NSF Nuclear Physics Overview

Allena K. Opper

- FY19 Budget – focus on PHY
- Announcements
- Highlights
- Physics Division Personnel

NSF's 10 Big Ideas

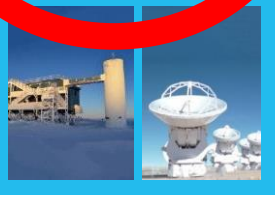
RESEARCH IDEAS

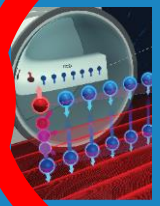
Harnessing Data for 21st Century Science and Engineering

Work at the Human-Technology Frontier: Shaping the Future

Navigating the New Arctic

Windows on the Universe: The Era of Multi-messenger Astrophysics





The Quantum Leap: Leading the Next Quantum Revolution

Understanding the Rules of Life: Predicting Phenotype

PROCESS IDEAS

Mid-scale Research Infrastructure

NSF 2026

Growing Convergence Research at NSF

NSF INCLUDES: Enhancing STEM through Diversity and Inclusion

FY19 Funding for NSF Big Ideas

(Dollars in Millions)

Big Ideas	FY 2019 Request
Research Ideas	**$180.00**
Harnessing the Data Revolution for 21st- Century Science and Engineering - HDR (CISE/ITR)[1]	30.00
Navigating the New Arctic - NNA (GEO/ICER)	30.00
The Future of Work at the Human-Technology Frontier - FW-HTF (ENG/EFMA)[1]	30.00
The Quantum Leap - QL (MPS/OMA)	30.00
Understanding the Rules of Life - URoL (BIO/EF)	30.00
Windows on the Universe - WoU (MPS/OMA)	30.00
Process Ideas	**$102.50**
Growing Convergence Research - GCR (IA)	16.00
Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science - NSF INCLUDES (EHR)	20.00
Mid-Scale Research Infrastructure (IA)	60.00
NSF 2026 Fund (IA)	6.50
Total, NSF Big Ideas	**$282.50**

FY19 PHY $266.73M

(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change Over FY 2017 Actual Amount	Change Over FY 2017 Actual Percent
Total	**$281.43**	**-**	**$266.73**	**-$14.70**	**-5.2%**
Research	**178.57**	**-**	**159.01**	**-19.56**	**-11.0%**
CAREER	10.04	-	7.30	-2.74	-27.3%
Centers Funding (total)	4.60	-	5.00	0.40	8.7%
STC: Center for Bright Beams	4.60	-	5.00	0.40	8.7%
Education	**5.87**	**-**	**4.92**	**-0.95**	**-16.2%**
Infrastructure	**96.99**	**-**	**102.80**	**5.81**	**6.0%**
IceCube Neutrino Observatory (IceCube)	3.50	-	3.50	-	0.0%
Large Hadron Collider (LHC)	16.00	-	16.00	-	0.0%
Laser Interferometer Gravitational Wave Observatory (LIGO)[1]	41.93	-	45.00	3.07	7.3%
National Superconoducting Cyclotron Laboratory (NSCL)	24.00	-	24.00	-	0.0%
Midscale Research Infrastructure	5.85	-	8.00	2.15	36.8%
Pre-construction Planning:					
High-Luminosity LHC Upgrade Planning	5.71	-	6.30	0.59	10.3%

[1]FY 2017 includes one-time supplemental funding of $2.50 million for a critical vacuum repair.

Budget Trends – NSF Nuclear Physics

Includes co-funding and other leveraged funds

~ 25% = Research
~ 75% = Operations

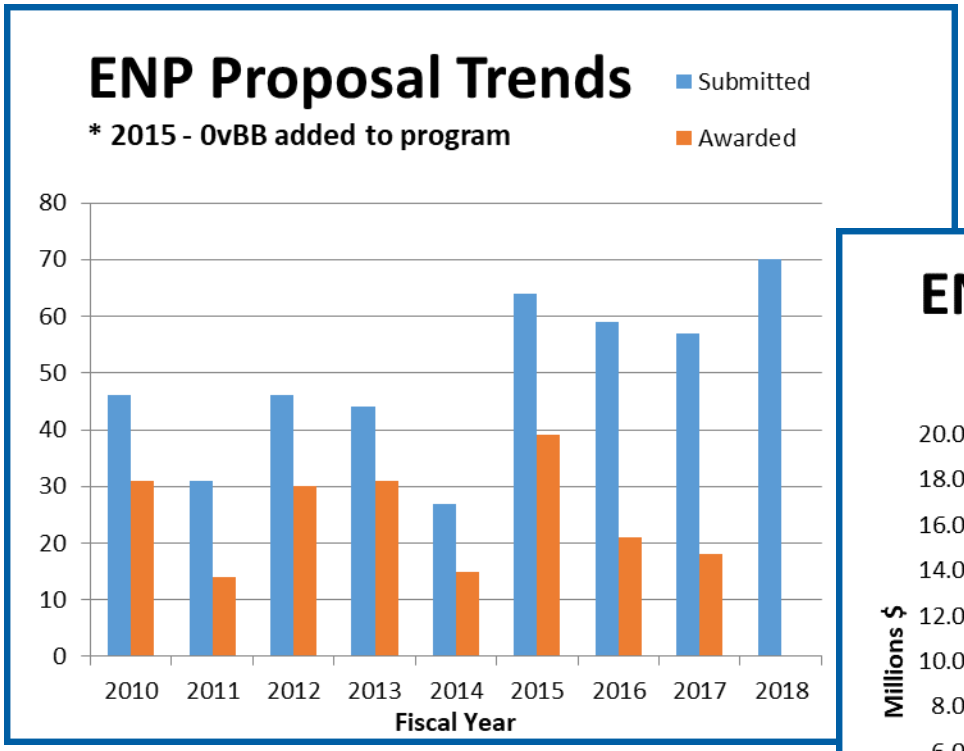
FY	Nucleon & Hadron QCD (k$)	Nuclear Astroph, Reactions, Structure (k$)	Prec Meas'ts & Fund. Symm. (k$)	Total Exp't Nuclear Physics (k$)	Nuclear Theory (k$)	Nuclear Program Total (k$)	NSCL (k$)	JINA & JINA -CEE (k$)	MRI (K$)	Mid-Scale (K$)	Total Nuclear Physics (k$)
2012	7,969	4,185	6,343	18,497	3,829	22,326	21,500	2,150	2,744		48,720
2013	6,183	4,693	5,653	16,509	3,474	20,008	21,500	2,150	2,996	490	47,144
2014	5,826	5,189	5,999	17,014	3,514	20,528	22,500	2,280	1,038	1,188	47,533
2015	6,769	4,702	7,304	18,774	4,183	22,957	23,000	2,280	1,801	1,367	51,406
2016	7,141	5,046	7,391	19,579	4,223	23,802	24,000	2,280	1,869	3,238	55,189
2017	6,955	6,273	6,692	19,920 base = 17,800	4,344	24,264	24,000	2,280	530	2,990	54,064

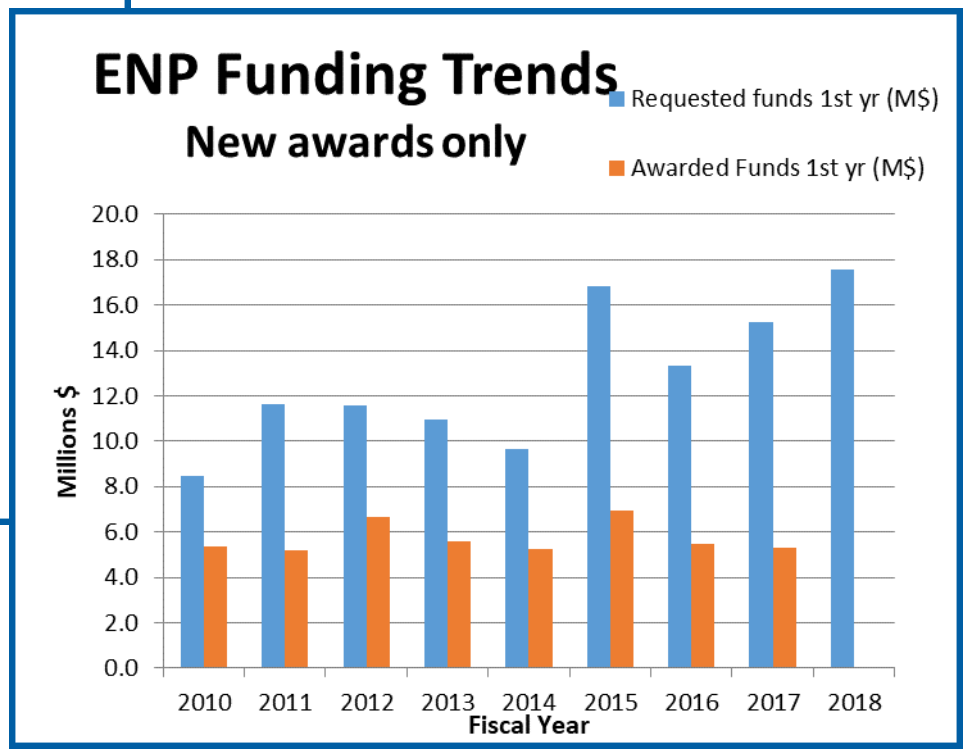
FY15 Fundamental Symmetries: + $1.32M for $0\nu\beta\beta$

MRI: competes each year; one-time acquisition/development funds

Mid-scale: ad hoc competition; design and construction funds (nEDM & MUSE)

Experimental Nuclear Physics





Career Program

- Solicitation: 17-537
- Must include excellent research proposal as well as excellent educational plan
- There are eligibility requirements: e.g., must be assistant professor, untenured
- 5 year awards, $400,000 minimum
- Proposal deadline: **July 20, 2018**
- PECASE nominees are chosen from CAREER winners
- Contact program officer for information/advice ahead of time (budget, scope)

AGEP GR *Supplements*

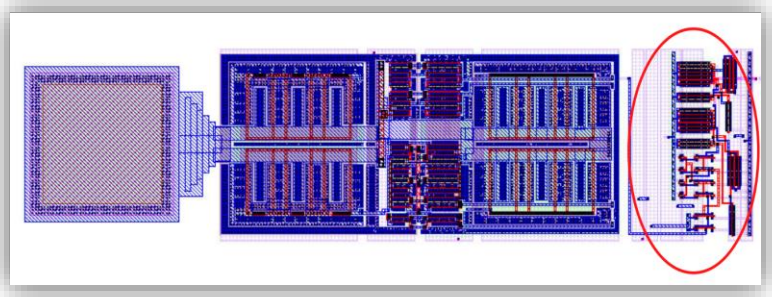
- Available to PIs at AGEP or AGEP Legacy Institutions
  https://www.nsf.gov/mps/broadening_participation/index.jsp
- Graduate Student Eligibility
  - Emphasis placed on under-represented groups
  - Not currently supported by federal government (NSF, DOE, NIH, …)
  - US Citizen, US National, or US Permanent Resident
- Stipend, tuition, benefits, and IDC (~$60k)
- Renewable up to two times

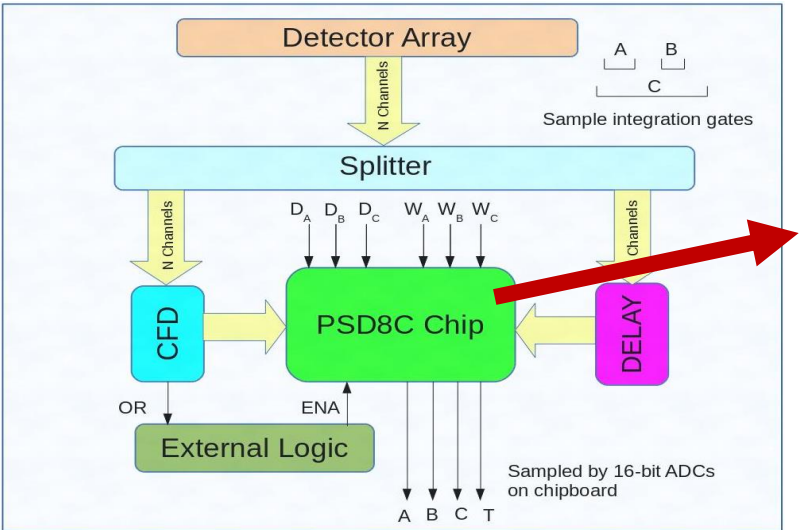
See us and DCL 16-125 for more information

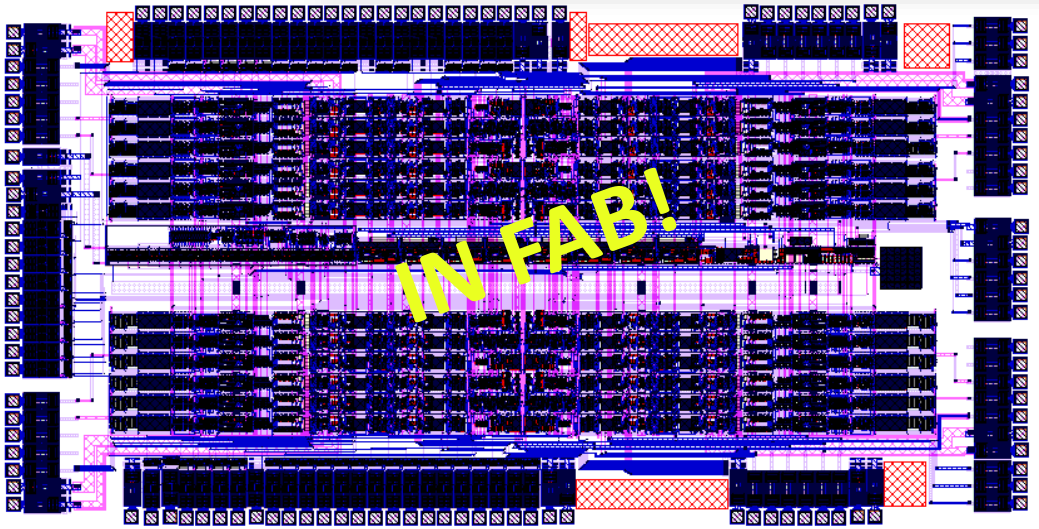
Highlights – MRI Awards

Development: ASIC Suite for Analog Processing of Signals from Large Arrays of Silicon-Strip Detectors and PSD-Capable Scintillators

- 16 ch HI chip, improved resolution and high dynamic range; Si strip use
- 8 ch PSD IC w/ PID;
  scintillator use



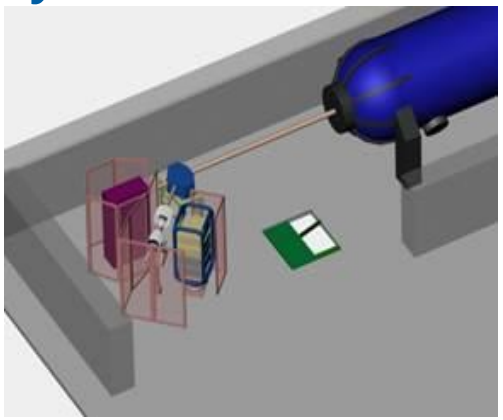




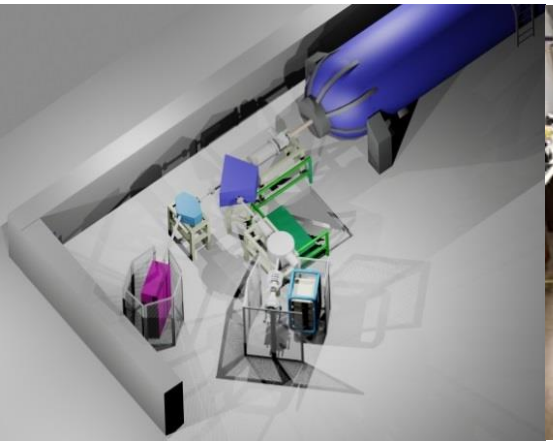
Highlights – MRI Awards

Development: 45˚Electrostatic Analyzer and Modification of Low Energy Injection System

- Higher mass resolution → improved isotopic selectivity
- Improved sensitivities



Pre-upgrade layout



Post upgrade layout. In the photo the FN tank can be seen towards the back

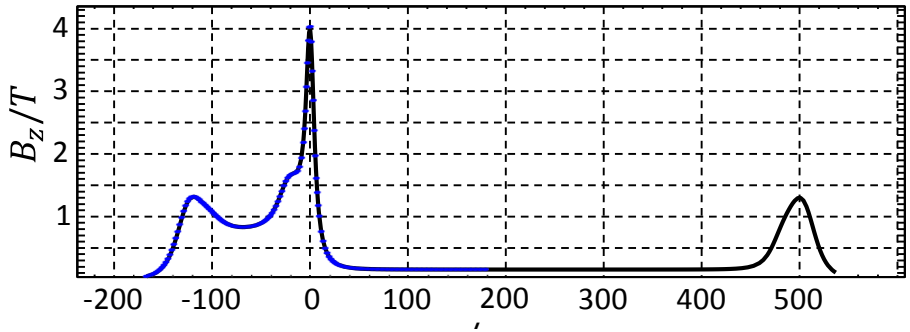
Highlights – MRI Awards

Nab Expt @ SNS

- Measure n decay parameters a & b

  → $\lambda = g_A/g_V$

- Novel scalar and tensor interactions
- MRI → spectrometer



Commissioning & data taking expected to start in late 2018.

Highlights

Super-Enge Split-Pole Spectrograph (Yale) → FSU Tandem-LINAC

- High resolution, high acceptance
- FSU & LSU collaboration


Spectrograph Assembly 1/2017

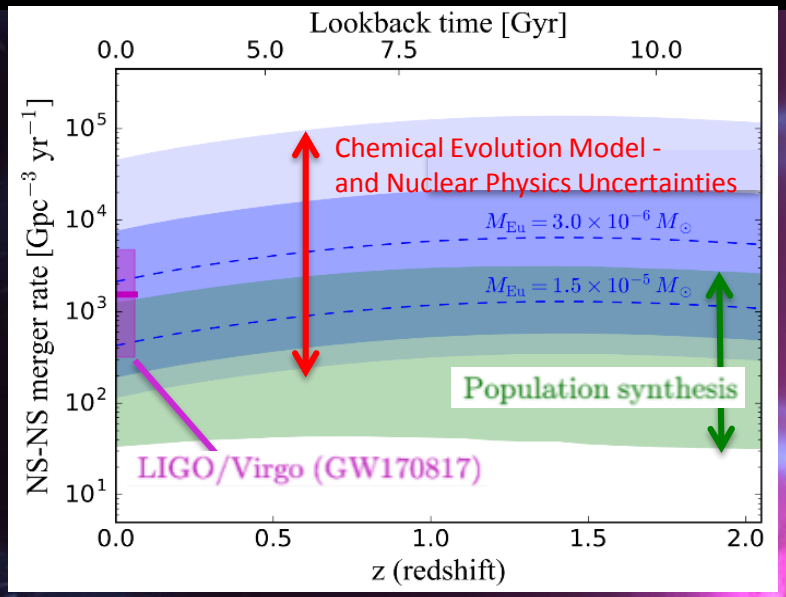

"First Light" March 2, 2018

- "First Light" March 2018: α from ^{228}Th detected @ focal plane, dispersed thru spectrograph

JINA-CEE NSF Physics Frontiers Center

Nuclear Astrophysics in the era of Gravitational Wave Astronomy: Understanding the origin of the elements

Connecting Nuclear Physics, Observations, Chemical evolution models, and LIGO data



→ Concordance of required merger rates and LIGO constraints
→ Uncertainties are large
→ Need future work on nuclear and model uncertainties (and more GW observations with EM counterpart)

Livestream Panel on Implications for Nuclear Science

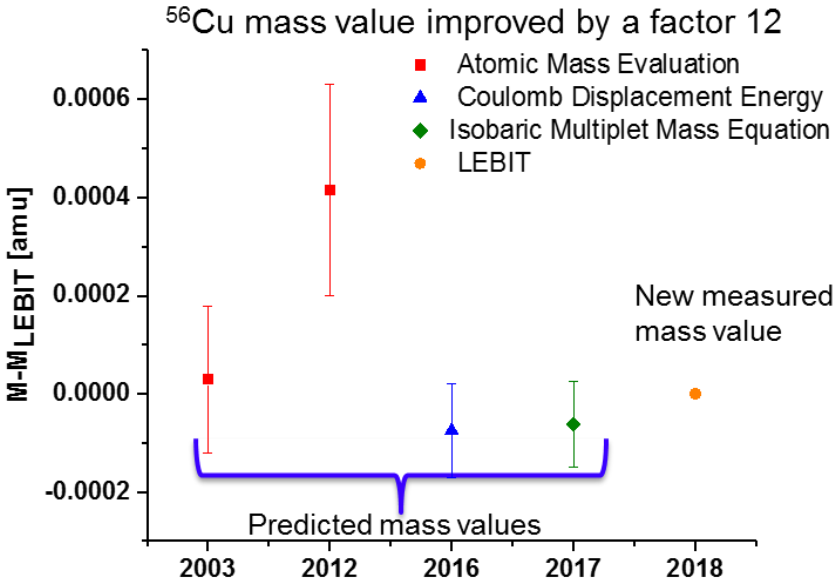
400 live participants, 930 views, jinaweb.org/gwnuclear

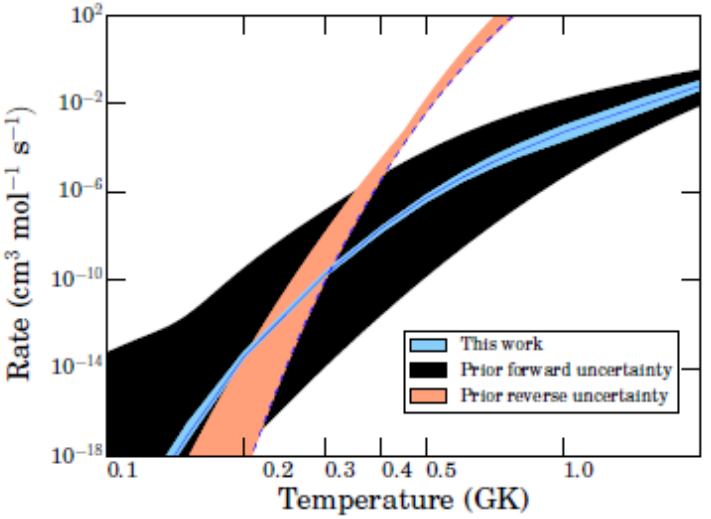
Multi-messenger observations a major opportunity for nuclear science
→ Use nuclear data (NSCL/FRIB, ANL) to determine elements made in GW170817 & to tease out astrophysical conditions from observations
→ Combine GW constraints on neutron stars with nuclear exp. data

Highlights

High Precision Mass Measurements Pin Down Nucleosynthesis in Stellar Explosions

- ^{56}Cu mass critical for reaction rates & pathway of rp-capture; occurs in binary star systems, fuels XRB
- Meas'd @ LEBIT → reduce uncert in ^{55}Ni(p,γ)^{56}Cu rate
- rp-process calcs → heavier elems produced more quickly than previously thought





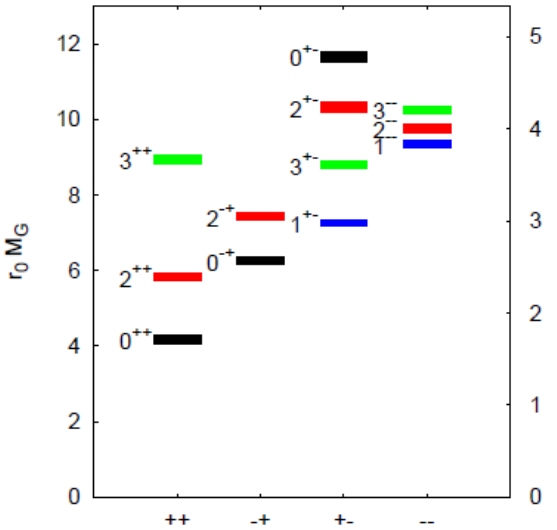
Rate uncertainty for the ^{55}Ni(p,γ)^{56}Cu reaction. Both the forward and reverse rates are shown.

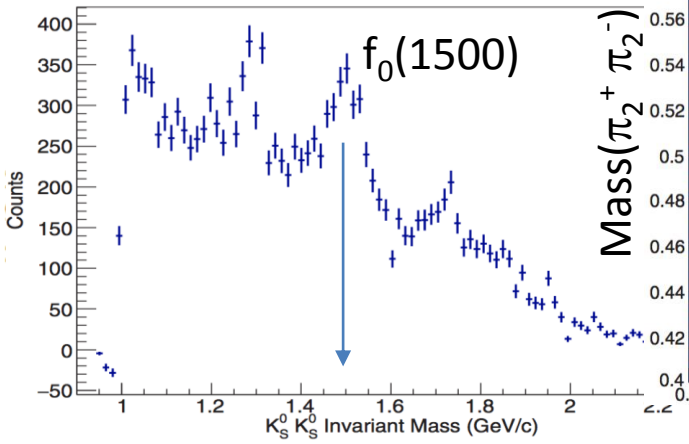
Highlights

Scalar Mesons and Glueballs from CLAS

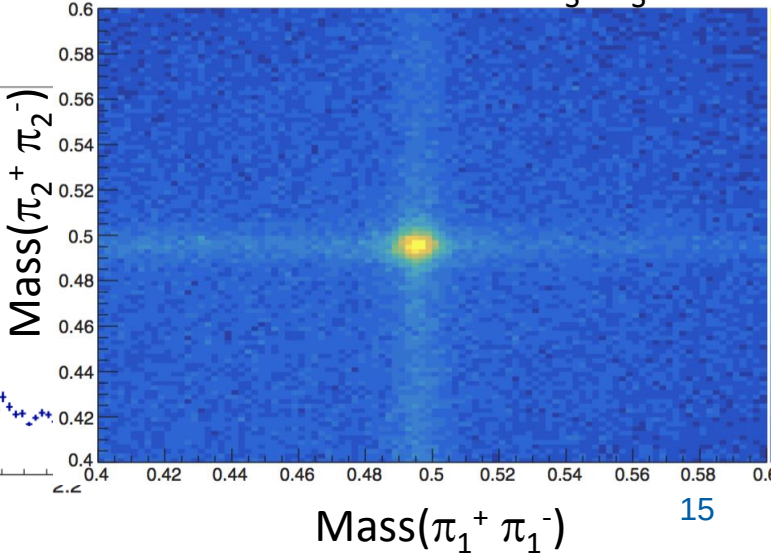
- There are **4 isoscalar states** identified by experiment: $f_0(980)$, $f_0(1370)$, $f_0(1500)$ and $f_0(1710)$
- There are **only 2** slots for the f_0 states in the quark model

- Result: $f_0(1500)$ strong t-channel coupling to γ → it does NOT have significant glueball mixing
- S. Chandavar (CLAS), PRC 97 025203 (2018)





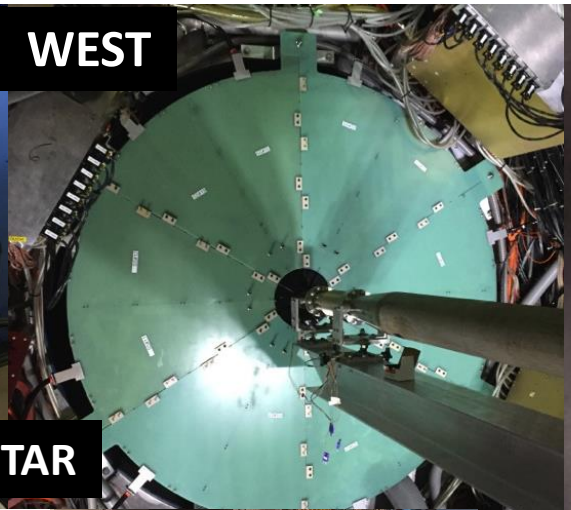
Clear coincidence K_S^0 K_S^0



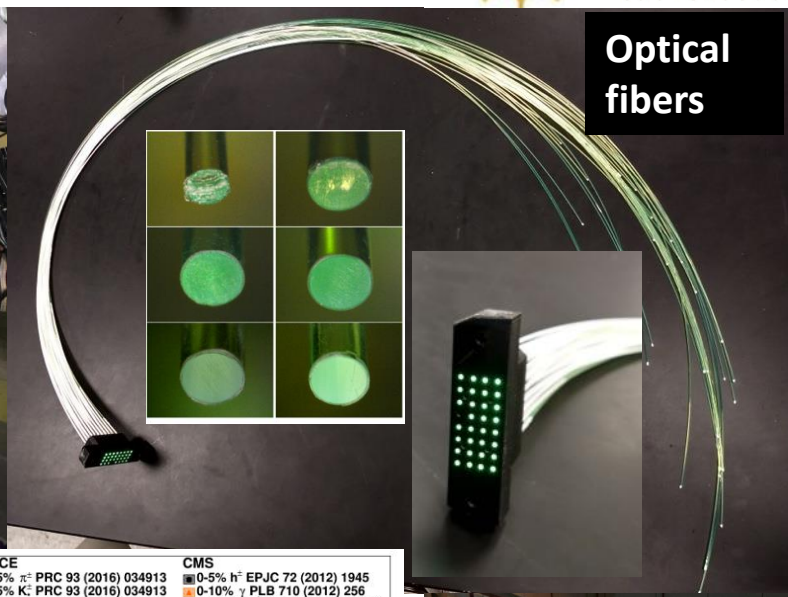
Lehigh Reed Group @ STAR+sPHENIX

Rosi Reed

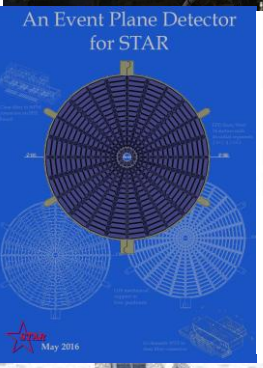
EAST WEST

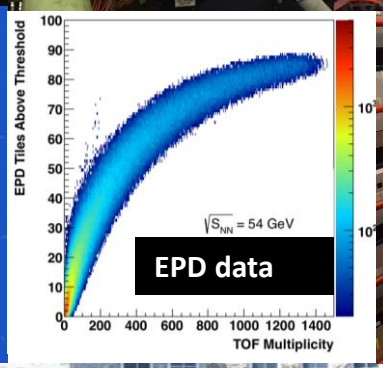


EPD@STAR



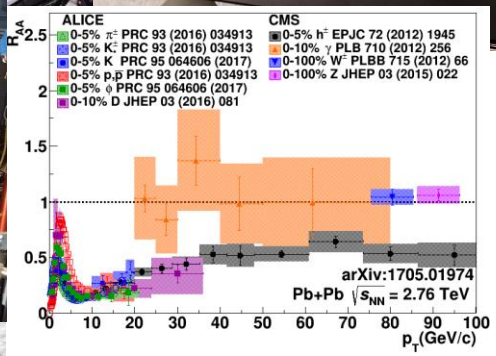
Optical fibers

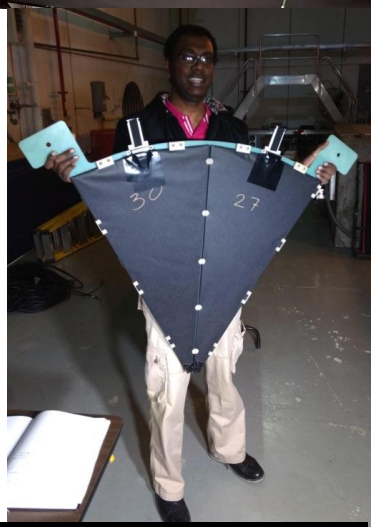




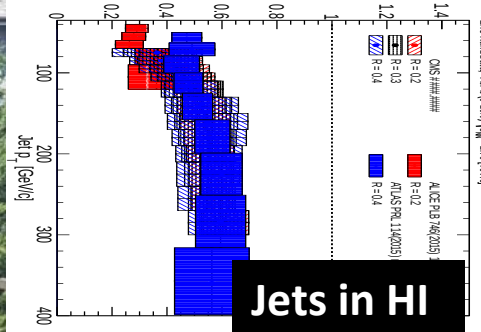
EPD data

EPD Integration





Lehigh Group + REU students

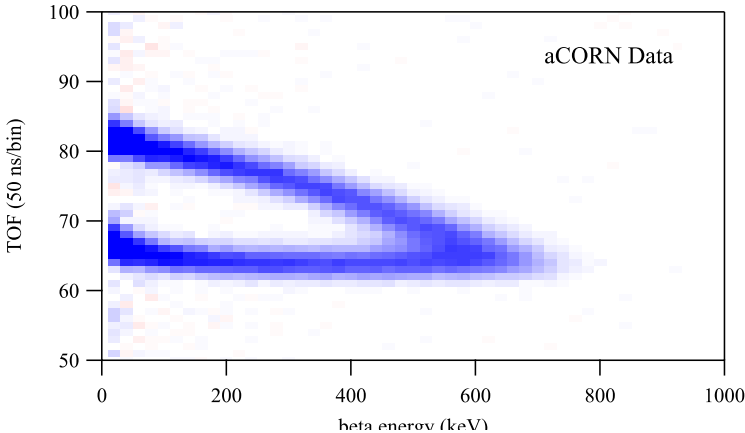


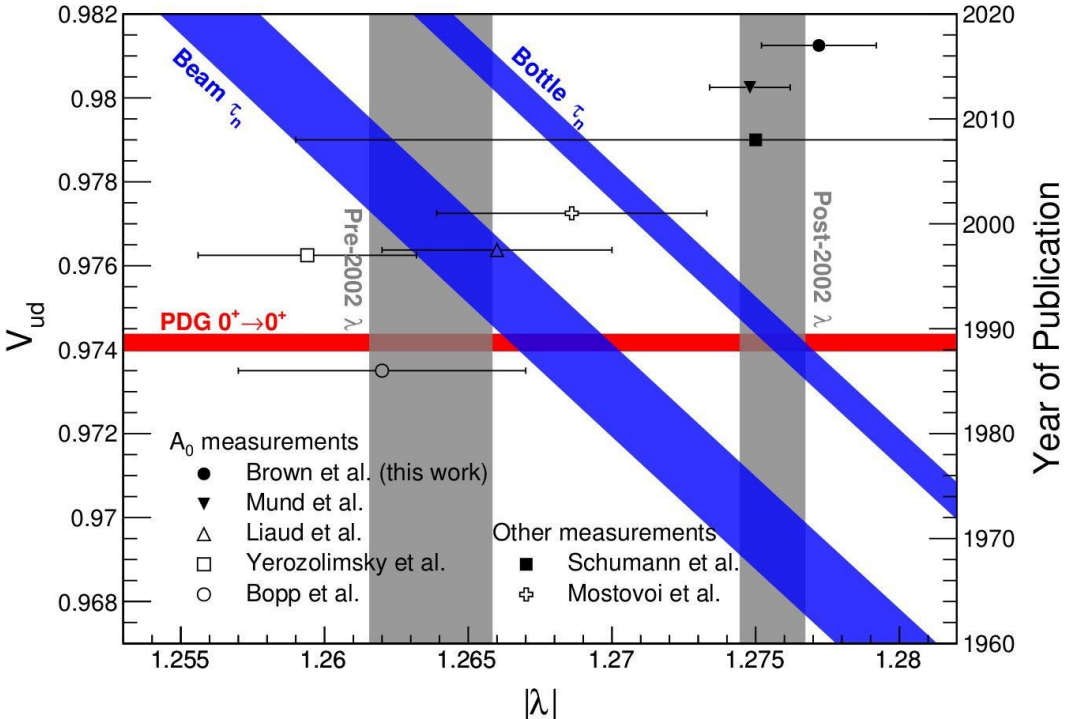
Jets in HI

Prashanth Shanmuganatha

Highlights –
Precision meas'ts w/ cold & ultracold neutrons

- aCORN: e-$\bar{\nu}$ corr'n @ NIST
  - a = -0.1090 ± 0.0030 (stat) ± 0.0028 (sys)
  - G. Darius, et al. , PRL 119, 042502 (2017)
  - 2015-2016 run: 10 X data
- UCNTau @ LANL
  - τ_n = 877.7 ± 0.7 (stat) +(
  - 2017-2018 data set
- UCNA @ LANL
  - $A_0 = -0.12054(44)_{stat}(68)_s$
  - $\lambda = g_A/g_V = -1.2783(22)$





Joint DOE/NSF Statement on 0νββ

Neutrinoless double beta decay (NLDBD) is one of the most compelling and challenging topics in physics and was identified as one of a limited number of recommendations made in the most recent NSAC Long Range Plan for Nuclear Physics (2015). The Office of Nuclear Physics at DOE and the Division of Physics at NSF currently support first generation NLDBD experiments and R & D leading to next generation experiments. *The optimal utilization of national resources in support of NLDBD requires coordination between the agencies.* The NSAC Subcommittee on Neutrinoless Double Beta Decay (NLDBD) has established the criteria for down selecting the most promising technology approach to the next generation experiments, assessed the critical R & D needs for each candidate technology, and recommended support for R & D aimed at solving specific technical issues relevant to the down selection. Meanwhile, significant technological progress has been made with many demonstrators now operational.

Funding availability now demands that more focused efforts be taken, with priority given to proposals related to technologies that are projected to reach the above referenced down-select criteria in a timely manner and to proposals for staged approaches using current generation technologies that have discovery potential. The agencies intend to move forward and continue their coordinated approach with this perspective.

NSF/MPS/Physics Personnel

- France Córdova – Director
- Anne Kinney – Assistant Director for MPS
- Denise Caldwell – Physics Division Director
- Brad Keister – Deputy Division Director
- Bogdan Mihaila – Nuclear Theory Program Director
- Edmundo Garcia – Expt'l Nuclear Physics Program Director
- Allena Opper – Expt'l Nuclear Physics Program Director

http://www.nsf.gov/pubs/2015/phy15001/phy15001.jsp?org=PHY

http://www.nsf.gov/careers/rotator/index.jsp

For the latest updates, check out

http://www.nsf.gov/div/index.jsp?div=PHY

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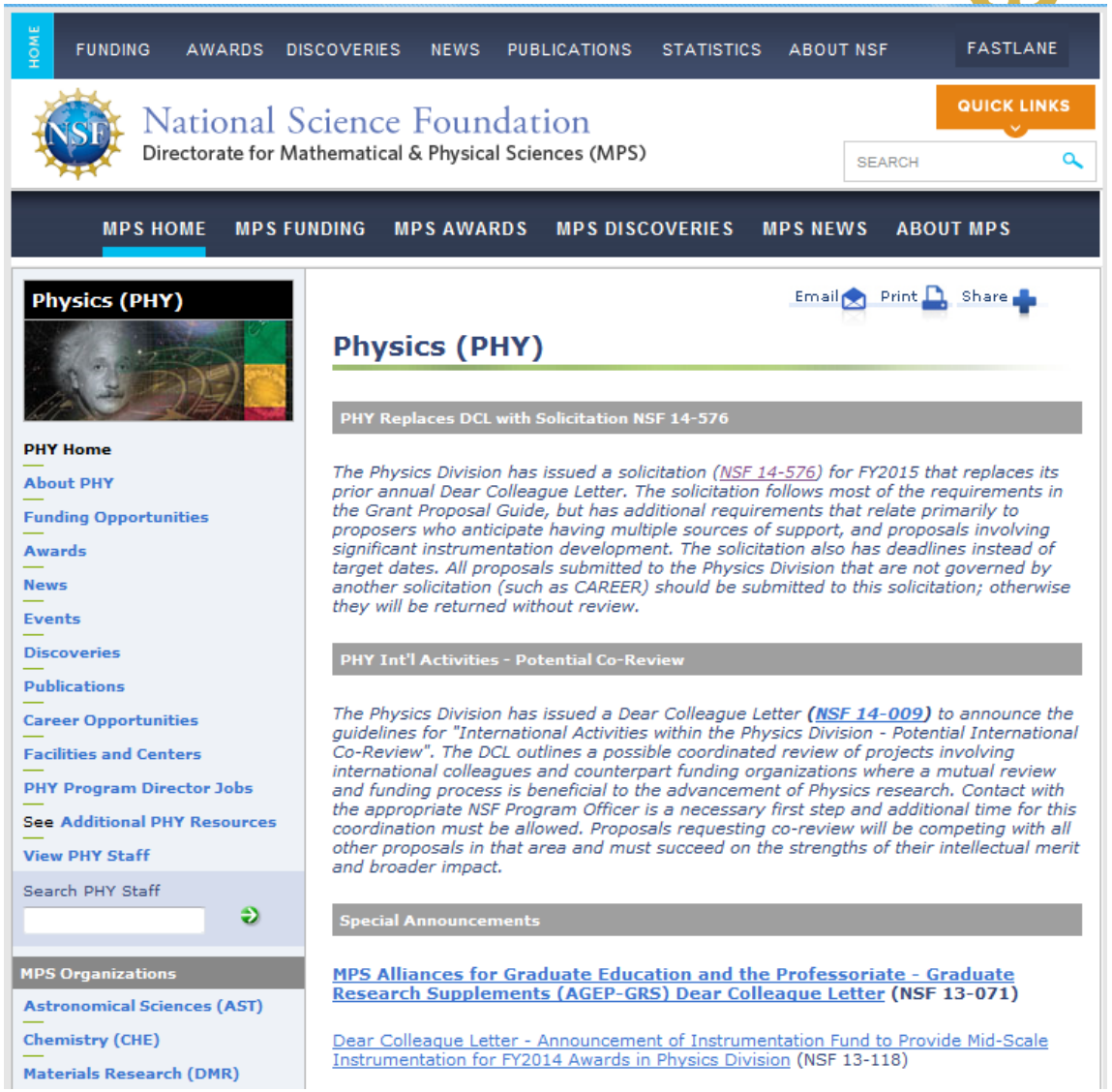

Backup Slides

FY19 NSF Request $7,472 M

NATIONAL SCIENCE FOUNDATION
SUMMARY TABLE
FY 2019 BUDGET REQUEST TO CONGRESS
(Dollars in Millions)

NSF by Account	FY 2017 Actual	FY 2018 Annualized CR	FY 2019 Request	FY 2019 Request change over FY 2017 Actual Amount	Percent
Research & Related Activities	$6,006.51	$5,992.67	$6,150.68	$144.17	2.4%
Education & Human Resources	$873.37	$874.02	$873.37	-	-
Major Research Equipment & Facilities Construction	$222.78	$207.58	$94.65	-$128.13	-57.5%
Agency Operations & Award Management	$382.06	$327.76	$333.63	-$48.43	-12.7%
National Science Board	$4.27	$4.34	$4.32	$0.05	1.2%
Office of Inspector General	$15.10	$15.10	$15.35	$0.25	1.6%
Total, NSF	$7,504.10	$7,421.47	$7,472.00	-$32.10	-0.4%