# Study on duplicate tracks

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## **Duplicated tracks**



- Multiple tracks are reconstructed for one particle
- Inheriting duplicated seeds:
  - for 5 layers of trackers, a seed with 3 space points gives  ${}_5C_3 = 10$
  - Further reduction to 3 by requiring using middle space point only once (as a middle space point)

If we have a particle at mid-rapidity which hits layers L0, L1, L2, L3, and L4, then we can make the following combinations:

> 1. L0,L1,L2 2. L0,L2,L3 3. L0,L3,L4 ¥ 4. L0,L1,L3 ¥ 5. L0,L1,L4 **≭** 6. L0,L2,L4 **≭** 7. L1,L2,L3 **≭** 8. L1,L2,L4 🗙 9. L1,L3,L4 🗰 10. L2,L3,L4

Parameter	Description	My New Default
bFieldInZ	z component of magnetic field	1.7 T
rMax	Maximum r value to look for seeds	440 mm
rMin	Minimum r value to look for seeds	33 mm
zMin	Minimum z value to look for seeds	-1500 mm
zMax	Maximum z value to look for seeds	1700 mm
beamPosX	Beam offset in x	0
beamPosY	Beam offset in y	0
deltaRMinTopSP	Min distance in r between middle and top SP in one seed	10 mm
eltaRMinBottomSP	Min distance in r between middle and bottom SP in one seed	10 mm
deltaRMaxTopSP	Max distance in r between middle and top SP in one seed	200 mm
eltaRMaxBottomSP	Max distance in r between middle and top SP in one seed	200 mm
ollisionRegionMin	Min z for primary vertex	-250 mm
ollisionRegionMax	Max z for primary vertex	250 mm
cotThetaMax	Cotangent of max theta angle	27.29
minPt	Min transverse momentum	100 MeV/cotThetaMax
maxSeedsPerSpM	Max number of seeds a single middle space point can belong to - 1	0
sigmaScattering	How many standard devs of scattering angles to consider	5
adLengthPerSeed	Average radiation lengths of material on the length of a seed	0.1
impactMax	Max transverse PCA allowed	3 mm
rMinMiddle	Min R for middle space point	20 mm
rMaxMiddle	Max R for middle space point	400 mm
bFieldMin	min B field	0.1





From Rarak's slides

## η- p<sub>T</sub>- dependence?



- Caveat: not perfectly corresponds to acceptance: regions defined with polar angle of MC particle
- Most probable case: 3 duplicated tracks, inheriting from duplicated seeds->problematic as sets associated hits are almost identical
  - Larger duplicate tracks at forward/backward region
  - Mild  $p_T$  dependence should be verified (based on  $\eta$ )





# **Seed filter in ACTS**

https://indico.cern.ch/event/1252748/contributions/5561968/attachments/2731962/4749842/Connecting%20The%20Dots.pdf

### CPU Based Seeding - ACTS Default Seeding

### **Seed Confirmation:**

After selecting the SP-triplets, a seed confirmation procedure is applied to all the triplet combinations:

- Compare seeds with similar helix radius Ο
- Rank the seeds based on a customisable weight Ο

 $w = (c_1 \cdot N_t - c_2 \cdot d_0 - c_3 |z_0|) + ext{detector specific cuts}$ 

More measurements leads to higher quality Smaller IP  $\rightarrow$  higher probability of track arriving from the interaction point

Improving the quality of the final track collections by rejecting lower-quality seeds

In the end we keep only the best ranked seeds





Connecting The Dots 2023

Post seeding process natively implemented in ACTS

Idea is simple; parameters should be optimized

# Seed filter parameter tuning (1)



# Seed filter parameter tuning (2)



beam axis, z (mm)

# Summary and outlook

- Private version of ElCrecon running on Perlmutter / Some python scripts for QA are ready
  - High Q^2 DIS events and DIS + background can be studied at the same time
- Duplicated tracks mainly from duplicated seeds
  - Usage of SeedFilter in ACTS and optimization of parameters ongoing
  - Expect to remove most of duplicate tracks having exact same sets of associated hits
  - Faster tracking process
- Plan B: introducing 2 step tracking: tracking without trackers, removing duplicates and refit once again
- Still other sources of duplicated tracks rejection based on chi2/ndf, residuals

