Events and tracking selection in ALICE

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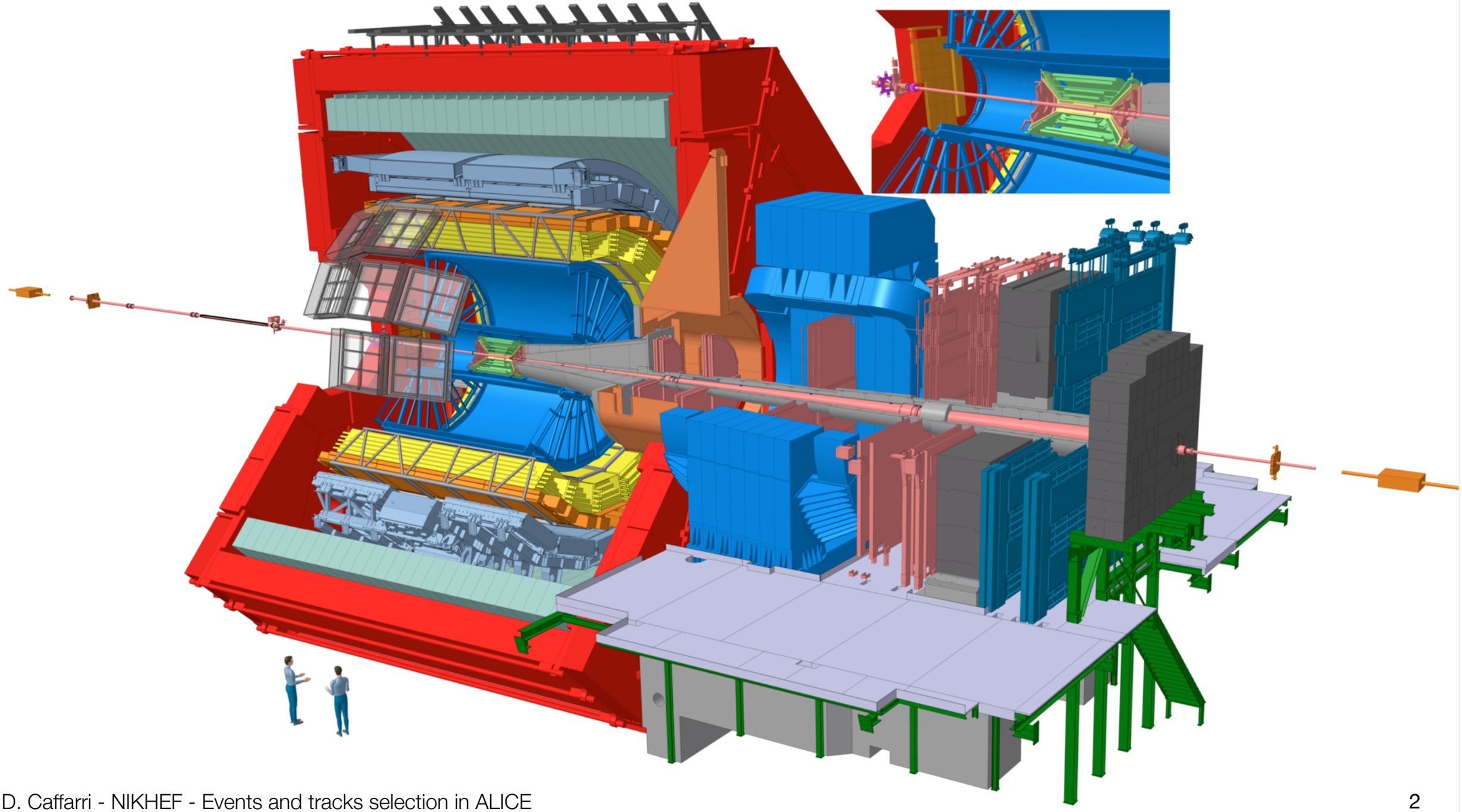
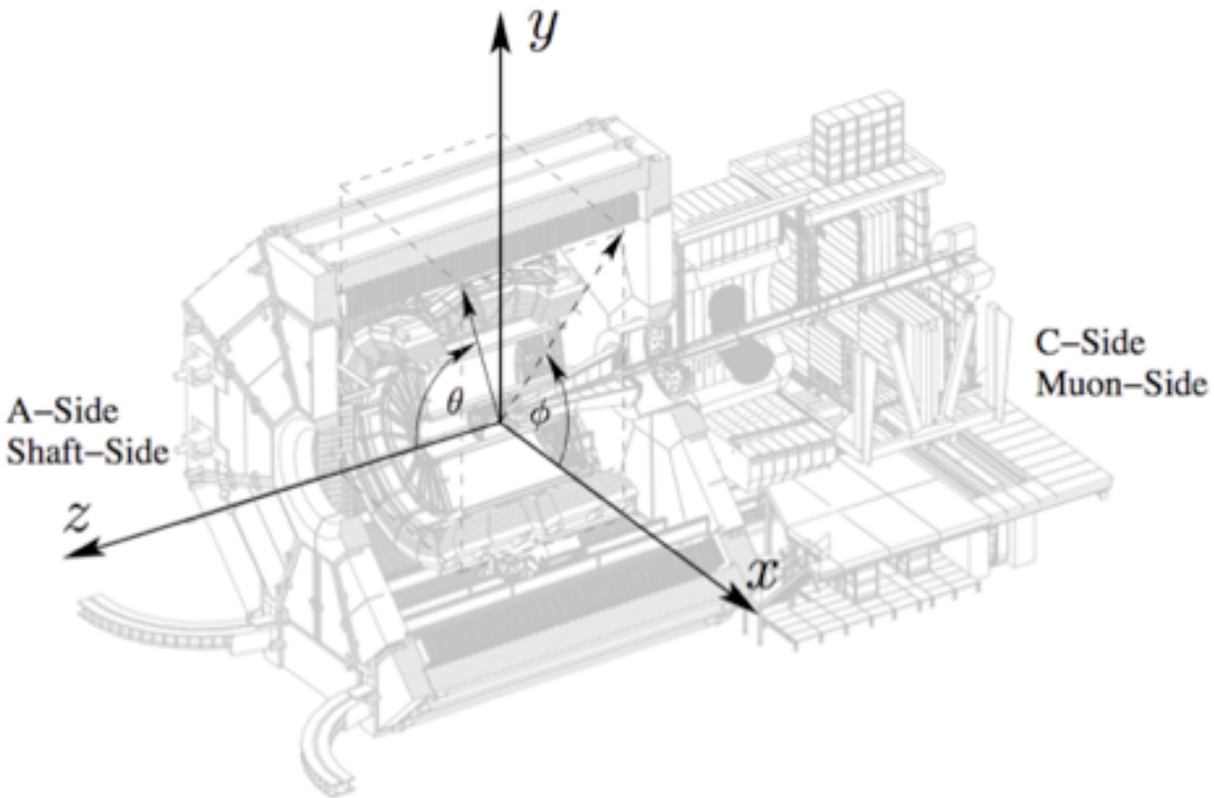
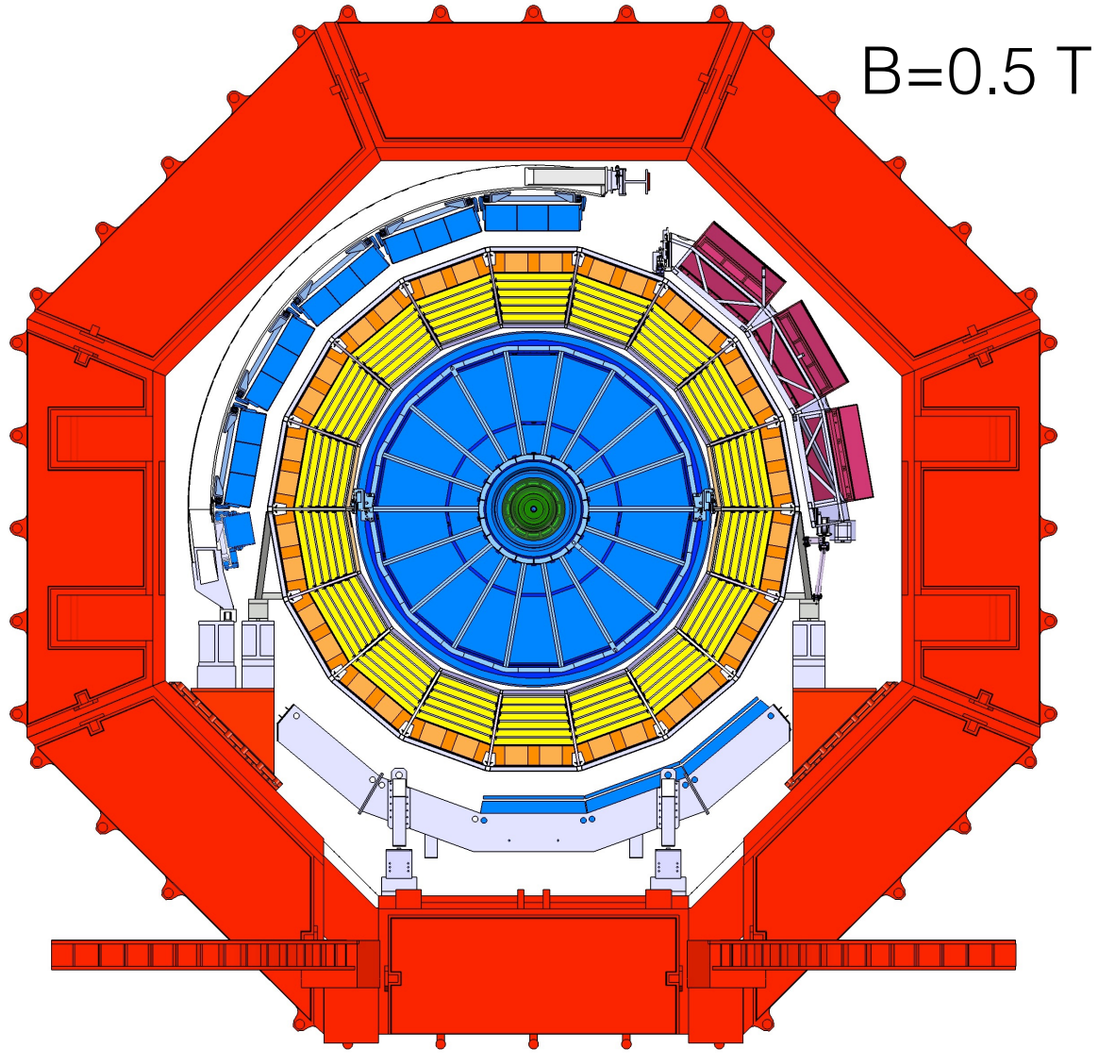
ALICE
A JOURNEY OF DISCOVERY

A Large Ion Collider Experiment (ALICE)



Kinematic variables





transverse momentum $p_{\mathrm{T}} = p\sin(\theta_{\mathrm{CM}})$

rapidity relative to the beam axis i.e. longitudinal angle of emerging particle

$$y = \frac{1}{2}\ln\frac{E + p_z c}{E - p_z c}$$

if $m \ll p \Rightarrow E \approx p \Rightarrow \eta \approx y$

$$\eta = -\ln\left[\tan\left(\frac{\theta_{\mathrm{CM}}}{2}\right)\right]$$

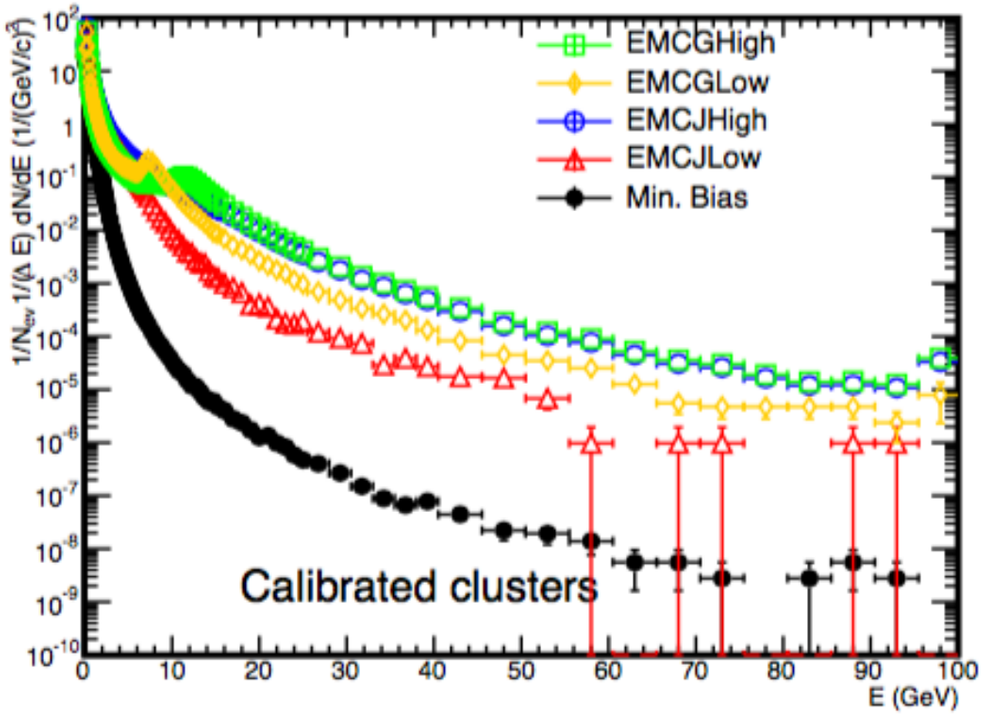
Δη is Lorentz invariant under boost along longitudinal axis

ALICE Trigger

- Due to the high luminosity of the LHC, not all pp collisions can be registered:
  - Trigger is fundamental, in particular for ATLAS, CMS, LHCb
  - Important also for ALICE but our scheme are simpler.

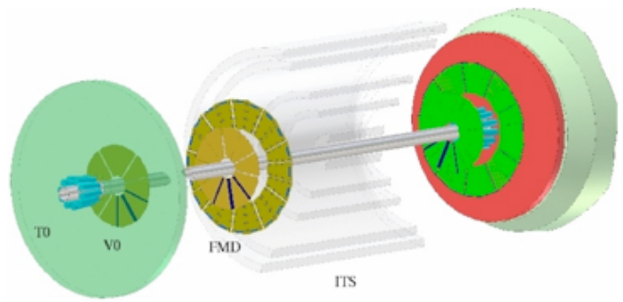
- A trigger is an online selection that decide if an event has to be stored or not
  - usually based on an algorithm that decide if an event is “interesting” or not.
  - looking for “special signatures” in the event (H → 2Z → 4μ)
  - important to be fast and efficient

- Triggers allow to enhance the number of rare probes wrt a general sample of events without any selection



ALICE Trigger

- In ALICE we have few triggers the ones you might be interested:
  - Minimum Bias (the looser we have) kMB - 1 hits in the SPD | 1 in one of the two scintillators of the V0
  - kINT7 - at least 1 hit per V0 hodoscope
  - Centrality trigger. Used in PbPb 2011 data to enhance the number of events in central and semicentral collisions.
  - High Multiplicity Trigger - threshold on the number of tracks in the events Used to enhance High multiplicity events
  - Muon triggers - single muons, di-muons, …
  - Electron Trigger - EMCAL, TRD
  - Jet trigger - EMCAL
  - …



- Two arrays of plastic scintillators
- located at z ~340 cm (V0A) and -90 cm (V0C)
  - $2.8 < \eta < 5.1$ (V0A)
    $-3.7 < \eta < -1.7$ (V0C)

In your analysis be sure which trigger your are selecting!

ALICE Trigger

In your analysis be sure which trigger your are selecting!

- In your AddTask or RunMacro add the line:

```
myTask -> SelectCollisionCandidates(AliVEvent::kINT7)
```

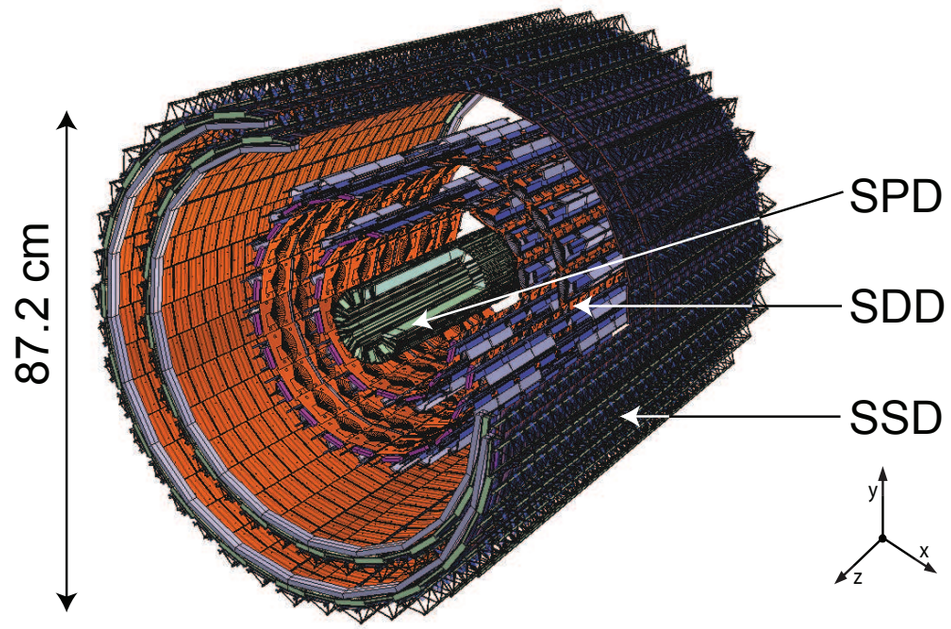
method of AliAnalysisTaskSE that takes into account the trigger selection

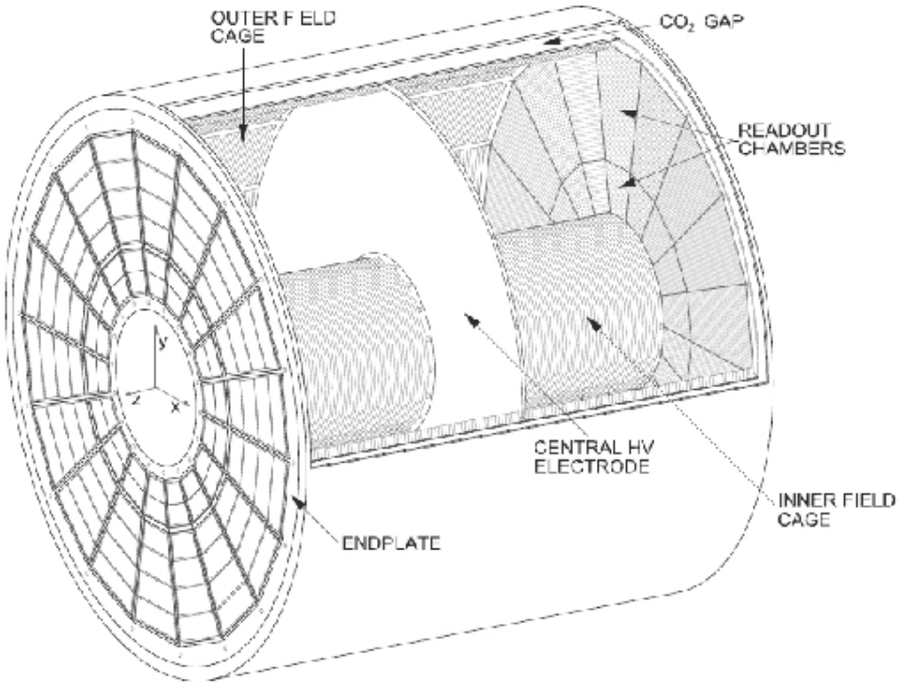
if you plan to run over different data samples (that might have different trigger) think how to do this configurable…

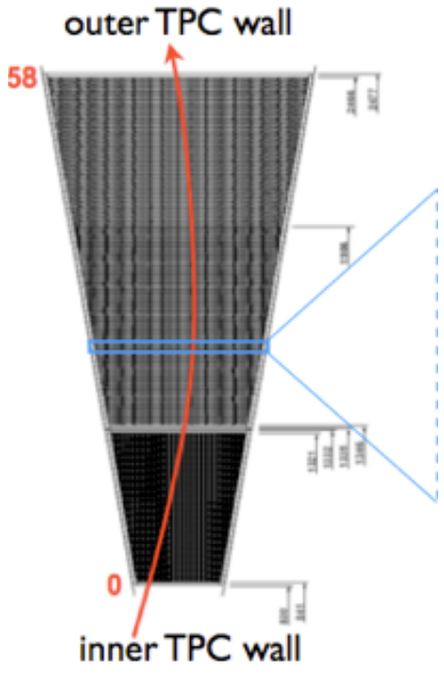
Recap: ALICE tracking devices

- Inner Tracking System (ITS)
  - Silicon Pixel Detector (SPD)
  - Silicon Drift Detector (SDD)
  - Silicon Strip Detector (SSD)

Max Nb of “points” in the ITS: 6



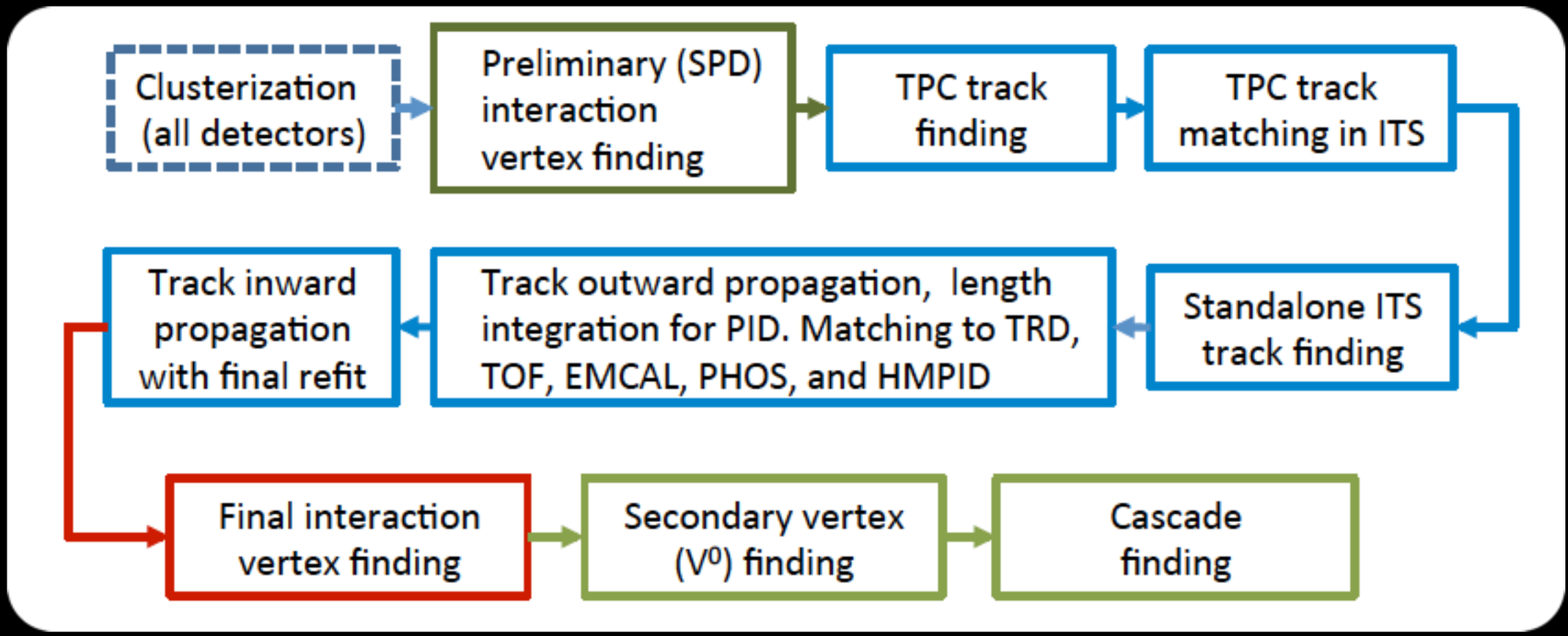




- Time Projection Chamber:
  - x,y from MWPC at the endcaps
  - z from drift velocity and time

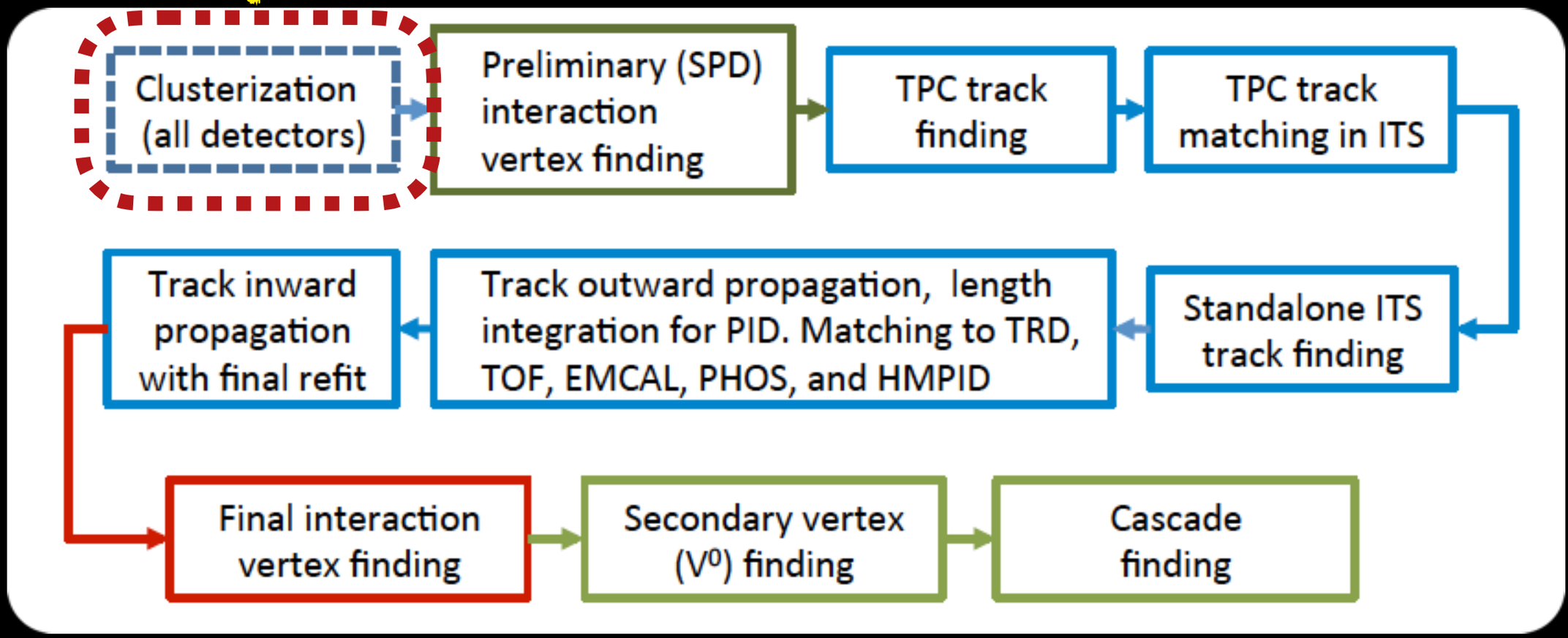
Max Nb of “points” in the TPC: 159

Central barrel tracking in a nutshell

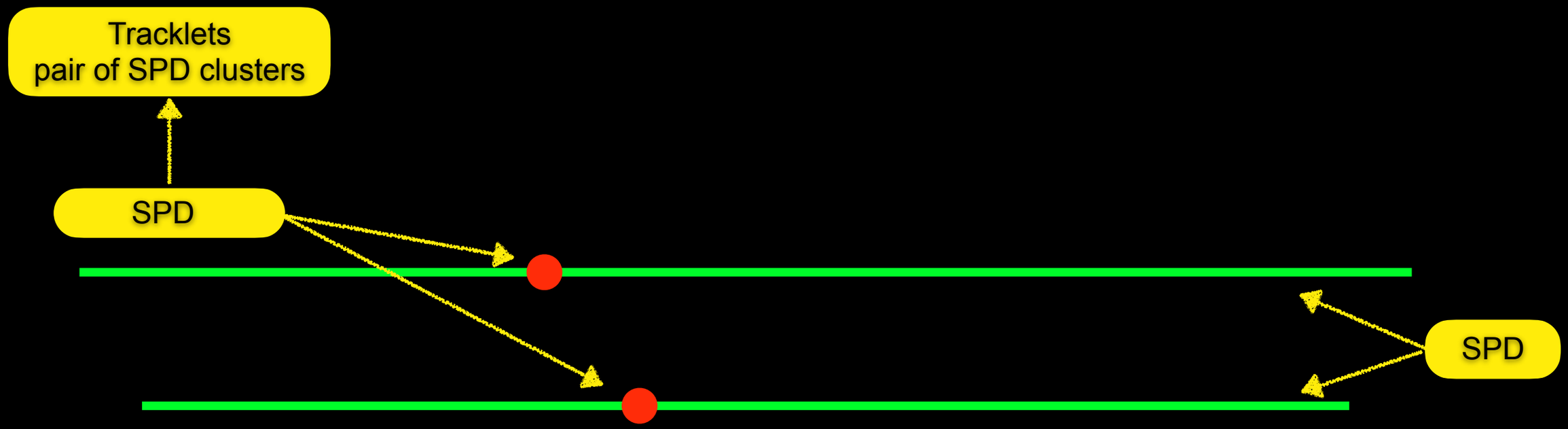


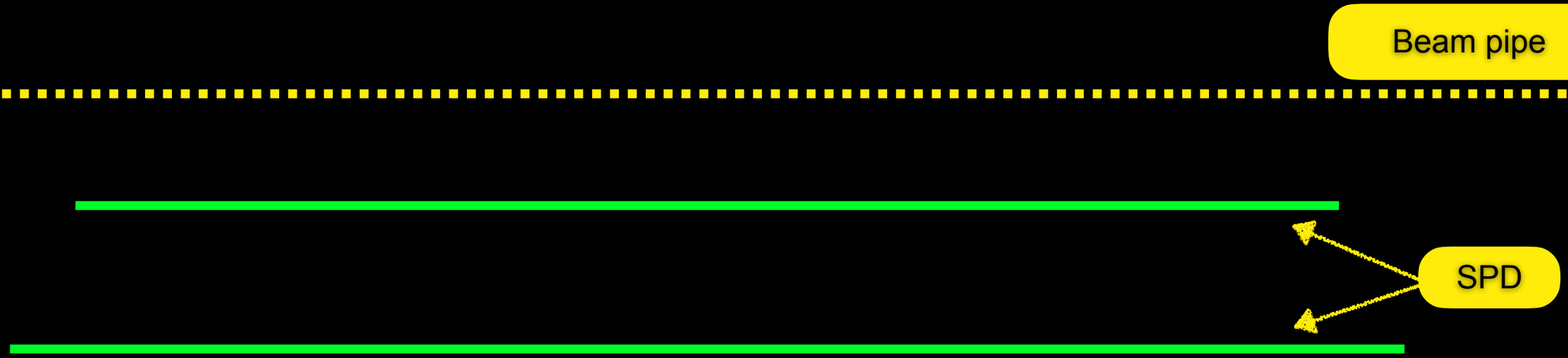
Central barrel tracking in a nutshell

- separately for each sub-detector
- position/amplitudes/times + errors



(Preliminary) Vertex finding





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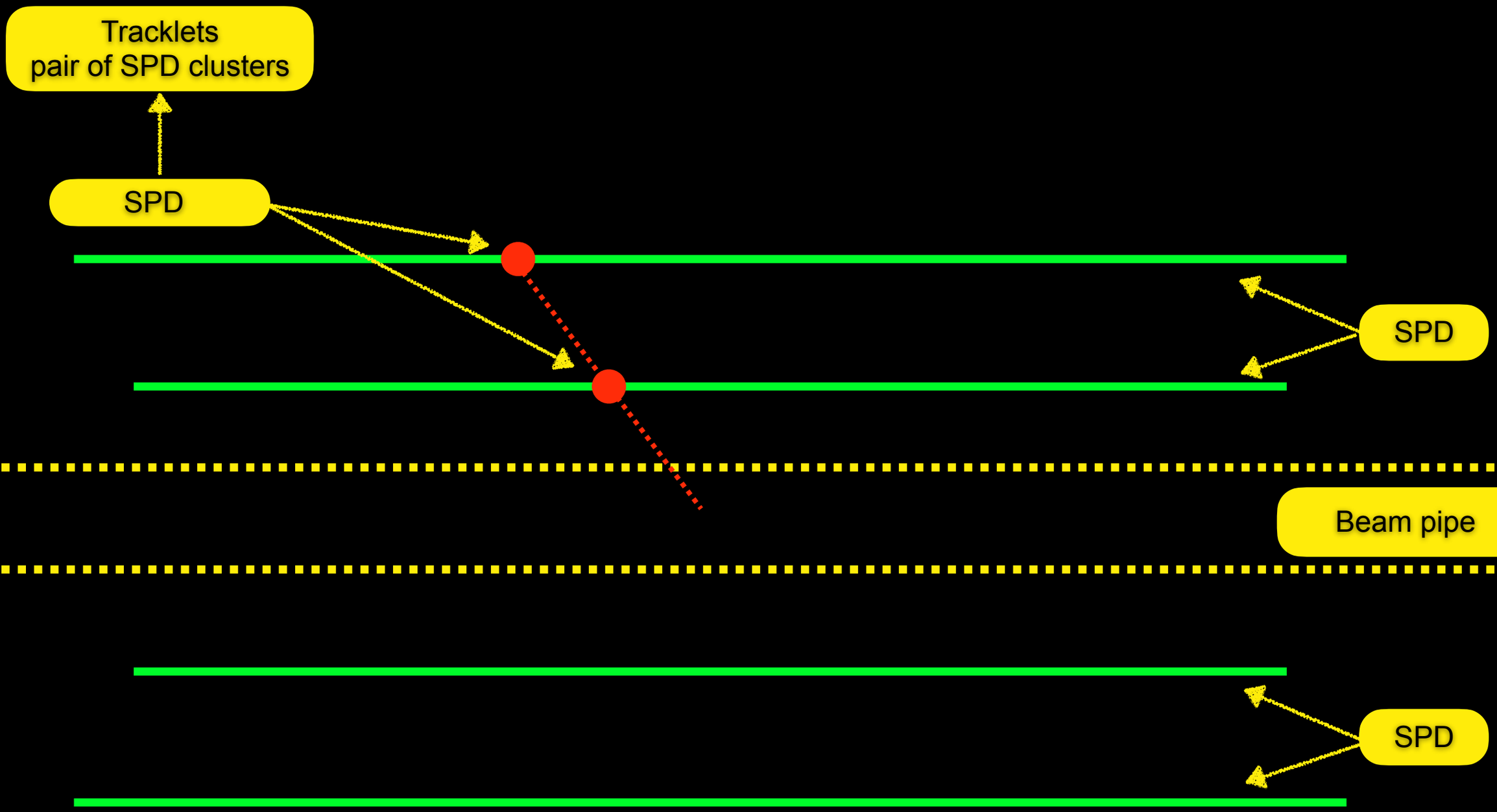

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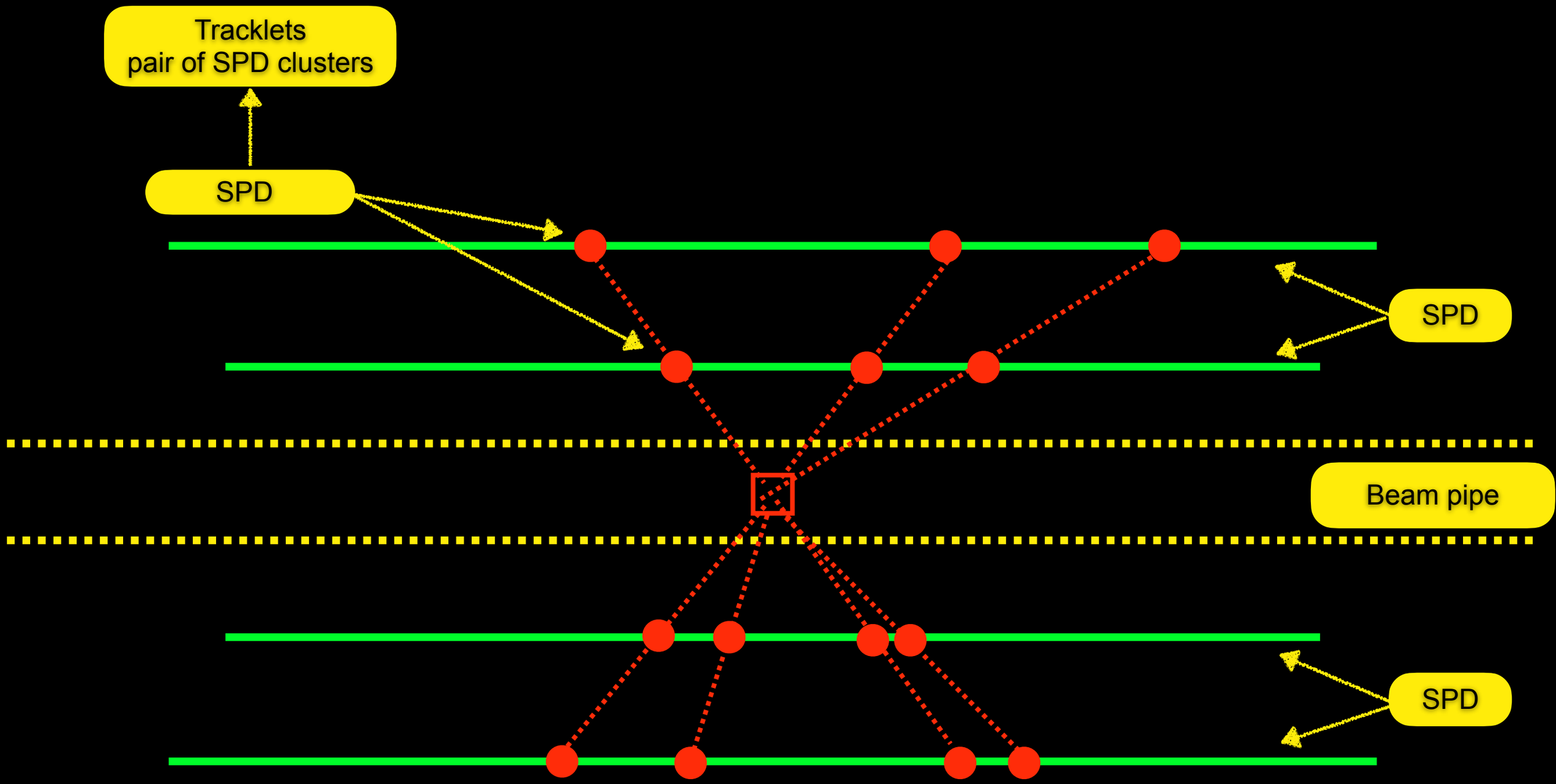


(Preliminary) Vertex finding

Tracklets
pair of SPD clusters

SPD

SPD

Primary vertex

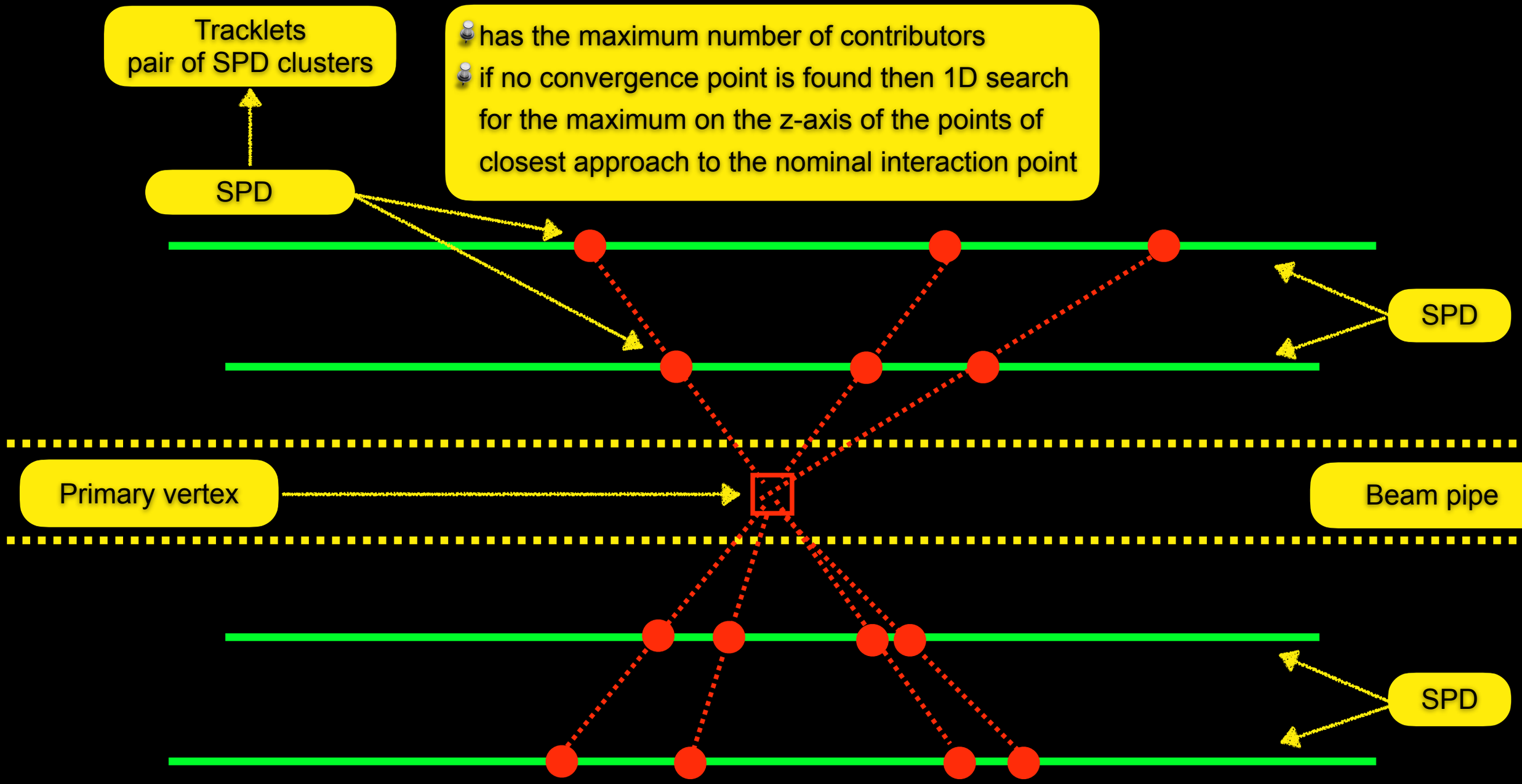
Beam pipe

SPD

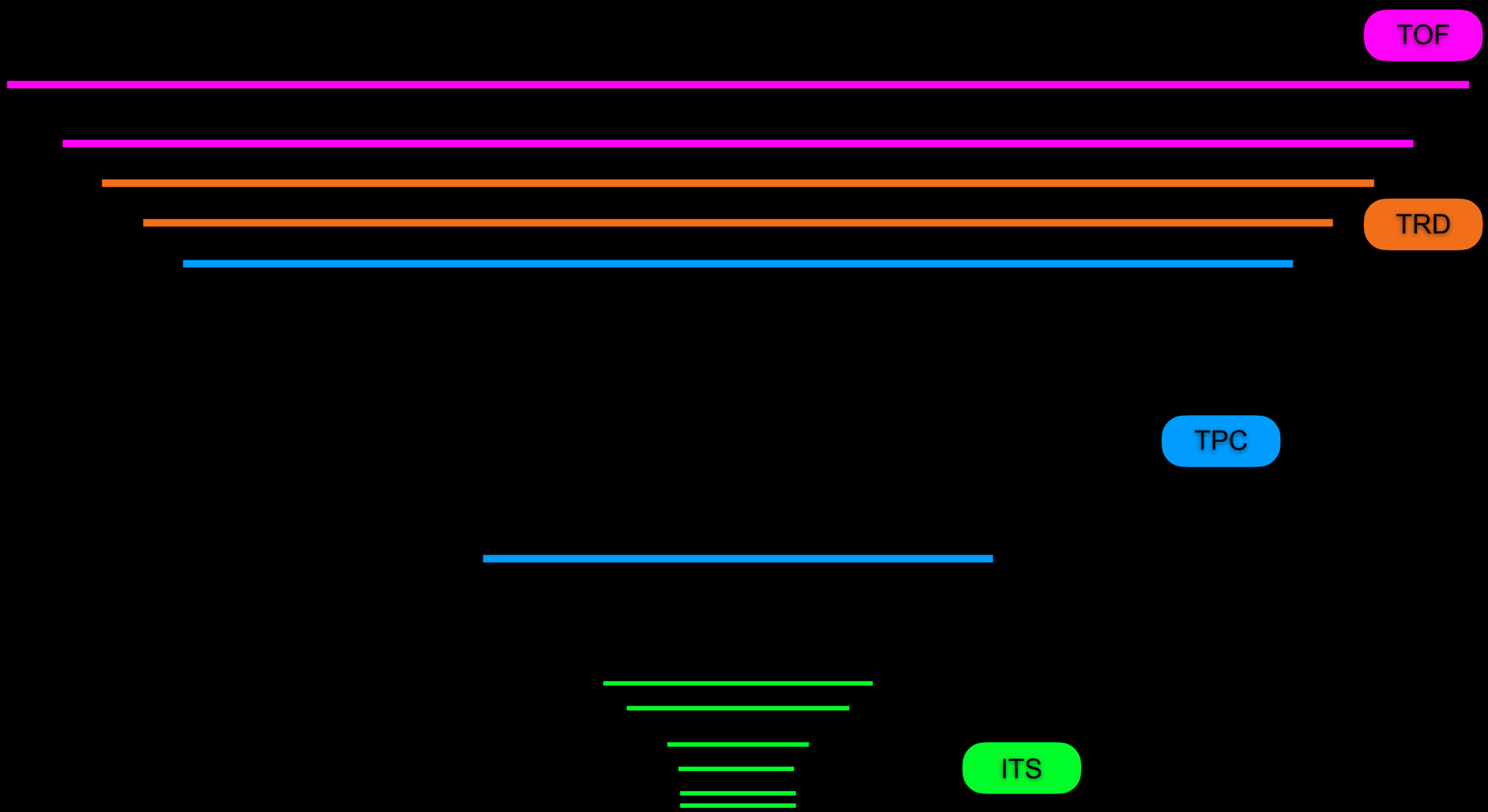
(Preliminary) Vertex finding

Tracklets
pair of SPD clusters

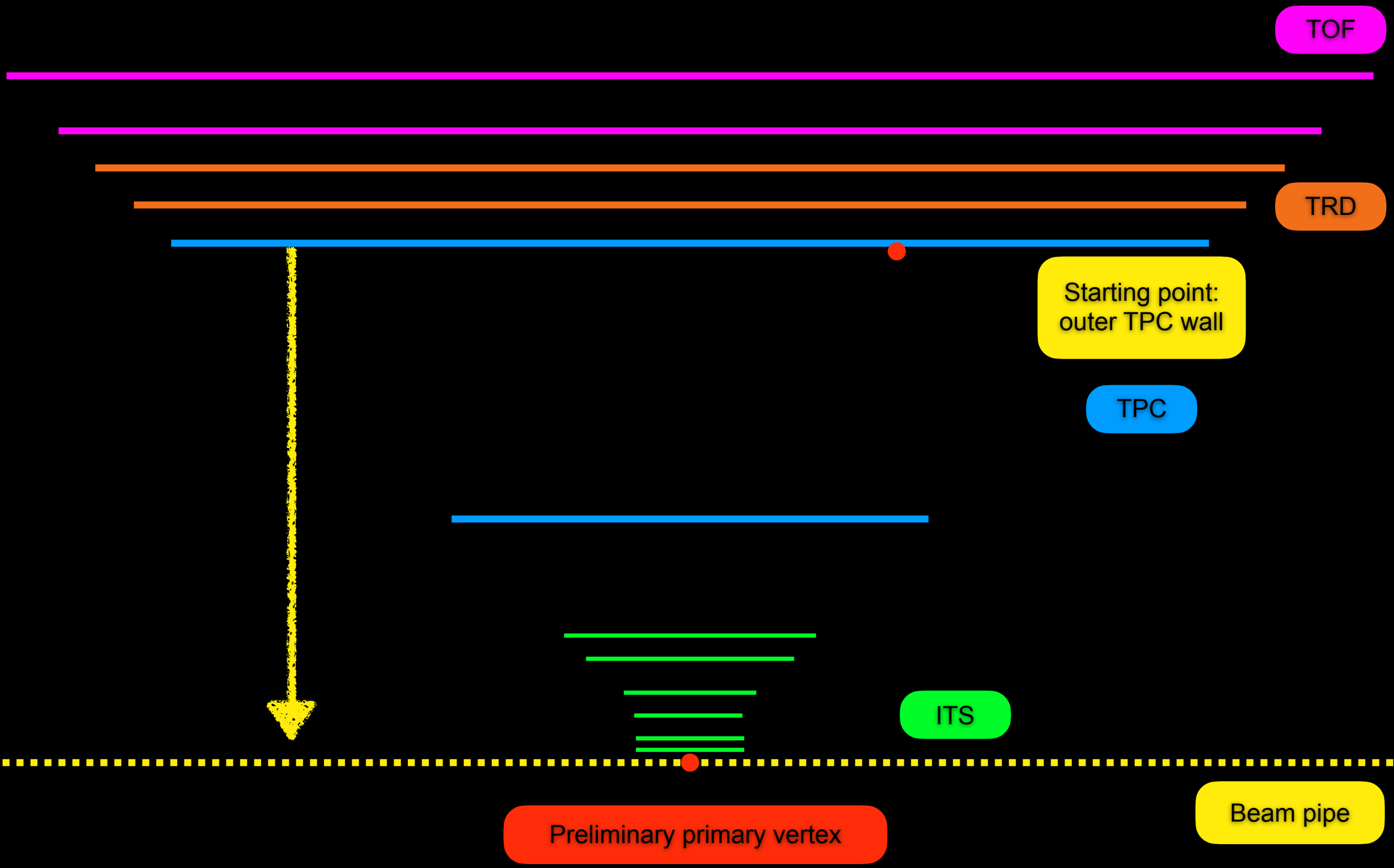
- has the maximum number of contributors
- if no convergence point is found then 1D search for the maximum on the z-axis of the points of closest approach to the nominal interaction point



Tracking



Tracking: 1st iteration



Tracking: 1st iteration

TOF

TRD

TPC

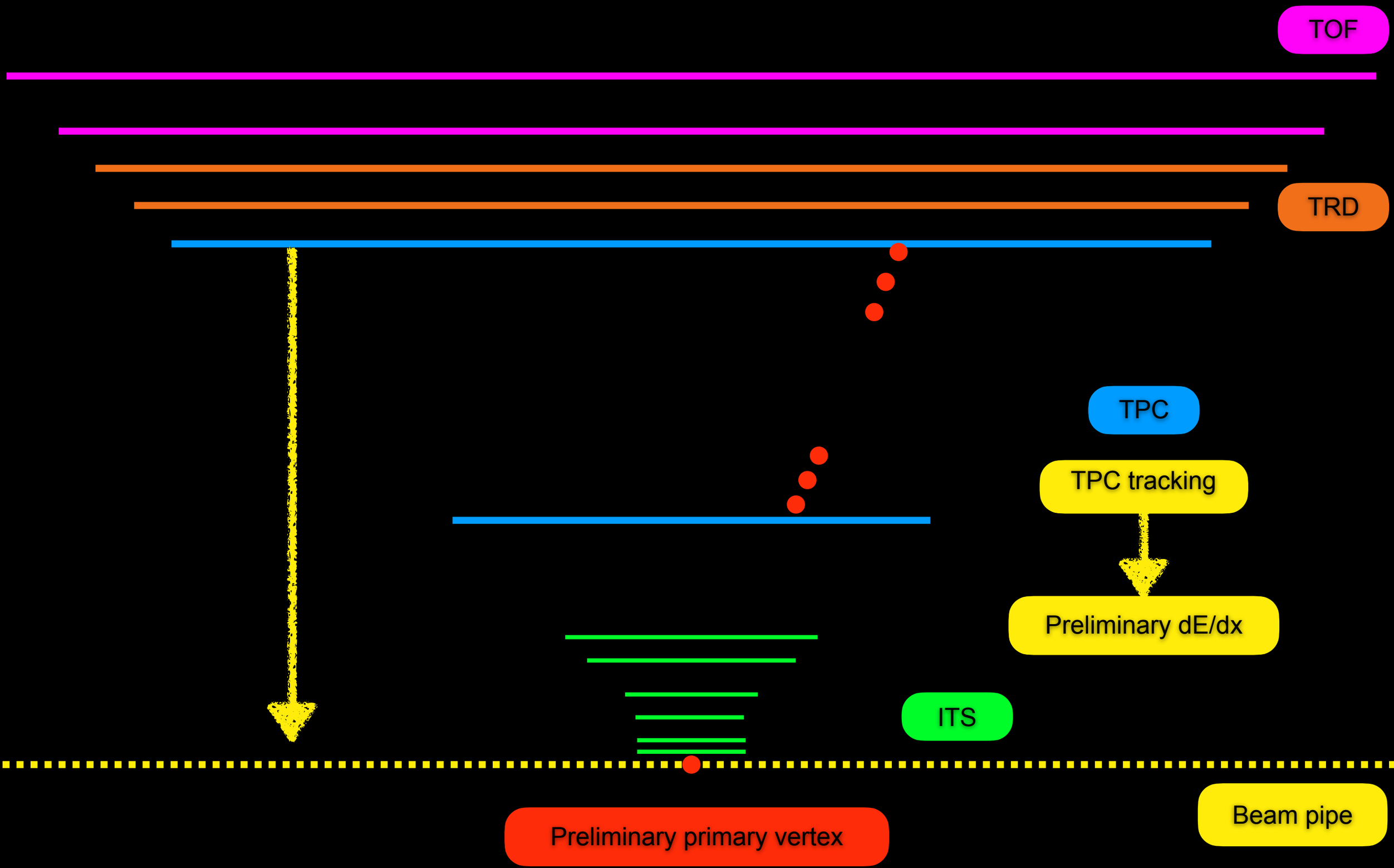
TPC tracking

ITS

Beam pipe

Preliminary primary vertex

Tracking: 1st iteration

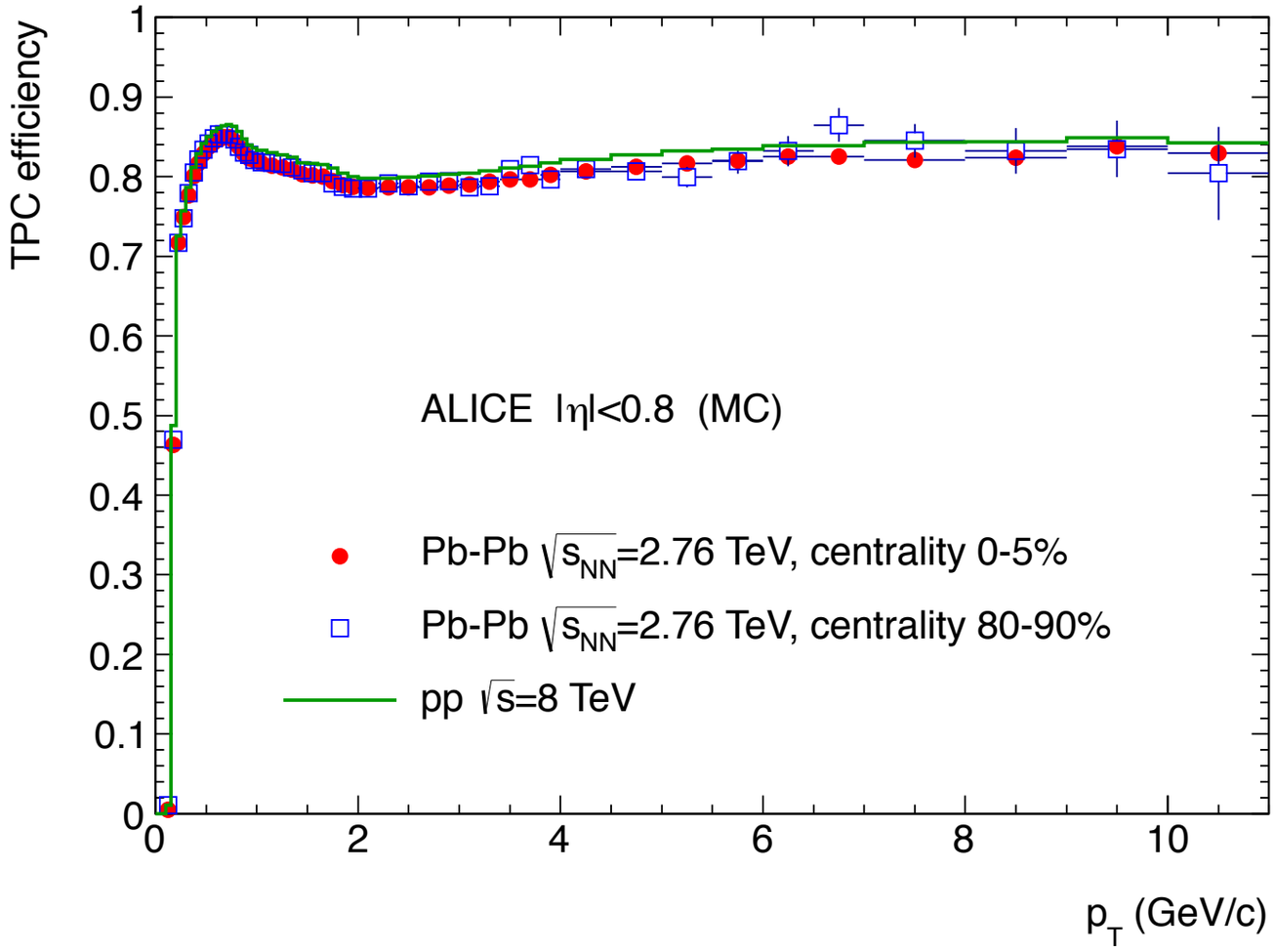


Track Finding Efficiencies

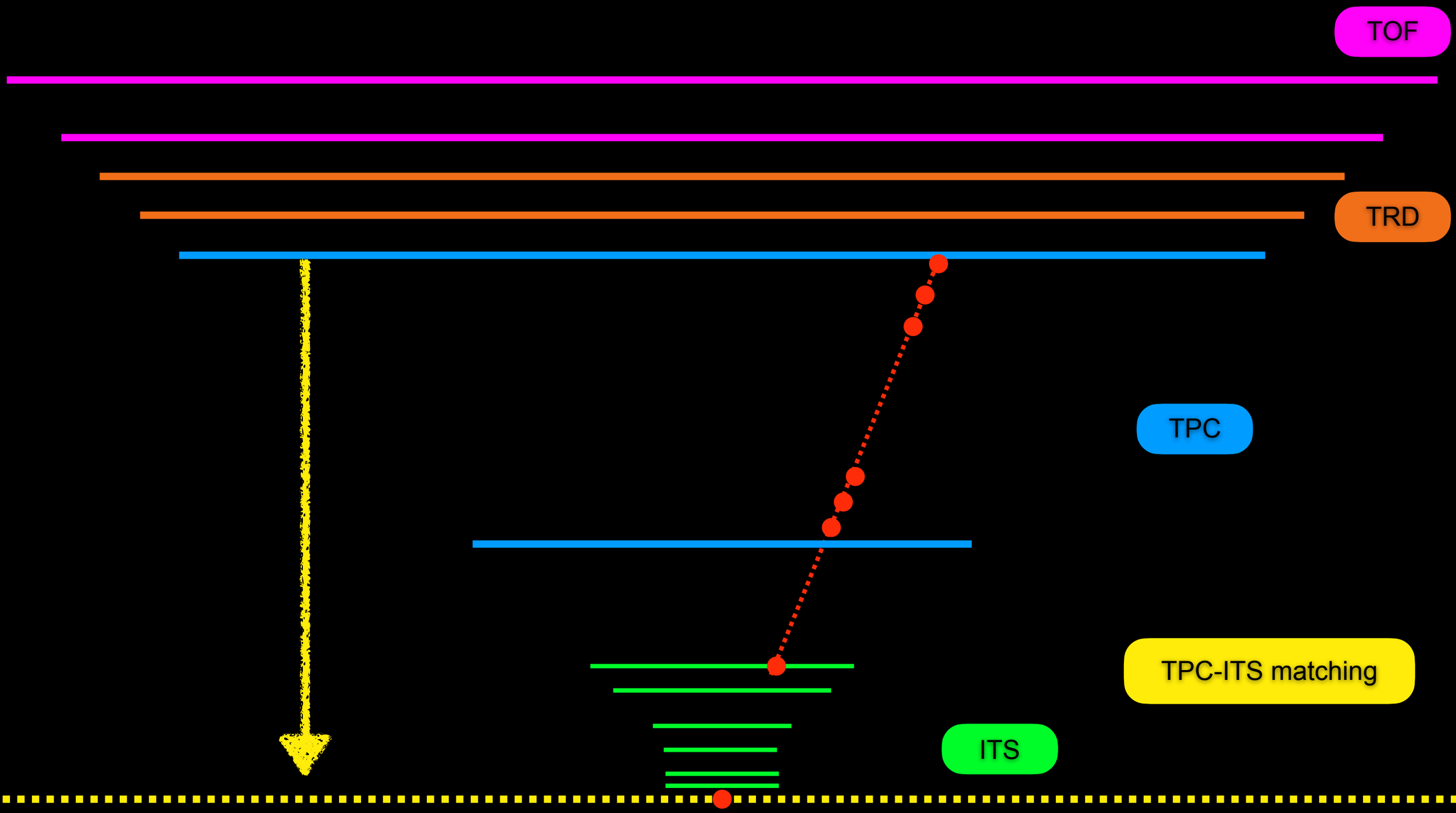
- TPC efficiency = Nb of reconstructed tracks / Nb of generated tracks

- Very similar results in pp, peripheral Pb-Pb and central Pb-Pb collisions

- Drop at 500 MeV due to energy loss in the material



Tracking: 1st iteration



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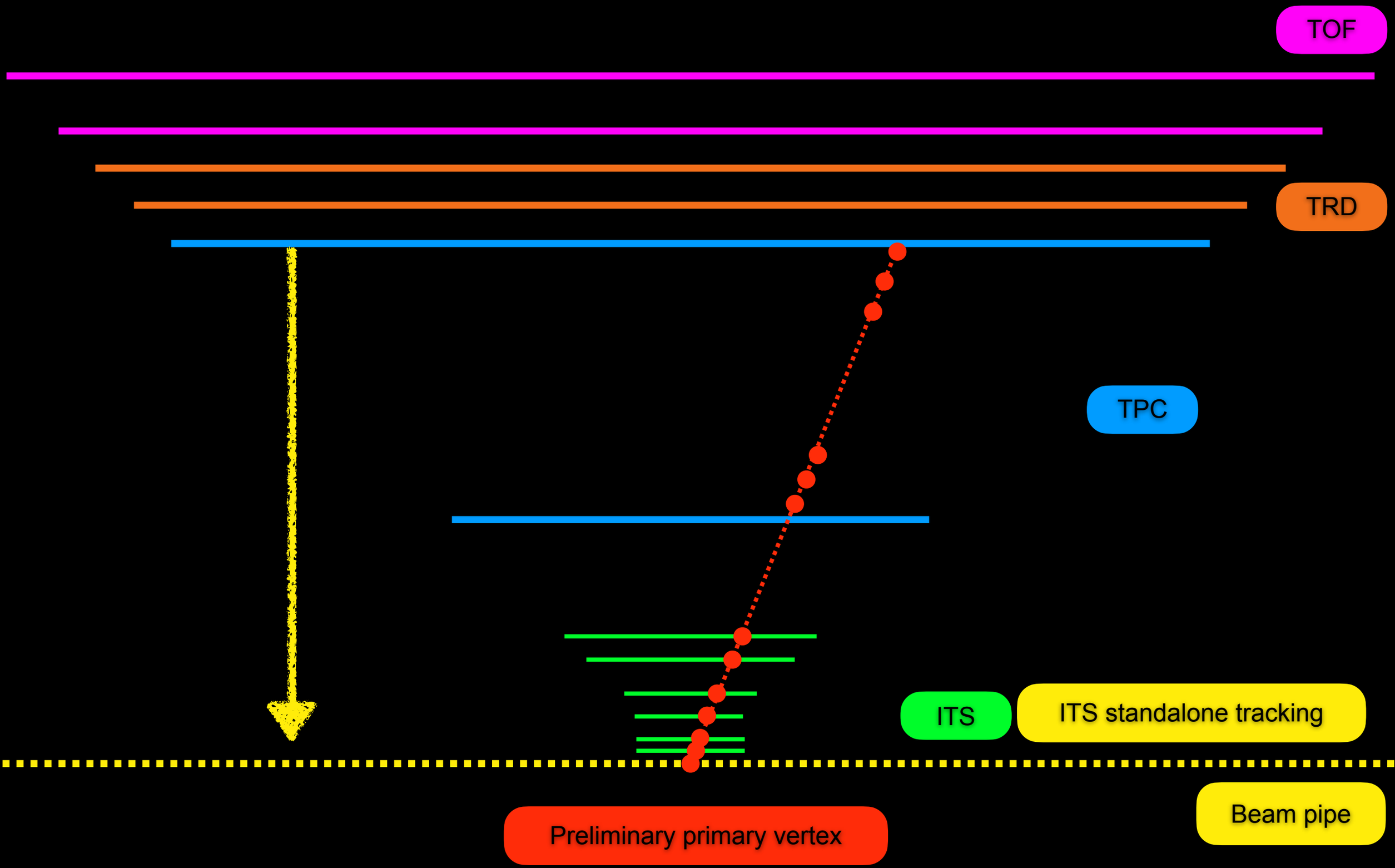
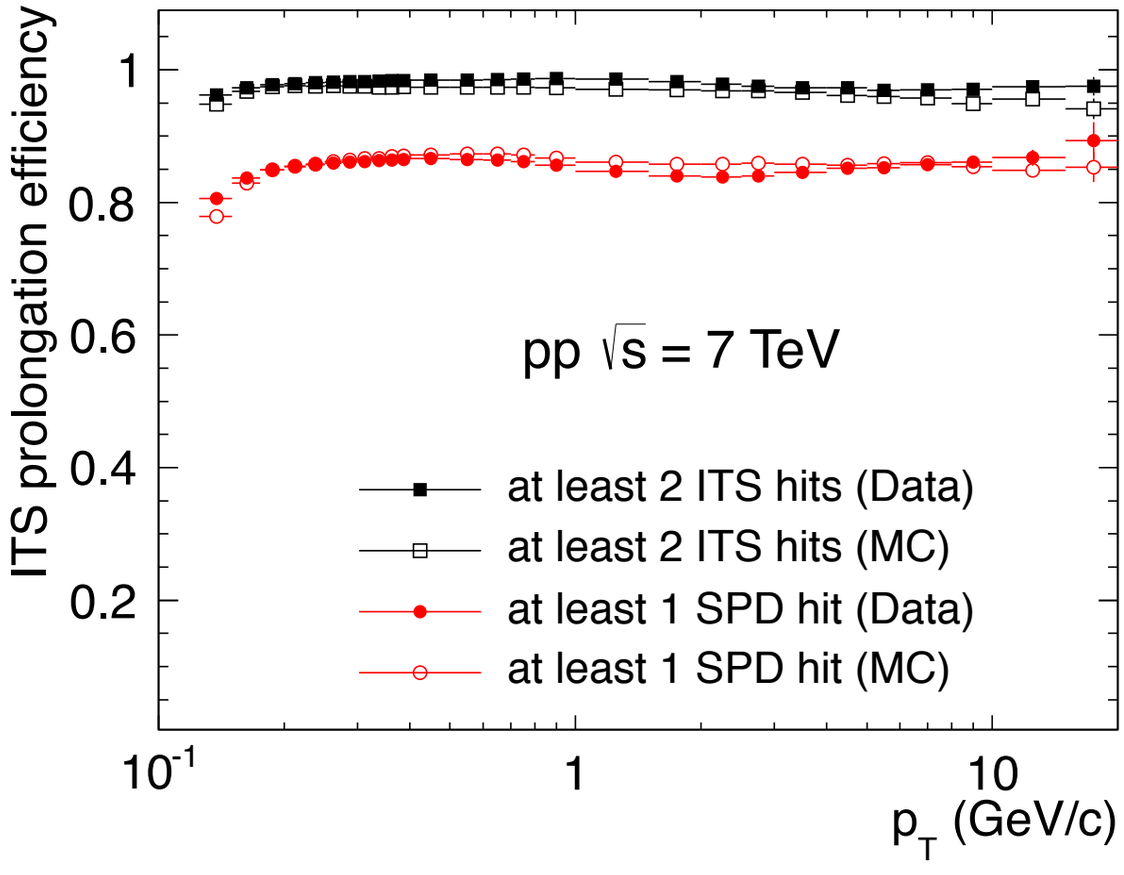
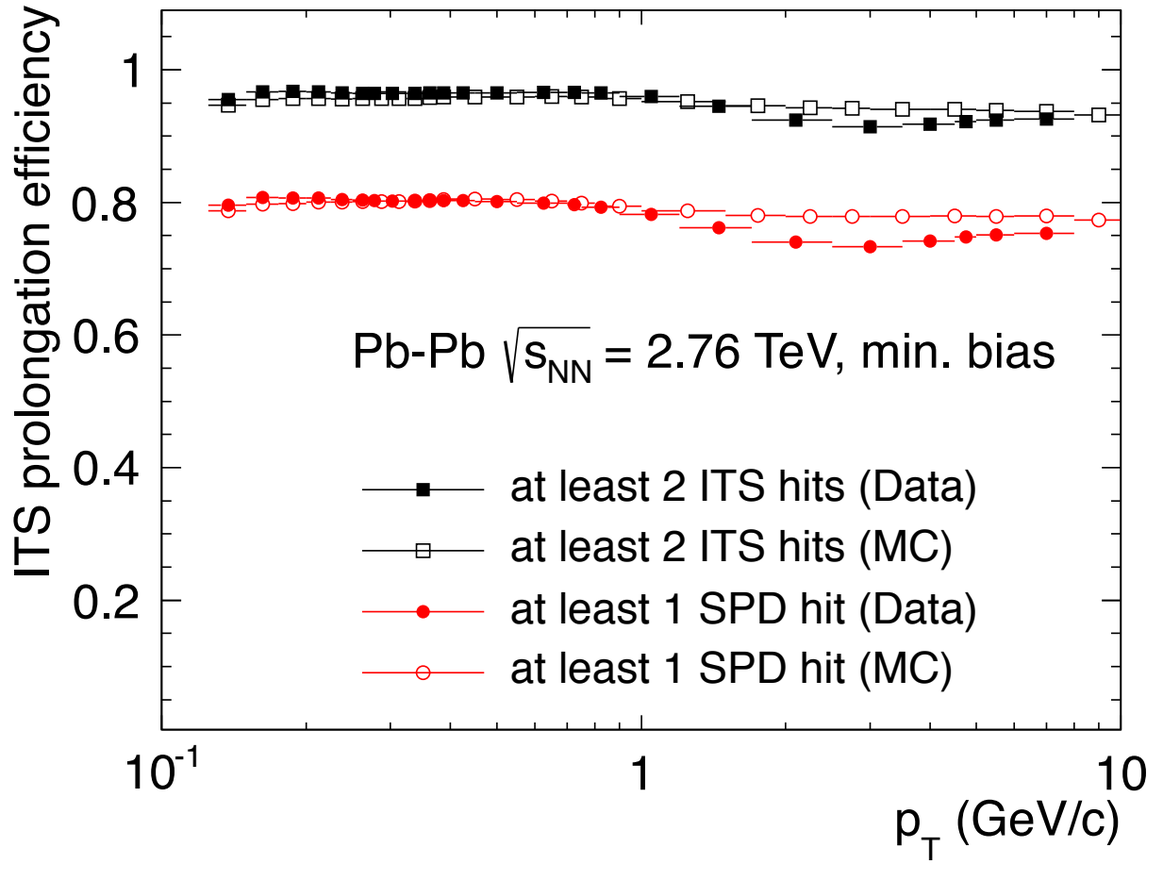


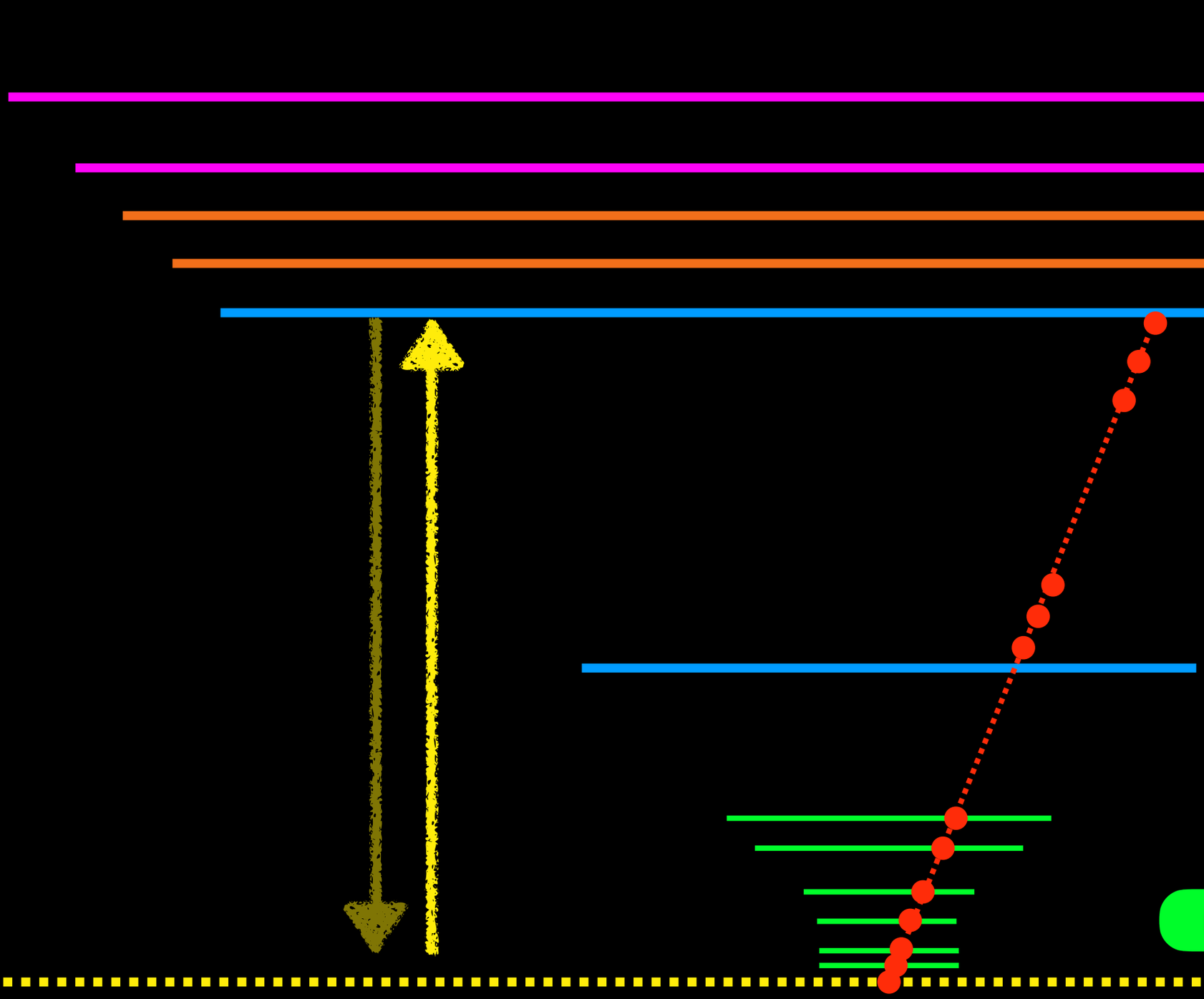
ITS Prolongation Efficiencies





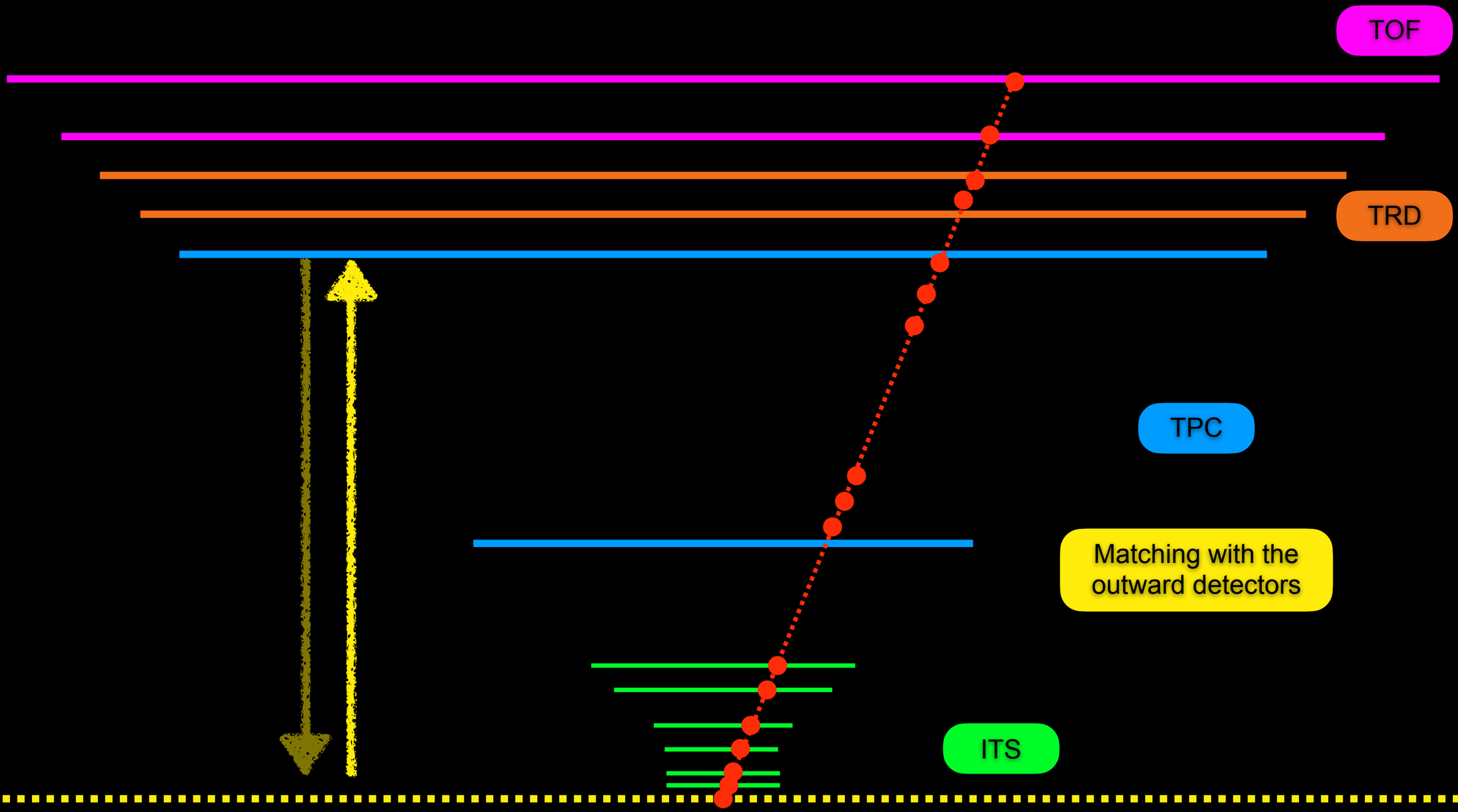
- Nb of tracks matched in the ITS / Nb of tracks reconstructed in the TPC
- Very similar results in pp and Pb-Pb collisions. Very good agreement between data and MC.
- Dependency on the requirement you make on the track itself.

Tracking: 2nd iteration

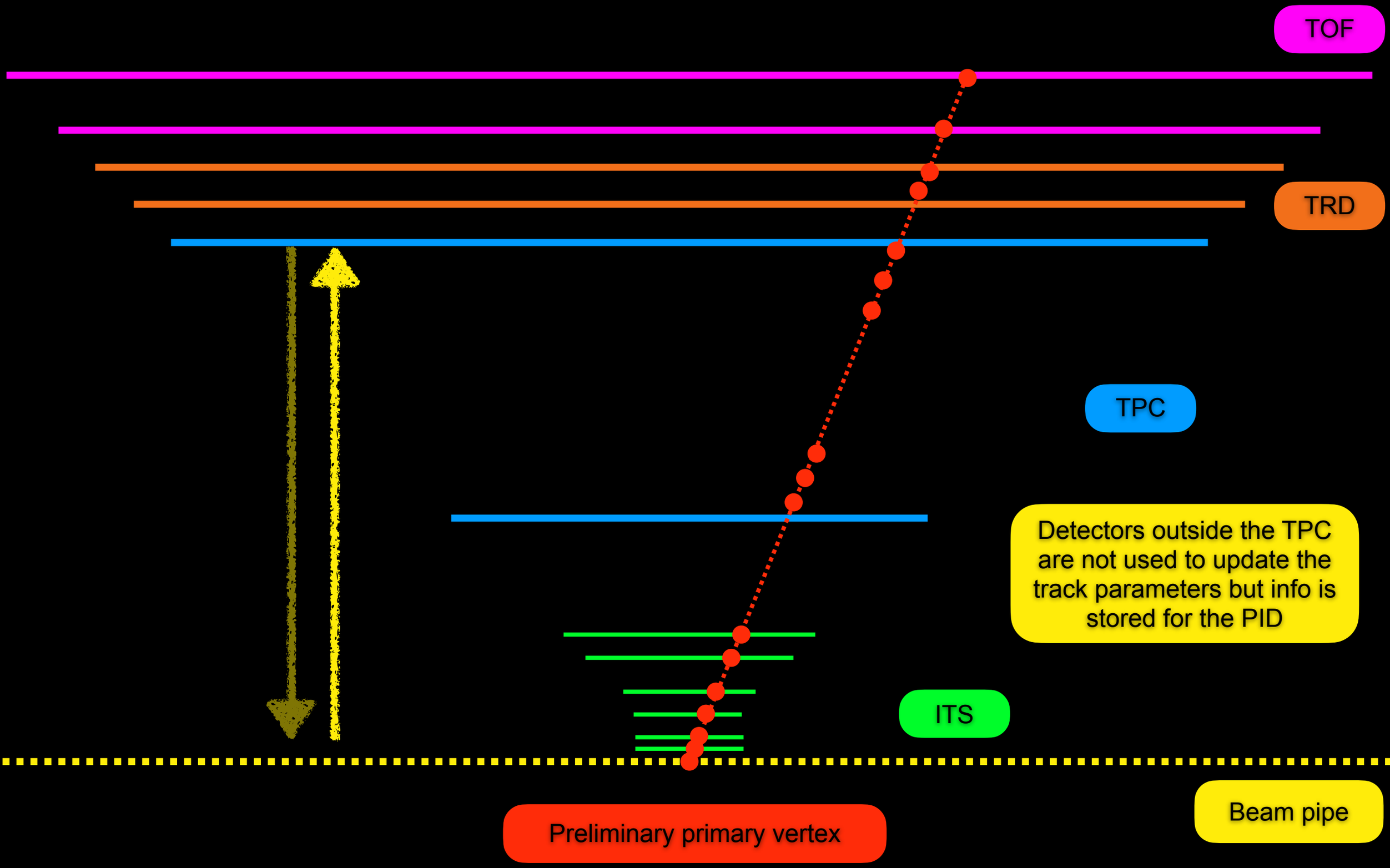


- outwards propagation using the same clusters found before
- track length integral & time of flight calculated for every particle species hypothesis

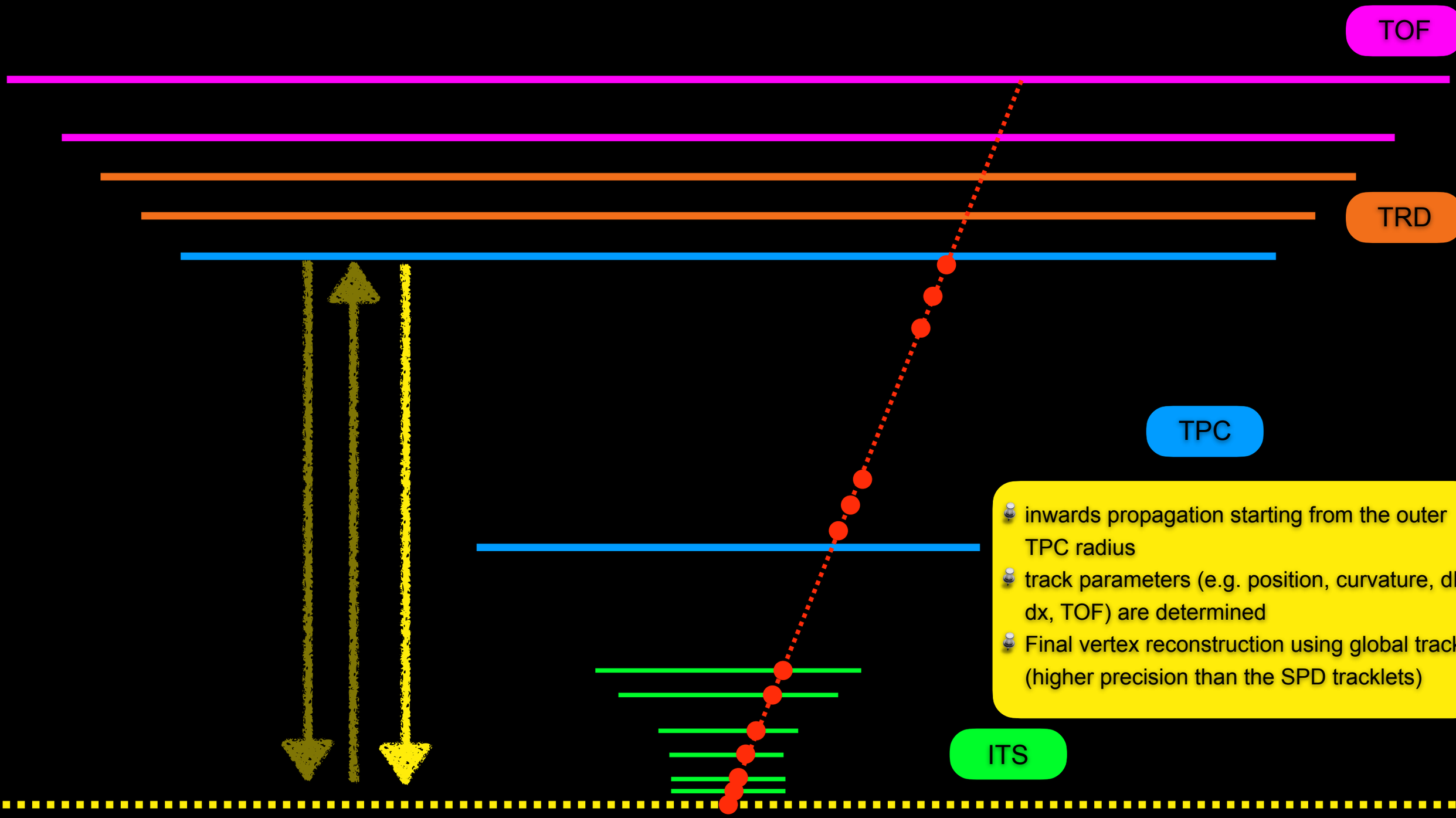
Tracking: 2nd iteration



Tracking: 2nd iteration



Tracking: 3rd iteration (refit)



- inwards propagation starting from the outer TPC radius
- track parameters (e.g. position, curvature, dE/dx, TOF) are determined
- Final vertex reconstruction using global tracks (higher precision than the SPD tracklets)

Type of reconstructed tracks

- The tracks reconstructed are mainly primaries
  - ★ Tracks coming from the primary collision
- The tracking algorithm is also able to reconstruct tracks that do not originate from the primary vertex:
  - ★ Secondary tracks ➡ products of weak decays of particles (e.g. $\Lambda \rightarrow p\pi^-$)
  - ★ Background tracks ➡ products of the interaction of a particle with the detector material
- In the majority of the analyses we are interested in **primaries**
- How do we distinguish between those three categories? How do we “get rid” of the other guys?
  - ★ Applying a dca (distance of closest approach) cut we can reduce the contamination from both secondary and background tracks

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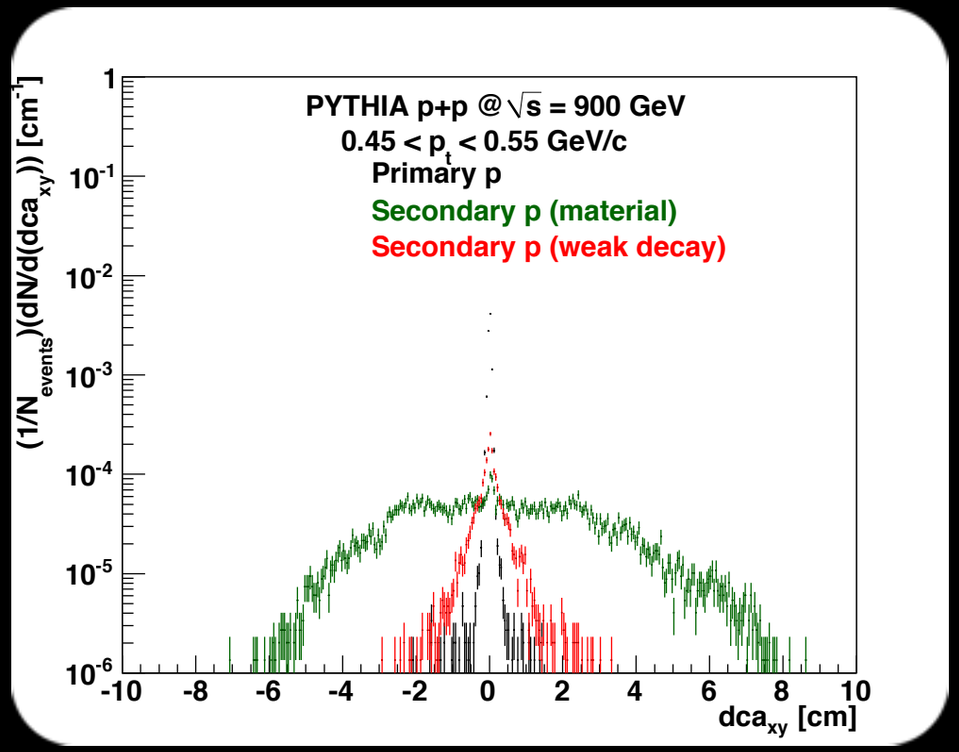

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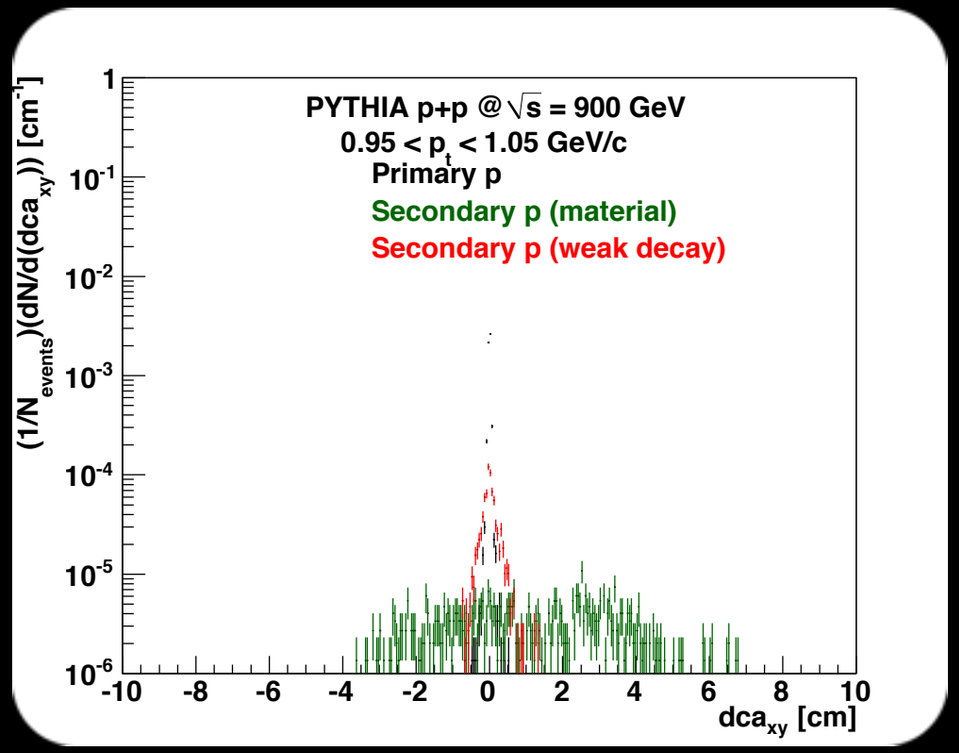

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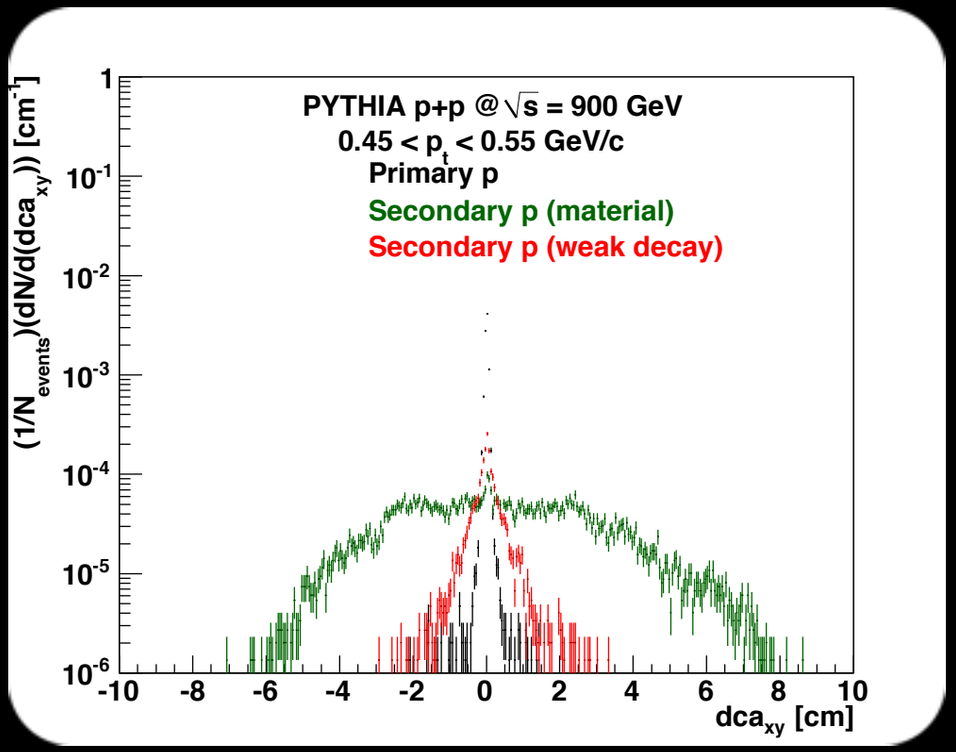

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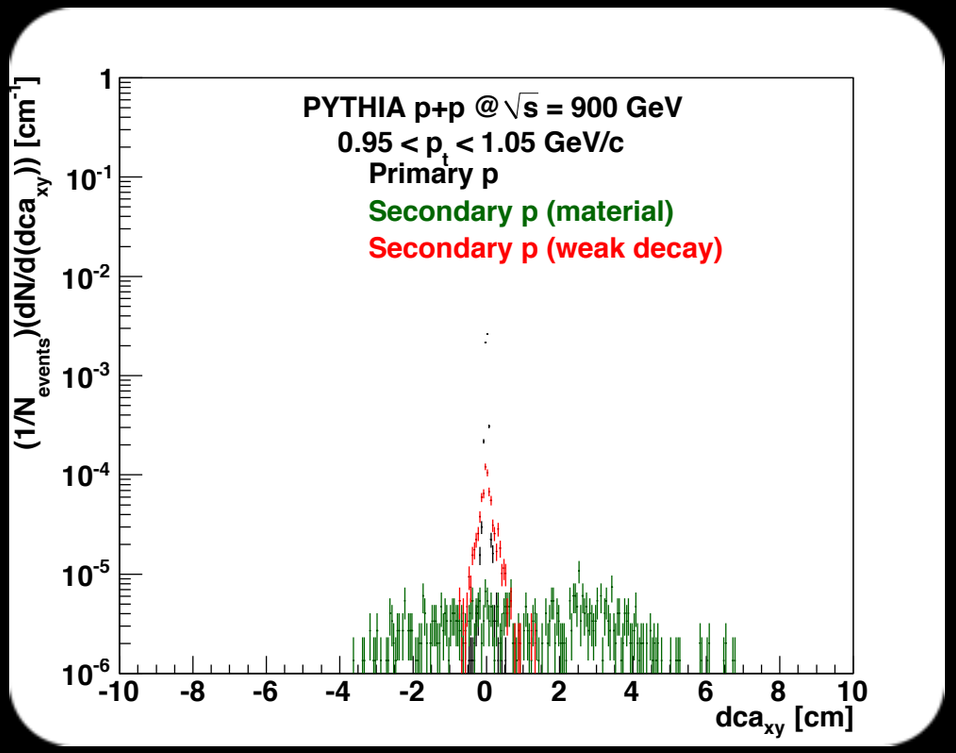
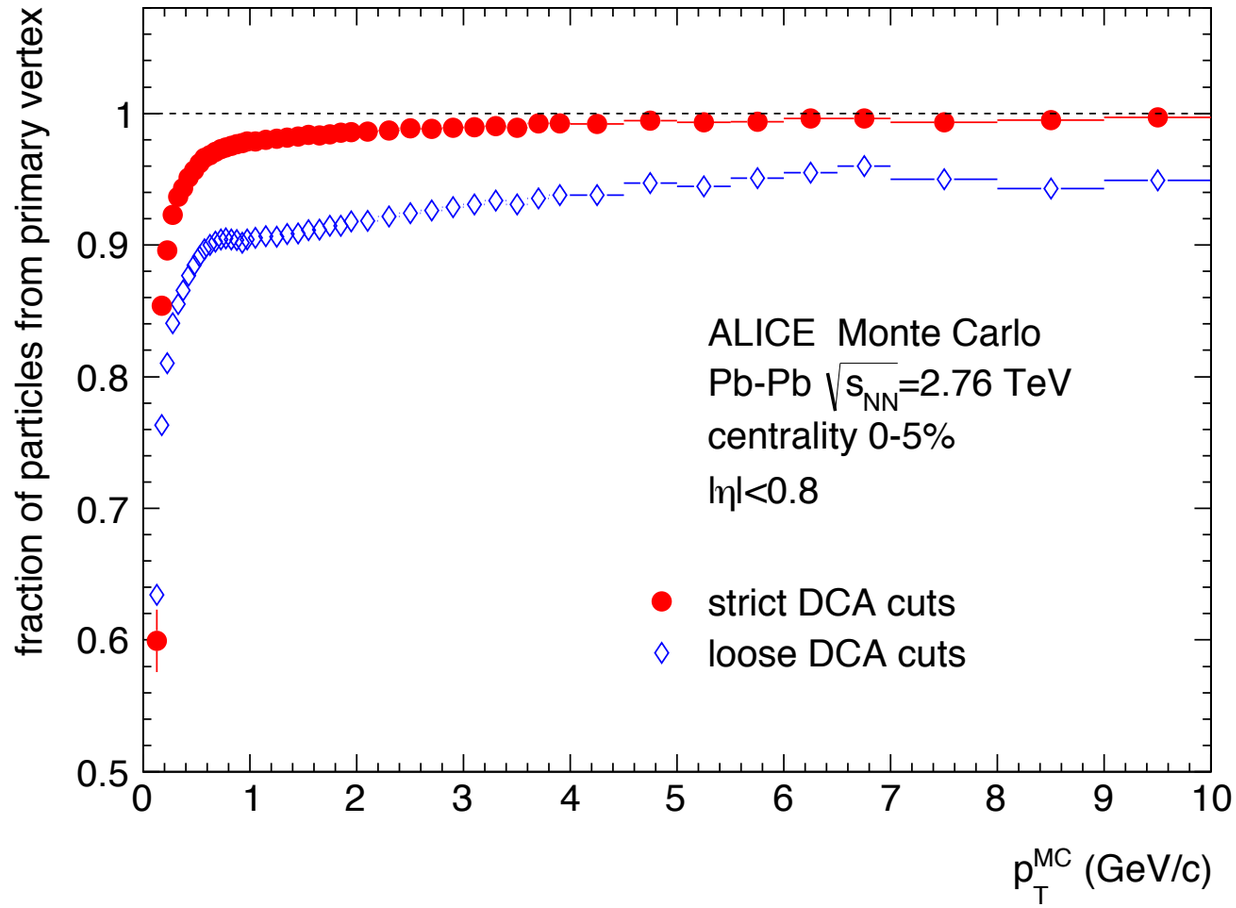
Strongly depends on p_T and particle species!!!



Primary tracks vs dca cuts

- Fraction of particles coming from the primary vertex
  - with two different dca cuts
  - majority comes from low-pT



Type of reconstructed tracks to be analysed

- Tracks with “good quality”
  - ★ Apply selection criteria that define a “good” track
- Primaries
  - ★ Apply a p_T-dependent dca cut
- Identified (e.g. pion, kaon, proton)
  - ★ Wait until next week

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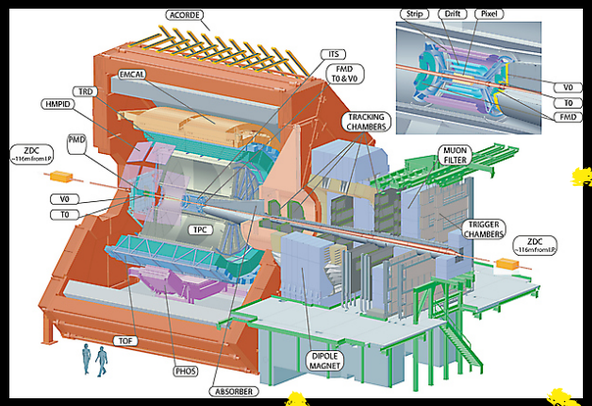
All these selection criteria are already applied for the analysers when filtering the ESD to create an AOD

What do we analyse? A reminder…

Online



HLT

Trigger (CTP)

DAQ

Raw data

Offline (reconstruction)

Analysis Object Data (AOD)

Event Summary Data (ESD)

Clusters

Tracks

AOD tracks

In an AOD we store several different lists of tracks for every event

- Standalone TPC tracks
- Standalone ITS tracks
- Global tracks with loose dca cuts
- Global tracks with tight dca cuts
- Hydrid tracks
  - ★ combination of TPC standalone and global tracks
  - ★ used to ensure a uniform φ-acceptance
- …

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Knowing what tracks you are using means you know what e.g. kind of selection criteria filter bit 512 consists of

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Filter Bit definition

Bit	Cuts	Methods
Bit 0 (001)	Standard cuts on primary tracks	GetStandardTPCOnlyTrackCuts() (*)
Bit 1 (002)	ITS stand-alone tracks(ESD Track Cuts)	SetRequireITSStandAlone(kTRUE)
Bit 2 (004)	Pixel OR (necessary for the electrons) AND Standard track cuts (SetFilterMask(1) of AliESDtrackCuts)	SetClusterRequirementITS(AliESDtrackCuts::kSPD, AliESDtrackCuts::kAny)
Bit 3 (008)	PID for the electrons AND Pixel Cuts (SetFilterMask(4) of AliESDpidCuts)	SetTPCnSigmaCut(AliPID::kElectron, 3.5)
Bit 4 (016)	Standard Cuts with very loose DCA	GetStandardITSTPCTrackCuts2011(kFALSE) SetMaxDCAToVertexXY(2.4) SetMaxDCAToVertexZ(3.2) SetDCaToVertex2D(kTRUE)
Bit 5 (032)	Standard Cuts with tight DCA cut	GetStandardITSTPCTrackCuts2011()
Bit 6 (064)	Standard Cuts with tight DCA but with requiring the first SDD cluster instead of an SPD cluster tracks selected by this cut are exclusive to those selected by the previous cut	GetStandardITSTPCTrackCuts2011() SetClusterRequirementITS(AliESDtrackCuts::kSPD,AliESDtrackCuts::kNone) SetClusterRequirementITS(AliESDtrackCuts::kSDD,AliESDtrackCuts::kFirst)
Bit 7 (128)	TPC only tracks,constrained to SPD vertex in the filter	GetStandardTPCOnlyTrackCuts **esdfilter->SetTPCOnlyFilterMask(128)**
Bit 8 (256)	Extra cuts for Hybrids: - first the global tracks we want to take	AliESDtrackCuts::GetStandardITSTPCTrackCuts2011(kFALSE) SetMaxDCAToVertexXY(2.4) SetMaxDCAToVertexZ(3.2) SetDCAToVertex2D(kTRUE) SetMaxChi2TPCConstrainedGlobal(36) SetMaxFractionSharedTPCClusters(0.4) **esdfilter->SetHybridFilterMaskGlobalConstrainedGlobal((1<<8));** // these normal global tracks will be marked as hybrid
Bit 9 (512)	Than the complementary tracks which will be stored as global constraint, complement is done in the ESDFilter task	SetClusterRequirementITS(AliESDtrackCuts::kSPD,AliESDtrackCuts::kOff) SetRequireITSRefit(kTRUE) **esdfilter->SetGlobalConstrainedFilterMask(1<<9);** // these tracks are written out as global constrained tracks esdfilter->SetWriteHybridGlobalConstrainedOnly(kTRUE); // write only the complement
Bit 10(1024)	Standard Cuts with tight DCA cut, using cluster cut instead of crossed rows	GetStandardITSTPCTrackCuts2011(kTRUE,0) (**)

Filter Bit definition

```
(**) GetStandardITSTPCTrackCuts2011(Bool_t selPrimaries, Int_t clusterCut){

  if(clusterCut == 0) SetMinNClustersTPC(50);
  else if (clusterCut == 1){
  SetMinNCrossedRowsTPC(70);
  SetMinRatioCrossedRowsOverFindableClustersTPC(0.8);
  }
  SetMaxChi2PerClusterTPC(4);
  SetAcceptKinkDaughters(kFALSE);
  SetRequireTPCRefit(kTRUE);
  SetRequireITSRefit(kTRUE);
  SetClusterRequirementITS(AliESDtrackCuts::kSPD, AliESDtrackCuts::kAny);
  if(selPrimaries) SetMaxDCAToVertexXYPtDep("0.0105+0.0350/pt^1.1");
  if(selPrimaries) SetMaxChi2TPCConstrainedGlobal(36);
  SetMaxDCAToVertexZ(2);
  SetMaxDCAToVertex2D(kFALSE);
  SetRequireSigmaToVertex(kFALSE);
  SetMaxChi2PerClusterITS(36);
}
```

Filter Bit selection

```
if (!track->TestFilterBit(fAODTrackCutBit))
        continue;

AliAODTrack::TestFilterBit(UInt_t filterBit)

fAODTrackCutBit can be 768, 96, …
```

Back up