

PNNL Membership in the RD51 Collaboration

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PNNL-SA-93346



Proudly Operated by Battelle Since 1965

Outline

Introduction

PNNL RD51 members

Proposed research

Current status of PNNL RD51 triple-GEM detector kit

Introduction

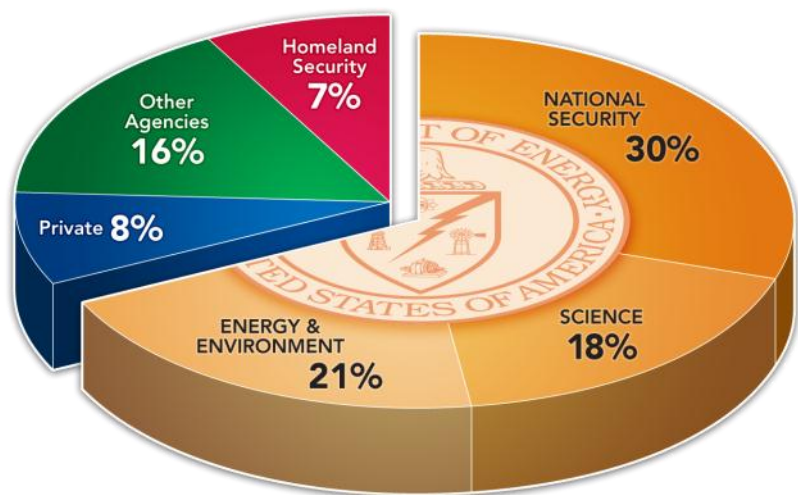
- PNNL is one of ten U.S. Department of Energy (DOE) national laboratories managed by DOE's office of science



Making an Impact within the Scientific Community

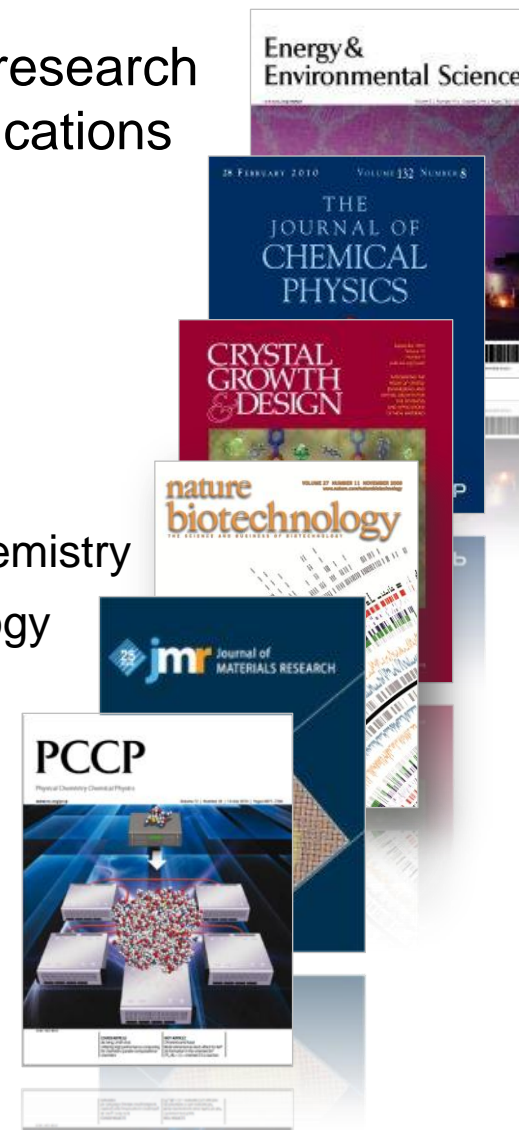
FY12 Facts

- ▶ *\$1B in R&D expenditures*
- ▶ *More than 4,700 staff*
- ▶ *2000+ users & visiting scientists*
- ▶ *1,041 peer-reviewed publications of which*
- ▶ *44 patents & 176 inventions*



▶ Among top 1% of research institutions in publications and citations in:

- Chemistry
- Geosciences
- Physics
- Engineering
- Biology and biochemistry
- Environment/ecology
- Materials science
- Clinical medicine
- Microbiology



▶ High Energy Physics Projects

- Heavy flavor physics (Belle, Belle II)
- Neutrino physics (Majorana, Project 8) (Nuclear Physics)
- Dark matter science (CoGeNT, COUPP, SuperCDMS)
- Collaboration with FNAL (Mu2e, Project X, PXIE)
- Fission TPC (DOE-NE)
- HEP computing (Belle, Belle II, Fission TPC, ILC)

▶ Related R&D

- Extending underground science capability
 - Under ground laboratory, low background materials, assay, low noise electronics, radiochemistry, gas handling
- Improved photocathode R&D for electron LINAC
- Ion processing of Cu, Al to mitigate electron cloud
- Nuclear LQCD calculations
- Generic detector R&D

A 5-year, \$15M+ investment by PNNL that aspires to...

- **Develop the capability to exploit new radioisotope signatures for nuclear security**
- **Produce science outcomes through an ongoing fundamental physics program performing ultra-rare event measurements**
- **Become recognized as a leader in international measurement comparisons of trace radioisotope samples**
- **Establish PNNL's shallow underground laboratory as a national asset supporting fundamental science, environmental science, and national security**

Unifying Goal

To discover & exploit signatures from rare physical events and trace radioisotopes not currently accessible

Key Questions

How do we detect nuclear proliferation and verify future treaties?

How do we reveal environmental pathways using ultra-trace analysis of nature's radioisotopes?

What is the composition of the universe and the origin of mass?



Brian Miller, Ph.D.

- RD51 representative, neutron, alpha particle, low-energy electron detection

David Asner, Ph.D.

- Laboratory Research Manager for High Energy Physics

Estanislao (Tani) Aguayo Navarrette, Ph.D.

- Hardware, low-background applications

Brian Clowers, Ph.D.

- High-pressure ion detection applications

Malachi Schram, Ph.D.

- Radiation modeling

Michael Dion, Ph.D.

- Hardware, negative ion drift, Garfield/FEM modeling

Lynn Wood, Ph.D.

- Hardware, electronics, applications

Proposed Research

- ▶ Bring GEM detector capability to PNNL
- ▶ Thermal neutron detection
 - Neutron imaging / He-3 replacement technology
 - Materials of interest:
 - Gadolinium-157
 - Lithium-6
 - Boron-10
- ▶ Low-background counting:
 - Alpha particle detection
 - Uranium/Thorium assay

Isotope	Reaction	Neutron absorption cross section (barns) (at 2,200 m/s)	Charged particles and energies (keV)	Gamma-ray production?
^3He	$^3\text{He}(n,p)^3\text{H}$	5333	p: 573, ^3H : 191	No
^6Li	$^6\text{Li}(n,\alpha)^3\text{H}$	940	^3H : 2727, α : 2055	No
^{10}B	$^{10}\text{B}(n,\alpha)^7\text{Li}$	3835	α : 1472, ^7Li : 480	Yes
$^{\text{nat}}\text{Gd}$	$^{\text{nat}}\text{Gd}(n,\gamma)$	49700	Conversion electron 29–191	Yes
^{157}Gd	$^{157}\text{Gd}(n,\gamma)^{158}\text{Gd}$	259000	Conversion electron 29–182	Yes
^{235}U	$^{235}\text{U}(n,f)$	681	Various fission products	Yes

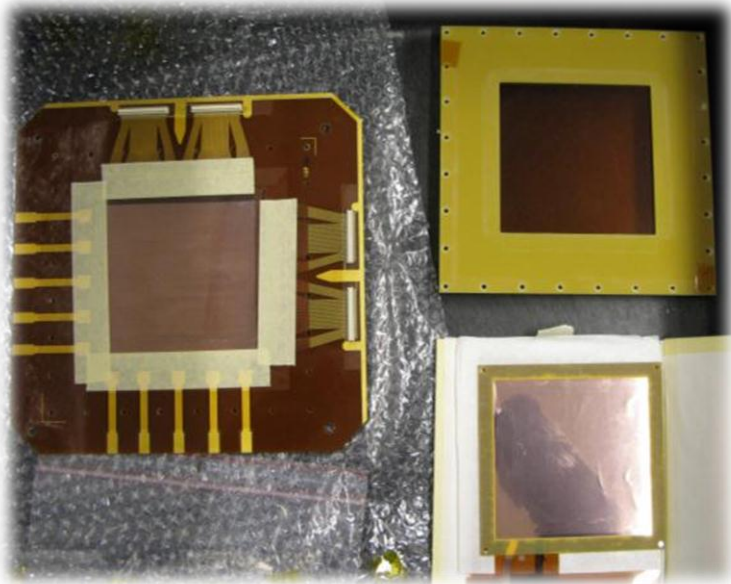
Current status of PNNL triple-GEM detector

Triple-GEM kit has arrived

Preparing to test and assemble in class 1000 clean room

Designing gas system

Awaiting SRS electronics



February/March

- Assemble triple-GEM detector
- Uniformity tests with Fe-55
- Alpha/Beta particle detection tests

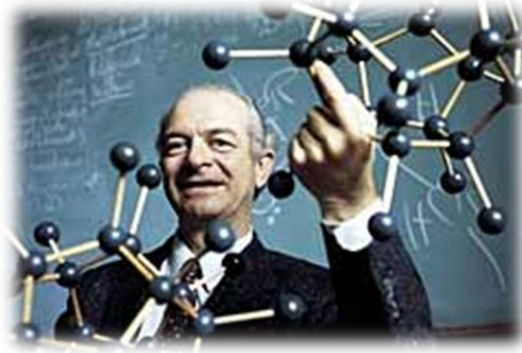
Pending Electronics: Software acquisition development

- LabVIEW (Eraldo Oliveri and Riccardo De Asmundis)
- Script-based software (Martin Purschke BNL)



Acknowledgements

Linus Pauling Distinguished Postdoctoral Fellowship



Ultra-Sensitive Nuclear Measurements Initiative

RD51 MPGD Collaboration

