
Recycling of the reflected laser pulse for efficient ion acceleration

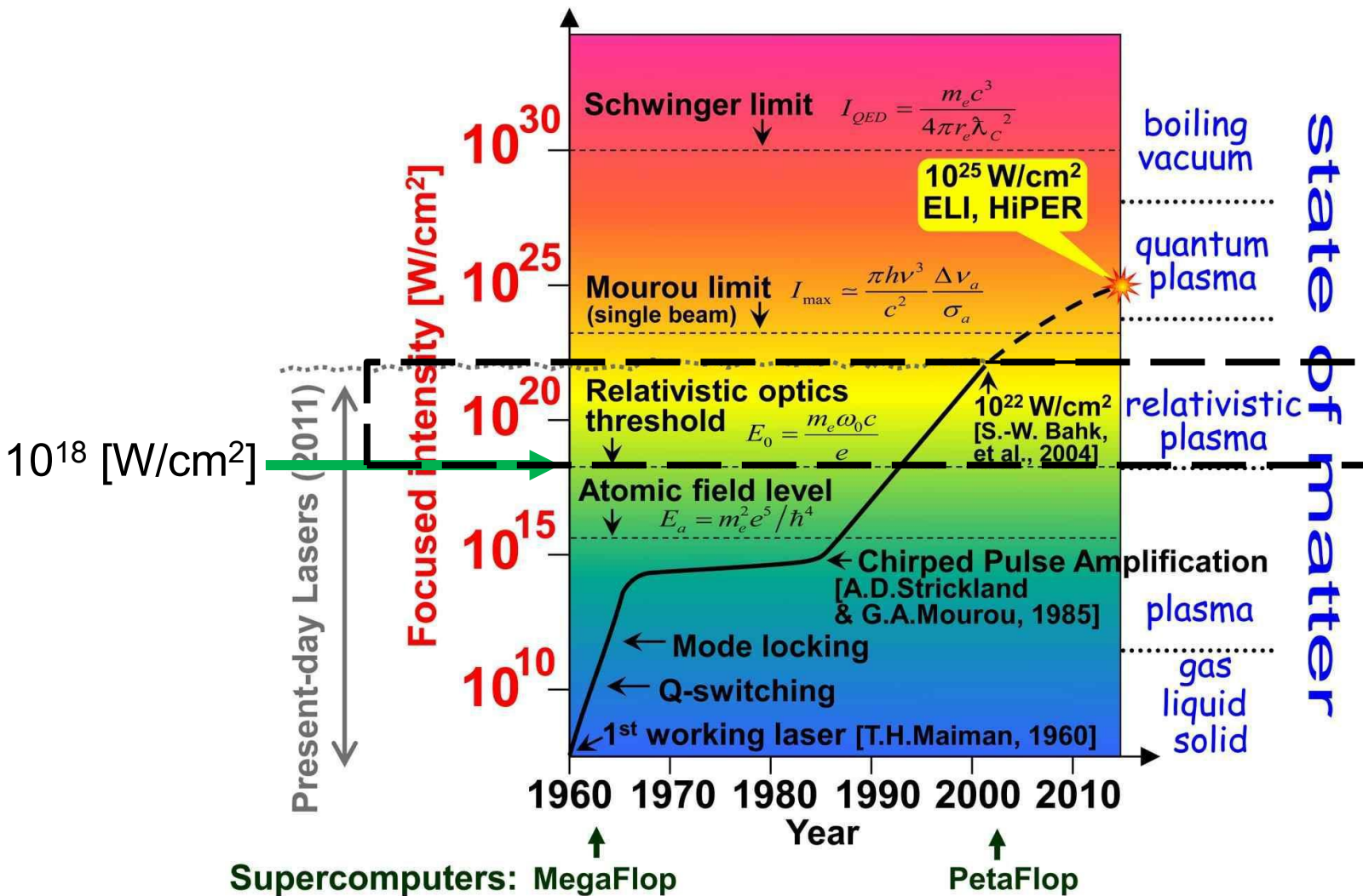
Young-Kuk Kim, Teyoun Kang, Min Sup Hur
Department of Natural Science, UNIST, Korea

Intense laser and its applications.

Ion acceleration in plasmas.

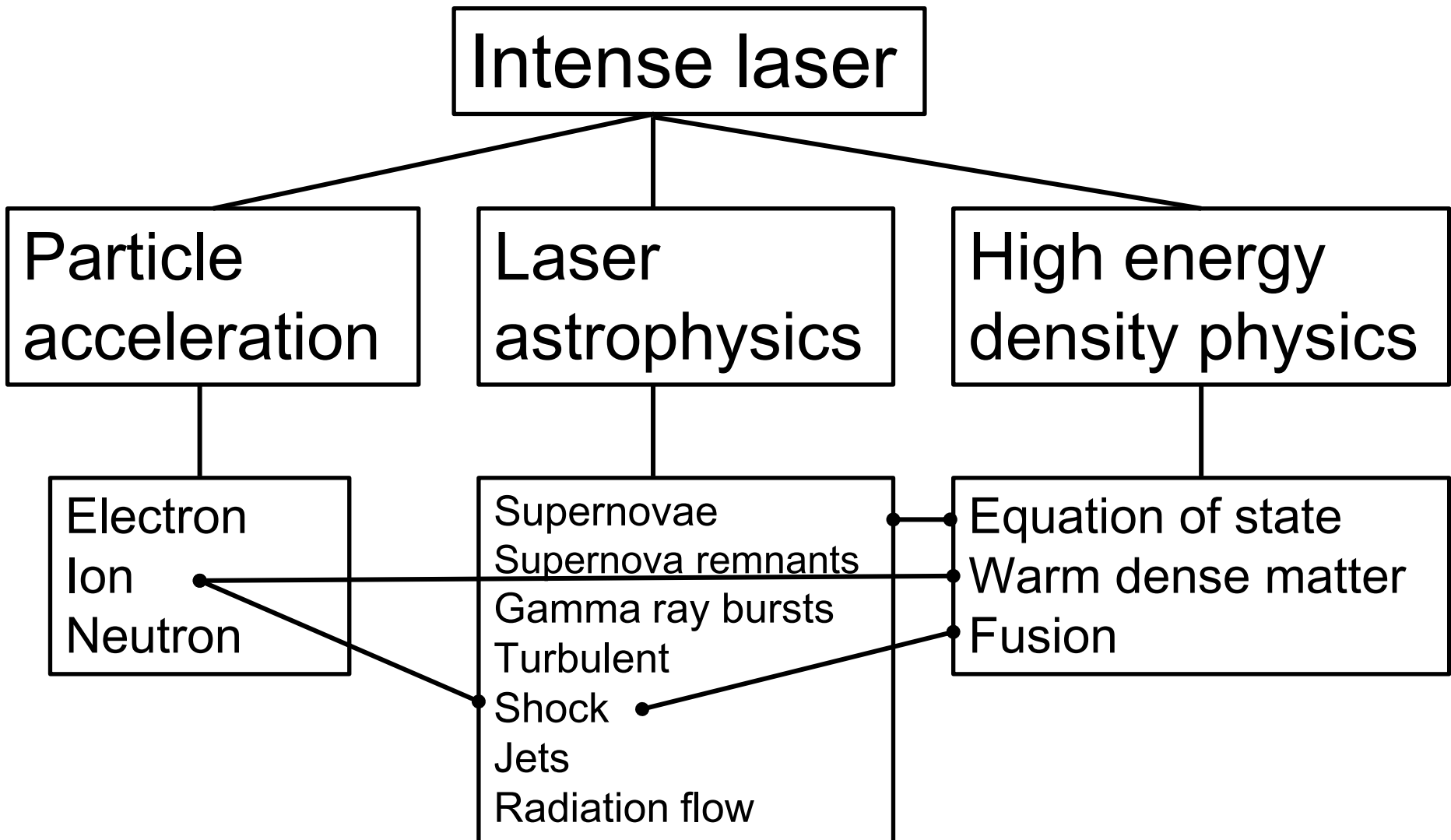
Target design and PIC simulation.

Summary.



Intense laser pulse can generate

1. high velocity ($\sim c$) ← relativistic plasmas
2. high temperature ($\sim \text{MeV}$)
3. high density ($\sim \text{solid}$)
plasmas.

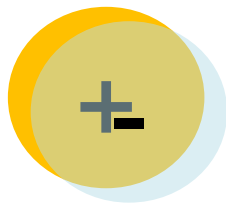


Currently available laser can not directly accelerate heavy ion.
($I > 10^{24}$ W/cm² is required for $m_i \geq 1836m_e$)

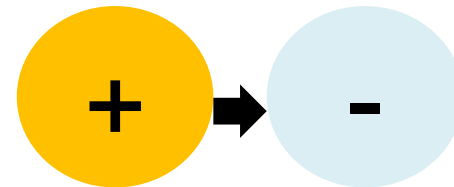
How to accelerate ion.

1. Electron gets energy from the laser pulse.
2. Variation of charge distribution.
3. Ion acceleration by charge distribution (static field)

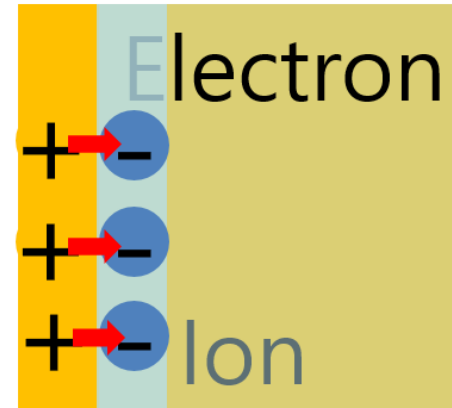
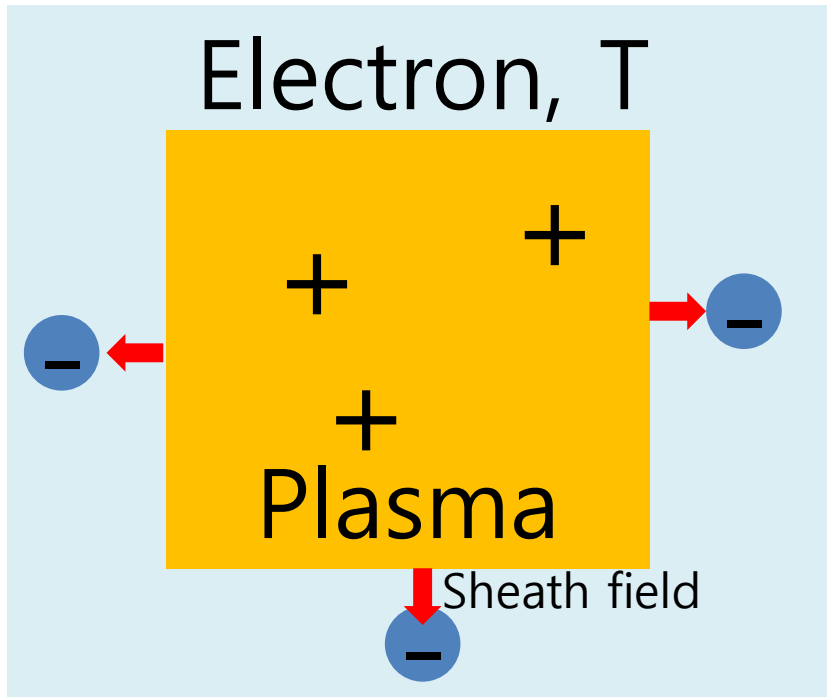
Any how we should make non-neutral charge distribution.



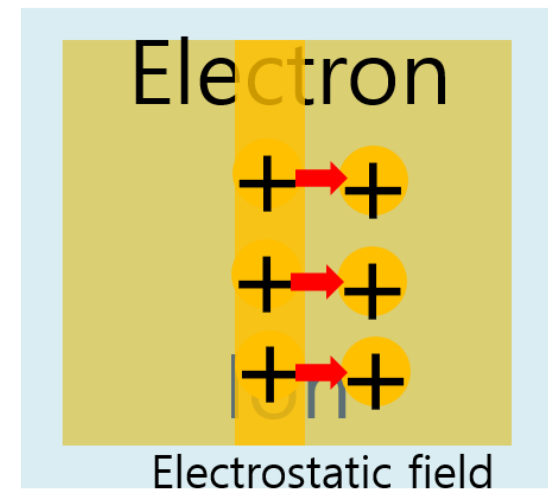
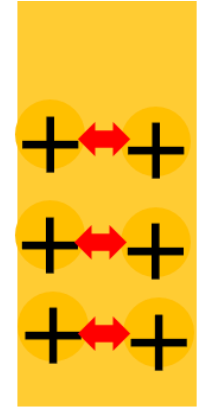
Quasi-neutral plasma

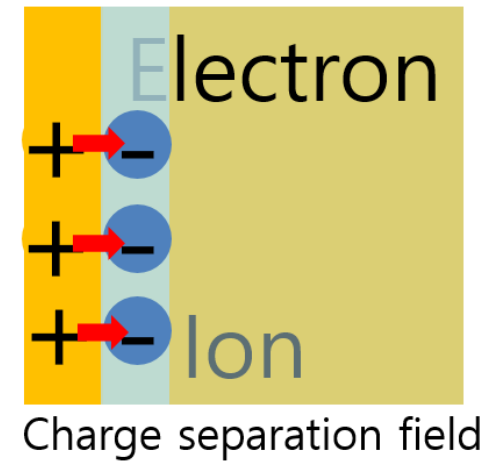
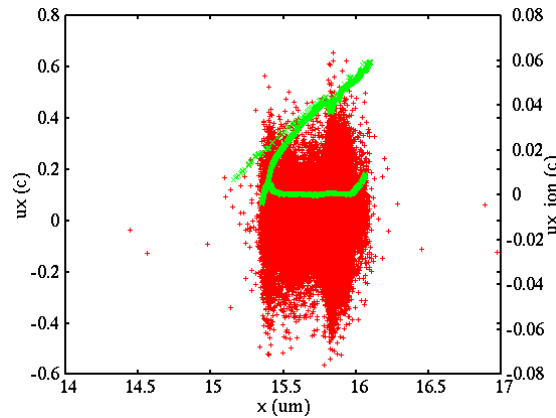
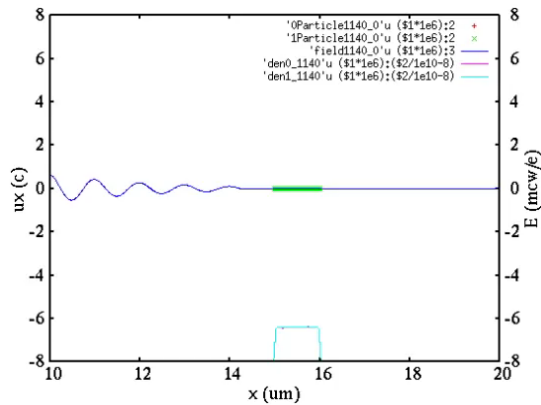
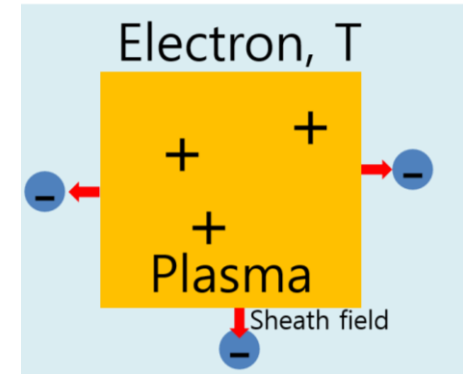
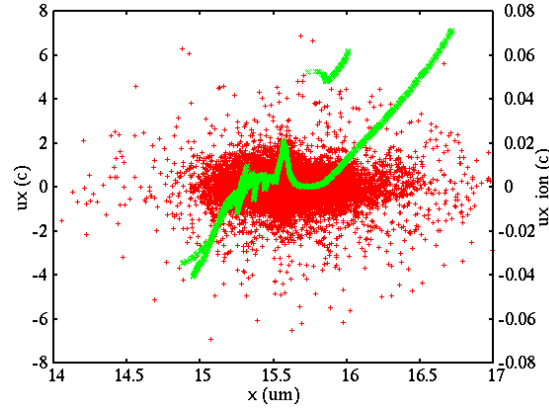
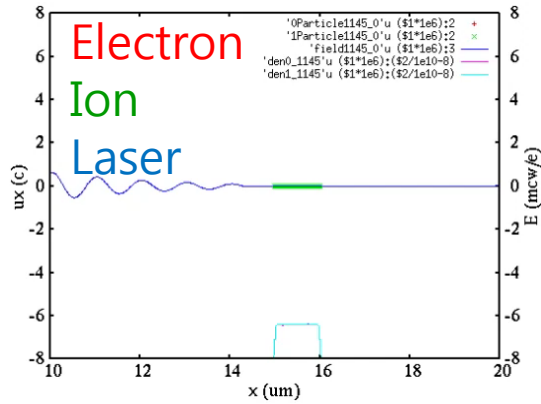


Static field



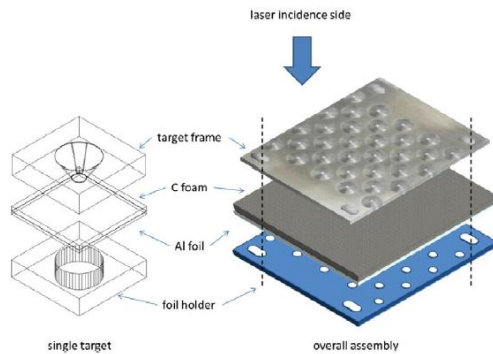
Charge separation field Coulomb explosion





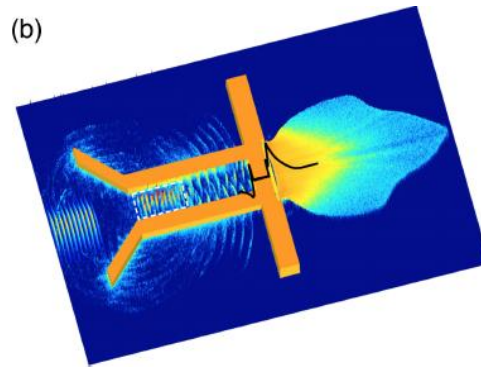
Q. How can we make a high temperature plasma?

A. Laser energy \rightarrow plasma



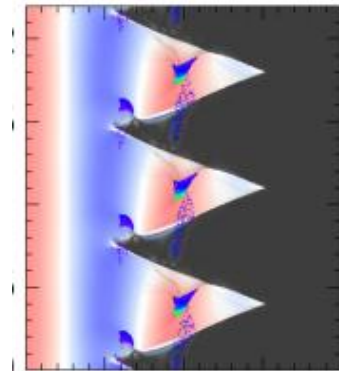
Coating

PPCF 58 034019 (2016)



Microstructure

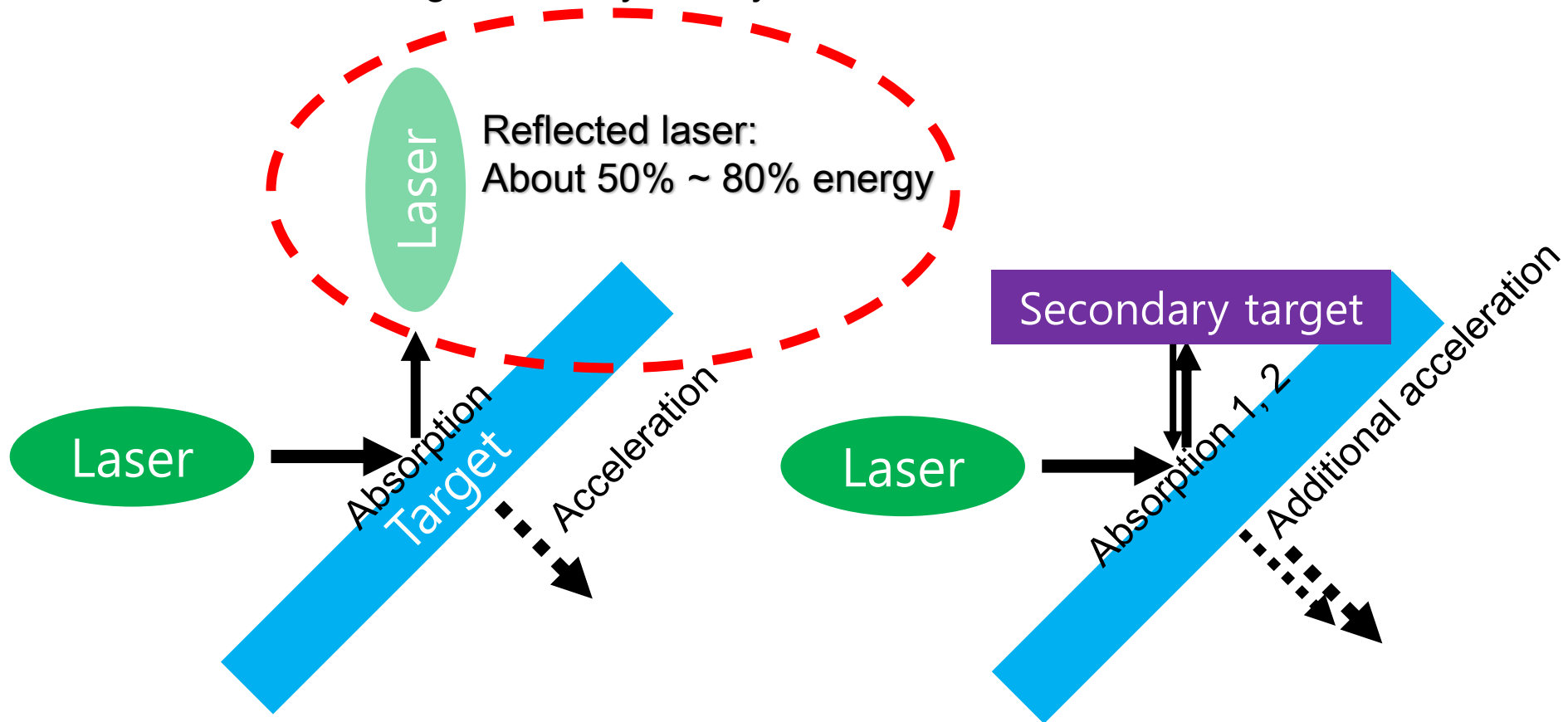
AIP Advances 6 015303 (2016)



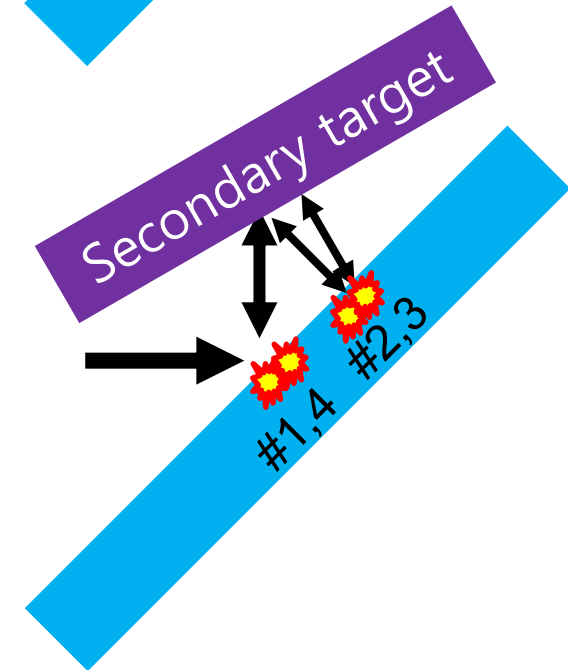
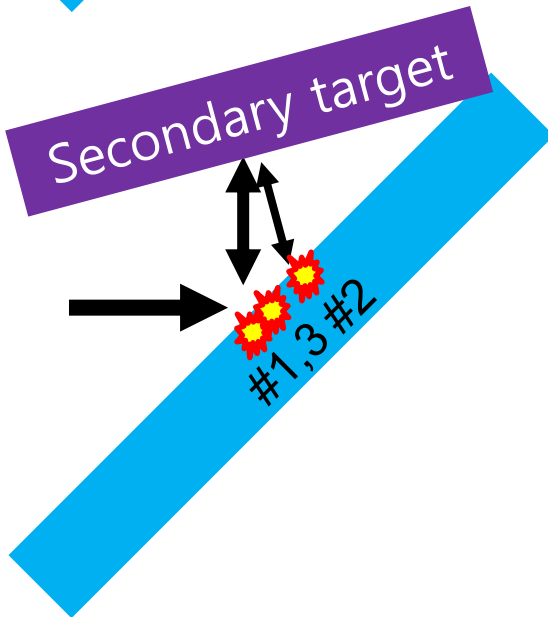
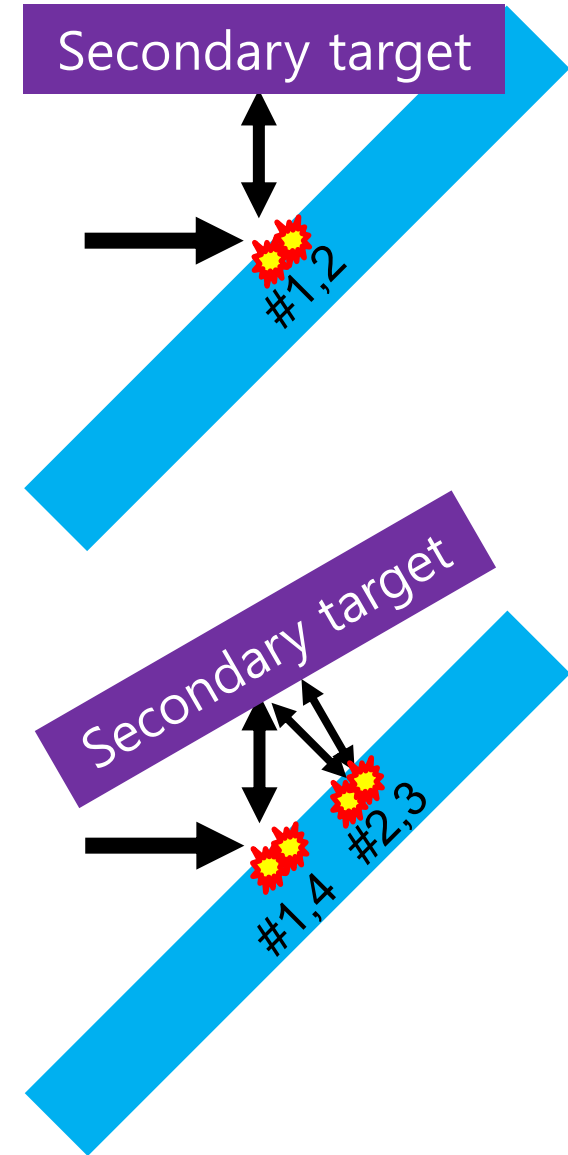
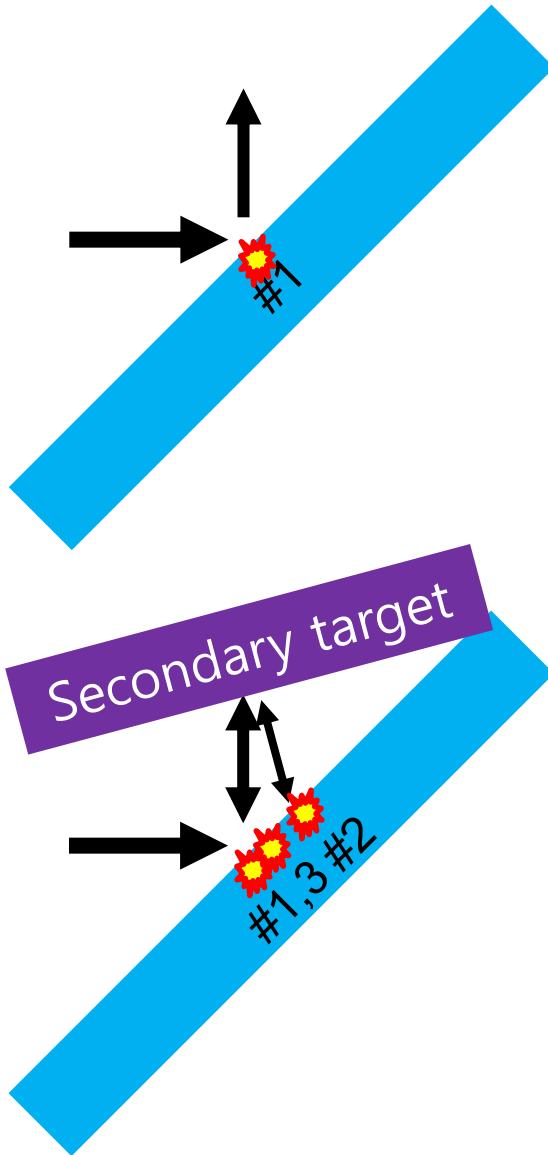
Nanostructure

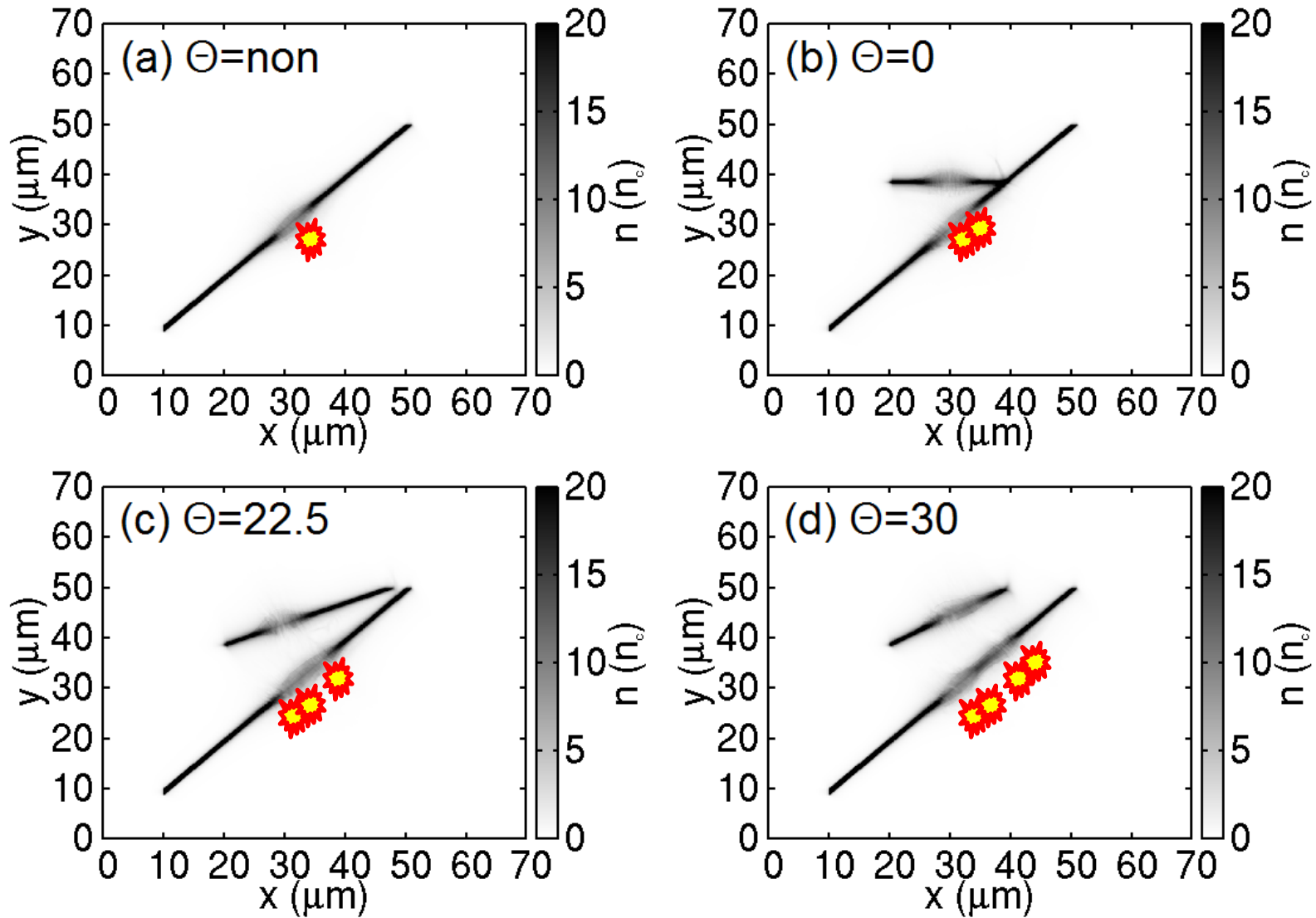
New. J. Phys. 19 033004 (2017)

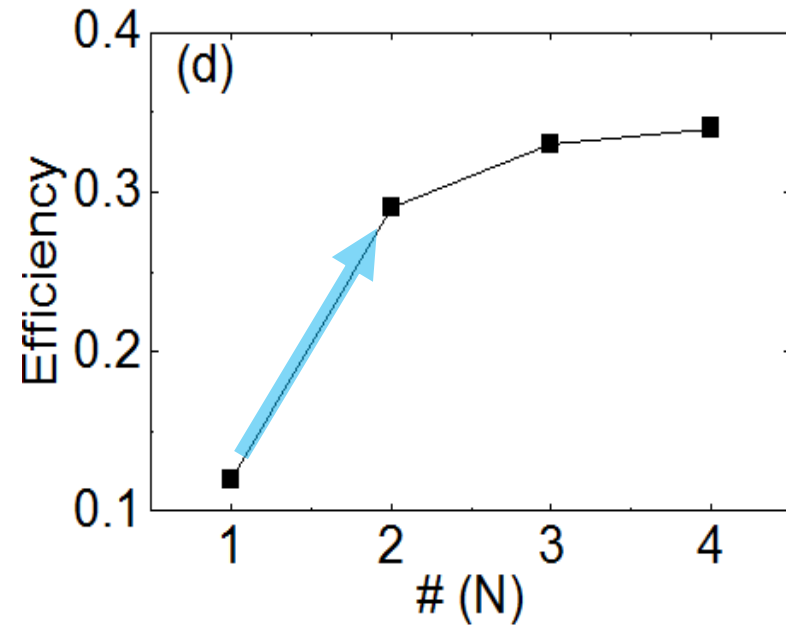
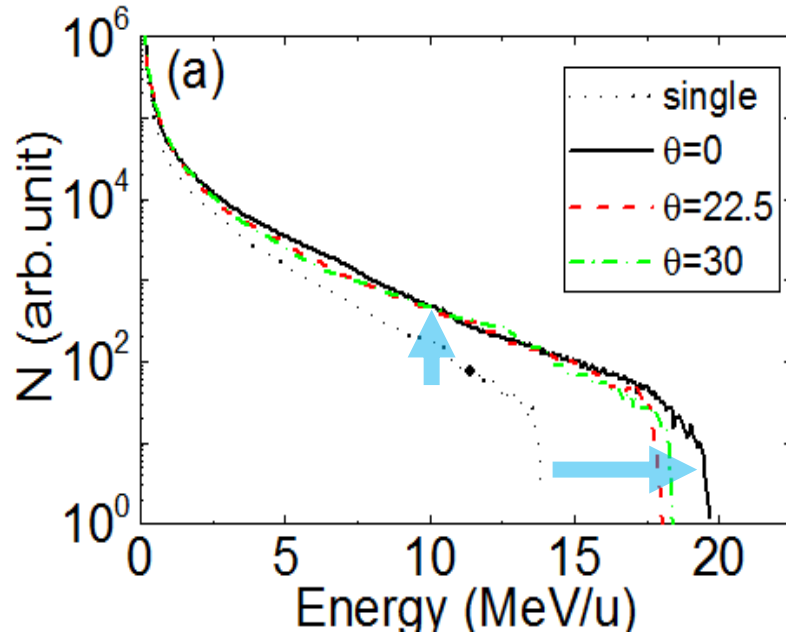
We thought it was a waste of laser energy.
So we thought of a way to recycle it.



A secondary target with angle

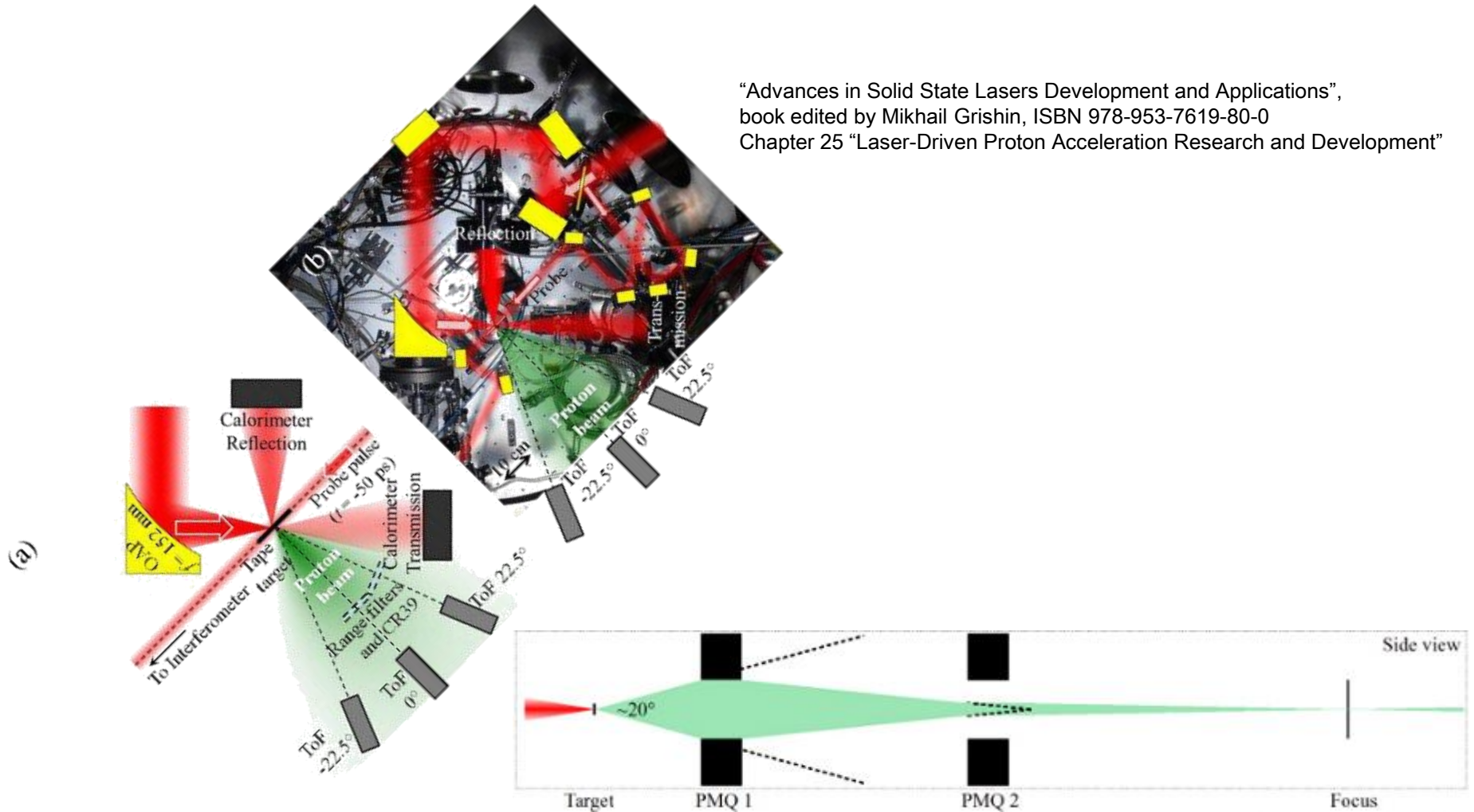


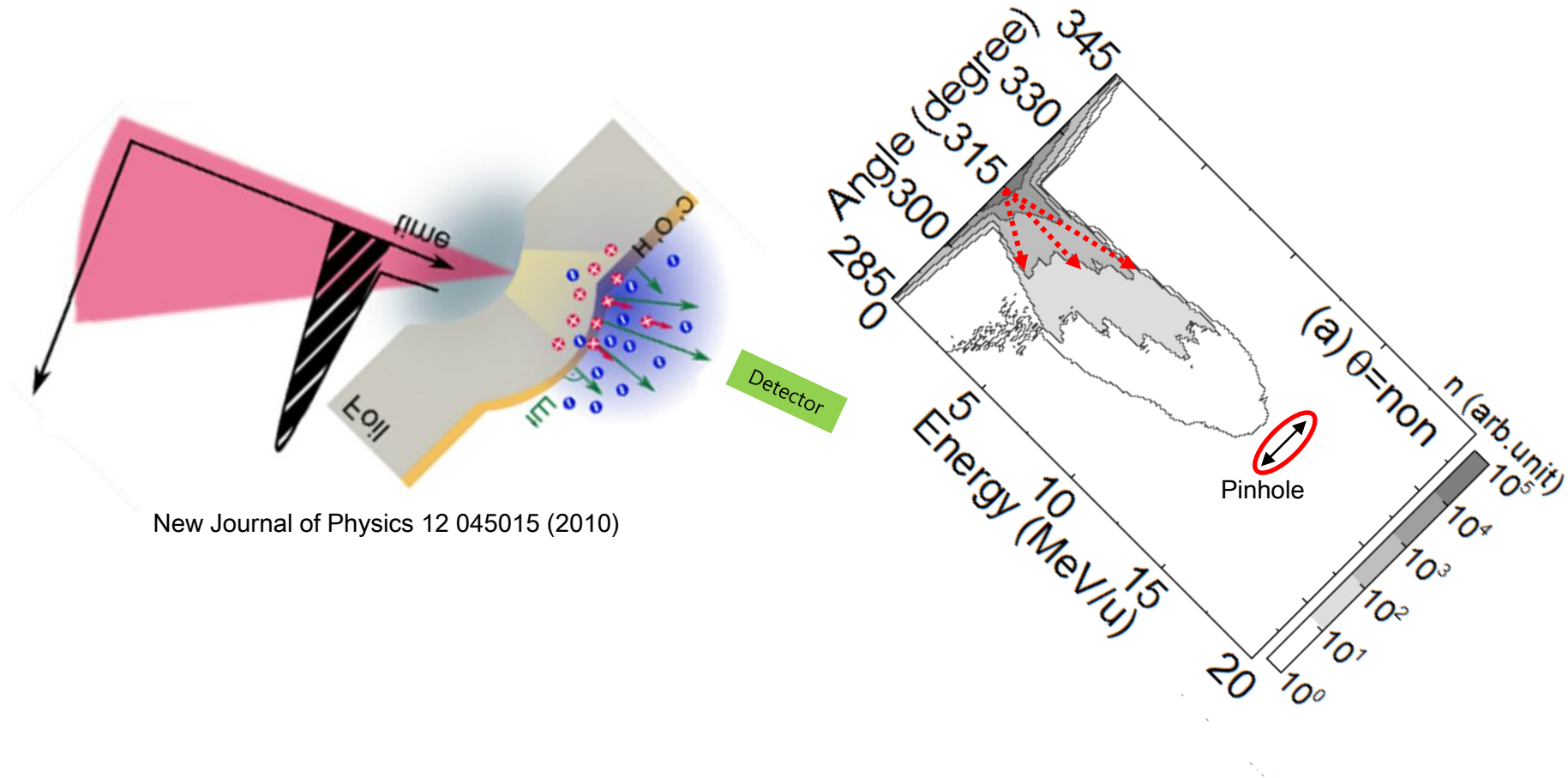




$\theta = 0$ ($\# = 2$): maximum energy 45% \uparrow . Charge 250% \uparrow . Ion/Laser: 250% \uparrow .

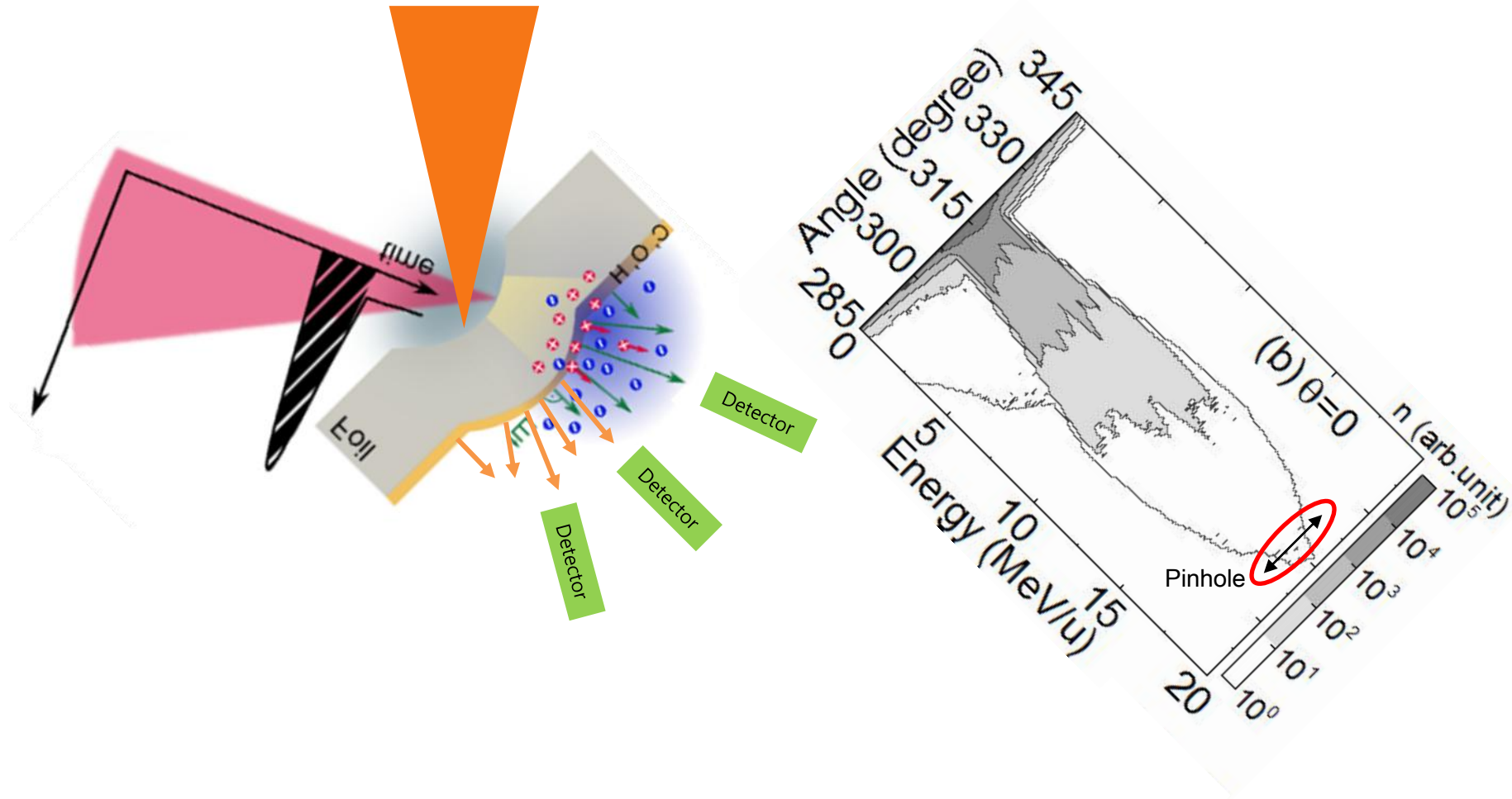
“Advances in Solid State Lasers Development and Applications”,
book edited by Mikhail Grishin, ISBN 978-953-7619-80-0
Chapter 25 “Laser-Driven Proton Acceleration Research and Development”



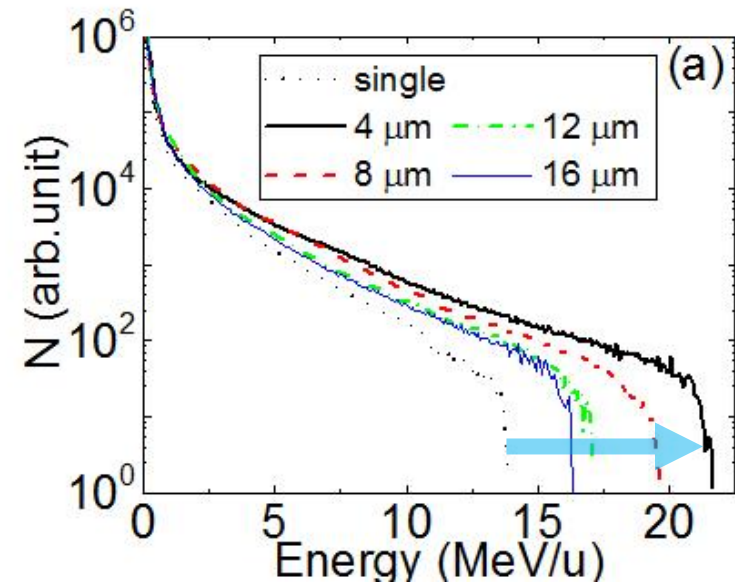
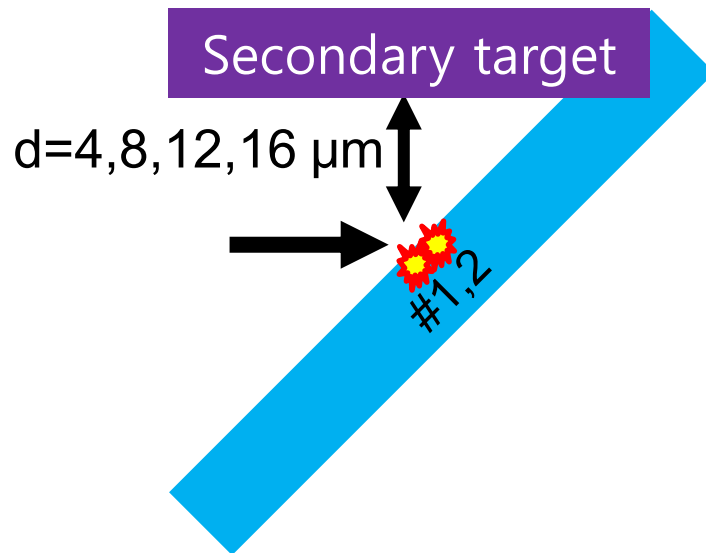


New Journal of Physics 12 045015 (2010)

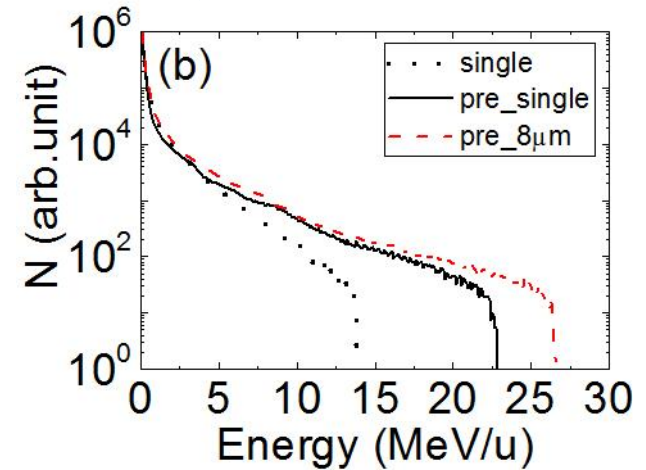
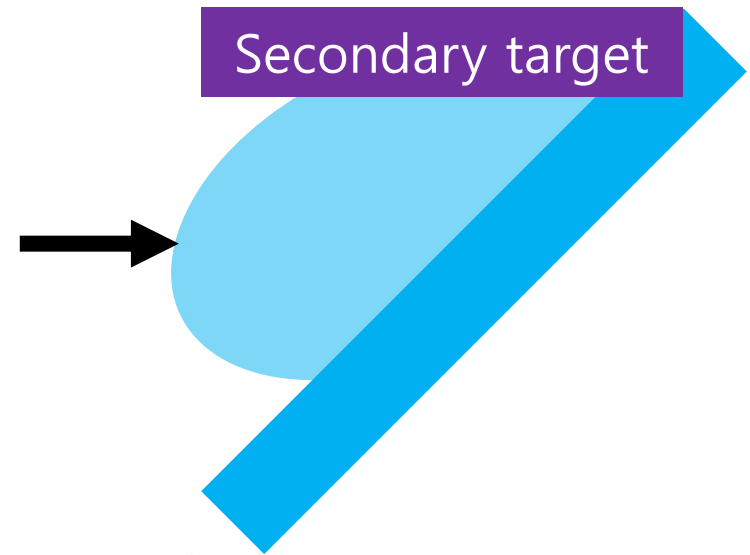
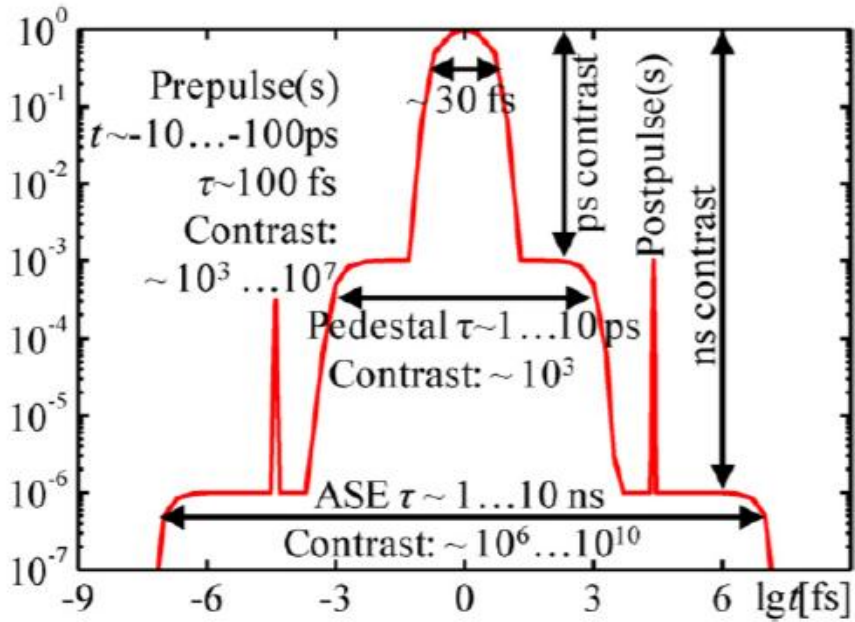
Direction of ion beam is dependent on the direction of laser pulse.
One carefully selects the position of detector.



Angular distribution becomes uniform by the secondary target.
Pinhole size can be increased.



The shorter the distance, the larger the energy of the ions.



The secondary target is effective even in the presence of preplasma.

A brief introduction of research areas using an intense laser.

A secondary target is efficient to increase energy, charge, and efficiency.

The secondary target makes situation of double pulse irradiation without additional laser system.

This target is easy to understand and to adopt experiment.