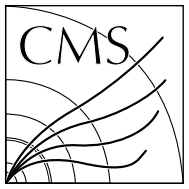
Available on CMS information server

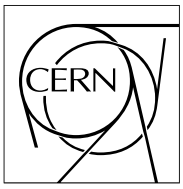
CMS DP -2024/102



The Compact Muon Solenoid Experiment

CMS Performance Note

Mailing address: CMS CERN, CH-1211 GENEVA 23, Switzerland



28 October 2024

Check-Sort-Push and its application in CMS iRPC subsystem

CMS Collaboration

Abstract

Results on the Check-Sort-Push and its application in CMS iRPC subsystem

Check-Sort-Push
and its application in CMS iRPC subsystem

CMS Collaboration

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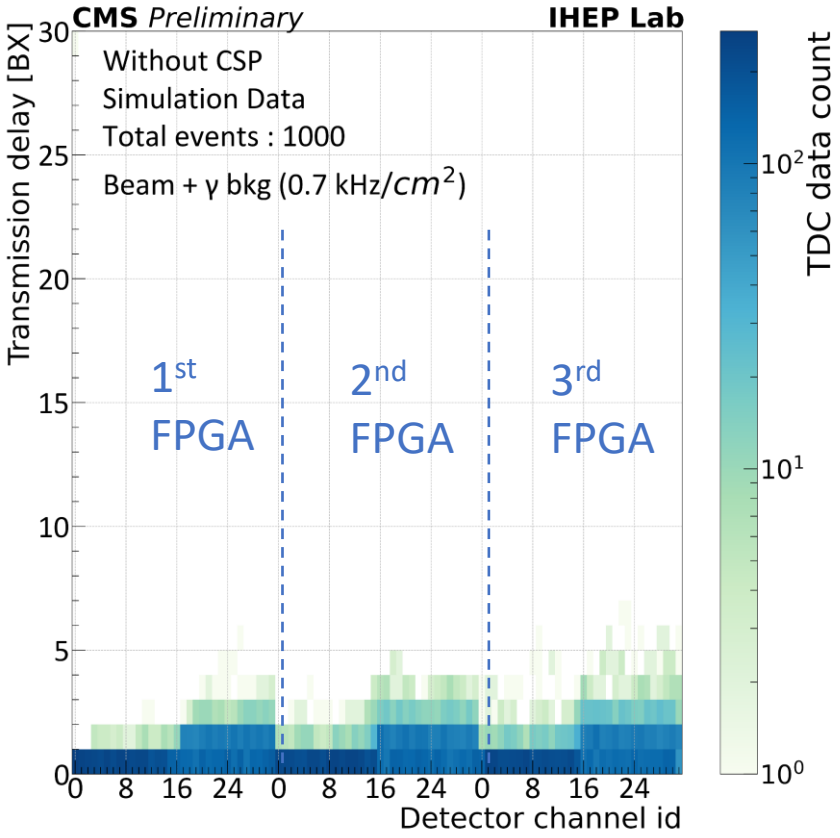
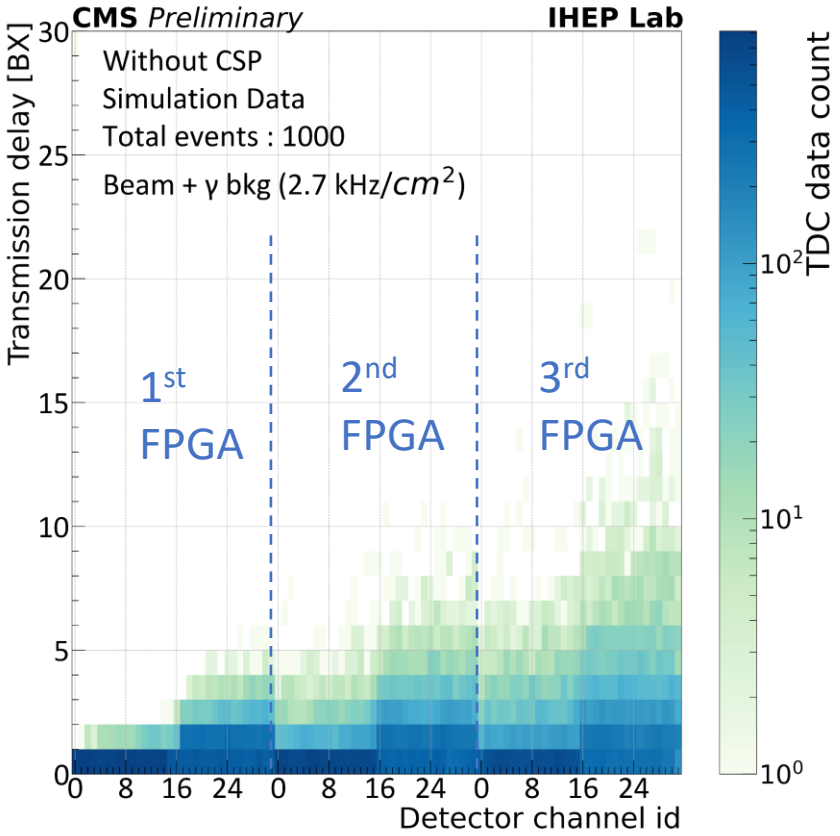
Transmission delay behavior with detector channel id



Caption:

- This plot shows the transmission delay behavior with detector channel id without CSP based on simulation data (beam + 0.7 kHz/cm2 γ background (bkg)). The transmission delay is increasing with detector channel id.
- Transmission delay (unit: BX): Time difference between data generation time and data sending time.
- TDC data count: Original data with channel id and timestamp after being digitized by frontend ASIC.
- BX: Bunch crossing = 25 ns.
- CSP: Check-Sort-Push. A protocol for which data is sent based on its generation time.
- Simulation data: Simulate different cluster number and size situations in muon + γ bkg (0.7/1.2/1.8/2.7 kHz/cm2) .
- Measurements performed at IHEP Lab, a electronics laboratory in Beijing used to study and develop iRPC backend electronics.

Transmission delay behavior with detector channel id



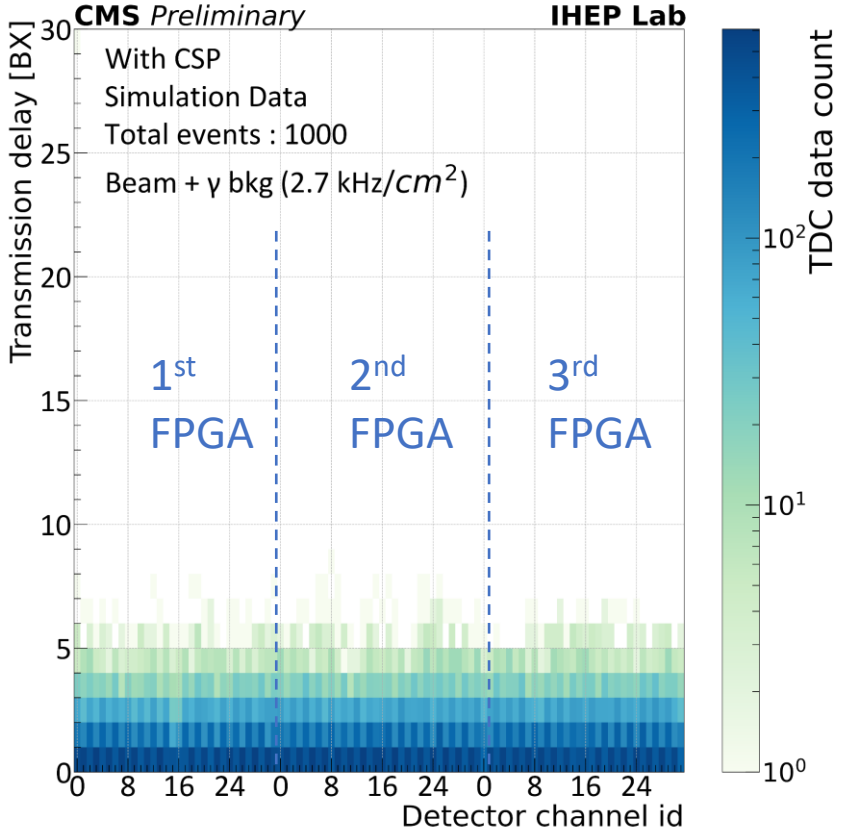
Caption:

This plot shows the transmission delay behavior with Detector channel id without CSP based on simulation data (beam + 2.7 kHz/cm2 γ bkg).

The transmission delay is increasing with detector channel id.

Comparing it with the one in beam + 0.7 kHz/cm2 γ bkg, the maximum transmission delay becomes bigger, around 15 BX.

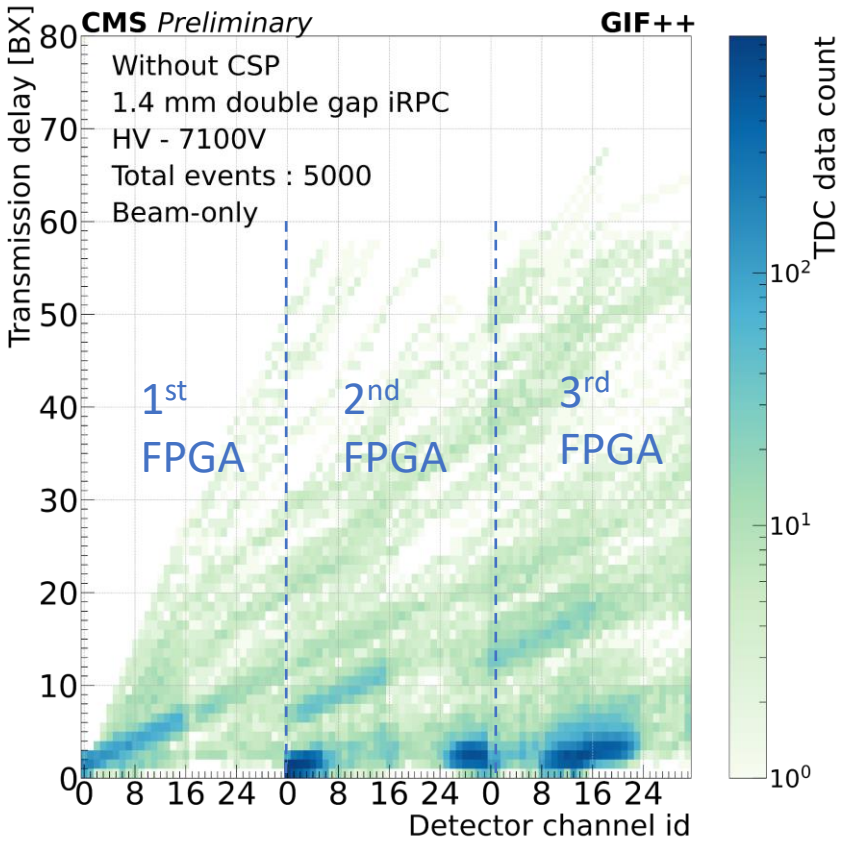
Transmission delay behavior with detector channel id



Caption:

This plot shows the transmission delay behavior with detector channel id with CSP based on simulation data (beam + 2.7 kHz/cm2 γ bkg). The transmission delay does not have a dependence on detector channel id. Comparing it with the one without CSP, the maximum transmission delay decreases by ~50%, from ~15BX (previous plot) to ~7BX (this plot).

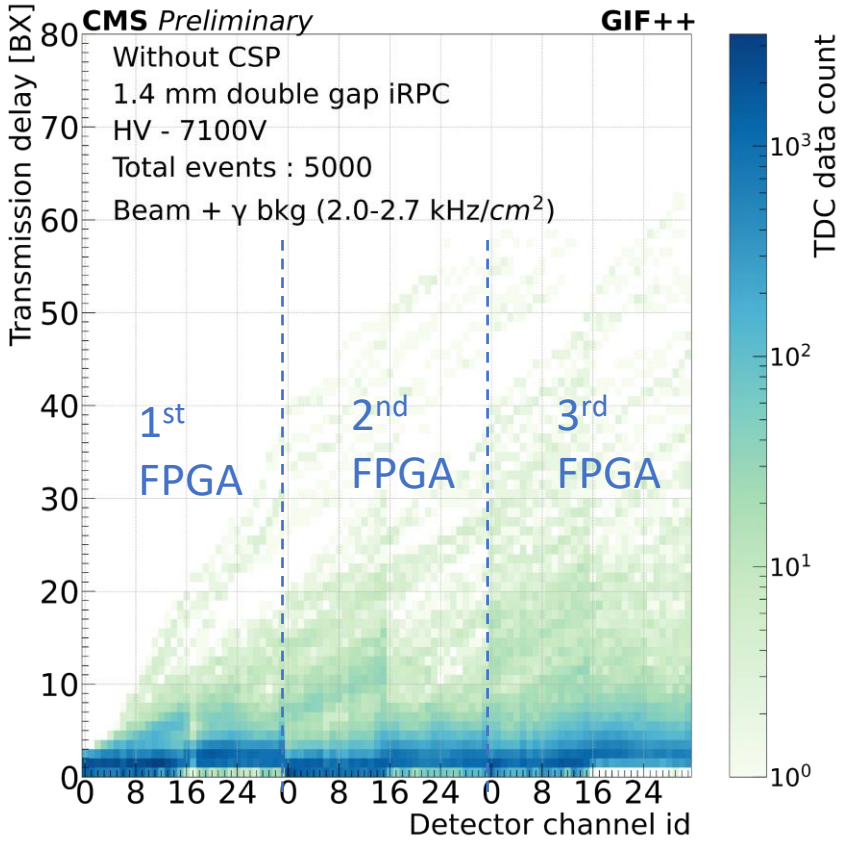
Transmission delay behavior with detector channel id



Caption:

- This plot shows the transmission delay behavior with detector channel id without CSP in test beam (beam-only). Transmission delay has a strong dependence on detector channel id. The maximum delay is around 60 BX. This phenomenon is caused by polling readout (sequential readout) and it means a larger DAQ window and receiver latency window to transmit TDC data is needed.
- GIF++: Gamma irradiation facility used for test beams at CERN.
- HV – 7100V: High voltage of iRPC chamber is 7100 V (usual working point).

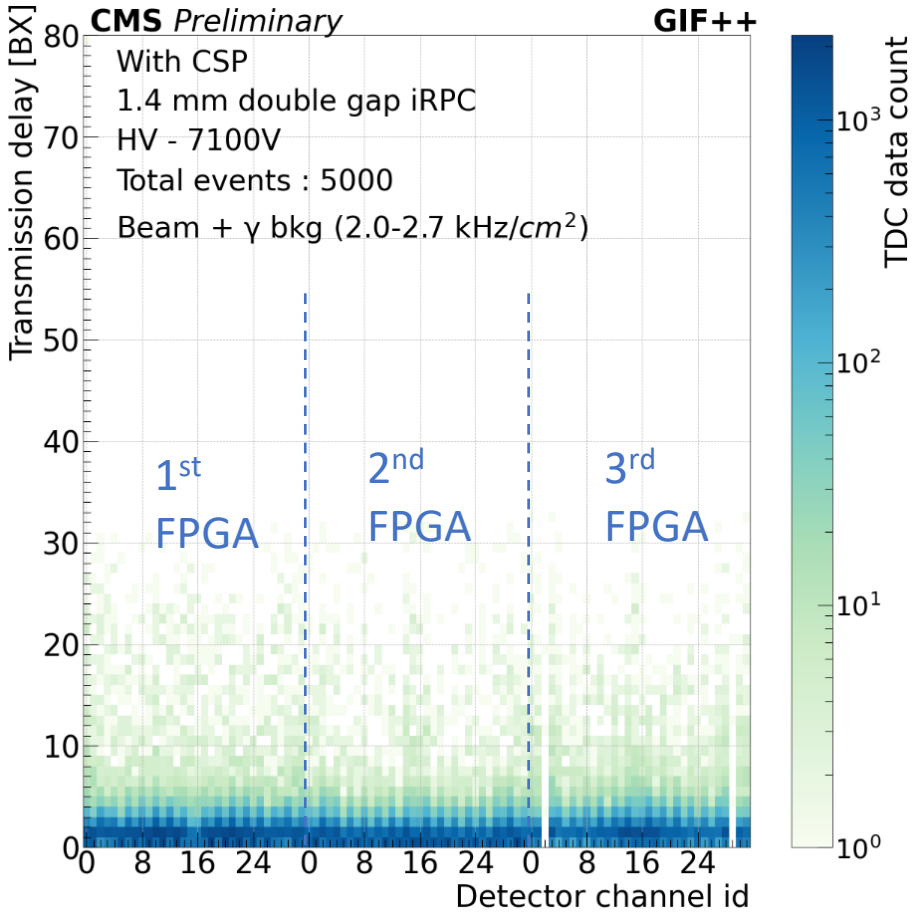
Transmission delay behavior with detector channel id



Caption:

- This plot shows the transmission delay behavior with detector channel id without CSP in test beam (beam + 2.0-2.7 kHz/cm2 γ bkg). Transmission delay has a strong dependence on detector channel id. The maximum delay is around 60 BX.
- 2.0-2.7 kHz/cm2 γ bkg: In GIF++ beam test, γ bkg rate is a range. But in simulation case, γ bkg rate is fixed.

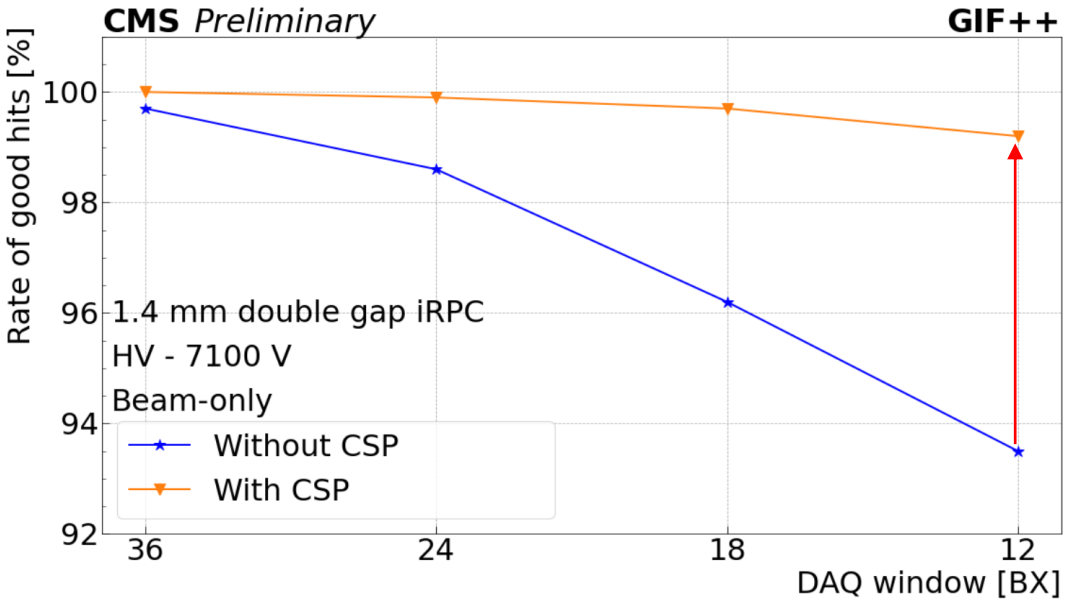
Transmission delay behavior with detector channel id

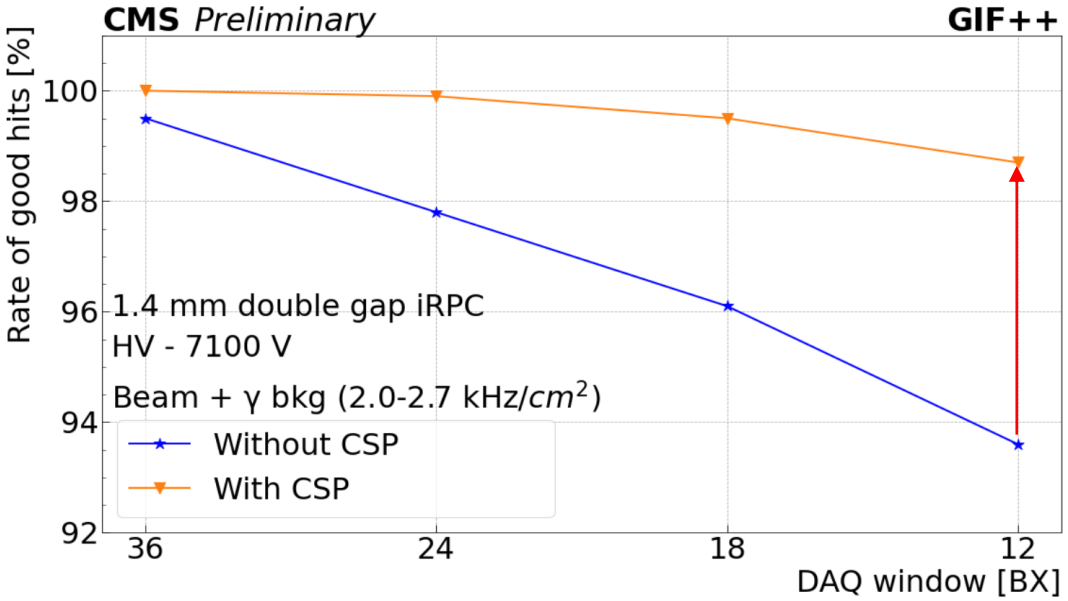


Caption:

This plot shows the transmission delay behavior with detector channel id with CSP in test beam (beam + 2.0-2.7 kHz/cm2 γ bkg). It shows transmission delay does not have a dependence on detector channel id and maximum delay decreases from 60 BX (previous plot) to 30 BX (this plot).

Rate of good hits in different DAQ windows

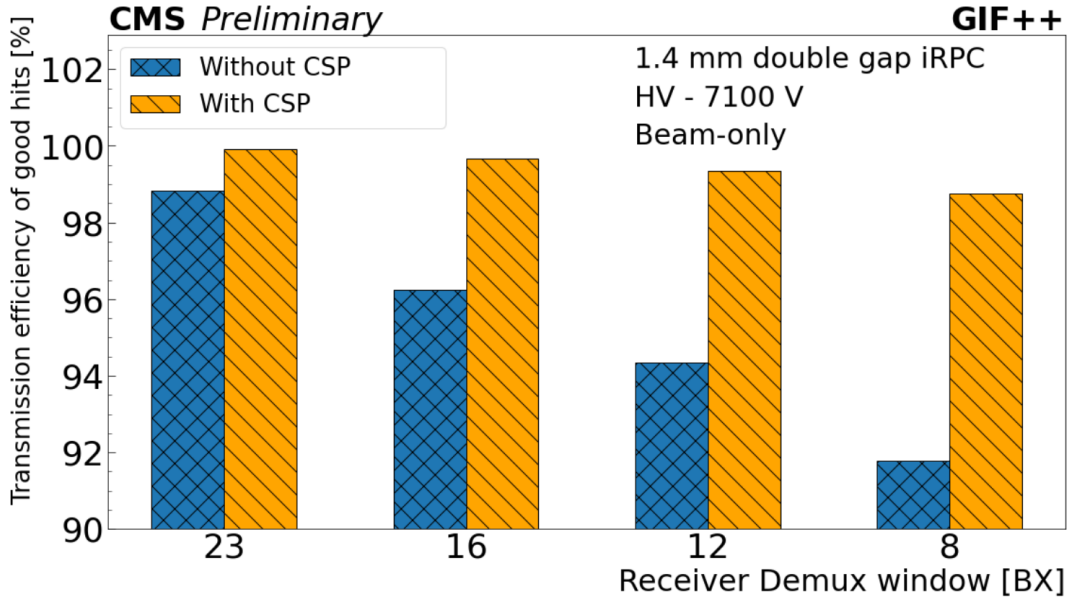


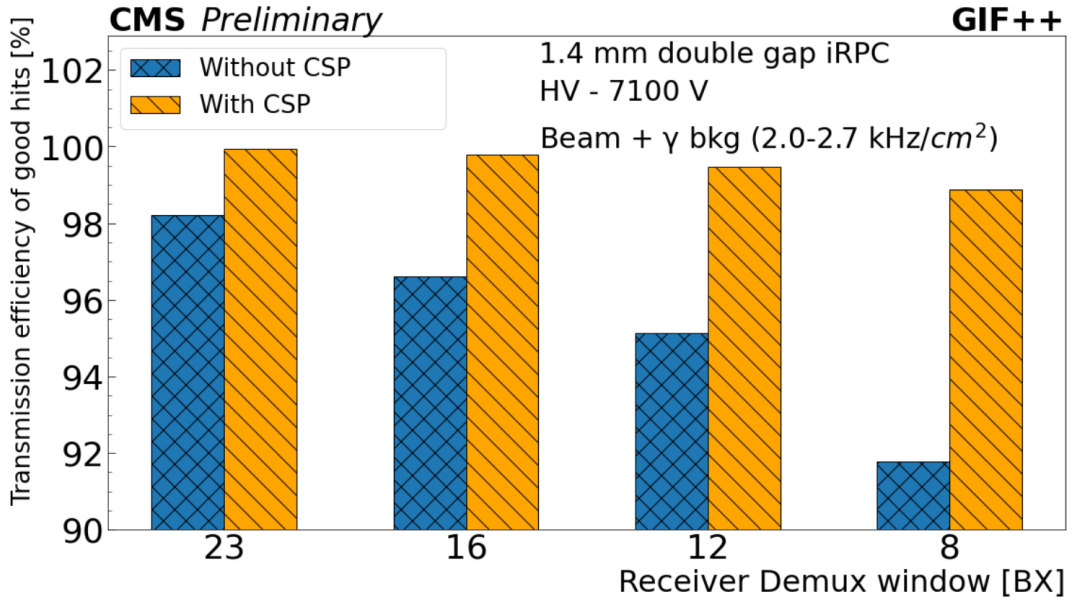


Caption:

- These plots show the rate of good hits in different DAQ windows in test beam. Rate of good hit in 24 BX window is good enough with help of CSP. The CSP function allows us to reach a narrow DAQ window and aiming to a small DAQ window at 12 BX in both beam-only and beam + γ bkg (2.0-2.7 kHz/cm2) , rate of good hits increases from 93% to 99%.
- A good hit is a hit with paired tdc data whose position is within scintillator aera and time is fixed with L1A.
- $Rate\ of\ good\ hits\ (x) = \frac{Good\ hits\ count\ in\ window\ x}{Total\ good\ hits}$

Transmission efficiency in different receiver Demux windows





Caption:

- These plots show the transmission efficiency of good hits in different receiver Demux windows. Above 99% good hits are received within 23 BX Demux window with the help of CSP. Transmission delay decreases greatly to reach a narrow receiver Demux window. With receiver Demux window of 8 BX in both beam-only and beam + γ bkg (2.0-2.7 kHz/cm2) , transmission efficiency of good hits increases from 92% to 99%
- Receiver Demux window: A Buffer depth. The buffer in backend electronics firmware is used to solve the TDC data sending time uncertainty caused by frontend electronics.

Transmission efficiency in different receiver Demux windows

- Continued from previous slide
  - $Transmission\ efficiency\ of\ good\ hits(x) = \frac{Good\ hits\ count\ in\ receiver\ Demux\ window\ x}{Total\ good\ hits}$
  - Receiver Demux window 23 BX->16 BX-> 12BX -> 8BX: A smaller receiver Demux window means less firmware resource is needed so we are interested in obtaining it. Decreasing the Demux window from 23 BX to 8 BX is helpful to evaluate the transmission efficiency improvement in smaller windows.