Accelerator Driven Subcritical Experiments at The University of Texas

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Reactor-Accelerator Coupling Experiments (RACE)

- Transmutation research project of the U.S. Advanced Fuel Cycle Initiative (AFCI)
- Additional support in Texas from INIE program
- It is a series of accelerator-driven subcritical system experiments conducted at Idaho State University (ISU) (Phase I), University of Texas at Austin (UT) (Phase II) and Texas A&M University (tamu) (Phase III)
- Computational support from University of Michigan and University of Nevada-Las Vegas

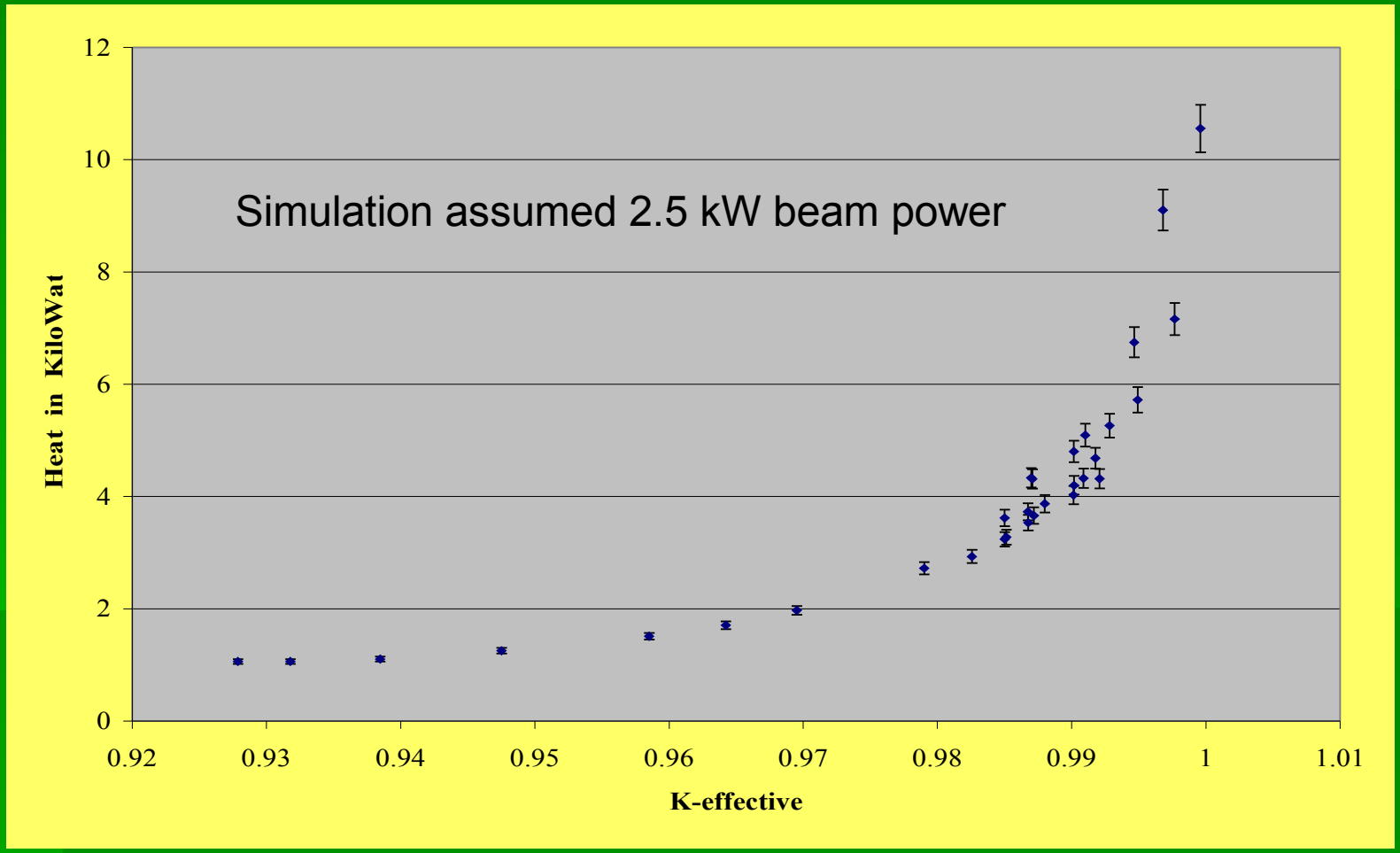
Now an International Project

- In June 2005, a Memorandum of Understanding (MOU) was signed between U.S. DOE and the EUROTRANS (European Research Program for the Transmutation of High Level Nuclear Waste in an Accelerator Driven System)
- This made RACE and ECATS (Experimental activities on the Coupling of an Accelerator, a Target and a Subcritical blanket) a cooperative, international research program
- Many opportunities exist for the sharing of research staff and students

Purpose of RACE

- Support international efforts in high level radioactive waste transmutation
- Design, model and conduct electron accelerator-reactor coupling experiments as a first-of-its-kind experiment
- Predict and measure subcriticality and subcritical multiplication with and without thermal feedback
- Predict and analyze unique subcritical source-driven transients and reactivity control methods
- Evaluate neutron instrumentation in high gamma flash background
- Evaluate asymmetric injection ADSS design concepts
- Investigate power/current/source importance relationships

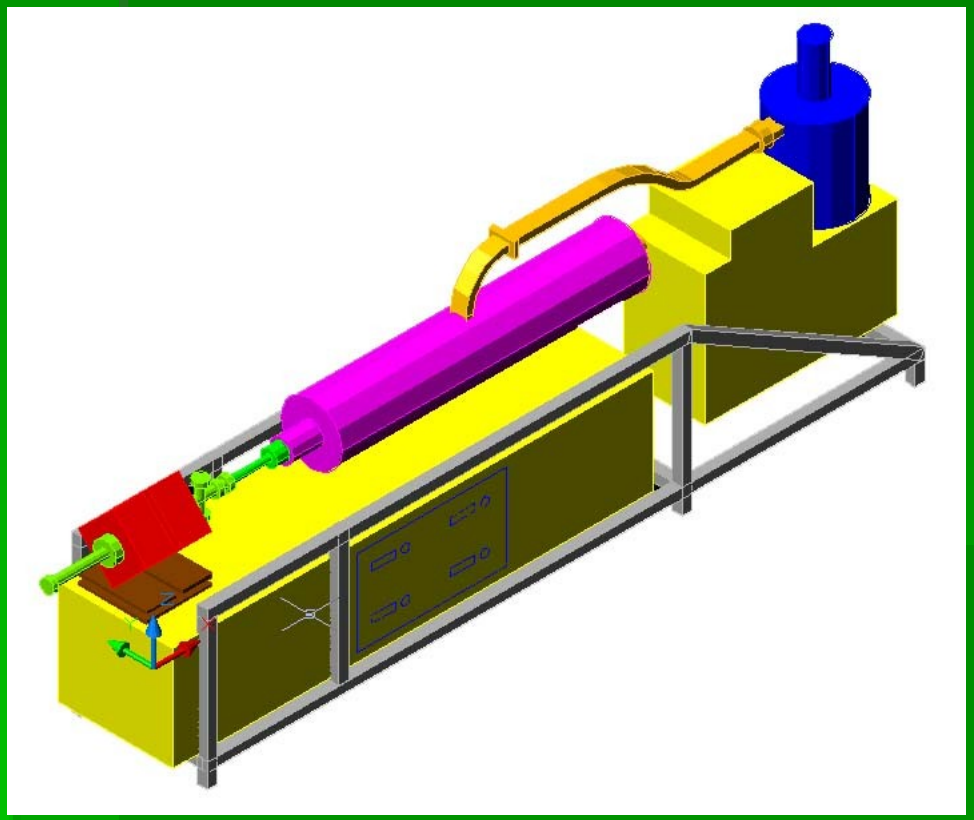
Expected Heat Generation Rate

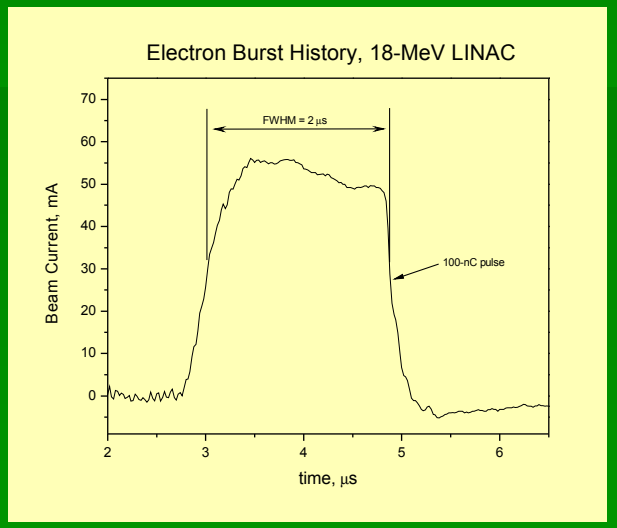


Summer 2005 Schedule

- June:
  - Perform experiments for students using critical reactor
- July:
  - Perform annual maintenance (2 weeks)
  - Dismantle BP#5 Cave-Rebuild Cave (2 BIG steps)
  - Unload TRIGA core
  - Install Linac, test systems, train operators
- August
  - Linac operations (originally planned for 3-4 weeks but…..)
- September
  - Return to critical operations

“Portable” Electron Linac

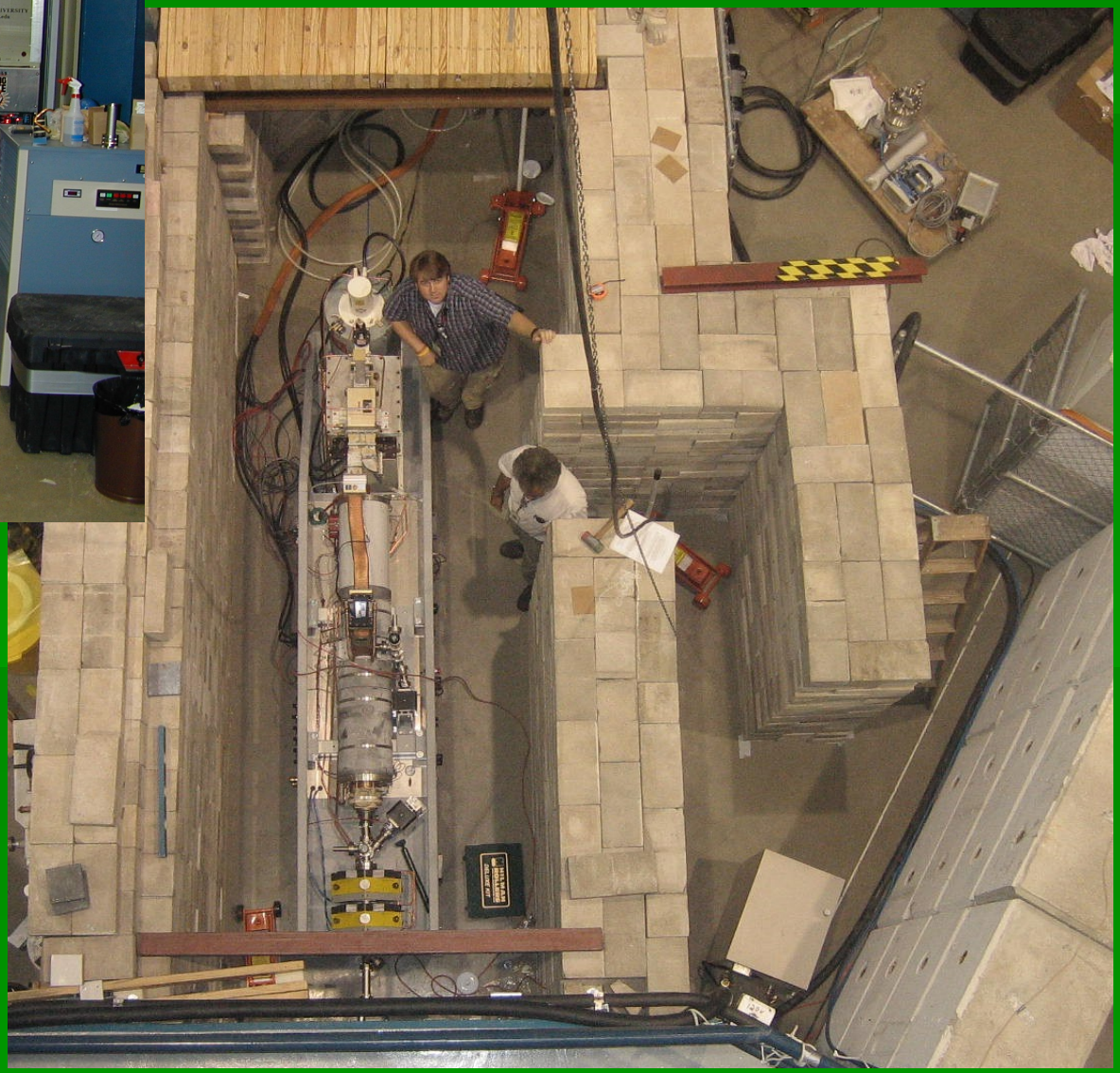




- 20 MeV “Clinac”
- 180 Hz maximum frequency producing beam power of almost 2 kW
- Approx. 80-100 mA beam current

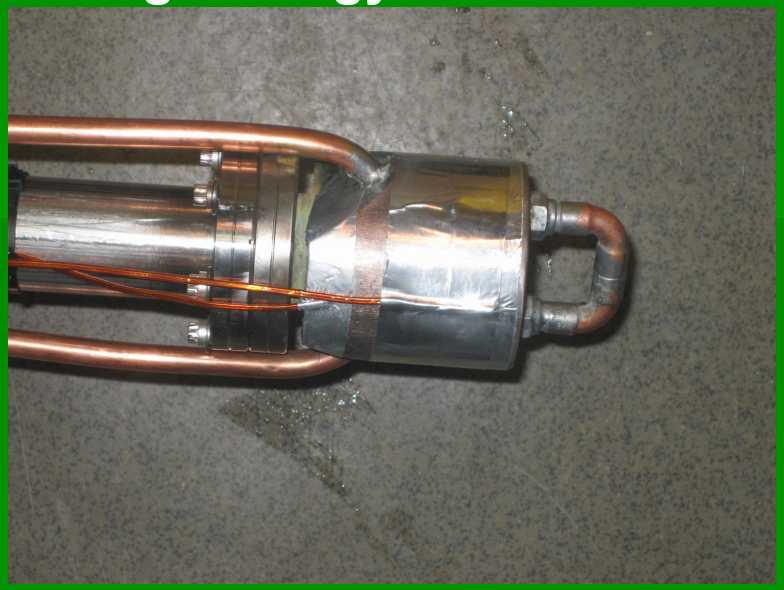
Linac power supplies, vacuum systems and main chiller
Note: large extension cord

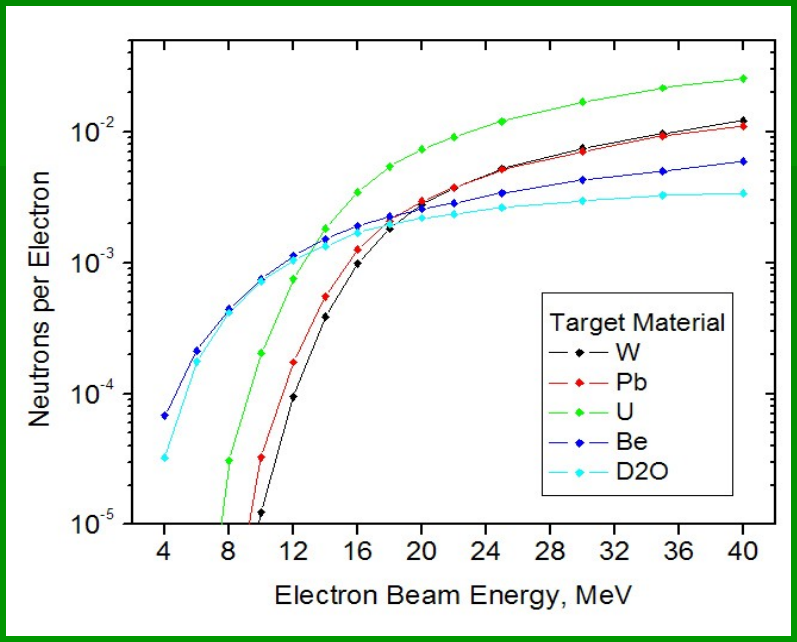
Linac in place prior to installation of cave roof



Electron Linac Produces Neutrons

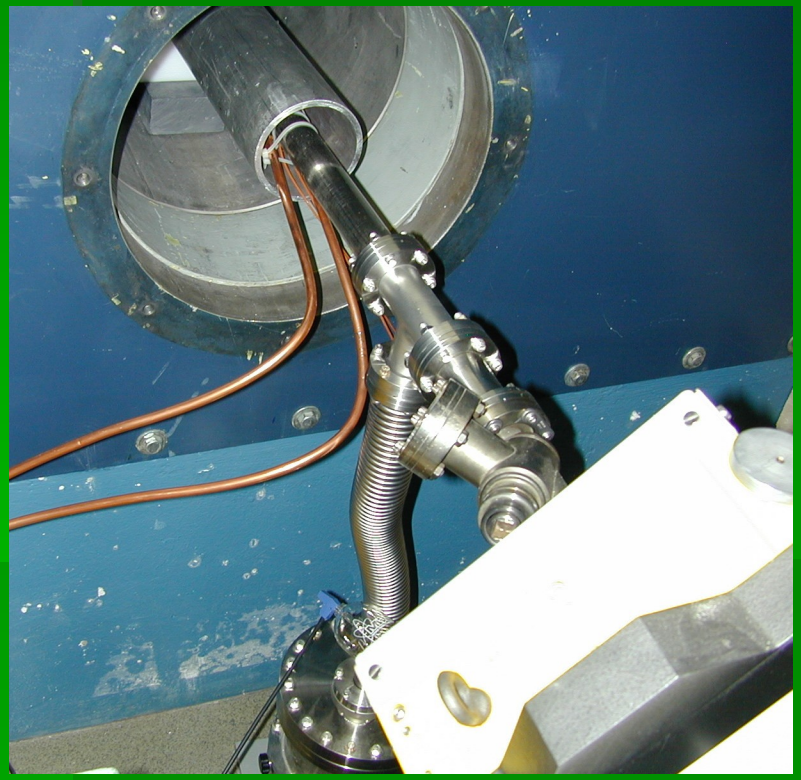
Electron Linac induces bremsstrahlung photoneutrons in target producing approximately 10^{12} neutron/sec with an average energy of 2 MeV





Target is currently a water cooled W-Cu (75%-25%) block that is brazed to stainless steel vacuum flange

Linac Installed in Cave



Operational Problems

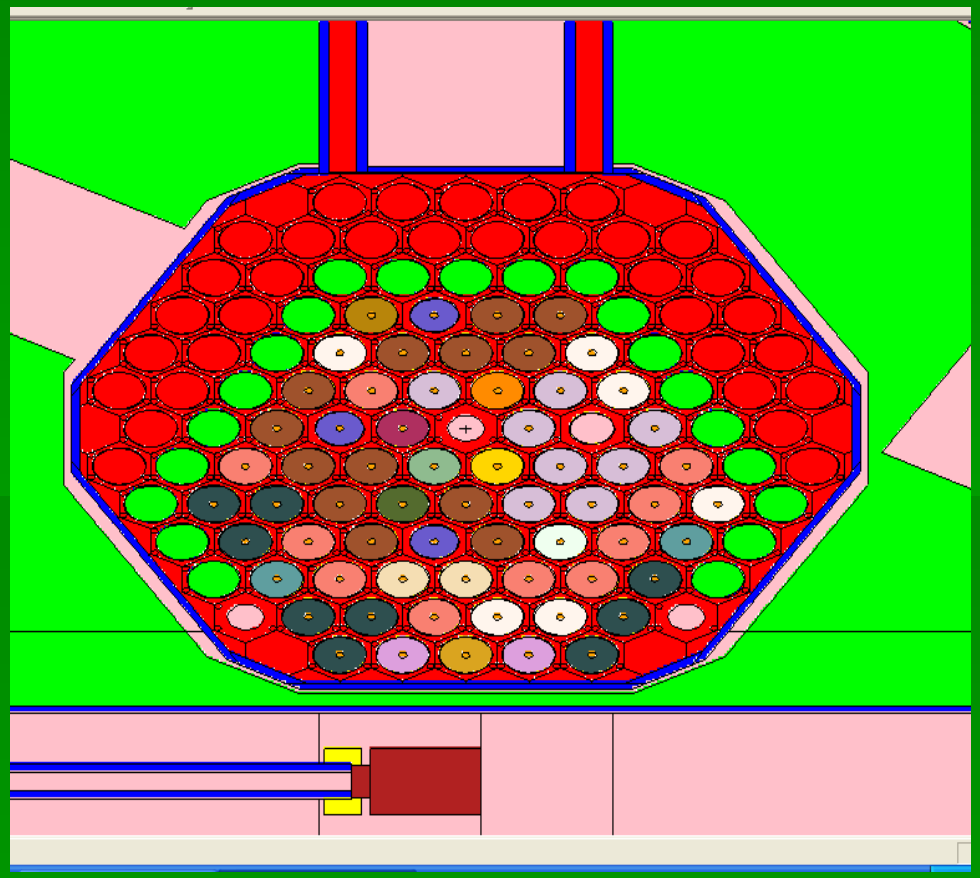
- Linac was not “plug and play” and required a few adjustments on-site
  - Rollers to move linac were too high
  - Target cooling lines caused failure during brazing and two new targets were made
- Initial linac shielding was not sufficient for full power
- Gamma “Flash” was significant and interfered with neutron counting due to saturated preamplifiers and noise
- Weekend water leak in RF Driver cabinet caused project to stop early and postponed additional tests in August

Subcritical NETL Core

- TRIGA Core was configured for maximum coupling to the neutron source while still in a subcritical configuration

- Essentially, this offset the entire assembly in the existing grid plate against one side

- Subcriticality was verified prior to experiments but 1/M confirmed actual critical loading after experiments



Lessons Learned (so far)

- W-Cu metal is really hard to braze
- Temperature of target at full power was less than 39C and easily controlled
- Gamma flash background requires new techniques for monitoring subcritical systems (proton system problem, too)
- Better system of beam monitoring is needed

Dual-use Beam Port #5

- NETL committed to support RACE-ECATS while meeting commitments for UT students
- BP5 is normally used for neutron radiography
- Linac system had to be designed for “easy” removal for normal reactor operations.

Linac in Stored Position

Next Steps..

- Additional testing is planned for early October on sub-critical core for calculated power of approximately 1 kW equivalent reactor power
- Full set of subcritical measurements with additional neutron detection systems is planned for 3 months in Spring 2006
- Linac will be transferred to TAMU for similar tests on new core following HEU conversion
- Ongoing design and analysis with EUROTRANS collaborators for possible high power RACE system in the future (30 kW target)

Acknowledgements

- Idaho Accelerator Center
  - Director-Frank Harmon
  - Accelerator Eng.- Kevin Folkman
  - Accelerator Eng.- Chad O'Neil
- NETL
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  - Electronics Technician – Larry Welch
  - Grad Student – Taylor Green
  - All the other NETL students!

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