Solving the inverse problem at the event level with GANs

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Particle physics workflow

Step1: define the reaction

$$A(q_1) + B(q_2) \to C(p_1) + D(p_2) + \dots$$

Step2: reconstruct **detector level** PDF

$$\rho_{\text{detector}}(p_1, p_2, ..|q_1, q_2)$$

Step3: reconstruct **vertex level** PDF

$$\rho_{\text{detector}}(p_1, p_2, ..|q_1, q_2) = R \otimes \rho_{\text{vertex}}(p_1, p_2, ..|q_1, q_2)$$

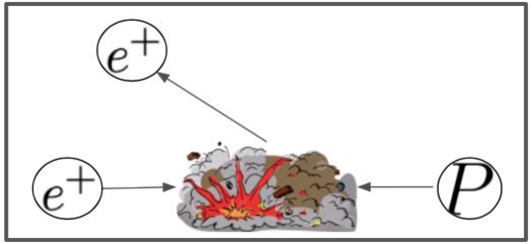
Direct connection with theory

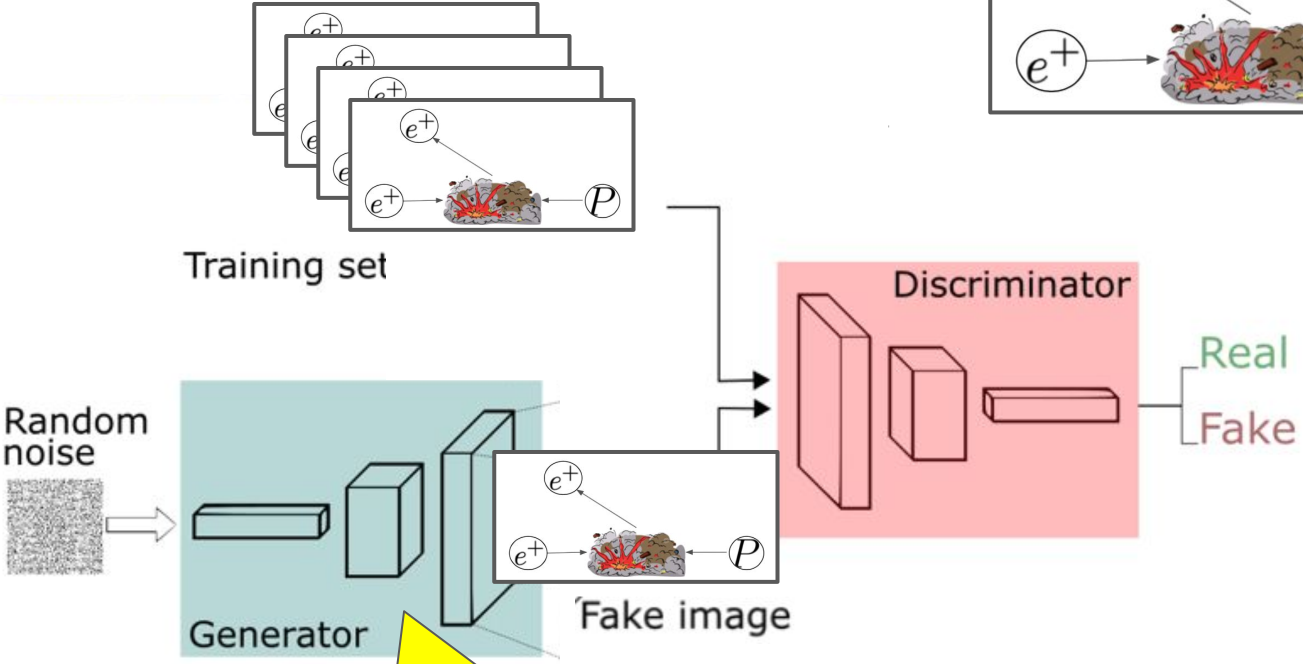
The inverse problem

$$\rho_{\text{detector}}(p_1, p_2, ..|q_1, q_2) = R \otimes \rho_{\text{vertex}}(p_1, p_2, ..|q_1, q_2) \quad (1)$$

- R needs to be extracted from detector simulators
- R is easier to represent at the event level
- Eq (1) is easier to solve at event level

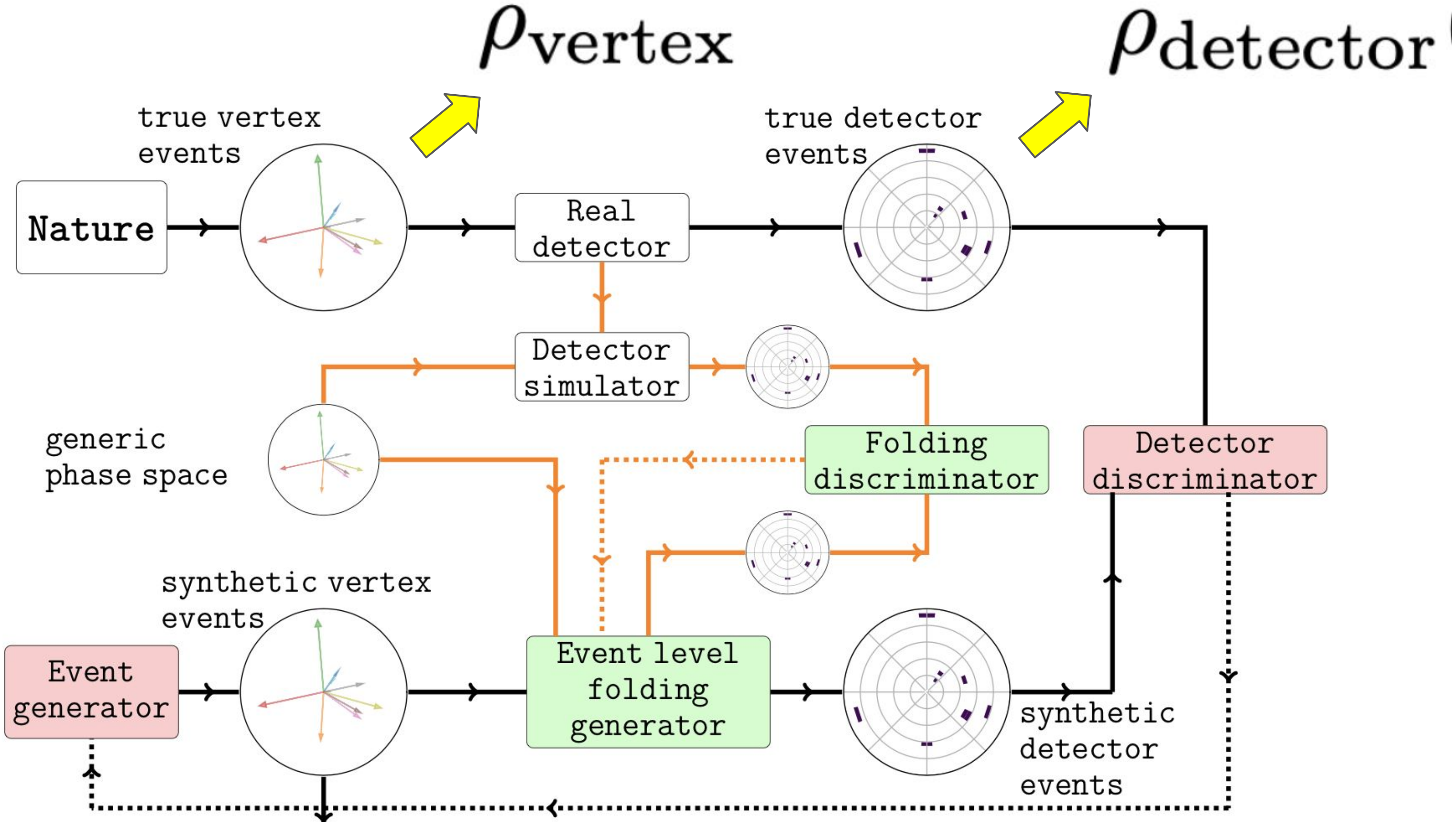
GAN as event generator





Underlying law for particle momentum distributions

The GAN approach



Ok easy to say than do ....

- **Quality** of the GAN -> fine details for the pdf
- **Confidence** -> uncertainty quantification