Western Norway
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Alpide SystemC Simulations

FOCAL

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Simulation setup

- Using SystemC simulation model for Alpide and ITS
  - Relatively accurate model of readout of Alpide
  - Inner barrel and outer barrel mode
- Simulation model also includes pCT and FoCal simulation (as of recently)

Event generation

ITS

Simulation model includes an «event generator»

- Time between events follows exponential distribution, and is randomly generated
- The actual hits to the chips can be:
  - Randomly generated (simple «toy model»)
    - Multiplicity of hits follows discrete distribution for the experiment
    - Not a true event generator, in the sense that it does not generate proper physics events
  - Taken from a pool of discrete MC events, generated by e.g. AliRoot

pCT

- Hits (random or from MC files) are continuously inputted to Alpide chips

Detector geometry

ITS

- Creates all 7 layers of ITS
  - Configurable how many layers (and staves per layer) to include in simulation
  - With correct connections and configuration of chips
    - IB vs. OB mode: shared data link in OB mode, 1200 Mbps in IB, 400 Mbps in OB
  - With correct number of chips connected to an RU

pCT

- Builds detector based on IB staves
- Up to 41 layers (configurable)
- Up to 12 staves per layer (configurable)
- 1 RU per detector layer

Focal simulation

- Implemented by combining ITS event generation, with pCT detector configuration
  - Only 1 pCT detector plane, and 2 layers allowed (currently)

- Input data:
  - Monte carlo files simulated/generated by Marco van Leeuwen
  - Focal plane: 1.6m x 1.6m, centered around beam pipe
  - Plane divided into 3200 x 3200 «macro pixels»
    - Each macro pixel is 0.5mm x 0.5mm
  - 2 detector planes:
    - S1 (layer 0 in SystemC simulation)
    - S3 (layer 1 in SystemC simulation)

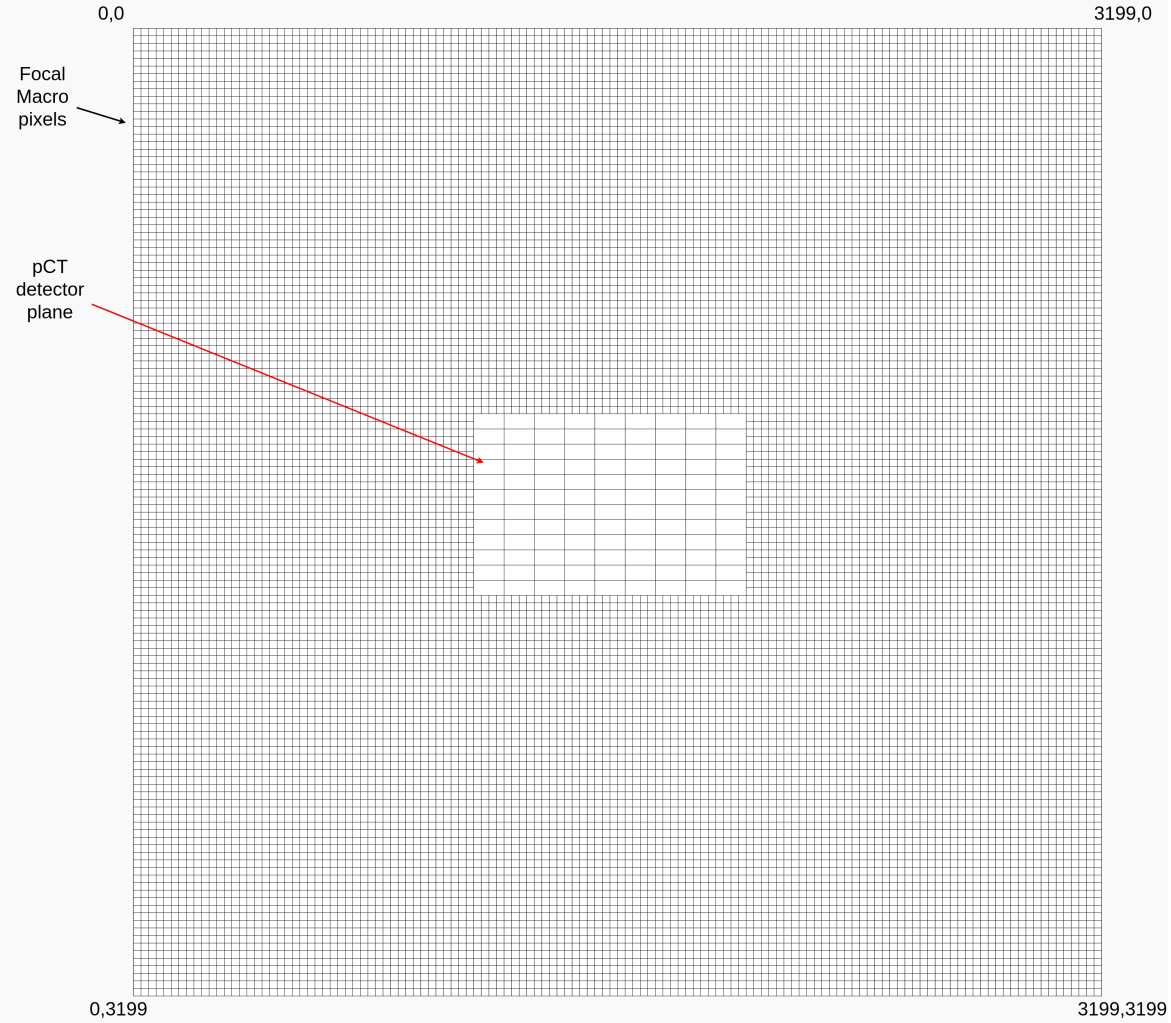
Focal simulation

- Input data cont'd:
  - For each event in the monte carlo file, the following is specified (for each layer):
    - nPixS1/nPixS3:
      - Number of macro pixels that had hits in the event
    - rowS1[nPixS1], colS1[nPixS1], rowS3[nPixS3], colS3[nPixS3]:
      - A list of macro pixels that were hit (row and column)
    - ampS1[nPixS1], ampS3[nPixS3]:
      - A list with number of Alpide pixel hits, per macro pixel that was hit

- The specified number of pixel hits (ampS1/S3) is generated for each macro pixel hit (row/col)
  - Row/columns which are not within the bounds of the pCT/Focal detector plane are ignored
  - Hits are randomly generated within the macro pixel (0.5mm x 0.5mm), following a flat/ uniform distribution
  - No clustering is performed (but simple 2D gaussian clustering could easily be added)

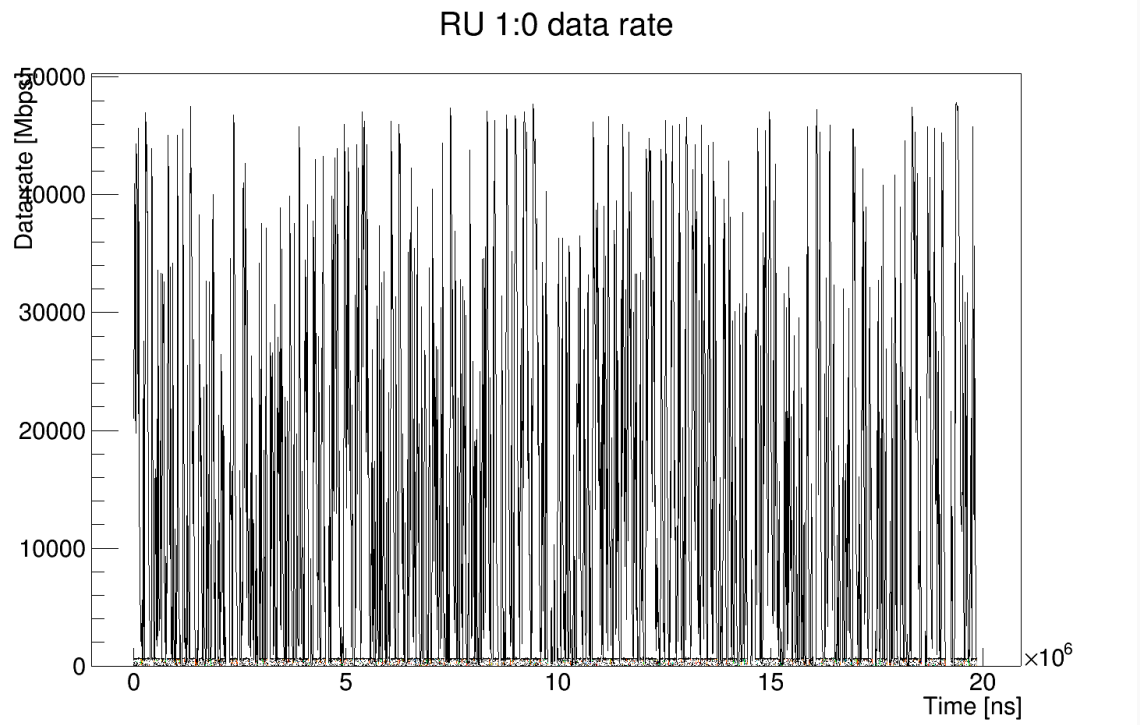
Focal simulation

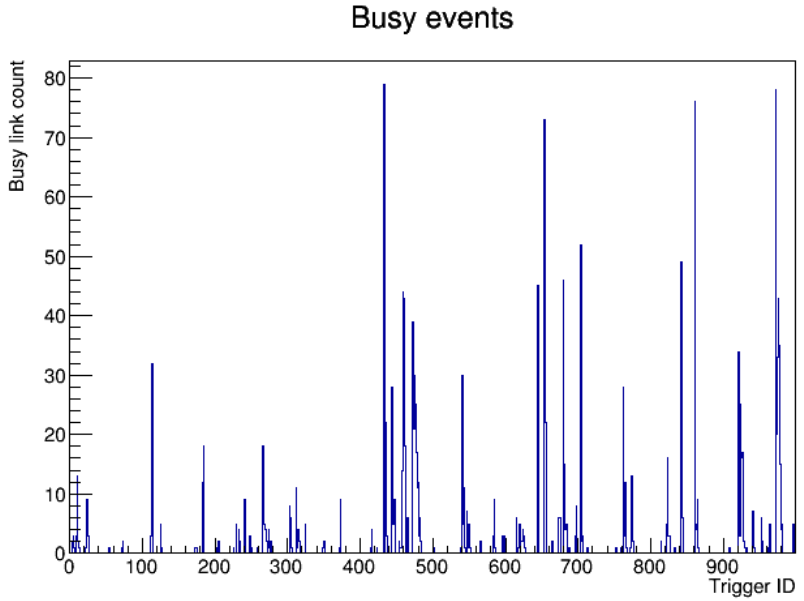
- By analyzing the .root files it appeared that the highest occupancy of hits was at the center of the 1.6m x 1.6m Focal plane
- Therefore, the pCT detector plane (12 IB staves, ie. 12x9 chips) used to simulate, was centered on the Focal plane, where the occupancy is highest

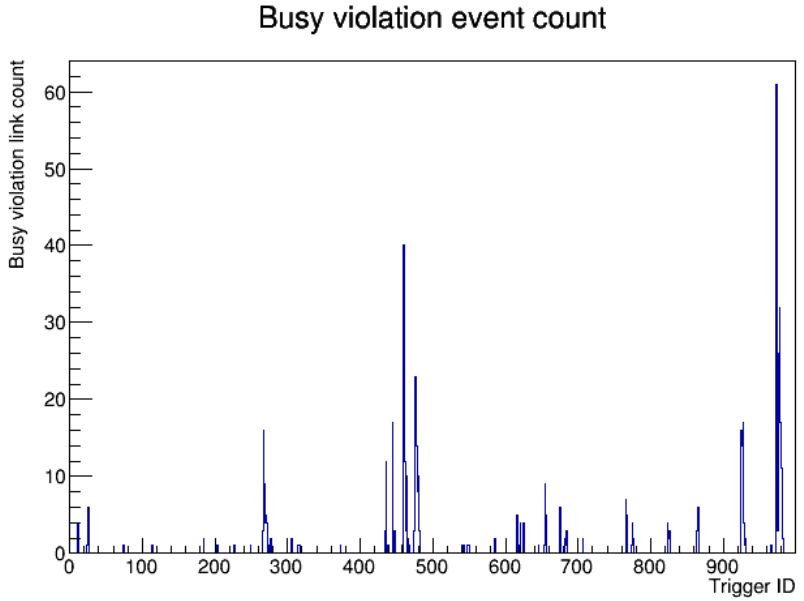


Simulation Results – 50 kHz PbPb Triggered

Mbps





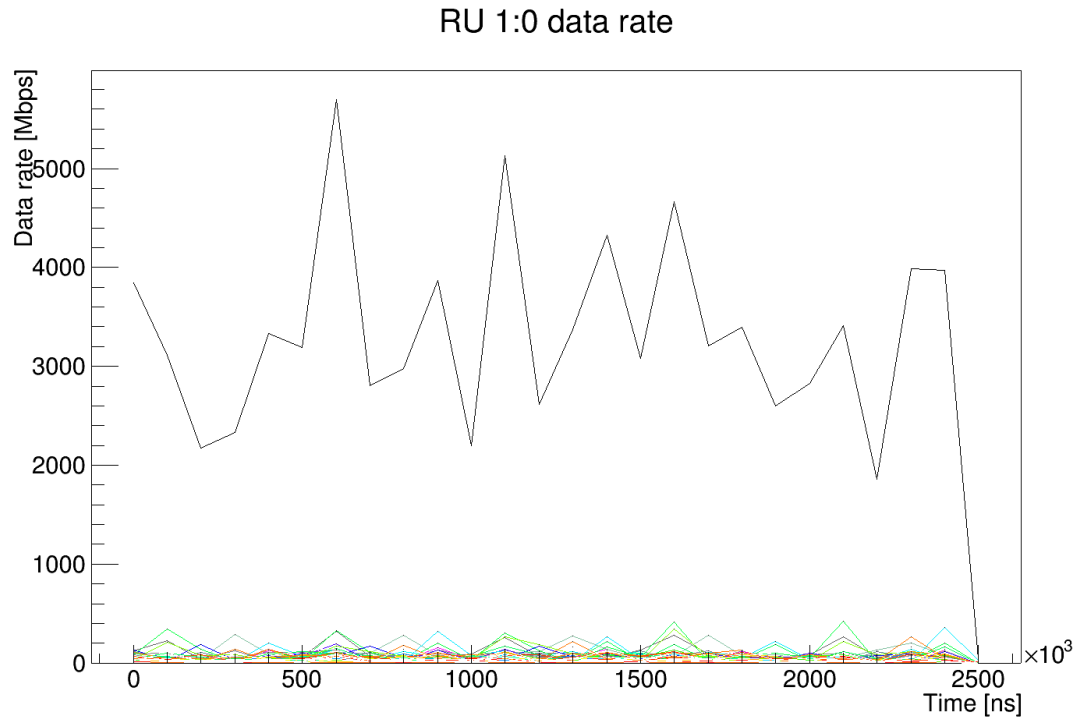


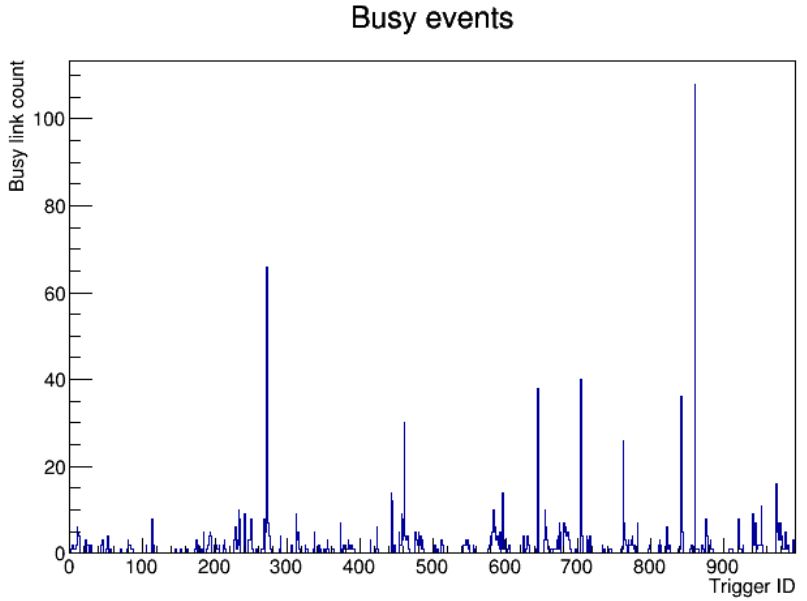
Note: 108x 1.2Gbps Alpide links per RU in simulation

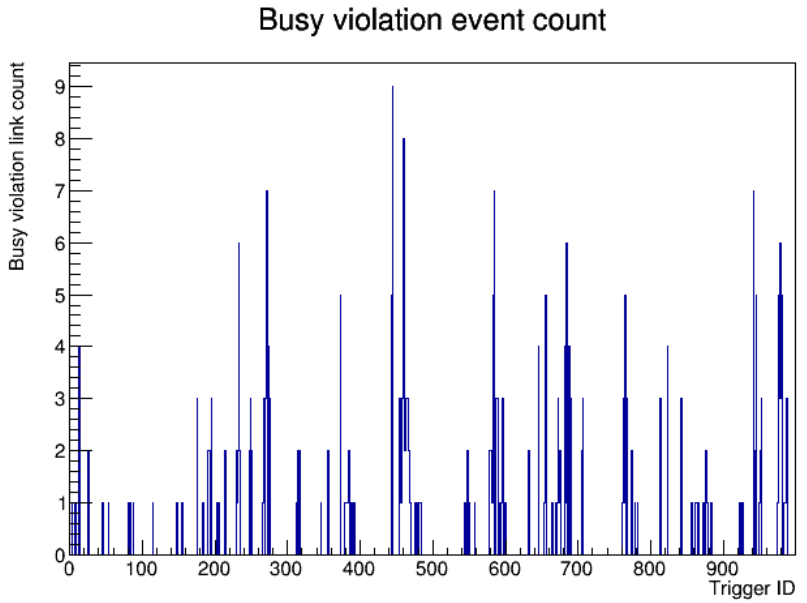
Busy violation = frame lost (for chip that had busy violation)

Simulation Results – 400 kHz pp Triggered

Mbps







Note: 108x 1.2Gbps Alpide links per RU in simulation

Busy violation = frame lost (for chip that had busy violation)

Simulation Results – Triggered mode

Data rate	50 kHz PbPb	400 kHz pp
Layer 0 (S1)	29.8 Gbps	664.5 Mbps
Layer 1 (S3)	29.5 Gbps	689.8 Mbps

	50 kHz PbPb	400 kHz pp
Readout efficiency	98.78%	99.68%
Data loss	1.22%	0.32%

- Simulated 1000 events, both cases
- Events used in sequence from event ROOT files, and «reused» to achieve 1000 events
- Triggered mode
  - 100 ns strobe
- Constant 6 us pixel shaping time (time over threshold)