From truth to reconstruction

Noam Tal Hod

WEIZMANN INSTITUTE OF SCIENCE

Sep 29 2020

Illustrating the abstract procedure

- Using Tony's electron+laser setup as an example
  - not sure if I'm doing the conversion to TTree properly (in principle it is the same as it used to be with the 2019 setup)

- Using the tracker response as an example

- Looking the positrons rate for different ξ and χ

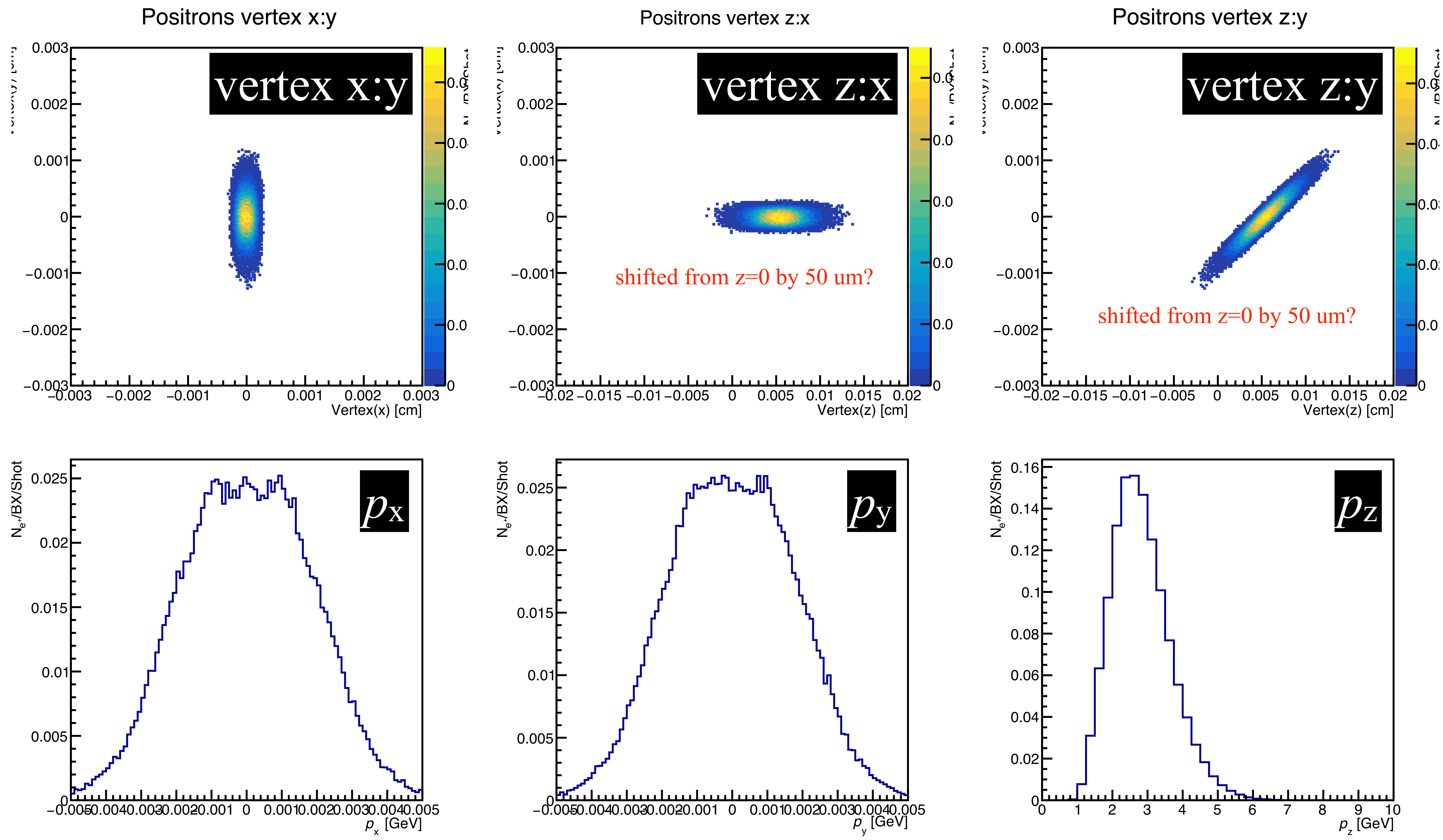
From Tony (true for Sep 22)

Experiment Config	$w_0 = 3\mu$m	$w_0 = 3.5\mu$m	$w = 0, 4.0\mu$m	$w_0 = 4.5\mu$m	$w_0 = 5.0\mu$m	$w_0 = 8.0\mu$m	$w_0 = 20.0\mu$m	$w_0 = 50.0\mu$m	$w_0 = 100.0\mu$m
peak SQED ξ	5.12	4.44	3.88	3.45	3.1	1.94	0.78	0.31	0.15
peak SQED χ (16.5 GeV)	0.9	0.79	0.69	0.61	0.55	0.34	0.138	0.055	0.028
JETI40 e-laser 16.5 GeV	939	951	946	949	938	1000	193	1232	200
JETI40 e-laser 17.5 GeV	1138	1000	1000	1000	1000	699			
JETI40 g-laser (coarse) 16.5 GeV	1000	1000	999	1000	1000	1000			
JETI40 g-laser 16.5 GeV	785	789	928	844	872	879			
JETI40 g-laser 17.5 GeV									
JETI40 misalignments									
JETI40 mCP production									

	$w_0 = 3.0\mu$m	$w_0 = 8.0\mu$m	$w_0 = 9.0\mu$m	$w_0 = 10.0\mu$m	$w_0 = 11.0\mu$m	$w_0 = 12.0\mu$m			
peak SQED ξ	16.7	6.27	5.57	5.01	4.56	4.18			
peak SQED χ (16.5 GeV)	2.96	1.11	0.99	0.89	0.81	0.74			
phaseII e-laser 16.5 GeV	in progress	997	1000	993	831	814			
phaseII e-laser 17.5 GeV		1011	1119	998	1000	1000			
phaseII g-laser 16.5 GeV		408	422	475	373	447			
phaseII g-laser 17.5 GeV									
phaseII misalignments									
phaseII mCP production									

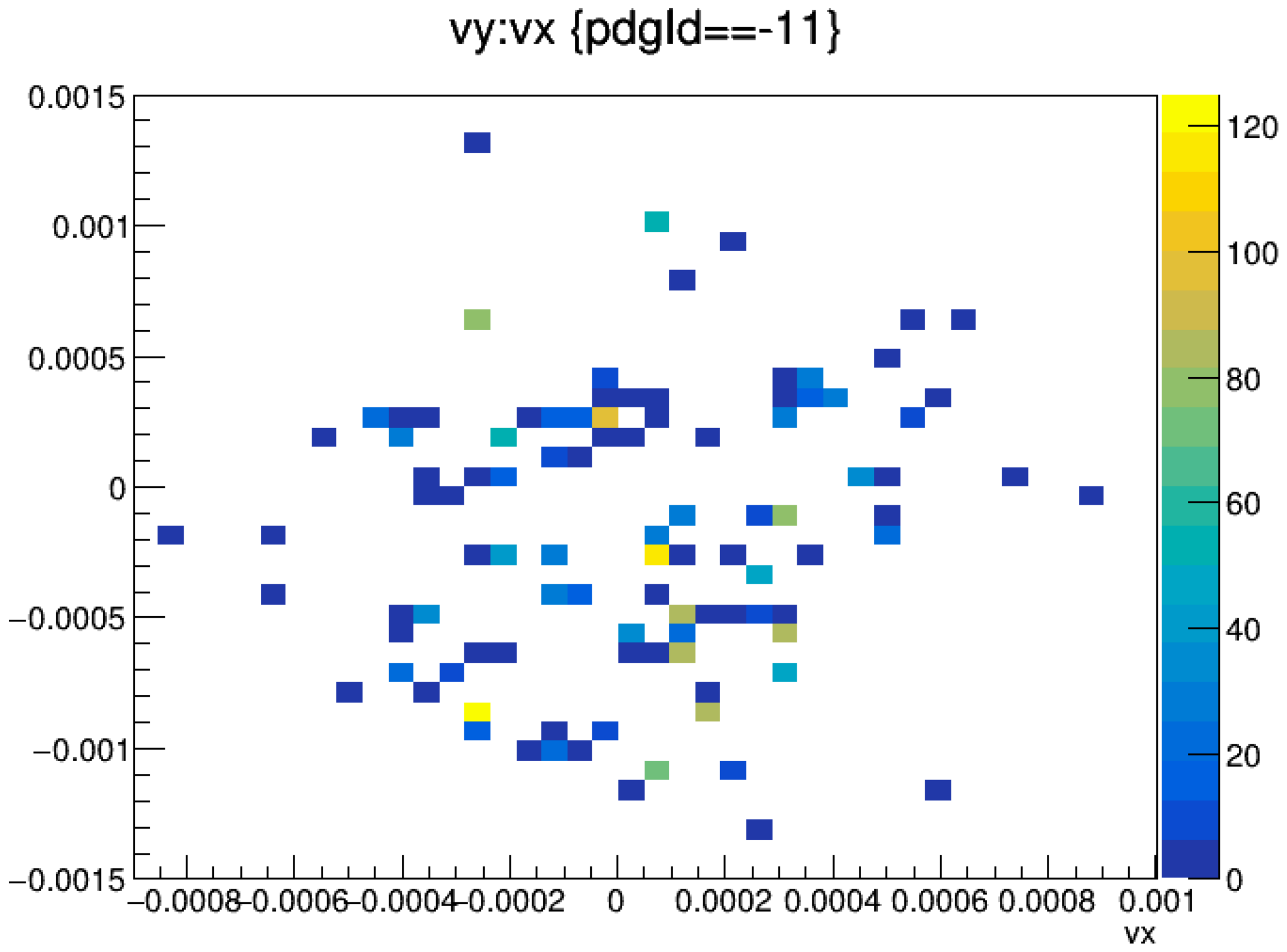
Vertex and momenta

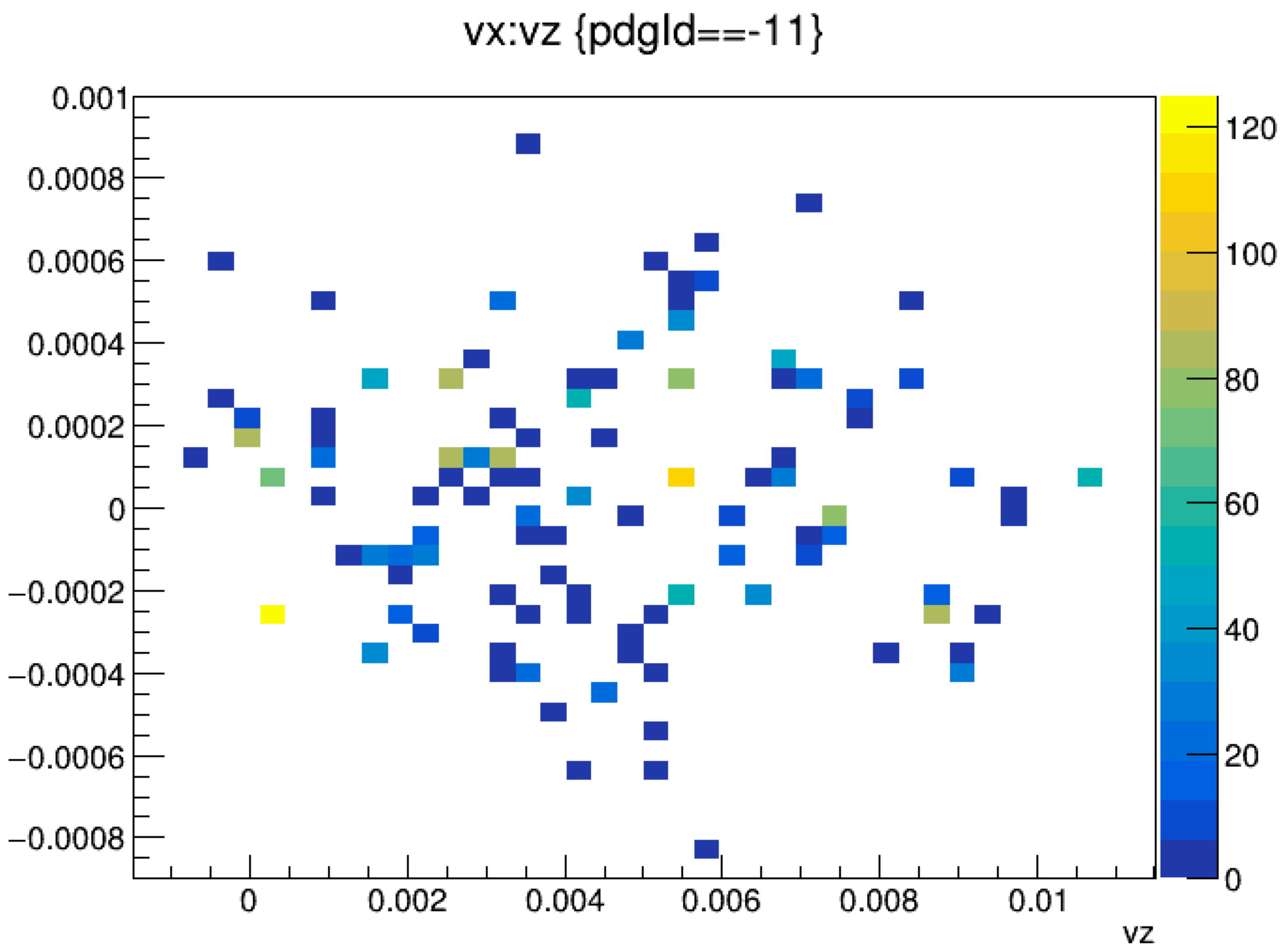
JETI40/e_laser/16.5GeV/w0_3000nm

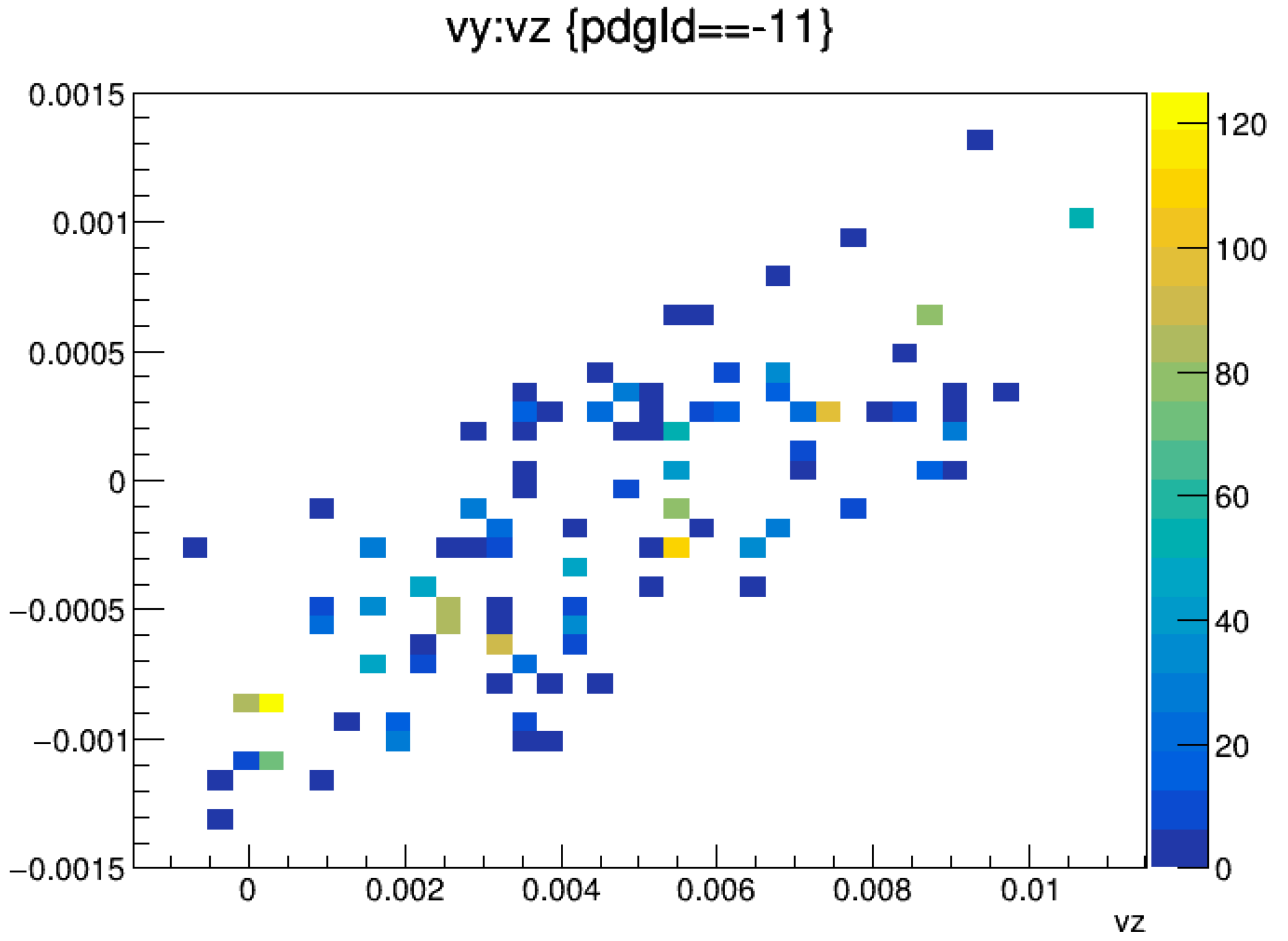


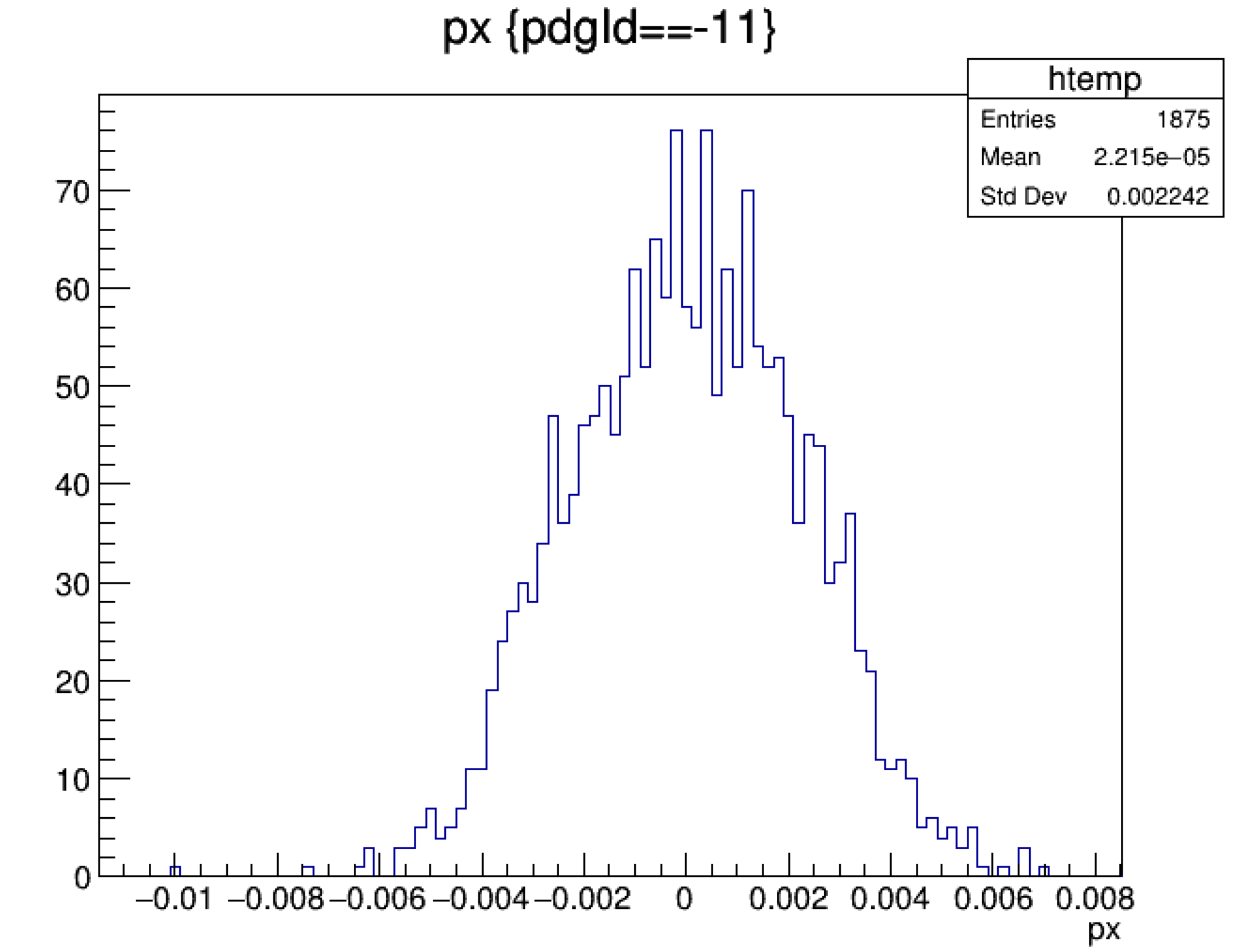
Vertex and momenta

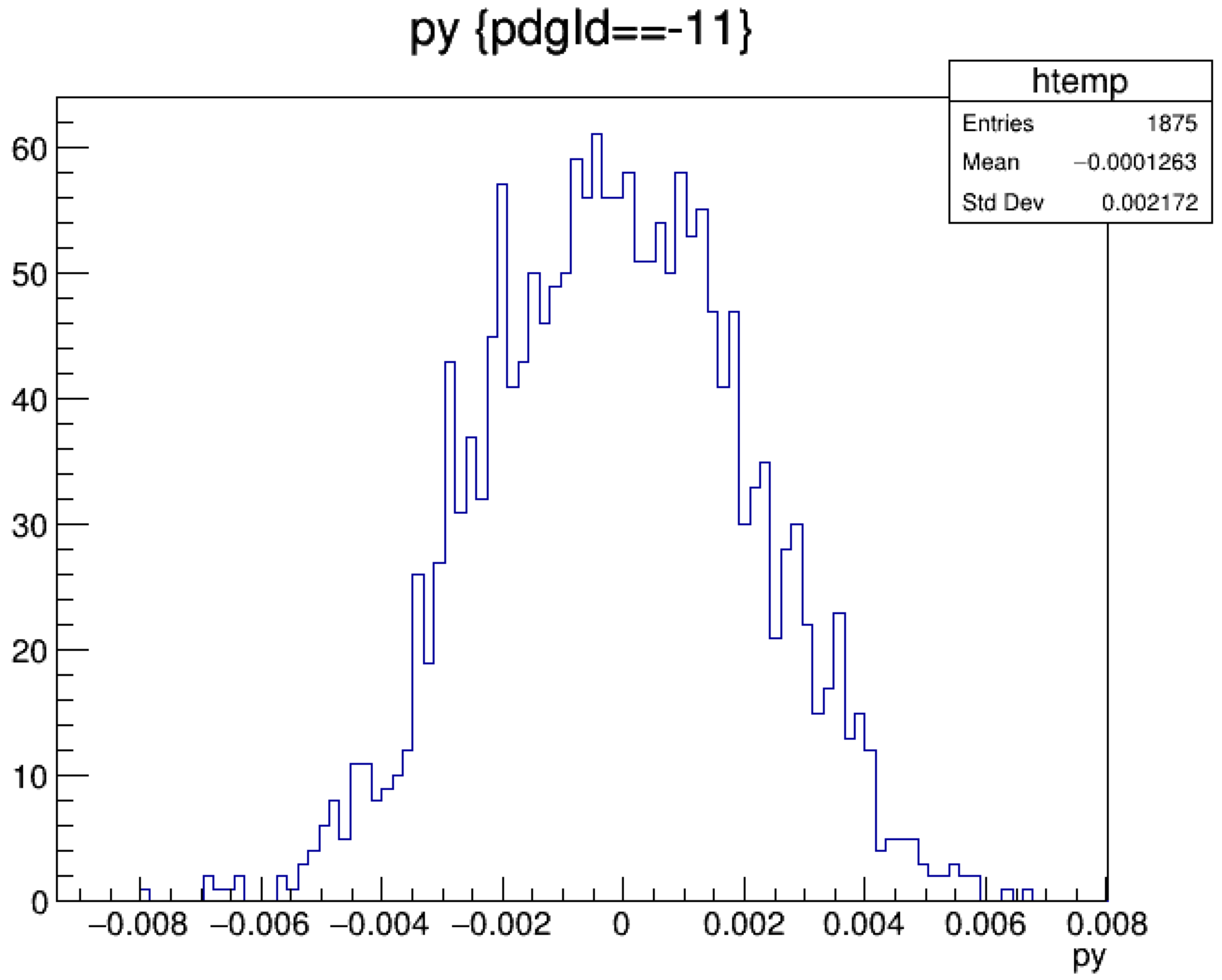
JETI40/g_laser/16.5GeV/w0_8000nm

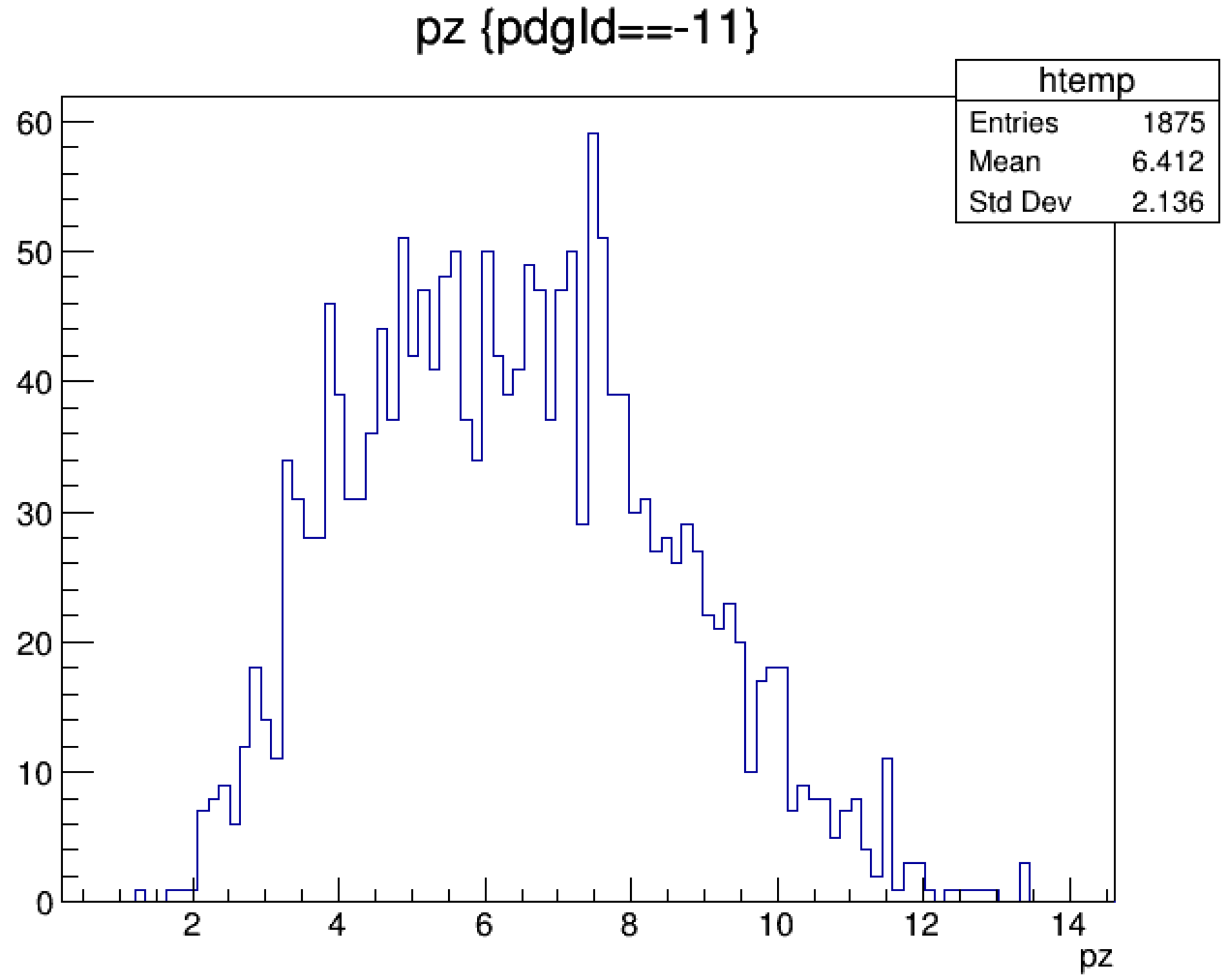






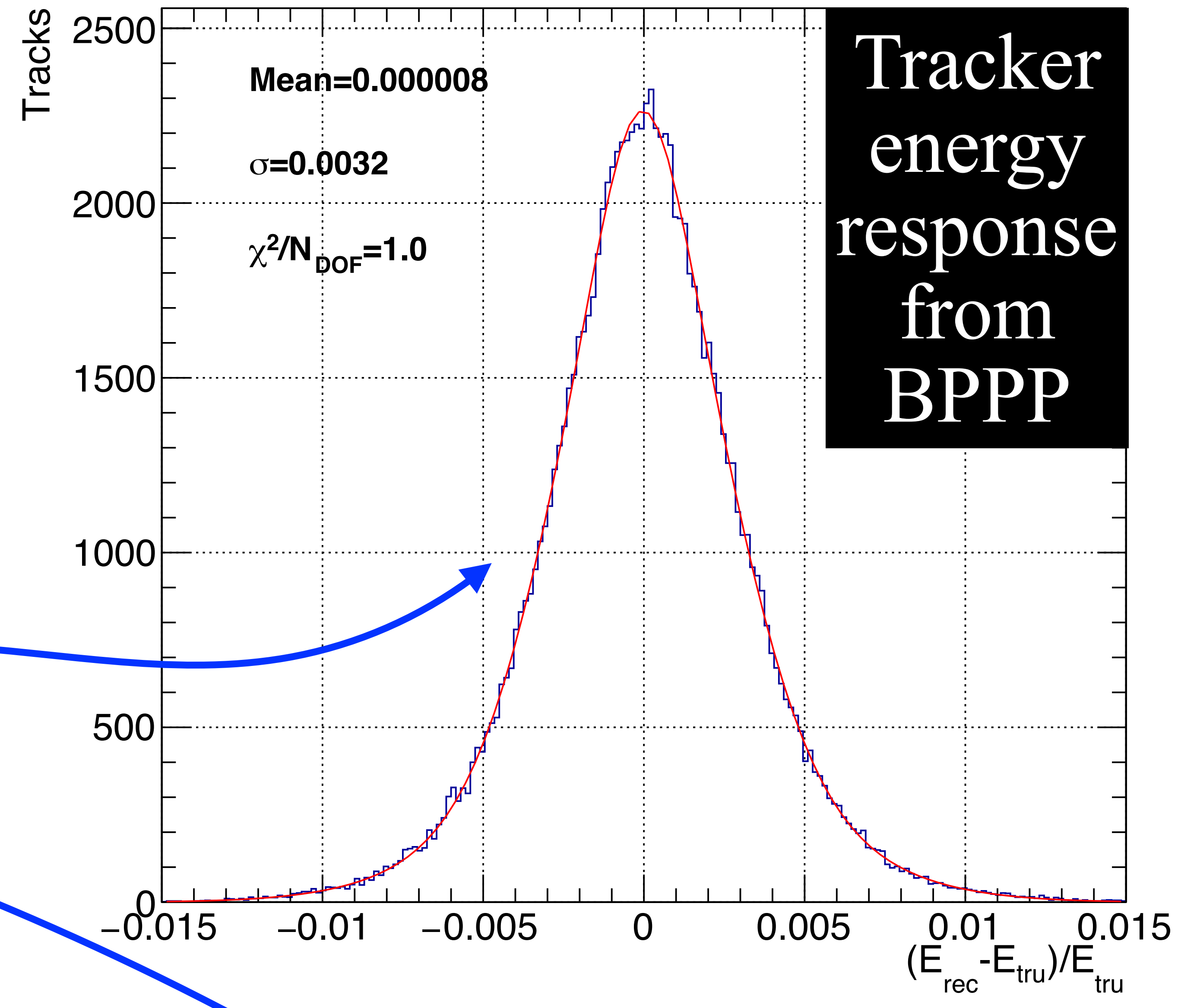


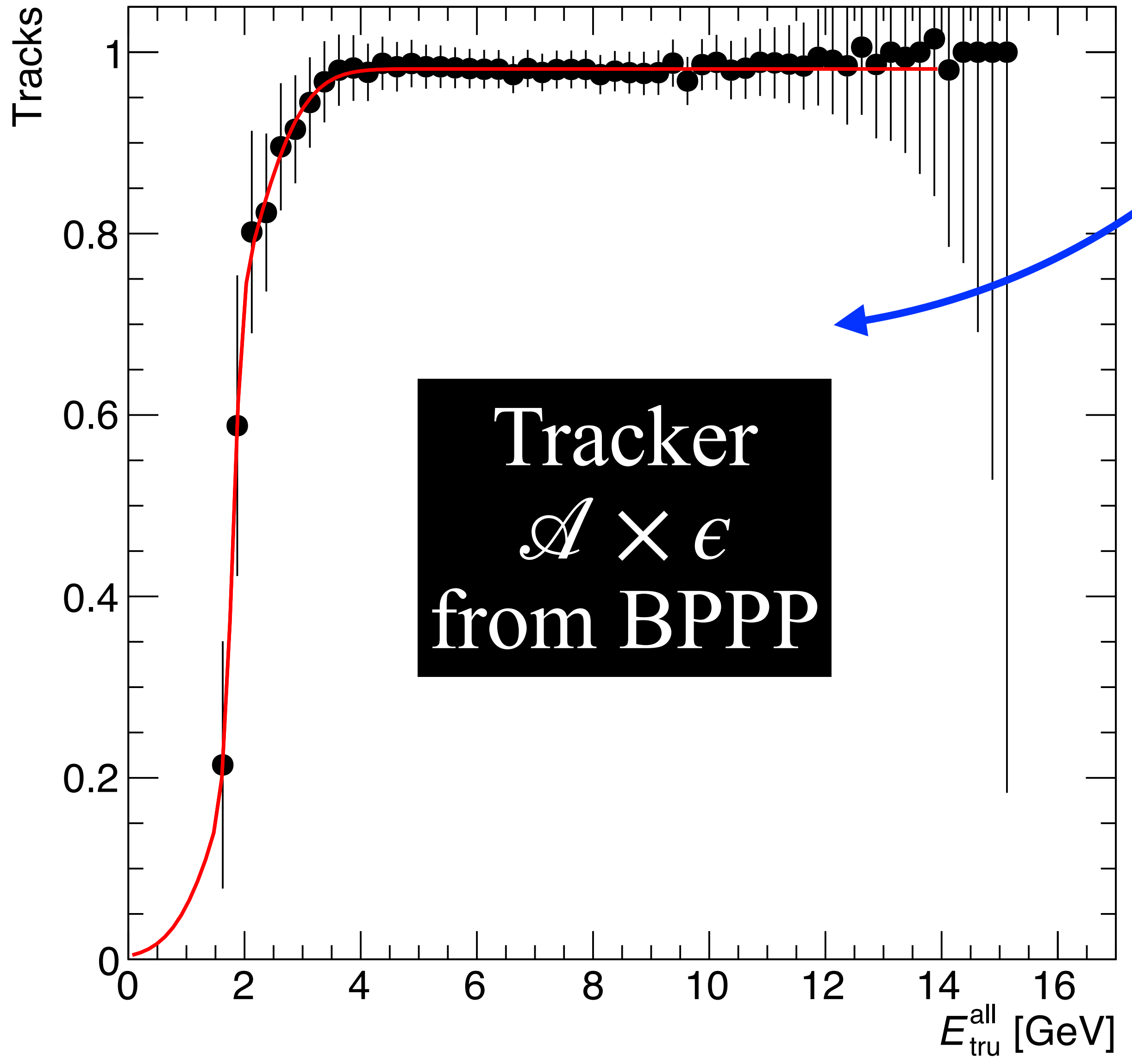


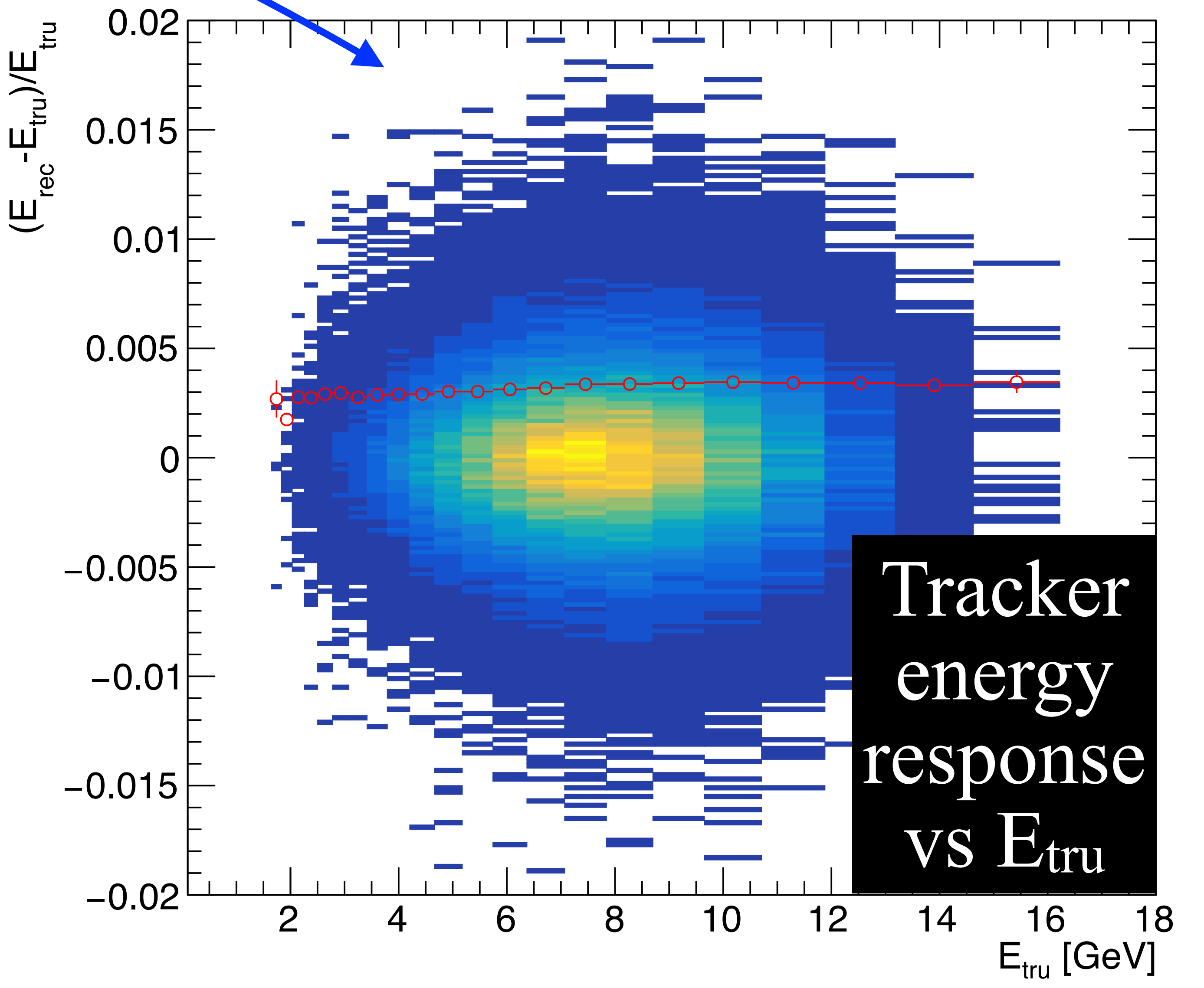


Emulating reconstruction

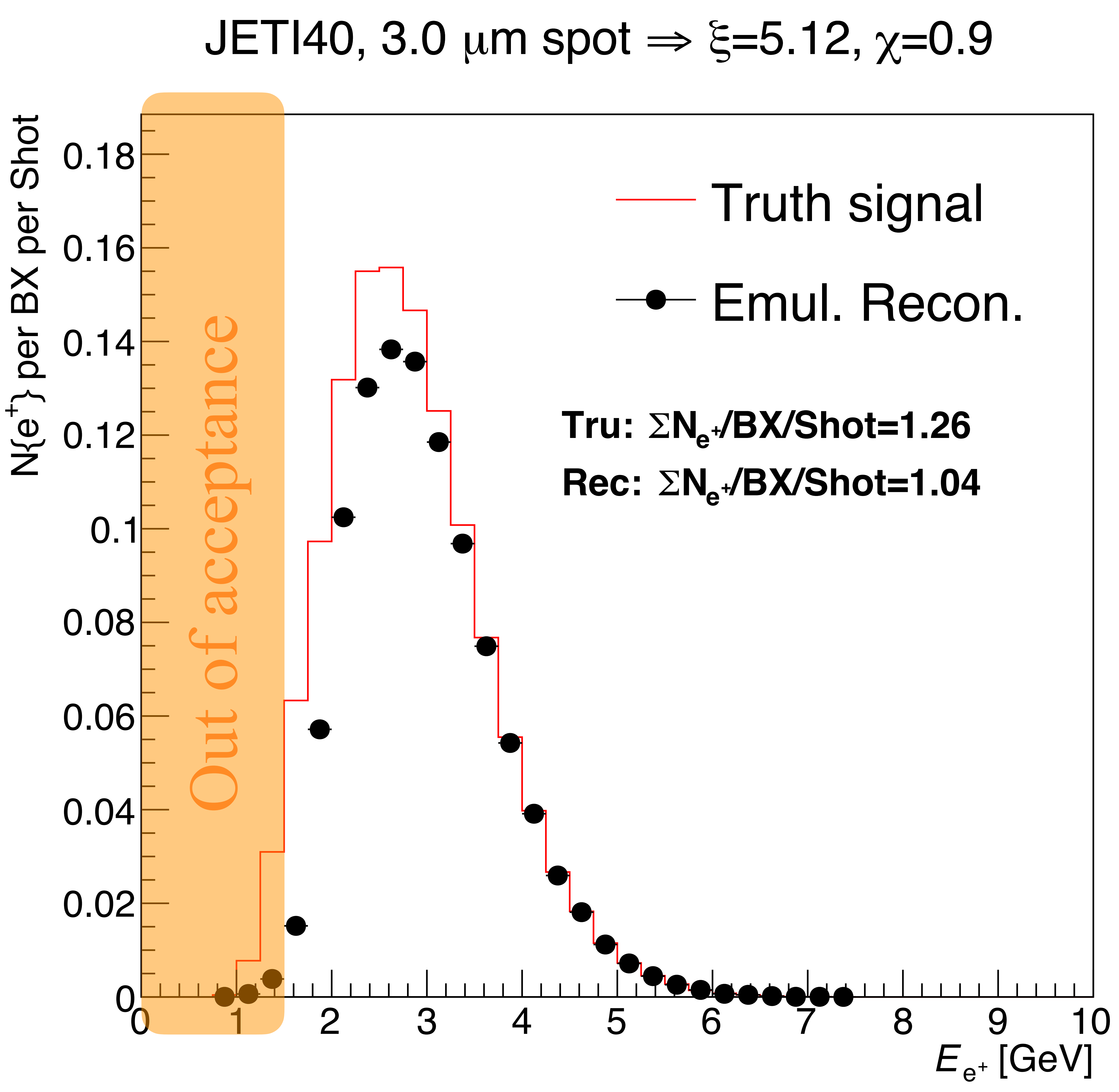
- Evaluate the detector response from fast simulation: ResponseFit and AccEffFit (save as TF1 objects)
  - NOTE: we do this with background overlaid (need to tune to match what we see from Sasha)
- Loop over the signal(s) BXs from Tony and transform the truth information to reco like this:
  - smearing the truth energy is done per particle like: $E_{rec}=E_{tru}\times(1+\text{ResponseFit.GetRandom()})$
    - NOTE: this response in the tracker case is ~flat across all values of E_{tru}
  - convoluting with the acceptance times efficiency is done like: Weight=AccEffFit.Eval(E_{tru})
    - histograms are filled with this weight per particle!
- Normalise the distribution to the number of BXs
- Integrate to get the number of particles/BX/Shot
- Compare the emulated reco shapes with the truth ones



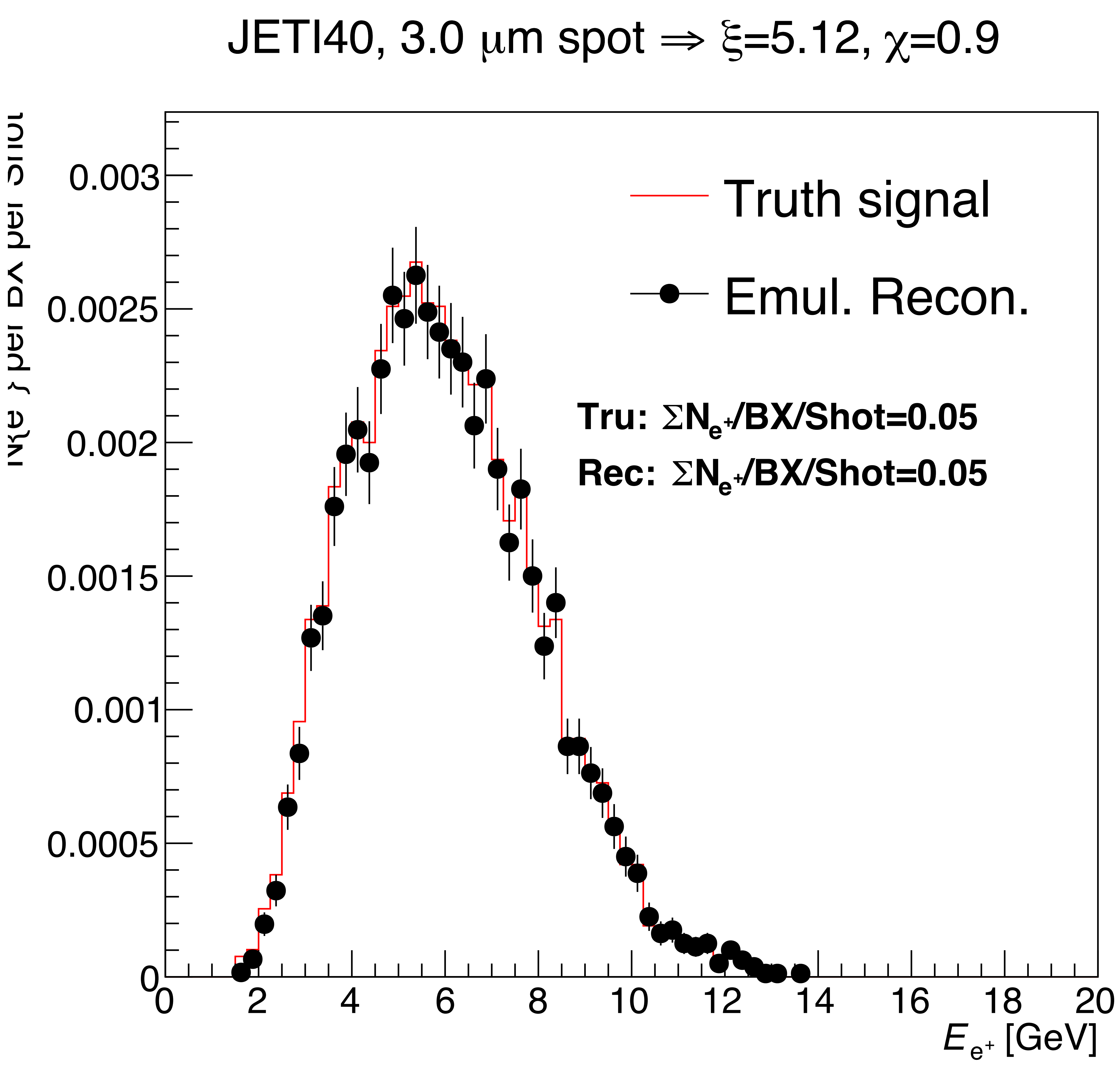




JETI40/(e/γ)_laser/16.5GeV/w0_3000nm

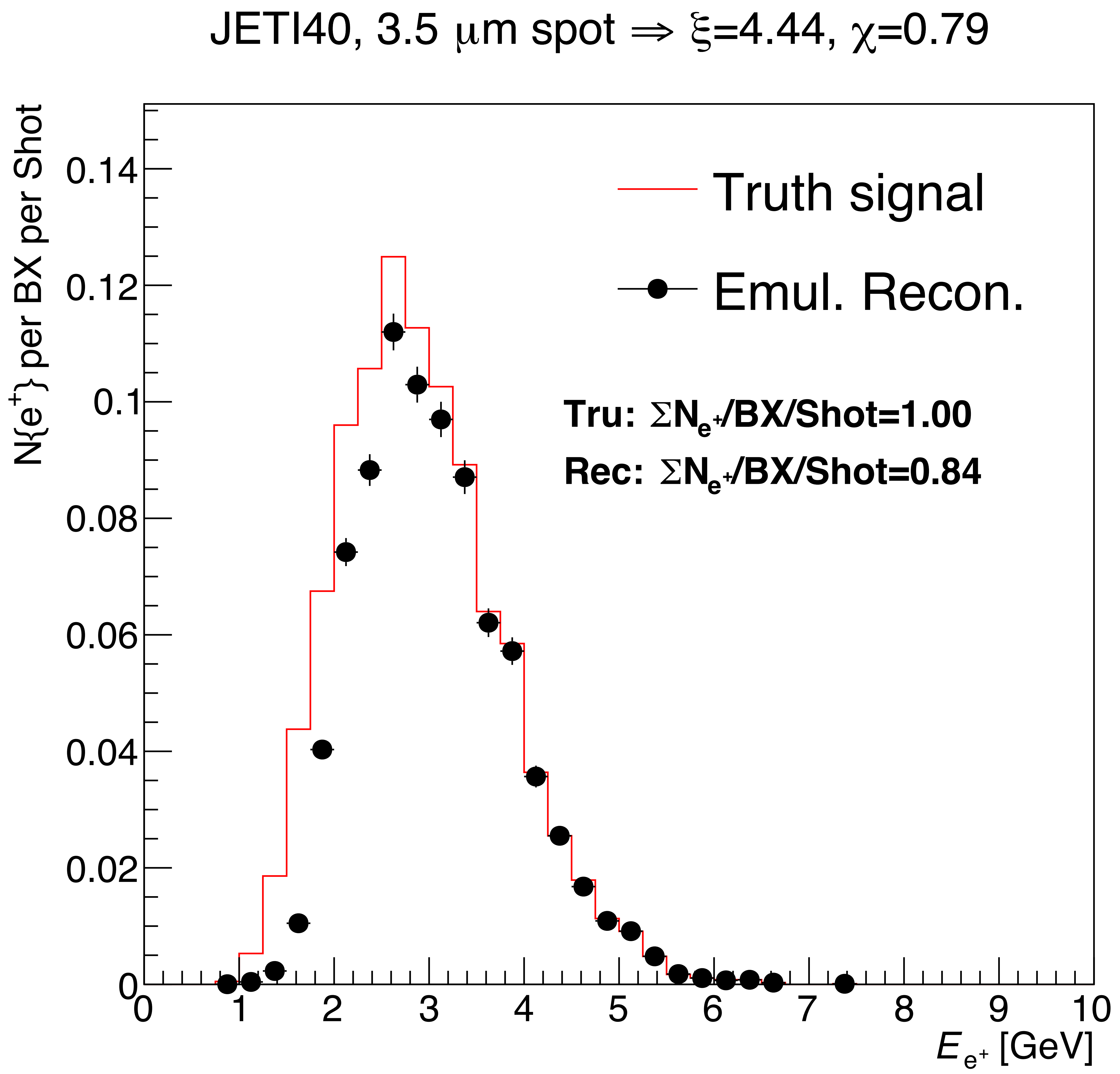


e+laser

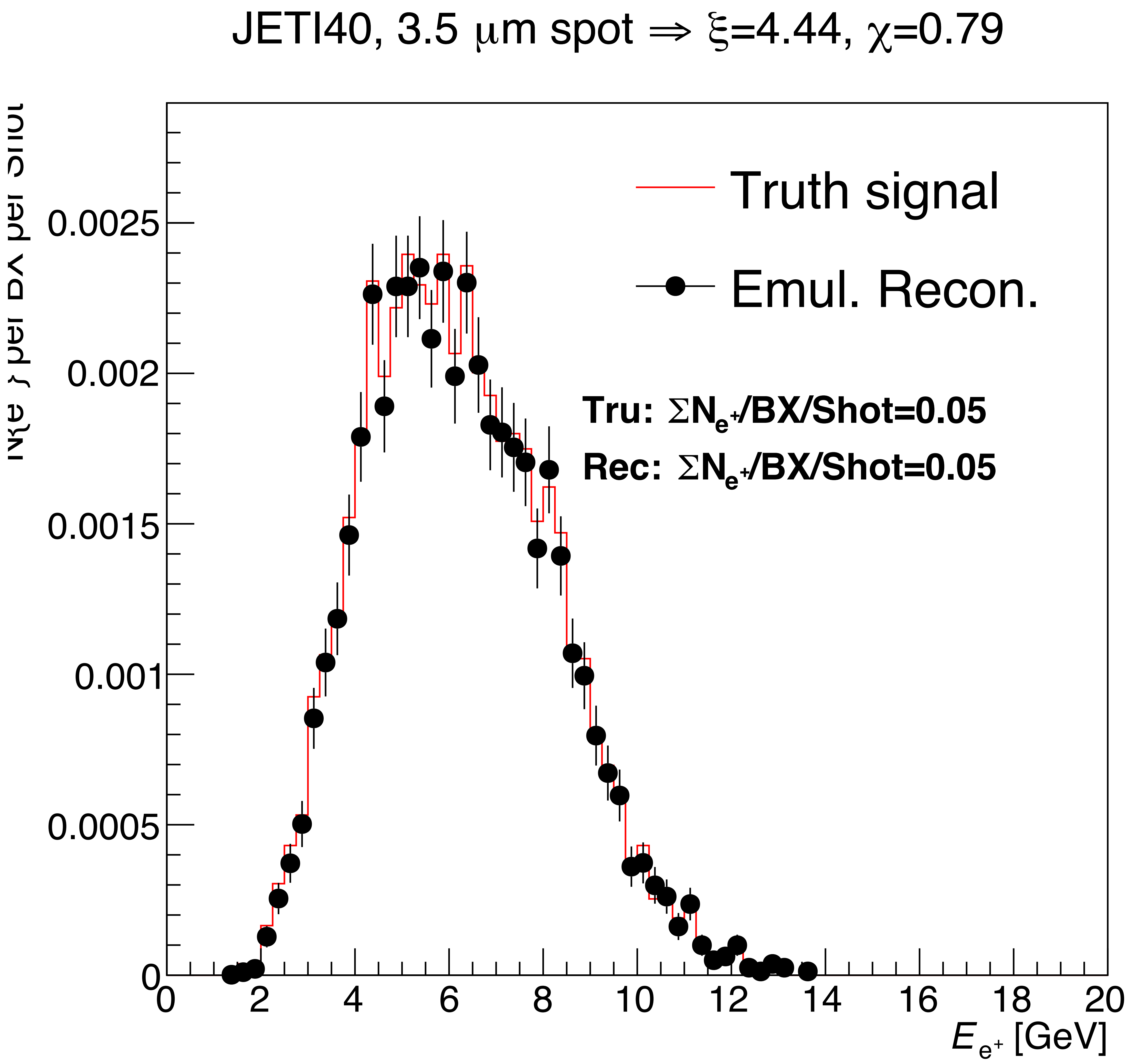


γ+laser

JETI40/(e/γ)_laser/16.5GeV/w0_3500nm

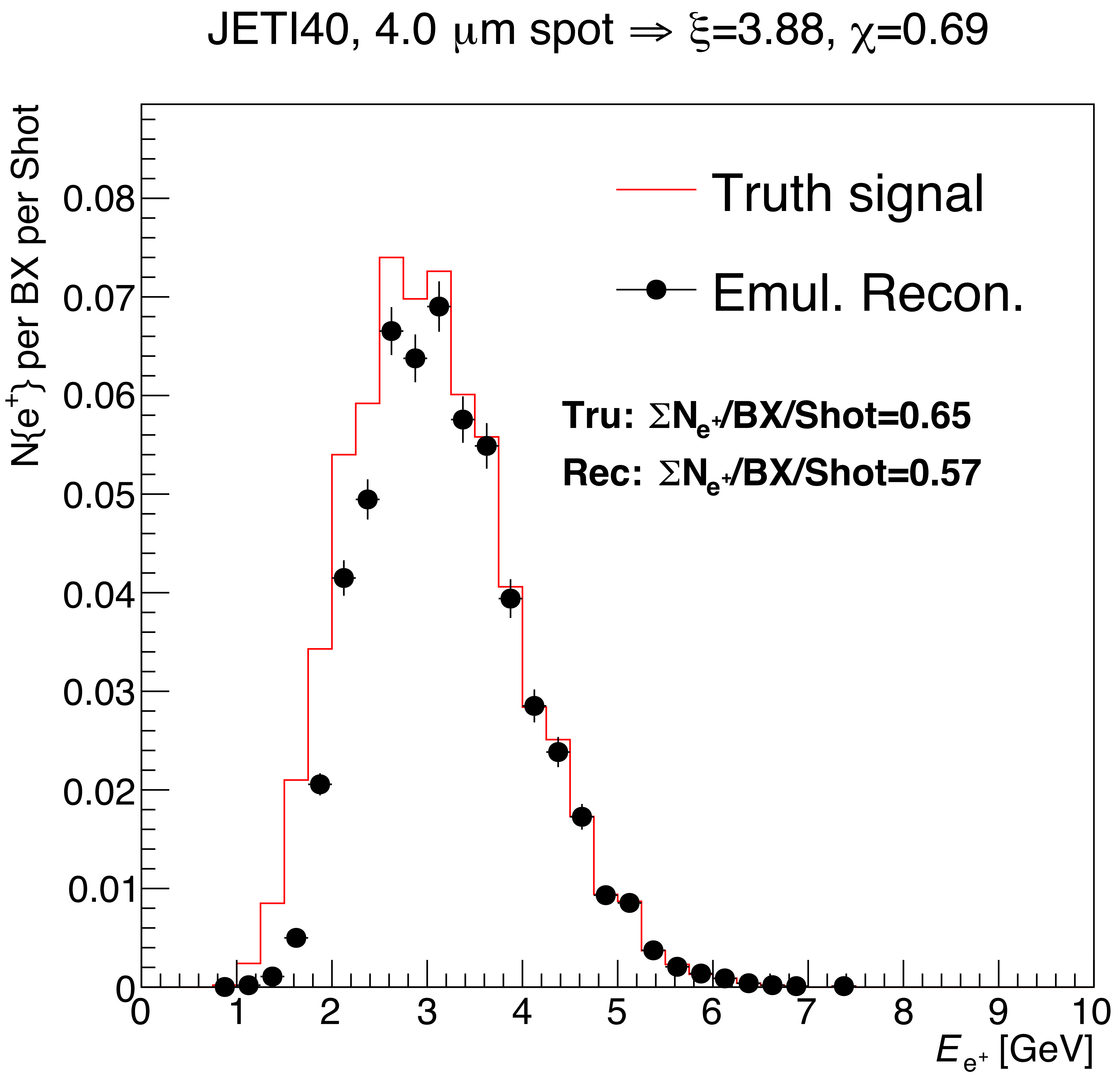


e+laser

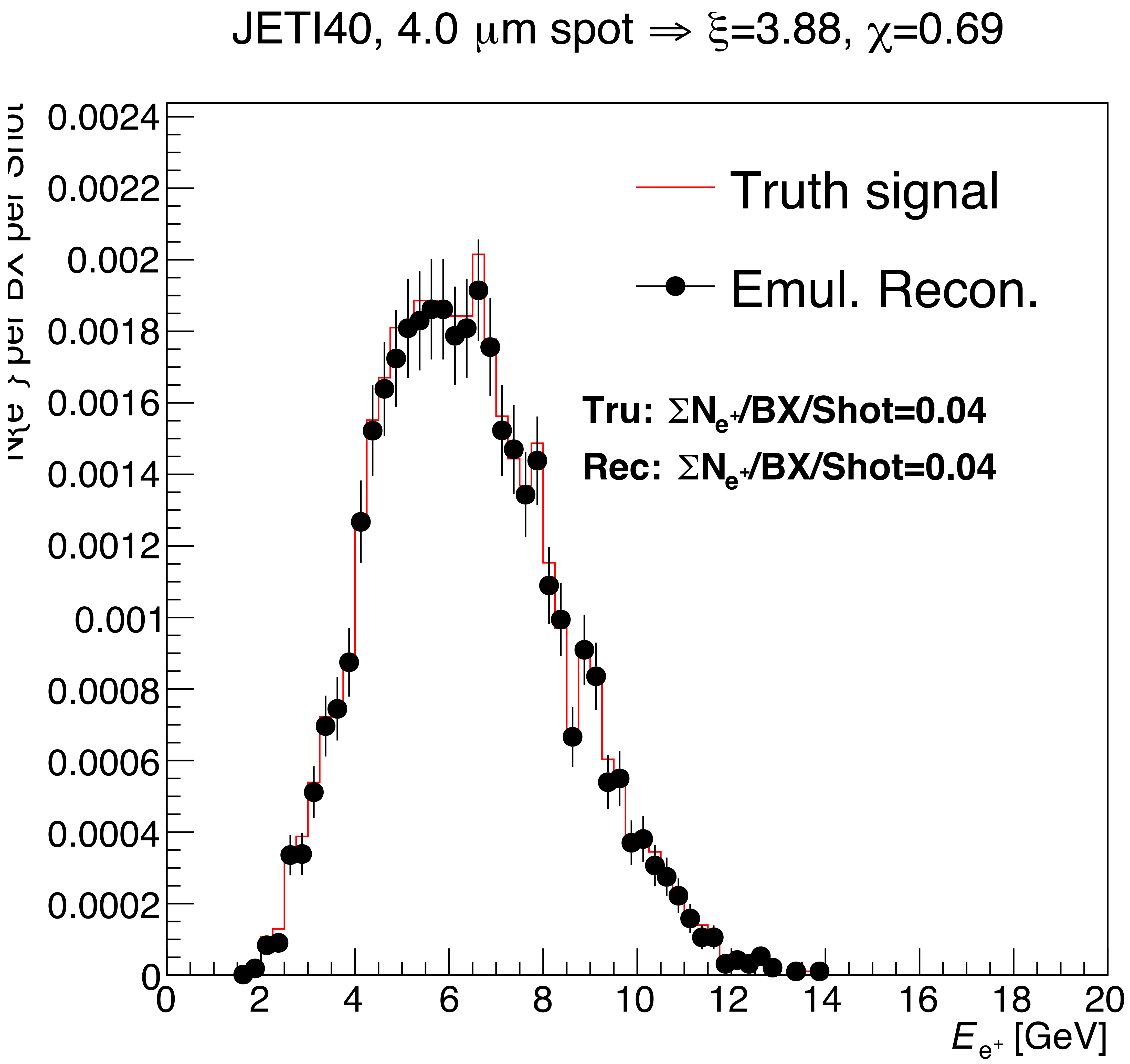


γ+laser

JETI40/(e/γ)_laser/16.5GeV/w0_4000nm

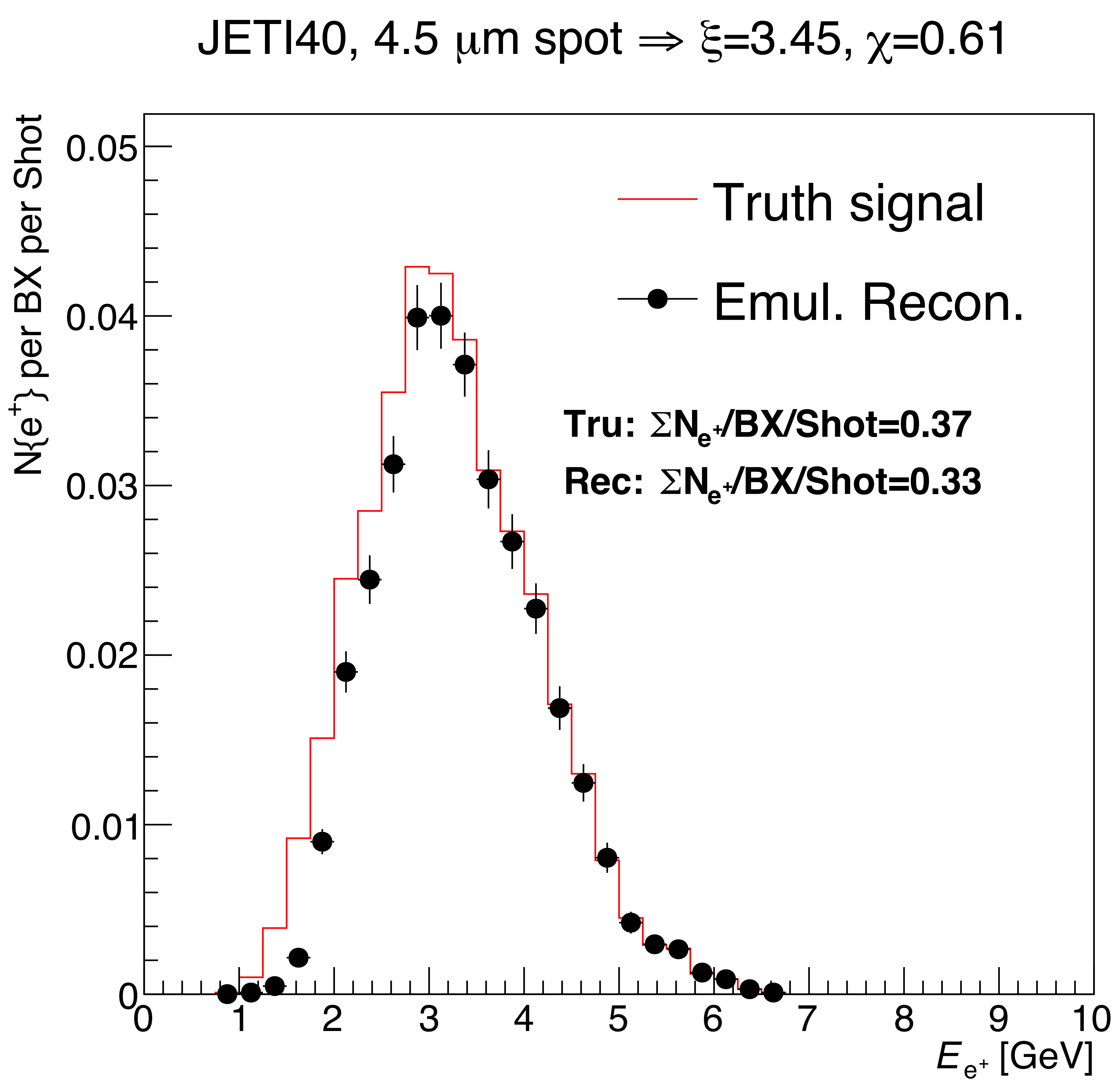


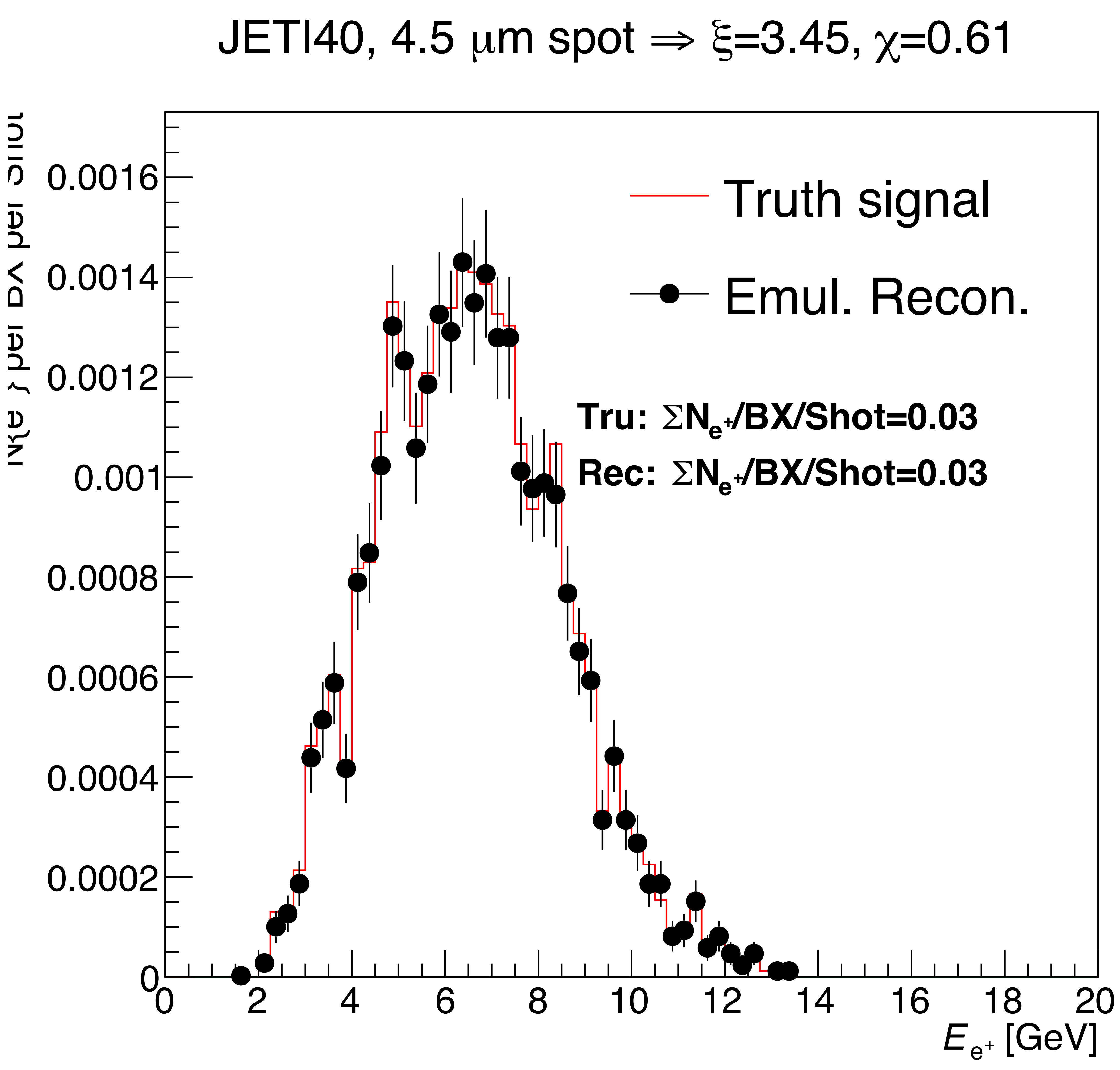
e+laser



γ+laser

JETI40/(e/γ)_laser/16.5GeV/w0_4500nm

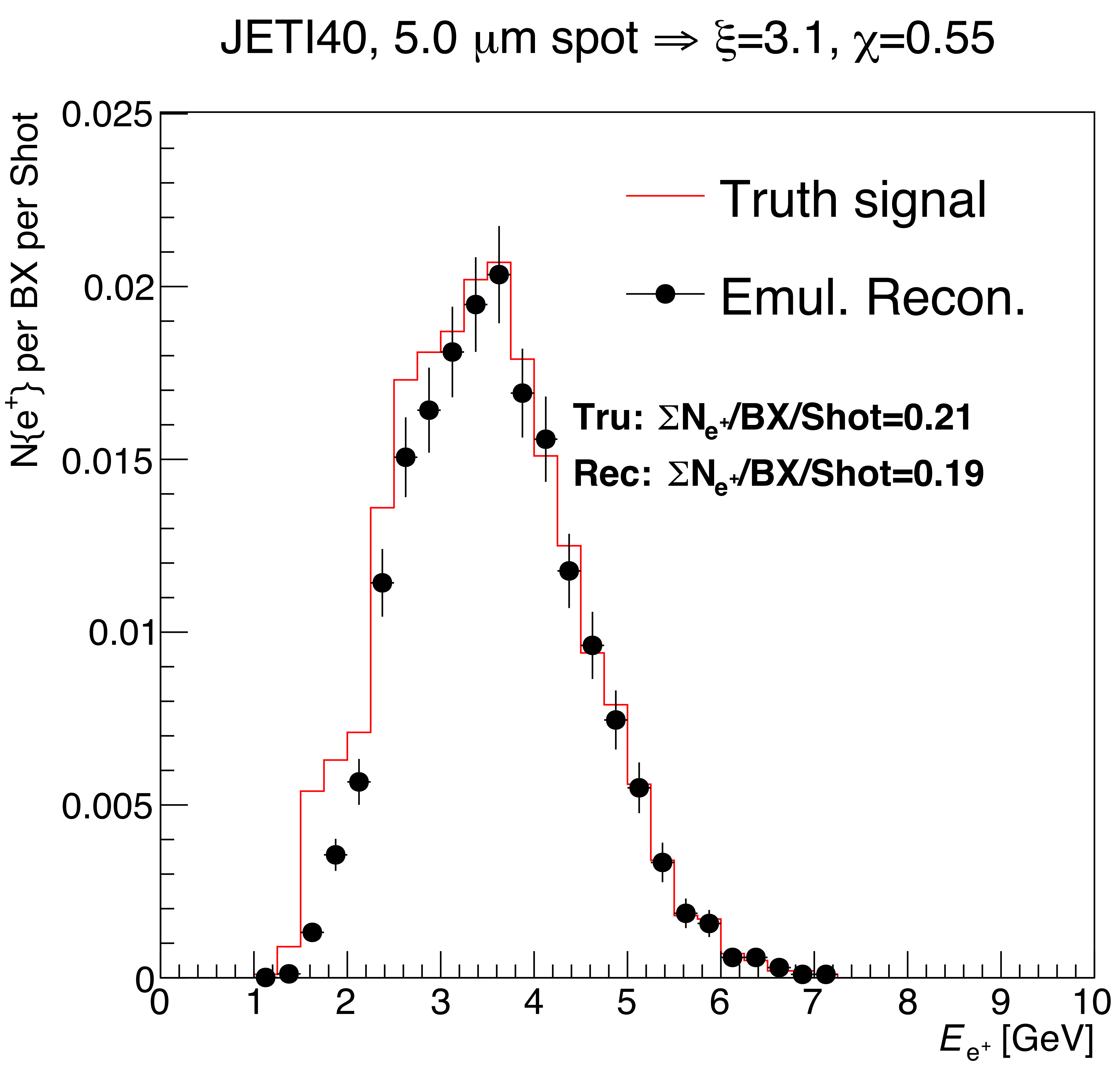




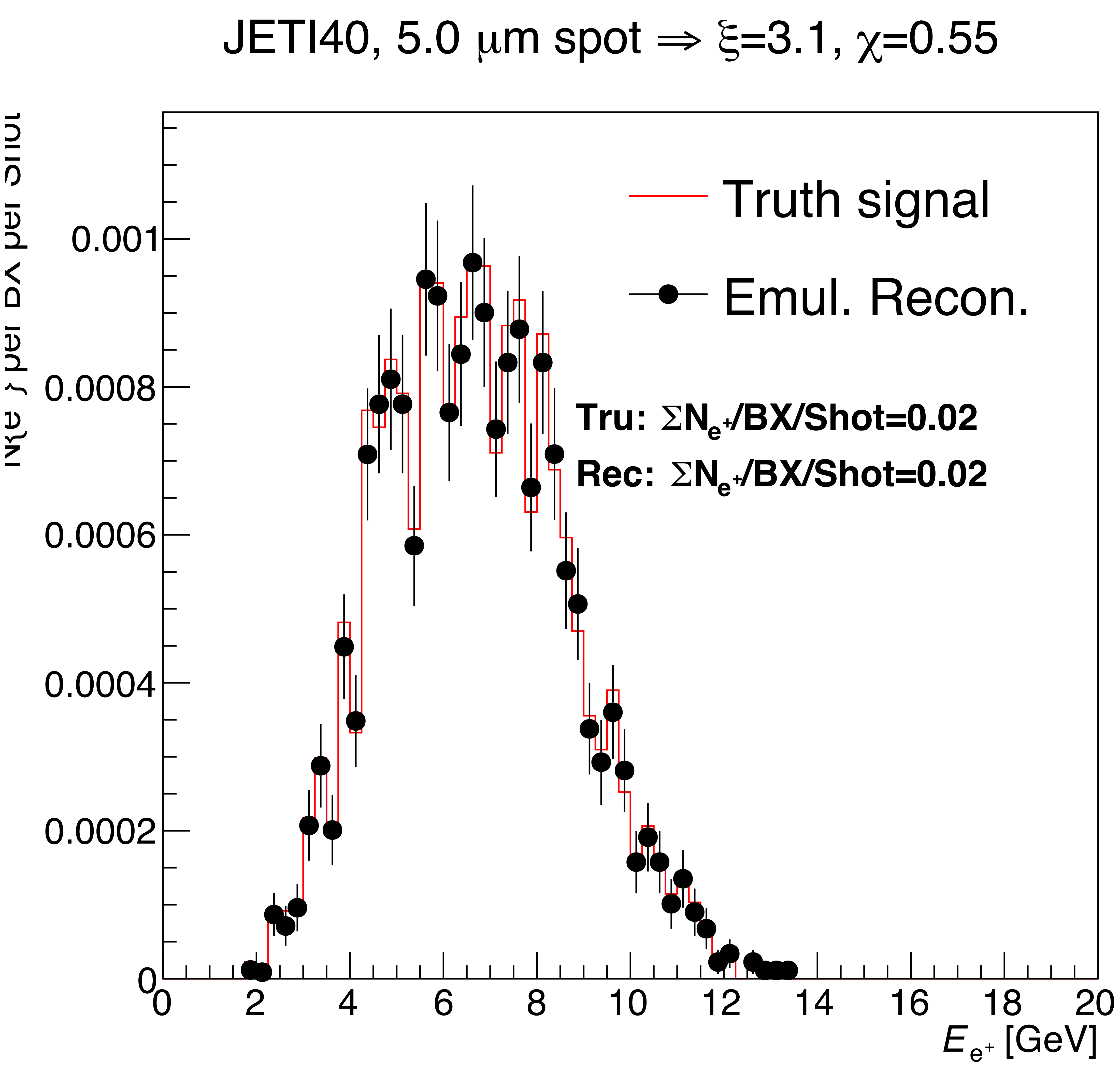
e+laser

γ+laser

JETI40/(e/γ)_laser/16.5GeV/w0_5000nm

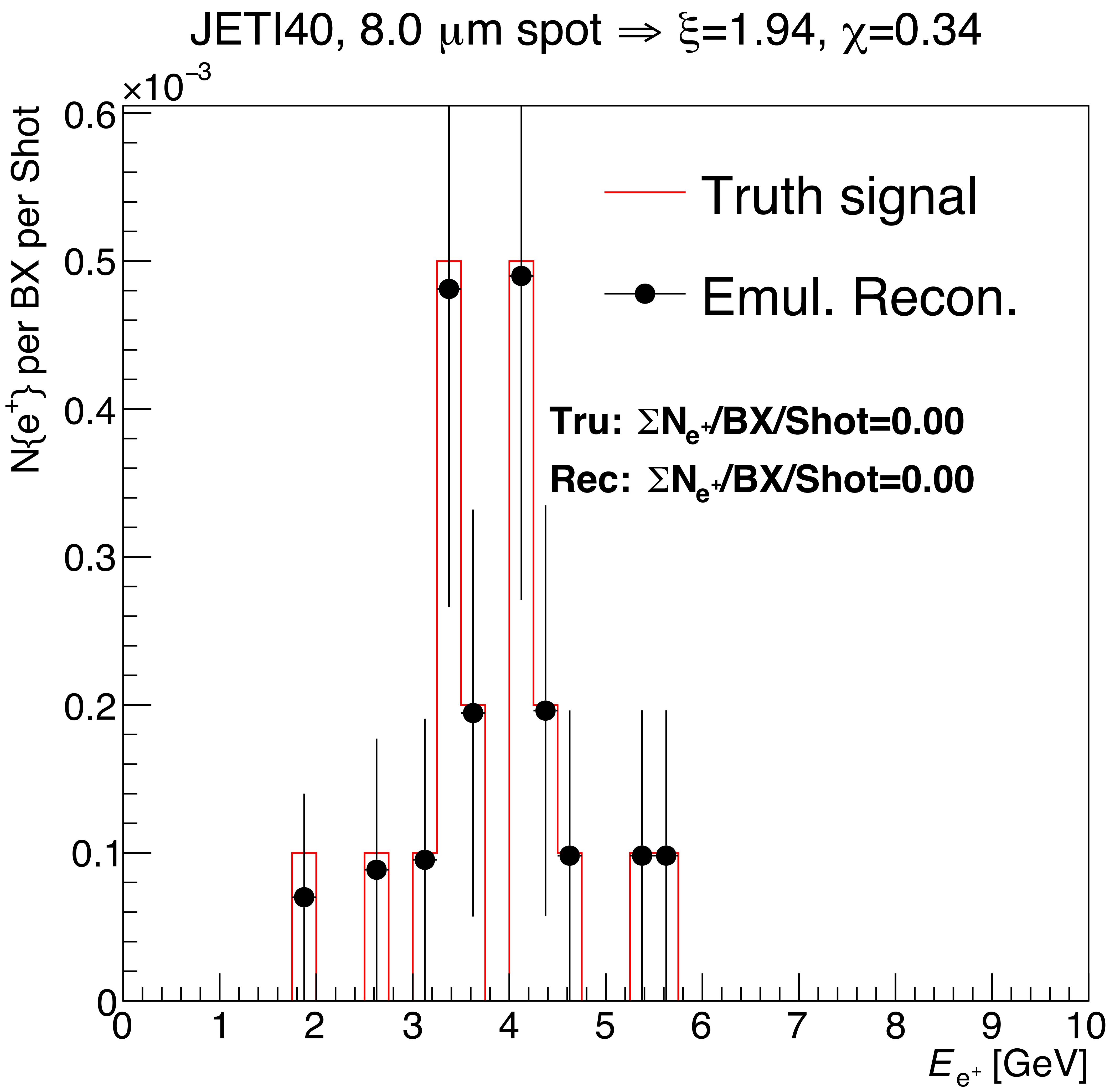


e+laser

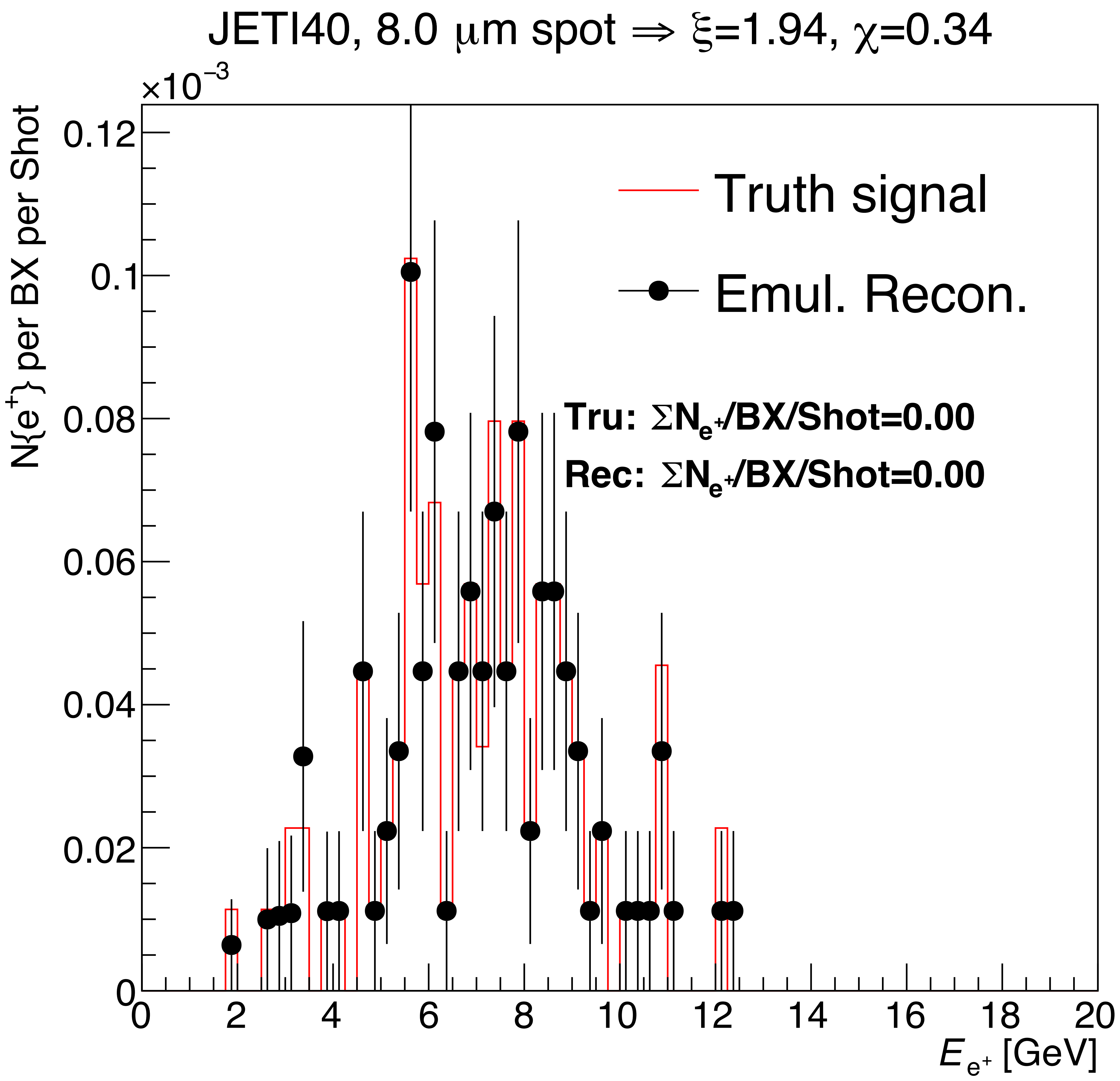


γ+laser

JETI40/(e/γ)_laser/16.5GeV/w0_8000nm

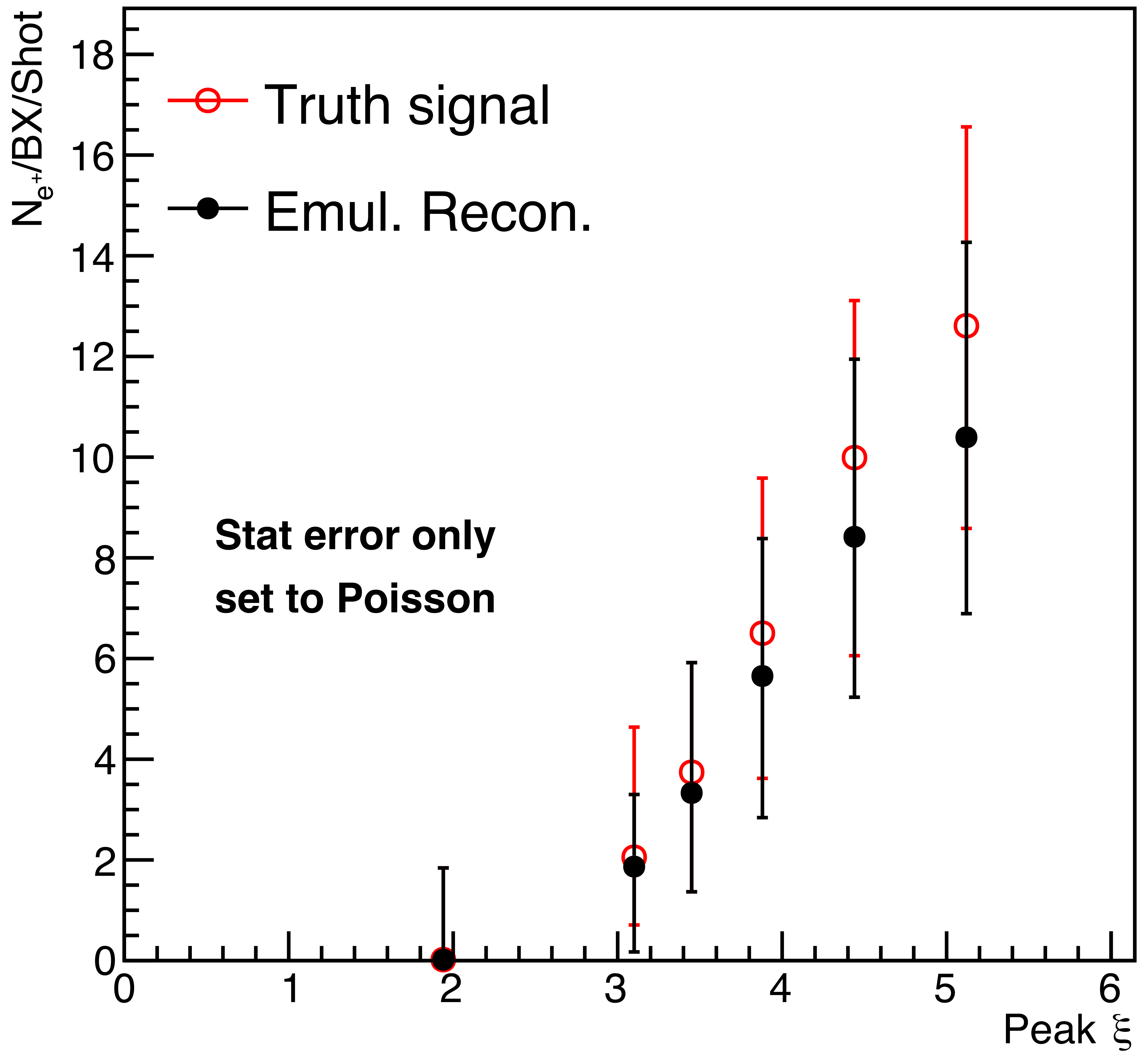


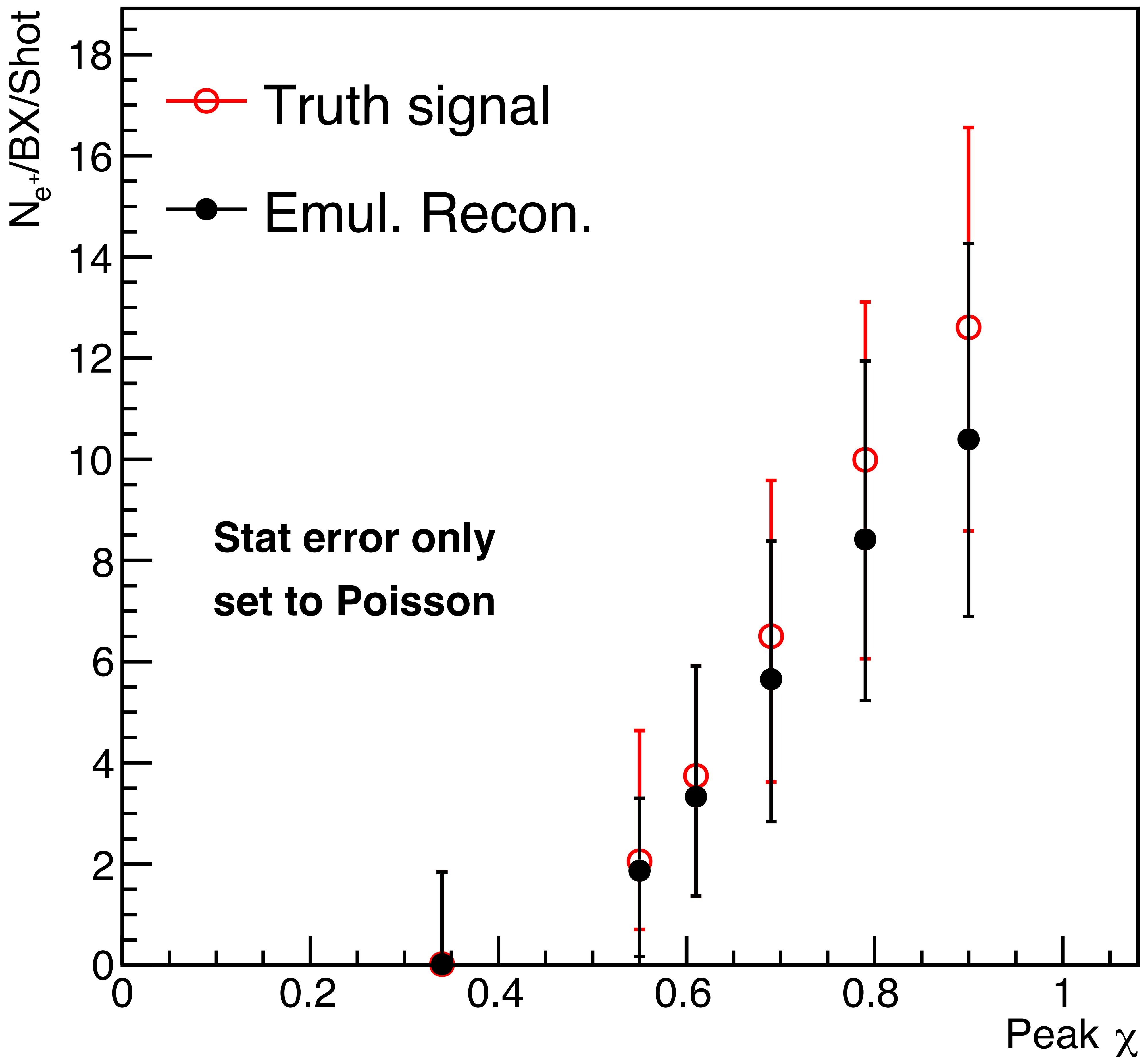
e+laser



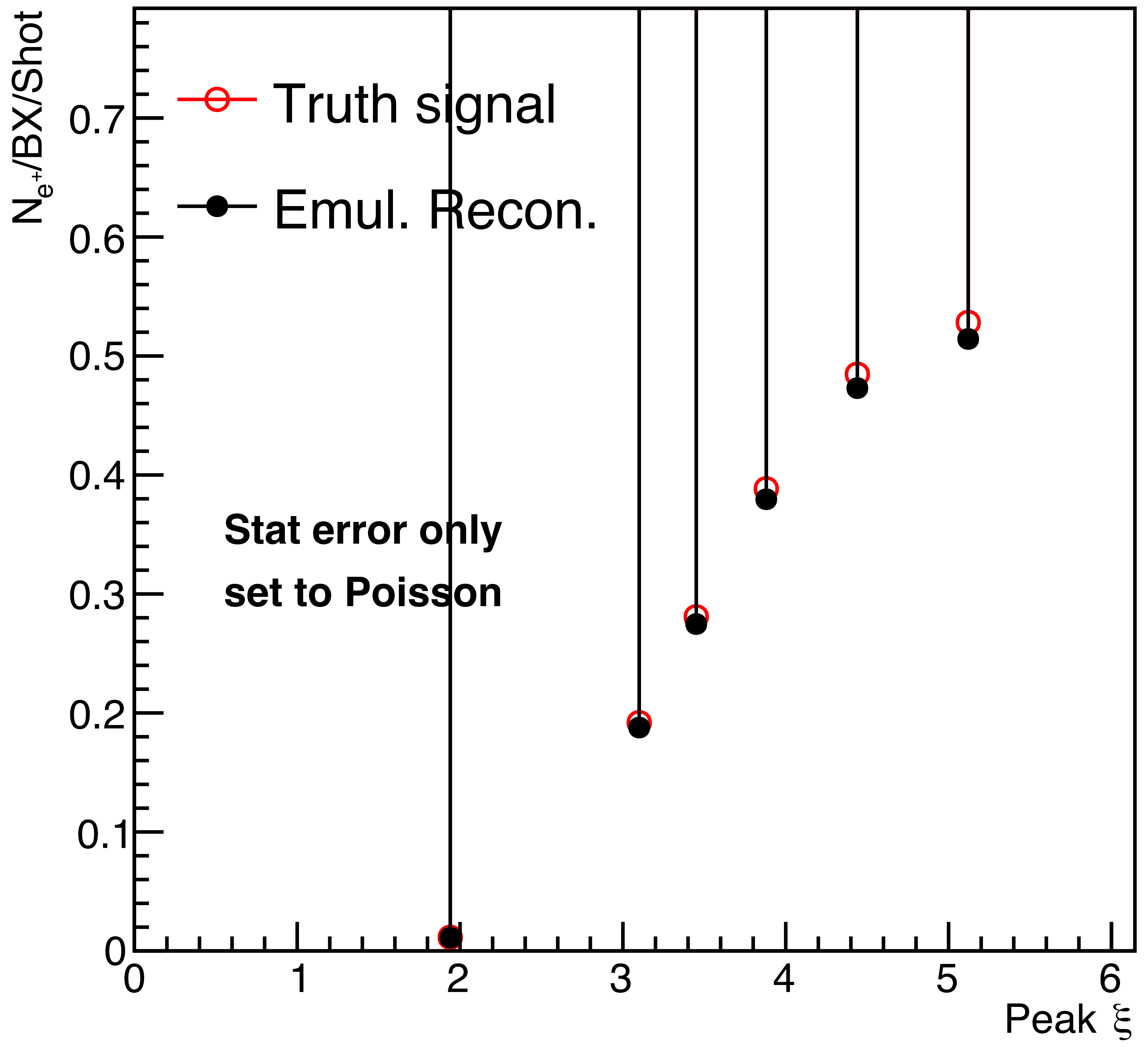
γ+laser

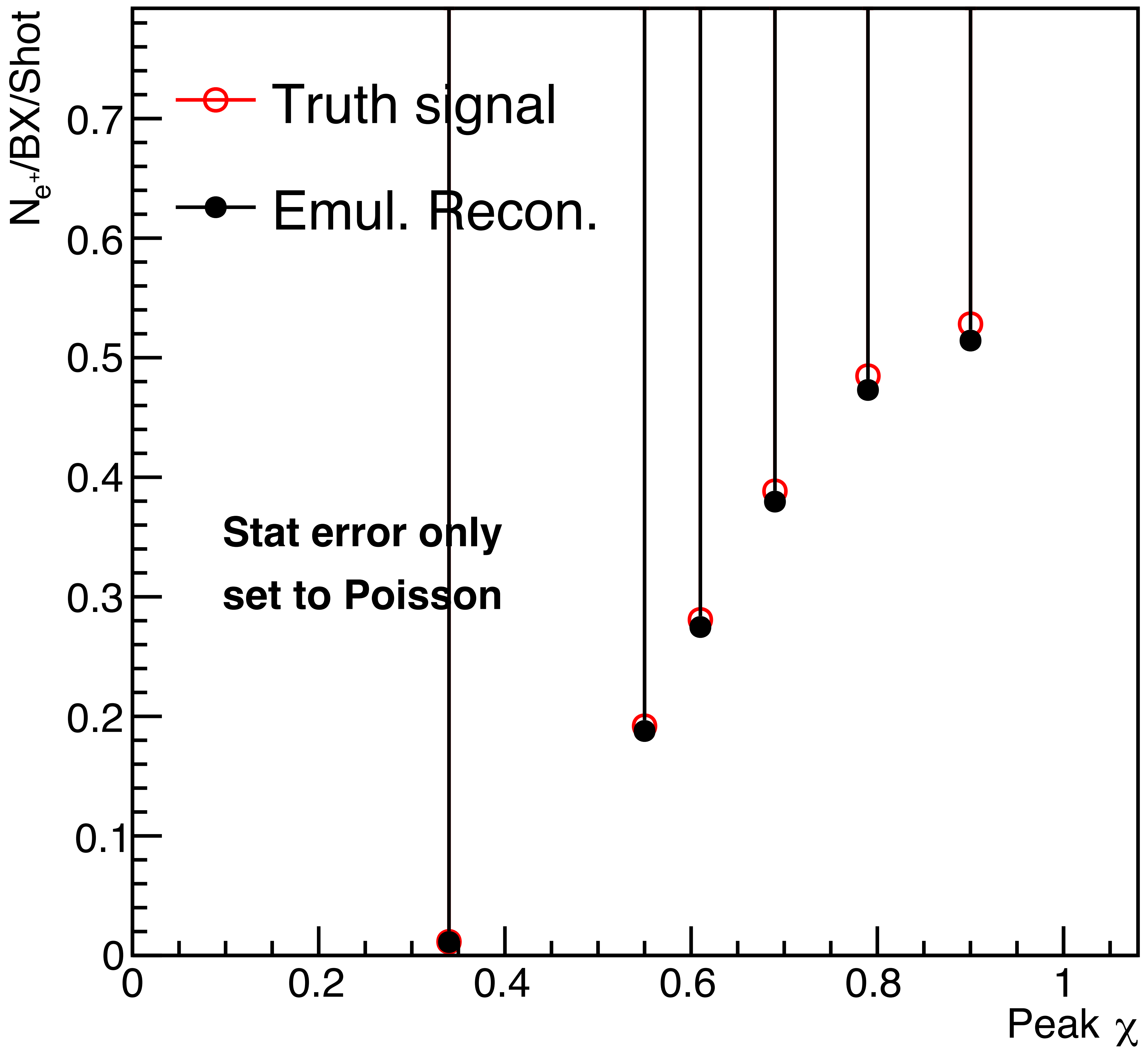
JETI40 e+laser N_{e^+}/BX/Shot vs the peak ξ and χ



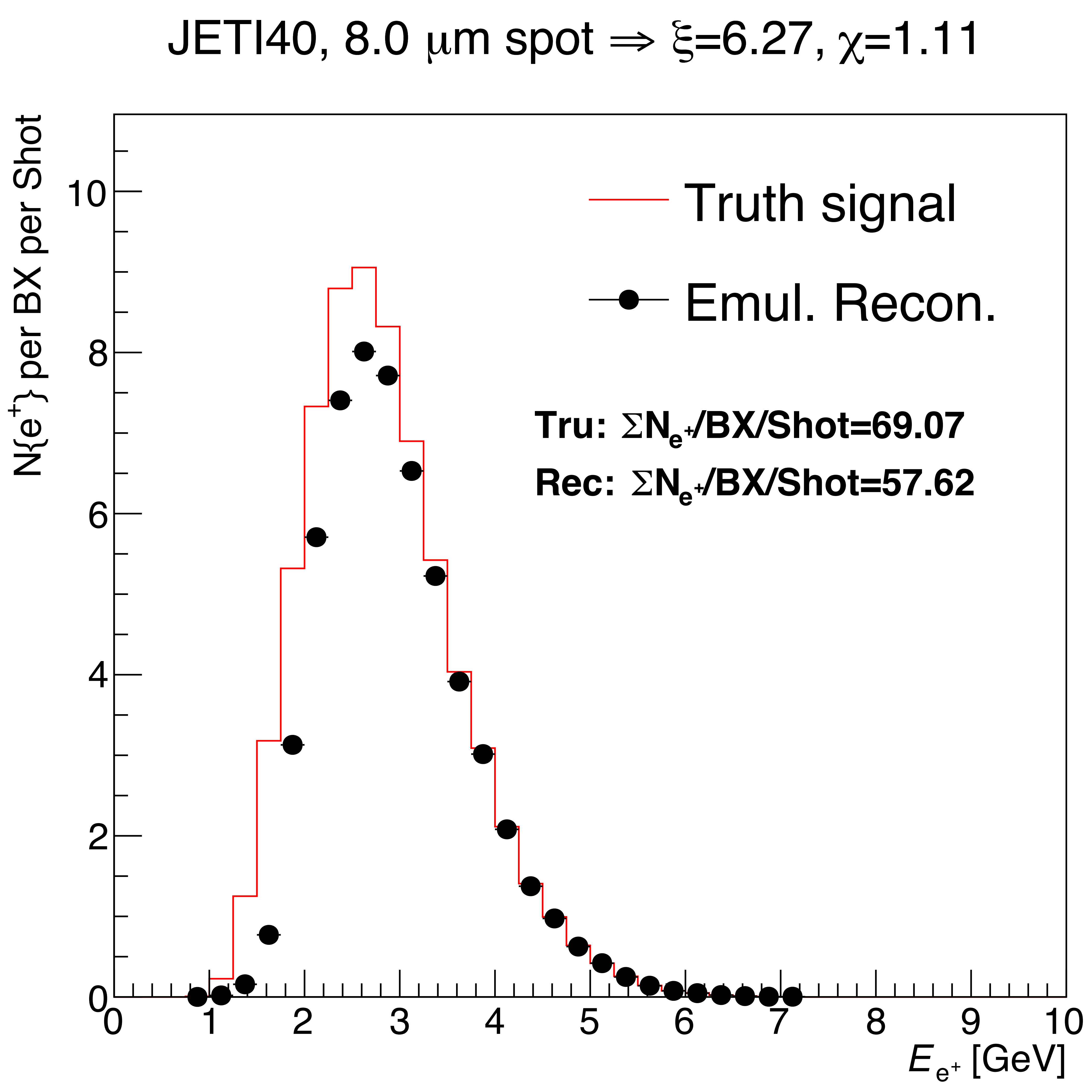


JETI40 γ+laser N_{e^+}/BX/Shot vs the peak ξ and χ

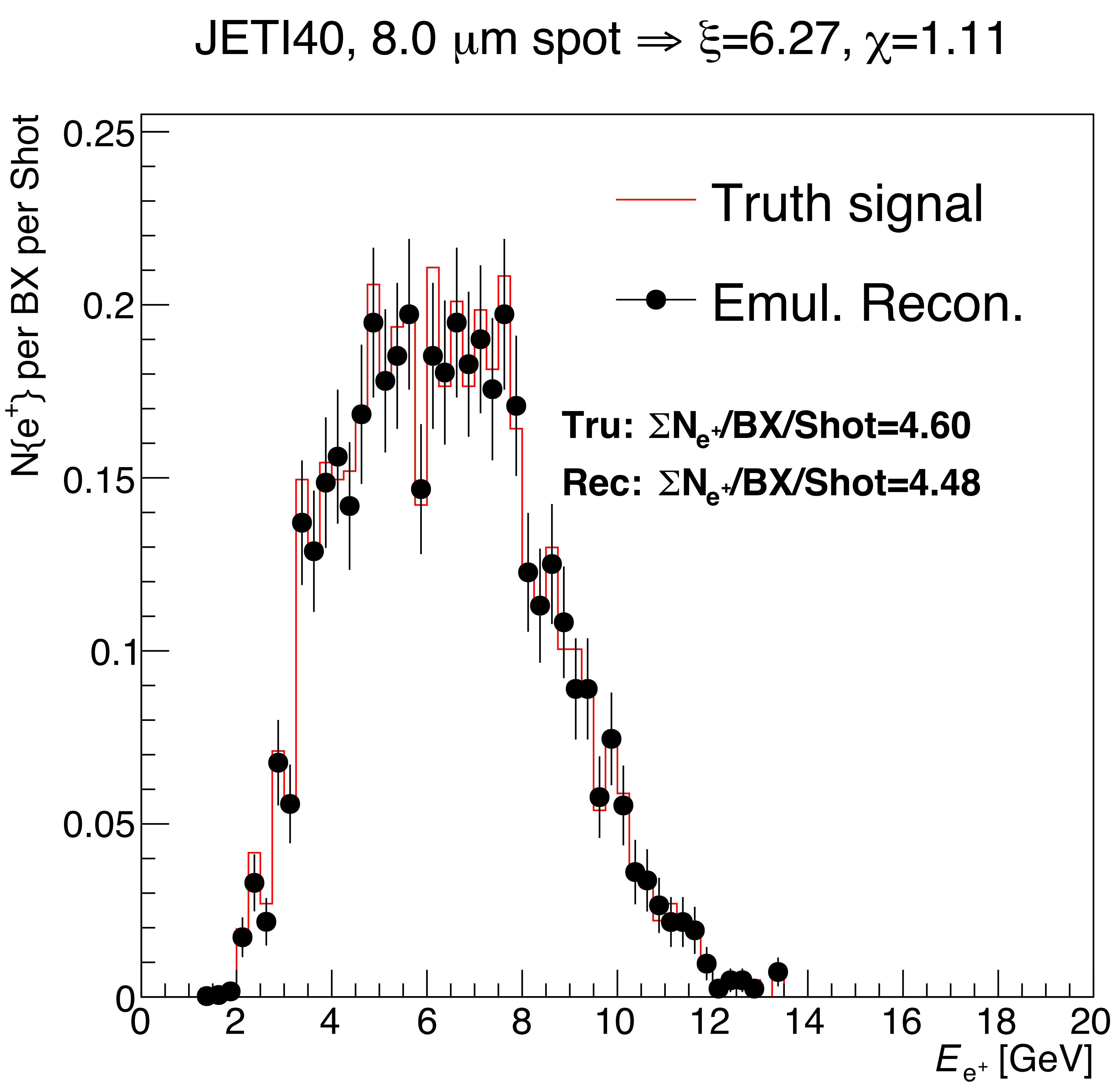




PhaseII/(e/γ)_laser/16.5GeV/w0_8000nm

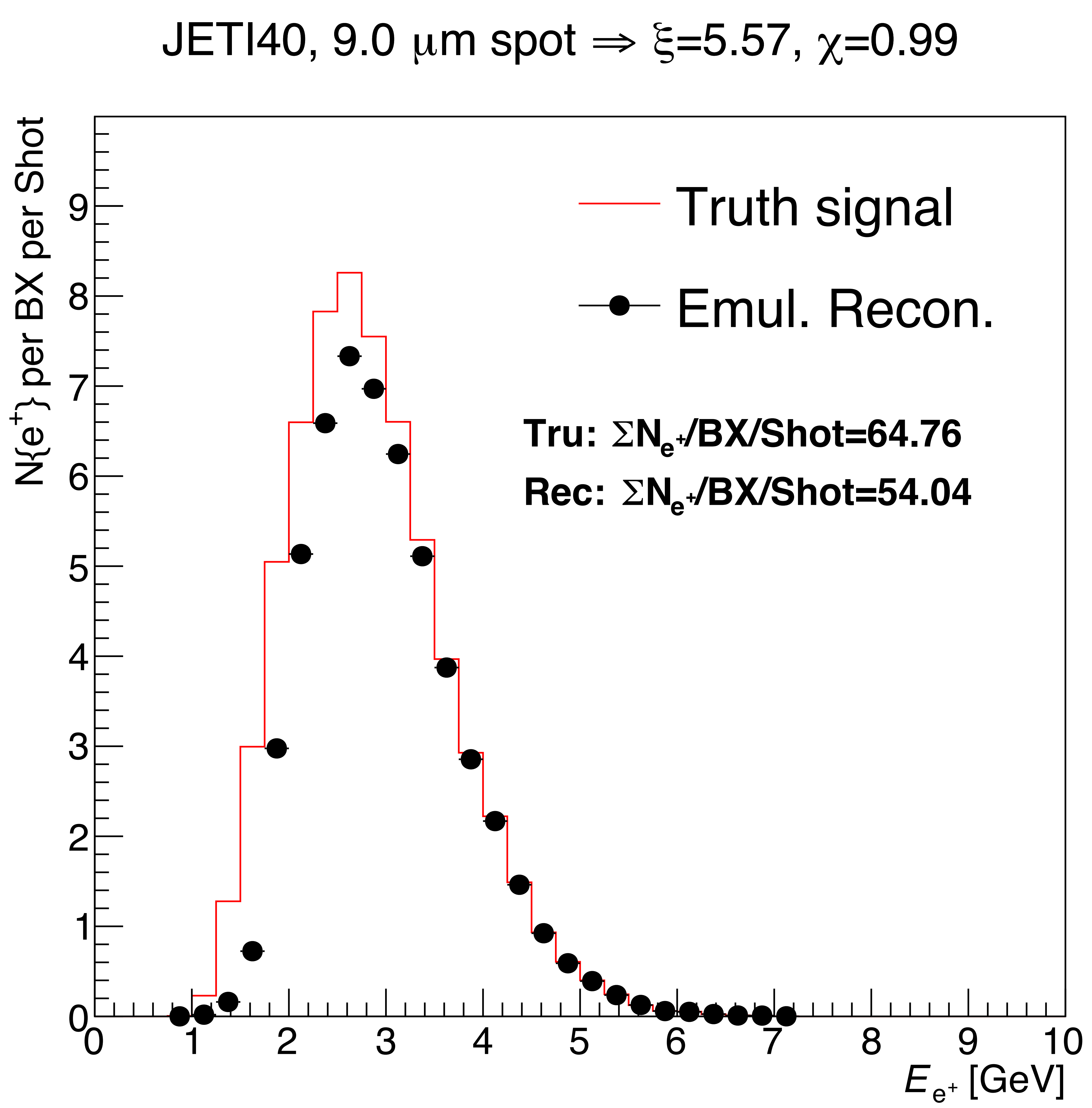


e+laser

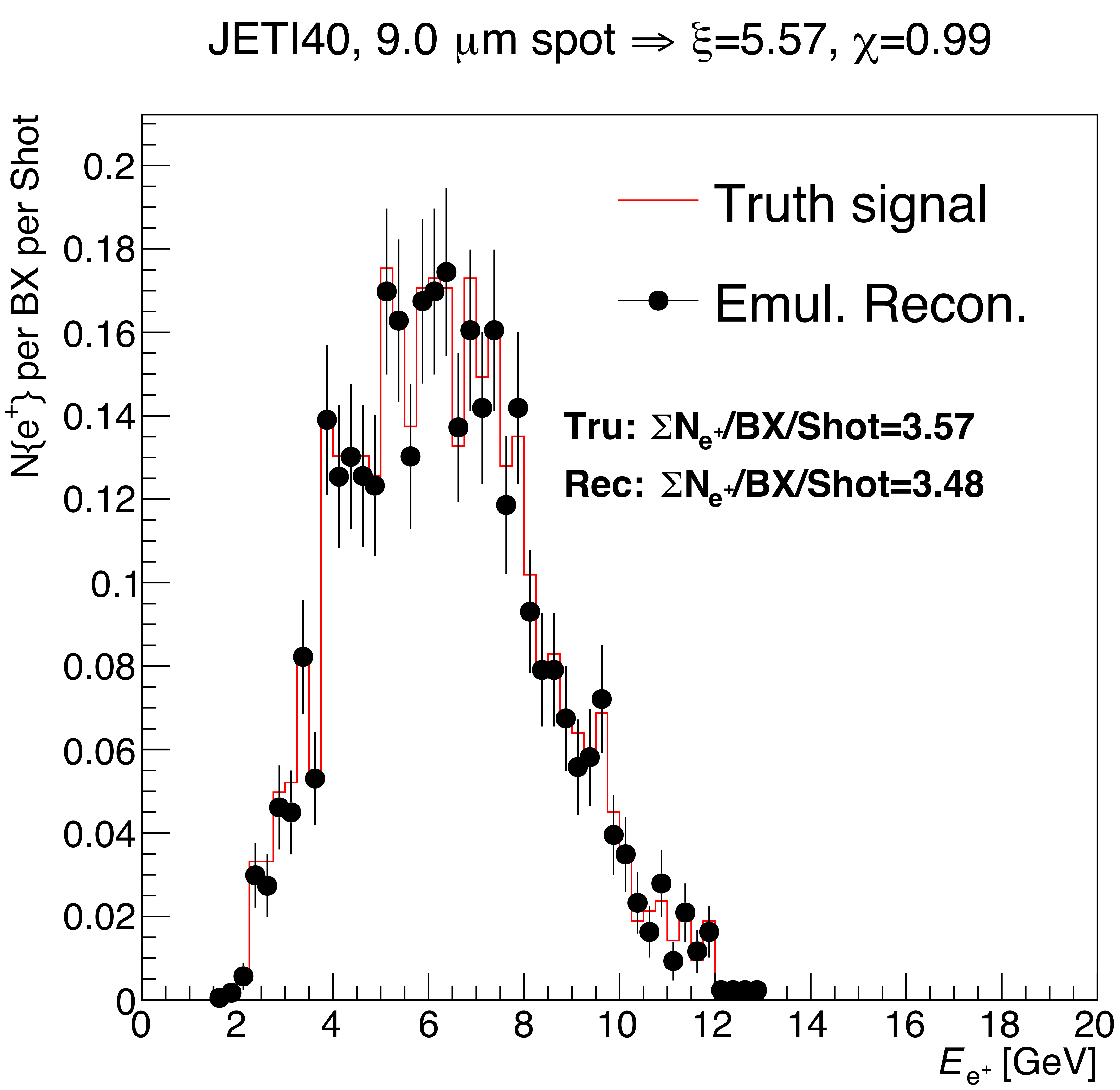


γ+laser

PhaseII/(e/γ)_laser/16.5GeV/w0_9000nm

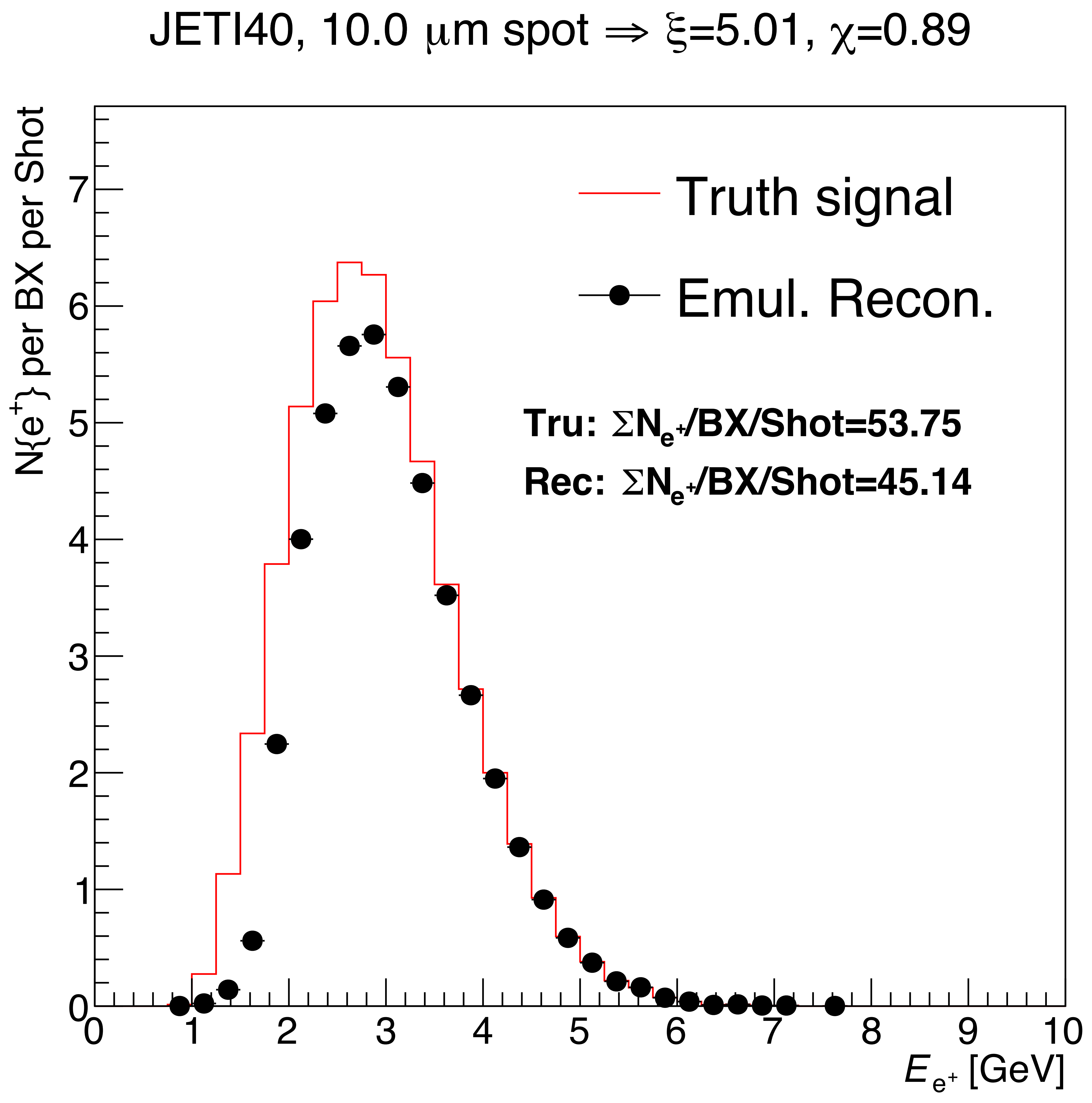


e+laser

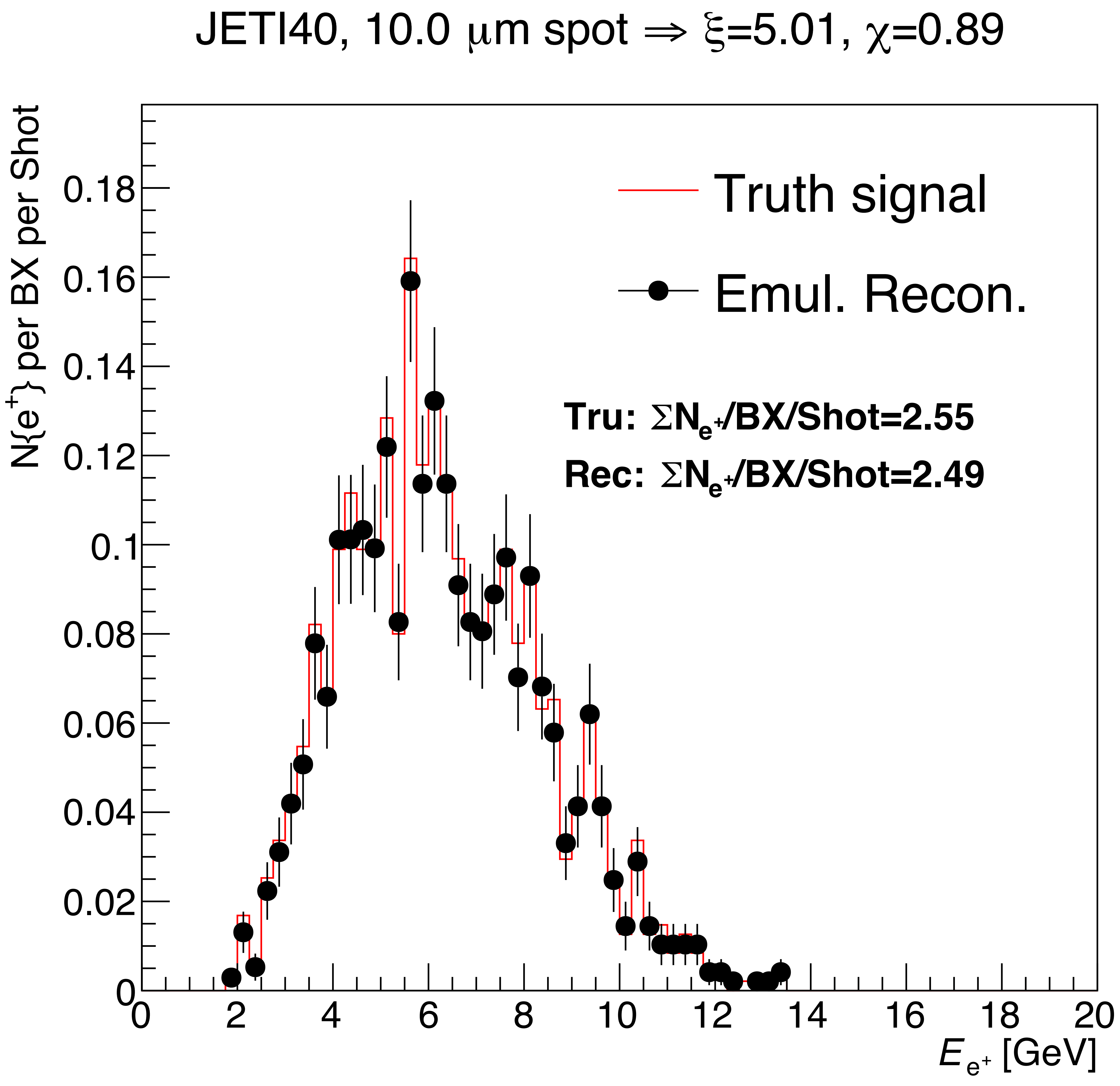


γ+laser

PhaseII/(e/γ)_laser/16.5GeV/w0_10000nm

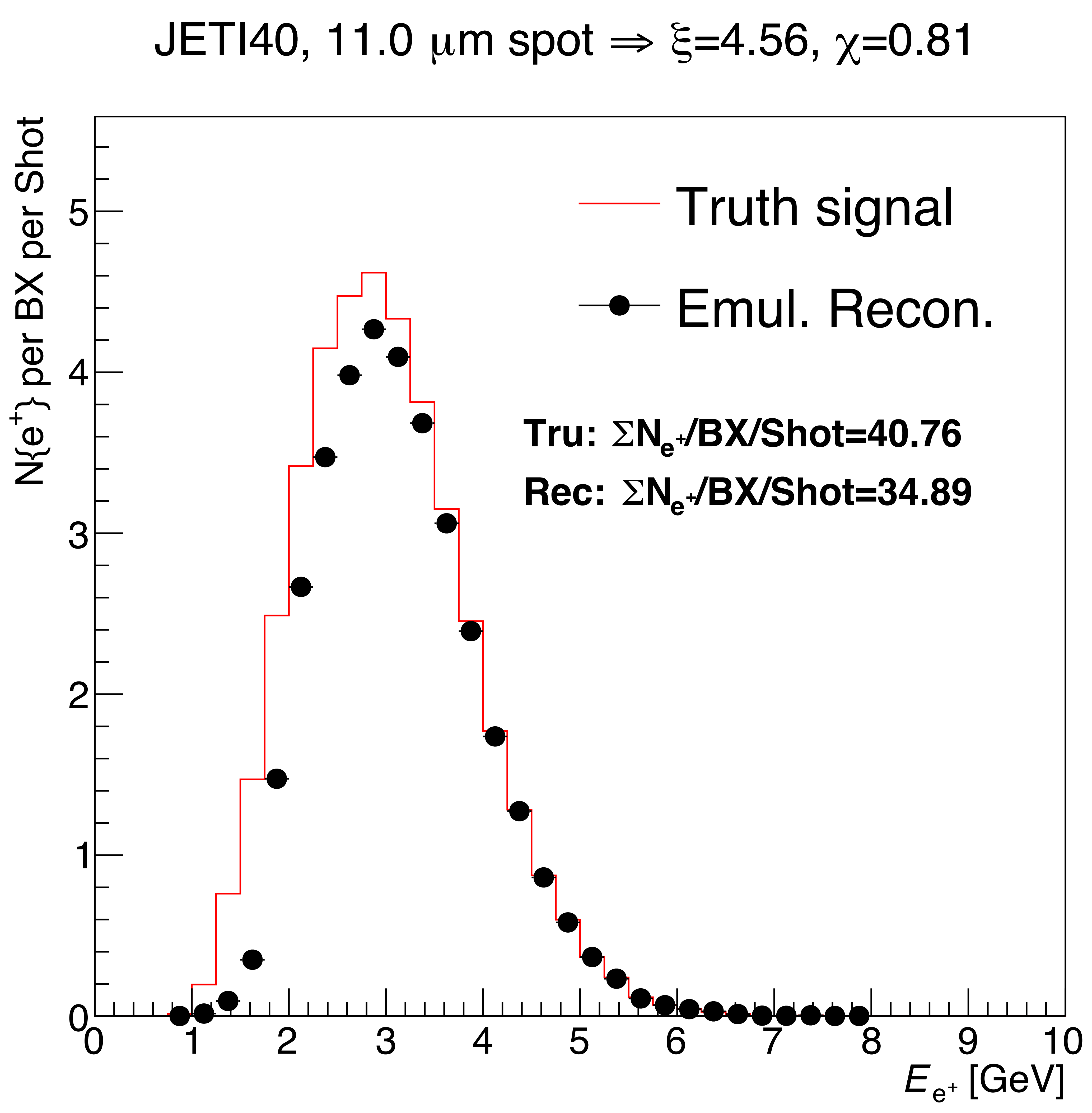


e+laser

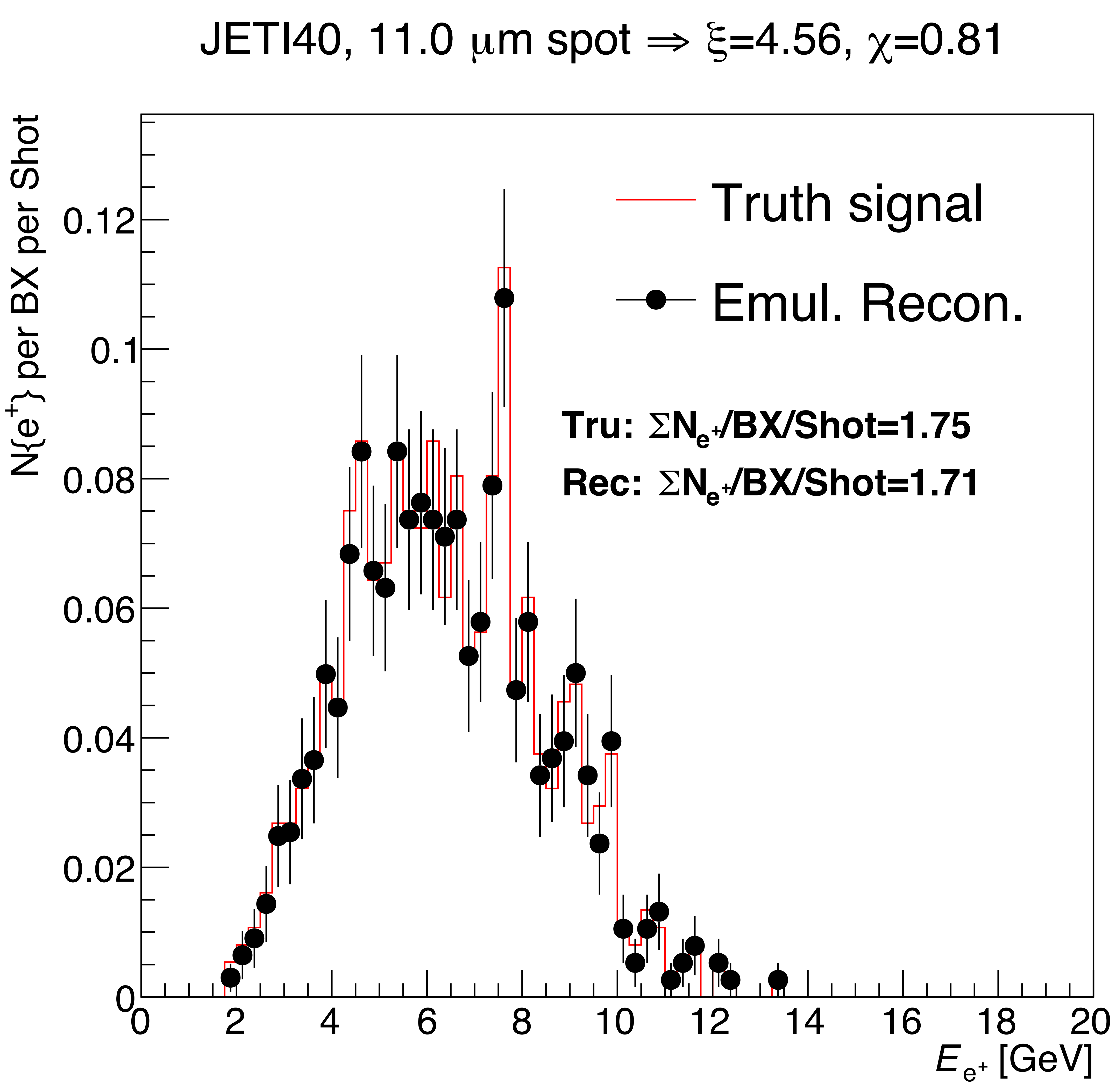


γ+laser

PhaseII/(e/γ)_laser/16.5GeV/w0_11000nm

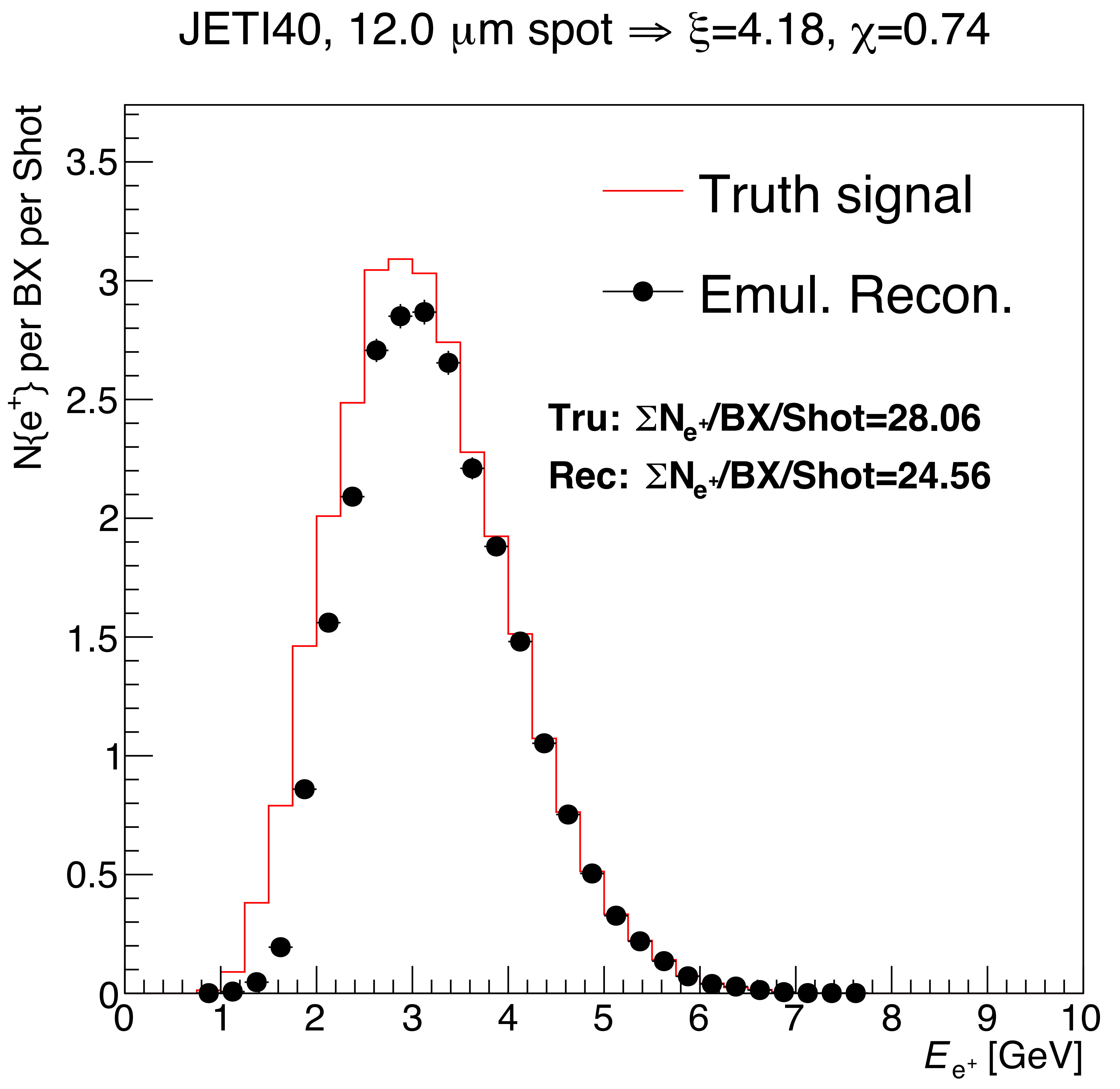


e+laser

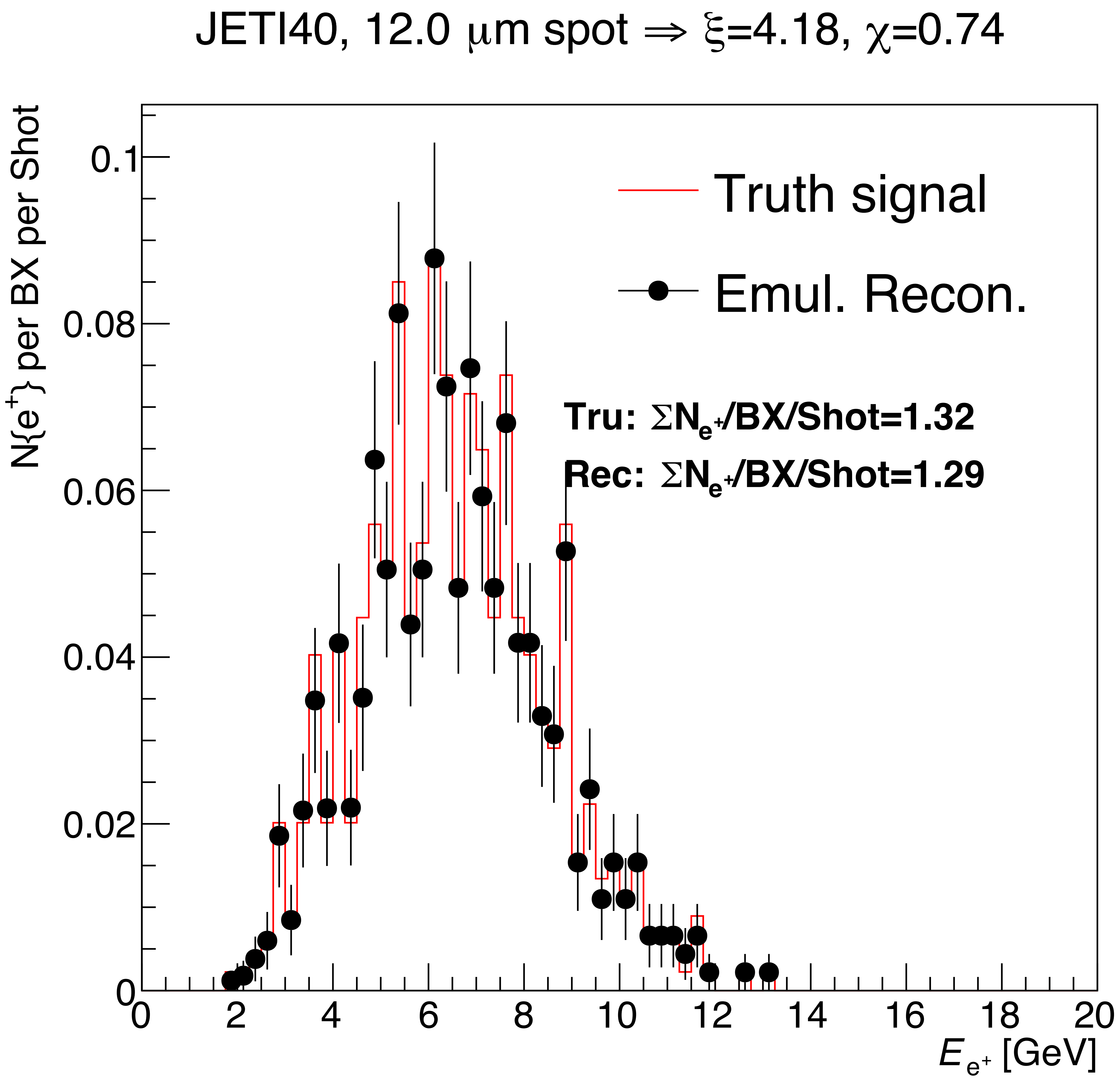


γ+laser

PhaseII/(e/γ)_laser/16.5GeV/w0_12000nm

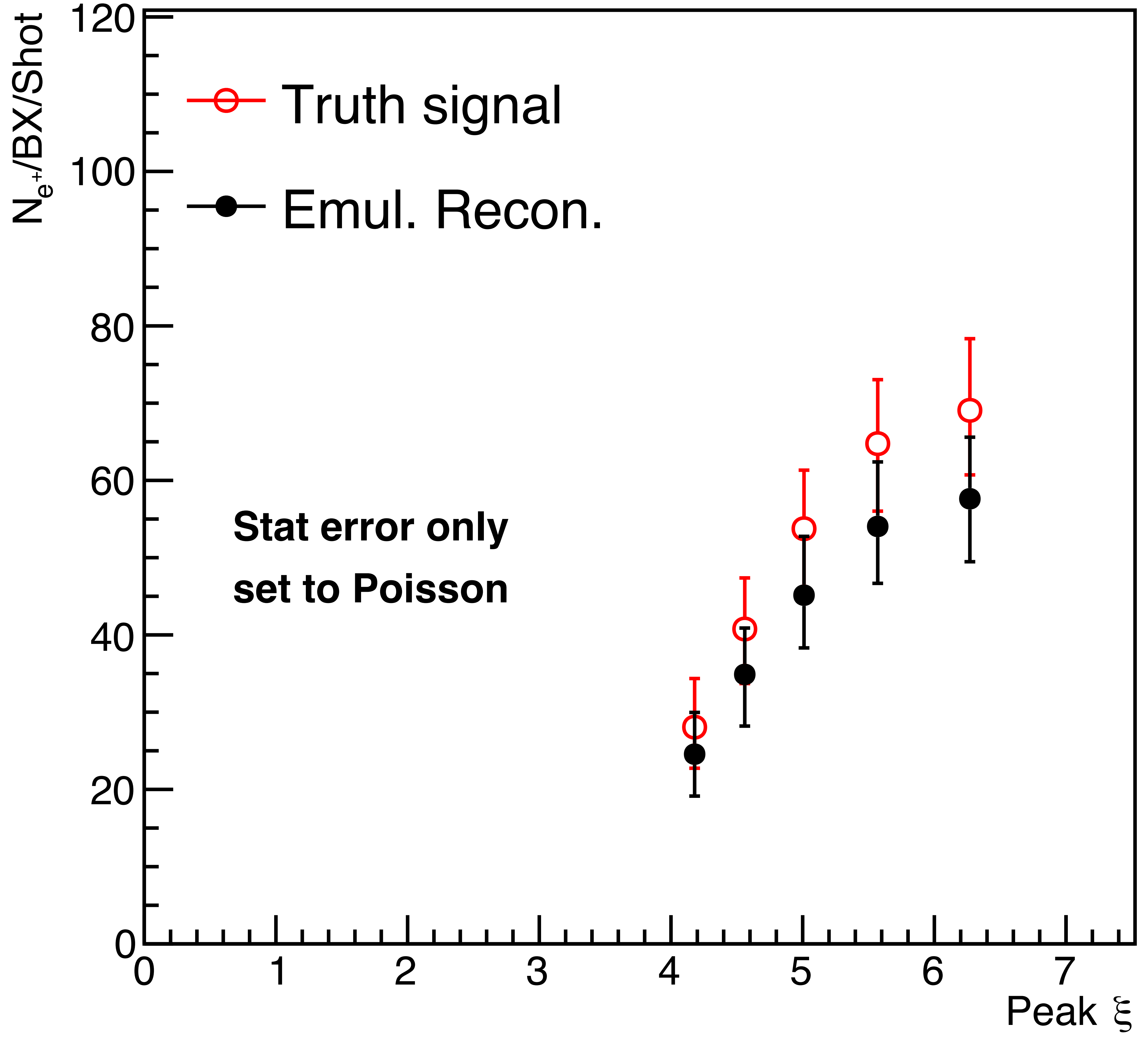


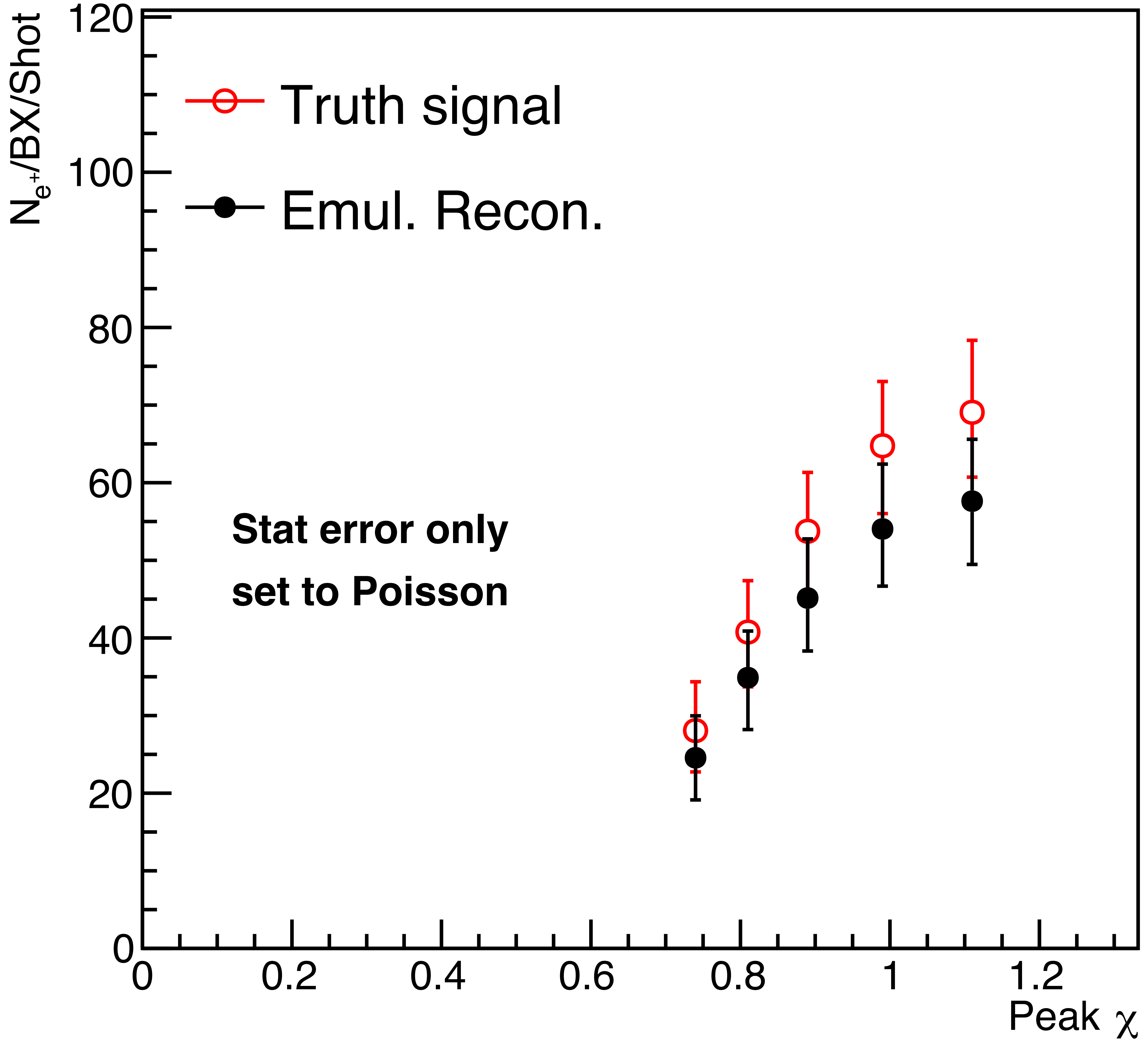
e+laser



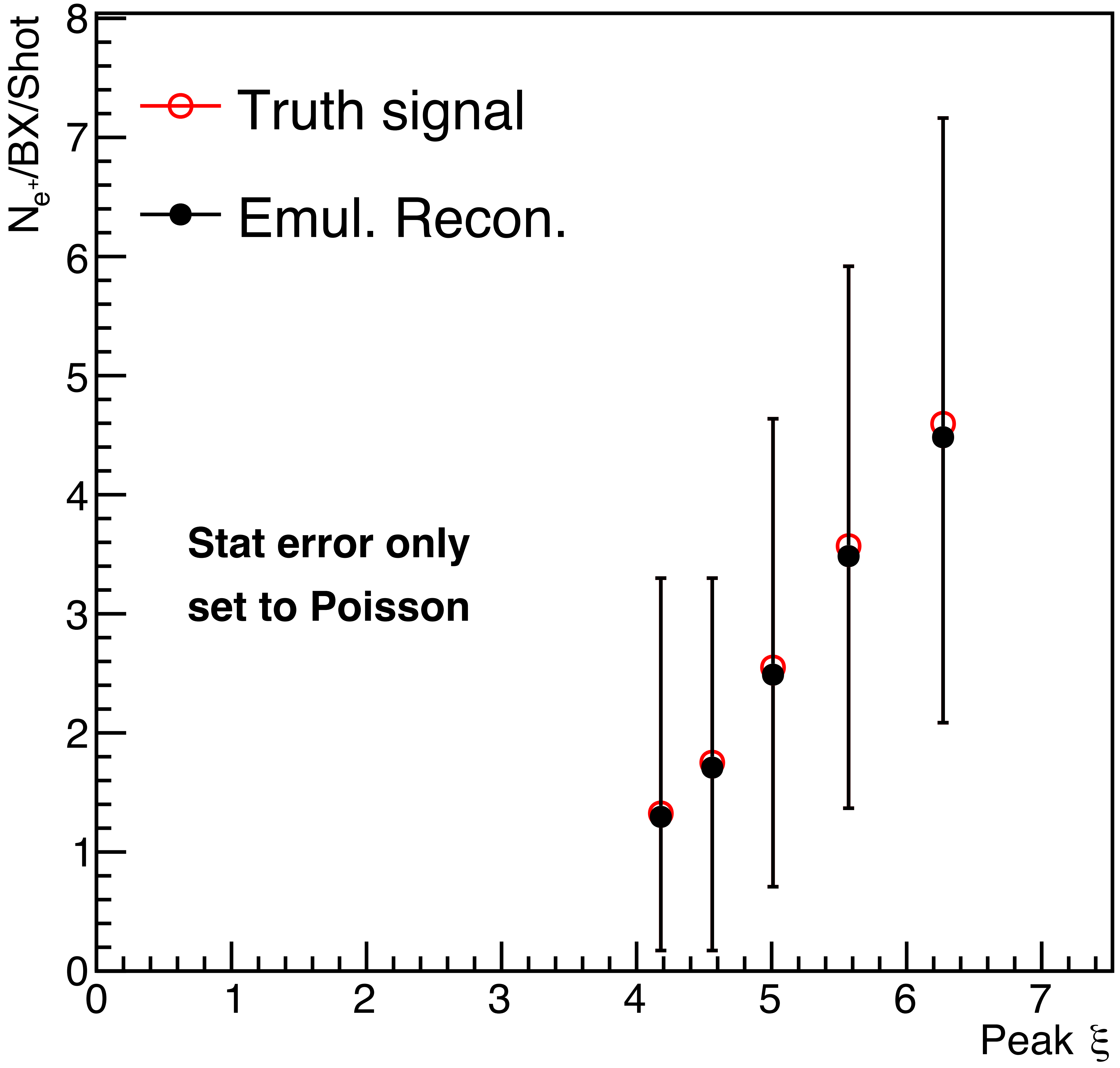
γ+laser

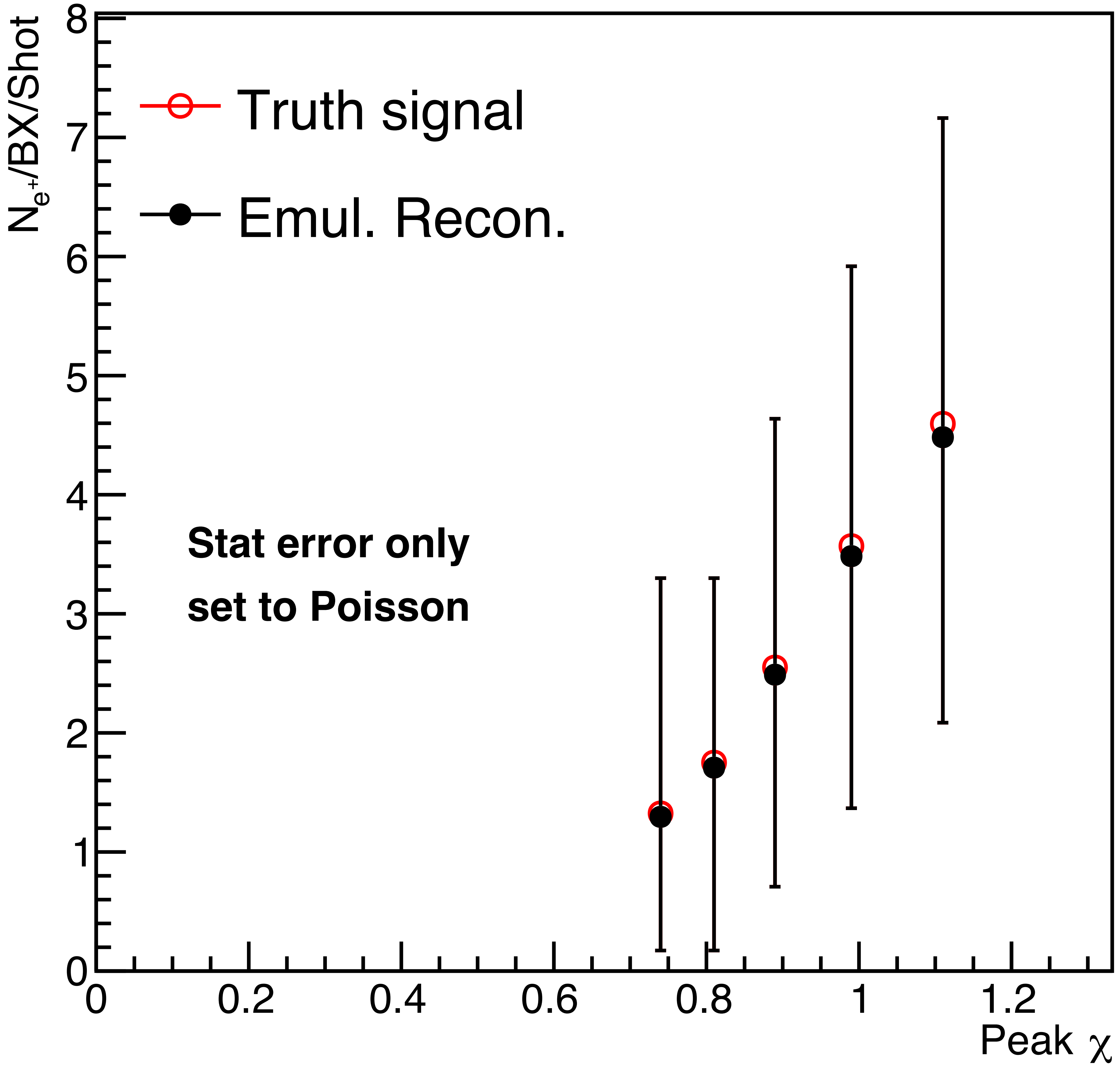
PhaseII e+laser N_{e^+}/BX/Shot vs the peak ξ and χ





PhaseII <u>γ+laser</u> N_{e^+}/BX/Shot vs the peak ξ and χ





LOI γ+laser N_{e^+}/BX/Shot vs the peak ξ and χ

Not sure why the phaseII numbers are way smaller than in the LOI for the same ξ (with 300 TW at 3 μm) and almost the same beam energy (1 GeV difference)

	30 TW, 8μm	300 TW, 8μm	300 TW, 3μm
Laser energy after compression (J)	0.9	9	9
Percentage of laser in focus (%)	40	40	40
Laser energy in focus (J)	0.36	3.6	3.6
Laser pulse duration (fs)	30	30	30
Laser focal spot FWHM (μm)	8	8	3
Peak intensity in focus (Wcm^{-2})	1.6×10^{19}	1.6×10^{20}	1.1×10^{21}
Dimensionless peak intensity, ξ	2	6.2	16
Laser repetition rate (Hz)	1	1	1
Electron-laser crossing angle (rad)	0.35	0.35	0.35
14 GeV electrons			
Electron Lorentz factor	2.7×10^4	2.7×10^4	2.7×10^4
Quantum parameter χ	0.32	1	2.6
17.5 GeV electrons			
Electron Lorentz factor	3.4×10^4	3.4×10^4	3.4×10^4
Quantum parameter χ	0.41	1.26	3.26

Table 3. Typical laser and interaction parameters for different initial laser power and focussing geometry, for two different electron energies: 14 GeV and 17.5 GeV.

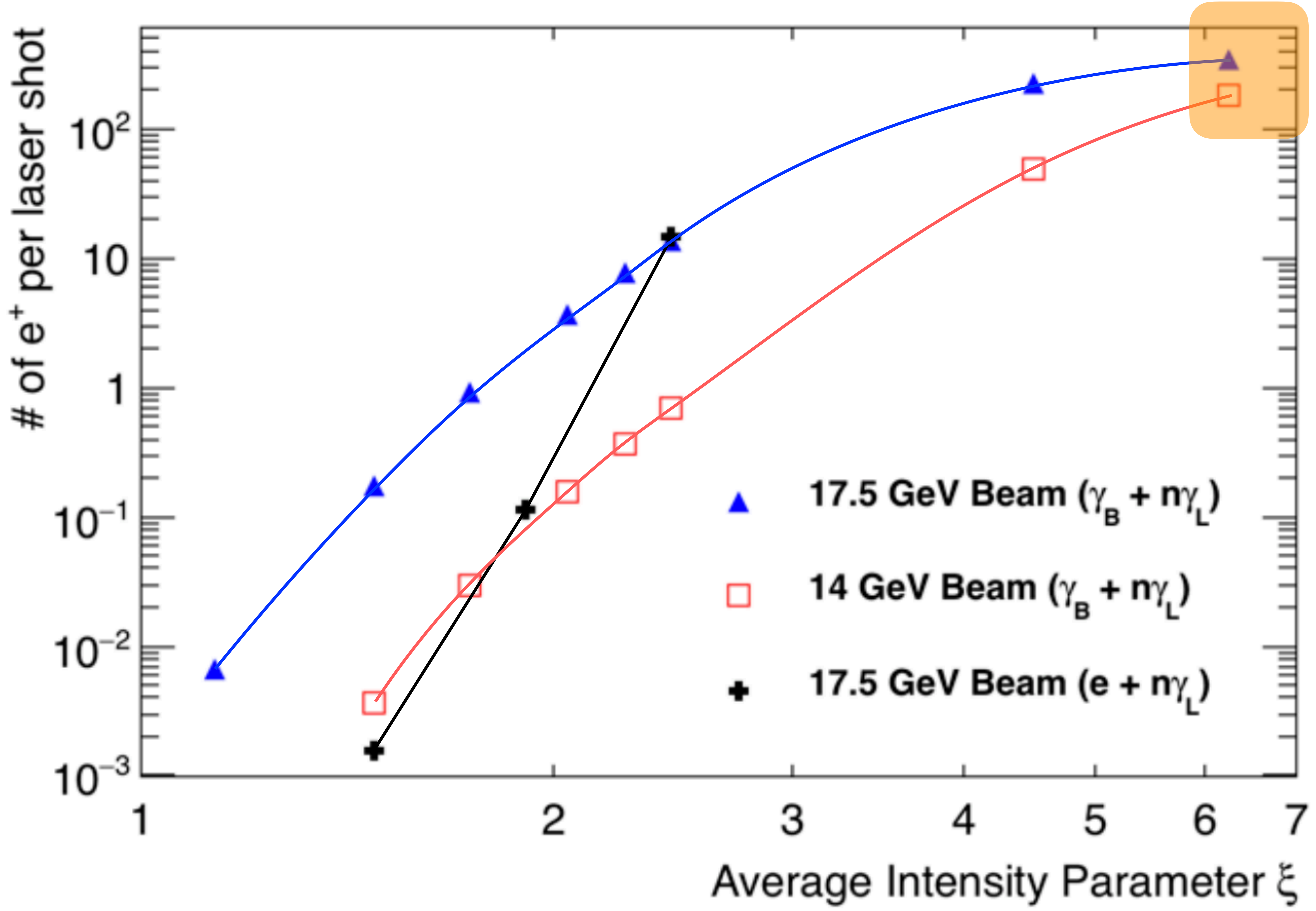


Figure 10. Number of positrons per laser shot versus the mean value of ξ in the γ_B–laser (for $E_{\text{beam}} = 17.5$ and 14.0 GeV) and the two-step trident process in the e–laser setup. No uncertainties are shown. It is expected that the statistical precision achieved will be between about 10% at low ξ and $\ll 1\%$ at high ξ.

Summary

- Some things still to understand regarding the g+laser distributions and overall rates
- The acc*eff which was optimised for the g+laser setup (incl. toy bkg) works well for the g+laser setup as expected while there's room for improvement for the e+laser (e.g. tilting the layers?)
- The resolution is already very good and the smearing has negligible impact
- Stat uncertainty isn't small.