

Herwig

– Recap, Status and Preview –



Johannes Bellm

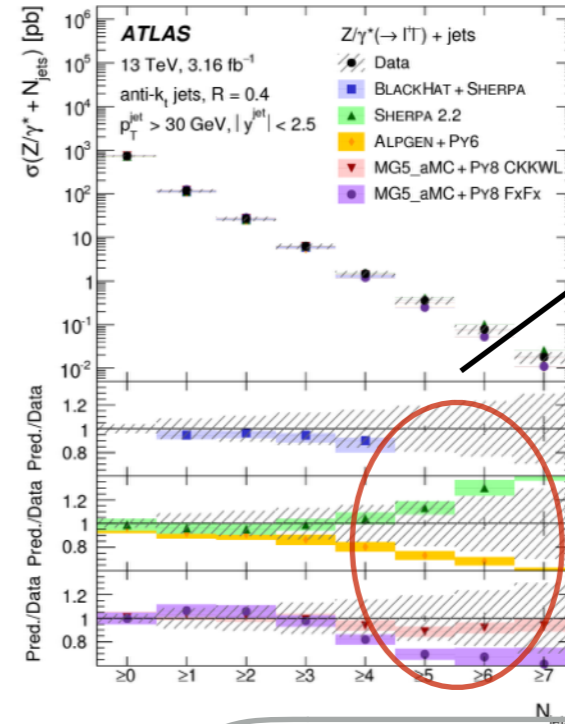
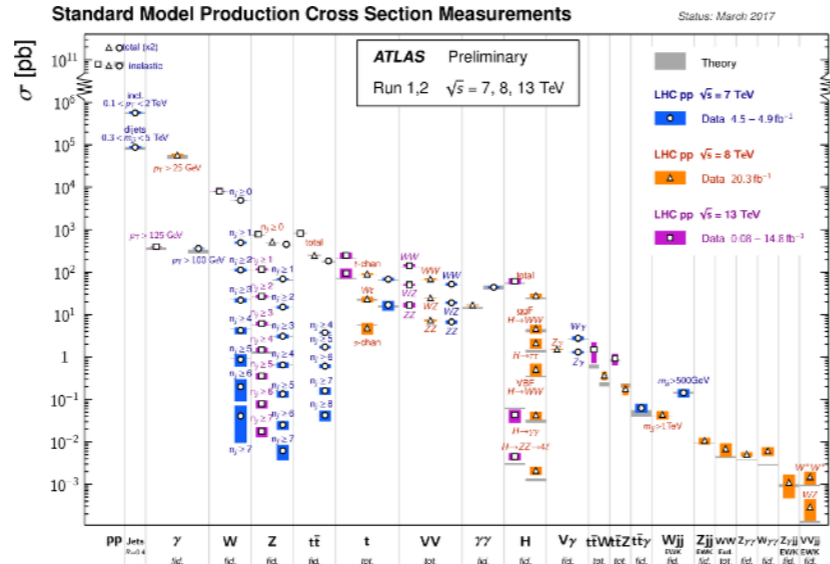


for the Herwig collaboration

ATLAS-CMS MC workshop
@ CERN 2017

Some Motivation (if needed at all)

Run I



will be able to differentiate

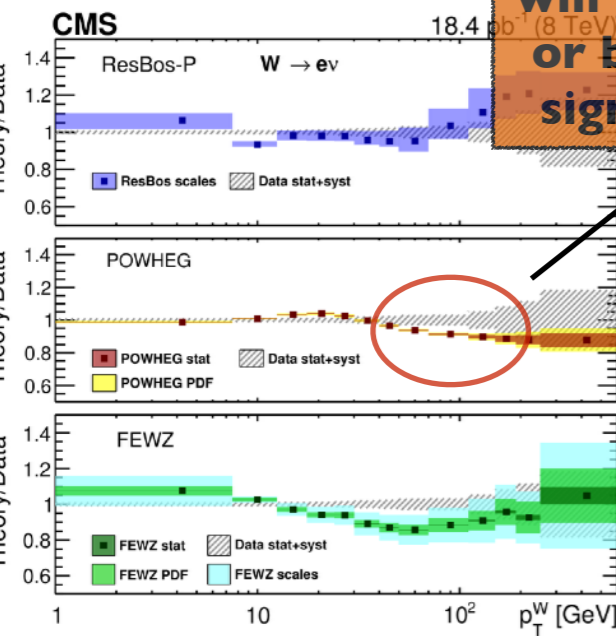
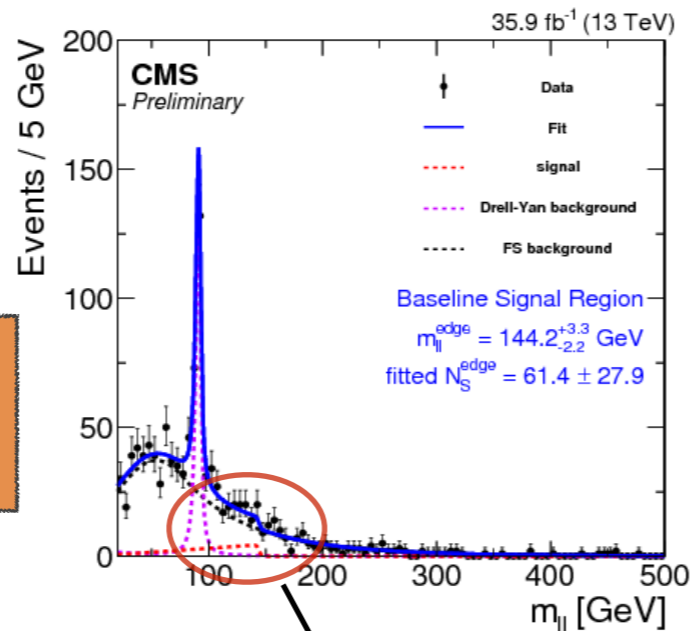
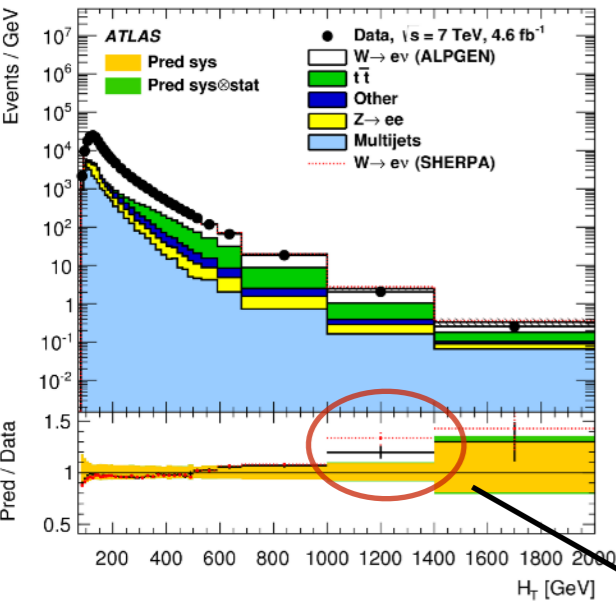
Run II

more luminosity
more jets
more UE/Soft data
more statistics in tails

collection from
ATLAS and CMS official web page
caution — some may be no issues anymore

results will be used to conclude on new physics

will go away or become significant



Outline

◆ releases of Herwig

◆ the past

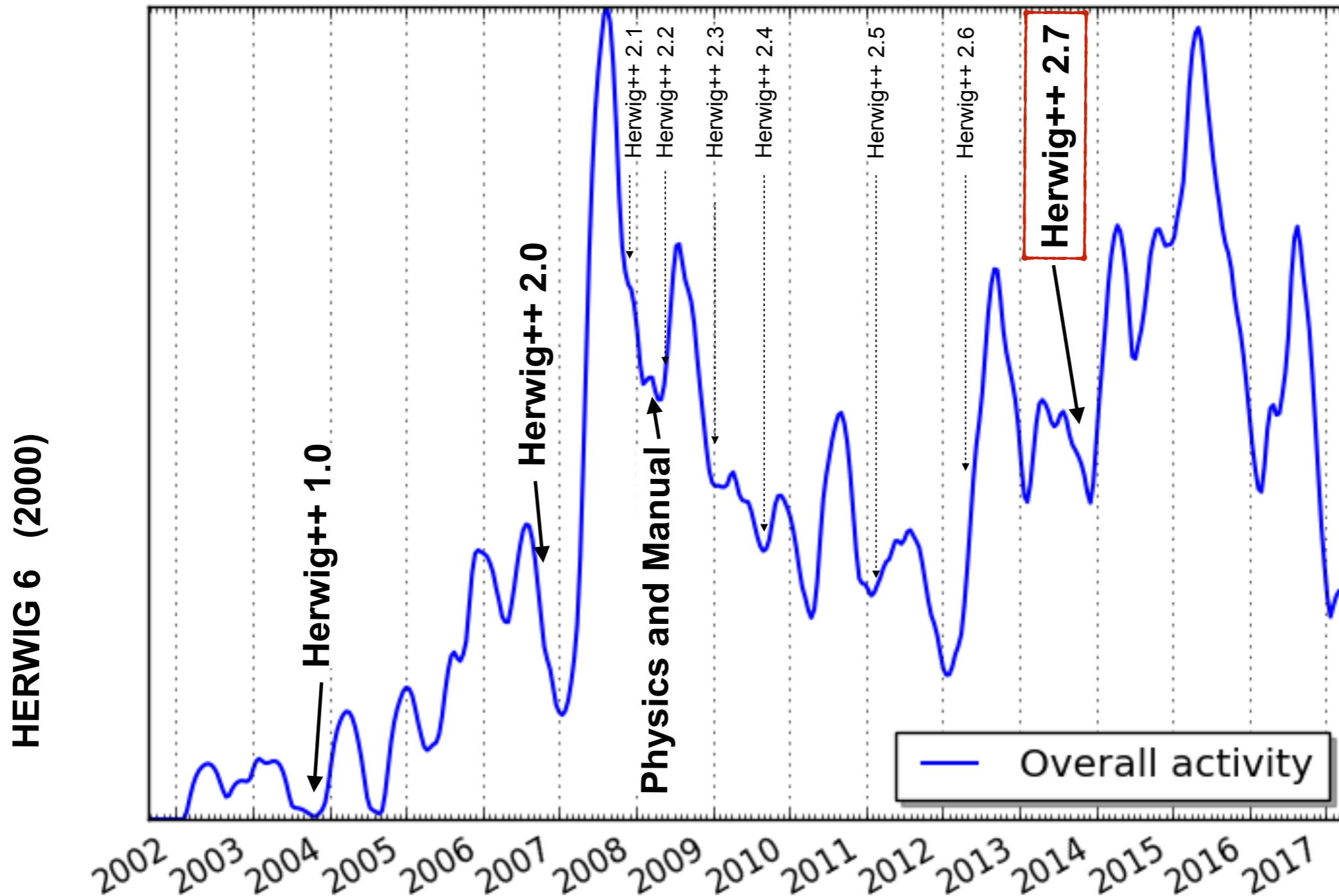
◆ the present

◆ the near future

◆ current testing

The Release Wave Pattern

commits over time



The Past

Main features of HERWIG/Herwig++

Angular ordered Shower
Cluster Hadronization
UFO Support
MPI Model
Selected processes at NLO
ME corrections

JHEP 0101 (2001) 010

Eur.Phys.J. C58 (2008) 639–707

H++ 2.7

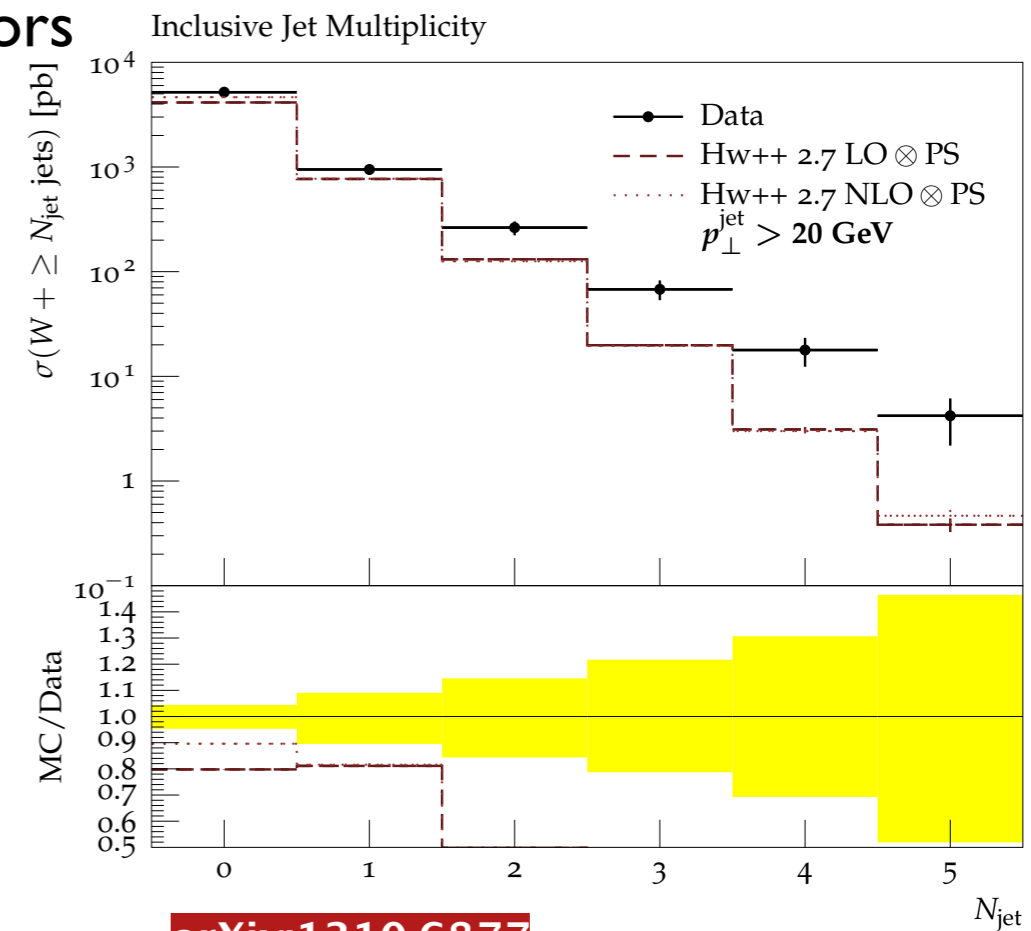
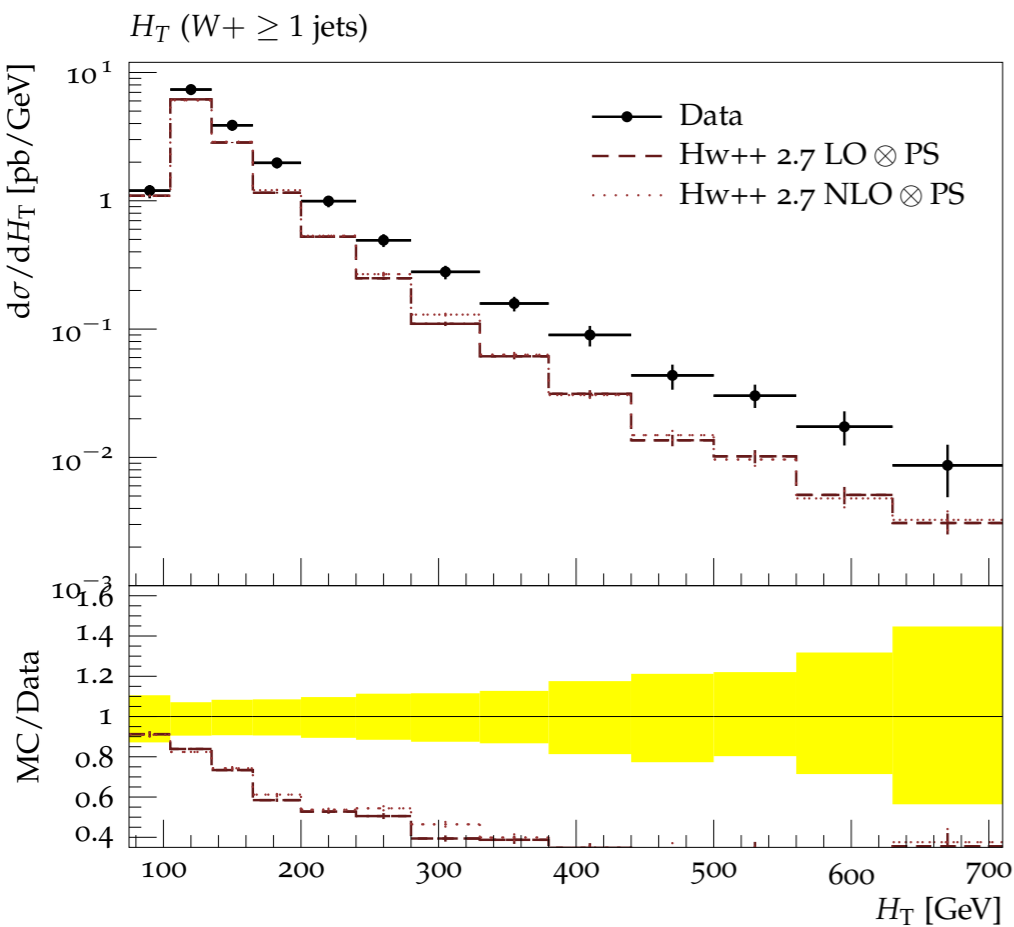
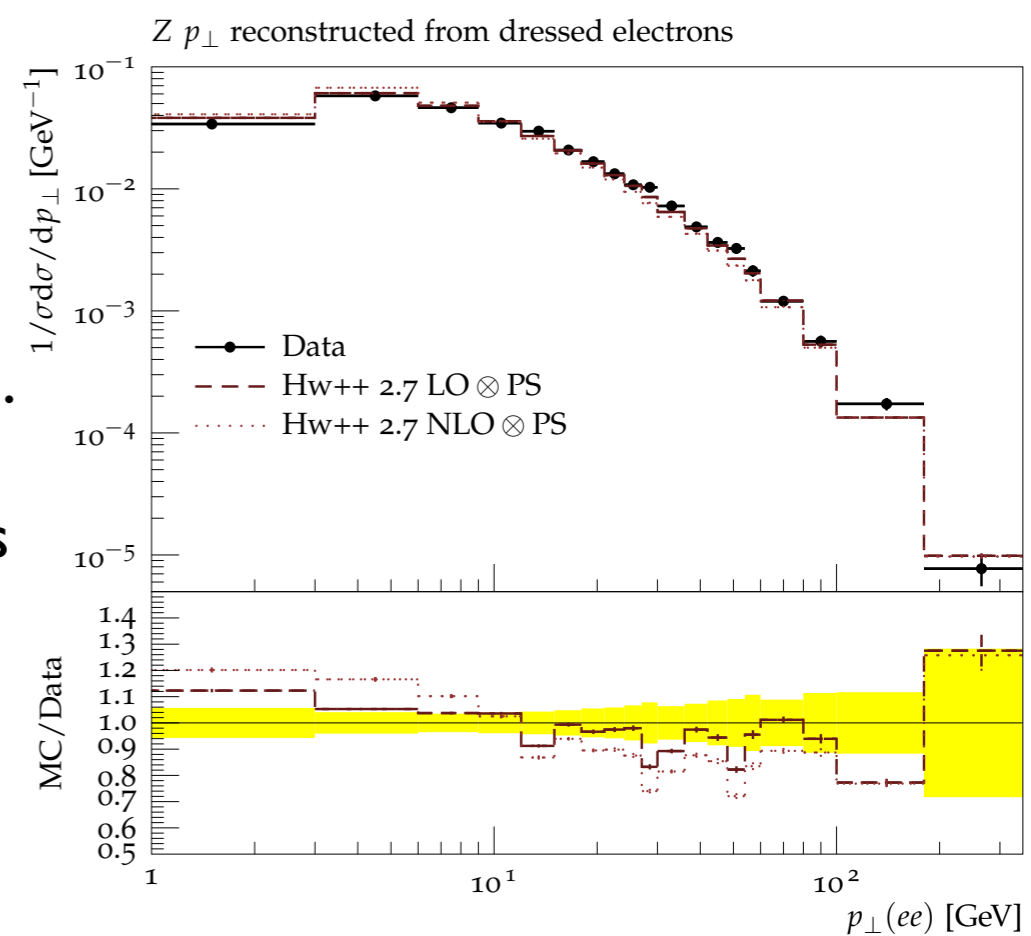
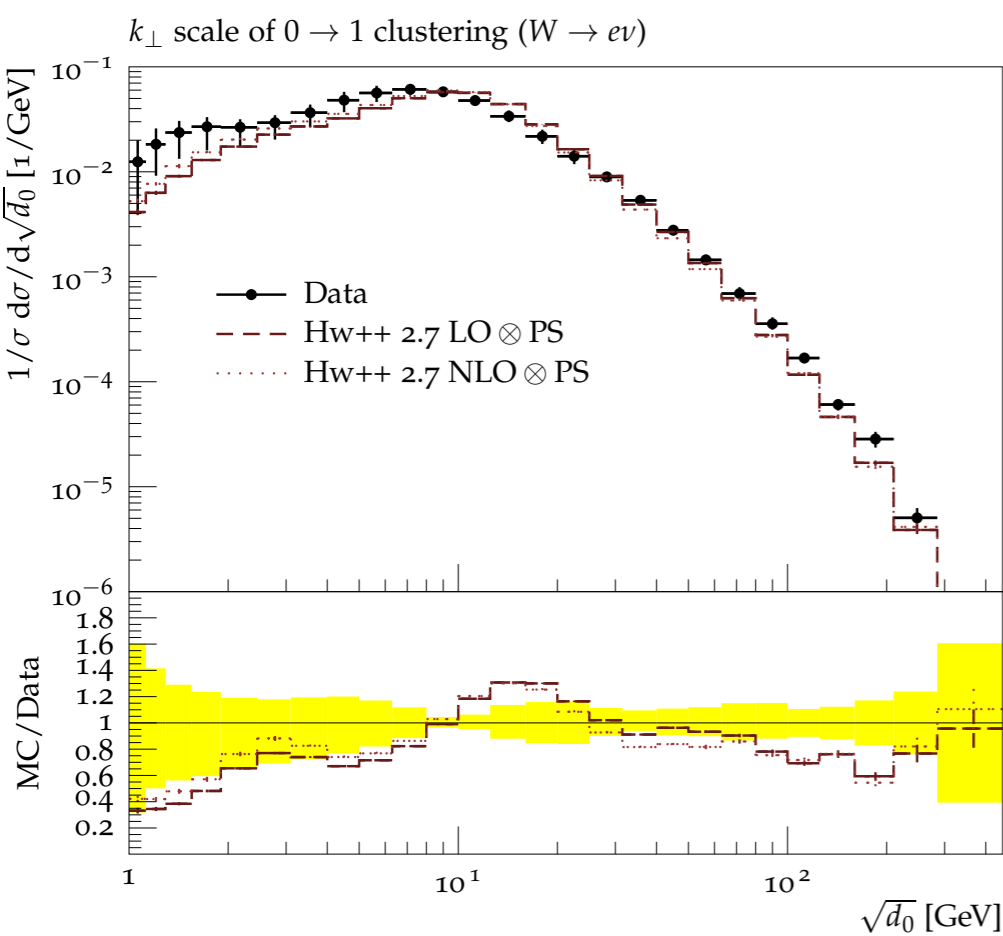
Well described first emission for *normalised* distributions.

Multiple hard emissions not well described.

Building POWHEG for simple processes.

Multiple new scale factors introduced to assign uncertainties beyond the hard process.

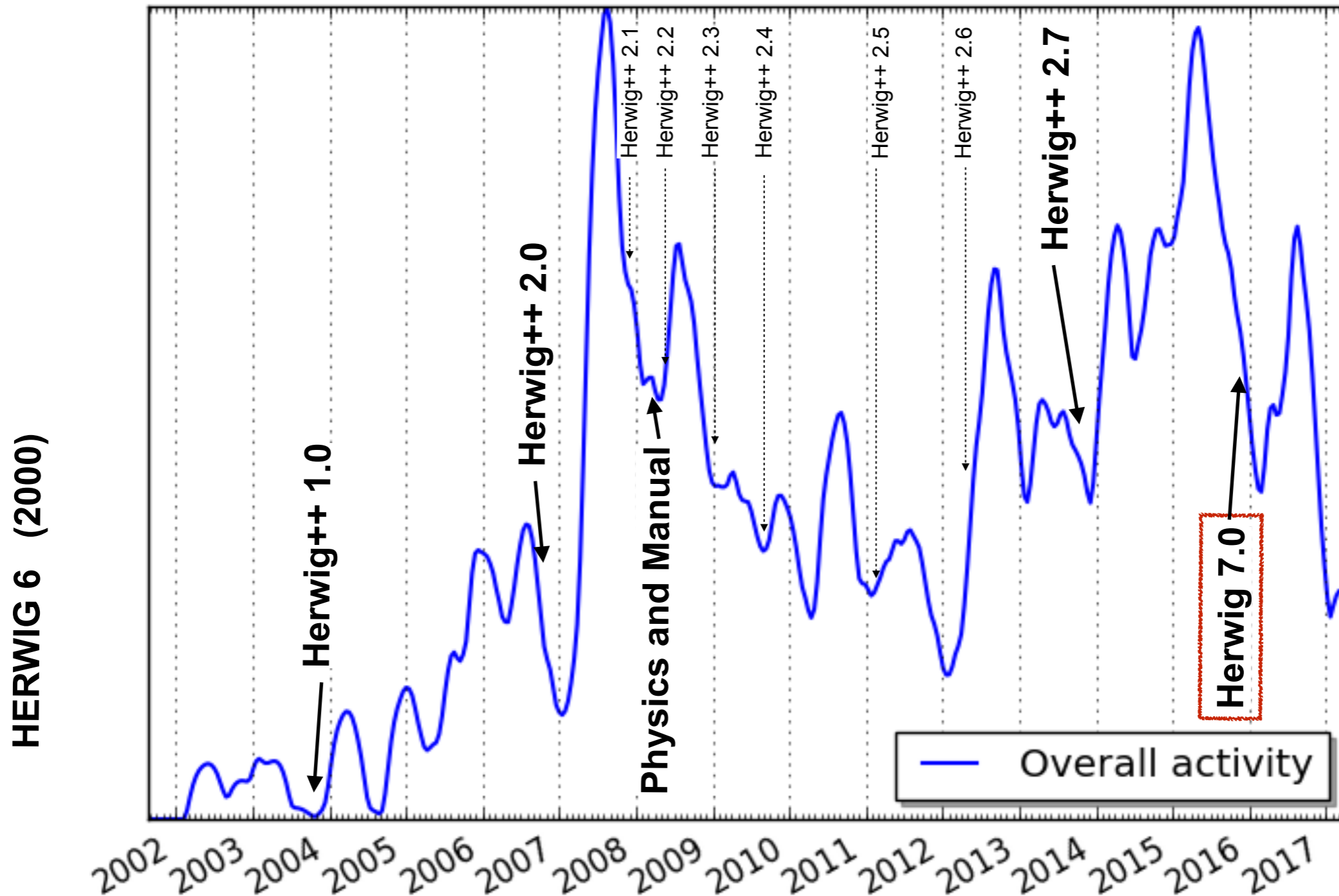
Since 2.6:
Early stage NLO matching in Matchbox.
Dipole Shower as second option.



arXiv:1310.6877

The Release Wave Pattern

commits over time

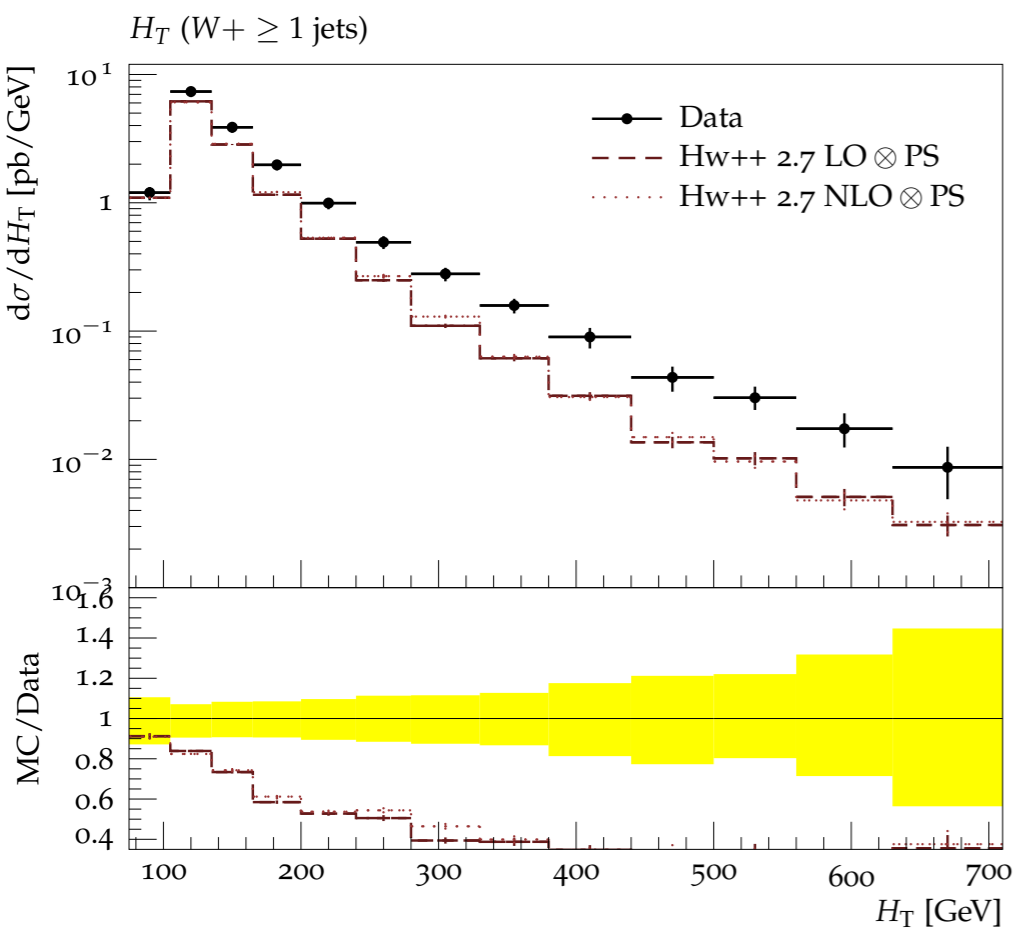
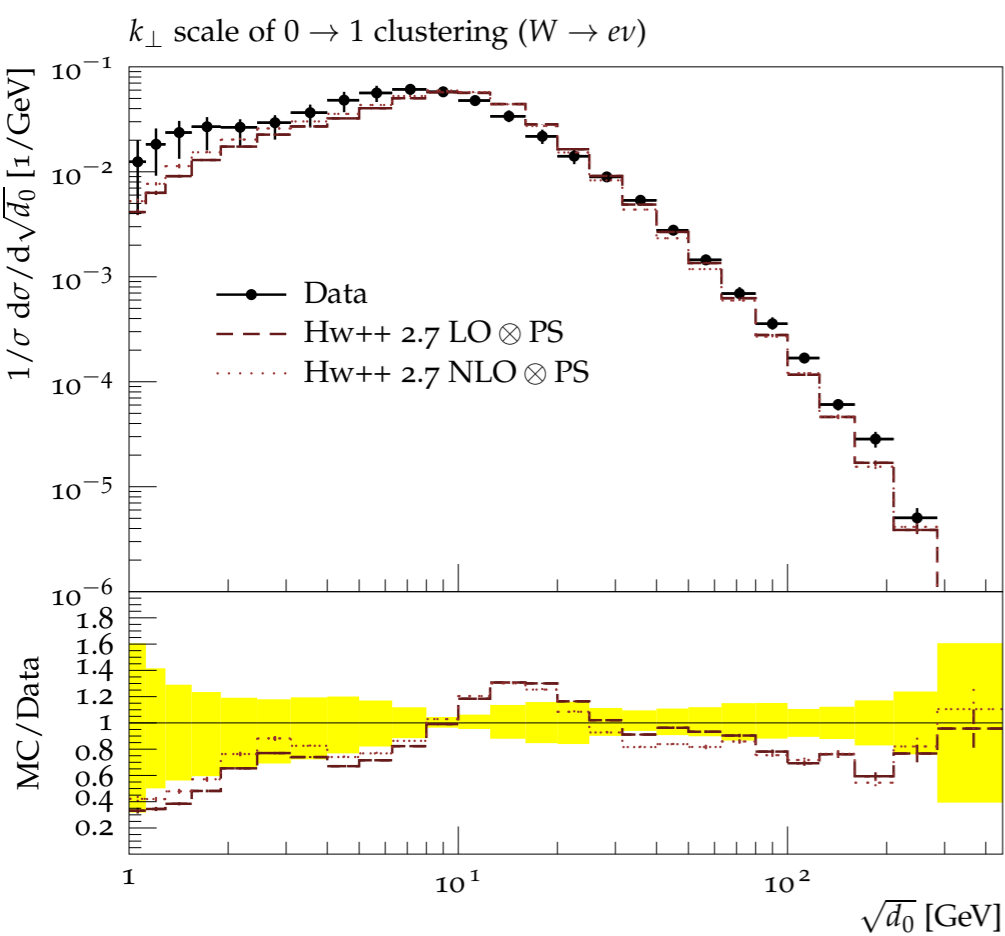


Eur.Phys.J. C76 (2016) no.4, 196

The Present

Herwig 7.0(.4)

Two Showers
Automated NLO
Multiple ME Interfaces
Two NLO Matching Schemes
Spin Correlations in AO Shower
Improved Sampling/Integration
QED radiation in AO shower
Improved Documentation
On the fly Reweighting
Simple Input files
New Tunes



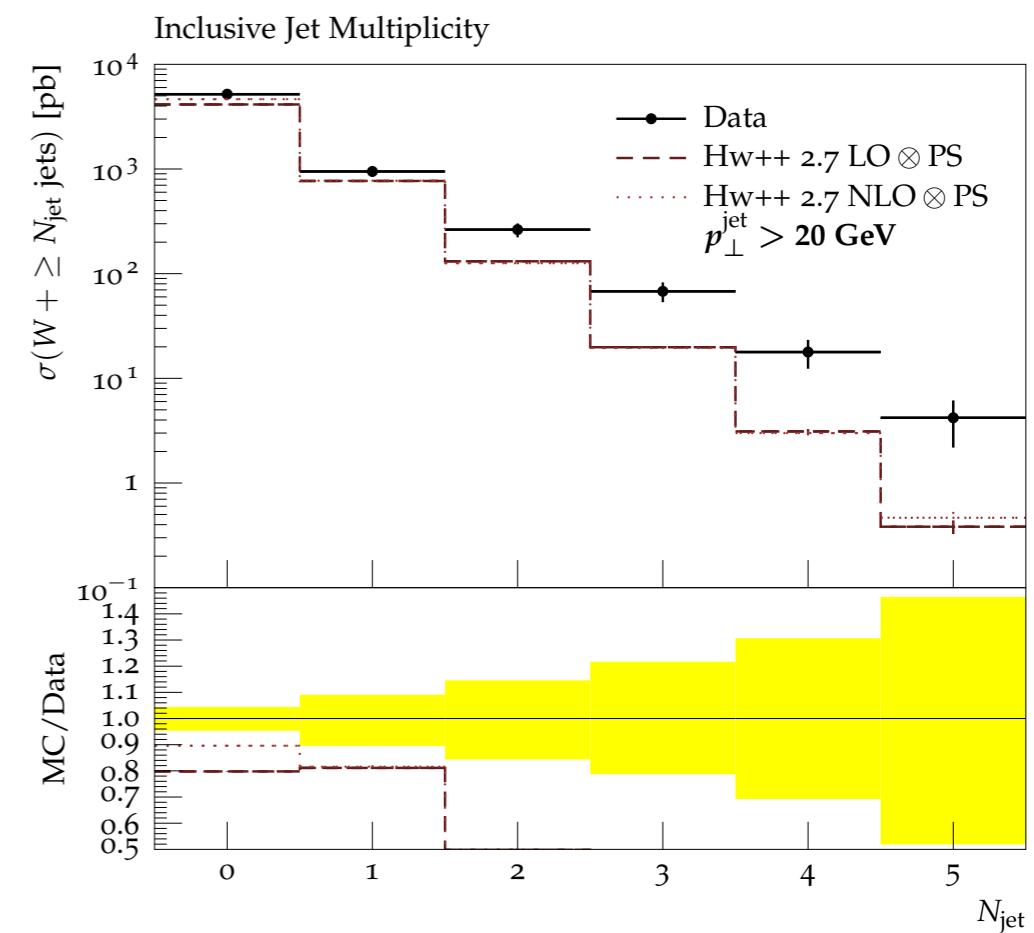
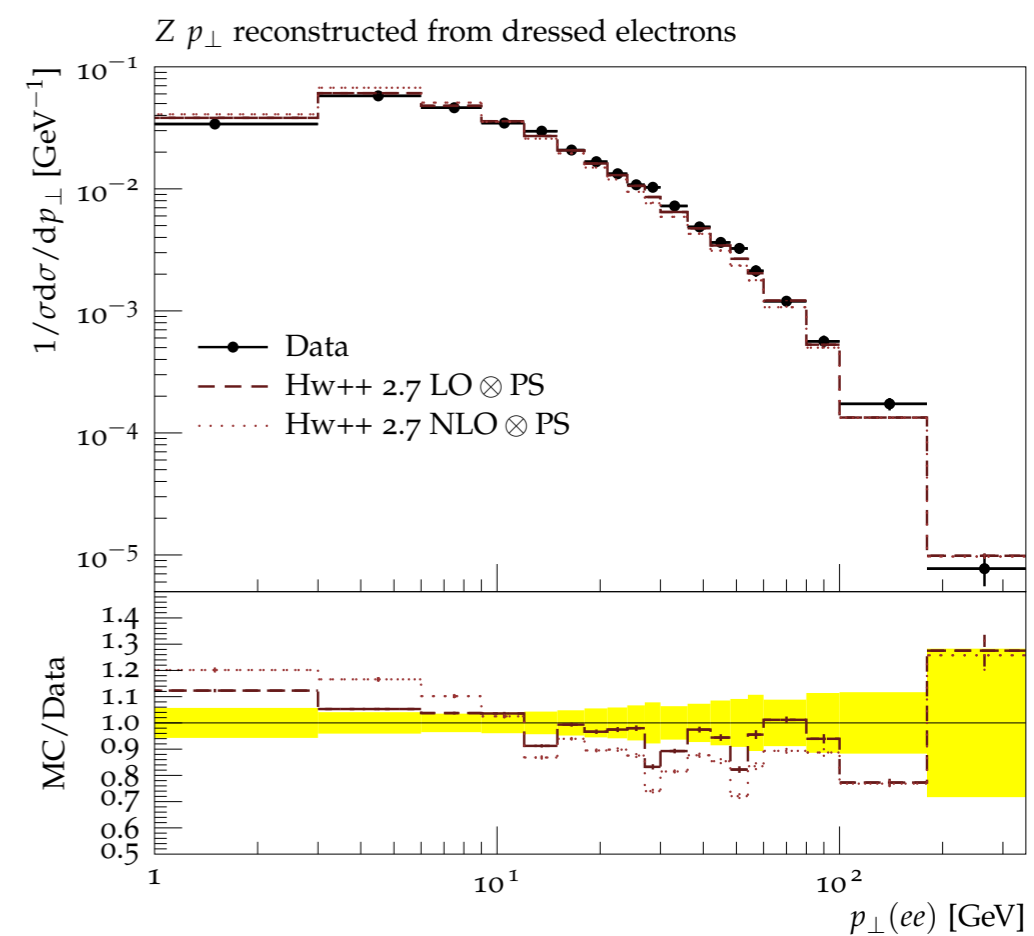
H++ 2.7

The plots are produced by the validation procedure.

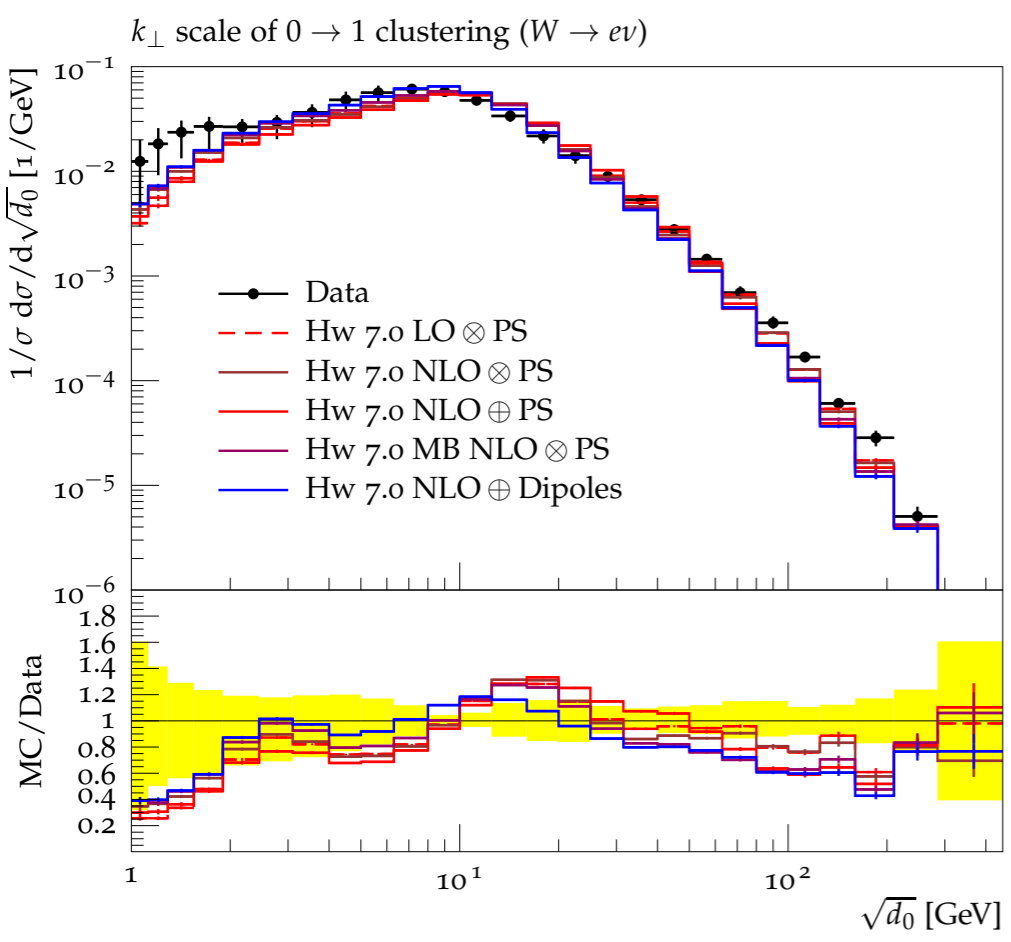
No process specific modification used.

Here only plots that we had for H++2.7.

New plots with new data later on.

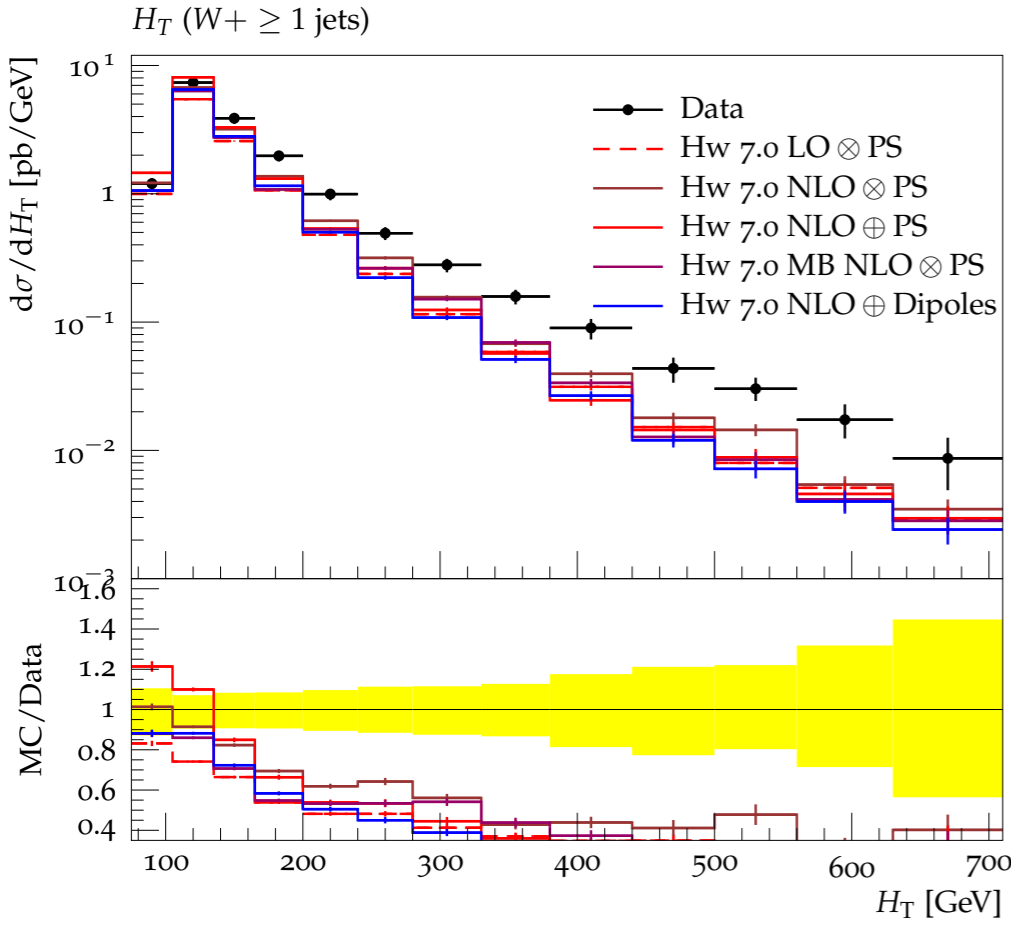
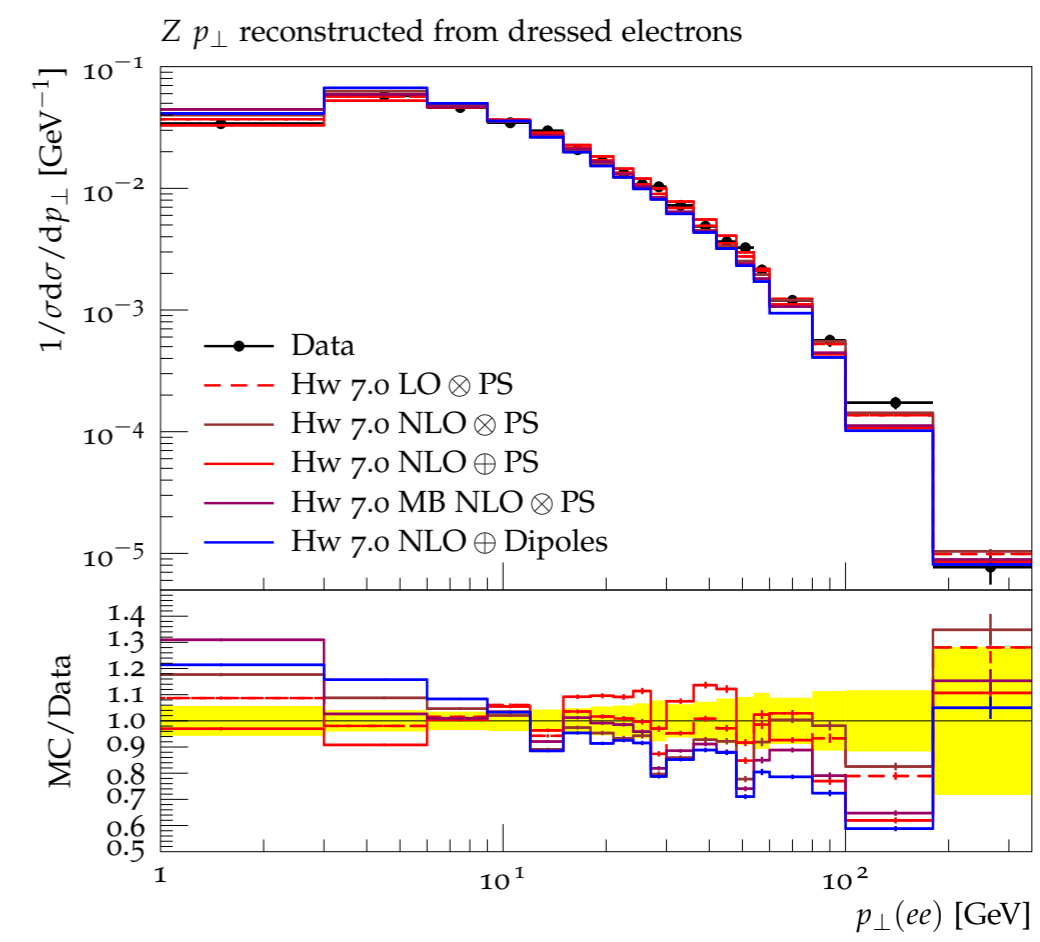


Herwig 7



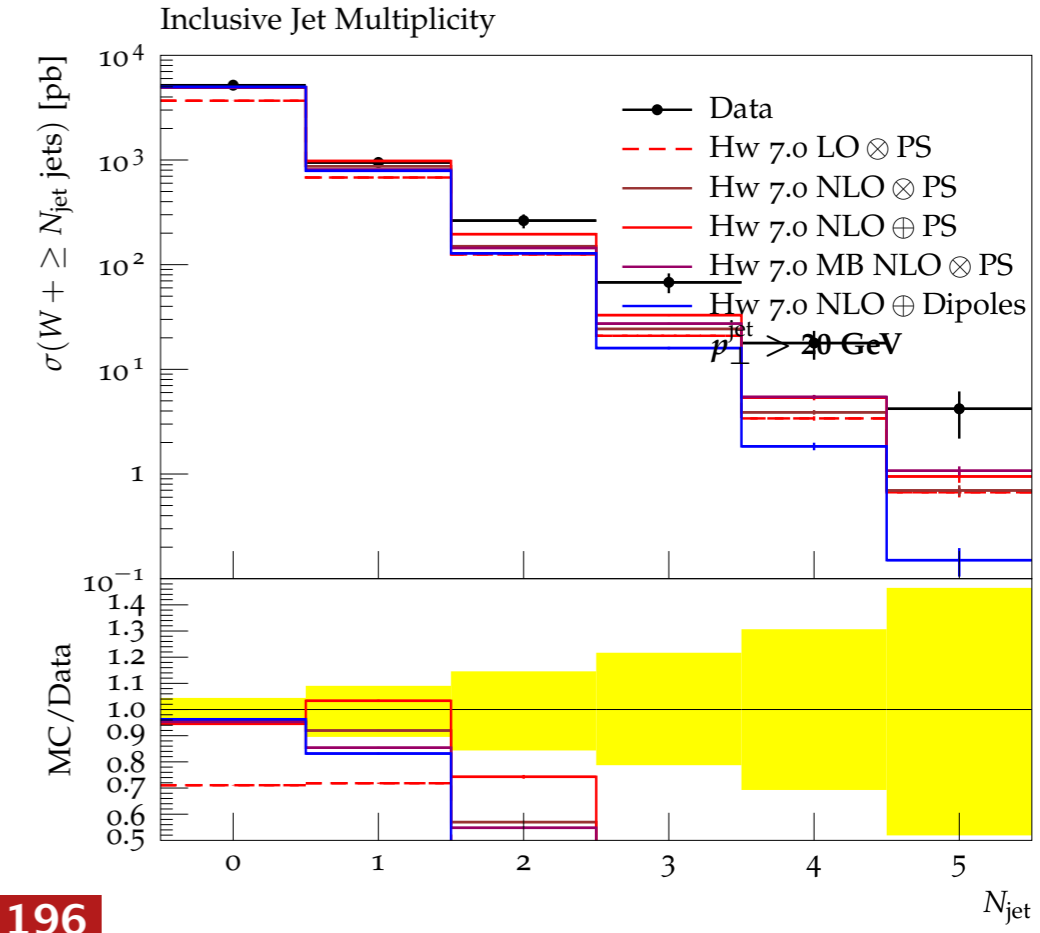
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Multiple hard emissions not well described.



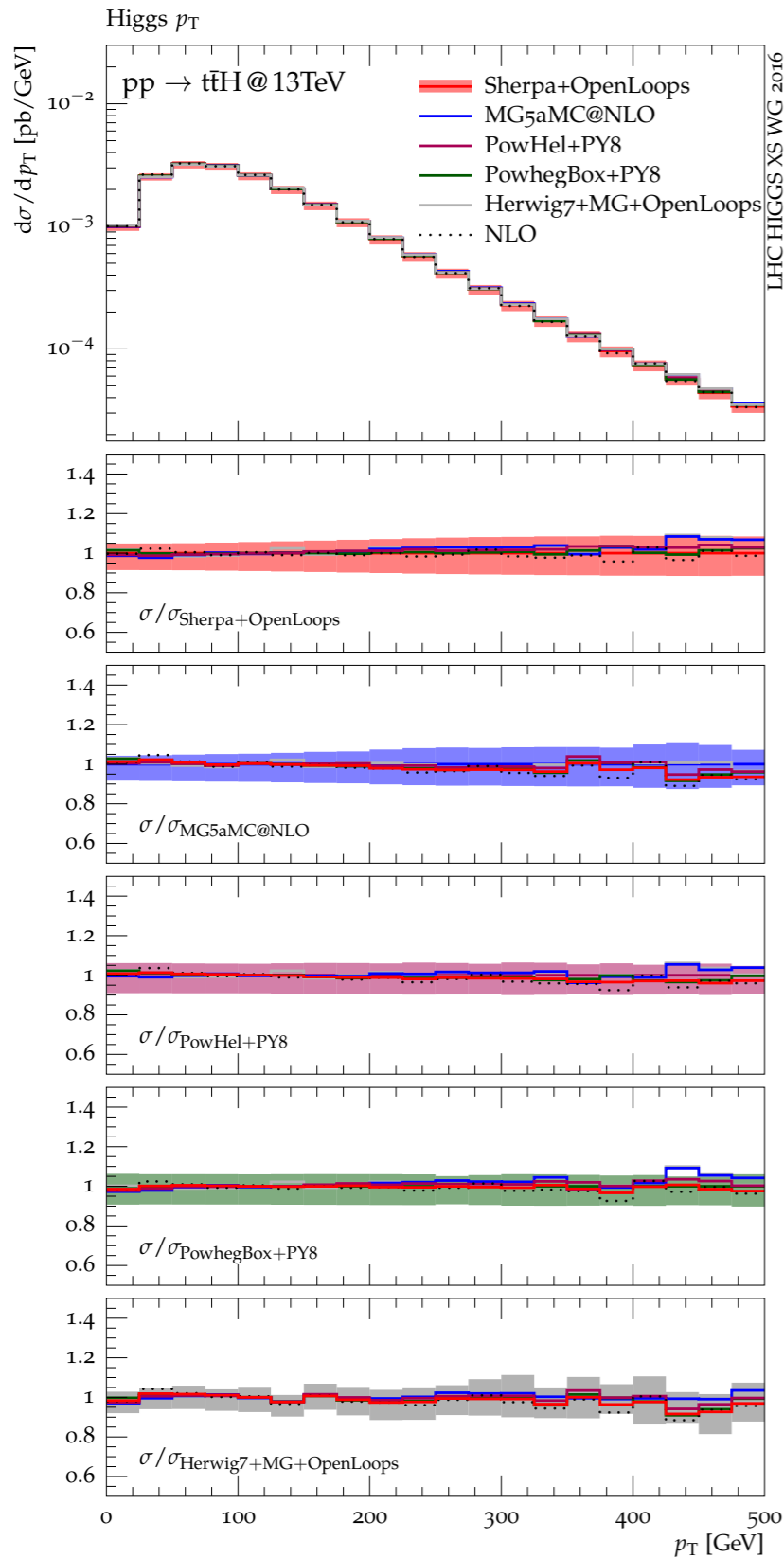
Soft region not well described

Full NLO automation with two showers with two schemes



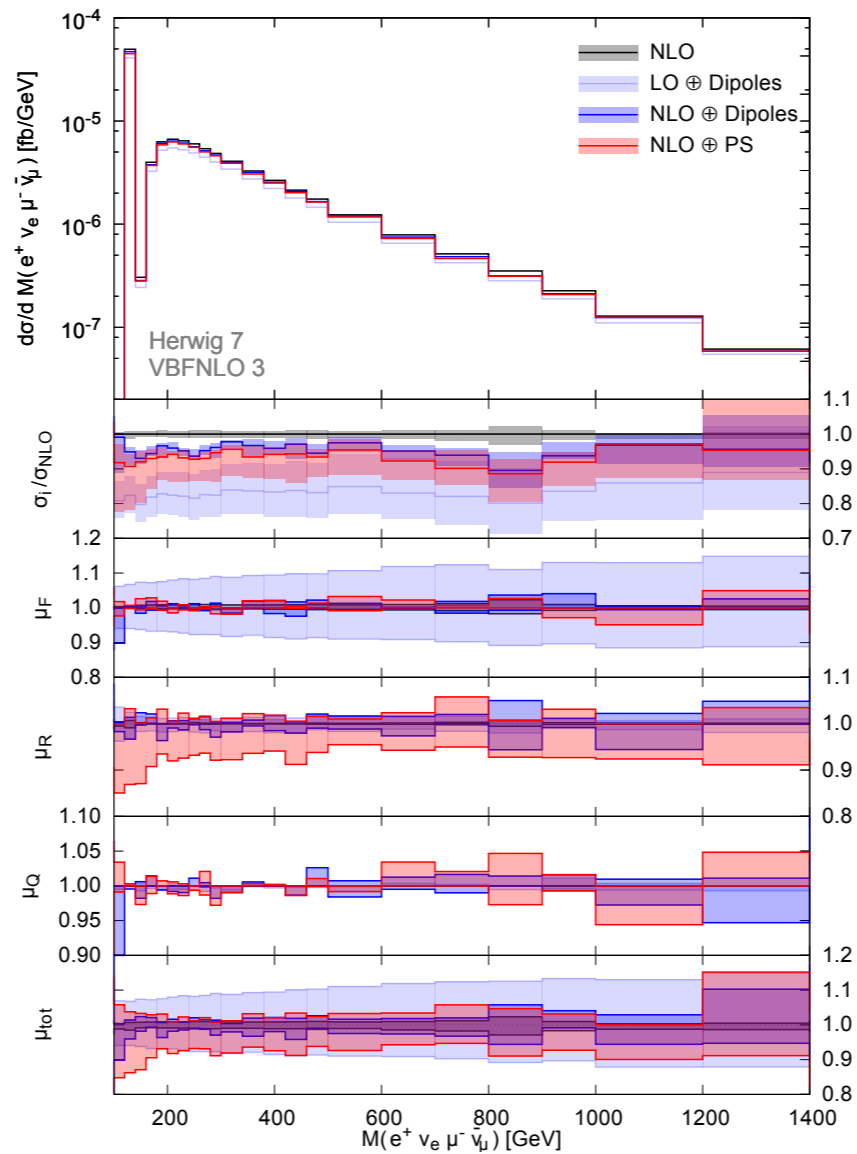
ttH Production for HXSWG

arXiv:1610.07922



VBF WW Production

arXiv:1605.07851

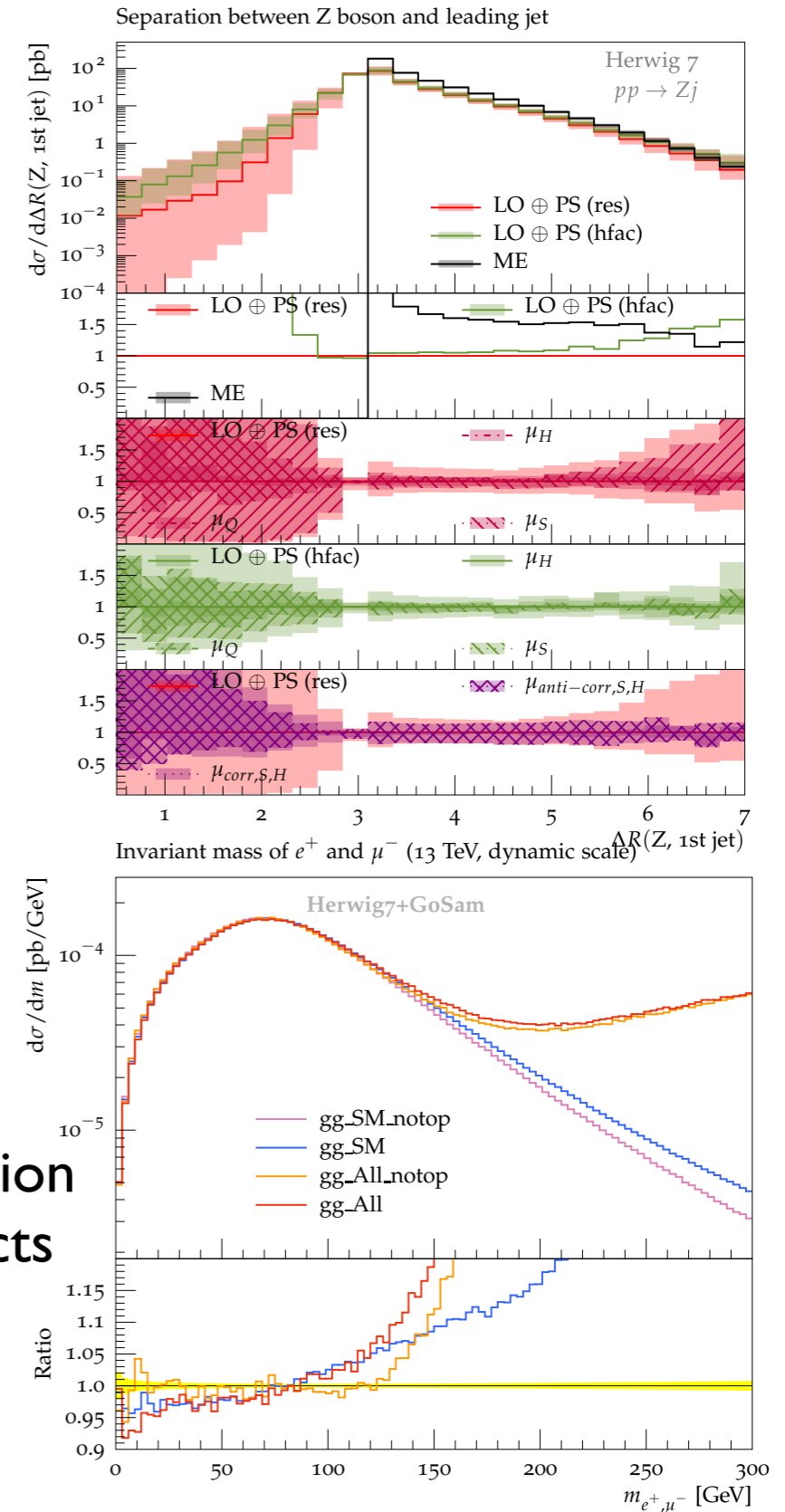


Loop Induced WW Production with BSM and top mass effects

JHEP 1605 (2016) 106

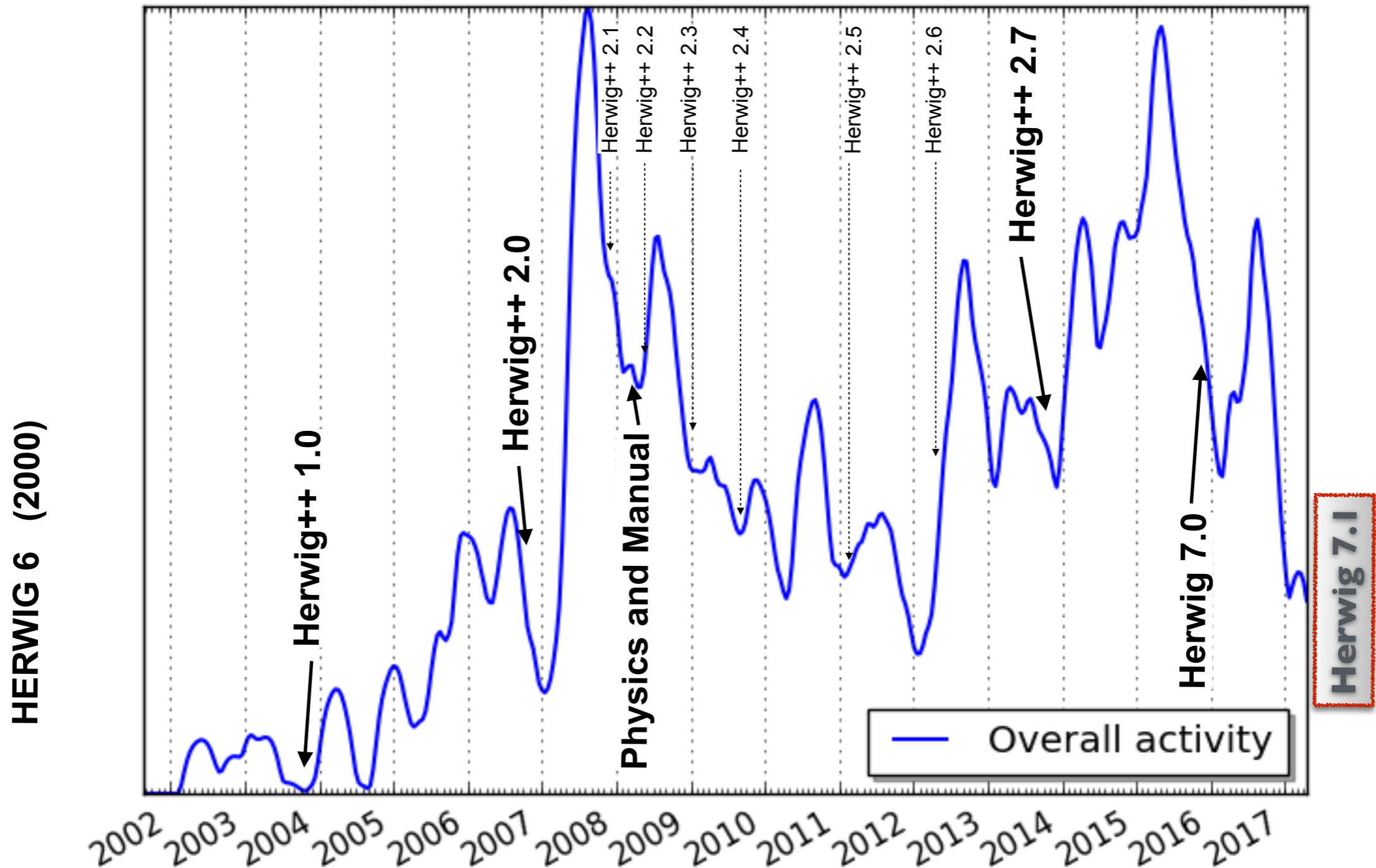
LO Uncertainties

Eur.Phys.J. C76 (2016) no.12, 665



The Release Wave Pattern

commits over time



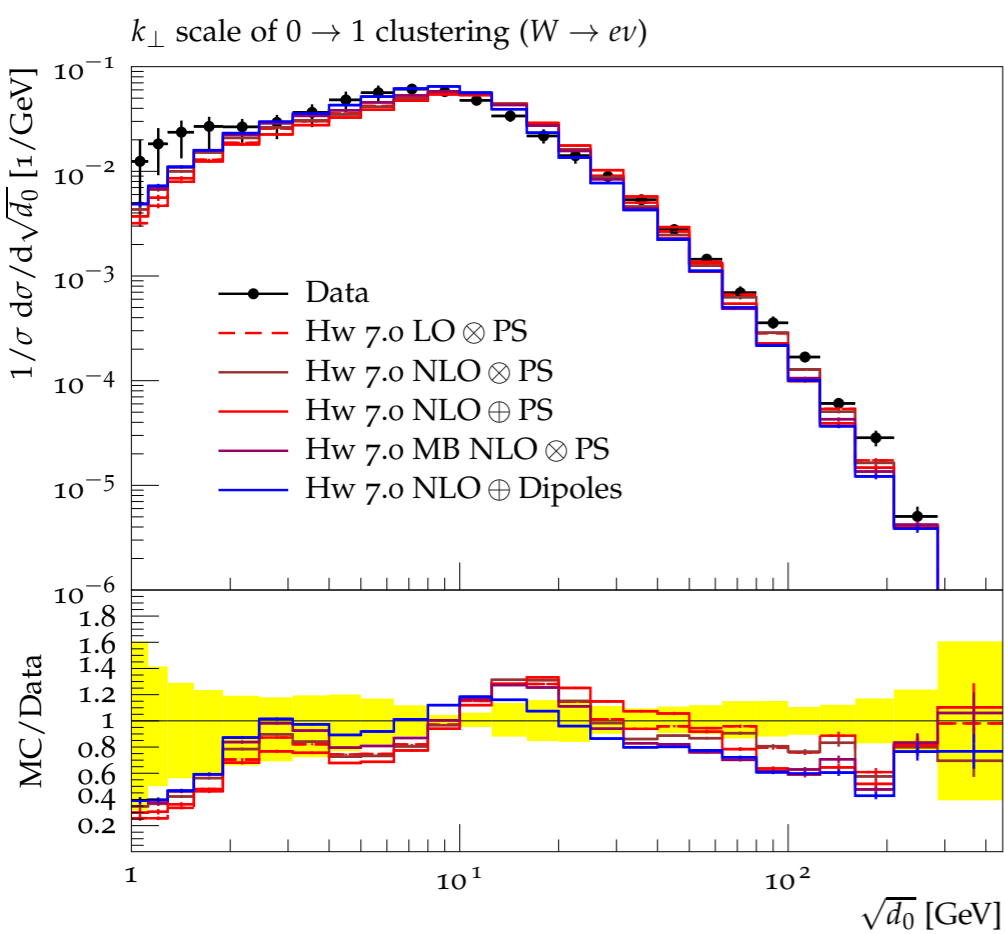
The near Future

Herwig 7.1



EVTGen
New Soft Model
Improved Massive DS
NLO Merging with DS
KrkNLO Matching
New Tunes

Lets compare apples with oranges...



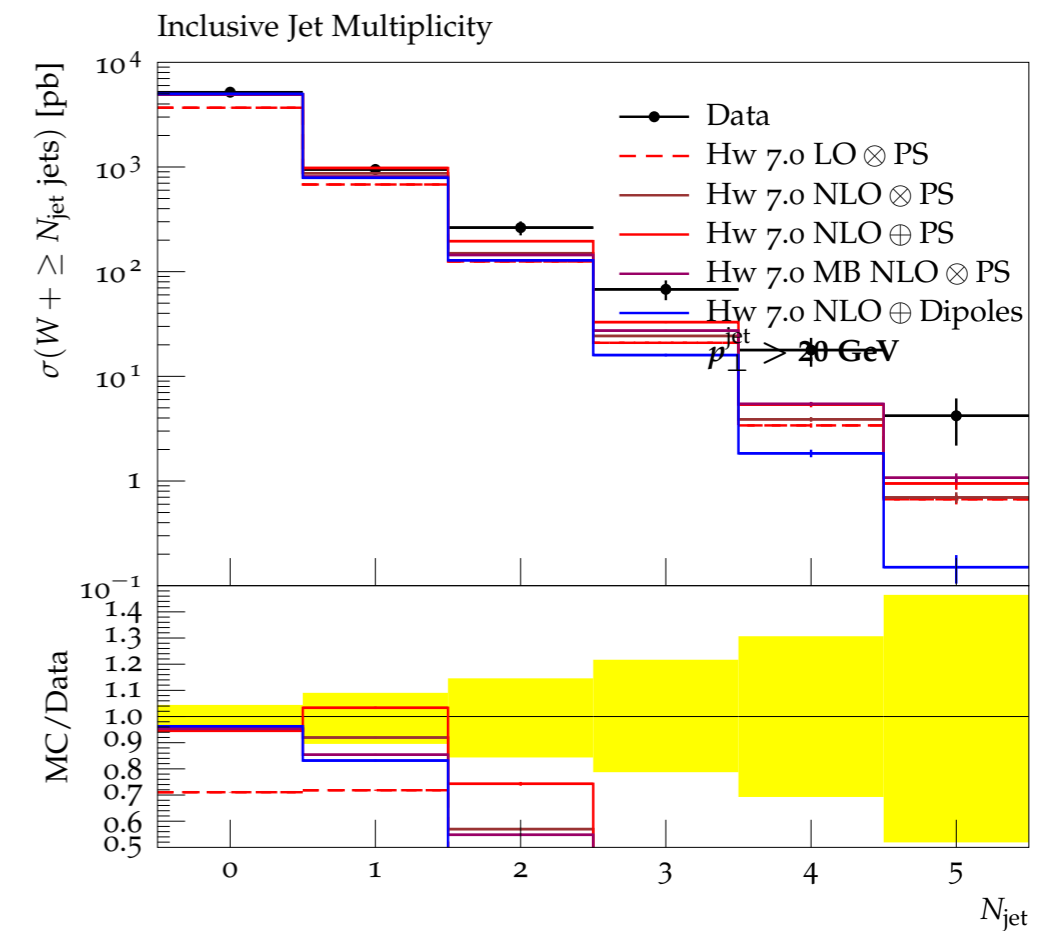
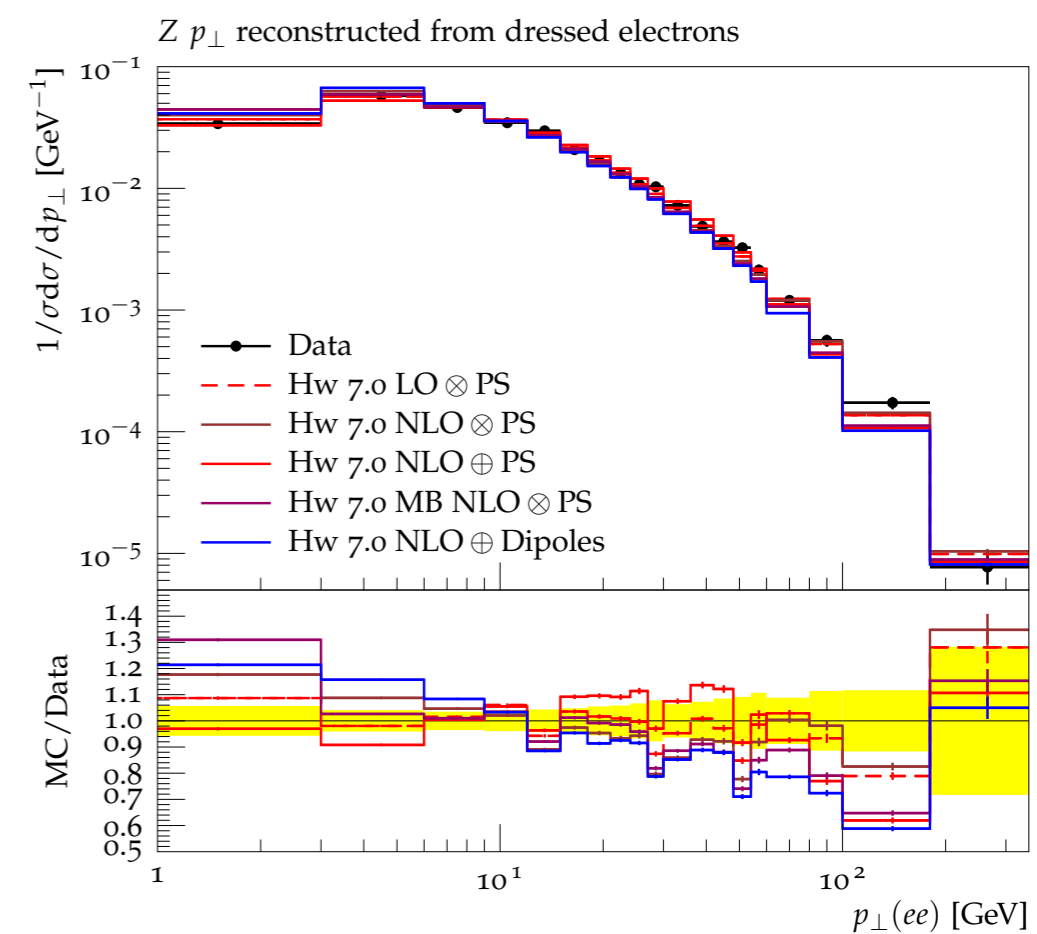
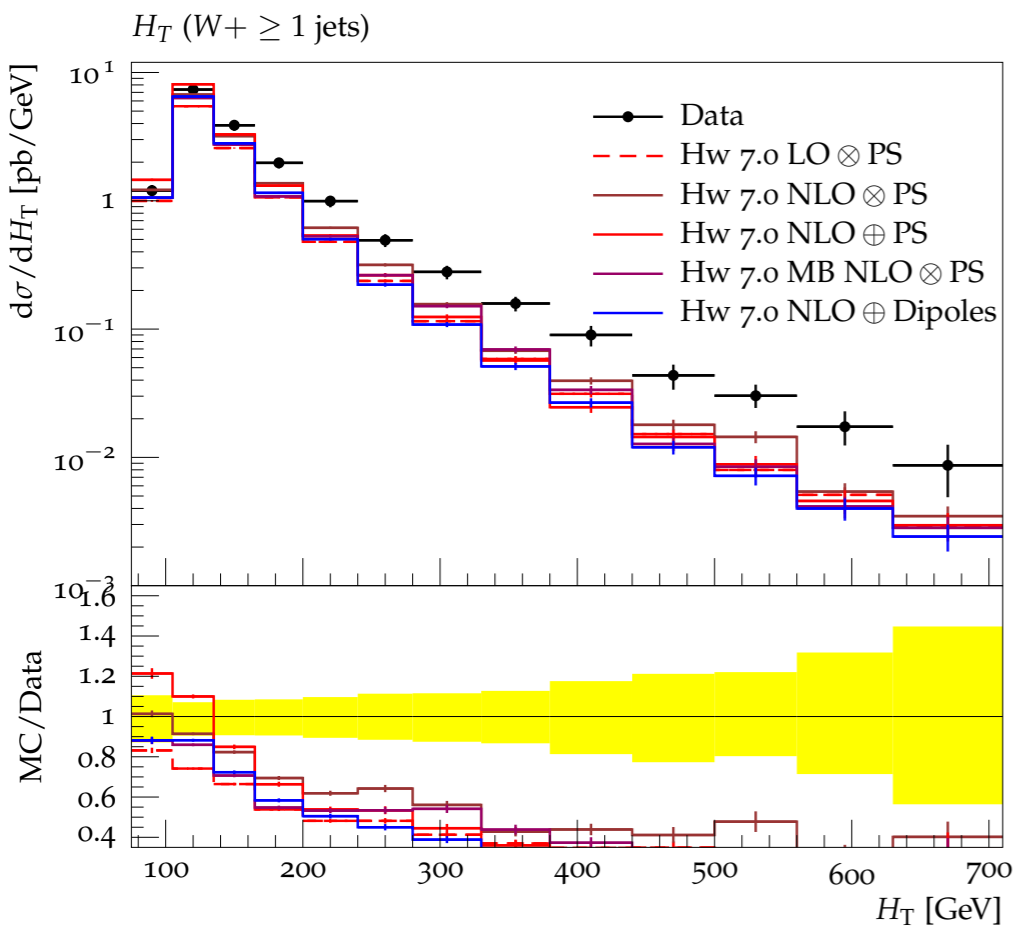
Herwig 7

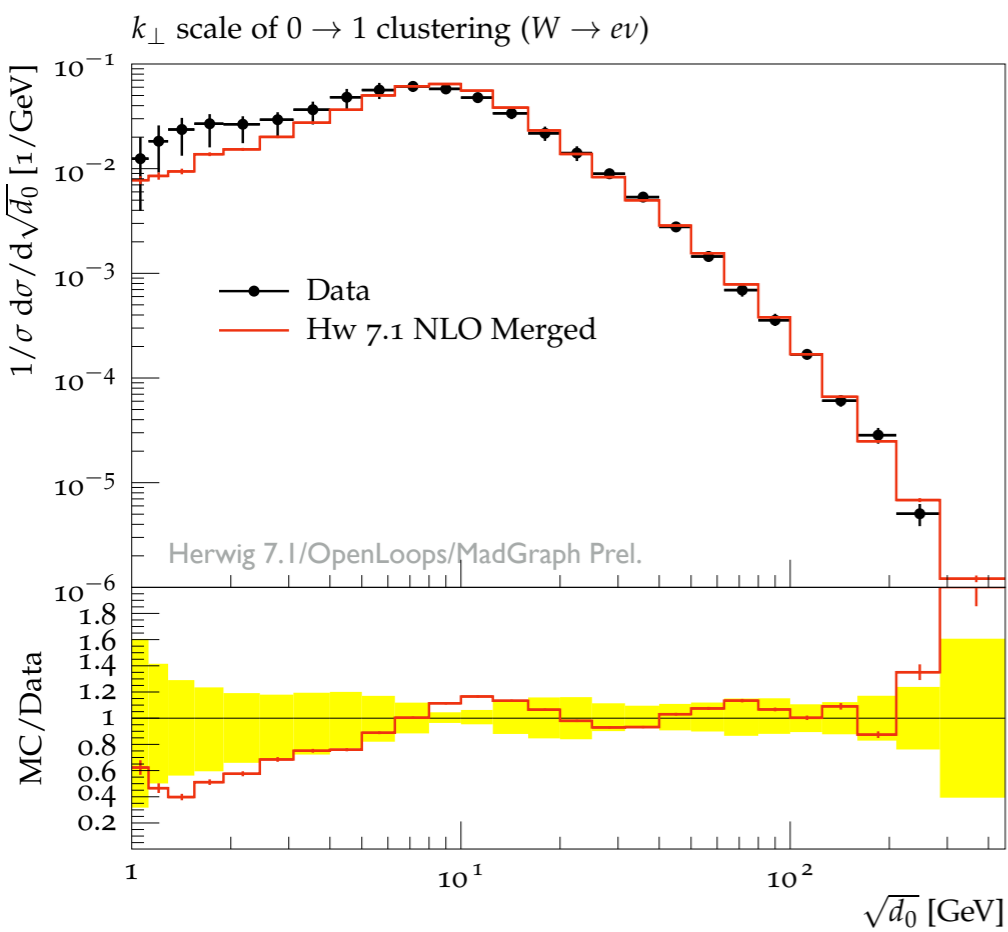
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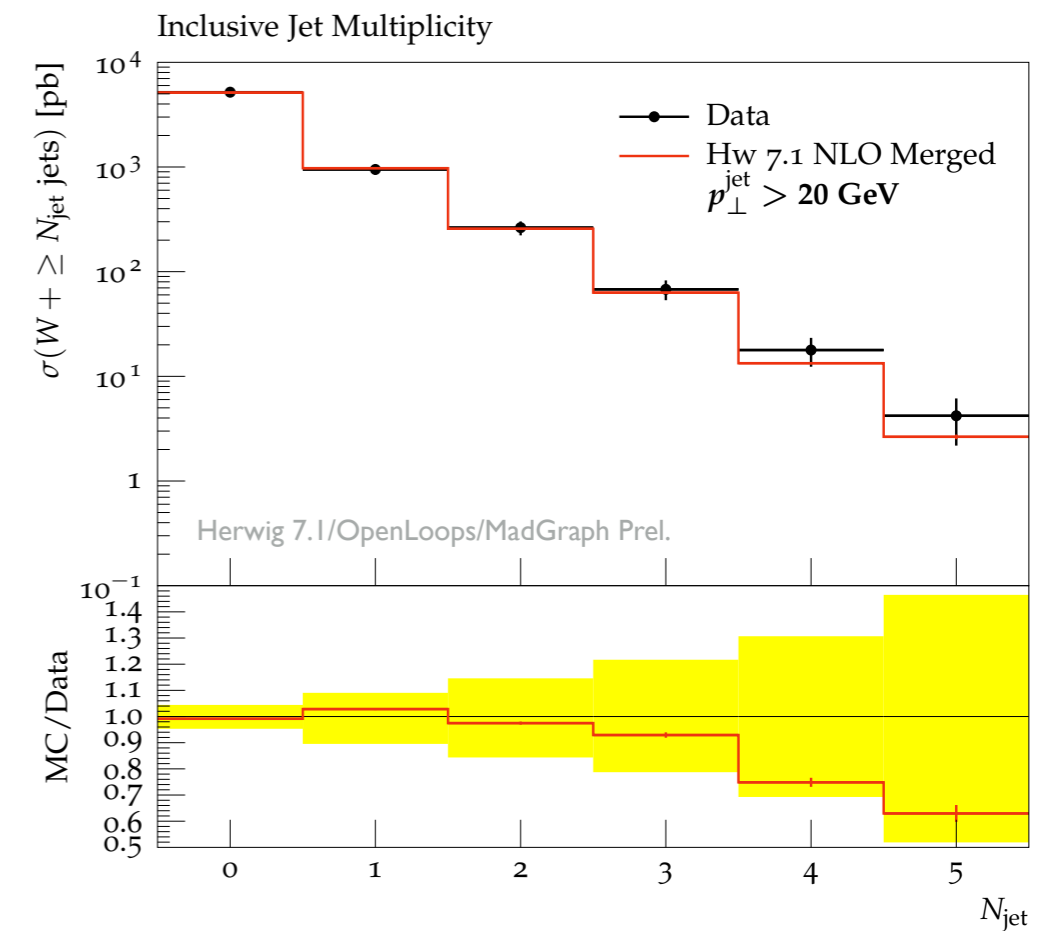
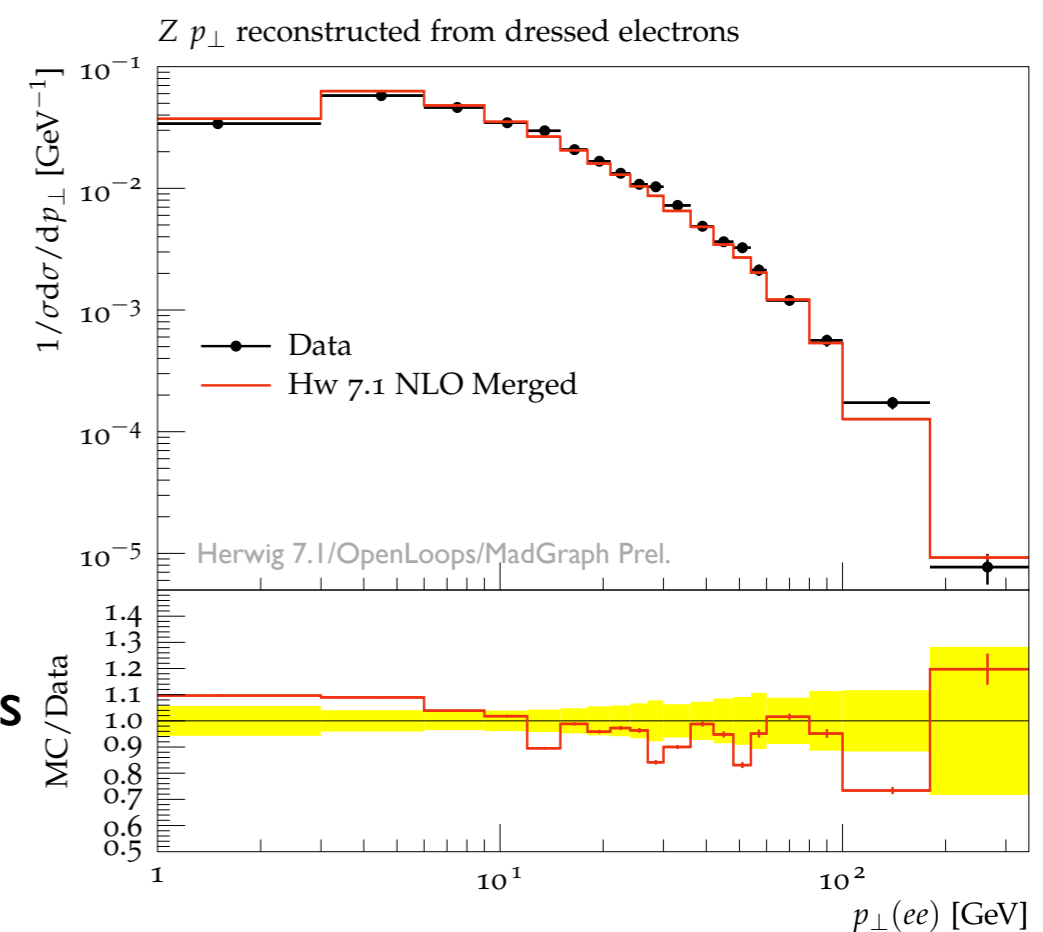
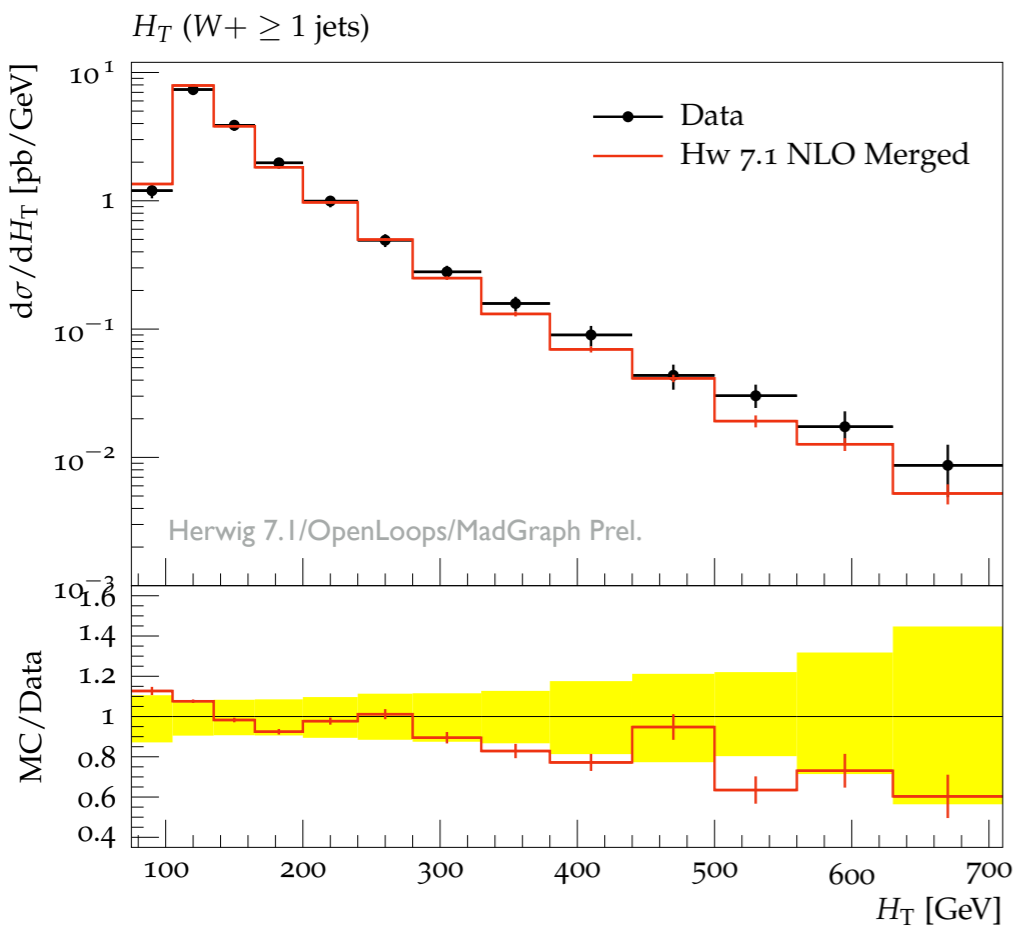
Well described first emission for *all* distributions.

Multiple hard emissions well described.

Soft region well described

Full NLO merging automation

Based on *unitarised* merging procedure.

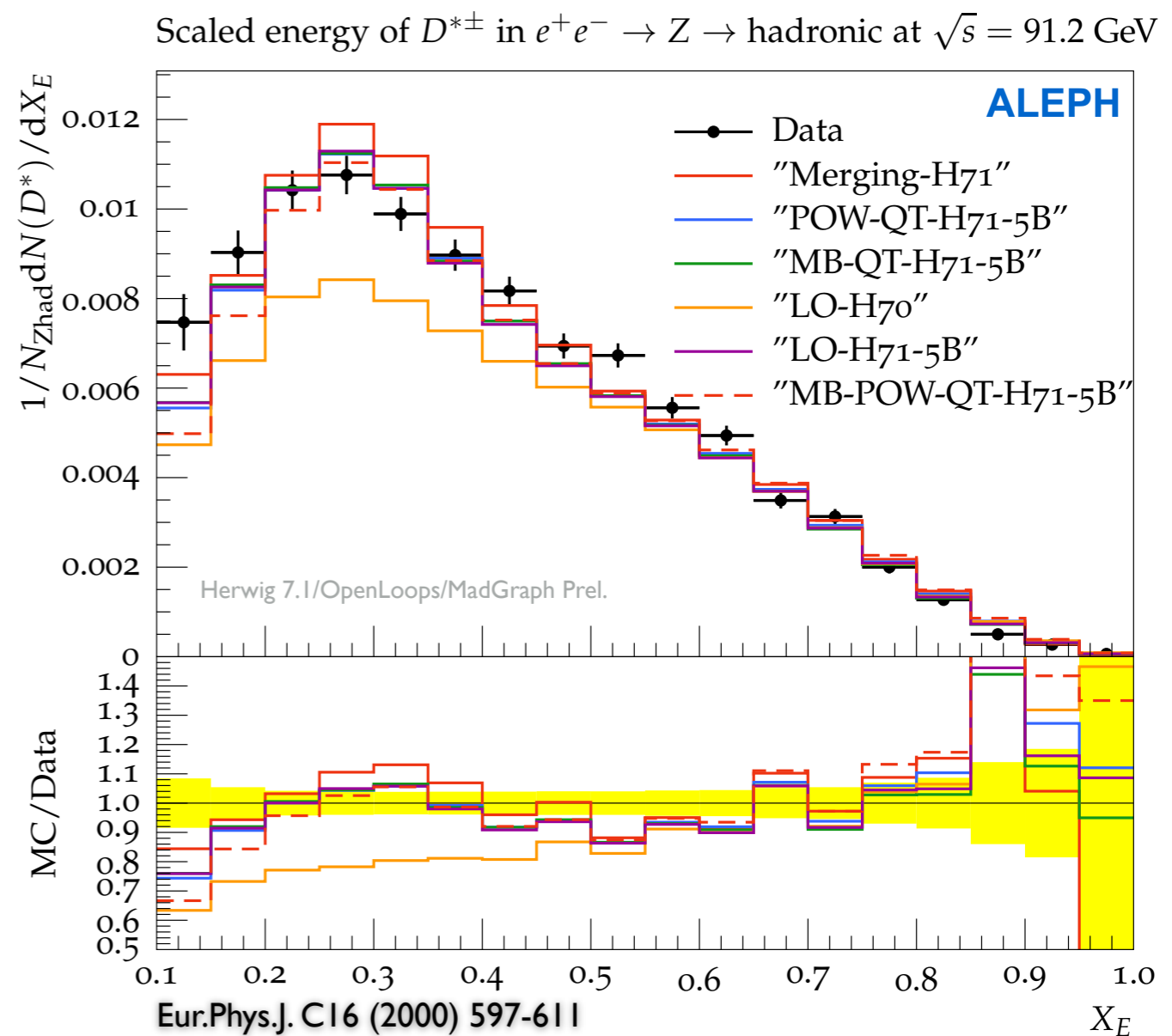


Herwig 7.1

EVTGen

New Soft Model
Improved Massive DS
NLO Merging with DS
KrkNLO Matching
New Tunes

P. Richardson



- B decays can be interfaced to be performed by EVTGen
- Communication of spin correlations in the decays
- Improving e.g. various fragmentation functions at LEP

Herwig 7.1

EVTGen

New Soft Model

Improved Massive DS

NLO Merging with DS

KrkNLO Matching

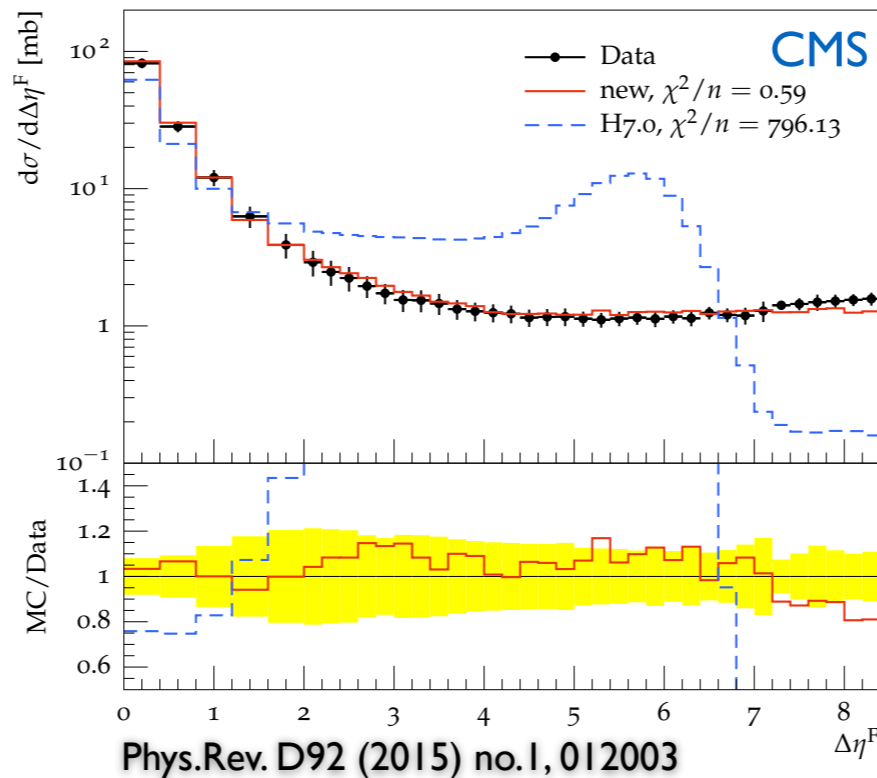
New Tunes

Eur.Phys.J. C77 (2017) no.3, 156

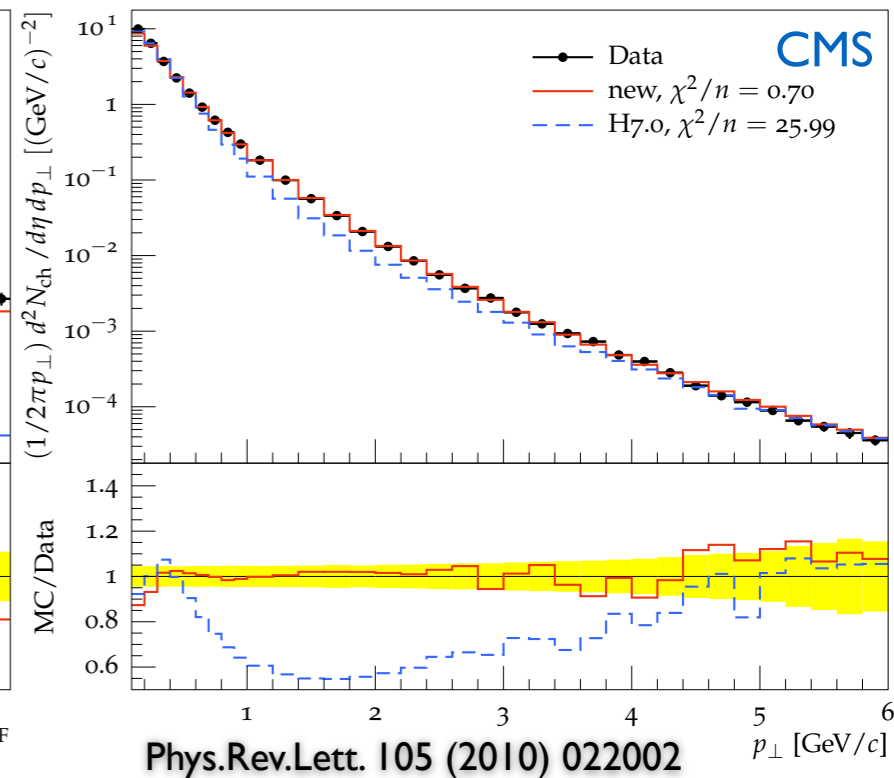
- Ladders produce partons flat in rapidity
- Adding SD and DD for Plateau
- Motivated by Regge Theory
- Tuned to MinBias data
- New default Model

See more details
in Patricks talk.

Rapidity gap size in η starting from $\eta = \pm 4.7$, $p_T > 200$ MeV

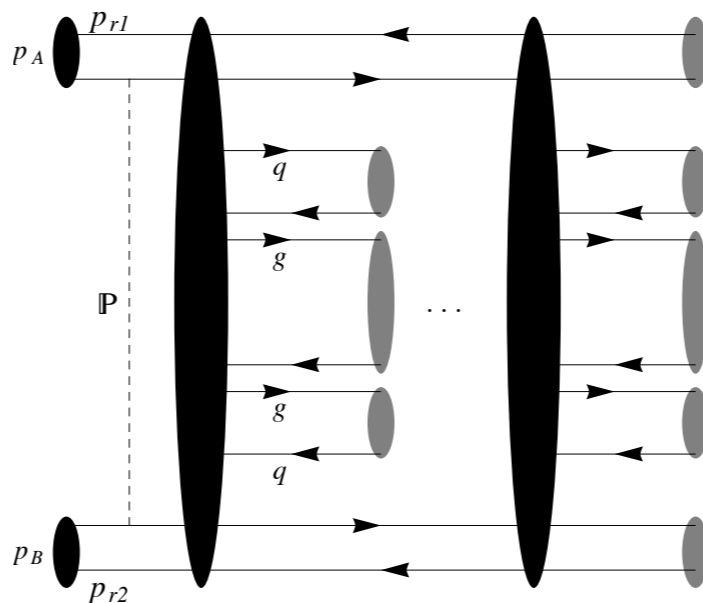
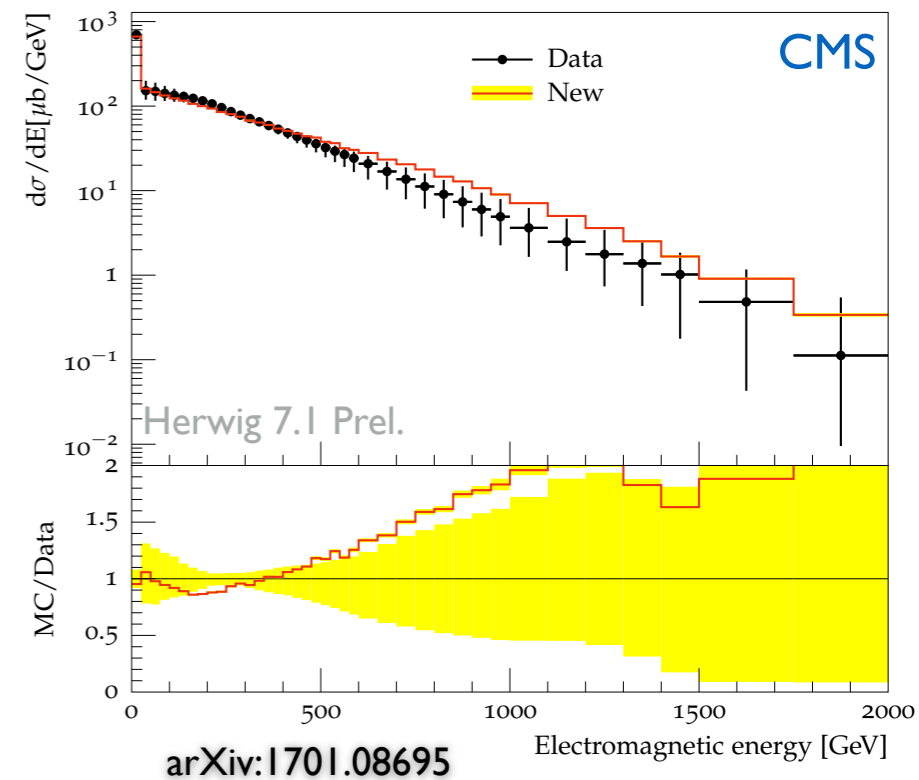


Charged hadron p_{\perp} for $|\eta| < 2.4$ at $\sqrt{s} = 7$ TeV



S. Gieseke, F. Loshaj, P. Kirchgaerber

CMS, 13 TeV, Electromagnetic energy spectrum ($-6.6 < \eta < -5.2$)



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EVTGen
New Soft Model

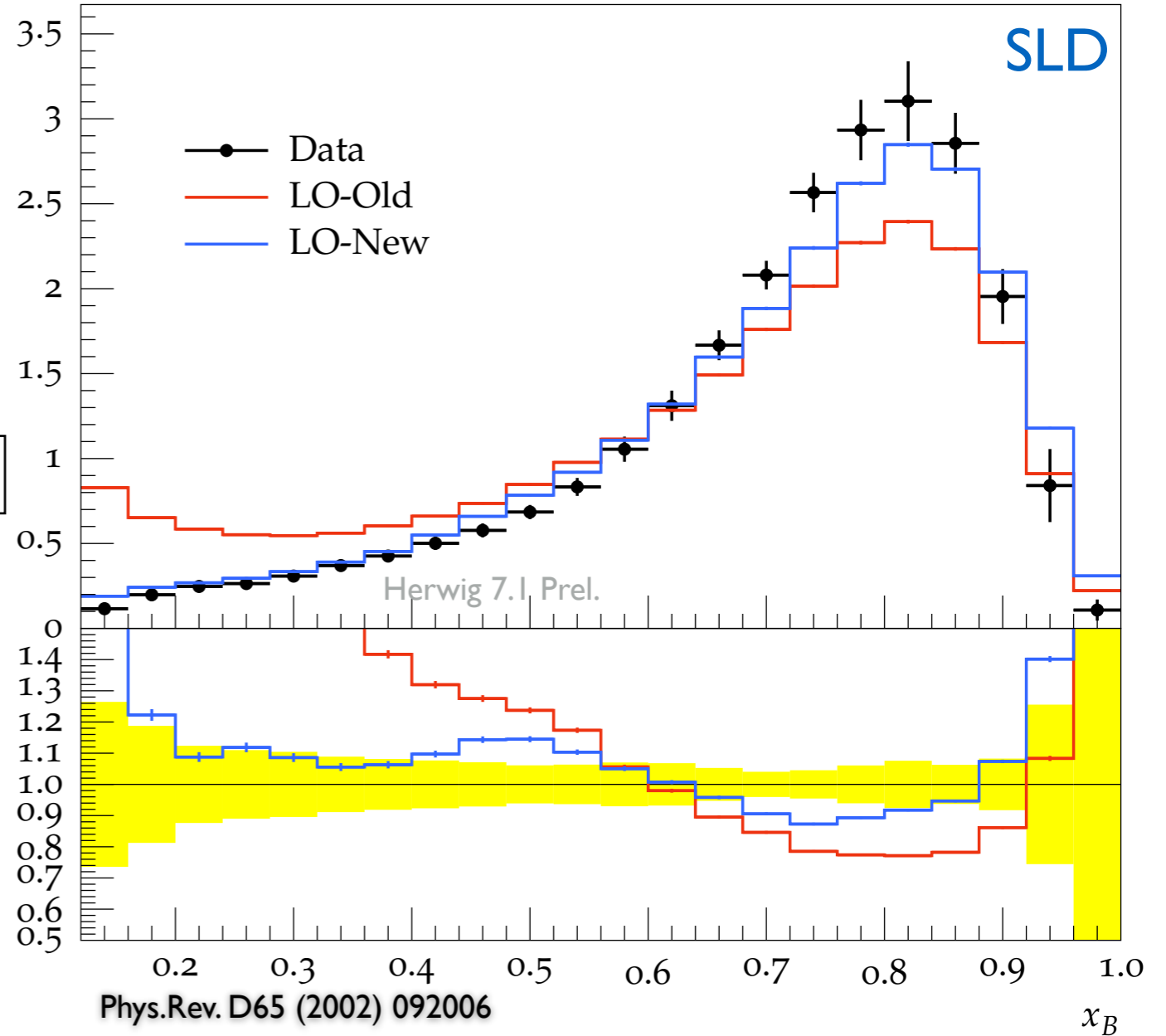
Improved Massive DS

NLO Merging with DS
KrkNLO Matching
New Tunes

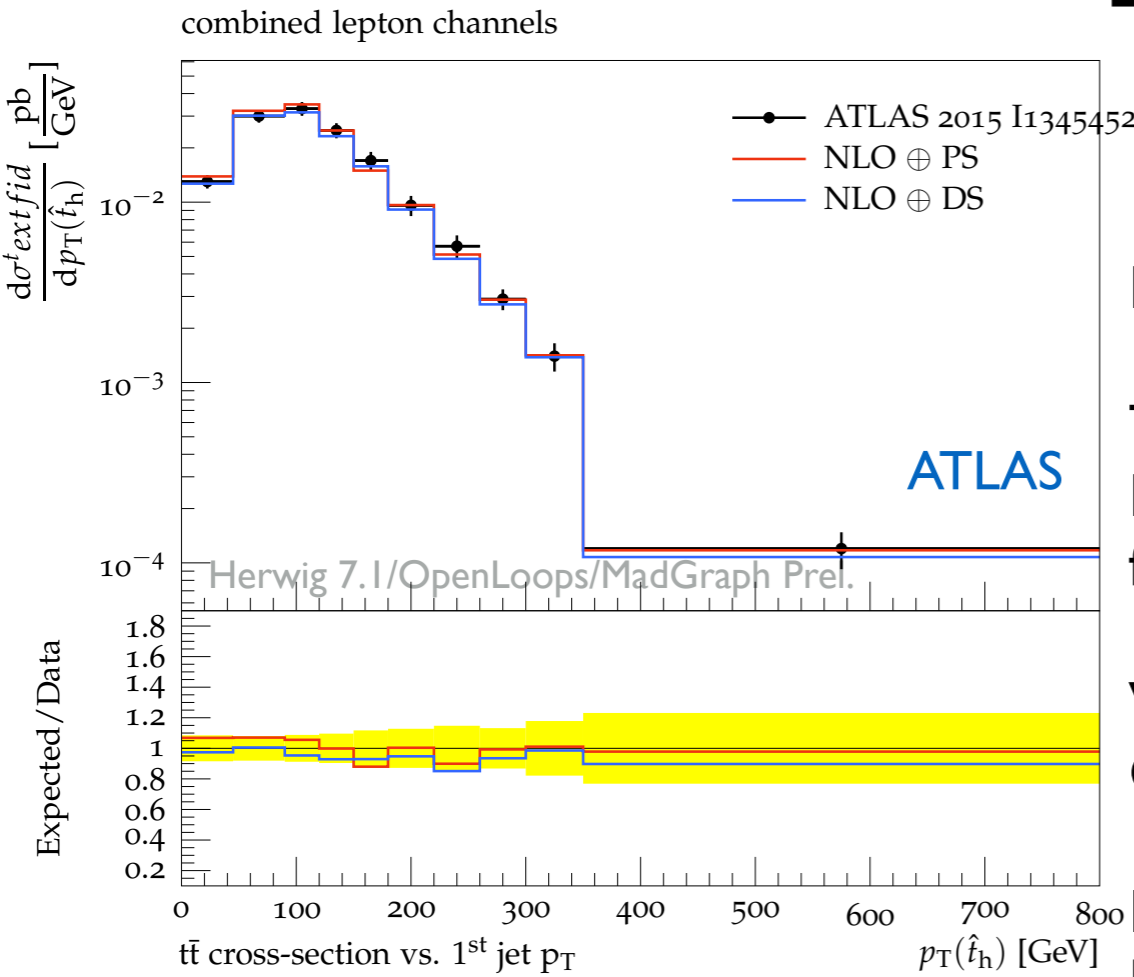
S. Plätzer, S. Webster

- Improvements to massive kinematics for Dipole Shower
- Heavily improved b-fragmentation
- Also revisited initial state emissions with heavy final state spectators

$1/N dN/dx_B$



Top studies



NNLO K Factor

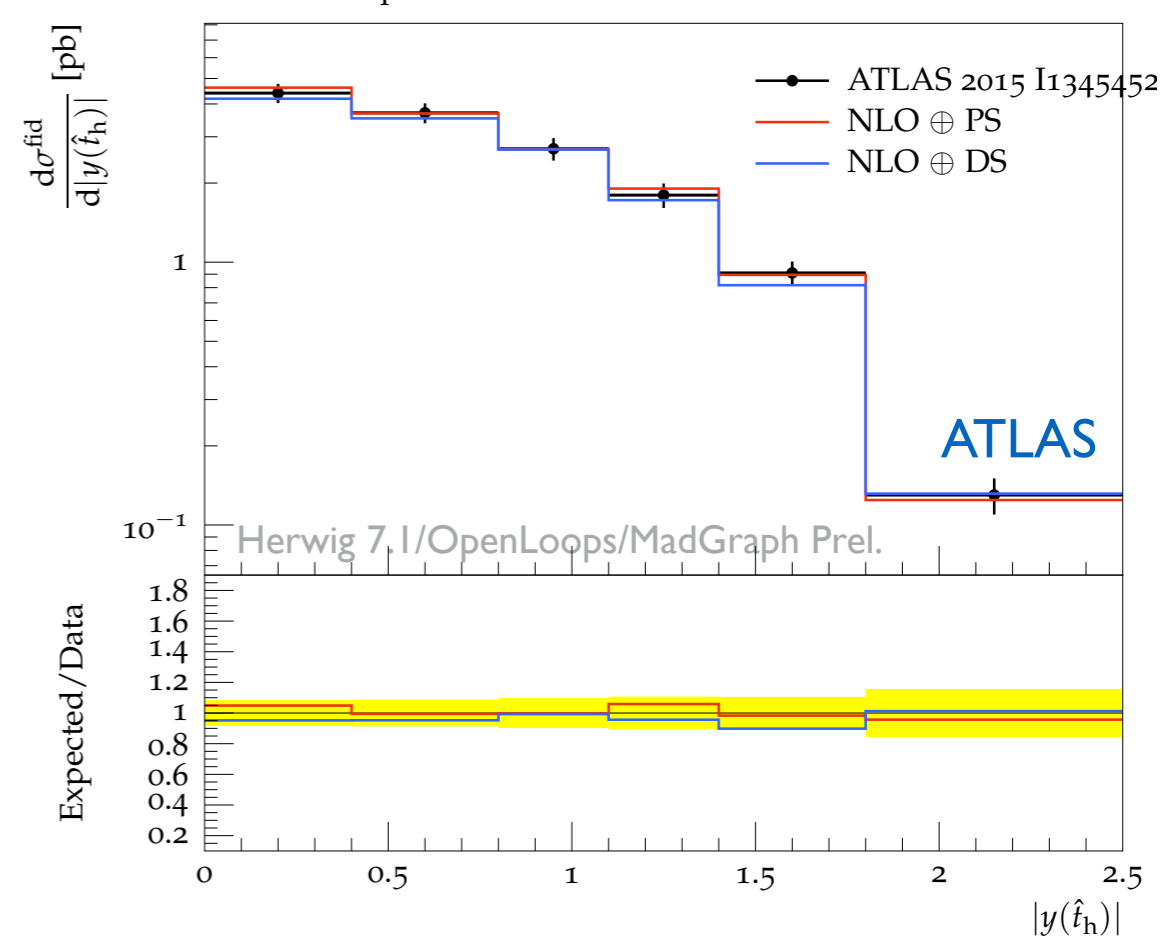
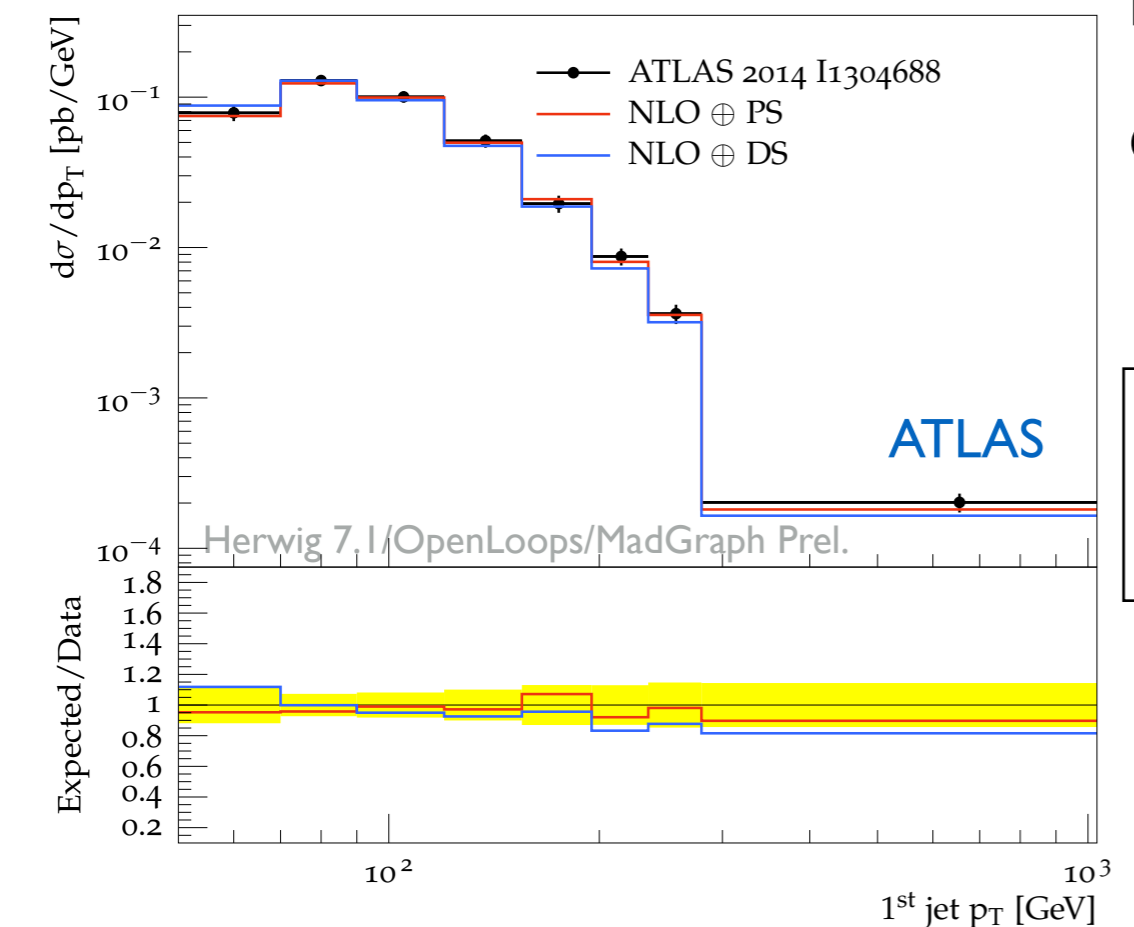
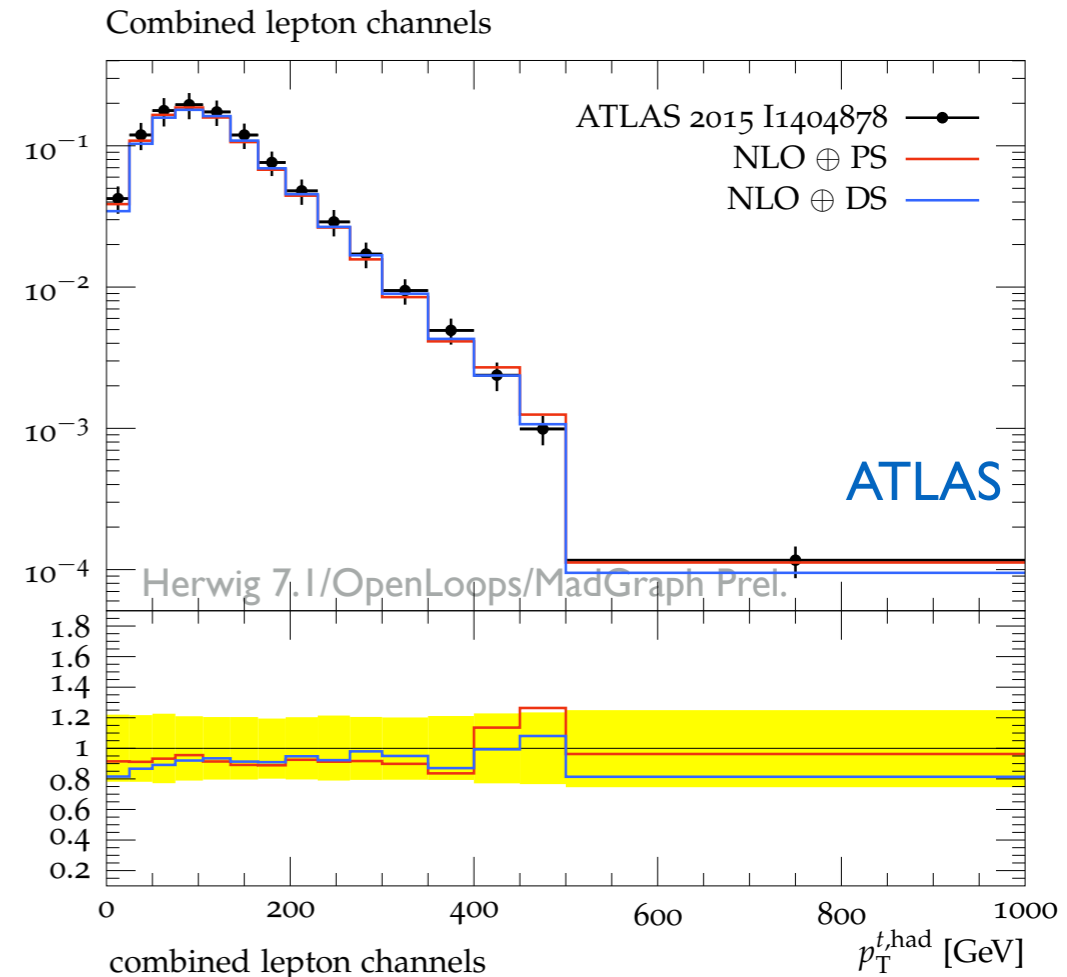
Top decays with NLO corrections for dipole shower

Various Scale Choices tested

Improved Kinematics

Ongoing studies

S. Plätzer,
P. Richardson,
S. Webster



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EVTGen

New Soft Model

Improved Massive DS

NLO Merging with DS

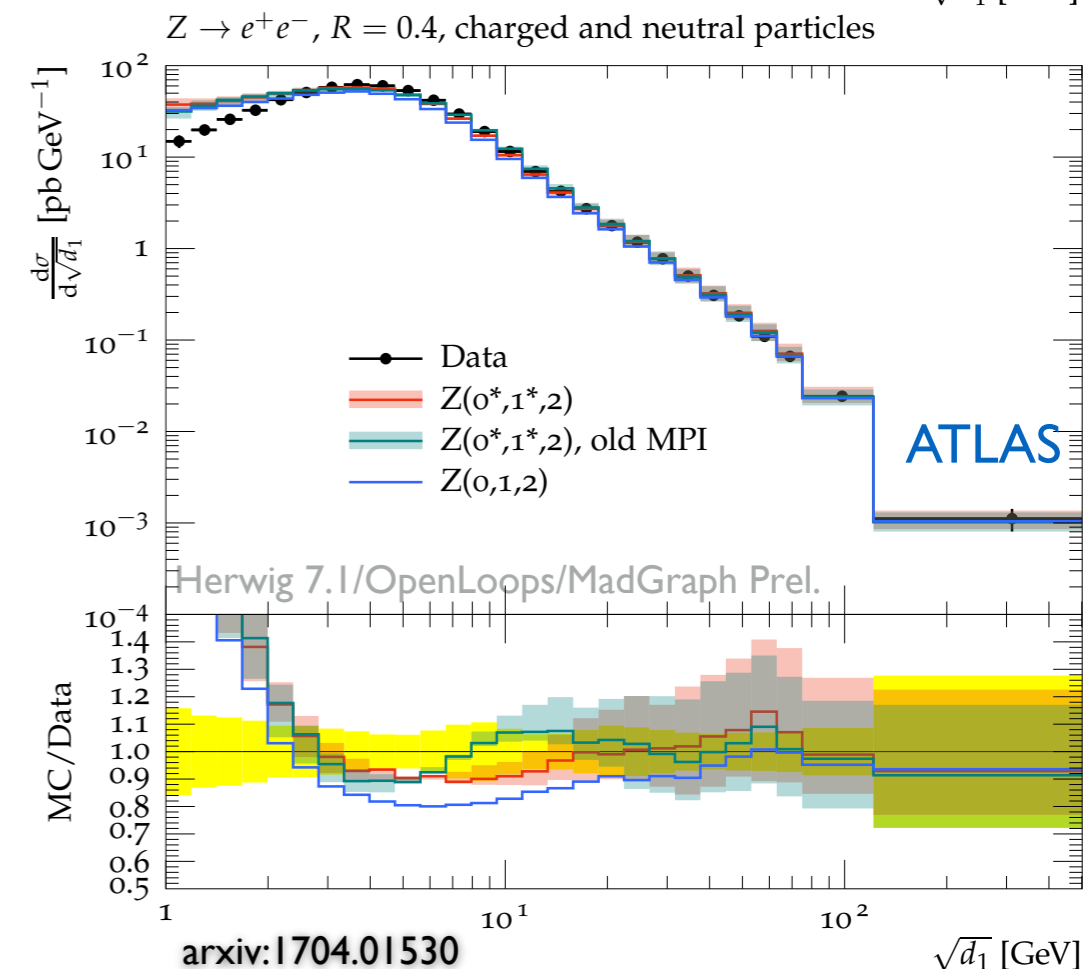
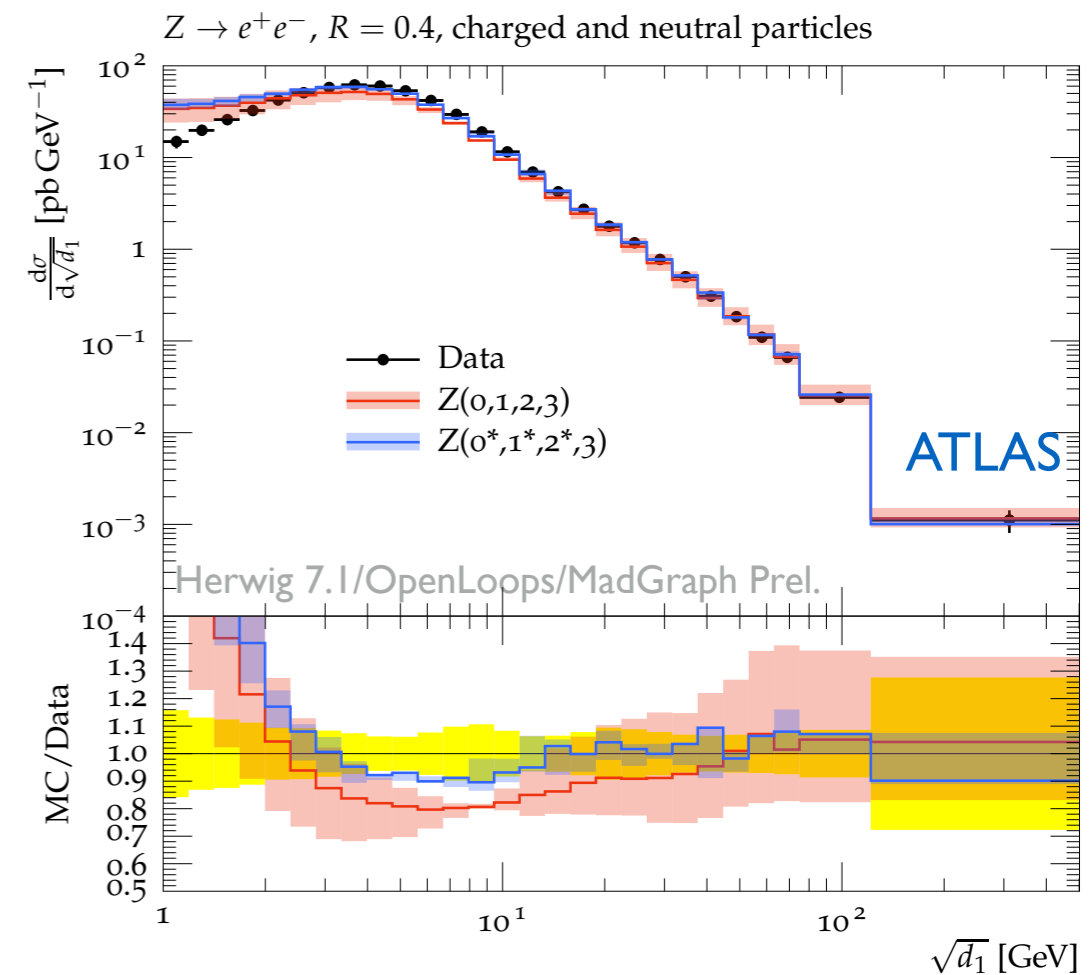
KrkNLO Matching

New Tunes

JB, S. Gieseke, S. Plätzer

- Based on unitised merging idea
- Not fully unitarised
- Various schemes to estimate uncertainties
- Simple input file structure:
do MF:Process p p -> e+ e- [j j j]
do MF:NLOProcesses 3

See more details and data comparisons in talk on Thursday.



Herwig 7.1

Eur.Phys.J. C77 (2017) no.3, 164

EVTGen

New Soft Model

Improved Massive DS

NLO Merging with DS

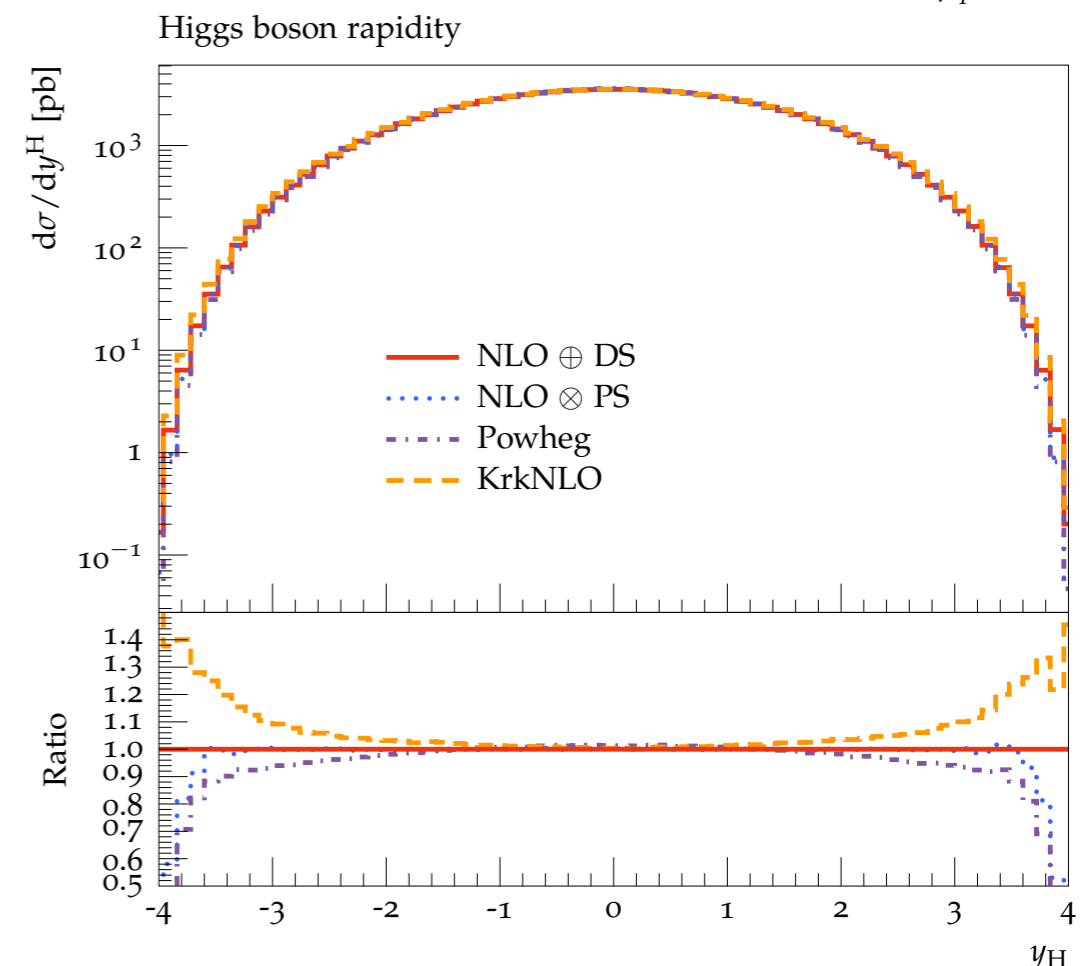
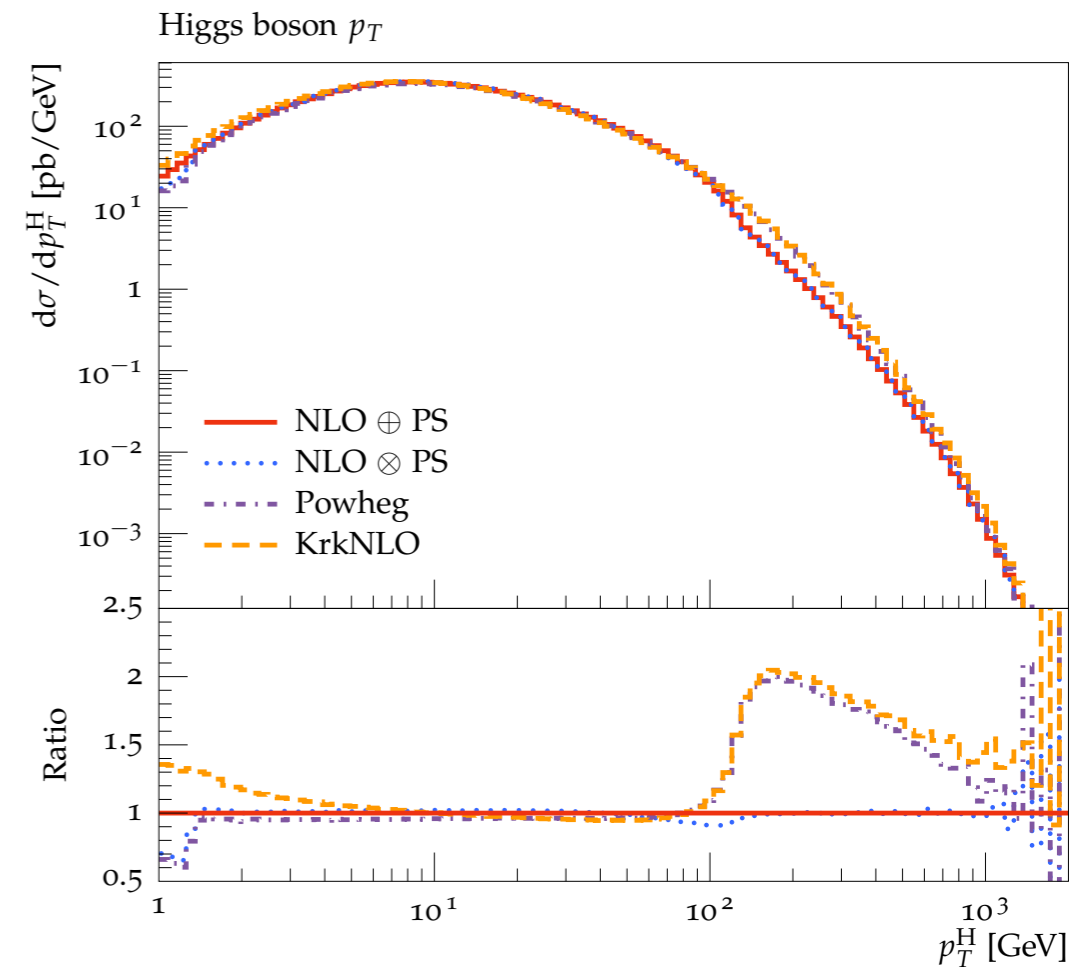
KrkNLO Matching

New Tunes

S. Jadach , G. Nail, W. Płaczek,
S. Sapeta, A. Siodmok, M. Skrzypek

- Introducing MC scheme for PDFs
- Redefine PDFs
- Idea close to what CMW is for α_S , here for PDFs
- Currently limited to Drell-Yan like processes
- No kink at the hard shower scale

<https://krknlo.hepforge.org>

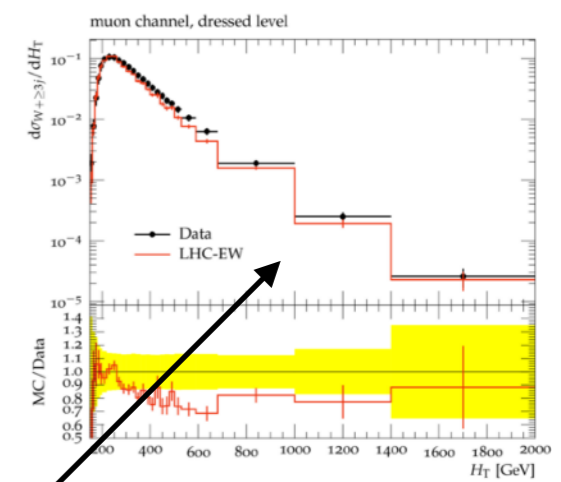
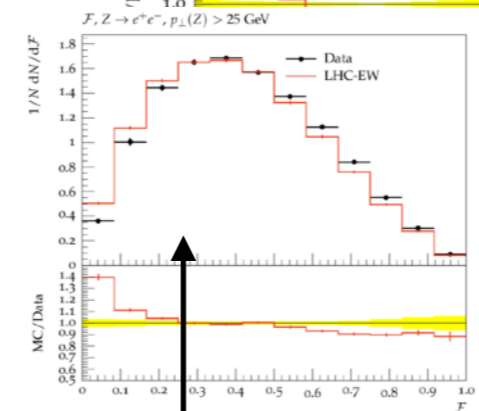
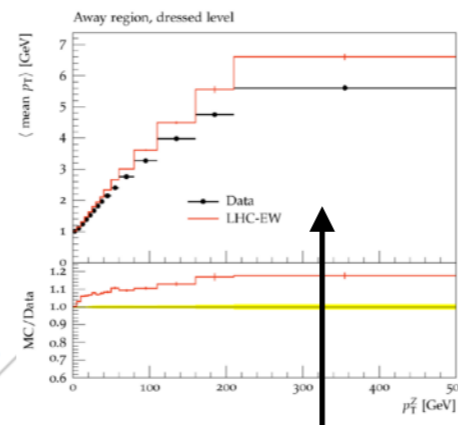
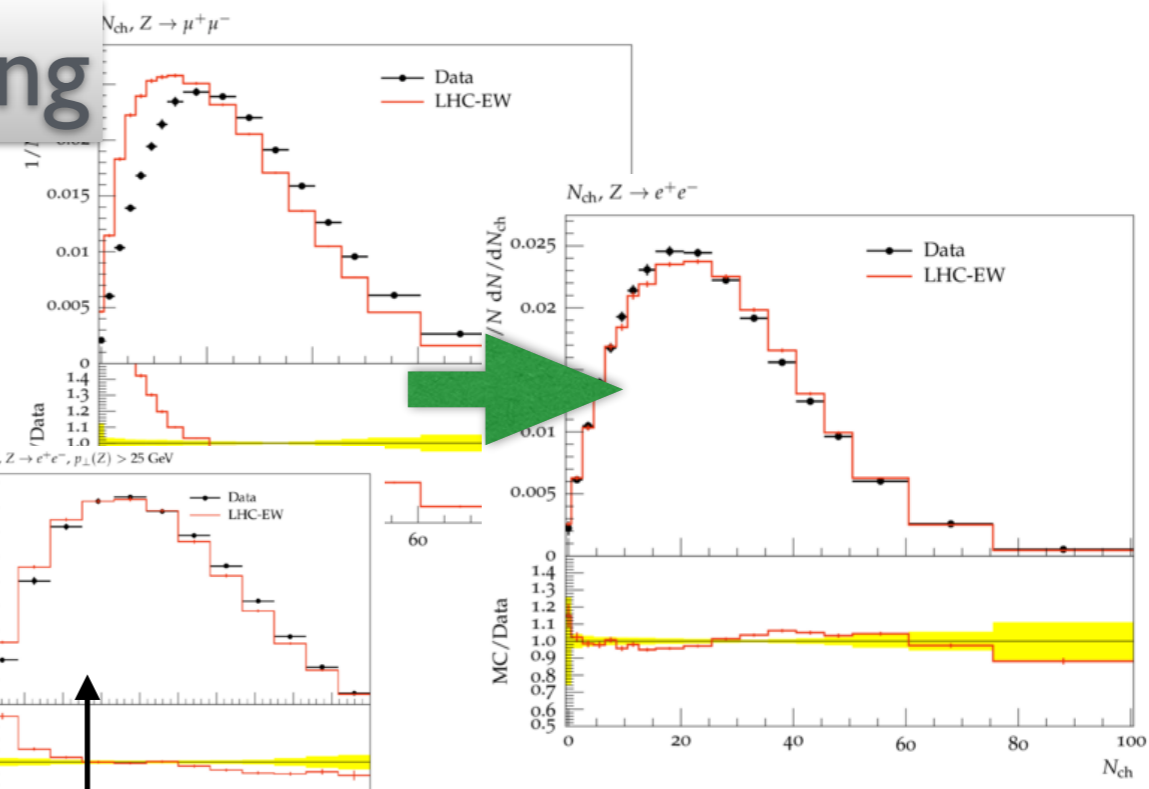


Herwig 7.1 - Release Status / Testing

Currently ~20000 observables

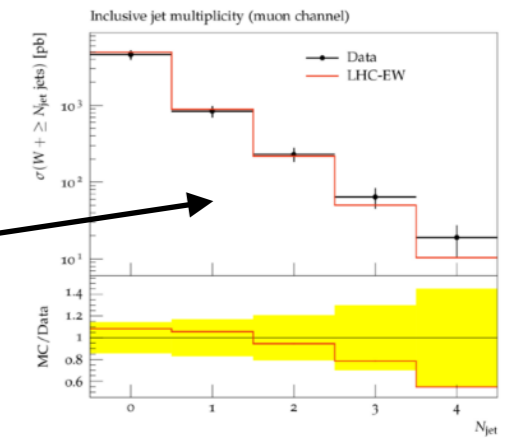
Need a way to structurally filter results.

JB, S.Webster,
P.Richardson



	Revisions	BFactory	TVT-Photon	LHC-EW	LHC-Photon	DIS-NoME	LHC-Jets	LEP	SppS	TVT-WZ	TVT-Jets	DIS
Merging-H71-cormPI-RES	---	---	0.11	---	---	0.35	---	---	---	---	---	---
MB-QT-H71-5B-RES	---	---	1.66	---	---	0.41	0.71	---	---	0.57	5.38	---
POW-QT-H71-OB-RES	---	---	---	---	---	0.76	---	---	1.48	---	1.37	---
MB-POW-QT-H71-OB-RES	---	---	---	---	---	1.04	---	---	---	---	3.40	---
LO-H71-OB-RES	0.84	0.87	1.33	0.81	0.86	0.82	0.80	0.67	1.83	0.76	1.43	---
POW-QT-H71-5B-RES	---	---	2.07	---	---	0.57	0.71	---	0.72	0.53	1.13	---
MB-QT-H71-OB-RES	---	---	---	---	---	0.82	---	---	---	---	3.57	---
LO-H70-RES	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LO-H71-5B-RES	0.99	0.87	1.11	0.80	1.22	0.85	0.69	0.68	0.94	0.86	1.25	---
MB-POW-QT-H71-5B-RES	---	---	2.07	---	---	0.57	1.04	---	0.81	0.53	5.77	---
Merging-H71-RES	---	---	0.16	---	---	0.35	0.94	---	0.67	0.89	2.14	---

$p_{\perp}^{\text{electron}}$ [e]	p_{\perp}^{muon} [e]	p_{\perp}^{jet}	jet multiplicity	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}	N_{jet}
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1



Summary and Outlook

◆ close to release

◆ successive improvements

◆ well described Z/W/Tops/jets physics

◆ New soft model

◆ Extensive testing

Thank You!