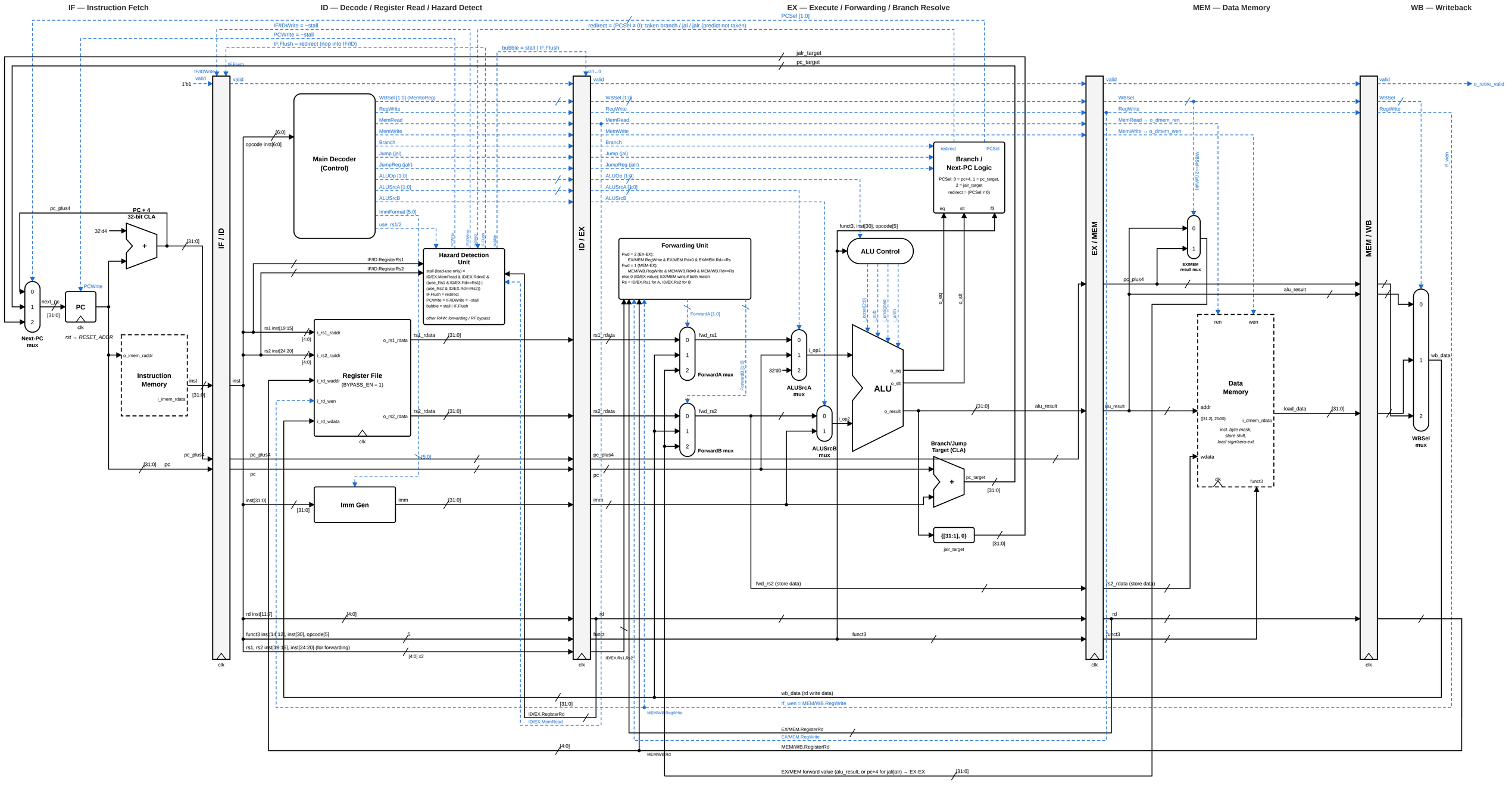


Black solid = datapath Blue dashed = control

Data hazards: EX-EX (from EX/MEM) and MEM-EX (from MEM/WB) forwarding via ForwardA/B muxes; producer in WB → RF bypass; load-use → 1-cycle stall (hold PC + IF/ID, bubble ID/EX).

Control hazards: predict not taken. Taken branch / jal / jalr resolved in EX → redirect: PC loads target, IF.Flush nops IF/ID, ID/EX bubbled (2-cycle penalty; 0 if not taken).

o_retire_* driven from MEM/WB (inst, pc, next_pc, rs1/rs2 addr + forwarded data, dmem access); not drawn. Widths labeled on first appearance; / marks multi-bit in later stages.