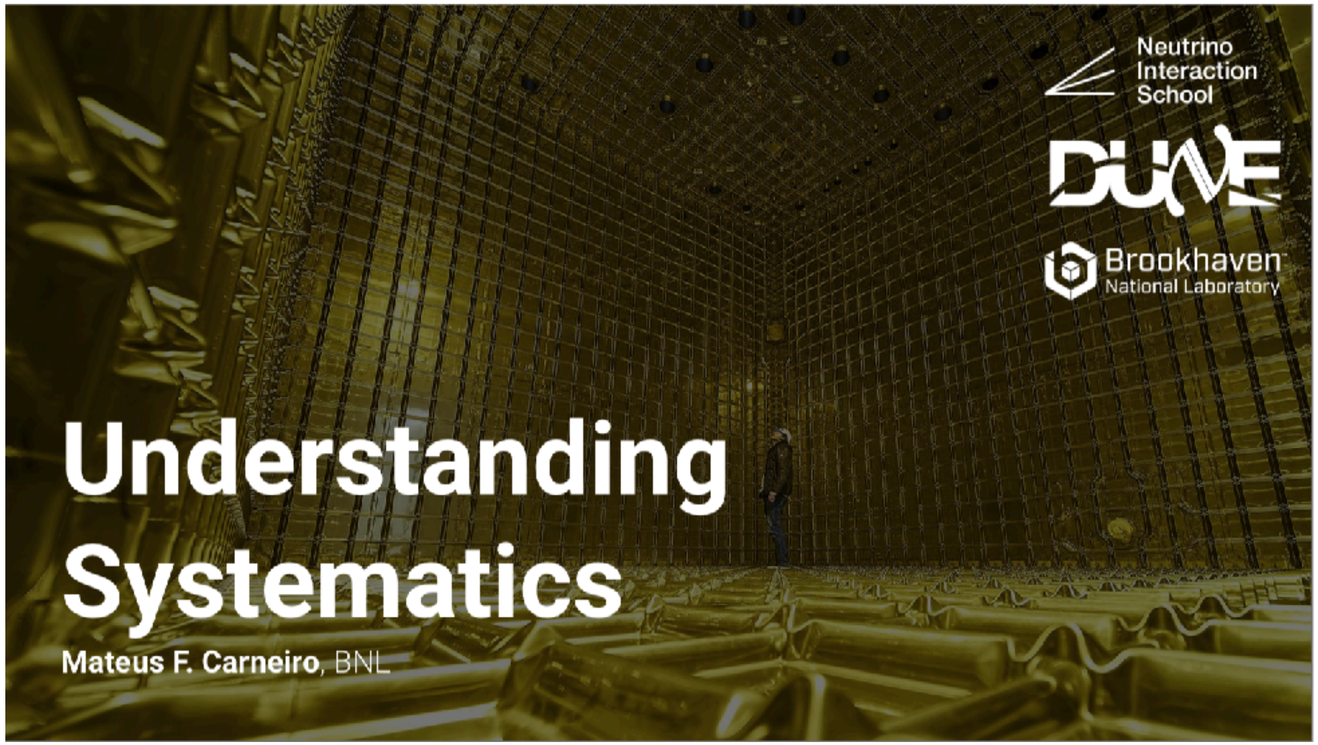
Evaluating uncertainties

Cheryl Patrick, July 6th 2021

For everything you wanted to know about uncertainty…

Mateus Carneiro's talk, June 28th

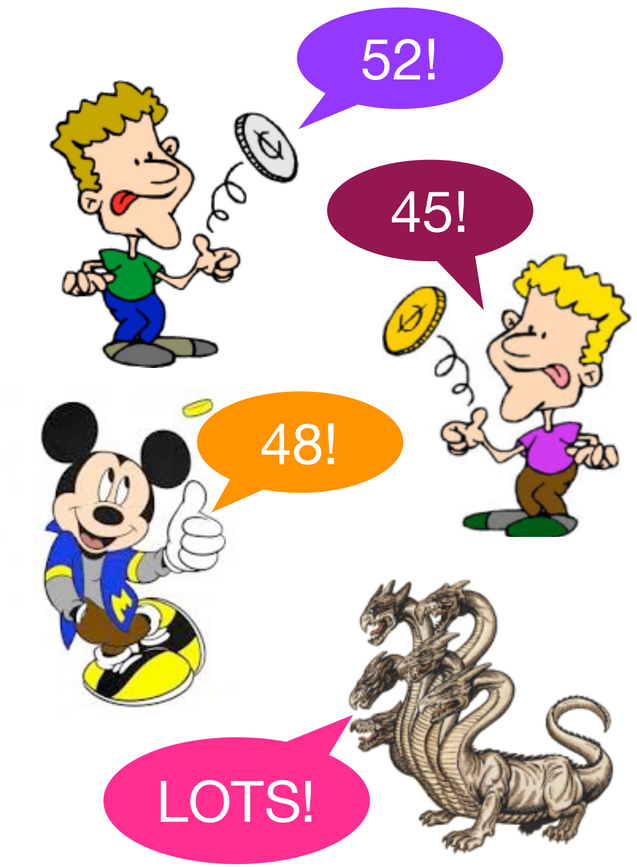


https://indico.fnal.gov/event/48900/contributions/217474/attachments/144815/184198/Understanding%20Systematics%20-%20Nu%20interaction%20School%202021%20%283%29.pdf

https://youtu.be/67jeEPpmhm8

Statistical uncertainty - random processes

Toss a coin 100 times… how many heads?



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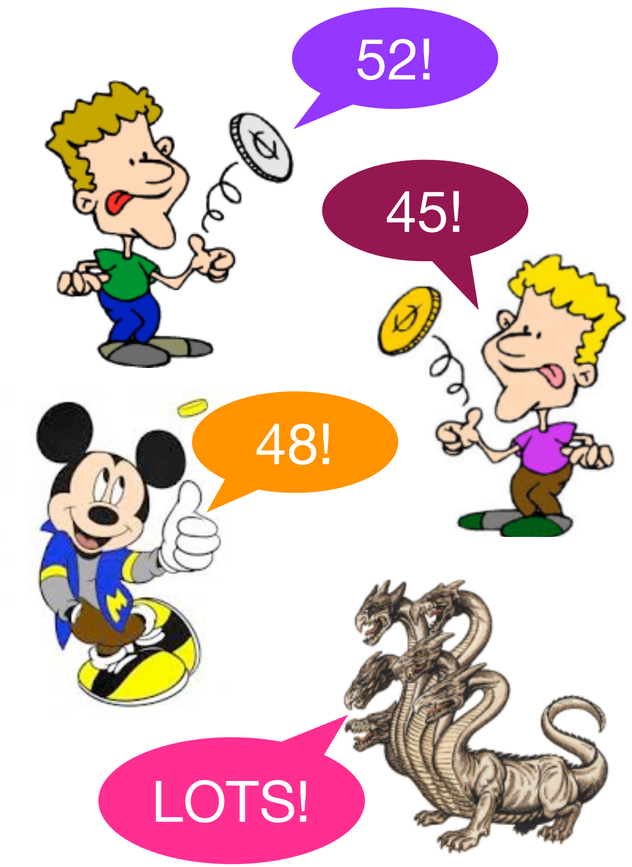
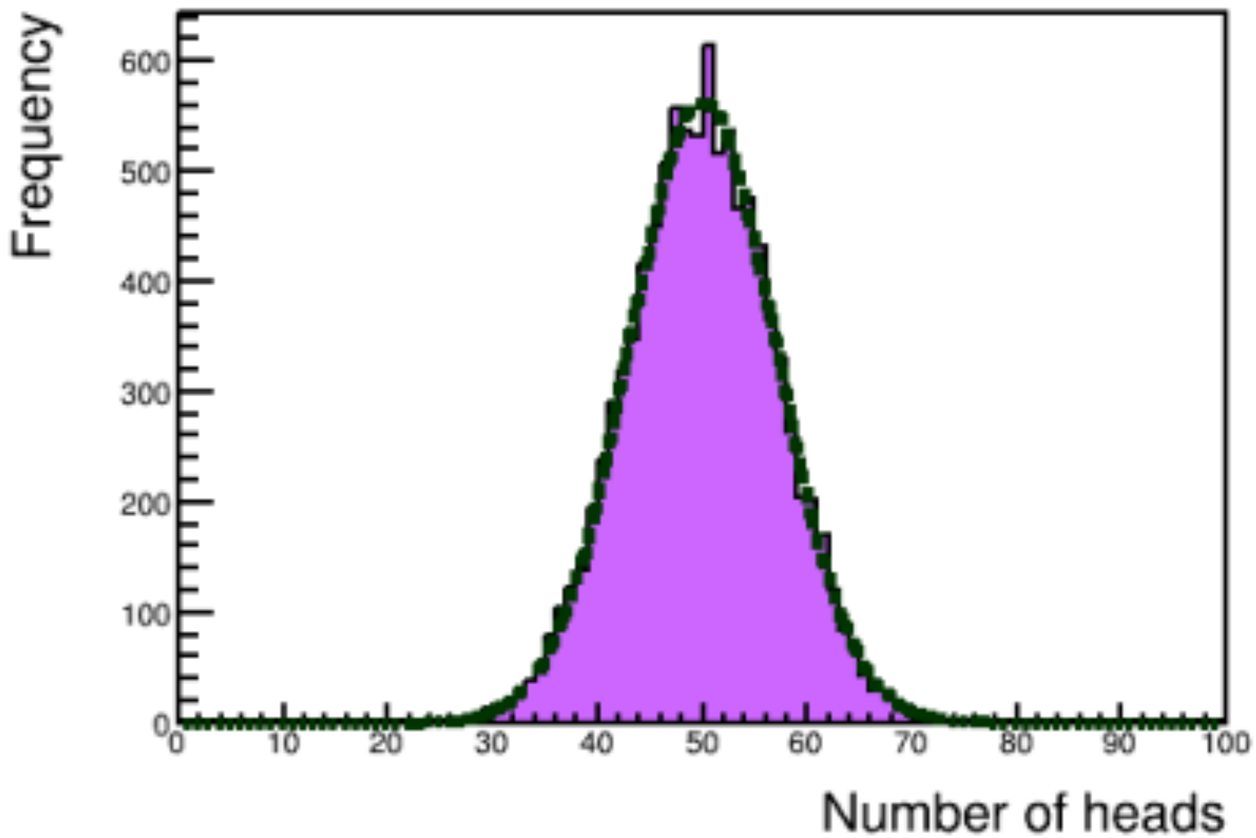


10,000 tossers



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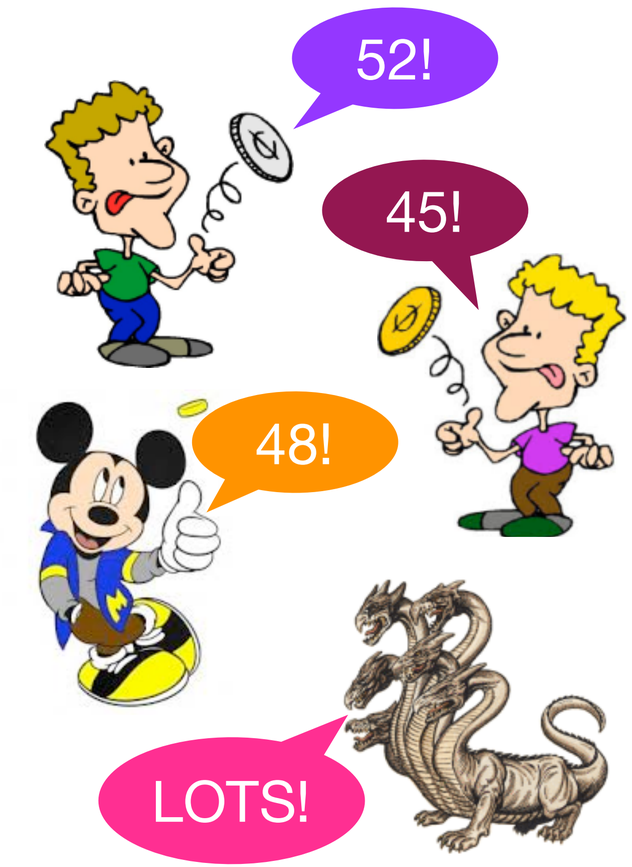

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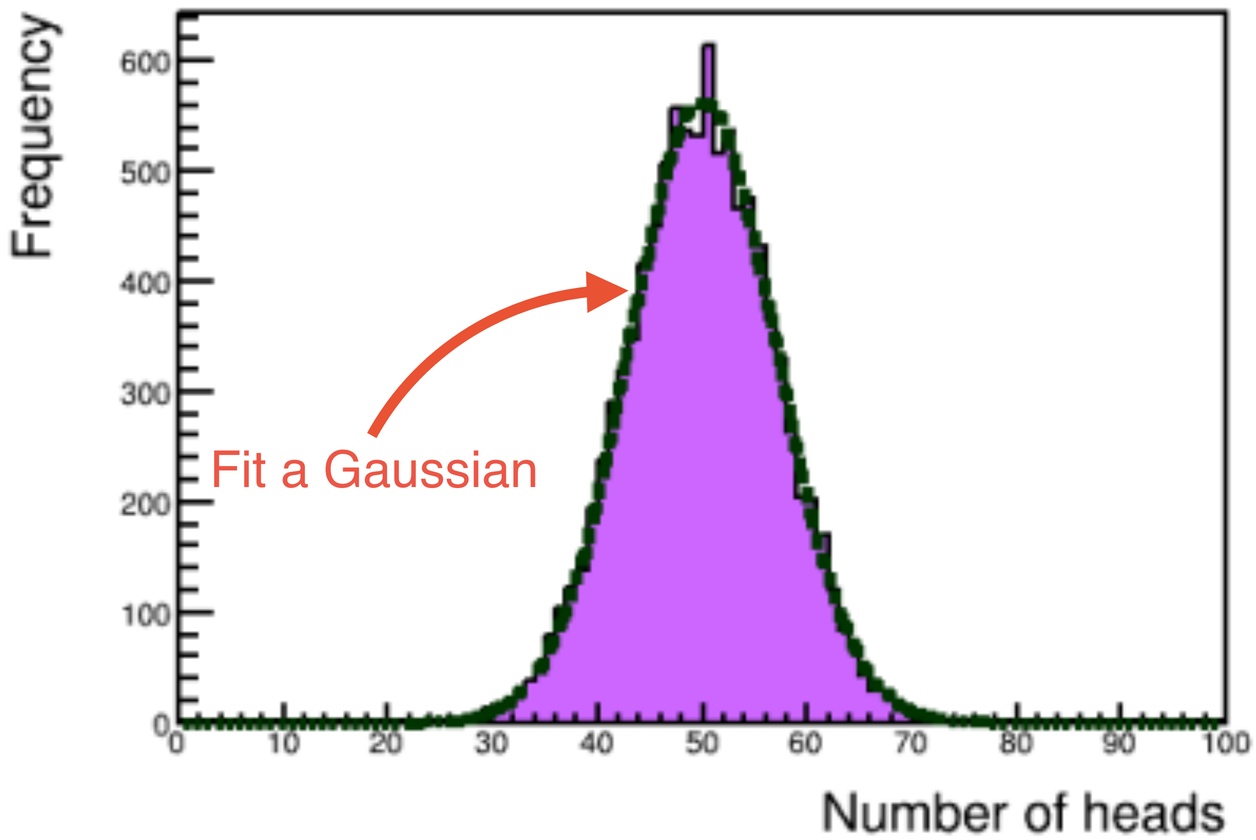

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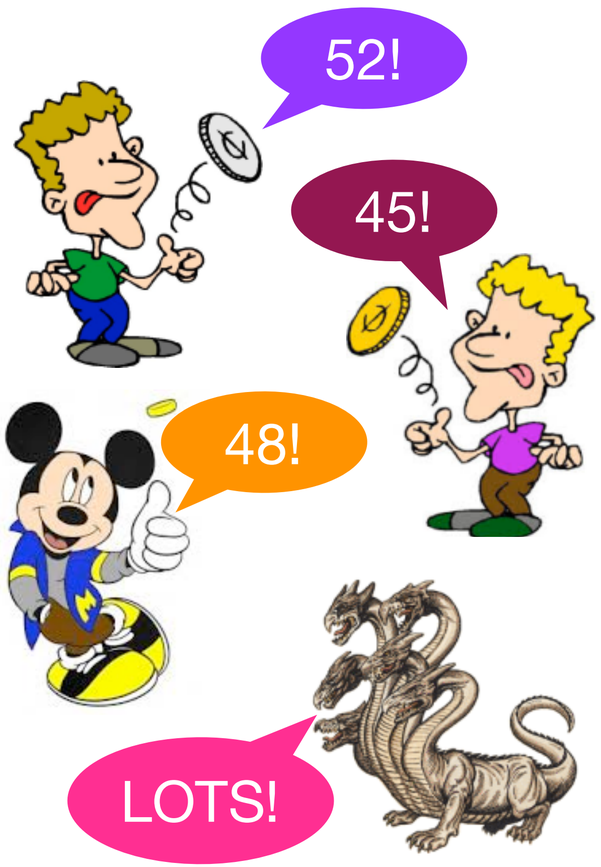

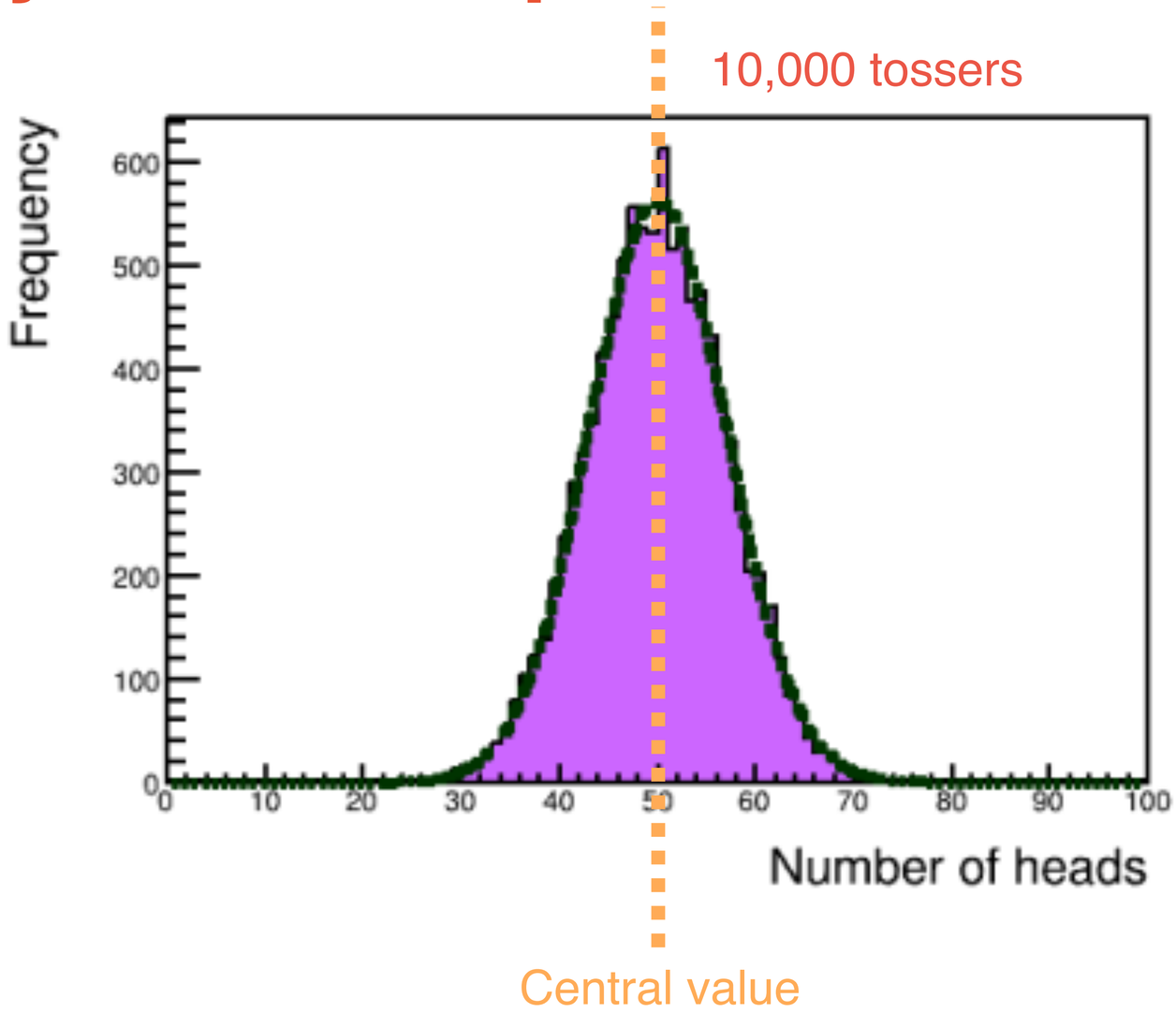

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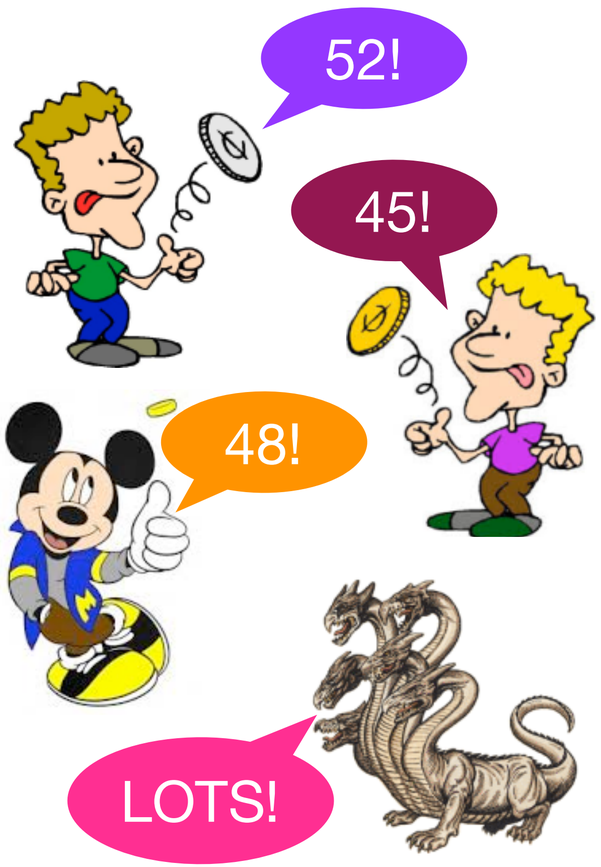

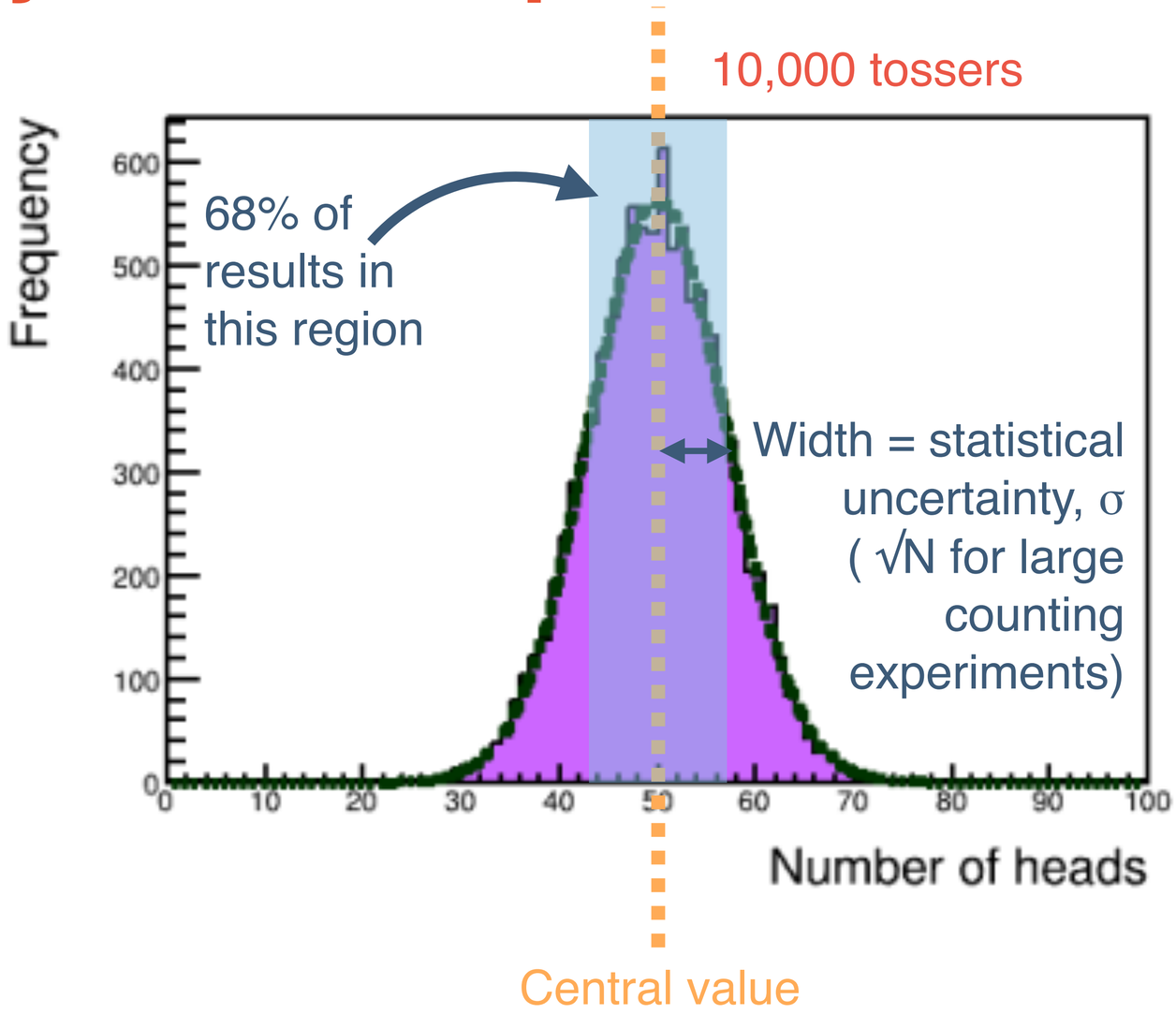

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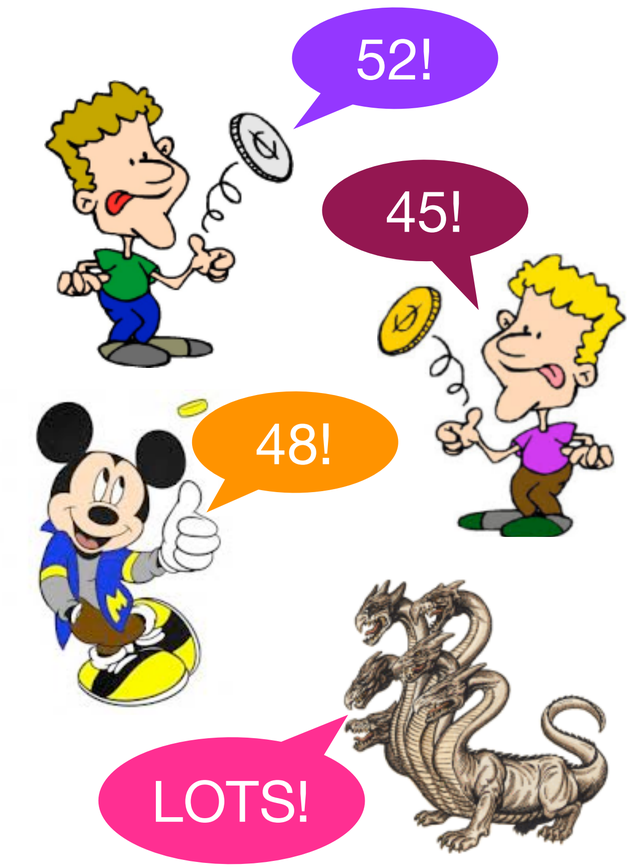
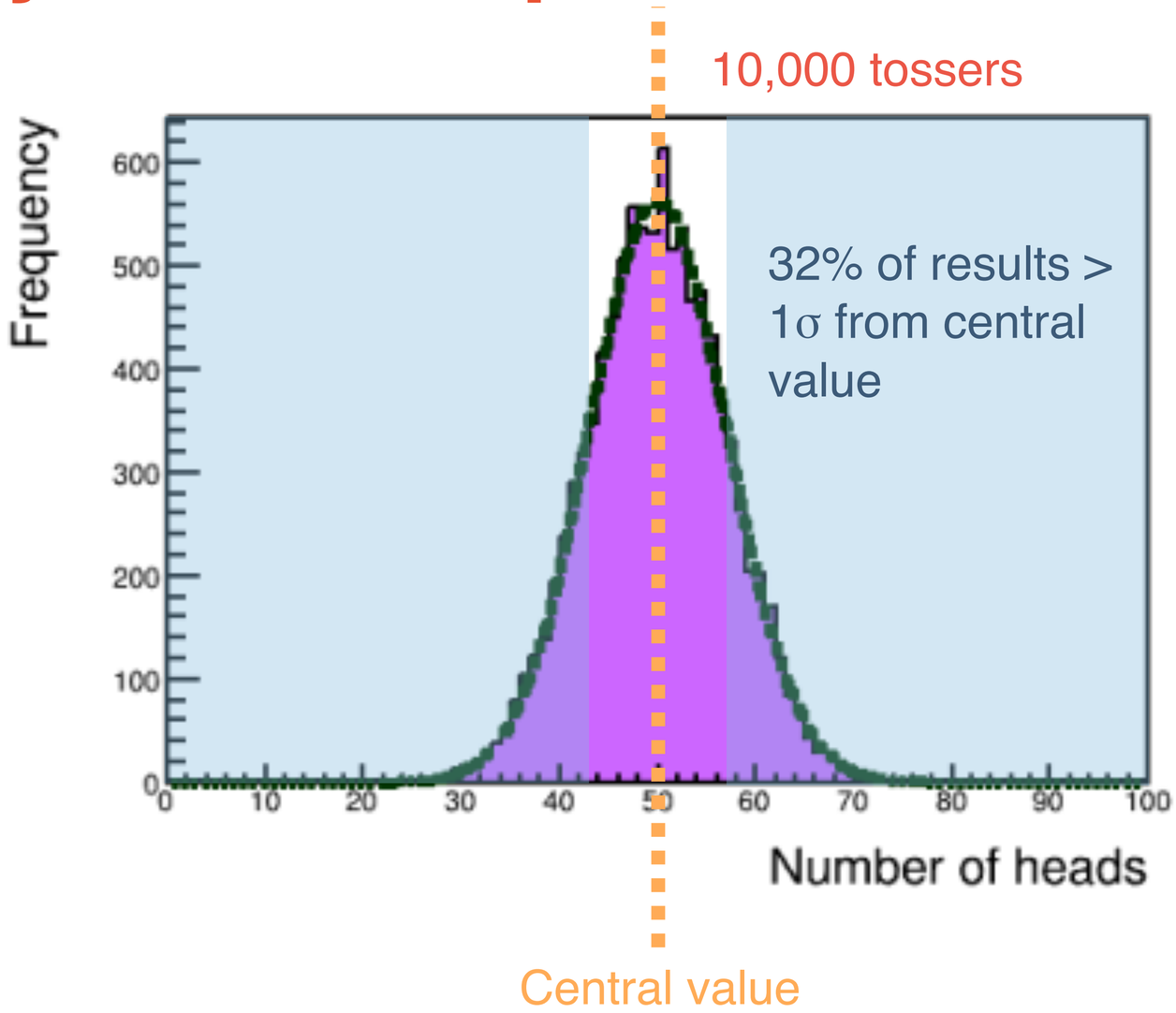
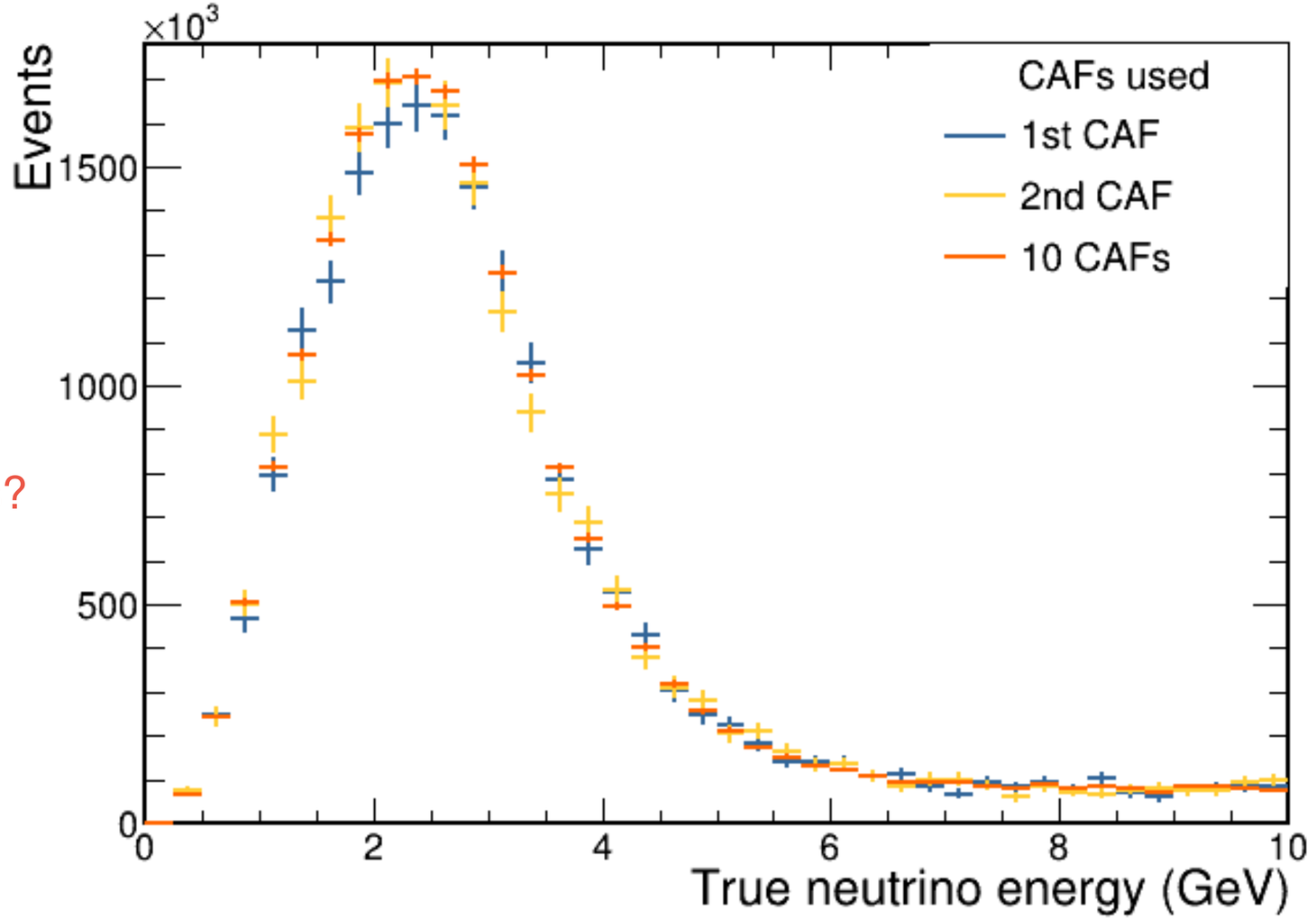




Our CAFs are from a random process!

Exercise 1

What's the statistical uncertainty?
How does it change with POT?
How does it change between samples?
Or with sample size?



Systematic uncertainty - how well can we measure / model?

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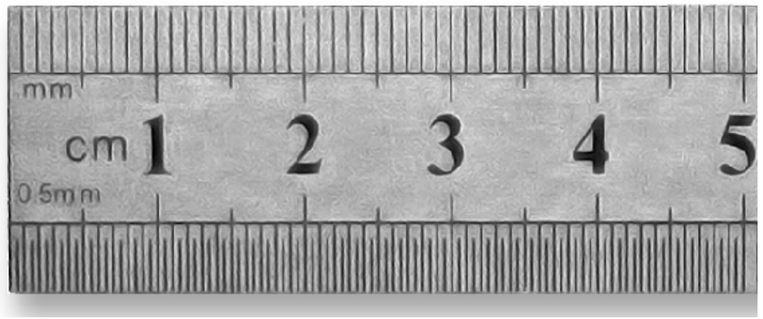
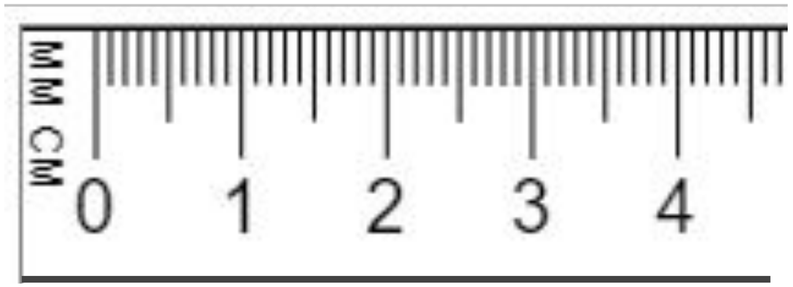
An unknown **bias**?



vs.



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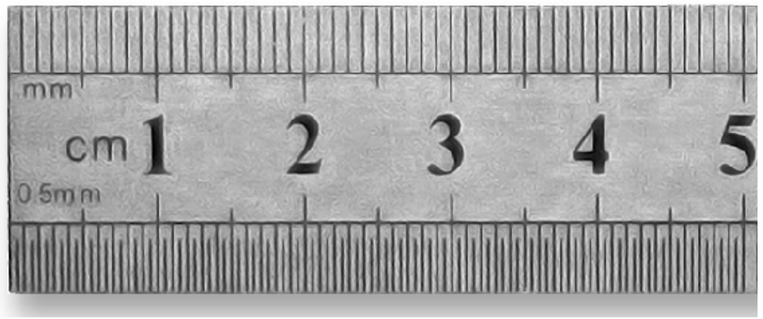

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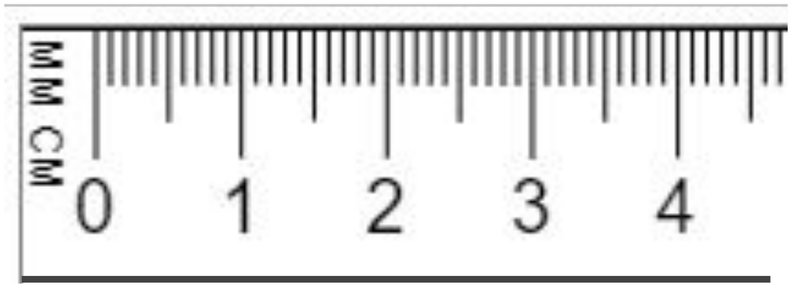

Measurement **resolution**

vs.

Systematic uncertainty - how well can we measure / model?

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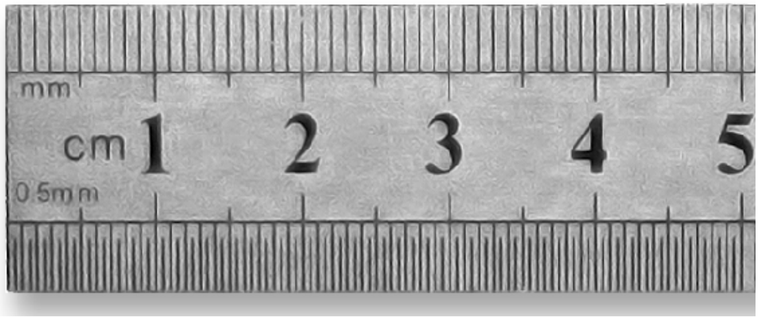

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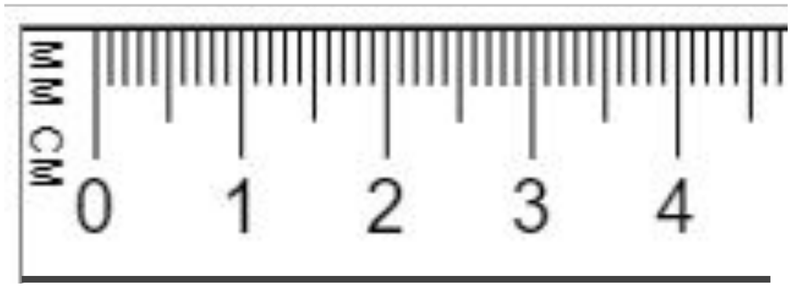
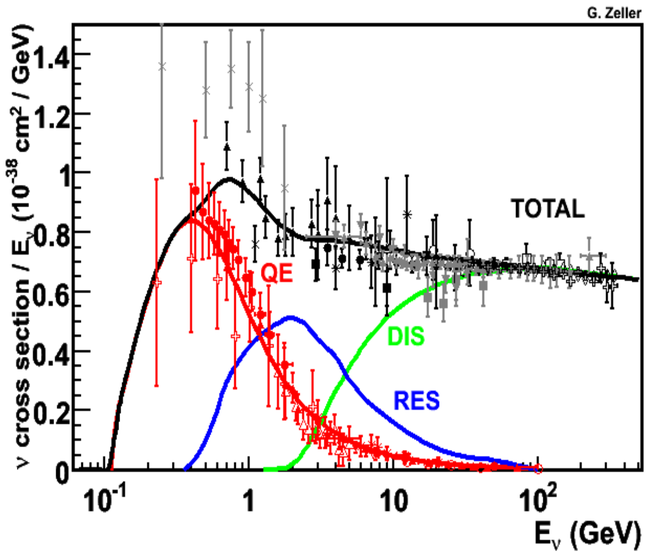


Measurement **resolution**

vs.

Model uncertainty



Exercise 2: systematic uncertainty

An unknown **bias**?

Measurement **resolution**

Model uncertainty

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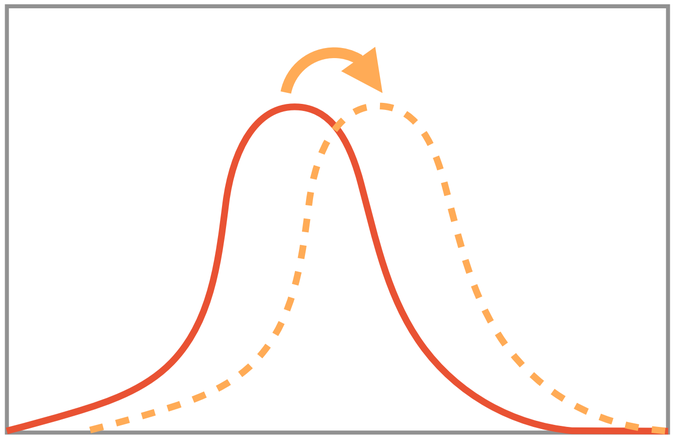
An unknown **bias**?

Measurement **resolution**

Model uncertainty

Shift the muon energy



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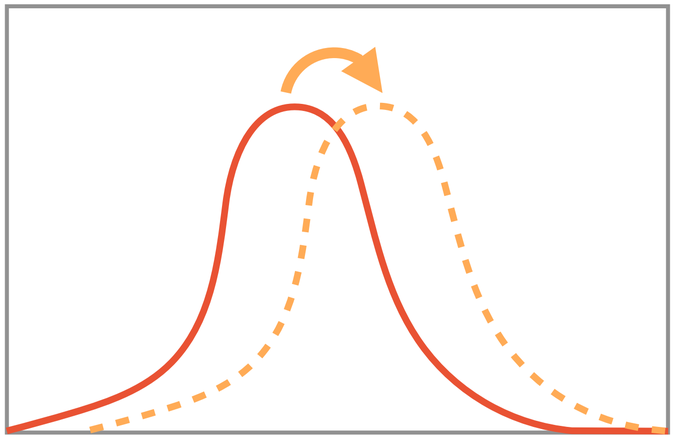
Shift the muon energy



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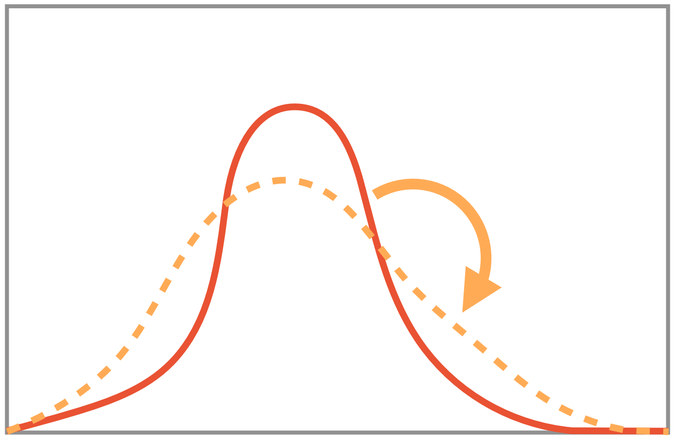
Smear muon energy



Model uncertainty

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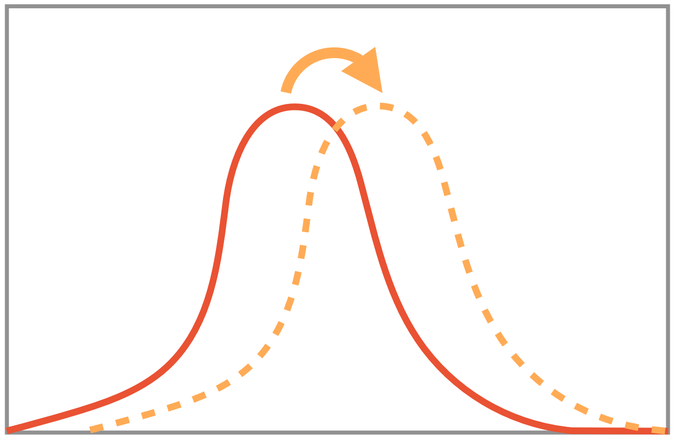

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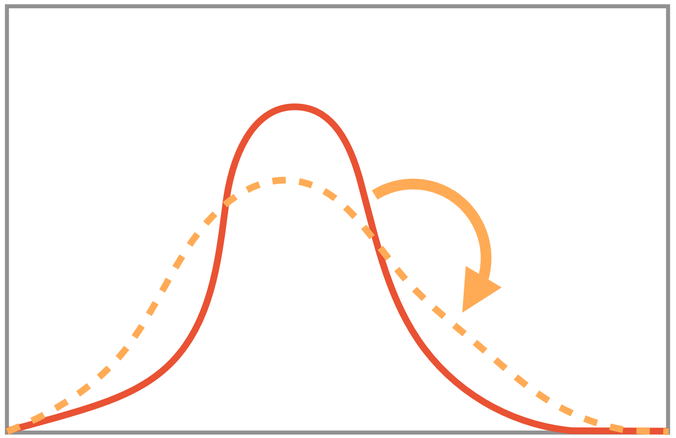
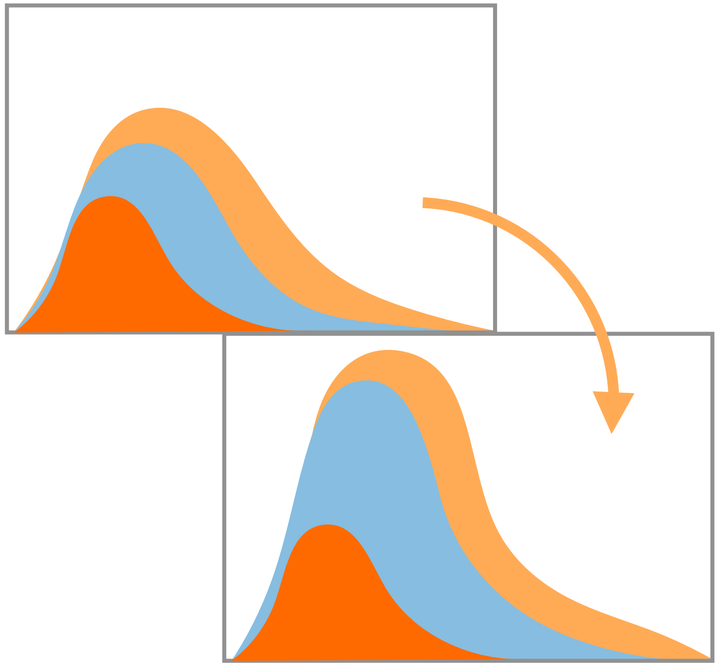


Model uncertainty

Increase resonant contribution



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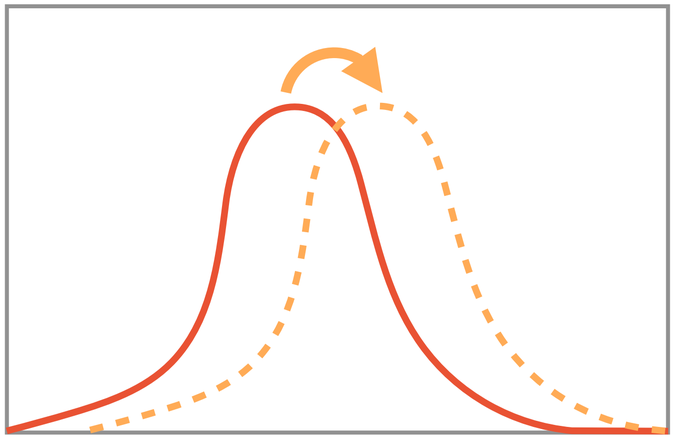

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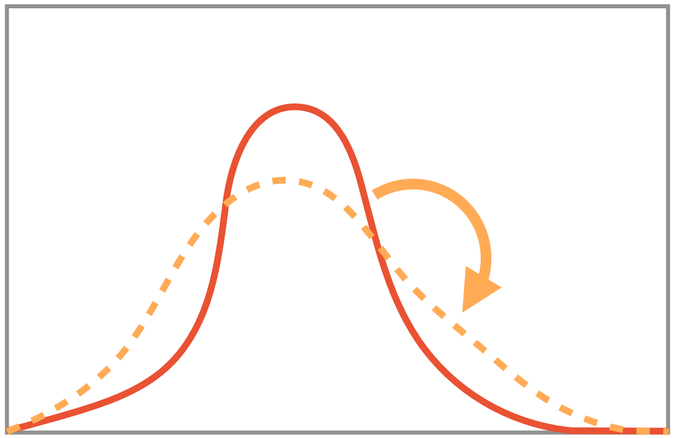

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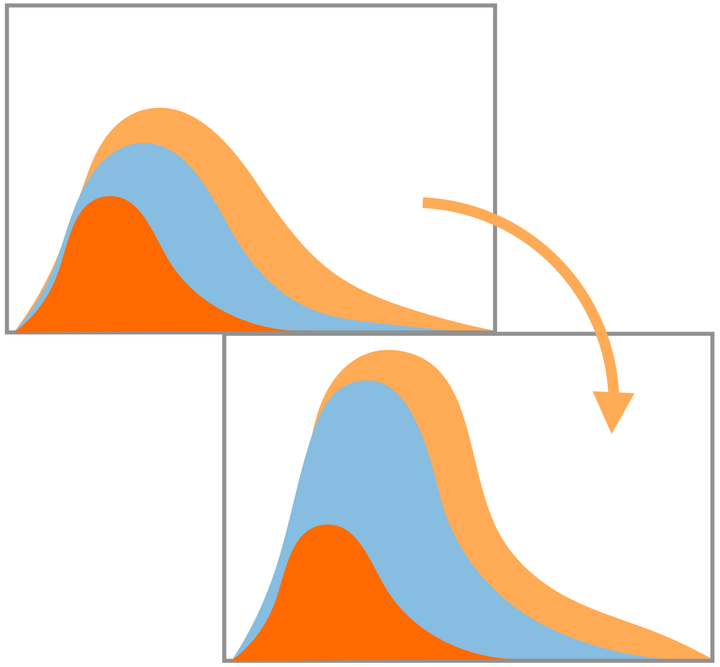


How do they affect our distributions?
Systematic vs statistical

CAFAna - remember last time

A data source (`SpectrumLoader`)

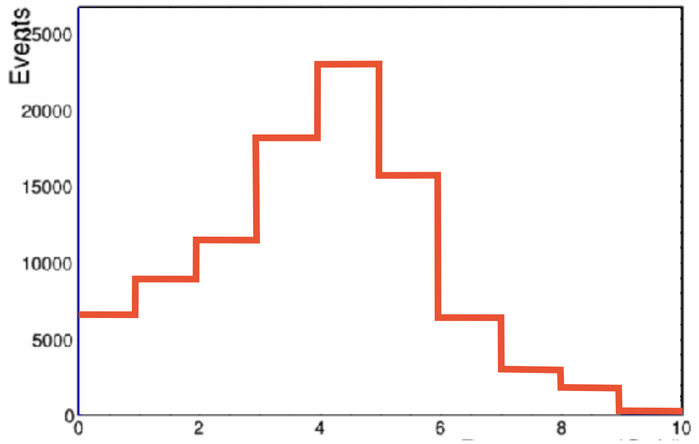
An event selection (`Cut`)

A variable to plot (`Var`)

`HistAxis`

How to group it (`Binning`)

`Spectrum`



A systematic shift

SysShifts

Code the effect of your shift - e.g.
- adjust energy,
- change probability of some events

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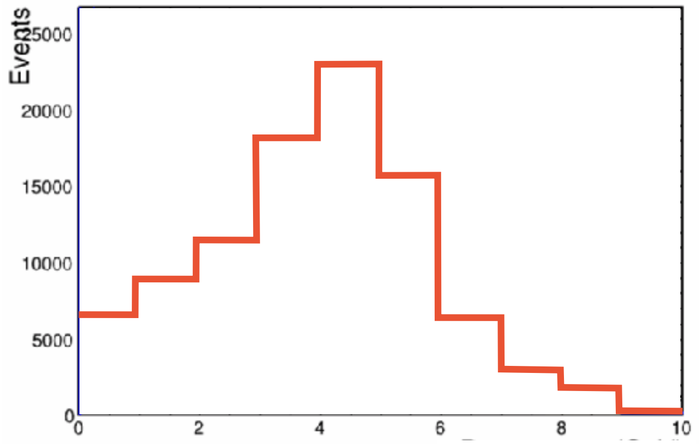

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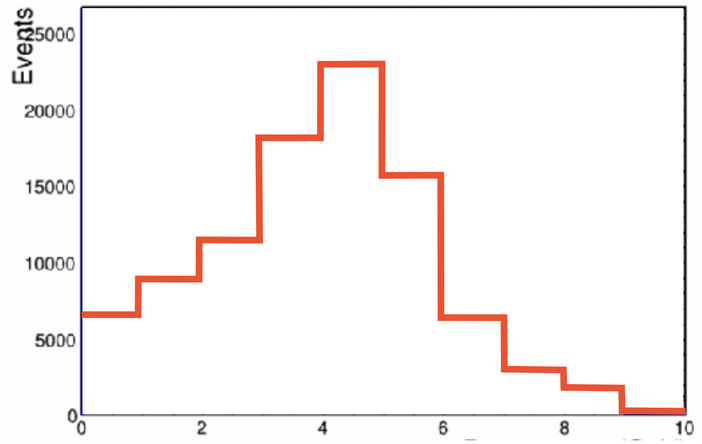

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Change value of variable e.g. muon energy → + 10%

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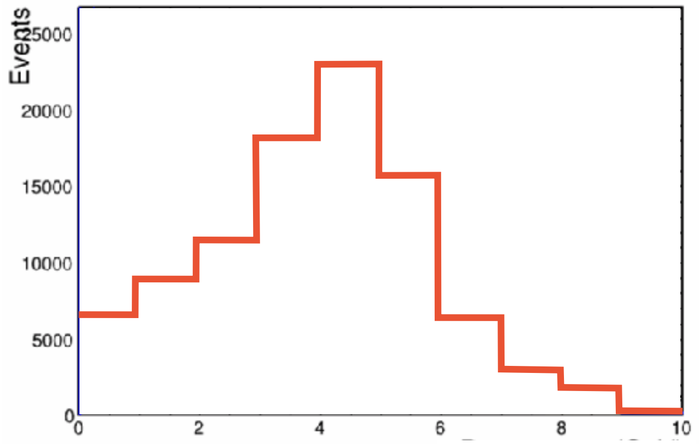

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A systematic shift

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Does the new variable still pass your cuts?

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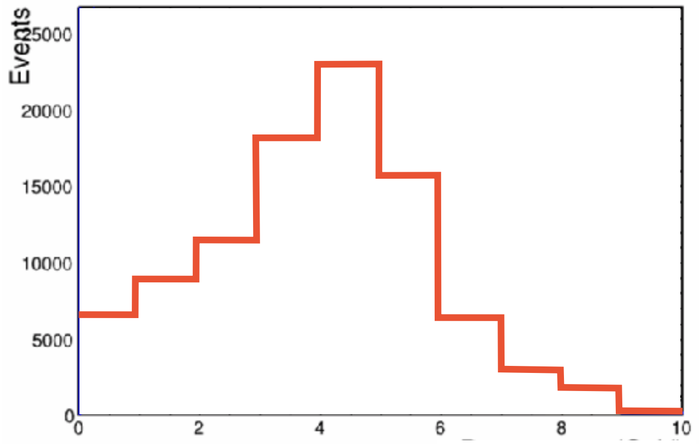

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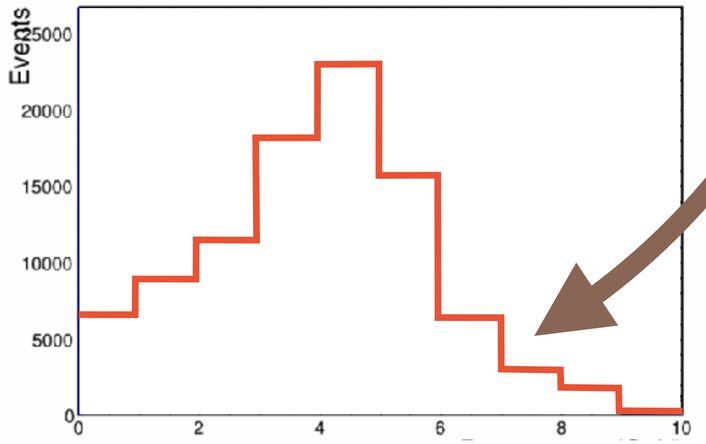

How much should the event contribute (weight)?

A systematic shift

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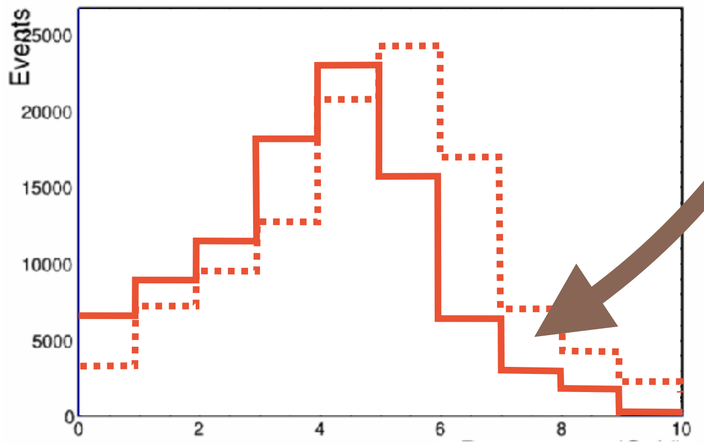

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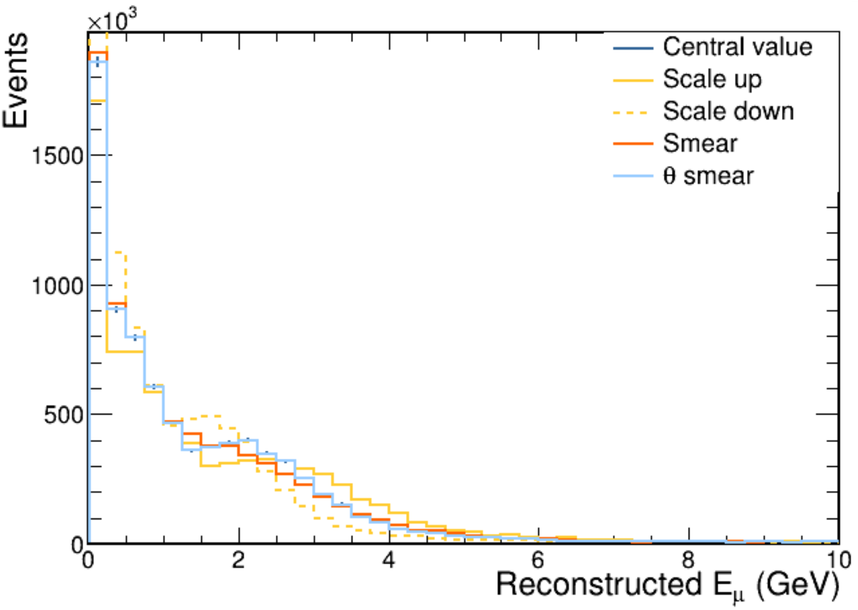
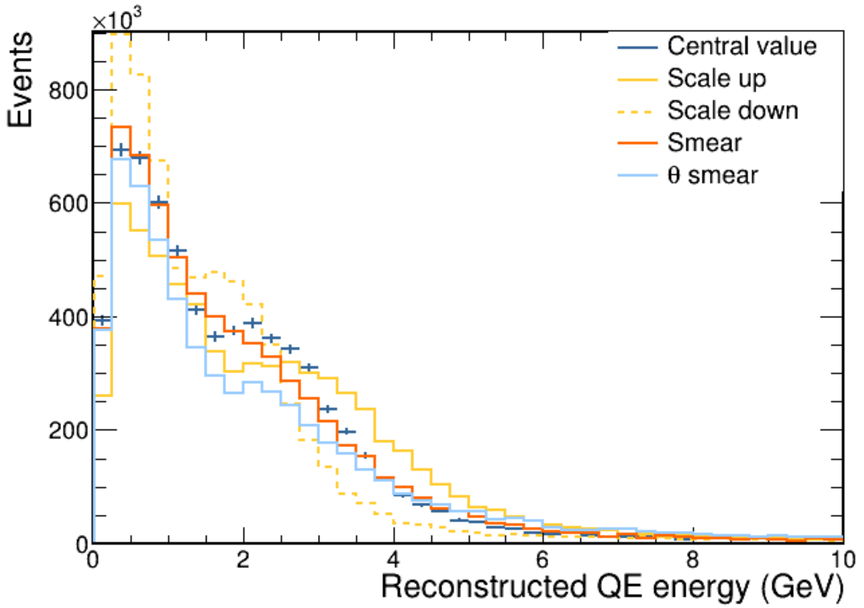
Try it yourself!

Follow the worksheet on Indico!

Effect of a bias, smear, and model uncertainty





Effect on reconstructed quantities

Fractional uncertainty