# Bayesian Networks for the LHC

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# One number is not a measurement

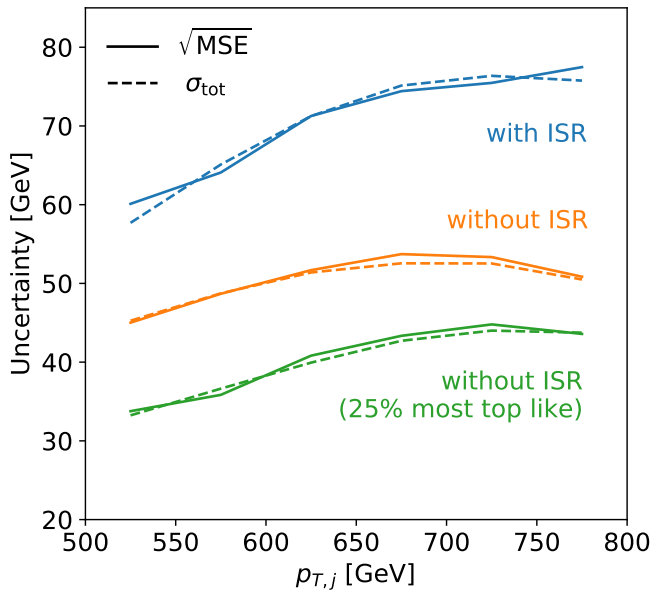
## Regression: transverse momentum of top-jet [Kasieczka, Luchmann, Otterpohl, TP (2003.11099)]

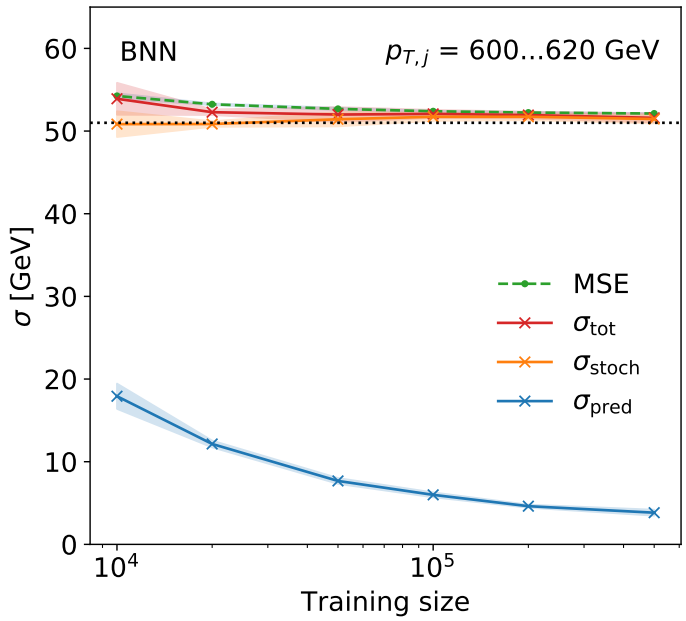
- input: QCD jet constituents
  measurement: top energy with error bar
- Bayesian NN for noisy and size-limited training [frequentist definition]

  $\sigma_{\text{stoch}}$ stochastic training data

  $\sigma_{\text{pred}}$ limited training sample
- Gaussian combination $\sigma^2_{\text{tot}} = \sigma^2_{\text{stoch}} + \sigma^2_{\text{pred}}$

$\Rightarrow$ Error estimate works



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## Things we play with [Bollweg, Haußmann, Kasieczka, Luchmann, TP, Thompson (1904.10004)]

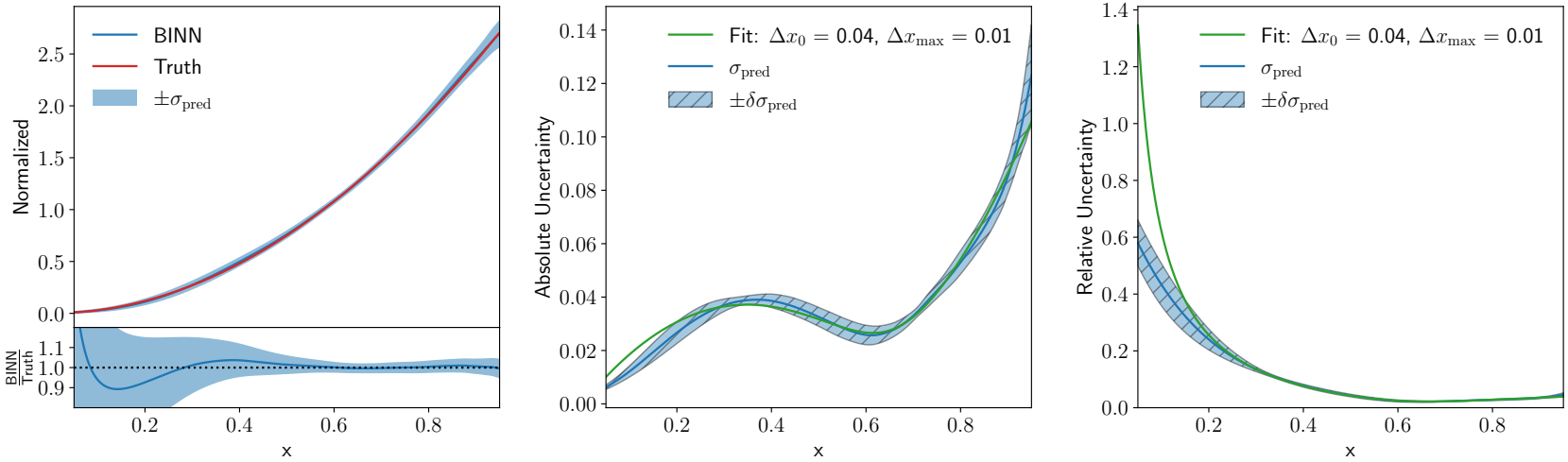
- compare to truth MSE
- validate with many determistic networks
- separate sources of uncertainty
- confirm no prior dependence
- allow Gaussian mixture output
- test calibration
- test stability [classification]
- design adversarial-attack augmentations

# One number is not a prediction

## Bayesian generative network [Bellagente, Luchmann, Haußmann, TP (2104.04543)]

- generate events with error bars
  i.e. learn density and uncertainty maps over phase space
- normalizing flow/INN [Köthe etal]
- 2D toy models: wedge ramp, kicker ramp, Gaussian ring

$\Rightarrow$ Error estimate works...




...and we see how the network learns!

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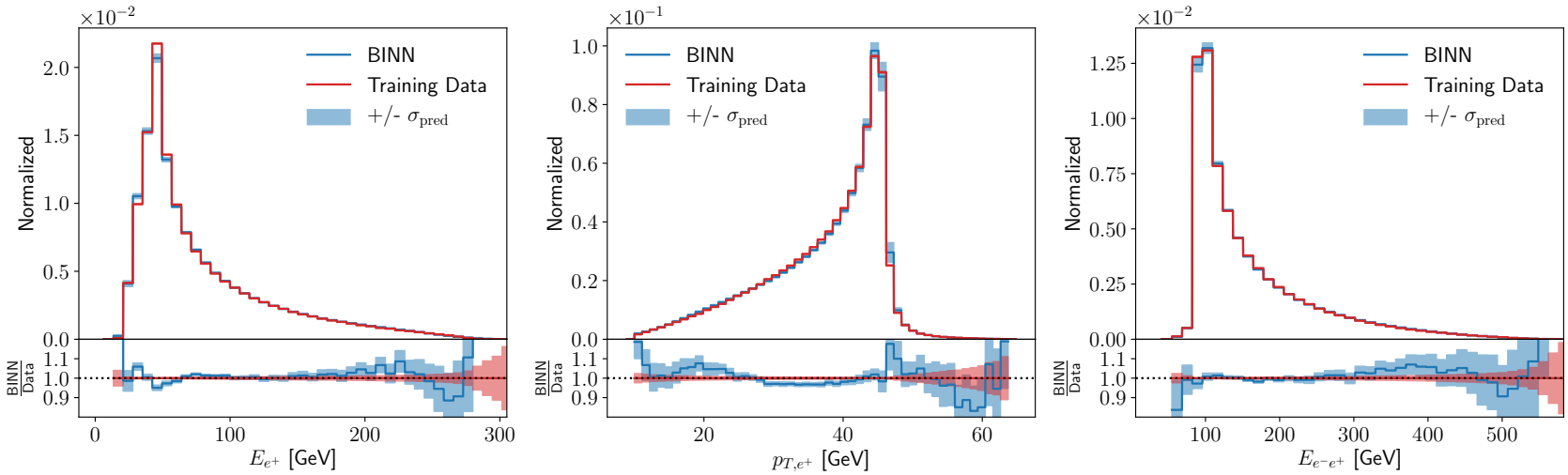
## Simple LHC process

- 1D kinematic distributions with errors




$\Rightarrow$ Game changer in NN-simulations!?

# Join our discussion!