Career Reflections on Industry and National Labs:

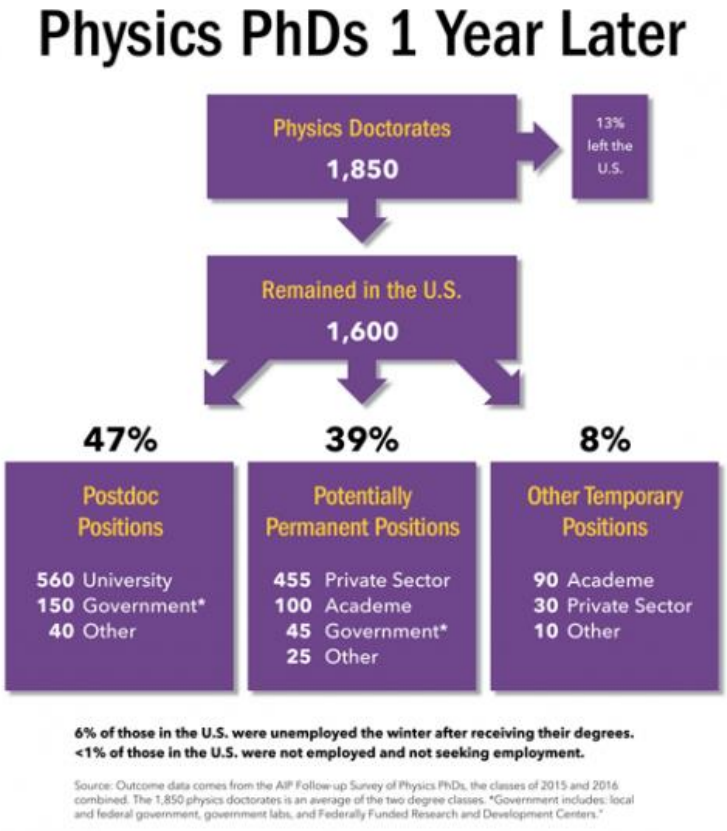
Advice, Tips, Advantages, and Pitfalls

Dr. Tory Carr

(CU Boulder) Ultrafast condensed matter physics
(IBM Research) Material Process Development
(Los Alamos National Laboratory) Advanced Material Characterization Techniques

LA-UR-21-29211

Where do Physicists go after PhD?



Type of Employment of Physics PhDs by Employment Sector One Year After Degree, Classes of 2013 & 2014 Combined

Sector of Employment	Initial Employment Type: Postdoc %	Potentially Permanent %	Other Temporary %	Overall %
Academic*	75	20	71	52
Private	1	70	18	31
Government	21	8	3	14
Other	3	2	8	3
	100%	100%	100%	100%

Note: Data only include US-educated physics PhDs who remained in the US after earning their degrees. Data are based on the responses of 655 postdocs, 523 individuals working in potentially permanent positions and 126 individuals working in "other temporary positions."

*The academic sector includes two- and four-year colleges, universities, and university affiliated research institutes.

http://www.aip.org/statistics

Landscape Overview: What are my research options?

National Lab

“Small” Company

4 year undergraduate
(eg. Liberal Arts)

Large University

2 year college

Large Company

Road to Industrial Material Science Research:

2009

Tear Down experiment

Build new & improved experiment

Data collection & initial analysis

Internship

Thesis writing
Paper writing

Feb 2015

TJ Watson Research Center
Yorktown Heights, NY

Why do an internship? "Academia vs Industry"

It will delay my graduation, the time lost will hurt my chances for academia…

- Wanted to see what Industrial Research was like

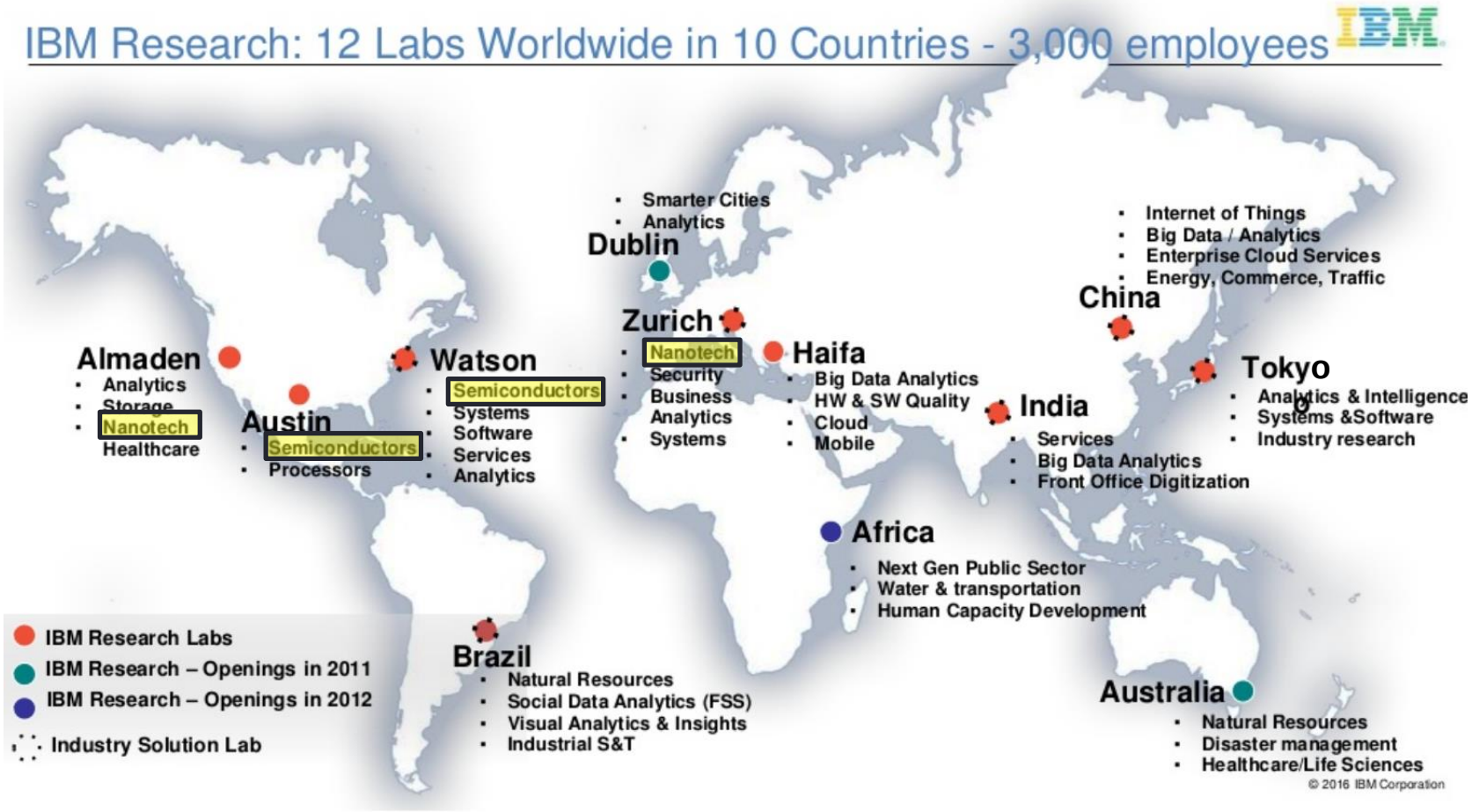
- What type of resources?
- How restricted are you in projects?
- Creativity involved?

Geared towards what? End Goals?

- Completely different than current research?
- Certain skill that you want to learn that don't get from PhD?
- Need tangible results? Paper/ Job offer / Github library padding?

How do I make those connections that could lead to an internship?

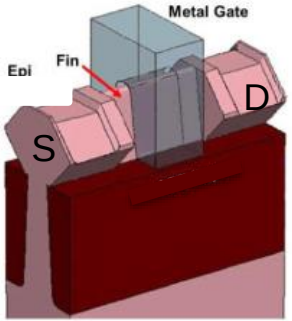
IBM Research *(~3.000 researchers)*



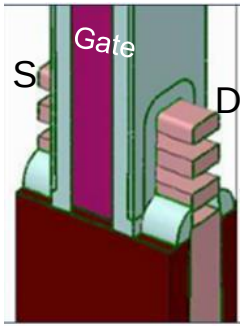
Into the realm of CMOS technologies:

IBM Research - Albany

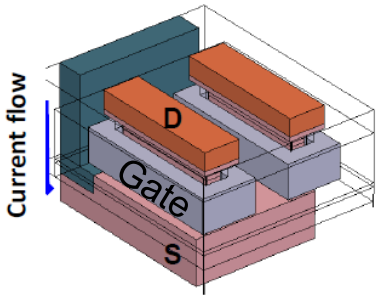
- 24x7 300mm wafer research fab (Class 1 cleanroom space)
- On site joint-development projects with AMAT, ASML, LAM, TEL
- Focus Areas:
  - Computational Memory
  - MRAM
  - Advanced Logic Architectures



FinFET



Nanosheet (h-GAA)



Vertical FET (v-GAA)

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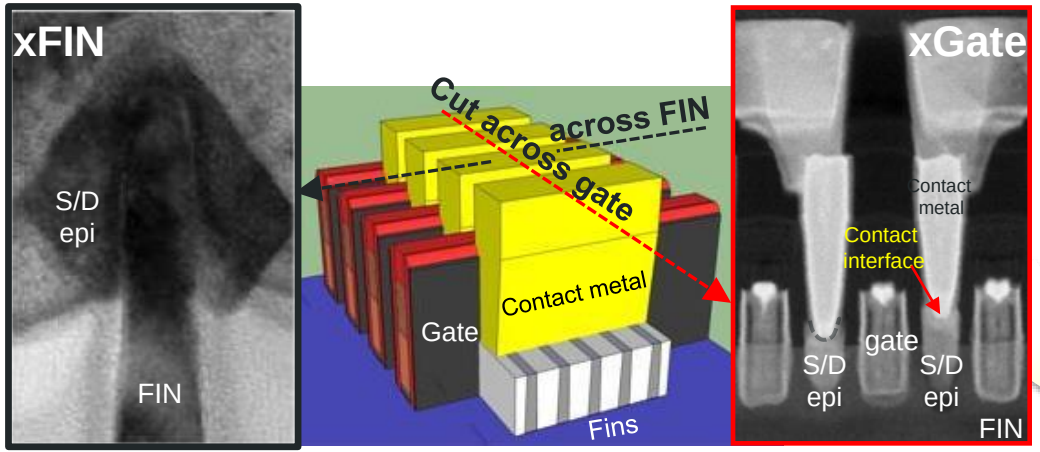
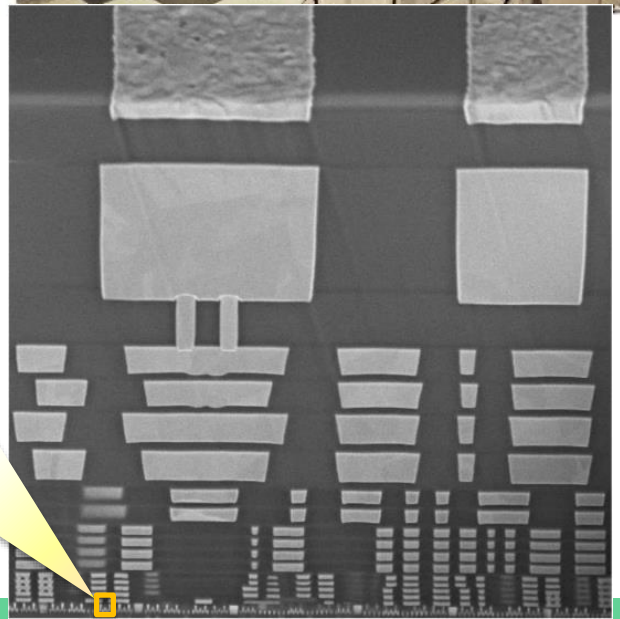
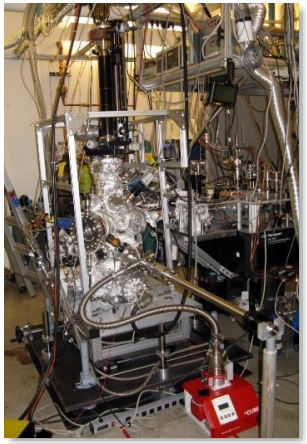




Gate

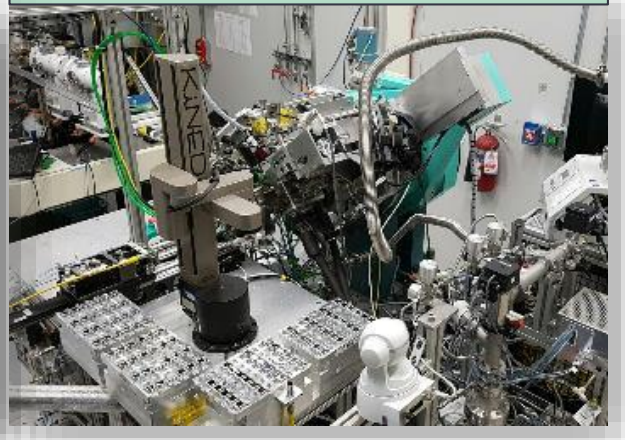
Combination of resources for characterization:

- “Data on tap” – XRR, XRD, XPS, Ellipsometry, XRF, scatterometry, SEM, TEM
- Supplement with synchrotron beamline characterization



XRD End Station at **CHESS**

IBM RTA End Station at **CLS**
Remote and Automated Operation

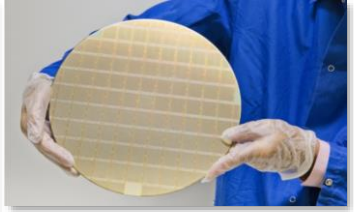


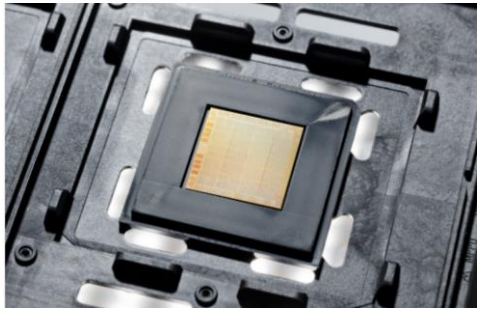
NEWS

IBM Unveils Its First 7nm Processor, Complete With “Memory Inception”

August 18, 2020 by Jake Hertz

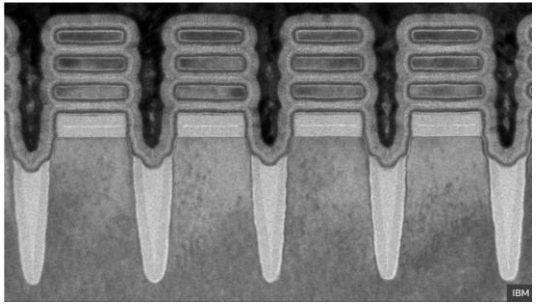
This week, IBM announced its new POWER10 processor, the 7nm successor to POWER9.





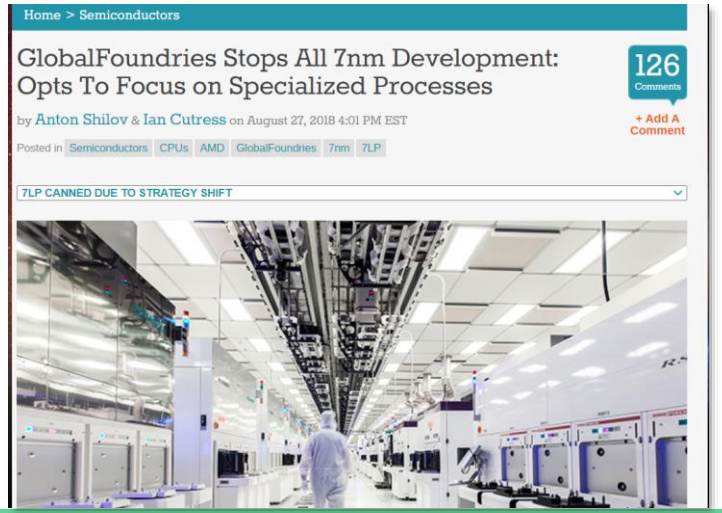
IBM 2nm chip breakthrough claims more power with less energy

6 May



The Blessing and the Curse: *Industry can be volatile*

- Industries can actively decide to change direction – *fast*
    - IBM sold off manufacturing to Globalfoundries in 2015 – migrated to more “research for hire” model
    - Globalfoundries decided to stop pursuing “bleeding edge” research in 2018
- Small companies can live or die by grant/ seed funding



The Large Industry Experience

- Day-to-day is balancing:
  - Managing projects
  - Analyzing data
  - Deriving insights from data and improving methods
  - Communicating insights to others – and *often*
- Expected to present research to company stakeholders/ customers – Clear tie to business outcomes needed
- Abundance of resources and expertise
- Involved in larger projects with real-world impact
  - Potential pitfall: Narrow focus and roles that purely support business goals
  - Offers pathways to roles that can significantly drive direction

The Small Industry Experience

- Day-to-day resembles academia
  - building experimental hardware
  - you wear many, many hats
  - opportunities for proposal writing, seeking your own funding and driving own research

- 3 Categories (papers are not the “product”)
  - “Lifestyle” Company
  - IP-licensing focus
  - Commercialization/ Product-focused company

- Environment is variable dependent on the company and people you work with

Where to start looking?

- Determine what you value: Publishing, small R vs big R, small team/ large team
- LinkedIn for:
    - Former group members
    - Former classmates
- Small companies
    - SBIR Website
    - likely will have “standing invitations” to apply
- Large companies
    - Will only have widely advertised positions open – difficult to “create” a position

Small Industry Science - SBIR

- Small Business Innovative Research Grants
- Small Business Technology Transfer

Small Industry Science - SBIR

- Small Business Innovative Research Grants
  - Company must be for profit, US owned and operated, under 500 people
  - Work must be done in the US
  - Focus is on performing R&D – Not purchasing equipment, commercializing a technology that has already been developed or one that has very low risk and only needs capitol

Small Industry Science - SBIR

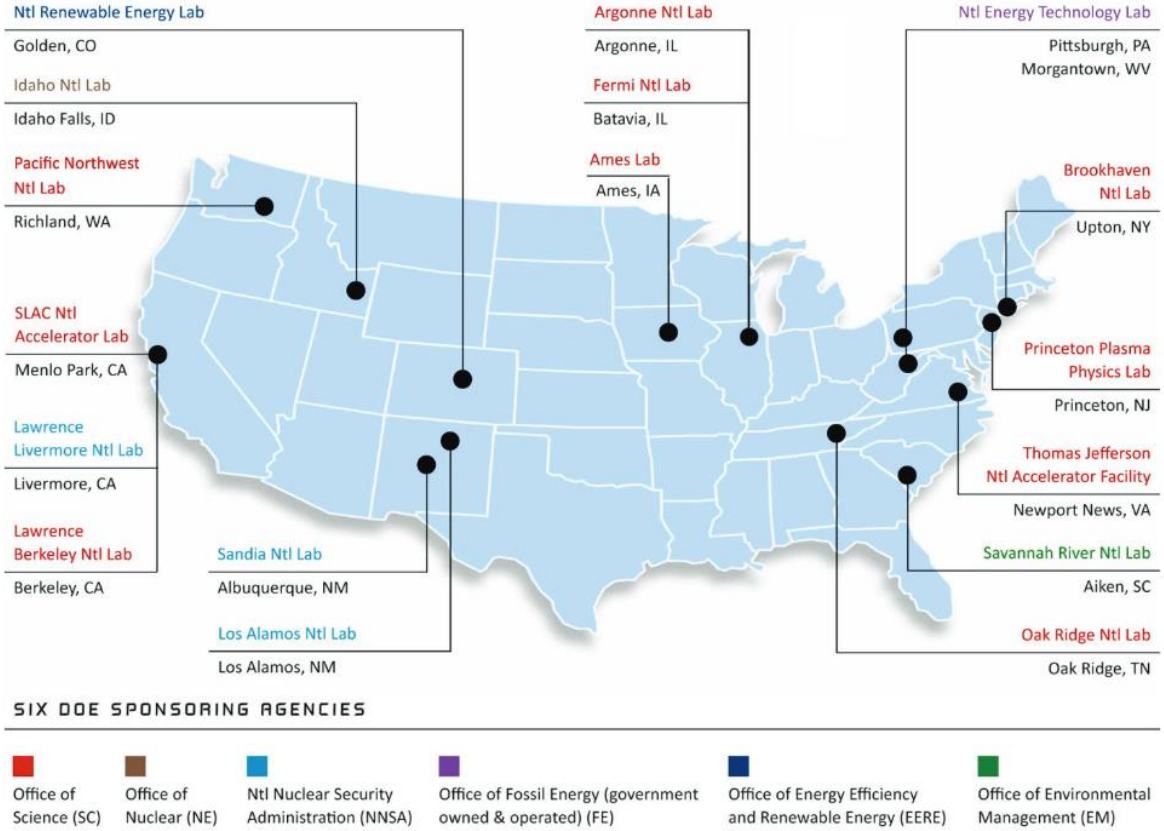
- Small Business Innovative Research Grants
  - Offered by each funding agency (NSF, DoD, DoE, NASA, NIH, etc)
  - Typically 3 Phases:
    - Phase 1 – 6 to 9 mo. 100-200k
    - Phase 2 – 24 mo. 1.5M
    - Phase 3 – varies – Commercialization
  - Supports a vibrant ecosystem of small business research
  - Commercialization focused

Application process *(Industry)*

- Who are YOU? How do you want to label yourself?
- Determine your core skillsets
    - With few exceptions, no one will care you did “core-hole clock spectroscopy”
    - Will care you can do: time-series analysis, FIB/ Sample Preparation, inferential statistical analysis, Python machine learning packages, etc…
- Distill your resume to 2 pages – You’ve done GREAT work, but you don’t need to list all your papers over 5 pages
    - Put skills summary on first page
- Write a cover letter – Tailor it to each position

On to the National Lab….

But First: The DOE National Lab basics…

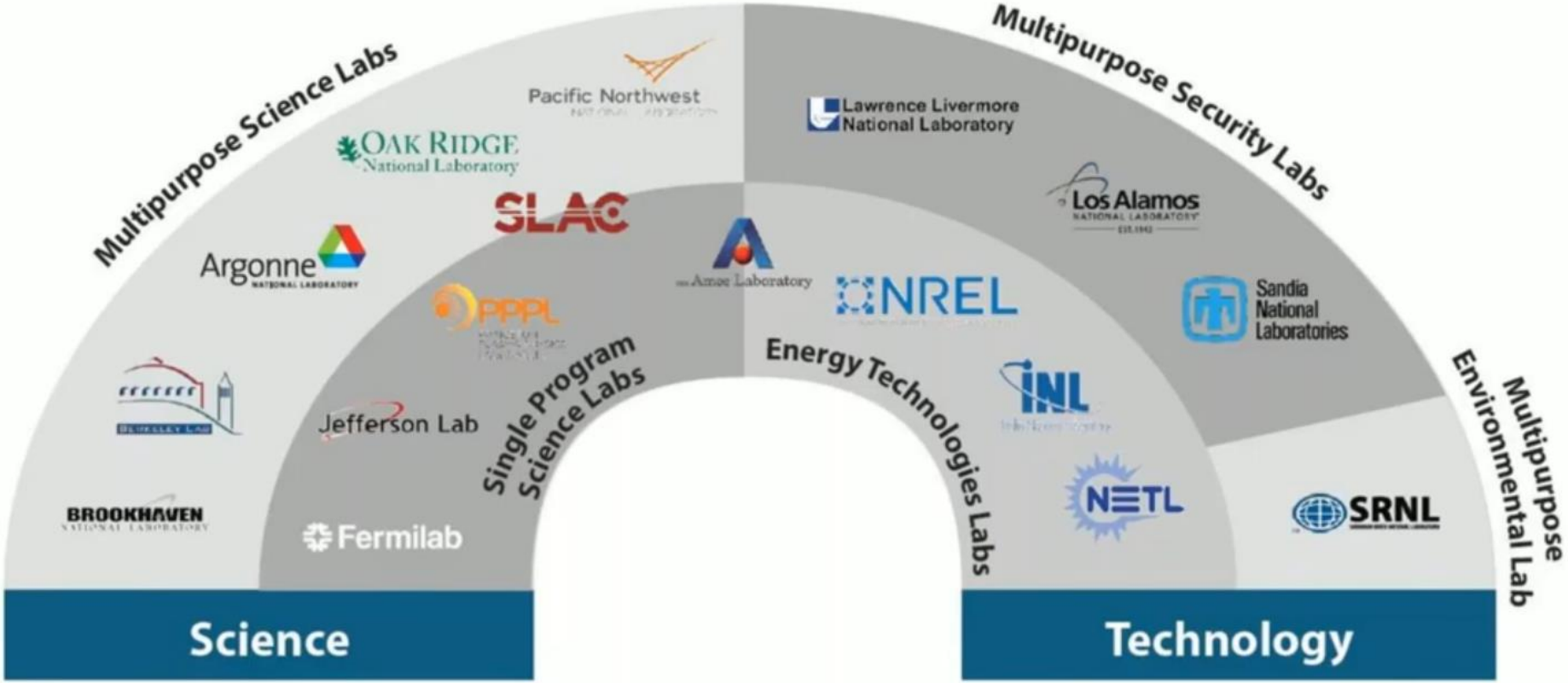


Dept of Energy has 4 basic missions:

- Clean energy innovation
- Scientific leadership and discovery
- Nuclear security
- Environmental stewardship of the nuclear weapons complex

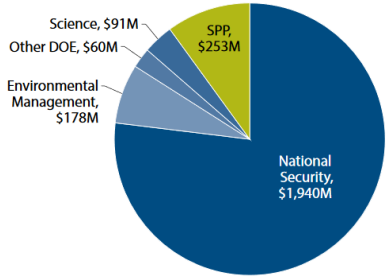
Dr. Peter Fiske's lecture: https://www.youtube.com/watch?v=RyUbU-r_Wt8
Joint Report on DOE National Lab improvements: https://www2.itif.org/2013-turning-page-national-lab-innovation-economy.pdf
Overview of All DOE National Labs: https://nationallabs.org/site/wp-content/uploads/2017/05/National-Labs-all-r.pdf

Research Focus varies greatly across a spectrum…

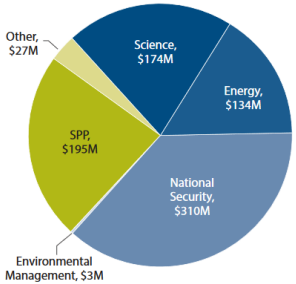


Dr. Peter Fiske's lecture: https://www.youtube.com/watch?v=RyUbU-r_Wt8

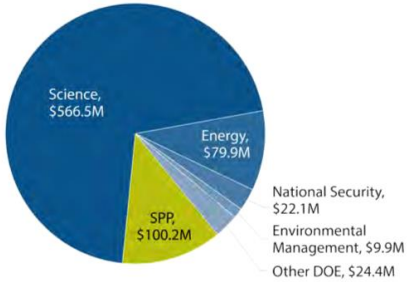
Los Alamos



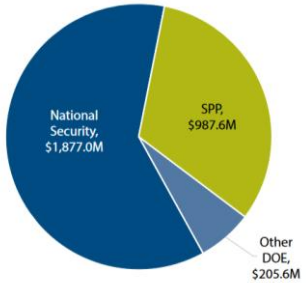
PNNL



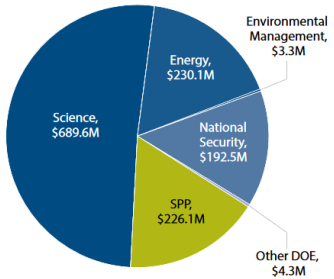
LBNL



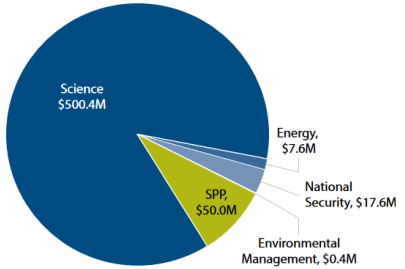
Sandia



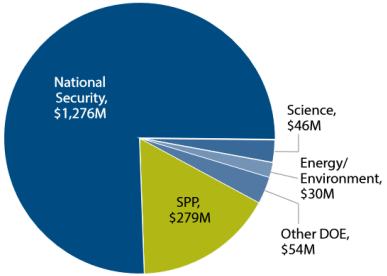
Oakridge



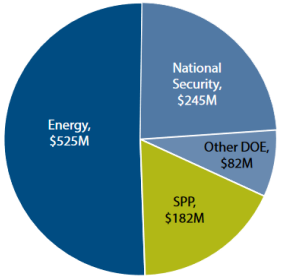
BNL



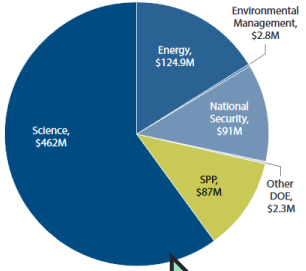
LLNL



Idaho NL

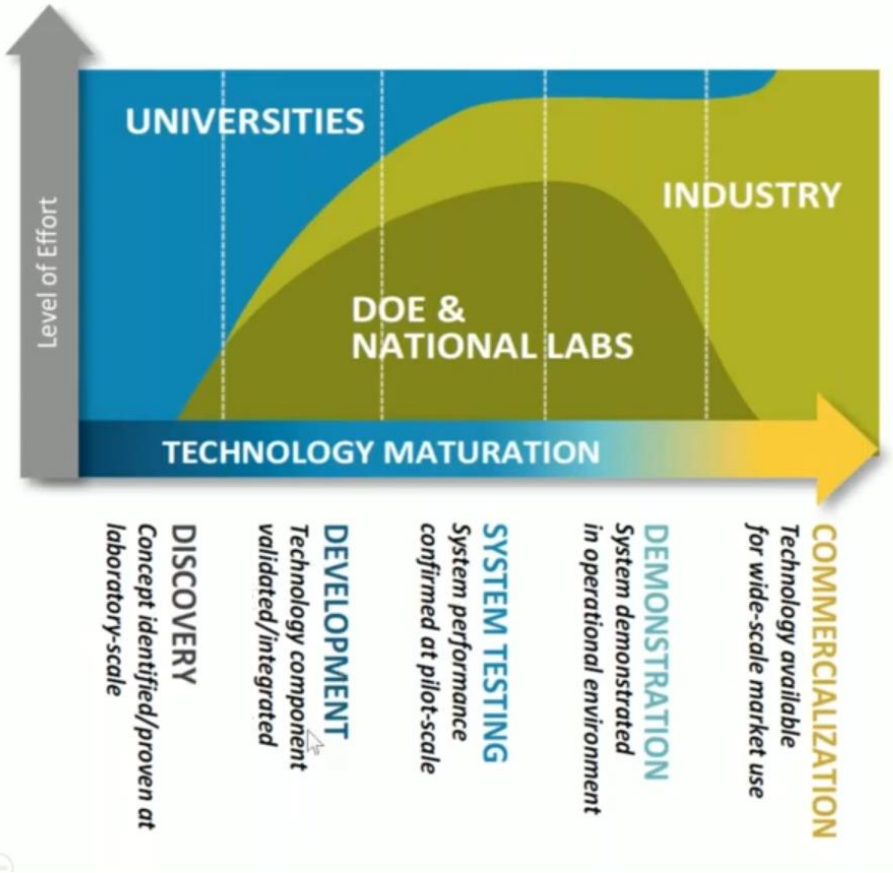


ANL



National Security **FY2016 Funding by Source** *Basic Science*

What sold me…



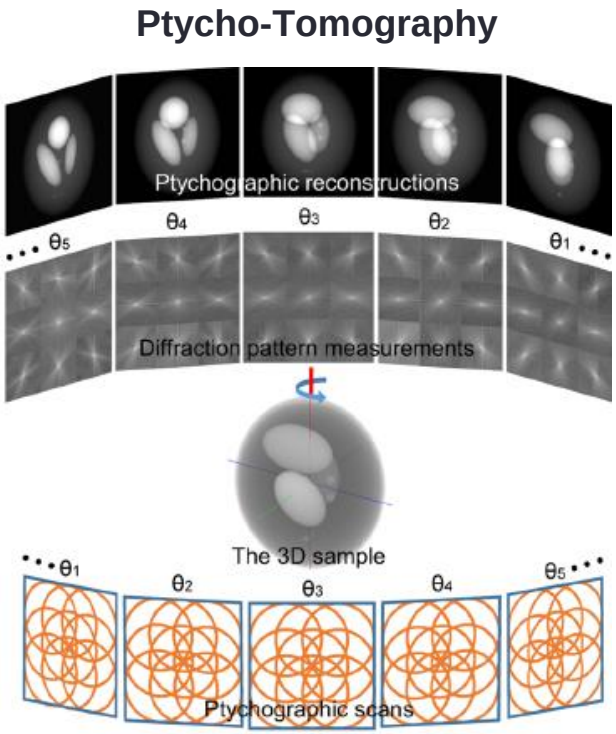
- Still felt like I had mobility within research areas
- Large-scale projects with applications (and impact)
- Broad range of research from Basic Sciences to applied areas:

Center for Integrated Nanotechnologies
Los Alamos Neutron Science Center
National High Magnetic Field Laboratory Pulsed Field Facility
Quantum Institute
Superconductivity Technology Center
Additive Manufacturing
Nuclear Nonproliferation
Remote Sensing
Climate Science
Geophysics and Planetary Science
…

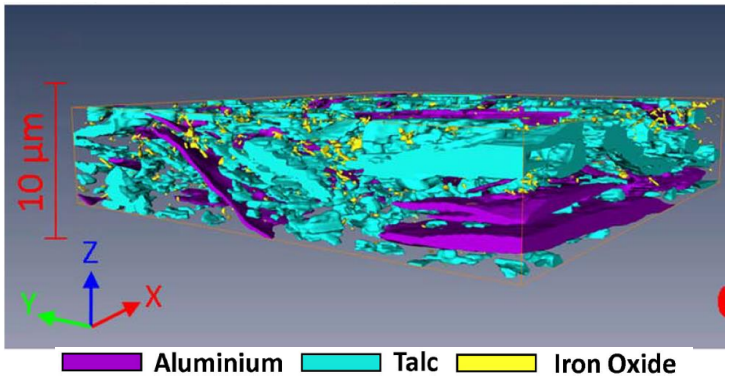
Application process *(National Lab: Los Alamos)*

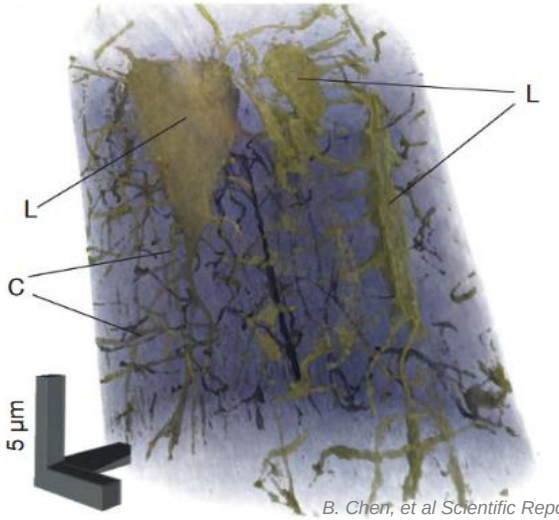
- Varies between “Basic Science” divisions vs “applied” divisions
  - Basic Science Divisions more closely resemble academia
    - Publishing *(Still had publishing history during industry)*
    - Conference/ Scientific community involvement
    - Initial work close to previous work
      Mobility to learn new areas once you have “foot in door”
- Post Doctoral positions available if < 5 years out of PhD *(varies by lab)*
- Post Doctoral Fellowships available

Computational Imaging for improved material characterization



P. Li A. Maiden Sci Reports, 8:2049 (2018)





B. Chen, et al Scientific Reports, 3, 1177 (2013)
M. Dierolf et al., Nature 467, 436–439 (2010)

Pros

- Large organization
  (collaborations galore, in-house expertise)
- Excellent capabilities
  (Equipment is cheap compared to labor)
- Many opportunities for funding
- Uniquely rewarding to be part of impactful research

Cons

- Large organization
  (heavy bureaucracy, more restrictions
- People are often very oversubscribed
  (Splitting time on many projects)
- *…(but needs to be mission-relevant)*
- Depending on nature of your work, will be restricted on ability to publish this research

Tips I wish I knew when I was first applying *(to either)*:

- “Applied Science” is not a bad word
- Find a mentor
- Skills that were less important in grad school/ post-docs become VERY important
    - Interpersonal relationship skills
    - Communicating **value** of your work (concise, clear, effective)
    - Communicating technical ideas to people not with your background
    - Project management
- You WILL interact with a diverse array of backgrounds – need to learn to navigate these interactions
- Take some time to figure out what you value

The two body problem

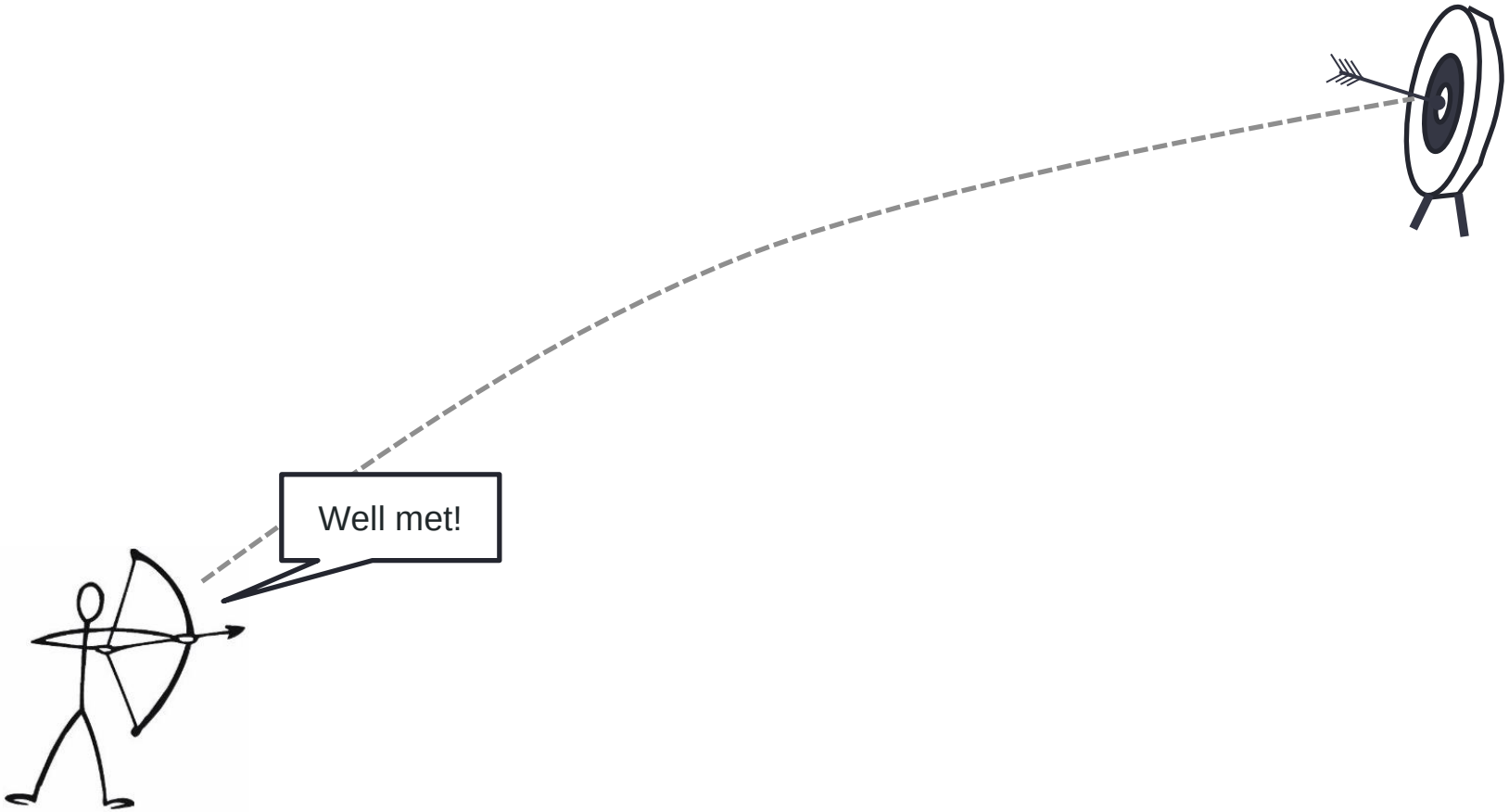
- Yes, its hard
- Don’t be afraid to talk about it → People will often work with you
- Compromises are often involved (but that’s ok)
- Conversation is key

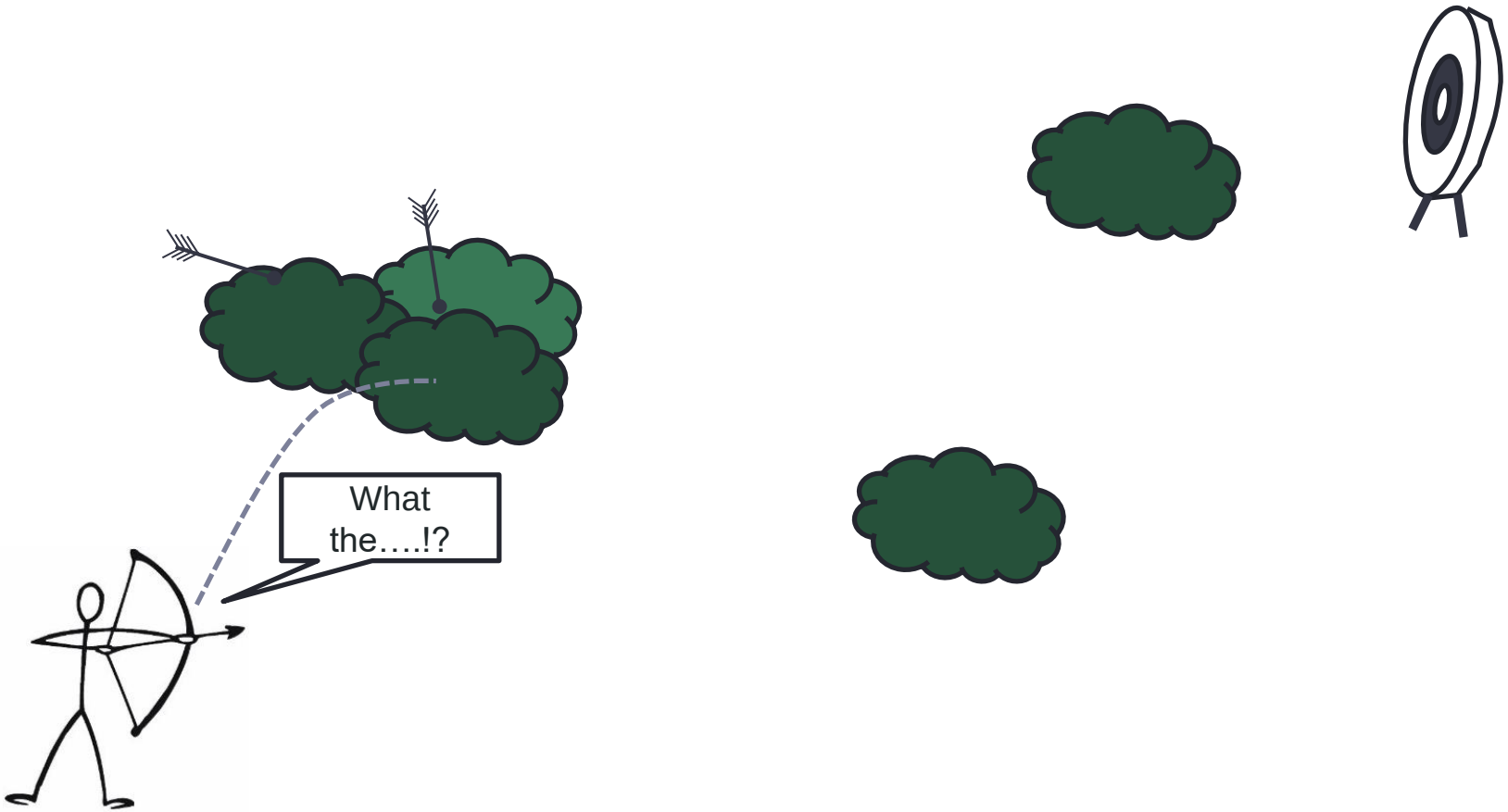
A note on maternity leave

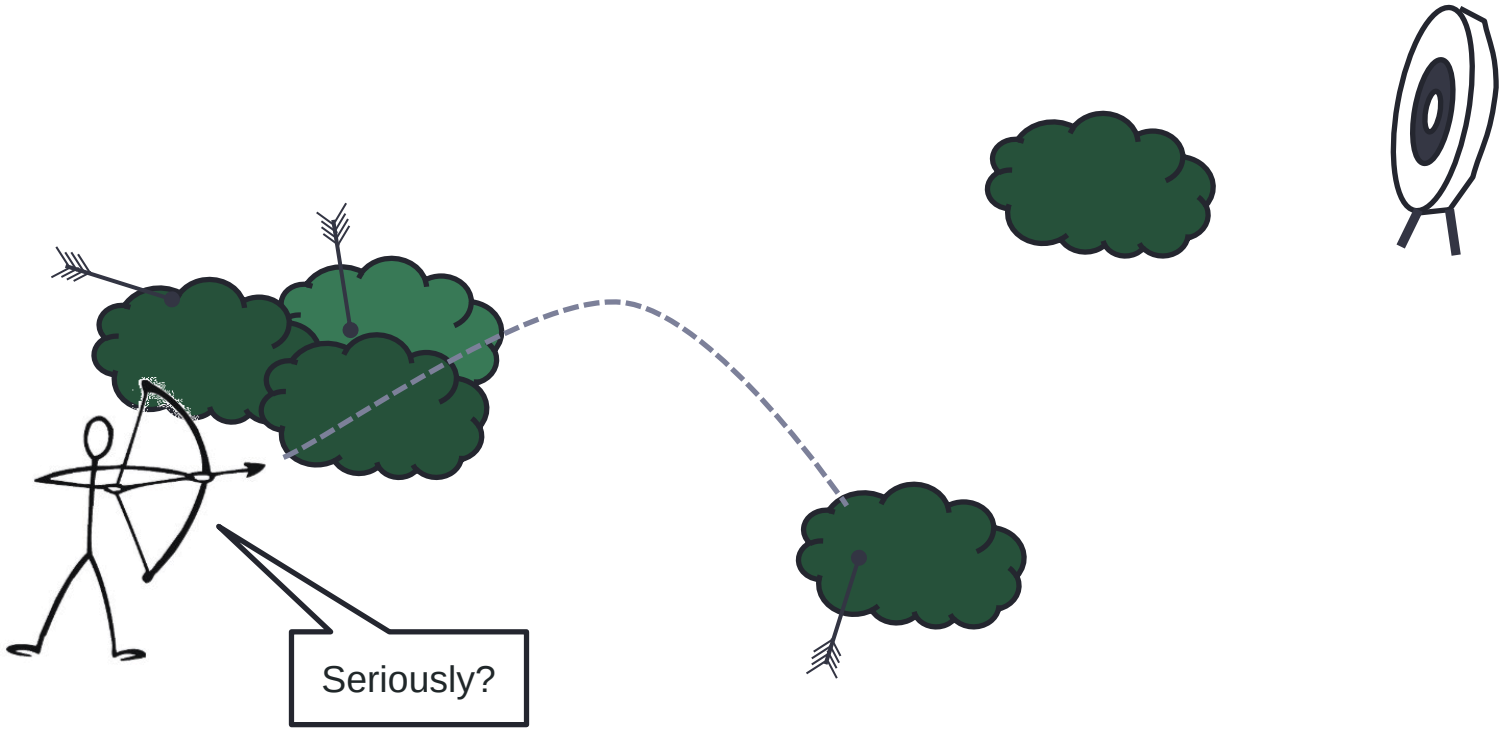
- Discuss options when you apply to the job: Some can be negotiated as part of starting package (Industry) and some can’t (National Lab)

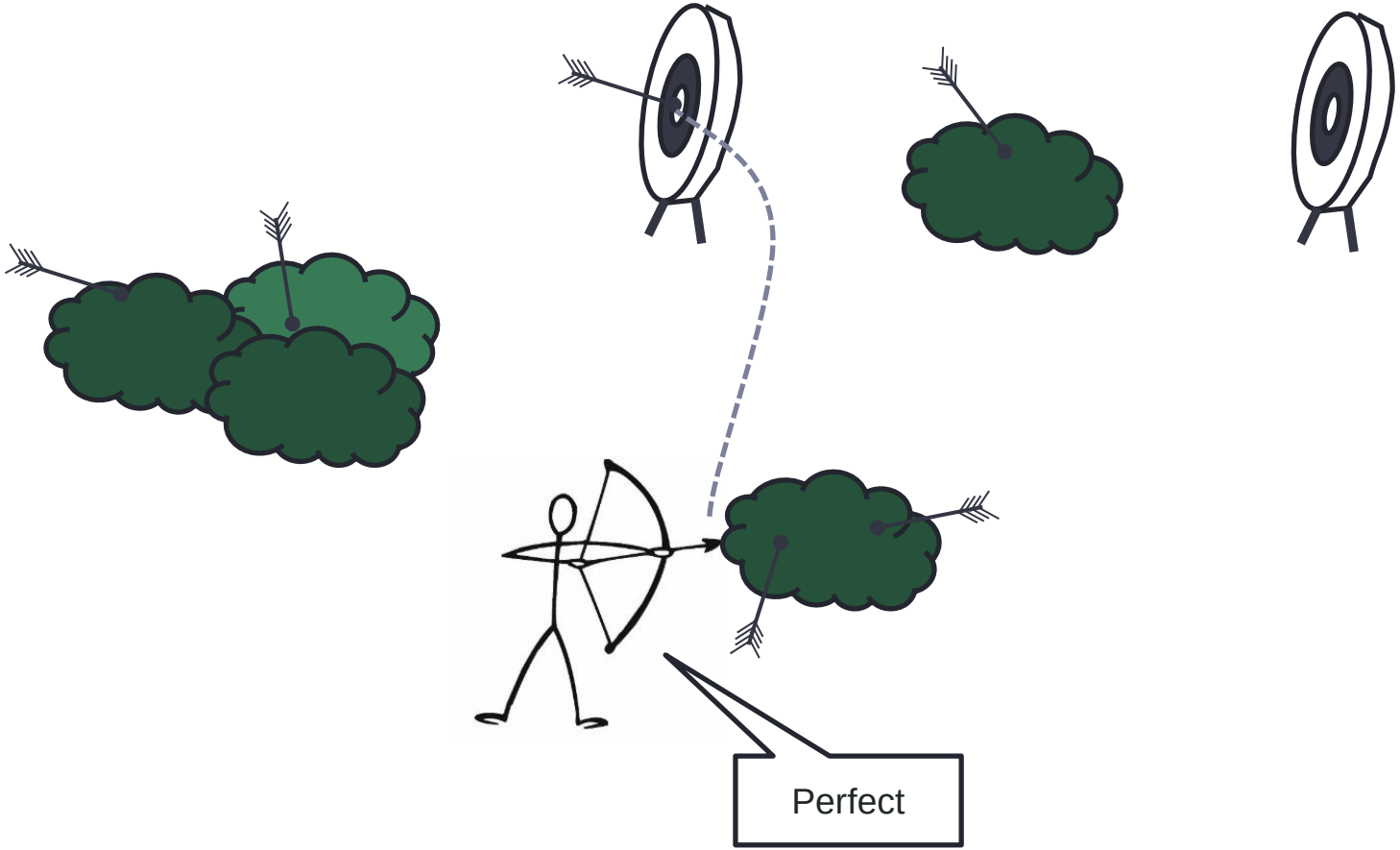
- **National Lab:** 6-9 weeks
- **Industry:** As long as 12 weeks

- Parental Leave: Yes, your partner should get some time off too
- Family Medical Leave Act


Well met!


What
the….!?


Seriously?


Perfect

Please reach out with questions!

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