L2IT

J. Stark

ATLAS France CAF-User meeting
Lyon, 28th November 2024

Team by the end of 2024

Composition of the team

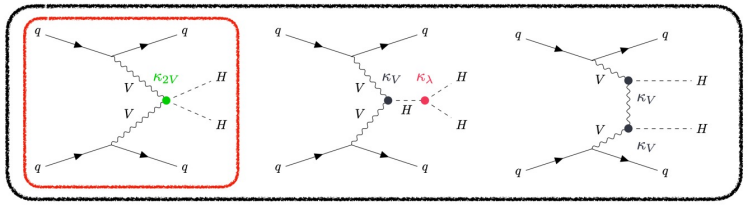
1 EC, 2 CNRS, 2 post-docs, 4 PhD students
2 (2 FTE) engineers in scientific computing

Angela Burger will join us on January 1st.

Analyses

VBS same-sign WW: Measurement and interpretation of same-sign *W* boson pair production in association with two jets in *pp* collisions at $\sqrt{s}$ = 13 TeV

VBS VVh Run 2+3: A complementary channel to study Higgs self-coupling (hhh) and quartic coupling (VVhh). Competitive sensitivity with di-Higgs analyses expected.



$H \to Za \to ll\gamma\gamma$ Run 2+3

Di-Higgs non-resonant $HH \to \gamma\gamma bb$ Run 2+3 / Di-Higgs non-resonant $HH \to bb\tau\tau$ Run 2+3

Di-Higgs non-resonant $HH \to \gamma\gamma bb$ Matrix Element Method

Events (LO or NLO)

Total cross section

Transfer function

$$L^P_{\text{process}}(\mathbf{h} \mid \mathbf{x}^i)d\mathbf{x}^i = \frac{(2\pi)^4}{\sigma^{obs}_P(pp \to F).s} \int_y \int_{q_1,q_2} \sum_{a_1,a_2} f_{a_1}(q_1) f_{a_2}(q_2). \frac{|\mathcal{M}_P(a_1 a_2 \to \mathbf{y}; \mathbf{h})|^2}{q_1 q_2} \cdot W(\mathbf{x}^i, \mathbf{y}) \delta(a_1 + a_2 - \sum_j^n y_j) \mathrm{d}q_1 \mathrm{d}q_2 \mathrm{d}y^{4n}$$

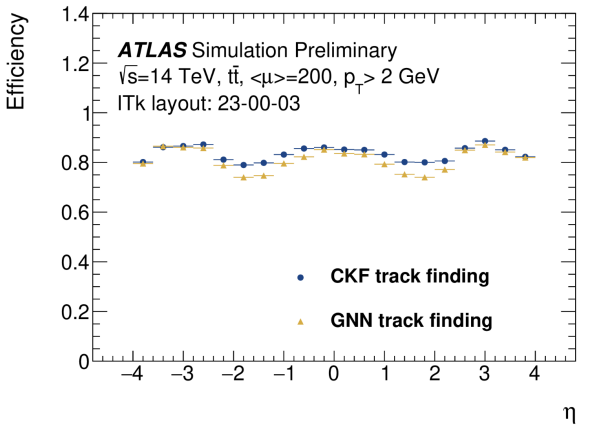
Matrix element (LO or NLO)

S&C involvement 2024

Involvement in Software

- git merge request review (class 2 shifts)

- GNN4ITk tracking demonstrator:
  - Sylvain Caillou, Christophe Collard, Warren Guérin, Heberth Torres, Alexis Vallier, Jan Stark
  - coordination au sein de la collaboration ATLAS : JS avec Paolo Calafiura (LBL Berkeley)
  - To be sure: this is not “ACTS”, this is a demonstrator of the ATLAS collaboration



Clickable link
to detailed report at
ATLAS S&C week

The GNN4ITk demonstrator

GNN4ITk team

Jared Burleson, Jackson Burzynski, Sylvain Caillou, Paolo Calafiura, Jay Chan, Christophe Collard, Steven Farrell, Benjamin Huth, Xiangyang Ju, Alina Lazar, Ryan Liu, Tuan Minh Pham, Daniel Murnane, Mark Neubauer, Santosh Parajuli, Charline Rougier, Jan Stark, Heberth Torres and Alexis Vallier

Upgrade Software and Reconstruction
at the *Software & Computing week* in Oslo, June 6th 2024

Involvement in Upgrade Tracking

- subgroup coordinator since October 2023: Alexis Vallier
- recently completed QTs: Matthias Tartarin, Anna Tegetmeier
- ongoing QTs: Alexandro Martone, Warren Guérin

Un grand merci aux collègues au CC !

(Parenthèse sur les services et équipements)

- Il n'y a pas de services ni d'équipements lourds (autres que les bureaux, PC portables, imprimante multifonctions, routeur [connexion à RENATER]) au L2IT.

- Ceci est possible grâce aux nombreux services et infrastructures que nous fournit le Centre de Calcul de l'IN2P3 (CC-IN2P3) :
  - Calcul et stockage lourd
  - ferme GPU et plateforme expérimentale
  - services collaboratifs (messagerie, « box », …)
  - routeur piloté par les experts au CC (connexion RENATER)
  - …

Vu dans l'une de nos publications récentes

Dark siren cosmology with binary black holes in the era of third-generation gravitational wave detectors

Niccolò Muttoni [1,2,*] Danny Laghi [1] Nicola Tamanini [1] Sylvain Marsat [1] and David Izquierdo-Villalba [3,4]

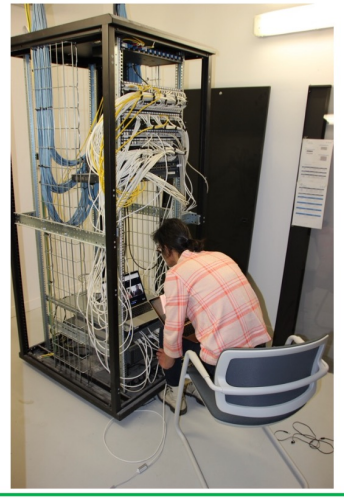
[1] *Laboratoire des 2 Infinis - Toulouse (L2IT-IN2P3), Université de Toulouse, CNRS, UPS, F-31062 Toulouse Cedex 9, France*
[2] *Département de Physique Théorique and Gravitational Wave Science Center, Université de Genève, 24 quai Ernest Ansermet, 1211 Genève 4, Switzerland*
[3] *Department of Physics G. Occhialini, University of Milano - Bicocca, Piazza della Scienza 3, 20126 Milano, Italy*
[4] *INFN, Sezione di Milano-Bicocca, Piazza della Scienza 3, 20126 Milano, Italy*

(Dated: March 21, 2023)

ACKNOWLEDGMENTS

ERC Consolidator Grant "Binary Massive Black Hole Astrophysics" (B Massive, Grant Agreement: 818691) and from INFN H45J18000450006. Most of the numerical analyses have been performed at the IN2P3 computing centre (CC-IN2P3) in Lyon (Villeurbanne), which we thank for assistance and computational resources.

L'une des très rares interventions physiques sur notre routeur par un membre du L2IT (25 avril 2023).
Le gros du travail est fait par le CC à distance.



EAOM 2024-2025 **Laboratoire des 2 Infinis – Toulouse (L2IT)** 23/04/2024 33

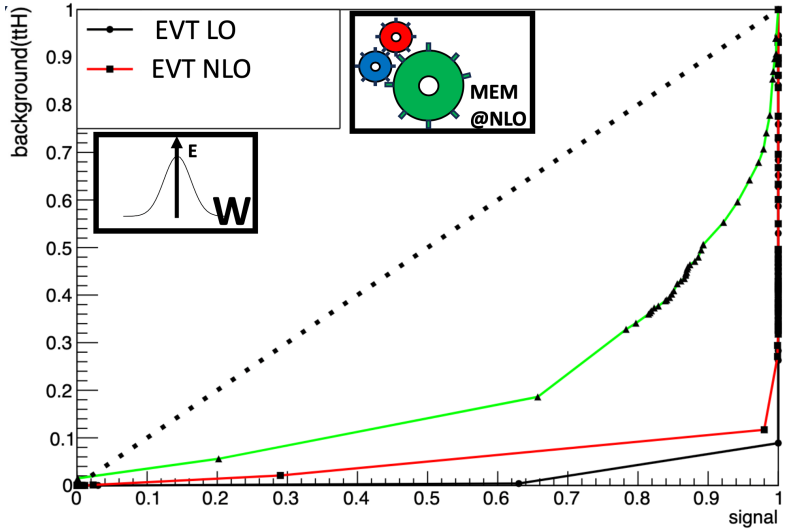
Transparent montré au dernier Entretien Annuel Objectifs Moyens (EAOM) du L2IT

Analyses and needs for 2024

Di-Higgs and di-boson scattering, polarisation

- Expect mostly “business as in 2024”, with the notable exception of the next item
- Matthias finally has a working implementation of the MEM at NLO for HH. Production running is ongoing.

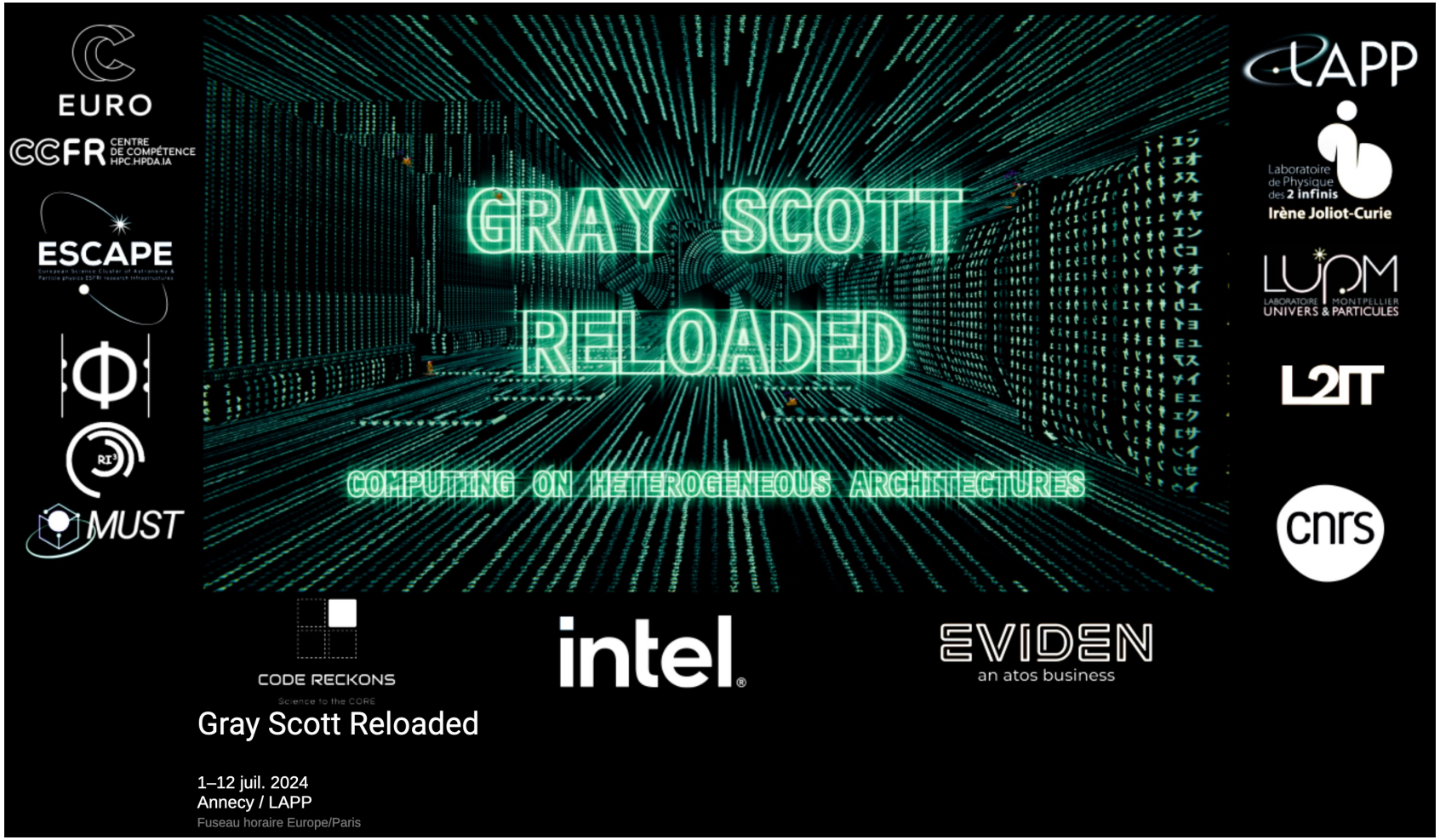
  Expect significant spike in CPU usage during first half of 2025. [Twice the current load ??]



GNN-based tracking

Expect similar, significant needs (storage, GPU) as in 2024

A Participation in *Gray Scott Reloaded*



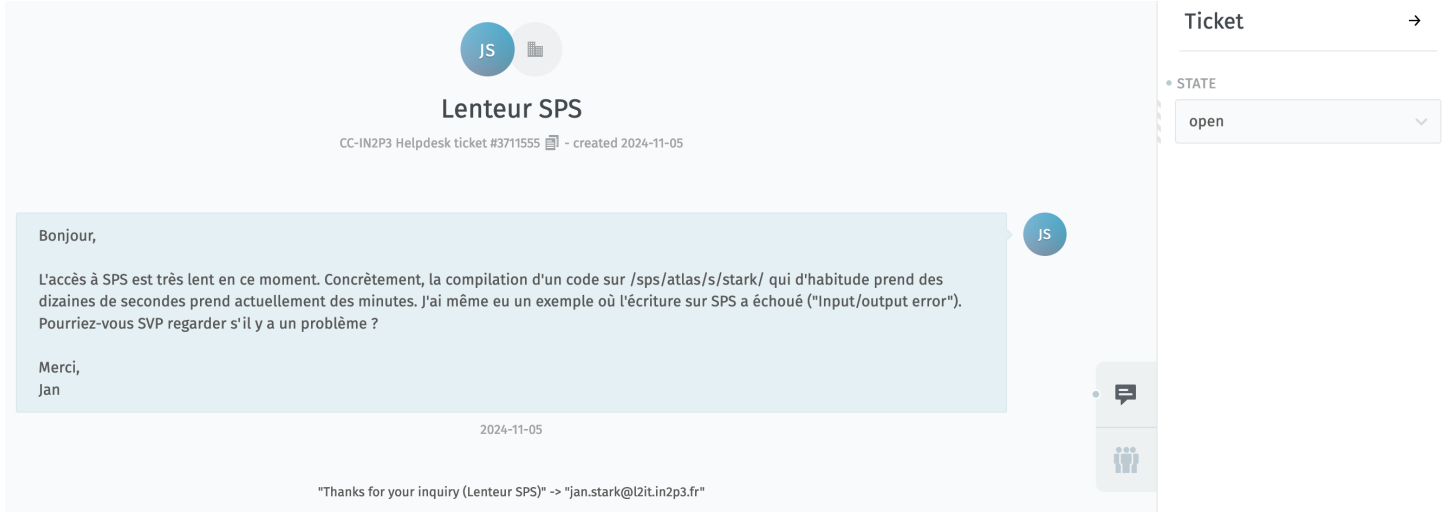
Sites Satellites

Un Site Satellite retransmet en direct la formation de la Gray Scott School auprès de son propre public (employés, public externe, étudiants, etc).

Premiers Sites Satellites de l'école :

- L2IT, CALMIP, CERFACS, ONERA et CUTIS (Toulouse)
- CPPM (Marseille)
- CRIANN (Rouen)
- ROMEO (Reims)
- Maison de la Simulation (IDF)
- Mines Paris - PSL - Cemef (Sophia Antipolis)
- ISDM (Montpellier)
- UTC : Université de technologie de Compiègne (Compiègne)
- Université de Namur (Belgique)
- College of computing de l'UM6P (Maroc)
- CINERI : Cyber Infrastructure nationale pour l'Enseignement supérieur, la Recherche et l'innovation (Sénégal)
- GLICID (Nantes)

“Problem of the moment”



“Problem of the moment”

```
[stark@cca015 RaceAthena]$ pwd
/pbs/throng/l2it/stark/RaceAthena
[stark@cca015 RaceAthena]$ date ; git clone https://:@gitlab.cern.ch:8443/jstark/athena.git athena-jstark ; date
Wed Nov 27 05:40:24 PM CET 2024
Cloning into 'athena-jstark'...
remote: Enumerating objects: 1429504, done.
remote: Counting objects: 100% (1429504/1429504), done.
remote: Compressing objects: 100% (348008/348008), done.
remote: Total 1429504 (delta 1077174), reused 1415331 (delta 1063054), pack-reused 0 (from 0)
Receiving objects: 100% (1429504/1429504), 418.48 MiB | 29.05 MiB/s, done.
Resolving deltas: 100% (1077174/1077174), done.
Updating files: 100% (59765/59765), done.
Wed Nov 27 05:44:07 PM CET 2024
[stark@cca015 RaceAthena]$
```

Clone of athena to /pbs/throng at CC-IN2P3

Total time (wall-clock): <4 minutes

```
[stark@cca015 RaceAthena]$ mkdir /sps/atlas/s/stark/RaceAthena
[stark@cca015 RaceAthena]$ cd /sps/atlas/s/stark/RaceAthena
[stark@cca015 RaceAthena]$ pwd
/sps/atlas/s/stark/RaceAthena
[stark@cca015 RaceAthena]$ date ; git clone https://:@gitlab.cern.ch:8443/jstark/athena.git athena-jstark ; date
Wed Nov 27 06:07:33 PM CET 2024
Cloning into 'athena-jstark'...
remote: Enumerating objects: 1429504, done.
remote: Counting objects: 100% (1429504/1429504), done.
remote: Compressing objects: 100% (348008/348008), done.
remote: Total 1429504 (delta 1077174), reused 1415331 (delta 1063054), pack-reused 0 (from 0)
Receiving objects: 100% (1429504/1429504), 418.48 MiB | 31.03 MiB/s, done.
Resolving deltas: 100% (1077174/1077174), done.
Updating files:  12% (7553/59765)
```

Clone of athena to /sps at CC-IN2P3

Test aborted at 19h04, i.e. after roughly one hour

Additional material

QT Matthias Tartarin

Summary

Qualification status:

Qualification Project Period	2022-11-21	2023-11-29
	100%	
Qualified Author Period	2023-11-29	N/A
	3.82%	

Project info:

Project Description	The ACTS Kalman Filter (KF) is a new implementation of the Kalman fit formalism. Its performance has been tested inside Athena by refitting standard ATLAS tracks and comparing the resulting tracks to the original one. The long-term goal is to move the ATLAS track fit completely to ACTS, paramount for the long-term maintainability of the ATLAS tracking code. A standalone track fit in ATLAS begins from uncalibrated measurements, which are calibrated by a detector-subsystem-aware piece of code. The ACTS KF has an extension point allowing to configure and experiment-aware calibrator function, that can be used to invoke e.g. the RIO_OnTrackCreator. As a first step, code was added to convert the input tracks from the existing Athena format into a format that ACTS understand. Specifically, this includes converting the starting track parameters, as well as the calibrated measurements from the ATLAS format into the ACTS format for fitting. This conversion handles the measurement position and local covariance. In addition, the reference surface of the measurement is translated into its equivalent ACTS version. These conversions are implemented in ActsATLASConverterTool. This refit operates entirely on the already calibrated measurements. The refitting procedure itself is implemented in ActsReFitterAlg. This algorithm can be scheduled at the end of a reconstruction job to run refitting on all output Trk::Track s of the standard reconstruction. The resulting refitted tracks in ACTS format are also converted into Trk::Track (which is only done for validation purposes but will be removed in the future), to allow a 1:1 comparison to Athena. By converting them into xAOD::TrackParticles, like the standard tracking output, the performance can be compared between the Athena and ACTS fit. The refitting procedure has been tested in the past using the current Inner Detector silicon geometry. Various improvements were added to the ACTS KF to improve the performance comparisons, and remaining differences are believed to be due to remaining differences in the description of passive material. The configuration and conversion algorithms have been updated to run on the ITk geometry. This included the addition of a dedicated method to handle the ITk Strip endcap modules, which have a particular shape. This QT focusses on improving the fitting capabilities using the ACTS KF. The overall goal is to demonstrate the ITk track-fitting inside Athena using ACTS. As a first step, the existing refitting configuration will be executed with the ITk geometry and samples. Results of calibrated measurement refits will be compared to the original tracks. If significant discrepancies are observed, the qualifier will work with experts to improve the KF, and help to update the passive material description used by ACTS. When reasonable agreement is achieved, the next step is to update the ActsKalmanFitter tool wrapping the KF to allow injecting the RIO_OnTrackCreator as a calibrator. To test this, the same refitting procedure can be used, but instead of refitting the calibrated measurements directly, the associated uncalibrated measurements will be used. This demonstrates the fitting and the calibration code. As a final step, once the calibration hook is working, the ACTS KF will be used to execute fits on smeared truth hits directly, in order to establish its performance as a standalone track fitter until the deployment of the ACTS pattern recognition is complete. Depending on the initial step of the project, the full scope might be larger than what is expected for a QP. All work carried out after satisfying the QT can count as OTP. Goals: Establish ACTS KF refitting performance on ITk from ROTs, Implement / wrap ROT creators into the ACTS calibrator interface, Test track refitting from PRDs and compare to ROT refit and original track, Test fitting smeared truth hits directly and compare to truth properties, write an ATLAS note. OTP task 530211 subtask 553495
Local Supervisor	**VALLIER, Alexis**
Technical Supervisor	**GESSINGER, Paul**
Proposed Start Date	2022-11-21

QT Anna Tegetmeier

Summary

Qualification status:

Qualification Project Period	2023-07-05	2024-10-07
	100%	
Qualified Author Period	2024-10-07	N/A
	0.55%	

Project info:

Project Description	The current (Run-3) ATLAS Inner tracking chain includes a dedicated secondary pass to recover performance for particles such as electrons originating from photon conversions. This pass uses hits not already assigned to tracks in previous passes and only looks for tracks in "Regions of Interest" (RoI) around deposits in the electromagnetic calorimeter. In the current detector, the track finding proceeds outside-in from the TRT, hence it is colloquially known as the "backtracking" pass. Some performance studies for such RoI-seeded tracking were performed in the context of Branch 21.9, but nothing has been done yet on master/main/Rel.24. This project will be run jointly with the E/Gamma group to assess what are the performance requirement for this tracking pass in the context of the ITk. Since the TRT will not be present in Run 4, there is ample opportunity to rethink the method outside of the backtracking paradigm. Since full electron & photon reconstruction has not been completely validated for Run 4, this QP will focus on characterizing & optimizing the track selection efficiency. Since computing performance is a known limiting factor, it will also be taken into account. Objectives - Setup to use the current implementation of the method in the main development branch, taking into account the conclusion of the studies done in 21.9 - Characterize the performance of the method to figure out how electron track efficiency is lost and/or track quality is degraded - Improve the method in the context of the ITk - Document work in Internal ATLAS note on CDS Methods - As stated above, evaluation will focus on tracking efficiency & computing performance - Concrete workflow to be discussed with E/gamma in joint meeting once QP starts
Local Supervisor	**MANJARRES, Joany**
Technical Supervisor	**VARNI, Carlo**
Proposed Start Date	2023-07-05

QT Alexandro Martone

Summary

Qualification status:

Qualification Project Period	2024-04-05	2025-04-05

64.66%

Project info:

Project Description	The current (Run-3) ATLAS Inner tracking chain includes a dedicated secondary pass to recover performance for particles such as electrons originating from photon conversions. This pass uses hits not already assigned to tracks in previous passes and only looks for tracks in "Regions of Interest" (RoI) around deposits in the electromagnetic calorimeter. In the current detector, the track finding proceeds outside-in from the TRT, hence it is colloquially known as the "backtracking" pass. Some work is already ongoing to characterize and optimize the track selection efficiency for this ROI tracking pass with ITk in the Athena "legacy" chain (A. Tegetmeier QP). Once this work is done, this will establish the baseline of ROI secondary tracking pass performances. In the effort to upgrade all tracking-related algorithms to ACTS-based code, we need now to use the ACTS ROI tracking pass. Therefore this qualification project aims to implement a configuration in Athena to run the ACTS ROI tracking pass (instead of the Athena legacy one) and evaluates its performance. Objectives - Setup in Athena a configuration to be able to run the ACTS ROI tracking pass, including modifications to the Data prep EDM converters to select objects not used in previous passes. To have a fair comparison with the full legacy chain, we should run the ROI secondary pass from Athena main or ACTS on the same inputs - Compare the Athena legacy and the ACTS ROI tracking passes seeding performances. - Compare the Athena legacy and the ACTS ROI tracking passes CKF performances. The computing performance will also be taken into account in the evaluations.
Local Supervisor	**MANJARRES, Joany**
Technical Supervisor	**VARNI, Carlo**
Proposed Start Date	2024-04-05

QT Warren Guérin

Summary

Qualification status:

Qualification Project Period	2024-10-11	2025-10-11
	12.88%	

Project info:

Project Description	The ITk tracking performances have been already extensively studied with simulations including a detector in ideal conditions [1]. The robustness of the tracking performance with non-ideal detector conditions remains to be demonstrated, both for the legacy CKF tracking chain and the GNN tracking chain currently under development [2,3]. [1] https://cds.cern.ch/record/2902371 [2] https://cds.cern.ch/record/2882507 [3] https://cds.cern.ch/record/2910663 The aims of this Qualification Project are: 1. Evaluate the tracking performance with non-ideal detector conditions, defining an optimistic and pessimistic scenario of detector conditions. 2. Investigate where the potential performance drop comes from for the GNN The performance evaluation will be performed using the standard IDPVM package.
Local Supervisor	**VALLIER, Alexis**
Technical Supervisor	**VARNI, Carlo**
Proposed Start Date	2024-10-11