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Physikpraktikum für Vorgerückte (VP)

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Development of a charged particle tracker with plastic scintillating ber and Geiger-mode avalanche photodiode

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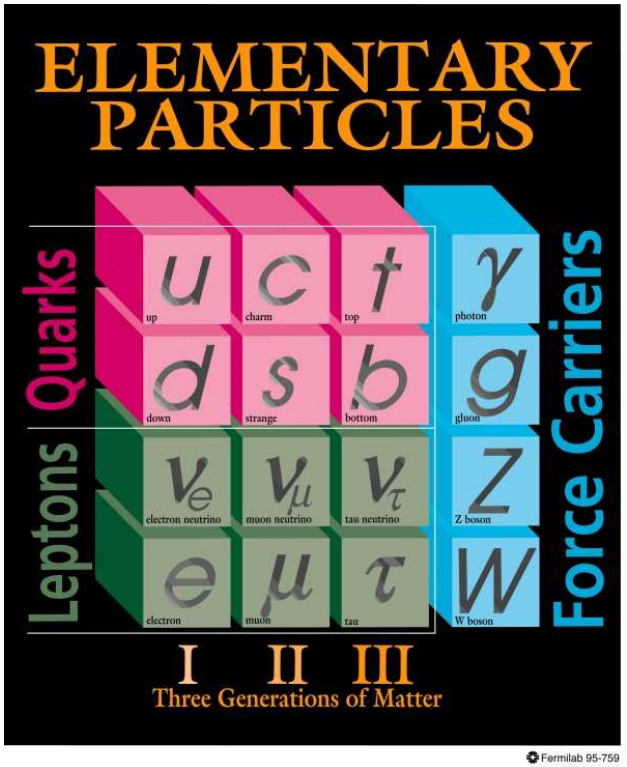
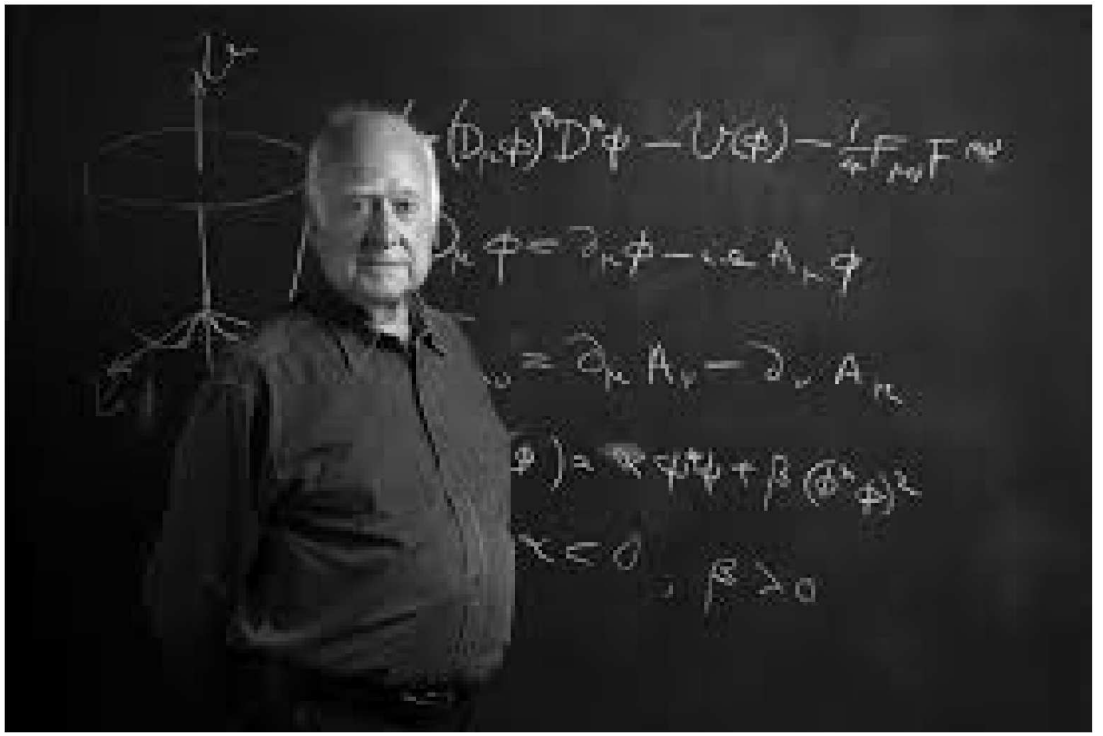
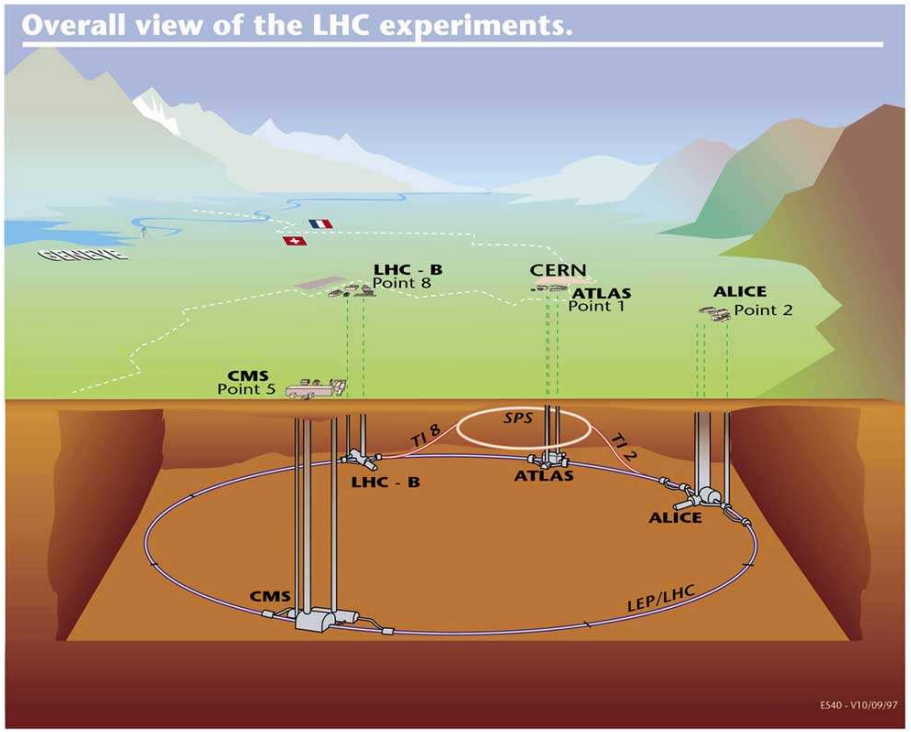
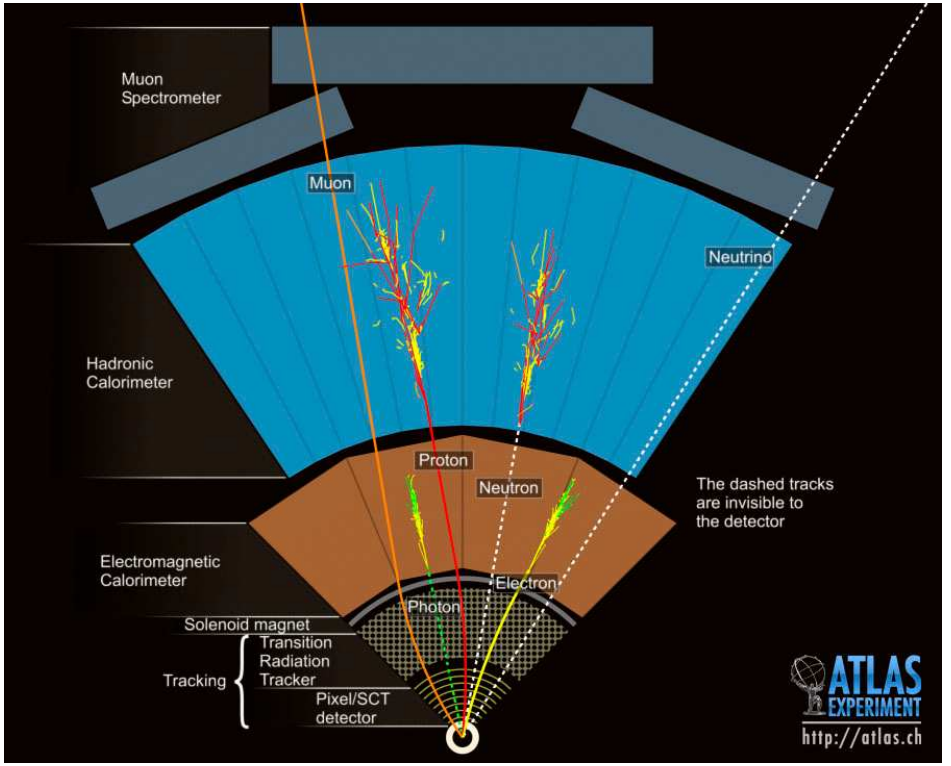




What is the Standard Model?

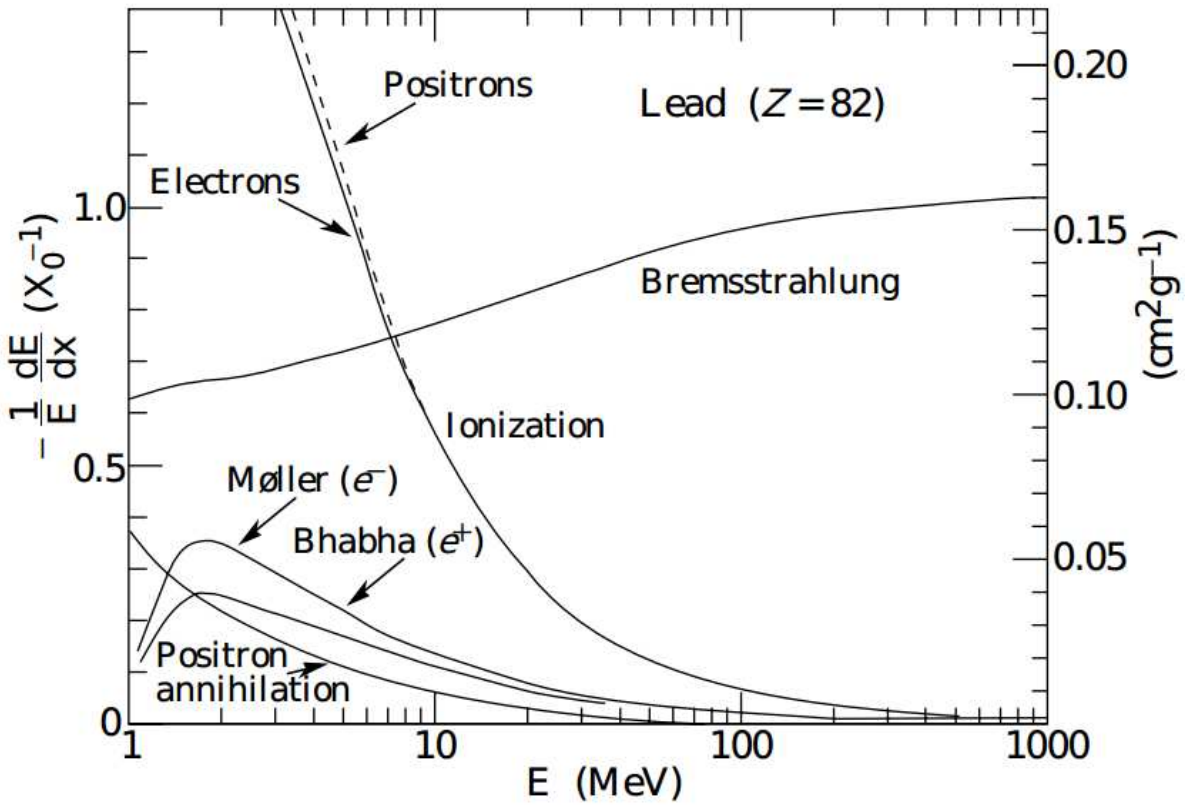
- Theory that describes the interactions between a family of elementary particles
- All those particles and their interactions are observed and tested to very high precision
- The final missing piece - Higgs was found and confirmed last year (Nobel Prize in Physics 2013)





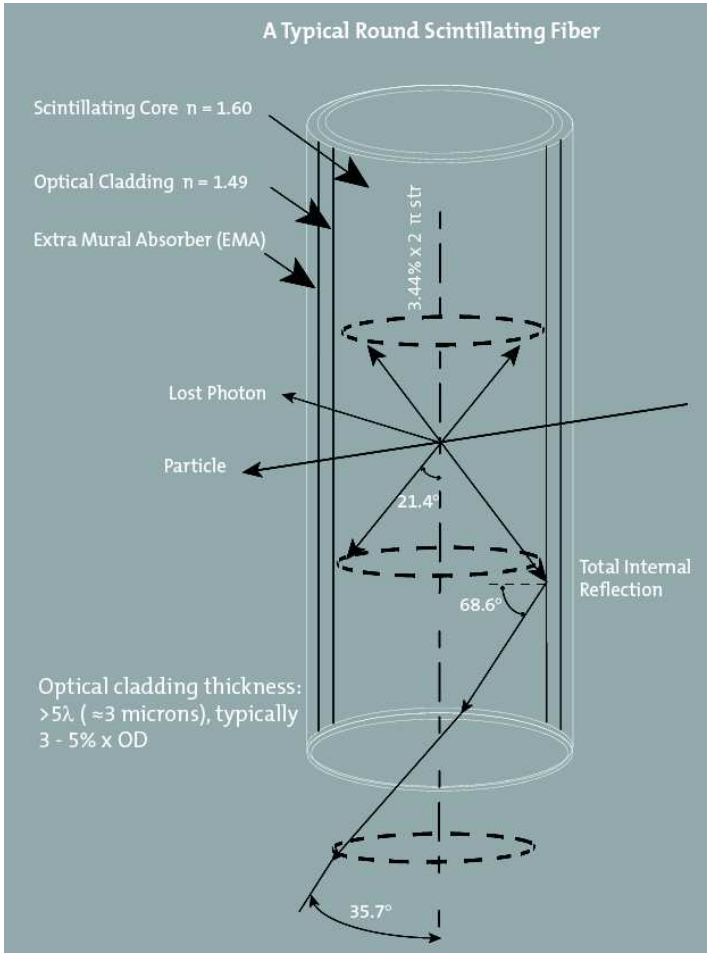
But how they did it?

- Accelerators (Atom smasher)
- Particle detectors (Charged particles, neutral particles, photon)
- Simulations of interactions of particles with detectors (GEANT4, COMSOL)
- Data Analysis (PAW, ROOT)



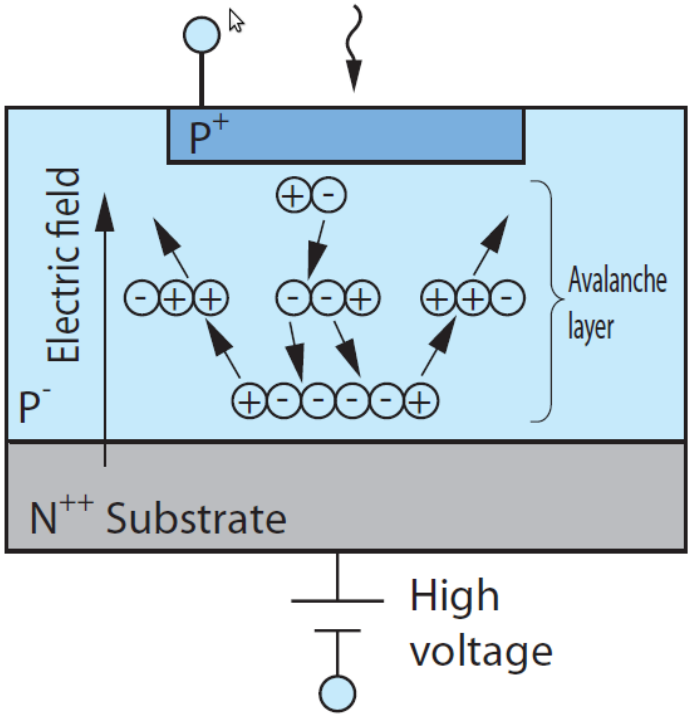
2 main processes of energy loss

- Ionisation (creating electron and ion pair)
- Bremsstrahlung (Interacting with the EM fields inside atom)



Basic principle of detection

- Charged particle losses energy to the molecules inside
- Molecules are excited and drop back to the ground state by emitting photons
- Photons that are trapped inside can travel to the both ends of the fiber



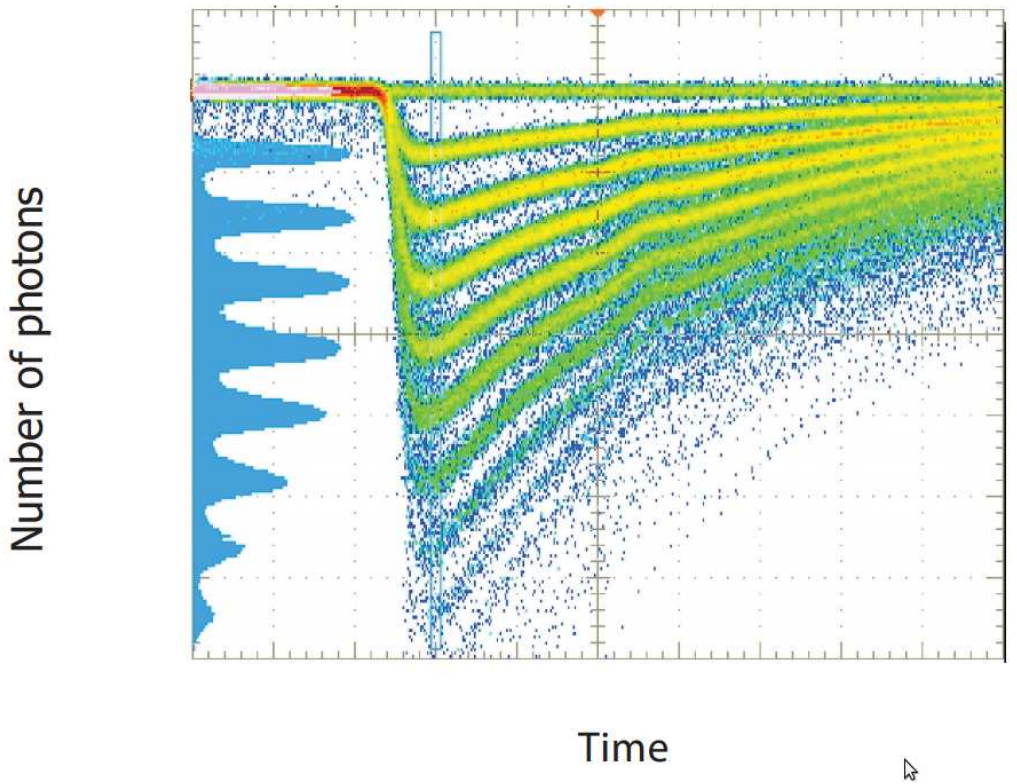
Generated carriers produce new electron-hole pairs while being accelerated by high electric field. Ionization

Newly generated carriers are also accelerated to produce further electron-hole pairs, and this process repeats itself. Avalanche multiplication

Gain proportional to the applied reverse bias voltage can be obtained.

Basic principle

- Photons hitting the entrance will create electron-hole pairs
- Electrons will be accelerated in electric field and repeating the process
- The electrons are detected as a current at the end

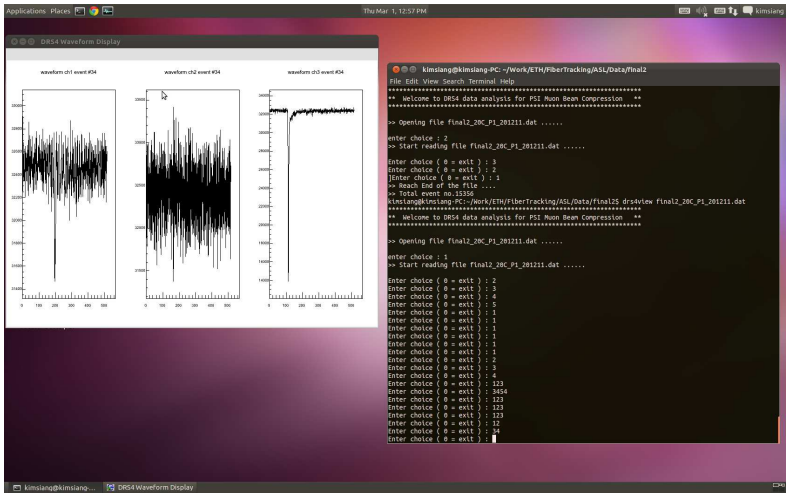


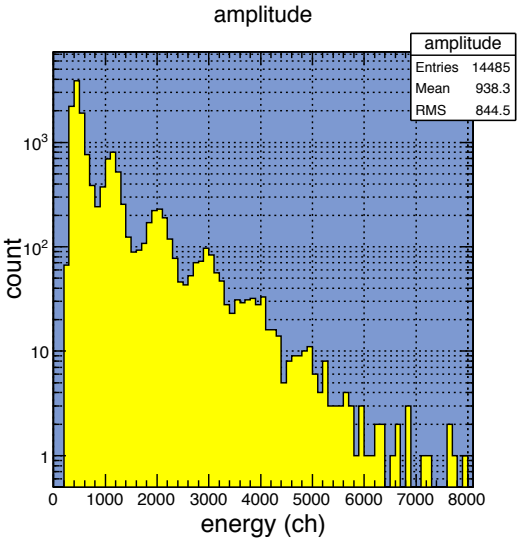
Counting single photon

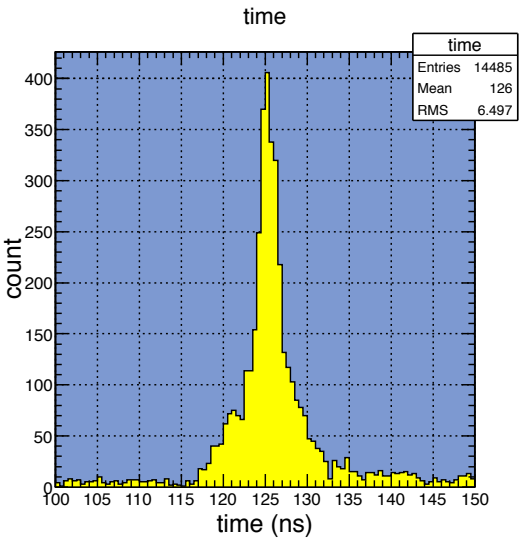
- MPPC (Hamamatsu) is an array of those G-APDs
- 1 Photon can hit 1 pixel which then gives a pulse
- 2 Photon can hit 2 pixels which then gives a pulse of twice the height before

Analog to Digital converter (Digitizer)

- Convert the signal (pulse) to a waveform
- Store them as ROOT files
- Data analysis can be done anytime later







Waveform analysis and histogramming

- Operating system will be LINUX (Ubuntu distribution)
- Terminal will be used extensively
- Determine the timing and the height of the pulse
- Cut analysis to select "goodëvents
- Decide the timing resolution, etc of the detector