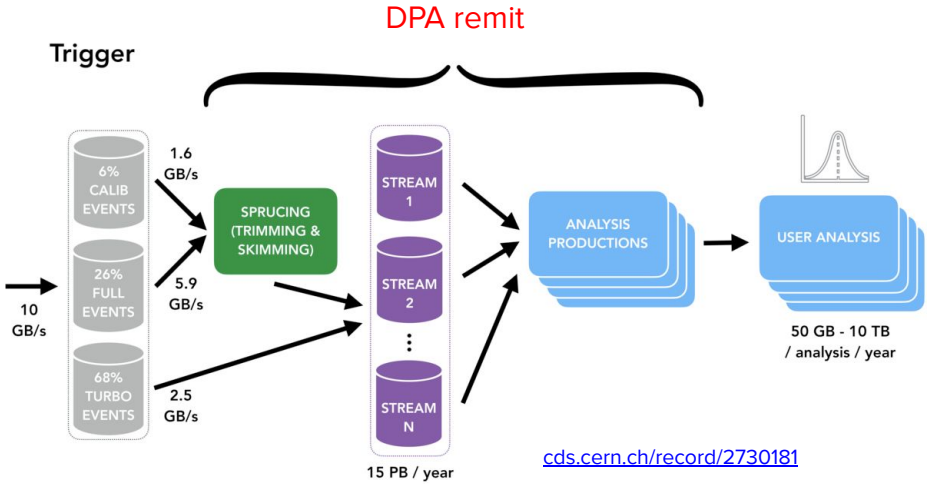
Analysis facilities @ LHCb

N. Skidmore

Analysis Ecosystems workshop II

Where do analysis facilities fit into LHCb?

- Increased data rate in Run 3 poses significant Offline data processing and analysis challenges for LHCb
- Coordination of these activities by DPA project
  - Software project on same level as detector projects



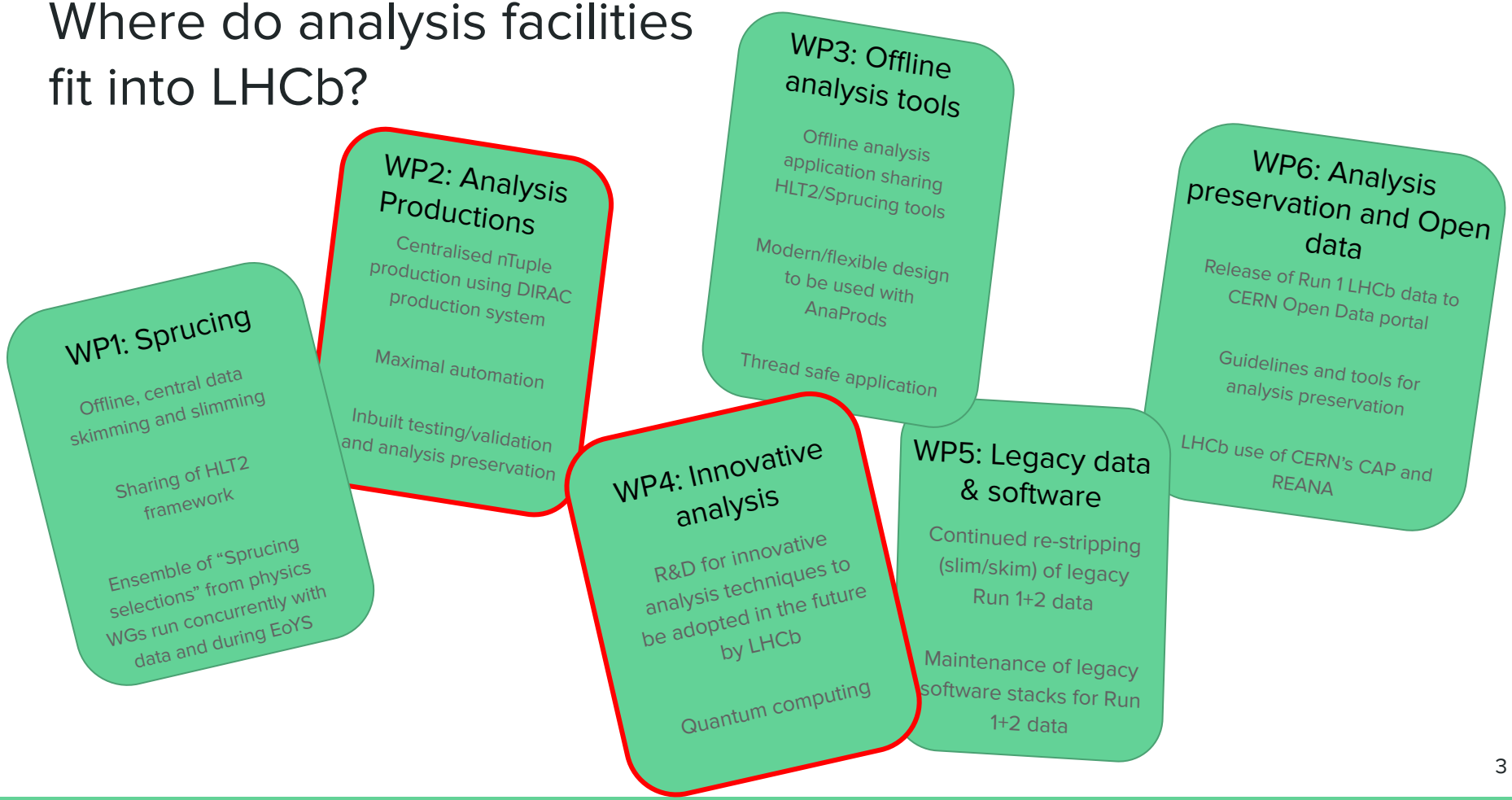
cds.cern.ch/record/2730181

DPA project
Offline processing/selections/analysis

WP1 - Sprucing
WP2 - Analysis Productions
WP3 - Offline Analysis Tools
WP4 - Innovative Analysis Techniques
WP5 - Legacy Software & Data
WP6 - Analysis Preservation & Open Data

Six work packages

Where do analysis facilities fit into LHCb?



WP2 : Analysis productions (AnaProd)

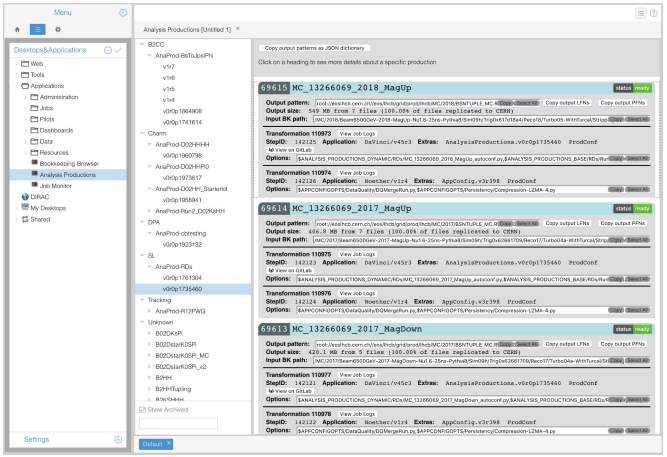
In Run 1/2 analysts created nTuples individually from data on disk using Ganga... does not scale well for Run 3

➔ Run 3 model relies on the WLCG as a main component of the default dataflow

Analysis productions are centralised ntuple producing jobs run on the WLCG with high level of automisation

Analysis productions submit nTupling jobs centrally using DIRAC transformation System (already in use for legacy data)

- Does not require analyst to babysit grid jobs
- Options tested automatically upon push to GitLab (CI).
- Job details/configuration/logs automatically preserved in LHCb bookkeeping/EOS
- Automated error interpretation/advice
- Results displayed on webpage



Using WLCG rather than other dedicated AF for first stage of (all) analyses

WP4 : R&D Innovative analysis techniques

Think tank for innovative analysis techniques and exploitation of new analysis facilities with heterogeneous computing resources (GPU/CPU/FPGA)

LHCb has very diverse range of analyses making use of different resources hence AF possibilities are vast (and complicated)

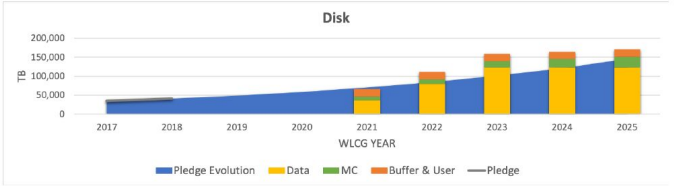
- GPU resources usage in analyses:
  - ML @HPC cluster "Marconi" Cineca Bologna: DNN for b- vs c- jet tagging
  - Zfit and likelihood inference in Zurich
  - DNN and ultra-fast simulation Florence
  - Amplitude Analyses, Aix Marseille, CNRS/IN2P3
  - Charm Analyses, Manchester
  - Amplitude Analysis Λ_b Tsinghua
  - Analysis of ϕ_s Santiago
- Quantum Computing application to HEP
  - Quantum Machine Learning for b-jet identification. Use of GPU cluster for hardware simulation arxiv.org/abs/2202.13943

Users access resources with custom code/methods

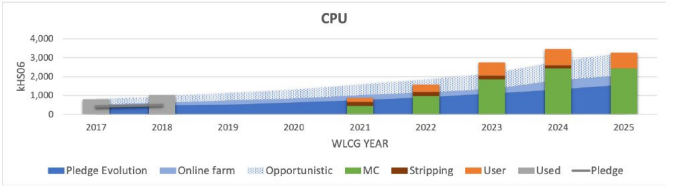
Most WLCG sites do not have GPUs - many institutes have their own resources

In Run 3 and beyond LHCb will have a GPU farm at its disposal (HLT1 processing farm) during detector downtime - we will exploit this!

In Run 3 LHCb will produce ~ 15PB of data on disk per year



Real data will dominate disk storage but simulation will dominate CPU needs - 90% of total offline CPU resources



Can we develop significant LHCb payloads to run on GPUs?

GANs to train models describing LHCb sub-detector response - GPUs speed up GAN training - *Ultra-fast simulation*

Key points

LHCb does not have a dedicated analysis facility like other LHC experiments - we are following closely developments eg. Coffea-casa, Analysis Grand Challenge...

We rely heavily on the WLCG as a main component of the default Run 3 dataflow

For further analysis analysts are largely free - encourage common solutions, packaged for reuse (e.g. lb-conda) on shareable resources (analysis preservation) - very AF friendly!

WIll have a dedicated GPU farm to use in detector downtime :)

Next stages for LHCb in AFs are

- A lot of analysis is done “in-house” using institute resources so need to canvas the community
- Collect use cases
    - What are people running and where?
    - What will this look like at the end of Run 3? - scalability?
    - Develop a LHCb “requirements document” for potential AF