Pomwig / Herwig and Beyond

MC generators

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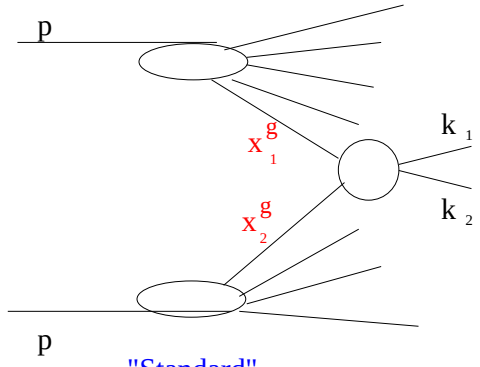
Outline

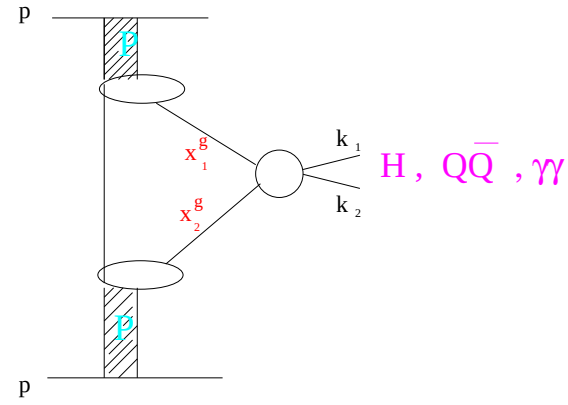
- DiffHiggs
- Pomwig
- Beyond Pomwig
- Simulation

DiffHiggs

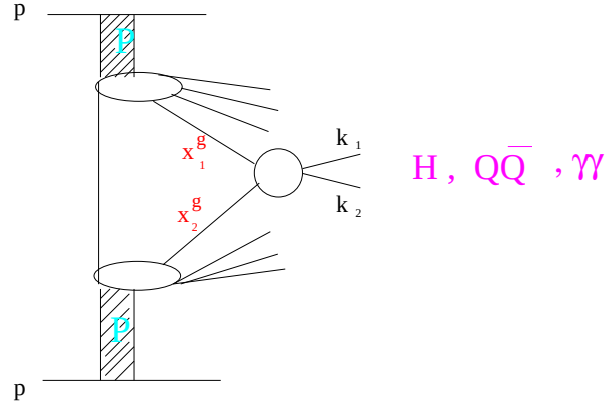
- Nonfactorizable Model: M. Boonekamp, R. Peschanski, C. Royon; [hep-ph/0301244]
- Motivation: Bialas-Landshoff model, A. Bialas, P.V. Landshoff; *Phys. Lett* **B 256** (1991)
- Physical Picture:



"Standard"



"Exclusive "



"Inclusive"

DiffHiggs

- Factorization:

$$d\sigma = \sum_{i,j} \int dx_1 dx_2 d\xi_1 d\xi_2 \; F_{\mathcal{P}/h_1}(\xi_1) F_{\mathcal{P}/h_2}(\xi_2) \; f_{i/\mathcal{P}}(x_1) f_{j/\mathcal{P}}(x_2) \; d\hat{\sigma}(ij \to M_X)$$

- Pomeron Flux: (taken from the original model, $\beta = 4\,\mathrm{GeV}^{-2}$, $\mathcal{N}$ is arbitrary)

$$F_{\mathcal{P}/h}(\xi) = \mathcal{N} \int_{t_{min}}^{t_{max}} \frac{e^{\beta\, t}}{\xi^{2\alpha_{\mathcal{P}}(t)-1}}$$

- Regge trajectory: (factorization breaking, $\alpha_{\mathcal{P}}(0) = 1.08$, $\alpha'_{\mathcal{P}} = 0.25\,\mathrm{GeV}^{-2}$)

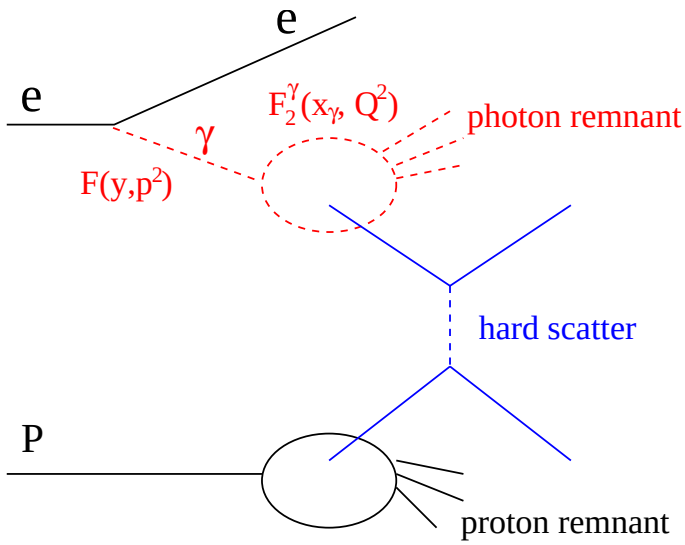
$$\alpha_{\mathcal{P}}(t) = \alpha_{\mathcal{P}}(0) + \alpha'_{\mathcal{P}} t$$

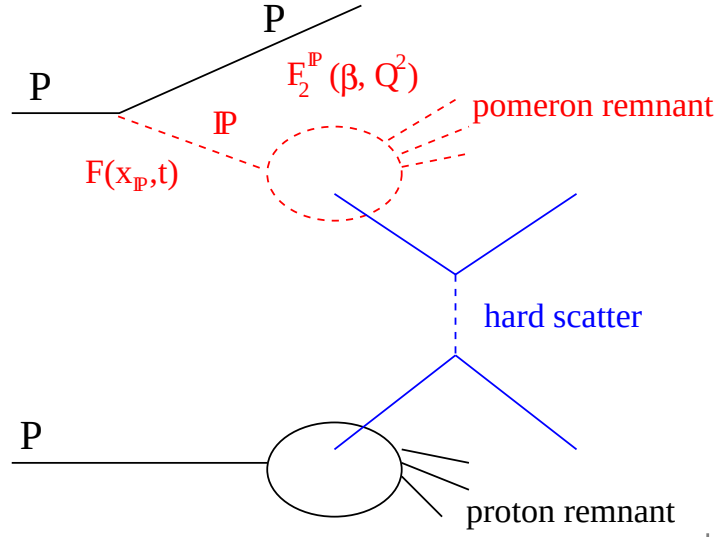
DiffHiggs

- $f_{i/\mathcal{P}}(x)$: PDFs in a Pomeron
  - Extracted from DIS data (H1 Collaboration, *Z. Phys.* **C 76** (1997))
  - QCD hard factorization
  - Dominance of a gluon component

Pomwig

- Factorizable model: B. Cox, J. Forshaw; [hep-ph/0010303]
- Differences from DiffHiggs:
  - Slope of the Regge trajectory $\alpha_{\mathcal{P}}(0) = 1.2$ as extracted from HERA data
  - DiffHiggs uses $f_{g/\mathcal{P}}(x) = xg(x)$, while Pomwig uses $f_{g/\mathcal{P}}(x) = g(x)$
- Pomwig implemented as an extension of Herwig (MC generator)
- Idea: Pomeron exchange events in hadron - hadron collisions lool like resolved photoproduction events in lepton - hadron collisions:





Pomwig

- Advantage:
  - Herwig contains a large library of hard processes
  - Parton level, showering and hadronization in one package
- Typical Event record for Higgs production in DPE

—INITIAL STATE—

IHEP	ID	IDPDG	IST	MO1	MO2	DA1	DA2	P-X	P-Y	P-Z
1	E+	-11	101	0	0	4	5	0.00	0.00	1000.00
2	E-	11	102	0	0	6	7	0.00	0.00	-1000.00
3	CMF	0	103	4	6	0	0	0.42	-0.24	56.61
4	GAMMA	22	3	1	0	0	0	0.04	0.17	98.46
5	E+	-11	1	1	0	0	0	-0.04	-0.17	901.54
6	GAMMA	22	3	2	0	0	0	0.38	-0.41	-41.85
7	E-	11	1	2	0	0	0	-0.38	0.41	-958.15

—HARD SUBPROCESS—

IHEP	ID	IDPDG	IST	MO1	MO2	DA1	DA2	P-X	P-Y	P-Z
8	UBAR	-2	121	10	9	11	9	0.03	0.15	82.80
9	UQRK	2	122	10	8	13	8	0.33	-0.36	-36.53
10	HIGGS	25	120	8	9	25	25	2.35	0.58	46.29

—STRONG HADRON DECAYS—

IHEP	ID	IDPDG	IST	MO1	MO2	DA1	DA2	P-X	P-Y	P-Z
25	HIGGS	25	195	10	25	31	32	2.35	0.58	46.29

—H/W/Z BOSON DECAYS—

IHEP	ID	IDPDG	IST	MO1	MO2	DA1	DA2	P-X	P-Y	P-Z
31	BQRK	5	123	25	32	33	32	-47.94	-1.24	48.97
32	BBAR	-5	124	25	31	35	31	50.29	1.82	-2.69

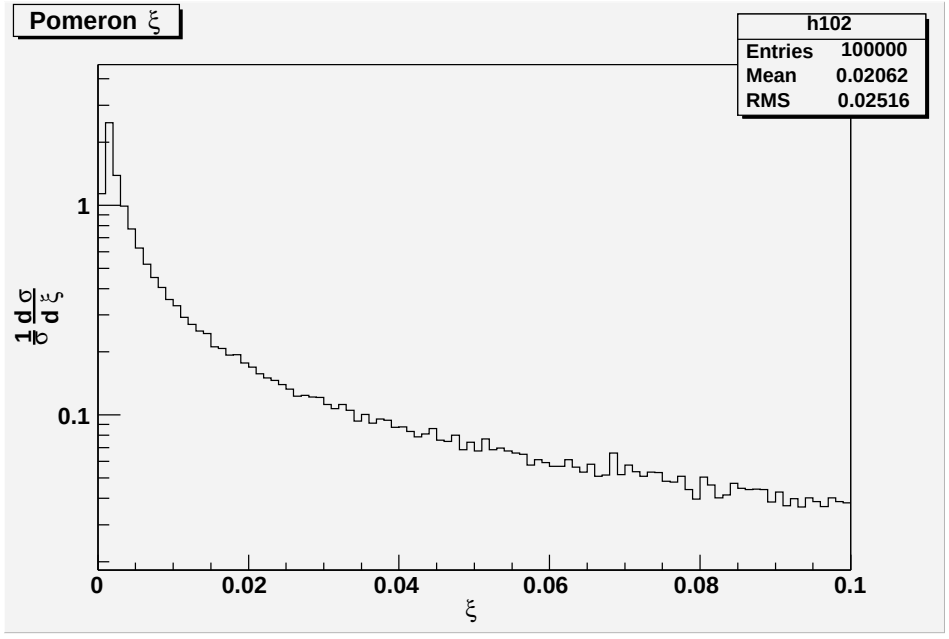
Beyond Pomwig

Implementation of the following processes in Herwig according to DiffHiggs:

- Inclusive DPE:
  - Higgs ($gg \to H$)
  - Dijet ($gg \to q\bar{q}, gg$)
  - Dilepton ($q\bar{q} \to l\bar{l}$)
  - Digamma ($q\bar{q} \to \gamma\gamma$, $gg \to \gamma\gamma$)
- Exclusive DPE:
  - Higgs
  - Dijet
  - Digamma
- Heavy-Ion collisions:
  - Higgs
  - Dijet
  - Digamma
  - Dilepton

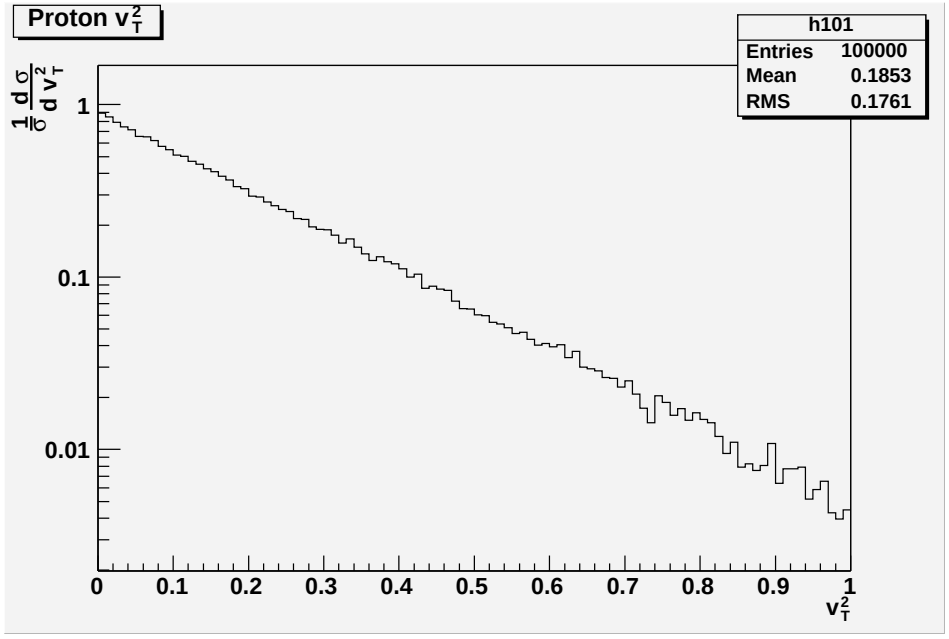
Beyond Pomwig

- Cross section for Exclusive processes:
  - Set $f_{i/\mathcal{P}}(x) = \delta(1-x)$:
  - Only projection with $J_Z = 0$ and $P = +1$ contributes to $\hat{\sigma}$
  - Color singlet production of massive system in $gg \to M_X$
  - Flux stays the same as for Inclusive processes
- ξ distribution for exclusive Higgs production in DPE



Beyond Pomwig

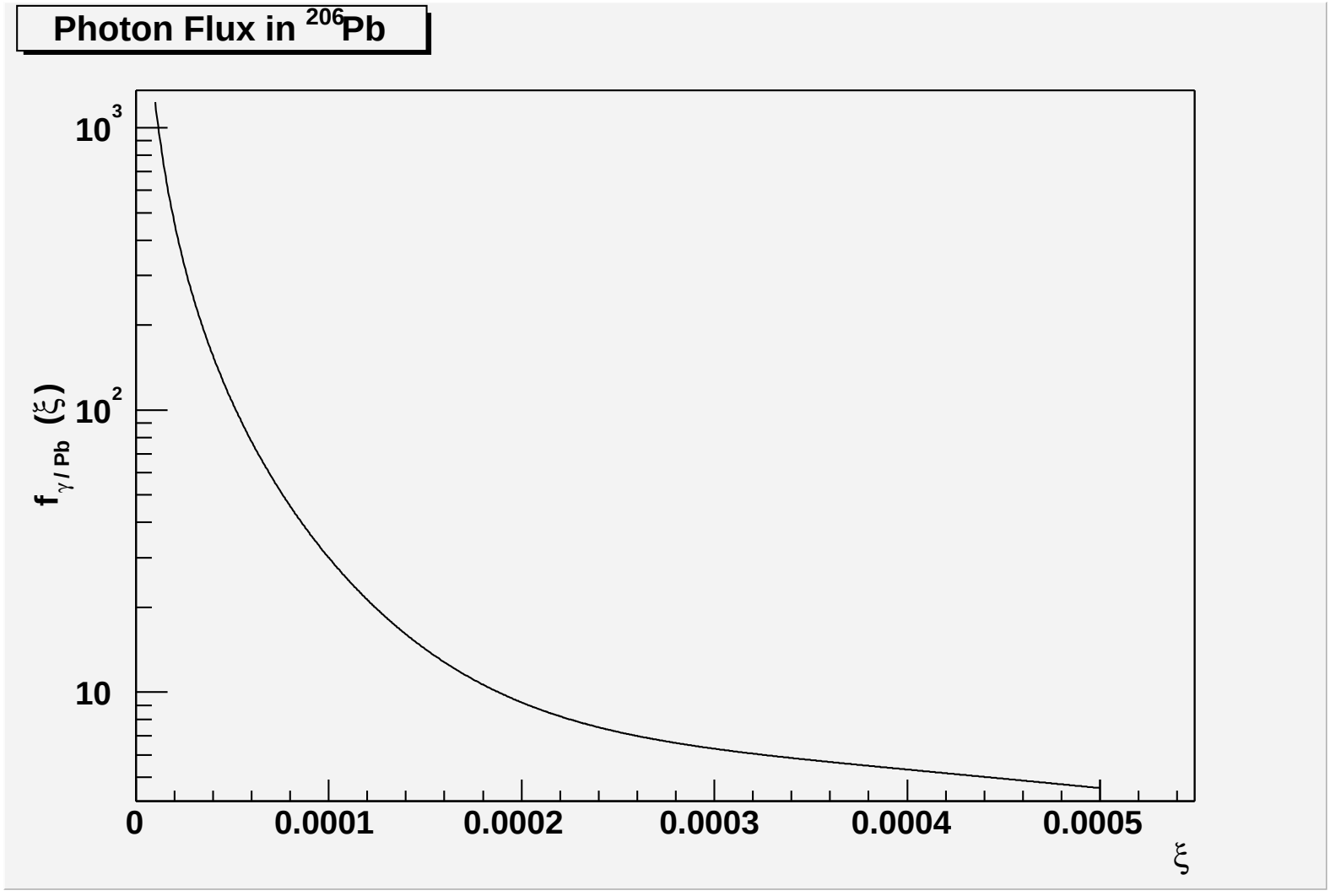
- v_T^2 distribution for exclusive Higgs production in DPE



- Cross section for Heavy-Ion collision:
  - Higgs ($\gamma\gamma \rightarrow H$)
  - Dijet ($\gamma\gamma \rightarrow q\bar{q}$)
  - Dilepton ($\gamma\gamma \rightarrow l\bar{l}$)
  - Digamma ($\gamma\gamma \rightarrow \gamma\gamma$)
  - No PDFs

Beyond Pomwig

- Photon Flux from heavy-ion instead of Pomeron Flux: E. Papageorgiu, *Phys. Lett.* **B 250** (1990); M. Drees, J. Ellis, D. Zeppenfeld, *Phys. Lett.* **B 223** (1989)



Simulations

- Simulation Chain:
  1. Event generator
  2. Initial conditions at interaction point
  3. Simulation of the detector response
  4. Reconstruction of kinematics from simulated data
- 2. - 4. will be performed in coming weeks