

Research Updates:

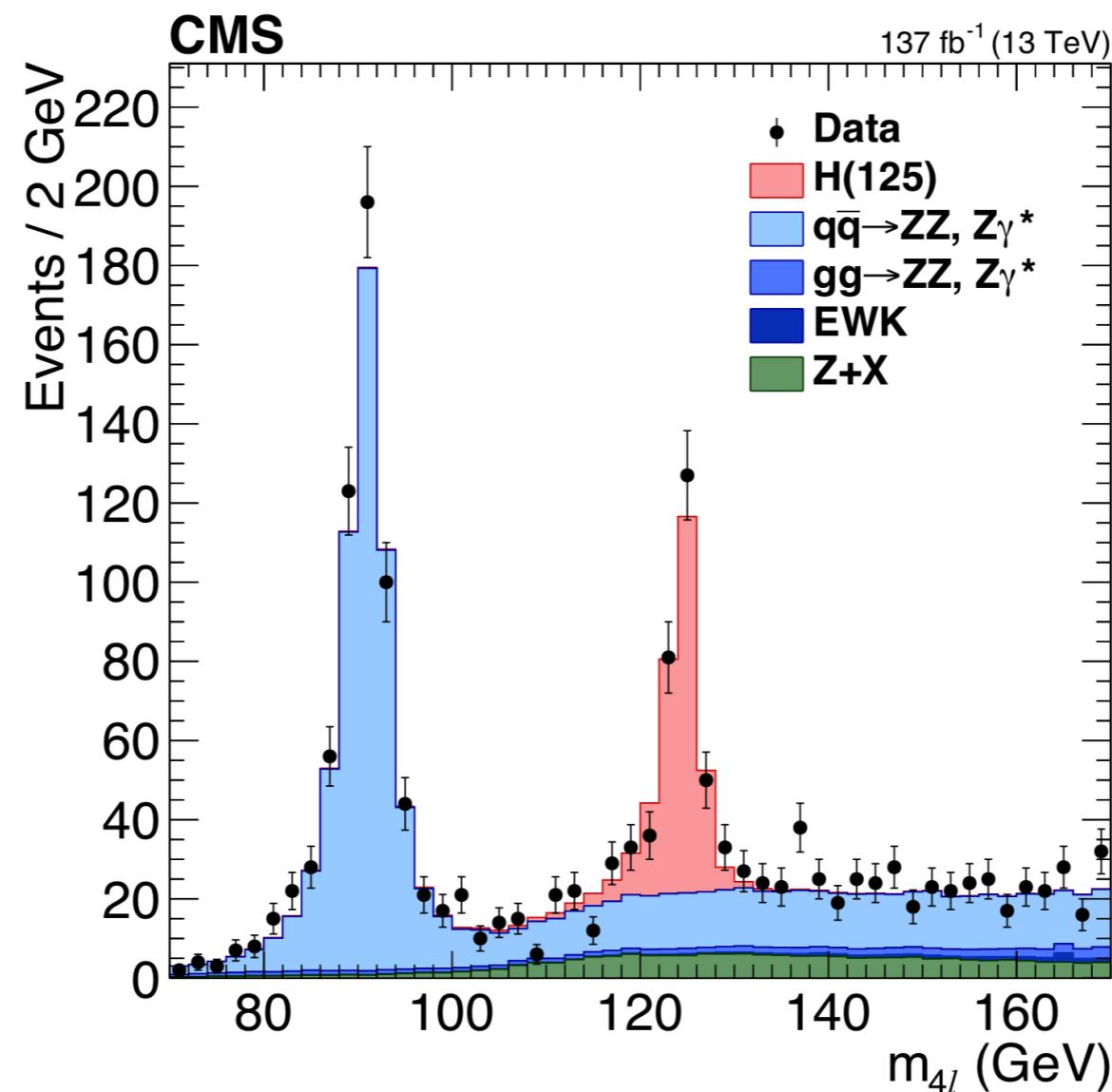
2021 Summer Schedule:			
Date	Day	Activity	Topic
2021-05-25	T	Intro	
2021-05-27	R	Physics Training (PT)	
2021-06-01	T	PT	
2021-06-03	R	Update	Mentors 1-3 Jake, Neha, John
2021-06-08	T	Update	Mentors 4-7 Evan, Suz, Osvaldo, Nik
2021-06-10	R	PT	
2021-06-15	T	PT	
2021-06-17	R	Update	Mentee Group 1 Sean, Pawan, Amilqar
2021-06-22	T	Update	Mentee Group 2 Alex, Brian, Haben, Thai
2021-06-24	R	PT	
2021-06-29	T	PT	
2021-07-01	R	Update	Mentee Group 1
2021-07-06	T	Update	Mentee Group 2
2021-07-08	R	PT	
2021-07-13	T	PT	
2021-07-15	R	Update	Mentee Group 1
2021-07-20	T	Update	Mentee Group 2
2021-07-22	R	PT	
2021-07-27	T	PT	
2021-07-29	R	Update	Mentee Group 1
2021-08-03	T	Update	Mentee Group 2
2021-08-05	R/F	Summer Symposium!	
2021-08-06			End of semester

- **Mentors:**
 - ▶ Showcase your research.

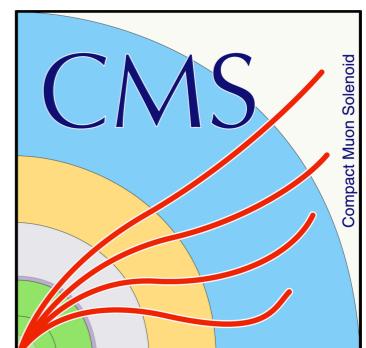
- **Mentees:**
 - ▶ Gives us research updates.
 - ▶ Tell us what you've learned.
 - ▶ Ask questions that you have.

The "Golden Channel"

Higgs Boson Mass Measurement



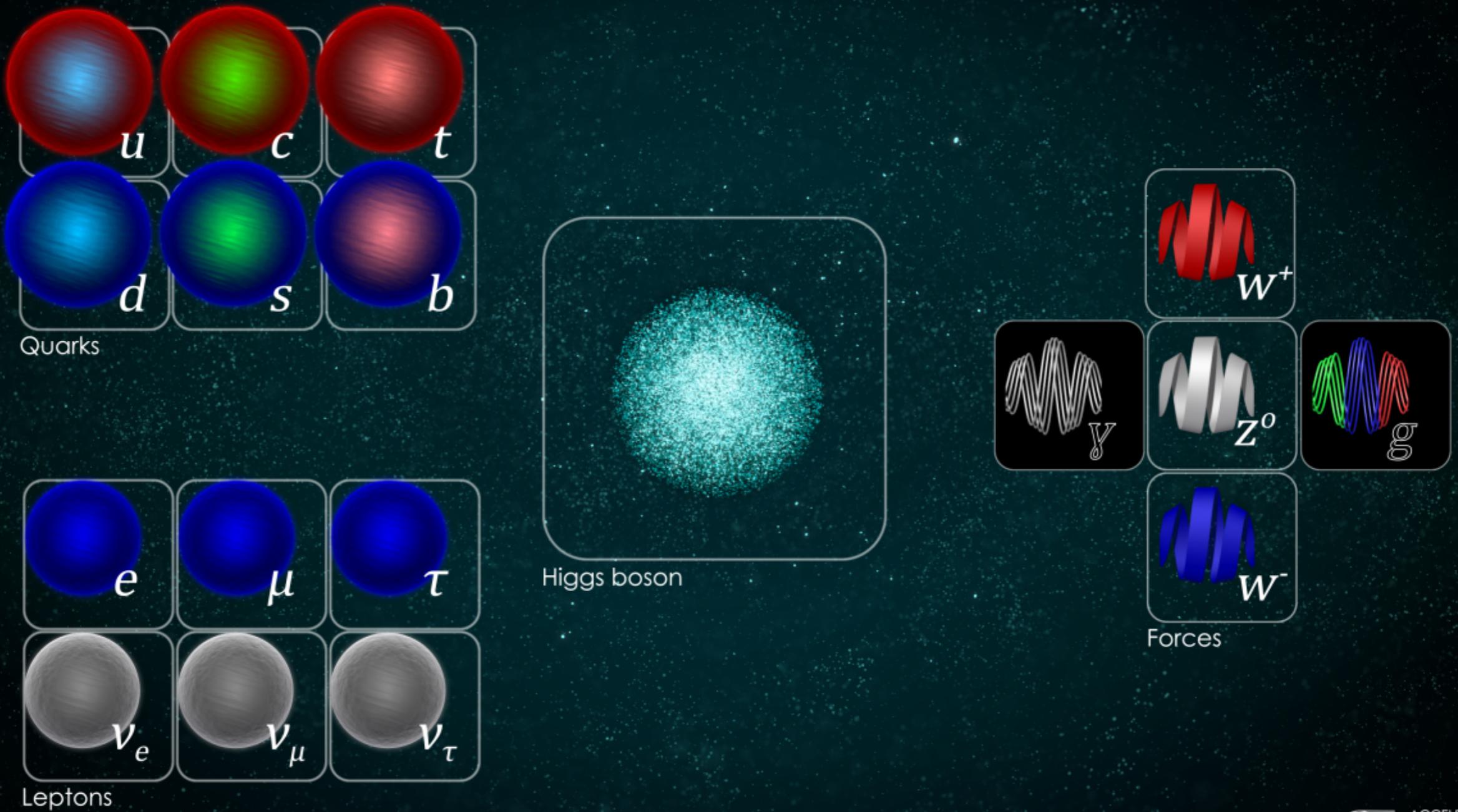
Jake Rosenzweig
2021-06-03



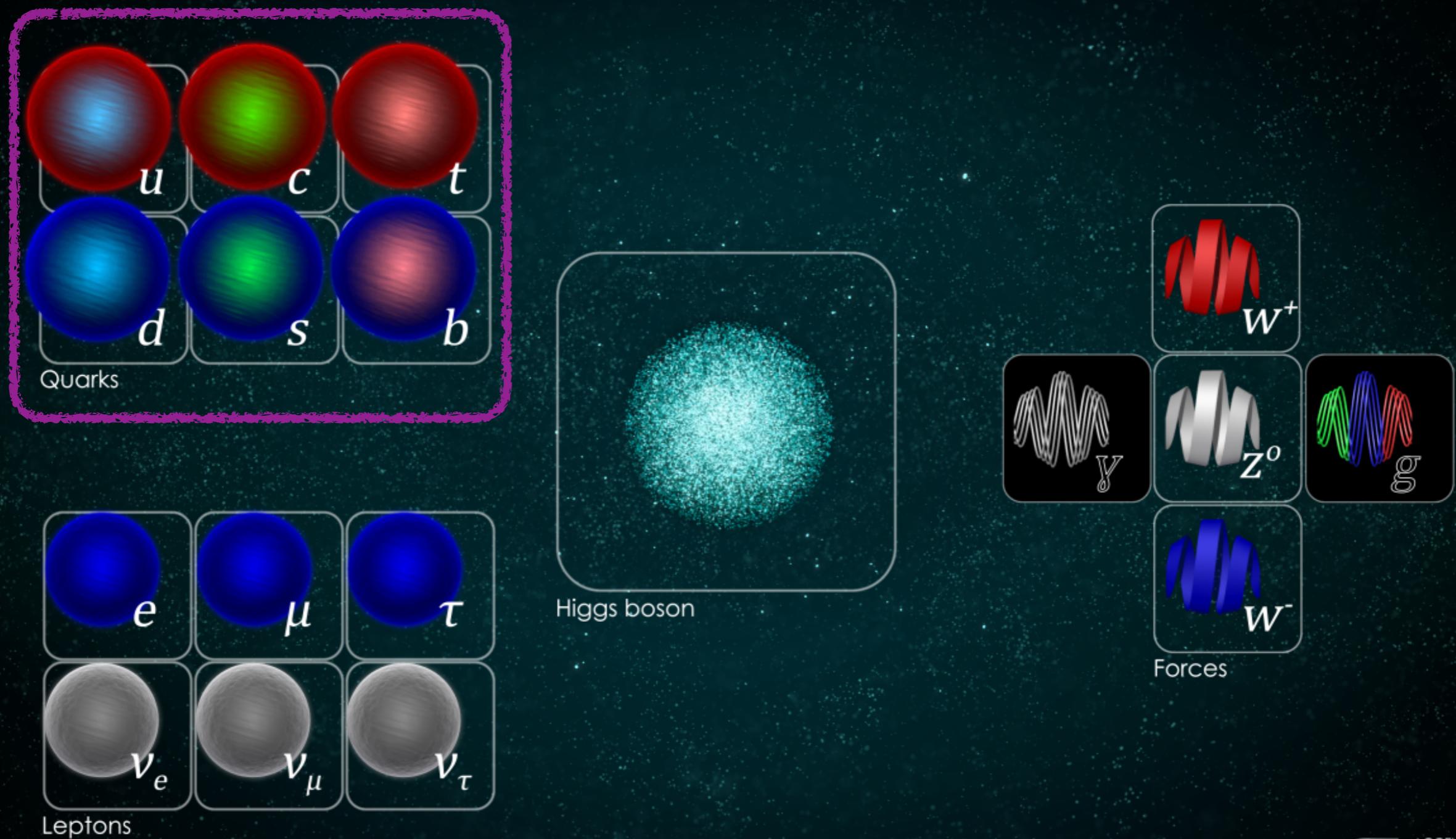
Outline:

- The FUNdamental Particles
- A "Bunch" of LHC Facts
- Higgs: OK to Decay
- Invariant "Math" Calculation
- The Golden Histogram

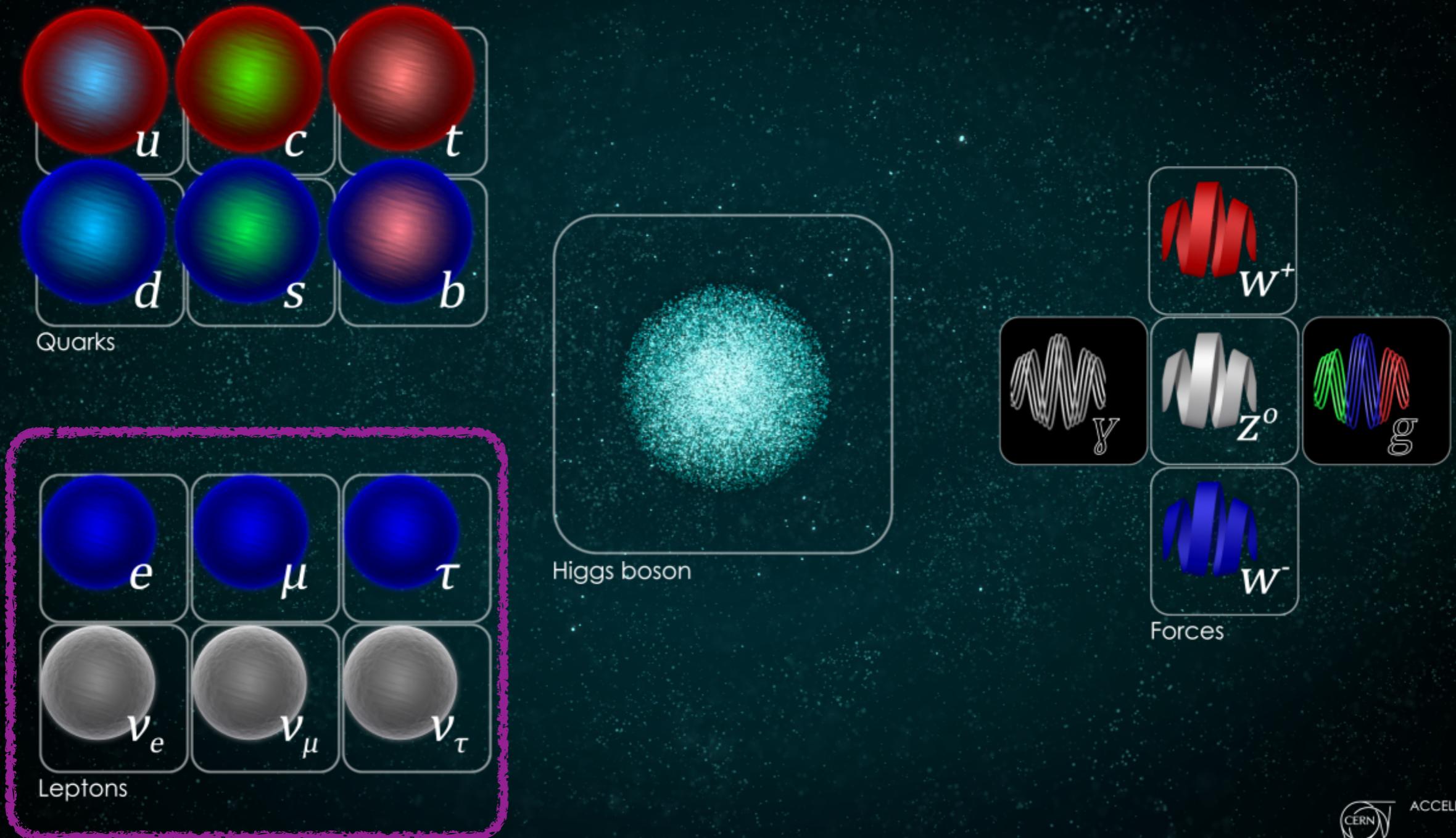
Meet Your Friendly Neighborhood Particles:



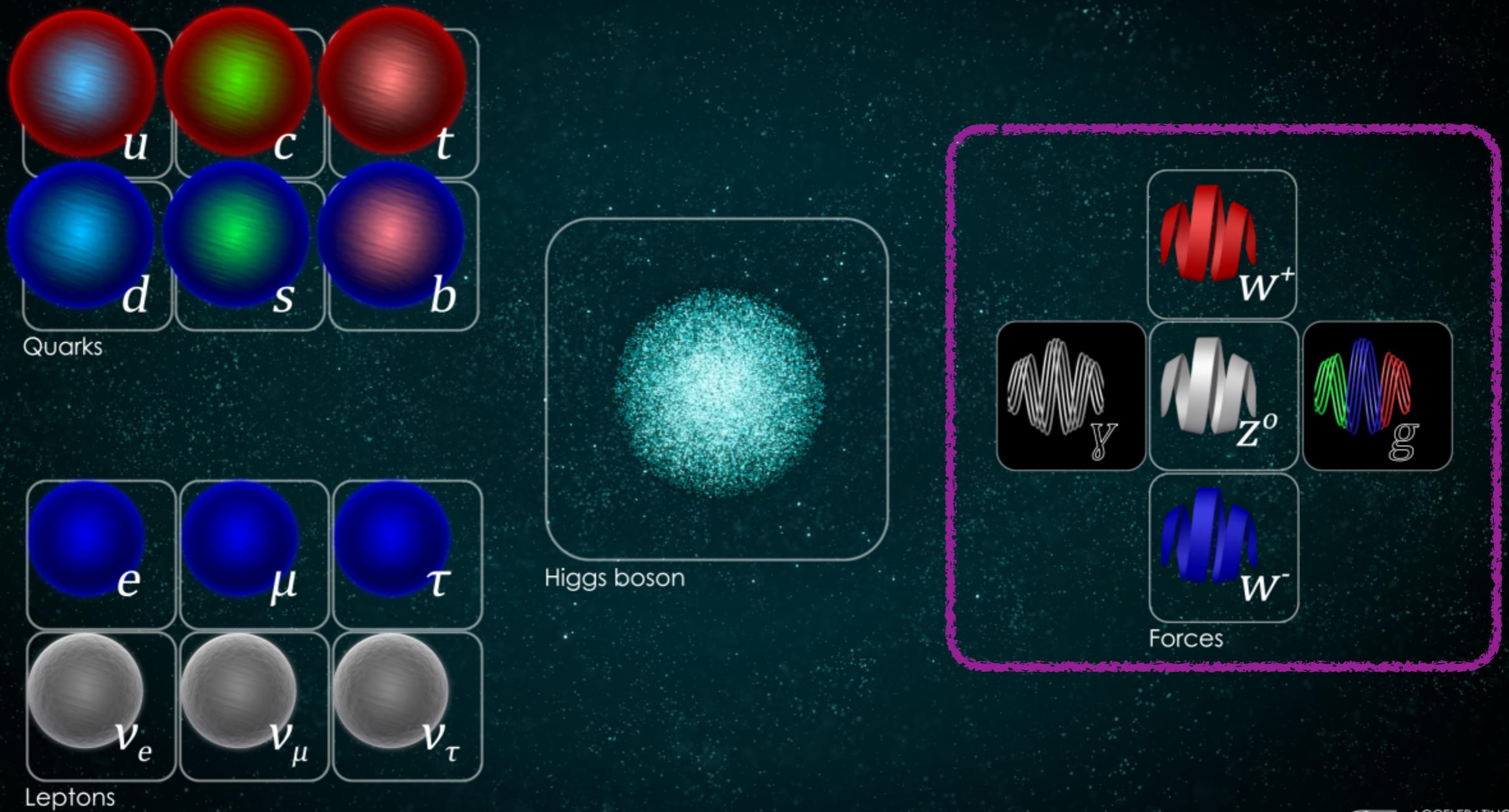
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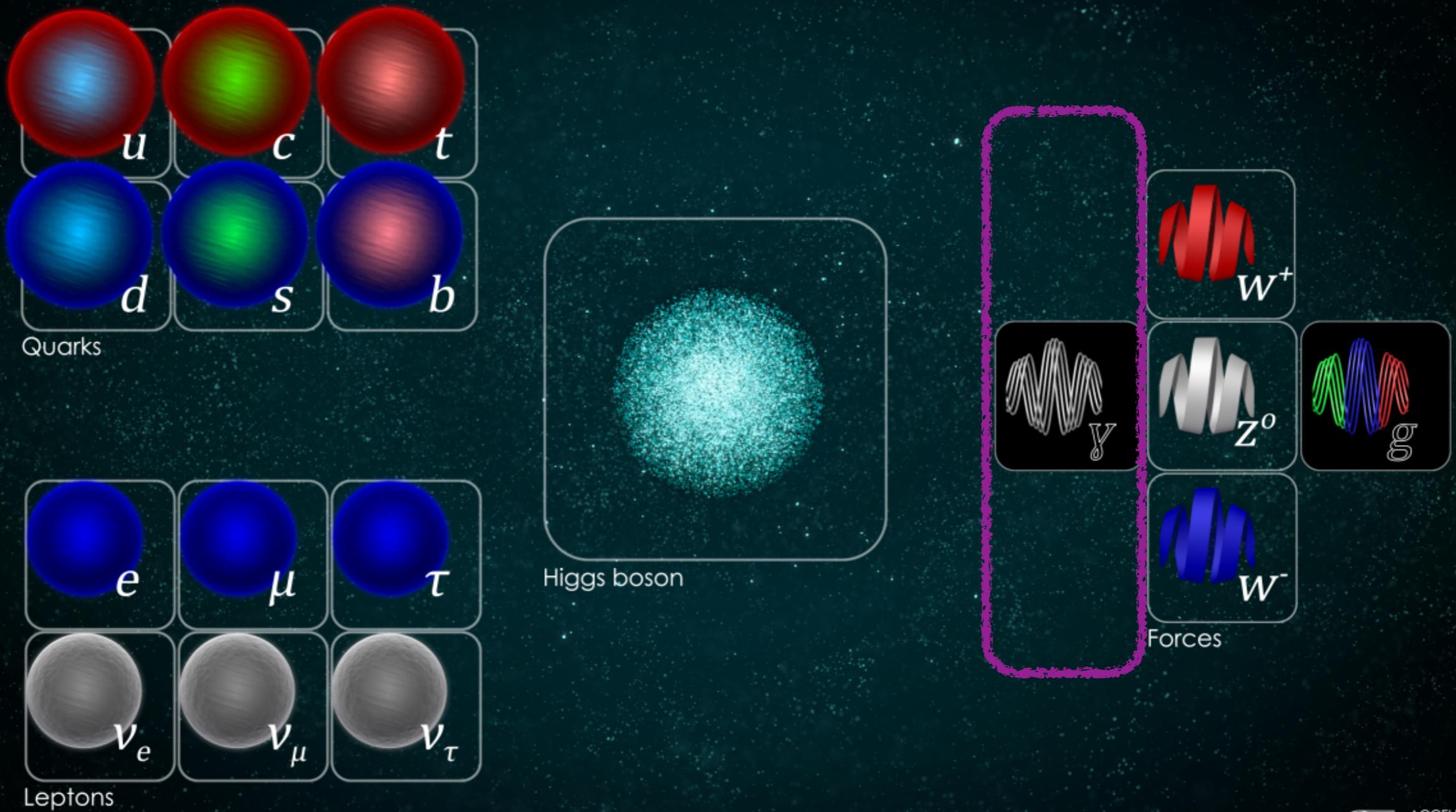
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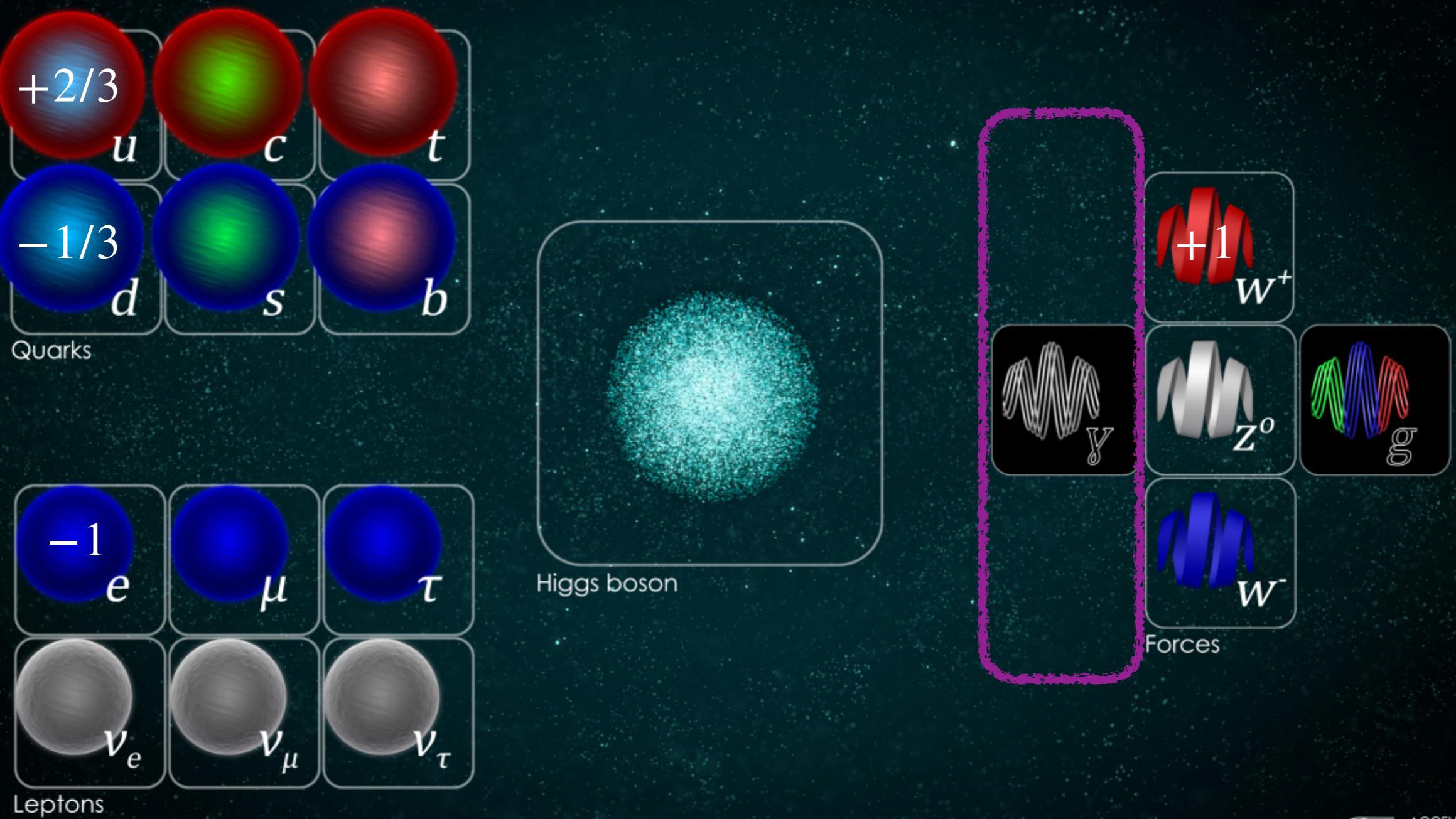
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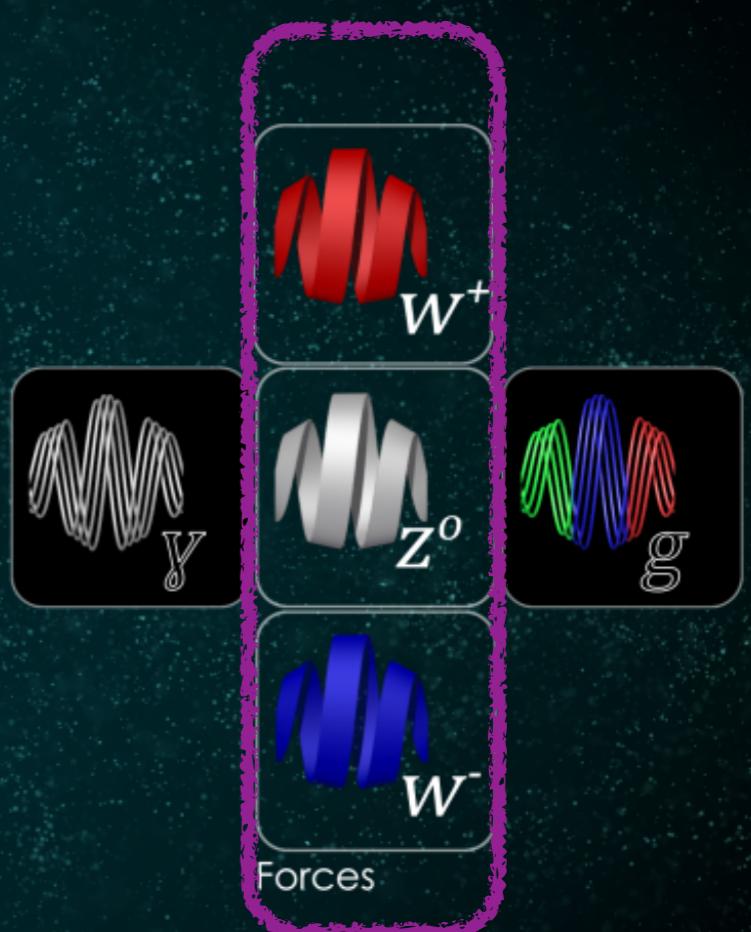
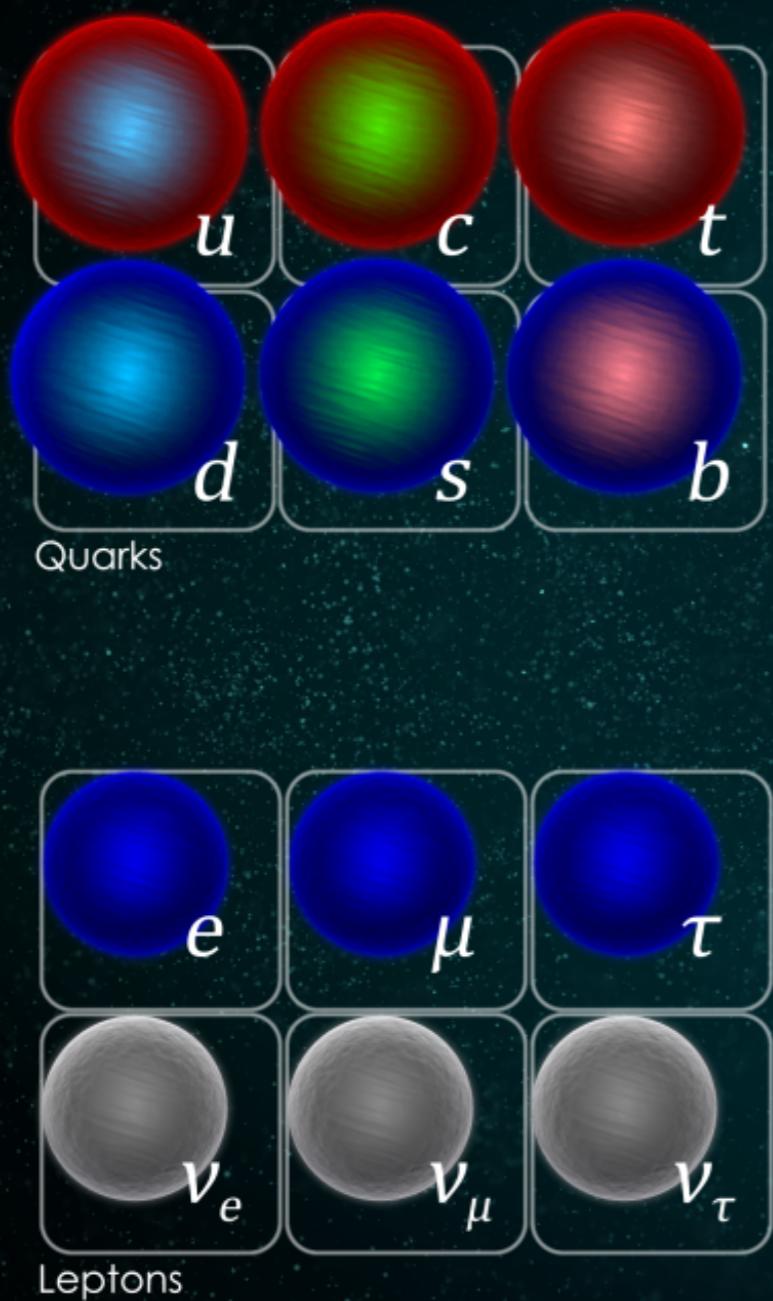
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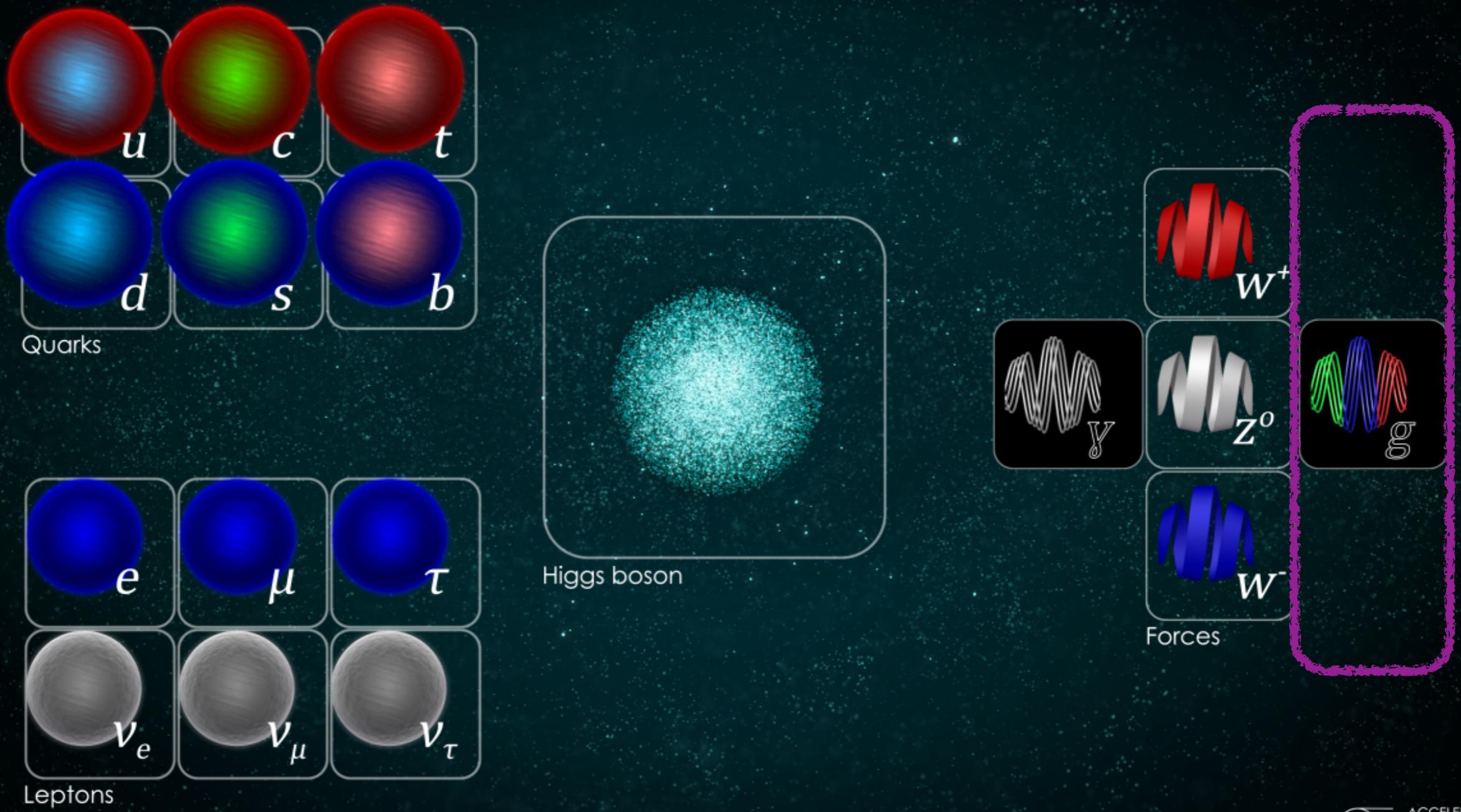
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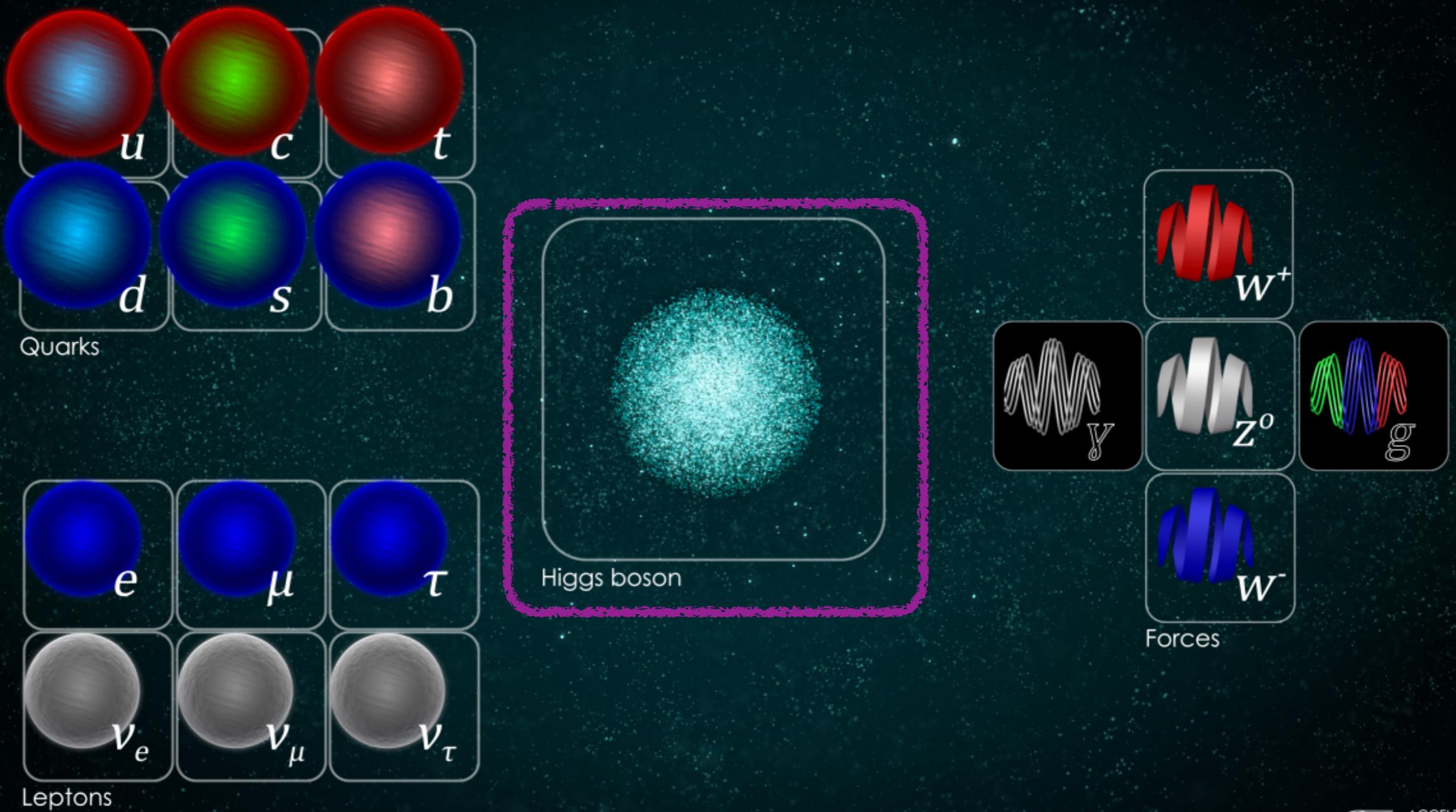
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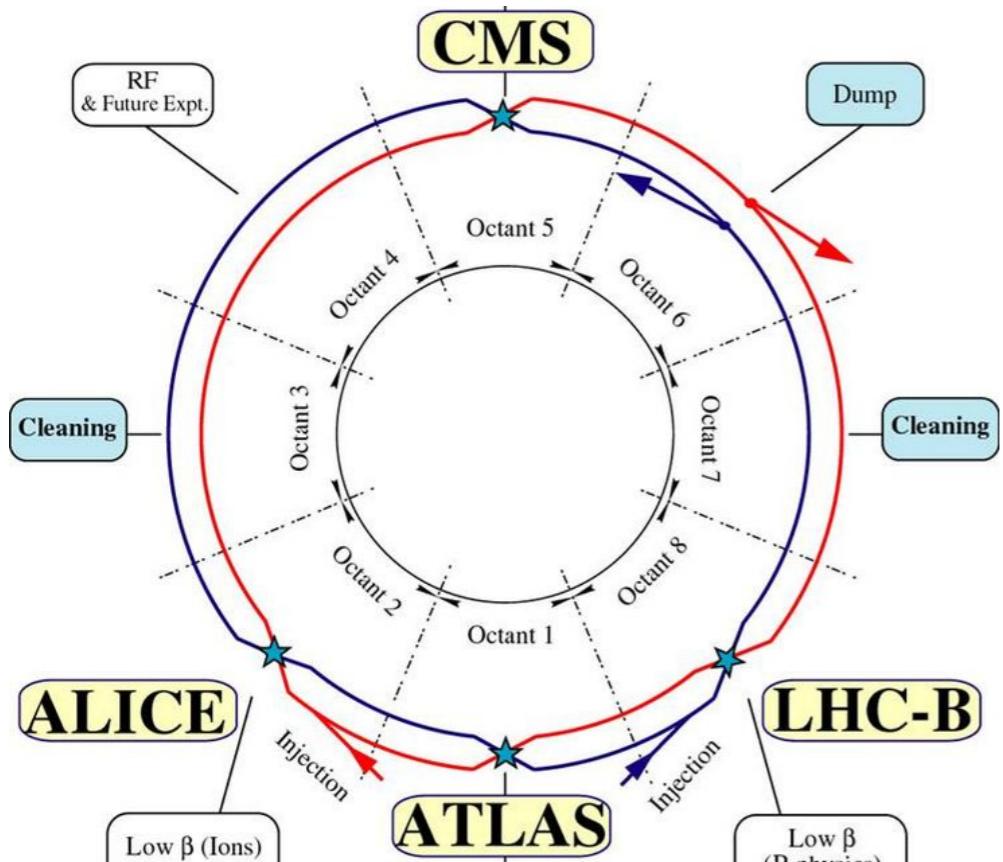
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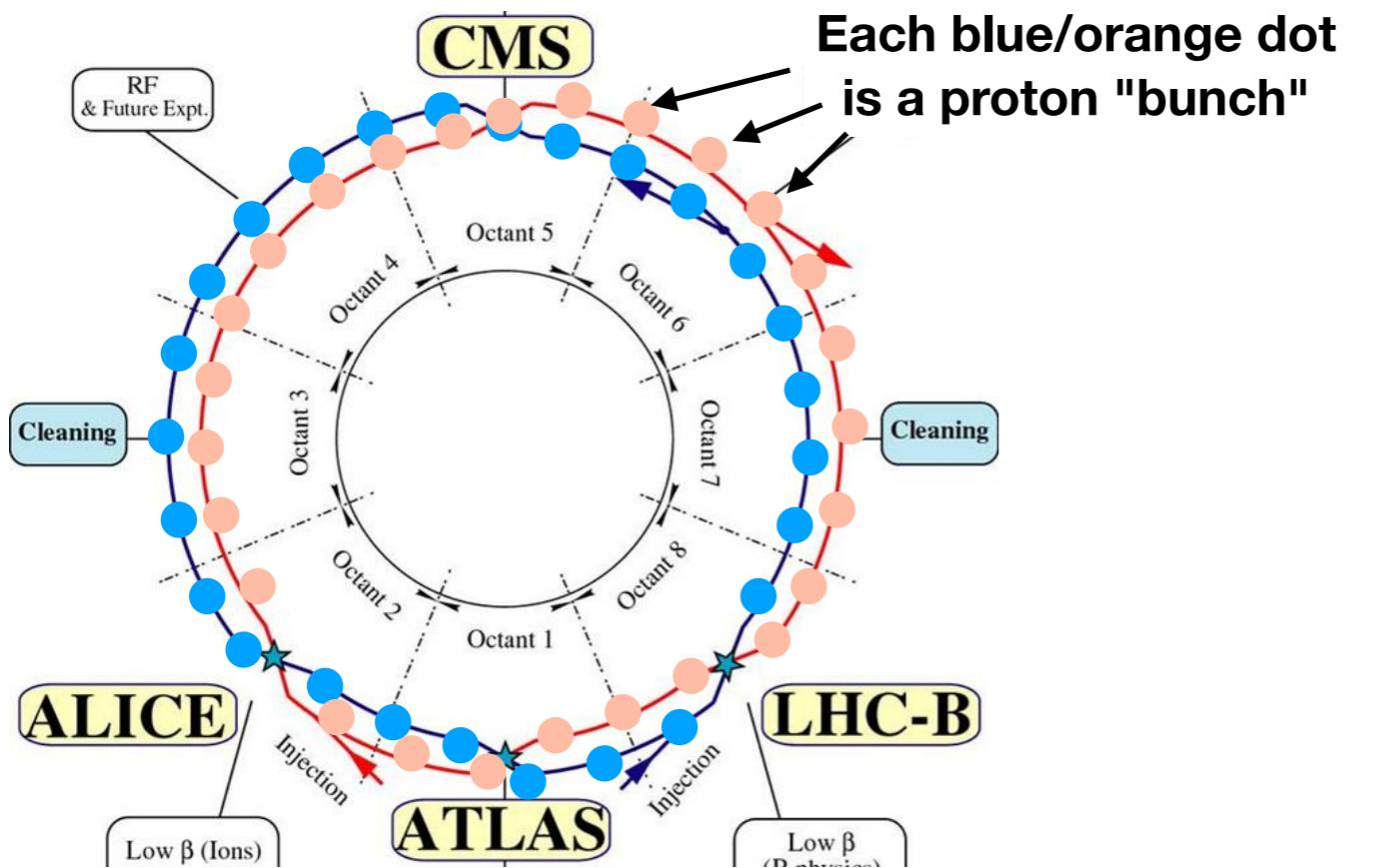
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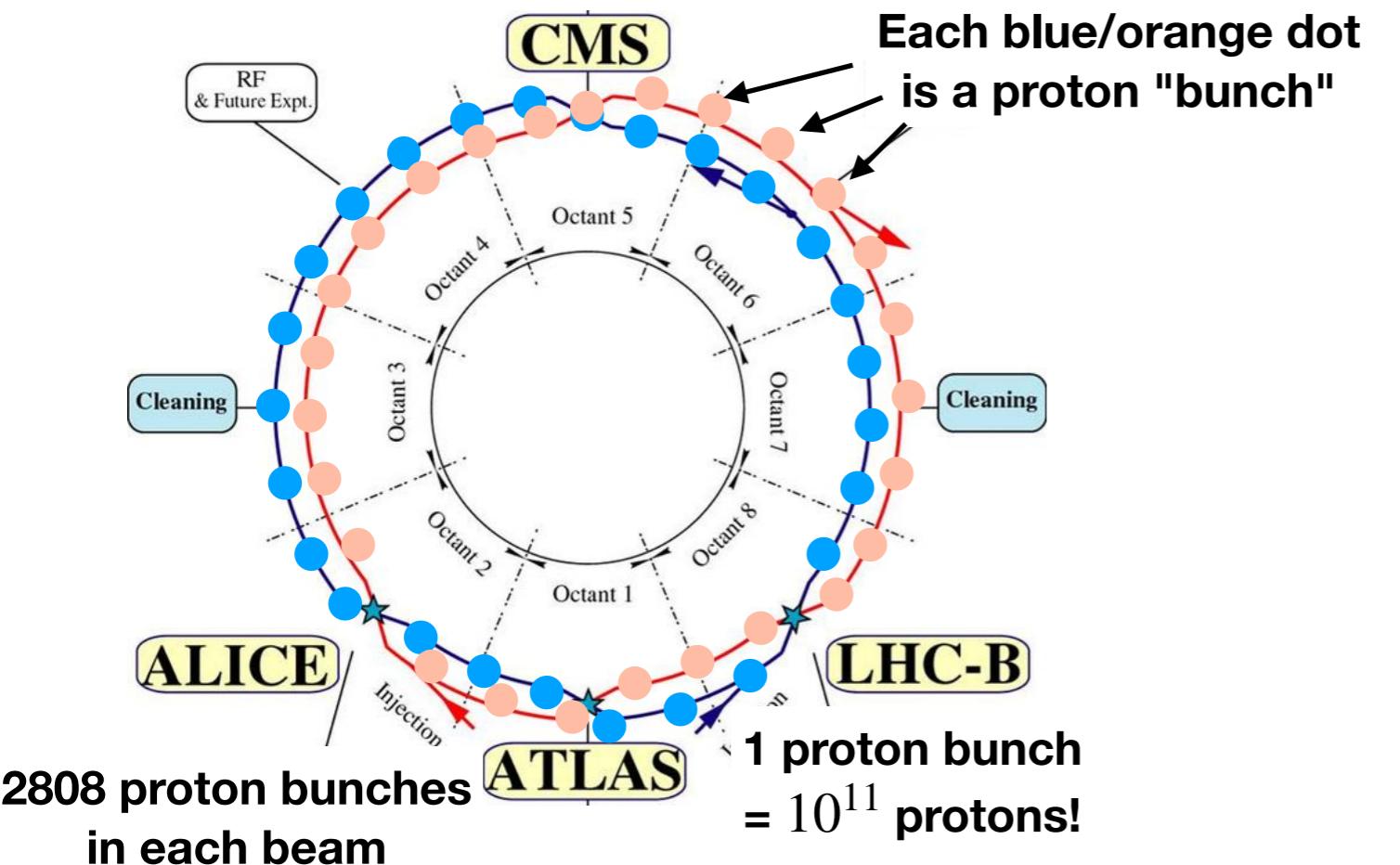
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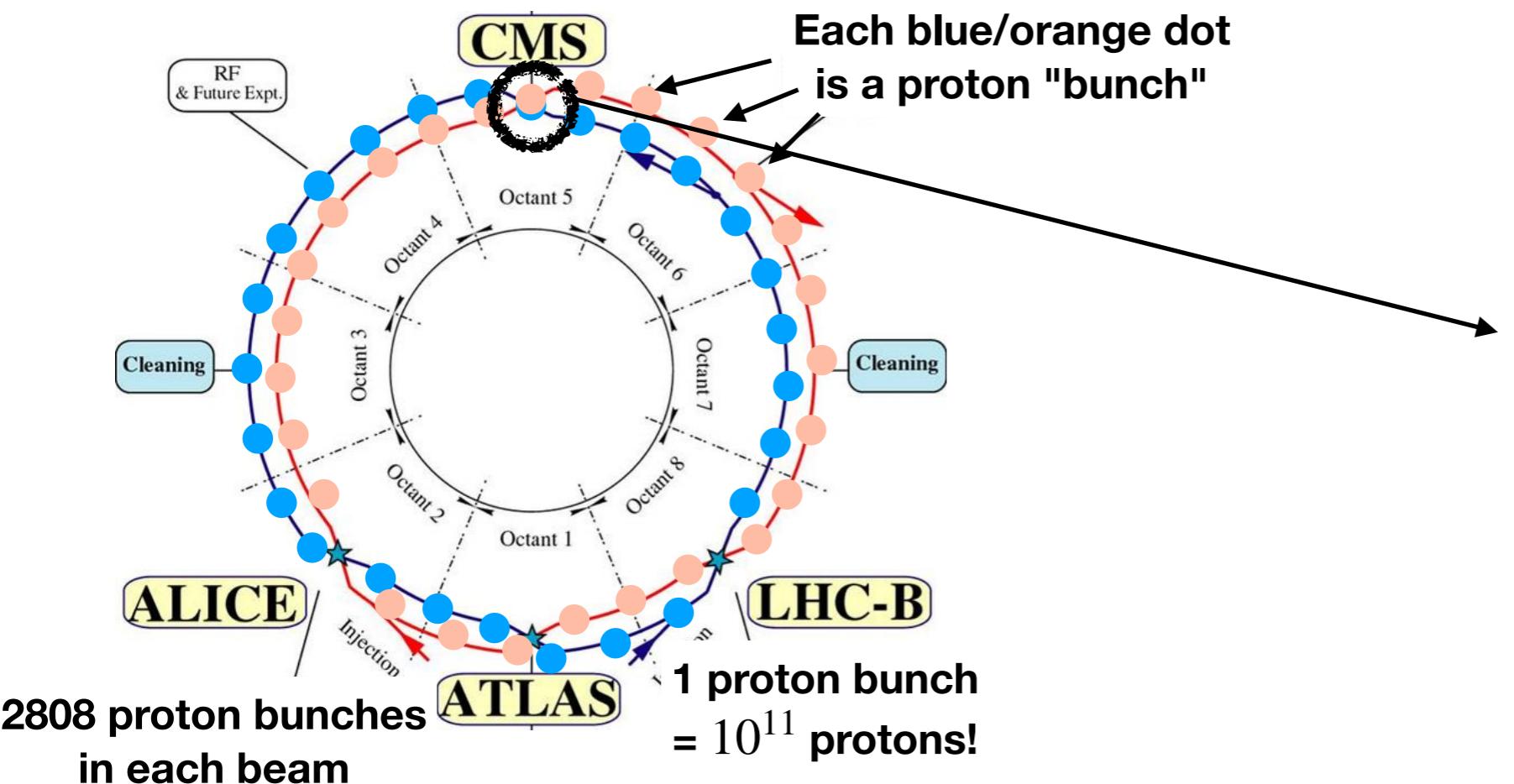
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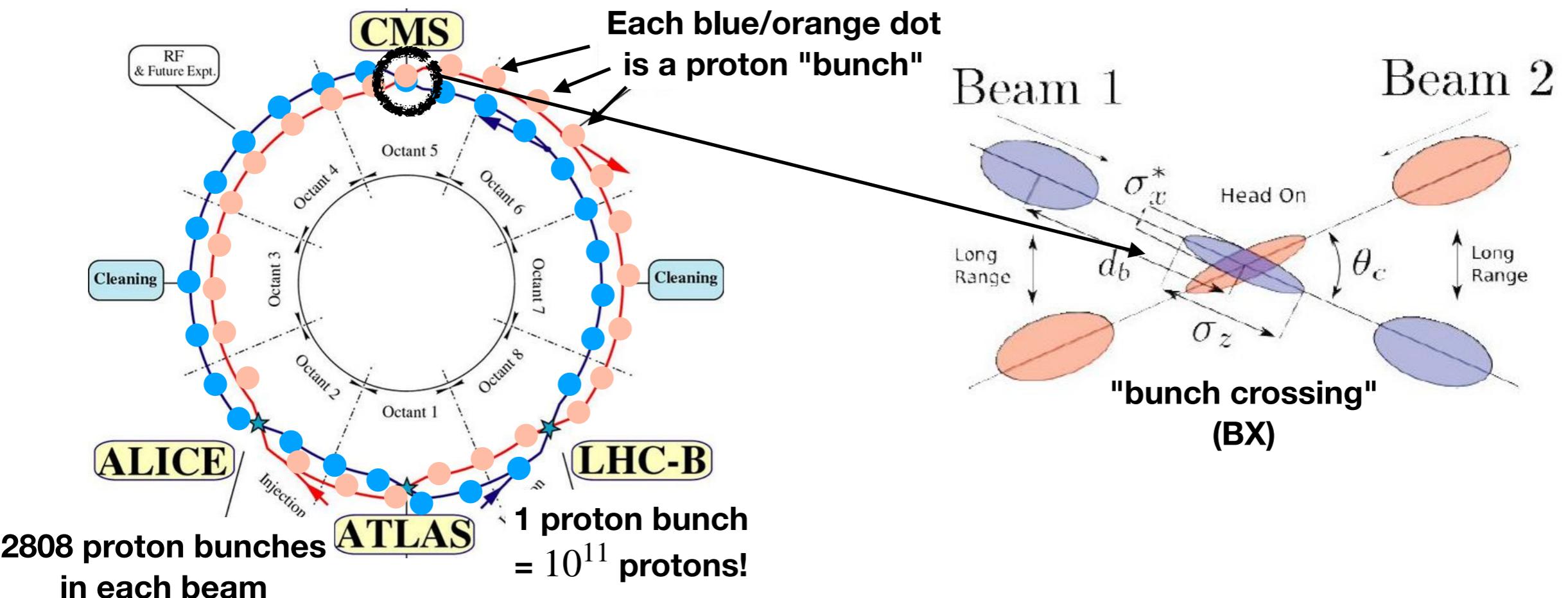
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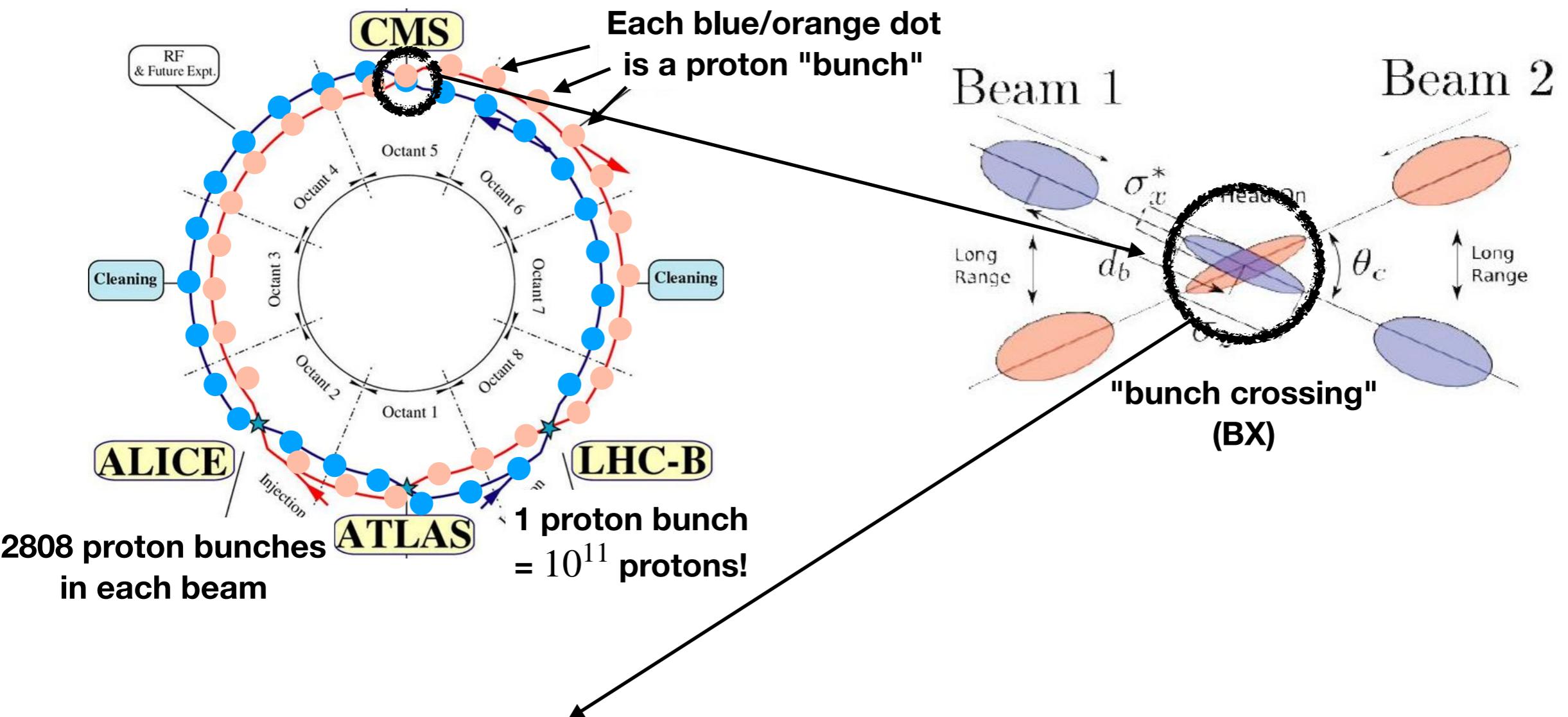
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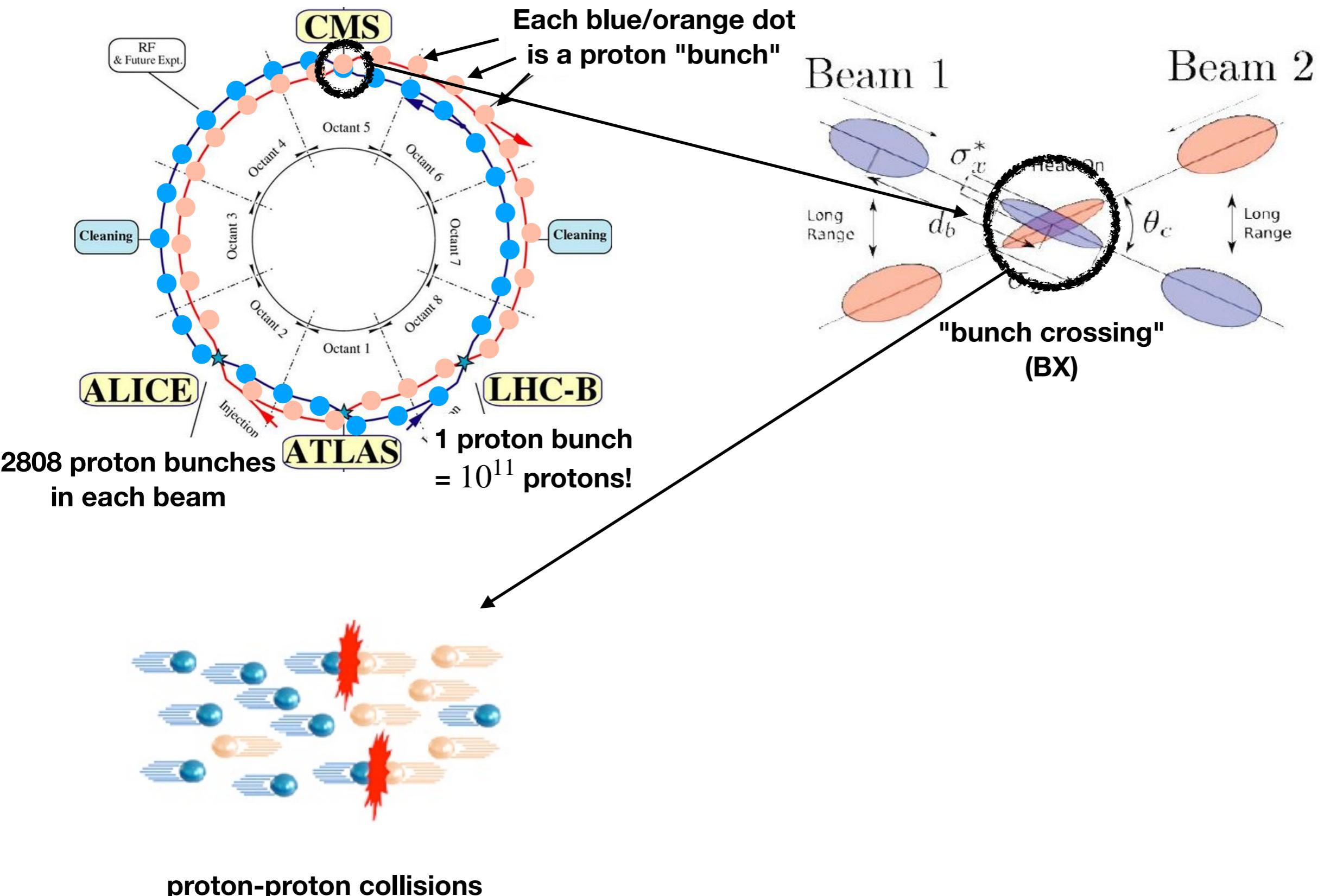
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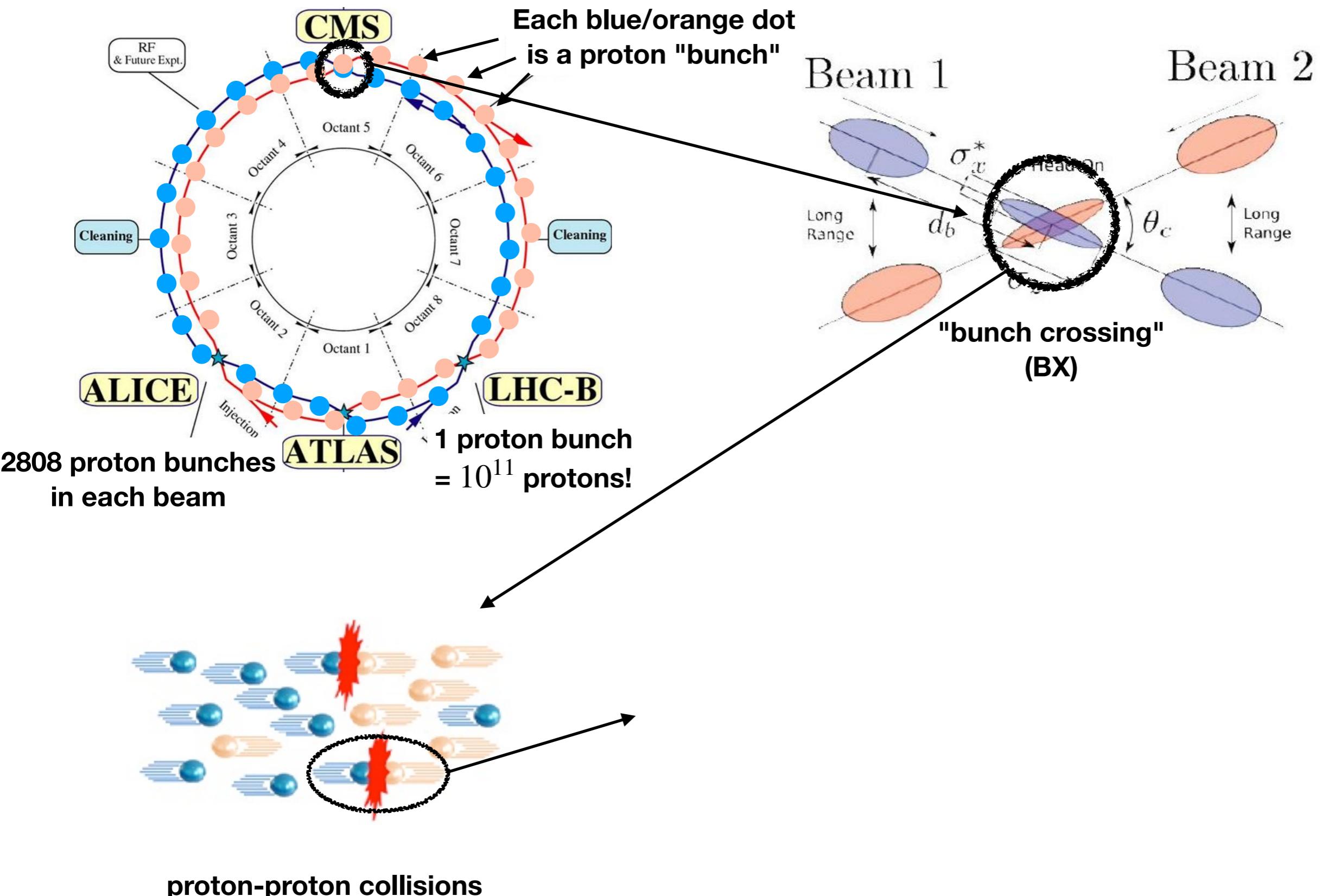
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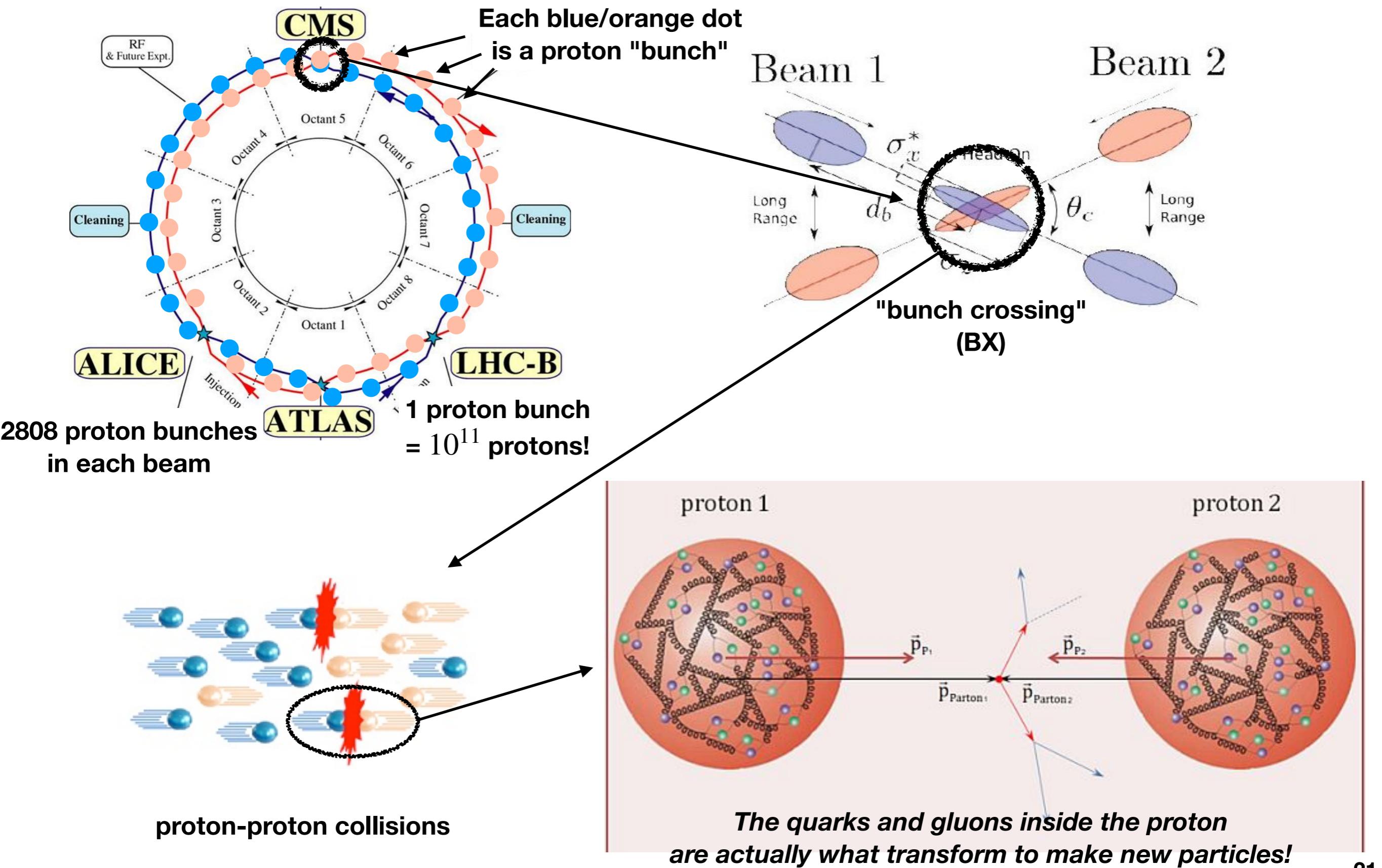
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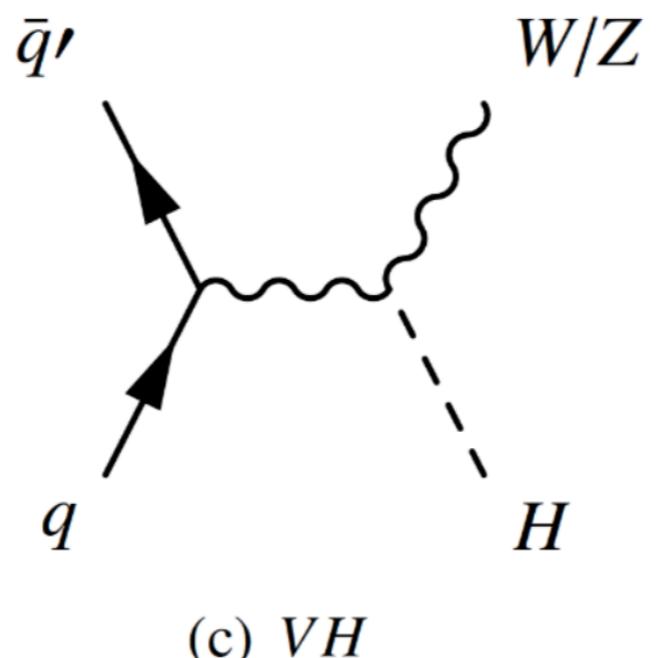
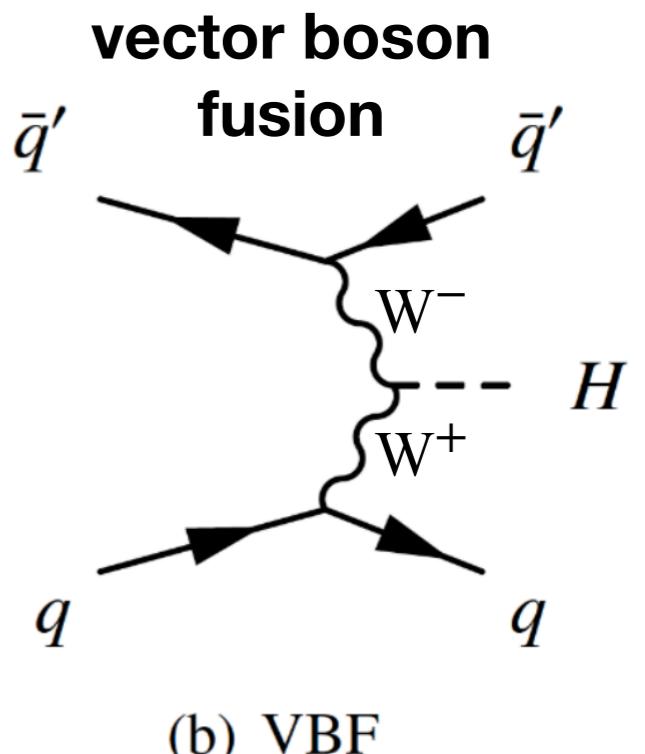
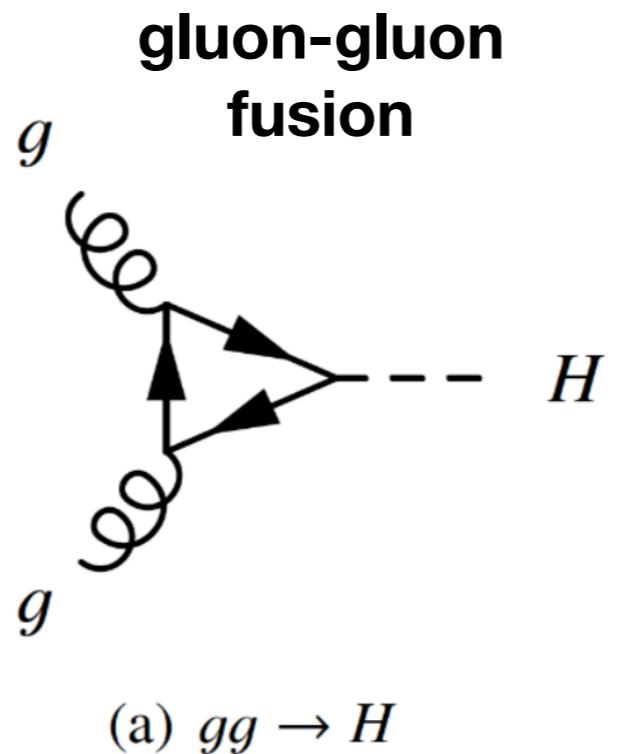


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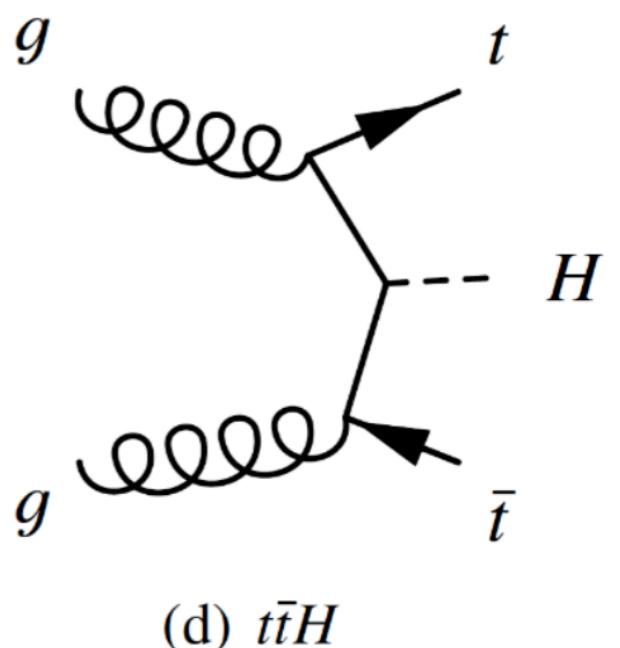


How to Make a Higgs:

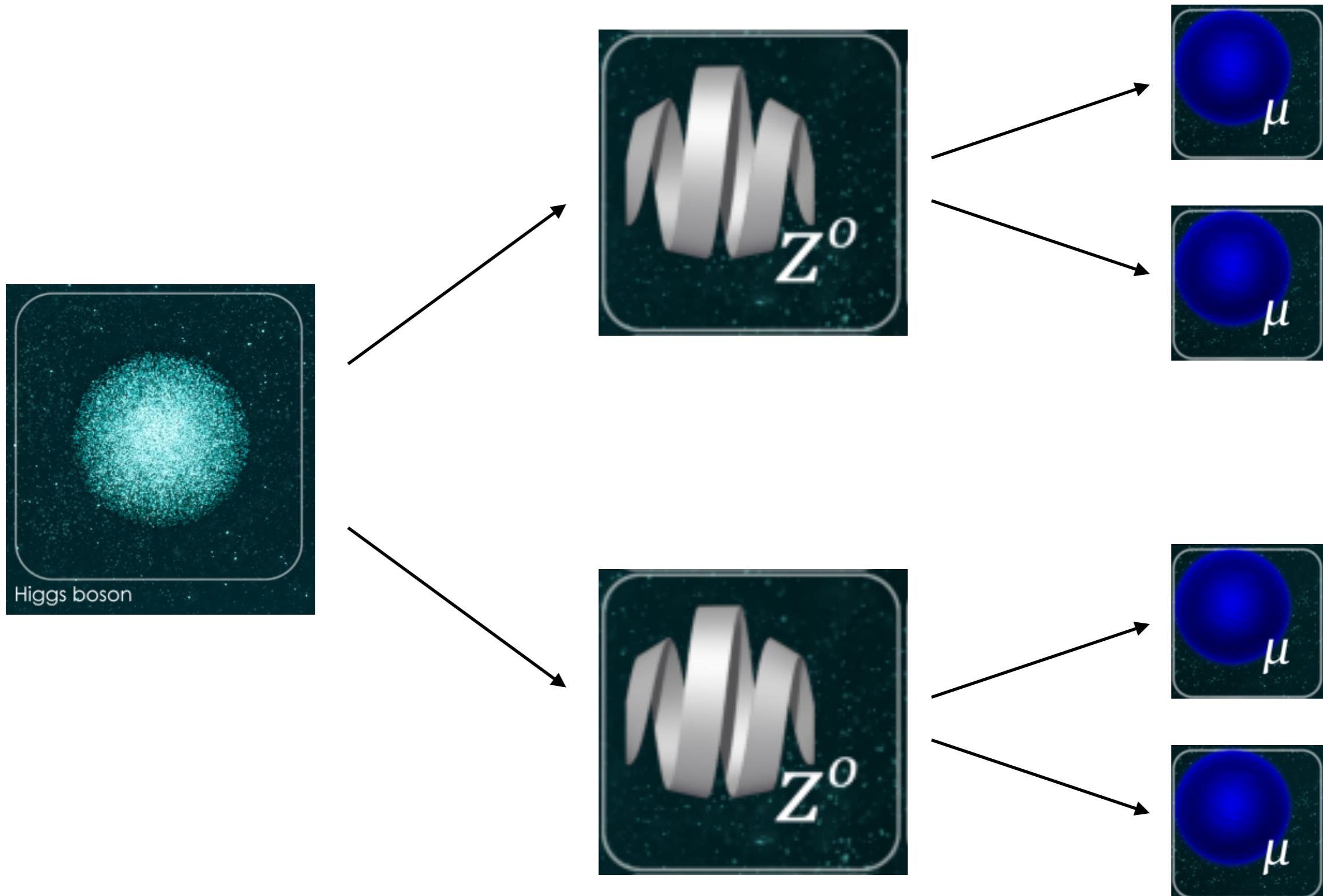
- At least 4 different "Production Modes"
- $5/10^9$ chance to make a Higgs boson
- Make proton bunches cross at 40 million Hz!



quark-antiquark annihilation

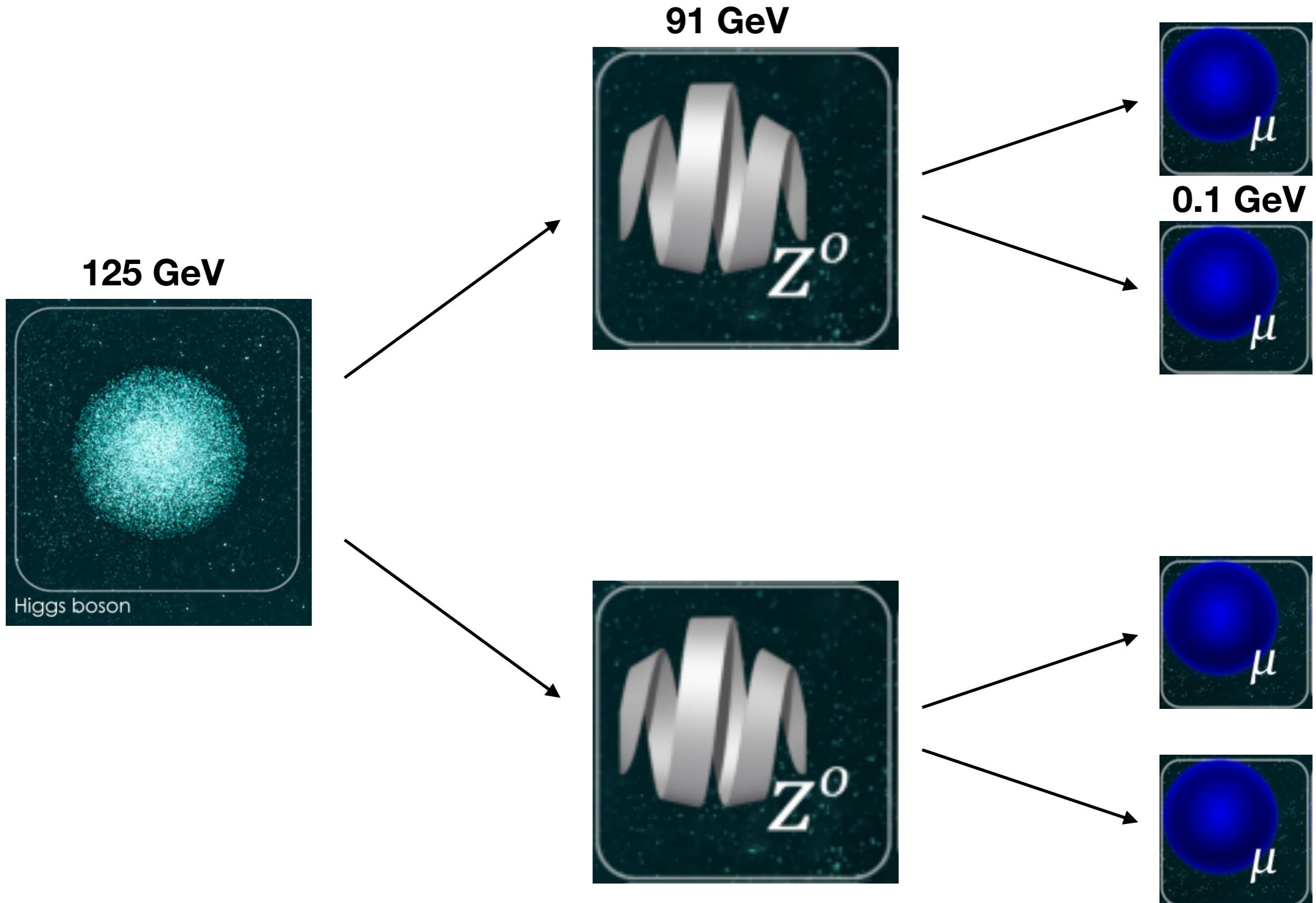


Higgs Decay: $H \rightarrow ZZ \rightarrow 4\mu$



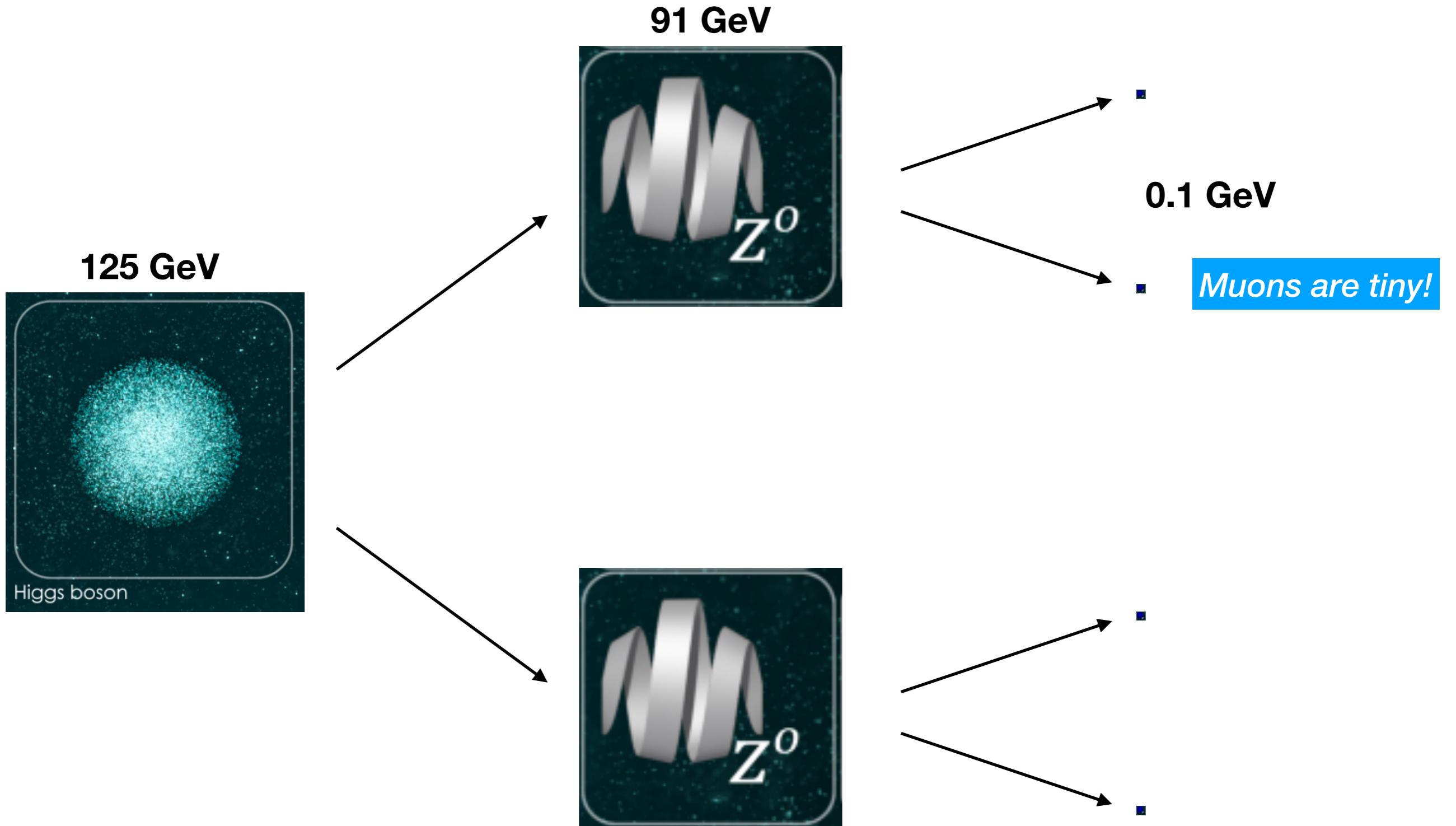
Higgs Decay: $H \rightarrow ZZ \rightarrow 4\mu$

- What if the size of each image here were \propto mass of particle?

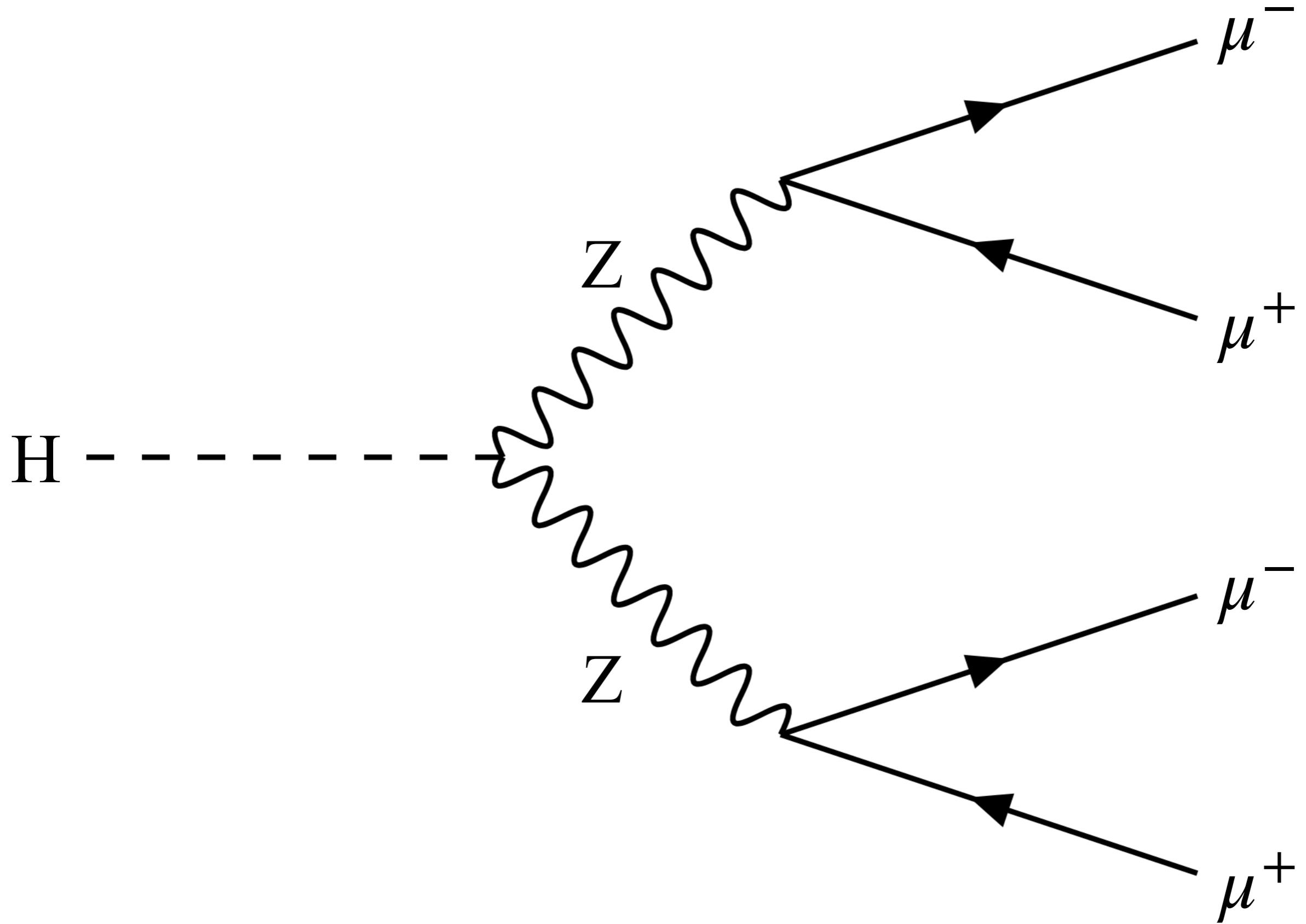


Higgs Decay: $H \rightarrow ZZ \rightarrow 4\mu$

- What if the size of each image here were \propto mass of particle?



Feynman Diagram of the Higgs Decay:



Q: How do you weigh a Higgs boson?

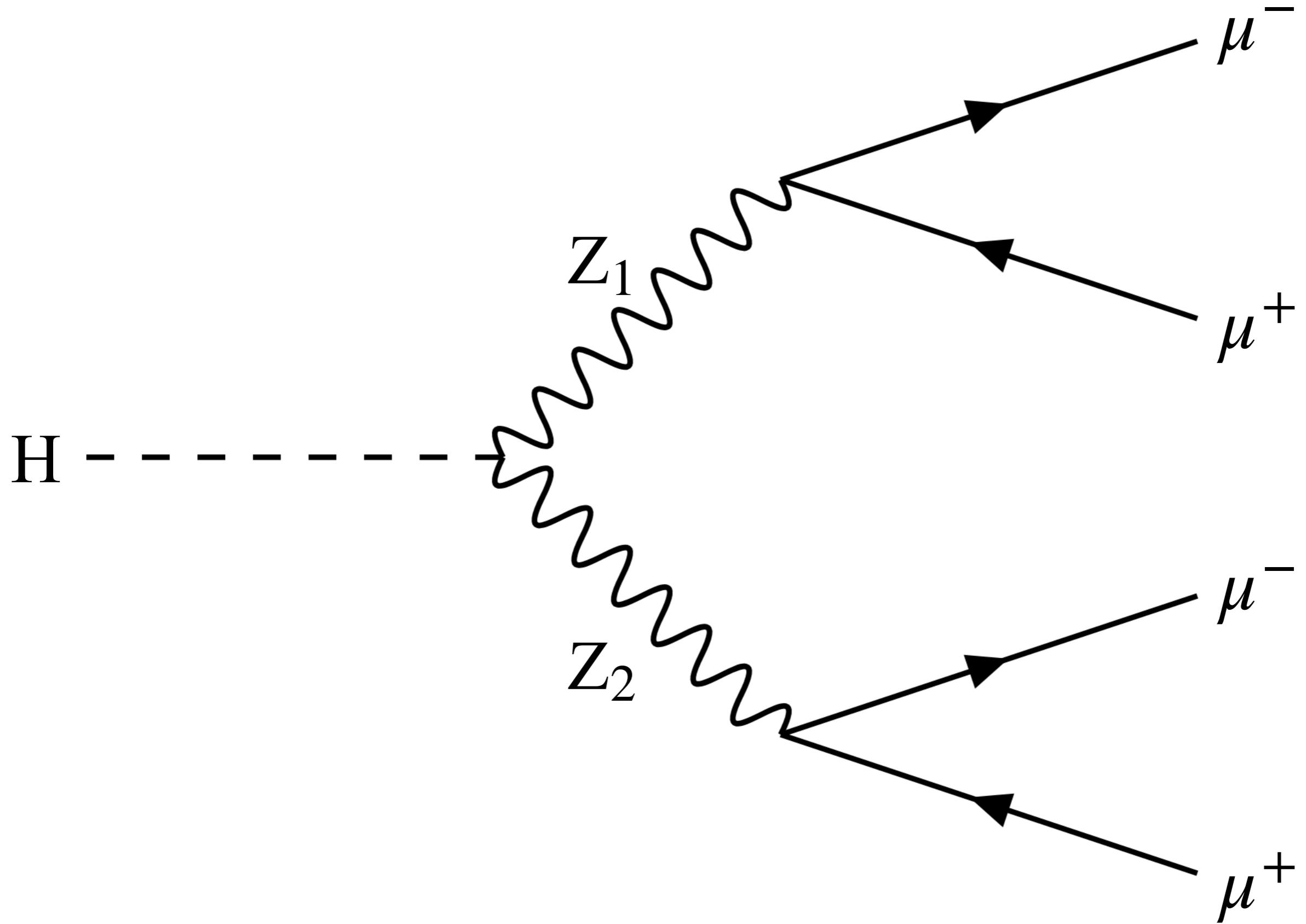


You learned how in physics 1...

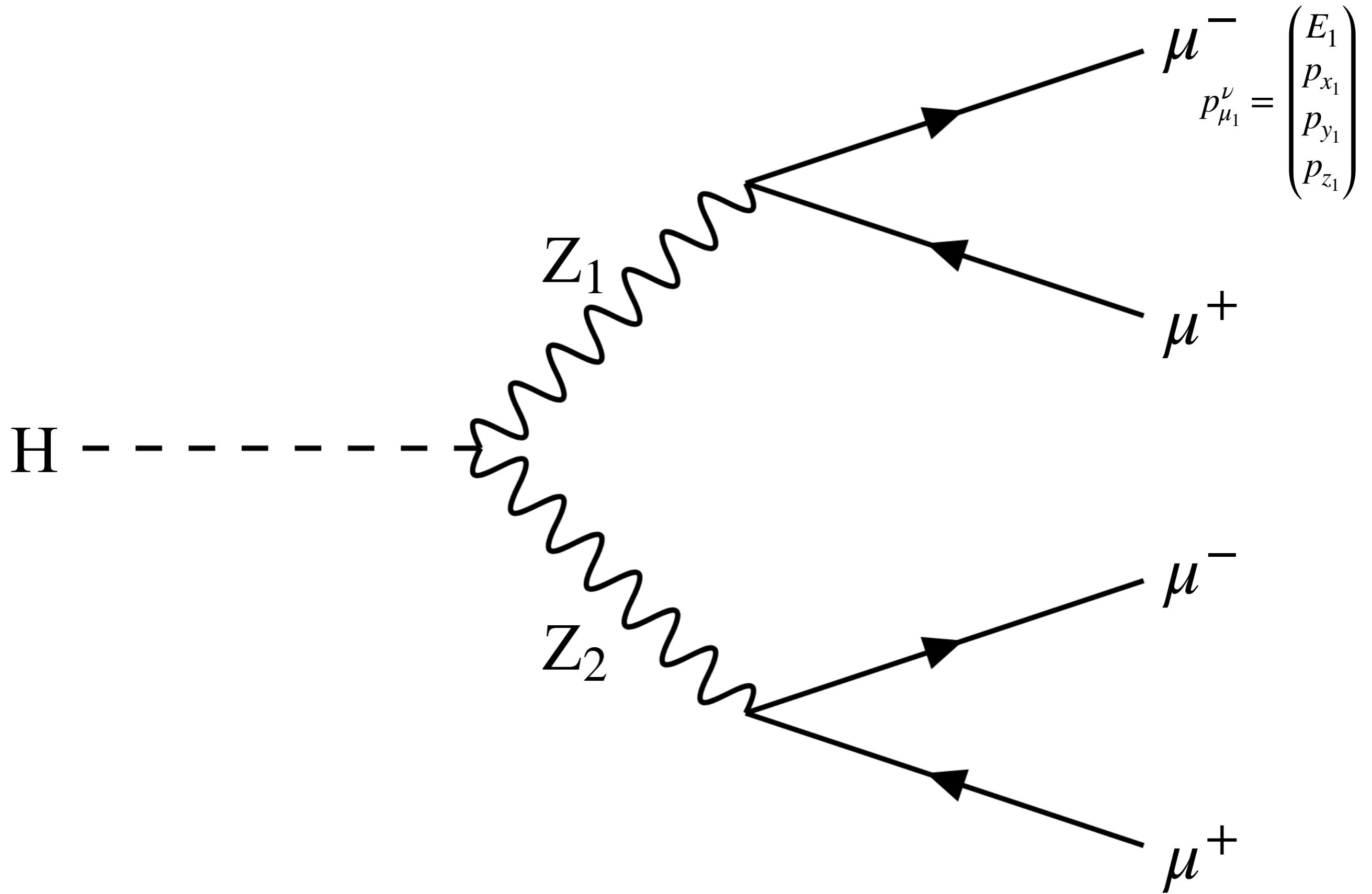
Conservation of energy and momentum!



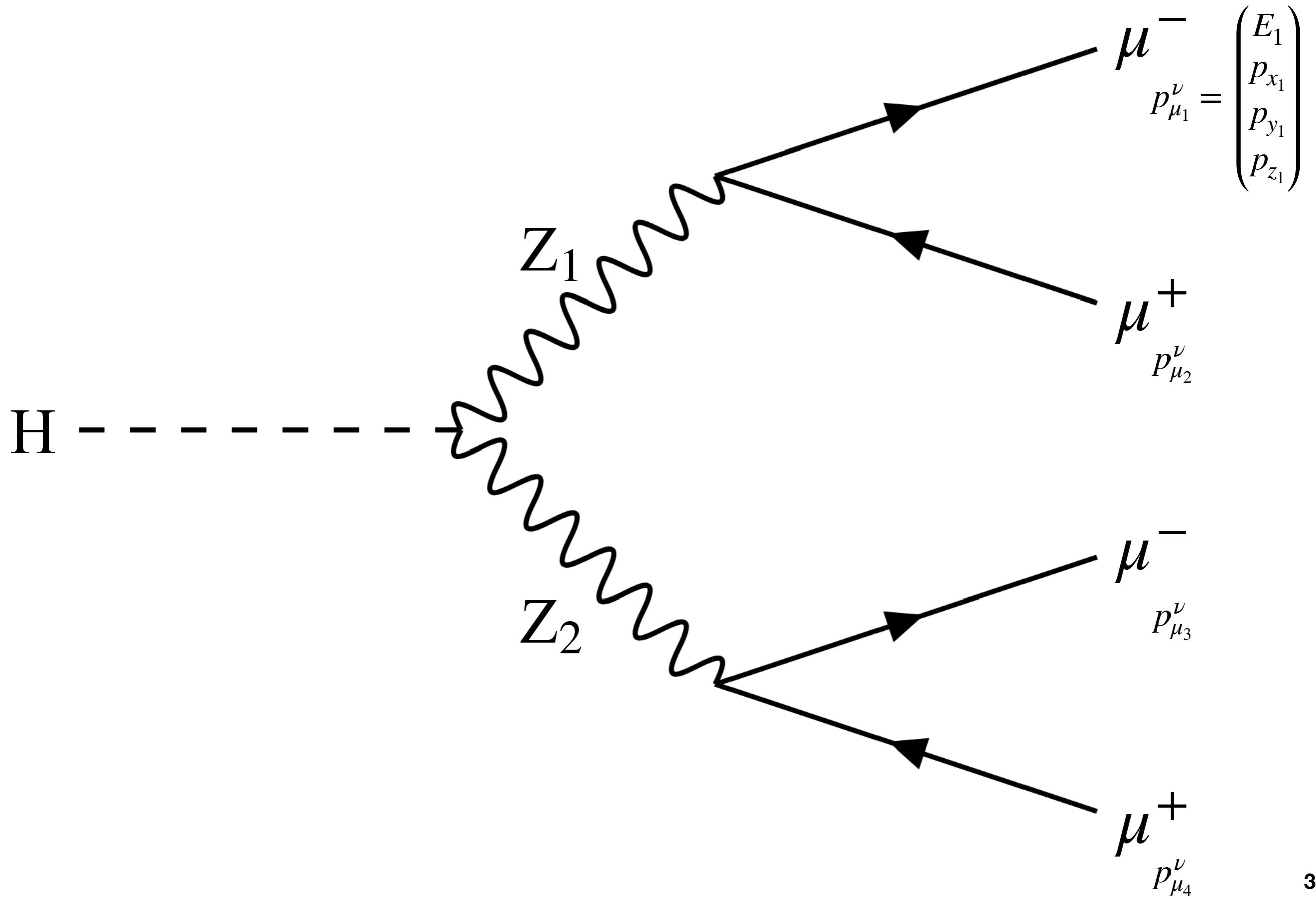
Use Conservation Laws:



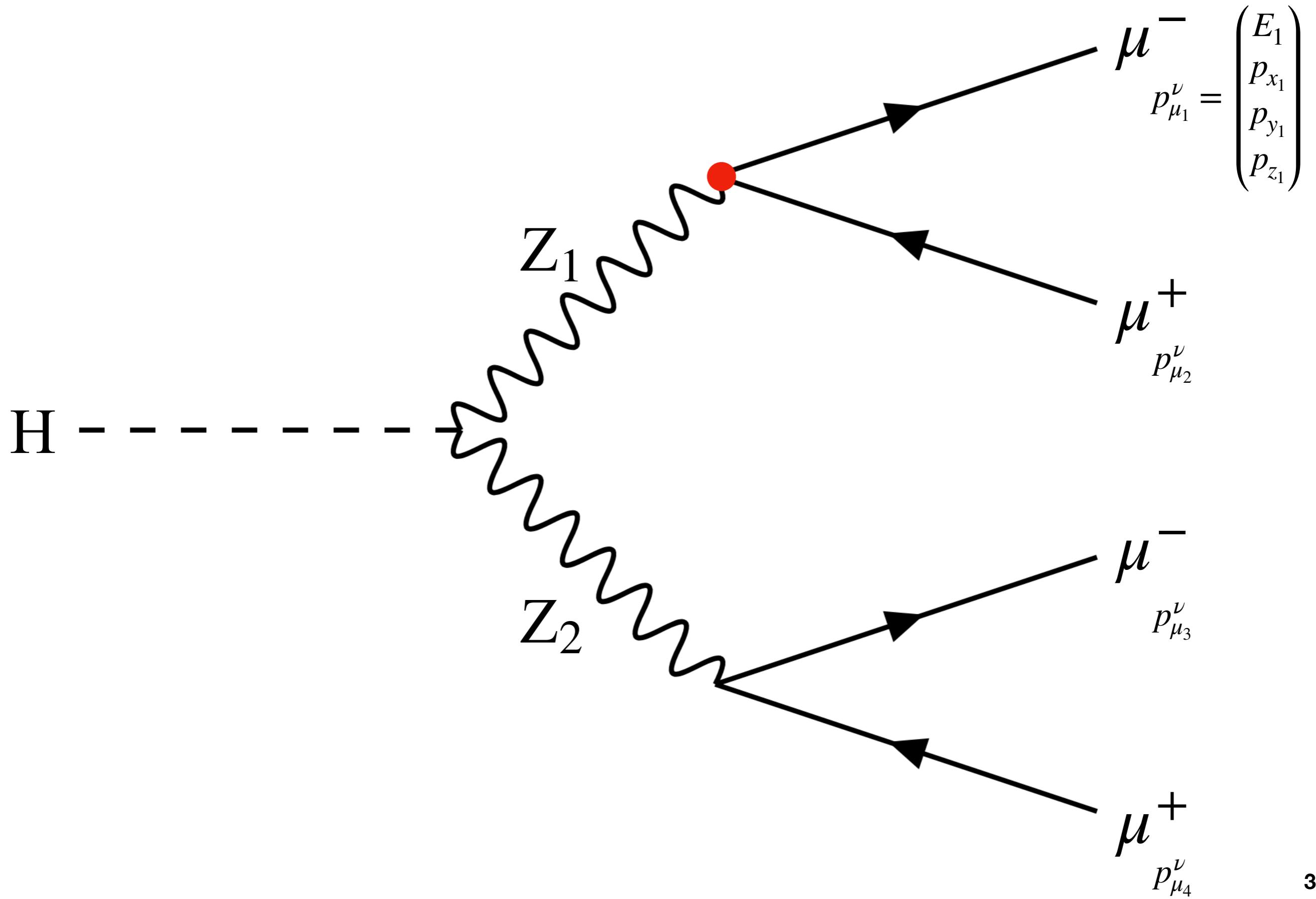
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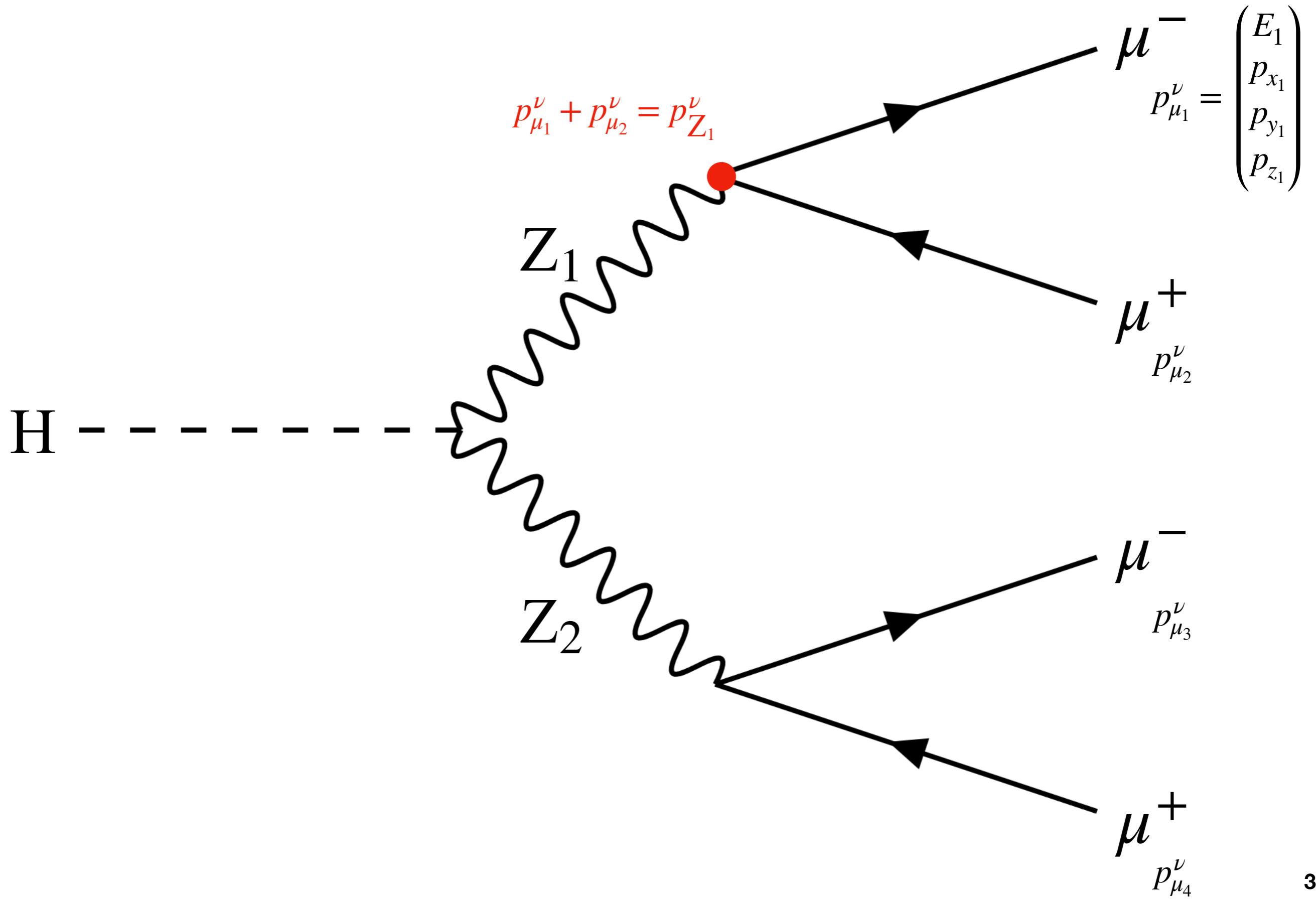
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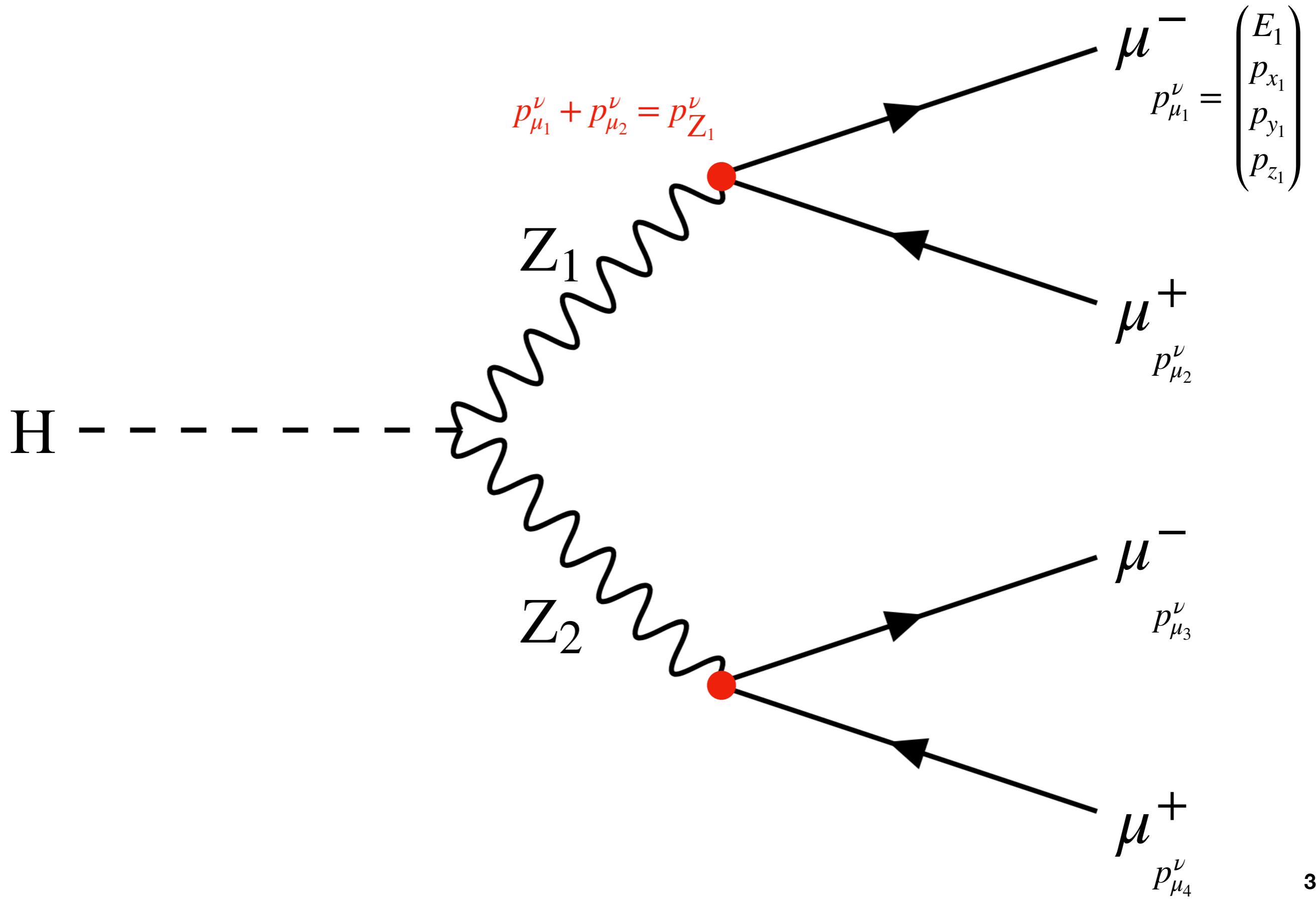
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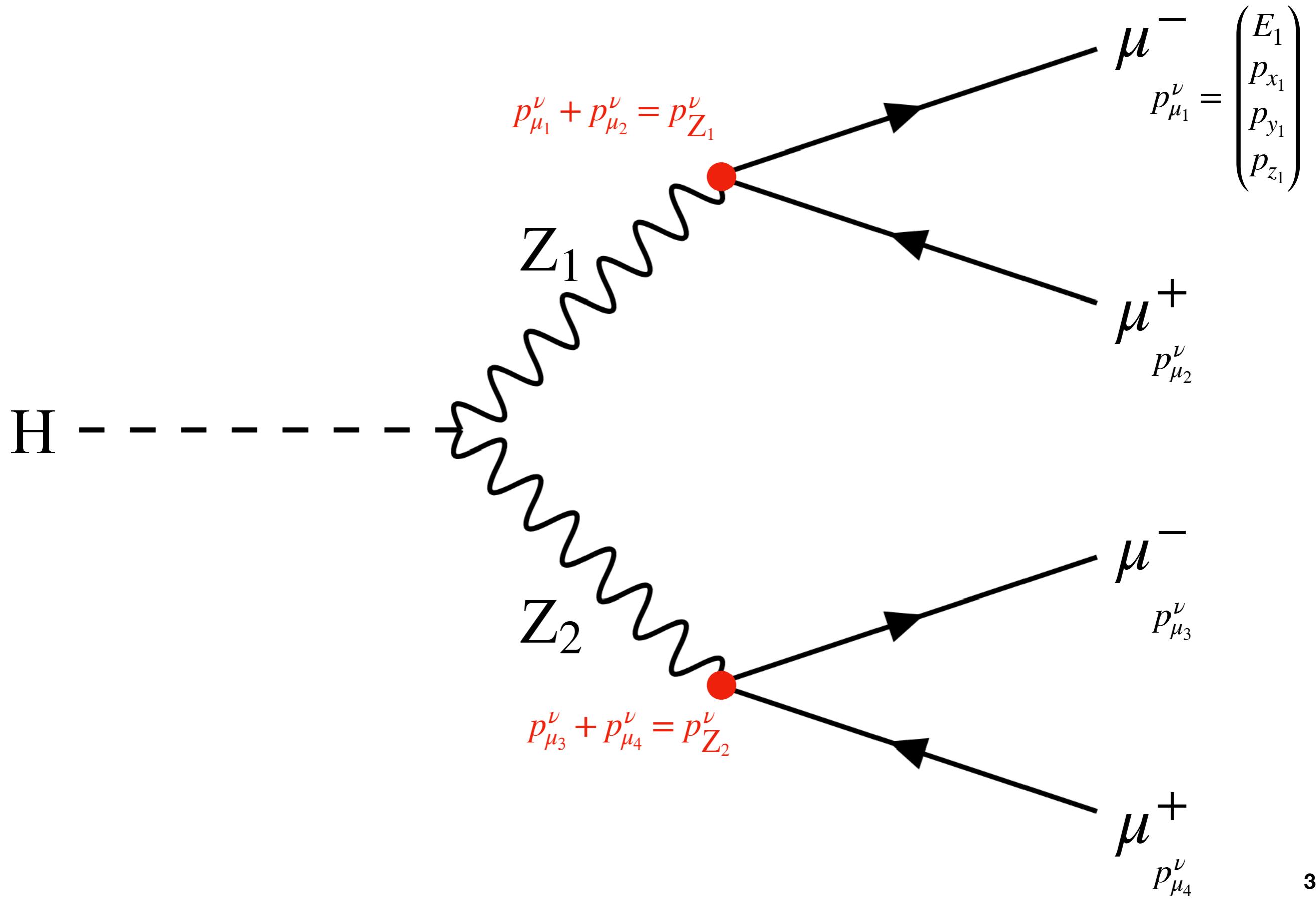
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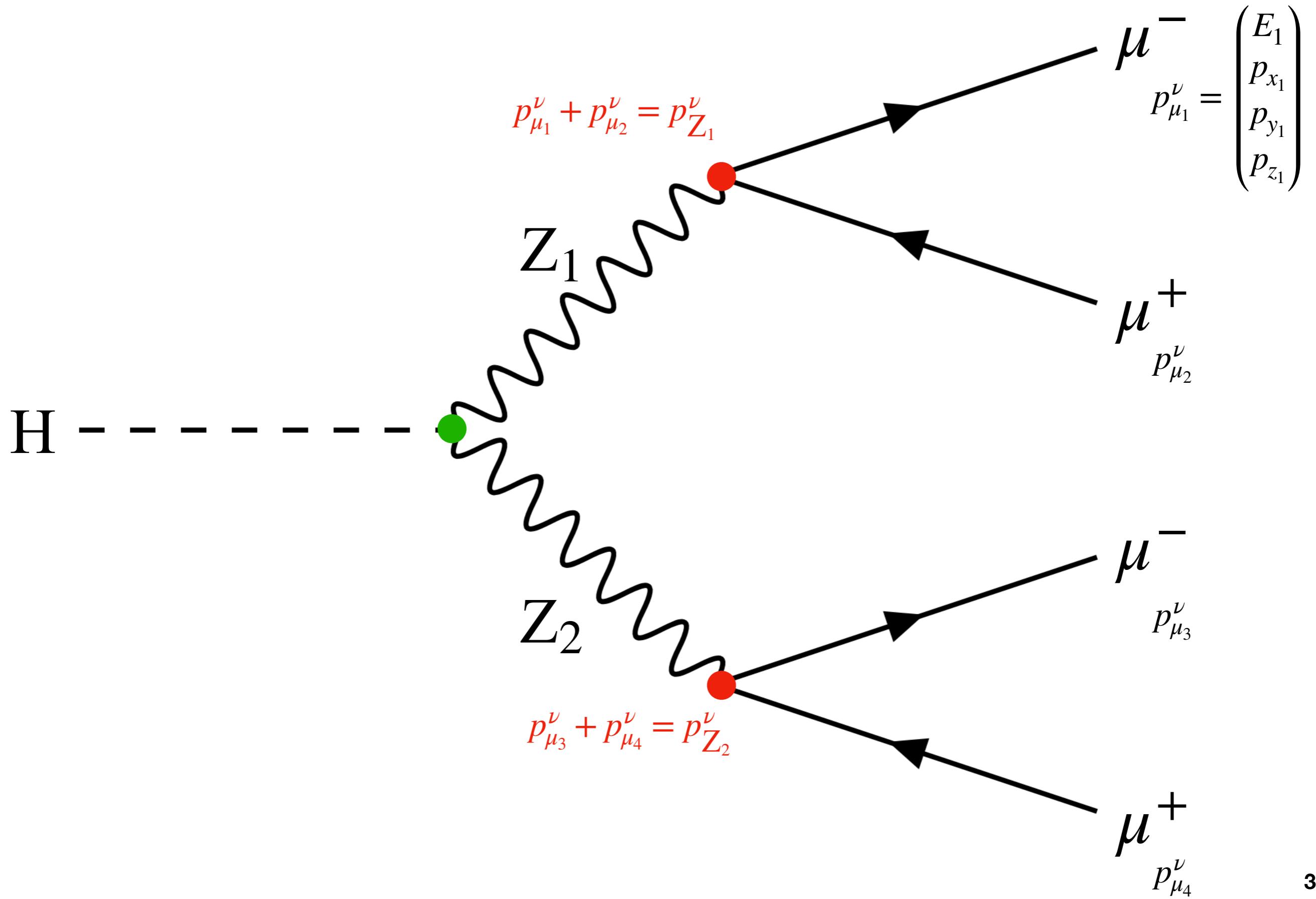
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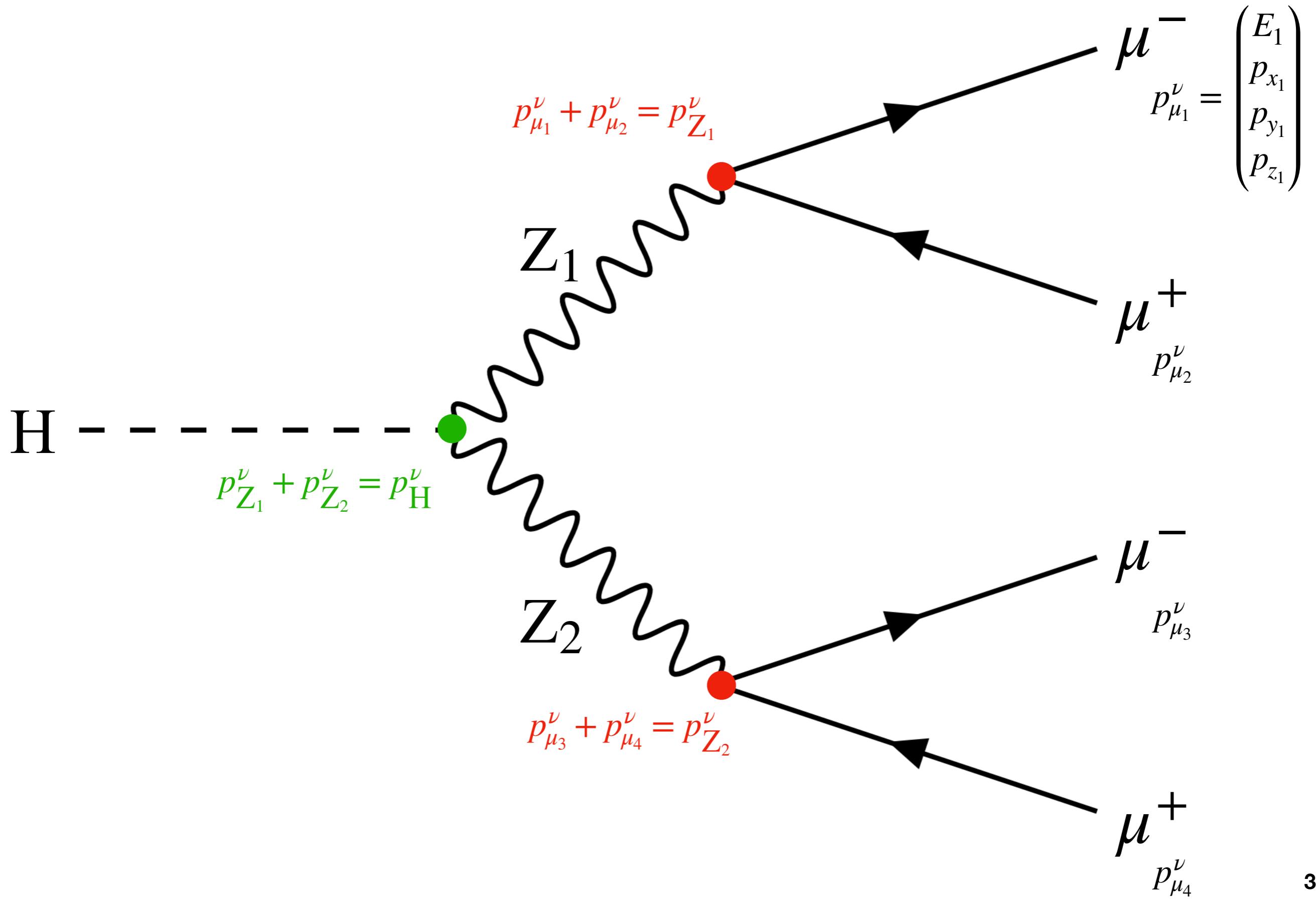
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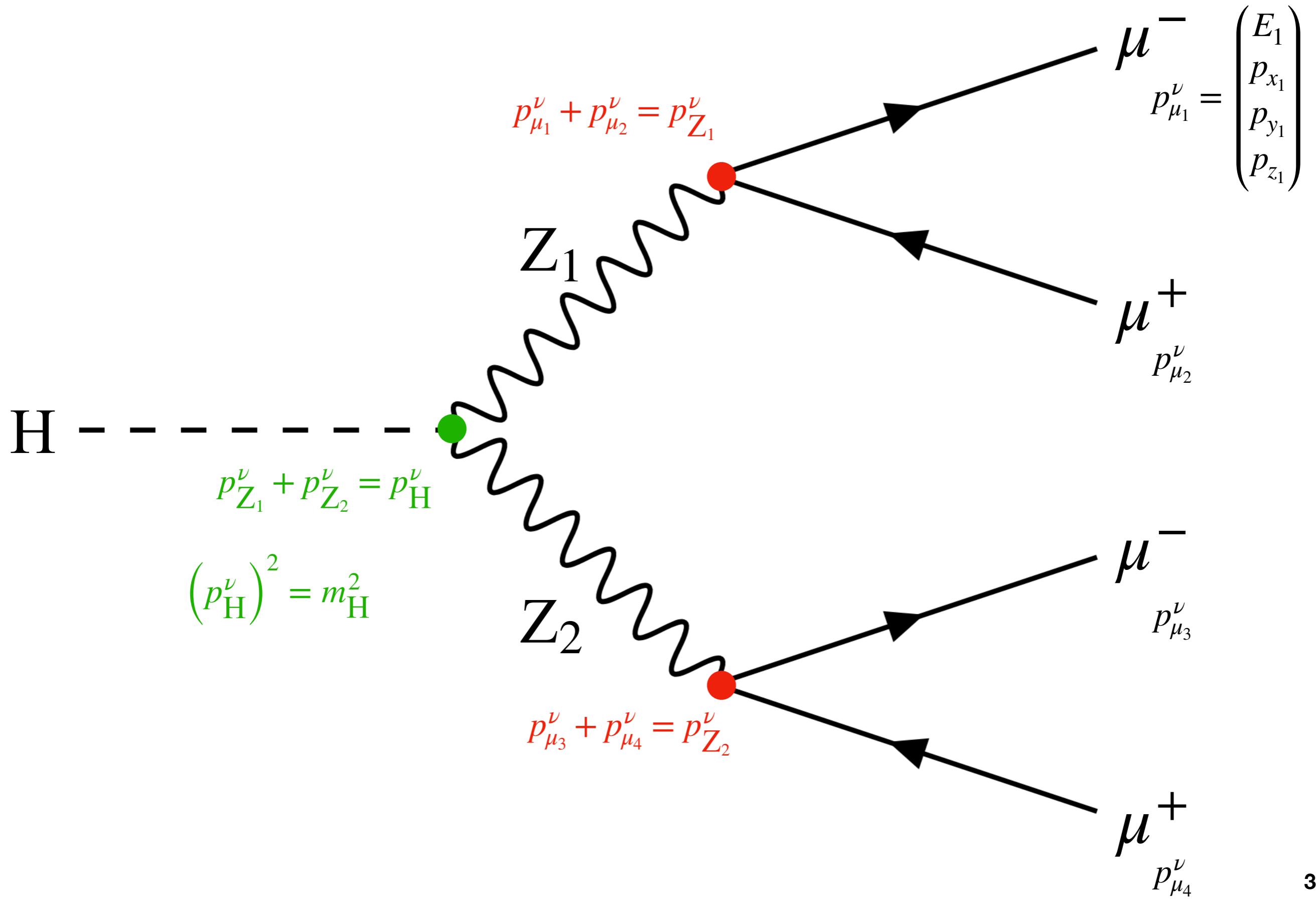
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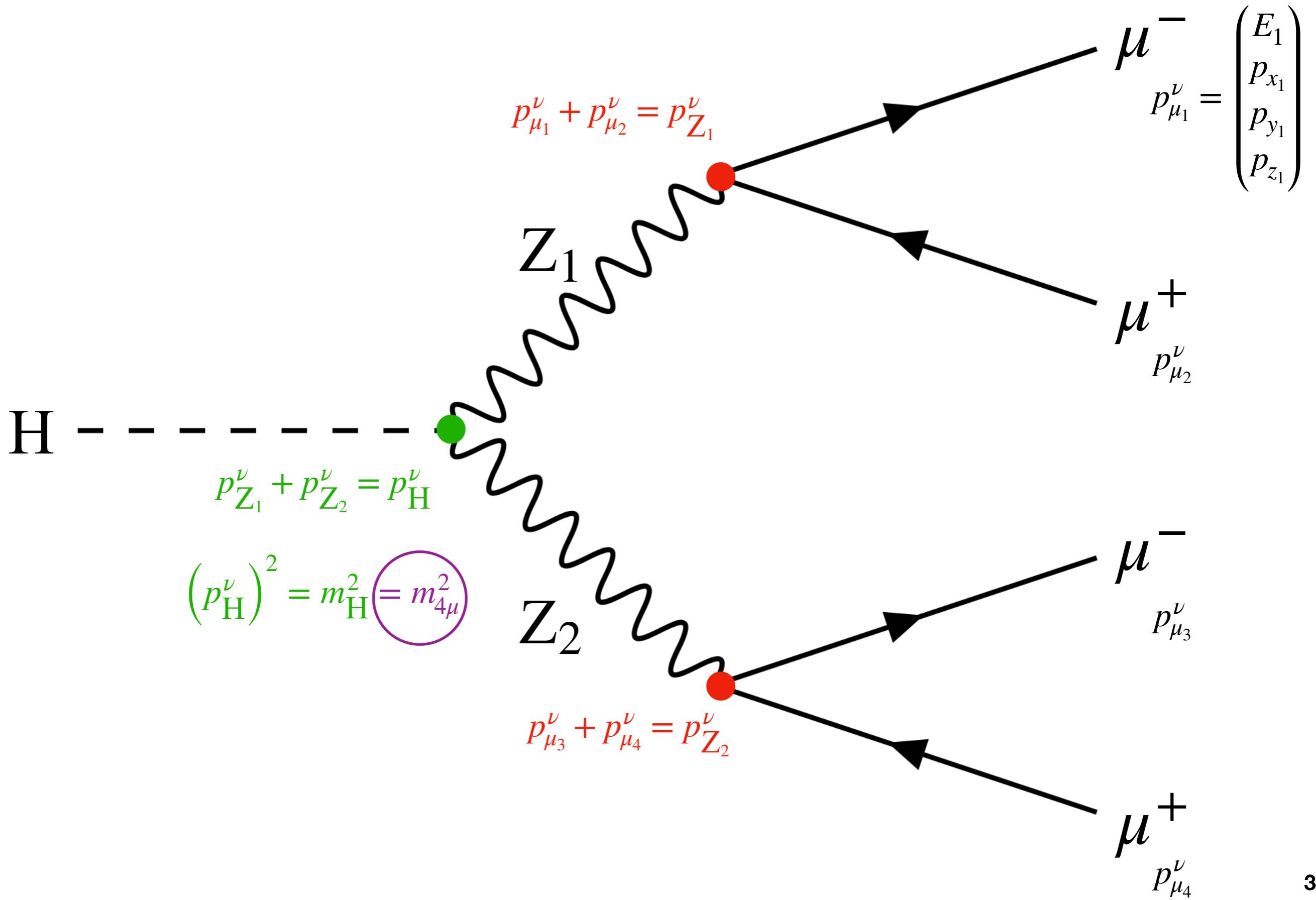
Use Conservation Laws:



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Final Step: Count how many times you get $H \rightarrow ZZ \rightarrow 4\mu$

- Make a *histogram*:
 - ▶ A "count" plot.
- The black points are **data** that CMS *actually* collected
- The colored regions are **Monte Carlo** (MC) simulation
 - ▶ This is our best prediction of what data we should get
- We are interested in how well Data and MC agree
- Finally, "read" off the mass of the Higgs boson!
 - ▶ It's actually not that simple at all...
 - ▶ But it gives you a taste of the analysis!

