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Summary

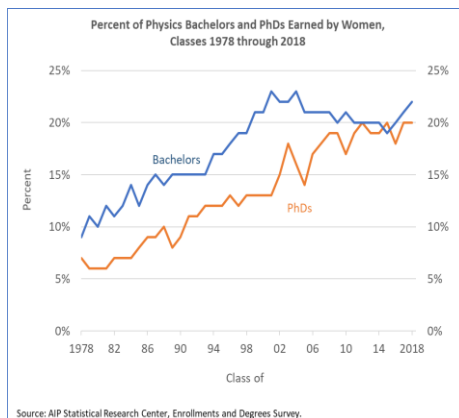
- Challenges and successes for women in:
 - Representation
 - Doctoral Experiences
 - Employment Experiences

In this presentation, we will discuss the challenges and successes for women in representation, doctoral programs, and employment. It is important that we recognize the barriers women encounter, while also acknowledging the improvements in women's experiences over time.

CHALLENGES IN REPRESENTATION IN THE U.S.

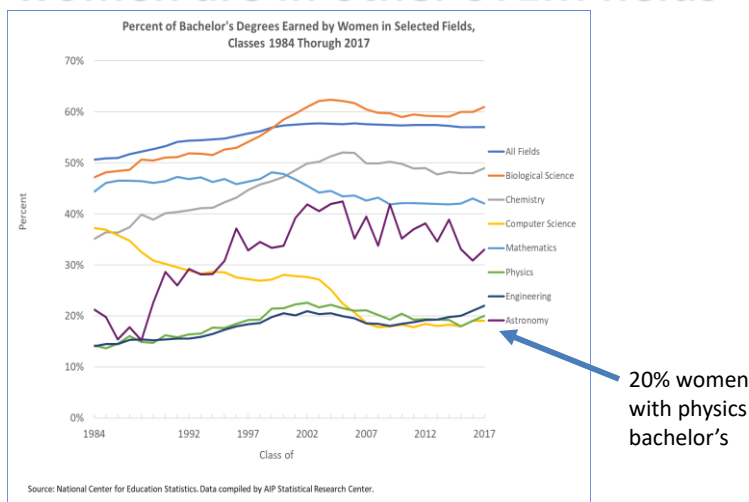
Women are underrepresented in physics

Women with physics bachelors: 22%
 Women with physics PhDs: 20%

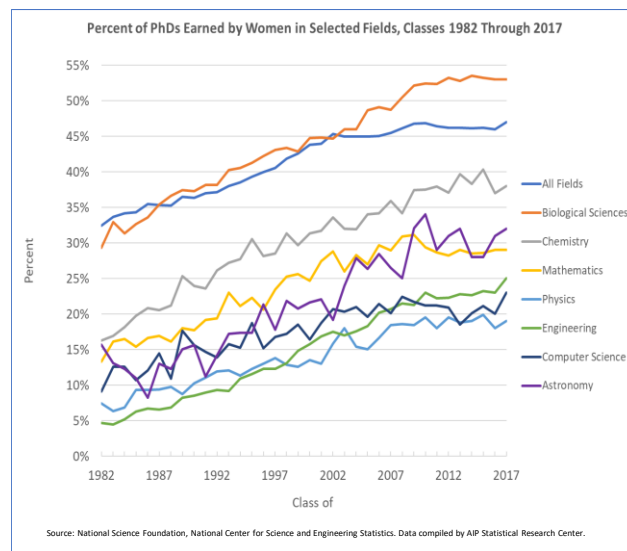


The number of women earning physics bachelor's and doctoral degrees has increased over time. In 2018, over 1,900 women earned bachelor's degrees in physics and over 350 earned doctorates in physics. Over the last ten years, the percentage of women earning physics bachelor's degrees and doctorates has slightly increased by 1-2 percentage points. Back in 2007, women earned 21% of physics bachelor's degrees and 18% of physics doctoral degrees. This data was collected from our annual Enrollments and Degrees Survey, which is sent to all physics departments in the United States and has a 90% response rate from departments.

More women are in other STEM fields

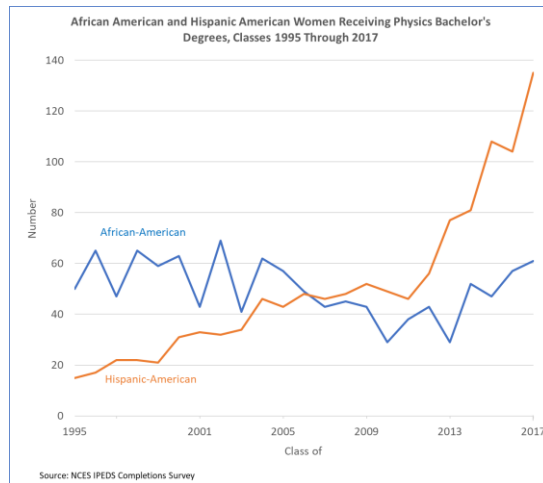


Compared to other fields in Science, Technology, Engineering, and Mathematics (STEM), women are more underrepresented in physics. Across all fields in academia (not just STEM), women earned 57% of all bachelor's degrees, showing that women are over-represented among bachelor's degree recipients. Based on 2017 data from the National Center for Education Statistics (NCES), women earned around 60% of bachelor's degrees in biological science, 50% of degrees in chemistry, 40% of degrees in mathematics, and 35% of degrees in astronomy. Women earned only around 20% of bachelor's degrees in physics, engineering, and computer science.



The representation of women earning STEM doctorates tells a similar story. Physics, engineering, and computer science had the lowest percentage of women among doctorate recipients. Data was analyzed based on results from the 2017 Survey of Earned Doctorates distributed by the National Science Foundation.

Minority women in physics



When comparing different racial/ethnic groups, African American, Hispanic, and Native American women are underrepresented in physics. Out of all women earning physics bachelor's degrees in 2017, Hispanic women were 8% of bachelor's degree recipients and African American women were 4% of bachelor's degree recipients. Over time, the number of Hispanic women earning physics bachelor's degrees is increasing, while the number of African-American women has not changed much. These groups are underrepresented among physics doctorate recipients as well. Hispanic and African American women were 3-5% of female physics doctorate recipients in 2017. The number of Native American women were not reported in this figure due to small group sizes. We want to protect their identifiability.

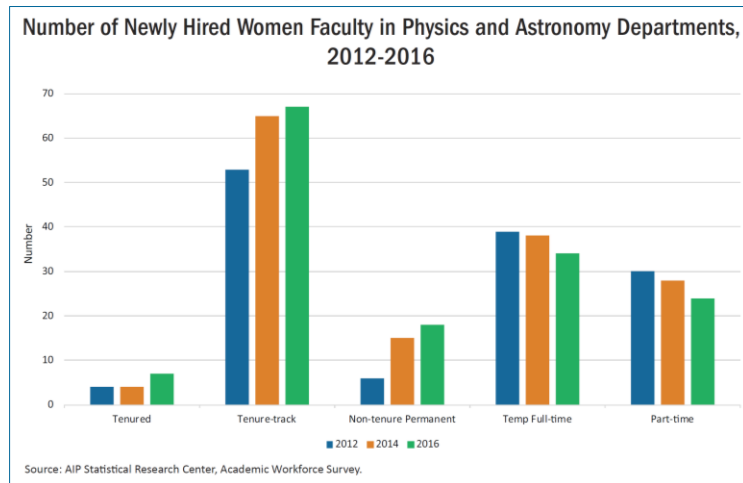
The number of African American women shown here may be influenced by changes in how the NCES asked race/ethnicity questions. Starting in 2008, NCES added a "two or more races" category to their questionnaire. African-American women selecting "two or more races" were not included in these numbers after 2008, which might explain the slight decrease in African American women shown in more recent years.

Women's representation in departments is increasing

Academic Rank	2010	2014	2018
Full Professor	8%	10%	12%
Associate Professor	15%	18%	21%
Assistant Professor	22%	23%	25%
Instructor / Adjunct	21%	23%	27%
Other Ranks	18%	20%	19%
Overall	14%	16%	19%

In physics departments, the percentage of women among almost all faculty positions has increased over time.

More women hired into higher-level positions



Among new faculty hires in physics departments, more women are being hired into tenured, tenure-track, and permanent positions over time. In 2018, women were 32% of new hires, which suggests that women are being hired at higher rates than men. If they were hired at similar rates, women would be 20% or less of new hires, which is the percentage of women who earned physics doctorates in the past.

CHALLENGES IN DOCTORAL AND EMPLOYMENT EXPERIENCES AROUND THE WORLD



Global Survey of Scientists Contractor:

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2018 Global Survey of Scientists Project

- Surveyed scientists in 159 unique countries in 8 disciplines
- Over 7,500 respondents for physics
 - 37% women
- Analysis
 - Regressions were done for all variables
 - Controlled for age, region, level of development, employment sector



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Most respondents in the survey worked in academia (70%). On the survey, the gender question only included “men,” “women,” and “prefer not to respond” as options. Other gender identities were not included due to cultural reasons. In some countries, identifying as any other gender identity could lead to negative consequences, so the option was not included to protect at-risk individuals in those countries from being identified. Women are over-represented in this sample due to sampling methods. We used snowball sampling to recruit more women, and the percentage of women in the international physics population is probably lower than 37%.

Doctoral Study Experiences



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For all four variables, regressions showed that gender differences were significant even controlling for other factors. Overall, most people had positive experiences in their doctoral programs.

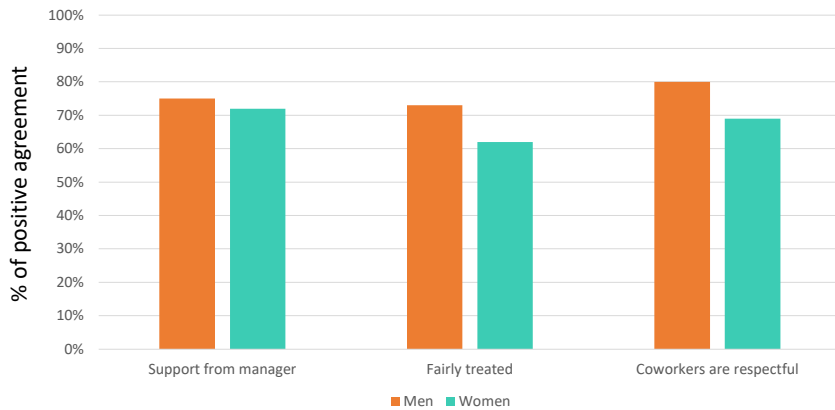
Program quality: 87% of men and 84% of women rated their program as excellent, very good, or good

Advisor relationship: 87% of men and 80% of women rated their advisor relationship as excellent, very good, or good

My program treated everyone fairly: 76% of men and 63% of women agreed

Other students were respectful of everyone: 84% of men and 72% of women agreed

Employment Experiences



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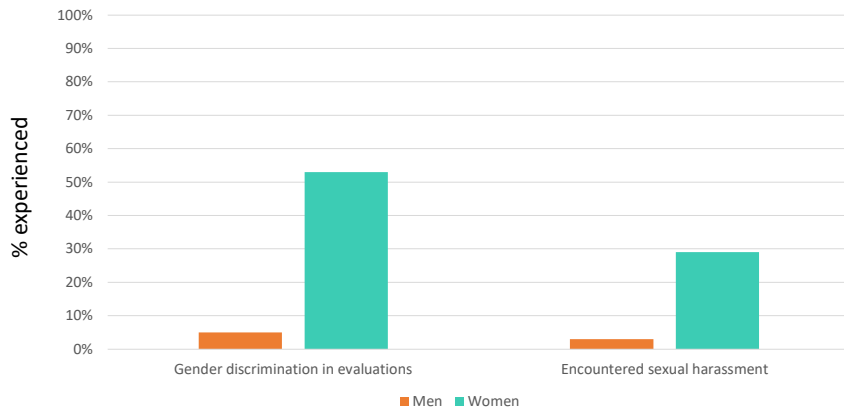
All three variables had significant gender differences. Overall, most people had positive experiences in their workplace.

I have support from my primary manager or boss: 75% of men and 72% of women agreed

My employer treats everyone fairly: 73% of men and 62% of women agreed

My coworkers are respectful of everyone: 80% of men and 69% of women agreed

Discrimination and harassment



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About half of women (53%) felt discriminated in the assessment or evaluation of their achievements because of their gender. 37% of women reported never feeling discriminated in their achievements for any reason.

29% of women reported personally experiencing sexual harassment at school or work.

Employment activities

No gender differences:

- Spoke as an invited speakers at conferences
- Acted as a boss or manager
- Was an editor of a journal
- Served on a Board of Directors
- Supervised graduate students

Significant gender differences:

- Men were more likely to supervise undergraduate students
- Women were more likely to serve on conference committees



GENDER GAP
IN SCIENCE

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50% of women and 49% of men served on conference planning committees. 75% of women and 81% of men supervised undergraduate students.

Other non-significant gender differences in employment activities include: attended a conference abroad, conducted research abroad, served on a committee for a grant agency, served on a committee at an institution or company, acted as a leader for a scholarly association, served on a dissertation or thesis committee (not as an advisor), and gave a public talk or interview.

These findings differ from our Global Survey of Physicists (2010) performed ten years ago. We asked the same exact question in the 2010 survey and the current survey. In 2010, men were more likely to report acting as a manager, journal editor, graduate supervisor, or invited speaker. We can think of two potential reasons why we no longer find gender differences in these survey items. 1) We have a different sample than before or 2) More women are doing these activities than 10 years ago.

Employment resources

- Women were significantly less likely to report having enough:
 - Equipment (73% of women had enough)
 - Technical support (69%)
 - Travel money (63%)
 - Funding (62%)
 - Clerical support (61%)
 - Employees or students (54%)



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Overall, the majority of women (54%-73%) reported having enough resources. There were no significant gender differences for the following resources: office space, lab space, computing power, access to data, and access to literature.

This is similar to our findings in the 2010 Global Survey of Physicists. It appears that even though women are performing a similar amount of employment activities as men in 2018, they still seem to report having less resources in their careers.

Family influences

- 33% of women took a career break, mostly for family reasons
- After becoming a parent, women were significantly more likely to:
 - Spend less time at work (43% of women)
 - Choose a more flexible schedule (42%)
 - Feel their career or promotion rate slowed (30%)
 - Change their employer or field (10%)
 - Become a stay at home parent (7%)
 - Get demoted or lose their job (3%)



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16% of men and 33% of women reported taking a break in their career. 2/3 of women took a break for family reasons, 3/4 of men took a break for non-family reasons. Men were also significantly more likely to report that their career did not change after having children.

STORIES ABOUT SUCCESSES AND CHALLENGES DURING CAREERS

2011 PhD Plus 10 Project

- 1,860 mid-career physics PhD recipients from the classes of 1996, 1997, 2000, and 2001
 - PhD programs in the United States
 - 45% working in academia, 34% private sector, and 15% government, and 6% in another sector
 - 14% female

This study contacted mid-career professionals who earned their physics doctorates 10-15 years prior to 2011 in the United States. We surveyed professionals working in multiple employment sectors to examine more diverse career experiences. Within our sample, most participants were male and worked in academia. In this analysis, we only compared men and women, and did not examine other gender identities.

Qualitative analysis approach

- Asked two questions:
 - “What has helped you succeed in your career?”
 - “What have been the barriers to your career?”
- Read over 1,700 quotes and organized them into categories
 - Used inductive analysis processes
 - Includes only those who chose to respond

It is important to note that the answers to these two open-ended questions are not representative of everyone who did the survey. Not everyone chooses to answer these questions.

During qualitative analysis, we read all the quotes from open-ended responses, and organized the content of those quotes into meaningful categories. In inductive analysis, categories are not defined before starting the analysis, and we did not create a list of categories in advance. Instead, we created categories or codes organically as we read each quote for the first time. This is a process called open coding, and is done to prevent our own assumptions from influencing the analysis. A single quote could be coded with multiple open codes. After coding each individual quote, we went over all the quotes again, revised them, and organized them into broader categories or themes. We show examples of how we did this process in the next slide.

Analysis example

Success quote: “Support and collaboration with intelligent and generous colleagues”

Open code → supportive colleagues and collaborations

Broader category → social support

Barrier quote: “There are not many jobs in physics in my current location”

Open code → difficulty obtaining employment

Broader category → career opportunity barrier

These examples show how we assigned categories to each quote. Open codes more closely represent what is described in the quote, and the broader categories indicate the larger themes the participants discussed.

There were 47 codes for quotes about career success factors. The categories for career success factors were: career opportunities, education and career background, organizational support, personal drive, skills and abilities, and social support.

There were 40 codes for quotes about career barriers. The categories for career barriers were: career opportunity barriers, education and career background barriers, gender/race/ethnicity barriers, organizational barriers, personal drive barriers, skill and ability barriers, and social barriers.

What types of success factors did they discuss most?

Career Success Factor	Men	Women
Career opportunities	8%	8%
Education and career background	14%	8%
Organizational support	2%	4%
Personal drive	23%	25%
Skills and abilities	41%	32%
Social support	12%	23%

Looking at the broader categories, men more often discussed education, career background, and skills or abilities as success factors in their careers. Education and career background includes discussions about the quality of their graduate programs, their physics training, training in other scientific fields, and experience in previous jobs. Skills and abilities include various traits like problem solving, communication, teamwork, writing, presenting, programming, or research.

Women more often discussed social support as success factors, including family, friends, mentors, colleagues, and students. Both genders reported personal drive as important factors, including hard work, persistence, and passion for their work.

Overall, both genders seemed to attribute most of their success to personal factors like personal drive, skills, or abilities. They less often discussed outside factors like organizations in their success.

What helped them succeed? (Ten most discussed success factors)

Men

1. Hard work
2. Problem solving skills
3. Education
4. Interpersonal skills
5. Persistence
6. **Experience in certain fields**
7. Mentors
8. Flexibility in work
9. Colleagues
10. Passion for work

Women

1. Hard work
2. Mentors
3. Persistence
4. Colleagues
5. Problem-solving skills
6. Interpersonal skills
7. **Friends/family**
8. Passion for work
9. Education
10. Flexibility in work

Here I have listed the ten most frequent codes discussed by men and women. Interestingly, men and women mention very similar success factors. Both genders discussed the role of hard work in their success the most often, and reported the value of mentors, problem-solving, colleagues, flexibility, passion, persistence, education, and interpersonal skills. Men more often discussed how experience in certain fields (e.g. computer science, mathematics, physics, technology) helped them succeed, while women more often discussed how support from friends and family helped them succeed.

Women also discussed how experience in certain fields helped them succeed, and men discussed how friends and family helped them succeed. These factors in success are important and valued by both genders, but one gender discussed them more often than the other. That is why these factors only appear in the 10 most frequent list for one gender and not the other.

All 47 codes can be viewed in the online report in the appendix section here: <https://www.aip.org/statistics/reports/physics-phds-ten-years-later-success-factors-and-barriers-career-paths>

Women's quotes about success

"Hard work and persistence."

"Deep love of physics, astronomy, and teaching."

"Working in a good team."

"Excellent training I received in graduate school."

"Being able to adapt to new situations."

"My family and the support of the community have helped me succeed."

"Great mentors who helped show me how to make good decisions."

Here are some examples of what women believed helped them succeed.

What types of barriers did they discuss the most?

Career Barrier	Men	Women
Career opportunity barriers	17%	12%
Education and career background barriers	6%	4%
Gender, race, or ethnicity barriers	2%	15%
Organizational barriers	38%	25%
Personal drive barriers	8%	4%
Skill and ability barriers	15%	9%
Social barriers	14%	31%

When looking at the broader categories, women more often discussed social barriers such as issues with mentors, colleagues, managers, and balancing family life (especially maternity leave and child-care). They also reported more issues with experiencing gender bias in the workplace. Men more often discussed organizational barriers such as issues with funding, promotions, administration, overwork, and lack of autonomy. Men also discussed skill barriers more often, such as having a lack of interpersonal skills, business skills, programming, teaching, and grant writing skills.

Unlike successes, both genders more often discussed barriers from external sources, like organizations, job markets, or other individuals. Rather than discussing internal barriers such as lack of skills or personal drive.

What were the barriers? (Ten most discussed barriers)

Men

1. Lack of funding
2. Overwork
3. **Lack of interpersonal skills**
4. **Field not valued at work**
5. Difficulty obtaining employment
6. **Unsupportive administration**
7. **Difficulty advancing at work**
8. **Lack of interest in work**
9. Family obligations
10. Issues with management

Women

1. Family obligations
2. **Gender bias**
3. **Issues with mentors**
4. Lack of funding
5. Overwork
6. **Difficulty relocating for work**
7. Issues with management
8. **Lack of staff/equipment**
9. Difficulty obtaining employment
10. **Lack of networks/contacts**

While women and men discussed similar factors in career success, they seemed to have more different experiences with career barriers. Both genders experienced issues with funding, overwork, management, balancing family obligations, and obtaining employment.

Men more often discussed not having enough interpersonal skills, and a lack of interest in their work. They also reported more organization-level issues, such as issues getting promoted (not receiving tenure or not being considered for management positions), working for administrators who don't support science, or navigating bureaucratic processes. Many discussed how their specialty or field is looked down on in their work environment. In certain academic departments, teaching or specific subfields in physics are not valued, while in certain industry settings, a background in science or research is not valued.

Women reported more issues with a lack of resources, such as not having enough staff, students, equipment, or others to collaborate with. They reported more difficulties working with mentors who were neglectful, gave bad advice, or unsupportive. They also reported more issues with gender bias in the workplace such as not being respected or seen as an equal by their colleagues, or being treated on a different standard than male colleagues. This was mostly reported in academic work settings.

Once again, all these barriers were discussed by both genders, but with different levels of frequency. Therefore, some may appear in the 10 most frequent barriers for one gender but not another.

All 40 codes can be viewed in the report online in the appendix:

<https://www.aip.org/statistics/reports/physics-phds-ten-years-later-success-factors-and-barriers-career-paths>

Women's quotes about barriers

"Poor advice and mentoring."

"Since my children were born many aspects of my career have been much more difficult."

"Being a member of a dual physics career couple has limited my employment choices."

"No one at my college that I can collaborate with on research."

"Being the only woman in a group of 40 or so physicists was extremely difficult for me."

"The inability of male peers to see me as an intellectual equal."

Here are some examples of barriers that women discussed.

Conclusions

- The number of women is increasing over time, but women are still underrepresented
- Most women have positive experiences in doctoral programs and employment
 - Report less positive experiences than men
 - Still experience sexual harassment
- Women make more career compromises for family reasons

Women still have many challenges in physics, but there are just as many successes for women that we should highlight. Although women are underrepresented in physics (around 20%), representation is still increasing over time, especially in academic departments. Among new hires, women are being hired at a greater rate than men (32% in 2018), and more are being hired into higher status tenure-track or permanent positions.

Although women report significantly less positive experiences compared to men, most women report good experiences in doctoral programs and employment (60-80%). However, sexual harassment still occurs in work and school environments (reported by 29% of women).

More than any other factor, women struggle with balancing work and family obligations, especially maternity leave and child-care. More women than men choose to change or limit their work schedule, become a stay at home parent, and report that their career progression has slowed.

How can we help women succeed?

- Based on reports from women, we should focus on:
 - Maternity leave and child-care support
 - Good mentor relationships
 - Support from colleagues
 - Collaboration opportunities
 - Address gender bias issues

Based on our data and reports from women, supporting maternity leave and child-care seems to be the most important factor in women's careers. At doctoral programs, the most important factor seems to be fostering supportive and positive mentor relationships. Encouraging support from colleagues and research collaborations would also help women succeed. Not all women report issues with gender bias or harassment, but some women are still encountering it in the workplace or at school.

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**Thanks to our colleagues
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For more information

Anne Marie Porter
Survey Scientist
American Institute of Physics
301-209-3039
amporter@aip.org

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Thank to you to all my colleagues who helped collect and report this data! If you have any questions about our work or results, feel free to contact me at 301-209-3039 or amporter@aip.org.