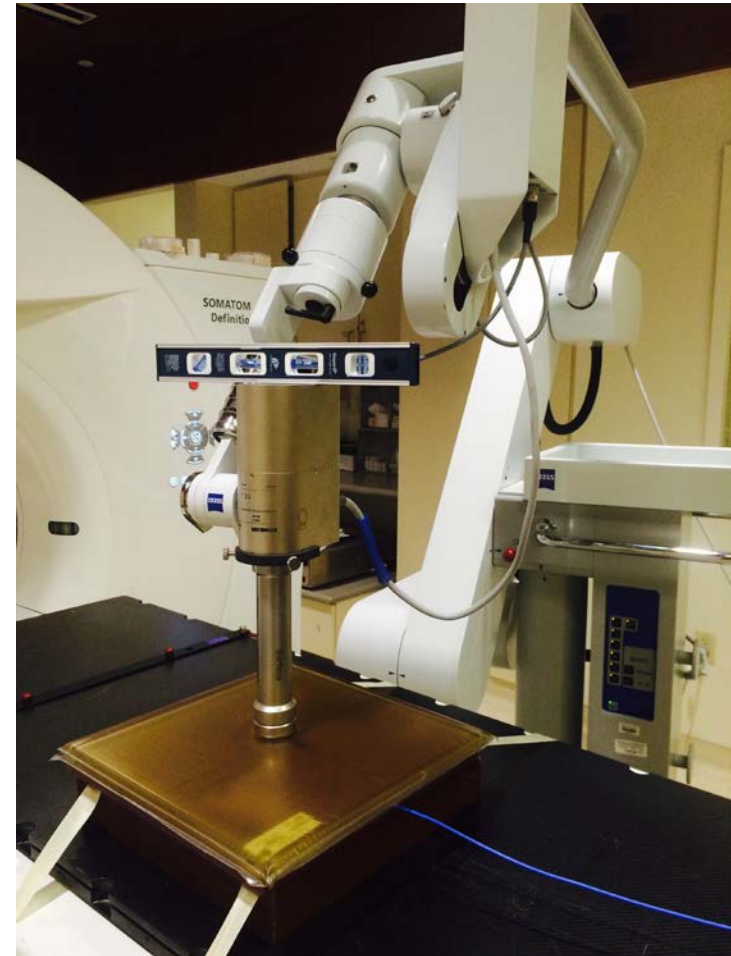
- A lytic metastasis leaves an air cavity in place.
- The target volume to be irradiated includes the air cavity and its surrounding bone tissues.
- The spinal cord dose needs to be checked before IORT.



- ✓ Monte Carlo planning may serve as an ultimate tool.
- ✓ **Direct depth dose measurements in different materials can provide insightful knowledge and be used for verification of analytical and/or MC calculation.**

Depth Dose Measurements

- **X-ray source:** INTRABEAM 50 kVp with a demo needle applicator secured on an Intrabeam stand
- **Absolute dose:** PTW TN34013W soft x-ray ion chamber embedded in a chamber holder of solid water
- **Tissue equivalent materials:**
Gammex bone slabs (min. 2 mm)
Solid water slabs (min. 1 mm)
- **Movement in depth:** The slabs placed on a 6 DOF treatment couch with a digitally controlled step size of 0.1 mm



Preliminary Results

➤ Dose rate at 10 mm (Gy/min):

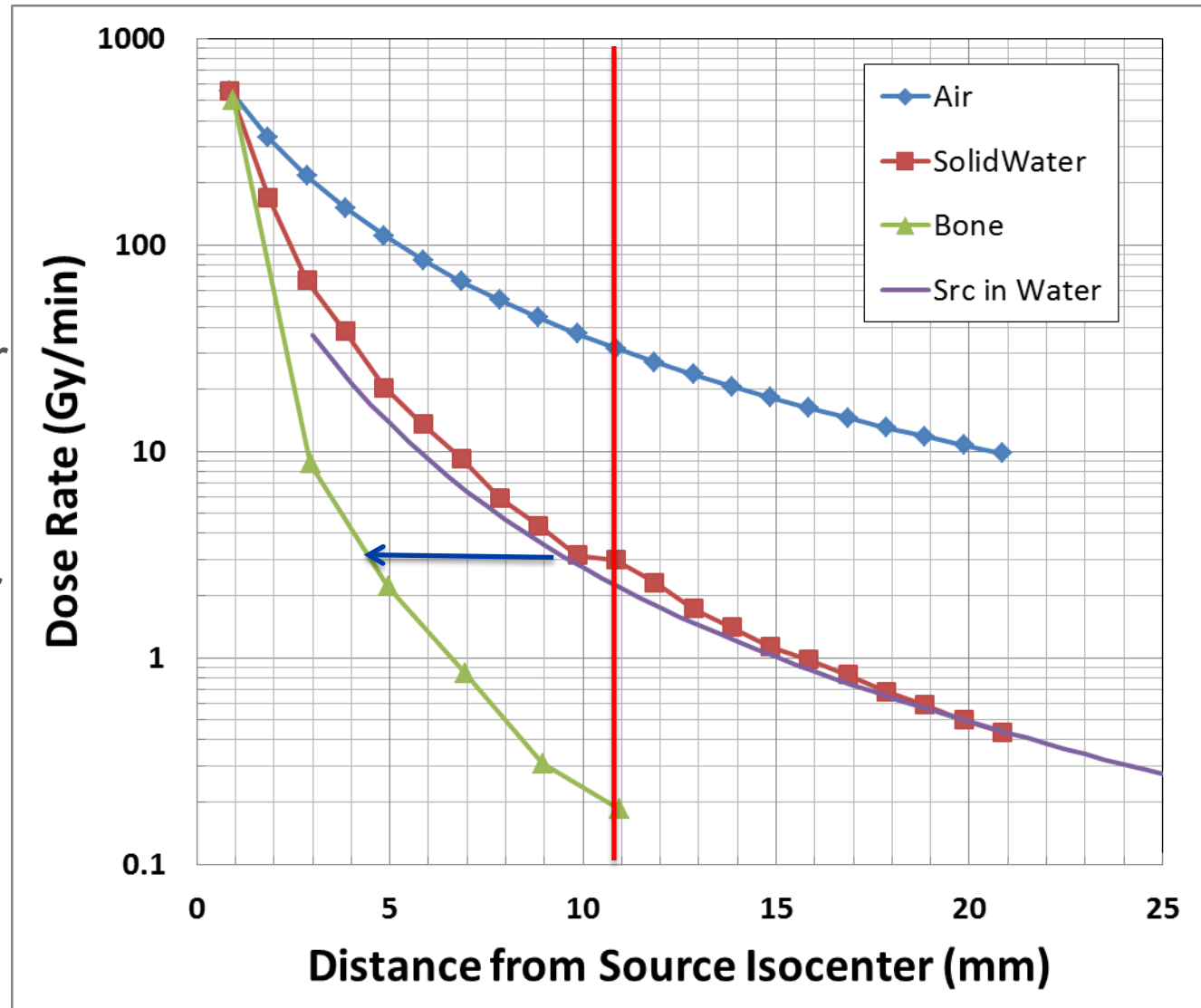
31.5 in air

3.0 in solid water

0.18 in bone

➤ The 10 mm water equivalent depth in bone:

3.5 mm



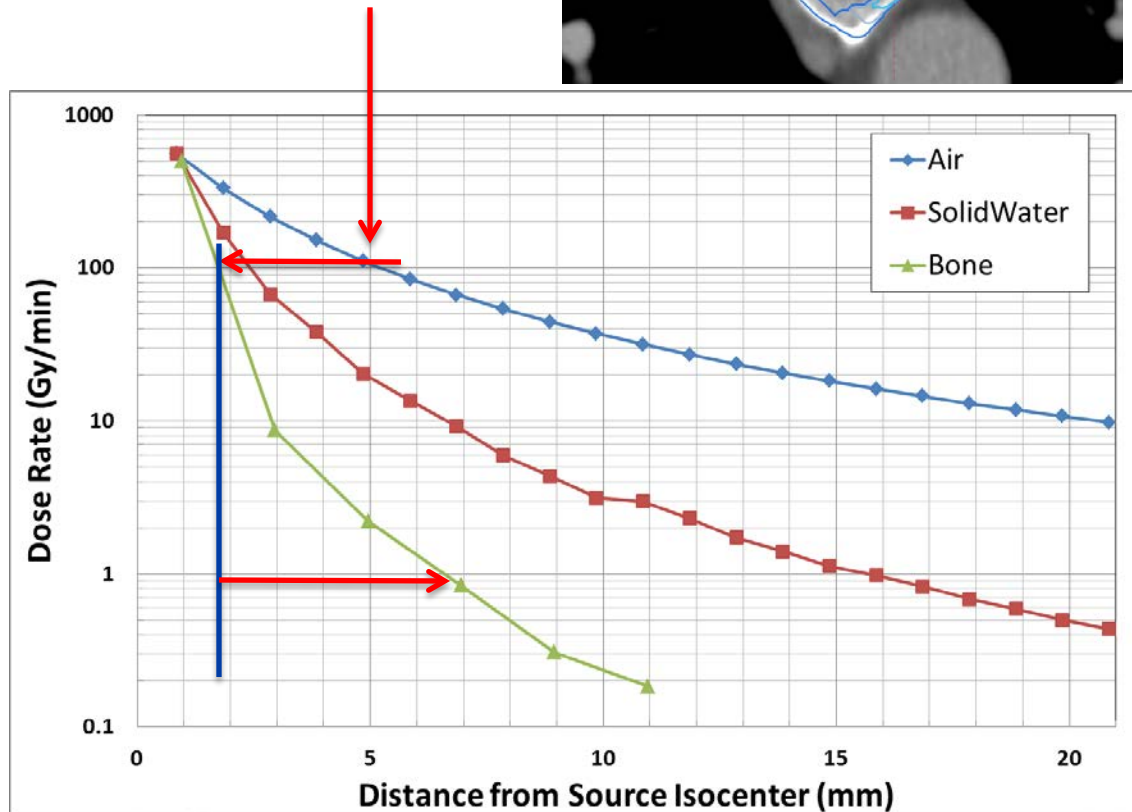
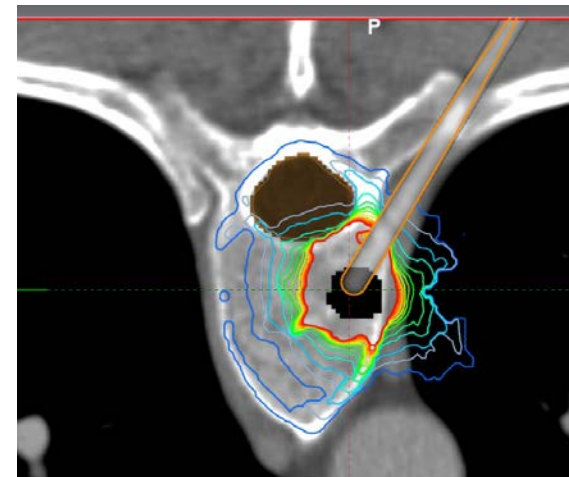
Treatment Calculation

➤ *Prescription:*

e.g., 5 Gy in 5 mm depth of bone surrounding a 1 cm air cavity

➤ *Calculation:*

- ✓ Finding dose rate at 5 mm in air
- ✓ Finding its equivalent depth in bone with the same dose rate
- ✓ Finding dose rate 5 mm deeper in bone
 - ~ 0.9 Gy/min
- ✓ Treatment Time
 - ~ **5.6 min**



OAR Dose Estimate

➤ Prescription:

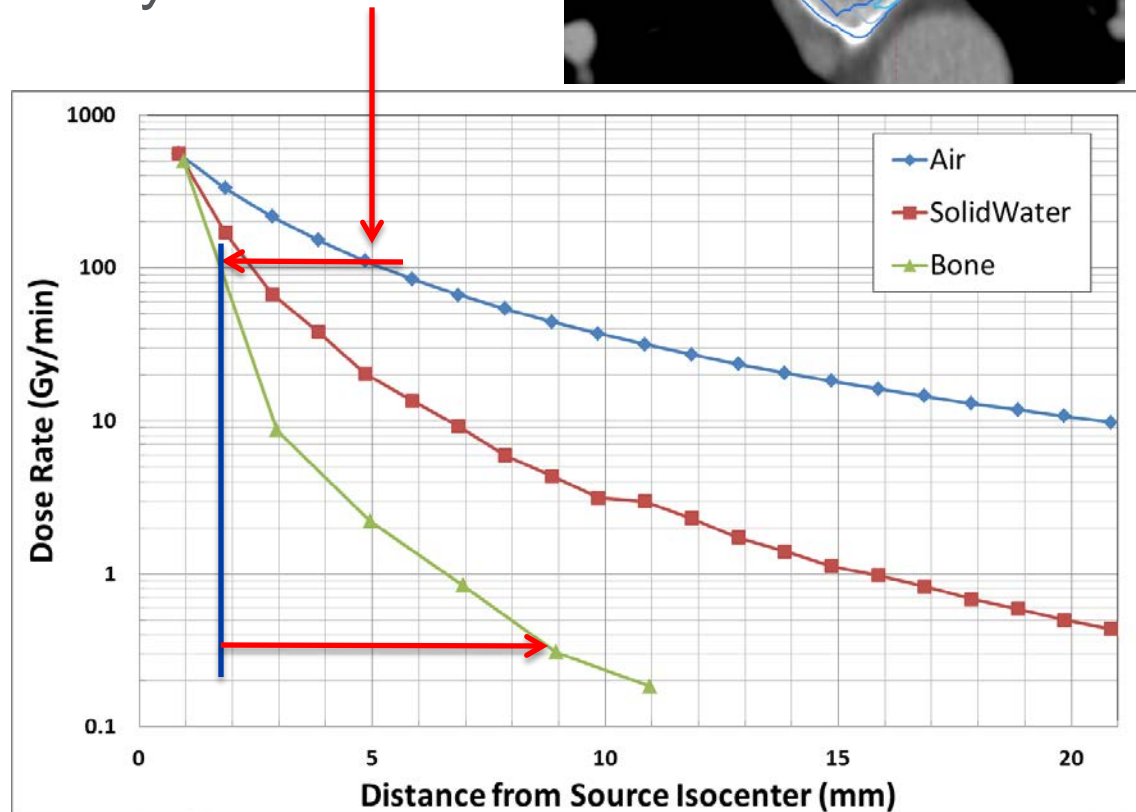
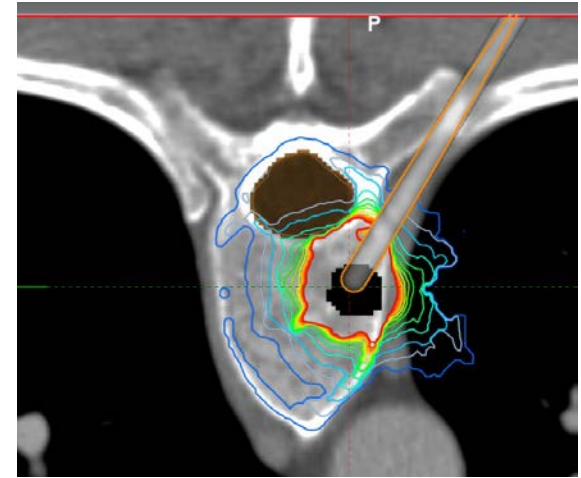
5 Gy in 5 mm depth of the bone

➤ **OAR considered:**

e.g., spinal cord of 7 mm away from the air cavity separated by bone

➤ **Estimate:**

- ✓ Finding dose rate at 5 mm in air
- ✓ Finding its equivalent depth in bone with the same dose rate
- ✓ Finding dose rate **7 mm** deeper in bone
~ 0.33 Gy/min
- ✓ Estimate dose for OAR
~ 185 cGy



Summary

- The proposed method would yield more accurate delivery dose for planning dose on target when different tissues involved than just considered in water.
- The proposed method would be used to successfully estimate the dose to critical organs in IORT taking into account the heterogeneous effect.
- The further validation includes analytical calculation using known elemental composition and attenuation coefficient data of the materials, and Monte Carlo simulation.

Thank You



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