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An abstract is a brief summary of a research article, thesis, review, conference proceeding or any in-depth analysis of a particular subject or discipline, and is often used to help.

Contents

1 Analysis Summary

1.1 Encoding Summary

Table 1: Encoding Combination Used

Combination No.	Seq Name	Codec Name	Config Name	QP
1	['RaceHorses_416x240_30']	hm	encoder_lowdelay_main	22
2	['RaceHorses_416x240_30']	hm	encoder_lowdelay_main	27
3	['RaceHorses_416x240_30']	hm	encoder_lowdelay_main	32
4	['RaceHorses_416x240_30']	hm	encoder_lowdelay_main	37

Table 2: Encoding Results

Combination No.	Bitrate	Y-PSNR	CPU Time	Enc_FPS/FR
1	3428.7600	41.0101	3.290s	0.02
2	2044.8000	36.8827	2.130s	0.031
3	1188.9600	33.2687	2.220s	0.03
4	627.9600	30.0505	1.360s	0.049

1.2 Decoding Summary

Table 3: Decoding Combination Used

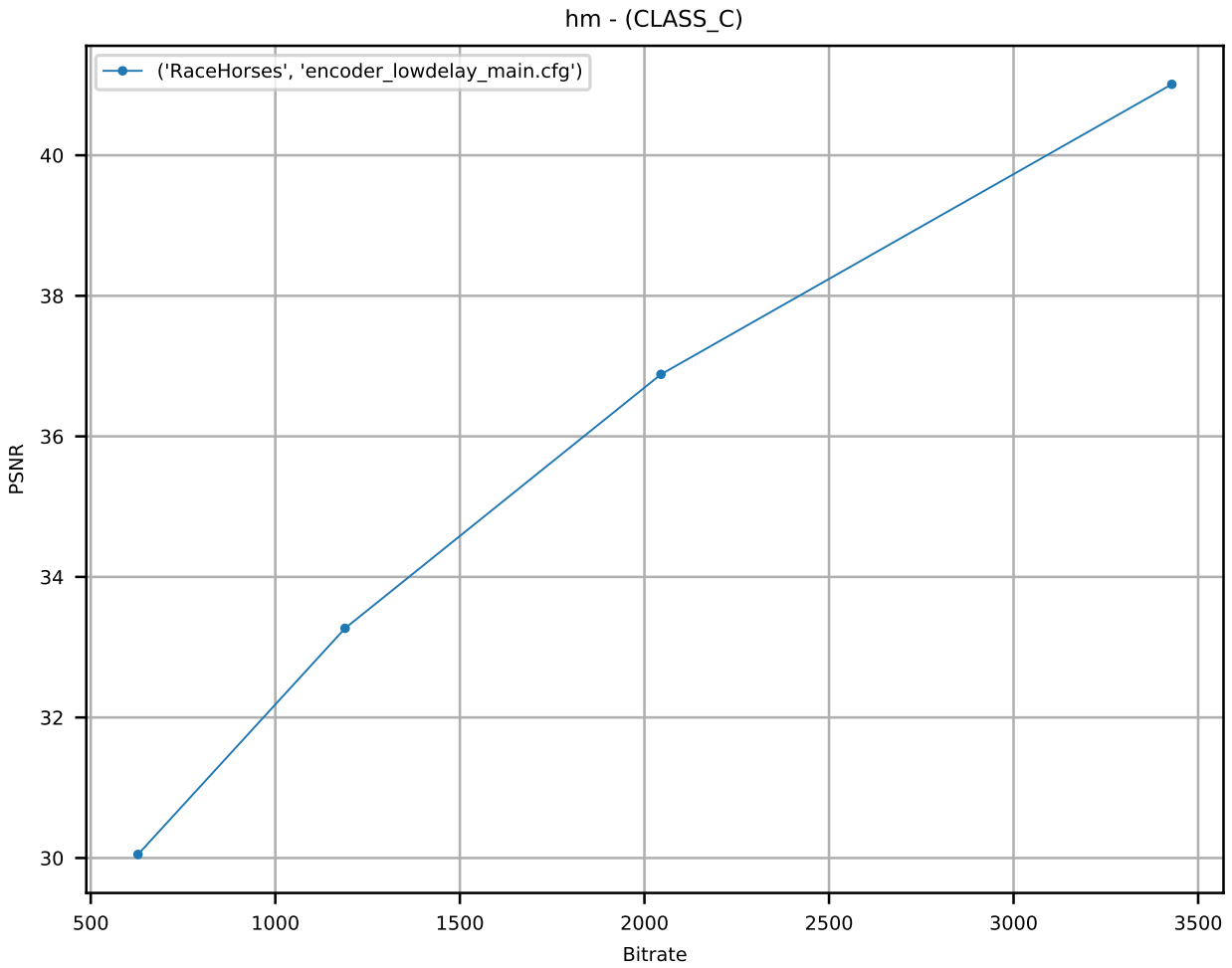
Combination No.	**Seq**	**Codec**	**Cfg**
1	RaceHorses_416x240_30_QP_22	hm	encoder_lowdelay_main.cfg
2	RaceHorses_416x240_30_QP_27	hm	encoder_lowdelay_main.cfg
3	RaceHorses_416x240_30_QP_32	hm	encoder_lowdelay_main.cfg
4	RaceHorses_416x240_30_QP_37	hm	encoder_lowdelay_main.cfg

Table 4: Decoding Results

Combination No.	**Bitrate (kbps)**	**CPU Time**	**Average Power (mW)**	**Total Energy (mJ)**
1	3428.7600	0.020s	5363.03	193.12
2	2044.8000	0.040s	10953.05	197.57
3	1188.9600	0.030s	6924.34	174.5
4	627.9600	0.030s	5250.44	111.76

2 Complexity Analysis - (Codec Name: HM)

2.1 HM ENCODER's Complexity



2.1.1 Config Name: encoder_lowdelay_main.cfg, Class Name: CLASS_C

Table 5: Hotpots By Class (RaceHorses, QP =22)

Class	**CPU Time (%)**
xRateDistOptQuant	27.599
codeCoeffNxN	8.693
getSigCtxInc	4.621
encodeBin	2.675
xEstimateInterResidualQT	2.432
estBit	2.067
xPredIntraAng	2.067
filter<(int)8, (bool)0, (bool)1, (bool)0>	1.824
xIntraCodingTUBlock	1.824
xCalcHADs4x4	1.58
xGetSAD8	1.216
filter<(int)8, (bool)1, (bool)0, (bool)1>	1.216
xGetExpGolombNumberOfBits	1.216
resetBits	1.094
xGetSSE32	0.973
estIntraPredLumaQT	0.973
xGetSSE8	0.973
xWriteCoefRemainExGolomb	0.972
getIntraDirPredictor	0.73
estSignificantMapBit	0.73

Table 6: Hotspots By Function
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C
(RaceHorses, QP =22)

Function	**CPU Time**
TComTrQuant::xRateDistOptQuant	0.908015
TEncSbac::codeCoeffNxN	0.285994
TComTrQuant::getSigCtxInc	0.152019
___memmove_avx_unaligned_erms	0.107963
___memset_avx2_unaligned_erms	0.104025
TEncBinCABACCounter::encodeBin	0.087996
TEncSearch::xEstimateInterResidualQT	0.080001
TEncSbac::estBit	0.068002
TComPrediction::xPredIntraAng	0.067992
TComInterpolationFilter::filter<(int)8, (bool)0, (bool)1, (bool)0>	0.060003
TEncSearch::xIntraCodingTUBlock	0.059998
TComRdCost::xCalcHADs4x4	0.051996
_Z15simd8x8HAD1D32bPDv2_xS0_	0.047994
simdHADs8x8	0.043996
TComRdCost::xGetSAD8	0.040011
TComInterpolationFilter::filter<(int)8, (bool)1, (bool)0, (bool)1>	0.039999
TComRdCost::xGetExpGolombNumberOfBits	0.039999
TComRdCost::xGetSSE32	0.032021
TEncSearch::estIntraPredLumaQT	0.032000
TComRdCost::xGetSSE8	0.031996

Table 7: Memory Consumption
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C
(RaceHorses, QP =22)

Function	**Allocation/Deallocation Delta**
func@0x8f3f0	72704.000000
main	4096.000000
__libc_csu_init	1040.000000
__static_initialization_and_destruction_0.constprop.69	1040.000000
EnvVar::EnvVar	690.000000
__register_frame	480.000000
_GLOBAL__sub_I__ZN3SEI19prefix_sei_messagesE	212.000000
indentNewLines	210.000000
TAppEncCfg::parseCfg	0.0
TAppEncCfg::xCheckParameter	0.0
TAppEncTop::encode	0.0
TAppEncTop::xGetBuffer	0.0
TComCUMvField::create	0.0
TComDataCU::create	0.0
TComLoopFilter::create	0.0
TComOutputBitstream::addSubstream	0.0
TComOutputBitstream::write	0.0
TComPic::create	0.0
TComPic::prepareForReconstruction	0.0
TComPicSym::TComPicSym	0.0

Table 8: Performance Snapshot
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**IPC**	**Effective Logical Core Utilization**	**Effective Physical Core Utilization**	**Microarchitecture Usage**	**GPU Active Time**
RaceHorses QP = qp	2.141s	2.183	14.4% (1.150 out of 8)	27.6% (1.105 out of 4)	56.5% of Pipeline Slots	1.2%
RaceHorses QP = qp	1.933s	2.128	14.1% (1.132 out of 8)	27.8% (1.113 out of 4)	55.1% of Pipeline Slots	1.3%
RaceHorses QP = qp	1.413s	2.253	14.6% (1.171 out of 8)	28.7% (1.147 out of 4)	59.9% of Pipeline Slots	0.6%
RaceHorses QP = qp	2.854s	2.004	13.9% (1.109 out of 8)	26.6% (1.064 out of 4)	53.9% of Pipeline Slots	1.2%

Table 9: Instruction Mix
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**SP FLOPs**	**DP FLOPs**	**x87 FLOPs**	**Non-FP**	**FP Arith/Mem Rd Instr. Ratio**	**FP Arith/Mem Wr Instr. Ratio**
RaceHorses QP = qp	2.141s	0.0% of uOps	1.2% of uOps	0.1% of uOps	98.8% of uOps	0.044	0.100
RaceHorses QP = qp	1.933s	0.0% of uOps	1.2% of uOps	0.1% of uOps	98.8% of uOps	0.045	0.100
RaceHorses QP = qp	1.413s	0.0% of uOps	1.1% of uOps	0.1% of uOps	98.8% of uOps	0.042	0.095
RaceHorses QP = qp	2.854s	0.0% of uOps	1.2% of uOps	0.1% of uOps	98.7% of uOps	0.046	0.107

Table 10: GPU Usage
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**GPU Utilization when Busy**	**Active**	**Stalled**	**Idle**	**Occupancy**
RaceHorses QP = qp	2.141s	17.4%	17.4%	32.7%	49.9%	30.5% of peak value
RaceHorses QP = qp	1.933s	22.1%	22.1%	33.9%	44.0%	36.2% of peak value
RaceHorses QP = qp	1.413s	7.4%	7.4%	33.5%	59.1%	21.3% of peak value
RaceHorses QP = qp	2.854s	16.8%	16.8%	30.2%	53.0%	28.8% of peak value

Table 11: Memory Access Analysis
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**CPU Time**	**L1 Bound**	**L2 Bound**	**L3 Bound**	**DRAM Bound**	**Store Bound**	**LLC Miss Count**	**Average Latency (cycles)**
RaceHorses QP = qp	1.500s	5.5% of Clockticks	0.5% of Clockticks	0.5% of Clockticks	0.0% of Clockticks	1.4% of Clockticks	0	9
RaceHorses QP = qp	3.013s	5.9% of Clockticks	0.3% of Clockticks	0.7% of Clockticks	0.0% of Clockticks	1.0% of Clockticks	0	9
RaceHorses QP = qp	1.208s	4.5% of Clockticks	0.6% of Clockticks	0.6% of Clockticks	0.0% of Clockticks	1.7% of Clockticks	0	10
RaceHorses QP = qp	3.044s	6.4% of Clockticks	0.3% of Clockticks	0.5% of Clockticks	0.0% of Clockticks	0.8% of Clockticks	0	8

Table 12: Micro Architecture Exploration
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**Clockticks**	**Instructions Retired**	**CPI Rate**	**Bad Speculation**	**Branch Mispredict**	**Vector Capacity Usage (FPU)**
RaceHorses QP = qp	2.593s	5,338,800,000	12,364,200,000	0.432	9.1% of Pipeline Slots	9.1% of Pipeline Slots	25.0%
RaceHorses QP = qp	2.984s	6,807,600,000	15,359,400,000	0.443	12.5% of Pipeline Slots	12.5% of Pipeline Slots	25.0%
RaceHorses QP = qp	1.277s	4,273,200,000	10,402,200,000	0.411	7.6% of Pipeline Slots	7.6% of Pipeline Slots	25.0%
RaceHorses QP = qp	3.685s	9,318,600,000	20,179,800,000	0.462	14.1% of Pipeline Slots	14.1% of Pipeline Slots	25.0%

Table 13: Front-End Bound Analysis
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**Front-End Bound**	**Front-End Latency**	**ICache Misses**	**ITLB Overhead**	**Branch Resteers**	**Front-End Bandwidth**
RaceHorses QP = qp	2.593s	19.0% of Pipeline Slots	7.1% of Pipeline Slots	2.0% of Clockticks	0.3% of Clockticks	3.9% of Clockticks	11.9% of Pipeline Slots
RaceHorses QP = qp	2.984s	19.2% of Pipeline Slots	8.1% of Pipeline Slots	1.6% of Clockticks	0.2% of Clockticks	4.7% of Clockticks	11.1% of Pipeline Slots
RaceHorses QP = qp	1.277s	18.3% of Pipeline Slots	6.3% of Pipeline Slots	2.5% of Clockticks	0.3% of Clockticks	3.1% of Clockticks	12.0% of Pipeline Slots
RaceHorses QP = qp	3.685s	19.4% of Pipeline Slots	8.1% of Pipeline Slots	1.7% of Clockticks	0.4% of Clockticks	5.7% of Clockticks	11.3% of Pipeline Slots

Table 14: Back-End Bound Analysis
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**Back-End Bound**	**L1 Bound**	**L2 Bound**	**L3 Bound**	**DRAM Bound**	**Store Bound**	**Store Latency**
RaceHorses QP = qp	2.593s	9.5% of Pipeline Slots	5.1% of Clockticks	1.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	1.0% of Clockticks	10.3% of Clockticks
RaceHorses QP = qp	2.984s	8.2% of Pipeline Slots	6.3% of Clockticks	0.8% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0.8% of Clockticks	8.1% of Clockticks
RaceHorses QP = qp	1.277s	11.9% of Pipeline Slots	5.1% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	1.3% of Clockticks	10.5% of Clockticks
RaceHorses QP = qp	3.685s	11.6% of Pipeline Slots	6.4% of Clockticks	0.6% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0.6% of Clockticks	7.0% of Clockticks

2.2 HM DECODER's Complexity

2.2.1 Config Name: encoder_lowdelay_main.cfg, Class Name: CLASS_C

Table 15: Hotpots By Class (RaceHorses, QP =hm)

Class	**CPU Time (%)**
istream	369.815
decodeBinEP	100.01
decodeBin	50.115
parseQtCbf	50.0
xPredInterUni	40.005

Table 16: Hotspots By Function
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C
(RaceHorses, QP =hm)

Function	**CPU Time**
std::istream::get	0.021999
TComPrediction::xPredInterUni	0.008001
Function	CPU Time
std::istream::get	0.019977
TDecBinCABAC::decodeBin	0.010023
TDecBinCABAC::decodeBinEP	0.010000
Function	CPU Time
std::istream::get	0.011987
TDecBinCABAC::decodeBinEP	0.010002
TDecSbac::parseQtCbf	0.010000
func@0x11350	0.008012
Function	CPU Time
std::istream::get	0.020000

Table 17: Memory Consumption
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C
(RaceHorses, QP =hm)

Function	**Allocation/Deallocation Delta**
byteStreamNALUnit	350840.000000
func@0x8f3f0	72704.000000
main	4096.000000
___libc_csu_init	1040.000000
___register_frame	480.000000
_GLOBAL___sub_I___ZN3SEI19prefix_sei_messagesE	212.000000
TAppDecCfg::parseCfg	0.0
TAppDecTop::decode	0.0
TComCUMvField::create	0.0
TComDataCU::create	0.0
TComInputBitstream::extractSubstream	0.0
TComLoopFilter::create	0.0
TComPic::create	0.0
TComPicSym::TComPicSym	0.0
TComPicSym::allocateNewSlice	0.0
TComPicSym::create	0.0
TComPicSym::prepareForReconstruction	0.0
TComPicSym::xInitTiles	0.0
TComPicYuv::create	0.0
TComPicYuv::createWithoutCUInfo	0.0

Table 18: Performance Snapshot
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**IPC**	**Effective Logical Core Utilization**	**Effective Physical Core Utilization**	**Microarchitecture Usage**	**GPU Active Time**
RaceHorses QP = 32	0.048s	1.764	51.5% (4.119 out of 8)	93.3% (3.733 out of 4)	7.5% of Pipeline Slots	4.9%
RaceHorses QP = 37	0.044s	1.779	43.6% (3.487 out of 8)	76.1% (3.042 out of 4)	8.1% of Pipeline Slots	47.2%
RaceHorses QP = 22	0.078s	0.335	73.0% (5.838 out of 8)	100.0% (4.000 out of 4)	13.2% of Pipeline Slots	18.2%
RaceHorses QP = 27	0.053s	1.781	31.1% (2.488 out of 8)	59.1% (2.363 out of 4)	8.2% of Pipeline Slots	4.4%

Table 19: Instruction Mix
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**SP FLOPs**	**DP FLOPs**	**x87 FLOPs**	**Non-FP**	**FP Arith/Mem Rd Instr. Ratio**	**FP Arith/Mem Wr Instr. Ratio**
RaceHorses QP = 32	0.048s	0.2% of uOps	0.5% of uOps	0.1% of uOps	99.3% of uOps	0.005	0.014
RaceHorses QP = 37	0.044s	0.2% of uOps	0.5% of uOps	0.1% of uOps	99.2% of uOps	0.011	0.031
RaceHorses QP = 22	0.078s	0.1% of uOps	0.1% of uOps	0.0% of uOps	99.8% of uOps	0.007	0.015
RaceHorses QP = 27	0.053s	0.2% of uOps	0.5% of uOps	0.1% of uOps	99.1% of uOps	0.004	0.011

Table 20: GPU Usage
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**GPU Utilization when Busy**	**Active**	**Stalled**	**Idle**	**Occupancy**
RaceHorses QP = 32	0.048s	39.5%	39.5%	23.9%	36.6%	47.6% of peak value
RaceHorses QP = 37	0.044s	25.5%	25.5%	12.6%	61.9%	30.4% of peak value
RaceHorses QP = 22	0.078s	35.4%	35.4%	15.0%	49.6%	41.9% of peak value
RaceHorses QP = 27	0.053s	39.8%	39.8%	24.1%	36.2%	47.9% of peak value

Table 21: Memory Access Analysis
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**CPU Time**	**L1 Bound**	**L2 Bound**	**L3 Bound**	**DRAM Bound**	**Store Bound**	**LLC Miss Count**	**Average Latency (cycles)**
RaceHorses QP = 32	0.038s	4.6% of Clockticks	4.6% of Clockticks	4.6% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0	10
RaceHorses QP = 37	0.036s	5.8% of Clockticks	0.0% of Clockticks	5.8% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0	7
RaceHorses QP = 22	0.027s	6.2% of Clockticks	3.1% of Clockticks	0.0% of Clockticks	3.1% of Clockticks	0.0% of Clockticks	0	8
RaceHorses QP = 27	0.044s	8.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	4.0% of Clockticks	0.0% of Clockticks	0	8

Table 22: Micro Architecture Exploration
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**Clockticks**	**Instructions Retired**	**CPI Rate**	**Bad Speculation**	**Branch Mispredict**	**Vector Capacity Usage (FPU)**
RaceHorses QP = 32	0.046s	49,140,000	76,500,000	0.642	8.2% of Pipeline Slots	0.0% of Pipeline Slots	0.0%
RaceHorses QP = 37	0.045s	44,280,000	64,440,000	0.687	7.0% of Pipeline Slots	0.0% of Pipeline Slots	0.0%
RaceHorses QP = 22	0.060s	70,020,000	112,320,000	0.623	11.6% of Pipeline Slots	0.0% of Pipeline Slots	0.0%
RaceHorses QP = 27	0.052s	62,280,000	93,780,000	0.664	11.6% of Pipeline Slots	0.0% of Pipeline Slots	0.0%

Table 23: Front-End Bound Analysis
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**Front-End Bound**	**Front-End Latency**	**ICache Misses**	**ITLB Overhead**	**Branch Resteers**	**Front-End Bandwidth**
RaceHorses QP = 32	0.046s	24.7% of Pipeline Slots	22.0% of Pipeline Slots	11.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	2.7% of Pipeline Slots
RaceHorses QP = 37	0.045s	27.9% of Pipeline Slots	13.9% of Pipeline Slots	0.0% of Clockticks	1.2% of Clockticks	12.2% of Clockticks	13.9% of Pipeline Slots
RaceHorses QP = 22	0.060s	19.3% of Pipeline Slots	7.7% of Pipeline Slots	7.7% of Clockticks	0.8% of Clockticks	7.7% of Clockticks	11.6% of Pipeline Slots
RaceHorses QP = 27	0.052s	28.9% of Pipeline Slots	23.1% of Pipeline Slots	0.0% of Clockticks	0.9% of Clockticks	0.0% of Clockticks	5.8% of Pipeline Slots

Table 24: Back-End Bound Analysis
Config Name: encoder_lowdelay_main.cfg,
Class Name: CLASS_C

Seq Name	**Elapsed Time**	**Back-End Bound**	**L1 Bound**	**L2 Bound**	**L3 Bound**	**DRAM Bound**	**Store Bound**	**Store Latency**
RaceHorses QP = 32	0.046s	20.3% of Pipeline Slots	0.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	11.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks
RaceHorses QP = 37	0.045s	9.4% of Pipeline Slots	24.4% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks
RaceHorses QP = 22	0.060s	26.7% of Pipeline Slots	7.7% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks	0.0% of Clockticks
RaceHorses QP = 27	0.052s	7.5% of Pipeline Slots	8.7% of Clockticks	0.0% of Clockticks	8.7% of Clockticks	8.7% of Clockticks	0.0% of Clockticks	8.7% of Clockticks