

# Setting up SCT Links

- Data Links
- TTC Links
- Timing in detector
- Monitoring bit errors

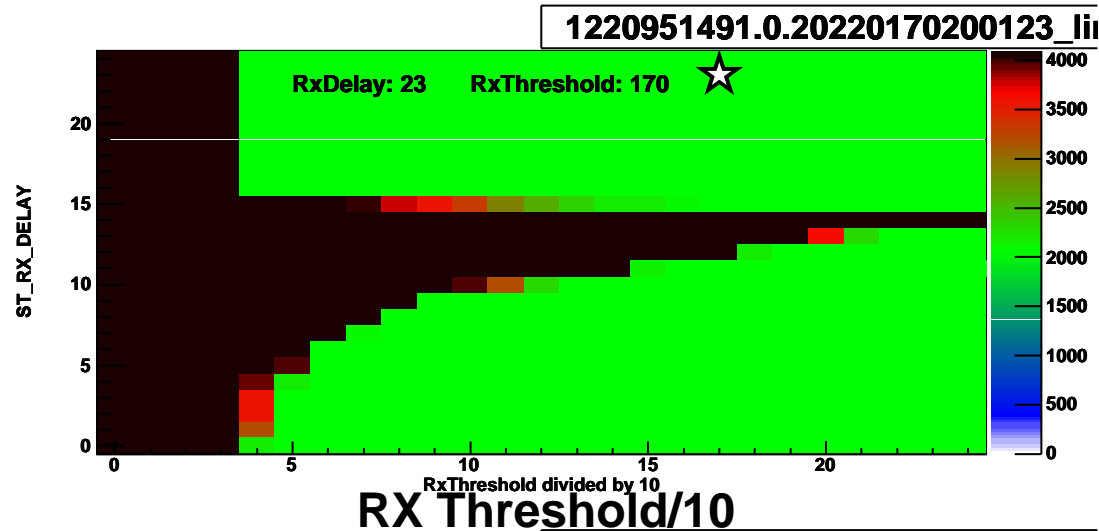
# Data Links

- Can adjust
  - VCSEL current,
  - Receiver threshold (this is a DC coupled link)
  - Timing wrt receiver electronics (ie phase of local copy of 40 MHz clock).
- In practice set VCSEL current to 10 mA and only change if required (radiation damage).

# RX threshold/Phase

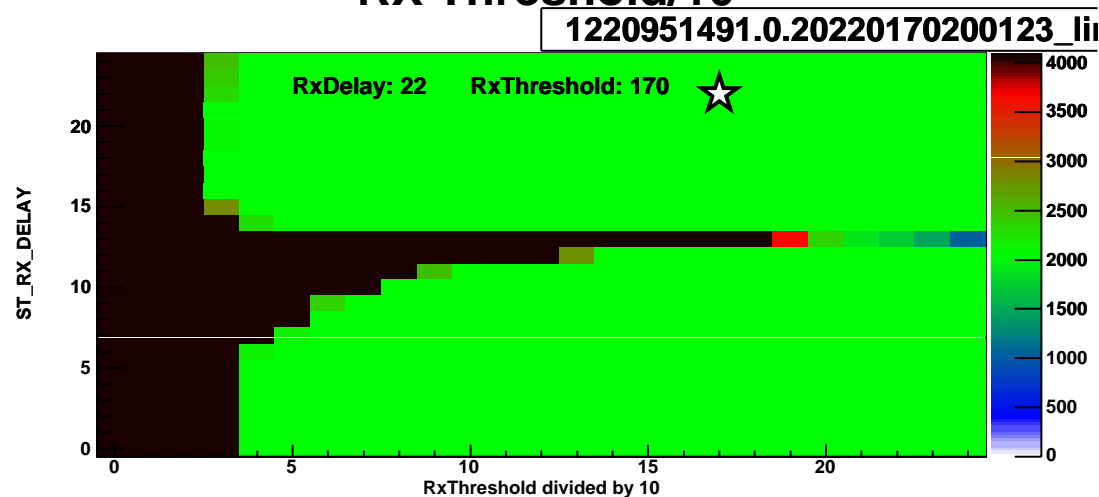
- 2D scan using clock/2 mode of FE module ie i/p 40 MHz clock → o/p 20

Clock Delay



Triggers

Green 50% “1”  
→ good region



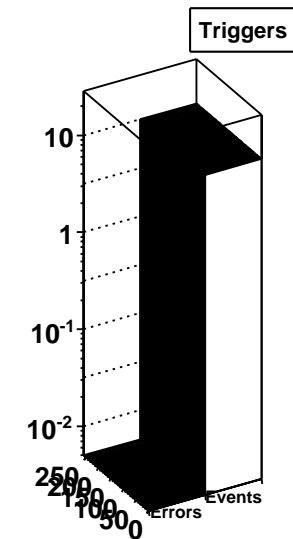
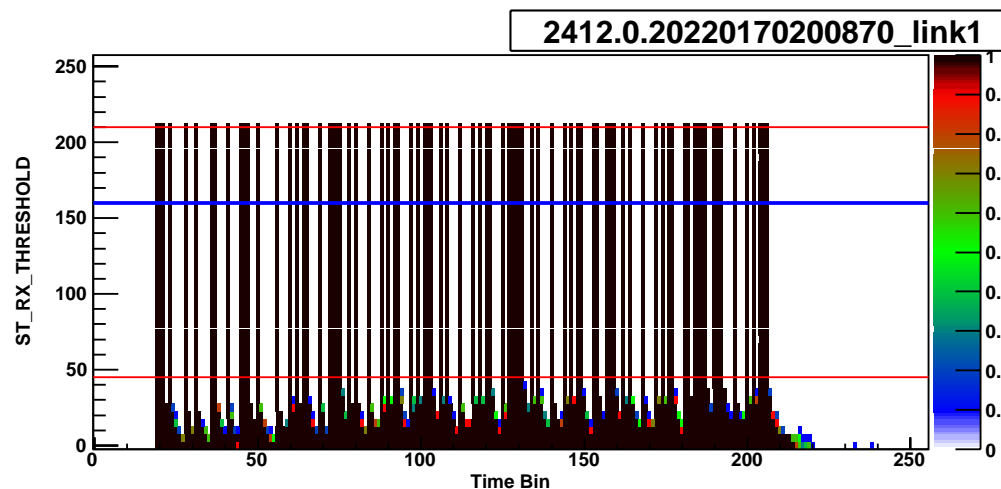
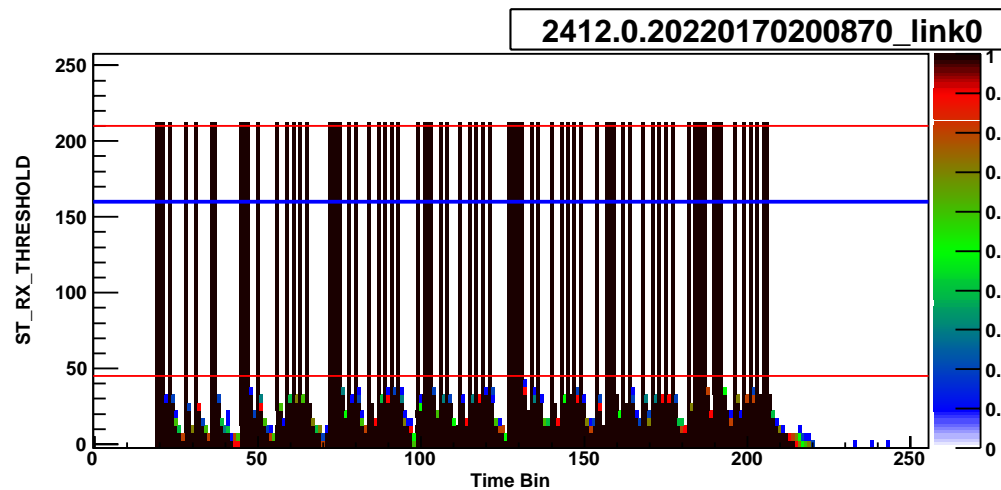
Set delay to be  
away from  
black strip ie  
edge

Toi

# RX Threshold

- Still need separate RX threshold scan using burst data because of non-balanced code

Send burst of  
fixed data  
pattern

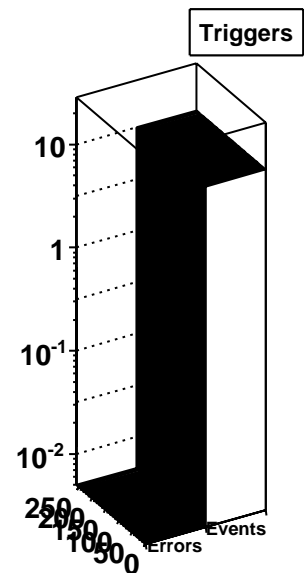
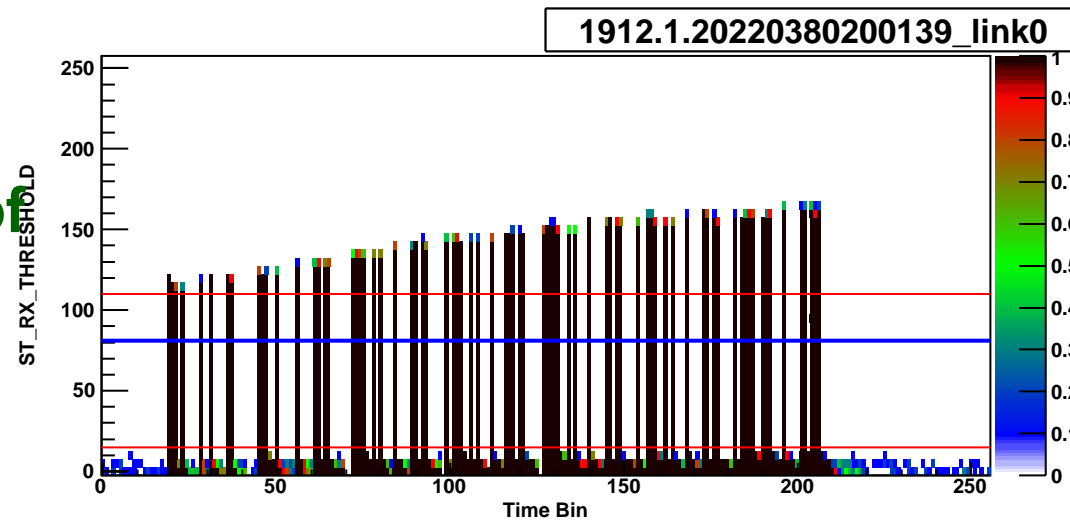


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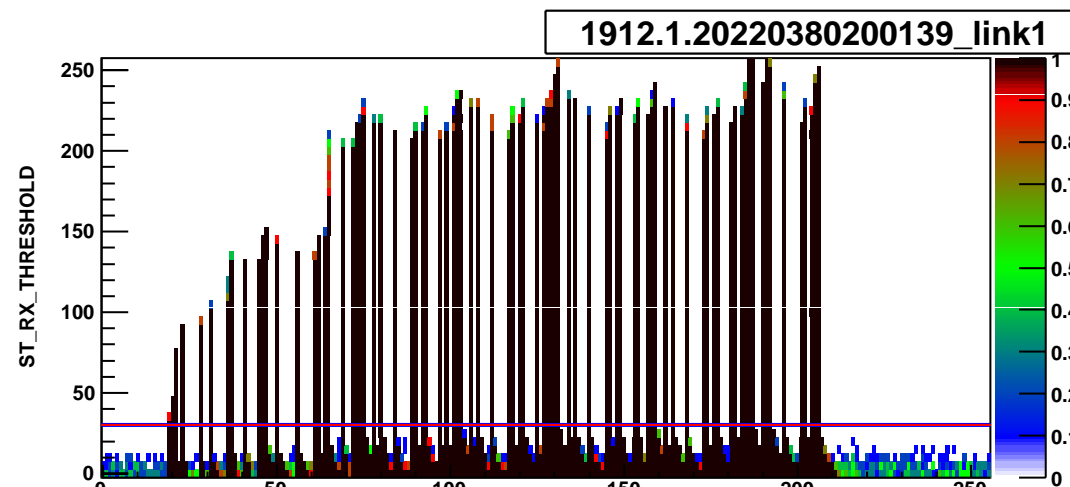
# RX threshold

- Slow-turn on channels

Small effect of  
slow turn-on



Very bad  
channel



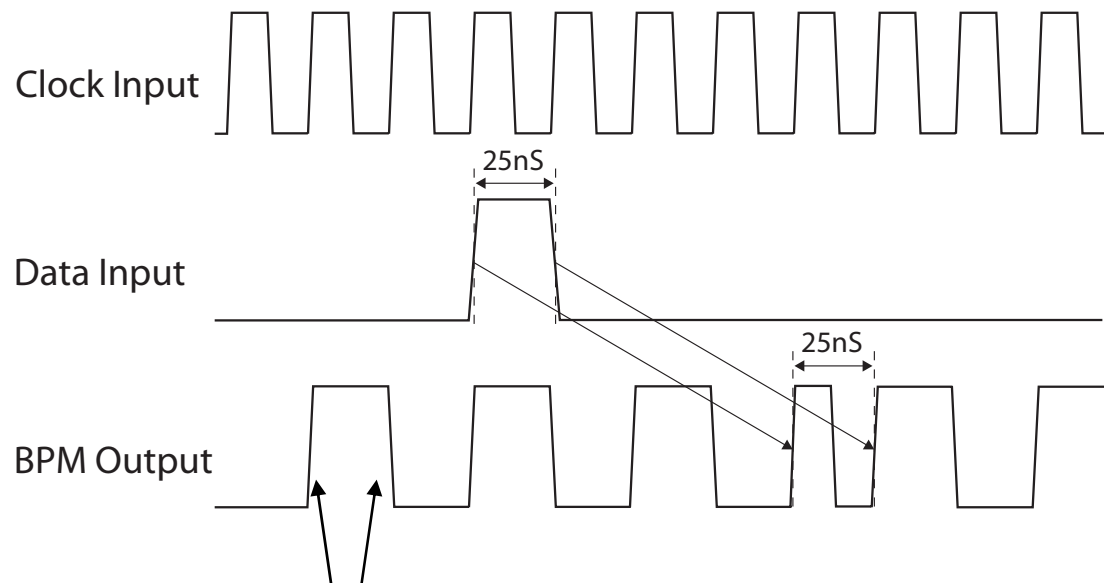
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# TX Links

- Uses BiPhase Mark (BPM) encoding → balanced code.
- To set-up links only parameter to adjust is VCSEL current (pin bias set to 6V don't adjust until needed by radiation damage).
  - Just set to default 10 mA and leave it until required (radiation damage for p-i-n diodes).
  - Check that p-i-n current  $I_{pin}$  is reasonable.
- **Links with balanced codes much easier to set-up and operate!**

# Mark: Space Ratio Adjustment

- Non 50:50 MSR  $\rightarrow$  jitter in recovered 40 MHz clock  $\rightarrow$  Need to adjust MSR.

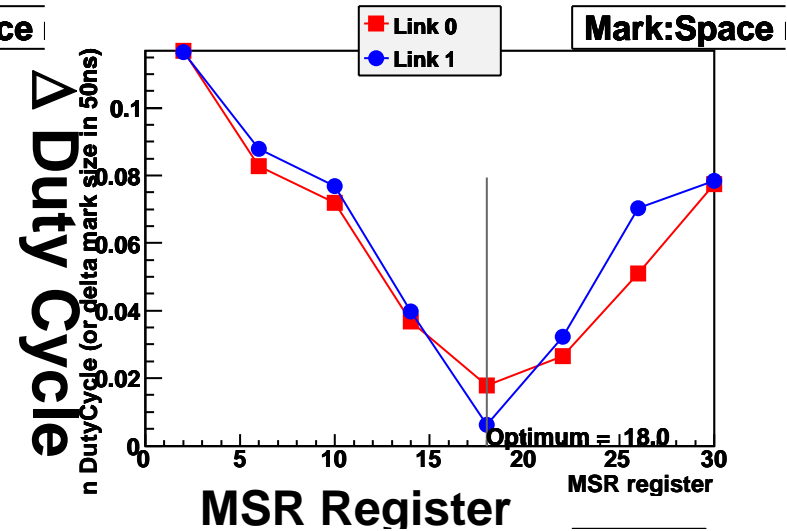
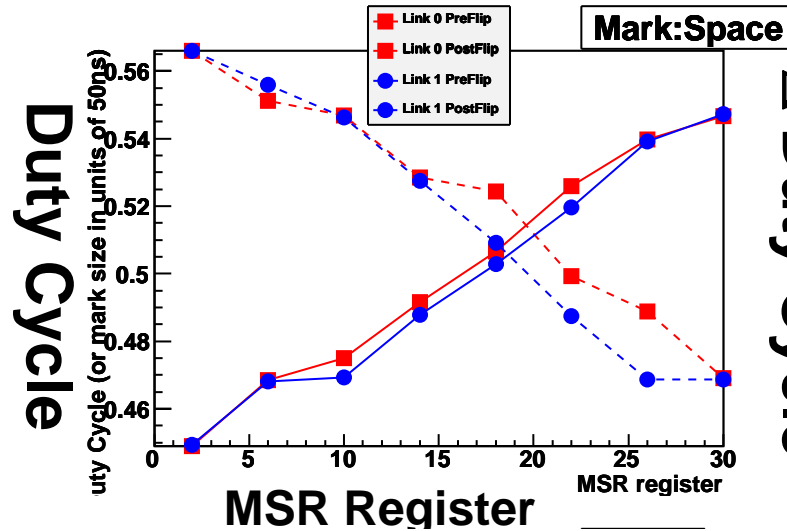


**Both edges used to recover 40 MHz clock**

# MSR Optimisation

- Use modules in clock/2 mode, look at returned data.
  - Use chains of inverters to stretch pulse. MSR register settable from s/w.
  - Set MSR value
  - Scan receiver phase → measure duty cycle of received clock.
  - Flip phase of BPM signal (send data “1”) and repeat scan.

# MSR Scans



Use clock delay scan to measure duty cycle before and after flip

Plot asymmetry vs MSR

# MSR Summary

- Scans work:
  - 2 links see same BPM signal agree on optimal MSR register value.
- Still need more work to optimise this scan
  - Finer steps in MSR values
  - Finer scan of phase using 40 ps steps instead of 1ns steps.
- BPM ok for SCT operation (RMS jitter < 1 ns) but difficult to achieve a very low jitter recovered clock → eg don't use 160 MHz BPM signal → 3.2 Gbits/s clock.

# Timing Adjustment

- Need to trigger on correct BC!
- Need to set clock delay accurately to optimise detector efficiency.
- Can adjust
  - L1 trigger signal in units of 25 ns
  - BC clock fine delay in units of 0.35 ns
- Set-up timing with dead reckoning and verify/scan with beam.

# Dead Reckoning

- Measure propagation delays in cables/chips from trigger o/p to o/p of BPM-12 chip.
- Measure propagation times in fibre cables.
  - Very simple system used: send pulse down one fibre in a ribbon and connect a “reflector ribbon” at the other end to send the light back. Used optical probe/digital scope to measure propagation delay.
- Calculate propagation times for short lengths of on-detector fibres.
- Correct for time of flight for particles from vertex to detector modules.

# Trigger Timing with Cosmics



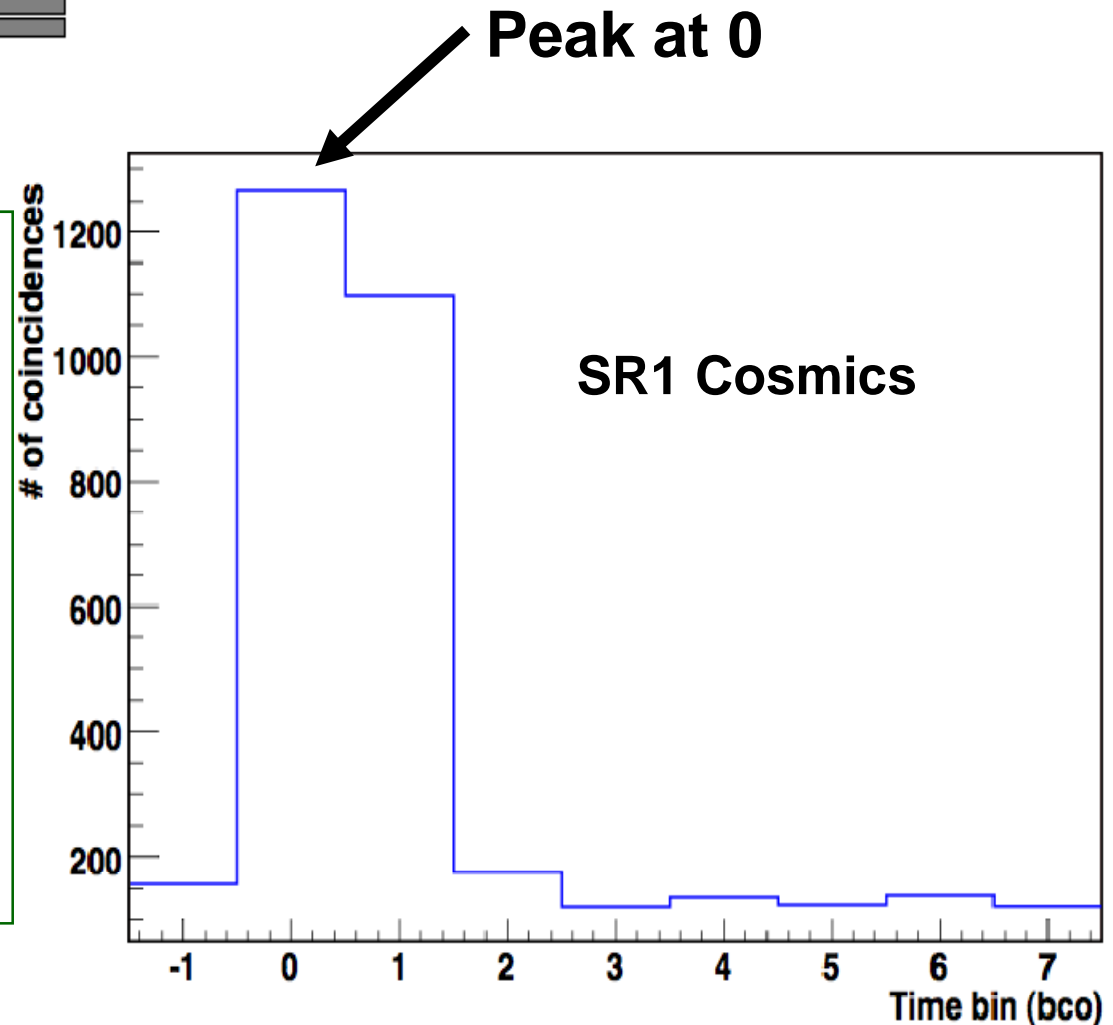
**Look at number of coincidences between chip hits from two sides of modules**

**Vary time delay, find maximum coincidences**

**Dead reckoning was correct!**

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ATL



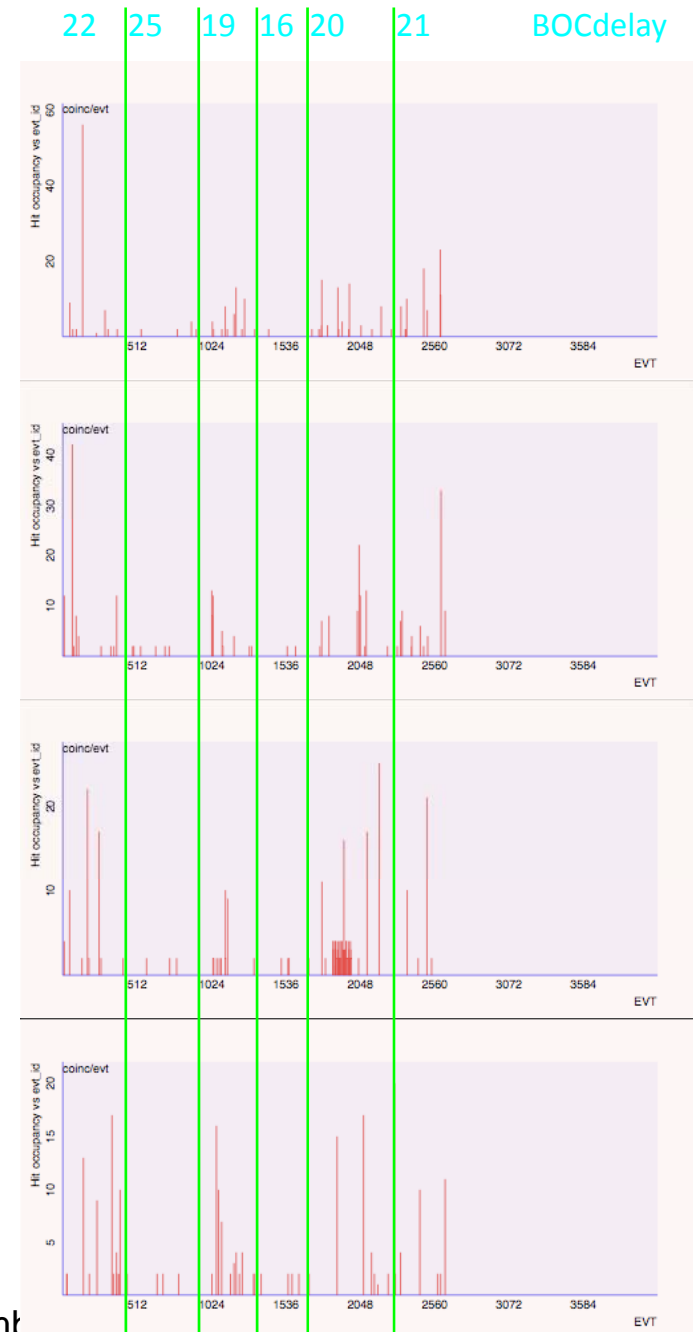
# M6 timing in for pit cosmics

- Scintillator trigger
- Threshold: 1.2 fC
- Cosmics mode: 3 BC + level hit
- Each ROS samples 1/4 barrel
- Pause/resume to change BOC delay
- Plot # coincidence hits vs event

```
run 42135 (initial delay 22)
pause at event 450
  delay += 3 (25)
pause at event 860
  delay -= 6 (19)
pause at event 1300
  delay -= 3 (16)
pause at 1680
  delay += 4 (20)
pause at 2370
  delay += 1 (21)
stop run 42135 after ~ 2675 trigs
conclude that 20 is the
optimal offset
```

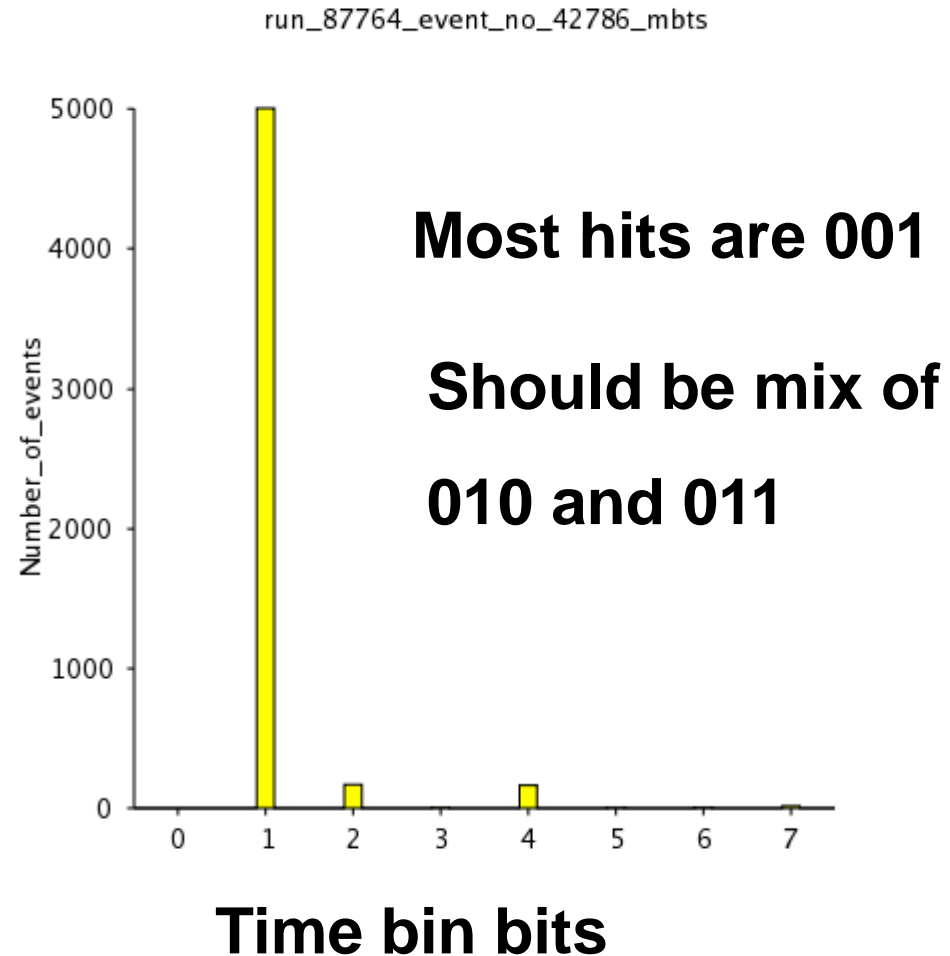
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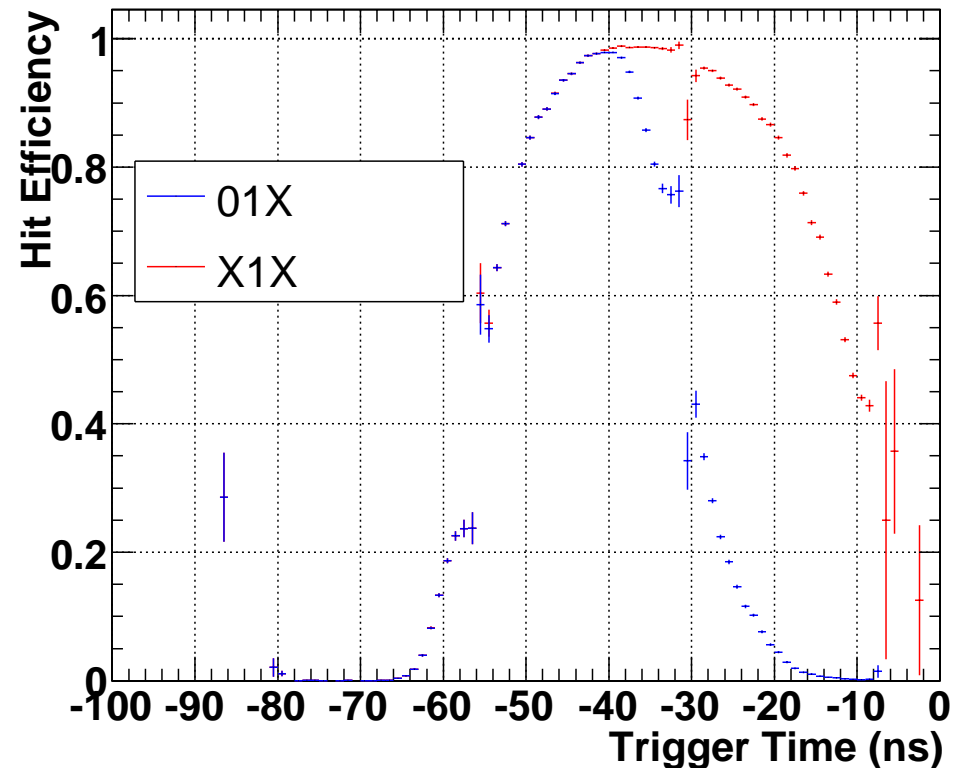
# Timing from 1 event: beam splash

- Coincident hits from single beam splash event (10/9/08)
- Time bits → adjust by 2 clock cycles
- Coarse timing can (almost) be set with only 1 event!



# Cosmic Fine Delay Scans

- SR1 Cosmic scans
- Used trigger scintillator → timing
- Measure module hit efficiency versus trigger time.
- Readout if hit in 3 time bins but record bit time pattern.



# Fine Delay With Beam

- Set fine-delays to calculated values.
- Scan fine delay and measure module hit efficiencies.
- Make adjustments in groups of 12 modules as we use 12 way ribbons.
- Needs 5000 tracks → 17000 min bias events → ~ 2 hours to perform scan.
- Should be very stable?

# Monitoring Link Errors

- Data pattern has some fixed bits (preamble, part of header and trailer).
- Send 8 LSBs of L1 and 4 of BC to module, compare with full L1 and BC in ROD.
- See few modules with L1 and BC errors but not fixed run to run...under investigation.
- Can monitor BER in-situ.

# Summary

- Can set up data and TTC links but DC coupled links much more difficult than
- Can optimise MSR for BPM signals to get low enough clock jitter but small jitter will remain.
- **Timing adjustments ok.**
- **BER can be monitored in-situ.**