Conceptual drawing of the Macondo well, blowout preventer, and broken piping after the BP well exploded on April 20, 2010, and the Deepwater Horizon drilling rig sank. Rendering by Sabrina Fletcher. *Courtesy Lawrence Livermore National Laboratory.*

Conveying Scientific Information Visually

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With thanks to Brian DeMarco for Slides 7–13, many fruitful discussions, and excellent advice
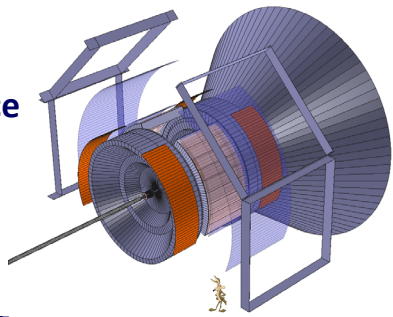
1

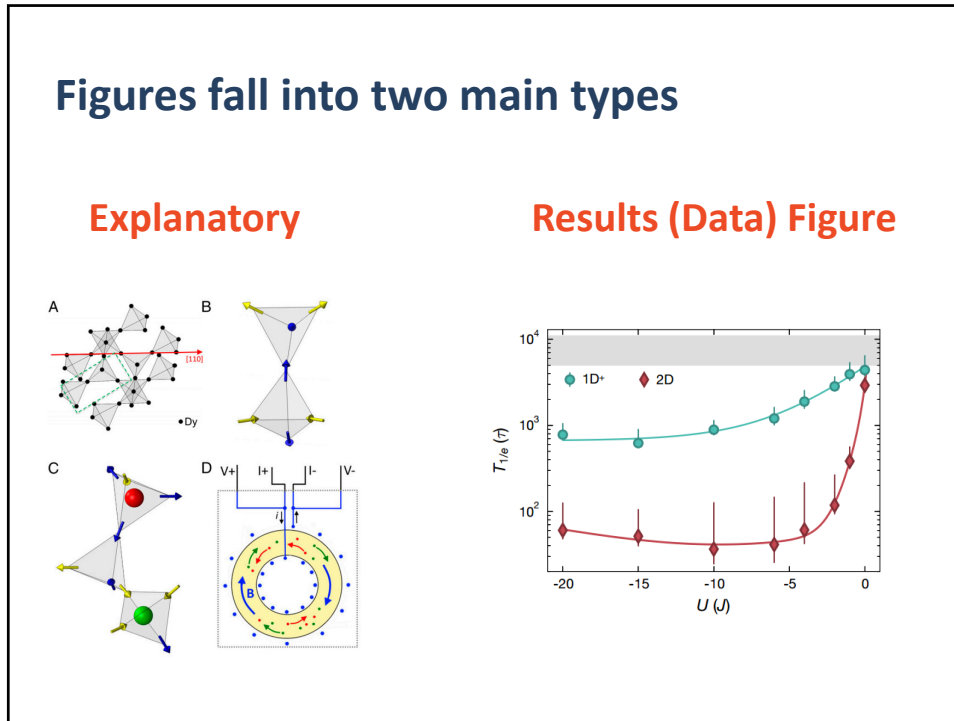# Let's review the four reasons to use figures

1. **Engage the audience and capture their interest**

2. **Provide supporting evidence**

3. **Help explain complex ideas and relationships quickly**

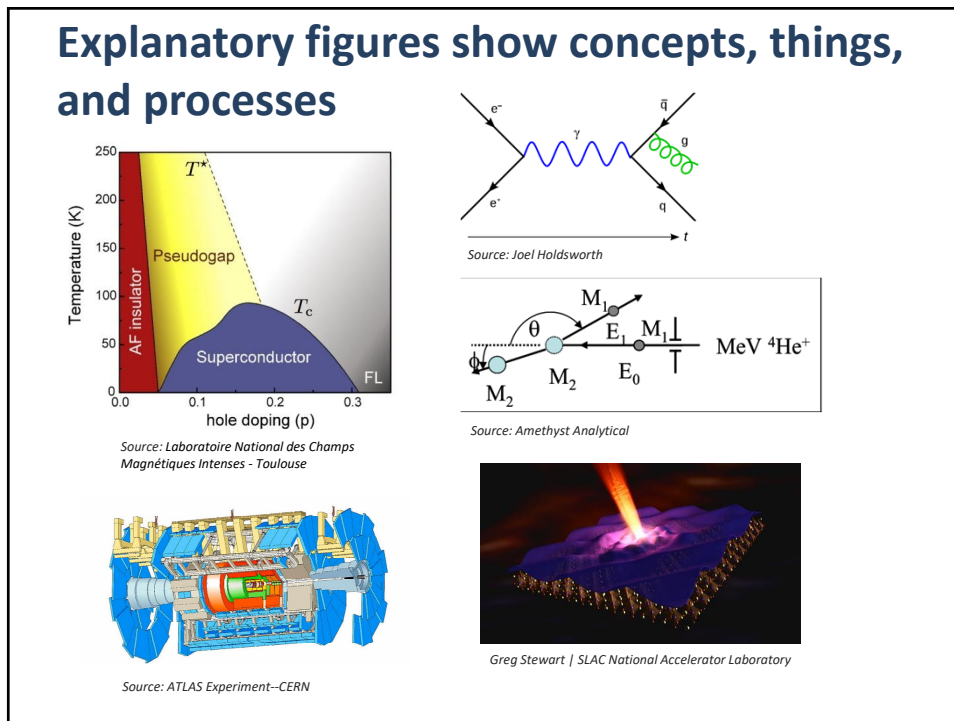4. **Give the audience a visual, memorable "hook" to hang your key ideas on**

PHENIX detector at the Relativistic Heavy Ion Collider
Courtesy M. Grosse Perdekamp

Each figure should have a single "point"

2

Figures fall into two main types

Explanatory

Results (Data) Figure

3

Explanatory figures show concepts, things, and processes

Source: Laboratoire National des Champs Magnétiques Intenses - Toulouse

Source: Joel Holdsworth

Source: Amethyst Analytical

Greg Stewart | SLAC National Accelerator Laboratory

Source: ATLAS Experiment--CERN

4

Explanatory figures show concepts, things, and processes

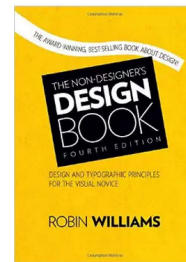**Gives overview, summary, or big picture**

Often schematic

Not data or results

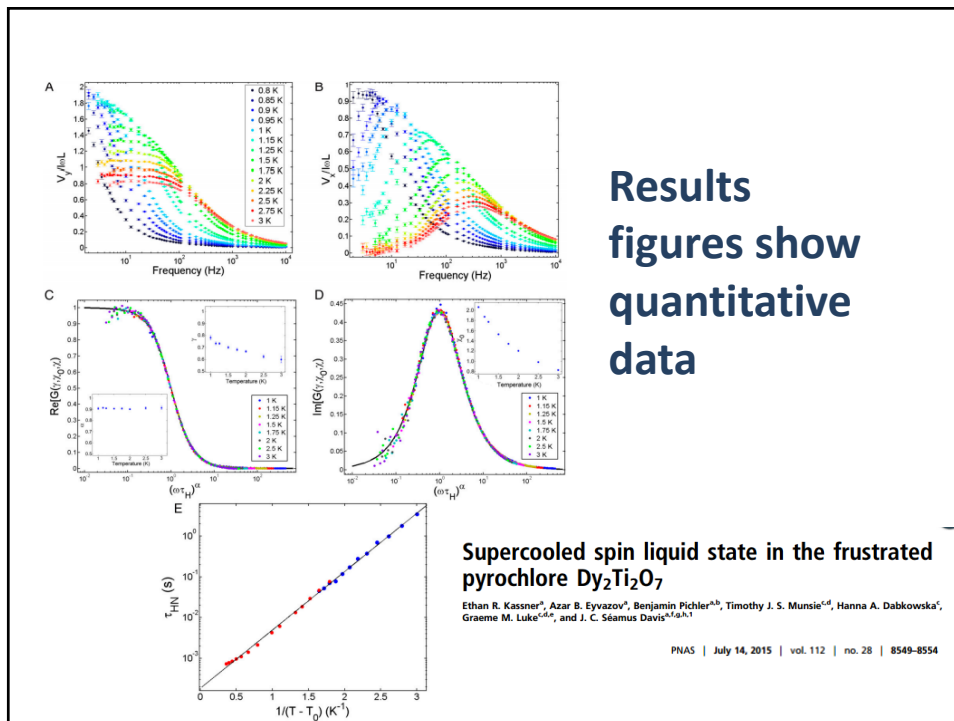**Important to (over-) simplify without introducing errors**

Important to be visually interesting and attractive

Brian DeMarco recommends:

**Learn a software platform:
Illustrator, CorelDraw, Powerpoint...**

THE AWARD-WINNING, BEST-SELLING BOOK ABOUT DESIGN
THE NON-DESIGNER'S
DESIGN BOOK
FOURTH EDITION
DESIGN AND TYPOGRAPHIC PRINCIPLES
FOR THE VISUAL NOVICE
ROBIN **WILLIAMS**

5

Results figures show quantitative data

Supercooled spin liquid state in the frustrated pyrochlore $Dy_2Ti_2O_7$

Ethan R. Kassner[a], Azar B. Eyvazov[a], Benjamin Pichler[a,b], Timothy J. S. Munsie[c,d], Hanna A. Dabkowska[c], Graeme M. Luke[c,d,e], and J. C. Séamus Davis[a,f,g,h,1]

PNAS | July 14, 2015 | vol. 112 | no. 28 | 8549–8554

6

Results figures show numerical data

Usually a graph

Can encode a lot of information
Brian DeMarco: Be careful! Too much is deadly

Axes must be labeled clearly and correctly
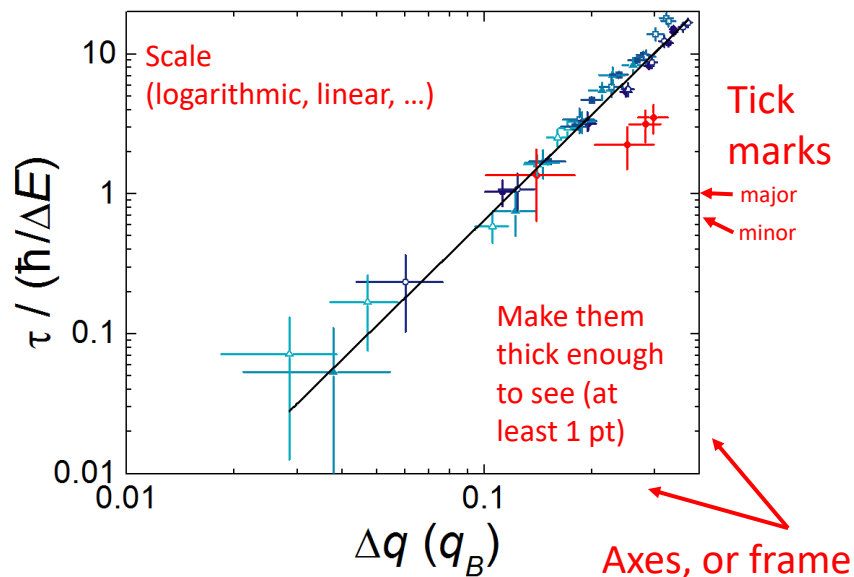Axes labels must show variable AND unit
Use appropriate (and visible!) tick marks

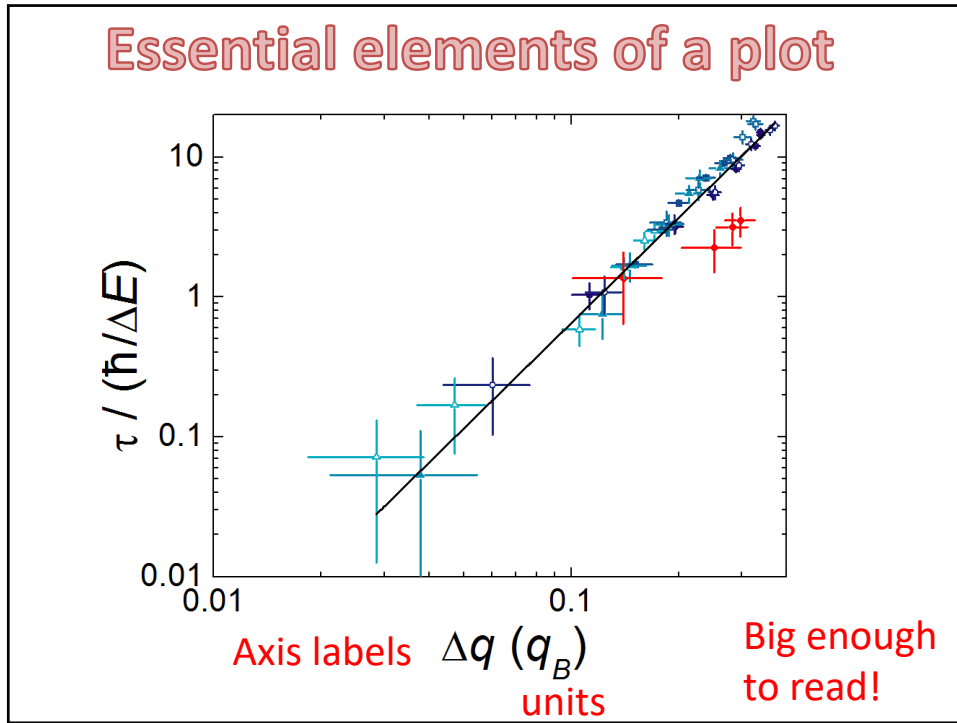**Points, lines, error bars must be visible and distinct**
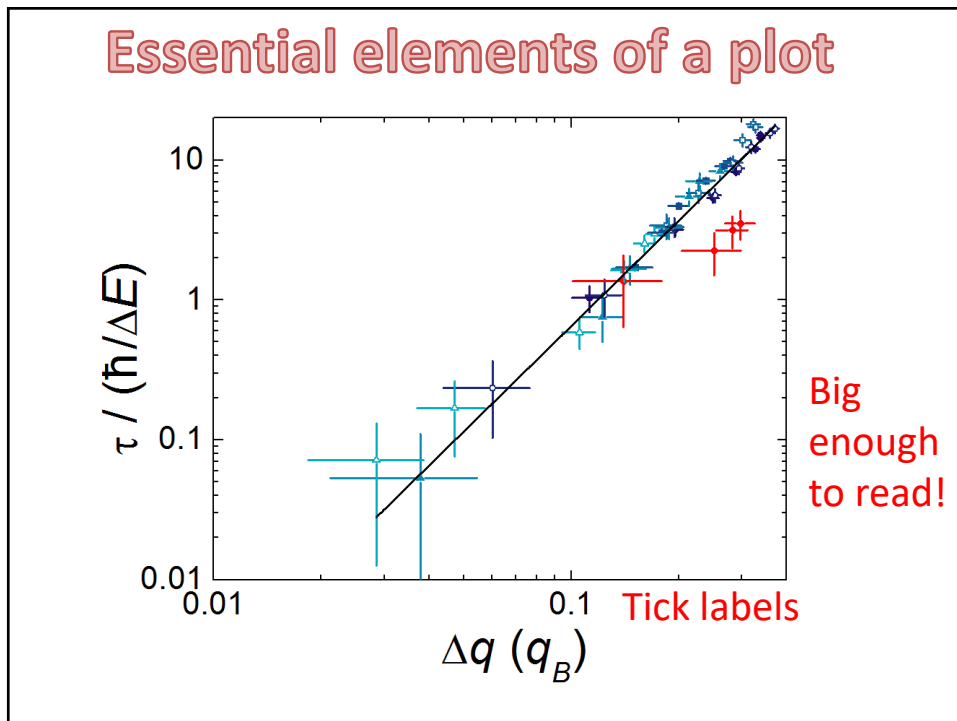
Be cautious about using color to convey information
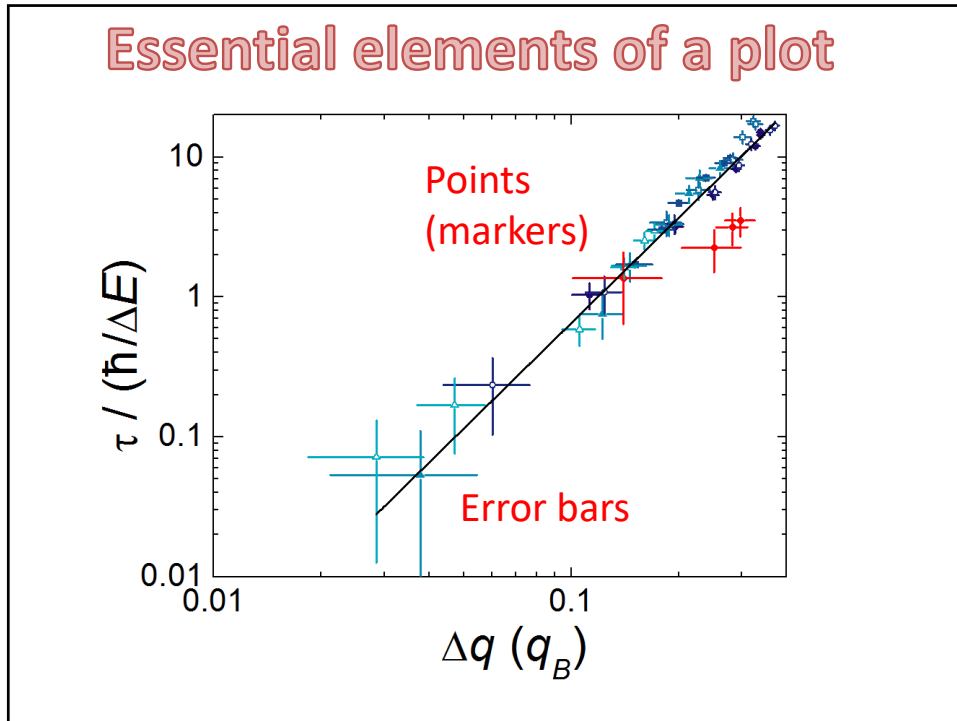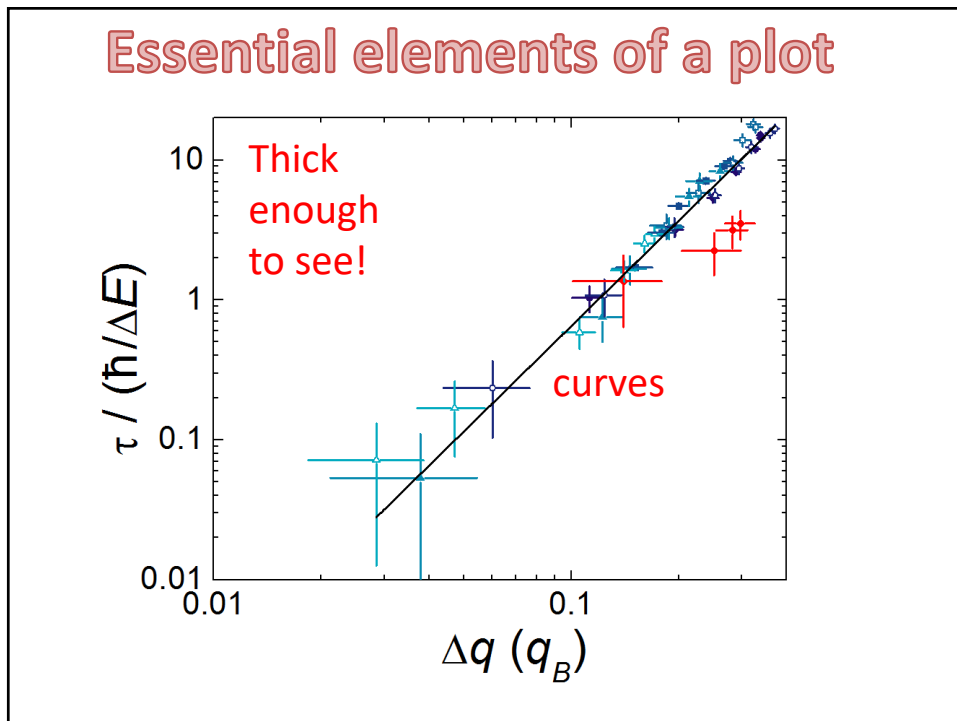
7

Essential elements of a plot

8

Essential elements of a plot

9

Essential elements of a plot

10

Essential elements of a plot

Points
(markers)

Error bars

$\tau / (\hbar/\Delta E)$

$\Delta q \ (q_B)$

11

Essential elements of a plot

Thick
enough
to see!

curves

$\tau / (\hbar/\Delta E)$

$\Delta q \ (q_B)$

12

Essential elements of a plot
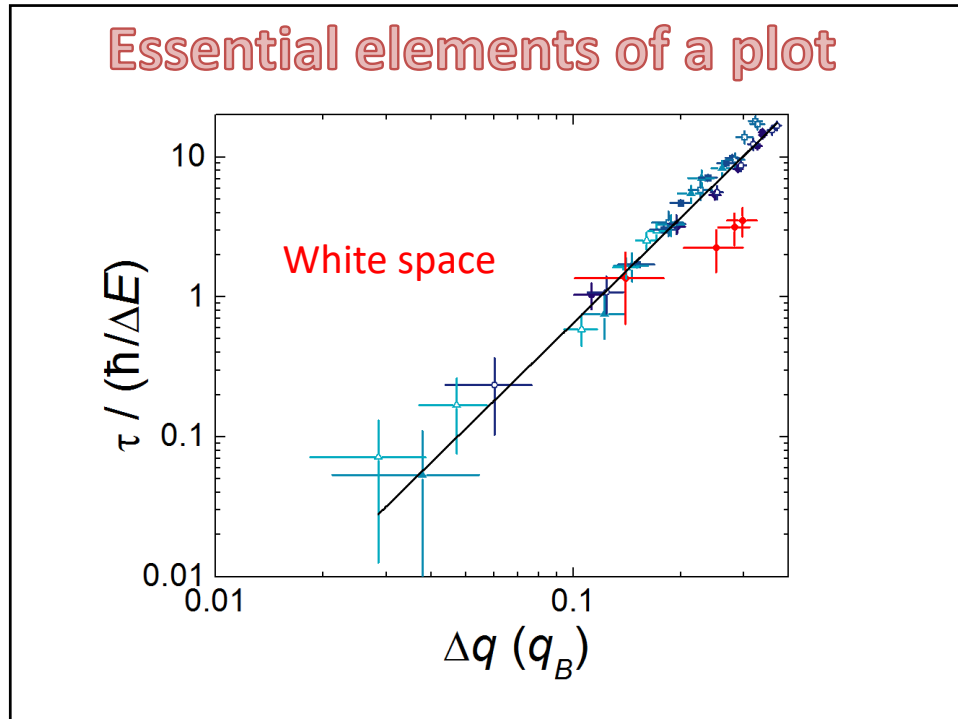
White space

$\tau / (\hbar/\Delta E)$

$\Delta q\ (q_B)$

13

Great advice from Brian DeMarco:

Use legible (*sans serif*) fonts

Print the figure at reproduction scale

Pay attention to line thickness

Use color judiciously—avoid too-similar colors, pastels, red/green

Use physical, standard units; avoid arbitrary units

Include scale bars & color bars

Use high-resolution, high-contrast images

Use vector graphics when possible

14

More advice from the old copy editor:

Label all elements of a figure; show the audience what they're supposed to be looking at and what it is

Remove superfluous details—crop photos, use cutaway drawings instead of photos

Position figures so they are discussed in the text before they appear in the manuscript

Number figures in consecutive order in which they are discussed in the text

Every figure must have a caption (stay tuned…)

15

Worst figure I have ever seen…
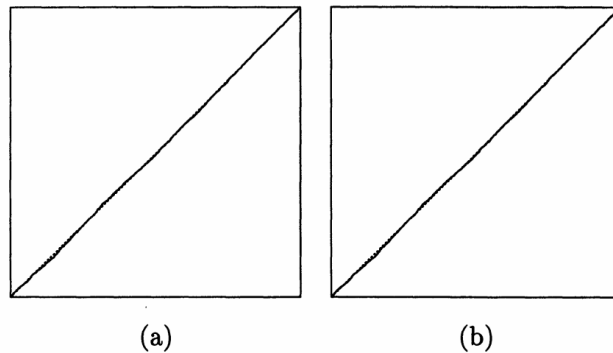

(a)   (b)

Figure 1. SRQ Plots of T_i/T_n (Vertical Axes) Against i/n (Horizontal Axes) for the Gibbs Sampler (a) and an Alternating Gibbs/Independence Sampler (b) for the Pump Failure Data Based on Runs of Length 5,000. Lines through the origin with unit slope are shown dashed; axis ranges are from 0 to 1 for all axes.

Source: P. Mykland, L. Tierney, and B. Yu, "Regeneration in Markov Chain Samplers," *J. Am. Statistical Assoc.* **90**, 233–241 (1995).
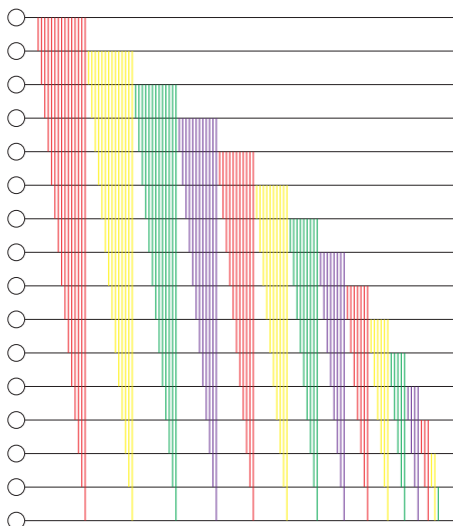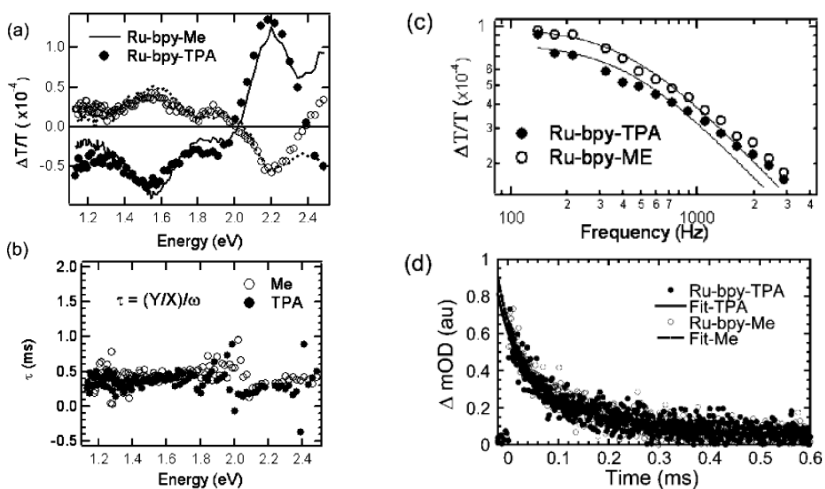
16

Second worst…

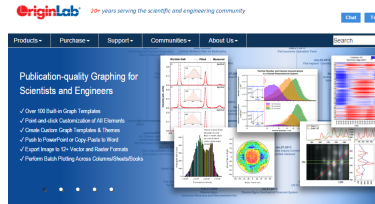FIG. 2. (Color online) Possible layout for the 16-qubit chip.

17

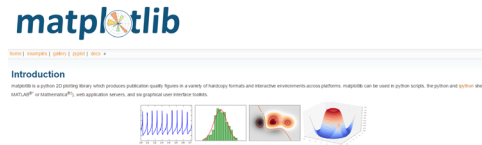## If you're going to show data, make sure the reader can decipher it

18

Use specialized software for making professional-quality plots

Origin (Webstore)

Matplotlib (Python)

MATLAB, Mathematica...caution

Excel   **(According to Professor DeMarco)**

19

Use specialized software for making professional-quality images

Line / vector art

Illustrator, CorelDraw
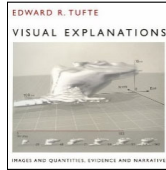**Inkscape (free)**
Mathematica

3D Illustration

SketchUp (free), VPython (free), Blender (free)
Autodesk products (free for students)

20

More great resources:

Edward R. Tufte, *Visual Explanations: Images and Quantities, Evidence and Narrative*
(Cheshire, CT, Graphics Press, 1997)

"Graphing Resources"
(http://www.ncsu.edu/labwrite/res/res-homepage.htm)**,**
particularly their "Revising your Visuals" section

21

To recap:

Use figures to tell your story
    For things that are hard to explain in words
    To emphasize your main points
    To give the audience something to remember

Label all elements in a figure

Pay attention to the DeMarco rules for plots

Use specialized software to create your figures

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http://physics.illinois.edu/people/Celia/

22