NEUTRONS - ITS PRODUCTION IN EXPERIMENTAL FACILITIES AND PARTICLE DETECTORS

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Abstract. Neutron comprised of three quarks i.e. one up (u) quarks and two down (d) quarks. As the most abundant particle and bounded together with protons in a nucleus, neutrons neutralise the repulsive charge of protons within the nucleus to stabilise the nucleus. However, productions of neutrons in particle detectors, as a result of photons interaction with the material of the detector, have been reported, apart from neutrons produced directly from direct particle collision. This paper discusses various process of neutron production in such detectors.

Introduction. In particle detectors, neutrons are produced in a number of mechanism. neutrons are produced from photon interaction with incoming particles or as a result of direct interaction of photons with the material of the detector. This paper discusses various neutron productions in the detectors of some experimental facilities.

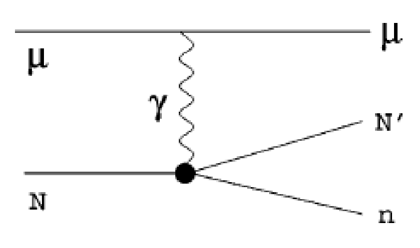


Figure 3. Predicting neutron production from cosmic-ray muons,

Neutron Production at HERA (Hadron Electron Ring Accelerator):

There are three types of neutron production being studied at HERA:

(i) leading neutron (i.e. majority of the energy is carried by neutron) production through one-pion exchanged, where the leading neutrons moved in straight trajectory as incoming protons, and was detected at the FNC (Forward Neutron Calorimeter), refer to Figure 1.

(ii) As decay product of Λ^0 as in Figure 2, where the neutrons being produced .In $\Lambda \rightarrow n\pi^0$ channel, neutrons moves in straight direction through EMC (electromagnetic calorimeter) to HACs (hadronic calorimeter) of the ZEUS detector, and the undetected (i.e. uncharged tracks) by the CTD (Central lTracking Detector)

(iii) As a byproduct of proton acceleration upstream of the ZEUS detector - during proton acceleration, proton interaction with structural material and rest gas mass, causing\reaction $\pi^+ \rightarrow \mu^+$; interaction of μ^+ with bound state nucleons N through photon γ produces neutron n^0 [10] (refer Figure 3)

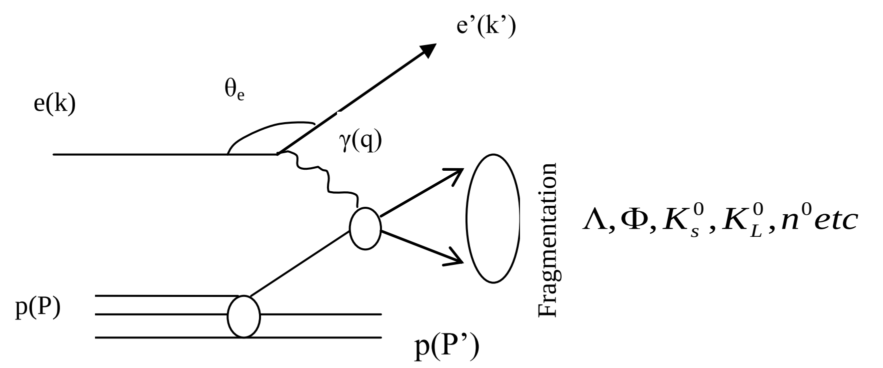


Figure 2.1 Figure 1 Kinematic variables in the electron-proton collision, with P, k , q as the momentum of proton, electron, and photon respectively (generated in the process), Λ^0 decay produced $\Lambda \rightarrow n\pi^0$

Neutron Production at Belle-II

- In Belle-II detector, neutrons were produced as results of scattered electrons interaction with the material of the detector. The collosion of electron and positron at √s ~10.58GeVin the detector produces background neutrons that effected the efficiency of the detector response.
- In BKLM section of Belle-II dector, calculations have shown that replacement of inner layers of Resistive Plate Chamber (RPC) with scintillator layers such as TiO_2 could increase the efficiency of the BKLM detector from 33% to >90%.

Conclusions. Neutrons were produced as a result of photon interaction with the incoming particles or with the material of the detector, In the latter background neutrons are produced, while in former, neutrons produce as part of hadron fragmentation from the particle collision such as e-p near the speed of light.

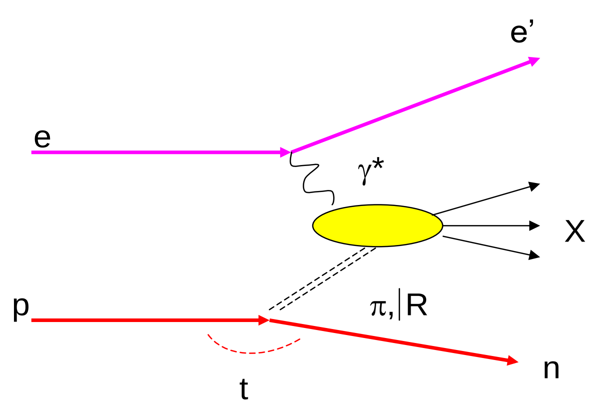
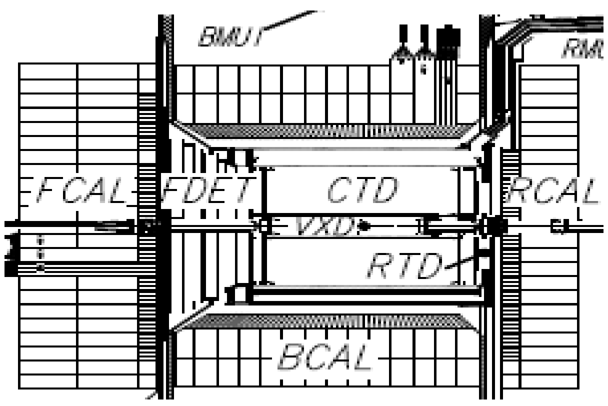
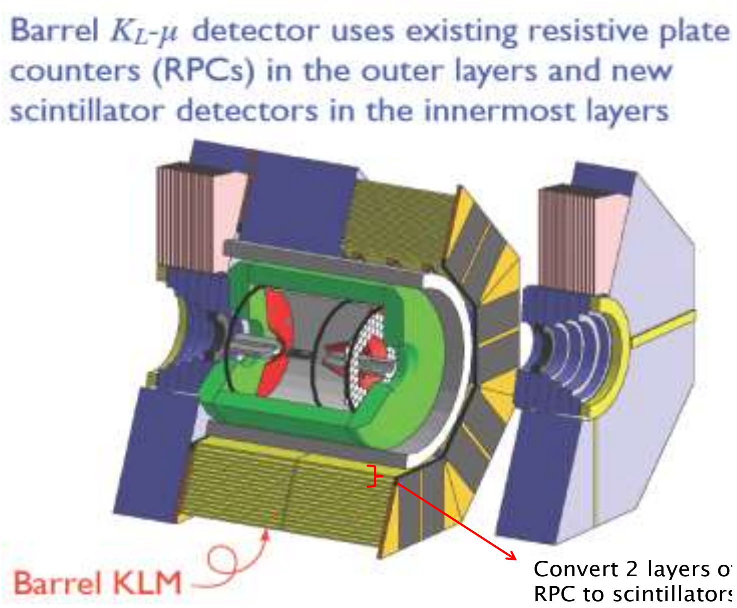


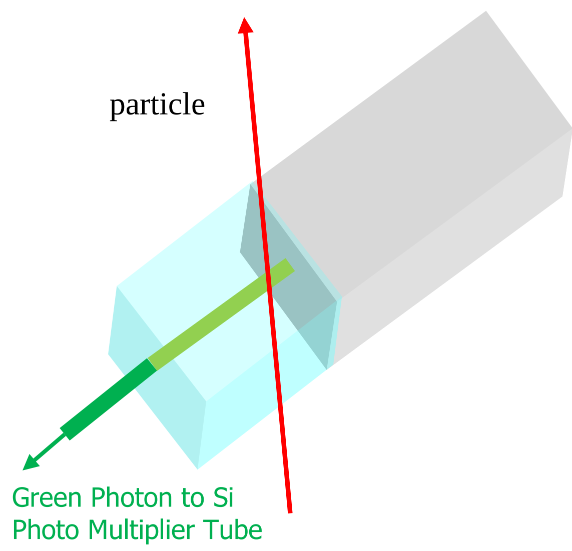
Figure 1. Leading baryon X (neutron) production via an exchange of an exchange



. X-Y Cross section of ZEUS Detector

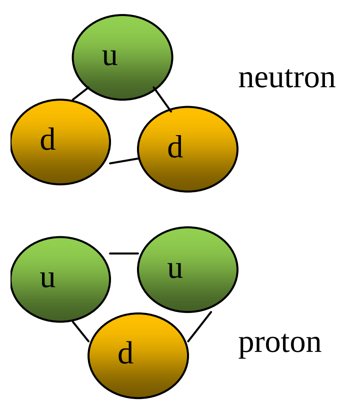


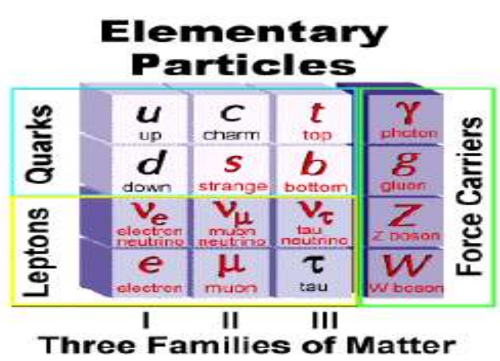
Belle-II detector showing the BLKM section



Light collection via wavelength-shifting fibre. Scintillators are good neutron absorbers, used to reduce background neutron in the BLKM detector in Belle-II

Quarks in Neutron n^0,, proton p^+ (*bottom*)., are bounded strong forces. In **Quantum Chromodynamics**, changes of one quark flavors into another involves the radiation of gluons mediating strong interactions.





Standard Model of Particle Physics