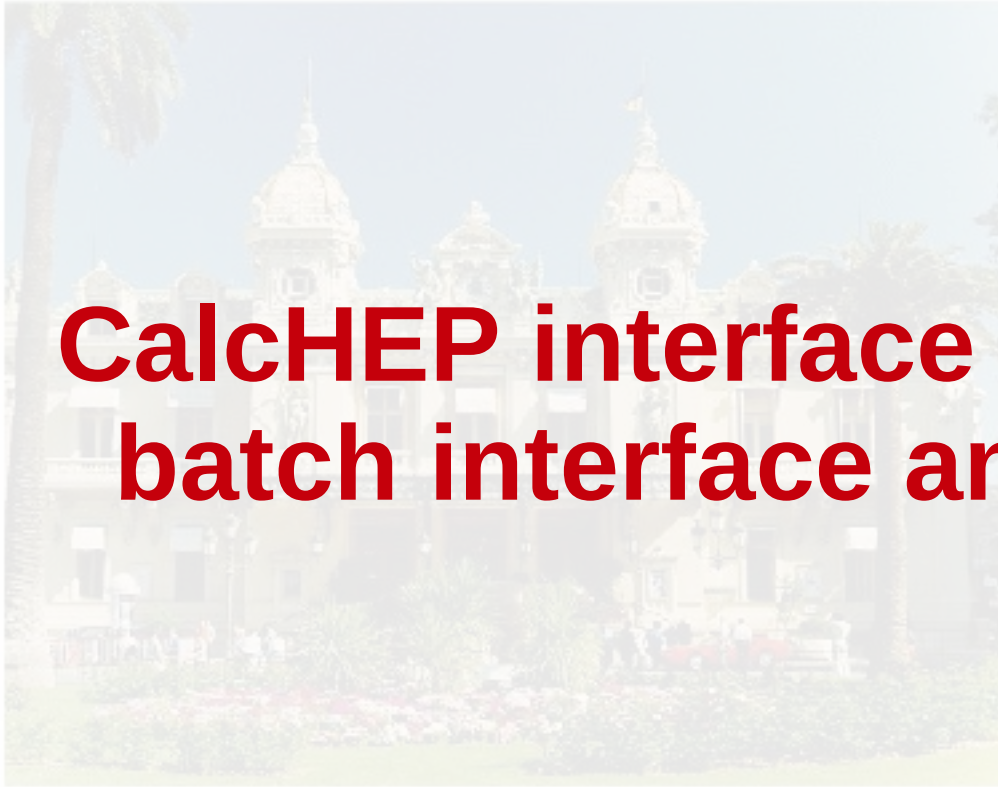
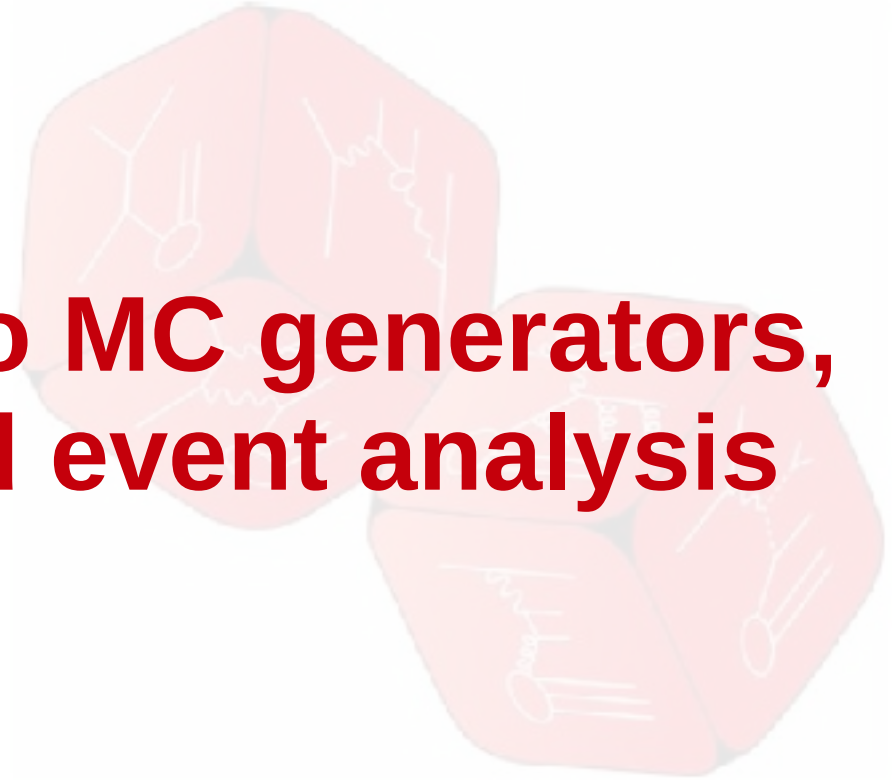


A tour to Monte Carlo



CalcHEP interface to MC generators, batch interface and event analysis

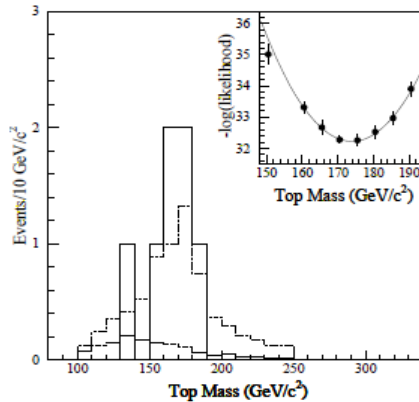


... because Einstein was wrong: God does throw dice!

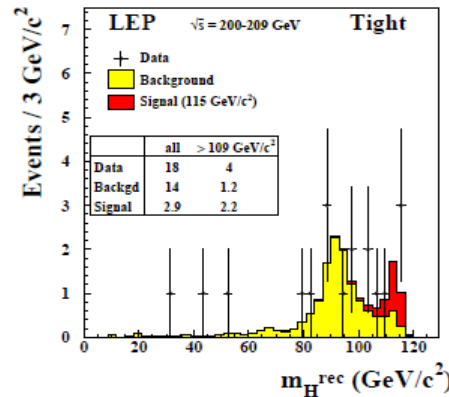
Quantum mechanics: amplitudes \Rightarrow probabilities

Anything that possibly can happen, will! (but more or less often)

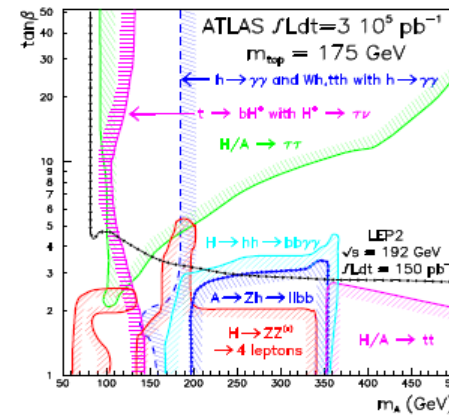
Why generators?



top discovery
and mass
determination



Higgs (non)
discovery

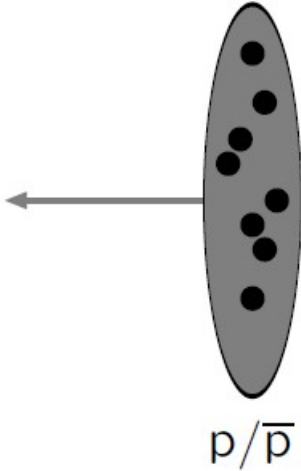
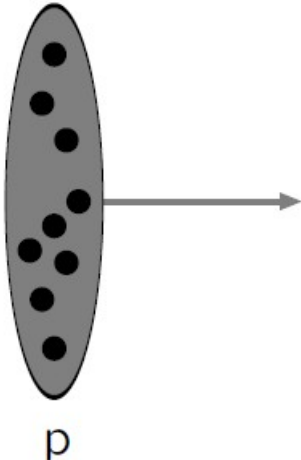


Higgs and
supersymmetry
exploration

not feasible without generators

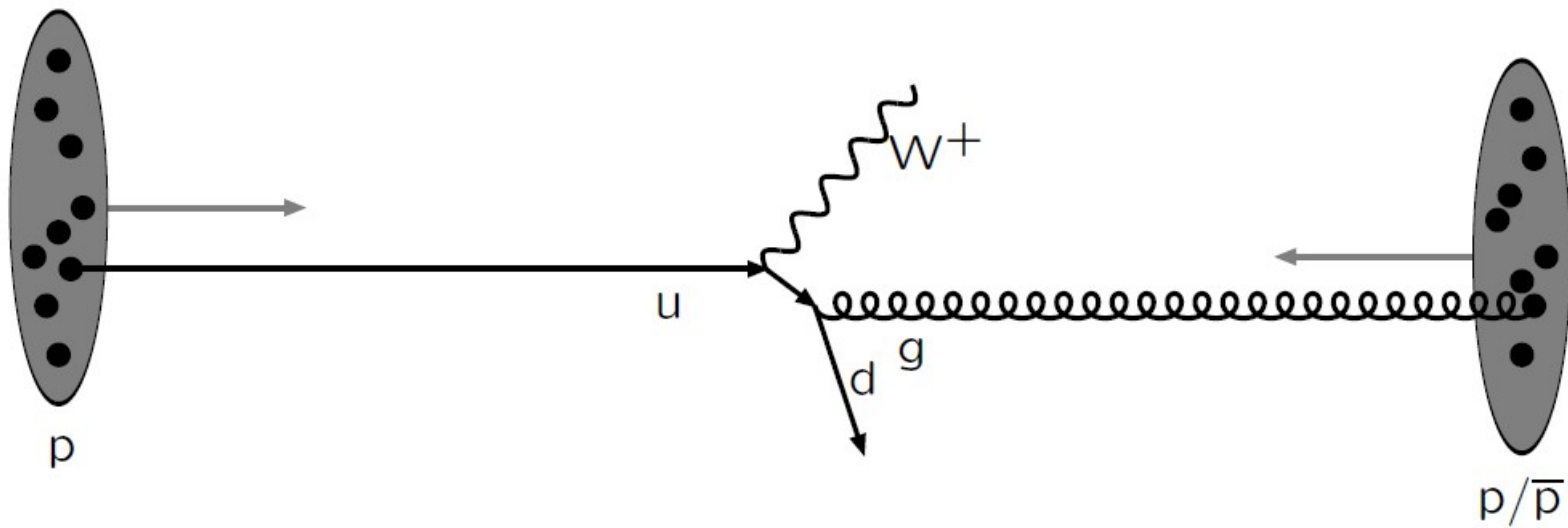
- Allow theoretical and experimental studies of **complex multiparticle physics**
- Analytical tools can not represent the complexity of the real picture!
- Many aspects of **theory-phenomenology-experiment** to be answered:
 - ➔ from complexity of theoretical picture
 - ➔ to phenomenological understanding of features and observability of **signal versus the background**
 - ➔ to understanding/optimization of **detector features/requirements, acceptances to observe and study this theory**

Event Structure



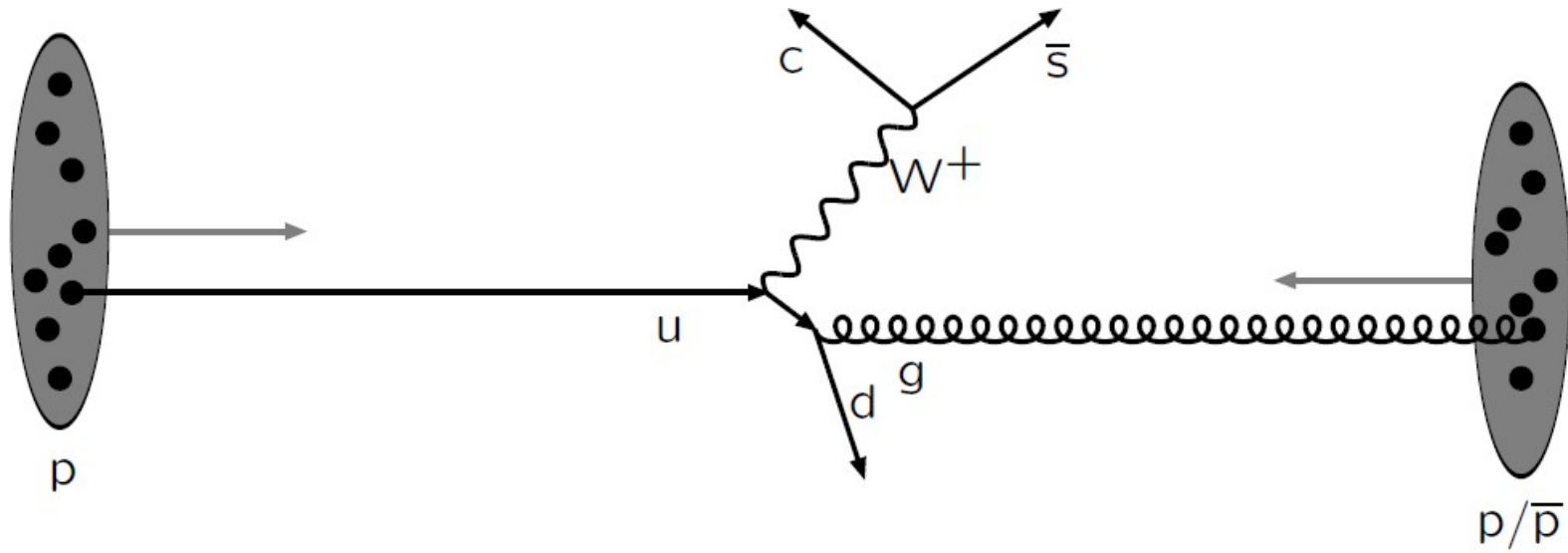
Incoming beams: parton densities

Event Structure



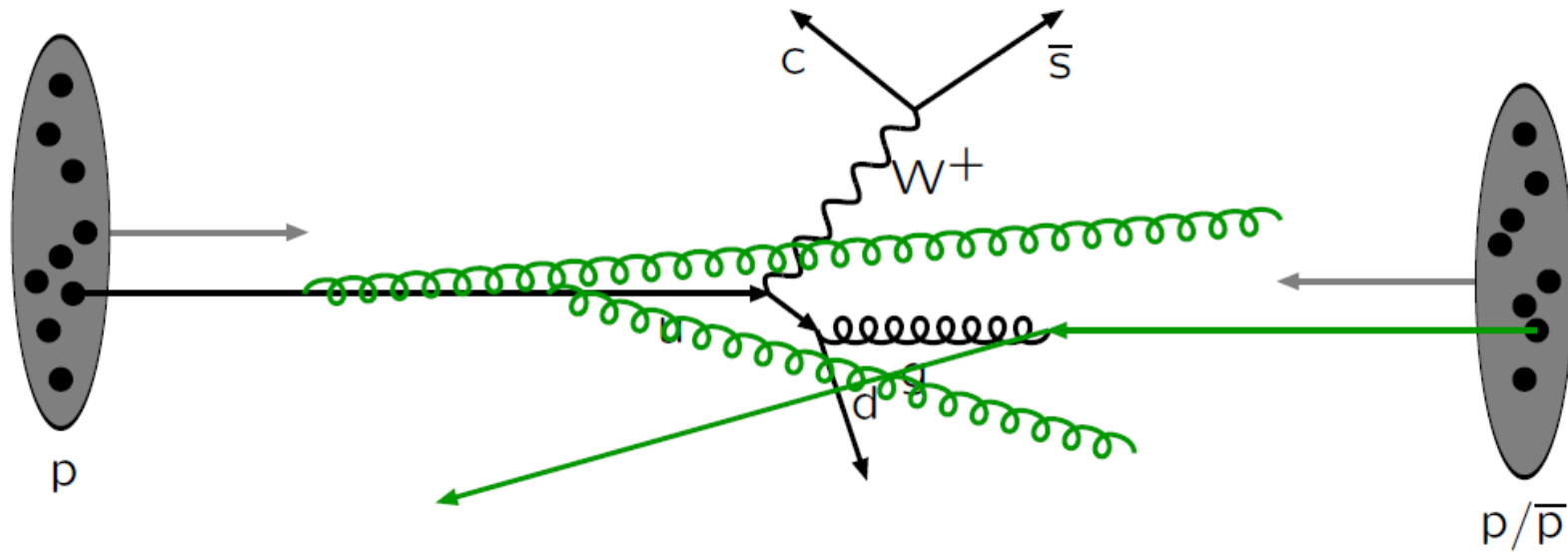
Hard subprocess: described by matrix elements

Event Structure



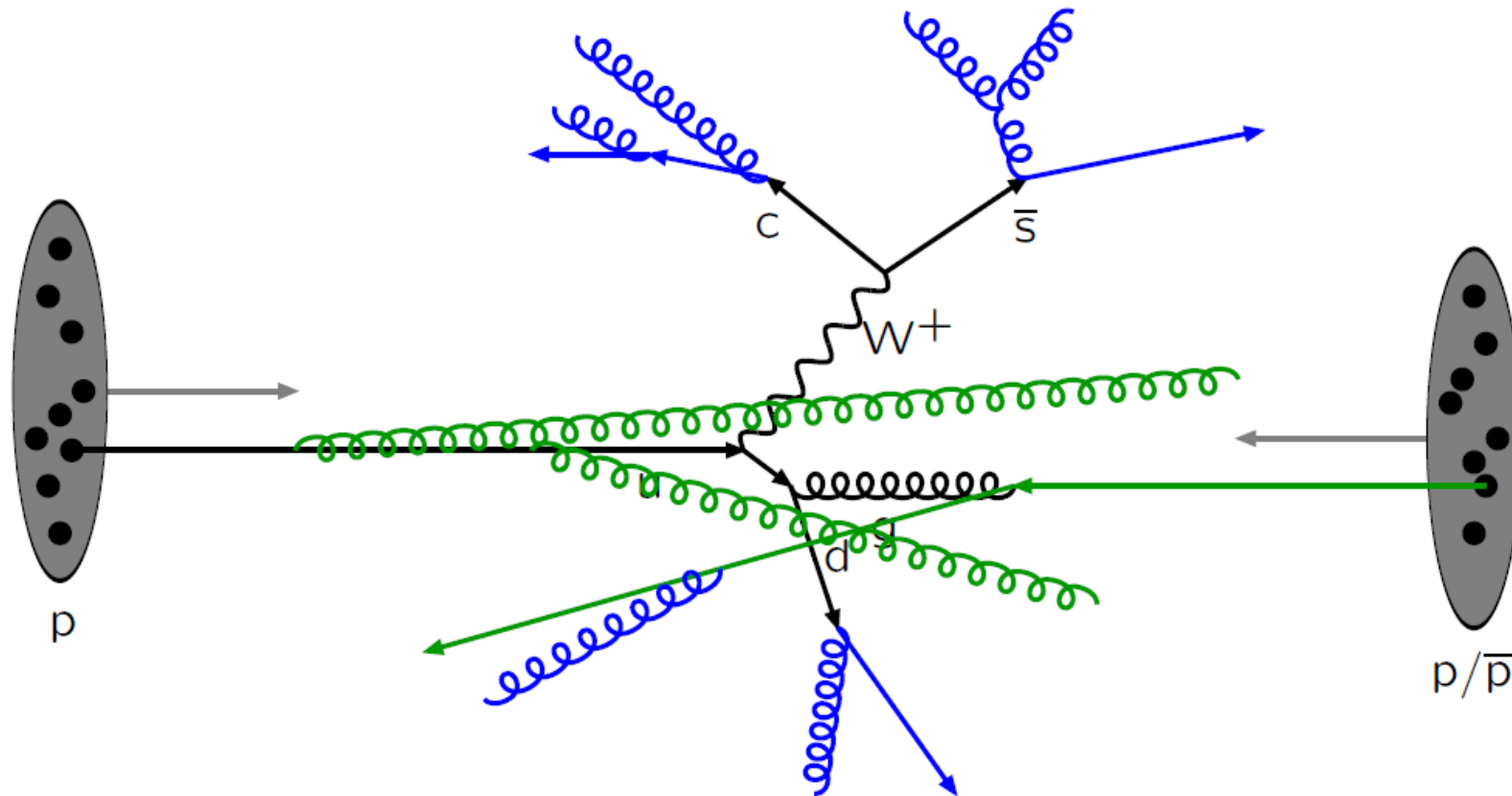
Resonance decays: correlated with hard subprocess

Event Structure



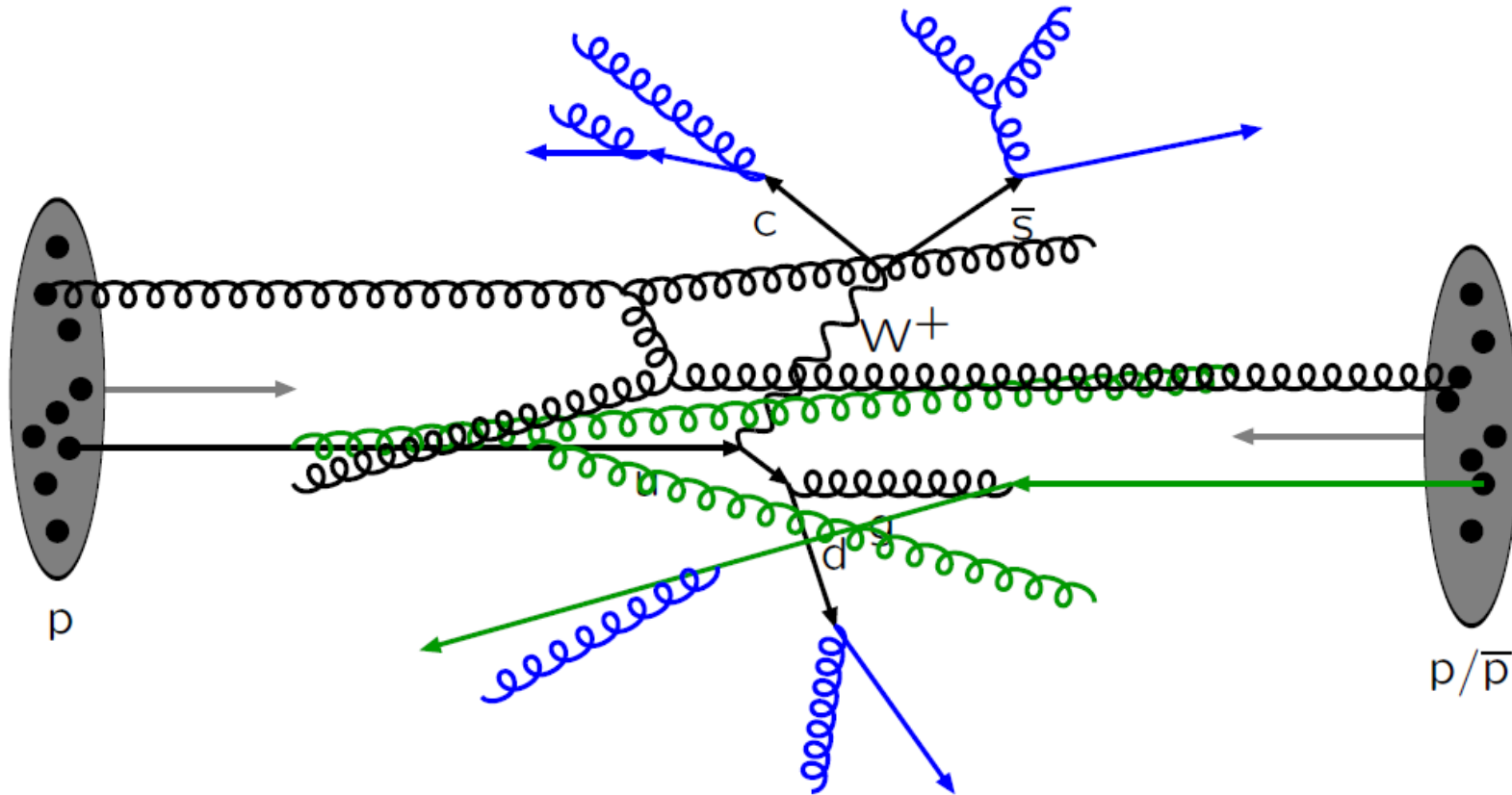
Initial-state radiation: spacelike parton showers

Event Structure



Final-state radiation: timelike parton showers

Event Structure



Multiple parton-parton interactions ...

PYTHIA subprocesses(1)

No.	Subprocess
Hard QCD processes:	
11	$f_i f_j \rightarrow f_i f_j$
12	$f_i \bar{f}_i \rightarrow f_k \bar{f}_k$
13	$f_i \bar{f}_i \rightarrow gg$
28	$f_i g \rightarrow f_i g$
53	$gg \rightarrow f_k \bar{f}_k$
68	$gg \rightarrow gg$
Soft QCD processes:	
91	elastic scattering
92	single diffraction (XB)
93	single diffraction (AX)
94	double diffraction
95	low- p_{\perp} production
Open heavy flavour: (also fourth generation)	
81	$f_i \bar{f}_i \rightarrow Q_k \bar{Q}_k$
82	$gg \rightarrow Q_k \bar{Q}_k$
83	$q_i f_j \rightarrow Q_k f_l$

No.	Subprocess
84	$g\gamma \rightarrow Q_k \bar{Q}_k$
85	$\gamma\gamma \rightarrow F_k \bar{F}_k$
Closed heavy flavour:	
86	$gg \rightarrow J/\psi g$
87	$gg \rightarrow \chi_{0c} g$
88	$gg \rightarrow \chi_{1c} g$
89	$gg \rightarrow \chi_{2c} g$
104	$gg \rightarrow \chi_{0c}$
105	$gg \rightarrow \chi_{2c}$
106	$gg \rightarrow J/\psi \gamma$
107	$g\gamma \rightarrow J/\psi g$
108	$\gamma\gamma \rightarrow J/\psi \gamma$
W/Z production:	
1	$f_i \bar{f}_i \rightarrow \gamma^*/Z^0$
2	$f_i \bar{f}_j \rightarrow W^{\pm}$
22	$f_i \bar{f}_i \rightarrow Z^0 Z^0$
23	$f_i \bar{f}_j \rightarrow Z^0 W^{\pm}$
25	$f_i \bar{f}_i \rightarrow W^+ W^-$
15	$f_i \bar{f}_i \rightarrow g Z^0$

No.	Subprocess
16	$f_i \bar{f}_j \rightarrow g W^{\pm}$
30	$f_i g \rightarrow f_i Z^0$
31	$f_i g \rightarrow f_k W^{\pm}$
19	$f_i \bar{f}_i \rightarrow \gamma Z^0$
20	$f_i \bar{f}_j \rightarrow \gamma W^{\pm}$
35	$f_i \gamma \rightarrow f_i Z^0$
36	$f_i \gamma \rightarrow f_k W^{\pm}$
69	$\gamma\gamma \rightarrow W^+ W^-$
70	$\gamma W^{\pm} \rightarrow Z^0 W^{\pm}$
Prompt photons:	
14	$f_i \bar{f}_i \rightarrow g\gamma$
18	$f_i \bar{f}_i \rightarrow \gamma\gamma$
29	$f_i g \rightarrow f_i \gamma$
114	$gg \rightarrow \gamma\gamma$
115	$gg \rightarrow g\gamma$
Deeply Inel. Scatt.:	
10	$f_i f_j \rightarrow f_k f_l$
99	$\gamma^* q \rightarrow q$

PYTHIA subprocesses(2)

No.	Subprocess
Photon-induced:	
33	$f_i\gamma \rightarrow f_i g$
34	$f_i\gamma \rightarrow f_i\gamma$
54	$g\gamma \rightarrow f_k\bar{f}_k$
58	$\gamma\gamma \rightarrow f_k\bar{f}_k$
131	$f_i\gamma_T^* \rightarrow f_i g$
132	$f_i\gamma_L^* \rightarrow f_i g$
133	$f_i\gamma_T^* \rightarrow f_i\gamma$
134	$f_i\gamma_L^* \rightarrow f_i\gamma$
135	$g\gamma_T^* \rightarrow f_i\bar{f}_i$
136	$g\gamma_L^* \rightarrow f_i\bar{f}_i$
137	$\gamma_T^*\gamma_T^* \rightarrow f_i\bar{f}_i$
138	$\gamma_T^*\gamma_L^* \rightarrow f_i\bar{f}_i$
139	$\gamma_L^*\gamma_T^* \rightarrow f_i\bar{f}_i$
140	$\gamma_L^*\gamma_L^* \rightarrow f_i\bar{f}_i$
80	$q_i\gamma \rightarrow q_k\pi^\pm$
Light SM Higgs:	
3	$f_i\bar{f}_i \rightarrow h^0$
24	$f_i\bar{f}_i \rightarrow Z^0 h^0$
26	$f_i\bar{f}_j \rightarrow W^\pm h^0$

No.	Subprocess
32	$f_i g \rightarrow f_i h^0$
102	$gg \rightarrow h^0$
103	$\gamma\gamma \rightarrow h^0$
110	$f_i\bar{f}_i \rightarrow \gamma h^0$
111	$f_i\bar{f}_i \rightarrow gh^0$
112	$f_i g \rightarrow f_i h^0$
113	$gg \rightarrow gh^0$
121	$gg \rightarrow Q_k\bar{Q}_k h^0$
122	$q_i\bar{q}_i \rightarrow Q_k\bar{Q}_k h^0$
123	$f_i f_j \rightarrow f_i f_j h^0$
124	$f_i f_j \rightarrow f_k f_l h^0$
Heavy SM Higgs:	
5	$Z^0 Z^0 \rightarrow h^0$
8	$W^+ W^- \rightarrow h^0$
71	$Z_L^0 Z_L^0 \rightarrow Z_L^0 Z_L^0$
72	$Z_L^0 Z_L^0 \rightarrow W_L^+ W_L^-$
73	$Z_L^0 W_L^\pm \rightarrow Z_L^0 W_L^\pm$
76	$W_L^+ W_L^- \rightarrow Z_L^0 Z_L^0$
77	$W_L^\pm W_L^\pm \rightarrow W_L^\pm W_L^\pm$

No.	Subprocess
BSM Neutral Higgs:	
151	$f_i\bar{f}_i \rightarrow H^0$
152	$gg \rightarrow H^0$
153	$\gamma\gamma \rightarrow H^0$
171	$f_i\bar{f}_i \rightarrow Z^0 H^0$
172	$f_i\bar{f}_j \rightarrow W^\pm H^0$
173	$f_i f_j \rightarrow f_i f_j H^0$
174	$f_i f_j \rightarrow f_k f_l H^0$
181	$gg \rightarrow Q_k\bar{Q}_k H^0$
182	$q_i\bar{q}_i \rightarrow Q_k\bar{Q}_k H^0$
183	$f_i\bar{f}_i \rightarrow gH^0$
184	$f_i g \rightarrow f_i H^0$
185	$gg \rightarrow gH^0$
156	$f_i\bar{f}_i \rightarrow A^0$
157	$gg \rightarrow A^0$
158	$\gamma\gamma \rightarrow A^0$
176	$f_i\bar{f}_i \rightarrow Z^0 A^0$
177	$f_i\bar{f}_j \rightarrow W^\pm A^0$
178	$f_i f_j \rightarrow f_i f_j A^0$
179	$f_i f_j \rightarrow f_k f_l A^0$

PYTHIA subprocesses(3)

No.	Subprocess
186	$gg \rightarrow Q_k \bar{Q}_k A^0$
187	$q_i \bar{q}_i \rightarrow Q_k \bar{Q}_k A^0$
188	$f_i \bar{f}_i \rightarrow g A^0$
189	$f_i g \rightarrow f_i A^0$
190	$gg \rightarrow g A^0$
Charged Higgs:	
143	$f_i \bar{f}_j \rightarrow H^+$
161	$f_i g \rightarrow f_k H^+$
Higgs pairs:	
297	$f_i \bar{f}_j \rightarrow H^\pm h^0$
298	$f_i \bar{f}_j \rightarrow H^\pm H^0$
299	$f_i \bar{f}_i \rightarrow A^0 h^0$
300	$f_i \bar{f}_i \rightarrow A^0 H^0$
301	$f_i \bar{f}_i \rightarrow H^+ H^-$
New gauge bosons:	
141	$f_i \bar{f}_i \rightarrow \gamma/Z^0/Z'^0$
142	$f_i \bar{f}_j \rightarrow W'^+$
144	$f_i \bar{f}_j \rightarrow R$

No.	Subprocess
Technicolor:	
149	$gg \rightarrow \eta_{tc}$
191	$f_i \bar{f}_i \rightarrow \rho_{tc}^0$
192	$f_i \bar{f}_j \rightarrow \rho_{tc}^+$
193	$f_i \bar{f}_i \rightarrow \omega_{tc}^0$
194	$f_i \bar{f}_i \rightarrow f_k \bar{f}_k$
195	$f_i \bar{f}_j \rightarrow f_k \bar{f}_l$
361	$f_i \bar{f}_i \rightarrow W_L^+ W_L^-$
362	$f_i \bar{f}_i \rightarrow W_L^\pm \pi_{tc}^\mp$
363	$f_i \bar{f}_i \rightarrow \pi_{tc}^+ \pi_{tc}^-$
364	$f_i \bar{f}_i \rightarrow \gamma \pi_{tc}^0$
365	$f_i \bar{f}_i \rightarrow \gamma \pi_{tc}'^0$
366	$f_i \bar{f}_i \rightarrow Z^0 \pi_{tc}^0$
367	$f_i \bar{f}_i \rightarrow Z^0 \pi_{tc}'^0$
368	$f_i \bar{f}_i \rightarrow W^\pm \pi_{tc}^\mp$
370	$f_i \bar{f}_j \rightarrow W_L^\pm Z_L^0$
371	$f_i \bar{f}_j \rightarrow W_L^\pm \pi_{tc}^0$
372	$f_i \bar{f}_j \rightarrow \pi_{tc}^\pm Z_L^0$
373	$f_i \bar{f}_j \rightarrow \pi_{tc}^\pm \pi_{tc}^0$
374	$f_i \bar{f}_j \rightarrow \gamma \pi_{tc}^\pm$

No.	Subprocess
375	$f_i \bar{f}_j \rightarrow Z^0 \pi_{tc}^\pm$
376	$f_i \bar{f}_j \rightarrow W^\pm \pi_{tc}^0$
377	$f_i \bar{f}_j \rightarrow W^\pm \pi_{tc}'^0$
381	$q_i q_j \rightarrow q_i q_j$
382	$q_i \bar{q}_i \rightarrow q_k \bar{q}_k$
383	$q_i \bar{q}_i \rightarrow gg$
384	$f_i g \rightarrow f_i g$
385	$gg \rightarrow q_k \bar{q}_k$
386	$gg \rightarrow gg$
387	$f_i \bar{f}_i \rightarrow Q_k \bar{Q}_k$
388	$gg \rightarrow Q_k \bar{Q}_k$
Compositeness:	
146	$e\gamma \rightarrow e^*$
147	$dg \rightarrow d^*$
148	$ug \rightarrow u^*$
167	$q_i q_j \rightarrow d^* q_k$
168	$q_i q_j \rightarrow u^* q_k$
169	$q_i \bar{q}_i \rightarrow e^\pm e^{*\mp}$
165	$f_i \bar{f}_i (\rightarrow \gamma^*/Z^0) \rightarrow f_k \bar{f}_k$
166	$f_i \bar{f}_j (\rightarrow W^\pm) \rightarrow f_k \bar{f}_l$

PYTHIA subprocesses(4)

No.	Subprocess
Leptoquarks:	
145	$q_i l_j \rightarrow L_Q$
162	$qg \rightarrow l L_Q$
163	$gg \rightarrow L_Q \bar{L}_Q$
164	$q_i \bar{q}_i \rightarrow L_Q \bar{L}_Q$
Left-right symmetry:	
341	$l_i l_j \rightarrow H_L^{\pm\pm}$
342	$l_i l_j \rightarrow H_R^{\pm\pm}$
343	$l_i^\pm \gamma \rightarrow H_L^{\pm\pm} e^\mp$
344	$l_i^\pm \gamma \rightarrow H_R^{\pm\pm} e^\mp$
345	$l_i^\pm \gamma \rightarrow H_L^{\pm\pm} \mu^\mp$
346	$l_i^\pm \gamma \rightarrow H_R^{\pm\pm} \mu^\mp$
347	$l_i^\pm \gamma \rightarrow H_L^{\pm\pm} \tau^\mp$
348	$l_i^\pm \gamma \rightarrow H_R^{\pm\pm} \tau^\mp$
349	$f_i \bar{f}_i \rightarrow H_L^{++} H_L^{--}$
350	$f_i \bar{f}_i \rightarrow H_R^{++} H_R^{--}$
351	$f_i f_j \rightarrow f_k f_l H_L^{\pm\pm}$
352	$f_i f_j \rightarrow f_k f_l H_R^{\pm\pm}$
353	$f_i \bar{f}_i \rightarrow Z_R^0$
354	$f_i \bar{f}_j \rightarrow W_R^\pm$

No.	Subprocess
Extra Dimensions:	
391	$f \bar{f} \rightarrow G^*$
392	$gg \rightarrow G^*$
393	$q \bar{q} \rightarrow g G^*$
394	$qg \rightarrow q G^*$
395	$gg \rightarrow g G^*$
SUSY:	
201	$f_i \bar{f}_i \rightarrow \tilde{e}_L \tilde{e}_L^*$
202	$f_i \bar{f}_i \rightarrow \tilde{e}_R \tilde{e}_R^*$
203	$f_i \bar{f}_i \rightarrow \tilde{e}_L \tilde{e}_R^* +$
204	$f_i \bar{f}_i \rightarrow \tilde{\mu}_L \tilde{\mu}_L^*$
205	$f_i \bar{f}_i \rightarrow \tilde{\mu}_R \tilde{\mu}_R^*$
206	$f_i \bar{f}_i \rightarrow \tilde{\mu}_L \tilde{\mu}_R^* +$
207	$f_i \bar{f}_i \rightarrow \tilde{\tau}_1 \tilde{\tau}_1^*$
208	$f_i \bar{f}_i \rightarrow \tilde{\tau}_2 \tilde{\tau}_2^*$
209	$f_i \bar{f}_i \rightarrow \tilde{\tau}_1 \tilde{\tau}_2^* +$
210	$f_i \bar{f}_j \rightarrow \tilde{\ell}_L \tilde{\nu}_\ell^* +$
211	$f_i \bar{f}_j \rightarrow \tilde{\tau}_1 \tilde{\nu}_\tau^* +$
212	$f_i \bar{f}_j \rightarrow \tilde{\tau}_2 \tilde{\nu}_\tau^* +$
213	$f_i \bar{f}_i \rightarrow \tilde{\nu}_\ell \tilde{\nu}_\ell^*$

No.	Subprocess
214	$f_i \bar{f}_i \rightarrow \tilde{\nu}_\tau \tilde{\nu}_\tau^*$
216	$f_i \bar{f}_i \rightarrow \tilde{\chi}_1 \tilde{\chi}_1$
217	$f_i \bar{f}_i \rightarrow \tilde{\chi}_2 \tilde{\chi}_2$
218	$f_i \bar{f}_i \rightarrow \tilde{\chi}_3 \tilde{\chi}_3$
219	$f_i \bar{f}_i \rightarrow \tilde{\chi}_4 \tilde{\chi}_4$
220	$f_i \bar{f}_i \rightarrow \tilde{\chi}_1 \tilde{\chi}_2$
221	$f_i \bar{f}_i \rightarrow \tilde{\chi}_1 \tilde{\chi}_3$
222	$f_i \bar{f}_i \rightarrow \tilde{\chi}_1 \tilde{\chi}_4$
223	$f_i \bar{f}_i \rightarrow \tilde{\chi}_2 \tilde{\chi}_3$
224	$f_i \bar{f}_i \rightarrow \tilde{\chi}_2 \tilde{\chi}_4$
225	$f_i \bar{f}_i \rightarrow \tilde{\chi}_3 \tilde{\chi}_4$
226	$f_i \bar{f}_i \rightarrow \tilde{\chi}_1^\pm \tilde{\chi}_1^\mp$
227	$f_i \bar{f}_i \rightarrow \tilde{\chi}_2^\pm \tilde{\chi}_2^\mp$
228	$f_i \bar{f}_i \rightarrow \tilde{\chi}_1^\pm \tilde{\chi}_2^\mp$
229	$f_i \bar{f}_j \rightarrow \tilde{\chi}_1 \tilde{\chi}_1^\pm$
230	$f_i \bar{f}_j \rightarrow \tilde{\chi}_2 \tilde{\chi}_1^\pm$
231	$f_i \bar{f}_j \rightarrow \tilde{\chi}_3 \tilde{\chi}_1^\pm$
232	$f_i \bar{f}_j \rightarrow \tilde{\chi}_4 \tilde{\chi}_1^\pm$
233	$f_i \bar{f}_j \rightarrow \tilde{\chi}_1 \tilde{\chi}_2^\pm$
234	$f_i \bar{f}_j \rightarrow \tilde{\chi}_2 \tilde{\chi}_2^\pm$

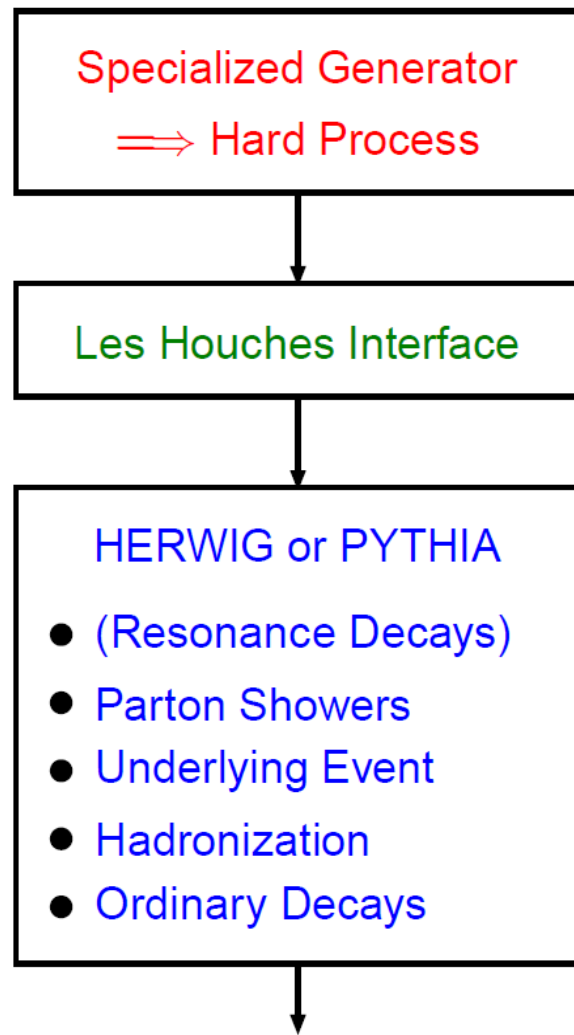
PYTHIA subprocesses(5)

No.	Subprocess
235	$f_i \bar{f}_j \rightarrow \tilde{\chi}_3 \tilde{\chi}_2^\pm$
236	$f_i \bar{f}_j \rightarrow \tilde{\chi}_4 \tilde{\chi}_2^\pm$
237	$f_i \bar{f}_i \rightarrow \tilde{g} \tilde{\chi}_1$
238	$f_i \bar{f}_i \rightarrow \tilde{g} \tilde{\chi}_2$
239	$f_i \bar{f}_i \rightarrow \tilde{g} \tilde{\chi}_3$
240	$f_i \bar{f}_i \rightarrow \tilde{g} \tilde{\chi}_4$
241	$f_i \bar{f}_j \rightarrow \tilde{g} \tilde{\chi}_1^\pm$
242	$f_i \bar{f}_j \rightarrow \tilde{g} \tilde{\chi}_2^\pm$
243	$f_i \bar{f}_i \rightarrow \tilde{g} \tilde{g}$
244	$gg \rightarrow \tilde{g} \tilde{g}$
246	$f_i g \rightarrow \tilde{q}_{iL} \tilde{\chi}_1$
247	$f_i g \rightarrow \tilde{q}_{iR} \tilde{\chi}_1$
248	$f_i g \rightarrow \tilde{q}_{iL} \tilde{\chi}_2$
249	$f_i g \rightarrow \tilde{q}_{iR} \tilde{\chi}_2$
250	$f_i g \rightarrow \tilde{q}_{iL} \tilde{\chi}_3$
251	$f_i g \rightarrow \tilde{q}_{iR} \tilde{\chi}_3$
252	$f_i g \rightarrow \tilde{q}_{iL} \tilde{\chi}_4$
253	$f_i g \rightarrow \tilde{q}_{iR} \tilde{\chi}_4$

No.	Subprocess
254	$f_i g \rightarrow \tilde{q}_{jL} \tilde{\chi}_1^\pm$
256	$f_i g \rightarrow \tilde{q}_{jL} \tilde{\chi}_2^\pm$
258	$f_i g \rightarrow \tilde{q}_{iL} \tilde{g}$
259	$f_i g \rightarrow \tilde{q}_{iR} \tilde{g}$
261	$f_i \bar{f}_i \rightarrow \tilde{t}_1 \tilde{t}_1^*$
262	$f_i \bar{f}_i \rightarrow \tilde{t}_2 \tilde{t}_2^*$
263	$f_i \bar{f}_i \rightarrow \tilde{t}_1 \tilde{t}_2^* +$
264	$gg \rightarrow \tilde{t}_1 \tilde{t}_1^*$
265	$gg \rightarrow \tilde{t}_2 \tilde{t}_2^*$
271	$f_i \bar{f}_j \rightarrow \tilde{q}_{iL} \tilde{q}_{jL}$
272	$f_i \bar{f}_j \rightarrow \tilde{q}_{iR} \tilde{q}_{jR}$
273	$f_i \bar{f}_j \rightarrow \tilde{q}_{iL} \tilde{q}_{jR} +$
274	$f_i \bar{f}_j \rightarrow \tilde{q}_{iL} \tilde{q}_{jL}^*$
275	$f_i \bar{f}_j \rightarrow \tilde{q}_{iR} \tilde{q}_{jR}^*$
276	$f_i \bar{f}_j \rightarrow \tilde{q}_{iL} \tilde{q}_{jR}^* +$
277	$f_i \bar{f}_i \rightarrow \tilde{q}_{jL} \tilde{q}_{jL}^*$
278	$f_i \bar{f}_i \rightarrow \tilde{q}_{jR} \tilde{q}_{jR}^*$
279	$gg \rightarrow \tilde{q}_{iL} \tilde{q}_{iL}^*$

No.	Subprocess
280	$gg \rightarrow \tilde{q}_{iR} \tilde{q}_{iR}^*$
281	$bq_i \rightarrow \tilde{b}_1 \tilde{q}_{iL}$
282	$bq_i \rightarrow \tilde{b}_2 \tilde{q}_{iR}$
283	$bq_i \rightarrow \tilde{b}_1 \tilde{q}_{iR} + \tilde{b}_2 \tilde{q}_{iL}$
284	$b\bar{q}_i \rightarrow \tilde{b}_1 \tilde{q}_{iL}^*$
285	$b\bar{q}_i \rightarrow \tilde{b}_2 \tilde{q}_{iR}^*$
286	$b\bar{q}_i \rightarrow \tilde{b}_1 \tilde{q}_{iR}^* + \tilde{b}_2 \tilde{q}_{iL}^*$
287	$f_i \bar{f}_i \rightarrow \tilde{b}_1 \tilde{b}_1^*$
288	$f_i \bar{f}_i \rightarrow \tilde{b}_2 \tilde{b}_2^*$
289	$gg \rightarrow \tilde{b}_1 \tilde{b}_1^*$
290	$gg \rightarrow \tilde{b}_2 \tilde{b}_2^*$
291	$bb \rightarrow \tilde{b}_1 \tilde{b}_1$
292	$bb \rightarrow \tilde{b}_2 \tilde{b}_2$
293	$bb \rightarrow \tilde{b}_1 \tilde{b}_2$
294	$bg \rightarrow \tilde{b}_1 \tilde{g}$
295	$bg \rightarrow \tilde{b}_2 \tilde{g}$
296	$b\bar{b} \rightarrow \tilde{b}_1 \tilde{b}_2^* +$

External user process and interface with CalcHEP: Les Houches accord



Some Specialized Generators:

- AcerMC: $t\bar{t}b\bar{b}$, ...
- ALPGEN: $W/Z + \leq 6j$,
 $nW + mZ + kH + \leq 3j$, ...
- AMEGIC++: generic LO
- CompHEP: generic LO
- GRACE+Bases/Spring:
generic LO+ some NLO loops
- GR@PPA: $b\bar{b}b\bar{b}$
- MadCUP: $W/Z + \leq 3j$, $t\bar{t}b\bar{b}$
- MadGraph+HELAS: generic LO
- MCFM: NLO $W/Z + \leq 2j$,
 $WZ, WH, H + \leq 1j$
- O'Mega+WHIZARD: generic LO
- VECBOS: $W/Z + \leq 4j$

Apologies for all unlisted programs

External user process and interface with CalcHEP: Les Houches accord

Initialization

```
INTEGER MAXPUP
PARAMETER (MAXPUP=100)
INTEGER IDBMUP,PDFGUP,PDFSUP, IDWTUP, NPRUP, LPRUP
DOUBLE PRECISION EBMUP, XSECUP, XERRUP, XMAXUP
COMMON/HEPRUP/IDBMUP(2), EBMUP(2), PDFGUP(2), PDFSUP(2), IDWTUP,
&NPRUP, XSECUP(MAXPUP), XERRUP(MAXPUP), XMAXUP(MAXPUP), LPRUP(MAXPUP)
```

IDBMUP: incoming beam particles (PDG codes, $p = 2212$, $\bar{p} = -2212$)

EBMUP: incoming beam energies (GeV)

PDFGUP, PDFSUP: PDFLIB parton distributions (not used by PYTHIA)

IDWTUP: weighting strategy

- = 1: PYTHIA mixes and unweights events, according to known $d\sigma_{\max}$
- = 2: PYTHIA mixes and unweights events, according to known σ_{tot}
- = 3: unit-weight events, given by user, always to be kept
- = 4: weighted events, given by user, always to be kept
- = -1, -2, -3, -4: also allow negative $d\sigma$

NPRUP: number of separate user processes

XSECUP(i): σ_{tot} for each user process

XERRUP(i): error on σ_{tot} for each user process

XMAXUP(i): $d\sigma_{\max}$ for each user process

LPRUP(i): integer identifier for each user process

The event

```
INTEGER MAXNUP
PARAMETER (MAXNUP=500)
INTEGER NUP, IDPRUP, IDUP, ISTUP, MOTHUP, ICOLUP
DOUBLE PRECISION XWGTUP, SCALUP, AQEDUP, AQCDUP, PUP, VTIMUP, SPINUP
COMMON/HEPEUP/NUP, IDPRUP, XWGTUP, SCALUP, AQEDUP, AQCDUP,
&IDUP(MAXNUP), ISTUP(MAXNUP), MOTHUP(2, MAXNUP), ICOLUP(2, MAXNUP),
&PUP(5, MAXNUP), VTIMUP(MAXNUP), SPINUP(MAXNUP)
```

IDPRUP: identity of current process

XWGTUP: event weight (meaning depends on IDWTUP weighting strategy)

SCALUP: scale Q of parton distributions etc.

AQEDUP: α_{em} used in event

AQCDUP: α_s used in event

NUP: number of particles in event

IDUP(i): PDG identity code for particle i

ISTUP(i): status code (-1 = incoming parton, 1 = final-state parton,
 2 = intermediate resonance with preserved m)

MOTHUP(j, i): position of one or two mothers

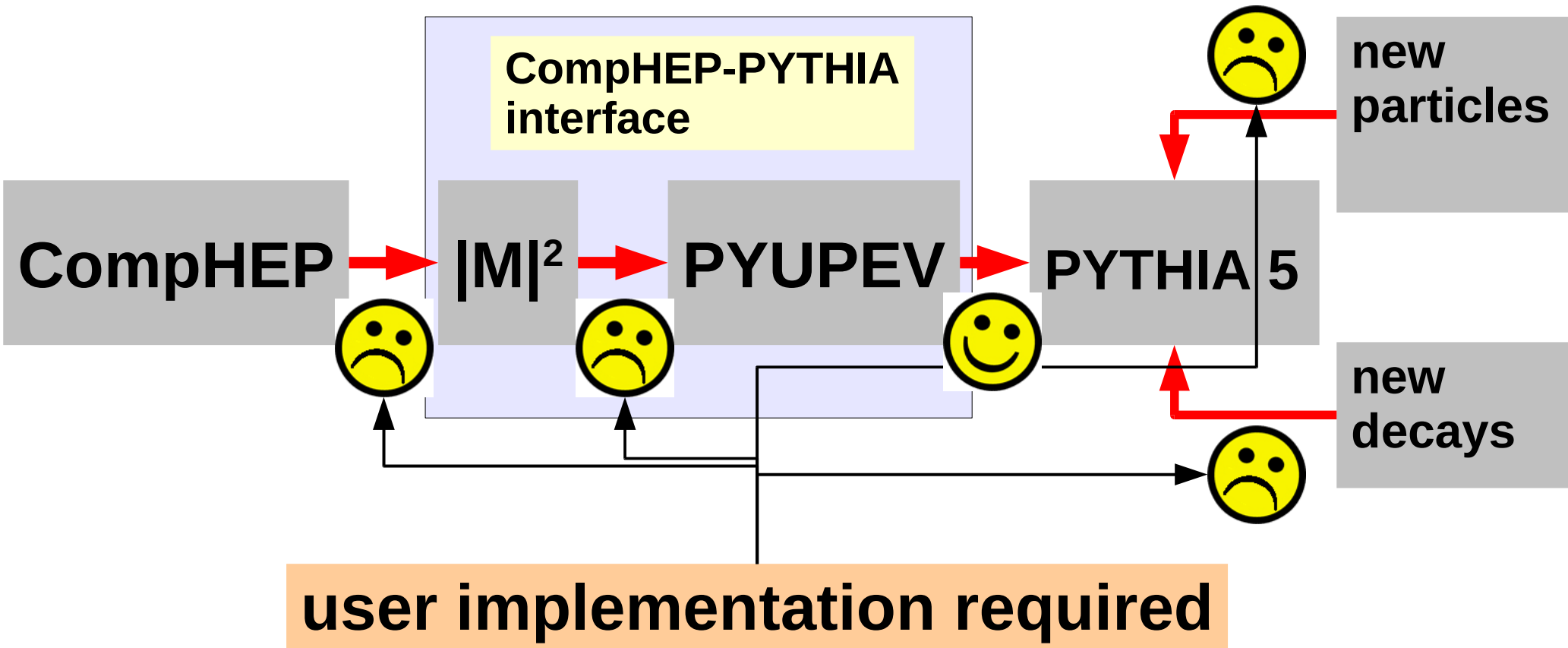
PUP(j, i): (p_x, p_y, p_z, E, m)

VTIMUP(i): invariant lifetime $c\tau$

SPINUP(i): spin (helicity) information

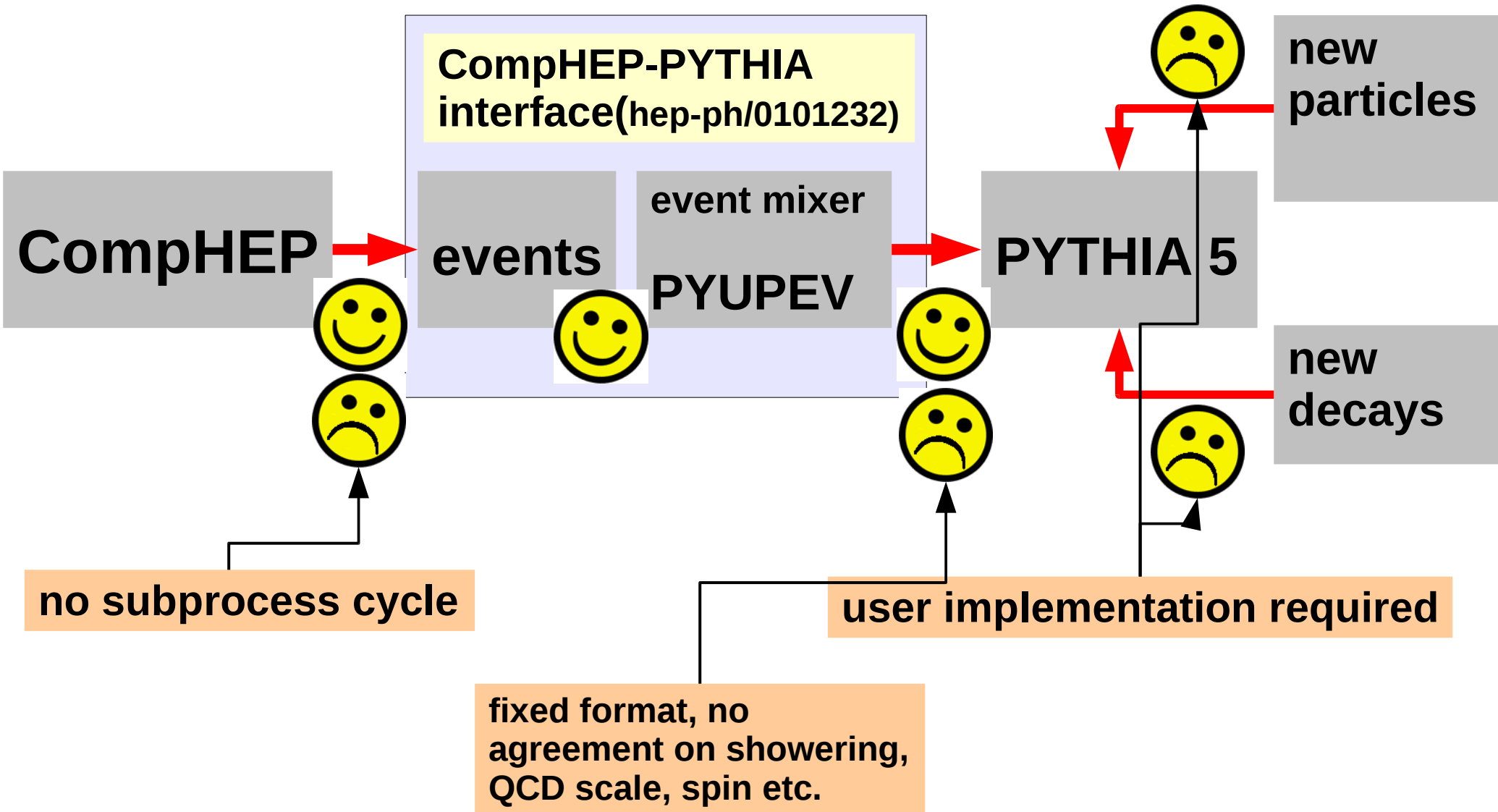
History of CalcHEP(ComPHEP) interface with MC generators

TIMELINE: 90's



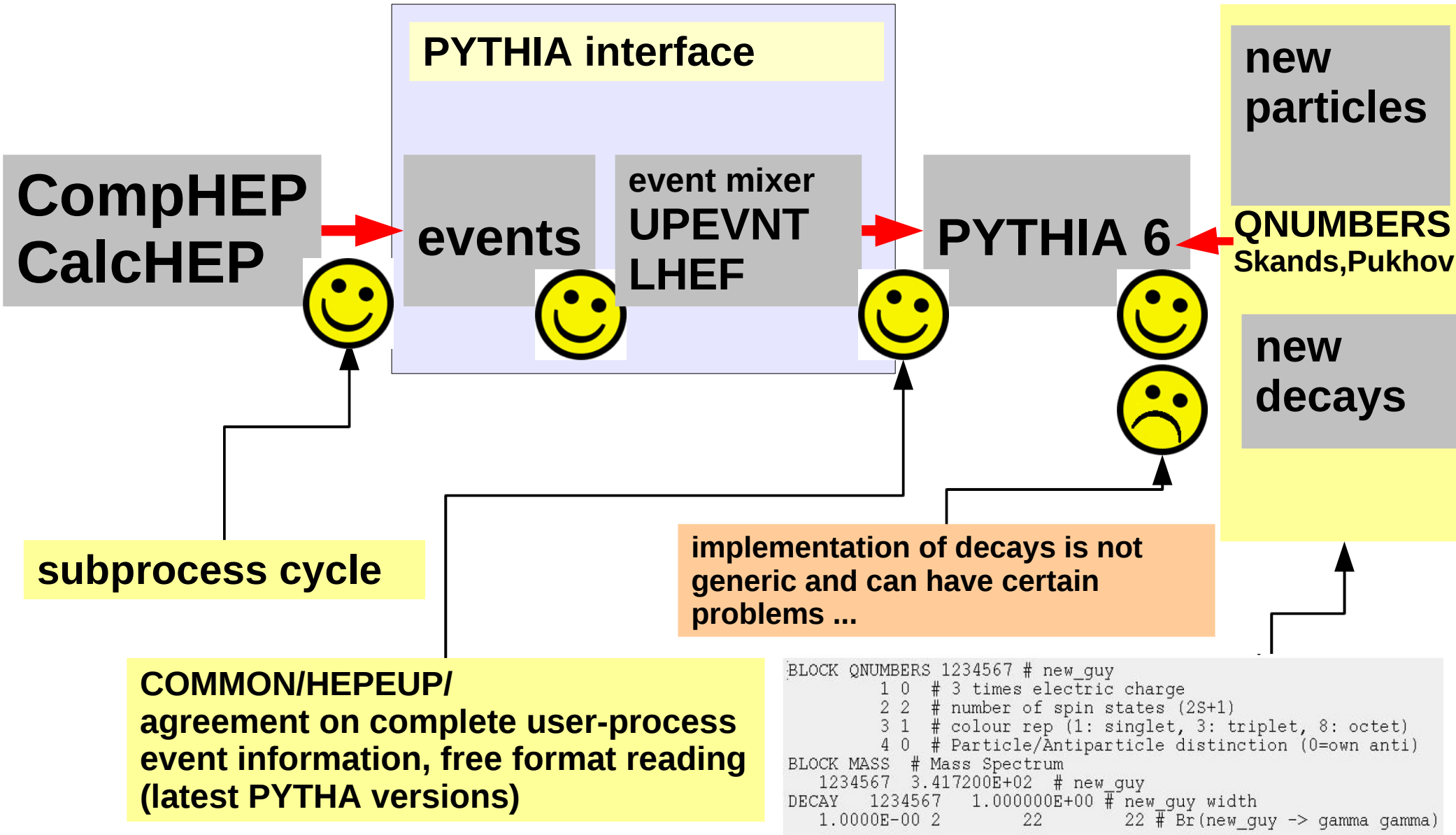
History of CalcHEP(CompHEP) interface with MC generators

TIMELINE: end of 90's



History of CalcHEP(ComPHEP) interface with MC generators

TIMELINE: 00's, LHEF accord [hep-ph/0609017]



Present Status of CalcHEP-MCG interface

