



HMT Status + threshold tuning

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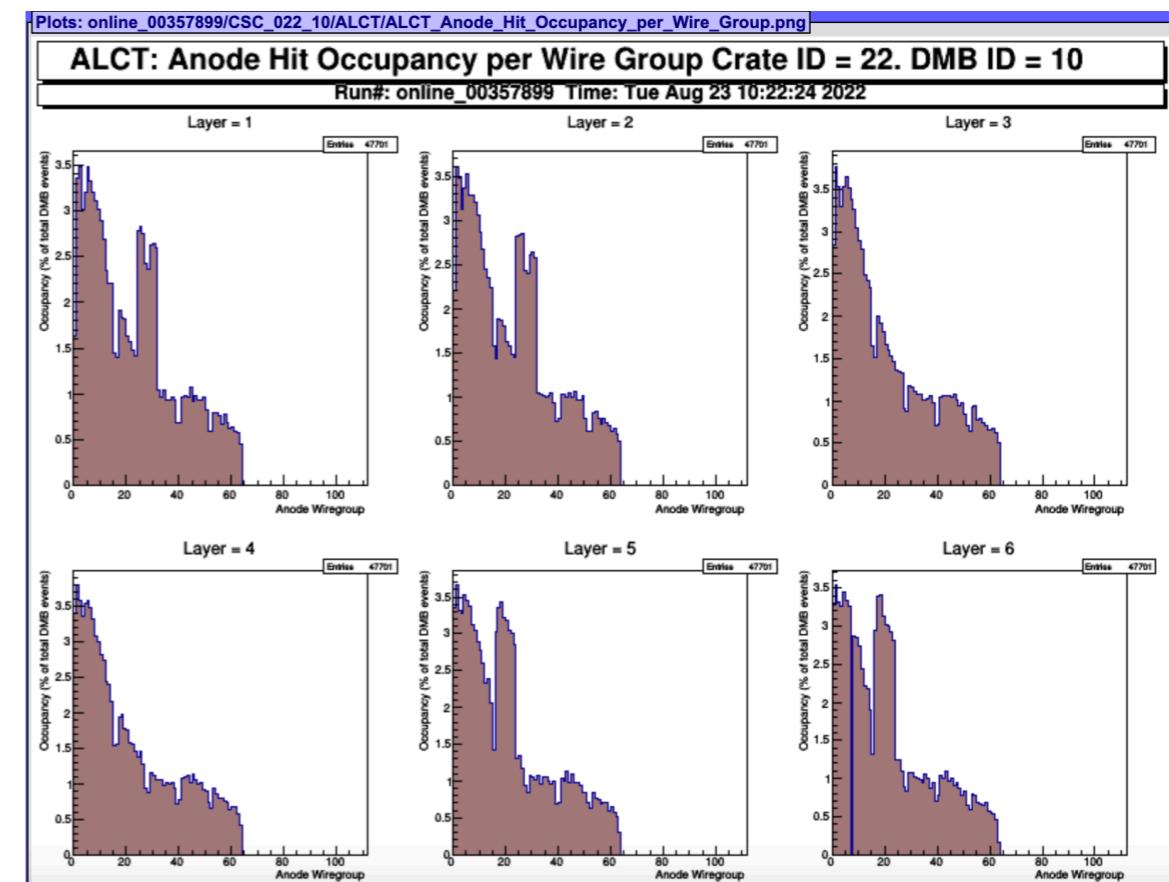
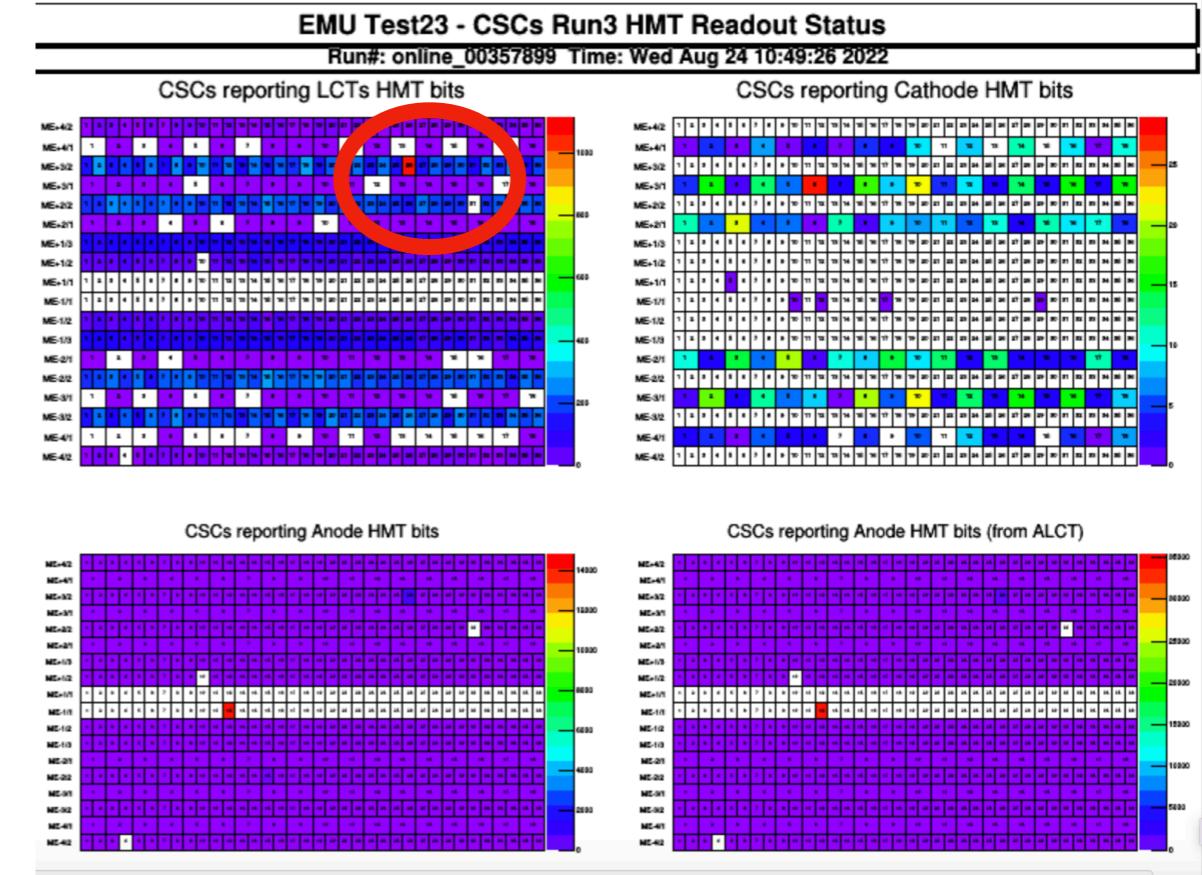
CSC Weekly Meeting

Outline

- ME+3/2/26 issue
- Rate spike in HMT
- New thresholds for HMT rate reduction

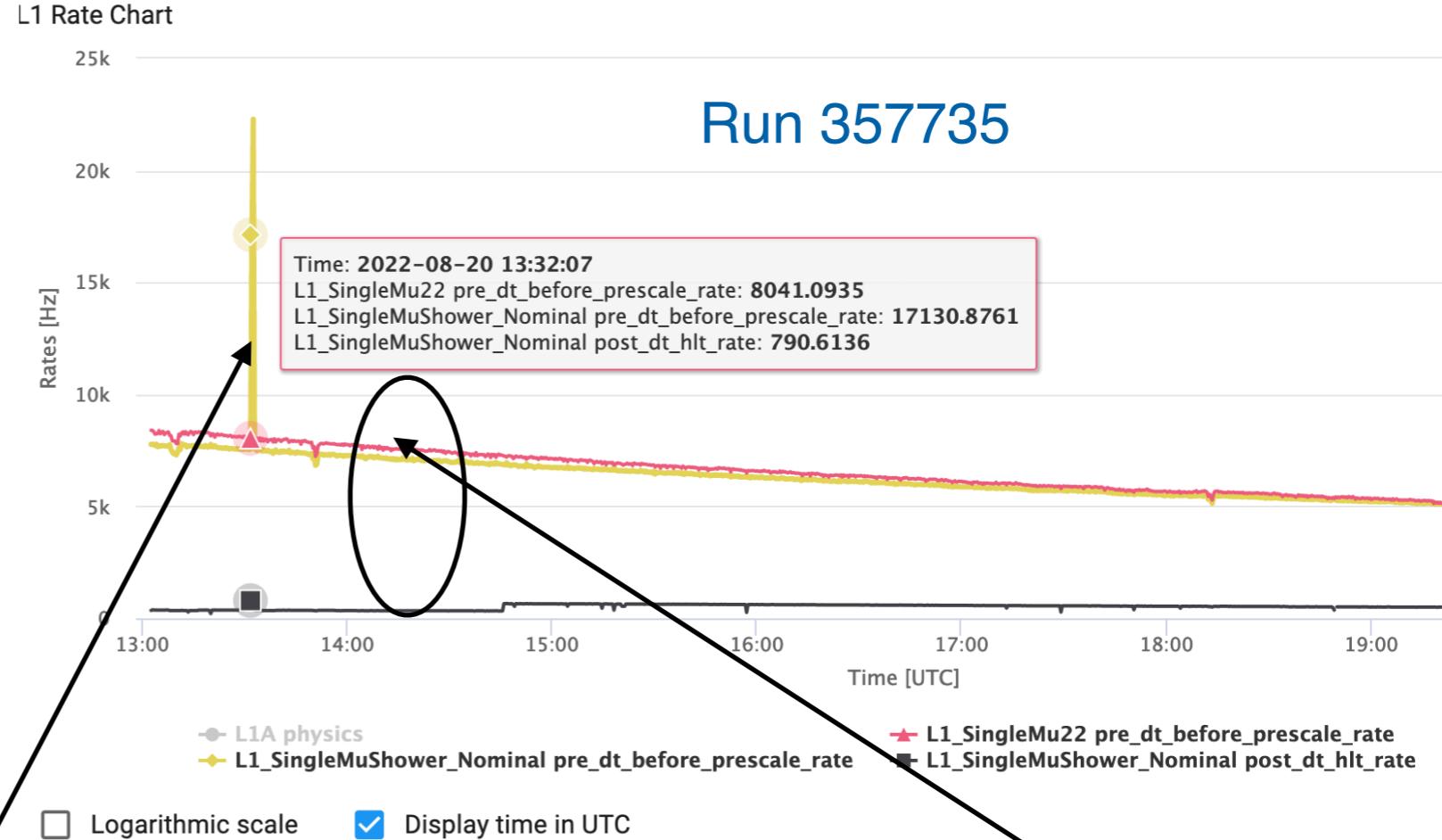
ME+3/2/26 issue

- A few wire groups in ME+3/2/26 has very high Anode hit occupancy
 - AFEB 9 and 10
- Causing high HMT occupancy
 - Reported last week: [link](#)
- Mikhail increased the thresholds by 2 ADC count ([elog](#))
 - Did not see improvement in 357899
- We should explore recovery options before disabling HMT for the chamber
 - These bad wires will have (small?) physics impact other than HMT

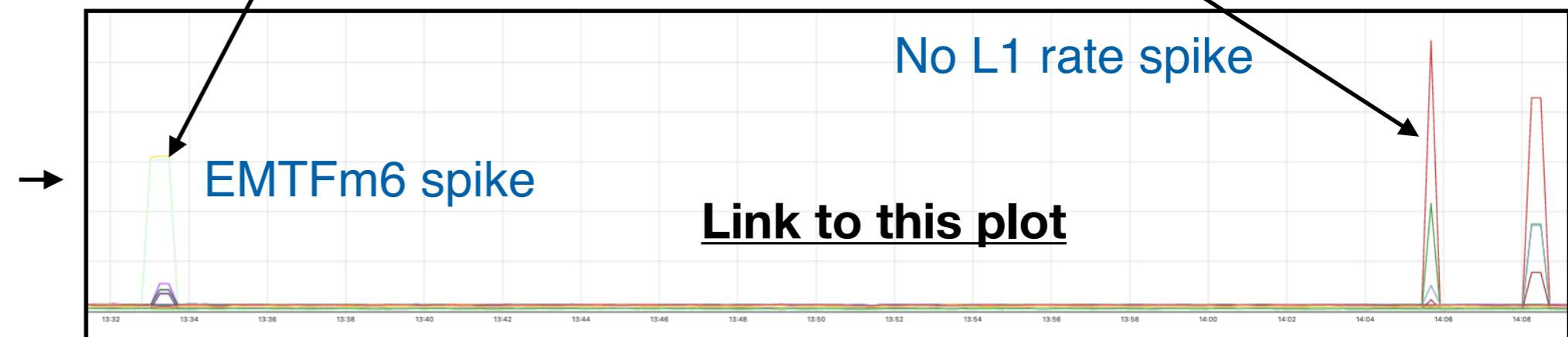


Rate spikes

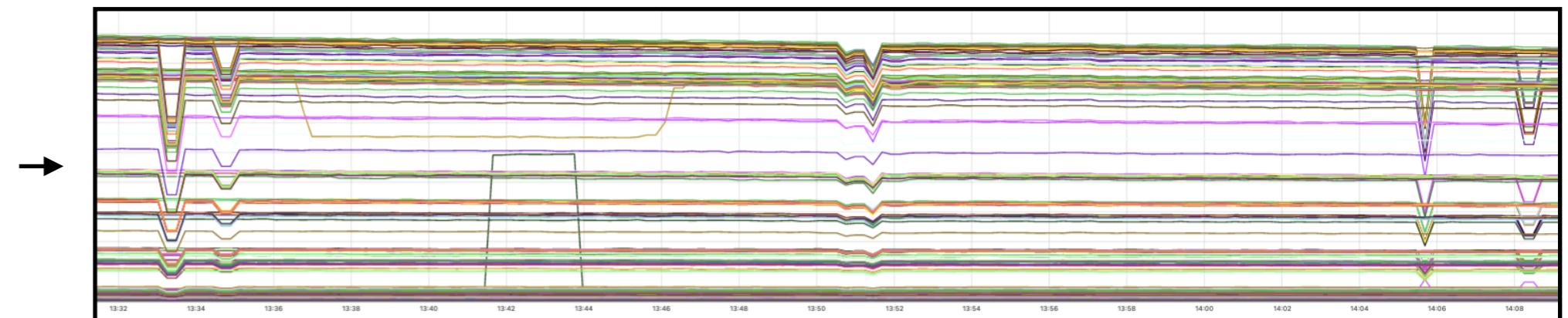
- Spikes in for HMT seed(yellow) but not in SingleMu22 rate(red)
- From L1 mon, this spike comes from 1 sector of EMTF(m6)
- More spikes in L1mon that are not seen in rate
- EMTF needs to block more data during some transition?



HMT rate in each EMTF sectors

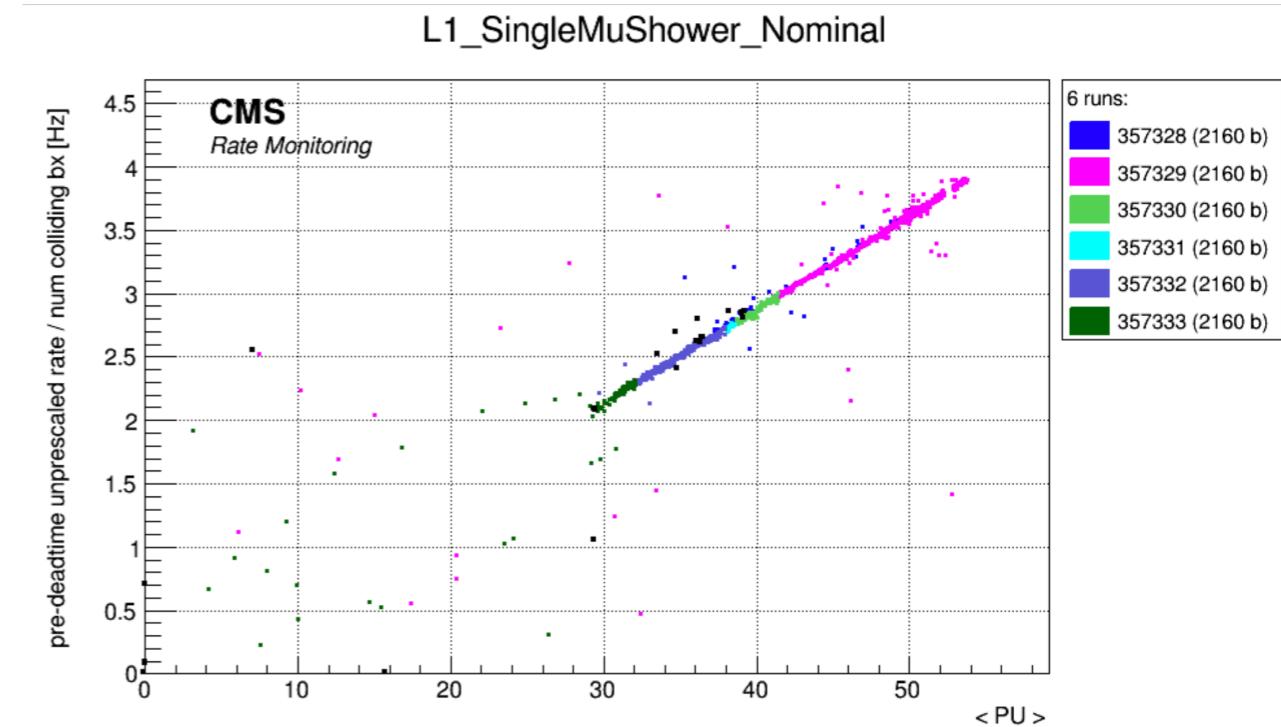
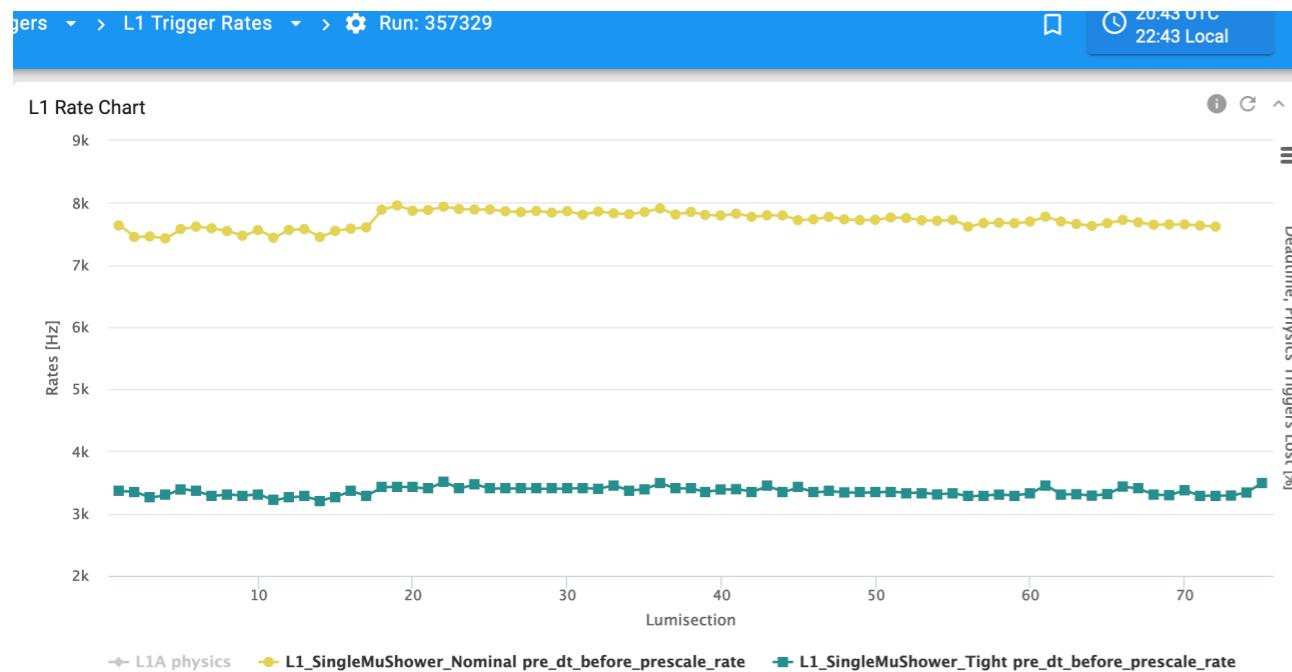


LCT rate per EMTF link



HMT Rates

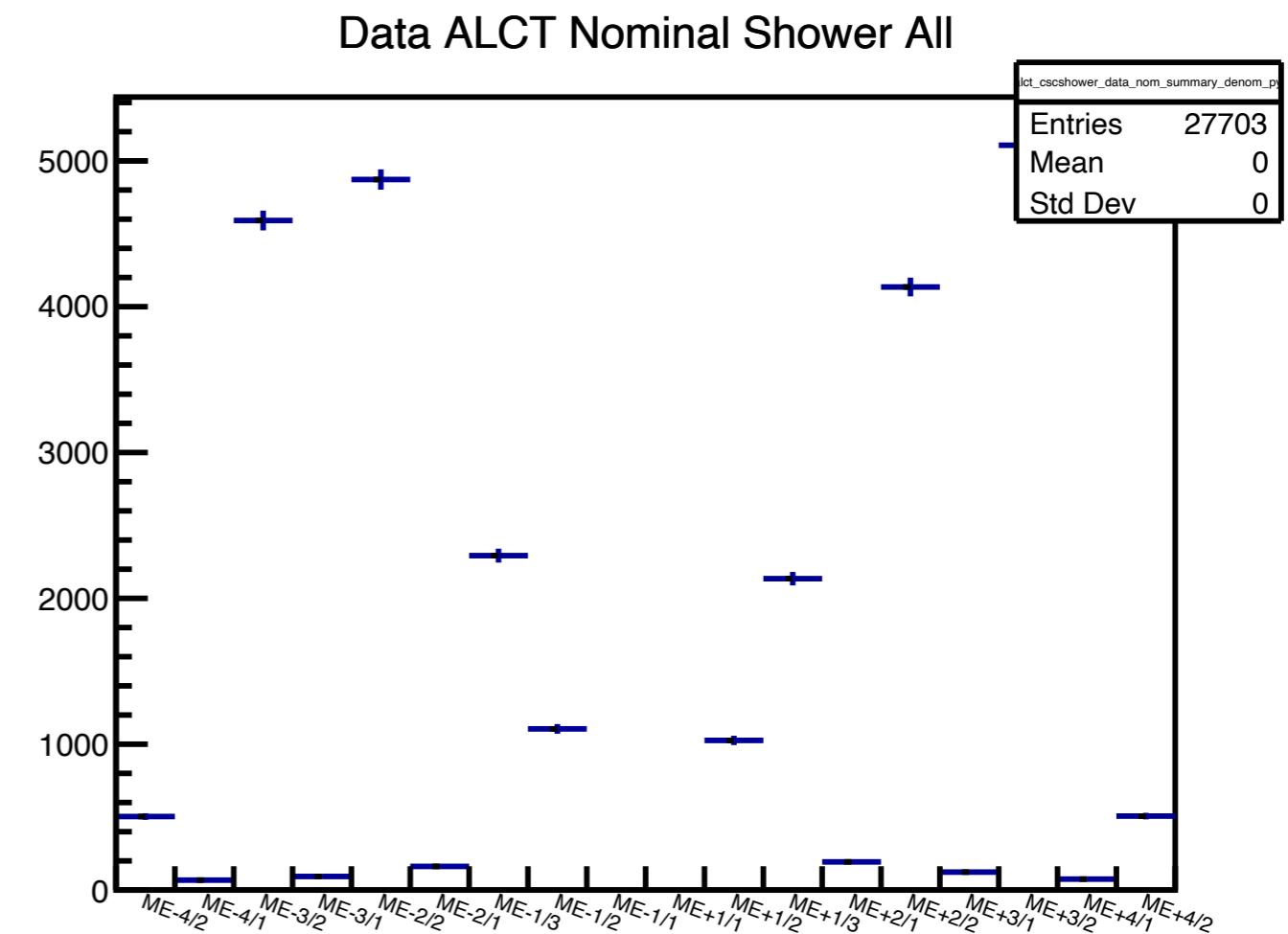
- HMT enabled with physics thresholds on (Aug11)
- Rate is ~5x higher than estimation:
 - Rate estimated from 2018 ZB (~PU40): 1.42 kHz Nominal / 0.65 kHz Tight
 - Rate from OMS 357329 (~PU50): 7 kHz Nominal / 3.5 kHz Tight
- PU dependence is linear
- Rate spike observed in some runs [more on this next slide]



Rate tuning

- Occupancy dominated by ME13/ME22/ME32
 - Outer rings only counts anode wire hits
- Inner rings accounts <1% of rates
 - Combination of a) higher thresholds and b) anode+cathode hit counting

	<i>Fraction of rate[%]</i>
ME11	0.00
ME12	6.72
ME13	19.47
ME21	0.11
ME22	32.50
ME31	0.14
ME32	37.39
ME41	0.03
ME42	3.63
Total	100



Deadtime in the old emulator

- Possible cause for the rate discrepancy
- Old emulator included dead time when counting wire hits
 - e.g. Wire hit > thresholds in bin [7,8]
Emulator will not count this hit due to dead time,
but FW counts as long as Wire hit > thresholds at BX8
- Effectively emulator **counts less hits** than ALCT FW
- To be confirmed if this caused the discrepancy

Data sees **nominal** shower; Emulator sees **loose** shower

Emul ALCT: (endcap,station,ring,chamber) = (1,4,2,13)

bits=CSC Shower: in-time bits 1

Data ALCT[TMB]: (endcap,station,ring,chamber) = (1,4,2,13)

bits=CSC Shower: in-time bits 2

Full WireDigi collection

```
Layer= 1 wires= CSCWireDigi wg: 25, First Time Bin On: 8, Time Bins On: 8 9
Layer= 1 wires= CSCWireDigi wg: 26, First Time Bin On: 8, Time Bins On: 8
Layer= 1 wires= CSCWireDigi wg: 37, First Time Bin On: 7, Time Bins On: 7
Layer= 1 wires= CSCWireDigi wg: 38, First Time Bin On: 8, Time Bins On: 8
Layer= 1 wires= CSCWireDigi wg: 39, First Time Bin On: 7, Time Bins On: 7 8
Layer= 2 wires= CSCWireDigi wg: 38, First Time Bin On: 7, Time Bins On: 7 8
Layer= 2 wires= CSCWireDigi wg: 39, First Time Bin On: 8, Time Bins On: 8 9
Layer= 2 wires= CSCWireDigi wg: 40, First Time Bin On: 8, Time Bins On: 8
Layer= 2 wires= CSCWireDigi wg: 42, First Time Bin On: 7, Time Bins On: 7 8
```

WireDigi used by Emulator

```
[ALCT Emulator] ilayer = 0 iwire = 25 times = 8 count hits? = 1
[ALCT Emulator] ilayer = 0 iwire = 36 times = 7 count hits? = 0
[ALCT Emulator] ilayer = 0 iwire = 37 times = 8 count hits? = 1
[ALCT Emulator] ilayer = 0 iwire = 38 times = 7 count hits? = 0
[ALCT Emulator] ilayer = 1 iwire = 37 times = 7 count hits? = 0
[ALCT Emulator] ilayer = 1 iwire = 38 times = 8 count hits? = 1
[ALCT Emulator] ilayer = 1 iwire = 39 times = 8 count hits? = 1
[ALCT Emulator] ilayer = 1 iwire = 41 times = 7 count hits? = 0
```

Dead time after first time-on

nHits Bx8= 28

hitsInTime = 16
=> Loose shower

Threshold tuning

- Online system:
 - Nominal/Tight rate = 444.46 / 192.45Hz
 - Tight / Nominal ~ 0.43
- Offline analysis using Ephemeral HLT Physics dataset
 - Predict the ratio between tight/nominal
 - Cutting at tight thresholds in anode gives ~ **0.40**
 - Reasonable agreement with online system

Offline sample:

- Runs
357696,357700,357735,357756
- 77k events triggered by HMT

<i>Fraction of rate</i>	<i>nominal [%]</i>	<i>Tight [%]</i>
ME11	0.00	0.00
ME12	7.12	5.20
ME13	20.64	4.63
ME21	0.12	0.11
ME22	32.99	14.0
ME31	0.14	0.13
ME32	35.39	14.0
ME41	0.04	0.04
ME42	3.40	1.69
Total	100	39.8

Threshold tuning

- Raise thresholds that gives 1/5 and 1/10 reduction
- HLT vetos clusters with hits in ME11 or ME12
 - Re-distribute rates from ME12 to avoid raising ME13/22/32 too much
- Target same rate as original estimation

Current anode thresholds

Station	11	12	13	21	22	31	32	41	42
nom	140	41	12	56	18	55	16	62	27
tight	140	45	16	58	22	57	20	64	31

Fraction of rate	OLD	Nominal		Tight	
	nominal [%]	Fraction[%]	Thres. chg	Fraction[%]	Thres. chg
ME11	0.00	0.00		0.00	
ME12	7.12	0.03	41->140	0.03	45->140
ME13	20.64	8.75	12->14	2.70	16->18
ME21	0.12	0.11		0.11	
ME22	32.99	4.92	18->28	2.68	22->32
ME31	0.14	0.13		0.13	
ME32	35.39	5.89	16->26	1.87	20->34
ME41	0.04	0.04		0.04	
ME42	3.40	1.69		1.69	
Total	100	21.56		9.3	

Threshold tuning

- Run 2 estimate:
 - Nominal 1.42kHz / Tight 0.63 kHz
- New proposal:
 - Nominal = 7 kHz ***0.21** = 1.47 kHz
 - Tight = 7 kHz ***0.093** = 0.63 kHz

Current anode thresholds

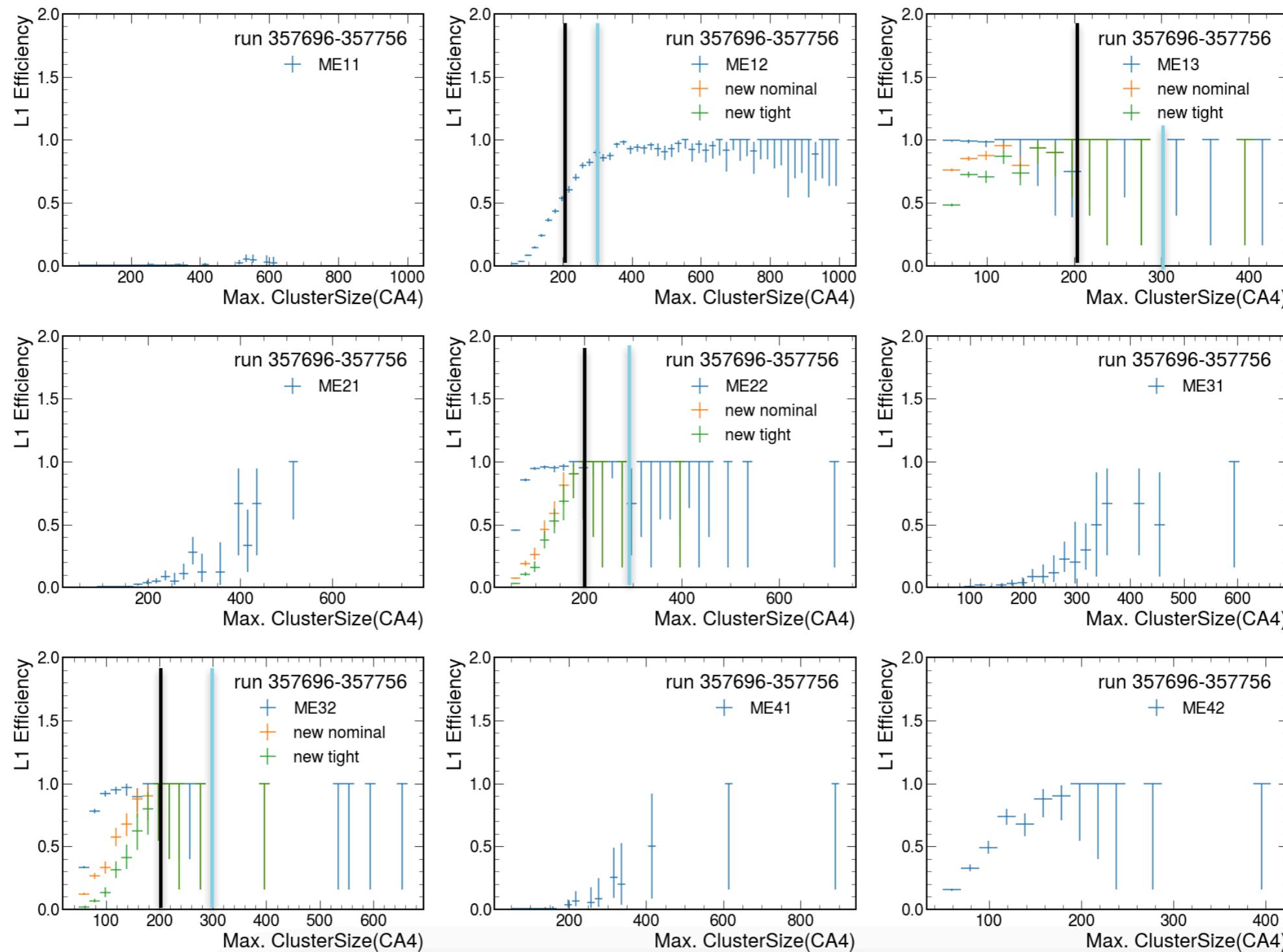
Station	11	12	13	21	22	31	32	41	42
nom	140	41	12	56	18	55	16	62	27
tight	140	45	16	58	22	57	20	64	31

Fraction of rate	Nominal			Tight	
	nominal [%]	Fraction[%]	Thres. chg	Fraction[%]	Thres. chg
ME11	0.00	0.00		0.00	
ME12	7.12	0.03	41->140	0.03	45->140
ME13	20.64	8.75	12->14	2.70	16->18
ME21	0.12	0.11		0.11	
ME22	32.99	4.92	18->28	2.68	22->32
ME31	0.14	0.13		0.13	
ME32	35.39	5.89	16->26	1.87	20->34
ME41	0.04	0.04		0.04	
ME42	3.40	1.69		1.69	
Total	100	21.56		9.3	

— HLT loose thres.
— HLT Medium thres.

L1 efficiency at new thresholds

- L1 should be fully efficient at HLT thresholds, even with higher thresholds



Summary

- Understood the origin of high-rate from HMT
 - Run 2 estimation included dead time when counting anode hits
- Propose raising the anode thresholds for ME12/13/22/32

<i>Station</i>	<i>Loose</i>	<i>Nominal</i>	<i>Tight</i>
<i>ME12</i>	140	140	140
<i>ME13</i>	14	14	18
<i>ME22</i>	28	28	32
<i>ME32</i>	26	26	34

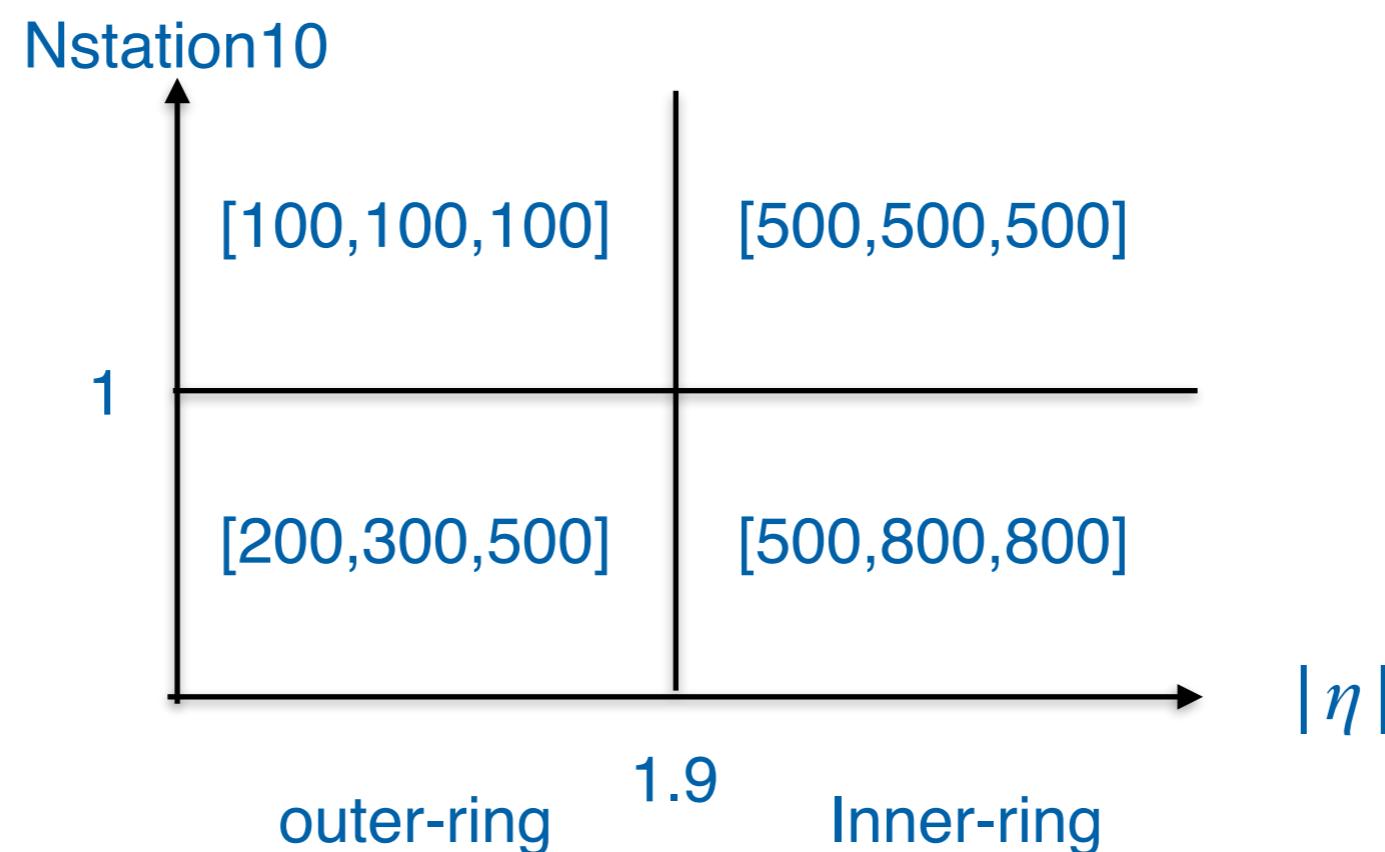
- Expect to give same rate as original proposal
 - Remains fully efficient for HLT selection
- Next step: Raise the thresholds to confirm rate reduction of 5x and 10x
- Then: Remove pre-scale at L1/HLT
- Find LLP in run 3!

Back up

HLT cuts

- HLT size thresholds depends on eta/Nstation10
 - Outer ring > 200, Inner-ring > 500
- New thresholds should still be fully efficient at HLT
 - Previous plot shows Nstation10==1

[Loose/Medium/Tight] thresholds on cluster Size at HLT



HMT Threshold proposal Aug23

- Raise to Run 2 PU thresholds
- Note1:
CLCT loose should be always set to CLCT nominal (until peakCheck has been enabled in FW)
- Note2:
HMT above loose threshold is valid, and CSC chamber will be read out.
Loose thresholds should be set to same as nominal to avoid high readout rate in Run 3
- As a result,
both anode & cathode HMT's loose thresholds should be set to the same as nominal

Run 2 thresholds
Run 3 thresholds

	ME11	ME12	ME13	ME21	ME22	ME31	ME32	ME41	ME42
Anode loose	140	140	14	56	28	55	26	62	27
Anode Nom	140	140	14	56	28	55	26	62	27
Anode Tight	140	140	18	58	32	57	34	64	31
Cathode Loose	100	N/A	N/A	33	N/A	31	N/A	34	N/A
Cathode Nom	100	N/A	N/A	33	N/A	31	N/A	34	N/A
Cathode Tight	100	N/A	N/A	35	N/A	33	N/A	36	N/A



HMT Timing

- HMT is timed in to nominal BX
 - BX=5 in data
- Emulator has good agreement with data

