

## Experimental evaluation of a 10-PW-driven Nano Accelerator for IFE

D.E. Rivas<sup>(1)</sup>, A. Fazzini<sup>(1)</sup>, M.M. Günther<sup>(1)</sup>, V. Scutelnic<sup>(1)</sup>, A. Ailincutei<sup>(2)</sup>, J.J. Bekx<sup>(1)</sup>, G. Bleotu<sup>(4)</sup>, C. Bild<sup>(1)</sup>, C. Braganza<sup>(1)</sup>, G. Bodini<sup>(1)</sup>, A.F. Brodersen<sup>(1)</sup>, A. Cavalli<sup>(1)</sup>, O. Chalus<sup>(3)</sup>, L. Chopinet<sup>(1)</sup>, G. Cojocaru<sup>(4)</sup>, J. D’Mello<sup>(1)</sup>, I. Dancus<sup>(4)</sup>, F. Deurvorst<sup>(1)</sup>, C. Derycke<sup>(2)</sup>, D. Doria<sup>(4)</sup>, M. Ehrmantraut<sup>(1)</sup>, E. Gaul<sup>(1)</sup>, D. Gengenbach<sup>(1)</sup>, P. Ghenuche<sup>(4)</sup>, D. Ghita<sup>(1)</sup>, B. Gonzalez-Izquierdo<sup>(1)</sup>, M. Gugiu<sup>(4)</sup>, O. Juina<sup>(1)</sup>, J. Jung<sup>(1)</sup>, K. Kenney<sup>(1)</sup>, S. Kumar<sup>(1)</sup>, M. Martinez-Pacheco<sup>(1)</sup>, I. Minguez Bacho<sup>(1)</sup>, M. Nöth<sup>(1)</sup>, N. Poetranto<sup>(1)</sup>, G. Raj<sup>(1)</sup>, E. Schork<sup>(1)</sup>, M. Speicher<sup>(1)</sup>, M. Stein<sup>(1)</sup>, M. Talposi<sup>(4)</sup>, A. Toma<sup>(4)</sup>, M. Tosca<sup>(1,5)</sup>, M. Touati<sup>(1)</sup>, A. Ubarhande<sup>(1)</sup>, L. Vasescu<sup>(4)</sup>, M. S. Schollmeier<sup>(1)</sup>, H. Ruhl<sup>(1)</sup> and G. Korn<sup>(1)</sup>

<sup>(1)</sup> *Marvel Fusion GmbH (Germany)*

<sup>(2)</sup> *Thales Systems Romania (Romania)*

<sup>(3)</sup> *Thales LAS France (France)*

<sup>(4)</sup> *Extreme Light Infrastructure – Nuclear Physics, (Romania)*

<sup>(5)</sup> *Extreme Light Infrastructure – Beamlines (Czech Republic)*

Highly ordered nanowire arrays with sub-wavelength diameter can be engineered to absorb multi-PW laser pulses with intensities above  $10^{20}$  W/cm<sup>2</sup>, an ultra-high-contrast ( $<10^{-12}$  on ps timescales) and sub-100-fs duration with an efficiency nearing 100%. A large fraction of the absorbed energy is converted by this Nano Accelerator to high-current ion flows in a controlled manner [1]. The ion flow can then heat and potentially compress fusible material made of hydrogen, boron, deuterium and tritium [1,2] in close vicinity to IFE-relevant conditions.

In this contribution, we will present the first experimental demonstration of the Nano Accelerator driven by 10 PW laser pulses. Experiments were conducted with the HPLS laser at the Extreme Light Infrastructure for Nuclear Physics (ELI-NP), which was operated at approximately 200 J of energy on target at a pulse duration of 23 fs. The original focusing geometry was modified from F/60 to F/20 with a double plasma-mirror telescope leading to intensities of  $8 \times 10^{20}$  W/cm<sup>2</sup> with a uniform focal spot volume of 20  $\mu$ m FWHM and  $>200$   $\mu$ m length [3]. The intense laser pulse was used to irradiate  $100 \times 100$   $\mu$ m<sup>2</sup> patches of highly aligned, high-aspect-ratio nanowires. Monitoring the specularly reflected laser light and detecting ion emission via multiple Thomson Parabola & CR-39 spectrometers, we demonstrate an efficient laser power absorption capability of  $>5$  PW and conversion to high energy ions nearing 30% efficiency, in line with theoretical expectations [1]. In addition, we show the possibility of tailoring the emitted ion spectra by varying the interaction parameters, which enables scaling and further optimization of the Nano Accelerator as a driver for IFE targets [1].

### References

- [1] Ruhl and G. Korn, arXiv, 2212.1294 (2022), H. Ruhl and G. Korn, arXiv, 2302.06562 (2023)
- [2] H. Ruhl, et al., submitted
- [3] V. Scutelnic., et al., submitted