Hydrogenated boron nanofoams for laser-driven proton-boron fusions

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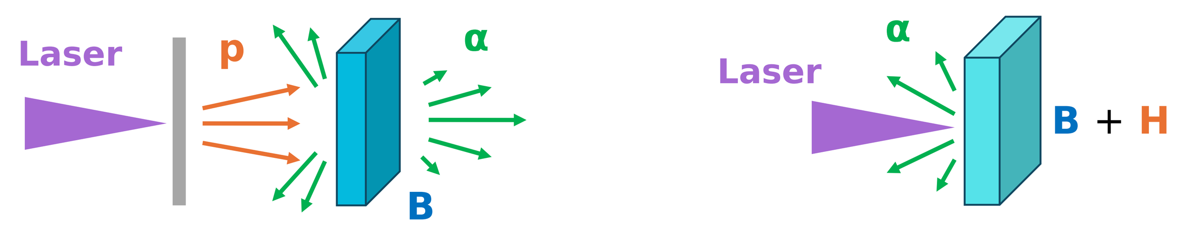
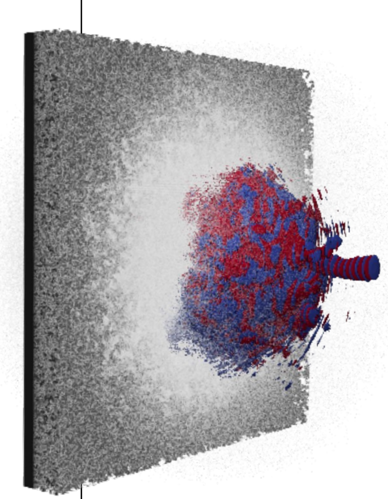
1 BACKGROUND

- Proton-boron fusion reaction: p + ^{11}B → 3 · α + 8.7 MeV
- Aneutronic, abundant fuel, efficient alpha heating… But small cross-section at low temperatures
- Applications: bright alpha sources, Proton-Boron Capture Theraphy, II Generation fusion reactors (beyond DT) [1,2]
- Laser-driven proton-boron fusion schemes: pitcher-catcher vs in-target
- **Advanced targets** can enhance the fusion yield!



2 MOTIVATIONS & GOALS

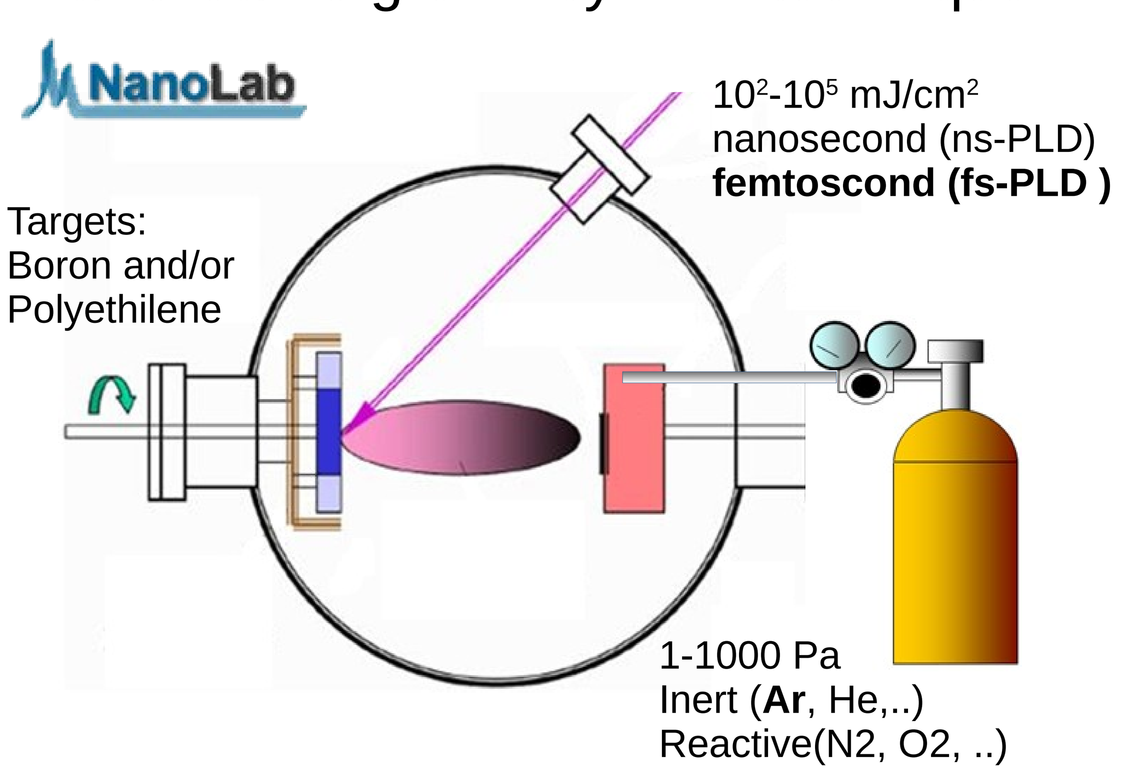
We propose a new class of targets for LD-PBF: Boron-based nanofoams by Pulsed Laser Deposition



- Nanofoams have been already explored for ultra-short (t<100 fs), ultra-intense (I>10^{18} W/cm^2) laser acceleration [3,4]
- Carbon nanofoams show potential as capsule ablator for direct-drive ICF schemes [see 0-48, M. Cipriani].
- Boron-based nanofoams might combine the benefits of controlled morphology, density, and composition

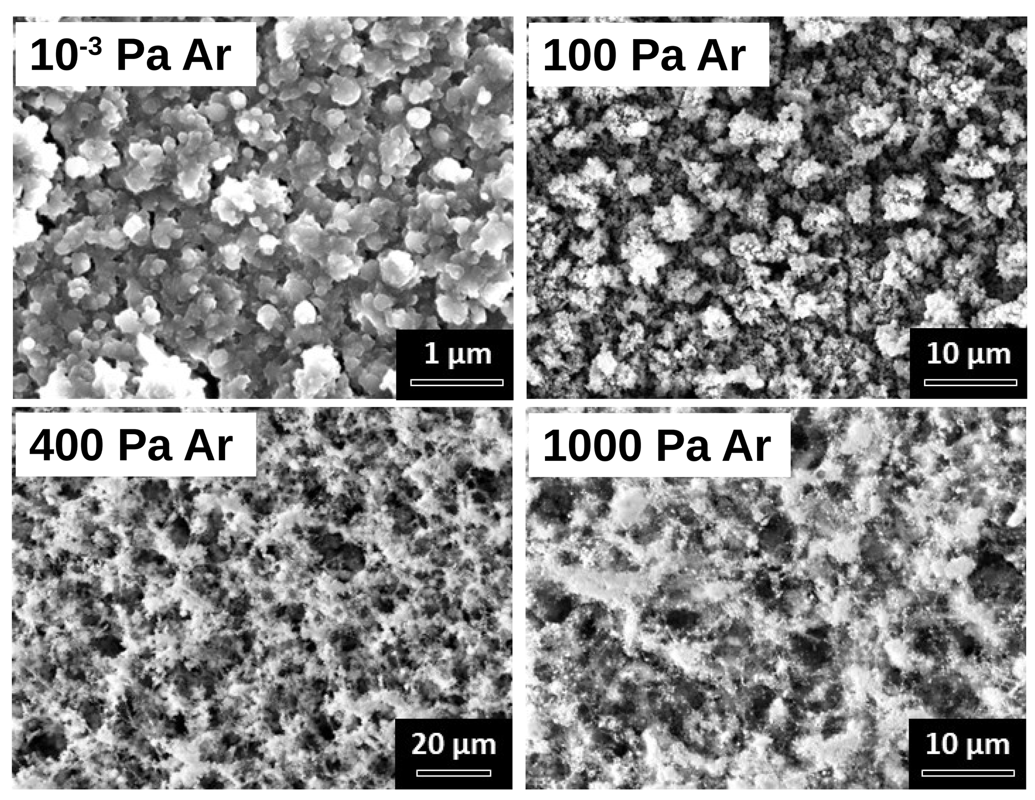
3 NANOFOAM PRODUCTION

Nanofoams grown by **PLD** technique

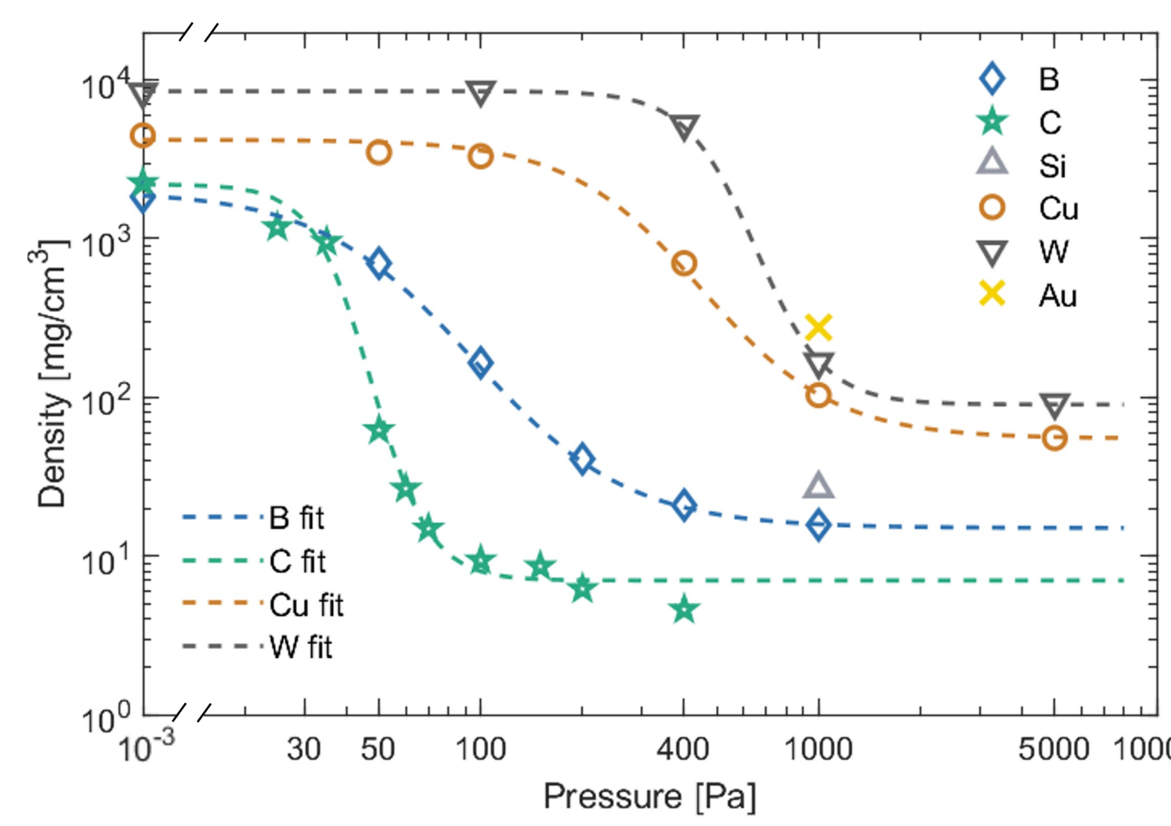


✓ Virtually any kind of substrate
✓ Versatility through process parameters [5,6]

Controlled **morphology** & nanostructure



Tunable **density** (6 – 100 mg/cm^2)



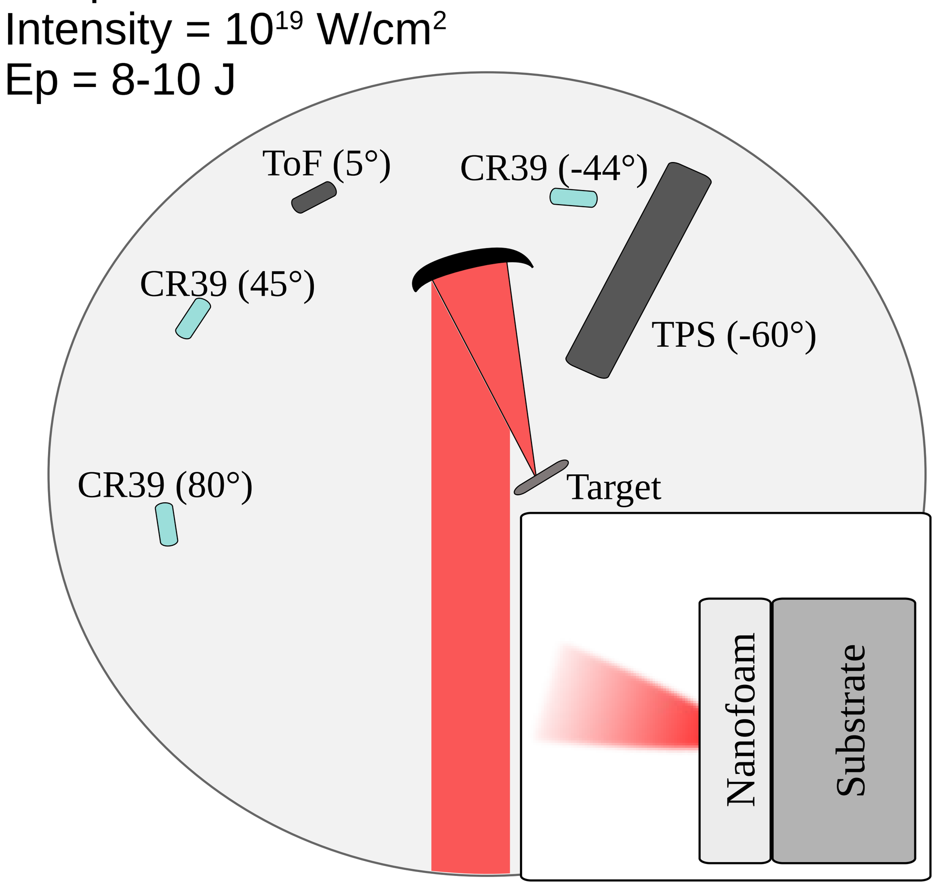
4 IRRADIATION EXPERIMENT @ TARANIS

Taranis Laser

Wavelength = 1053 nm
Temporal FWHM = 800 fs
Intensity = 10^{19} W/cm^2
Ep = 8-10 J

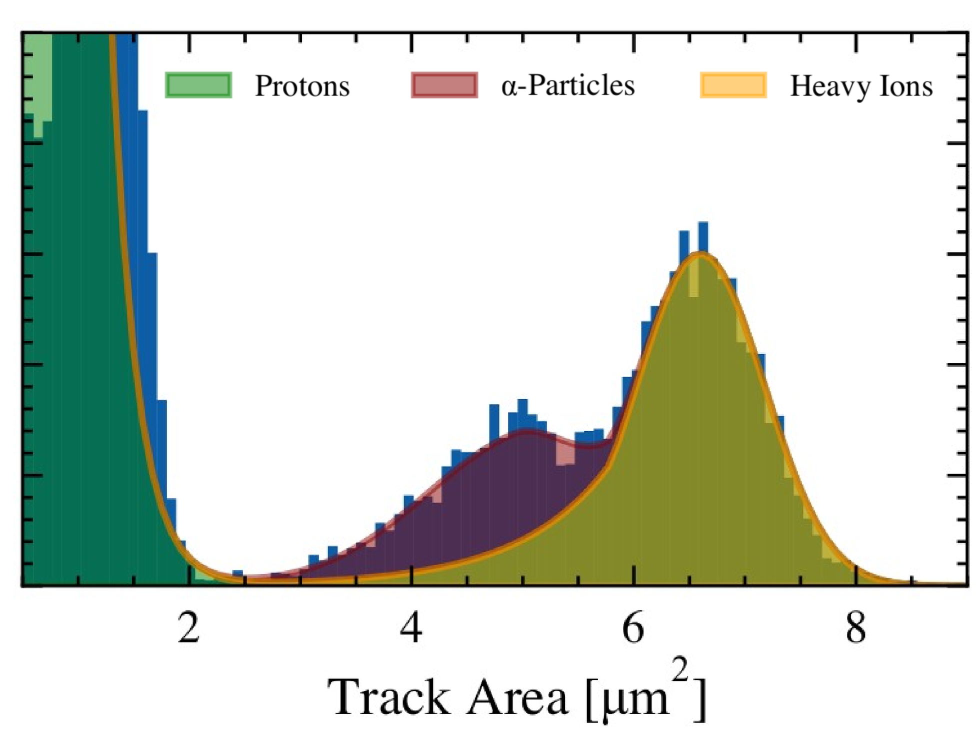
Several CR39:

Different shieldings to discriminate alphas from protons



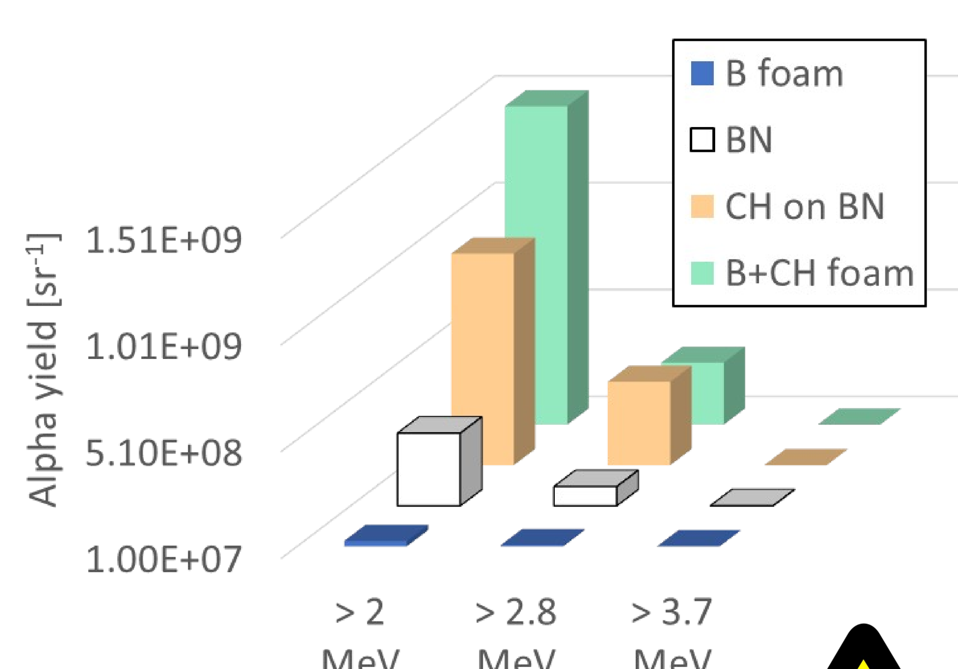
B + CH nanofoam on PP

CR39 @ 45° + 6.5 µm Al
Etching in 6.25 M NaOH for 60 min

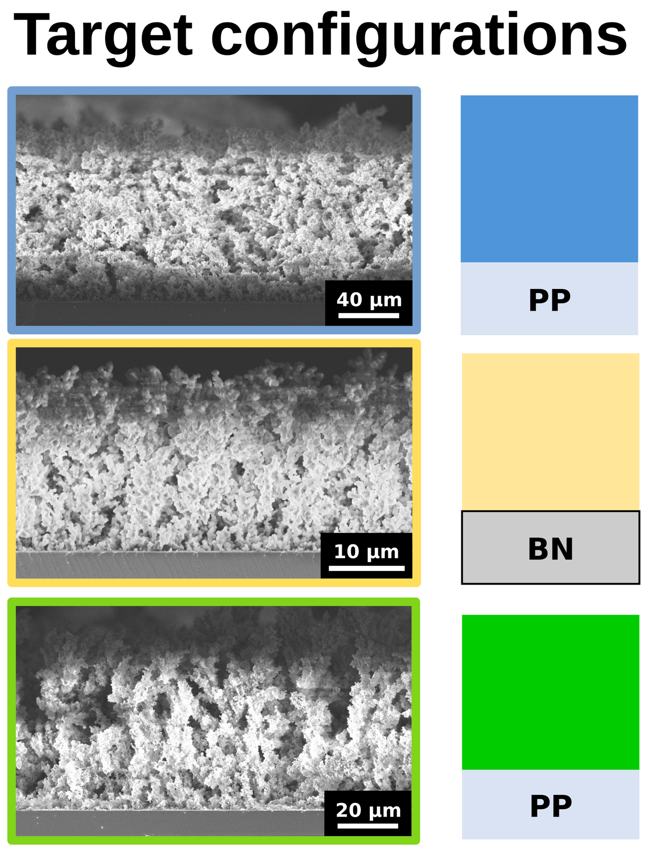


Alpha yield comparison

CR39 @ 45°; 6.5, 10, 14 µm Al
Etching in 6.25 M NaOH for 60 min



Target configurations



B nanofoam on PP substrate
50-100 mg/cm^3
50-100 µm

CH nanofoam on BN substrate
120 mg/cm^3
10-20 µm

B + CH nanofoam on PP substrate
40-80 mg/cm^3
50-100 µm

5 CONCLUSIONS

- Advanced targets allow significant α yield with moderate (~10 TW) laser power
- Up to ~ 5 × 10^7 α/sr/J with B+CH foam
- Strong evidence for in-target fusion for B + CH nanofoam
- Ongoing work: comparison with PIC+Hydro simulations
- Future work: optimize nanofoam parameters for further increase fusion yield

6 REFERENCES

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