



Update on the double injection threshold scan

Thanks to Maurice Garcia-Sciveres, Timon Heim and Magne Lauritzen

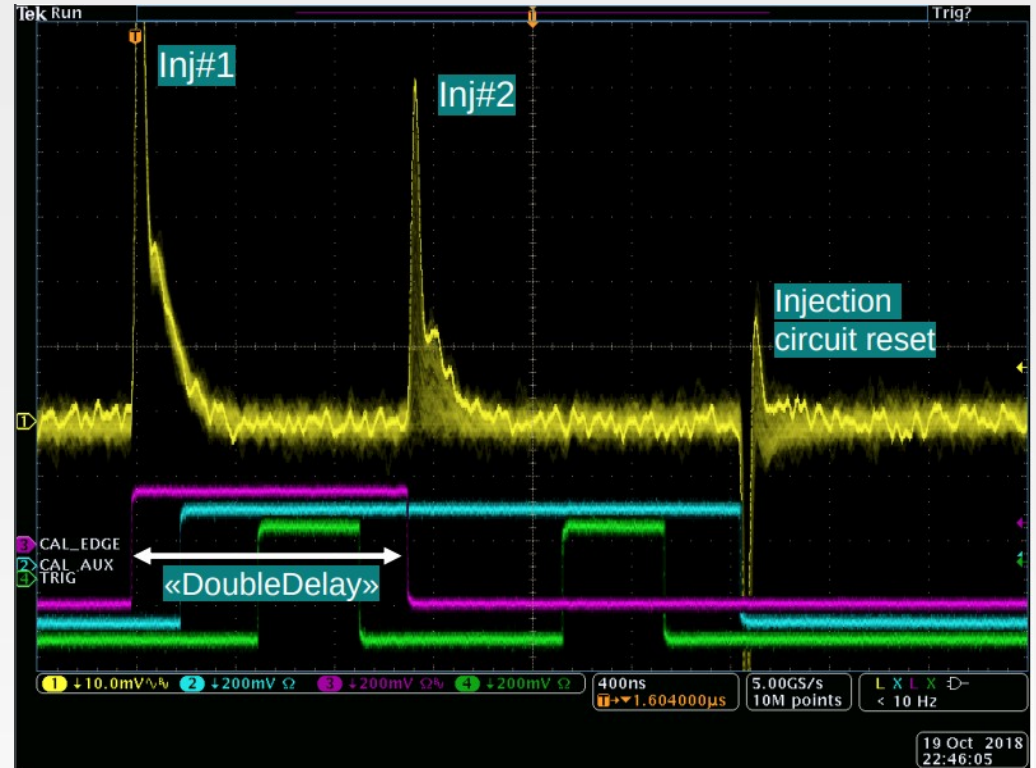
Presented by Simon K. Huiberts





Introduction

- Purpose is to investigate the behavior of the Front-end (FE) after charge injections and data readout
- Study here by using a **double injection scan**
- **Double injection scan** injects **two consecutive charge injections** into each pixel
 - Done via Cal commands which controls the capacitor injection for a selected pixel
- **How it's done:**
 - Injecting a constant charge into the pixel (Inj#1)
 - Wait a set period (DoubleDelay)
 - Injecting a second charge of varying magnitude (Inj#2)
 - Send triggers to read out the data



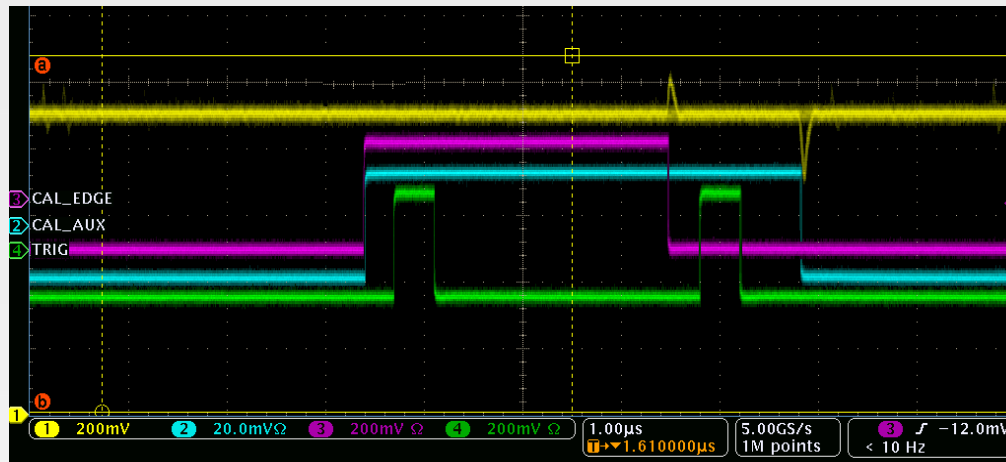
- Double injection scan taken by an oscilloscope. Figure by Magne Lauritzen



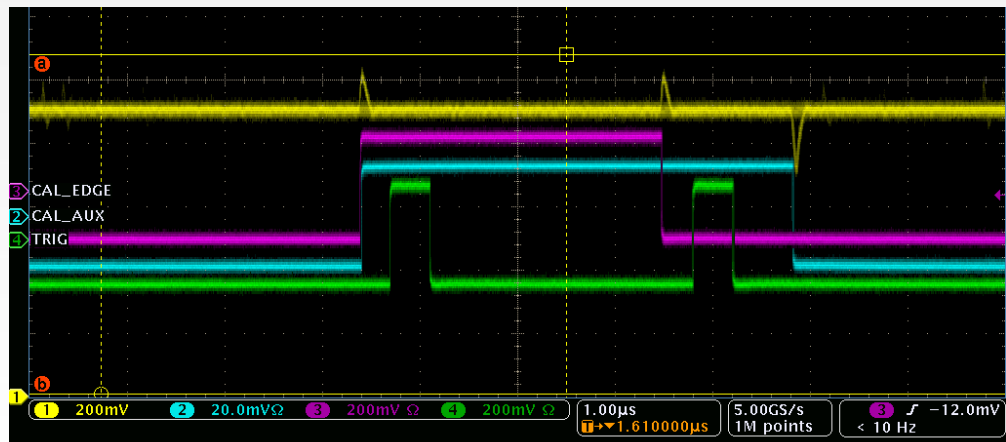
Method

- For each allowable value of the double delay, perform:
 - A double injection threshold scan with **#Inj1 set to 0e** (Upper figure)
 - Gives a **baseline** use to compare the effect of the next scan:
 - A double injection threshold scan with **#Inj1 = 2000e** (Bottom figure)
 - Injection 1 crosses the pixel threshold
- **Probe** the effect that the #Inj1 = 2000e has on the threshold distribution

Baseline (Only have the second charge of varying magnitude)



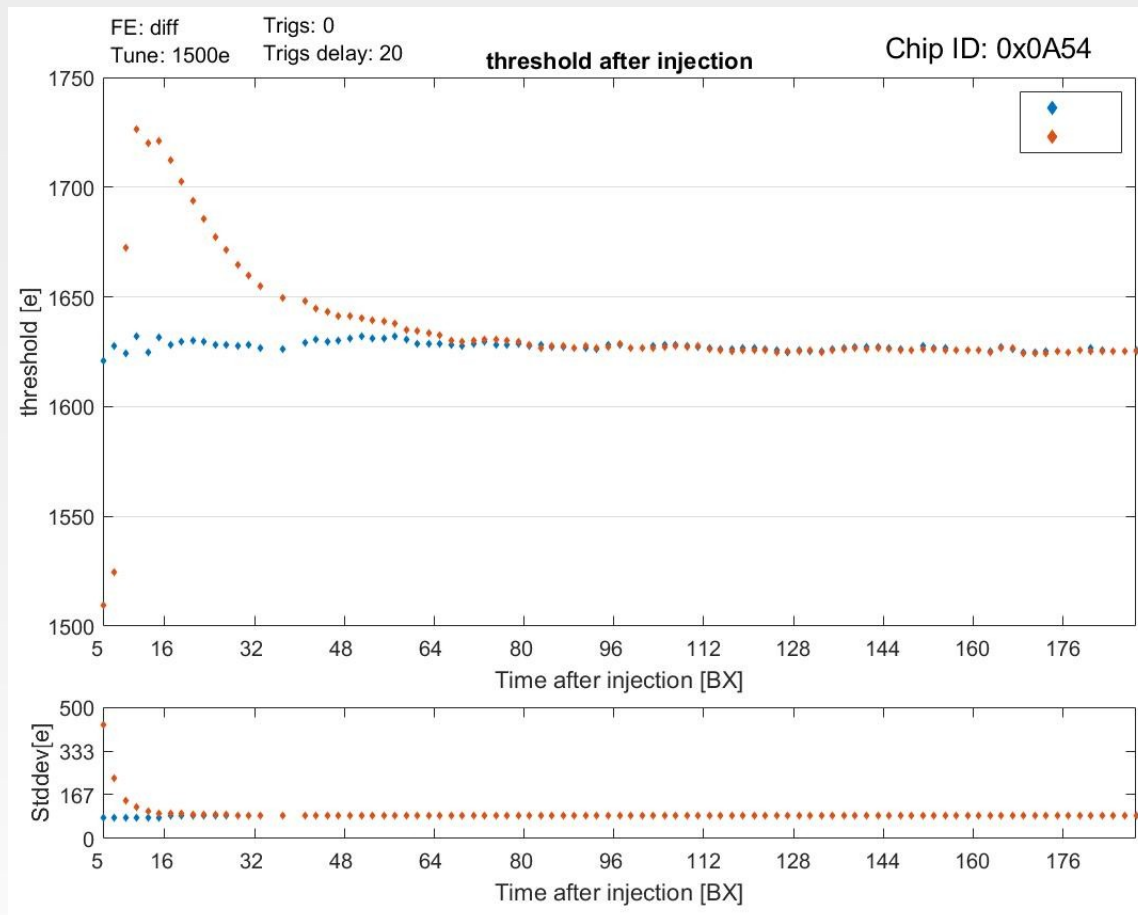
Inject 2000e and then inject a second charge of varying magnitude





Threshold mean vs. Double delay (Differential FE)

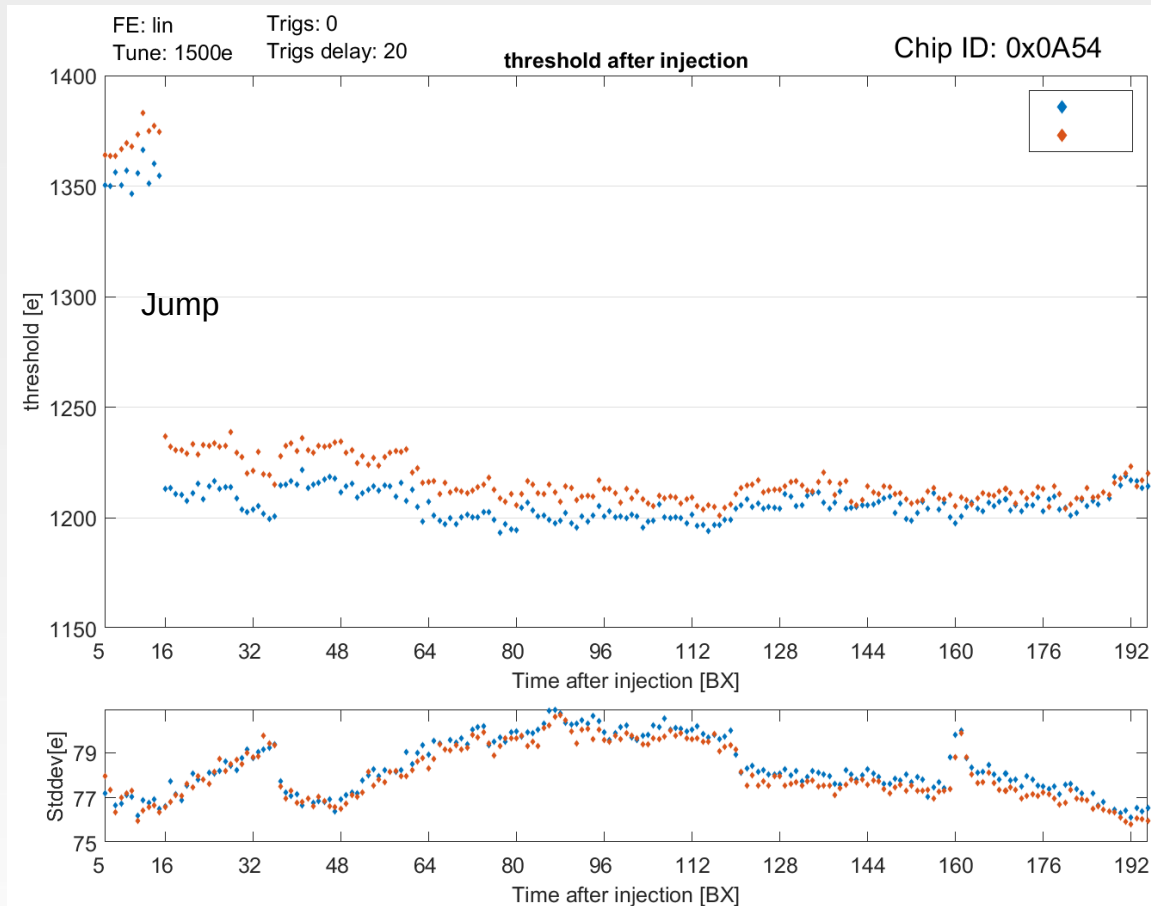
- Diff FE: Tuned to 1500e
- **Blue points: Baseline** (Only have the second charge of varying magnitude)
- **Red points: Inject 2000e** and then inject a second charge of varying magnitude
- X-axis shows the time between the two injections (double delay)
- When the double delay is small - > the mean of threshold increases when having a first injection of 2000e (**Red points**)
- Most likely caused by the disturbance of the first analog injection or the readout





Threshold mean vs. double delay (Linear FE)

- Lin FE: Tuned to 1500e
- Blue points: **Baseline** (Only have the second charge of varying magnitude)
- Red points: **Inject 2000e** and then inject a second charge of varying magnitude
- X-axis shows the time between the two injections (double delay)
- High threshold jump on both injection and baseline sequence from **15 [BX] to 16 [BX]**
- Two different injection commands is used here
- Timewalk: Reason why its only observed here is because the FEnds behaves different in terms of timewalk
- When $dd > 16$ [BX] Small difference for low double delay values and points merge at larger double delay values

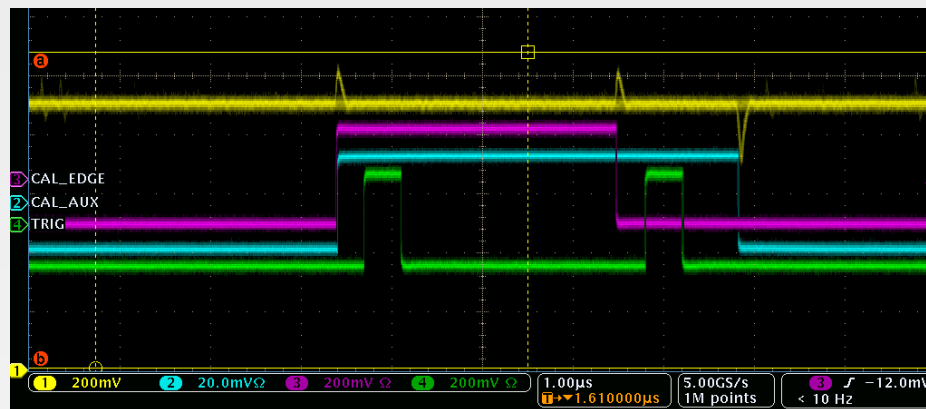




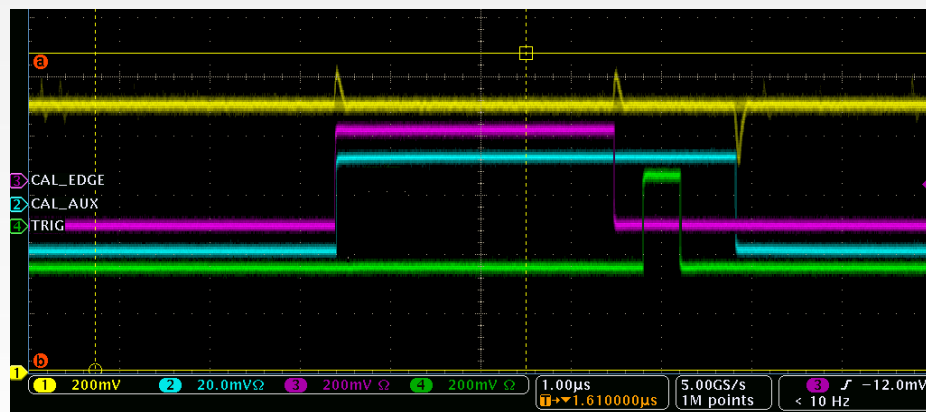
Future work

- Study this further by **separating** the effect of the **analog injection** and the effect of the **digital readout**
- Example show probing the effect only of the digital readout by having two injections on both scans
- Could also probe the effect of the analog injection with the same scans but having only one trigger sequence on both
- Also inject into fewer pixel to study if the observed effect comes from the pixel itself or cross-talk effect
- Fix the timewalk issue
- Merge the code into YARR

Two injections and two trigger sequences



Two injections and one trigger sequences





Conclusion

- A double injection scan sends out two consecutive charge injections into a single pixel
- Updated the existing code to create a double injection sequence that works when double delay > 16 (Two CAL commands)
- Observed an effect on the differential FE for small double delay values
- Future work will consist of studying the effect of the analog injection and readout separately
- Update the code to a state where its ready to be fully merged



Thank you for your attention!



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Backup



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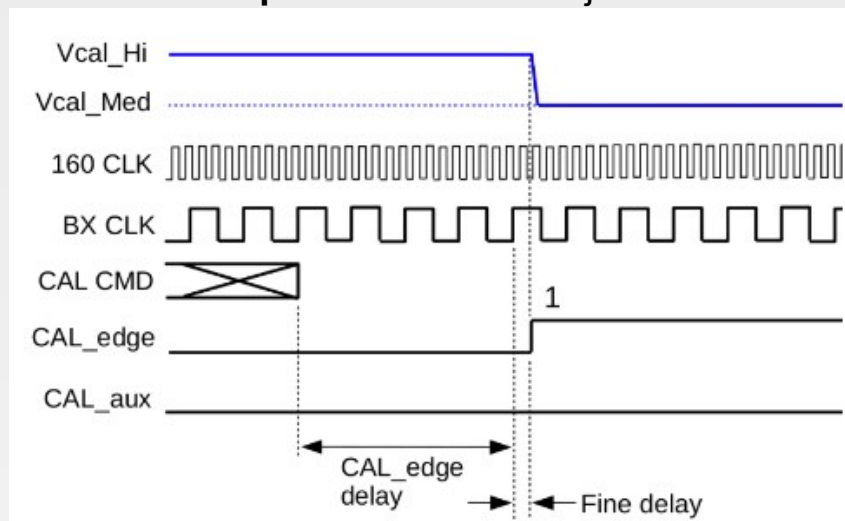




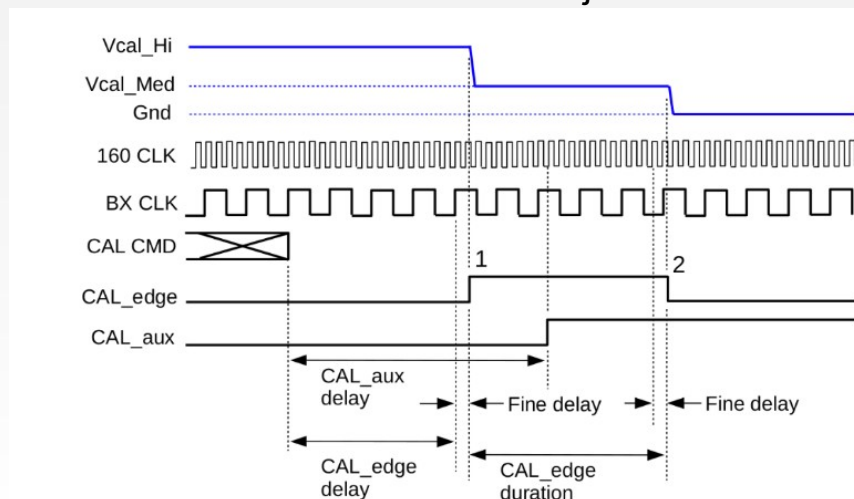
Cal command

- The **Cal command** controls the generation of two internal signals **CAL_edge** and **CAL_aux**
- Injecting charge into the pixel is done when these internal signals are changed
 - Top figure: The CAL command changes CAL_edge from **low to high**
 - Inject charge from **Vcal_Hi to Vcal_Med**
- CAL_edge can either be set to a **single step mode** (top figure) or a **pulse mode** (bottom figure)
 - In **step mode** CAL_edge it will **stay up**
 - In **pulse mode** it will **stay up** only for a given time and **then go low** again
 - Inject **twice** with only one **CAL command**

Step mode with one injection



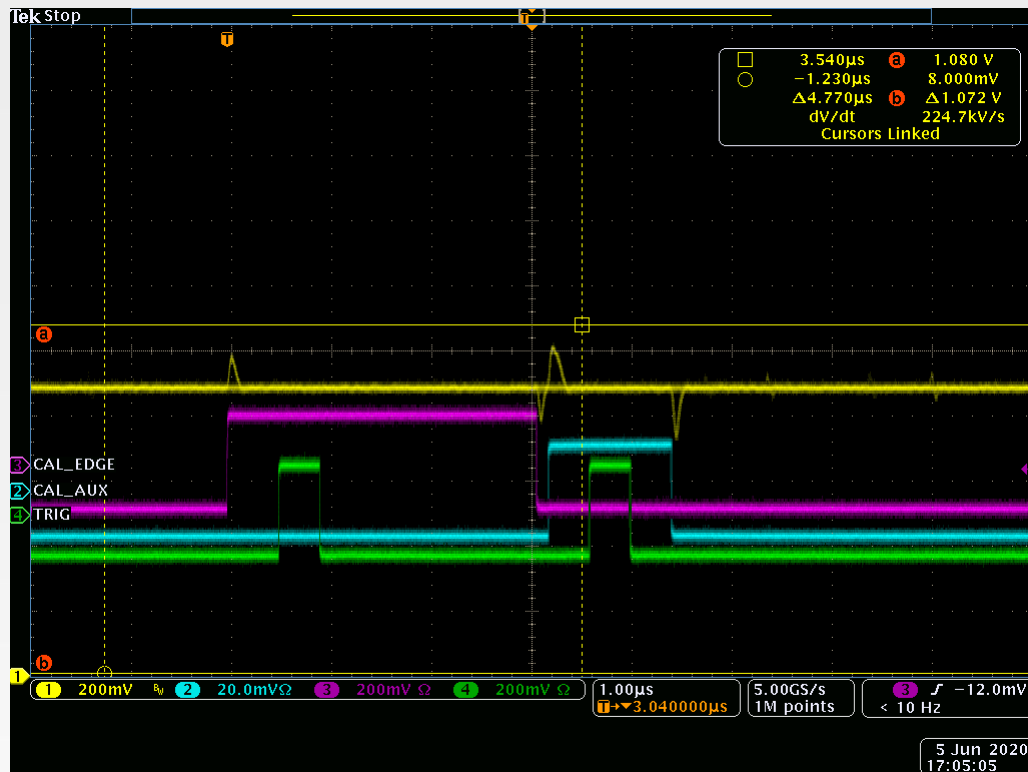
Pulse mode with two injections





Scan sequence in original code

- Due to a bug in the RD53A chip, the cal edge would go low (if high) after receiving a CAL CMD.
- This would cause a second injection to interfere with the threshold scan injection as show in the figure





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