GE1/1 GEM-CSC Interface

USCMS Muon Upgrade Meeting

December 7, 2016

Introduction

A quick review…

GEM front end boards called VFATs generate fixed latency trigger data (aka S-bits/trigger bits/trigger pads), which are an OR of adjacent strips (2,4,8 or 16) depending on electronics version and configuration.

- For slice test, pad size = 16 strips
- For installation, planned pad size = 2 strips

Trigger data is sent to a concentrator card called the Optohybrid.
The Optohybrid encodes and compresses the trigger data
~14:1 bandwidth reduction

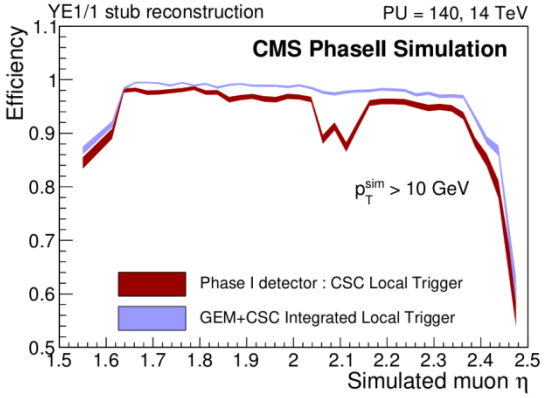
GEM also has a full-granularity DAQ path, which will use the CERN GBT links

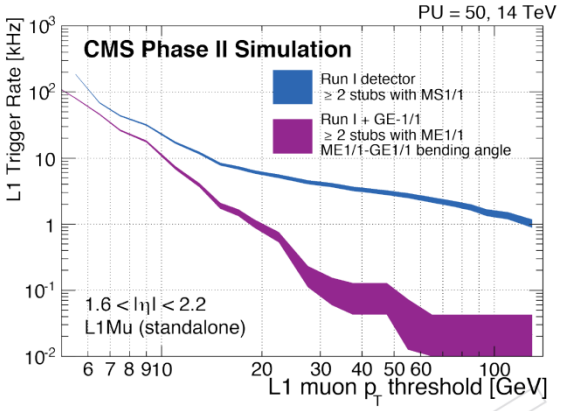
- GBT=rad hard deserializer supports DAQ, JTAG, slow control, ADCs, etc.

There are four trigger fibers to off-chamber electronics:

- Redundant paths: 2x to CSC OTMB and 2x to GEM uTCA crate
- Links at 3.2 Gbps

OTMB will use GEM data to improve LCT efficiency.
uTCA crate will forward trigger data to the muon trackfinder
Trackfinder will use extra layers to improve pT assignment and suppress rates.



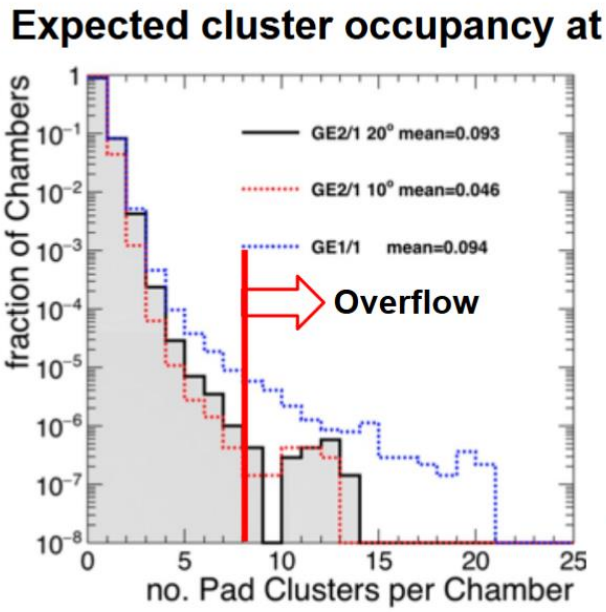


(both plots from GEM TDR)

GEM Cluster Encoding

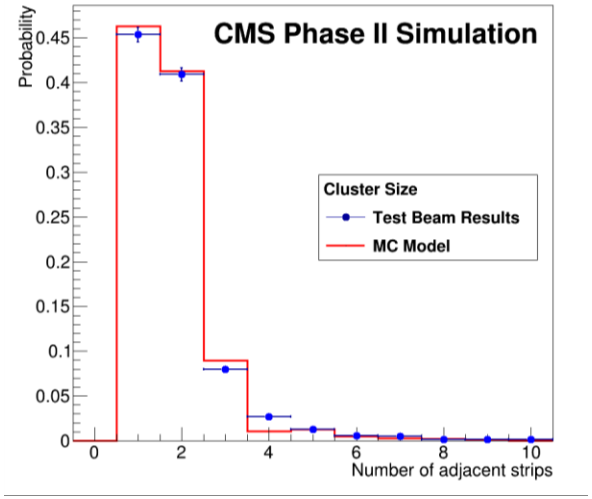
A significant fraction of GEM hits will deposit charge on multiple adjacent strips.
… so we group adjacent trigger bits and transmit trigger data as a cluster

cluster = “first” pad address + size (# of extra adjacent pads)
(11 bits address + 3 bits size)



Note: log scale

Jason Lee, University of Seoul



Cluster size distribution
(from GEM TDR)
n.b. these are strips not trigger pads

GEM Trigger Data Paths

OTMB Link

OTMB needs to deserialize clusters, perform co-pad matching, perform coordinate translation, match to ALCT / CLCT.

Extra processing is large, and latency is **critical**! Need to optimize everything we can.. Don't want to add to overall CSC trigger latency.

uTCA Link

An identical copy of the trigger data will be sent to both the CSC's OTMB and the GEM's uTCA crate.

We enough bandwidth to forward all clusters to the uTCA crate
(using 9.6 Gbps links, 8 fibers per sector)

If we perform co-pad matching in the uTCA, can send only the matched copads.

- uTCA -> trackfinder link is almost certainly lower latency than the CSC -> trackfinder link, even with copad processing. Latency shouldn't be a problem.
- **Do we lose much by not having all the clusters?**
- Would then be able to either (1) reduce # of fibers needed or (2) reduce link rates

vFat channels

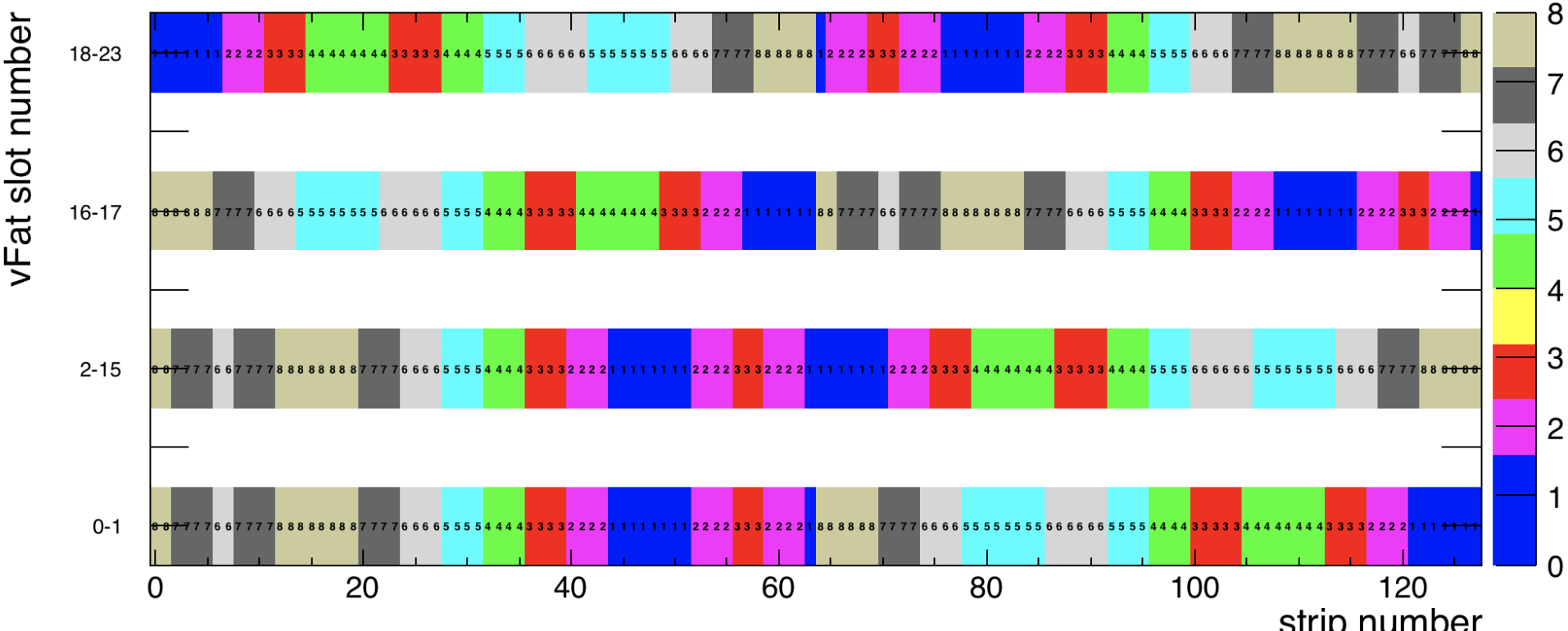
GEB readout order != physical strip order

Mapping depends slot #

vFats produce pads by taking an or of 16 contiguous channels

Trigger pads = span entire vFat

Pad assoc. to physical strip number by vFat slots



vFat channels

For the slice test

Will need to have vFat level trigger pads (128 strips)

Can build firmware for slice test that can apply to new electronics with better granularity

- Was already planning on this…vFat2 16 strips per pad vs vFat3 with 2
- Useful for proof of concept testing

Trigger data in slice test may not be as useable…

- Can't do tests that require anything with fine granularity
- Will need to instead focus more on offline studies using tracking data
  - e.g. testing channel multiplicity

For the actual detector

Electronics design needs to be updated/verified to produce usable pad data

CSC-GEM integrated trigger

December 2016 - Interface

GEM data read into OTMB and timed in

Jan-Feb 2017 - Preparation

Offline analysis on 904 *superchamber*

Use CSC to build 904 LUT for matching

Further validate trigger path and get ingredients for FW

Feb-March 2017 - First iLCTs

First version iLCTs

LCT with time and spatial matching to gem (co)-pads

Tested with cosmics in 904

June 2017 - Data taking

For slice test detectors readout TMB data with ALCTxL1a

- Allows for rate+efficiency studies with full tracking granularity

July-Sep 2017 - Development

Use P5 data to motivate FW development
Test in 904 before implementing at P5
Also begin discussion with TF group on what extra information they can use

Oct-Nov 2017 - Proof of concept

Put together ~finalized FW that can be tested in some capacity at P5
Either as a TMB data type or L1A decision