



U.S. DEPARTMENT OF
ENERGY

Office of
Science

HEP Computing and Data Challenges

DOE SC Exascale Requirements Review: High Energy Physics
Bethesda Hyatt, June 10, 2015

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High Energy Physics

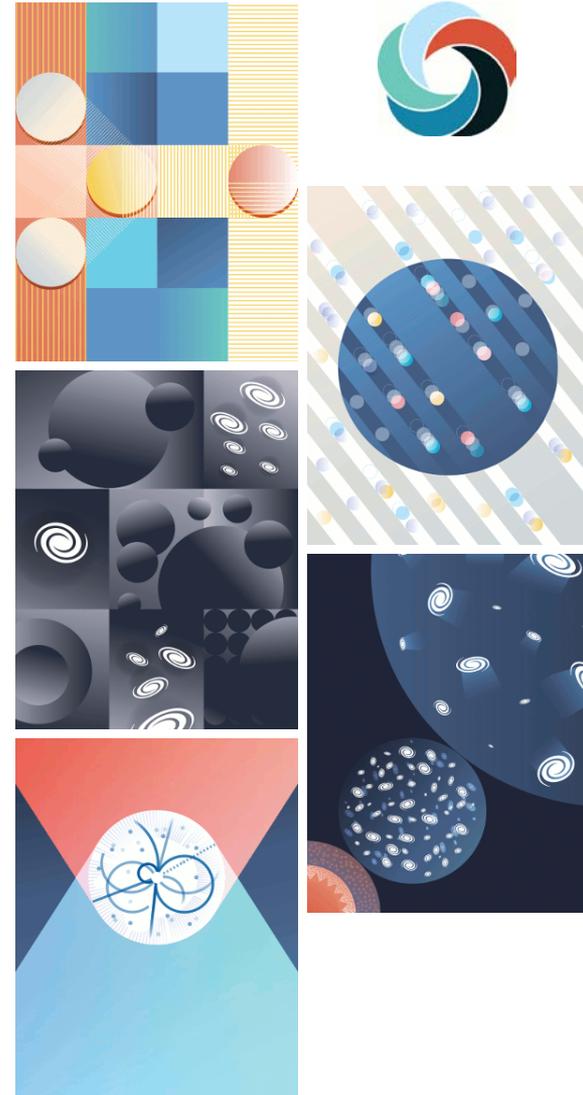
- What's new?
- In May 2014, the U.S. particle physics community updated its vision for the future
 - The P5 (Particle Physics Project Prioritization Panel) report presents a strategy for the next decade and beyond that enables discovery and maintains our position as a global leader
- Long-term program guided by five intertwined Science Drivers
 - Enabling the next discovery requires coherent effort between Experiment, Theory and Computing
 - HEP must both advance certain areas of Technology while taking advantage of advances elsewhere to fulfill our mission-driven science



The Science Drivers of Particle Physics

These compelling lines of inquiry show great promise for discovery:

- Use the **Higgs boson** as a new tool for discovery
- Pursue the physics associated with **neutrino** mass
- Identify the new physics of **dark matter**
- Understand **cosmic acceleration**: dark energy and inflation
- **Explore the unknown**: new particles, interactions, and physical principles



HEP Science Drivers - Computing & Data Challenges

Higgs

Neutrinos

Dark Matter

Dark Energy / CMB

New particles

Science Pursued Via Frontiers,
Experiments, Projects & Technology



Computing - Simulations, Software, Tools, Data Solutions,
Hardware, Systems, and Networks, mostly funded vertically within
Experiments, Projects, and Lab Operations

Cross Cut & Global Solutions Increasingly Important:

Address the Facts of Technology Changes

Optimize Resources, Share innovation, Avoid Duplication,

Maximize External Resources and Partnerships

Expand Computing across the Vertical Towers



HEP Forum for Computational Excellence (FCE)

- **HEP-FCE Directors: Rob Roser and Salman Habib**
 - Part of HEP Response to P5 Recommendation on Computing
 - Also follows Reports from a Topical Panel on Computing and Snowmass Computing Frontier in 2013
 - Presentation at 2015 April HEPAP meeting
- **Initial Focus:**
 - Optimize U.S. Resources & Expertise
 - Includes industry partnerships
 - Foster cross cut computing & data solutions
 - Strengthen interactions with ASCR
 - Exploit new architectures & technologies
 - Facilitate cross cut communication for various HEP collaborations
 - OSG, G4, USQCD, SciDAC, CAMPA, HSF etc.



HEP Computing Needs are Large and Growing

- Use of DOE LCFs is very important for us
- Traditionally the Lattice QCD community has been using them very efficiently and continue to do so
- Also Cosmology Simulations and Accelerator Modeling have been and continue to be major users
- Recently we have been encouraging other non traditional users and we have some successes
- We value the partnerships with ASCR and look forward to this Review Meeting strengthening these
- We like the idea of jointly discussing our data, software, and networking challenges and our comprehensive computing needs along with HPC use



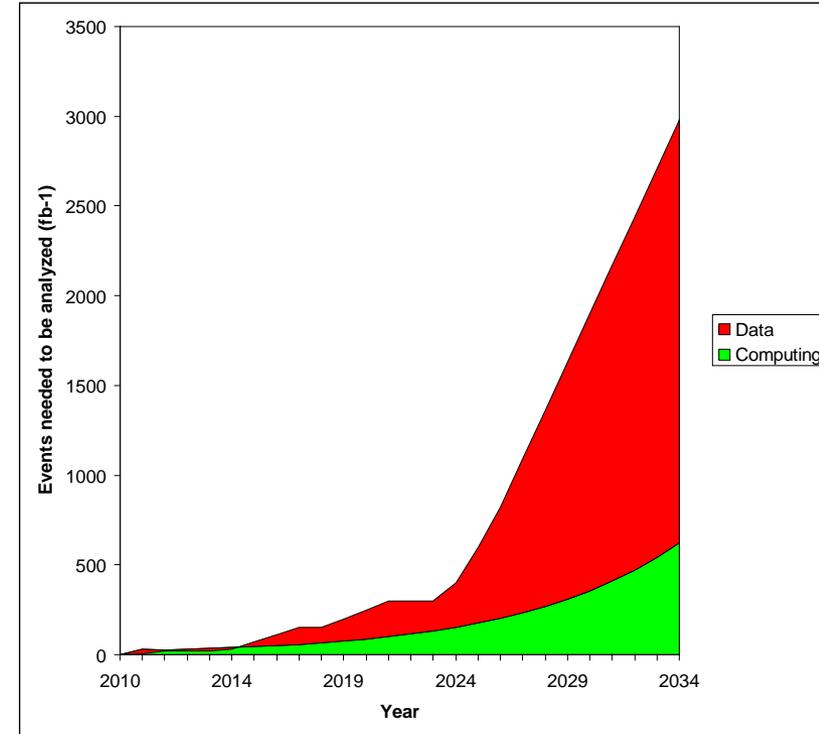
HEP Computing and Challenges: Example LHC

- **LHC Data: 14 PB per year now; 130 PB expected in 2021**
- **Need innovative data & network research**
- **Optimize External Computing Resources**
- **Resolve Multiple Software Challenges**
- **Supercomputers/Clouds/Partnerships can complement/supplement current Grid Computing**
- **HPC (High Performance Computing) efforts at DOE special success for some events and large fast jobs**
- **Europe (CERN) is looking into Computing Strategies with non HEP Partners**



HEP & Non-traditional Use of HPC

- **HEP computational needs are continually growing**
 - Traditional solution of larger farms of commodity PCs is not a sustainable solution
 - Industry is trending towards more and smaller cores with less memory per core
 - High Performance Computers (HPCs) are ahead of the curve on these trends
- **HEP experimental computing needs have recently initiated successful use of HPC**
 - Capacity: HEP needs growing faster than the Grid
 - Capability: Current code not optimized for HPCs
- **HEP partnership with ASCR, via the Forum for Computational Excellence and other modes will help address these issues to meet future computing needs -**
- **For traditional and non traditional HPC use and for Comprehensive Compute/Data/network/software solutions**

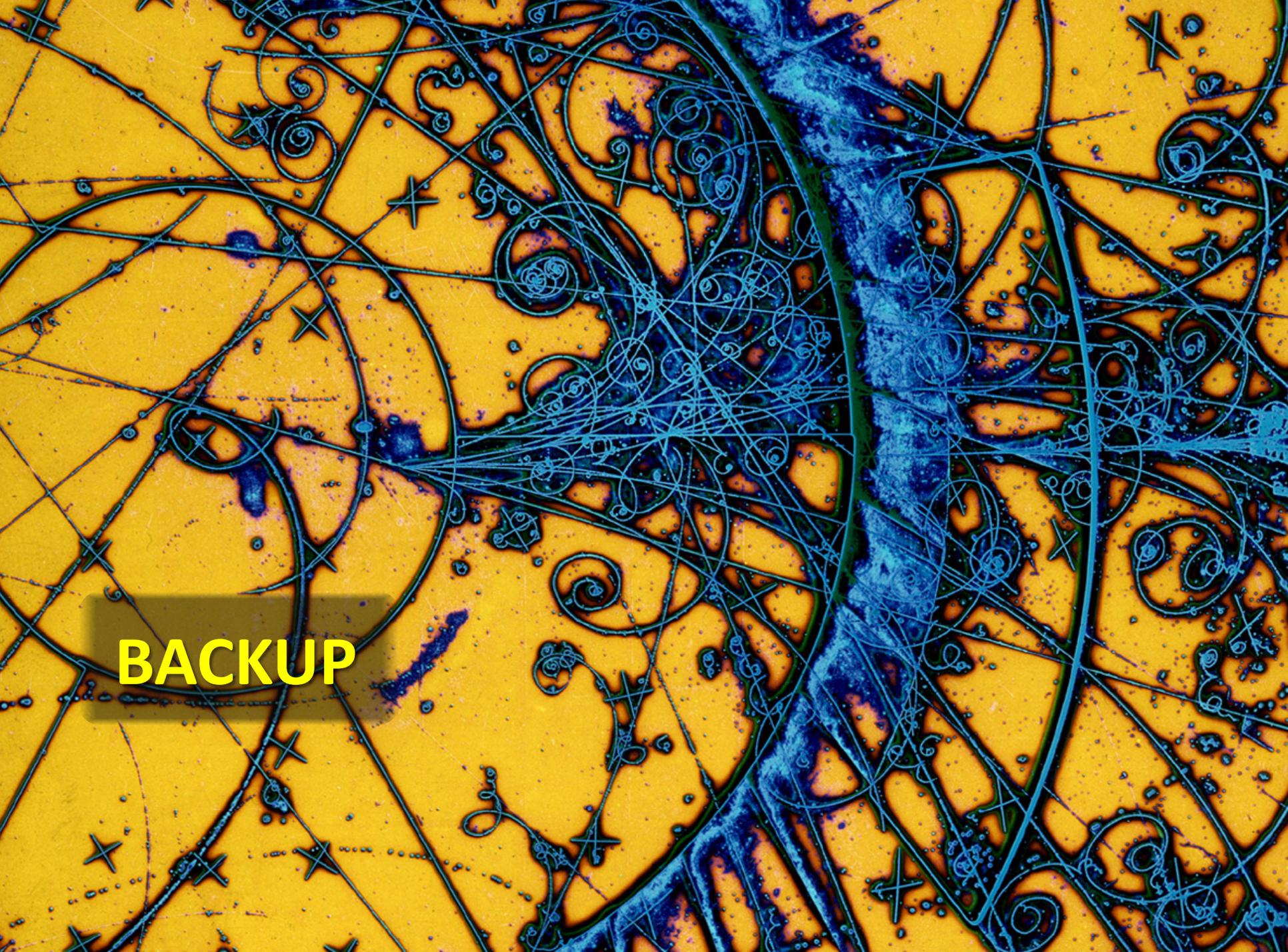


Estimated ATLAS Computing Requirements

The green assumes 15% growth per year from Run 1, and that Run 1 had exactly enough capacity.

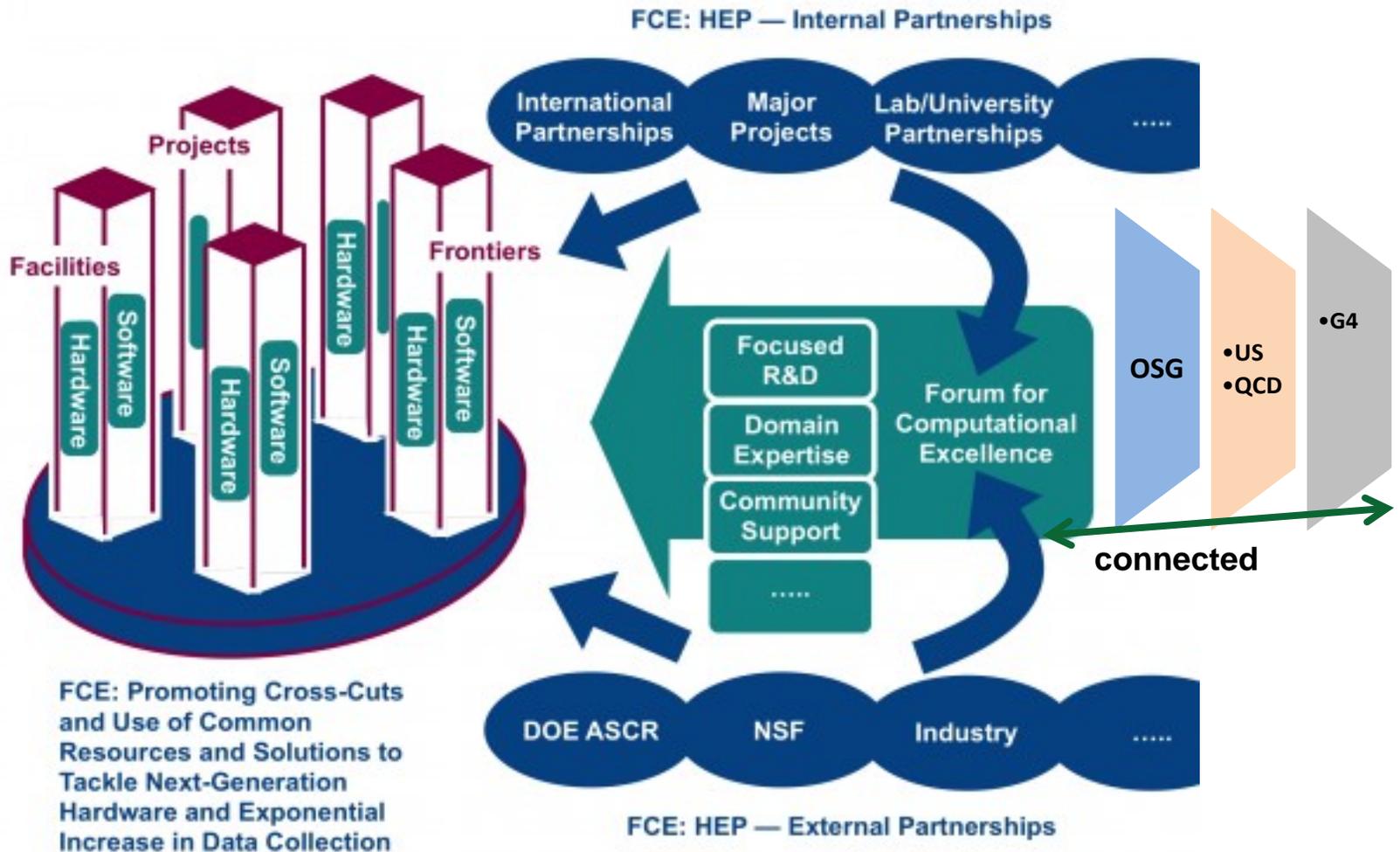
Additional CMS needs and requirements for non LHC experiments





BACKUP

HEP FCE Long Term Vision



Computing and P5

- [Recommendation 29]
- Strengthen the global cooperation among laboratories and universities to address computing and scientific software needs, and provide efficient training in next-generation hardware and data-science software relevant to particle physics.
 - HEP Response: Set up Forum for Computational Excellence to work with HEP to address this Recommendation
 - The Forum for Computational Excellence has been set up by DOE to follow up on these issues among other topics <http://hepfce.org/>
 - Directors: Rob Roser (FNAL) and Salman Habib (ANL)
 - Strengthen partnerships with ASCR – organizing this meeting with ASCR Facilities.

