<u>Study of the trackfinding performances for an</u> <u>upgrade of the Belle II vertex detector</u>



Outline

- Belle II detector
 - Current vertex detector
- Definitions for tracking
- Upgraded geometry
- Method for performance evaluation
- Results
 - Number of layers
 - Background level

Belle II detector

range of interesting momentum : (50 MeV/c - 6 GeV/c)

e (76eV)



e+(4GeV

Belle II detector



4

Current vertex detector



Lead to occupancy > 1 %, Possible issurs for tracking with higer luminosity

- Monte-Carlo (MC) track finder. Reconstructs MC-tracks from simulated hits associated to same true generated particles. The ensemble of MC-tracks defines all particles which can be reconstructed. Only limited by detectors acceptance
- Pattern-recognition algorithm. Uses all simulated hits, generated by all true particles from the collisions, beam background, detector noise, reconstructs so-called PR-tracks.

For a given pair of MC-track/PR-track :

• <u>Hit efficiency :</u>

h.e = # of hits of MC-track contained in PR-track # of hits in the PR-track

• <u>Hit purity :</u>

h.p = # of hits of the PR-track contained in MC-track # of hits in the MC-track

 <u>Matching criteria</u> : hit purity > 66% hit efficiency > 5%

PR-track with highest hit-purity is considered as <u>matched</u>, the other are marked as <u>clones</u>

If PR-track fails the hit-purity requirement, then PRtrack is defined as a <u>fake</u>.



• <u>Track finding efficiency :</u>

T f e = $\frac{\# of matched MC-tracks}{all MC-tracks}$

• Fake rate :

F r = # of fake PR-tracks Total # of PR-tracks

The VXD upgrade

- Proposition : replace all sensor by pixellated fast sensor
- CMOS sensor :
 - Pitches: 30-40 µm
 - Integration times < 100 ns
 - Material budget: 0.1% to 0.5%
 - Thickness < 50 μ m
 - Power dissipation < 200 mW/cm²



New geometry

- 2 main propositions :
 - 5 layers : 3 inner layers + 2 external layers
 - 7 layers : 3 + 4

5-Layers	1	2	3	4	5
Radius (cm)	1.4	2.2	3.9	8.9	14.0
# of ladders	6	10	8	18	26
Width (cm)	1.9	1.9	3.0	3.0	3.0

7-Layers	1	2	3	4	5	6	7
Radius (cm)	1.4	2.2	3.5	6.0	9.0	11.5	13.5
# of ladders	6	10	14	12	18	22	26
Width (cm)	1.9	1.9	1.9	3.0	3.0	3.0	3.0





Method for performance evaluation

- Simulated data set only
- 1000 events
- Focus on tracking efficiency and fake rates
 - Modification of background :
 - BGx1 = simulated background at full expected luminosity extrapolated from real background
 - BGx1, x2, x5, x10
 - Interpretations :
 - Safety factor
 - Longer integration time

5 layers vs 7 layers



5 layers vs 7 layers















Fake rates

fake rate by Seed θ profile



Conclusion

- 7 layers seems better than 5 layers (not prevalent)
- BG up means efficiency down and fake rate up
 - BGx10 efficiency is not acceptable
 - Maximum safety factor is 5
 - Maximum integration time is 500 µs with no safety factor
 - Integration time = 200 $\mu s \rightarrow$ safety factor = 2



