

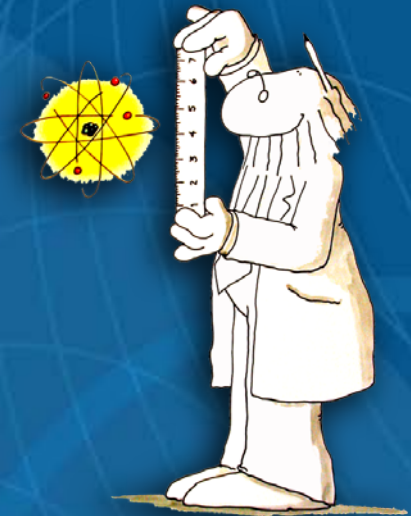
# Evaluation of scatter effects on in-air irradiation of TLD badge dosimeters

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# Overview

- Objective
- Experiment
- Monte Carlo simulation
- Connecting experiment with simulation

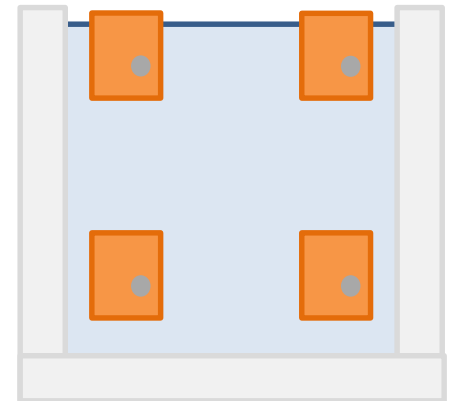
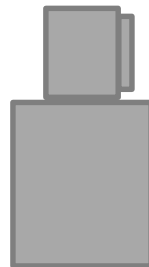
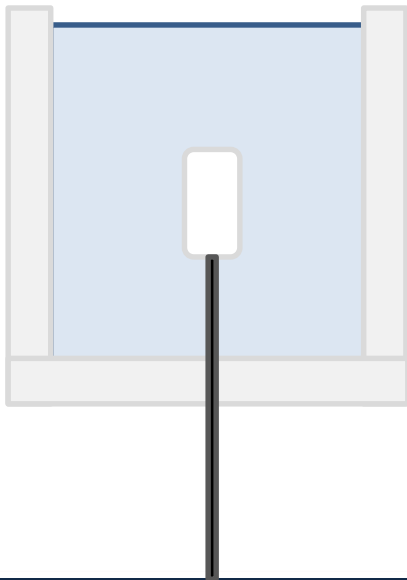
# Objective

- Determine scatter correction factor when irradiating TLD badges and compare with historical data
- Investigated scatter variation based on:

1) Location on Sheet

2) Source to Badge Distance

3) Badge Proximity



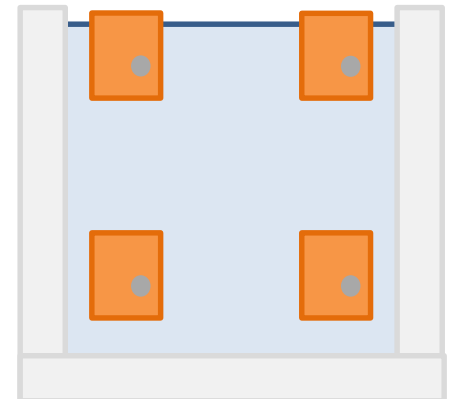
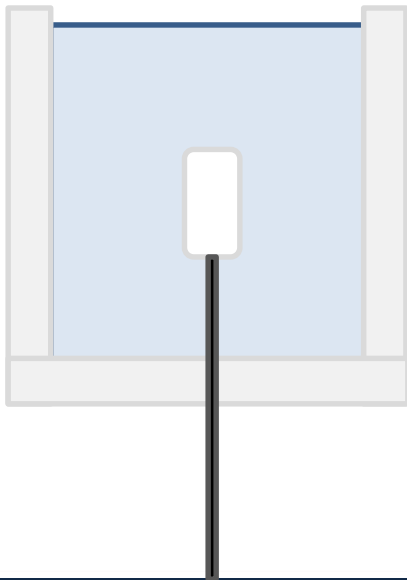
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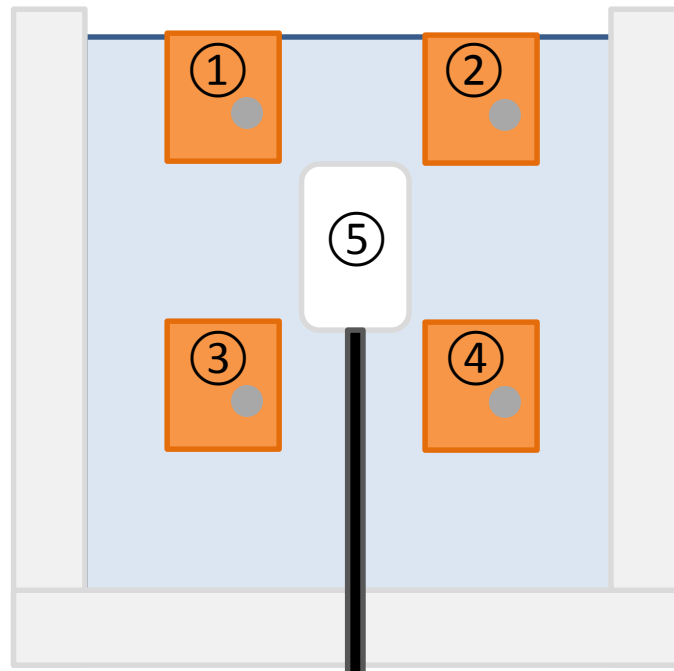
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# Experimental Setup

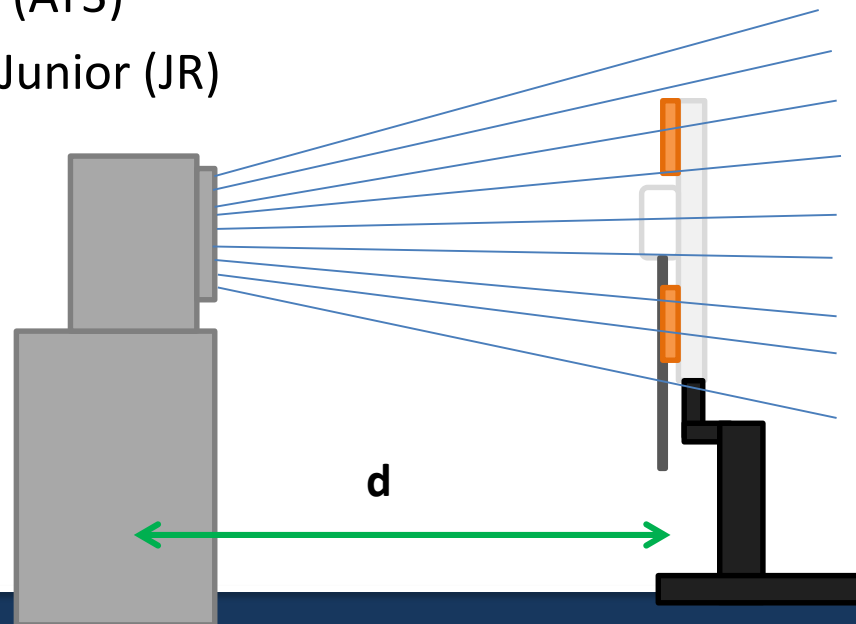
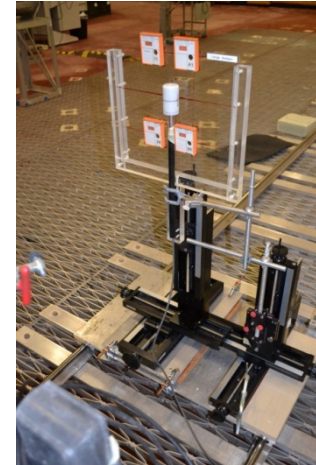
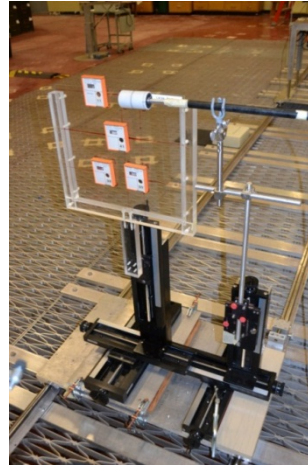
- 33.1 x 30.9 cm Lucite sheet with 5 placements for badges
- NE2530 35cc ion chamber is substituted as the fifth badge

 can be placed in any of the 5 positions using the independent stage system



# Experimental Setup

- 1m or 3 m source to sheet distance  $d$
- Ion chamber positioned in front of sheet, centered on a substituted position of a badge
- Two  $^{60}\text{Co}$  irradiators:
  - Atlan-Tech (AT3)
  - Theratron Junior (JR)

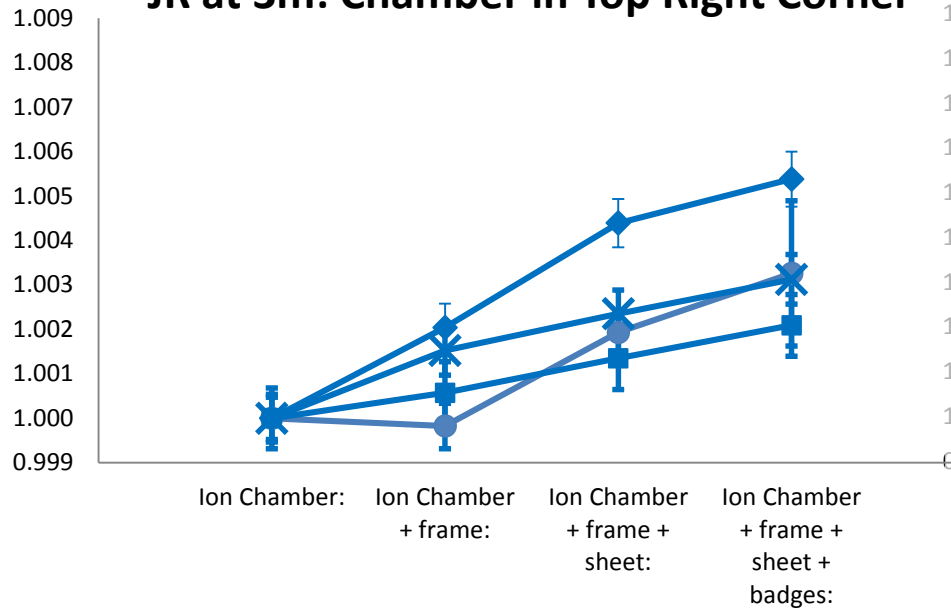


# History Repeats Itself!

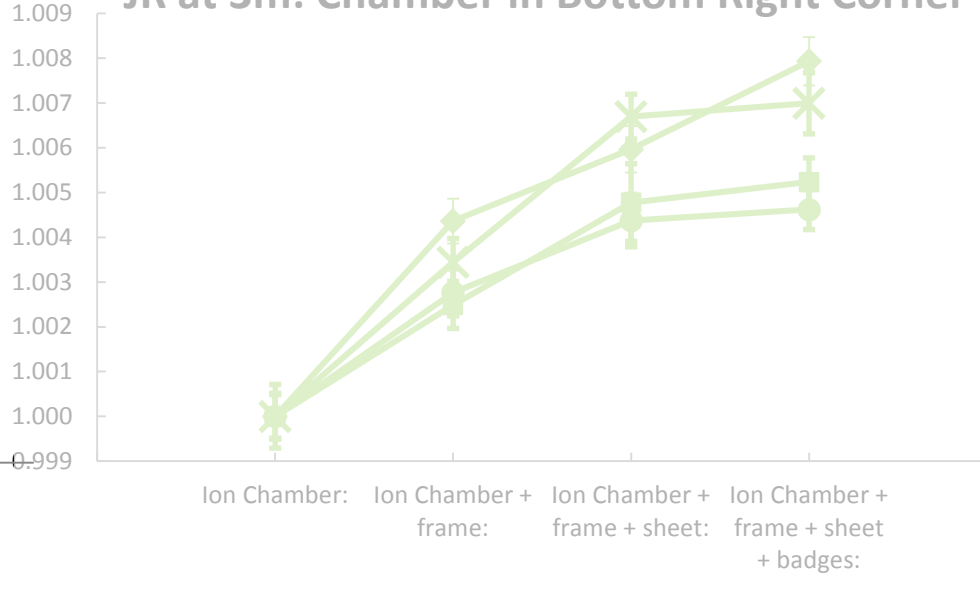
- Using the JR source at 3m, with the Ion Chamber in the center position:

Historical:	<b>1.0040</b>
Sept 2008:	<b>1.0058</b>
Feb. 2017:	<b>1.0050 ± 0.0008</b> (k=2 Error)

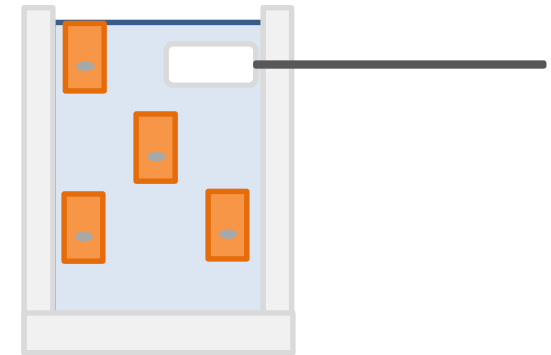
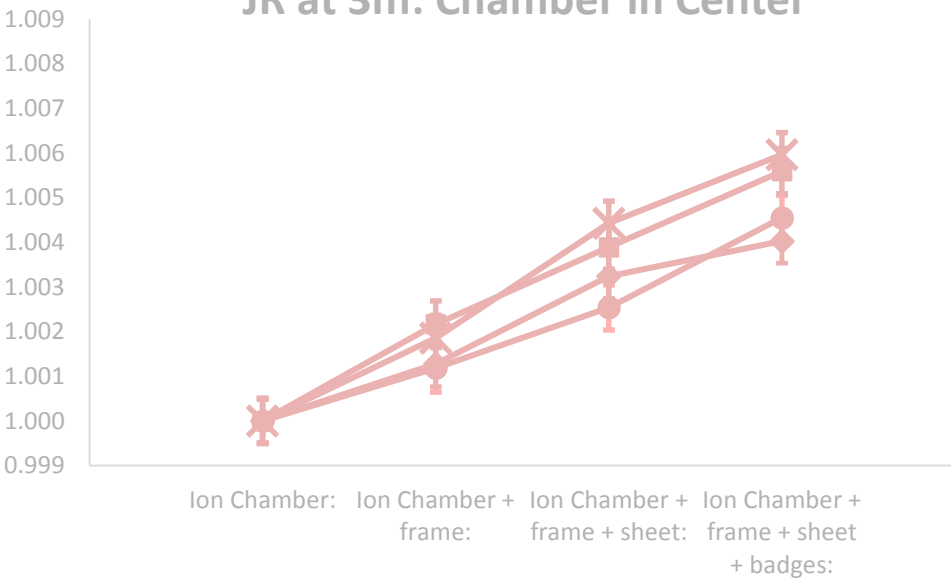
### JR at 3m: Chamber in Top Right Corner



### JR at 3m: Chamber in Bottom Right Corner



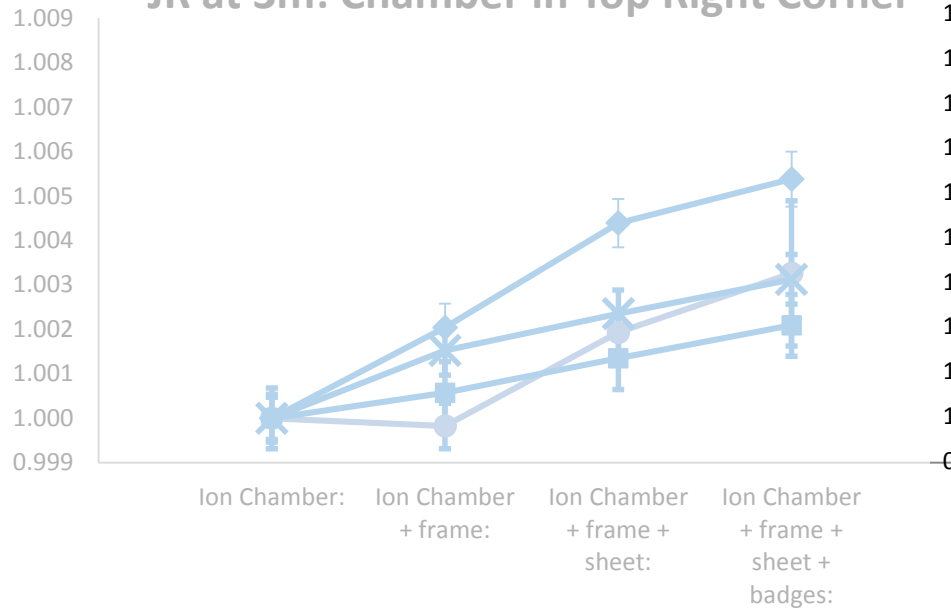
### JR at 3m: Chamber in Center



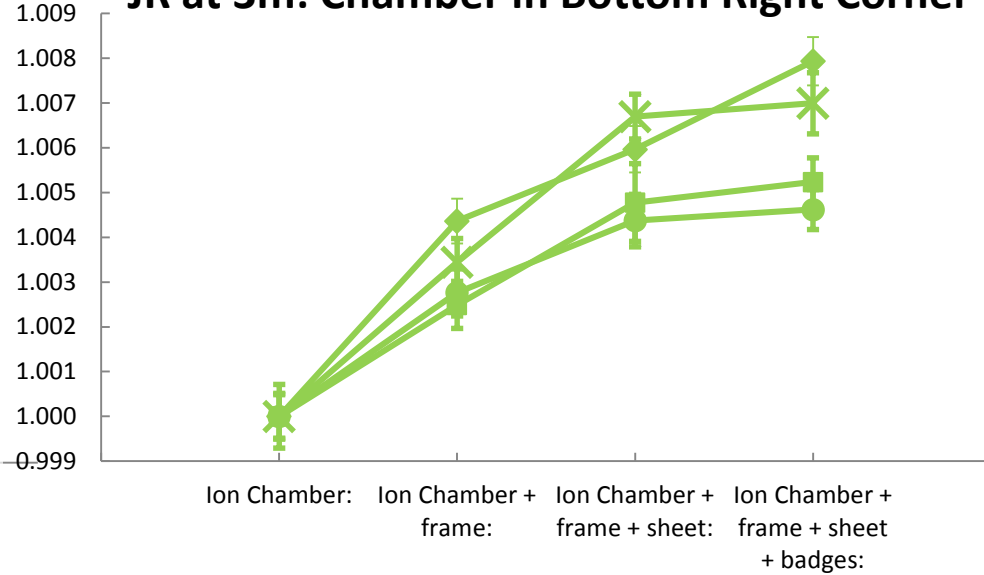
*Abscissa is detector signal normalized to ion chamber signal in air*



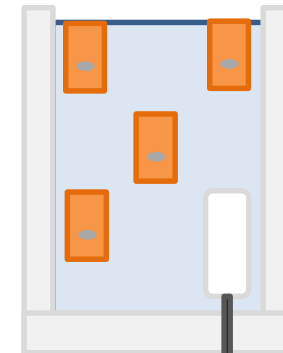
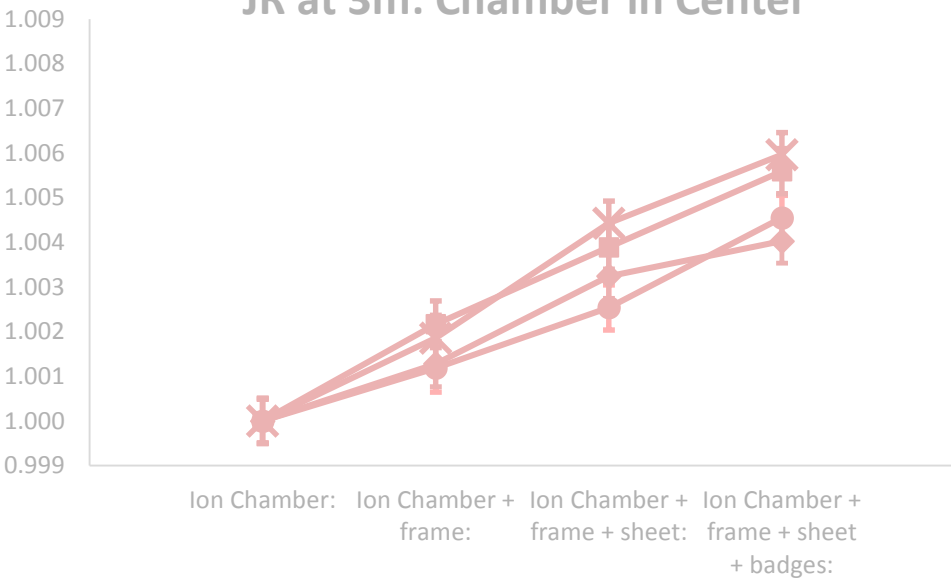
**JR at 3m: Chamber in Top Right Corner**



**JR at 3m: Chamber in Bottom Right Corner**

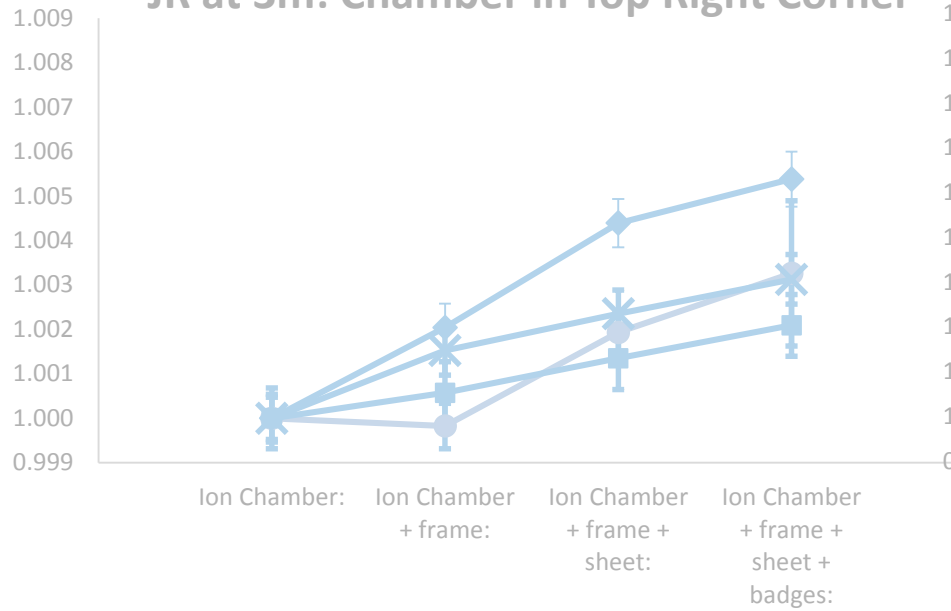


**JR at 3m: Chamber in Center**

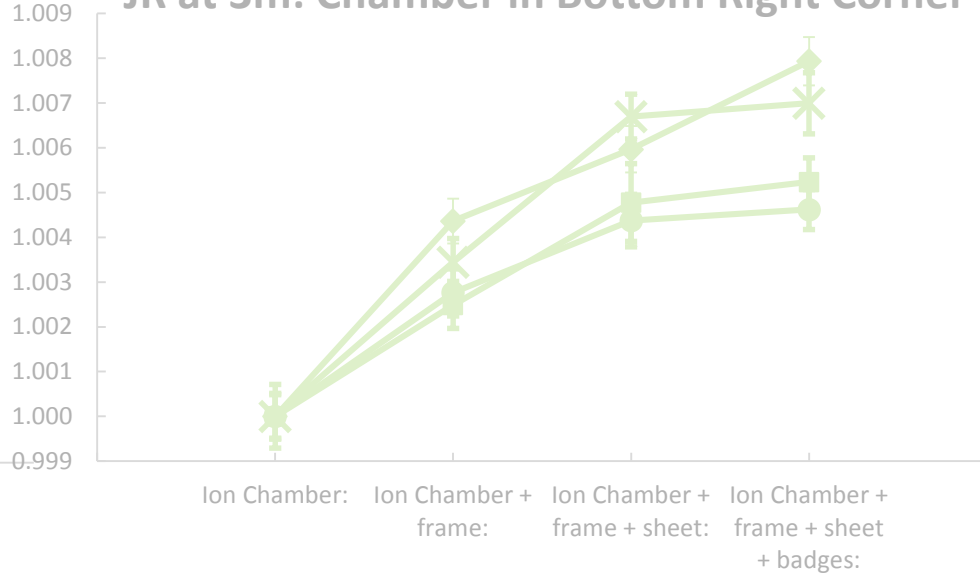


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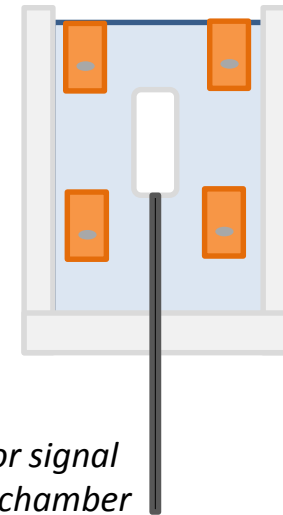
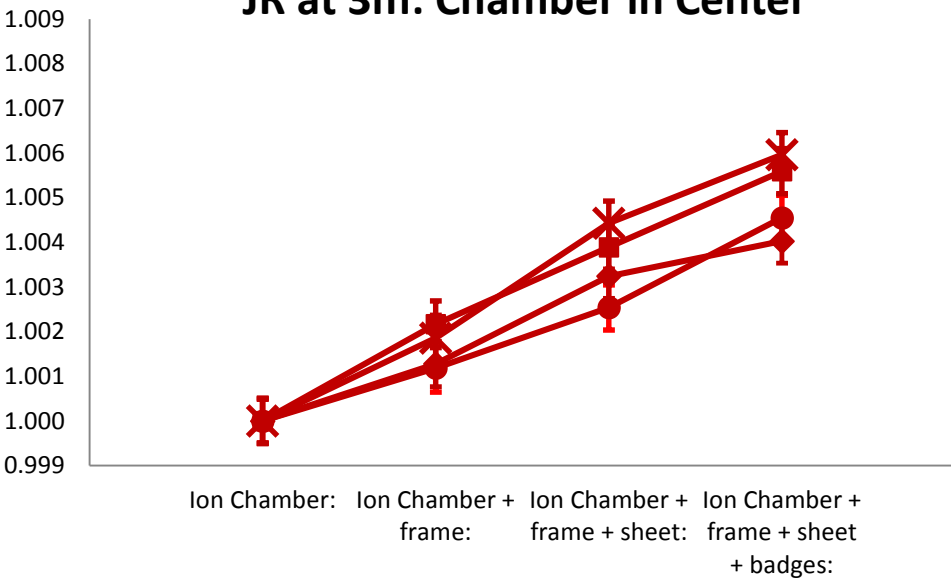
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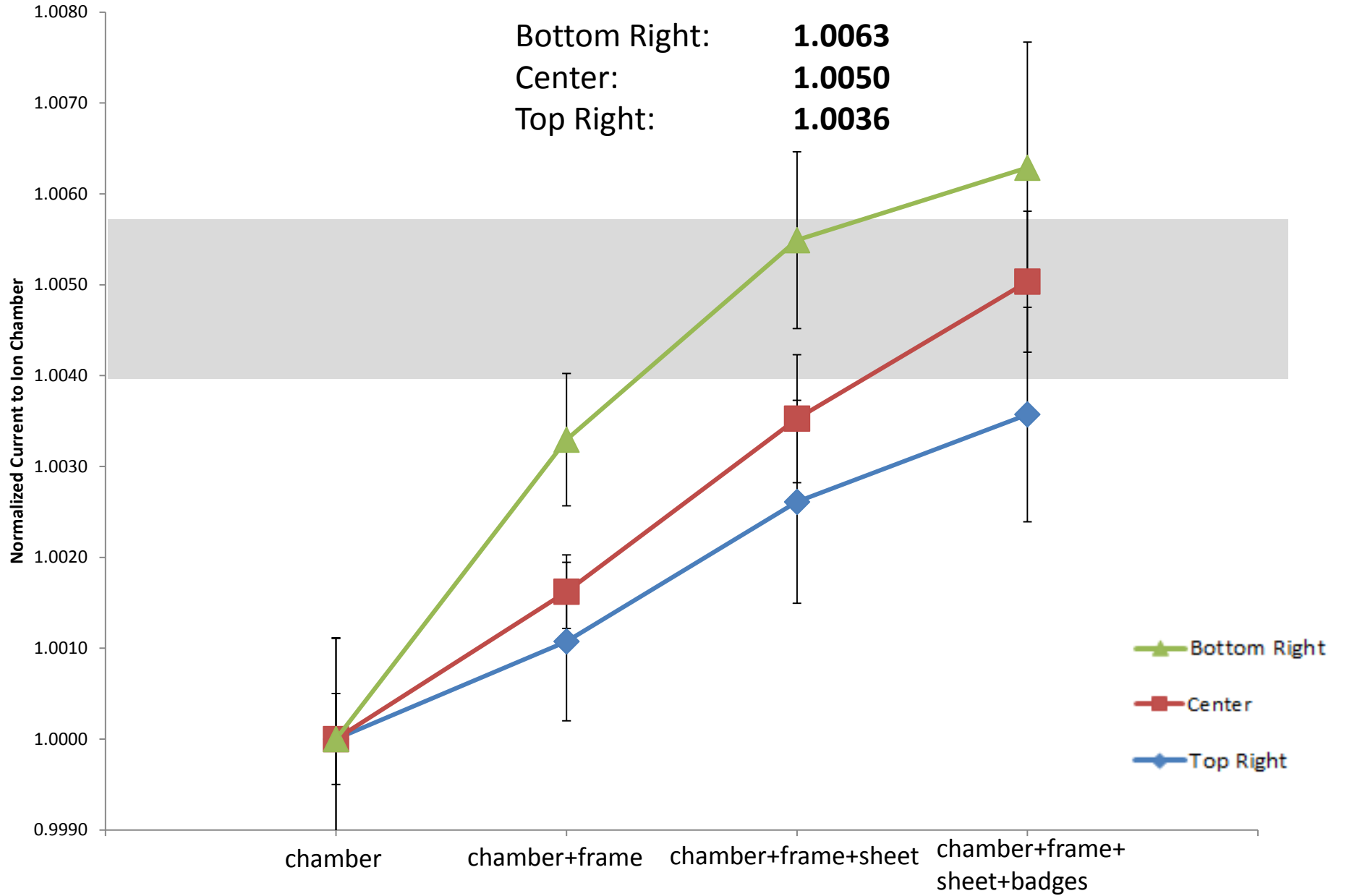


**JR at 3m: Chamber in Center**

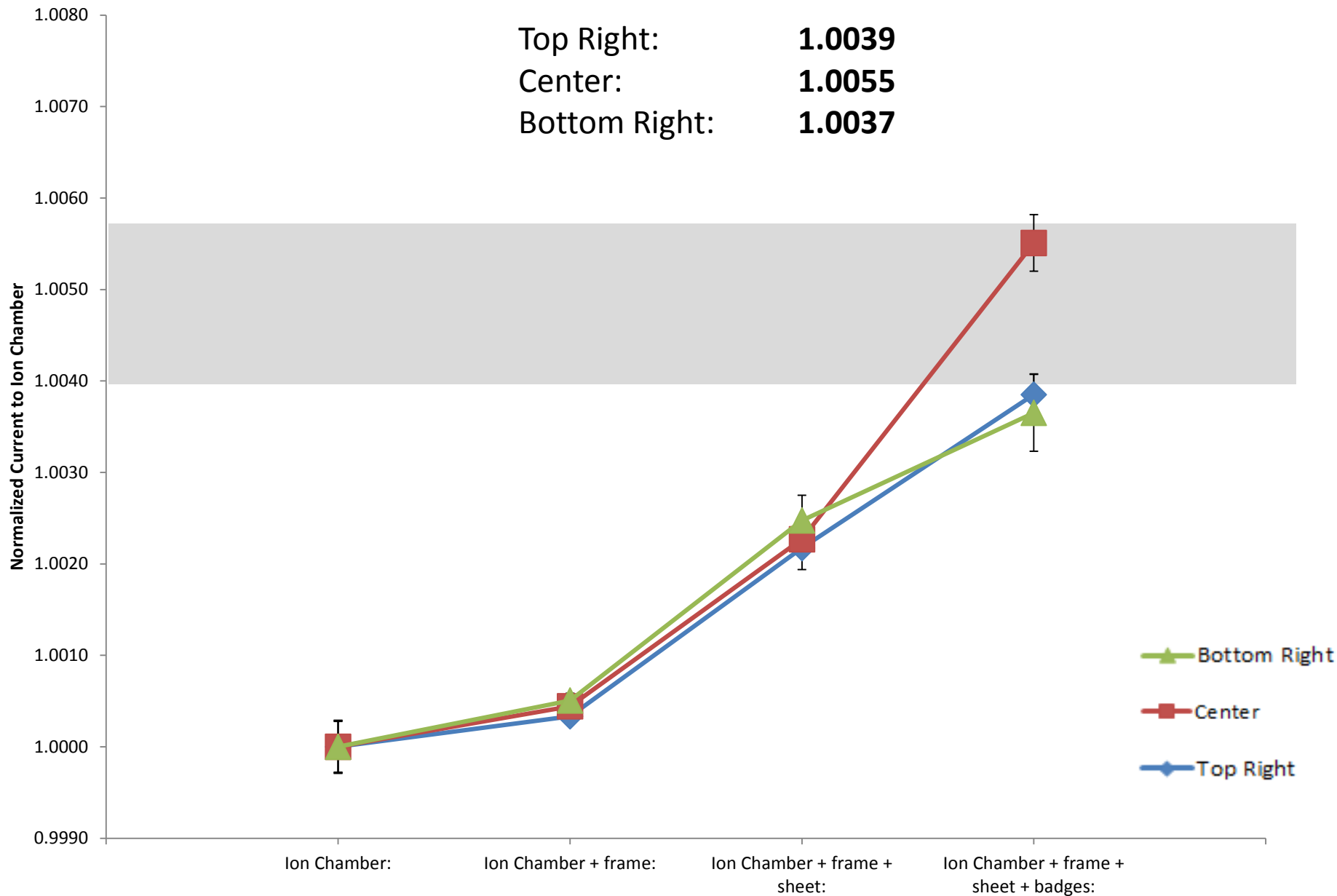


*Abscissa is detector signal normalized to ion chamber signal in air*

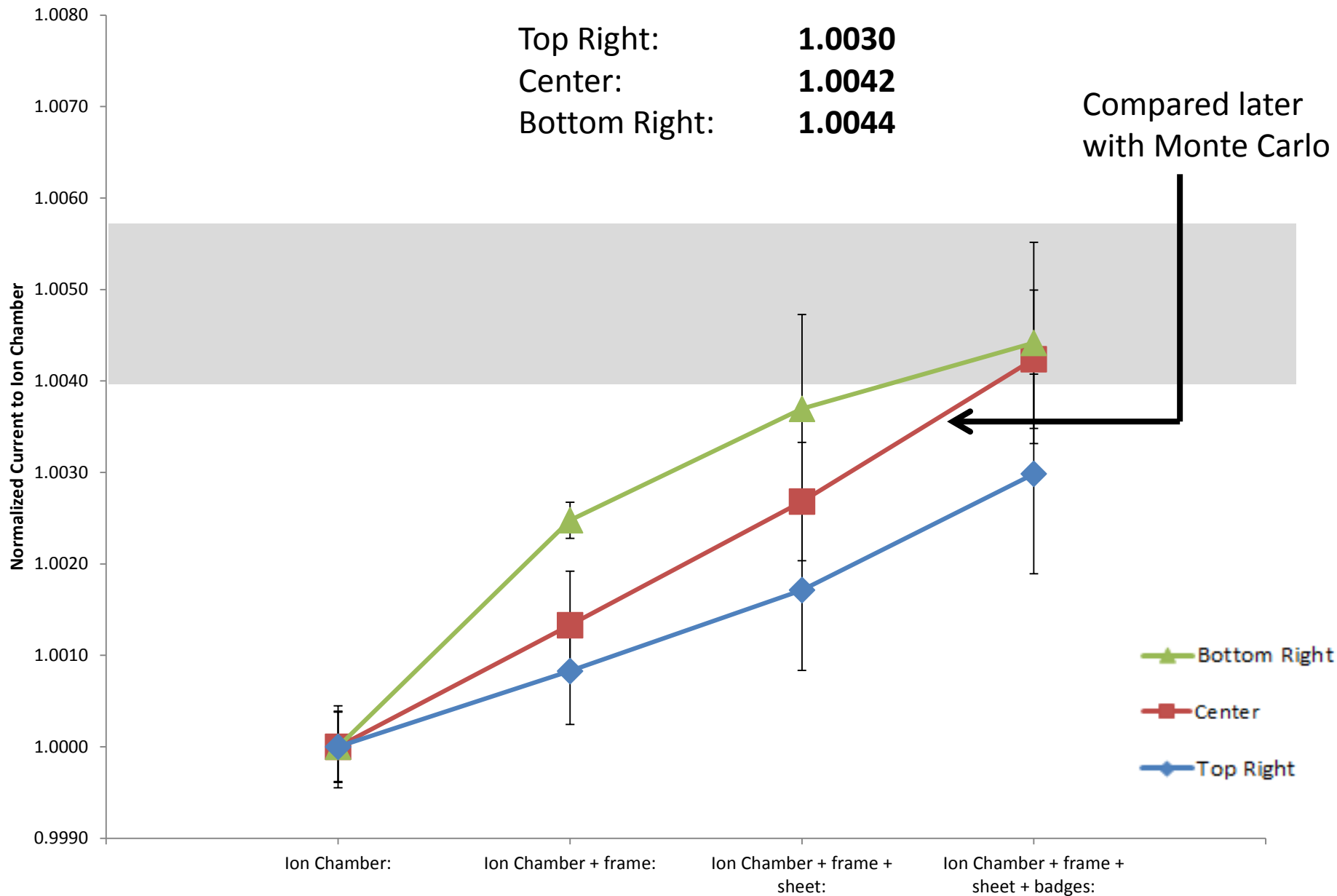
# Scatter Contributions from Varying Positions of Ion Chamber: JR at 3m



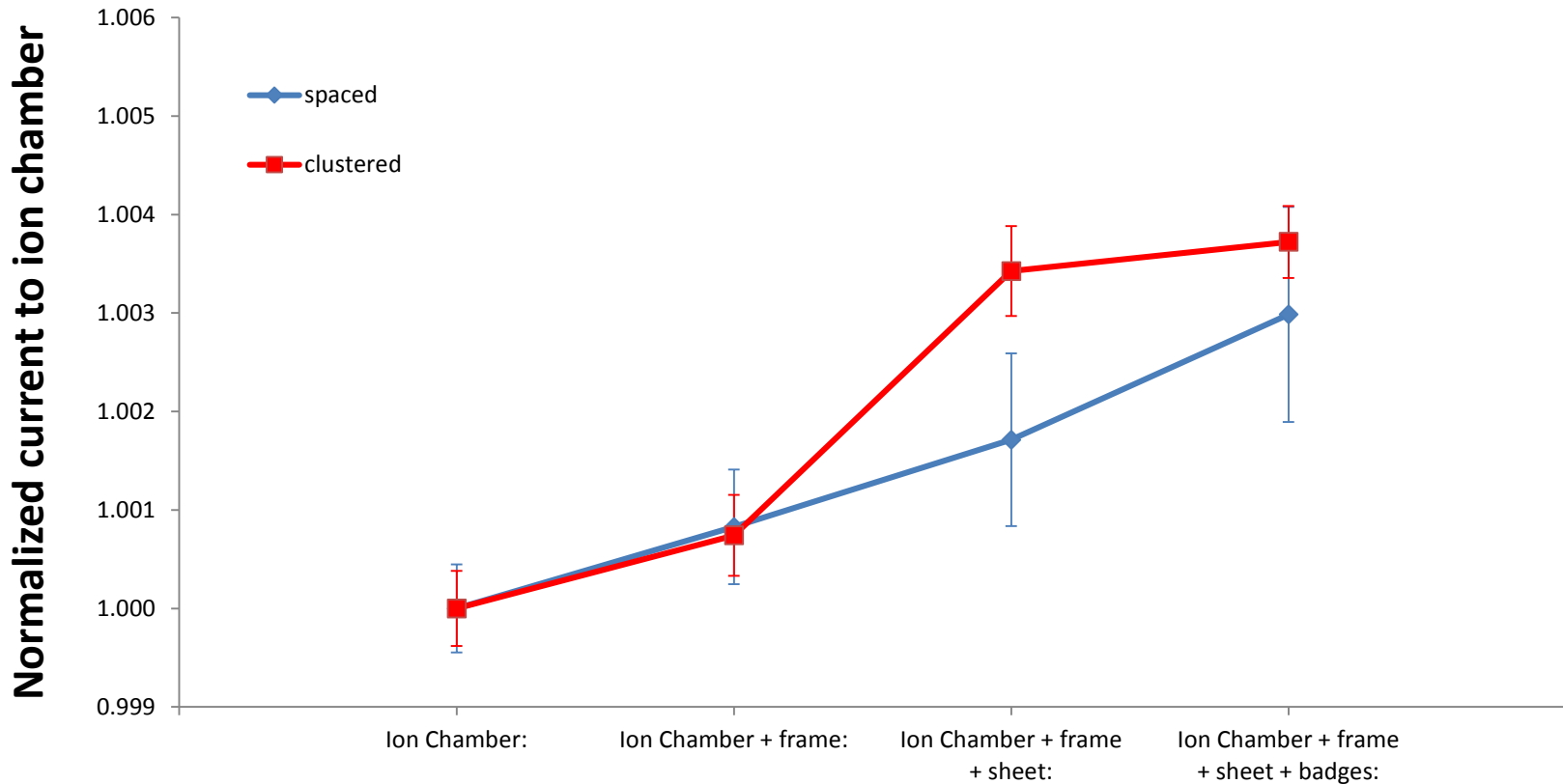
# Scatter Contributions from Varying Positions of Ion Chamber: JR at 1m



# Scatter Contributions from Varying Positions of Ion Chamber: AT3 at 1m

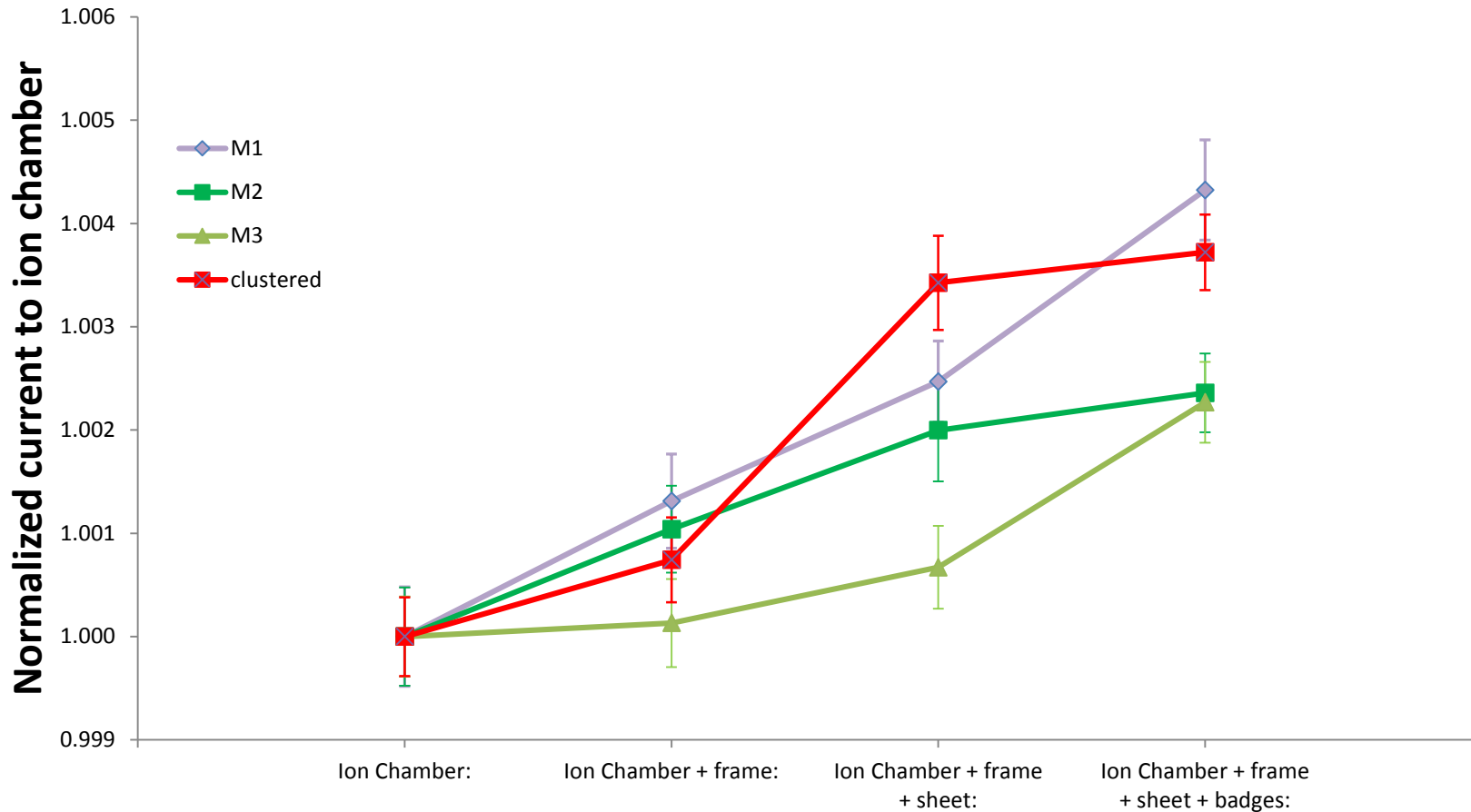


## Effects of Badge Proximity on Scattering: AT3 at 1m



**Note:** The spaced data taken from an average of 3 measurements with the chamber in the top right corner and the clustered data is taken from one measurement with the chamber in the same position.

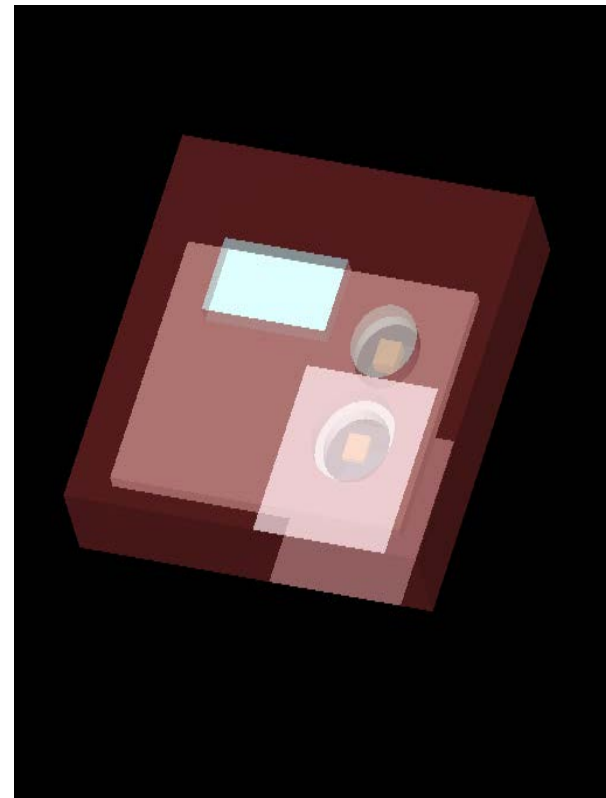
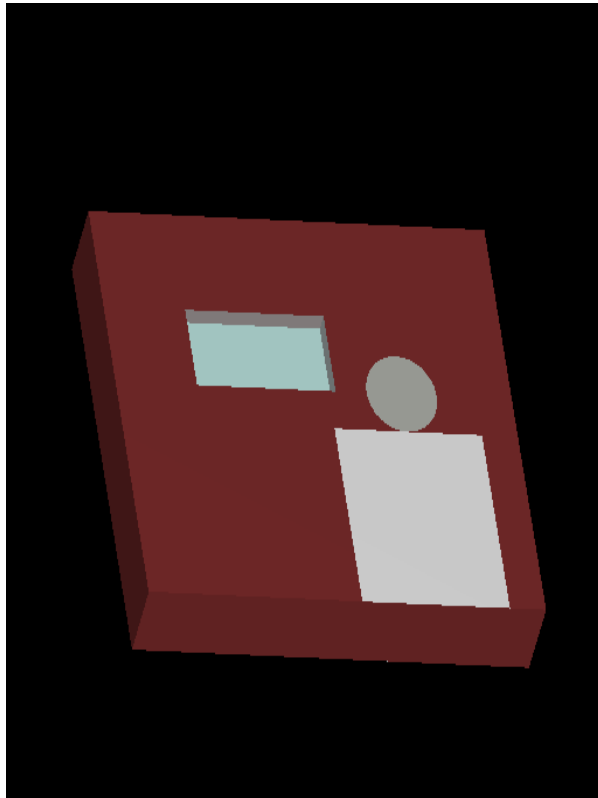
## AT3 at 1m: Chamber in Top Right Corner



**Note:** The spaced data taken from an average of 3 measurements with the chamber in the top right corner and the clustered data is taken from one measurement with the chamber in the same position.

# Modelling the Irradiation Setup

**EGSnrc Monte Carlo simulation system:** Shown to calculate dose to the cavity of an ionization chamber at the 0.1 % accuracy level by means of Fano test calculations.

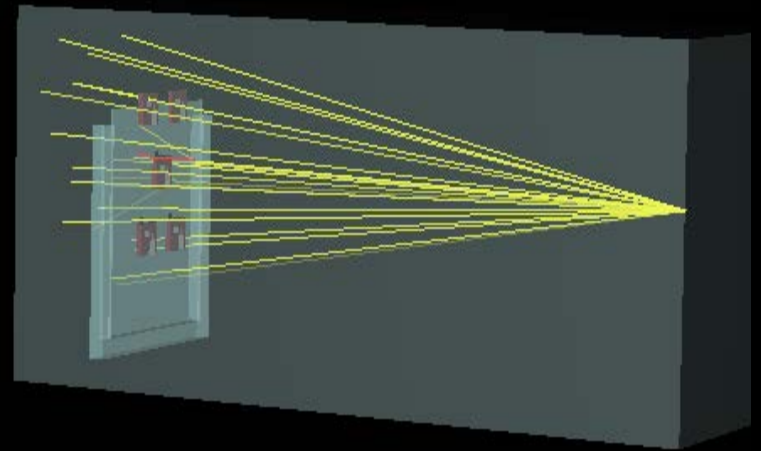
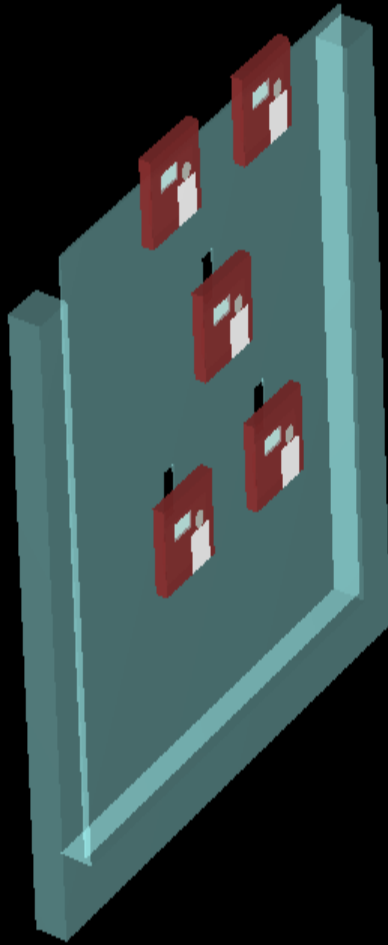




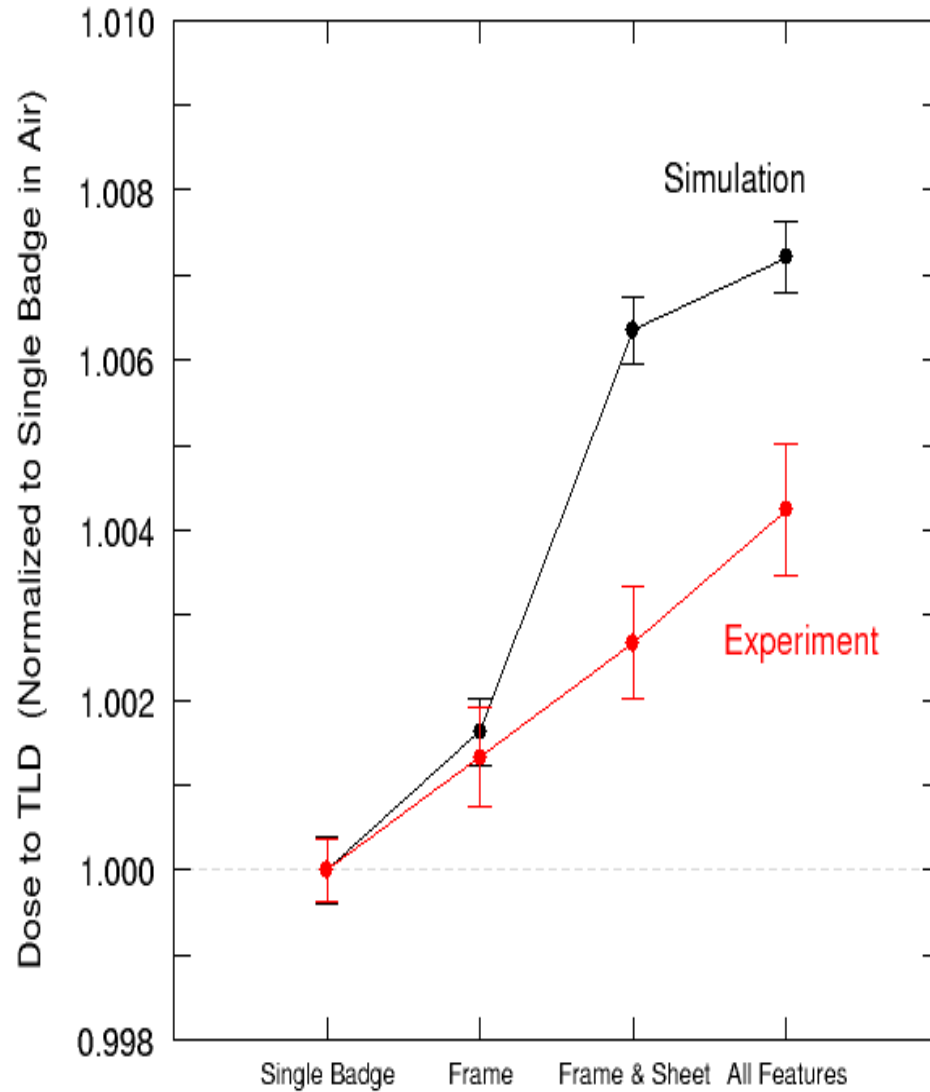
# EGSnrc Monte Carlo Simulation System

- Simulates transport of photons, electrons and positrons between 1 keV and 100 GeV
- Fast electron transport algorithm accurate at the 0.1% level for ion chamber simulation
- Distributed with tailored applications to solve a large range of problems
- Applications make extensive use of variance reduction techniques speeding up calculation times significantly

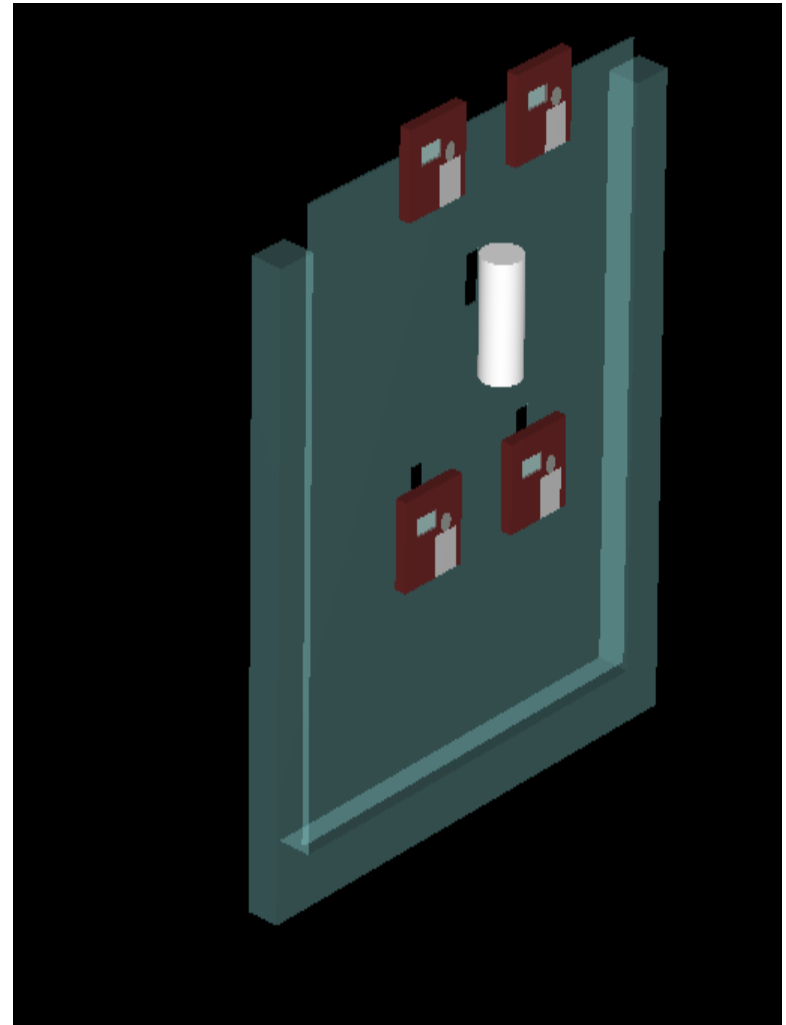
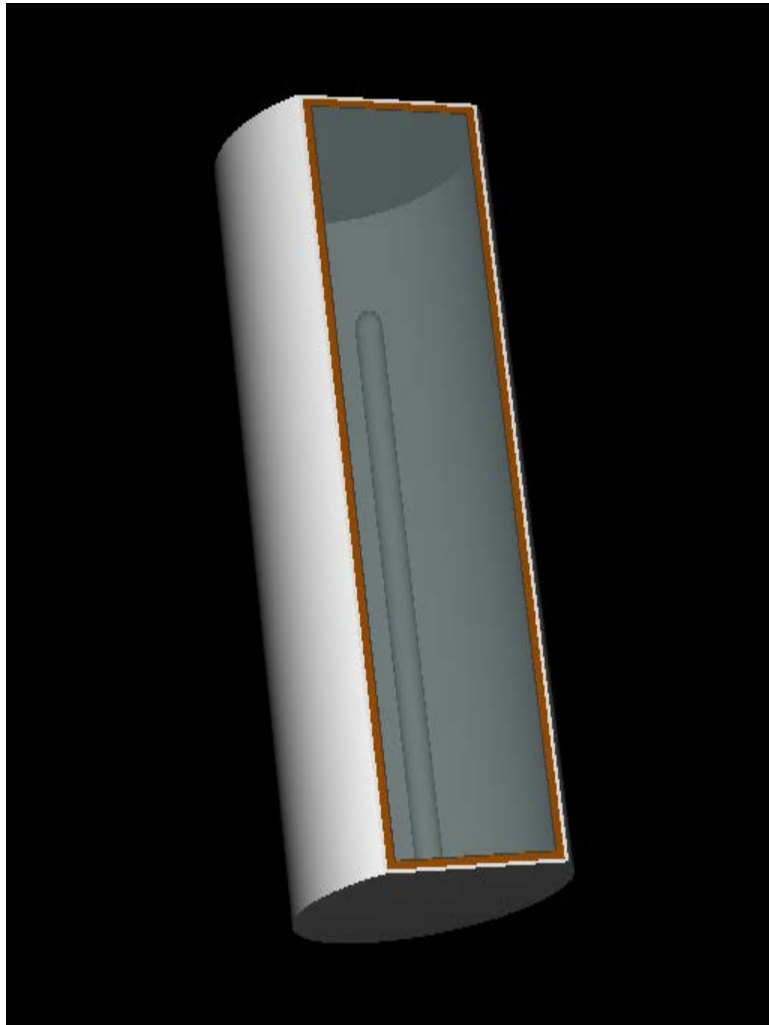
# Modelling the Irradiation Setup



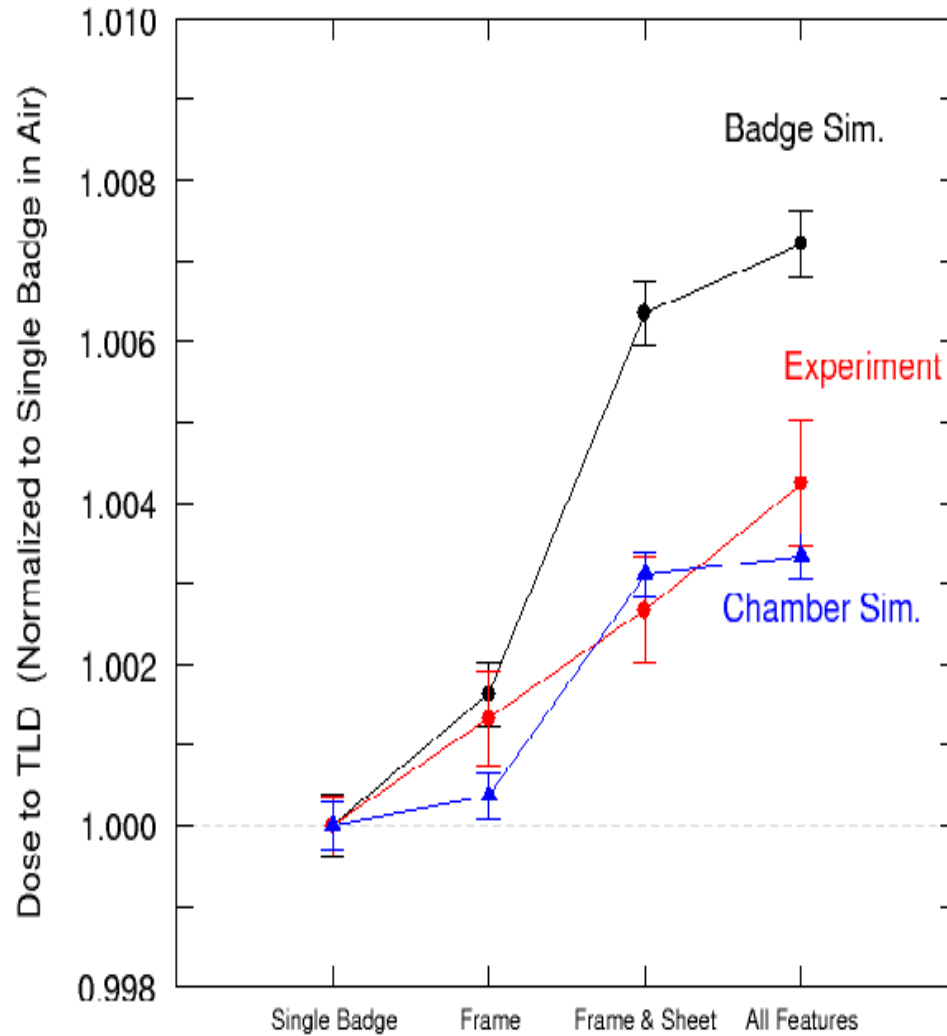
# Badge Results



# Adding the Ionization Chamber



# Ion Chamber Results



# Conclusions

- Current results confirm historical value of a **small** scatter contribution
- Ion chamber underestimates scatter **“seen”** by the badges
- Excellent agreement between experiment and chamber simulation warrants the use of a MC badge scatter correction

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