Today is a good day to sit up front fyi

Go ahead and log into your computer. It takes time for it to set up.

Experimental Schedule

Sample	Availability
LSMO	Ready
FeS/FeTe (altermagnets?)	Completed/Ready
Fe thin film	Ready
Topological insulator	Shipping label sent, waiting on Oak Ridge

Groups (experiments will run for ~24-72 hours, but you don't have to be on call, will text if need anything from you)

- Oct. 5, Monday 4pm: Ryan, Gavin, Alp **Completed**
- Oct. **27**, Tues. 10:15am: Evan, Jeffrey, Austin (part broke)
- Oct. 16, Friday 5pm: Melissa, Shelby, Leeam
- Oct. 20, Tuesday 4pm: Bryce and Tyler
- Oct. 23, Friday 1:30pm: Nickolai and Durham

Good/Bad Graphs
Bring in examples of good and bad graphs from a paper. I don't need the whole paper. Discuss why you think they are good or bad. DO NOT just google looking for good and bad graphs. I want YOU to practice recognizing what makes a graph good or bad-- not someone else. It's ok if we disagree on what is good or bad.

Why Important Papers and Proposal deadlines? Because the Lab Notebook is *supposed to be* a second try on the same questions. And a second round of feedback.

Date	293 Topic	Homework (with goals color)
18-Aug	Pre-Surveys; What is this Class About?	Partner/Scheduling Info
20-Aug	Distinguishing Types of Magnetism	Reading 1 on Perusall
25-Aug	Holcomb Group Discovery	Reading 2 on Perusall
27-Aug	MOKE versus Other Magnetometry	Watch Video on Perusall
1-Sep	Project Planning: What Kinds of Magnetic Measurements	Syllabus Read/Agree
3-Sep	Finding Published Papers Relevant to Your Project	Bring a Related Paper to Class
8-Sep	Reading and Evaluating Papers	
10-Sep	Best Practices with Lab Notebooks 50% after Oct 22	University Safety Requirement
15-Sep	MOKE Hands-On Demonstration	
17-Sep	VSM Hands-On Demonstration 50% after Oct 13	Important Papers. Why? (2-5)
22-Sep	How to Give Peer Feedback and Group Project Planning	
24-Sep	Planning Group Oral Reports and Peer Grading	Mini Reports (in class)
29-Sep	Group Project Planning and Refinement	Quality Reading on Perusall
1-Oct	Assessing the Quality of Materials 50% after Oct 13	Project Proposal
6-Oct	Best Practices with Graphing 50% after Oct 22	Good/Bad Graphs
8-Oct	Fall Break (No Class)	
13-Oct	Introduction to Excel: Spreadsheets, Graphing and Fitting	Due Today!
15-Oct	Understanding and Processing Your Data	Lab Notebook Check-In
20-Oct	Building a Story with Your Data When It Isn't Obvious	5% on time bonus
22-Oct	Check-In and How Are Materials Grown	
27-Oct	How to Give a Good Talk	
29-Oct	Peer Evaluation of Lab Notebooks (Bring Notebooks)	Can submit early for feedback
3-Nov	Election Day (Vote If You Can)	
5-Nov	Project Speed Dating: Share Your Project with Others	Graphs of Your Data 5% Bonus
10-Nov	Time for groups to Discuss Presentation/Data Planning	
12-Nov	10-15 Min Group Presentations FeS/LSMO	Presentations
17-Nov	Rest	Presentations No Bonus
19-Nov	How to Write a Good Abstract	
1-Dec	Ask Your Final Questions of Instructor, Partners or Class	5% on time bonus
3-Dec	Discussion of Research and Scholarship Opportunities	Abstract & Notebook

What is Graded for Early Check-In (Oct 15)

25% of total lab notebook score

Will probably check for in class journaling (2 so far, Sept 1&29)

Lab Notebook Rubric (Early lab noteobook focuses on experiment planning/motivation.)

Category	Far below threshold (1)	Below the threshold (2)	Meets the threshold (3)	Exceeds the threshold (4)	Score
Communicate / Define Topic Introduction/ Motivation/ Goals	Does not include background or previous work. Does not identify the purpose, the project, the main question(s) or issue being addressed.	Gives very little background or information. May include the main question(s) or issue but does not identify the purpose for addressing them. Unrelated background	Gives a listing of the background information and previous work but does not tie them together well to show how they lead to the purpose of the present work and the questions being addressed.	Effectively ties background to the research question(s) and purpose that directly leads into the question(s) being addressed and the purpose of the research.	This is a step up from Why Important. ¾ here is still good!
Define Topic / Gather Sources / Analyze Figures explaining the background	Only one figure is provided that relates to the background of the experiment or material. The relevance of the figure is unclear or not explained.	One or more figures related to explaining the key concepts of the experiments are included. Only one is well discussed and related to the project.	Two or more figures related to explaining the key concepts of the project are included. One may not be explained well or relation clear.	At least two figures clearly illustrate and reinforce the key background concepts and are well integrated into the narrative.	
Gather Sources / Communicate Description of material uniqueness	The uniqueness of the material selected is not addressed, or is very general, **such as saying "it hasn't been studied before."** Why might we expect it to be interesting?	Attempts to explain the uniqueness of the material, but the rationale for its interest or value is unclear.	It is communicated what is unique about the material that was selected by the group and at least one application of the material is discussed.	It is well communicated what is unique about the material that was selected and potential material applications (and their importance) are discussed.	
Gather Sources References	Referenced information is insufficient to verify where the information was found.	While a reference list exists within the lab notebook, it's not always clear what information was taken from the sources. Formatting poor.	While references are in a nice list and near where the information is mentioned, it could be more clear exactly what information is taken from the reference.	References are cited inline with short names (such as "NIST"), enabling the reader to easily trace information and a full reference list occurs elsewhere.	You must have references to not score a zero here!

At least 2 references

Define Topic ↔ Gather Sources ↔ Experiment ↔ Analyze ↔ Communicate

TODAY: PRACTICE PLOTTING GRAPHS

1. FIGURING OUT HOW TO DO IT

The nuts and bolts of making graphs

- ✓ Choose data
- ✓ Choose axes
- ✓ Scale the axes
- ✓ Plot the points
- ✓ Add labels
- ✓ Add a legend

A TECHNICAL SKILLSET

Important. Necessary.
But it's not the whole story.

Both are important.

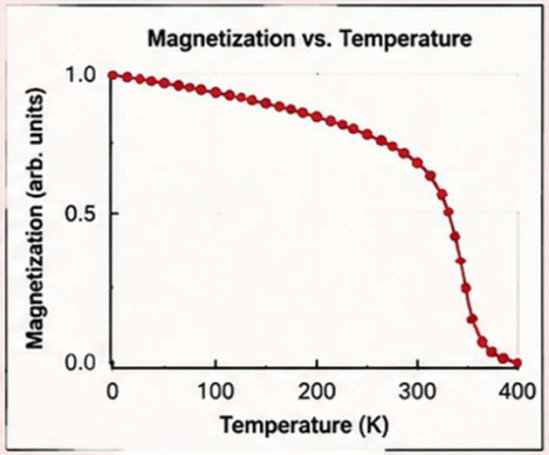
GRAPHING TOOLBOX

Great graphs need **both** skills!

2. DESIGNING IT TO COMMUNICATE YOUR MESSAGE

The visual part of graphing

- Clarity
- Focus
- Balance
- Audience

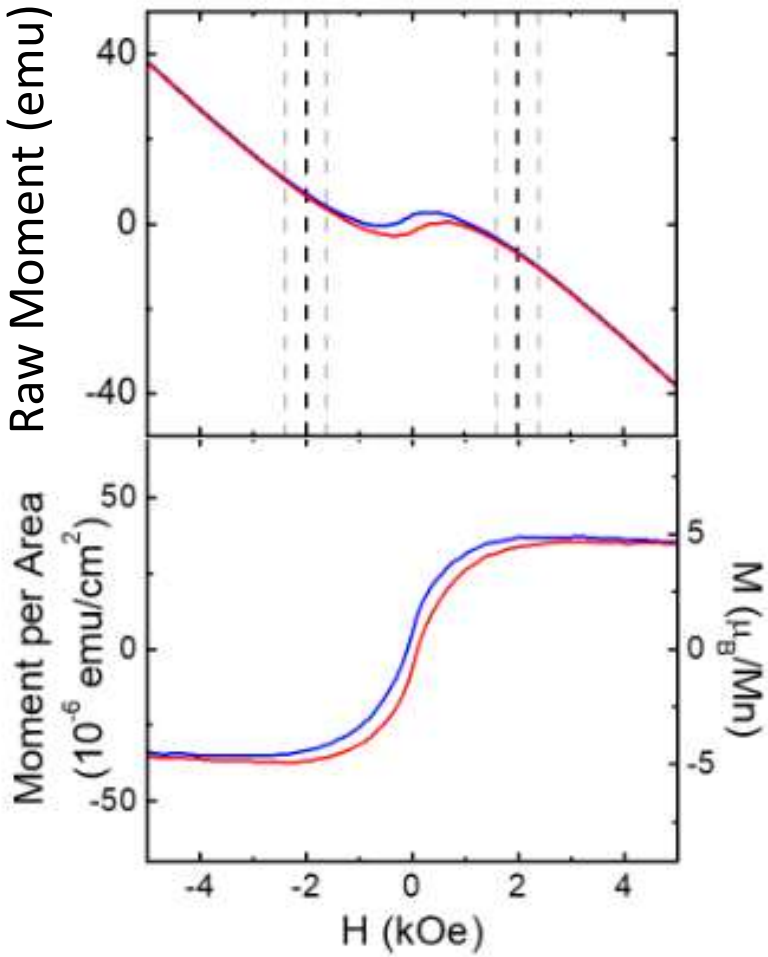


A DESIGN SKILLSET

It turns data into insight.
It helps others see what matters.

Today's Agenda

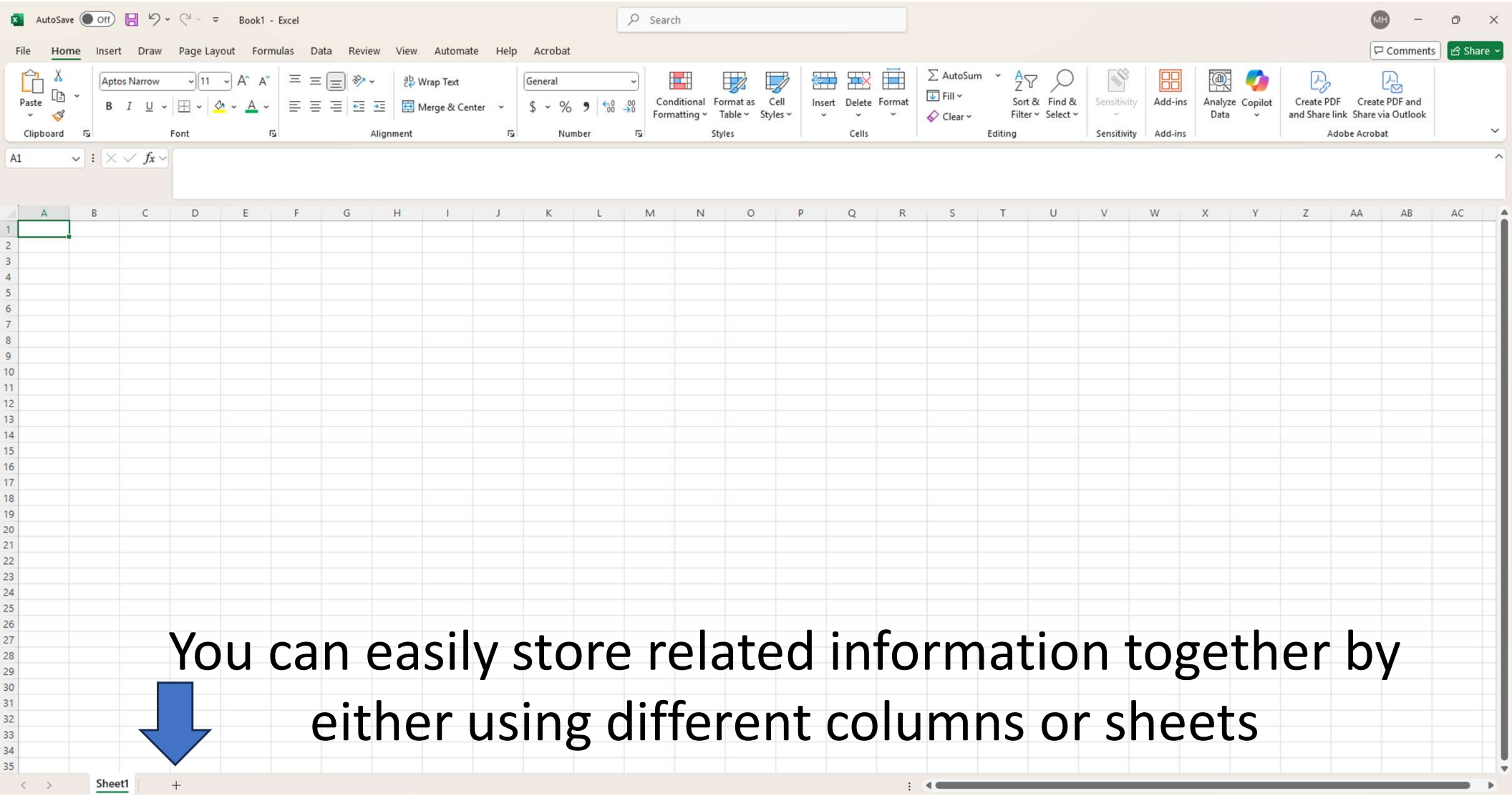
- Brief Discussion Comparing Ways to Graph
- Discussion of Many Ways to Use Excel
- Some Excel Basics with Practice
- Walking Through Manipulating Data Very Similar to Yours



Every graphing program has pros and cons

Roughly increasing in difficulty:

- Excel/Google Sheets: easy, normally accessible, graphing has some clunky features (Pretty easy for beginners)
- Desmos.com: fairly easy, free, graphs as you go which is nice (Best for when collecting one data point at a time)
- Origin: Free for 6 months, user-friendly, point-and-click graphical interface for plotting and statistical analysis
- MatLab is a more powerful (not free), code-based environment for numerical computation and advanced modeling
- Python: free, initial setup confusing, widely used in science, but getting used to using takes more time than we have in this class (Our department is debating adding a computation class for this purpose.)



Excel can be used for information storing, calculations, graphing, fitting

Ways I Use Excel: Scheduling

21-Aug	Introduction to Project/Motivation/ Schedule (Why Interactions Matter)	Partner/Scheduling Info
28-Aug	Distinguishing Types of Magnetism and Our Discovery	Perusall & Reading 1
4-Sep	Project Planning: What Kinds of Magnetic Measurements Could We Do?	Reading 2 & Syllabus
11-Sep	Finding and Evaluating Relevant Literature and AI Best Practices	P. Reading 3 & Safety
18-Sep	Assessing the Quality of Materials (Focus on X-Ray Diffraction, earlier)	Reading 4 on Perusall
25-Sep	Best Practices with Lab Notebook Documentation and Graphing	Good/Bad Graphs Homework
2-Oct	Raman Demonstration	
9-Oct	Fall Break (No Class)	
16-Oct	Understanding and Processing Your Raman Data	Project Planning
23-Oct	Check-In and How Are Materials Grown and Why Can They Oxidize	
30-Oct	Guest Chemist; Introduction to Excel: Spreadsheets, Graphing an	
6-Nov	Building a Story with Your Data (Particularly When It Isn't Obvi	
13-Nov	Check-In and Project Speed Dating: Share Your Project with Otl	
20-Nov	How To Write a Good Abstract and Short Talk with Examples	
	Have a Wonderful Thanksgiving Break!	
4-Dec	Five Minute Group Presentations	
11-Dec	Longer Discussion of Further Research Opportunities	

Such as class scheduling and colloquia

Wednesdays 2:30 (check them out!)

Date	Host*	Speaker Name	Research /	Institution
20-Aug	First Day of Classes - No Colloquium			
27-Aug	Title IX Training	Title IX Training		WVU
3-Sep	Maura McLaughlin	Multiple Within Department	Multiple	WVU
10-Sep	Thomas Steinberger	Jack Hare	Plasma	Cornell
17-Sep	Left empty to experiment with potential colloqium fatique; do we think it helped?			
24-Sep	Jason E. Ybarra	Rebecca A. Charbonneau	Astro Hist	NRAO / AIP
1-Oct	Micky Holcomb	Brenden Magill	CMP	VA Tech
8-Oct	Fall Break - No Colloquium			
15-Oct	Chris Jacobs	Valentin Walther	AMO	Purdue
22-Oct	Dunc Lorimer	Adam Dong	Astro	Green Bank
29-Oct	N/A	Maura McLaughlin	N/A	WVU
5-Nov		Greg Riggs	Plasma	WVU
12-Nov	Thomas Steinberger	Piyush Mehta	Plasma/Sp	WVU; Director: Center for Innovation in
19-Nov	Leaving empty; there is some big conference this week			
26-Nov	Thanksgiving - No Colloquium			
3-Dec	Danielle Maldonado	Charlotte Selton		American Physical Society
10-Dec		Jason E. Ybarra	Astro	WVU
17-Dec	No Colloquium			

Date	Host*	Speaker Name	Research /	Institution
14-Jan	First Week of Classes - No Colloquium			
21-Jan	Plasma Search?			
28-Jan	Plasma Search			
4-Feb	Plasma Search			
11-Feb	Plasma Search			

Storing information on related items

Some details on a few of our NASA samples

You can also have columns for what you have measured and brief interpretations

	SAMPLES	LOCATIONS	DESCRIPTION	Details	Thickes
					nm
Al	Al Samples				
	These samples come from the same wafers as the samples that were delivered to WVU for the previous study in June 2021. Original sample fabrication was completed by Larry Hess and Mona Mirzaei in June 2021. The pieces from these wafe stored in an ambient office environment since June 2021. They also have been stored loose in a larger size wafer holder and likely may have come in contact with both other wafer pieces in the holder, or the holder itself during this time. I also c that areas of the surface may not have come in contact with tweezers during the previous handling and cleaving of samples from this wafer in 2021.				
1	1. **Al 20nm Sample 1 (A, B, C)**	WH 403	AJA deposited 20nm thick aluminum with HF dip and reverse bias prior to deposition, no chemical processing after deposition.	HF Dip	20
2	2. **Al 20nm Sample 2 (A, B, C)**	WH 403	AJA deposited 20nm thick aluminum with HF dip and reverse bias prior to deposition, then purposely thickly fluorinated by exposing to SF6 in RIE, No O2	HF Dip+ SF6	20
3	3. **Al 20nm Sample 3 (A, B, C)**	WH 403	AJA deposited 20nm thick aluminum with HF dip and reverse bias prior to deposition, then purposely thickly oxidized by exposing to long O2 plasma	HF Dip+ O plasma	20
4	4. **Al 20nm Sample 4 (A, B, C)**	WH 403	AJA deposited 20nm thick aluminum with HF dip and reverse bias prior to deposition, then purposely coated with fluorocarbon from one cycle of DRIE passivation	HF Dip+ C-F	20
5	5. **Al 20nm Sample 5 (A, B, C)**	WH 403	AJA deposited 20nm thick aluminum with HF dip and reverse bias prior to deposition, then purposely coated with HMDS.	HF Dip+HMDS	20
6	6. **Al 20nm Sample 6 (A, B, C)**	WH 403	AJA deposited 20nm thick aluminum with HF dip and reverse bias prior to deposition, then purposely coated with HMDS, then HMDS removed by O2 plasma.	HF Dip+HMDS, removed O plasma	20
7	7. **Al 20nm Sample 7, (A, B, C)**	WH 403	AJA deposited 20nm thick aluminum with HF dip and reverse bias prior to deposition, patterned with our standard Al etch process, O2 ash done in final step to remove HMDS in AXIC system.	HF Dip+HMDS, removed O ash	20
8	8. **Al 20 nm Sample 8, (A, B, C)**	WH 403	AJA deposited 20nm thick aluminum with HF dip and reverse bias prior to deposition, patterned with our standard Al etch process, O2 ash done in final step to remove HMDS in March RIE system.	HF Dip+HMDS, removed O RIE	20
9	9. **Al 20nm Sample 9, (A, B, C)**	WH 403	AJA deposited 20nm thick aluminum with HF dip but no reverse bias prior to deposition, no chemical processing after deposition.	HF Dip	20
Nb	Nb Samples				
	These samples were stored since fabrication and chip dicing was completed in drybox conditions, with a protective PR coating layer. The PR coating layer was removed via a solvent clean just prior to packaging in the 1" holders.				
1	1. 40nm thick "Dustbuster" project samples **(D4 R5C11, D4 R3C3, D4**		AJA deposited Nb with July 2022 EXCLAIM/Dustbuster liftoff process, underwent sidewall etch cycle process. Wafer ID DT4. Measured 42nm thick Nb after processing. Sample fabrication completed July 2022 by Archana Devasia.		42
2	2. 500 nm thick "EXCLAIM" project samples **(GW1 500nm, GW2 500 nm, GW3 500nm)**		AJA deposited Nb with EXCLAIM Nb ground plane liftoff patterning process. ~500 nm thick. Witness wafer to fall 2022 EXCLAIM product wafers. Sample fabrication completed October 2022 by Larry Hess, Mona Mirzaei.		500
3	3. 70 nm thick "EXCLAIM" project samples **(GW1 70nm, GW2 70 nm, GW3 70nm)**		AJA deposited Nb with EXCLAIM Nb ground plane liftoff patterning process. ~500 nm thick. Witness wafer to fall 2022 EXCLAIM product wafers. Sample fabrication completed October 2022 by Larry Hess, Mona Mirzaei.		500
	Niobium oxide, sometimes called columbium oxide,[citation needed] may refer to: Niobium monoxide (niobium(II) oxide), NbO (Super); Niobium dioxide (niobium(IV) oxide), NbO2 (semi/insulator); Niobium pentoxide (niobium(V) oxide), Nb2O5 (insulator)				
	Wafer 1	Nb dep 250r	Sidewall etch	Oxide Clean	Al dep 20n
	Wafer 2	Nb dep 250r	Sidewall etch	No Oxide Clean	Al dep 20n
	Wafer 3	Nb dep 250r	No Sidewall etch	Oxide Clean	Al dep 20n
	Wafer 4	Nb dep 250r	No Sidewall etch	No Oxide Clean	Al dep 20n

Personal Finance

You can use both to budget and then to check that you spent what you planned to, so that you can make adjustments if not

Expenses	Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Average
Rent/Mortgage	30th	1840	1840	1840	1840	1840	1840	1840	1840	1840	1840	1840	1840		1840
Internet/Cable	30th	221	221	222	222	222	222	225	225	222					222.44
Home Gas	30th	172	165	137	95	46	42	34	25	34					83.333
Water	29th	56	82	56	50	50	56	57	50	57					57.111
Electricity	15th	56	137	118	117	92	103	206	90	163	110				119.2
Car/Home Insurance	16th	125	125	125	125	125	125	125	125	303	240				154.3
Car Payment	16th	0	0	0	0	0	0	0	0	329	329				65.8
Cell Phone	11th	103	103	103	103	103	103	103	90	90	90				99.1
Vehicle Gas															
Parking		40	40	40	40	20	0	0	20	40	42				
Trash															
Health Insurance		508	508	508	508	254	0	0	270	540	540	540	540		
Grass Cutting		0	0	0	0	56	56	56	56	56					
Groceries/Kroger		700	700	700	700	700	700	700	700	700					
Entertainment															
Amazon/Walmart/etc															
Other								400	290						
Total		3821	3921	3849	3800	3508	3247	3746	3781	4374					3783
								HOA fee	car delivery fee						
Income (9 month employee)		100%	100%	100%	100%	50%	0	0	50%	100%	100%	100%	100%		

You can break down rows as much or as little as you like. Entertainment could be broken down into restaurants, bars, gaming, etc. if you needed to evaluate how to reduce costs

Grant Budgetting

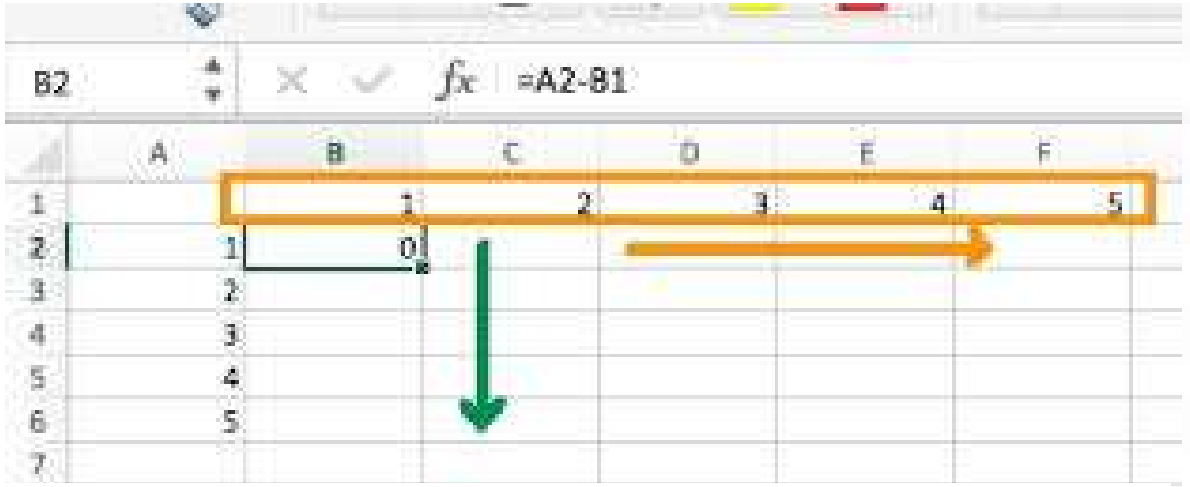
Note: Grad students in sciences get paid to be researchers or teaching assistants

		Year 1			Benefits
Name	**12 Month Base**	**Months**	**Request**	**Fringe**	**Total**
Mikel Holcomb (PI)	$ [redacted]	0.925	$ [redacted]		
John Stewart (Co-PI)	$	0.48	$		
Total Key Personnel			**$**		
GRA (2)	$ 28,515.00	15	$ 35,644.00	$ 3,208.00	$ 38,852.00
UG Student	$ 22,880.00	1.5	$ 2,860.00	$ 49.00	$ 2,909.00
Total Other Personnel			**$ 38,504.00**	**$ 3,257.00**	**$ 41,761.00**
Total Personnel			**$ 53,492.00**	**$ 6,704.00**	**$ 60,196.00**
Materials and Supplies					$ 5,027.00
Publication Costs					$ 100.00
Advisory Board					$ 975.00
Other					$ 1,078.00
Total Other					**$ 7,180.00**
Total Direct Costs					**$ 67,376.00**
Modified Total Direct Cost Base					$ 67,376.00
Indirect Costs (F&A)	*Rate*	*52%*			*$ 35,036.00*
Total					**$ 102,412.00**

Indirect costs at a university cover university-wide expenses not tied to a specific student or grant, including facilities and administrative support (like building maintenance, utilities, and IT). The rate is negotiated with the government.

Common uses

Let’s practice!

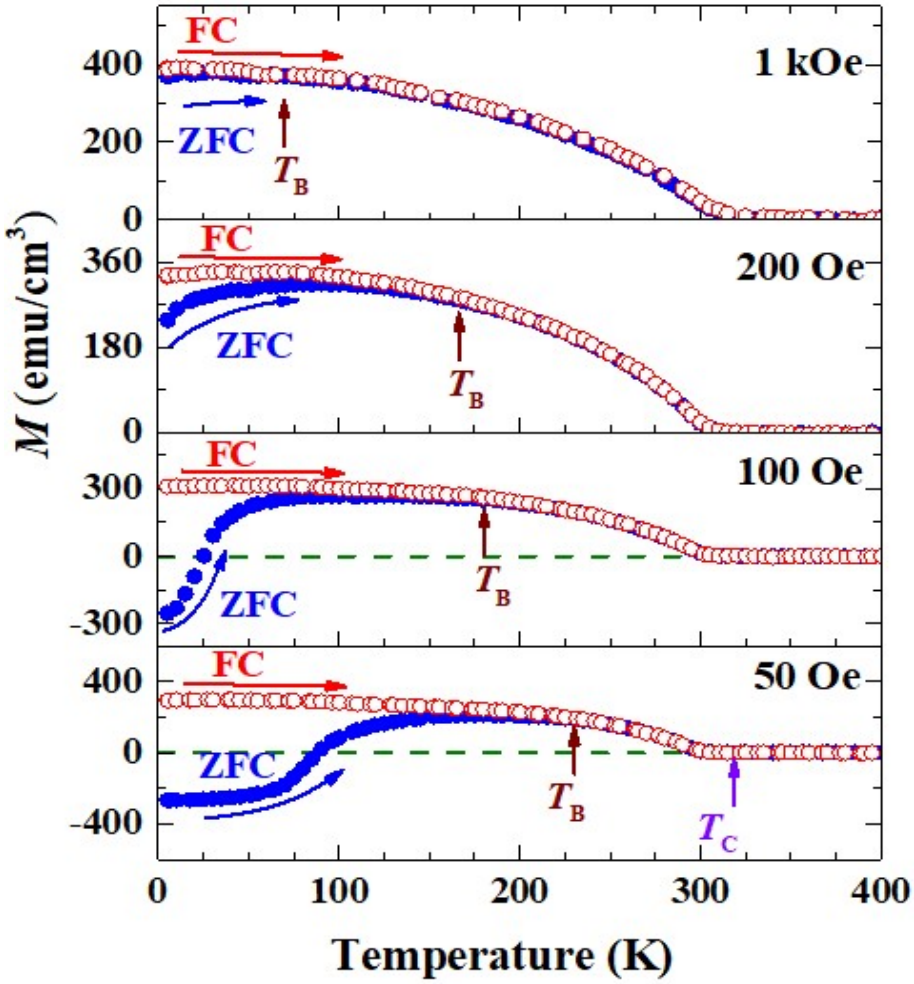


- Click on boxes and extend to copy entries
- Click on two adjacent boxes to start a sequence. Even works for dates (Oct 15).
- =A3 + A4 + A5 to sum up specific values
- =SUM(A3:A5) would give the same result
- =AVG(A3:A5) to average a set of numbers
- =MIN (A3:A5) to identify min of numbers (same with max/median/standard deviation)
- Subtracting one column from another column (or row)

First off, what kind of data is this? What are we measuring?

Time Stamp (sec)	Temperature (K)	Magnetic Field (Oe)	Moment (emu)	M. Std. Err. (emu)
53673675.47	20.014	19.99	8.1255E-06	3.09E-07
53673684.60	20.011	19.99	7.9203E-06	3.27E-07
53673686.96	20.020	19.99	8.0473E-06	3.18E-07
53673689.04	20.043	19.99	7.9380E-06	3.35E-07
53673691.36	20.078	19.99	8.1117E-06	2.90E-07
53673693.61	20.133	19.99	8.1125E-06	3.26E-07
53673696.05	20.227	19.99	7.9503E-06	2.60E-07
53673698.35	20.308	19.99	7.8792E-06	2.97E-07
53673700.84	20.411	19.99	8.0325E-06	3.48E-07
53673703.05	20.559	19.99	8.0667E-06	3.45E-07
53673705.10	20.706	19.99	7.8289E-06	3.28E-07
53673707.18	20.837	19.99	7.9786E-06	3.40E-07
53673709.71	20.958	19.99	8.1089E-06	3.66E-07
53673712.32	21.119	19.99	7.7736E-06	3.27E-07
53673714.07	21.227	19.99	7.9295E-06	3.54E-07
53673716.22	21.323	19.99	8.0209E-06	3.56E-07
53673718.22	21.409	19.99	8.0302E-06	3.21E-07
53673720.07	21.482	19.99	7.8165E-06	3.55E-07
53673721.66	21.515	19.99	8.0333E-06	3.13E-07
53673723.80	21.585	19.99	8.0025E-06	2.81E-07
53673726.06	21.656	19.99	8.0436E-06	2.74E-07
53673728.49	21.734	19.99	7.9827E-06	2.96E-07
53673730.86	21.791	19.99	8.2089E-06	2.93E-07
53673733.41	21.894	19.99	7.4449E-06	3.37E-07

Skill: Looking at your data helps you figure out what is measured.
What you don't know is what happened before this data and that can matter because hysteresis.



What can we infer?

✓ Magnetization is being measured

✓ Temperature is changing

✓ Field is constant

✓ Probably an M vs T experiment