mkFit + LST slides

IRIS-HEP 2022 Oct Retreat

Core Team:

Allie, Avi, Balaji, Dan, Gavin, Giuseppe, Leonardo, Manos, Mario, Matevz, Matthew, Matti, Peter, Philip, Slava, Steve, Tres, Yanxi

Cornell, FNAL, Princeton, UF, UCSD

Recent team changes:

- Philip Change
  - UCSD pdoc → UF professor
  - Continue working and contributing to LST
  - Brought in student Matthew
- Princeton
  - Engineer Bei left for NVIDIA
- Cornell
  - Student Tres about to graduate
  - New student Gavin joined
- UCSD
  - Student Balaji about to graduate
  - New student Yanxi joined
  - New pdoc Manos joined

Parallelized & Vectorized KF Tracking (CMS) Brief Status

- Development of infrastructure for multiple iterations, using hit masking.
  - Above item triggered a major re-structuring of hit format to be identical to that used in CMSSW, thereby minimizing reformatting overhead.
- Work on the CMSSW side to:
  - Configure mkFit
  - Accept tracks built by mkFit, fit and store in track collection
  - Run standard CMS track validation module

Overall, project is progressing well and first implementation is in place.

Refinement and bug hunting ongoing…

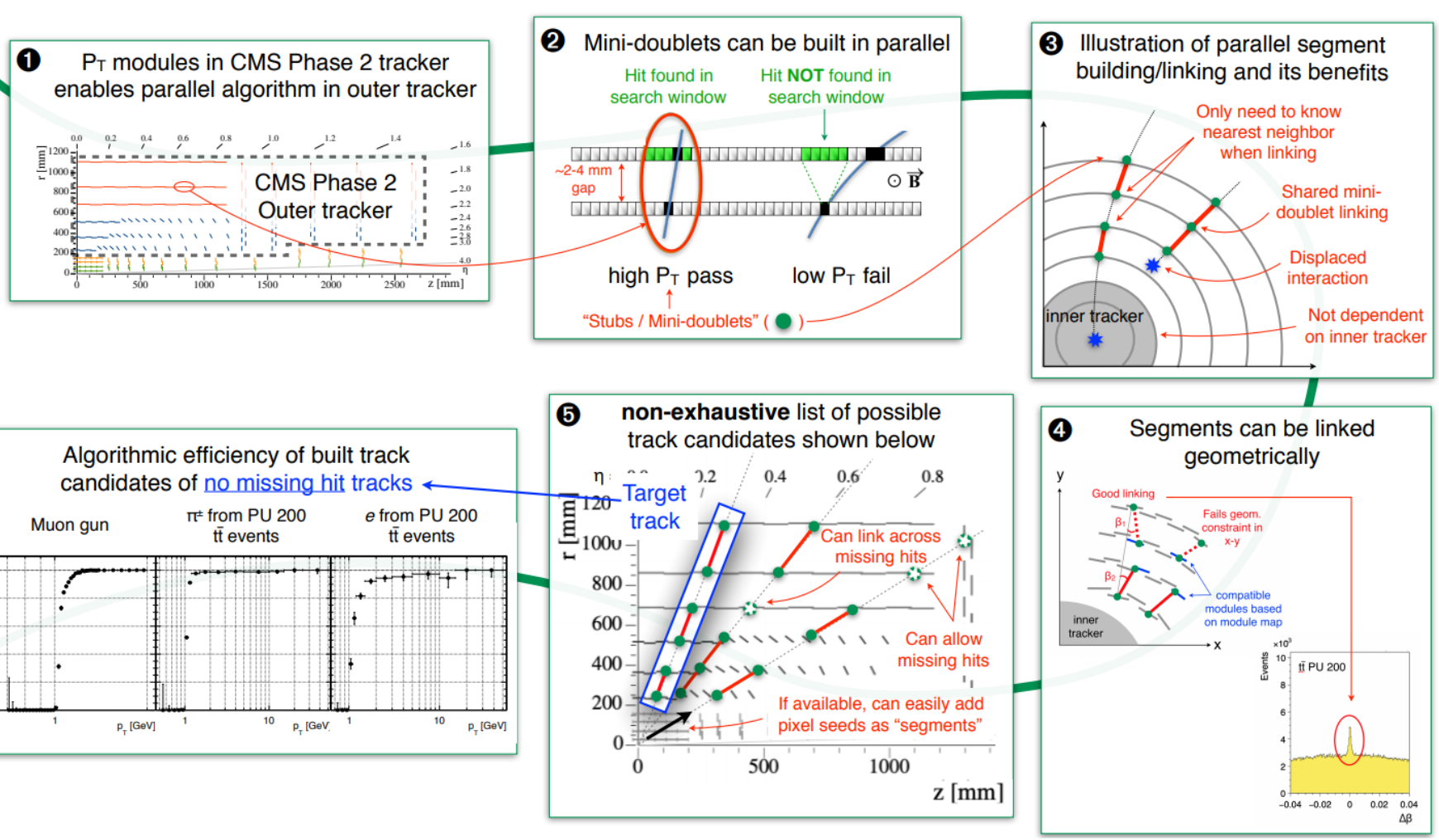
➔ Fully integrated into CMSSW

➔ Tracking default for Run3 main iterations (~90% of tracks used)

➔ In iterations used, pattern recognition is faster than fitting

LST - Algorithm Overview

- Load hits
- Make mini-doublets (MD)
- Make segments (LS)
  - Import pixels (pLS)
- Create tracklets
  - Triplets (T3)
  - Quadruplets (T4)
  - Quintuplets (T5)
- Create track candidates
  - pT3, pT4..
  - T5
- [MTV-like Validation]



Line Segment Tracking – LST (CMS)
Brief Status

- Novel tracking algorithm designed and developed targeting GPUs.
- Based on Phase-2 CMS tracker geometry.

- Achieved good efficiency for PU200
- Working to reduce linking combinatorics (redundancy in track building)
- Algorithmic development started on CPU, “mirrored” to GPU.
  - Now GPU based.
- Significantly:
  - Reduced memory footprint (14GB → less than 1GB)
  - Increased speed ~26ms per event for ttbar+PU200 events
- Integration into CMSSW started

➔Included in HLT TDR for HL-LHC

➔Similar Physics Performance to current KF based baseline

Plans for this year

- mkFit Run3 related:
  - Improve and fix implementation ‘shortcuts’
  - Replace additional iterations
  - Re-tune DNN for track quality ranking (don’t own it forever)

- mkFit Phase2 related:
  - Adjust to phase-2 geometry
    - Initial as-is test for one iteration on new geometry ~worked

- LST related:
  - Continue development and refinements
  - Deployment into CMSSW and testing performance in-situ WRT baseline

Plans next 5 years

Long term ‘vision’:

1. Pixel tracking (patatrack)
2. Outer tracker hit unpacking and clustering (Dan, GPU)
3. LST - outer tracker confirmation and add detached tracks (R&D)
4. mkFit complete tracks and perform final fit (R&D)

➔Aiming at both offline and HLT

- mkFit Run3 related:
  - Cleanup and consolidate implementation “shortcuts” physics tuning

- mkFit Phase2 related: (Postdocs: Mario, Leonardo, Dan)
  - Adjust to phase-2 geometry, test, and adjust as needed
    - Usage of min-doublet?
    - Usage of patatracks as seeds?
  - Develop vectorized final fit

- LST related: (Students: Tres, Balaji, Yanxi, Postdocs: Manos)
  - Continue development with emphasis on timing and memory footprint
  - Deployment into CMSSW and testing performance in-situ