A Novel Mouse Dosimetry with MOSFET Technology in Orthovoltage X-ray Irradiator

Duke University, Durham, NC

Samuel Brady*, Garrett Muramoto, Greta Toncheva, Lauren Daigle, Giao Nguyen, John Chute, Mark Dewhirst, Terry Yoshizumi

Goals

- Application of MOSFET technology in small animal dosimetry using TLD as gold standard
- Determine the efficacy of MOSFET in small animal dose assessment

Materials

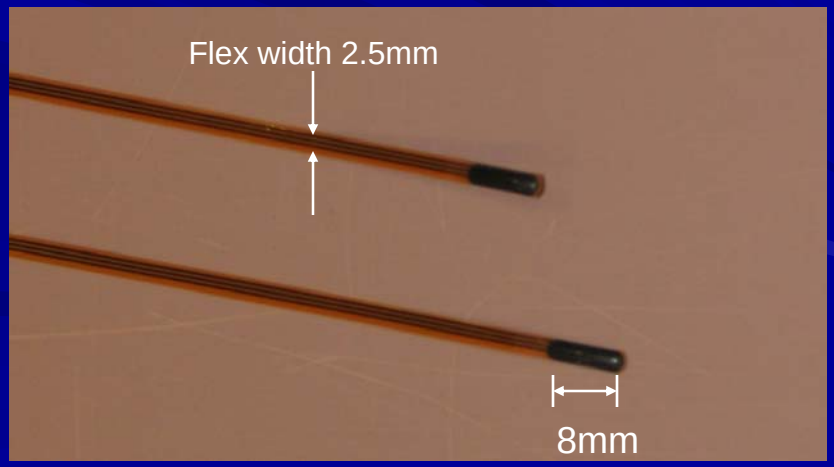
- X-ray Irradiator: AGFA X-RAD 320 orthovoltage (AGFA NDT Pantak Seifert GmbH & Co.KG, Ahrensburg, Germany)
  - Irradiator parameters:135 kVp and 22 mA
  - filter type #4 (0.1 mm Copper + 2.5 mm Aluminum).

Materials

- mobileMOSFET dosimetry system (Best Medical Canada, LTD, Ottawa, Canada)
  - mobileMOSFET wireless system (model TN-RD-70-W)
  - PC-based user interface software (TN-RD-75)
  - Bluetooth wireless transceiver (TN-RD-38)
  - Reader module (TN-RD-16)
  - 5 high sensitivity detectors (TN-1002RDM)

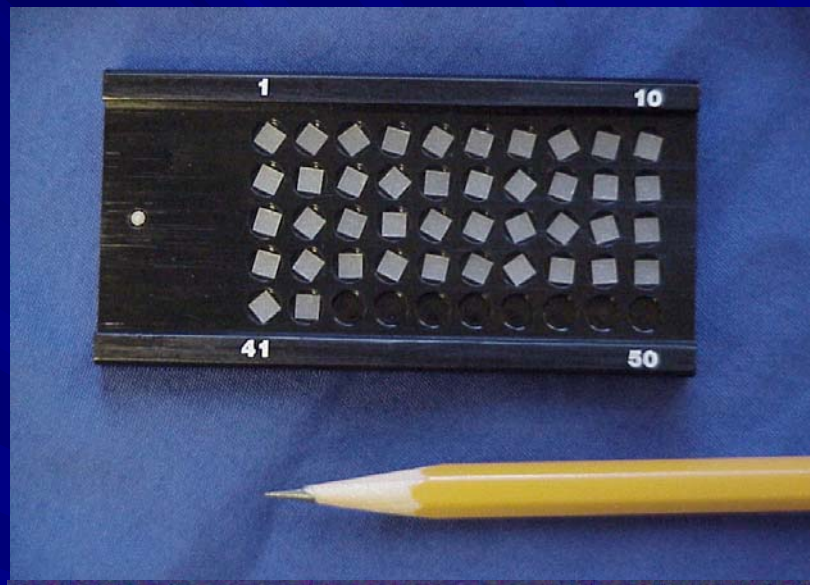
Materials

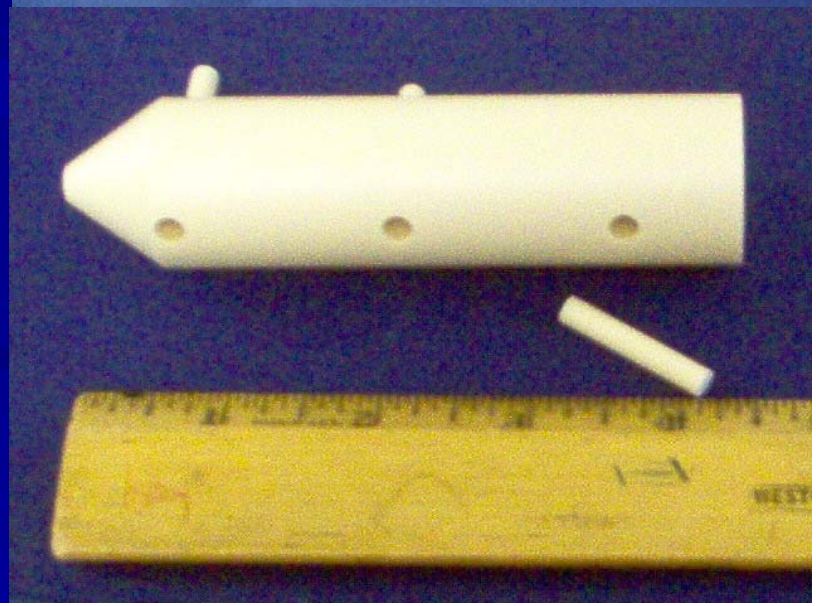
- Metal Oxide Semiconductor Field Effect Transistor (MOSFET)
  - Active area 0.2mm x 0.2mm
  - Voltage measurements are proportional to absorbed Dose



Materials

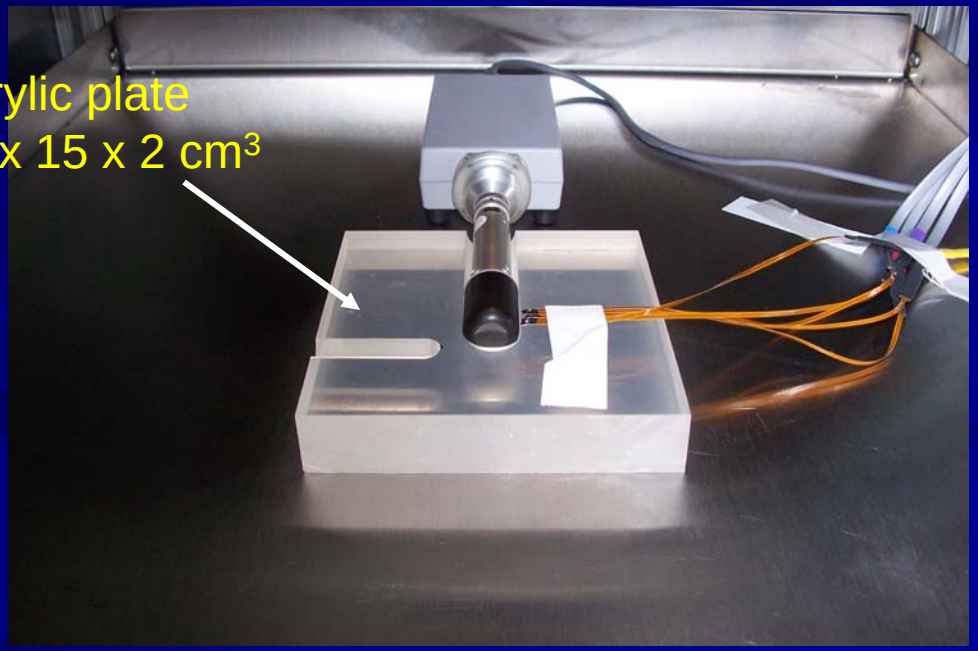
- Harshaw TLD-100 chips (Thermo Scientific, Franklin, MA)
  - TLD dimensions: 3x3x1mm^3
- Ion Chamber 6cc (Model 9015, Radcal, Monrovia, CA)
- Tissue equivalent mouse phantom (CIRS, Norfolk, VA)
  - 115.4 mm x 29 mm diameter





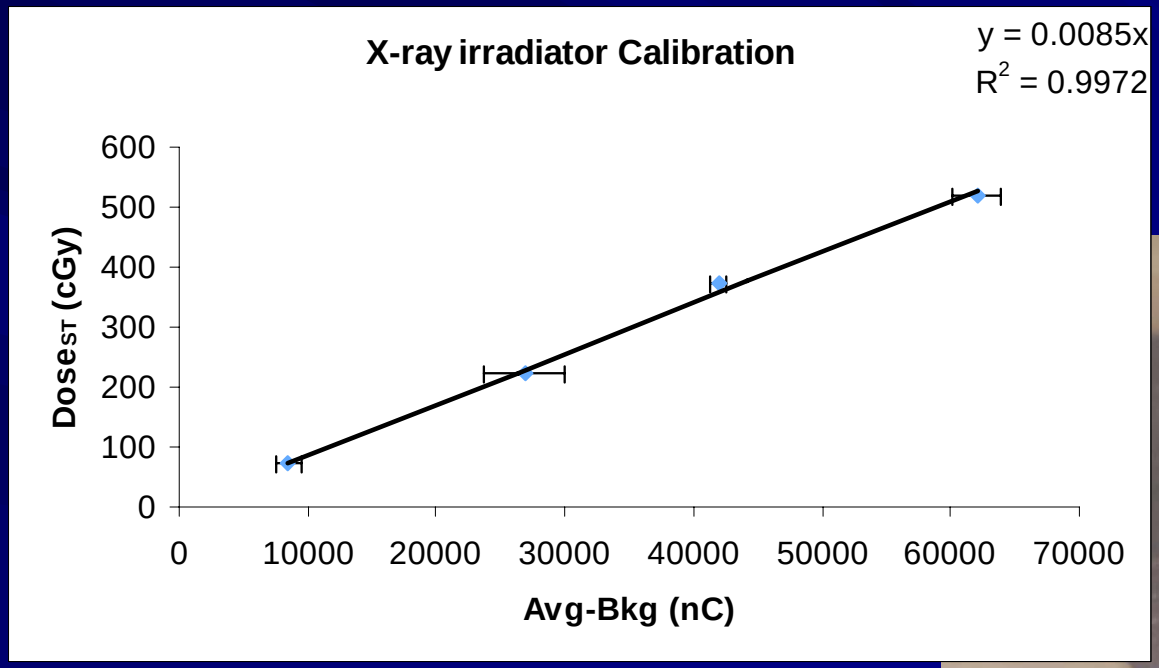
Methods
mobileMOSFET calibration

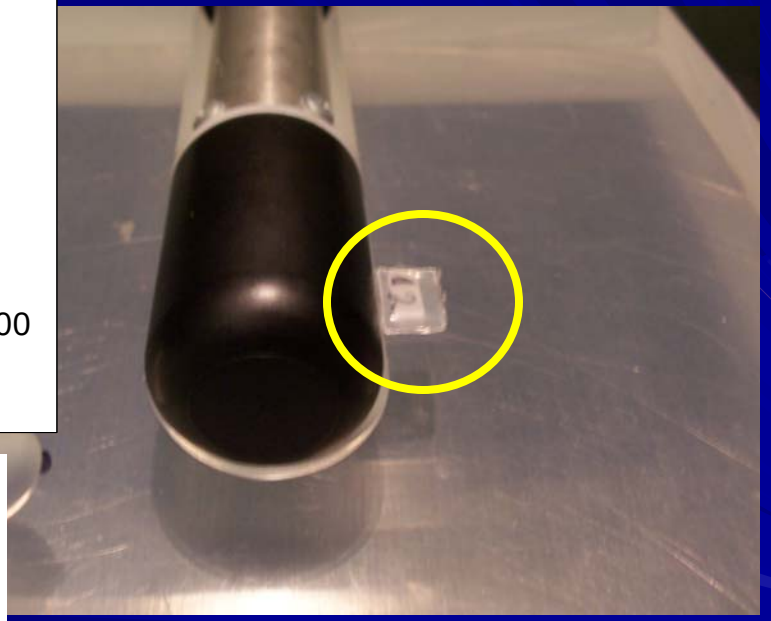
MOSFET calibration parameters			
Run	**Time (min)**	**X (R)**	**Dose (cGy)**
1	5	445.4	390.17
2	5	447.3	391.83



Dosimeter	CF (mV/cGy)
1	4.68
2	4.49
3	4.71

Methods
TLD calibration

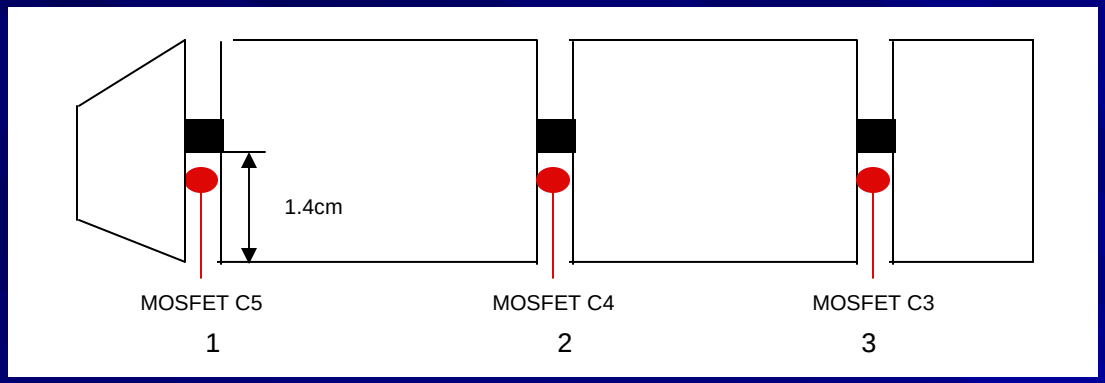


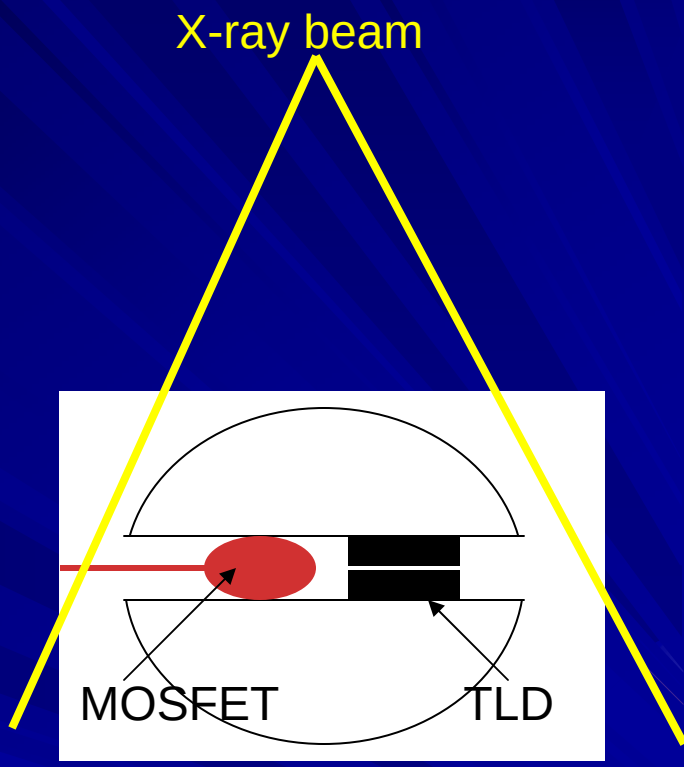


$$D_{ST}(rad) = 0.867\left(\frac{rad}{R}\right)\cdot X(R)\cdot\left(\frac{\left(\frac{\mu}{\rho}\right)_{ST}}{\left(\frac{\mu}{\rho}\right)_{Air}}\right)$$

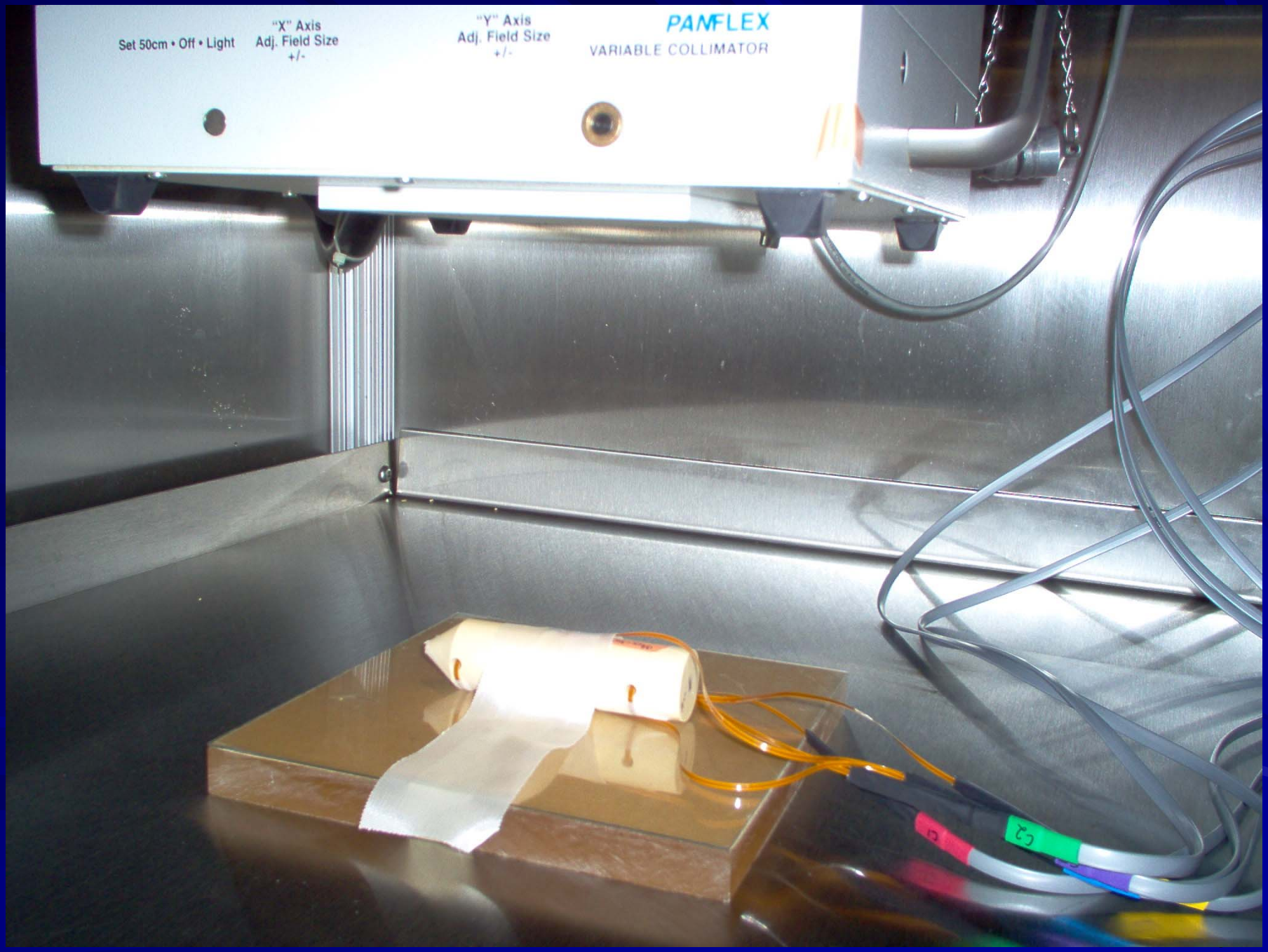
Methods

X-ray beam



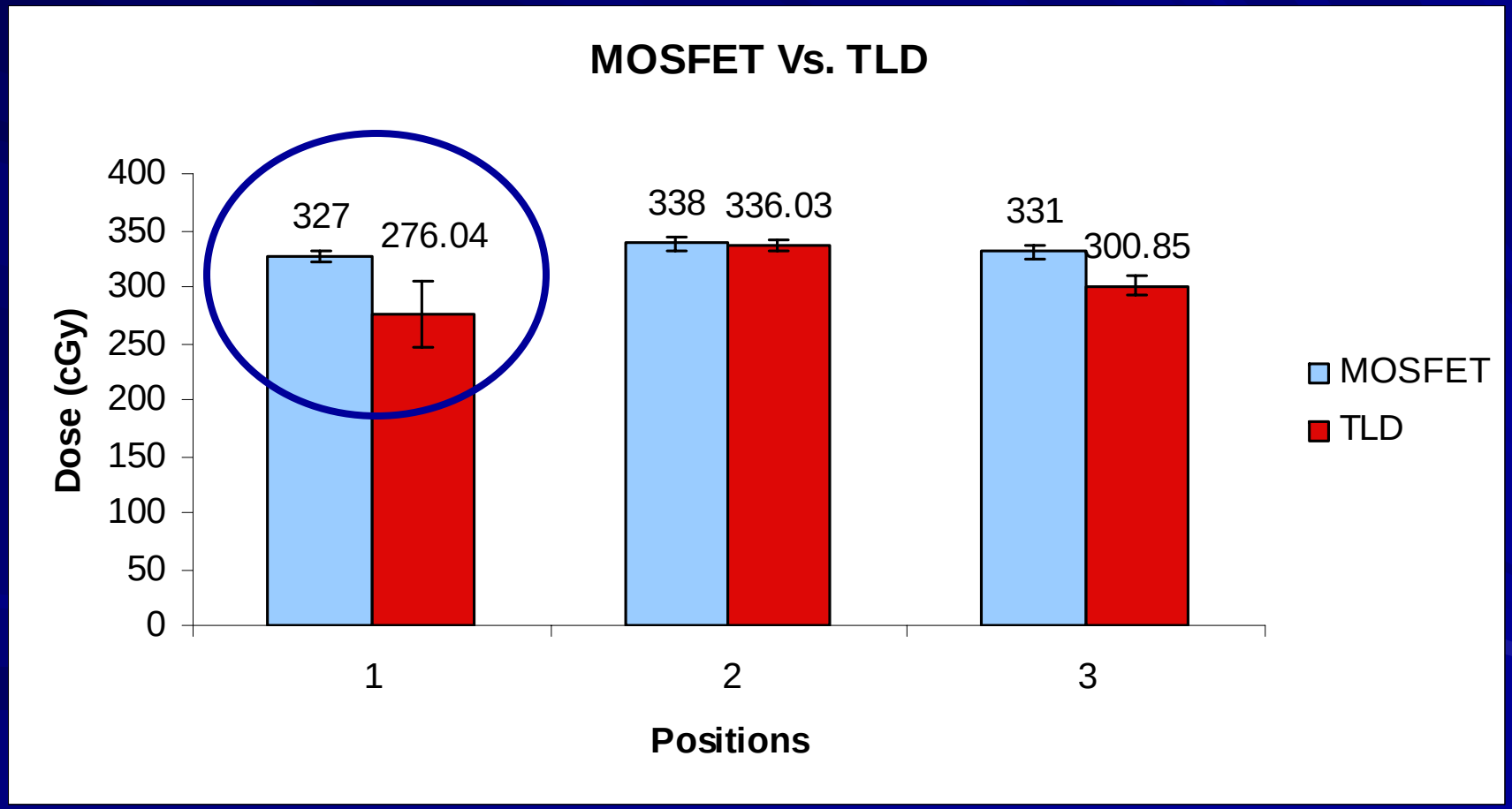


- MOSFET detectors (red)
- TLD (black)


Set 50cm • Off • Light
"X" Axis
Adj. Field Size
+/-
"Y" Axis
Adj. Field Size
+/-
PANFLEX
VARIABLE COLLIMATOR

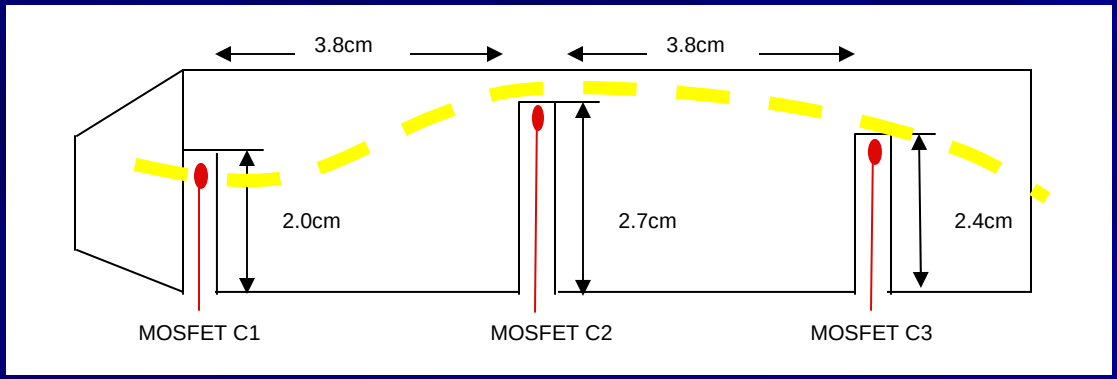
Results

- Detector surface Perpendicular to the beam



Additional Results

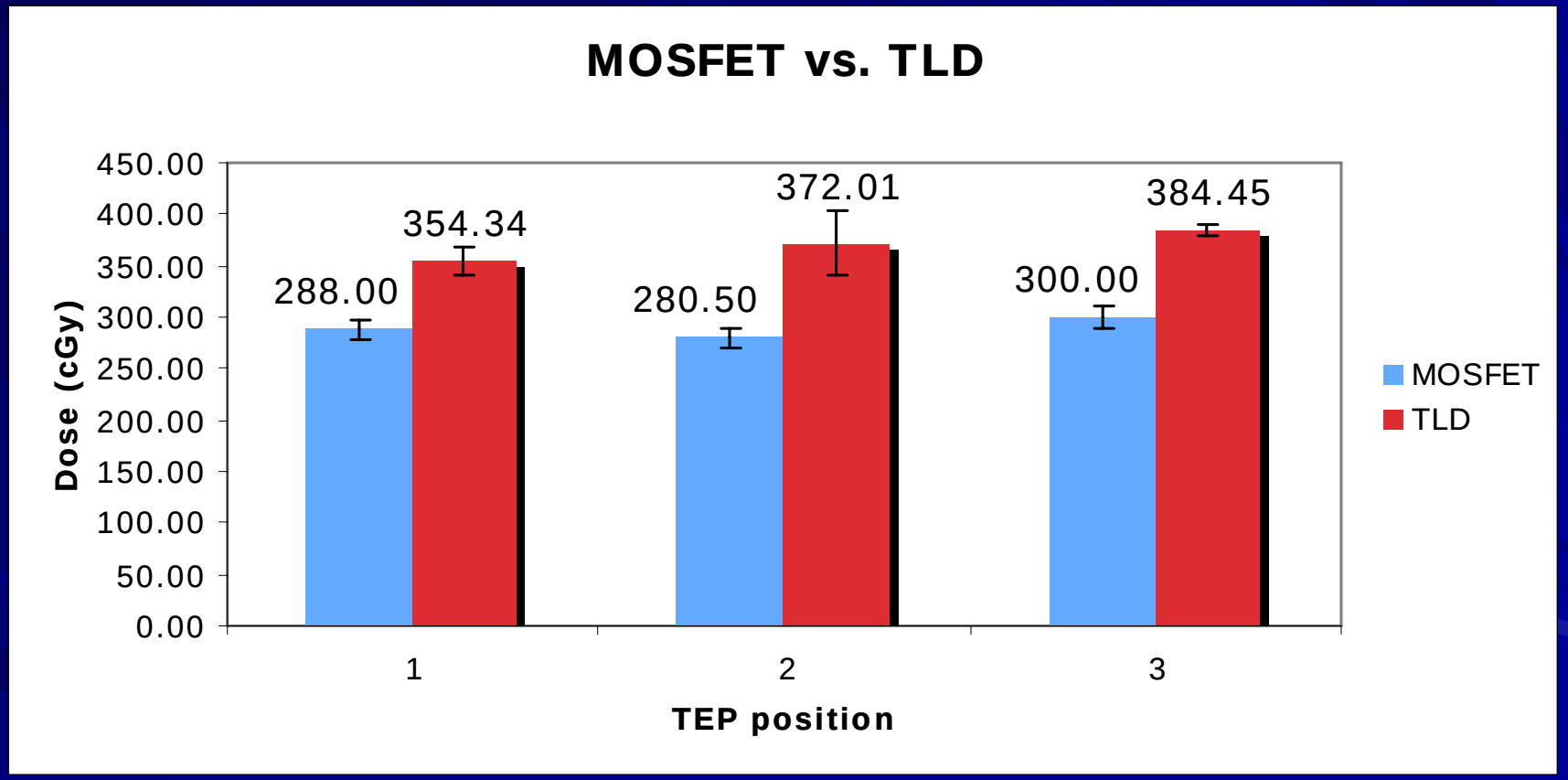
- long-axis of detector surface parallel to the beam



X-ray beam

Additional Angular Dependency Results

- long-axis of detector surface parallel to the beam



Conclusion

- MOSFET showed good agreement with TLD
- MOSFET advantages:
  - Small size
  - Immediate readout
- MOSFET disadvantages
  - Energy dependence
  - Costly (> $22k for small animal dosimetry)
- MOSFET provides alternative to labor-intensive TLD method

Acknowledgments

- Beverly Steffey
- Oana Craciunescu
- Dave Jorgensen