IMPROVED ABLATOR AREAL DENSITY ANALYSIS BY INVESTIGATING BACKGROUND GAMMA-RAY SIGNAL

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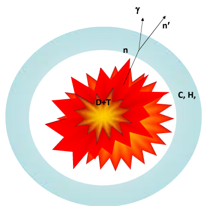
Areal density (ρR) of imploding capsules can be inferred from gamma-ray yields

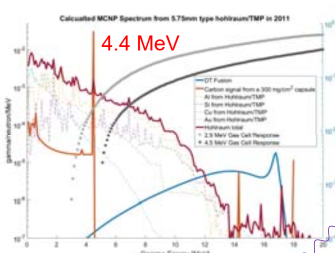


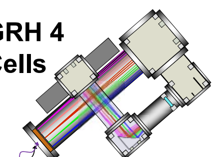
- 14 MeV neutrons from D+T fusion reactions generate γ rays via inelastic scattering on nuclei in capsule ablator
- Intensity of 4.44-MeV $^{12}C(n,n'\gamma)$ line from ablator is proportional to (capsule's fusion yield) X (ablator's areal density)

$$Y_{\gamma C} \cong \frac{\sigma_{^{12}C(n,n')}}{m_C} < \rho_C R > Y_{nDT}^{total}$$

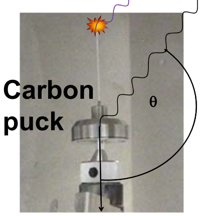
- ^{12}C ρR depends on: (1) ablator mass remaining, (2) ablator compression, (3) spatial distribution (convergence & mix)

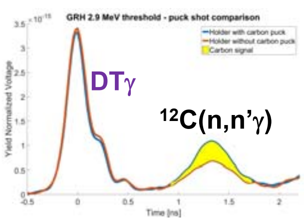
2.9 MeV & 4.5 MeV GRH channels are dedicated to areal density measurement



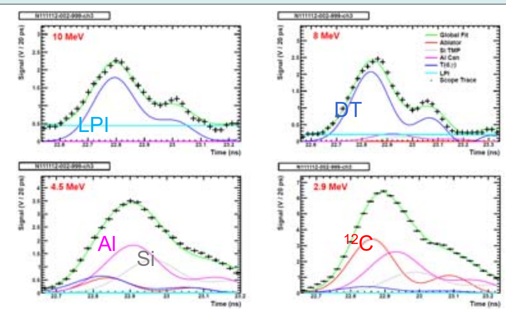


Recently, exploding pusher carbon puck shots provide GRH calibration to a known carbon ρR (25.8 mg/cm²)





Forward fit approach is being reinstituted to provide ultimate method for carbon ρR in the future



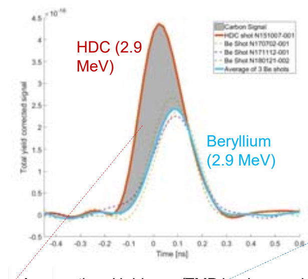
D. B. Sayre, *et al.*, Rev. Sci. Instrum. 83, 10D905 (2012)

- However, we must first understand uncertainties

Integrated signal approach for uncertainty determination

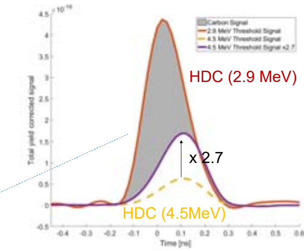
Quantifying 12C signal from 2.9 MeV Eth GRH requires background Hohlraum/TMP signal subtraction (Beryllium ablators provide the background signal without 12C 4.4MeV line)

1st approach: estimating hohlraum/TMP background using a Beryllium campaign



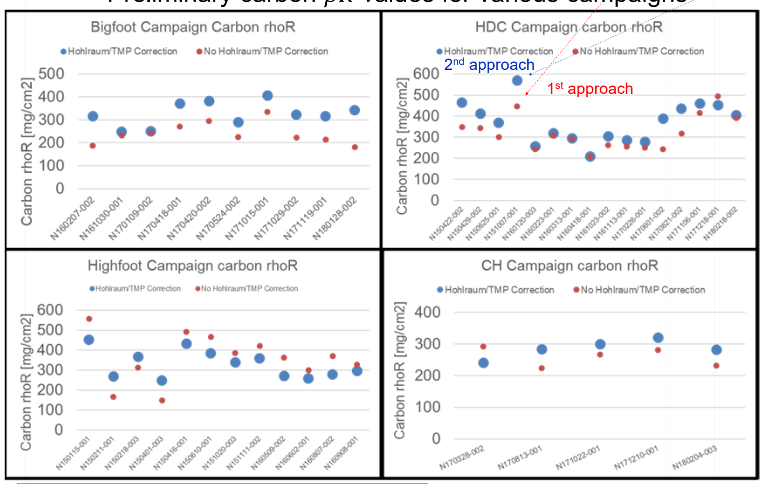
- Assumption: Hohlraum/TMP background gamma signals for all campaigns are the same as that of Beryllium campaign

2nd approach: measuring hohlraum/TMP background using a 4.5 MeV threshold. Then scale it by x2.7 (determined from Beryllium campaign)



- Assumption: a factor of 2.7 scaling factor (= 2.9 MeV / 4.5 MeV) is a constant for all campaigns

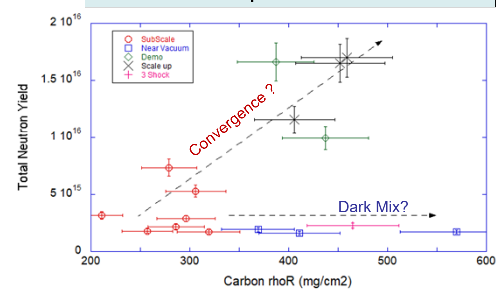
Preliminary carbon ρR values for various campaigns



Uncertainty sources

- A background scaling factor (a factor of 2.7 = 3 MeV / 4.5 MeV) determined by Beryllium campaign may not be applied directly to other campaign since each campaign uses a different hohlraum/TMP packages
- PMT gain difference between actual physics shot and puck calibration shot
- Total yield inferred from line-of-sight neutron yield (13-15 MeV) and DSR (10-12 MeV) measurements may not be accurate

Carbon ρR holds information about shell performance



Conclusion and future work

- Successful GRH carbon puck calibration in Jan 2018
- Use of beryllium campaign for reducing uncertainty in background subtraction
- Signal integration approach to estimate carbon rhoR across NIF campaigns
- ^{12}C ρR will constrain models & may give indication of ablator mix into cold fuel
- Future work
  - Reestablish forward fit approach
  - Reduce and quantify uncertainty
  - Include Pulse Dilation PMT to improve analysis