





# Challenging Times:

COVID, Fires, Hurricanes, Systemic Racism, Ice Storms ...

... Spring, Vaccines



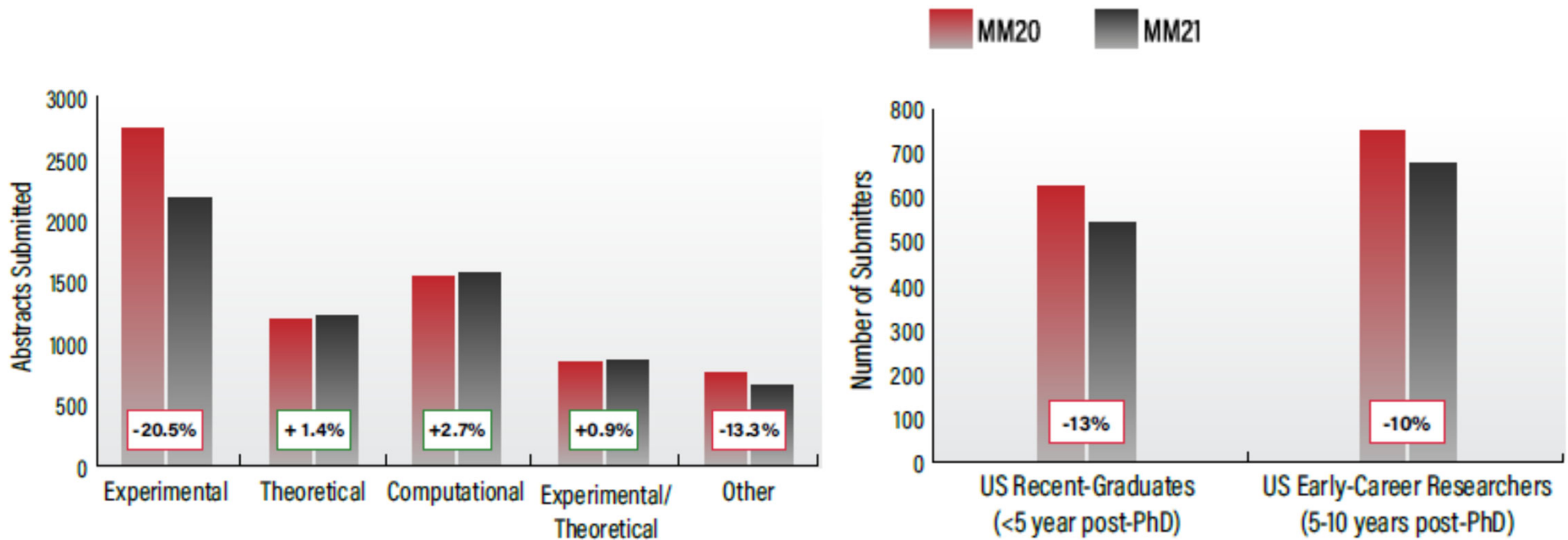
## Outline

- COVID Impacts
- Announcements
- FY21 Budget Info
- Highlights





# Covid Impacts: APS March Meeting Abstracts

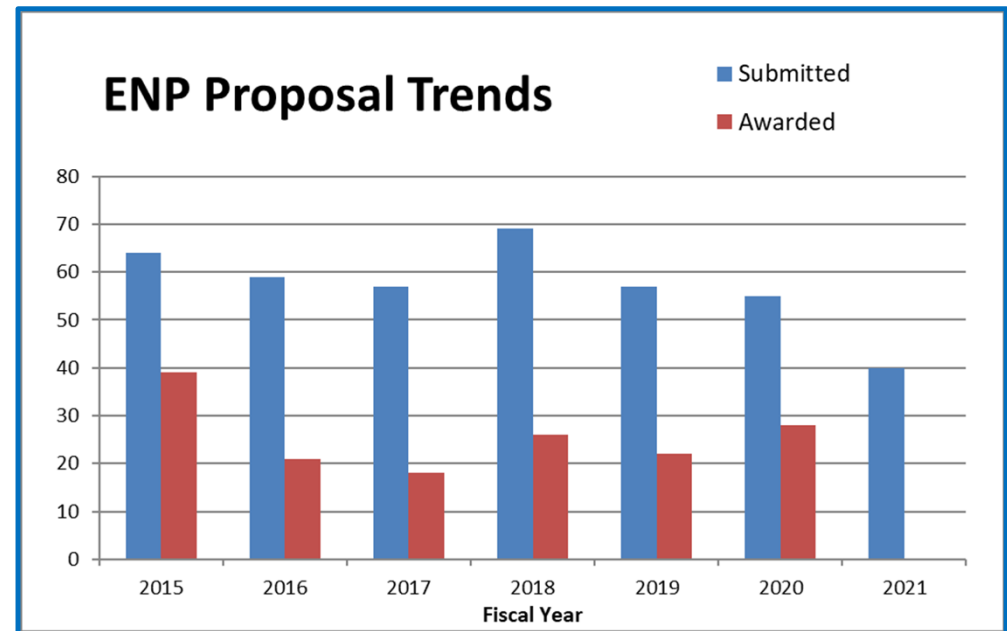
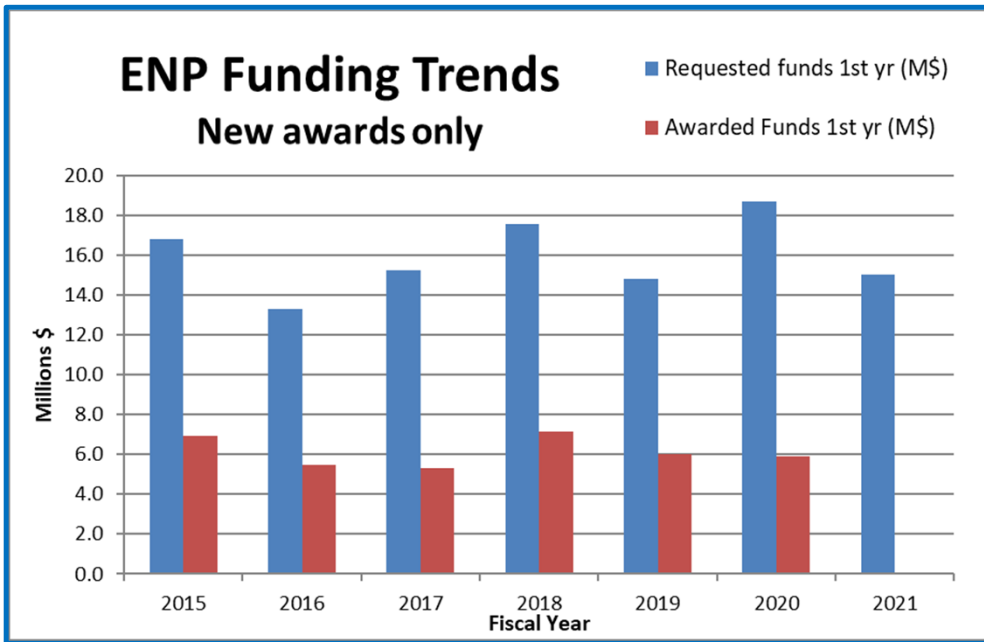


Impact on Research: NSF Nuclear Physics community quickly pivoted to analysis and simulation work – but we may have exhausted many of those projects.





# Proposal Trends in Experimental Nuclear Physics



# PHY Investigator Initiated Research NSF 20-580



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

- **Deadlines:** First Tuesday in December for *Experimental & Theoretical Nuclear Physics* FY22 Proposals due ⇒ **December 7<sup>th</sup>, 2021**

- 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).

*Annual Reports must include goals and accomplishments of the award's  
Intellectual Merits and its Broader Impacts*



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## Busy Time at NSF/MPS/PHY

- PHY Solicitation Deadline for *Experimental & Theoretical Nuclear Physics*
  - **FY21 Proposals were due December 1, 2020** (Annually)
- Major Research Instrumentation NSF 18-513 (Annually)
  - \$100,000 < total request < \$4M
  - **FY21 Proposals were due 19-Jan-2021**
- Mid-scale Research Instrumentation-1 (MSRI-1) NSF 19-512 (Every other year)
  - Imp. & Des. & Construct. < \$20M
  - Des. & Construct. \$600,000 < total request < \$20M
  - **Preproposals were due 7-jan-2021; full proposals due 23-Apr-2021 (by invitation)**
- Mid-scale Research Infrastructure-2 (MsRI-2) NSF 21-537 (Every other year)
  - Total request: \$20M - \$100M;
  - **Preproposals were due 5-mar-2021; full proposals due 20-Sep-2021 (by invitation)**

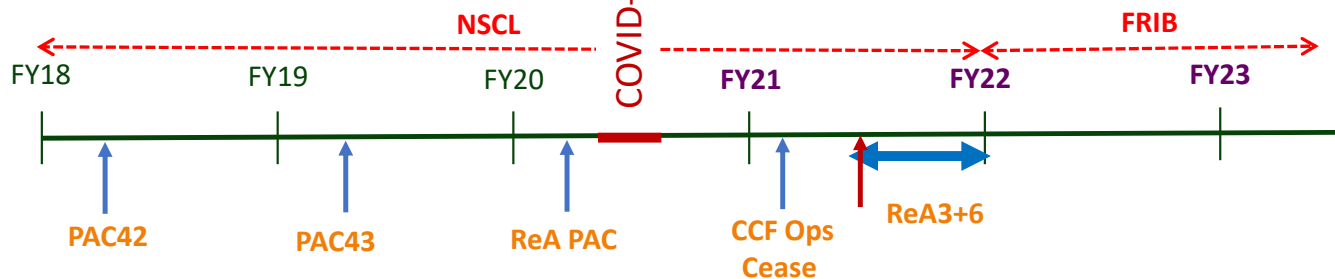
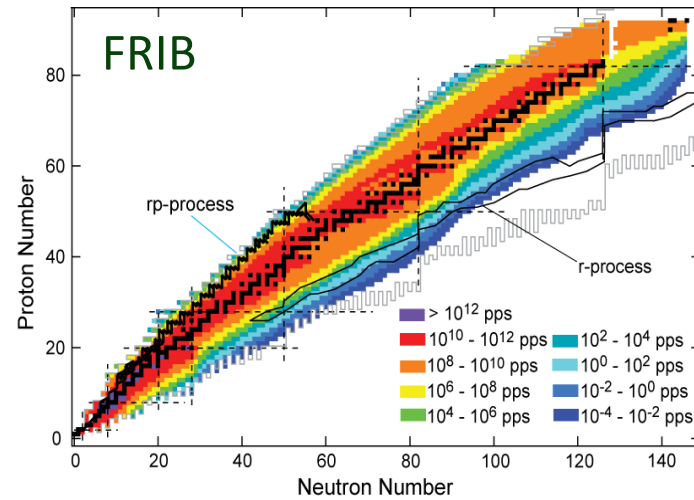
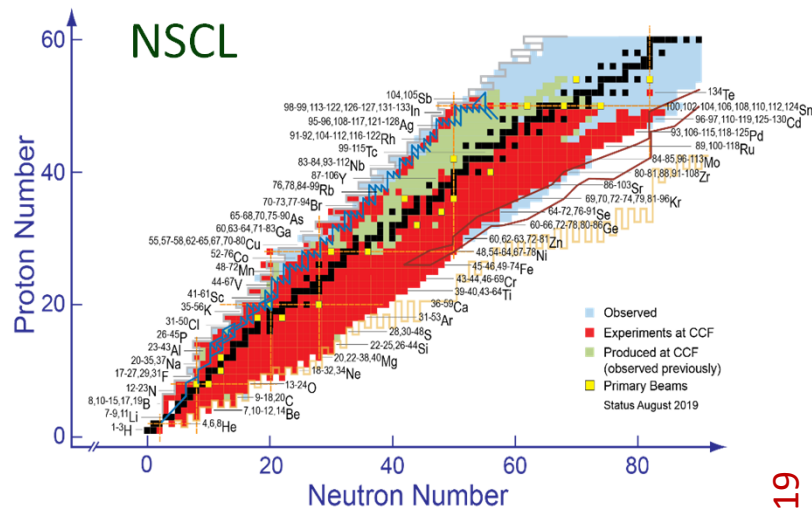
*Thank you to our many reviewers and panelists!*





# NSCL / FRIB Transition

Smooth & close coordination → exciting opportunities

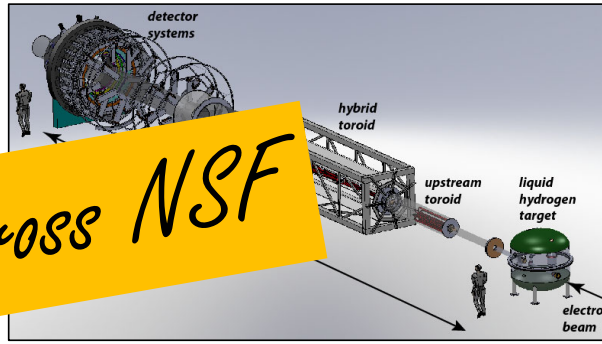




# NSF and DOE Coordination in Nuclear Physics

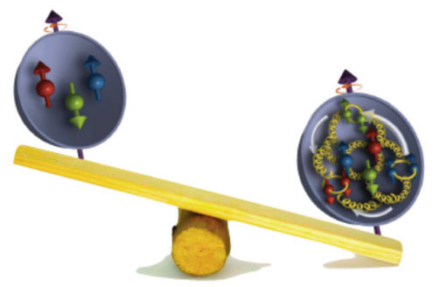


- MOLLER – parity violating Moller (elastic  $\vec{e} e$ ) scattering
  - DOE CD-1 Dec 2020
  - NSF PHY Mid-scale award for specific scope
- EIC – the next “big thing” in US Nuclear Physics
  - DOE CD-0 in Dec 2019; BNL sol
  - Project includes



*NSF responds to proposals with competition across NSF*

- support: CUOREcino, CUORE, MJD, EXO-200, KamLAND-Zen, NEMO, ...
- LEGEND-200 = GERDA + MJD + new detectors → 200 kg  $^{76}\text{Ge}$  &  $t_{1/2} = 10^{27}$  year for 1 ton-year exposure
- DOE  $0\nu\beta\beta$  portfolio review

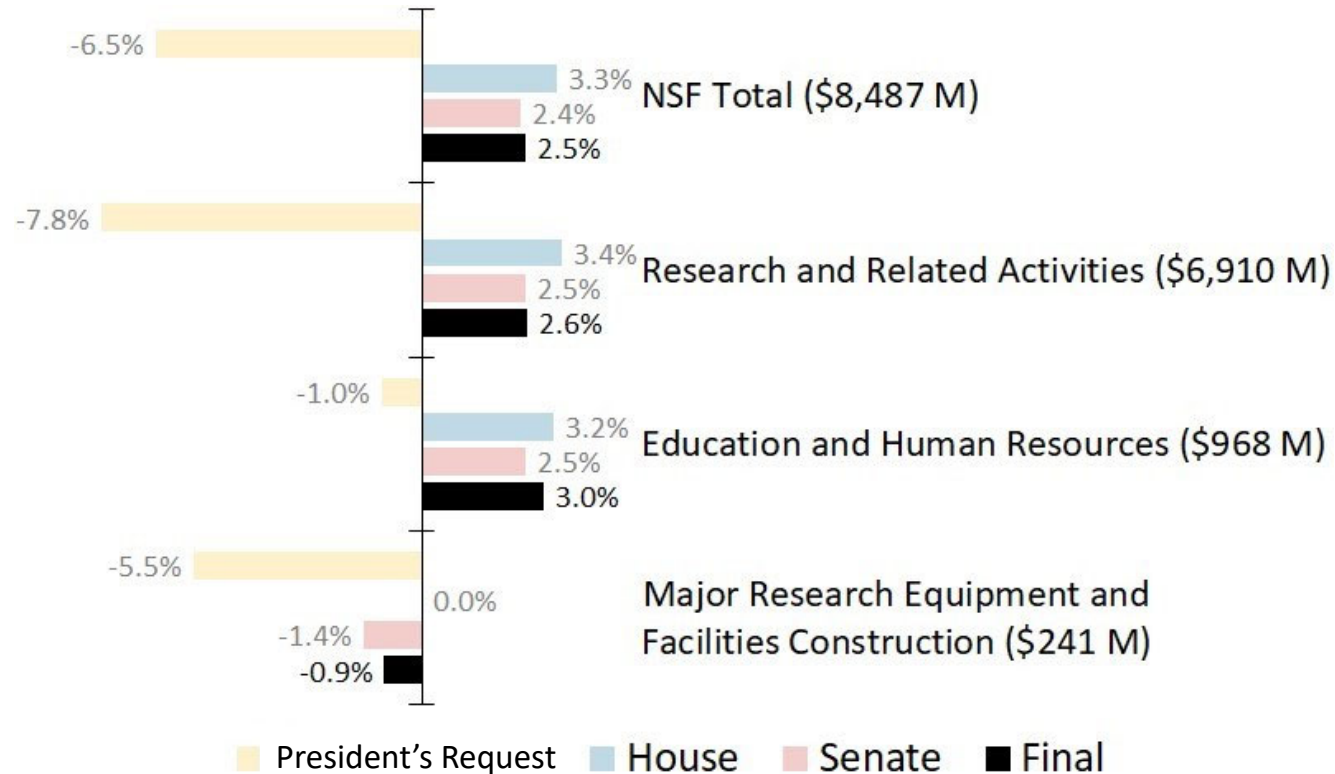






# NSF FY21 Budget Appropriations

\$ in ( ) = FY21 amounts



American Institute of Physics | [aip.org/fyi](http://aip.org/fyi)



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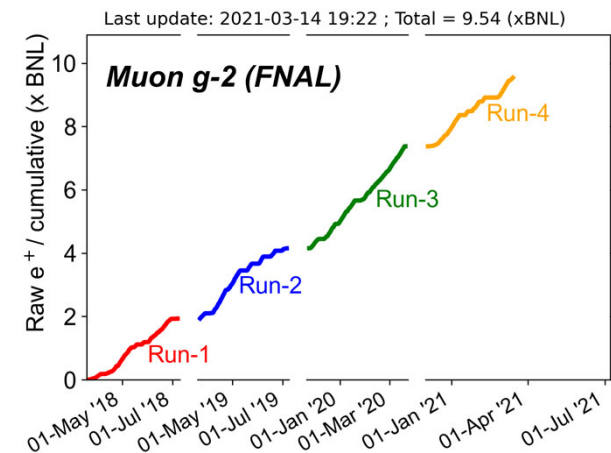
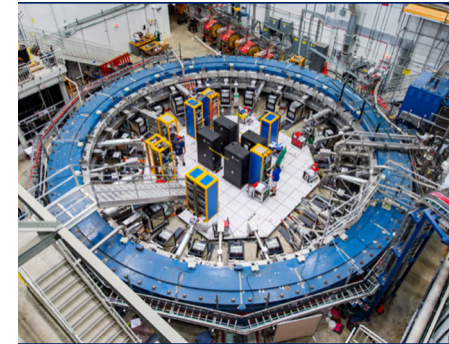


# First results from FNAL $\mu$ (g-2) coming April 7



<https://theory.fnal.gov/events/event/first-results-from-the-muon-g-2-experiment-at-fermilab/>

- Precision test of Standard Model and BSM
- Approved in 2012 (CD0)
  - Move Magnet from BNL to FNAL
  - Lots of redesign and rebuilding
  - First observation of anomalous precession in 2017 engineering run
- Four data runs (Run-4 currently underway)
- Run-1 analysis complete  $\approx$  BNL error



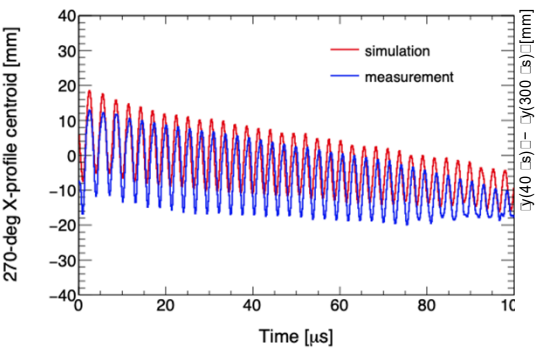


# First results from FNAL $\mu$ (g-2) coming April 7

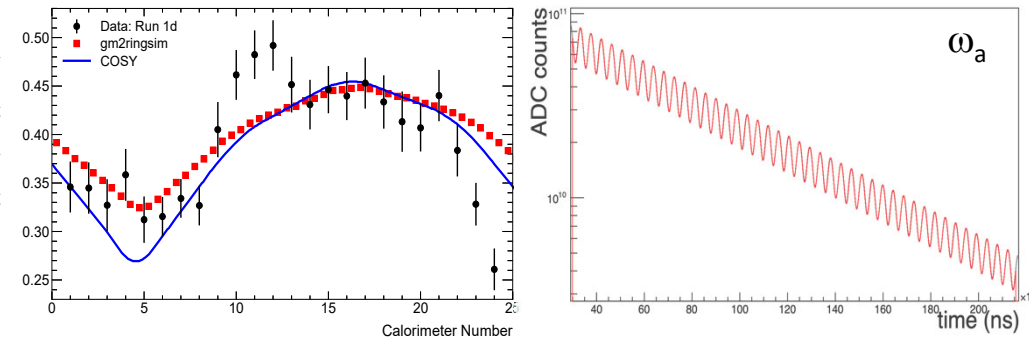


<https://theory.fnal.gov/events/event/first-results-from-the-muon-g-2-experiment-at-fermilab/>

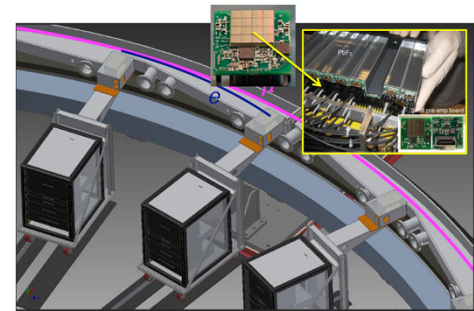
### Fiber harps (RU)



### Simulations and Integrated energy analysis(UKy)

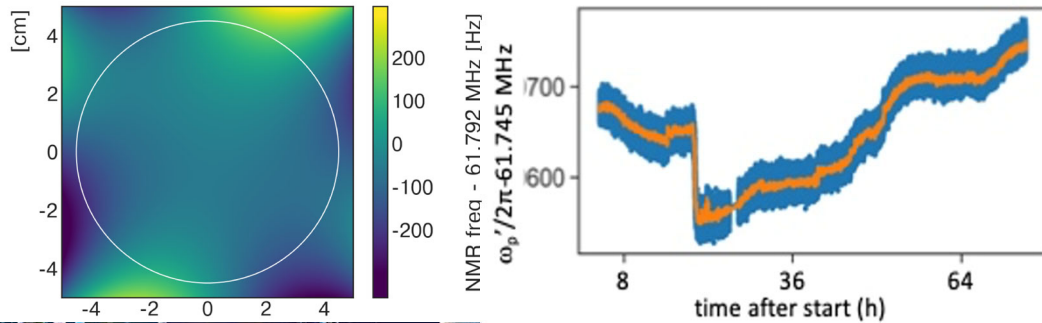


### MRI (UW and Cornell)

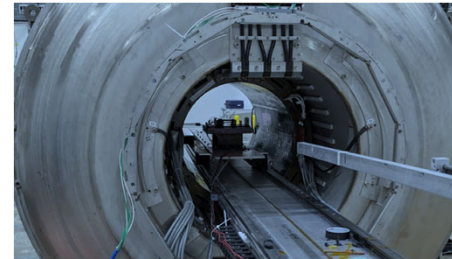


### Calorimeter XLs, SiPMs, electronics, ...

### Field maps and tracking (JMU, UM, UVa)



### <sup>3</sup>He Calibration (UM)



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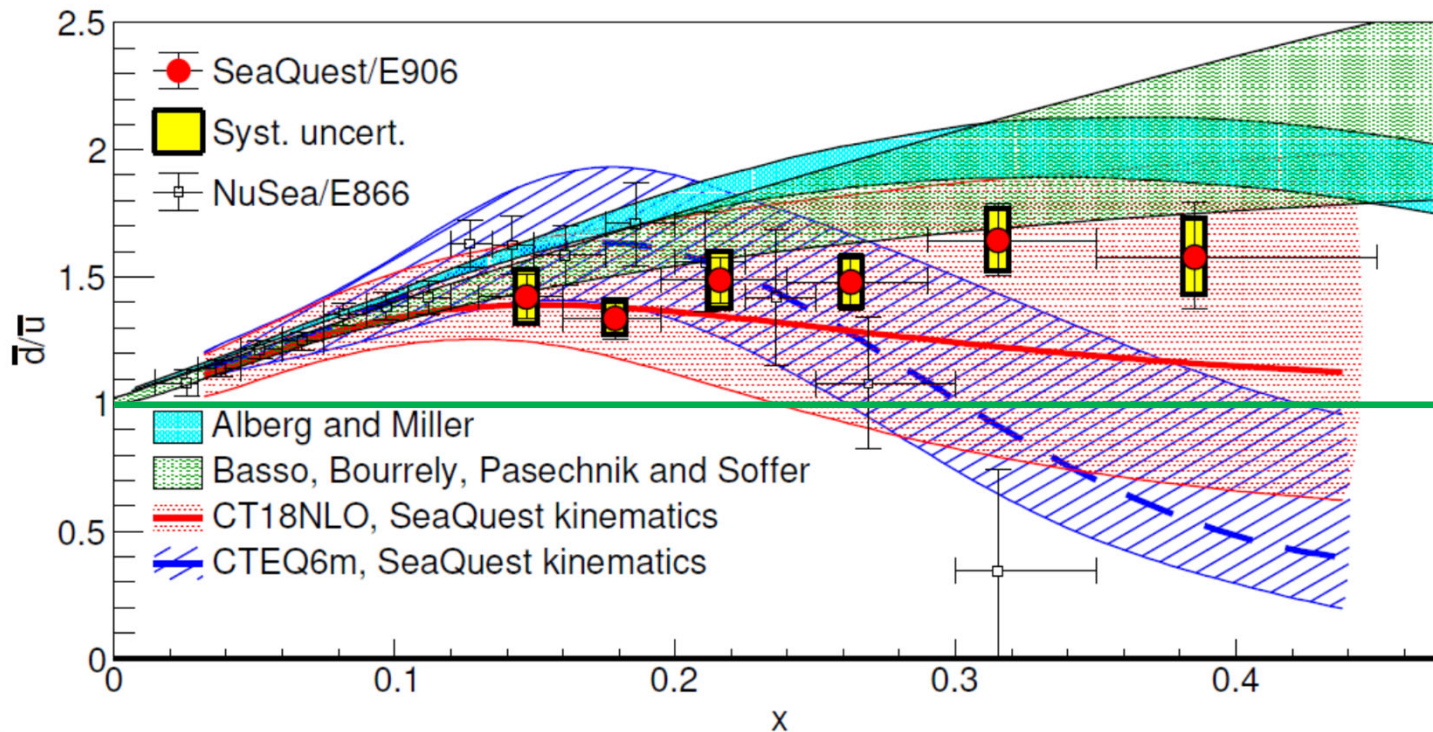
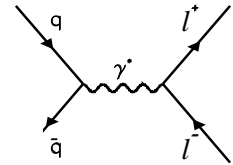
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# SeaQuest D-Y FNAL– more $\bar{d}$ than $\bar{u}$ in protons

at  $x_1 > x_2$ : Drell-Yan:  $\sigma^{pd} / 2\sigma^{pp} \sim \frac{1}{2}(1 + \bar{d}(x_2) / \bar{u}(x_2))$



Figures from

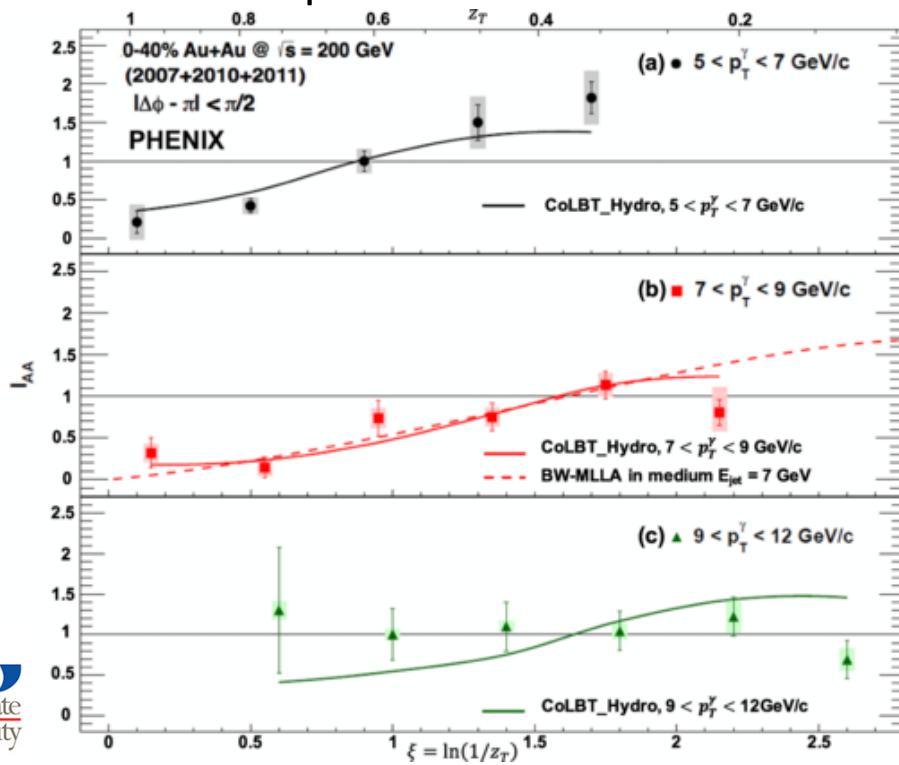
- J-C Peng (UIUC)
- C Aidala & W. Lorenzon (U of Mich)





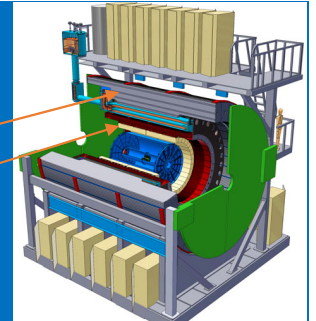
# Jet Measurements and a Novel Hadronic Calorimeter at RHIC

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



## sPHENIX Hadronic Calorimeter

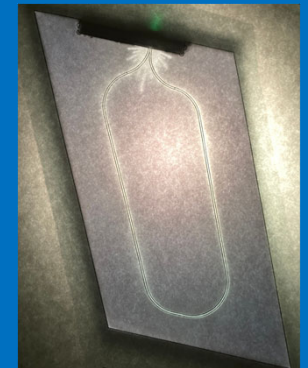
Outer Hcal Tile Testing complete



Inner Hcal Tile production and testing has started



6/16/2020  
HCal Lab  
GSU



Inner Hcal Tile  
matched to drawing



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

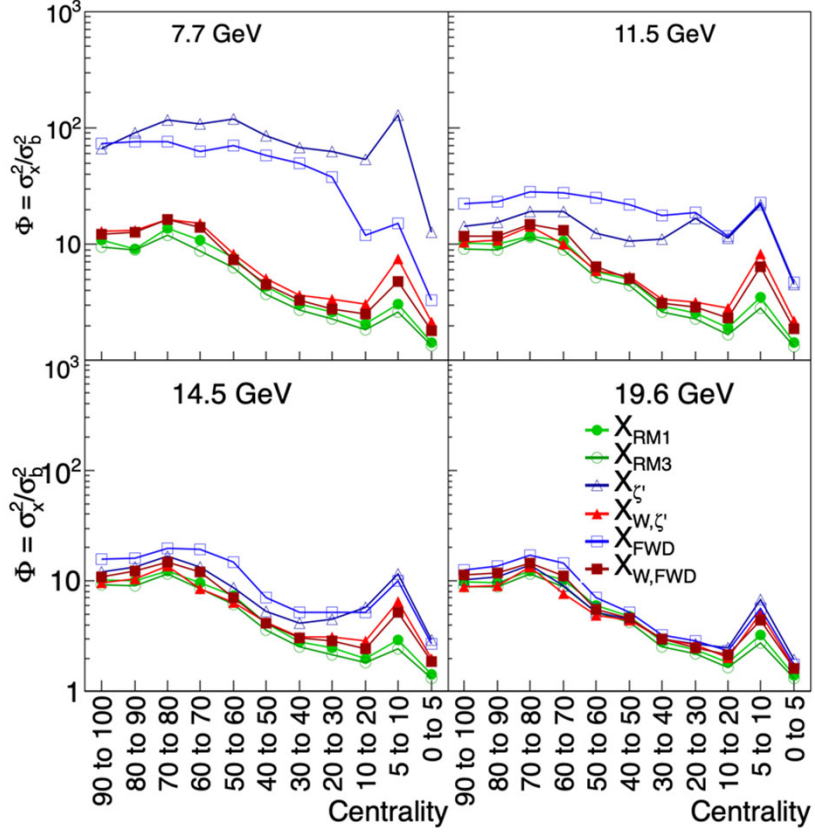
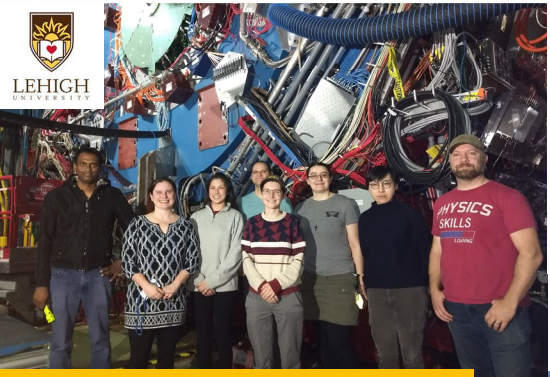
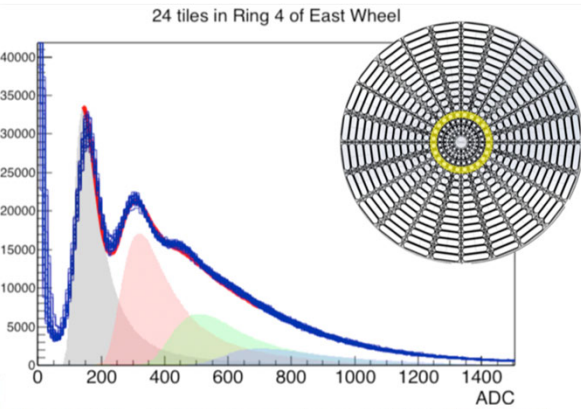




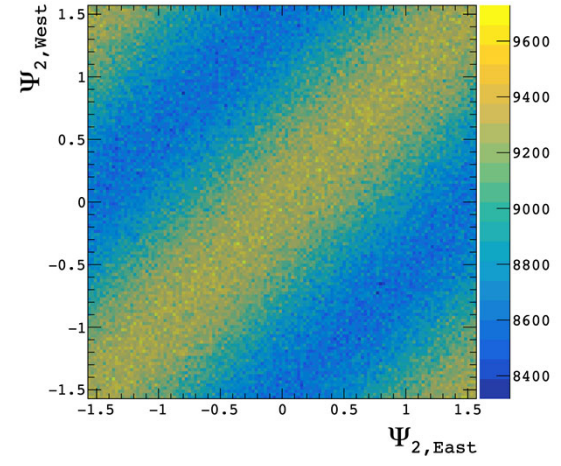
# Centrality Determination with Forward Detector – RHIC BES



EPD performance channel by channel



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



Accepted for publication  
in PRC

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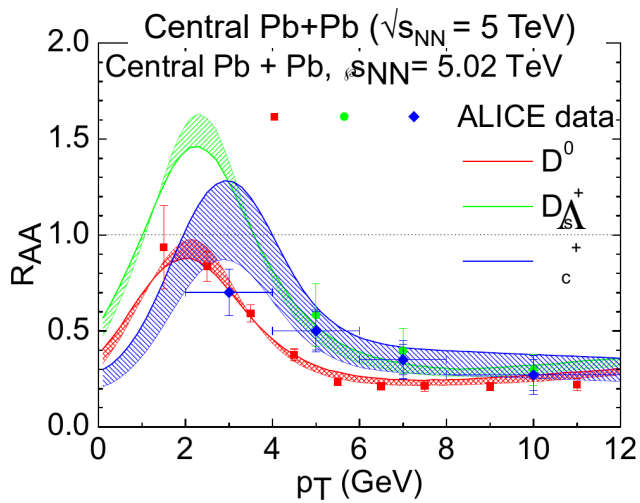
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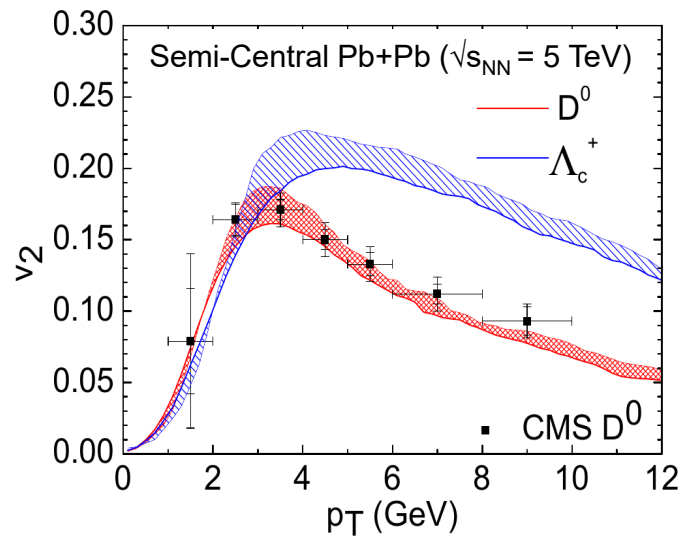
# Heavy-Flavor Hadron Observables



## Nuclear Modification Factor

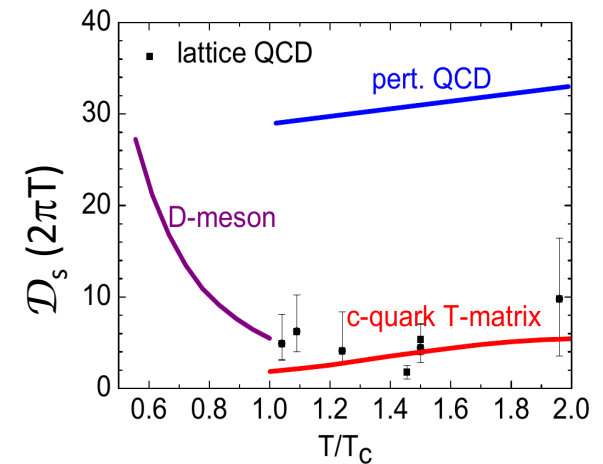


## Elliptic Flow



## Large elliptic flow

→ large “drag force” on heavy quarks by expanding QCD medium  
 ⇒ extracted diffusion coefficient,  $(2\pi T)\mathcal{D}_s$ , near lower quantum bound ( $\sim 1$ )

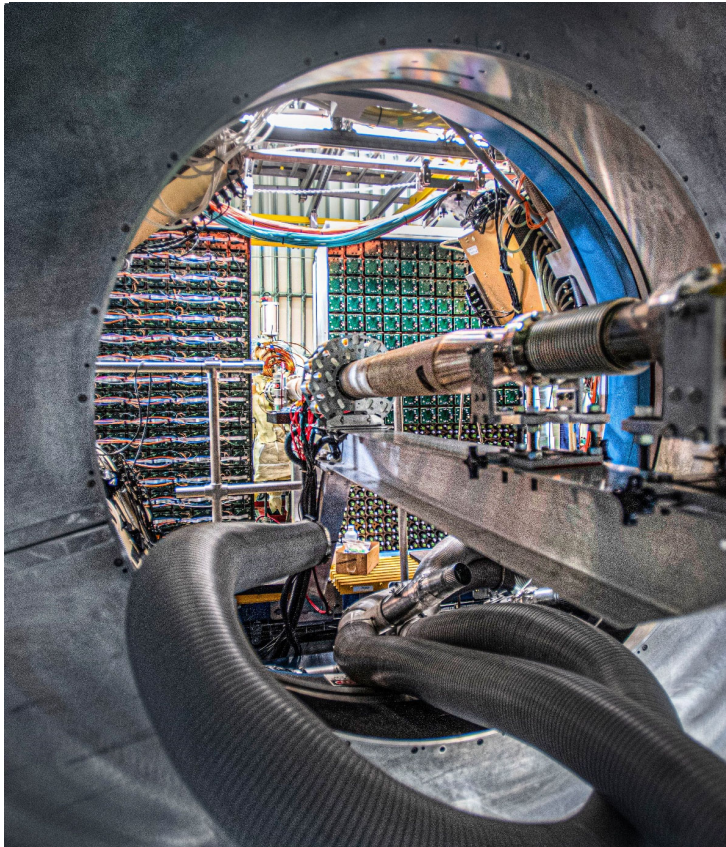


Distinct hierarchy of hadronic species  
 → signature of recombination





# Calorimetry in place for 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

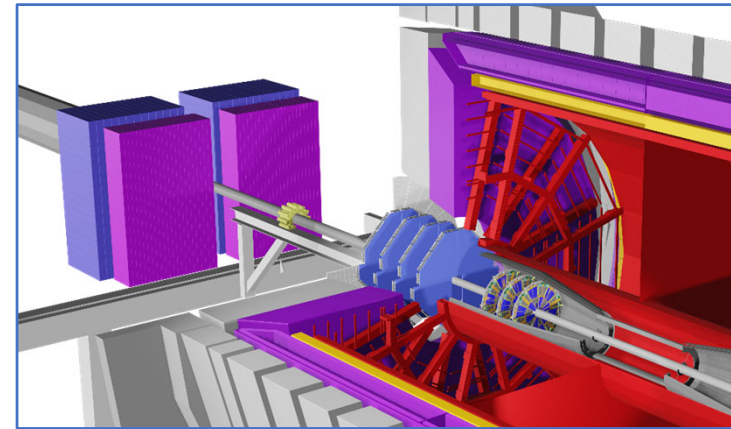


Photo courtesy of <https://www.bnl.gov/newsroom/news.php?a=217681>



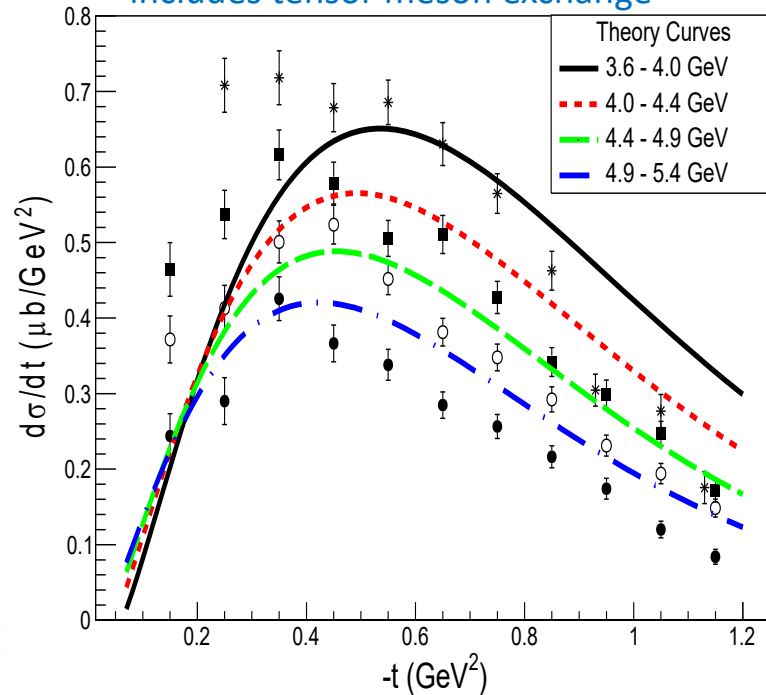




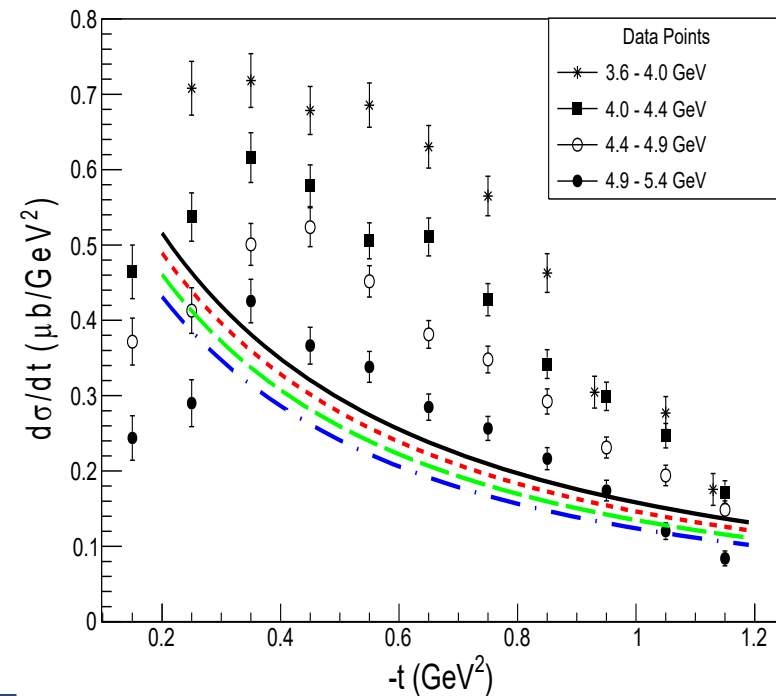
# Photoproduction of the $f_2$ meson from the CLAS Collaboration

Is the  $f_2$  meson a quark model ( $q$ - $q$ bar) state? Or is it a resonance of two  $\rho$ -mesons?

CLAS data compared with JPAC model  
– includes tensor meson exchange

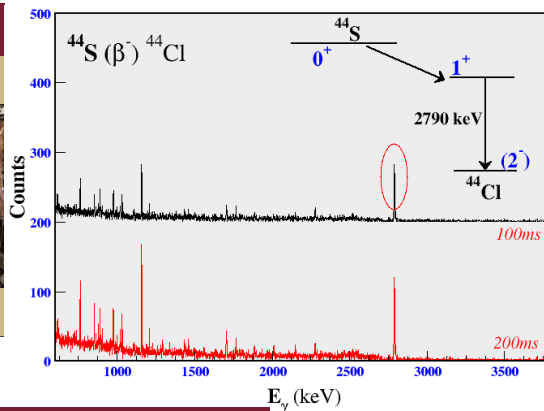
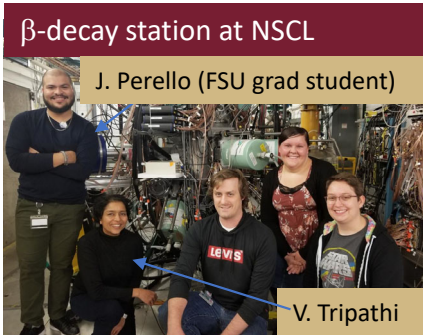


CLAS data compared with tetra-quark model of Xie and Oset model





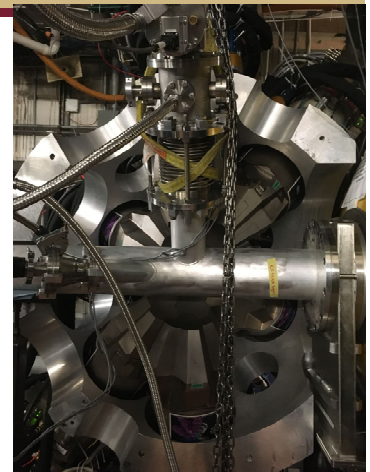
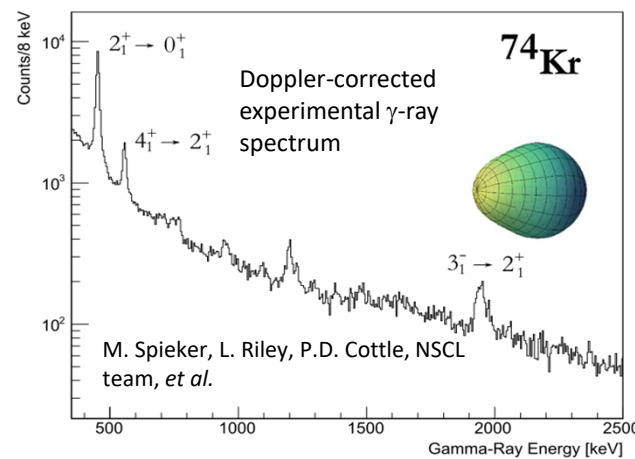
# $\gamma$ -ray spectroscopy experiments at NSCL Benchmarking Nuclear Structure



- Kr isotopes – Shape changes, shape coexistence and octupole collectivity**
- Spokesperson: M. Spieker
  - Inelastic proton scattering in inverse kinematics with GRETINA@S800.
  - Experiment ran successfully in August 2020 **during pandemic**.
  - Previously unknown octupole strength in  $^{74,76}\text{Kr}$  measured.

URSINUS/NSCL LH<sub>2</sub> target @ GRETINA+S800

- Detailed  $\beta$ -decay studies in the N=28 island of inversion**
- Spokesperson: V. Tripathi
  - New  $\beta$ -decay data on a multitude of neutron-rich isotopes close to N=28
  - Selective population of opposite-parity, intruder states.
- One example: Strong excitation of  $^{44}\text{Cl}$   $1^+$  state in  $\beta$ -decay of  $^{44}\text{S}$  will provide sensitive test of Shell Model.



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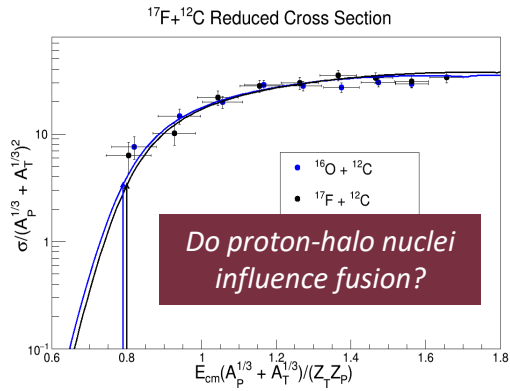
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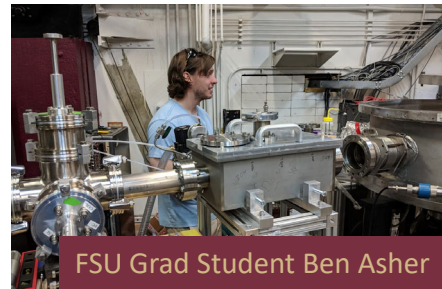
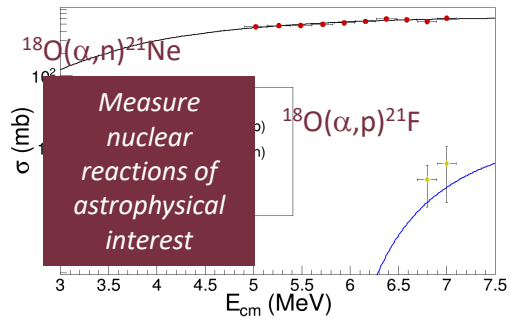


# Nuclear Structure Studies at Florida State Univ

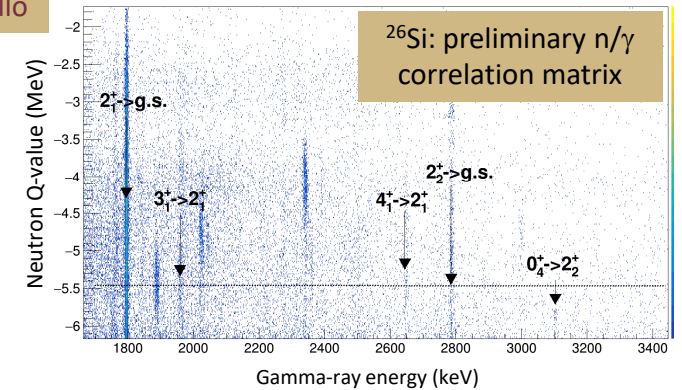
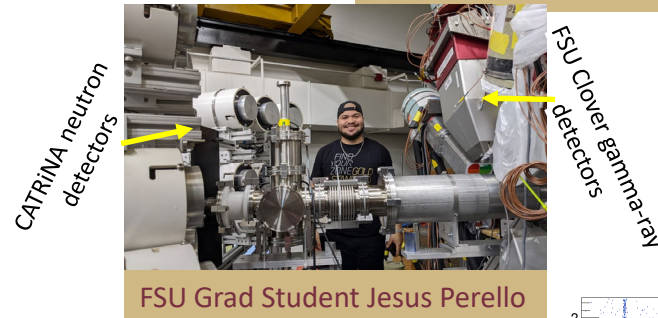
## The *Encore* active target detector at FSU



Encore has been used at FSU to measure fusion reactions as well as  $(\alpha, n)$  and  $(\alpha, p)$  reactions



## The *CATrINA* neutron detector at FSU



Neutron/gamma coincidence measurement of the  $^{24}\text{Mg}(^3\text{He}, n/\gamma)^{26}\text{Si}$  reaction  $\rightarrow$   $\gamma$ -branching ratios in  $^{26}\text{Si}$



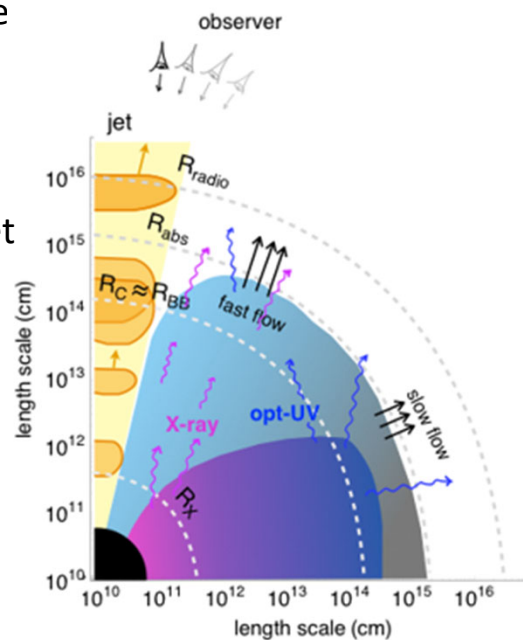
# A concordance scenario for the observed neutrino from a tidal disruption event



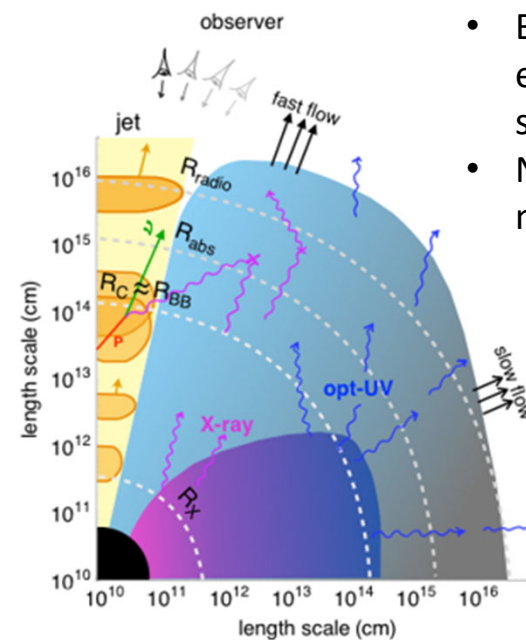
**Tidal Disruption Event (TDE):**  
 star is shredded and accreted  
 onto a supermassive Black Hole

*Model* : a relativistic jet

- neutrino production caused by X-rays scattered into the jet
- X-ray time scale + jet evolution explain late neutrino arrival
- Consistent with multi-wavelength observations and TDE numerical simulations



a) Early ( $t-t_{\text{peak}} < 17$  day)



b) Late ( $t-t_{\text{peak}} \gg 17$  day)

Coincidence of a IceCube neutrino with Tidal Disruption Event AT2019dsg

- Brightest *sustained* X-ray emission of ZTF TDE sample
- Neutrino detected  $\sim 5$  months post-peak

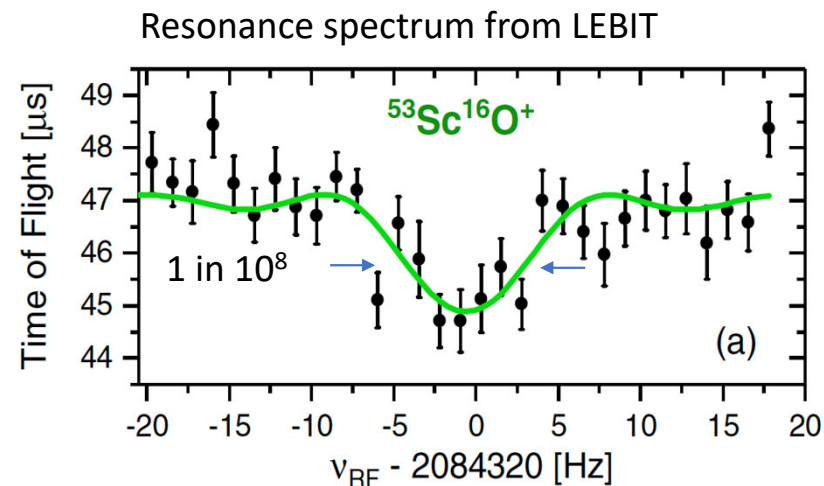
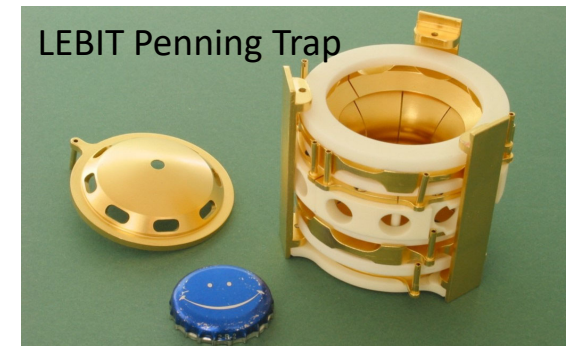


# Mass Spectrometry Experiments Clinch New Magic Neutron Numbers in Scandium



LEBIT (NSCL) & TITAN (TRIUMF) expts

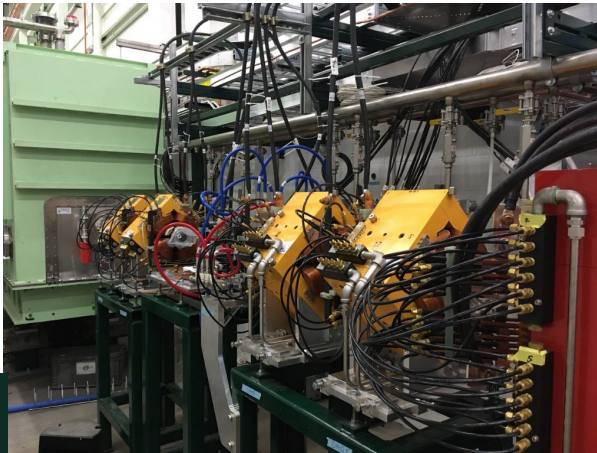
- mass measurements of  $^{50}\text{Sc}$  -  $^{55}\text{Sc}$  with precision of 1 in  $10^8$
- detailed map of the evolution of  $N=32$  and  $N=34$  neutron shell closures above calcium
  - showing the expected  $N=32$  gap but not the  $N=34$  gap.



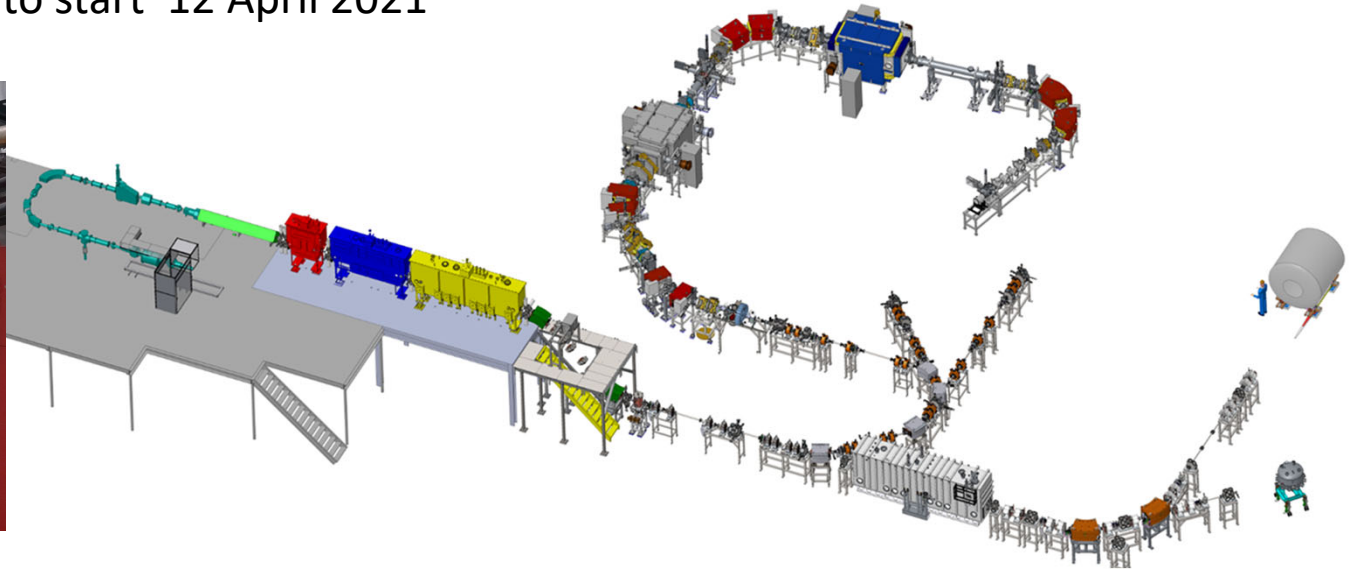


# NSCL ReA6 Upgrade Nears Completion

- The first ReA6 experiment to start on 1 May 2021
- Connection between ReA3 and ReA6 completed
- ReA6 Cryomodule cooled down started
- ReA6 beam commissioning to start 12 April 2021



ReA6 beam line





# “My Nuclear Life”

Podcast interviews on various nuclear physics topics by Shelly Lesher



<https://mynuclearlife.com>

On July 16, 1945 in a New Mexico desert, the Trinity Test ushered in the Nuclear Age. No other piece of technology has penetrated the American consciousness like the nuclear bomb and found a place in everything from culture to medicine. This podcast explores how nuclear science has impacted and changed our world in both beneficial and destructive ways. We explore the intersection of nuclear science and society using interviews from historians, policy makers, experts in their fields, and first-hand accounts to weave a picture of your nuclear life.

Guests Include: Author Richard Rhodes, Lead sanctions negotiator of the JCPOA Richard Nephew, Hanford Historian Robert Franklin, nuclear energy entrepreneur Leslie Dewan. 12 Episodes



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March 2021



# For the latest updates:

<https://www.nsf.gov/physics>

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- [jhthomas@nsf.gov](mailto:jhthomas@nsf.gov)

or call (703)292-2911

- [aopper@nsf.gov](mailto:aopper@nsf.gov)

or call (703)292-8958

The screenshot shows the NSF Directorate for Mathematical & Physical Sciences (MPS) website. The top navigation bar includes links for HOME, FUNDING, AWARDS, DISCOVERIES, NEWS, PUBLICATIONS, STATISTICS, ABOUT NSF, and FASTLANE. The main header features the NSF logo and the text "National Science Foundation Directorate for Mathematical & Physical Sciences (MPS)". A search bar is located on the right. Below the header is a secondary navigation bar with links for MPS HOME, MPS FUNDING, MPS AWARDS, MPS DISCOVERIES, MPS NEWS, and ABOUT MPS. The main content area is titled "Physics (PHY)" and includes a sub-header "Physics (PHY)" with options for Email, Print, and Share. The primary article is titled "PHY Replaces DCL with Solicitation NSF 14-576" and contains the following text: "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 a section titled "PHY Int'l Activities - Potential Co-Review" with the 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." A "Special Announcements" section follows, listing "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)". A left sidebar contains a "Physics (PHY)" header with a photo of Albert Einstein, followed by 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. At the bottom of the sidebar is a "Search PHY Staff" field with a search button. Below the sidebar is a "MPS Organizations" section listing Astronomical Sciences (AST), Chemistry (CHE), and Materials Research (DMR).

