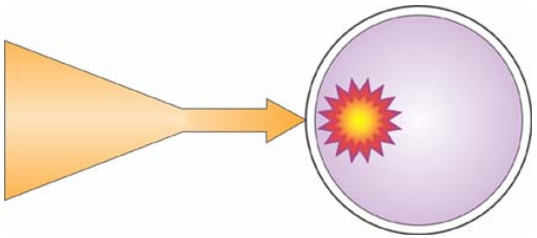


6th Meeting of Fusion Science Center for Excellence for Extreme States of Matter and Fast Ignition Physics

Terawatt Facility

Department of Physics
University of Nevada, Reno

T.E. Cowan and Y. Sentoku groups:
E. d'Humieres (P.D.)
M. Bakeman, T. Burris-Mog, B. Chrisman, S. Gaillard,*
R. Mishra, J. Rassuchine (Graduate students)

Jacobs School of Engineering, UCSD
4-5 August 2007

**direct support from FSC*

FSC-relevant activities at UNR:

- Collisional PIC simulations (PICLS) of cone-in-shell fast ignition targets*
  (see talk by Y. Sentoku)
- Nevada Terawatt Facility 100 TW laser facility commissioning
- Nanofabrication of sharp-tipped conical targets
- PICLS simulations of fundamental laser-cone interaction physics*
  - UT-UNR expts (THOR) on x-ray production in free-standing pyramids & cones
  - LANL-UNR expts (Trident) on enhanced proton acceleration using cones
  - LULI-UNR expts (LULI 100 TW) on enhanced isochoric heating using cones

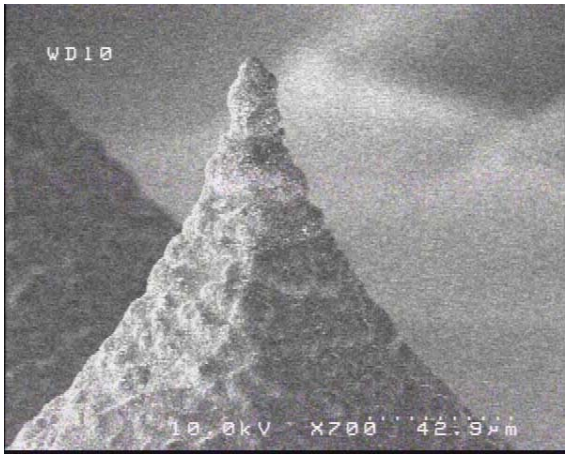
* Direct support from FSC

100 TW Leopard laser commissioning progress

- Laser chain commissioned (ongoing "routine" operation)
  - 30 J into vacuum compressor
  - 18 J compressed (300 fs)
  - 10^{-6} intensity contrast
- Next steps:
  - Contrast improvement with fast Pockel Cells (in process)
  - OAP focusing, high-intensity shots (fall/winter 2007)
  - Combined laser – Z pinch experiment for magnetized isochoric heating (Oct 2007: Presura, Cowan, Sentoku *et al.*)
  - 2ω conversion – laser-cone coupling (fall/winter 2007)
- Change in facility management, late August 2007
- Access for future FSC-relevant experiments…to be determined….

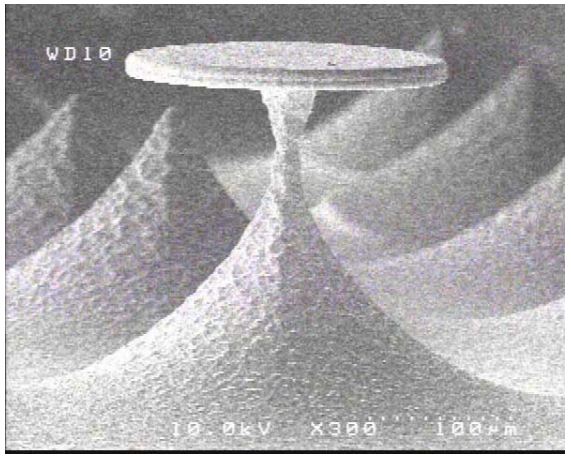
Significant progress with nanofabricated cone-shaped laser targets….

Free Standing Au (10 μm wall)

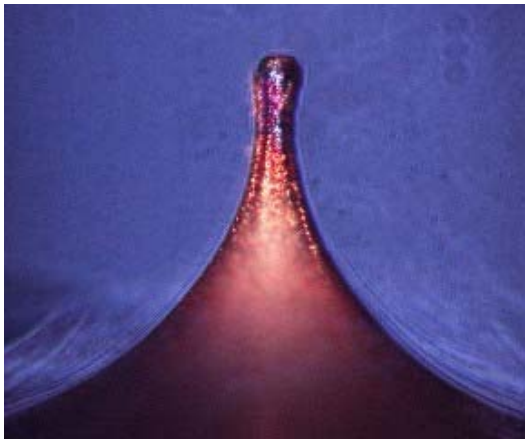


x-ray

proton

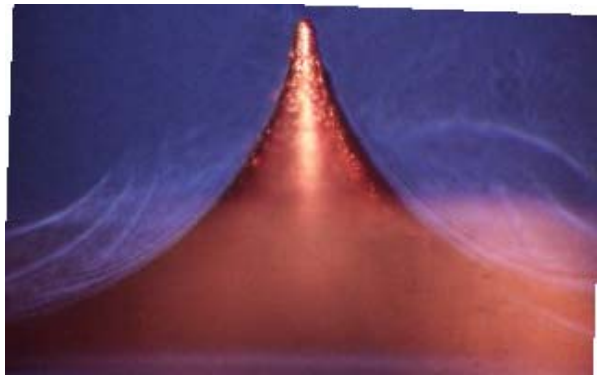


Free Standing Cu (10μm wall)



HED

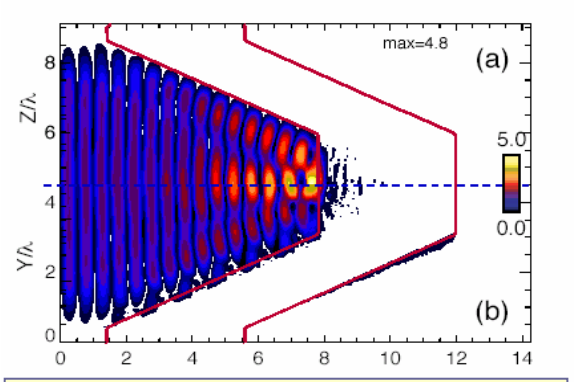
x-ray



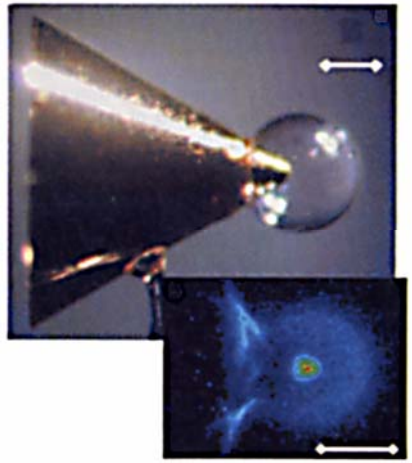
Smoother (!) than prior cones

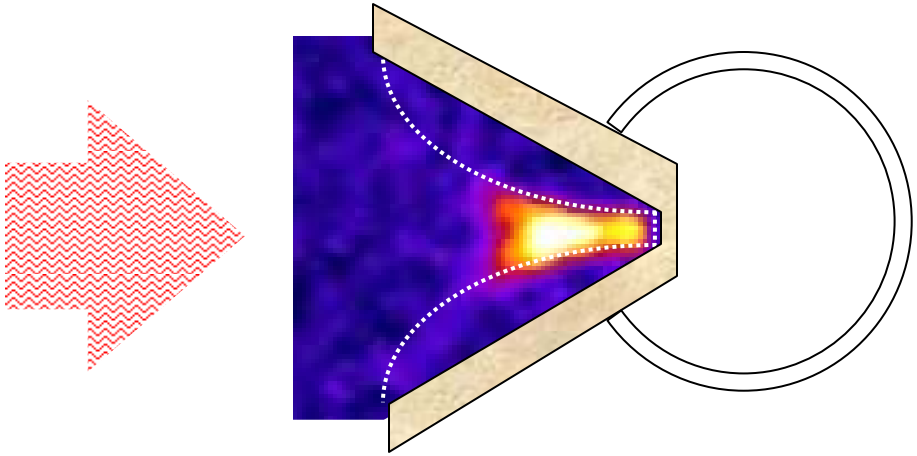
Potential benefit for Fast Ignition from *Fundamental Laser-Cone Interaction Physics*

Y. Sentoku, K. Mima, H. Ruhl, Y. Toyama, R. Kodama, T.E. Cowan,
"Laser Light and Hot Electron Micro Focusing using a Conical Target,"
Phys. Plasmas **11**, 3083 (2004)



Enhanced electron energy, yield, and conversion efficiency in μm-tipped cones





Sharp-tipped insert to FI target for increased conversion efficiency

Laser-Cone Interaction Experiments

2004/06 UT-UNR (Ditmire, Cowan, Sentoku, Le Galloudec, *et al.*)
- Sharp-tipped reentrant Si pyramids/wedges (UT)
- Free standing Au pyramids (UNR)

➔ hotter electrons with P polarization

2006 LANL-UNR-GSI (Flippo, Hegelich, Cowan, Sentoku *et al.*)
- "Pizza"-top tapered Au cones (UNR)

➔ Enhanced proton acceleration (laser conversion efficiency)

2006/07 LULI-Milan-Osaka-GA-UNR (Baton, Batani, Kodama, Back, Cowan, Sentoku *et al.*)
- Narrow tapered free-standing Cu cones (UNR)
- Osaka Au cones, GA reduced mass targets (C. Back)
- Ultra-high contrast (2ω) irradiation

➔ Self-generated magnetic confinement, Enhanced material heating
(J. Rassuchine, Ph.D. dissertation, UNR)

2007 UT-UNR (Ditmire, Le Galloudec, Sentoku *et al.*)
- Free standing Cu cones (UNR)

Results from Experiments and PICLS modeling

Prospect of sharp-tipped cone targets for Fast Ignition

Enhanced proton acceleration, electron confinement,
and heating observed ! (few-fold increase in laser conversion?!)

Can sharp-tipped cones improve Fast Ignition ?

Questions to be addressed:

- Improved conversion efficiency for those electrons which penetrate to core?
- Does laser pressure keep the cone open during FI-length pulse?
- Can nested cones protect sharp-tip from implosion?
- If laser-cone physics proves favorable, can high contrast FI pulse be produced?