Timing analysis of CRAFT09 and preparation for the first collisions – Status report

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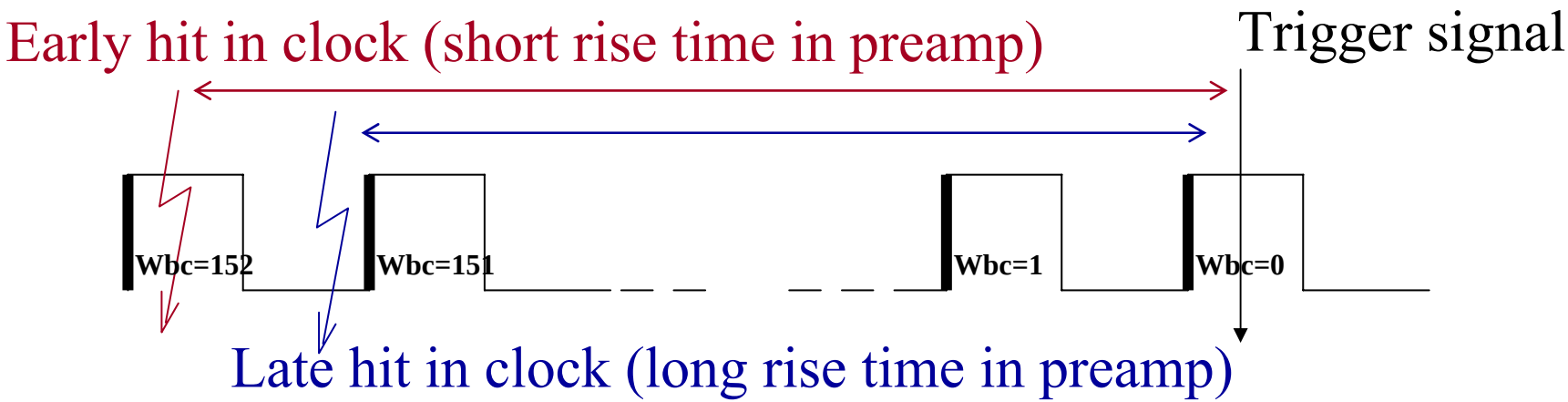
Status report

- Served 1 week shift on the Pixel detector last week
- Processed the cosmic muon data collected in 2009
  - Results of efficiency scan will be show in following slides
  - Code that will be used for timing in beam-collisions is being tested
- Presentation in CMS tracker forum:
  - Prepared plans for performing timing calibration of Pixels in 2009 and 2010
- Planning to study pixel efficiency from the analysis point of view

Reminder: Trigger latency (WBC) scan

- Pixel ROCs store hits with a time-stamp in units of bx
  - When trigger signal arrives, hits corresponding to a pre-set time stamps (WBC) are read out (*WBC is counted at the edges of the LHC clock*)
    - **Arrival time of trigger signal within the clock is irrelevant**
  - Consequences:
    - **Hits only in a single bunch-crossings can be retrieved**
    - **Time of a hit within a clock is unknown**

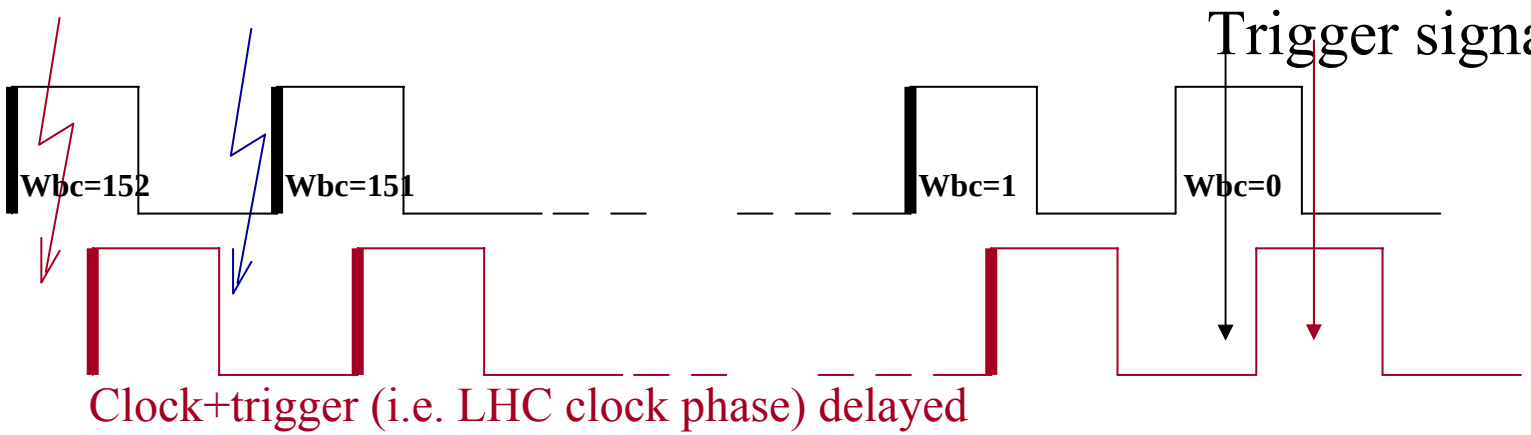
- Need to find right WBC setting first – WBC scan



(Note: cosmic events have both „early" and „late" early hits)

Reminder: Clock phase scan

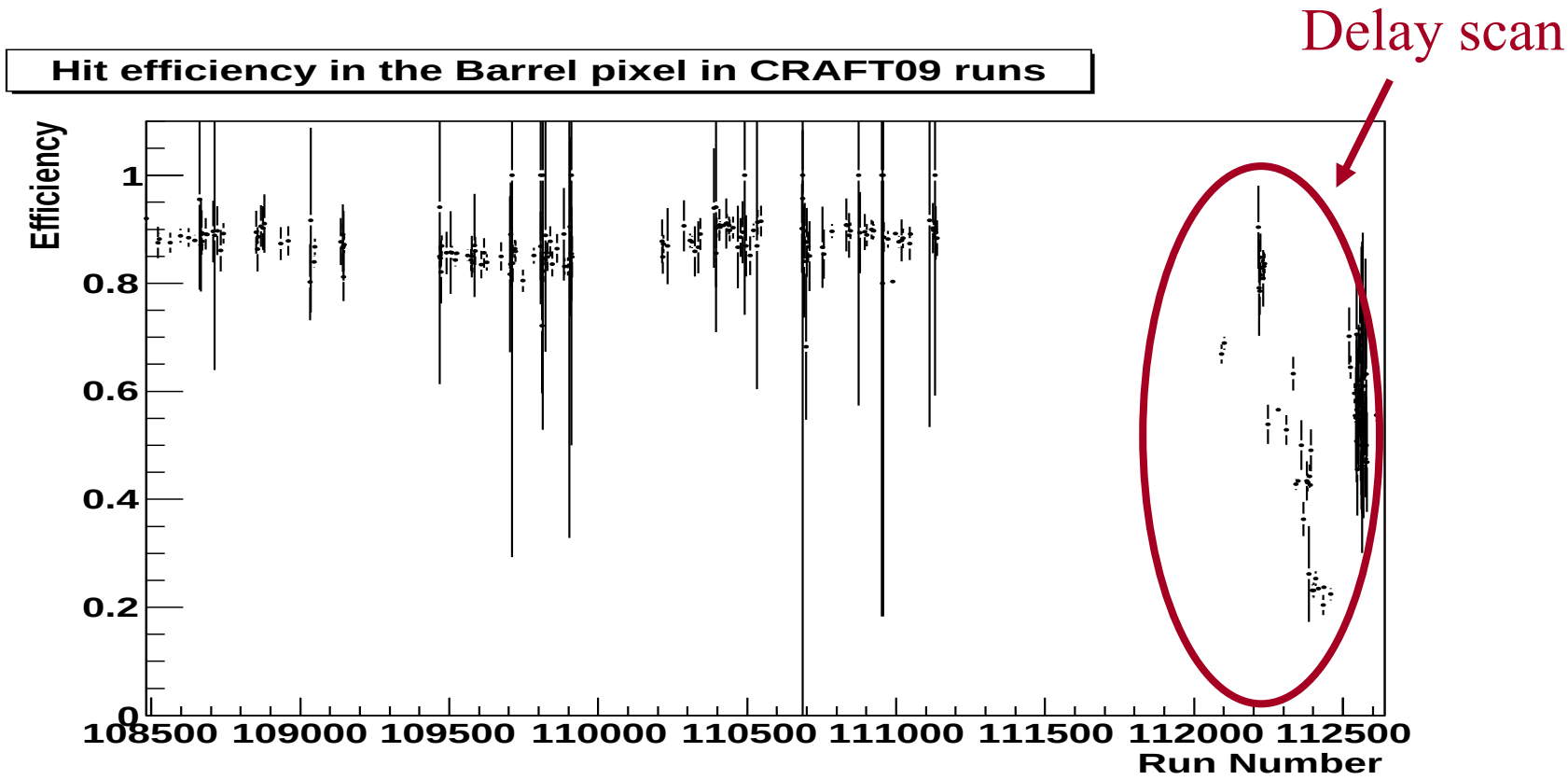
- If trigger/clock delays are not integrals of a bunch-crossing?
  - What really matters is the phase of the clock
  - Clock phase delayed w.r.t LHC clock → early particles fall in larger WBC



Clock phase scan:

1. Find WBC of the best efficiency (WBC scan)
2. Increase delay to find later hits within WBC chosen in step 1.
3. „Decrease" delay to include earlier hits (in WBC+1) if needed

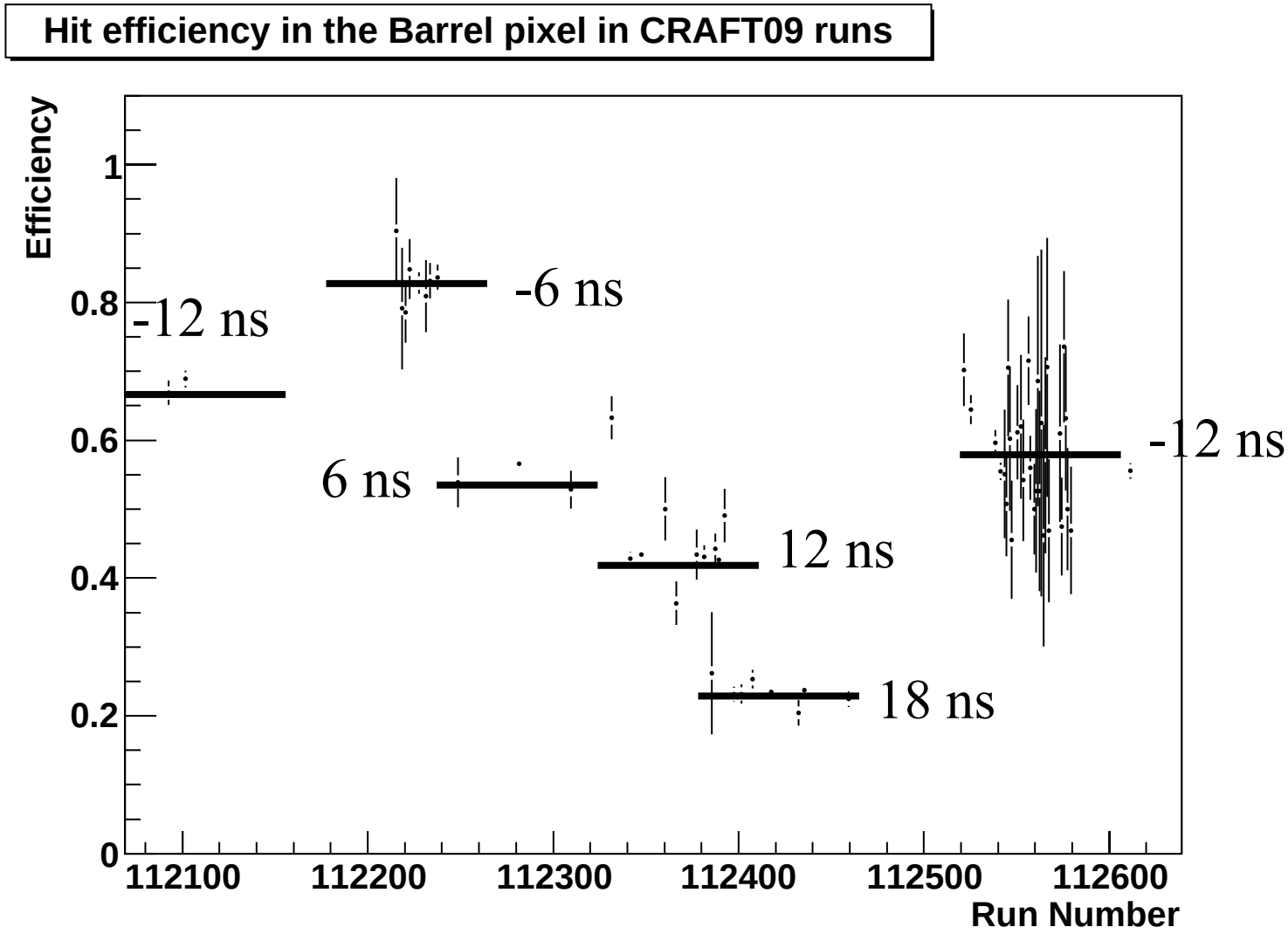
Pixel hit efficiency in CRAFT09



- Pixel hit efficiency = fraction of valid hits found by tracking in intersections of trajectories and detector layers

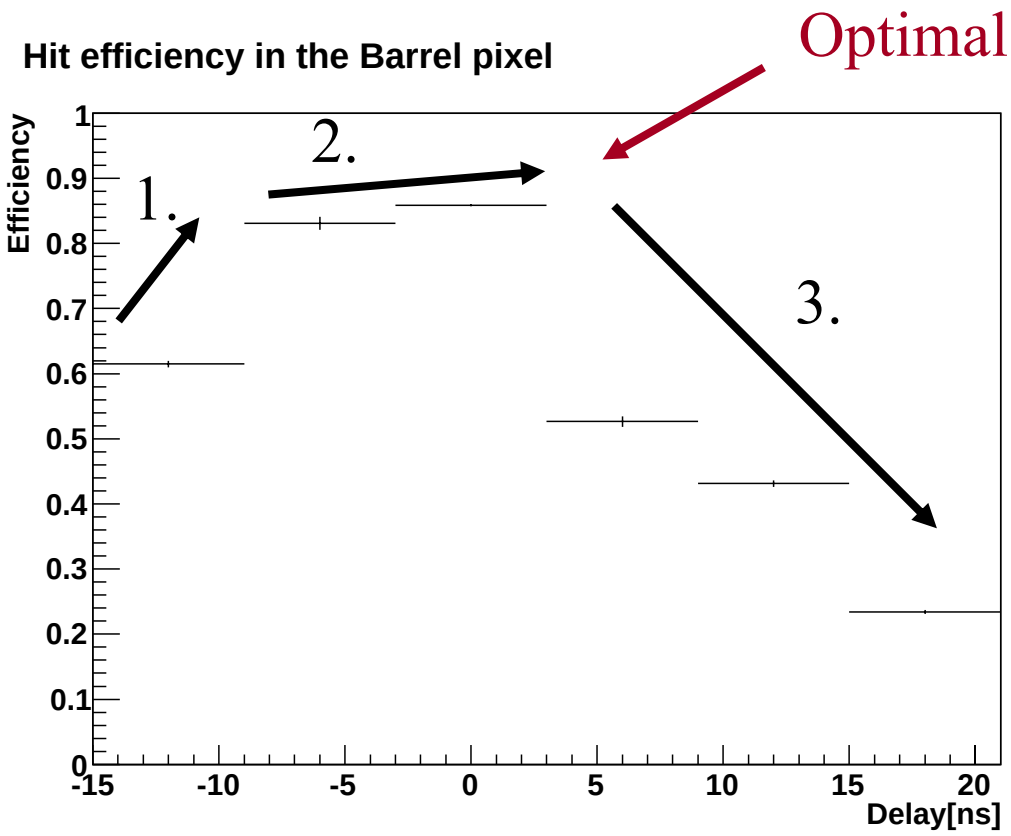
- Only requirement is telescope cut on trajectory (muon trajectory crosses a layer at least once at –y and once at +y)

Delay scan in CRAFT09



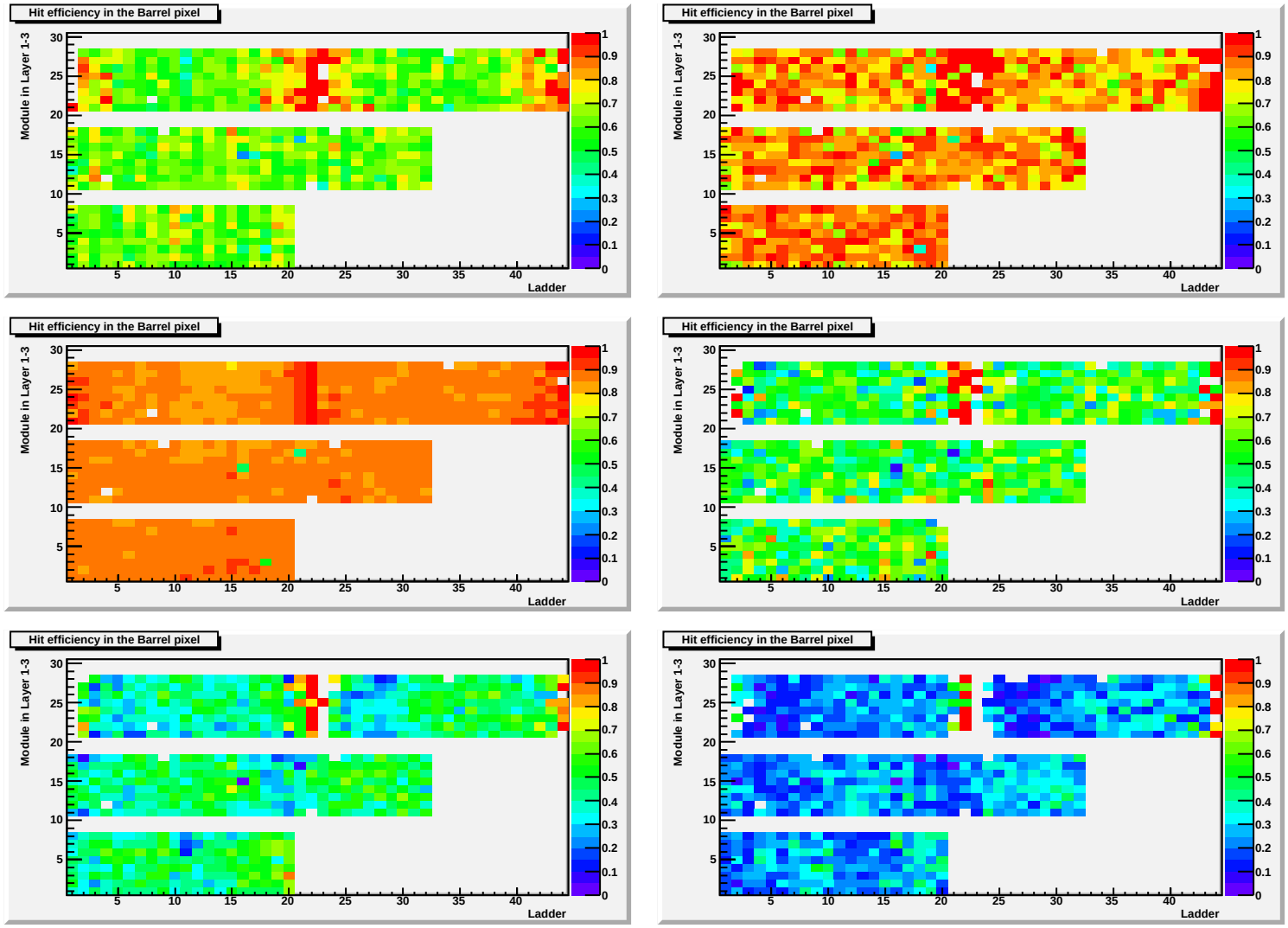
CRAFT09 delay-scan

- Similar trend is expected in beam collisions (Note: this kind of plot will require tracking)
- Used statistics: ~5000 – 25000 hits / delay point



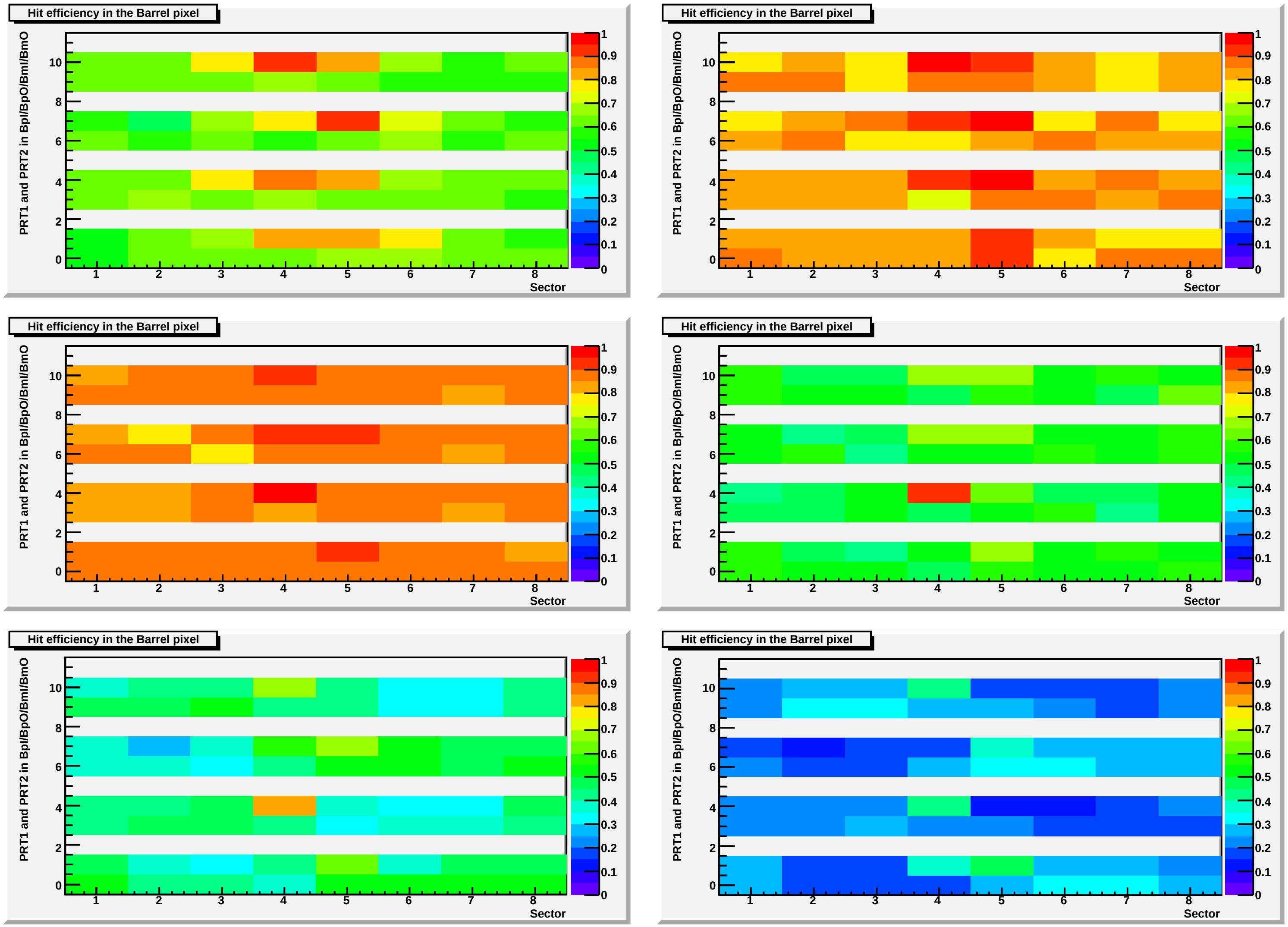
1. Accumulation of early muons
2. Muon yield unchanged, accumulation of late hits of early muons?
3. Loss of muon yield, accumulation of late hits of late muons

Module efficiency in the barrel



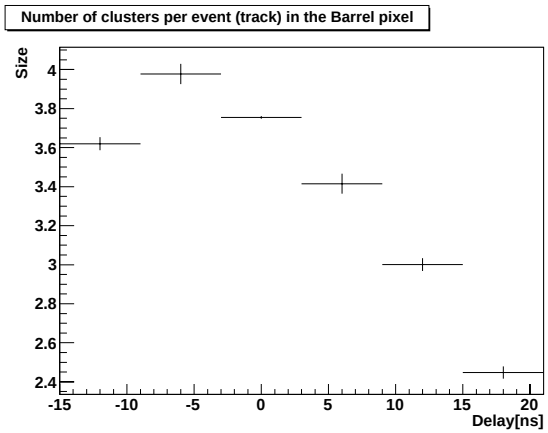
Not enough statistics to say anything about this

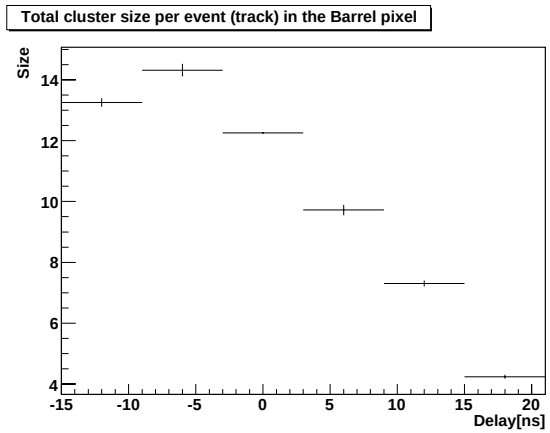
Efficiency per read-out group in the barrel

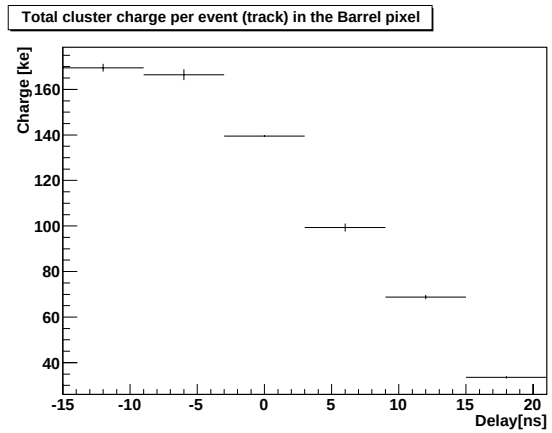


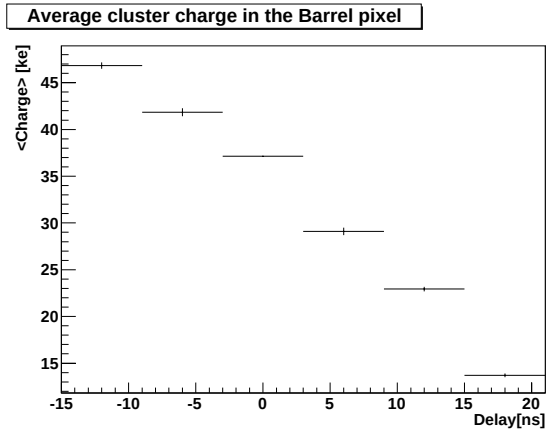
Overall improvement is see, but not sure one can judge about the best setting

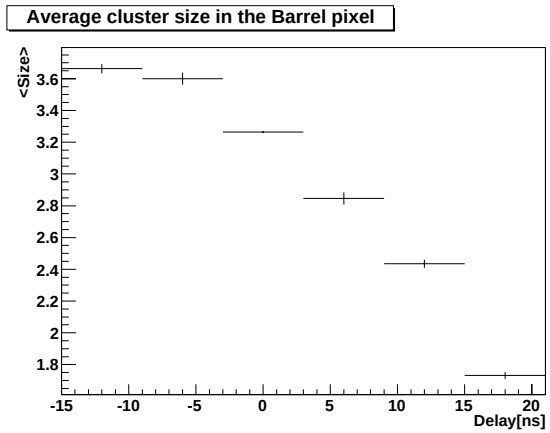
What quantity to optimize without tracks?











- Cluster occupancy and total size seems to work
- Average cluster properties do not work due to the fact that the clusters that contribute in the increase of efficiency have small charges and sizes

Expected schedule for timing calibration

- 2009, Goal: finding a working point for data taking in December
  - 1. Perform a WBC scan in 2-3 WBC values
  - 2. Do a quick scan in 4 point with 5 ns steps, 5 min/step
  - Required time: data taking in 7 steps + manual actions = ~2 hours
  - Note: Internal synchronization is already sufficient for this purpose

- In 2009, synchronization and alignment to beam with ~5ns accuracy, slide 7 implies that layer efficiency will not be less than 95% of maximum efficiency

- 2010, Preparation for long term data taking
  - Goal:
    - Synchronize read-out groups with each other
    - Study efficiency at the module level
    - Optimize clock phase for the whole detector – i.e. gain the last few % in efficiency
  - Scan 24 points with 1 ns steps, take data for 20 min/step
  - Comissioning time: 1 day (~2 shifts with safety margin)
  - Make use of experience from 2009