Uncertainty analysis for dose measurements using OSLD nanoDots

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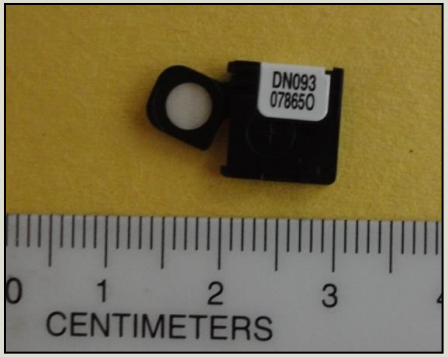
Introduction

- NanoDots are a popular dosimeter
- IROC Houston (formerly RPC) uses OSLD to monitor beam output
  - Reference conditions



- How precise is the OSLD program?

Dose calculation

- Signal: $M_{cor} = \left(\frac{\sum_n M_{raw,n} \cdot k_{d,n}}{n} \right) \cdot k_{s,i}$
- $D = M_{cor} \cdot C_D \cdot k_E \cdot k_F \cdot k_L$
- Calibration factor (C_D) is based on irradiation of standards to a known dose
- $C_D = \frac{D_S}{M_{cor,s} \cdot k_{F,s} \cdot k_{L,s}}$

Methods

- Estimated Uncertainty in each parameter
- Based on commissioning data for batches of 5,000 – 20,000 dosimeters
- Fancy error propagation
  - Recursive solving of: $var(XY) = var(X)var(Y) + var(X)E(Y)^2 + var(Y)E(X)^2$

    and $var(X+Y) = var(X) + var(Y) + 2CoV(X,Y)$

    where x is *Mcor* and Y is the product of the remaining factors used to calculate dose.
  - No assumptions about shape of distribution
  - Accounts for cross correlation
- Based on measurement with 2 detectors

Calculated Uncertainty Results

$$D = M_{cor} \cdot C_D \cdot k_L \cdot k_E \cdot k_F$$

- $$D = D_s \cdot \frac{M_{cor}}{M_{cor,s}} \cdot \frac{k_L}{k_{L,s}} \cdot \frac{k_E}{k_{E,s}} \cdot \frac{k_F}{k_{F,s}}$$

Parameter	CV (%)
D_S	0.6
M_{cor}	0.8
k_L	0.3
k_E	0.8
k_F	0.1
Total	**1.6%**

Reference conditions:

100 cGy
Read after 5 days
Irradiated with Co-60

For doses ranging between 90-110 cGy
For time ranging between 2 and 30 days
These can be expanded to 25-300 cGy and 1-120 days:
The uncertainty increases to **1.7%**

IROC Houston measured results

- Photons:

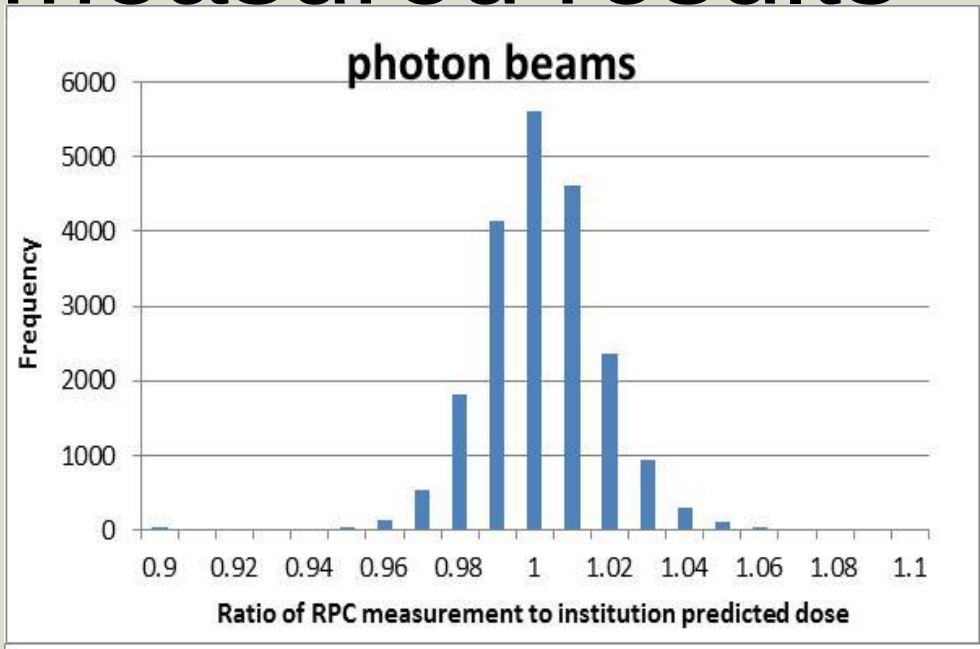
  IROC-H/Inst:

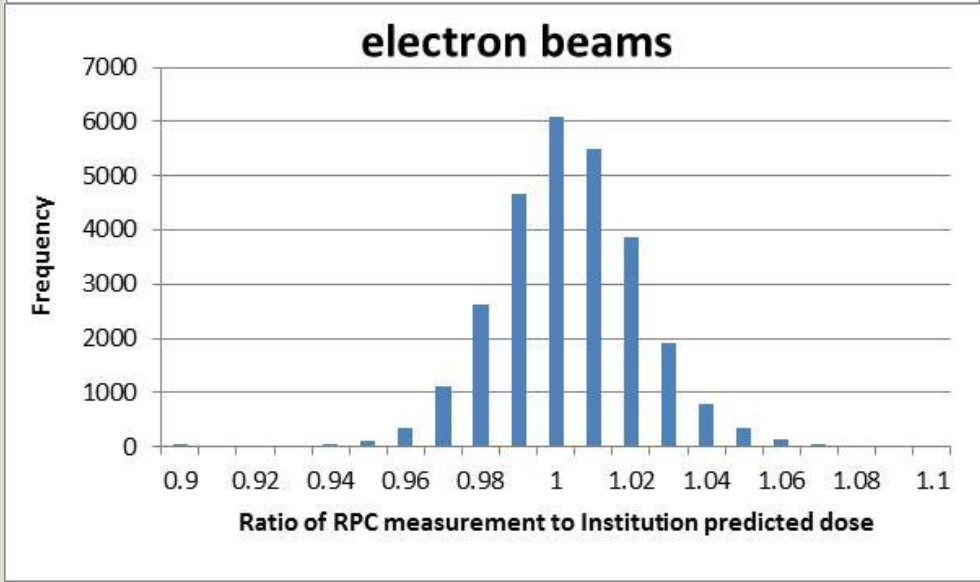
  0.997 +/- 1.6%

- Electrons:

  IROC-H/Inst:

  0.999 +/- 1.9%





Summary

- Under well controlled conditions, 2 dosimeters provide ±1.6% uncertainty.
  - 1 sigma level

- This is consistent with the uncertainty in TLD measurements (±1.3% for 3 detectors) Kirby et al, Med Phys 1992.
- IROC Houston's 5% criterion is reasonable

Thank You!

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