

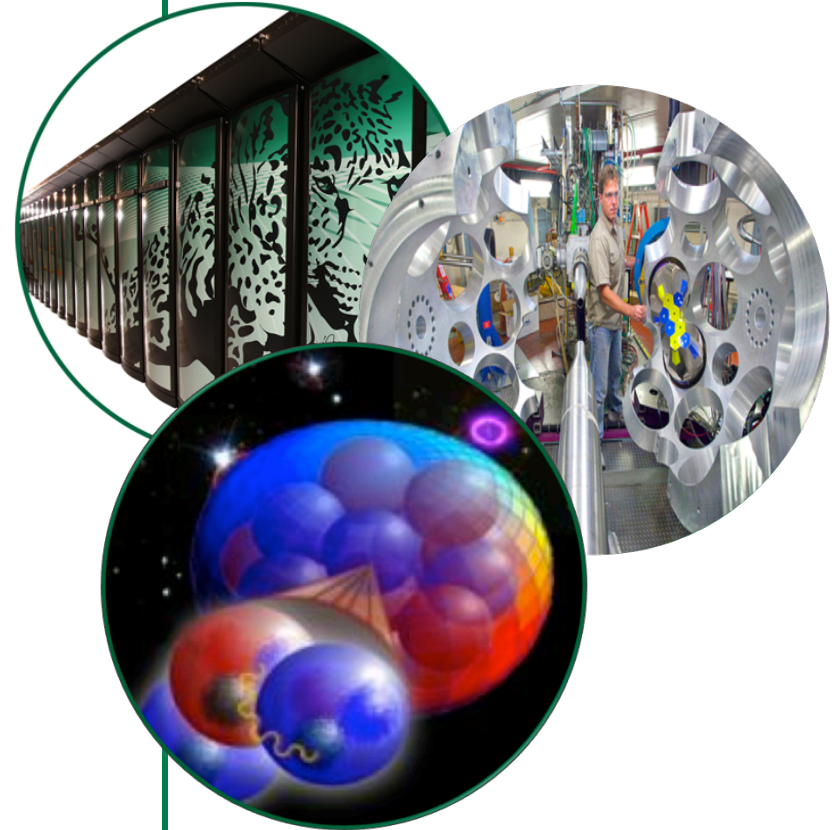
Computational Nuclear Physics: Random Walks...

David J. Dean

Physics Division

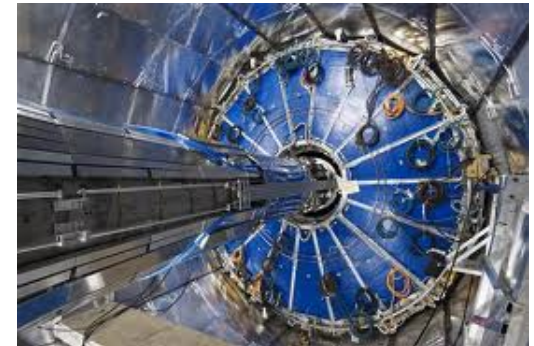
Oak Ridge National Laboratory
Oak Ridge, Tennessee

July 2012



Different Missions

- The mission of the **Advanced Scientific Computing Research (ASCR)** program is to discover, develop, and deploy computational and networking capabilities to analyze, model, simulate, and predict complex phenomena important to the Department of Energy (DOE).
- The mission of the **Nuclear Physics (NP)** program is to discover, explore, and understand all forms of nuclear matter.



The tools will continue to change rapidly

CDC 7600s at Livermore



These were our supercomputers in the 1970's and 1980's



1986:
X-MP/48 ~220 Mflop sustained
120-150kW (depending on model)
\$43M for computer+disks (FY12\$)



Sequoia: 16.3 PF; 7.8 MW (#1) NNSA
Mira; 8.2 PF (ANL part of INCITE, #3)

Just a year ago (2011):



NNSA:
Roadrunner at 1.105 PF (LINPACK)
LANL; 2.5 MW



SC/ASCR:
Jaguar at 2.331 PF (LINPACK)

ORNL; 6.9 MW

RAPID CHANGE requires
CS/AM/Domain coupling

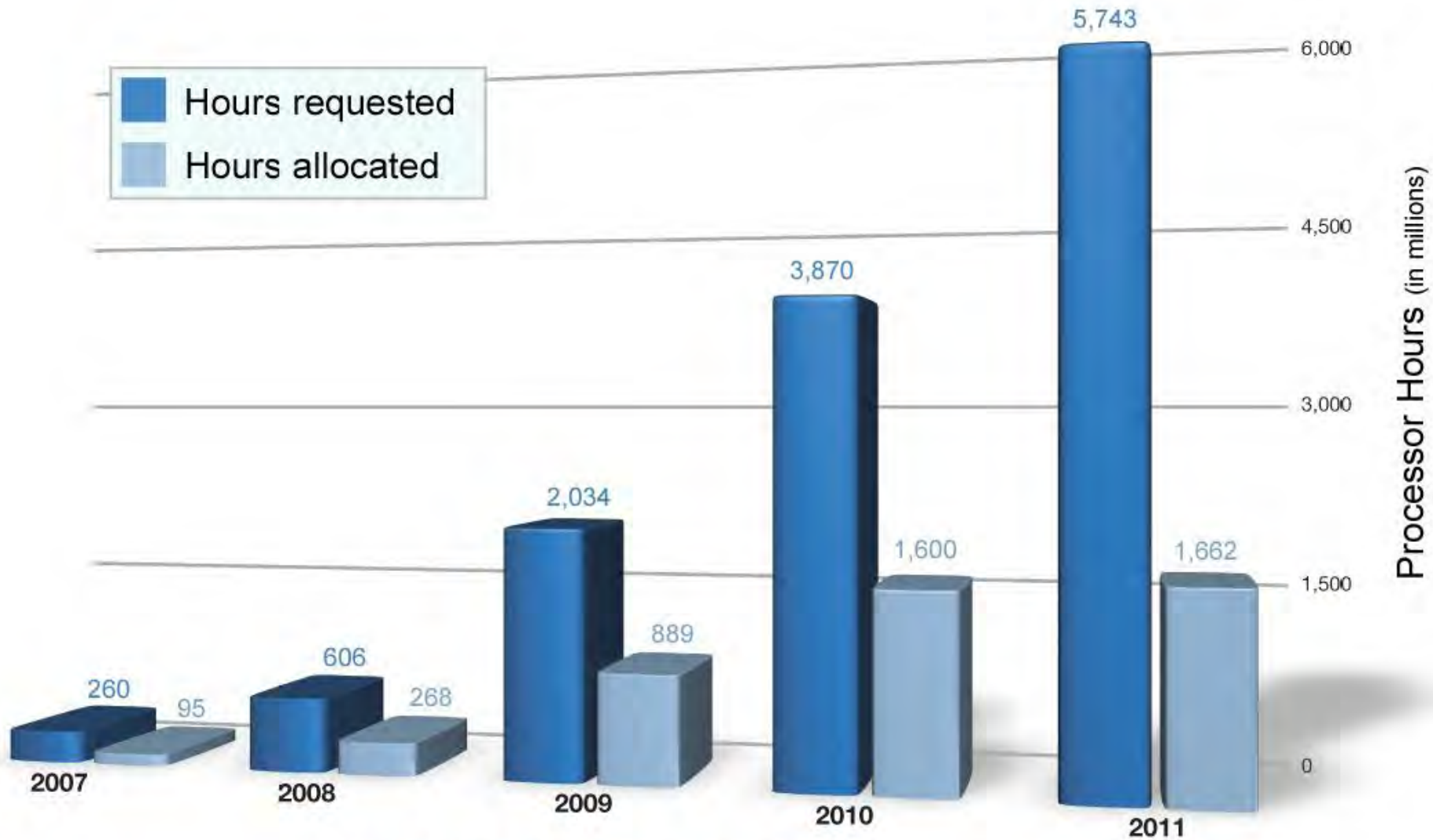
Factor 1×10^7 in speed
Factor of 18 in power

20 PF coming SOON:
Titan at ORNL

SO WHAT? `

- WHAT DOES DOE (NP/ASCR) NEED FROM YOU?
- A GOOD (better) STORY that SELLS in both NP and ASCR
 - Scientifically valid
 - Important to the MISSION (of both ASCR and NP)
 - Works in the elevator
 - What is the PROBLEM you are trying to solve?
 - Visit ASCR and NP...
- Is there any real urgency here?

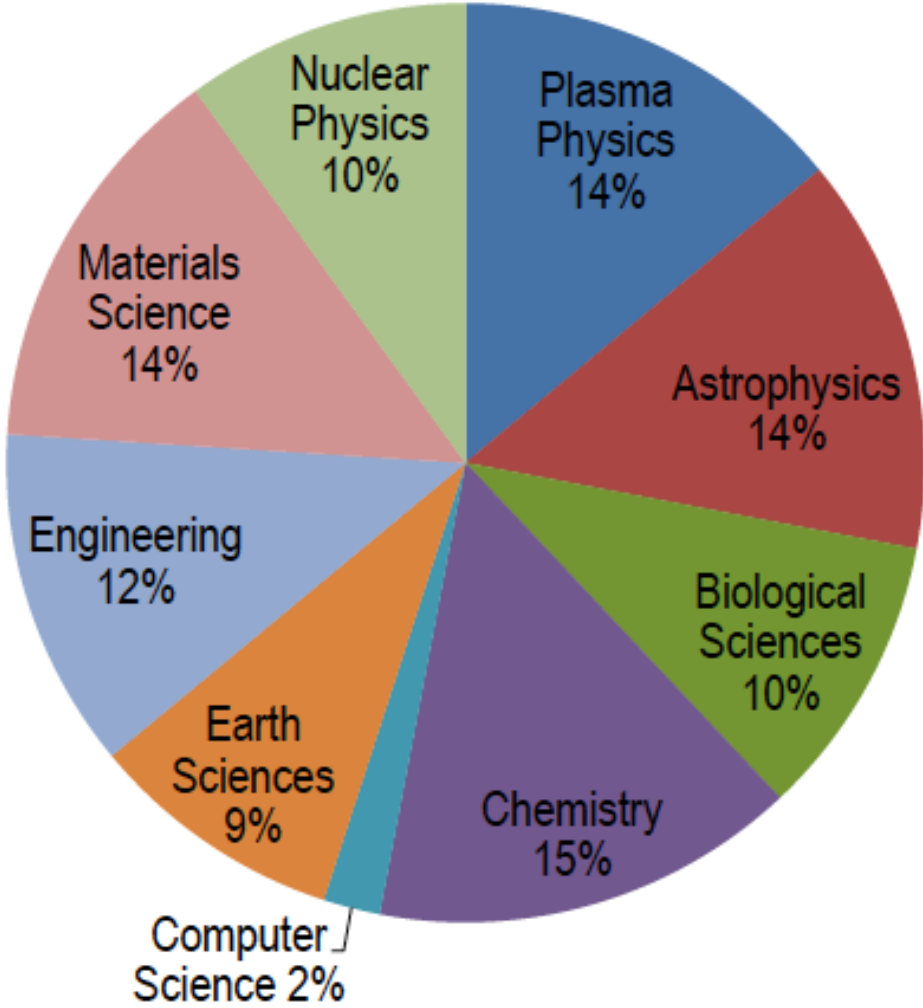
INCITE Demand (2011)



INCITE Demand

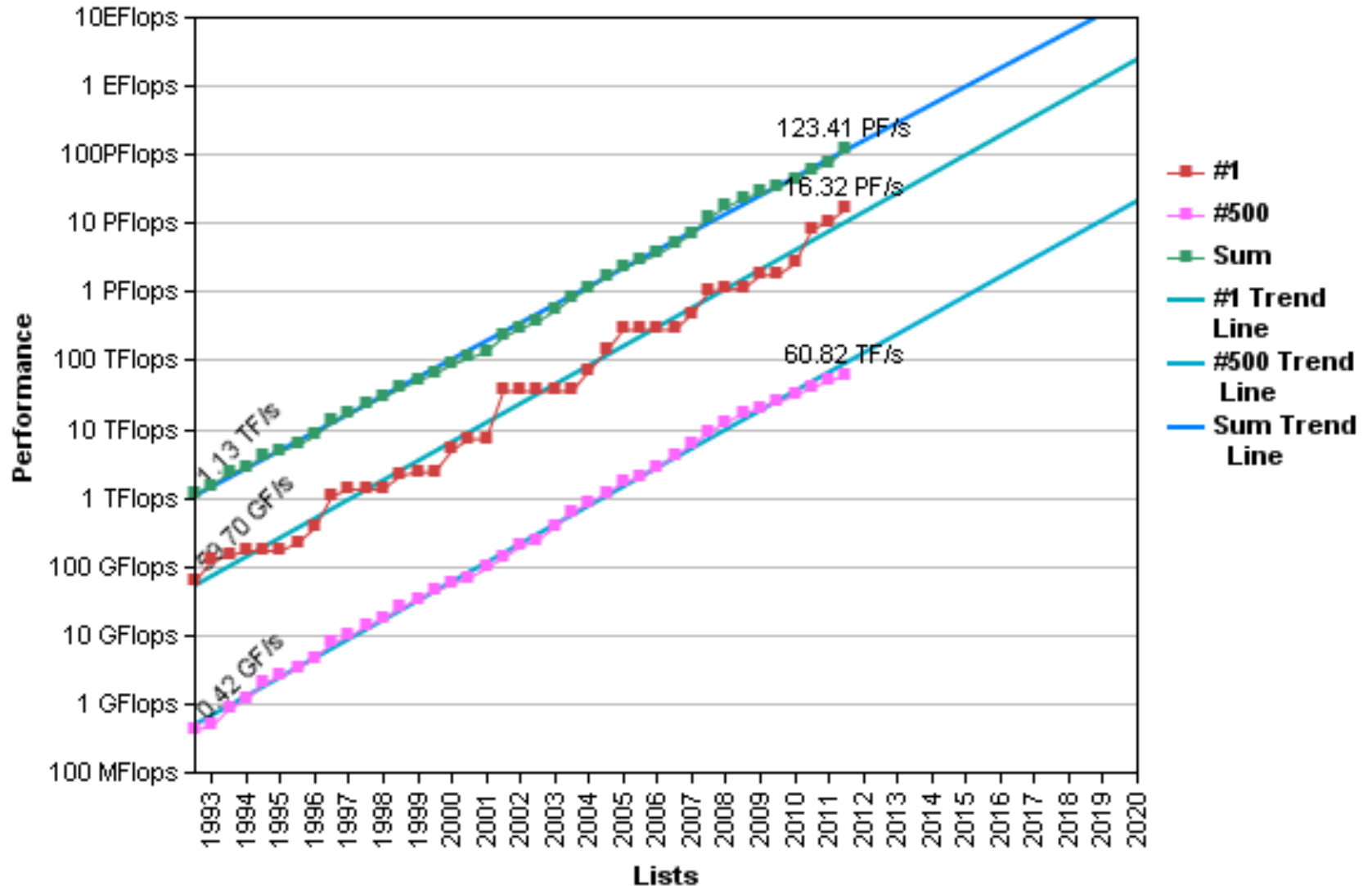
2011 INCITE awards 1.7B hours:

32 new projects and 25 renewal projects awarded
33% of new submittals and 89% of renewals accepted



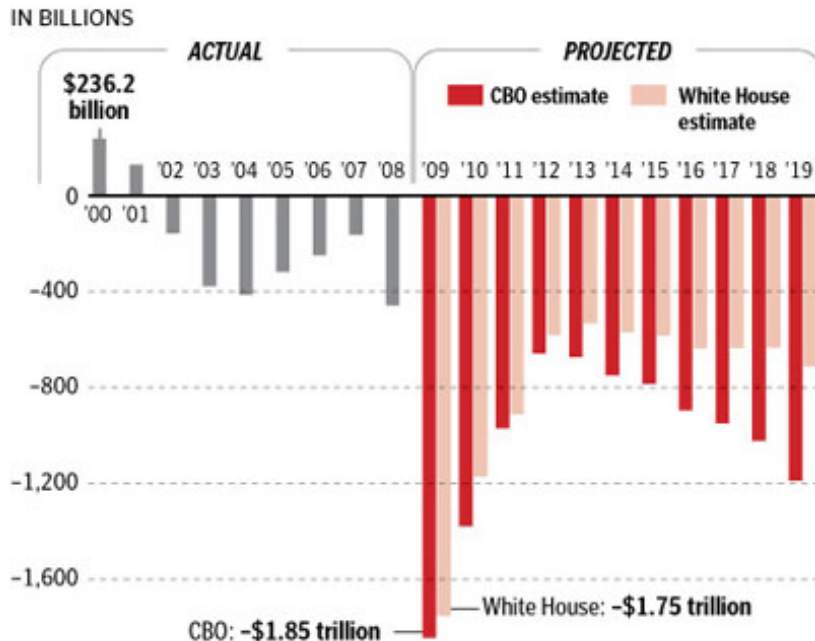
Where are we headed (June, 2012)?

Projected Performance Development



DOE NP support and impacts

SC/NP FY13	FY 2011	FY 2012 (estimated)	FY 2013 (estimated)
# University Grants	225	215	205
Average Size per year	\$315,000	\$315,000	\$300,000
# Laboratory Groups	34	34	33
# Permanent Ph.D.s	725	715	645
# Postdoctoral Associates	359	350	315
# Graduate Students	538	530	475
# Ph.D.s awarded	86	80	80



- Trends indicate a down-sizing of DOE NP research
- This could change (it did in 2006); but dynamics are different this time
- Hang on for the ride
 - Sequestration (BCA) looms

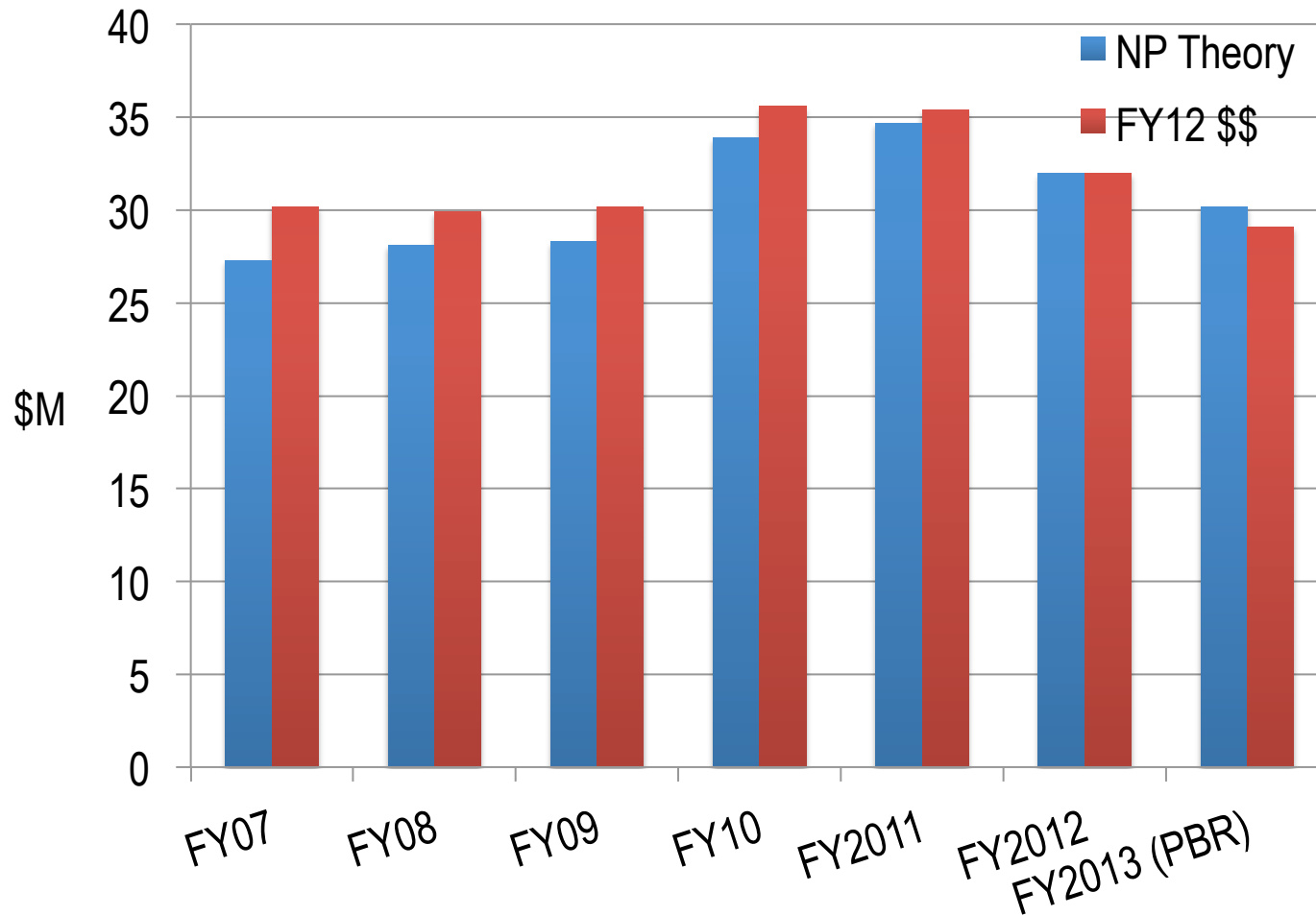
Workforce

The GOOD: UNEDF student/post doc list → matriculation to positions (lab/academic); USQCD ?

NEEDS IMPROVEMENT:

Stability of Theory FUNDING in US (underlying weakness since many theorists are also computational; UNEDF and NUCLEI funding principally for early career; all decreases in theory and computation hit people (infrastructure maintained by ASCR). First to go are students/post-docs.

Nuclear Theory Funding Trends



Education

The GOOD:

A few schools offer a sustained ‘computational physics’ courses at the graduate level. A lot of ‘summer school’ activities or site specific training for HPC going on.

NEEDS IMPROVEMENT:

Need to introduce systematically at the Undergrad Level...NSF grant in this area?

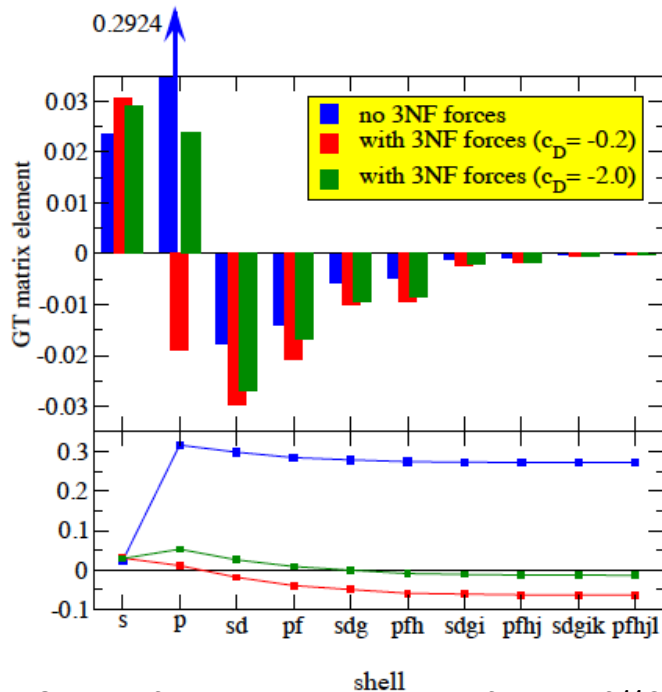


Coupling to experimental facilities

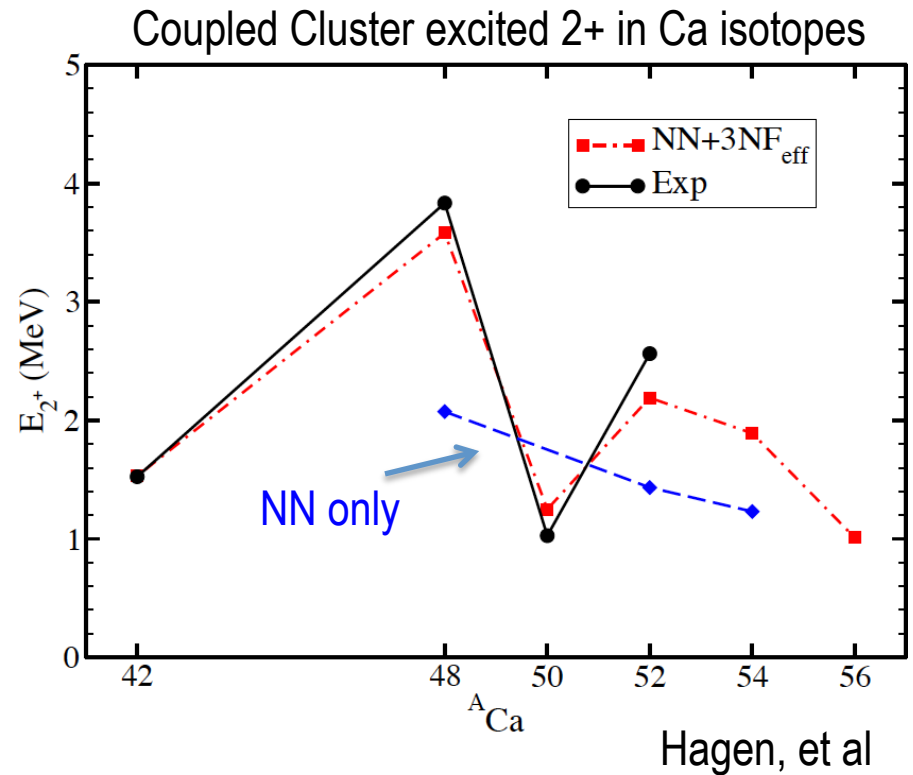
Where do we PREDICT something:

- Drip line uncertainties (Nuclear DFT)
- 2+ states in neutron rich calcium nuclei
- Fluorine example
- QCD examples?

TNFs matter in light and medium mass nuclei



Origin of the anomalous long lifetime of ^{14}C
 Maris, Vary, Navratil, Ormand, Nam, Dean,
 PRL 106, 20502 (2011)



Hagen, et al

- Binding Energies
(first discussed in 1978, maybe earlier)
- Spectra
- Operators
Carbon dating...

Predicting the future – trends