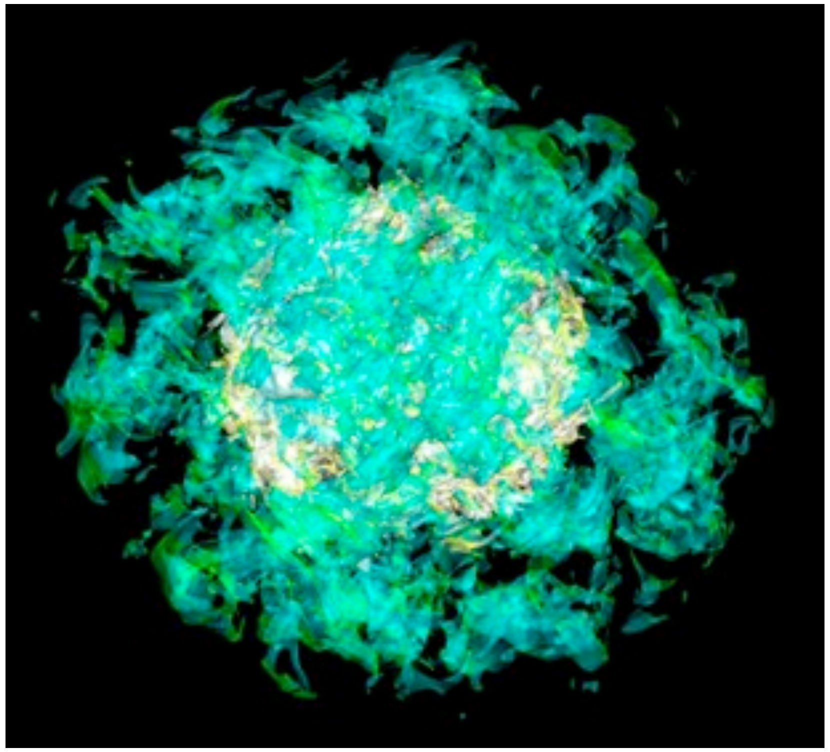
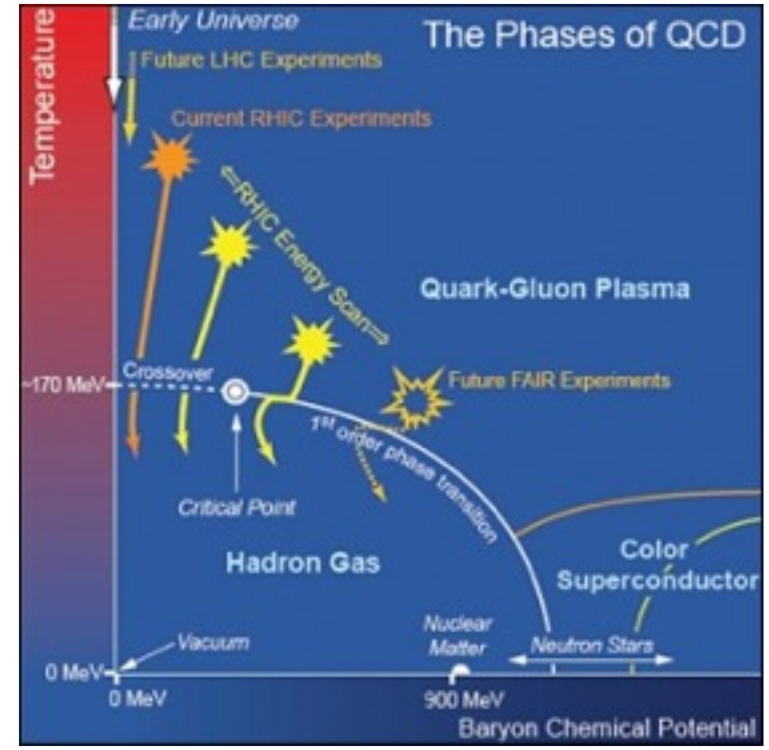
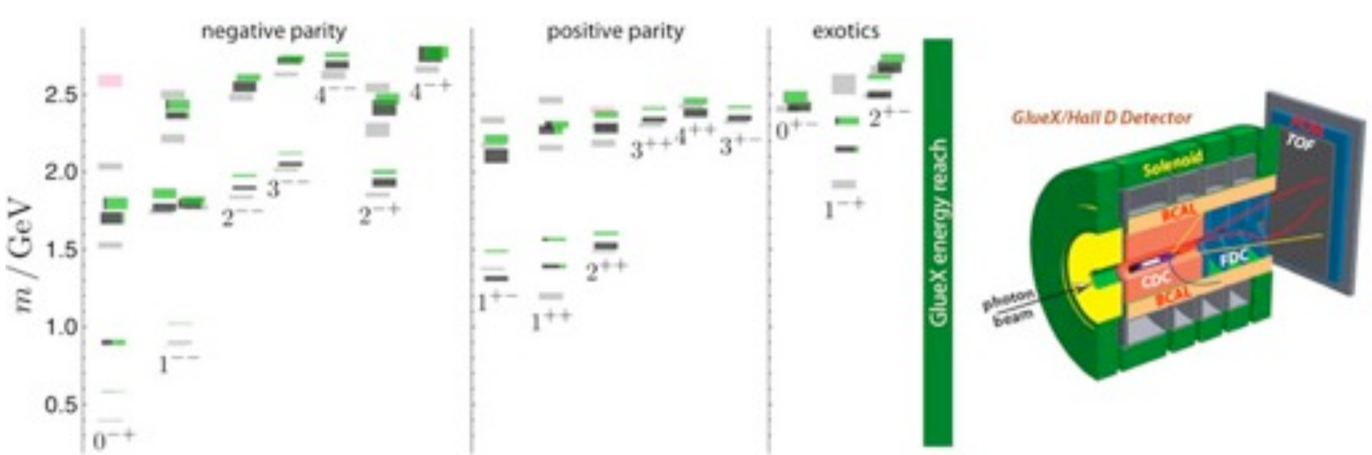
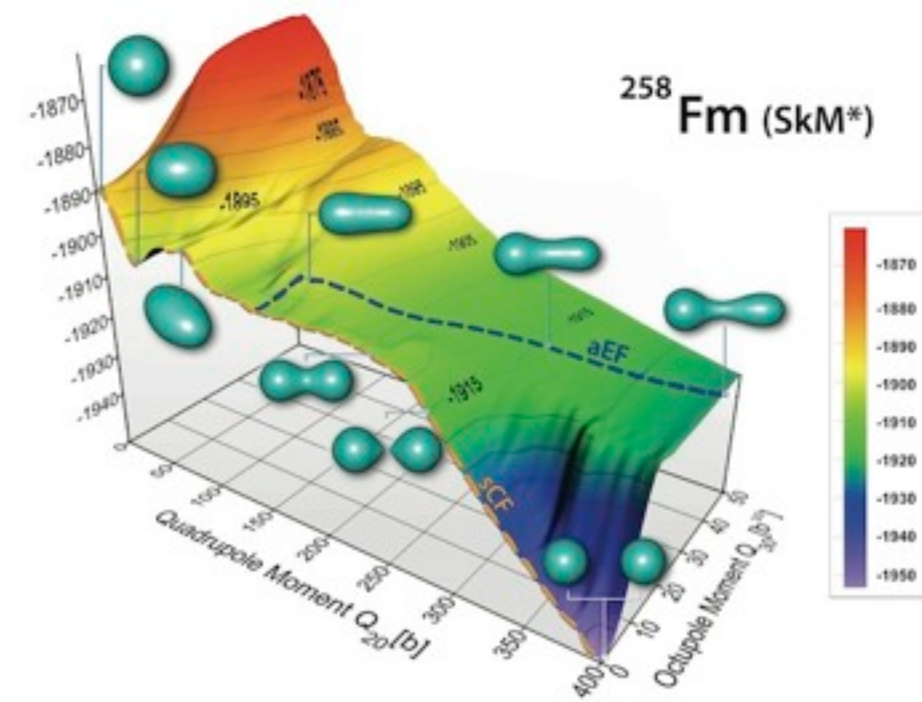








Computational Nuclear Physics

Summary and Whitepaper

SURA Headquarters
Washington D.C.
July 23-24, 2012

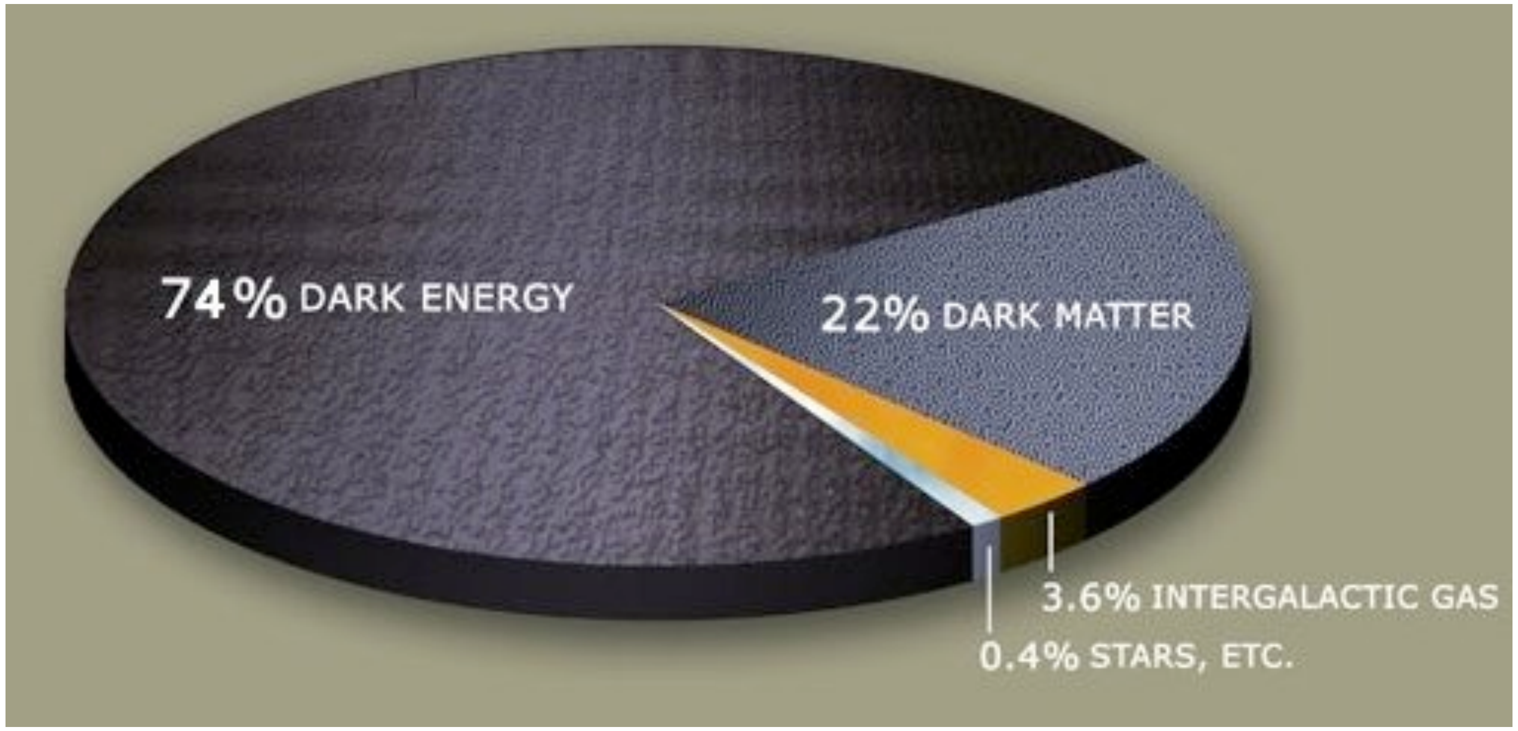
Computational Nuclear Physics

Nuclear Physics Research

Unraveling the Origin and Nature of the Visible Matter

Nuclear Physics

Quantum Chromodynamics
Electroweak Interactions

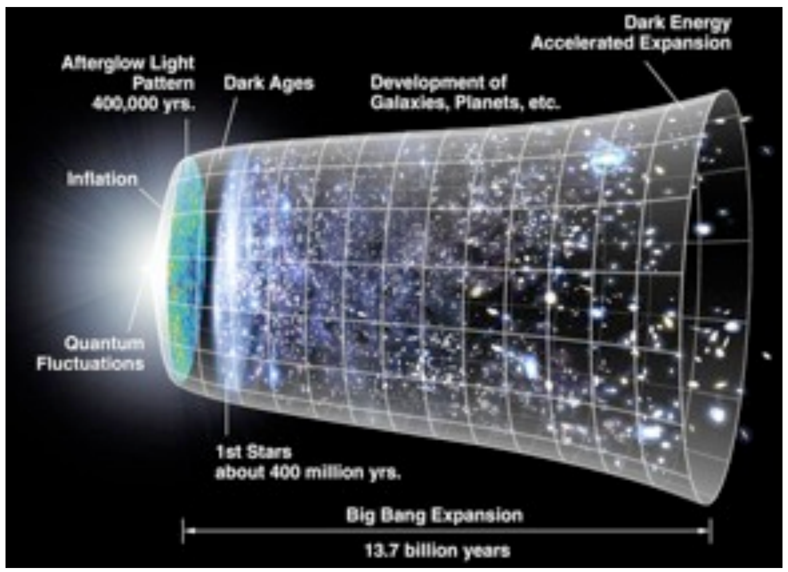


Establishing and verifying the capability to reliably predict

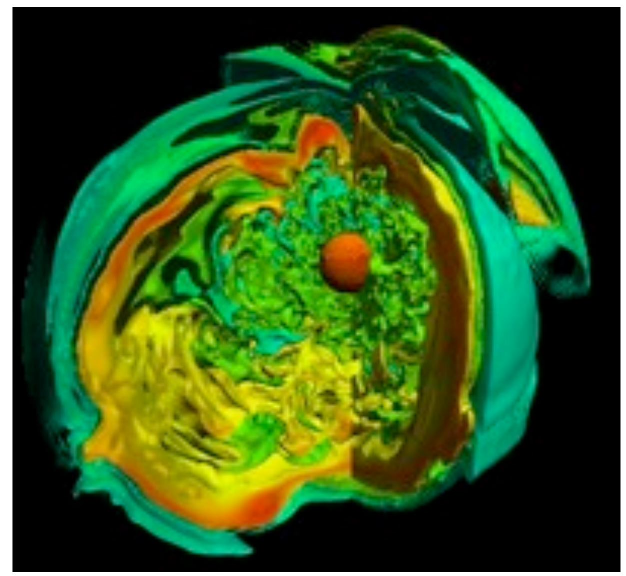
Computational Nuclear Physics

A Broad and Balanced Nuclear Physics Agenda

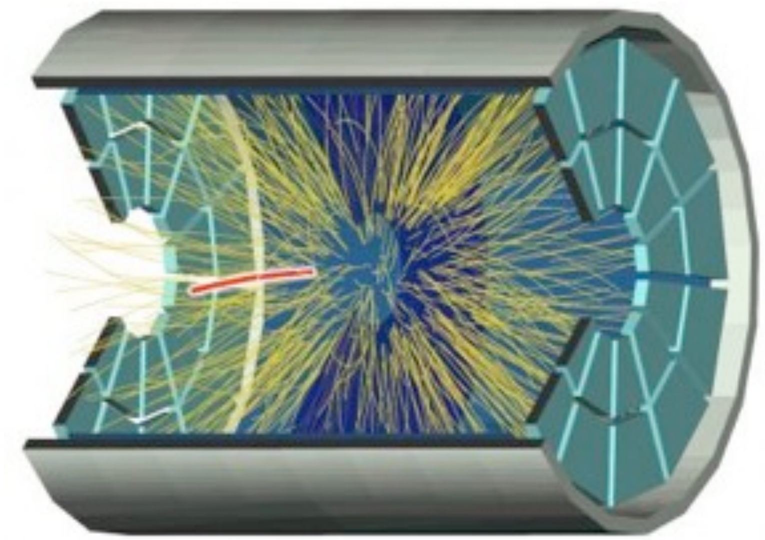
Phase transition(s) at early times, light sources at later times



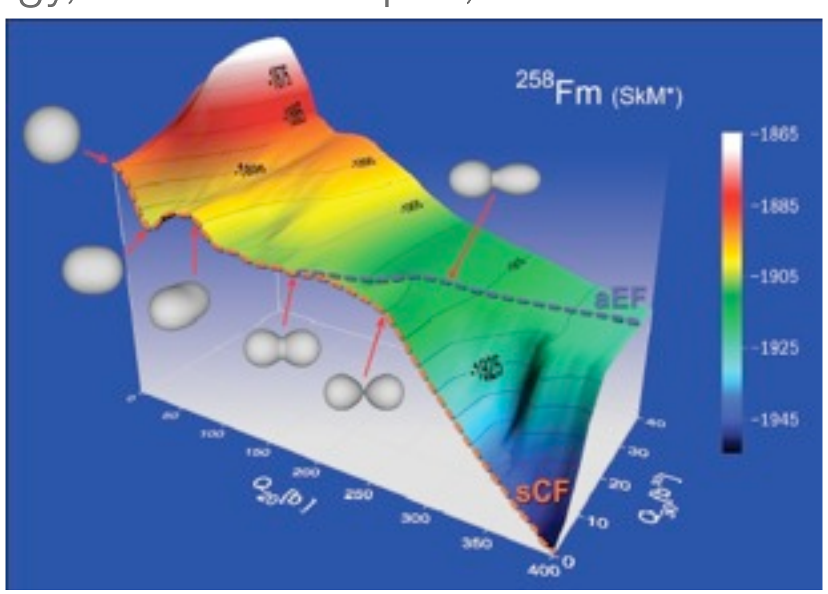
Production of most elements in the cosmos



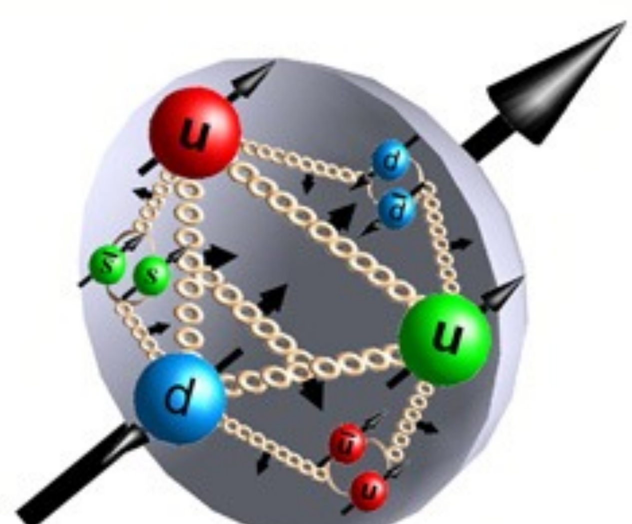
Matter under extreme conditions



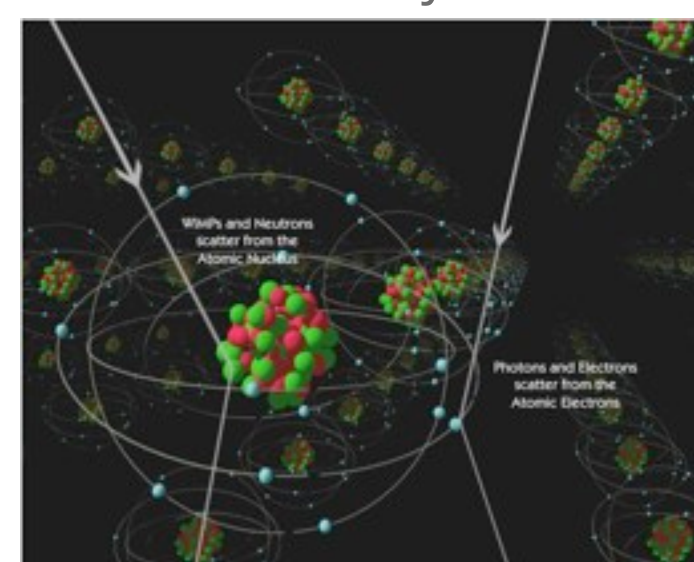
Nuclei and their reactions:
Energy, Medical Isotopes, National Security,...



The structure of, and forces between, nucleons



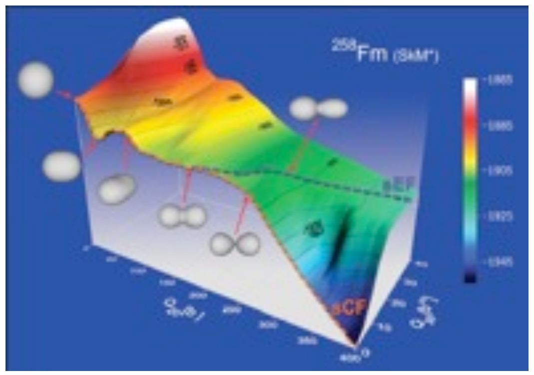
Search for New Physics

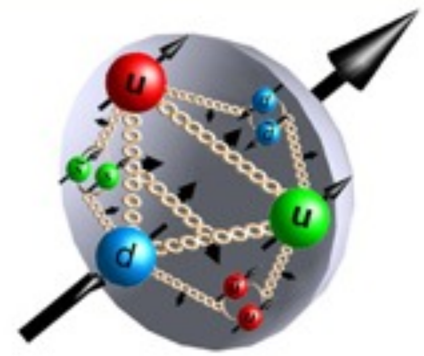


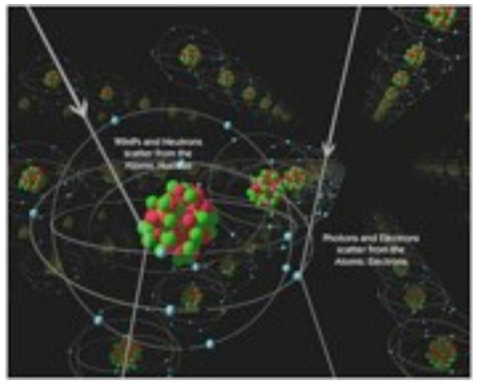
Enormous range of length scales involved

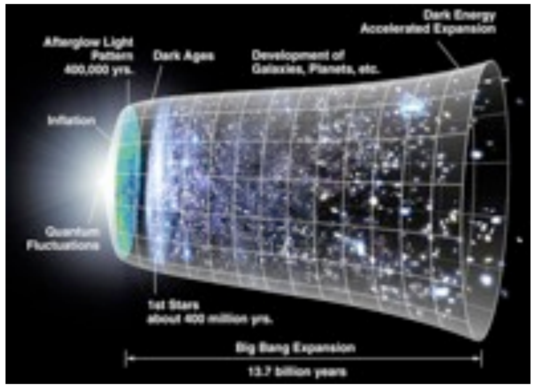
Computational Nuclear Physics

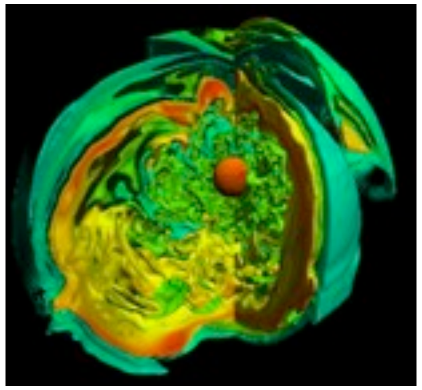
Computing is Essential

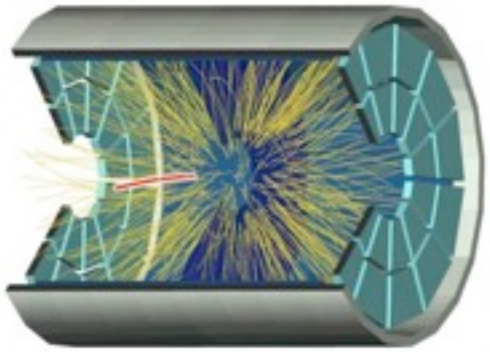












Computing is Essential

High Performance Computing provides answers to questions that neither experiment nor analytic theory can address;
hence, it becomes the third leg supporting the field of nuclear physics

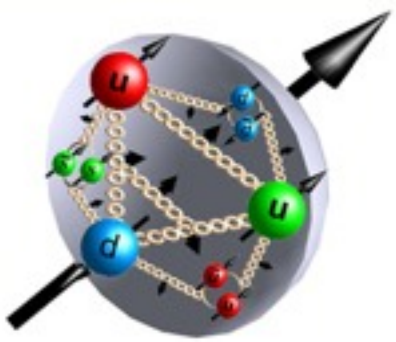
National Academy Report
(2012)

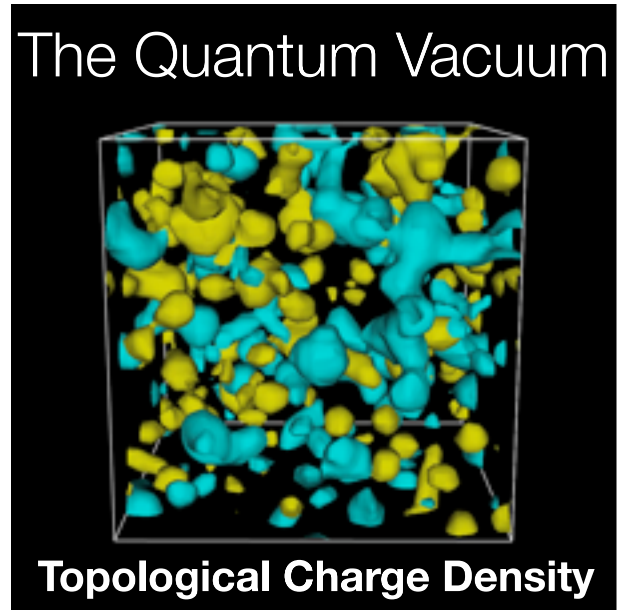
Computational Nuclear Physics

Cold QCD

Nature is finely tuned

capacity resources





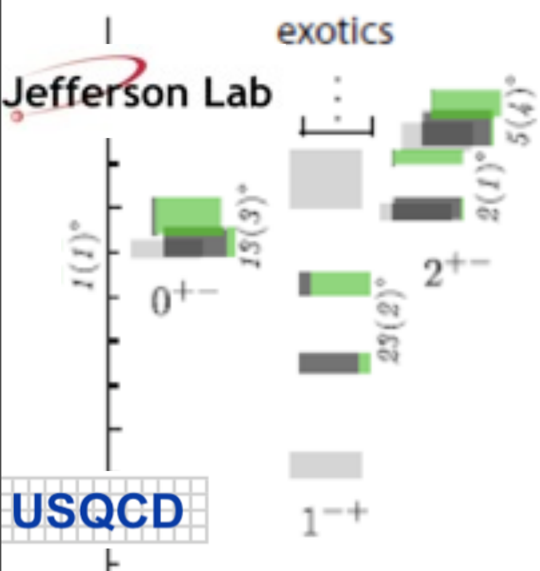
(Massimo DiPierro)

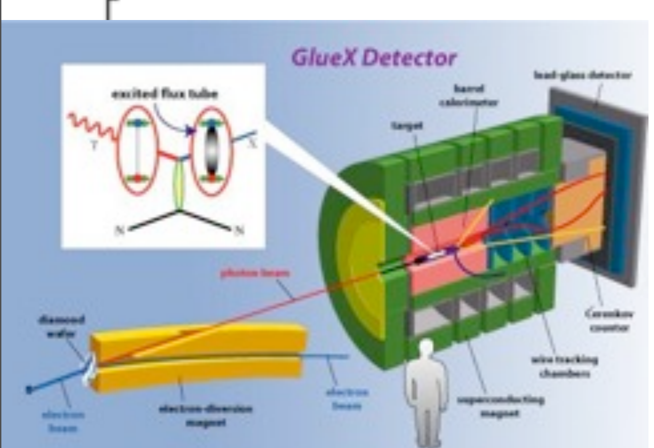
capability resources

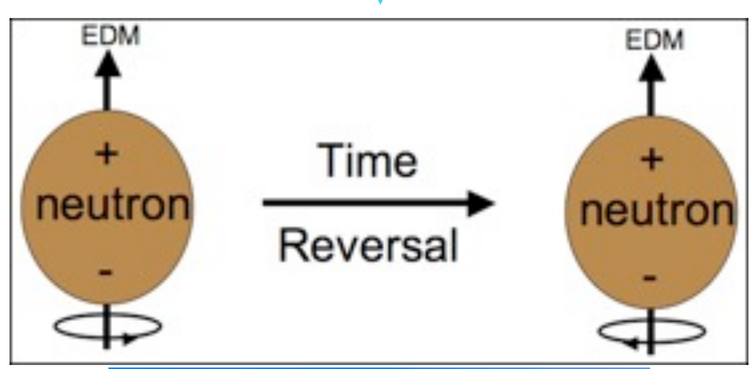
$L \sim 4$ fm

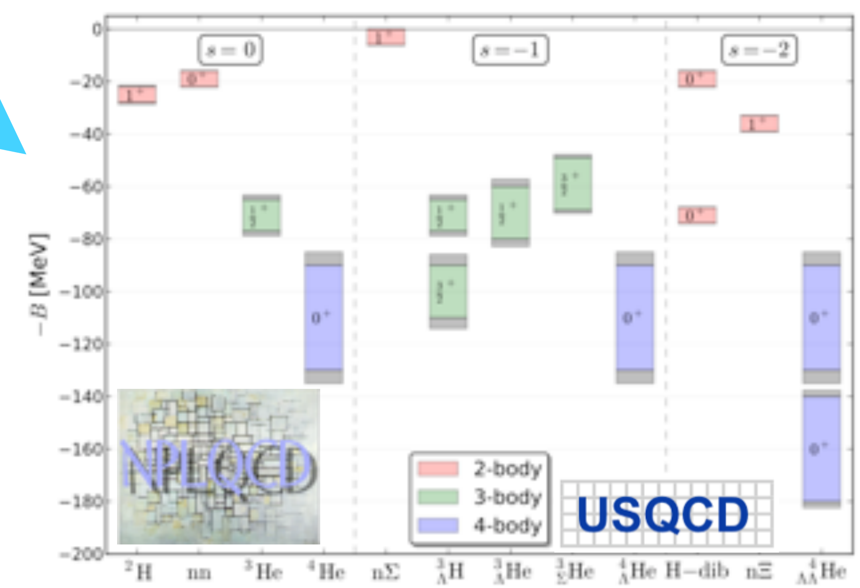
$\Delta t \sim 6 \times 10^{-24}\ s$

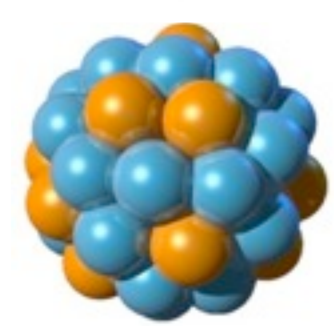
capacity resources





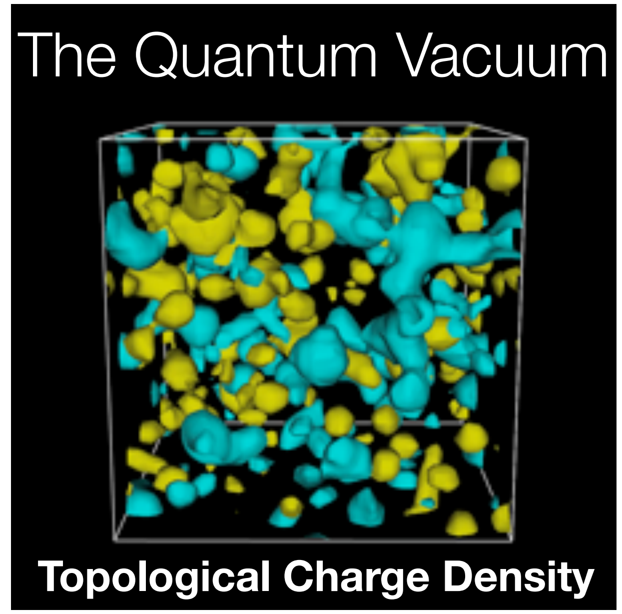




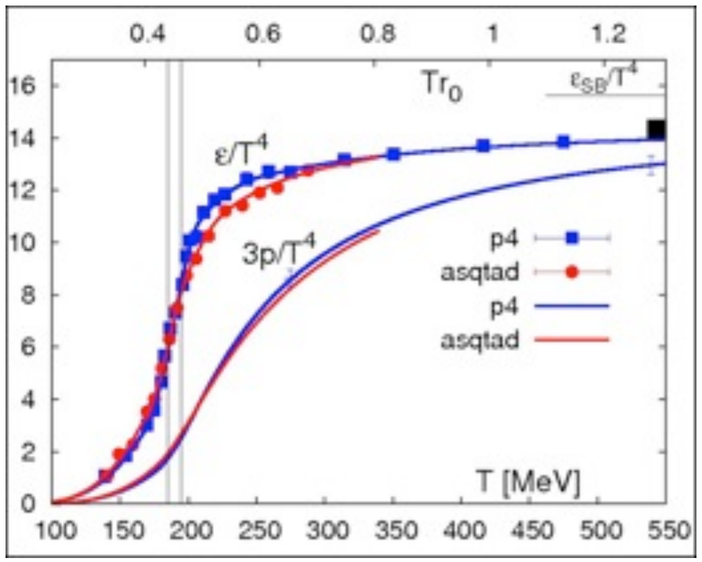


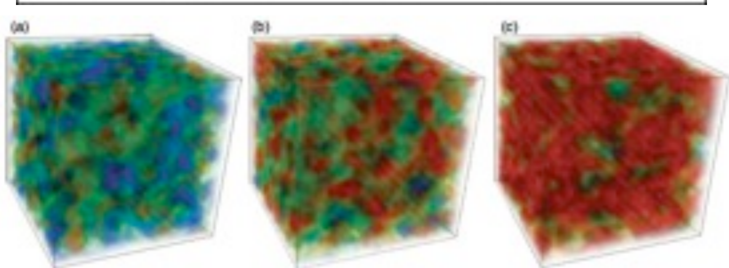
Computational Nuclear Physics

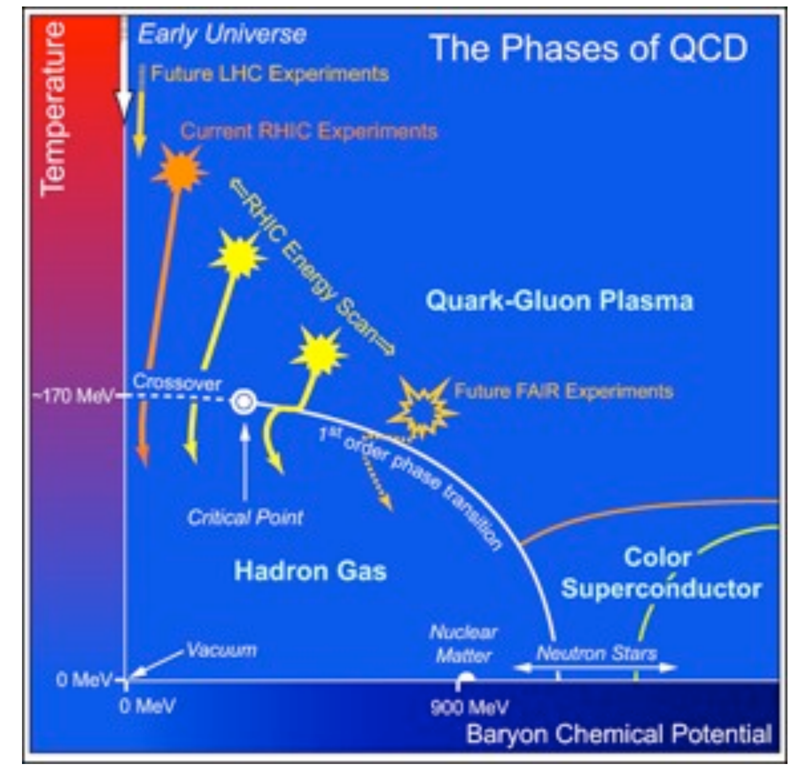
Hot QCD

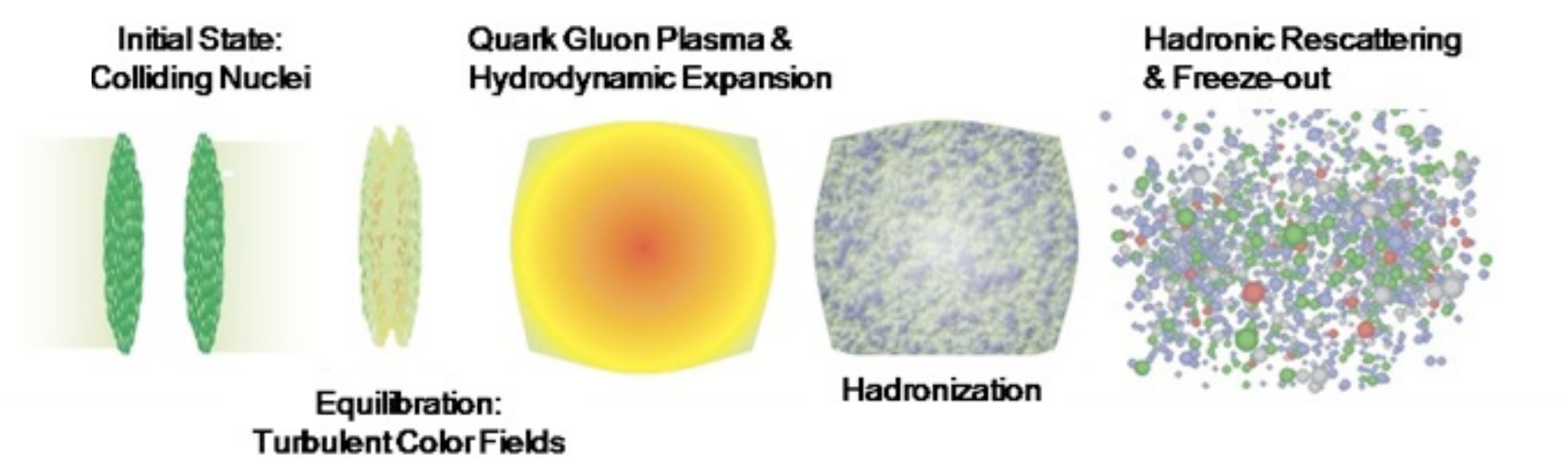


(Massimo DiPierro)



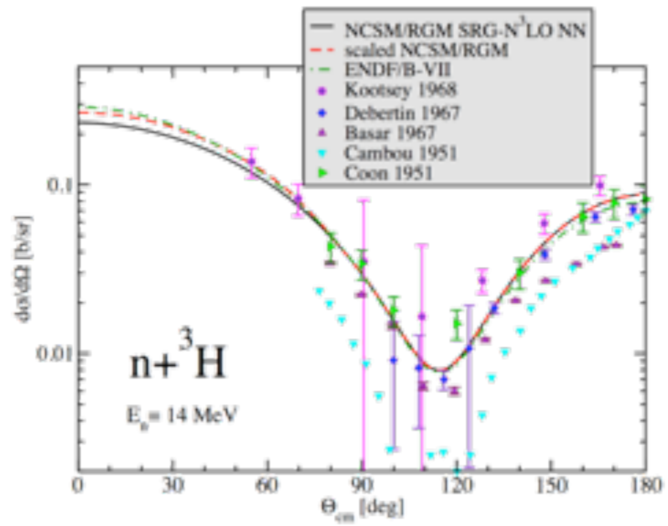


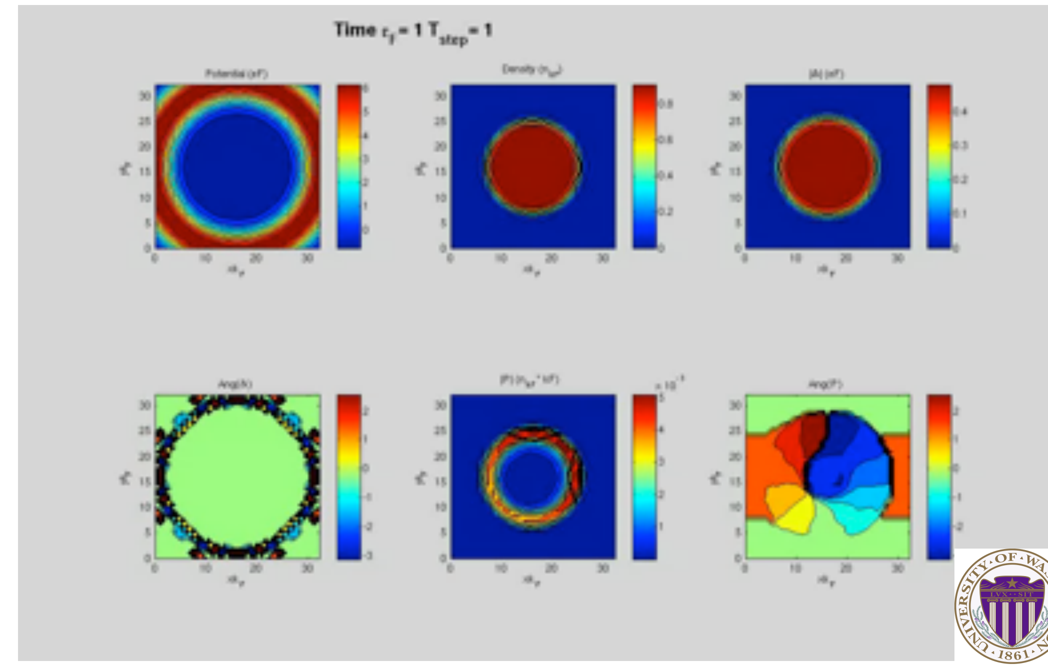


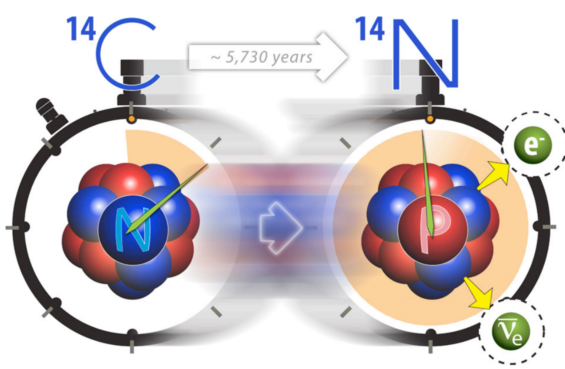


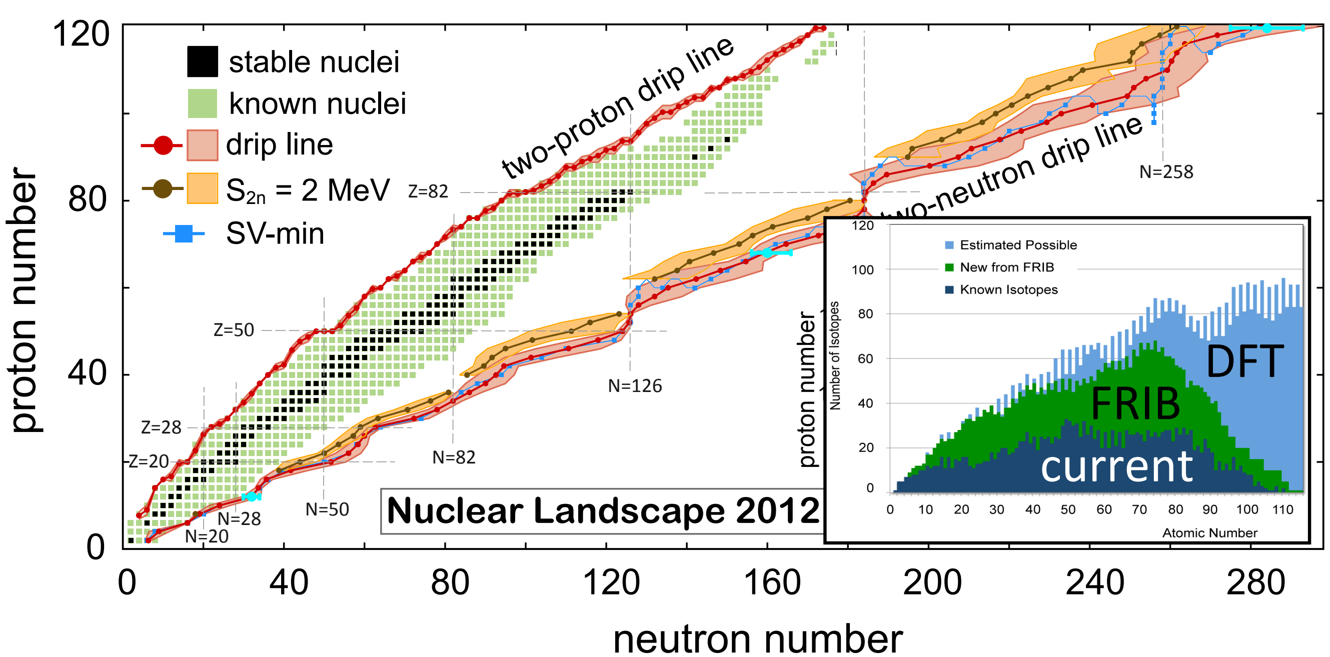
Computational Nuclear Physics

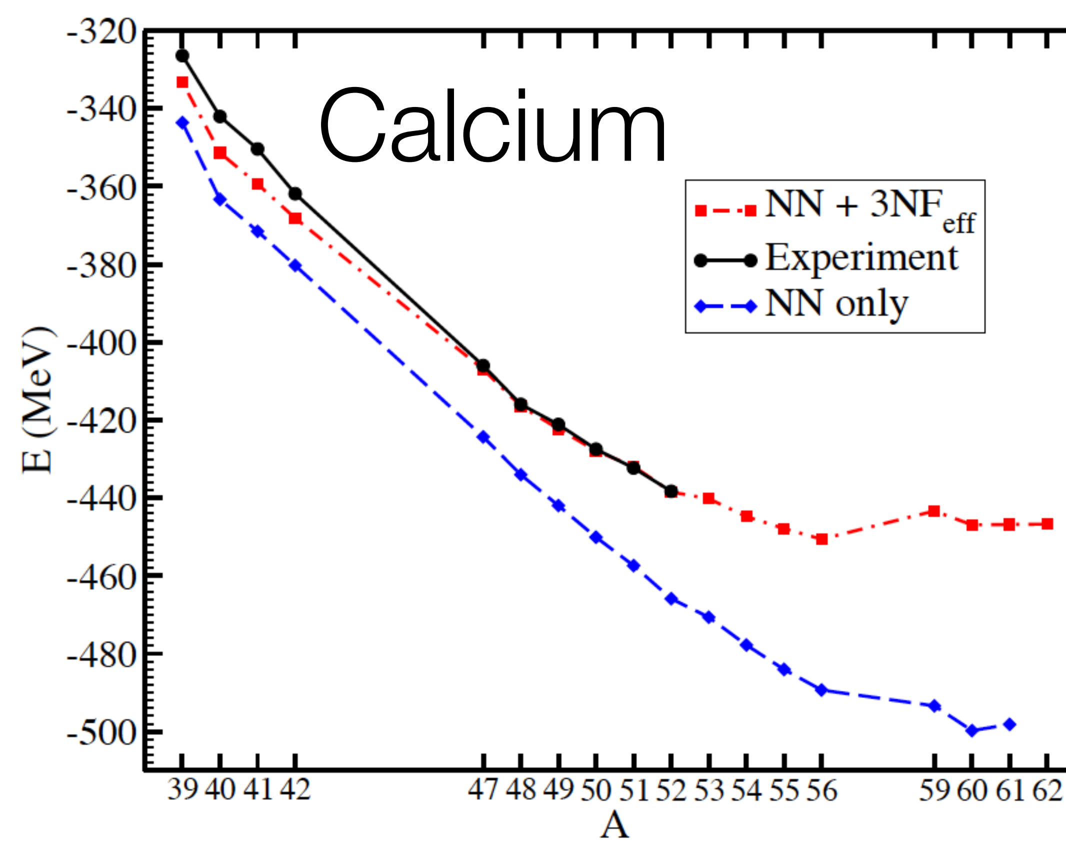
Nuclear Structure and Reactions





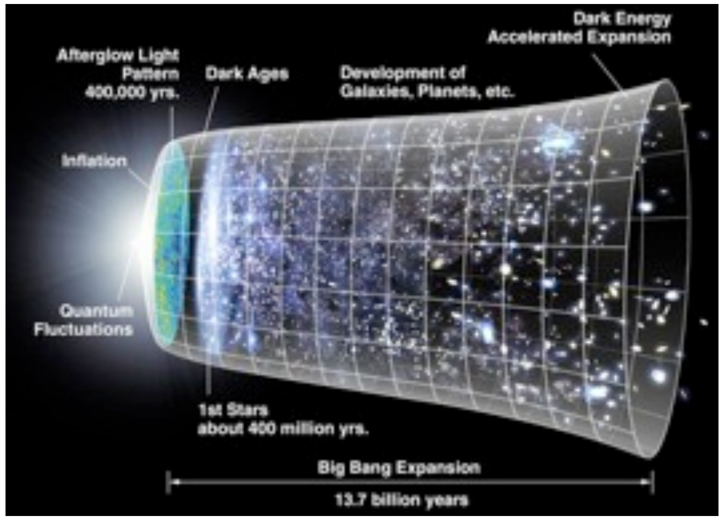


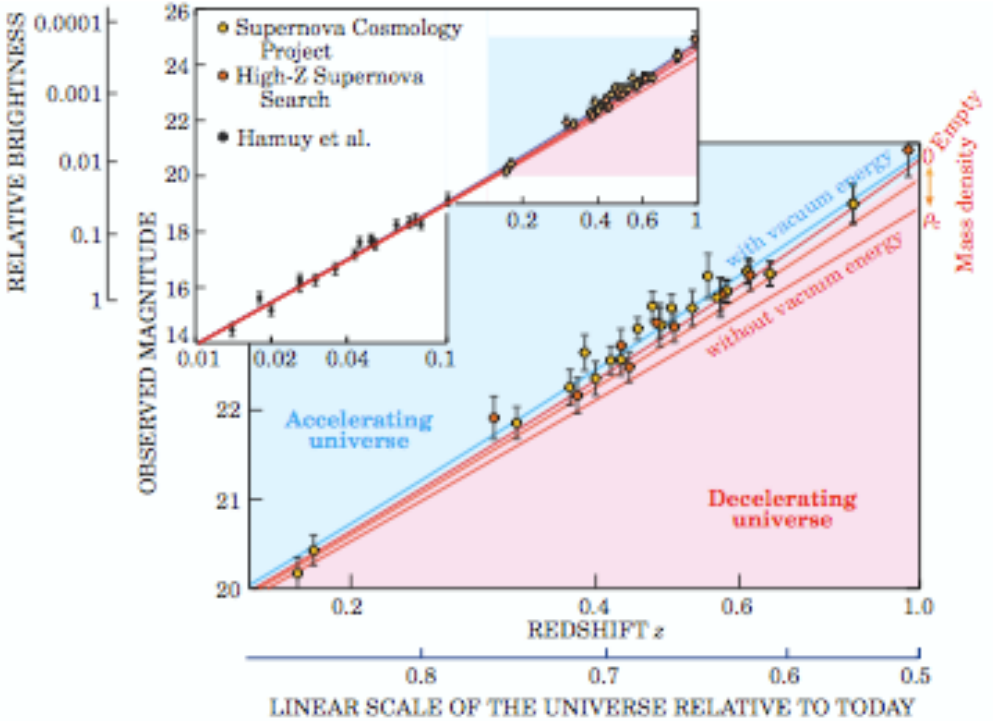


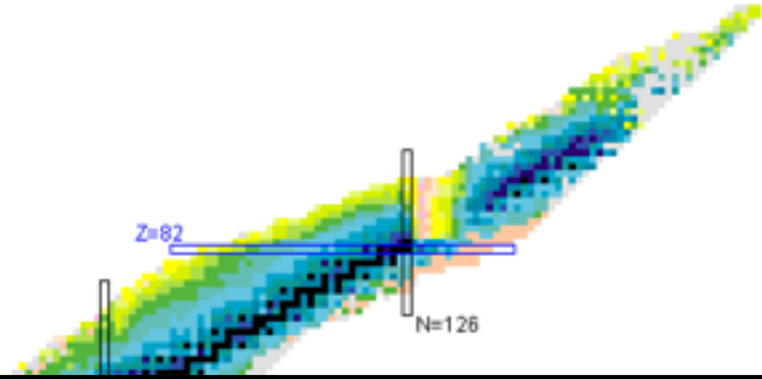


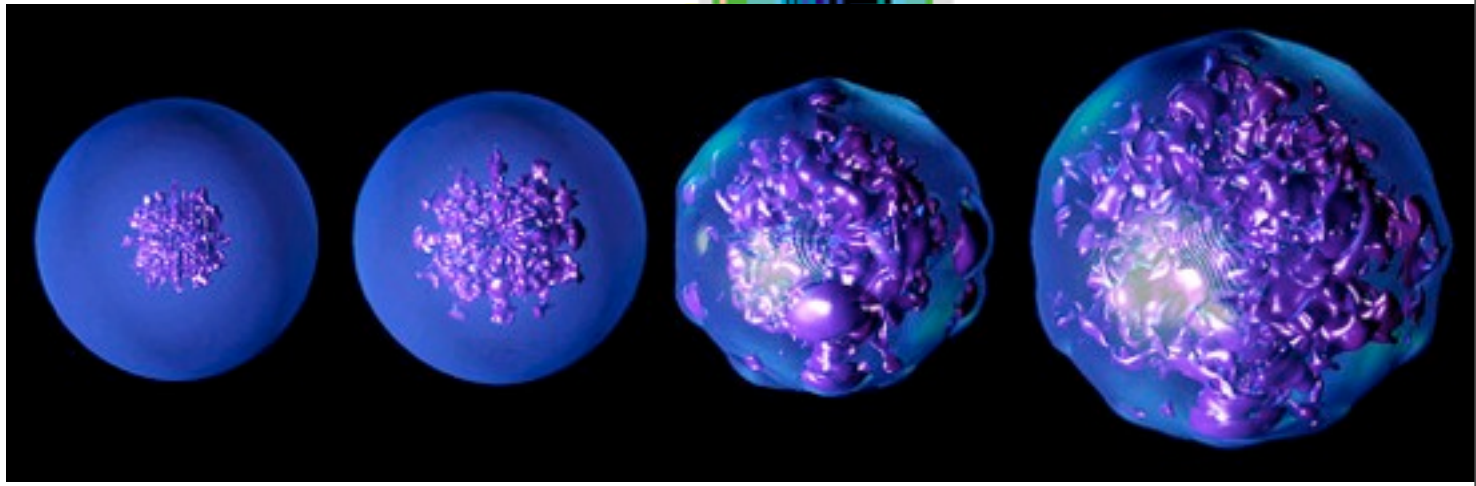
Computational Nuclear Physics

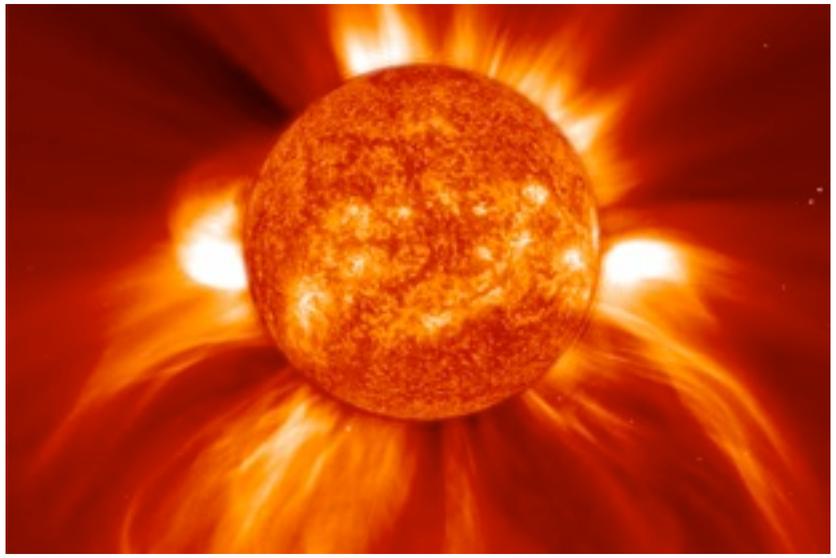
Nuclear Astrophysics





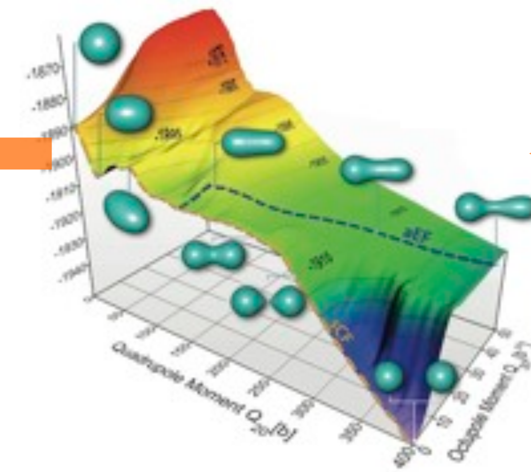


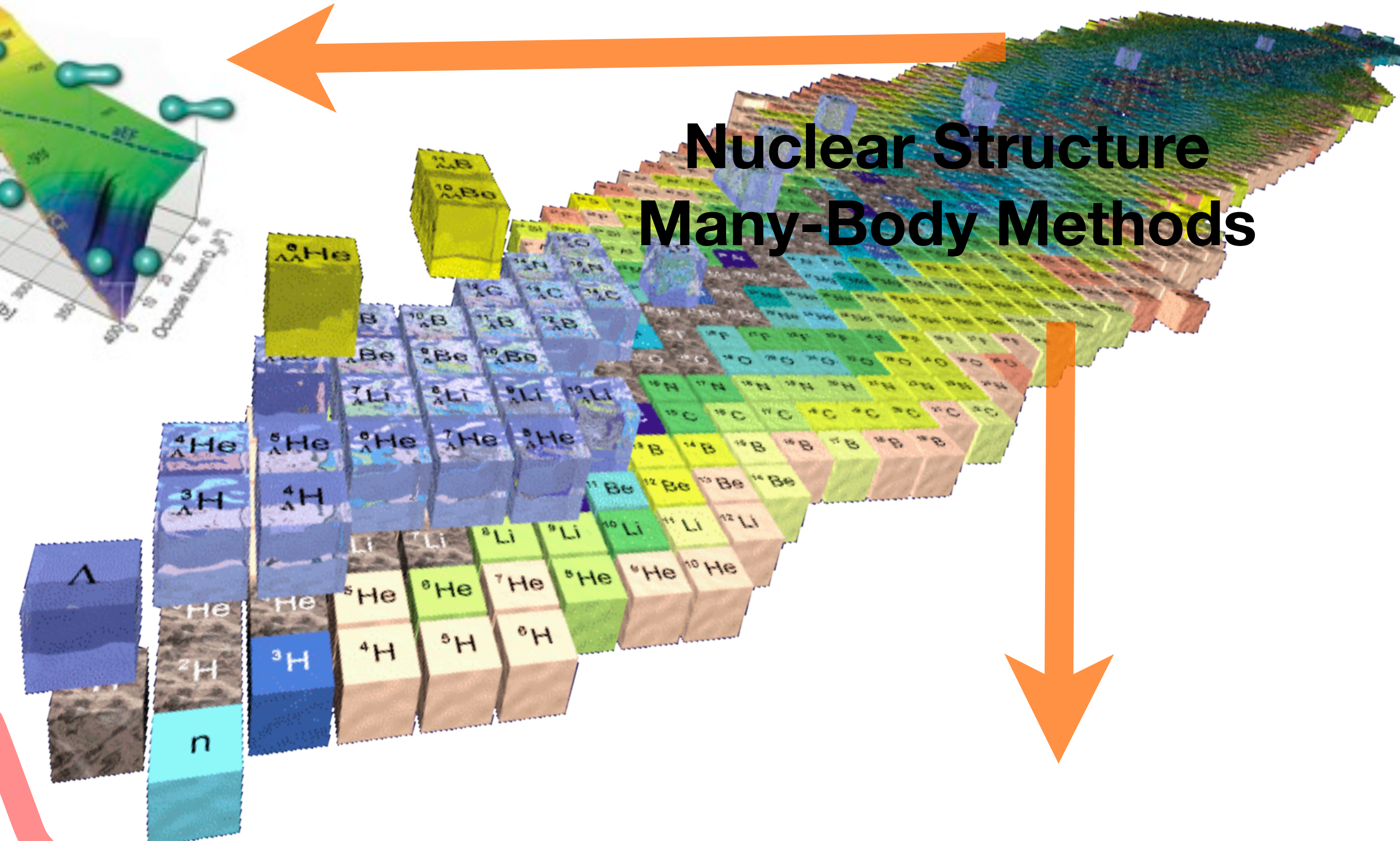


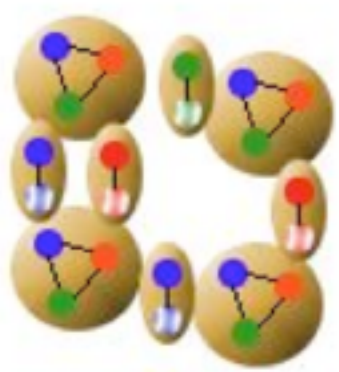


Computational Nuclear Physics

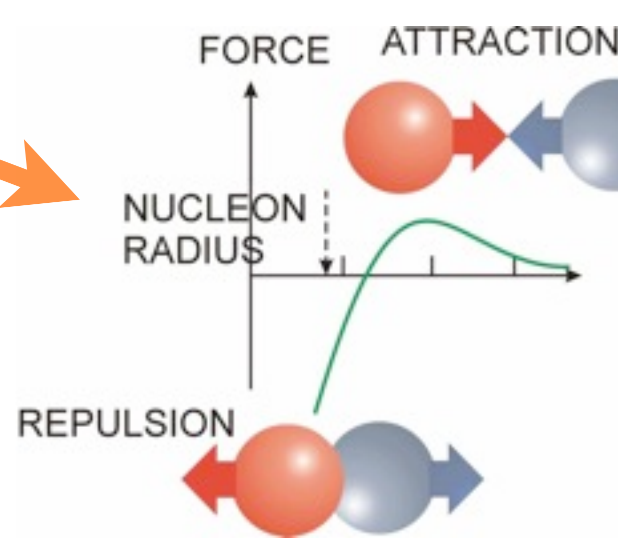
(Partial) Unification of Nuclear Physics
- Quantifiable Uncertainties
- Predictive Capability

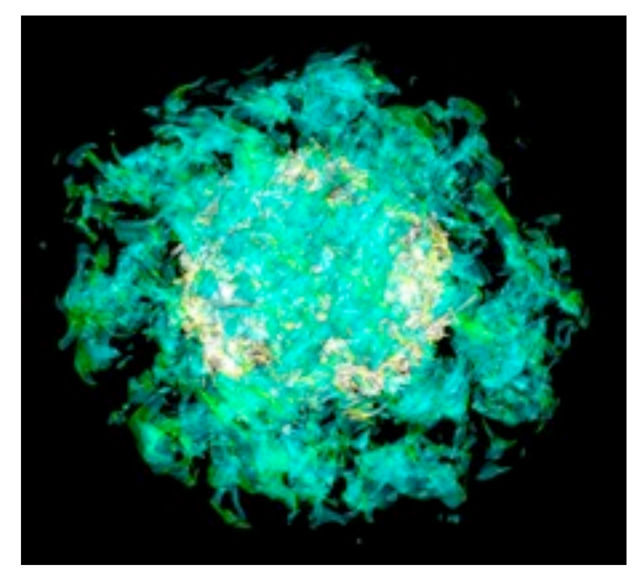






Solve QCD



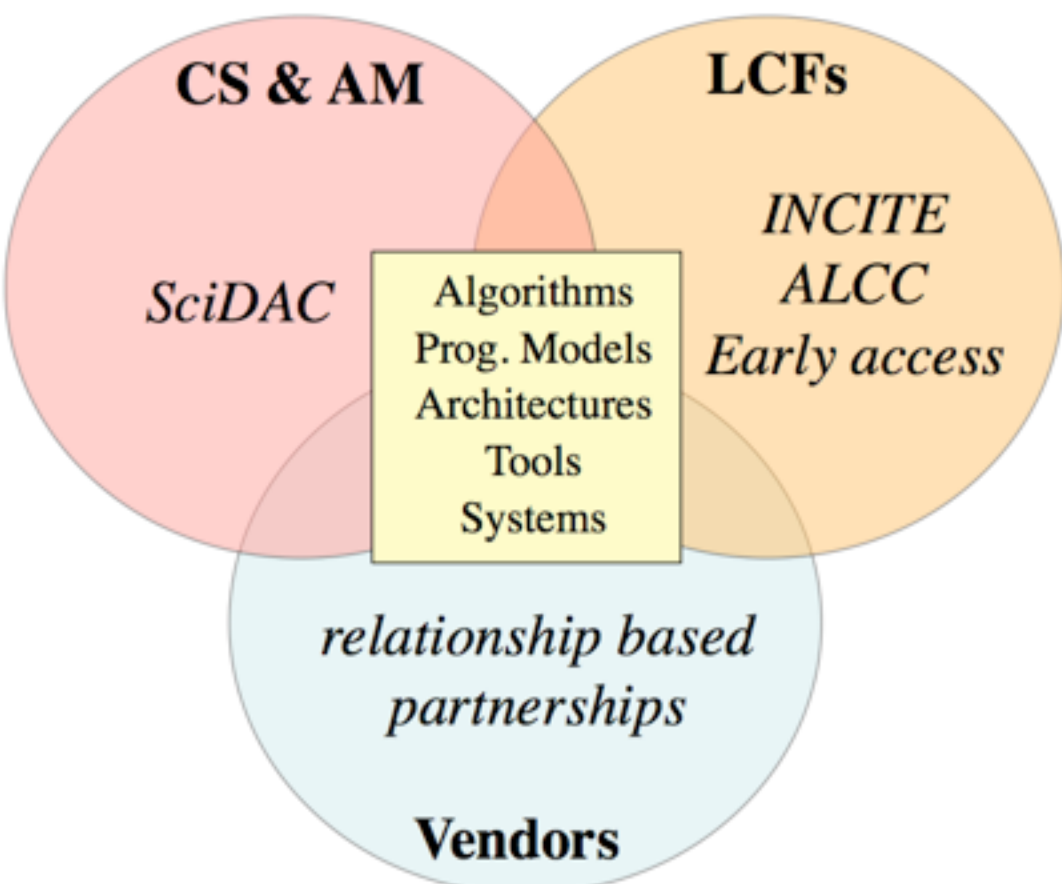


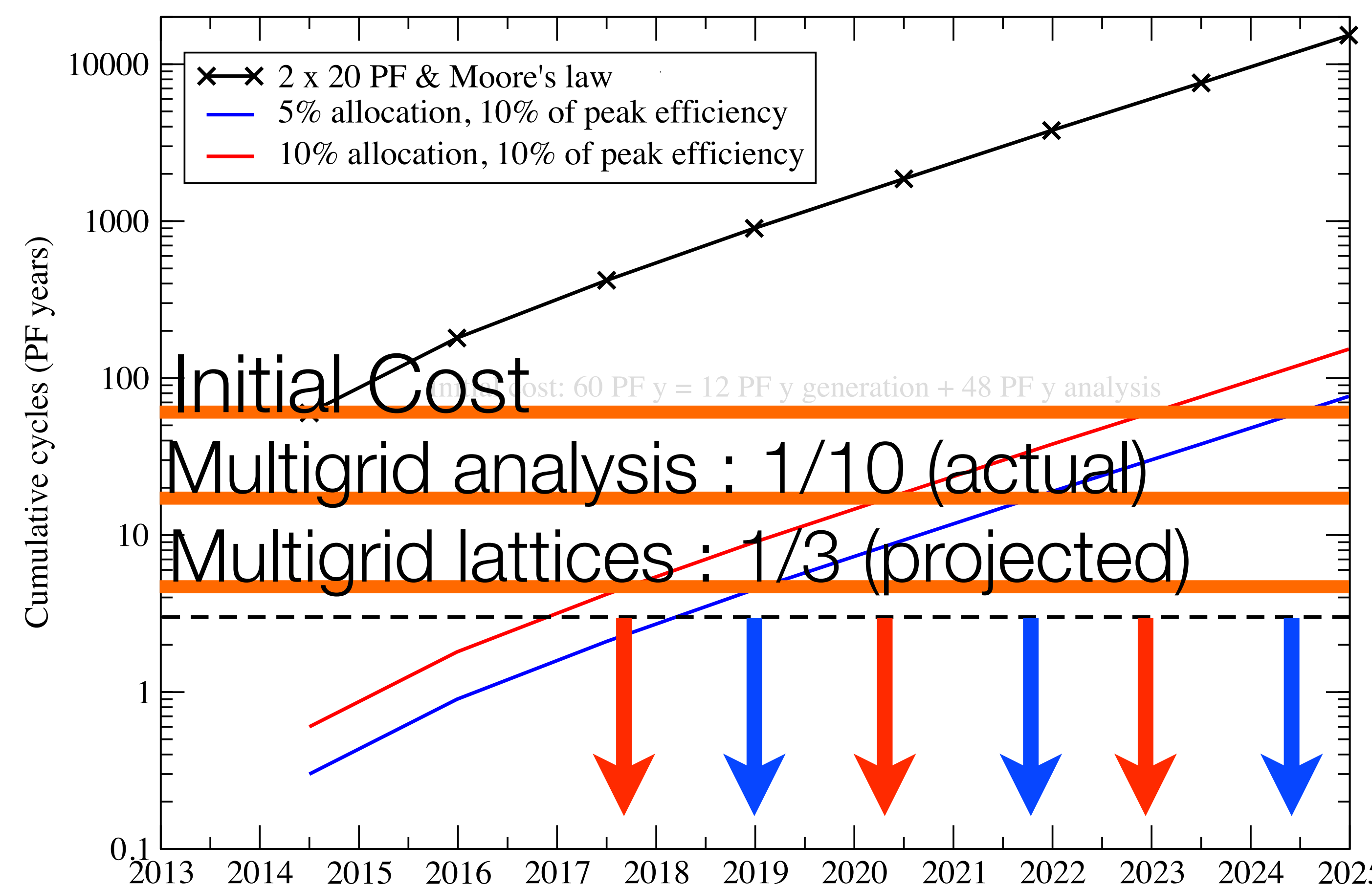
Computational Nuclear Physics

Collaboration with CS/AM

SciDAC
Scientific Discovery through Advanced Computing

SciDAC (Collaboration) has been crucial in progress





Computational Nuclear Physics

Present Day Resources






2011-2012 : capability and capacity

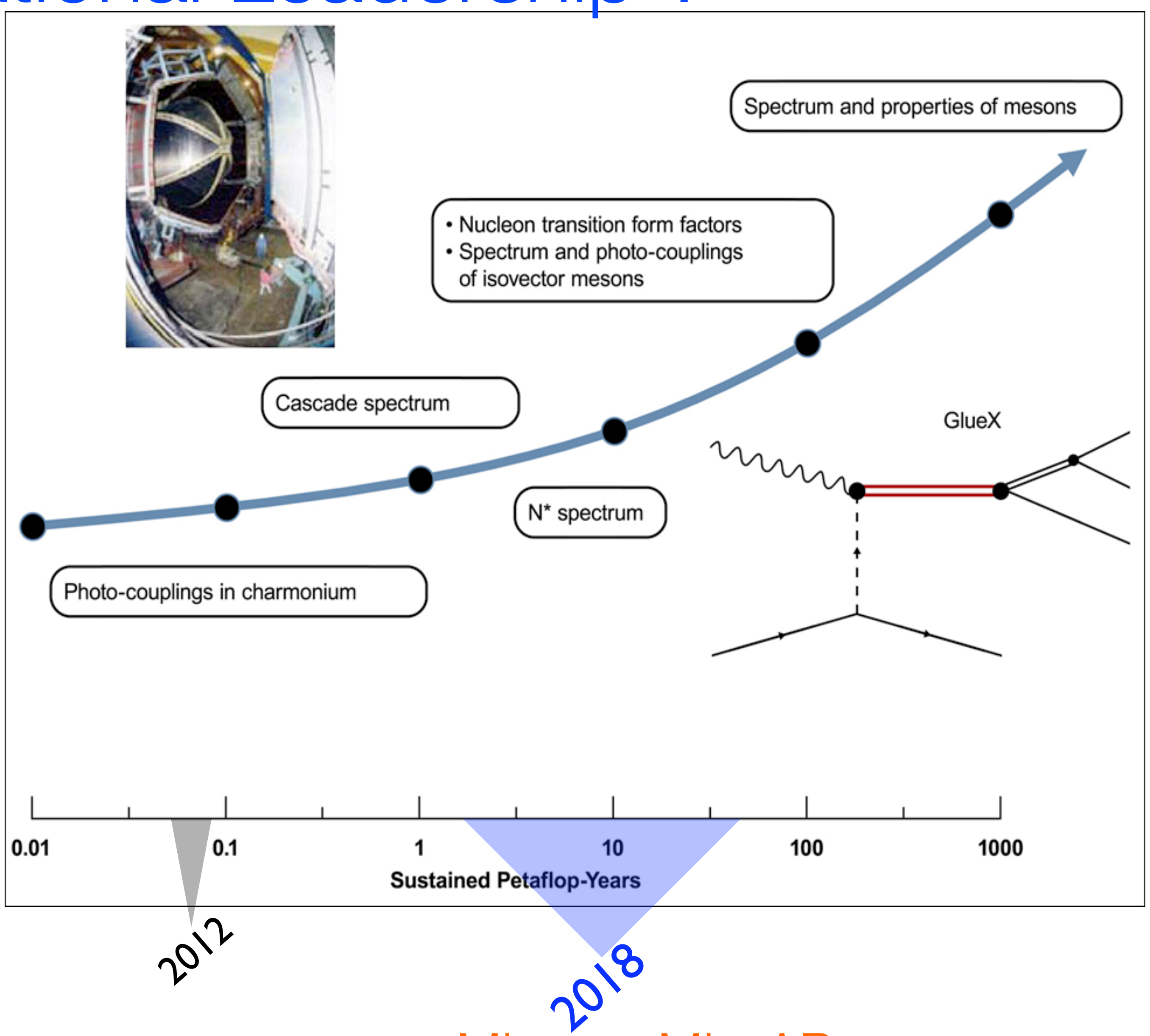
Cold QCD	~ 50 Tflops	1 : 4
HotQCD	~ 50 Tflops	
Nuclear Structure and Reactions	~ 20 Tflops	
Nuclear Astrophysics	~ 10 Tflops	
Total	~ 130 Tflops	(sustained)

Computational Nuclear Physics

Resources for Viability, Impact of Flat Funding

Getting the job done - but when ? NSAC Milestones ?
Synchronized with the experimental program (+- n-years) ?
International Leadership ?

e.g. Hadronic Spectrosopy



ML ML+AP

Flat + COLA
Moore's Law
Algorithm Potential

Computational Nuclear Physics

Resources for Viability, Impact of Flat Funding

Getting the job done - but when ? NSAC Milestones ?
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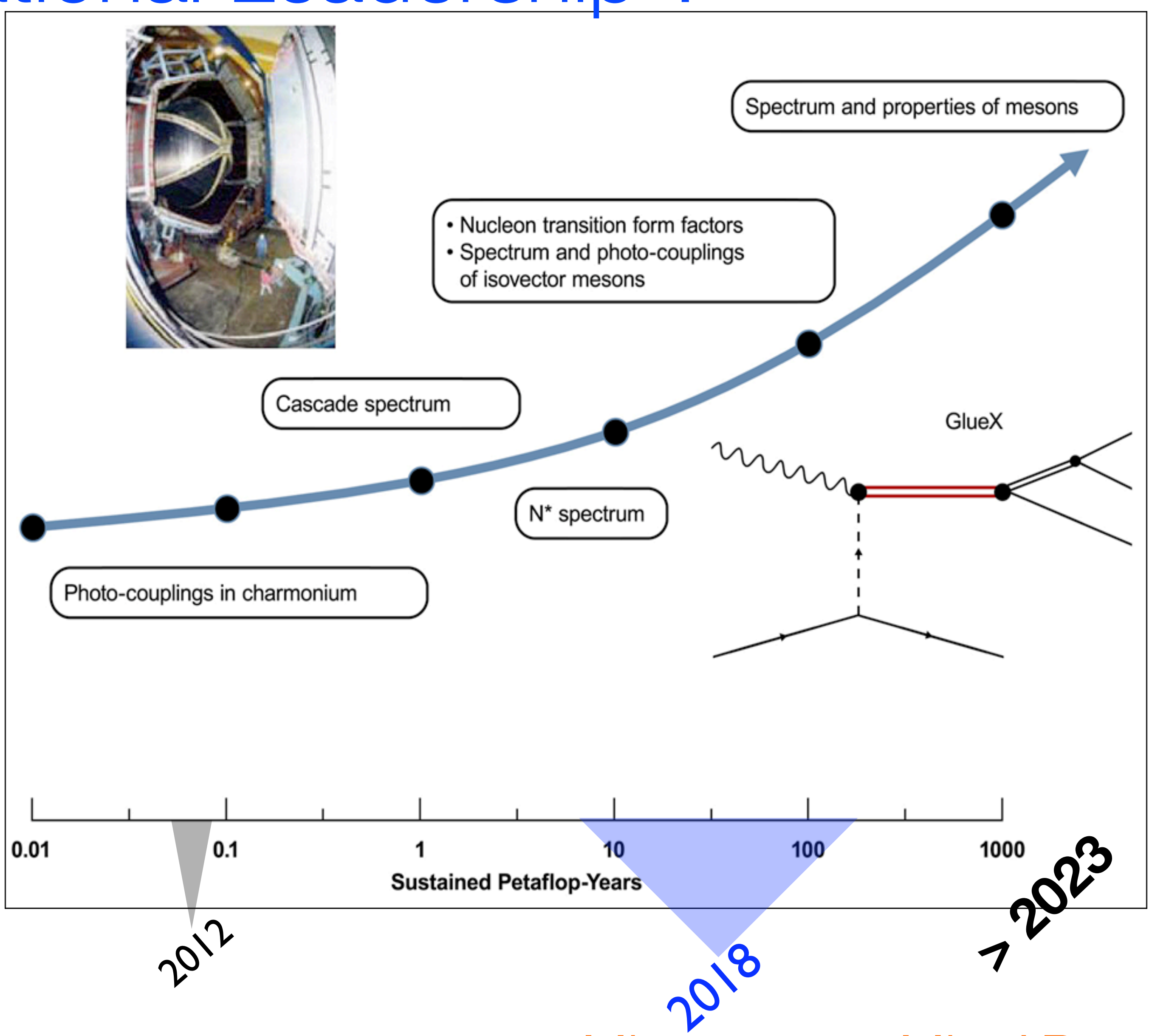
International Leadership ?

e.g.
Hadronic
Spectrosopy



5 x ML 5 x ML+AP

Viable (?)
5 x Moore's Law
Algorithm Potential

Computational Nuclear Physics

US Competitiveness

Today : US Nuclear Physics is under-resourced

Japan :

K-Machine ~ 2 Petaflops (sustained)

Nuclear Physics allocation ~ 20% for >= 1 year

400 Tflops (sustained) = 8 x US cold-QCD NP resource

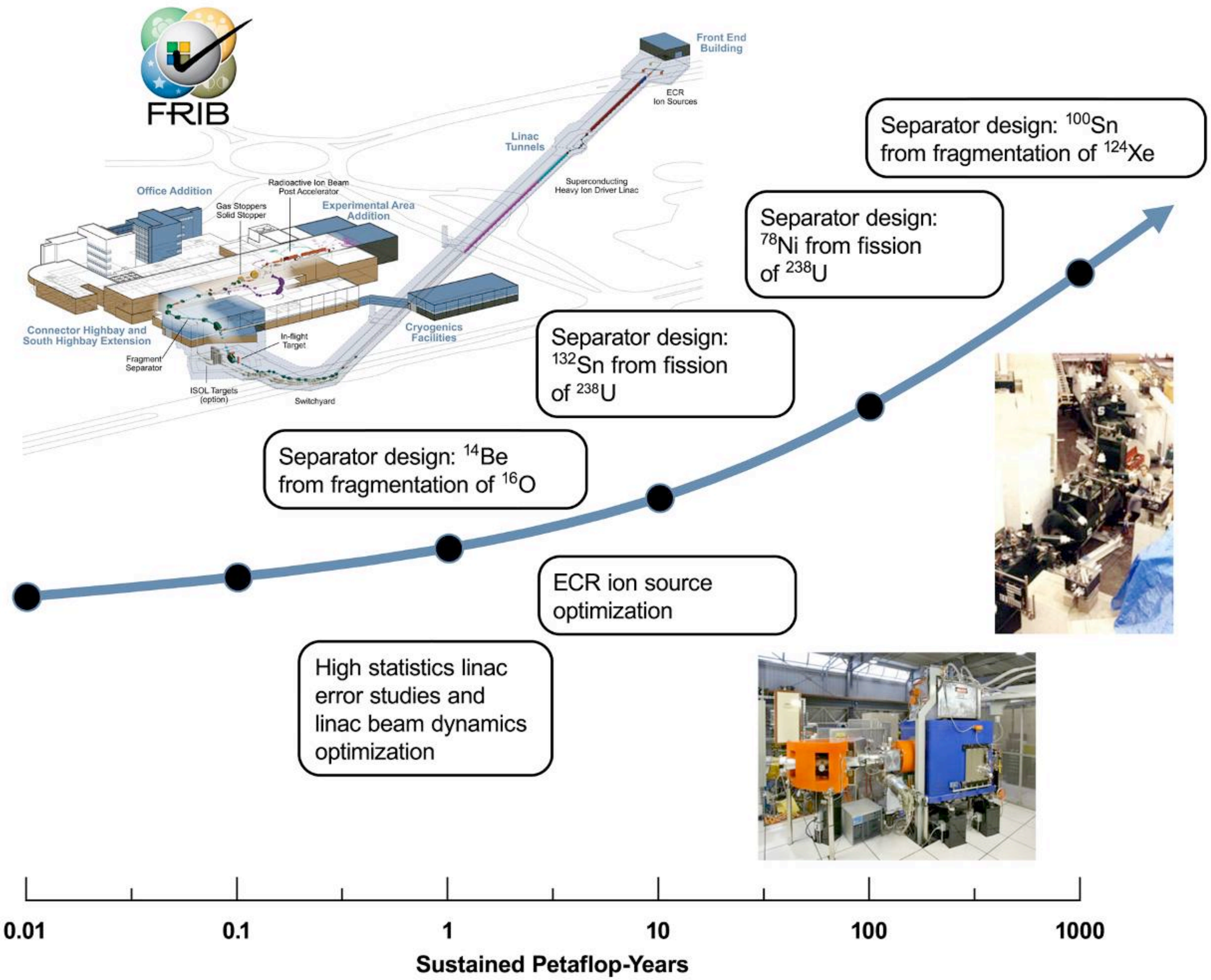
For entertainment purposes : cold-QCD :

Japan : 3.2 Mflops/citizen

USA : 160 kflops/citizen !!!

Computational Nuclear Physics

Machine Design and Optimization



Assume facilities will present their needs separately

Computational Nuclear Physics

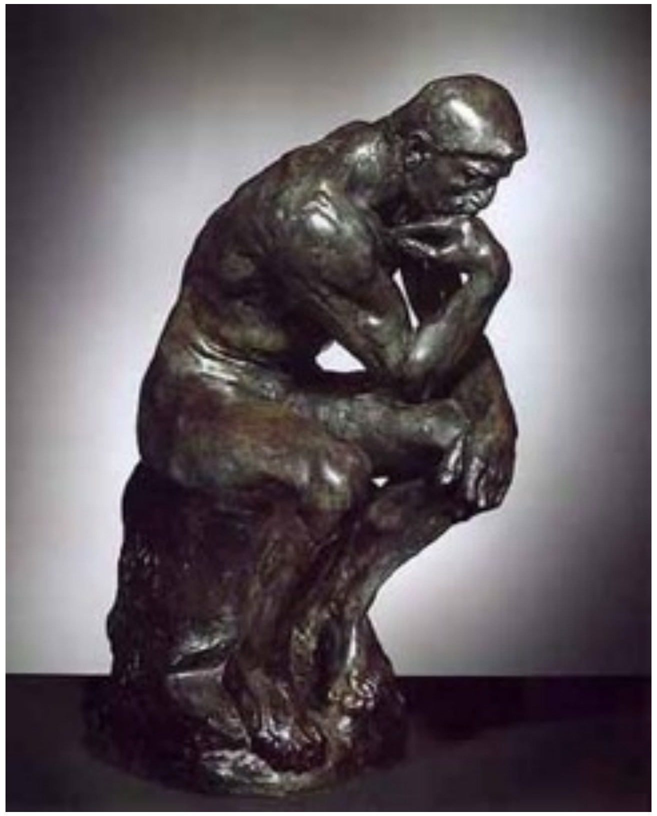
Collaboration is Essential

- Different areas in Nuclear Physics
    - coherent community effort - partial unification of NP
    - with Particle Physics, Plasma, Fluids, ...
- Computer Scientists
    - hardware development
    - optimizations
    - new coding paradigms
    - data management, visualization....
- Applied Mathematicians
    - algorithm development
- Statisticians
    - Monte Carlo
- Many collaborations currently exist
    - embraced and strengthened
    - requires support mechanism
    - International and multi-Institutional

Computational Nuclear Physics

Human Resources

- For viable program we need to grow HPC expertise in the NP community
    - faster than Moore's Law
    - not business as usual

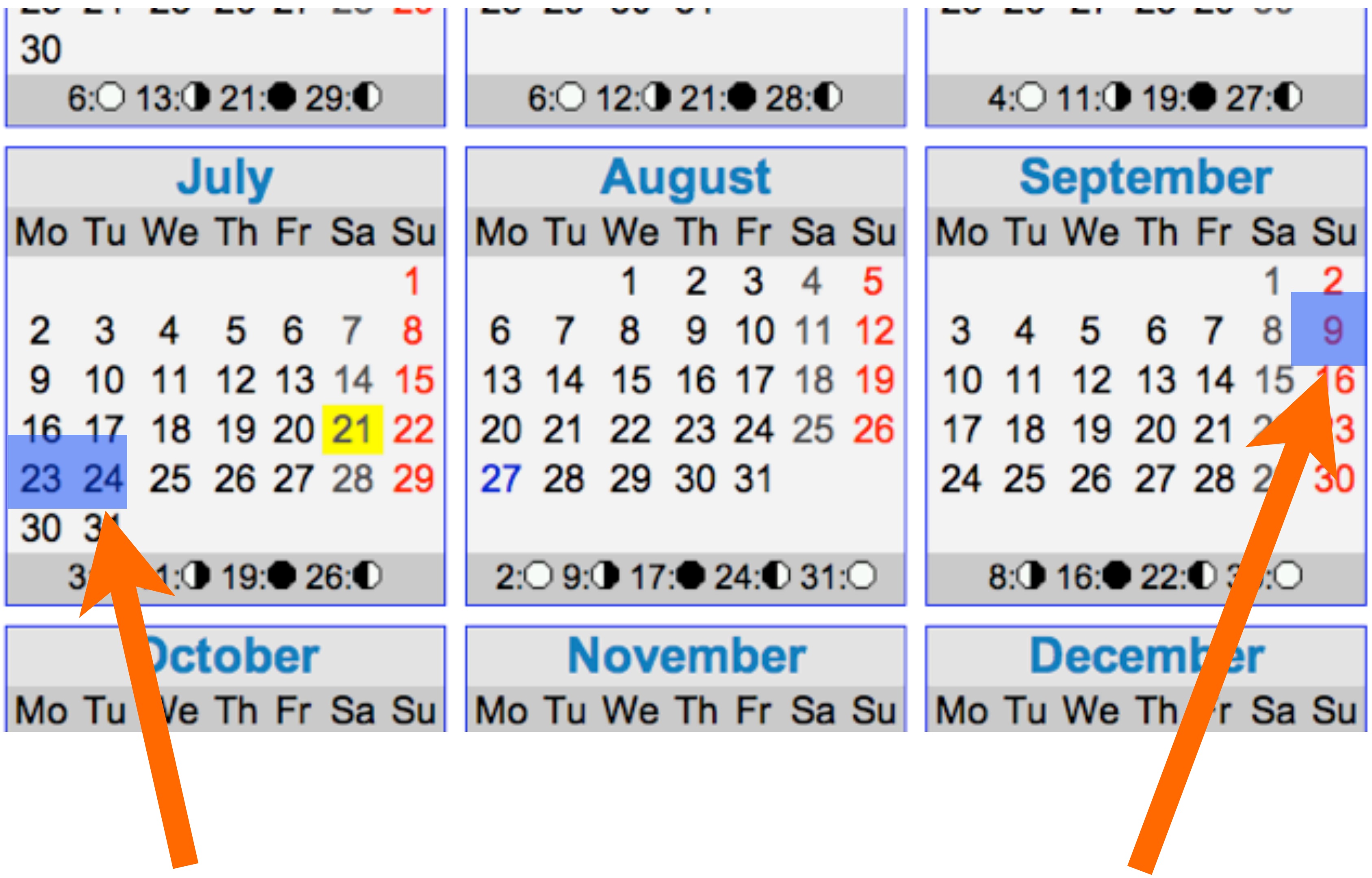


- The standard interdisciplinary hiring problems exist
    - challenge at Universities (at Labs?)
    - new training models, start today for 2020?

- Broad collaborations
    - Graduate students and postdocs hired into collaboration
        - naive scaling from UNEDF programs (2009 estimate) = enhancement in person-power (+10+10 per project ?)
    - Organization in the Nuclear Physics community

Computational Nuclear Physics

The Timeline



This meeting

Presentation

Organizers/Writers

- Adam Burrows
- Joe Carlson
- Robert Edwards
- Witek Nazarewicz
- Peter Petreczky
- David Richards
- Martin Savage

Computational Nuclear Physics

NSAC
Tribble Committee Questions

Most Important :

Present a compelling case for significant enhancements in resources dedicated to NP research program

(seems easy to me !)

- clearly articulate what we want to do
- my view : this is the right time to ***go for it***
- will lose leadership if we don't
- will lose scientists if we don't
- not necessarily a scaling of present

(e.g. tighter coupling between allocations and base support?)

Computational Nuclear Physics

The Agenda

Monday, July 23 , 2012		
8:30 8:35	Welcome	Jerry Draayer
8:35-8:45	Introduction	Martin Savage
8:45-9:45	Cold QCD	Tom Luu, Balint Joo
9:45-10:45	Hot QCD	Peter Petreczky, Swagato Mukerjee
10:45-11:15	*Coffee Break*	
11:15-12:15	Nuclear Structure and Reactions	Joe Carlson, Ewing Lusk
12:15-13:15	*Lunch Break*	
13:15-14:15	Astrophysics	Adam Burrows, Bronson Messer
14:15-14:45	Additional Opportunities for Computational Nuclear Physics-5 Minutes and Maximum of Two Transparencies From Floor	
14:45-15:15	*Coffee Break*	
15:15-15:35	Whitepaper: Aims and Plans	Martin Savage
15:35-	General Discussion, With Attendance by Agency Representatives	
Tuesday, July 24, 2012		
8:25 8:30	Introduction to the 2nd Day	Martin Savage
8:35-10:00	Computational Requirements Working Session	Robert Edwards (Chair)
10:00-10:30	*Coffee Break*	
10:30-12:00	Evolution of Computational Physics and Cross-Cutting	David Dean (Chair)
12:00-13:00	*Lunch Break*	
13:00-14:00	Summary, Resolutions, and Closeout	Witold Nazarewicz, David Richards
14:00-15:30	Writing Group Session	

DAQ - phase

Computational Nuclear Physics

NSAC
Tribble Committee Questions

(1) What major scientific accomplishments and discoveries have occurred in your area of high-performance computing since the 2007 LRP was drafted?

(2a) What compelling and unique science can be carried out in the program in the next five years assuming support similar to FY13 that includes cost of living increases?
(2b) What additional impact would flat-flat funding to FY18 have on (2a)?

(3) What is the minimum level of support (cycles, new hardware, etc.) needed to maintain a viable program in computational nuclear physics?

(4) What workforce (physicists, CS, AM, students) is needed to maintain a viable program?
What will it require to take the community to the exascale era (e.g., training of students and postdocs)?

(5) What science would you expect to pursue in the program in 2020 and beyond?
What is needed to support this?
What science would you expect to pursue without access to major supercomputer centers?

(6) What is role of the science in your research area in the international context?
If the US effort in high-performance computing were seriously curtailed, to what degree would efforts in other countries fill the gap?
And, to what degree would US scientists be able to advance research in this area by working outside of the country?

(7) How does high performance computing contribute to the educational mission of training the future workforce in nuclear physics and associated applied areas?

The End, or is it the Beginning