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Magnetic field sources

Laser-driven mm-scale capacitor coils can generate B-fields (1-1000T) on nanosecond timescales [1-3]

All-optical platform for magnetized HED physics:

- Magnetized ICF [3,7]
- Charged-particle collimation
- Laboratory astrophysics [1,2]

Experimental aims:

- Understand underlying physics [6]
- Tailor **B**-field strength, shape and duration

Figure 1. Schematic of Capacitor Coil arrangement

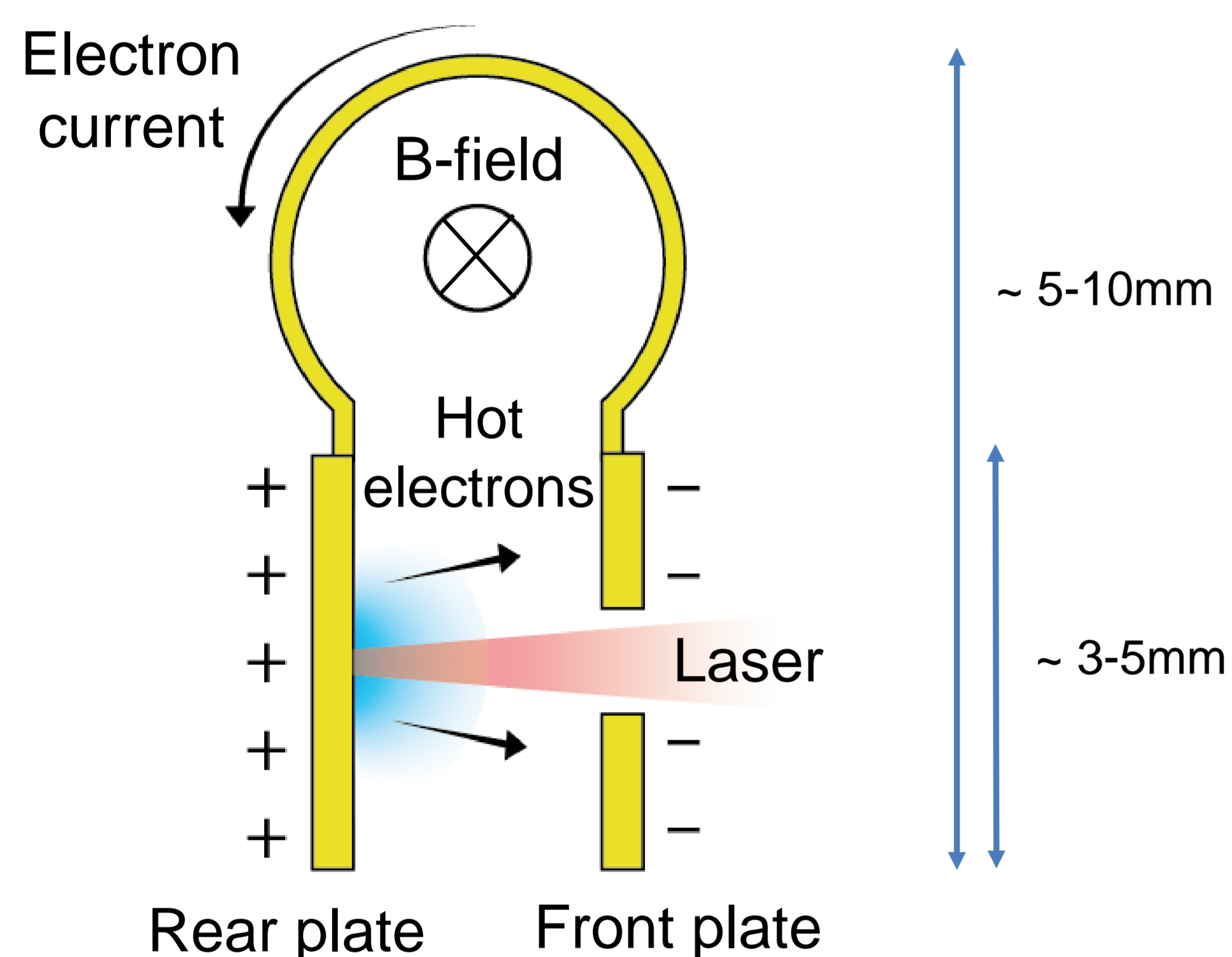
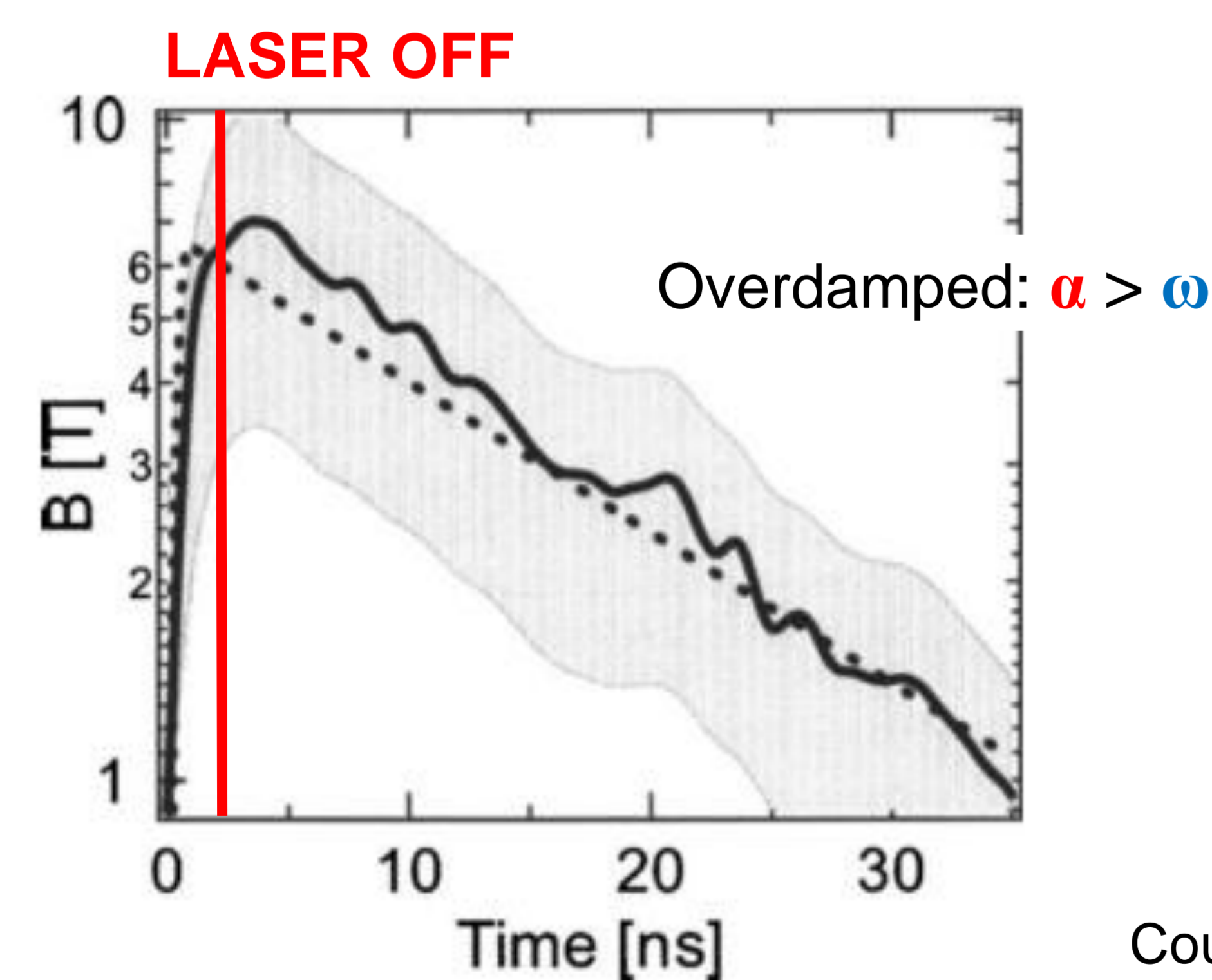


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RLC equivalent circuit model:

$$I'' + 2\alpha I' + \omega^2 I = 0$$

$$\alpha = R/2L, \quad \omega = 1/\sqrt{LC}$$



Courtois *et al.* [1]

EMP Mitigation

Laser-driven EMP can damage electronic equipment and degrade electrical measurements. It is sensitive to a range of target foil, target stalk and laser parameters [4,5].

Bandwidth: DC to THz

Magnitude: Over $MV m^{-1}$ for petawatt lasers at 1m from the target [5]

Model: Antenna emission caused by charge separation and RLC circuit discharge (GHz frequency)

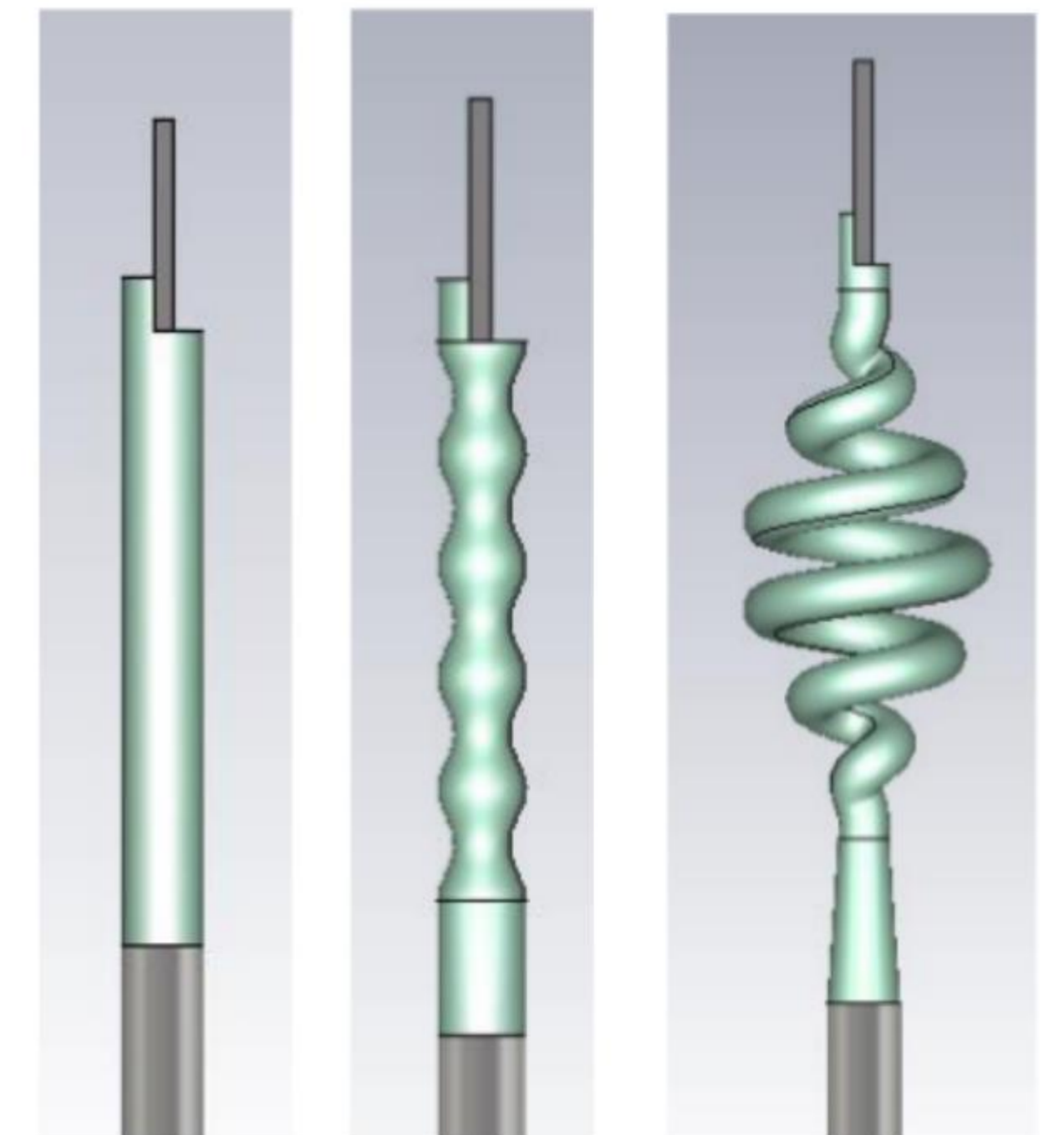
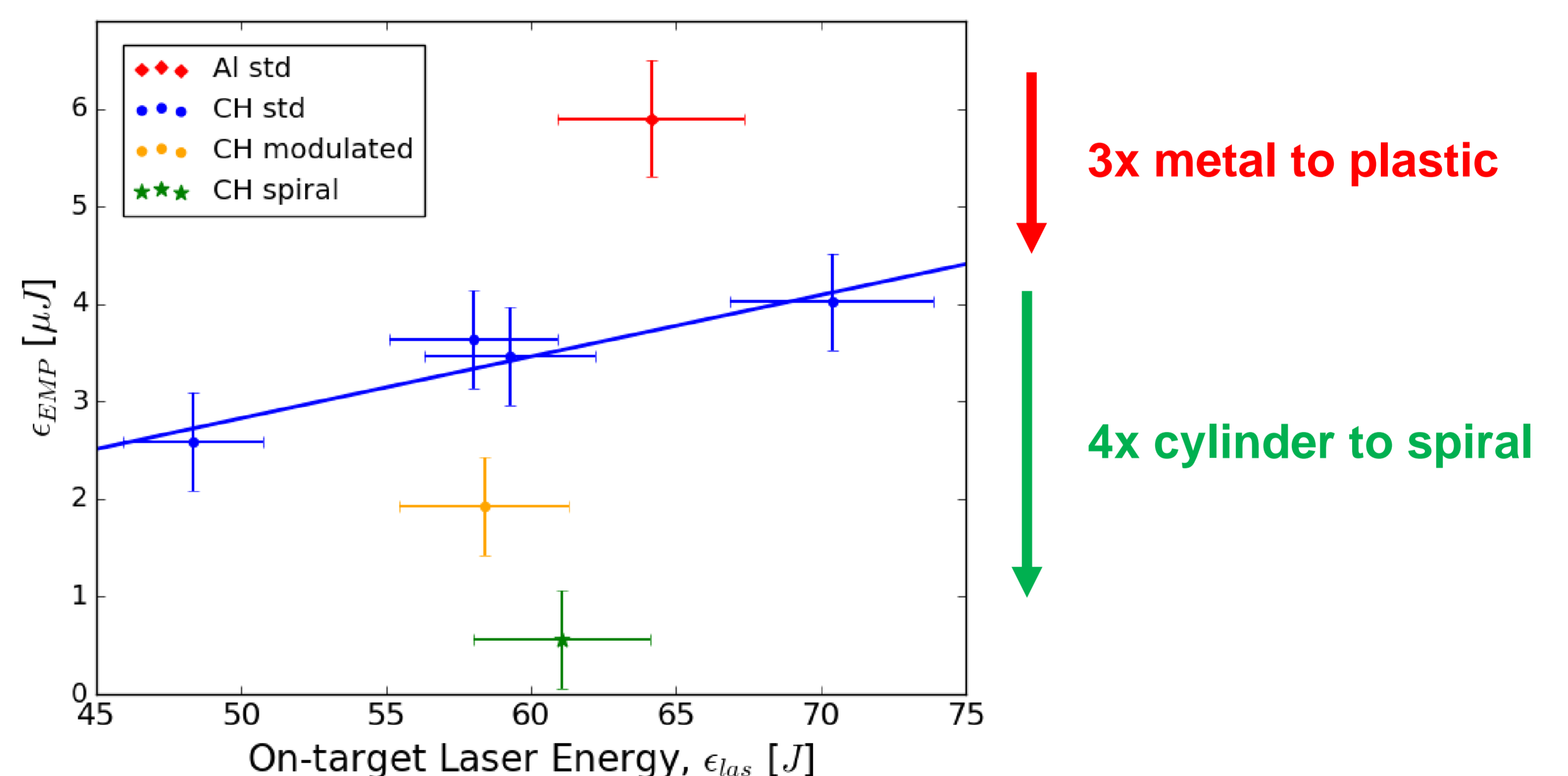


Figure 2. Target stalk designs arranged in order of increasing geodesic path length

VULCAN laser experiment:

1054nm, $I = 10^{17}-10^{19} W cm^{-2}$, $t = 1 ps$

EMP energy calculated from B-dot and D-dot probe measurements [4]



Increase geodesic path length → Reduce EMP energy

3D PIC and EM wave simulations (F. Consoli) were used to examine the effect of stalk geometry on EMP

- No advantage was found for sinusoidally-modulated stalks and spiral stalks showed only a 20% reduction in EMP energy
- **Photoionization** and **charge implantation** could generate an ionized layer of free charges along the stalk surface
- Modified stalks produce a marked reduction in EMP energy. Explanation may involve a **shadowing effect** that inhibits surface current flow across the target stalk

References

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Acknowledgements

We gratefully acknowledge funding from the LLNL Academic Partnership in ICF, EPSRC grants EP/L01663X/1 and EP/L000644/1, the Newton China grant and NSFC/11520101003. We would also like to acknowledge the support of staff at the Central Laser Facility and the Key Laboratory for Laser Plasmas at Shanghai Jiao Tong University.

