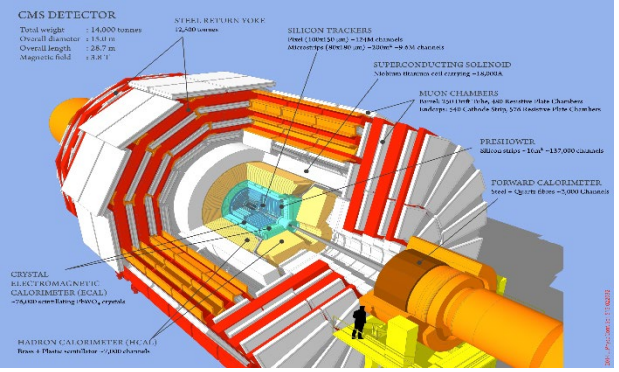
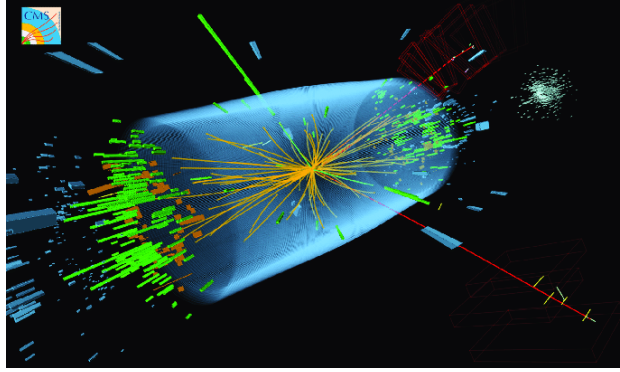


FIRE: THE FIRST-YEAR
INNOVATION & RESEARCH EXPERIENCE

SIMULATING PARTICLE DETECTION



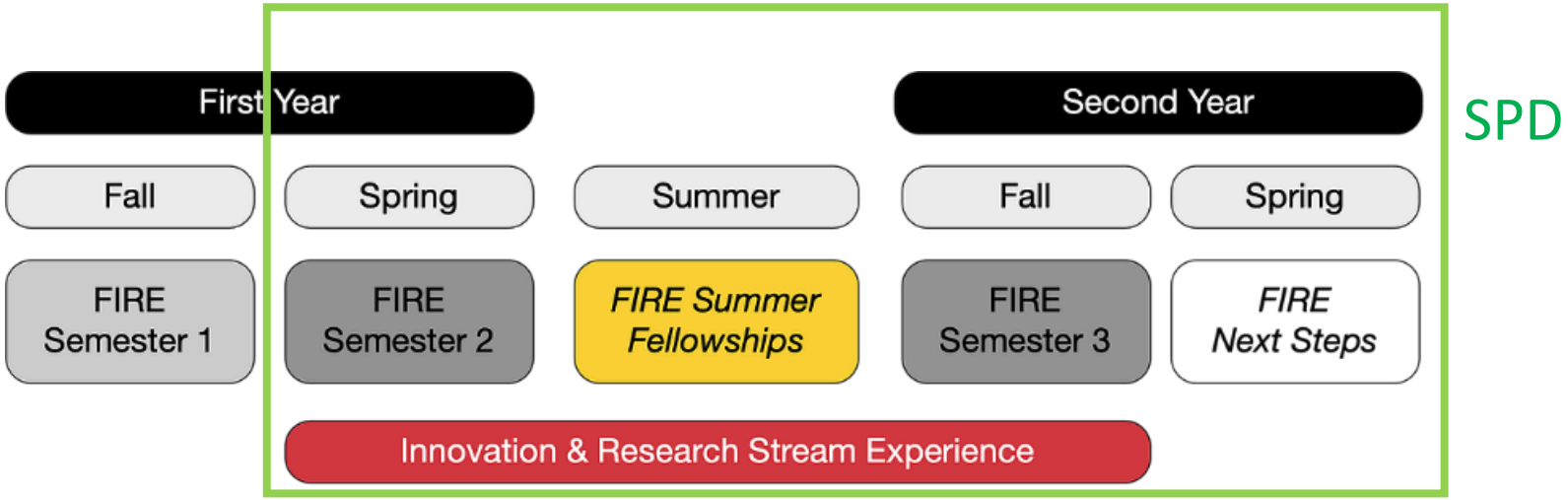
Particle Physics Course-based Research Experience During Remote-Learning

Müge Karagöz, UMD, College Park, MD

APS DPF 2021 Virtual Meeting, 7/13/2021

Where I teach?

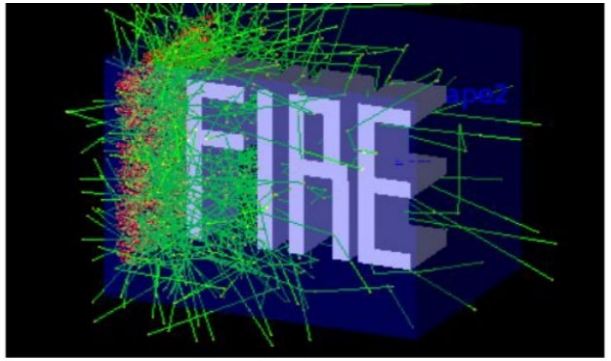
- FIRE Simulating Particle Detection (SPD): A curriculum-based research course ("stream") at UMD as part of the First-Year Innovation & Research Experience program. FIRE is a 3-semester gen-ed program with ~ 500 undergraduates and ~15 FIRE streams of diverse disciplines.
- Each stream is a research group of one faculty leader, 1-2 faculty advisors, ~ 30 students, and up to 15 Peer Research Mentors. PRMs are FIRE graduates that stay in the stream to help the research agenda and the course. FIRE students practice research for about 5-6 hours/week and attend a 1 hr lecture.



The 3-semester FIRE gen-ed Program (©FIRE)

What I teach?

- Introduction to experimental HEP, concentrating on computing and data analysis: “a dry lab”.
- SPD primarily aims to research CMS HGCAL upgrade detectors, and cover:
  - Understanding basic concepts of particle physics
  - Investigating particle detectors by analyzing simulation data, and doing performance studies
- HEP practice and philosophy is great for teaching in the classroom:
  - It gives the undergraduates:
    - “Big Data” computing, analysis & visualization experience
    - Cutting-edge technology appreciation
  - It also gives career and transferrable skills (individual and collaborative)
    - Collaboration as teams and as the whole community (peer-reviewing, resource-sharing, community-building)
    - Effective dissemination of findings via in-person and digital methods
    - Critical-thinking, risk-learning and taking action in performing research as an iterative process
    - Value of empowerment, leadership and mentoring while learning independence
- The SPD UMD faculty advisors are Sarah Eno and Alberto Belloni. I am reasonably autonomous in running my stream’s research and curriculum.
- I find it powerful, fun, and relatively easy, to add active-learning components in my classes (HEP tradition and philosophy helps!).



A fun GEANT simulation by SPD 2019 Summer fellows (J. Li)

How I teach?

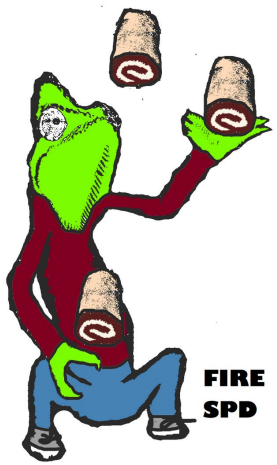
Course sequence:

- **SPD semester 1:** Basic skills and a knowledge base building. Teams (of 3-4) start working on topics for “ownership of research” for SPD semester 2. Choice of topics is encouraged, promoting curiosity-driven research.
- **SPD summer:** Exploring exciting, new topics (e.g. ML applications, fun outreach projects), assisting fall preparations.
- **SPD semester 2:** Growing from trainees’ to practitioners. Mimic a HEP conference process: Presentation abstract, peer-reviewing of drafts, practice talks, “Proceedings”… : full research experience.
- **SPD+:** Working as PRMs or with other UMD faculty. Higher access to communication with and visibility within the CMS collaboration. Wonderful opportunity for undergrads to get into our wonderful HEP community!
- Each year, students produce 7-8 presentations for the FIRE Fall events.

Research and Training Tools Used:

- Basic C++, Python, Linux, LaTeX
- ROOT, GEANT, DataCamp, CERN Open data, Jupyter books (Binder), CMS software framework, Google workspace apps, GitHub, linux clusters, Trello
- HEP specific literature sites (PDG, Arxiv, Inspire), and HEP lab resources
- How-to videos (by me, students, and PRMs): was crucial for remote-learning!
- Communication (slack, zoom): also crucial for remote-learning!
- E-portfolios and networking (LinkedIn, Portfolium) (FIRE-wide)

Program community and its diversity



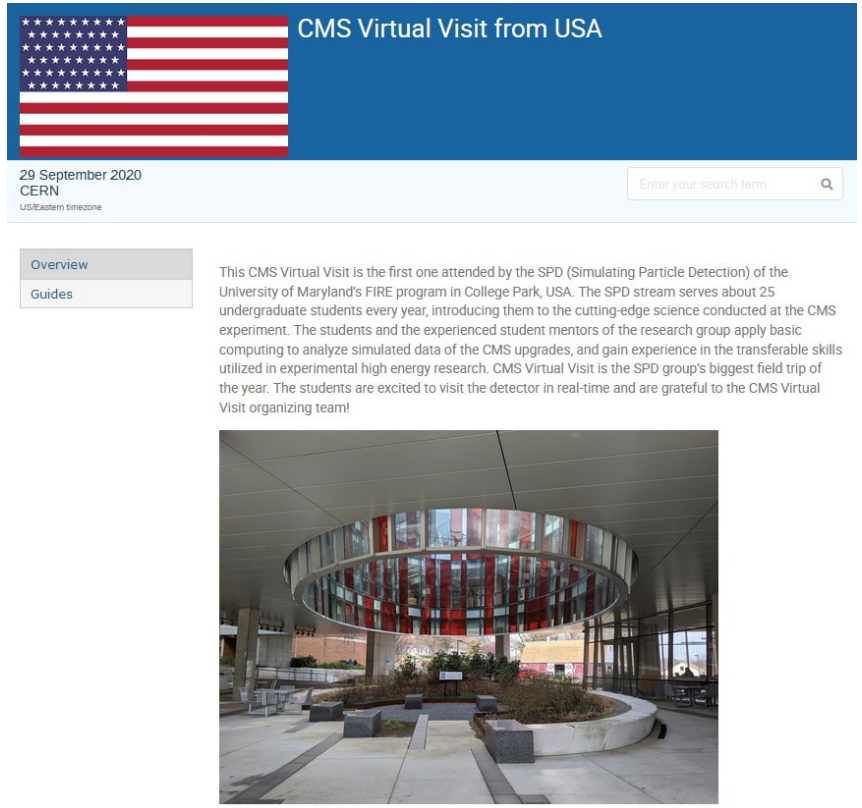
- An important part of SPD is its diversity:
  - UMD has a large international student body.
  - FIRE is a gen-ed program open to all 1st-years.
  - HEP is traditionally international and multi-disciplinary.
- Since 2019, SPD has attracted ~ 25- 30 students/year from various majors.
- About 20% is non-(physics & comp science).
- This diversity is also reflected in SPD PRM and SPD summer enrollment: Some of my Comp Sci students went on to become PRMs and started physics minors.
- The stream is a miniature model of large scale HEP experiments, therefore, SPD easily adapted HEP's concepts and values in fostering community.

CMS Experiment, CERN

SPD 2019 students, UMD

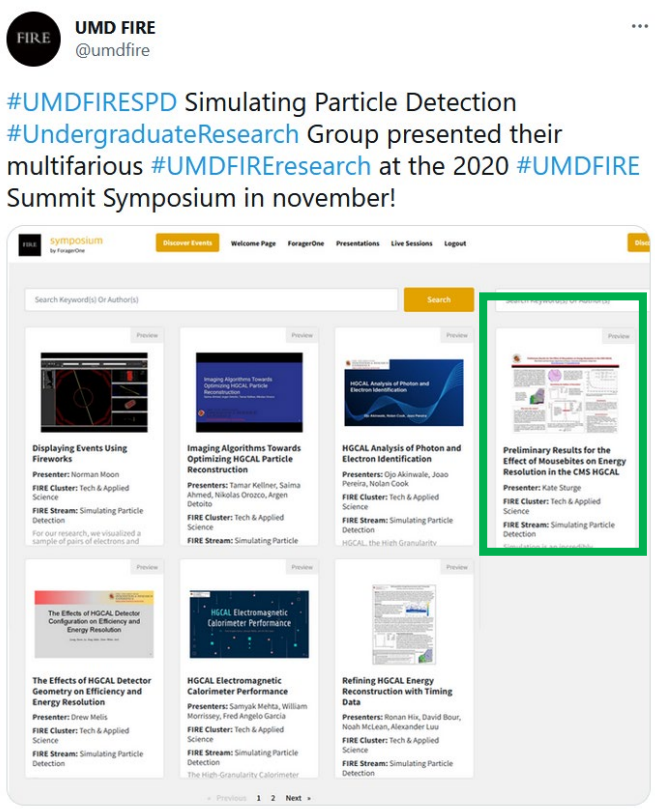
Academic activities during remote-learning

- Most in-person activities easily shifted online
  - **In-class presentations**: via zoom, or multi-media recordings
  - **Guest speakers:** via zoom, many international HEP community visits which are always a highlight for my students!
  - **Field trips:** was sad to drop these, but thanks to CMS outreach community, we had a field trip to CMS in fall (students still mention how “cool” this was!)
  - **In-class activities:** shifted to tools like google jamboard (slide 9)

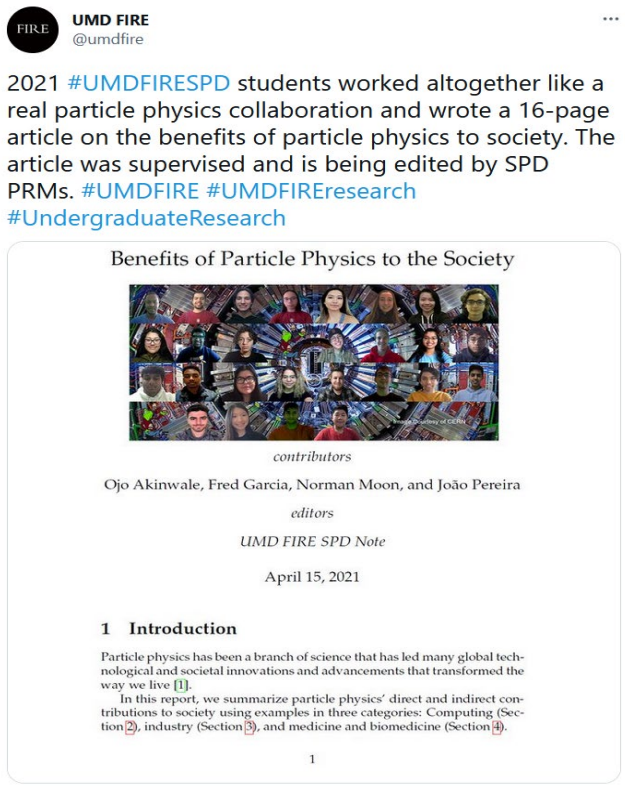


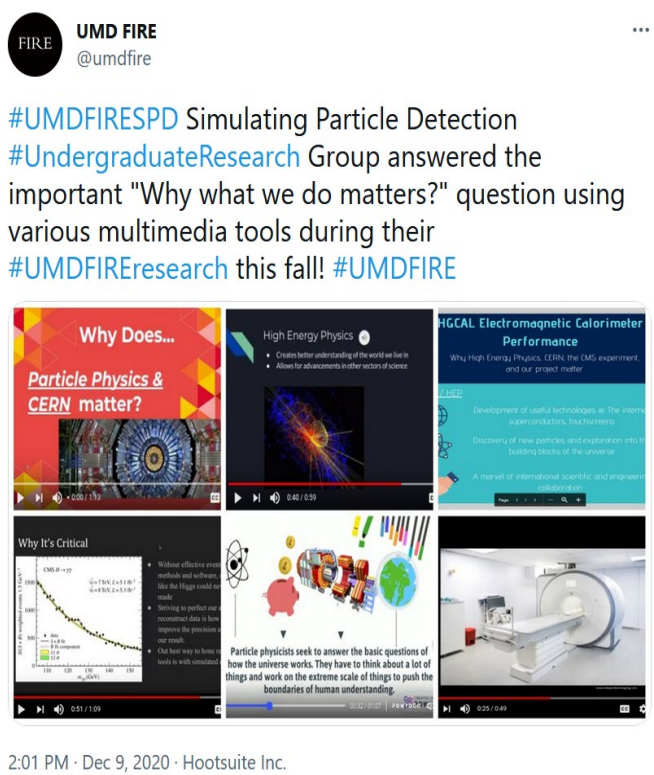
Research and outreach during remote-learning- I

- Students produced great research output and showcased using online collaborative tools, such as google slides and overleaf. They also used Trello for project management (for summer)!
- SPD always includes “why HEP matters?” in its curriculum. Students also used multi-media tools to explore these.



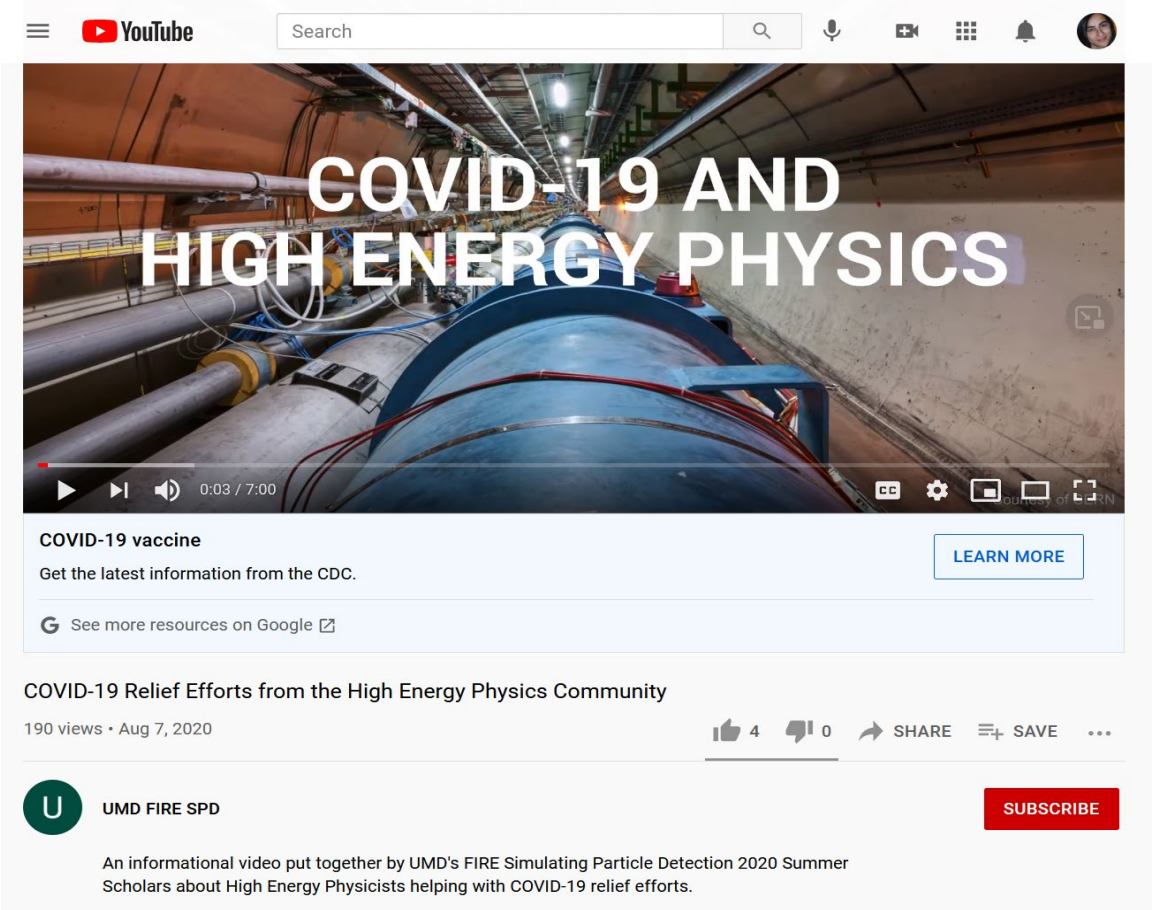
Also presented at the virtual AAPT SM2020





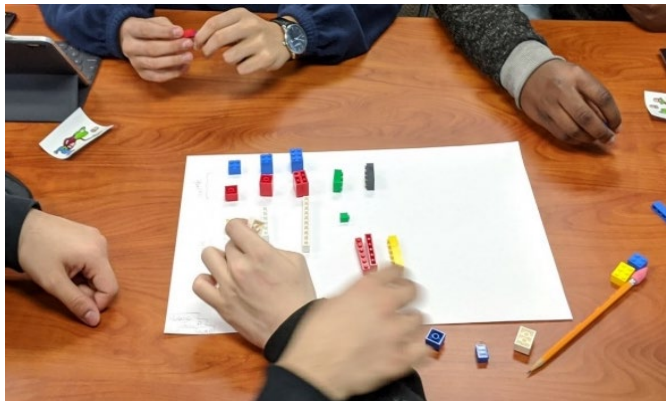
Research and outreach during remote-learning - II

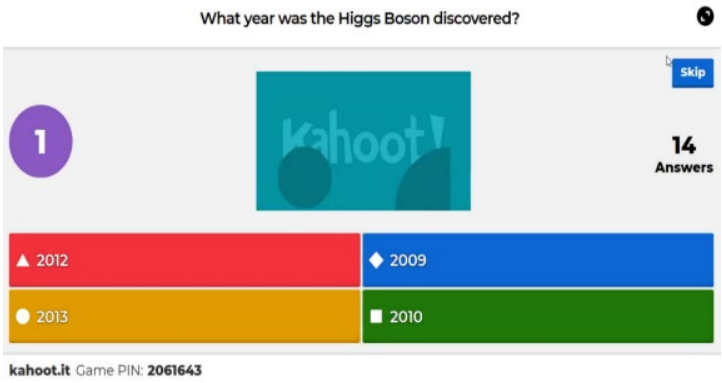
- Students produced great research and output and showcased using online collaborative tools, such as google slides and overleaf. They also used trello for project management (for summer)!
- SD always includes “why HEP matters?” in its curriculum. So, students also used multi-media tools to explore these.



Examples for Interactive tools used during R-L

- What pedagogical purposes can interactive tools be used for?
  - Community-building, fun ice-breaking
  - Educational & Research activities
- Being a curriculum-based research course, and a computational technology stream that concentrates on collaborative and research tools, I've already utilized many online tools in-person.
- During the pandemic, I started exploring more tools and used tools like Google Jamboard or menti (it is an ocean of collaborative tools out there!)

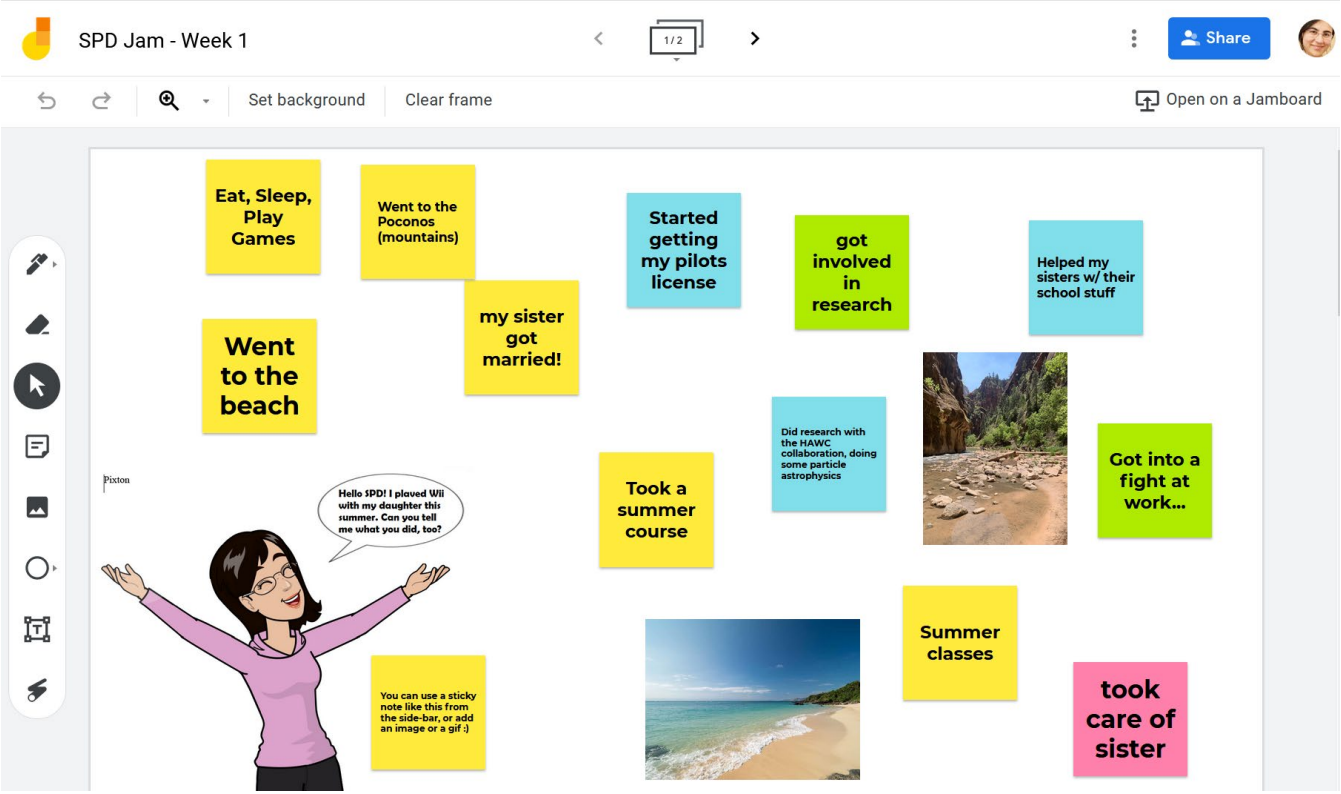




Pre-pandemic activities: Left: I ported to jamboard, right was already online tool. Such educational activities also foster community building

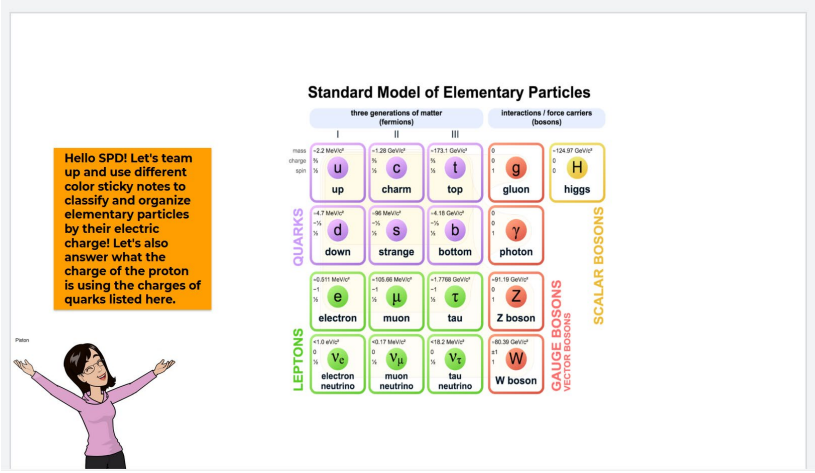
Example 1: Community Building/Ice-breaking

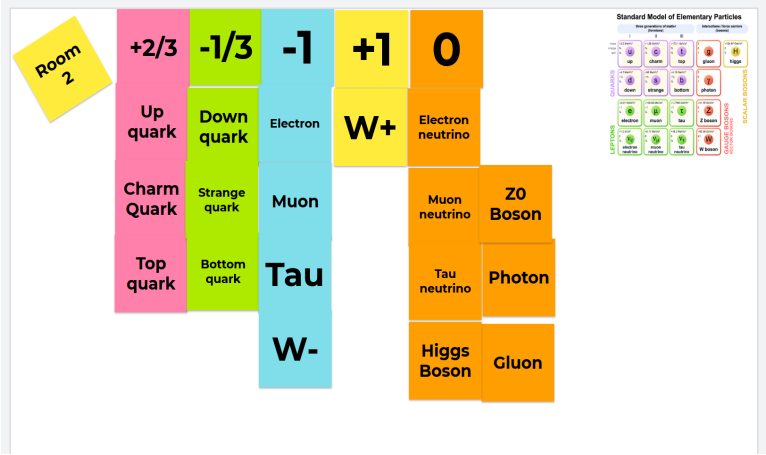
- Jamboard is an online interactive whiteboard tool for collaboration across multiple devices. UMD gives students full access to Google tools/apps.
- Depending on the week's load, in my online classes, I start my zoom session with a fun question for students. As students come in, they "join the conversation". For simple use like this, this works seamlessly.



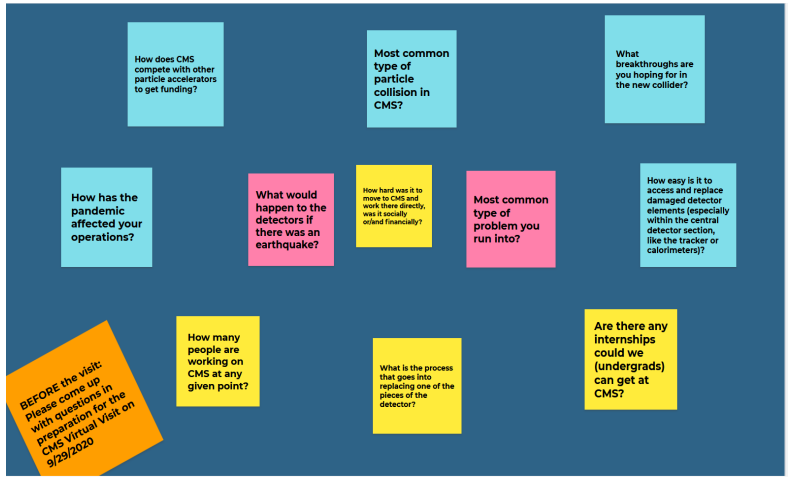
Example 2: Education

- I use jamboards for zoom breakout room sessions for active group learning for my physics topics.
- Sometimes I simply use one jamboard frame for a whole class research activity. Depending on the exercise, each group can get their own “jamboard frame” and we may discuss outcome as the whole class once rooms are closed.
- Jamboards are great for flipped-learning. Students can also learn the material and do the exercise before class, ready for discussion.





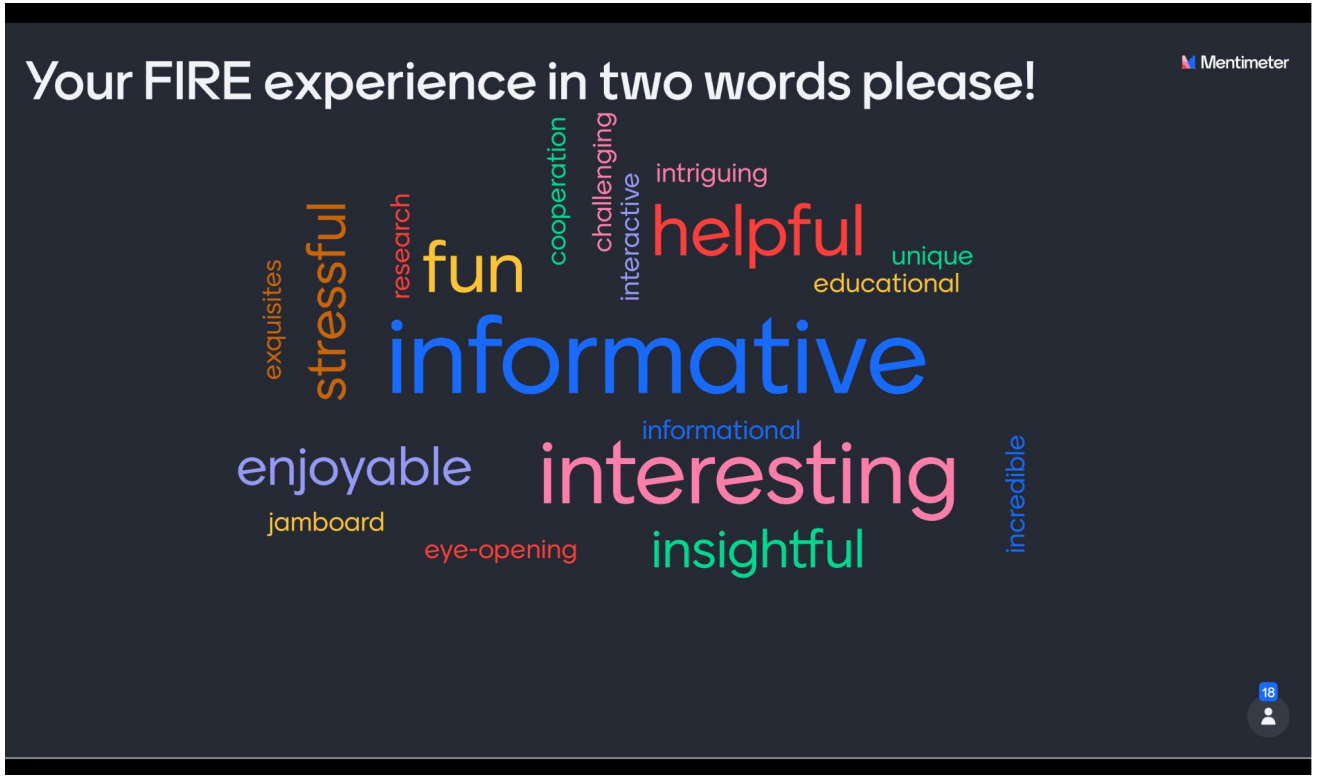
A “prompt” frame and a group frame for in-class active learning exercise



Pre-class exercise for flipped-learning

Example: Feedback word-cloud using mentimeter

- Mentimeter lets you create, store and share interactive presentations for polls, quizzes, etc.
- Very easy to run in-class and fun (much better than poll-everywhere)
- So far, I have only used menti for my end-of-course feedbacks. Anonymity gives students a chance to be open and sincere!



Conclusions

- It is wonderful to be teaching HEP research to undergraduates who are so eager to learn!
- Teaching a HEP research course where collaboration is the name of the game, I find it powerful to add active-learning components and collaborative tools in my classes, for both research and education.
- Thanks to today's internet technology, shift to remote-learning was made possible, and we, the instructors, had the freedom and possibility to use online tools for various purposes.
- I will continue exploring tools and methods in active physics teaching/research courses.
- I will continue using some of the online tools mentioned when back in-person, but not as extensively: We as HEP folk are undoubtedly the masters of remote-collaboration, but for teaching nothing really replaces face-to-face student-teacher interaction!

Any questions/comments?

- Please feel free to email *mkaragoz@umd.edu* . *Also feel free to check out my personal UMD page*.
- Thank you!

Acknowledgements: UMD FIRE, UMD Physics, Prof. Eno, Prof. Belloni and the whole UMD CMS and T3 group, USCMS, and the CMS Collaboration. And my amazing undergraduates!

(This talk used some material from my previous AAPT SM2020 poster and my CSAAPT Spring 2021 talk).