ALPGEN TOOLS

- **Actual Alpgen version**
- **Fortran code modifications**
- **Unique interface**
- **Running via script**
- **ROOT tools**

Claudio Ferretti

University of Michigan

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Alpgen version: V1.1

hep-ph/0206293 code **http://home.cern.ch/mlm/alpgen**

- **Implemented processes:**

  1) $W(\to \ell\nu) + Q + \overline{Q} + (N \leq 4)\ jets \qquad Q = c, b, t$

  2) $Z/\gamma^*(\to \ell\ell/\nu\nu) + Q + \overline{Q} + (N \leq 4)\ jets \qquad Q = c, b, t$

  3) $W(\to \ell\nu) + (N \leq 6)\ jets$

  4) $Z/\gamma^*(\to \ell\ell/\nu\nu) + (N \leq 6)\ jets$

  5) $kW + \ell Z + mH + (N \leq 3)\ jets \qquad [k + \ell + m + N \leq 8]$

  6) $Q + \overline{Q} + (N \leq 6)\ jets \qquad Q = b, t$

  7) $Q + \overline{Q} + Q' + \overline{Q}' + (N \leq 4)\ jets \qquad Q = b, t$

  8) $Q + \overline{Q} + H + (N \leq 4)\ jets \qquad Q = b, t$

- **Phase space in 2 steps:**

  - **warm-up: N it * N' events (user selected) saved every iteration into a "name".grid1. The sampling efficiency is improved in successive iterations.**

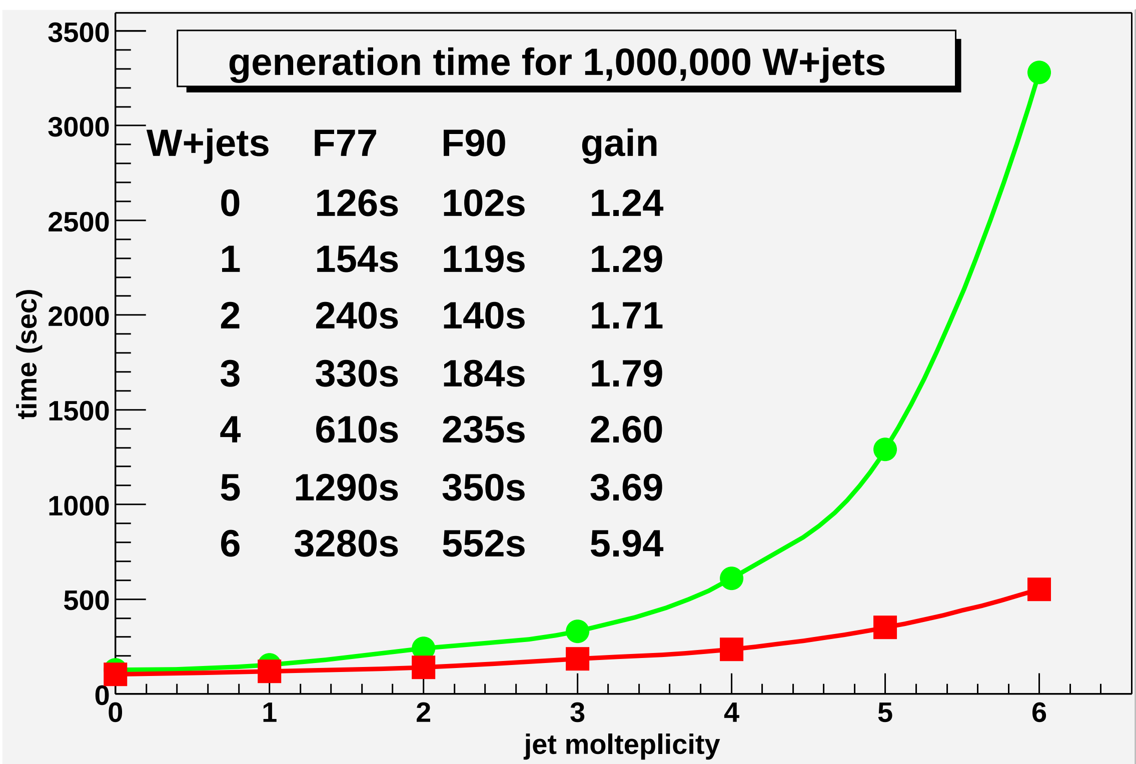
  - **generation: a real event generation writes on disk an update file .grid2**

- **pre-unweighting: weighted event saved on disk only if pass the unweighting test with 1 % of the dinamically calculated max-weight.**

- **PDF (not all with both parametric and tabular form)**

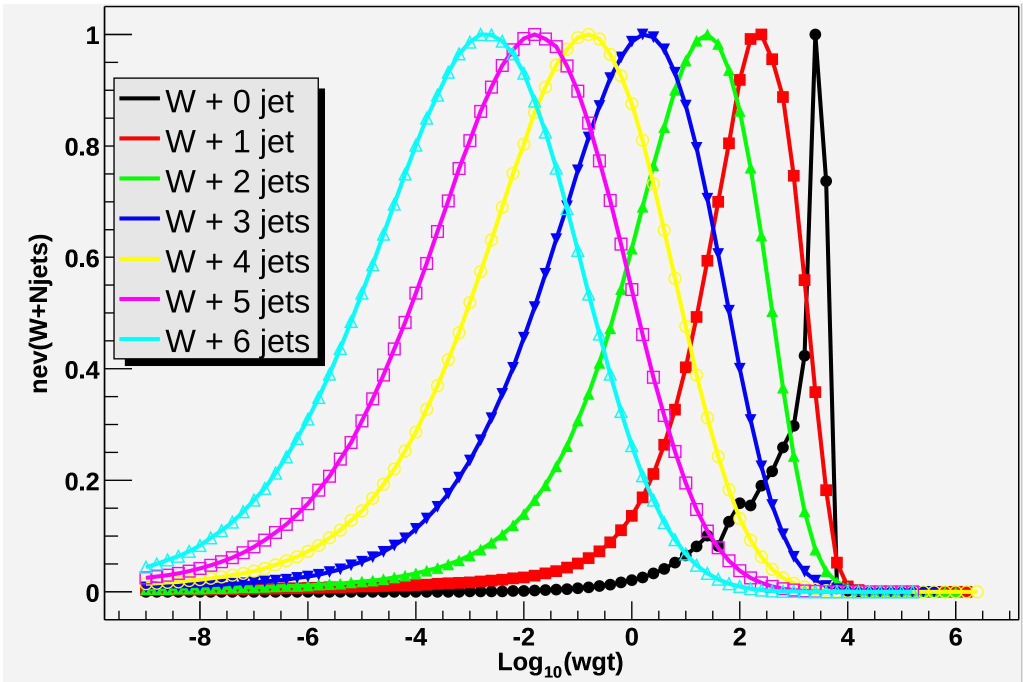
ndns	PDF	$\alpha_s(m_Z)_{n_{\rm loop}}$	ndns	PDF	$\alpha_s(m_Z)_{n_{\rm loop}}$
1	CTEQ4M	$[0.116]_2$	101	MRST99-1	$[0.1175]_2$
2	CTEQ4L	$[0.116]_2$	102	MRST01-1	$[0.119]_2$
3	CTEQ4HJ	$[0.116]_2$	103	MRST01-2	$[0.117]_2$
4	CTEQ5M	$[0.118]_2$	104	MRST01-3	$[0.121]_2$
5	CTEQ5L	$[0.127]_1$	105	MRST01J	$[0.121]_2$
6	CTEQ5HJ	$[0.118]_2$	106	MRSTLO	$[0.130]_1$
7	CTEQ6M	$[0.118]_2$			
8	CTEQ6L	$[0.118]_2$			

- **F90 ALPHA code: performance improved by a factor 2 - 6.** (The absolute time on the Y axis depends on the CPU !)

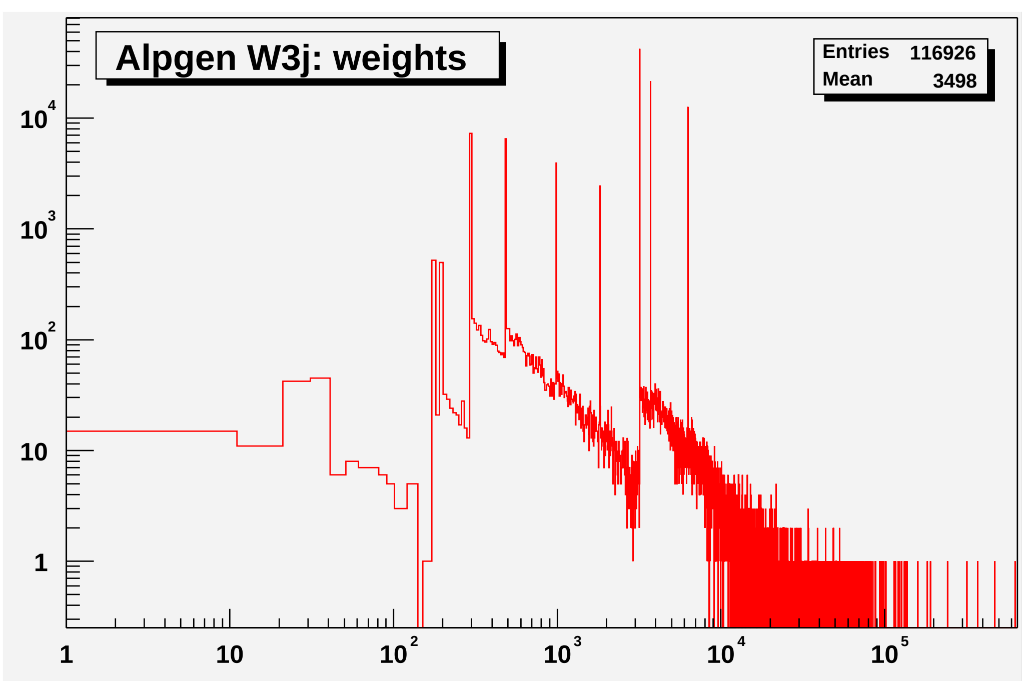


ALPGEN weighted events

Weight distributions for 10^7 W + N partons



Effect of the pre-unweighted on W + 3 partons



Fortran modification

- **New subroutine HWGINI to initialize (almost) all of the Herwig parameters.**

  Version with a switch to prevent the user from chaning what a matrix element generator supply (quark masses, Γ_W, Γ_Z, α_s,...)

- **HEPEVT common saved into an output ASCII file ("formatted") if the variable LWEVT is not null via HGWINI.**

- **User analysis HWABEG, HWANAL, HWAEND subroutines (empty) now with code to open, fill, close the output file "name".her.**

- **Code to save an output ASCII file (same format) for Andrea Messina's Pythia Interface.**

ALPGEN Fortran code intact !

First attempt: a new Fortran program that builds the input file for all of the 8 executables in ALPGEN, accordingly to the user input and proposing a standard name for the output file.

Interface to ALPGEN

From the user point of view (mine) it would be nice:

- **to avoid to select different executables depending on the physical process, editing the input file to change parameters, with the inevitable craches for wrong parameter in the input file;**
- **to have an automatic way from generation to the final format (HEPG banks for CDF), at least after shower;**
- **to have as output something more than event file and topdraw plots: PAW/ROOT objects.**

It's hard to fully interface ALPGEN, since the code is organized in 8 separated executables.

Reorganization of the Fortran code in just one executable:

Pro: **Easier to use**

Probably faster to compile

Con: **Time to do and debug something already working,**

Harder future debugging,

Harder future adding new processes

I didn't think that this was the right way $\Longrightarrow$ external interface as decoupled form the Fortran code as possible.

Interface structure

Selection process and cuts

↓

Grid generation

↓

Weigthed events generation

↓

Unweighting

↓

Files chaining

↓

Showering

↓

Conversion to HEPG

You decide the starting point !

Filename convention (README) hidden under the hood,

(necessary to begin from an intermediate point).

DEBUG ? C. Neu (Ohio) is doing a woderful job.

Interface abilities

1. **Modes: interactive and via script ("name".run); Timing for each step added to the script file.**
2. **Each step is indipendent**
3. **Possibility to redirection of the I/O for each step;**
4. **Safe settting all of the ALPGEN parameters (Q^2 , heavy flavour type, generations cuts, . . .);**
5. **For event generation, it looks for old grid asking if you want to use it with it's own generation cuts;**
6. **Generation in many runs of enough events to macth the final number of requested unweighted events;**
7. **Unweighting: possible different methods:**

   0) ALPGEN default;

   1) improved: neglecting x % of σ with higher weights;

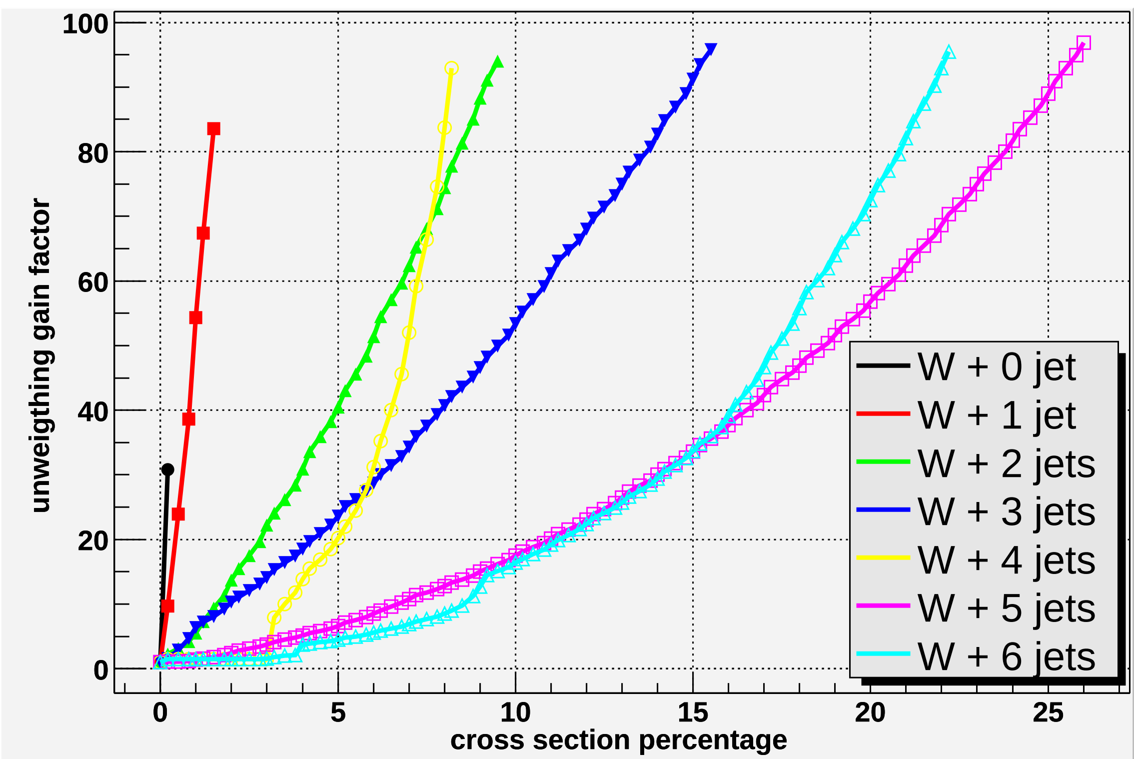
   2) extreme: maxwgt rescaled to 1 % of the real one.
8. **Chaining: unw. events ordered in files of K events. For processes with W/Z, 1/more lepton type(s);**
9. **Shower: you can use Herwig and/or Pythia;**
10. **HEPG: check offline version, then ASCII → HEPG.**

ALPGEN unweighting

Example of 10^7 W + N jets :

W+jet	N(wgt)	σ (pb)	MAX(w)	ε_{unw}	N(unw)
$W+0$	2907315	2042.4 ± 0.5	$1.2199 \cdot 10^6$	$1.6742 \cdot 10^{-3}$	17606
$W+1$	866210	523.2 ± 0.5	$2.1234 \cdot 10^6$	$2.4638 \cdot 10^{-4}$	2630
$W+2$	167090	147.0 ± 0.3	$1.3794 \cdot 10^6$	$1.0658 \cdot 10^{-4}$	1415
$W+3$	116926	41.0 ± 0.2	$0.6302 \cdot 10^6$	$6.5051 \cdot 10^{-5}$	712
$W+4$	30960	12.1 ± 0.4	$3.6518 \cdot 10^6$	$3.3151 \cdot 10^{-6}$	38
$W+5$	26909	3.10 ± 0.04	$0.1772 \cdot 10^6$	$1.7493 \cdot 10^{-5}$	220
$W+6$	9089	0.85 ± 0.03	$0.2311 \cdot 10^6$	$3.6826 \cdot 10^{-6}$	36

Improved unweigthing: gain 1-2 orders of magnitude in N(unw) ignoring a few % of the total cross section.



Full run example

Sample: requested 10^5 unweighted W + 2, 3, 4 partons.

Grid: 5,000,000 events times 2+# jets iterations.

Parton: $E_t(p) > 10\ GeV$ **,** $|\,\eta(p)\,| < 2.5$ **,** $\Delta R\,(p-p) \geq 0.4$

Electron: no cuts $E_t(\ell) > 0$ **,** $|\,\eta(\ell)\,| < 10$ **,** $\Delta R\,(\ell-p) \geq 0$

	N(gen)	N(wgt)	N(unw)	gain	σ (pb)	time	size MB
W+2	$2 \cdot 10^7$	399,575	127,571	∼30	147.0 ± 0.4	1h 30'	17+45
W+3	$3 \cdot 10^7$	265,839	107,753	∼40	41.0 ± 0.2	2h 30'	14+46
W+4	$8 \cdot 10^7$	334,389	100,820	∼50	12.1 ± 0.1	3h 45'	16+48

Without improved unweighting (F90 code + old grid):
12 days (4 partons), 4d (3 partons), 2d (2 partons).

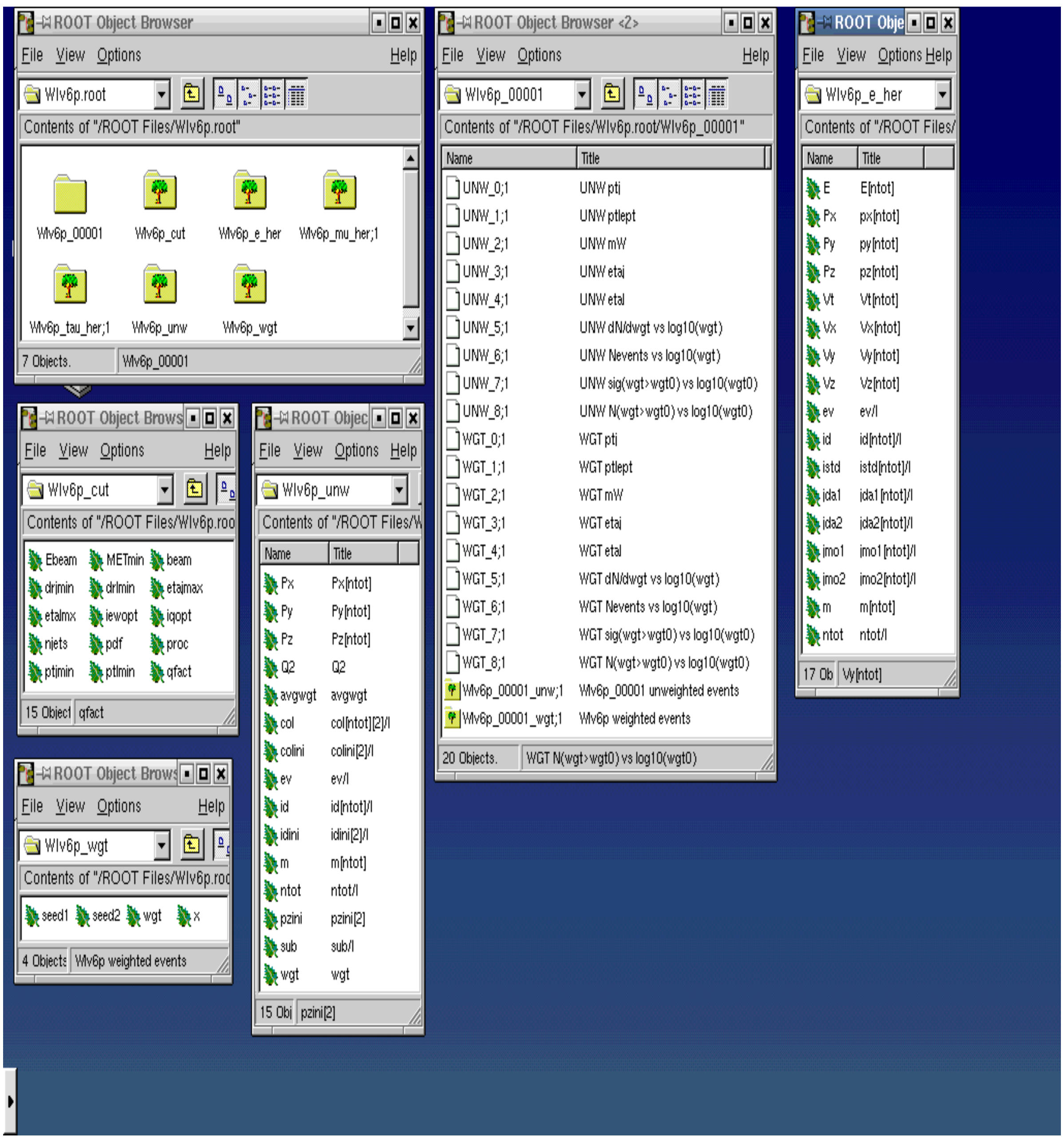
These 10^5 events are organized in 40 files of 2,500 ev/file for each one of the three decay $W \to \ell\nu_\ell$

	Herwig		ASCII→HEPG		TOTAL	
W+jet	time	size MB	time	size MB	time	size
$W+2$	43'	130×40	1h 10'	25×40	3h 30'	6.3 GB
$W+3$	50'	145×40	1h 30'	28×40	4h 50'	6.9 GB
$W+4$	53'	164×40	1h 10'	31×40	8h	7.5 GB

Most of the space occupied by the ASCII shower output.

ROOT tools

- a TTree with the generation parameters;
- a TTree with the weighted event (even run by run);
- a TTree with the unweighted event (even run by run);
- a TTree with the Herwig/Pythia event;
- a TTGraph for each topdraw plot (run by run).



On parton generator selection

Problem: parton P_t to generate jet of a given E_t.

Sample 5,000 ALPGEN W $\rightarrow e\nu + 3\ jets$ with:

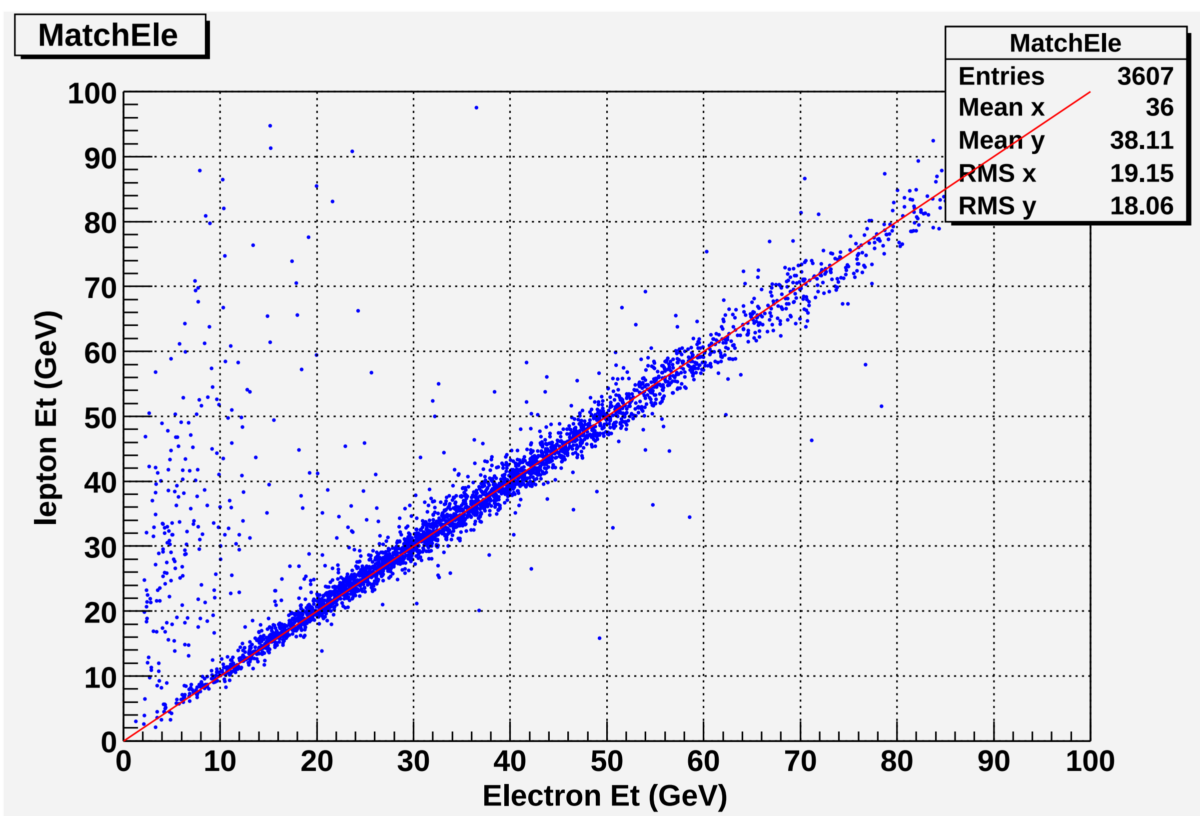
Parton: $\mathrm{P_t(p)} > 10$ GeV/c $|\eta(\mathrm{p})| < 2.5$ $\Delta\mathrm{R(p\text{-}p)} > 0.4$

Lepton: $\mathrm{P_t}(\ell) > 0$ GeV/c $|\eta(\ell)| < 10$ $\Delta\mathrm{R}(\ell\text{-p}) > 0$

Shower: Herwig 6.4 (default parameters+ π^0 stable), then CDF simulation and Production (ver 4.8.4).

Geometrical matching of a jet (cone 0.4) in $\Delta\mathrm{R_{match}} = 0.4$ around the parton direction. Double counting avoided starting the match from the most energetic jet.

"Electron removal" from jet 0.4 checks the matching.

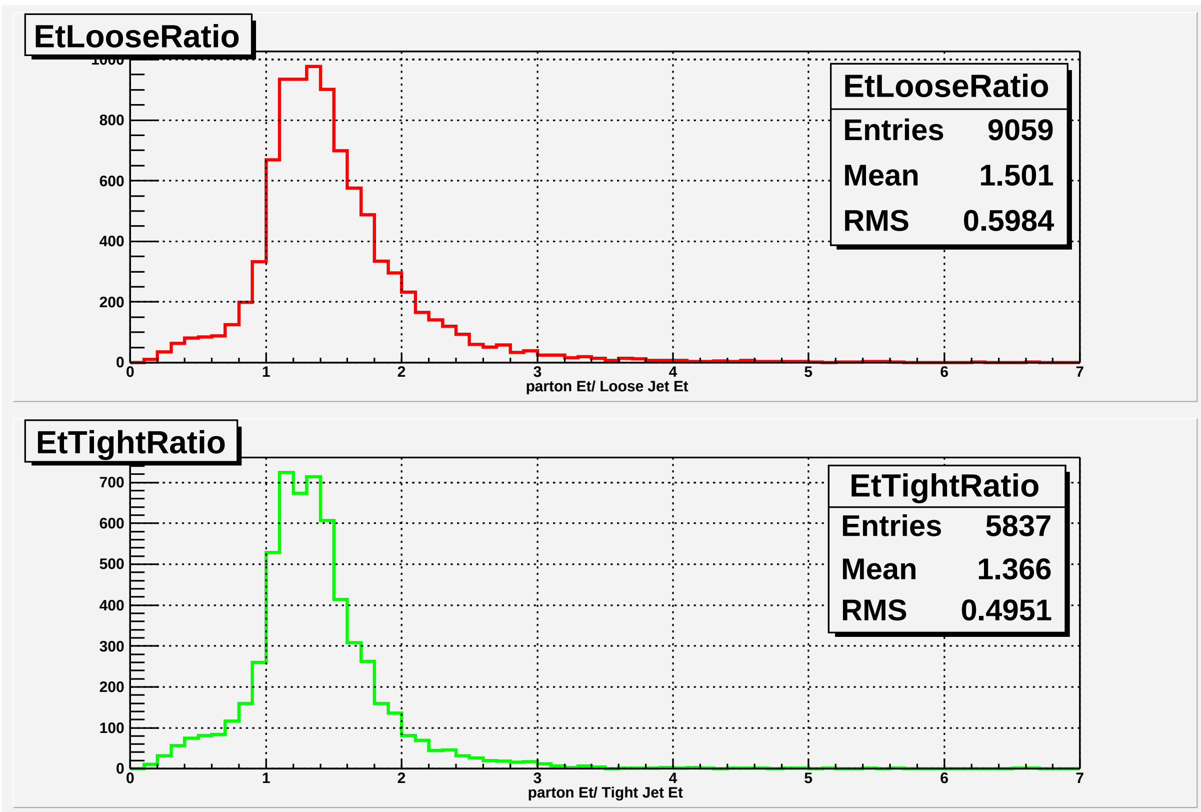


Definition for jets $\Delta R = 0.4$:

Loose jet $Pt(j) > 8$ GeV/c $|\eta(j)| < 2.5$

Tight jet $Pt(j) > 15$ GeV/c $|\eta(j)| < 2.0$

For both loose and tight jets (even with $\Delta R_{match} = 0.2$) the result is similar: $E_t(parton) \approx 1.4 - 1.5 * E_t(jet)$



A jet-cone 0.4 at $E_t(j) > 8$ GeV in average comes from a parton with $P_t(p) \sim 5$ Gev/c.

To efficiently generate events, we need to tune all of the generation cuts: $|\eta(p)|$, ΔR(p-p) for partons, $P_t(\ell)$, $|\eta(\ell)|$ for leptons, even if W/Z already select quite a lot them.