Chain finder studies and Event Display

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From BONuS to TDIS

I adapted the code I developed initially in BONuS to handle TDIS information. In principle, the code is 'blind' to the geometry of the detector. It only takes spatial variables and generates chains from an initial hit point exploring the nearby hit points and moving the search to the accepted points until the hit pool is exhausted of potential candidates. Then, the algorithm continues searching other chains. When the hit pool is completely examined, the algorithm stops and starts with the next run event.

The code is based in Howard Fenker's algorithm for BONuS6 with extra restrictions in the hit selection. In literature, the method is called Naïve Track Following:
R.Mankel, arXiv:physics/0402039v1

Details of the algorithm has been presented before:

BONuS/TDIS Collaboration, December 12, 2016
https://clasweb.jlab.org/rungroups/bonus/wiki/index.php/Joint_BONuS12/TDIS_meeting
DPWG Clas Collaboration Meeting, March 30, 2017
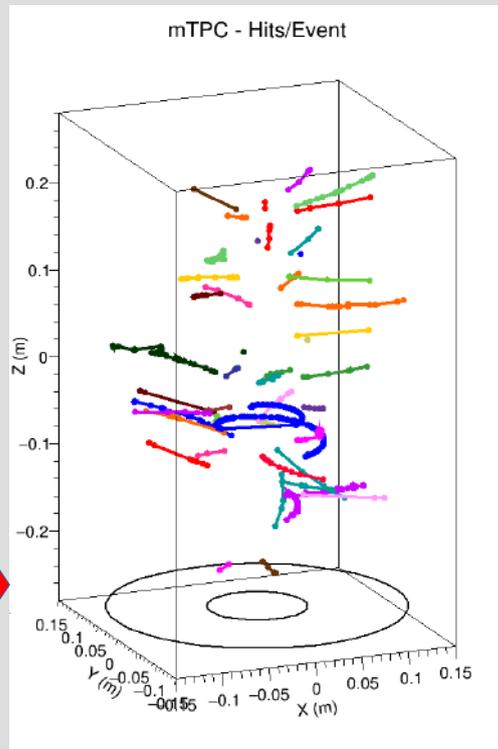https://indico.jlab.org/event/201/

First, an Event display

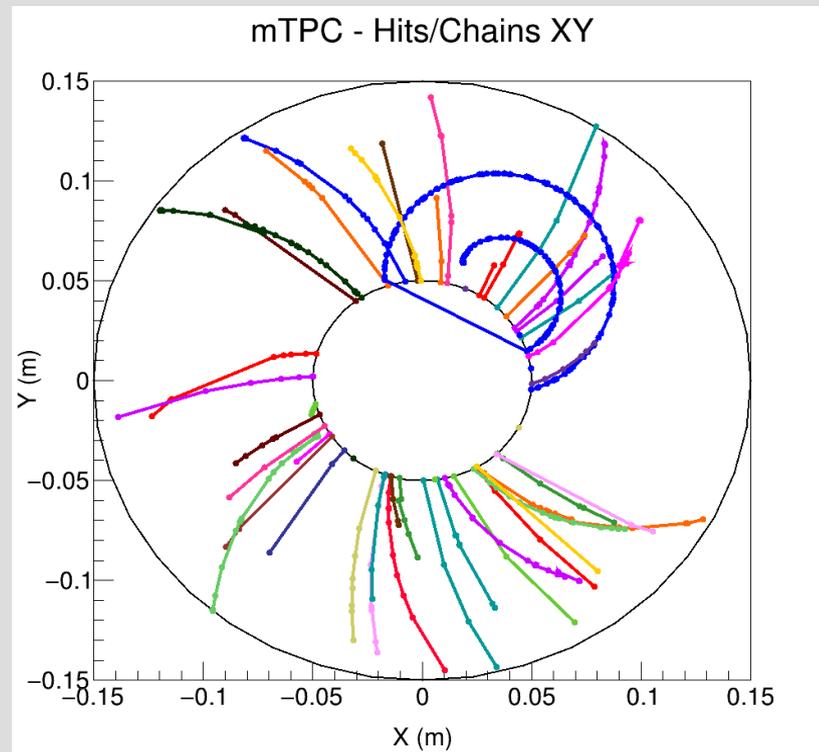Quite simple program making use of ROOT classes to represent the output from g4sbs.

For some reason, running as a macro gives some issues, which I think are coming from the use of stl:: vector.
Compiling the code gave no issues.

The 3D output allows to rotate the graph in any direction.
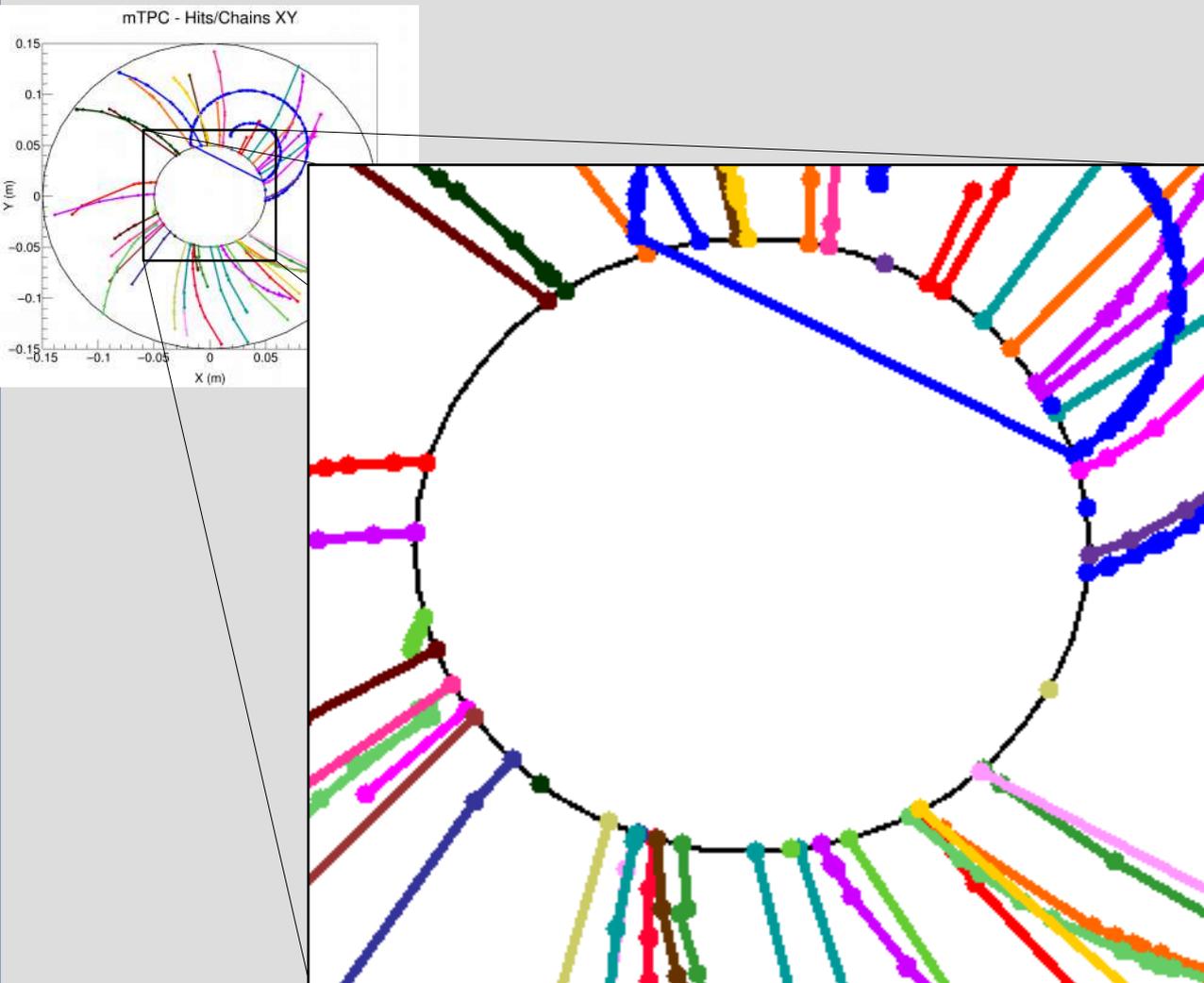
50 QE g4sbs protons with p<400MeV/c

mTPC - Hits/Event

mTPC - Hits/Chains XY

A projection in the X-Y plane helps to visualize better the tracks

First "issue"

mTPC - Hits/Chains XY

The first hit on each event starts at the inner kapton distance. For the track finder, that is not an issue, but maybe it is for further analysis.

```
Entry: 0

Hit: 0 x: 0.0247969 y: -0.0434318 z: 0.203962
Radius (cyl): 0.0500121

Hit: 1 x: 0.03342 y: -0.055369 z: 0.208807
Radius (cyl): 0.0646732
(...)

Entry: 1

Hit: 0 x: 0.0423682 y: 0.0265735 z: -0.174295
Radius (cyl): 0.0500121

Hit: 1 x: 0.0523834 y: 0.0370613 z: -0.174454
Radius (cyl): 0.0641682
(...)

Entry: 2

Hit: 0 x: -0.0104591 y: -0.0489062 z: 0.0197546
Radius (cyl): 0.0500121

Hit: 1 x: -0.00973801 y: -0.0591202 z: 0.0243124
Radius (cyl): 0.0599168
(...)
```
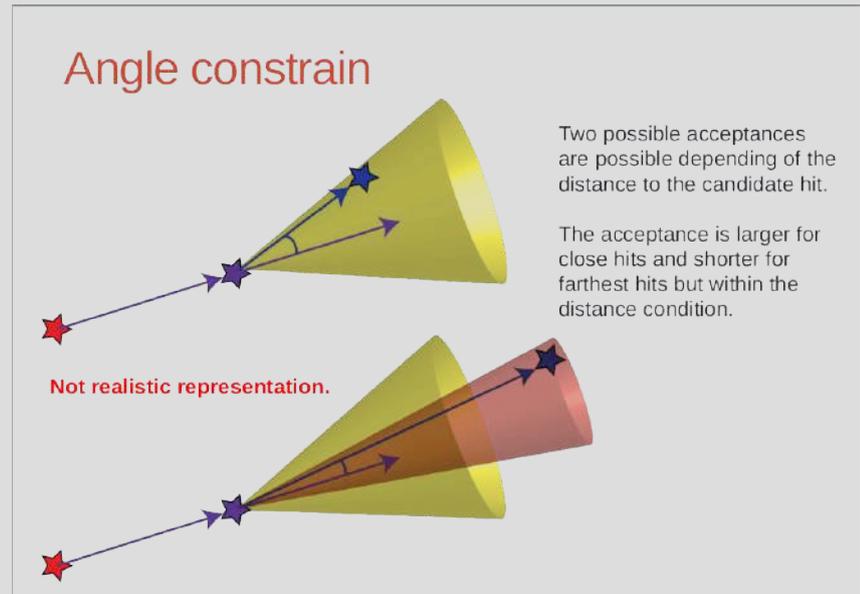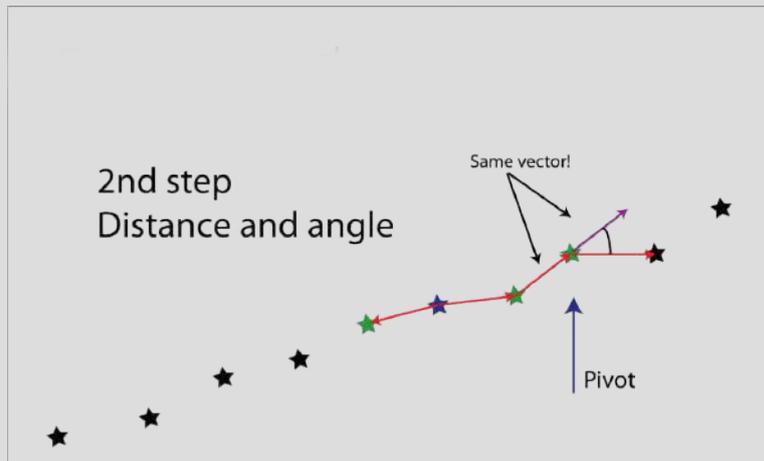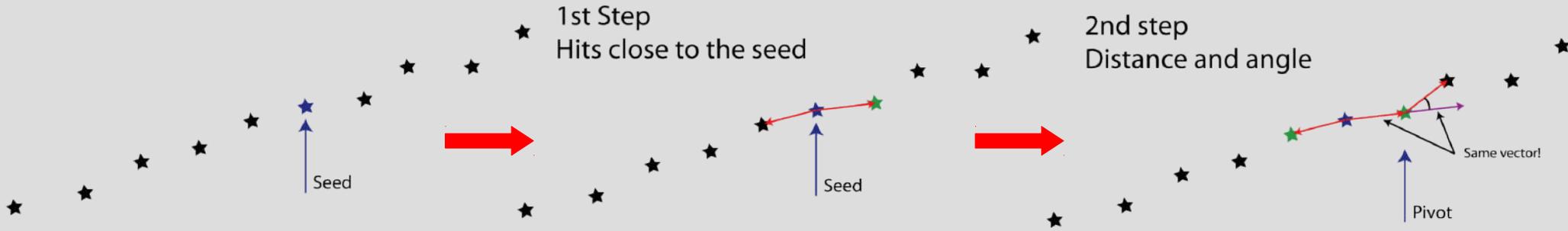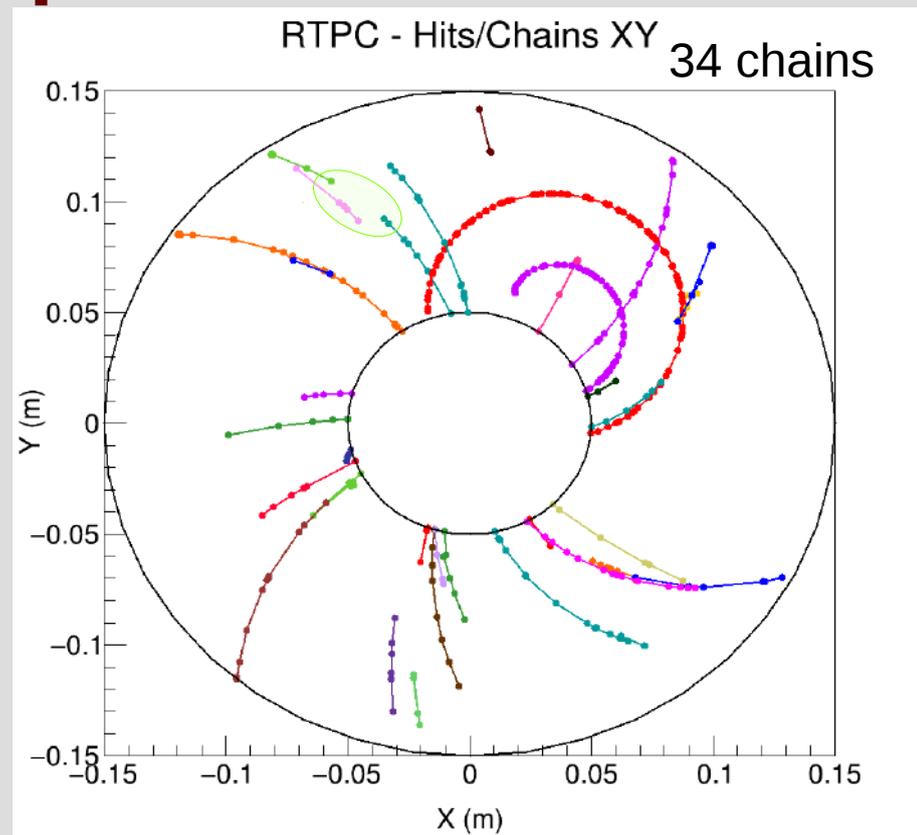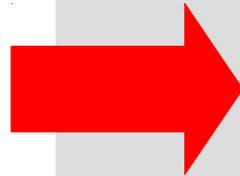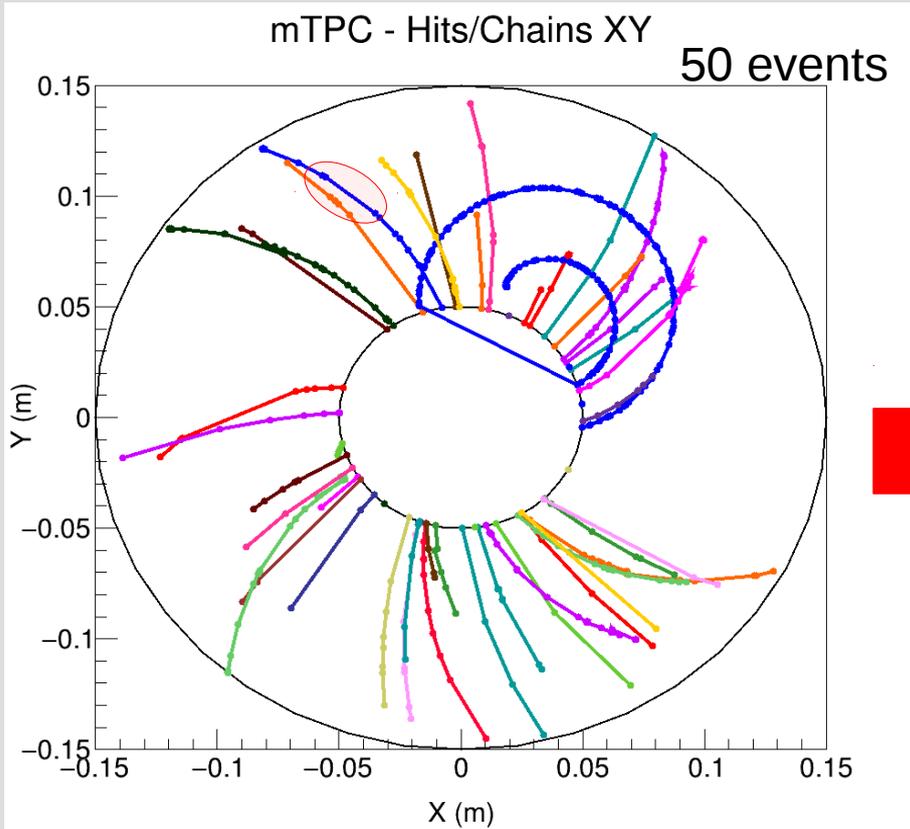
Graphic explanation of the chain finder

1st Step
Hits close to the seed

Seed

2nd step
Distance and angle

Same vector!

Pivot

2nd step
Distance and angle

Same vector!

Pivot

The process is repeated until there are not more hits in the pool which fulfill the requirements

Angle constrain

Two possible acceptances are possible depending of the distance to the candidate hit.

The acceptance is larger for close hits and shorter for farthest hits but within the distance condition.

Not realistic representation.

Chain finder – one proton/event

Parameters:
Max distance between hits: 25mm Long distance angle: 15.3deg Min # of hits: 4
Short distance angle: 20deg Max distance between hits: 15mm

Chain finder – 25 protons/event

2 superevents

24 chains

50 g4sbs events were comprised in 2 'superevents'

mTPC - Hits/Chains XY

RTPC - Hits/Chains XY

Line was supressed

Parameters:
Max distance between hits: 25mm   Long distance angle: 15.3deg   Min # of hits: 4
Short distance angle: 20deg   Max distance between hits: 15mm

Notes

- I used the data directly from g4sbs
  - Although the digitization is done (*R. Montgomery TDIS Bi-monthly meeting, 2021 February 23*), I am not sure it is implemented into g4sbs.
  - Making use of the reconstructed spatial variables, is simple to implement, and could help introducing extra information (time)
- The parameters used are set 'by hand'
  - Some systematic studies, like path length, edep, direction of tracks, could help to set them
  - Filtering good events from the MC and study the efficiency in detection changing the parameters is an option
  - I found some events with very long path, with momentum = 0, need to dig more on them.
- Due to the nature of the simulation and how the hits are stored, the search direction now is inner to outer (the inner hits are first in the pool)
  - The addressed issue in TDIS is the high occupancy in the inner sectors. Sorting the hit pool outer to inner could help to identify chains.
  - Definitely, having time as an extra search parameter will improve it.