LLP8 + HSF meeting notes

Eighth Long-lived Particles Community Workshop Agenda Meeting agenda

In this live document we will collect all the input and comments, try to capture the discussion and possible follow-up on the HSF session of the eighth LLP community workshop.

Intro to LLP & HSF - J. Beacham, C. Doglioni

Contributions:

Codex-b
Speaker: Vava Gligorov

Objective of CODEX-b: full integration with LHCb (including on the trigger/software side)
LHCb: triggerless readout in Run-3, all the bunch crossings are taken
CODEX-b can become another sub-detector of LHCb to simplify things: can reuse not only Gaudi but also reconstruction, physics event model…also can do joint physics analysis.

CODEX-b: 0-background experiment, reducible/irreducible backgrounds (by shield veto). Irreducible backgrounds are o(10) particles in 300/fb. So all you have to do in the trigger is reconstruct particles in CODEX-b and if you see something then you keep and reconstruct it.

Demonstrator CODEX-beta: 8m3 based on RPCs from ATLAS upgrade. No shield, but that helps getting some particles to reconstruct (smaller volume, 1% of full amount) → data rates similar
Data sent via GBT link to FPGA readout boards
Integrate data formats WIP (preliminary simulation)

CODEX-beta: 1 single FPGA, probably not using the whole of it. Trying to reconstruct tracks directly on the card? Full CODEX: 50 FPGAs, could benefit from same choices as DAQ design for Upgrade-2.

CODEX-b uses same software/integration of LHCb, possible thanks to triggerless readout. Reuse of software + Quality Assurance = reduces workload [and increases the return on investment for LHC software]

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Q: not sure there is someone from Totem here: similar?
A: Triggerless readout is what helps here. This is relatively specific to LHCb. ALICE could do something similar?
Active shield: layers of (Si?), do some tracking, put information together and do a veto. Secondary production inside the shield itself. From a DAQ/readout POV, this makes sense because it's triggerless and done in software.

FASER ("Success has a thousand fathers")

Speaker: Dave Casper

FASER: status & plans, then software reuse in terms of packages / work by others.

FASER: small experiment, 64 people from 18 institutions. Financed mostly by private foundations.
Idea: put detector along the line of sight of the collision in ATLAS. Small side tunnel used in LEP for injection, small detectors that reuses some of the Si tracker modules / LHCb ECAL models.

Physics goals: Long-lived dark photon search, TeV-scale measurement of neutrino (3 flavors).

Experiment small, but software system doesn't scale with the size of the experiment and collaboration: offline software has to do most of the things that ATLAS/CMS/LHCb have to do even though with fewer subdetectors and channels. This doesn't change the mission-critical things that the software has to do, and that's a big list.

With 10 part-time developers, hard to DYI from scratch → using the Athena ATLAS release under Apache 2.0 license (Athena relies on Gaudi framework).

Pro: knowledge transfer from ATLAS (shared developers), stable Quality Assurance framework
Con: probably too complex? Parallel development requires care.

Software: Calypso: "daughter of Athena", on top of "chipping away everything that didn't look like FASER".

Development cycle: need to be aware of the active development in ATLAS (eg multithreading, new job config, python3…) → maintain one's own branch [project] and only using 15% of the packages, then install that on cmvfs.

More details on reuse:

1. Detector description: GeoModel, now a standalone package which has been adapted to FASER. New paradigm of using plugins can use FASER as proof of concept test. Can also load other volume trees (eg LHCb ECAL)
2. Event generation: more complex than ATLAS, eg. neutrino scattering simulation in collider experiment.
    a. This topic has its own generator (GENIE).
3. Tracking: ACTS (common, experiment-independent software), will have more developments that may feed back into it.

Take-home points:

- Standing on the shoulder of giants for software has been successful for a small experiment with sizable software needs

Q: Why ATLAS software?
A: software experience as members of ATLAS, using one of the subdetectors, detector description & digitization comes for free.

Q [CD]: grid jobs?
A: Not required. Small. Paid by others.
Graeme: if you're getting conditions from cmvfs, you can bolt on Dirac/Panda and run on the grid.
James: how challenging would this be to take those jobs on lxplus/grid?
A: we are granted a certain amount of batch resources. We worked through the numbers and it fits. Grid may not be justified yet.

Q: software authorship / attribution?
A: discussed a bit, doing whatever ATLAS feels appropriate. Not very demanding statement on git repo to refer to publications, citing those. We will also acknowledge ATLAS and LHCb for hardware and software

Graeme Stewart: conditions and databases that you mention, one doesn't want a lot of complexity if you can get away from it, but you don't want to build "one solution will ever work". Do you foresee that jobs could be ran anywhere with minimal infrastructure, or are you running the jobs at CERN?
A: the idea is to distribute the databases (SQLite) together with the software via cmvfs.
Graeme: good idea.
A: IT division not too happy to use Coral and COOL → go talk to ATLAS, we will change when they do.

LDMX
Speaker: Geoffrey Mullier

Lightweight Distributed Computing System

LDMX: accelerator-based direct dark matter detection experiment, US/Sweden.
Will be installed at SLAC using e- beam.
Backgrounds are challenging, requires large datasets.

LDMX software:

- Framework in C++, using G4, Wrapper for configuration in Python
- What does it do: 1) simulation 2) reconstruction 3) analysis
- What does it need: dataset cataloguing, computing resources, re-simulation

Computing infrastructure should be reliable and scalable (small team and limited time)

Solution: don't reinvent the wheel, use ARC and Rucio.

- Extensive documentation and use base
- Integration & setup easy
- Can be used for small/medium scale projects as it's experiment-independent

Q [Dave Casper]: why is it different from the grid?

A: we didn't have a "claim" to the grid. Everyone has resources, but people don't necessarily link them - this is connecting computing clusters in the different
Q: do you have data in certain places, or…
A: each site has different requirements, different cache or computing requirements. Everything is copied to SLAC servers for now, but each individual site can form local copies.

CMS
Speaker: Sven Dildick

Focusing on a hardware solution for hadronic shower trigger in CMS in Run-3.
"Hadronic shower trigger team" → displaced jets

Physics goal: LLPs decaying to "hadronic" fermions.

- Displaced trigger usually relies on high jet pT / high HT and is sensitive to heavier LLPs.
- Need for triggers for low LLP mass and large LLP displacement

"Inspiration" from ATLAS: ROI trigger with muon hits at L1 w/dedicated reconstruction:

- 2 muon vertices, 1 muon vertex + MET
- ATLAS is using this since Run-2 and has better reach for LLP masses between 10 and 500 GeV

What can CMS do? It has more iron, pi-to-mu misidentification rate is 0.1% so we have high-purity results. A LLP may just leave hits with no tracks.
Idea to have a L1 trigger for hadronic showers in the CSC because there is more information → more bits that can be added to the data stream, can use bandwidth to identify high-multiplicity events.

Considerations needed for the decision:

- There is 1 bit/chamber/BX
- Latency is extremely tight
- FPGAs are not too new

→ breakthrough: new encoding scheme allows to have 4 bits/chamber/BX for more information (compression also needed).

This will give 10x / 20x improvement in sensitivity.

Q [James]: sensitivity studies planned to be public, or we have to wait?
A: benchmark studies on rate & efficiencies, not yet clear on exclusion plot.
[sxie?] we will release a result for Moriond and then extrapolate from there.