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NCSP
NUCLEAR CRITICALITY SAFETY PROGRAM

LLNL TNCT Measurements

Presented at the Nuclear Criticality Safety Program (NCSP) Technical Program Review
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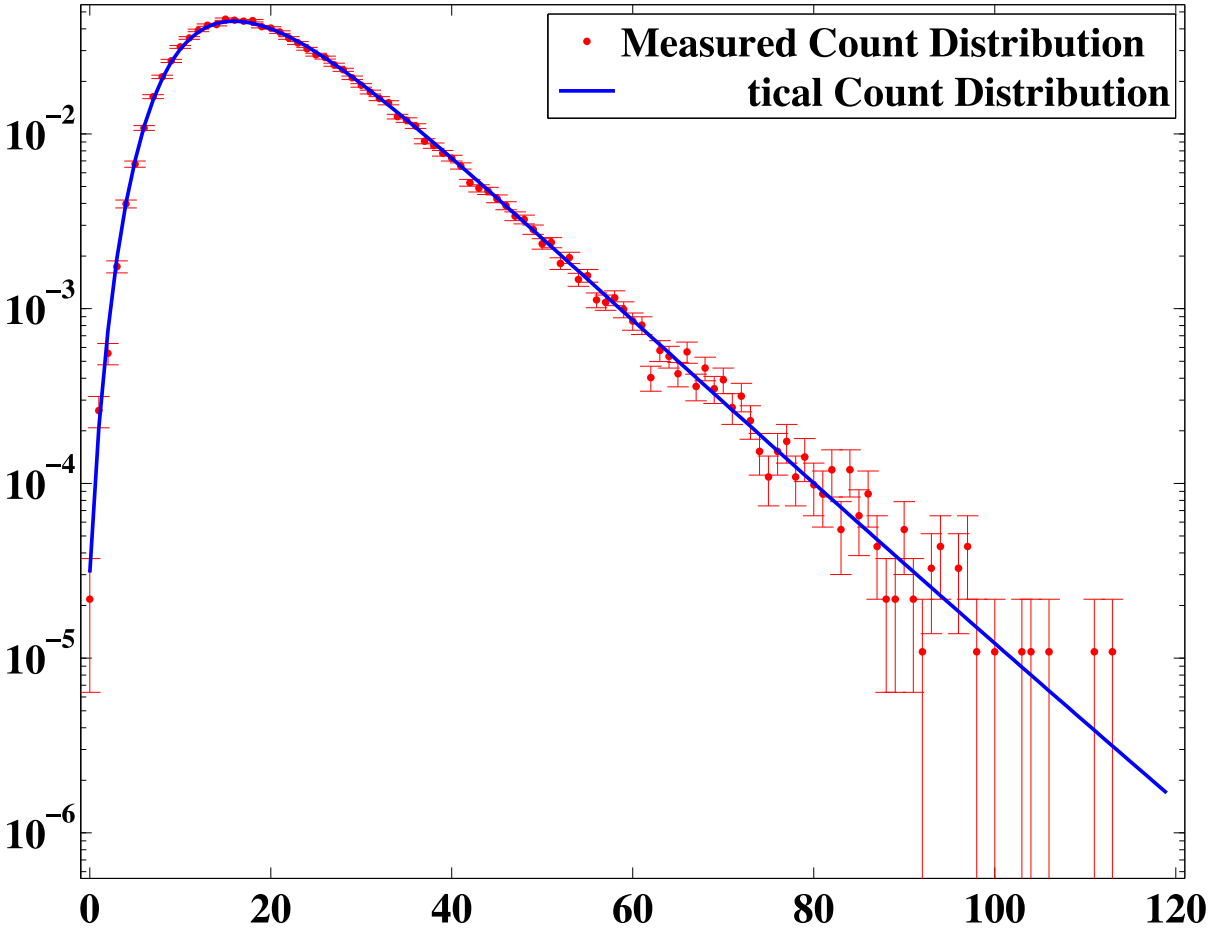
Nuclear Material Assay

- Neutron multiplicity measurements count up the number of time gates of a given duration T where the detector saw n neutrons
- Theoretical distributions can be calculated for any given:
  - k_{eff}
  - Mass of the spontaneously-fissioning ^{240}Pu m_{S}
  - Detection Efficiency ε
  - Diffusion time λ^{-1}
- Measured multiplicity distributions were compared to theory using χ^2 minimization for non-zero values of the multiplicity distributions for:
  - $T = 250\ \mu\text{s}$
  - $T = 300\ \mu\text{s}$
  - $T = 350\ \mu\text{s}$
  - $T = 400\ \mu\text{s}$
  - $T = 450\ \mu\text{s}$
  - $T = 500\ \mu\text{s}$
  - $T = 550\ \mu\text{s}$
  - $T = 600\ \mu\text{s}$

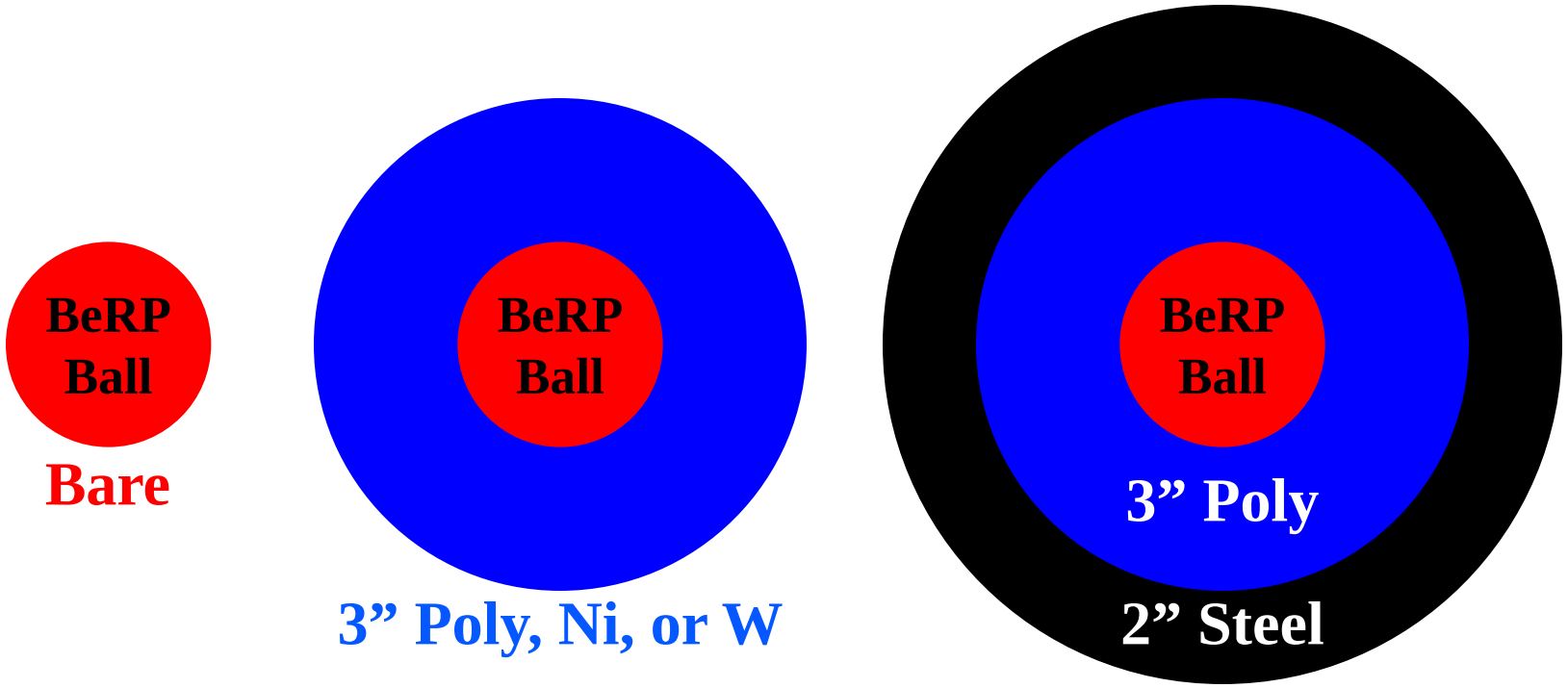
Example of a Multiplicity Distribution



Detection Efficiency

- Detection Efficiency was determined from ^{252}Cf measurements configured exactly how the BeRP ball measurement was configured:
  - Moderation, reflection, and shielding replicated
  - Detector distance replicated
- Fitting $Y_{2F}(T)$ for the various time gates T gives R_{2F}
  - $R_{2F} = \varepsilon \times \nu_2 / \nu_1$
  - The constants ν_2 and ν_1 are the first two combinatorial moments of the neutron multiplicity distribution for induced fission of ^{252}Cf

Five Configurations

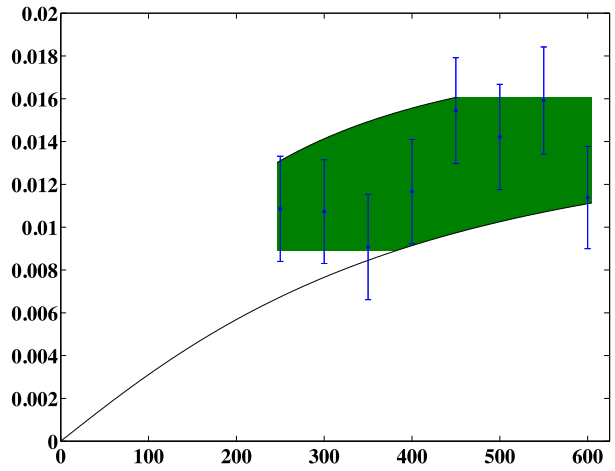


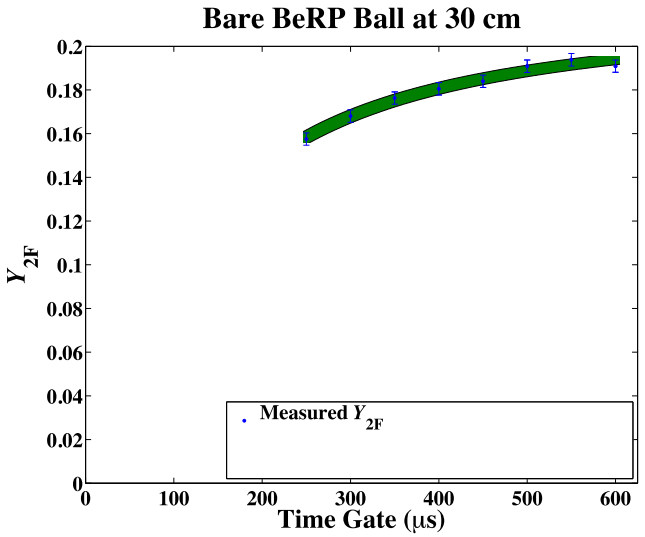
Results

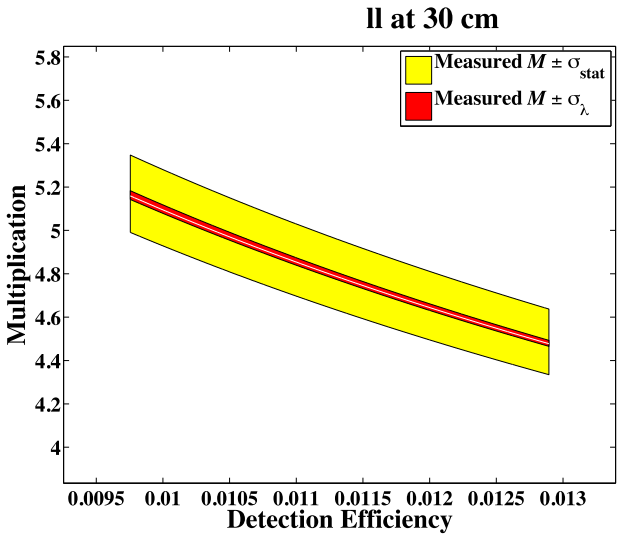
Configuration	Efficiency	Multiplication	Mass of ^{240}Pu (g)
Bare BeRP Ball, 30 cm	0.0113 ± 0.0016	4.8 ± 0.5	277 ± 29
BeRP in 3” Poly, 25 cm	0.0381 ± 0.0018	16.3 ± 1.3	269 ± 18
BeRP in 3” Poly in 2” Steel, 25 cm	0.0101 ± 0.0004	16.2 ± 0.6	282 ± 9
BeRP in 3” Ni, 30 cm	0.0168 ± 0.0013	10.7 ± 0.7	244 ± 15
BeRP in 3” Cu, 29 cm	0.0146 ± 0.0009	15.5 ± 1.1	282 ± 18

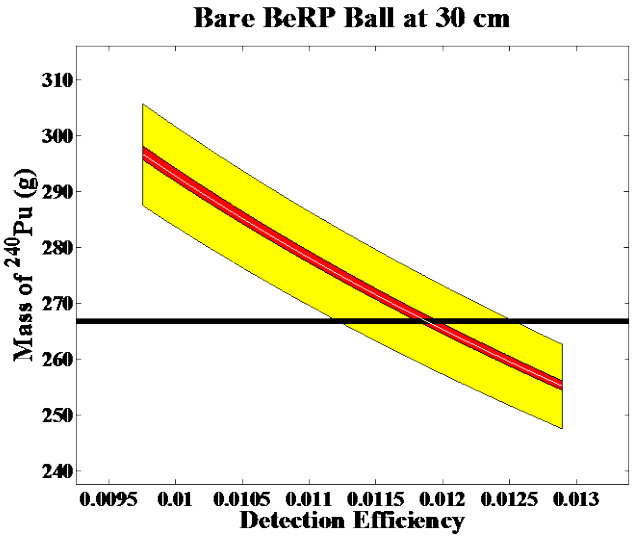
True Mass of ^{240}Pu = 266.8 ± 0.5 grams

Bare BeRP Ball

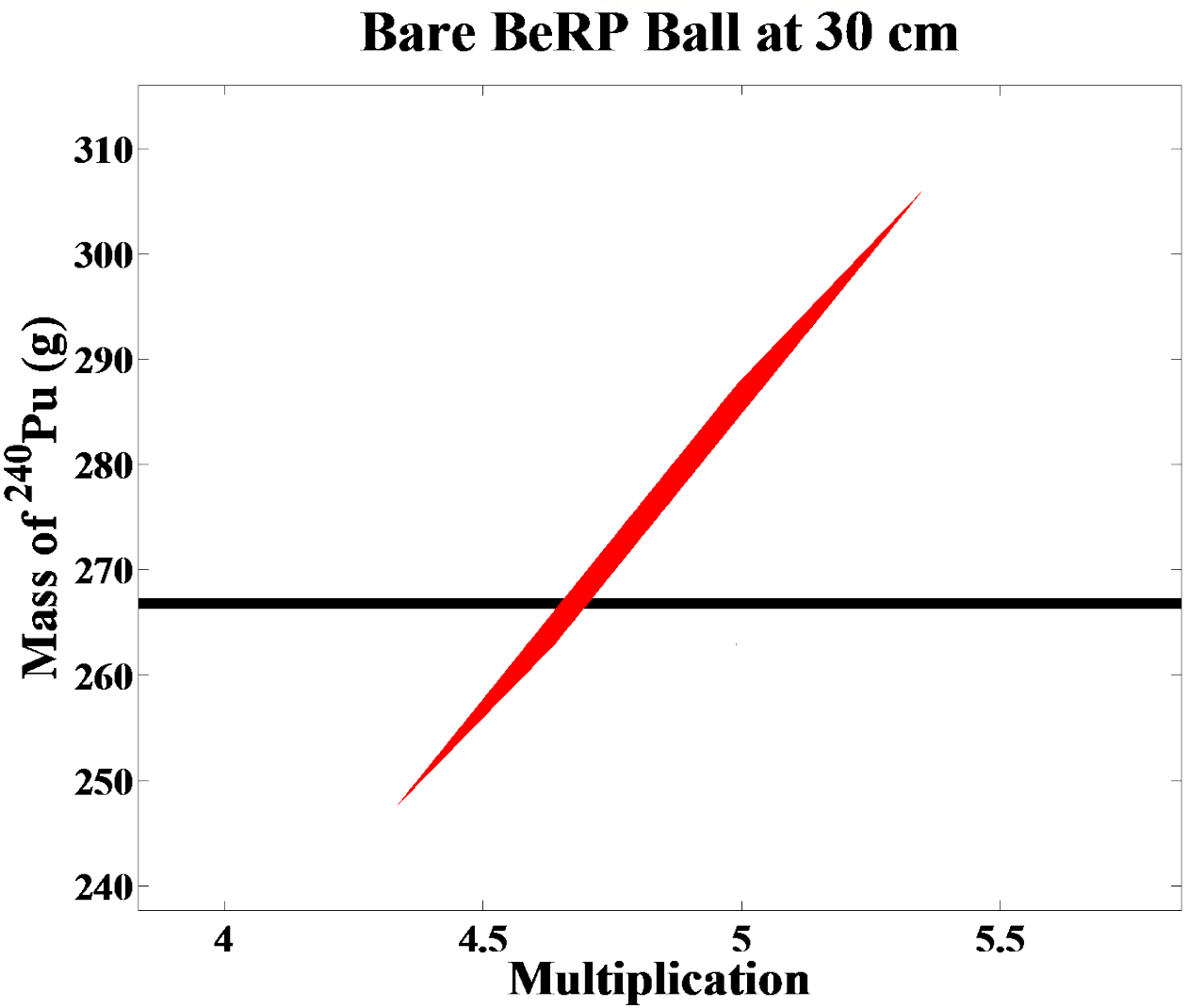




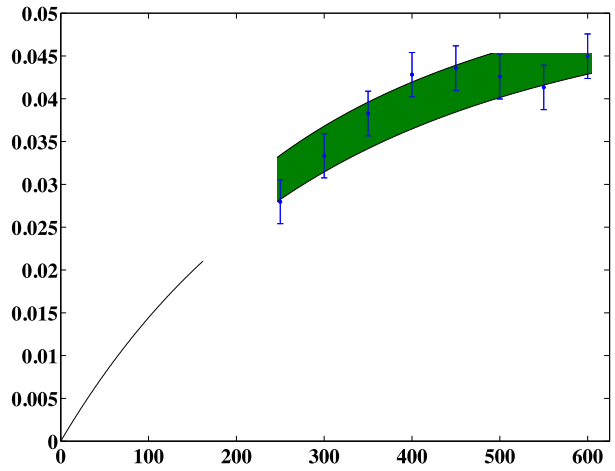


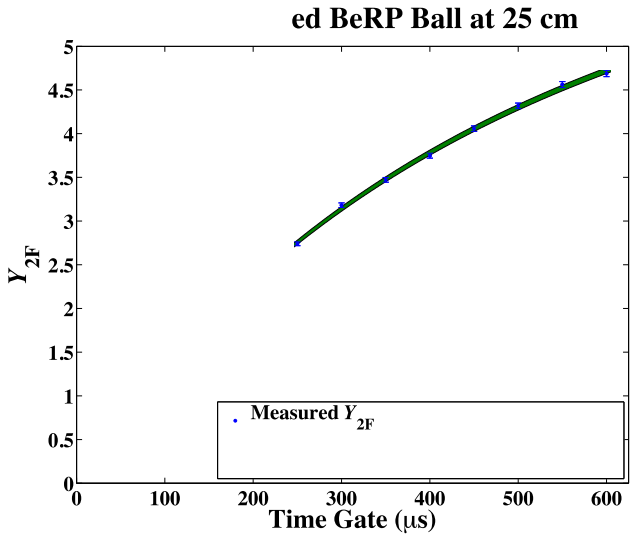


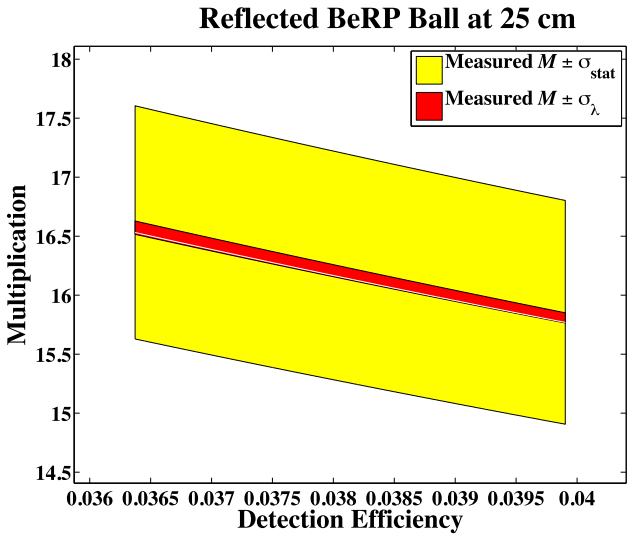
Bare BeRP Ball

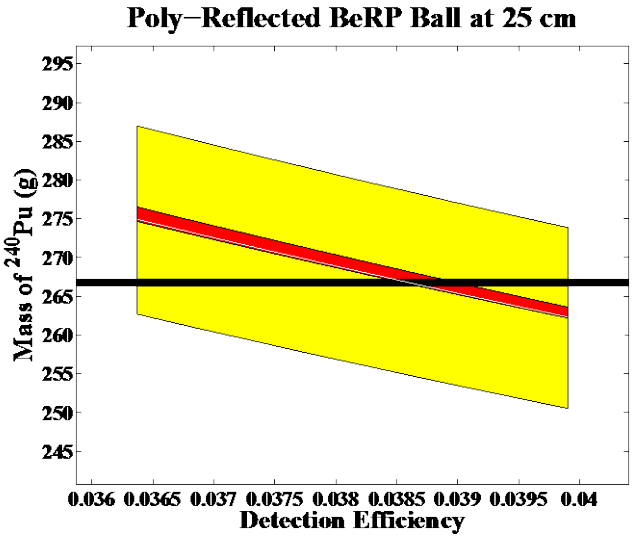


Polyethylene-Reflected BeRP Ball









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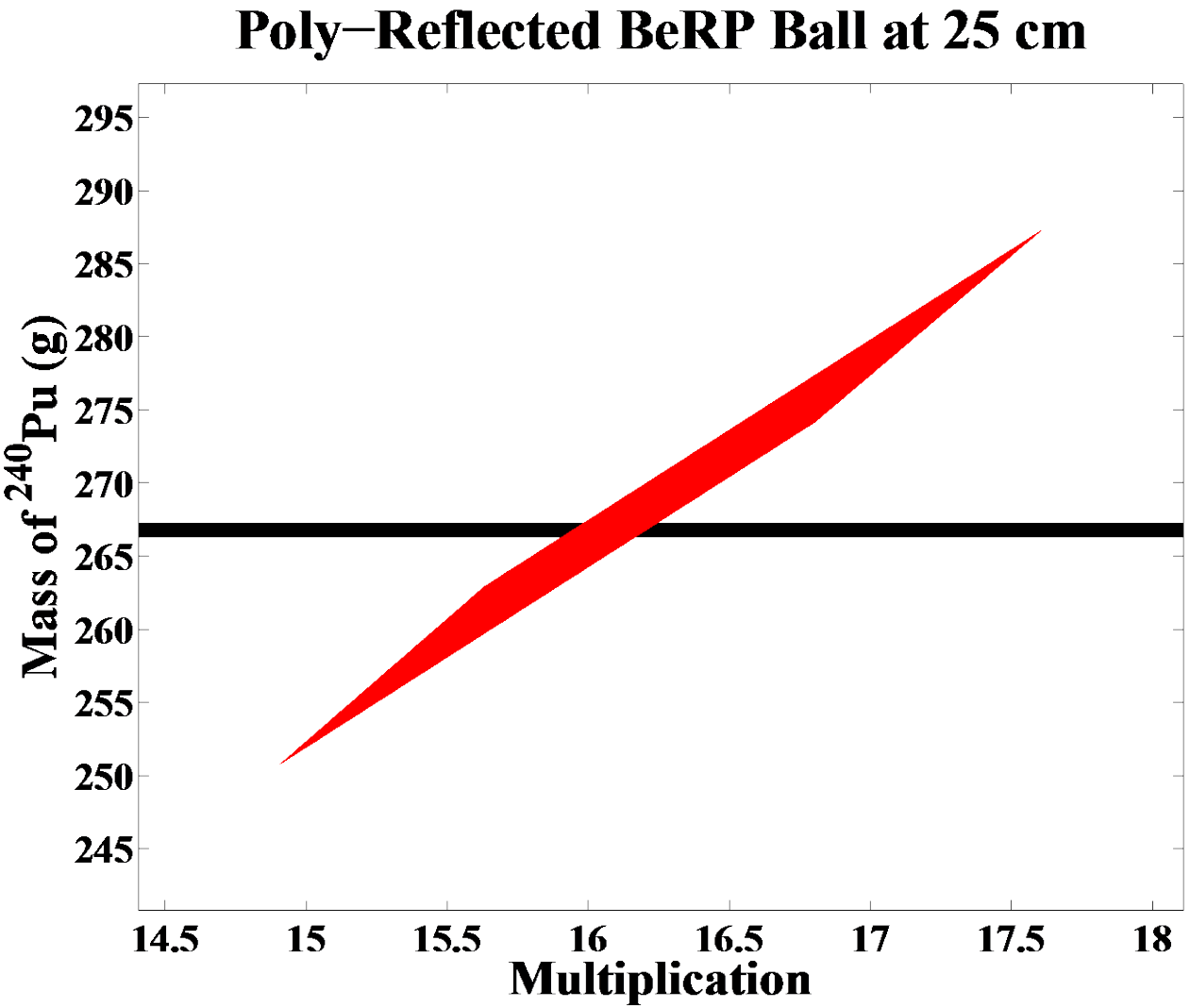
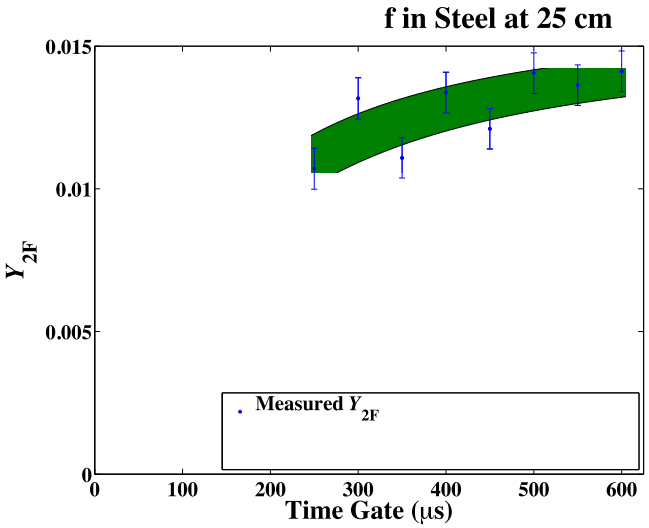
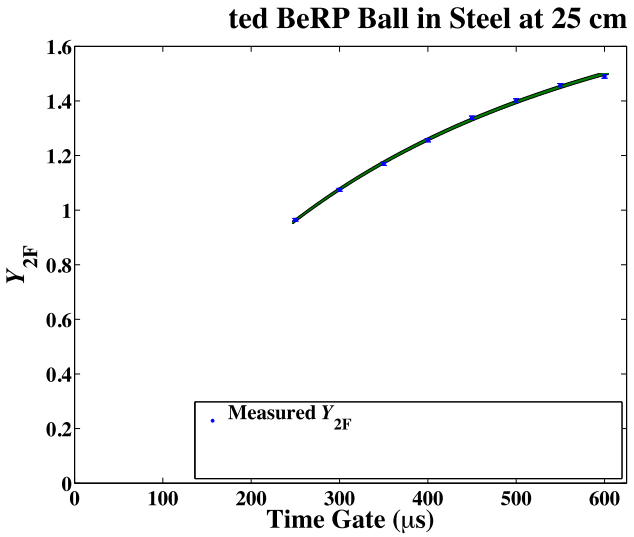
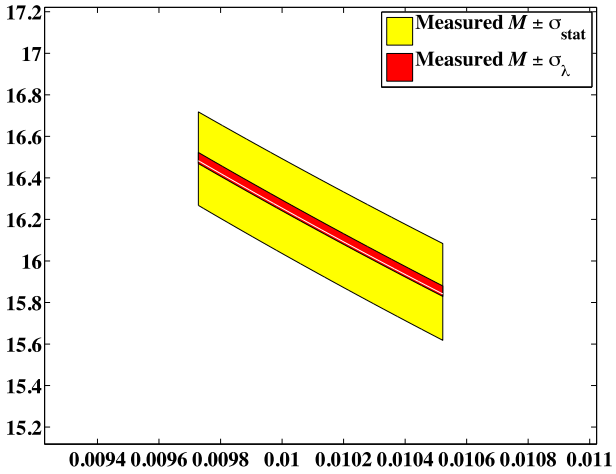
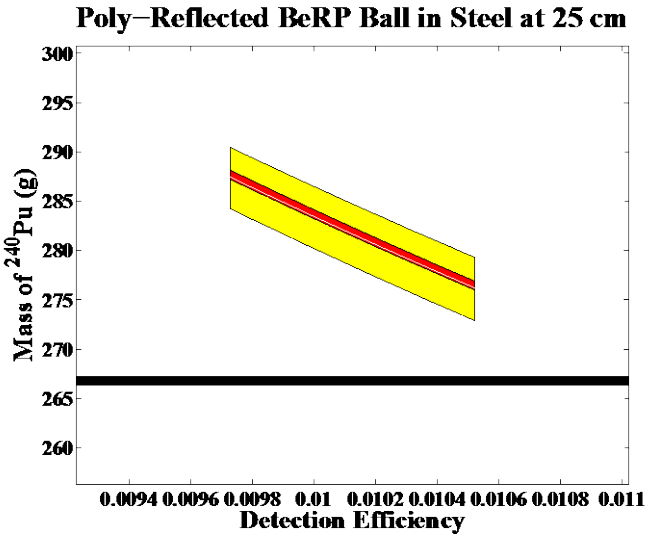


Polyethylene-Reflected BeRP Ball in Steel









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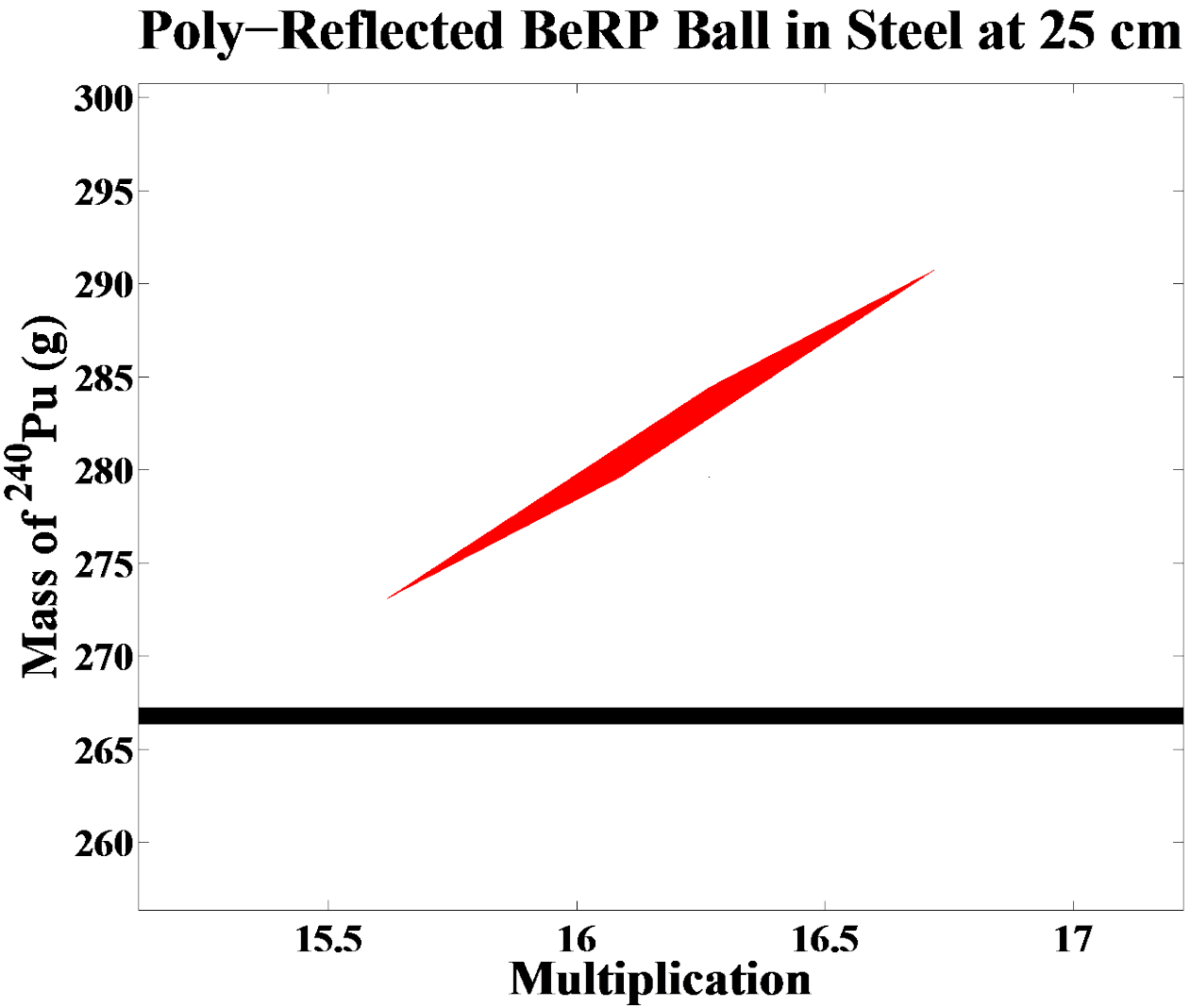
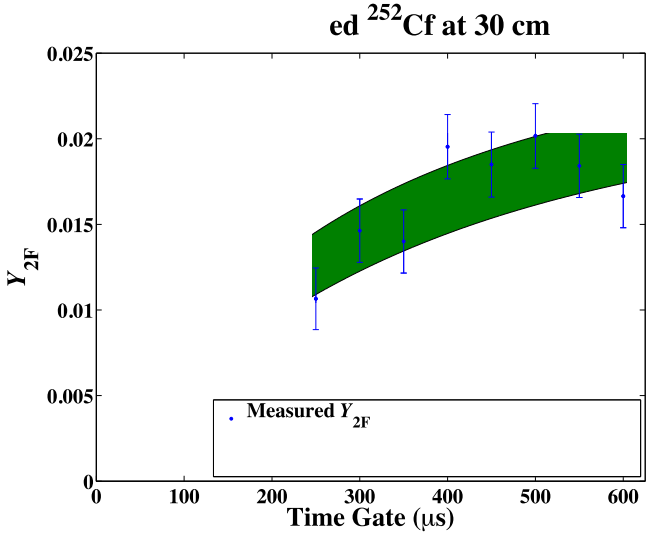
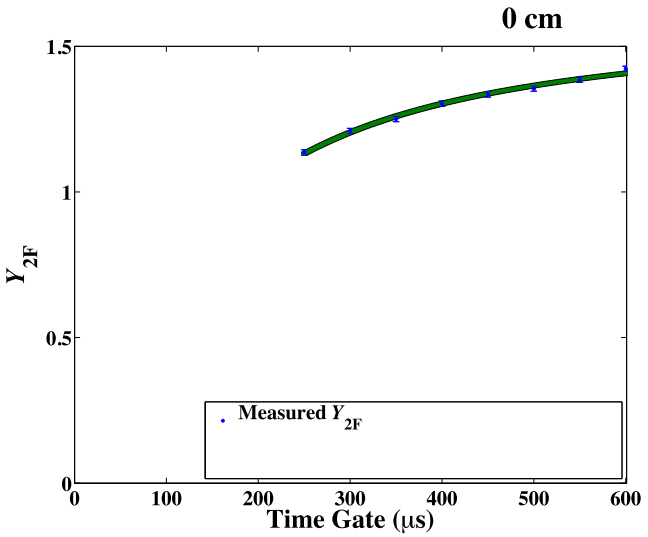
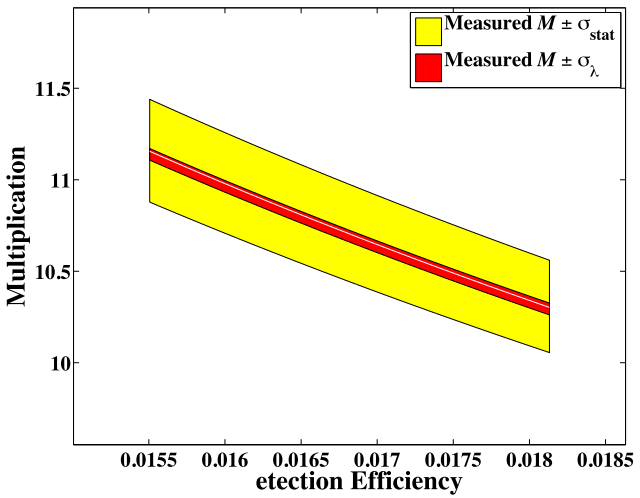
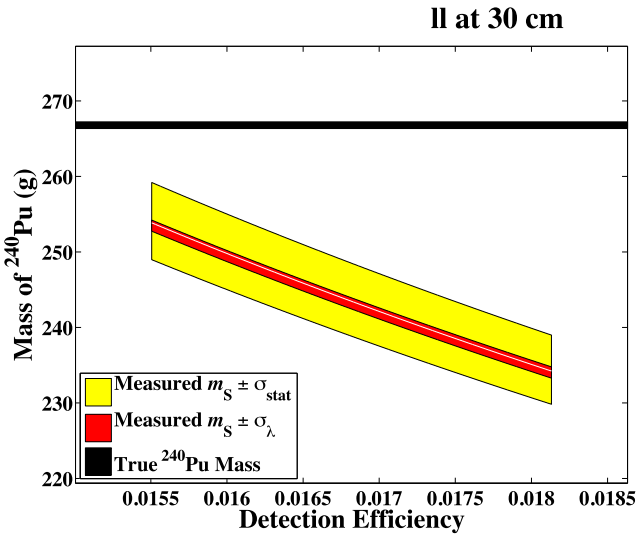


Nickel-Reflected BeRP Ball









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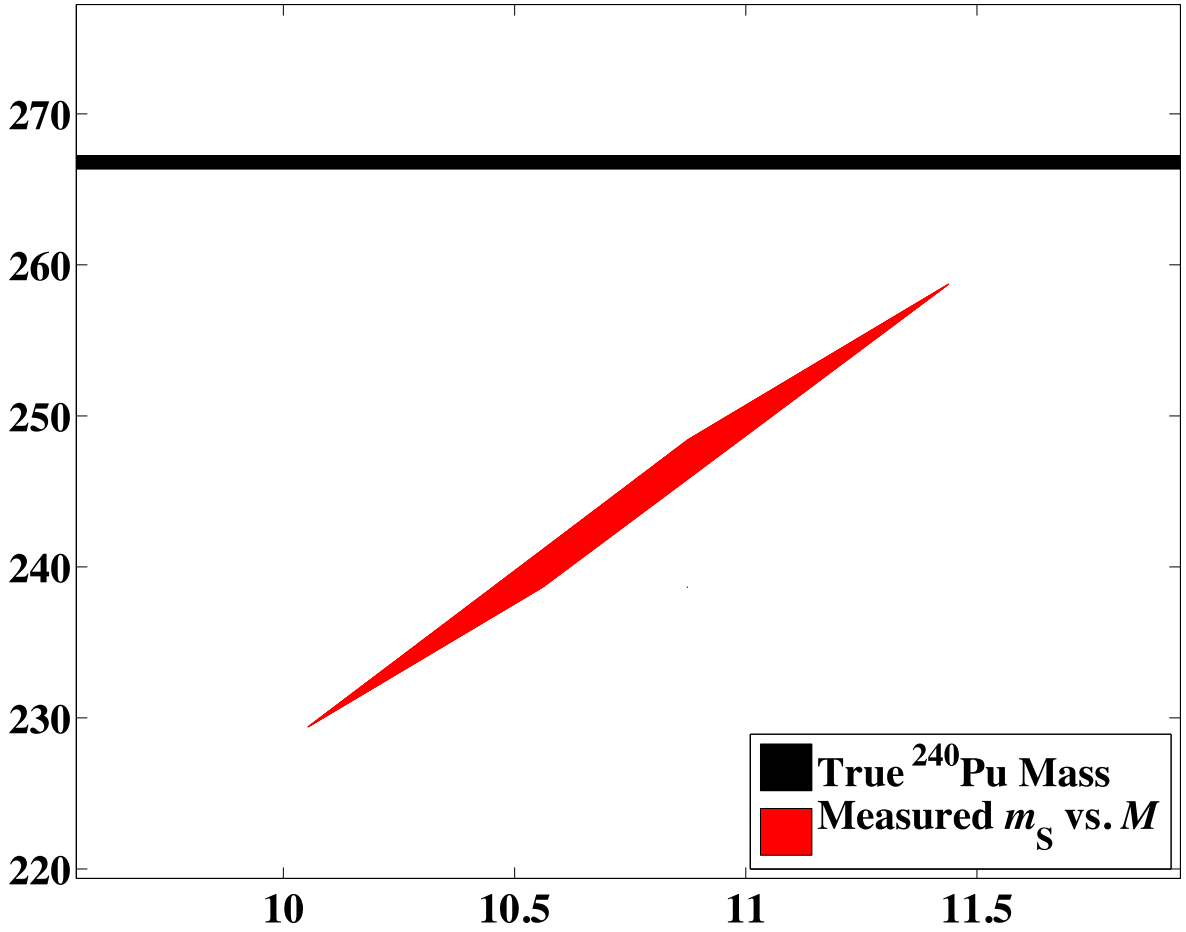
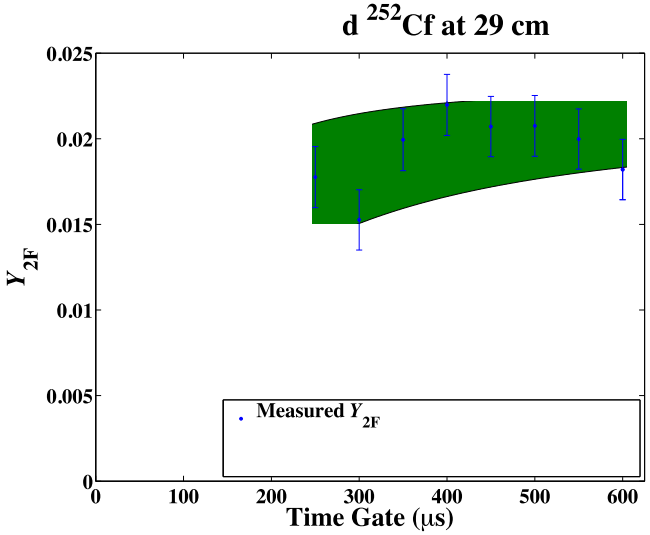
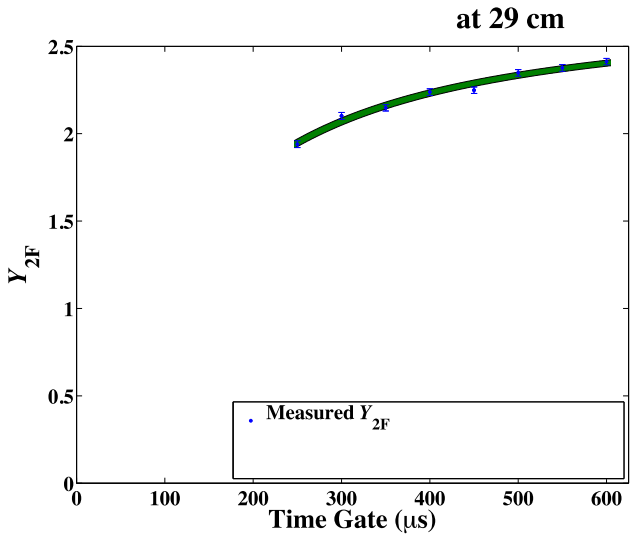
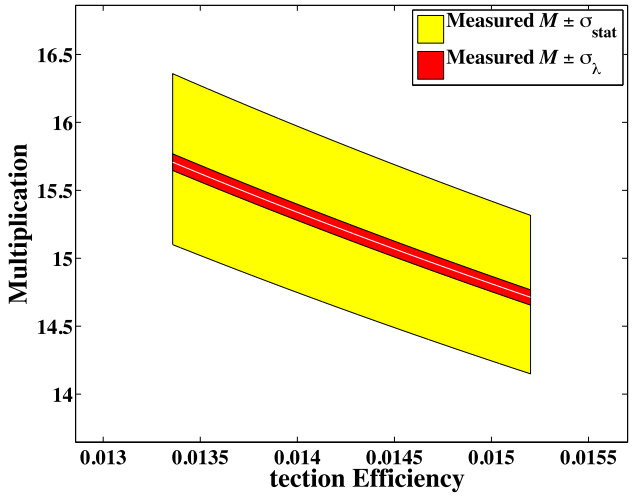
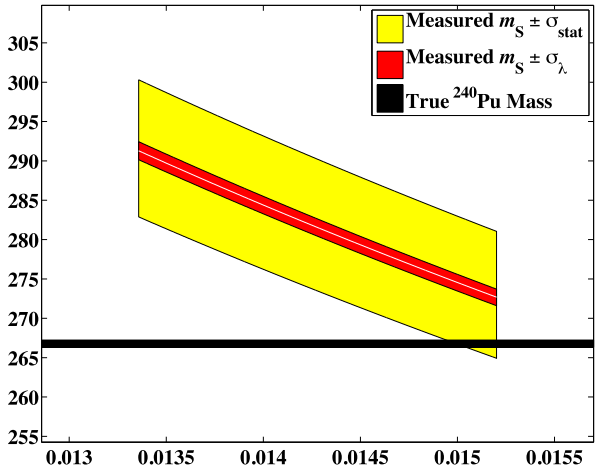
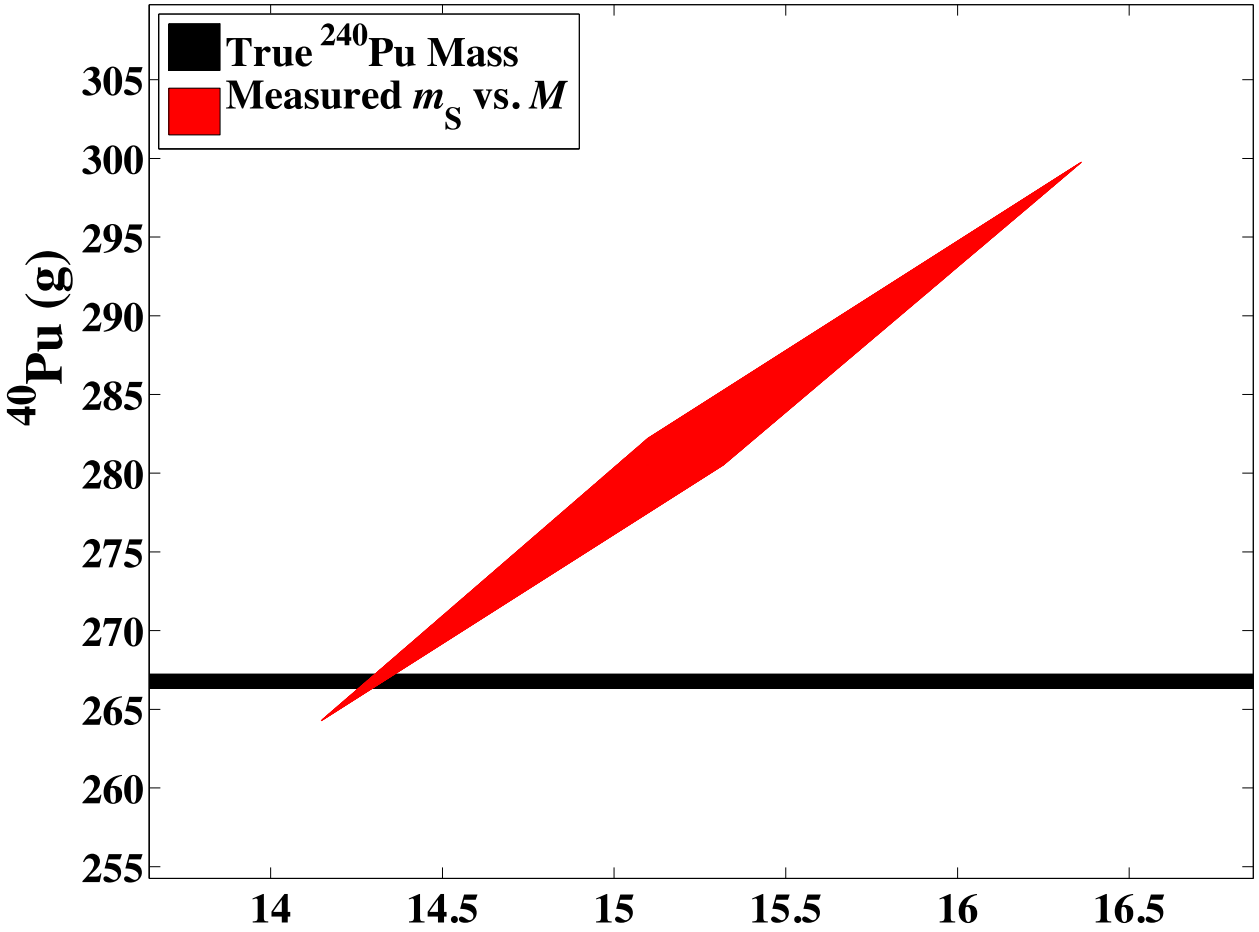


Tungsten-Reflected BeRP Ball









Tungsten-Reflected BeRP Ball