MULTIDIMENSIONAL, ULTRAFAST LASER-BASED ANALYSIS OF COMPLEX, GAS PHASE MOLECULES

Analysis technology based on:

- **All molecules have a mass and signature fragmentation**
- **Universal ionization using intense, ultrafast laser pulses**
  - **(tunable from intact to dissociative ionization)**
- **Rapid time-of-flight mass analysis (kHz rep rate)**
- **Bond selective dissociation via laser pulse shaping**
  - **(10^40 distinct pulse shapes or sensors)**
- **Multi-Dimension Sensor and Detection Space**
- **Signal processing and optimization of sensor pulses**

Expected metrics:

- **10 kHz sensor update rate**
- **Universal detector**
- **Sub-picomol sensitivity**
- **Capable of handling unknown compounds**

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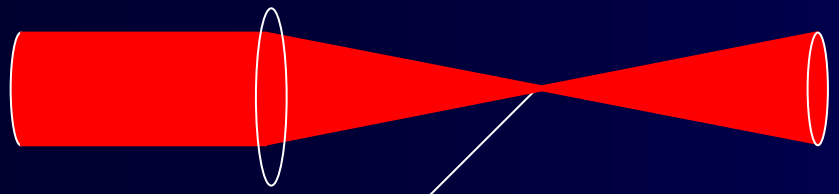
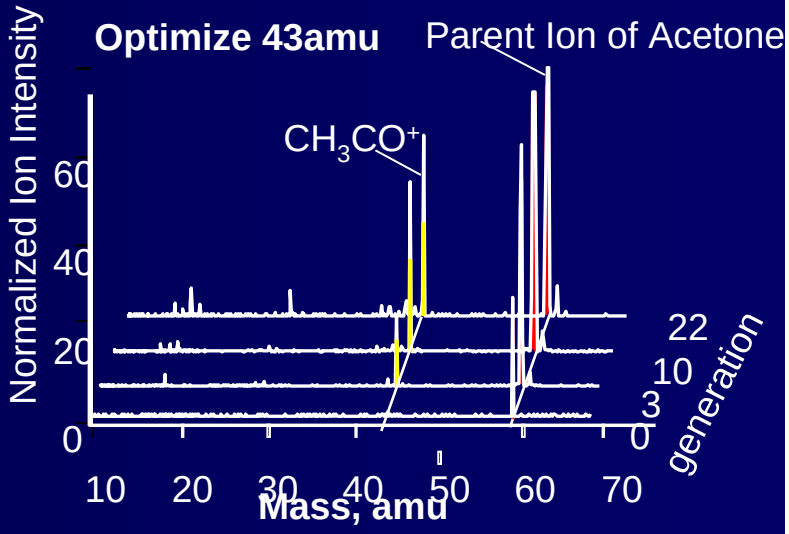
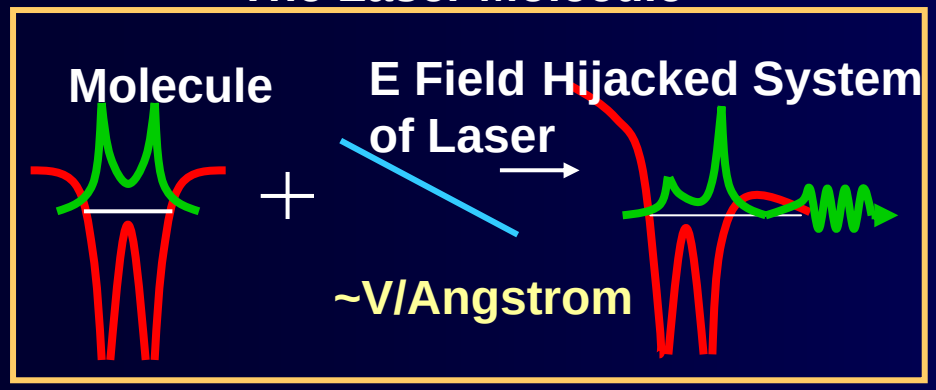
Optimal Control of Chemical Reactions

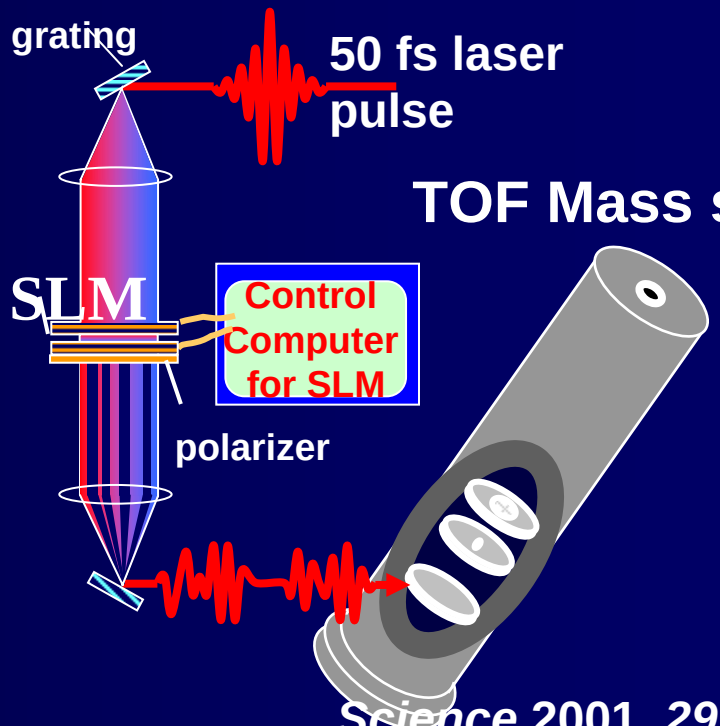


Given 1mJ, 60fs focused to 100 micron diameter:
photon density **~10^9 photons/cubic wavelength**
electric field strength **~6 Volts per Angstrom**.



The Laser Molecule





$nh\nu + ABC \rightarrow$

$A + B + C$	(MPD)
$AB^+ + C$	(Dissociative Ionization)
$A^+ + B^+ + C^+$	(Coulomb Explosion)
$ABC^+ + e^-$	(Molecular Ionization)
ABC^*	(Electronic Excitation)
$ABC^* + h\nu'$	(Nonlinear Optics)

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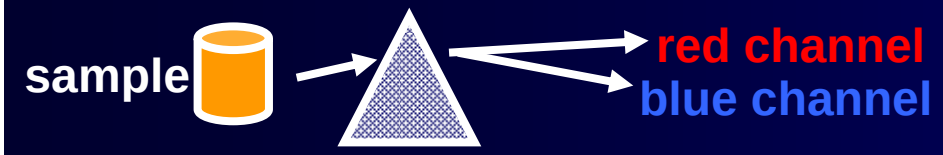
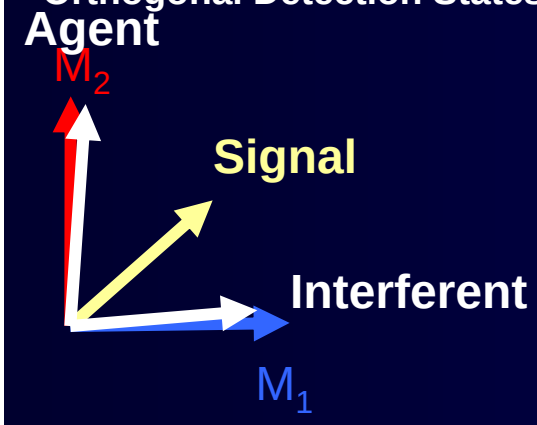
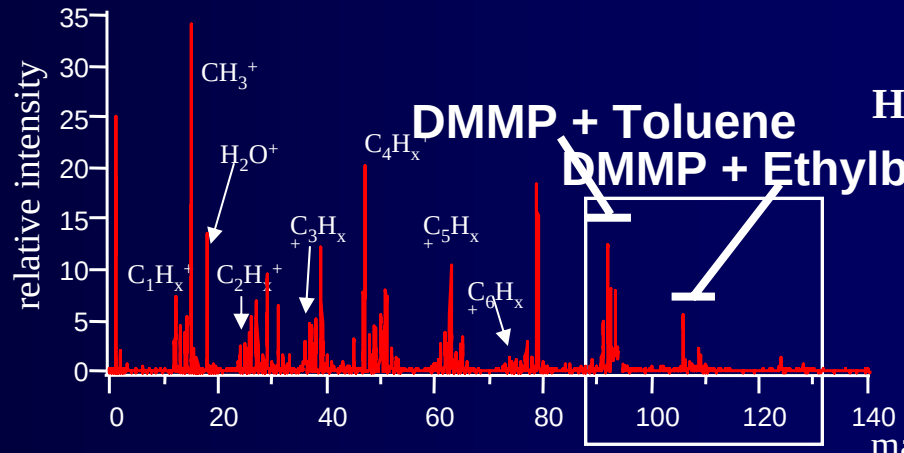
The PACT Challenge: Discriminating Multiple Targets in Interferent Background

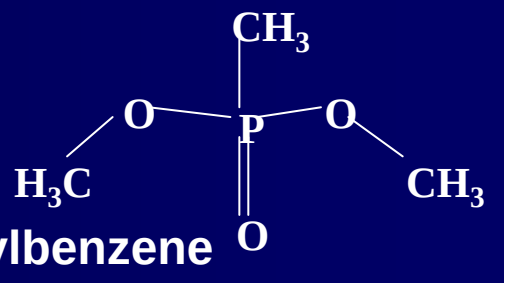


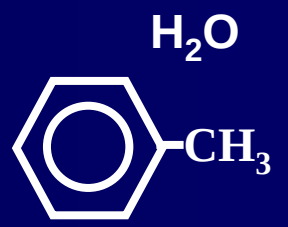
Demonstration of Vector Rotation for Complex Interferent Problem: DMMP in Fuel/Water

Ideal Situation:
Orthogonal Detection States



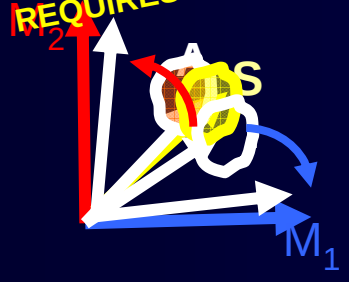


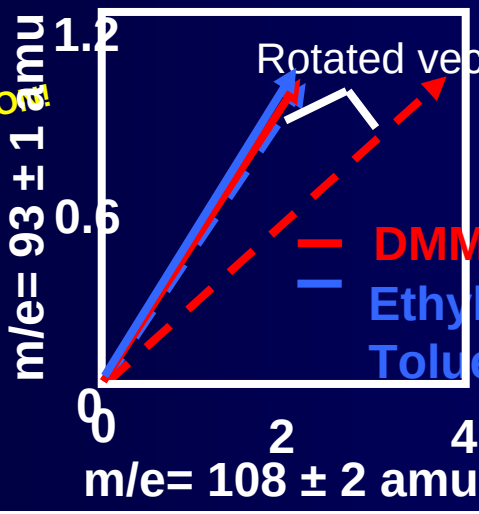


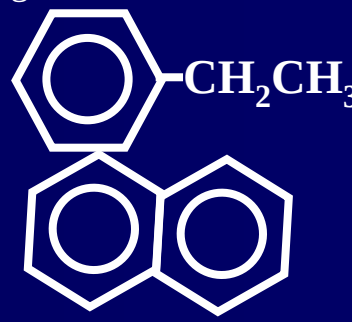


Less than Optimal:
Ill-Resolved Detetion States

REQUIRES HAMILTONIAN MANIPULATION!







Journal of Modern Optics
55 (1): 177-185 (2008)