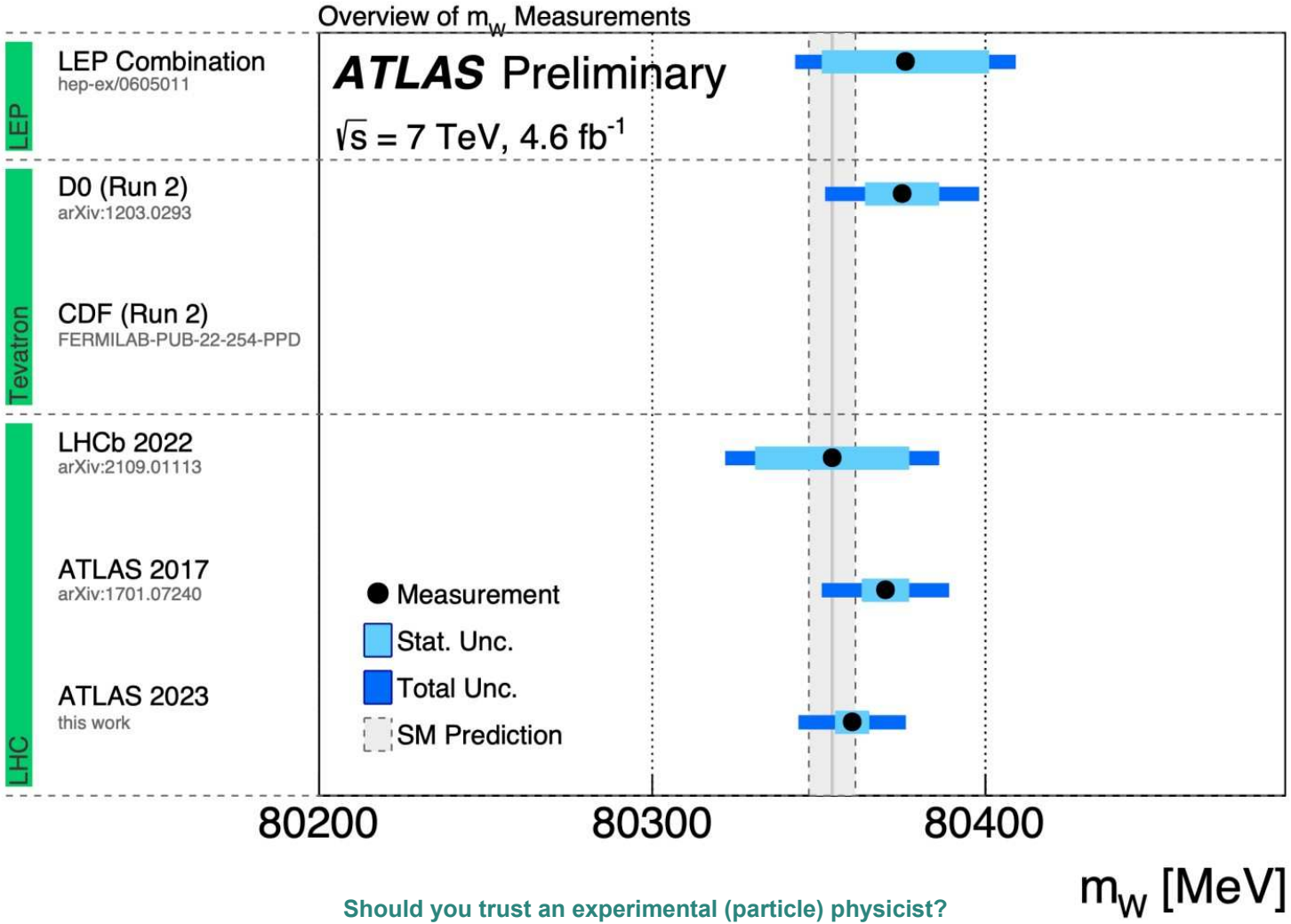
Overview of m_W Measurements
ATLAS Preliminary
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LEP
LEP Combination
hep-ex/0605011
Tevatron
D0 (Run 2)
arXiv:1203.0293
CDF (Run 2)
FERMILAB-PUB-22-254-PPD
LHC
LHCb 2022
arXiv:2109.01113
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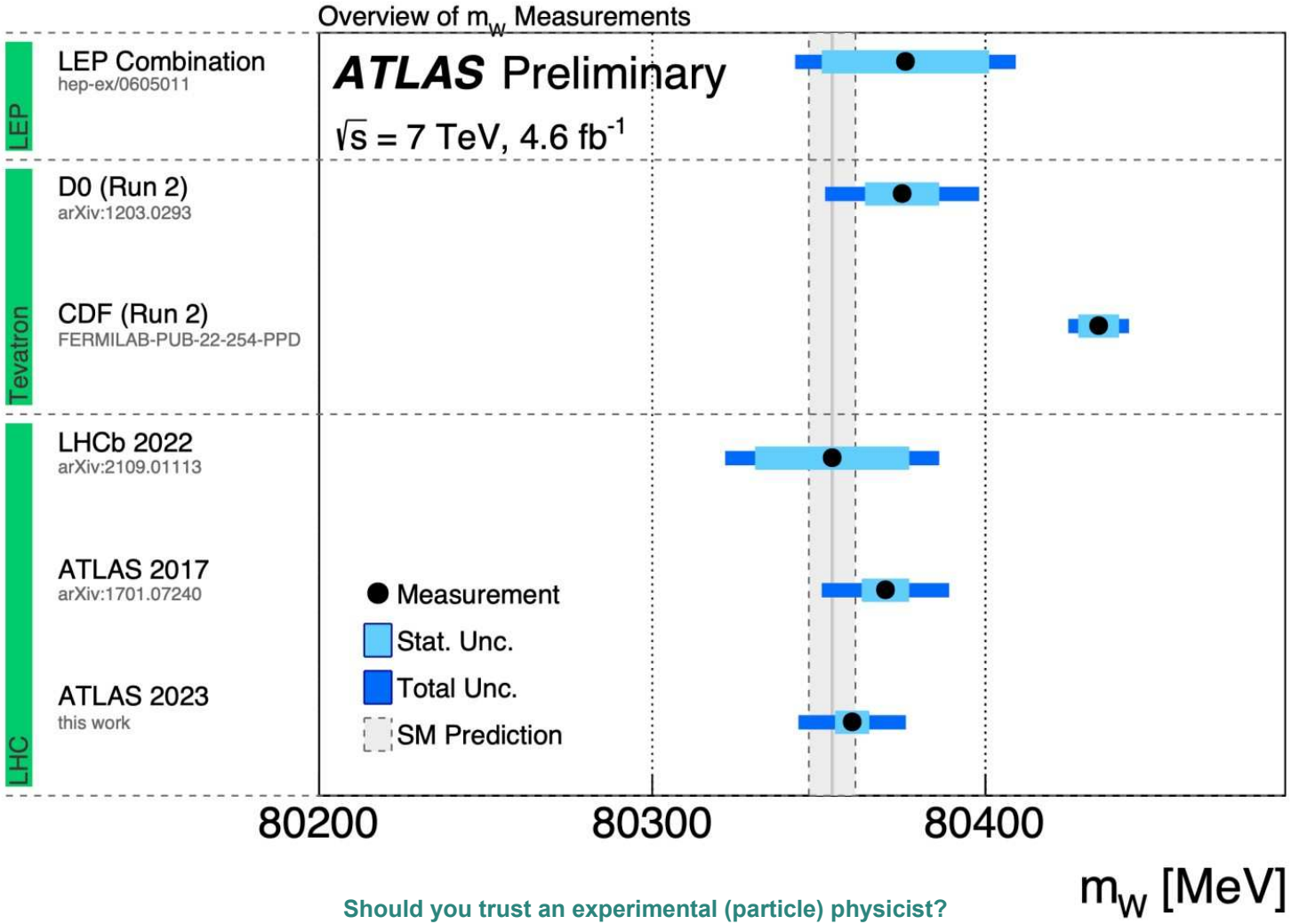
this work
Measurement
Stat. Unc.
Total Unc.
SM Prediction
80200
80300
80400
m_W [MeV]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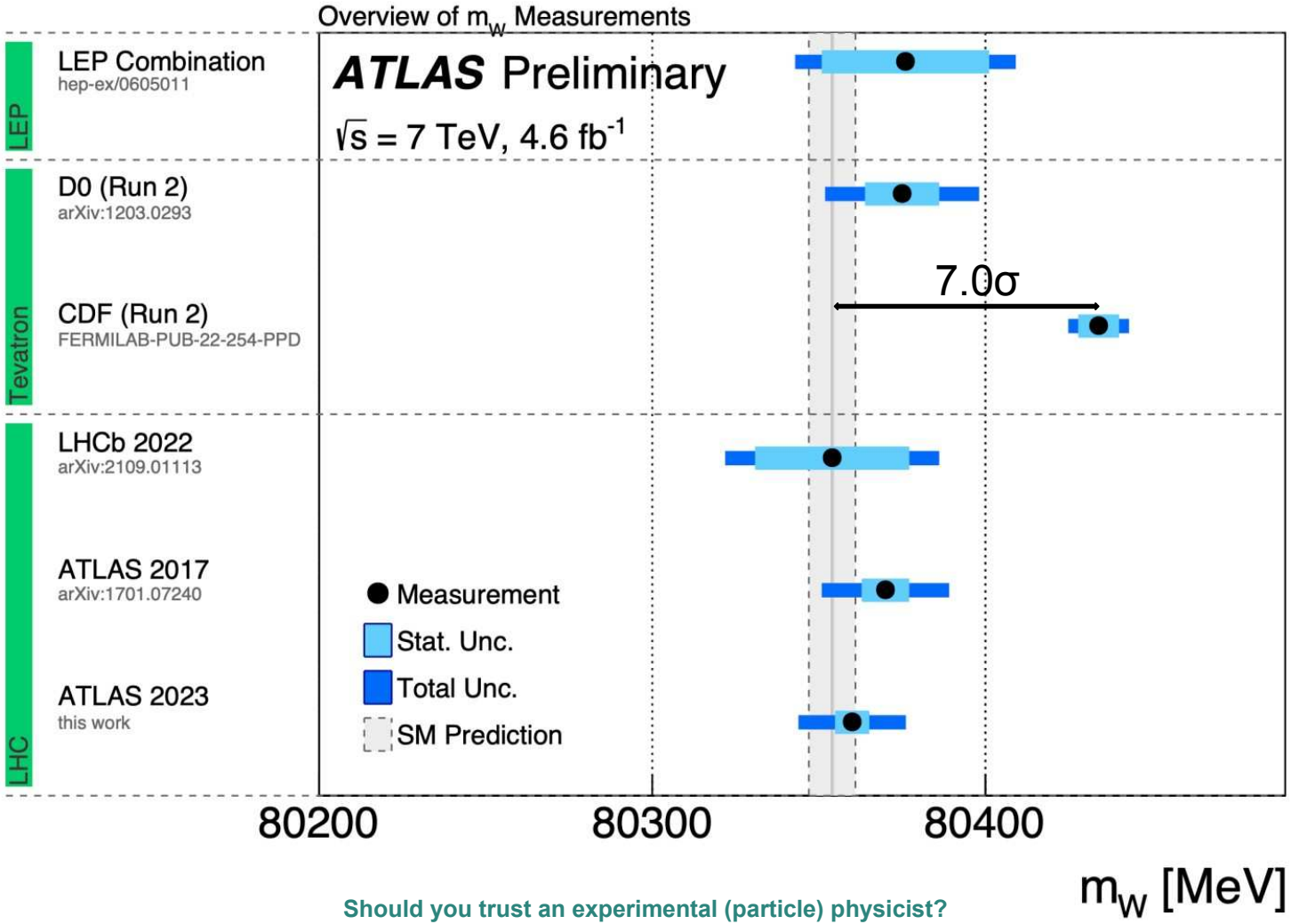
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Possible sources for divergence

Possible sources for divergence

P(Odds)

Possible sources for divergence

P(Odds) + P(NP)

Possible sources for divergence

$$P(\text{Odds}) + P(\text{NP}) + P(\text{Mistake})$$

Possible sources for divergence

$$P(\text{Odds}) + P(\text{NP}) + P(\text{Mistake}) = 1$$

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SM↔CDF2: 7σ → P_{SM}(CDF2 or more extreme result)=$2.56 \cdot 10^{-12}$

Possible sources for divergence

$$P(\text{Odds}) + P(\text{NP}) + P(\text{Mistake}) = 1$$

SM↔CDF2: 7σ → P_{SM}(CDF2 or more extreme result)=$2.56 \cdot 10^{-12}$

Old Avg.↔CDF2: 3.7σ → $P_{\text{Old Avg.}}$(CDF2 or more extreme result)=0.02%

MAX-PLANCK-INSTITUT FÜR PHYSIK

Belle II

Should you trust an experimental (particle) physicist?

Oskar Tittel

Young Scientists Workshop 2023 - Ringberg

23.11.2023

What do we expect?

What do we expect?

$$\text{Value} \pm \text{statistical error} \pm \text{systematic error} \rightarrow \text{Value} \pm \sqrt{(\sigma_{\text{stat.}}^2 + \sigma_{\text{syst.}}^2)}$$

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Expect results to follow normal distribution

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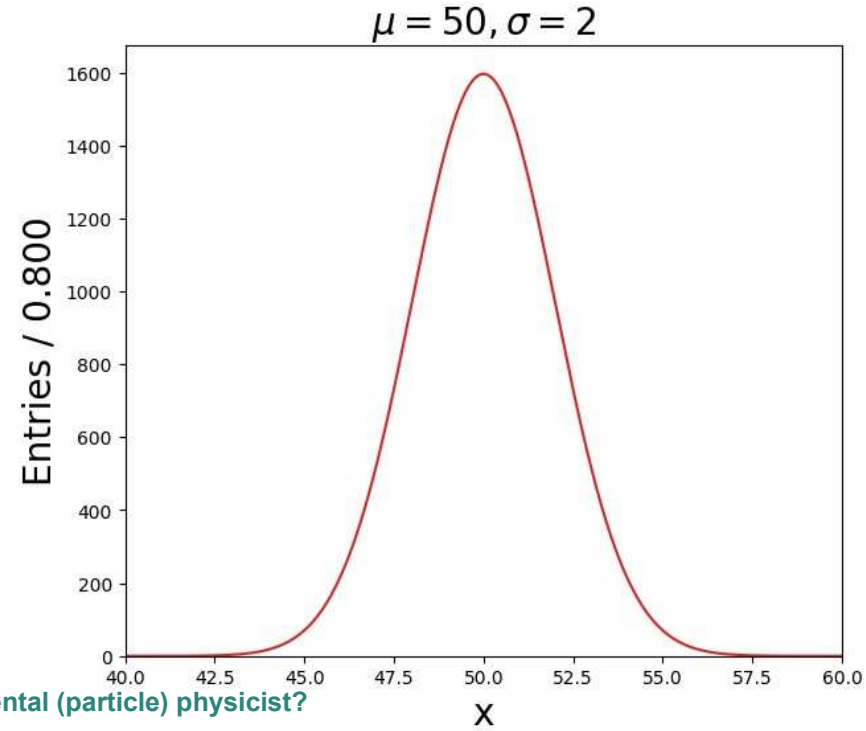
$$x$$



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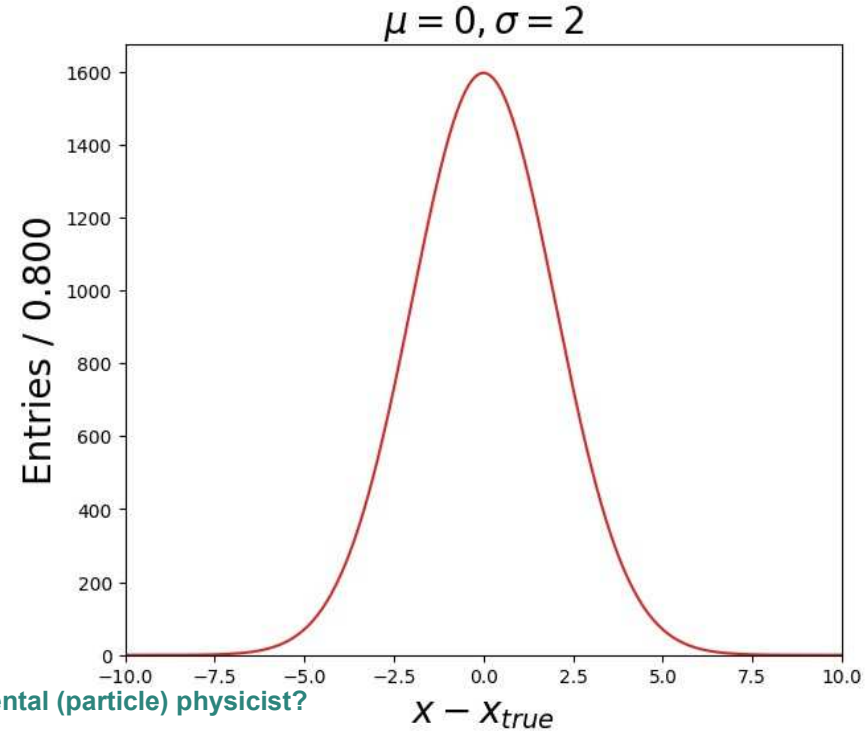
$$x - x_{true}$$



What do we expect?

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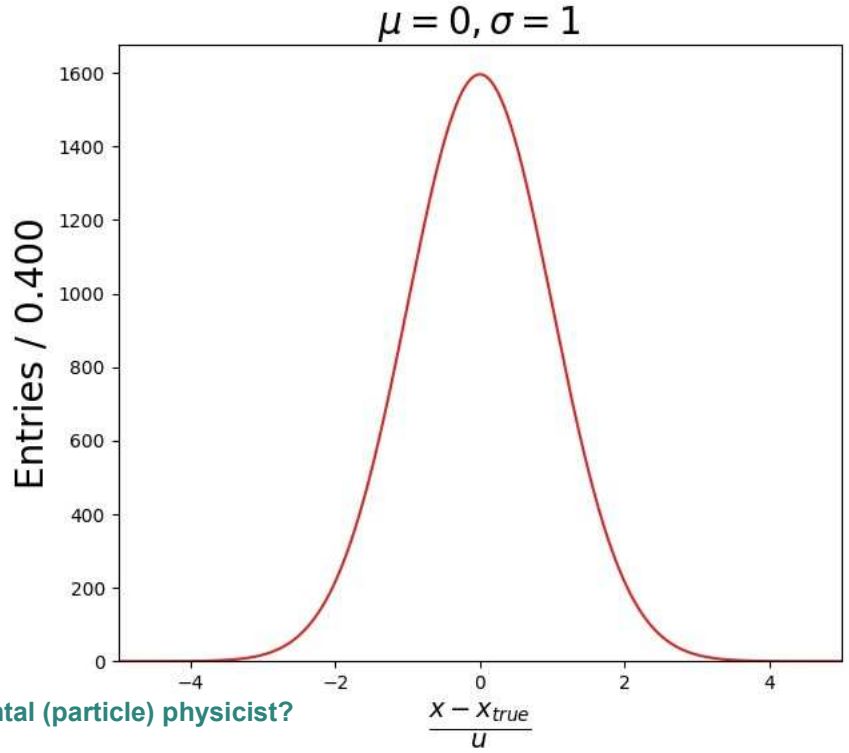
$$\frac{x - x_{true}}{u}$$



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Value ± statistical error ± systematic error → Value ± $\sqrt{(\sigma_{stat.}^2 + \sigma_{syst.}^2)}$

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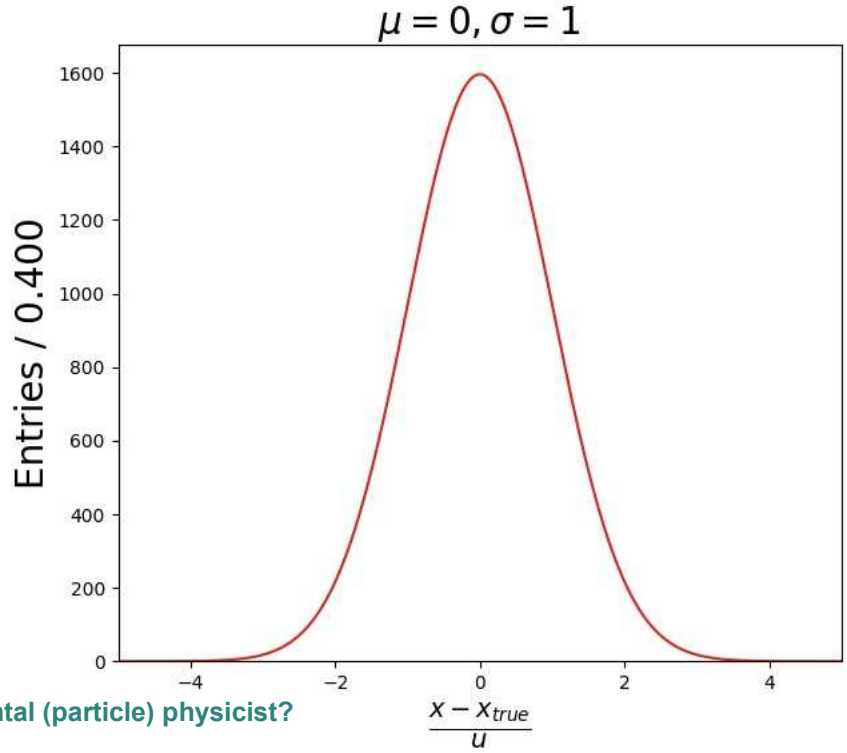
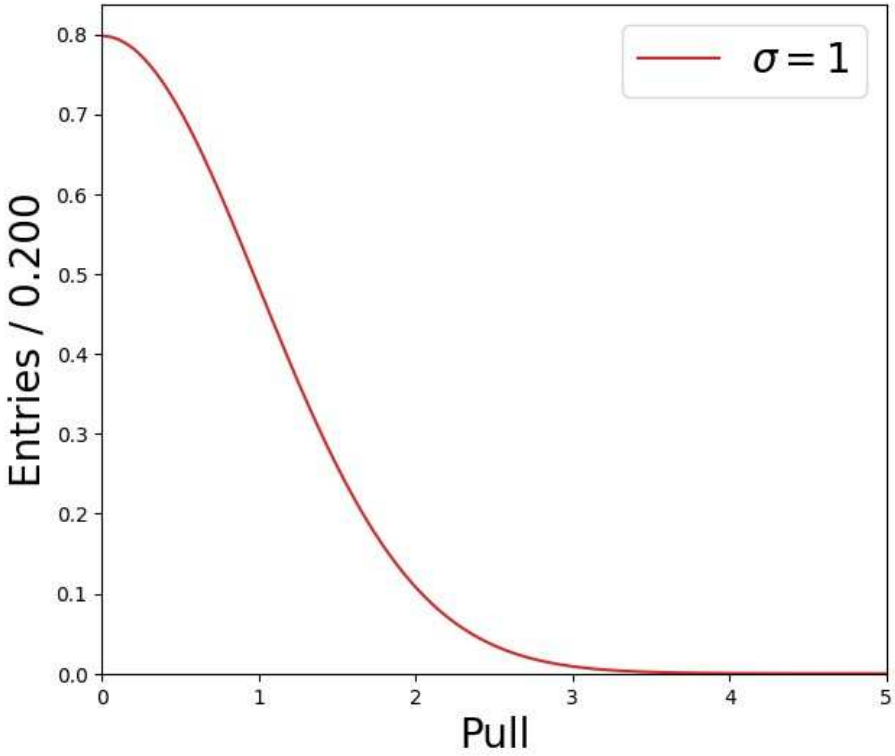
$$\frac{x_i - x_j}{\sqrt{u_i^2 + u_j^2}}$$



Over- and Under-Confidence



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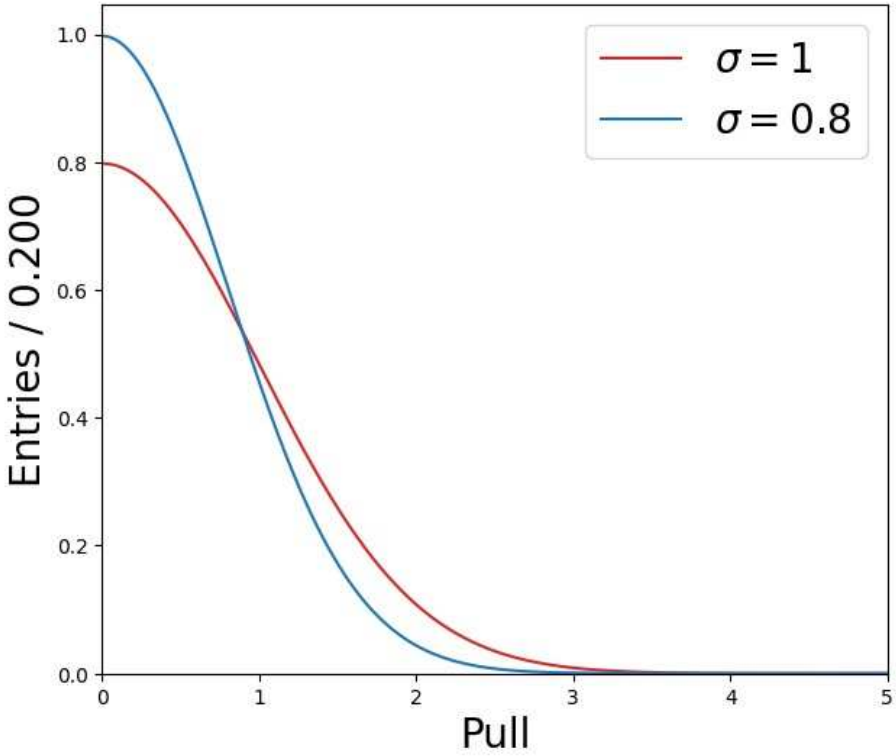
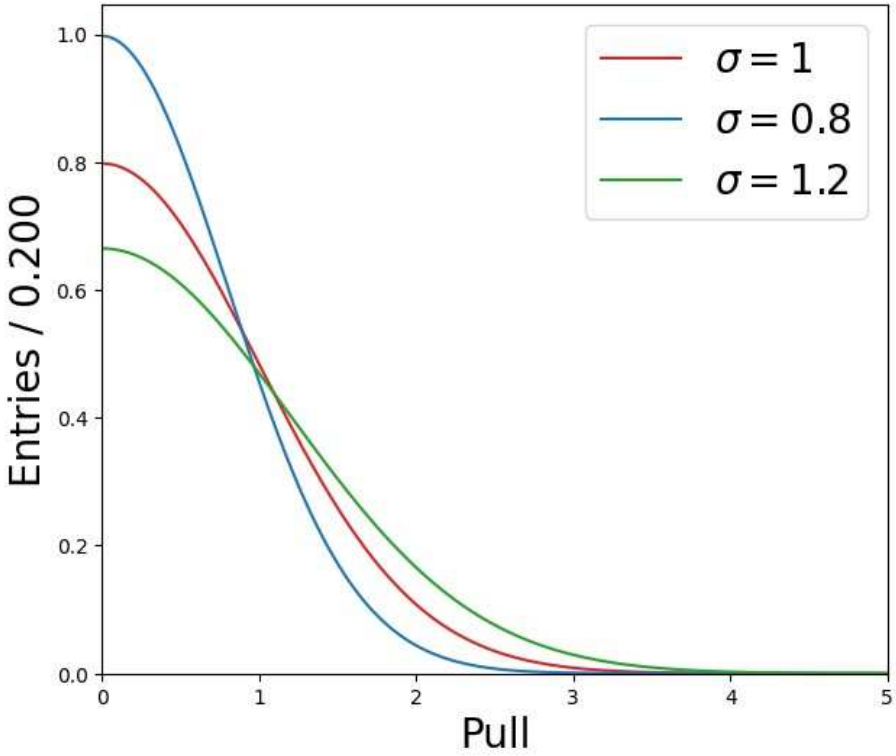


σ<1: Errors are overestimated

Over- and Under-Confidence



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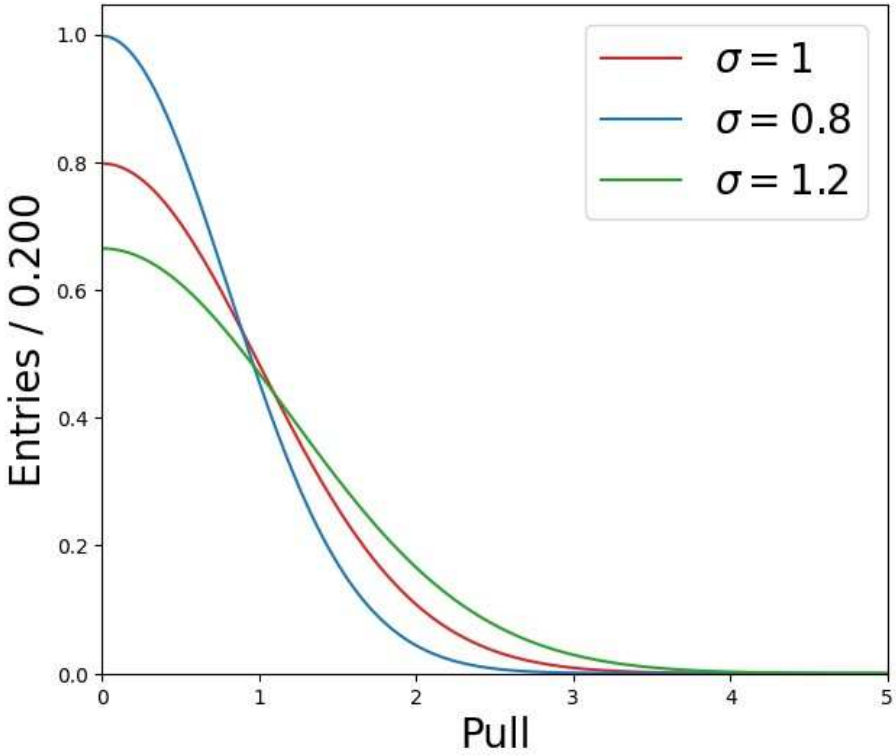

σ<1: Errors are overestimated

σ>1: Errors are underestimated

Describe data with non-std. Student's t-probability distribution:

$$S_{\nu,\sigma}(z) = \frac{\Gamma((\nu+1)/2)}{\Gamma(\nu/2)} \frac{1}{\sqrt{\nu\pi}\sigma} \frac{1}{(1+(z/\sigma)^2/\nu)^{(\nu+1)/2}}$$

Results

D.Bailey:

Not Normal: the uncertainties of scientific measurements

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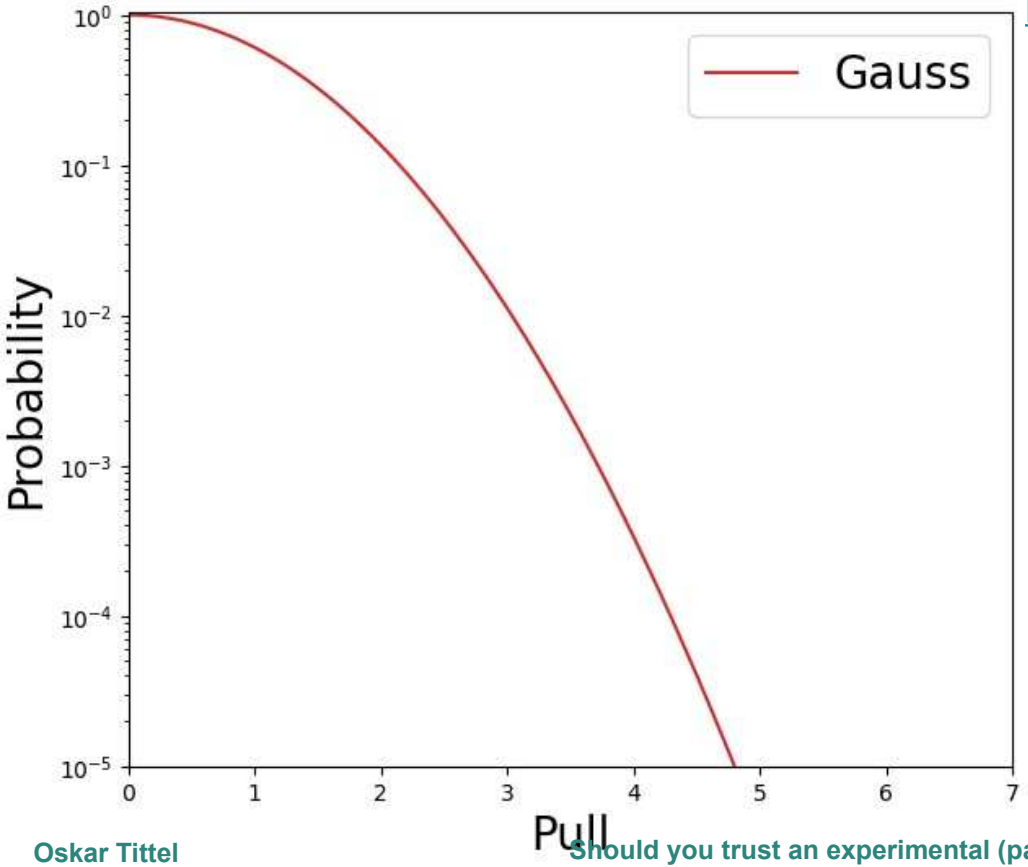

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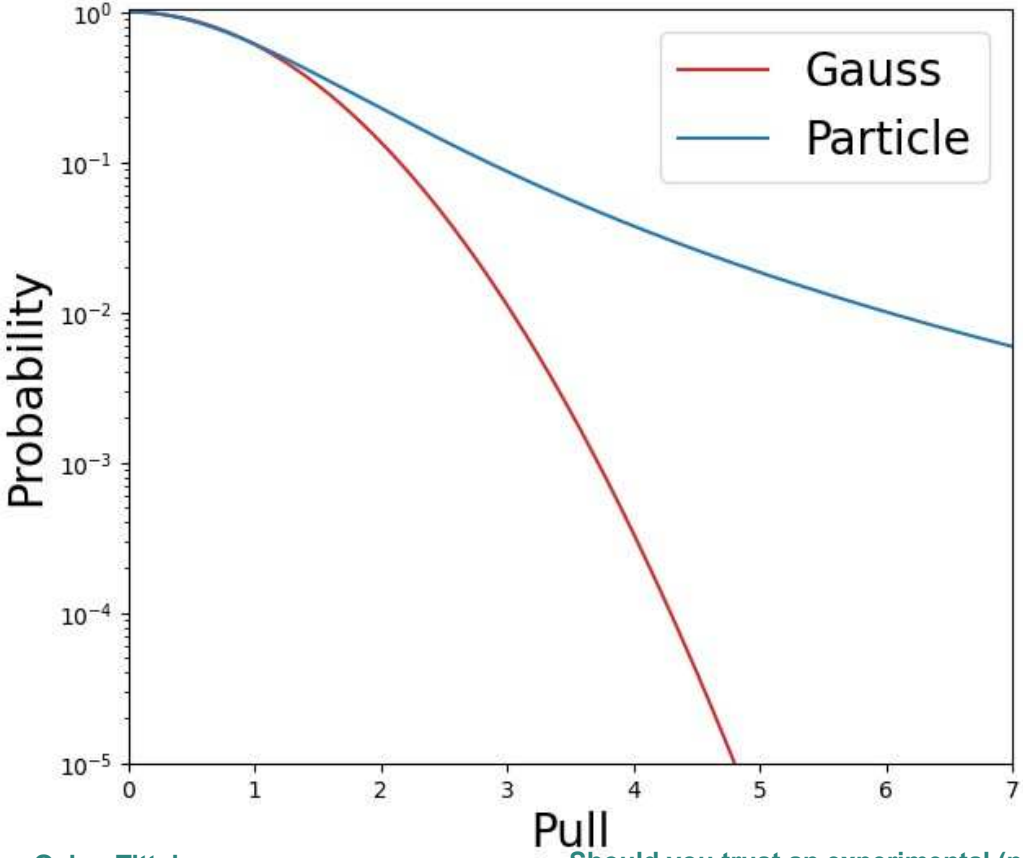

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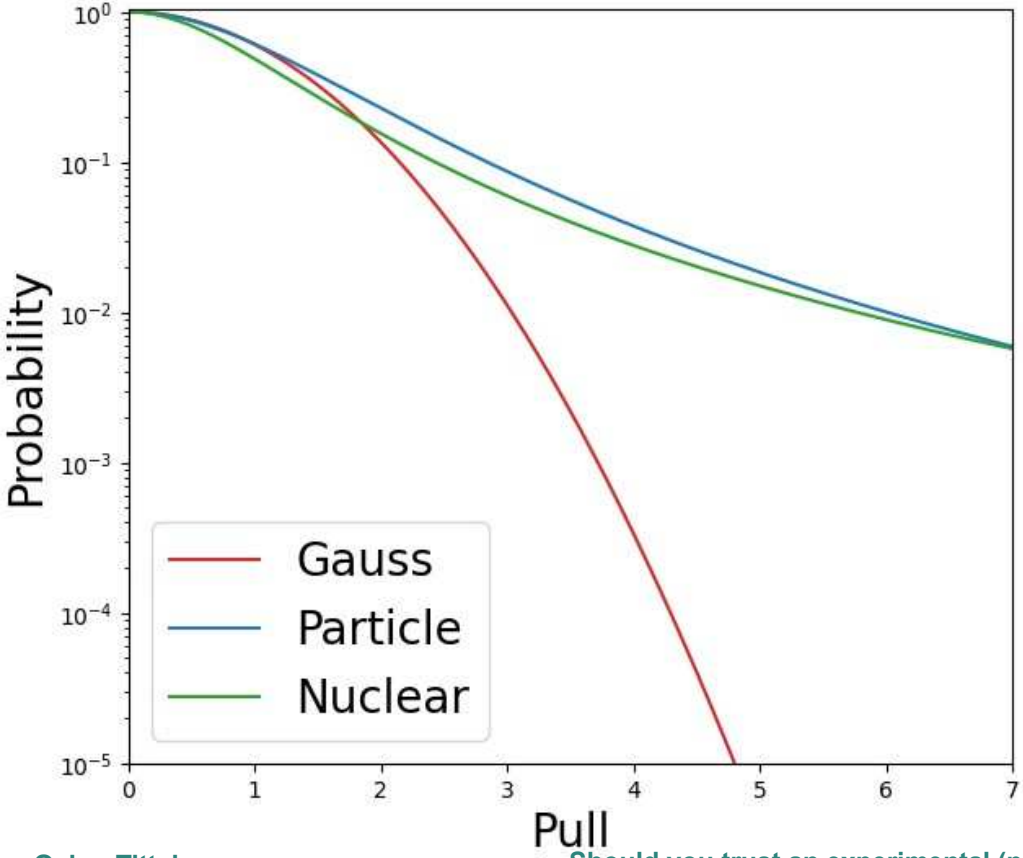

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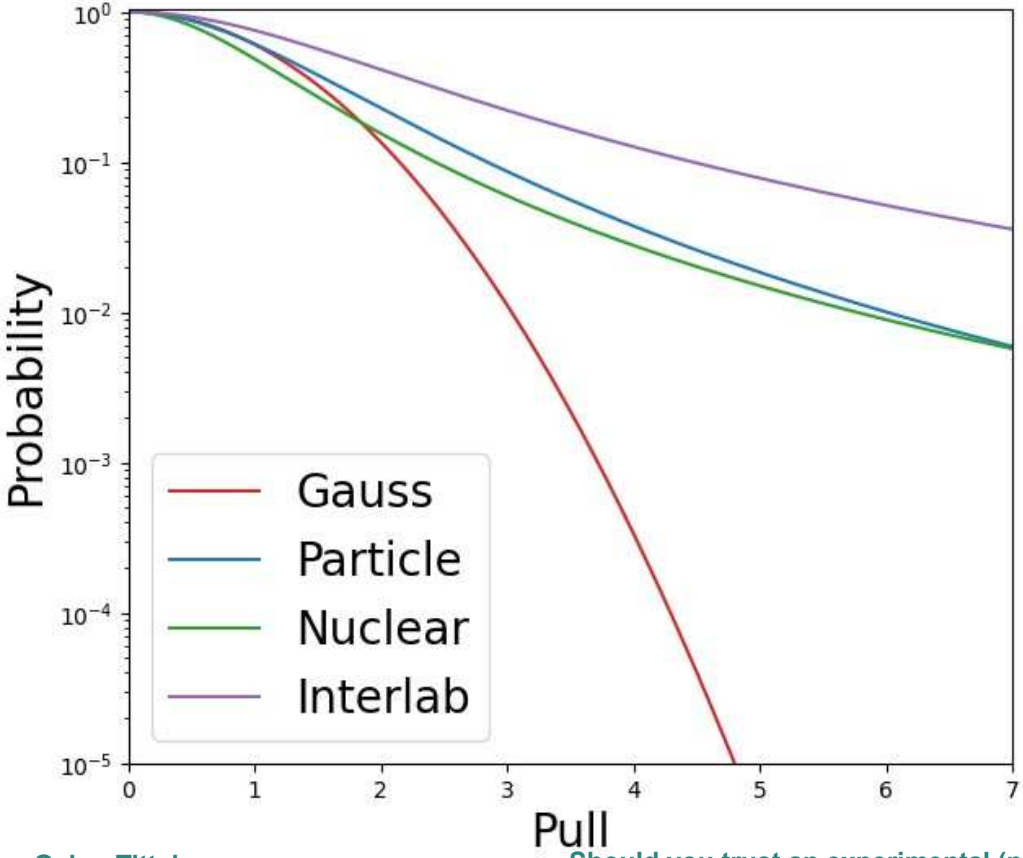

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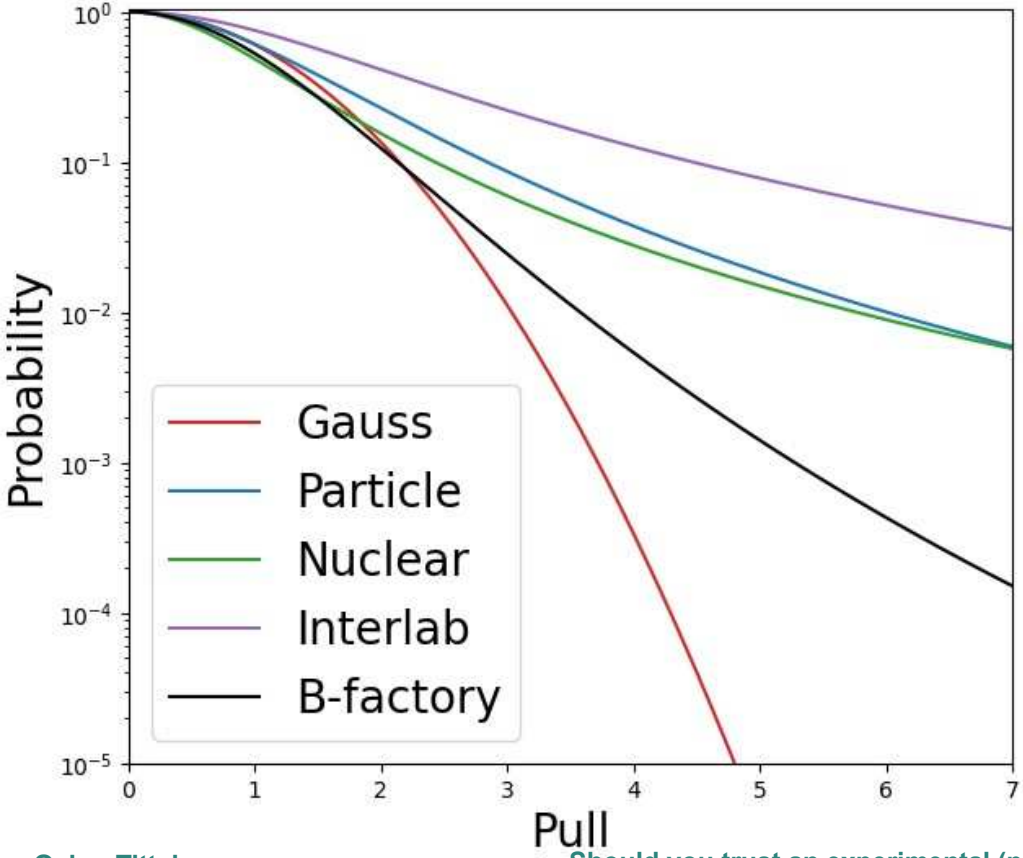

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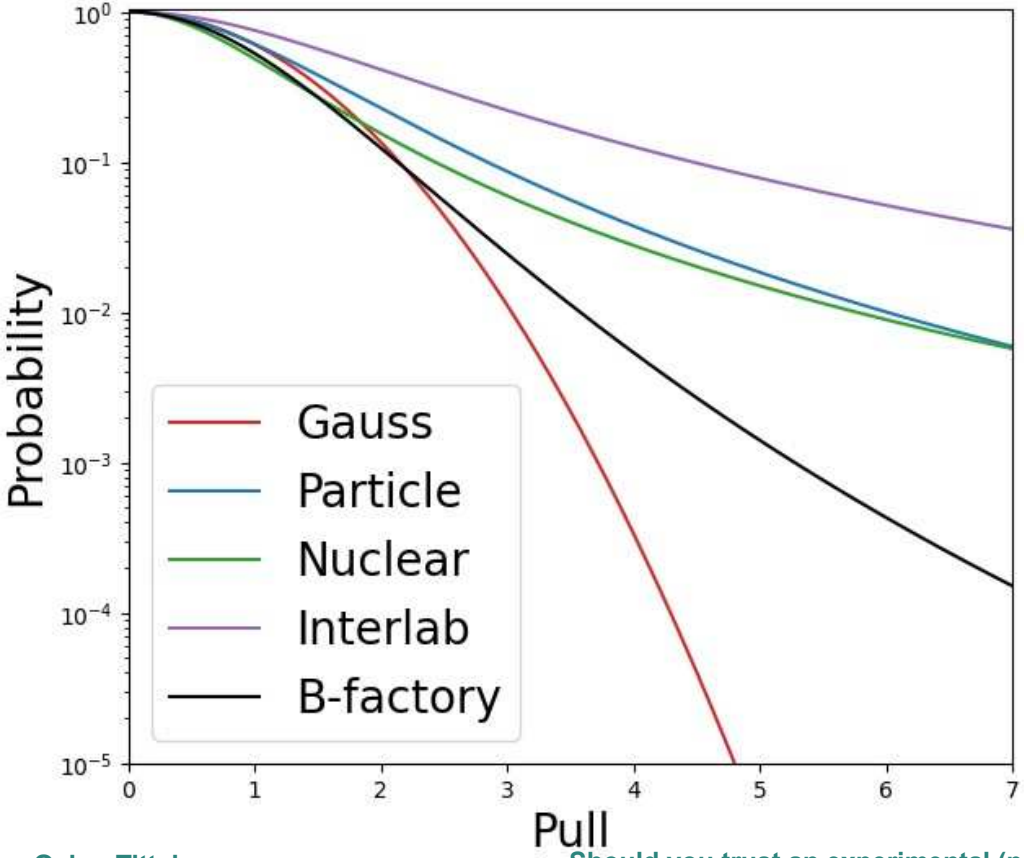


D.Bailey:

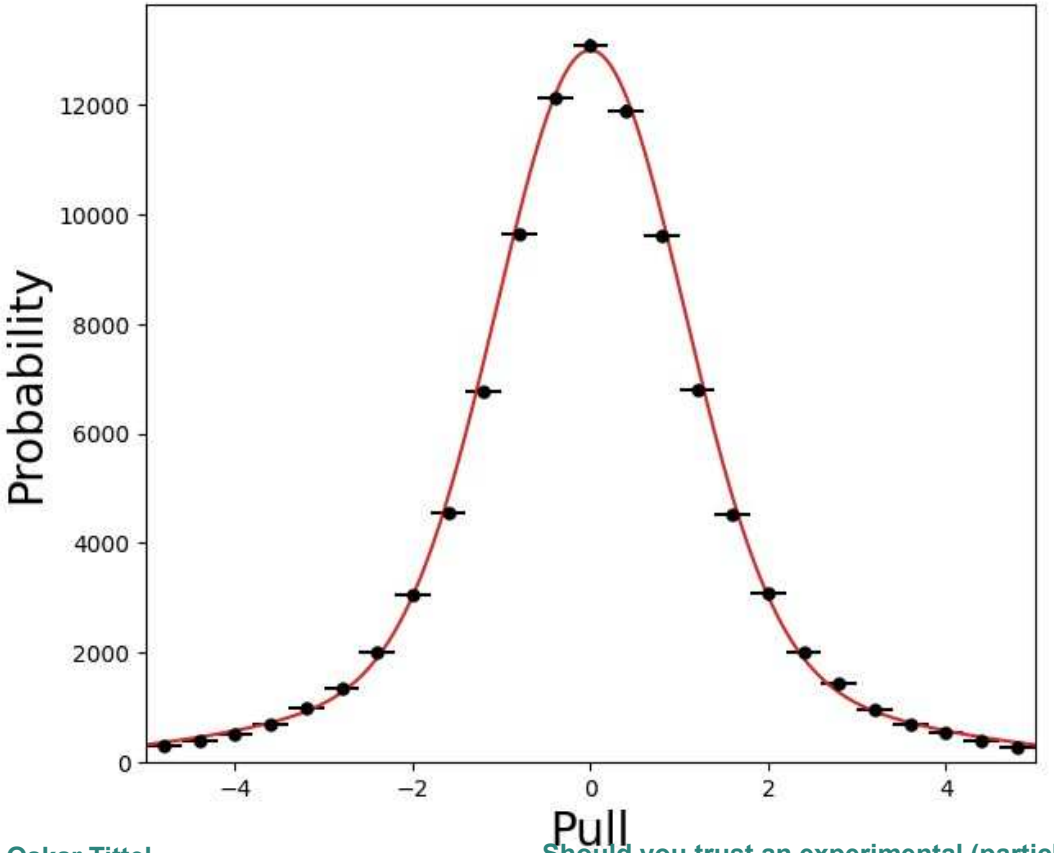
Not Normal: the uncertainties of scientific measurements

Probabilities for a 5σ deviation or more:

Gauss:	5.7E-7
Particle:	2.4%
Nuclear:	3.3%
Interlab:	12%
B-factory:	0.1%

A non-perfect fit - triple Gaussian

A non-perfect fit - triple Gaussian



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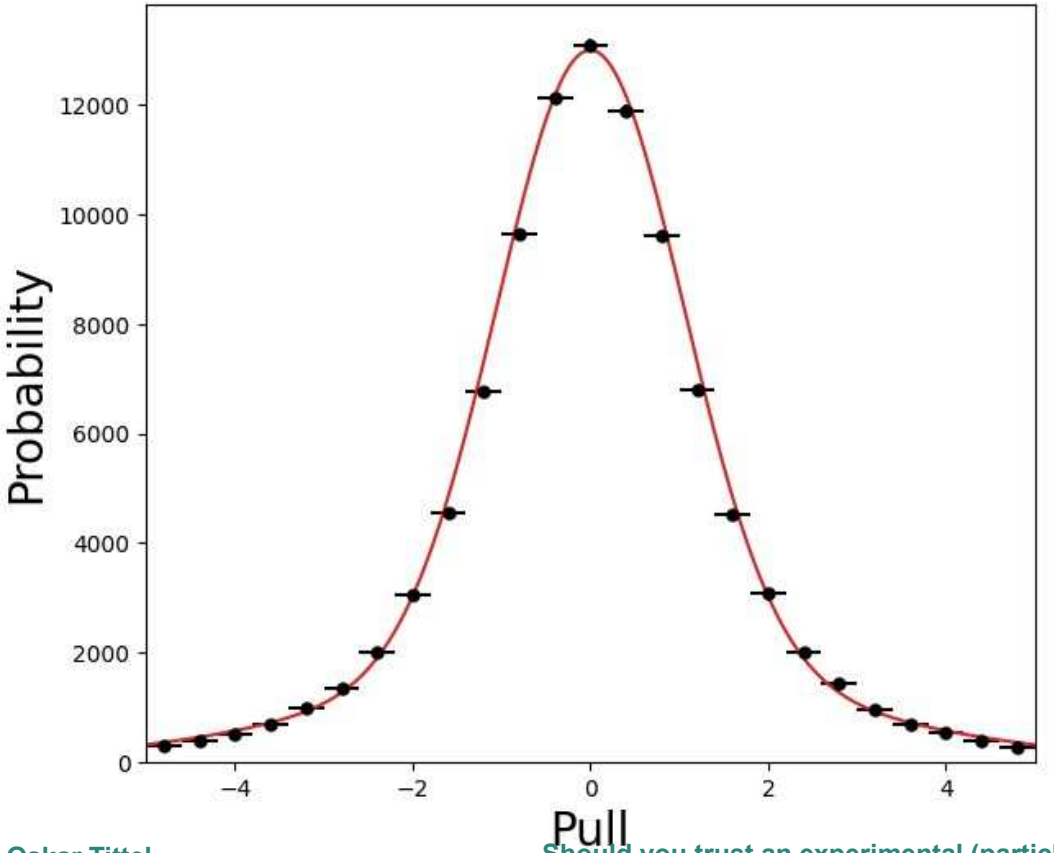

PDF=

$0.721 \cdot g(\mu=0, \sigma=1.04) +$

$0.268 \cdot g(\mu=0, \sigma=2.71) +$

$0.011 \cdot g(\mu=0, \sigma=12.7)$

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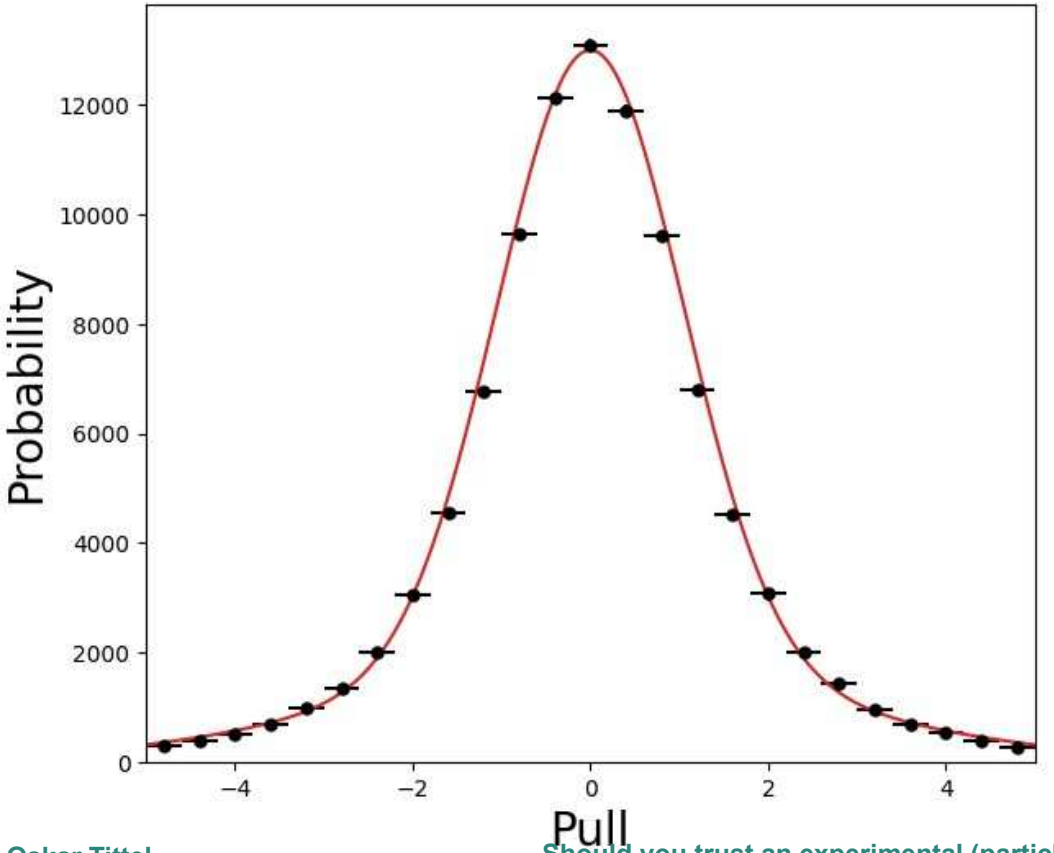

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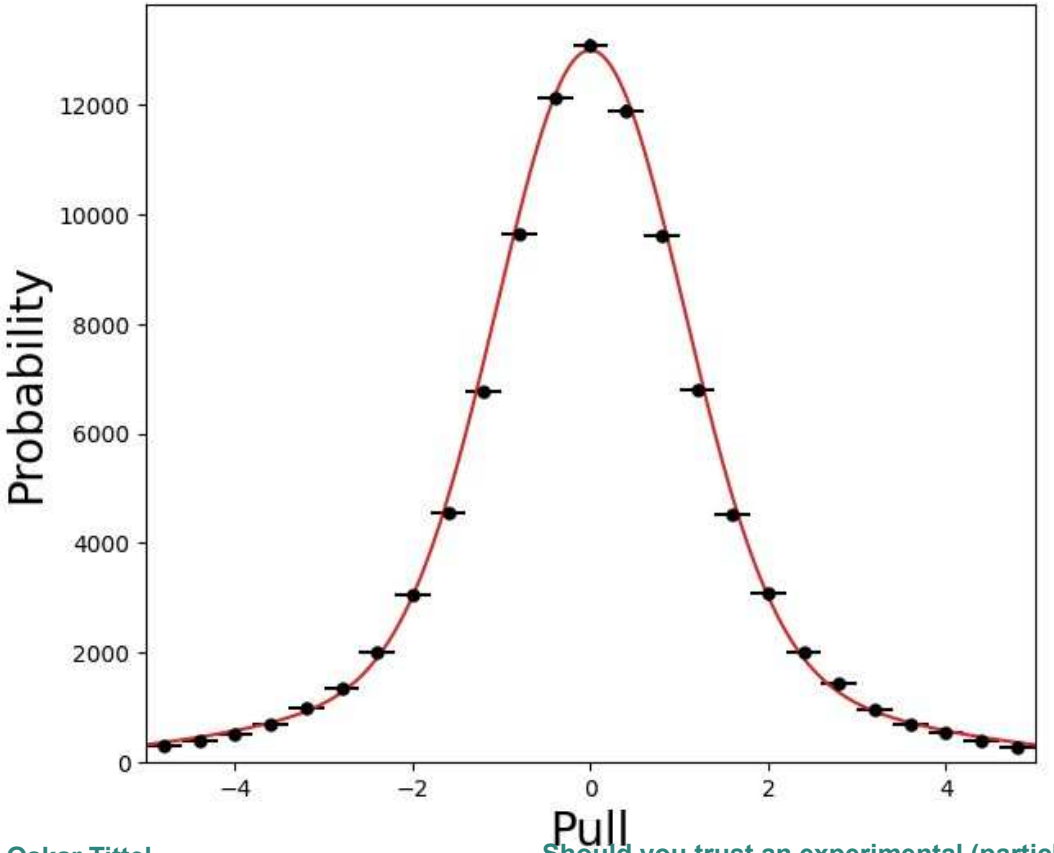
→ **YES!**

A non-perfect fit - triple Gaussian



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→ **YES!**

(72% of the cases)

Discussion

Mistakes are good:

- Mistakes tell us what we did not understand
- “Right” mistakes lead to the right answers

Possible sources of mistakes:

- Unknown unknowns (misID in LHCb R(K) measurement)
- Underestimation (Partial Wave Analysis)
- Non valid error estimation (Control Channel)
- Human sources (biases, time/success pressure)

Backup

Method

D.Bailey:

[Not Normal: the uncertainties of scientific measurements]

Data: Particle Physics (8469 meas, 864 quantities), Nuclear physics, Medical data, Interlab

$x_i \pm u_i$ **es:**

$$z_{ij} = \frac{|x_i - x_j|}{\sqrt{u_i^2 + u_j^2}}$$

Non-stand. Student's t prob:

$$S_{\nu,\sigma}(z) = \frac{\Gamma((\nu+1)/2)}{\Gamma(\nu/2)} \frac{1}{\sqrt{\nu\pi}\sigma} \frac{1}{(1+(z/\sigma)^2/\nu)^{(\nu+1)/2}}$$