

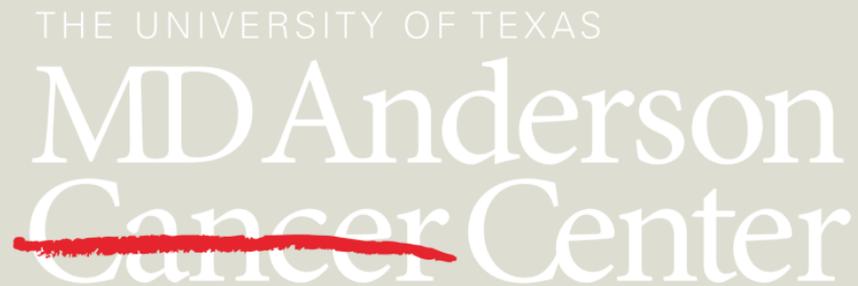
Uncertainty analysis for dose measurements using OSLD nanoDots

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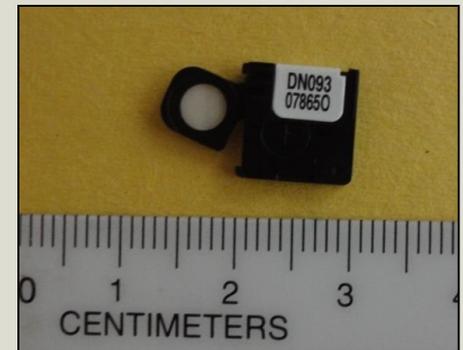
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Introduction

- 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: $\text{var}(XY) = \text{var}(X)\text{var}(Y) + \text{var}(X)E(Y)^2 + \text{var}(Y)E(X)^2$

and

$$\text{var}(X + Y) = \text{var}(X) + \text{var}(Y) + 2\text{CoV}(X, Y)$$

where x is M_{cor} 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

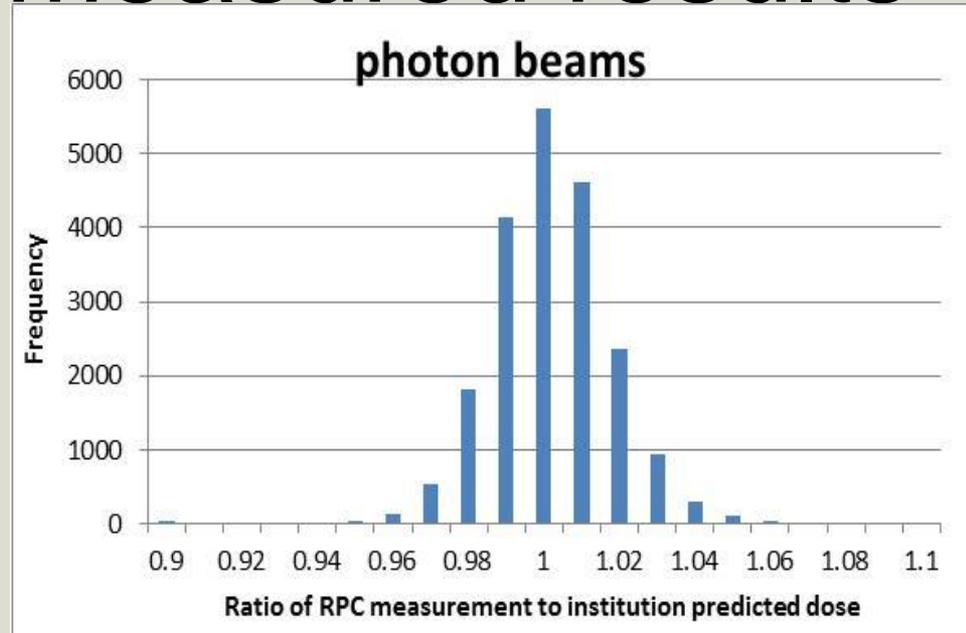
For time ranging between 2 and 30 days

These can be expanded to 25-300 cGy and 1-120 days:

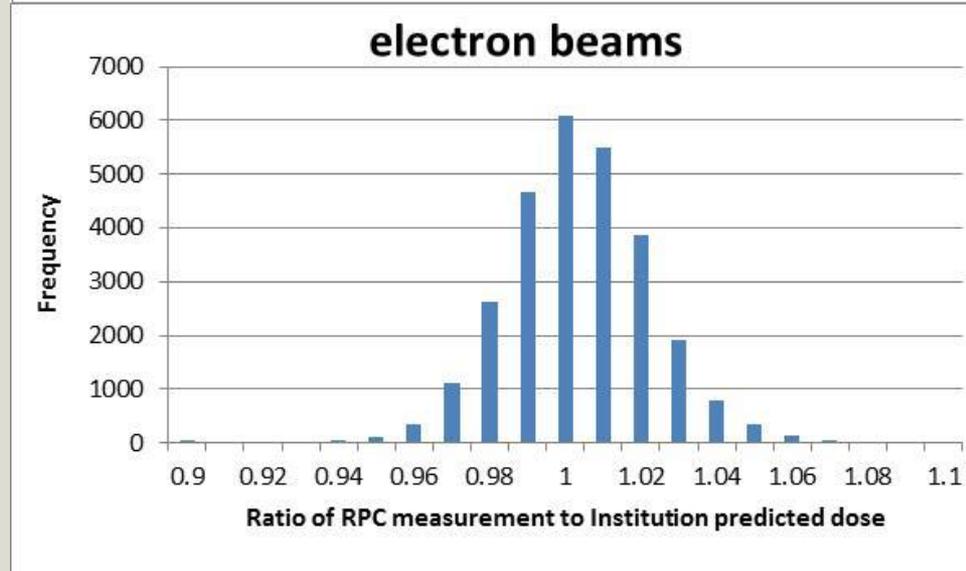
The uncertainty increases to **1.7%**

IROC Houston measured results

- Photons:
IROC-H/Inst:
 $0.997 \pm 1.6\%$



- Electrons:
IROC-H/Inst:
 $0.999 \pm 1.9\%$



Summary

- Under well controlled conditions, 2 dosimeters provide $\pm 1.6\%$ uncertainty.
 - 1 sigma level
- This is consistent with the uncertainty in TLD measurements ($\pm 1.3\%$ for 3 detectors) Kirby et al, Med Phys 1992.
- IROC Houston's 5% criterion is reasonable

Thank You!

- This work was supported by grant CA010953

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