The Notre Dame Nuclear Science Laboratory

Michael Wiescher

NSL facilities
NSL people
NSL research
Non-NSL activities
New equipment developments in 2011-2013

Sta. ANA (MRI & ND)

St. George (JINA & ND)

IceBall (Upitt)

Beam-lines (MRI & ND)

SAND (IU, ND)

HIPPO (JINA)

GEORGINA (MRI)

UNIVERSITY OF NOTRE DAME
The AMS System

MRI proposal for up-grading the ion source arrangement for improved AMS resolution was successful!
FN Tandem Operation

Projected Operational hours 2013-2014
Total Runtime is 4000h

On average: 50% user operation;
30% local groups, 20% maintenance
**5U Pelletron (St. ANA) Status**

- **Achievements:**
  - Construction completed in March 2012
  - Testing completed in June 2012
  - First production run (ANL) July 2012
  - Main beam line completed in Nov. 2013
  - Target room set-up on-going

- **Scheduled:**
  - St. George testing with beams
  - $^{23}\text{Na}(p,\gamma)^{24}\text{Mg}$ with LUNA collaboration
  - $^{13}\text{C}(\alpha,\gamma)^{17}\text{O}$ with UMich detectors
  - $^{12}\text{C}^{+}{^{12}\text{C}}$ particle channels with SAND

Beams tested:
- $^1\text{H}$, $^4\text{He}$, $^{14}\text{N}$, $^{16}\text{O}$, $^{40}\text{Ar}$ in different charge states

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![Pie chart](chart.png)

- **APR. ’13 - SEP. ’13 5U OPERATION TOTAL OF 164 DAYS**
  - Machine down, 5
  - NEC work / Maintenance, 71
  - Conditioning, 10
  - Trouble shooting, 9
  - Running, 69
The NSL research faculty

25% female

Helmholtz
EMMI support

NSF support

JINA support

Micha Kilburn
NSL Outreach

Ed Stech
NSL Operation

Daniel Robertson
Development & Operation

Project based DOE support

Mary Beard
Theory Support

University support

George Berg
SECAR

Jay Laverne
Rad. Chemistry

Joachim Görres
Research Support

Wanpeng Tan
User Support
NSL postdocs

James DeBoer 5U Experiments & R-matrix NSL/NSF
Hyu-Soon Jung St. George recoil separator NSL/NSF
Khachatur Manukyan Material & target development JINA/ND
Scott Marley Trapping measurements JINA/NSF
Matt Mumpower r-process simulations JINA/ND
Patrick O’Malley TwinSol development ND
Kiana Setoodehnia Target system & tests DIANA/NSF

28% female
Postdoc placement 2005-2012

- Andreas Best 2011-1013: Researcher, U. of Naples, Italy
- Ian Bentley 2010-2012: Faculty, St. Mary’s College IN
- Dan Robertson 2010-2012: Research faculty, Notre Dame, IN
- Basanta Nayak 2008-2009: Senior Researcher, Bhabha Atomic Research Center, India
- Masahiro Notani 2007-2009: Researcher, Fermilab, Batavia, IL
- Daniel Schürmann 2007-2009: Researcher, CIRCE, Caserta, Italy
- Francesco Raiola 2007-2008: Researcher, ATOMKI, Debrecen, Hungary
- Manoel Couder 2005-2008: Faculty, U. of Notre Dame, IN
- Heide Costantini 2005-2006: Faculty, U. of Marseilles, France

Postdoc bridge positions for successful graduate students for helping in the job placement!
NSF grant, TA support (University), Other grants (DOE NSF) & fellowships (NSF&NNSA)
<table>
<thead>
<tr>
<th>Name</th>
<th>Year</th>
<th>Institute/Company</th>
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<tbody>
<tr>
<td>Karl Smith</td>
<td>2014</td>
<td>University of Tennessee</td>
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<tr>
<td>Brian Bucher</td>
<td>2014</td>
<td>Lawrence Livermore Laboratory</td>
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<tr>
<td>Daniel Ayangekaa</td>
<td>2013</td>
<td>Argonne National Laboratory</td>
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<tr>
<td>Matt Bowers</td>
<td>2013</td>
<td>Bechtel Marine Propulsion Corp</td>
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<td>Ethan Uberseder</td>
<td>2013</td>
<td>Texas A&amp;M University</td>
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<tr>
<td>Andreas Best</td>
<td>2012</td>
<td>University of Naples, Italy</td>
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<td>Sergio Almaraz</td>
<td>2012</td>
<td>Argonne National Laboratory</td>
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<tr>
<td>Antonios Kantos</td>
<td>2012</td>
<td>Michigan State University</td>
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<tr>
<td>James DeBoer</td>
<td>2011</td>
<td>University of Notre Dame (U. of Naples, Italy)</td>
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<tr>
<td>Georgios Magkotsios</td>
<td>2011</td>
<td>University of Southern California</td>
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<tr>
<td>Mary Beard</td>
<td>2010</td>
<td>EMMI-GSI, Germany</td>
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<td>Paul J. LeBlanc</td>
<td>2010</td>
<td>CANBERRA Industries, Inc.,</td>
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<td>Shawn O'Brien</td>
<td>2010</td>
<td>US Government (CIA)</td>
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<tr>
<td>Matt Quinn</td>
<td>2010</td>
<td>FermiLab, Radiation Protection,</td>
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<tr>
<td>Daniel Robertson</td>
<td>2010</td>
<td>NSL, University of Notre Dame,</td>
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<tr>
<td>Christopher Schmitt</td>
<td>2010</td>
<td>Community College, Knoxville, TN</td>
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<td>Annalia Palumbo</td>
<td>2009</td>
<td>Brookhaven National Laboratory</td>
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<tr>
<td>Tao Li</td>
<td>2008</td>
<td>Knight Capital, New York</td>
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<tr>
<td>Xiaofeng Wang</td>
<td>2008</td>
<td>Florida State University</td>
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Nuclear Science Research

Nuclear Astrophysics
- Stellar Nucleosynthesis
- Nucleosynthesis in explosive Binary Systems
- Shock front induced Nucleosynthesis
- Nuclear Matter, Equation of State

Nuclear Structure & Reaction Physics
- Nuclear Incompressibility
- Novel modes of Quantal Rotation
- Modes of Vibrational Excitation
- Masses and Structure far off Stability
- Radioactive Beam Physics

Techn. Developments & Applications
- Recoil Separator Techniques
- AMS Techniques
- XRF/PIXE Applications
- Radiochemistry
- Isotope Research
Recent Goals & Highlights

**Stellar Nucleosynthesis**
Mapping pp and CNO neutrino sources (3 PhD projects, 8 publications)
Stellar neutron sources (2 PhD projects, 3 publications)
Progress in $^{12}\text{C}+_^{12}\text{C}$ fusion (2 PhD projects, 2 publications)

**Explosive Nucleosynthesis**
$^{146}\text{Sm}$ Half-Life & Implications for $^{146}\text{Sm}$-$^{142}\text{Nd}$ Chronology (1 PhD project, 1 publication)
Sensitivity of r-process nuclei experiments (undergraduates with postdoc supervision, 7 publications)

**Nuclear Structure**
Nuclear cluster configuration of the Hoyle State (1 PhD project, 1 publication)
Confirmation of tidal wave excitations in nuclei (1 PhD project, 1 publication)

**Instrumentation**
Installation of 5U accelerator and St. George separator,
MRI for Georgina and AMS
TwinSOL as Helicital Spectrometer
Broader Impacts

- New class development for non physics majors
  (Art & Archaeology, Climate Physics, Environment & Energy, Medical Physics, Nuclear Warfare)

- Research projects & training for undergrad students
  (REU program; International exchange programs (Armenia, Brazil, China, Europe, India, Mexico);
  Liberal Arts projects (Anthropology, Architecture, Library Collection)

- User Program with broad national & international accessibility
  (ANL, USA; Birmingham, UK; CMU, USA; Fermilab, USA; Frankfurt, Germany; ININ, Mexico; IU Bloomington, USA; IU South Bend, USA; Jerusalem, Israel; Kocaeli U, Turkey; Livermore, USA: U. Michigan, USA; Mumbai, India; Naples, Italy; NSCL/MSU, USA; ORNL, USA; Ohio U, USA; Princeton, USA; SANDIA, USA; Sao Paulo, Brazil; Surrey, UK; U. Tennessee, USA; Tennessee Tech, USA; UNAM, Mexico; UNC, USA; Vienna, Austria; Washington U, USA; WMU, USA)

- Interdisciplinarity of the scientific and academic program
  (Astrophysics; Archaeometry; Dark Matter; Homeland Security; Isotope research)
NSL involvement in other nuclear physics efforts

Science projects and activities
- Aprahamian (ANL, NSCL/MSU)
- Bardayan (ANL, NSCL/MSU)
- Brodeur (ANL, NSCL/MSU, TRIUMF)
- Collon (ANL, Idaho, VERA/Vienna)
- Couder (NIF, NSCL/MSU, SURF)
- Garg (ANL, RCNP/Osaka, Saha/Kolkata, Tata/ Mumbai)
- Wiescher (GSI, i-Themba, RCNP/Osaka, SURF)

Development projects and activities
- FRIB separator (SECAR) design work
- CASPAR accelerator design work
- RIKEN separator design work