A Roadmap for Nuclear Physics: Objectives and Performance Targets

2006 | 2008 | 2010 | 2012 | 2014 | 2016

Medium Energy Nuclear Physics

- Obtain first polarized high energy proton-proton data studying the proton spin **(2006)** NSF
- Determine the strange quark content of the proton **(2007)** NSF
- Begin search for an electric dipole moment of Radium-225 **(2007)**
- Determine gluon contribution to proton spin **(2010)** NSF
- Establish basic properties of the proton, neutron, and simple nuclei using high intensity polarized electron beams at 6 GeV **(2012)** NSF
- Begin measurements to find exotic mesons to gain understanding of quark confinement **(2013)** NSF
- ⬡ Demonstrate progress in realizing a quantitative understanding of the quark substructure of the proton, neutron, and simple nuclei by comparison of precision measurements of their fundamental properties with theoretical calculations **(2015)**

Heavy Ion Nuclear Physics

- Begin studies of rare processes in the formation of hot, dense nuclear matter **(2004)**
- Determine if quark-gluon plasma, the matter of the infant universe, can be made in the laboratory using colliding beams of atomic nuclei **(2007)**
- ⬢ Experiments at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory will have established the basic characteristics of a fundamental new form of nuclear matter that exists at extremely high temperatures and densities **(2008)**
- Begin measurements of the behavior of high transverse-momentum particles through hot, dense, nuclear matter that is dominated by gluons **(2011)** NSF
- ⬡ Demonstrate progress in searching for, and characterizing the properties of, the quark-gluon plasma by recreating brief, tiny samples of hot, dense nuclear matter **(2015)**

Low Energy Nuclear Physics

- Establish reaction rates for understanding how light elements are created in supernovae **(2006)**
- Develop three-dimensional computer simulations for the behavior of supernovae, including core collapse and explosion, which incorporate the relevant nuclear reaction dynamics **(2006)**
- Quantify neutrino mixing using neutrinos from the sun, cosmic-ray interactions, and nuclear reactors **(2006)** HEP
- Complete measurements in new regions of nuclear structure and develop the nuclear many-body theory to predict nuclear properties **(2008)** NSF
- Begin studies of nuclei at the limits of stability using the new GRETINA gamma-ray detector, revolutionizing detector technology **(2010)** NSF
- Launch next-generation neutron experiments studying decay of the neutrons **(2010)** NSF
- Establish an electron neutrino mass **(2011)** HEP
- Begin a high-precision search for the electric dipole moment of the neutron, which will test new theories of fundamental particle interactions **(2013)** NSF
- Begin experiments to look for neutrinoless double beta decay to provide essential information about the absolute scale of neutrino masses **(2013)** HEP NSF
- ⬡ Demonstrate progress in investigating new regions of nuclear structure, study interactions in nuclear matter like those occurring in neutron stars, and determining the reactions that created the nuclei of atomic elements inside stars and supernovae **(2015)**
- ⬡ Demonstrate progress in determining the fundamental properties of neutrinos and fundamental symmetries by using neutrinos from the sun and nuclear reactors and by using radioactive decay measurements **(2015)**

Future Facilities
(Cross cut and support multiple objectives and targets):

- **Continuous Electron Beam Accelerator Facility (CEBAF) Upgrade:** Construction begins to upgrade of the CEBAF - a cost-effective way to double the energy of the existing beam **(2007)** — **Upgraded CEBAF** operations begin **(2012)**
- **Rare Isotope Accelerator (RIA):** Begin construction of the world's most powerful research facility dedicated to producing and exploring new rare isotopes that are not found naturally on Earth. **(2009)** — **RIA** operations begin **(2015)**
- **Double Beta Decay Underground Detector:** Begin construction to enable measurements of neutrino masses and determination of whether the neutrino and its anti-particle are identical. **(2007)** NSF HEP — **Double Beta Decay** operations begin **(2013)**

Interdependencies:
(Descriptions)

*Broadly with **ASCR** on computational developments, both hardware and software, affecting all facets of basic research and advanced instrumentation.*

NSF *= with NSF*
HEP *= with HEP*

⬢ =Key Intermediate Objective from DOE Strategic Plan
⬡ =Long Term Success Measure from PART

This timeline is for planning purposes only and does not constitute financial or contractual commitments by the Federal Government.