An Update on Quenching Factor Measurements at TUNL

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Introduction and Motivation

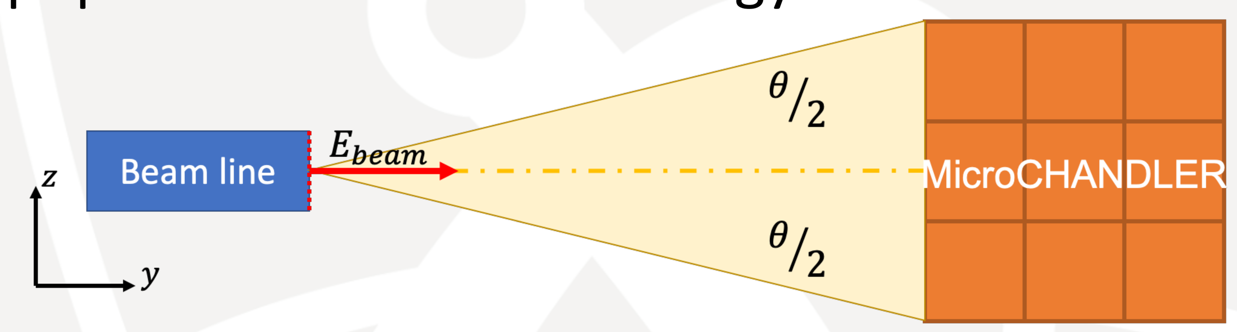
- When a particle interacts in a detector, the energy it leaves behind flows into several channels.
- The amount of an incident particle's energy that goes into a particular channel depends on the detector medium and the type of particle.
  - Neutrons, neutrinos, and dark matter all produce nuclear recoils.
- Quenching factors characterize the signal ratio of nuclear recoils to electron recoils.
- I worked closely with Dr. Jonathan Link of Virginia Tech to measure quenching factor in MicroCHANDLER, a prototype reactor monitor.

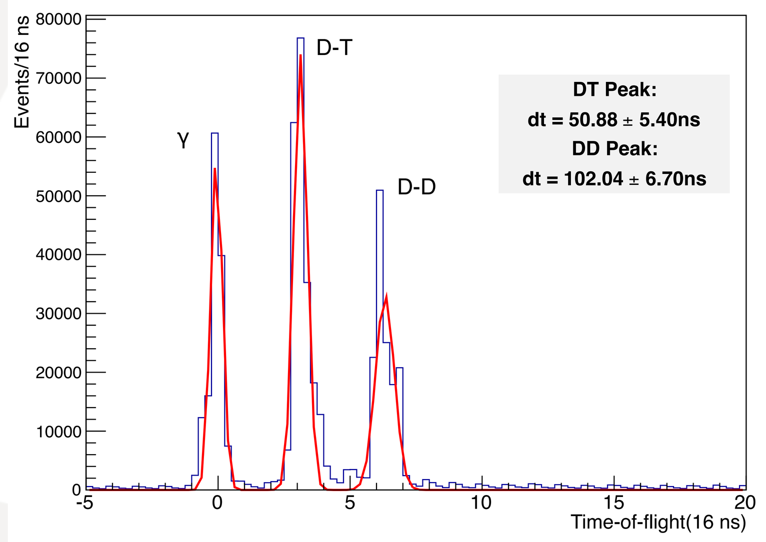
Mission Relevance

- Nuclear reactors are an intense source of antineutrinos.
- These antineutrinos carry spectral information that can be used to understand the state of the reactor core.
- The CHANDLER detector technology is intended to sensitively measure these neutrinos as part of a robust anti-proliferation program.
- Fast reactor neutrons are an important background – understanding the detector response to such events is critical to mission success.

Technical Approach

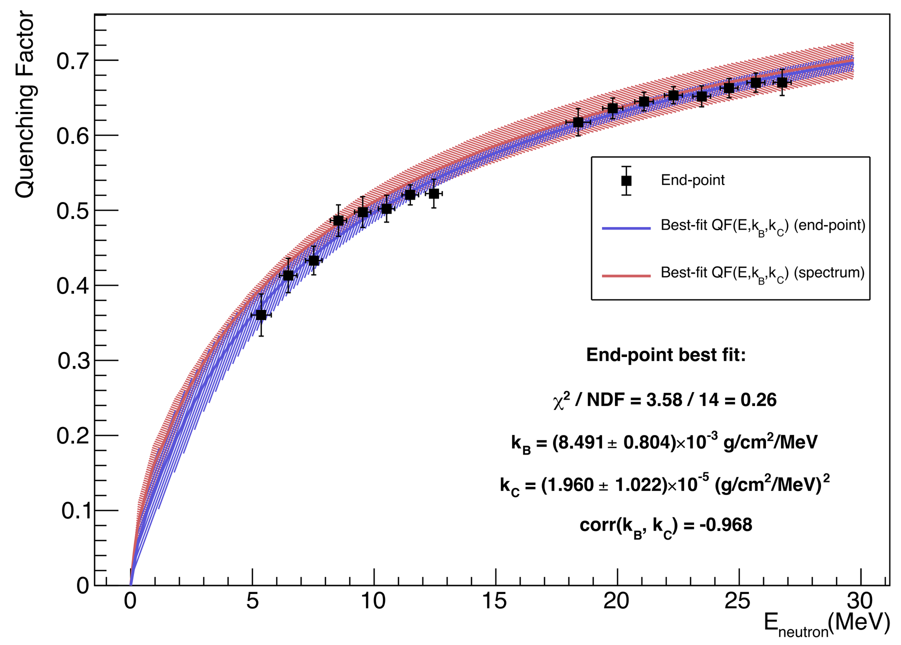
- We used the Triangle Universities Nuclear Laboratory's Tandem Van de Graff accelerator to produce a pulsed beam of deuterons.
- These deuterons interact with a tritiated target to produce monoenergetic neutrons with a Q value of +3.5 MeV. Additional interactions with deuterons embedded in the target produce a second neutron population with lower energy.





Top: Diagram of the experiment.
Bottom: Time of flight data from MicroCHANDLER demonstrating the three distinct signal populations. All plots from [1].

Results



Expected Impact

- This technology, if successful, will provide a powerful new tool for reactor monitoring and fundamental physics.

MTV Impact

- Technology transitions
  - The North Anna reactor has expressed interest in the technology and is allowing test deployments to their site.
  - We've collaborated with Dr. Jonathan Link's group at Virginia Tech on this measurements campaign, including work on upgrading the detector.

Conclusion

- This work was recently published in JINST [1].
- [1] C. Awe, P. Barbeau, A. Haghighat, S. Hedges, T. Johnson, S. Li, J.M. Link, V. Mascolino, J. Runge, J. Steenis, T. Subedi, and K. Walkup. *Measurement of proton quenching in a plastic scintillator detector.* JINST 16 P02035

Next Steps

- The next steps will be to apply MicroCHANDLER's upgrades to MiniCHANDLER and redeploy to a reactor. The TUNL group hopes to remain involved in the future.

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