Simulating Background with PYTHIA

E.Chudakov[1]

[1]JLab

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http://www.jlab.org/~gen/gluex/talk_pythia_1.pdf

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Outline

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Minimum Bias Events

There are several reasons to simulate “minimum bias events”:

- Estimate the backgrounds for given processes of interest
- Tune the trigger logic
- .....

How to simulate them?

Empirical collection

- Measured processes
- Use experimental $\sigma(E_\gamma)$
- Best way
- Never complete
- Need to know $\frac{d\sigma^n}{dt \cdot d\theta_{GJ} \ldots}$

LUND models: full simulation

- PYTHIA photoproduction
- Hadronization and decays
- Complete
- Does it match experimental results?

PYTHIA settings

Original PYTHIA version: 6.225

- Tuned for HERMES physics and energies (Elke *et al*)
- Elaborate photoproduction model, but for $E_\gamma > 25$ GeV
- Radiative corrections added

$$\sigma^{\gamma p}_{tot} = \sigma^{\gamma p}_{dir} + \sigma^{\gamma p}_{VMD} + \sigma^{\gamma p}_{anomal}$$

$\sigma^{\gamma p}_{dir}$: $\gamma q \to qg, \gamma g \to q\bar{q}$, $\sigma^{\gamma p}_{anomal}$: GVMD $\gamma \to q\bar{q}$ off–shell

PYTHIA 6.225 adaped for GLUEX physics

- Nearly all HERMES changes kept, rad.corr. removed
- Minimal energy $E_\gamma = 7$ GeV
- Interface to (COM)GEANT:
  - Random numbers $\Leftarrow$ GEANT
  - Some decays can be left to GEANT
  - Output NTUPLE: LUND record added

Photoproduction at 9 GeV

I	N:o	Type	Number of points Generated	Number of points Tried	Sigma (mb)
I	0	All included subprocesses	10000	8114	7.874E-02
I	11	f + f' -> f + f' (QCD)	56	0	4.385E-04
I	12	f + fbar -> f' + fbar'	2	0	1.722E-05
I	13	f + fbar -> g + g	2	0	1.722E-05
I	28	f + g -> f + g	44	0	3.434E-04
I	53	g + g -> f + fbar	0	0	0.000E+00
I	68	g + g -> g + g	9	0	6.520E-05
I	91	Elastic scattering	1264	1264	9.688E-03
I	92	Single diffractive (XB)	286	286	2.075E-03
I	93	Single diffractive (AX)	220	220	1.897E-03
I	94	Double diffractive	0	0	0.000E+00
I	95	Low-pT scattering	8006	8192	6.337E-02
I	131	f + gamma*_T -> f + g	93	343	6.766E-04
I	135	g + gamma*_T -> f + fbar	18	52	1.519E-04
I	1	VMD * hadron	9605	5507	7.538E-02
I	2	direct * hadron	111	395	8.285E-04
I	3	anomalous * hadron	284	2212	2.538E-03
I	4	DIS * hadron	0	0	0.000E+00

	Experiment	PYTHIA
$\sigma_{tot}^{\gamma p}$	120 μb	79 μb

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Comparison with experiments - non-strange particles

Partial cross section normalized to: $\sigma_{tot}^{\gamma p} = 120\ \mu$b

process $\gamma p \to$	via	Experiment E_γ, GeV	Experiment σ, μb	PYTHIA E_γ, GeV	PYTHIA σ, μb
1 prong		9.3	8.5±1.0	9.0	6.2
3 prong		9.3	64.4±1.5	9.0	59.0
5 prong		9.3	34.2±0.9	9.0	44.0
7 prong		9.3	6.8±0.3	9.0	8.3
$p\pi^+\pi^-$		9.3	14.7±0.6	9.0	14.5
	$p\rho^\circ$	9.3	13.5±0.5	9.0	13.0
$p\pi^+\pi^-\pi^\circ$		9.3	7.5±0.8	9.0	7.0
	$p\omega$	9.3	1.9±0.3	9.0	1.4
$p2\pi^+2\pi^-$		9.3	4.1±0.2	9.0	3.7

Reasonably good agreement!

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Comparison with experiments - strange particles

Partial cross section normalized to: $\sigma_{tot}^{\gamma p} = 120\ \mu$b

process $\gamma p \to$	via	Experiment E_γ, GeV	Experiment σ, μb	PYTHIA E_γ, GeV	PYTHIA σ, μb
strange		5.6	8.7±0.9	9.0	24.0
pK^+K^-		9.3	0.58±0.05	9.0	0.47
	$p\phi$	9.3	0.27±0.03	9.0	0.26
$pK^+K^-\pi^+\pi^-$		9.3	0.46±0.05	9.0	0.60

Full strange cross section is $\times 3$ larger

Partial strange cross sections are reasonable

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Differential cross section

		Experiment	PYTHIA
ρ°	t-slope, $(\mathrm{GeV/c})^{-2}$	6.2 ± 0.2	7.7 for $p\rho^\circ$

ρ°t-distributions

- Not too bad for an exclusive channel
- Has a peak at $t \sim 0$ for inclusive events (?)
- Needs more studies

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Conclusion

- PYTHIA results look promissing
- More studies are needed for:
  - Strange particles
  - t-distributions
  - GJ-distributions
  - No meson resonances simulated beyond the main octet and nonet

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