Report from the NSF

Jim Thomas
Program Director for Nuclear Physics

June 10th, 2021

Celebrating recent news & achievements @ BNL

- Congratulations to Haiyan Gao on being selected as the new Associate Laboratory Director for Nuclear and Particle Physics @ BNL
  - A spokesperson for the PRAD collaboration, among many other remarkable things
  - Now headed for new adventures at BNL …
  - Congratulations to the BNL community on a brilliant selection for ALD

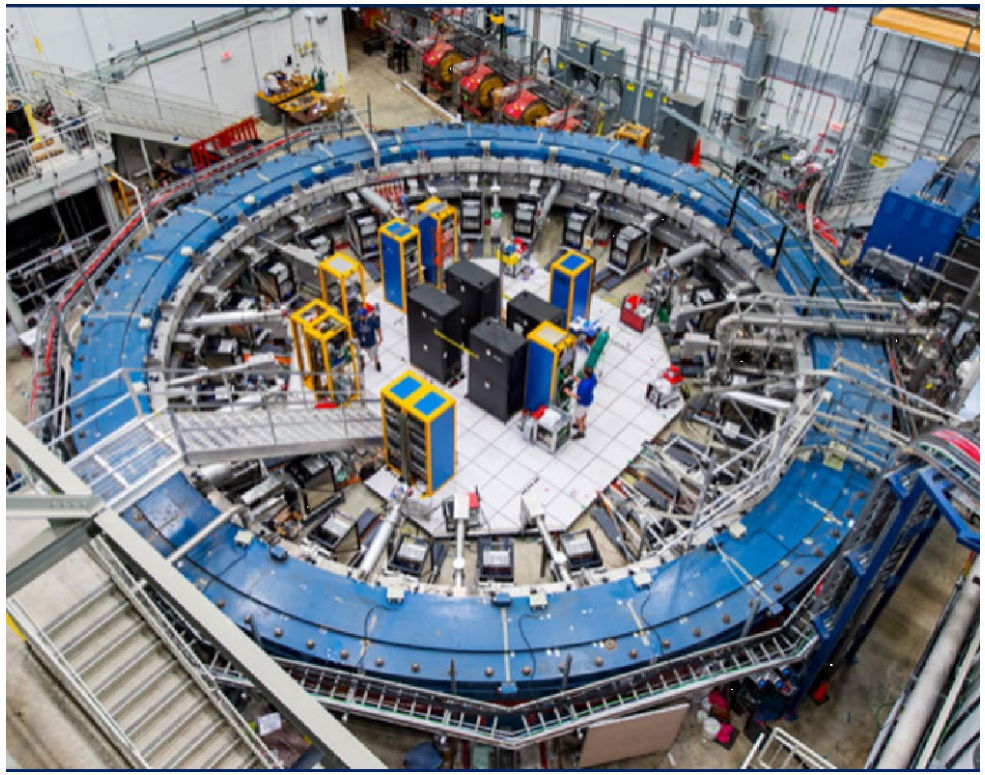
- Congratulations to Berndt Mueller on his return to academia
  - Seven wonderful years at BNL
  - Herman Feshbach Prize in Theoretical Nuclear Physics

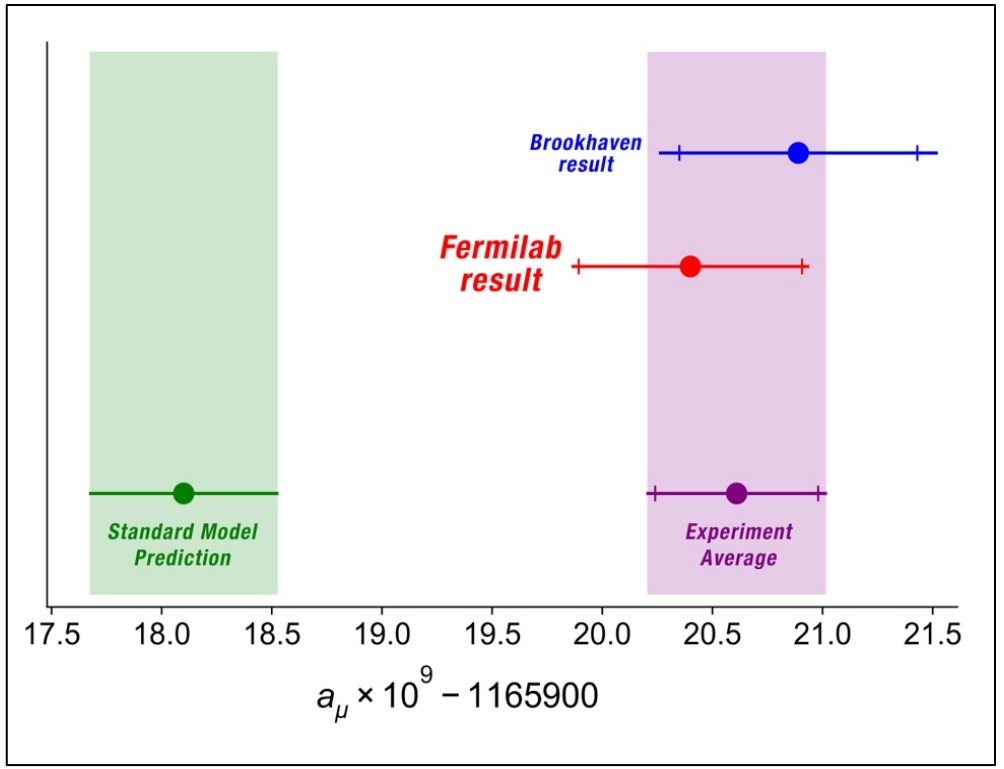
What will Duke University do next?

Born at BNL: Results from FNAL μ(g-2) announced April 7th

- Theory: g = 2.00233183620(86) a = 0.00116591810(43)
- Exp avg: g = 2.00233184122(82) a = 0.00116592061(41)
- Δ = 4.2 σ

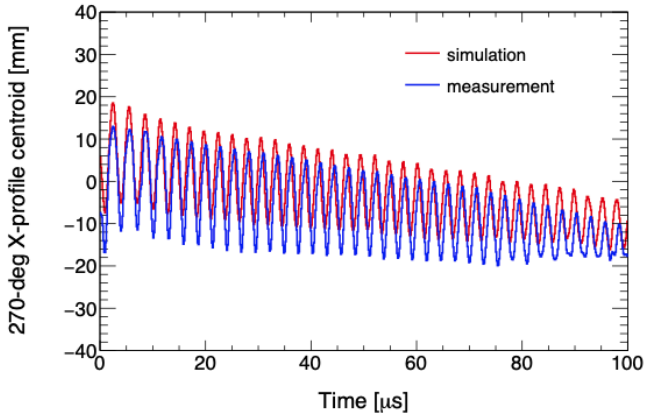
$$a_\mu^{SM} = a_\mu^{QED} + a_\mu^{EW} + a_\mu^{Hadron}$$



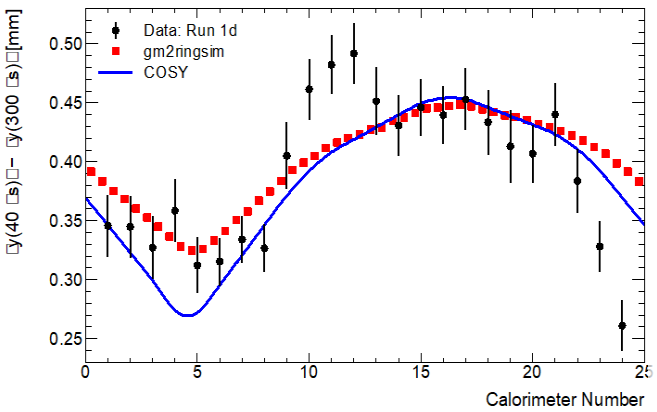


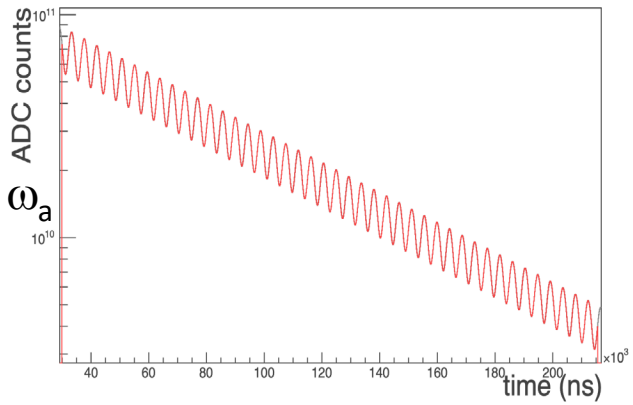
First results from FNAL μ(g-2) - some key investments

Fiber harps (Regis U.)

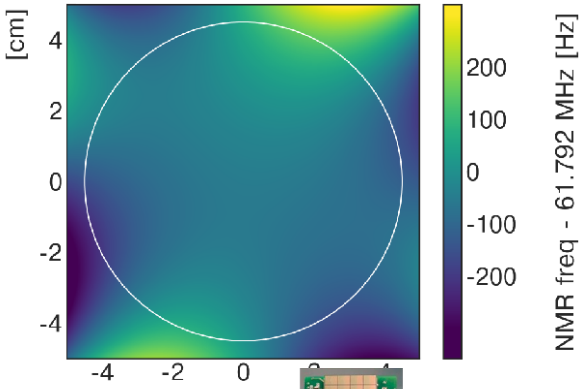


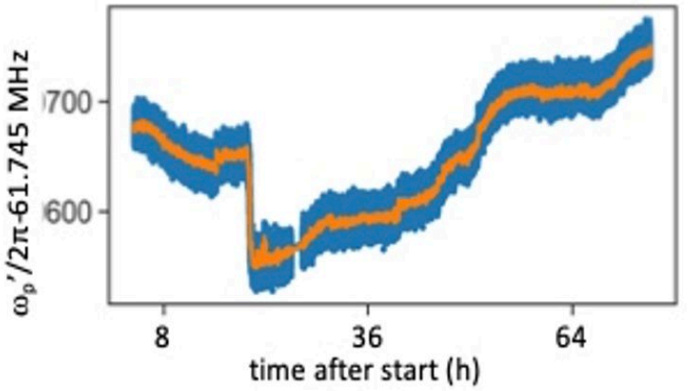
Simulations and Integrated energy analysis(U. Ky)

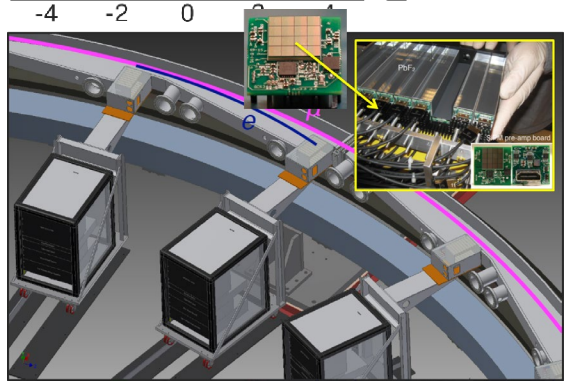




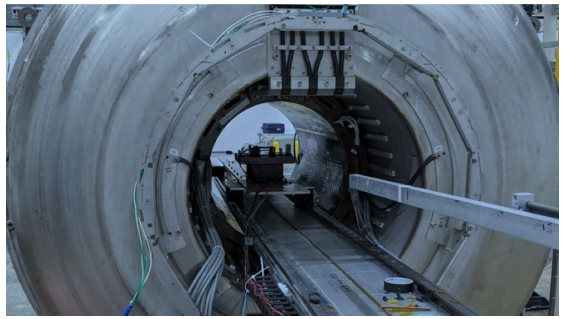
Field maps and tracking (JMU, UM, UVa)







^{3}He Calibration (UM)

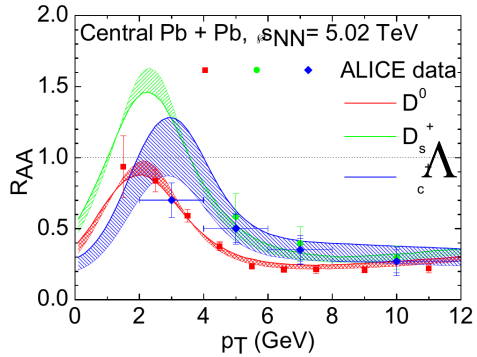


MRI (UW, Cornell, …)

Calorimeter XLs,
SiPMs, electronics, …

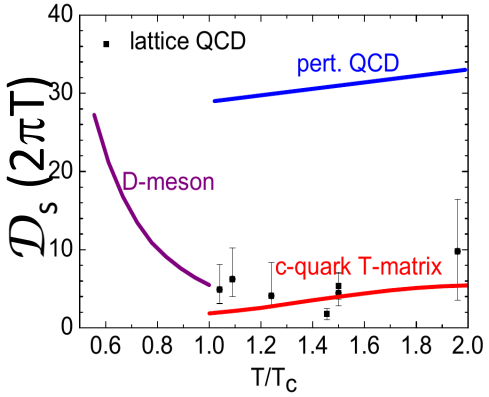
Theory: Heavy-Flavor, QCD Crossover @ finite μ_b, Energy Density

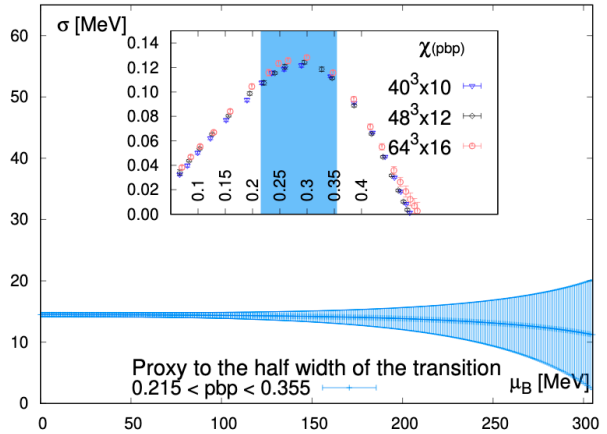
Elliptic Flow & R_{AA}



Large **elliptic flow** → large **"drag force"** on heavy quarks:

Extracted diffusion coefficient, $(2\pi T)\mathcal{D}_s$, near lower quantum bound (~1)



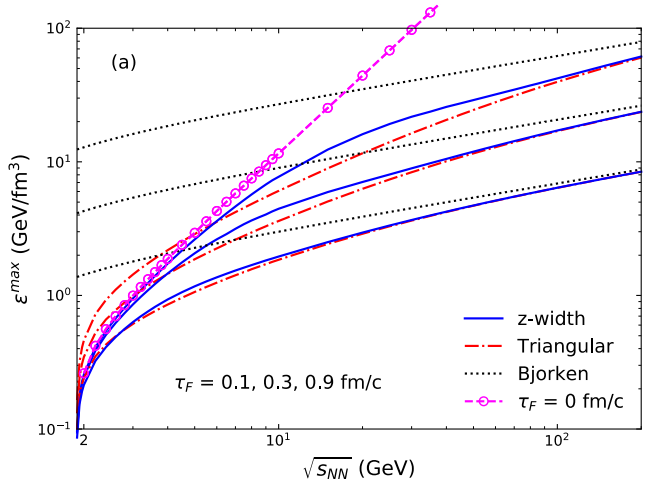


The QCD crossover at finite chemical potential from lattice simulations: no criticality up to μ_B=300 MeV

Borsanyi, Ratti, et al.
PRL **125**, 052001 (2021)

Distinct hierarchy of hadronic species → signature of recombination

He & Rapp,
PRL **124**, 042301 (2020)

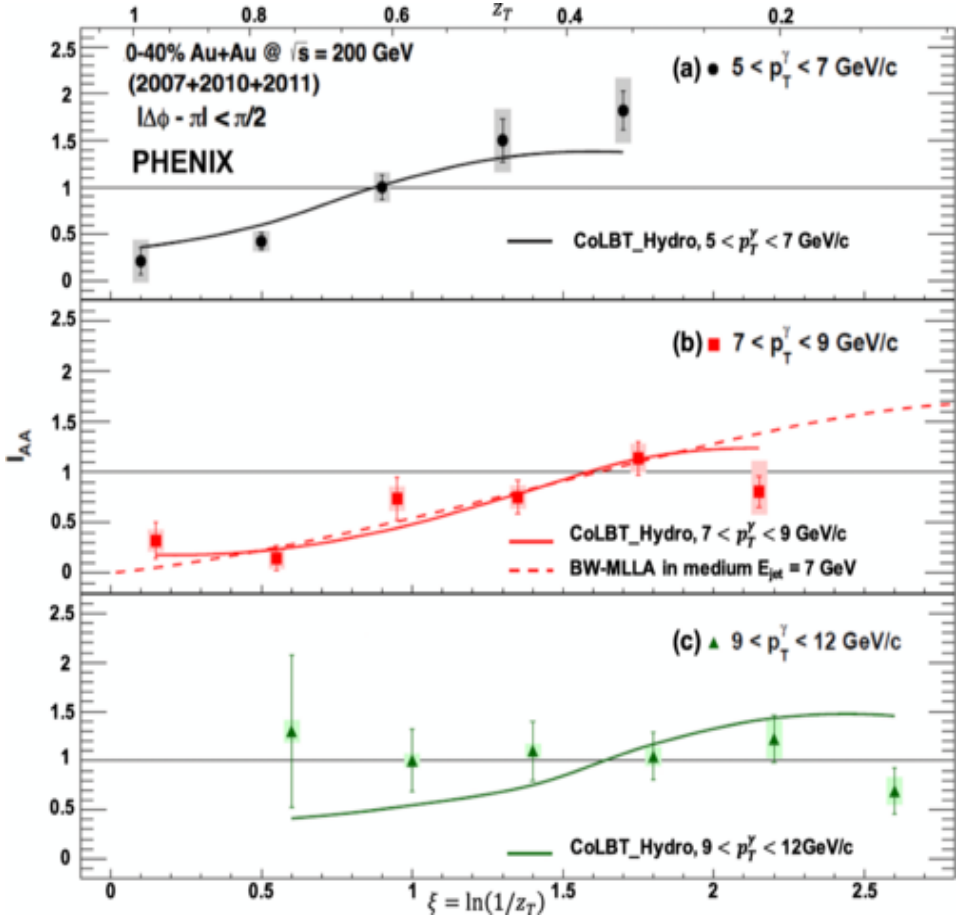


Initial Energy Density including finite nuclear thickness: At low energies, the maximum energy density ε_{max} is much lower than the Bjorken formula but it increases with $\sqrt{(s\_NN)}$ much faster

Mendenhall & Z-W. Lin,
PRC **103**, 024907 (2021)

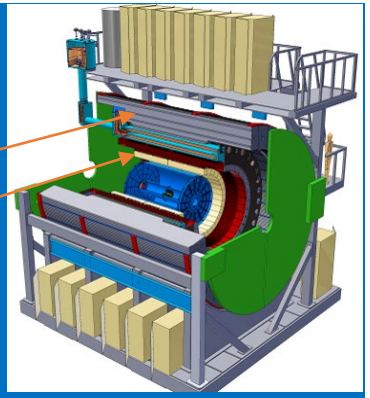
Jet Measurements and a Novel Hadronic Calorimeter at RHIC

Jet modification in Au+Au collisions with direct photon-hadron correlations

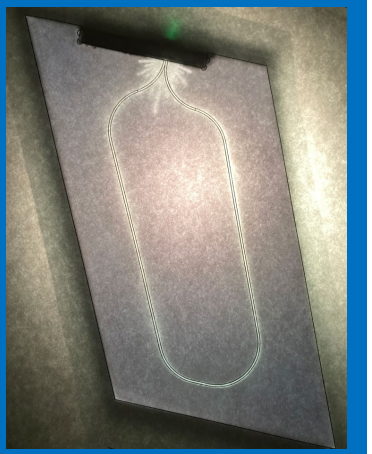


sPHENIX Hadronic Calorimeter

Outer Hcal Tile Testing complete



Inner Hcal Tile production and testing has started



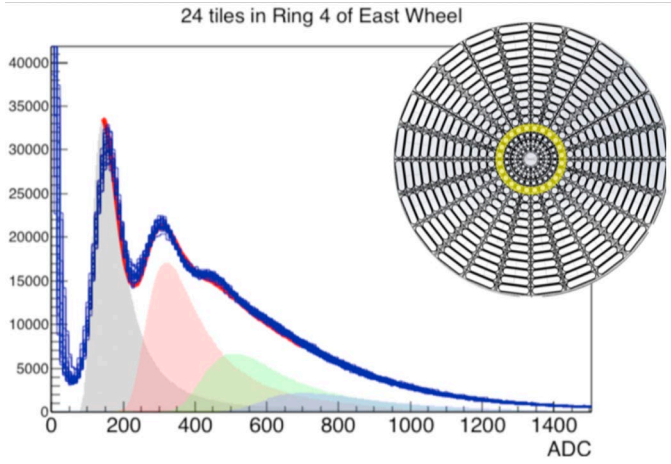
Inner Hcal Tile matched to

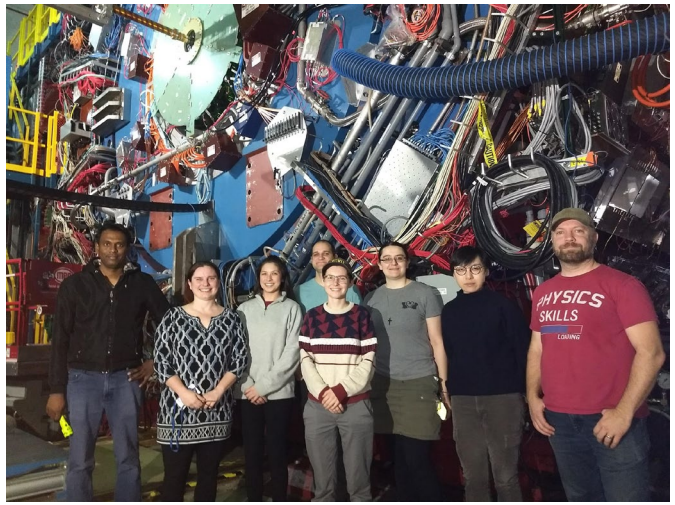
U. Acharya et al., Phys Rev **C102**, 054910 (2020)

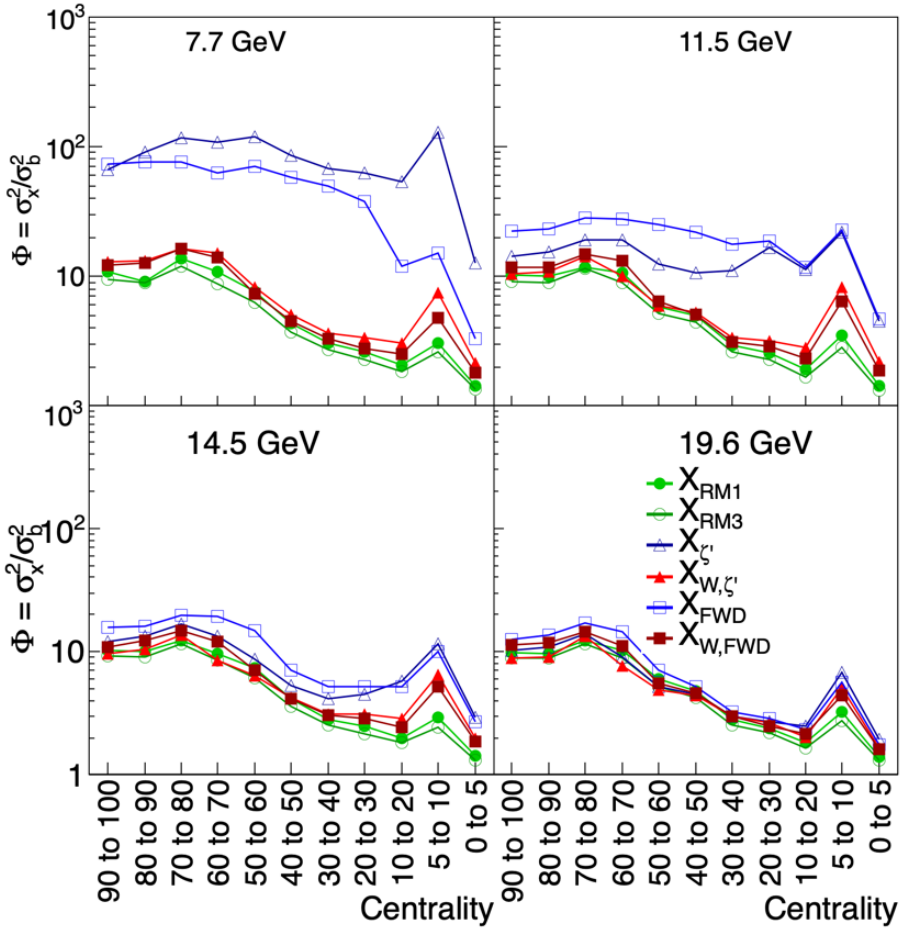
Megan Connors – CAREER award 2018

Centrality Determination with Forward Detector – RHIC BES

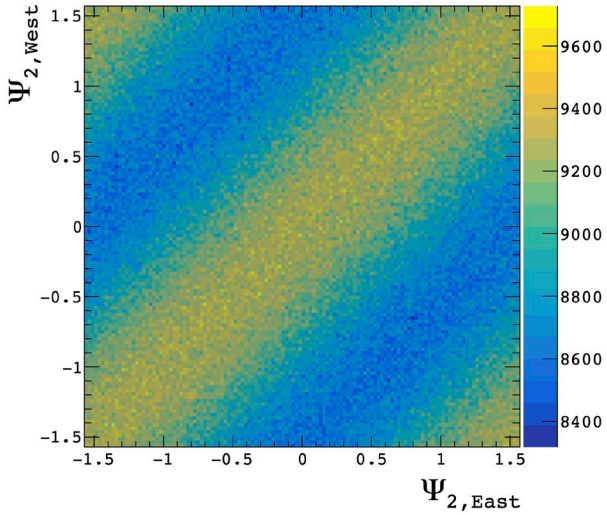
EPD performance channel by channel







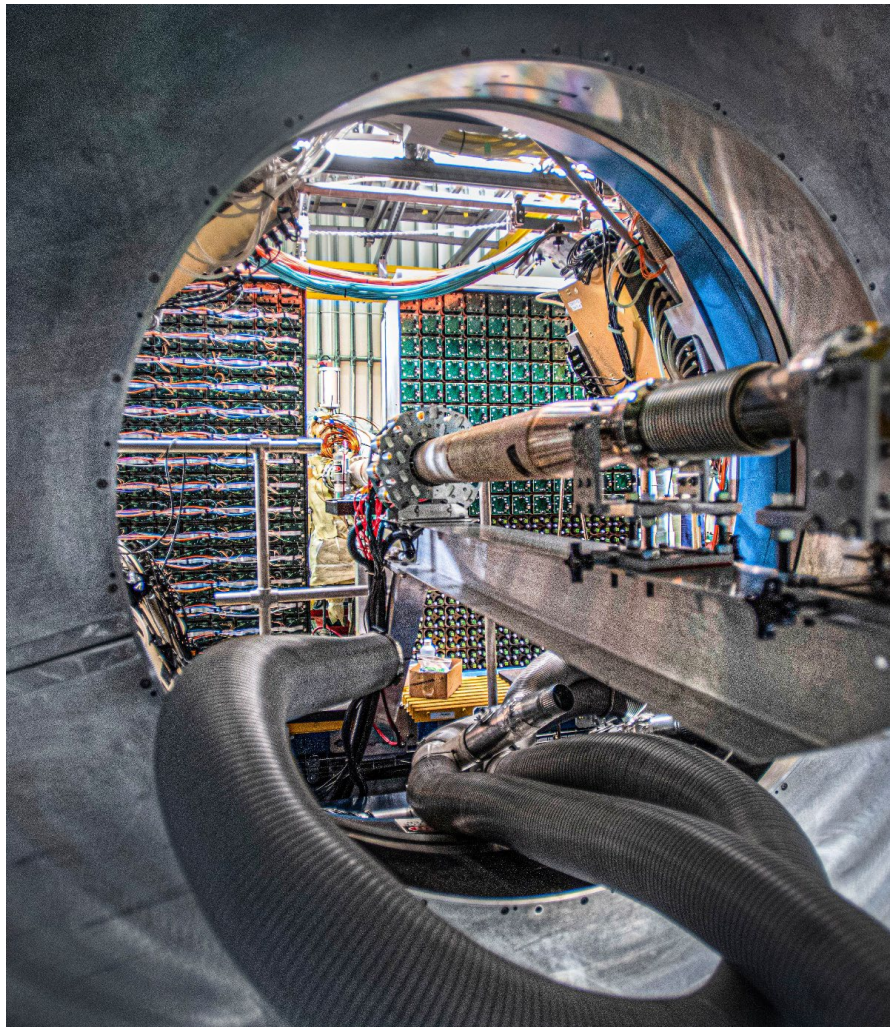
EPD event plane East vs West – jet v2 measurement at RHIC



Kagamaster, Reed & Lisa
Phys. Rev. C 103, 044902 (2021)

Rosi Reed – Lehigh U.
CAREER award 2019

Calorimetry in place for the STAR Forward Upgrade



EM and hadronic calorimeters (NSF MRI), viewed through the Endcap EMC

STAR + Forward Tracking → precision measurements on the spatial, momentum, and spin distributions

- gluons & quarks in nucleons & nuclei
- especially at high and low Bjorken-*x*

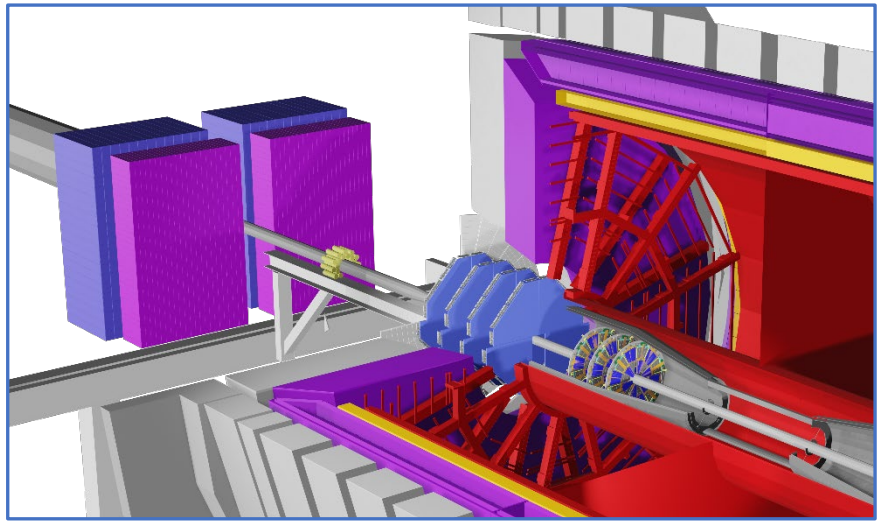


Photo courtesy of https://www.bnl.gov/newsroom/news.php?a=217681

MRI Award: Scott Wissink et al, Indiana, Kentucky, OSU, Texas A&M, ACU & BNL

The National Science Foundation

- The NSF responds to proposals from a wide community
  - Extraordinary science from University groups
  - Extraordinary science from small Colleges
  - With compelling Broader Impacts
- Two review criteria
  - Intellectual Merit — The heart of every proposal
  - Broader Impacts — Reach out and touch society!
    - Education & Outreach
    - Building the economy & workforce of the future through STEM
    - Broadening participation
    - Impact on other fields of science & engineering
    - National Security … more
- Thank you to everyone who reviewed proposals and sat on (virtual) panels
  - The COVID crisis is not over but …. we appreciate your patience & dignity
  - Reviewers and Panelists worked quickly & on short deadlines, thank you!

Faculty Career Development Program (CAREER)

- CAREER & PECASE NSF 20-525
  - CAREER - Awards in support of early-career faculty who have the potential to serve as academic role models in both research and education
    - Integration of Research and Education - CAREER proposals should describe an integrated path that will lead to a career as a researcher and educator
  - PECASE - Presidential Early Career Awards for Scientists and Engineers from among the most meritorious recent CAREER awardees
    - PECASE nominees are chosen from within the pool of CAREER winners
- Selection for these awards is based on two important criteria:
  - Innovative research (IM)
  - Community service […] through leadership in education & outreach (BI)
- Eligibility – must be assistant professor, untenured …
  - Five year awards
  - Deadline: Fourth Monday in July ⇒ July 26, 2021
  - Frequently asked questions ⇒ search for NSF 20-025

Standard Grants

- Investigator Initiated Research Projects NSF 20-580
  - All proposals submitted to the Division of Physics programs go through this solicitation … including Experimental & Theoretical Nuclear Physics
  - as well as Physics Midscale Instrumentation $4M-$15M (see next slides)
- Deadlines:
  - Proposals due the first Tuesday in December ⇒ December 7th, 2021
  - Follow the Proposal Preparation checklist
- Collaborators and Other Affiliations Template
  - List conflicts of interest … not everyone in your collaboration

Standard Grant solicitation includes Mid-Scale Instrumentation

- Physics Midscale NSF 20-580
  - $4M - $15M
  - Physics Midscale Instrumentation is part of the standard grant solicitation
  - Proposals due the first Tuesday in December ⇒ December 7th, 2021
  - non-renewable one-time grant
  - Grants are awarded annually
  - Design, Construction or Acquisition of Instrumentation
    - Early R&D is expected to be funded by the base program
  - For more details, see the section on mid-scale instrumentation in 20-580

Watch for an update to NSF 20-580 which is likely to be published in September.

MRI – Major Research Instrumentation

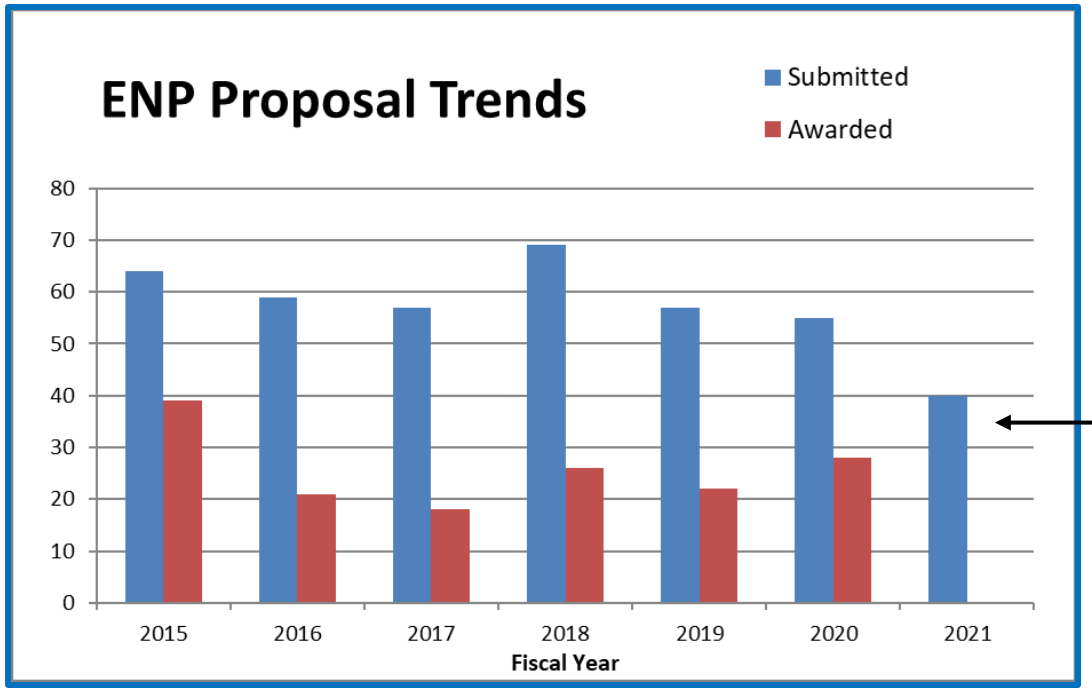
- Two tracks: NSF 18-513
  - Track 1 $100 k < $ from NSF < $1 M; max of 2/university
  - Track 2 $1 M < $ from NSF < $4 M; max of 1/university
- Two types: development and acquisition
- Deadlines & details
  - Proposal window ⇒ January 1 – January 19, annually
  - contact your program directors well ahead of time to discuss & avoid pitfalls
- Maximum award is $4M
  - 30% cost share req'd for PhD granting institutions
  - Awards above $1M compete across the entire Foundation

NSF and DOE – Future Coordination in research thru NSAC

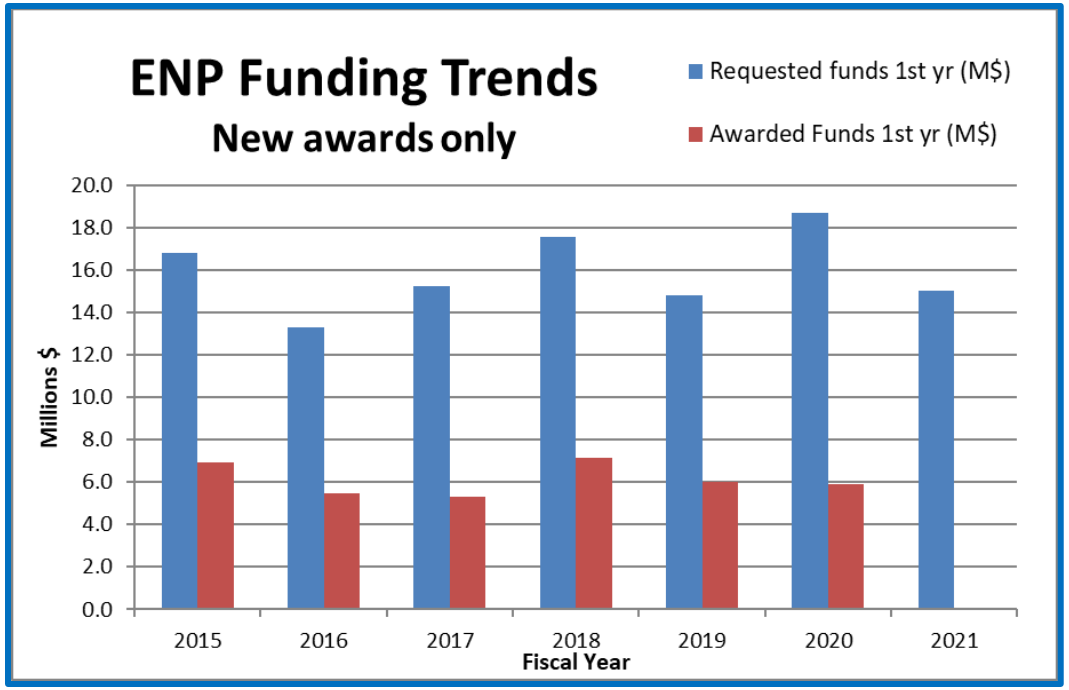
- MOLLER – parity violating Møller scattering (elastic $\vec{e}\,e$) @ JLAB
  - DOE CD-1 Dec 2020
  - NSF PHY Mid-scale award for specific scope in January 2021
- Next Generation $0\nu\beta\beta$
  - Prior NSF support: CUOREcino, CUORE, MJD, EXO-200, KamLAND-Zen, NEMO, …
  - LEGEND-200 = GERDA + MJD + new detectors $\Rightarrow$ 200 kg ^{76}Ge & $\tau_{1/2} = 10^{27}$ yr for 1 ton-year exposure
  - Upcoming … DOE $0\nu\beta\beta$ portfolio review
- EIC – the next "big project" in US Nuclear Physics
  - DOE CD-0 in Dec 2019; BNL selected for site
  - Project funding includes EIC + 1 detector

The NSF responds to proposals … there is no guarantee of NSF participation in a future mission-driven science project but, I can promise, we are listening carefully and enthusiastically!

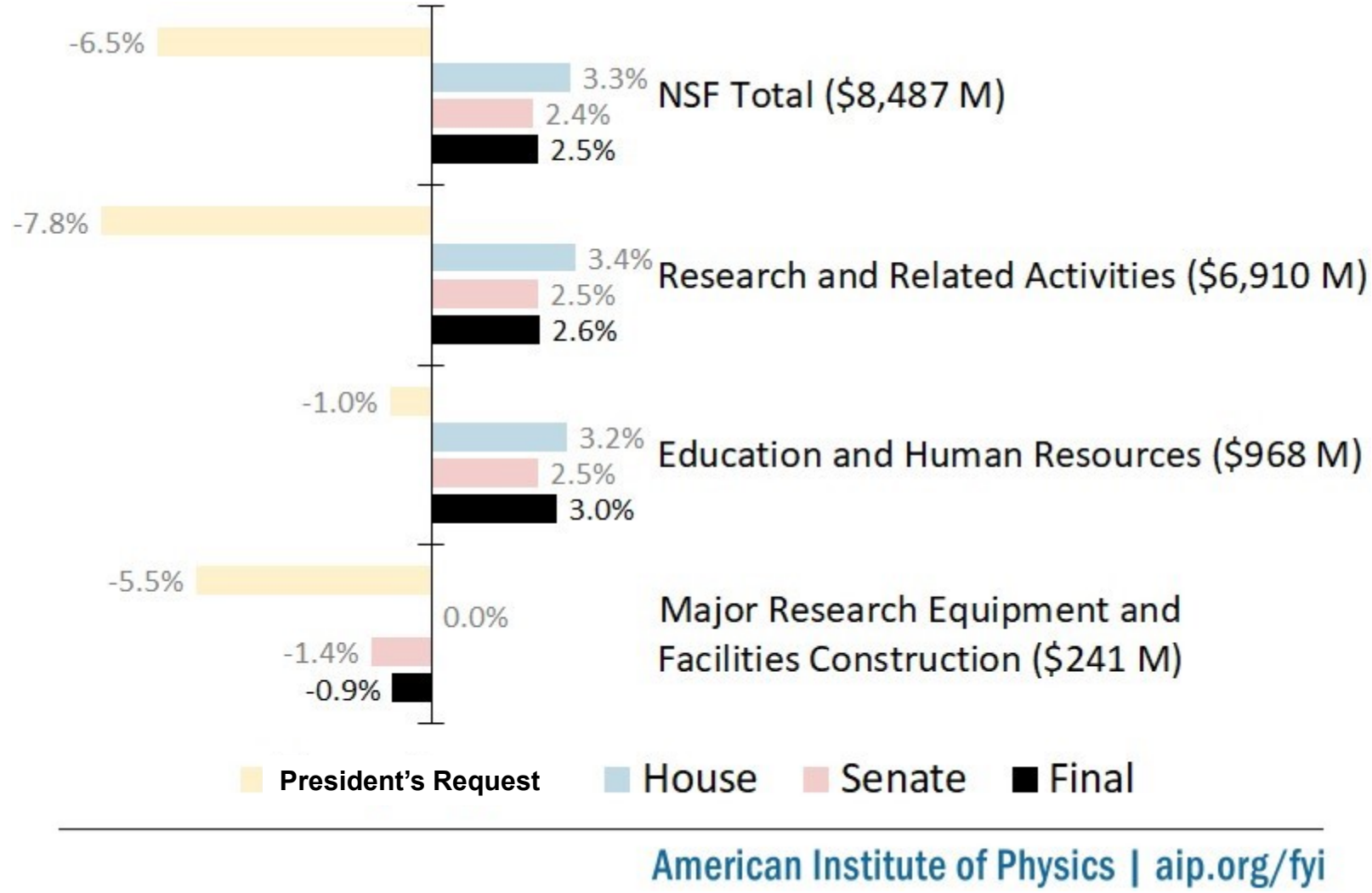
Proposal Trends in Experimental Nuclear Physics



Covid impact?

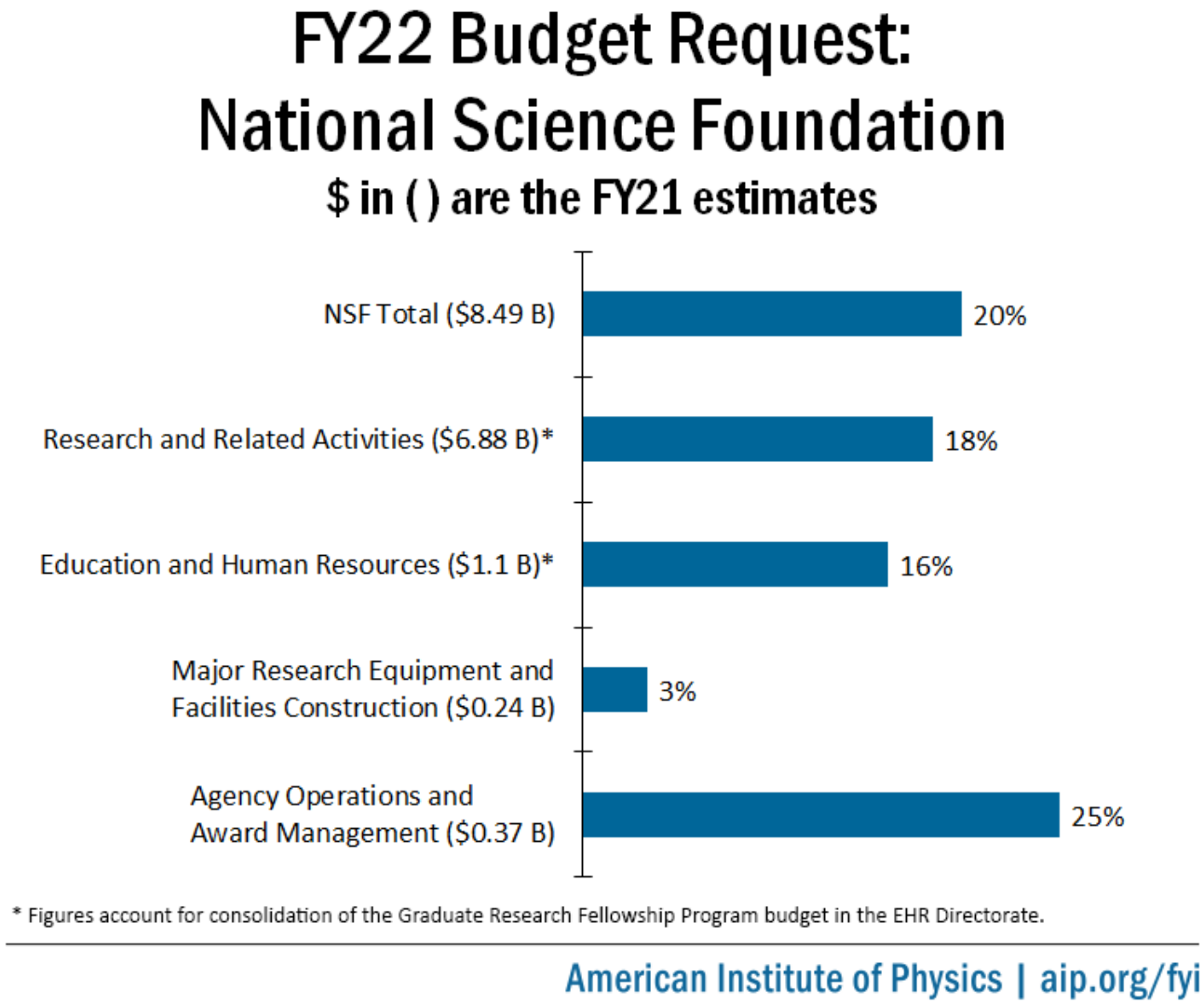


FY21 Budget Appropriations



A stable budget for FY21

FY22 Presidents Budget Request



- The Presidents request for the NSF budget in FY22 is impressive
- But by the time you drill down to Physics the relative requested increase is 4%

https://www.aip.org/fyi/2021/fy22-budget-request-national-science-foundation

More information

- News & updates
  - https://www.nsf.gov/physics

- Contact us:
  - bmihaila@nsf.gov
    (703) 292-8235
  - aopper@nsf.gov
    (703) 292-8958
  - jhthomas@nsf.gov
    (703) 292-2911

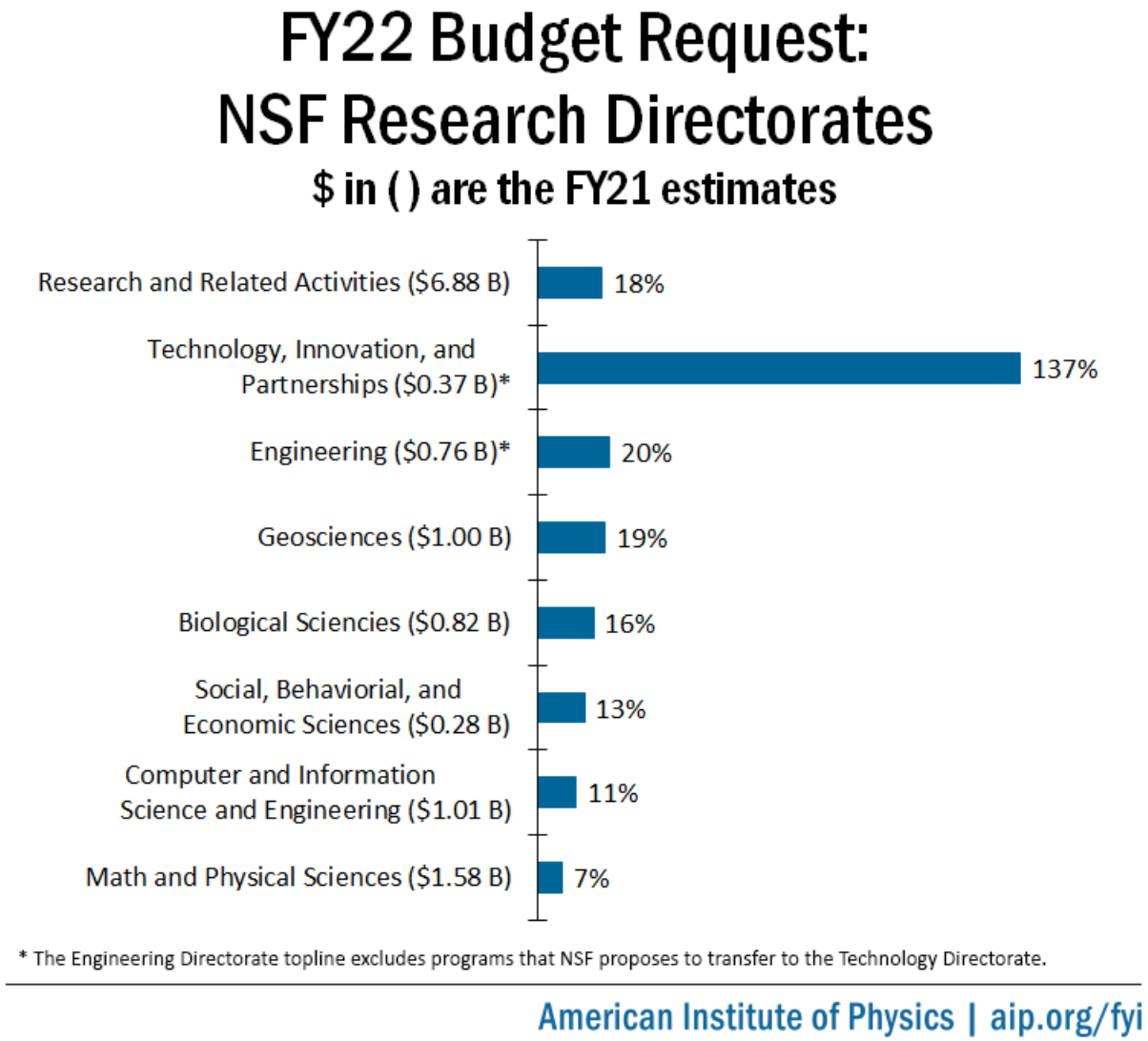

Backup Slides

Commitment

- The NSF is committed to increasing the participation of traditionally underrepresented groups in all NSF activities and programs.

- The Nuclear Physics Programs encourage proposals with meaningful actions that address the longstanding underrepresentation of various populations including women, minorities and persons with disabilities, in physics at all levels (K-12, undergraduate, graduate, and postgraduate).

FY22 Presidents Budget Request



- The Presidents request for the NSF budget in FY22 is impressive
- But by the time you drill down to Physics the relative requested increase is 4%

https://www.aip.org/fyi/2021/fy22-budget-request-national-science-foundation

aip.org/fyi fyi-this-week/week-april-12-2021

Sethuraman Panchanathan speaks at a Senate hearing in 2019 shortly before his nomination to be director of the National Science Foundation.

NSF Expansion Proposals up for Debate in Congress

A series of hearings this week will offer key congressional committees their first opportunity to publicly weigh in on proposals to dramatically expand the National Science Foundation. NSF Director Sethuraman Panchanathan will testify before Senate and House appropriators on Tuesday and Wednesday, respectively, to discuss President Biden's request to increase NSF's budget by 20% to just over $10 billion for the next fiscal year and create a directorate focused on translating research advances into new technologies. Biden has also proposed Congress provide the agency $50 billion over several years through infrastructure legislation, in large part to jumpstart the new directorate. Separately on Wednesday, the Senate Commerce, Science, and Transportation Committee is holding a hearing to review the Endless Frontier Act, which similarly envisions creating a massive technology-focused NSF directorate. Among the six witnesses is Kelvin Droegemeier, who led the White House Office of Science and Technology Policy during the Trump administration and briefly doubled as acting NSF director before Panchanathan's confirmation.

https://www.aip.org/fyi/2021/fy22-budget-request-national-science-foundation

The National Science Foundation's budget request for fiscal year 2022 fleshes out the Biden administration's vision for adding a technology directorate to the agency and provides details on how the pandemic has disrupted facility construction projects.

- NSF states the proposed "Directorate for Technology, Innovation, and Partnerships" (TIP) would work to "advance science and engineering research and innovation leading to breakthrough technologies as well as solutions to national and societal challenges." It would also aim to "accelerate the translation of fundamental discoveries from lab to market," in part by funding "prototyping, technology demonstration, and scale-up work, including licensing of NSF-funded research outputs."

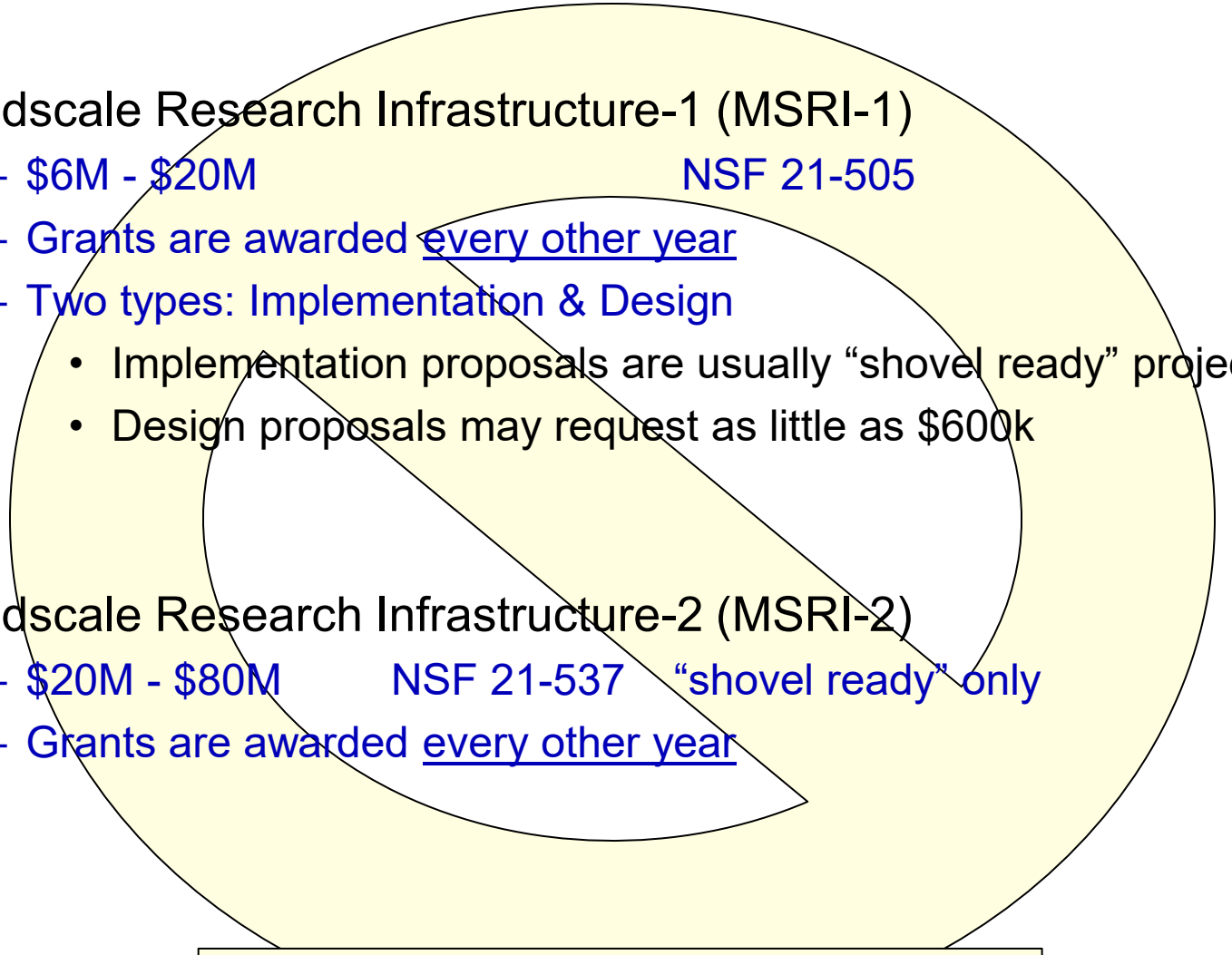
- In its fiscal year 2022 budget request to Congress, the Biden administration is seeking to increase the National Science Foundation's discretionary budget by 20% to $10.2 billion.

- Marquee items in the request include expanding STEM workforce diversity programs and establishing a technology directorate that would expand NSF's portfolio of "use-inspired" research. The request also includes steady funding for major facilities under construction as NSF works to pin down cost increases and schedule delays caused by the COVID-19 pandemic.

- On top of the discretionary budget request, the Biden administration has separately proposed that Congress provide the new directorate with $50 billion over 10 years as part of an infrastructure initiative. However, the administration recently stated it would be willing to push for that funding through other legislation in order to lower the infrastructure package's price tag.

Mid-Scale Research Infrastructure MsRI-1 & MsRI-2

- Midscale Research Infrastructure-1 (MSRI-1)
  - $6M - $20M NSF 21-505
  - Grants are awarded every other year
  - Two types: Implementation & Design
    - Implementation proposals are usually “shovel ready” projects
    - Design proposals may request as little as $600k
- Midscale Research Infrastructure-2 (MSRI-2)
  - $20M - $80M NSF 21-537 “shovel ready” only
  - Grants are awarded every other year



No Solicitation in FY 22

FY22 President's Budget Request – MPS ($M)

	FY 2020 Actual[1]	FY 2020 CARES Act Actual	FY 2021 Estimate[1]	FY 2022 Request	Change over FY 2021 Estimate	
					Amount	Percent
Astronomical Sciences (AST)	$279.10	-	$277.05	$294.05	$17.00	6.1%
Chemistry (CHE)	260.37	-	259.71	284.14	24.43	9.4%
Materials Research (DMR)	330.15	-	329.78	349.92	20.14	6.1%
Mathematical Sciences (DMS)	244.09	-	243.54	259.47	15.93	6.5%
Physics (PHY)	304.39	-	303.90	316.59	12.69	4.2%
Office of Multidisciplinary Activities (OMA)	112.01	6.00	166.50	186.57	20.07	12.1%
MPS Total	$1,530.12	$6.00	$1,580.48	$1,690.74	$110.26	7.0%

FY22 President's Budget Request – NSF ($M)

NSF by Account	FY 2020 Actual	FY 2020 CARES Act Actual	FY 2021 Enacted[1]	FY 2022 Request	FY 2022 Request change over: FY 2020 Actual Amount	FY 2020 Actual Percent	FY 2021 Enacted Amount	FY 2021 Enacted Percent
BIO	$809.31	$19.00	-	$948.51	$139.20	17.2%	N/A	N/A
CISE	996.40	15.00	-	1,116.06	119.66	12.0%	N/A	N/A
ENG	754.31	15.00	-	916.79	162.48	21.5%	N/A	N/A
GEO	993.72	-	-	1,194.92	201.20	20.2%	N/A	N/A
MPS	1,530.12	6.00	-	1,690.74	160.62	10.5%	N/A	N/A
SBE	280.35	9.50	-	319.66	39.31	14.0%	N/A	N/A
TIP[2]	352.31	3.55	-	864.87	512.56	145.5%	N/A	N/A
OISE	51.04	-	-	75.32	24.28	47.6%	N/A	N/A
OPP	480.59	-	-	506.29	25.70	5.3%	N/A	N/A
IA[3]	352.97	1.95	-	504.90	151.93	43.0%	N/A	N/A
U.S. Arctic Research Commission	1.60	-	-	1.65	0.05	3.1%	N/A	N/A
Research & Related Activities	**$6,602.70**	**$70.00**	**$6,909.77**	**$8,139.71**	**$1,537.01**	**23.3%**	**$1,229.94**	**17.8%**
Education & Human Resources[3]	**$1,084.24**	**$5.00**	**$968.00**	**$1,287.27**	**$203.03**	**18.7%**	**$319.27**	**33.0%**
Major Research Equipment & Facilities Construction	**$154.84**	**-**	**$241.00**	**$249.00**	**$94.16**	**60.8%**	**$8.00**	**3.3%**
Agency Operations & Award Management	**$347.58**	**$1.00**	**$345.64**	**$468.30**	**$120.72**	**34.7%**	**$122.66**	**35.5%**
Office of Inspector General	**$16.30**	**-**	**$17.85**	**$20.42**	**$4.12**	**25.2%**	**$2.57**	**14.4%**
Office of the National Science Board	**$4.43**	**-**	**$4.50**	**$4.60**	**$0.17**	**3.9%**	**$0.10**	**2.2%**
Total, NSF Discretionary Funding	**$8,210.09**	**$76.00**	**$8,486.76**	**$10,169.30**	**$1,959.21**	**23.9%**	**$1,682.54**	**19.8%**
Education and Human Resources - H-1B Visa	114.78	-	157.00	162.47	47.69	41.6%	5.47	3.5%
Donations	21.06	-	40.00	10.00	-11.06	-52.5%	-30.00	-75.0%
Total, NSF Mandatory Funding	**$135.83**	**-**	**$197.00**	**$172.47**	**$36.64**	**27.0%**	**-$24.53**	**-12.5%**
Total, NSF Budgetary Resources	**$8,345.92**	**$76.00**	**$8,683.76**	**$10,341.77**	**$1,995.85**	**23.9%**	**$1,658.01**	**19.1%**