The Electronics Challenge

- The Small (~0.5 mm FWHM) charge footprint of the μMegas Detectors results in excellent position and double track resolution
- Results in a very large number of channels (order 10^6)
- Two Functions of the Readout:
  - Provide Precision measurement of charge and time at Trigger Level 1 accept
  - Provide in real time vector with ~1 mrad resolution to assist Trigger Level 1

- First task relatively easy to accomplish by highly multiplexed, data driven system
- Custom front end ASIC being under development

BUT, How about Trigger?
Need to process in Parallel at 40 MHz

How can we take advantage of the 0.5 mm strip pitch?

Assume that we use ONLY one hit (the strip with the first arriving signal above a set threshold) from each 64-channel chip at each bunch crossing

This way:

- We have a trigger system with granularity of 3.2 cm (64 channels x 0.5 mm) BUT
- With spatial resolution ~ 0.5 mm
- We now have to deal with ~30,000 channels and not 2 million

But are we paying a price for this? i.e. efficiency loss?

Consider worst case at $\eta = 2.4$:
Rate r = 10 kHz/cm^2, strip length l = 50 cm, strip width w = 0.5 mm

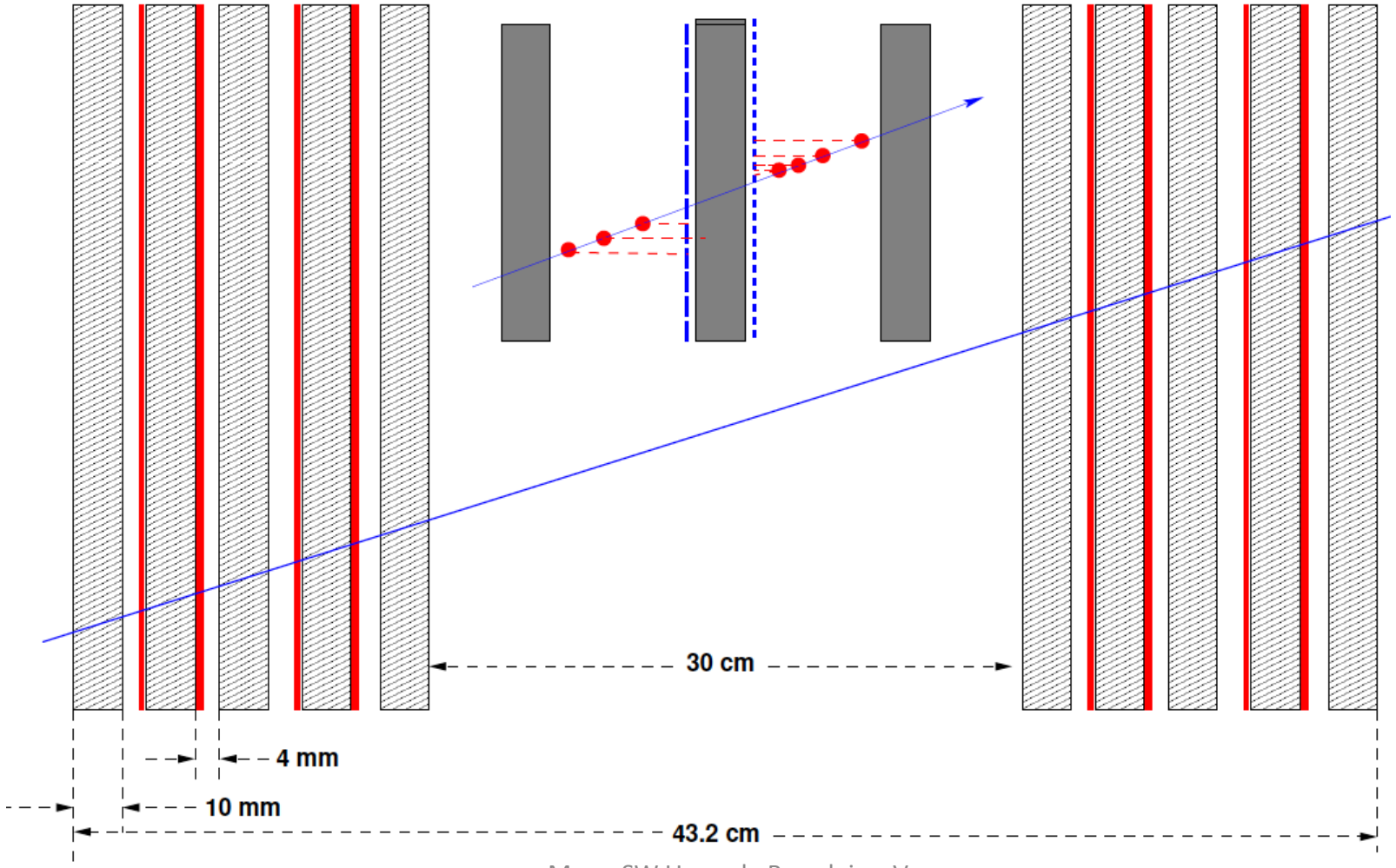
Occupancy/BC = rlwt = 6.25×10^{-4}

	Probability per Front End IC [%]	
# Hits	Probability per Chip per Bunch Crossing	Probability per Chip per 3 Bunch Crossings
0	96.1	88.7
1	3.8	10.6
>=2	0.1	0.6

Note: ONLY 12% of hits are from track segments (Results from CSC data at present Lumi.)

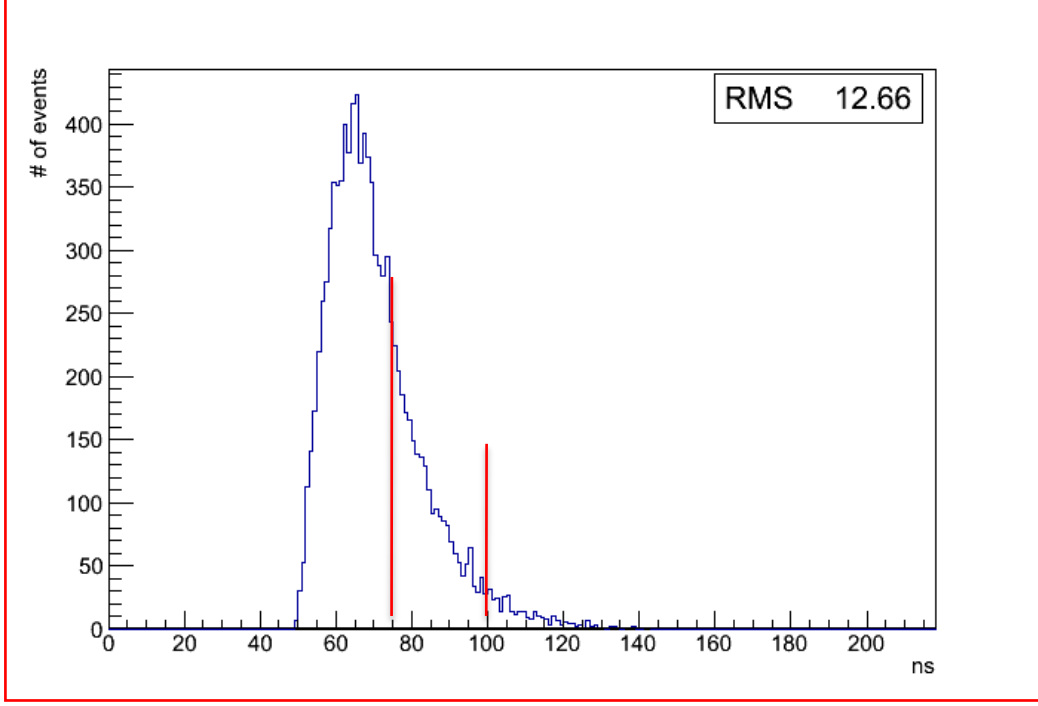
Simulation with George Iakovididis
And Theo. Alexopoulos

Chamber arrangement used in the simulation

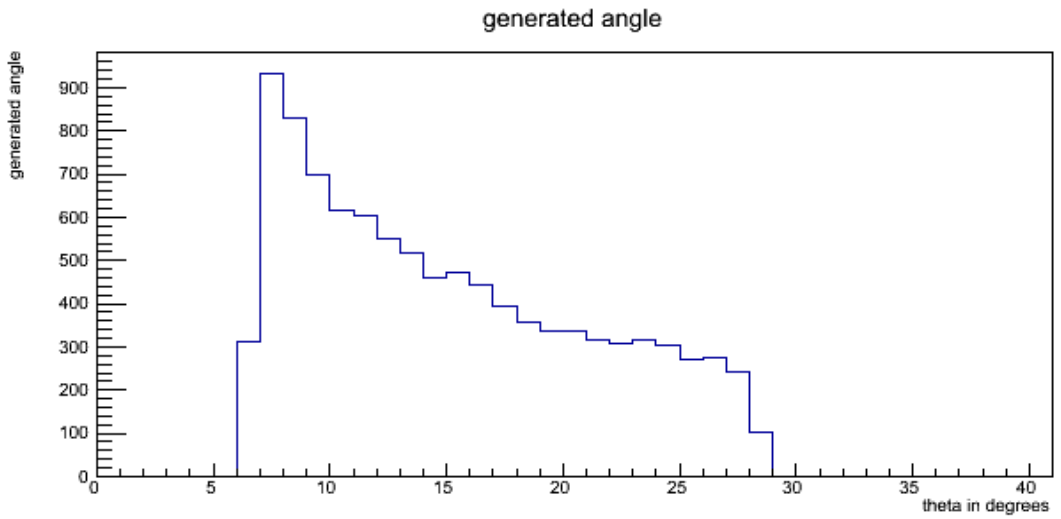


Earliest Arrival time
Incident Angle = 20°
Integration Time 50 ns

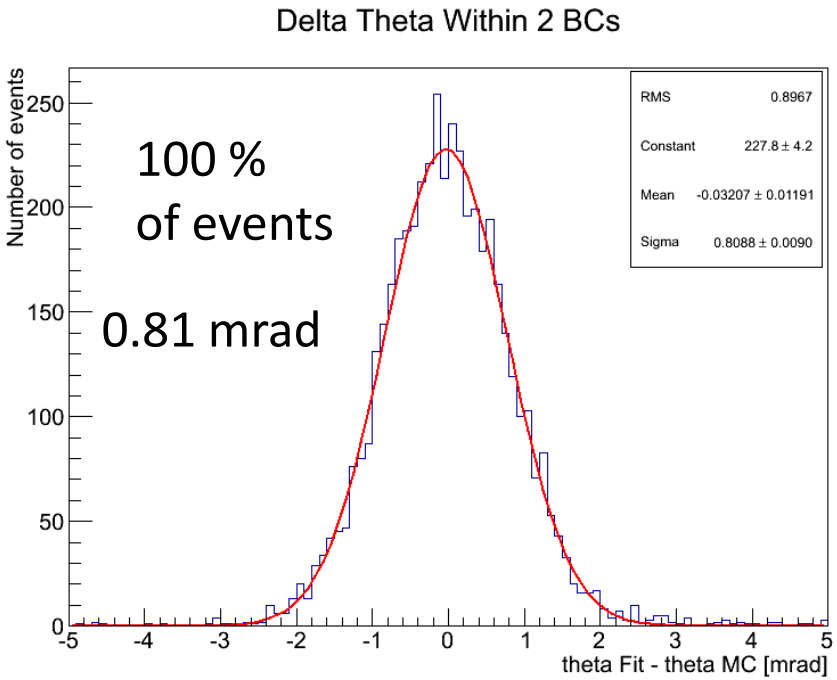
Earliest Peak above threshold of 1e

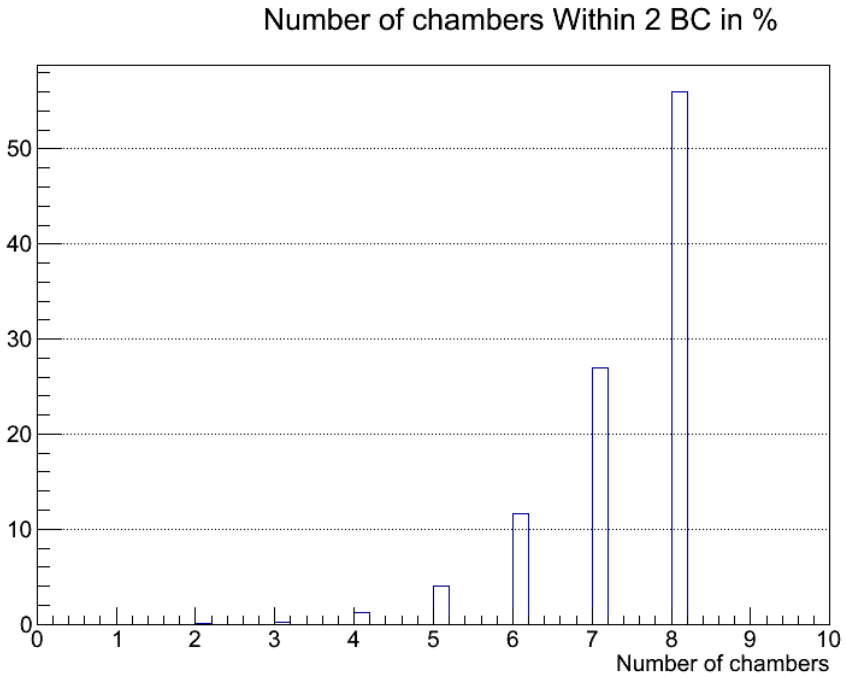


Small Wheel
Angle Generation



Rolling Window of 2 Bunch Crossings

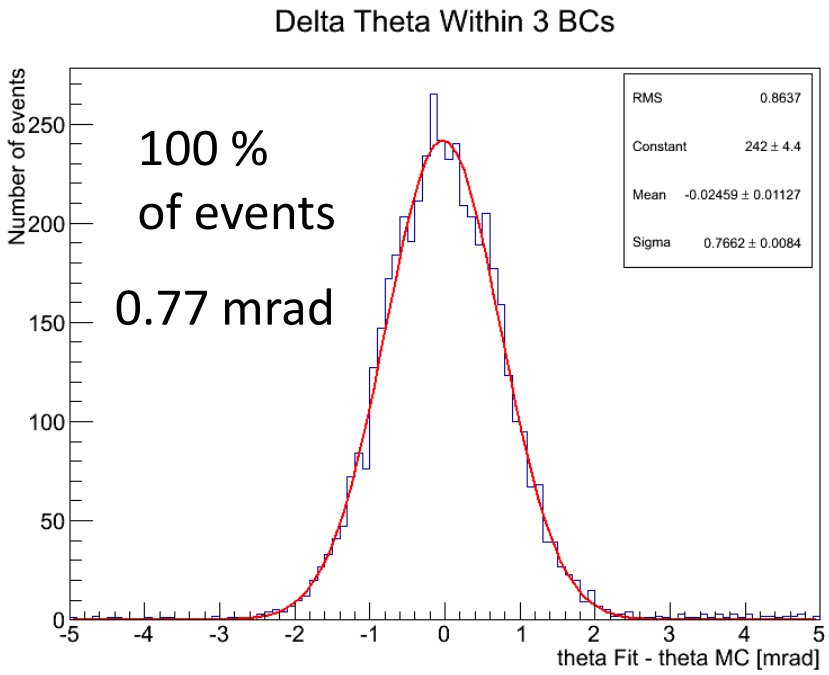




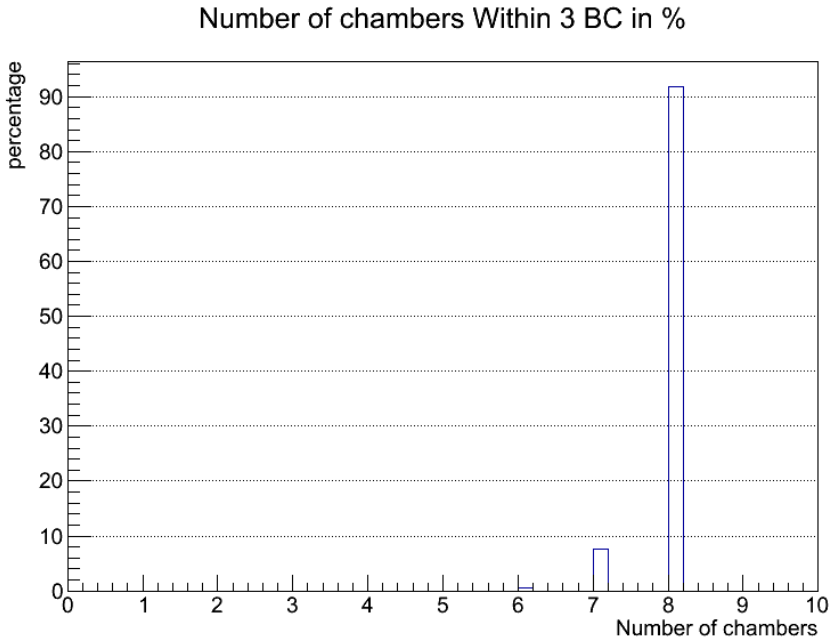
Track Segment Resolution with hits in a Rolling Window of 2 bunch crossings

Probability of n chambers in a Rolling Window of 2 bunch cossing

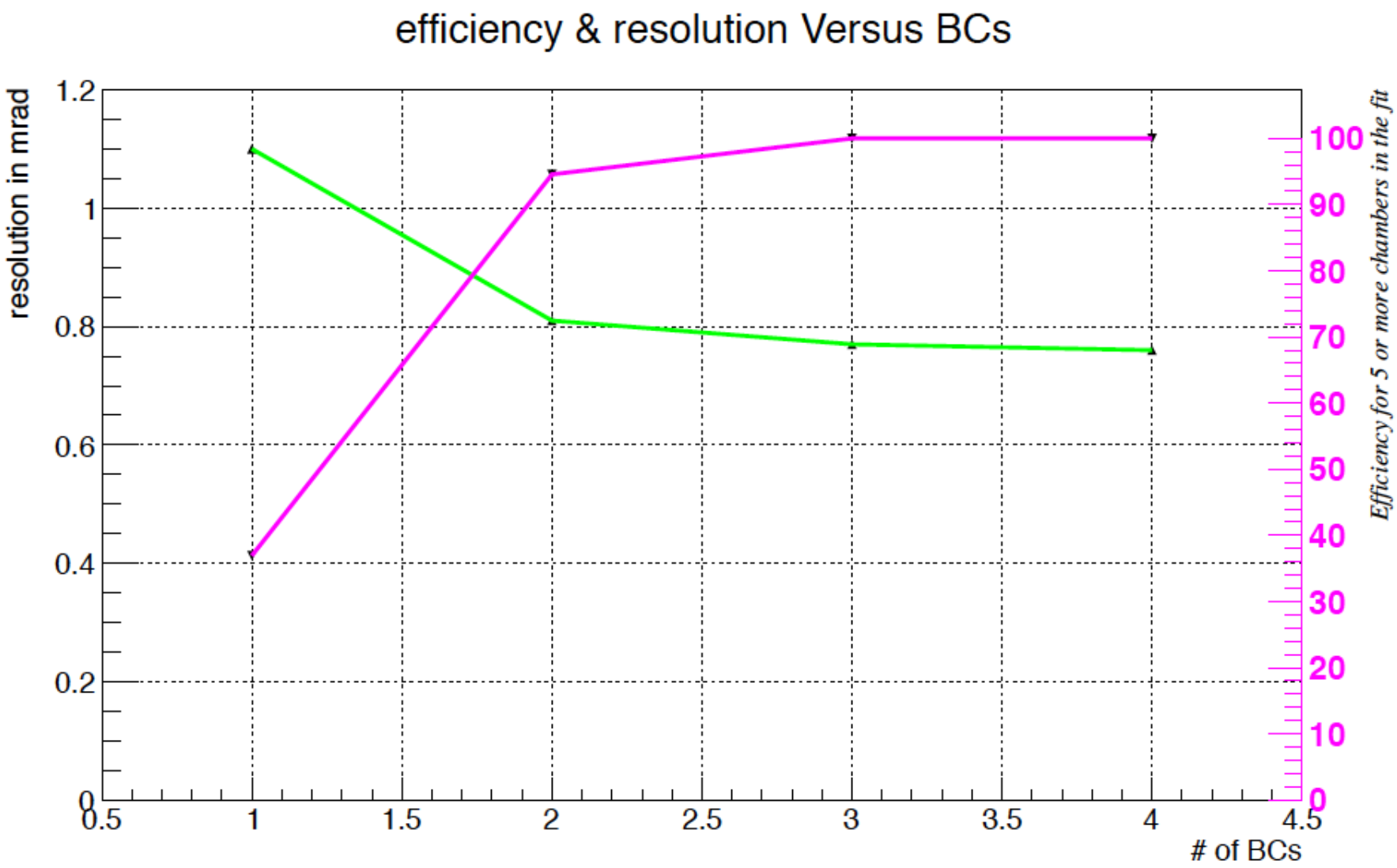
Rolling Window of 3 Bunch Crossings



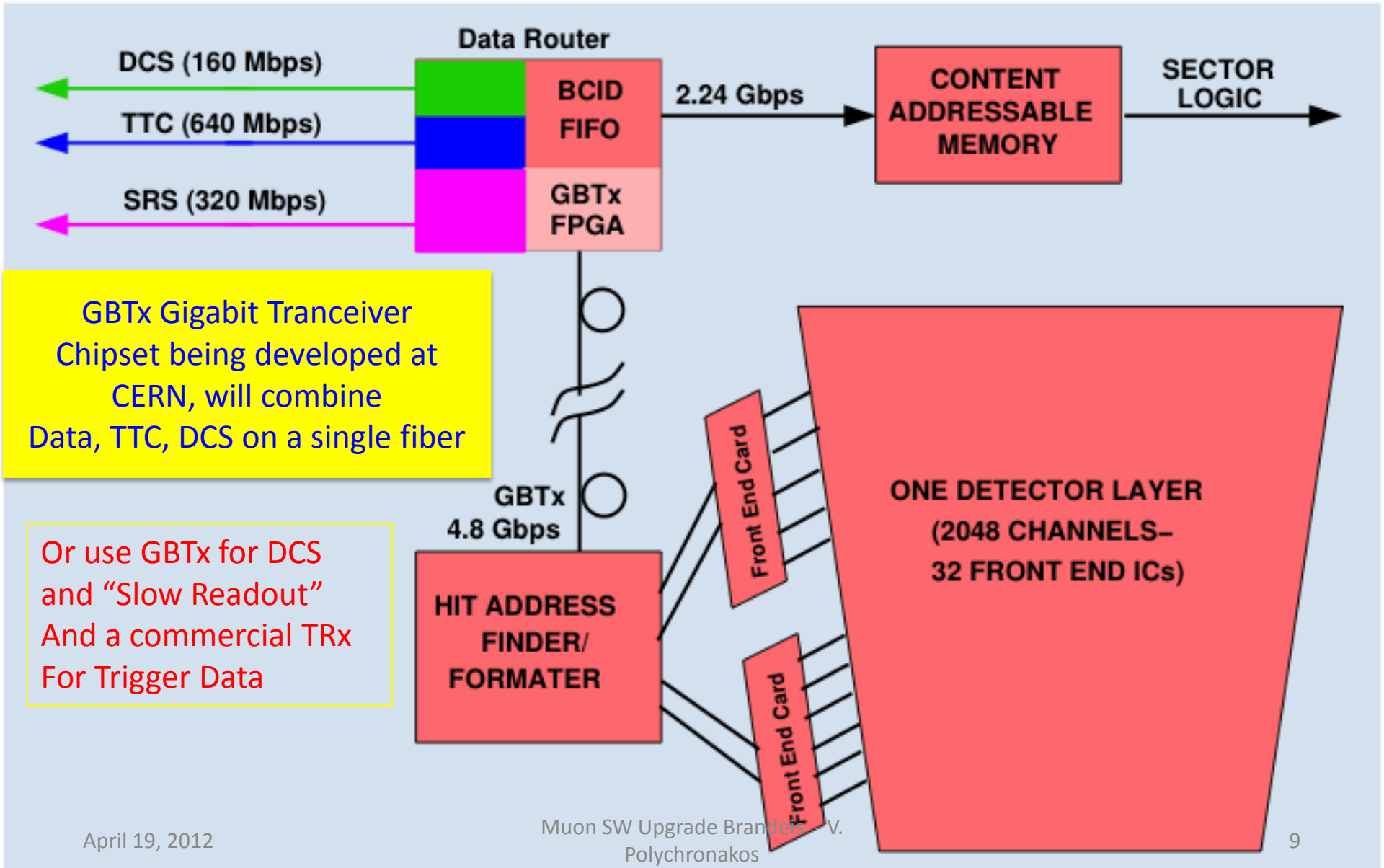
Track Segment Resolution with hits in a Rolling Window of 3 bunch crossings



Probability of n chambers in a Rolling Window of 3 bunch crossings


efficiency & resolution Versus BCs
resolution in mrad
1.2
1
0.8
0.6
0.4
0.2
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
# of BCs
Efficiency for 5 or more chambers in the fit
100
90
80
70
60
50
40
30
20
10
0

Trigger/DAQ Block Diagram



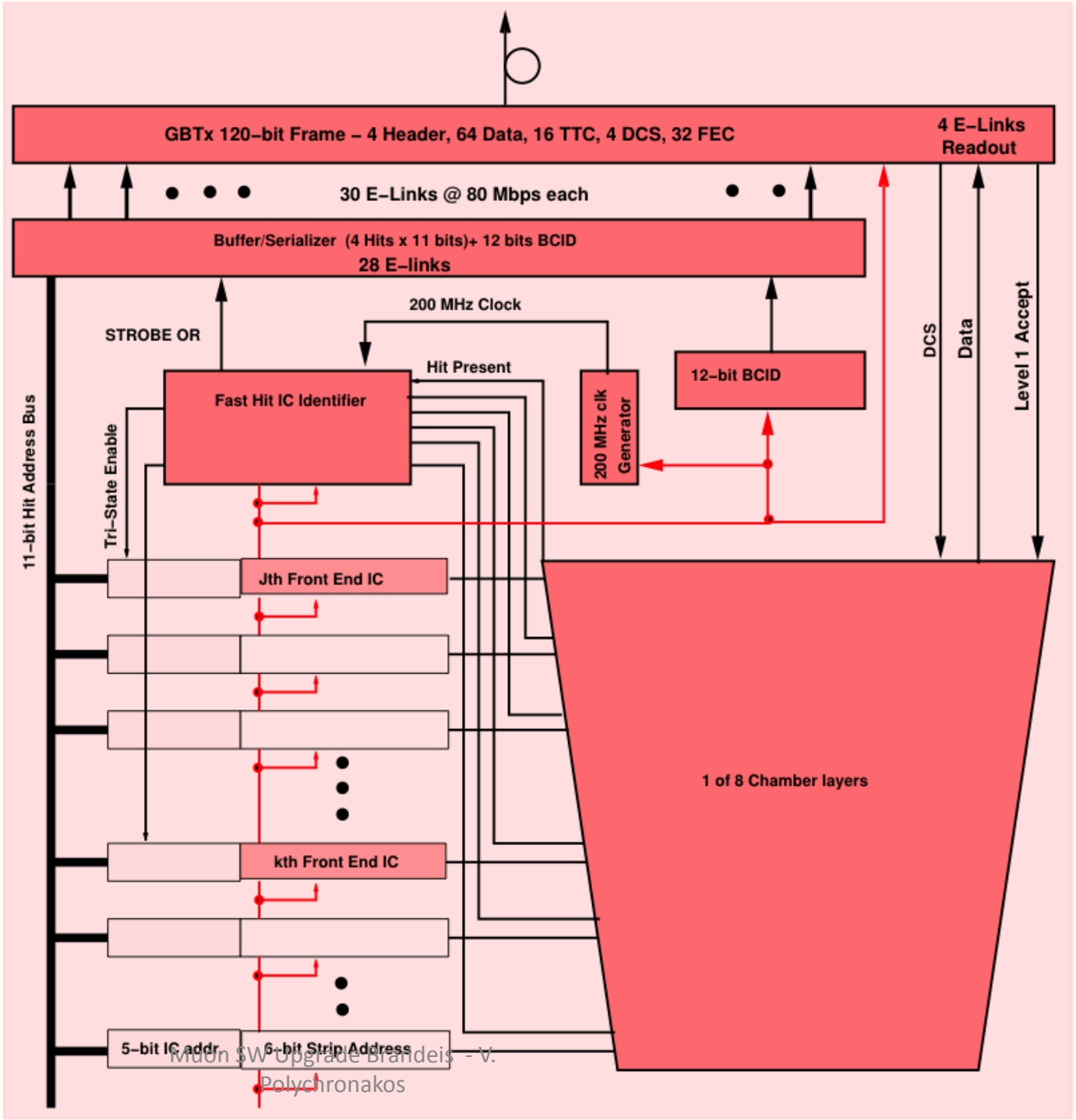
On-Detector Card

6 bit prompt strip address

5 bit IC address per plane

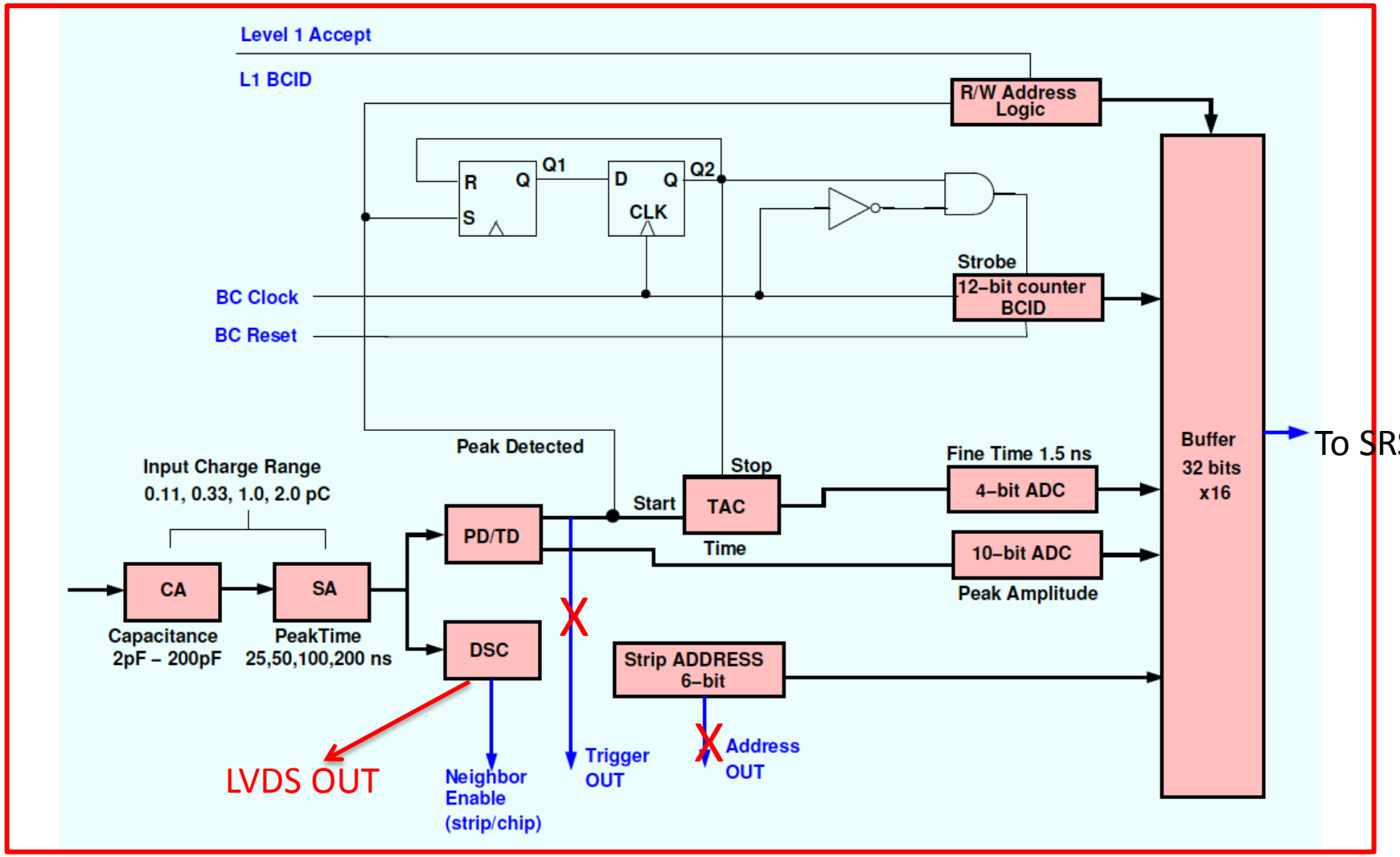
Up to 4 hits per plane transferred in 2 BC

Possibility to incorporate this function in Front End or a Custom Digital IC



How does the a Mmegas System complements the Primary sTGC System

New Common Front End ASIC



For TGC there will be fewer (16 or 32) channels with LVDS outputs of individual discriminators
All other features remain the same

From Lorne's sTGC talk

Balance conflicting requirements

Micromegas

Very rare access, congested location, 1Mrad at innermost radius

- Minimum on-chamber complexity for reliability ✔
  - But minimum cables to periphery — No Cables to Periphery
- Minimum on-chamber power dissipation
- Minimum on-chamber radiation tolerant electronics — Just the front ends and fiber Drivers
  - But want programmable logic to future-proof the design — Nothing Programmable
- Maximum access to electronics for repair — No need for access

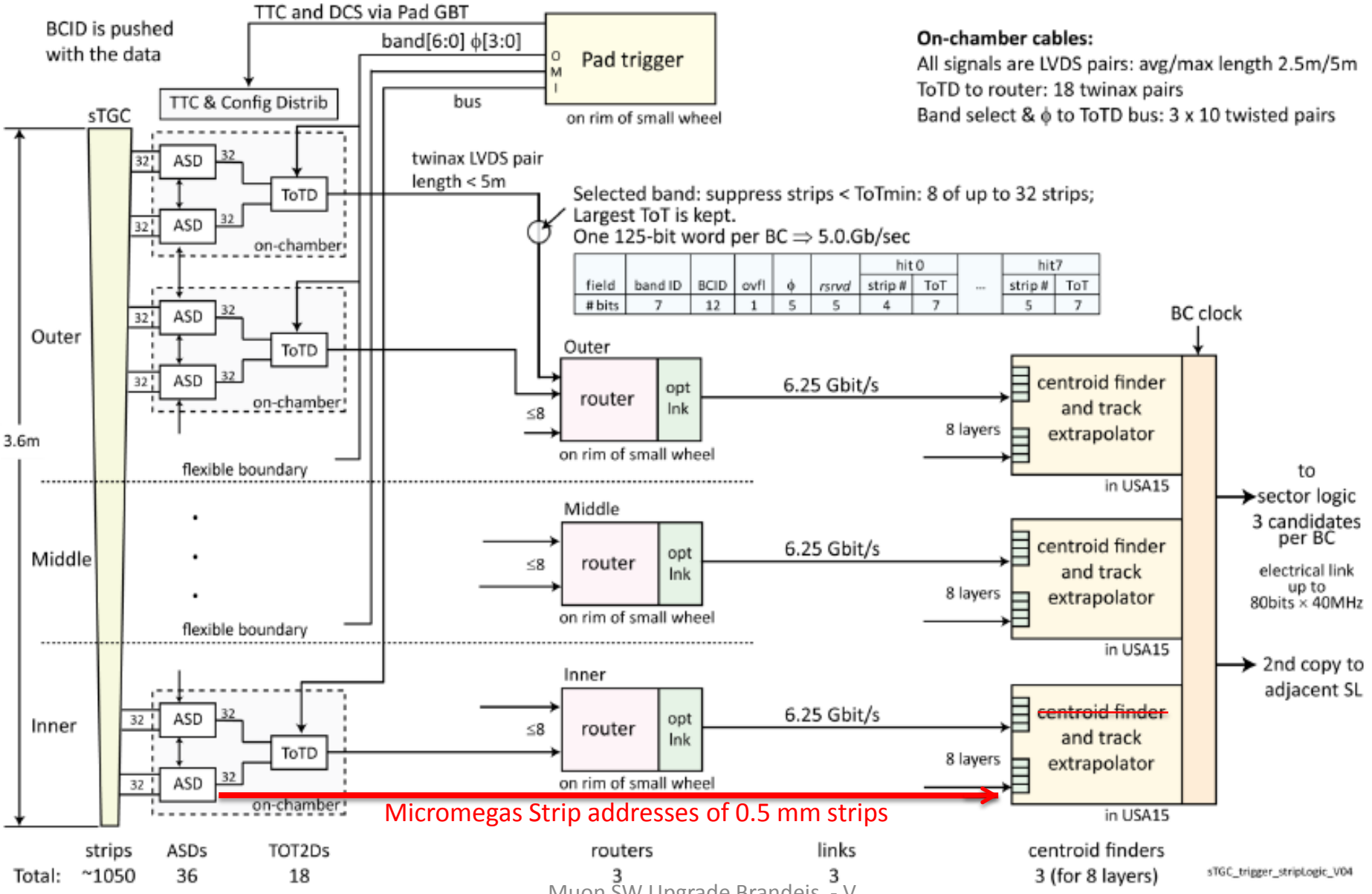
Advantages of this solution

- Simple, no-extreme technology for links or logic
- Trigger generation is simple so its simulation is straight forward and therefore easy to verify.

sTGC trigger: strip logic: one layer of one 1/16th

~65 overlapping bands of strips per layer
Typically 20, but up to 32, strips in a band
A band may bridge two ToTDs.
Gaps in ASD allowed due to chamber boundaries

On-chamber cables:
All signals are LVDS pairs: avg/max length 2.5m/5m
ToTD to router: 18 twinax pairs
Band select & ϕ to ToTD bus: 3 x 10 twisted pairs



Summary

- Synchronous Trigger Data from Front End available in USA15 without any further on-detector processing
- No need for access during run
- Minimum Power, Services
- Common Front End (Only Trigger information different)
- Choice of how to use the trigger information
  - Provide redundant segment to Sector Logic
  - Combine information before segment → Segment from 16 planes
  - Possible to use Pad Logic to selectively read strips for full compatibility with sTGC