Update of the CLRP TG-43 parameter database for brachytherapy sources

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INTRODUCTION

- Presently, brachytherapy dosimetry and planning is based on single source consensus data published in TG-43 reports.
- In 2008, EGSnrc BrachyDose-based version 1 of the CLRP TG-43 database (CLRPv1) containing TG-43 data for 42 low- and high-energy brachytherapy sources was published

AIM

- To update CLRP TG-43 database for brachytherapy sources using EGSnrc application egs_brachy.
- Presently, CLRPv2 includes 45 sources [17 ^{103}Pd, 22 ^{125}I, 1 ^{131}Cs, and 5 (more to come) ^{192}Ir]. The database documents source models which will be part of egs_brachy distribution. Database available at:
- https://physics.carleton.ca/clrp/egs_brachy/seed_database_v2.

METHOD

- Systematic recoding of source model using egs++ geometry package and its egs_brachy extensions.
- Calculated DRCs, radial dose functions, 1D and 2D anisotropy functions, along-away dose-rate tables, a few primary-scatter separation dose tables, and mean photon energy escaping sources.
- New statistical uncertainties of source volume corrections for phantom voxels which overlap with sources are implemented in egs_brachy.
- Air-kerma strength per history is calculated for models of NIST's WAFAC and for point detectors.
- For validation, results are compared with CLRPv1 data and other data in the literature.

RESULTS

- Statistical uncertainties, source volume corrections, and source geometry models have all been improved.
- DRC values for sources without geometry changes agreed within 0.6% with CLRPv1, and 4 sources with geometry changes agreed within 4.2% (Fig.1a)
- egs_brachy DRC values of low-energy sources are significantly lower than TG43 consensus values due to errors and uncertainties in measured values (Fig.1b).
- Mean (range) of differences between egs_brachy and TG-43 consensus DRC values for ^{103}Pd, ^{125}I, and ^{131}Cs sources were -3.3% (-6%,-0.3%), and -2.7% (-6.1%, 1.5%), and 0.7% respectively (Fig.1b).
- For ^{192}Ir sources TG-43 consensus DRCs are based only on MC values, and for the 3 cases with comparable values, the mean (range) difference is only 0.2% (0.02%, 0.5%).

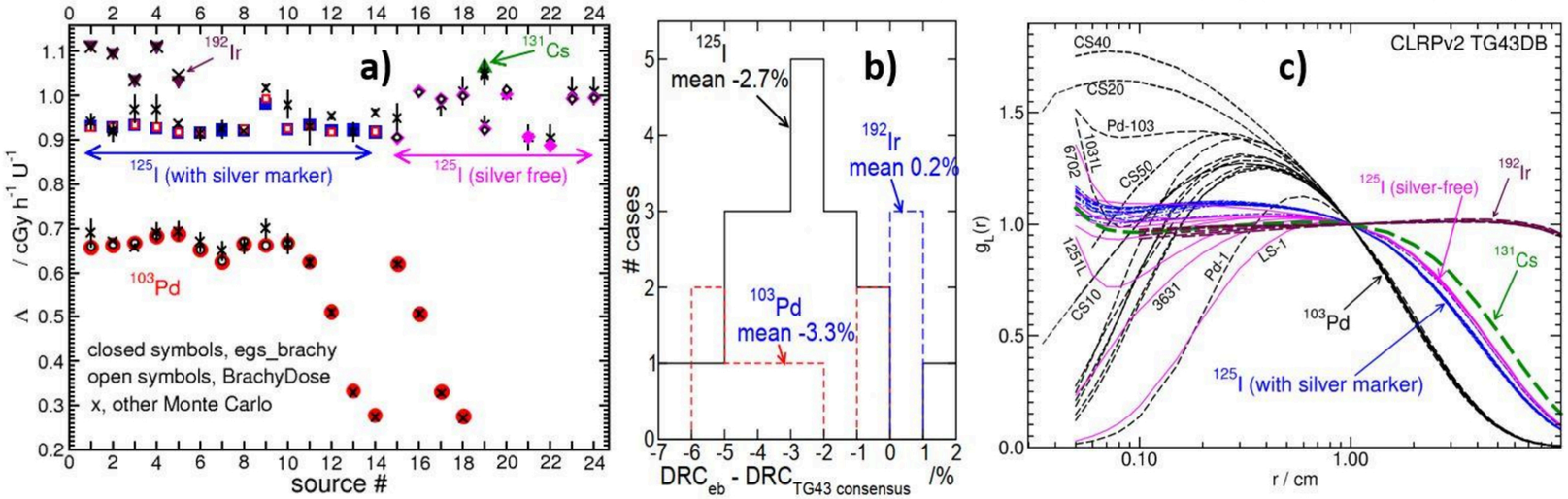

Figure 1. **a**) *DRC Values for 18 ^{103}Pd (red circles); 14 ^{125}I without silver marker (blue squares) or 10 with silver marker (pink diamonds); 1 ^{131}Cs (green triangle up); 5 ^{192}Ir (orange triangle down); CLRPv2 values calculated with egs_brachy are closed symbols which can appear open if the open-symbol BrachyDose values (CLRPv1) are on top of CLRPv2 values. DRCs from other MC codes are also shown (x symbol).* ***b)****. The DRC differences between egs_brachy and TG43 consensus values.* ***c)****. Radial dose function for different sources, including ^{103}Pd (black dashed lines), ^{125}I (blue dashed lines with silver marker and purple solid without silver), ^{131}Cs (green thick dashed line), and LDR ^{192}Ir sources.*

CONCLUSIONS:

- CLRPv2 database provides accurate TG43 dosimetry parameters, complementing the verified source models freely distributed with egs_brachy.
- A systematic difference between the TG43 consensus values of DRCs and those calculated by egs_brachy have been identified
- This database has applications in research, dosimetry, and brachytherapy planning, and will contain datasets for other high-energy sources.

REFERENCES:

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