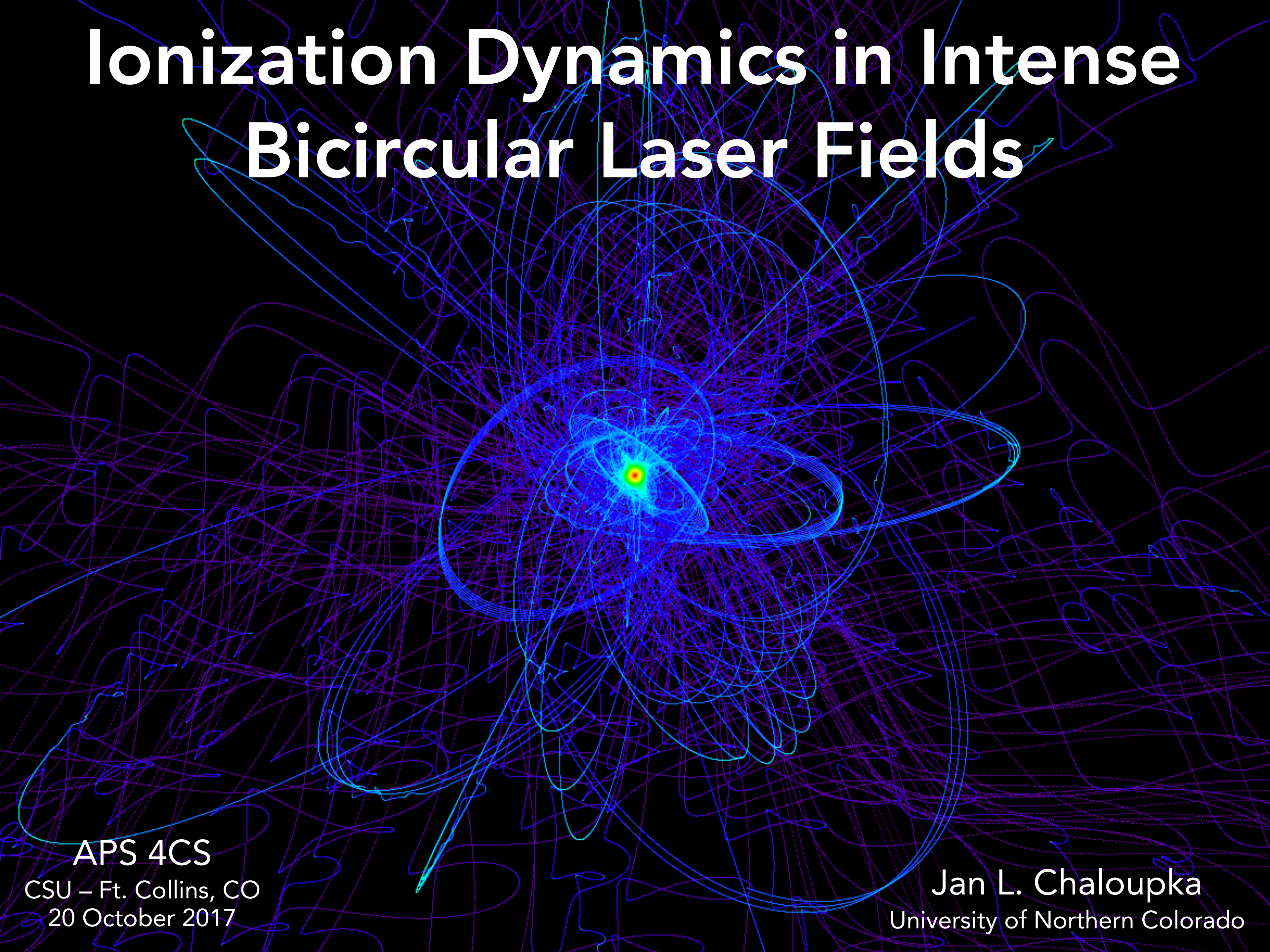
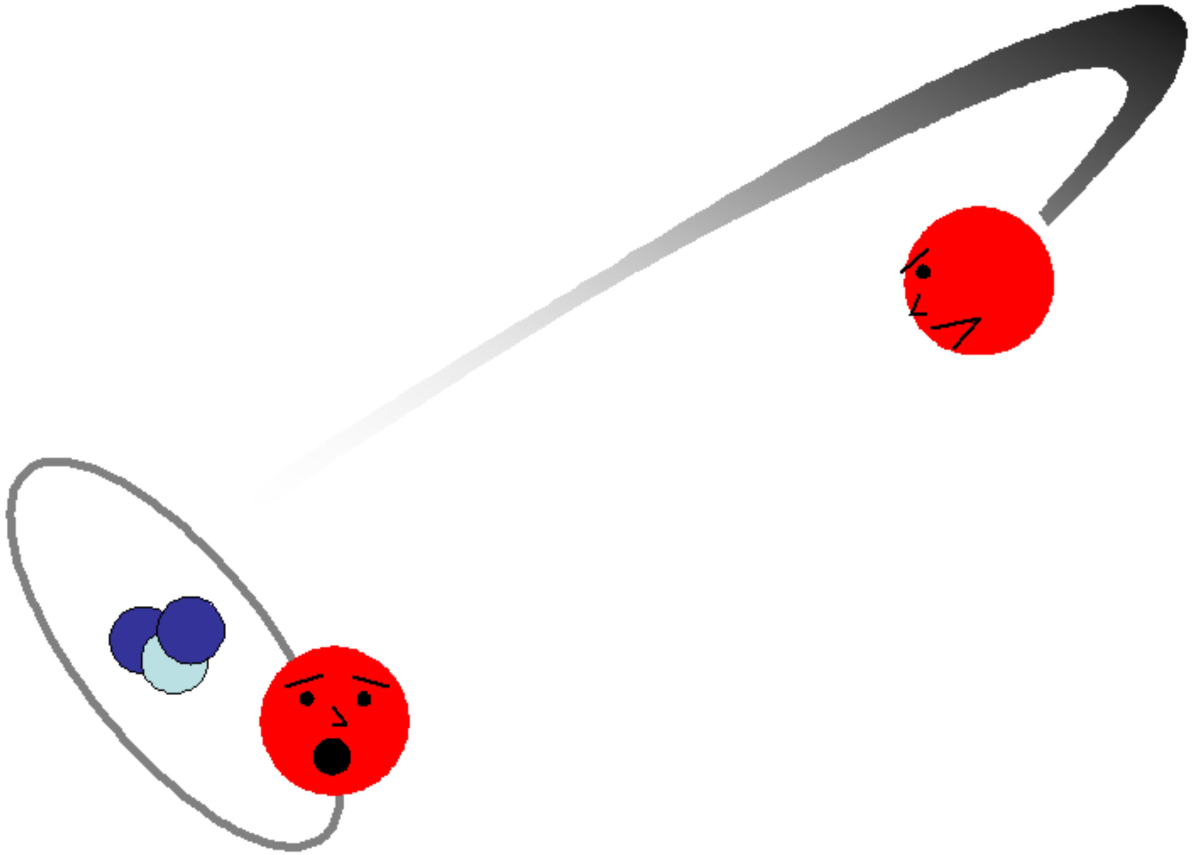
Ionization Dynamics in Intense Bicircular Laser Fields



APS 4CS
CSU – Ft. Collins, CO
20 October 2017

Jan L. Chaloupka
University of Northern Colorado

BROOKHAVEN
NATIONAL LABORATORY



HHG with two-color, counter-rotating fields

nature photonics

ARTICLES

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Generation of bright phase-matched circularly-polarized extreme ultraviolet high harmonics

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RAPID COMMUNICATIONS

PHYSICAL REVIEW A VOLUME 51, NUMBER 5 MAY 1995

Polarization-dependent high-order two-color mixing

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W. Becker,* S. Long, and J. K. McIver
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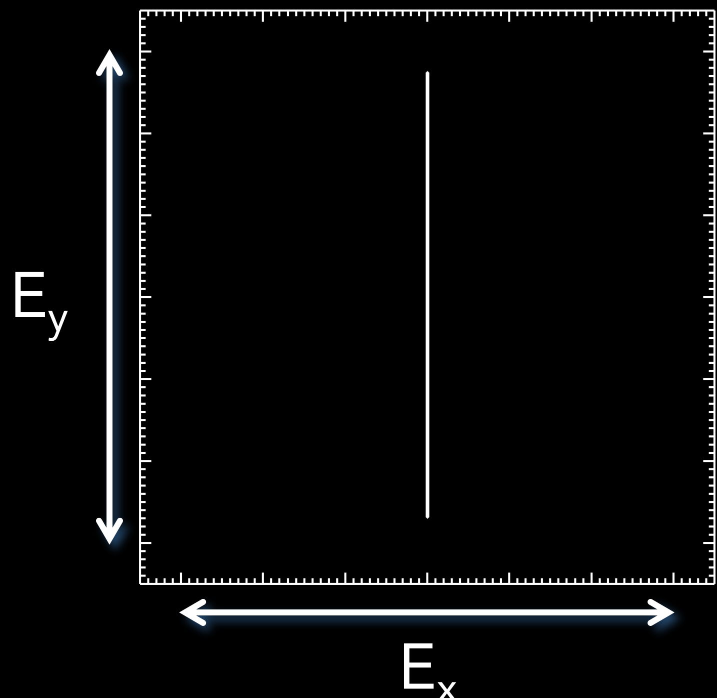
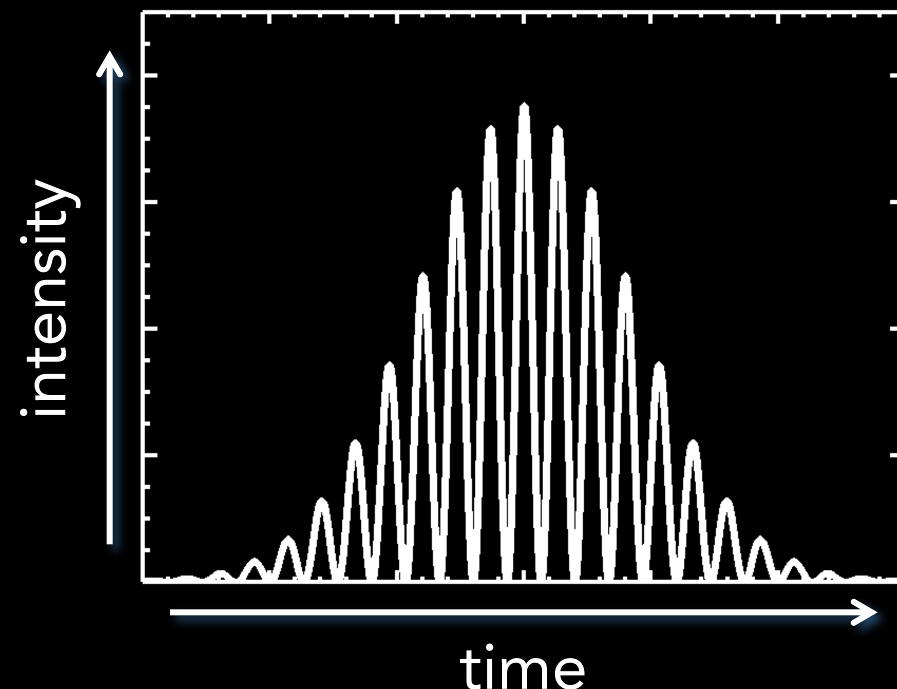
(Received 1 December 1994)

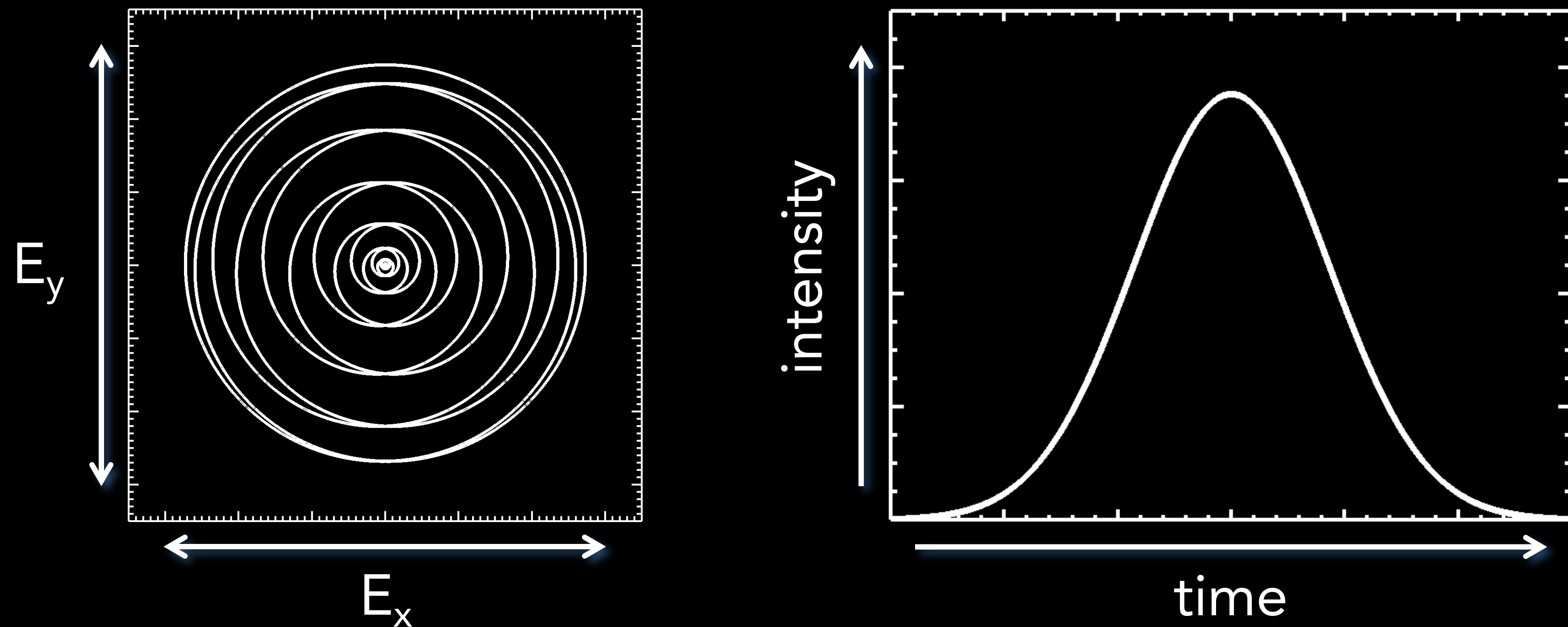
High-order frequency mixing experiments using the radiation of a high-power Ti:sapphire laser and its second harmonic are described and discussed. Linearly and circularly polarized light fields with comparable intensities have been used. For the theoretical description a three-dimensional quantum-mechanical calculation with a δ-function potential has been applied, showing quite good agreement with the experiments.

single-color linear polarization

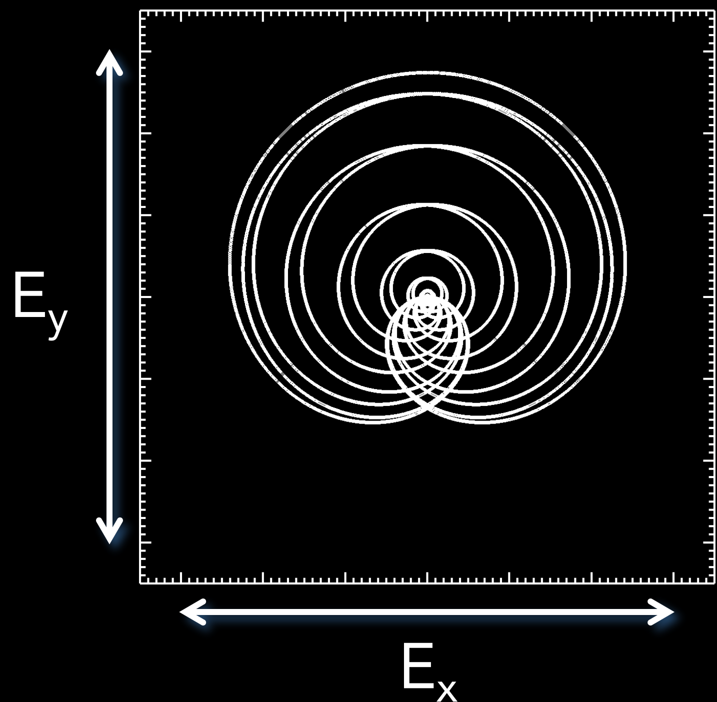


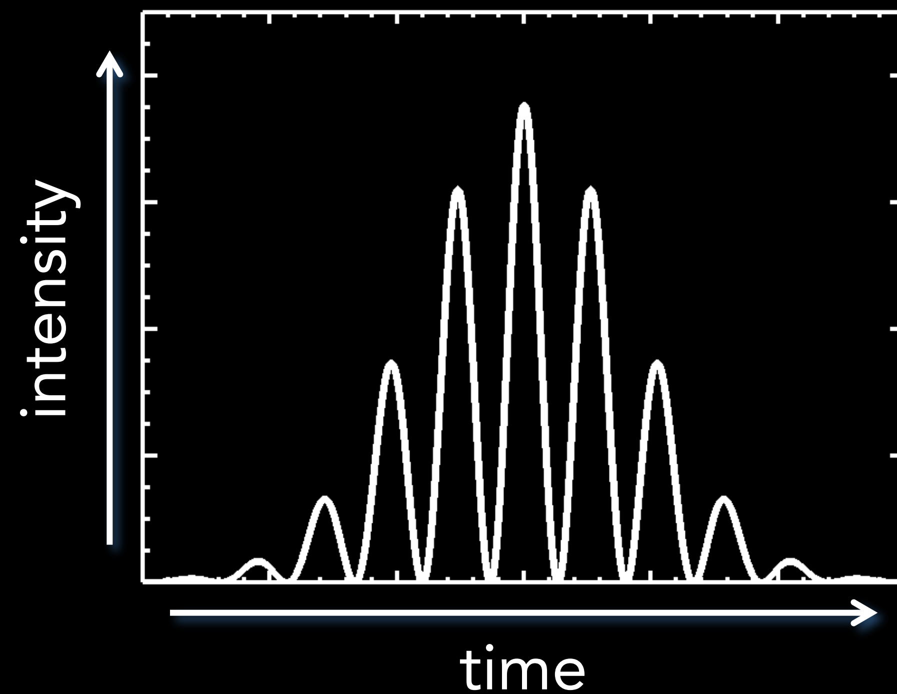


single-color circular polarization

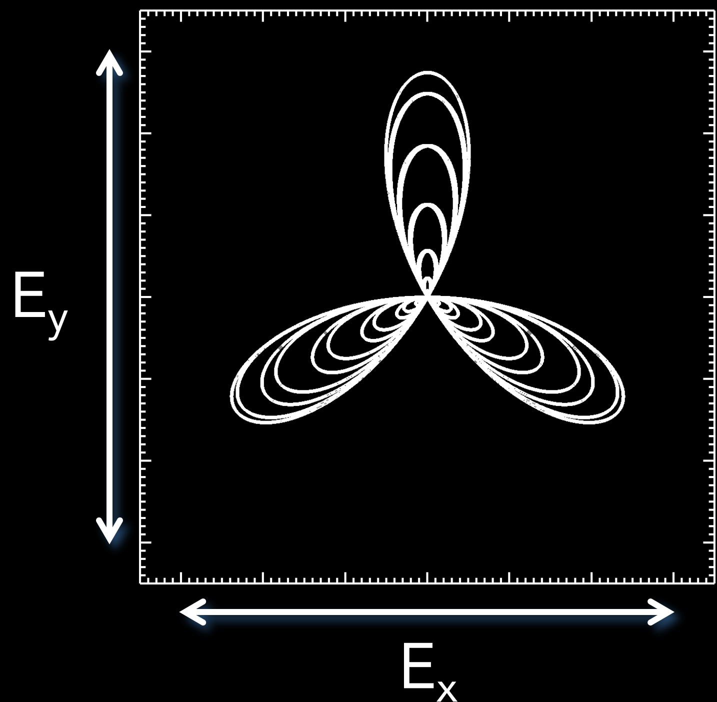


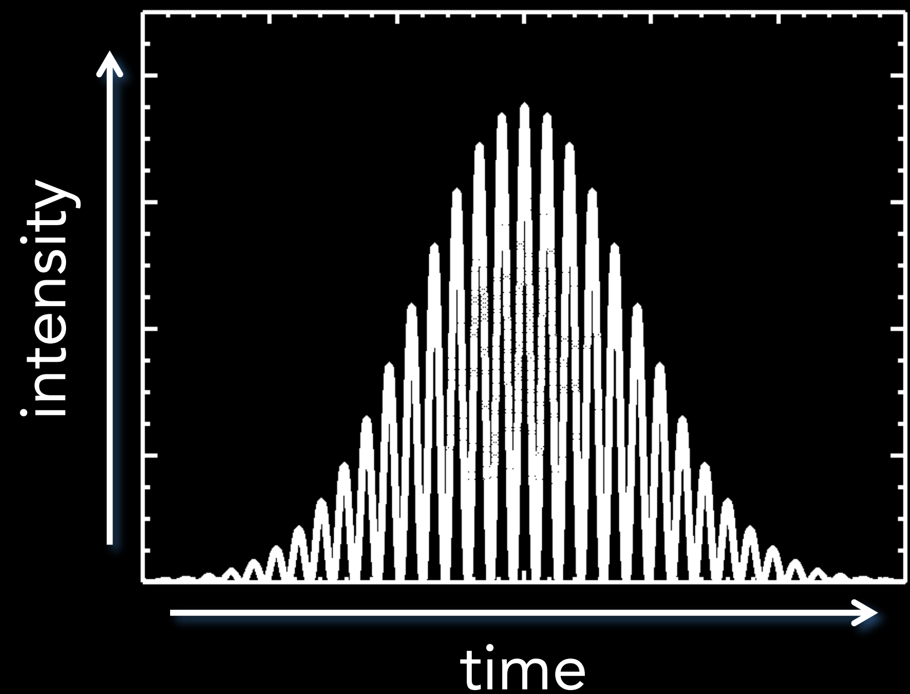
two-color co-rotating fields





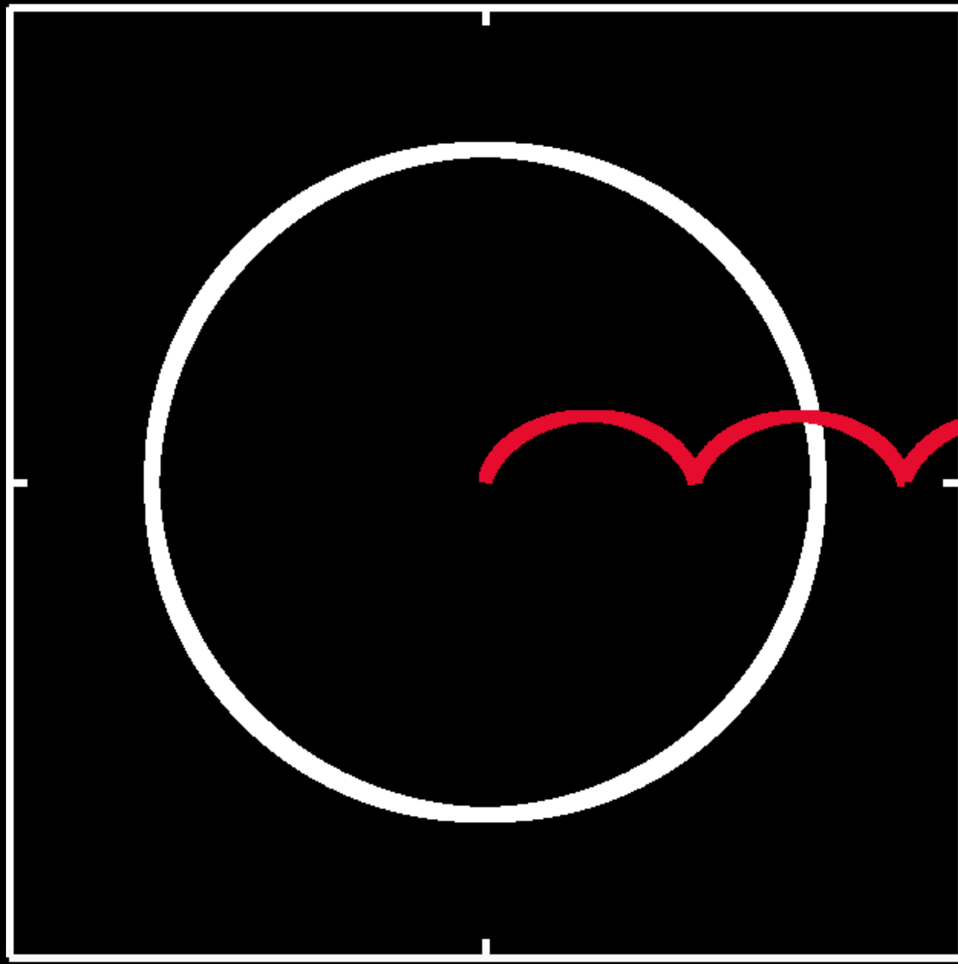
two-color counter-rotating fields





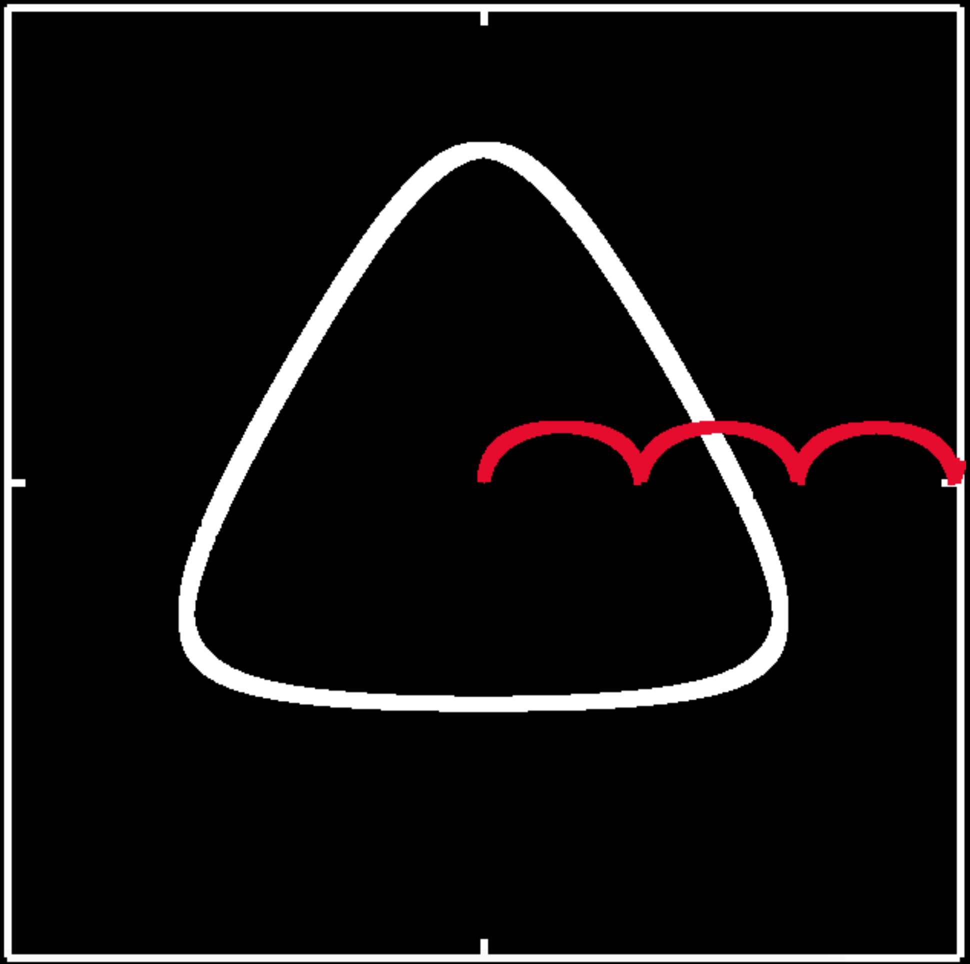
simple trajectories

circular polarization



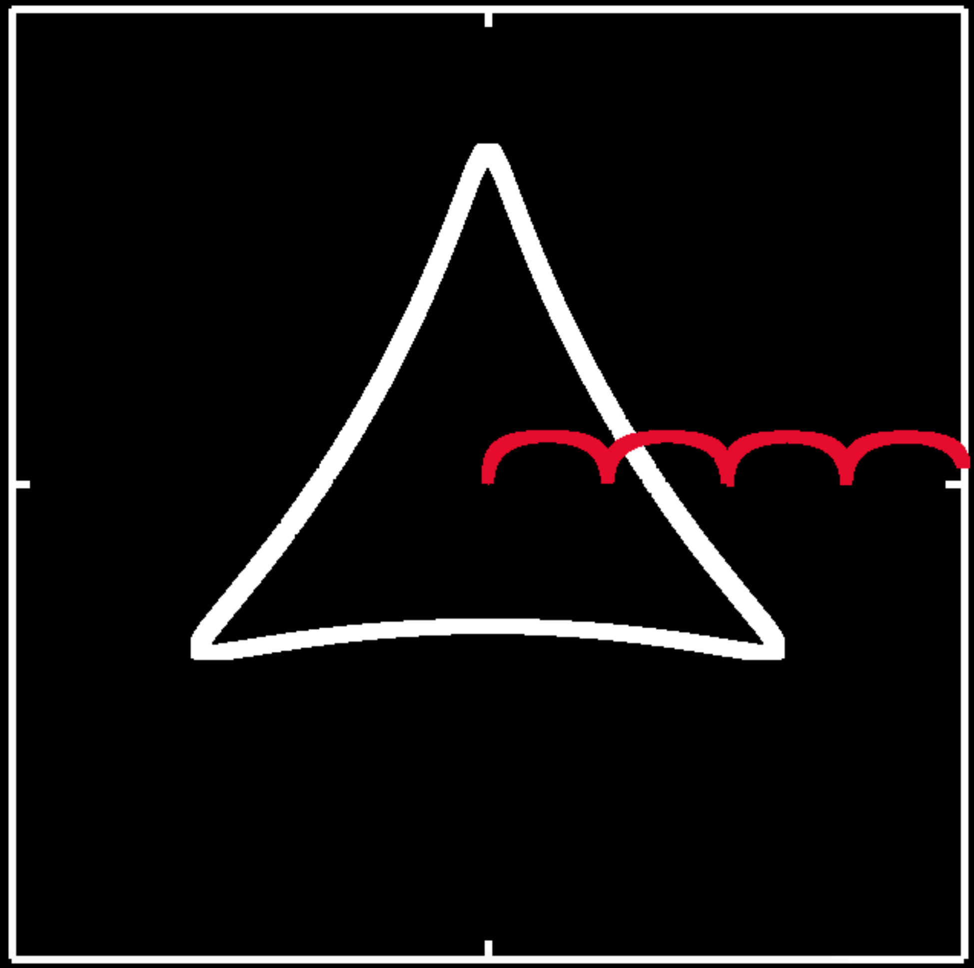
simple trajectories

0.2:1 counter-rotating 2ω:ω



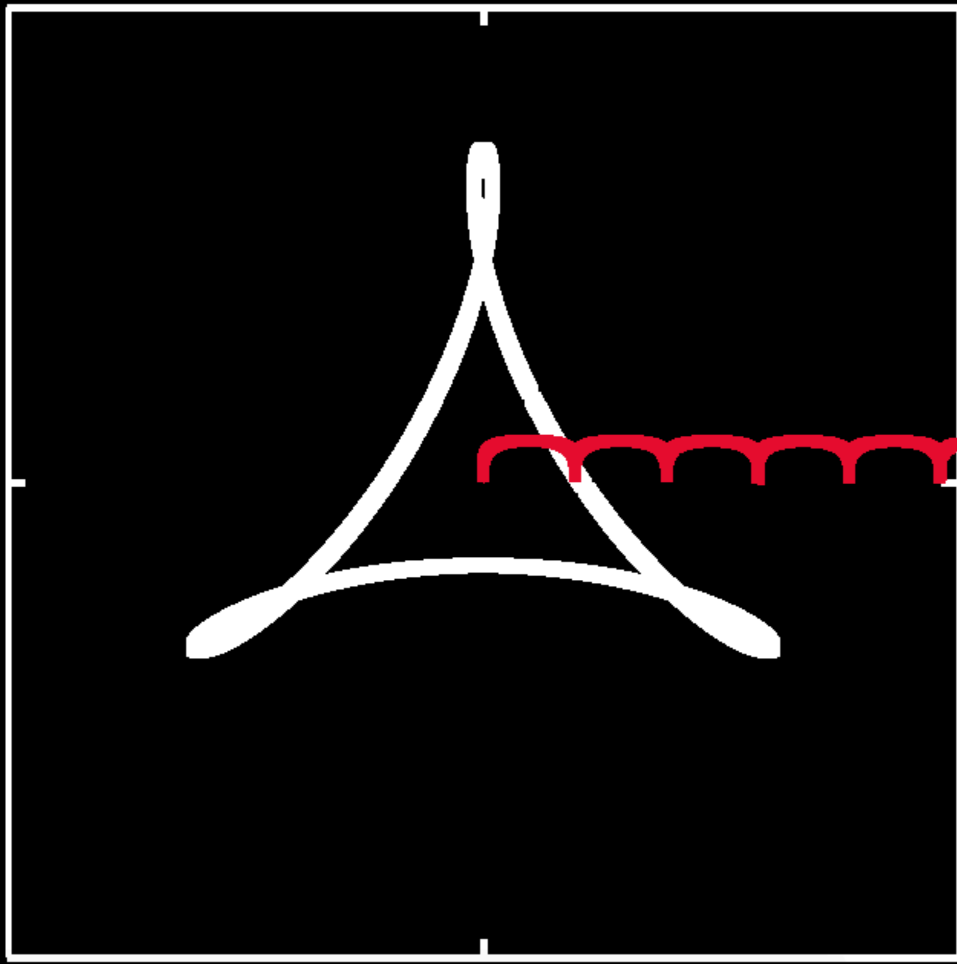
simple trajectories

0.4:1   counter-rotating 2ω:ω



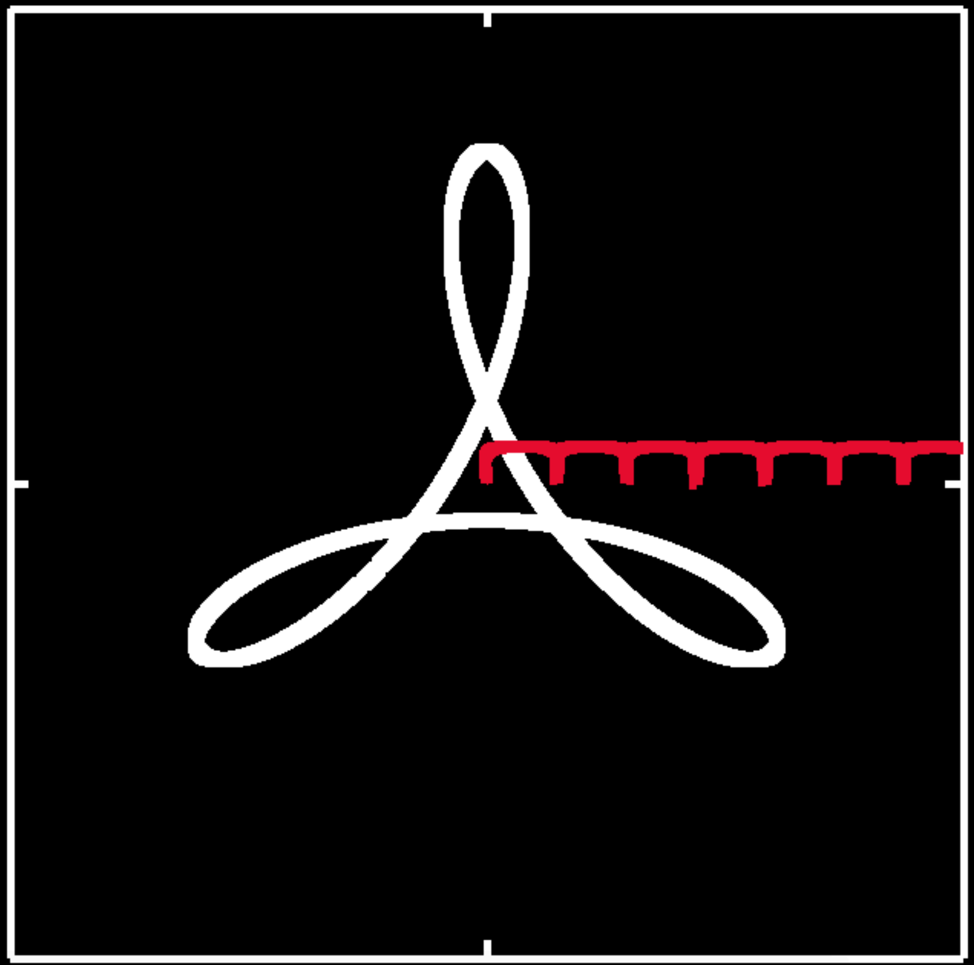
simple trajectories

0.6:1 counter-rotating 2ω:ω



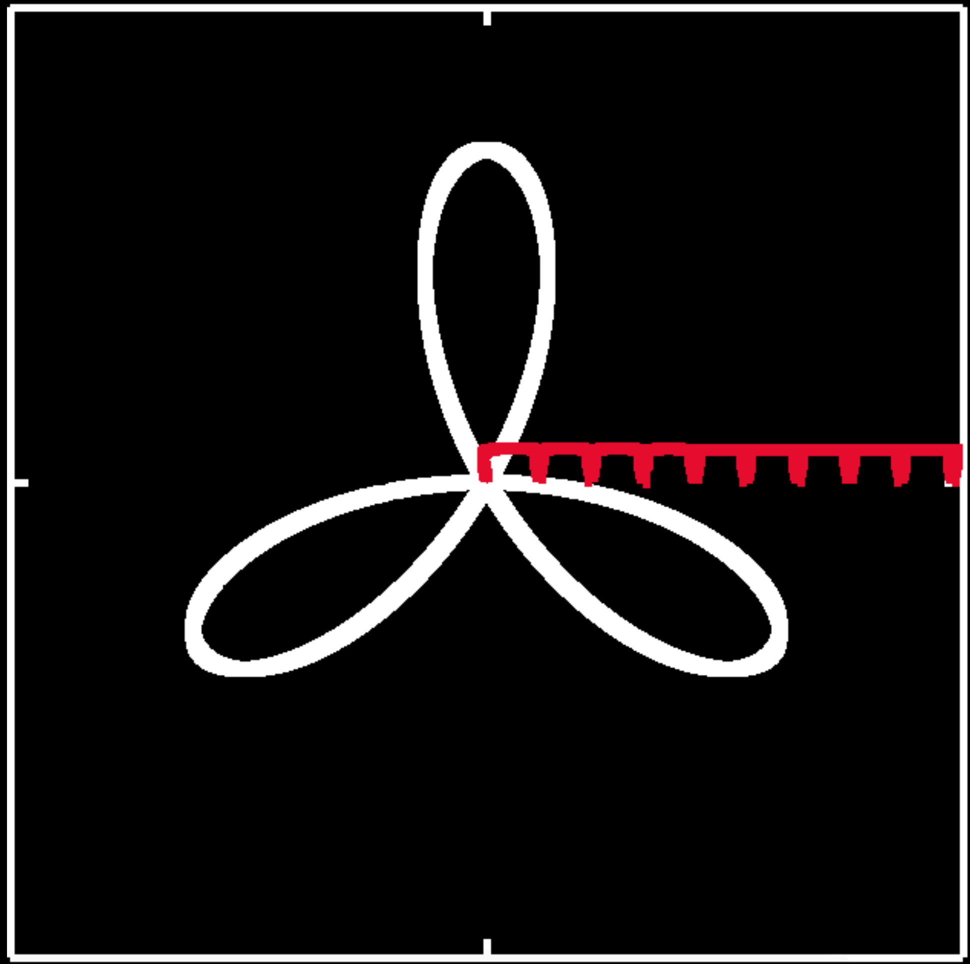
simple trajectories

0.8:1 counter-rotating 2ω:ω



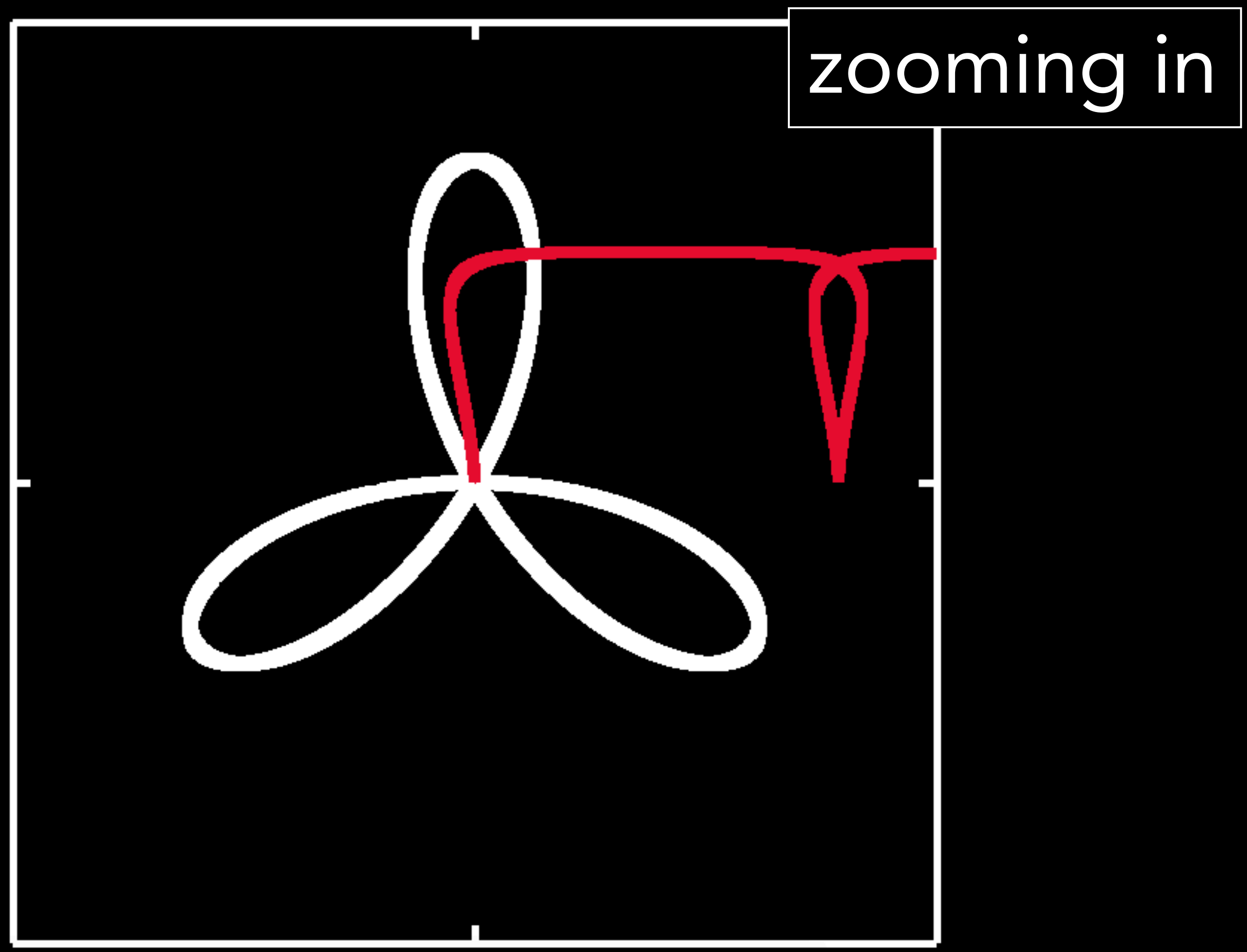
simple trajectories

1.0:1   counter-rotating 2ω:ω



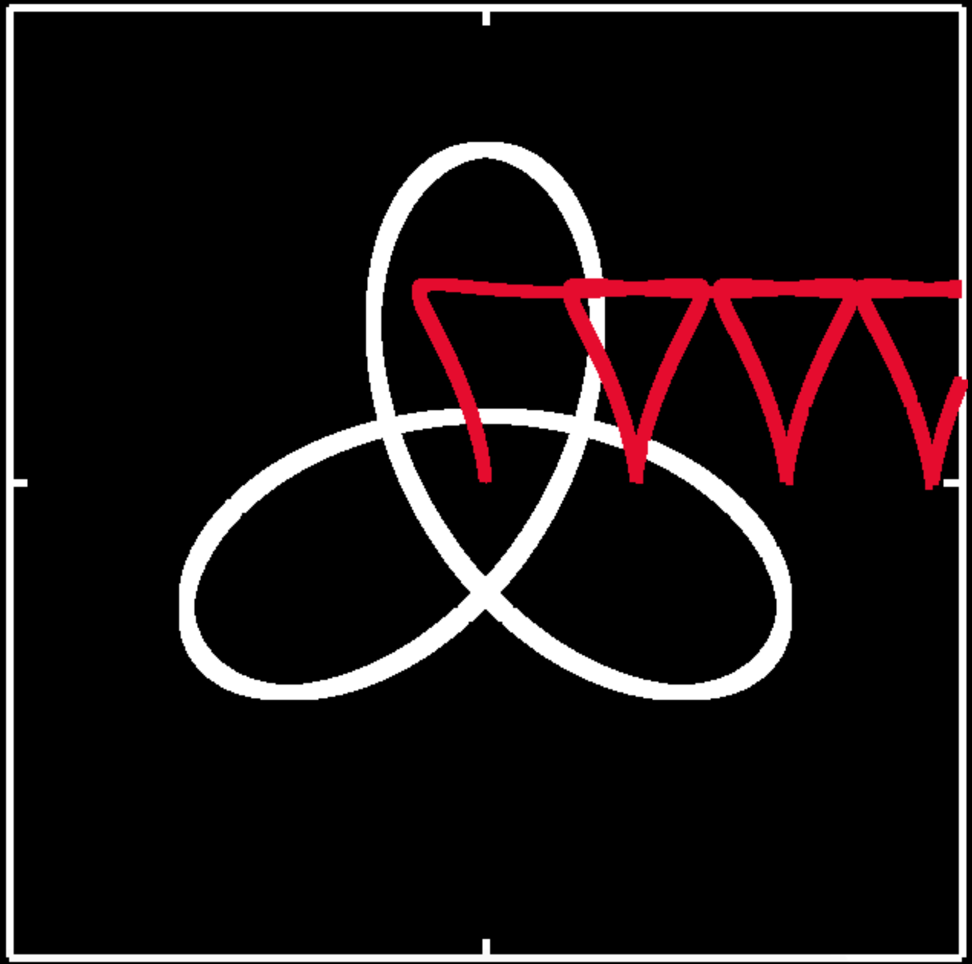
simple trajectories

1.0:1 counter-rotating 2ω:ω



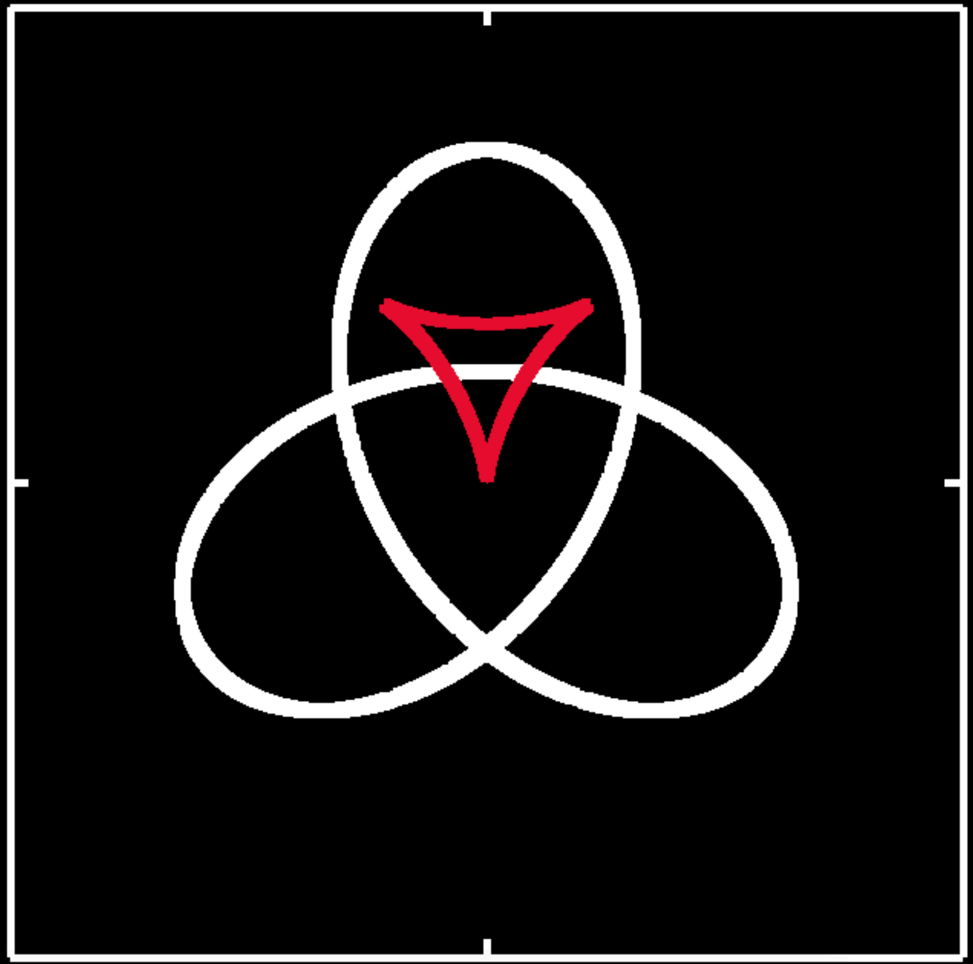
simple trajectories

1.5:1 counter-rotating 2ω:ω



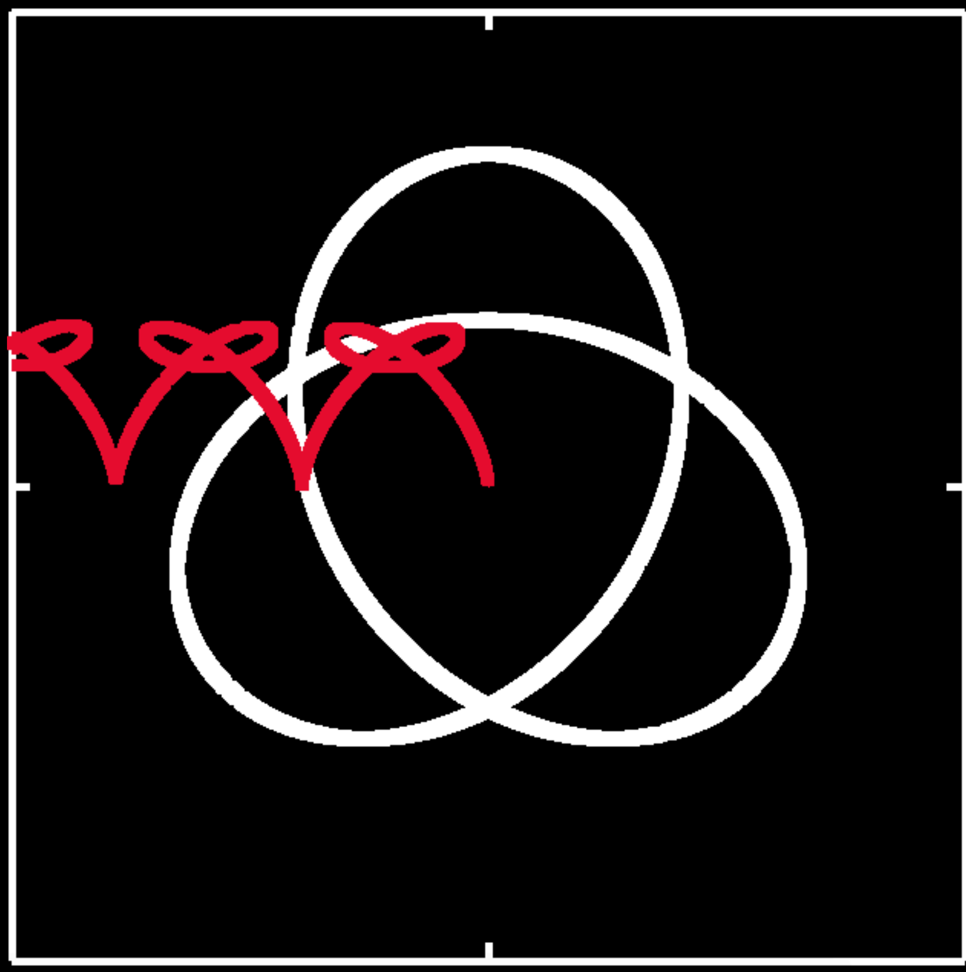
simple trajectories

2.0:1   counter-rotating 2ω:ω

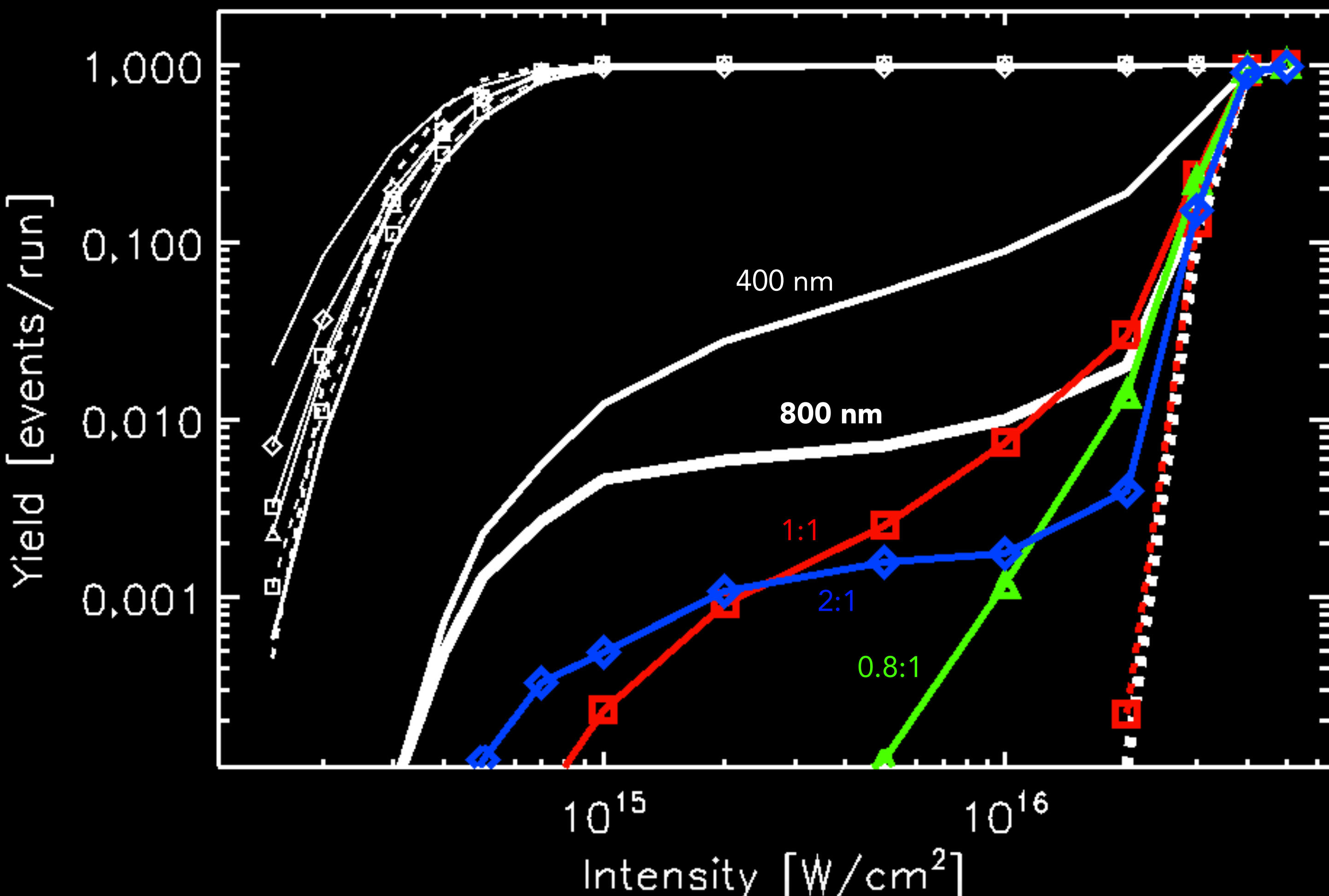


simple trajectories

3.0:1 counter-rotating 2ω:ω

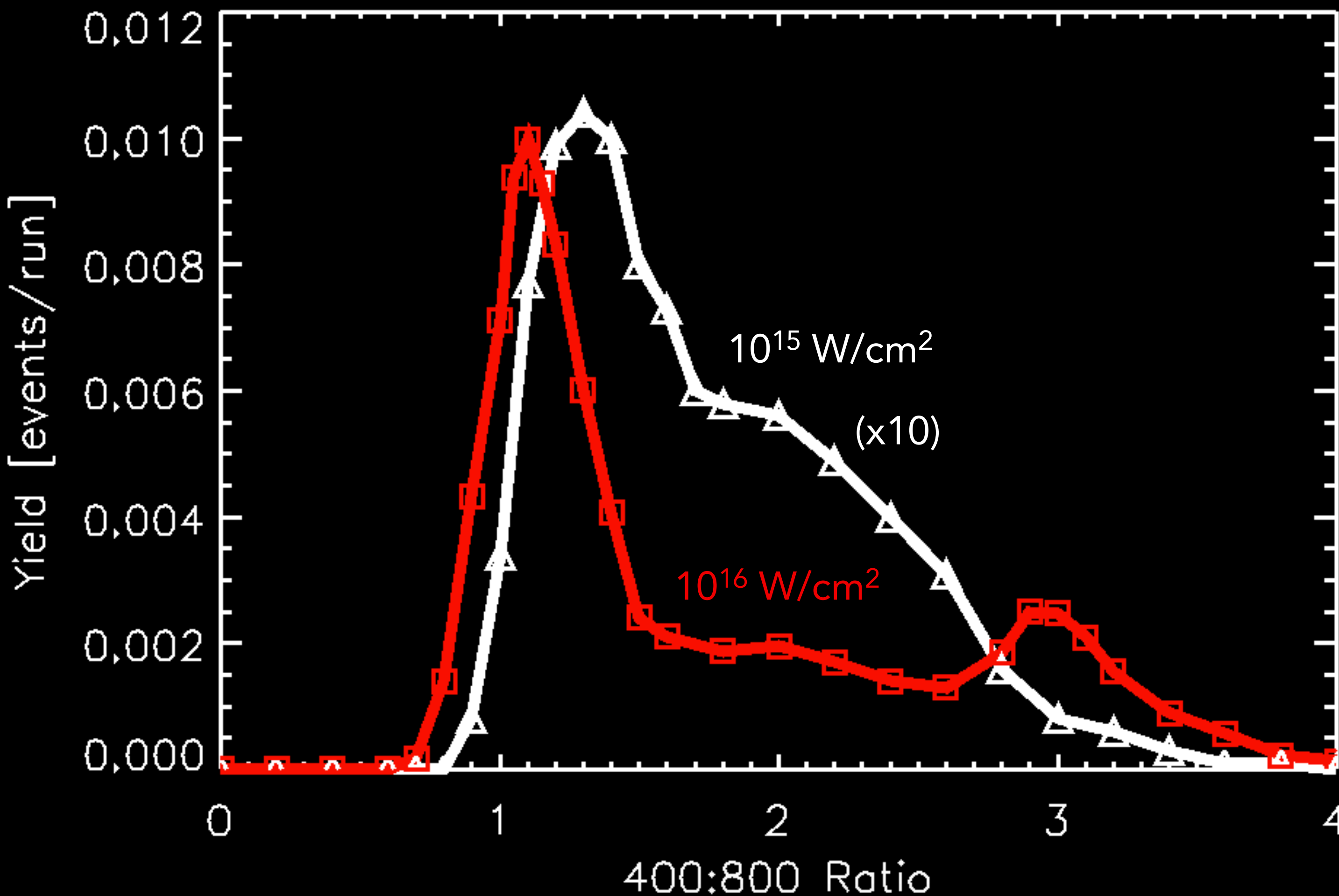


helium ionization yield curves



Chaloupka & Hickstein, *Physical Review Letters* (April 2016)

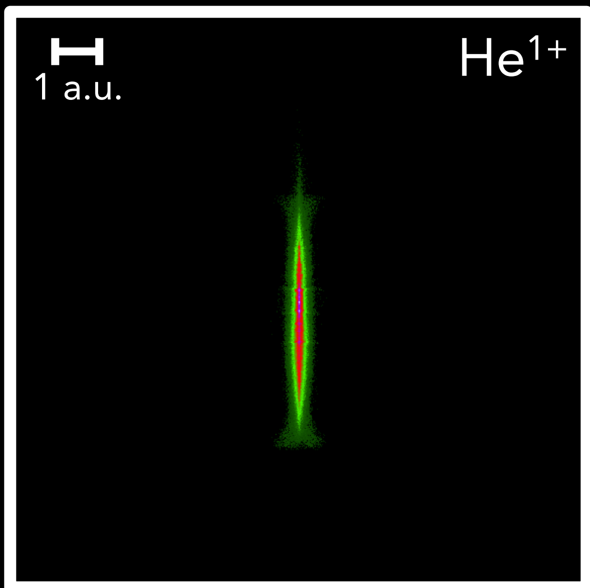
yield vs 400:800 ratio

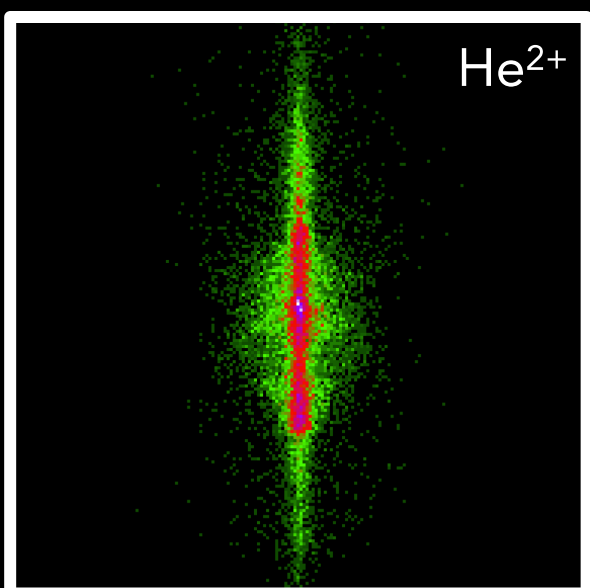


electron momenta & timing (linear 800nm)

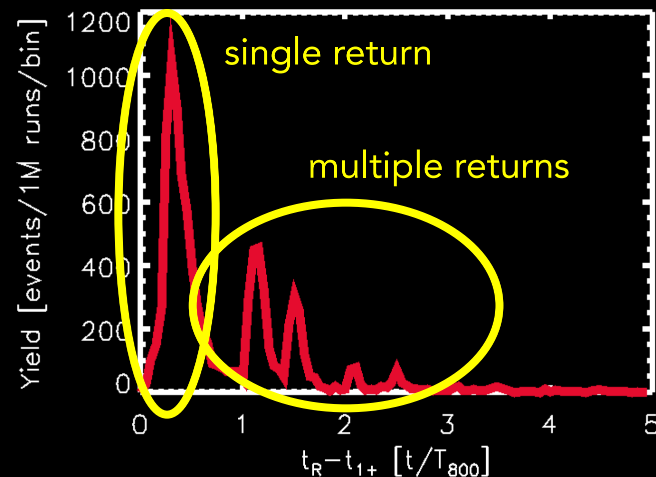
10^{16} W/cm^2
10^6 runs
linear

transverse electron momenta

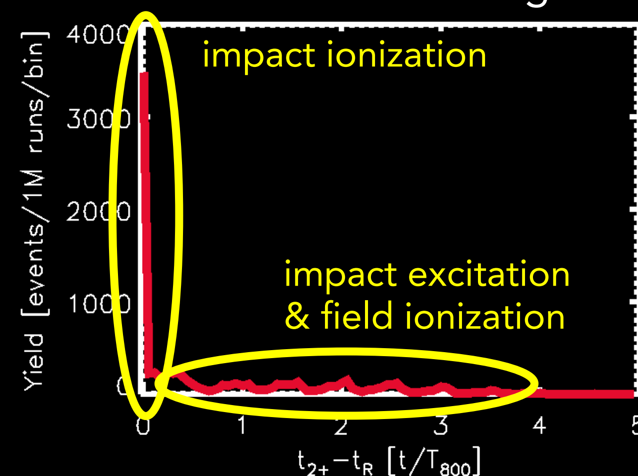




rescattering timing



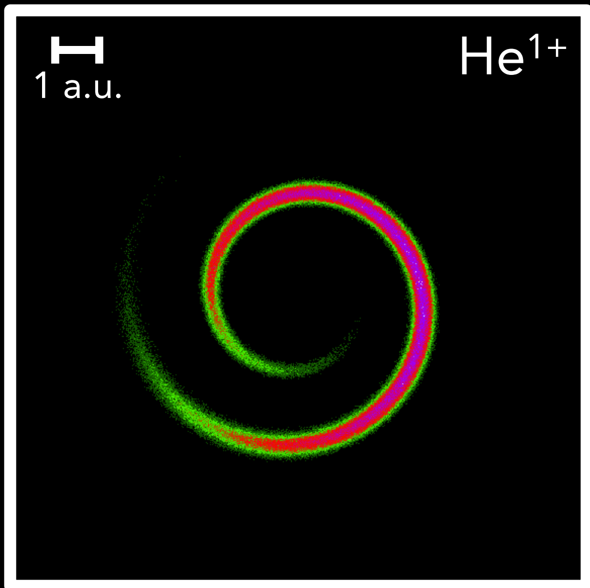
double
ionization timing

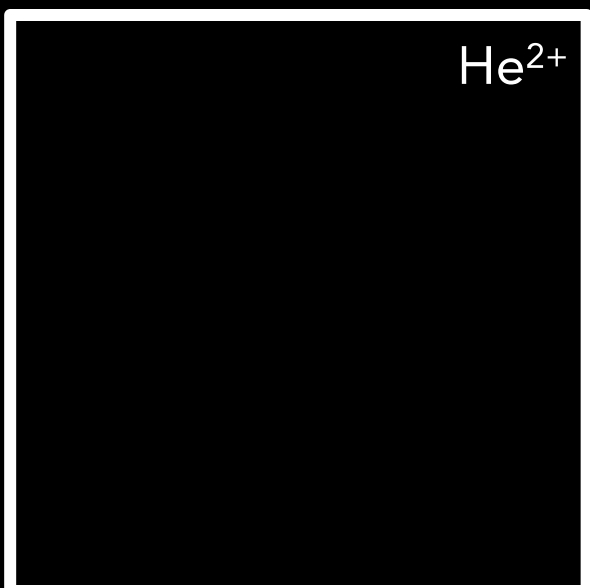


electron momenta & timing (circular 800nm)

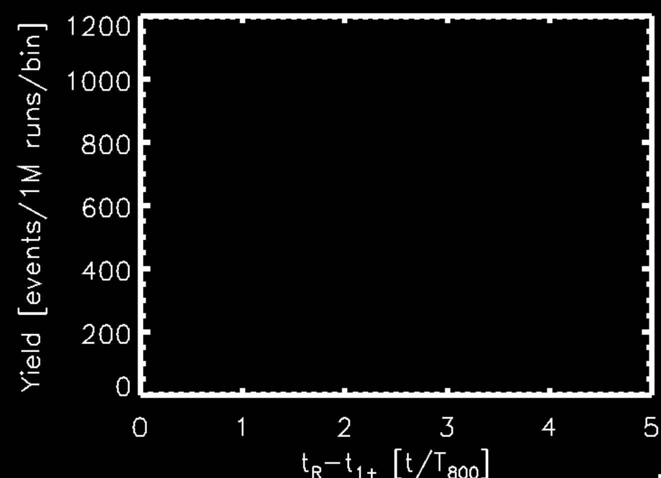
10^{16} W/cm^2
10^6 runs
circular

transverse electron momenta

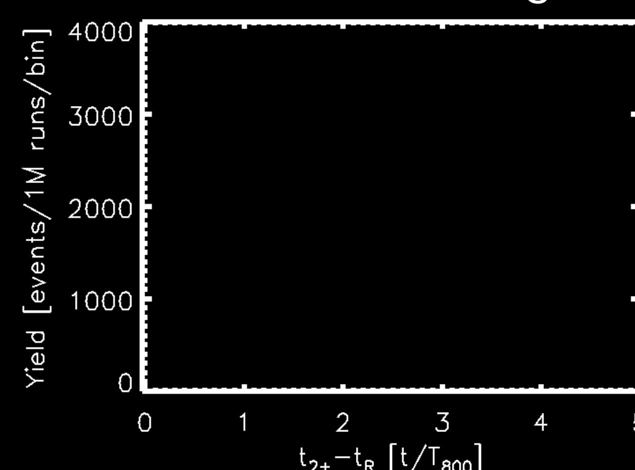




rescattering timing



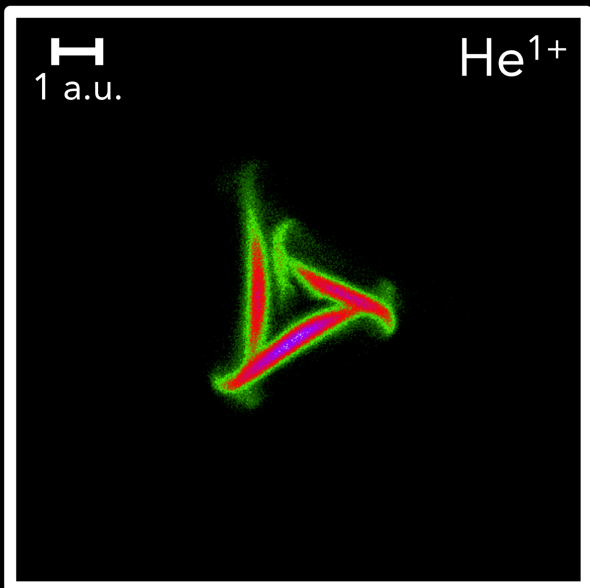
double ionization timing

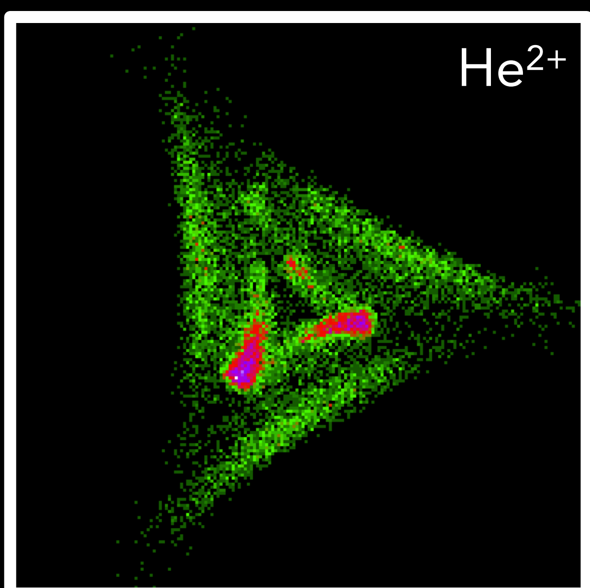


electron momenta & timing (400:800 1:1)

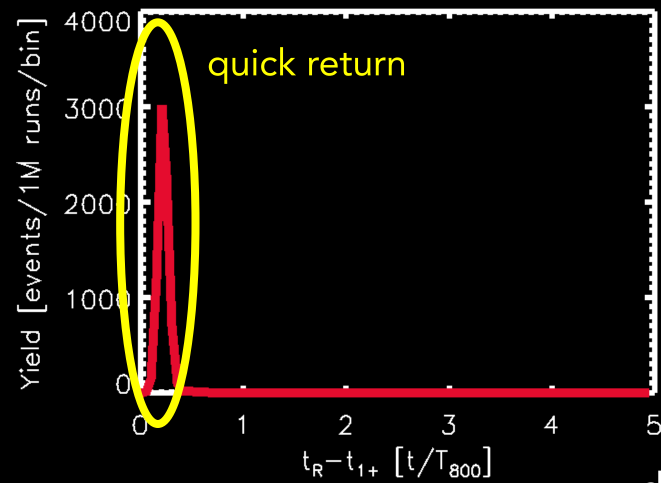
10^{16} W/cm^2
10^6 runs
1:1

transverse electron momenta

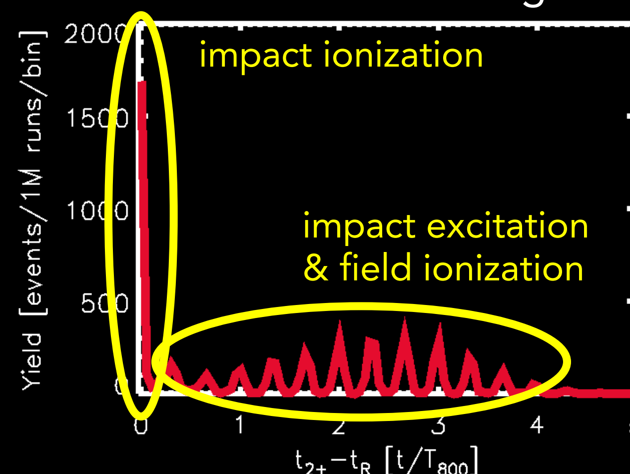




rescattering timing



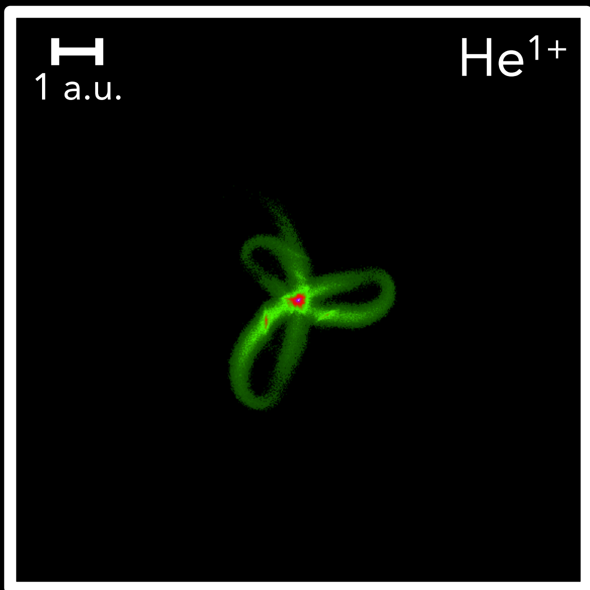
double ionization timing

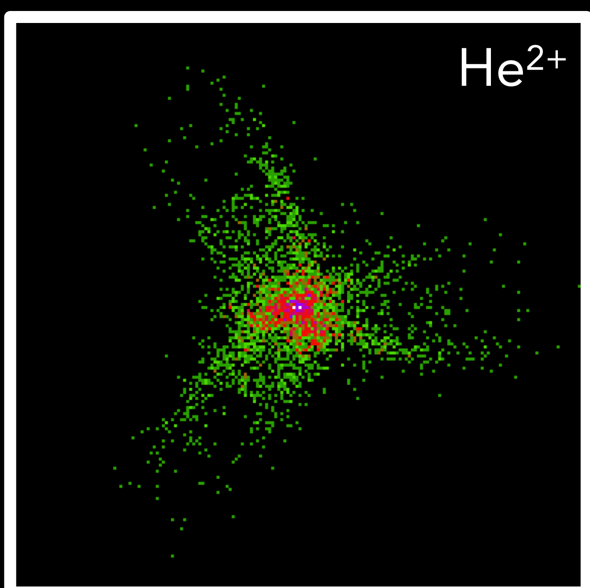


electron momenta & timing (400:800 2:1)

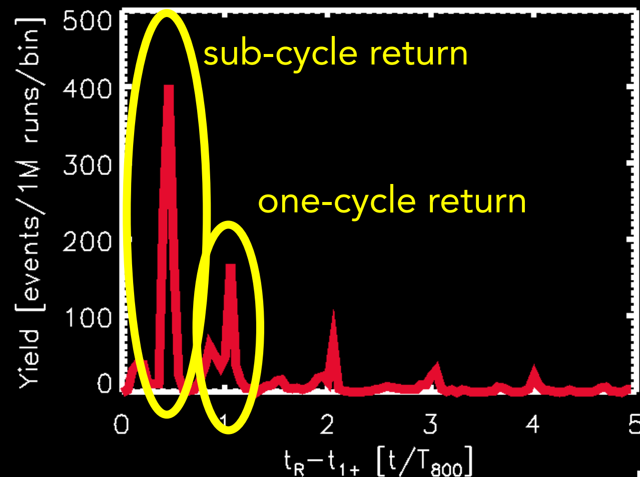
10^{16} W/cm^2
10^6 runs
2:1

transverse electron momenta

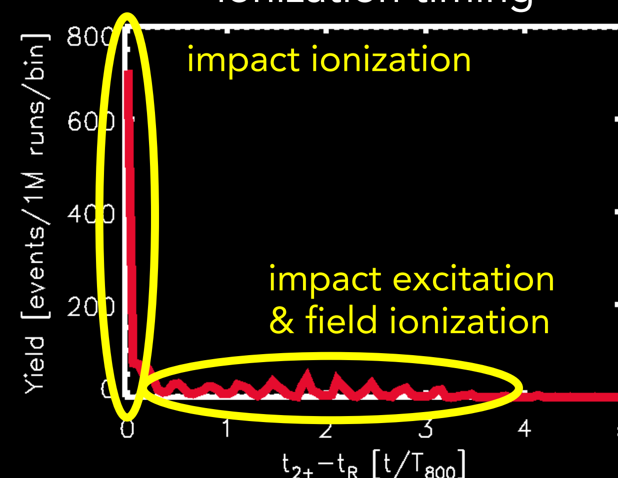




rescattering timing



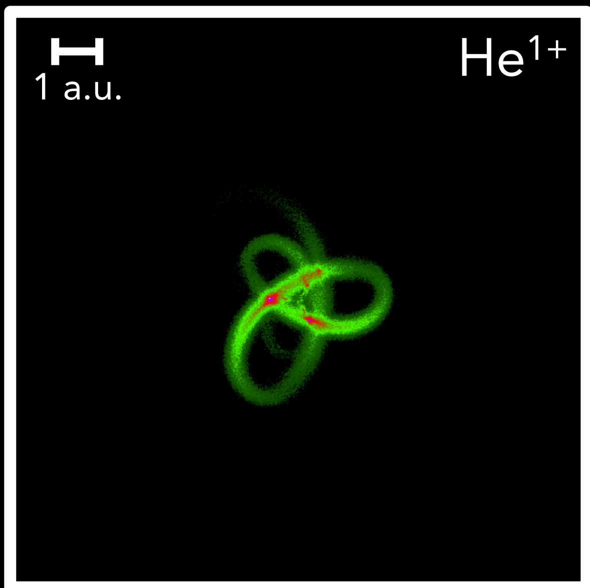
double ionization timing

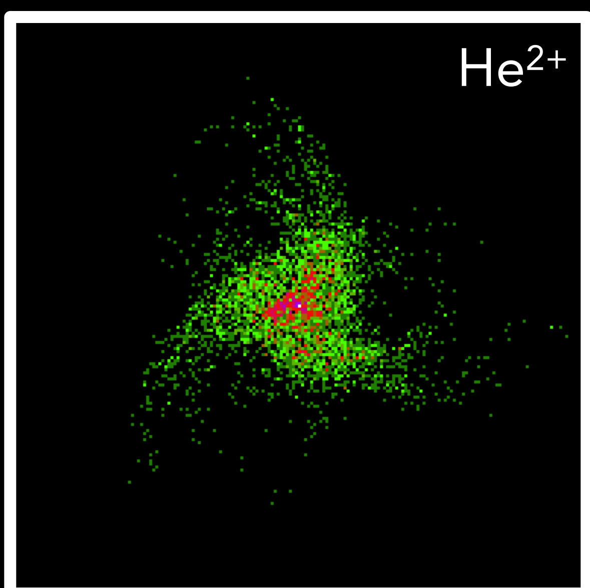


electron momenta & timing (400:800 3:1)

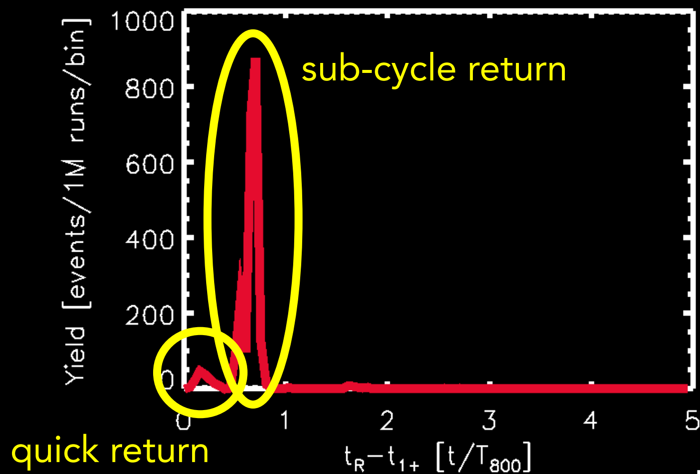
10^{16} W/cm^2
10^6 runs
3:1

transverse electron momenta

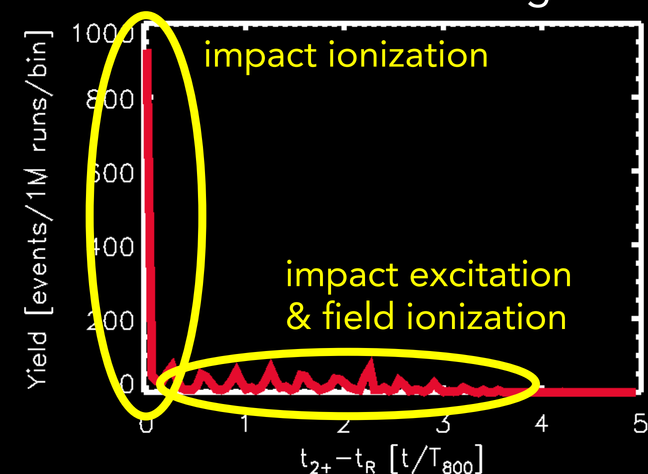




rescattering timing

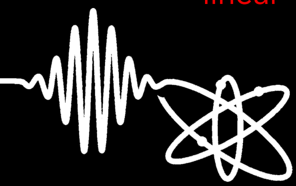


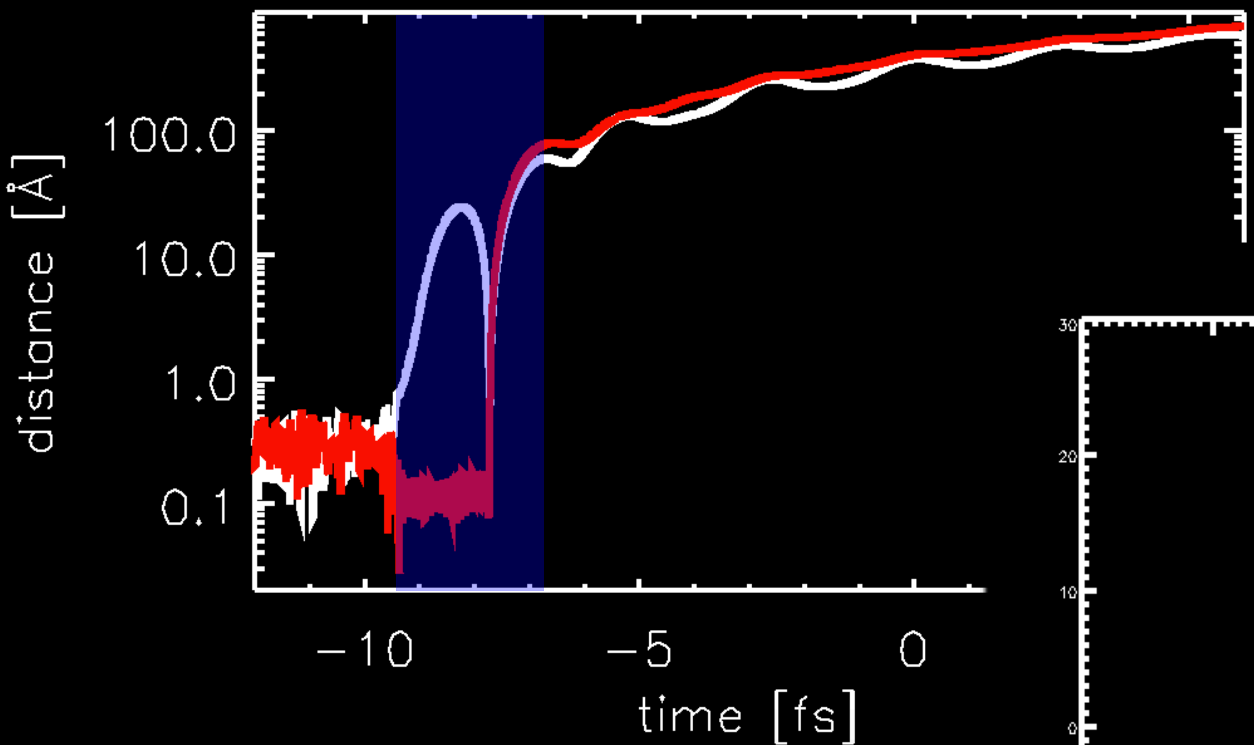
double ionization timing

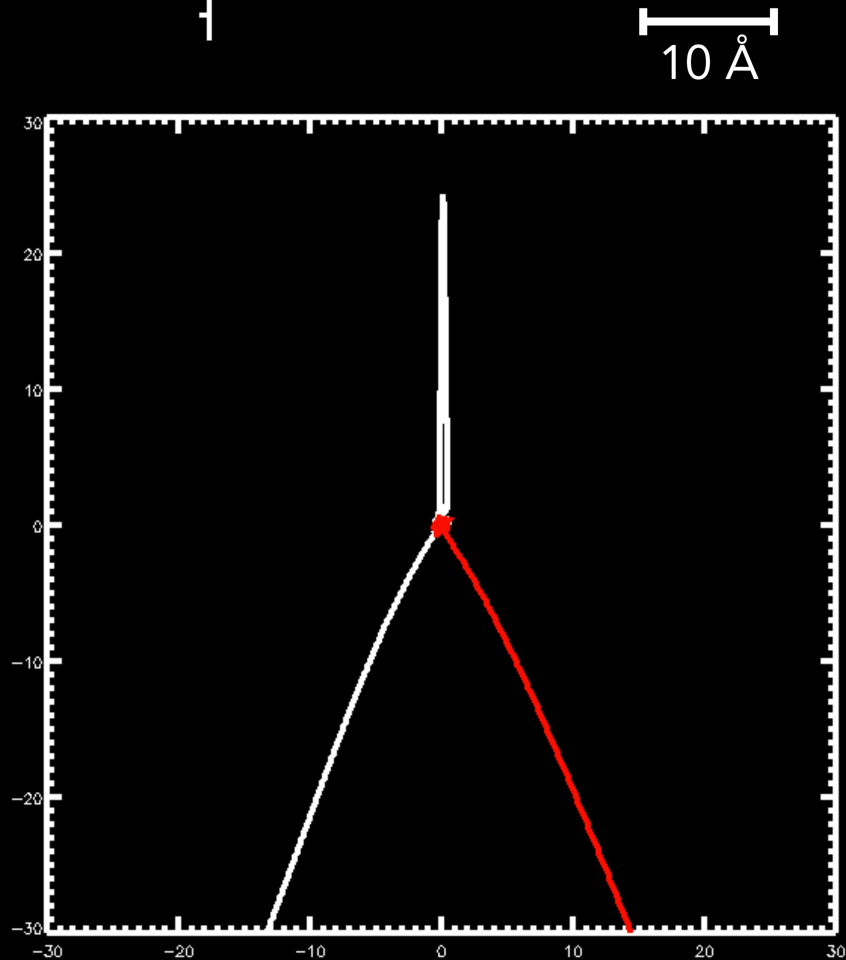


sample trajectories (linear 800nm)

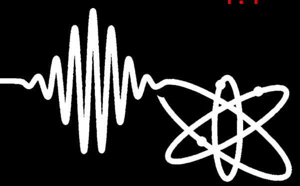
10^{16} W/cm^2
sample
linear

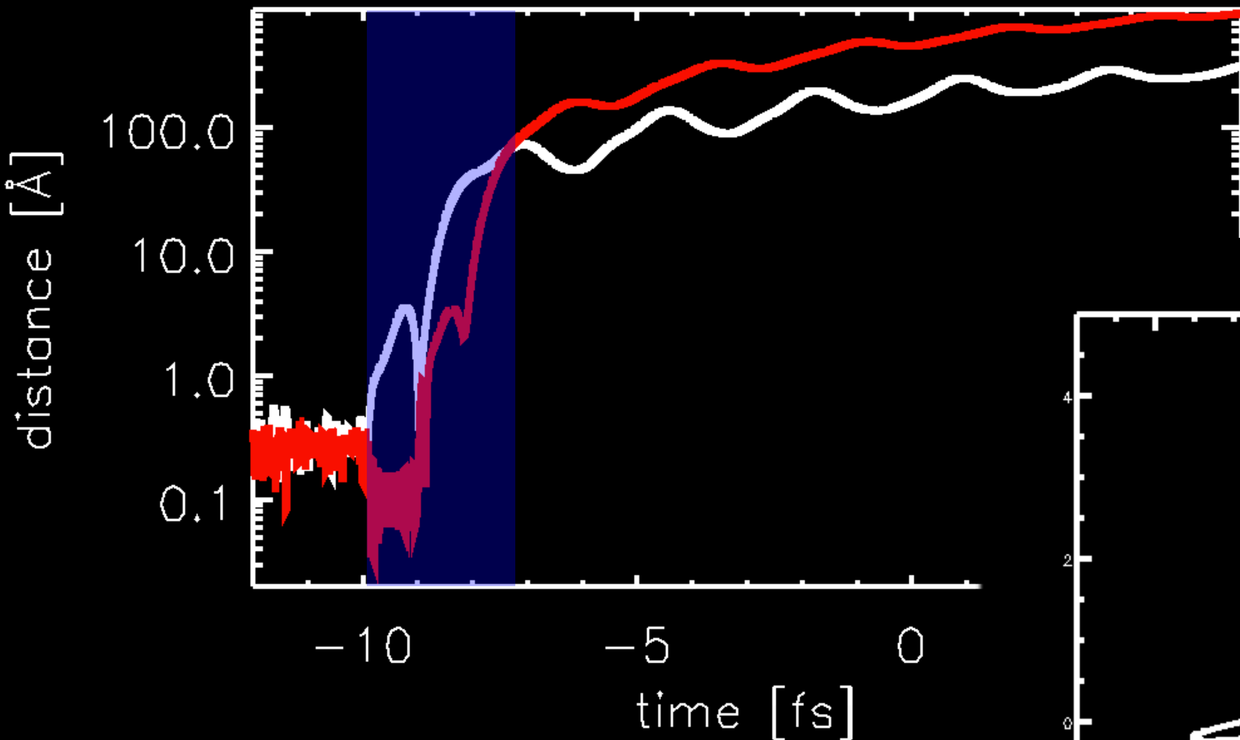


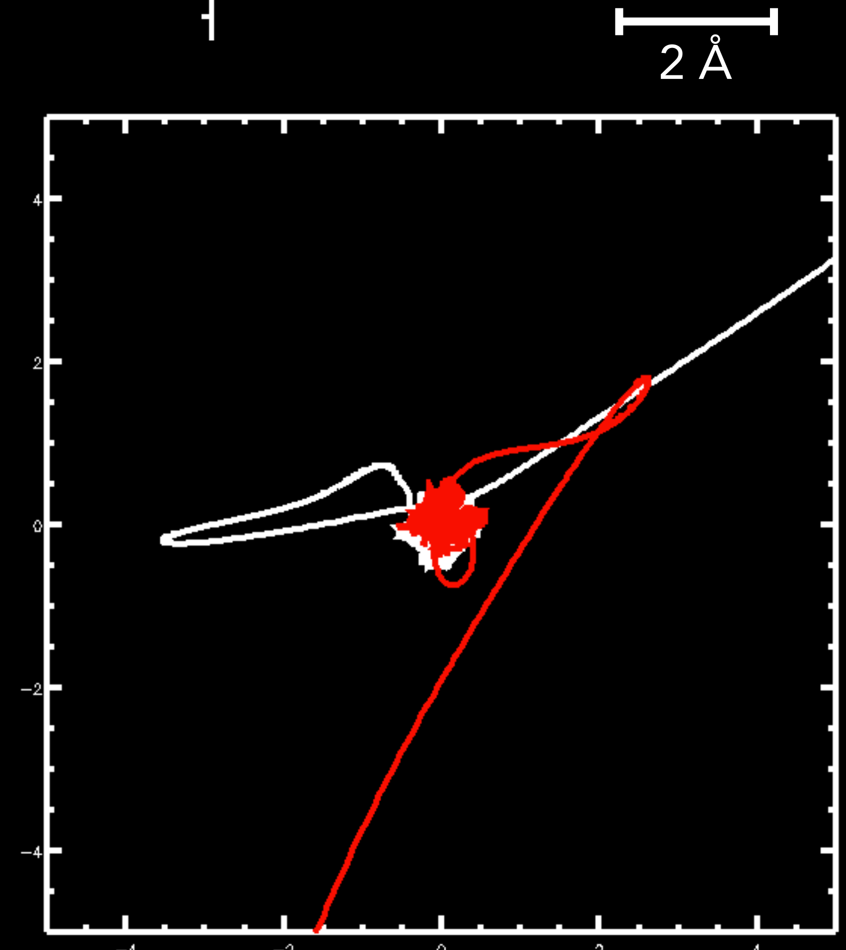




sample trajectories (800:400 1:1)

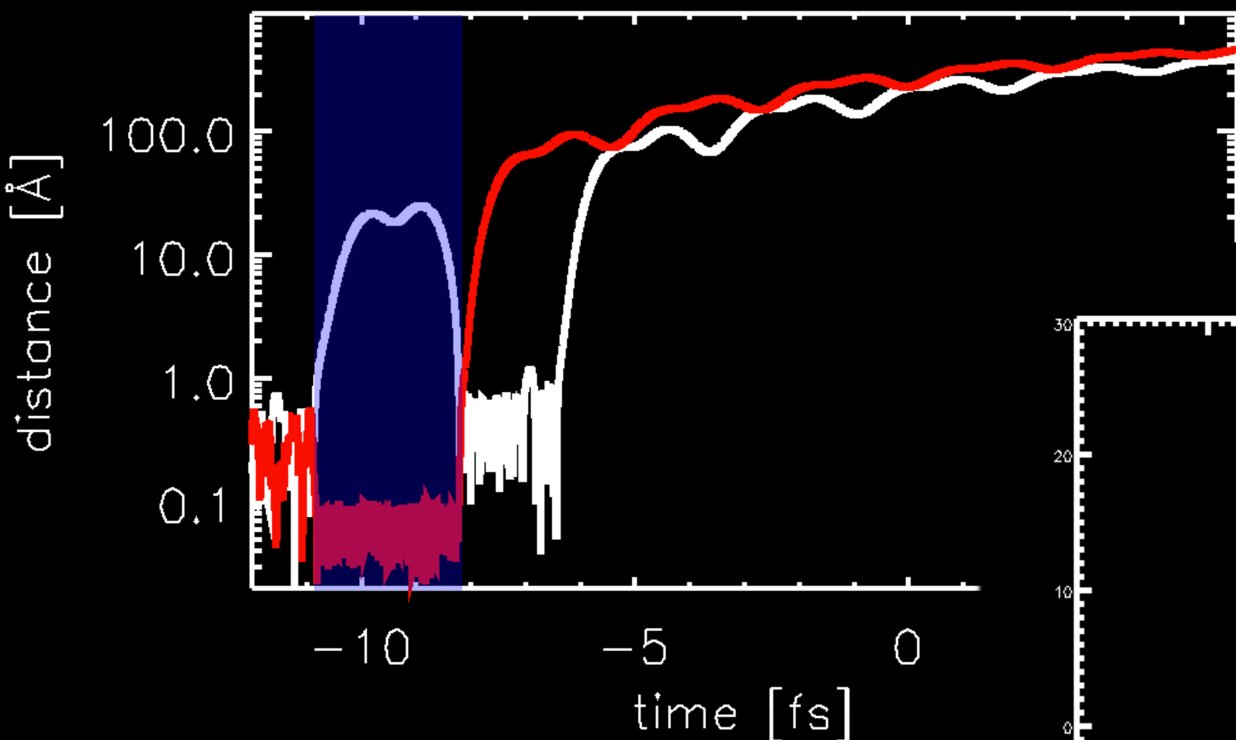




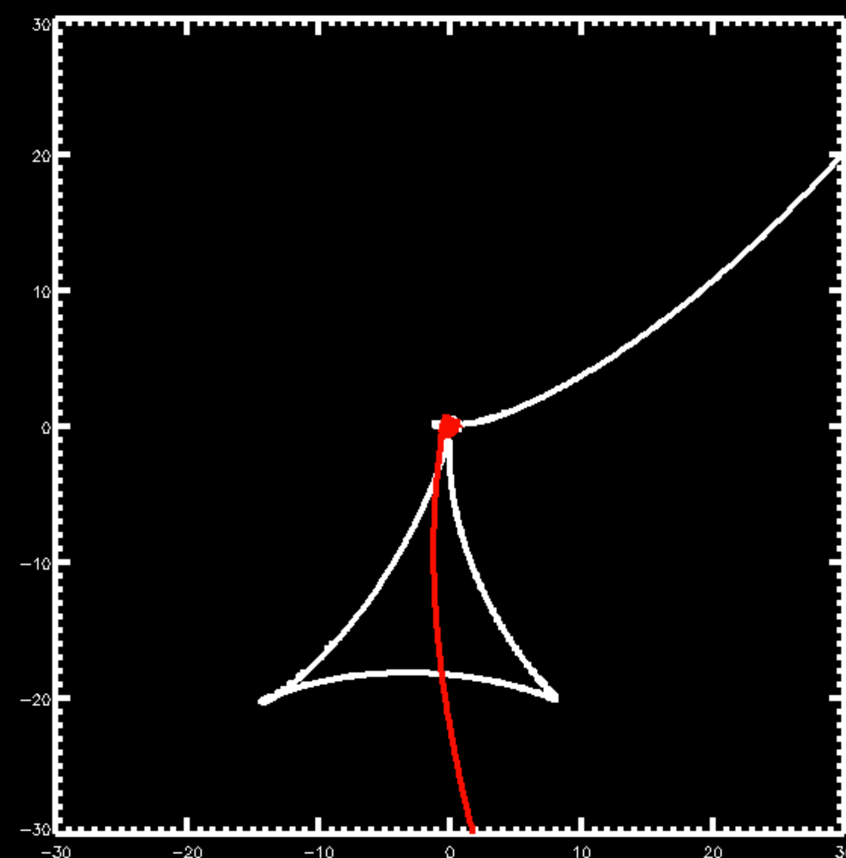


sample trajectories (800:400 2:1)

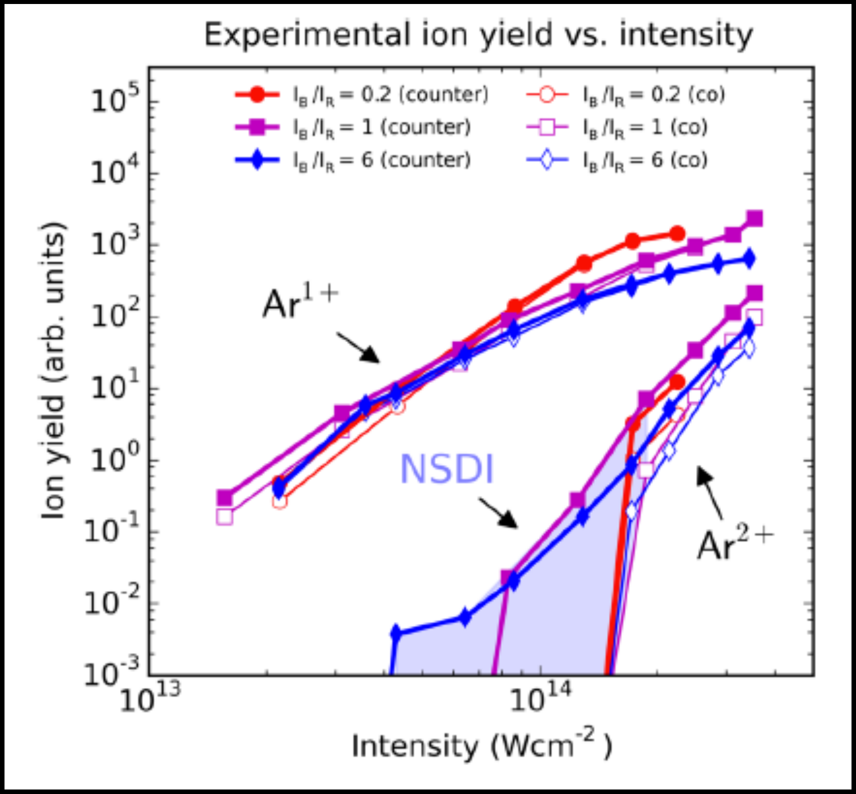
10^{16} W/cm^2
sample
2:1

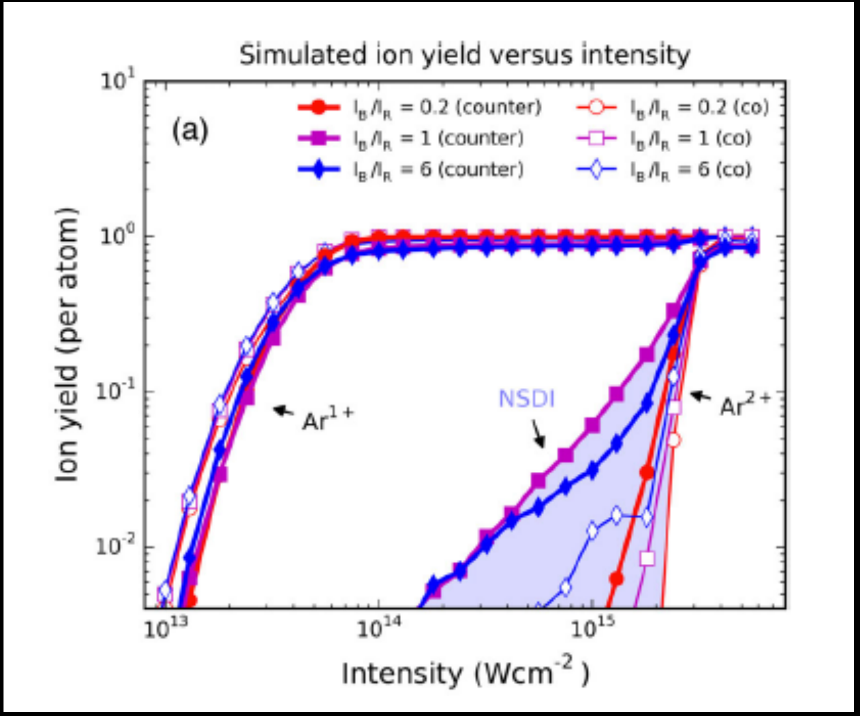


10 Å



experimental confirmation of non-seq DI yield

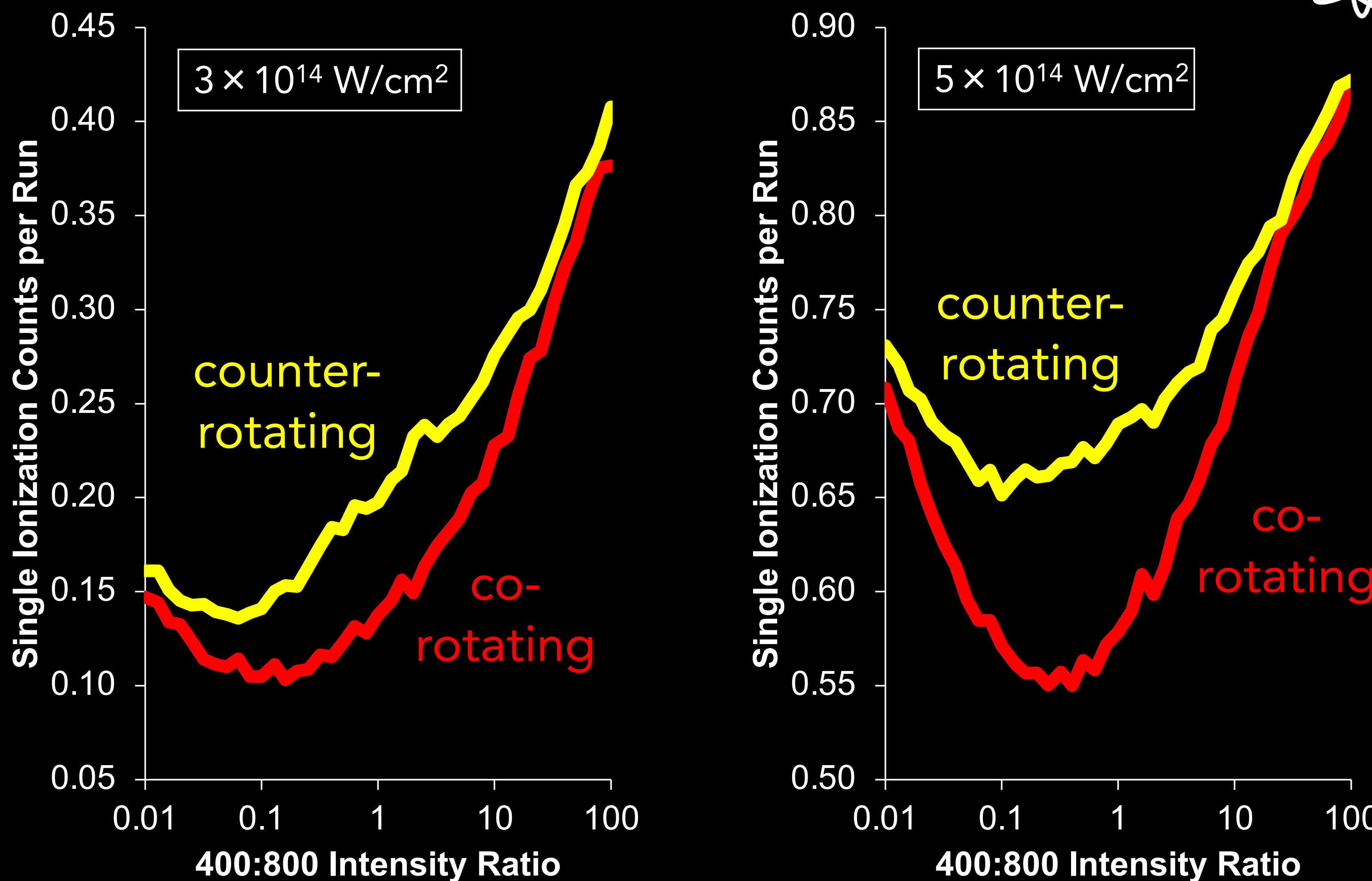




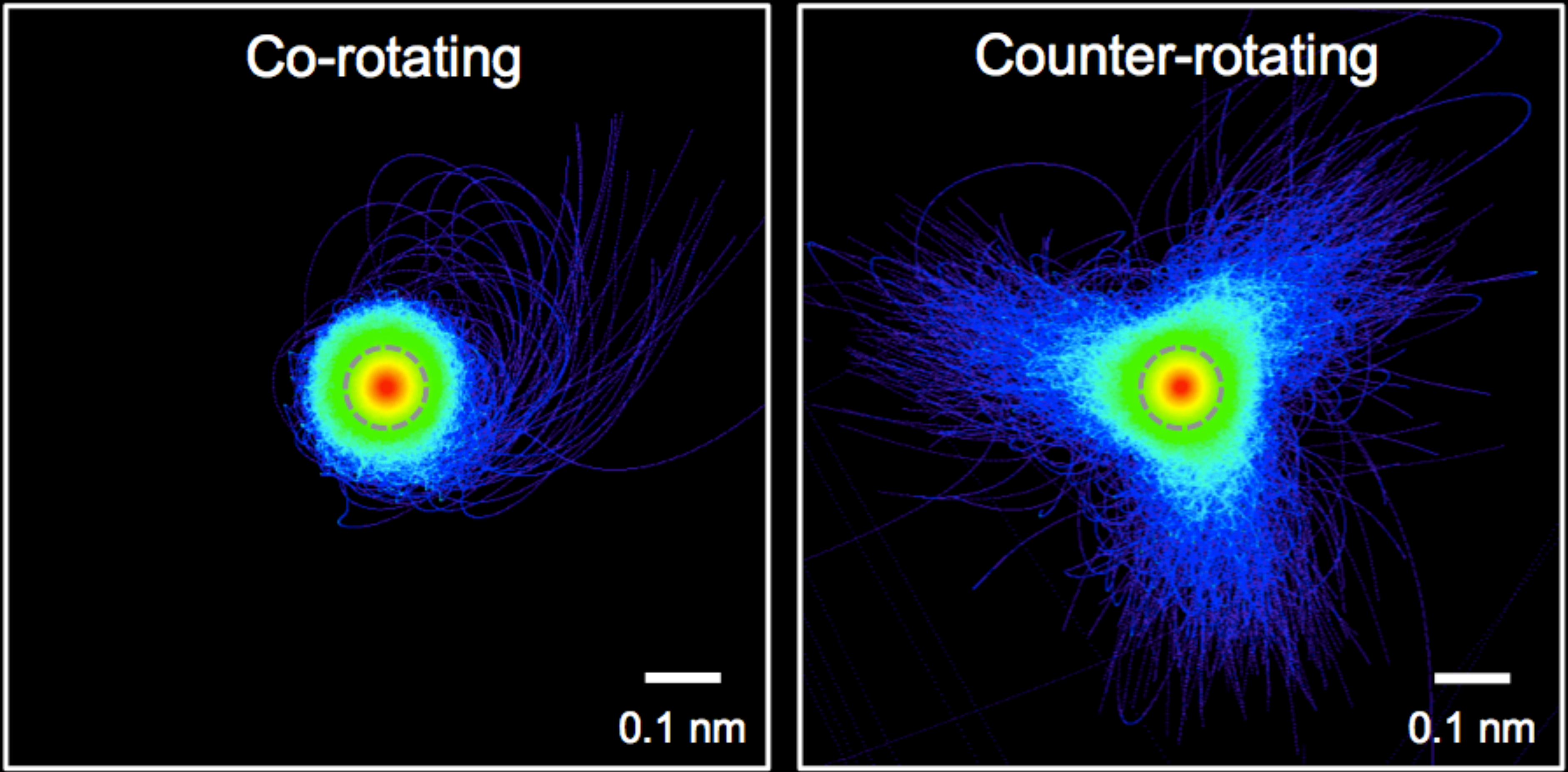
Mancuso, Dorney, Hickstein, Chaloupka, Ellis, Dollar, Knut, Grychtol, Zusin, Gentry, Gopalakrishnan, Kapteyn, Murnane, Physical Review Letters (September 2016)

also: Eckart, Richter, Kunitski, Hartung, Rist, Henrichs, Schlott, Kang, Bauer, Sann, Schmidt, Schöffler, Jahnke, Dörner, Physical Review Letters (September 2016)

enhancement of single ionization



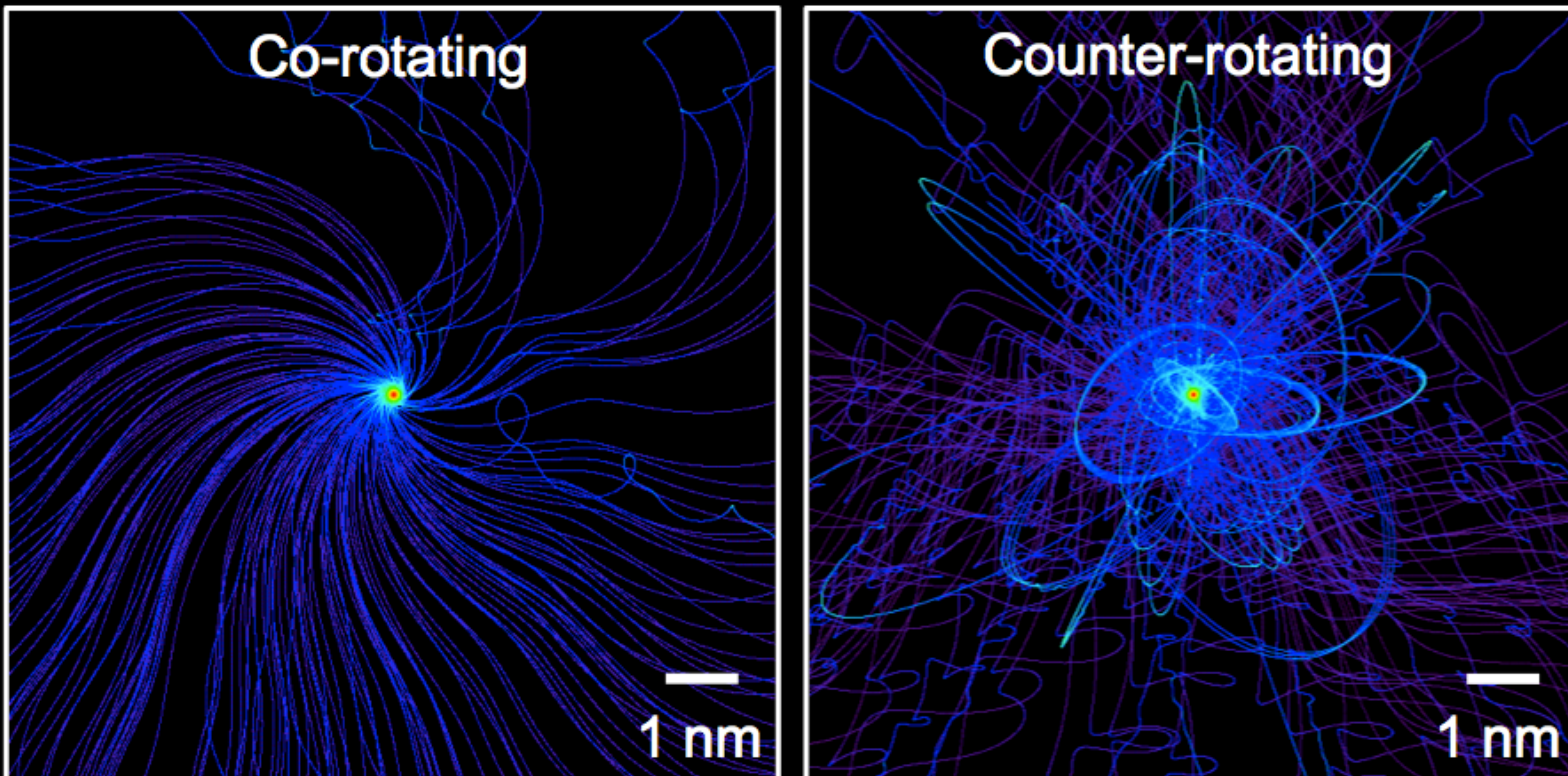
rescattering for single ionization

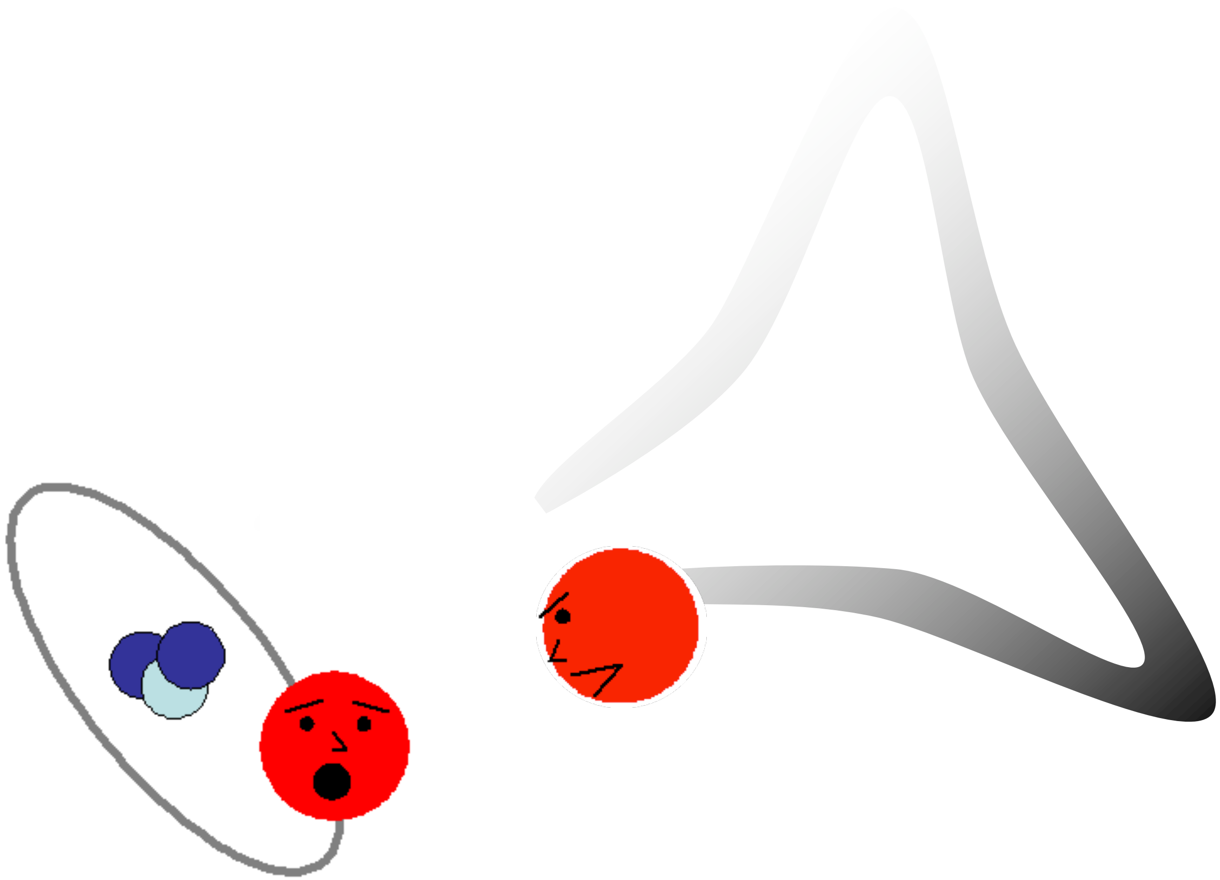


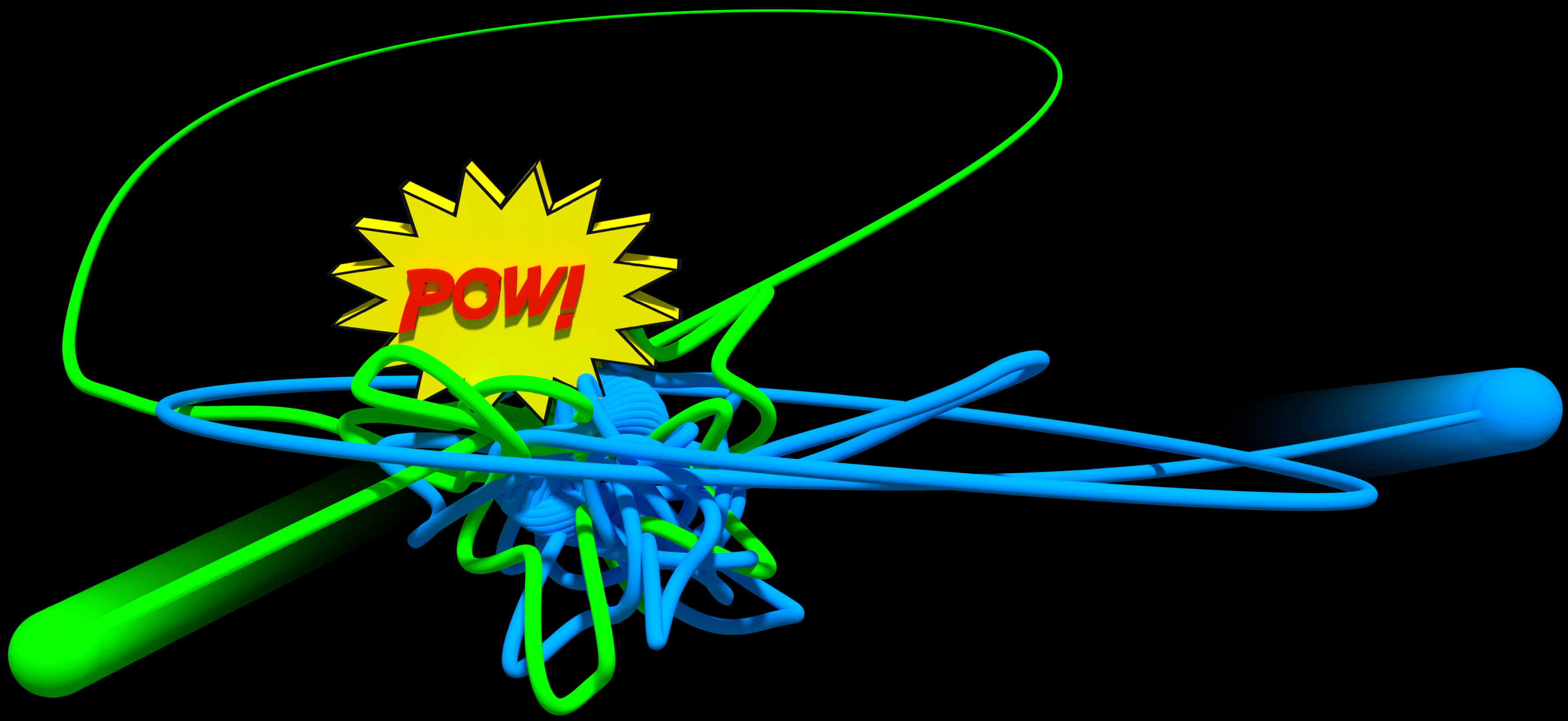
Mancuso, Dorney, Hickstein, Chaloupka, Tong, Ellis, Kapteyn, Murnane
Physical Review A (August 2017)

5×10^{14} W/cm^2
250 runs
1.8:1

generation of highly excited states







Questions?