Measurements of the Speed and Mean Life of Cosmic-Ray Muons as a Test of Special Relativity

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Is there a relationship between velocity and time?

Special Relativity

- In 1902 Einstein published his theory...
- Objects moving near the speed of light...
- Time dilation ...

Muons

- Former MIT Professor Bruno Rossi observed cosmic ray muons...

Einstein - Circa 1912

Rossi - Circa 1987

Make Slide Titles Informative!

...and keep your audience focused.

- Summary of Key Physical Relationships - NO LONG DERIVATIONS!
- Identify assumptions, e.g. data are Poisson distributed, our calculations disregard 2nd order effects, etc... characterized by, σ_i
- Maximizing the probability of the dataset $\Rightarrow$ Mimimizing χ^2

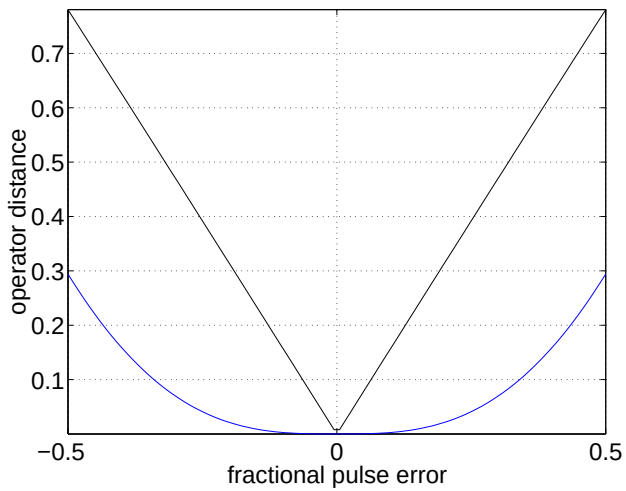
$$\chi^2_\nu = \sum \left[\frac{y_i - f(x_i)}{\sigma_i} \right]^2$$

- If you show present equations, you MUST identify every variable.
- Also try to tell what the equation MEANS!!!
  - $\chi^2_\nu >> 1 \rightarrow$ Bad fit
  - $\chi^2_\nu << 1 \rightarrow$ Probably overestimated errorbars on data

2nd Theory Slide...Describe limiting behaviors...

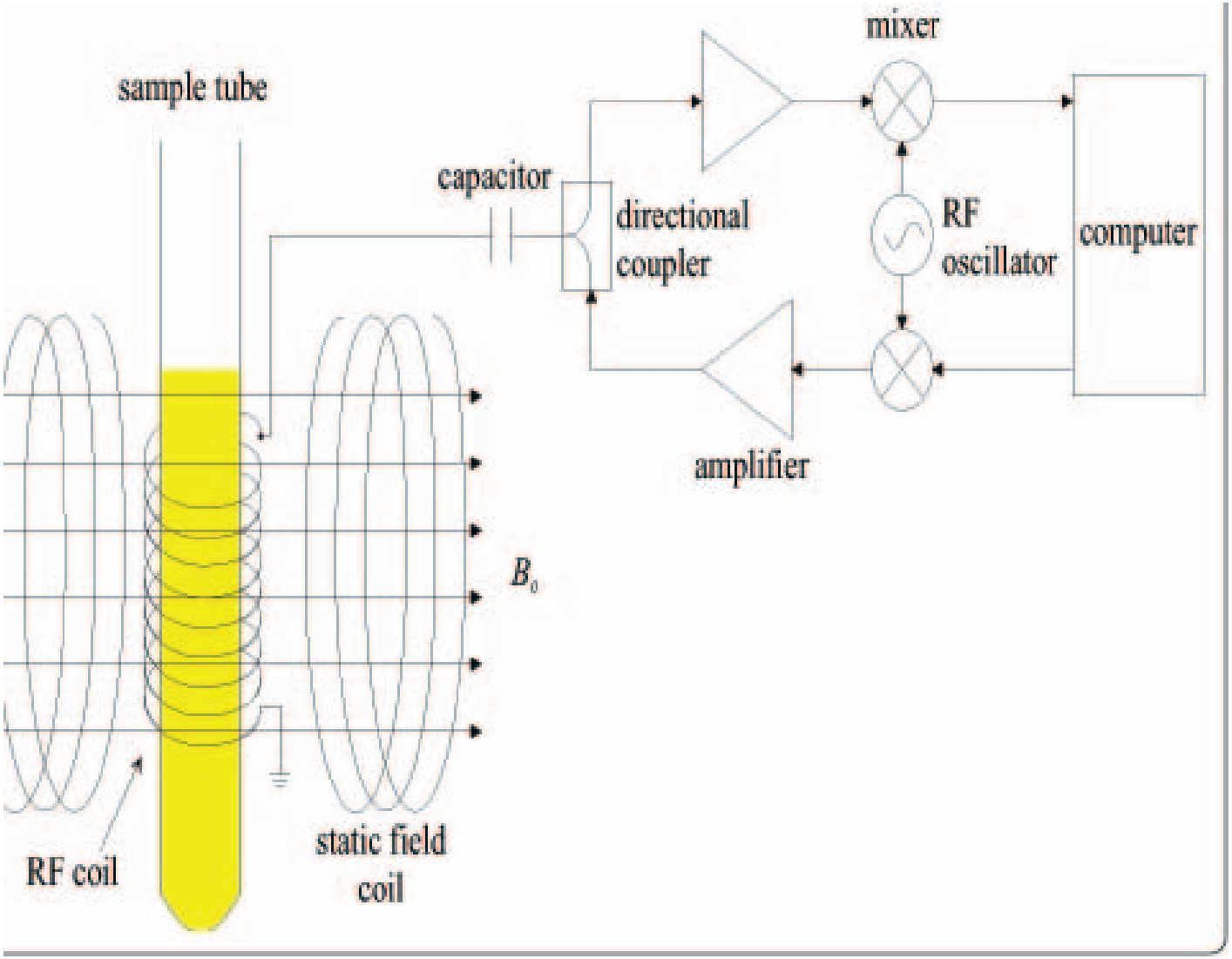
- A spin evolves in a magnetic field according to the Hamiltonian $H = \vec{\mu} \cdot \vec{B} + H_{RF}$
- Free precession is

$$R_z = \exp[i\omega_z t \sigma_z / 2]$$



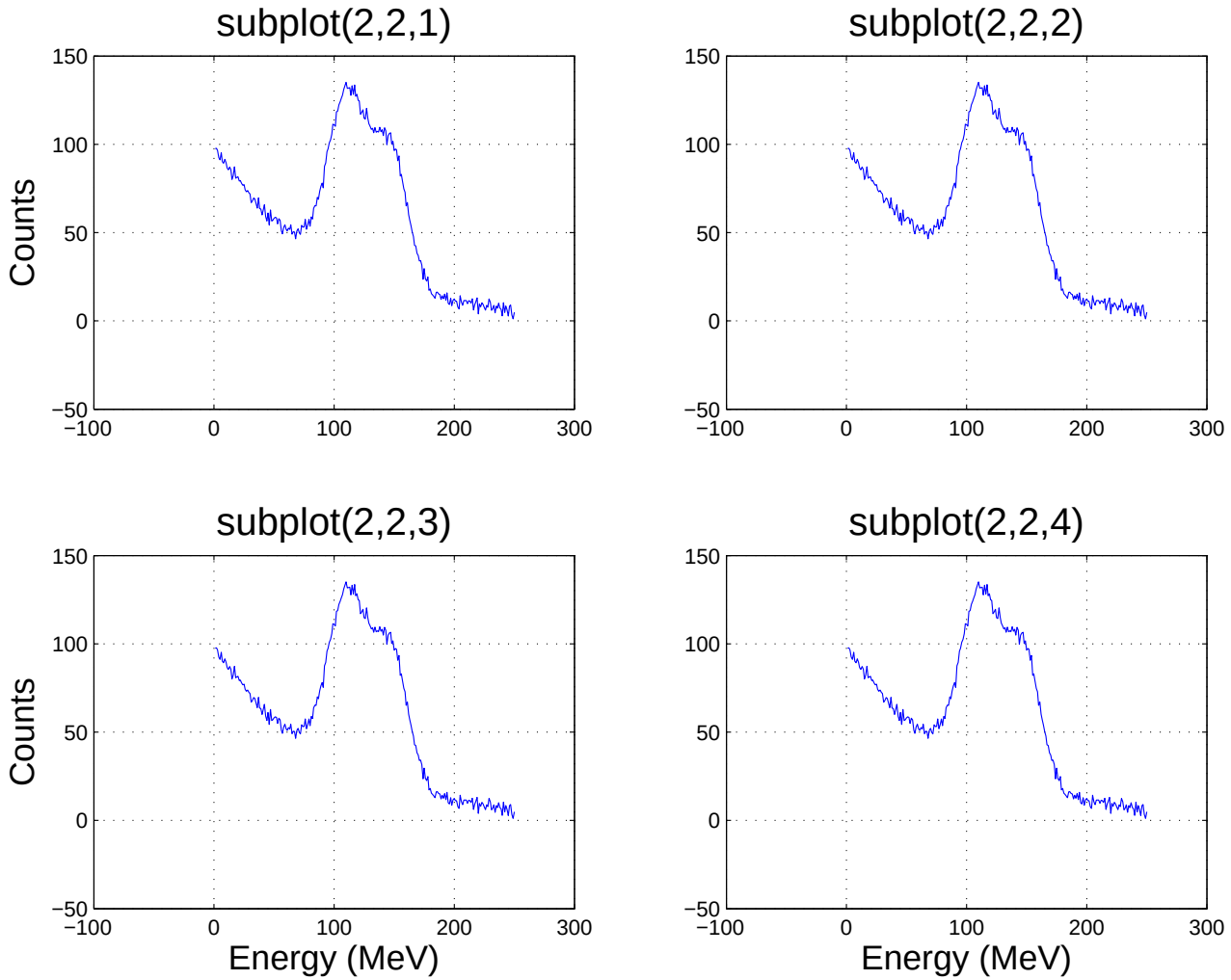
Note all text on plots should be at least 16 point!

Basic Elements of an NMR Spectrometer



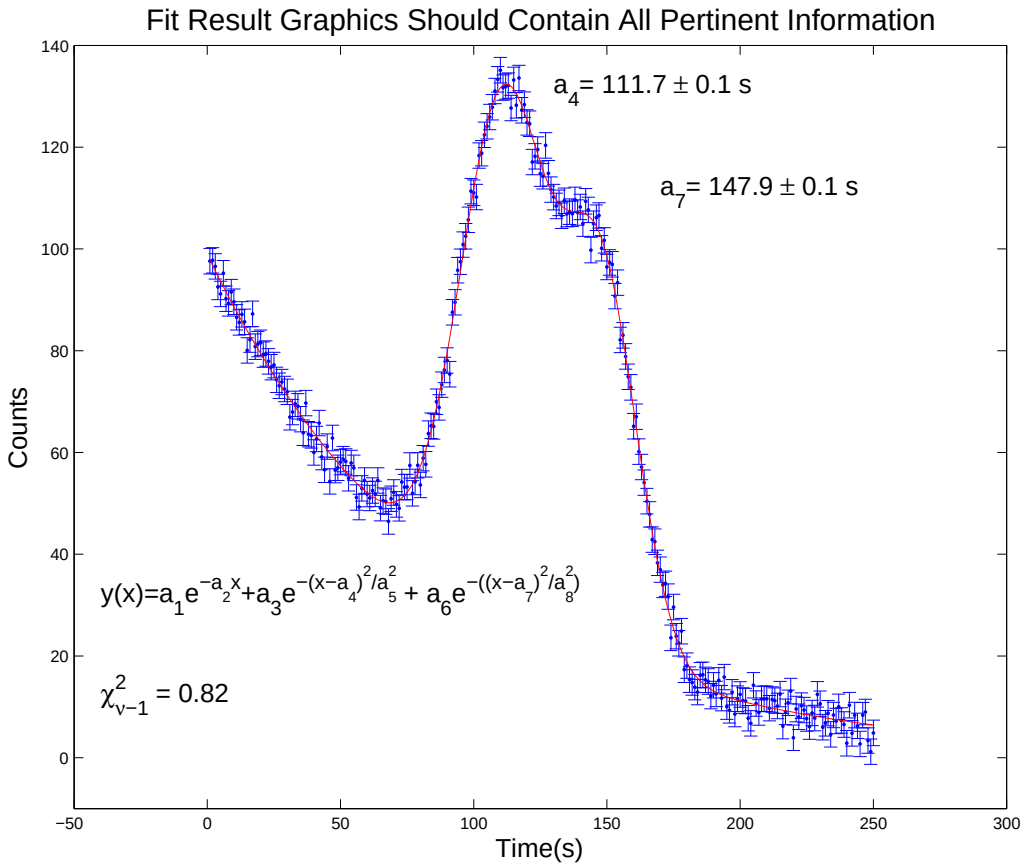
- Don't bombard your audience with too many details but DO identify critical elements.

Always present some of your raw data...



- Identify things like integration time, any instrumental gain and/or filtering...

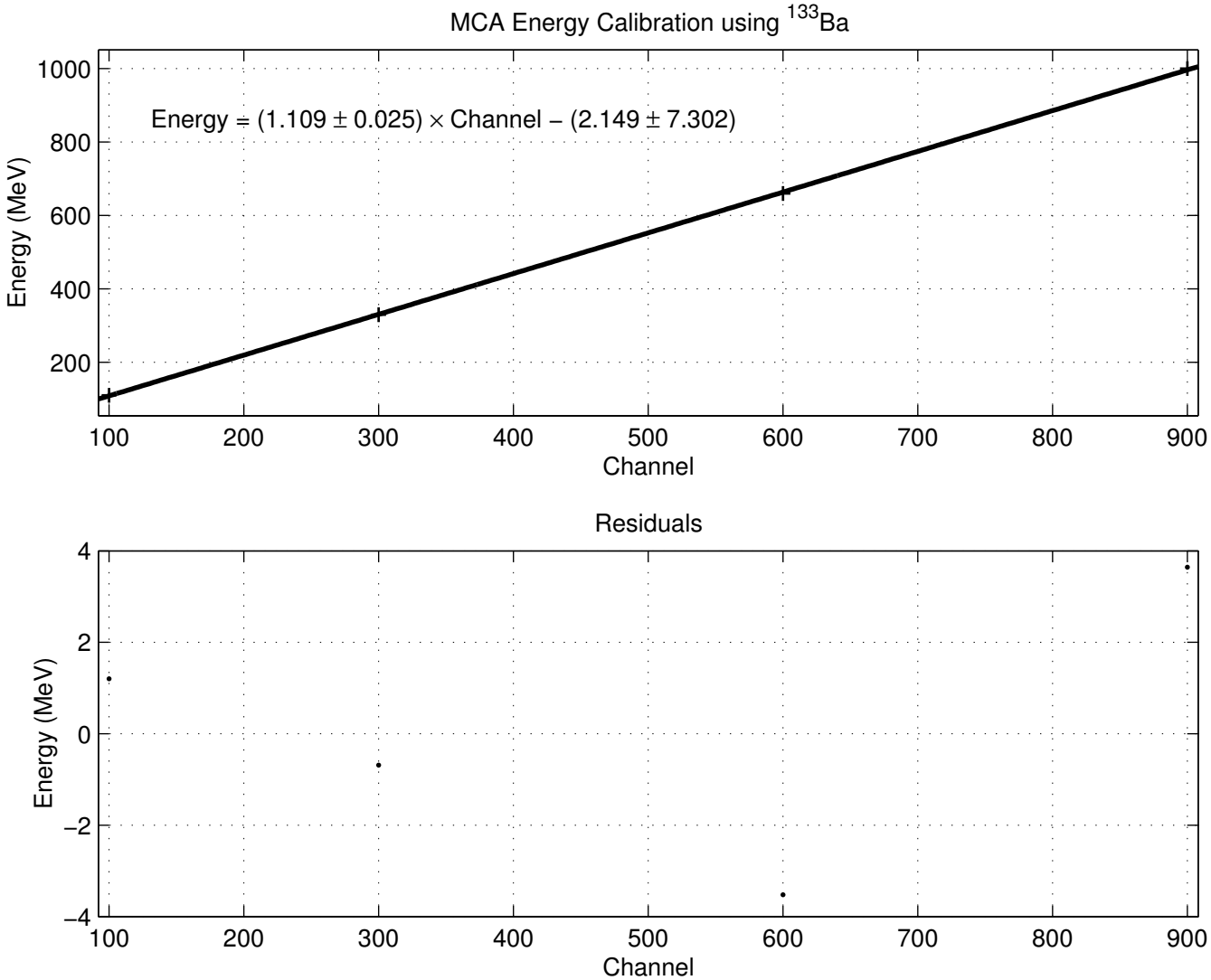
And some reduced data...



- Explicitly state where your uncertainties come from!
- If residuals are significant, plot and discuss!

Muon Time of Flight Vs. Relativistic Prediction

Always compare to a physical model!



As you can see our data show a discrepancy at higher energies

Results and Interpretation

- Give results as $x = (y.yy \pm \delta y_s ys \pm \delta y_r an)10^{zz}$ and compare to known values in terms of being so many standard deviations away...
- Description and Analysis of Errors, show how δy is made up, discuss random and systematic contributions.
- If you're more than 3 σ away from the known value, prepare to suggest possible systematics and persuasively argue their likely order of magnitude.
- What calibrations would you like to have performed...

Summary and Conclusions

- Does the data support your conclusions?
- If not, why not (speculate but be prepared to defend your reasoning!)
- Things you could have done better...

- The first main message of your talk in one or two lines.
- The second main message of your talk in one or two lines.
- Perhaps a third message, but not more than that.

Final Thoughts

- This template is just a guide. Slides may be added or removed based on length of talk, target audience or instructor advice.
- Bring a paper copy of your slides to your exam just in case you have AV difficulties.
- Arrive 10 minutes earlyand dress as you would for any other important public presentation.
- Practice, practice, practice!