L1 Muon Endcap Trigger Phase-0 & Phase-1 Upgrade

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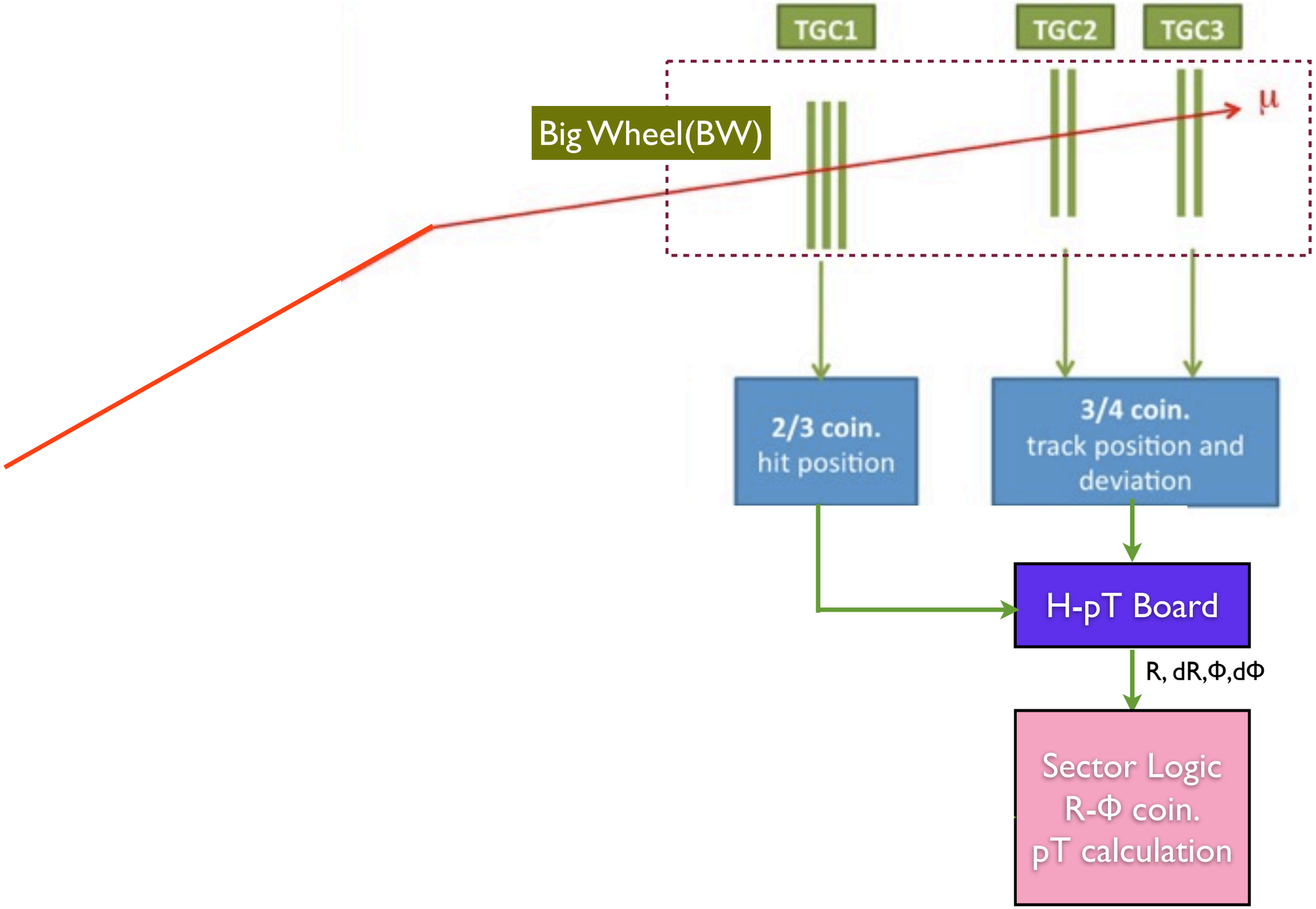
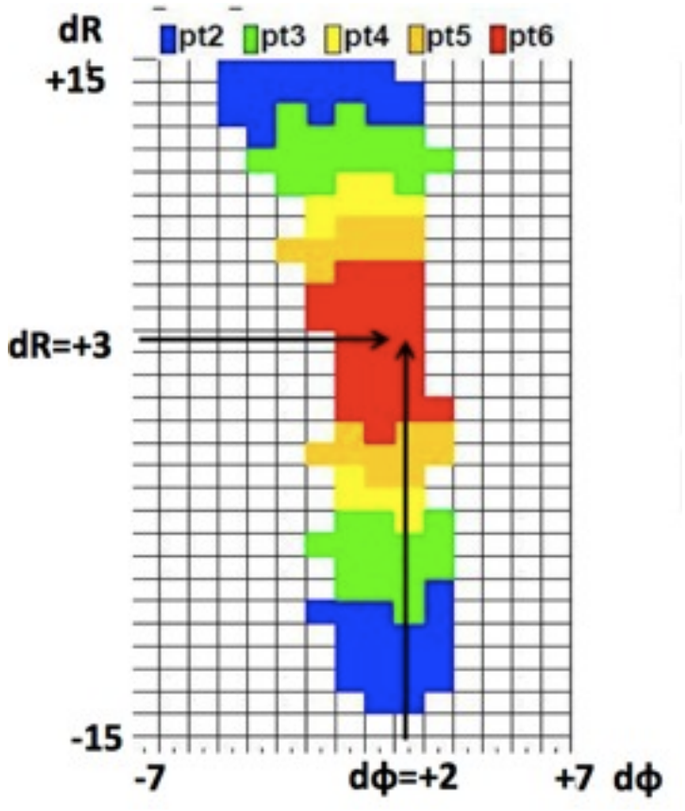
Current trigger detectors in the Endcap



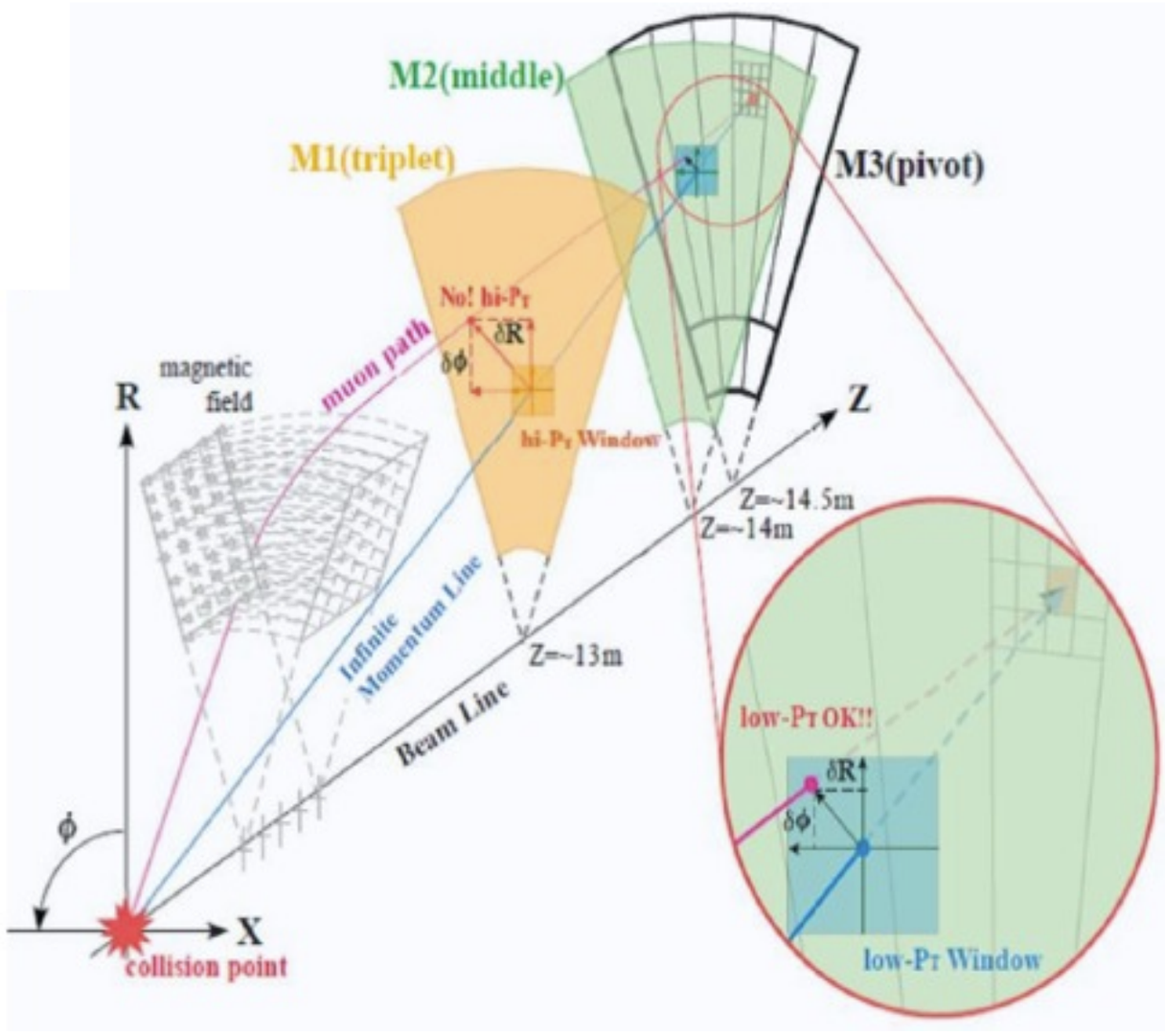
present TGC muon trigger scheme

- Deviation from infinite momentum track(dR,dΦ) is measured with 3 TGC stations

- Coincidence Window is used to calculate pT
  - implemented in Sector Logic
  - each (dR,dΦ) corresponds to pT[1,6]



Coincidence Window Example

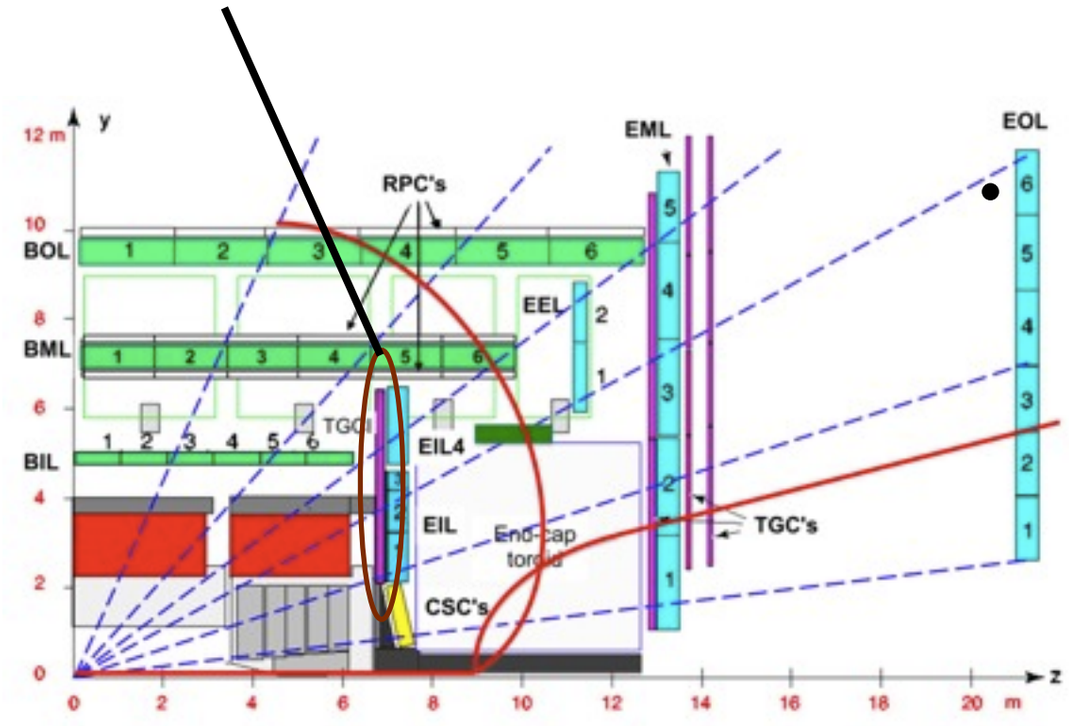


muon hit position deviation
(dR,dΦ)

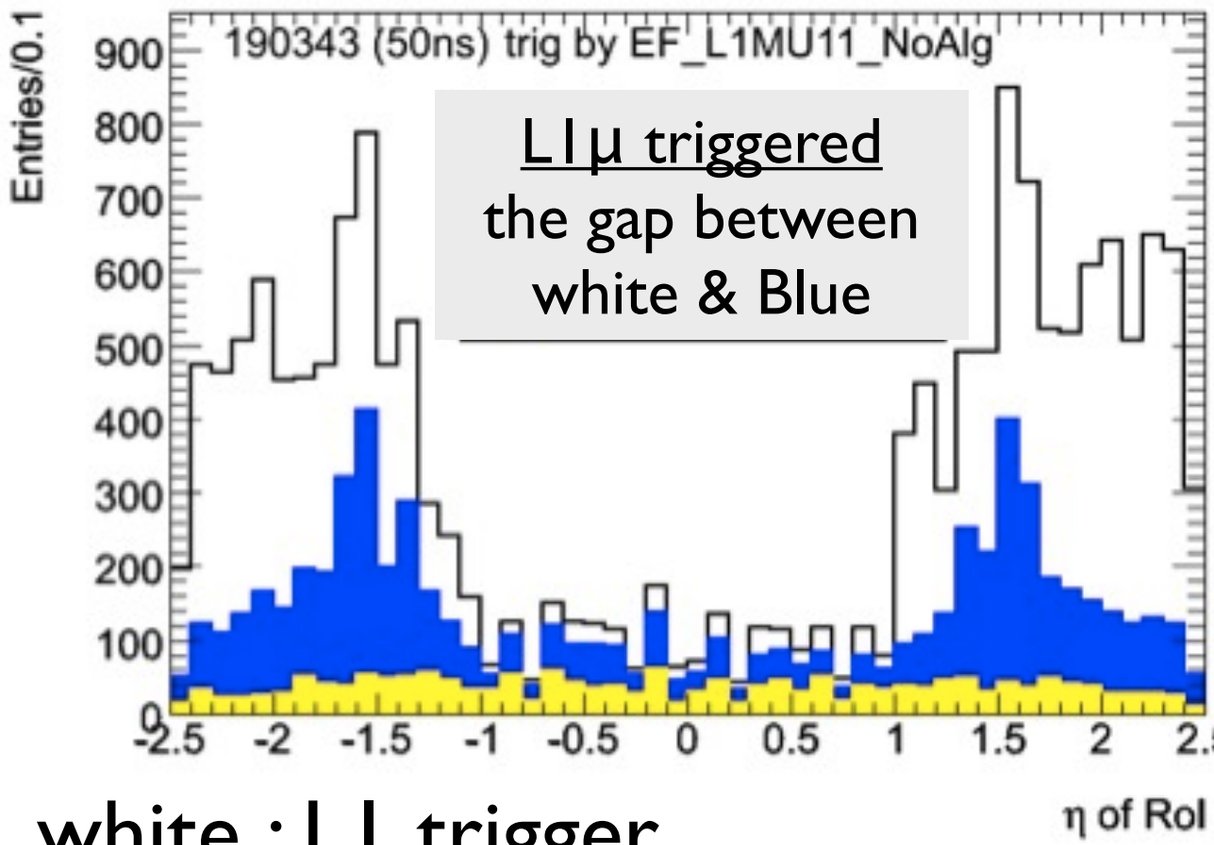
Phase-0 upgrade

- require hit in muon Endcap Inner station (EI/FI)
- take EI/FI - BW coincidence in Sector Logic

EI/FI



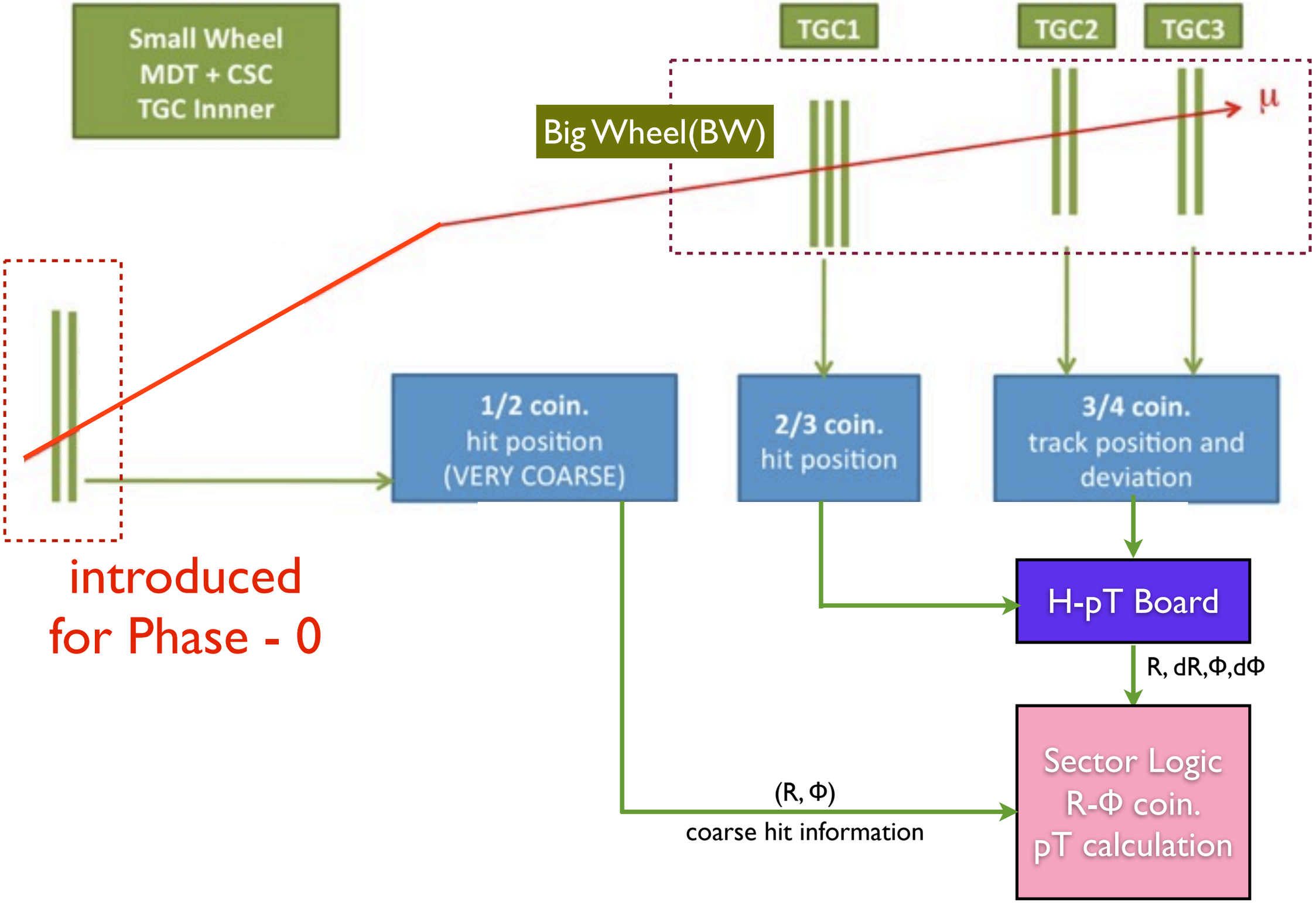
- particle production at the beam pipe
  is the dominant source of the background.



white : L1 trigger

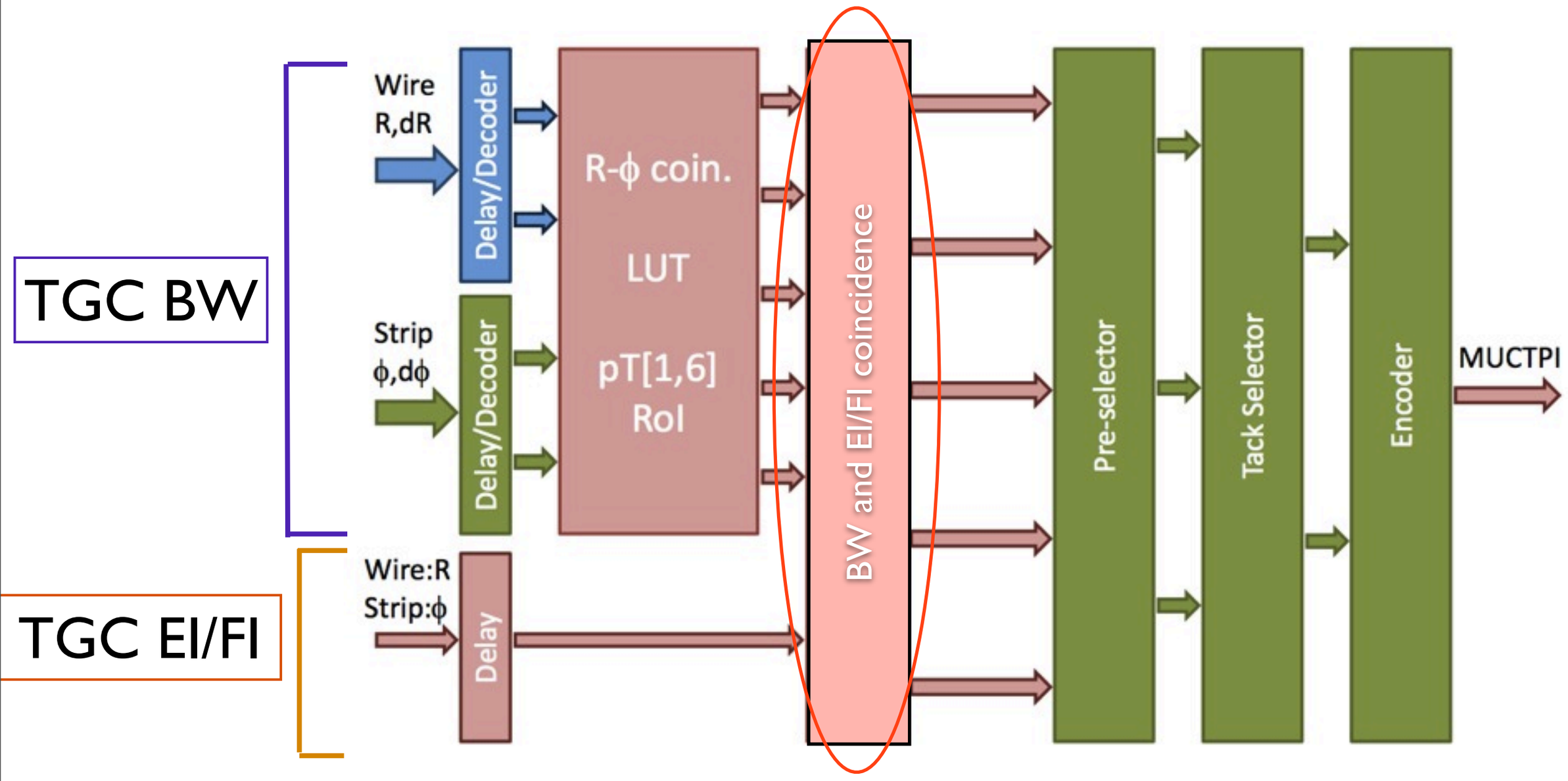
blue: L1 trigger with offline track

Phase - 0 trigger scheme in the Endcap



Upgrade on Sector Logic

- New function is introduced to take BW-EI/FI coincidence.



New function

- with 2 operating modes

Current Status of Sector Logic Upgrade

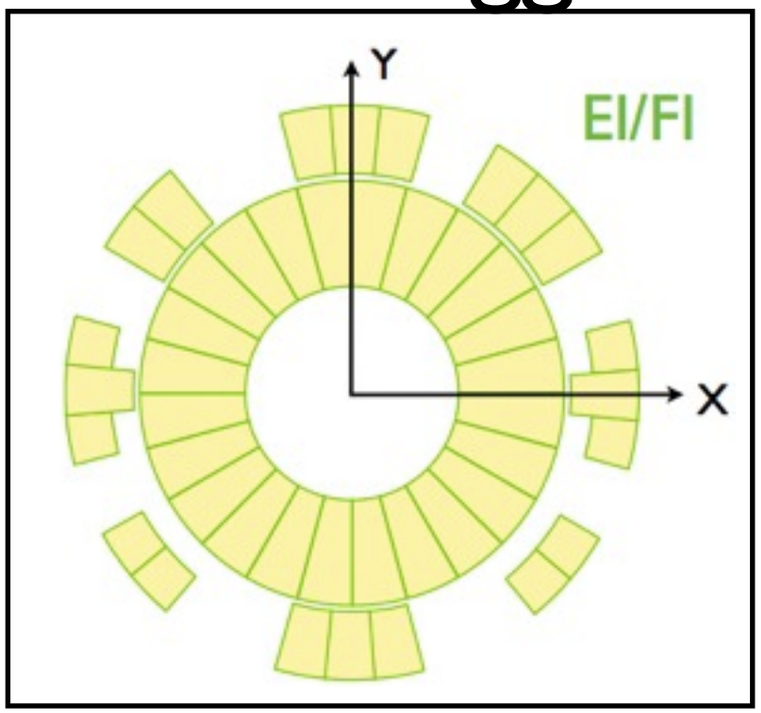
- New coincidence logic is implemented (Done)
  - tested at the testbench system

- New cotrol registers are prepared (Done)
  - to determine which pT and ROI to require EI/FI hit
  - to select operating mode
    - * "flagging mode" : NOT change trigger result
    - * "main mode" : change trigger result

- Additional flag is introduced in R/O information.
  - to monitor SL behaviour in flagging mode.
    - * flag = 1 : candidate is rejected in "main mode"
    - * flag = 0 : candidate is NOT rejected in "main mode"

testbench system

Trigger efficiency study in Phase-0

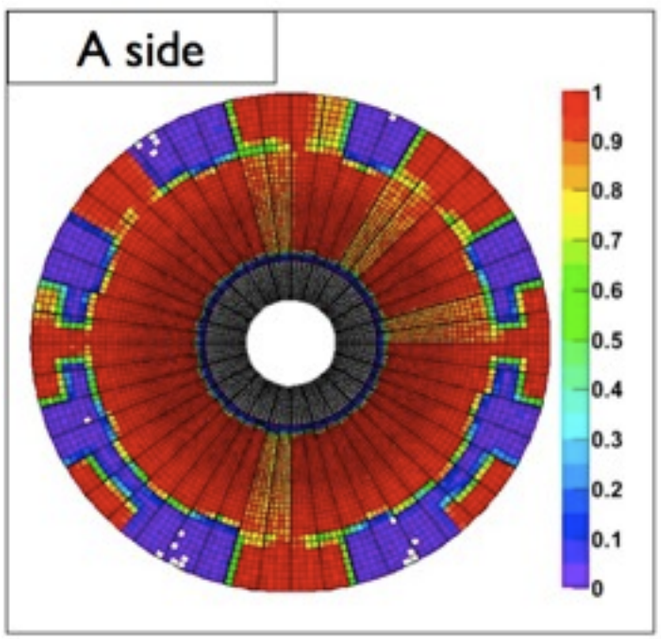


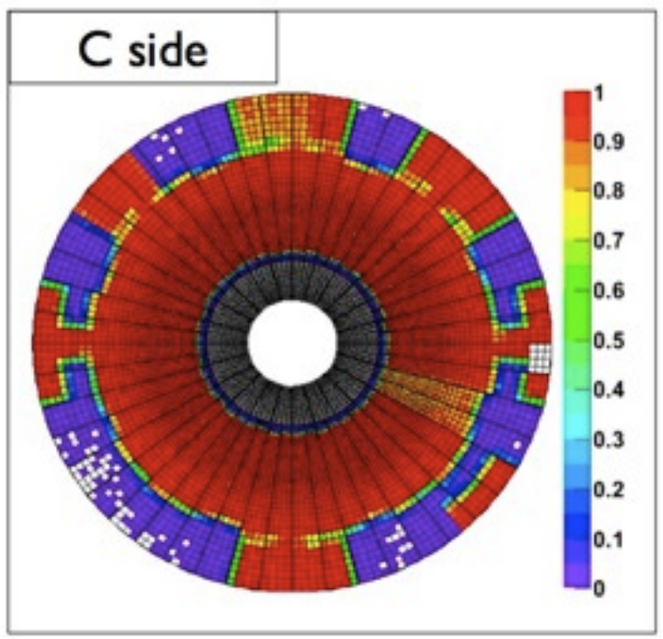
- EI/FI does not cover all the BW region.

coverage
BW : η = 1.05 - 2.4
FI : η = 1.3 - 1.9
EI : η = 1 ~ 1.3 (but missing in Φ)

- ROI to take coincidence should be chosen carefully.

- Efficiency study using single muon MC





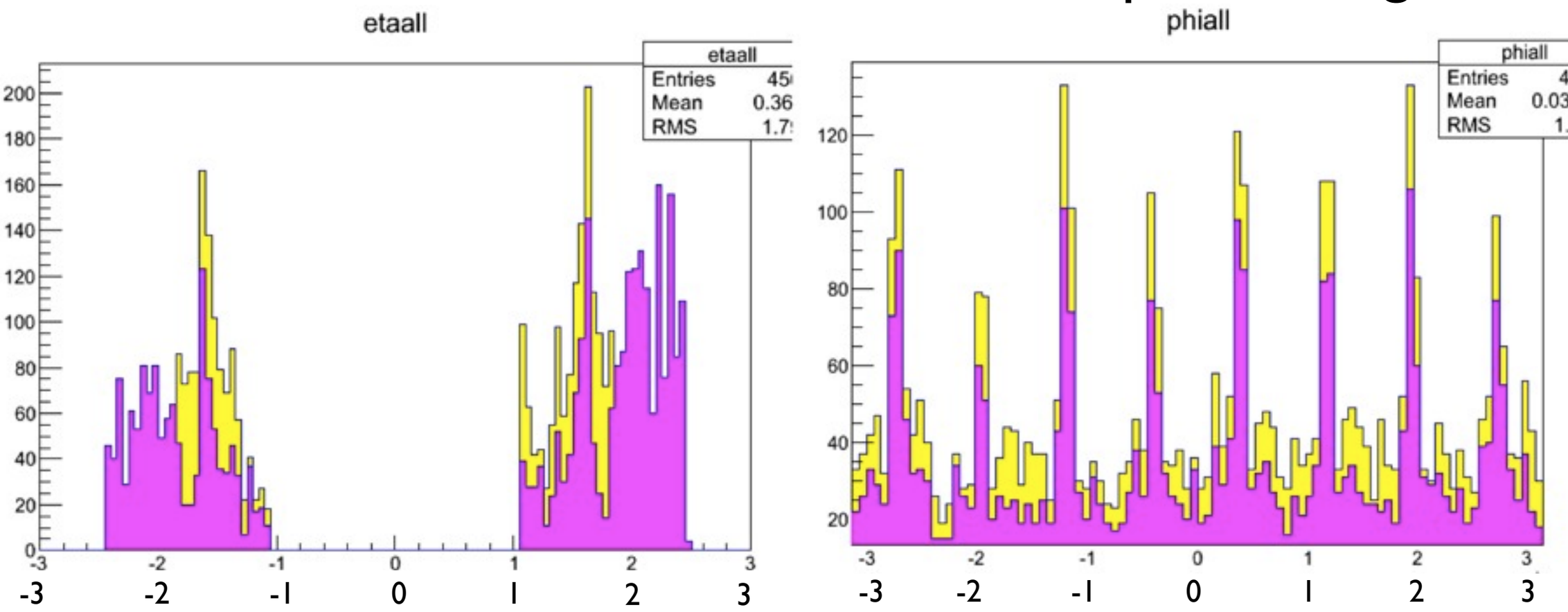
- efficiency = {trigger with hit in EI/FI} / trigger

- EI is quite complicated

(Tani , Kobe)

Trigger rate reduction in Phase-0

L1-MU11 in data 2011 → emulate phase-0 logic



yellow : trigger without EI/FI hit

red : trigger with hit in EI/FI

$$\frac{\text{trigger with hit in EI/FI rate}}{\text{trigger rate}} = 73\%$$

hit in EI/FI = detected in both EI/FI wire and strip

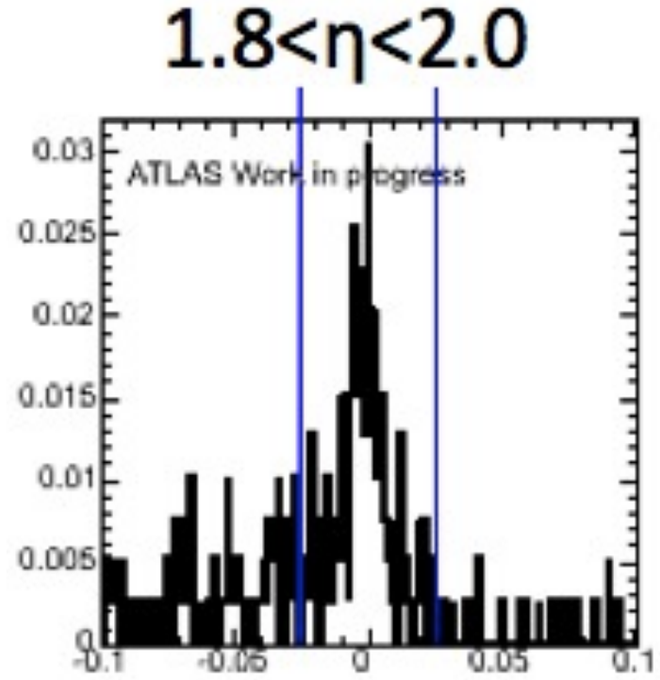
trigger rate is suppressed by 27%

(Tamagawa, Shinshu)

Phase I Upgrade

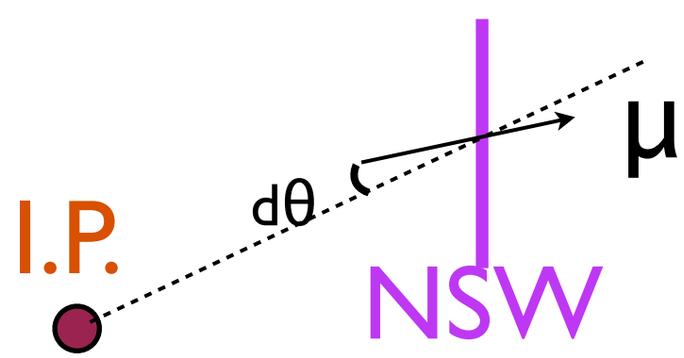
- New detectors are installed
  - sTGC
  - MicroMegas
) New Small Wheel (NSW)

- Small Wheel coverage will be extended
  - η = 1.3 - 2.4 (for trigger)

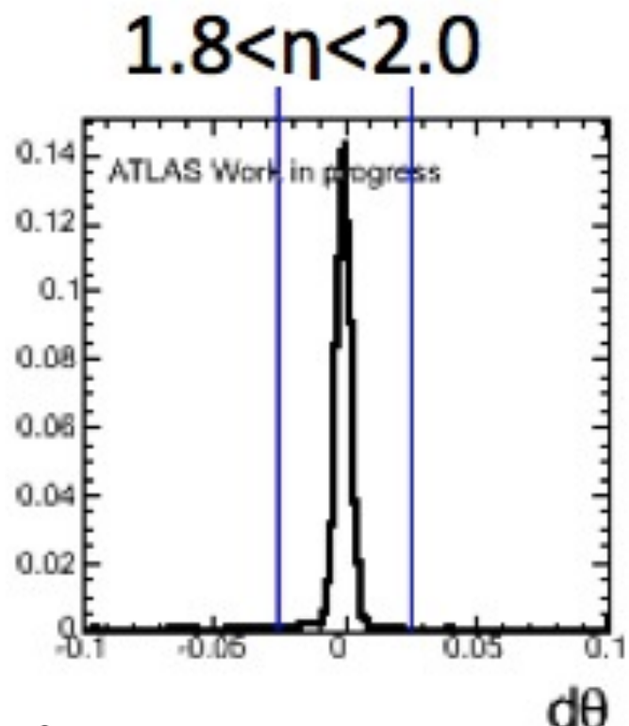


dθ in L1 triggered dθ

- Incidence angle is measured with ~0.1mrad resolution
  - -dθ : the incident angle deviated from the track pointing to IP
  - clean up tracks not pointing to IP.

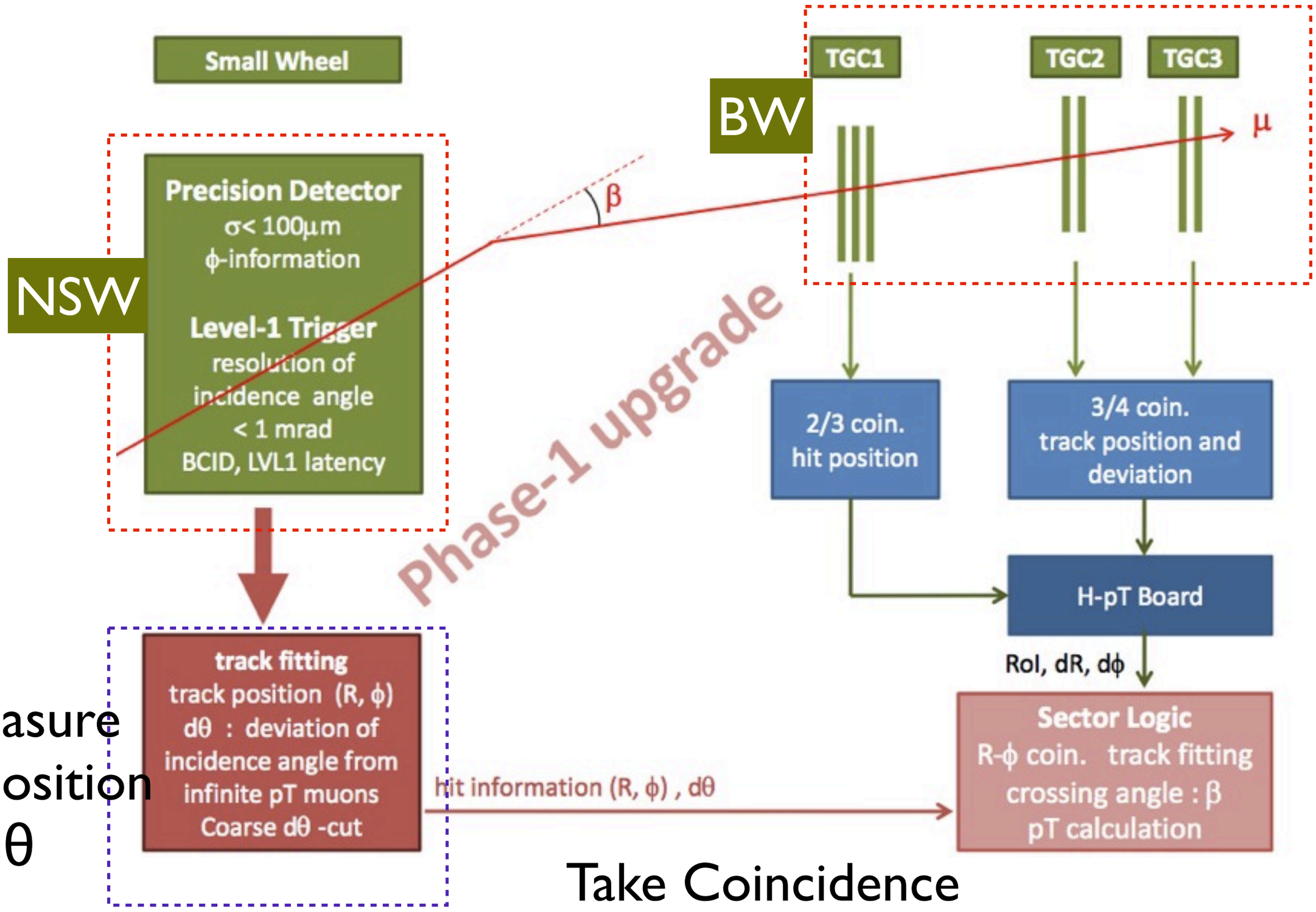


(Suzuki, KEK)



dθ in offline muon mesuared by SW

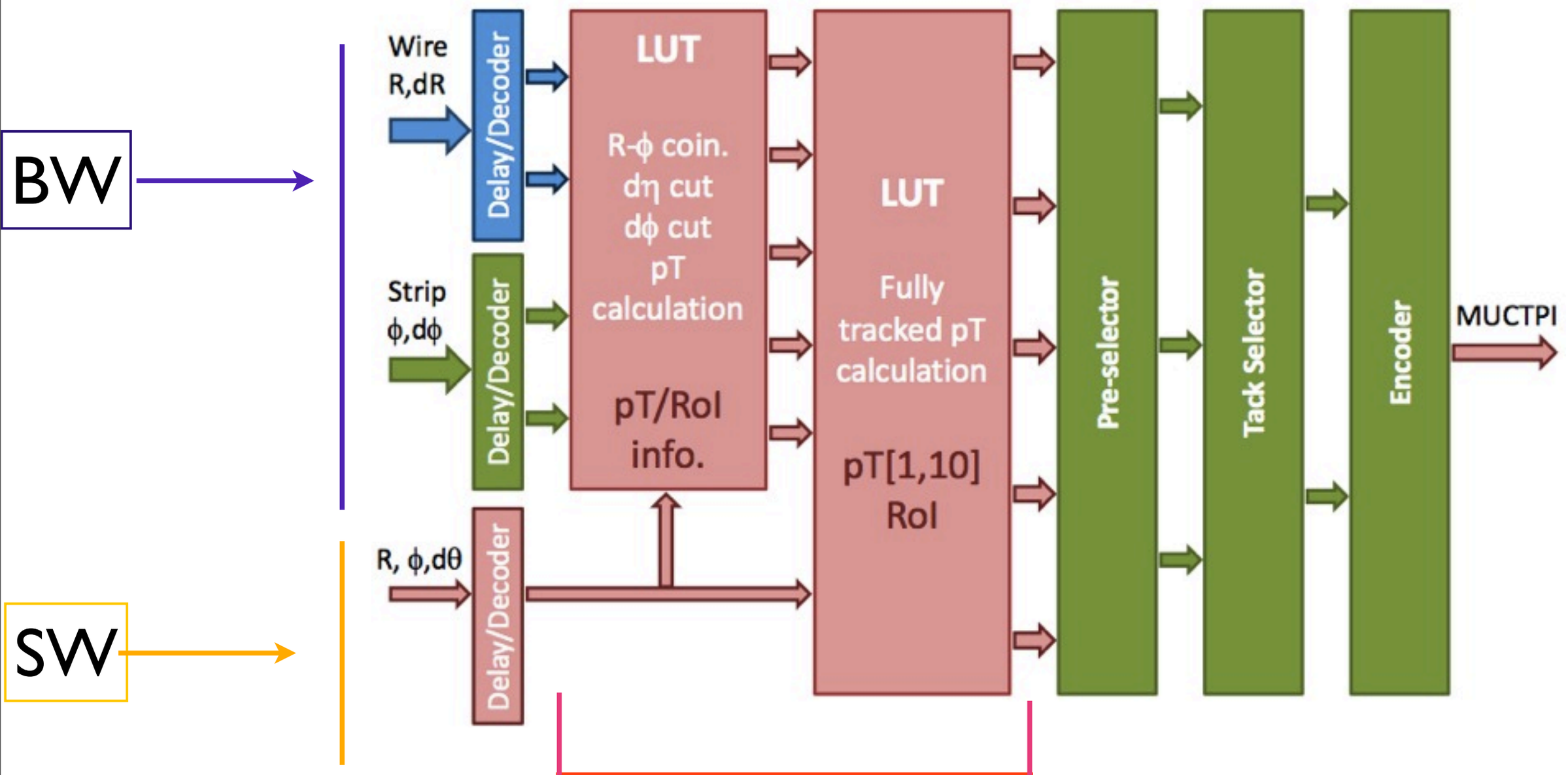
Phase I detectors



measure
- position
- dθ

Take Coincidence

New Sector Logic Board



2-steps of LUT

- SL spends 10 clocks
  -present SL spends 7

New Small Wheel(NSW)

- hit data
  - 16 bit / track
    * position :10 bit
    * dθ : 5 bit
    * hit flag : 1 bit
    * total : 16 bit
  - 4 tracks / fibre

- Connection NSW - New SL
  - [3(Large) + 2(Small)] × 8 × 2 = 80 fibers
  - 2 input /sector for spare

Requirements to Trigger Processor of NSW detector

- Outputs to Sector Logic should be fully synchronous to 40 MHz clock.

- NSW detectors should combine track information (MM-sTGC) before SL.

- Latency to Sector Logic should be shorter than 44 clocks.

Summary

- Phase-0 upgrade
  - New coincidence logic , EI/FI - BW : Done
  - optimisation of trigger condition : ongoing
  - preparation to install in ATLAS : ongoing
  - trigger rate reduction in simple condition is 27%

- Phase-1 upgrade
  - A trigger scheme has been studied . (dθ info.)
  - Data format between NSW - New SL is under discussion.