

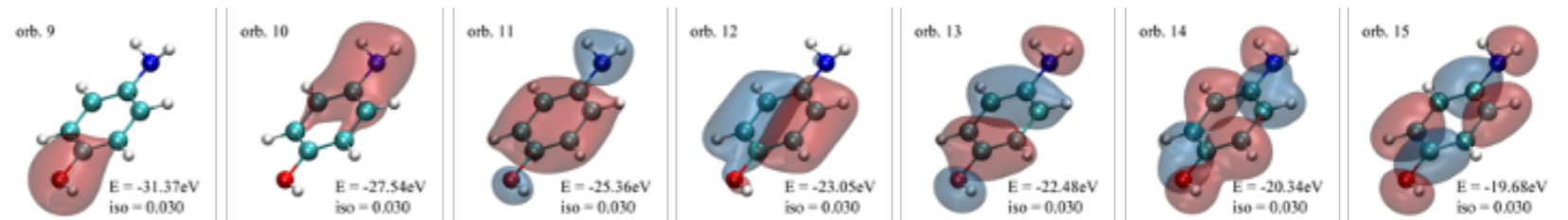
# What new physics are expected to be discovered and measured, and what is the advantage over laser driven relativistic flying mirrors?

## 1) ~100 as pulses

Impulsive excitation of valence electronic wave-packets in pump/probe experiments

Non-linear or Relativistic VUV optics

## 2) 10 as or less



Courtesy F. Martin

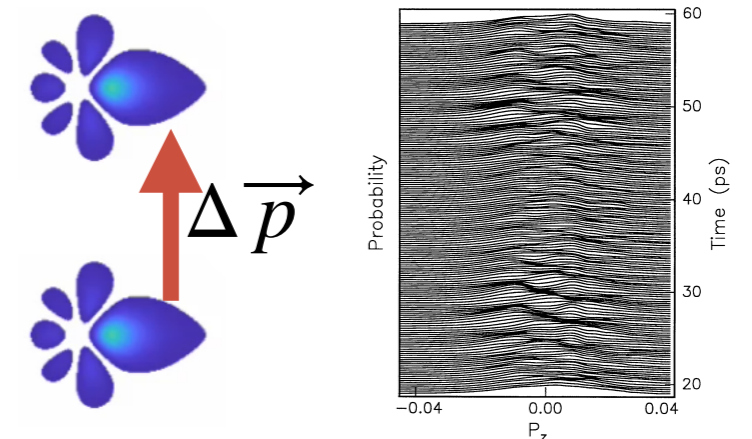
Impulsive ionization of valence states (direct probe of momentum-space electronic wavefunction)

Universal response to ionization

4-wave mixing experiments

## Advantage over ROM

- Intrinsic synchronization with e-beam (for VUV pump/X-ray probe application)
- No pedestal in driving field



Jones, R. R. "Creating and probing electronic wave packets using half-cycle pulses." *Physical review letters* 76.21 (1996): 3927.

**Q: Can this be combined with other TR proposal (D. Reis)?**

YES

Overlapping collaboration

Similar setup and sample environment

**Q: Coherence is sparsely discussed in the proposal. What experiments are foreseen to prove coherence and ability to manipulate the phase to achieve shortest pulses?**

In first experiment we will only prove bandwidth broadening.

In subsequent experiments we will perform streaking experiment to measure pulse duration. These provide info on longitudinal coherence since they reconstruct **time-energy distribution**.

Good transverse coherence can be proven by focusing the radiation to a small spot and observe non-linear phenomena OR with waist-scan measurements.

If setting up a photoelectron streaking measurement probably the first option would be the easiest.

To generate the shortest pulses the focus should be in increasing the e-beam field strength to drive electrons to even higher energies (therefore inducing stronger doppler shift)

Q: Will such source potentially make FELs obsolete?

**NO**

1) AMO community is a sizable fraction of FEL users but NOT a majority.  
Most users interested in narrow bandwidth pulses (e.g. structural biology)

2) In the specific case of SLAC, it is hard to imagine how this could ever scale to MHz repetition rate given that we blow up the radiator at every shot. So LCLS-II will not be obsolete. Smaller facilities with normal conducting technology would be more vulnerable.

**HOWEVER**

**FEL** facilities are Swiss-army knives. If successfully demonstrated in VUV and extended to soft X-rays this would be a very powerful addition to the LCLS-X science program (and of other facilities).