DOE Nuclear Physics Perspectives: Update on Recent Events

NSAC Meeting
September 28, 2022

Dr. Timothy J. Hallman
Associate Director of the Office of Science for Nuclear Physics
Funding
The Trend of Appropriations Supporting the NP Work Plan

Recent Ops increases largely due to bringing FRIB online and making reliability upgrades at CEBAF
CHIPS and Science Act Authorization Targets Useful Guidance For the Next LRP

FY 2023 House Mark $780M
FY 2023 Senate Mark $805.2M
# Inflation Reduction Act Funding for NP

<table>
<thead>
<tr>
<th>Project</th>
<th>Lab</th>
<th>B&amp;R</th>
<th>BRN</th>
<th>Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIC</td>
<td>BNL</td>
<td>KB9503000</td>
<td>LIC</td>
<td>$96,180,000</td>
</tr>
<tr>
<td>EIC</td>
<td>BNL</td>
<td>KB0203011</td>
<td>OPE</td>
<td>$9,000,000</td>
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<tr>
<td>EIC</td>
<td>TJNAF</td>
<td>KB9503000</td>
<td>LIC</td>
<td>$32,060,000</td>
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<tr>
<td>EIC</td>
<td>TJNAF</td>
<td>KB0203011</td>
<td>OPE</td>
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<tr>
<td>GRETA</td>
<td>LBNL</td>
<td>KB0406011</td>
<td>EQU</td>
<td>$7,700,000</td>
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<tr>
<td>MOLLER</td>
<td>TJNAF</td>
<td>KB0406013</td>
<td>EQU</td>
<td>$31,100,000</td>
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<td>MOLLER</td>
<td>TJNAF</td>
<td>KB0406013</td>
<td>OPE</td>
<td>$120,000</td>
</tr>
</tbody>
</table>

To go out in October, 2022

NLDBD: $8M+

HRS at FRIB: $29.67M
<table>
<thead>
<tr>
<th>Project</th>
<th>Location</th>
<th>Status</th>
<th>Cost</th>
<th>CPI</th>
<th>SPI</th>
<th>CD-4</th>
<th>Operation cost plan</th>
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<tbody>
<tr>
<td><strong>Construction Projects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Facility for Rare Isotope Beams (FRIB)</td>
<td>MSU</td>
<td>CD-4</td>
<td>$730M</td>
<td>1.00</td>
<td>1.00</td>
<td>6/2022</td>
<td>Included in NP budget formulation</td>
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<tr>
<td>Electron-Ion Collider (EIC)</td>
<td>BNL</td>
<td>CD-1</td>
<td>$1.7B to $2.8B</td>
<td></td>
<td></td>
<td>Q4 FY33</td>
<td>RHIC operations funds redirected to EIC project recovered for EIC operations</td>
</tr>
<tr>
<td><strong>Major Items of Equipment</strong></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>Gamma Ray Energy Tracking Array (GRETA)</td>
<td>LBNL</td>
<td>CD-2/3</td>
<td>$58.3M</td>
<td>0.98</td>
<td>0.94</td>
<td>4/2028</td>
<td>Mostly covered by host laboratory operations experimental support</td>
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<tr>
<td>Super Pioneering High Energy Nuclear Interaction Experiment (sPHENIX)*</td>
<td>BNL</td>
<td>PD-3</td>
<td>$27.0M</td>
<td>1.02</td>
<td>0.85</td>
<td>12/2022</td>
<td>Covered by RHIC operations experimental support</td>
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<tr>
<td>Measurement of Lepton-Lepton Electroweak Reactions (MOLLER)</td>
<td>TJNAF</td>
<td>CD-1</td>
<td>$45.8M to $56.6M</td>
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<td></td>
<td>Q4 FY27</td>
<td>Covered by TJNAF operations experimental support</td>
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<tr>
<td>High Rigidity Spectrometer (HRS)</td>
<td>MSU</td>
<td>CD-1</td>
<td>$85.0M to $111.4M</td>
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<td>Q2 FY29</td>
<td>Covered by FRIB operations experimental support</td>
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<tr>
<td>Ton Scale Neutrinoless Double Beta Decay (TS-NLDBD)</td>
<td>TBD</td>
<td>CD-0</td>
<td>$215M to $250M</td>
<td></td>
<td></td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Blue indicates “Completed”, Chartreuse “Fully Funded”, and orange, “Substantially Funded”
The EIC Project On the Move

Progress Continues on the Electron-Ion Collider

- Located at BNL and with TJNAF as a major partner. Estimated cost between $1.7 and $2.8 billion.
- Utilizes existing RHIC assets; adds electron storage ring, & electron cooling
- NAS: A US-based EIC will uniquely answer
  - How does the mass of the nucleon arise?
  - How does the spin of the nucleon arise?
  - What are the emergent properties of dense systems of gluons?
- The international community is already highly engaged with over 1350 collaborators, from 36 countries, and 267 institutions actively working on EIC development

The EIC Project continues to target sufficient progress to be prepared for a CD-2 Review in the first half of FY 2024. The timing is important to attempt to avoid a very large RIF and loss of needed skills in FY 2025.

- $~90M anticipated detector in-kind (~30%)
- $~50M anticipated accelerator in-kind (~5%)
- $100M grant from New York State
The EIC User Community On The Move

The EIC User Group

There are now >1350 EIC Highly Active Users from 267 Institutions in 36 countries

EIC Users by Country

EIC Institutions by Country

STFC (UK) and IN2P3 will pursue commitments in CY2023
The Global Campaign to Determine the Fundamental Nature of the Neutrino

The Search for Neutrino-less Double Beta Decay ($0
\nu\beta\beta$): in a selected nucleus, two neutrons decay into two protons and two electrons, with no neutrinos being emitted.

\[ \text{n} \rightarrow \text{d} \rightarrow \text{p} \]

\[ \text{n} \rightarrow \text{d} \rightarrow \text{p} \]

It required the two neutrinos from the two $W^-$ particles to annihilate, proving the neutrino is its own anti-particle.

Three Proposed Technologies

- Scintillating bolometry ($\text{CUPID}$, $^{100}\text{Mo}$ enriched $\text{Li}_2\text{Mo}_4$ crystals)
- Enriched $^{76}\text{Ge}$ crystals ($\text{LEGEND-1000}$, drifted charge, point contact detectors)
- Liquid Xenon TPC ($\text{nEXO}$, light via SiPM, drifted ionization)

Potential Partners: Italy, Canada, and Germany
Diversity, Equity, and Inclusion:

The rollout of a major new thrust, underscoring that we all have an important role to play in enhancing DEI will take place next Monday.
There has been a long tradition in Nuclear Science of effective partnership between the community and the agencies in charting compelling scientific visions for the future of nuclear science.

Key factors:

1) Informed scientific knowledge as the basis for recommendations and next steps

2) Mutual respect among scientific sub-disciplines

3) Commitment to the greater good of nuclear science as a discipline

4) Meticulously level playing field leading to respect for process and outcomes

5) Deep appreciation for the wisdom of Ben Franklin

Staying united we can accomplish great things together

Division will setback the entire field and is the last thing needed right now