

Evaluation of the front-end electronics with dual-gain amplification

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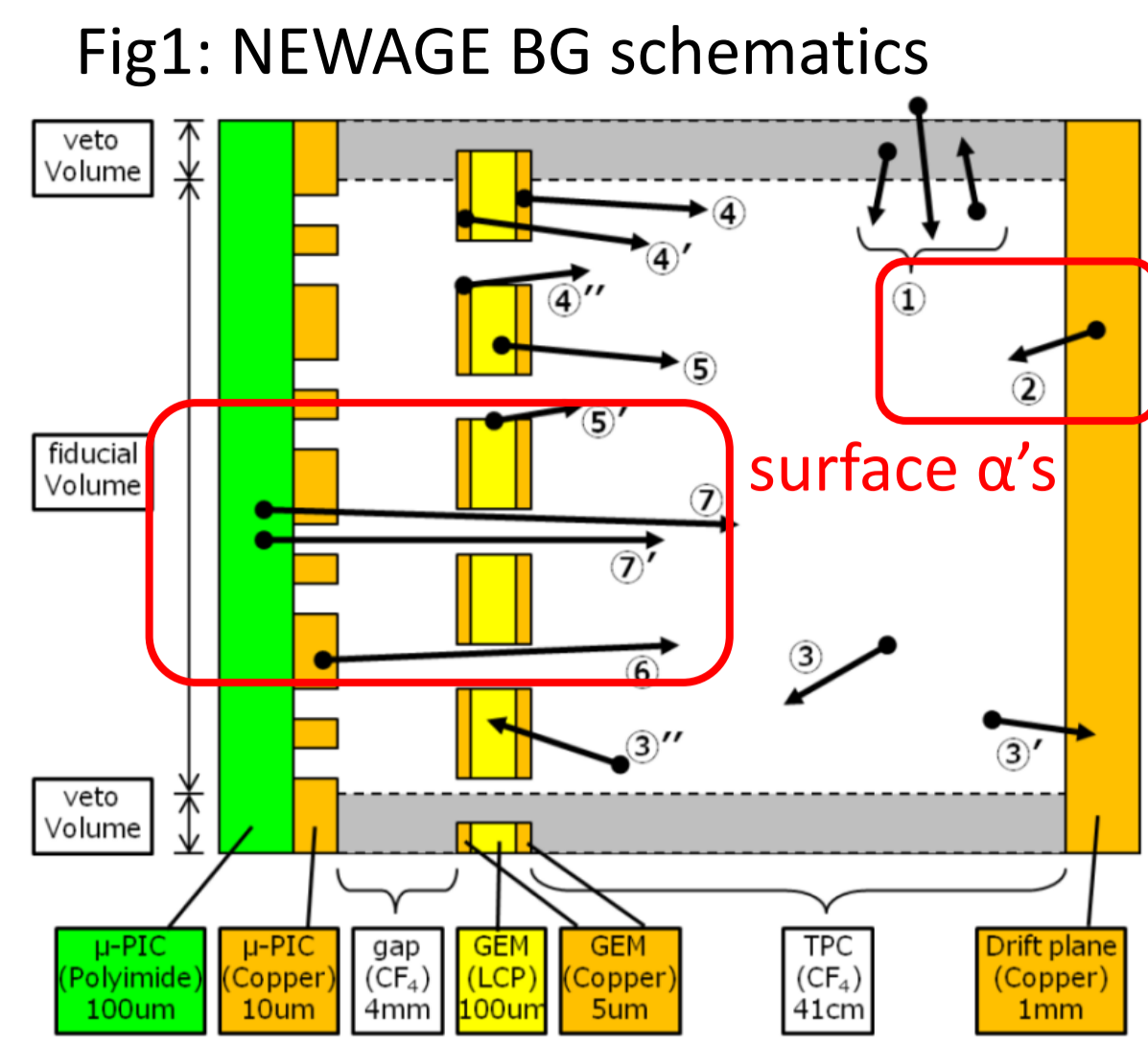
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Direction Sensitive
WIMP-search
NEWAGE

1. Introduction

- α - rays from the readout plane (μ -PIC) are serious background (BG) source in NEWAGE (Fig.1).
- "Negative-ion TPC" will help us to reduce these BG.



- Negative ion TPC
 - Drift negative ions, not electrons
 - smaller diffusion
 - better angular resolution
 - Some types of negative ion gas (SF_6 , CS_2) have more than one species of negative ions with different drift velocities (Fig. 2).

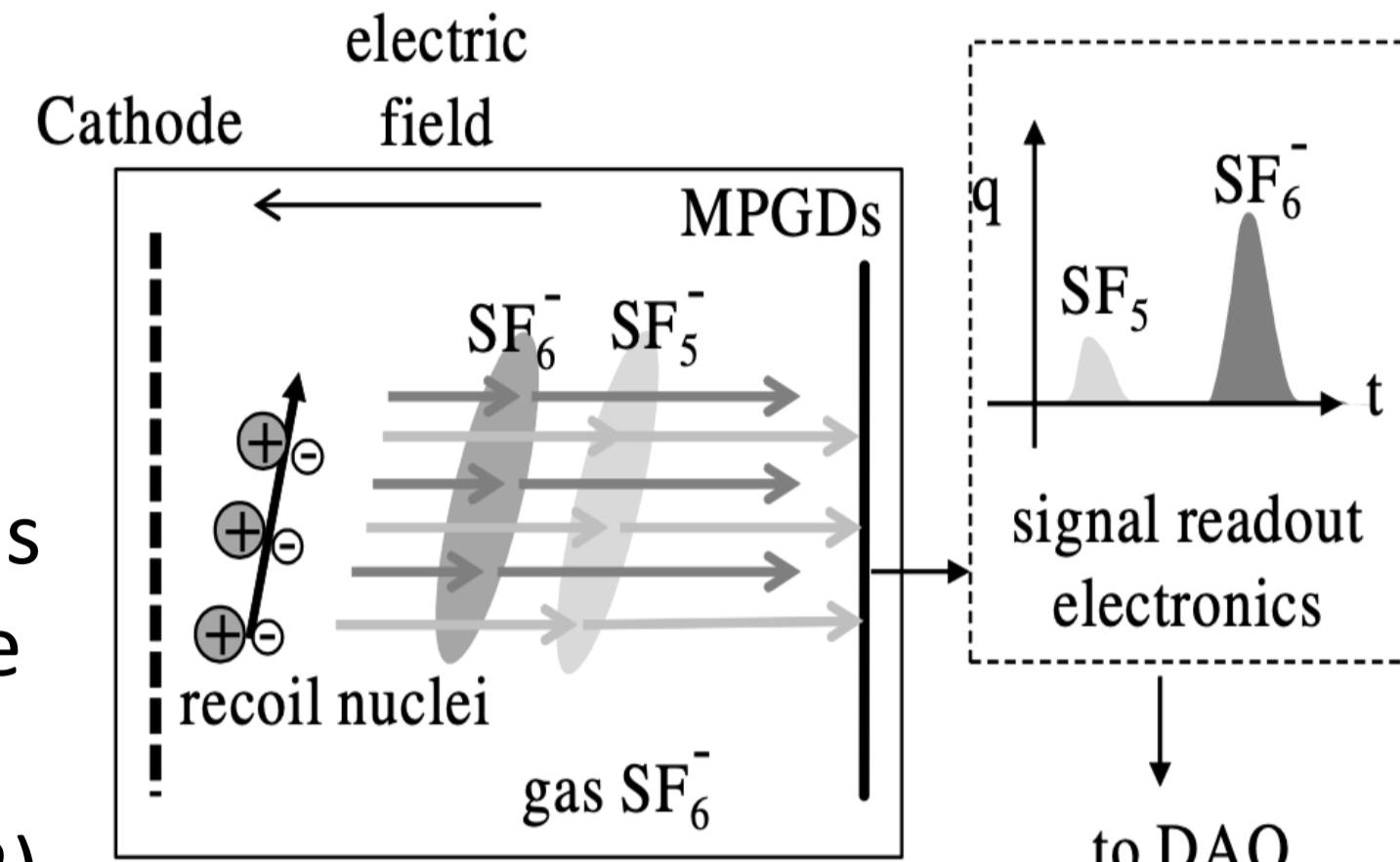


Fig2 : Negative ion TPC concepts [1]

- Absolute position along the electric field can be know from the arrival time difference (SF_6^- and SF_5^- in SF_6)
- CAVEAT: SF_5^- signal size is TINY; $SF_6^- : SF_5^- = 97 : 3$
 - We need a wide dynamic range for readout.
- In order to achieve it, we had developed a readout electronics chip "LTARS2018_K06B" [1].

3. Purpose of this study

- Until this study, it was unclear whether gain switching really occurs for one pulse.
- The purpose of this study is to confirm this "dynamic gain switch."

4. Performance test

- A control board, "SIRONEKO" (Fig. 4), was used to:
 - input control signals to LTARS2018_K06B
 - set the threshold value
 - inject a test pulse
- Check signals with oscilloscope pulse by pulse
 - Ch1(Y): Test pulse
 - Ch2(B): Output signal from LTARS2018_K06B OUT
 - Ch3(P): Comparator state (HG or LG)
- Fig. 6 and Fig. 7 are static gain mode for HG and LG, respectively.

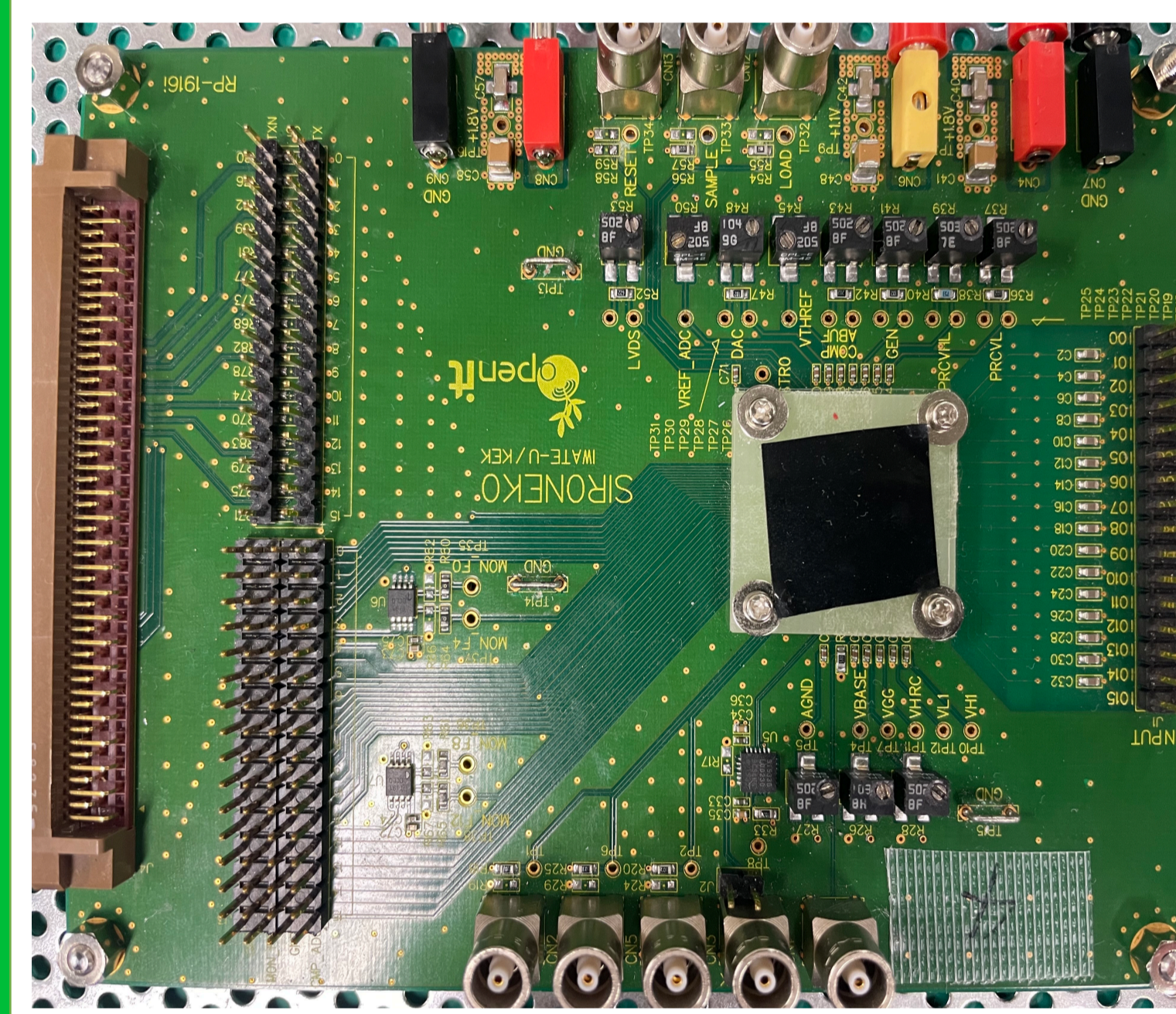


Fig4 : SIRONEKO board

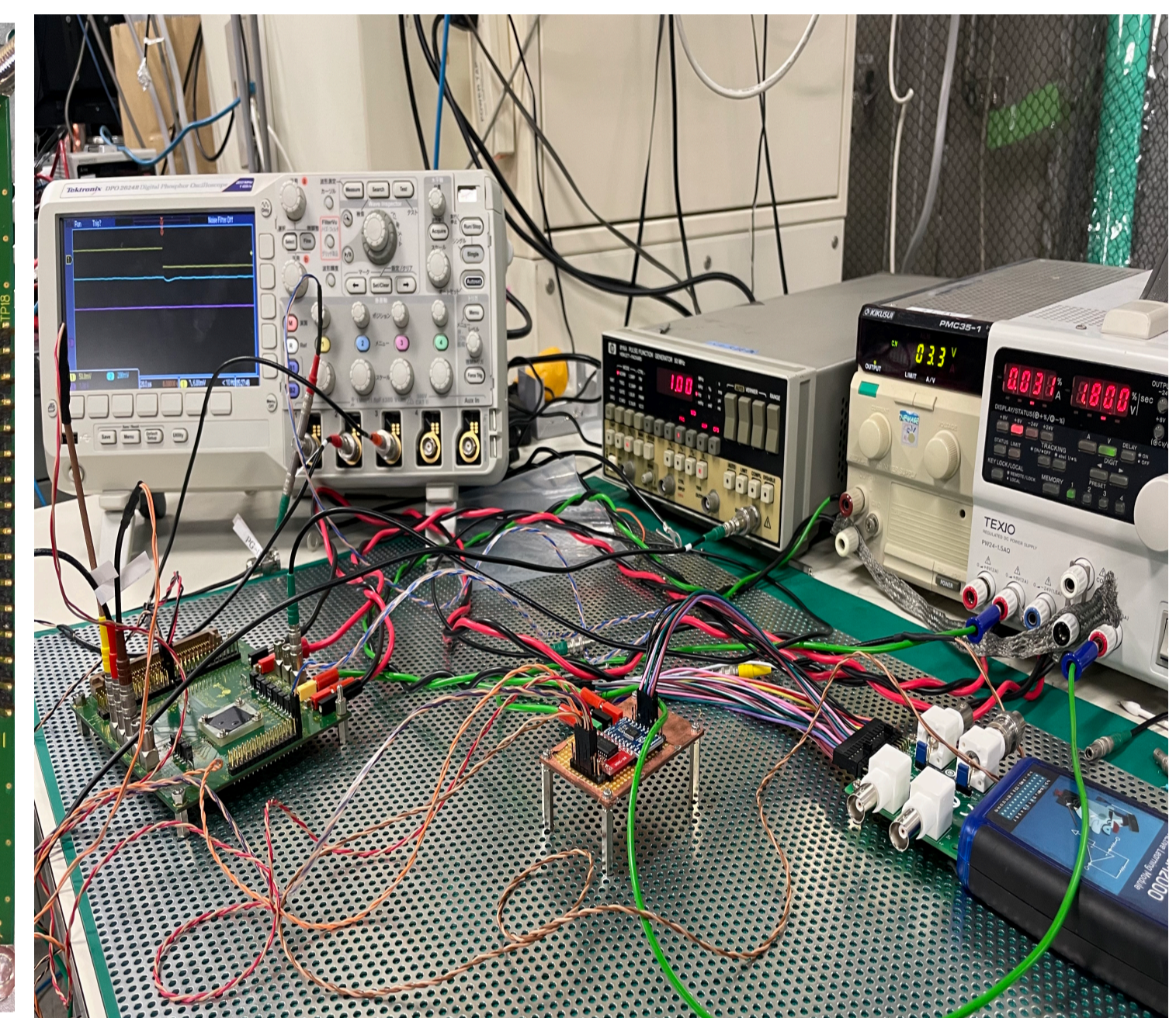


Fig5 : Setup for this study

2. LTARS2018_K06B

- IC chip for the negative-ion gaseous TPC and liquid argon TPC.
- Dynamic gain change:
 - Feedback capacitance \odot can be automatically switched \bigcirc for a large signal (high gain (HG) → low gain (LG)).
 - Switch Low gain mode(LG) from High gain mode (HG)
- RESET signal \bigcirc switches back to HG.

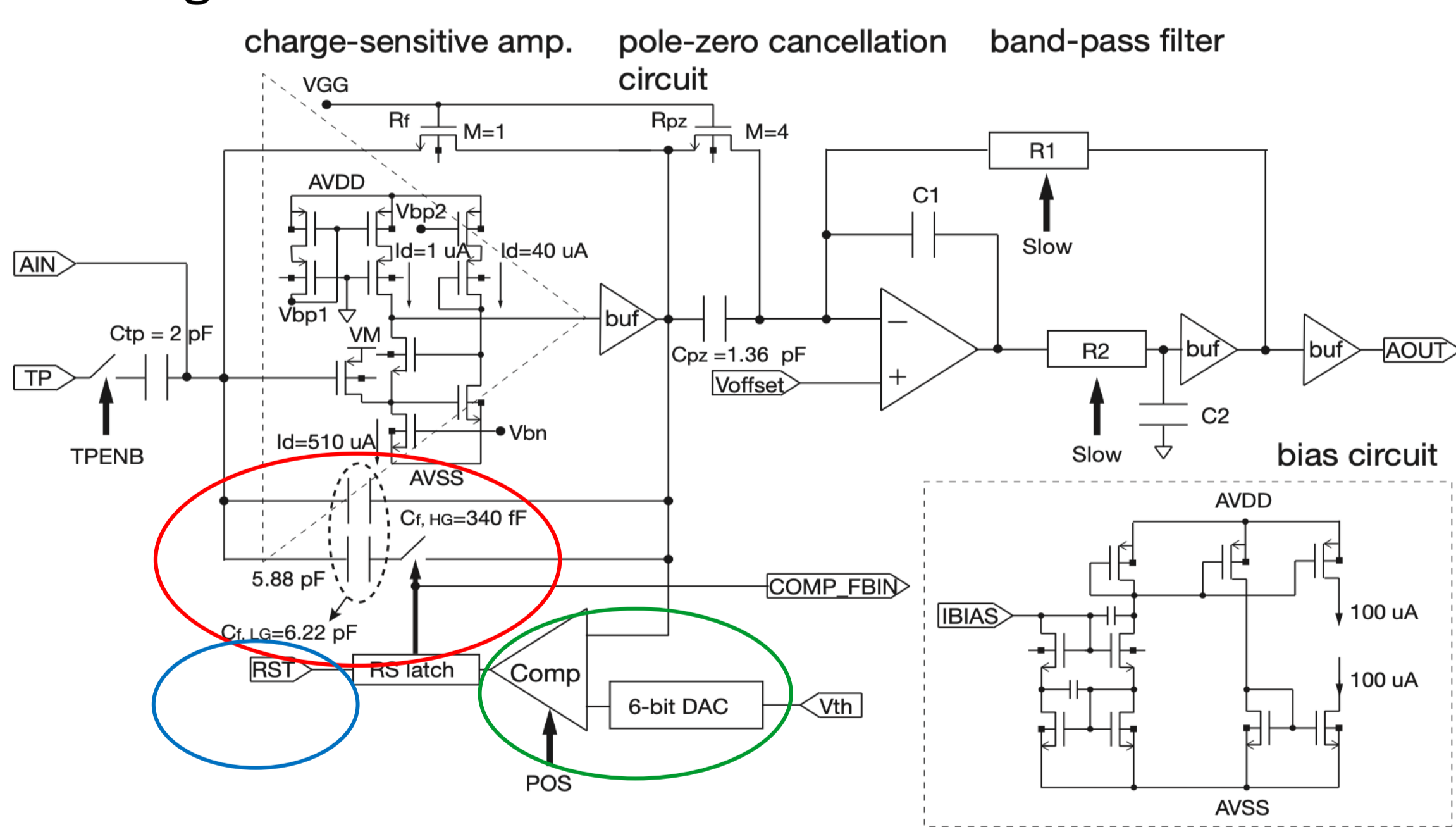


Fig3 :circuit diagram of LTARS2018_K06B [1]

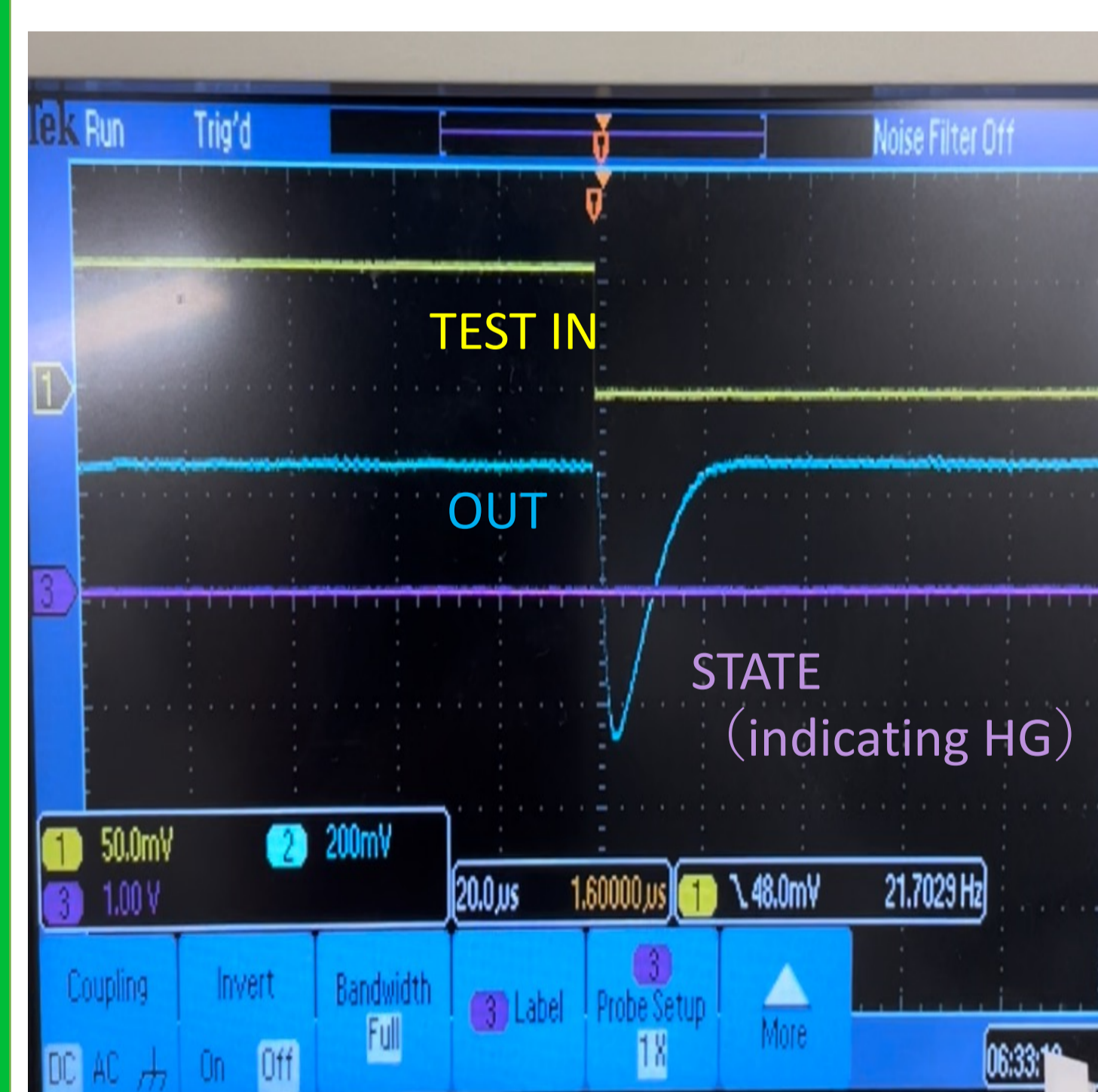


Fig6: HG mode

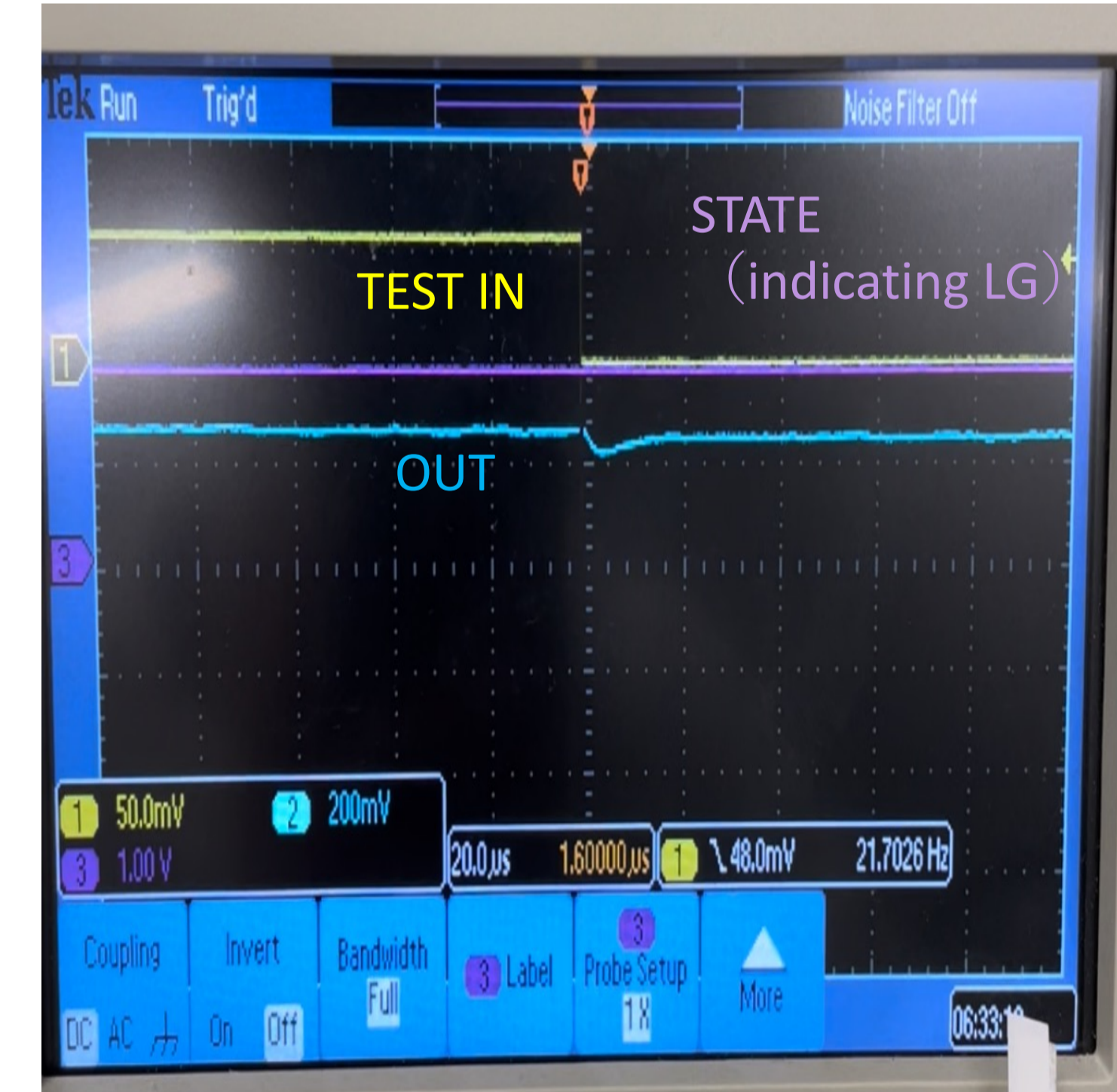


Fig7: LG mode

5. Result

- Fig 7, clearly seen that gain mode is **DYNAMICALLY SWITCHED** when the comparator is turned on
- Switching gain mode allow us to detect the signal in a wide dynamic range

6. Conclusion

- Dynamic gain switch function of LTARS2018_K06B was confirmed for the first time.
- This performance test showed that LTARS2018_K06B can be used for negative-ion TPC.
- We plan to design new board which has O(100) readout channels.

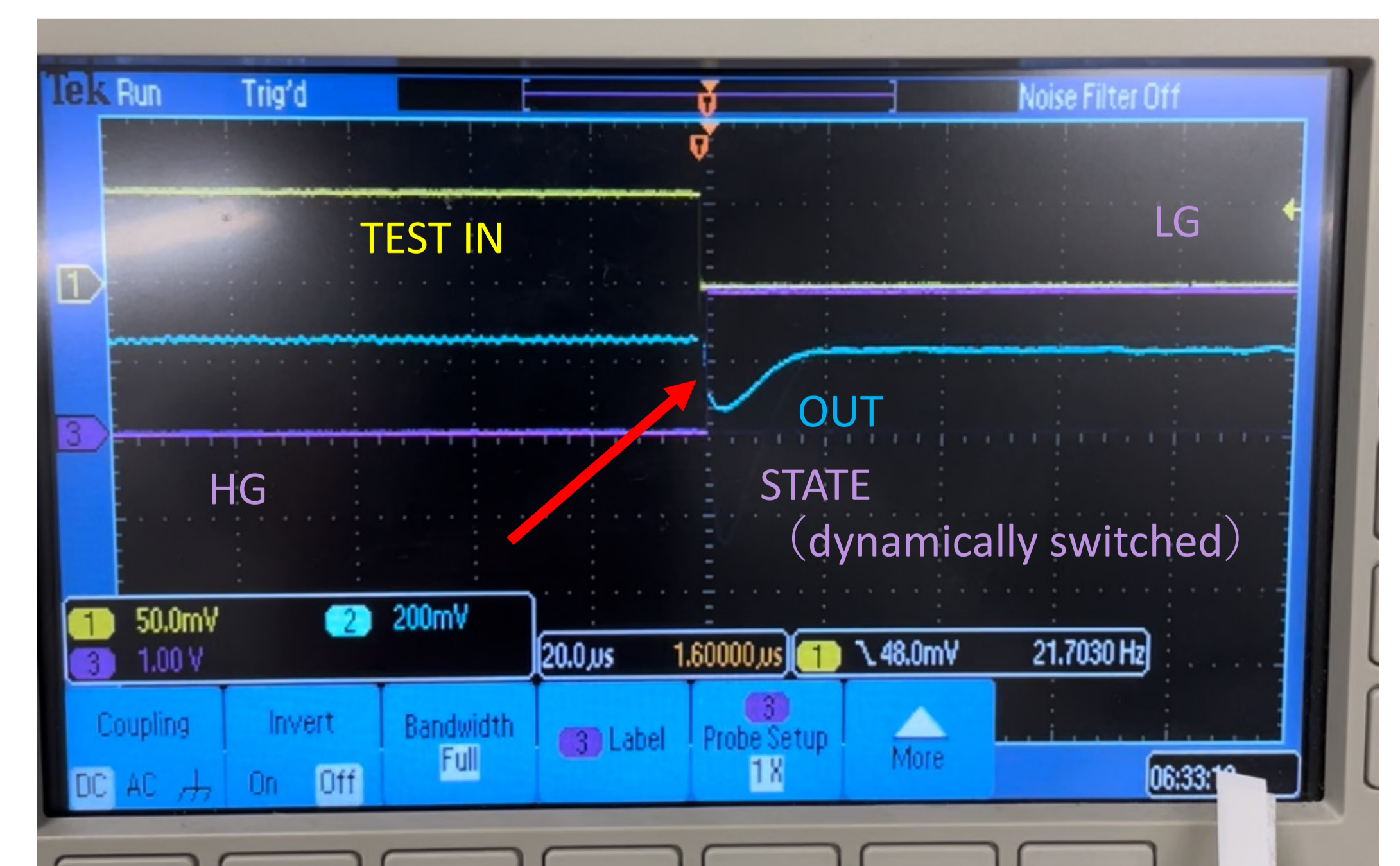


Fig8 : Dynamic gain switch

7. Ref

- [1] T. Kishishita , LTARS: analog readout front-end ASIC for versatile TPC-applications , et al 2020 JINST 15 T09009
- [2] 五十嵐大翔 修士論文「TPC測定器で用いる信号読み出しエレクトロニクスの開発」(2020)