

How to Write and Give a Good Scientific Talk

some practical and specific advice...

Janet Conrad,
Columbia University

WISC meeting,
Feb 7, 2005

The final act in the process of scientific discovery



is reporting what you have learned.

I will use a lot of examples from my own talks.

Just to quickly orient you:

- ★ I am a particle physicist
- ★ These talks all focus on an elementary particle called the neutrino.
- ★ Neutrinos have a number of odd properties,
including one which is called "oscillations"
- ★ My experiment, MiniBooNE, searches for exotic neutrino processes
including an unexpected form of oscillations.

The Golden Rule:

Give the talk that you would like to hear.

Over and over you will hear me say the words...

Explain

Convince

Entertain

A successful talk does all three!

Since all good talks are divided into three parts...

- Preparing to write your talk...
- Making your slides....
- Presenting your talk....

How to prepare to write a good talk:

1. What are the goals?
2. What type of talk is needed?
3. A fool-proof plan

For example

Start by writing down, in one sentence, your goal:

Convince an audience of physicists that neutrinos oscillate, while highlighting that interesting questions remain.

Convince the Fermilab Physics Advisory Committee that MiniBooNE works as advertised and will have final results soon.

Convince Columbia Senior Faculty to tenure me because of my interesting data analysis and leadership of an exciting future experiment

Identify

- Your audience
- Your basic subject
- Possibly a secondary subject

So who *IS* your audience? What kind of talk are you giving?

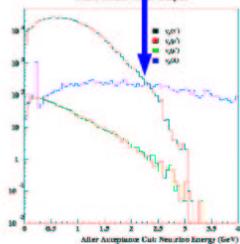
A talk within your collaboration --

Your audience will know the acronyms, jargon, and concepts, nevertheless, **a one page reminder** of the larger subject, before jumping into the details, **really helps!**

For example: I am working on an analysis on MiniBooNE, when I report to the collaboration, I start this way...

Update on looking at the High Energy Box:
x-factors for contained and exiting events.

Why am I doing this?
Neutrinos from kaons dominate at high energies.



Get information on kaon production needed to understand

- 1) the x-factor and
- 2) kaon systematics.

Janet Conrad
Sept 30

A Seminar --

Audience participates in your subfield and know the typical jargon.
But are likely to not be on your experiment and don't know acronyms, etc.

In a 1 hour talk, plan 5-10 slides of intro to your main subject.

For all following slides, look over each slide to remove
or explain experiment specific acronyms, names, etc.

1st 5 slides of the 1st section of my seminar on MiniBooNE:

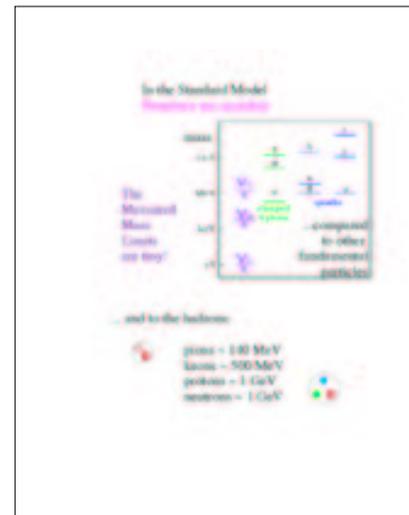
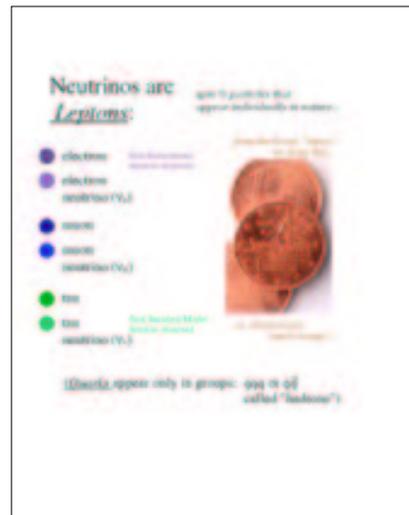
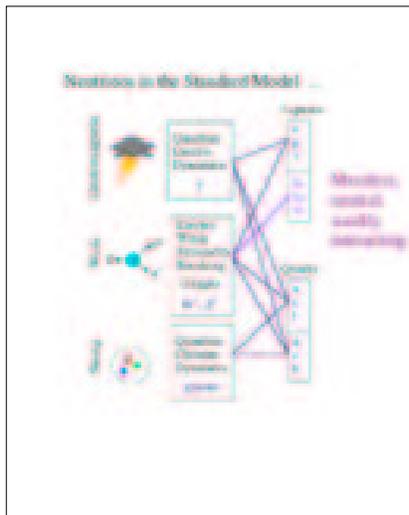
1. The theory of neutrino oscillations
2. The status of the world's data on neutrino oscillations
3. Focus on the LSND results which motivate MiniBooNE
4. Reminder of why these results don't fit into the Standard Model
5. If you want to test LSND, what sort of experiment do you need?

A colloquium --

Your audience participates in many, diverse areas within your field.
People from related fields may be attending.
Grad students and even seniors may be in the audience.

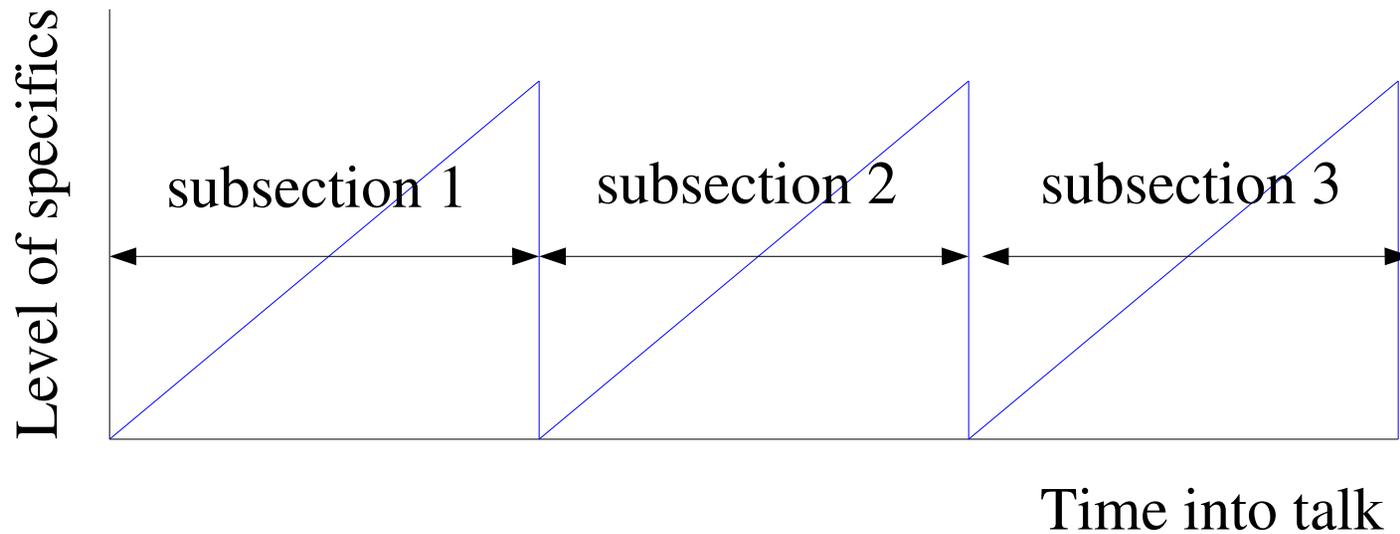
You will need **a few page introduction to your field.**
Followed by several pages of introduction to the main idea.

First few slides from first section from my colloquium,
"Seeking the small, silent type..."

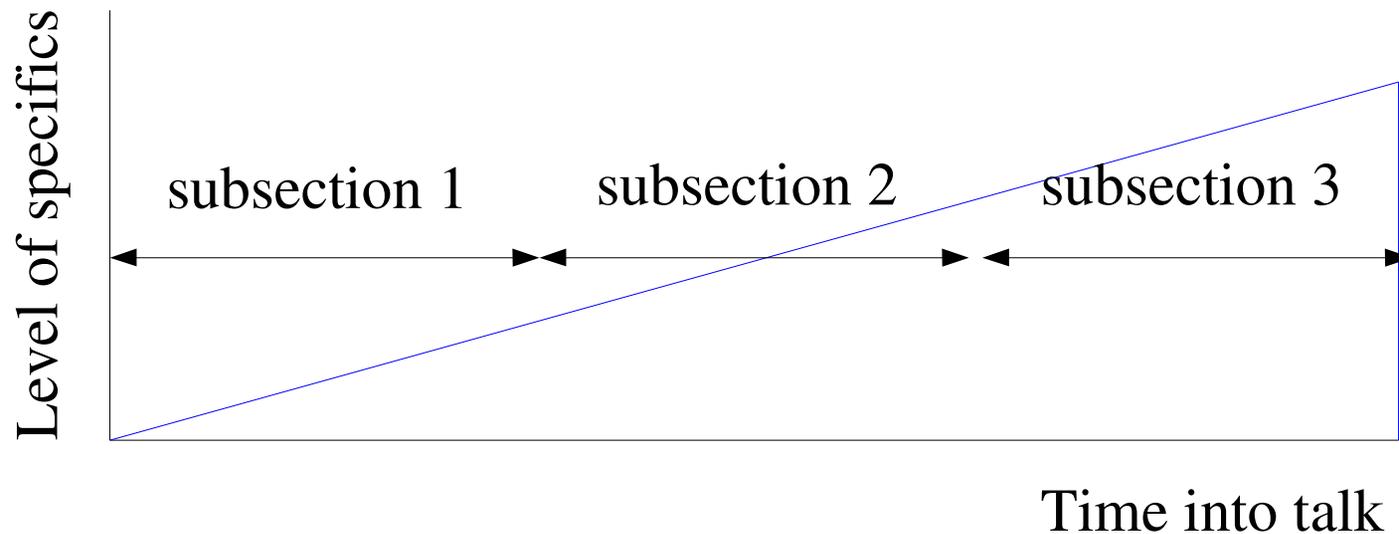


Colloquia, continued:

Best if there is something for everyone:



Works better than



Are more or less like...

Other kinds of talks:

a seminar

a colloquium

An "internal" thesis defense



An "external" thesis defense



A "parallel session"
at a conference



A "plenary session"
at a conference



If you have *any* question about the level,
go learn more about your audience:

- What do they do?
- Can you look up past talks?
- Can you talk with past speakers?

Now that you know what kind of talk you are doing,

Go listen to a few talks of this type,
with the purpose of analyzing the talk.

What did you like about these talks?
What was really irritating?

Grade each talk:

Give one grade for organization and content.

Give a second grade for presentation.

Be critical. Don't grade inflate.

Example lay-outs, where the goals were....

A fool-proof organization:

Convince the audience
that neutrinos oscillate,
but highlight that
interesting questions
remain

Convince the
Fermilab Physics
Advisory Committee
that MiniBooNE works
as advertised and will
have final results soon.

Introduction

About oscillations

Motivation

Main Body

subtopic 1

subtopic 2

subtopic 3

solar neutrino results

atmospheric results

accelerator results

Design of Detector

Proof Detector works

First Results

Conclusion

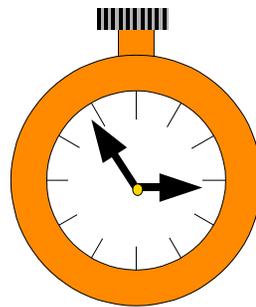
How well does it
fit together?

From here to a final
result

One last comment before getting started on writing:

Never underestimate how much time it takes to write a good talk...

Be sure to start working on your talk
well in advance
of the date it will be given

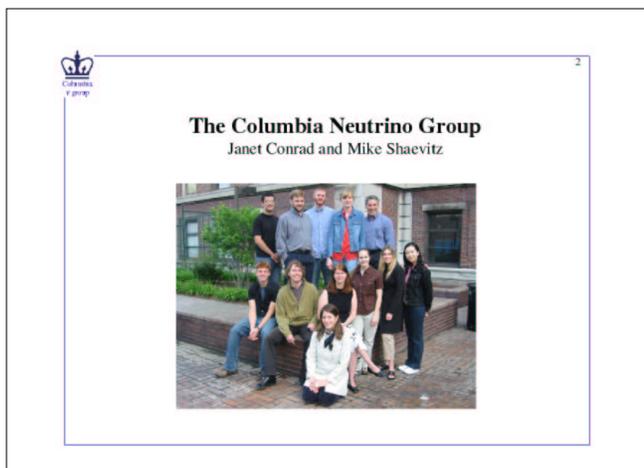


Making your slides:

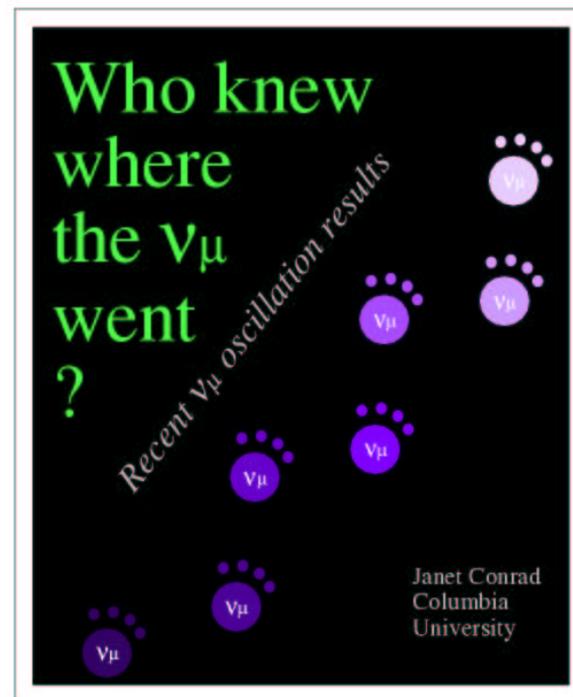
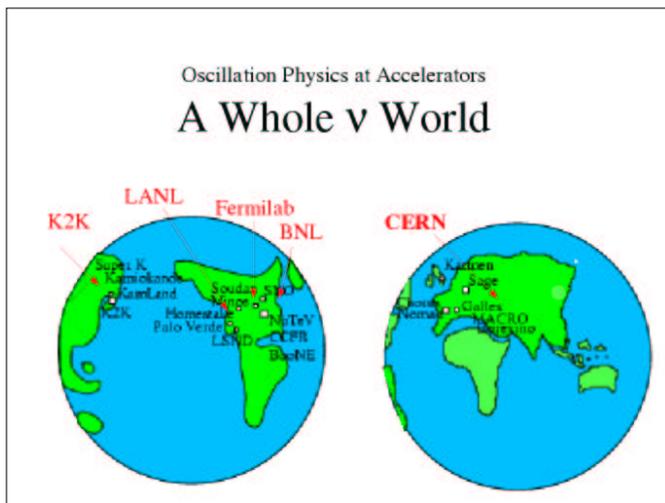
1. Selecting content and theme...
2. Design Tips
3. Giving your audience a break.

Choose a talk title...

It can be very simple...



If it is "clever," it should also clearly express ideas from your talk...

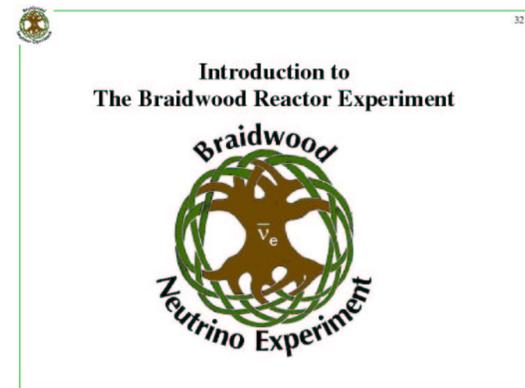
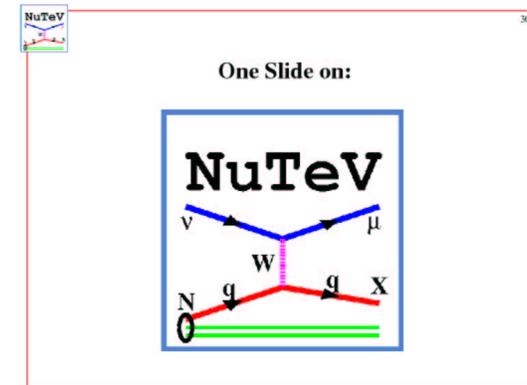
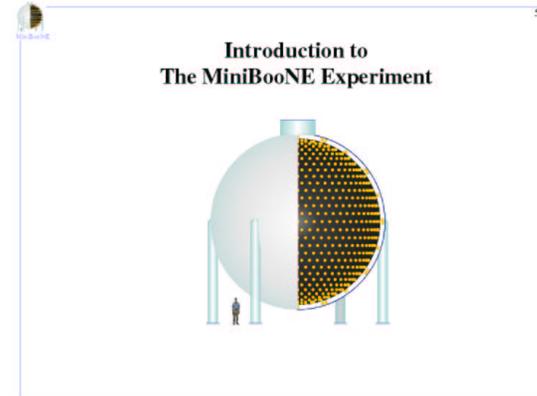


A little bit of "fun" is ok, as long as 90% of the talk is serious.

The 1st or 2nd slide should be an outline

Transition slides connected to the outline appearing before each subsection make a talk easier to follow...

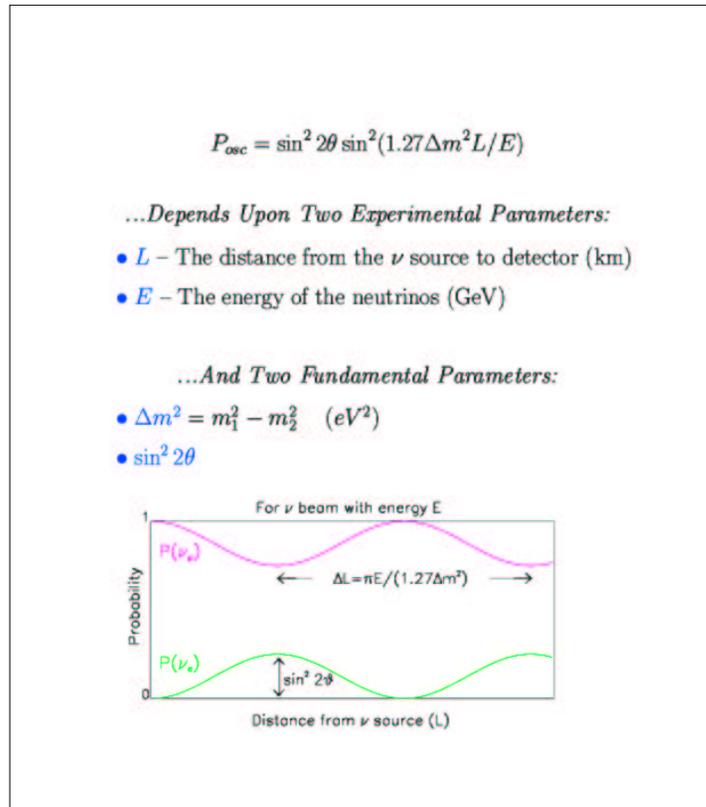
- About the Columbia Neutrino Group
- MiniBooNE results
- NuTeV results
- Braidwood Plans
- Summary of our Group's physics goals



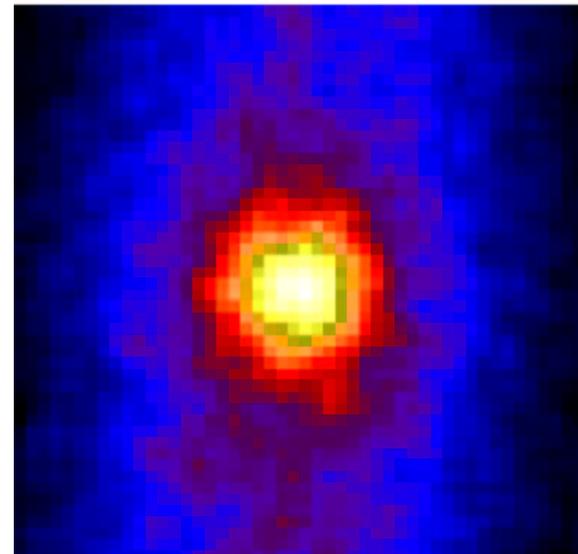
Now fill in each subsection.
Each subsection is a story...

What is the point of the story? Identify the "bottom line" plots.
What plots/slides do you need to support the story?

Slides that explain...



Plots that convince...



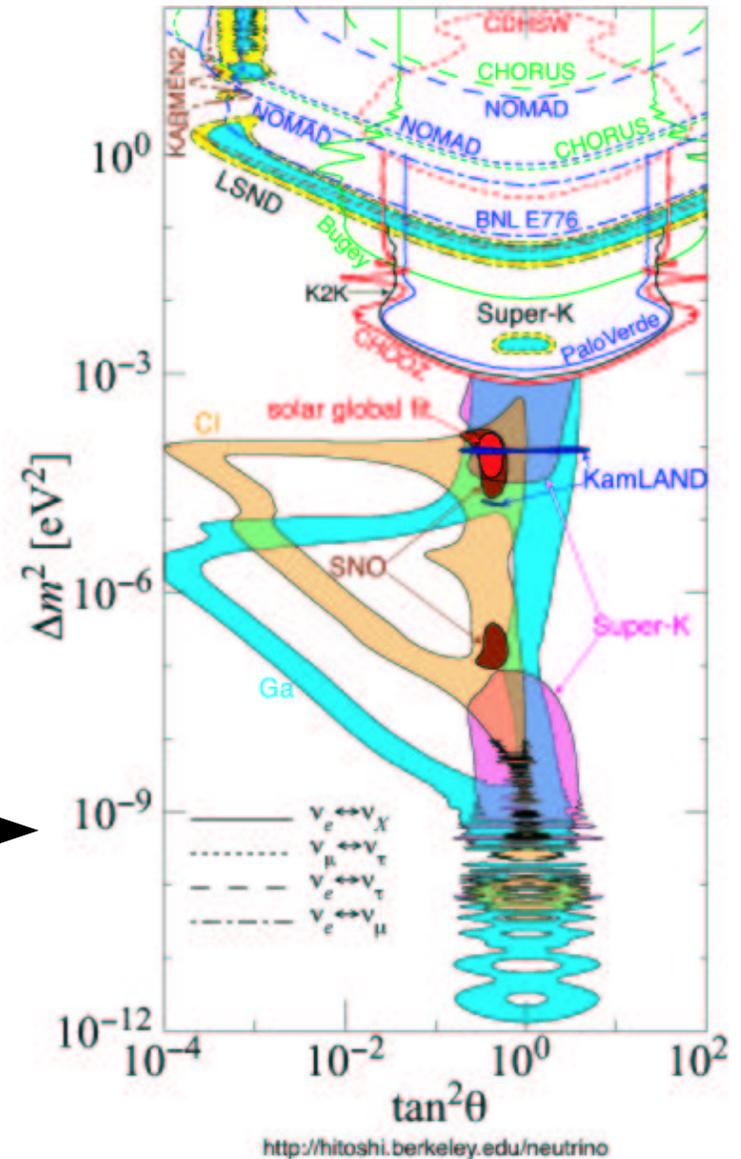
Reconstructed solar neutrino
events in the Super K detector

Be careful about using other people's plots!

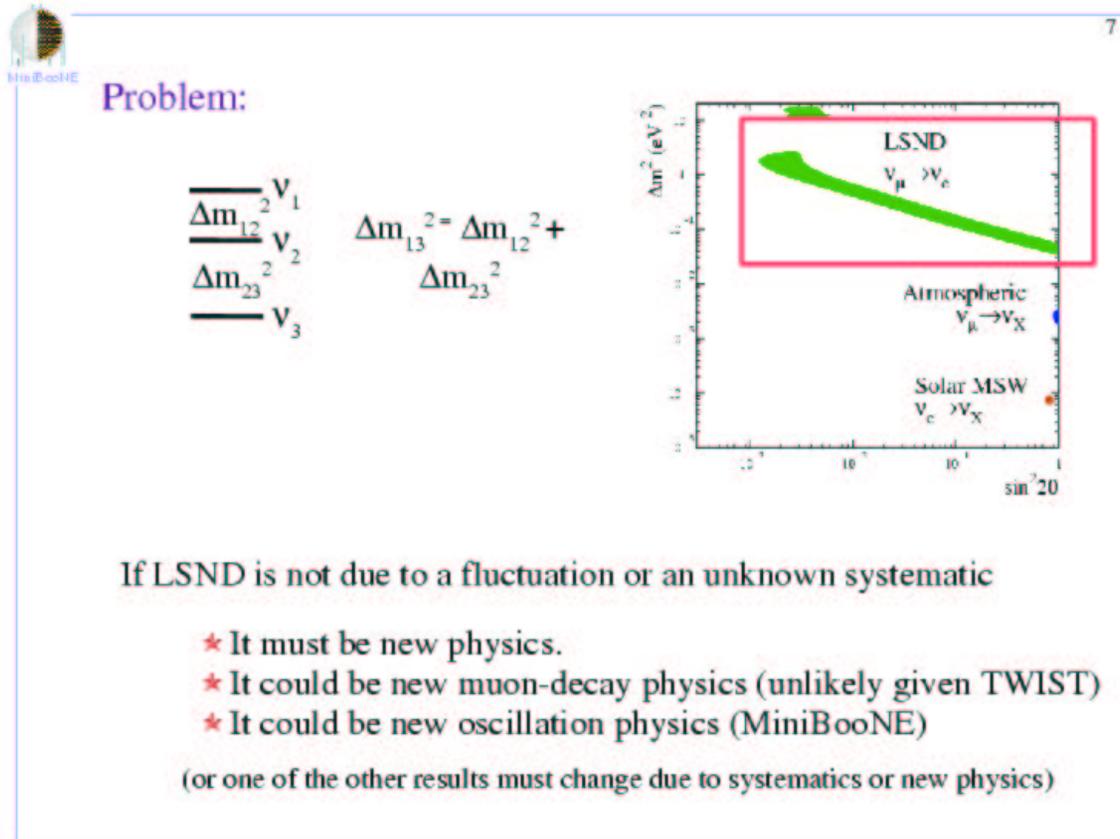
Make sure you know the meaning of every line on every slide!

Even better... eliminate irrelevant lines.

Never, ever show a plot that looks like this

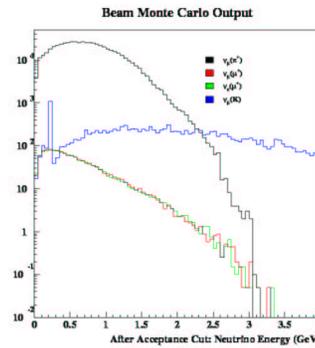
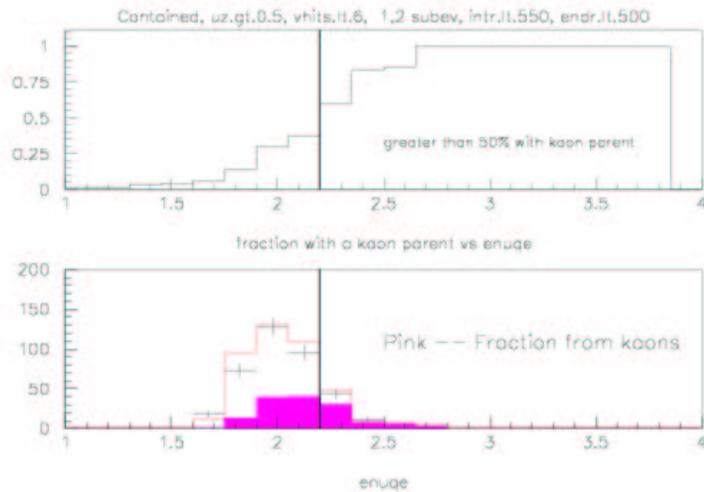


In the case of plots with extra information, judicious use of red boxes can help...

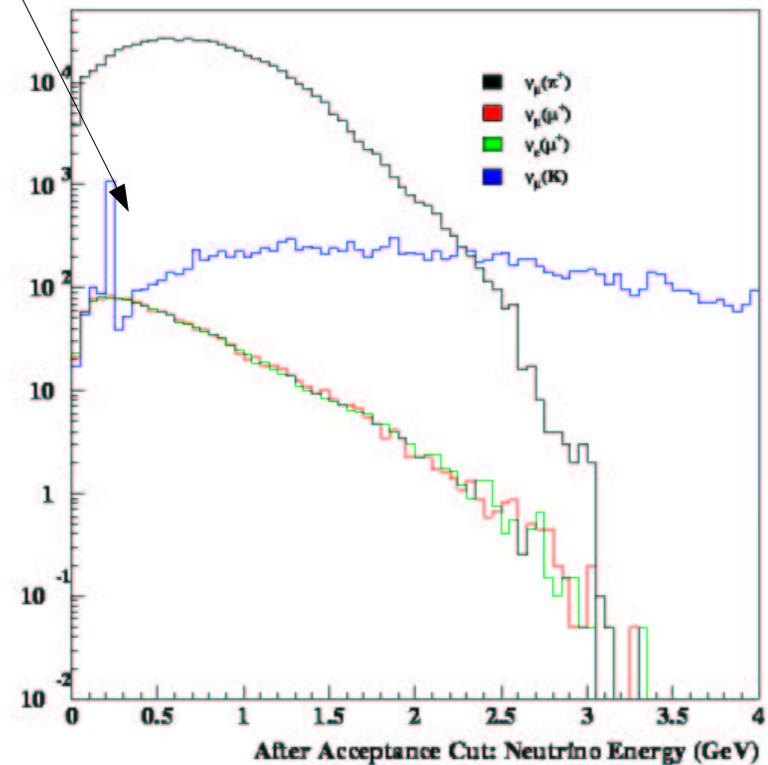


Narrow lines are hard to see...

it is very irritating to an audience to not be able to see.



Beam Monte Carlo Output



Make the lines bolder or just make the image larger...

An effective way to show large bits of text...

**Report of the APS
Multidisciplinary Study
on the future of Neutrino Physics**

The Neutrino Matrix

*Also endorsed in the Superbeam
and Theory Recommendations*

4 Recommendations

Our recommendations for a strong future U.S. neutrino physics program are predicated on fully capitalizing on our investments in the current program. The present program includes the longest baseline neutrino beam and a high-flux short baseline beam, both sited in the U.S. Elsewhere, American scientists and support are contributing in important ways to the burgeoning world program in neutrino physics, including a long-baseline reactor experiment in Japan, solar and atmospheric neutrino experiments in Canada, Italy, Japan, and Russia, a direct mass measurement in Germany, ultra high energy astrophysics experiments in Antarctica and Argentina, and other experiments. We congratulate not only the scientists involved but also the Agencies for their perceptive support of this developing program, which has been so spectacularly fruitful.

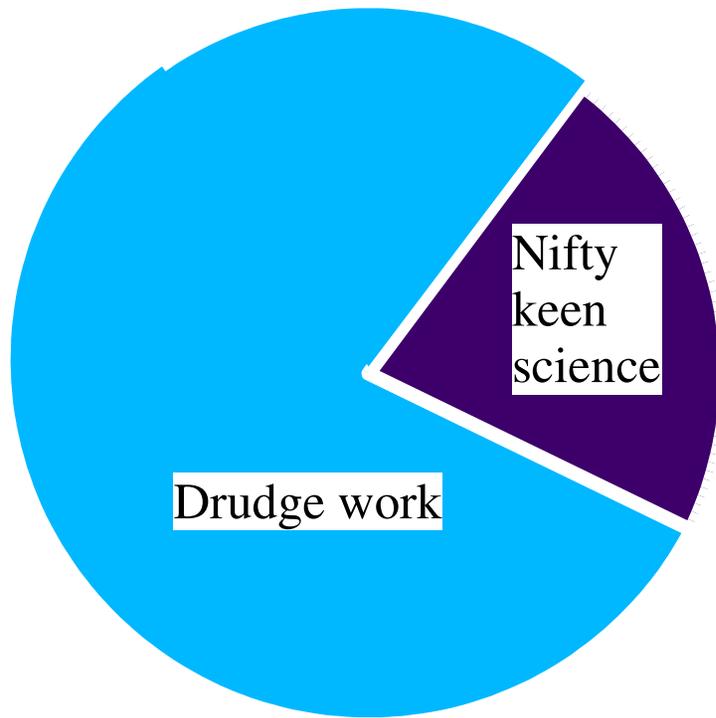
Four issues deserve special mention.

1. Support for continued increases of proton intensity for Fermilab neutrino experiments, as is necessary for the present experiments to meet their physics goals.
2. Support for decisive resolution of the high- Δm^2 puzzle. This issue is currently addressed by a single experiment now running in a neutrino beam at Fermilab. Ultimately, a decisive resolution of the puzzle may require additional studies with beams of antineutrinos.
3. Support for determination of the ^7Be solar neutrino flux.

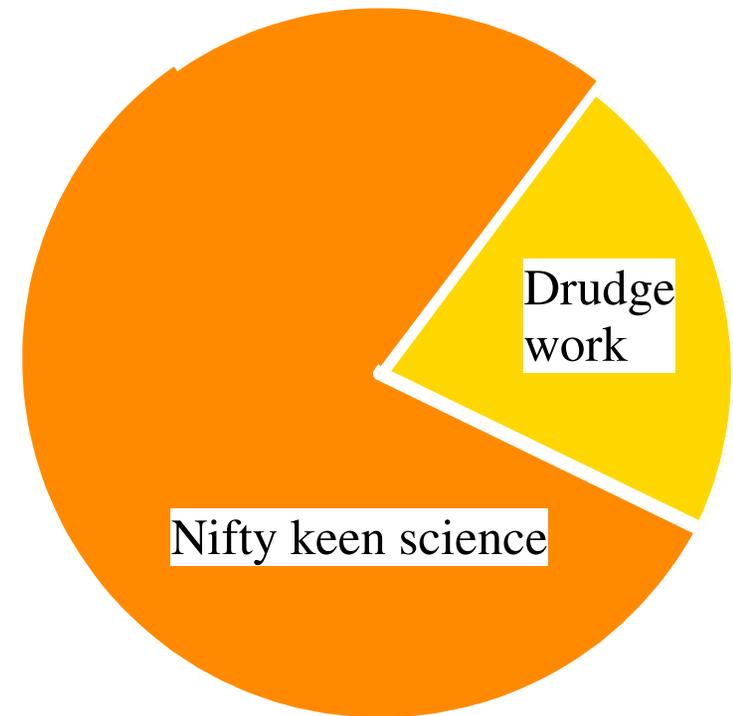
Works best if your audience has a hard-copy of your slides...

When talking about work YOU did:

The Pie Chart of your life....



Your talk....



Do not apportion time in your talk based on how long it took you to do the task!

Select only enough material to fill your allotted time

**NEVER GO
OVERTIME**

General Design Tips:

Beware of light green.
Beware of yellow.

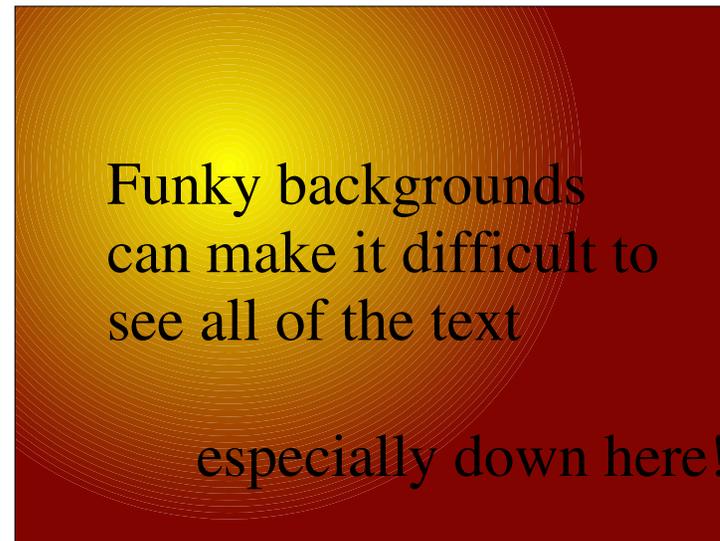
Men who are color-blind
cannot distinguish

Red from Green
Blue from Purple

Do not use a tiny font.

Do not use a tiny font.

A common look to all slides
(coordinating background,
common logo in corner, etc)
makes the talk look "put together"



A picture is worth 1000 words

Slides that are only text
are boring...

A Seminar--

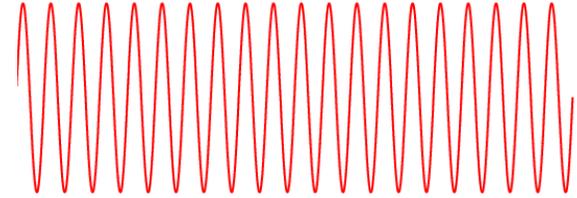
Audience participates in your subfield and know the typical jargon.
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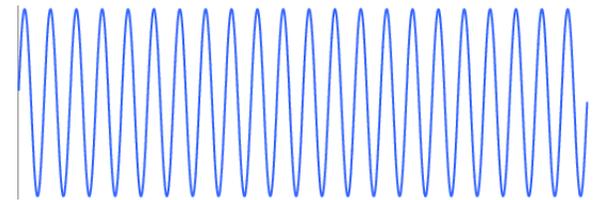
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1st neutrino
wave



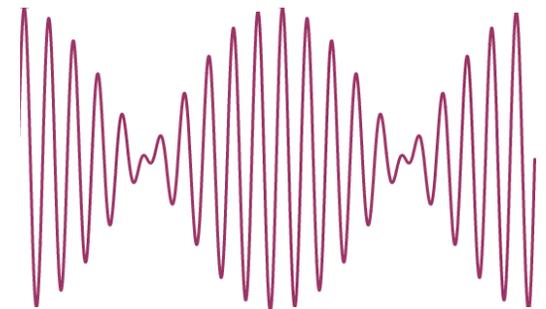
+

2nd neutrino
wave



=

Neutrino
Oscillations
are just
"beats"



Animation:

Only use animation when it is relevant to the talk.

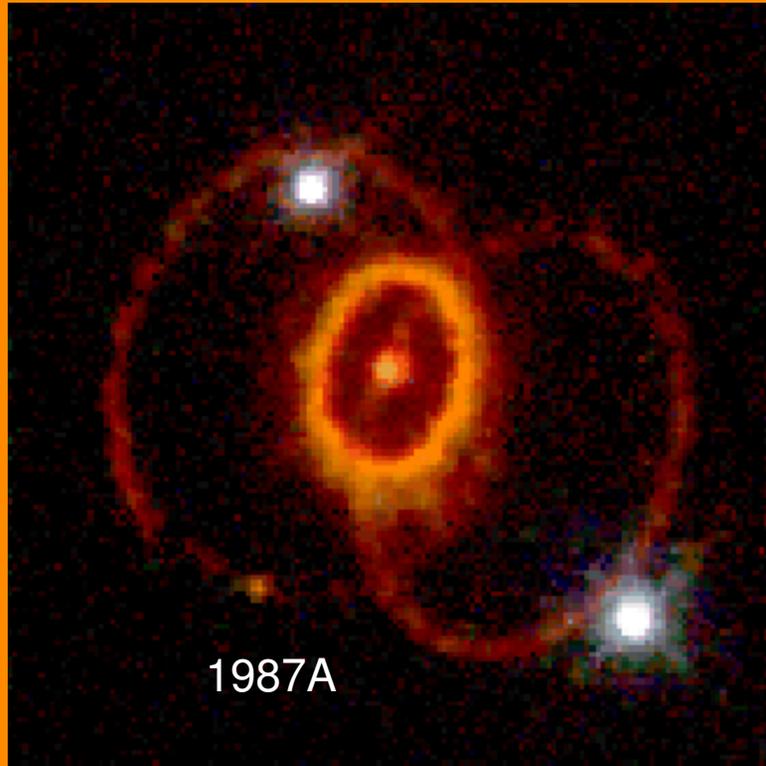


This animation is cool but irrelevant

Sometimes, when you steal other people's slides, odd things happen...

Watch out for unexpected animation!

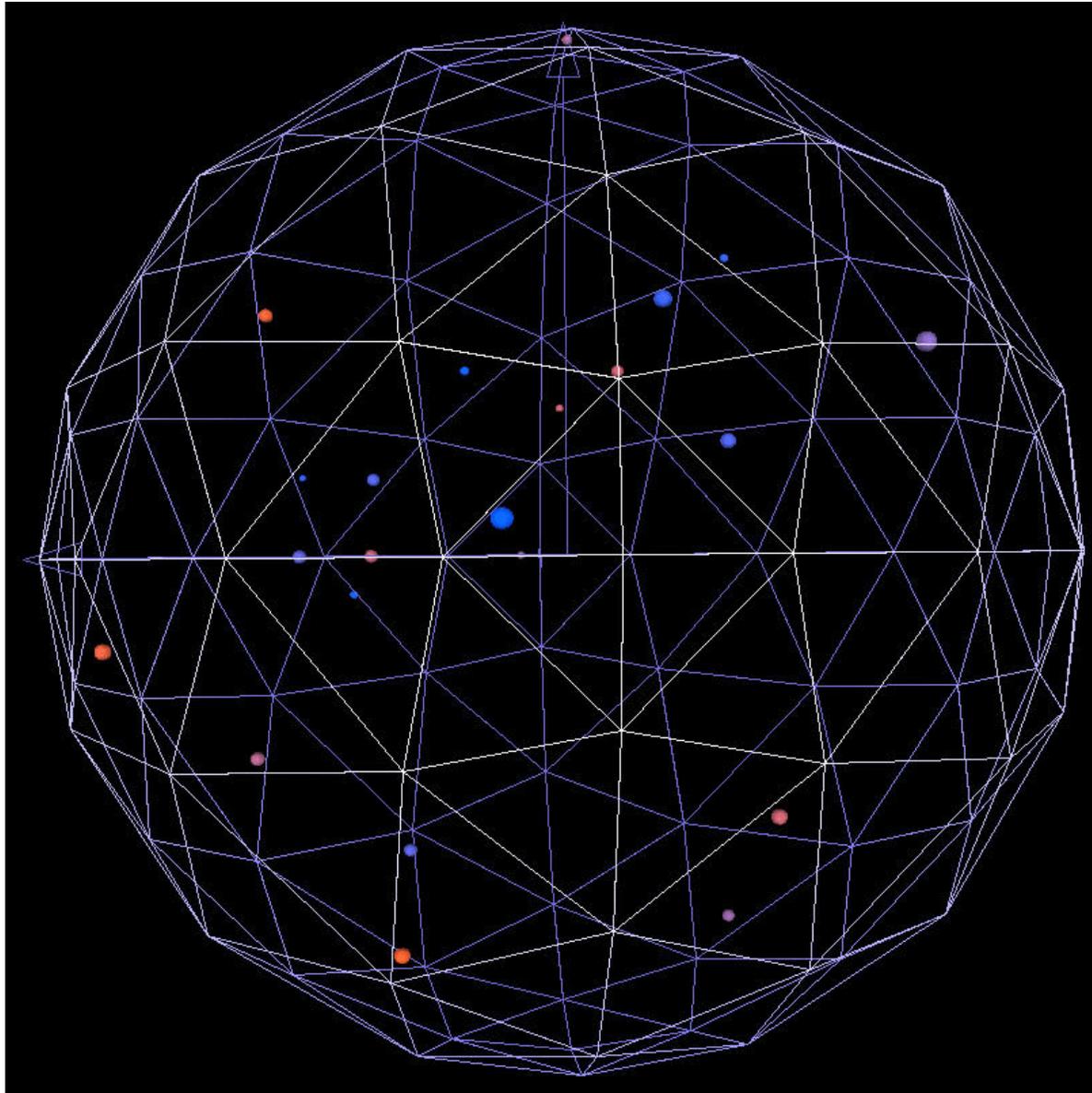
Supernovae radiate over 99% of their energy in neutrinos



There are 3 supernovae/century in our galaxy

The time it takes for these neutrinos to reach earth will be longer
if neutrinos have mass

This is an example of relevant animation.



**Muon Identification
Signature:**

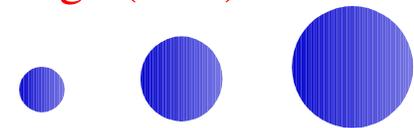
$$\mu \rightarrow e \nu_{\mu} \nu_e$$

after $\sim 2\mu\text{sec}$

Animation

Each frame is 25 ns
with 10 ns steps.

Charge (Size)



Low

High

Time (Color)



Early

Late

Personal touches are nice...

Derivations especially for grad students,

Photos which are relevant and include audience members,

References to work being done by people in the audience,

Choosing a talk title to reflect the place...

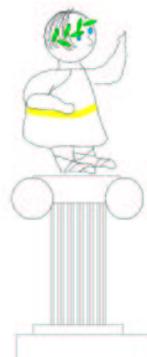
...etc.

Vive la 
Difference!

1. Neutrinos are different
The Standard Model
2. Surprisingly different!
Mass and Oscillations
3. Maybe way, way different!
LSND and MiniBooNE

Janet Conrad
Columbia University

The Status of MiniBooNE:



Veni,
Vidi,
Almost!
Vici

Janet Conrad
ECT, WINA
June, 2003

Talk given in Rome

Talk given in France...

Always acknowledge your collaborators.

The BooNE Collaboration



Y. Liu, I. Stancu *Alabama*

S. Koutsoliotas *Bucknell*

E. Hawker, R.A. Johnson, J.L. Raaf *Cincinnati*

T. Hart, **B. Nelson**, E.D. Zimmerman *Colorado*

A. Aguilar-Arevalo, L. Bugel, J.M. Conrad,
J. Formaggio, J. Link, **J. Monroe**, **D. Schmitz**,
M.H. Shaevitz, **M. Sorel**, G.P. Zeller *Columbia*

D. Smith *Embry Riddle*

L. Bartoszek, C. Bhat, S. J. Brice, B.C. Brown,
D.A. Finley, B.T. Fleming, R. Ford, F.G. Garcia,
P. Kasper, T. Kobilarcik, I. Kourbanis,
A. Malensek, W. Marsh, P. Martin, F. Mills,
C. Moore, P. J. Nienaber, E. Prebys,
A.D. Russell, P. Spentzouris, R. Stefanski,
T. Williams *Fermilab*

D. C. Cox, A. Green, H.-O. Meyer, R. Tayloe
Indiana

G.T. Garvey, C. Green, W.C. Louis, G. McGregor,
S. McKenney, G.B. Mills, V. Sandberg,
B. Sapp, R. Schirato, R. Van de Water,
D.H. White *Los Alamos*

R. Imlay, W. Metcalf, M. Sung, M.O. Wascko
Louisiana State

J. Cao, Y. Liu, B.P. Roe *Michigan*

A.O. Bazarko, P.D. Meyers, **R.B. Patterson**,
F.C. Shoemaker, H.A. Tanaka *Princeton*

You can also fit in acknowledgements while using photographs to communicate other ideas...



...Like a sense of the size of the detector

Do not ever use personal images (like of your baby), no matter how cute. This is a professional talk. Don't include personal information.

Give your audience a break: Humor, Fun Facts, etc...

If your talk is 20 minutes or less, you need very little humor.
You don't have time for jokes.
And the time-span is too short to lose the audience.

For longer talks, humor can wake people up,
and it can be used to make a point.
But too much humor just makes you look silly.
Keep it down to 4-5 slides per 1 hour talk

Humor must always augment,
and never overshadow,
the science

Humor don'ts:

Don't tell long stories or long jokes.

Don't put in something which is irrelevant to your train of thought.

Don't offend! *e.g.* avoid religious, ethnic, or political humor.

Don't use offensive language.

Don't make degrading jokes about other people or results.

Don't use cartoons with long captions or that need explanation.

Don't be too obscure or clever.

Humor do's:

Do use visual humor ... People "get this" much faster than words.

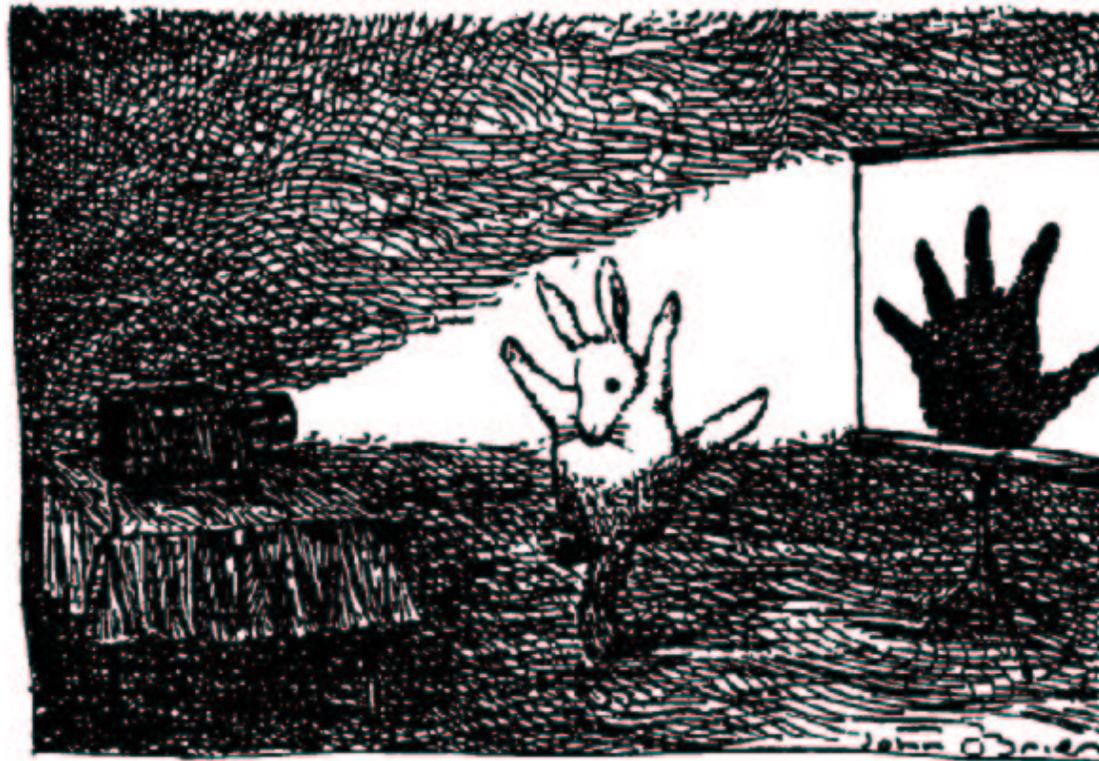
Do make the humor a seamless part of the talk, if possible.

Do make pointed statements with humor.

Do aim for chuckles rather than full-throttle laughter

Some examples that worked...

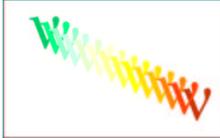
From a colloquium on particle "jet" production in muon scattering...



Transition slides
to add humor...

from a plenary talk
at an APS Meeting...

Front Page V's
Long Beach edition Sunday, April 30, 2000 ONE DOLLAR



Neutrinos may have mass

Have oscillations been sighted?

- Introduction to oscillations
- The solar neutrino deficit
- The atmospheric neutrino deficit
- Limits from reactors & accelerators & the LSND Signal
- How do we interpret this?

Janet Conrad

The Sun Times
Chicago edition Thursday, January 25, 2001



A solar ν deficit is observed!

3 types of experiments see deficit!

implication is small Δm^2
 $\sim 10^{-5}$ or 10^{-10} eV^2
see article on page 7 inside!

U.S. Nu's & World Report

Accelerator & reactor experiments exclude large parameter space



LSND experiment sees signal:
 $\Delta m^2 \sim 0.1 - 10 \text{ eV}^2$



Nu'sweek
January 25, 2001

What's next for the Standard Model?



How can we explain this?

Are there more than 3 neutrinos?



That's the V's from the world of neutrino oscillations

Where the detectors are big the forces are weak

and all of the excitement is above average!

A transition slide from a seminar on MiniBooNE...

And what happens if
MiniBooNE sees a signal?



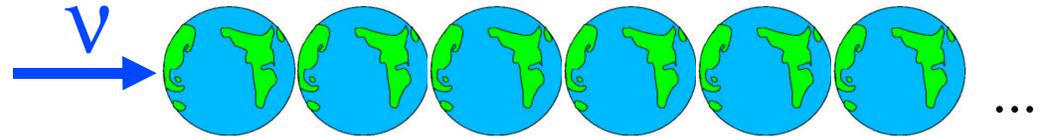
"Fun Facts" can also provide a nice break for the audience...

Lepton

*from the Greek, "leptos",
meaning thin...*



*or, alternatively,
"small change"...*



100 GeV neutrinos have a good chance of
traveling through
200 earths before interacting at all!

Did you know...

That you emit 200,000 neutrinos/min?



... it's that ^{40}K !

And then there is always the well placed poem...

*Neutrinos, they are very small.
They have no charge and have no mass
and do not interact at all.
The earth is just a silly ball
To them,
 through which they simply pass...
...and pierce the lover and his lass*

from a poem by
John Updike

A nice design,
A clever theme,
A set of coordinating slides,
a touch of humor...

are all important to maintain
audience interest.

But when you finally have the talk written,
Go back over it to

Make sure that
None of the above overwhelms the science.

The last step in writing the talk:

Go back over your slides, looking for
typos & errors

Presenting your talk:

1. Do a practice talk!
2. Presentation Basics
3. Handling Questions

Do a practice talk:

In front of a knowledgeable audience...

Run through the talk from beginning to end,
Timing it,
and having the audience write down corrections.

Then go back through the talk slide-by-slide,
to hear the comments and corrections.

*You can always take or leave the suggestions.
But ignoring the suggestions
usually isn't very smart.*

I do a practice talk for all talks outside of the collaboration.

Everyone in my collaboration does practice talks...
From the Full Professors to the Undergraduates.

No matter how experienced you are...

**NOTHING WILL HELP MORE THAN
DOING A PRACTICE TALK**

After the practice talk:

Cut some of the content if you went overtime.

Select which slides you will skip if you start to go overtime during the talk.

Setting up for the talk:

Have a back-up copy of your talk, in pdf format, on the web.

This can be shown using anyone's laptop.

Ask for 15 minutes well before the talk to double check that the equipment works as you expect.

Find out how to use the remote slide-changer and the laser-pointer *before* the talk.

Identify where the clock is located in the room.

People are likely to see your computer's desk top.

Remove personal images from the background.

Disable the screen-saver.

Remove music-downloads and other personal files.

When you give the talk, behave professionally.

The audience should be looking at your slides
and not you...

Avoid distracting clothes:

Clothes with words on them.
Midriff-cut sweaters.
Shoes that you cannot balance in.

*Dressing well is a statement
of respect for your audience.*

Avoid distracting antics:

Don't ski into a talk at a ski conference.
Don't ever sing.
Etc.

Become famous, not infamous.

Behaving in a professional manner,
does not imply
being low-key or monotonous.

If you are excited about your work,
the audience will become excited about the work.

Spoken Words:

Written paragraphs read aloud sound strange.

★ Don't read your slides. ★

I do not like them in a house.

I do not like them with a mouse.

I do not like them here or there.

I do not like them anywhere.

I do not like green eggs and ham.

I do not like them, Sam-I-am.

- ★ Repeat your point, using almost the same phrasing, ★
strategically throughout the talk.

Mainly use correct grammar,

- ★ but sometimes it is ok to use colloquial phrasing. ★

"To boldly go where no man has gone before..."

Help your audience pick out what is important.

Say:

"This is an important point..."

"This plot is the bottom line."

"What I hope you can see from this slide is..."

Use these lines sparingly -- on only what's important.

Movement & Body Language:

You give a talk in the room that they have and not the room you wish you had.

Try to get out from behind large lab tables, so there is nothing between you and your audience.

Don't wander too far from the computer if you do not have a remote to change the slides.

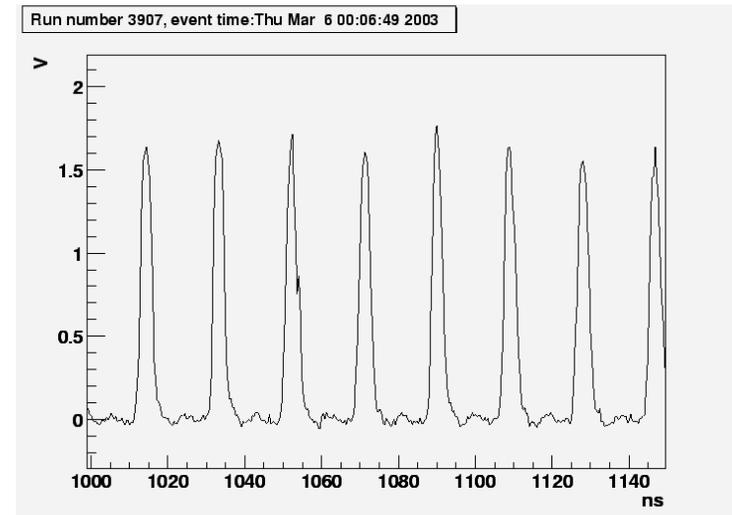
If you are on a stage, stay within the area which is lit.

Gesturing broadly while holding a stick pointer can be frightening to people in the front row.

Never twirl the stick pointer like a baton.

Other useful presentation tips:

It helps to say what is on the axis of each plot.



If you are coming back to an idea you introduced earlier, remind people by saying "If you remember from the first section of my talk..."

Move the laser pointer around -- otherwise it is sometimes hard to see the dot (also, don't shoot the audience with the laser)

If you are using transparencies, put them on the projector and leave the transparencies alone. Don't move them around a lot. if they slide off, use a quarter to hold them down.

The audience wants you to succeed.

Dealing with nerves:

Don't drink coffee before your talk.

The better you know your first five slides, the easier the start of the talk.
More or less memorize what you will say for the 1st 5 minutes.

At the start, look up at the audience, smile, say "Thanks for inviting me."
This will ... 1) cause them to smile back 2) make you feel better.

Find a friendly person in the audience and talk to them until you start to feel more confident.

Your talk comes in 5 parts (intro, 3 main points, conclusion),
focus on each element separately, don't worry about what's next

Remember: You know more about your subject than anyone else
in the room -- honestly! This is nearly always true.

Dealing with questions:

Try to think of the obvious questions ahead of time and make back-up slides.

If this is a defense or an exam, go ask other students for a list of previously-asked questions.

A question may sound much more complicated than it really is because the questioner didn't have the right vocabulary.
if you are stumped, try rearranging the words in your head, or ask the questioner or the host to re-phrase the question.

Walking slowly across the stage
after a question is asked
buys you some time to sort out your answer.

Dealing with questions (cont'd):

- Let the questioner complete the question.
- If you don't know the answer, **don't guess**. Instead say...
"That's interesting. Let me think about it and get back to you."

or

if there is an expert in the audience on that topic,
graciously defer to her/him

A very "pro" move

*Remember: Most questions are genuine and
not meant to be confrontational...*

Dealing with Belligerent Questioners

Remember: The problem is with the questioner, not you.

No matter how obnoxious the person, don't get rattled.

Specific Tactics

Don't let a belligerent questioner rearrange the order of your talk.

If the answer is coming up, say firmly "**I'll get to that in a moment.**"

Don't let the questioner go on and on about his/her own theories.

Say, "**Those are interesting points, let's discuss them after the talk.**"

Use body language to communicate that you are in control of this talk.

It is the job of the host to protect you from belligerent questioners.

So if it goes on for too long, *look your host in the eye and make it clear you expect intervention.*

Sometimes bad things happen:

You knock over the water.

The projector dies and you have to ad-lib for a while

Images in your file disappear for no reason.

The airline loses the bags with your clothes.

You fall off the stage.

It's ok. Even the very best physicists fall off the stage.

Get up and go on.

Grade your talk:

One grade for organization and content
One grade for presentation.

Curve your grade on the basis of the other talks.
But don't grade inflate.

Be critical. Learn from each experience.

Conclusions:

This "conclusion" has too many points to be very effective.

- Organizing a talk well from the start is important.
- Knowing your audience is crucial.
- The 3 section/3 subsection formula is very successful
- Pick and choose the best material to make your case in the time constraints you are given
- Nice design, humor, etc, helps maintain interest.
- Always do a practice talk!
- When you present your talk, the focus should be on the science.
- Remember: your audience wants you to succeed.

Conclusions:

Good ideas on giving talks seem to come in threes...



- 1) "Doing a talk" has 3 steps:
Organization, Writing and Presentation.
- 2) At each stage in the process, you should aim for 3 things:
Explain, Convince and Entertain.
- 3) The 3 main section/3 central subsection design is really foolproof.

*A clear "ending slide" is important
and since every talk should end with something to think about...*

Did I use this talk on How to Write and Give a Talk
in order to Write and Give this talk?

