# In-class Active Learning Examples

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**CSAAPT Fall Meeting, 10/22/2022**

# Outline

- Who am I?
- What I recently taught?
- In-class active learning examples
- Conclusions

**Disclaimer:**
I am not claiming material covered here is groundbreaking or completely original.
I won't cover implementations elsewhere. I will exemplify my experiences.
I hope to brainstorm on ideas through this sharing opportunity.

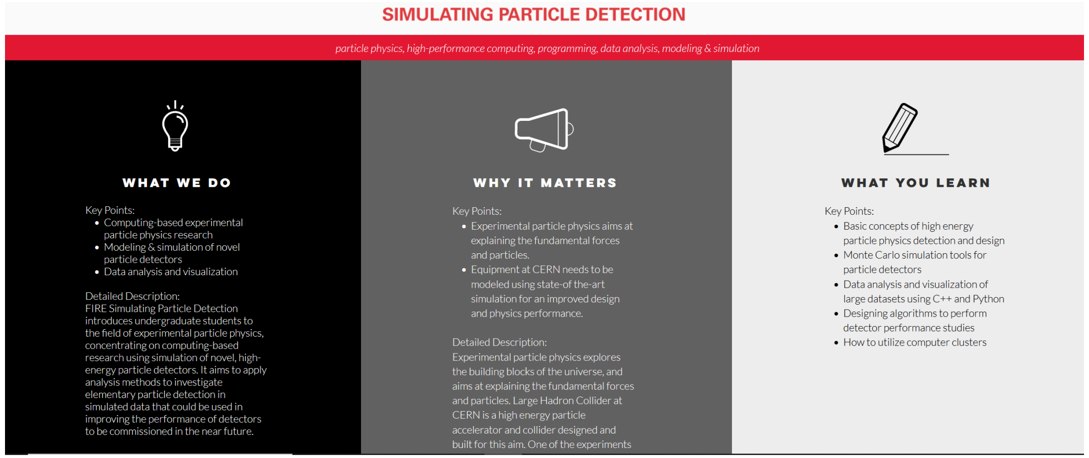
# Who am I?

- A particle physicist, an educator, and a mother
- Ph.D., Physics & Astronomy, Northwestern University
- M.Sc. & B.S., Physics, Boğaziçi University, Turkey
- Worked at multi-national labs (Fermilab/USA,  CERN/CH)
- Taught at Oxford/UK, Chaminade/USA, UMD/USA
- Volunteered & worked at K-12 schools, as well as labs like LIGO/USA
- Why telling you all this? Exposure to diverse research and education communities adds immensely to one's idea bucket!


Image courtesy  LIGO


http://physics.rockefeller.edu/luc/images/CDF30May2002.jpg

# What I recently taught?



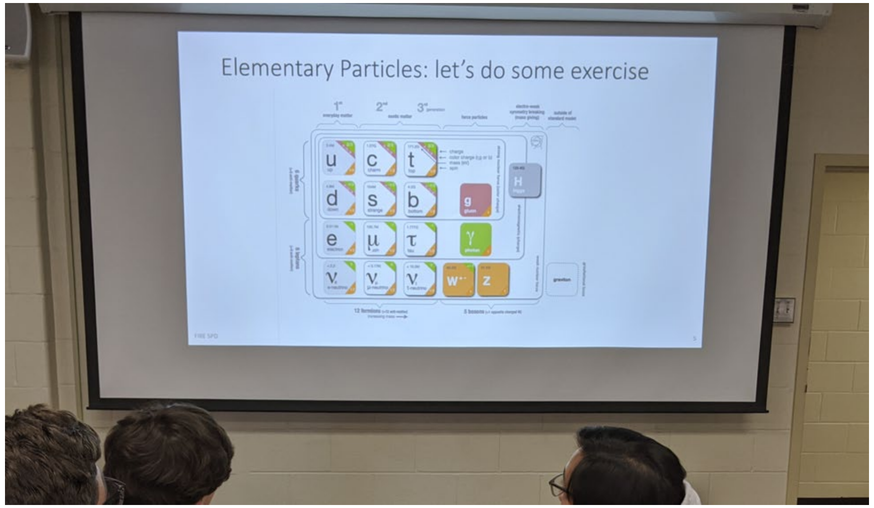

- UMD FIRE SPD (“Simulating Particle Detection”): A 2-sem gen-ed research course. 1 hr lecture and ~4 hrs/week lab time. Summer research.
- A Faculty Leader, ~ 30 students, ~4 Peer Research Mentors a year. Diverse group from different majors.
- Aimed to instill appreciation of curiosity-based basic sciences & introduction to high energy physics (HEP) research.
- Computing & data analysis (visualization, ML, detector simulation, …). Authentic research!
- Was reasonably autonomous in research and curriculum. Followed experimental HEP philosophy: collaboration & community, leadership, peer-reviewing, resource-sharing, mentoring, hands-on learning.
- Found it useful to add a variety of in-class learning components.

# A course that facilitated active learning

- **Accessible:** A 9-5 lab helped for mentored hands-on learning
- **Active:** Projects could be done actively in the classroom (peer-reviewing, presentation, research, …) (CSAAPT, S2022)
- **Collaborative:** Many online tools in-person or remotely (Google Suite incl. jamboard, GitHub, Overleaf, trello, menti, …) (CSAAPT, S2021)
- **Experiential:** Including (self-)reflections, idea testing, iterations, revisions, …, in assignments and activities
- **Flipped:** Supporting in-class activities by pre-class assignments (e.g, simulations). A useful necessity!
- **Competitive:** Combination of group and individual activities, where some included competitiveness (e.g., Kahoot!)
- And other elements…

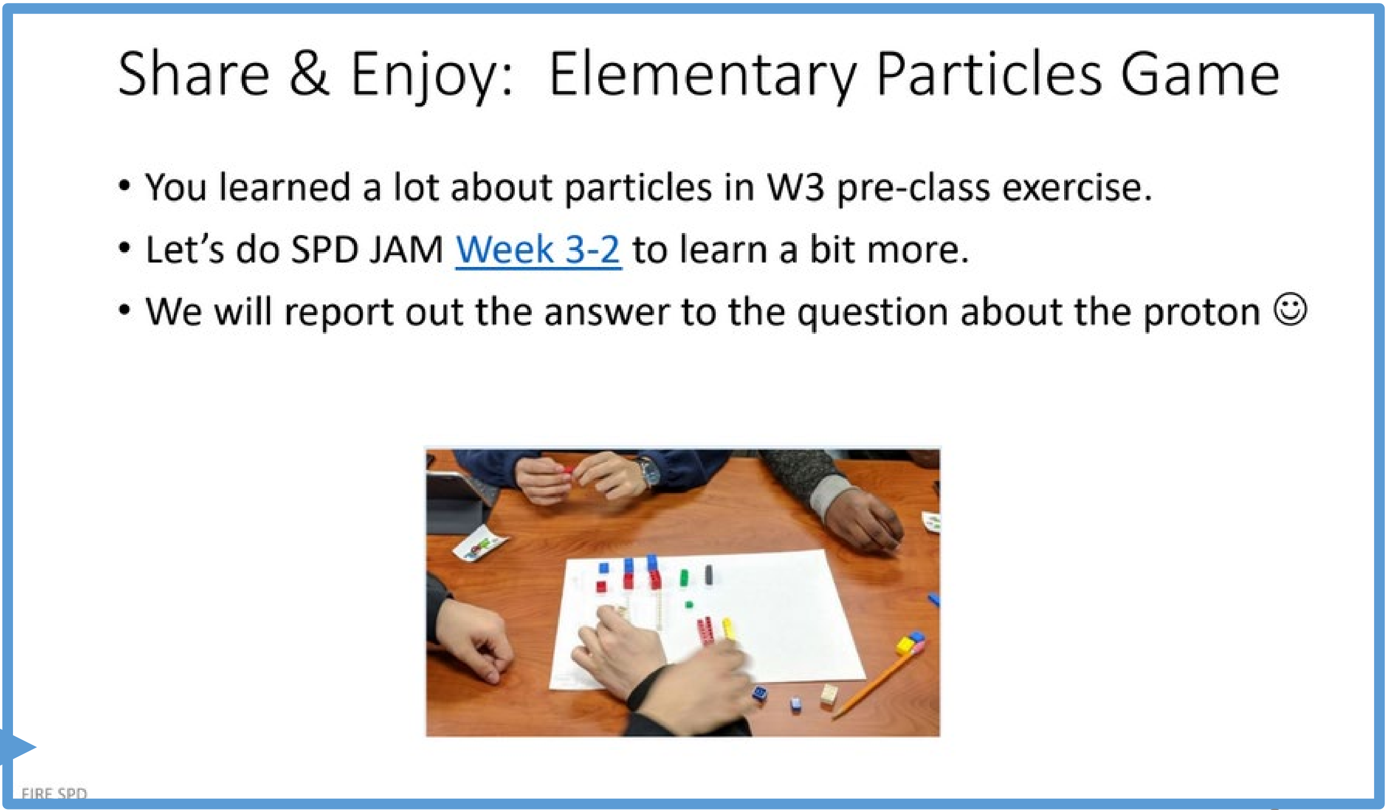

2021 End of year origami party - proposed by my students

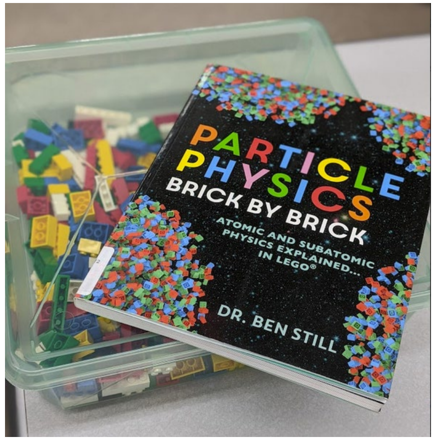
# A visual thinking, object-based learning activity for classifying particles




- The students were given Lego® pieces as learning objects to classify elementary particles in a group work
- Highlights visual thinking, creativity and imagination. Facilitates ease of applying critically thinking and learning for students.

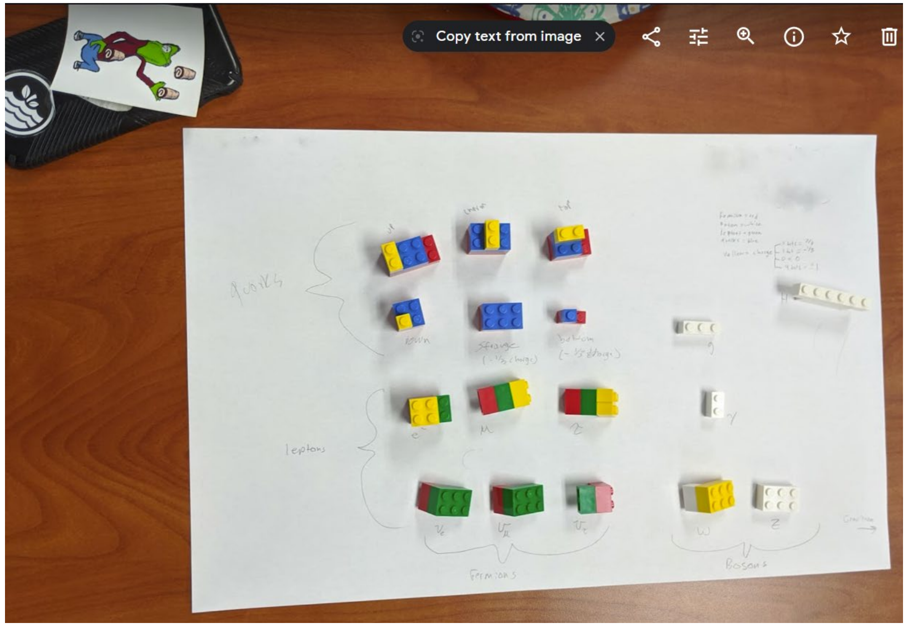
Slide used in class

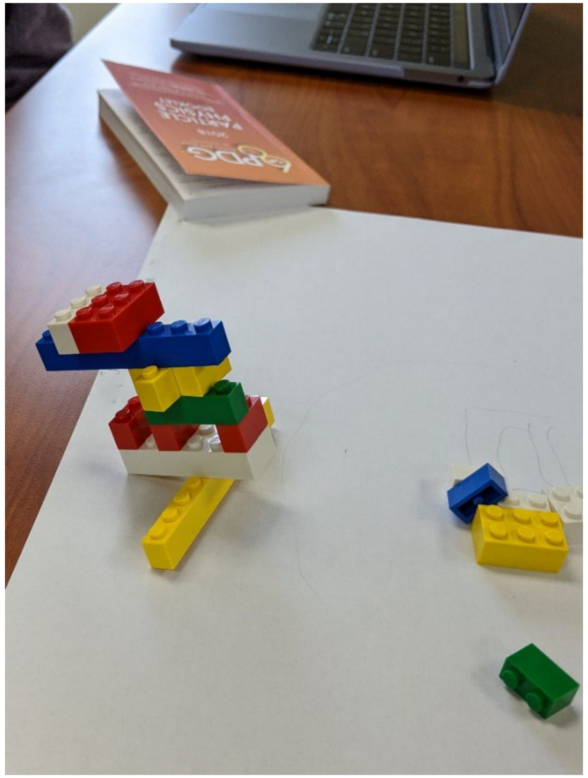





# Games using objects foster learning in a fun way

The variety in approaches students show in representing the same (boring! ) SM periodic table were amazing!



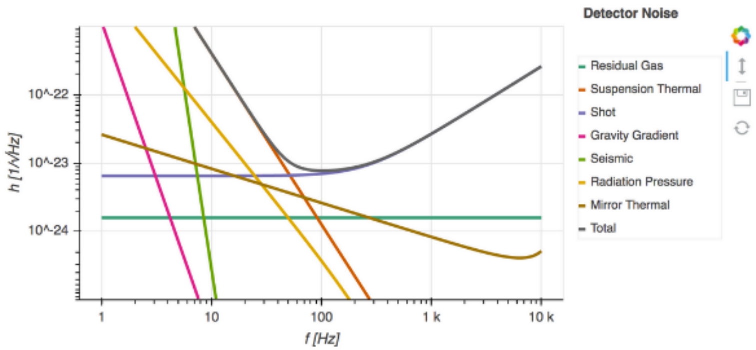



# Active learning through games

- LIGO Design Challenge using [Space-time quest](#) app by LaserLabs: learning how to optimize detector design individually and as teams
- I think computer games are a great way for experiential learning and critical thinking!


## Share & Enjoy: LIGO detector design

- Let's team up to see how well we can do in the [LIGO detector design game](#) on this SPD Jam: [SPD Jam – Week 4 - LIGO](#)
  - What has your team decided as the most important aspect in detector design for the best scientific output?
  - What is your team's score (if you'd like to share)?




FIRE SPD

# Flipped learning complements in-class activities

LIGO challenge activity was given as a pre-class Canvas assignment ("thinking and setup")

This is a graded discussion: 1 point possible

due Feb 15 at 2pm

ASN13 W4: Pre-class exercise

Muge Karagoz

Feb 10 at 10:41am

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## ASN13 W4: Optimizing Detector Design

Like any big enterprise, big experimental apparatus take a long time to design. Every experiment has to consider and juggle a few factors during their design process: how to optimize the experiment's scientific **output** (like discovering extra dimensions) in the shortest **time** scale possible, and usually, within a limited **budget** (manpower, maintenance and construction costs included).

Btw, does the above statement remind you of the "**unattainable triangle**" in industry? Indeed, you will soon realize that physics experiments represent any big enterprise, in their entirety. In fact, large particle physics experiments have been in the forefront of project management, not just in the forefront of hardware and computing.

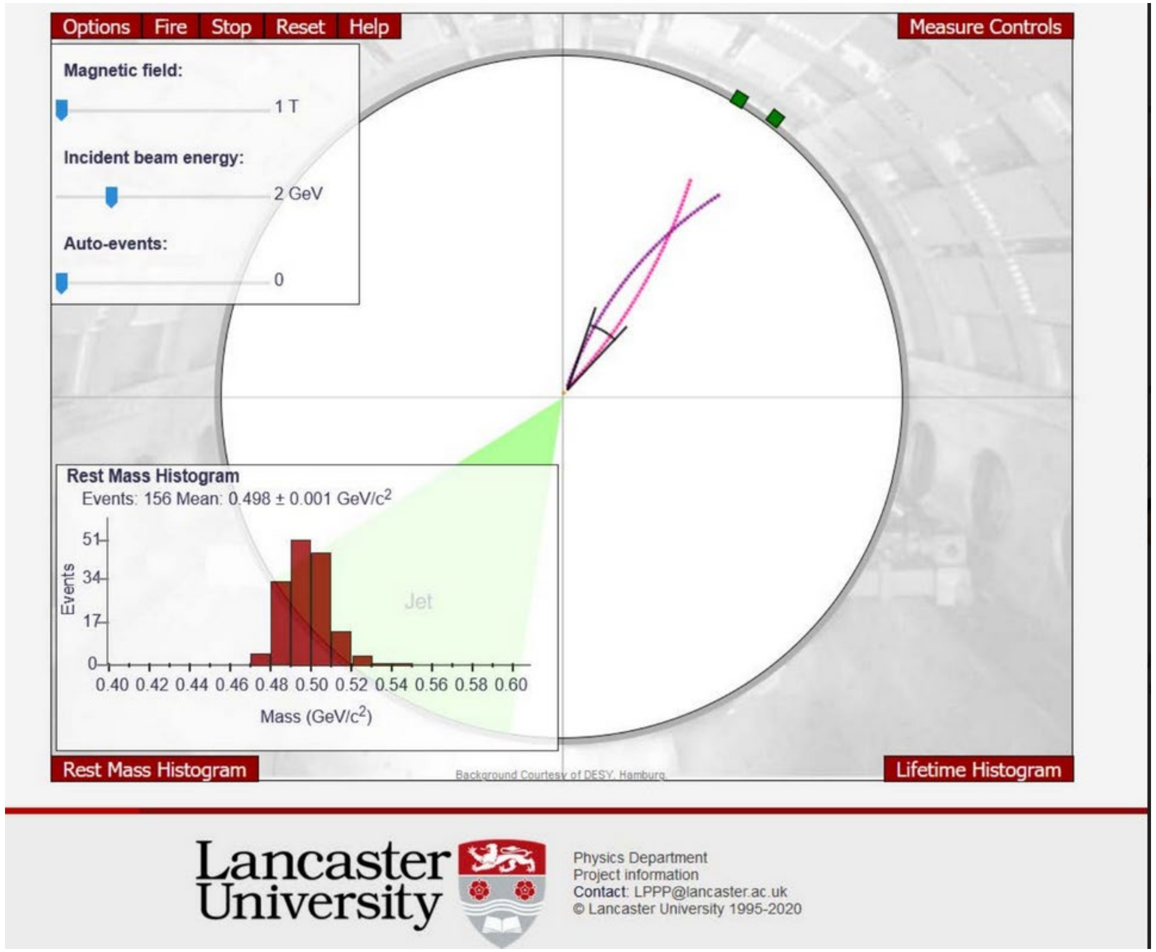
In this exercise, we will setup a game in order to play and discuss during the class! Last year, one desk managed to achieve 285.6 Mpc in class. Let's see what we get this year!

1. Please go to https://www.laserlabs.org/spacetimequest.php, and read the instructions and background information on what the game is aiming to teach. The game is written for the LIGO experiment, whose scientific quest is different than that of CMS's, but it is a big, delicate physics detector, so the main idea of detector design definitely applies.
2. Please feel free to download the game on your phones or laptops (https://laserlabs.itch.io/spacetimequest or https://github.com/gwoptics/SpacePyQuest). The desktop option uses Jupyter notebook. I suggest downloading the phone app, as it has better integration. However, if you choose to run the python version, you may get a chance to screen-share it with your teammates in class.

Please discuss below:

# Interactive Simulations as Hands-on learning

- Lancaster simulation package: successfully used for masterclasses across the UK.
- Allows students select parameters and do “real-time” measurements in a generic collider experiment.
- Digital active learning is possible to perform remotely as well. I used this package both in-person and in remote learning.

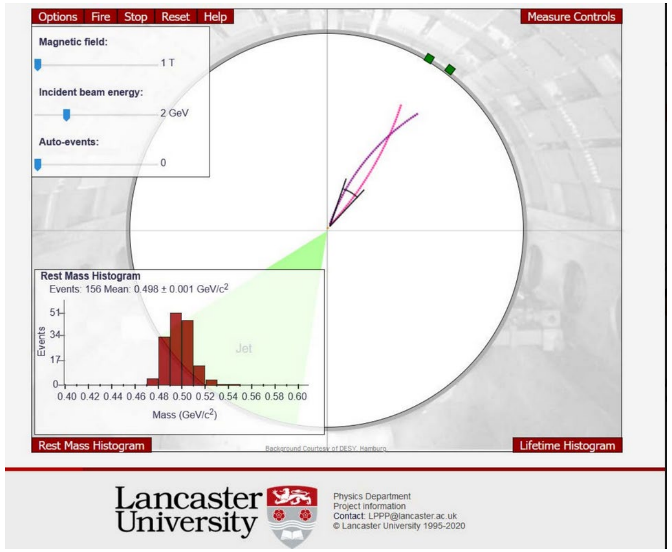


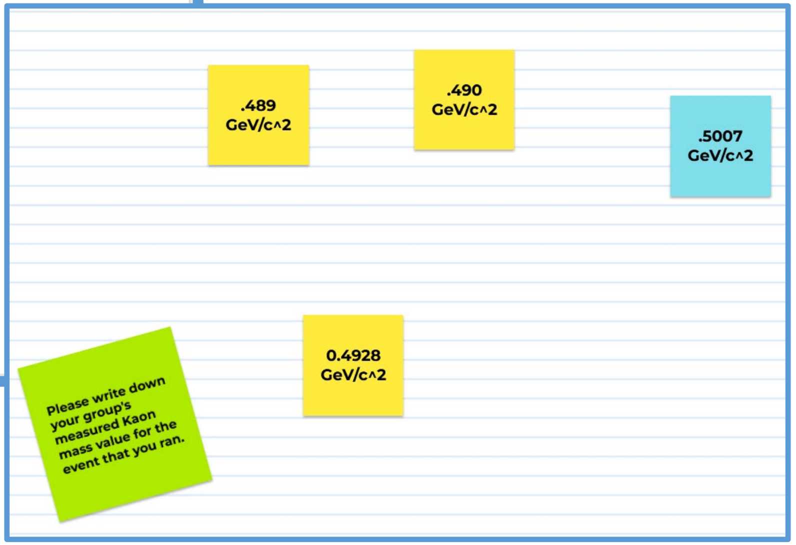
# A typical exercise with the Lancaster package

## Share & Enjoy: Lancaster Package

- Use kaon particle rest mass calculation as an example. What is a Kaon? Let's check PDG.
- Neutral kaon rest mass ($m_K$) = 0.498 GeV/$c^2$, lifetime= 0.9 $10^{-9}$ sec
- Let's set Energy = 2 GeV, magnetic field strength = 1 T, ant auto-events=150
- Let's fill up the jamboard with one rest mass point per team
- Report out and compare

FIRE SPD



# Conclusions

Implementation of active learning components in physics courses is not always easy, but not impossible.

Lucky to design a research course where I could apply multiple instructional and pedagogical approaches and add active-learning components.

Proud to have brought in what I learnt from 20+year of collaborative experiments.

My (qualitative) take-away is that active learning components are useful to students.

In teaching, it is easy to fall into pitfalls even with the best intentions. I constantly and actively aim to revise and self-steer as well (“experiential teaching” :) ).

# Questions/Comments?

- Happy to brainstorm on activities as well as discuss any details and reflections that were not possible to list here.
- Please feel free to email me at *mkaragoz@umd.edu*.
- Some information on my past research group may be found here.
- Thank you!

**Acknowledgements:** UMD FIRE, UMD Physics, UMD CMS group and the whole HEP community. My amazing past students!