TurboSim@LHC

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Workshop on Fast Simulator for the LHC

CERN

11 – 12 June, 2012

Outline

- Introduction
- TurboSim
- Studies/Status
- Conclusions

Acknowledgements

TurboSim

- Bruce Knuteson (formerly, MIT)
- Kaldoun Makhoul (formerly, MIT)
  (arXiv:hep-ex/0402029v1 17 Feb 2004)

developed almost a decade ago, in collaboration with several like-minded individuals including Steve Mrenna

(I have borrowed freely from presentations by Bruce and Kaldoun.)

Introduction

There are basically three ways to do a fast detector simulation

1. Build a parametric representation of the mapping from the particle level to the reconstruction level

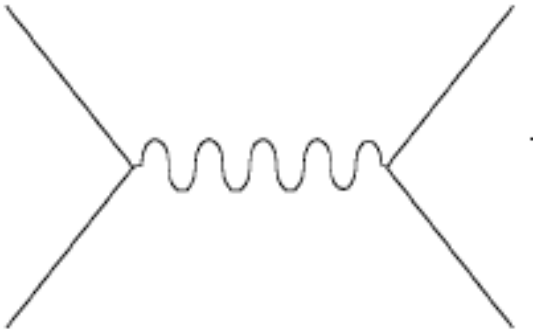
2. Simplify and, or, speed-up the full detector simulation

3. Abstract the mapping from a large sample of fully simulated events and apply it to particle or generator level events

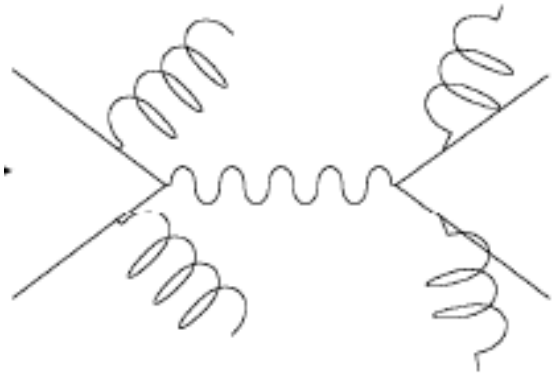
$$p(\vec{x} \mid M) = \int D(\vec{x} \mid \vec{y})\, p(\vec{y} \mid M)\, d\vec{y}$$

TurboSim – 1

Tree Level

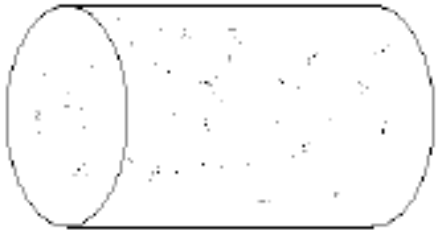


Showering

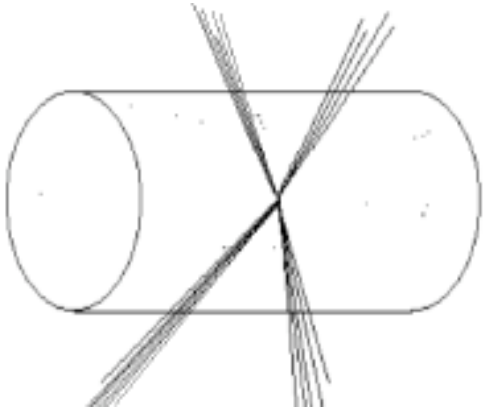


Fragmentation

Simulation



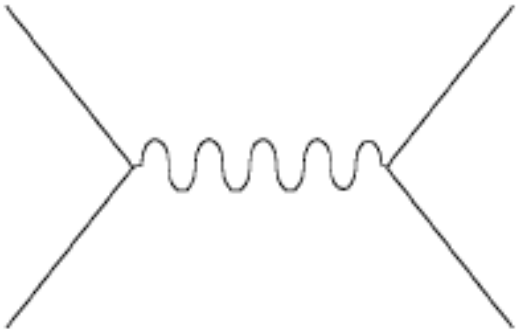
Reconstruction



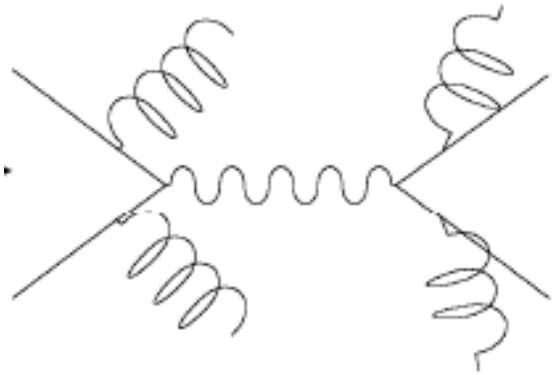
4-Vectors

TurboSim – 2

Tree Level



Showering



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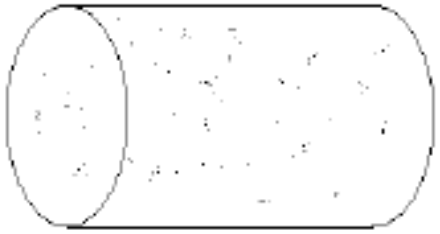
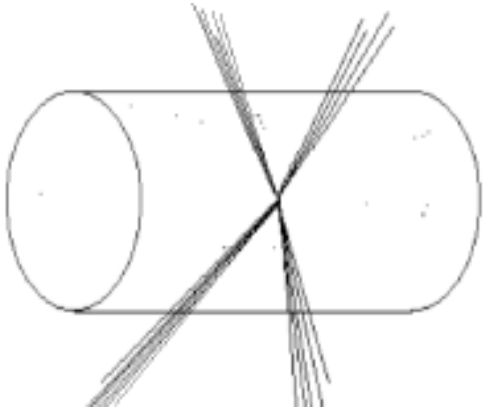
Simulation



Reconstruction



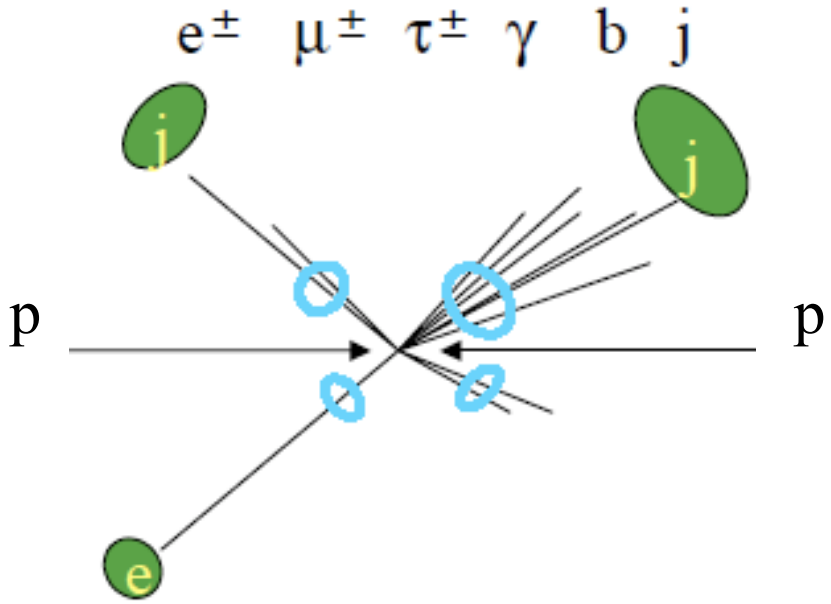
4-Vectors

TurboSim – 3

Using fully simulated and reconstructed events

- Cluster parton objects using a cone algorithm (to form "parton" jets – pjets in Dzero jargon)

- Associate parton jets to reconstruction level objects



TurboSim – 4

TurboSim constructs a large lookup table:

Parton Level						Reconstruction Level				
zvtx	object	p_T	η	ϕ		object	p_T	η	ϕ	
2.98	e+	67.111	0.536	61.2	; ->	e+	72.969	0.531	61.37	;
18.04	e+	16.555	-0.038	47.21	; ->	j	18.955	0.003	46.05	;
5.46	j	86.379	1.689	50.96	; ->	j	81.975	1.686	50.95	;
29.48	j	46.449	1.464	-7.56	; ->	j	27.835	1.896	-21.23	
						j	23.815	1.008	10.42	;
-5.72	j	15.606	0.225	-153.94	; ->	;				
-10.73	j	38.434	0.194	17.88	; ->	mu+	36.603	0.193	17.66	;
-3.16	e+	11.556	-0.72	-64.11						
	mu+	9.506	-0.777	-59.12	; ->	j	22.364	-0.81	-60.98	;
-9.13	e+	30.031	0.004	12.62						
	ph	16.402	-0.055	10.59	; ->	e+	46.904	-0.028	10.96	;
3.13	mu+	24.717	1.161	-27.75	; ->	;				
-5.47	mu+	47.093	2.045	54.12	; ->	mu+	54.087	2.041	54.09	;

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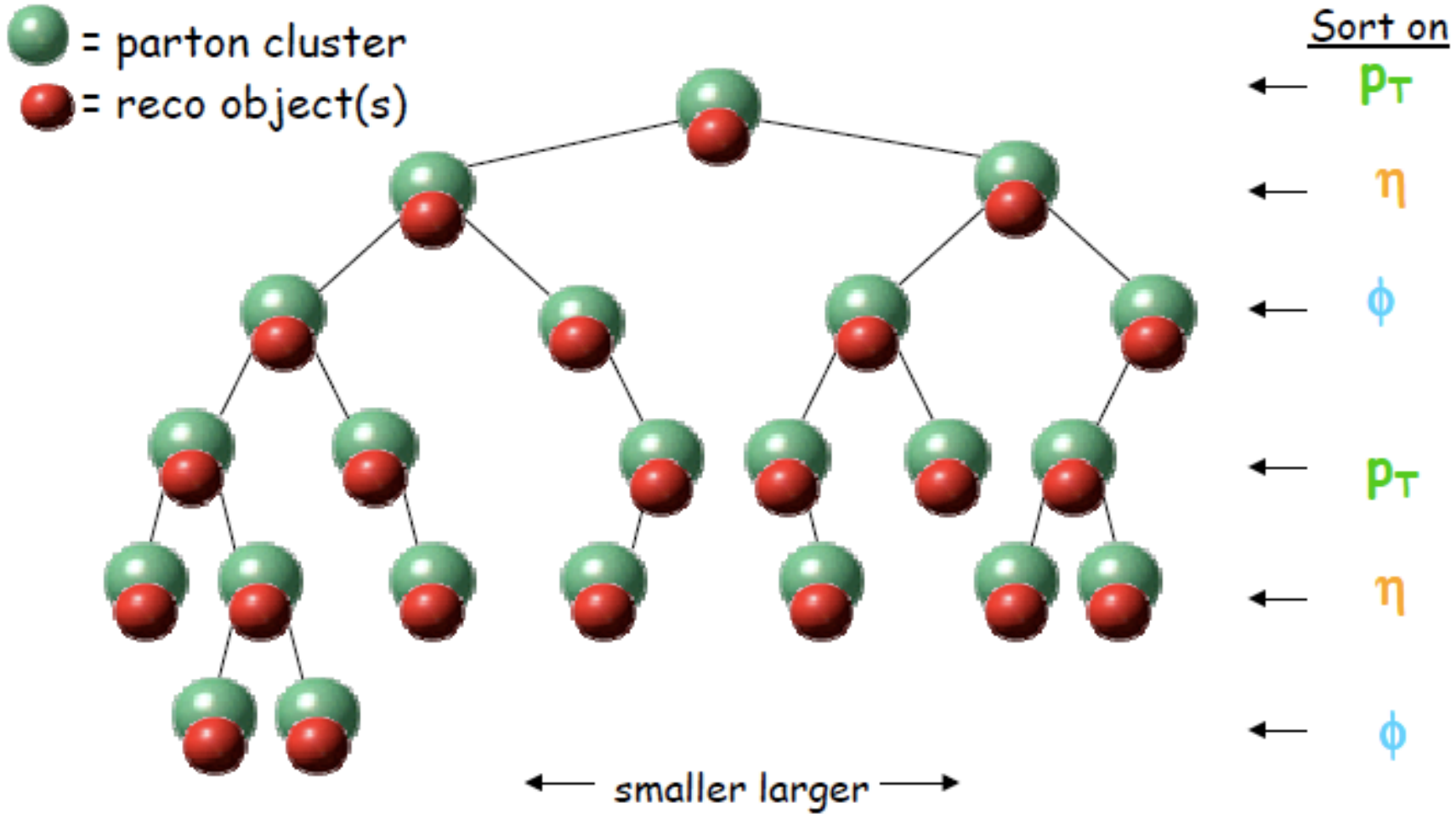
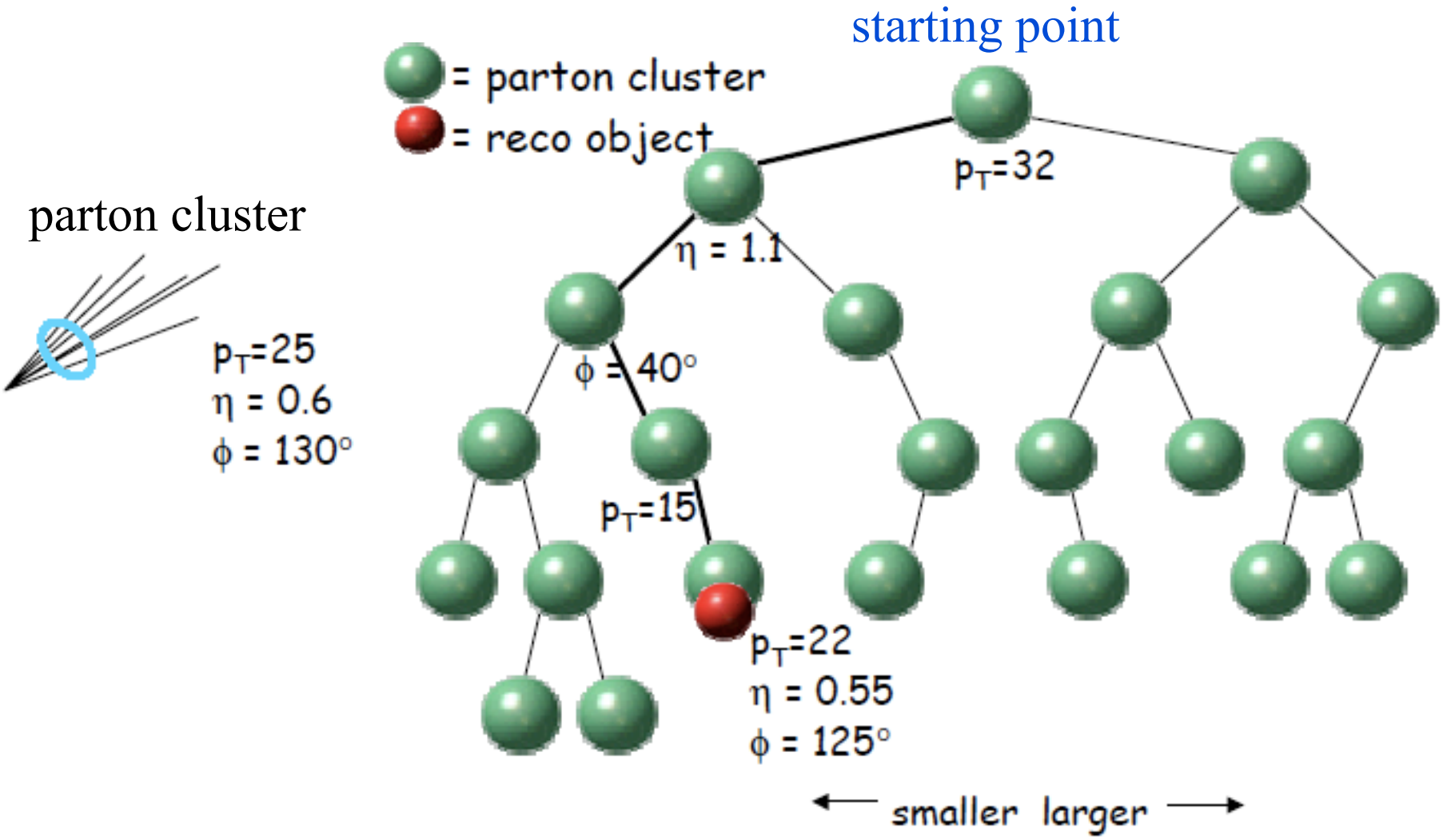
Implementation – 1

Table implemented as a binary tree



Implementation – 2



"Training" TurboSim

- **"partonEvent_train.txt":** The gen level input file (both for training and simulation).

  Sig 0 1 pp 10000 xxx zvtx part pt eta phi jet mass pt eta phi.. ;

  Sig 0 1 pp 10000 143.652 0 tau+ 95.925 3.939 -75.52 j 0 38.54 4.252 96.56 ;

  Sig 1 1 pp 10000 241.04 0 tau- 38.47 2.92 153.27 j 0 182.218 3.78 -36.1 ;

- **"recoEvent_train.txt":** The reco level input/ouput file (Note the events without any reconstructed particle).

  Sig 33 1 pp 10000 0 -0.00229183 ;

  Sig 34 1 pp 10000 108.37 -0.002 j 8.55 49.10 1.30 -162.93 e- 20.19 1.257 -167.61 ;

  Sig 35 1 pp 10000 218.17 -0.002 j 6.35 72.17 1.25 3.80 j 4.26 67.07 0.056 179.51 e+ 40.81 0.07 -178.79 e- 38.11 1.25 1.19 ;

- **Create the Morphism Tables:** The morphism tables are created with following command,

  turboSim -create turbosimMorphisms.txt partonEvent_train.txt recoEvent_train.txt

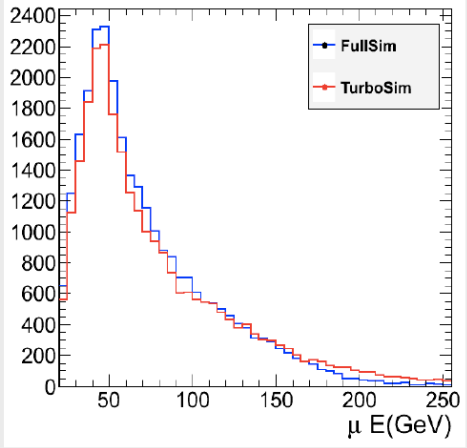
TurboSim Studies @ CMS

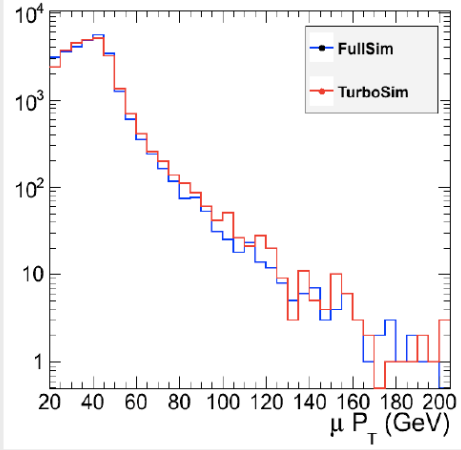
Using TurboSim for Fast Detector Simulation

A. P. Singh[(1)], S. B. Beri[(1)], L. K. Saini[(1)], H. B. Prosper[(2)]

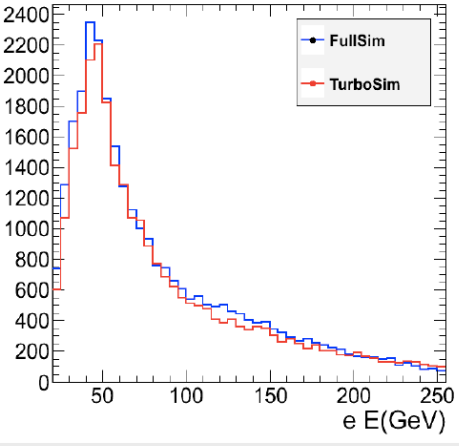
[(1)]Panjab University, Chandigarh, IN.
[(2)]Florida State University, U.S.

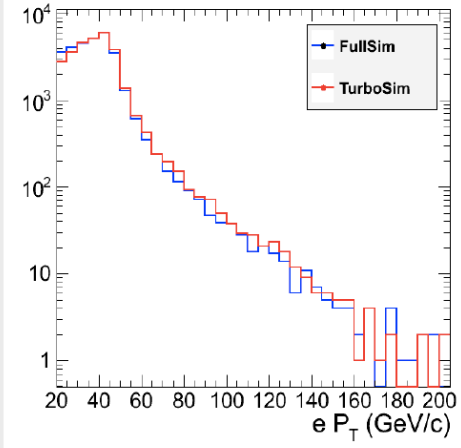
Muons

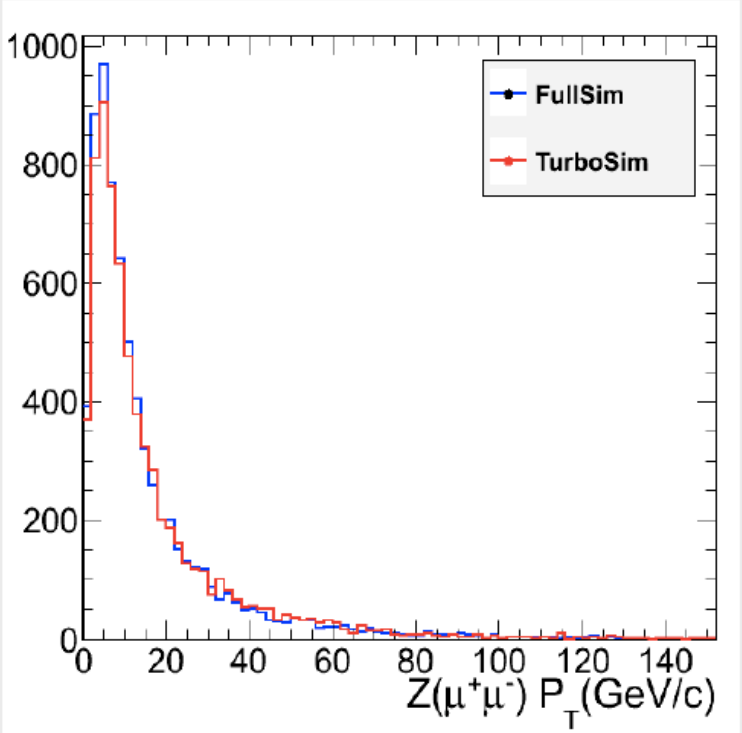




Electrons







TurboSim@LHC - Status

A version of the code currently resides in Steve's area

UserCode/Mrenna/Validation

Alas, since my maintainer has moved on to brighter pastures, I have no one to maintain the code, which is currently broken!

It would be very good to find a team of no more than a couple of people to bring the code back to working order.

Conclusion

- The use of large lookup tables as a means of approximating $D(x \mid y)$ in

$$p(\vec{x} \mid M) = \int D(\vec{x} \mid \vec{y})\, p(\vec{y} \mid M)\, d\vec{y}$$

  has been very successful at the Tevatron and at Hera. Preliminary studies at CMS (done two years ago!) indicate that the same should hold at the LHC
- Wanted: a team of two people to bring the program back to working order both in CMS and in ATLAS
- Wanted: agreement from CMS and ATLAS that TurboSim morphism tables can be made public