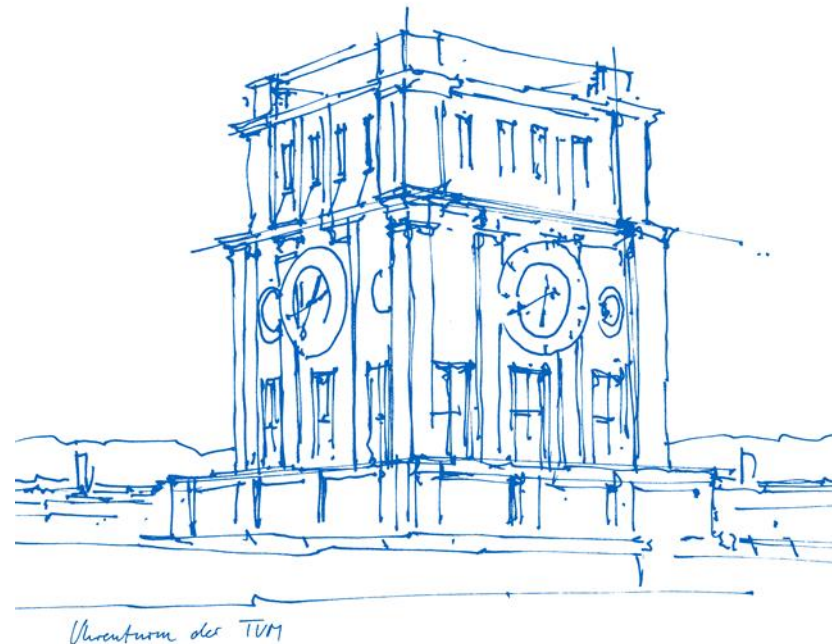# New PCIe spillbuffer

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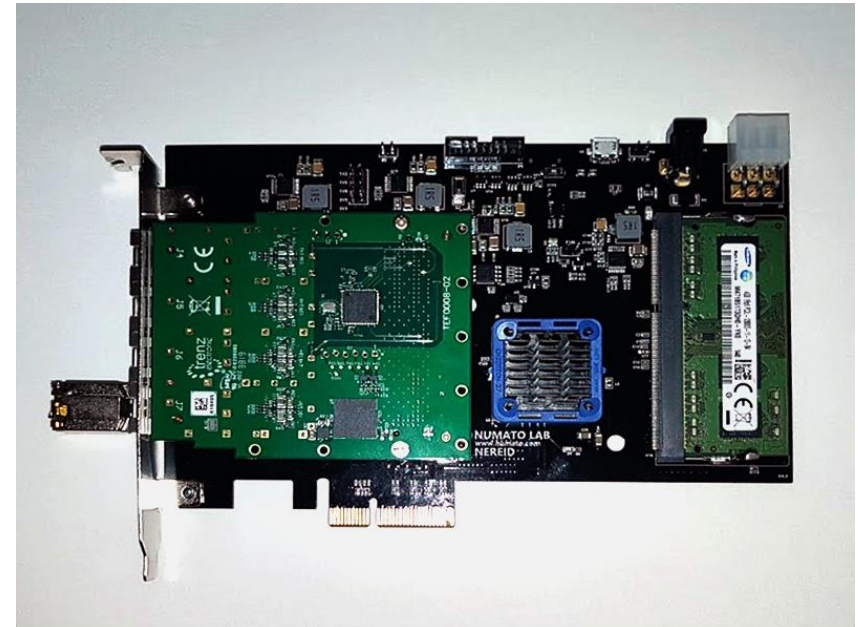
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COMPASS DAQ Workshop 03.03.2020

Spillbuffer card

- Nereid Kintex 7 PCI Express (1k €)
- Trenz FMC – SFP adapter (160 €)

- Kintex 7 XC7K160T FBG676
- 4x PCIe-Gen2 up to 2GByte/s
- 2GB DDR3 memory
- Only 6 Gbit/s per SFP
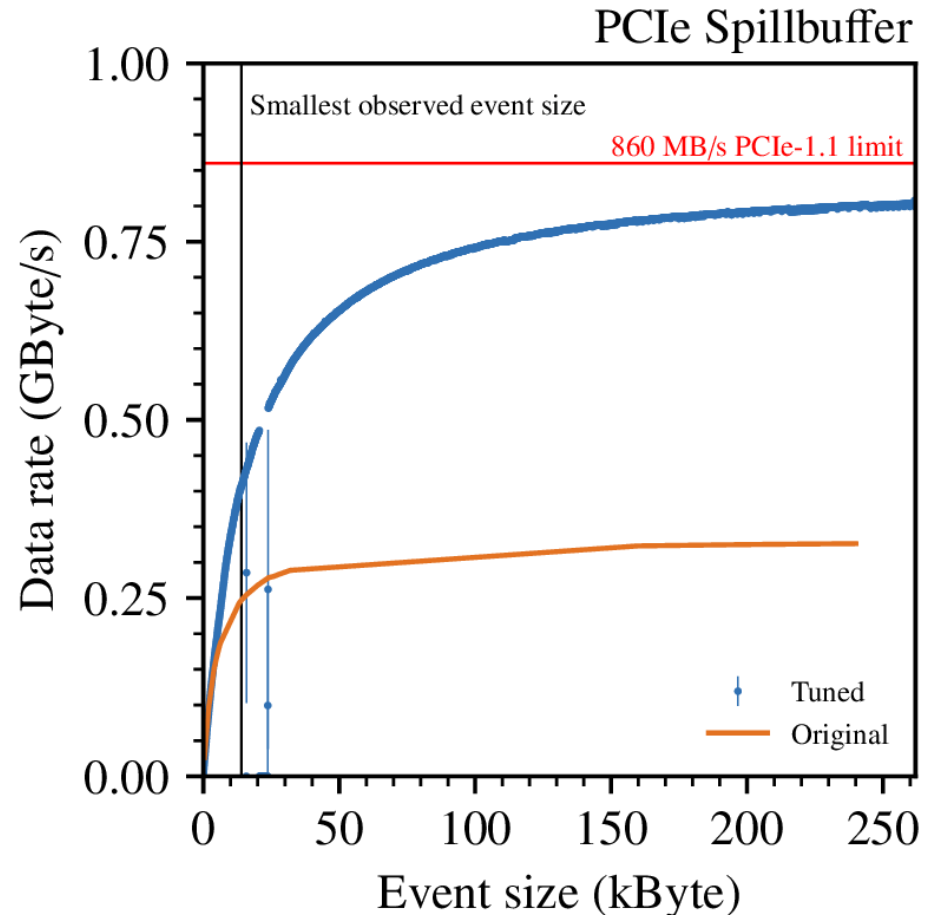
- No dedicated TCS interface

Basic performance limitation of PCIe

- Data is transferred via in packets with limited sizes
- 20 Bytes are used by header and trailers
    => significant overhead

- For DMA transfers, additional limit:
    - Payload limited to 128 Bytes by chipset
    - Better on other chipsets?

- Theoretical maximum transfer rate:
    - 860 Mbyte/s   PCIe Gen-1
    - 1720 Mbyte/s PCIe Gen-2

PCIe Spillbuffer

Link usage (%) vs Paload Size (Byte)

⇐ DMA limit
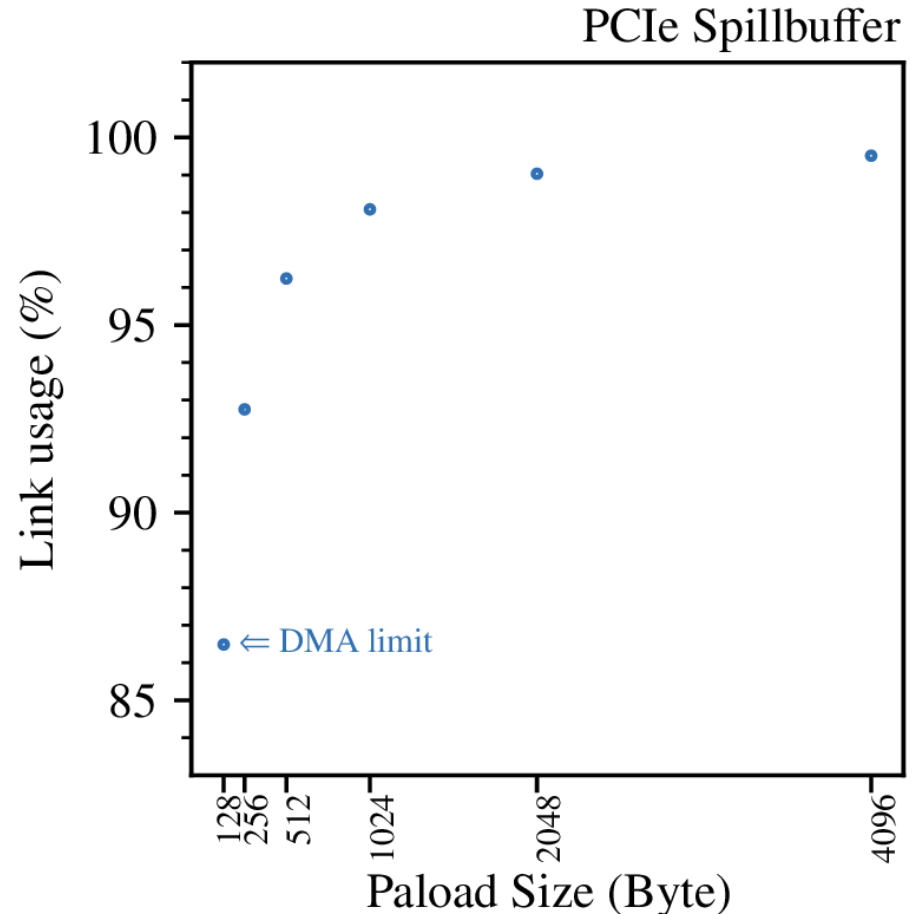
Performance improvements in firmware

- Started with firmware of the old Virtex-5

- Test conditions:
  - Internal generator (4byte 250 MHz) (continuously running)
  - Data stored to '/dev/null'
  - Host: PCIe Gen 1.1

- State machines not optimized
- Performance improvement ~ factor 3

- Maximum data rate for big events:
  794 Mbyte/s
- Tested with simplified driver
  only 10 Mbyte/s improvement

PCIe Spillbuffer

Smallest observed event size

860 MB/s PCIe-1.1 limit

Tuned

Original

Data rate (GByte/s) vs Event size (kByte)

Impact of the event size on the performance

- Interrupt for each event
- Indicates event boundaries to the computer

- 4Mbyte memory blocks allocated
- Check if these blocks are full
- Switching between the blocks
- New memory address transferred to FPGA

- Takes around 17us/event (PCIe Gen-1)
- Minimum event sizes 14kByte
- ~50% of maximum performance reached for these events
- Smaller setups => Smaller events
  - PRM
  - Test measurements
  - May have significant impact
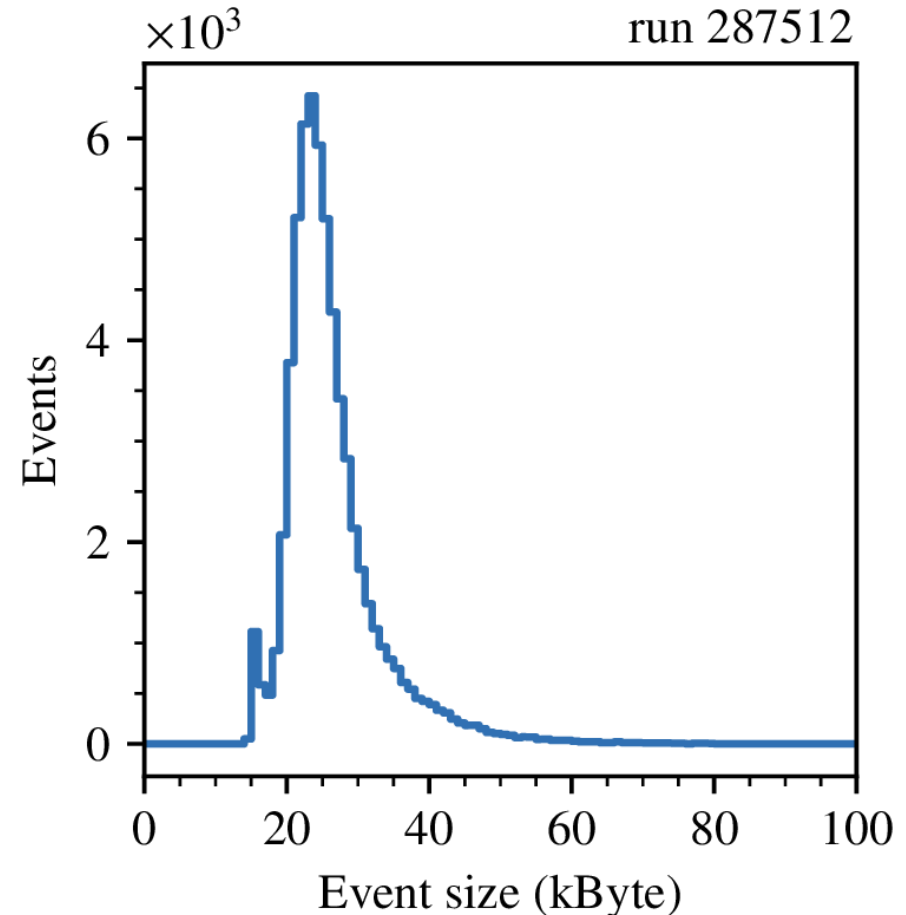
Tests with PCIe Gen2

- Test conditions:
  - Internal generator (4byte 250 MHz) (continuously running)
  - Upsizer 4byte -> 8 byte
  - Data stored to '/dev/null'
  - Host: PCIe Gen 2.1

- Generator limited to 1Gbyte/s

- Upsizer needed in order to run the DMA at the maximum speed

- 1Gbyte/s reached at event sizes of 29kByte

- Interrupt handling ~13us/event

PCIe Spillbuffer

Smallest observed event size

- PCIe-2.1
- PCIe-1.1
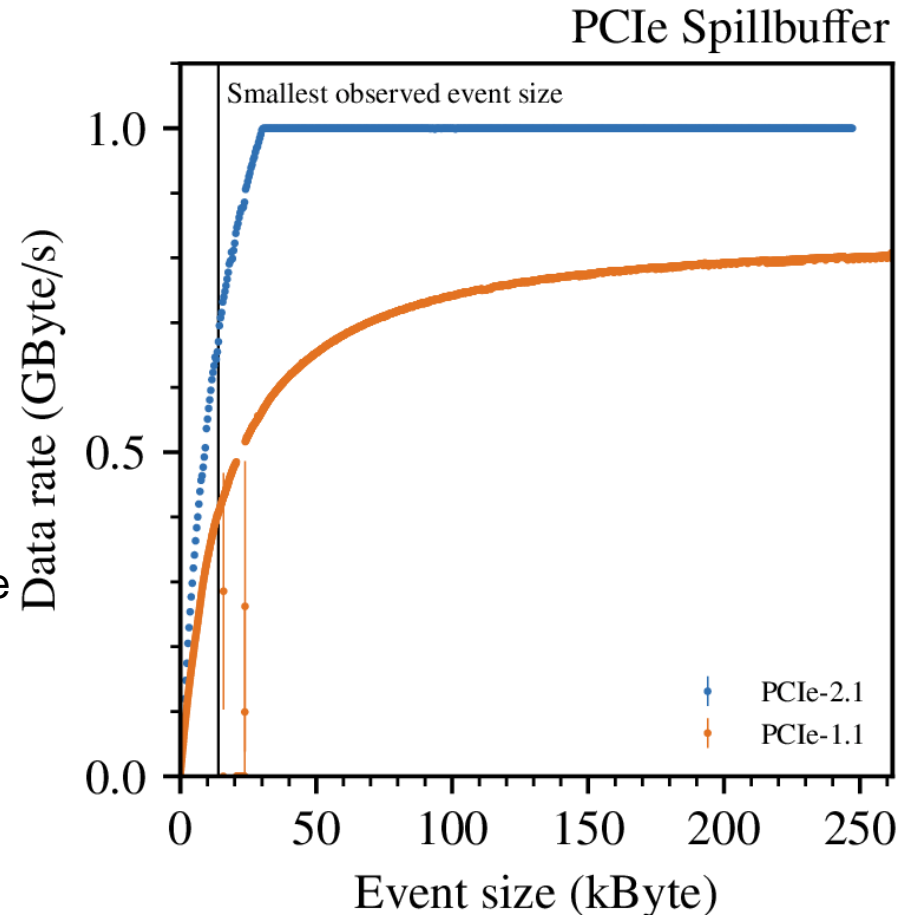
Outlook

- Change generator to go above 1Gbyte/s
- Test with external data source (Aurora)
- Test at COMPASSS
- Different payload sizes possible?

- Write memory interface for new EB logic
  (See talk by Dmytro Levit)
- TCS interface via SFP
- Event checks
- Merge several small events in one transfer

- Create UCF interface for Kintex7