Exceptions

Outline

- Exception Handling
- Precise and Imprecise exceptions
- Exceptions in OoO pipelines

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Events that request attention of the processor

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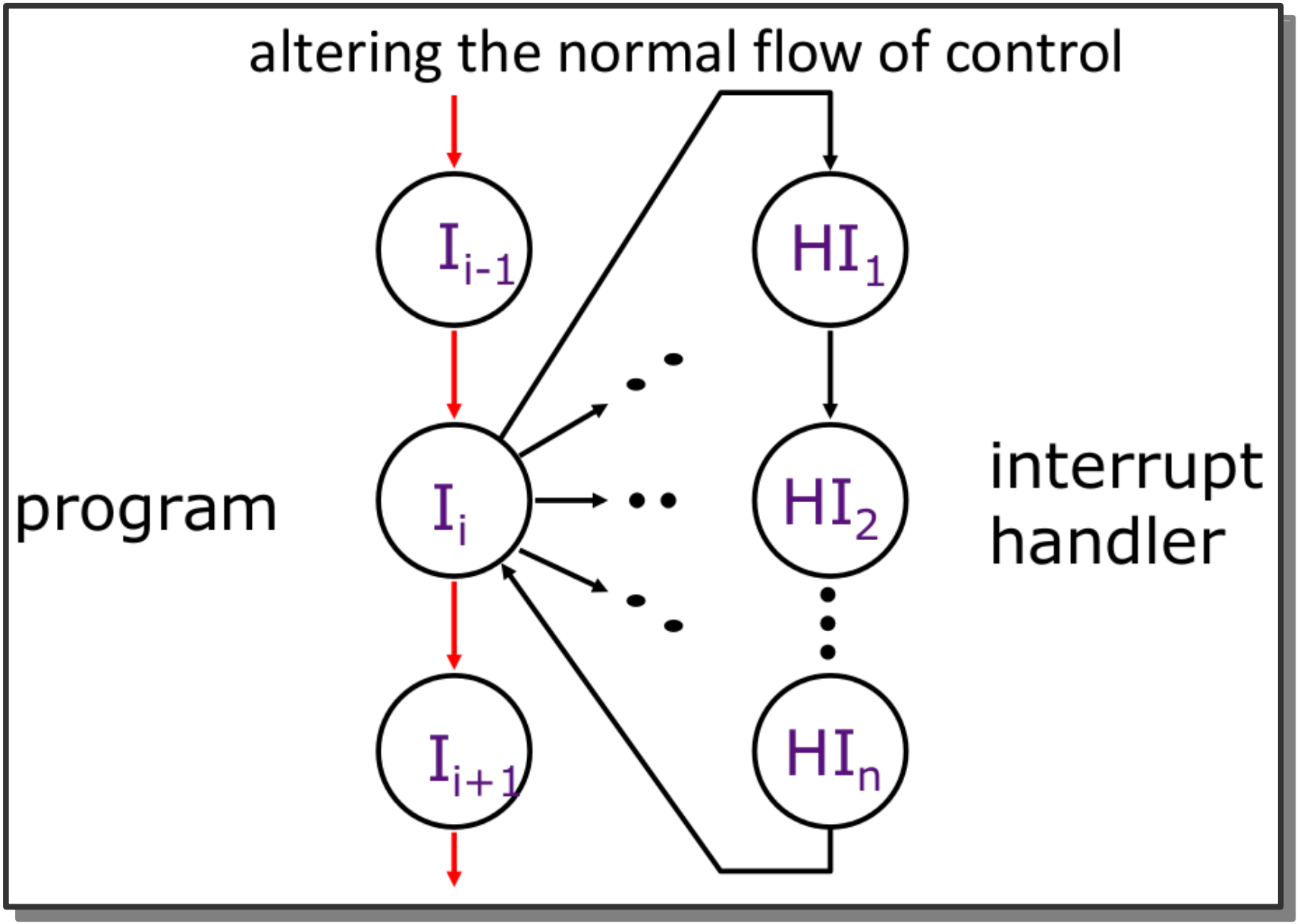
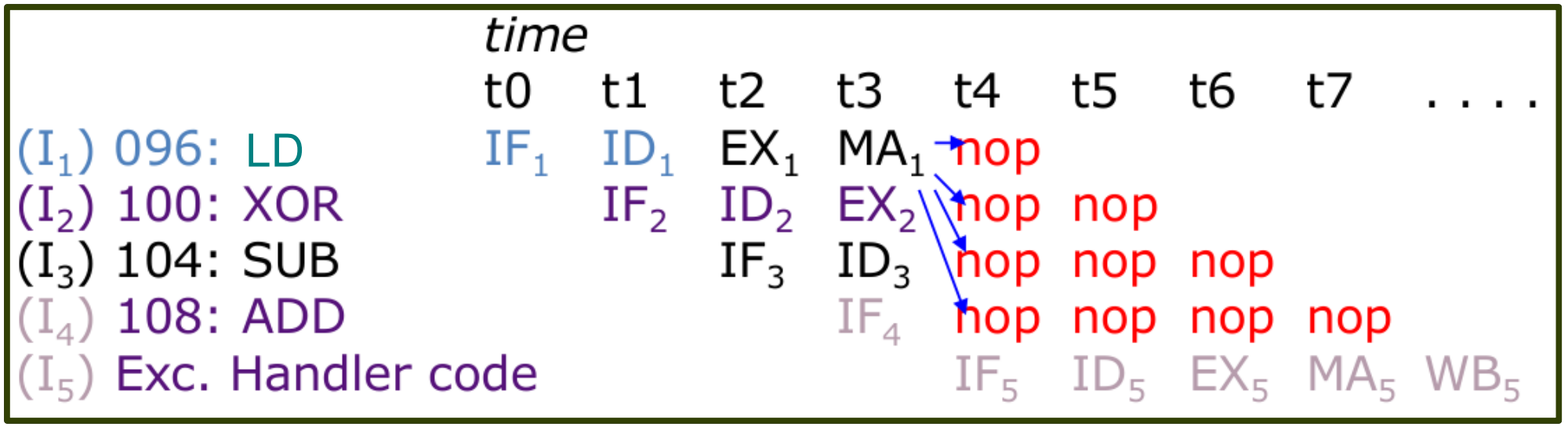
- I/O device request
- Invoking OS service from a user program
- Breakpoint (programmer-requested interrupt)
- Integer arithmetic overflow/FP arithmetic anomaly
- Page fault
- Undefined or unimplemented instruction
- Hardware malfunctions, Power failure

Events that request attention of the processor

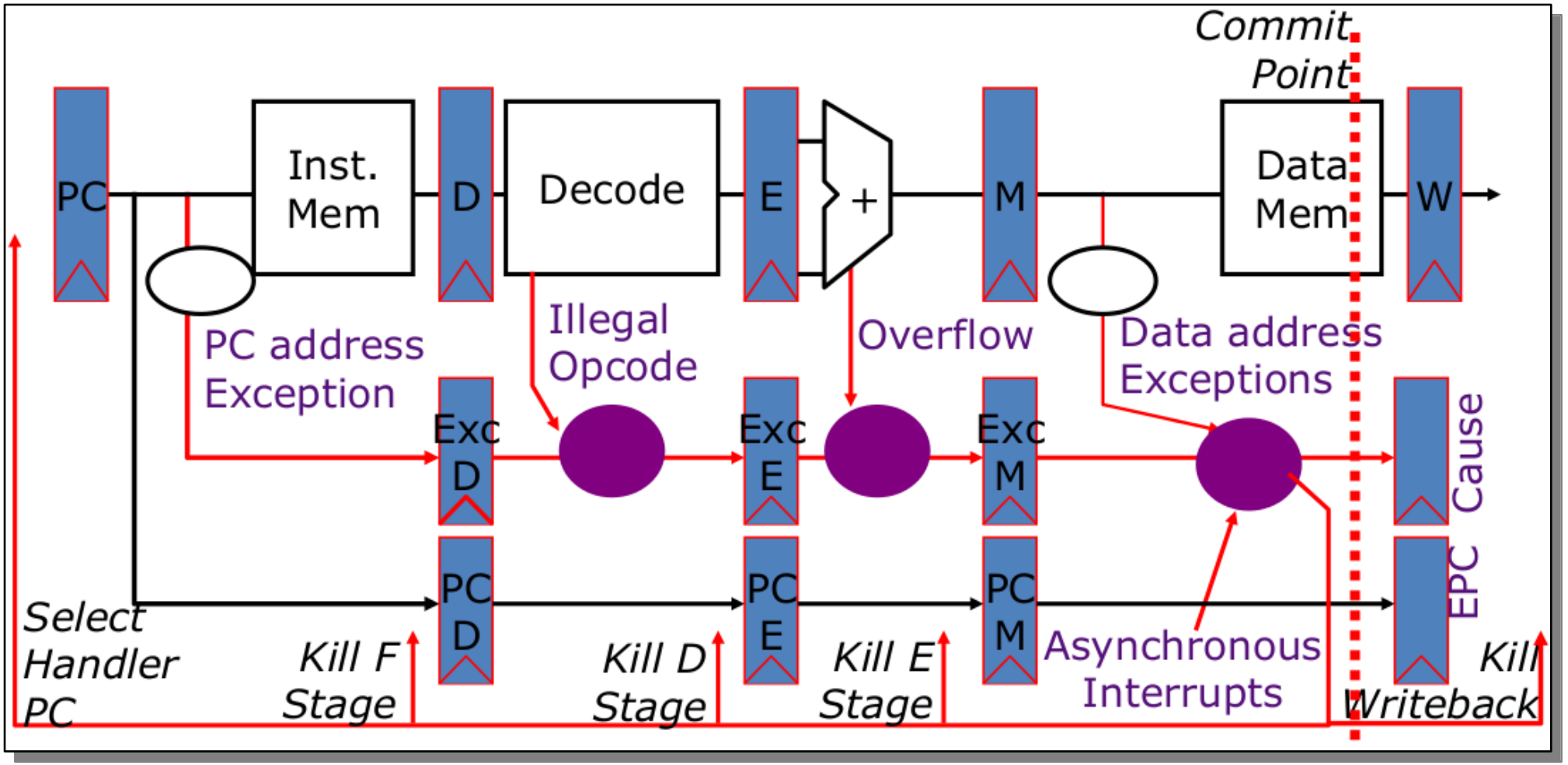
Exceptions


altering the normal flow of control
program
I_{i-1}
I_i
I_{i+1}
HI_1
HI_2
HI_n
interrupt handler

Precise Exception Handling



Precise Exceptions



- Instruction Status Vector: Check before *commit*

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- OS can terminate or may use EPC to restart program

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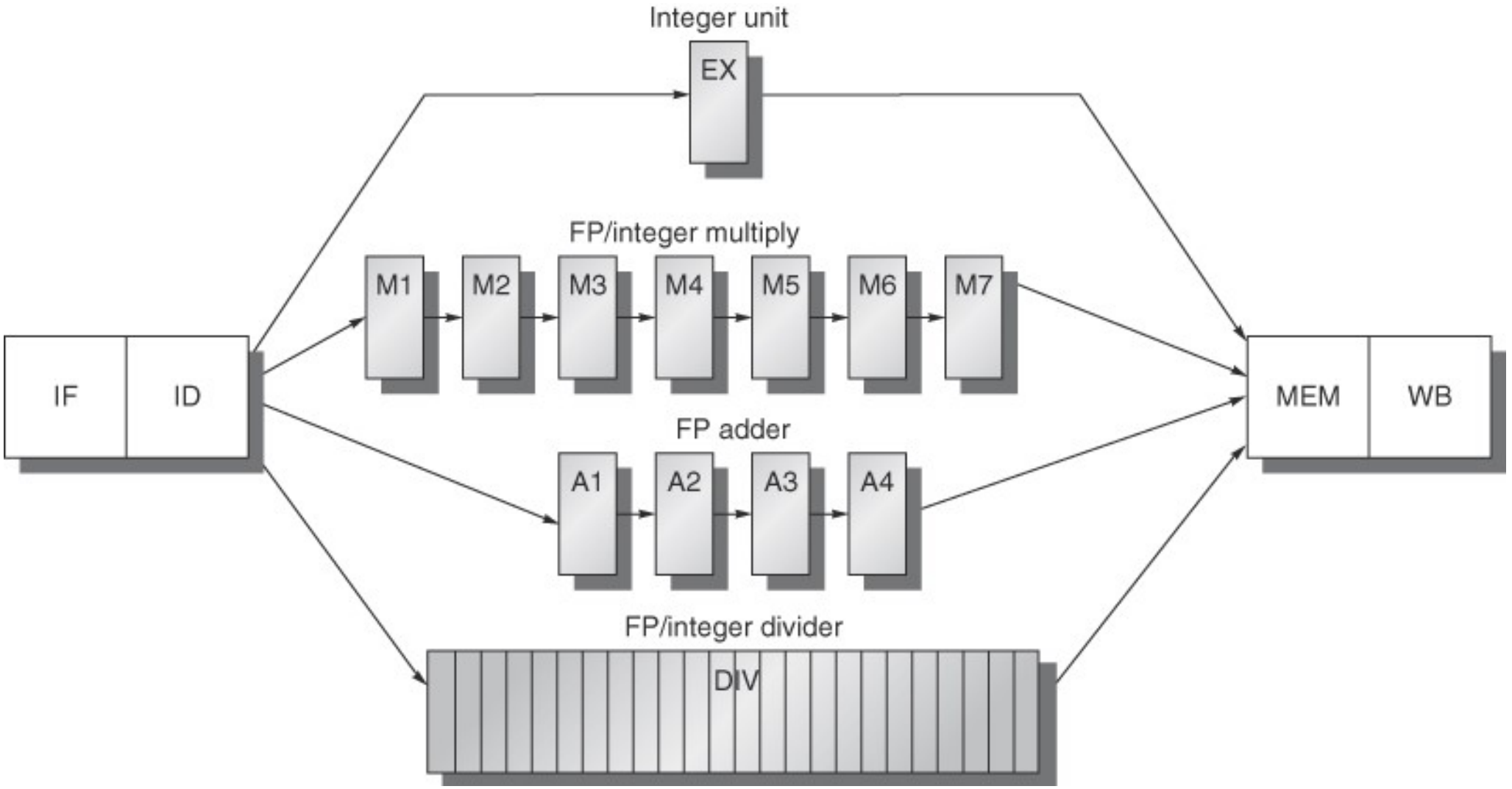
Multi-cycle Operations Pipeline



Precise Exceptions

DIV.D	**F0, F2, F4**
ADD.D	**F10, F10, F8**
SUB.D	**F12, F12, F14**

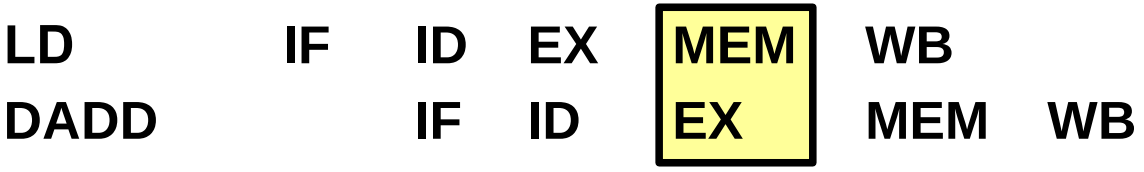
- Out of order completion
- Can't ignore exceptions
  - Virtual Memory, IEEE 754
- Fast mode vs. Slow mode with precise exceptions
- Store results of earlier operations in a buffer
  - History file, Future file.

Stopping and Restarting Execution

- Trap instruction, Turn off writes, Save PC, Save processor state, (Disable Exceptions), Exception handler, RFE
- Precise exceptions

Pipeline stage	**Problem exceptions occurring**
IF	Page fault on IF, misaligned memory access; memory protection violation
ID	Undefined or illegal opcode
EX	Arithmetic exception
MEM	Page fault on data fetch; misaligned memory access; memory protection violation
WB	None

Precise Exceptions



- Multiple exceptions in the same cycle
- Early exception by a later instruction
- Instruction Status Vector: Check before *commit*