

# Report and Perspective from Nuclear Sciences Advisory Committee (NSAC)

- NSAC `Implementation' Charge
- NP Organization
- Relevant Challenges
- Status on Planning

# NSAC Implementation Charge from DOE-NSF

We seek advice from NSAC on implementing the priorities and recommendations of the 2007 Long Range Plan in light of projected budgetary constraints and for guidance on developing a plan to implement the highest priority science in the context of likely available funding and world-wide capabilities.

Your report should describe how to optimize the overall nuclear science program over the next five years (FY 2014-2018), under at least the following funding scenarios for the nuclear science budgets at the two agencies: (1) flat funding at the FY 2013 request level, and (2) modest increases over the next five years.

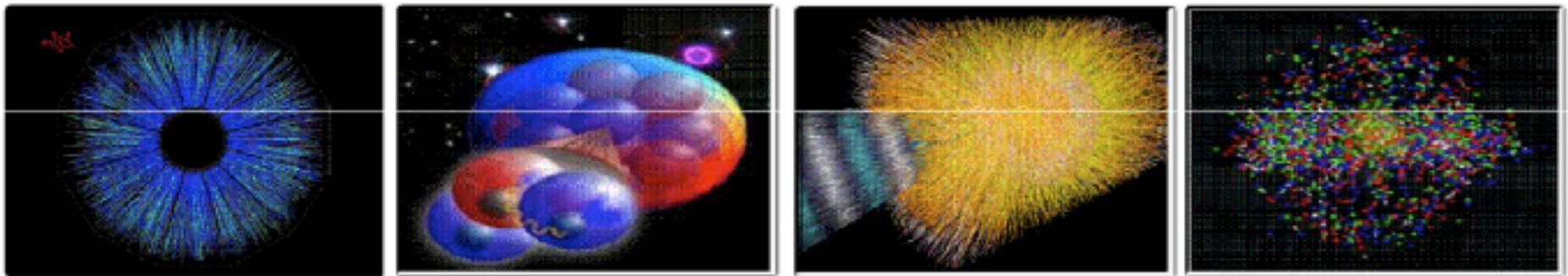
This effort is going on in parallel to the planning in HEP but has some major consequences for areas of overlap between the two.

(More about the 2007 Long Range Plan and the budget in a bit...).

# NP Science

Primary Goal:

A complete theory of quark matter in the regime of "infrared slavery."



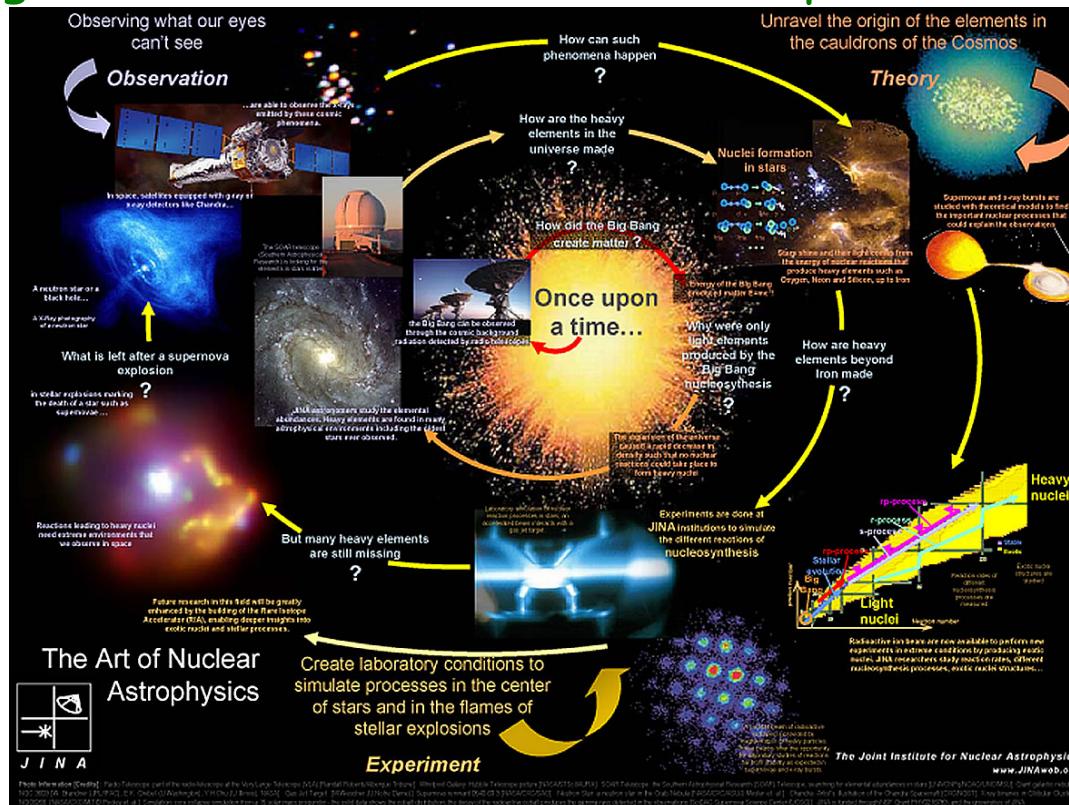
Should predict:

- Onset of confinement and complexity of phase transitions
- Meson spectroscopy
- Properties of the nucleons (spin, mass, etc.)
- Structure and behavior of nuclei up to and beyond exotica
- Nuclear reaction cross sections
- Origin of the light elements in the Big Bang
- Origin of the heavy elements in stars and supernovae

# NP Science

## Secondary Goal:

Nuclear Astrophysics---measurements of the processes that drive energy generation in stars and element production in supernovae



## Includes:

- Nuclear reactions at relevant energy scales
- Reactions involving radioactive beams
- Theory

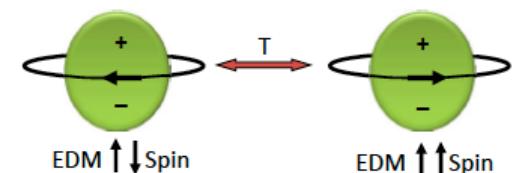
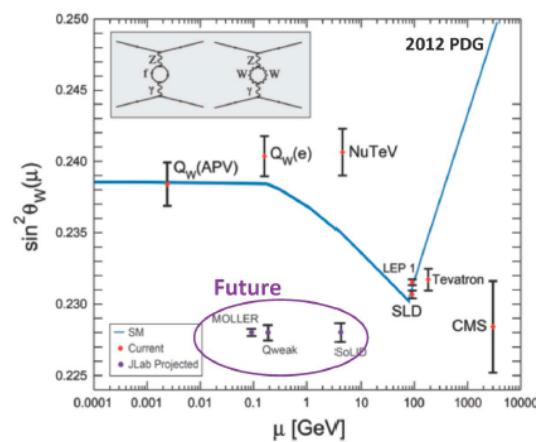
# NP Science

## Tertiary Goal:

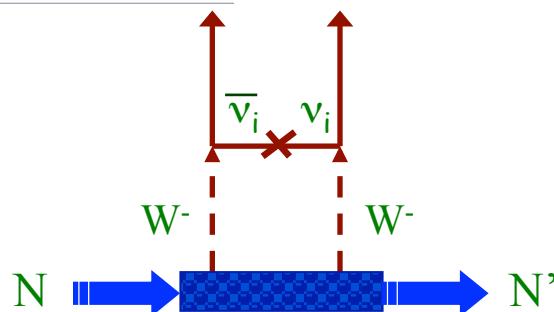
Using nuclear physics approaches for precision tests of the Standard Model and to answer other “fundamental” questions.

### Examples:

- Searches for neutron electric dipole moment (nEDM)
- Running Weak Charge



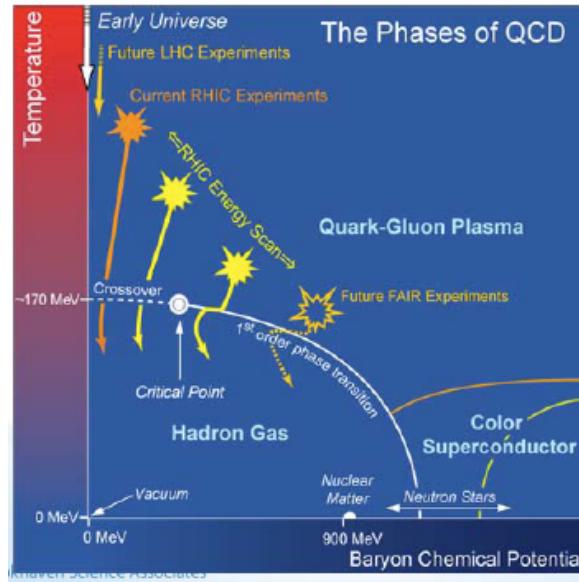
- Neutrinoless Double Beta Decay ( $0\nu\beta\beta$ )



# NP Organization--DOE

Subprograms/Budget Structure primarily follows facilities:

- Medium Energy: Nuclear structure
- Heavy Ions: QCD phases



- Low Energy: Nuclear reactions, astrophysics, neutrinos
- Isotope program: Managing needed isotopes (new mandate)
- Nuclear Theory
- Construction: FRIB, etc.

# DOE Major Facilities

- RHIC---Heavy Ions
- Jlab---Medium Energy
- ATLAS---Low Energy
- NSCL---Low Energy
- HRIBF (now off)
- FRIB (coming soon)---Low Energy

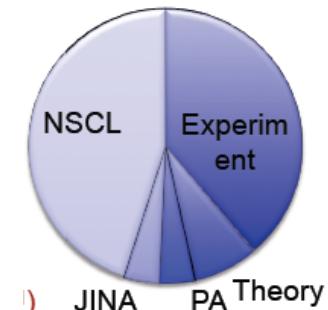


Others:

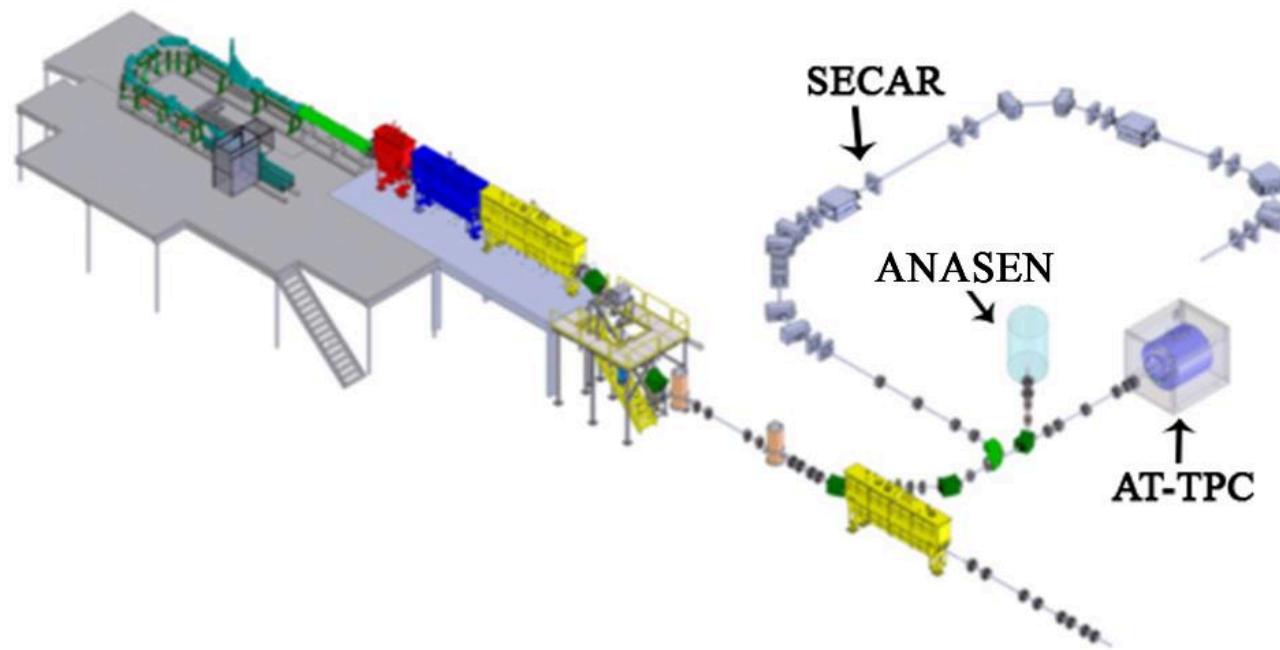
HIGS (TUNL), LENA (TUNL), CEPNAP (UW), ISNAP (Notre Dame), Edwards Lab (Ohio)....

Most facilities address all three goals.

# NP Organization--NSF



- NP Experiment
- NP Theory
- Particle Astrophysics and Non-accelerator Physics (PA)
- Frontier Center (Nuclear Astrophysics)
- National Superconducting Cyclotron Lab (NSCL)



# Priorities and New Planning

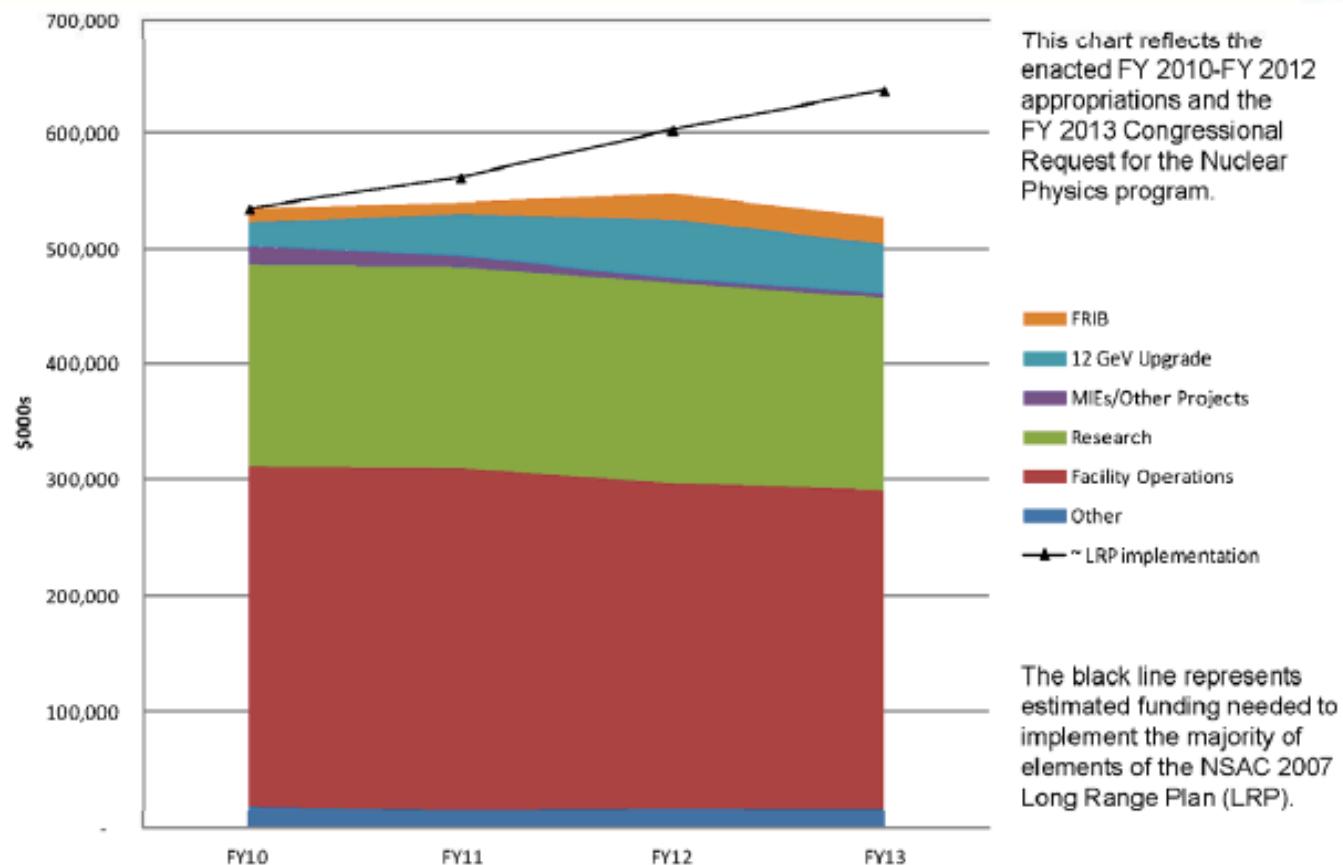
NP priorities are set by Long Range Plan ~every 5 years  
(most recent 2007)

Four recommendations for NP-Ex:

- I. Construction of 12 GeV upgrade for CEBAF
- II. Construction of FRIB
- III. 'Targeted Experiments' in Fundamental Symmetries and Neutrinos
  - a) DUSEL called out
- IV. RHIC II Luminosity Upgrade

New Long Range Plan is due, but...

# Priorities and New Planning



FY13: President's Request: -4%

House Mark: +0%

Senate Mark: -1.5%

Charge basically assumes flat from PR-FY13 onward.

# Implications for HEP

Biggest area of physics overlap is  
Fundamental Symmetries and Neutrinos

## *Four Components*

*EDM searches:*

*BSM CPV, Origin of Matter*

*$0\nu\beta\beta$  decay searches:*

*Nature of neutrino, Lepton number violation, Origin of Matter*

*Lepton accelerators:*

*SM Precision Tests, BSM “diagnostic” probes*

*Smaller scale:*

*Weak decays,  $m_\nu$ , “dark photons”, non-Newtonian gravity, theory...*

# Implications for HEP

Biggest area of physics overlap is Fundamental Symmetries and Neutrinos

- Identical physics being studied---e.g.,  
 $\Delta m^2$  is the same regardless of energy regime
- Non-accelerator methodology is essentially the same---e.g.,  
dark matter and  $0\nu\beta\beta$  both need u/g space, low bkds.

In NP, this all falls into a small portion of the Low Energy program.

Low Energy budget is down -7.3% in FY13---biggest cut (excepting construction)

# Implications for HEP

## Based on Science:

- There are selected NP science targets of opportunity with the potential for high-impact in fundamental symmetries, neutrons, and neutrinos.
- These experiments may take on even greater significance depending on the results of accelerator research in the next few years
- To the extent there are resources to pursue them and they are complementary to HEP research, such opportunities may be pursued.
- For nEDM the science goal continues to be strongly motivated and R&D continues; a decision point is expected within ~ 2 years whether to proceed with the full experiment
- $0\nu\beta\beta$  experiments are sufficiently costly, a down-select to the best technology across HEP and NP makes sense and is planned.



Office of  
Science

NSAC Meeting

September 21, 2012

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T. Hallman

# Implications for HEP

- To the extent there are resources to pursue them and they are complementary to HEP research, such opportunities may be pursued.

## A few questions:

- How will compelling physics not fall through the cracks between HEP and NP?
  - ◆ Solar neutrinos (Historically NP)
  - ◆ Supernova neutrinos (Historically HEP)
  - ◆ Ov $\beta\beta$  (Historically both)
  - ◆ Geoneutrinos (Historically both)
  - ◆ Relic supernova neutrinos (not much history)
  - ◆ Reactor antineutrinos (Historically both)
- Will there be no joint projects?
- What does "may" mean...?

Clearly, both planning exercises need to be following each other's progress.

# Biggest NP Symmetries/vs Programs

Domestically, Majorana Demonstrator is biggest effort:

Germanium detector and the cryostat for the Majorana Demonstrator (MJD 40-kg ultra-clean Ge detector).

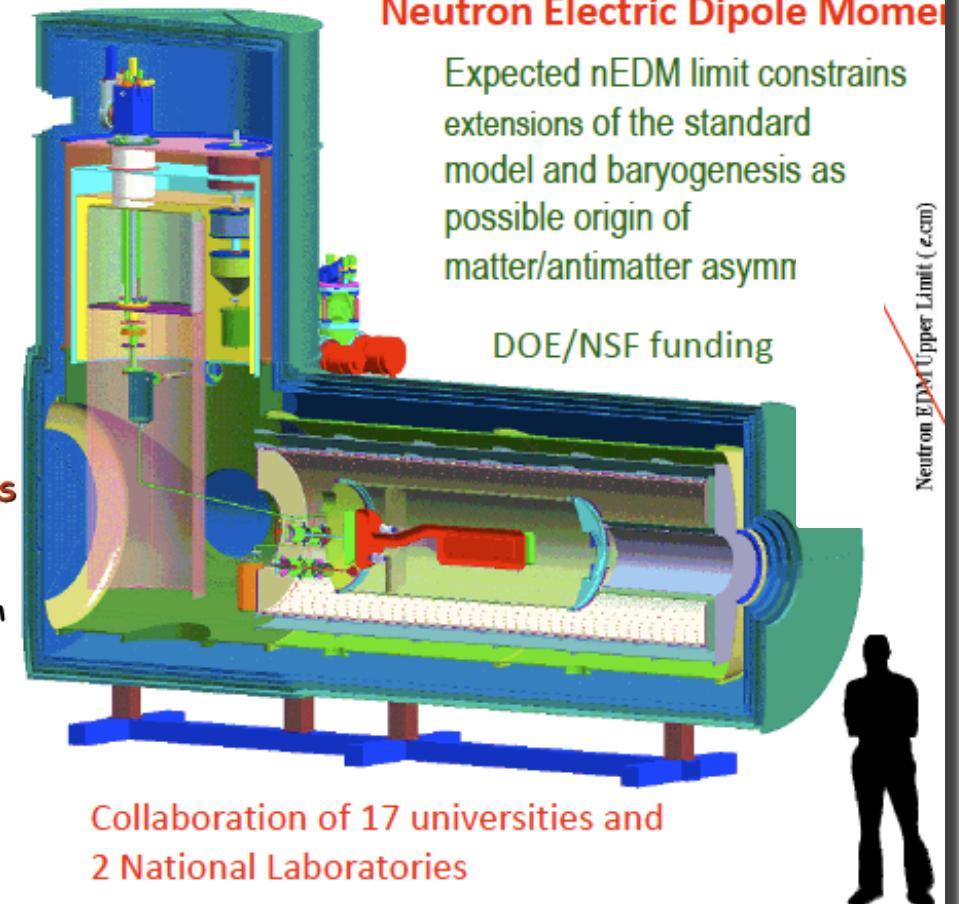
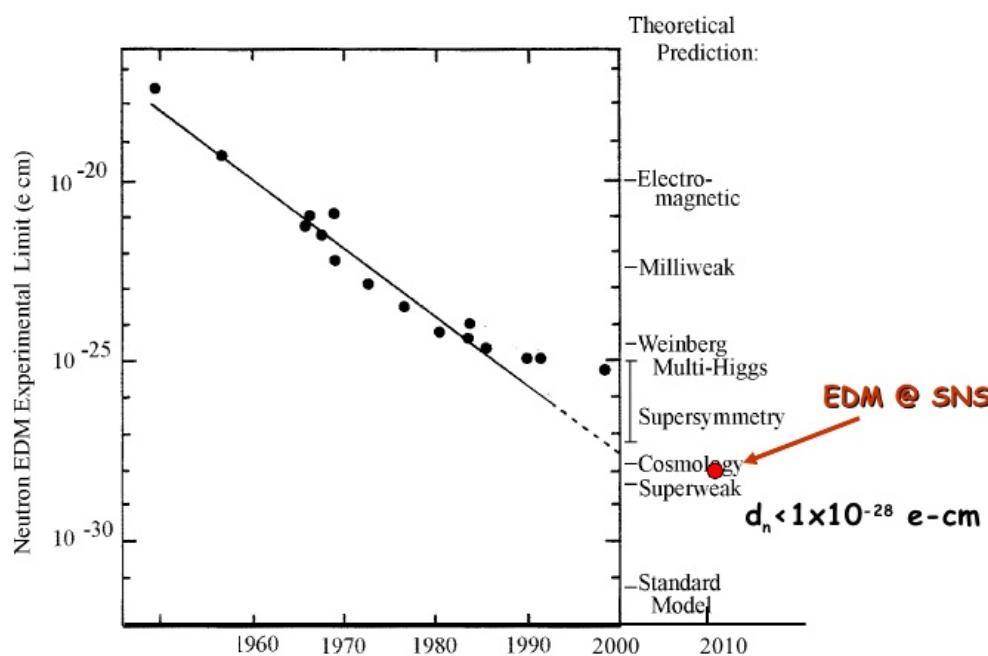


Cryostat for MJD

Part of a down-select of  $0\nu\beta\beta$  technologies to go toward the 'tonne-scale.'

# Biggest NP Symmetries/vs Programs

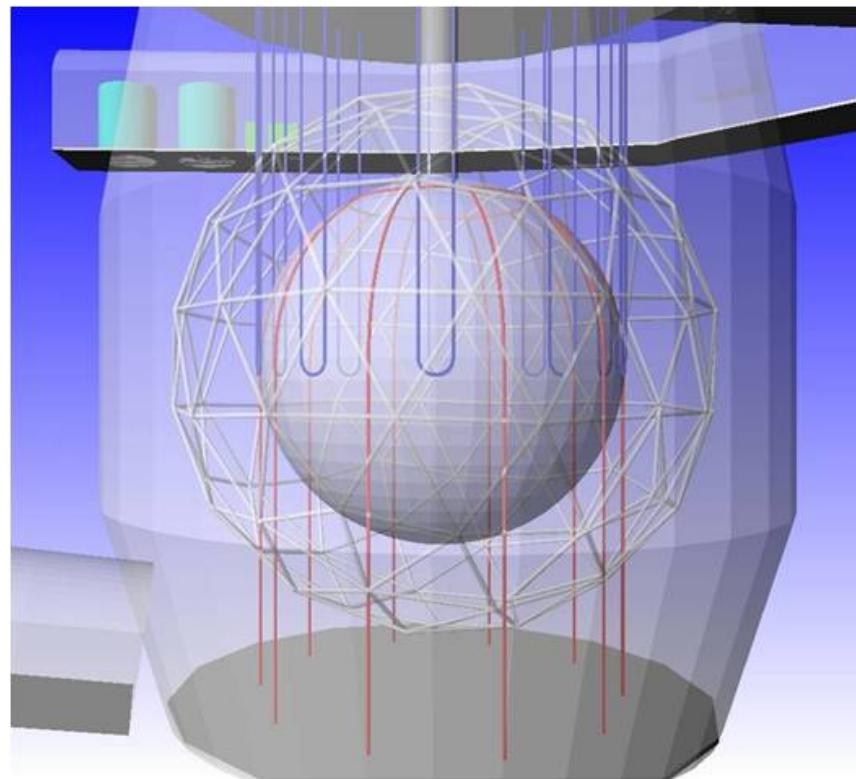
Neutron EDM is other big domestic project:



# Biggest NP Symmetries/vs Programs

Off-shore:

- CUORE:  $0\nu\beta\beta$  decay in Te bolometers
- KATRIN: Direct neutrino mass via tritium beta decay
- BOREXINO: solar vs (NSF)
- SNO+:  $0\nu\beta\beta$  decay in liquid scintillator, solar vs



# Progress on Planning Report

So far:

- Subcommittee chaired by R. Tribble formed
- First full subcommittee meeting past September
- Workshops on
  - Symmetries/Neutrinos
  - Heavy Ions
  - Medium energy
  - Low energy
  - Nuclear astrophysics, theory, and computing
- Interim report to NSAC presented overview of field, but not yet any discussion of the impact of future budget.
- Town meetings will be held at DNP meeting in October
- Resolution meeting in November
- Report to be submitted to NSAC Jan. 7.

# Summary

- NP planning exercise happening in parallel to HEP
- Budget 'crisis' is making this happen quickly
- Areas with overlap and impact on HEP are in a relatively fragile position
- Not yet clear the direction of the overall process---town meetings will be important venue.

