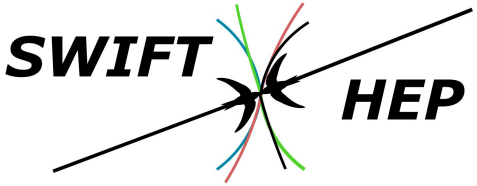
DRAFT 0.2

The content is there, slides need to be polished.

iris



Computing and Software for particle physics in the UK

13 September 2024

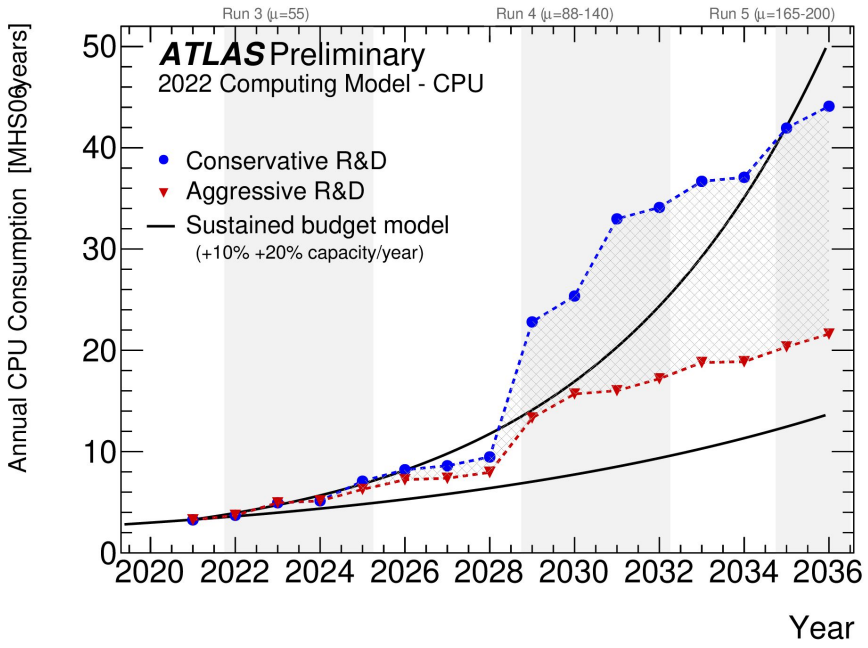
Quick overview of HEP computing

- Computing resources depend on experiments operation parameters, eg. for LHC
  - Luminosity
  - Trigger rates
  - Experiment software and computing models
- The UK provides Tier-1 resources to all major LHC experiments

UK fraction of resources provided by experiment (2022)

Experiment	Tier-1	Tier-2	
	UK Pledge		UK Group
ALICE	2.9%	1.9%	0.2%
ATLAS	15.8%	10.9%	1.1%
CMS	6.3%	4.1%	0.4%
LHCb	24.8%	16.2%	1.6%

Example: CPU predictions for ATLAS



UK HEP computing infrastructure

- GridPP: Provides the compute, disk, tape needed to operate PP experiments.
  As well as the software fabric and support needed to run the experiment payloads.

- IRIS: set up to bring coherence, collaboration, coordination and sharing across all of STFC (Smaller experiments, astronomy, facilities)

- DiRAC: UK high performance computing facility supporting STFC theory users

  Physical hardware is only part of the expense. We should remember about the staff effort to support the infrastructure!

UKRI Digital Research Infrastructure:

- Recent investments in AI machines, e.g. Isambard AI
  - Mainly GPU based and so not applicable to current HEP production workflows
- A large HPC may not suit PP requirements
  Not necessarily in sync with the needs from the PP community

Mostly I will cover LHC computing. Experiments' perspective covered in Monica's talk

Multi-experiment software and computing

The UK Particle Physics Technology Advisory Panel (PPTAP) (link) 2021

Closely follows similar recommendations from the CERN review of particle physics

[34] Likewise within software and computing the UK has significant leadership in a significant number of important areas, including in exploitation of computing accelerators, exploitation of low power compute units, computing operations, enabling software and computing, reconstruction algorithms, software framework development, development of cross- experiment development tools, use of HPC and development of collision simulation/generation programmes.

Layer	Domain	Experiment 1	Experiment 2	Experiment 3
6	Physicists	Analysis code	...	...
5	Experiment Physicists programmer and software engineers	Analysis framework. Simulation, Reconstruction, Calibration Code	...	...
4	Experiment Software Engineers	Software Frameworks	...	...
3	Common Software HSF / SWIFT-HEP	Common software components (Data management, Generators, Geant4, Accelerator integration)		
2	GridPP / WLCG	Middleware infrastructure for Distributed Computing		
1	GridPP / WLCG	Physical Hardware		

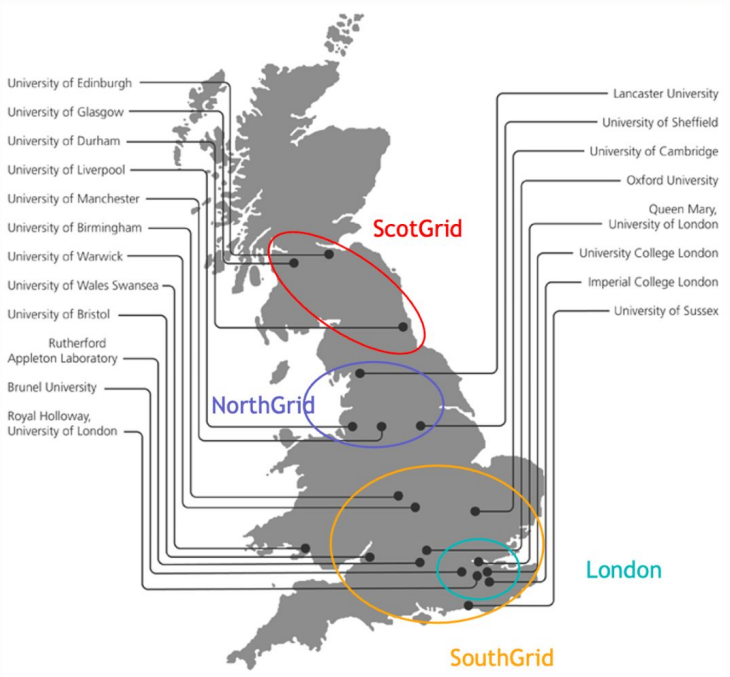
Moving Software down the stack

GridPP in size and numbers

Funded by STFC (£35M for 2024-28)

Tier-1 at Rutherford Lab (RAL)
4 Tier-2 sites distributed geographically

- 17 institutes hosting GridPP hardware
- 20 institutes signing the GridPP proposal



GridPP is central to the WLCG operation since the early 2000s

Hardware deployed at Tier-1(*):

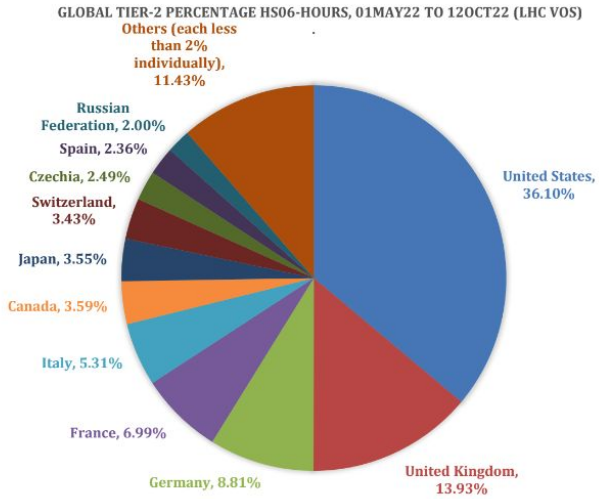
- Disk: 75 PByte
- Tape: 142 PByte
- CPU: 780k HepScore06

Hardware deployed at Tier-2s(*):

- Disk: xx PByte
- Tape: yy PByte
- CPU: zz HepScore06

Sustained network rate of
110 Gb/s during
Data Challenge 2024

(*) October 2024



GridPP Experiment support and staff

Experiments supported by GridPP and IRIS
Expect support for EIC, and DUNE operations

Core Hours in H2 of 2023:

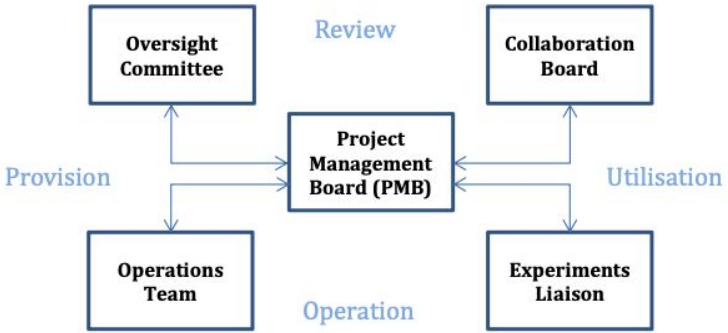
9,000 Mhrs	300 Mhrs	700 Mhrs
LHC VOs	**IRIS VOs**	**Other VOs**
ALICE	DUNE	BES
ATLAS	MicroBooNE	COMET
CMS	SoLiD	g-2
LHCb	JLab/CLAS12	HyperK
	LZ	IceCube
	CTA	ILC
	Virgo/LIGO	MICE
	UKSRC (SKA)	Mu3e
	SKAO	MoEDAL
	LSST/Rubin	NA62
	EUCLID	Pheno
		SBND
		T2K

(*) VO = Virtual organisation

GridPP Organized into 5 Work Packages:

- WP-A Site Operations
  11 FTE at Tier1 and 6.8 FTEs at Tier2
- WP-B Services
  5 FTE at Tier1 and 3 FTE at Tier2
- WP-C VO support
  3.25 FTE at Tier1 and 5.75 at Tier2
- WP-D Innovation (see example on next slide)
  1.75 FTE at Tier1 and 2.45 at Tier2
- WP-E Management
  1.65 FTE

Total of 39 FTE + 1.65 management



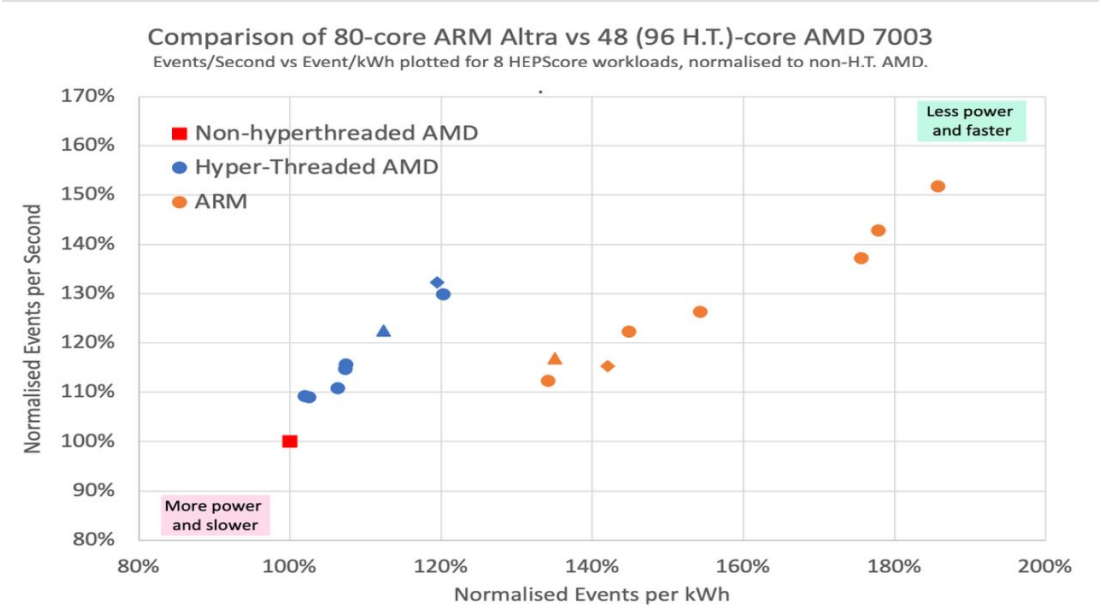
GridPP WP-D Innovation: Example

GridPP had a leading role in introducing ARM processors to WLCG

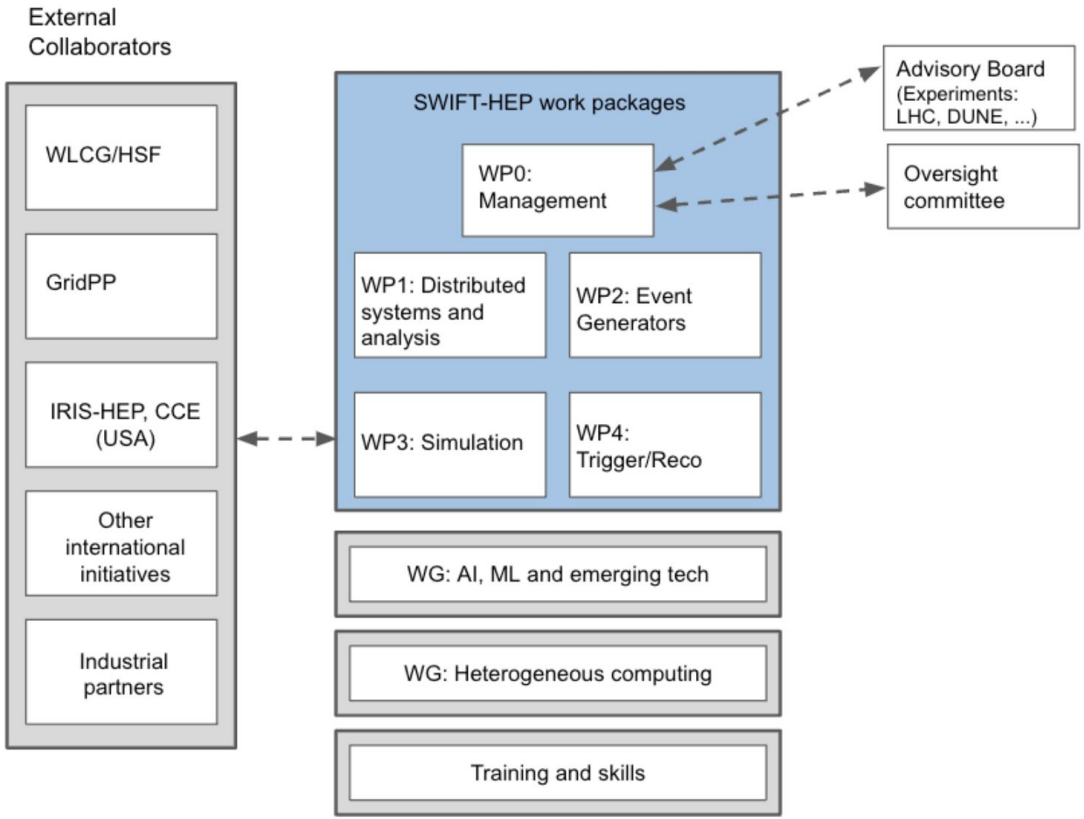
- Reduction in power consumption (and cost!)

(LHCC-158 minutes) The LHCC commends the Glasgow Tier2 for their thorough benchmarking efforts and looks forward to the results of power efficiency tests with newer CPU models. The committee encourages WLCG to streamline these findings to provide clear guidance to sites for their hardware purchases.

ARM resources can now be pledged for ATLAS, other experiments to follow



Cross experiment software development (SWIFT-HEP)



Crucial activity to deliver the computing needed in the 2030s

5 FTE funded by STFC from September 2020 until 2025 (so far)

2 FTE funded by the ExCALIBUR programme (software for exascale facilities)

Part fund people at Universities and national Labs to match with other projects

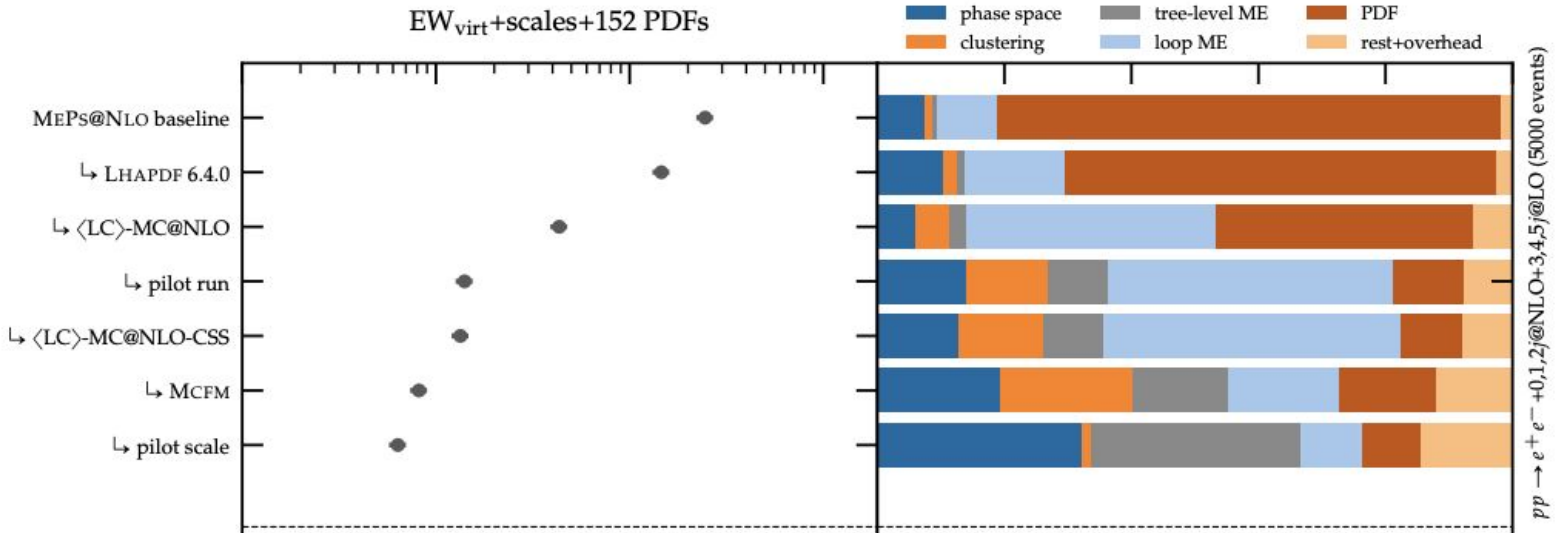
Overall about 10 people funded directly by SWIFT-HEP

Software improvements. An example from event generators

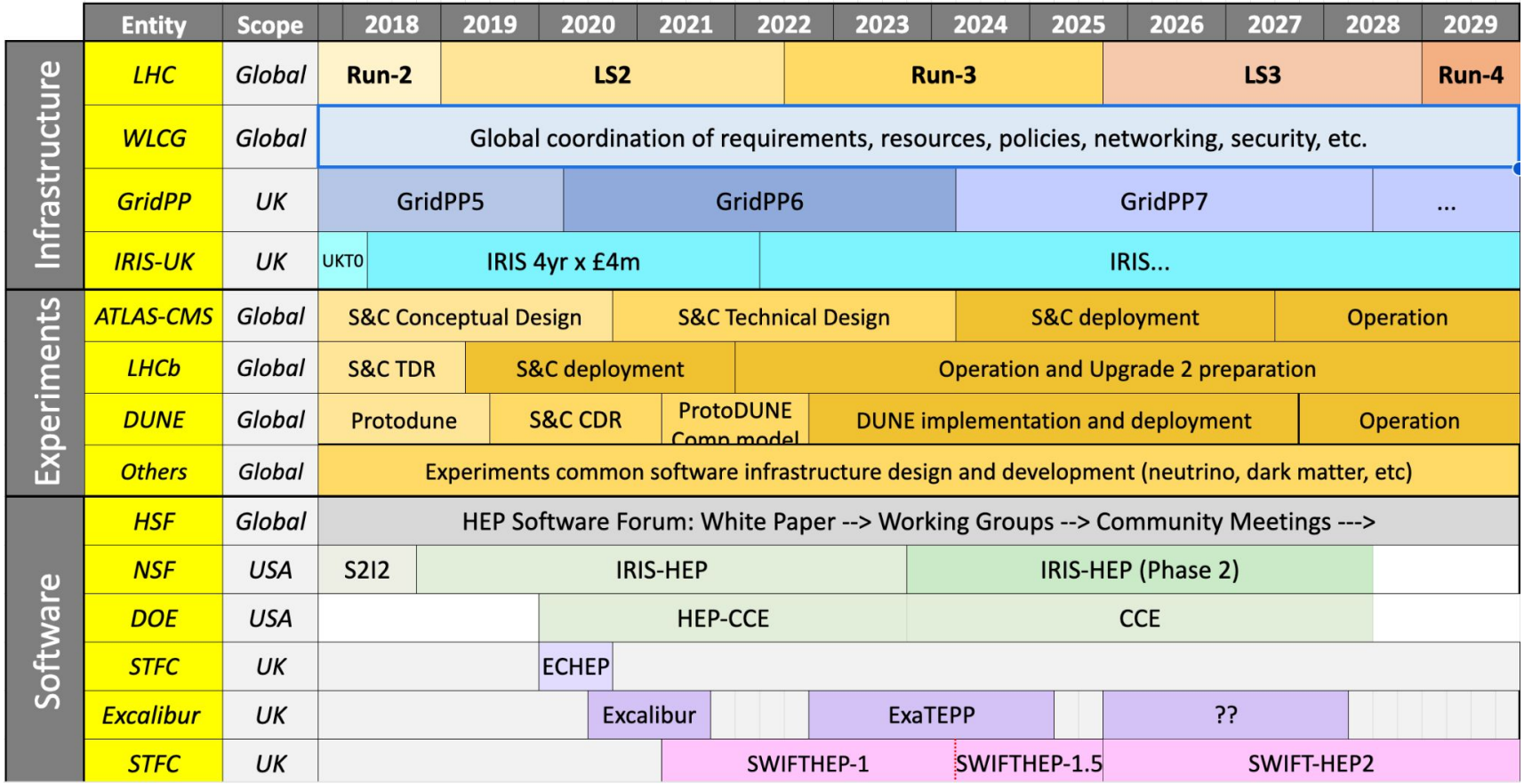
- Event generators are a key ingredient at the LHC
  - Higher precision generators needed for high precision physics
  - Not just the LHC, also neutrino physics (e.g. Genie)

UCL, Glasgow, Durham
Chris Gutschow et al,
EPJ C82 (2022) 12

- Same physics results with less computing (more info)
  - Example from Sherpa (possible thanks to SWIFT-HEP funding)



Timeline and history



Conclusions

The UK is an integral part of the Computing and Software infrastructure for Particle Physics

- key partner in the formation of LCG and WLCG
- We provide a significant fraction of resources and delivered pledges for 20 years
- Several leadership positions such as WLCG deputy project leader, WLCG/HSF liaison, Geant4 deputy spokesperson, …
- What is needed is long-term funding stability consistent with the flat-cash planning baseline.

It's all about people

- Recruiting and retaining staff is the most difficult part of the job
- People have careers and they have options outside HEP and research
- Research Software Engineers (RSE) pools are a good working model in the UK

Computing is recognised as essential to exploit future experiments

- More data, improved precision on measurement and theory
- Computing hardware evolving very rapidly
- Funding for computing is a significant fraction of the experiment costs