Readiness of Inner Detector SW to pileup

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Outline

- TRT tracking bug fox (Irreproducibility)
- Primary vertex finding readiness
- Timing of pileup (reminder)
- Plans

TRT tracking irreproducibility bug and pileup

- TRT standalone tracking and back tracking are not understood to a sufficient level in pileup scenarios since it has not been studied in depth recently.
- A full reprocessing prior to September would alleviate some of the concerns and doubts we have about the performance.
- For example, we don't want to be caught in the situation of the fix going in, high pileup arising and then the performance being found to be less than optimal.

Performance

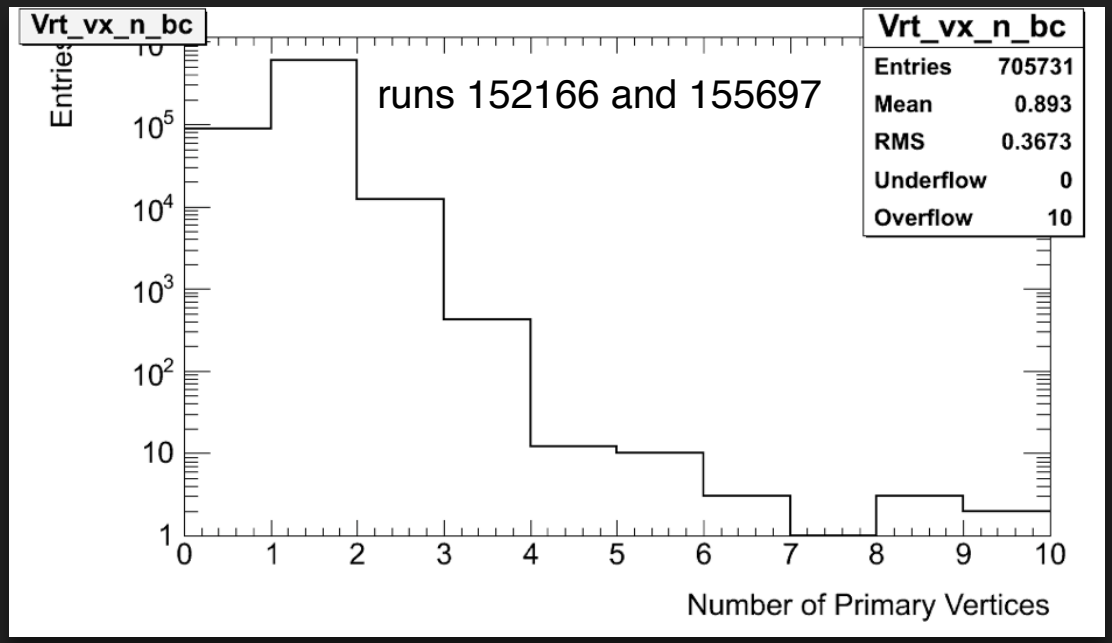
- InnerDetector Tracking changes according to Beam.numberOfCollisions(), so don't change this setting without alerting us first, as the plan is not to change the tracking setup during the running.

```
# --- switches for high lumi (5*10^33)
if jobproperties.Beam.numberOfCollisions() >= 10.0:
  # --- harden pt cut
  self.__minPT                    = 1.0 * Units.GeV
  # --- harden impact cuts
  self.__maxPrimaryImpact         = 2.0 * Units.mm
  self.__maxSecondaryImpact       = 20.0 * Units.mm
  # --- tighter cuts on holes in pattern
  self.__nHolesMax                = self.__maxHoles
  self.__nHolesGapMax             = 2*self.__maxDoubleHoles
```

- Primary Vertexing has had improvements put into 15.6.9.X to improve performance with respect to pileup
  - With beamspot constraint in play in ES2 and in Bulk processing the performance is not affected by pileup
  - In ES1, where it's used to find the beamspot the performance is a little degraded by pileup.

Primary Vertexing

- Iterative primary vertex finder is in use at Tier0. Currently the number of primary vertices per collision event is around 1.1 (roughly 10% of events have two or more vertices, some events with 4 vertices)
- The algorithm has been tested in MC samples where the mean number was 5 P.V.s per collision event.



Results using PerfMon

Summary	Without Pileup	With Pileup	
Inner Detector Reconstruction over 100 events			
File Sizes			Increase
AOD File size (kB/per event)	27	85	3.1
ESD File size (kB/per event)	63	189	3.0
CPU times			Increase
Initialisation (ms)	51213	52283	1.0
Event (ms)	1665	7766	4.7
[Si2ksec]	3163	14755	4.7
Finalisation (ms)	1171	1207	1.0
VMem (MB)			Difference (MB)
Initialisation	688	693	4.801
Event	735	797	62.051
Finalisation	791	857	65.925

Breakdown of CPU times (ms)

	CPU times (ms)	per event after the 1st event	
Inner Detector Reconstruction			
Algorithm	Without Pileup	With Pileup	factor increase
BeamConditionsMonitor	0.2	0.2	1
PRDformation	69.3	157.6	2.3
SPformation	3.6	13	3.6
NewTracking	463.8	2614	5.6
BackTracking	132.4	548.9	4.1
TRTStandalone	73.4	286.8	3.9
PixelSegmentAlone	44.1	210.2	4.8
SCTSegmentAlone	226.2	1516.3	6.7
TRTSegmentAlone	212.8	905.4	4
Merging	47.7	174.7	3.7
PrimaryVertexing	12	63.6	5
SecVtxFinder	11	42.3	3.8
ConversionFinder	24.7	172.9	7
V0Finder	12.7	58	4.6
LowBeta	6.1	23.5	3.9
ParticleCreation	1.2	5.1	4
InDetRecStatistics	5.6	25.1	4.5
IDMonManager	82.7	186.2	2.3
GlobalManager	48.3	253.8	5.3
AlignMonManager	20.5	64.2	3.1
AthenaStream	160.6	437	2.7
TOTAL	**1658.9**	**7758.8**	**4.7**

Plans

- If CPU and memory usage become a problem. Switch segments tracking off in the following order
  - SCT
  - TRT
  - Pixel

Backups

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Setup for pileup timing studies

- Without pileup
  - mc09_7TeV.107054.PythiaWtaunu_incl.recon.ESD.e514_s765_s767_r1250_tid127007_00/ESD.127007._000057.pool.root.1
- With pileup
  - mc09_7TeV.107054.PythiaWtaunu_incl.recon.ESD.e514_s765_s767_r1277_tid133828_00/ESD.133828._000016.pool.root.1
- Re-run of full Inner Detector reconstruction over the ESD
  - InDetRecExample/jobOptions.auto.py
- 15.6.9.4,AtlasProduction
  - rec.Commissioning = True
  - InDetFlags.useBeamConstraint = True
  - InDetFlags.doSlimming = False
  - InDetFlags.doTruth = False

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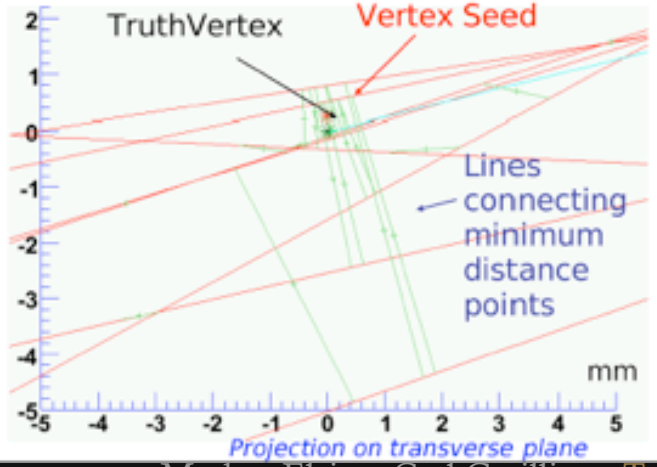
VMem in ‘evt’ stage

	VMem (kB) per event	
Inner Detector Reconstruction	From PerfMon in ‘evt’ stage	
Algorithm	Without Pileup	With Pileup
BeamConditionsMonitor	0	0
PRDformation	0	0
SPformation	0	0
NewTracking	0	177.1
BackTracking	0	31
TRTStandalone	0	20.7
PixelSegmentAlone	0	0
SCTSegmentAlone	0	0
TRTSegmentAlone	0	0
Merging	0	93.1
PrimaryVertexing	0	10.3
SecVtxFinder	0	0
ConversionFinder	0	0
V0Finder	0	0
LowBeta	0	0
ParticleCreation	0	0
InDetRecStatistics	0	10.3
IDMonManager	0	0
GlobalManager	0	0
AlignMonManager	0	0
AthenaStream	326.1	460.6
TOTAL	**326.1**	**803.1**

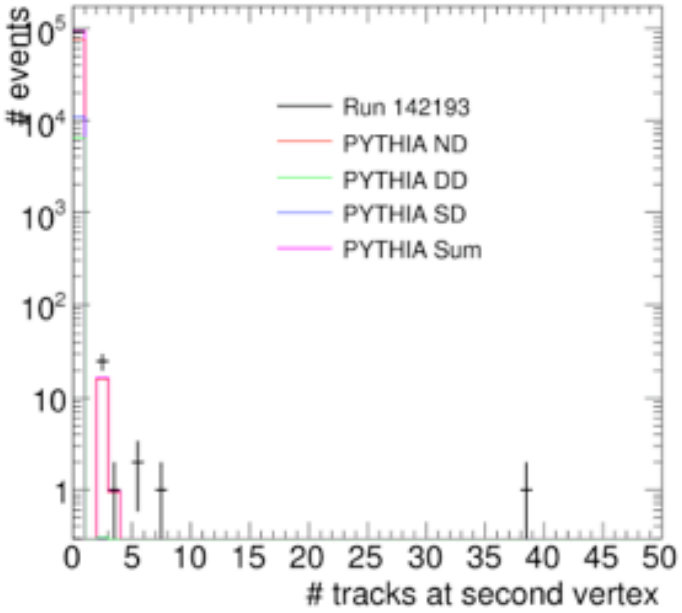
Algorithmic setup: pattern recognition (II)

- Second alternative (Iterative Finder):
  - 1) Use a "seed finding algorithm" to find a new seed
  - 2) Start from the seed and from tracks surrounding it to fit a new vertex
  - 3) Use all outliers (Prob(χ^2)<cut) and remaining tracks to restart from 1)
  - Advantage: best possible rejection of outliers
    independent on the beam line position
  - Disadvantage: less robust against real or fake secondary vertices
- 3d seed finding algorithm:
  - Find all mean points of distances between all pairs of tracks (<3 mm)
  - Use these points to find a "peak" in this 3d distribution
  - Good resolution: factor 2 worse than final vertex fit



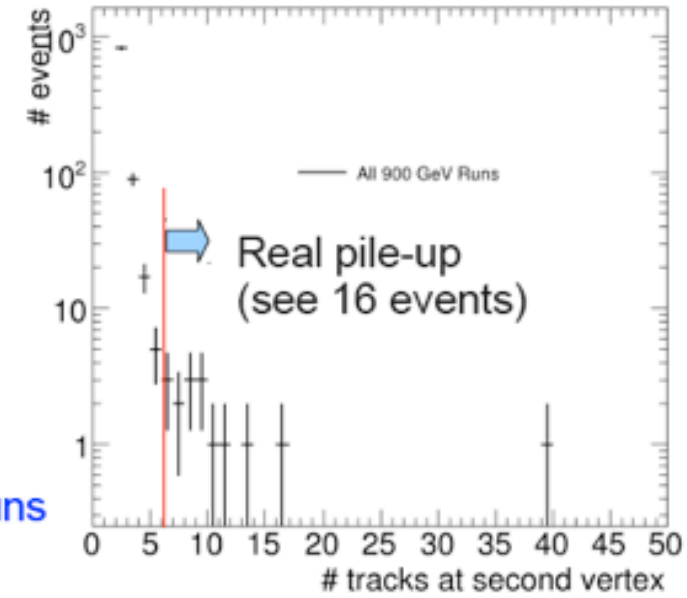
Algorithmic setup: pattern recognition (III)

- The second alternative (Iterative Finder) has been chosen to be used for the start of the 7 TeV run (in combination with the adaptive vertex fitter).
- Only tracks incompatible with the previous vertex by more than 7σ are used to seed a new vertex.
- With beam spot constraint on, in the 900 GeV data this reduces the number of additional vertices in single collision events to a rate of ~10^{-3}.



Run 142193 (expected pile-up rate: ~10^{-4})

All 900 GeV runs



PILEUP EFFECTS IN TRACKING (VALIDATION GROUP : Andrea Favareto)

http://indico.cern.ch/getFile.py/access?contribId=15&resId=0&materialId=2&confId=97933