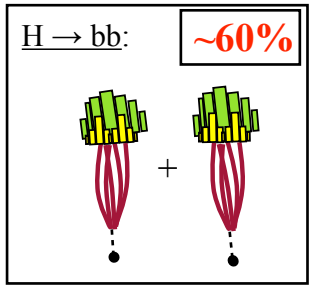
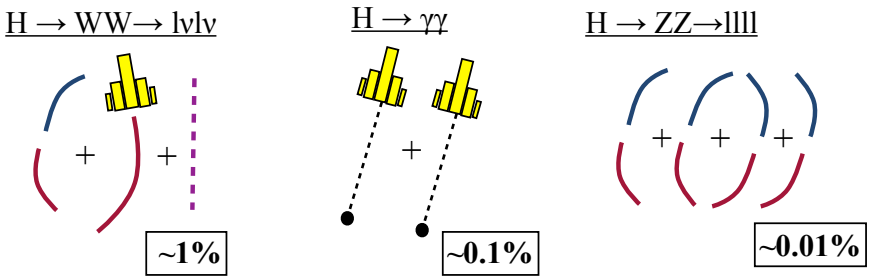
# Lecture 25

Higgs Boson:

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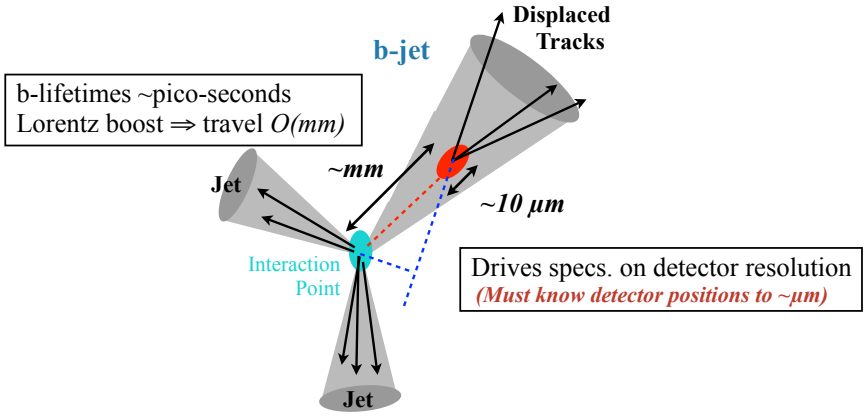
# b-jet Identification *(b-Tagging)*

Critical as b-jet ubiquitous in higgs final states.

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# Triggering

- LHC provides orders of magnitude more collisions than we can save to disk.
  - Can only keep 1 out of 40,000 events / Discarded data lost forever
- Interesting physics is incredibly rare:
  ~1 Higgs per billion events / ~1 Di-Higgs per trillion events

**Triggering**: Process of selecting which collisions to save for further analysis.

Triggering at the LHC:

- Custom Electronics + Commodity CPU
- Fast processing of images (micro-seconds / seconds)
- Events rate from 40 MHz → 1kHz.
- Data rate from 80 TBs (!) → 2 GB/s

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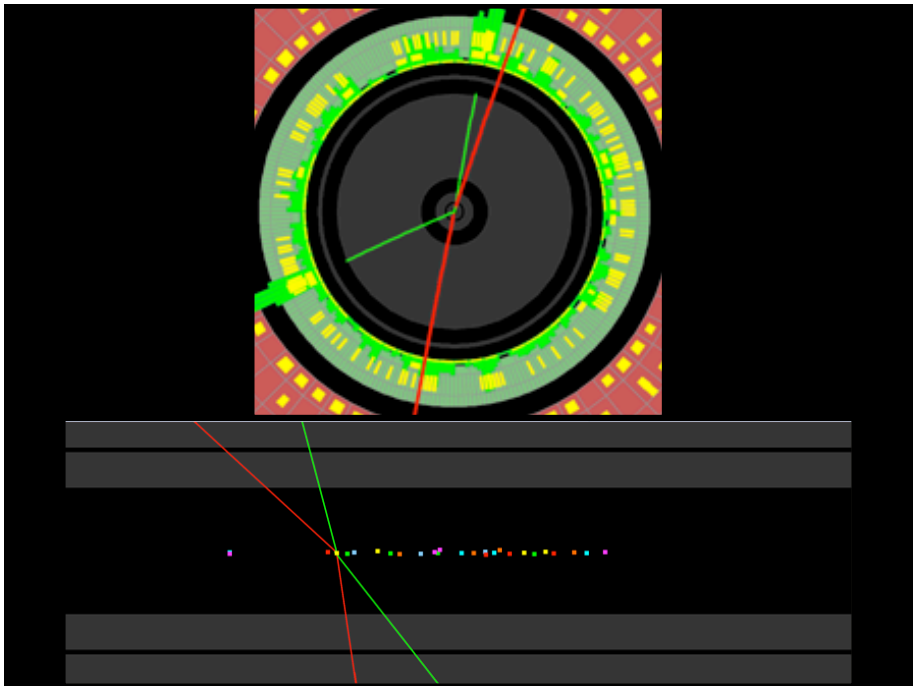
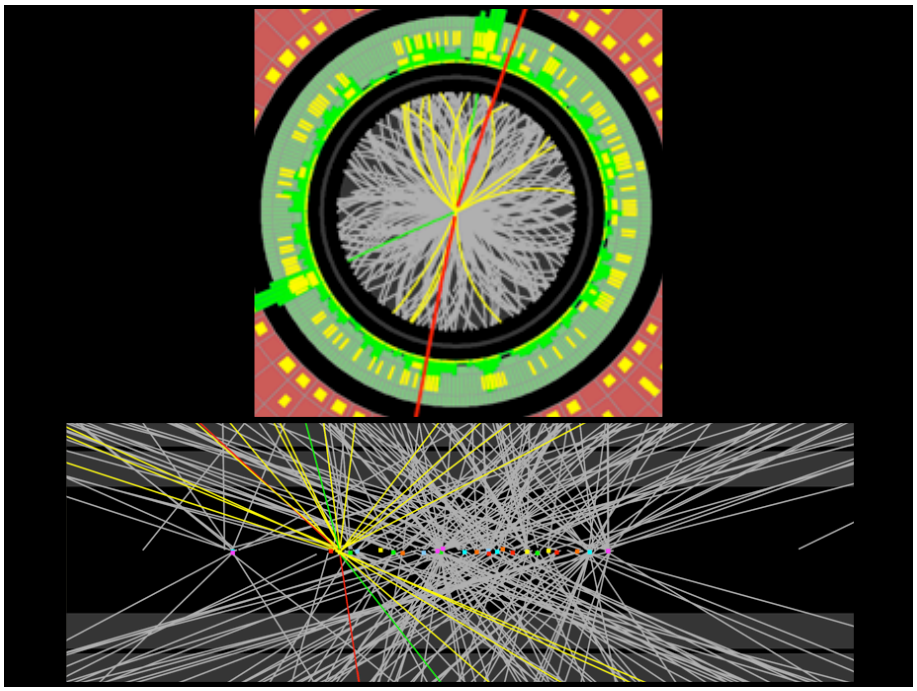
To collect data faster, each event has multiple proton collisions.

Significantly complicates analysis of events





## Vacuum Fluctuations

QM+Spaceetime ⇒ Anti-particles ⇒ Vacuum is interesting place.

Because of QM, need to put in Energy to probe smaller distances.

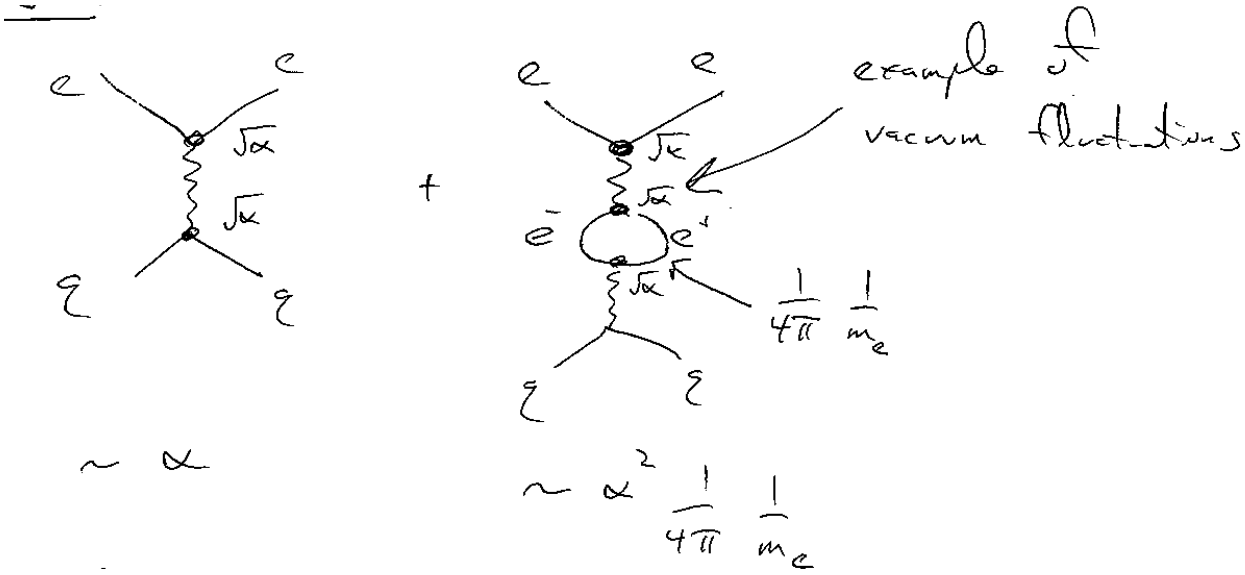
$$E \cdot t \sim E \cdot x \sim 1 \Rightarrow \text{Small distances} \Rightarrow \text{large E}$$

If $E >> 2m_2$ nothing stops you from making $e^+e^-$ pairs.

So operationally, should think of the vacuum as filled of particle-anti-particle pairs constantly coming in and out of existance:

No meaningful sense in which the vacuum is empty.

Example 1




Example 2

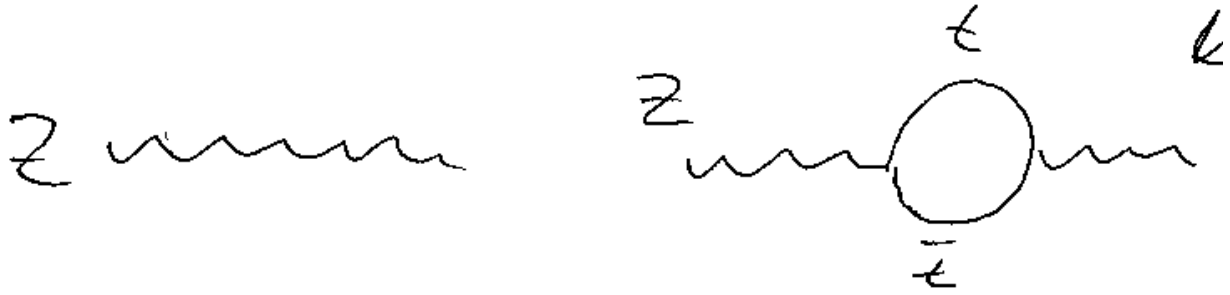



diagram gives a correction to the mass of the Z-boson from the top quark