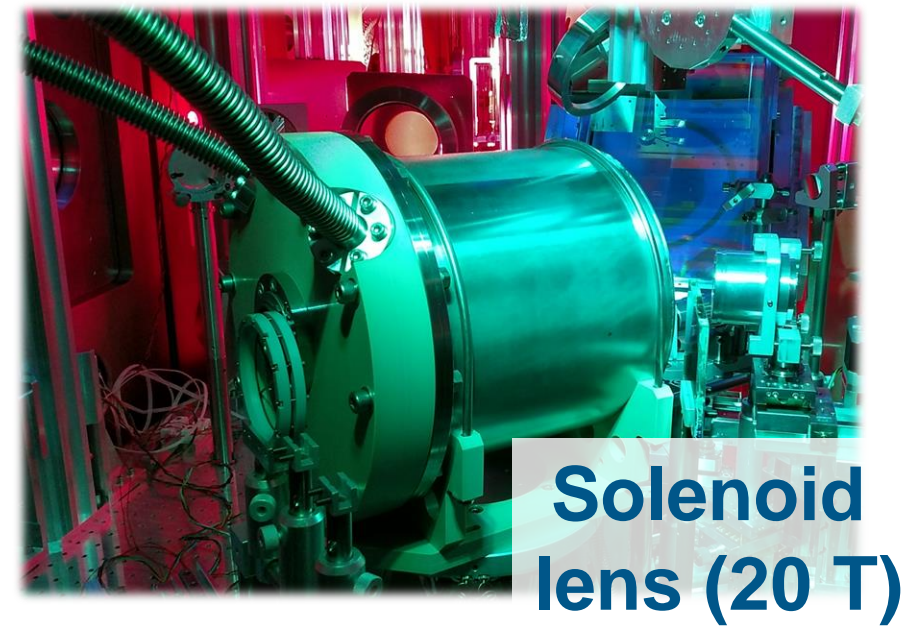


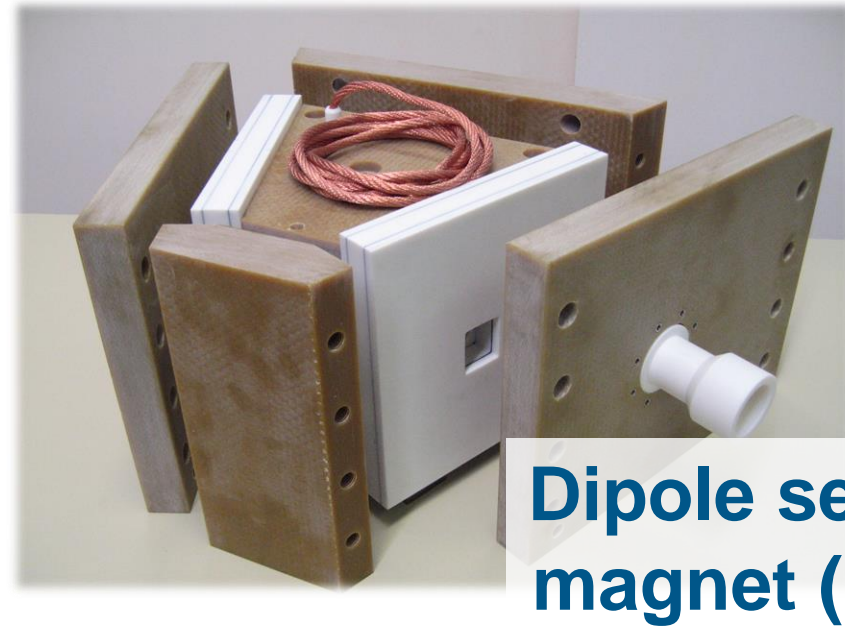
ALBUS – ADVANCED LASER-DRIVEN BEAMLINES FOR USER-SPECIFIC STUDIES

Florian Kroll, Florian-Emanuel Brack, Elke Beyreuther, Jörg Pawelke, Marvin Reimold, Joshua Schilz, Ulrich Schramm, Karl Zeil, Josefine Metzkes-Ng

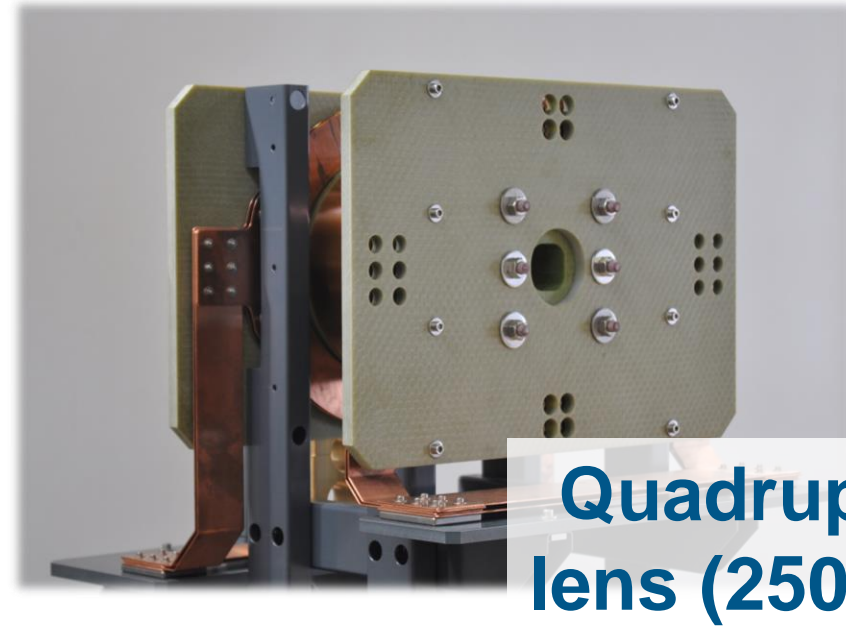
Technology Platform: Pulsed High-Field Magnets for Pulsed Particle & Plasma Sources



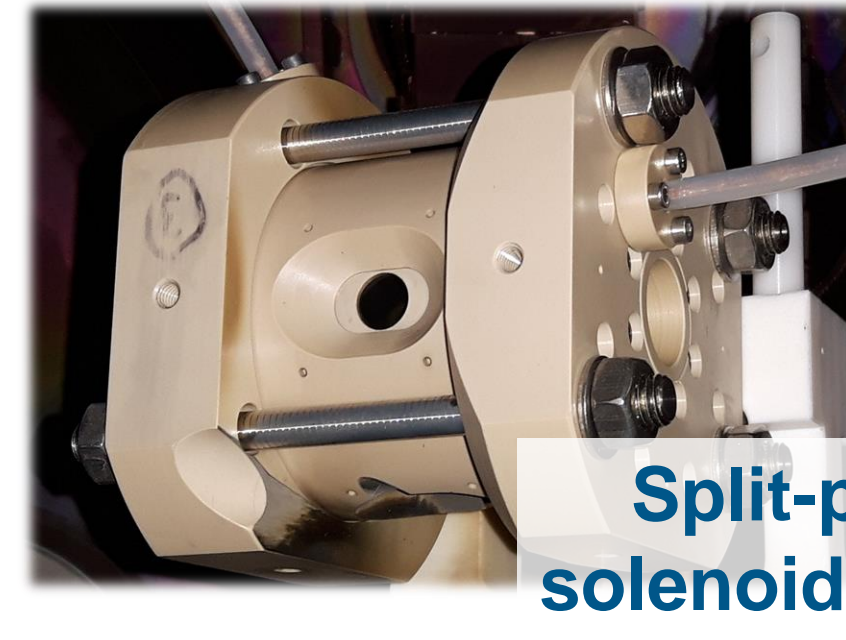
Solenoid lens (20 T)



Dipole sector magnet (10 T)



Quadrupole lens (250 T/m)



Split-pair solenoid (15 T)



Pulse generator ($E_{el} \leq 94$ kJ)

Research using ALBUS technology

Accelerator Physics

Reimold et al., *HPLSE* 11 (2023)
Gerlach et al., *HPLSE* 11 (2023)
Reimold et al., *Sci. Rep.* 12 (2022)
Metternich et al., *PRAB* 25 (2022)

Kroll et al., *Nat. Phys.* 18 (2022)
Brack et al., *Sci. Rep.* 10 (2020)
Haffa et al., *Sci. Rep.* 9 (2019)
Jahn et al., *PRAB* 22 (2019)

Jahn et al., *NIM-A* 909 (2018)
Jahn et al., *RSI* 89 (2018)
Masood et al., *PMB* 62 (2017)
Busold et al., *Sci. Rep.* 5 (2015)

Masood et al., *AP-B* 117 (2014)
Busold et al., *NIM-A* 740 (2014)
Busold et al., *PRAB* 17 (2014)
Busold et al., *PRAB* 16 (2013)

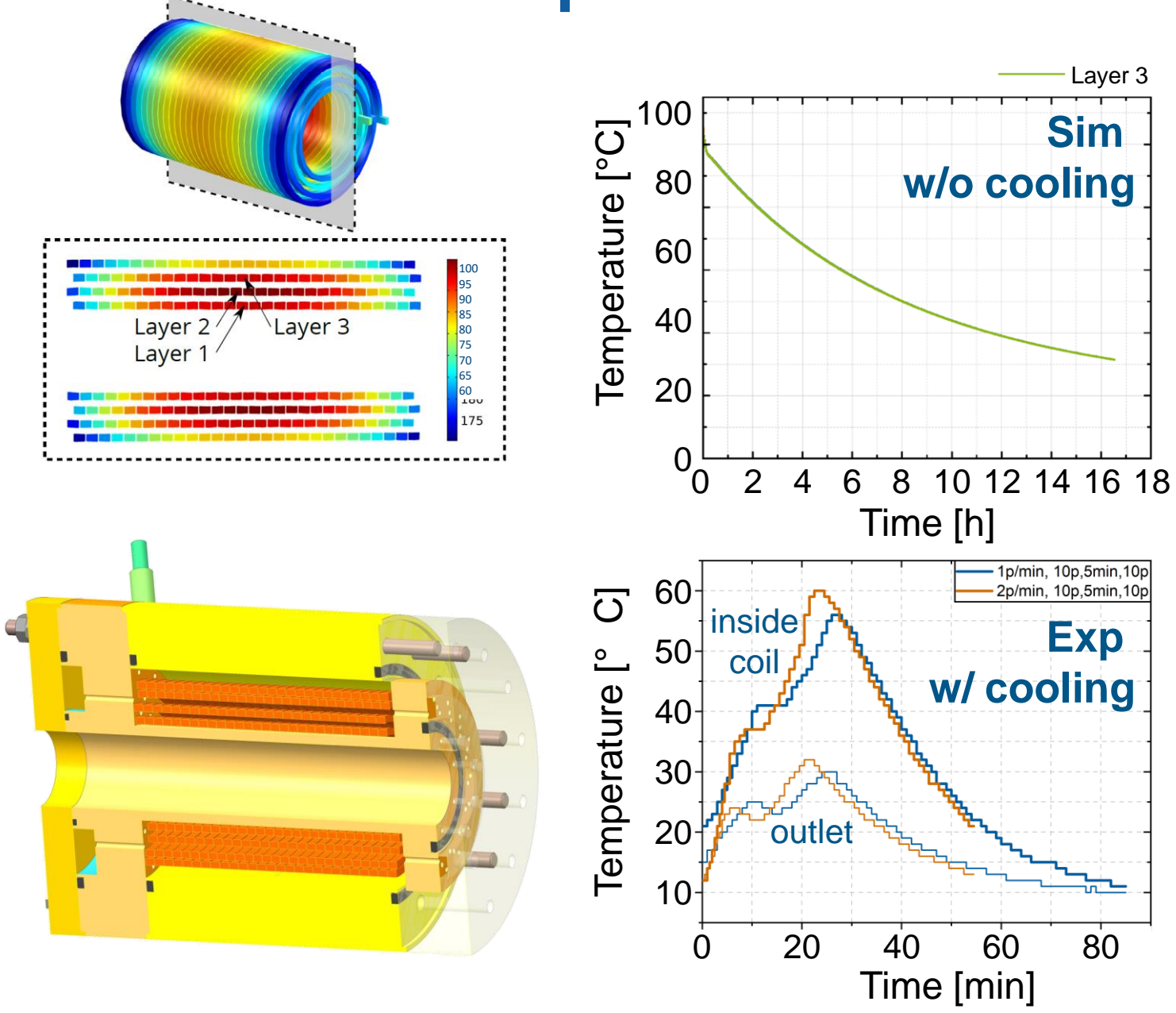
Laboratory Astrophysics

Perez-Martin et al., *HPLSE* 11 (2023)
Bohlin et al., *PPCF* 64 (2022)
Manuel et al., *MRE* 6 (2021)
Mabey et al., *Astrophys. J.* 896 (2020)

Mabey et al., *Sci. Rep.* 9 (2019)
Albertazzi et al., *HPLSE* 6 (2018)
Albertazzi et al., *Science* 346 (2014)
Albertazzi et al., *RSI* 84 (2013)

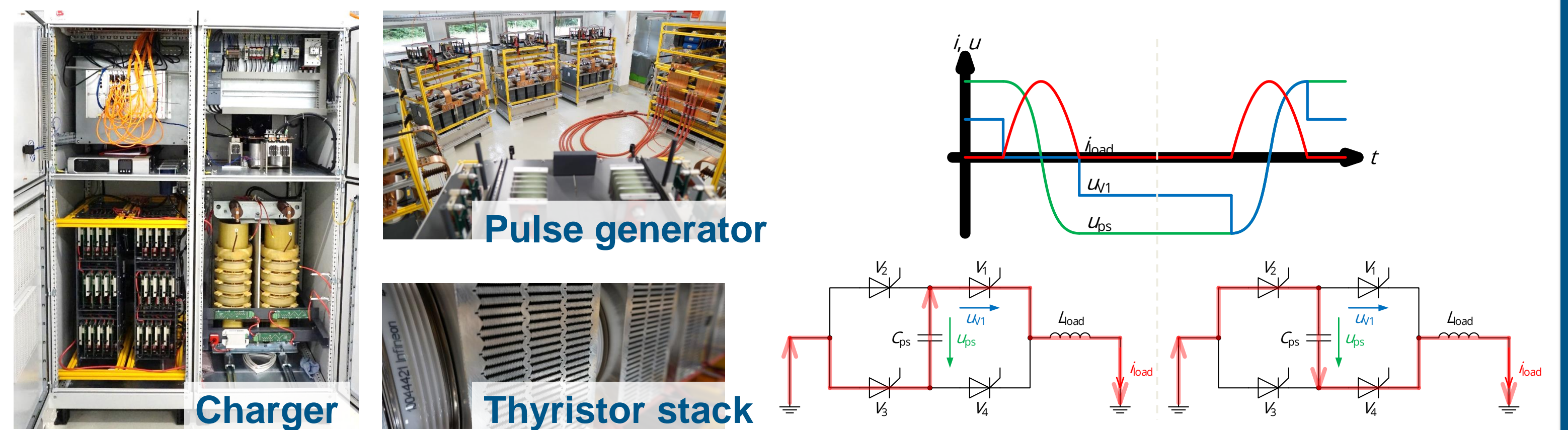
Developments Towards High Repetition Rate (~ 1 Hz)

Compact air-cooled solenoid magnet (20 T)



- Cool-down time: ~min
- Compact and light-weight PEEK body and housing

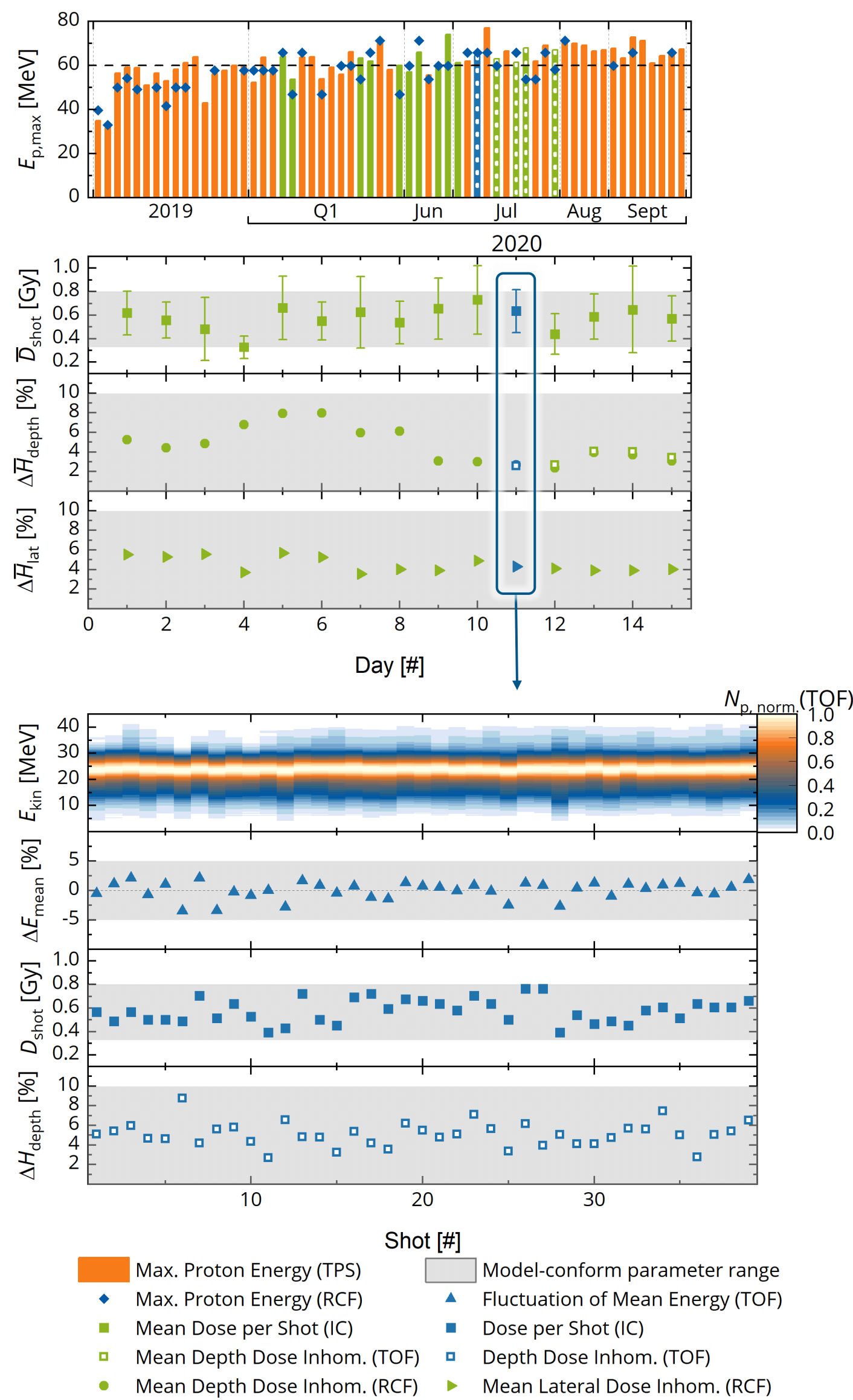
Rep-rate optimized current pulse generator ($E_{el} \leq 216$ kJ)



- Modular pulse generator design (125 – 750 μ F) capable of 10-Hz-operation
- Concept of energy recuperation fully tested and prototype assembled
- 1-Hz-charger under commissioning

ALBUS-2S Enables Worldwide First Tumor Irradiation in Mice with Laser-Driven Protons

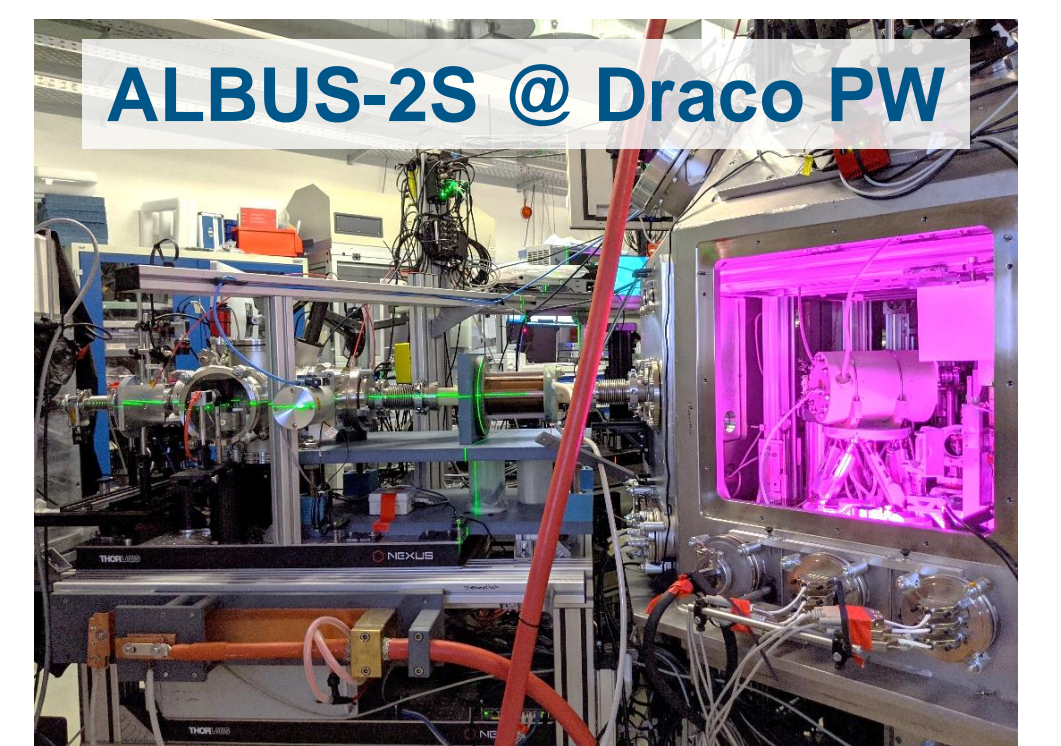
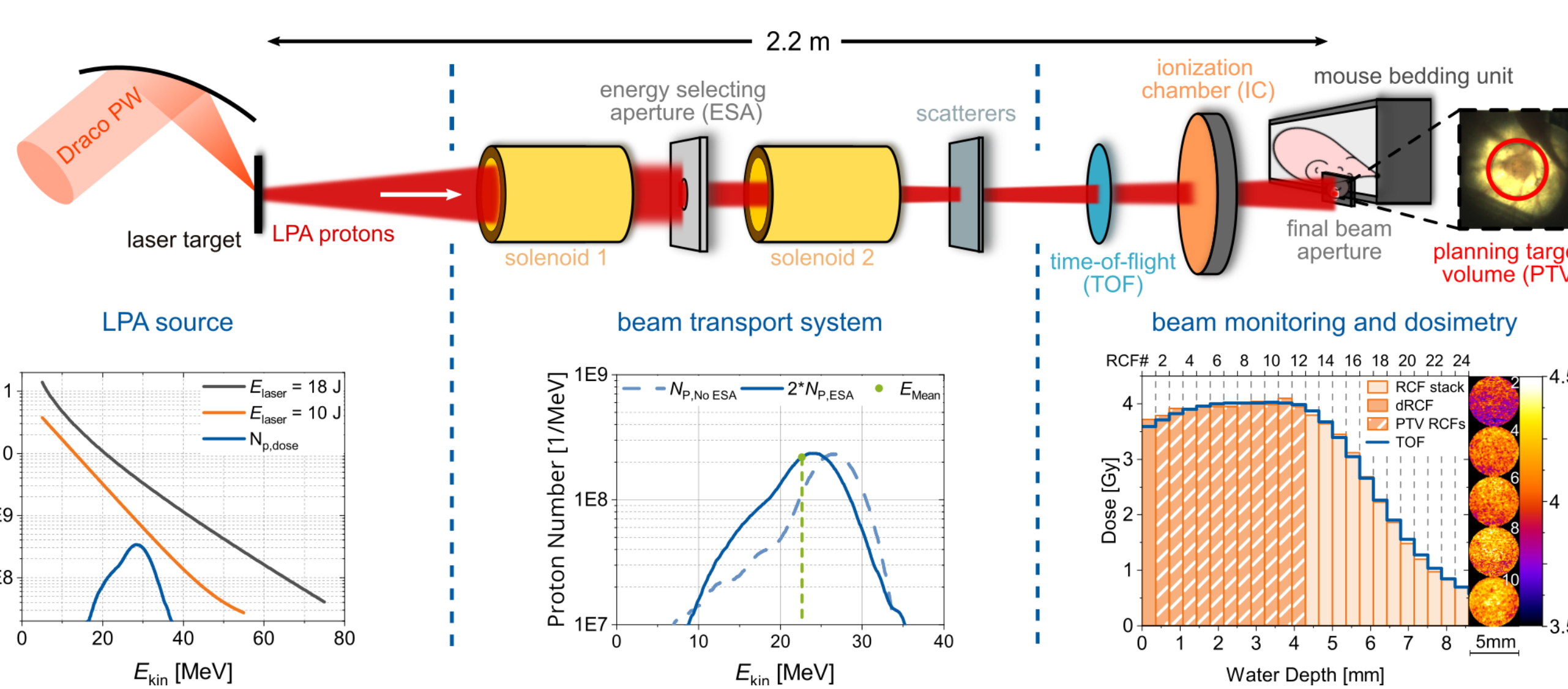
Accelerator readiness and beam delivery stability



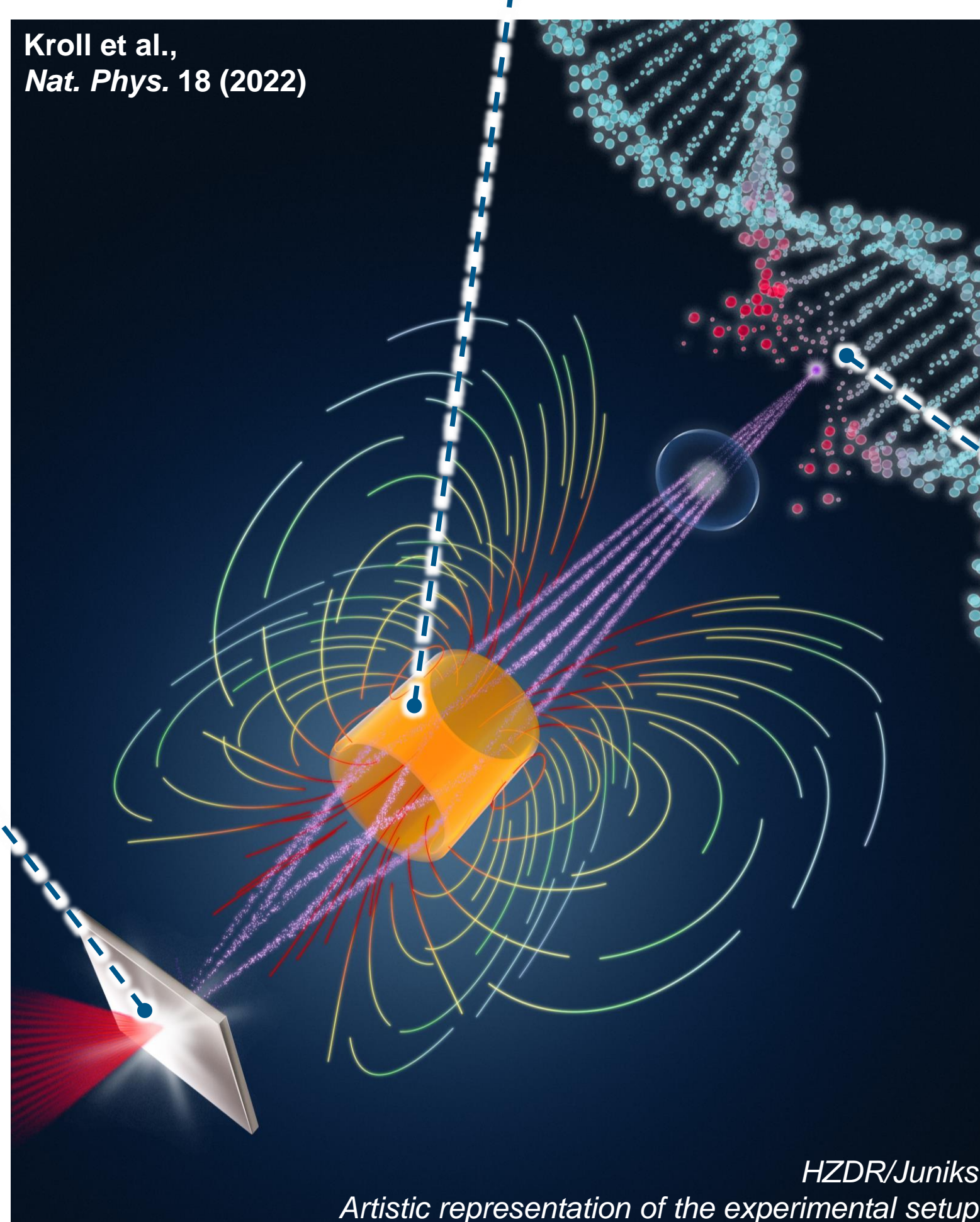
Stable, high-energy operation of laser-driven proton source over years

Reproducible dose delivery parameters in accordance with all radiobiologically prescribed margins (grey) over months

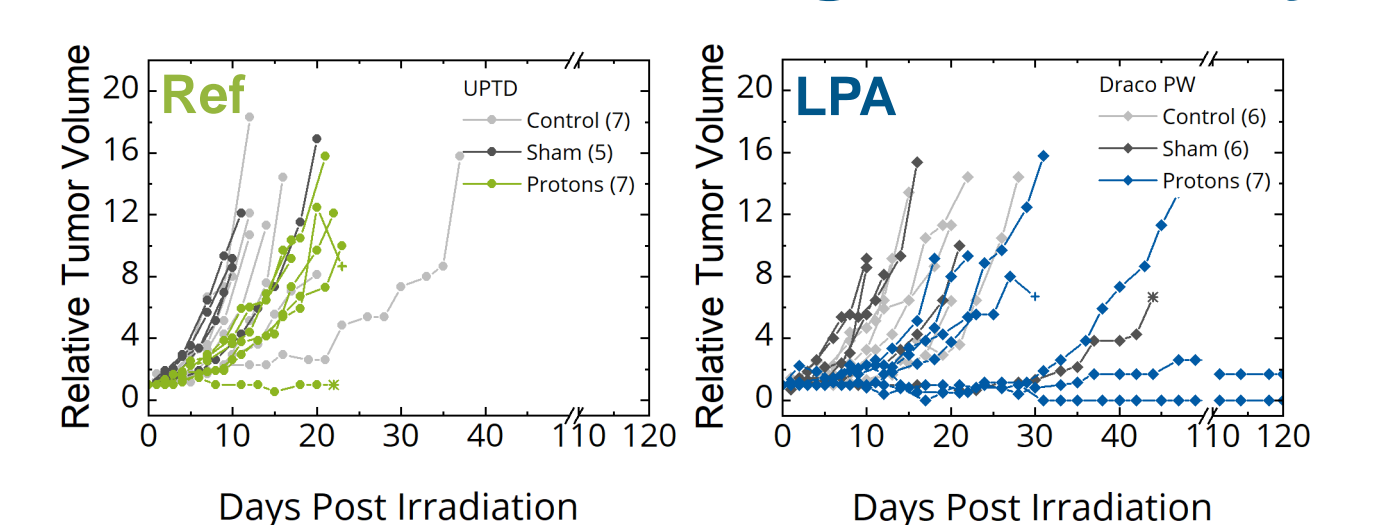
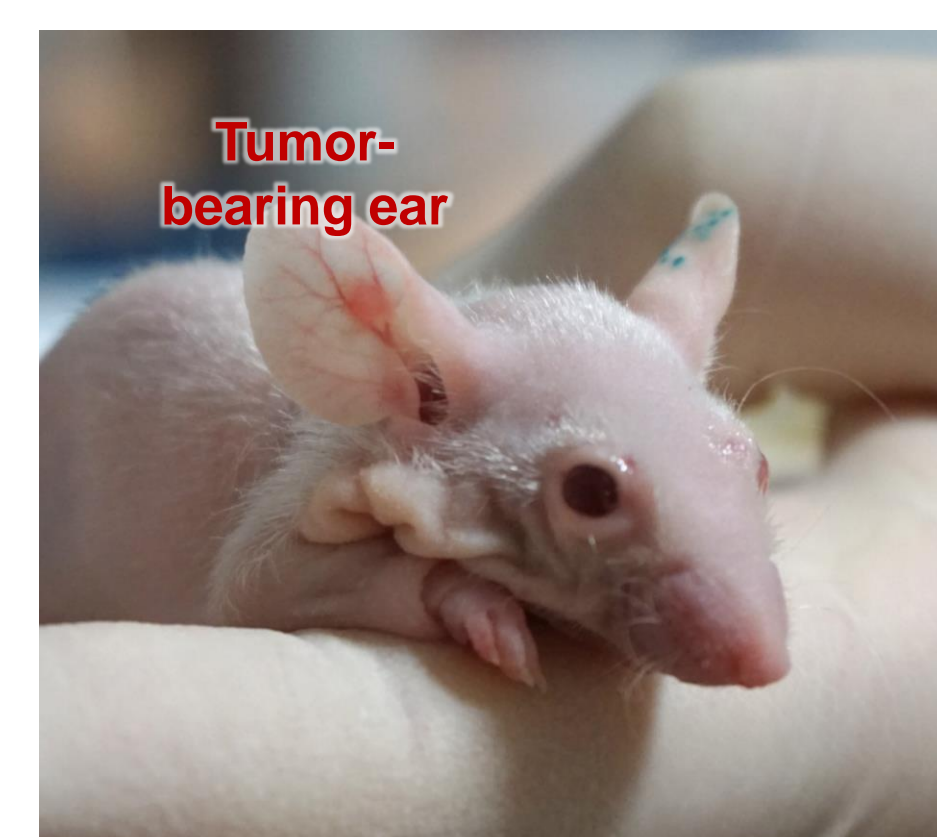
Dose delivery at Draco PW via ALBUS-2S high-field beamline



Precise prescribed dose delivery using multiple laser shots

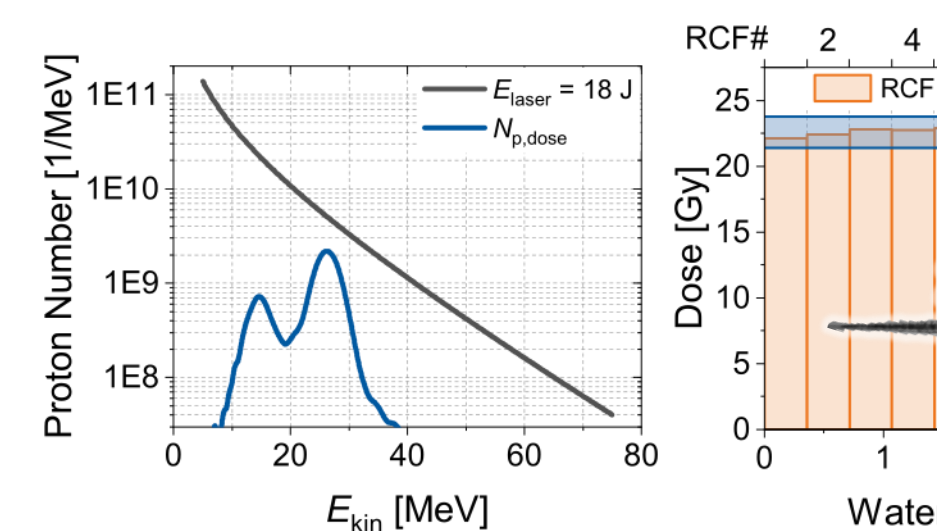


Irradiation of human HNSCC tumors on mouse ear with LPA protons – radiation induced tumor growth delay



LPA protons yield valuable radiobiological data comparable to clinical reference

Single-shot ultra-high dose rate capability



Homogeneous dose >20 Gy delivered within nanoseconds = FLASH relevant