GEM Tracker

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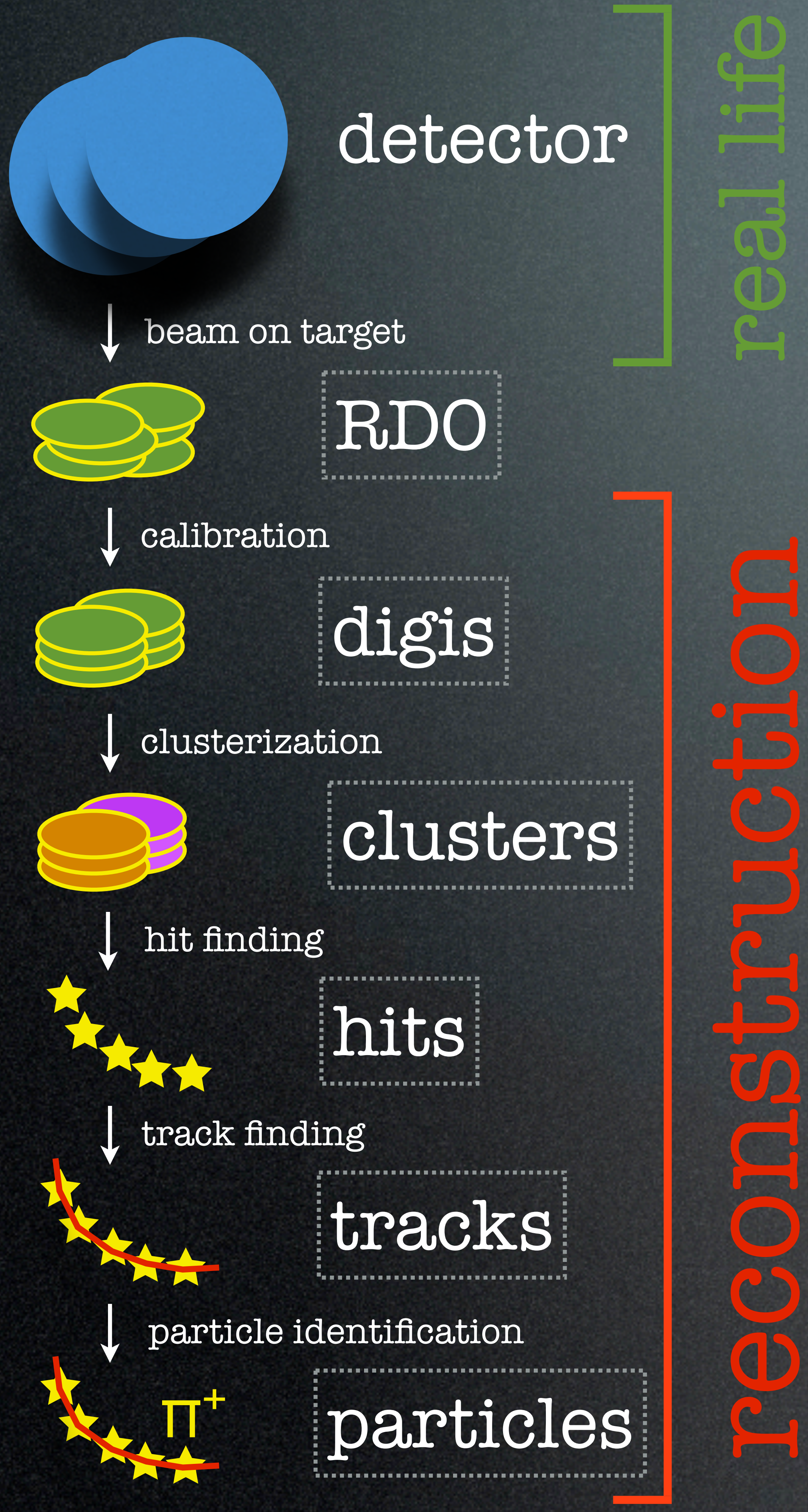
INTRODUCTION



real life

reconstruction

detector

↓ beam on target

RDO

↓ calibration

digis

↓ clusterization

clusters

↓ hit finding

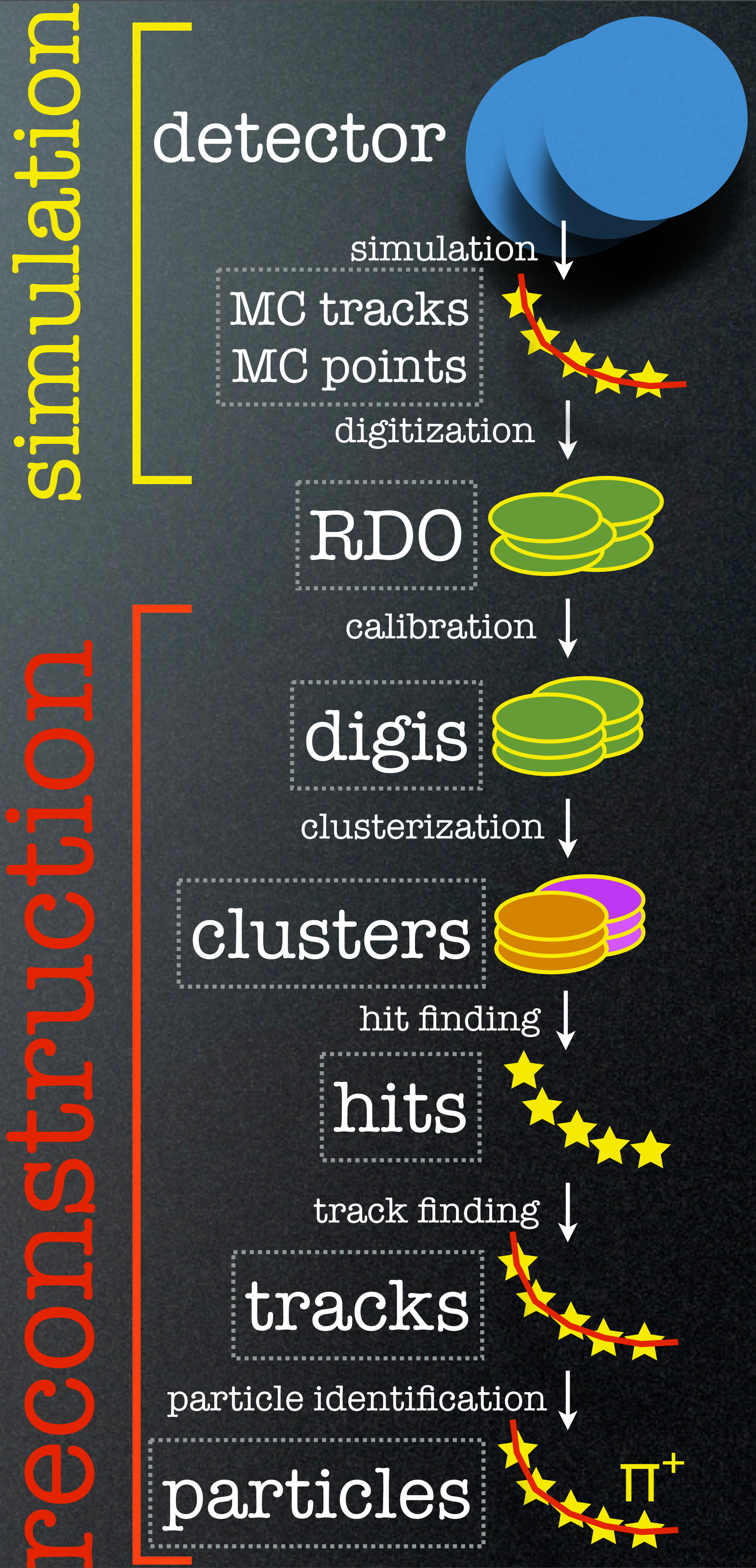
hits

↓ track finding

tracks

↓ particle identification

particles



simulation

reconstruction

detector

simulation ↓

MC tracks
MC points

digitization ↓

RDO

calibration ↓

digis

clusterization ↓

clusters

hit finding ↓

hits

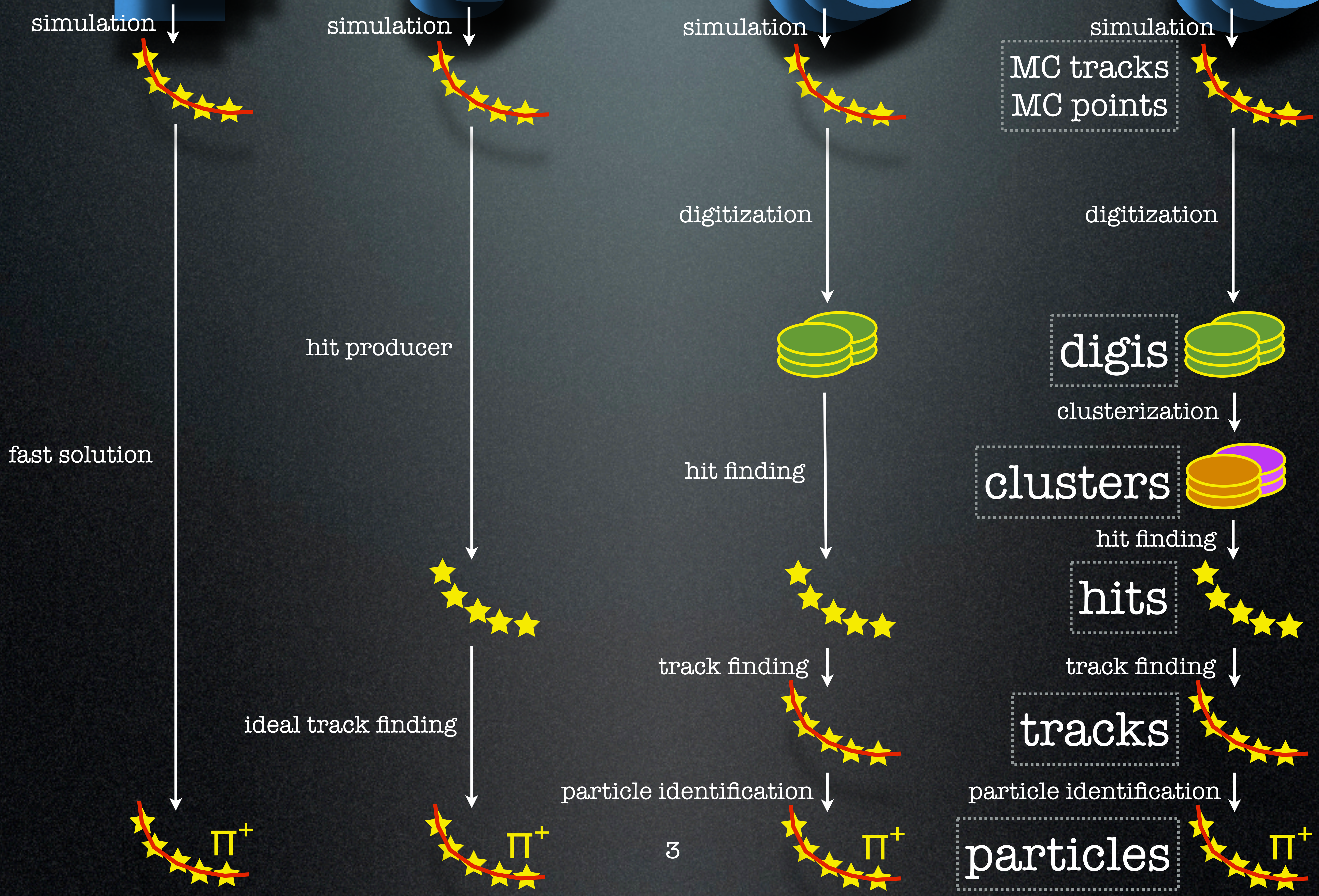
track finding ↓

tracks

particle identification ↓

particles

Implementation stages



simulation

fast solution

π^+

simulation

hit producer

ideal track finding

π^+

simulation

digitization

hit finding

track finding

particle identification

π^+

simulation

MC tracks
MC points

digitization

digis

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clusters

hit finding

hits

track finding

tracks

particle identification

particles

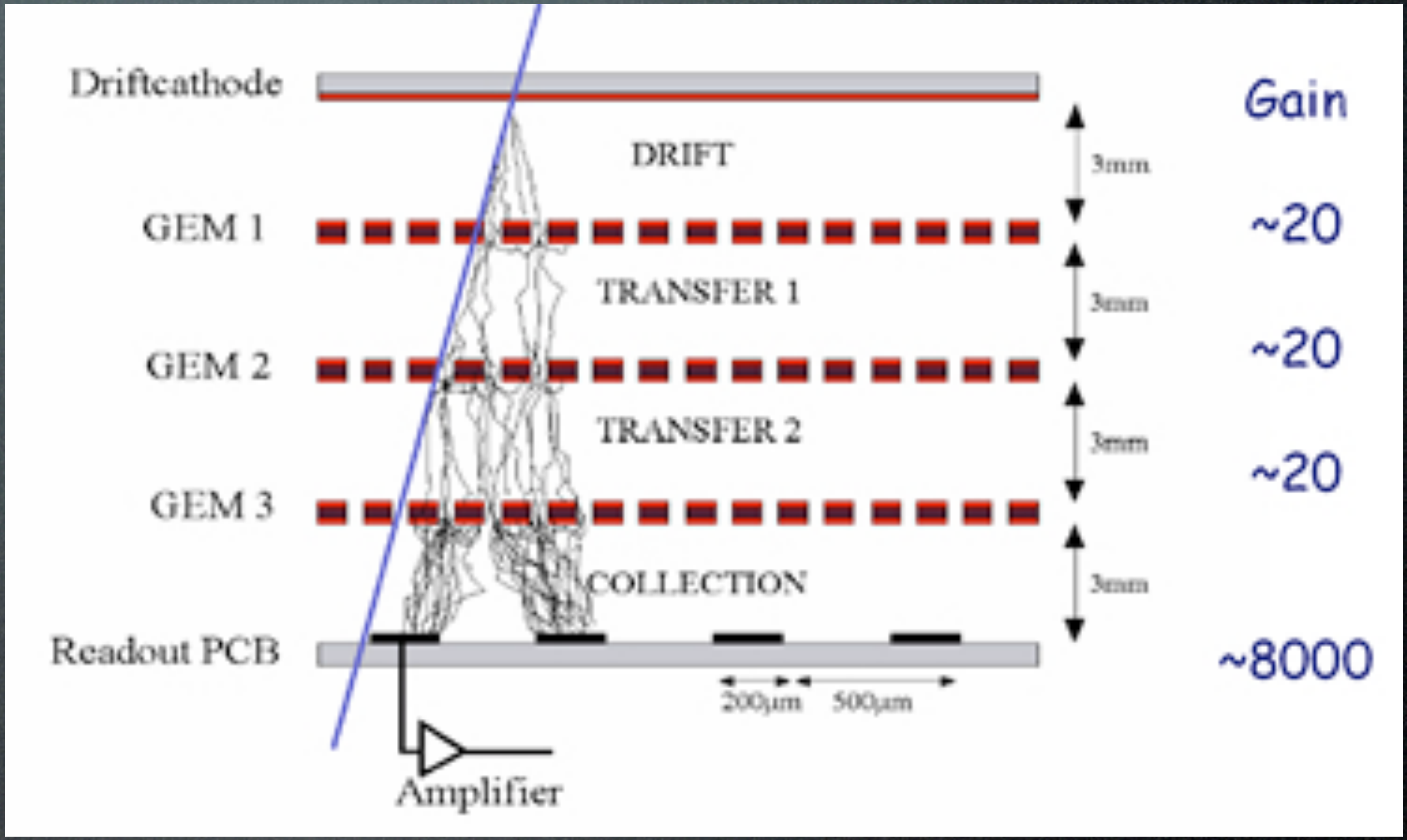
π^+

Plan

- Introduction
- Simulation
- Digitization
- Cluster finding
- Hit finding
- Tracking

GEM - what is this

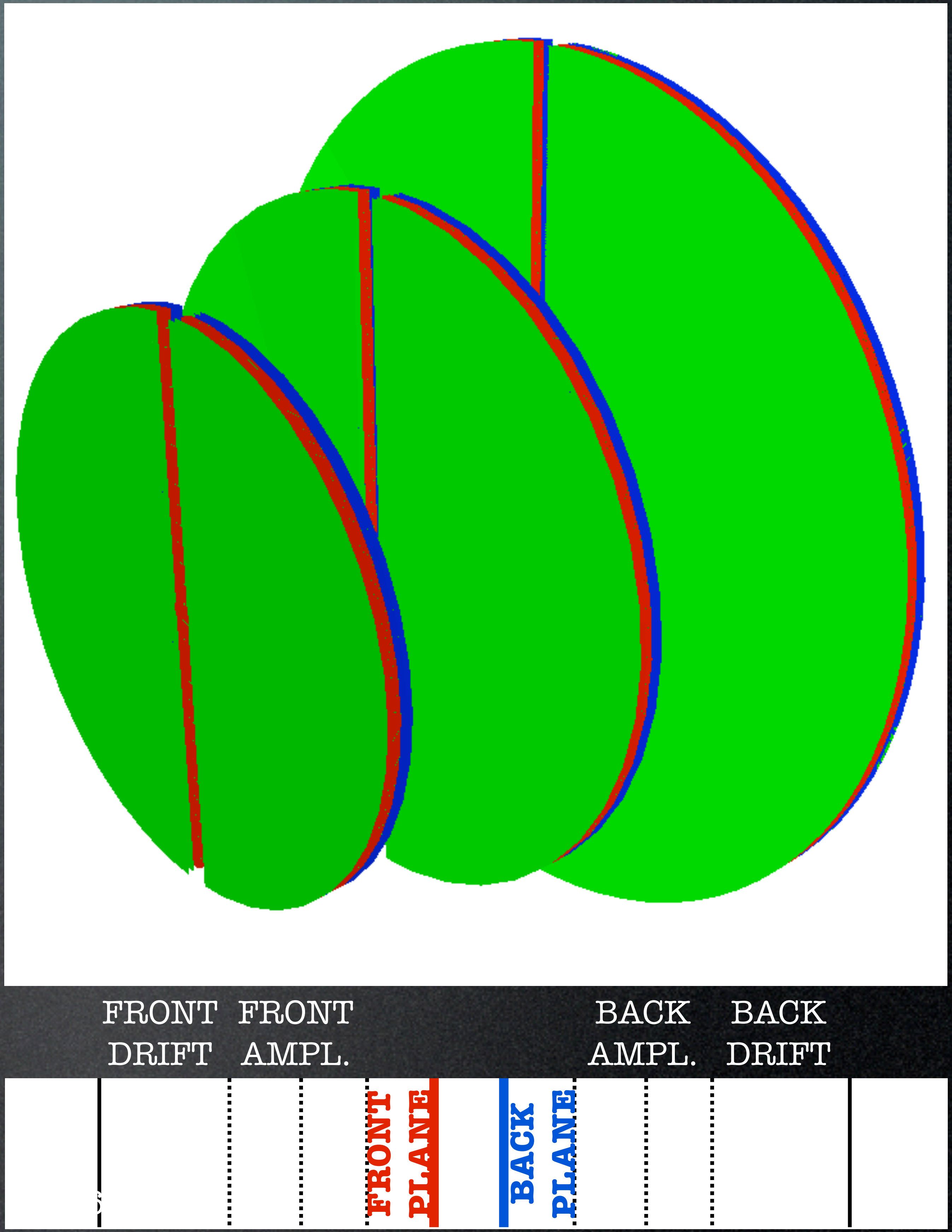
- GEM - Gas Electron Multiplier
- readout plane divided into strips (200 µm width)



- two different perpendicular strip orientations per readout plane implemented
- records trajectory position

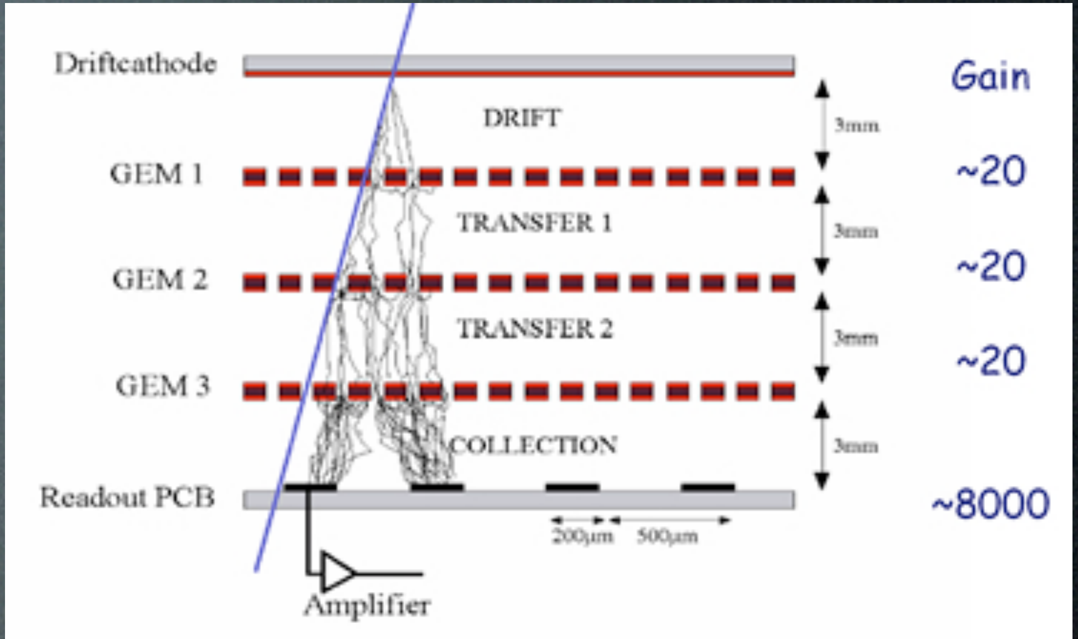
Tracker - what is this

- record track position at 3 stations at $z \approx 120,150,190$cm
- each station has two drift volumes and two sensitive planes: front and back (and therefore 4 different strip orientations)



Simulation

PndGemDetector
ProcessHits



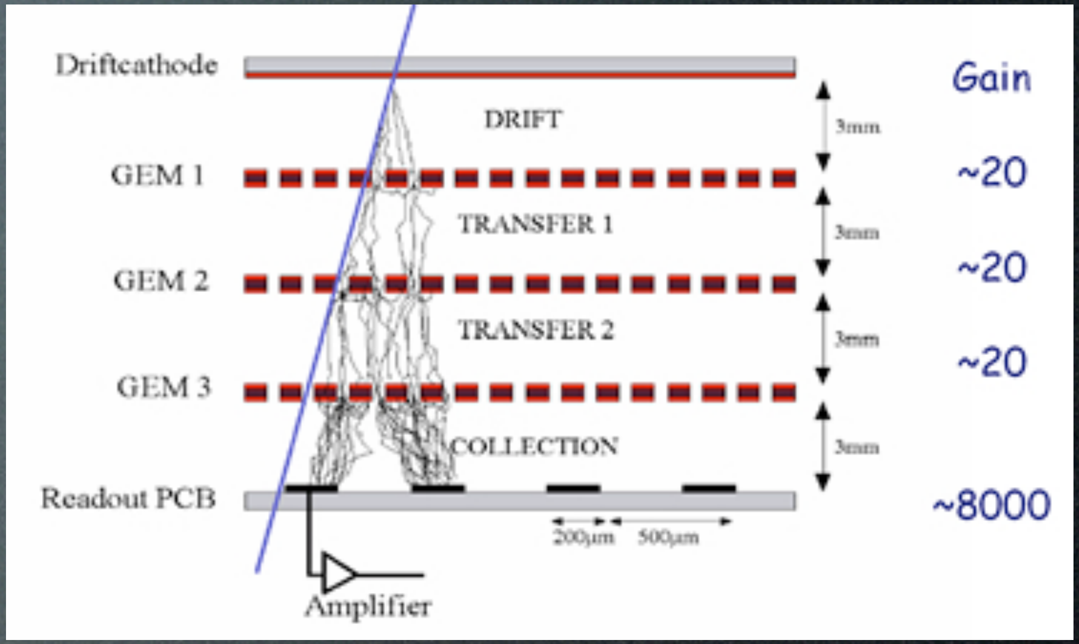
- Create MC points:
  - particle entrance point into the DRIFT volume
  - particle exit point from the DRIFT volume
  - particle energy loss in the DRIFT volume

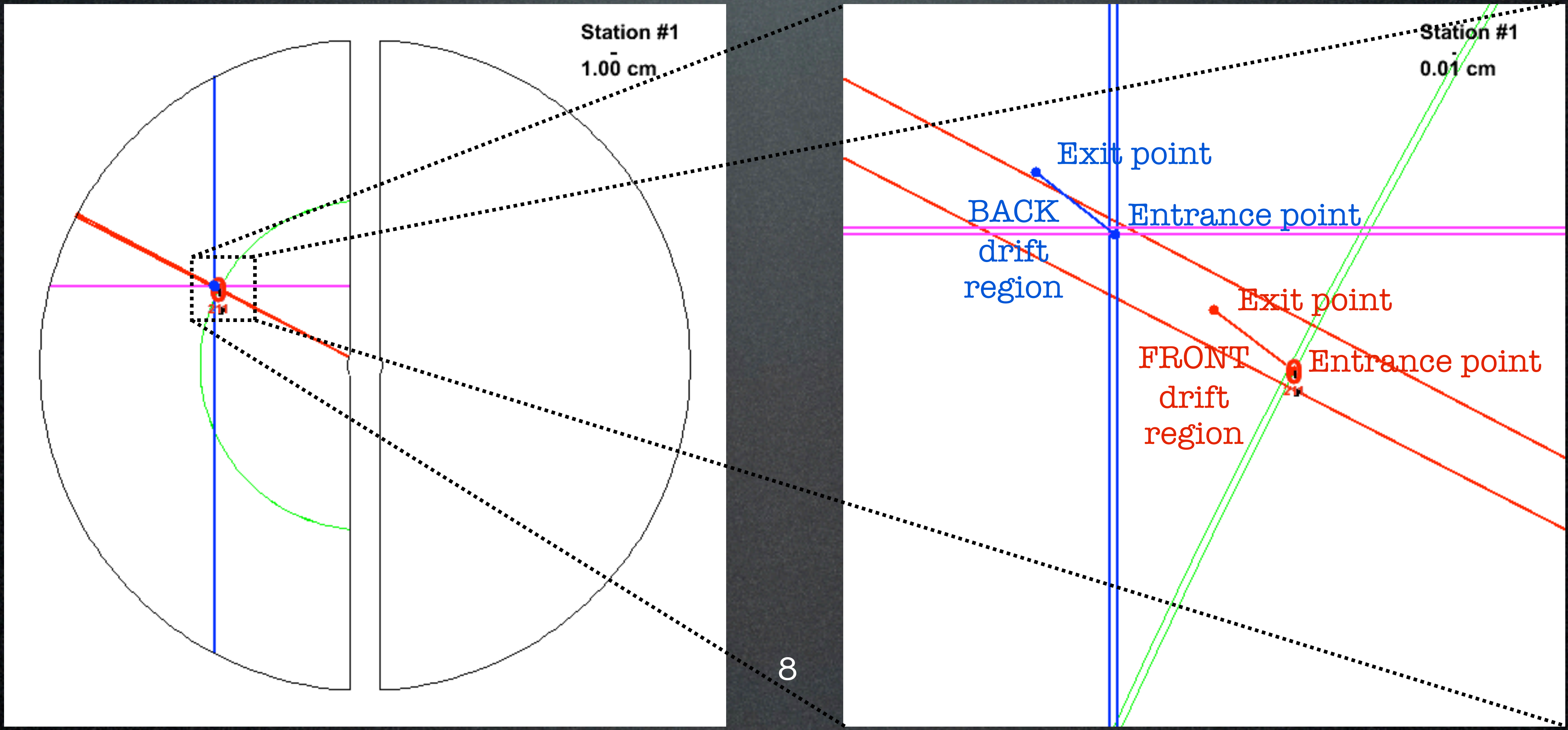
Digitization

PndGemDigitize

SetRealisticResponse(kFALSE)

- Ideal:
  - fire one strip per view (two strips for front and back drift regions)

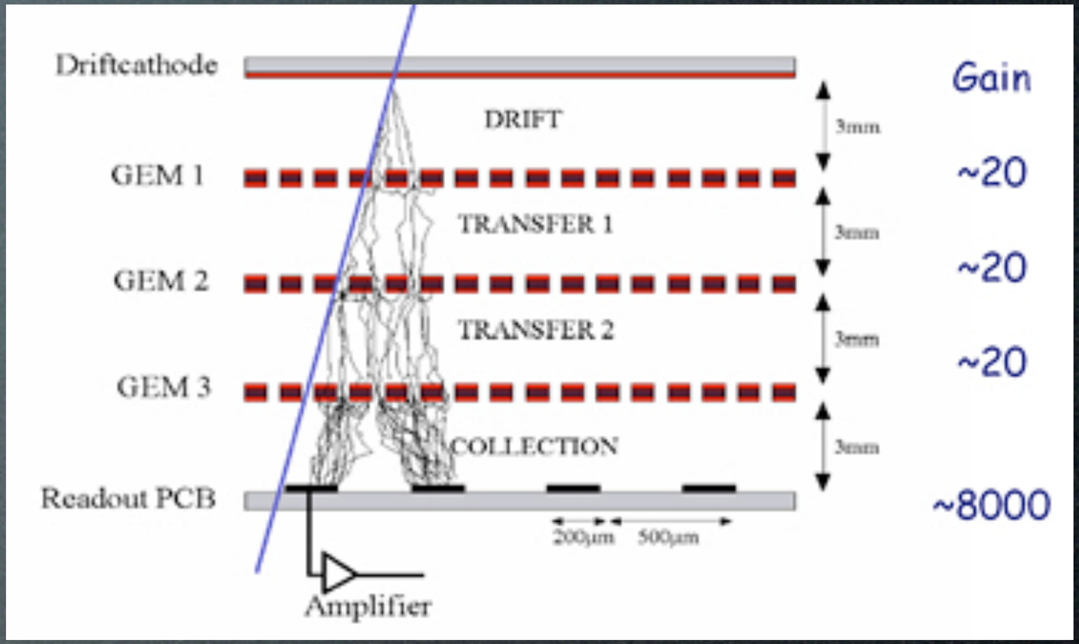




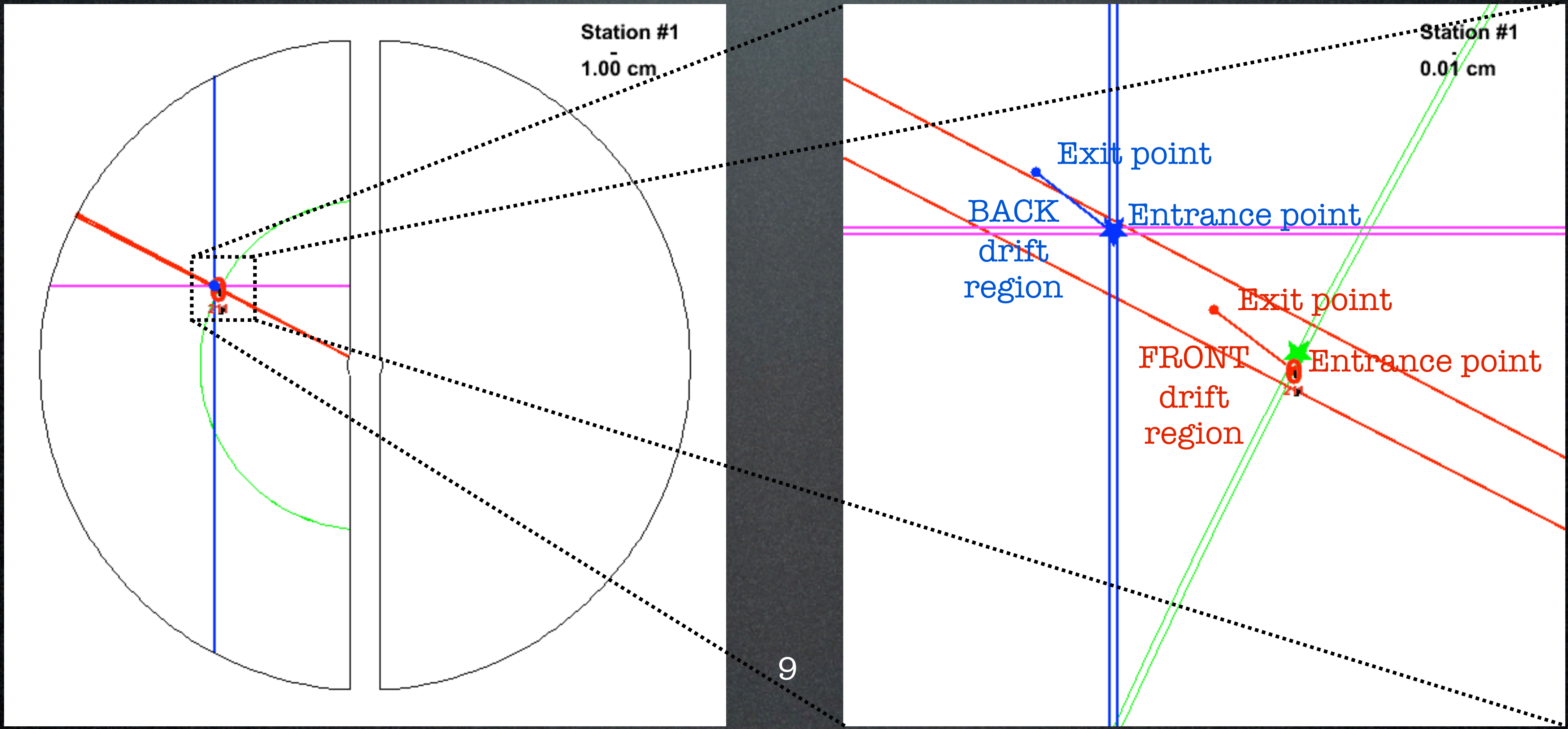
Hit finding

PndGemFindHits

SetUseClusters(kFALSE)



- Ideal:
  - create hits on front/back sensors separately where two strips cross

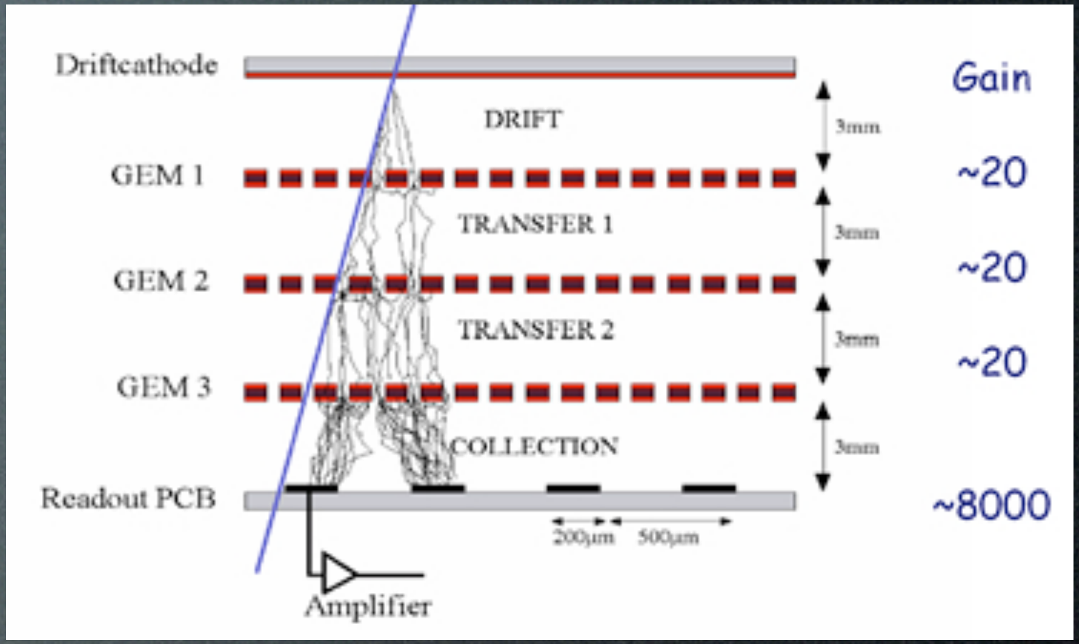


Digitization

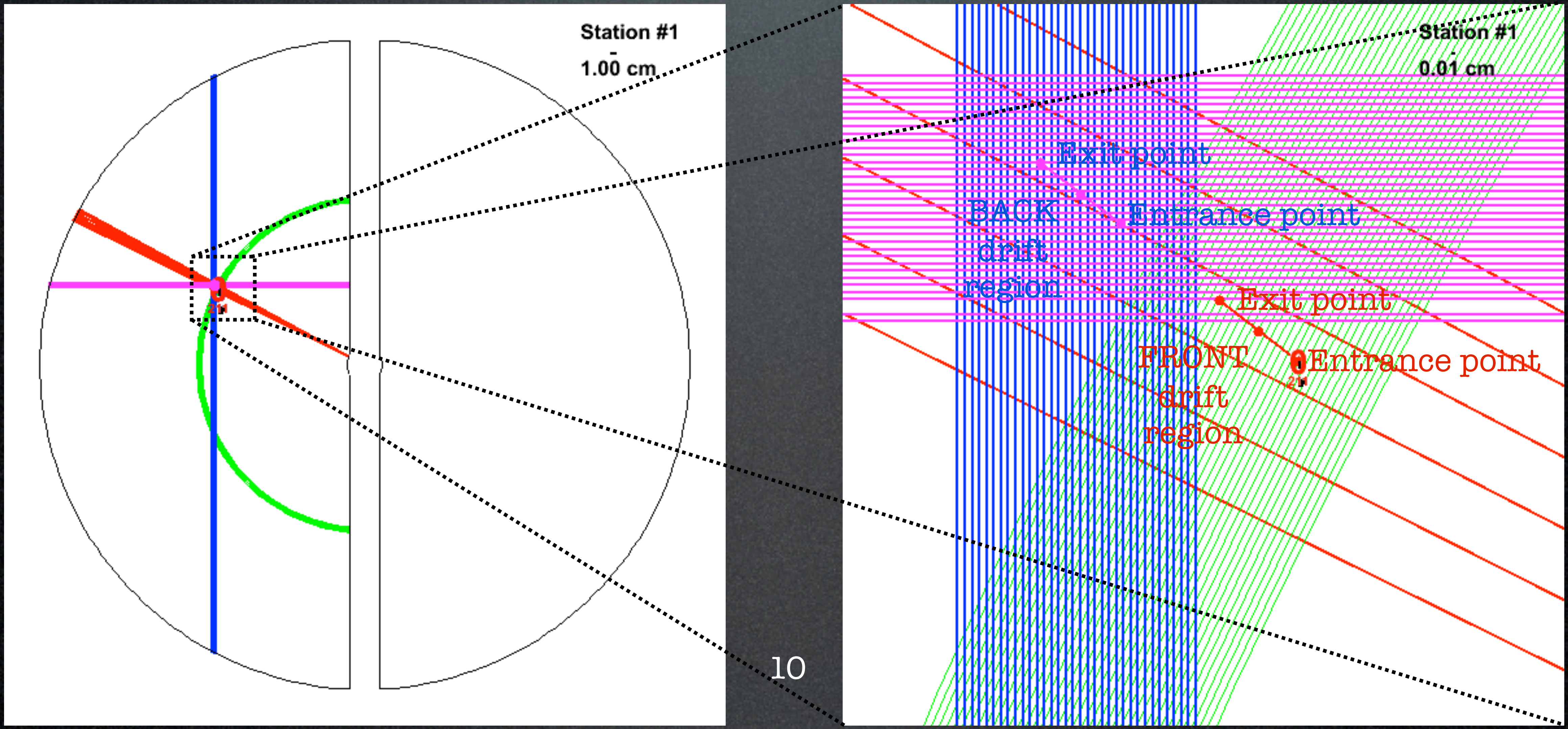
`PndGemDigitize`

`SetRealisticResponse(kTRUE)`

- Realistic:

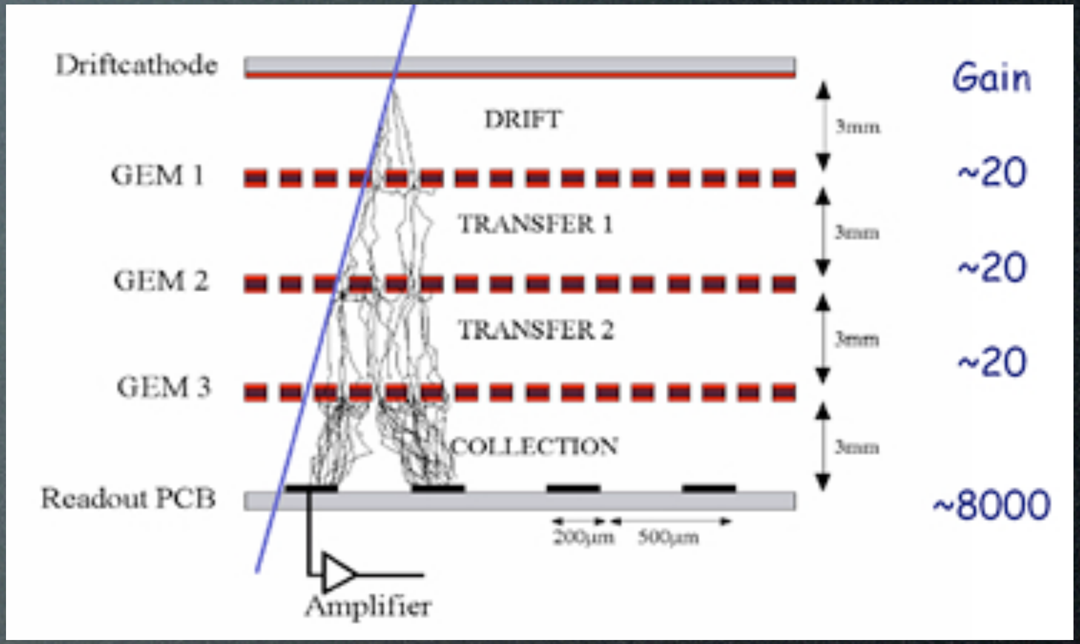


  - fire strips along the trajectory combined with charge diffusion

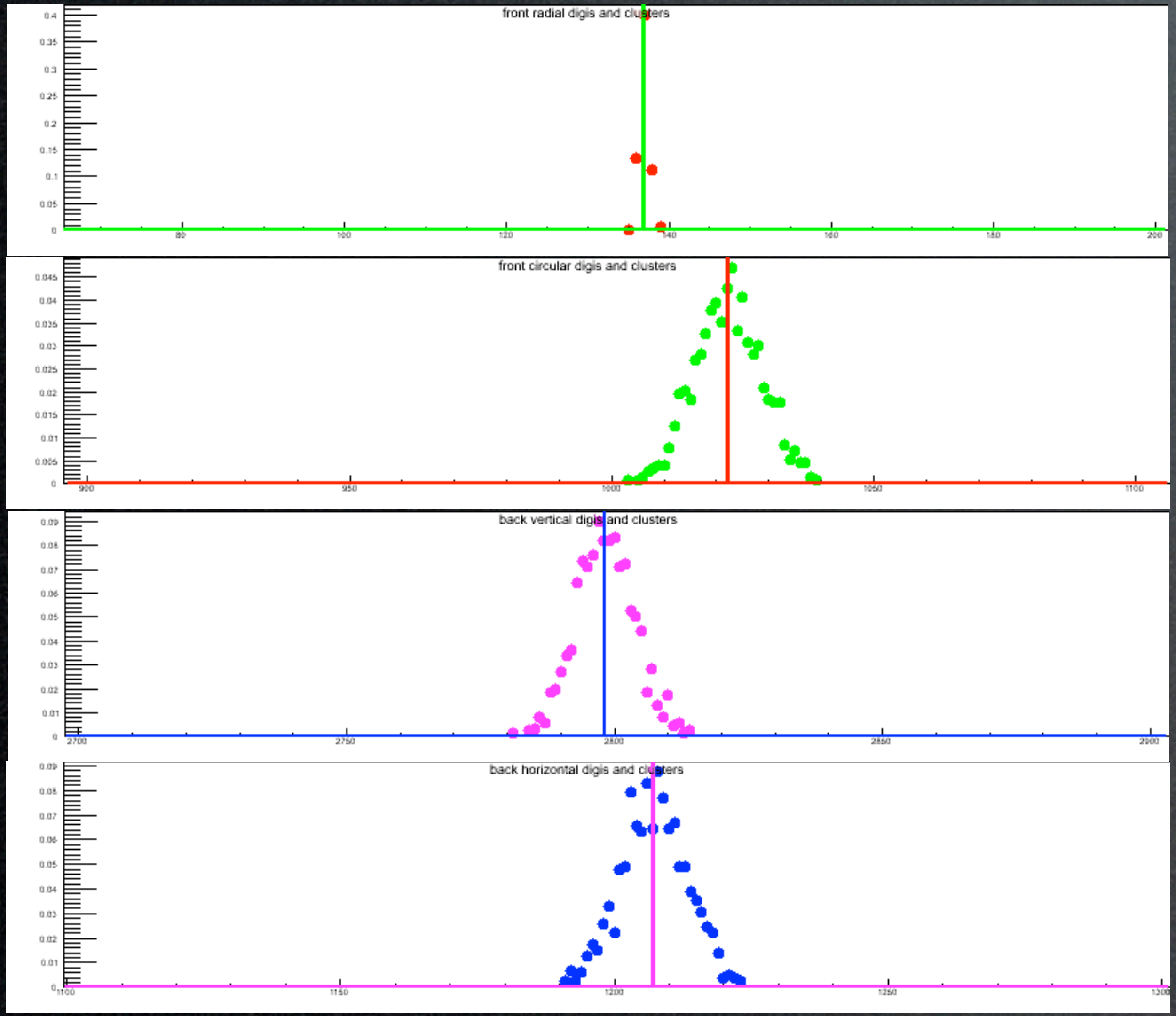


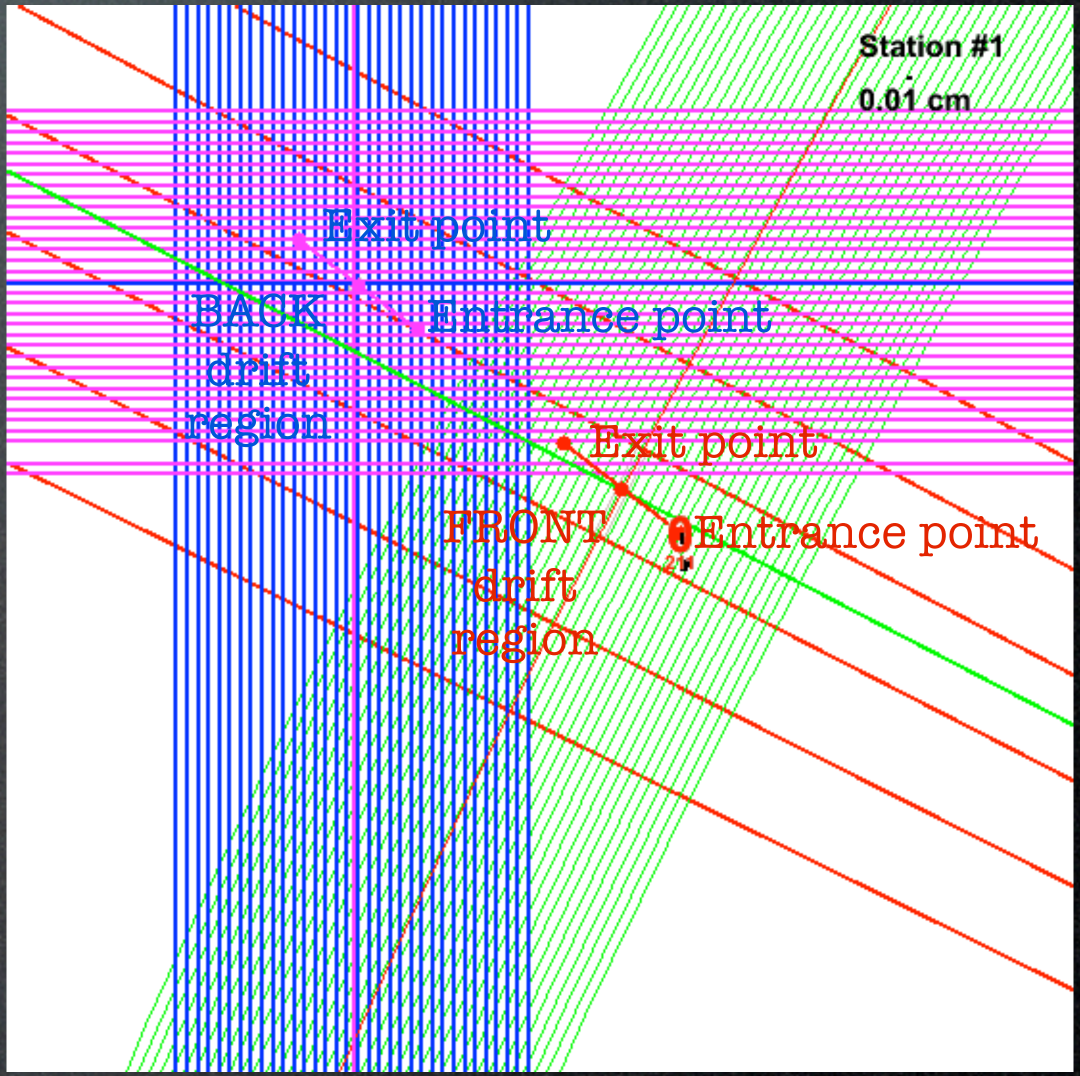
Cluster finder

PndGemFindClusters



- Realistic:
  - find maxima positions in charge strip distribution



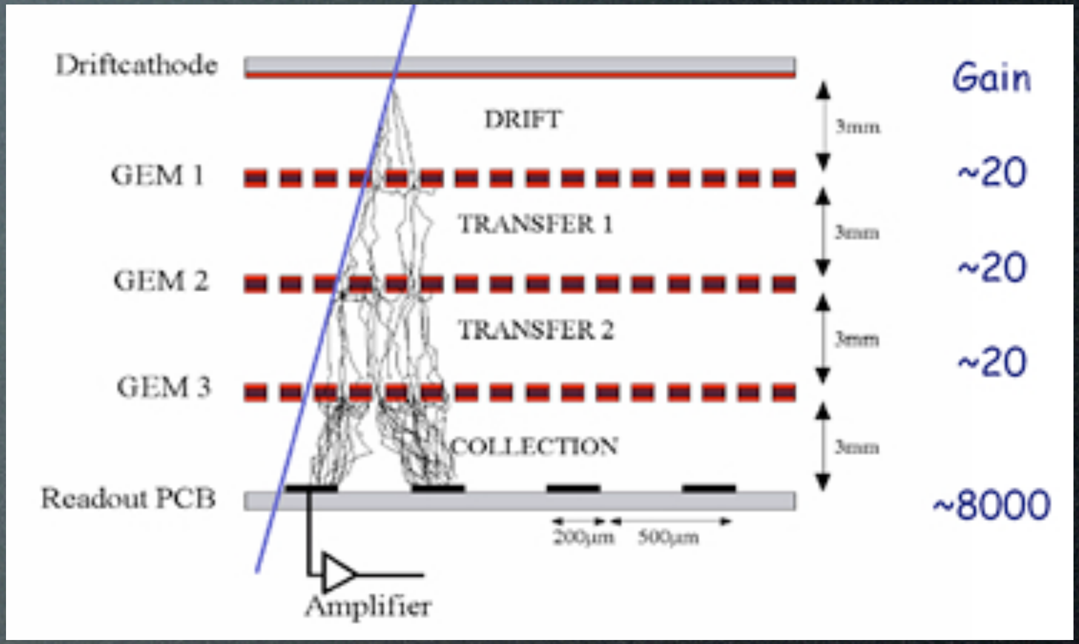


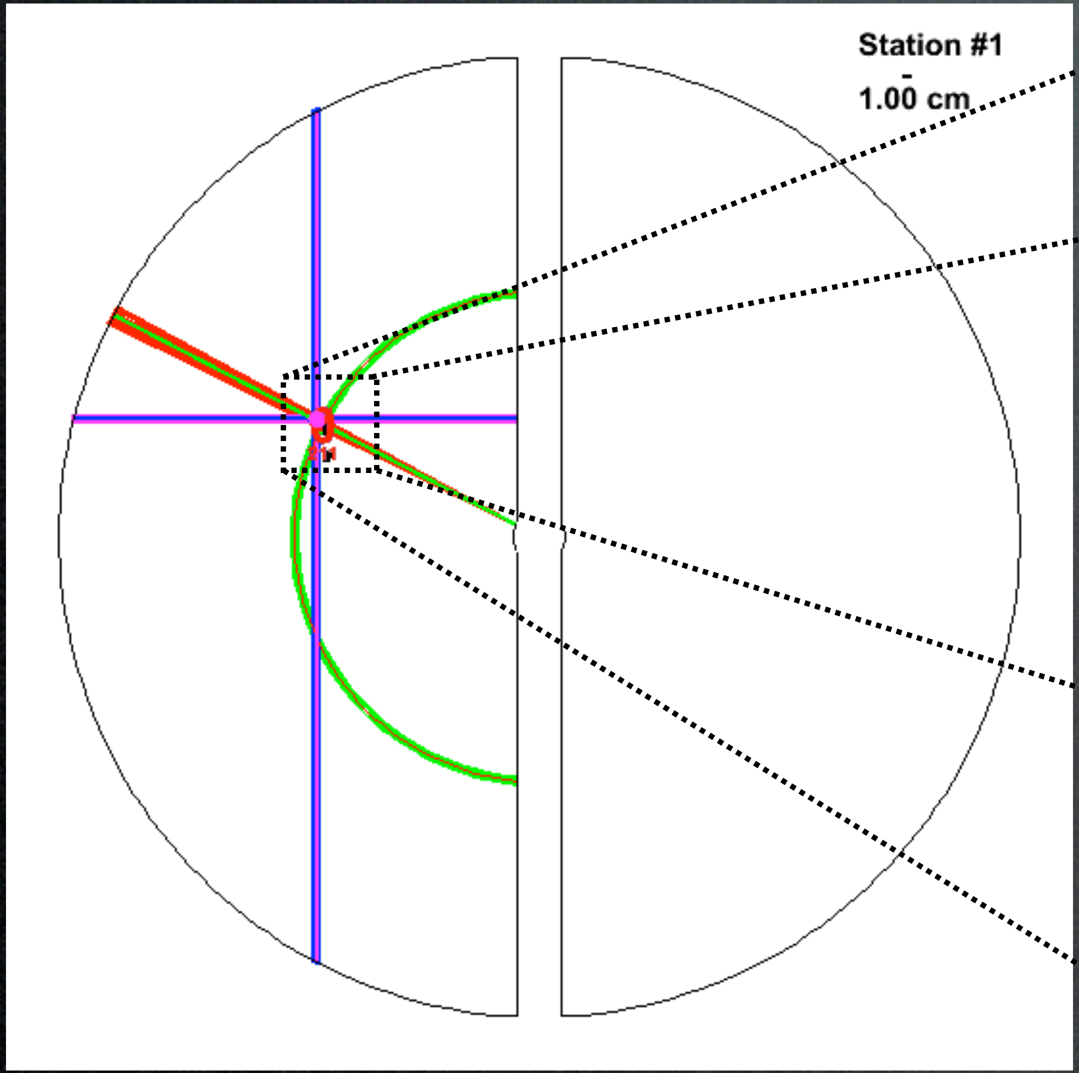
Hit finding

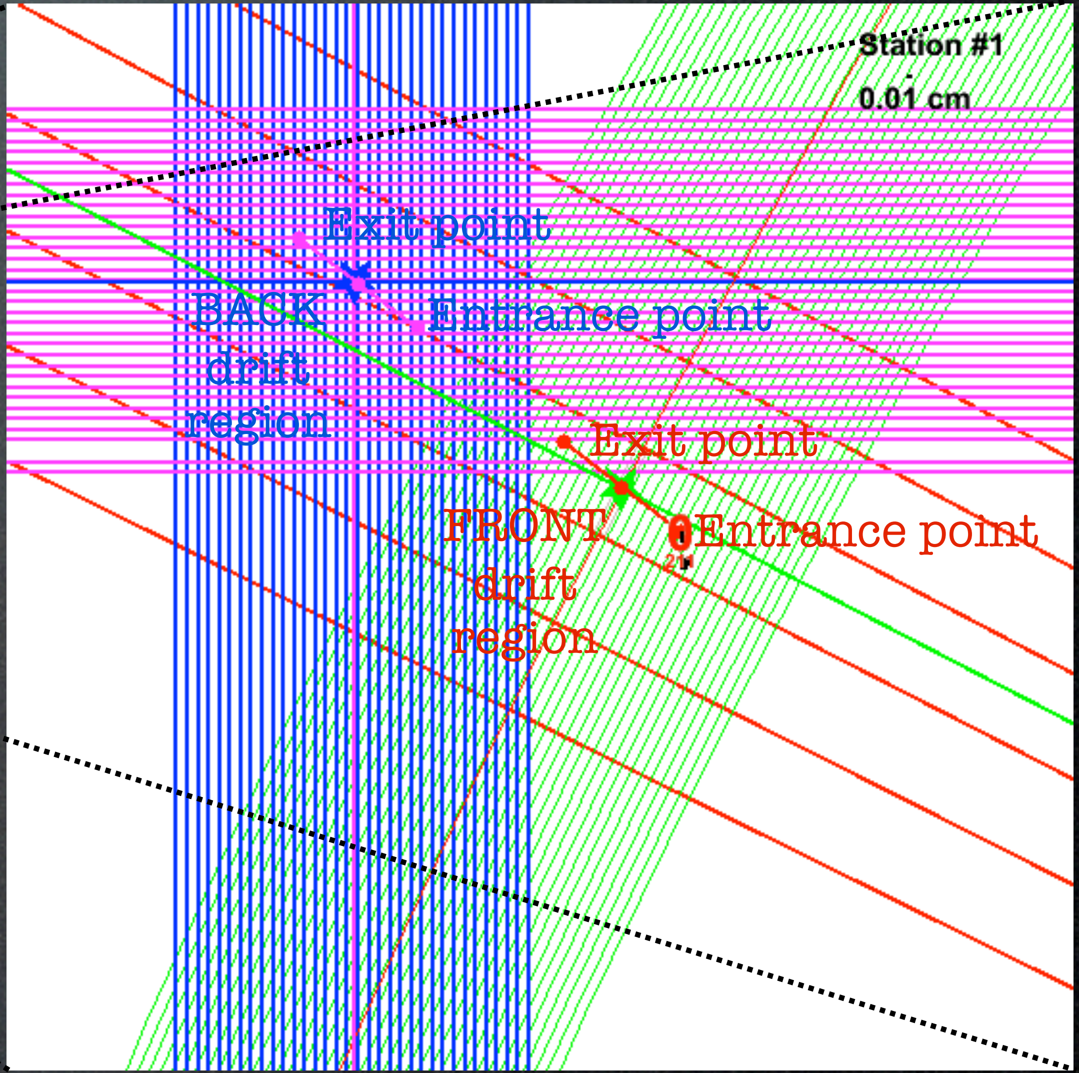
`PndGemDigitize`

`SetUseClusters(kTRUE)`

- Realistic:
  - create hits on front/back sensors separately where two clusters cross







Tracking

- GEM standalone track finding
  `PndGemTrackFinderOnHits`
- global track finding (MVD, STT, GEM)
  `PndBarrelTrackFinder`

GEM standalone tracking (2009)

- uses only GEM hits
- combines hits on each station's front/back sensors to reduce fake hits
- forms pairs of hits from different stations into simple tracklets, with momenta calculated assuming the tracklet emission from the vertex
- tracklets with similar momenta are joined to form tracks

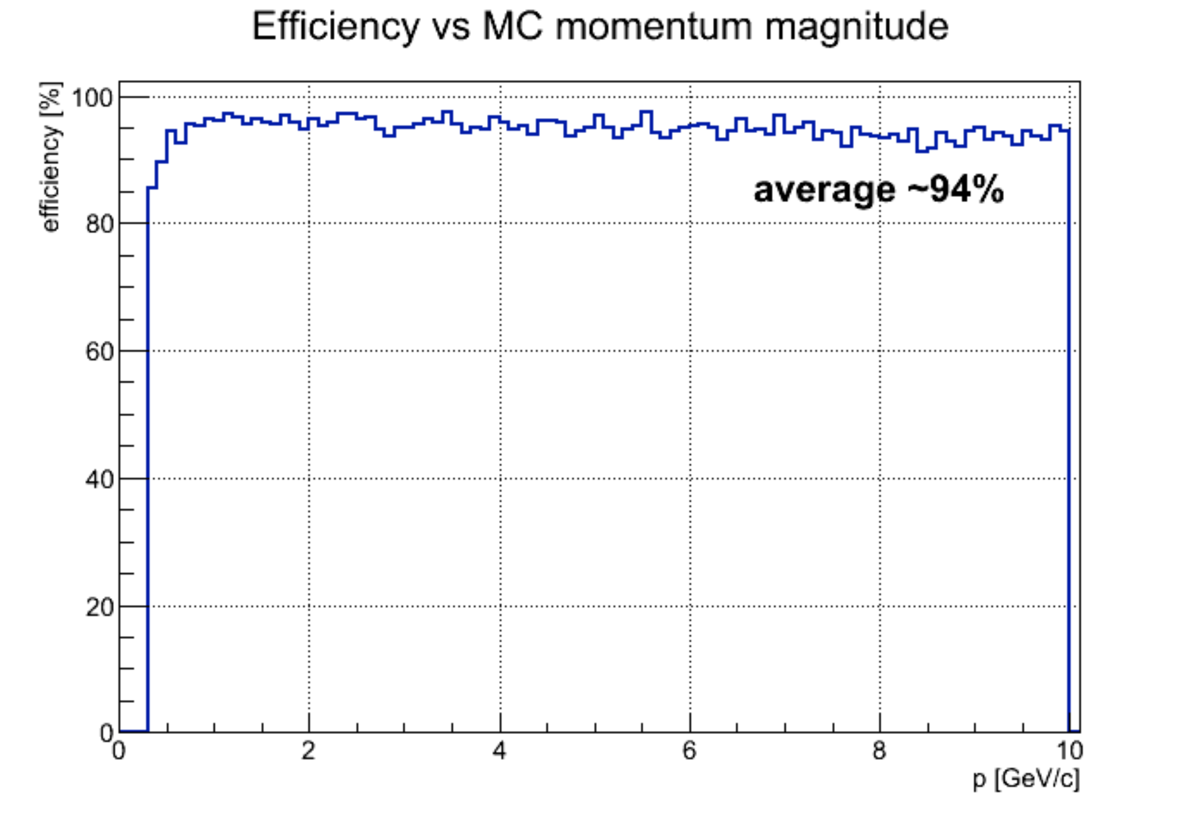
Global track finding (2010)

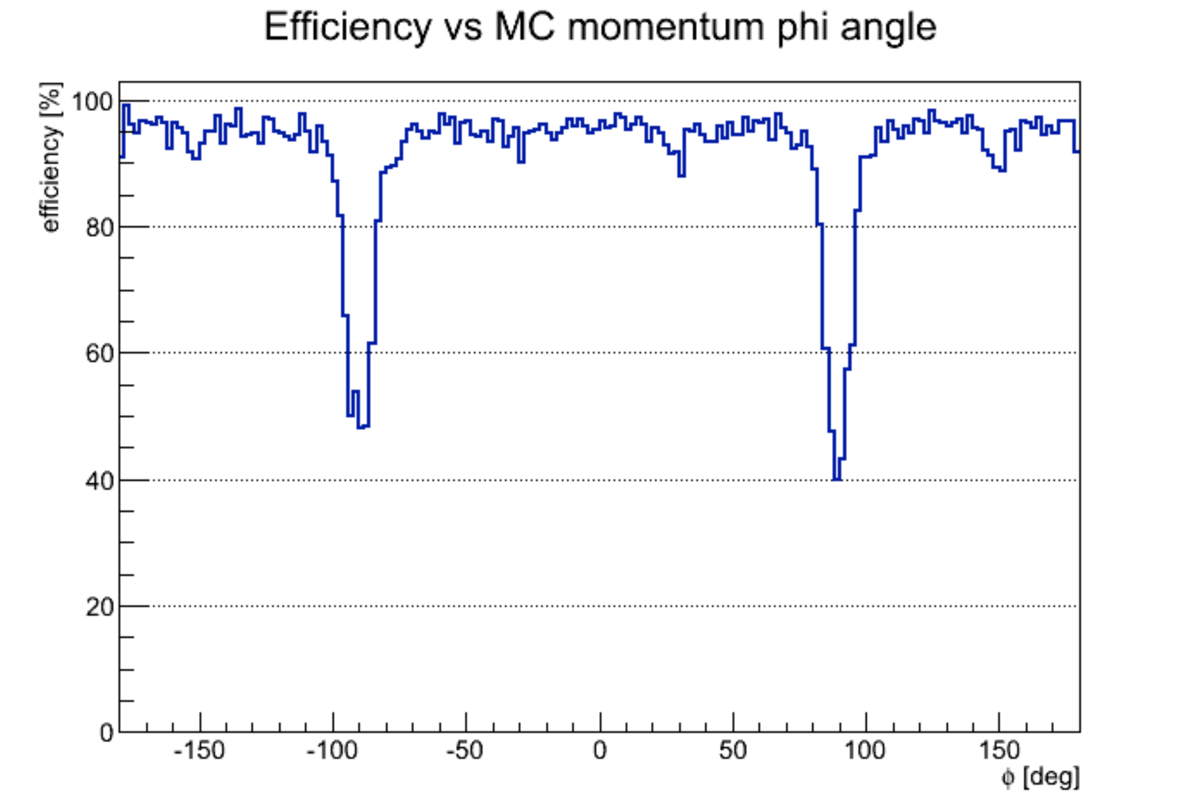
- uses MVD, STT, GEM hits

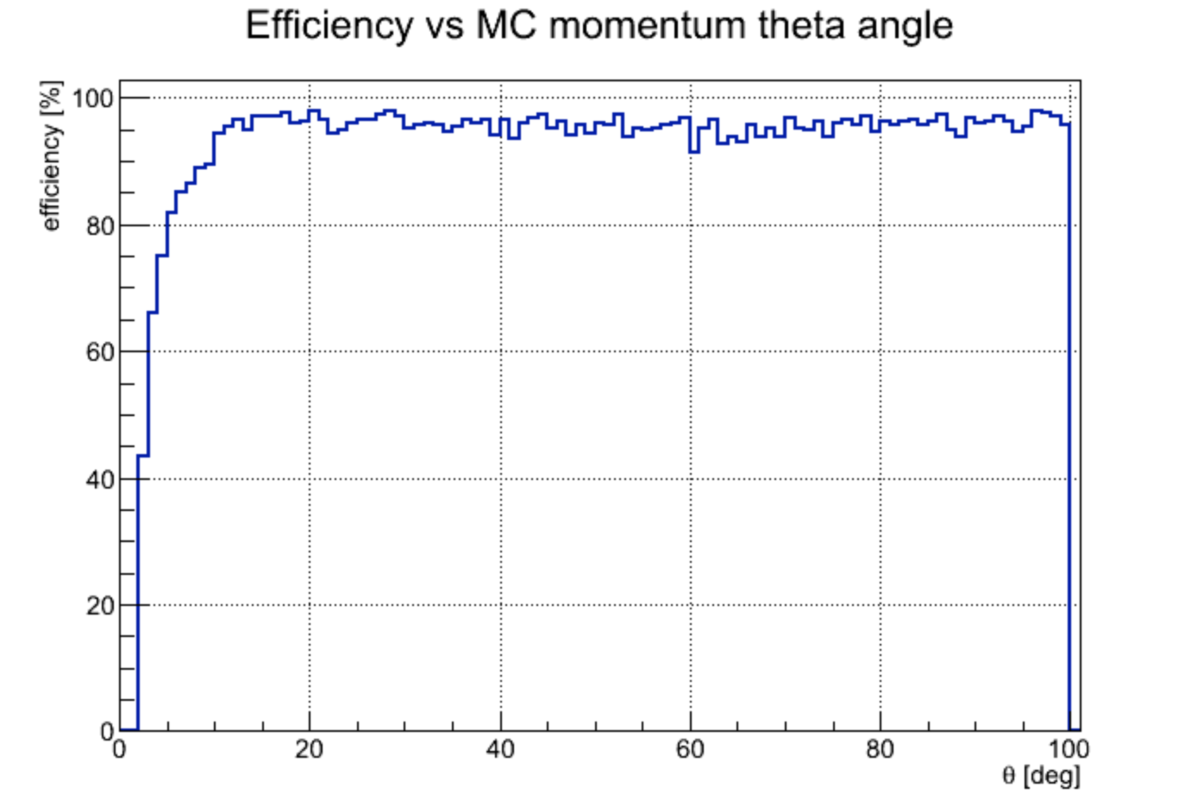
```
std::vector<Track> possibleTracks(0);
std::vector<Int_t> unusedHits(0);
for ( Int_t ihit = 0 ; ihit < nofAllHitsInEvent ; ihit++ ) {
  Int_t matching = 0;
  for ( Int_t itrack = 0 ; itrack < possibleTracks.size() ; itrack++ )
    matching += MatchHitToTrack(ihit,itrack);
  if ( matching > 0 ) continue;
  matching = 0;
  for ( Int_t iunh = 0 ; iunh < unusedHits.size() ; iunh++ )
    matching += CreateTrack(ihit,iunh);
  if ( matching > 0 ) continue;
  unusedHits.push_back(ihit);
}

CleanTracks();
```

Tracking efficiencies

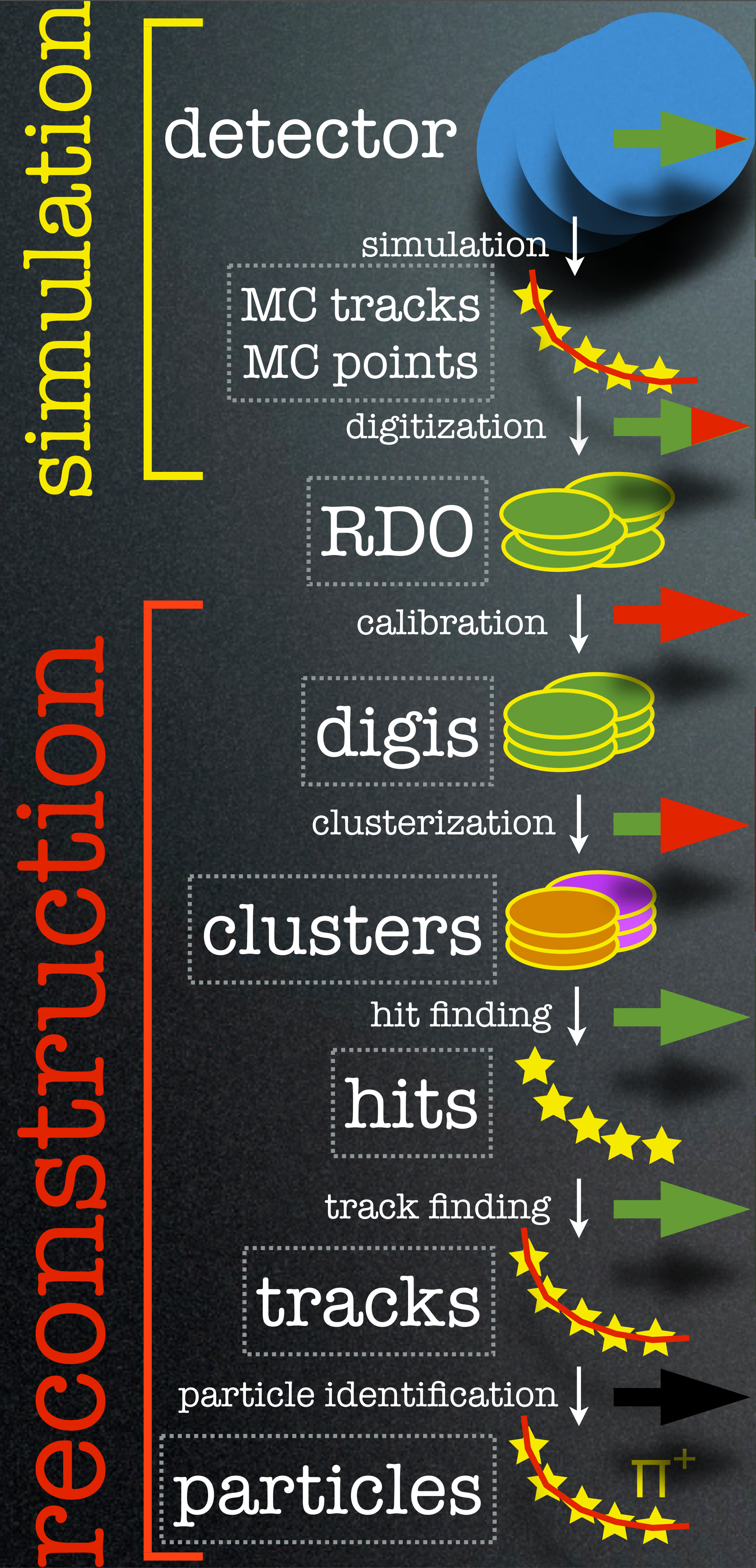
- 10000 events
- $2\mu^+$ and $2\mu^-$ / event
- $0.3<|p|<10$ GeV/c
- $0°<\theta<100°$
- $0°<\phi<360°$


Efficiency vs MC momentum magnitude


Efficiency vs MC momentum phi angle


Efficiency vs MC momentum theta angle

SUMMARY



simulation

detector

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π^+

- realistic detector geometry
- update sizes, positions, implement readout

- realistic detector response
- no time information, decrease time spent on this phase

- NOT TOUCHED

- initial version implemented
- some work still necessary, no time information available/used

- digi/cluster intersection-not much to do

- lots of possibilities
- lots of effort put into this

- not applicable to GEM

some remarks on programming

- do READ and USE coding rules, coding conventions!!!
- you will soon discover they are NOT ENOUGH, and you will develop your own habits, of course in accordance to the common rules and conventions

my hints on programming

- NEVER EVER use single letters as variable names. Using s.l.a.v.n. does not save time. It **costs** time and money. My shortest ever variable name is `iev`, like in:

  ```
  for ( Int_t iev = 0 ; iev < nofEvents ; iev++)
  ```

  Moreover, my Int_t loop variables always start with ‘i’; class members always start with ‘f’, and never with ‘_’.

- CHOOSE meaningful variable names, function names, class names. BTW, the longest class name in PandaRoot is:

  `PndMvdTPCRiemannTrackFinderTaskCutPar.cxx`

  I have the 2nd place with:

  `PndGemMagneticFieldVsTrackParameters.cxx`, 3rd place:

  `PndEmcMultiWaveformToCalibratedDigi.cxx`.

my hints on programming

- write comments. I mean it.
- personally, I don’t. At least not the standard ones with // or /* */. Nevertheless, I was told that my code is easy to read. Because of lots of:

```
if ( fVerbose > 3 )
  cout << "this stt hit belongs to track " << trackNo
       << " (cause dist = "
       << FindCircDist(circPar,sH1) << ")" << endl;
```

- generally, when writing, debugging, checking code the programmer needs to produce lots of screen printouts. Write them decent. Later do not delete them, but put them in “if(fVerbose)” or in “//”. At least this.

GEM in myMacro.C

- Simulation

```
FairDetector *Gem = new PndGemDetector("GEM", kTRUE);
Gem->SetGeometryFileName("gem_Gas_3Stations.root");
fRun->AddModule(Gem);
```

- Digitization

```
FairParRootFileIo* parInput1 = new FairParRootFileIo();
parInput1->open(“gem_Gas_3Stations.digi.par”);
PndGemDigitize* gemDigitize = new PndGemDigitize("GEM Digitizer", verboseLevel);
gemDigitize->SetRealisticResponse();
fRun->AddTask(gemDigitize);
```

- Cluster Finding

```
PndGemFindClusters* gemFindClusters = new PndGemFindClusters("GEM Find Clusters");
fRun->AddTask(gemFindClusters);
```

- Hit Finding

```
PndGemFindHits* gemFindHits = new PndGemFindHits("GEM Hit Finder", verboseLevel);
gemFindHits->SetUseClusters();
fRun->AddTask(gemFindHits);
```

- Standalone GEM Tracking

```
PndGemFindTracks* finderTask = new PndGemFindTracks("PndGemFindTracks");
fRun->AddTask(finderTask);
PndGemTrackFinderOnHits* mcTrackFinder = new  PndGemTrackFinderOnHits();
mcTrackFinder->SetPrimary(0);
finderTask->UseFinder(mcTrackFinder);
```

- Global Tracking

```
PndBarrelTrackFinder* barrelTF = new PndBarrelTrackFinder();
fRun->AddTask(barrelTF);
```