Tuning Pythia8 for future e^+e^- colliders

ILD Software & Analysis Meeting

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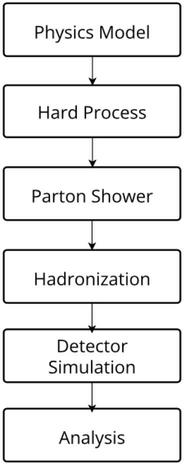
Overview

- Motivation
- Average Hadron Multiplicities
- ILD Simulation and Jet Energy Resolution (JER)
- Summary

Motivation

- Present events:
  - Leading order matrix elements are calculated by Whizard 1.95.
  - Parton shower and hadronization are performed by Pythia6.
  - OPAL tune is used.
- Purposes:
  - Upgrade the simulation chain to Whizard3+Pythia8.
  - Include NLO matching in the future.



Average Hadron Multiplicities

Details of the Whizard setup are

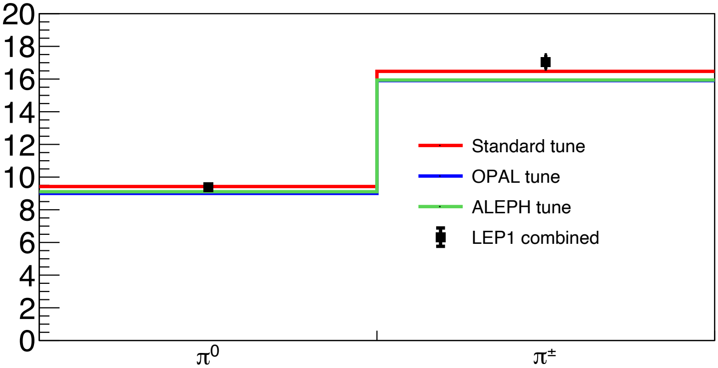
- Process: $e^+e^- \to q\bar{q}\ (q = u, d, s, c, b)$.
- The center of mass energy is $E_{cm} = 91.19$ GeV.
- Beams are un-polarized.
- Beam-strahlung is not considered.
- Initial state radiation (ISR) is switched on.

The parton shower and hadronization are performed by Pythia8. Three tunes are considered:

- The standard tune, using default parameters set of Pythia8.
- The OPAL tune.
- The ALEPH tune.

Average Hadron Multiplicities

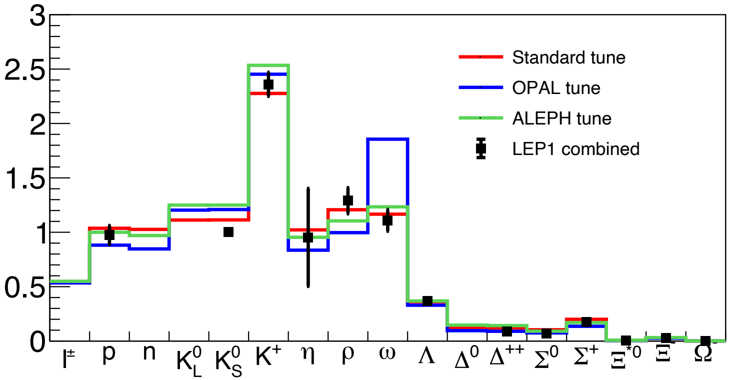
The dominant hadrons are pions. The average numbers of pions in events are



- LEP1 data are taken from A. Boehrer, 1997 and R. Barete *et al.*, 1998

Average Hadron Multiplicities

We also compare other hadrons



> The standard tune is closest to data.

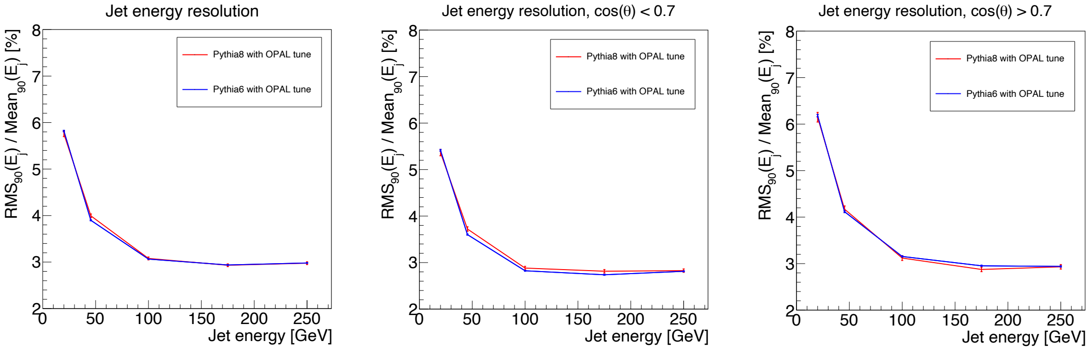
ILD Simulation and JER

Details for ILD simulation are:

- $e^+e^- \to q\bar{q}$ $(q = u, d, s)$ events are generated by Whizard3+Pythia8 as described above, but ISR is switch off.
- $E_{cm} = 40, 91, 200, 350, 500$ GeV.
- Simulation is performed by iLCSoft v02-02-03 with ILD_l5_o1_v02 model.

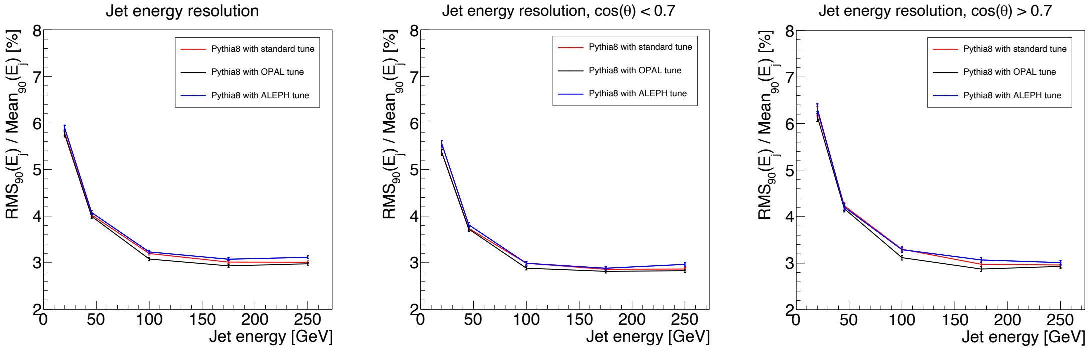
JER Results

- Compare with previous events that were used in ILD IDR [arXiv:2003.01116].



JER Results

Comparison with three tunes:



> OPAL tune can give the best resolution in this context.

Summary

- The MC simulation chain is necessary to upgrade to Whizard3+Pythia8.
- We compare three tunes: the standard Pythia8 tune, the OPAL tune and the ALEPH tune.
- The standard tune can give hadron multiplicities close to LEP1 data, and the OPAL tune can give the best JER.
- Next steps: test the NLO mode of Whizard and generate events by POWHEG matching.

Thank You

Backup slides

Pythia8 Parameters

Parameter	name in PYTHIA8	standard	OPAL	ALEPH
$P(qq)/P(q)$	StringFlav:probQQtoQ	0.081	0.085	0.105
$P(s)/P(u)$	StringFlav:probStoUD	0.217	0.310	0.283
$(P(su)/P(du))/(P(s)/P(u))$	StringFlav:probSQtoQQ	0.915	0.45	0.710
$\frac{1}{3}(P(ud_1)/P(ud_0))$	StringFlav:probQQ1toQQ0	0.0275	0.025	0.05
$(S=1)$ d,u	StringFlav:mesonUDvector	0.50	0.60	0.54
$(S=1)$ s	StringFlav:mesonSvector	0.55	0.40	0.46
$(S=1)$ c,b	StringFlav:mesonCvector	0.88	0.72	0.65
	StringFlav:mesonBvector	2.20	0.72	0.65
$S=1, s=0$ prob.	StringFlav:mesonUDL1S0J1	0.0	0.43	0.12
$S=0, s=1$ prob.	StringFlav:mesonUDL1S1J0	0.0	0.08	0.04
$S=1, s=1$ prob.	StringFlav:mesonUDL1S1J1	0.0	0.08	0.12
tensor mesons (L=1)	StringFlav:mesonUDL1S1J2	0.0	0.17	0.20
leading baryon suppr.	StringFlav:suppressLeadingB	off	on	on
	StringFlav:lightLeadingBSup	0.5	1.0	0.58
	StringFlav:heavyLeadingBSup	0.9	1.0	0.58
σ (GeV)	StringPT:sigma	0.335	0.4000	0.362
η' suppression	StringFlav:etaPrimeSup	0.12	0.40	0.27
a of LSFF	StringZ:aLund	0.68	0.11	0.40
b of LSFF	StringZ:aLund	0.98	0.52	0.824
Δa for s quark	StringZ:aExtraSQuark	0.0	0.0	0.0
Δa for Di-quark	StringZ:aExtraDiquark	0.97	0.5	0.5
ϵ_c	StringZ:usePetersonC	off	on	on
	StringZ:epsilonC	0.05	-0.031	0.04
ϵ_b	StringZ:usePetersonB	off	on	on
	StringZ:epsilonB	0.005	-0.002	0.0018
PS QCD cut-off (GeV)	TimeShower:pTmin	0.5	0.95	0.735
PS cut-off for QED adiation off quarks (GeV)	TimeShower:pTminChgQ	0.5	0.95	0.735