Hadron Injector Complex Staffing Requirements

Charge Q7

Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

C-AD Staffing - History and Present Actuals

Staffing Plan - Assumptions and Requirements

Staffing Requirements in Detail

Workforce Demographics

Summary

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Hadron Injector Complex Operations Review
25–26 September 2024

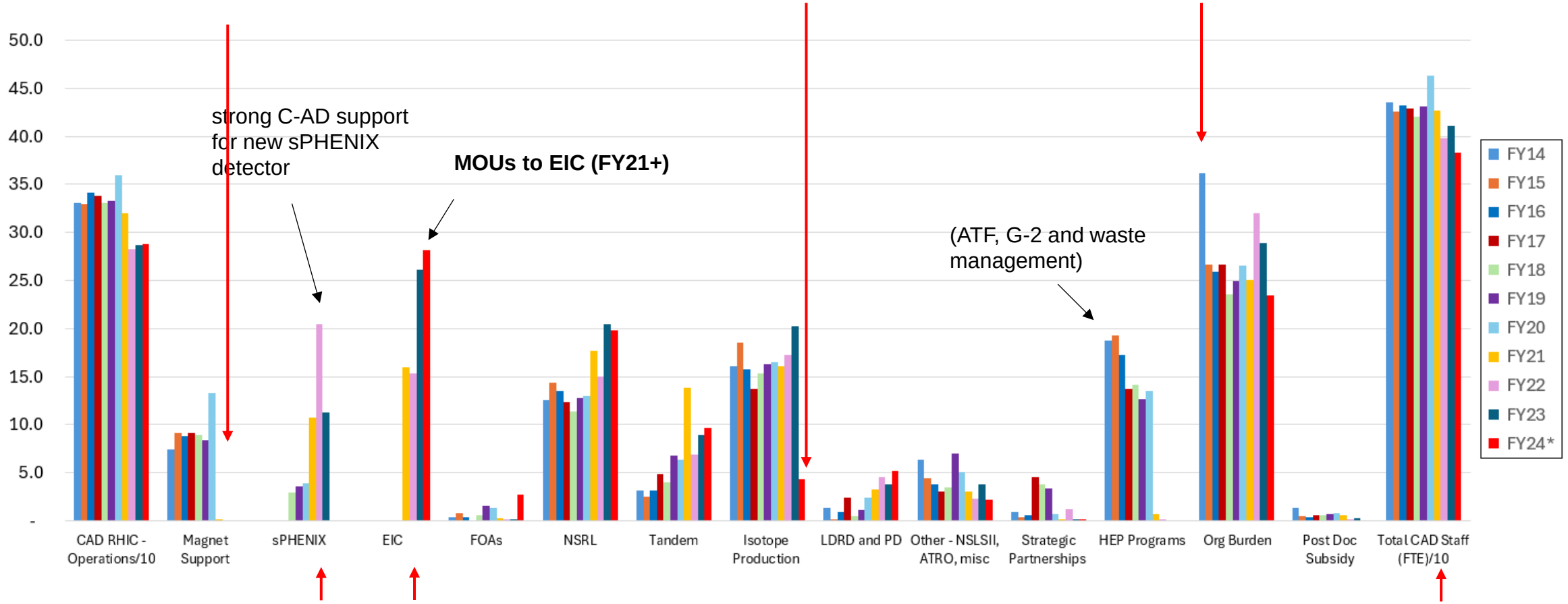
CAD Staffing – History and Present Actuals

C-AD Staffing History

(add animation to guide viewers)

FY24 (red bars) show present status – more details on next slide

Restructuring: magnet support and ATF (FY20), Isotope Production (FY24), and business office (FY14)



C-AD staff provided strong support for sPHENIX and for the EIC (via MOUs)

C-AD staff totals are declining due to transfers to the EIC, MOUs with the EIC, and retirements (with difficulty in recruiting qualified staff)

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CAD Staffing – Present Actuals, annualized (Aug 2024)

Funded by DOE Nuclear Physics
Funded by Others
Funded by DOE Isotope Program
Funded by BNL
Departmental Costs

CAD RHIC - Operations	287.9
EIC	28.1
FOAs	2.7
NSRL	19.8
Tandem	9.7
Isotope Production	4.3
LDRD and PD	5.2
Other - NSLSII, ATRO, misc	2.2
Strategic Partnerships	0.1
Org Burden	23.4
Total CAD Staff (FTE)	**383.4**

This talk will concentrate on these

… with a short summary of these

presently management (8.5) – department chair, admin and division heads
ES&H/QA (14.9)

Definitions:

"CAD RHIC – Operations" : includes all staff needed to support the Hadron Injector Complex and RHIC

"EIC" : indicates CAD staff working on the EIC through MOUs

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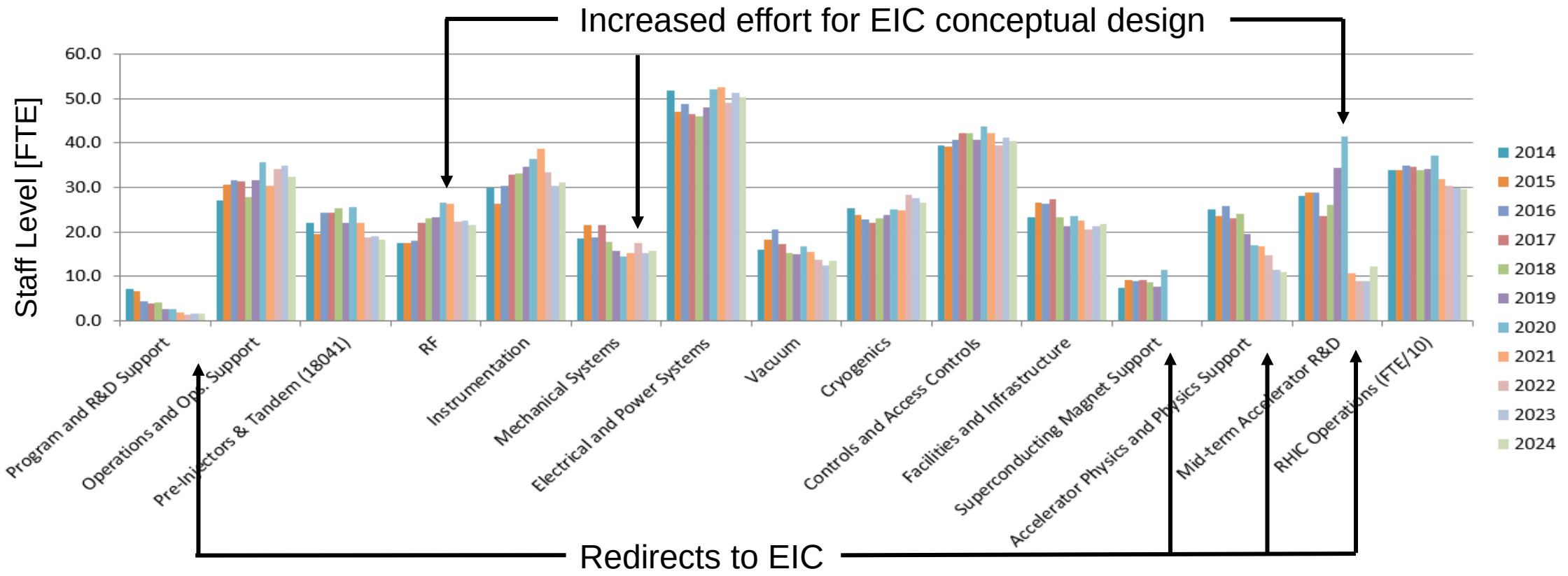
CAD – RHIC Operations Staffing History

From BNL Nuclear Physics FY2026 Budget Briefing (23 Feb 2024)



C-AD based RHIC ops staff: 297 FTEs (FY24), including

- 23 FTEs for experimental support
- 12 FTEs for mid-term accelerator R&D (including CeC)
- 10-15 FTEs for RHIC accelerator improvement (including in the injectors) and FOA support

Staffing Plan: Assumptions and Requirements

Staffing Plan - Assumptions

- FY24-FY25: completion of RHIC physics science mission; operation through the end of FY25 (possibly CY25).
- FY25: staffing reduced (with some programmatic risk) during final year of RHIC operations for physics.
- FY26 and beyond
    - maintain accelerator complex (ion sources, LINAC, AGS Booster, AGS) in a ready state for EIC operations,
    - continued operation of applications programs (NSRL, Isotope Production),
    - continued accelerator R&D in support of future NP facilities including the EIC,
    - continued upgrades and end-of-life replacements,
    - ARRs for LINAC/Booster (Apr 2026), the AGS (Oct 2027) + RF Test Facilities (per DOE O420.2D),
    - execute removal and repurpose (R&R) for the EIC.
- Staff transitions from RHIC (i.e. CAD) to the EIC continue throughout - Position Review Board recently created.

Aside on RHIC (CAD) to EIC Transition

From BNL Nuclear Physics
FY2026 Budget Briefing
(23 Feb 2024)

- The EIC project is organizationally outside of the NPP Directorate.
- A large fraction of the expertise and staff required by the EIC project resides at C-AD within NPP.
- Three main approaches to provide the EIC project with this expertise:
  - Staff transfers: in total 35 FTEs, including WBS level 2 and 3 leaders and accelerator physicists, have transferred from C-AD to the EIC project.
  - Staff matrixing: C-AD staff working with MOUs to the EIC.
    - FY24 projection 38 FTEs (144 heads)
    - FY23 actuals 27 FTEs (142 heads)
    - FY22 actual 16 FTEs (102 heads)
    - have reverse-MOUs (EIC-to-CAD) to support RHIC Ops if needed.

update: FY24 annualized actuals
33 FTEs (163 heads)

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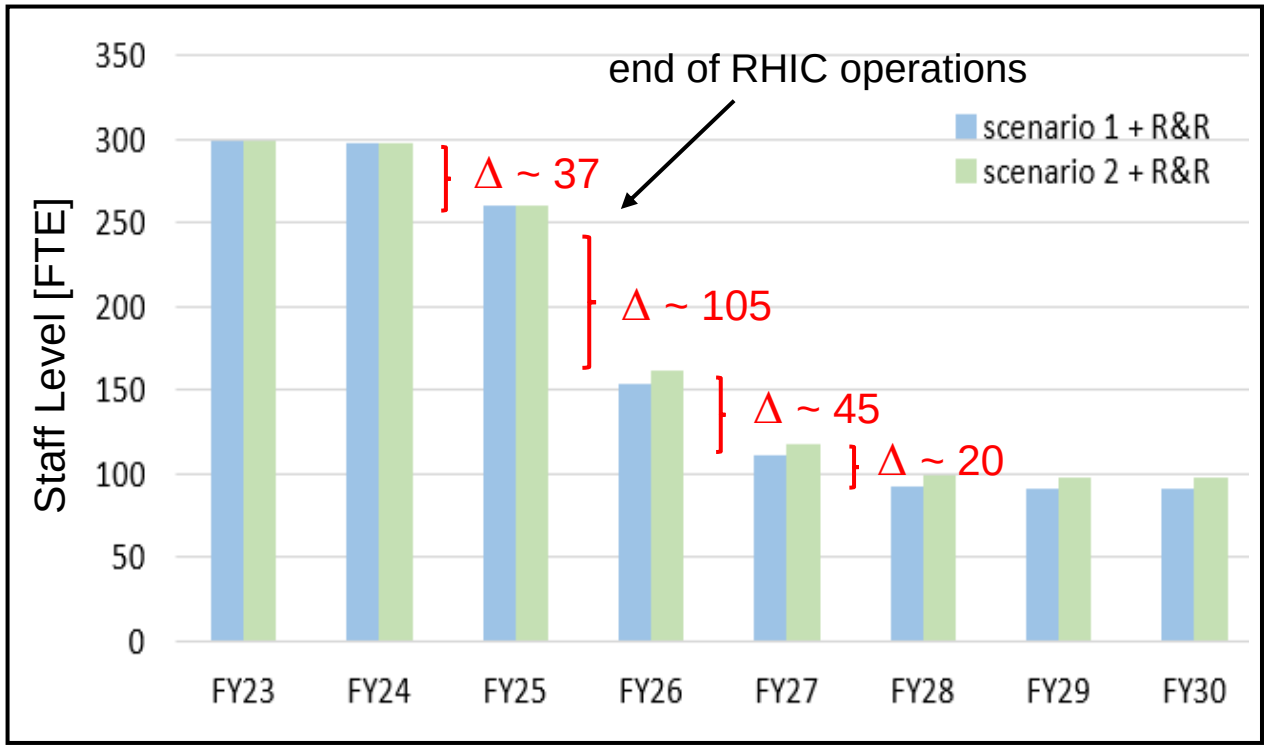
Staffing Requirements ("RHIC Ops", NPP-funded)

From BNL Nuclear Physics FY2026 Budget Briefing (23 Feb 2024)



	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30
scenario 1	298	297	260	90	90	90	90	90
scenario 2	298	297	260	97	97	97	97	97
R&R tunnel	0	0	0	52.3	13.4	0	0	0
R&R STAR	0	0	0	8.4	3.6	0	0	0
R&R sPHENIX	0	0	0	1.6	1.6	0	0	0
R&R muon wall	0	0	0	1.3	1.3	1.3	0	0

staff required to maintain hadron complex in a ready state for the EIC

(staff for R&R)

Note: experienced accelerator workforce could be lost if EIC project funding does not accommodate workforce released from RHIC operations.

Staffing Requirements in Detail
NPP funded staff
Non-NPP funded staff

Staffing Requirements in Detail – NPP Funded Staff

2017 senior level management estimate for maintaining the accelerator complex: 89 FTEs (T. Roser, W. Fischer)

2021 independent estimate based on group functions: 97.5 FTEs (M. Minty)

2023+ bottoms-up estimate in progress (D. Hatton)

2024 Off-project (R&R) scope was added with staffing estimates communicated to the DOE (Feb 2024 LMBB); J. Tuozzolo (EIC Technical Systems Division Director and C-AD Chief Mechanical Engineer) leading these estimates, which have evolved and been refined since the Feb 2023 LMBB.
An EIC Accelerator Dependencies Review was held 19-20 August 2024 to review the requirements (not covered in this review).

2024 the estimates from 2021 were updated (M. Minty), slide 17

Staffing Requirements – Methodology of 2021 Estimate

Until FY21 most groups - with the exception of Booster/AGS Ring PS systems and Collider Electrical PS systems - charged time to their groups, not to geographic regions.

Objective: estimate efforts of each group according to geographic region

Methodology: using group staffing data (slide 5, through 2019), estimated the allocation of each group's effort to support source/LINAC, Booster, AGS, RHIC, LEReC, CeC, sPHENIX and 56 MHz cavity, electron gun development at Stony Brook University, experimental support, eRHIC/EIC R&D, polarimetry, BLIP, NSRL, CBETA, LDRD & FOAs, management & general maintenance

a) using BNL job classifications (scientist, professional, technical, IT, administrative, management)
b) expanded labor estimates further into individual Work Group IDs (for incorporation into the Resource Comparison Tool (RCT) used by the EIC after recategorization of staff according to their work functions (as opposed to previous classification in PeopleSoft Work Groups, where personnel were assigned according to their reporting chain)
c) further subclassification of Work Groups into > 20 RCT Site Resource Groups (not completed)

Staffing Requirements – Methodology, continued

Estimates took into account organizational changes:

- elimination of the eRHIC R&D group
- elimination of Superconducting Magnet staff support
- addition of groups: beam cooling, electron source development, laser group

Estimates took into account future efforts only if funded.

Example: Electrical Systems Group – breakdown by job classification

Description RCT Work Group IDs	year	total FTE per past org charts (end-of-year)	scientist	post doc	professional	IT	technician	admin	management	E+T+S+IT+A+M
Electrical Systems Engineering ADCC - ~~Elec. Mngmnt (JS~~ ADCC - Elec. Engineering	2017	3.0			3.0					3.0
	2018	3.0			3.0					3.0
	2019	3.0			3.0					3.0
	2020	3.0			3.0					3.0
	2021				3.0					3.0
	2022				3.0					3.0
	2023				3.0					3.0
	2024				3.0					3.0
	2025				2.0					2.0
	2026				1.5					1.5
	2027				1.5					1.5
Electrical Systems Engineering ADDO - Elec. Eng'g Ring	2017	3.0			3.0					3.0
	2018	3.0			3.0					3.0
	2019	3.0			3.0					3.0
	2020	3.0			3.0					3.0
	2021				3.0					3.0
	2022				3.0					3.0
	2023				3.0					3.0
	2024				3.0					3.0
	2025				2.5					2.5
	2026				1.5					1.5
	2027				1.5					1.5
Electrical Systems Pulsed Power ADCF - Elec. Pulsed Pow Eng'g and Techs (JS)	2017	9.0			4.0		5.0			9.0
	2018	9.0			5.0		4.0			9.0
	2019	7.0			4.0		3.0			7.0
	2020	8.0			4.0		4.0			8.0
	2021				4.0		5.0			9.0
	2022				4.0		5.0			9.0
	2023				4.0		5.0			9.0
	2024				4.0		5.0			9.0
	2025				2.0		3.0			5.0
	2026				1.0		1.5			2.5
	2027				1.0		1.5			2.5
Electrical Systems Collider ADCK - Elec. Collider PS Eng'g and Techs (JS)	2017	14.0			4.0		10.0			14.0
	2018	14.0			4.0		10.0			14.0
	2019	15.0			4.0		11.0			15.0
	2020	16.0			3.0		13.0			16.0
	2021				3.0		14.0			17.0
	2022				2.5		14.0			16.5
	2023				2.5		13.0			15.5
	2024				2.5		13.0			15.5
	2025				1.0		7.5			8.5
	2026									0.0
	2027									0.0
Electrical Systems Booster/AGS ADCJ - Elec. AGS/Booste Eng'g and Techs (JS)	2017	18.0			1.0		11.0			12.0
	2018	18.0			3.0		11.0			14.0
	2019	19.0			3.0		13.0			16.0
	2020	19.0			3.0		13.0			16.0
	2021				3.0		13.0			16.0
	2022				3.0		12.0			15.0
	2023				3.0		11.0			14.0
	2024				3.0		11.0			14.0
	2025				1.5		10.0			11.5
	2026				1.0		6.5			7.5
	2027				1.0		6.5			7.5

input: historical staffing actuals

Output: staffing projections

Output: staffing release to the EIC

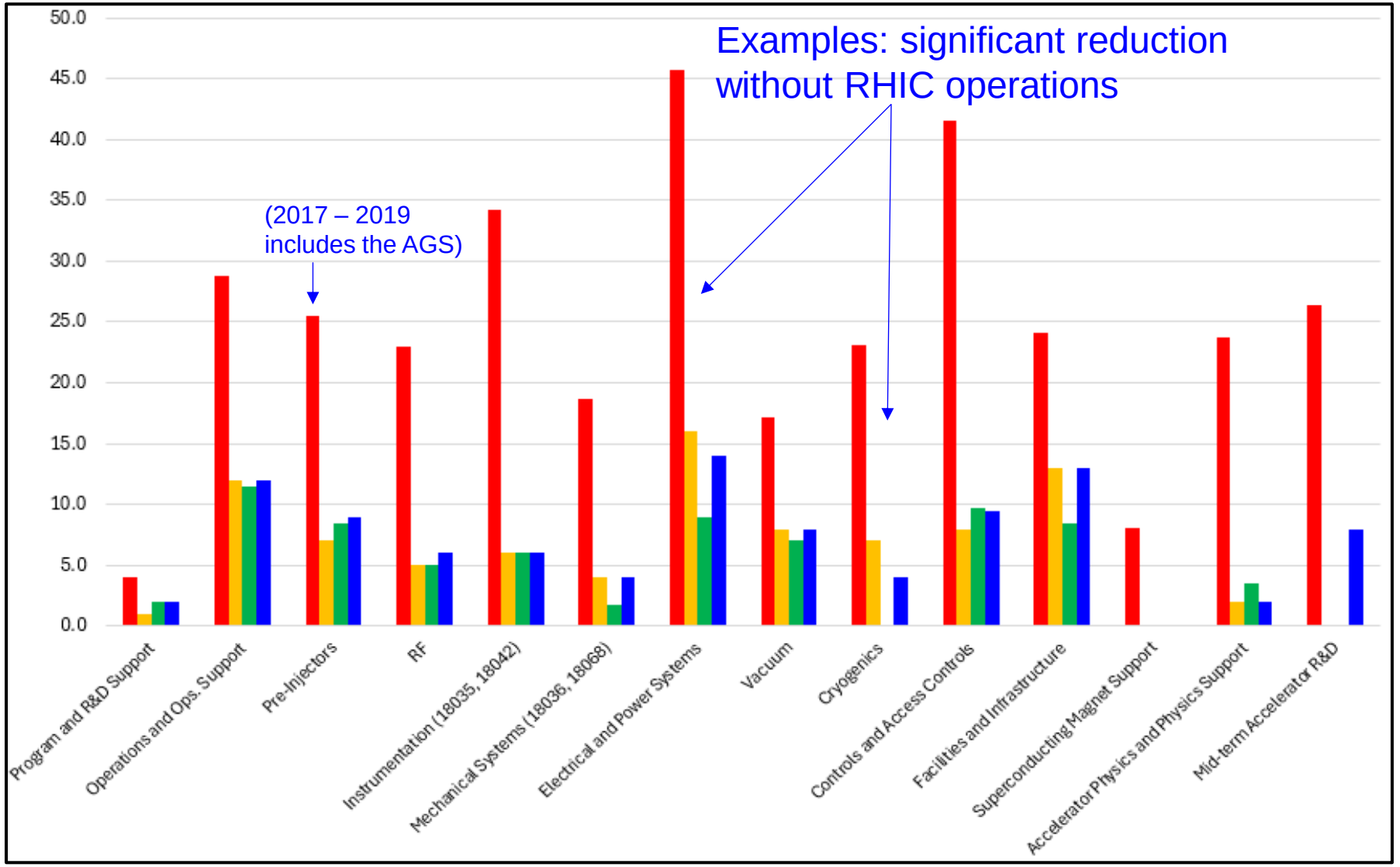
Note: had assumed that RHIC operations would end 30 Jun 2024

Example: Electrical Systems Group – breakdown detail

Effort levels by region assigned (best judgement) to match actuals in 2017, 2018, 2019, and 2020 and used to project requirements for after end of RHIC physics programs

Description RCT Work Group IDs	year	SC magnet division	Source/Linac	Tandem ops	Booster	AGS	RHIC	LEReC	CeC	CeC Ops	PHENIX/56 MH	E-Gun (SBU)	Experimental Support	eRHIC/EIC R&D	Polarimetry	Mgmt and Gen. Main	TOTAL NP	BLIP	NSRL	CBETA	DRD/FO	TOTAL all else	total requirements (NP+Other)	check M - BO	TOTAL NP+All Else
Electrical Systems Engineering ~~ADCC - Elec. Mngmnt (JS~~ ADCC - Elec. Engineering	2017				0.25	0.25	0.5					0.5				1.25	2.8	0.5		0.5		1.0	3.8	-0.75	3.8
	2018		0.5		0.25	0.25	0.5					0.5				1.25	3.3	0.5				0.5	3.75	-0.75	3.8
	2019		0.5		0.25	0.25	0.5					0.5				1.25	3.3	0.5				0.5	3.75	-0.75	3.8
	2020		0.5		0.25	0.75	0.5									1.25	3.3	0.5				0.5	3.75	-0.75	3.8
	2021		0.5		0.25	0.25	0.5									1.0	2.5	0.25				0.25	2.75	0.25	2.8
	2022		0.5		0.25	0.25	0.5									1.0	2.5	0.25				0.25	2.75	0.25	2.8
	2023		0.5		0.25	0.25	0.5									1.0	2.5	0.25				0.25	2.75	0.25	2.8
	2024		0.5		0.25	0.25	0.5									1.0	2.5	0.25				0.25	2.75	0.25	2.8
	2025		0.25		0.25	0.25	0.25									1.0	2.0	0.25				0.25	2.25	-0.25	2.3
	2026		0.25		0.25											1.0	1.5	0.25				0.25	1.75	-0.25	1.8
	2027		0.25		0.25											1.0	1.5	0.25				0.25	1.75	-0.25	1.8
Electrical Systems Engineering ADDO - Elec. Eng'g Ring	2017				0.25	0.25	0.5					0.5				1.25	2.8	0.5		0.5		1.0	3.8	-0.75	3.8
	2018		0.5		0.25	0.25	0.5					0.5				1.25	3.3	0.5				0.5	3.75	-0.75	3.8
	2019		0.5		0.25	0.25	0.5					0.5				1.25	3.3	0.5				0.5	3.75	-0.75	3.8
	2020		0.5		0.25	0.75	0.5									1.25	3.3	0.5				0.5	3.75	-0.75	3.8
	2021		0.5		0.25	0.25	0.5									1.0	2.5	0.25				0.25	2.75	0.25	2.8
	2022		0.5		0.25	0.25	0.5									1.0	2.5	0.25				0.25	2.75	0.25	2.8
	2023		0.5		0.25	0.25	0.5									1.0	2.5	0.25				0.25	2.75	0.25	2.8
	2024		0.5		0.25	0.25	0.5									1.0	2.5	0.25				0.25	2.75	0.25	2.8
	2025		0.25		0.25	0.25	0.25									1.0	2.0	0.25				0.25	2.25	0.25	2.3
	2026		0.25		0.25											1.0	1.5	0.25				0.25	1.75	-0.25	1.8
	2027		0.25		0.25											1.0	1.5	0.25				0.25	1.75	-0.25	1.8
Electrical Systems Pulsed Power ADCF - Elec. Pulsed Pow Eng'g and Techs (JS)	2017				1.0	2.0	4.0									1.0	8.0	0.5	0.25			0.75	8.8	0.3	8.8
	2018				1.0	2.0	4.0									1.0	8.0	0.5	0.25			0.75	8.8	0.3	8.8
	2019				1.0	2.0	4.0									1.0	8.0	0.5	0.25			0.75	8.8	-1.8	8.8
	2020				1.0	2.0	4.0									1.0	8.0	0.5	0.25			0.75	8.8	-0.8	8.8
	2021				1.0	2.0	4.0									1.0	8.0	0.5	0.25			0.75	8.8	0.3	8.8
	2022				1.0	2.0	4.0									1.0	8.0	0.5	0.25			0.75	8.8	0.3	8.8
	2023				1.0	2.0	4.0									1.0	8.0	0.5	0.25			0.75	8.8	0.3	8.8
	2024				1.0	2.0	4.0									1.0	8.0	0.5	0.25			0.75	8.8	0.3	8.8
	2025				1.0	1.0	2.0									0.5	4.5	0.5	0.25			0.75	5.3	-0.3	5.3
	2026				1.0											0.25	1.3	0.5	0.25			0.75	2.0	0.5	2.0
	2027				1.0											0.25	1.3	0.5	0.25			0.75	2.0	0.5	2.0
Electrical Systems Collider ADCK - Elec. Collider PS Eng'g and Techs (JS)	2017						13.0									2.0	15.0						15.0	-1.0	15.0
	2018						13.0									2.0	15.0						15.0	-1.0	15.0
	2019						14.0									2.0	16.0						16.0	-1.0	16.0
	2020						14.0									2.0	16.0						16.0	0.0	16.0
	2021						14.0									2.0	16.0						16.0	1.0	16.0
	2022						14.0									2.0	16.0						16.0	0.5	16.0
	2023						13.0									2.0	15.0						15.0	0.5	15.0
	2024						13.0									2.0	15.0						15.0	0.5	15.0
	2025						7.0									1.5	8.5						8.5	0.0	8.5
	2026																0.0						0.0	0.0	0.0
	2027																0.0						0.0	0.0	0.0
Electrical Systems Booster/AGS ADCJ - Elec. AGS/Boost Eng'g and Techs (JS)	2017		1.0		2.0	4.0	1.5	0.125	0.125				0.25			2.0	11.0	1.0	1.0			2.0	13.0	-1.0	13.0
	2018		1.0		2.0	4.0	1.5	0.125	0.125				0.25	1.0		2.0	12.0	1.0	1.0			2.0	14.0	0.0	14.0
	2019		1.5		3.0	4.0	1.5	0.125	0.125				0.25	2.0		2.0	14.5	1.0	1.0			2.0	16.5	-0.5	16.5
	2020		1.5		3.0	4.0	1.5	0.125		0.125			0.25	2.0		2.0	14.5	1.0	1.0			2.0	16.5	-0.5	16.5
	2021		1.5		4.0	4.0	1.5	0.125		0.125			0.25	0.5		2.0	14.0	1.0	1.0			2.0	16.0	0.0	16.0
	2022		1.0		4.0	4.0	1.5	0.125		0.125			0.25			2.0	13.0	1.0	1.0			2.0	15.0	0.0	15.0
	2023		1.0		3.0	4.0	1.5	0.125		0.125			0.25			2.0	12.0	1.0	1.0			2.0	14.0	0.0	14.0
	2024		1.0		3.0	4.0	1.5	0.125		0.125			0.25			2.0	12.0	1.0	1.0			2.0	14.0	0.0	14.0
	2025		1.0		3.0	2.0	0.75						0.25			2.0	9.0	1.0	1.0			2.0	11.0	0.5	11.0
	2026		1.0		3.0											1.0	5.0	1.0	1.0			2.0	7.0	0.5	7.0
	2027		1.0		3.0											1.0	5.0	1.0	1.0			2.0	7.0	0.5	7.0

Result: staffing, by groups



2021 estimate of 72.5 FTEs to maintain operation of the injectors with additional (historical) 25 FTEs for accelerator R&D and to-be-funded accelerator upgrades.

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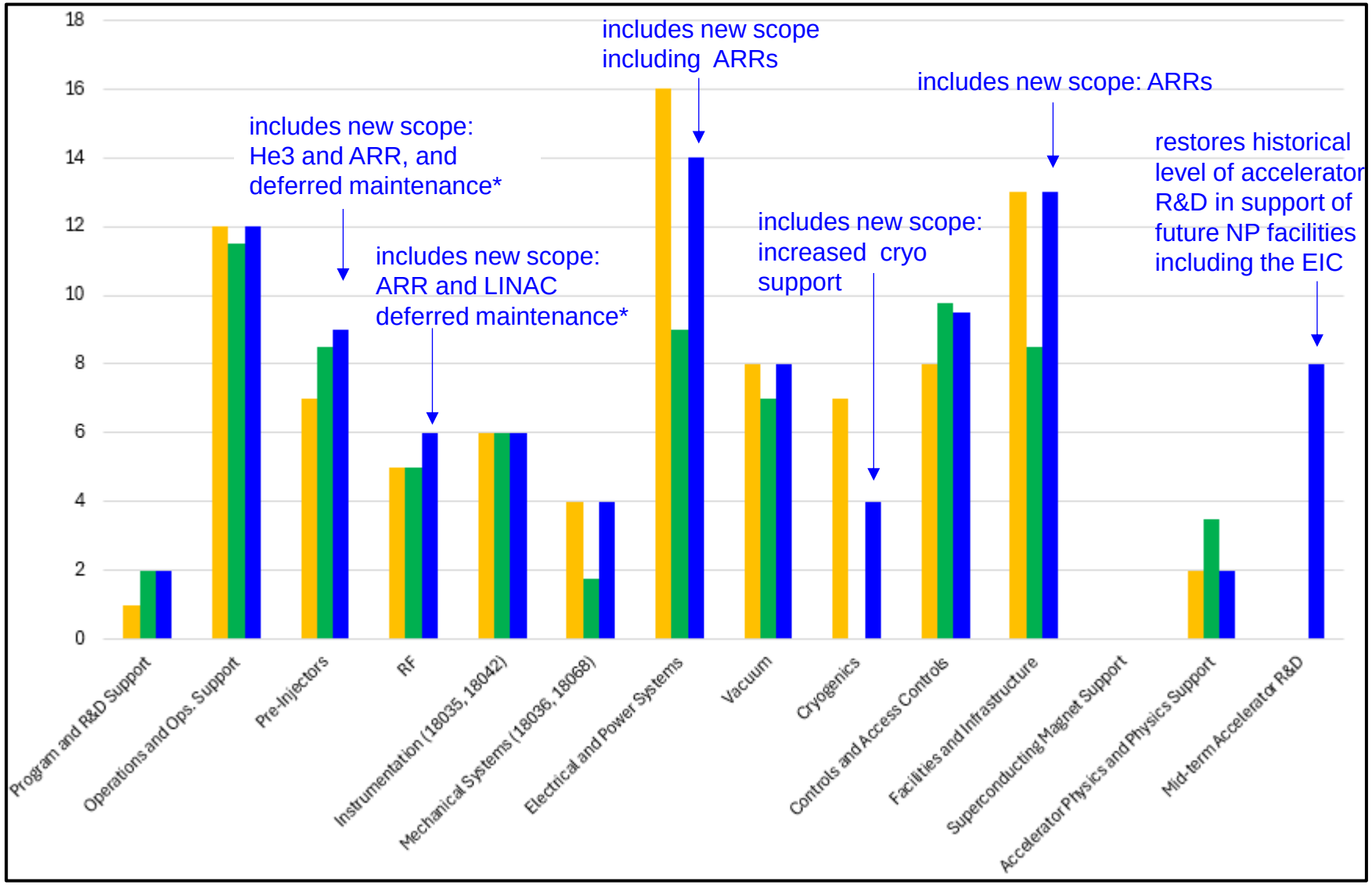
Result: staffing by groups, hadron injector complex only



Top-down estimate: why such high cryo support? why no mid-term R&D?

*deferred maintenance - backlog due to extended operating hours in support of Isotope Production [check of in agreement with business model] (if not, remove 'deferred maintenance')

CAD staff for Applications Programs, top 3 (with external funding)

NSRL and Isotope Program: assume constant level of effort at present funding levels

NASA Space Radiation Lab (NSRL)

AD Group	FTEs Support in FY24
Mechanical Systems	0.78
Design Group	1.28
Instrumentation Systems	0.74
Vacuum Systems	0.05
Electrical Systems	0.28
Facilities & Experimental Support	3.89
Water Systems	0.11
Communications & Electronic Support	0.01
Access Controls	1.31
Preinjector Systems	2.82
Accelerator Ops Support	5.08
RF Systems	0.11
Tandem Operations	0.02
NSRL	4.52
Total Support	**21.00**

Isotope Program

AD Group	FTEs Support in FY24
C-AD Admin and Training	1.26
Mechanical Systems	0.09
Design Group	0.70
Instrumentation	0.54
Vacuum Systems	0.28
Facilities & Experimental Support	0.54
Power Distribution	0.01
Water Systems	0.00
Communications & Electronic Support	0.03
Access Controls	0.04
ESSHQ	1.22
Total Support	**4.70**

Tandem van De Graaff: stand-alone non-designated User Facility (10 FTEs)
actively seeking to increase user base (including LDRD-funded experiments)

Workforce Demographics

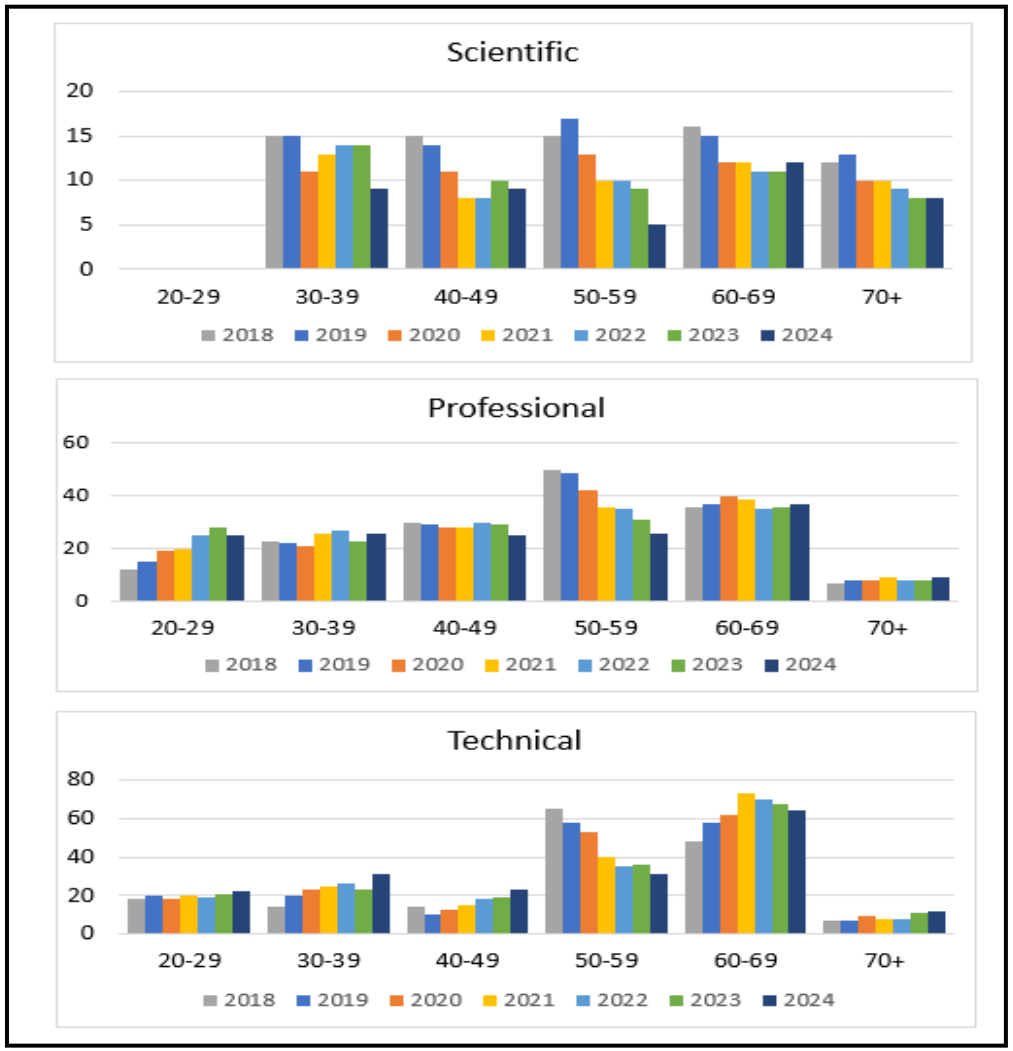
Age Demographics of C-AD Staff

From BNL Nuclear Physics FY2026 Budget Briefing (23 Feb 2024)

- The age distribution of C-AD staff is of concern
- Uptick in retirements: in FY20 – FY22 (40 FTEs) and FY23 (10 FTEs, shown in blue):
  - Technical 13 + 3
  - Professional 13 + 2
  - Administrative 4
  - Scientific 3 +3 phased retirement
    3 +2 emeritus
  - Management 2
  - Information tech 2

Update with FY24 actuals if time allows

- Planning for higher than (lab) average retirement rates after completion of RHIC physics program



On ensuring a trained and knowledgeable technical and professional workforce for EIC operation

This is challenging (reference DOE “Mini-Workshop on Accelerator Science and Technology Workforce in National Labs”, Jan 2024).

The largest risk (personal view) is further transfers of the best and brightest of CAD staff to the EIC:

- the EIC Technical Systems Division (TD) director is also CAD Chief Mechanical Engineer
- in the EIC Technical Division (TD)
  - 8 of 11 EIC TD group leaders were recruited from CAD
  - 3 of 5 EIC TD deputy group leaders were recruited from CAD
- the deputy Technical Director was also recruited from CAD

CAD has invested and will continue (when possible) to invest much effort in recruiting to backfill positions and ensure transfer of knowledge to new staff.

Summary

Summary

Charge Question #7

- C-AD staffing models were developed to estimate workforce needed to ensure proper maintenance of the hadron accelerator complex (proton- and ion sources, LINAC, AGS Booster synchrotron and the AGS) for later use as the Electron-Ion Collider (EIC) hadron injector complex and continued successful operation of the Applications Facilities (NSRL, Isotope Production and Tandem).
- AIP/CE funding for hadron complex funding has been redirected since FY23.
- The staffing model from 2021 was recently updated with estimates reflecting new additions:
  - Accelerator Readiness Reviews required by the DOE for the LINAC, AGS Booster, and the AGS
  - off-project scope for the EIC performed by CAD:
    - polarized He3 beam generation and delivery
    - cryogenic system upgrades
  - reinstatement of personnel for accelerator R&D in support of future NP facilities including the EIC
- Uncertainty exists in the effort levels due to
  - lack of estimate basis for performing ARRs for legacy accelerators
  - funding profiles, especially for the cryogenic systems
- A bottoms-up estimate is in development (D. Hatton/EIC) however challenged by the above-mentioned uncertainties.
- More detailed analyses would seem to require additional resources.

Reference Material

NPP / Collider-Accelerator Department (C-AD) R&D

Type	PROJECT	TITLE	PI
LDRD	26151	High repetition rate Lithium Laser Ion Source for neutron beam production	Shunsuke Ikeda
LDRD	26822	Ion Trap Test Stand and Laser Cooling Studies of Ultra-Low Emittance Bunches for High Luminosity	Stephen Brooks
LDRD	26823	A Section of a Fast Cycling Permanent Magnet Fixed Field Alternating (FFA) Synchrotron for Stony Brook University Hospital and Other Applications	Dejan Trbojevic
LDRD	26727	Development of a lithium beam driver for Boron Neutron Capture Therapy	Masahiro Okamura
LDRD	26728	Bringing the storage ring proton electric dipole moment (pEDM) experiment to BNL	Haixin Huang
PD	26859	Capture Plan for the High Energy Effects Test Facility	Kevin Brown
DOE Project-FOA	24686	Superconducting RF electron gun	Yichao Jing
DOE Project-FOA	24691	Photocathodes with 90% polarization and QE > 1% for DOE NP	Erdong Wang
DOE Project-FOA	25361	Cathode R&D for high intensity electron source in support of EIC	Mengjia Gaowei
DOE Project-FOA	26085	Development of high current highly charged laser ion source	Masahiro Okamura
DOE Project-FOA	26086	Advanced Modeling of Beam Physics and Performance Optimization for Nuclear Physics Colliders	Xiaofeng Gu
DOE Project-FOA	26695	CEBAF 20GeV Upgrade Studies-JLAB	Stephen Brooks
DOE Project-FOA	26634	Beam polarization increase in the BNL hadron injectors through physics-informed Bayesian Learning	Georg Hoffstaetter

To remove: charge and staff for ES&H ARRs

Subtitle

Maintaining accelerator Complex and Operations Review

Charge Question #7

Scope of review:

1) Operations costs, reliability upgrades, and FTEs required to maintain the RHIC accelerator complex in a ready state for EIC operations.
2) The improvement program of the accelerator complex to be ready for future EIC operations
3) Incremental costs (if any) associated with maintaining the RHIC injector complex in a fit state to support NSRL and BLIP operations. Cost to NASA and Isotope program for NSRL and BLIP operations, respectively.
4) Synergies and/or conflicts engendered by operating the complex for BLIP and NSREL and maintaining and developing the injector complex for EIC. Possible mitigation of conflicts
5) Annual funding profile required to support the above activities.

Charge questions

1) Are the requirements to maintain the injector complex clearly defined and are they well understood so that it is in ready-state for EIC operations?
2) Are any upgrades needed relative to existing performance to achieve EIC operations requirements well understood and appropriately scoped and costed?
3) Are the operational improvements planned prior to commissioning of the EIC accelerators adequate to ensure safe and efficient early operations of the EIC complex?
4) Are the requirements to support NSRL and BLIP operations clear and well defined? Are they different from those currently? If so, are those differences appropriately captured in the incremental costs to run NSRL and BLIP?
5) Are there any conflicts (synergies) between operating the injector complex for BLIP and NSRL and operating for EIC, and if any, are the plans to resolve such conflicts adequate?
6) Is the scope to maintain the injector complex during the dark period to be ready for EIC operations clearly defined and appropriate for the task?
7) Is the operations cost estimate reasonable and well justified with supporting documentation, including assumptions? Are the number of required FTEs appropriately calculated?

Staff for ARRs

Assumptions: scope here is in development of documents and procedures
effort levels for facility upgrades not included

1 engineer – SAD and ASE development
0.75 engineer – ARR preparation
0.25 engineer – QA

0.2 manager - ESSHQ Head
0.25 admin – procedure revisions/updates

0.5 physicist – Linac and EBIS LP
0.5 engineer – Linac and EBIS LE

0.5 physicist – Booster and NSRL LP
0.5 engineer – Booster and NSRL LE

0.5 physicist – AGS LP
0.5 engineer – AGS LE
0.5 physicist – Radiation Calc Updates ~ **6FTEs** total for all Linac/Booster and AGS ARRs.

If we are going to include the 2 RF test facilities, I would add another 0.5 LP and 0.5LE for each, some time for rad calcs and ODH calcs.

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Hadron Injector Readiness requirement

- The Hadron injector complex **must be ready to deliver beams** for EIC operation when beam commissioning starts, currently scheduled November 2030.

- Fulfilling the Hadron Injector Complex readiness requirement would involve :
  - Continuously replacing obsolete or aged equipment, hardware or systems throughout the EIC construction years
  - Continuing preventive maintenance of equipment, hardware, systems
  - Maintaining and upgrading technical infrastructure
  - Preparing an adequate number of technical component spares to ensure reliable operation of the EIC
  - Ensuring that a trained and knowledgeable technical and professional workforce is available in time for EIC operation