



PROMPT PHOTONS IN DIFFRACTIVE PHOTOPRODUCTION (status report)

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Goals

- Generate and funnel the Herwig MC samples with usual photoproduction processes for HERA1 period.
- Compare the 4-momentum and η distributions of Herwig and Pythia simulations on hadron and detector levels.

Data samples and event selection

■ photoproduction MC (nondiffractive signal) 9899e, 9900p, 0405e, 06e, 0607p.

1. *Pythia, v08b, prompt photon in php, direct+resolved*
2. *Herwig, v08b, prompt photon in php, direct+resolved*

True level selection

Event selection

$$0.2 < y < 0.7$$

$$Q^2 < 1 \text{ GeV}^2$$

Prompt photon selection

$$\text{Fmck_prt}[] = 29$$

$$-0.7 < \eta < 0.9$$

$$5 < E_t < 15 \text{ GeV}$$

$$E_{\text{particle}} / E_{\text{jet}} > 0.9$$

Hadronic jet selection

$$4 < E_t \text{ jet} < 35 \text{ GeV}$$

$$-1.5 < \eta \text{ jet} < 1.8$$

Diffractive event selection

$$\eta_{\text{max}} < 2.5 \text{ for } E_{\text{particle}} > 0.4 \text{ GeV}$$

$$X_p < 0.03$$

Detector level selection

Event selection

Trigger HPP16 on

$$|Z_{\text{vtx}}| < 40 \text{ cm}$$

$$|\text{BCAL time}| < 10 \text{ ns}$$

$$\text{Cal_pt} < 10$$

$$0.2 < Y_{\text{jb}} < 0.7$$

No SINISTRA electron with
 $\text{prob} > 0.9$ and $Y_{\text{el}} < 0.7$

Prompt photon selection

$$\text{Tufo}[][0] = 31$$

$$-0.7 < \eta < 0.9$$

$$5 < E_t < 15 \text{ GeV}$$

$$E_{\text{zufo}} / E_{\text{jet}} > 0.9$$

$$Z_{\text{ufoemc}} / Z_{\text{ufoecal}} > 0.9$$

track isolation in cone 0.2

Hadronic jet selection

$$4 < E_t \text{ jet} < 35 \text{ GeV}$$

$$-1.5 < \eta \text{ jet} < 1.8$$

Diffractive event selection

$$\eta_{\text{max}} < 2.5 \text{ for } E_{\text{zufo}} > 0.4 \text{ GeV}$$

$$X_p < 0.03$$

$$E_{\text{FPC}} < 1 \text{ GeV (in HERA1 case)}$$

Procedures of generation and funneling of Herwig MC samples

(due to great help of Andrii Verbytskyi)

1. The samples are generated with Herwig v6.5. The corresponding executable can be found at: [/afs/desy.de/group/zeus.zsmm/ZEUSysSoft/Released/Support/MonteCarlo/Generators/amadeus/v2010a/exe](#) or at <https://wwwzeus.mpp.mpg.de/dphep.html>.
2. The generation is done on DESY SL6 machine (any other real or virtual SL6/SL7 machine should work as well). Unique random number seeds are used for each Herwig run.
3. The outputs are renamed according to the FUNNEL naming rules: <http://zeusdp.desy.de/components/funnel/cgi-bin/formmaker.cgi> and copied to MPCDF (former RZG) storage.
4. Funneling is performed with standalone MC package on Grid (virtual machines can also be used). See details at <https://wwwzeus.mpp.mpg.de/dphep.html>.

The information about new Herwig MC samples

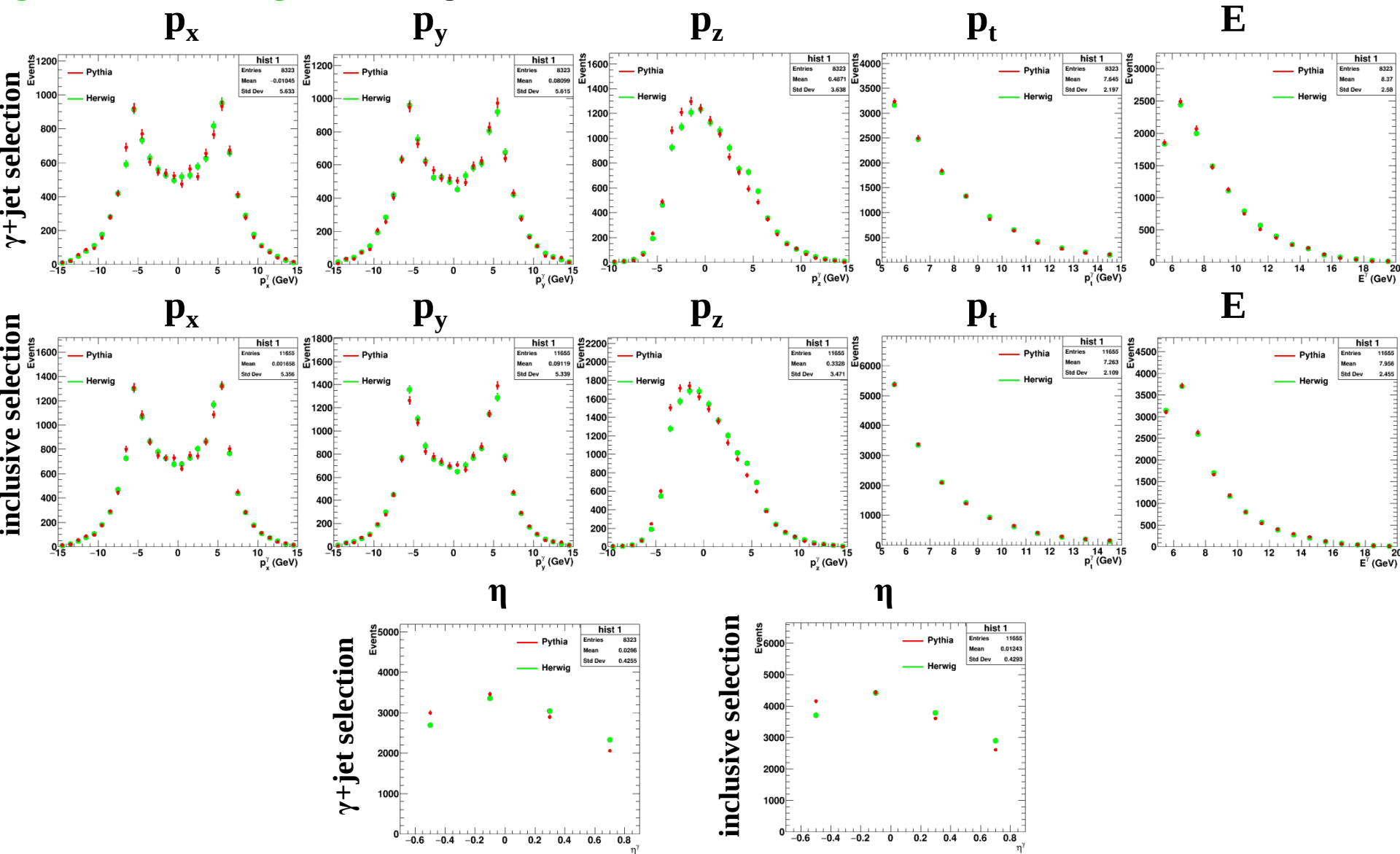
http://www.desy.de/~shyrma/her_php_signal_hera1/index_her_php_hera1.html

Generator	HERWIG v6.510
Process	photoproduction
Description	The following constraints were imposed on the virtuality, inelasticity and transverse momentum: $0 < Q^2 < 4$ $0.1 < y < 1.0$ $P_t^2 > 2.5$
proton PDF	CTEQ4 LO
photon PDF	SASph (for resolved only)
direct sigma	227.4 pb
resolved sigma	262.1 pb
number of generated events for direct photoproduction	500k
number of generated events for resolved photoproduction	1000k
Trigger and funnel configuration (period)	8iq819 (98/99e), 8ir020 (99/00p)
events per job	5000

HERA1
Herwig vs Pythia
detector level
no diff. cuts

HERA1, photon η and 4-momentum distributions, detector level, no diff cuts

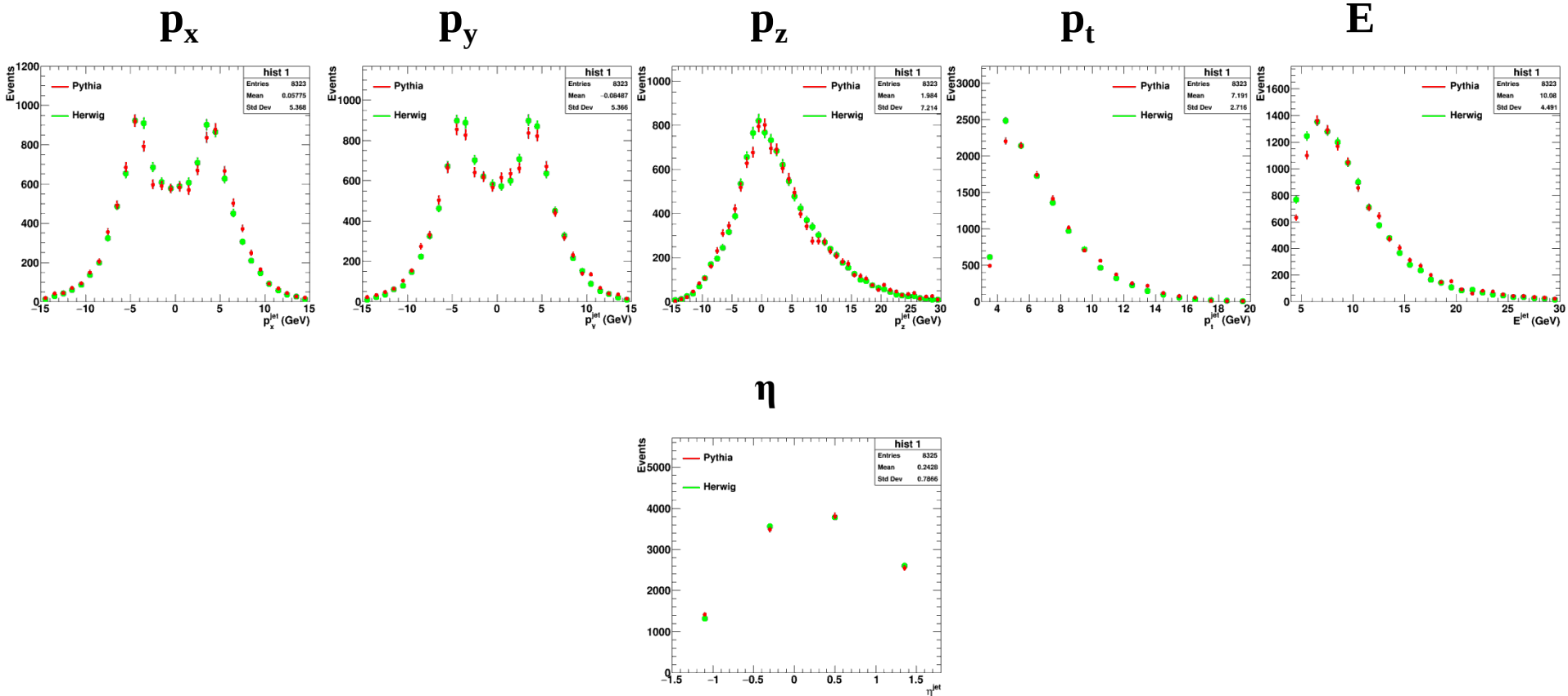
- red** – **Pythia** non-diff. signal, 50/50 sum;
green – **Herwig** non-diff. signal, 50/50 sum;



Herwig and Pythia have similar shapes.

HERAI, accompanying jet η and 4-momentum distributions, detector level, no diff cuts

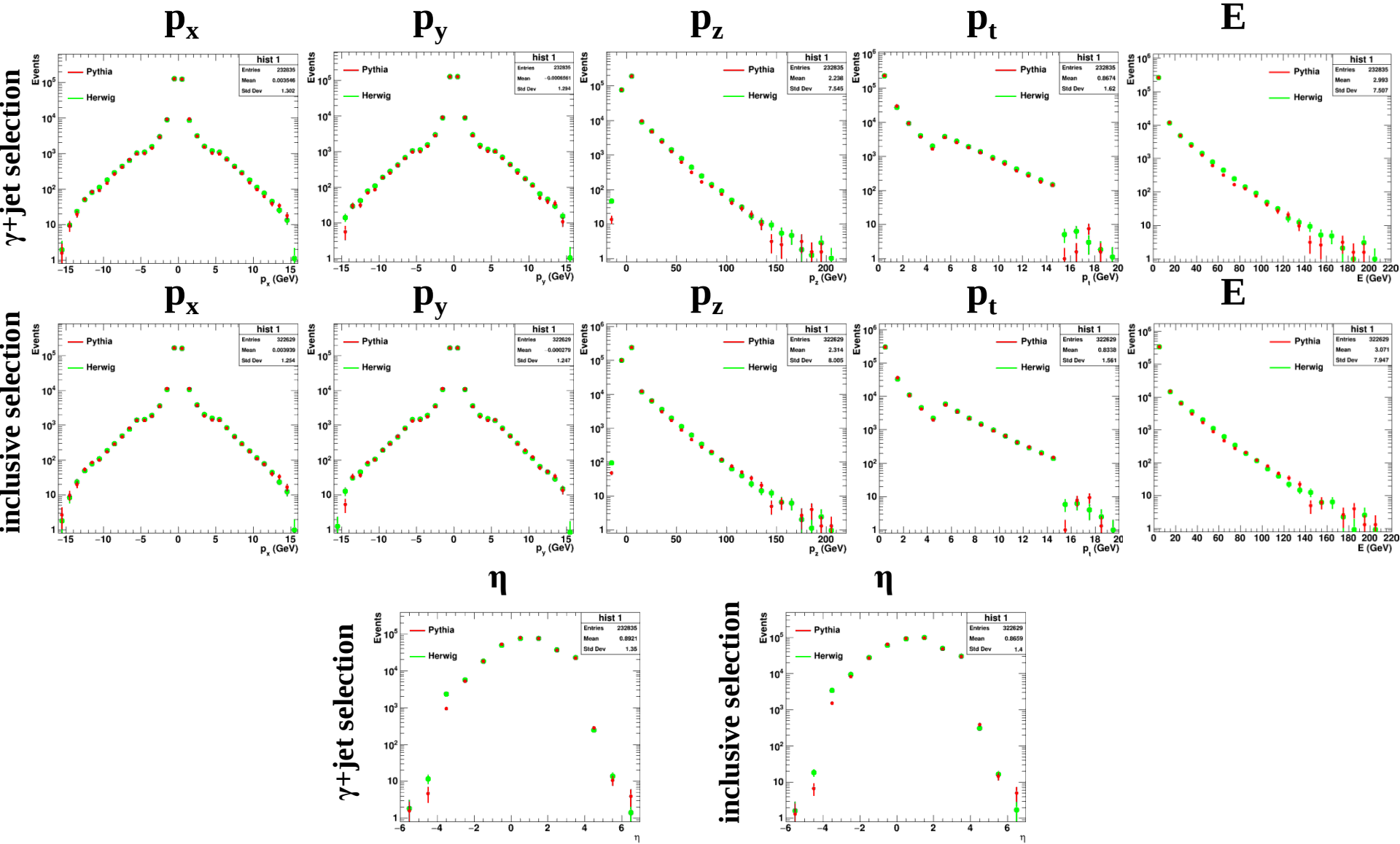
- red** – **Pythia** non-diff. signal, 50/50 sum;
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HERA1, all zufos η and 4-momentum distributions, detector level, no diff cuts

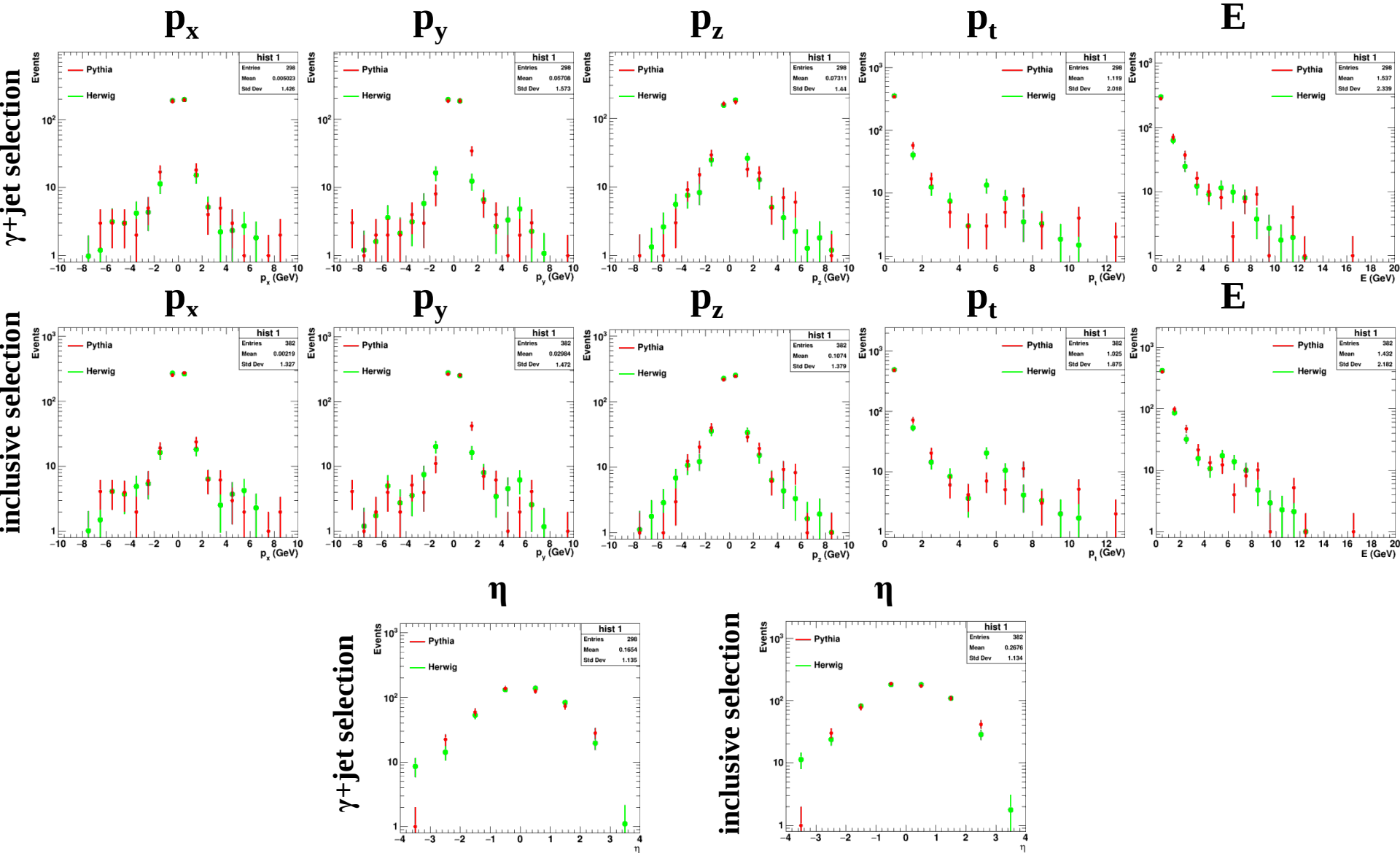
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HERA1
Herwig vs Pythia
detector level
 $\eta_{\text{max}} + X_{\text{p}} + E_{\text{FPC}}$ cuts

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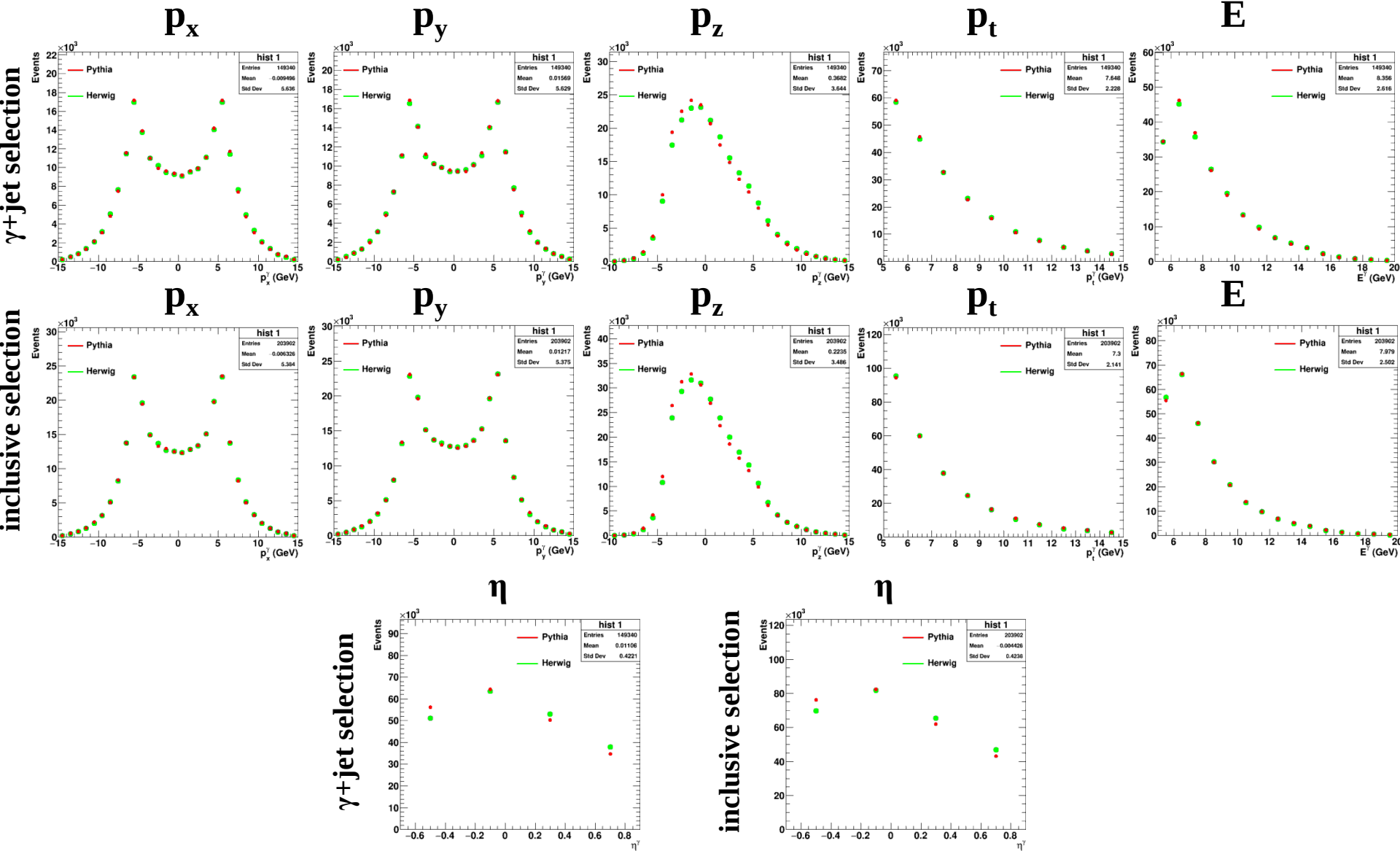


Herwig and Pythia have similar shapes.

HERA2
Herwig vs Pythia
detector level
no diff. cuts

HERA2, photon η and 4-momentum distributions, detector level, no diff cuts

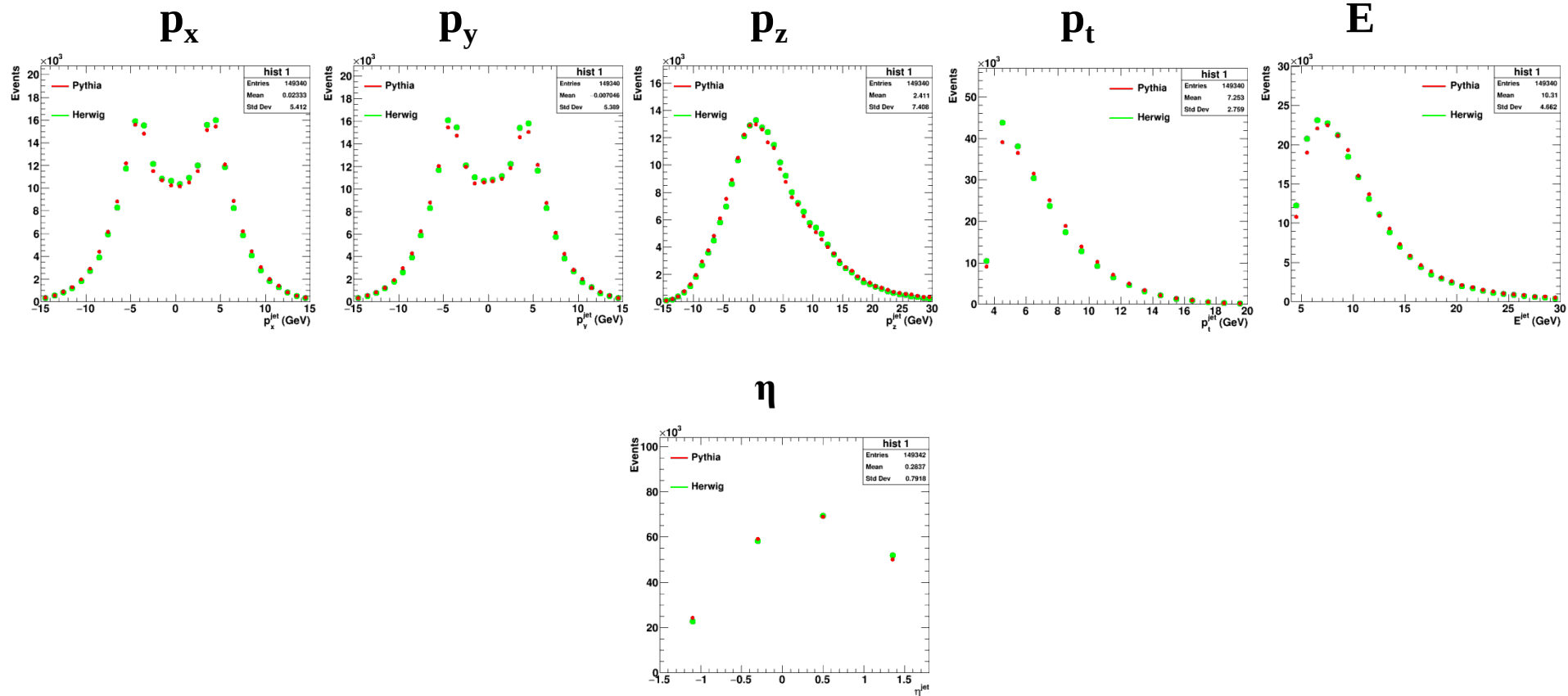
- red** – **Pythia** non-diff. signal, 50/50 sum;
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Herwig and Pythia have similar shapes.

HERA2, accompanying jet η and 4-momentum distributions, detector level, no diff cuts

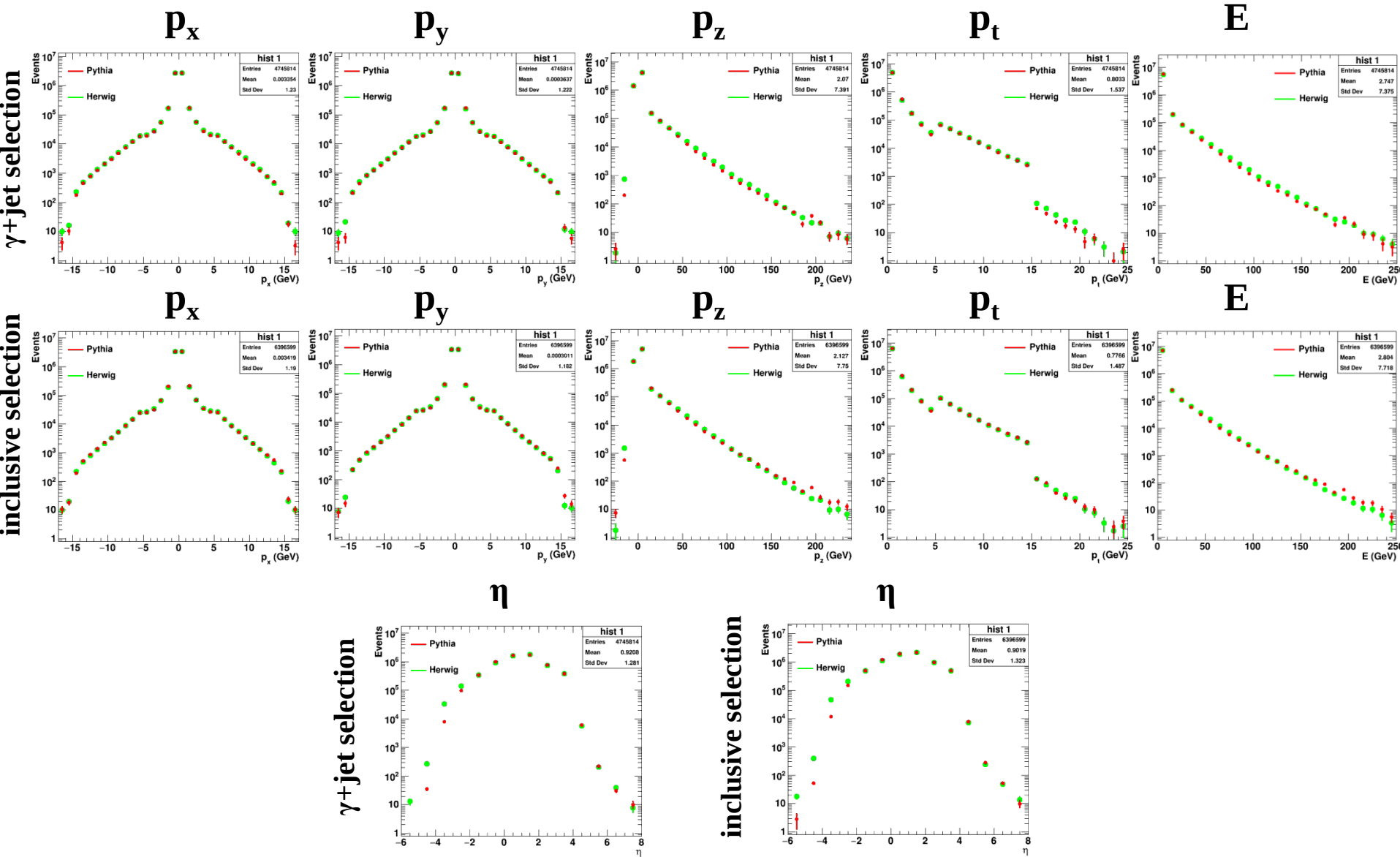
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HERA2, all zufos η and 4-momentum distributions, detector level, no diff cuts

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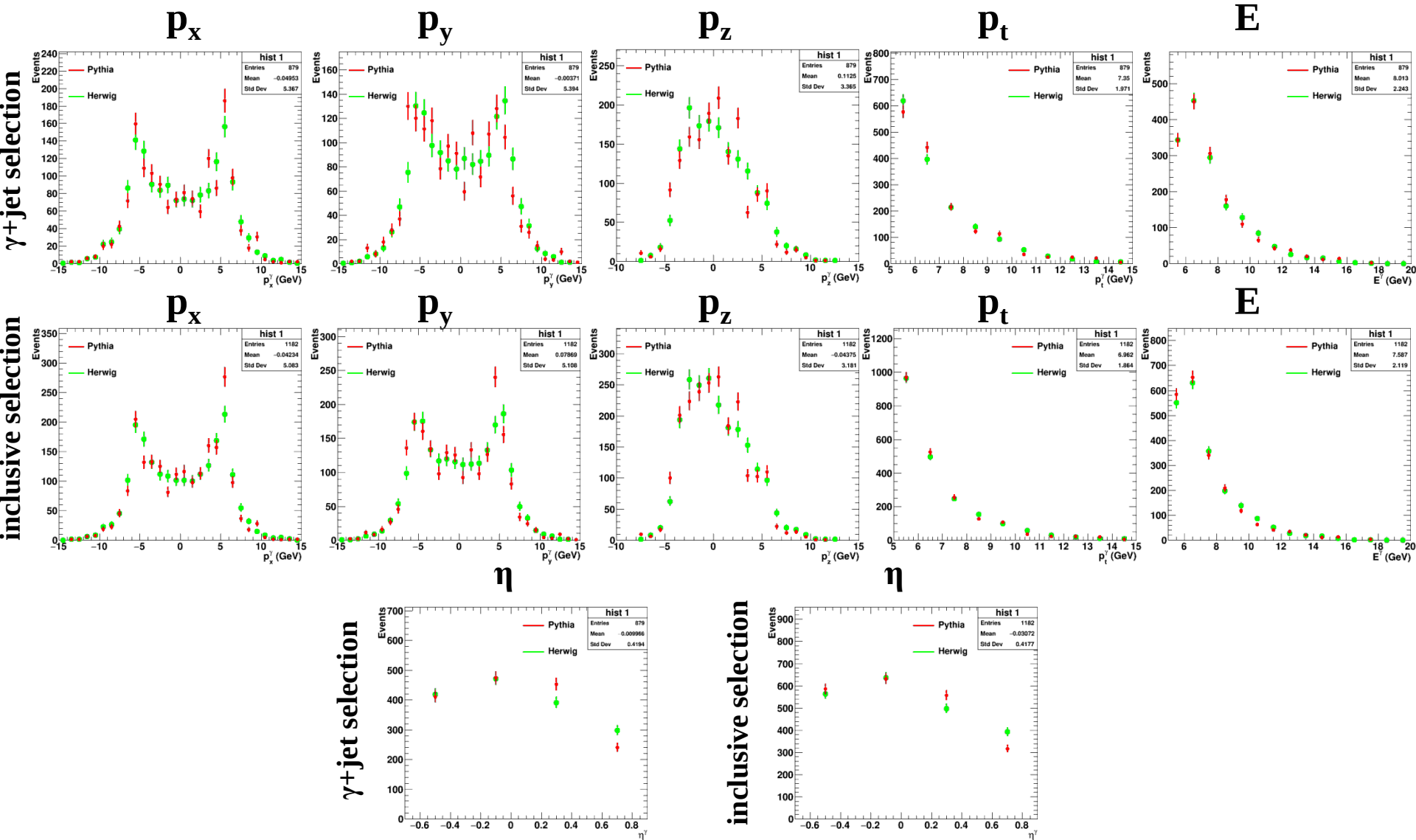


Herwig and Pythia have similar shapes.

HERA2
Herwig vs Pythia
detector level
 $\eta_{\text{max}} + X_p$ cuts

HERA2, photon η and 4-momentum distributions, detector level, $\eta_{\max} + Xp$ cuts

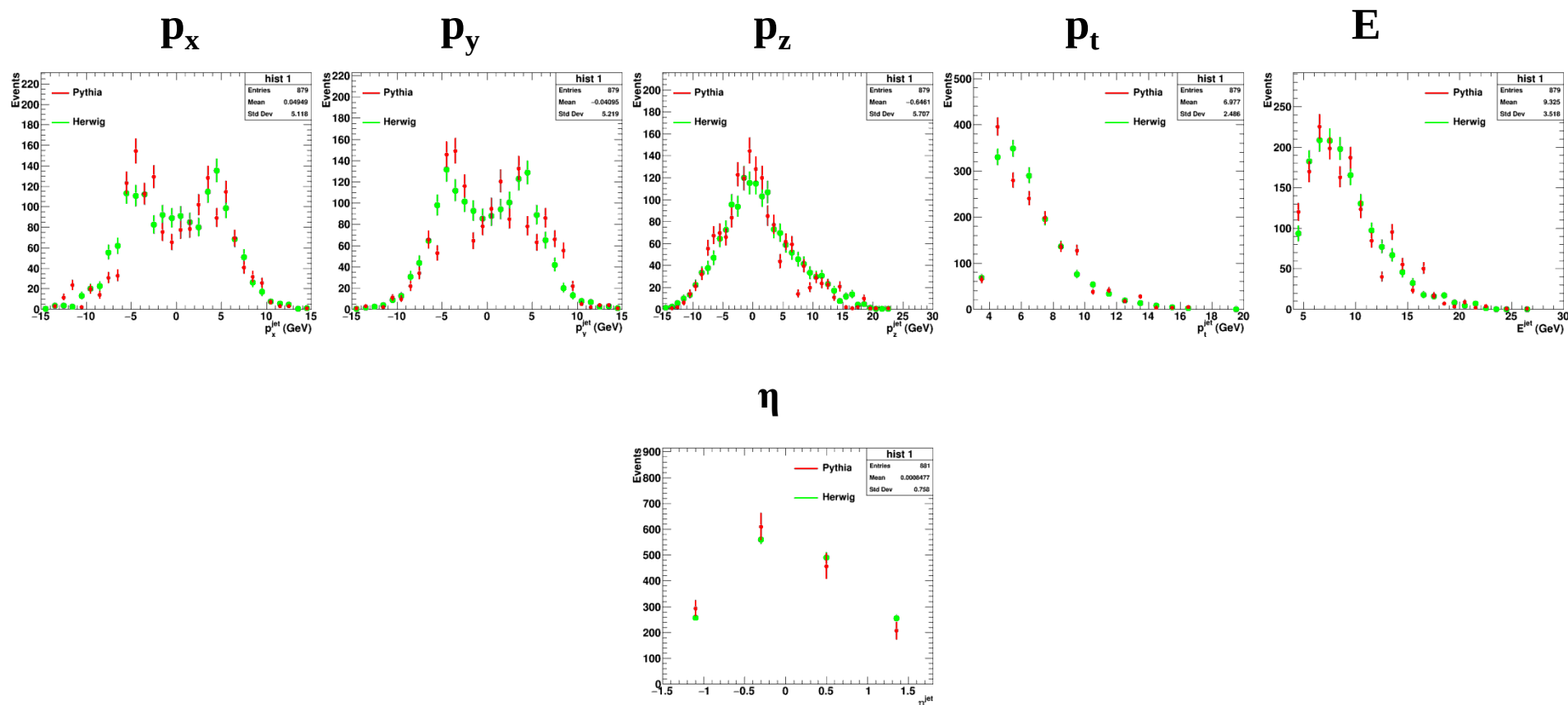
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HERA2, accompanying jet η and 4-momentum distributions, detector level, $\eta_{\max} + X_p$ cuts

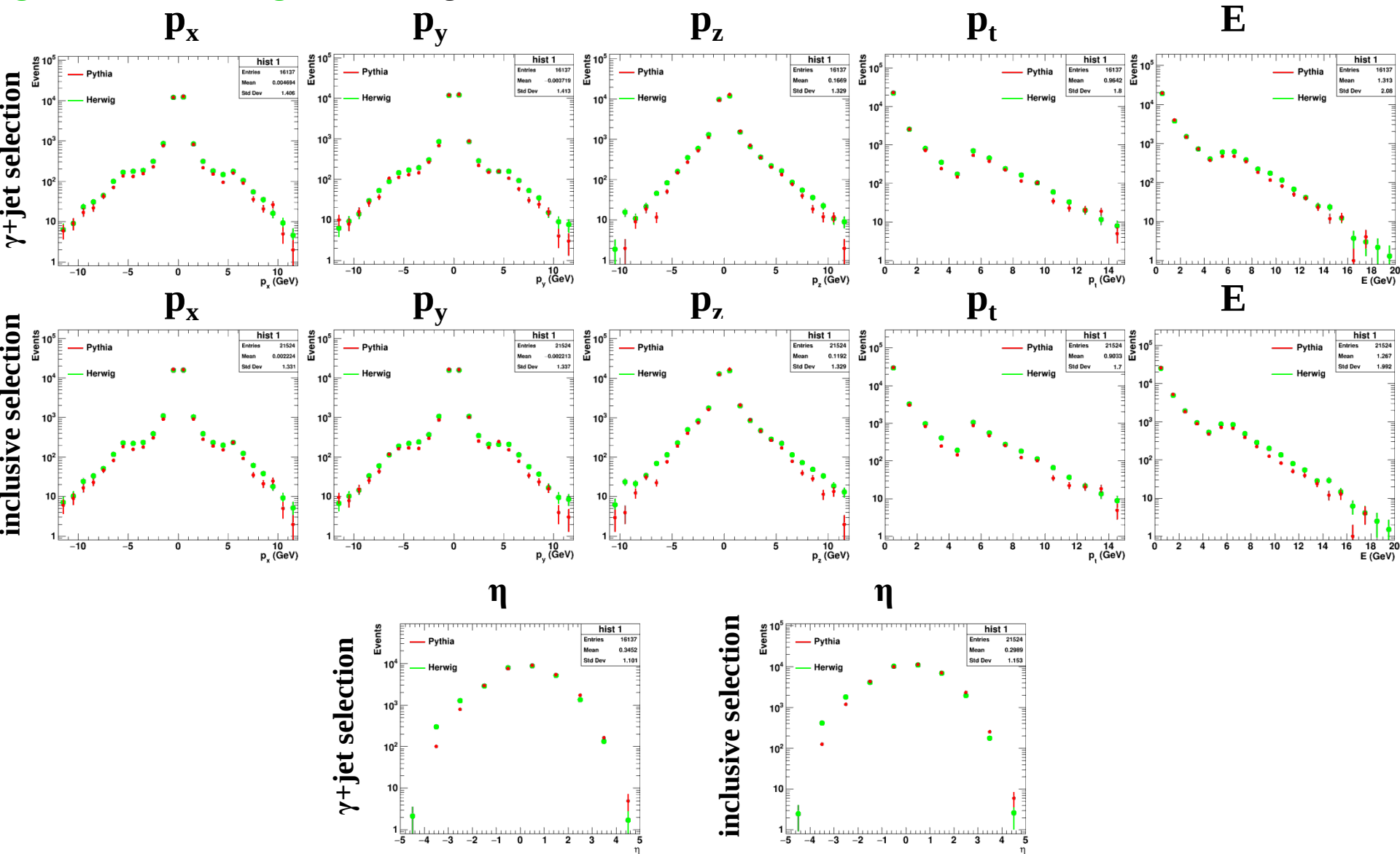
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Herwig and Pythia have similar shapes.

HERA2, all zufos η and 4-momentum distributions, detector level, $\eta_{\max} + Xp$ cuts

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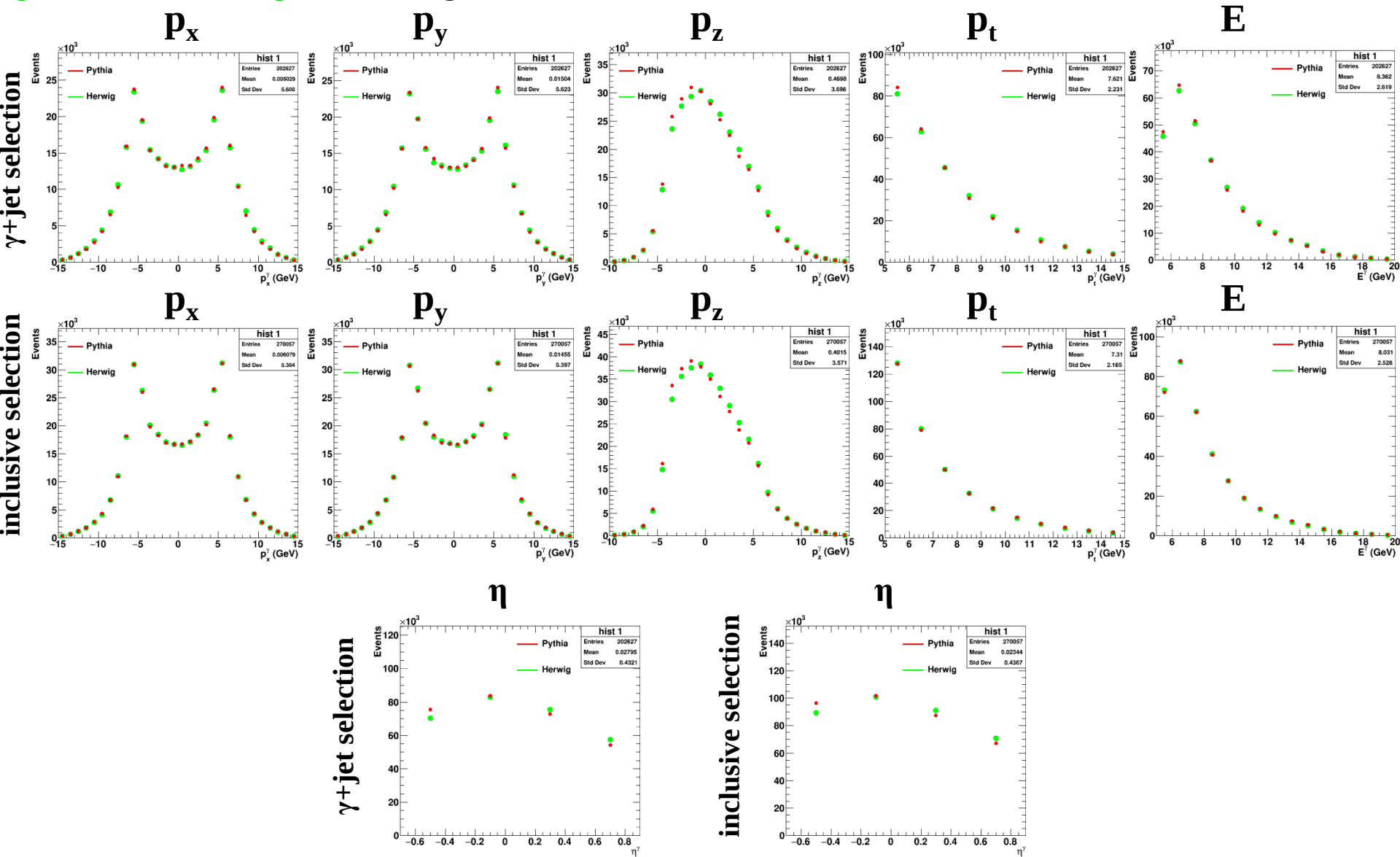


Herwig and Pythia have more or less similar shapes. Some discrepancies become to arise. **19**

HERA2
Herwig vs Pythia
hadron level
no diff. cuts

HERA2, photon (FMCKIN2) η and 4-momentum distributions, hadron level, no diff cuts

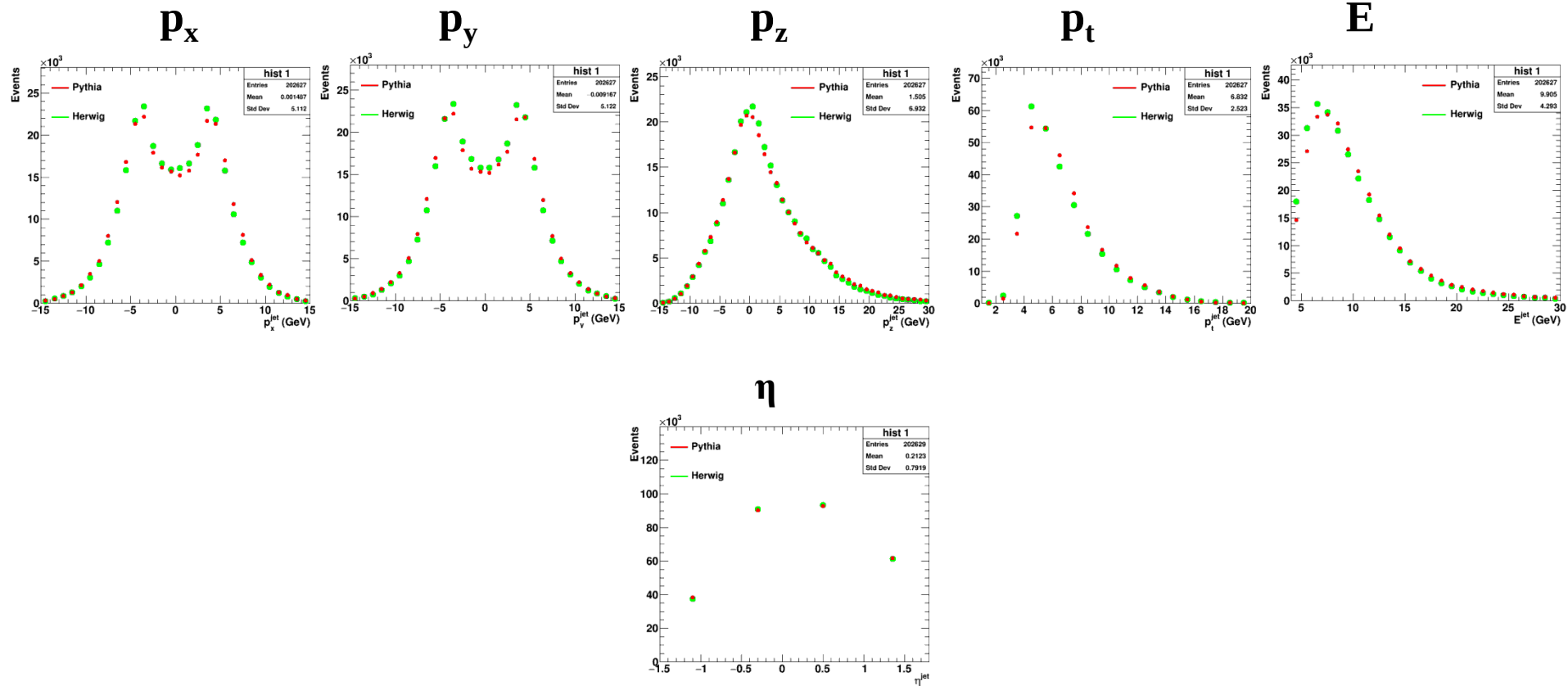
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green – **Herwig** non-diff. signal, 50/50 sum;



Herwig and Pythia have similar shapes.

HERA2, accompanying jet (FMCKIN2) η and 4-momentum distributions, hadron level, no diff cuts

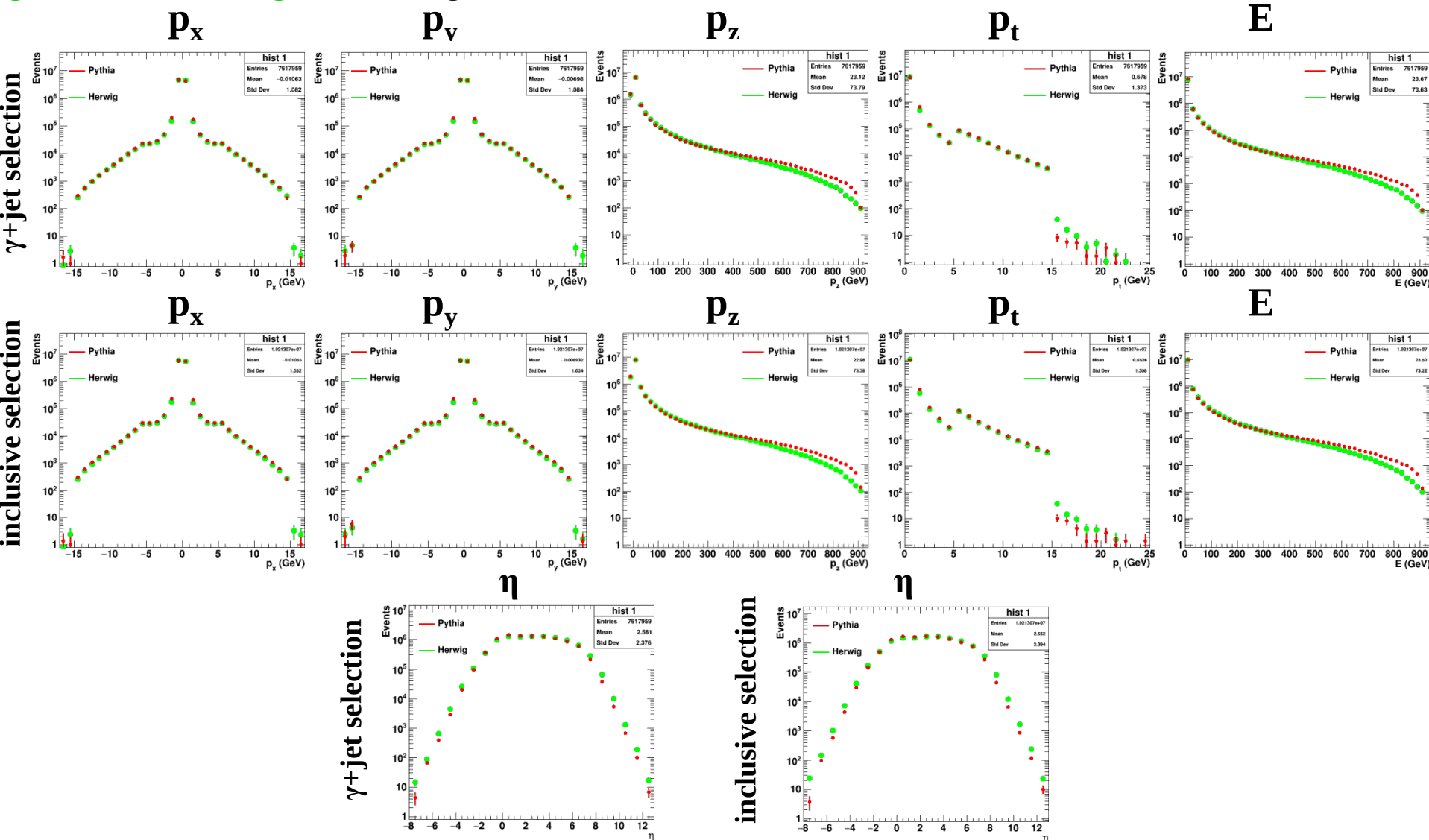
- red** – **Pythia** non-diff. signal, 50/50 sum;
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Herwig and Pythia have similar shapes.

HERA2, all particles (FMCKIN2) η and 4-momentum distributions, hadron level, no diff cuts

- red** – **Pythia** non-diff. signal, 50/50 sum;
- green** – **Herwig** non-diff. signal, 50/50 sum;

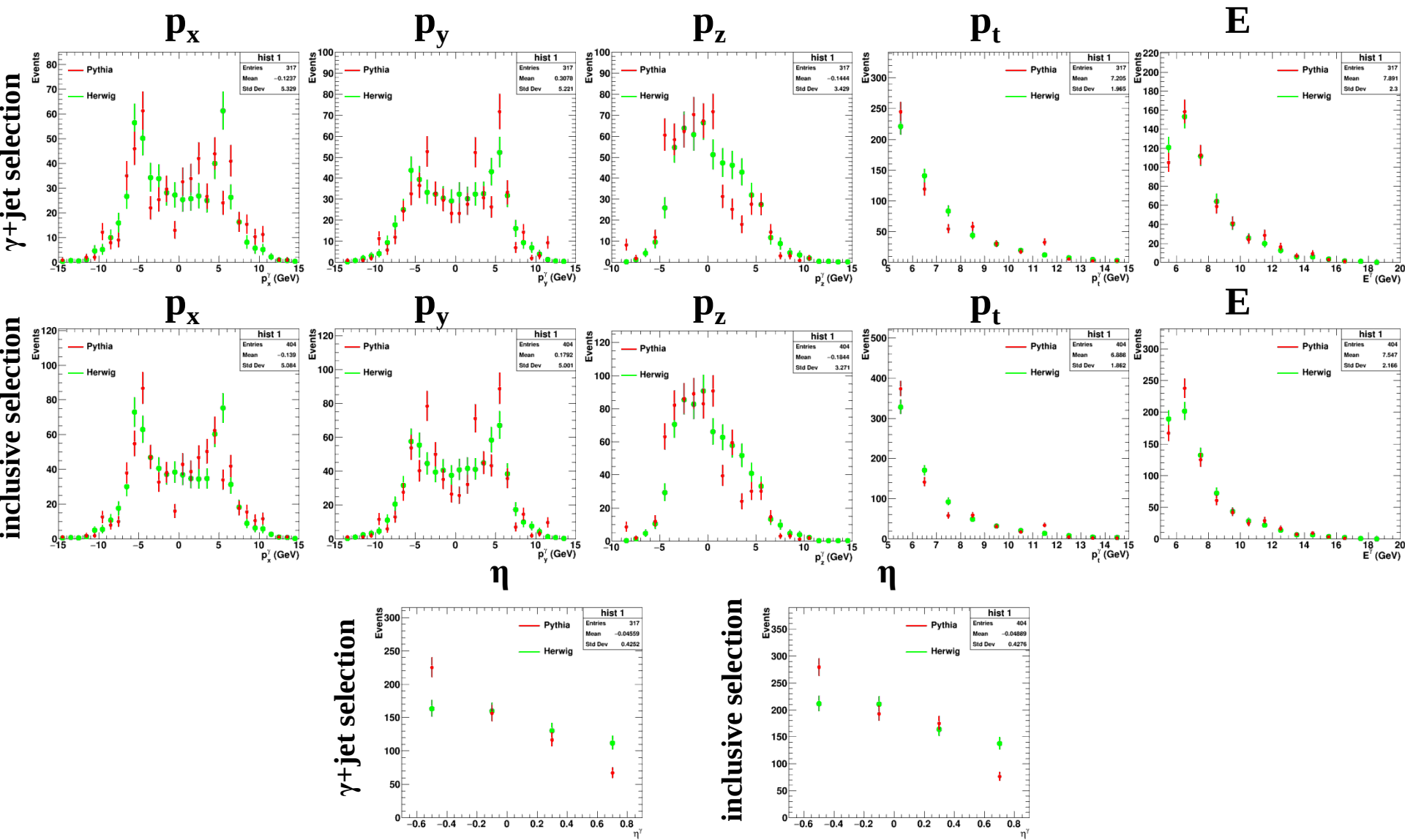


p_z and E distributions: Pythia contains more events at high E/p_z and less events at small E/p_z .
 η distribution: Herwig demonstrates the dominating of particles with high $|\eta|$.

HERA2
Herwig vs Pythia
hadron level
 η_{max} + Xp cuts

HERA2, photon (FMCKIN2) η and 4-momentum distributions, hadron level, $\eta_{\text{max}} + Xp$ cuts

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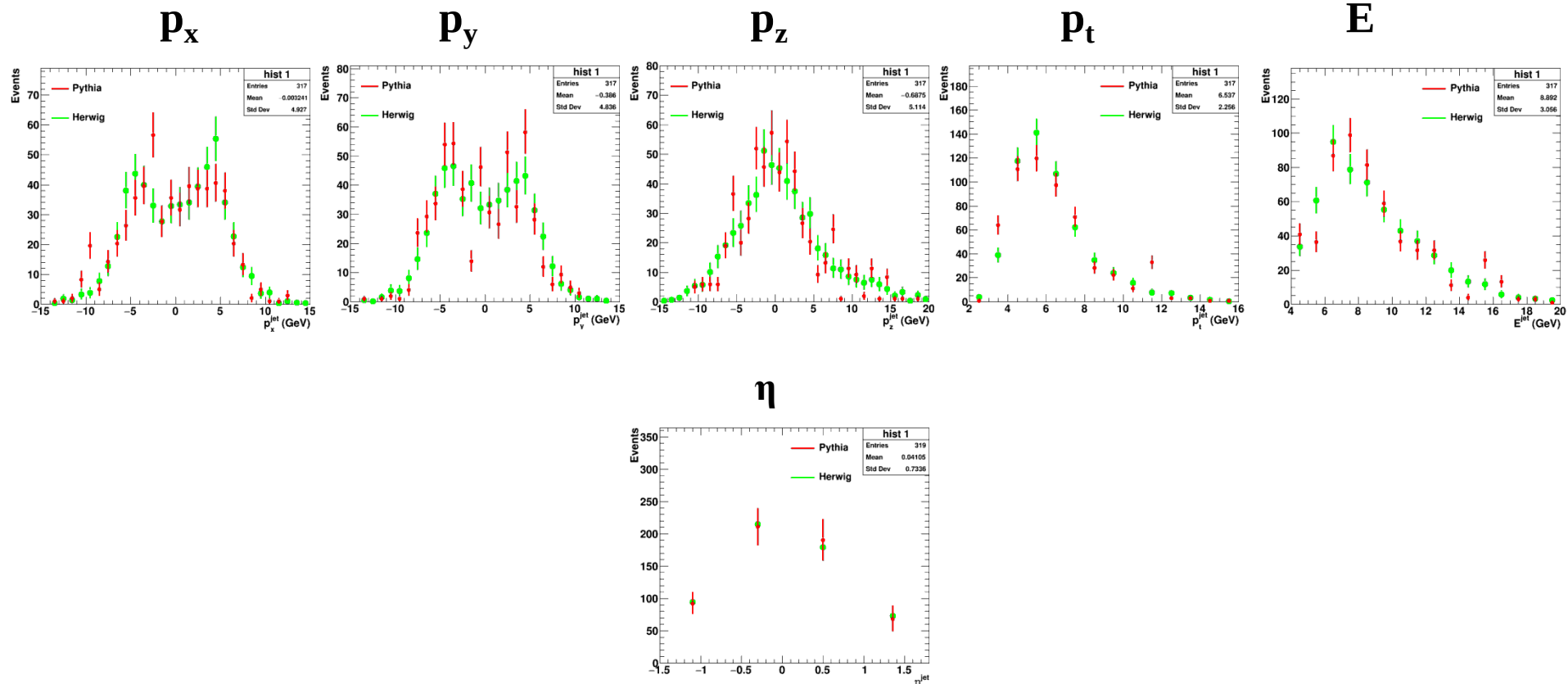


η distribution: Pythia indicates the tend to back direction compared to Herwig.

HERA2, accompanying jet (FMCKIN2) η and 4-momentum distributions, hadron level,

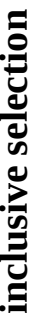
$\eta_{\max}$ + Xp cuts

- red** – **Pythia** non-diff. signal, 50/50 sum;
green – **Herwig** non-diff. signal, 50/50 sum;



Herwig and Pythia have similar shapes.

- **Pythia** non-diff. signal, 50/50 sum;
- **Herwig** non-diff. signal, 50/50 sum;



γ +jet selection

inclusive selection

p_z and E distributions: after applying the diff. cuts Pythia contains less events at high E/p_z and more events at small E/p_z compared to Herwig.

Conclusions

- The possibility of funneling of MC samples outside the DESY is tested and consider to be working correctly.
- On hadron level:
 - $\mathbf{p}_x, \mathbf{p}_y, \mathbf{p}_t$ distributions are in agreement.
 - $\mathbf{p}_z, E$ distributions of photons and jets are similar.
 - $\mathbf{p}_z, E$ distributions for all particles:
 - ✓ *without diff. cuts*: Pythia contains more events at high values and less events at small values compared to Herwig.
 - ✓ *with diff. cuts*: vice versa.
 - η distribution:
 - ✓ *without diff. cuts*: Herwig demonstrates the dominating of particles with high $|\eta|$ compared to Pythia.
 - ✓ *with diff. cuts*: Pythia indicates the tend to back direction compared to Herwig.
- On detector level the differences are smoothed: Pythia and Herwig distributions becomes similar.

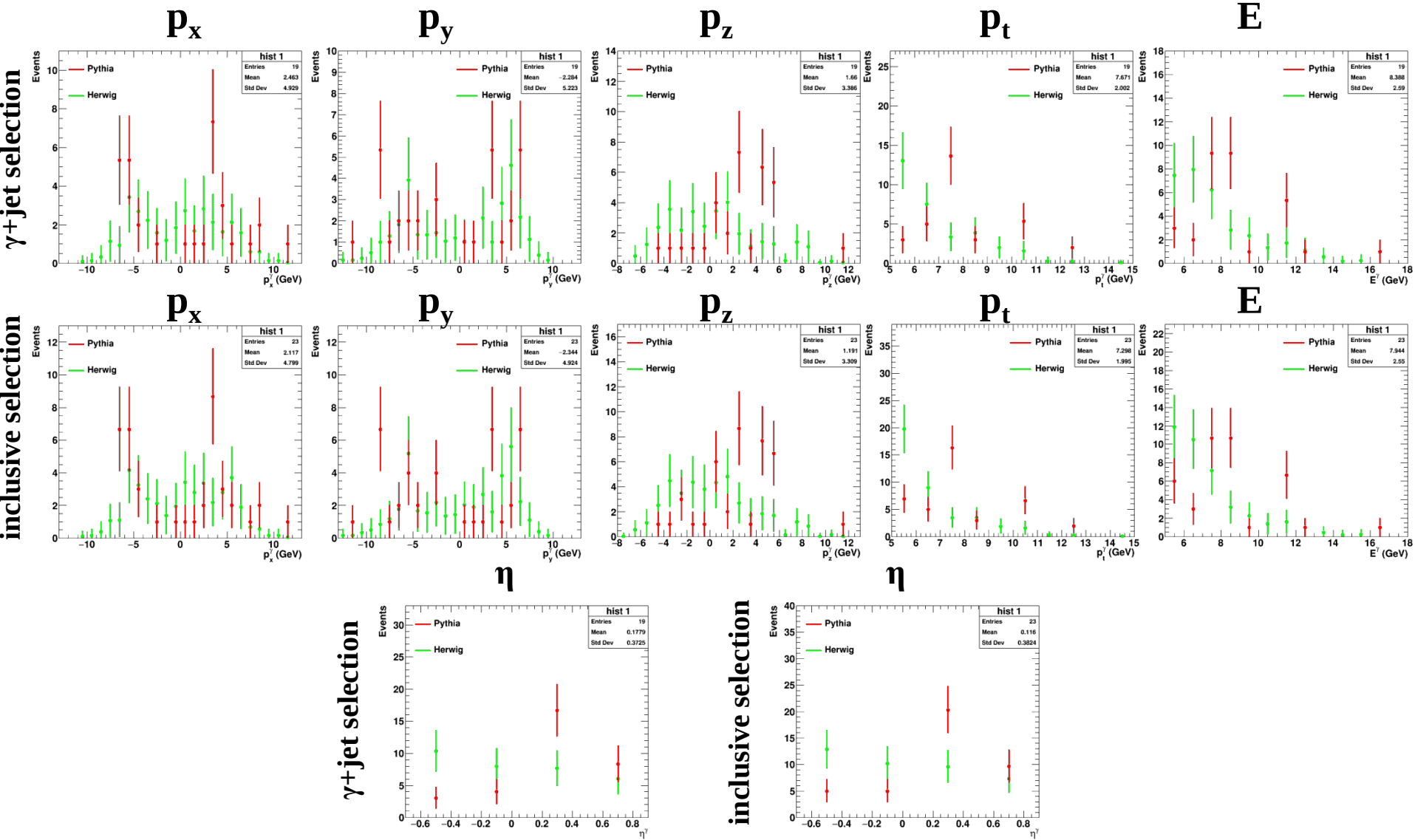
Future plans

- Decide how best to use Pythia and Herwig to evaluate non-diff. background.

Backup slides

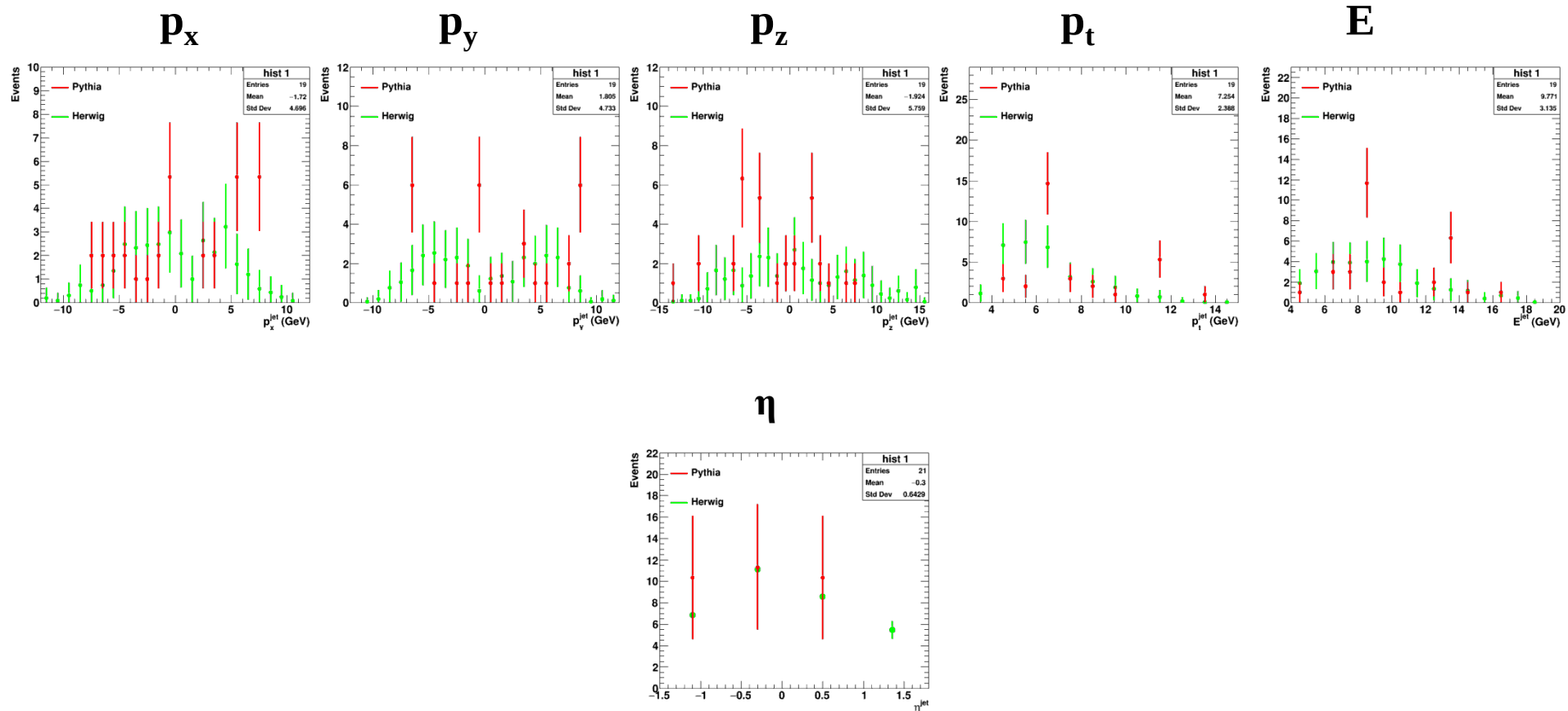
HERA1, photon η and 4-momentum distributions, detector level, $\eta_{\max} + X_p + E_{\text{FPC}}$ cuts

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HERAI, accompanying jet η and 4-momentum distributions, detector level, $\eta_{\text{max}} + Xp + E_{\text{FPC}}$ cuts

- red** – **Pythia** non-diff. signal, 50/50 sum;
- green** – **Herwig** non-diff. signal, 50/50 sum;



Pythia has not enough statistics.