Department of Energy, Office of Nuclear Physics Report

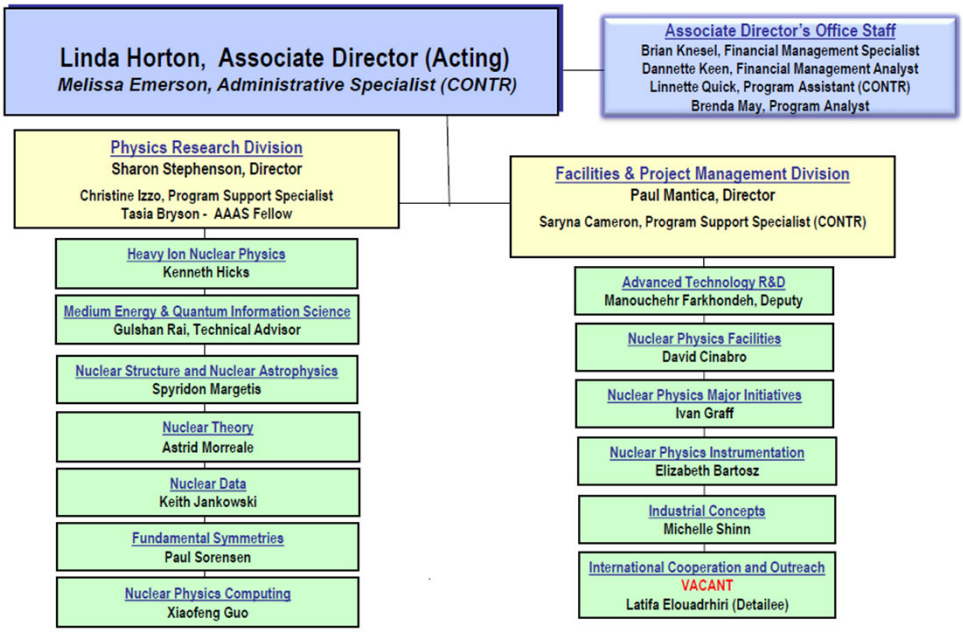
Sharon Stephenson
Office of Nuclear Physics (DOE-NP)
December 18, 2024

Energy.gov/science

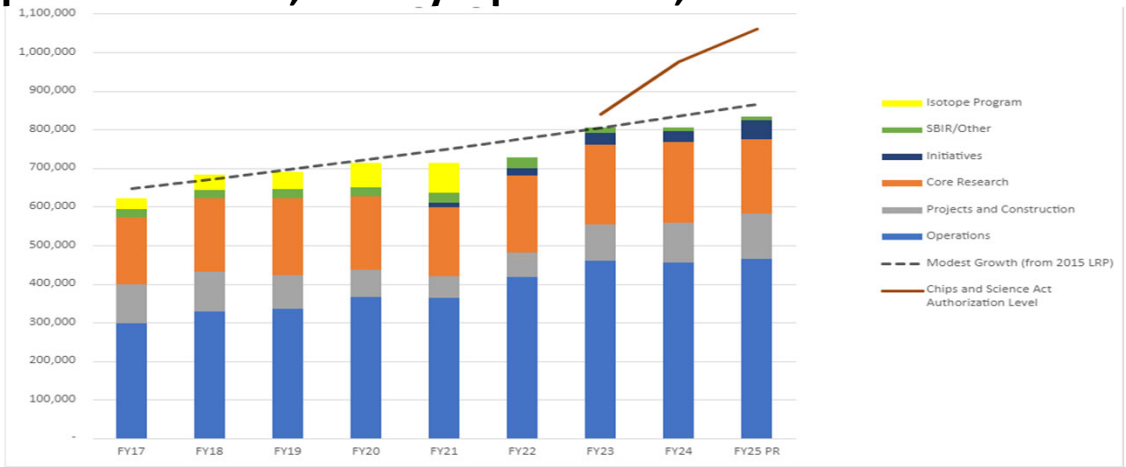
The DOE Nuclear Physics Program Supports…

- [illegible]
- [illegible]
  - Discovery of new isotopes; First reported production of a superheavy element with a beam other than ^{48}Ca; Understanding how matter formed out of the hot, dense soup of subatomic particles; Understanding how nucleons move between fusing nuclei
  - [illegible]
- [illegible]
- [illegible]
- [illegible]

DOE-SC Office of Nuclear Physics



Trend in DOE-NP Appropriations: FY 2024 Appropriation ($804M) supports Research, Facility Operations, and Construction



- **FY 2024 Enacted**: User facility operations at ~90%; Increased EIC project support; Initiatives - QIS, AI/ML, RENEW, FAIR, Accelerate, Microelectronics; EPSCoR participation. Core research up slightly.
- **FY 2025 PR** of ~$833M, ~3.6% above FY 2024: Facility operations at >90%; Increased EIC support; Research increases slightly, initiative support +$23M for AI/ML, RENEW, FAIR, core research down (~$17M). House mark ~flat with request; Senate Mark is +20M, including +$25 M for the EIC.

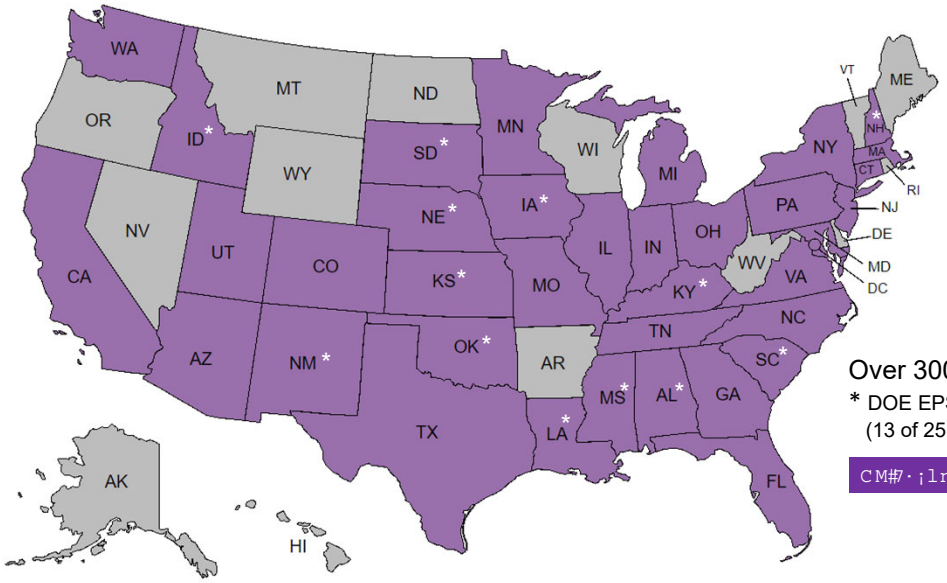
FY 2025 House and Senate Marks

- [illegible]
- [illegible]

in M$	FY 2024 Enacted	FY 2025 Request	FY 2025 House Mark	FY 2025 Senate Mark
Nuclear Physics "Research"	$709M	$723M	$705M	$715M
Construction (EIC)	$95M	$110M	$125M	$135M
Total	$804M	$833M	$830M	$850M

- [illegible]

States With DOE-NP Supported Researchers



Over 300 active awards

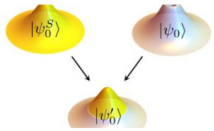
* DOE EPSCoR
(13 of 25 EPSCoR states)

CM#7·¡lnl

DOE-NP Research Impacts the Breadth of Nuclear Science

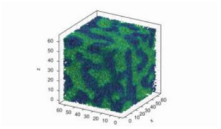
Smoother Surfaces Make for Better Particle Accelerators

An enhanced topographic analysis toolkit for forecasting and improving particle accelerator performance is helping scientists build better accelerators.



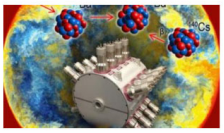
Making Difficult Quantum Many-Body Calculations Possible

Solving quantum many-body problems with wavefunction matching.



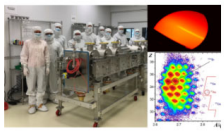
Simulating a Critical Point in Quark Gluon Fluid

Recent advances enable simulations near a possible critical endpoint of the transition between the quark gluon plasma and a hadron liquid.



Nuclear Physics Experiment Helps Identify Conditions for a New Astrophysical Process

New nuclear physics measurements shed light on the synthesis of heavy elements in stars.



Scientists Accelerate Uranium Beam with Record Power

The Facility for Rare Isotope Beams opens a new research avenue and observes three new rare isotopes.

Laser-Sharp Look at Spinning Electrons Sets the Stage for New Physics Discoveries

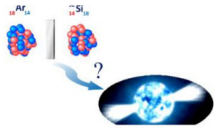
Nuclear physicists shatter a nearly 30-year-old record for the measurement of parallel spin within an electron beam.

Detecting the "Kick" from a Single Nuclear Decay

Scientists have detected nuclear decay by observing the recoil of a dust-sized particle when a single nucleus within it decays.

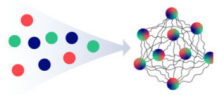
Discovery Sheds Light on the Origins of Matter in the Early Universe

A new calculation helps scientists understand how matter formed out of the hot, dense soup of subatomic particles created by the Big Bang.



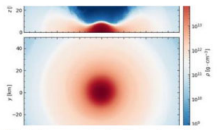
"Mirror" Nuclei Help Connect Nuclear Theory and Neutron Stars

Charge radii measurements of silicon isotopes test nuclear theories and guide descriptions of nuclear matter.



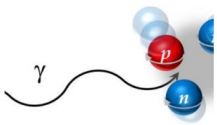
In Neutrinos, Quantum Entanglement Leads to Shared Flavor

Researchers find that the quantum flavor and momentum states of the neutrinos in a supernova are strongly entangled through frequent interactions.



What Happens to the Remains of Neutron Star Mergers?

Simulations of massive neutron star merger remnants reveal their structure and early evolution as they cool down by emitting neutrinos.



Exciting the Alpha Particle

New calculations confirm recent experimental results on the transition between the alpha particle and its first excited state.

Recent Science Highlights from the NP webpage -- https://science.osti.gov/np/Highlights

FY 2025 Initial Funding Opportunities/National Lab Calls
Notices of Funding Opportunities (NOFOs)

Title	Release Date
FY 2025 Continuation of Solicitation for the Office of Science Financial Assistance Program	10/1/2024
Early Career Research Program	TBD
EPSCoR Implementation Grants	9/12/2024
Nuclear Data Interagency Working Group Research Program	12/3/2024
Artificial Intelligence and Machine Learning Applied to Nuclear Science and Technology	10/15/2024

Join Mailing List

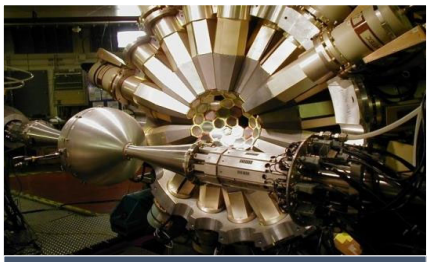
Signup for the Office of Science's GovDelivery email service, and check the box for the ***Nuclear Physics Program*** in your subscriber preferences.

Subscribe

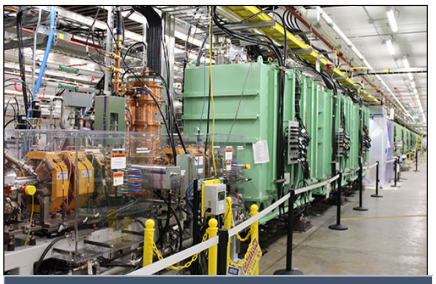
NP Operates Four World-Leading, Complementary User Facilities for Community Research & Scientific Leadership: ~4,200 Users/year

Pn}a#v"vfl#vj#Þ na"‰#£¡#. £}}xl nfi

. £¡#v¡·£·fl#2}nj#f£¡#na~ #
%jjn}nfa#£f#7ajv}v‰



%fl£¡¡n#$a¡ln~ #Av¡aj%jjn}nfa#£f#
Q‰fl#n~



7ajv}v‰#£f#Pafn#fl£#£«n#na~ fl

NP User Facility Operations Status

7\#˘"°#2¡aj#nl	7\#˘",#2¡aj#nl	7\#˘˘˝#MP
%}#C M#flnf##ajv}v#vnfl#£«nfia#n#a#Æ˘Î #£s#£«#v- a}#s·¡lv¡t#¡#7\#˘"°1 ◆ P9:. £«nfia#nfl#˝#»nn|fl#Ë¡Î #£«#v- a}½ ◆ .2-%7 £«nfia#nfl#°#»nn|fl#Ë¡Î #£«#v- a}½ ◆ %SA%Q £«nfia#nfl#¸˘#»nn|fl#Ë¡Î #£«#v- a}½ ◆ 7P:- £«nfia#nfl#¸#»nn|fl#ËÆÎ #£s#£«#v- a}½	%}#C M#flnf##ajv}v#vnfl#£«nfia#n#a#£·tu}%# Æ˘Î #£s#£«#v- a}#s·¡lv¡t#¡#7\#˘",1 ◆ P9:. £«nfia#nfl#Æ#»nn|fl#Ë¡Î #£«#v- a}½ ◆ .2-%7 £«nfia#nfl#˘#»nn|fl#Ë—Î #£«#v- a}½ ◆ %SA%Q £«nfia#nfl#Æ#»nn|fl#Ë·Î #£«#v- a}½ ◆ 7P:- £«nfia#nfl#¸#»nn|fl#Ë¡Î #£«#v- a}½	%}#C M#flnf##ajv}v#vnfl#£«nfia#n#a#£·tu}%# Æ˘Î #£s#£«#v- a}#s·¡lv¡t#¡#7\#˘˘˝1 ◆ P9:. £«nfia#nfl#¨#»nn|fl#Ë˝Î #£«#v- a}½ ◆ .2-%7 £«nfia#nfl#˝#»nn|fl#Ë-ÆÎ #£«#v- a}½ ◆ %SA%Q £«nfia#nfl#¸˘#»nn|fl#Ë˘Î #£«#v- a}½ ◆ 7P:- £«nfia#nfl#¸#»nn|fl#Ë˘Î #£s#£«#v- a}½

- P9:. #£«nfia#nl#˝#»nn\|fl#Ëv¡j}·lv¡t#¸#allv#v£¡a}#»nn\|fl#L·n##£#nafi}%#n¡l#£s#P·¡#¨°½#v¡#7\#˘",#s£j·fnl#£¡#«â« la#a#s£f#fM92C:[a¡l#QS%P#Sufinn#»nn\|fl#£s#%·â%·la#a##££\|#«}ajn#a##un#n¡l#£s#P·¡#˝,#»uvju#n...#n¡lnl#v¡#£#7\#˘˝˝1
- .2-%7#£«nfia#nl#s£f#˝˘#»nn\|fl#v¡#7\#˘",#»v#u#˝#allv#v£¡a}#»nn\|fl##£#j£~«}n#n#n...«nfiv~n¡#L#ljunl·}nl#v¡#Da}#%1
- %SA%Q#ia¡#s£f#¸˘#»nn\|fl#v¡#7\#˘",#Sun#¡·.%P:-T £«nfia#v£¡fl#£¡##iaj\|#s£f#nafi}%#˘˝˝#
- 7P:-#£«nfia#nl#s£f#˝,#»nn\|fl#v¡#7\#˘",#a#˝#\|Z #L n~£¡fl#ia#nl#˝#\|Z #£«nfia#v£¡fl#ja«aiv}v%#a##un#n¡l#£s#un#i·¡#«nfiv£l1

NP Projects Status

Project	Location	Status	Cost	CD-4
Construction Projects				
Electron-Ion Collider (EIC)	BNL	CD-3A	$1.7B to $2.8B (Est)	Q4 FY33 (Est)
Major Items of Equipment				
Gamma Ray Energy Tracking Array (GRETA) FF	LBNL	CD-2/3	$58.3M (TPC)	3/2028
Measurement of Lepton-Lepton Electroweak Reactions (MOLLER) FF	TJNAF	CD-2/3	$48.66 M (TPC)	Q4 FY28
High Rigidity Spectrometer (HRS)	MSU	CD-1	$85.0M to $111.4M (Est)	Q2 FY29 (Est)
Ton Scale Neutrinoless Double Beta Decay (TS-NLDBD) Program	TBD	CD-0	$215M to $250M (Est)	TBD

7\#˘"¸#2¡aj#nl	7\#˘"˝#MP
2:.#a#S2.#Es#Æ˝B#a¡l#EM.#Es#"ÆB	2:.#a#S2.#Es#''˘B#a¡l#EM.#Es#"ÆB
SQECA0-0a#°B#S2. 9PQ#a#°B#S2.	SQECA0-0a#"B#S2. 9PQ#a#°ı°B#S2.

The NP Long Range Plan

Capitalize on the extraordinary opportunities for scientific discovery made possible by the substantial and sustained investments of the United States. We must draw on the talents of all in the nation to achieve this goal.

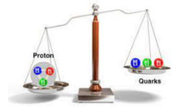
We reaffirm the exceptionally high priority of the following two investments in new capabilities for nuclear physics. The **Electron–Ion Collider (EIC)**, …will elucidate the origin of visible matter in the universe and significantly advance accelerator technology… Neutrinoless double beta decay experiments have the potential to dramatically change our understanding of the physical laws governing the universe.

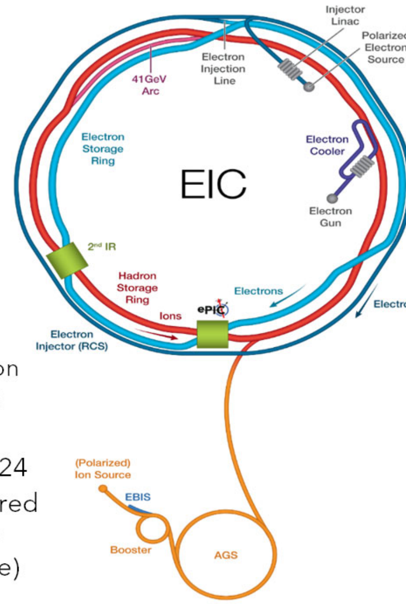
As the highest priority for new *experiment* construction…, lead an international consortium that will undertake a **neutrinoless double beta decay** campaign.

We recommend the expeditious completion of the EIC as the highest priority for *facility* construction.

Capitalize on the unique ways nuclear physics can advance discovery science and applications for society.

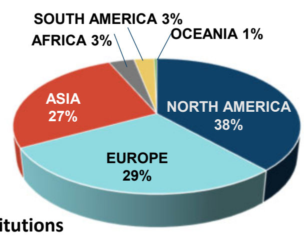
Top Priority for New Facility Construction in the 2023 Long Range Plan for Nuclear Science: Electron-Ion Collider





EIC Design and Construction: Opportunities for Domestic and International Collaboration

- [illegible]
  - [illegible]
  - [illegible]
- [illegible]
  - [illegible]
  - [illegible]

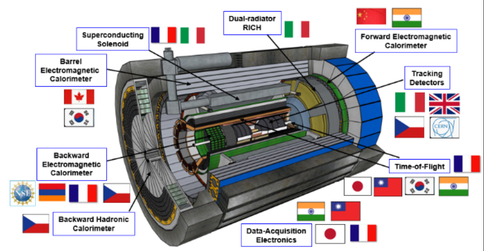


Institutions

DOE Lab Partners

Argonne National Laboratory, Brookhaven National Laboratory, Fermilab, Oak Ridge National Laboratory, Berkeley Lab, SLAC National Accelerator Laboratory, Los Alamos National Laboratory, Jefferson Lab

ePIC Detector Partners



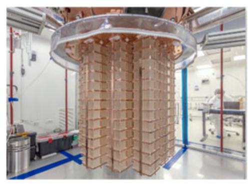
Top Priority for New Experiment Construction in the 2023 Long Range Plan for Nuclear Science: Neutrinoless Double Beta Decay

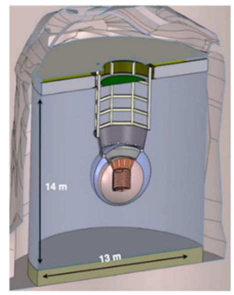
- [illegible]
- [illegible]
  - [illegible]
  - [illegible]
- [illegible]

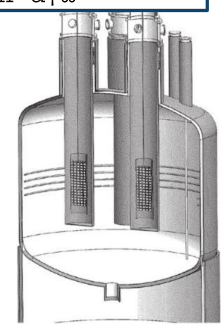
[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

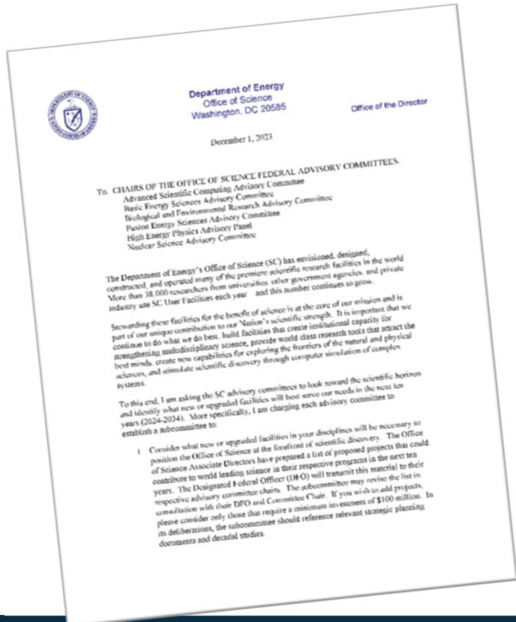






MP0

FY 2024: An Update to the SC Facility Plan to Advance U.S. Science & Innovation Leadership for the Next Decade+


Department of Energy
Office of Science
Washington, DC 20585

Office of the Director

December 1, 2023

To: CHAIRS OF THE OFFICE OF SCIENCE FEDERAL ADVISORY COMMITTEES
Advanced Scientific Computing Advisory Committee
Basic Energy Sciences Advisory Committee
Biological and Environmental Research Advisory Committee
Fusion Energy Sciences Advisory Committee
High Energy Physics Advisory Panel
Nuclear Science Advisory Committee

The Department of Energy's Office of Science (SC) has envisioned, designed, constructed, and operated many of the premiere scientific research facilities in the world. More than 38,000 researchers from universities, other government agencies, and private industry use SC User Facilities each year and this number continues to grow.

Stewarding these facilities for the benefit of science is at the core of our mission and is part of our unique contribution to our Nation's scientific strength. It is important that we continue to do what we do best: build facilities that create institutional capacity for strengthening multidisciplinary science, provide world class research tools that attract the best minds, create new capabilities for exploring the frontiers of the natural and physical sciences, and stimulate scientific discovery through computer simulation of complex systems.

To this end, I am asking the SC advisory committees to look toward the scientific horizon and identify what new or upgraded facilities will best serve our needs in the next ten years (2024-2034). More specifically, I am charging each advisory committee to establish a subcommittee to:

1. Consider what new or upgraded facilities in your disciplines will be necessary to position the Office of Science at the forefront of scientific discovery. The Office of Science Associate Directors have prepared a list of proposed projects that could contribute to world leading science in their respective programs in the next ten years. The Designated Federal Officer (DFO) will transmit this material to their respective advisory committee chairs. The subcommittee may revise the list in consultation with their DFO and Committee Chair. If you wish to add projects, please consider only those that require a minimum investment of $100 million. In its deliberations, the subcommittee should reference relevant strategic planning documents and decadal studies.

- [illegible]
- [illegible]
  - [illegible]
  - [illegible]
- [illegible]
- [illegible]

Slide 16

MP0 You will likely be asked when the outcome of the prioritization process is expected, and in what form.
Mantica, Paul, 2024-10-06T21:27:55.091

NSAC Facilities Charge Outcome

Major Nuclear Physics Facility	Scientific importance	Readiness for construction
Electron-Ion Collider (EIC)	(a) Absolutely central	(a) Ready to initiate
High Rigidity Spectrometer (HRS)	(b) Important	(a) Ready to initiate
Ton-scale Neutrinoless Double Beta Decay (TS-NLDBD)	(a) Absolutely central	(a) Ready to initiate
Project 8	(b) Important	(c) Mission and technical requirements not yet fully defined
FRIB Energy Upgrade (FRIB400)	(b) Important	(a) Ready to initiate
Solenoid Large Intensity Device (SoLID)	(b) Important	(a) Ready to initiate
EIC Detector II	(b) Important	(c) Mission and technical requirements not yet fully defined

The importance of the science for each project as assessed by the Subcommittee was tied closely to the 2023 LRP.
In considering the readiness for construction the Subcommittee was guided by the current status of the project and remaining challenges, including the DOE critical decision level, if any.

Summary

- CM#fl#n» afil fl#a#» £fi}lÐ}nal v¡t#k fi£tfia~ #v¡#¡·j}nafi#k u&flvjfl##ua##Ln}v"nffl#¡n» #ljvn¡jn]#£«nfia#nfl#·¡v»·n# }nalnffluv«#flnfi#ajv}v#vnfl#fl·««£fi#fl#a¡l#n¡ua¡jnfl#a#Lv"nffln#» £fi|s£fijn]#a¡l#Ln}v"nffl#v~ «aj#s·}# a««}vja#v£¡fl
- CM#Pnflnafiju#fl·««£fi#fl#a#j£~ «n}}v¡t#ljvn¡jn#k fi£tfia~]#k·ffl·v¡t#k fiv£fiv‰#aj#v"v#vnfl#£fi# ¡·j}nafi#ljvn¡jn]#% ½B A]#»·a¡#·~ #v¡s£fi~ a#v£¡#ljvn¡jn]#a¡l#- vjfi£n}njfi£¡vjfl1
  - -fi£aln¡v¡t#k afi#vjv«a#v£¡#v¡#£M#flnflnafiju#v¡j}·lnfl#n~ nfit v¡t#flnflnafiju#v¡fl#v·#v£¡fl#a¡l#2MQ.£P {·fivll vj#v£¡fl
- CM#-flnfi#ajv}v#vnfl#Ln}v"nfl#£«nfia#v£¡a}#u£·ffl#£fi#un#Lfi£al#- vflfiv£¡#l«ajn#£fi#¡·j}nafi#ljvn¡jn
  - Qnfi"v¡t#£"nf#,Ï˘˘#flnffl#knfi#anafi#a¡l#Ln}v"nfiv¡t#v~ «aj#s·}#flnflnafiju
- CM#fl#»£fi|v¡t#£#Ln}v"nfi‰#ja«aiv}v#vnfl#£·#}v¡nl#L‰#fl#fia#ntvj#k}a¡¡v¡t
  - Sun#2:.#Mfi£{nj#k fi£tfinflflnfl#£»afil fl#.0Ð°-#ÐA£¡tÐAnal#Mfi£j·fin~ n¡#a¡l#un#¡n...#0E2#La#n»a‰#.0Ð°#‰««fi£"n# Mnfis£fi~ a¡jn#-afln}v¡n½
  - Mfiv£fiv#v a#v£¡#fl#¡lnfi»a‰#£#£j·fl#s·#·fin#ajv}v#‰#j£¡fl#fi·j#v£¡]#v¡j}·lv¡t#Cn·#fiv¡£}nflfl#0£·i}n#-n#a#0nja‰# n...«nfiv~ n¡#fl

Add COV for facilities here?

U.S. DEPARTMENT OF ENERGY | Office of Science

Energy.gov/science