How to give a science talk
in context of IYPT

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Preview

1. How it's already done
2. Who's your audience
3. What's your message
4. How to support the message throughout
5. How to finish

Standard scientific

How you see ~~IYPT~~ presentations

1. Problem statement
   Because we start with a given problem
2. Experimental setup
   Because we built a really great machine
3. ~~Theoretical~~Mathematical model
   Because math rules and we know fancy function names
4. Lots of experiments
   Because there are 4 parameters and we varied them all
5. Theory and experiment comparison
   Because our plots bend in the same direction
6. Conclusions
   Because my teamlead told me so
7. References
   Because they will complain if I don't have this slide

Think about your audience

- It cannot happen that most of your jury board is simultaneously incompetent.
- If they all don't get what you say – it's your problem.
- It's your job to do science work and make conclusions. It's their job to listen.
- When you're not reporting, observe yourself observing a talk. What matters for you, what convinces you, what bores?

Think about your message

- No elements of your talk are obligatory and Supreme Forces-required.
- You want to say that you solved the required problem. Saying how much you struggled on it doesn't help the case.
- You prove that you're correct by presenting a compelling argument.

Crafting an argument

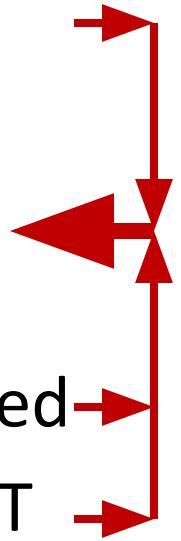
- Thesis
- Premises:
  - Premise 1
  - Premise 2
    - Subpremise 1
    - Subpremise 2
  - Premise 3
- Conclusion: thesis is true

Crafting a physics argument

- Problem statement: Effect X is observed. Investigate and explain.
- Thesis: Effect X is explained with theory T
- Premises:
  - P1: Setup S is proposed and built
  - P2: Theory T is suggested
  - P3: Series of experiments E is conducted
  - P4: Results of E fit with predictions of T
- Conclusion: Effect X is explained with theory T

Nonlinearity of the argument

- P1: Setup S is proposed and built
- P2: Theory T is suggested
  - P2.1: Assumption A is used to build theory
  - P2.2: Theory T gives predictions
- P3: Series of experiments E is conducted
- P4: Results of E fit with predictions of T



Assumption A is justified in setup S and is consistent with results of experiments E and predictions of theory T

How to tell proud from truth

- Audience generally believes what you say.
- If you claim that you've done all the thinking work yourself, it is obnoxious.
- Your novelty is only visible in contrast with existing knowledge.
- Making unified conclusions is harder than measuring and writing formulas and reading papers. Be proud of your higher-level achievements.

Why cite and reference

- Building up from basic physics is cool, but it's unlikely that each your idea is original. Some ideas are, and conclusions are.
- For this reason referencing contemporary research and journals is more respectable than referencing textbooks.
- Often existence of reference is more important than its content.

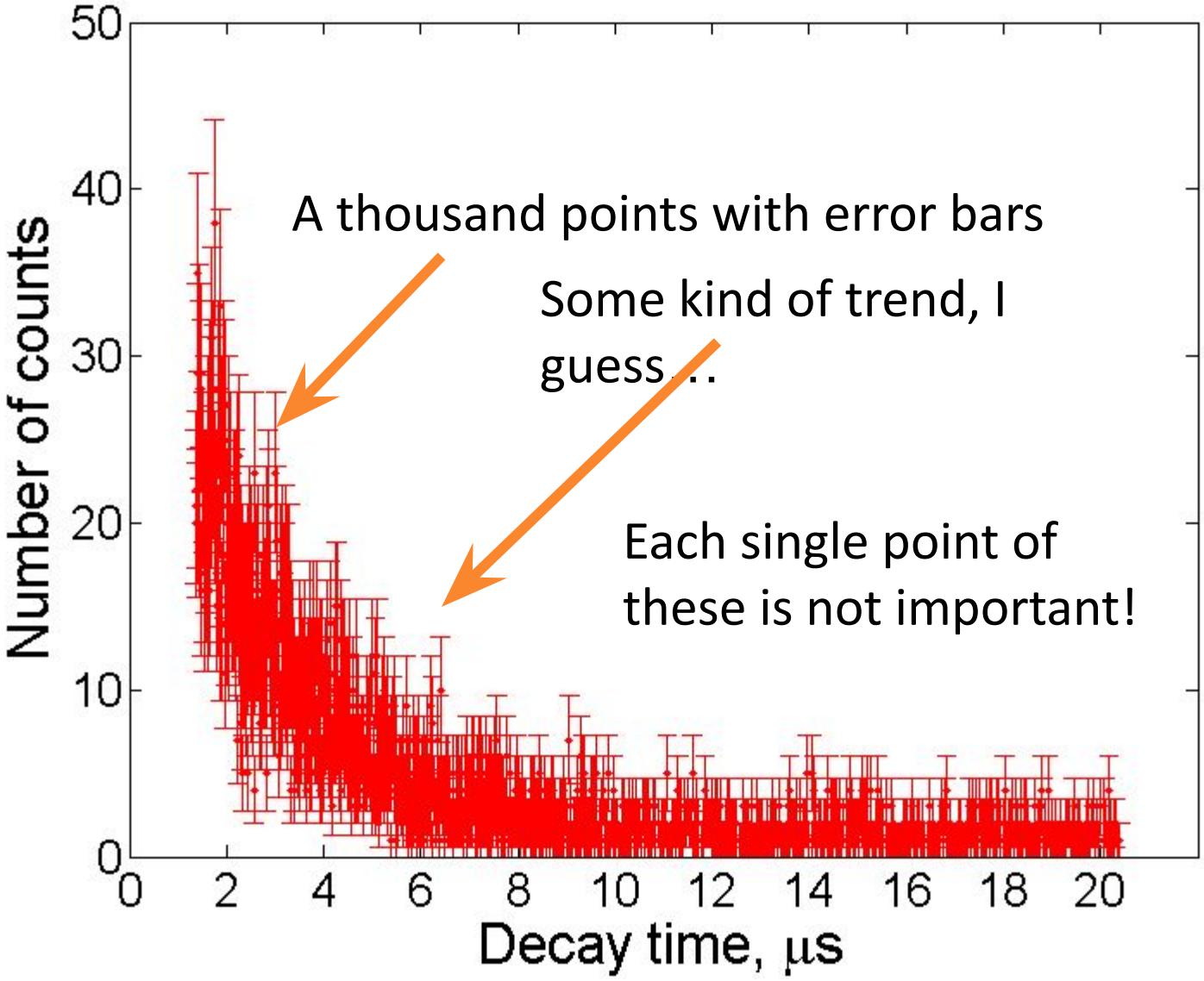
HOW TO MAKE THEM UNDERSTAND YOU

Trick 1: Thin down/skip/gloss over
Trick 2: Walk-through
Trick 3: Dichotomies (comparing of two objects)

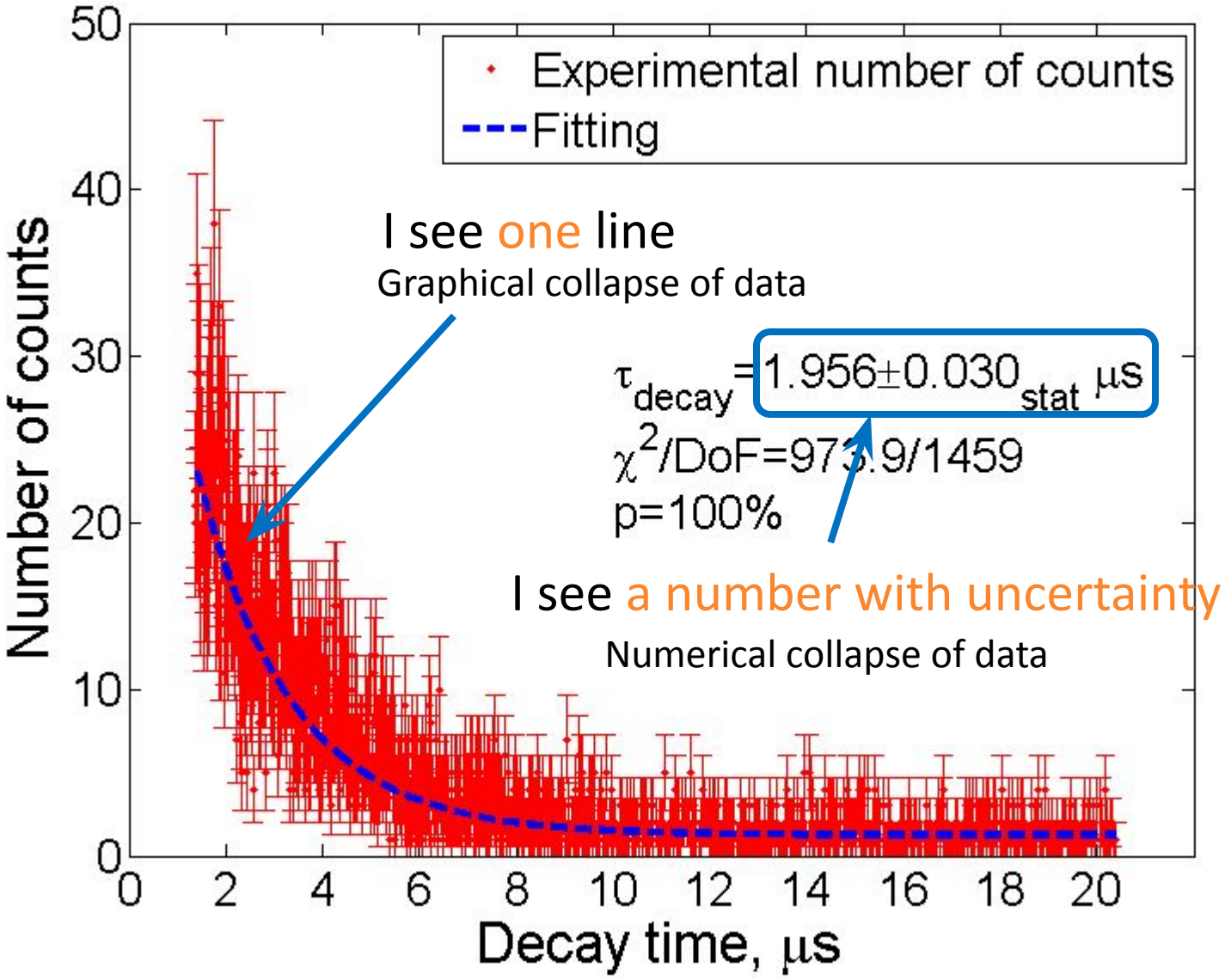
Perception of many objects

- Human brain cannot process too many objects at the same time. It does not depend on the competence of the viewer, it depends on the quality of presentation.
- Fortunately, you usually really don’t need to draw attention to many objects to convey your message.

One bad plot – what do you see?



One good plot – what do you see?

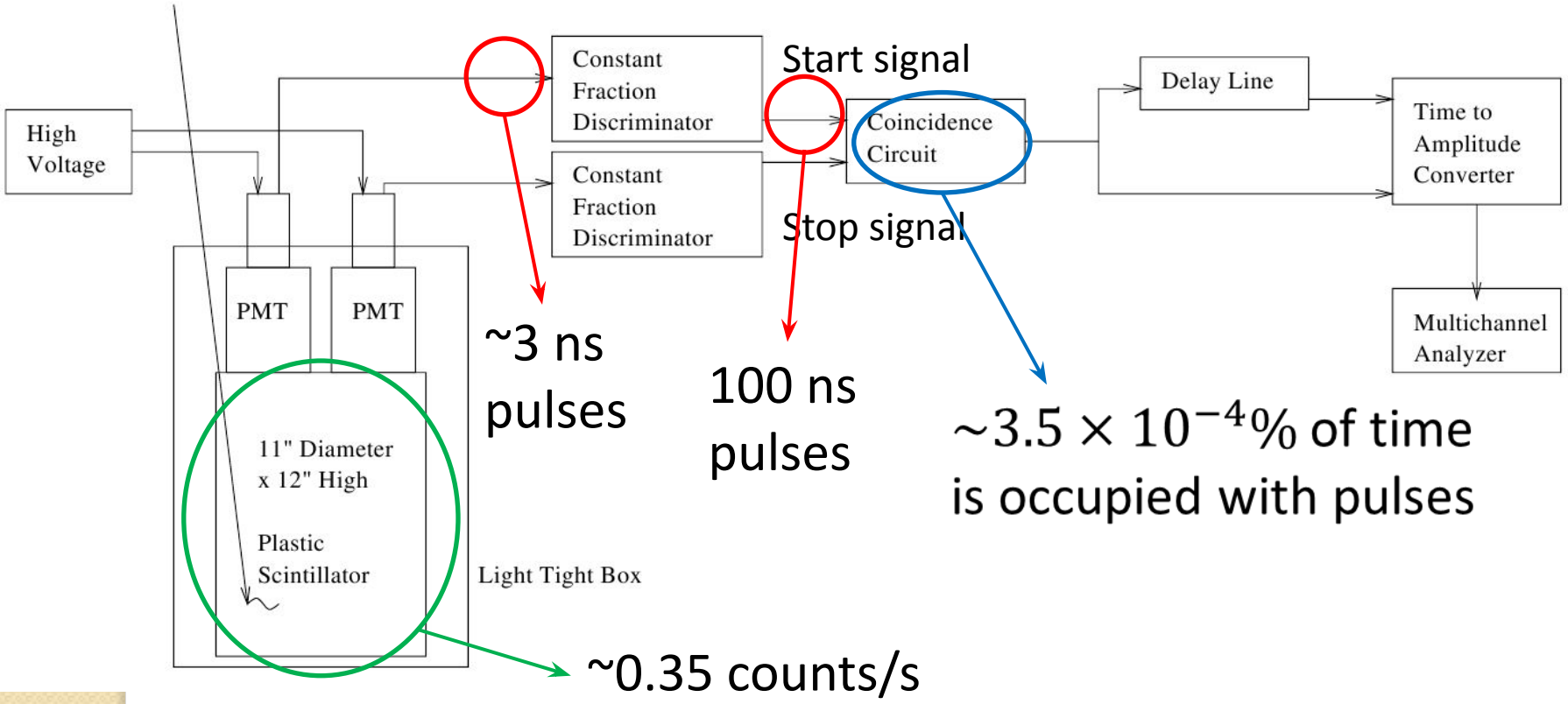


Trick 1

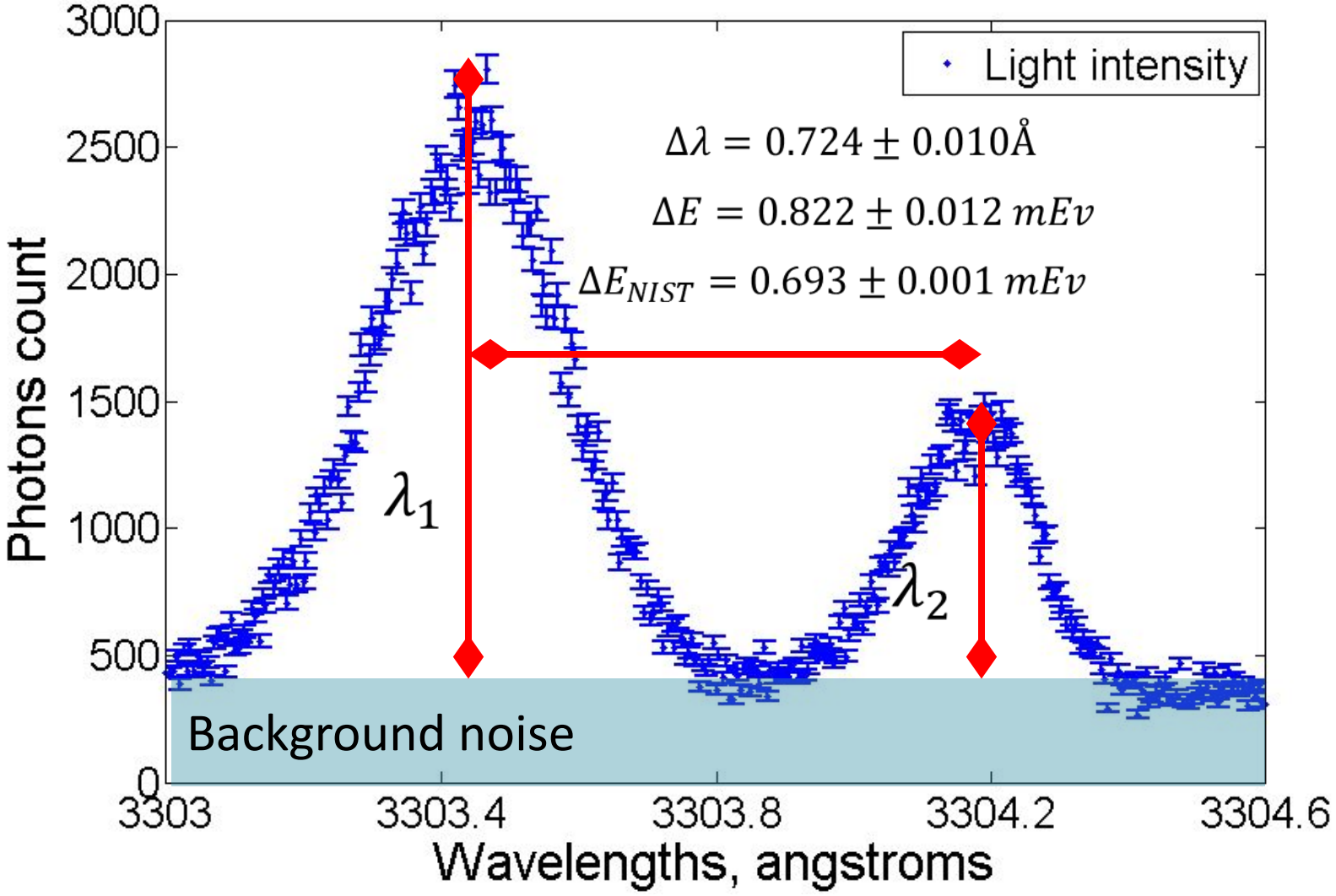
What did I just do with one plot?

- I glossed over all my raw data showing that I did it.
- I distracted you by showing the trend line and the number, thinned down my data.
- I skipped telling you the methods of these collapses, and you still believe me.

A scary signal chain



A plot analysis

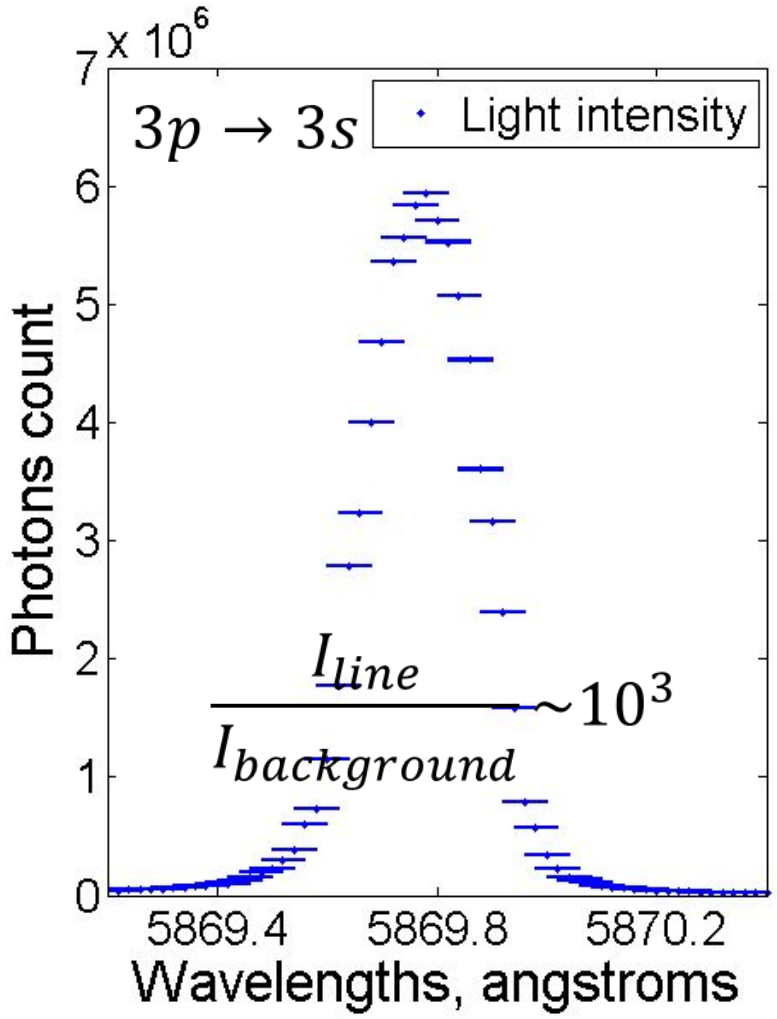


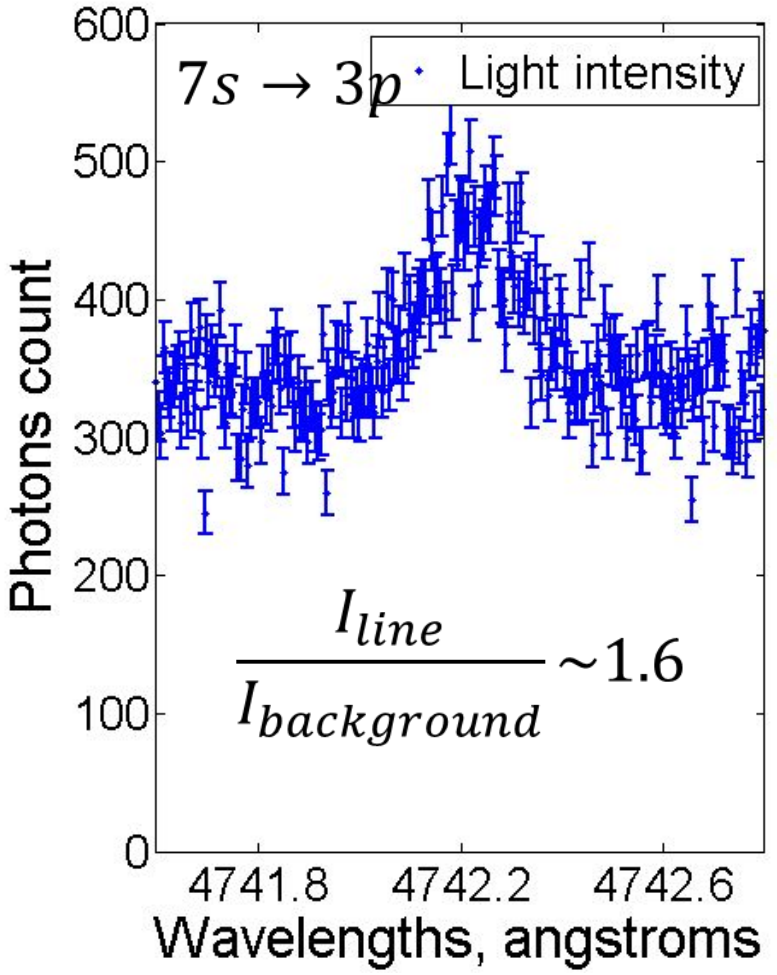
Trick 2

Why are these comprehensible?

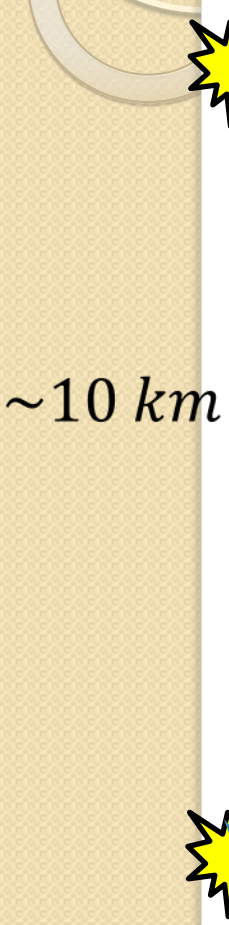
- I showed you the whole scheme/plot.
- I put animations showing technical details along the signal chain or plot analysis.
- I walked you through the chain/analysis.
- I used colored takeaway points.
- I showed different information with the main scheme and the takeaways.

Two plots shown together





Picture vs plot

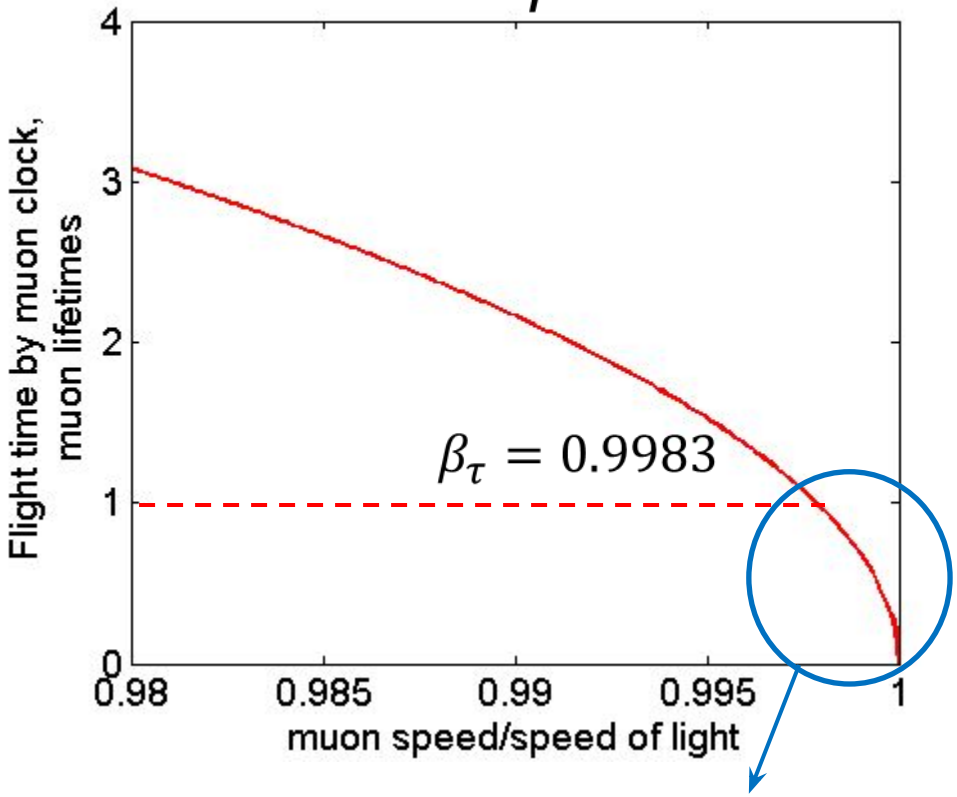


at $\frac{v}{c}$=0.997

$t_{lab} \approx 17\tau$

$t_{muon} \approx 1.3\tau$

$$t_{muon}(\beta) = \frac{h}{\beta c}\sqrt{1-\beta^2}$$



Only muons from this region are observed at ground level

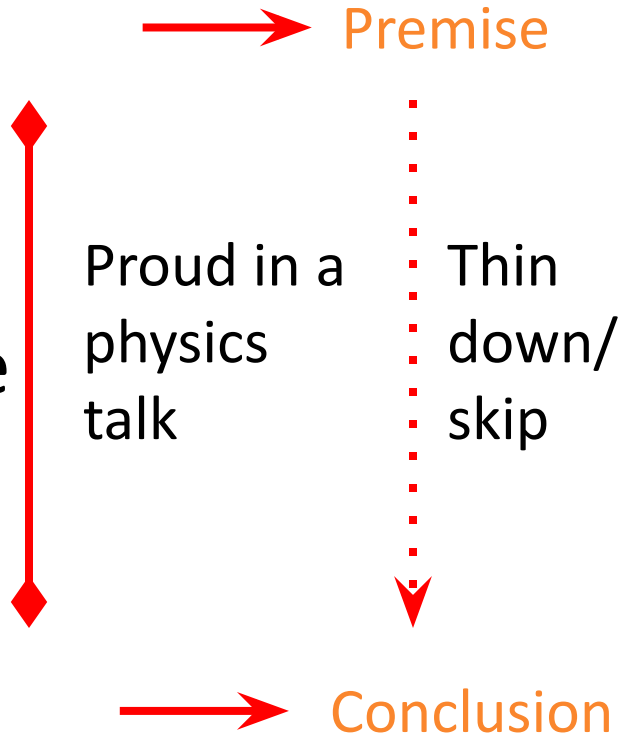
Trick 3

- I broke the slide in two halves.
- Each half has a comprehensible number of objects.
- Two halves complement each other.

On math

Calculating magnet's field

1. Bio-Savart law
   - Use Heaviside step fn
2. Fourier transform
3. Integral in Fourier space
   - Use Bessel fns
4. Fourier transform back
5. Plot the field



On results and uncertainties

- Usually it is not possible to measure anything exactly.
- Uncertainty defines the quality of result.
- Larger data doesn't just give larger proud, it gives smaller uncertainty in collapse.
- Quoting uncertainties not just enhances your argument, but also can make it succeed or fail.
- Discrepancy/uncertainty is a good gauge.

Conclusions

- Conclusions are a reiteration of the argument, they are not surprising.
- Your goal was to coordinate theory and experiment results. Show that you did it.
- Don’t stress the achievement of data. Stress the results and your confidence in them, that demonstrates data enough.

How much of it?

- Optimal reporting speed is about 1-2 slides per minute.
- If you want to show big data/scheme/math, don't waste audience's time in making them analyze it. It is your job. Use tricks to present.

Acknowledgements/references

- References are best given along the presentation and reiterated in the end. Remember, the audience cannot go back and forth as in reading a paper.
- Thanking contributing people for helpful discussions is a nice touch.

Common courtesies

- Provide the audience with the structure of your talk. Show section delimiters if it's long, provide an outline, provide visible slide numbers.
- Don't invite anybody to your extra slides. Whenever you go there, you are almost surely lost. Same rules of proud vs truth apply to extra slides.

If it's so good, how to criticize it?

- Opponent's performance is making an argument of critical evaluation, except for the conclusion is decided in the end.
- You can challenge validity of the argument: is the conclusion true if premises are? Or you can challenge the soundness: are the premises true?
- Your conclusion is that the reporter's argument is either good and sound, or needs some work or fails.

Attacking a physics argument

- Effect X
- Thesis: T<->X
- Premises:
  - P1: Setup S
  - P2: Theory T
  - P3: Experiments E
  - P4: E<->T
- Conclusion: T<->X

Does it capture all the effects?

Are the assumptions true?

Are uncertainties evaluated correctly?

Is there a numerical convergence with little uncertainty?

Are the theory and experiments sufficient to justify the conclusion?

This is the Battleship game – you can't sink the argument with one shot

How to review it?

- You are to evaluate the argument of the reporter and the counterargument of the opponent.
- If they are in strict opposition, no more than one of them can win.
- You can reconcile the two, ask for more investigation, or agree with one of them.

Thanks for your attention

- Think of the audience and the argument.
- Be brave and confident.