

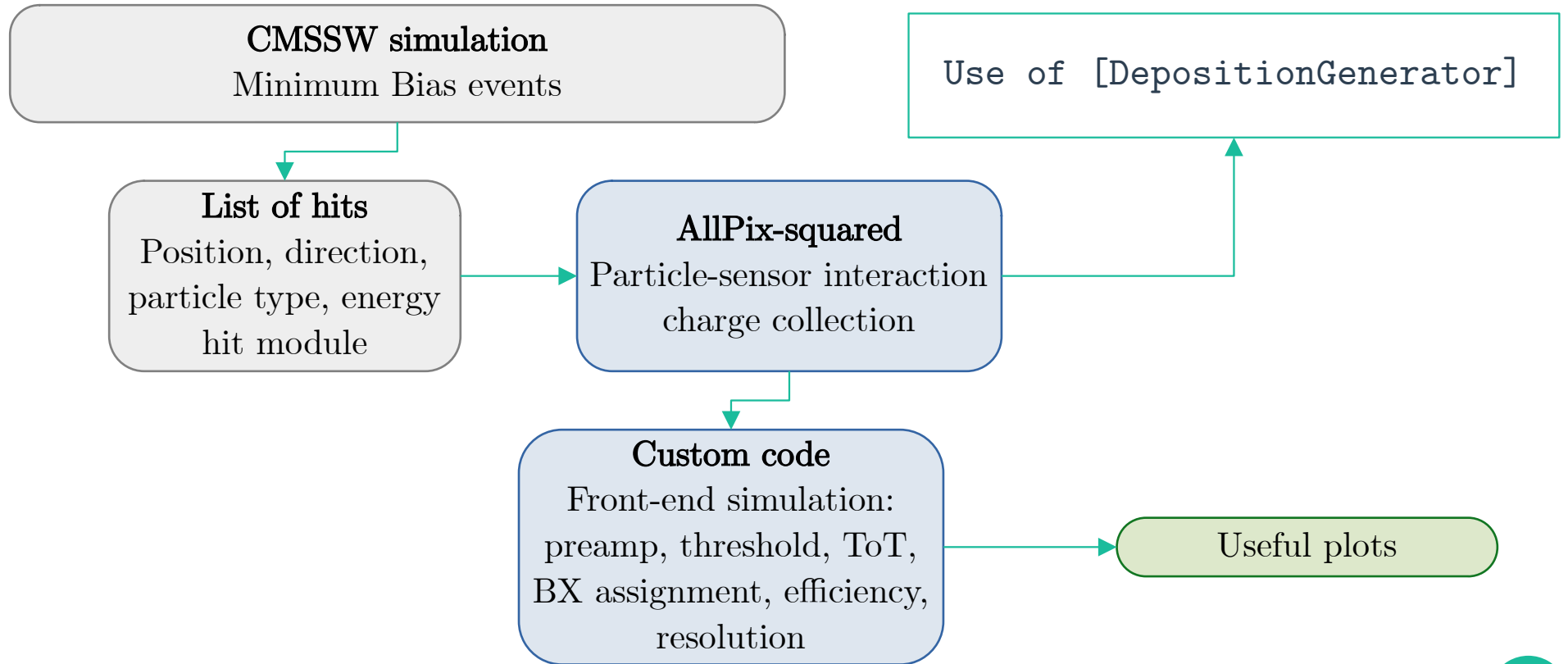
Assessing the Impact of Miscalibrating the RD53B-CMS Front End for the HL-LHC CMS Inner Tracker

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Statement of the Problem

- The aim of this study is to determine the impact of **chip configuration** & **calibration** on the **detector performance** for the commissioning of the HL-LHC CMS Inner Tracker.
- The RoC of interest is the RD53B-CMS Chip (CROC) and Modules are comprised of pixels with dimensions $(25 \times 100) \mu\text{m}^2$.
- Detector Performance means:
 - Efficiency.
 - Spatial Resolution of Tracker Modules.
 - Out of Time Hits.

Simulation Strategy



DepositionGenerator Implementation

```
}  
particles.emplace_back(      Simon Spannagel, 13 months ago • DepositionGenerator / Genie:  
    pdg_code_>At(i), energy_>At(i), G4ThreeVector(px_>At(i), py_>At(i), pz_>At(i)),  
    G4ThreeVector(gx_>At(i), gy_>At(i), gz_>At(i)), ltof_>At(i));
```

A Simple Review of the Front-End

Image from: *JINST*, Tracker Group of the CMS, Publication, 2021

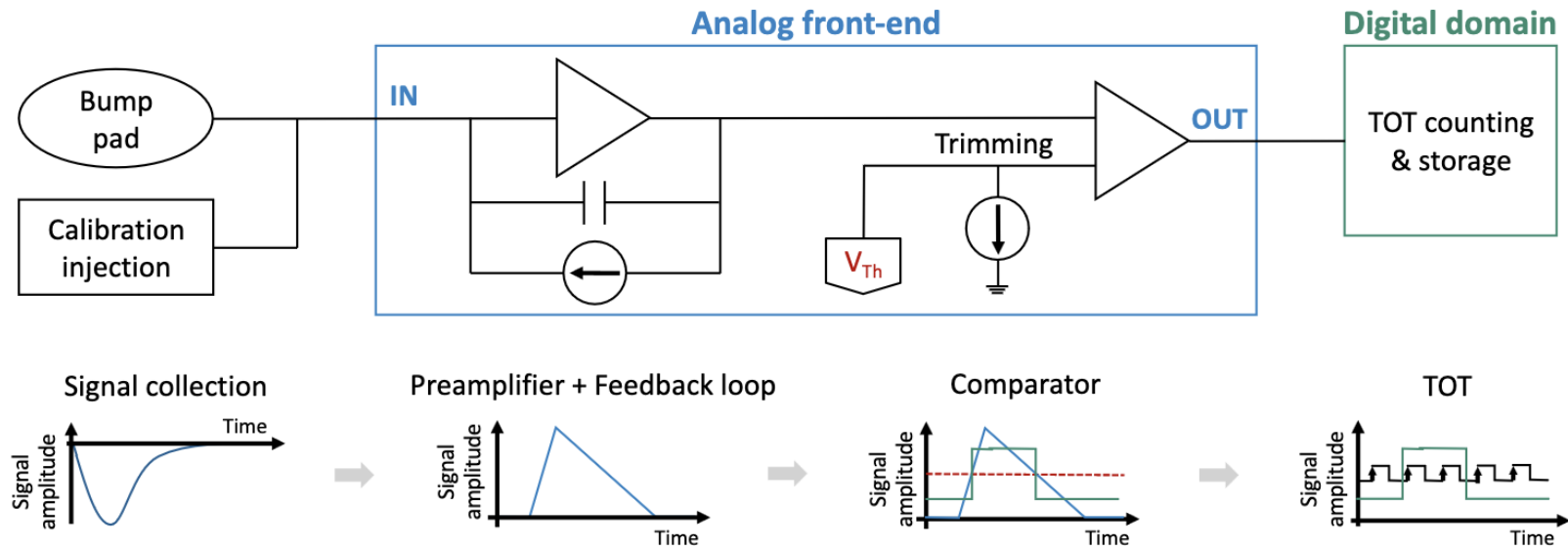
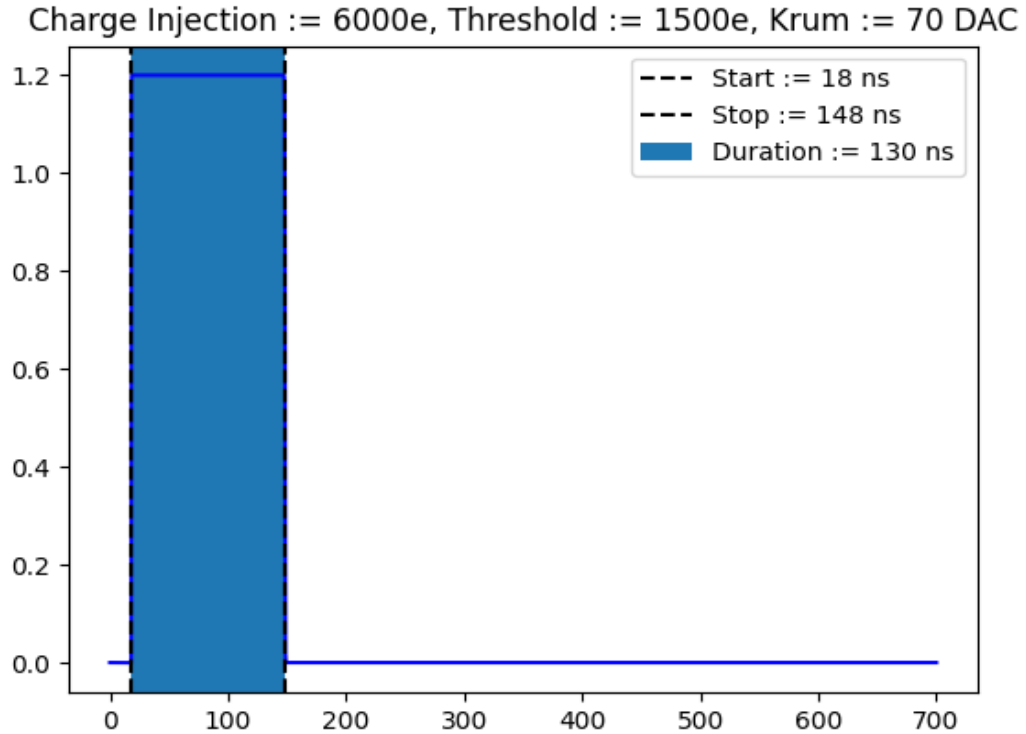
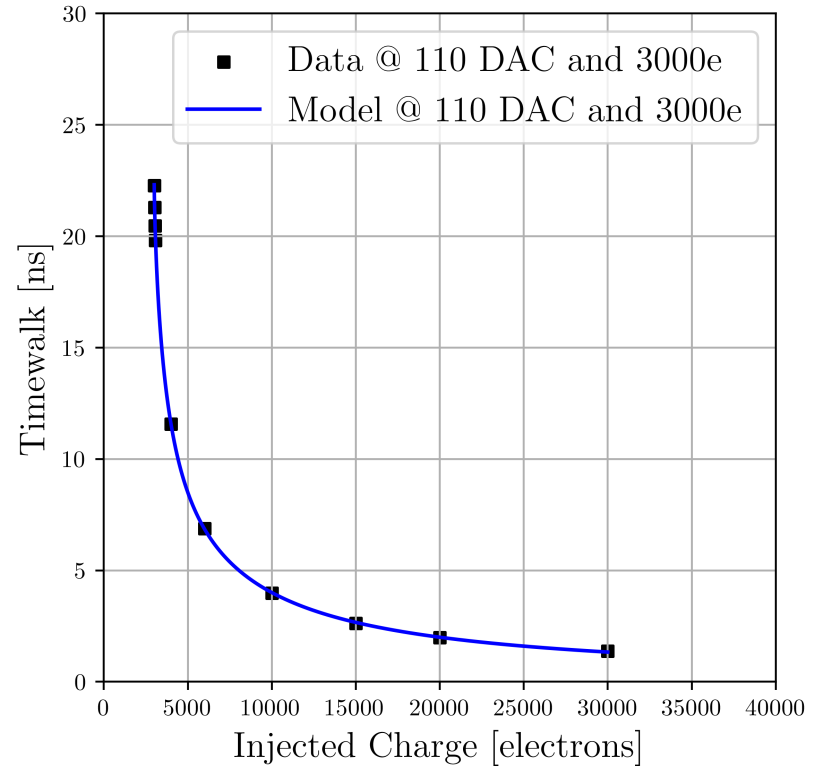
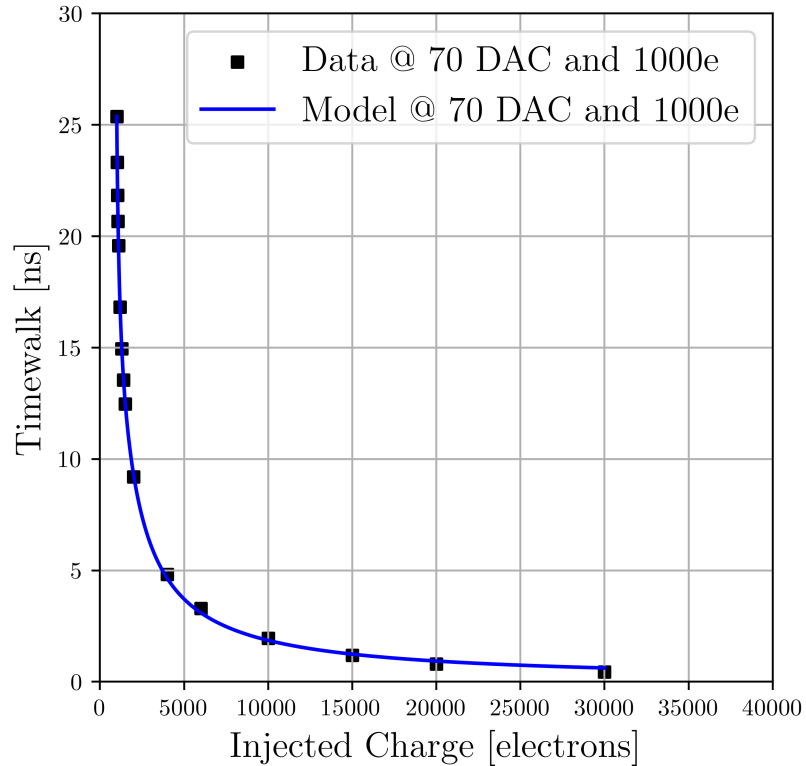


Figure 3. Signal processing steps in different stages of a generic analogue front-end, from signal collection to digitization.

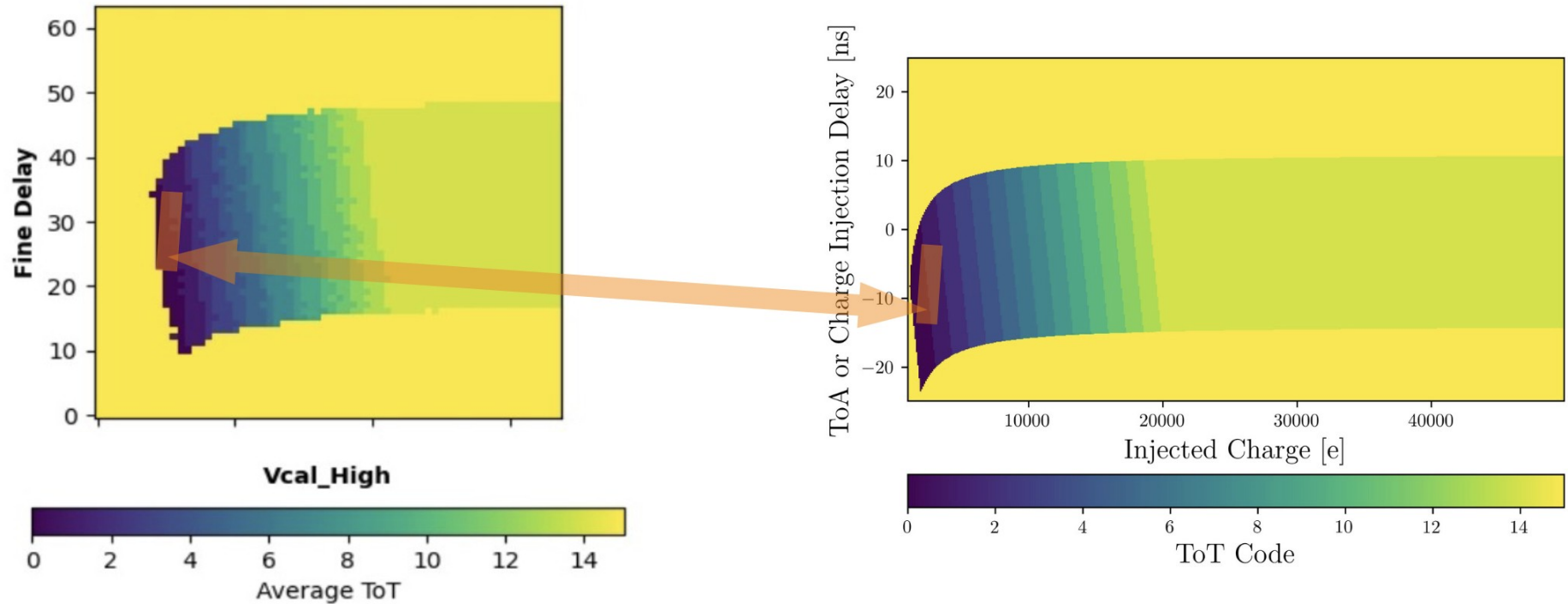
Models in the Front-End



Models in the Front-End: *Timewalk* Curves

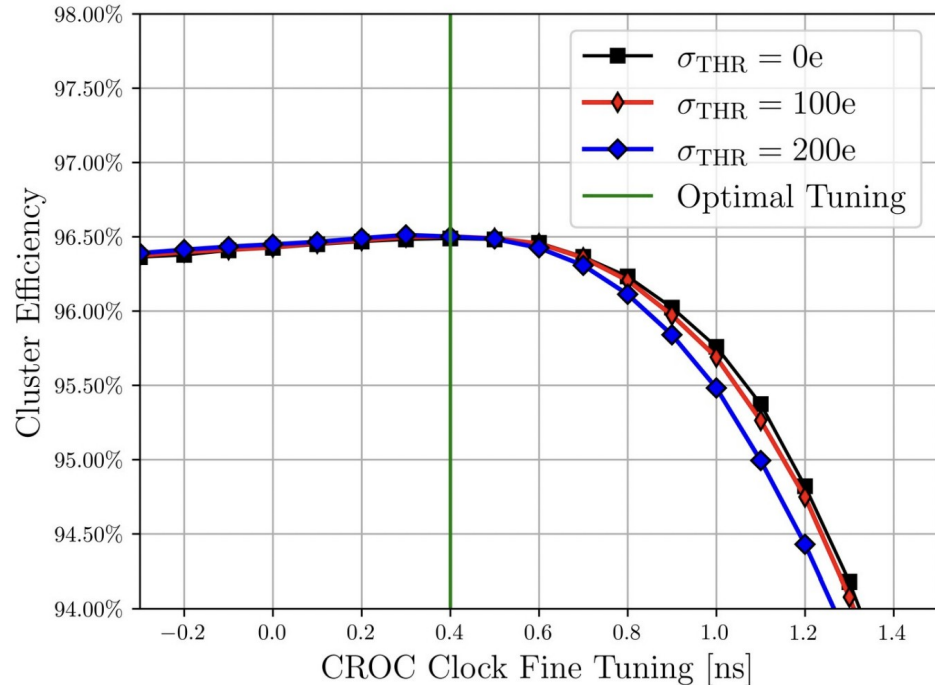


Validation of The Front-End Models



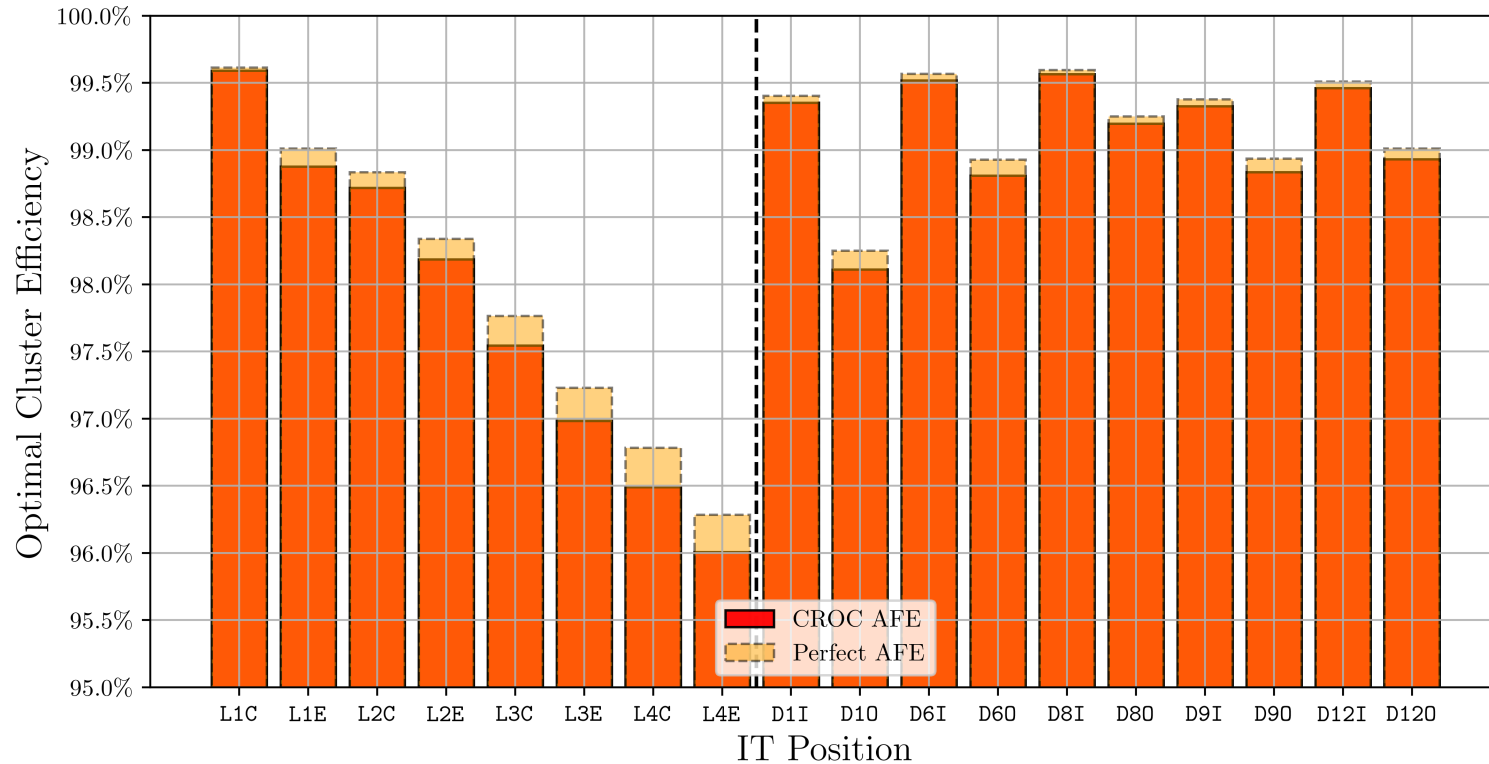
A Selection of Important Results

Cluster Efficiency vs. Clock Delay

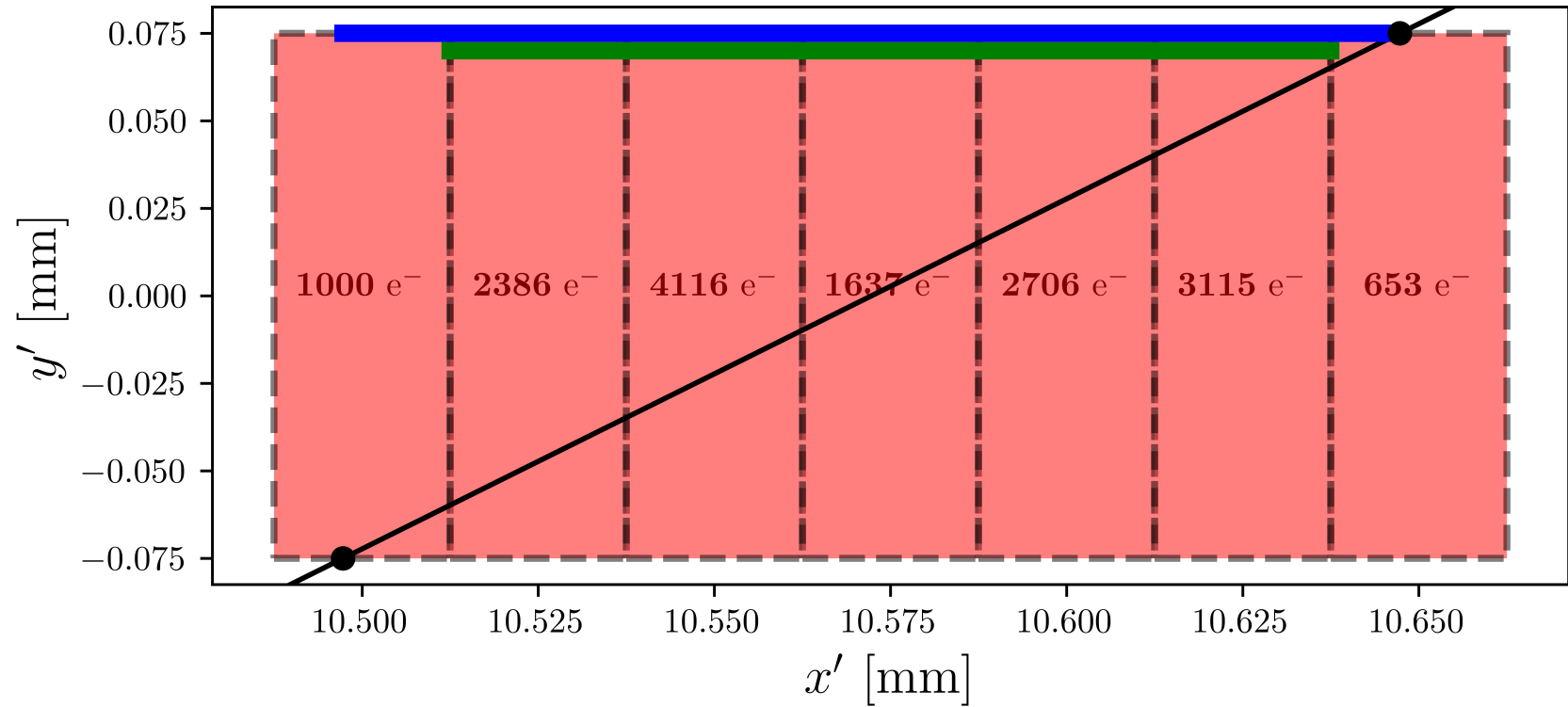


- Important commissioning process: *Time Alignment of the Modules.*
- Pixel Threshold exhibits a variation of $\sim 100e$.

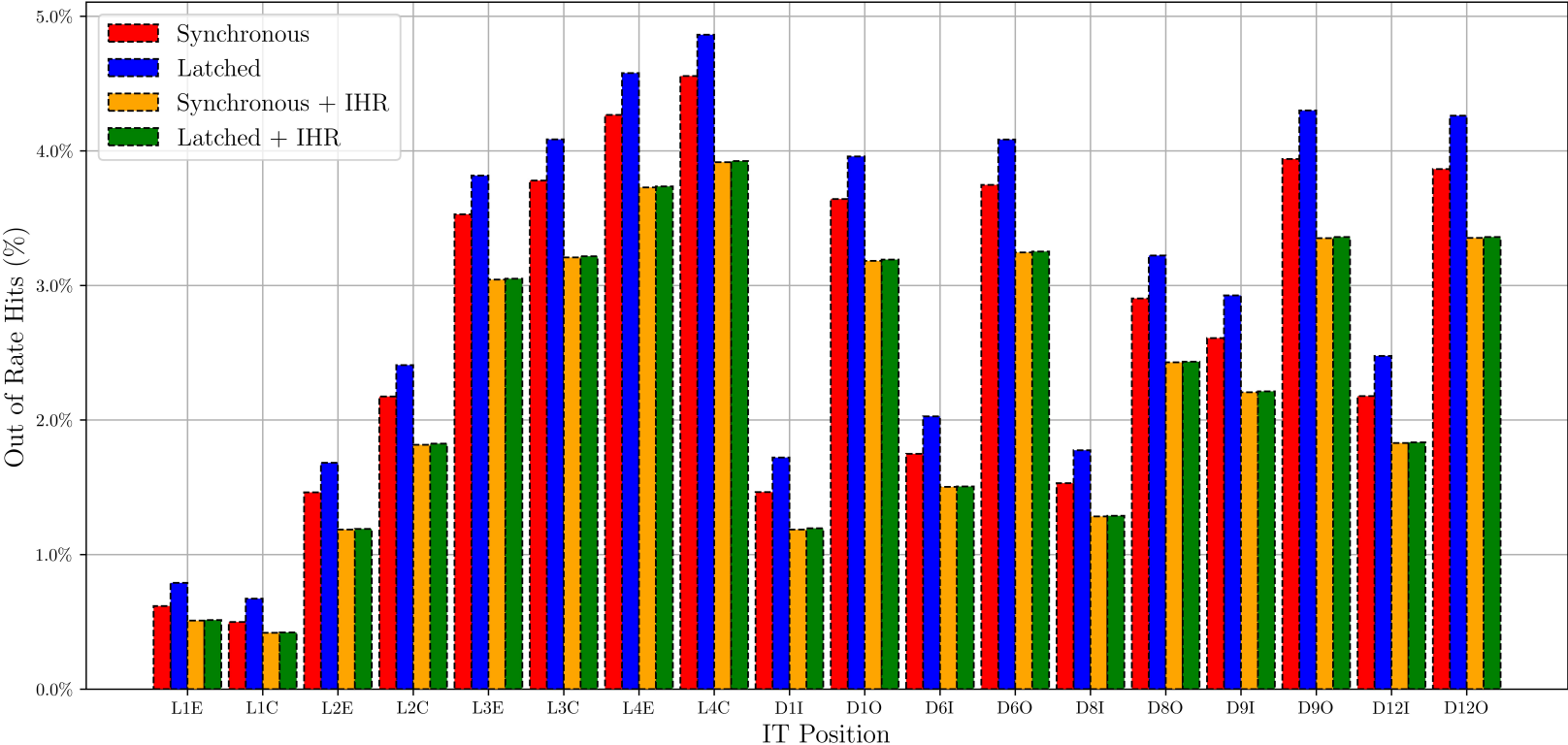
Optimal Efficiency vs. Detector Position



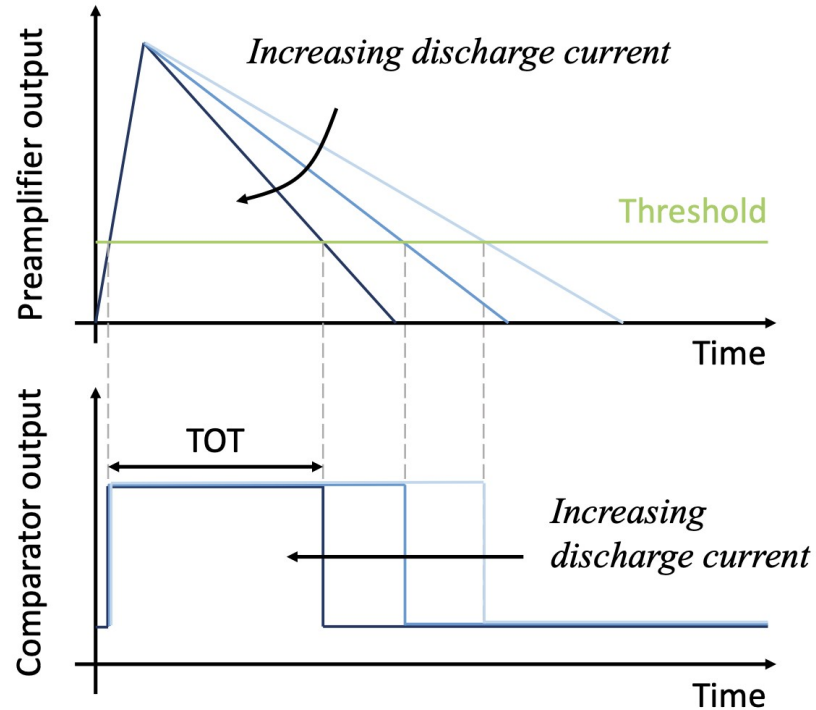
A Representative Event



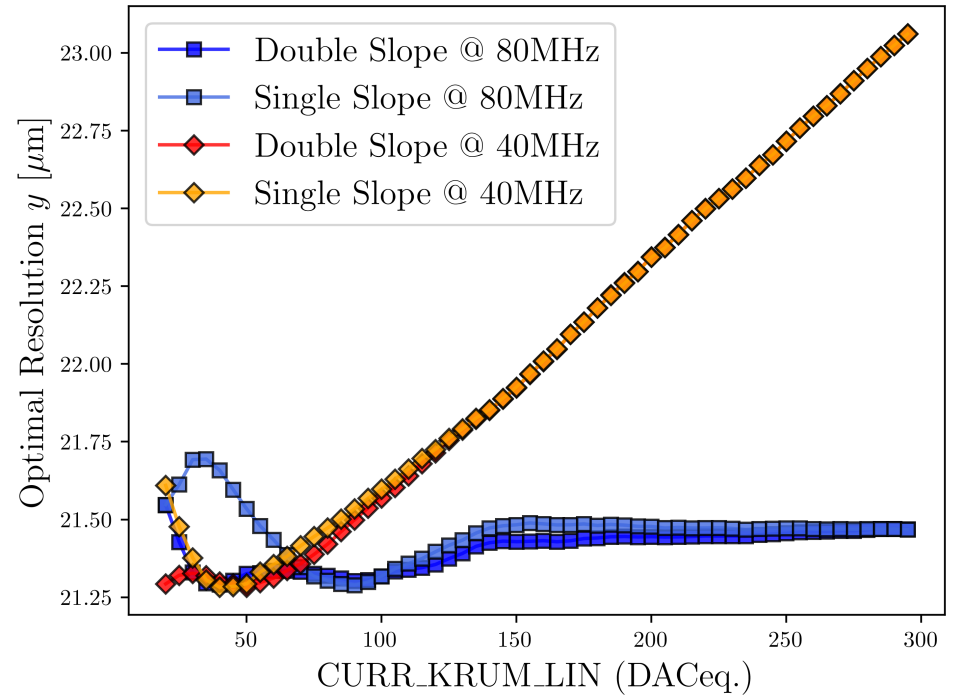
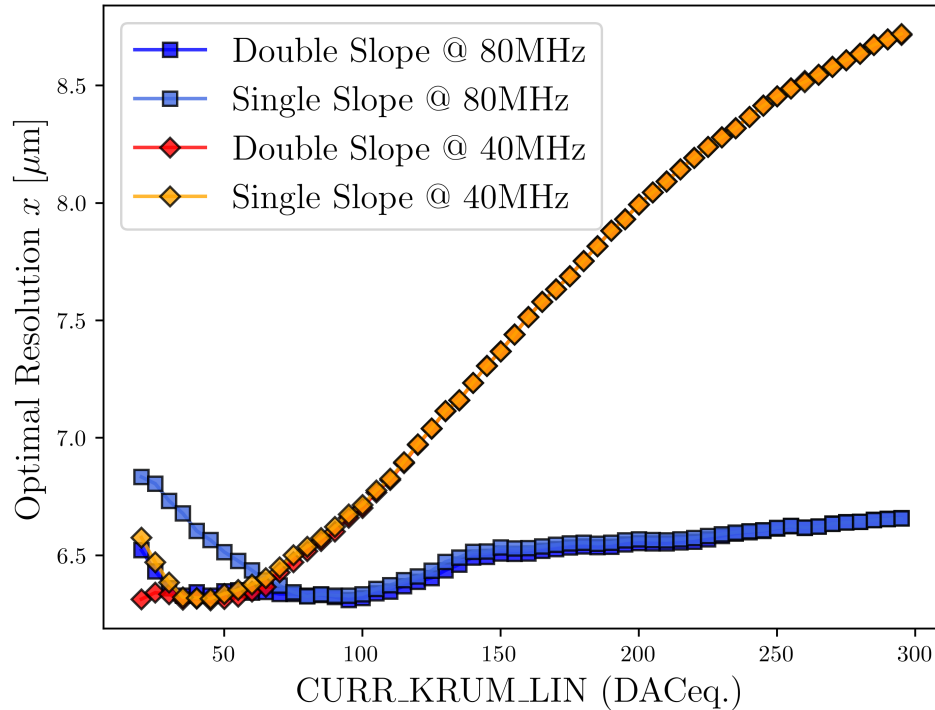
Fraction of Late Pixel Hits



Spatial Resolution vs. Discharge Current (Krummenacher)



Spatial Resolution vs. Krummenacher Setting



Conclusions and Future Directions

- A Framework has been created, wrapped around Allpix², with which we can calibrate modules at the CMS experiment's Inner Tracker for the High Lumi LHC.
- Extend the study to the CMS Outer Tracker, by implementing the respective RoCs (e.g. SSA, MPA).
- Simulate Calibration strategies for the commissioning of the detector (e.g. Time Alignment).

Thank you for your attention!