Streamlining the ATLAS Tracking Code

By Richard Cunningham
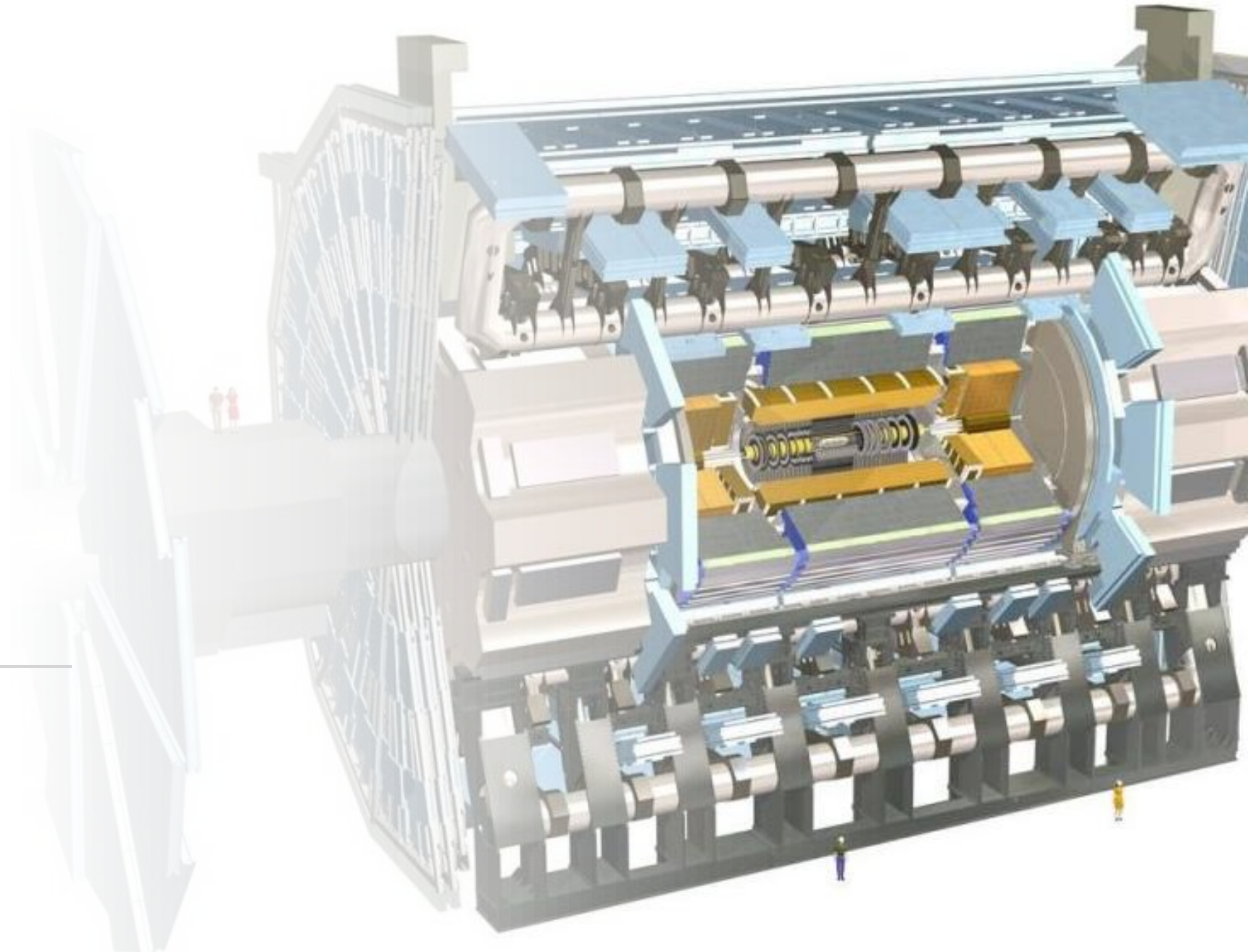
Contents

CERN

- Established in 1954 and based near Geneva, CERN started as a scientific collaboration between 12 member states in Western Europe, which has since expanded to 23 member states, with various associate members and observers across the globe.

- CERN is host to various experiments in Nuclear and Particle Physics, of note is the Large Hadron Collider (LHC).

The Large Hadron Collider
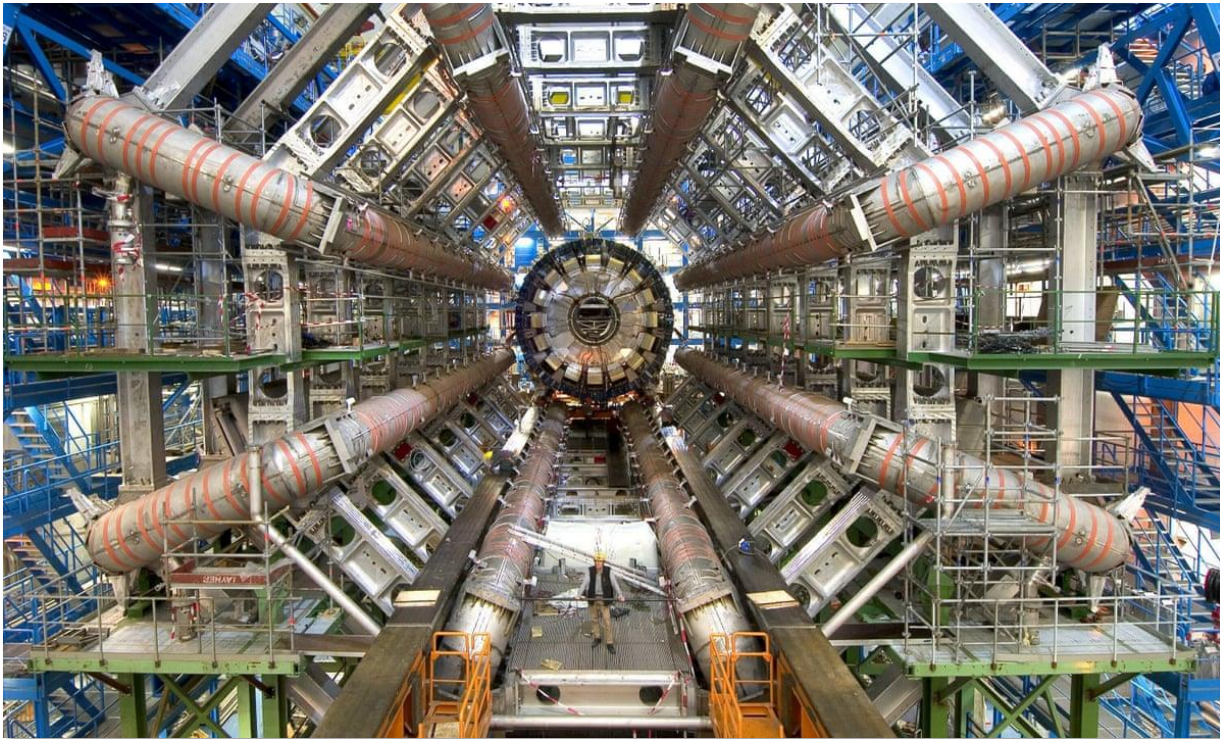
- The LHC operates by accelerating particle beams (packets of charged particles like Protons) in a ring using superconducting magnets to high energies, before colliding each beam with one another. The LHC has reached a total collision energy of 13.6 TeV.

- Some findings of the LHC are the detection of the Higgs Boson and various precision measurements of the Standard Model.

ATLAS
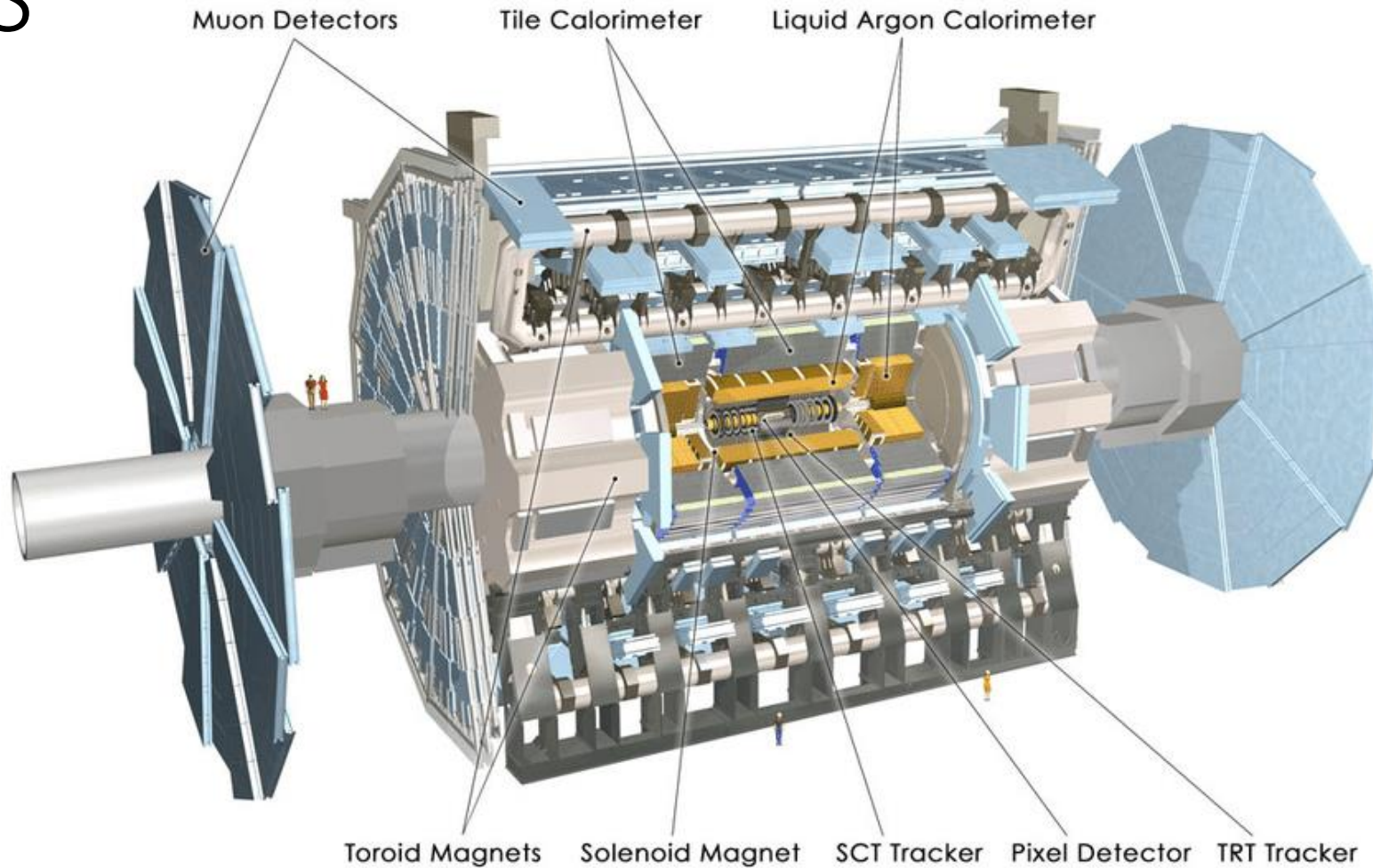
# Particle Tracks
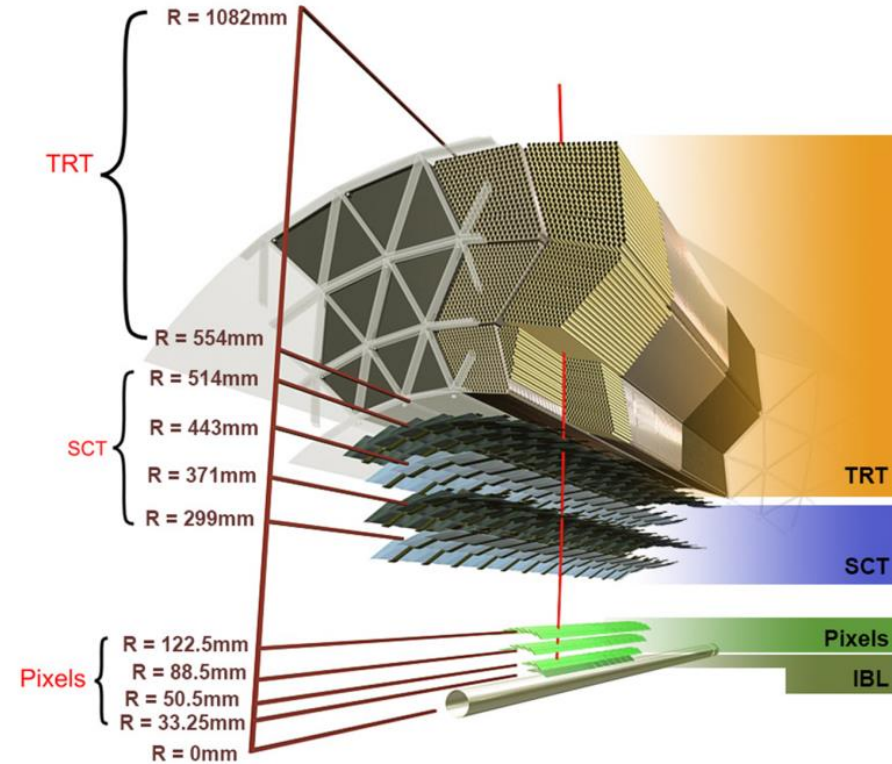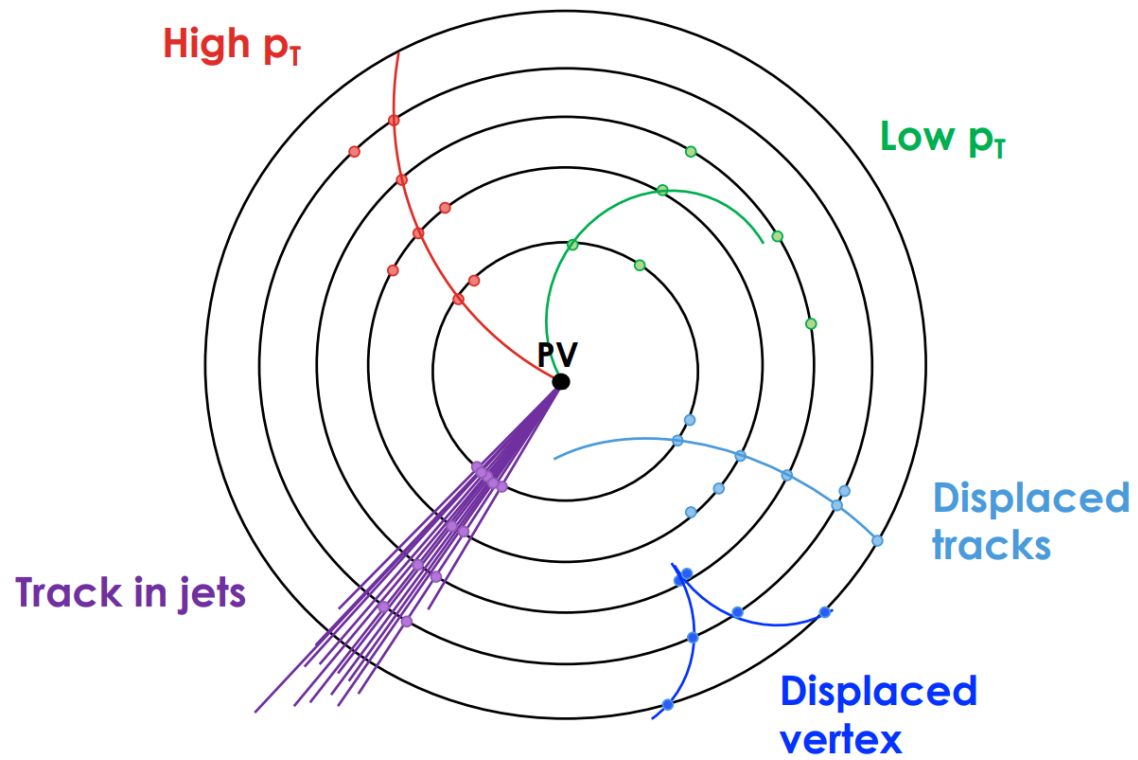
Trigger Overview

Fast Track Finder and Motivation

FastTrackFinder (FTF) is an algorithm which reconstructs medium quality tracks.

TrigHitDVHypoAlg is an algorithm in another file which determines if there is a displaced vertex in the event.

- FTF contains and calls a function called findHitDV, which fills three containers of spacepoints, seeds and tracks.
- HitDVHypoAlg determines if these containers to determine if an event has a displaced vertex.

Spacepoints

FTF

Tracks

findHitDV

Containers (written out to StoreGate)

HitDVHypoAlg (returns a y/n)
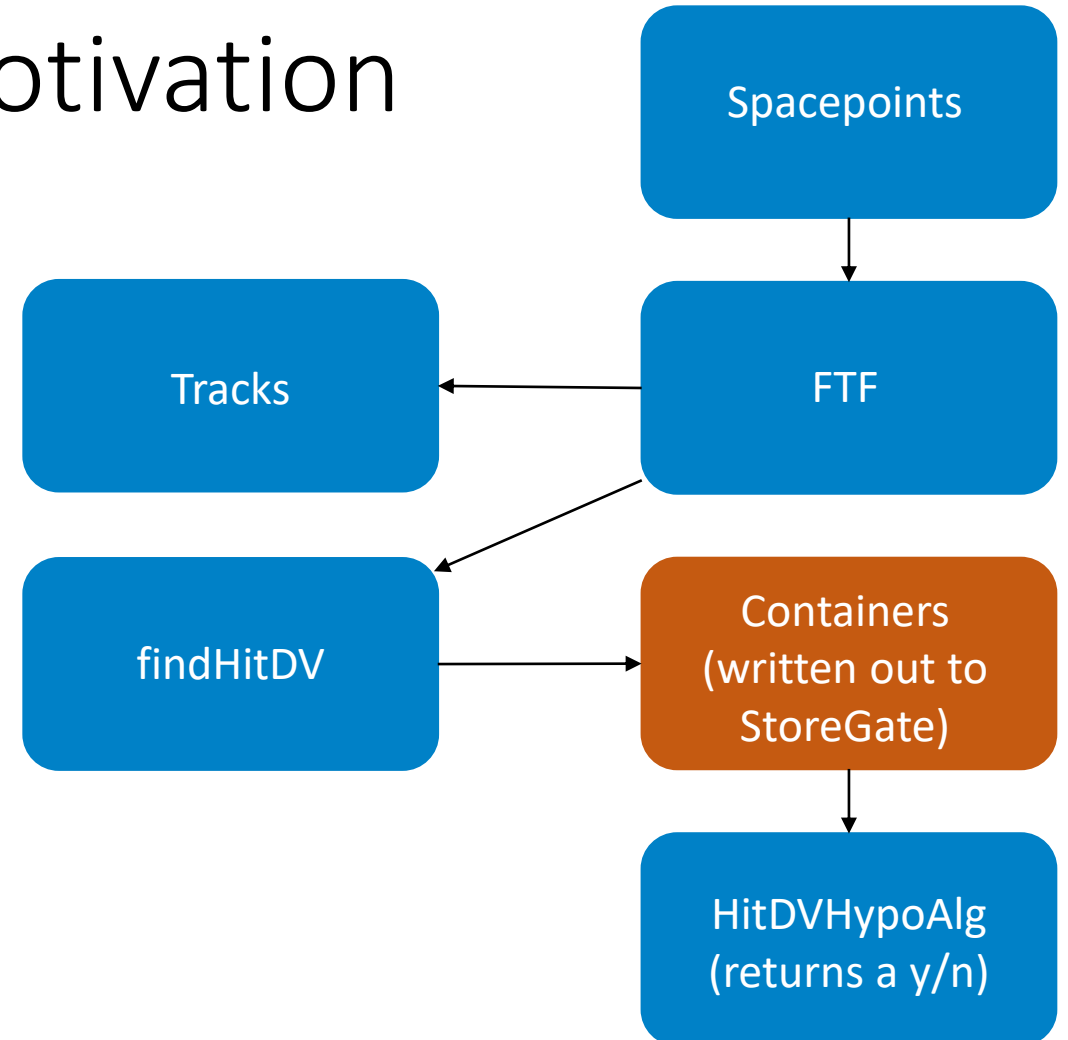
Fast Track Finder and Motivation

findHitDV processing could be moved out of FTF, instead being preformed in TrigHitDVHypoAlg.

- This would improve the readability of FTF (more to come out than just findHitDV!)

- This would remove the need to create these containers and to pass them around.

- Furthermore, since findHitDV is called now only when TrigHitDVHypoAlg is called (and TrigHitDVHypoAlg is not called as often as findHitDV) there are more time savings.
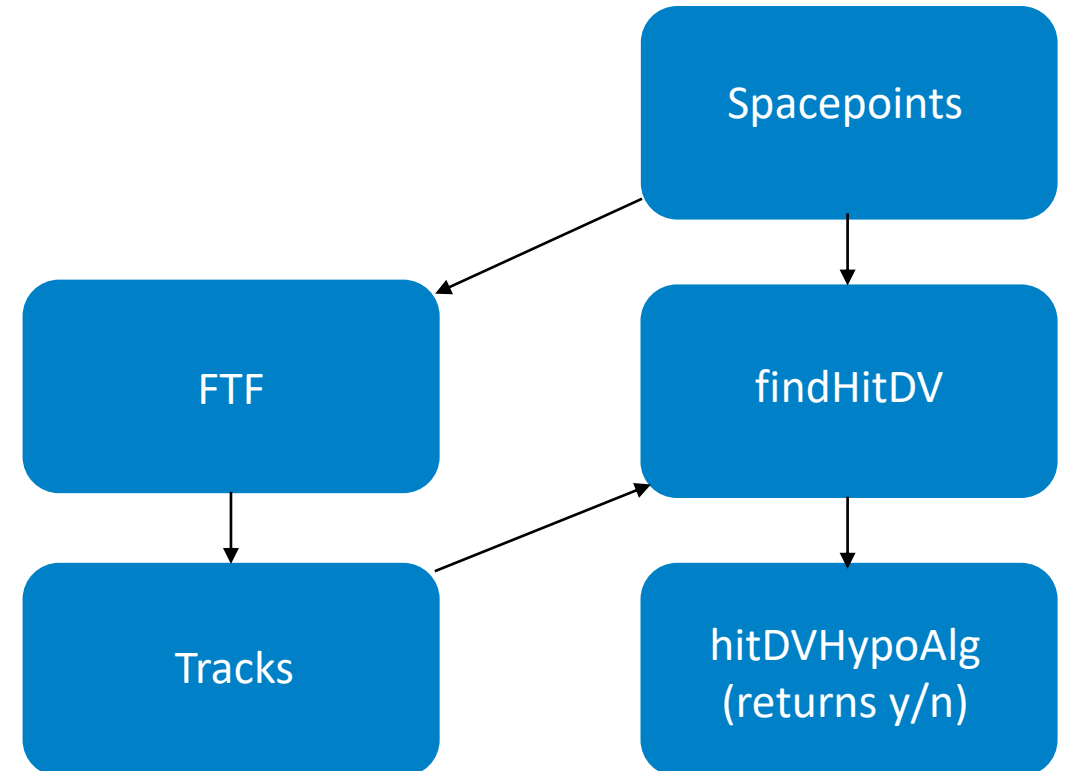
Project Results

By the start of Monday this week, findHitDV was successfully moved across into TrigHitDVHypoAlg.

- Success was verified by tests on ATLAS data.
- The draft merge request can be found on Gitlab!
- https://gitlab.cern.ch/atlas/athena/-/merge_requests/64893

| C++ | TrigHitDVHypoAlg.cxx | +663 -38 |
| C++ | TrigFastTrackFinder.cxx | +0 -528 |

Some Numbers…

Name	Alg Total Time (%)
TrigFastTrackFinder_jet	31.83
HitDV	1.405

ATLAS trigger running without any of the project changes.

Run	Time (ms)
Reference	545.513 +/- 27.926
Test	516.707 +/- 27.76

Running with the projects changes.

- Using data from both tables, 31.83*516.707/545.513 = 1% faster.

- Overall, findHitDV is called five times less often, resulting in the improvement.

Next Steps for the Project

The changes to FTF and TrigHitDVHypoAlg need to be circulated across the collaboration and approved.

- Any requests from other members will need to be considered before the move can be merged.
- Code should be rewritten to remove the intermediate containers and to include further optimisations.
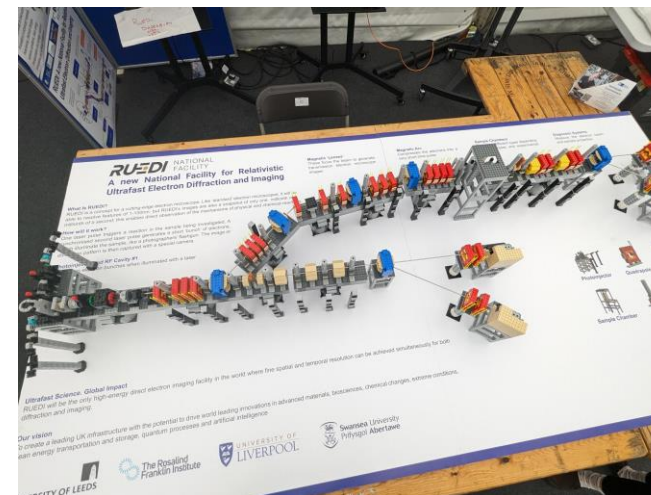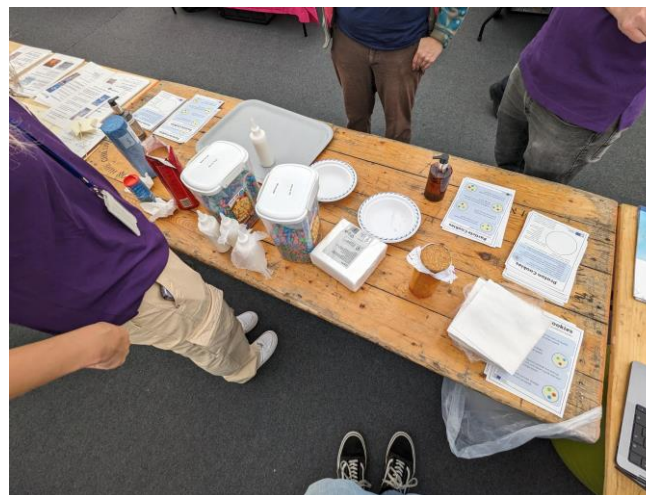
For this final week, various utility functions are to be moved out of TrigHitDVHypoAlg, further improving readability.

My Experience

- I came into this project without much C++ nor Linux experience. Learning how to use the language of each was extremely valuable (and fun!).
- Furthermore, have learnt how to work in a modern software development environment, using Gitlab to present code, manage changes and to take feedback from various members of the collaboration.
- From a physics perspective, learnt a great deal about ATLAS and the LHC, as well as how modern particle physics research is preformed. Have been exposed to the inner workings of the software trigger system.

Daresbury

- Daresbury open day Viki and I attended with Stewart.

- Over 5000 attendees!

- Ran a proton cookies stall.

- Lots to see!

Thank You for Listening.