

Bubble Sort

Start regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x0  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x0  
r15 = 0x0  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

End regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x1  
r11 = 0x8  
r12 = 0x78  
r13 = 0x10110e1  
r14 = 0x7  
r15 = 0x1  
r16 = 0x9  
r17 = 0xc  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

Check Vowel

Start regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x0  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x0  
r15 = 0x0  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

End regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x1  
r11 = 0x0  
r12 = 0x63656843  
r13 = 0x776f566b  
r14 = 0x3  
r15 = 0x1  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

Fibonacci

Start regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x0  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x0  
r15 = 0x0  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

End regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x1  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x37  
r15 = 0x1  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

GCD

Start regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x0  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x0  
r15 = 0x0  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

End regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x1  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x4  
r15 = 0x1  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

SimpleAdd

Start regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x0  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x0  
r15 = 0x0  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

End regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x1  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x5  
r15 = 0x1  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

Simplelf

Start regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x0  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x0  
r15 = 0x0  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

End regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x1  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x7  
r15 = 0x1  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

SumArray

Start regfile dump

r0 = 0x0
r1 = 0x0
r2 = 0x1011111
r3 = 0x0
r4 = 0x0
r5 = 0x0
r6 = 0x0
r7 = 0x0
r8 = 0x0
r9 = 0x0
r10 = 0x0
r11 = 0x0
r12 = 0x0
r13 = 0x0
r14 = 0x0
r15 = 0x0
r16 = 0x0
r17 = 0x0
r18 = 0x0
r19 = 0x0
r20 = 0x0
r21 = 0x0
r22 = 0x0
r23 = 0x0
r24 = 0x0
r25 = 0x0
r26 = 0x0
r27 = 0x0
r28 = 0x0
r29 = 0x0
r30 = 0x0
r31 = 0x0

End regfile dump

r0 = 0x0
r1 = 0x0
r2 = 0x1011111
r3 = 0x0
r4 = 0x0
r5 = 0x0
r6 = 0x0
r7 = 0x0
r8 = 0x0
r9 = 0x0
r10 = 0x1
r11 = 0x0
r12 = 0x0
r13 = 0x0
r14 = 0x2d
r15 = 0x1
r16 = 0x0
r17 = 0x0
r18 = 0x0
r19 = 0x0
r20 = 0x0
r21 = 0x0
r22 = 0x0
r23 = 0x0
r24 = 0x0
r25 = 0x0
r26 = 0x0
r27 = 0x0
r28 = 0x0
r29 = 0x0
r30 = 0x0
r31 = 0x0

Swap

Start regfile dump

r0 = 0x0
r1 = 0x0
r2 = 0x1011111
r3 = 0x0
r4 = 0x0
r5 = 0x0
r6 = 0x0
r7 = 0x0
r8 = 0x0
r9 = 0x0
r10 = 0x0
r11 = 0x0
r12 = 0x0
r13 = 0x0
r14 = 0x0
r15 = 0x0
r16 = 0x0
r17 = 0x0
r18 = 0x0
r19 = 0x0
r20 = 0x0
r21 = 0x0
r22 = 0x0
r23 = 0x0
r24 = 0x0
r25 = 0x0
r26 = 0x0
r27 = 0x0
r28 = 0x0
r29 = 0x0
r30 = 0x0
r31 = 0x0

End regfile dump

r0 = 0x0
r1 = 0x0
r2 = 0x1011111
r3 = 0x0
r4 = 0x0
r5 = 0x0
r6 = 0x0
r7 = 0x0
r8 = 0x0
r9 = 0x0
r10 = 0x1
r11 = 0x10110f1
r12 = 0x0
r13 = 0x0
r14 = 0xe
r15 = 0x1
r16 = 0x0
r17 = 0x0
r18 = 0x0
r19 = 0x0
r20 = 0x0
r21 = 0x0
r22 = 0x0
r23 = 0x0
r24 = 0x0
r25 = 0x0
r26 = 0x0
r27 = 0x0
r28 = 0x0
r29 = 0x0
r30 = 0x0
r31 = 0x0

SwapShift

Start regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x0  
r11 = 0x0  
r12 = 0x0  
r13 = 0x0  
r14 = 0x0  
r15 = 0x0  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

End regfile dump

```
r0 = 0x0  
r1 = 0x0  
r2 = 0x1011111  
r3 = 0x0  
r4 = 0x0  
r5 = 0x0  
r6 = 0x0  
r7 = 0x0  
r8 = 0x0  
r9 = 0x0  
r10 = 0x1  
r11 = 0x10110f1  
r12 = 0x0  
r13 = 0x0  
r14 = 0x26  
r15 = 0x1  
r16 = 0x0  
r17 = 0x0  
r18 = 0x0  
r19 = 0x0  
r20 = 0x0  
r21 = 0x0  
r22 = 0x0  
r23 = 0x0  
r24 = 0x0  
r25 = 0x0  
r26 = 0x0  
r27 = 0x0  
r28 = 0x0  
r29 = 0x0  
r30 = 0x0  
r31 = 0x0
```

Paths and Stalls in action

Add.x (rs1 MX_bypass)

```

1000114: 800000b7 lui x1,0x80000
1000118: fff08093 addi x1,x1,-1 # 7fffffff
<begin_signature+0x7efffa5f>
100011c: fffff8137 lui x2,0xfffff8
1000120: 00208f33 add x30,x1,x2
1000124: 7fff8eb7 lui x29,0x7fff8

```



BubbleSort.x (Stalls BGE, load/use)

```
10001f0: 00e7d863 bge x15,x14,1000200 <test+0x5c> //
```

this is a good example of load use delay for branches

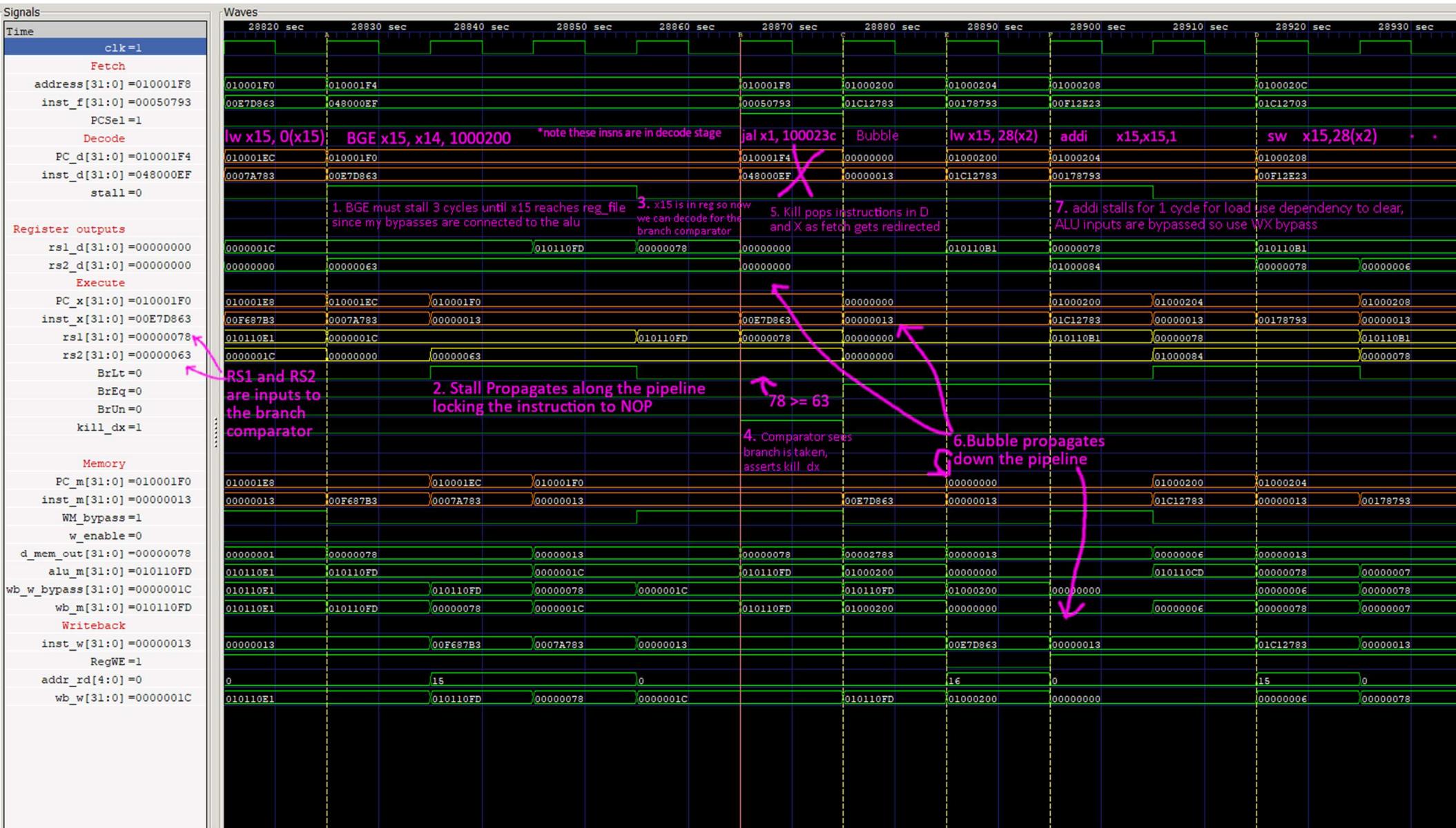
```
10001f4: 048000ef jal x1,100023c <fail>
```

```
10001f8: 00050793 addi x15,x10,0
```

```
10001fc: 0240006f jal x0,1000220 <test+0x7c>
```

```
1000200: 01c12783 lw x15,28(x2)
```

```
1000204: 00178793 addi x15,x15,1
```

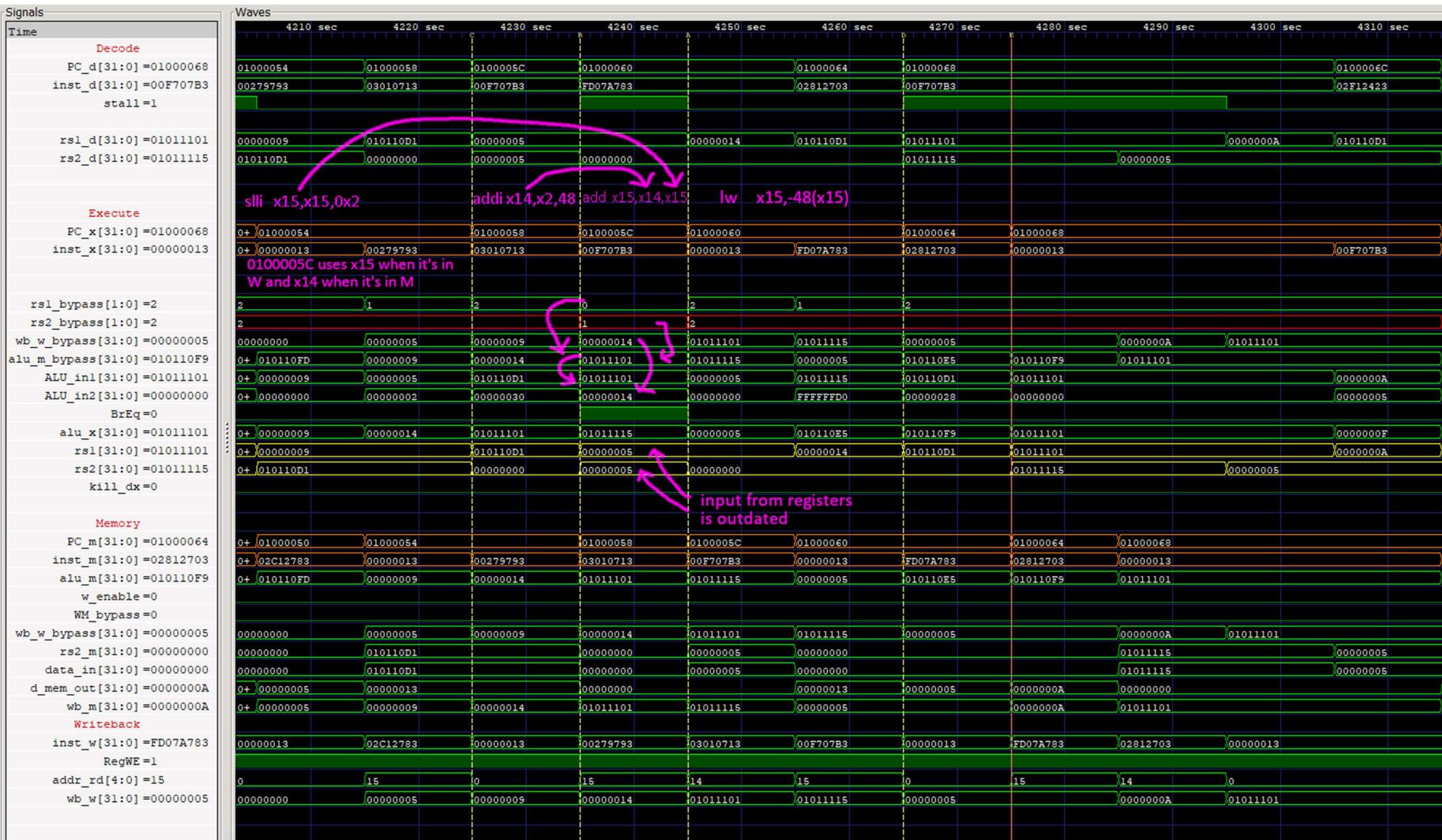


SumArray.x (rs1 MX_bypass & rs2 WX_bypass)

```

1000054: 00279793 slli x15,x15,0x2
1000058: 03010713 addi x14,x2,48
100005c: 00f707b3 add x15,x14,x15
1000060: fd07a783 lw x15,-48(x15)

```

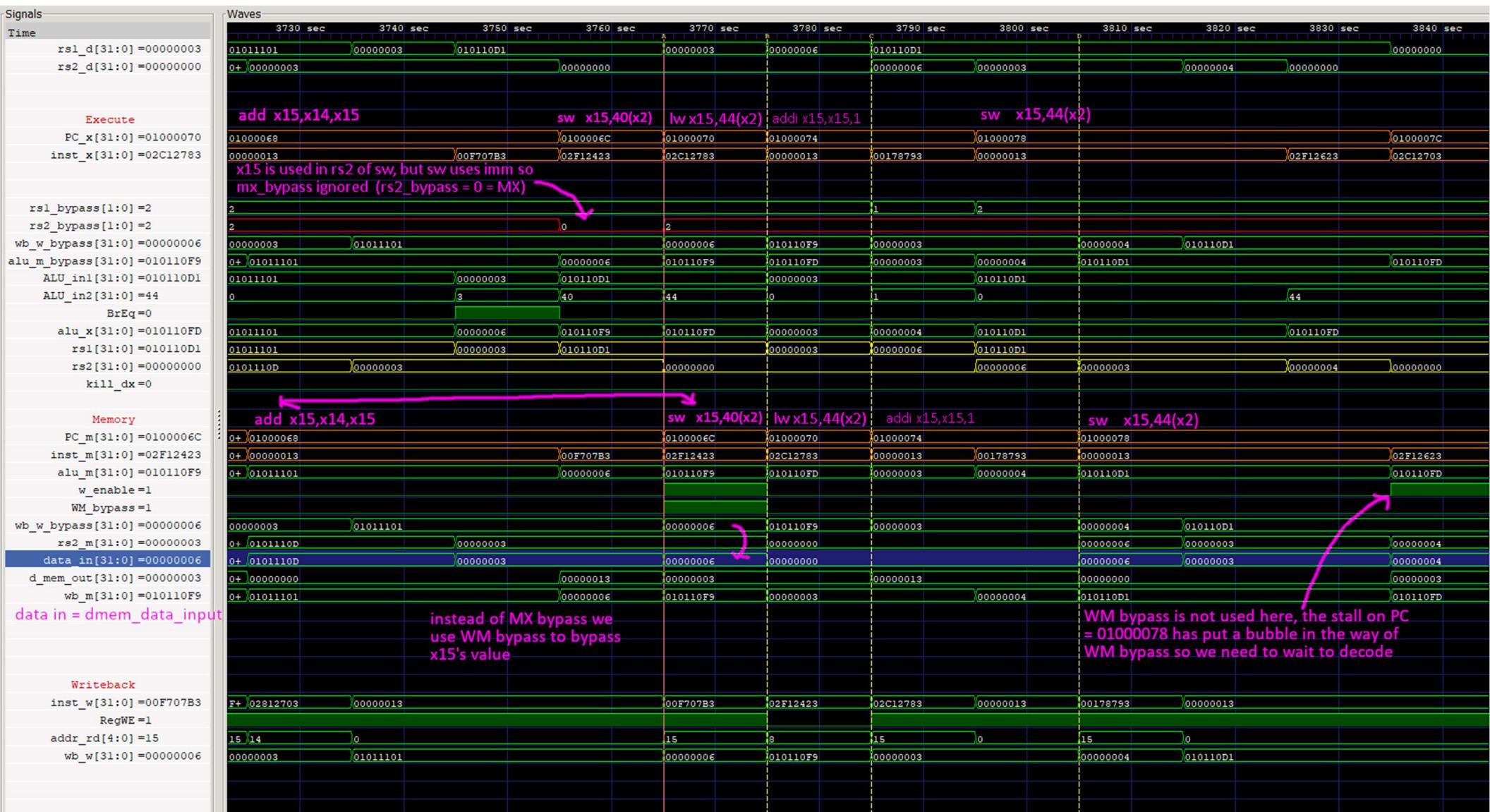


SumArray.x (WM Bypass)

```

1000068: 00f707b3 add x15,x14,x15
100006c: 02f12423 sw x15,40(x2)
1000070: 02c12783 lw x15,44(x2)
1000074: 00178793 addi x15,x15,1
1000078: 02f12623 sw x15,44(x2)

```



Sw.x (rs2 MX bypass)

```

1000454: 00000013 addi x0,x0,0
1000458: 122330b7 lui x1,0x12233
100045c: 00108093 addi x1,x1,1 # 12233001
1000460: 00112a23 sw x1,20(x2)

```



Swap.x (rs1 wx bypass)

```

100003c: 00f12223 sw x15,4(x2)
1000040: 00812783 lw x15,8(x2)
1000044: 0007a783 lw x15,0(x15)
1000048: 00f12023 sw x15,0(x2)
100004c: 00412703 lw x14,4(x2)

```

