

Tuning at the LHC

Hendrik Hoeth
(Durham University)



Overview

LHC tunes – what's on the market

Legacy – why things should die

Introduction

I won't talk about Professor, because that's boring.

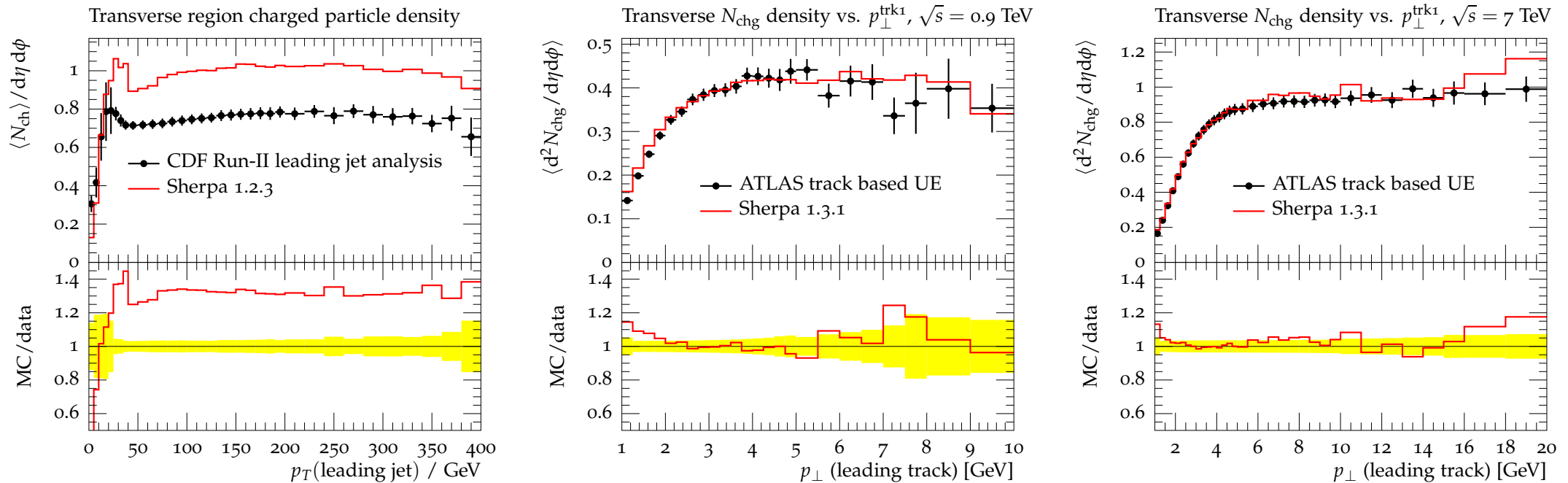
So let's talk about tuning at the LHC:

- Tuning at the LHC generally is working well.
- ATLAS has a very active tuning group, which might need to re-tune their focus away from Pythia 6 and towards modern event generators.
- CMS has Rick, and recently Albert Knutsson and Mohammed Zakaria (focussing on Pythia 6/8).
- Not sure about LHCb and ALICE?

And in more detail?

LHC tunes – the Tevatron mystery

Describing UE at Tevatron and LHC simultaneously is ... difficult:



So far we don't know the reason; the other generators look similar.

We hope to get new insight from the Tevatron energy scan.

LHC tunes – the Strange problem

Strangeness production is underestimated, at least by Pythia, and the general trend seems to be: The stranger, the worse.

Plots for this have been shown in many meetings. Nothing new here.

Herwig++ is about to re-tune the fragmentation, and Sherpa will release a version with improved hadronisation this year (even though it does a good job on the strangeness already now).

LHC tunes – ATLAS

ATLAS has a very active, albeit Fortran-centric, tuning group:

- Full set of Pythia 6 tunes, including improved shower tuning, for multiple PDFs (LO, mLO, NLO). They also have uncertainty variations, using the Professor eigentune features. Public so far: AMBT2B/AUET2B.
- Herwig/Jimmy tune: AUET2. Probably the last tune of this generator. Ever. Hopefully.
- They start to look into tuning Pythia 8, but so far they use 4C.

Mid- to long-term: Push away from Pythia 6 and Jimmy, towards the C++ generators.

LHC tunes – ATLAS

Some issues they see:

- Tension between MB and UE in Pythia 6 – hence the two separate tunes.
- AUET2B cocks up the $Z-p_T$, because it was tuned to the CDF measurement. Can be fixed by tweaking the shower scales.
- mLO PDFs screw up minbias observables, so no mLO for minbias in ATLAS.

LHC tunes – CMS

Tuning in CMS is much smaller than in ATLAS:

- Tune Z2, based on ATLAS MB tune.
- Recently: Z2* uses Professor to re-tune MPI cut-off and energy evolution.
- Recently: 4C* re-tunes MPI cut-off, energy evolution and color reconnection.

So far they use the defaults for Herwig++ and Sherpa, 4C and Z2 for Pythia, and they are looking into Perugia2011.

Is there a “best” tune?

Clearly not. But there is an effort to let some bad ones die (cf. Les Houches 2011) – note that this table is already out of date:

Deviation metrics per gen/tune and observable group:

Gen	Tune	UE	Dijets	Jets	Jet shapes	W and Z	Photons	Fragmentation
AlpGen	HERWIG6	–	–	–	–	0.91	–	–
	PYTHIA6-AMBT1	–	–	–	–	0.53	–	–
	PYTHIA6-D6T	–	–	–	–	1.67	–	–
	PYTHIA6-P2010	–	–	–	–	1.48	–	–
	PYTHIA6-P2011	–	–	–	–	0.24	–	–
	PYTHIA6-Z2	–	–	–	–	0.48	–	–
	PYTHIA6-profQ2	–	–	–	–	1.29	–	–
HERWIG	AUET2-CTEQ6L1	0.43	0.48	0.33	0.28	0.58	–	22.80
	AUET2-LOxx	0.25	0.58	0.37	0.30	0.88	–	22.13
Herwig++	2.5.1-UE-EE-3-CTEQ6L1	0.27	1.36	0.36	0.54	0.98	–	10.58
	2.5.1-UE-EE-3-MRSTLOxx	0.23	1.55	0.44	0.52	0.65	–	10.58
PYTHIA6	AMBT1	0.39	1.00	0.66	0.80	0.27	–	1.00
	AUET2B	0.18	0.72	0.16	1.17	0.96	–	0.37
	D6T	0.58	0.70	0.74	0.51	1.25	–	0.53
	DW	0.81	0.70	0.53	0.48	1.33	–	0.53
	P2010	0.30	1.09	0.87	0.61	0.30	–	0.57
	P2011	0.12	1.06	0.61	0.45	0.53	–	0.58
	ProfQ2	0.51	0.64	0.41	0.31	0.64	–	0.39
	Z2	0.18	0.88	0.44	0.78	0.30	–	1.09
Pythia8	4C	0.30	0.83	0.35	0.15	0.90	–	0.45
Sherpa	1.3.0	0.48	0.64	0.33	0.65	0.52	–	0.76
	1.3.1	0.68	0.51	0.39	1.04	0.36	–	0.92

Live and Let Die

Some observations so far:

- Pythia tunes that work well stand-alone screw up big times in combination with Alpgen. Not a surprise, but people didn't pay much attention until recently. If you want to use Alpgen + something, pick wisely. Perugia2011 is a good choice.
- The C++ generators do well (remember Herwig++ will come out with an improved fragmentation soon).
- There is *no* good reason to keep e.g. D6T or DW alive. Please let go and move on.

What to use

It depends:

- For Sherpa and Herwig++: The tunes provided by the authors. There are tunes for multiple PDFs and even some error variations. Go and ask them.
- For Pythia 8: 4C or 4C*.
- For Pythia 6: First ask yourself if you really want this. And then ... probably one of the new ATLAS tunes published this or next week. Or Perugia2011. I guess Peter Skands also has error variations.

Summary

- There has been lots of effort to tune to LHC data.
- There are good tunes around, for all generators. Don't use old crap just because you know how to spell it.
- If you use matching: Use a generator that works. Or pick a tune *that was specifically made for it (like P2011)*.