ALFF Workshop Summary

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ALFF : Argonne Linear FEL Facility … is a proposed upgrade to LEUTL

Potential for new users and new science at the APS:

- Based on free-electron laser (FEL)
- Femtosecond pulsed visible-VUV
- Currently operational part time
- Funding request to DOE

ALFF will be a unique source

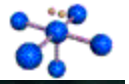
Parameter	Current (LEUTL)	Upgrade (ALFF)
Tuning range	660-120 nm	450-55 nm
Photon energy (E)	2-10 eV	2.7-22 eV
Bandwidth (ΔE/E)	>0.4%	0.3%
Pulse energy	30 μJ	>200 μJ
Pulse duration	<300 fs	<300 fs
Repetition rate	6 Hz	30 Hz
Availability	3%	96%

Workshop charge: two questions

- What are the scientifically important experiments that can only be done with the proposed ALFF facility?
- Are the combined ALFF characteristics of pulse energy, tunability, pulse length and coherence sufficiently unique to justify establishing a user facility at this time?

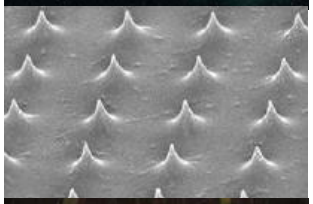
Diverse User Science was Represented

Four working groups and panel:

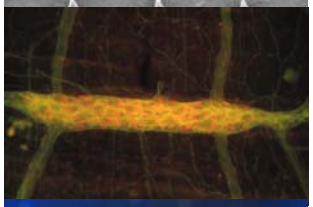


AMO and Chemical Physics

Cosmochemistry and Geochemistry



Materials Science

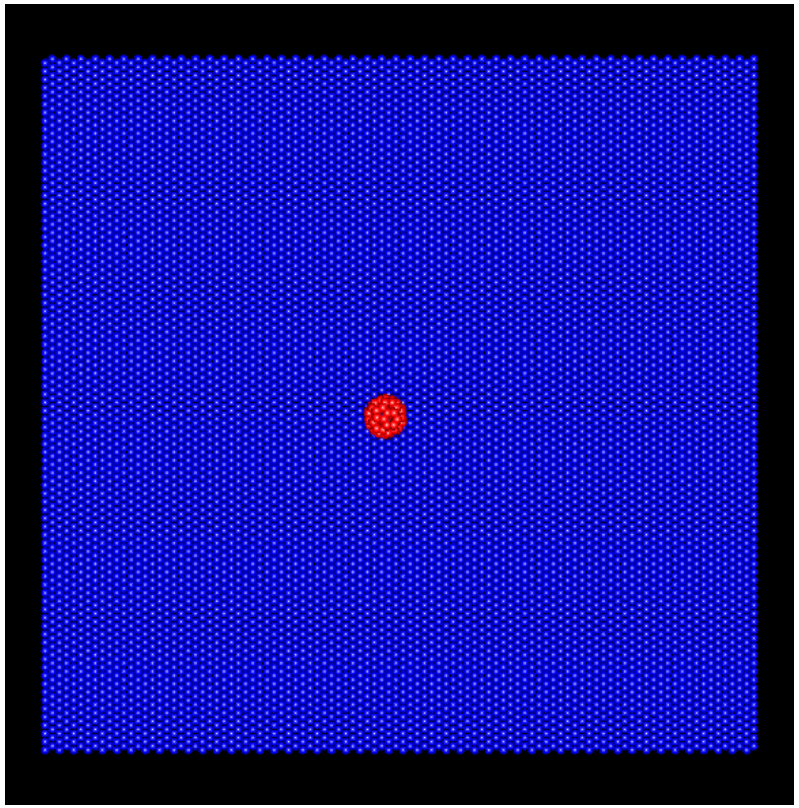


Biology and Environmental Science

Panel: Tabletop VUV/EUV Sources

Desorption is a fundamental phenomenon

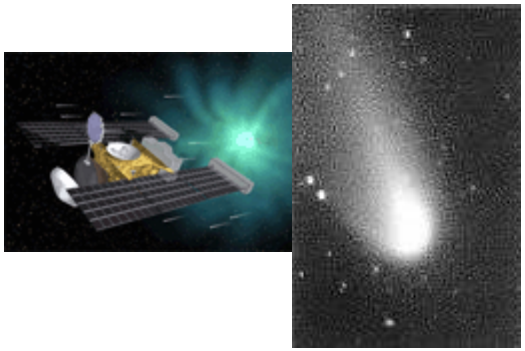
Solid-gas chemistry, plasma processes, deposition, fusion reactor walls (ITER), analysis methods



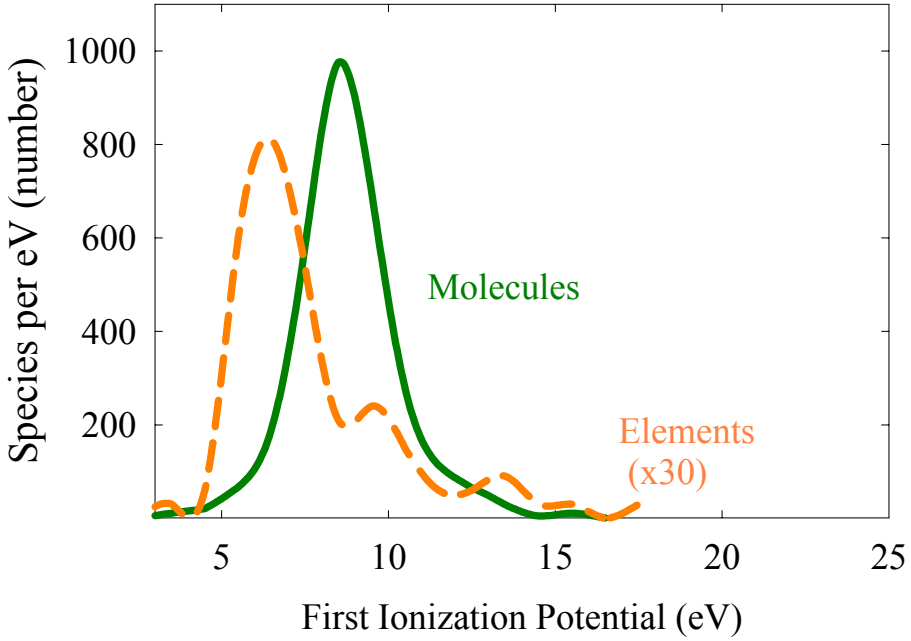
ALFF will dramatically impact understanding of desorption

Isotopes are the signature of nucleosynthesis

NASA: Stardust and Genesis Discovery Missions



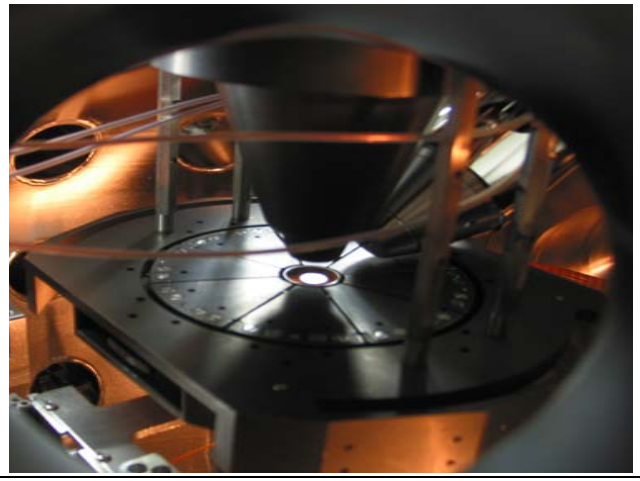
ALFF will allow efficient measurement of isotope ratios by single photon ionization (SPI)



SPIRIT is the First User Instrument at the FEL

Single Photon Ionization or Resonant Ionization to Threshold

- Novel time of flight mass spectrometer
- High efficiency
- Low noise and background – vital for ultratrace measurements



Ion source region of SPIRIT

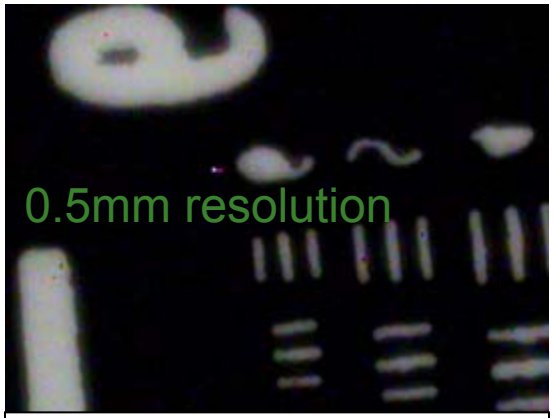
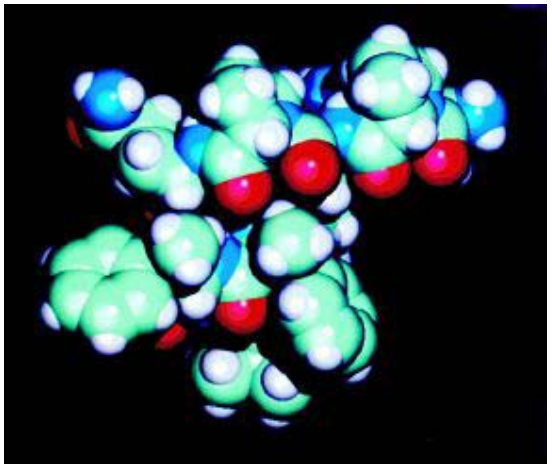
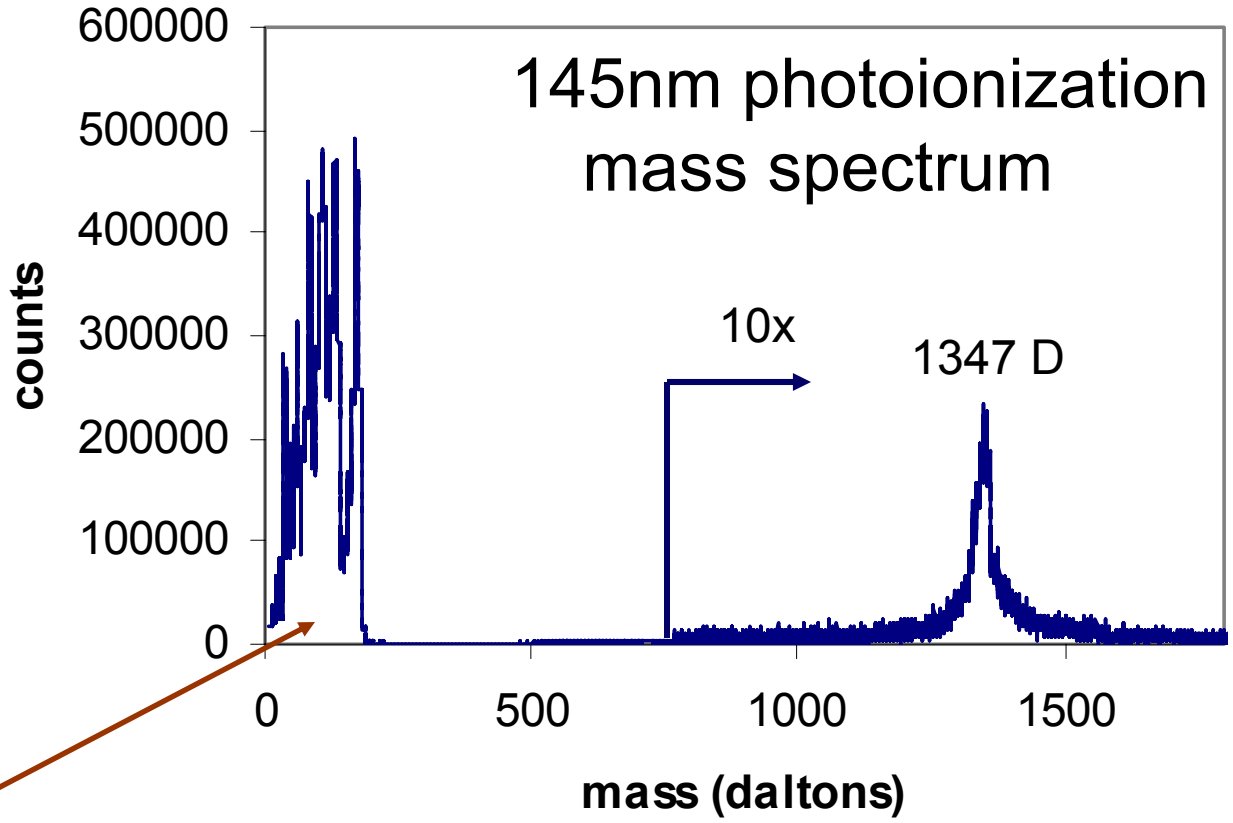


Image from integrated optical microscope

Peptide Analysis is Possible!



Substance P



Matrix signal
(background)

Presented by B.V. King, University of Newcastle

Breakthrough results with SPIRIT

- Peptide intact mass measurement
- Anomalous sputtering from gold alloys
- Selective detection of high ionization energy species (Be, P, Si)
- 200x increased sensitivity for measuring nucleobase-adduct (biomolecule)
- 24% useful yield – 1 in 4 atoms counted!

Very limited beamtime; much commissioning remains

Proposed studies at ALFF – selected

Mark Knickelbein/ANL	Photoabsorption of clusters
Laurie Butler/ U of C	Photodissociation of radicals
Steve Pratt /ANL	Double photoionization of Kr
Cheuk Ng/ UC Davis	Spectroscopy of radicals and ions
Andreas Wucher	Fundamental studies of sputtering processes
Bruce King	Sputtering of nanoparticles: where are the limits to the collision cascade theory
Igor Veryovkin	Surface analysis by SPI of atoms and molecules

More proposed studies

Robert Clayton / U of Chicago	RIMS of carbon, nitrogen, oxygen, and noble-gas isotopes in special samples
C. H. Winston Chen / ORNL	VUV Ionization of Nanoparticles & Biopolymers
Typhoon Lee / Academia Sinica, Taiwan	Nuclear Astrophysical Origin of Stardusts from comets and meteorites
M. Paul Chiarelli/ Loyola University Chicago	Controlled fragmentation of Biomolecules by VUV photoionization
H. Gnaser/ Dept. of Physics, Kaiserslautern University of Technology	Desorption and VUV ionization of organic/bioorganic molecules from nanocrystalline TiO_2 films

More proposed studies

Libor Juha/	Materials Processing by Laser Ablation
Dave Keavney/ ANL	Sub-ps magnetic domain imaging
David Patterson/ ANL	Single-shot spatial coherence measurement
Nick Lockyer/ UMIST	Imaging cells with C_{60} bombardment and VUV postionization
Luke Hanley/ UI-Chicago	Two-photon photoemission as an electronic structure probe of conducting polymers
Martina Schmeling/ Loyola University Chicago	Study of atmospheric aerosols by laser post-ionization TOF mass spectrometry
J. Albert Schultz/	Analysis of biological samples (with no matrix) and an orthogonal TOF-MS

Second charge point addressed

• Are the combined ALFF characteristics of pulse energy, tunability, pulse length and coherence sufficiently **unique** to justify establishing a user facility at this time?

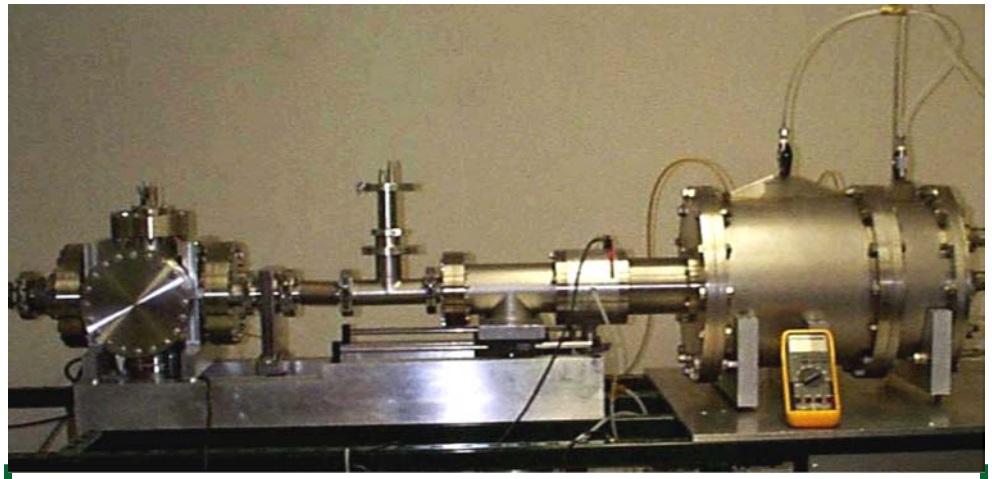
Invited:

Jorge Rocca – Colorade State University
Margaret Murnane – JILA / UC Boulder

In addition to many laser experts among the potential users

Ne-like Ar Capillary discharge laser

Colorado State University

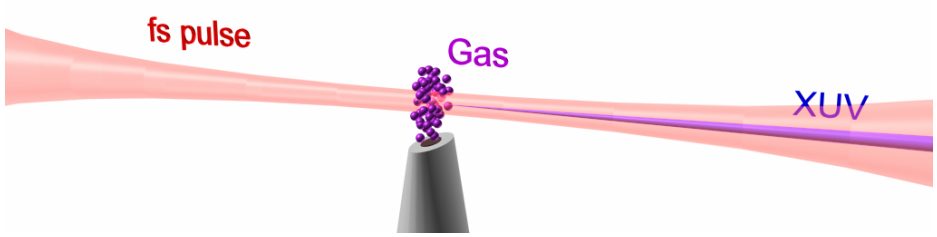


λ=46.9nm

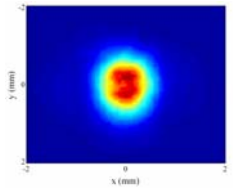
- Pulse Energy: 0.88 mJ @ 4 Hz
- Pulsewidth : 1.2 - 1.5 ns

High pulse energy but not tunable

High harmonic generation



Gas jet



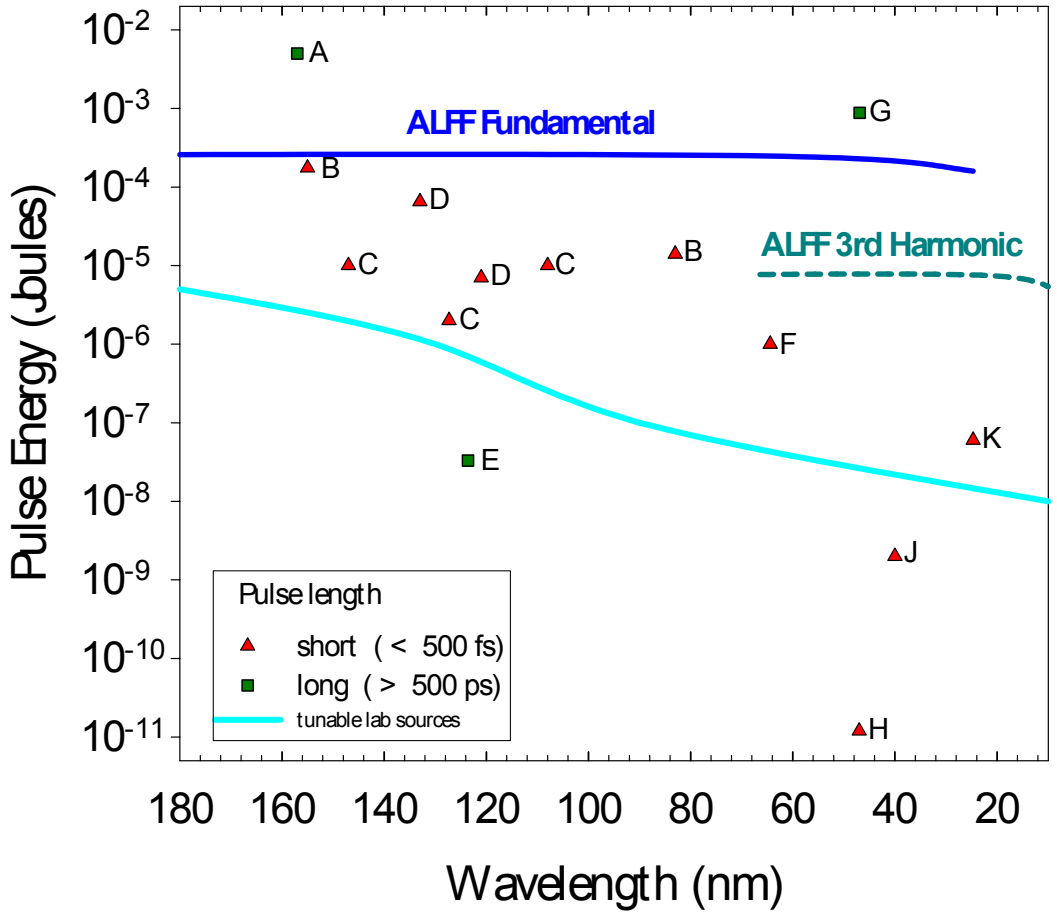
EUV beam

High rep rate, femtosecond, mostly tunable in EUV

- Broad range of harmonics generated simultaneously from 4.5 - 550 eV
- "Laser-like" coherent beams in EUV **(Science** 297**, 376 (2002), Nature** 406**, 164 (2000))**

But pulse energy low and tunability limited in UV and VUV!

Unique tunability, pulse energy, pulse length



- What are the scientifically important experiments that can only be done with the proposed ALFF facility?
  - Over 30 user-proposed experiments
  - 5 different user instruments
  - “When can we start ?!”
  - Parameters a good match for science in most cases
  - SPIRIT is already producing results, but more beamtime, energy needed

• Are the combined ALFF characteristics of pulse energy, tunability, pulse length and coherence sufficiently unique to justify establishing a user facility at this time?

YES! State of the art VUV (and EUV) lasers are complimentary, but not sufficient.

Interest in using such lasers for pump-probe experiments

Workshop chair = film director

Talks and workshop report
http://www.aps.anl.gov/conferences/ALFFworkshop

Workshop committee

- Catherine Eyberger
- Kwang-Je Kim (chair)
- John Lewellen
- Steve Milton
- Dennis Mills
- Elizabeth Moog
- Jerry Moore
- Michael Pellin