

NSF Nuclear Physics Overview



Allena K. Opper

- Announcements
- Budget – focus on PHY
- Announcements



NSF/MPS/Physics Personnel

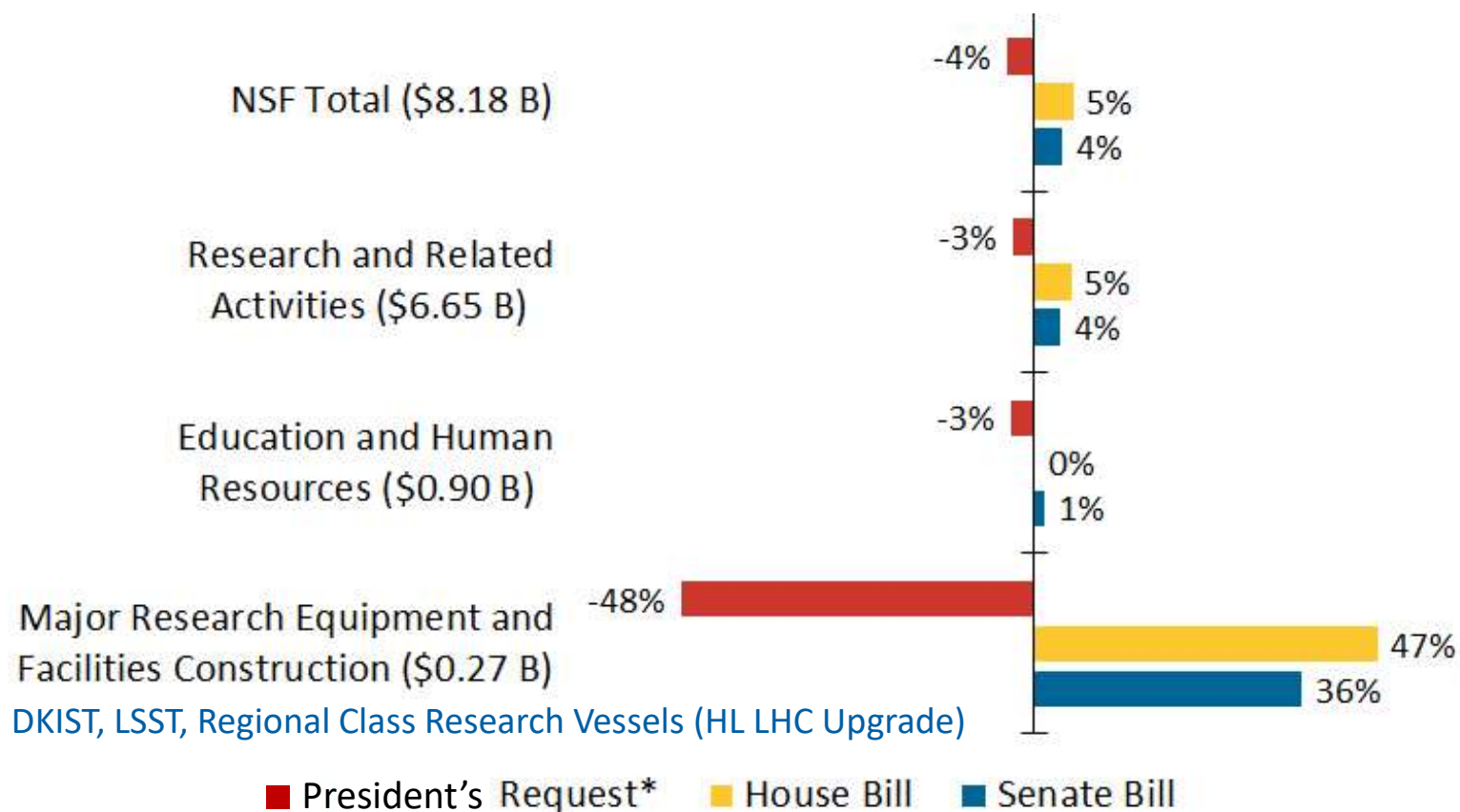
- **France Córdova** – Director
- **Anne L Kinney** – Assistant Director for MPS
- **Denise Caldwell** – Physics Division Director
- ★ **Jean Cottam Allen** – Acting Deputy Division Director
- **Bogdan Mihaila** – Nuclear Theory Program Director
- ★ **Jim Thomas** – Expt'l Nuclear Physics Program Director
- **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>



NSF FY19 Spending Proposals (% change from FY18 enacted) \$ in () = FY18 House Marks



*The administration submitted the budget request to Congress before the final amounts for fiscal year 2018 were set.

FY19 PHY \$266.73M



(Dollars in Millions)

| | FY 2017 Actual | FY 2018 (TBD) | FY 2019 Request | Change Over FY 2017 Actual | |
|--|-------------------|------------------|--------------------|-------------------------------|---------------|
| | | | | Amount | 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 Superconducting 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% |

¹FY 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 | 4,344 | 24,264 | 24,000 | 2,280 | 530 | 2,990 | 54,064 |
| 2018 | 7,160 | 5,058 | 7,700 | 19,908 base = 17,800 | 4,384 | 24,291 | 24,000 | 2,280 | 3,970 | 5,249 | 59,791 |

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

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

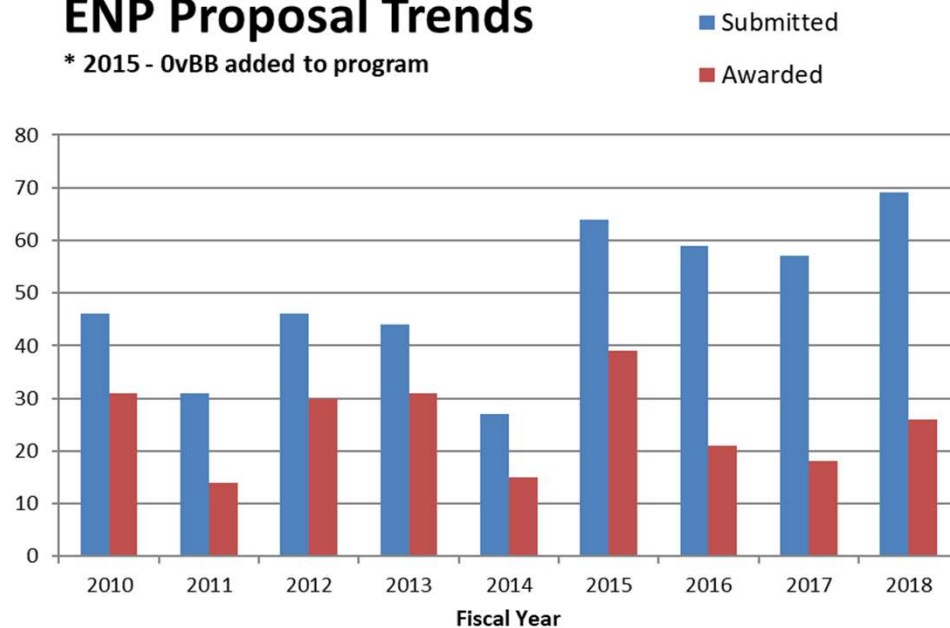
Mid-scale: ad hoc competition; design and construction funds (L-200, MUSE, nEDM)

Experimental Nuclear Physics



ENP Proposal Trends

* 2015 - 0vBB added to program

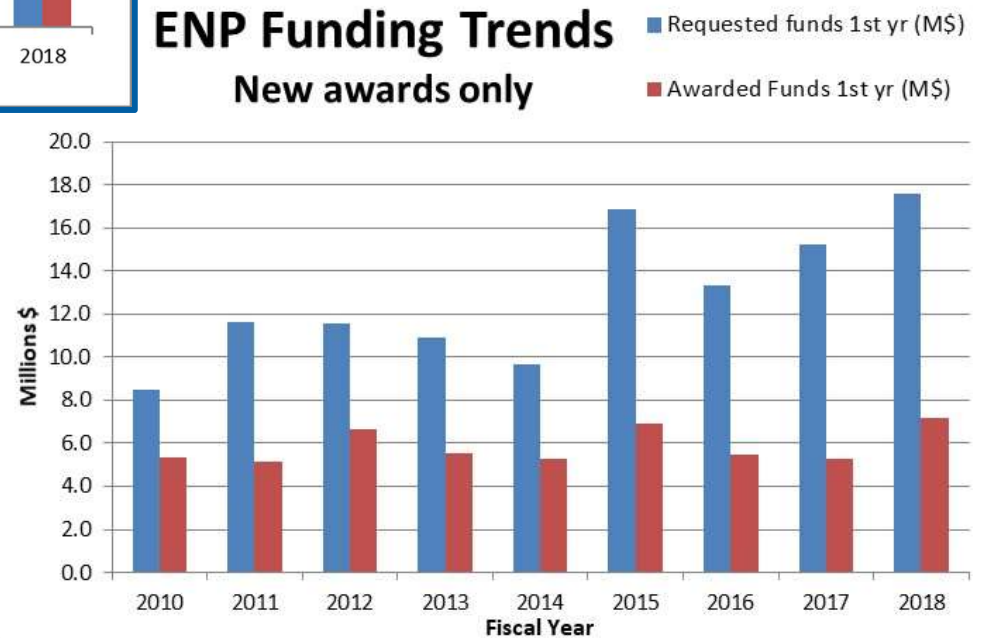


Proposal pressure

Funding pressure

ENP Funding Trends

New awards only

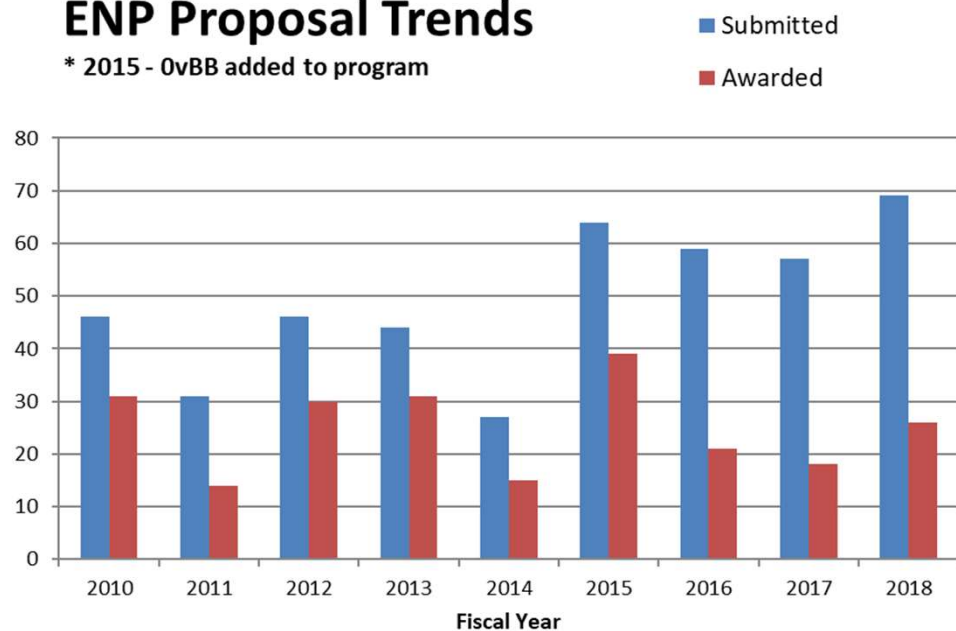


Experimental Nuclear Physics



ENP Proposal Trends

* 2015 - 0vBB added to program



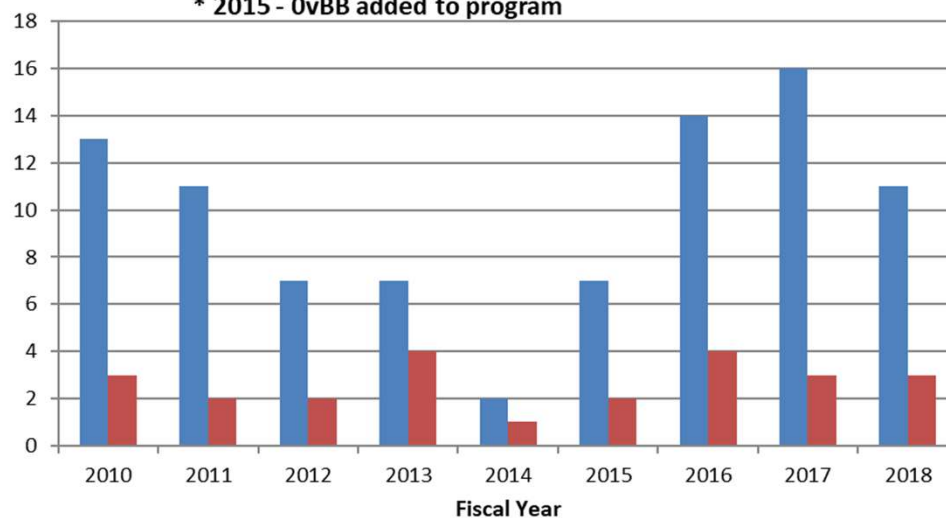
Proposal pressure

Funding pressure
for new PIs

ENP Proposal Trends

- new PIs

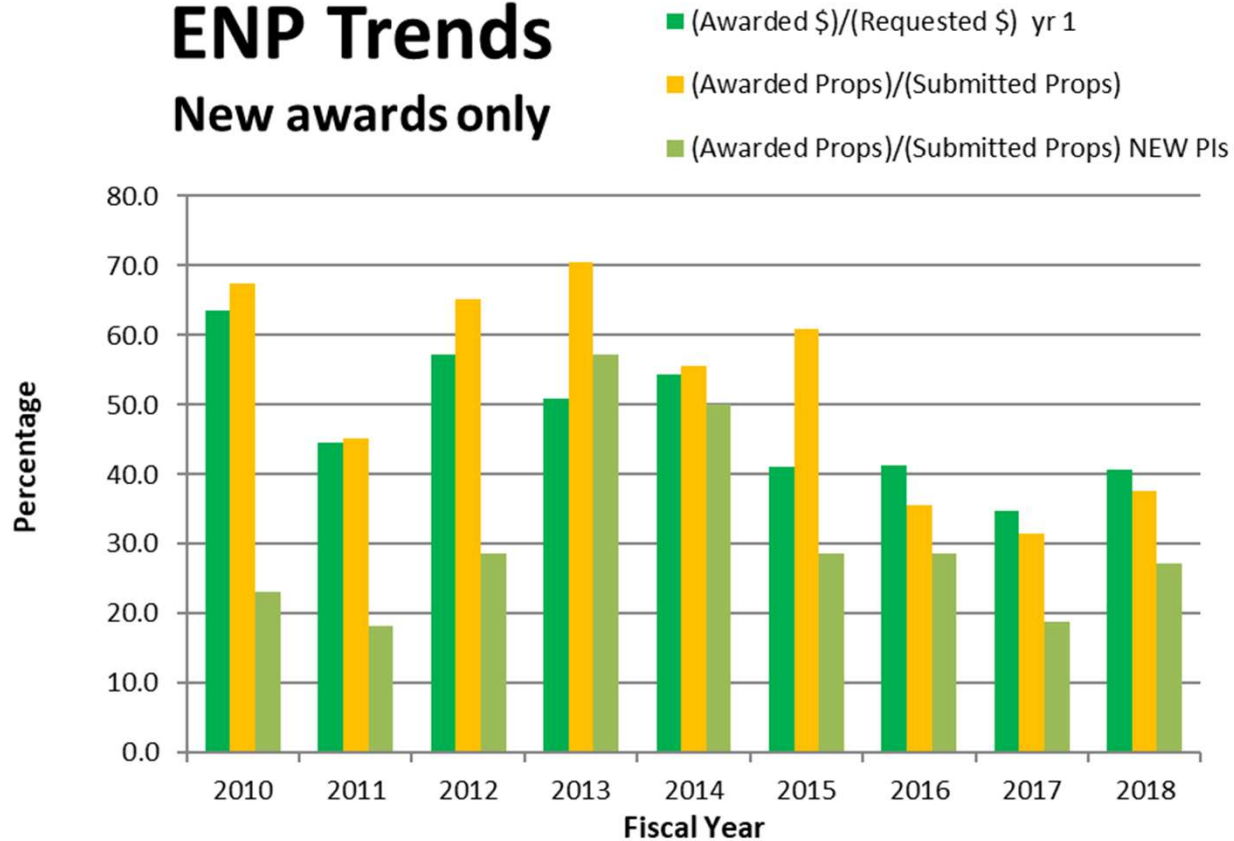
* 2015 - 0vBB added to program



Experimental Nuclear Physics



ENP Trends New awards only



Since ~ 2013:
\$ requested > 2 X \$ avail

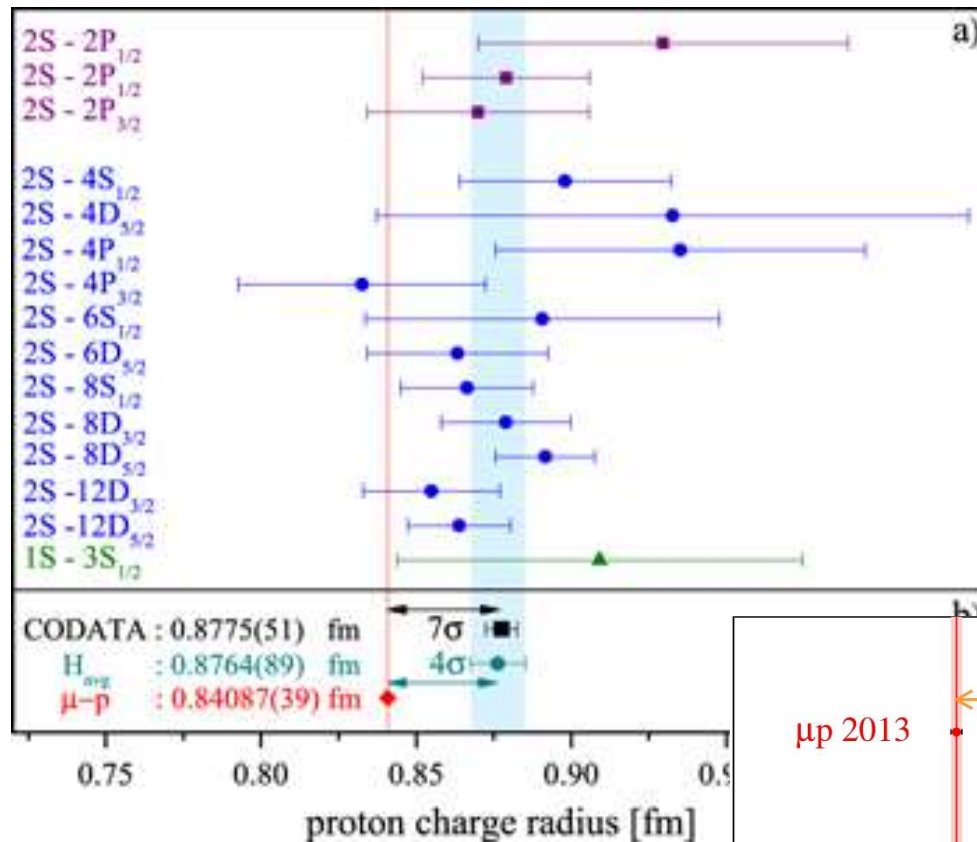
Since 2016:
Proposal
funding rate < 40%

Funding rate of new PIs
~ tracks rate of
established PIs



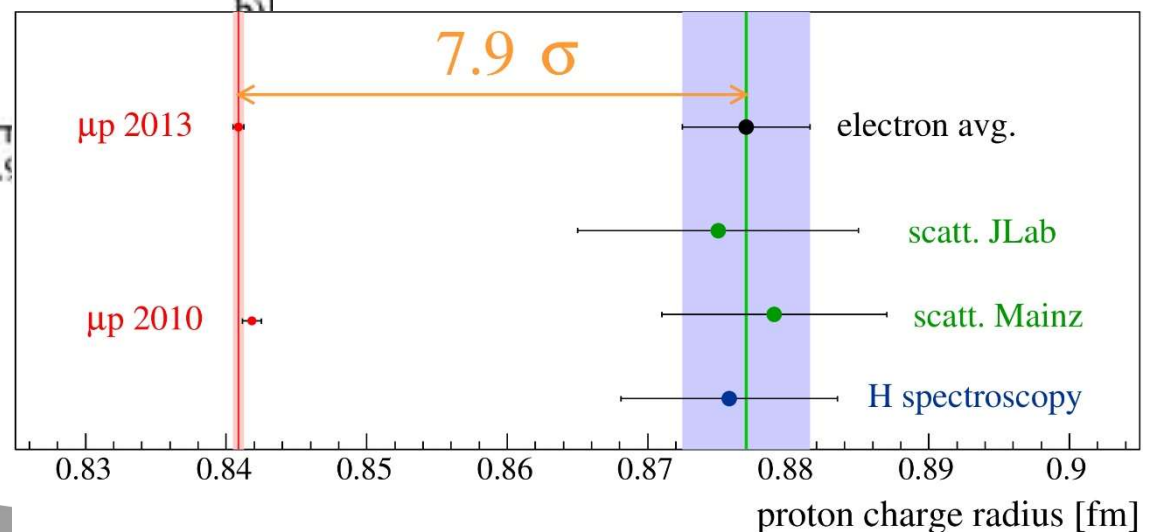
Proton Charge Radius “Problem”

Atomic meas't μ -H \rightarrow p radius 7σ smaller than e-H



and elastic e-p scattering

$$\langle r_p^2 \rangle = 6 \frac{dG_E^p(Q^2)}{dQ^2} \Big|_{Q^2=0}$$



Proton Charge Radius “Problem”



Critically important quantity for:

- nuclear physics (QCD, Lattice, ...)
- atomic physics (QED, Lamb shifts, ...)
- directly **correlated to the Rydberg constant**
(the most accurately known constant in physics)
- potential for “**New Physics**”

Two nuclear physics experiments to address this:

- Simultaneous elastic e-p & μ -p scattering
 - MUSE @ PSI – Dec 2018: final commissioning
- Elastic e-p scattering @ low momentum transfer
 - PRad @ JLab – completed

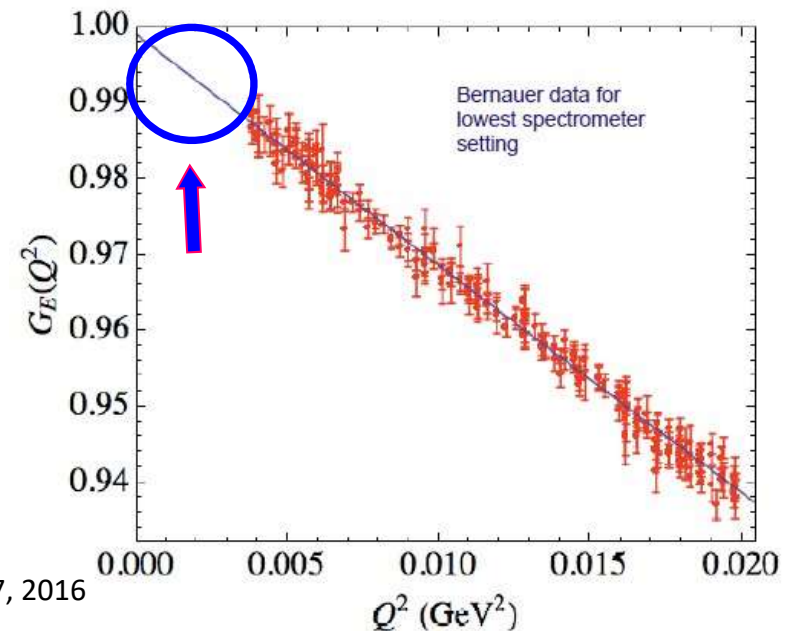
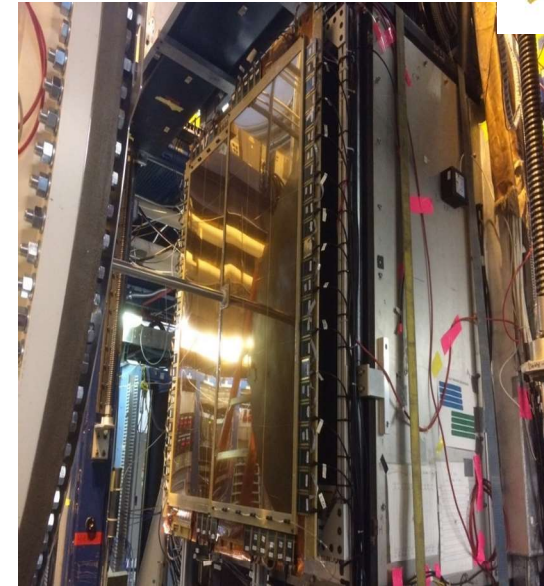




PRad Experiment @ JLab Hall B



- PRad goals:
 - large Q^2 range in 1 experimental setting
 - very low Q^2 range ($\sim 10^{-4}$ GeV/C²)
 - sub-percent precision in cross section
- PRad solutions:
 - high resolution, high acceptance calorimeter:
 - smaller scattering angles: ($\vartheta_e = 0.7^\circ - 7.0^\circ$):
($Q^2 = 2 \times 10^{-4} - 6 \times 10^{-2}$) GeV/c²)
 - simultaneous detection of $ee \rightarrow ee$ Moller scattering (control of systematics)
- Use high density windowless H₂ gas flow target:
 - beam background under control
 - minimize experimental background



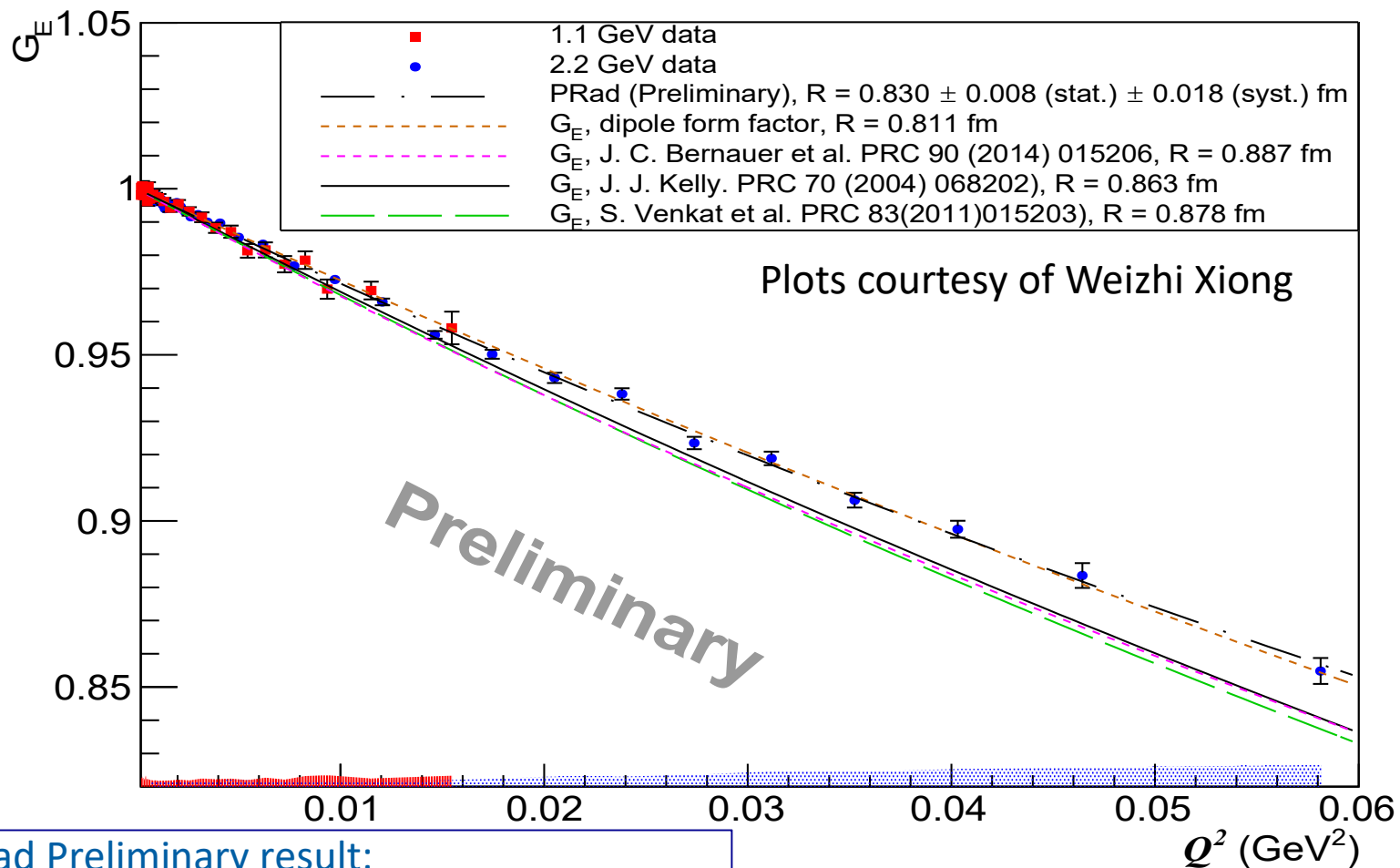
$$\langle r_p^2 \rangle = 6 \left. \frac{dG_E^p(Q^2)}{dQ^2} \right|_{Q^2 = 0}$$

Mainz low Q^2 data set
Phys. Rev. C 93, 065207, 2016



Proton Charge Radius "Problem"

Proton Electric Form Factor G_E

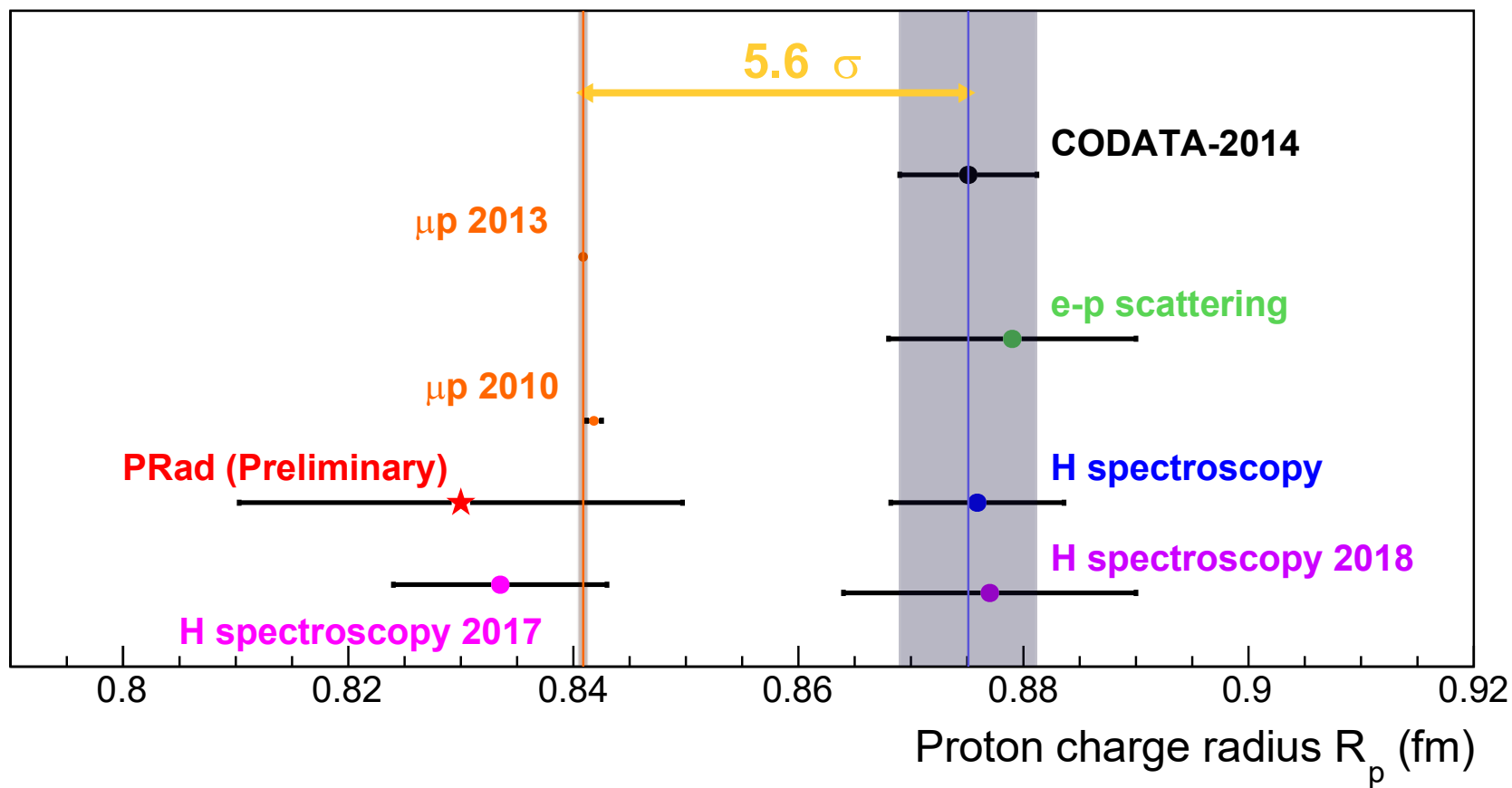


PRad Preliminary result:
 $R_p = 0.830 \pm 0.008$ (stat.) ± 0.018 (syst.) fm

Nilanga Liyanage 2018 DNP Meeting



Proton Charge Radius “Problem”



PRad Preliminary result:
 $R_p = 0.830 \pm 0.008$ (stat.) ± 0.018 (syst.) fm

Nilanga Liyanage 2018 DNP Meeting



Solicitation for NSF Physics Division Investigator-Initiated Research Projects 18-564

All proposals submitted to the Division of Physics programs must go through this solicitation.

- **Deadlines:**
 - **December 4, 2018** for Particle Astrophysics, Elementary Particle Physics, *Experimental & Theoretical Nuclear Physics*
- Has text on **Midscale Instrumentation & Long Duration Efforts**
- Follow Proposal & Award Policies & Procedures Guide (PAPPG)
https://www.nsf.gov/pubs/policydocs/pappg17_1/index.jsp
 - Follow the Proposal Preparation checklist
- Collaborators and Other Affiliations Template
- Follow instructions that are specific to this solicitation

Major Research Instrumentation (MRI) NSF 18-513



- Two tracks:
 - Track 1 \$100 k < \$ from NSF < \$1 M; max of 2/university
 - Track 2 \$1 M < \$ from NSF < \$4M; max of 1/university
- Two types: development and acquisition
- Contact program directors well ahead of submission to discuss (avoid pitfalls)
- Maximum award is \$4M; awards above \$1M compete across the entire Foundation
- Due date **January 22, 2019**

FY18

- *Physics: 34 proposals, 10 in ENP (7 for > \$1M)*
 - *Nathan Frank: Development of a Charged Particle Telescope ~ \$83k*
 - *Zach Meisel: He Ion Source Upgrade ~ \$187k*
 - *David DeMille: Cold molecule Nuclear Time Reversal EXperiment ~ \$1.2M*
 - *Chen-Yu Liu: Room Temp nEDM ~ \$ 2.2M*

Alliances for Graduate Education and the Professoriate (AGEP)



The AGEP program goal is to increase the number of historically underrepresented minority faculty, in specific STEM disciplines and STEM education research fields, by advancing knowledge about pathways to career success. **See NSF 16-662 for details.**

AGEP GR Supplements to MPS awards

- 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

Writing proposals: Mentoring program



GOAL: make the proposal writing expertise of senior researchers available to junior investigators

How does it work?

- The Mentee requests a Mentor (email us at aopper@nsf.gov or jhthomas@nsf.gov).
- We will send a list of Mentor Volunteers to Mentee, who contacts Mentors without identifying them to NSF.
- **The Mentor will read the Mentee's proposal and provide feedback once. Send the proposal early – Mentors are busy people!**
- NSF accepts no responsibility on the interaction/outcome of the program!

Needed: Mentors!

email us at aopper@nsf.gov or jhthomas@nsf.gov



For the latest updates, check out
<https://www.nsf.gov/div/index.jsp?div=PHY>

Contact us:

- bmihaila@nsf.gov
or call (703)292-8235
- jhthomas@nsf.gov
or call (703)292-2911
- aopper@nsf.gov
or call (703)292-8958

The screenshot shows the NSF website interface. At the top, there is a navigation bar with links for HOME, FUNDING, AWARDS, DISCOVERIES, NEWS, PUBLICATIONS, STATISTICS, ABOUT NSF, and FASTLANE. Below this is the NSF logo and the text "National Science Foundation Directorate for Mathematical & Physical Sciences (MPS)". A search bar and a "QUICK LINKS" button are also visible. The main content area is titled "Physics (PHY)" and includes a sub-header "PHY Replaces DCL with Solicitation NSF 14-576". The text below this header states: "The Physics Division has issued a solicitation (NSF 14-576) for FY2015 that replaces its prior annual Dear Colleague Letter. The solicitation follows most of the requirements in the Grant Proposal Guide, but has additional requirements that relate primarily to proposers who anticipate having multiple sources of support, and proposals involving significant instrumentation development. The solicitation also has deadlines instead of target dates. All proposals submitted to the Physics Division that are not governed by another solicitation (such as CAREER) should be submitted to this solicitation; otherwise they will be returned without review." Below this is another section titled "PHY Int'l Activities - Potential Co-Review" with text: "The Physics Division has issued a Dear Colleague Letter (NSF 14-009) to announce the guidelines for 'International Activities within the Physics Division - Potential International Co-Review'. The DCL outlines a possible coordinated review of projects involving international colleagues and counterpart funding organizations where a mutual review and funding process is beneficial to the advancement of Physics research. Contact with the appropriate NSF Program Officer is a necessary first step and additional time for this coordination must be allowed. Proposals requesting co-review will be competing with all other proposals in that area and must succeed on the strengths of their intellectual merit and broader impact." At the bottom of the page, there is a "Special Announcements" section with two links: "MPS Alliances for Graduate Education and the Professoriate - Graduate Research Supplements (AGEP-GRS) Dear Colleague Letter (NSF 13-071)" and "Dear Colleague Letter - Announcement of Instrumentation Fund to Provide Mid-Scale Instrumentation for FY2014 Awards in Physics Division (NSF 13-118)". On the left side of the page, there is a sidebar with a "Physics (PHY)" header and a list of links: PHY Home, About PHY, Funding Opportunities, Awards, News, Events, Discoveries, Publications, Career Opportunities, Facilities and Centers, PHY Program Director Jobs, See Additional PHY Resources, and View PHY Staff. There is also a search bar for PHY Staff.