Reconstruction overview

Fast 3D field parametrization in |Z|<260 cm region

- Activated with AliMagF->AllowFastField(), o2::Base::MagneticField->setAllowFastField())

  CPU time (s) per random query:

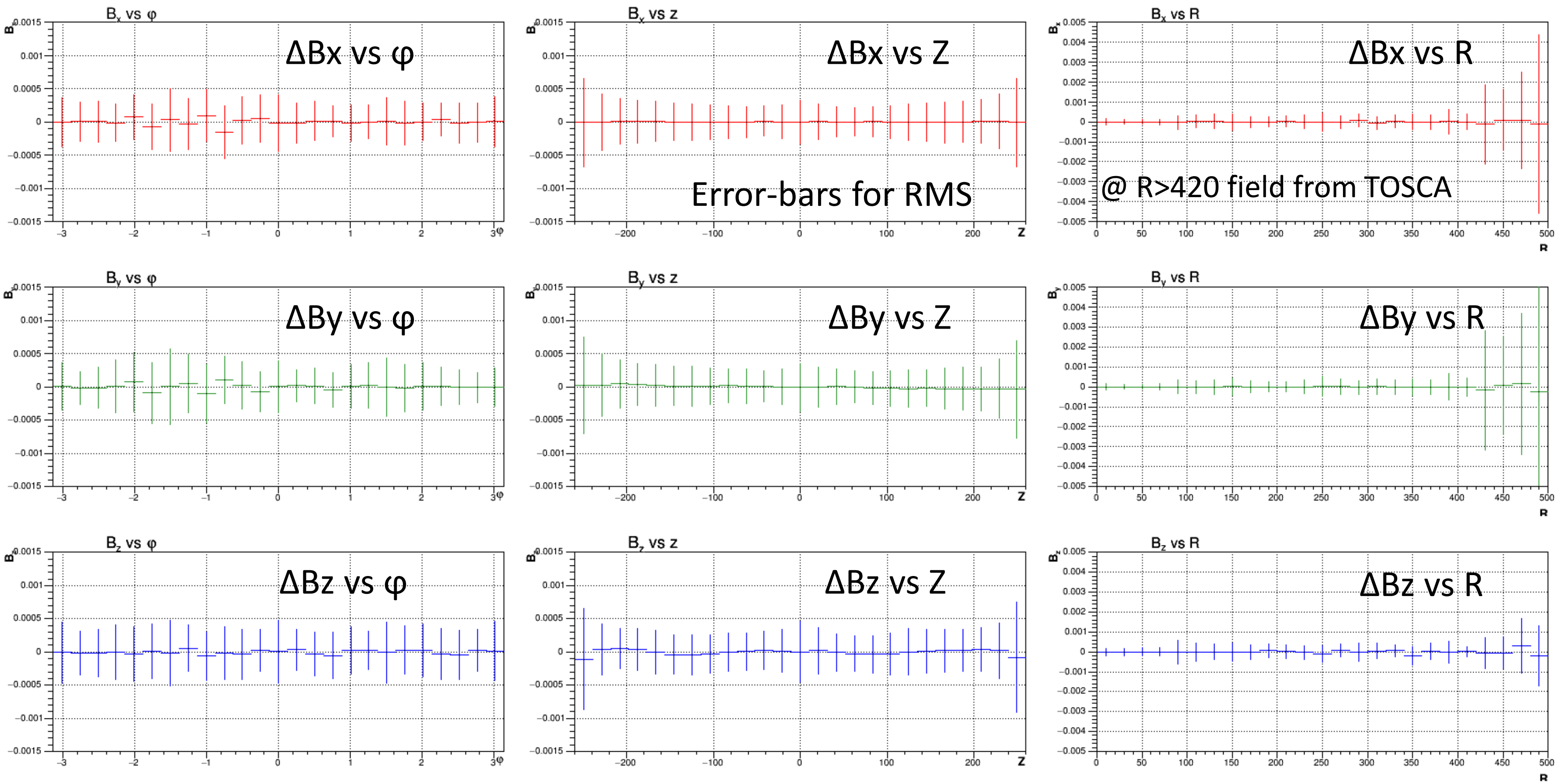
  Exact param: 5e-07

  Fast param: 4e-08

  -> **speed-up factor 12.5**

- Work on Dipole in progress

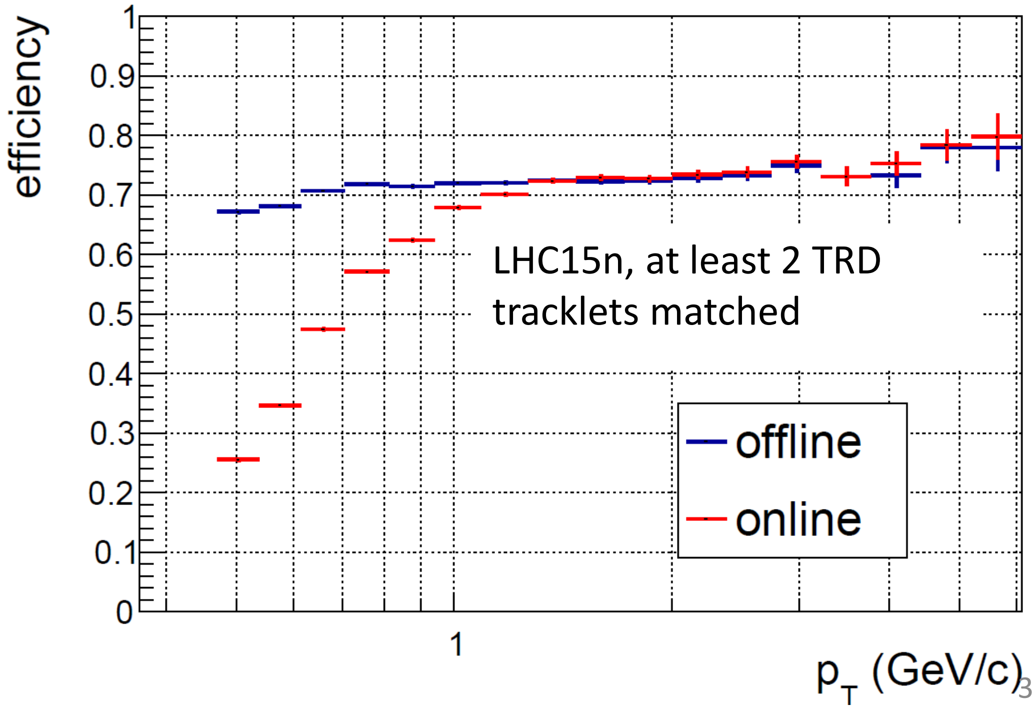
Δ to exact	<Δ>,kG (wrt Bz,%)	RMS(Δ),kG (wrt Bz,%)
Bx	6.5e-05(0.0013%)	2.4e-4(0.0048%)
By	6.7e-06(-0.0001%)	2.8e-4(0.0056%)
Bz	6.7e-06(-0.0001%)	3.6e-4(0.0071%)



TRD tracking with online tracklets (1)

Ole Schmidt

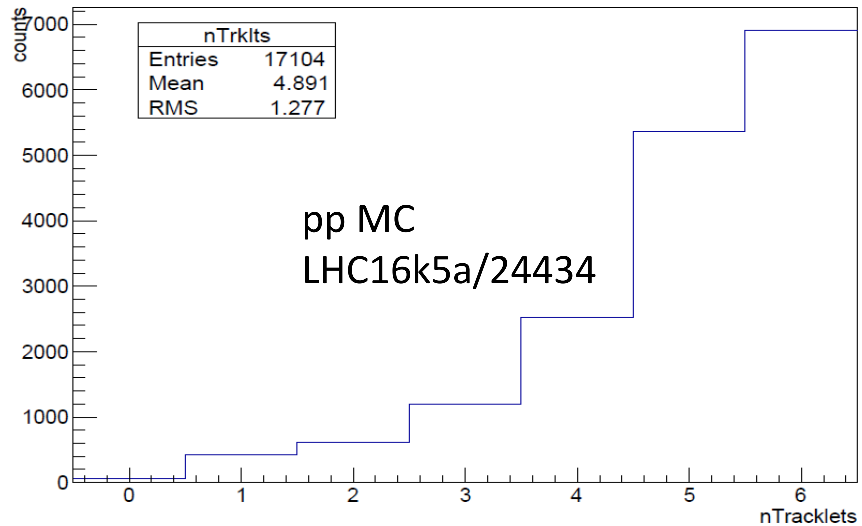
- Current method: TPC seed following in the TRD with closest (in χ^2) tracklet attachment: no competition between different track prolongation hypotheses.
- **OK for p-p**: efficiency of reconstruction with online tracklets is similar to that in offline for tracks with pT>1 GeV.
  Update from last "HLT hands-on" meeting: verification with MC truth (p_T>1GeV):
  - Fake tracklets attachment on per-mille level
  - ~92% of matched tracklets have correct label of TPC seed, the rest correspond to secondaries from the seed.
- Below 1GeV online tracklet building efficiency drops (by construction of the online algorithm):
  - Project to improve tracklet building efficiency up to ~0.5 GeV: currently Summer student O.Matonoha)
- Assume improvements with updated HLT TPC tracker (see later).

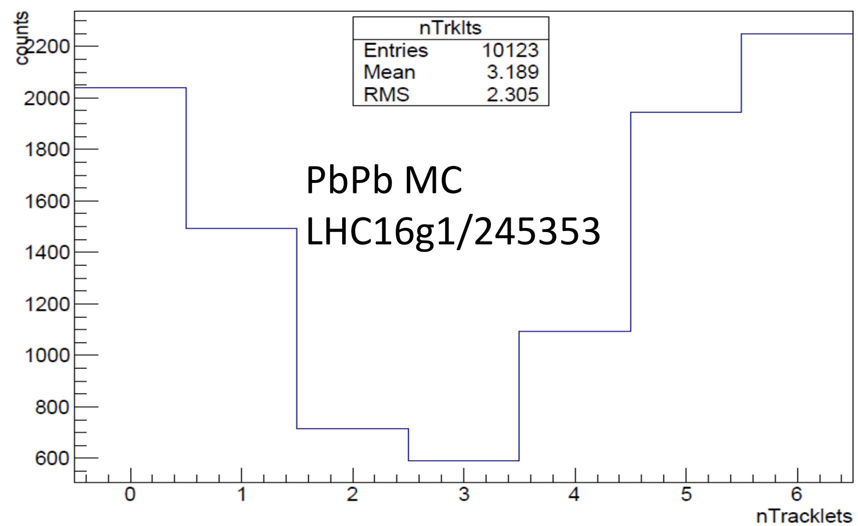


TRD tracking with online tracklets (2)

- TPC-TRD matching in (central) **Pb-Pb**
  - Significantly lower efficiency and higher fake matches contamination (~22%)
- Code being modified to consider multiple seed prolongation hypothesis at every TRD layer, with check for acceptance holes and penalty for layers w/o contribution

Number of tracklets attached to seed (existence of tracklet at last layer requested)





Loop finding in TPC: Malta Uni. group (1)

Johann Briffa

- Hough transform in 2D:
  - Accumulate in phase space of circles of radius ***r*** (restricted to ***r<r(p$_{T,max}$~40MeV)*** and centered at {***x,y***} the likelihood of every phase point as sum over all clusters
  - Define for each cluster likelihood of belonging to circle as:

$$A(x,y,r) = \sum_{i=1}^{n} G(r - r_i, \sigma) \times \frac{(x_i^2 + y_i^2)^{0.75}}{2\pi r}$$

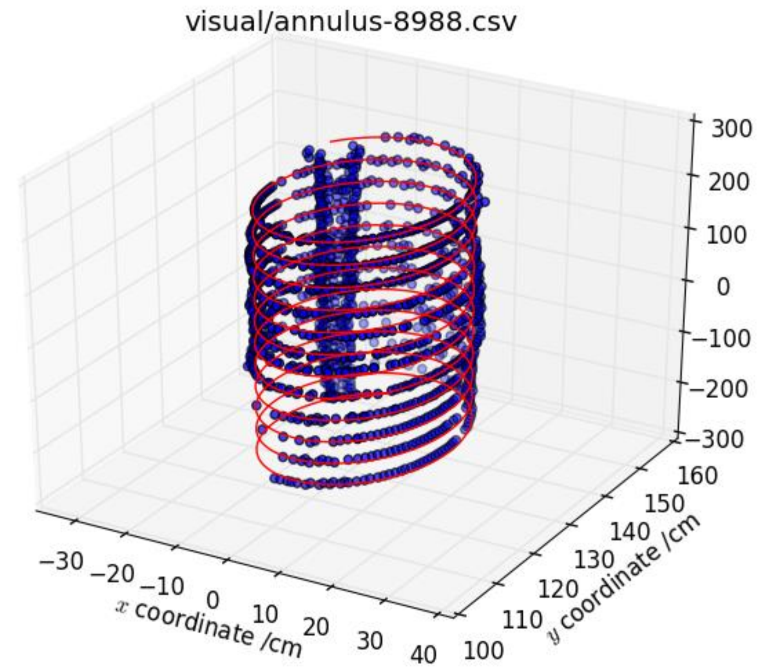
$$\text{where } r_i = \sqrt{(x_i - x)^2 + (y_i - y)^2} \text{ and } G(x,\sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{x^2}{2\sigma^2}}$$

$$\lambda_i = \max_{x,y,r} A(x,y,r) G(r - r_i, \sigma)$$

- Hough transform in 3D:
  - Select set of circles as {r,x,y} tuples with max. contribution from at least 1 cluster

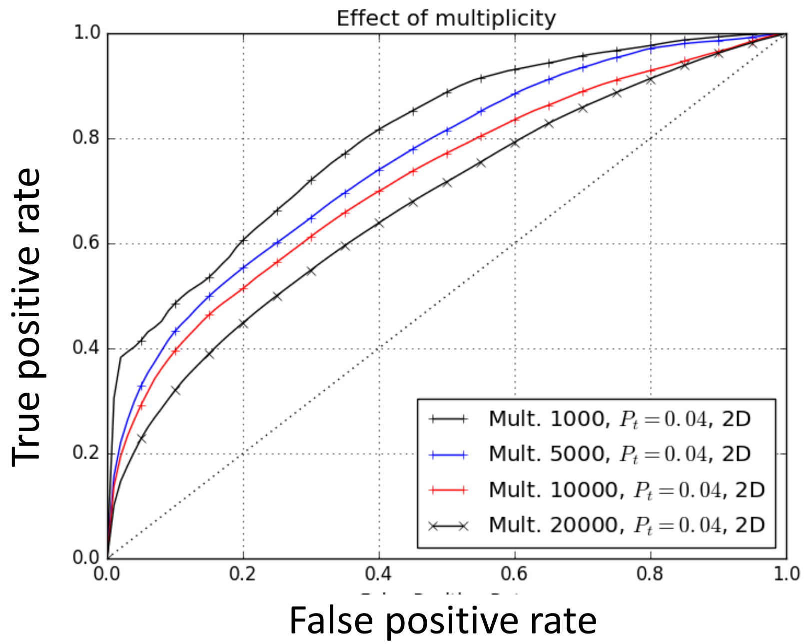
$$U\left(\arg\max_{x,y,r} A(x,y,r) G(r - r_i, \sigma)\right) = 1$$

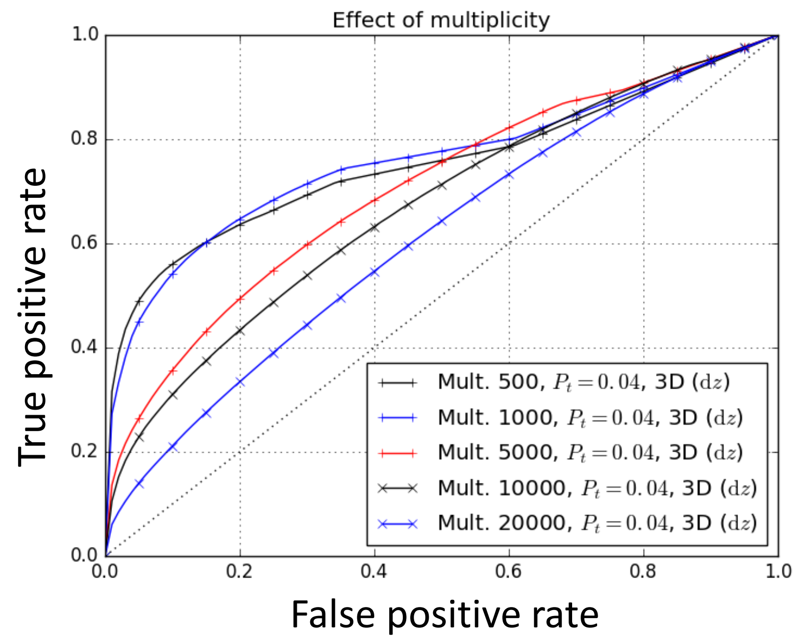
  - Iterate over circle candidates selecting the clusters matching to circle within 2cm and fit helix parameters (different methods tested), assign to clusters metric of its contribution to fitted helix, allowing further classification



Loop finding in TPC: Malta Uni. group (2)

Result of 2D and 3D algorithms for different multiplicities

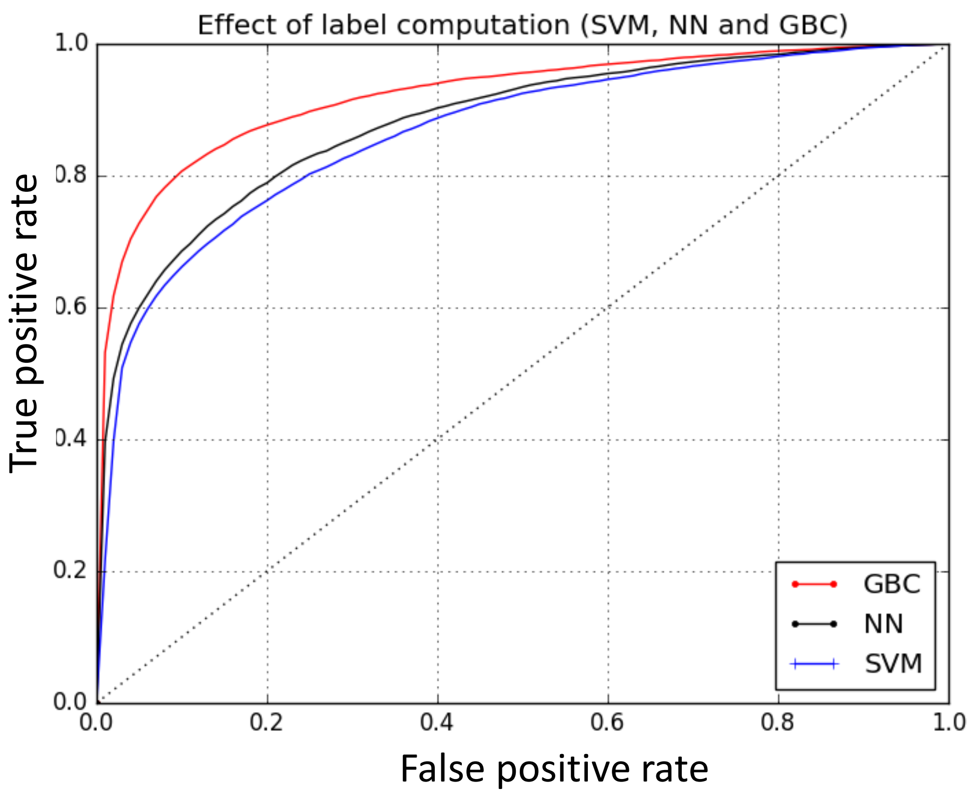




- Clusters attached to tracks already found by “physics” tracks reconstruction are not removed: this step will strongly suppress “Fake positive rate”
- The multiplicity we should target in Run3 is corresponds to ~100,000

Loop finding in TPC: Malta Uni. group (3)

- Alternative: instead of making decision using the scalar metric, use vector of features calculated in the 3D algorithm as an input for Machine Learning Classifiers:
  - Neural networks (NN)
  - Gradient Boosting Classifier (GBC)
  - Support Vector Machine (SVM)

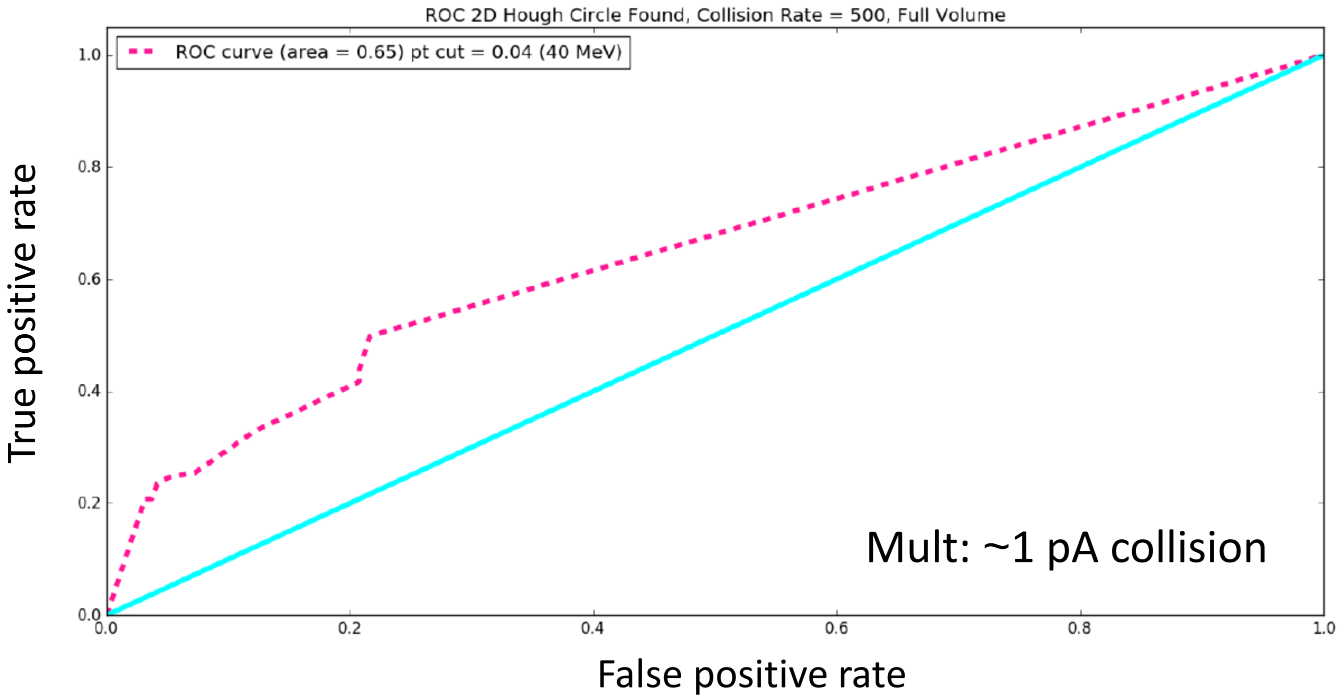


- Next steps:
  - Evaluate performance of algorithms running on clusters not used in "physical tracks" finding
  - Continue investigation of selection with ML techniques
  - Speed optimization

Loop finding in TPC: LIPI

Rifki Sadikin

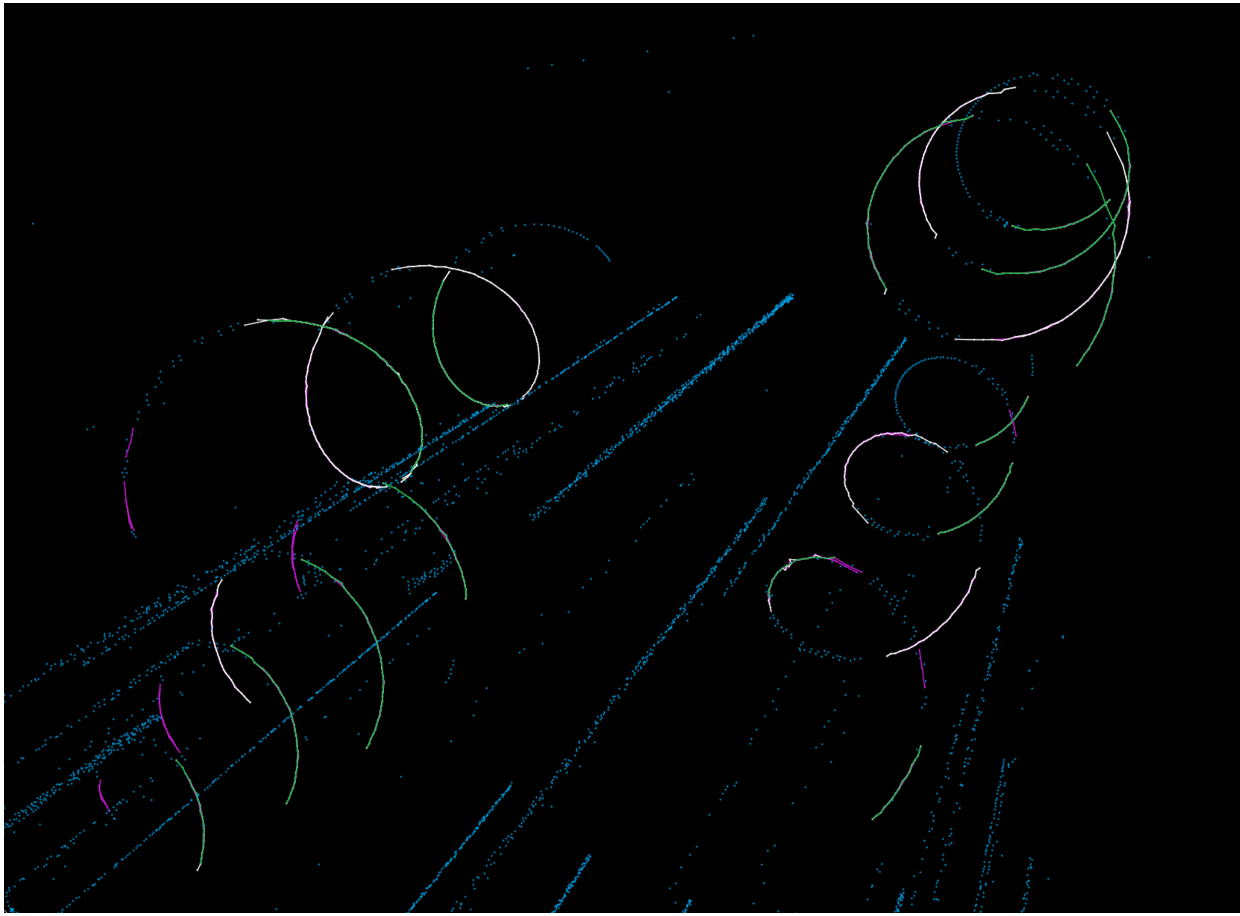
- ❑ Seed finding:
  - Hough Transform from cluster x_i, y_i coordinates to {r, x, y} phase space
  - Circle candidates as local maxima in phase space ⇒ r,x,y estimate of seed
  - Helix fit: mapping cluster {x,y,z} to {arc-length:z} ⇒ linear fitter
- ❑ Kalman helix filter



Loop finding in TPC with HLT tracking

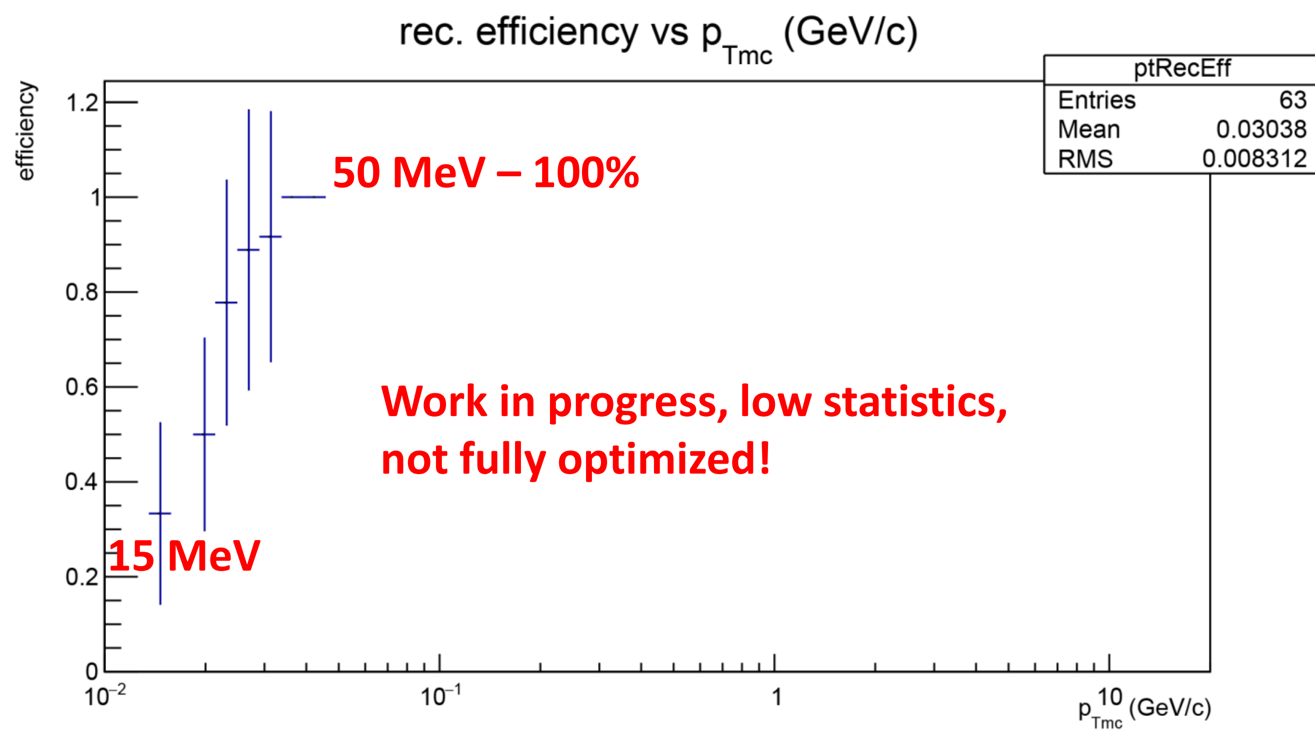
David Rohr

- General idea: extend "HLT" TPC tracking algorithm as low as possible in pT to find loopers in the same pass of synchronous reconstruction (comes for free).
  - Find, merge and fit helices with standard algorithm (bit relaxed tolerances and some special treatment): allow short "bad" legs, but accurate after merging.
  - Use inter-/extrapolation of helix for fast search of non-attached clusters (high inclination angle segments, two clusters in one row)
- Preliminary results:
  - Yet, only cuts removed such that low-Pt tracks are not rejected.
  - *Blue: Unused clusters*
  - *Purple: Segments found in first CA seeding phase where track prolongation did not find good track.*
  - *White: Track prolongation found track, but rejected later (cut, refit, merging).*
  - *Green: Final tracks*
- Tracks down to 30 Mev robustly found (at least 50% of legs).



Loop finding in TPC with HLT tracking

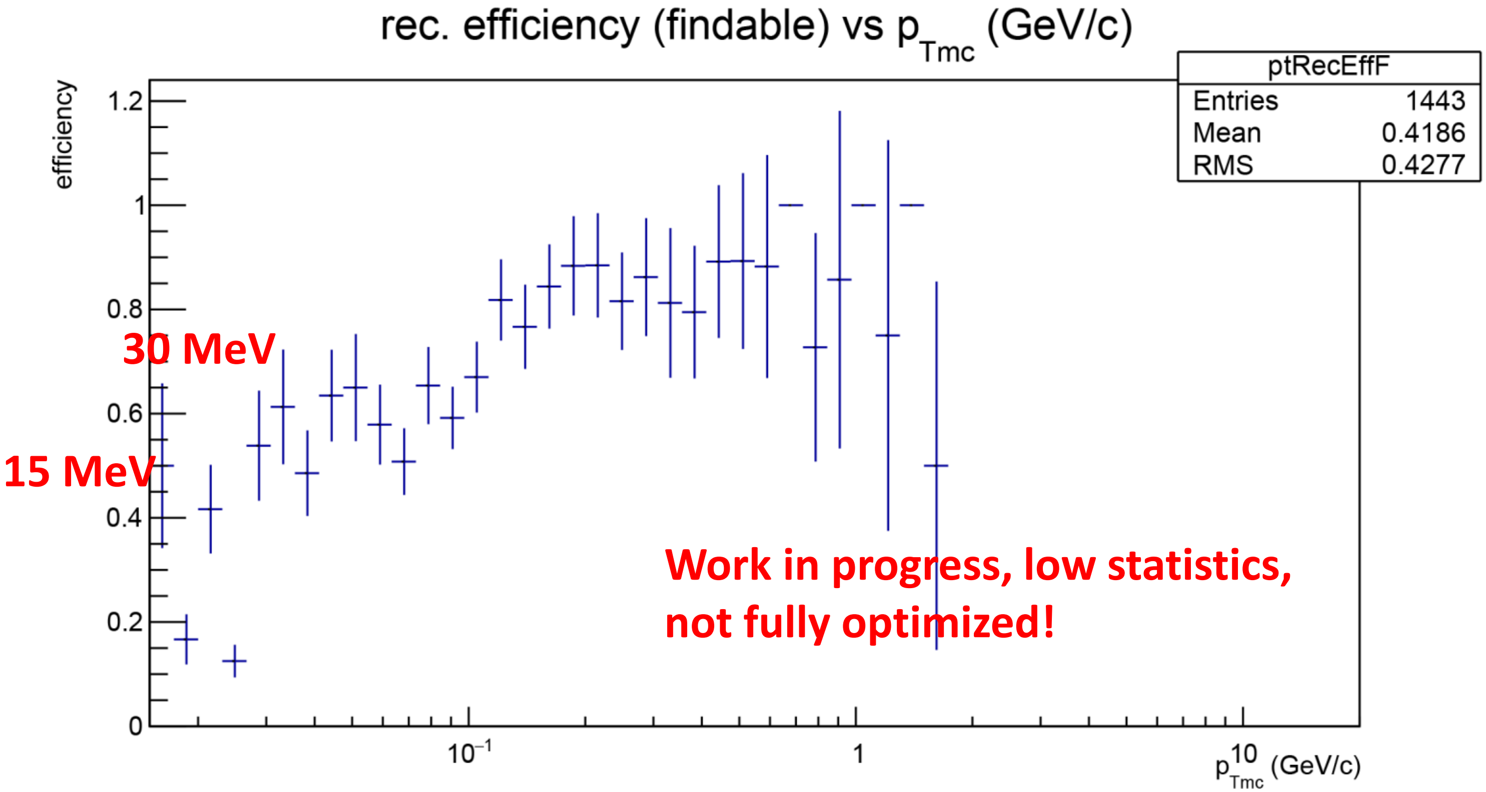
- ❑ First tests with single/few injected low-Pt tracks.
  - All tracks (> 30 MeV) principally found, but some not propagated.
  - Track finding works down to 15 MeV (r ~ 10cm) with decreasing efficiency.



- ❑ Several tracks are found, but rejected during refit. Work ongoing to improve this.

Loop finding in TPC with HLT tracking

- First tests with secondaries in Pb-Pb monte-carlo (0-100% centrality)



- Only tracks with at least 70 hits in the TPC (findable).
- Still, several unfindable tracks in there (looping at end of TPC, only high inclination Angle, etc.)
- In addition, regression in HLT CA tracking efficiency affects the results, still investigating.
- Compared to baseline (200 MeV to 1 GeV), only 20% degradation at 30 MeV.

Related online tracking improvements

- Many improvements and clean up performed for this study (needed anyway for O2 tracking).
  - Rejection of clusters in Refit (before fit was aborted, particularly important for “bad quality” low-Pt tracks.
  - Three-way fit (in – out – in).
    - This is supposed to improve TRD tracking as well (propagation of outer track parameters still needs to be implemented).
  - A couple of fixes for running HLT components on MC data (most importantly, MC data needs timestamps for new TPC distortion calibration (was 0 before). The whole HLT emulation framework for digits did not support timestamps.)
  - Improvement of cluster ordering for refit for merged low-Pt legs.
  - Lack of some MC-related reconstruction information during QA (number of clusters per MC track), now stored in special extra tree on demand.

- Still missing:
  - Merging still insufficient for low-Pt loopers (requires far extrapolation, not possible for small helixes).
  - Understand why track-following and refit still fails for some low-Pt tracks.
  - Correct propagation that is aware of multiple legs.
  - Merging of helixes over sector boundaries (currently, can merge only one side of the helix).

TPC data compression

- Details presented in next talk:
  - Using new HLT hardware cluster finder and reduced precision for cluster charge and width, data compression can improve by factor 1.47.
  - By adding track-model compression, we estimate a total compression factor of 9.1 for O2.
  - Assumptions for this factor validated during HLT HWCF validation.

Online tracking conclusions

- Confident that we can find tracks down to 30 MeV with current CA tracker (with some tuning).
- Extendable down to 15 MeV with some efficiency degradation.
- Some technical issues need to be solved for proper merging and fitting.

- Online tracker will create two lists of clusters attached to tracks:
  - Clusters used for track fit (this is what we have today).
  - Other clusters not used for the fit of other tracks, most likely belonging to the track (2 hits per row, high inclination angle, low-Pt looper).
- This second list can be used for rejecting clusters of tracks not used for physics, but also for better track-model compression.

- All new developments directly applicable for O2.
  - Tracking and compression developed as standalone code, executable within AliRoot, or O2, or totally standalone.
- HLT tracking runnable for O2 data using the standalone version already know, by dumping clusters and tracks in binary format (pretty inconvenient).
  - Work on a real O2 interface started.

- The seed information **(purple hits)** from the HLT could be used in an afterburner step to find more very-low Pt tracks. (E.g. Huff-transform on clusters in seeds that did not make it into a final track. CA tracker algorithm alone insufficient due to excess of bad seeds in high multiplicity Pb-Pb events.