

The Latency Validation of the Optical Link for the ATLAS Liquid Argon Calorimeter Phase-I Trigger Upgrade

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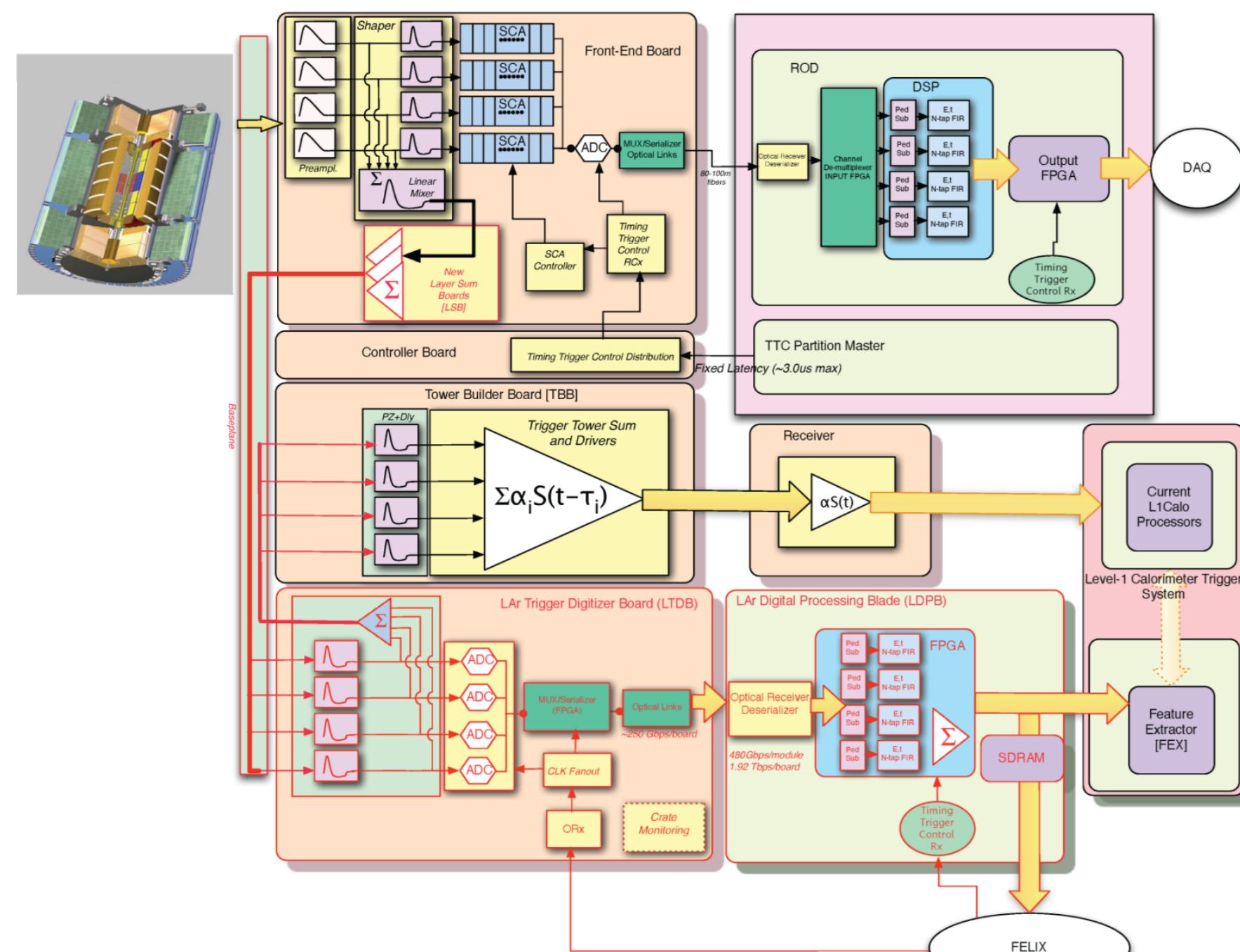
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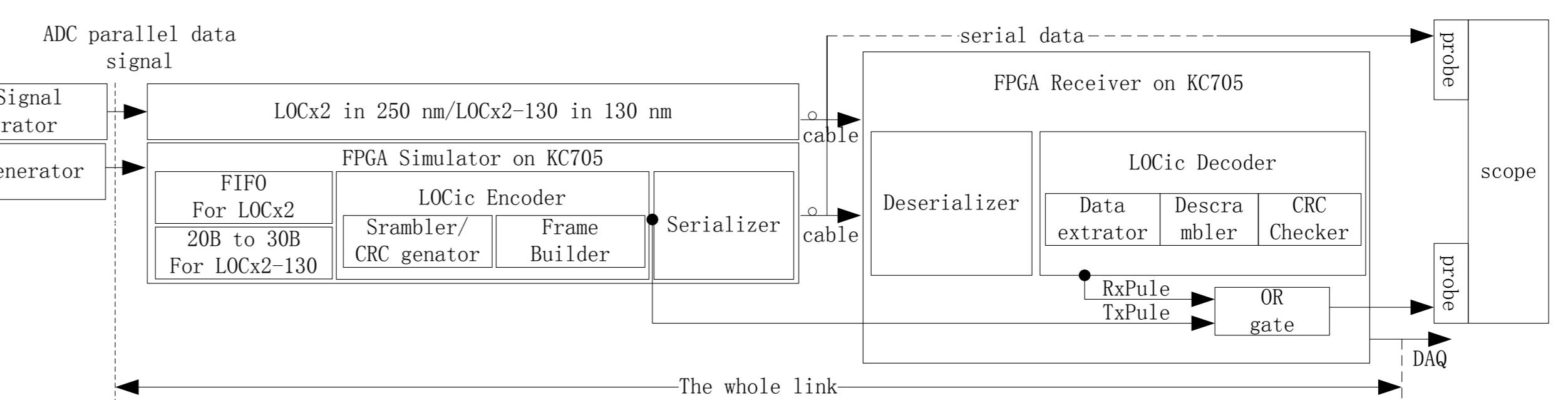
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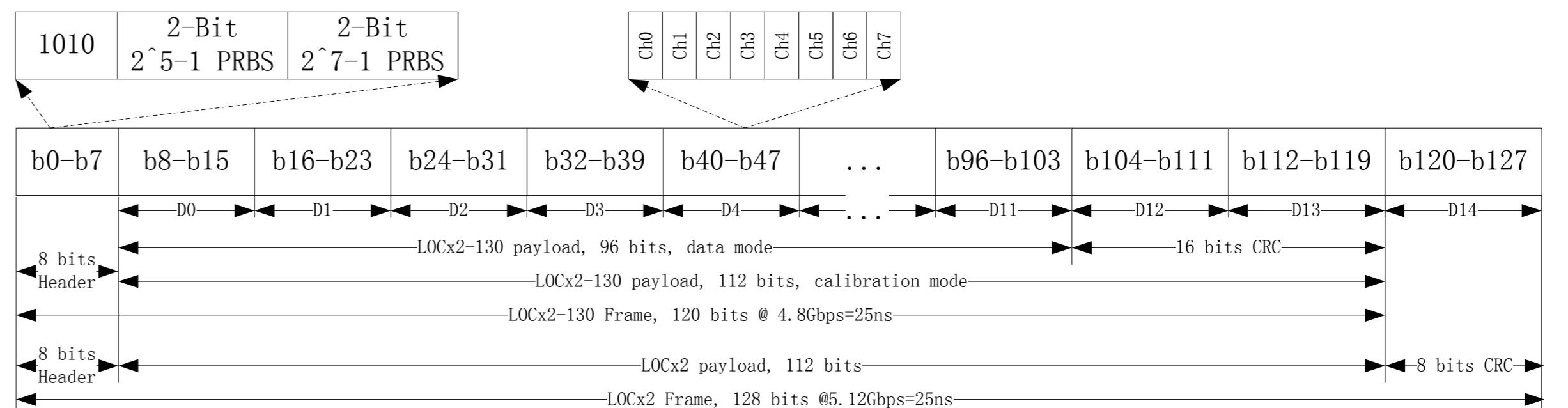
Block diagram of the ATLAS LAr calorimeter Phase-I upgrade

Introduction

- In the ATLAS Liquid Argon (LAr) Calorimeter Phase-I upgrade, the optical link is used to transmit the front-end detector data to the backend control room.
- Two Application Specific Integrated Circuits (ASICs), LOCx2 and LOCx2-130 (the baseline and a backup), have been designed for the ATLAS Liquid Argon (LAr) Calorimeter Phase-I upgrade.
- Each ASIC has two channels of serializers with custom encoders.
- The latency of the optical link is critical.
- The latency budget is 75 ns for each ASIC itself and 150 ns for the whole data link.**

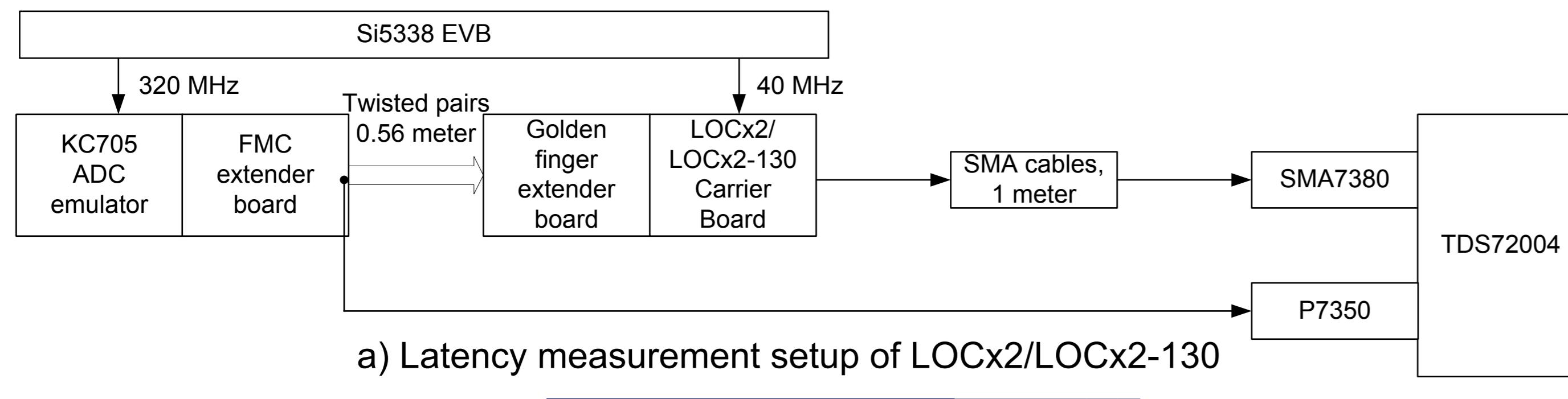


b) Block diagram of the link system

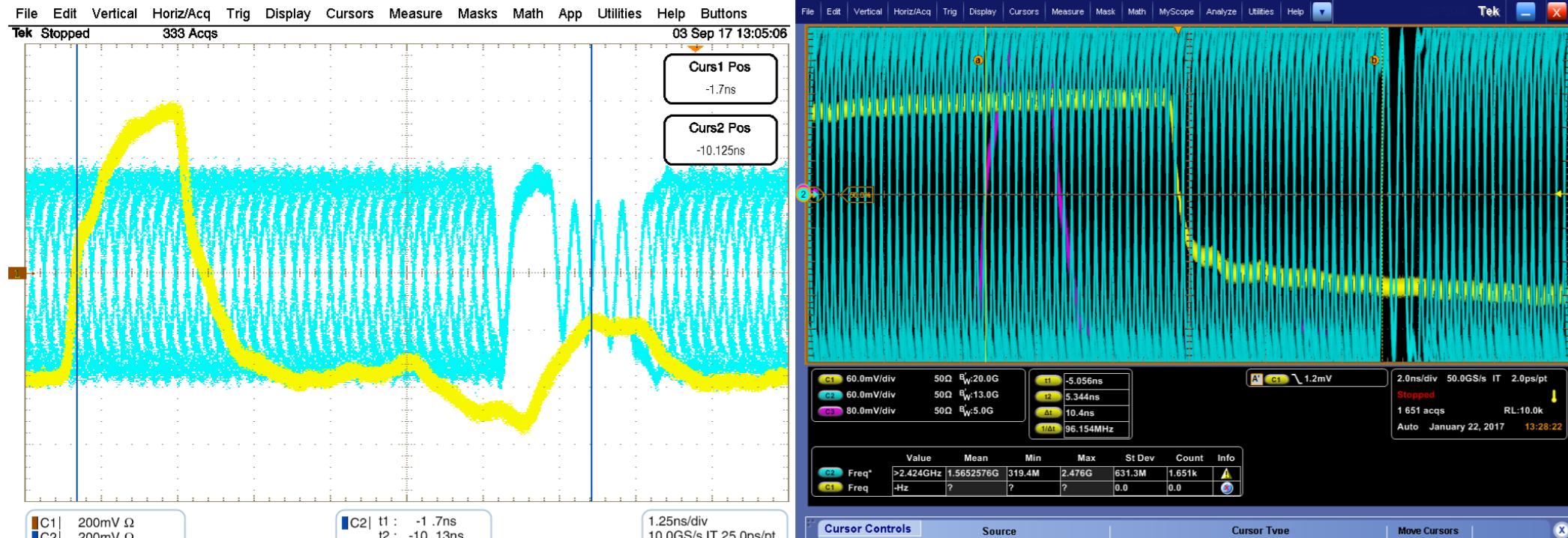


c) Frame definition of LOCx2 and LOCx2-130

ASIC latency measurements



a) Latency measurement setup of LOCx2/LOCx2-130

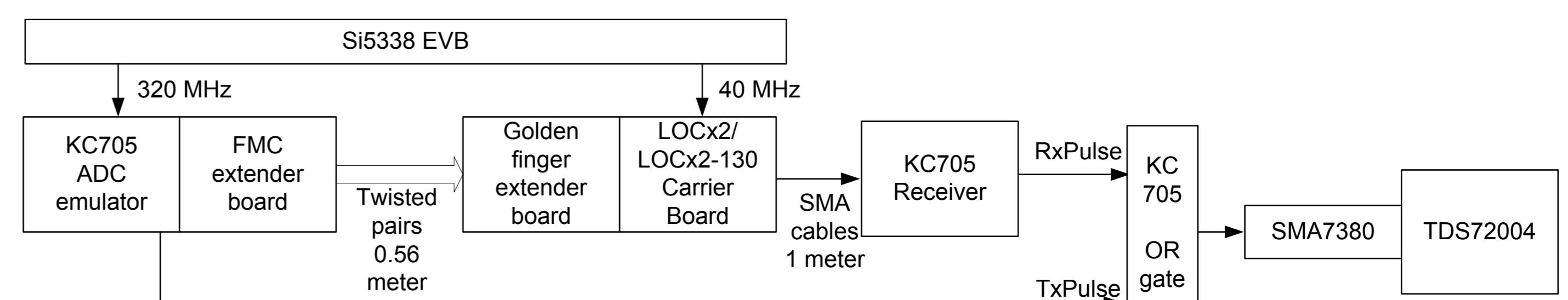


b) LOCx2 link latency

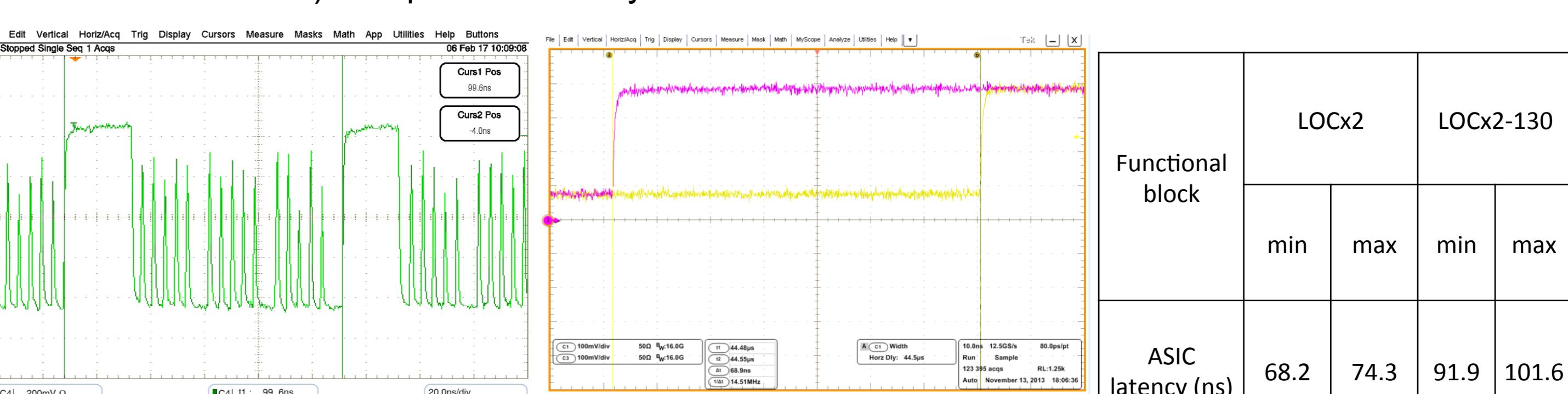
c) LOCx2-130 link latency

d) results

Whole link latency measurements



a) Setup of the latency of the LOCx2/LOCx2-130 whole data link

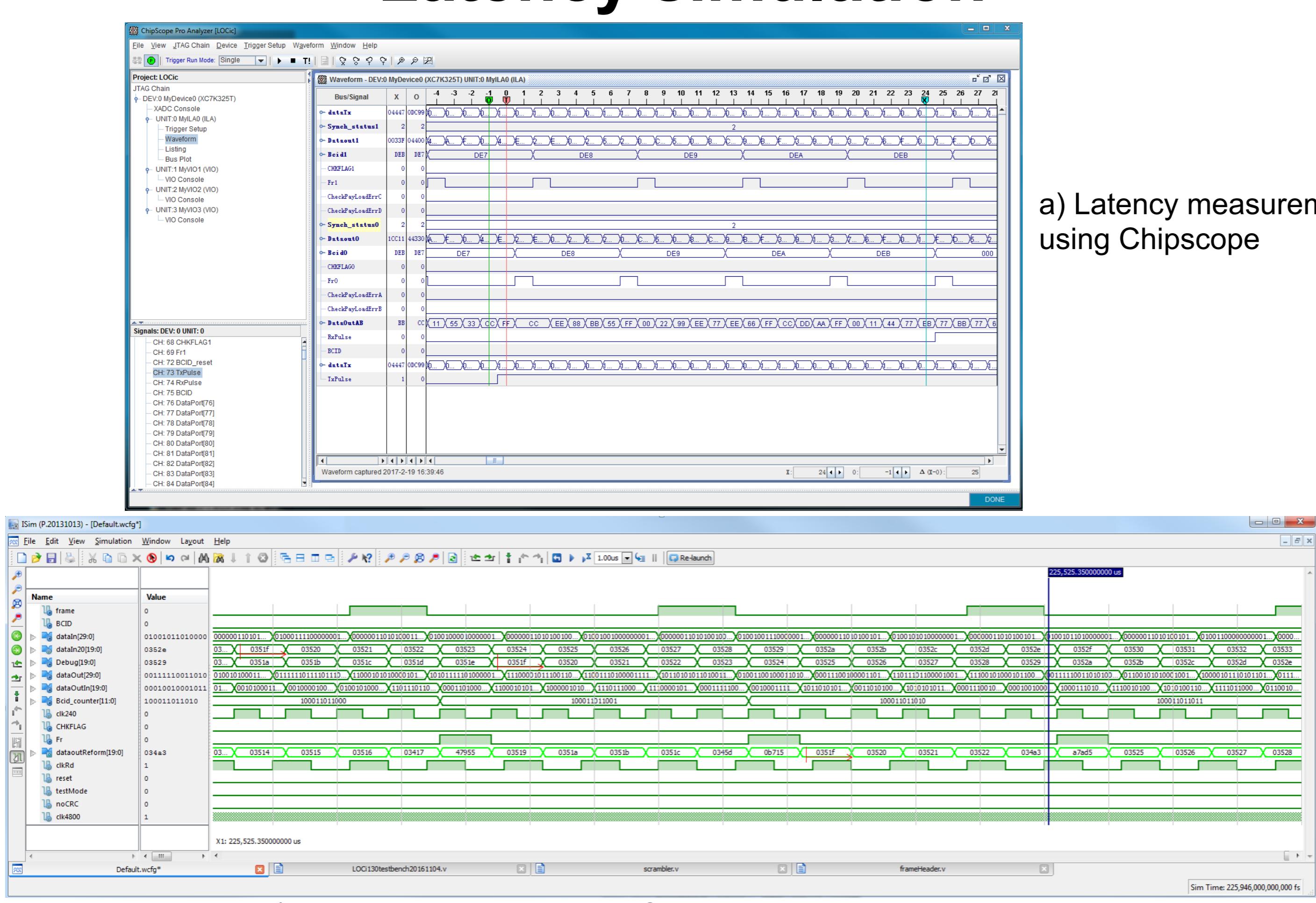


b) LOCx2 whole link latency

c) LOCx2-130 whole link latency

d) results

Latency simulation



a) Latency measurement using Chipscope

b) Latency simulation using ISim

Acknowledgments

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The latency results

Functional block		LOCx2		KC705 (LOCx2) estimation		LOCx2-130		KC705 (LOC130) estimation	
		min	max	min	max	min	max	min	max
TX	encoder	0.0	0.0	0.0	0.0	0	0	12.5	12.5
		8.4	11.6	3.1	6.3	16.4	22.7	0.0	0.0
		6.3	6.3	3.1	3.1	0.0	0.0	0.0	0.0
	scramble/CRC gen	6.3	6.3	3.1	3.1	6.3	6.3	6.3	6.3
	Frame builder	3.1	3.1	3.1	3.1	6.3	6.3	8.3	8.3
RX	serializer	0.0	0.0	0.0	0.0	0.0	0.0	20.3	20.3
		6.3	6.3	14.4	14.4	11.7	11.7	20.3	20.3
		24.0	27.2	23.8	26.9	34.4	40.7	47.4	47.4
	deserializer	28.5	31.4	28.5	31.4	36.7	40.1	33.1	41.4
	decoder	9.4	9.4	9.4	9.4	12.5	12.5	12.5	12.5
total receiver		3.1	3.1	3.1	3.1	4.2	4.2	4.2	4.2
		3.1	3.1	3.1	3.1	4.2	4.2	0.0	0.0
total link		44.1	47.0	44.1	47.0	57.5	60.9	49.8	58.1
		68.2	74.3	67.9	73.9	91.9	101.6	97.2	105.5

References

- L. Xiao et al., A low-power, low-latency, dual-channel serializer ASIC for detector front-end readout, 2017 JINST 12 C01049.
- ATLAS collaboration, ATLAS liquid argon calorimeter Phase-I upgrade technical design report, CERN-LHCC-2013-017, ATLAS-TDR-022 (2013).

