Calibration of Multiple LDR Sources

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LDR Brachytherapy Sources

- In addition to seeds, these sources also have been coming in the forms of strand sources, coils, needles, etc.
- Some third party vendors have been providing sources that are calibrated.
- This does not fit the intent of TG-40, TG–56, or TG-64

Importance of Source Calibration for Clinics

- AAPM, ABS and FDA recognize need for accurate calibration in terms of well defined physical quantity.
- The Medical Physicist is responsible for the dose calculated for the patient. Output should be independently validated. TG-56 & TG-40
- Third party calibrations do not provide an independent check by the institution physicist

Responsibility of Med Physicist

- Med Phys 33: 247-248 states the AAPM approach
- The AAPM has stated that the Medical Physicist is responsible for independent check
- Third Party assay does not satisfy this
- Therefore the Med Physicist now has the problem how to measure strands.

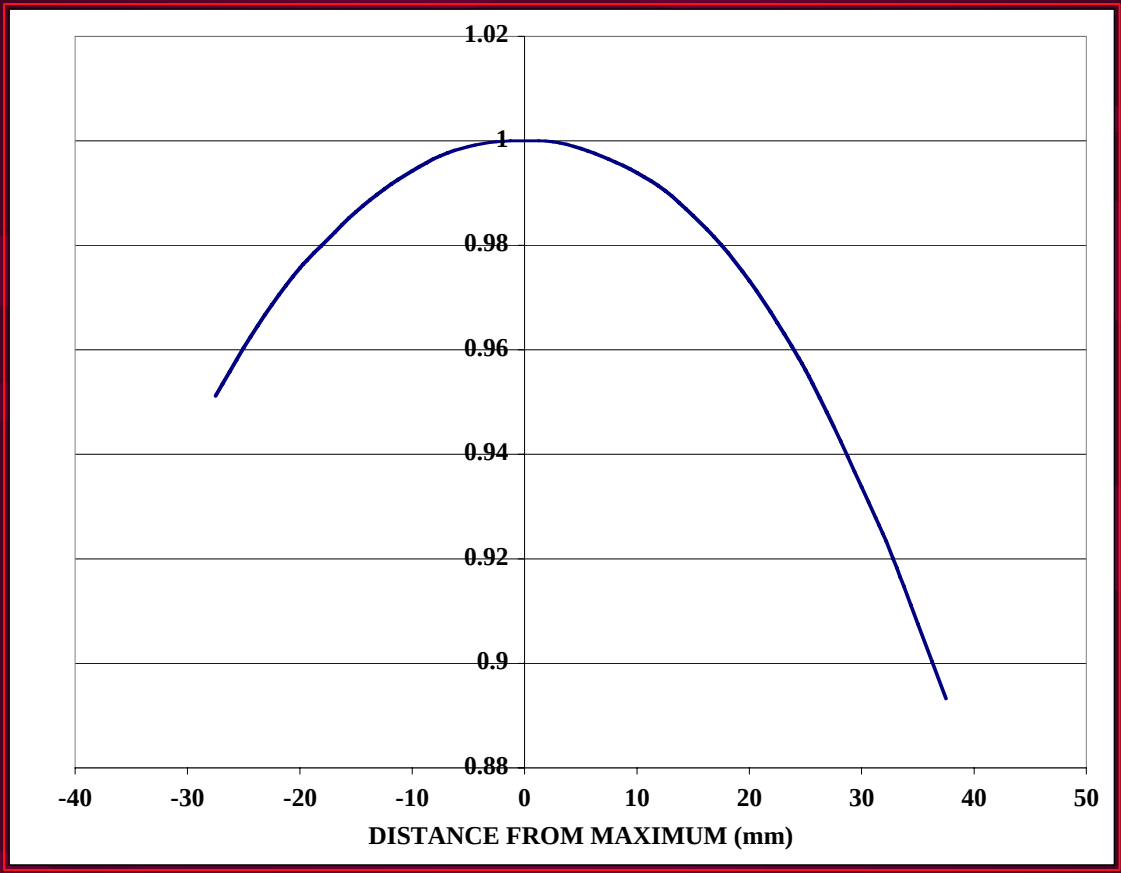
Important Point for Physicists

- **Measure your seeds before use with a well chamber.**
- **There have been examples of dead seeds, some seeds with twice the output of the others in the batch.**
- **Generally uncertainty for manufacturer is in the range of $\pm$4% to $\pm$7%**
- **Don’t just trust what manufacturer has sent you. Measure it!!!!**

Well chamber

- Clinical measurements of S_K for all sources are with a calibrated well chamber

Response with Length for a Well Chamber



Clinical Well Chamber Calibration

- Use a well chamber calibrated from an ADCL
- ADCL uses the technique mentioned here to give N_k which is used in clinic to give S_k

$S_k = Rdg * N_{sk} * C_e * C_{tp}$

Where Rdg is the electrometer reading in amperes

N_{sk} is the calibration factor provided by the ADCL (U/A)

C_e is the electrometer scale correction factor

C_{tp} is the air density correction factor

  - For unsealed chambers and low energy sources, there is a pressure correction

Characteristics of Well Chambers

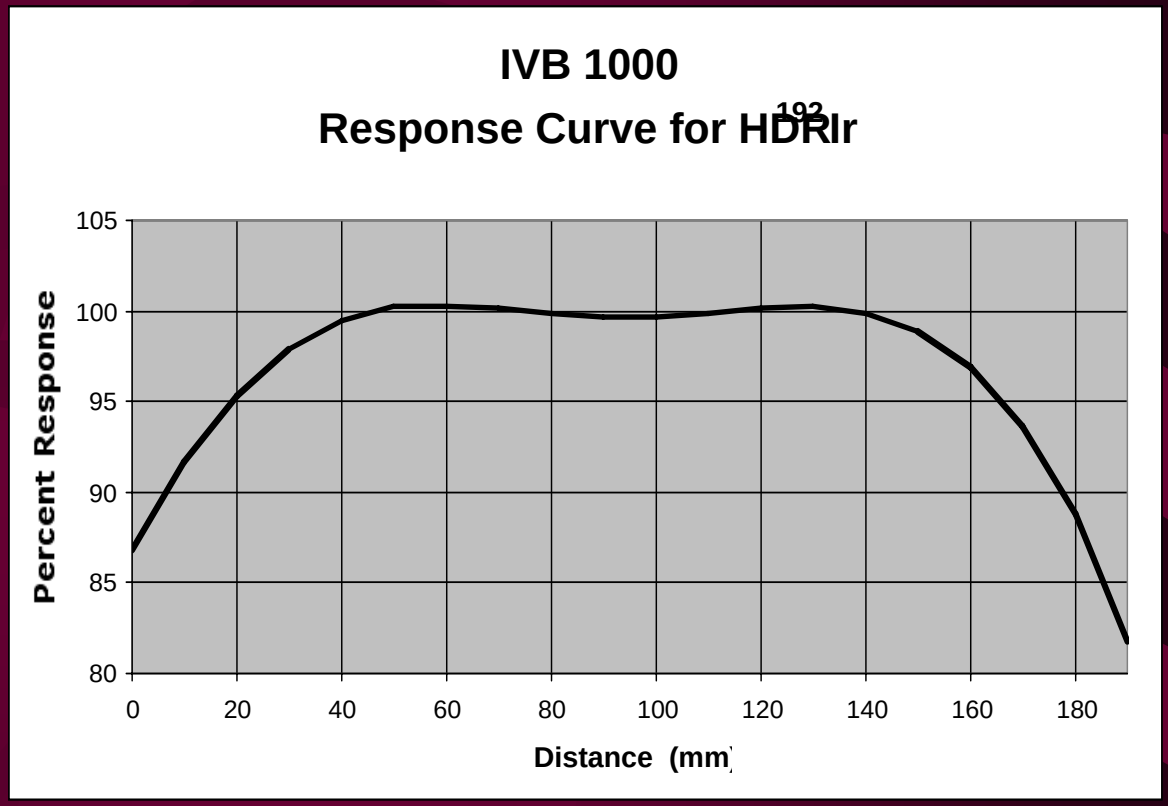
- Typically calibration of well chambers involve using a single seed at the axial maximum (sweet spot)
- Problem with strands is “fall off” of the “sweet spot” of well chambers due to axial geometry limitations and the effect this has on various lengths of source trains.
- Manufacturers made modifications to obtain extended “sweet length”

Extended Length Chamber Example

- Note insert allowing for differing length trains.
- The insert is an important part of the calibration.

Measurements of Axial Sweet Length of IVB 1000

- An HDR ^{192}Ir source was used to allow high precision scanning of chamber axial response.
- Similar Response for other sources



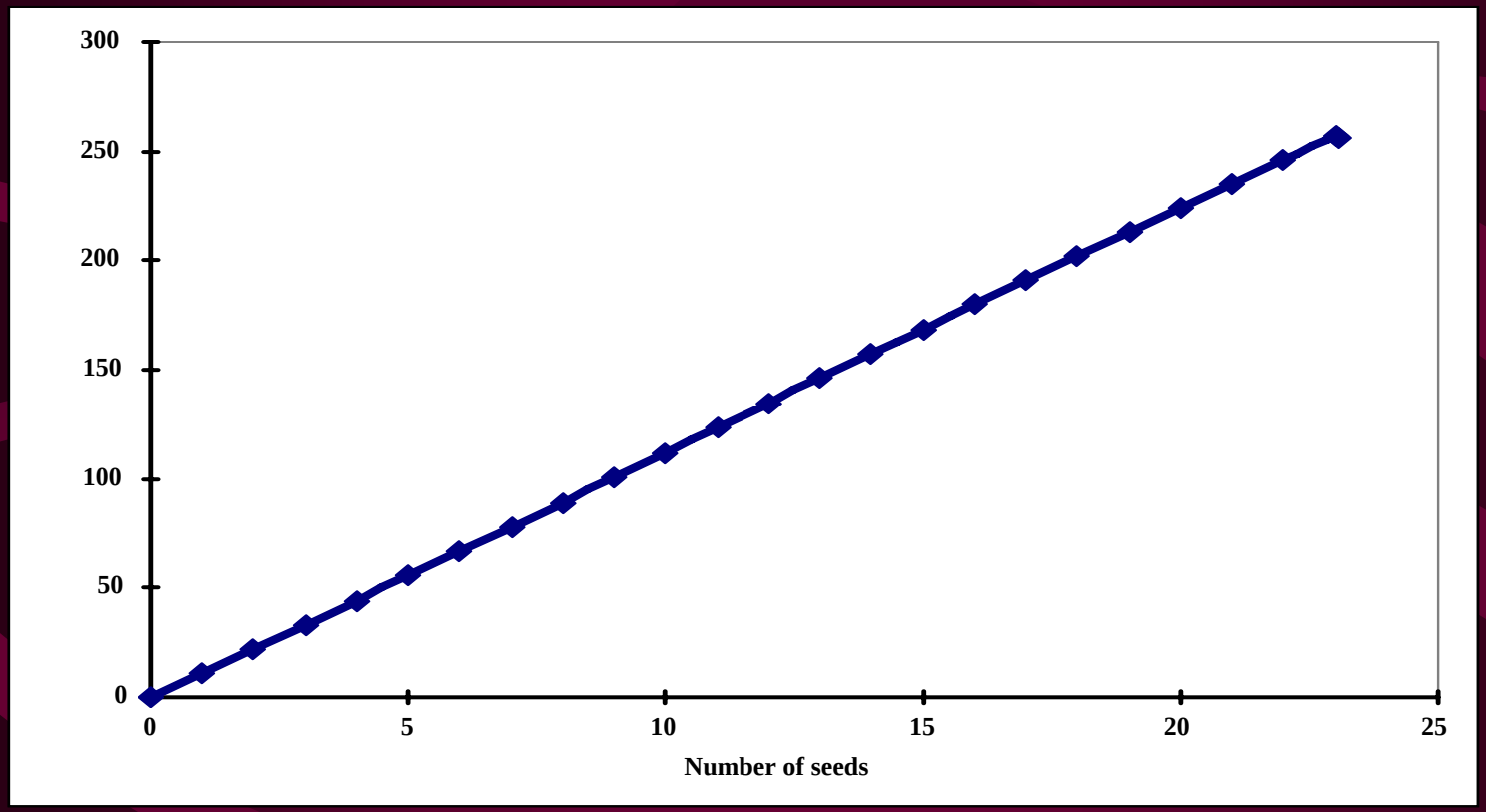
Calibration of Photon Source Strand [Med Phys 33:3804 (2006)]

- Calibration with single seed in sweet length performed
- Measurement of 23 seeds in train.
- One seed cut from train and the remaining 22 seeds in train were measured. Each single seed cut from the train is individually measured in another calibrated chamber.
- The above procedure was repeated for each seed

Results for photon source strand

- Using this procedure, a calibration factor for the chamber was determined for each possible length of source train.
- Individual seed calibration factors fell between $\pm$ 0.3% for the entire 23 seed train geometry.
- Average chamber response for all seeds was the same to $\pm$ 0.2% Agreement to single seed calibration to within 0.1%

Air kerma strength versus number of seeds



LDR I-125 seed strands

- Strand measured and then seeds removed and measured as done previously
- Various length strand measured and each seed independently

Strand I-125 with IVB1000

Number of Seeds (seed number)	Ratio of known to measured S_K
7	1.009
6	1.014
5	1.014
4	1.012
3	1.008
2	1.008
1	0.994

Analysis of strands

- Calibration with one seed of type used
- Measure the strand. (generally within $\pm$1.5%)
- Assume all same activity - divide by n
- Measure by contact radiograph if greatly different source strength
- Or measure in well chamber relative output by using a Pb slit in the chamber.

Multiple Sources

- Using this technique, multiple sources were measured. Various lengths of strands (or RadioCoils -Adam Paxton paper later) were measured using a well chamber with a long enough sweet spot.
- Sources in needles cannot be measured this way since variation in needle wall thickness results in 30% difference in photon output.
- Use a sterilizable insert.

Acknowledgements

- Many thanks to
- John Micka, Shannon Holmes and Tim Bohm (co-authors)
- All graduate students and staff of the UW Radiation Calibration Laboratory
- Finally to all of you that send chambers for calibration to support this work.