Topic 12

- Pick your favourite experimental particle physics discovery of the past century. e.g. “W/Z bosons”, “Higgs”, “neutrino oscillations”, “Charm quark / GIM mechanism”, “Weak CP violation”, etc.
- Why/how was it (theoretically) predicted?
- How was it measured? What was the experimental setup? What was the detection signature?
- What was the largest source of uncertainty in the result?

Topic 13

- Pick your favourite ‘most promising’ new physics model that you want to search for. Leptoquarks? Additional Higgses / quarks / leptons? Z-prime? SUSY? Dark matter / long-lived hidden sector bosons / heavy neutral leptons? etc.. What would the experimental signature look like?
- Work out design choices in an experiment you want to build, to obtain the highest discovery sensitivity to this new particle.
- Does it need accurate tracking? Particle ID? Calorimetry?
  Does it need cooling? Magnets?
- What is the expected cross-section? how ‘big’ should your detector be? How long do you need to measure?
- What is the data rate you expect? (In rare signatures, think background rates). What ‘signatures’ would you ‘trigger’ on? How much ‘computing’ should you need?
- How would you finance it?
- What are current experiments doing, and what are their limits/sensitivity?

Topic 14

- Do the same as topic 13, but pick a different ‘new physics’ model to search for.
- Discuss with the ‘topic 13’ people to make sure it’s a very different model or approach.

Big questions in physics

- What is dark matter?
- What is the mass of neutrinos?
- Where do the ultra high energy cosmic rays come from?
- Are protons unstable?
- Where did all the antimatter go?
- What happened during the big bang?

- Why is the Higgs mass so fine-tuned?
- Why are there (only) three generations?
- What is the top quark mass?

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Considerations

- Purpose of detector? Spend your money:

 very good momentum resolution (—> thin mass peaks)

 complete (4 pi) coverage (—> efficiency, closeness)

 excellent vertex resolution (—> good lifetime resolution)

 very fast timing (—> high event rate)

 little energy loss during travel (—> no radiation loss)

 must deal with high occupancies (—> no saturation)

 good energy resolution (—> good for jets & background)