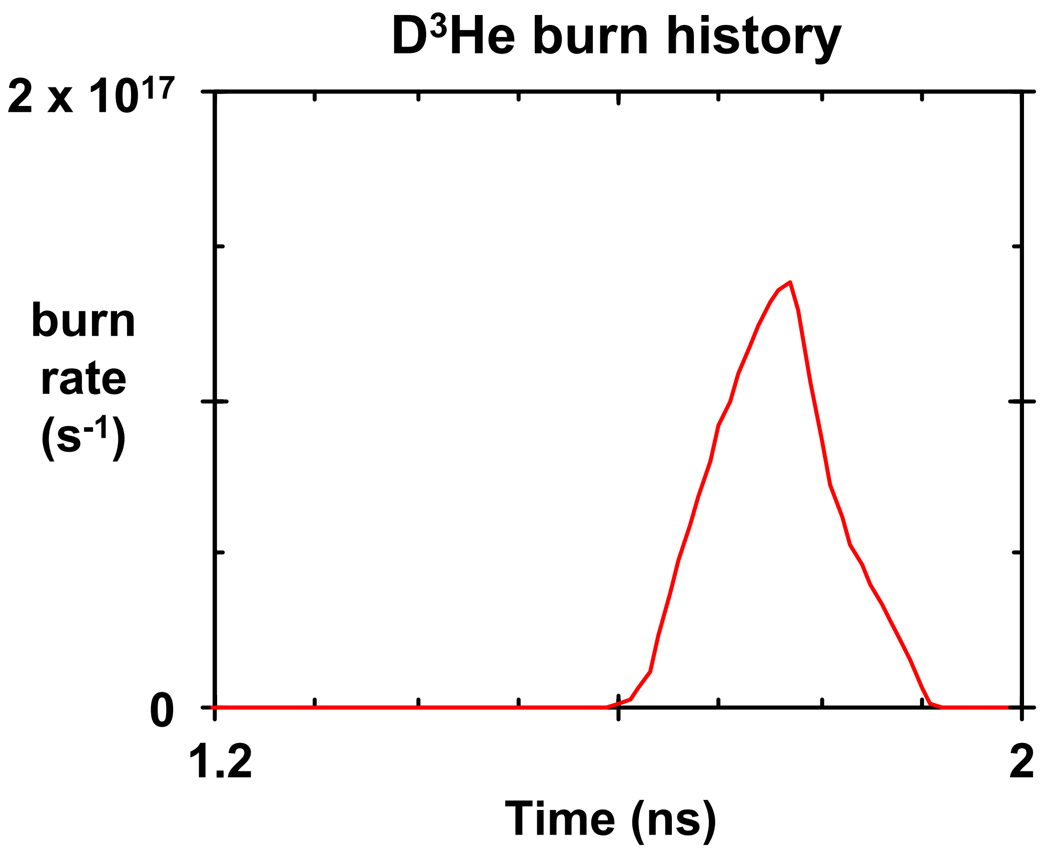
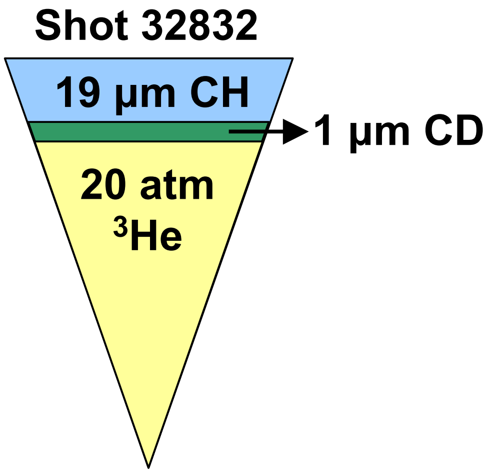
Experimental studies of time-dependent mix in OMEGA direct-drive implosions





J.R. Rygg et al.
MIT - PSFC

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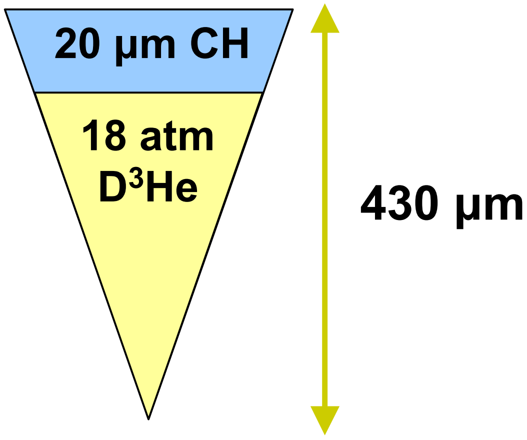
Summary

- Measurement of D^3He burn history opens new windows on capsule dynamics during the deceleration phase, including:
  - T_i
  - n_{fuel}
  - ρR
  - r_{shell}
  - v_{shell}
  - a_{shell}

- These inferred histories are being used to construct a self consistent picture of mix dynamics

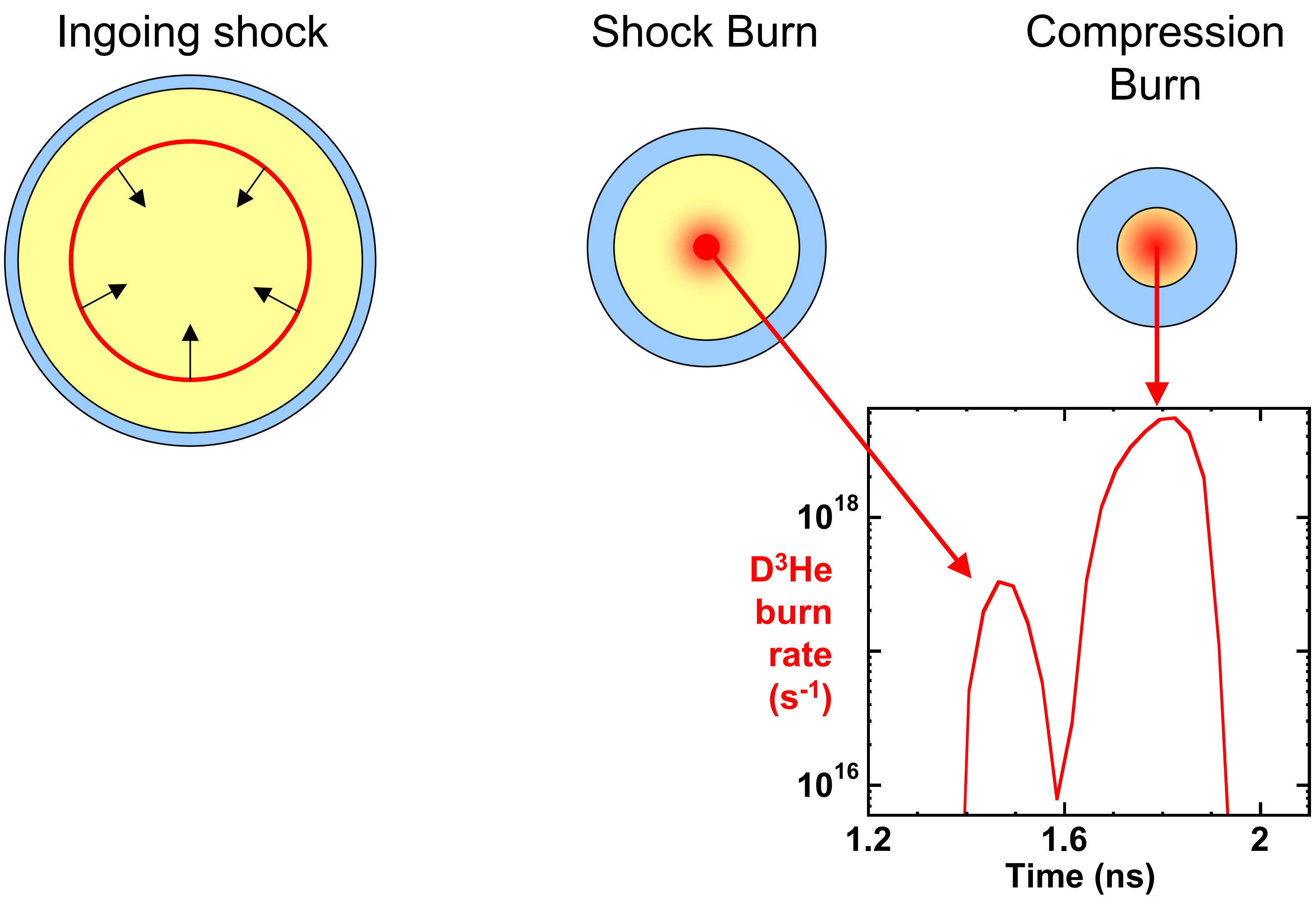
D-^{3}He filled capsule implosions will emit 14.7 MeV protons

D + ^{3}He $\Rightarrow$ α(3.6) + p(14.7 MeV)

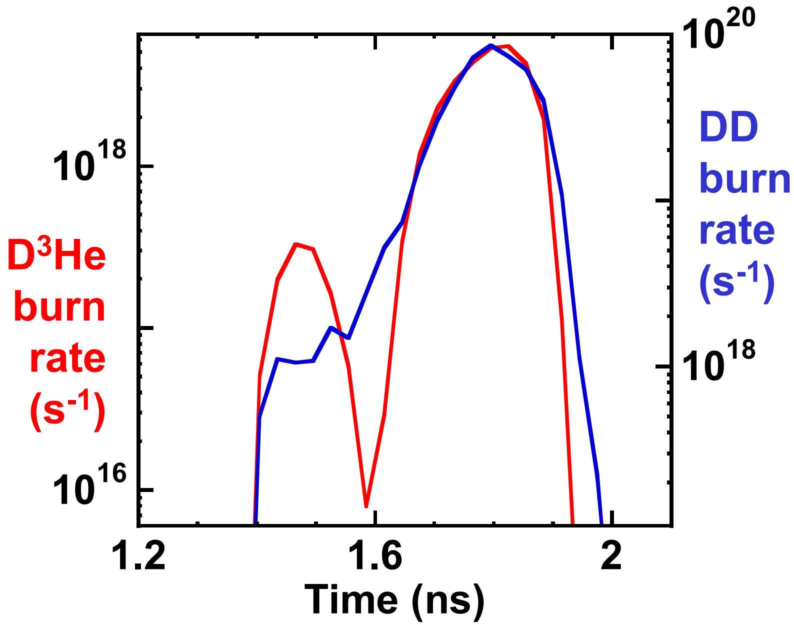


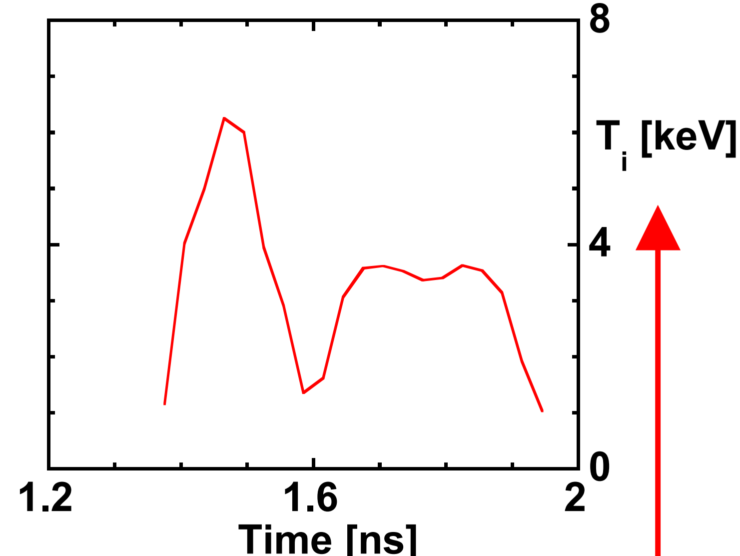
D-^{3}He protons are emitted when the fuel gets sufficiently hot

There are typically two peaks in the D-^{3}He burn history

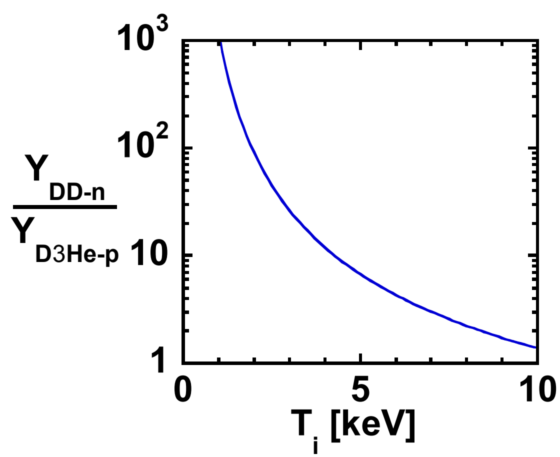


T_i evolution can be inferred from the ratio of DD and D^3He burn histories



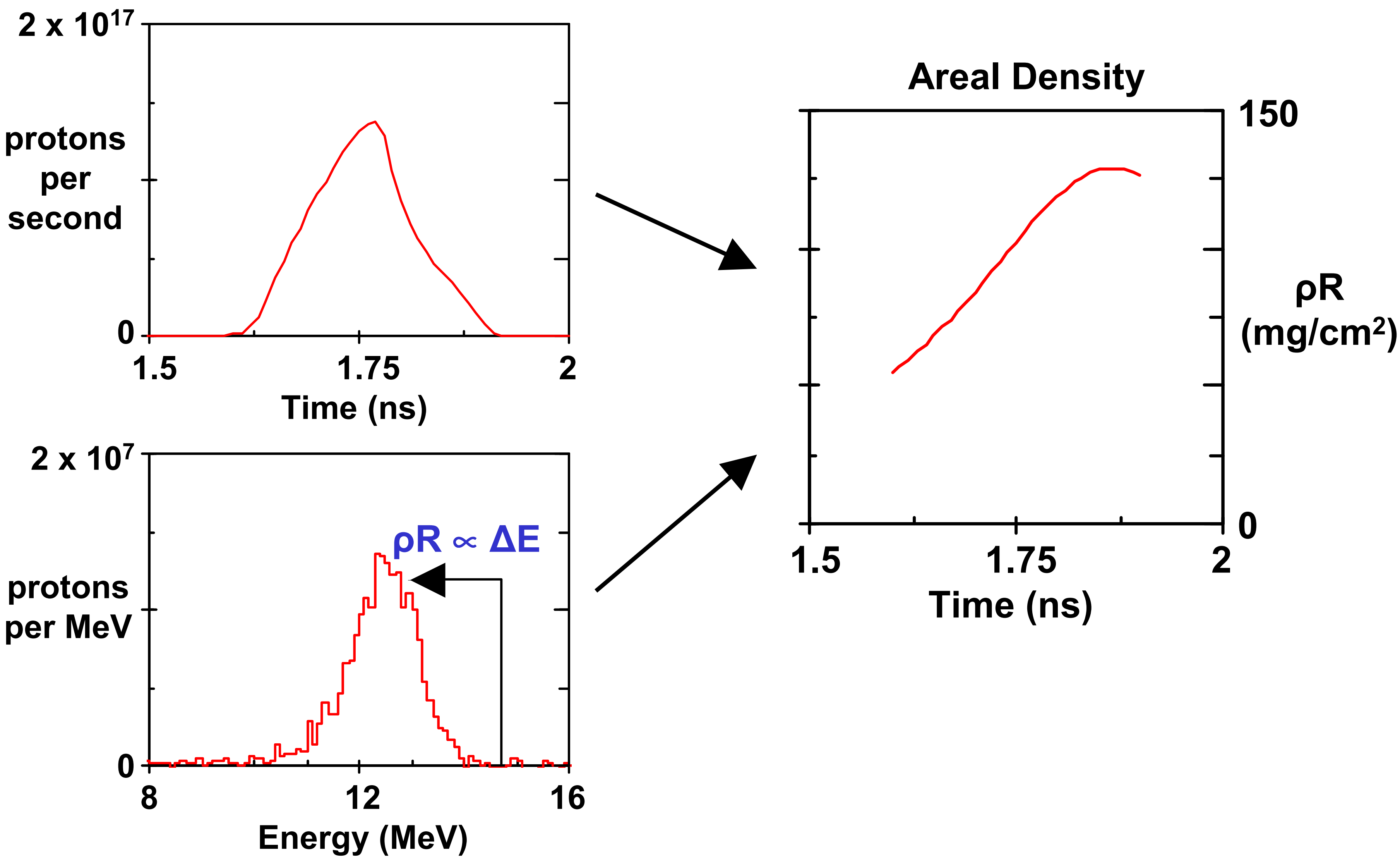


Take the ratio

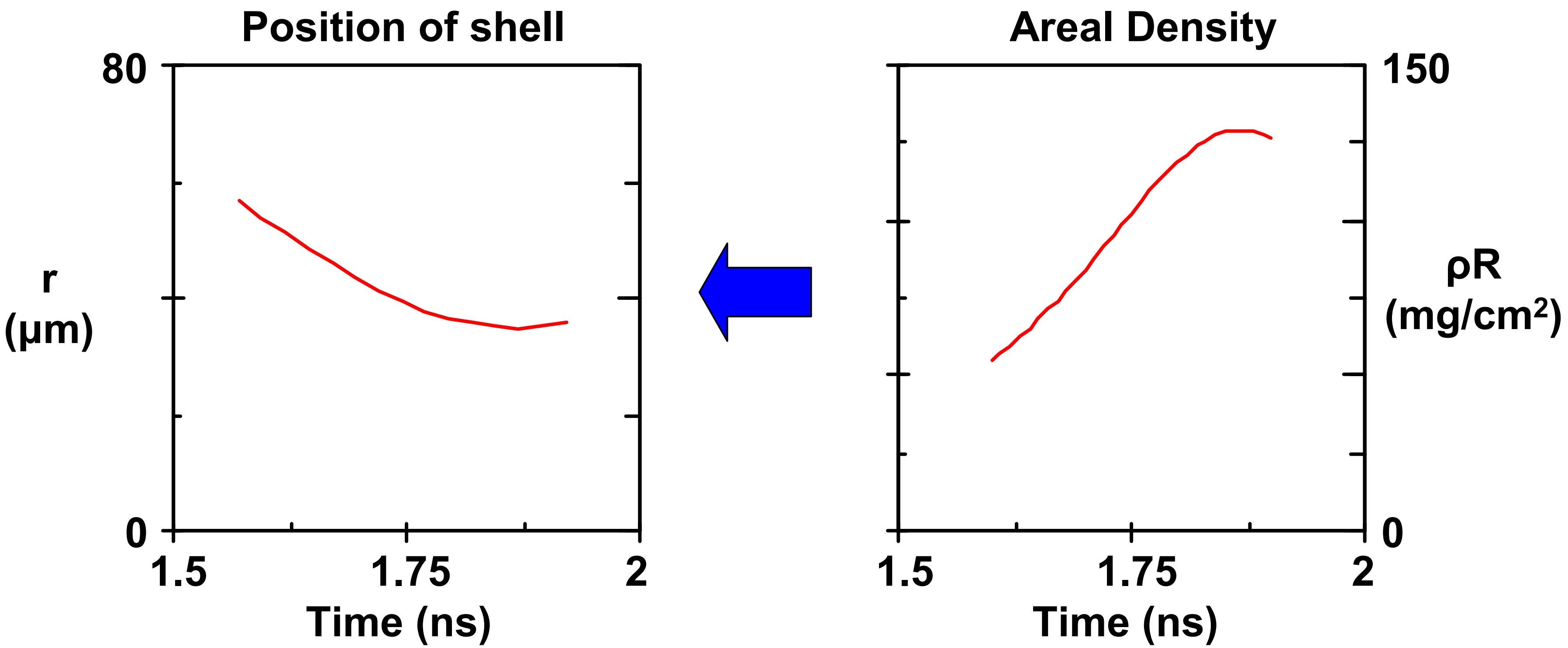


Recover T_i

ρR(t) can be inferred by combining D^3He burn history with the measured D^3He proton spectra

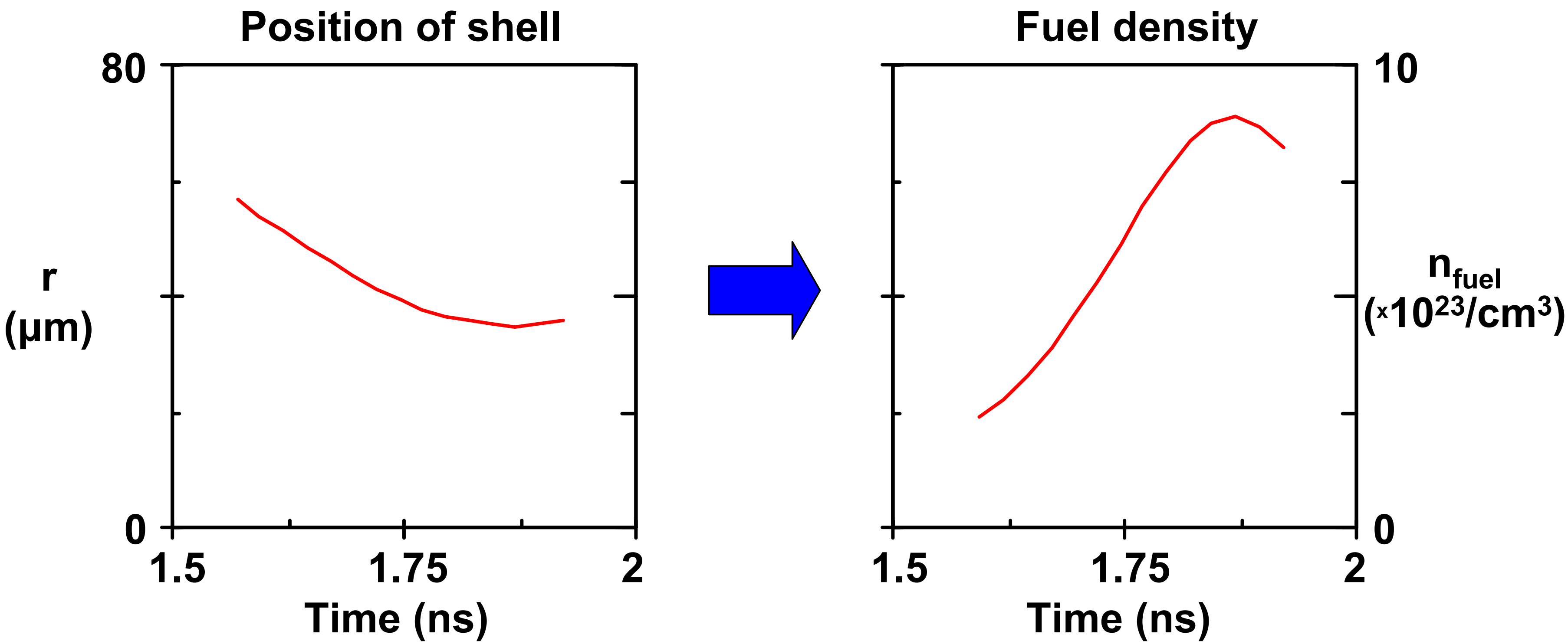


r(t) can be inferred from ρR(t)



$$r(t) \approx r_0 \sqrt{\frac{f \cdot \rho R_0}{\rho R(t)}}$$

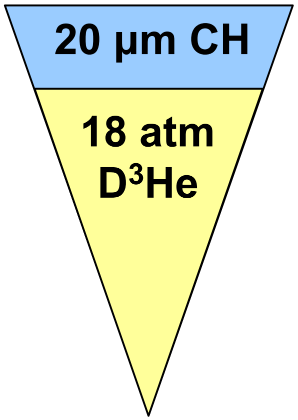
r(t) will give us $n_{fuel}(t)$



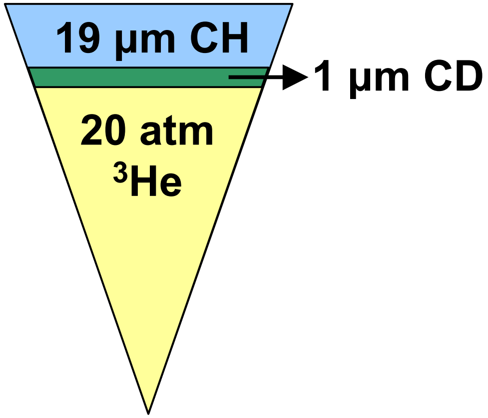
$$n_{fuel}(t) = n_0 \left(\frac{r_0}{r(t)} \right)^3$$

^{3}He-filled, CD shelled capsules make an excellent probe of fuel-shell mix

D + ^{3}He $\Rightarrow$ α(3.6) + p(14.7 MeV)

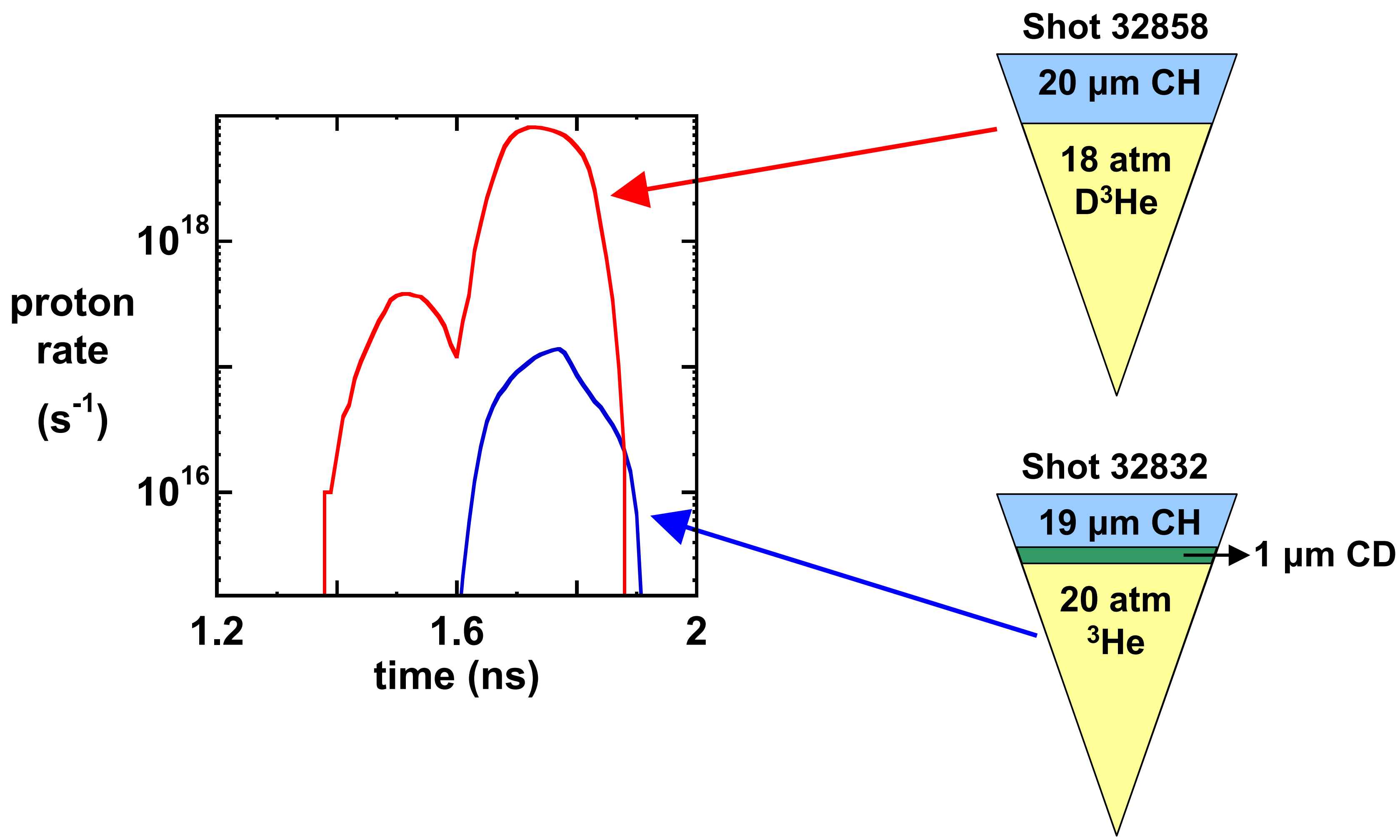


D-^{3}He protons are emitted when the fuel gets sufficiently hot

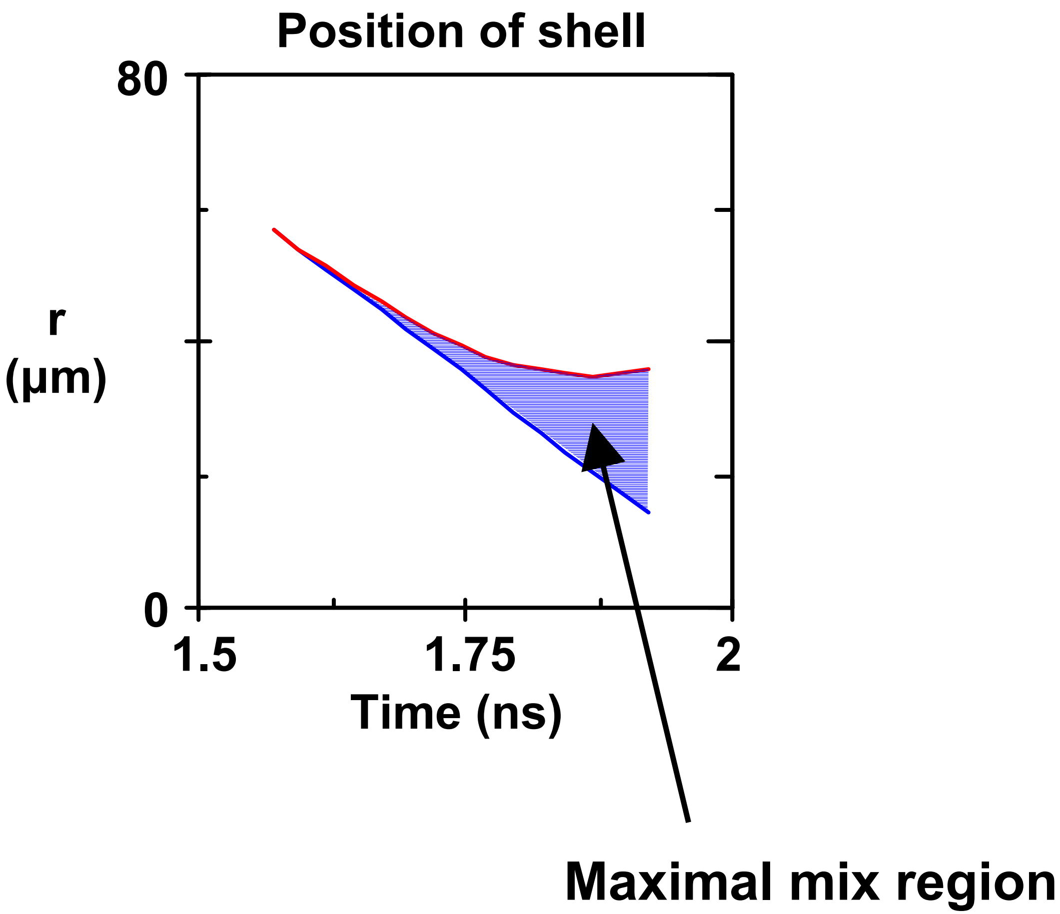


D-^{3}He protons are emitted *only* when there is mixing of the fuel and the shell on the atomic level.

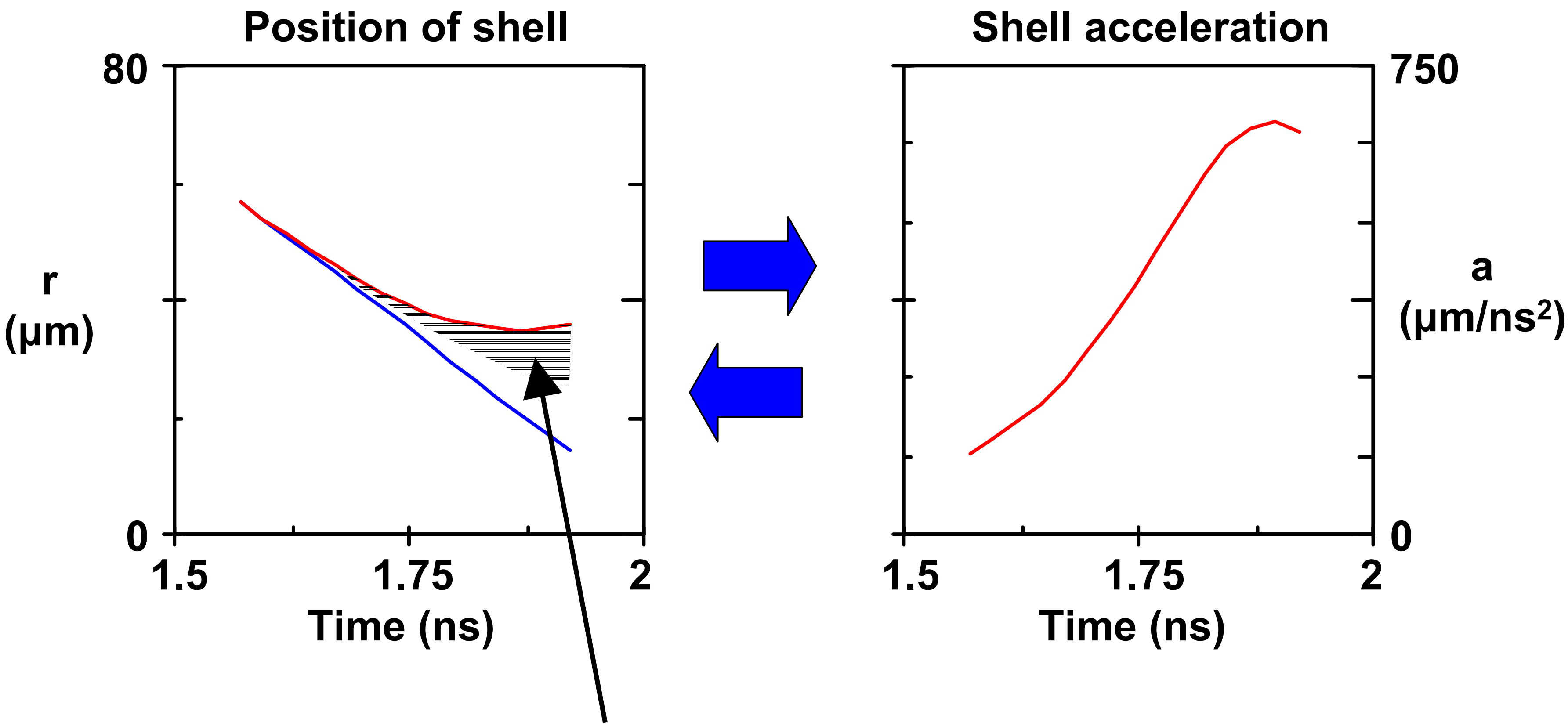
There is no shock burn in the burn history of ^{3}He filled capsules



Mixed region will not converge faster than the free-fall trajectory



Using the shell acceleration, we can better estimate the amount of mix



Improved estimate of mix region

Empirical, dynamic mix model

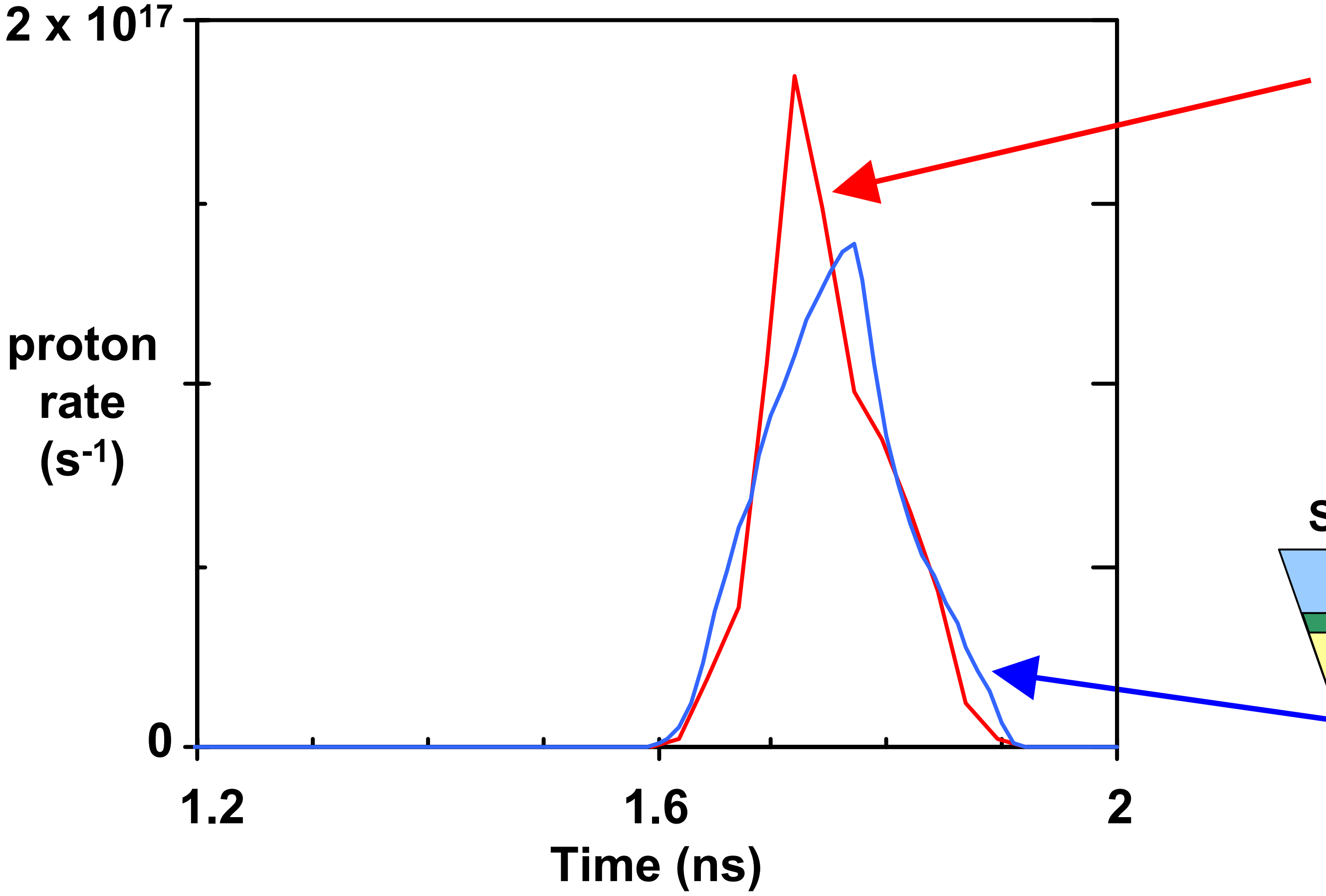
- Estimate the size of the mixed region using a(t)

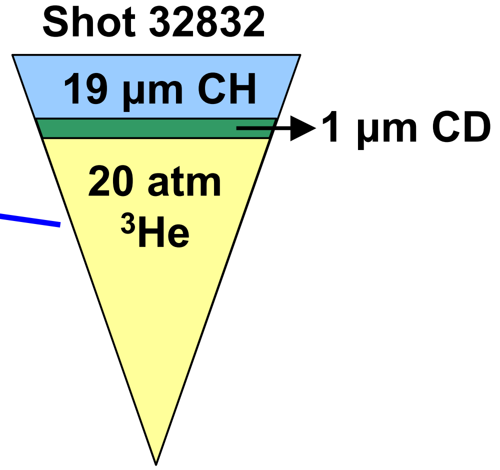
- Calculate the D^3He proton production rate:

$$protons(t) = \int_{mix\_region(t)} n_D(t)\, n_{^3He}(t) \left\langle \sigma v(T_i(t)) \right\rangle 4\pi r^2 dr$$

- Check that this calculated proton rate is consistent with the measured proton rate

Preliminary results from this empirical mix model look promising





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