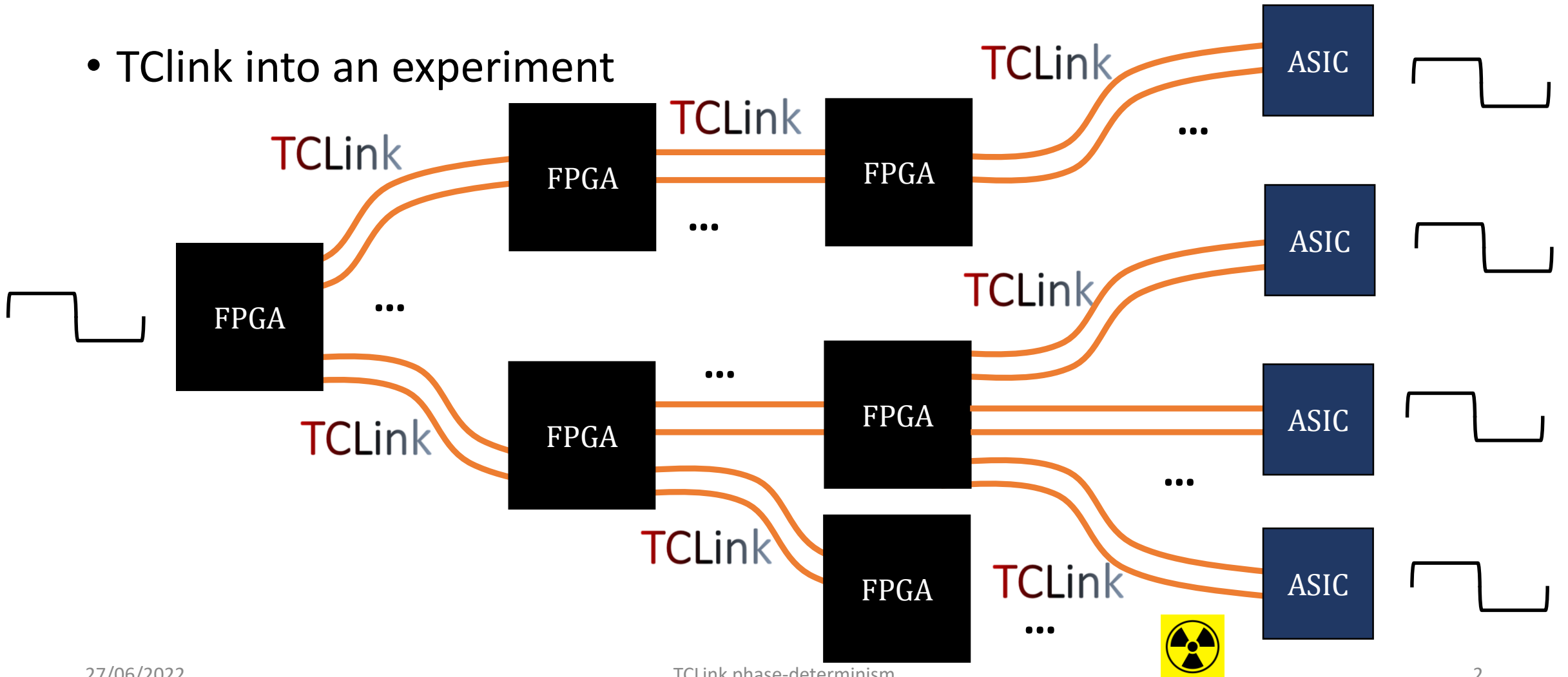# TCLink

Discussion on phase-determinism tests

Sophie B. / Eduardo M. – 27/06/2022

Introduction

- TClink into an experiment
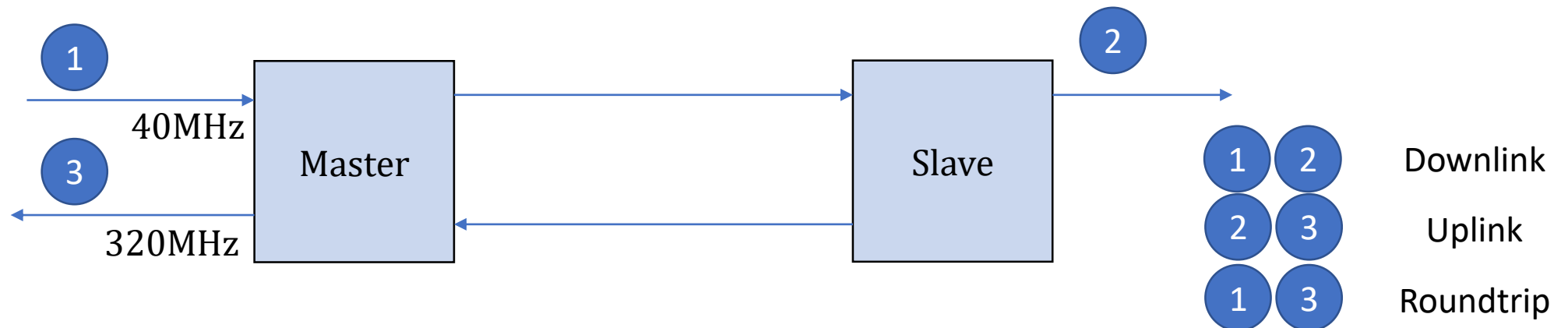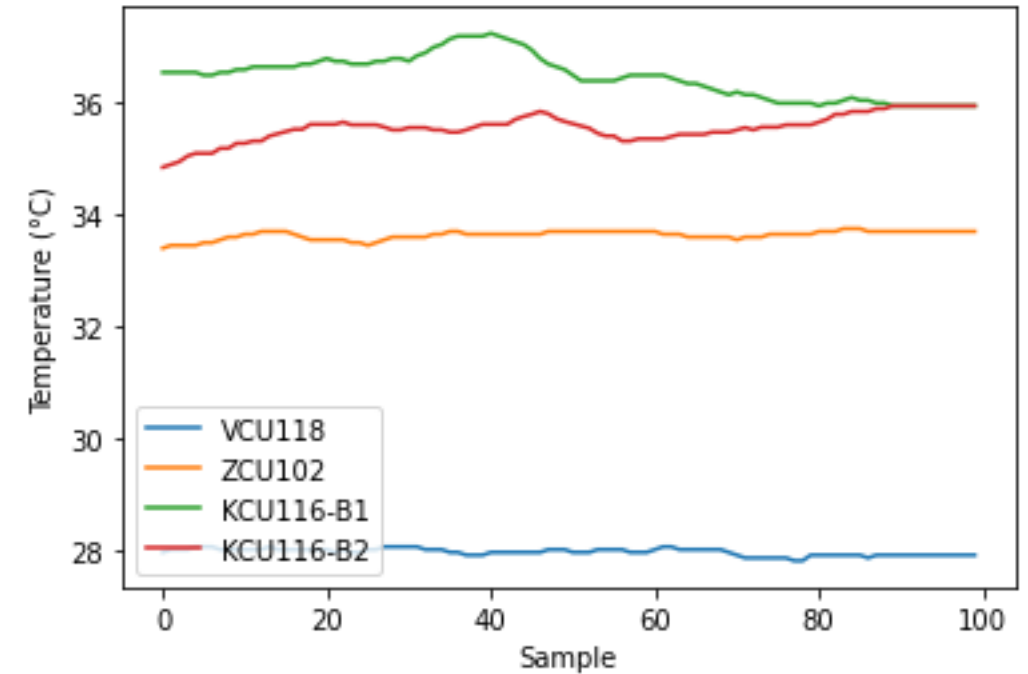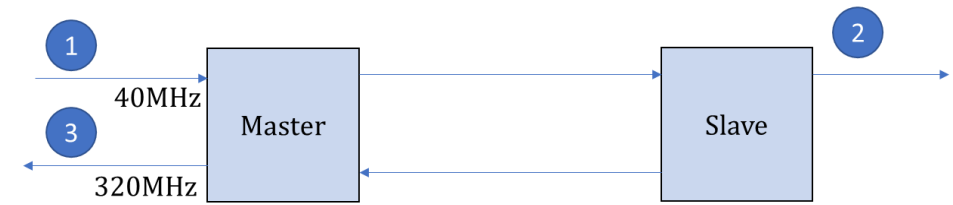
TCLink phase-determinism

Overview

- Preliminary studies

- New Rx architectures
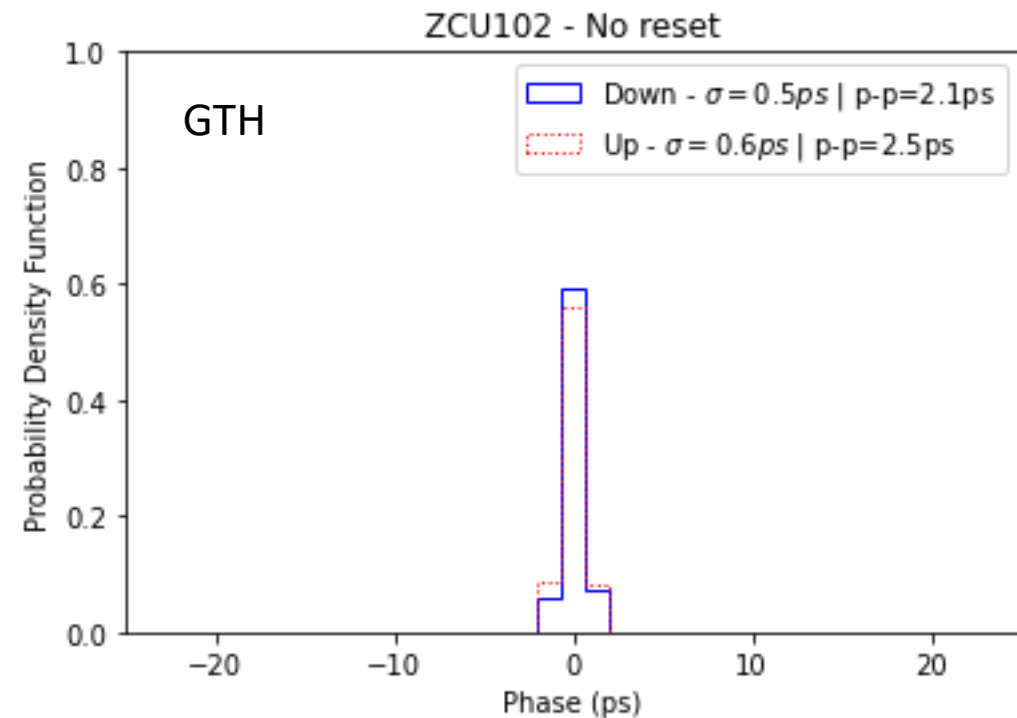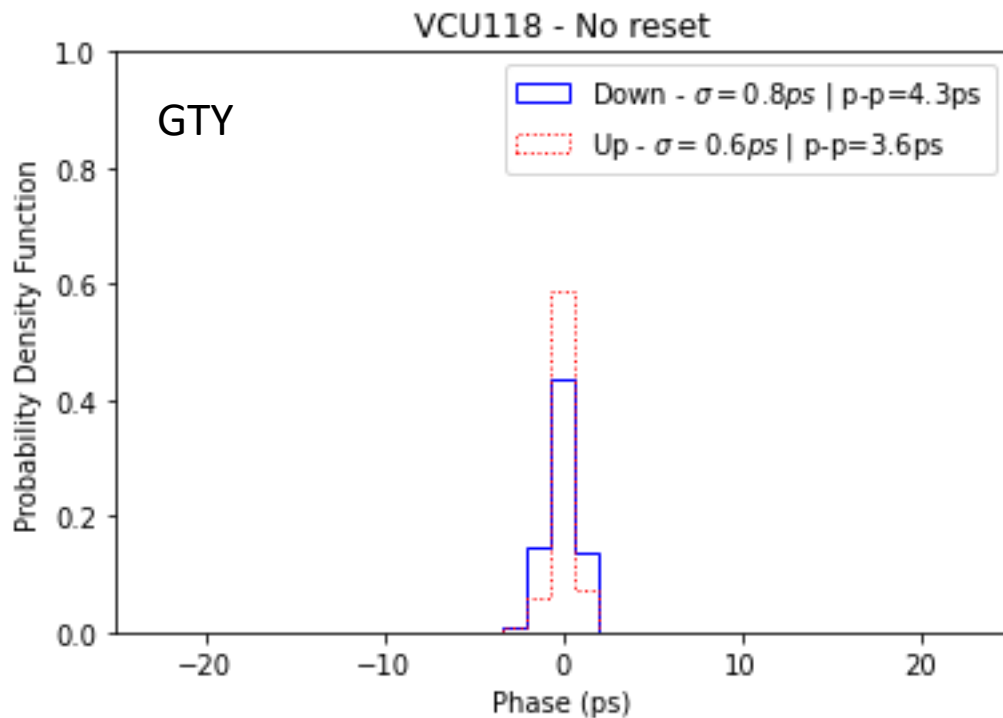
Example design

- Master/slave share same FPGA
  - ZCU102 –Ultrascale+ GTH
  - VCU118 – Ultrascale+ GTY
  - KCU116 – Ultrascale+ GTY (2 boards)
- Master Rx uses rxslide PCS: up mod UI
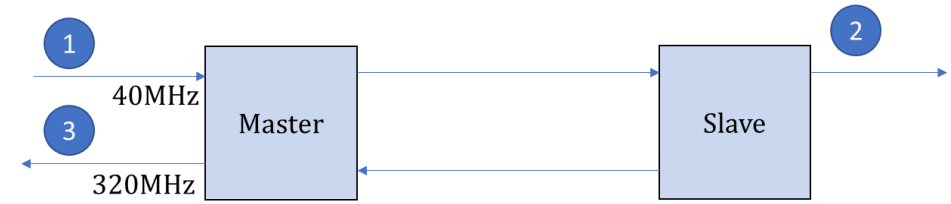- Low temperature variation
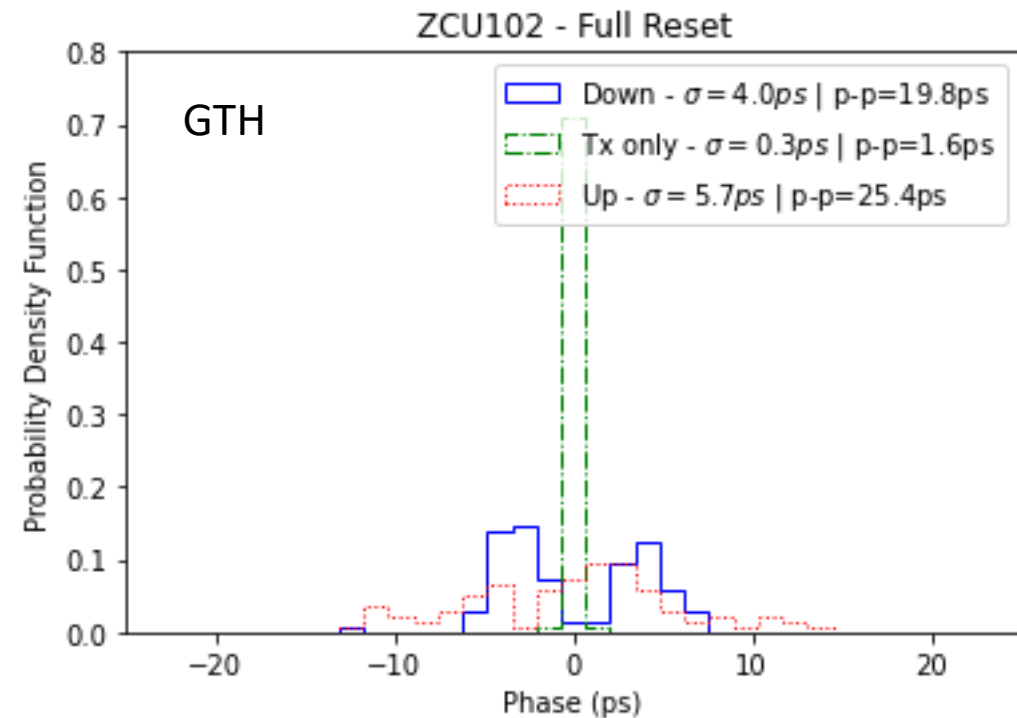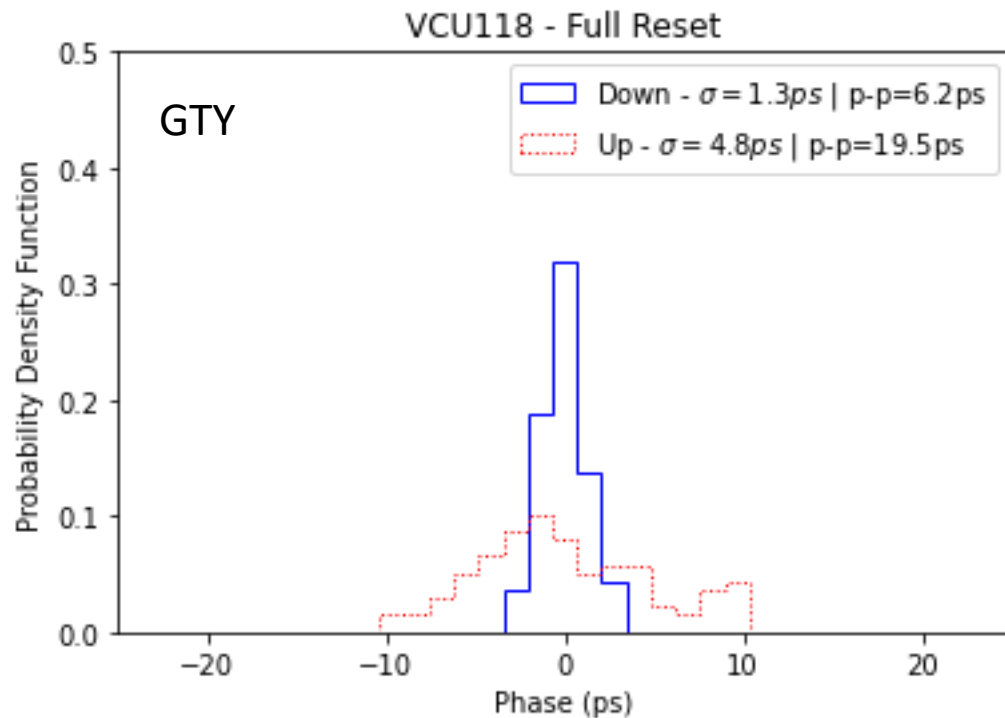
Meas. Control (no reset)

- Very little phase variation for both tests
- Our measurement methodology is good

Full reset

40MHz

Master

Slave

320MHz

- Phase variation seems to come from Rx (see ZCU102 Tx only)

- Are GTY better than GTH?

VCU118 - Full Reset

GTY

Down - $\sigma = 1.3ps$ | p-p=6.2ps
Up - $\sigma = 4.8ps$ | p-p=19.5ps

ZCU102 - Full Reset

GTH

Down - $\sigma = 4.0ps$ | p-p=19.8ps
Tx only - $\sigma = 0.3ps$ | p-p=1.6ps
Up - $\sigma = 5.7ps$ | p-p=25.4ps

Summary so far…

- Around 4ps rms for GTH and 3ps rms for GTY
- Is there a true difference on GTY vs. GTH?

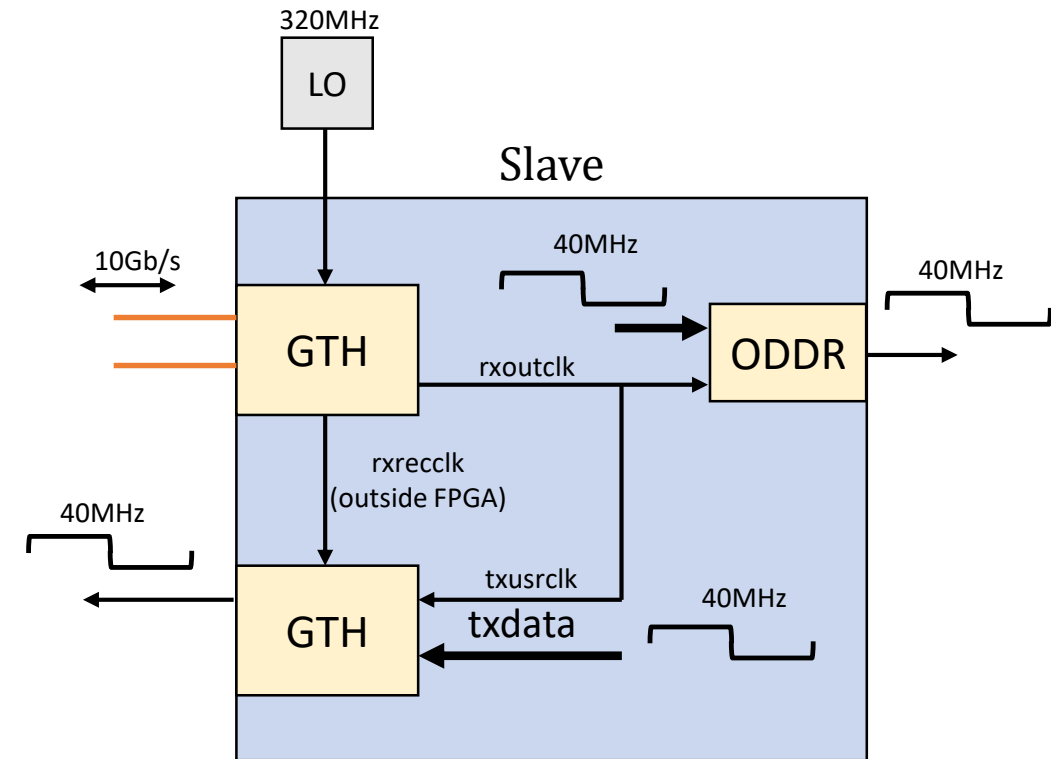TCLink phase-determinism
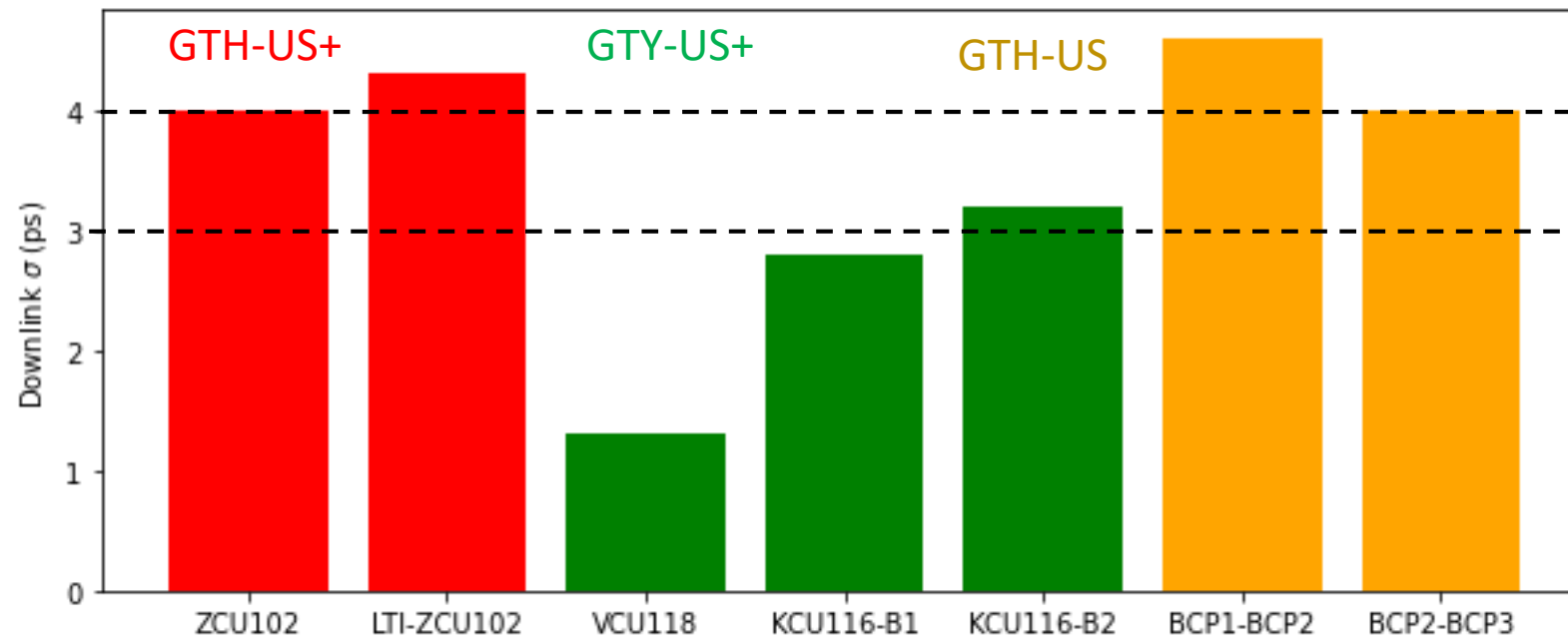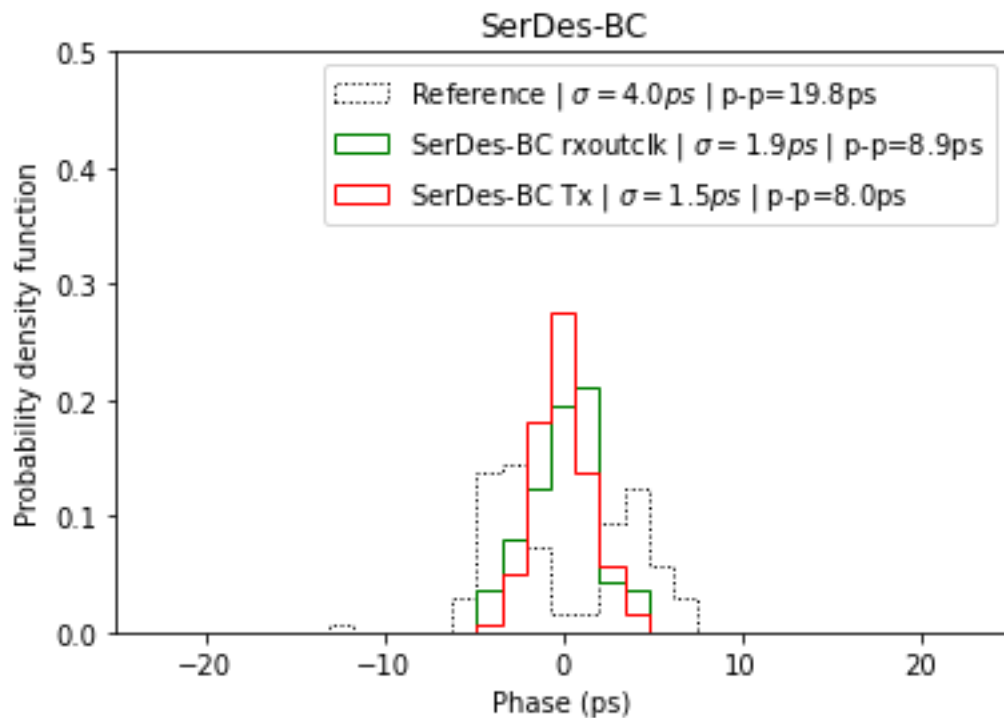
New architectures
More advanced studies with ZCU102

- SerDes-BC
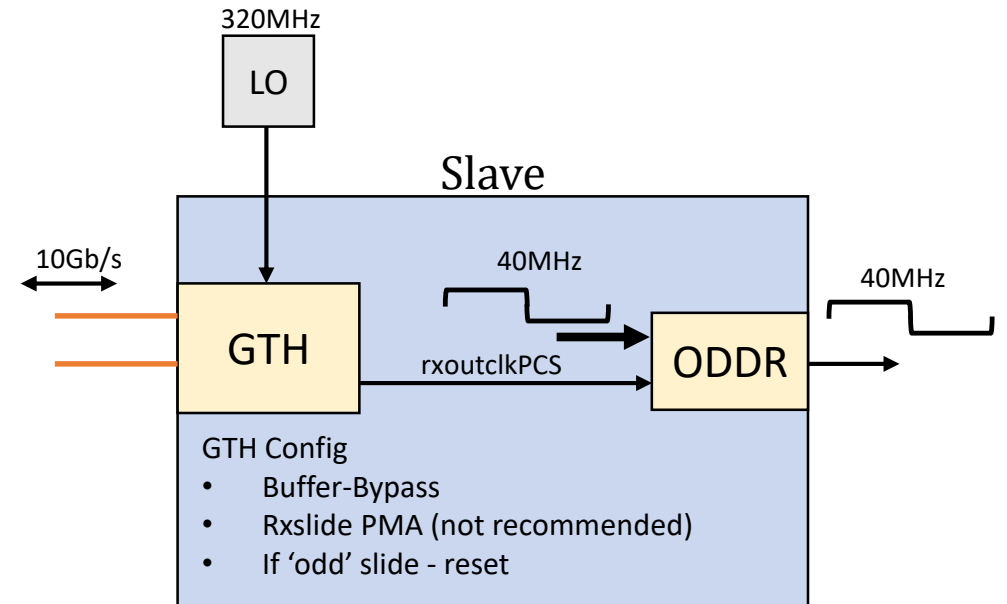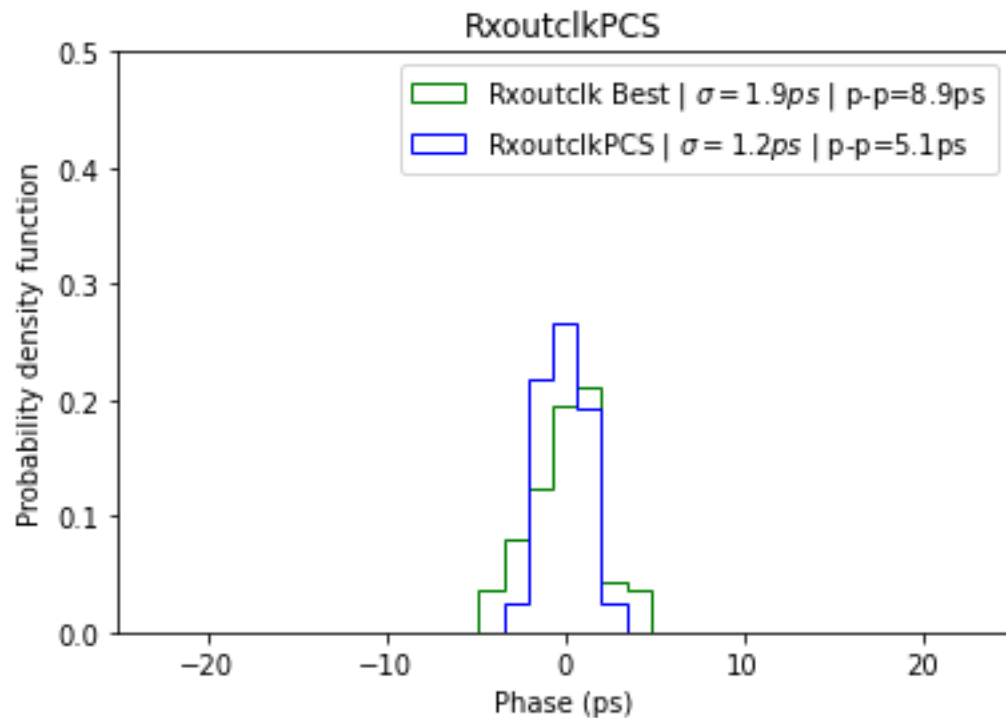- RxoutclkPCS
- Roulette
- Roulette FIFO

New architecture: SerDes-BC

- Sacrifice two reference clock pins and one SerDes
- Good results but... rxoutclk also significantly improved (?)

SerDes-BC

Reference | $\sigma = 4.0ps$ | p-p=19.8ps
SerDes-BC rxoutclk | $\sigma = 1.9ps$ | p-p=8.9ps
SerDes-BC Tx | $\sigma = 1.5ps$ | p-p=8.0ps

New architecture: RxoutclkPCS

- Use dedicated RxoutclkPCS pin - same overall architecture
- **Higher temperature variability** as studied by Nikitas-CMS
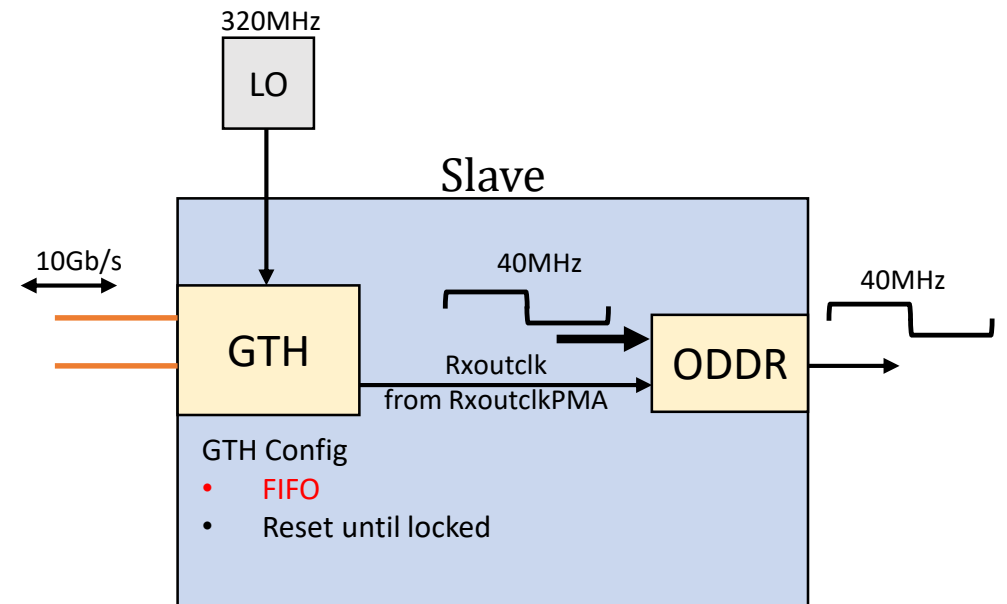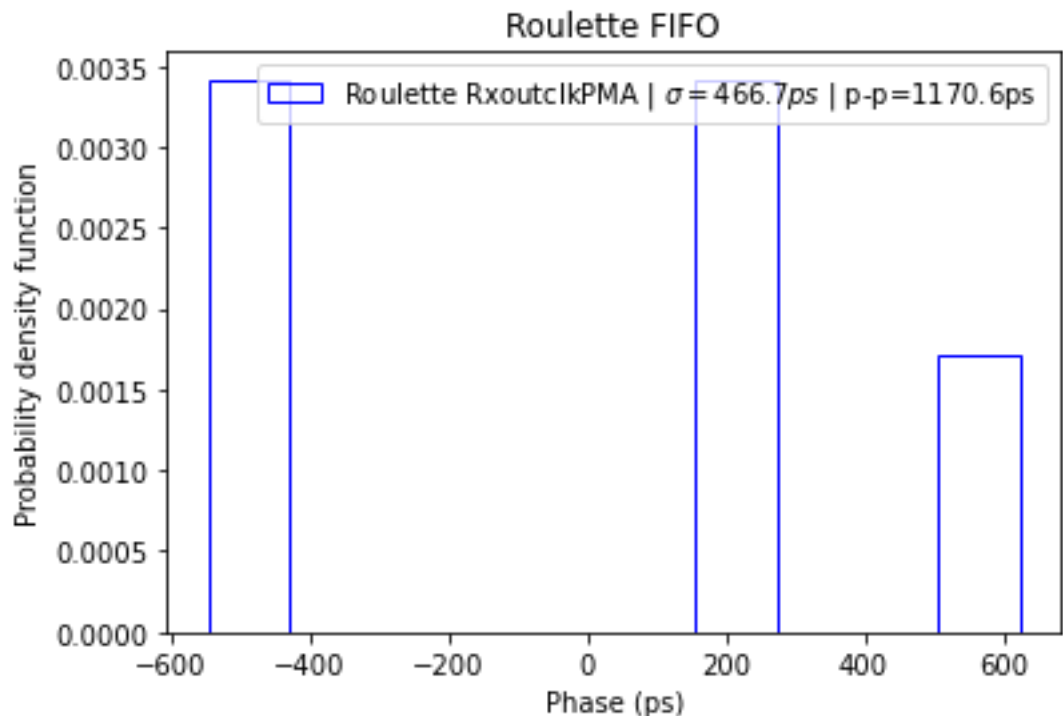

TCLink phase-determinism

New architecture: Roulette

- Roulette (reset until locked) in buffer-bypass mode is not better...
- What about if FIFO is enabled?

Roulette Buffer-Bypass

Rxslide Rxoutclk Best | $\sigma = 1.9ps$ | p-p=8.9ps
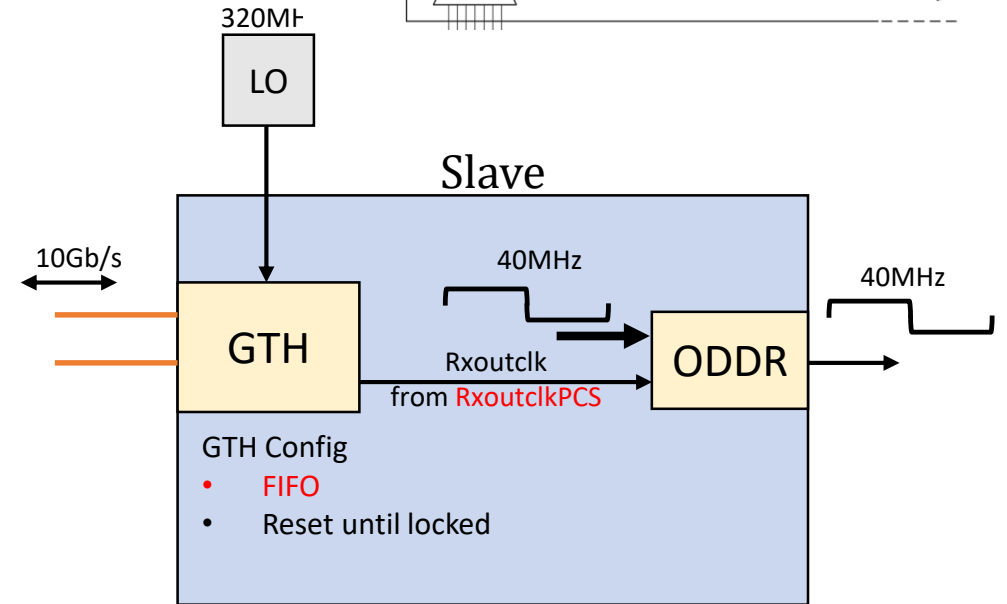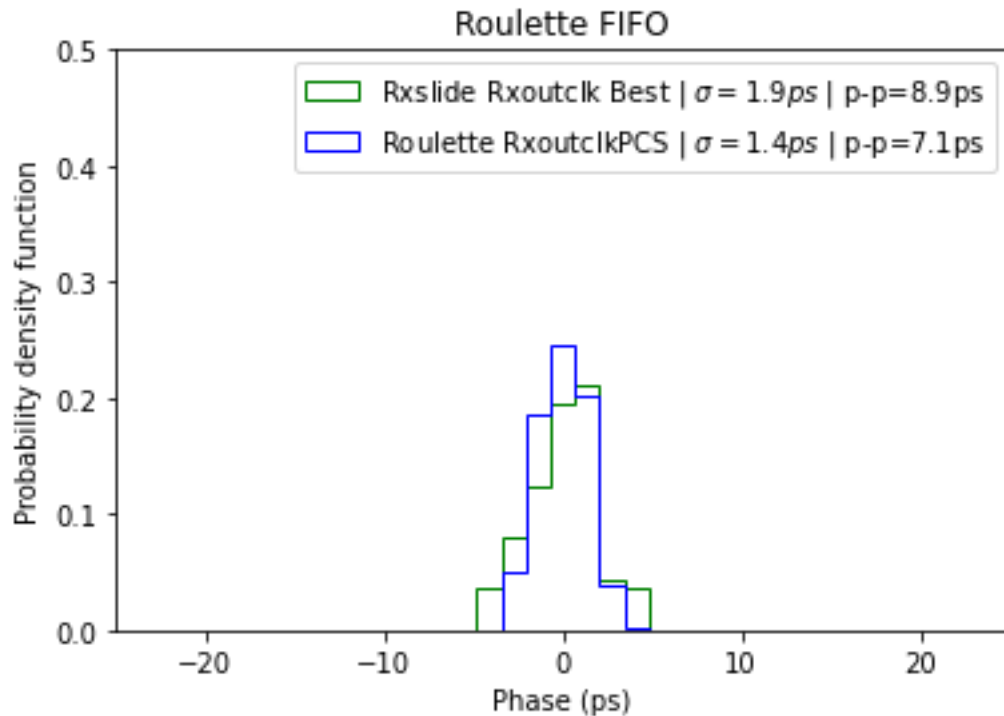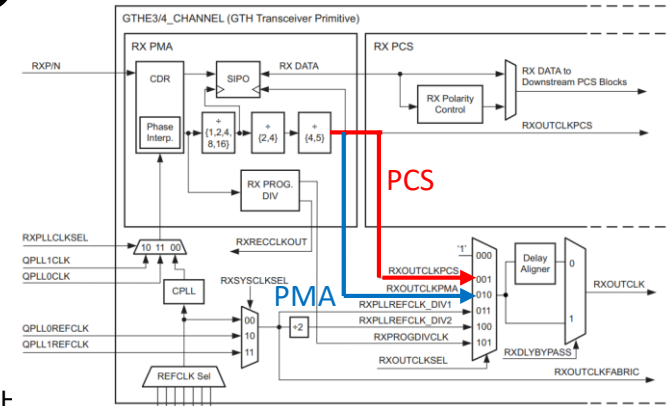Roulette | $\sigma = 4.8ps$ | p-p=16.8ps
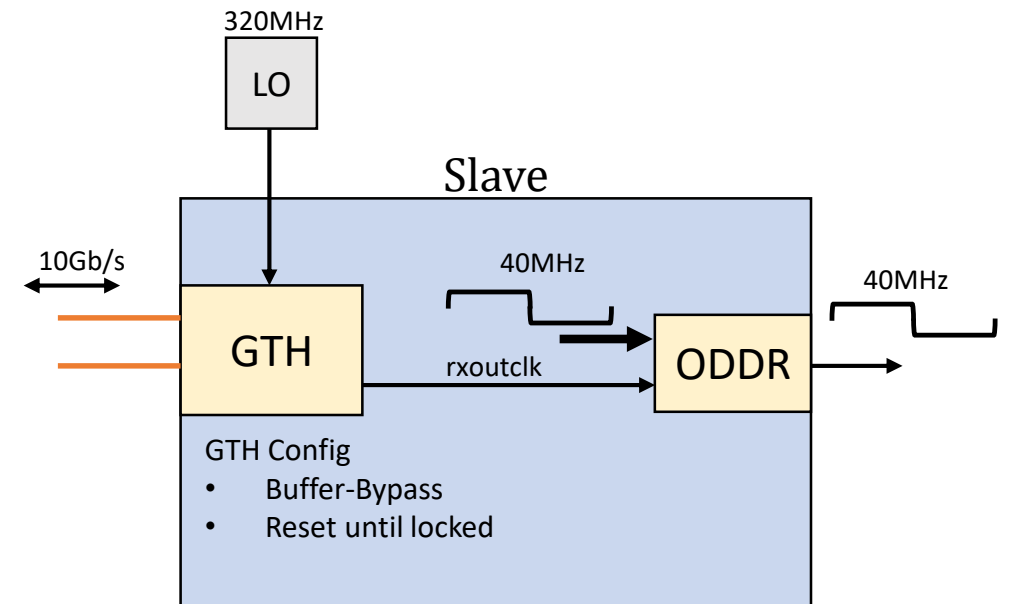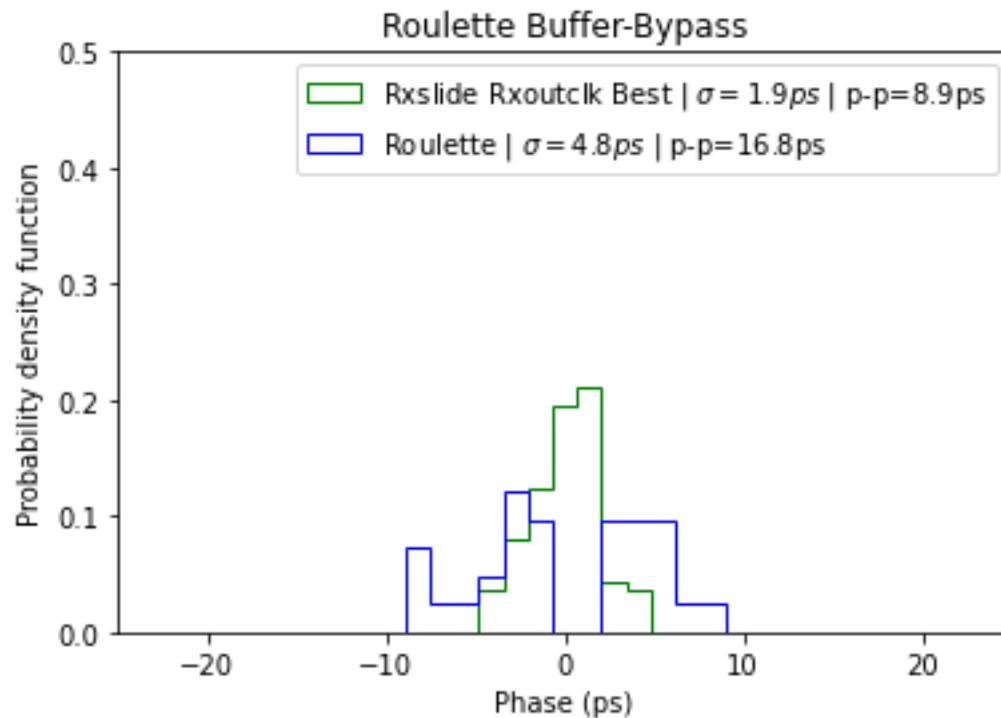
New architecture: Roulette FIFO

- When rxoutclk comes from rxoutclkPMA: phase is not fixed
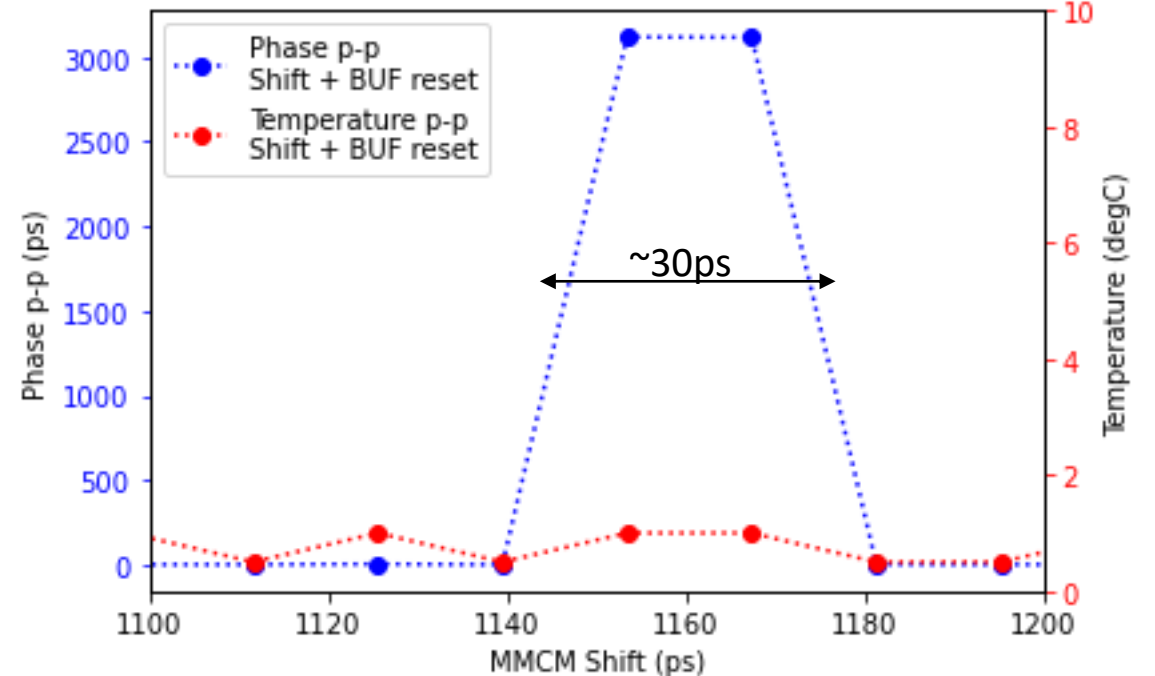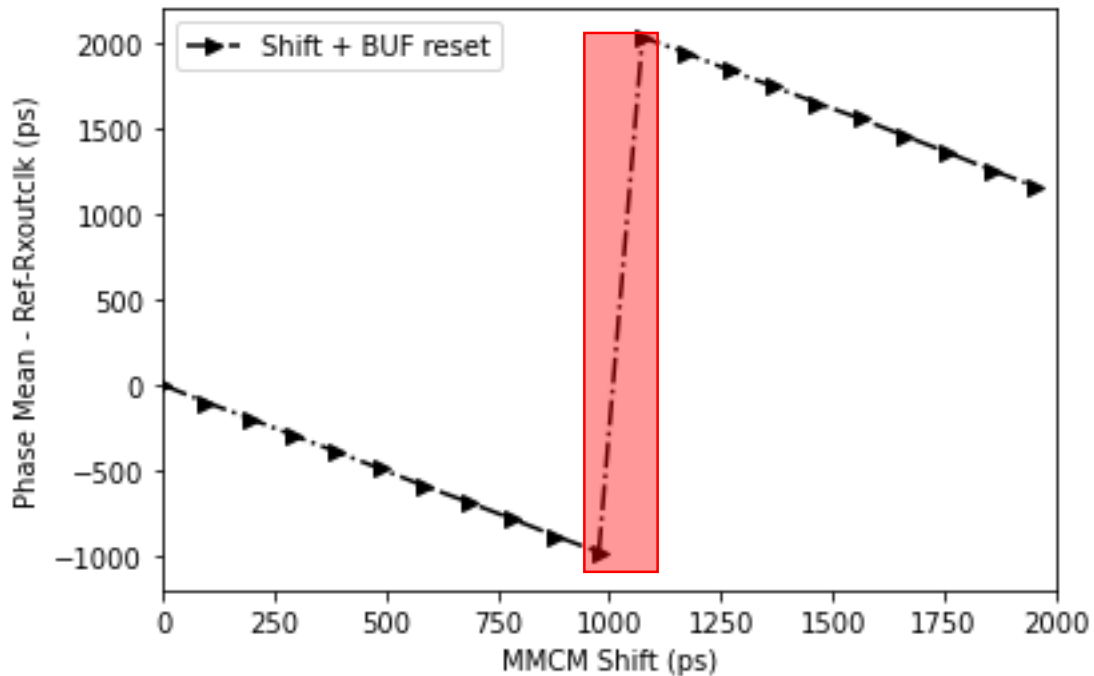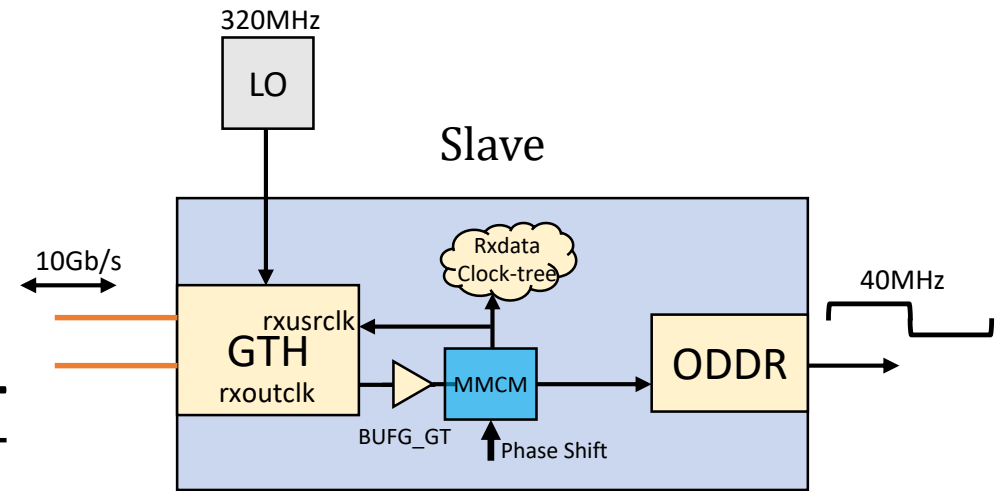- UI jumps (just ran a few points here)

New architecture: Roulette FIFO

- Fixed phase (why is it different: PMA/PCS?)
- But this represents a risk...
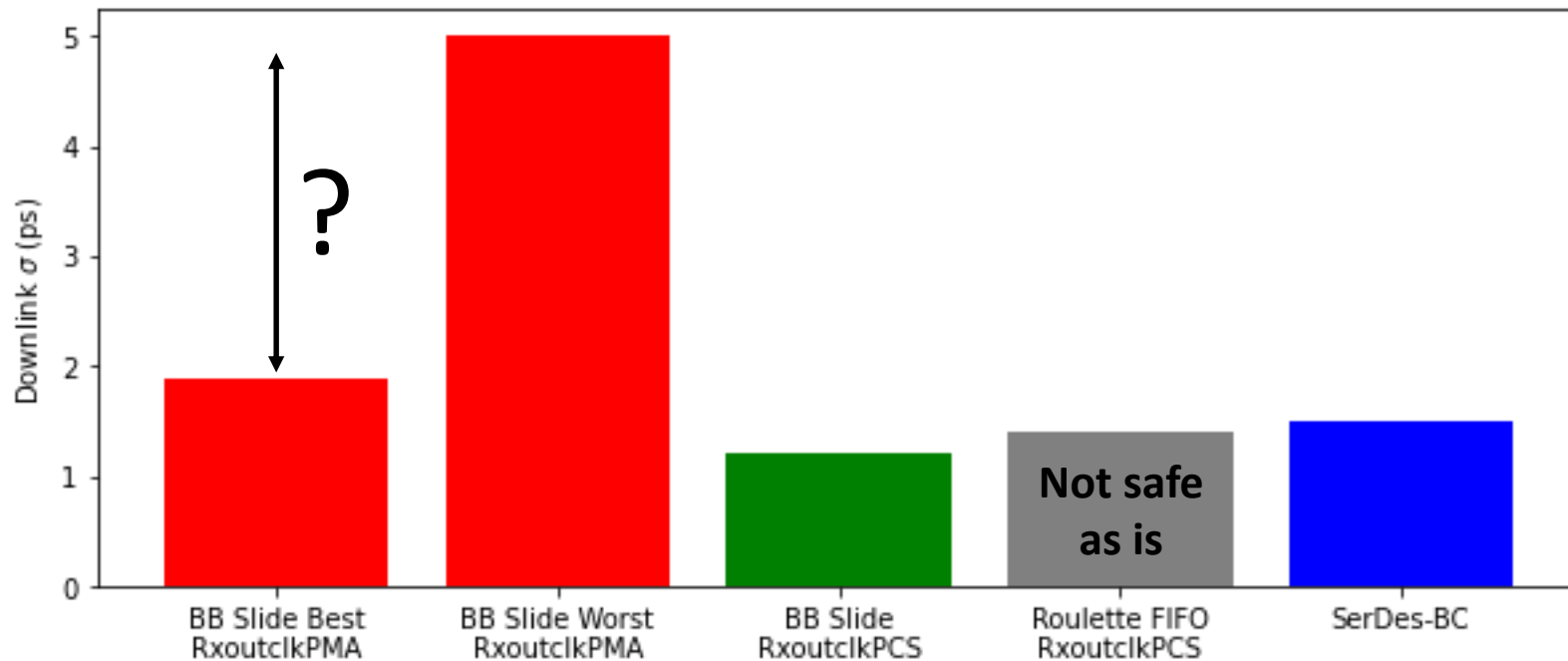
Roulette FIFO: the risk

- Full-period jumps in <u>metastability</u> zone
- Phase depends on **implementation & PVT**

- This architecture **requires additional mitigation technique**!

Summary

- Four different architectures were explored for receiver fixed-phase
  - Help needed
- Large variability observed seems related to clock-tree

- Hard to assess performance if we don't understand variability