Hit Reconstruction in the CMS Inner Tracking System

- For true but precise measurement points

Pixel and strip signals are clustered with nearest neighbor independent algorithm using variable S/N thresholds.

- Hit Reconstruction in the CMS Inner Tracking System

- Few but precise measurement points

- Pixel detector
- 3 barrel layers
  - r = 4.4 cm to 0.2 cm, L = 55 cm
  - 2 disks in each endcap
- Outer strip layer
  - r = 8.9 cm to 10.2 cm, L = 53 cm
  - 10 disks

- Strip cluster position is calculated from the charge centroid on small clusters and cluster edges weighted method is used.

- Pixel detector
  - Position monitoring during assembly.

- Detector Alignment

- Construction/Hardware/Software based alignment

- Millipede II, 320 9.3 millions strips
  - 12 disks in each endcap
  - 10 barrel layers
  - r = 4.4 cm to 10.2 cm, L = 53 cm

- Endcap region
  - Double silicon barrel layers
  - r = 8.9 cm to 10.2 cm, L = 53 cm

- Road Search algorithm

- Combinatorial Track Finder
  - Fast, inside-out, robust, Kalman combination of compatible hits

- Hit Pairs Trajectory Seeding
  - High efficiency trajectory seeding

  - Redundant selection of pair of tracker layers are searched for hits compatible with the interaction region and furthermore, if required, to a specific phi region. Hit pair is fast, very efficient but low purity in the baseline due to loose constraints. Pixel pairs is used as a trajectory seeding for inside-out pattern recognition. Strip pairs and mixed pairs seeding can be used to increase the efficiency on tracks originating further than the pixel detector volume.

- Pixel Hit Triplets Finding
  - Low fake rate trajectory seed and fast track reconstruction

  - Pixel triplets are build from pixel pairs (cf hit pair section) for which a consistent third hit can be found in the outer pixel layer. As part of the baseline reconstruction, pixel triplet search is optimum above 1 GeV/Pt. Higher efficiency is achieved at lower momenta with dedicated algorithms. Pixel triplet strongly constrain Helix parameters consistent with the interaction region.

- High Level Trigger: tracker related

  - Tracker optimum resolution used via local track reconstruction.

  - The CMS trigger has a hardware-based first level (L1) which task is to reduce input event stream from LHC frequency (40 MHz) to 50-100 kHz. The next, and last level of triggering is fully software-based: the High Level Trigger (HLT) which rate is 100 Hz. The inner tracking detector is not part of the L1 decision and regional track reconstruction has to be triggered from external/Calorimeter primitives. Thus, electromagnetic from the ECAL, jet from the HCAL or muons from the muon system are used.

  - For muon seeded track reconstruction the baseline algorithm uses a L2-muon (see poster of R. Bellan) constrained to originate from the interaction region. A region of interest is defined around the object to construct pixel pairs. Pattern recognition and track fitting is then carried on and hence provides the mean HLT with track parameters of better resolution. Other algorithms are under development to have a robust muon reconstruction at HLT for LHC start-up. The best balance of timing, efficiency and purity has to be found between different approaches to regional reconstruction.

  - In addition to regional track reconstructions, pixel triplets can serve as fast track reconstruction and be used for vertex reconstruction. Vertex reconstruction at HLT stage is important to trigger on b jets, tau candidates... early trigger stages.