（別紙様式２）

フォトンサイエンス国際卓越大学院プログラム（XPS）

光科学特別実習　報告書

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会議名	The 29th International Workshop on Vertex Detectors
日程	西暦 2020 年 10 月 5 日～西暦 2020 年 10 月 8 日

Content of the report

The slides for the 5-minutes short presentation are uploaded to:
https://indico.cern.ch/event/895924/contributions/3988295/attachments/2104861/3559093/slides.pdf,
and the poster is also uploaded to the same place:
https://indico.cern.ch/event/895924/contributions/3988295/attachments/2104861/3559052/poster.pdf.
The proceeding of the conference is published and available on the web:
https://journals.jps.jp/doi/pdf/10.7566/JPSCP.34.010017.
For a detailed and complete report, please check them.
For better readability of this report, I quote the abstract of the proceeding:
"For stable operation of the Belle II Silicon Vertex Detector in the future high-luminosity operation of SuperKEKB, we plan to reduce readout data-samples per trigger and to apply hit-selection using hit-time. To realize this plan, we developed novel hit-time estimation methods, one of which achieves the resolution of 2.28±0.04 ns evaluated in the current data acquisition mode. A study using Monte Carlo simulation also confirms that the hit-selection based on this hit-time improves track reconstruction performance."

Experience during the conference

Poster session: We used the online chat (CERN mattermost) for poster discussions. Figure 1 shows a screenshot of this web page. The questions were not many, but I think I could get the points and answer all of them. Here I list the discussion points:

- The chip-by-chip difference of APV25 shaping time. They are around 50 ns, but I could not show the precise numbers. However, this does not affect the hit-time estimation since it is calibrated sensor by sensor and side by side, corresponding to 4-6 chips.
- Radiation effect on the chips. It should be small since the circuits are analog, so no single event upset is expected.
- Reason to use double-Gaussian for fitting the signal hit-time distribution. It is empirically chosen and has no physics motivation but can represent the component delayed to the nominal signal timing that appears in the hit-time distribution. This component could be due to curlers – particles with low momentum curl many times in the magnetic field.
- Energy deposition difference in 3-sample and 6-sample acquisition mode. It is estimated to be small enough, less than 1%, if the trigger jitter is smaller than 10 ns in standard deviation.
    - Reason for no overestimation of energy deposition (underestimation can only happen). Energy deposition is taken from the largest of readout three or six ADC values. The readout three samples are included in the six samples, so the energy deposition in the 3-sample cannot be larger than in the 6-sample.

(Thanks to the questioner for giving me such feedback.)

Talks: Many presentations drew my interest. One of them was the talk by Miljenko Šuljić, about an upgrade plan of the inner tracking system of the ALICE experiment. (The slides are uploaded to:
https://indico.cern.ch/event/895924/contributions/3968853/attachments/2102500/3564066/alice_its3_msuljic_vertex2020.pdf.)

It was a completely new idea to me to bend the silicon wafers and readout circuits to the cylindrical shape. The sensors are self-supported, which allows them to remove the supporting structure densely packed before. Then, the sensors can be placed further close to the beam pipe, with a much smaller material budget. The perfectly cylindrical sensor geometry also removes the anisotropy of the material budget and hence the systematic error. As a spacer, low-density open-cell carbon foam is used. This spacer has a low material budget and allows air-cooling of the

readout circuits. Also, new wafer-scale chips for data readout are designed for these cylindrical-shape sensors – a serial combination of multiple readout circuits in the current detectors.
The presentation showed not only the merit of this concept but also its realizability. Twenty μm-thick silicon wafers were successfully bent to a radius of around 2 mm. The readout circuits were confirmed to work without performance degradation even after the bend. The currently-in-use 50 μm thick sensors were also tested after bending and successfully readout.
The talk was wholly impressive to me – I didn't think silicon wafer is bendable, and I didn't find any profits in making a cylindrical sensor.

<u>Outcome through this program</u>

Through this program, I have experienced some valuable things as a researcher.

First, giving even a short talk at the international conference itself was a good experience. Even though it was an online conference just sitting in front of my laptop, I felt pressured and got nervous a little. I think it is essential to make a presentation at many opportunities and become used to it for giving a better talk. I will make use of this experience next time.

Second, it was fruitful to discuss my studies with people from outside of the collaboration. Some of the questions asked by them were not pointed by the collaborators, probably because they could understand well based on their knowledge. It was meaningful for my understanding of the detector to think these points even though they turned out to be not problematic afterward.

Finally, it was interesting to hear the presentations on silicon detectors by the people from many experiments. These presentations showed new ideas I didn't think of before, which stimulated my curiosity, expanded my horizon of silicon detectors, and made me think about the future of silicon detectors.

I believe these experiences will help me to make a career as a researcher.

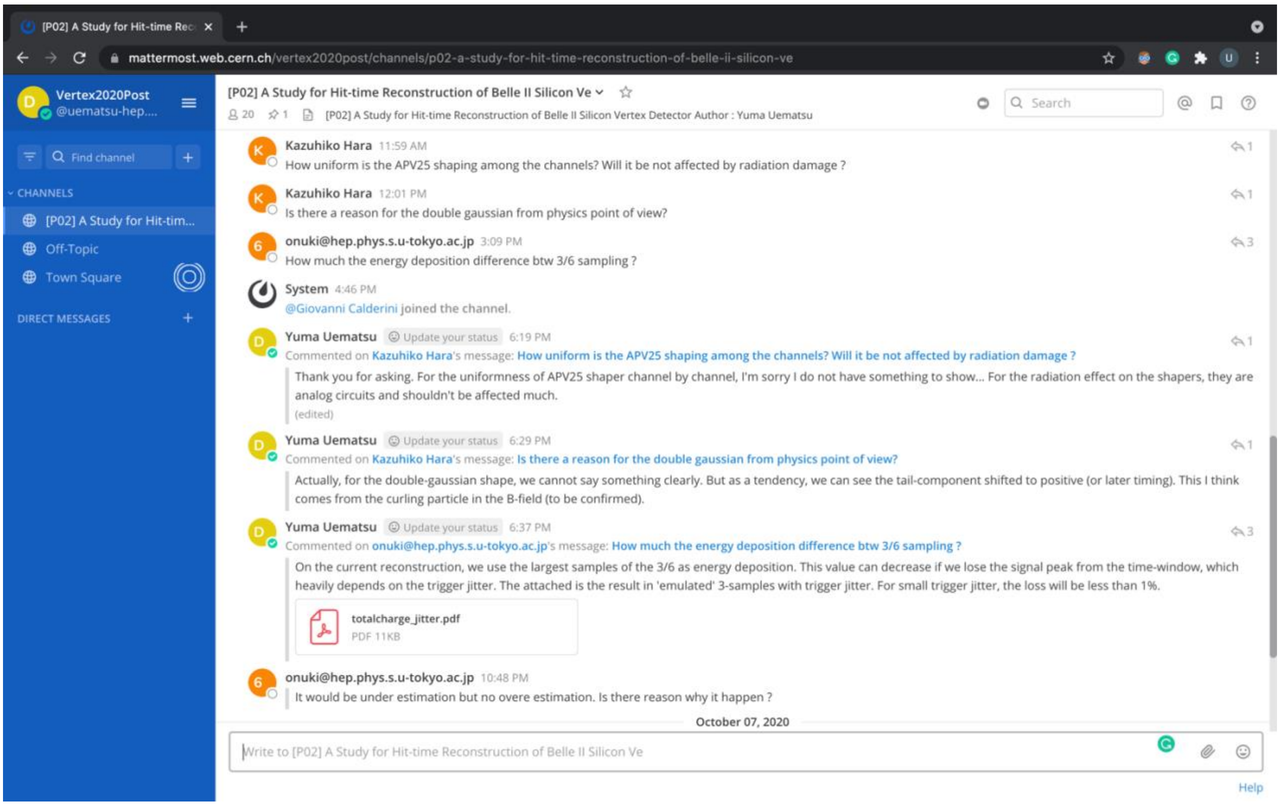

Figure 1. A screenshot of the poster discussion web page (CERN mattermost).