



UF



mkFit and Line Segment Tracking

IRIS-HEP retreat: IA section

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mkFit:

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mkFit and LST

- Two projects exploring track reconstruction innovative techniques in hadron collider environment with high pileup, focusing on massive parallelization/vectorization
- 1. mkFit : <https://iris-hep.org/projects/mkfit.html>
 - Aims to develop fully vectorized and parallelized tracking algorithms based on the Kalman Filter
 - The software has been integrated into CMSSW and is currently being used in CMS Run 3
 - matches "legacy" physics performance and with track building time reduction when using mkFit x3.5 and overall tracking time reduction of ~25%
 - Work has started to support CMS Phase-2 tracking geometry
 - Recent public status reports
 - [CMS-DP-2022-018](#), [CHEP 2023 presentation](#)
- 2. LST : <https://iris-hep.org/projects/lst.html>
 - Aims to exploit the CMS outer tracker geometry to make an inherently parallelizable and acceleratable tracking algorithm
 - Algorithm implementation physics performance is comparable to CMS standard tracking on a subset of seeding and enables displaced track reconstruction outside pixel inner tracker
 - CUDA implementation, being migrated to portable Alpaka framework
 - Recent public status reports
 - [CMS-DP-2023-019](#), [CHEP 2023 presentation](#)

Update on collaborators and co-funders

- Co-funder and originator:
 - US-CMS SW&C Ops program
 - NSF (originally PIF)
- Collaborators:
 - Cerati FNAL; Hall, US-Navy; Norris, Oregon

Experimental constraints / timescales

- In general:
 - LHC data taking schedule and related processing
 - Run3 for phase1 until 2025 + legacy rereco (specific for mkFit)
 - Run4 for phase2 from 2029
 - Data and MC production schedules in CMS (not known well in advance)
- As of now, none of these seems a concern

Forward looking plans and opportunities

- Overall the goal is to play a major role in CMS tracking
 - find/maintain best interplay between mkFit and LST in Phase-2
- Opportunities including scope within larger projects
 - naturally, stay in the CMS tracking-related projects: offline and online/HLT
 - explore options to integrate with visualization tools
 - support of the standalone execution option opens opportunity for use outside CMS

First-year goals

➤ mkfit

- Support and improve deployed mkFit code used in Run3.
- Re-tune windows, scoring in phase 1 after changes to propagation and layer navigation

➤ LST

- Introduce and test usage of new track patterns aiming to close the gaps in efficiency coverage
 - 4-layer outer tracker (T4s) for more displaced coverage
 - pixel tracker seed+ segment (pT2s) to cover well below p_T of 0.8 GeV
- Deploy light-weight ML-based inference in place of sets of multiple cuts
- Continuing integration with CMSSW
 - establish timing measurements
 - define interface formats with other GPU (Patatrack tracking upstream) and CPU algorithms (downstream)

Second-year goals

➤ mkfit

- Deploy mkFit in phase 2 beyond initial step
- Update/retune a version for Run 3 legacy processing
- Initial prototype of mkFit vectorized final fit

➤ LST

- Integrate LST in CMSSW packages
- Test feasibility of deploying LST & mkFit in HLT for phase 2

iris-hep 2.0 (hoped-for) goals

- Ultimately, plan to be in CMS production setup for Run 4
- Have LST and mkFit integrated with each other in CMSSW
 - LST produced tracks are fed into mkFit for completion and additional specialized iteration(s).
 - Ideally, with vectorized final fit as well.

Backup