NP Accelerator R&D Principal Investigators Exchange Meeting

December 2, 2020

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DOE Office of Nuclear Physics

U.S. DEPARTMENT OF ENERGY

Outline:

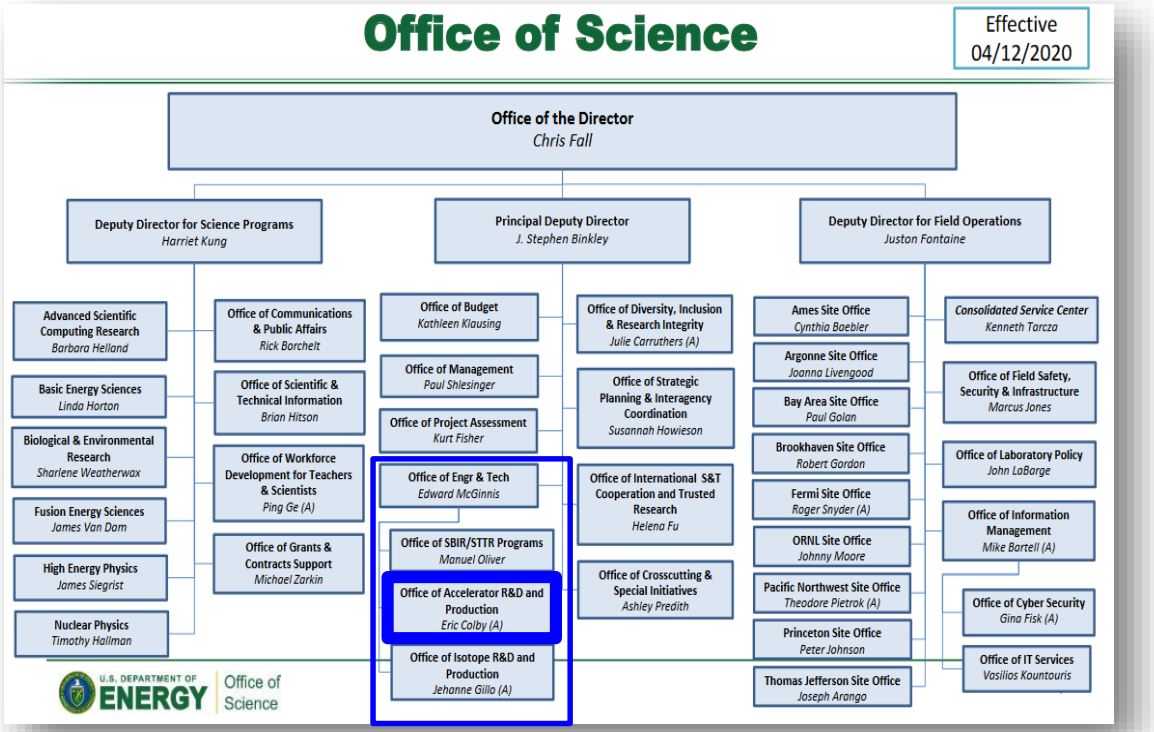
- This Meeting
- Office of Science Accelerator R&D Reorg
- FY20 FOA and awards
- FY20 Data, AI and ML Lab call and awards
- FY18-19 FOA and awards, (subject of this meeting)
- Presentation Guidelines

DOE SC code of conduct

- *The direct link is:*
- *https://science.energy.gov/sc-2/research-and-conduct-policies/diversity-equity-and-inclusion/*
- *"The DOE Office of Science (SC) is fully committed to fostering safe, diverse, equitable, and inclusive work, research, and funding environments that value mutual respect and personal integrity. Effective stewardship and promotion of diverse and inclusive workplaces that value and celebrate a diversity of people, ideas, cultures, and educational backgrounds is foundational to delivering on the SC mission. The scientific community engaged in SC-sponsored activities is expected to be respectful, ethical, and professional.*
- *The DOE SC does not tolerate discrimination or harassment of any kind, including sexual or non-sexual harassment, bullying, intimidation, violence, threats of violence, retaliation, or other disruptive behavior in the federal workplace, including DOE field site offices, or at national laboratories, scientific user facilities, academic institutions, other institutions that we fund, or other locations where activities that we support are carried out…"*

Reorganization
Office of Accelerator R&D and Production (ARDAP)

- **ARDAP (SC-24.2) was established April 12, 2020 in recognition of the central importance of accelerators and related technologies to the current and future scientific capabilities stewarded by SC programs.**



- **ARDAP activities will be tightly integrated with those in BES, FES, HEP, and NP, and will help coordinate accelerator R&D across SC, including the Strategic Accelerator Technology Initiative**
  - Accelerator Stewardship will move from HEP to ARDAP with the FY 2021 Appropriation.

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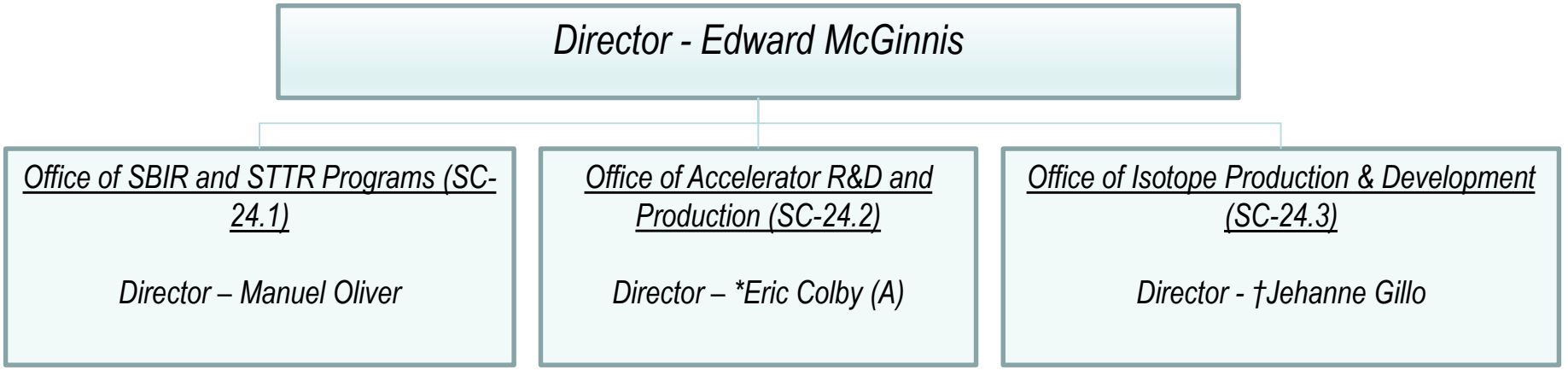
Office of Engineering & Technology (SC-24)



- ***ARDAP (SC-24.2) will***
  - *Develop and maintain a long-term accelerator science & technology (AS&T) strategy*
  - *Help to coordinate and maximize the synergy of the individual SC Programs' AS&T investments.*
  - *Invest in R&D and public-private partnerships to help rebuild the U.S. supply chain*
  - *Invest in use-inspired basic R&D to transition technology into broader applications in medicine, security, and industry.*

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ARDAP Mission

…is to coordinate and make accelerator R&D and production investments that are aimed at addressing Accelerator Science & technology (AS&T) gaps to help ensure that future U.S. accelerator-based physical science R&D priorities will be met.

- **ARDAP will fulfill its mission by:**
  - Maintaining a strategic picture of AS&T needs and worldwide competition;
  - Facilitating coordination of Programmatic AS&T R&D investments across SC;
  - Investing in selected cross-cutting AS&T areas;
  - Providing a system engineering perspective for SC facility projects;
  - Supporting workforce development, when needed;
  - Maturing key AS&T technologies and developing capable U.S. vendors;
  - Transitioning accelerator technology to broader uses.

Objective: Ensure a robust pipeline of next-generation AS&T to support physical sciences research while providing technology advances and industrial strength that position the U.S. to lead the world for decades to come.

***Slide* courtesy of Eric Colby**

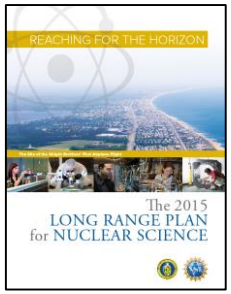
DOE Office of Nuclear Physics Accelerator R&D

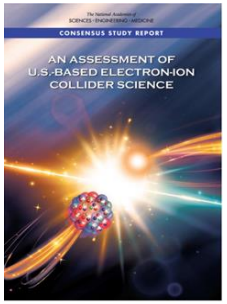
- Annual direct NP investment in EIC-related accelerator R&D through the competitive funding opportunity announcement (FOA) and National Laboratory Accelerator R&D for FY2018-19 has been on the order of $13.5 M per year. For FY 2020, Machine Learning (ML) and Artificial Intelligence (AI) was NOT included in the FOA. There was a Lab only AI/ML funding announcement from BES, HEP, and NP.

- NP is also investing in non-EIC accelerator R&D with focus on key technology areas and in core competencies at NP laboratories such as ATLAS-ANL, TJNAF and 88-inch-LBNL.

- Accelerator science proposals submitted to NP that are under consideration for FY 2020 and beyond (also part of SC Accelerator Initiative):
  - Next generation Ion source at the LBNL 88-inch- MARS-D proposal
  - SRF and in *situ* plasma processing for recovering Q_0 and gradient at TJNAF

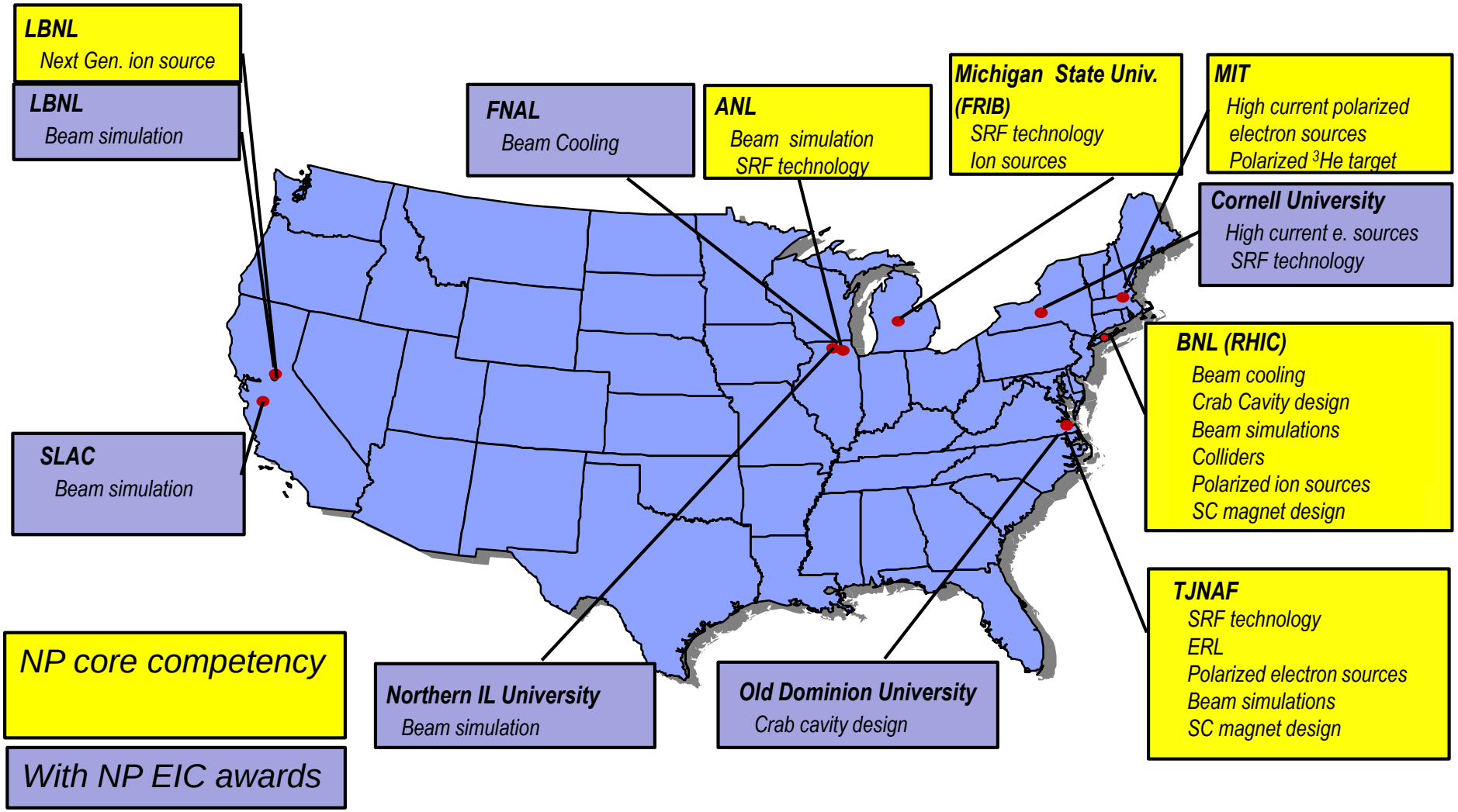
Electron Ion Collider recent events:





- ***NSAC Recommendation:*** *Recommendation for an EIC in Nuclear Science Advisory Committee (NSAC) Long Range Plan Report of 2015:*
- ***Technical Challenges:*** *2017 NP Community Panel Report on Electron Ion Collider (EIC) Accelerator R&D, February 2017 ("Jones Report"):*
- ***NAS Study:*** *2018 endorsement of EIC Science: National Academy of Sciences (NAS): An Assessment of U.S. Based Electron-Ion Collider Science,*
- ***Accelerator R&D:*** *FY18 FOA for accelerator R&D for next generation NP facilities: $8.8M FOA and ~$6-7M Labs activities for FY18 and FY19 each*
- ***Mission Need and CD-0 Approval:*** *Jan 2019 and December 2019*
- ***Site Assessment/Selection:*** *2019-2020, with ~10M Other Project Cost (OPC) for the EIC project at BNL.*
- ***EIC Project:*** EIC project team formed with both TJNAF and RHIC management and scientists. CD-1 Approval process reviews planned for 2021.

Core Competencies for EIC at NP Labs and Universities



FY20: Accelerator R&D FOA

***FUNDING OPPORTUNITY ANNOUNCEMENT** (FOA)*

Research and Development for Next Generation Nuclear Physics Accelerator Facilities
Funding Opportunity Number : DE-DE-FOA-0001230
ISSUE DATE: April 1, 2020
Application Due Date: May 1, 2020

- *Accelerator R&D for this announcement was in the following general categories:*
  - *Accelerator R&D that significantly advances the state-of-the art accelerator capabilities of relevance to next generation machines for the study of nuclear physics.*
  - *Accelerator R&D that significantly advances the state-of-the art accelerator capabilities of relevance to improving the performance of existing facilities studying nuclear physics.*
- *In particular, proposals in the following areas were encouraged:*
  - *Transformative accelerator R&D in SRF technology for restoring cryomodule performance at SRF-based accelerator facilities.*
  - *Transformative accelerator R&D in next generation ion and electron sources.*
- Artificial Intelligence and Machine Learning was not included in this FOA because of a standalone multi-office Laboratory call in this area.

FY20: Accelerator R&D FOA Awards

#	Proposal ID	Institution	Proposal Title	PI	Budget Req Year 1 ($)	FY2020 Funding	Total Collab funding Y1	Total 2-year funding (Tentative)
1	254578	TJNAF	Using improved growth techniques such as CBE to grow high polarization strained superlattice GaAs/GaAsP photocathodes, including those with Distributed Bragg Reflector structure	Stutzman, Marcy	$126,249	**126.2**	**126.2**	**252.5**
2	255054	Cornell	High current sources for spin polarized and un-polarized electron beams	Bazarov, Ivan	213,163	**184.0**	**367.9**	**367.9**
3	254811	TJNAF	Photocathodes with 90% polarization and QE greater than 1% for DOE NP	Poelker, Matthew	$200,000	**180.0**		
	254853	BNL		Wang, Erdong	$50,000	**50.0**	**230.0**	**460.0**
4	255032	MSU	Gas Stopper Developments for Improved Purity and Intensity of Low-Energy, Rare Isotope Ion Beams	Ringle, Ryan	208,000	**178.0**	**356.0**	**356.0**
5	*254,943*	ANL	Development of Practical Niobium-Tin Cavities for Ion Linacs	Kelly, Michael	710,454	**450.5**		
	254,946	RadiaBeam		Kutsaev, Sergey	99,987	**80.0**		
	349799	FNAL		Posen, Sam	68,186	**65.2**	**675.6**	**1191.3**
6	254442	TJNAF	High Voltage Insulators and Electrodes for 500 kV DC High Voltage Photogun with Inverted Insulator Design	Hernandez-Garcia, Ca	$315,450	**269.4**	**269.4**	**538.9**
7	255039	SUNY	Superconducting RF electron gun	Litvinenko, Vladimir	371,204	**201.3**		
	254801	FNAL		Yakovlev, Vyacheslav	149,053	**139.1**		
	254816	TJNAF		Poelker, Matthew	209,101	**200.1**		
	254881	BNL		Jing, Yichao	215,591	**180.6**	**922.4**	**1442.1**
8	254406	TJNAF	In Situ Plasma Processing of Superconducting Cavities	Powers, Tom	$754,377	**607.5**		
	254781	ORNL		Doleans, Marc	$93,538	**93.5**	**701.0**	**1402.0**
					Total Y1 Funding		**3648.6**	

Subject of next year PI meeting

SC AI Lab Call Lab-20-2261

DEPARTMENT OF ENERGY
OFFICE OF SCIENCE
BASIC ENERGY SCIENCES
HIGH ENERGY PHYSICS
NUCLEAR PHYSICS

DATA, ARTIFICIAL INTELLIGENCE, AND MACHINE LEARNING AT DOE SCIENTIFIC USER FACILITIES

DOE NATIONAL LABORATORY PROGRAM ANNOUNCEMENT NUMBER: LAB 20-2261

ANNOUNCEMENT TYPE: INITIAL

Announcement Issue Date:	**March 9, 2020**
Submission Deadline for Proposals:	**May 1, 2020, at 5 PM Eastern Time**

M. Farkhondeh, 2020 NP Accelerator R&D PI Meeting

NP Lab AI-ML proposals Lab-20-2261

- *This is a SC Laboratory call from BES, HEP and NP allowing 2 proposals per user facilities.*
- *NP received 3 proposals in accelerators and 2 in experiments and detectors.*
- *We have ~$1.0M set aside for this from the competitive pot of the Accelerator R&D funds in FY2020*

Institution Name	Proposal ID	Proposal Title (proposal hyperlinked)	PI
BNL	0000254542	AI Enhanced RHIC Controls for Improved Automation & Fast Optimization	Brown, Kevin
ANL-ATLAS	0000254486	Machine Learning Methods for Nuclear Physics Detectors	Santiago-Gonzalez, Daniel
ANL-ATLAS	0000254374	Use of Artificial Intelligence to Optimize Accelerator Operations and Improve Machine Performance	Mustapha, Brahim
TJNAF	0000254137	AI for Improved SRF Operation at CEBAF	Tennant, Christopher
TJNAF	0000253808	A.I. Assisted Experiment Control and Calibration	Lawrence, David

Accelerator
Detector/experiment

NP Recommended Selections

Funding Type	PI Name	Institution	Proposal Title	Recommended FY 2020 Funding ($)	Total Award $
New	David Lawrence	TJNAF	A.I. Assisted Experiment Control and Calibration	270,000	810,000
New	Christopher Tennant	TJNAF	AI for Improved SRF Operation at CEBAF	450,000	1,350,000
New	Brahim Mustapha	ANL	Use of Artificial Intelligence to Optimize Accelerator Operations and Improve Machine Performance	280,000	840,000

- *Each proposal was mail reviewed by 4 reviewers:*
- *Funding in Year-1 came from accelerator R&D base funds (total of $1M / year).*
- *These are 3 –year awards, FY21-22 funding are subject to availability of appropriated funds*

FY19: Accelerator R&D Funding

Subject of this exchange meeting

FY18 FOA was for 2 year funding

***FUNDING OPPORTUNITY ANNOUNCEMENT** (FOA)*
Research and Development for Next Generation Nuclear Physics Accelerator Facilities
Funding Opportunity Number : DE-DE-FOA-0001848
Announcement Type: Initial
CFDA Number: 81.049
ISSUE DATE: 12/01/2018
Application Due Date: 1/19/2018

- FY 19 appropriated fund enabled us to fund all FY18 awards for year 2.
- This was a two-year funding award. The next NP Accelerator R&D FOA was published in April 2020 for FY20-21 funding.

Communications between NP and PI for Accelerator R&D work

Two modes of communications between PIs and NP office: Quarterly reports and an annual face to face meeting with all PI in one place.

- Quarterly Reports
  - PIs are asked to submit quarterly reports to NP in a “Small Project” format. The FY2020 4th quarter request was sent on October 3rd,2020.

- PI Exchange Meeting
  - For accelerator R&D efforts NP conducts annual “PI Exchange” meetings with presentations on current status of work by all Principal Investigators who received awards under previous fiscal year funds. The 2020 PI meeting taking place today for all FY 18 and FY19 awards.

PI Exchange Meeting, December 2, 2020

- Presentations on current status of work by all Principal Investigators (PIs) who received awards under FY18 FOA DE-FOA-0001848**.** Cover the continued work under the FY 2017 Lab plans and FY18 FOA work in 2018 and 2019 (and continued in FY2020).

- This is not a review and no review panel is involved. Presentations will be made to NP Office Program Managers and Division Directors, and possibly a few PMs from HEP and BES Program Offices.

- To facilitate exchange of information between PIs and the NP Office and among PIs and institutions on all current and past EIC-related Accelerator R&D funded efforts.

- A continuation of yearly meetings on NP supported Accelerator R&D for next generation NP facilities.

PI Meeting Presentation Guidelines:

Each presentation should include the following information:

- Description of the project and the current status;
- The main goal of the project for which you received the FY 2018- 19 Accelerator R&D award.
- A table showing annual budget and the total received to date (see below);
- A table showing major deliverables and schedule; and
- There will be no written report or follow up actions required for this meeting.
- Summary of expenditures by fiscal year (FY):
- All talks will be posted on PI Exchange meeting page on NP website.

	FY10+ FY11	FY12+ FY13	FY14+ FY15	FY16 +FY17	FY18+ FY19	Totals
a) Funds allocated						
b) Actual costs to date						

FY2020 PI Meeting Agenda for Awards in FY 18-19

AGENDA : 2020 NP Accelerator R&D PI Exchange Meeting, Wednesday December 2, Via Zoom						
Time	**Dur. (min)**	**Principal Inv.**	**Institution**	**R&D Area**	**Presentation Title**	**Speaker(s)**
9:30 AM	30		DOE NP		NP supported Accelerator R&D and EIC	Farkhondeh
10:00 AM	25	Bazarov, Ivan	Cornell Univ.	Electron Sources	High current electron sources for strong hadron cooling and polarized sources for EIC	Cultrera/ Bazarov
10:25 AM	35	Luo, Yun Qiang, Ji Hao, Yue Roblin, Yves	BNL LBNL MSU TJNAF	Simulation Tools	Development and test of simulation tools for EIC beam-beam interaction	Luo/Qiang/ Hao/Roblin
11:00 AM	25	Erdelyi, Bela	NIU	Simulation Tools	Studies of Conventional and ERL-Based Re-circulator Electron Cooling for an Electron Ion Collider	Marzouk
11:25 AM	**15**	**Break**				
11:40 AM	30	Morozov, Vasiliy Huang, Haixin	TJNAF BNL	Spin Dynamics	Theoretical and experimental study of spin transparency mode in an EIC	Morozov/ Huang
12:10 PM	30	Delayen, Jean Wu, Qiong Krafft, Geoffrey	ODU/TJNAF BNL TJNAF	Crab Cavities	Crab Cavity Operation in a Hadron Ring	Wu/Krafft
12:40 PM	30	Conway, Zachary Rimmer, Bob	ANL/BNL TJNAF	Feedback system	High Bandwidth Beam Feedback Systems for a High Luminosity EIC	Rimmer
1:10 PM	**35**	**Lunch Break**				
1:45 PM	30	Nagaitsev, Sergei	FNAL	Beam Cooling	Ring-based high-energy electron cooler	Nagaitsev
2:15 PM	35	Willeke, Ferdinand Zholents, Alexander Stupakov, Gennady Zhang, Yuhong	BNL ANL SLAC TJNAF	Beam Cooling	Strong hadron cooling with micro-bunched electron beams	Wang, Erdong
2:50 PM	35	Benson, Stephen Krafft, Geoffrey Piot, Philippe Blaskiewicz, Michael	TJNAF ODU FNAL BNL	Beam Cooling	Development of innovative high-energy magnetized electron cooling for an EIC	Benson
3:25 PM	**10**	**Break**				
3:35 PM	35	Michalski, Timothy Sabbi, GianLuca Sullivan, Michael	TJNAF LBNL SLAC	IR Magnets	Validation of EIC IR Magnet Parameters and Requirements Using Existing Magnet Results	Michalski/ Sabbi/ Sullivan
4:10 PM	35	Anerella, Mike Sabbi, GianLuca Michalski, Timothy	BNL LBNL TJNAF	IR Magnets	High Gradient Actively Shielded Quadrupole	Anerella/ Sabbi/ Michalski
4:45 PM	35	Raparia, Deepak Milner, Richard	BNL MIT	Polarized He-3 target/polarimeter	Development of an absolute polarimeter and spin-rotator for a polarized He-3 ion source at RHIC and polarimetry for high energy He-3 beams	Raparia
5:20 PM	5	Closing Remarks				
5:25 PM		**Adjourn**				

Thank You

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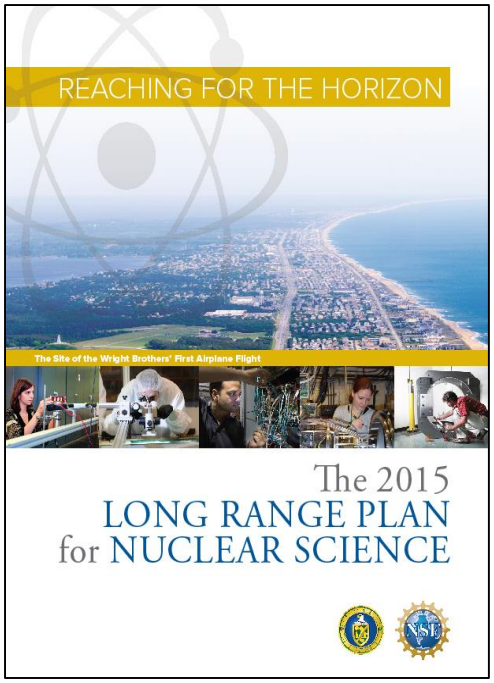
ARDAP's first task:

To develop an SC-wide AS&T Strategy

A substantive input process has started that will result in an AS&T investment strategy for the next 10-20 years:

- **Identifying high-level goals**
  - Plans for DOE's major facilities and future facility construction
  - Plans for other USG facilities
- **Analyzing domestic capability and plans**
  - Near- and long-term AS&T advances and actions needed
    - Virtual site visits to key institutions
    - Data calls, roundtables, RFIs, workshops (virtual)
    - Workforce and development pipelines
- **Analyzing international capabilities and plans**
  - Capabilities and plans for scientific facilities, AS&T R&D, and industrialization
- **Studying technology transfer examples through case studies**
  - Examples of public-private-partnerships, organizations, ecosystems, …

2015 NSAC LRP Report and EIC



RECOMMENDATION III (Page 4)

Gluons, the carriers of the strong force, bind ……

We recommend a high-energy high-luminosity polarized EIC as the highest priority for new facility construction following the completion of FRIB.

INITIATIVES : (Page 5)

B: Initiative for Detector and Accelerator Research and Development

……

We recommend vigorous detector and accelerator R&D in support of the neutrinoless double beta decay program **and the EIC.**

The **key EIC machine parameters** identified in the LRP were:

- Polarized (~70%) electrons, protons, and light nuclei,
- Ion beams from deuterons to the heaviest stable nuclei,
- Variable center of mass energies ~20-100 GeV, upgradable to ~140 GeV,
- High collision luminosity ~10^{33}-10^{34} $cm^{-2}sec^{-1}$, and
- Possibly have more than one interaction region.

Jones Panel for EIC Accelerator R&D

Priority: "High", "Medium", or "Low",

Sub-Priority: "A", "B", "C" or "None"

Proponent: "PANEL", "BNL" or "JLAB"

Design Concept: "RR", "LR" or "JLEIC"

- Sub-Priority-A: The R&D elements that the panel judged to be applicable to **all** concepts presented …….. These are considered **the most important** to be addressed to reduce overall design risk (lines 1-6).
- Sub-Priority-B: The R&D elements that the panel judged to be applicable to individual concepts. These are considered to be **second in importance** to reduce overall design risk (lines 7-22).
- Sub-Priority-C: The R&D elements self-identified by the proponents are tabulated in lines 23-75 with the priority as deemed by the panel.

➢ Will show lists of R&D items from the Jones report each lab currently believes still needed for their EIC design.

Report of the Community Review of EIC Accelerator R&D for the Office of Nuclear Physics

February 13, 2017

2017

Row No.	Proponent	Concept / Proponent Identifier	Title of R&D Element	Panel Priority	Panel Sub-Priority
1	PANEL	ALL	Crab cavity operation in a hadron ring	High	A
2	PANEL	ALL	High current single-pass ERL for hadron cooling	High	A
3	PANEL	ALL	Strong hadron cooling	High	A
4	PANEL	ALL	Benchmarking of realist EIC simulation tools against available data	High	A
5	PANEL	ALL	Validation of magnet designs associated with high-acceptance interaction points by prototyping	High	A
6	PANEL	ALL	Polarized ^{3}He Source	High	A
7	PANEL	LR	High current polarized and unpolarized electron sources	High	B
8	PANEL	LR	Completion of the ongoing CeC demonstration (proof of principle) experiment	High	B
9	PANEL	LR	High-current multi-pass ERL	High	B
10	PANEL	LR	Concept for 3D hadron CeC beyond proof of principle	High	B
11	PANEL	LR	SRF high power HOM damping	High	B
12	PANEL	RR	Complete design of an electron lattice with a good dynamic aperture and a synchronization scheme and complete a comprehensive instability threshold study for this design	High	B
13	PANEL	RR	High peak current multi-turn electron linac	High	B
14	PANEL	RR	Necessity to triple the number of and shorten the bunches in the proton / ion ring	High	B
15	PANEL	RR	Beam pipe copper coating with plasma ion bombardment	High	B
16	PANEL	RR	Simulation of the effect of electron bunch removal on the hadron beam	High	B
17	PANEL	JLEIC	Complete and test a full scale suitable superferric magnet	High	B
18	PANEL	JLEIC	Develop a high current magnetized electron injector	High	B
19	PANEL	JLEIC	High power fast kickers for high bandwidth (2ns bunch spacing) feedback	High	B
20	PANEL	JLEIC	Complete the design of the gear change synchronizations and assess its impact on beam dynamics	High	B
21	PANEL	JLEIC	Integrated magnetized beam/kicker circulation test using the existing ERL infrastructure	High	B
22	PANEL	JLEIC	Operate the JLAB Continuous Electron Beam Accelerator Facility in the JLEIC injector mode	High	B