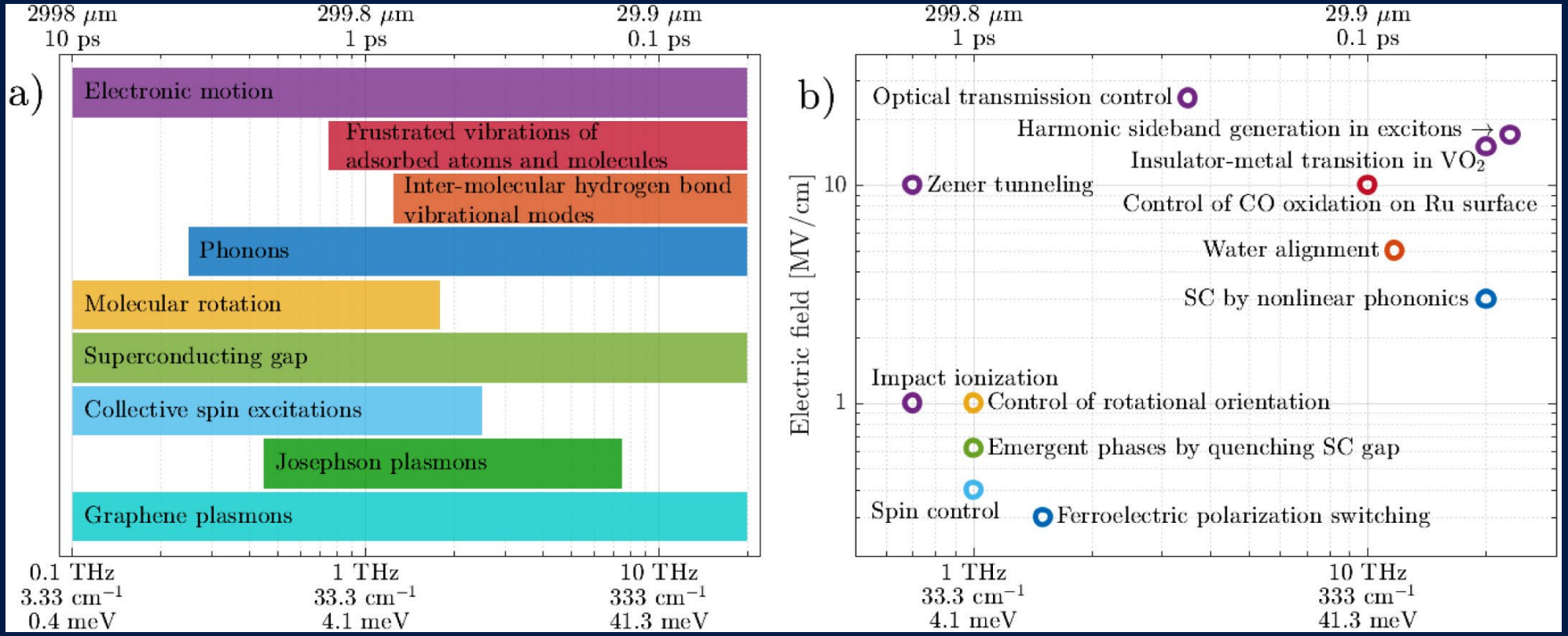
Dresden Advanced Light Infrastructure

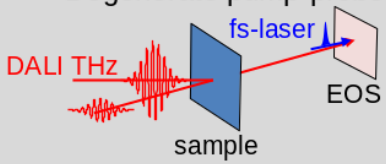
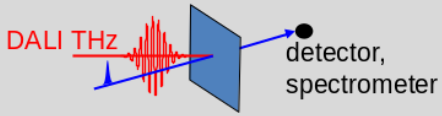
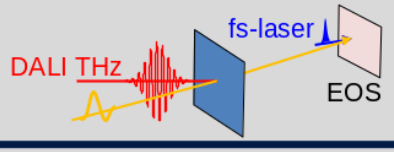
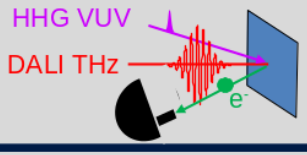
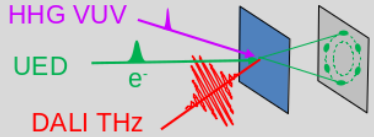
A Successor to ELBE for the HZDR

U. Lehnert, 3.10.2023

Science Case

THz Control and Probing of matter



Technique	Exemplary experiments
Degenerate pump-probe 	Nonlinear dynamics of low-energy excitations in solids
Two-color pump-probe with fs optical pulses 	Probing semiconducting band gaps, excitons, ferromagnetic systems
Two-color pump-probe with broadband THz 	Probing superconducting gaps, dynamic conductivity
THz pump – tr ARPES probe 	Probing band structures, phase transitions, dressed states
THz/VUV pump – UED probe 	Probing structural properties, phase transitions, electron-phonon coupling

Selective excitation of quantum processes

high fields → non-linear effects

low photon energies → collective excitations

Requirements

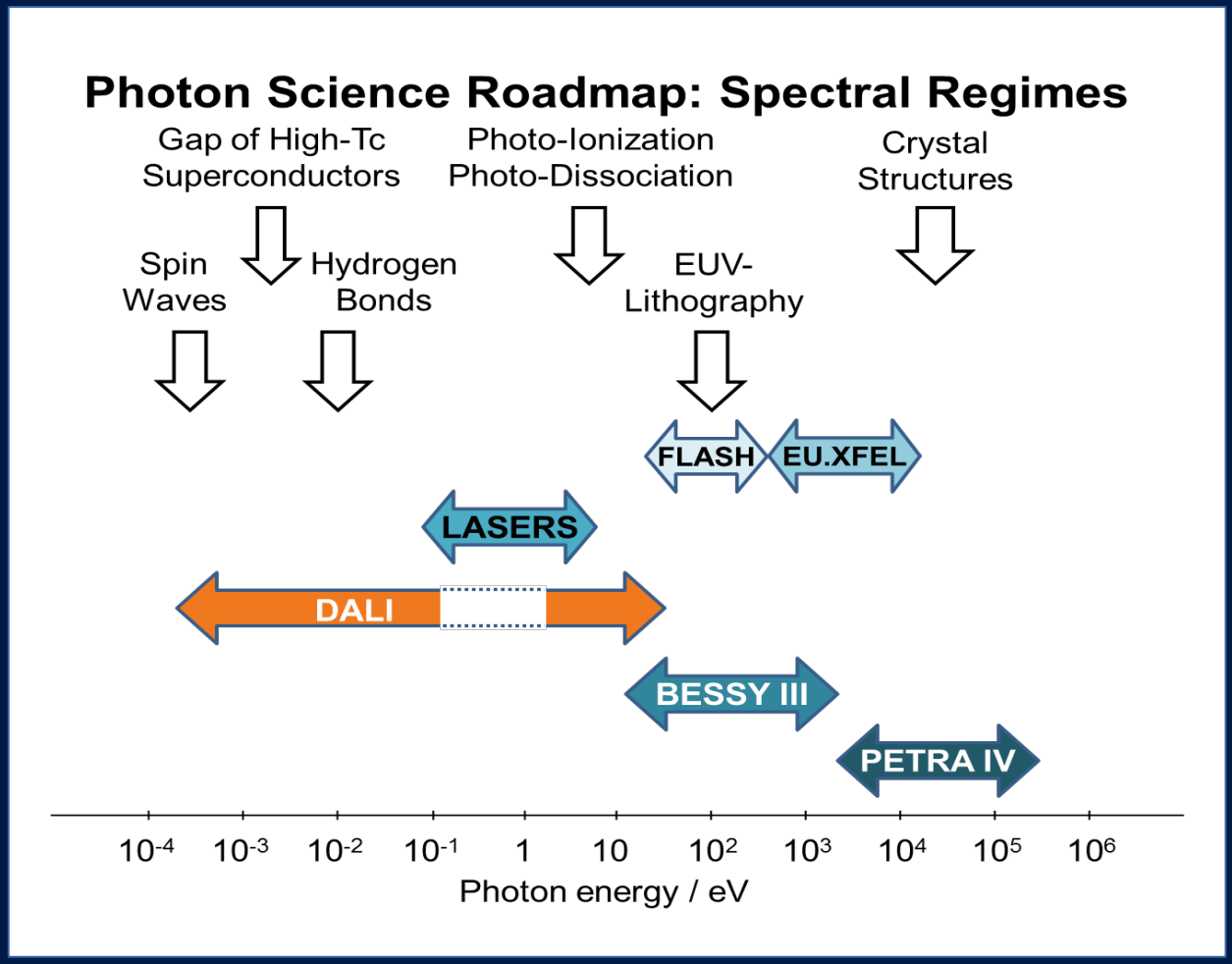
Spectrally dense pump pulses **tunable from THz to mid-IR**

Field strengths in **MV/cm** range

High repetition rate > **100 kHz**

HZDR

HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF



DALI

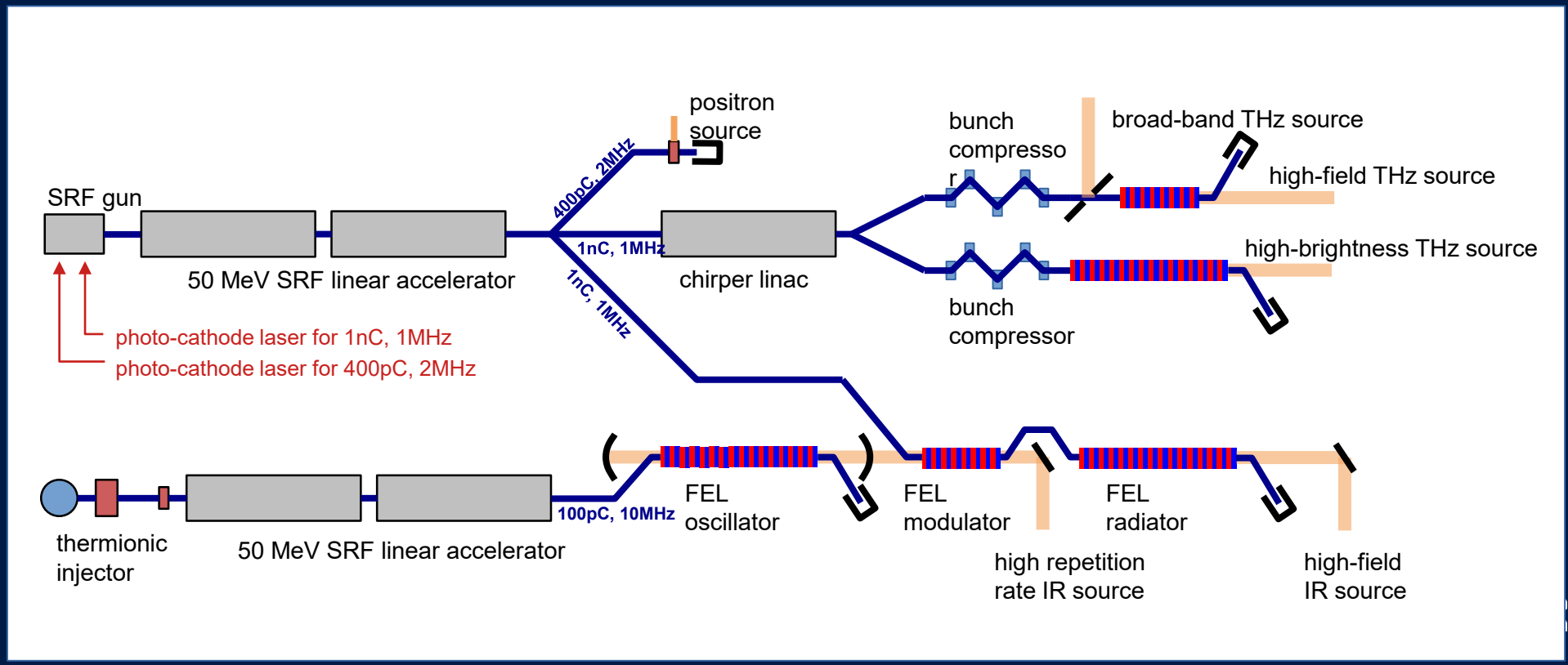
Dresden Advanced Light Infrastructure

Preliminary Conceptual Design Report 2020

HZDR

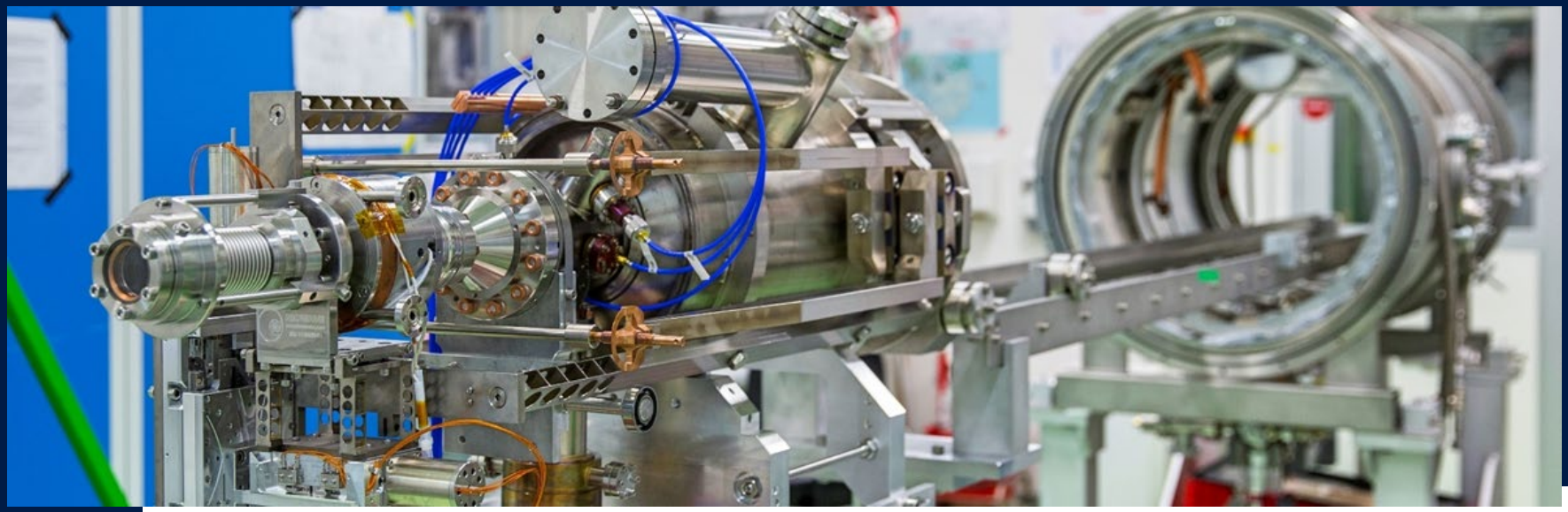
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

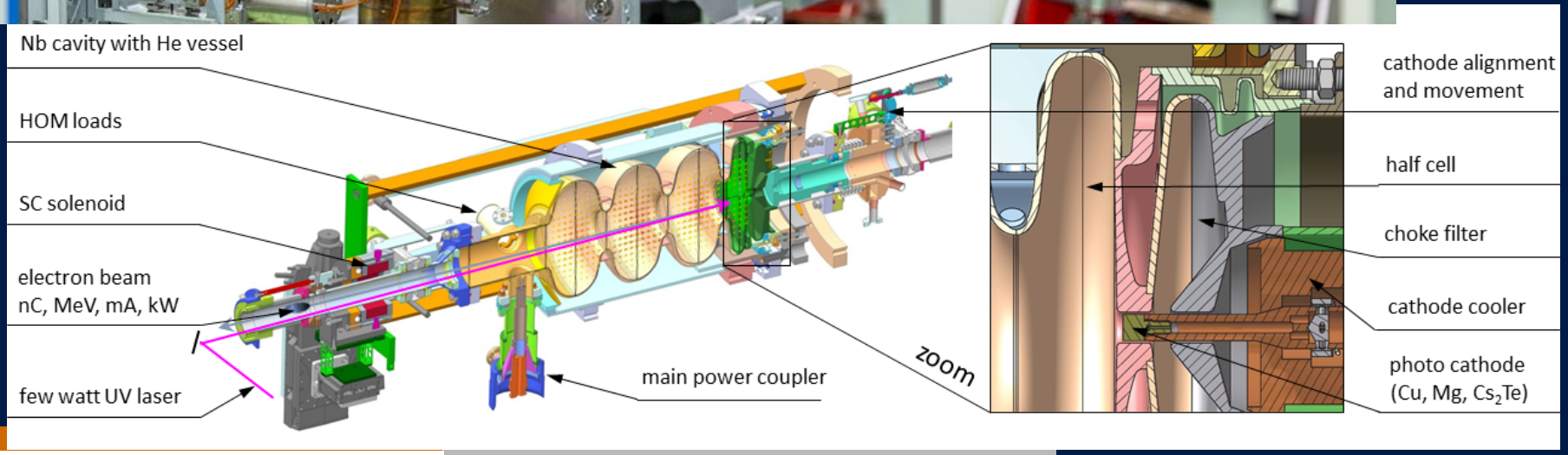
Machine Overview



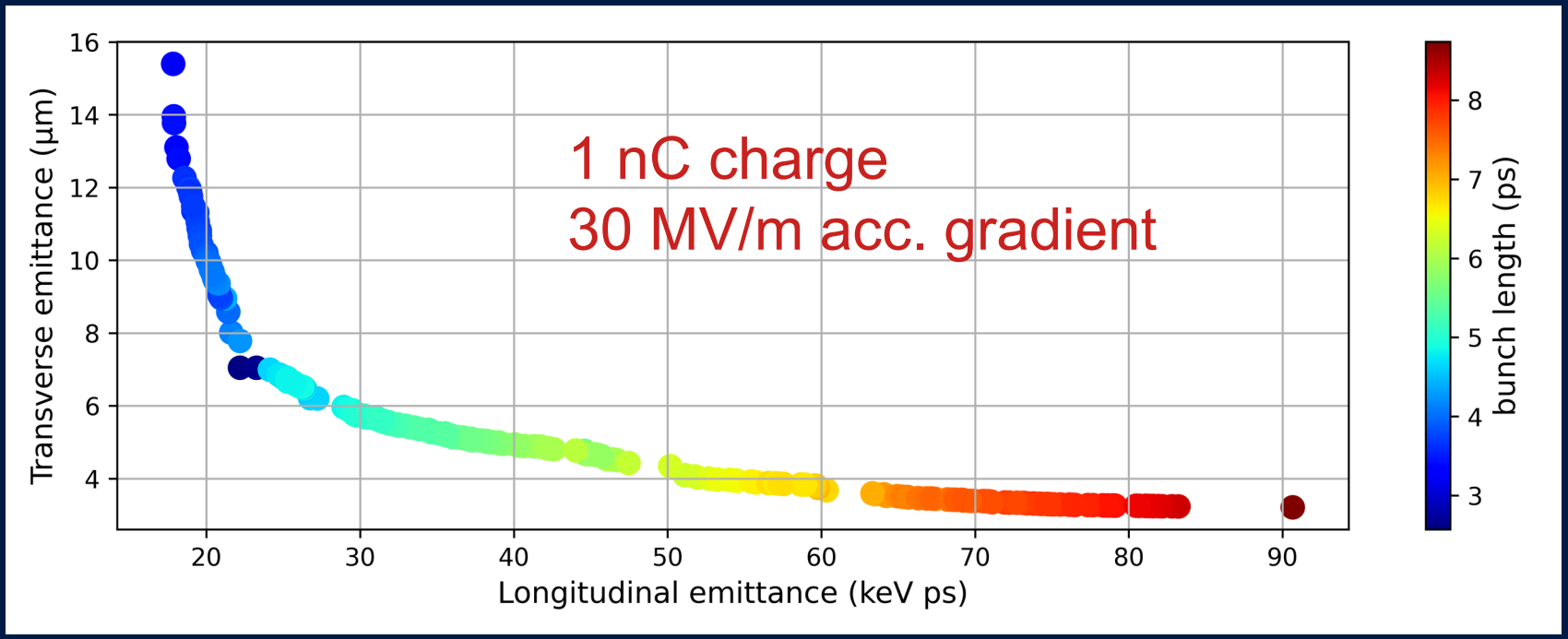
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

HZDR SRF electron





Optimizing Electron Beam Parameters from the SRF Gun



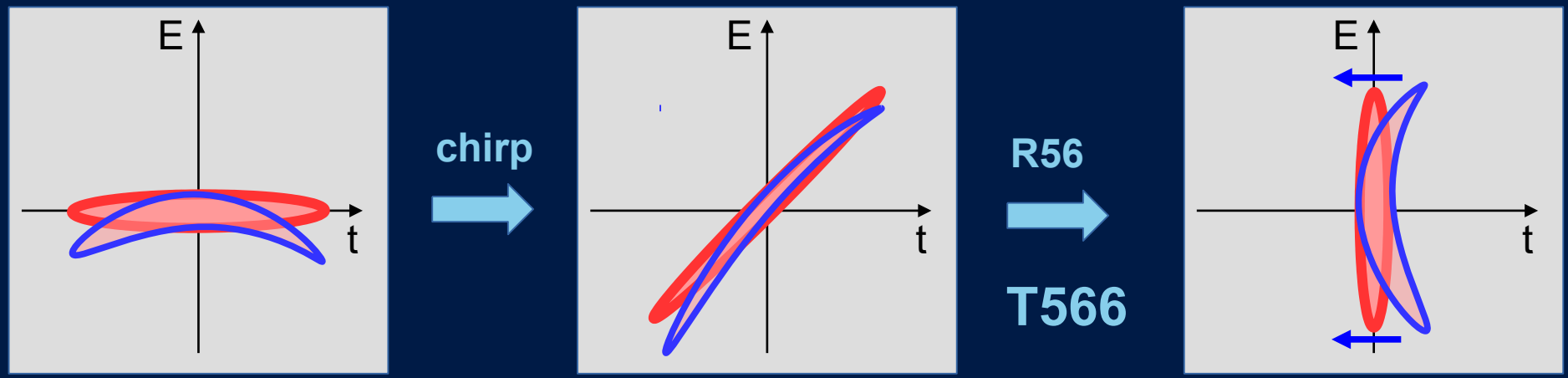
multi-objective optimization:

- longitudinal emittance
- transverse emittance
- bunch length
- slice energy spread

HZDR

HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

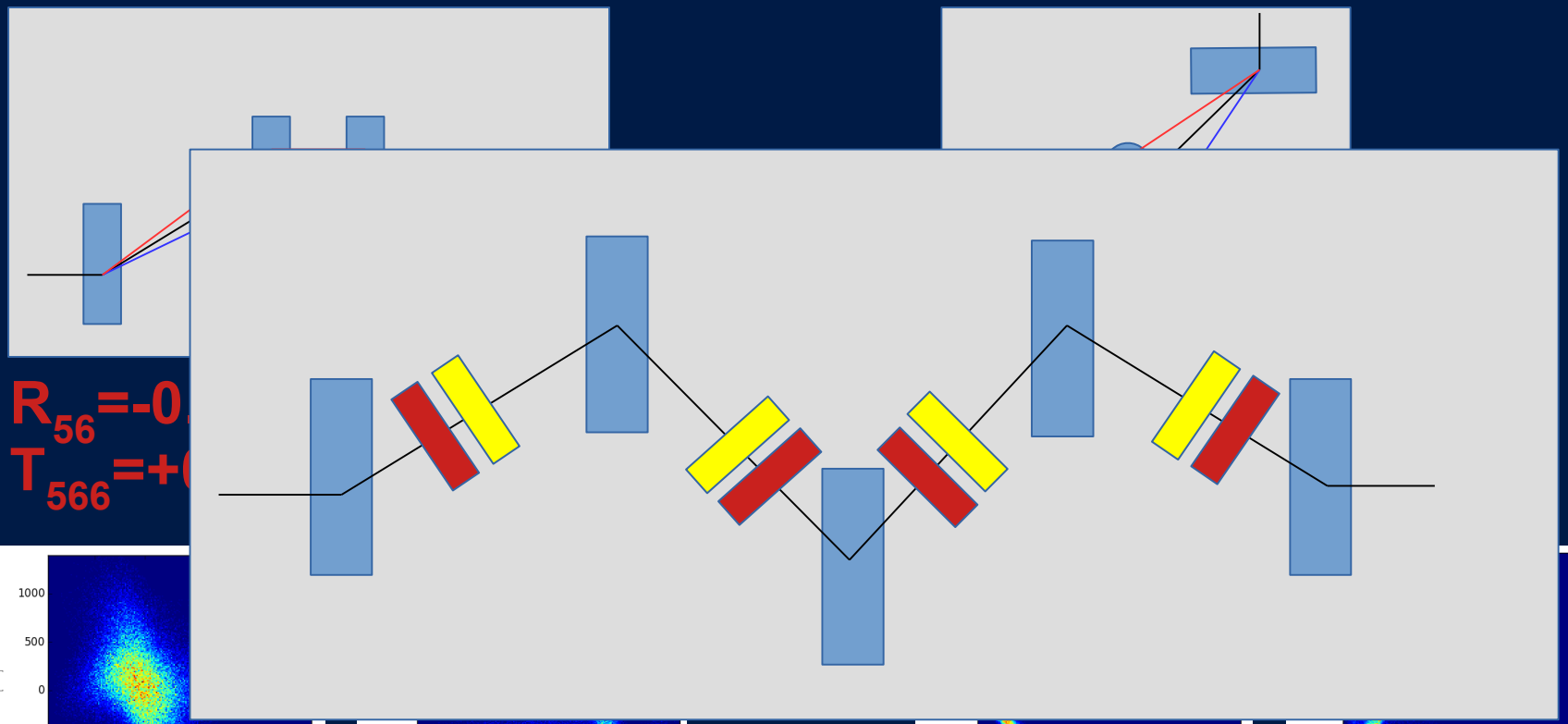
Bunch compression for the THz source



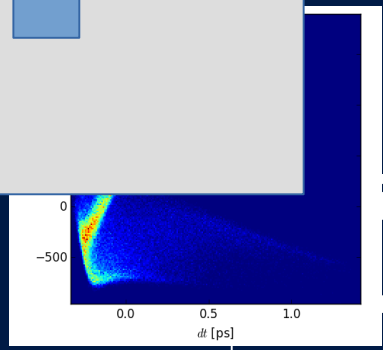
HZDR

HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

Bunch compressor options

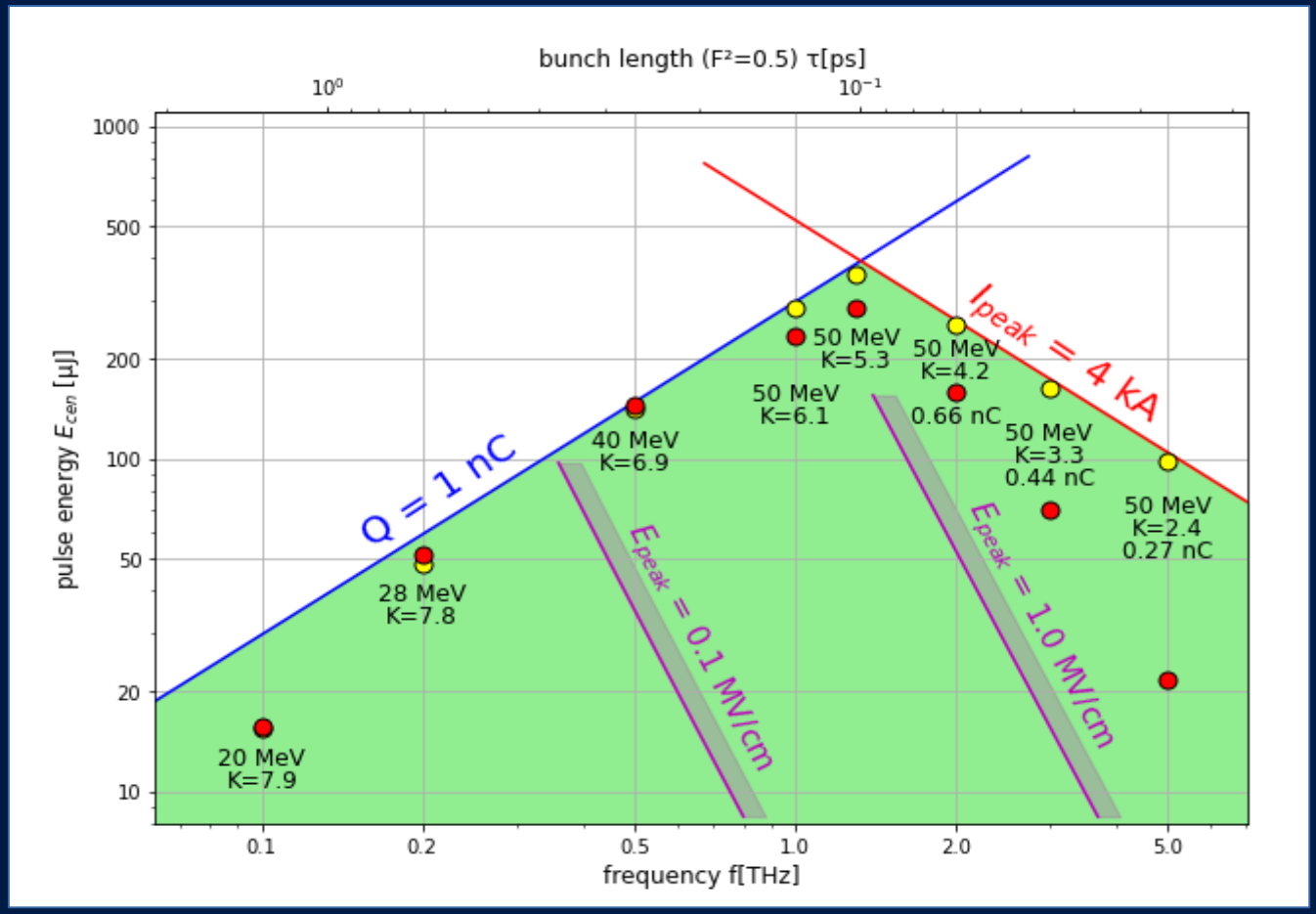


R_{56}=-0.
T_{566}=+(



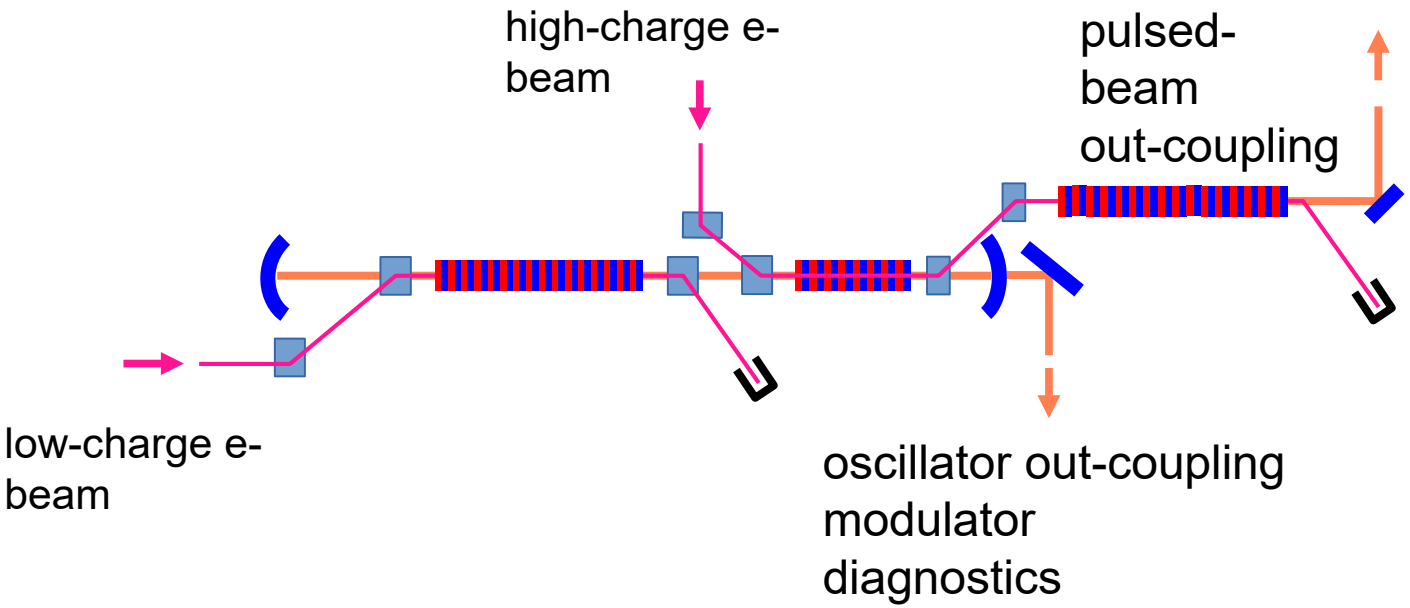
DRESDEN
ROSSENDORF

Pulse Energy output of the THz source

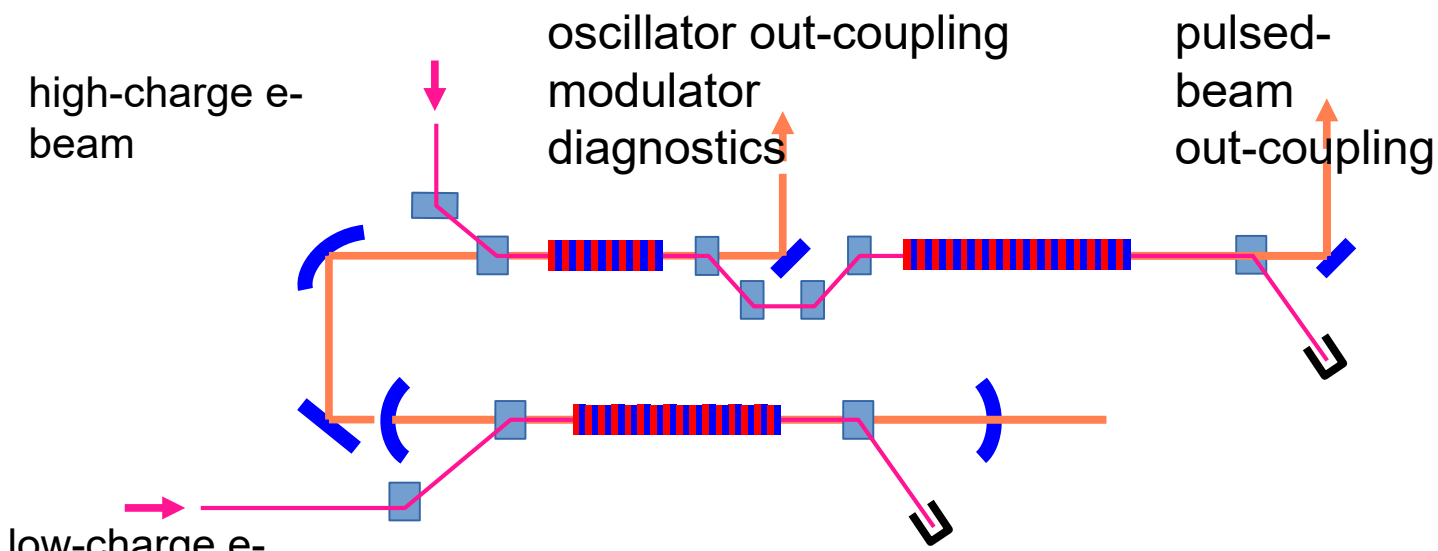


HZDR
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

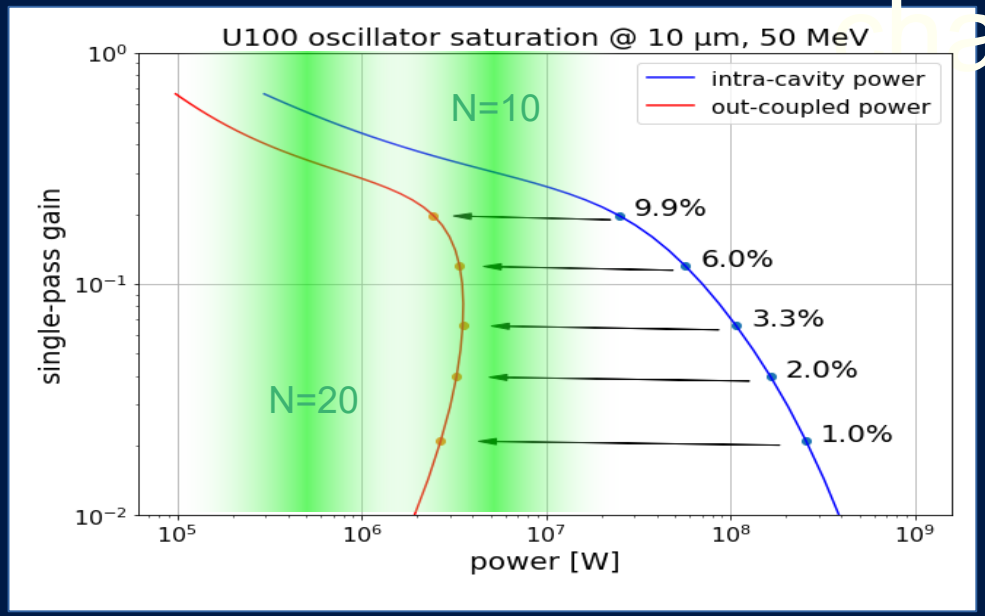
Mid-IR oscillator-radiator scheme using an intra-cavity modulator

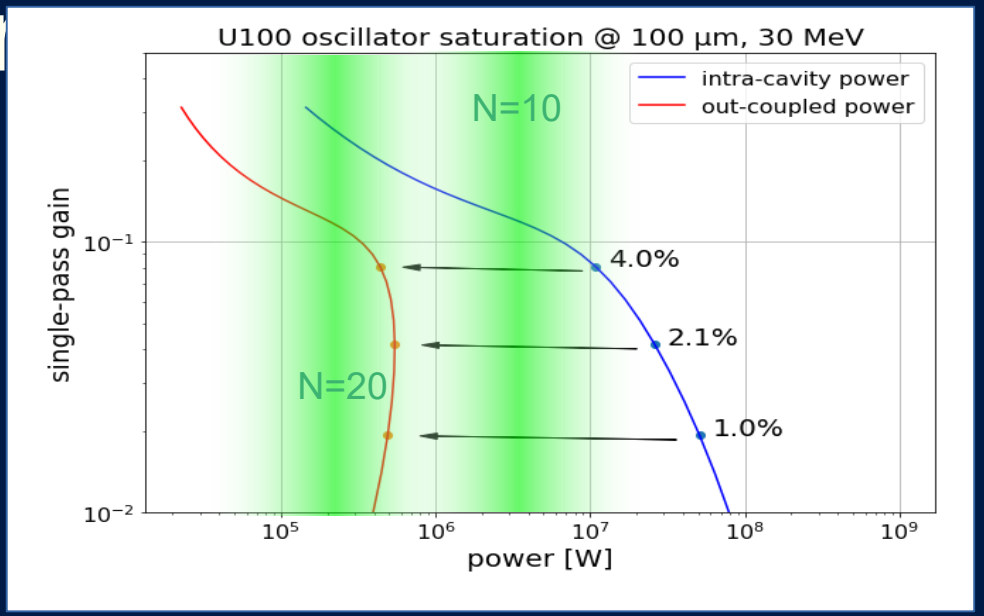


Mid-IR oscillator-radiator scheme using an out-coupled seed beam



FEL saturation at 50 pC bunch





Optimum power range for seeding underlaid green
for modulators of 10/20 undulator periods :

- - the energy modulation must exceed the inital energy spread
- - the bunching factor should not exceed 10%

HZDR
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

Dresden Advanced Light Infrastructure