Overview of Experiments and methods

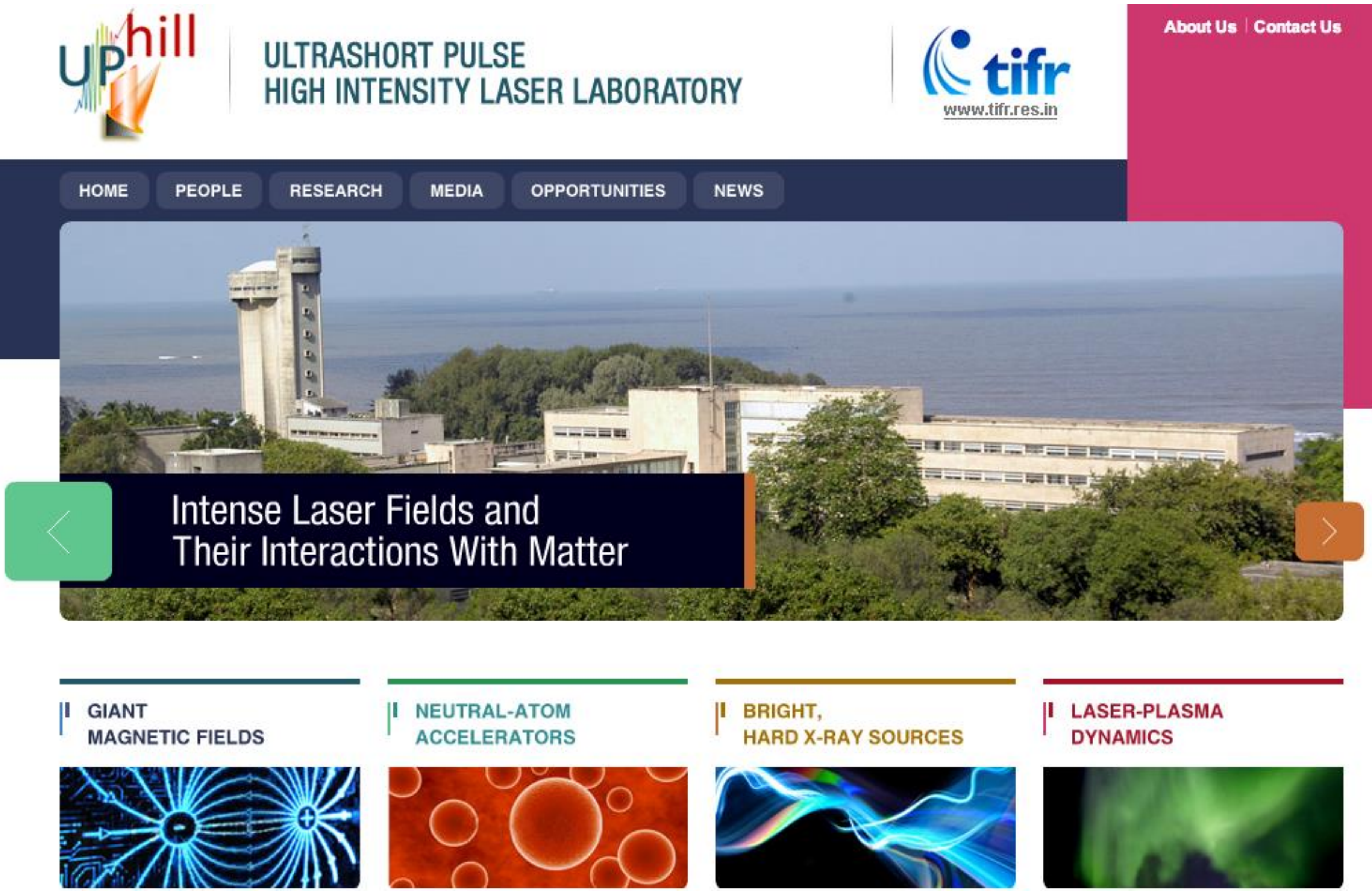
M. Krishnamurthy

Tata Institute of Fundamental Research (TIFR),

Mumbai & Hyderabad


Kabul
Islamabad
JAMMU AND KASHMIR
Pakistan
Lahore
HIMACHAL PRADESH
Chandigarh
PUNJAB
UTTARAKHAND
HARYANA
New Delhi
UTTAR PRADESH
Nepal
Kathmandu
SIKKIM
Bhutan
RAJASTHAN
Lucknow
ASSAM
Karachi
BIHAR
MEGHALAYA
Bangladesh
MANIP
MADHYA PRADESH
JHARKHAND
TRIPURA
GUJARAT
Ahmedabad
Indore
India
WEST BENGAL
MIZORAM
CHHATTISGARH
Surat
ODISHA
MAHARASHTRA
Mumbai
TELANGANA
Hyderabad
GOA
ANDHRA PRADESH
KARNATAKA
Bengaluru
Chennai
Bay of Bengal
Mysuru
TAMIL NADU
Kochi
KERALA
Google
Sri Lanka

http://www.tifr.res.in/~uphill



uphill

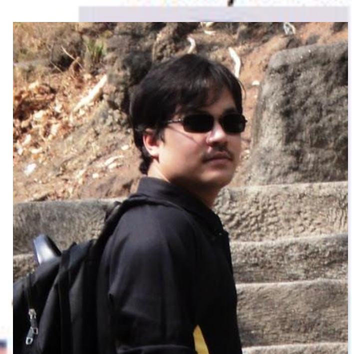
Prashant K. Singh

Gourab Chatterjee

Malay Dalui

pushan

G. Ravindra kumar



shugranshu

Amit D. Lad

krishanu

Sheroy tata

J. Jha

R. Rajeev

K. P. M. Rishad

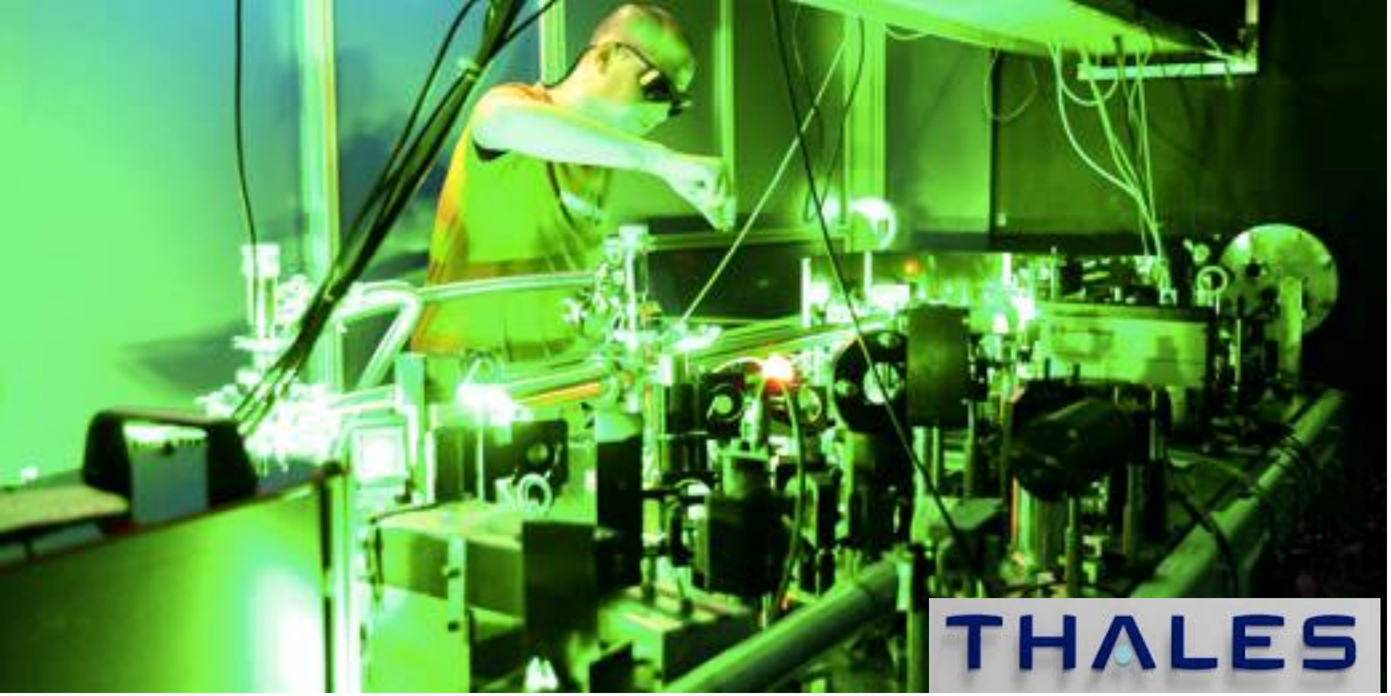
Madhu Trivikram

Angana monda

Soubhik sarkar

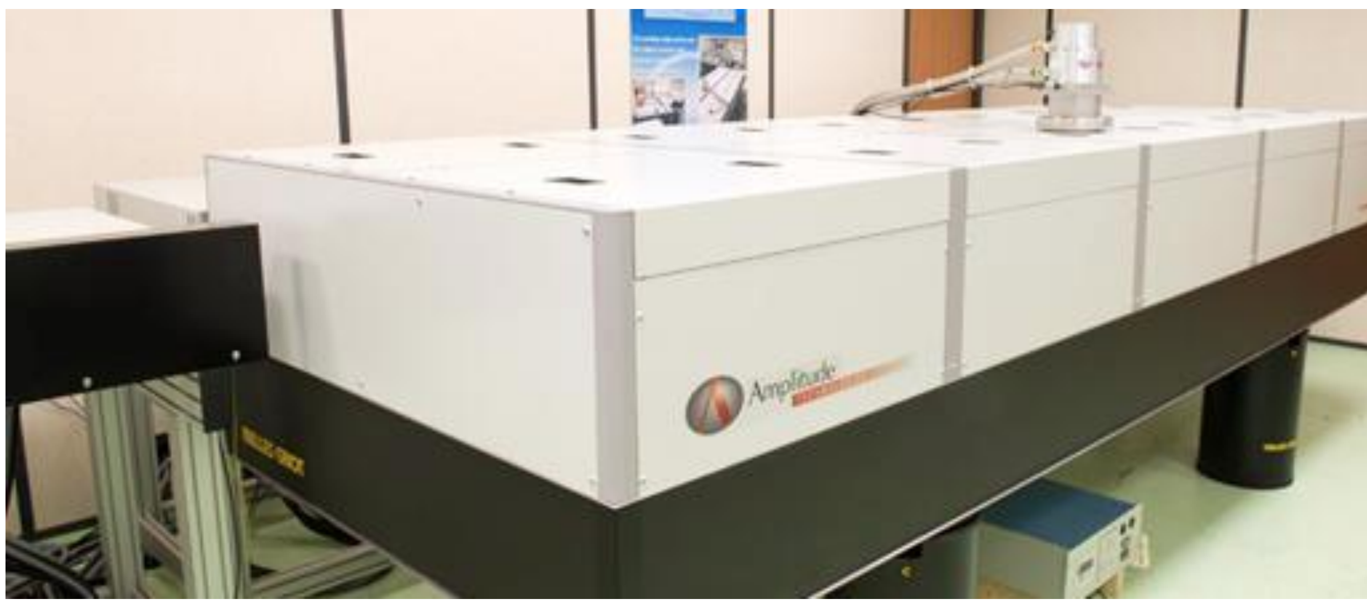
uphill tifr

Hyderabadi team



20 Tw
40 fs
10Hz

100 Tw
40 fs
10Hz



6 mJ @25 fs
or
1.8 mJ @6 fs

1000Hz

@Hyderabad

Main Theme

- Microscopics of intense field ionisation and plasma generation

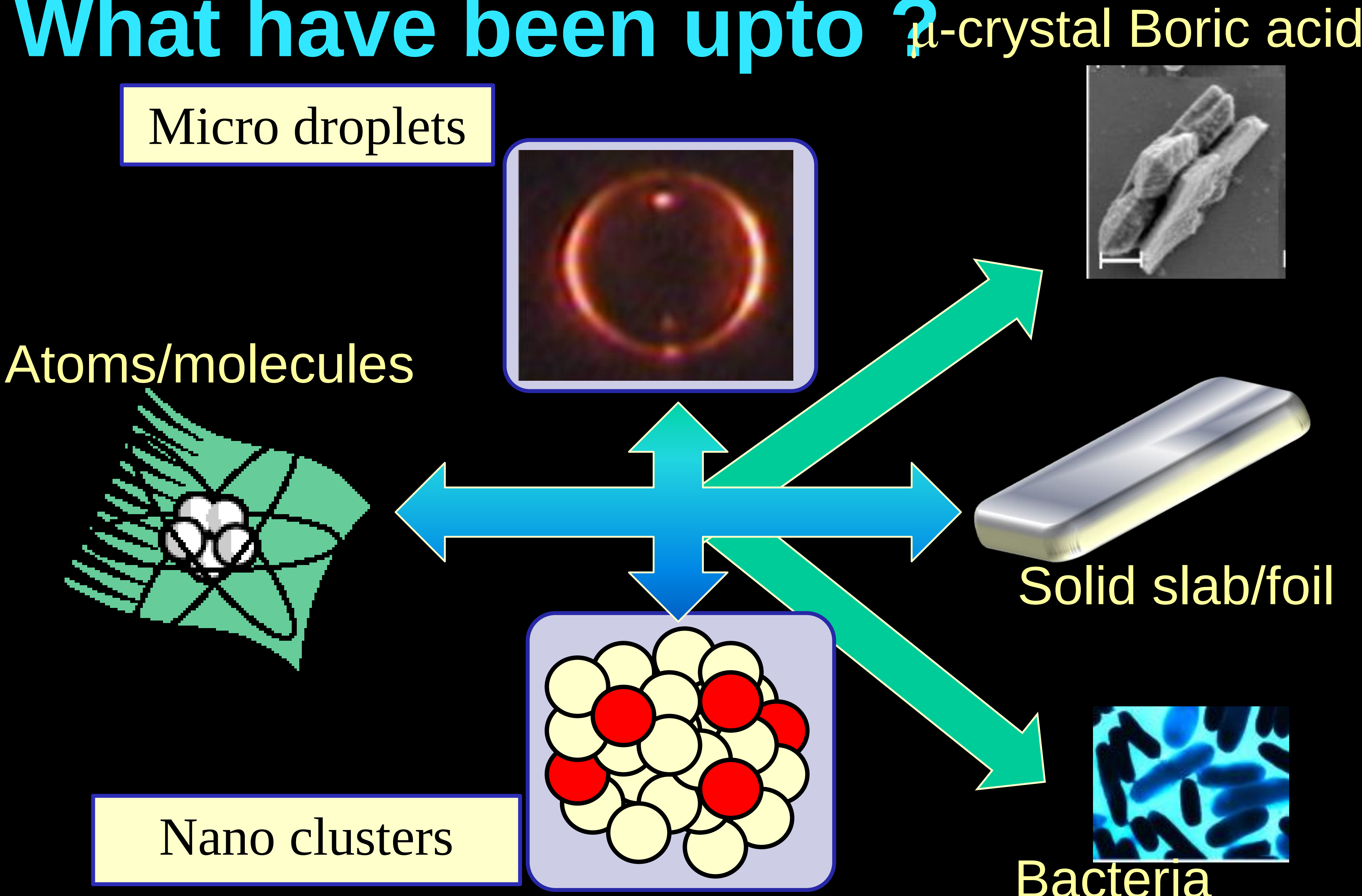
- Understanding the laser interaction in matter and
- Manipulating laser produced plasma for selective channeling of the absorbed energy

Hot electrons in plasma : Generation, propagation, magnetic fields

Neutral atom acceleration; negative ions generation; coloumb explosion

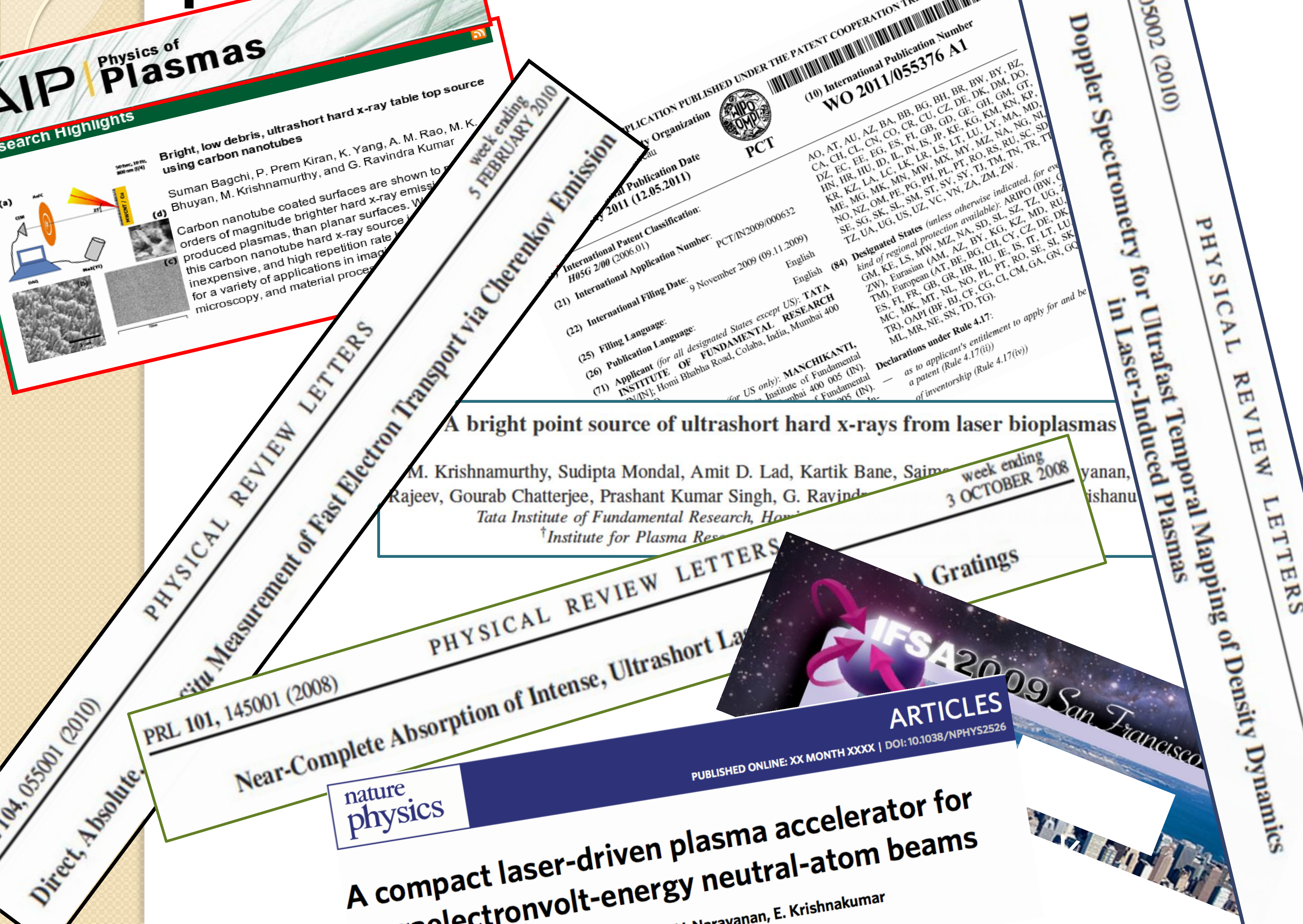
X-ray emission from novel targets; increasing absorption; lowering laser threshold

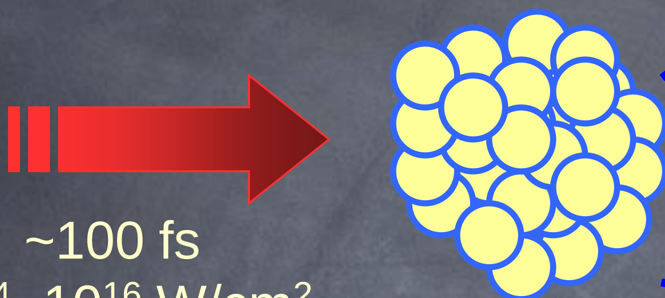
What have been upto ?



** @TIFR a unique environment is setup to study all the different states of matter under single roof with the same laser.

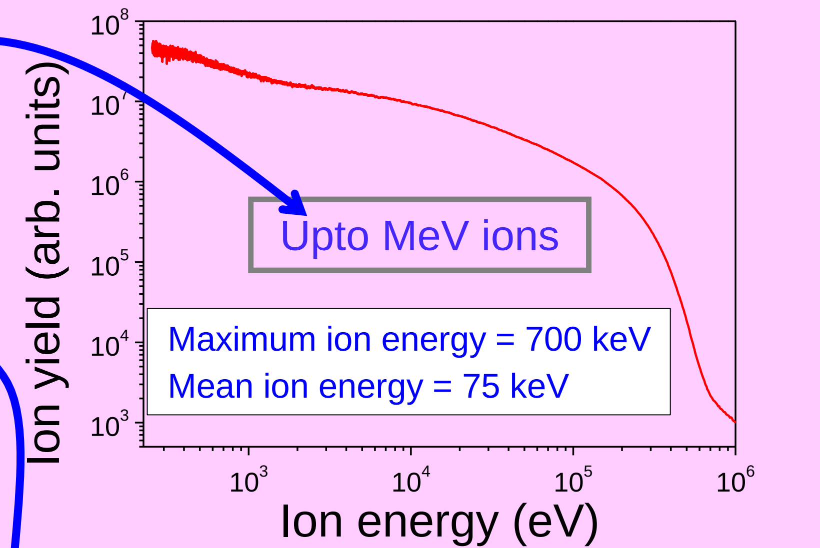
A Snapshot!


AIP Physics of Plasmas
Research Highlights
Bright, low debris, ultrashort hard x-ray table top source using carbon nanotubes
Suman Bagchi, P. Prem Kiran, K. Yang, A. M. Rao, M. K. Bhuyan, M. Krishnamurthy, and G. Ravindra Kumar
PHYSICAL REVIEW LETTERS
week ending 5 FEBRUARY 2010
Direct, Absolute, in situ Measurement of Fast Electron Transport via Cherenkov Emission
104, 055001 (2010)
PATENT COOPERATION TREATY (PCT)
(10) International Publication Number
WO 2011/055376 A1
PCT
A bright point source of ultrashort hard x-rays from laser bioplasmas
Tata Institute of Fundamental Research
PHYSICAL REVIEW LETTERS
week ending 3 OCTOBER 2008
PRL 101, 145001 (2008)
Near-Complete Absorption of Intense, Ultrashort Laser Light by Sub-λ Gratings
IFSA 2009 San Francisco
ARTICLES
PUBLISHED ONLINE: XX MONTH XXXX | DOI: 10.1038/NPHYS2526
nature physics
A compact laser-driven plasma accelerator for megaelectronvolt-energy neutral-atom beams
PHYSICAL REVIEW LETTERS
105, 105002 (2010)
Doppler Spectrometry for Ultrafast Temporal Mapping of Density Dynamics in Laser-Induced Plasmas

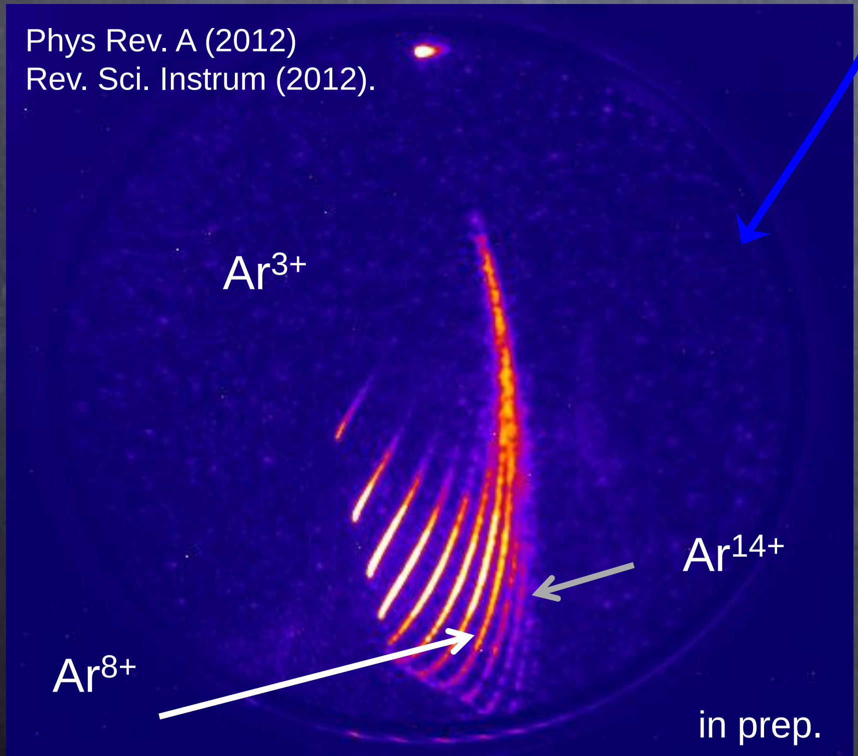


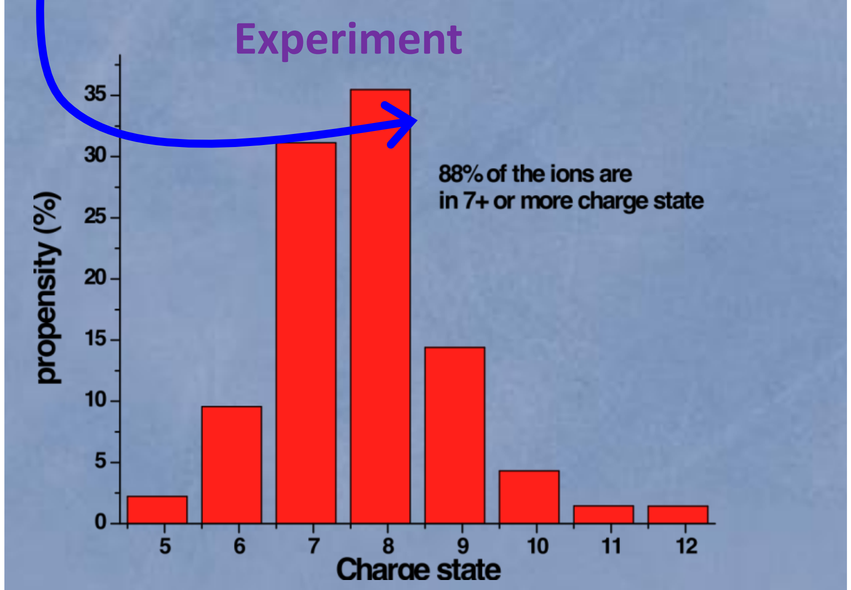
~100 fs
10^{14}- 10^{16} W/cm^2

10^3-10^4
atoms/cluster



Vinod et. al.Phys.Rev. Lett. 87, 085005(2001)





R.Rajeev et.al, ***Phys. Rev. A 85, 023201 (2012)***
J.Phys.B 39 625 (2006)

nature physics

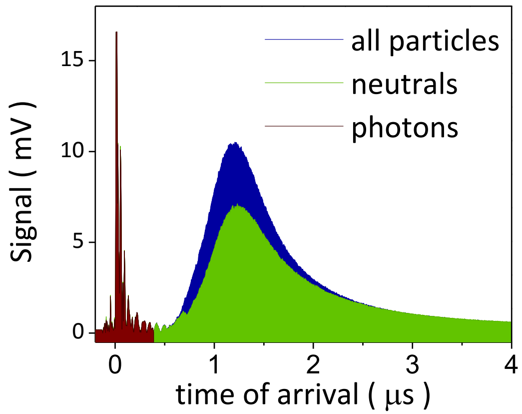
ARTICLES

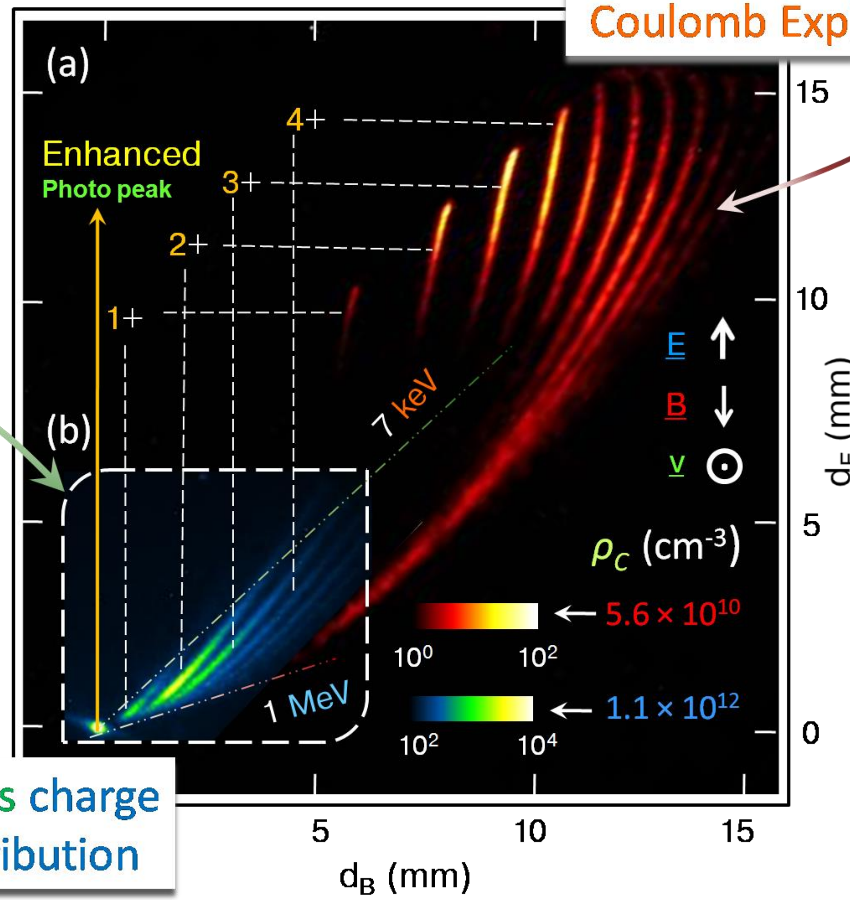
PUBLISHED ONLINE: XX MONTH XXXX | DOI: 10.1038/NPHYS2526

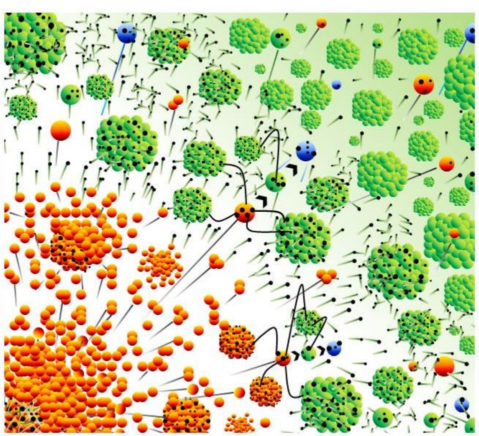
A compact laser-driven plasma accelerator for megaelectronvolt-energy neutral-atom beams

R. Rajeev, T. Madhu Trivikram, K. P. M. Rishad, V. Narayanan, E. Krishnakumar and M. Krishnamurthy*

Trace Signature for Coulomb Explosion

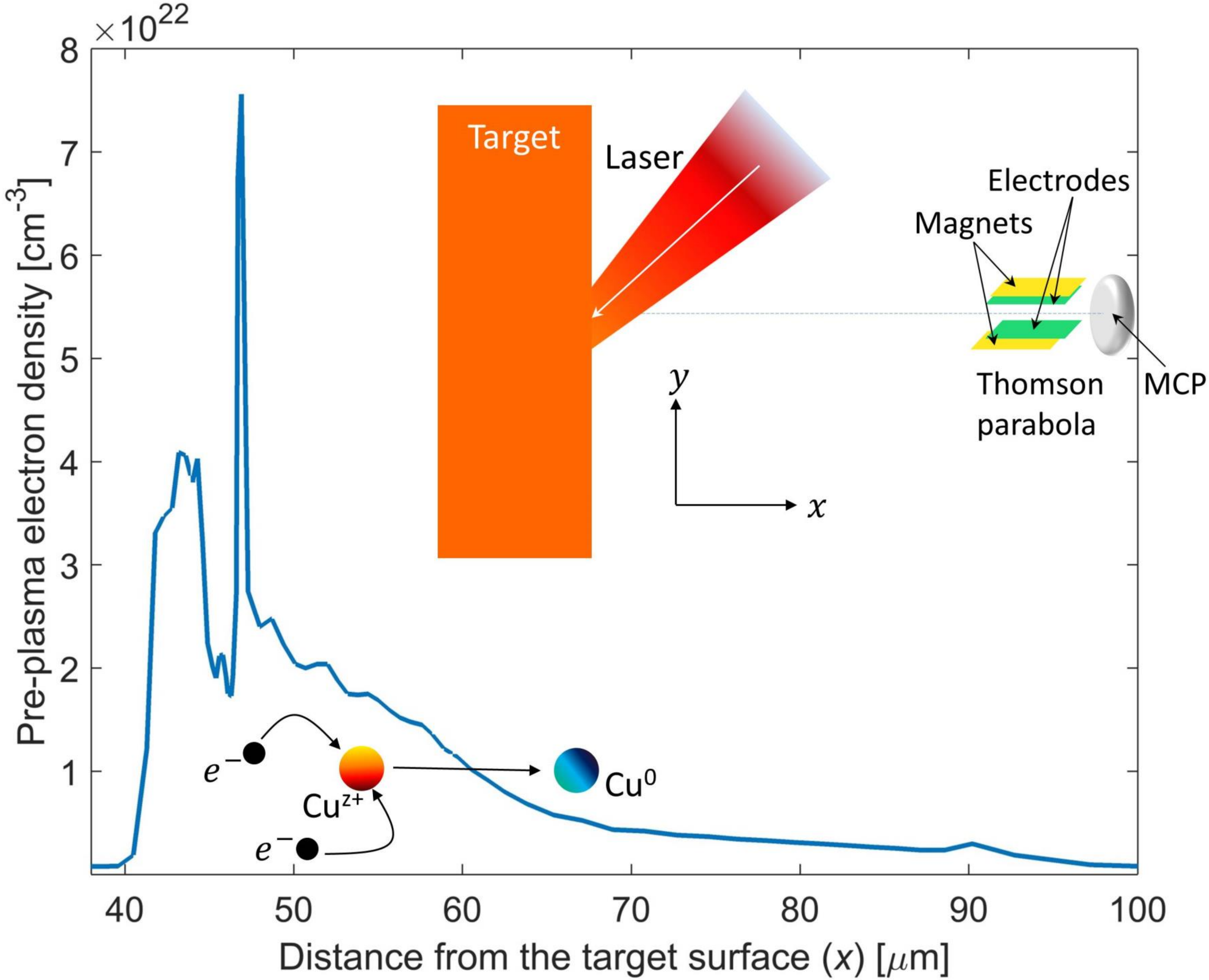




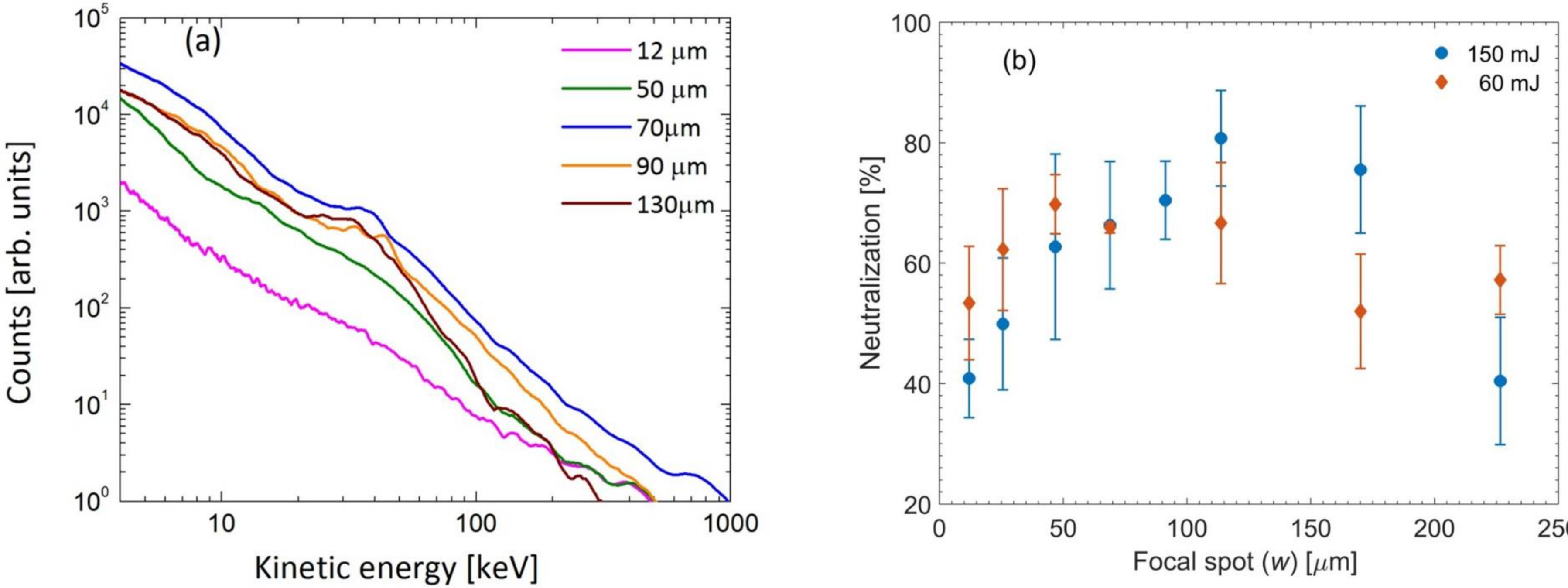


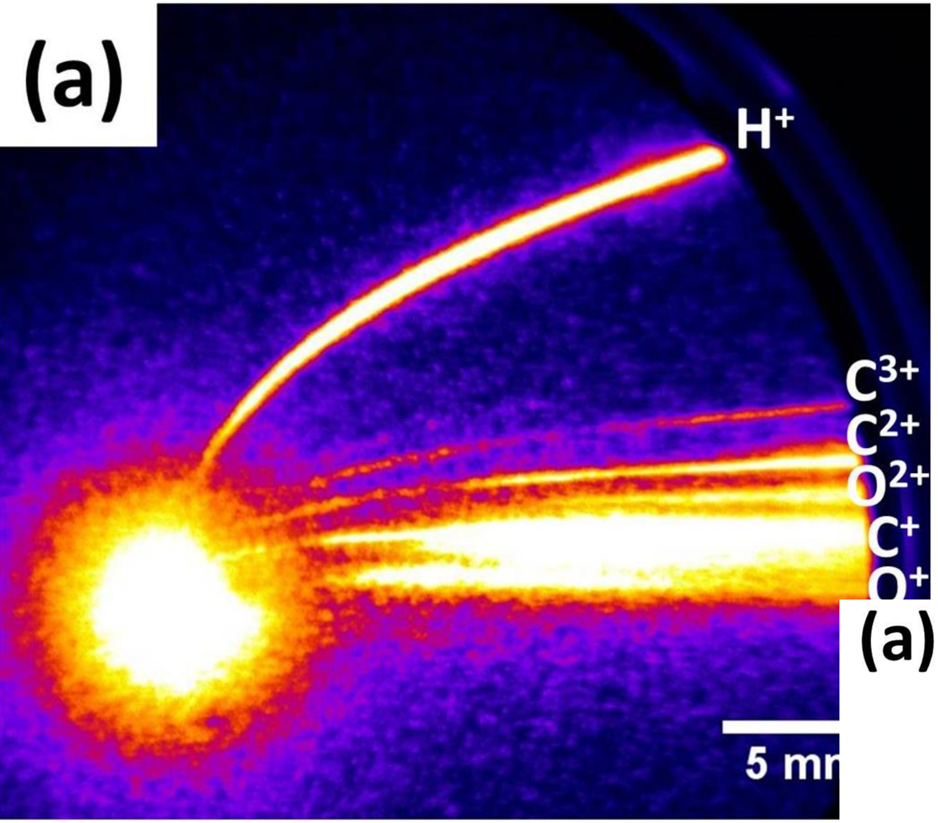
Anomalous charge state distribution

Cluster charged with neutrality

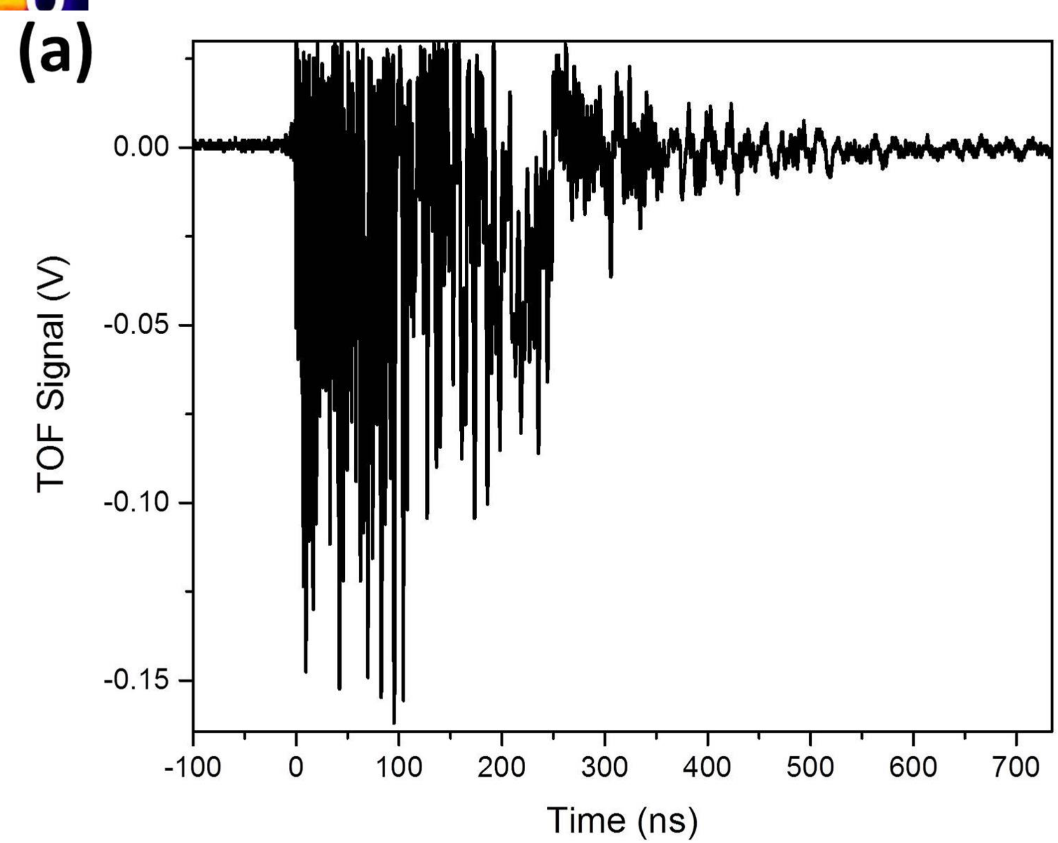


×10^22
8
7
6
5
4
3
2
1
Pre-plasma electron density [cm^-3]
40
50
60
70
80
90
100
Distance from the target surface (x) [μm]
Target
Laser
Electrodes
Magnets
Thomson parabola
MCP
y
x
e−
e−
Cu^z+
Cu^0

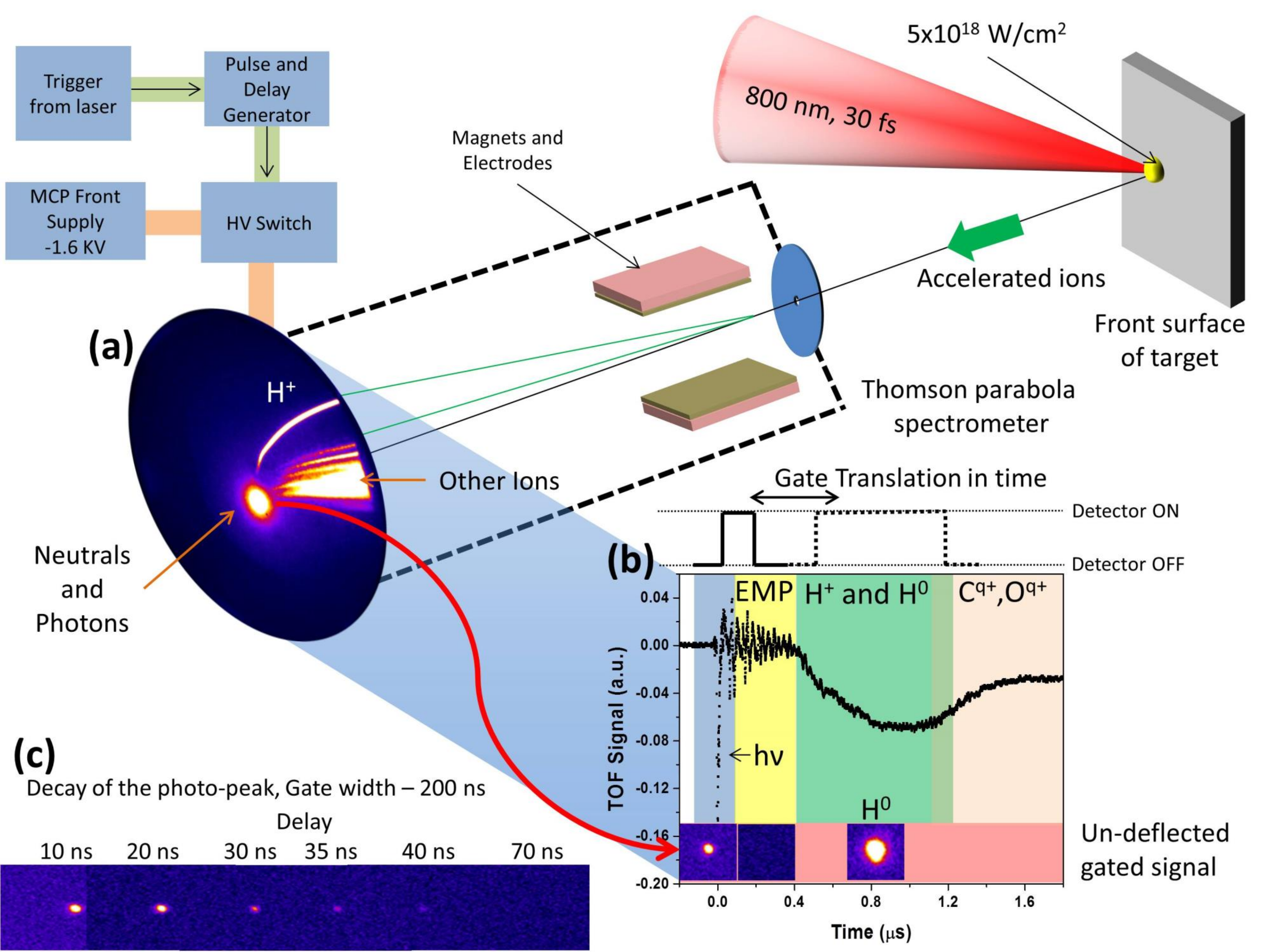

(a)
12 μm
50 μm
70μm
90 μm
130μm
Counts [arb. units]
Kinetic energy [keV]
(b)
150 mJ
60 mJ
Neutralization [%]
Focal spot (w) [μm]

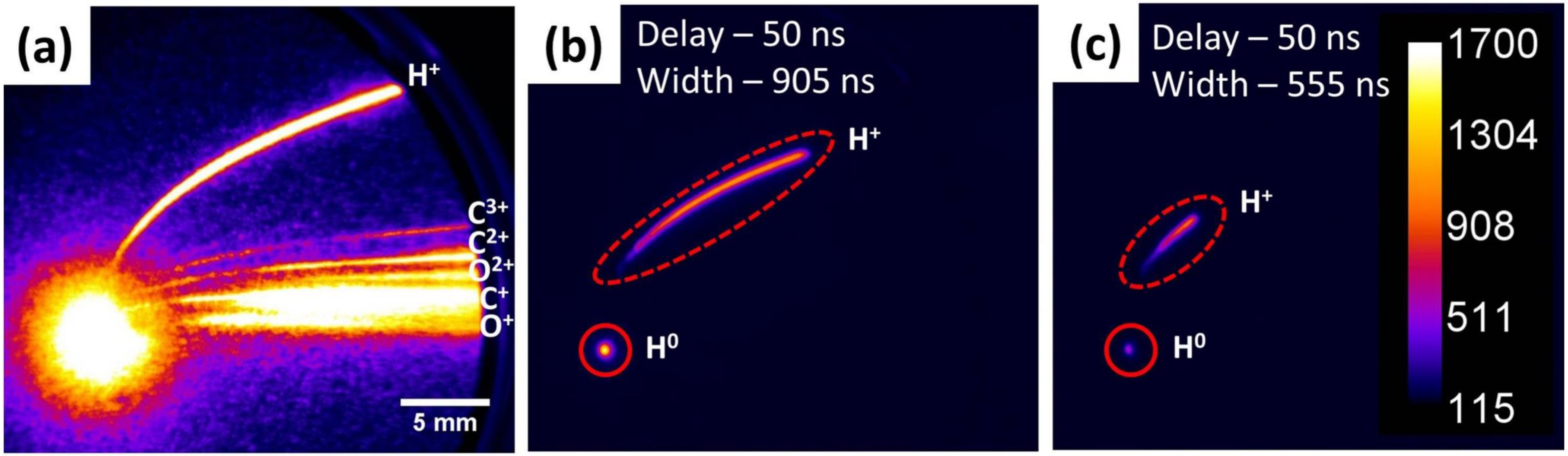


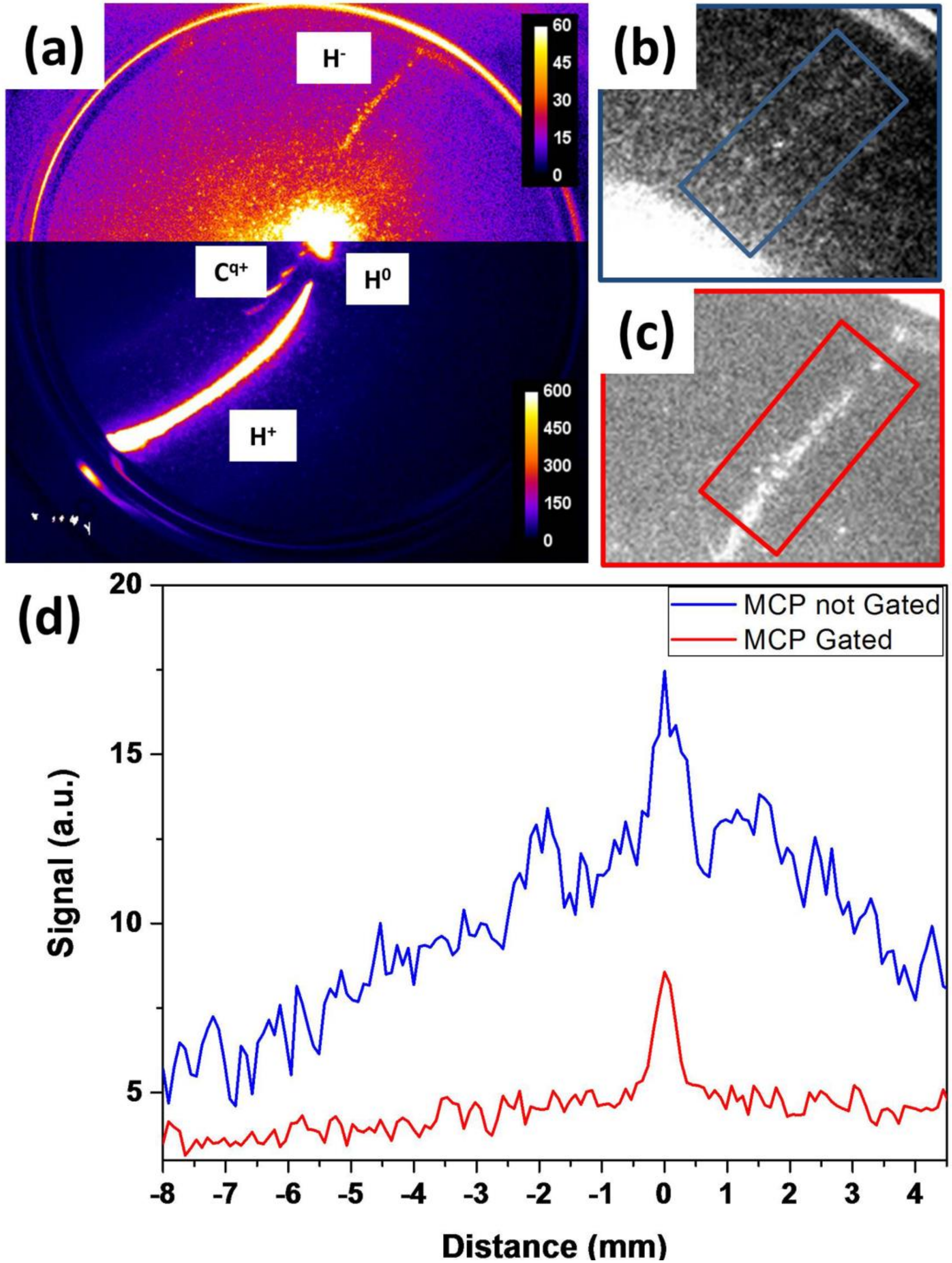
(a)
H+
C3+
C2+
O2+
C+
O+
5 mm



(a)
TOF Signal (V)
Time (ns)
0.00
-0.05
-0.10
-0.15
-100
0
100
200
300
400
500
600
700


Trigger from laser
Pulse and Delay Generator
MCP Front Supply -1.6 KV
HV Switch
Magnets and Electrodes
800 nm, 30 fs
5x10^18 W/cm^2
Accelerated ions
Front surface of target
Thomson parabola spectrometer
(a)
H+
Other Ions
Neutrals and Photons
Gate Translation in time
Detector ON
Detector OFF
(b)
EMP
H+ and H0
Cq+,Oq+
hν
H0
TOF Signal (a.u.)
Time (μs)
Un-deflected gated signal
(c)
Decay of the photo-peak, Gate width – 200 ns
Delay
10 ns
20 ns
30 ns
35 ns
40 ns
70 ns

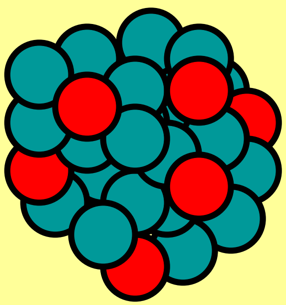

(a)
H+
C3+
C2+
O2+
C+
O+
5 mm
(b)
Delay – 50 ns
Width – 905 ns
H+
H0
(c)
Delay – 50 ns
Width – 555 ns
H+
H0
1700
1304
908
511
115



(a)
H-
60
45
30
15
0
Cq+
H0
H+
600
450
300
150
0
(b)
(c)
(d)
MCP not Gated
MCP Gated
Signal (a.u.)
Distance (mm)
20
15
10
5
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4

Doped cluster for better ion acceleration

novel and non-intutuitive



Ar clusters doped with water

~100 fs

10^{16} W/cm^2

10 fold in x-rays

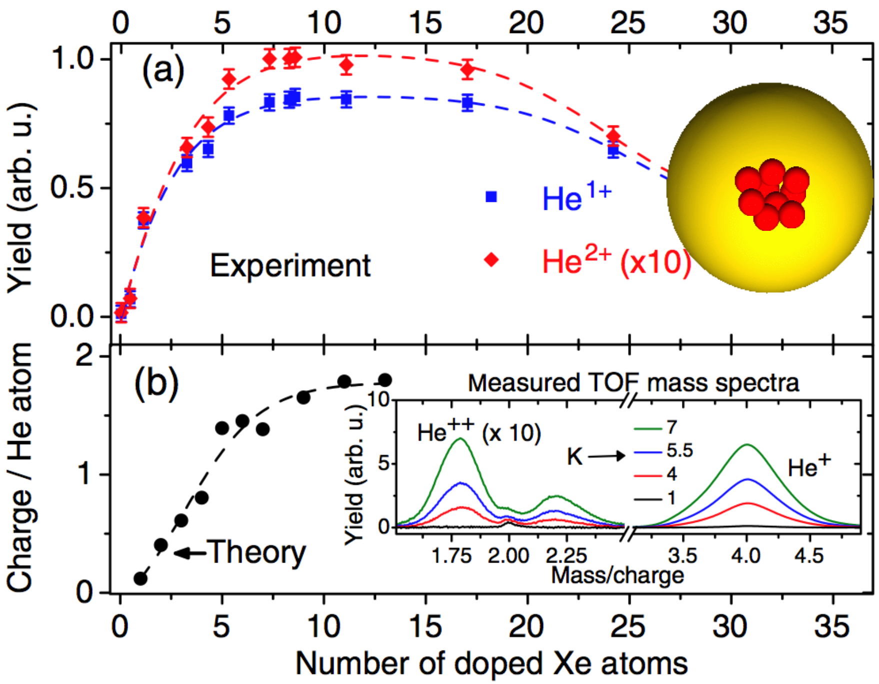
7 fold in electrons

3 fold in ions

Phys. Rev. Lett. (2001)
App. Phy. Lett (2006)
J.Phys. B Lett. (2005)
Chem. Phys. Lett. (2006)
Euro.Phys. Lett (2008)

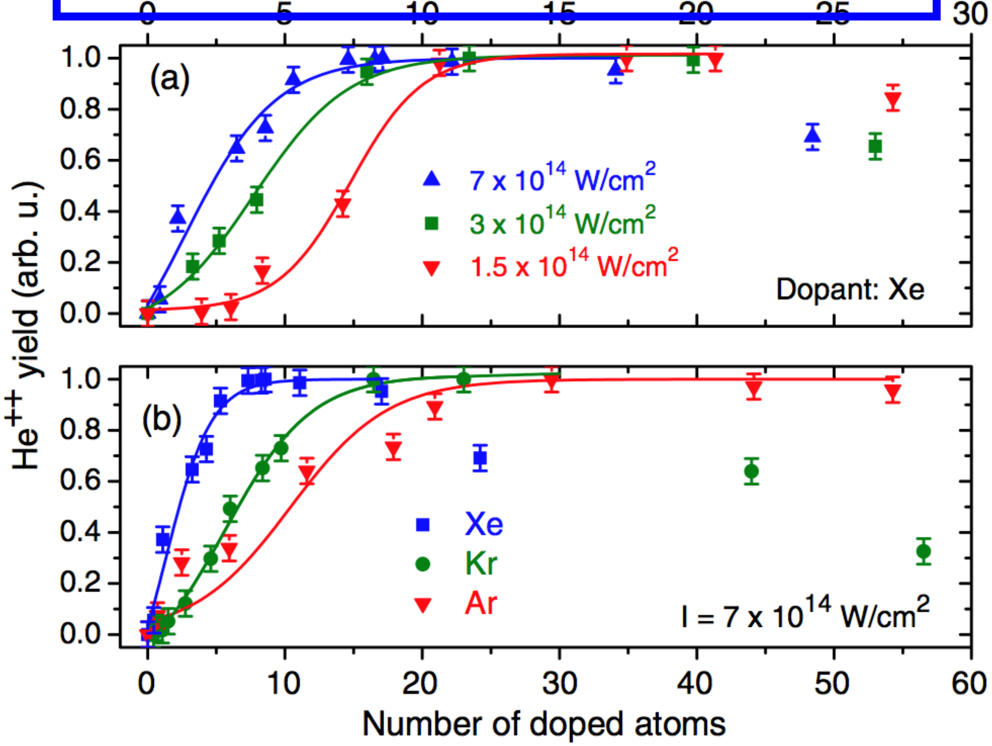
PRL 107, 173402 (2011) PHYSICAL REVIEW LETTERS week ending 21 OCTOBER 2011

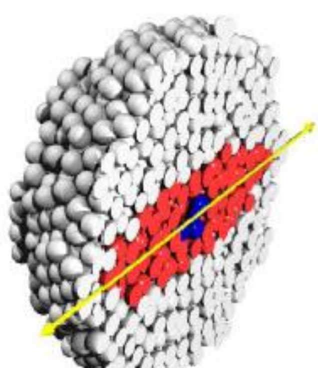
Dopant-Induced Ignition of Helium Nanodroplets in Intense Few-Cycle Laser Pulses



5 Xe atoms doped in 40,000 He
Ionize all the atoms!!!

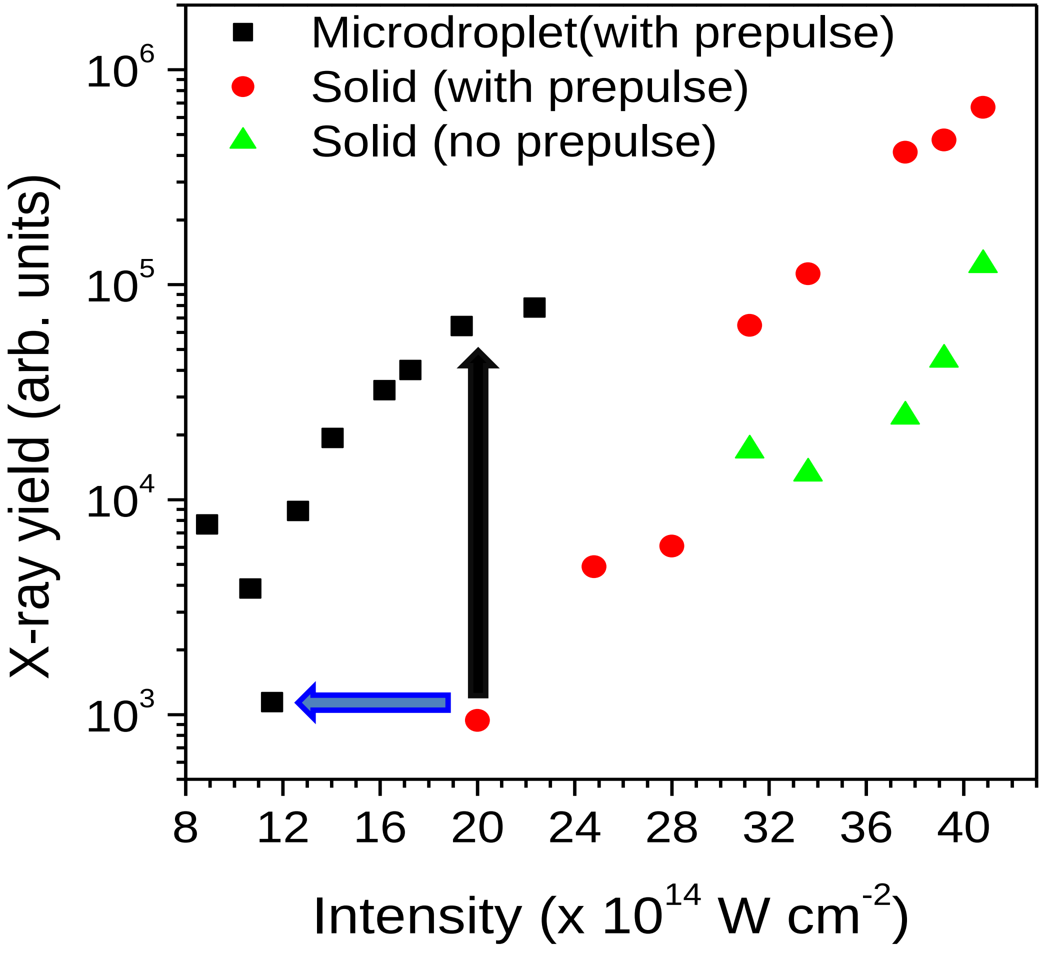
Under otherwise unionizable condition



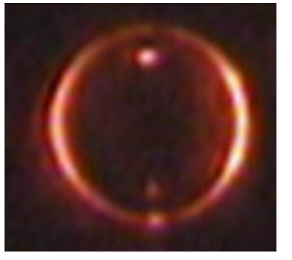


Done with Max planck partner group

X-ray Yield : Solid *vs* Micro-Droplets



68 times enhancement at 2×10^{15} W/cm^2



Patent :

Efficient Hard x-ray source - occurrence method and device

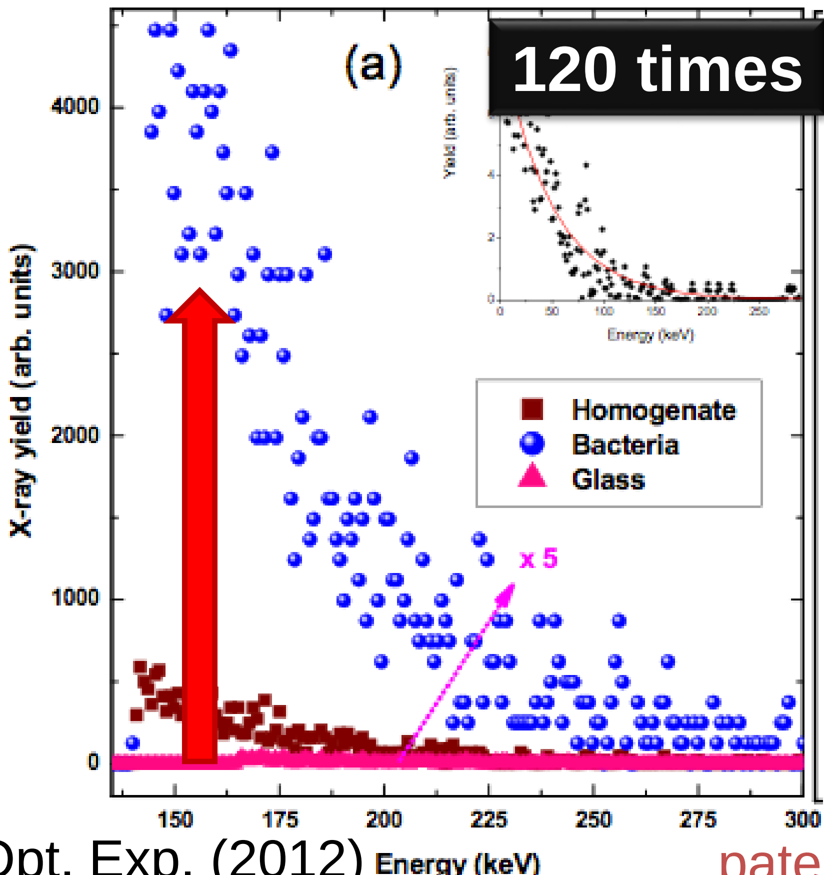
Patent :: JP/2004-162188

M. Anand *et al.*, Appl. Phys. Lett. 88, 181111 (2006).

X-ray brilliance of bacteria !?!

Biologically Inspired Plasma Science

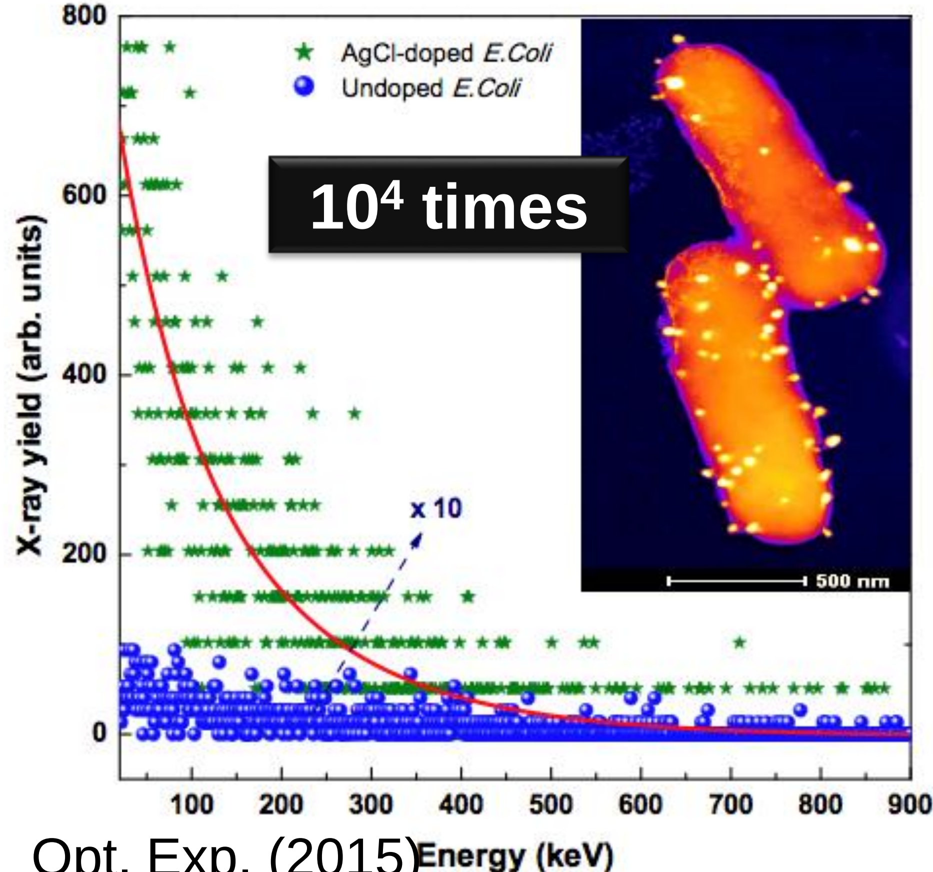
Normal Bacteria



Opt. Exp. (2012)

patented

Engineered Bacteria



Opt. Exp. (2015)

THz acoustics in a hot, dense laser plasma

PHYSICAL REVIEW LETTERS
moving physics forward

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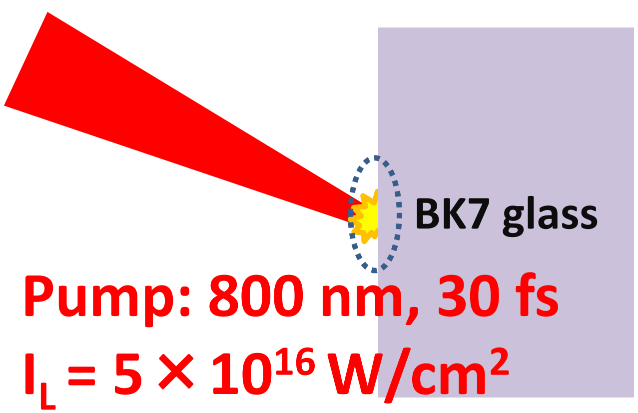
Terahertz Acoustics in Hot Dense Laser Plasmas

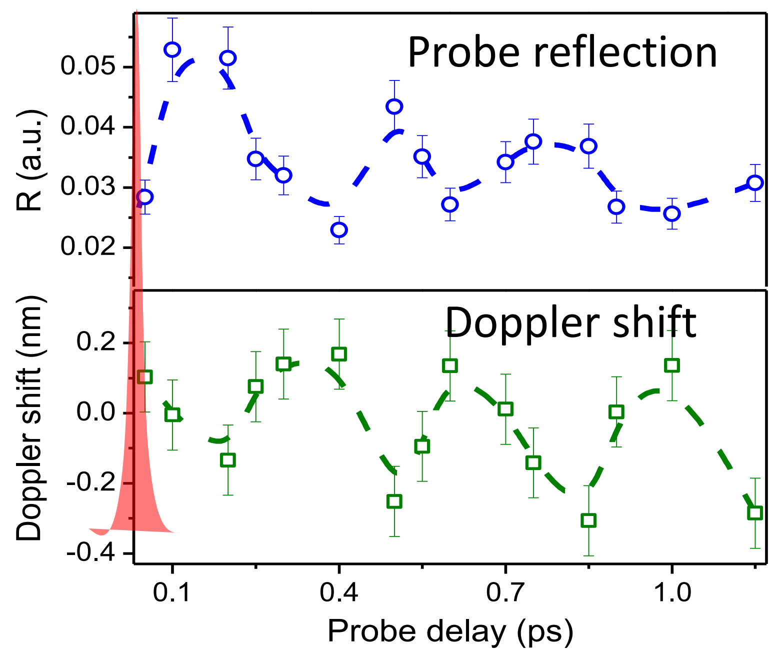
Amitava Adak, A. P. L. Robinson, Prashant Kumar Singh, Gourab Chatterjee, Amit D. Lad, John Pasley, and G. Ravindra Kumar

Phys. Rev. Lett. **114**, 115001 – Published 17 March 2015

147

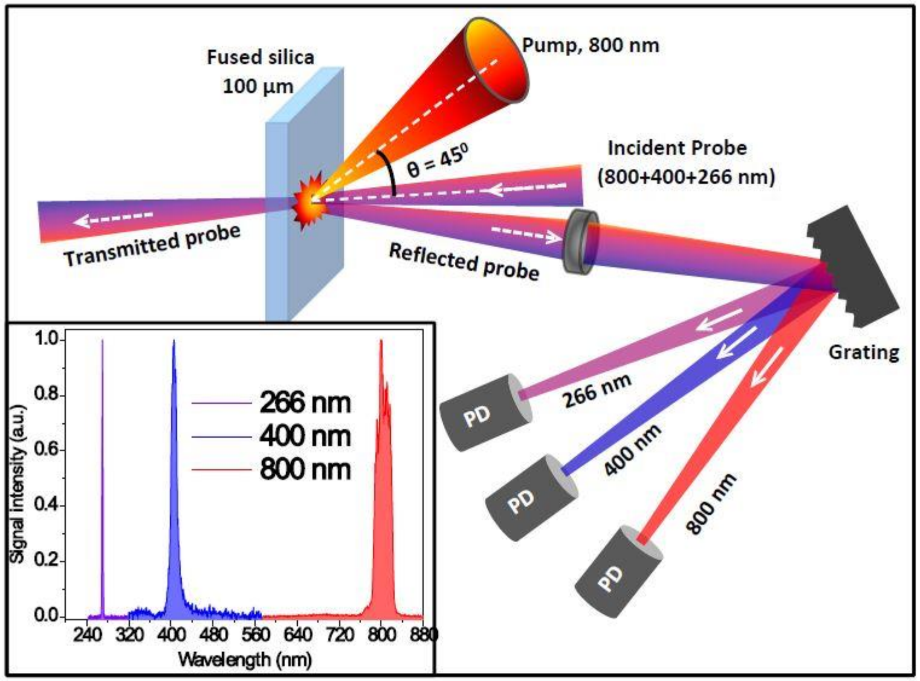
More





Ultrafast optics of solid density plasma using multicolor probes

Vol. 22, No. 19 | DOI:10.1364/OE.22.022320 | OPTICS EXPRESS 22320



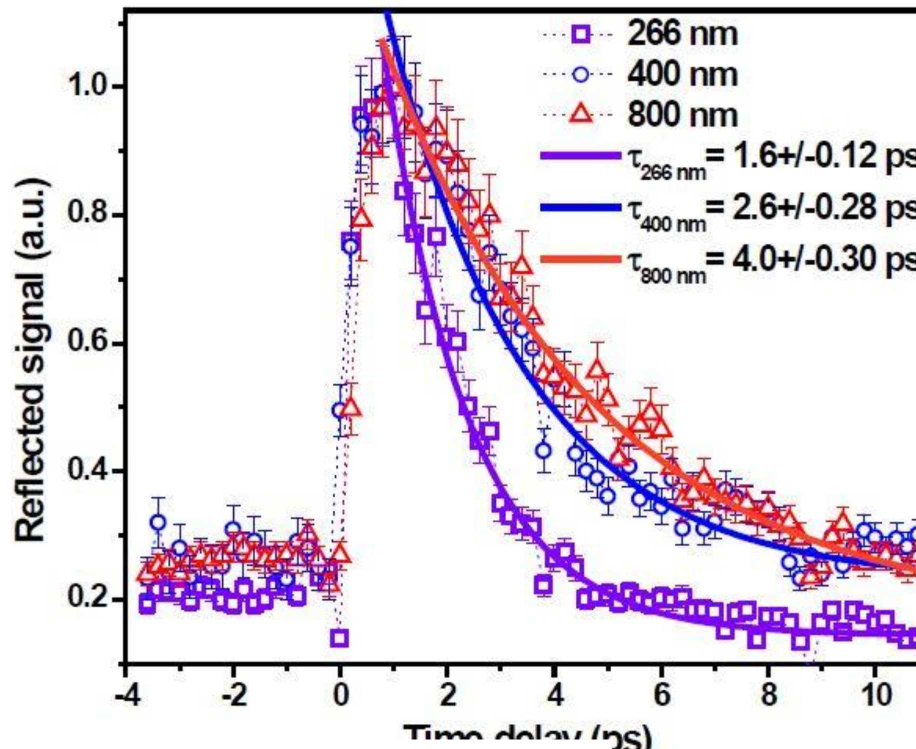
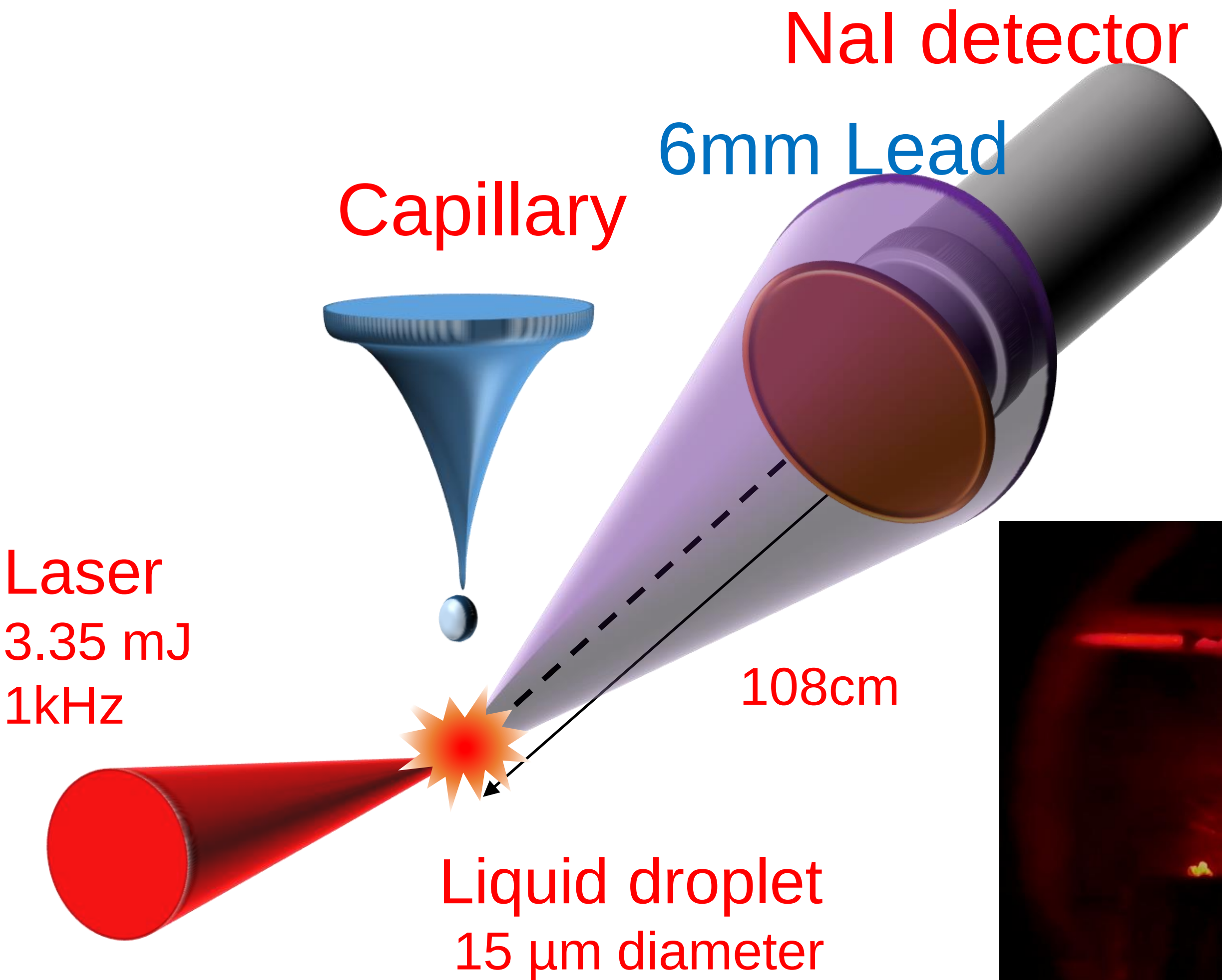
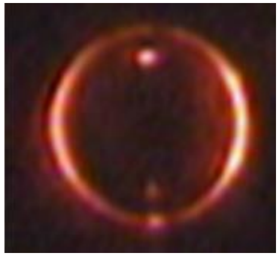


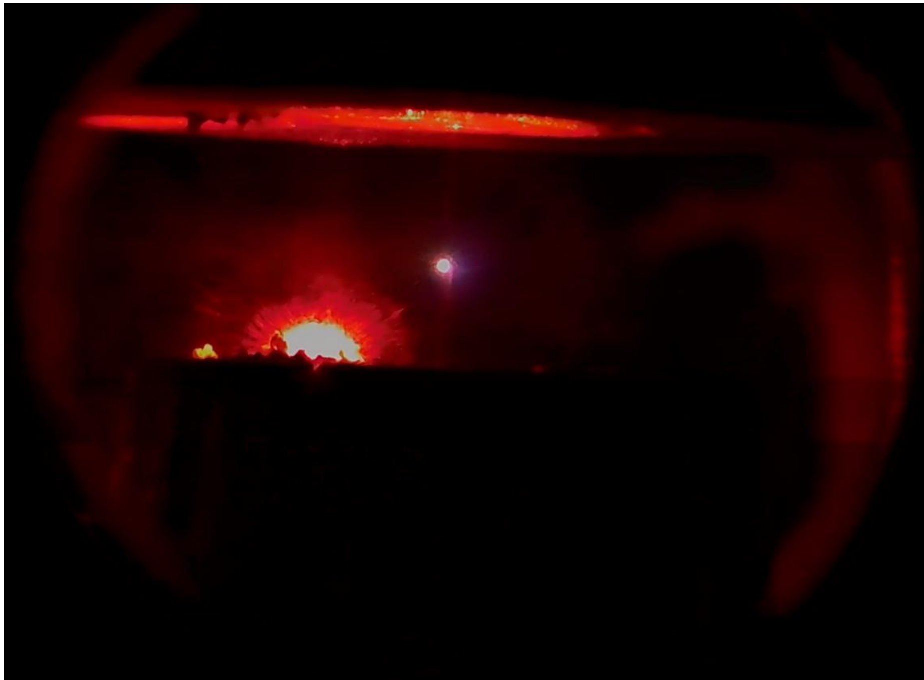
Table 1. Wavelength dependent reflectivity decay rate and estimated collision frequencies. λ : probe wavelength, n_c: critical density of probe, τ: reflectivity decay rate, $\nu_{ei}(n_c)$: electron-ion collision frequency estimated at n_c.

λ (nm)	n_c (cm^{-3})	τ (ps)	$\nu_{ei}(n_c)$ (s^{-1})
266	15.5×10^{21}	1.6 ± 0.1	$(7 \pm 1.1)\times10^{14}$
400	6.9×10^{21}	2.6 ± 0.3	$(4 \pm 0.7)\times10^{14}$
800	1.7×10^{21}	4.0 ± 0.3	$(2.8 \pm 0.5)\times10^{14}$

EXPERIMENTAL SET-UP

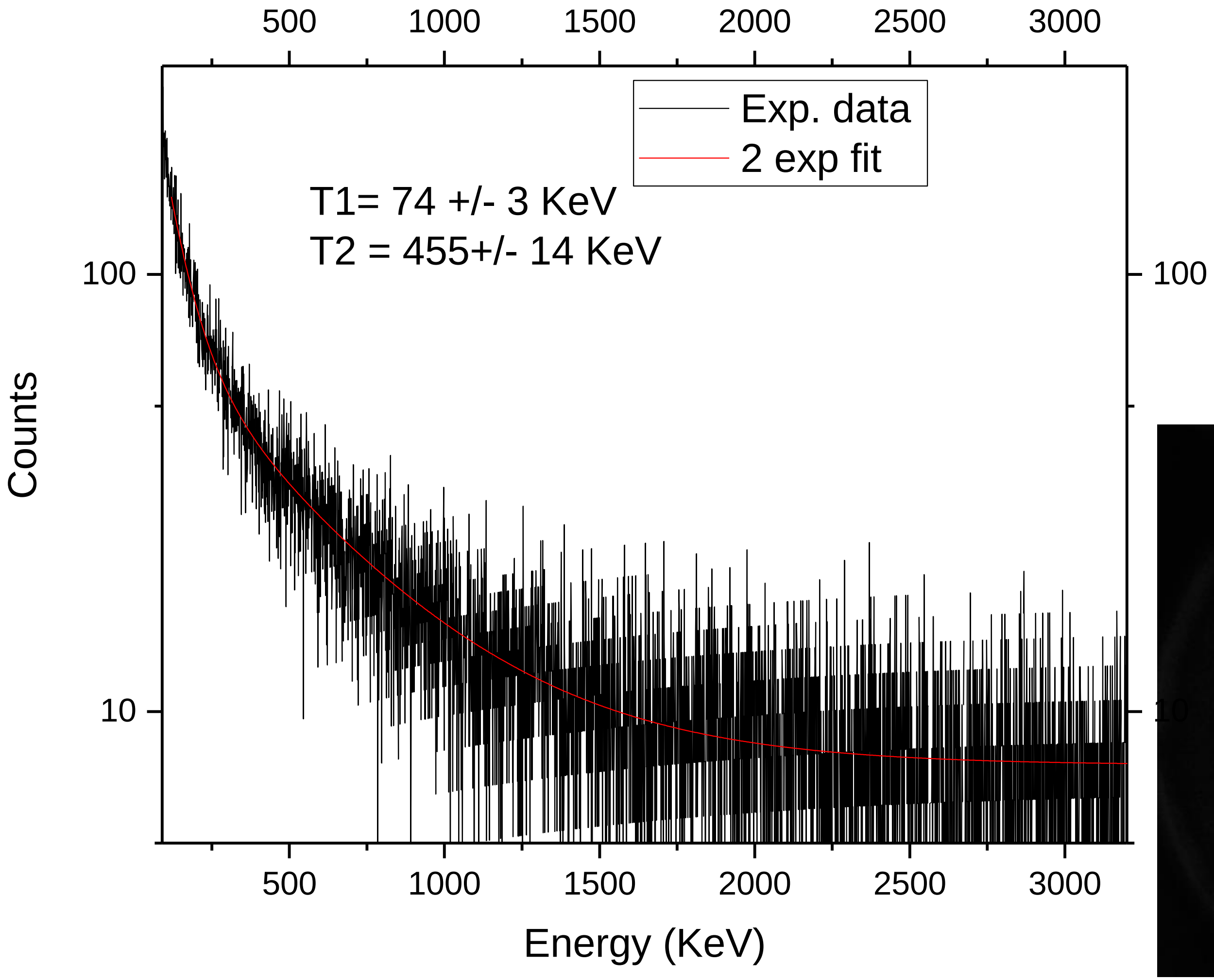


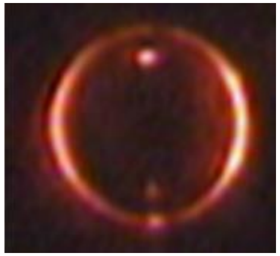


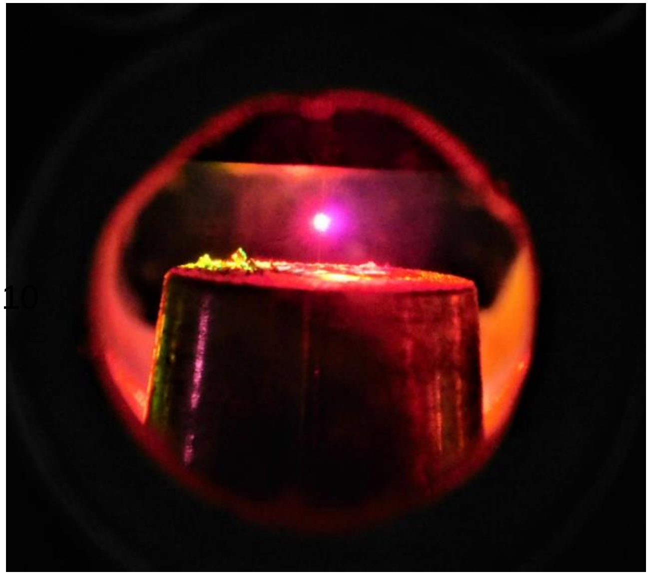


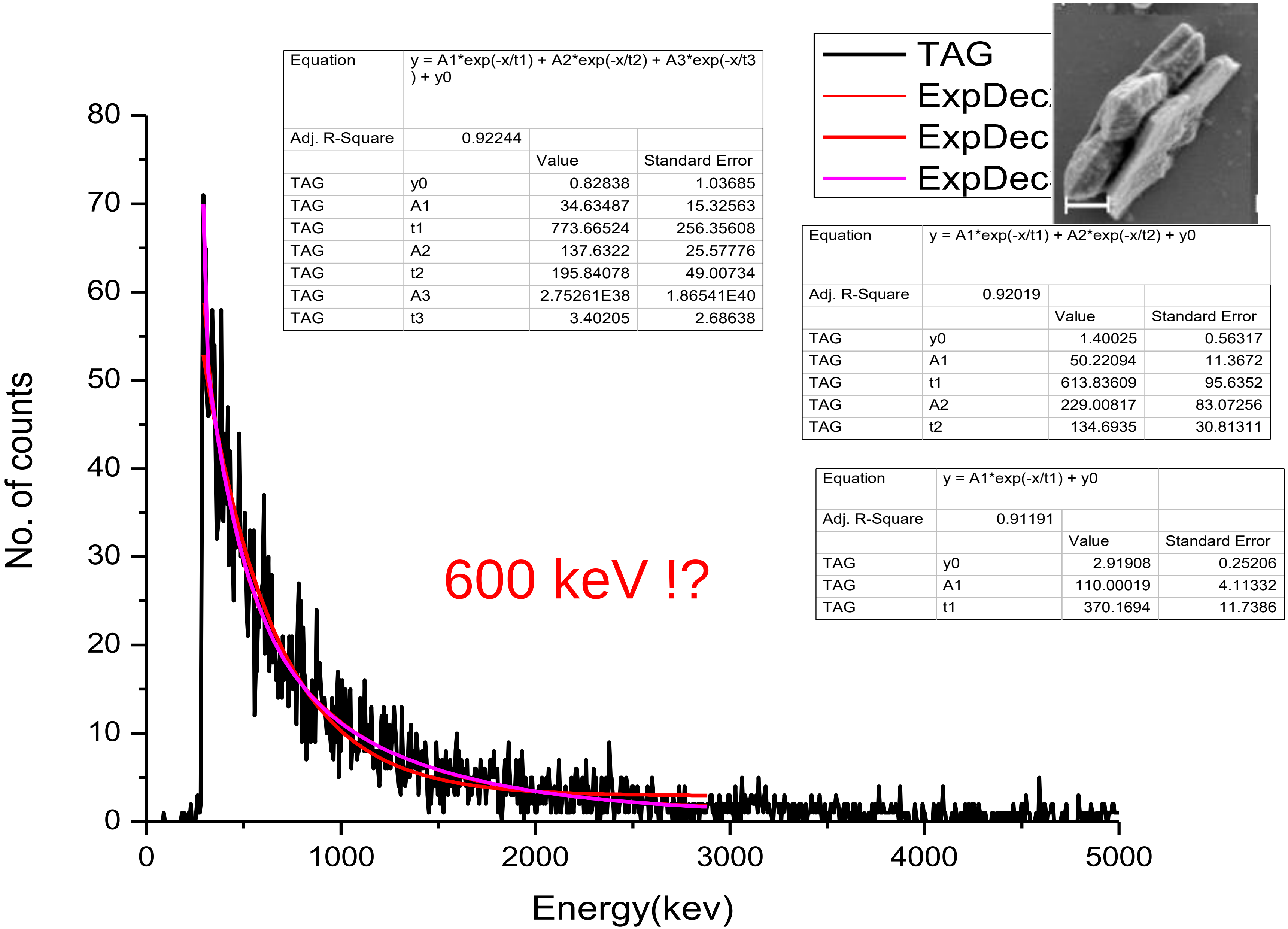
X-Ray data high energy 500 sec collection time

Relativistic energies and realistic rates?!?







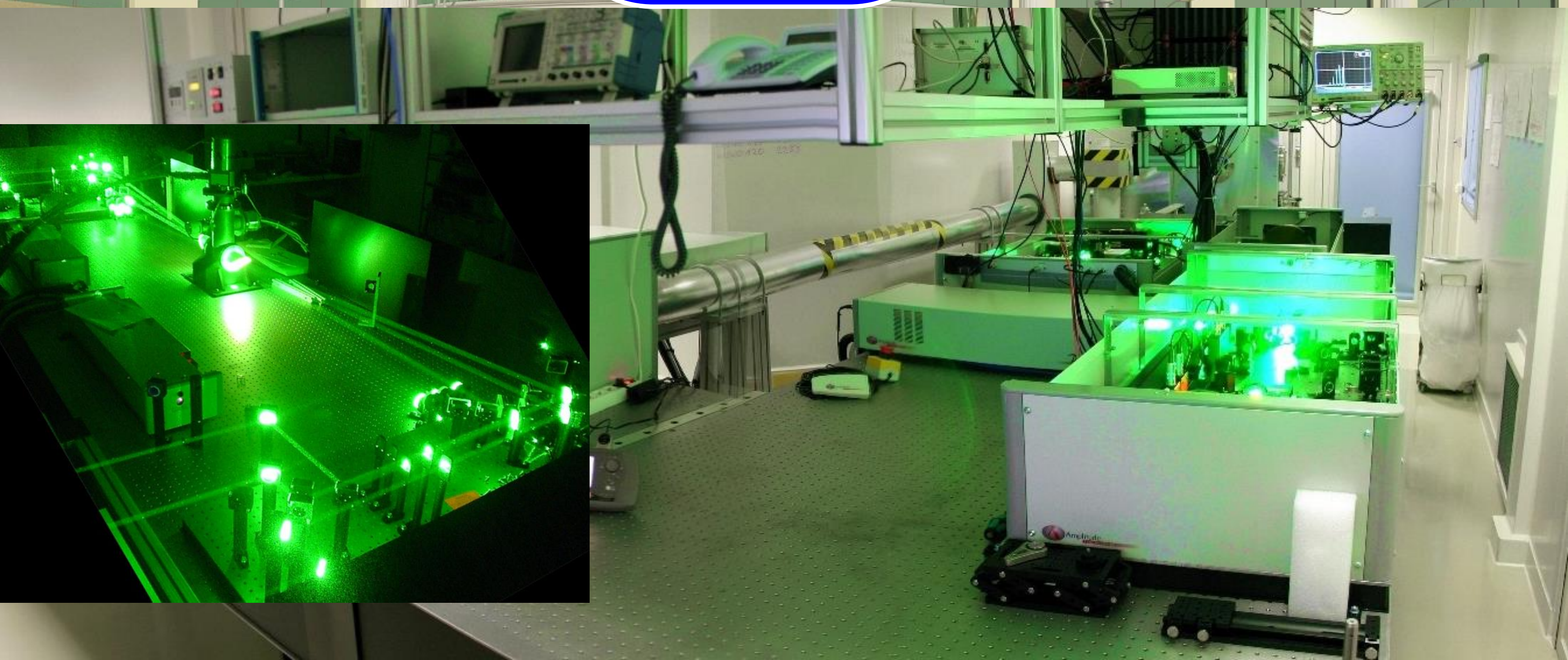


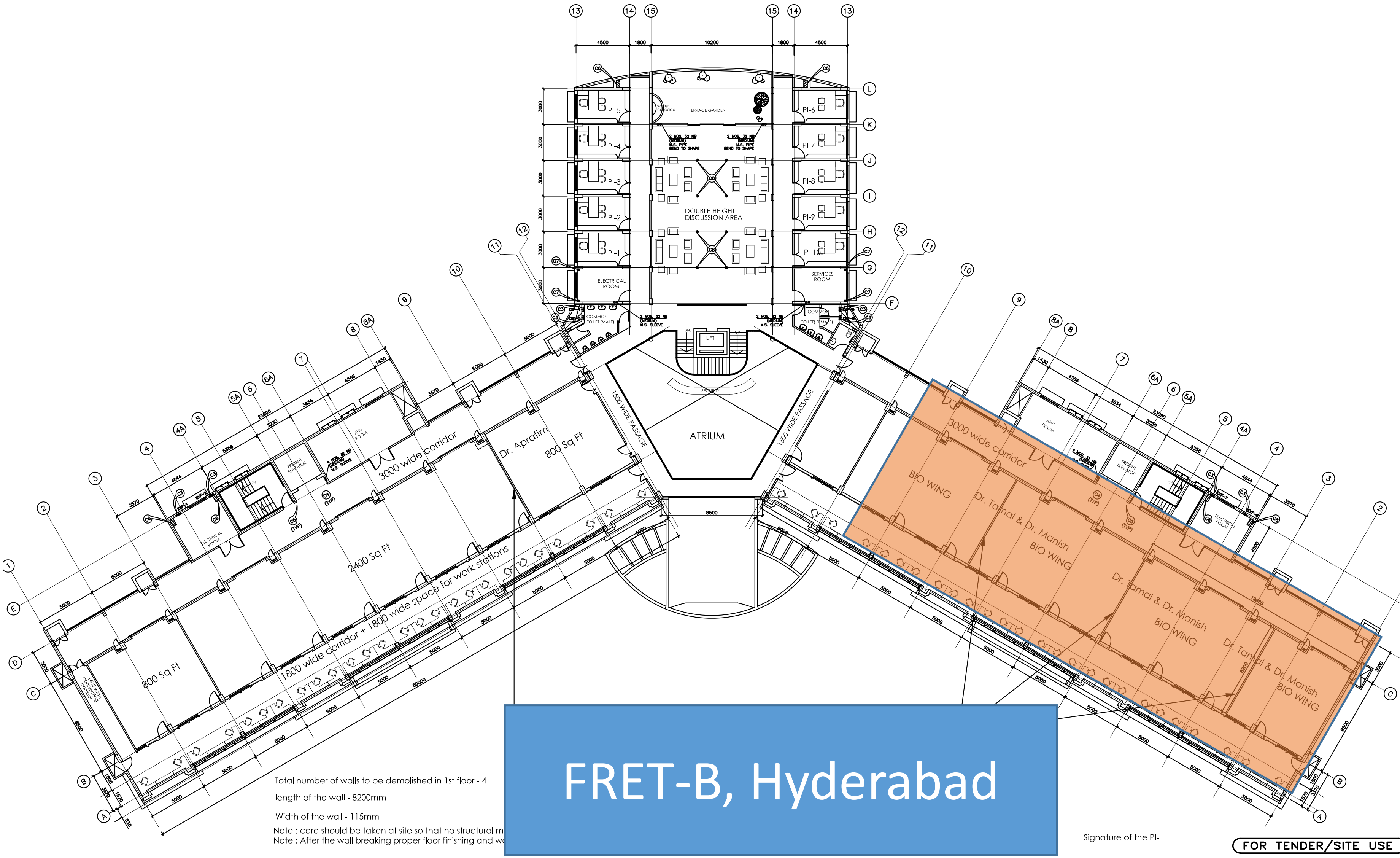
Equation	y = A1*exp(-x/t1) + A2*exp(-x/t2) + A3*exp(-x/t3) + y0		
Adj. R-Square	0.92244		
		Value	Standard Error
TAG	y0	0.82838	1.03685
TAG	A1	34.63487	15.32563
TAG	t1	773.66524	256.35608
TAG	A2	137.6322	25.57776
TAG	t2	195.84078	49.00734
TAG	A3	2.75261E38	1.86541E40
TAG	t3	3.40205	2.68638

Equation	y = A1*exp(-x/t1) + A2*exp(-x/t2) + y0		
Adj. R-Square	0.92019		
		Value	Standard Error
TAG	y0	1.40025	0.56317
TAG	A1	50.22094	11.3672
TAG	t1	613.83609	95.6352
TAG	A2	229.00817	83.07256
TAG	t2	134.6935	30.81311

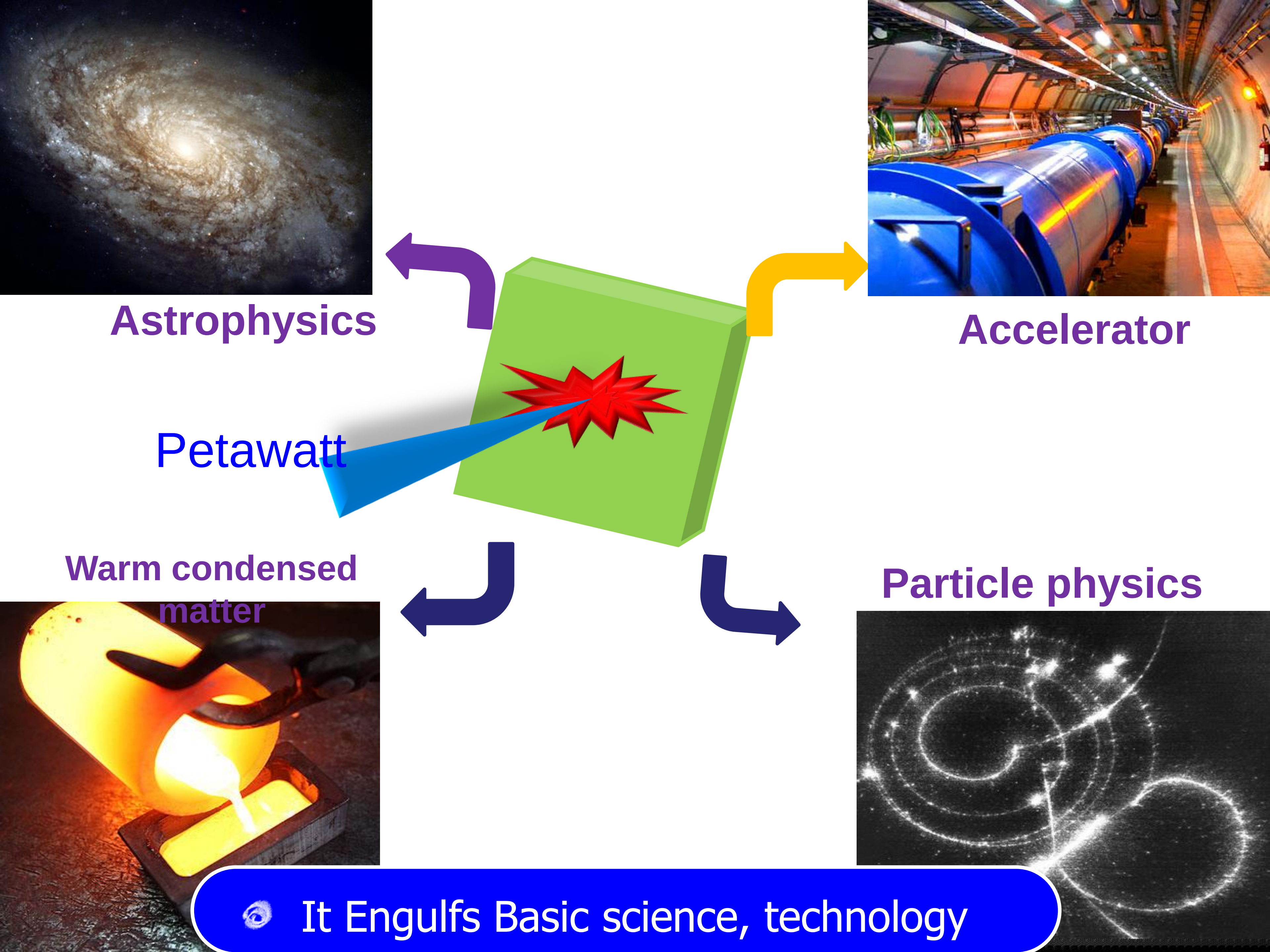
Equation	y = A1*exp(-x/t1) + y0		
Adj. R-Square	0.91191		
		Value	Standard Error
TAG	y0	2.91908	0.25206
TAG	A1	110.00019	4.11332
TAG	t1	370.1694	11.7386

Key proposition @TIFR.Hyd





PI-5
PI-4
PI-3
PI-2
PI-1
PI-6
PI-7
PI-8
PI-9
PI-10
TERRACE GARDEN
DOUBLE HEIGHT
DISCUSSION AREA
ELECTRICAL ROOM
SERVICES ROOM
LIFT
ATRIUM
1500 WIDE PASSAGE
1500 WIDE PASSAGE
3000 wide corridor
Dr. Apratim
800 Sq Ft
2400 Sq Ft
800 Sq Ft
1800 wide corridor + 1800 wide space for work stations
3000 wide corridor
BIO WING
Dr. Tamal & Dr. Manish
BIO WING
Dr. Tamal & Dr. Manish
BIO WING
Dr. Tamal & Dr. Manish
BIO WING
Total number of walls to be demolished in 1st floor - 4
length of the wall - 8200mm
Width of the wall - 115mm
Note : care should be taken at site so that no structural m
Note : After the wall breaking proper floor finishing and w
Signature of the PI-
FOR TENDER/SITE USE
FRET-B, Hyderabad


Astrophysics
Accelerator
Petawatt
Warm condensed matter
Particle physics
It Engulfs Basic science, technology

Thank you