Are Killer Apps Killing Exascale?

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CCDSC 2016

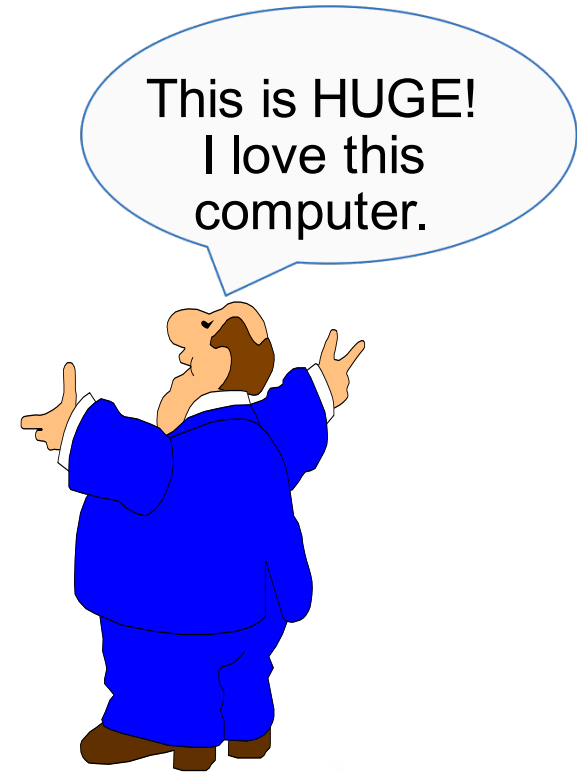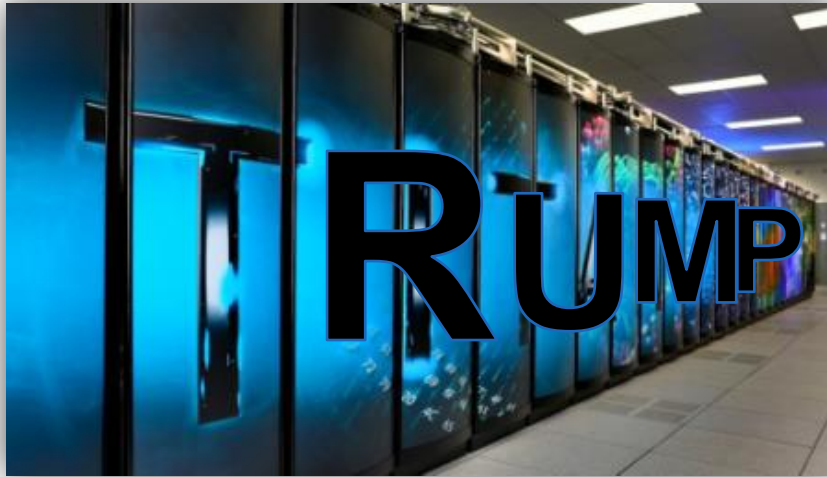**Lyon France**

October 4, 2016
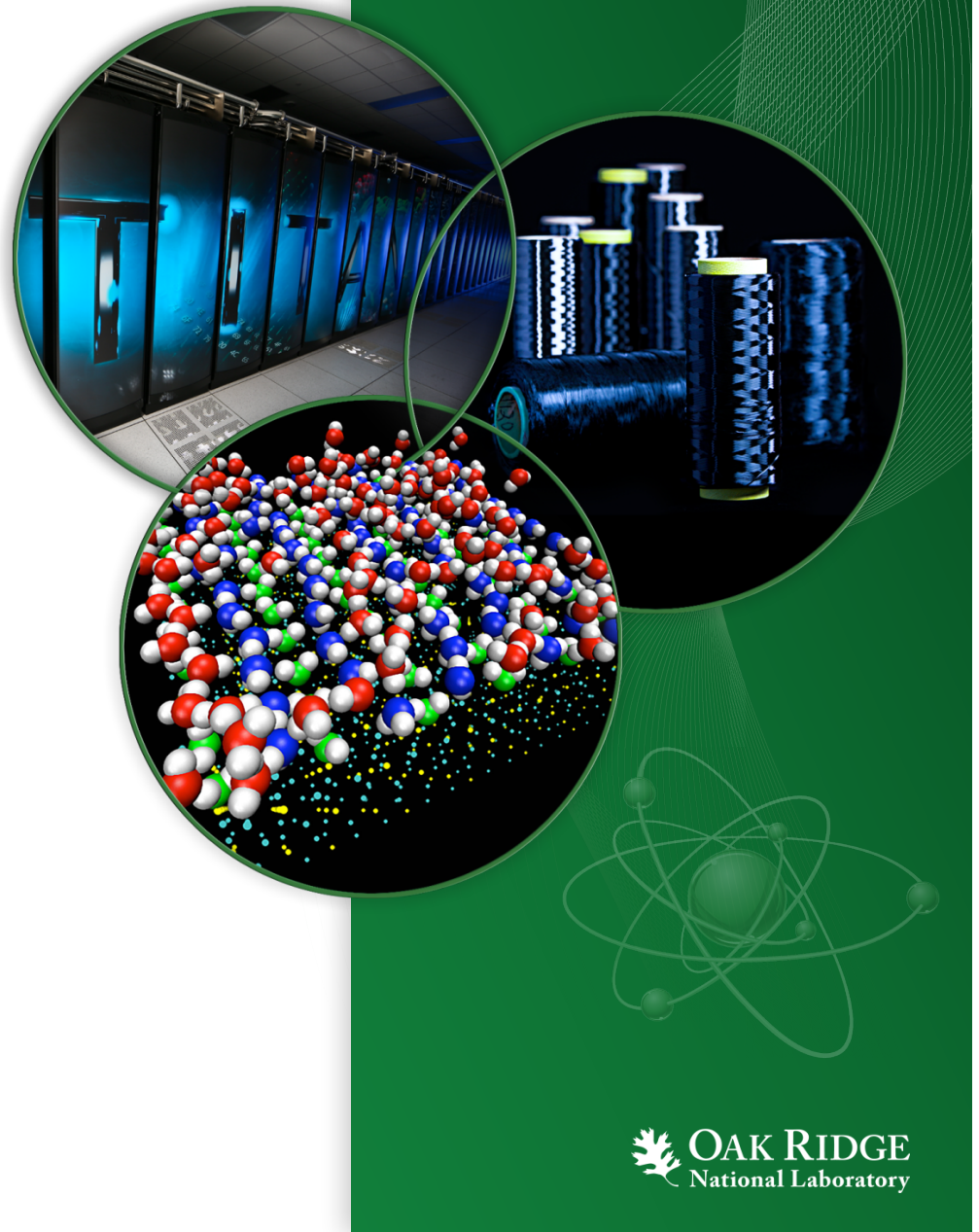
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This is HUGE!

U.S. Exascale System

This is HUGE!
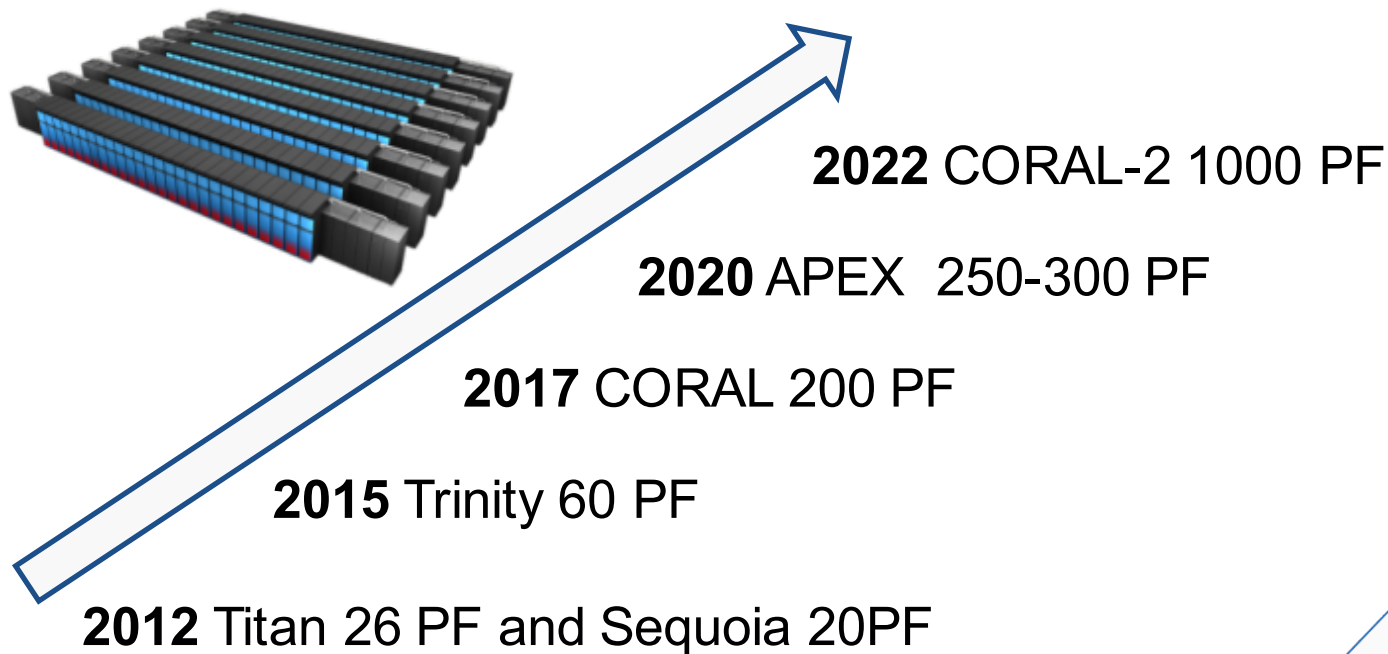I love this computer.

- 2009 the goal was to get to exascale by 2018

- 2013 the goal was slipped to 2020

- Today the U.S. Exascale Computing project is targeting 2023

Is it politics, technology, or the lack of any compelling killer apps that is driving out the target date for exascale?

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U.S. Exascale timeline driven by 4 year cadence for Leadership computers

DOE Facilities have a fixed 4-5 year cadence
Present Roadmap for Largest US supercomputers 2012 - 2022

2022 CORAL-2 1000 PF

2020 APEX 250-300 PF

2017 CORAL 200 PF

2015 Trinity 60 PF

2012 Titan 26 PF and Sequoia 20PF

Power constraints of 20-30 MW facilities and pay-off schedules of 4 year leases limit accelerating this Roadmap to 2020.

U.S. Vendors Surveyed:
## Asked can you do Exascale sooner?
What are Cost, Power, and Space?
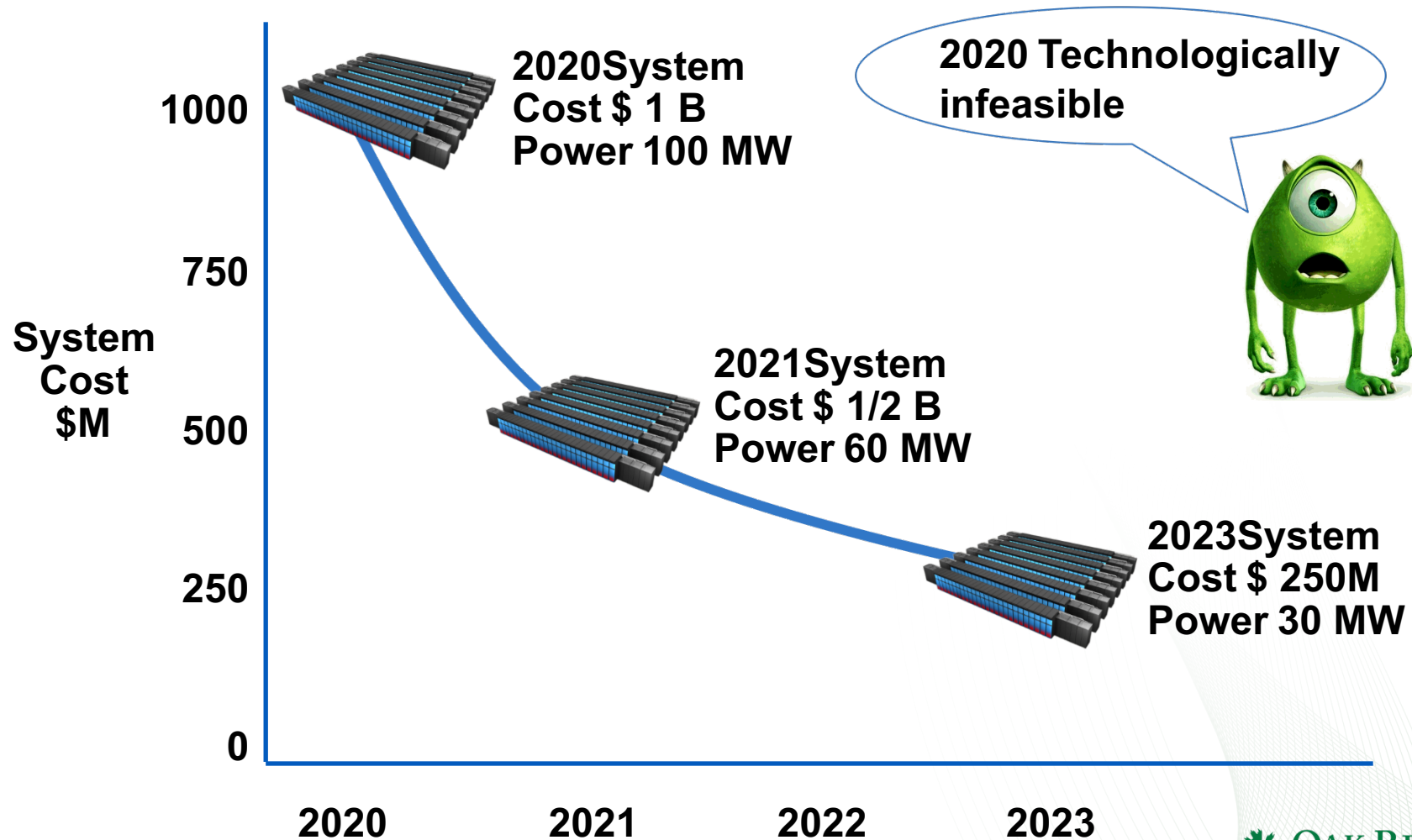
2016 U.S. Exascale Project Takes off

The Project has four parts: Apps, SW. HW, Systems, and leverages CORAL-2

The Project has three phases:
- Phase 1 – R&D before DOE facilities exascale systems RFP in 2019
- Phase 2 – Exascale architectures and NRE are known. Targeted development
- Phase 3 – Exascale systems delivered. Meet Mission Challenges

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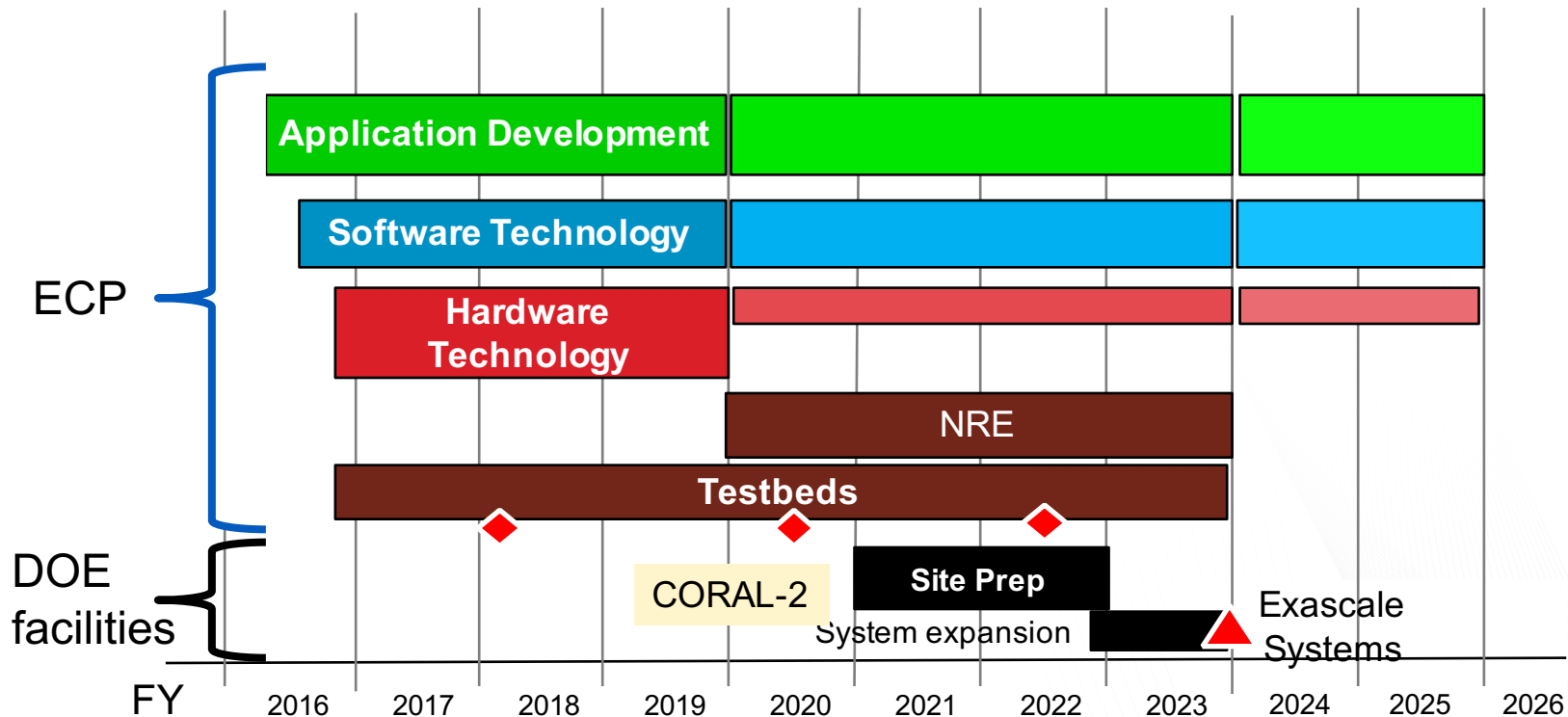
ECP Goals – But what is missing is a driving need – A Killer App

- Develop scientific, engineering, and large-data applications that exploit the emerging, exascale-era computational trends caused by the end of Dennard scaling and Moore's law

- Create software that makes exascale systems usable by a wide variety of scientists and engineers across a range of applications

- Enable by 2023 two diverse computing platforms with up to 50× more computational capability than today's 20 PF systems, within a similar size, cost, and power footprint

What is missing is a driving need that is time sensitive and

- **Saves millions of lives, for example a cure for cancer, or**

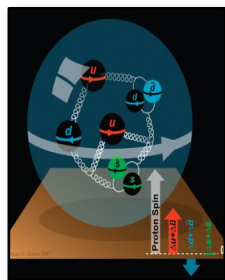- **Has huge global impact, for example cheap, clean, energy production**

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Exascale Applications – Important But not Time Sensitive

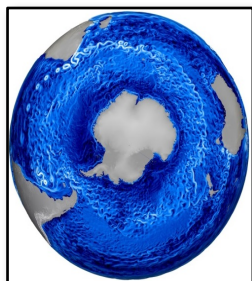**Lot's of "better science" but not an ultimate goal or solution like Higgs Boson**

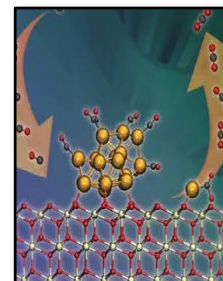| Fundamental Laws (NP)	Climate (BER)	Materials Science (BES)	Chemical Science (BES, BER)	Combustion (BES)
QCD-based elucidation of fundamental laws of nature: Standard Model validation and beyond SM discoveries	Accurate regional impact assessment of climate change*	Find, predict, and control materials and properties:	Biofuel catalysts design; stress-resistant crops	Design high-efficiency, low-emission combustion engines and gas turbines*
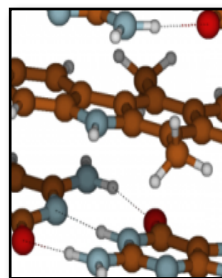
* Scope includes a discernible data science component

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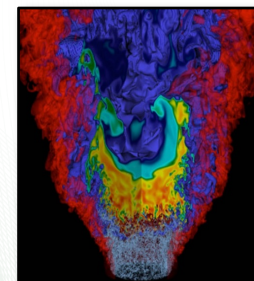
Exascale Applications – Important But not saving millions of lives

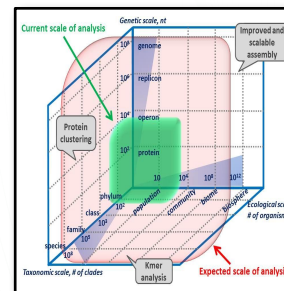| Precision Medicine for Cancer (NIH)	Seismic (EERE, NE, NNSA)	Genomics (BES)	Metagenomics (BER)	Chemical Science (BES)
Accelerate and translate cancer research in RAS pathways, drug responses, treatment strategies*	Reliable earthquake hazard and risk assessment in relevant frequency ranges* treaty verification	Protein structure and dynamics; 3D molecular structure design of engineering functional properties*	Leveraging microbial diversity in metagenomic datasets for new products and life forms*	Design catalysts for conversion of cellulosic-based chemicals into fuels, bioproducts
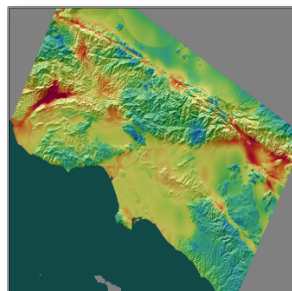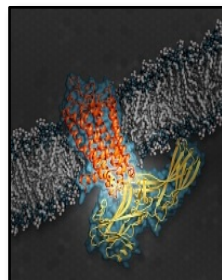
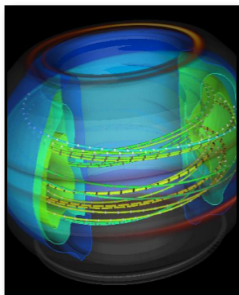* Scope includes a discernible data science component

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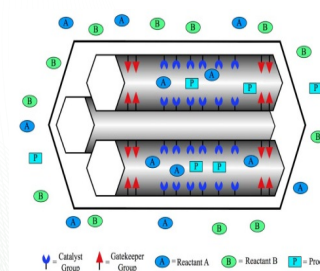
Exascale Applications – Important
But no guarantee of earth shattering impact

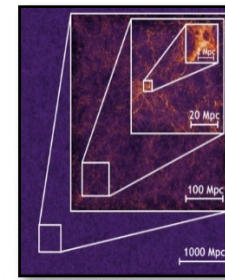| Magnetic Fusion Energy (FES)	Nuclear Energy (NE)	Wind Energy (EERE)	Cosmology (HEP)	Astrophysics (NP)
Predict and guide stable ITER operational performance with an integrated whole device model*	Accelerate design and commercialization of next-generation small modular reactors*	Increase efficiency and reduce cost of turbine wind plants sited in complex terrains*	Cosmological probe of standard model (SM) of particle physics: Inflation, dark matter, dark energy*	Demystify origin of universe and nuclear matter in universe*
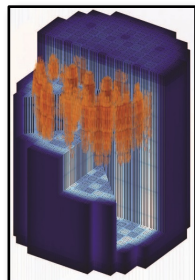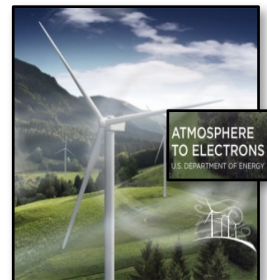
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Conclusion
U.S. Exascale Project Has Taken off
But How is it going to Land?

- Interest fades because no killer app to sustain and project peters out

- Runs out of gas (budget cut after 5 years) and project crashes

- Excitement maintained and U.S. exascale systems available in 2023 and success "declared" w/o science

- U.S. government understands the Importance of Science and the project goes till science is done in 2025

This is HUGE!
I invented science!

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