博士論文公聴会の公示（物理学専攻）

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論文題目：A Trigger System with Online Track Recognition for the μ-e Conversion Search in the COMET Phase-I Experiment
(COMET Phase-I 実験における μ-e 転換探索のためのオンライントリガーシステム)

日時： 2020 年 11 月 13 日（金） 13:30 — 15:00

場所：コロナウイルス感染防止のため、オンラインにより行う。URL 等については、学内の方は下記参照。

https://www.phys.sci.osaka-u.ac.jp/naibu/kouchoukai.html

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主査： 青木正治

副査： 川畑貴裕、久野良孝、南條創、能町正治

論文要旨：

The COMET Phase-I experiment searches for the μ-e conversion in an aluminium muonic atom, which is strongly prohibited in the Standard Model. The goal of a single event sensitivity is 3.0×10^{-15} in a 150 day-long physics measurement. To this end, a highly intense pulsed muon beam and a detector system are constructed at the Japan Proton Accelerator Research Complex. The detector system consists of a cylindrical drift chamber (CDC) and arrays of trigger hodoscopes. The CDC measures the momentum of the conversion electrons. The hodoscopes measure their timings.

An initial simulation study indicates the use of the new muon beam gives an unacceptably high trigger rate for the data acquisition system. This issue is solved by a high-level trigger system which is called the COMET trigger (COTTRI) system. The COTTRI system consists of FPGA-based electronics and handles hit information of the CDC to make triggers only for signal-like events. The data acquisition system requires a trigger rate of less than 26 kHz. The total processing time of the full trigger system must be less than 7 μs due to the buffering time of the CDC readout electronics.

The electronics related to the COTTRI system were newly designed and produced. The firmware written in the hardware description language was also developed. Firstly, the COTTRI system was installed in the full trigger system, and the total latency time was measured to be 3.2 μs. It meets the requirement. A 12-hour operation test of the COTTRI system was performed using one-sixth of the CDC readout region in a setup of a cosmic-ray measurement. As a result, the data transfer and processing in the COTTRI system were demonstrated to be robust and stable.

The performance of the COTTRI system was estimated by applying the full simulation of the COMET Phase-I experiment. The background level in the detector system changes with time because the pulsed beam is adapted. For this reason, the trigger efficiency is estimated for possible patterns of the time window. As a result of this study, the COTTRI system is expected to provide the signal event acceptance of 86.0% to 96.8% depending on the time window while keeping the trigger rate of 13 kHz including a safety factor of two.