NP Accelerator R&D Principal Investigators Exchange Meeting

November 7, 2019

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DOE Office of Nuclear Physics

Gaithersburg, MD

U.S. DEPARTMENT OF ENERGY

Outline:

- This Meeting
- Office of Science Accelerator R&D categories
- EIC Concepts
- NP Near Term Strategic Plan for Accelerator R&D and EIC
- 2017 NP Community EIC R&D Panel Report (Jones Report)
- Presentation Guidelines
- FY18-19 FOA and funding, FY20 FOA
- Summary Remarks

DOE Office of Science Accelerator R&D Categories

- **Short Term Accelerator R&D-** Accelerator R&D with the potential for improved performance and/or new capabilities to existing NP scientific user facilities that will lead to new capabilities or improved operations. This is supported by NP and other program offices.
- **Mid-Term Accelerator R&D**: Accelerator R&D with the potential for the development of the future generation of NP accelerators not under construction. This is supported by NP and other program offices.
- **Long-Term or generic Accelerator R&D**: This is directly supported by the Office of High Energy Physics (HEP) although NP work often relevant, and our advice on award selections is sought.

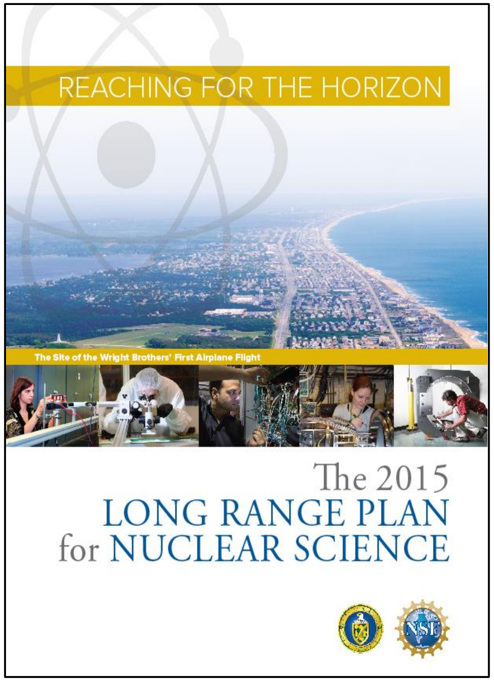
DOE Office of Nuclear Physics Accelerator R&D

- 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) with be included in the FOA. **The funding approach may be modified depending on the amount of OPC (Other Project Cost) provided for an EIC project by a 2020 Appropriation.**

- 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 2021:
  - 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 Beam cooling of hadrons and ERL R&D at BNL, Cornell and TJNAF, CBETA, etc.

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.

Planning Towards an EIC

- **National Academy of Sciences (NAS) Study:** Initiated an 18 month NAS study entitled: "US-BASED ELECTRON ION COLLIDER SCIENCE ASSESSMENT" Started in July 2016. (Report completed in 2018)
- **NP Community Panel Review:** Conducted NP community EIC R&D panel review charged with identifying high priority R&D aimed at technical risk reduction. Dr. Kevin Jones of SNS chaired this international panel. Panel Report published in February 2017: (https://science.energy.gov/np/community-resources/reports/)
- **FY17:** EIC-related Accelerator R&D plans received from Labs and universities and high priority R&D in the context of Jones report was supported.
- **Biennial FOA started in FY18:** Published bi-annual FOA for competitive accelerator R&D based on R&D priorities established in the EIC panel report.
  - **Funding level**: ~$8.8 M per year for FY18 and FY19.
  - **Funding sources:** Combination of NP competitive accelerator R&D funds augmented with RHIC and CEBAF Accelerator Operations budget funding.
- **2019:** DOE pursues **CD-0** (Mission Need) for the EIC and an **independent EIC site assessment** process.

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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

Technical Challenges for EIC from Jones Report

<u>EIC will be one of the most complex collider accelerators ever to be built.</u> It will push the envelope in many fronts including high degrees of beam polarizations, high luminosity, beam cooling, beam dynamics, crab cavities for both beams, and an interaction region with complex magnets.

Required Accelerator R&D Advances for EIC (list from the **Jones panel report)**

Items from Jones Report →

- Hadron cooling techniques (mitigation: with cooled/fresh ion bunches)
- Polarized electron sources- (no longer need high current polarized source)
- Ring magnet demonstrations (12T dipoles, LHC-HL prototype)
- Interaction region magnet design and prototyping (progress made)

← Progress since 2017

- Machine-detector interface (progress made)
- Superconducting RF technology
- Large scale cryogenics technology
- High current ERL Linacs
- Crab cavity design, fabrication and testing (2018 beam test at SPS-CERN)
- Beam and spin dynamics and benchmarking of simulation tools, (much progress made)
- Electron cloud mitigation techniques

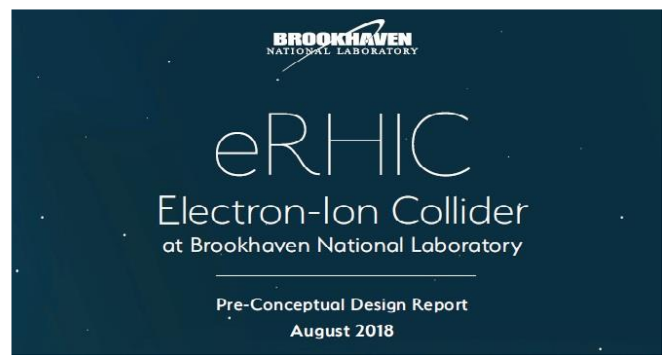
EIC Concepts

Current EIC concepts have emerged from the National Labs.

Strong collaborations at the labs and with universities to advance different concepts and common R&D relevant to all concepts:

- **BNL:** eRHIC based on a Ring-Ring concept
- **TNJAF:** JLEIC based on a high repetition rate figure-8 Ring-Ring concept

JLEIC pre-CDR, 9/2019



eRHIC pre-CDR, 8/2018

Core Competencies for EIC at NP Labs and Universities

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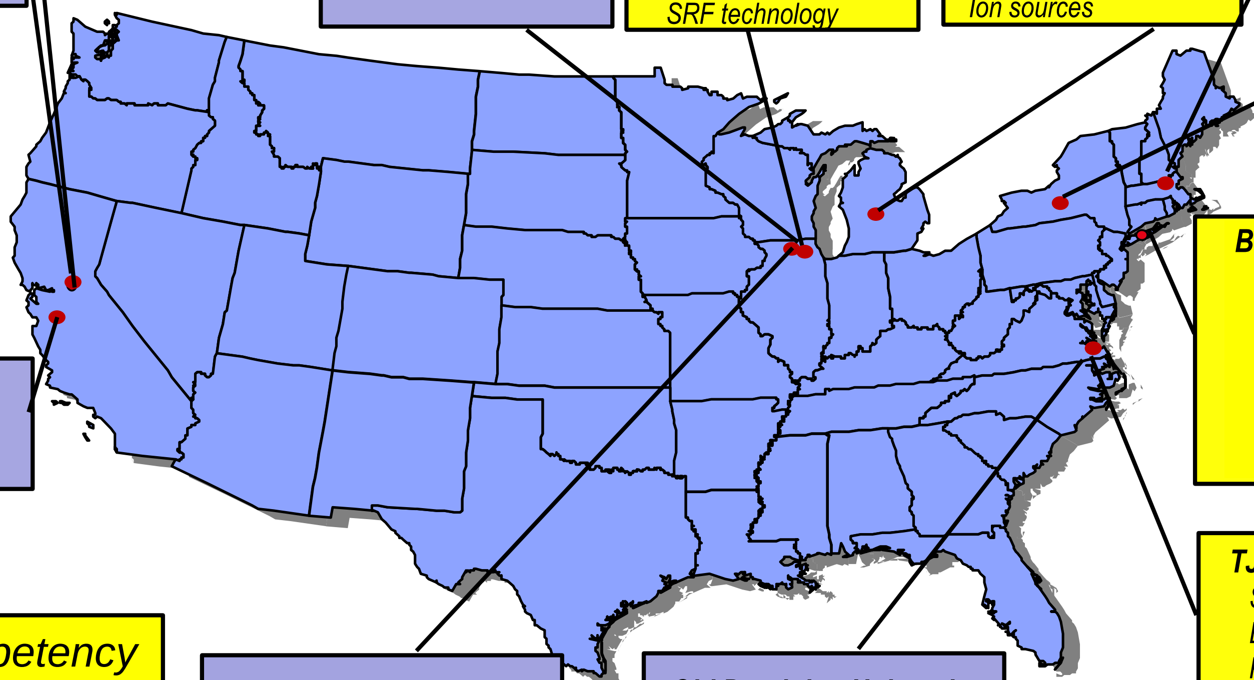

LBNL
Next Gen. ion source

LBNL
Beam simulation

FNAL
Beam Cooling

ANL
Beam simulation
SRF technology

Michigan State Univ. (FRIB)
SRF technology
Ion sources

MIT
High current polarized electron sources
Polarized ^{3}He target

Cornell University
High current e. sources
SRF technology

BNL (RHIC)
Beam cooling
Crab Cavity design
Beam simulations
Colliders
Polarized ion sources
SC magnet design

SLAC
Beam simulation

TJNAF
SRF technology
ERL
Polarized electron sources
Beam simulations
SC magnet design

Northern IL University
Beam simulation

Old Dominion University
Crab cavity design

NP core competency

With NP EIC awards

Remaining EIC accelerator challenges

- **eRHIC:** High bunch charge for electron beam- not a serious issue, best expertise exists at NP facilities on polarized electron sources. Use of alternate injection scheme similar to the "top-off" modes used in x-ray light sources.

- **JLEIC**: Center of mass energy of 140 GeV : Needs 12T dipole magnets to reach proton energy of 400 GeV. Prototype for LHC-High Luminosity (HL) reached ~11T in 2018 with Nb3Sn coils.

- **EIC (eRHIC and JLEIC):**
  - Strong hadron cooling (SHC): Both designs will benefit from SHC. However, both designs have mitigation plans to reach high luminosities without SHC.
  - IR magnets: should not be an issue by the time they are needed, but challenges exist for asymmetric IRs in detecting electrons at small forward angles.
  - Beam Dynamics:- Proton beam stability, multi-bunch stability and feedback, dynamic aperture with extreme beta in the IR.
  - Simulation tools: Benchmarking of realistic simulation tools against available data is being aggressively pursued by a multi-institution collaboration.

JLEIC update on Jones priority table

- **"No Longer Needed"** (rows with yellow highlights) **(as seen by JLEIC design team)**
  - One Sub-Priority A: High current single-pass ERL for cooling
  - 2 sub-priority B: Complete the design of the gear change synchronizations and assess its impact on beam dynamics. Full scale superferric magnet.
  - 6 sub-priority C and 6 medium priority.

Table 1: Prioritized List of Proposed R&D Activities (for J-Lab) — Response 9/20/2019

Row No.	Proponent	Concept / Proponent Identifier	Title of R&D Element	Panel Priority	Panel Sub-Priority	Still relevant	No longer needed	Still in progress
1	PANEL	ALL	Crab cavity operation in a hadron ring	High	A	x		x
2	PANEL	ALL	High current single-pass ERL for hadron cooling	High	A		x	
3	PANEL	ALL	Strong hadron cooling	High	A	x		x
4	PANEL	ALL	Benchmarking of realist EIC simulation tools against available data	High	A	x		x
5	PANEL	ALL	Validation of magnet designs associated with high- acceptance interaction points by prototyping	High	A	x		x
6	PANEL	ALL	Polarized 3He Source	High	A	x		
17	PANEL	JLEIC	Complete and test a full scale suitable superferric magnet	High	B		x	
18	PANEL	JLEIC	Develop a high current magnetized electron injector	High	B	x		
19	PANEL	JLEIC	High power fast kickers for high bandwidth (2ns bunch spacing) feedback	High	B	x		x
20	PANEL	JLEIC	Complete the design of the gear change synchronizations and assess its impact on beam dynamics	High	B		x	
21	PANEL	JLEIC	Integrated magnetized beam/kicker circulation test using the existing ERL infrastructure	High	B	x		
22	PANEL	JLEIC	Operate the JLAB Continuous Electron Beam Accelerator Facility in the JLEIC injector mode	High	B	x		x
37	JLAB	BDD1	Spin tracking in ion and electron rings	High			x	
38	JLAB	BDD2	Beam-beam simulation with gear changing	High	C		x	
39	JLAB	ECL1	Electron cooling simulations	High		x		x
40	JLAB	ECL3	ERL Cooler design for single and multi turn operations	High	C		x	
41	JLAB	ECL4	Magnetized source for the e-cooler 36mA	High	C		x	
42	JLAB	ECL5	Fast kicker prototype for multi turn cooler	High	C	x		x
43	JLAB	INJ6	Test of CEBAF electron injection mode	High	C	x		x
44	JLAB	IRS1	IR design and detector integration	High		x		x
45	JLAB	MAG1	Super-ferric 3T fast ramping short prototype	High	C		x	
46	JLAB	MAG4	IR compact large aperture, high radiation magnets	High	C	x		x
47	JLAB	SRF1	SRF cavity systems	High			x	
48	JLAB	SRF2	Crab cavity design, simulations, and prototype	High	C		x	

eRHIC update on Jones priority table

- **"No Longer Needed"** (rows with red highlights) **(as seen by eRHIC design team)**
  - one Sub-Priority A: Polarized 3-He source- complete
  - 2 sub-Priority B: High current multi-pass ERL, high peak current electron linac
  - 3 sub-priority C.

Table 1: Prioritized List of Proposed R&D Activities (for BNL) Response 9/08/2019

Row No.	Proponent	Concept / Proponent Identifier	Title of R&D Element	Panel Priority	Panel Sub-Priority	Still relevant	No longer needed	Still in progress
1	PANEL	ALL	Crab cavity operation in a hadron ring	High	A	x		x
2	PANEL	ALL	High current single-pass ERL for hadron cooling	High	A	X		
3	PANEL	ALL	Strong hadron cooling	High	A	x		
4	PANEL	ALL	Benchmarking of realist EIC simulation tools against available data	High	A	x		x
5	PANEL	ALL	Validation of magnet designs associated with high- acceptance interaction points by prototyping	High	A	x		x
6	PANEL	ALL	Polarized 3He Source	High	A		x	
7	PANEL	LR	High current polarized and unpolarized electron sources	High	B	x		X
8	PANEL	LR	Completion of the ongoing CeC demonstration (proof of principle) experiment	High	B	x		X
9	PANEL	LR	High-current multi-pass ERL	High	B		x	
10	PANEL	LR	Concept for 3D hadron CeC beyond proof of principle	High	B	x		x
11	PANEL	LR	SRF high power HOM damping	High	B	x		x
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	x		x
13	PANEL	RR	High peak current multi-turn electron linac	High	B		x	
14	PANEL	RR	Necessity to triple the number of and shorten the bunches in the proton / ion ring	High	B	x		x
15	PANEL	RR	Beam pipe copper coating with plasma ion bombardment	High	B			x
16	PANEL	RR	Simulation of the effect of electron bunch removal on the hadron beam	High	B			x
23	BNL	LR-A-1	R&D and Prototyping on the 6.2mA Polarized Electron Gun	High	C		x	
24	BNL	LR-A-2	Study of Beam-Beam Effect with Crab Cavities	High				x
25	BNL	LR-B-1	CBETA Project	High	C		x	
26	BNL	LR-B-2	Waveguide HOM Couplers for the BNL (eRHIC) ERL	High	C		x	
27	BNL	LR-C-2	Crab Cavity Prototype	High	C	x		x
28	BNL	LR-C-4	Design and prototyping of actively shielded IR quadrupole and dipole magnets	High	C			x
29	BNL	CeC	Completion of the ongoing CEC demonstration experiment	High	C	x		x
30	BNL	RR-A-1	Beam-Beam Parameter Validation	High				x

FY19: Accelerator R&D Funding

FY18 FOA was or 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.
- <u>This was a two-year funding. The next NP Accelerator R&D FOA is expected to be published for FY20-21 funding.</u>

FY20: Accelerator R&D Funding

FUNDING OPPORTUNITY ANNOUNCEMENT *(FOA)*

Research and Development for Next Generation Nuclear Physics Accelerator Facilities
Funding Opportunity Number : DE-DE-FOA-000XXXX
Announcement Type: Initial
CFDA Number: 81.049
ISSUE DATE: 12/2019 (Tentative)
Application Due Date:???

- If published post EIC site selection, need to evaluate what exactly to include in this FOA as FY2020 budget most likely will have OPC (Other project Cost) for the EIC "project". A long CR can affect our plan.
- R&D in Machine Learning and Artificial Intelligence will most likely be included in this FOA aimed at improving efficiencies of NP accelerator facilities specially addressing SRF cavity trips.
- This will likely be a two-year 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 first one for FY 2017 funds was requested for a 6 months period. The FY2019 4th quarter request was sent by Cassie on October 3rd, 2019.

- 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 2019 PI meeting will take place on November 7 for all FY 18 and FY19 awards.

PI Exchange Meeting, November 7, 2019

- 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.

- 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.

List of FY2018 FOA Awards Page 1

Proposal ID	Institution	Collab. num.	Proposal Title	PI
235278	FNAL		Ring-based high-energy electron cooler	Nagaitsev, Sergei
235263	BNL	Lead	Development and test of simulation tools for EIC beam	Luo, Yun
235254	LBNL		Collaboration	Qiang, Ji
235377	MSU		Collaboration	Hao, Yue
235315	TJNAF		Collaboration	Roblin, Yves
235309	TJNAF	Lead	Theoretical and experimental study of spin transparenc	Morozov, Vasiliy
235264	BNL		Figure-8 Ring (Collaboration)	Huang, Haixin
235325	TJNAF	Lead	Validation of EIC IR Magnet Parameters and Requirements Using Existing Magnet Results	Michalski, Timothy
235265	LBNL		Collaboration	Sabbi, GianLuca
235344	SLAC		Collaboration	Sullivan, Michael
235374	ODU	Lead	Crab Cavity Operation in a Hadron Ring	Delayen, Jean
235261	BNL		Collaboration	Wu, Qiong
235311	TJNAF		Collaboration	Krafft, Geoffrey
235335	BNL	Lead	Strong hadron cooling with micro-bunched electron bea	Willeke, Ferdi
235339	ANL		Collaboration	Zholents, Alexander
235343	SLAC		Collaboration	Stupakov, Gennady
235352	TJNAF		Collaboration	Zhang, Yuhong

Most awards went to collaborative proposals

List of FY2018 FOA Awards Page 2

Proposal ID	Institution	Collab. num.	Proposal Title	PI
235372	Cornell		High current electron sources for strong hadron cooling and polarized sources for EIC	Bazarov, Ivan
235236	BNL	Lead	High Gradient Actively Shielded Quadrupole	Wanderer, Peter
235273	LBNL		Collaboration	Sabbi, GianLuca
235324	TJNAF		Collaboration	Michalski, Timothy
235258	BNL	Lead	Development of an absolute polarimeter and spin-rotat	Raparia, Deepak
235336	MIT		Collaboration	Milner, Richard
235251	ANL	Lead	High Bandwidth Beam Feedback Systems for a High L	Conway, Zachary
235345	TJNAF		Collaboration	Rimmer, Bob
235303	TJNAF	Lead	Development of innovative high-energy magnetized electron cooling for an EIC	Benson, Stephen
235373	ODU		Collaboration	Krafft, Geoff
235277	FNAL		Collaboration	Piot, Philippe
235259	BNL		Collaboration	Blaskiewicz, Michae
235371	NIU		Studies of Conventional and ERL-Based Re-circulator Electron Cooling for an Electron Ion Collider	Erdelyi, Bela
	628	**Total**	**8802**	

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 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
  - ➢ **For each R&D task identify the priority and sub-priority designation(s) listed in the priority table of the 2017 Jones EIC R&D report.** Also list the row number in the Jones report Priority table that corresponds to each of your task (Rows 1-75).

PI Meeting Presentation Guidelines (P. 2):

- It is essential that Mrs. Brenda May has a copy of your final presentation by 8:00 am for the morning sessions and by 12:00 pm for the afternoon sessions on the day of your presentation.

- There will be no written report or follow up actions required for this meeting.

- Summary of expenditures by fiscal year (FY):

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

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FY2019 Award PI Meeting Agenda

PI's should register for the meeting at: https://www.orau.gov/2019accelrd

DRAFT AGENDA : 2019 NP Accelerator R&D PI Meeting, Thursday, November 7, 2019, Gaithersburg, MD

Time	Dur. (min)	Principal Inv.	Institution	R&D Area	Presentation Title	Speaker
8:30 AM	30		DOE NP		NP supported Accelerator R&D and EIC	Farkhondeh
9:00 AM	25	Bazarov, Ivan	Cornell Univ.	Electron Sources	High current electron sources for strong hadron cooling and polarized sources for EIC	Bazarov/ Cultrera
9:25 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	Lou/Qiang/ Hao/Robin
10:00 AM	25	Erdelyi, Bela	NIU	Simulation Tools	Studies of Conventional and ERL-Based Re-circulator Electron Cooling for an Electron Ion Collider	Erdelyi/ Marzouk
10:25 AM	**25**	**Break**				
10:50 AM	30	Morozov, Vasiliy Huang, Haixin	TJNAF BNL	Spin Dynamics	Theoretical and experimental study of spin transparency mode in an EIC	Morozov/ Huang
11:20 AM	30	Delayen, Jean Wu, Qiong Krafft, Geoffrey	ODU/TJNAF BNL TJNAF	Crab Cavities	Crab Cavity Operation in a Hadron Ring	Wu/Krafft
11:50 AM	30	Conway, Zachary Rimmer, Bob	ANL TJNAF	Feedback system	High Bandwidth Beam Feedback Systems for a High Luminosity EIC	Conway/ Rimmer
12:20 PM	**65**	**Lunch Break**				
1:25 PM	30	Nagaitsev, Sergei	FNAL	Beam Cooling	Ring-based high-energy electron cooler	
1:55 PM	35	Willeke, Ferdinand Zholents, Alexander Stupakov, Gennady Zhang, Yuhong	BNL ANL SLAC TJNAF	Beam Cooling	Strong hadron cooling with micro-bunched electron beams	Willeke/ Zhang/ Zholents/ Stupakov
2:30 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/ Piot/ Blaskiewicz
3:05 PM	**25**	**Break**				
3:30 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
4:05 PM	35	Anerella, Mike Sabbi, GianLuca Michalski, Timothy	BNL LBNL TJNAF	IR Magnets	High Gradient Actively Shielded Quadrupole	Anerella/ Sabbi/ Michalski
4:40 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	Milner/ Raparia
5:15 PM	25	Litvinenko	BNL	Beam Cooling	An update on the the Coherent Electron Cooling (CeC) PoP experiment at RHIC	Litvinenko
5:40 PM	10	Closing Remarks				
5:50 PM		**Adjourn**				

Summary Remarks

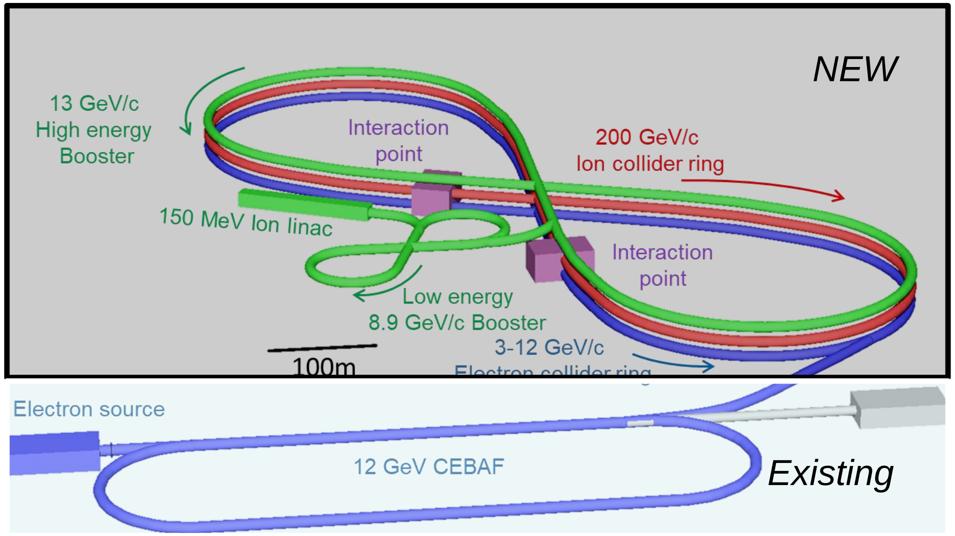
- With the 2015 NSAC LRP recommendation for an EIC, NP has developed a near-term plan for moving forward with an EIC:
  - √ A NAS study of merits of US-based EIC
  - √ An NP community panel review for setting priorities for EIC R&D
  - √ Increased accelerator R&D funding
  - √ Independent Cost Review
  - ⌛ **CD-0** (Mission Need) process for an EIC is in progress
  - An **independent EIC site assessment process** is also in progress**.**

- The realization of an EIC will require development of many cutting-edge accelerator technologies, securing U.S. leadership in accelerator R&D in the long-term.
- NP will continue to support and nurture the core competencies needed to implement an EIC and will continue EIC R&D.
- All NP funded accelerator R&D are tracked through quarterly reports by PIs and annual PI meetings. Today's meeting will cover all FY 2018-19 awards to Labs and universities.

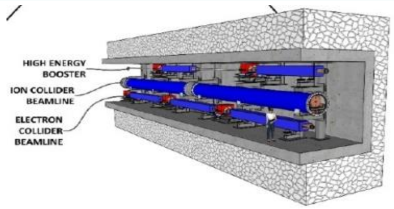
Backup

JLEIC Layout

Slide information- courtesy of A. Seryi-TJNAF

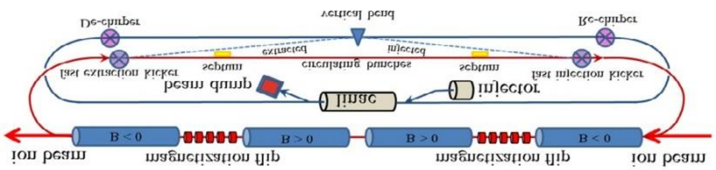


- ***Full-energy top-up injection** of 3-12 GeV polarized electrons from CEBAF (**Existing**)*
- ***Full-size high-energy booster (New)** Quick replacement of colliding ion beam*
- ***Figure-8 ring design** for electron and ion polarizations **(New)***
- ***High-rate collisions** of bunches.*
- ***Multi-stage electron cooling***
- ***Upgradable to 140 GeV CM** by replacing the 6T NbTi ion ring dipoles with 12T Nb_3Sn magnets.*



- *Design meets the high luminosity goal of* $L = 10^{33}$ $-10^{34} cm^2 s^1$

  - *Strong cooling requirement is mitigated by quick replacement of pre-cooled ion beam from booster.*



ERL based magnetized cooler

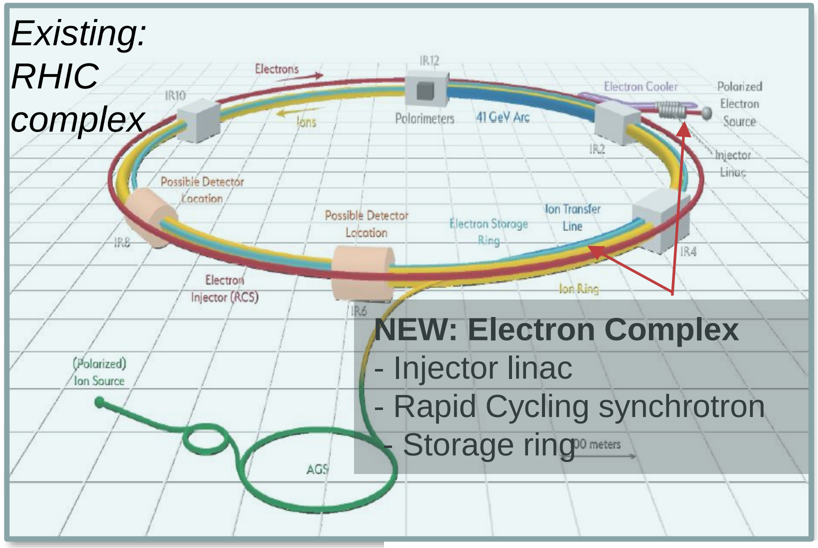
LHC-HL prototype 11 T magnet

eRHIC Layout

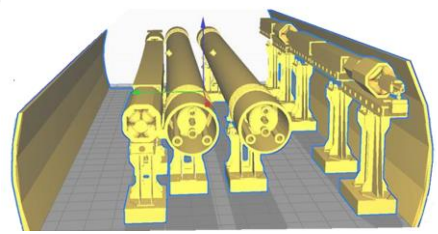
Design based on existing RHIC,

- **Hadron storage ring (existing)**
  - operate between 41 GeV and 275 GeV
  - many bunches (1160)
  - needs strong cooling **or** frequent injections

Electron storage ring (new)
  - operate between 2.5 GeV and 18 GeV
  - a rapid cycling synchrotron in the RHIC tunnel
  - many bunches
  - large beam current $I_e = 2.5$ A

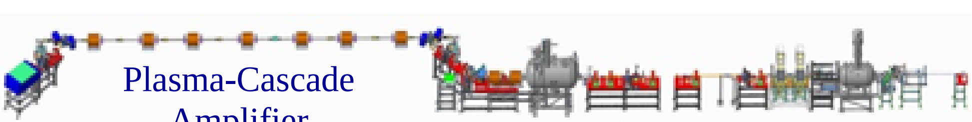


- ***Center of mass energy** range: 20-140 GeV*
- *Design meets the high luminosity goal of* ***$L = 10^{33}$ -$10^{34}cm^2s^1$***

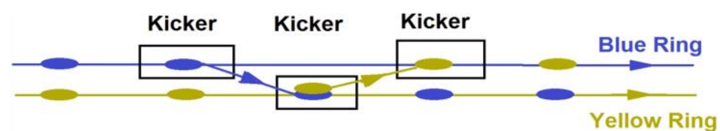


- *Strong cooling requirement is mitigated by replacing collider ion bunches from the Blue ring.*

RHIC Runs 20-22



Strong hadron cooling (CeC)



Blue ring for on-energy injection

Slide information- courtesy of TJNAF and BNL

State of the Art Accelerator Technology for EIC

- ***Beam Cooling:*** *Beam cooling has been one of the highest priority R&D for EIC. The challenge is to achieve the high collision luminosity of order ~10^{34} cm^{-2}sec^{-1}.*
  - *High current multi-pass energy Recovery Linac (ERL) – May not be needed*
  - *High current unpolarized electron injectors for ERL*
- ***Interaction Region***
  - ***Magnets:*** *Challenging magnet designs to meet required high fields and field free regions for passage of primary beams.*
  - ***Crab cavities:*** *Achieve maximized collision rates between bunches. First beam test of an ion crab cavity at the SPS-CERN was successful.*
  - ***Storage ring Magnets****: Challenging high field storage ring magnets are needed. JLEIC: Superconducting Cosθ magnets for 6T and LHC-HL for 12T*
  - ***Polarized electron Sources****: High bunch charges for the ring-ring concept*
- ***Simulation Codes:*** *Benchmarking of realist EIC simulation tools against available data needs to be aggressively pursued. Much progress made*

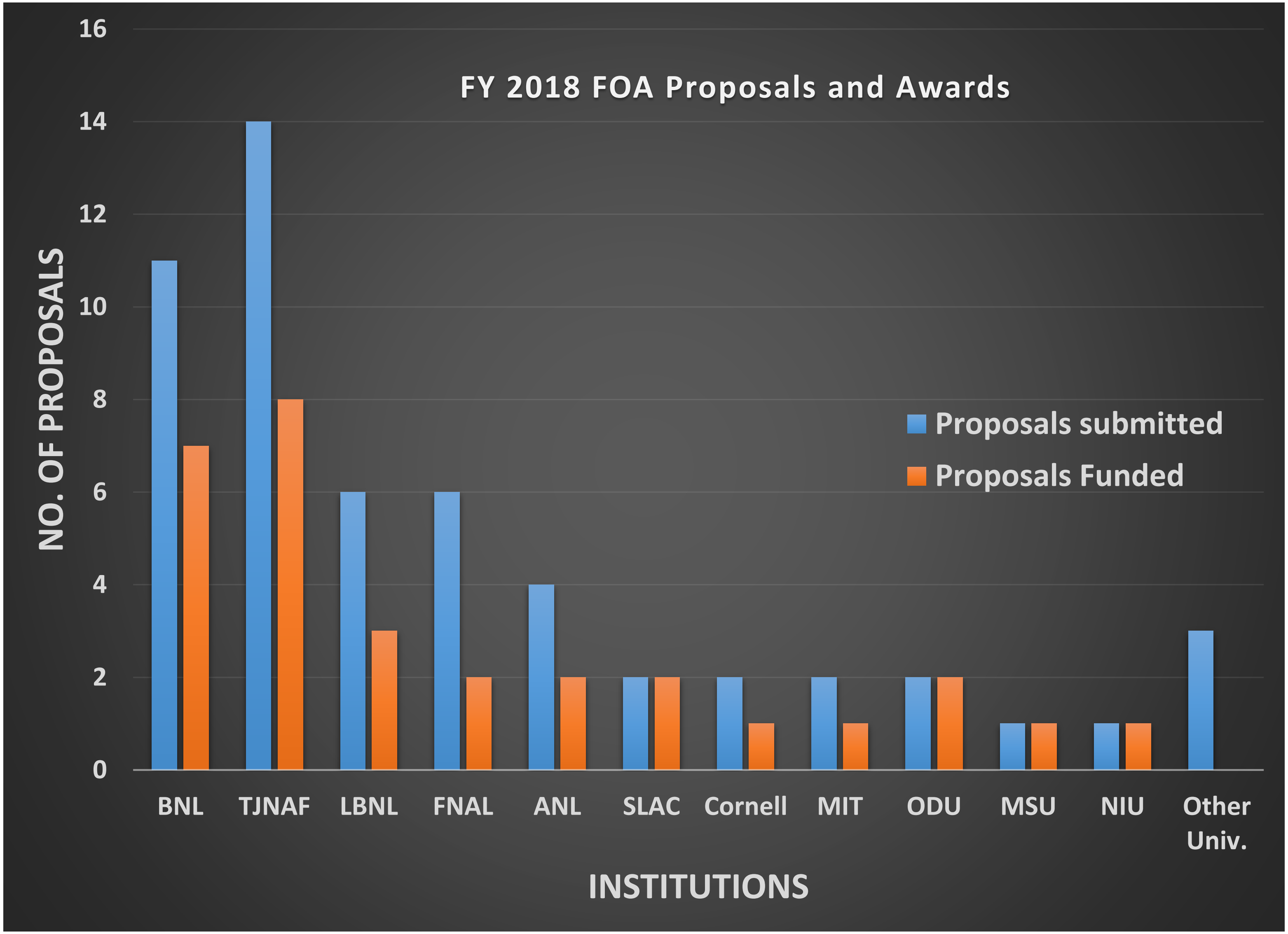
Core competencies in these areas exist at NP and SC Labs and universities. Collaborations have formed to address these technical challenges.

Proposals submitted to FY 2018 FOA

Institutions	Number of Proposals	Budget Request Y-1 ($k)	Budget Request y1+y2 ($k)
National Labs	43	17,526	34,481
Universities	12	3,966	7,931
Industry	1	107	213
Totals	**56**	**21,599**	**42,625**

Collaboration Proposals

Type of Proposals	No. of Proposals	Total Individual proposals
Collaborative	16	43
Non-collaborative	13	13
Totals	**29**	**56**



FY 2018 FOA Proposals and Awards
NO. OF PROPOSALS
0
2
4
6
8
10
12
14
16
Proposals submitted
Proposals Funded
BNL
TJNAF
LBNL
FNAL
ANL
SLAC
Cornell
MIT
ODU
MSU
NIU
Other Univ.
INSTITUTIONS

Review Criteria for FY2018 FOA

This FOA Supports:

This FOA is in support of pre-conceptual accelerator R&D aimed at technological challenges for the next generation NP facilities.

- Accelerator R&D with the potential for the development of future generation of NP accelerators not under construction or design.
- Accelerator R&D with the potential for improved performance and/or upgrades to existing NP national user facilities that will lead to new capabilities (to include Machine learning and Artificial intelligence)

Merit Review Criteria

Merit Review Criteria

1. Scientific and/or Technical Merit of the Project;
2. Appropriateness of the Proposed Method or Approach;
3. Competency of Applicant's Personnel and Adequacy of Proposed Resources; and
4. Reasonableness and Appropriateness of the Proposed Budget

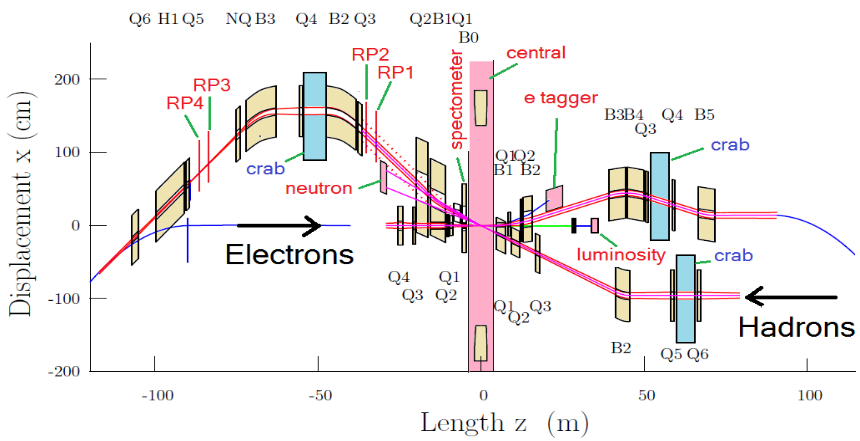
NP Program Criteria

Program Criteria:

5. Relevance to compelling scientific opportunities identified in the 2015 NSAC Long Range Plan.(LRP)
6. If appropriate, relevance of proposed electron-ion collider efforts to the R&D priorities identified in the Jones Report (with updated list).
7. The opportunity for training junior accelerator physicists in accelerator science and Technology.

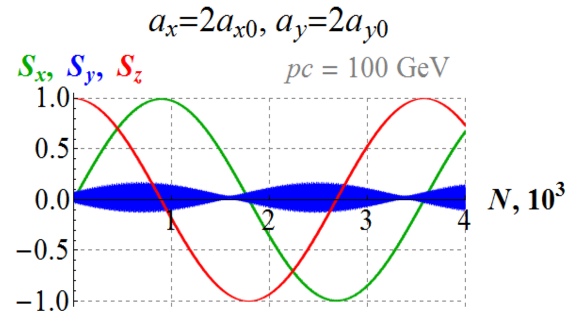
State of the Art Accelerator Technology for EIC

Schematic layout of IR



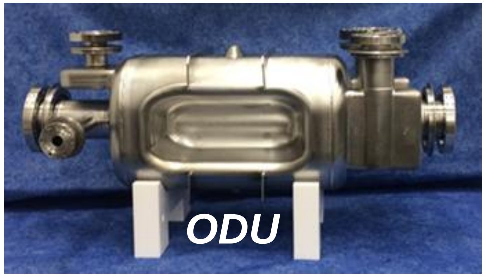
V. Ptitsyn et al.

Spin: Nonlinearity of orbital motion-



V. Morozov et al.

Crab Cavity

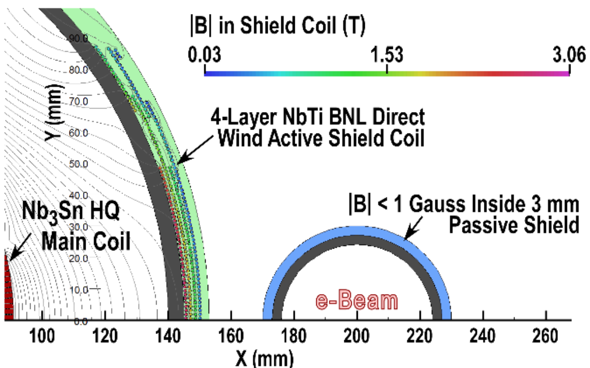


S. De Silva et. Al

952.6 MHz cooler ERL (SCRF)

B. Rimmer, et al.

IR quadrupole magnet



B. Parker, et al.