CFTA Fill Rate Study*

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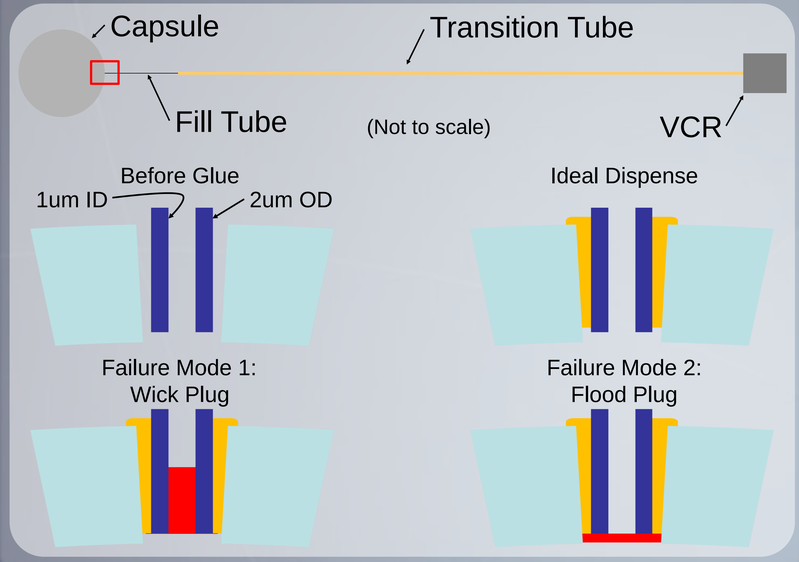
CFTAs and Plugs

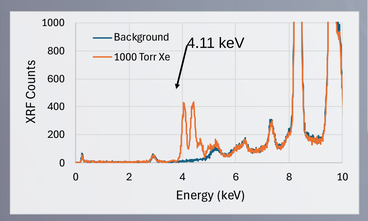
Plugs in Capsule Fill Tube Assemblies (CFTAs) are a manufacturing yield risk for Ignition Targets

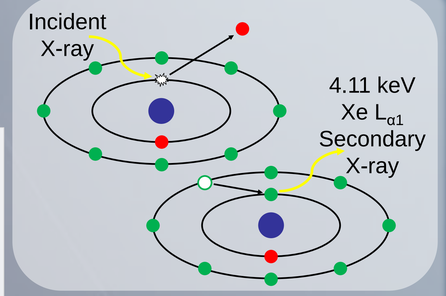
Prior to 2021, plugs were only checked after the Target build finished, risking components and assembly labor



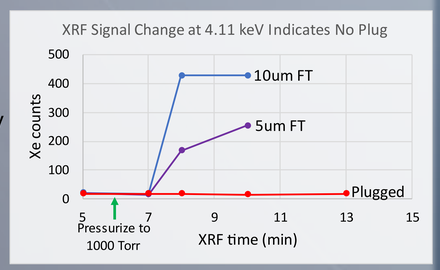
XRF Detection of Xe Indicates No Plug

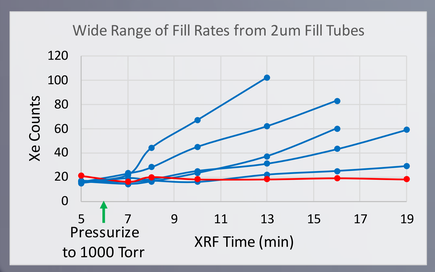
X-Ray Fluorescence (XRF) provides an understanding of the environment inside the capsule





5um and 10um CFTAs immediately show a strong Xe signal

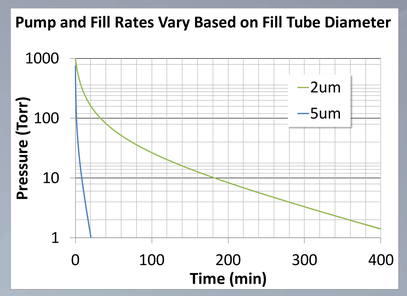




2um CFTAs fill slowly enough to observe the Fill Rate however the rate varies widely

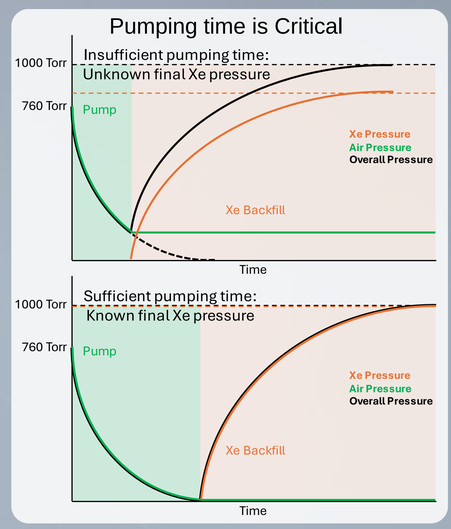
Slope Provides Info on CFTA Fill Rate

The slope of the XRF results is related to the Target Fill Rate at NIF, which is important for NIF shot planning and gas operations. By using XRF data, Fill Rate can be measured 2+ weeks before a Target is completed.



Pump and Fill Rates are further affected by partial glue plugs

Translating XRF data to Target Fill Rate requires a conversion from XRF counts to pressure

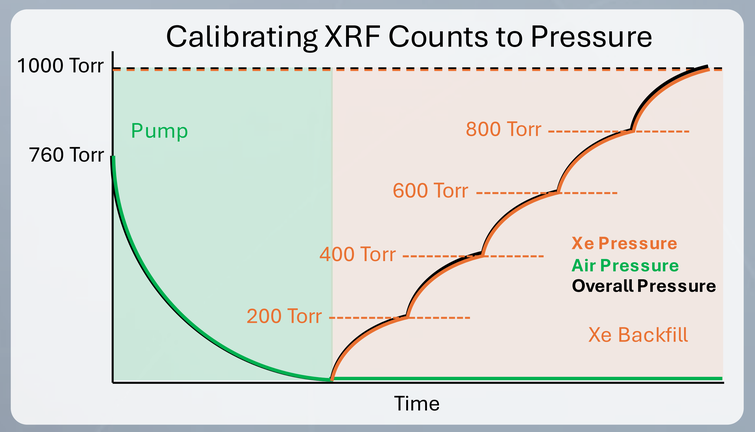


The pumping times below were used to guarantee <1 Torr residual air

Nominal Fill Tube OD (μm)	Theoretical Pumping Time	Actual Pumping Time
2	7.35 h	88 h†
5	20 min	30 min

†Pumped over long weekend

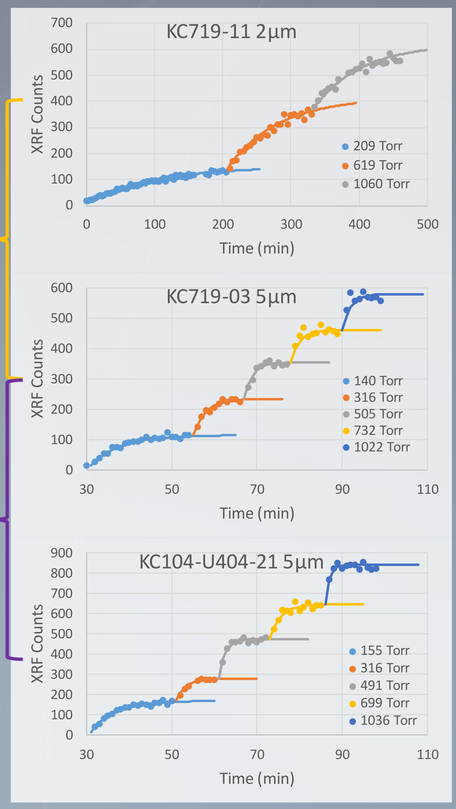
XRF/Pressure Calibration by Ramping Pressure



Repeat calibration for 2um and 5um CFTAs from the same Capsule Batch to verify saturation is not Fill Tube dependent

Repeat for different Capsule Batches to look for statistical variation and other significant factors

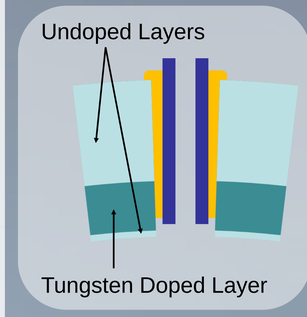
Results are Consistent within Batches and Dependent on Dopant



Asymptotic behavior is modeled with an exponential fit

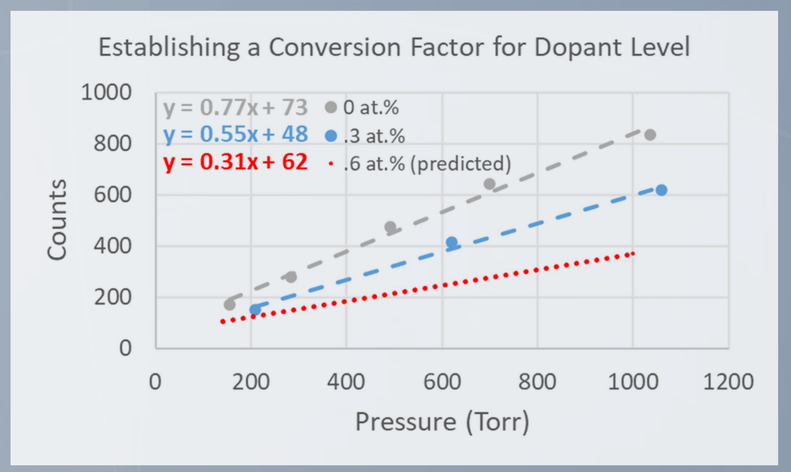
$$C = C_{max} - (C_{max} - C_{offset})e^{(t-t_0)/t_c}$$

Differences between Capsule Batches observed due to Tungsten Dopant



Tungsten Dopant is used to keep X-rays out of the fuel

Peak Counts and Pressure are linearly related.



Tungsten Dopant is known to block X-rays

Further testing needed with introduction of new Dopants

Future Work: Confirm XRF Fill Rate and Provide to NIF

- Establish dopant multiplier for conversion factor
- Use conversion on existing XRF data to determine Fill Rate
- Compare XRF Fill Rate with NIF Fill Rate from past shots
  - May require additional normalization
- Establish data flow to provide XRF Fill Rate early in Target build process

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