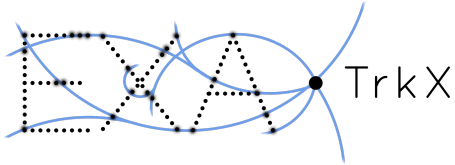
ExaTrkX integration into ACTS



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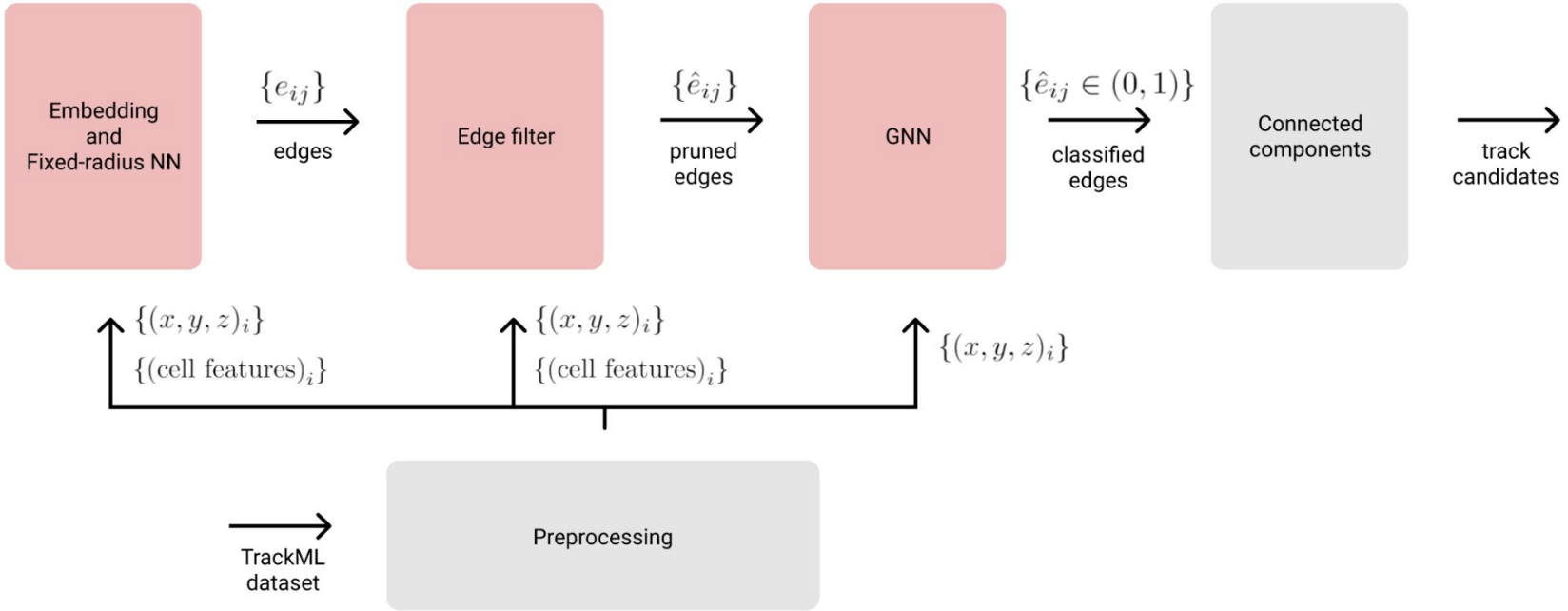
on behalf of the ExaTrkX team

ACTS Workshop
27 September, 2022

Introduction

- ExaTrkX implemented two C++ implementations of the GNN-based pipeline
  - https://github.com/exatrkx/exatrxk-cpp-ctd2022 (libTorch for ML)
  - https://github.com/exatrkx/exatrkx-acat2021 (onnxruntime for ML)
- We integrated the pipeline into ACTS
  - https://github.com/acts-project/acts/tree/main/Examples/Algorithms/TrackFindingExaTrkX (supports both libTorch and onnxruntime)
  - Thanks to Benjanmin Huth!
- We also “integrated” the pipeline into Athena 21.9, working on that for Athena, 23.
  - https://gitlab.cern.ch/xju/athena/-/tree/xju/exatrkx-rel21.9 (allows tracking performance evaluation with standard tools)

ExaTrkX track finding



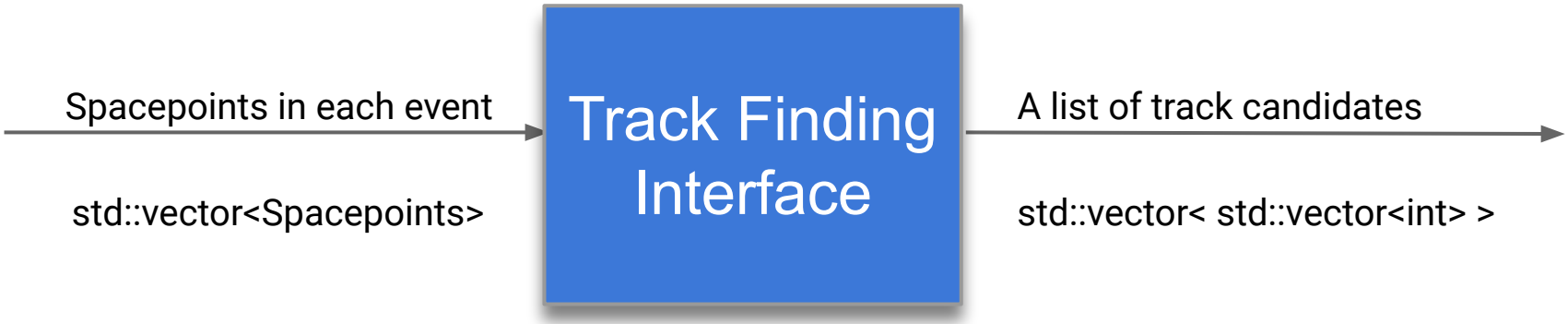
- Light red boxes are trainable stages

Reference: arxiv:2103.06995

In a nutshell

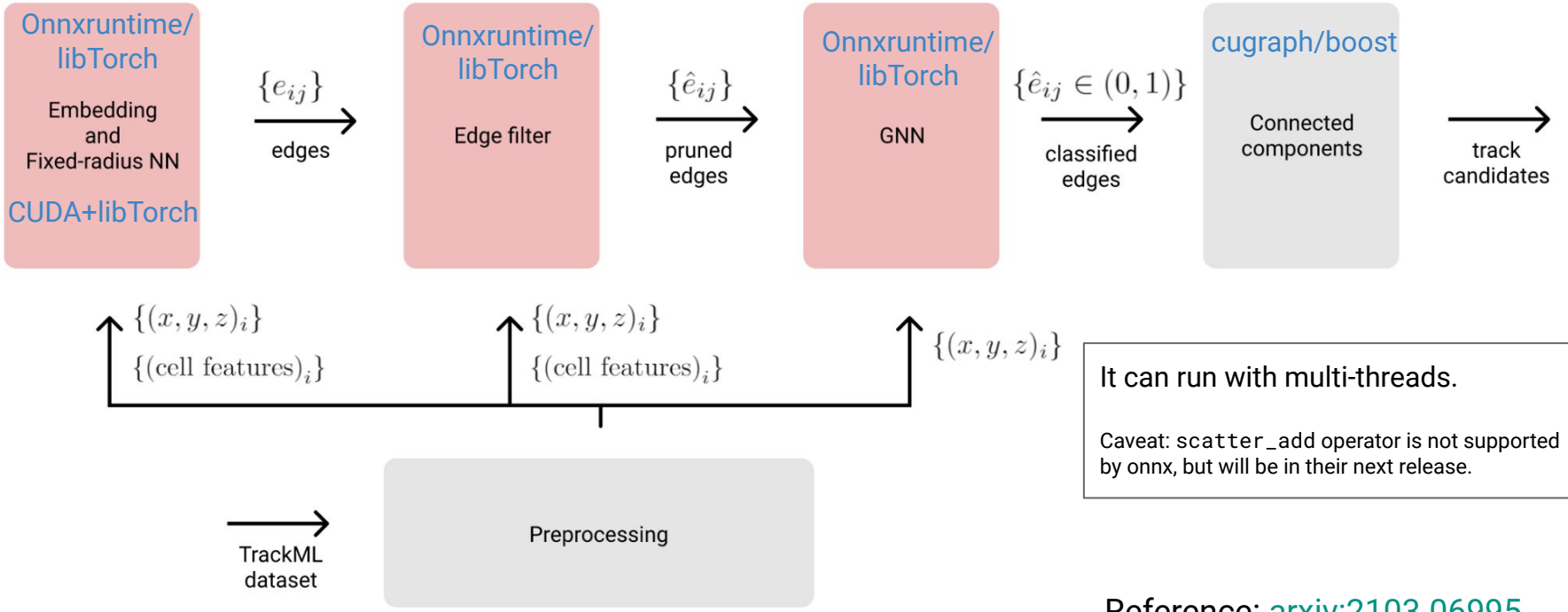
- Our track finding algorithm takes a list of *spacepoints* as inputs and produces a list of *track candidates* as outputs
- Track candidates are presented as a list of spacepoint IDs
    - For now, track candidate is presented as *ProtoTrack* in ACTS.

Build a generic interface



- We wrote a generic interface that works for any track finding algorithms, **ExaTrkXTrackFindingBase**
- The interface enables easy comparisons between different track finding algorithms

ExaTrkX track finding in C++

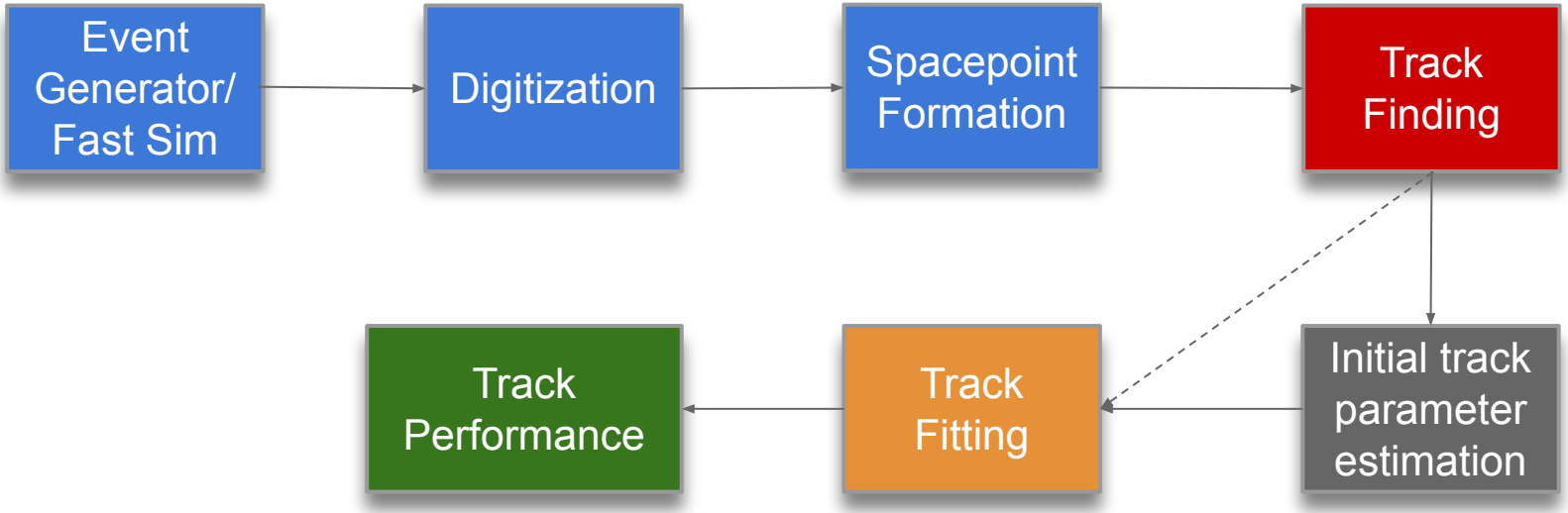


It can run with multi-threads.

Caveat: `scatter_add` operator is not supported by onnx, but will be in their next release.

Reference: arxiv:2103.06995

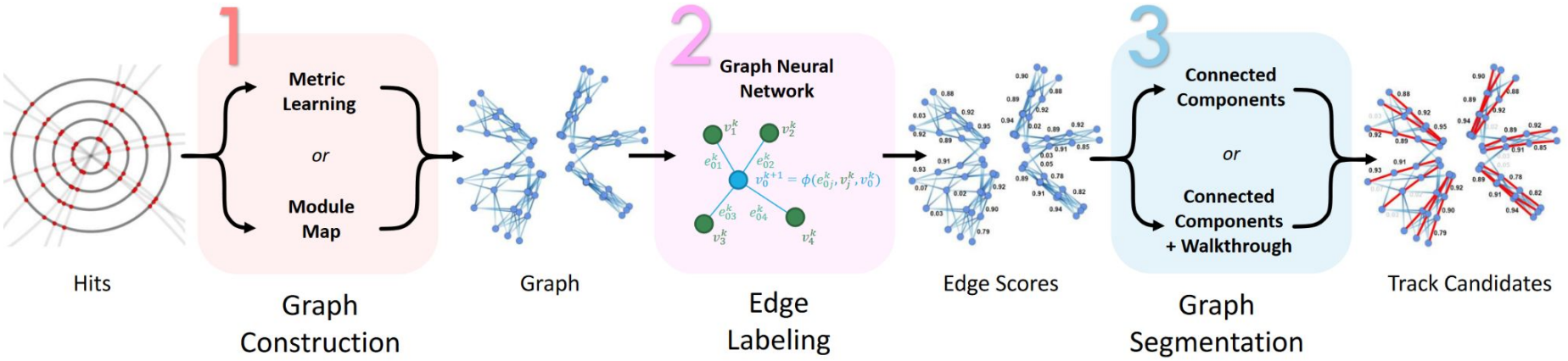
A tracking reconstruction chain



With existing ACTS example algorithms, we wrote a full tracking reconstruction chain.

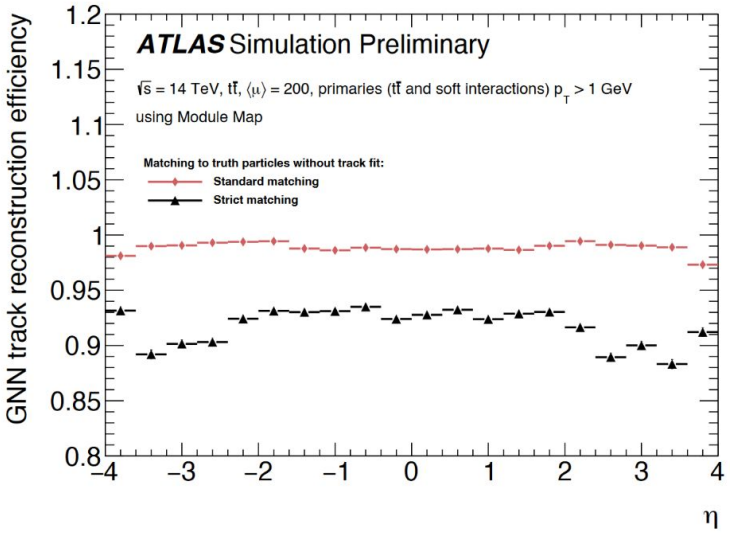
This workflow allows fair comparisons between different track finding algorithms

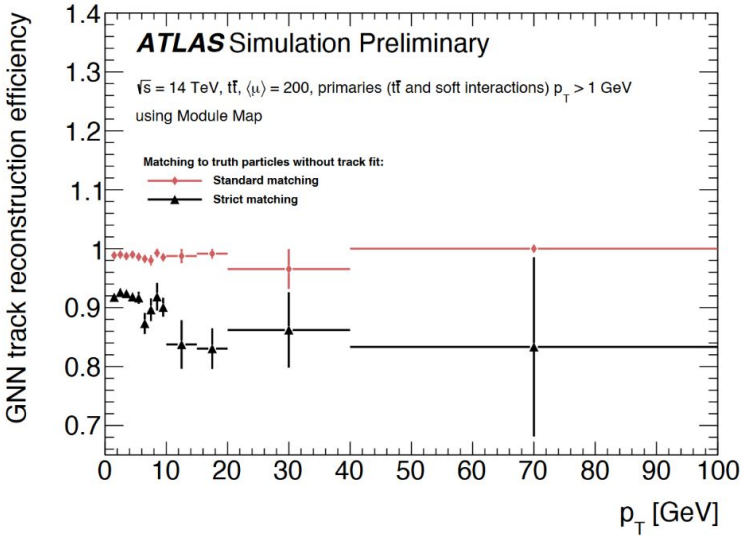
Latest pipeline for ITk



- Two graph construction algorithms in exploration
- Two graph segmentation algorithms
- Tend to support variations of the pipeline
  - >> Define separate interface for each stage

Latest results for ITk





Track candidate not matched to any particle = fake track

➡ found to be $O(10^{-3})$

Summary & Outlook

We implemented an implementation of the ExaTrkX track finding algorithm in ACTS

The algorithm can use multiple threads and runs on GPUs

We also implemented a ExaTrkX as a service: https://github.com/exatrkx/exatrxk-cpp-ctd2022

See Benjamin's tutorial for more details:
https://indico.cern.ch/event/1184037/contributions/5061741/

Outlook:

- Define separate interfaces for Graph Construction and Graph Segmentation so as to allow different algorithms