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Engineering advancements in x-ray pump–probe techniques using delayline technology at LCLS

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X-ray pump–probe techniques at XFELs have revolutionized ultrafast science by enabling precise control of X-ray pulse pairs with tunable delays. This talk highlights key engineering breakthroughs in LCLS behind two critical methods: magnetic chicane systems and split-and-delay optics. Magnetic chicane systems manipulate electron and photon beams to generate delays up to hundreds of femtoseconds, with LCLS upgrades extending tunable delays from 0 to 10 fs for attosecond-resolution studies. Split-and-delay optics use Laue crystals, diamond gratings, or mirrors to divide, delay, and recombine X-ray pulses, achieving delays from femtoseconds to sub-nanoseconds. We will explore the engineering challenges of designing, aligning, and stabilizing these systems, including high-precision mechanics, advanced control systems, and real-time diagnostics. Ongoing upgrades are enhancing performance and expanding opportunities in condensed matter physics, chemistry, and materials science, pushing the boundaries of ultrafast X-ray science.

Footnotes

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