

# Muller C-Element Metastability Containment - Appendix

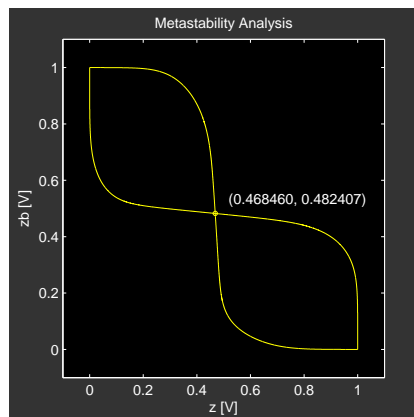
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## 1 Introduction

This appendix to our PATMOS 2012 paper [1] lists the simulation screenshots for all three discussed Muller C-element versions.

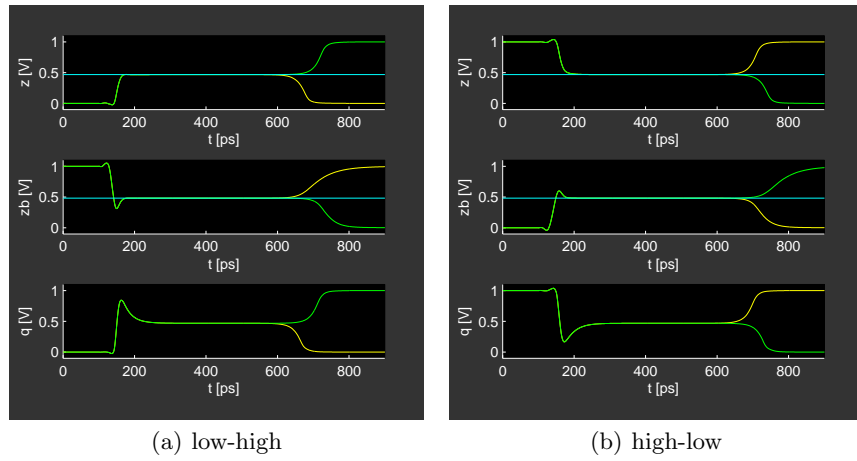
## 2 Van Berkel Implementation



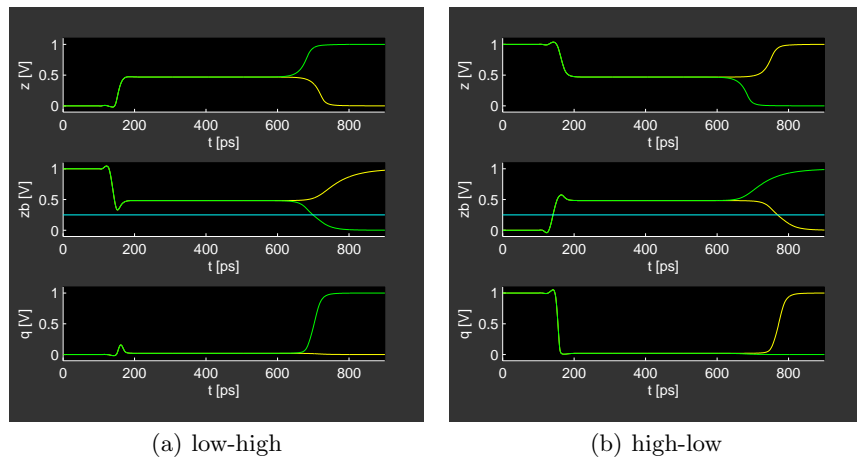
**Fig. 1.** DC Simulation result for a van Berkel Muller C-element

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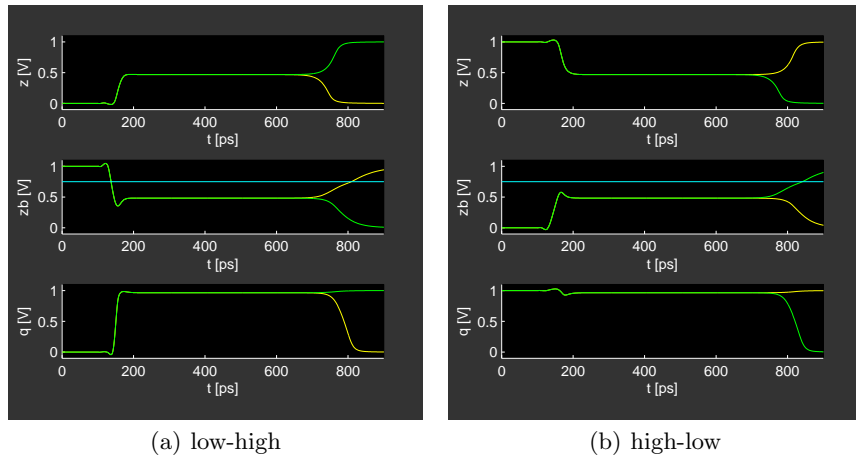
\*\* This work is supported by the Austrian Science Foundation (FWF, P21694).



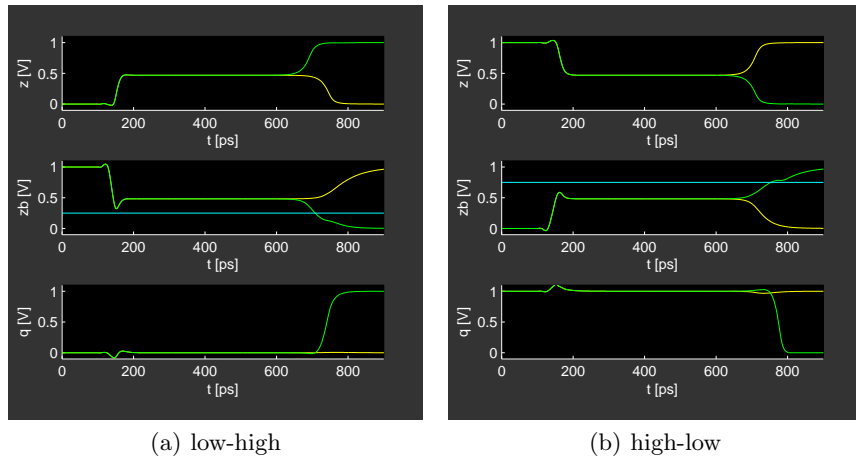
**Fig. 2.** Simulation result for the van Berkel implementation (normal output inverter)



**Fig. 3.** Simulation result for the van Berkel implementation (low threshold output inverter)

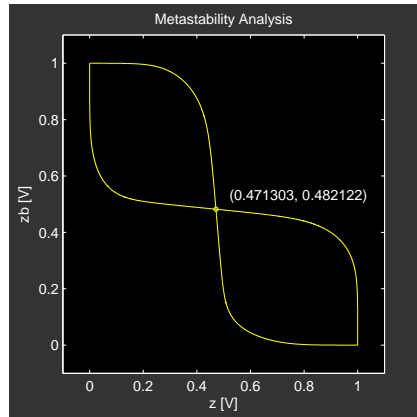


**Fig. 4.** Simulation result for the van Berkel implementation (high threshold output inverter)

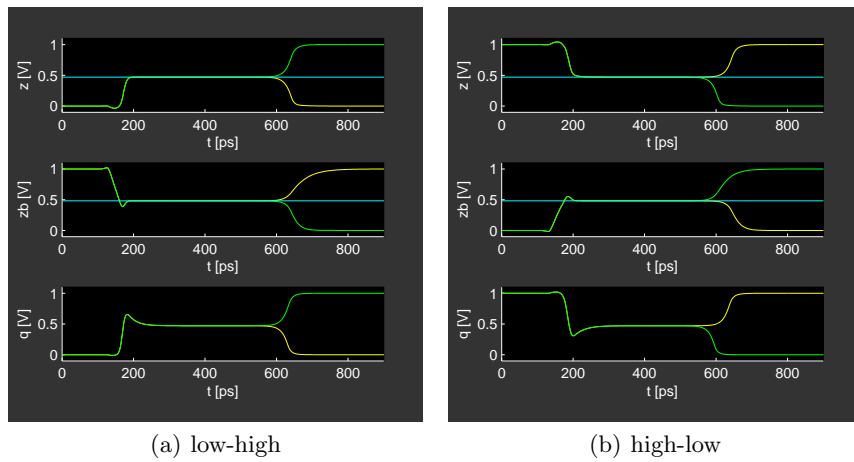


**Fig. 5.** Simulation result for the van Berkel implementation (Schmitt trigger output)

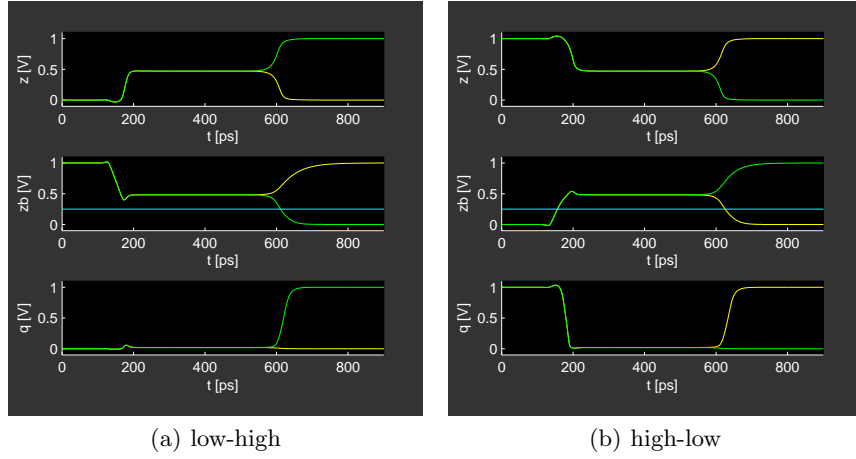
### 3 Conventional Implementation



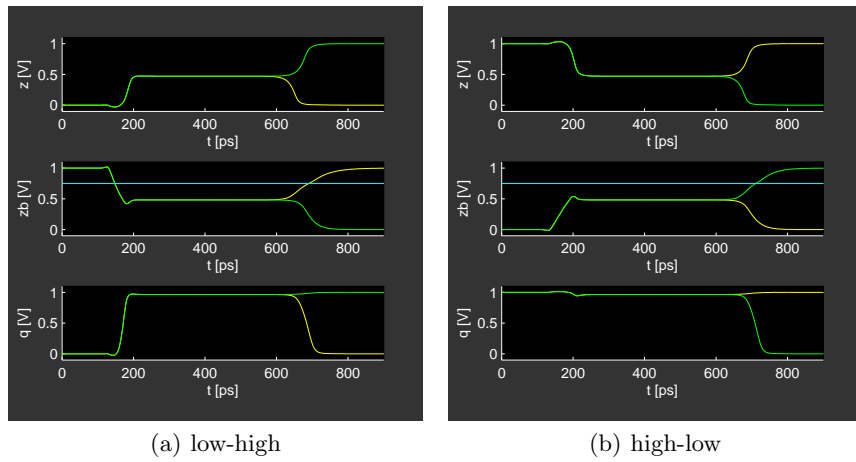
**Fig. 6.** DC Simulation result for a conventional Muller C-element



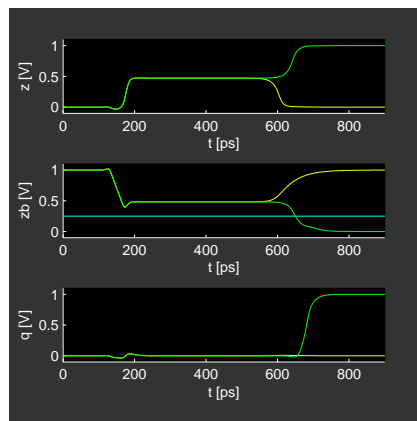
**Fig. 7.** Simulation result for the conventional implementation (normal output inverter)



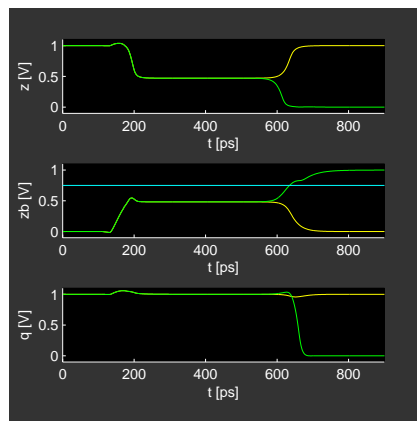
**Fig. 8.** Simulation result for the conventional implementation (low threshold output inverter)



**Fig. 9.** Simulation result for the conventional implementation (high threshold output inverter)



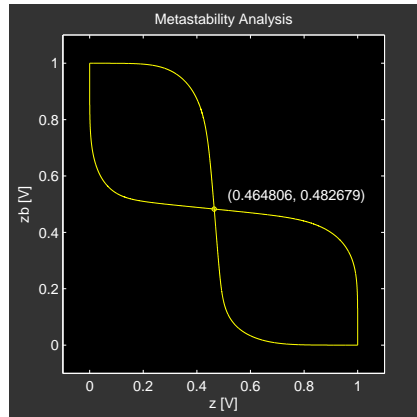
(a) low-high



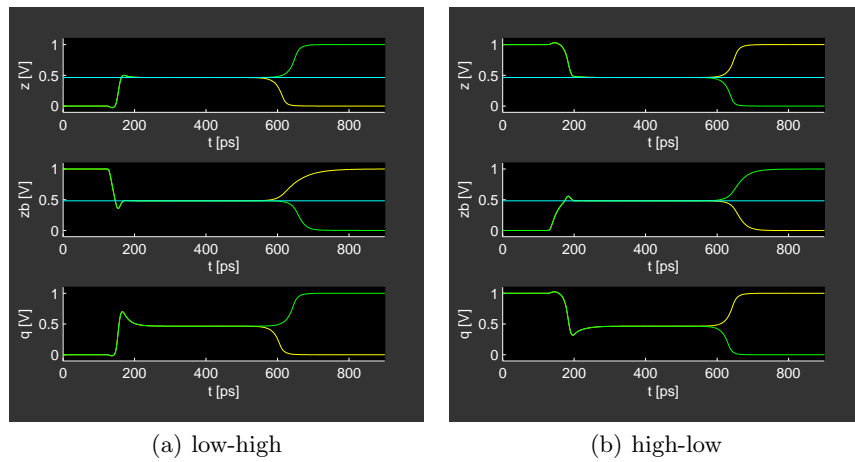
(b) high-low

**Fig. 10.** Simulation result for the conventional implementation (Schmitt trigger output)

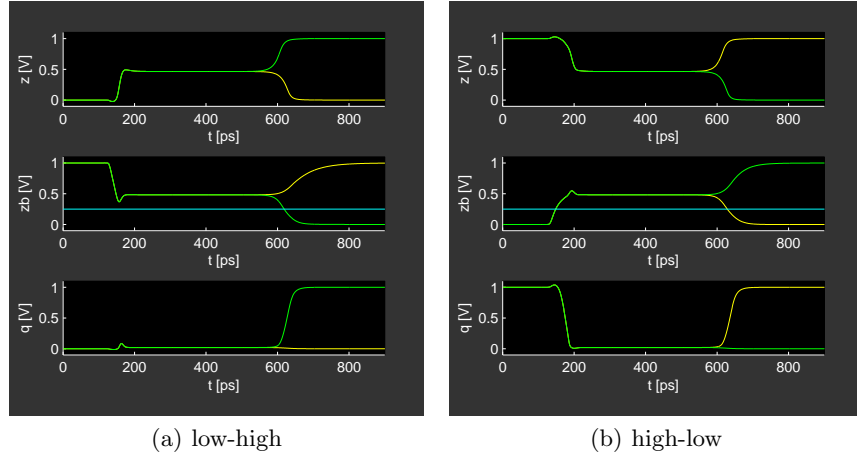
## 4 Weak Feedback Implementation



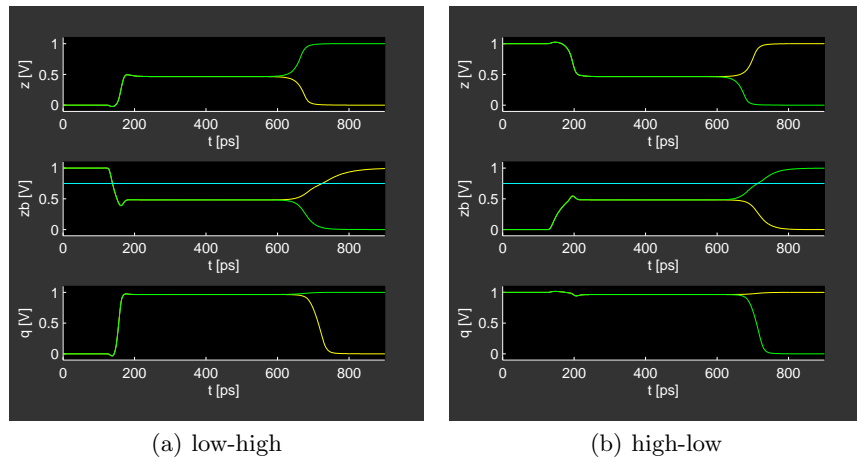
**Fig. 11.** DC Simulation result for a weak feedback Muller C-element



**Fig. 12.** Simulation result for the weak feedback implementation (normal output inverter)

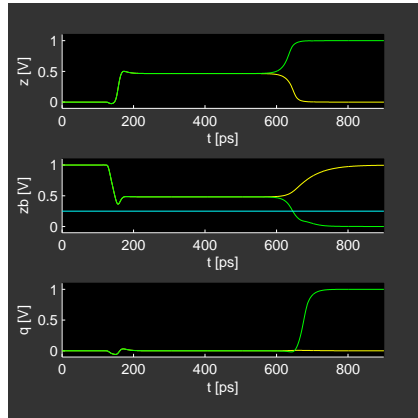


**Fig. 13.** Simulation result for the weak feedback implementation (low threshold output inverter)

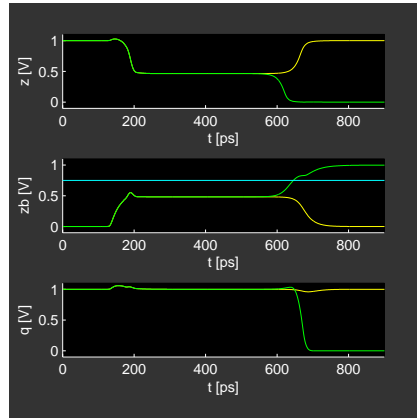


**Fig. 14.** Simulation result for the weak feedback implementation (high threshold output inverter)





(a) low-high



(b) high-low

**Fig. 15.** Simulation result for the weak feedback implementation (Schmitt trigger output)

## 5 Conclusion

The additional simulations show that the analysis based on the van Berkel implementation is indeed representative. All other implementations exhibit a similar behavior during metastability and the containment using a Schmitt trigger works independent of the underlying Muller C-element implementation.

## References

1. Polzer, Thomas, Steininger, Andreas, and Lechner, Jakob: Muller C-Element Metastability Containment. In: 22nd Workshop on Power And Timing Modeling, Optimization and Simulation (PATMOS2012). (2012)