Comments from NSF

Allena K Opper

- NSF Nuclear Physics Program Scope
- Announcements
  - New Solicitation
- Budget
- Physics Division Personnel

Nuclear Physics @ NSF

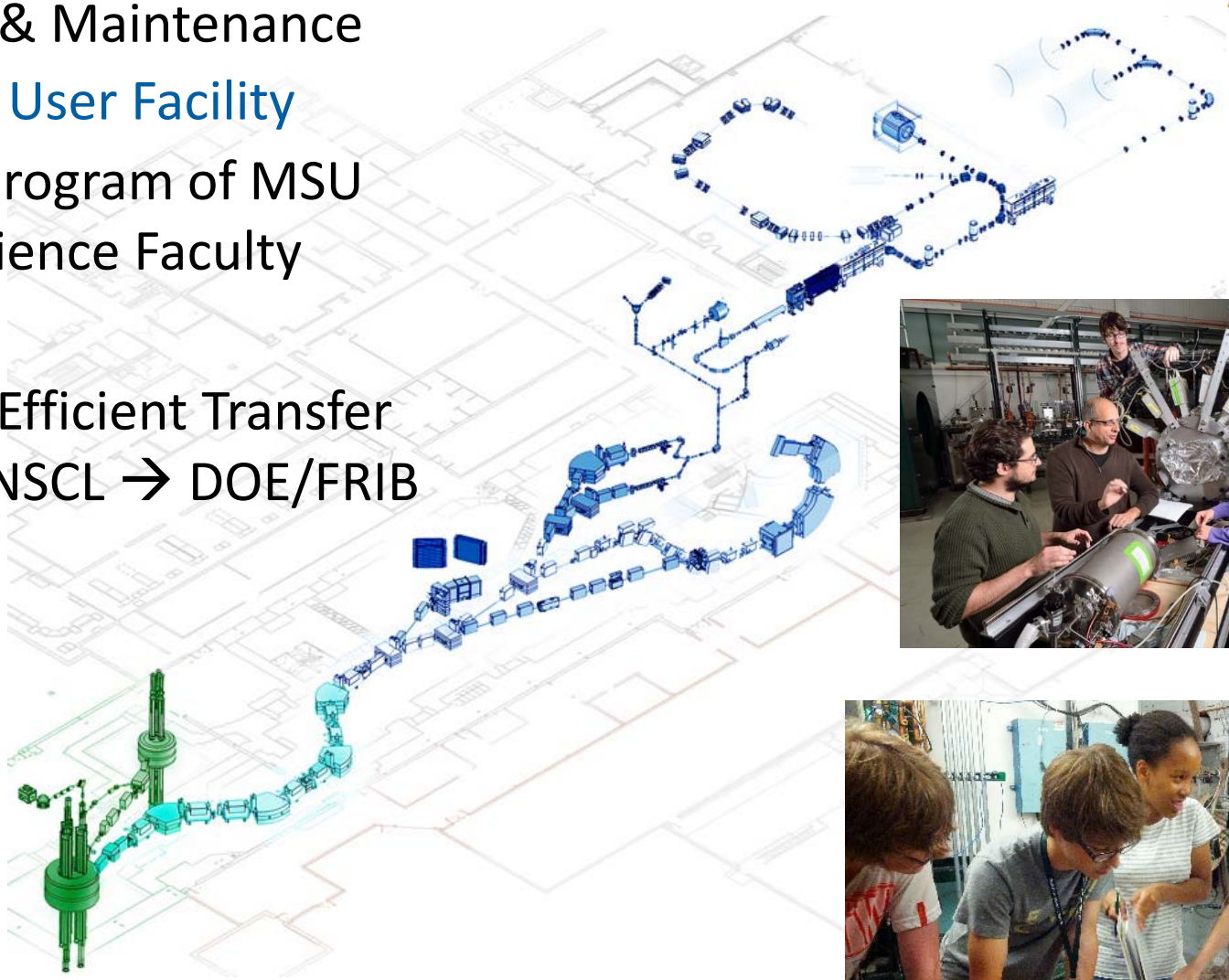
- **Nucleon and Hadron QCD** – properties and behavior of nucleons and nuclear matter under extreme conditions, confinement, hadron spectra, nuclear equation of state
- **Nuclear Reactions and Structure** – structure of many-body nuclei and reactions of relevance to structure
- **Nuclear Astrophysics** – origin of the elements, properties of dense matter in a compact object, nuclear reactions that drive stars and stellar explosions
- **Nuclear Precision Measurements and Fundamental Symmetries** – tests of QCD and chiral perturbation theory, tests of the Standard Model in a strongly interacting environment
- **Nuclear Theory** – structure and reactions of nuclei and of hadrons in few-nucleon and nuclear environments, the quark/gluon substructure expressed by QCD

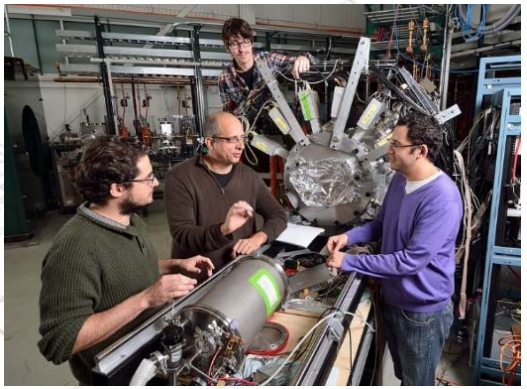
Highlights

- A few selected results shown here:
  - Results from some NSF PI's.
  - NSF experimental nuclear physics funds a broad range of experiments, and only a few results are highlighted. Apologies to those not included.
  - Send me your highlights!

NSCL: Five-year Renewal Award

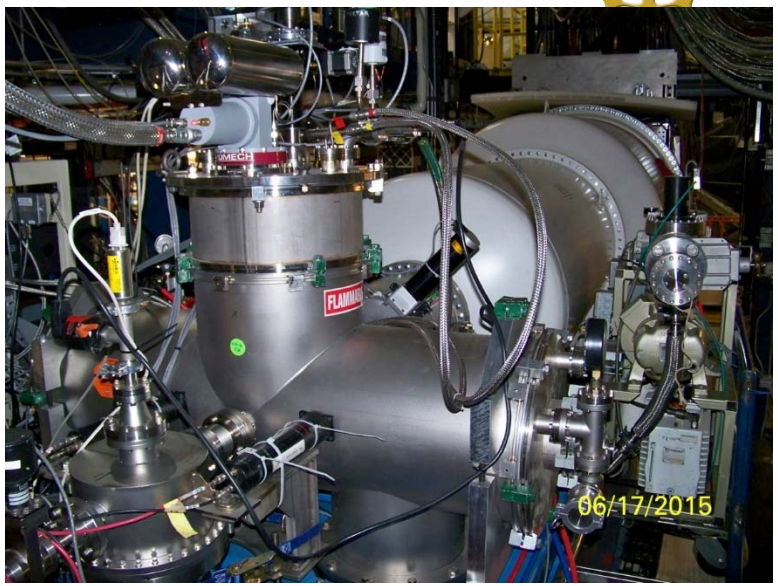
- Operation & Maintenance
  - National User Facility
- Research Program of MSU Nuclear Science Faculty
- Smooth & Efficient Transfer from NSF/NSCL → DOE/FRIB
  - MOU

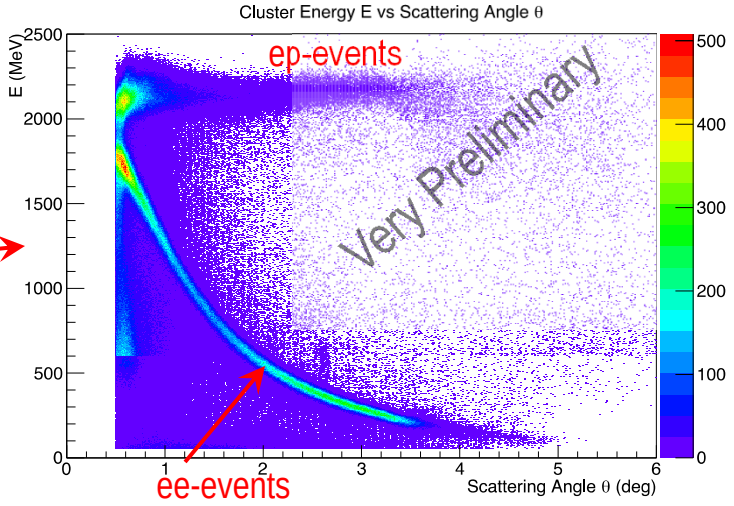




Prad Experiment (JLab Hall B)

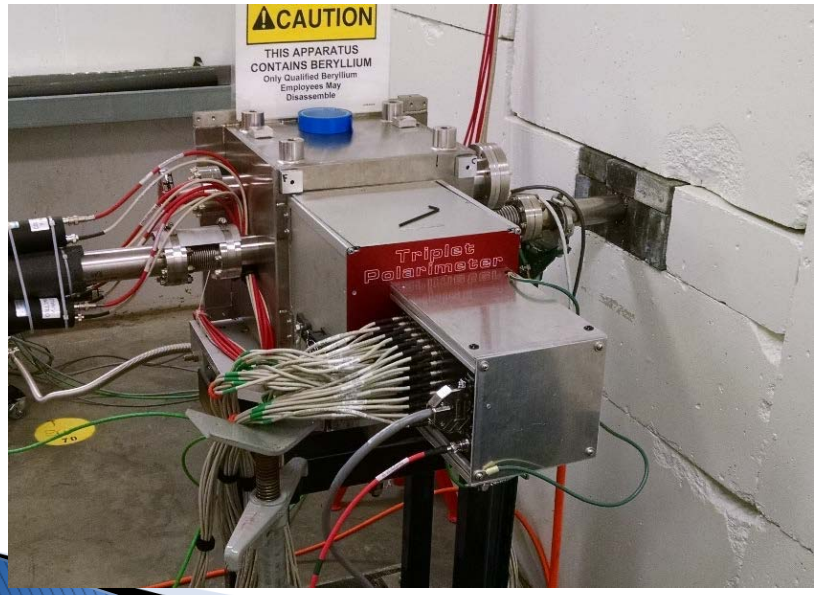
- PRad to address the *"Proton Radius Puzzle".*
  - ✓ novel hydrogen gas flow windowless target (funded by NSF MRI award: PHY-1229153);
  - ✓ HyCal calorimeter refurbished and tested;
  - ✓ GEM large-size detectors constructed and tested
  - ✓ integrated high-speed DAQ system developed and tested;
- PRad acquired data from May 13 to June 21, 2016.
  - ✓ data taking at 1.1 GeV and 2.2 GeV
- Major accomplishments so far:
  - ✓ $2x10^{+18}$ (H atoms/cm^2) areal density in hydrogen gas flow target achieved;
  - ✓ lowest Q^2 data set (~10^{-4} GeV/C^2) have been collected for the first time in ep-scattering experiments;
  - ✓ separation of Moller and ep-events at very low scattering angles demonstrated.

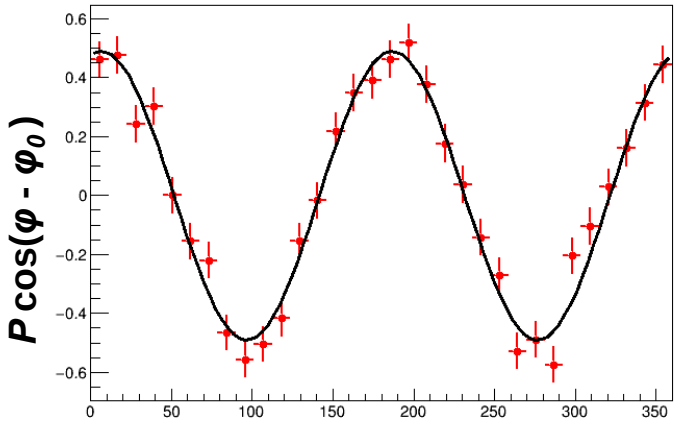


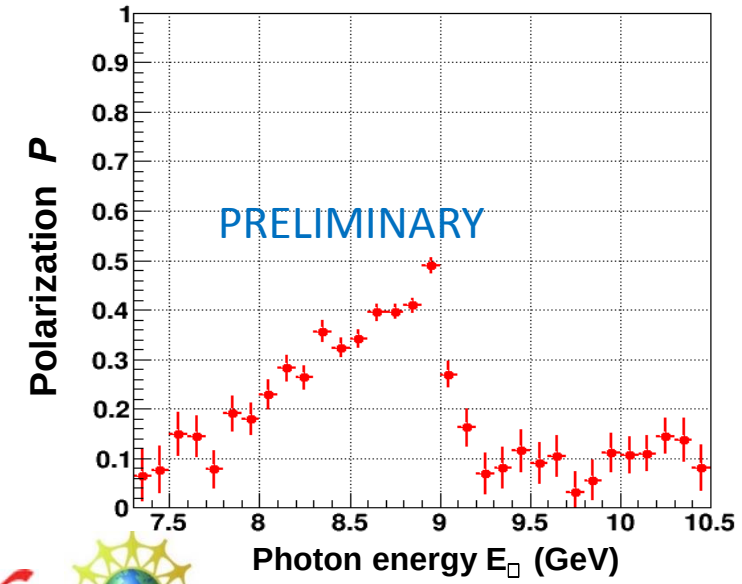


Hall D Triplet Polarimeter

- Uses triplet photoproduction process to measure photon beam polarization
  - Triplet production: pair production on an atomic electron
  - Polarization in photon beam yields asymmetry in recoil atomic electron distribution
- Double-sided silicon strip detector, vacuum housing, beryllium target, and custom electronics







CLAS12

Forward Tagger

(funded by NSF MRI award: PHY-1229060)

FT designed to detect electrons and photons at small angles

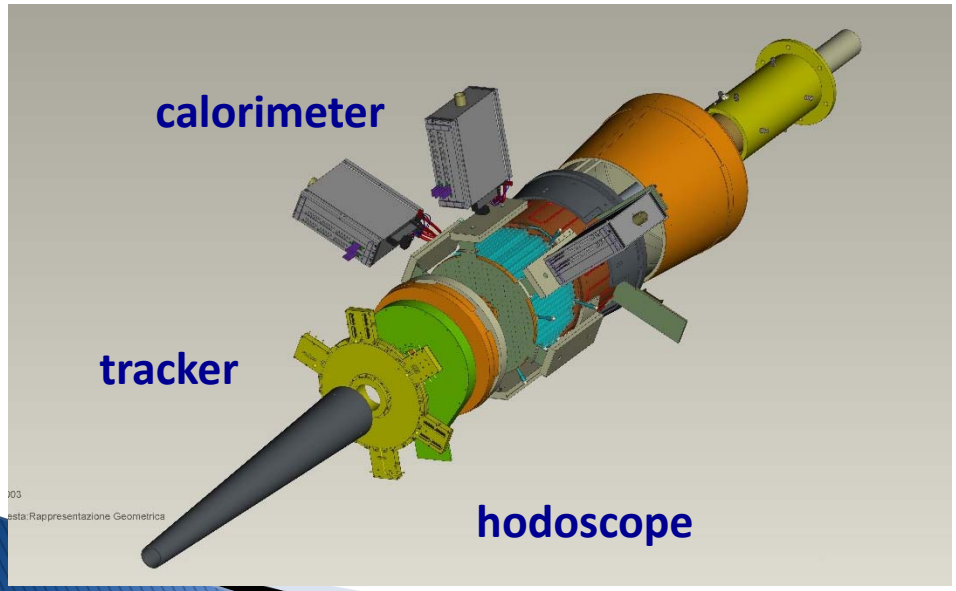
FT-Cal: calorimeter to measure electron energy/momentum

FT-Hodo: scintillation hodoscope to veto photons & backsplash

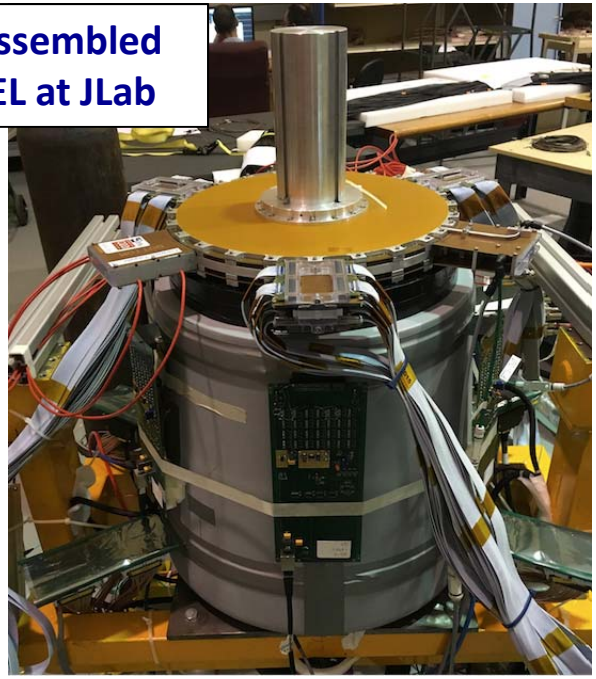
FT-Trk: micro-mega detector to measure electron angles, polarization plane

$$\theta = 2.5^\circ \rightarrow 4.5^\circ$$

$$\frac{\sigma(E)}{E} \leq \frac{0.02}{\sqrt{E\ (\mathrm{GeV})}} + 0.01$$



FT assembled in EEL at JLab

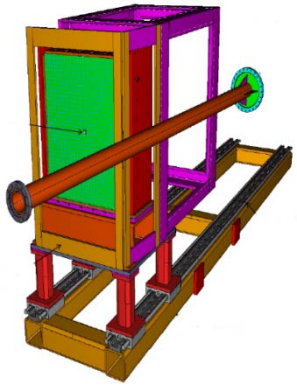


Schedule: Installation in CLAS12 - 11/2016

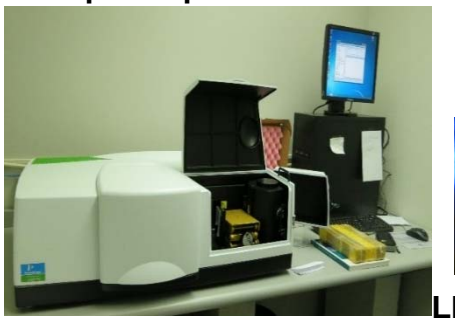
Neutral Particle Spectrometer (NPS)

Supported by
NSF-MRI 1530874

- Highly segmented $PbWO_4$-based EM calorimeter preceded by a sweeping magnet
  - Brings precision coincidence with neutral-particle detection
  - Required for five approved experiments in Hall C
- MRI provides for detector infrastructure and magnet assuming existing crystals
  - Steel for sweeping magnet on-site, design nearly final
  - Detector frame design concept completed, ready for detailed design
  - High voltage divider linearity optimization to begin
  - Significant efforts related to $PbWO_4$ crystals due to large variations that affect resolution performance requirements
    - In collaboration with EIC-related detector R&D
    - 45 SICCAS crystals being evaluated at CUA in collaboration with IPN-Orsay and Giessen University



Light transmittance of the crystals with spectrophotometer

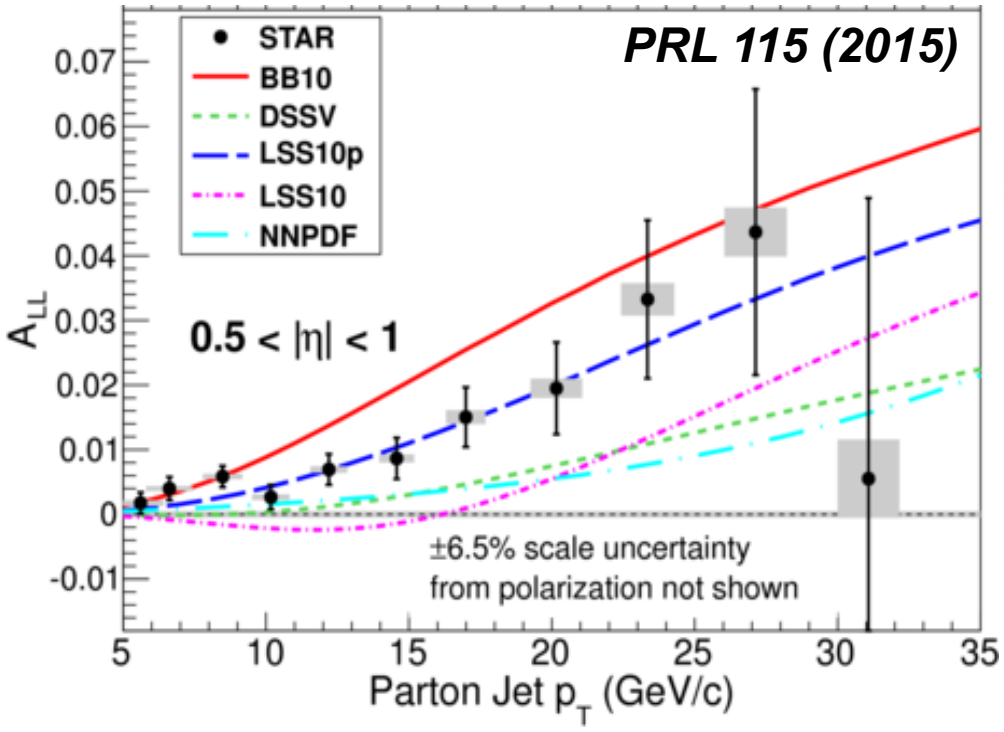


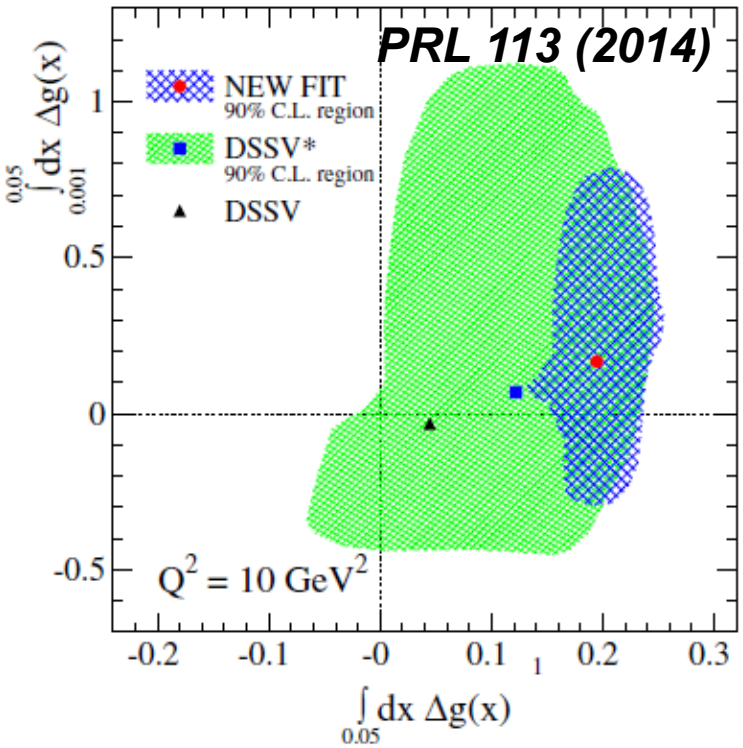
X-ray machine for radiation hardness characterization

LED annealing

STAR results:

Inclusive jets: Asymmetry results from 2009 data





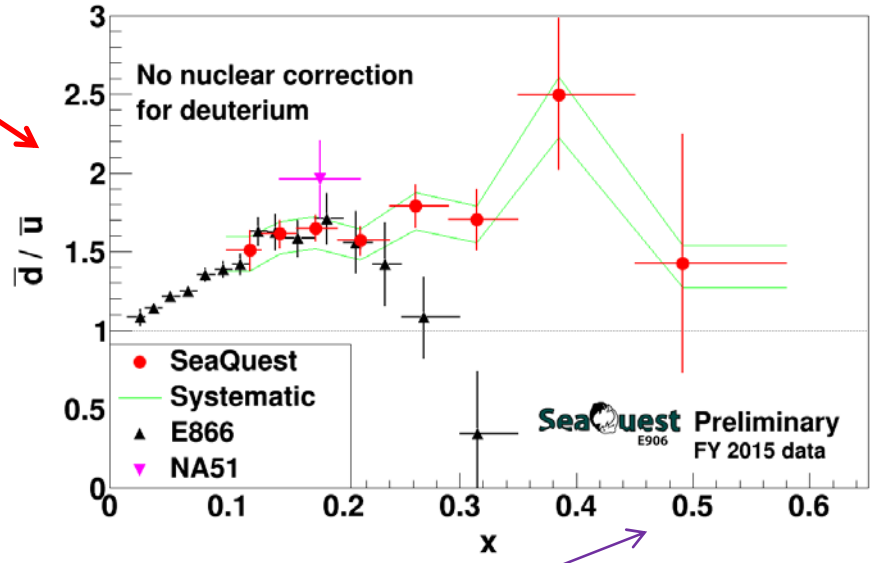
First strong evidence for non-zero gluon polarization in proton!

- Exploit greatly improved RHIC performance in luminosity, polarization
- Higher EMC trigger thresholds → increased focus on high-p_T region
- Combination of above → factor of 3-4 in stat. precision at high p_T

E906 SeaQuest at Fermilab

- **First physics result**
  anti-quark distribution in nucleon sea

- **Physics Program**
  dbar/ubar
  Sea quark EMC effect
  Absolute Drell-Yan cross sections
  Partonic Energy Loss in cold nucl matter
  J/ψ Nuclear Dependence
  TMDS: Bohr-Mulders function
  Dark Photon search



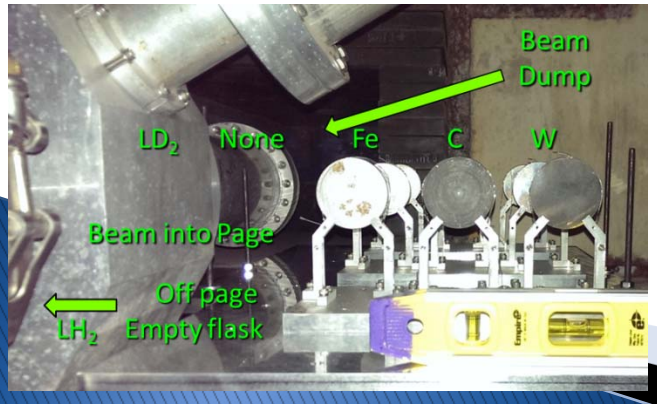
new D1 wire chamber:
access to large x

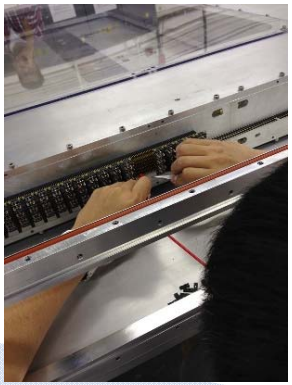
E. Kinney (Colorado)

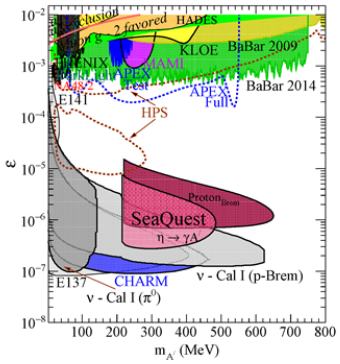
Dark Photon Search

R. Gilman (Rutgers)

- **Main Responsibilities (LD_2 & LH_2)**
  C. Aidala & W. Lorenzon (Michigan)

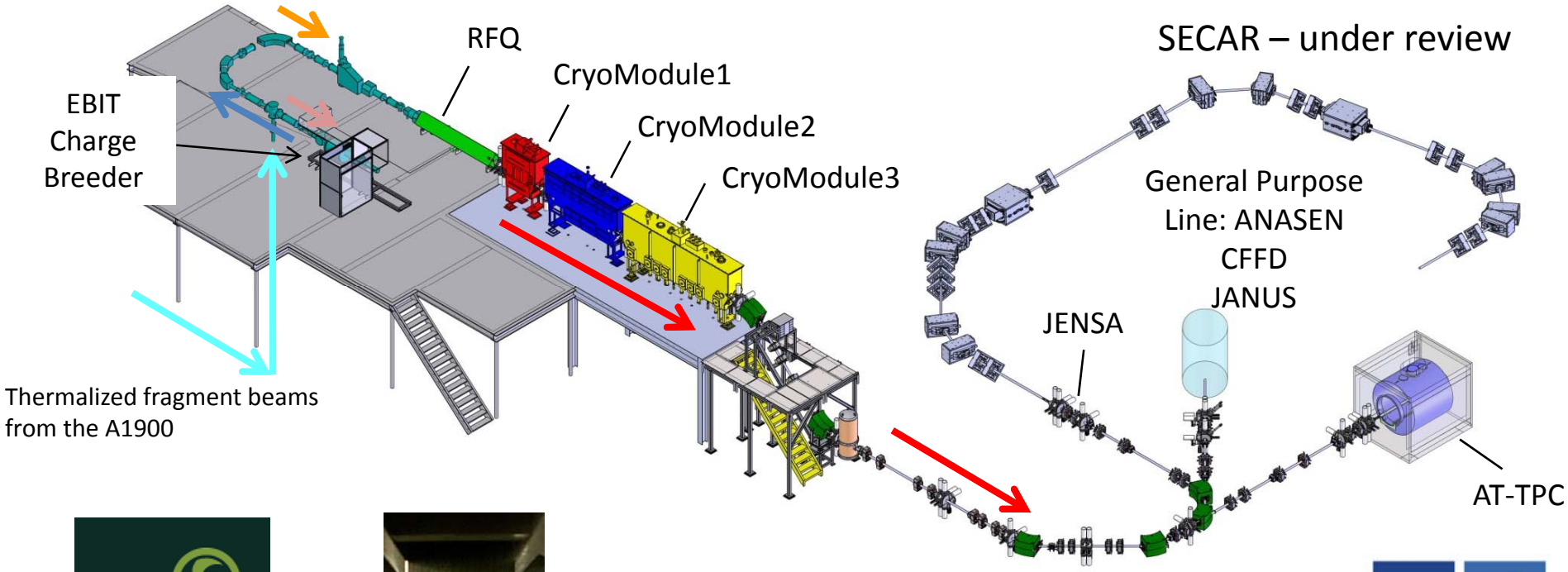






Re-Accelerator Facility at NSCL – Now Running!

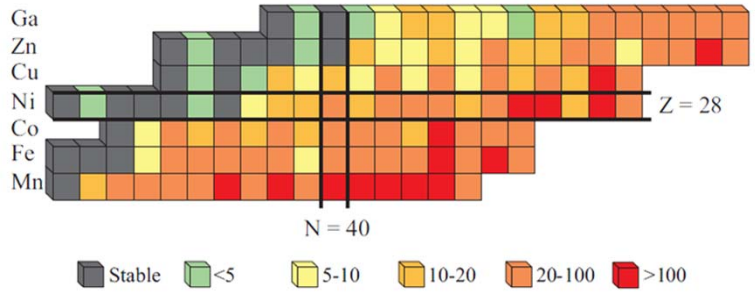
- First re-accelerator coupled to an in-flight rare isotope production facility



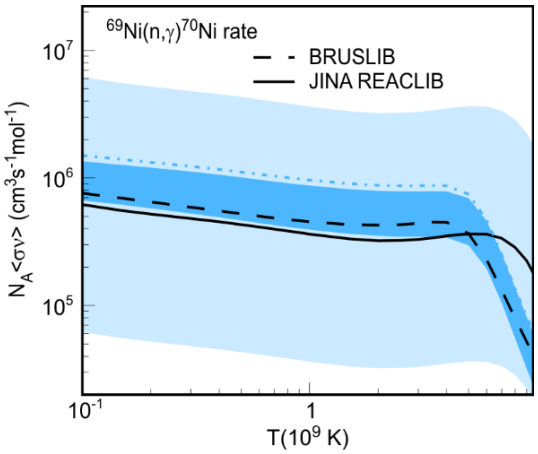
Nozzle of JENSA gas-jet target
(Colorado School of Mines, ORNL, JINA – funded by DOE Office of Science and NSF)

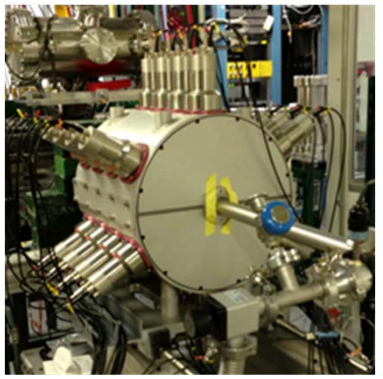
New work at NSCL: constrains neutron capture rates – key to modeling stellar explosions

- The abundance pattern from stellar events encodes the underlying physics.
- Nuclear reaction rates needed to test r-process models against observations
- Color = uncertainty of neutron-capture rates. Most key reactions are far from stability

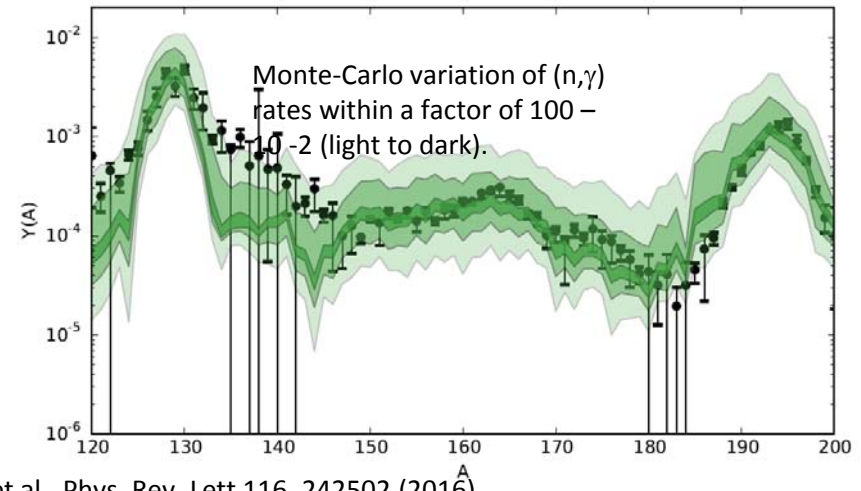


- New technique using γ-ray calorimetry developed by MSU and Univ of Oslo using SuN detector at NSCL used to extract ^{69}Ni(n,γ)^{70}Ni.
- Uncertainty is now approximately 2-3 (dark blue band) – achievable for rare isotopes far from stable
- Accurate rates allow model comparisons. With error of 2-3 dark green band is possible



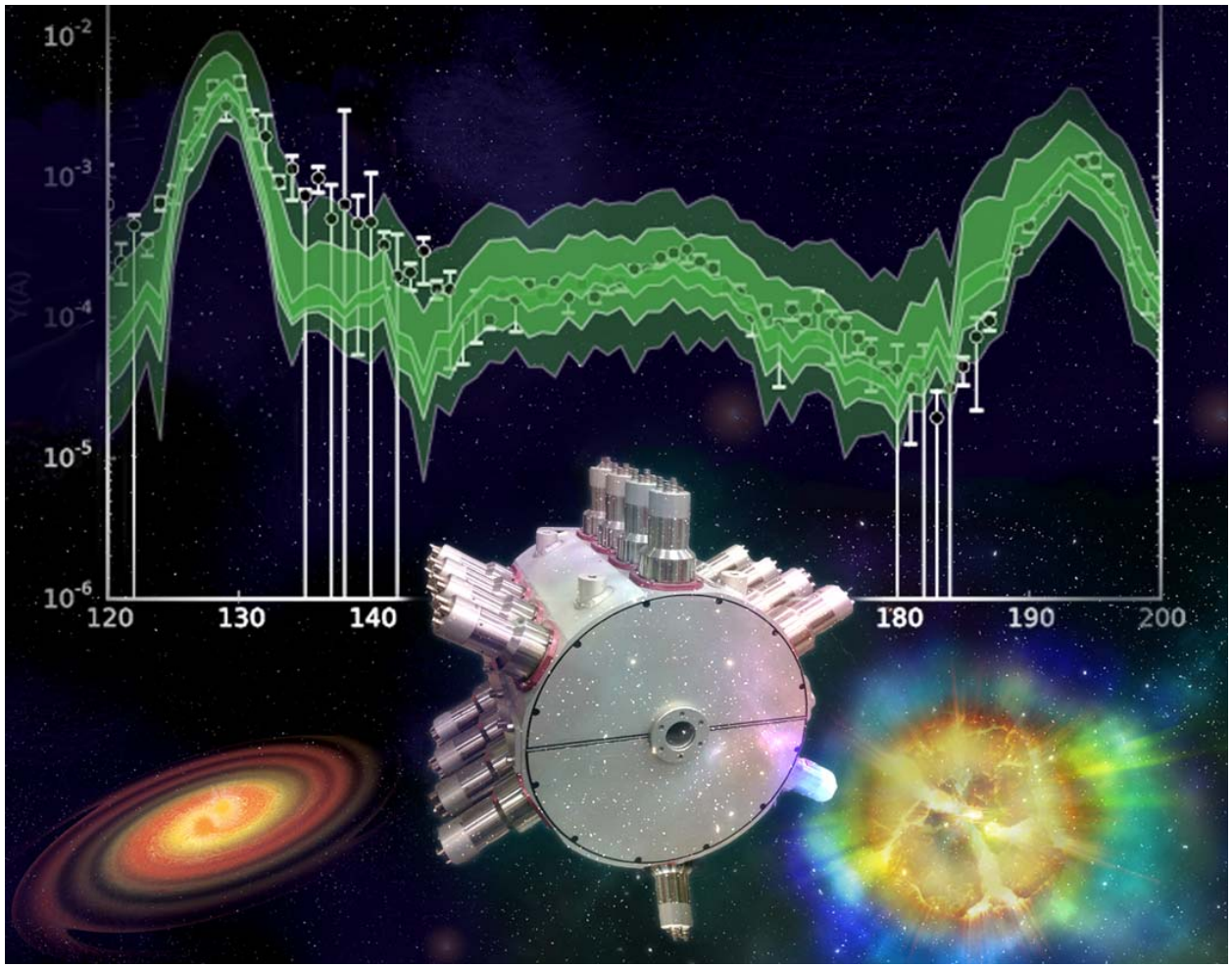


SuN detector at NSCL



S.N. Liddick, A. Spyrou et al., Phys. Rev. Lett 116, 242502 (2016)
http://physics.aps.org/synopsis-for/10.1103/PhysRevLett.116.242502

Connecting astrophysics and low-energy nuclear physics



Announcements: Solicitation for NSF Physics Division Investigator-Initiated Research Projects 16-566

- Deadlines:
  - **N*ovember 11, 2016 for Experimental Nuclear Physics & Theoretical Nuclear Physics***
  - December 1, 2016 Computational Physics
  - February 1, 2017 for Accelerator Science
- Follow Grant Proposal Guide checklist
- Other requests (conf. support, supplements, etc.)
  - Talk with us first (email or phone)
  - Submit at the same due date as above
  - Priority goes to summer schools and CEU
- Includes text on Midscale Instrumentation

REU Supplements

- Available to NSF grantees to fund an undergraduate student (US citizen or permanent resident) for the summer.
  - Typically about 5 requests per year.
- Usually $5,000 (awarded as a *supplement*)
- Submit in Fastlane as a supplement to current grant. Must contact program director before submitting request – funds may not be available.

Career Awards

- Must include excellent research program as well as excellent educational plan
- There are eligibility requirem[illegible] e.g., must be assistant professor, [illegible]
- 5 year award[illegible]imum
- Full propos[illegible]e: July 22, 2016 (for MPS)
- Contact program director for information/advice ahead of time (budget, scope)
- Solicitation: 15-555
- PECASE nominees are chosen from eligible CAREER winners

Under Review!

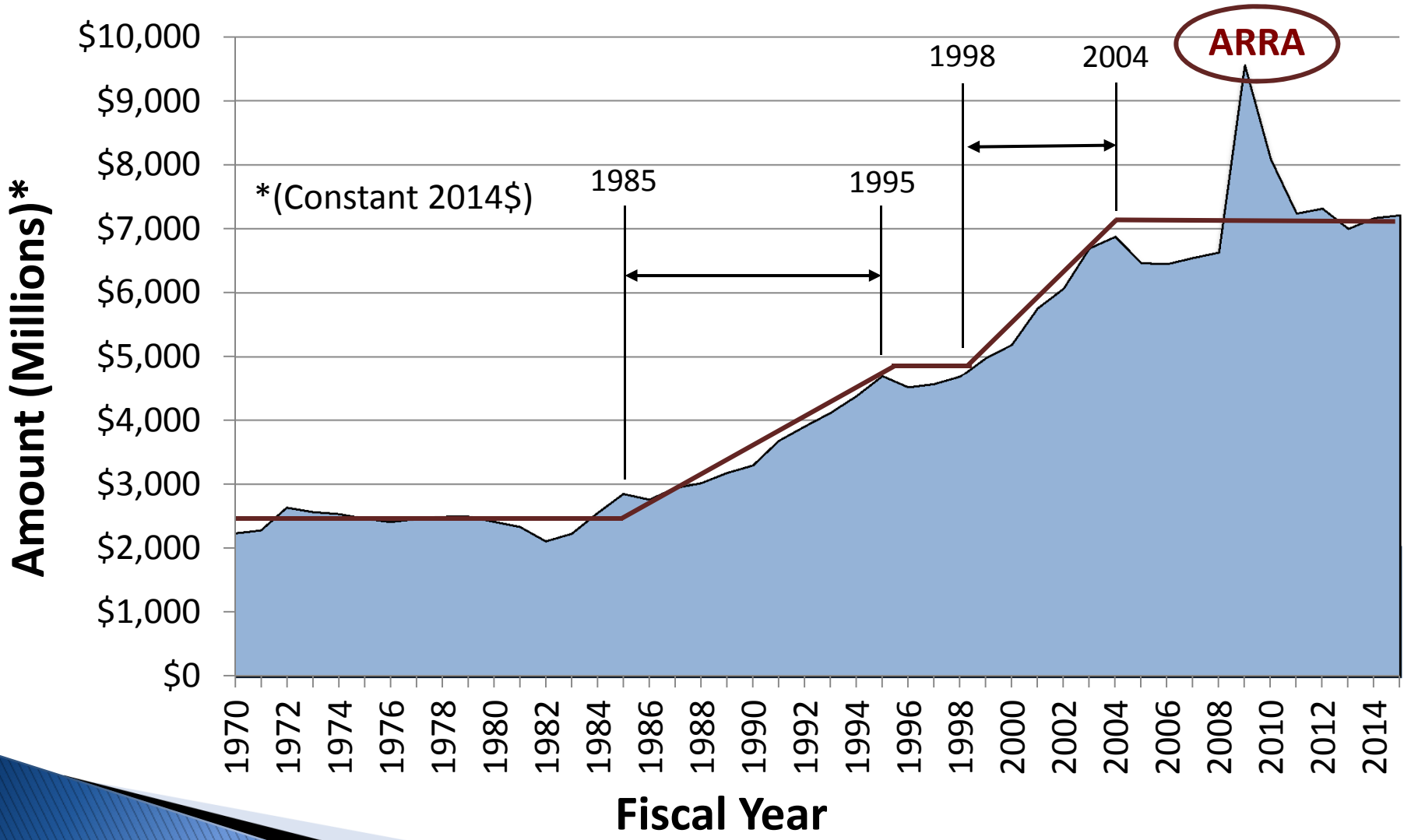
Major Research Instrumentation (MRI)

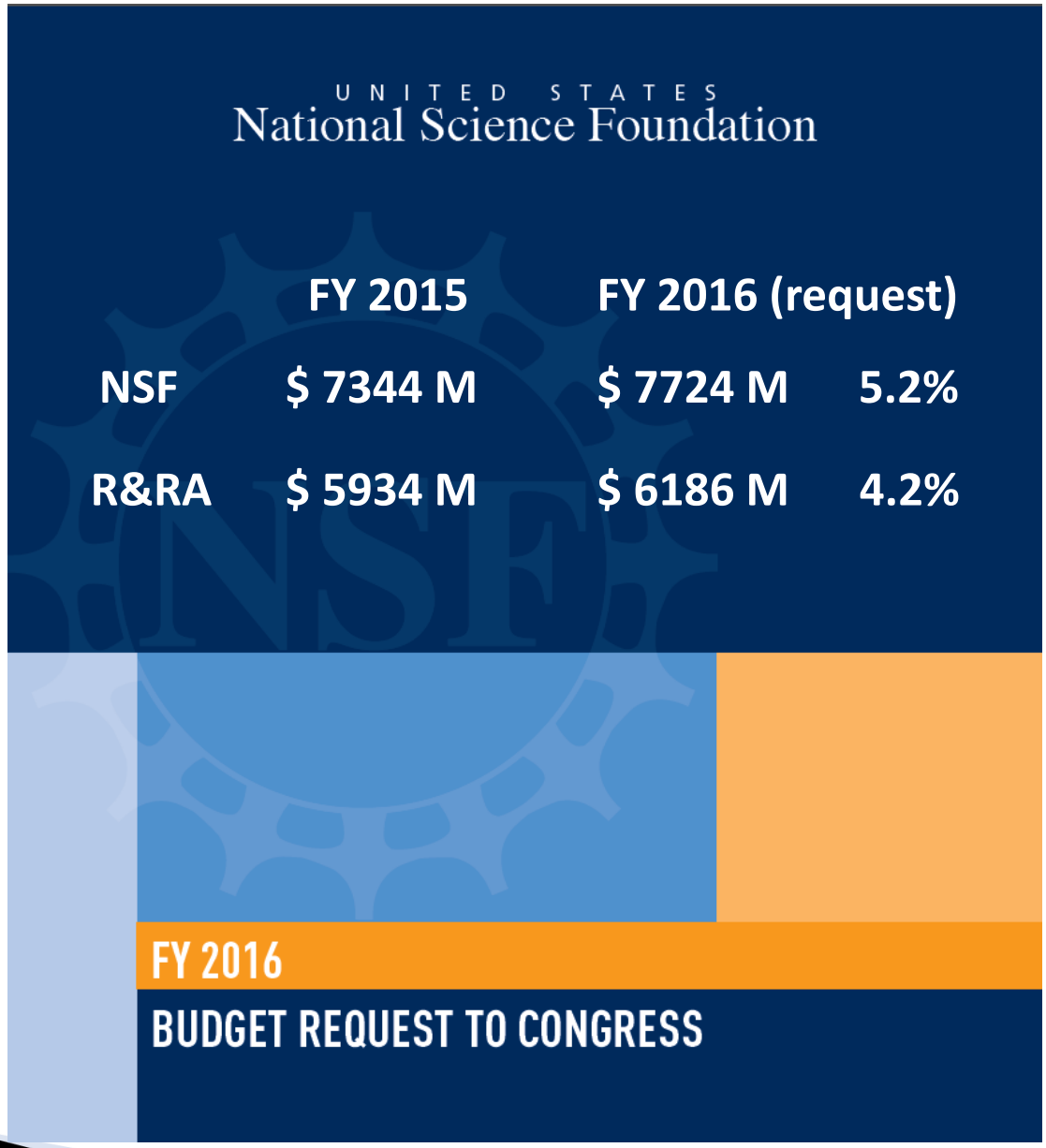
- Two types of awards: development and acquisition
- Contact program directors well ahead of submission to discuss (avoid pitfalls)
- Limited submissions from each university
- Maximum award is $4M; awards above $1M compete across the entire Foundation
- ***FY16: Physics received ~35 proposals, NP received 10 proposals***
  - Recommended funding for two ENP awards totaling $1.867 M
- Next deadline: Jan. 11, 2017

Mid-Scale Instrumentation

- The Physics Division has established a mid-scale instrumentation fund. The intention is to fund projects above $4 million (the MRI limit).
- This funding is NOT available for “operations” so program funds are used to run the experiment.
- Contact us for more information. PIs cannot apply to mid-scale directly; all proposals must go through the program. See solicitation 16-566.
- A priority of the division (and the directorate) is to increase the resources available for mid-scale.

NSF overall trends





	FY 2015	FY 2016 (request)		FY 2016 (estimate)	
NSF	$ 7344 M	$ 7724 M	5.2%	$ 7463 M	1.6%
R&RA	$ 5934 M	$ 6186 M	4.2%	$ 6034 M	1.7%

NSF PHY FY15 Estimate & FY16 Request

Physics (PHY) Funding

(Dollars in Millions)

	FY 2014 Actual	FY 2015 Estimate	FY 2016 Request	Change Over FY 2015 Estimate Amount	Change Over FY 2015 Estimate Percent
Total, PHY	**$267.09**	**$274.99**	**$277.37**	**$2.38**	**0.9%**
Research	**163.82**	**176.05**	**176.19**	**0.14**	**0.1%**
CAREER	8.57	7.44	7.45	0.01	0.1%
Centers Funding (total)	0.02	0.02	-	-0.02	-
Nanoscale Science & Engineering Centers	0.02	0.02	-	-0.02	-
Education	**5.38**	**5.56**	**5.32**	**-0.24**	**-4.3%**
Infrastructure	**97.89**	**93.38**	**95.86**	**2.48**	**2.7%**
IceCube Neutrino Observatory	3.45	3.45	3.45	-	-
Large Hadron Collider (LHC)	17.37	18.00	18.00	-	-
Laser Interferometer Grav. Wave Obs. (LIGO)	36.43	39.43	39.43	-	-
National Superconducting Cyclotron Laboratory (NSCL)	22.50	23.00	24.00	-	-
Research Resources	11.56	-	-	-	N/A
Mid-scale Research Infrastructure	6.58	10.00	12.48	2.48	24.8%

Totals may not add due to rounding.

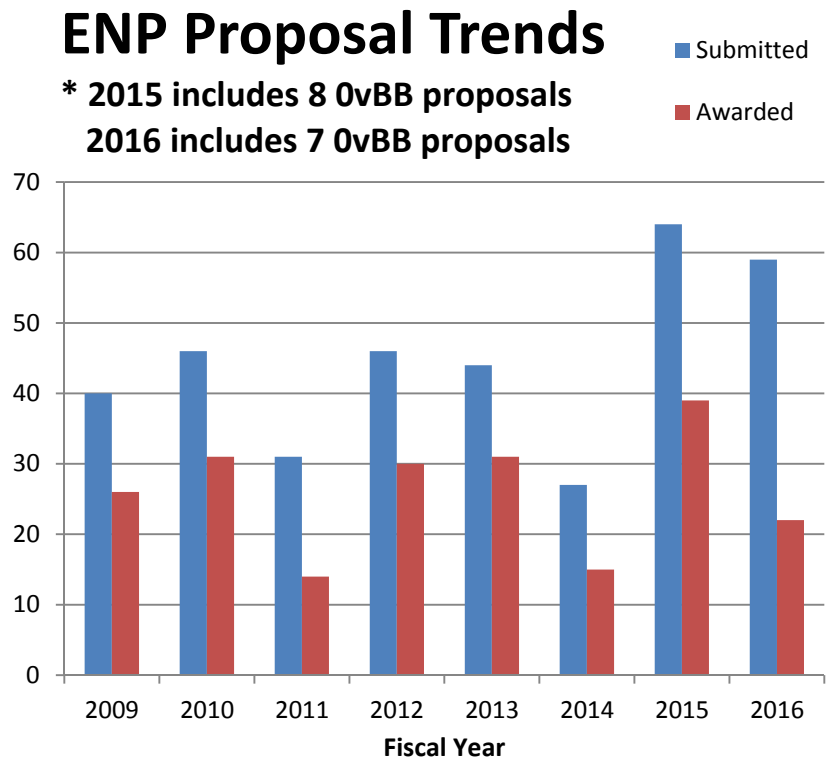
Budget Trends – NSF Nuclear Physics

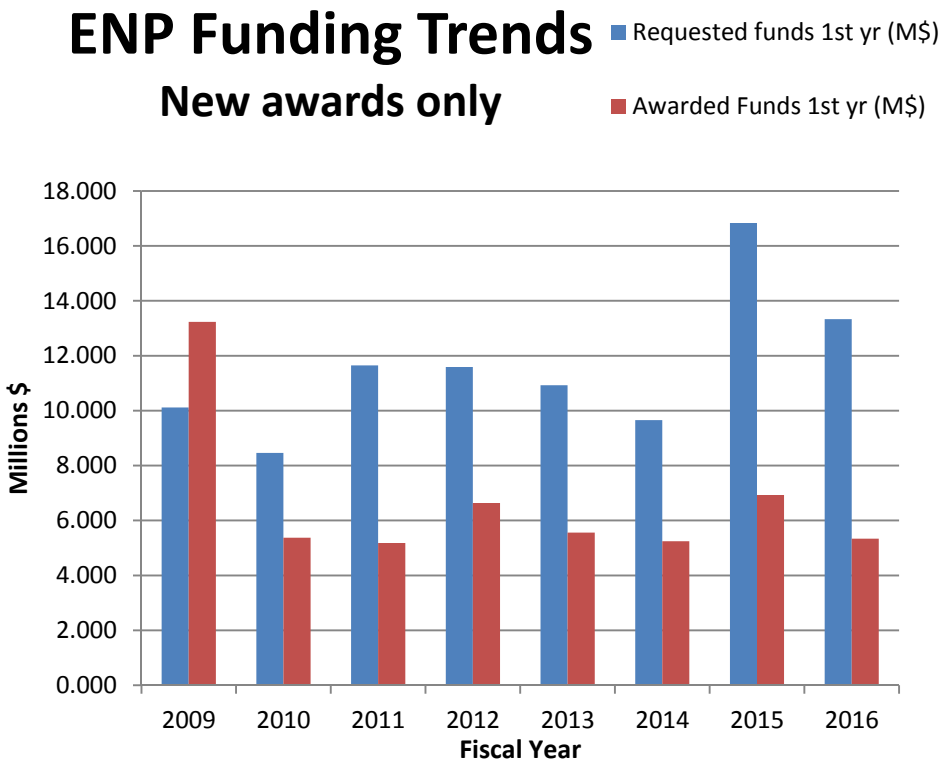
~ 25% = Research
~ 75% = Operations

FY	Hadrons & Light Nuclei (k$)	Structure & Heavy Ions (k$)	Fund. Sym. (k$)	Nucl. Astro. (k$)	Theory (k$)	Program Total (k$)	NSCL (k$)	JINA JINA -CEE (k$)	MRI (K$)	Mid-Scale (K$)	Total Nuclear Physics (k$)
2009	7,663	4,734	5,572	N/A	5,825	23,794	22,500	2,000	8,058	9,524	65,877
2010	6,421	6,863	5,532	1,078	3,855	22,672	21,000	2,150	1,134		46,956
2011	5,349	6,485	5,336	1,994	3,719	22,883	21,500	2,150	729		47,262
2012	7,657	3,375	5,855	1,610	3,829	22,326	21,500	2,150	2,744		48,720
2013	5,218	4,259	5,304	1,754	3,474	20,008	21,500	2,150	2,996	490	47,144
2014	5,275	4,215	5,250	2,475	3,514	20,728	22,500	2,280	1,038	1,188	47,733
2015	5,941	3,722	6,818	2,245	4,183	22,908	23,000	2,280	1,801	1,367	51,357

FY15 Fundamental Symmetries: includes $1.32M for $0\nu\beta\beta$
MRI: competes each year; supplemental one-time acquisition/development funds
Mid-scale: ad hoc competition; supplemental construction funds

Experimental Nuclear Physics Program





NSF/MPS/Physics Personnel

- France Cordova – Director
- Fleming Crim – Associate Director for MPS
- Denise Caldwell – Physics Division Director
- Brad Keister – Deputy Division Director
- Bogdan Mihaila – Nuclear Theory Program Director
- Ken Hicks – Expt'l Nuclear Physics Program Director – has returned to his institution
- Allena Opper – Expt'l Nuclear Physics Program Director

Search for a "rotator" Program Director in
Experimental Nuclear Physics nearly complete!
New person will likely start soon after September 2016
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

Contact us:

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- aopper@nsf.gov
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