Corrections for measurements of tritium in subterranean vapor using silica gel

Jeffrey J. Whicker

Jean M. Dewart

Shannon P. Allen

William F. Eisele

Michael W. McNaughton

Andrew A. Green

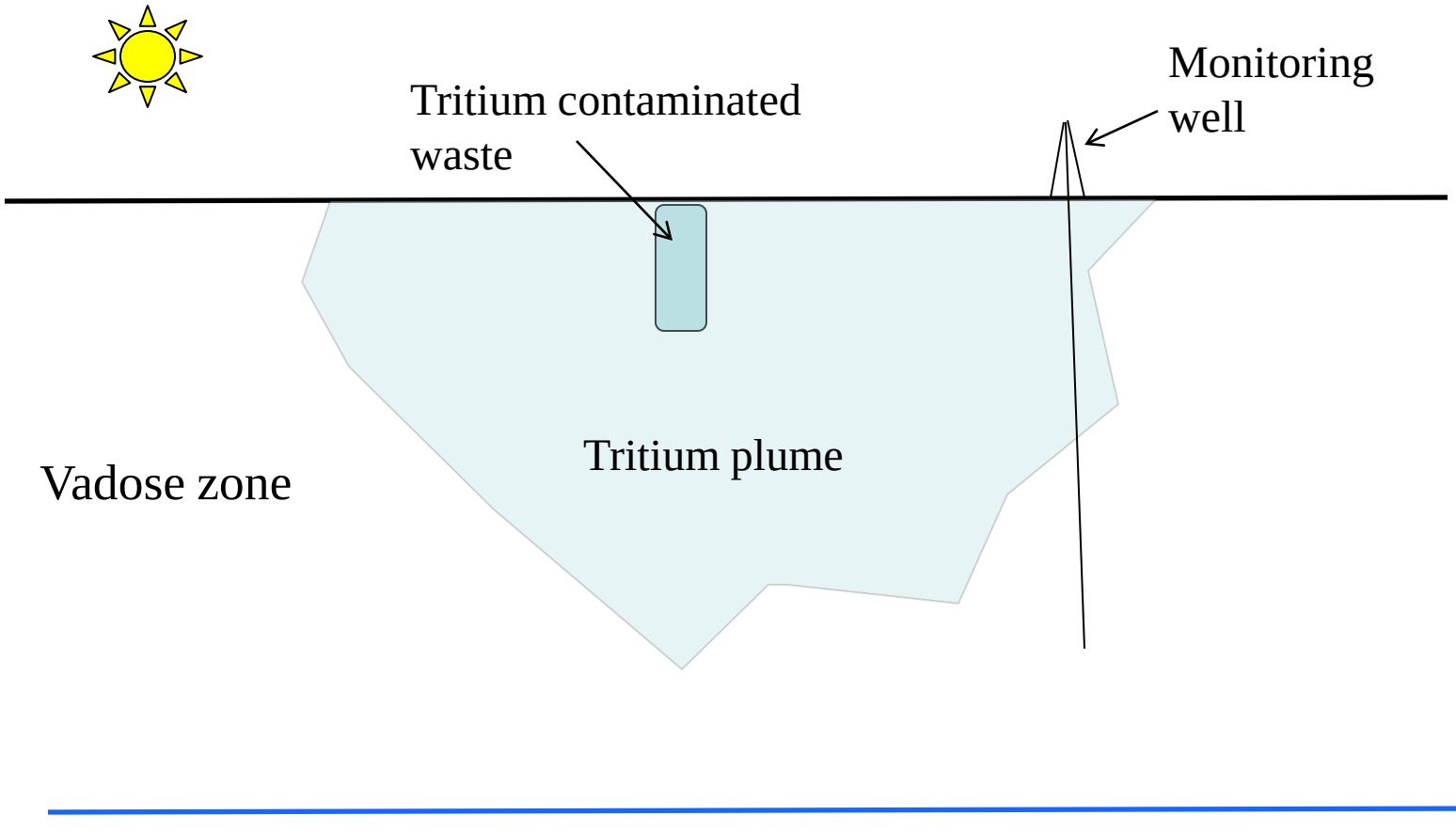
Presentation to HPS – Sacramento, CA July, 2012

Tritium contaminated wastes stored in underground shafts

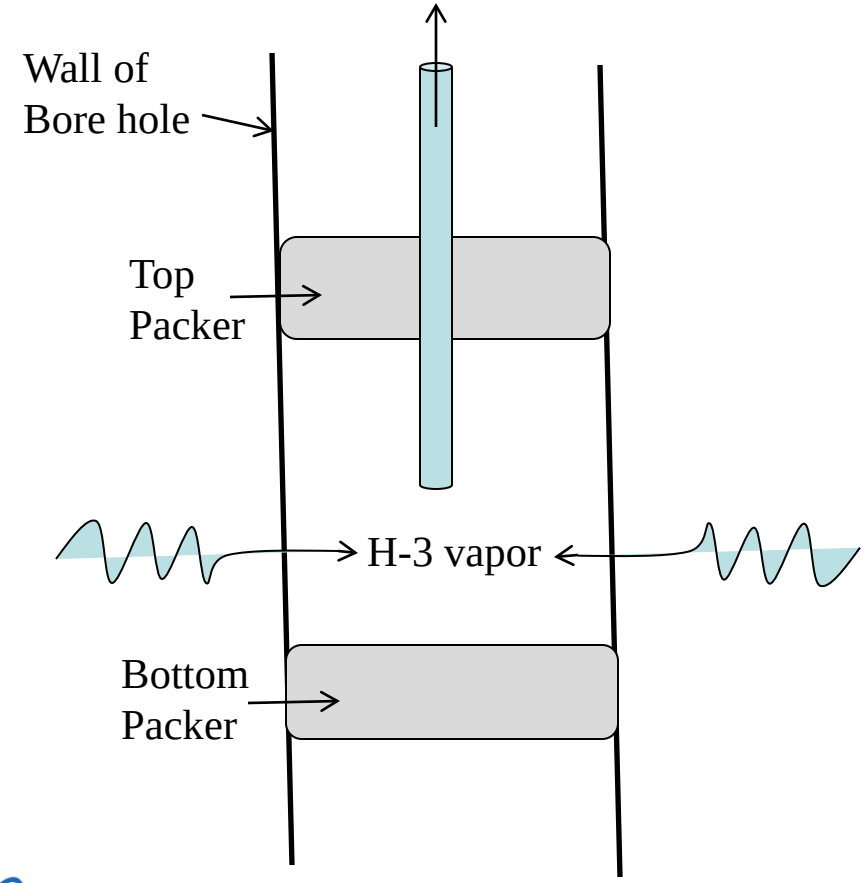
Arial View of LANL Radioactive Waste Disposal Area

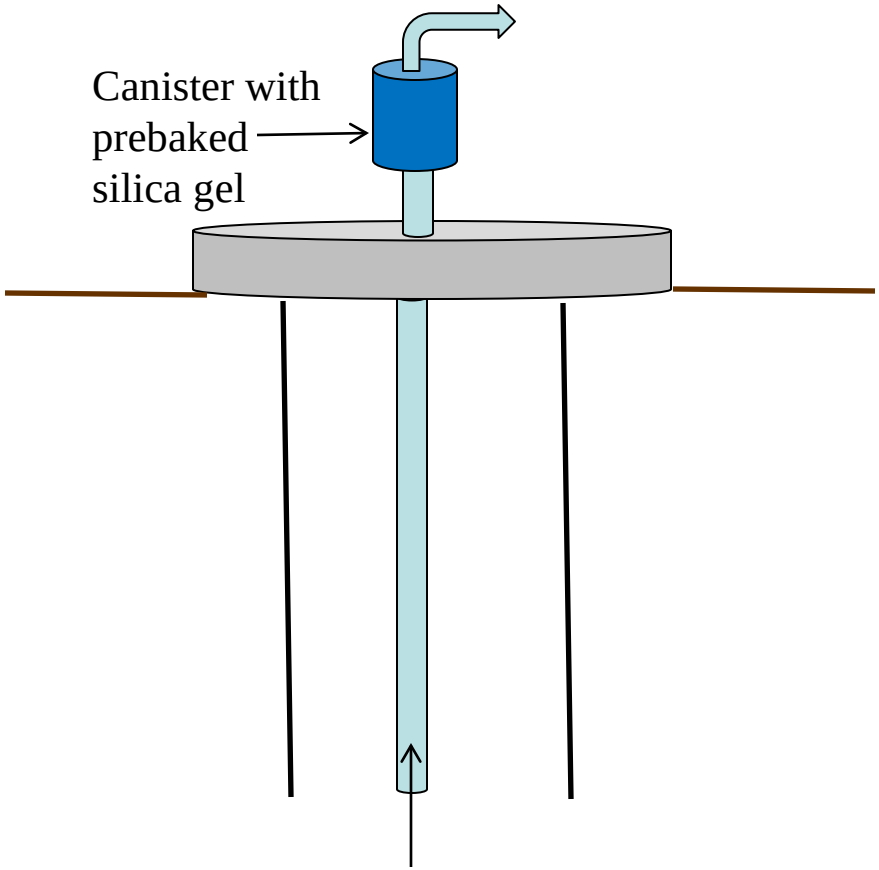


Purpose of sampling H-3 vapor in vadose zone is to monitor the spread of plume through time



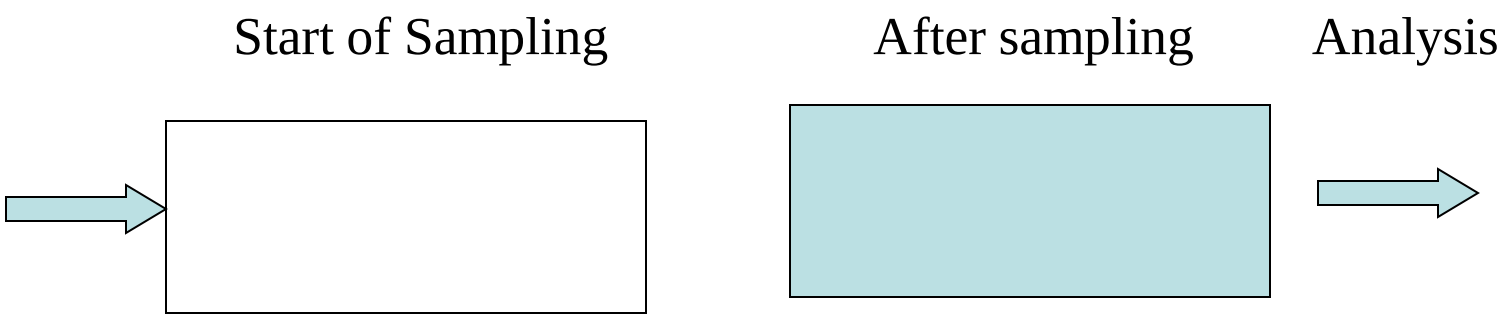
Vadose zone vapor sample extraction



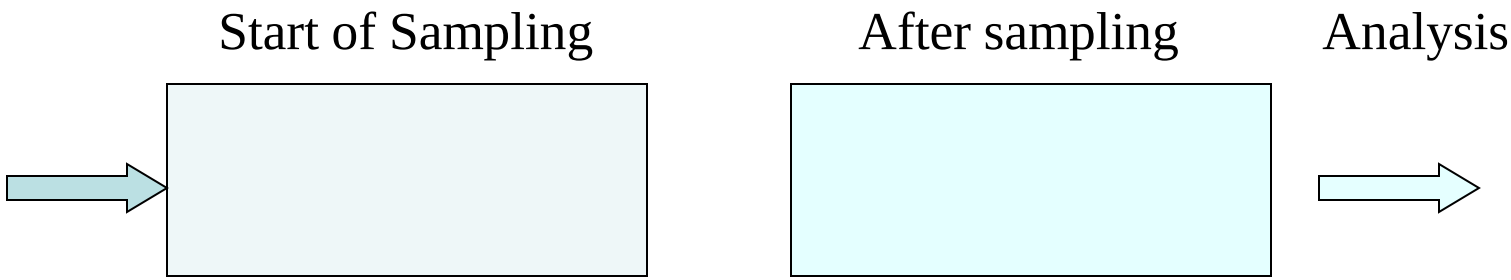


Problem: Residual water in silica gel even after prebaking at 100°C for over 48 hrs

Ideal Water-Based Sampling



Realistic Sampling



Correction factor is needed to account for residual moisture: Basic calculation for tritium concentration:

$$Tritium(Bq/L) = \frac{Bq_{measured}}{M_{Total} \div \rho_{Water}}$$

Correction Factor derivation:

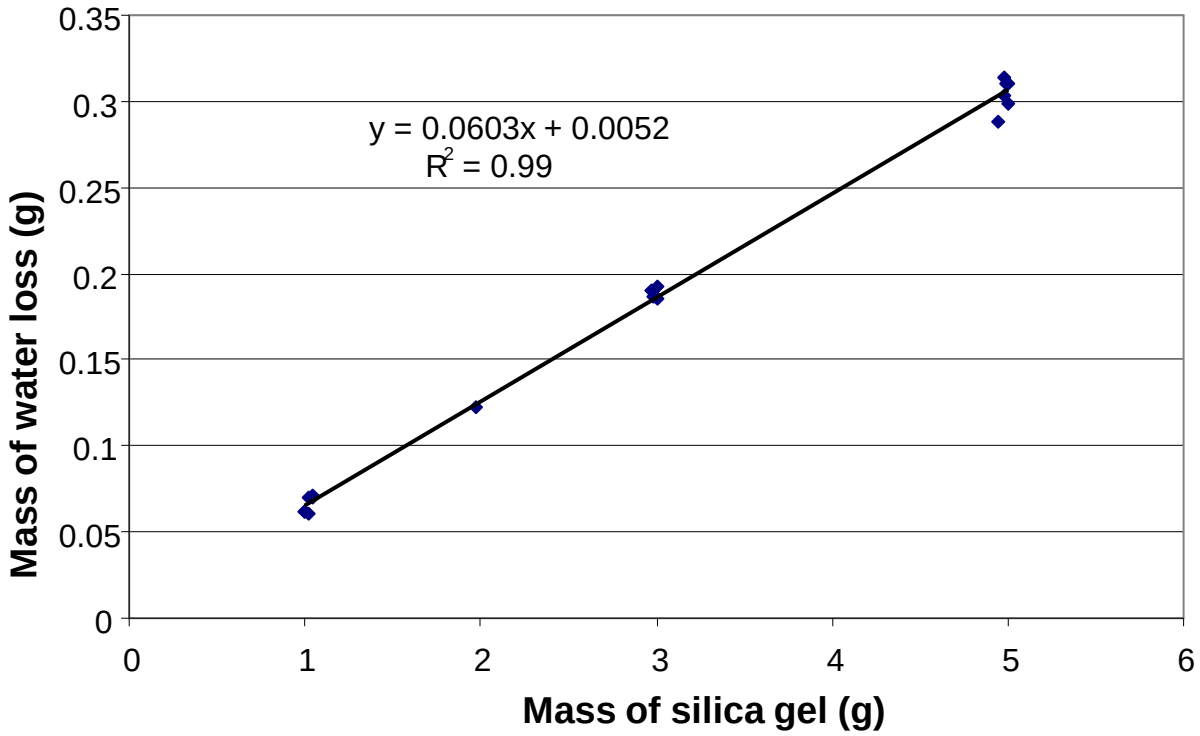
Proposed Calculation

$$Tritium_{\text{Proposed}}\,(Bq/L) = \frac{Bq_{measured}}{M_{Total} \div \rho_{Water}} \times \frac{M_{Total}}{M_{Collected}} = \frac{Bq_{measured}}{M_{Total} \div \rho_{Water}} \times CF$$

Where: Correction Factor (CF) is :

$$CF = \frac{M_{Total}}{M_{Collected}} = \frac{\left(M_{GEL} \times F_{GELMoisture}\right) + M_{Collected}}{M_{Collected}}$$

Determine F_{GEL}: Further heat silica gel at 200º C to drive off residual moisture



Slope is estimate of fraction of residual moisture in silica gel after pre baking (0.06)

Correction Factor can now be calculated

$$CF = \frac{M_{Total}}{M_{Collected}} = \frac{\left(M_{GEL} \times F_{GELMoisture}\right) + M_{Collected}}{M_{Collected}}$$

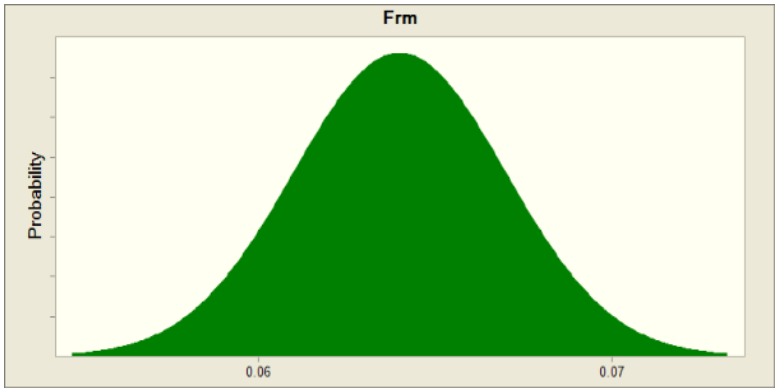
Where: M_{GEL} = ~135 g (estimated from typical amounts)
$M_{collected}$ = median 15 g (determined from recorded measurements)
F_{GEL} = mean is 0.06 (from measurements)

Typical CF calculation shows the correction is significant:

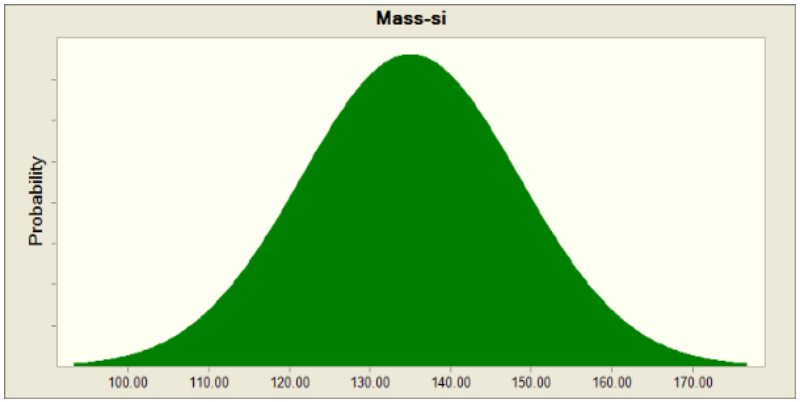
$$CF = \frac{\left(135g \times 0.06\right) + 15g}{15g} = 1.54$$

But, these parameters have some uncertainty to propagate through the calculation of CF using Crystal Ball software

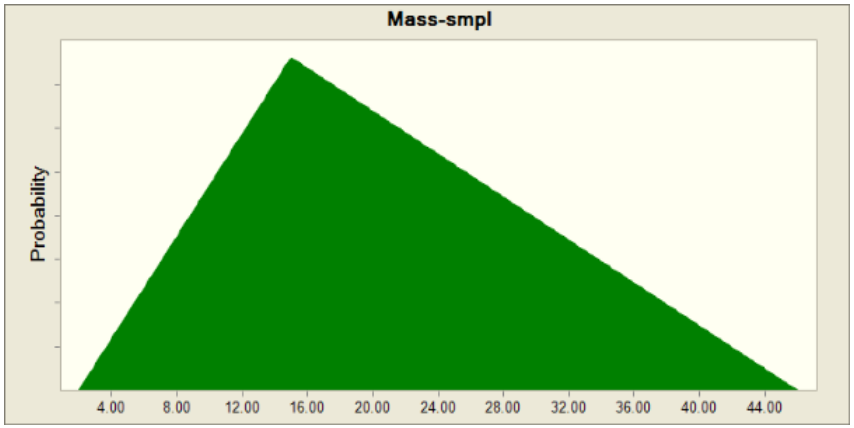
Fraction residual mass: 0.06 ± 0.03



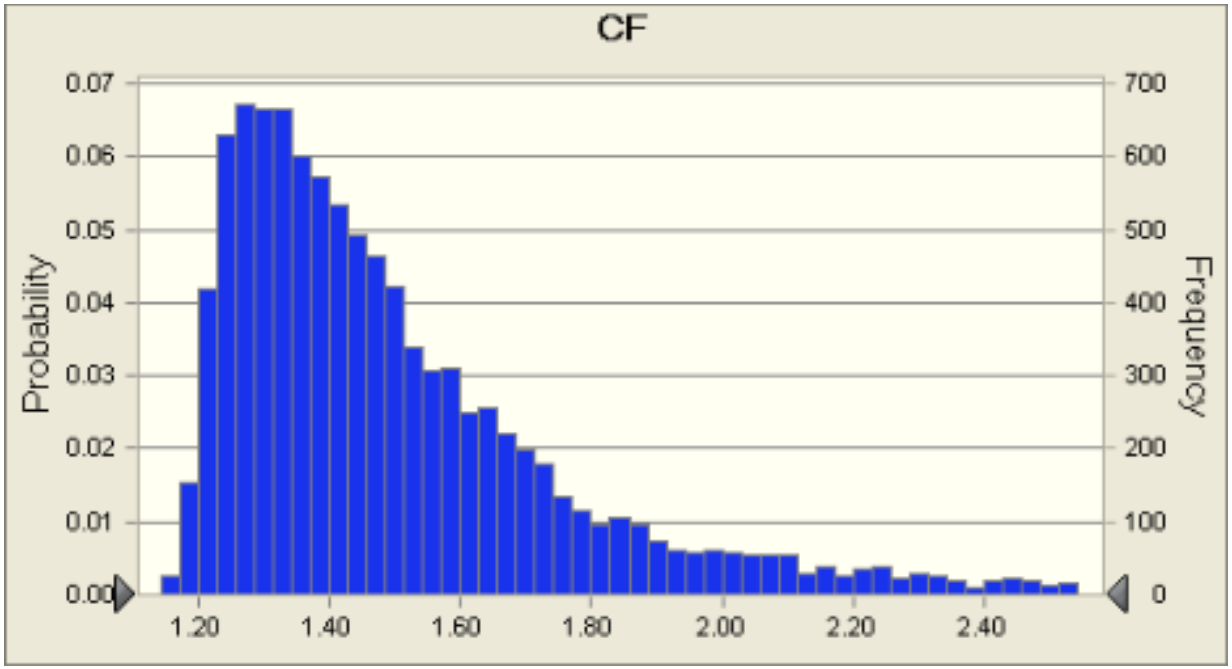
Mass of silicon gel: 135 ± 13.5



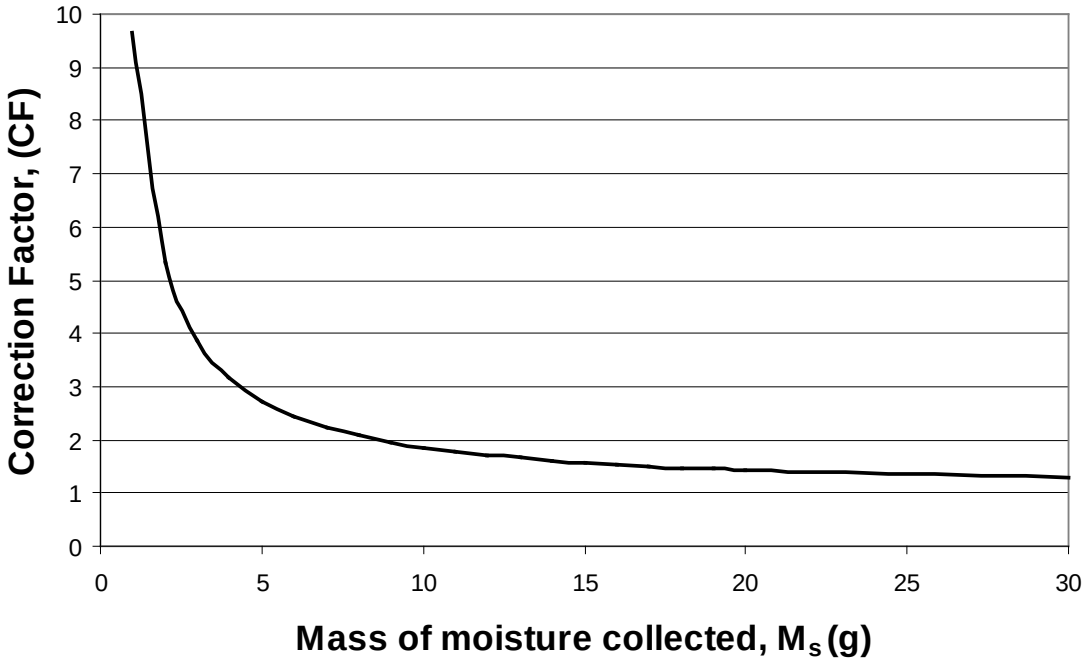
Mass of sample water: median 15, range 2-46



Results of 10,000 simulations: median 1.43; range 1.14 to 5.27- these CFs were used for past measurements where mass of sample or gel was not recorded



Correction factor as a function of moisture collected is nonlinear: Emphasize collection of > 5 g of moisture, if possible



Conclusions:

- Residual moisture in silica gel can significantly impact measurements of tritium in vapor through dilution
- Mathematical correction of the measurements provides more accurate estimates of tritium concentrations
- Corrections were applied to all past measurements at LANL
- Correction Factors are nonlinearly related to the mass of sample collected and begins to level out at masses > 5 g.

Thank you for your time!

