L2IT

J. Stark

ATLAS France CAF-User meeting
Lyon, 21st November 20234

Team by 01/01/24

Composition of the team

3 (~2,4 research FTE) physicists with permanent position / 2 post-docs (2 FTE) / 2 PhD students (2 FTE)
1 additional PhD student starting in February 2024 (CPJ)

2 (2 FTE) engineers in scientific computing

Currently have a postdoc opening

Involvement in Upgrade Tracking

- performance studies: Charline Rougier, Alexis Vallier
- subgroup coordinator since October 2023: Alexis Vallier
- qualification task in the process of completion: Matthias Tartarin
- ongoing qualification task: Anna Tegetmeier

Team by 01/01/24

Involvement in Software

- git merge request review (class 2 shifts)

- GNN tracking demonstrator:
  - Sylvain Caillou, Christophe Collard, 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

Please spread the word

Post-doctoral researcher on deep learning methods for the reconstruction and analysis of data from the ATLAS experiment at the LHC

L2IT, Toulouse • Europe

hep-ex cs PostDoc • Experiments: CERN-LHC-ATLAS

Deadline on Nov 30, 2023

Job description:
The Particle Physics group at *Laboratoire des 2 Infinis – Toulouse* (L2IT) invites applications for a postdoctoral contract by colleagues with a PhD in particle physics or in computer science with a strong specialisation in machine learning. The successful candidate will join our group to work on the development of deep learning methods for the reconstruction and/or the analysis of data from the ATLAS experiment.

The L2IT team plays a leading role within the ATLAS collaboration in the reconstruction of charged particle tracks using deep geometric learning (GDL). The person joining us can contribute to this effort, for example by applying GDL to signatures not considered in the existing studies (electrons or tracks produced far away from the centre of the detector). Other applications of machine learning for the reconstruction or the analysis of ATLAS data are possible, depending on the candidate's experience and motivation.

L2IT is a laboratory created in 2020 to conduct research in fundamental physics with new numerical and theoretical approaches to data analysis. The laboratory's research focuses on particle physics, gravitational waves and the equation of state of nuclear matter, and is supported by the concurrent development of data science and analysis methodologies. L2IT is a joint research unit of CNRS/IN2P3 and *Université Toulouse III - Paul Sabatier*. The L2IT Particle Physics team contributes to understanding the dynamics of the scalar sector of the Standard Model through studies of the Higgs boson and of the polarisation of vector bosons. It contributes to the development of data reconstruction software for the new tracker (ITk) that the ATLAS collaboration will install for the high-luminosity phase of the LHC. The successful candidate will work in close collaboration with other members of the Particle Physics team, and with members of the Computing, Algorithms and Data team at L2IT.

The position is for two years, and a starting date as early as December 1st, 2023 is possible. The position is based in Toulouse, with the possibility to travel to CERN as needed. Applicants must hold a Ph.D. degree obtained less than three years before the start date at L2IT.

Candidates should submit a curriculum vitae, a publication list and a statement of their research interests, and should arrange to have three letters of reference submitted on their behalf.

Applications must be made via the *Portail Emploi* website (https://emploi.cnrs.fr/Offres/CDD/UMR5033-JANSTA-003/Default.aspx?lang=EN). Inquiries and letters of reference should be sent to Jan Stark <jan.stark@l2it.in2p3.fr>. The position will remain open until filled. To receive full consideration, applications should be submitted by November 30th, 2023.

Analyses and needs for 2024

Di-Higgs and di-boson polarisation

- SH -> bbyy is finishing (-> publication)
- Anna's polarisation analysis is taking off. So far minimal resource usage (generator-level MC), expect analysis of Run 3 PhysLite samples in 2024.
- Matthias' studies of HH using the MEM at NLO show great conceptual progress. Moving on to validation phase. Expect significant spike in CPU usage in very early 2024; a bit like Florent Eble's studies in 2018.

Queue de distribution : p_T(Z->ll)

Non-trivial amount of disk space that cannot be freed yet (but don't expect any increase)

Analysis is over, but needs to be included in an HDR

GNN-based tracking

Expect similar, significant, needs (storage, GPU) as in 2023

Un grand merci à nos collègues au CC

Proceedings of the CTD 2023
PROC-CTD2023-18
17th November 2023

Physics Performance of the ATLAS GNN4ITk Track Reconstruction Chain

Jared Burleson[1], Sylvain Caillou[2], Paolo Calafiura[3], Jay Chan[3], Christophe Collard[2], Xiangyang Ju[3], Daniel Murnane[3], Mark Neubauer[1], Minh-Tuan Pham[4], Charline Rougier[2], Jan Stark[2], Heberth Torres[2], Alexis Vallier[2].

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[2]*Laboratoire des 2 Infinis – Toulouse, Univ. Paul Sabatier, CNRS/IN2P3, Toulouse, France;*
[3]*Scientific Data Division, Lawrence Berkeley National Laboratory, Berkeley CA, USA;*
[4]*Department of Physics, University of Wisconsin, Madison WI, USA.*

On behalf of the ATLAS Collaboration

ABSTRACT

Graph-based techniques and graph neural networks (GNNs) in particular are a promising solution for particle track reconstruction at the HL-LHC. Simulations of the HL-LHC environment produce noisy, heterogeneous and ambiguous data. We present an upgrade to the ATLAS GNN4ITk pipeline that allows detector regions to be handled heterogeneously. We perform direct comparisons of our results with those of existing tracking algorithms on a range of physics metrics, including reconstruction efficiency, track reconstruction performance in dense environments, and track parameter resolutions. By integrating this solution within the offline ATLAS Athena framework, we also explore different reconstruction chain configurations, for example using the GNN4ITk pipeline together with traditional techniques for track cleaning and fitting.

PRESENTED AT

Connecting the Dots Workshop (CTD 2023)
October 10-13, 2023

ACKNOWLEDGEMENTS

We thank our colleagues at the IN2P3 computing centre (CC-IN2P3) in Lyon (Villeurbanne) for the smooth operation of their GPU production platform, and for the successful deployment of a new experimental platform dedicated to machine learning developments that require large amounts of memory. Without these resources, the present studies would not have been possible.

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Additional material

QT Matthias Tartarin

Summary

Qualification status:

Qualification Project Period	2022-11-21	2023-11-21

99.73%

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-BEFURT, Paul**
Proposed Start Date	2022-11-21

QT Anna Tegetmeier

Basic Info | Employments | Qualification | Analysis | Appointments | Talks | Theses | OTP | SCAB | Grants

Summary

Qualification status:

Qualification Project Period: 2023-07-05 — 2024-07-05

37.71%

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