

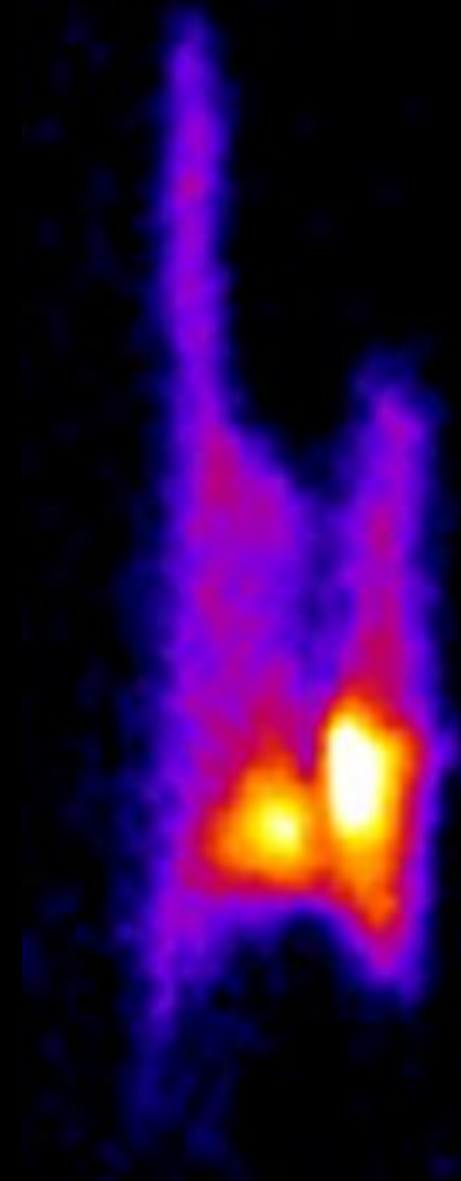
Beyond “single-shot” simulations

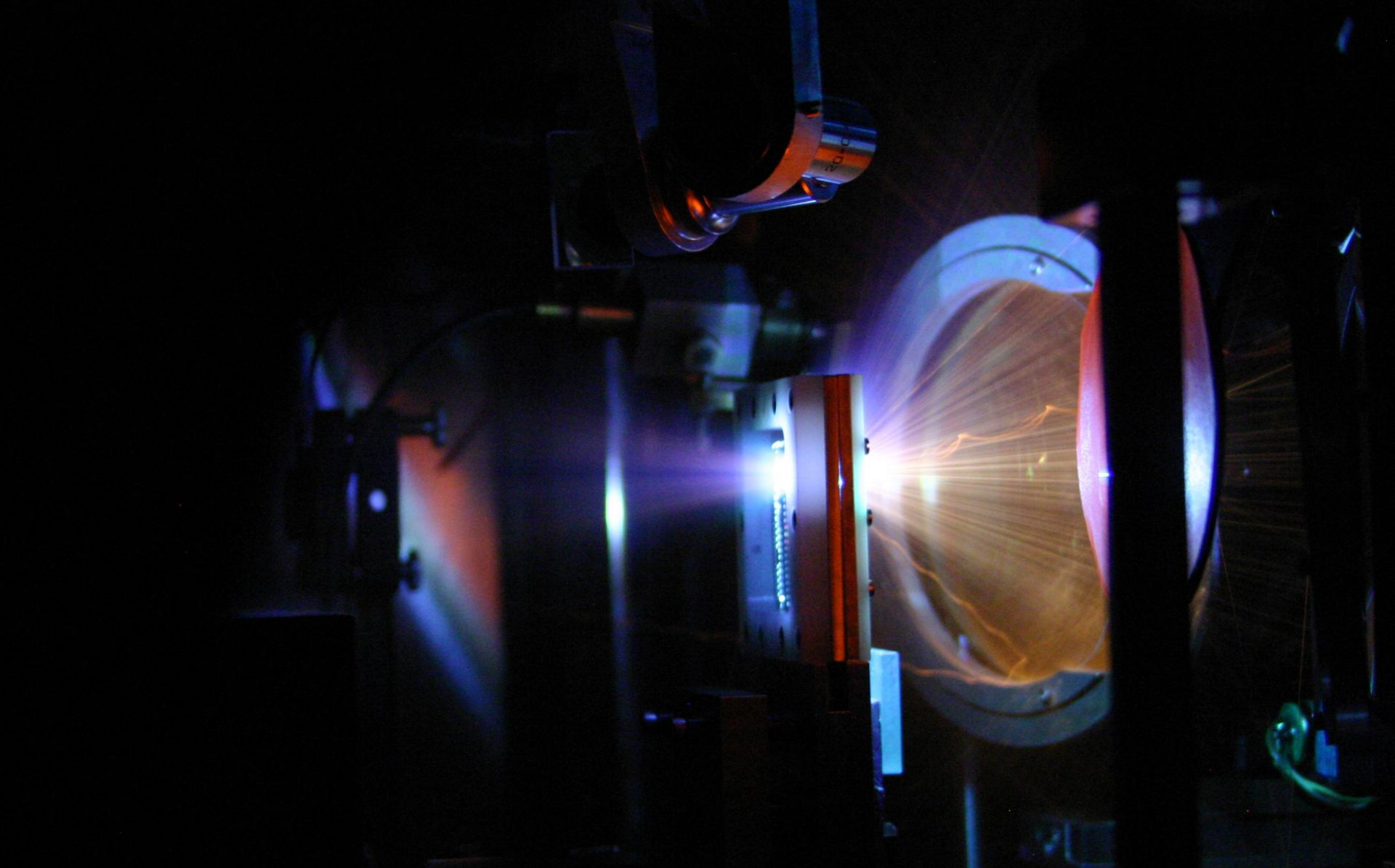
Can we simulate what is measured?

Michael Bussmann

hzdr

 **HELMHOLTZ**
ZENTRUM DRESDEN
ROSSENDORF

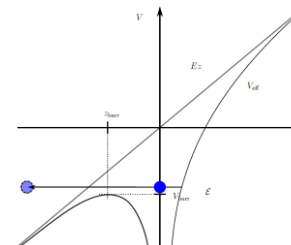
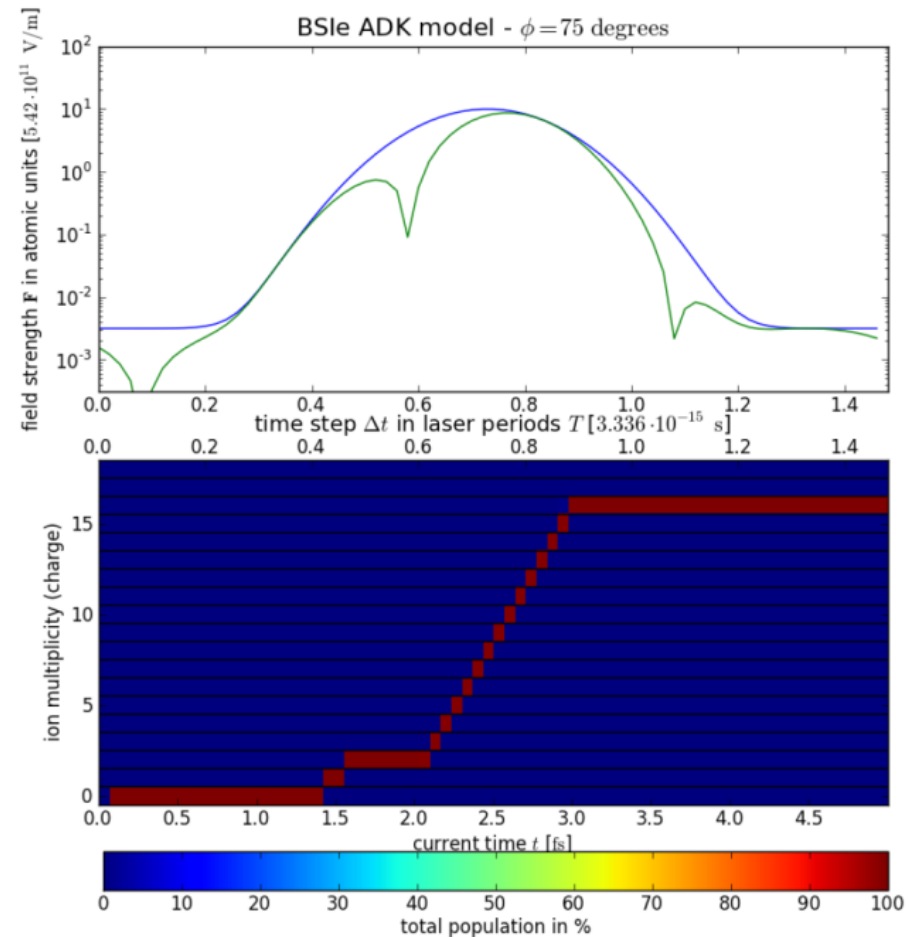
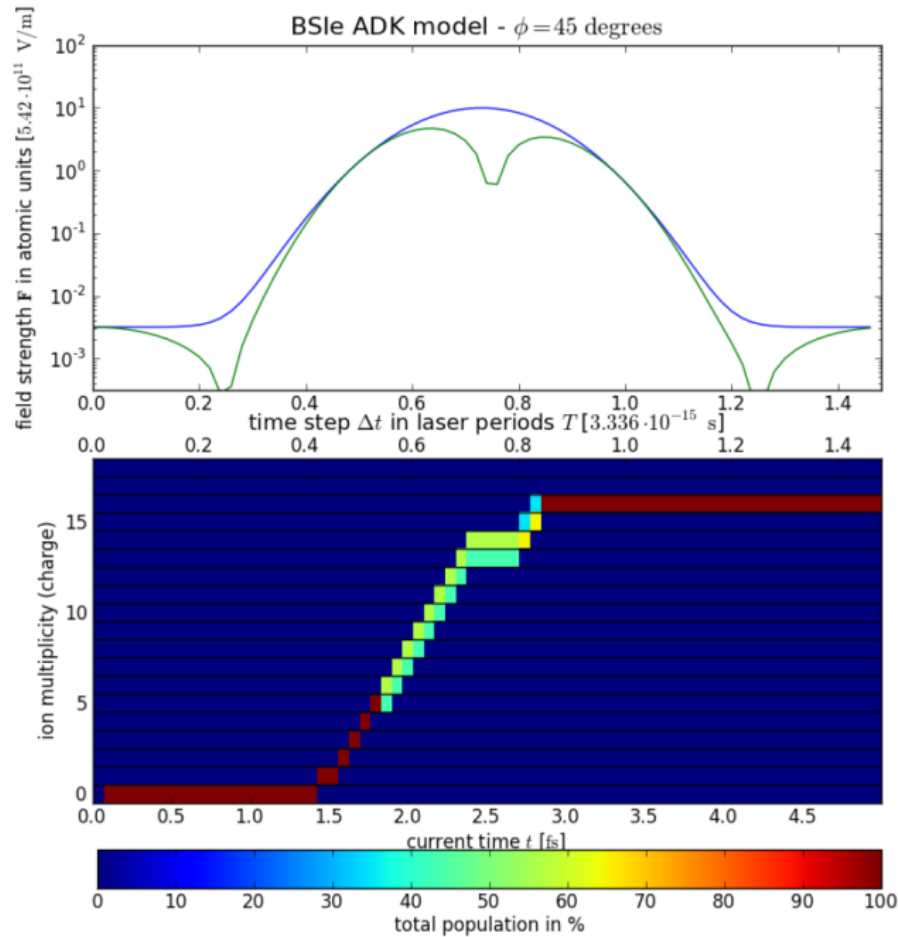




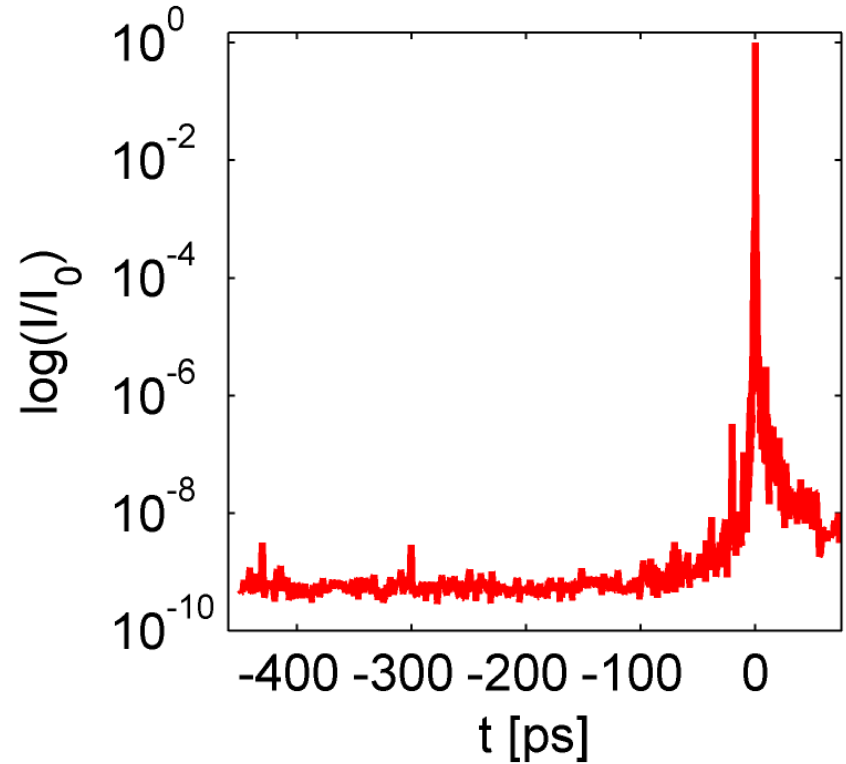
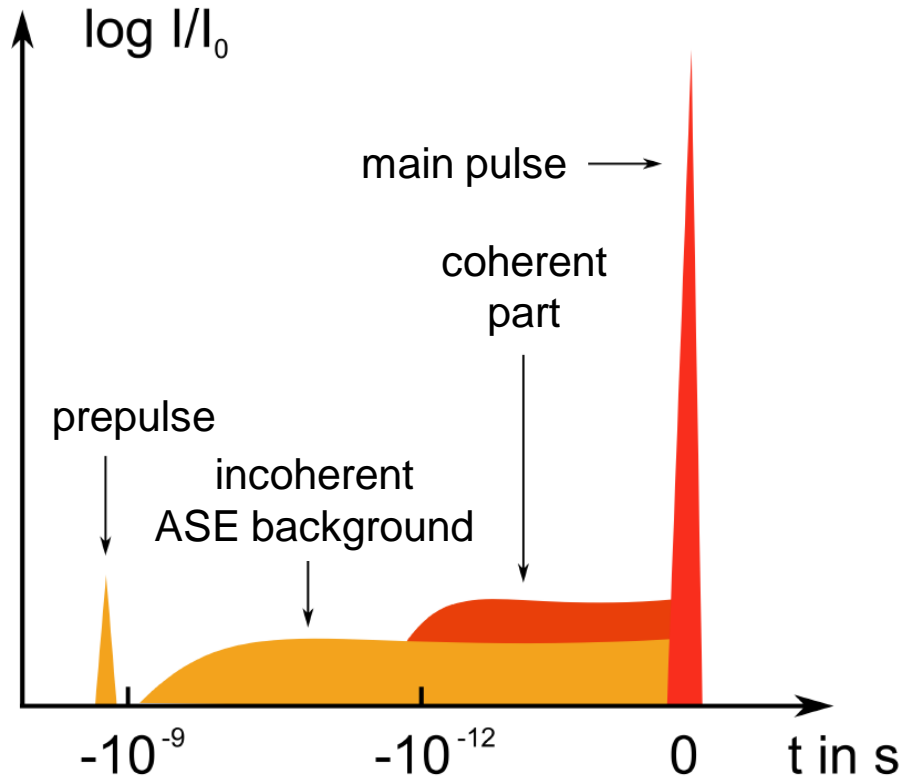
Stochastic Variations

„The Experimentalists won't tell us where each ion sits!“

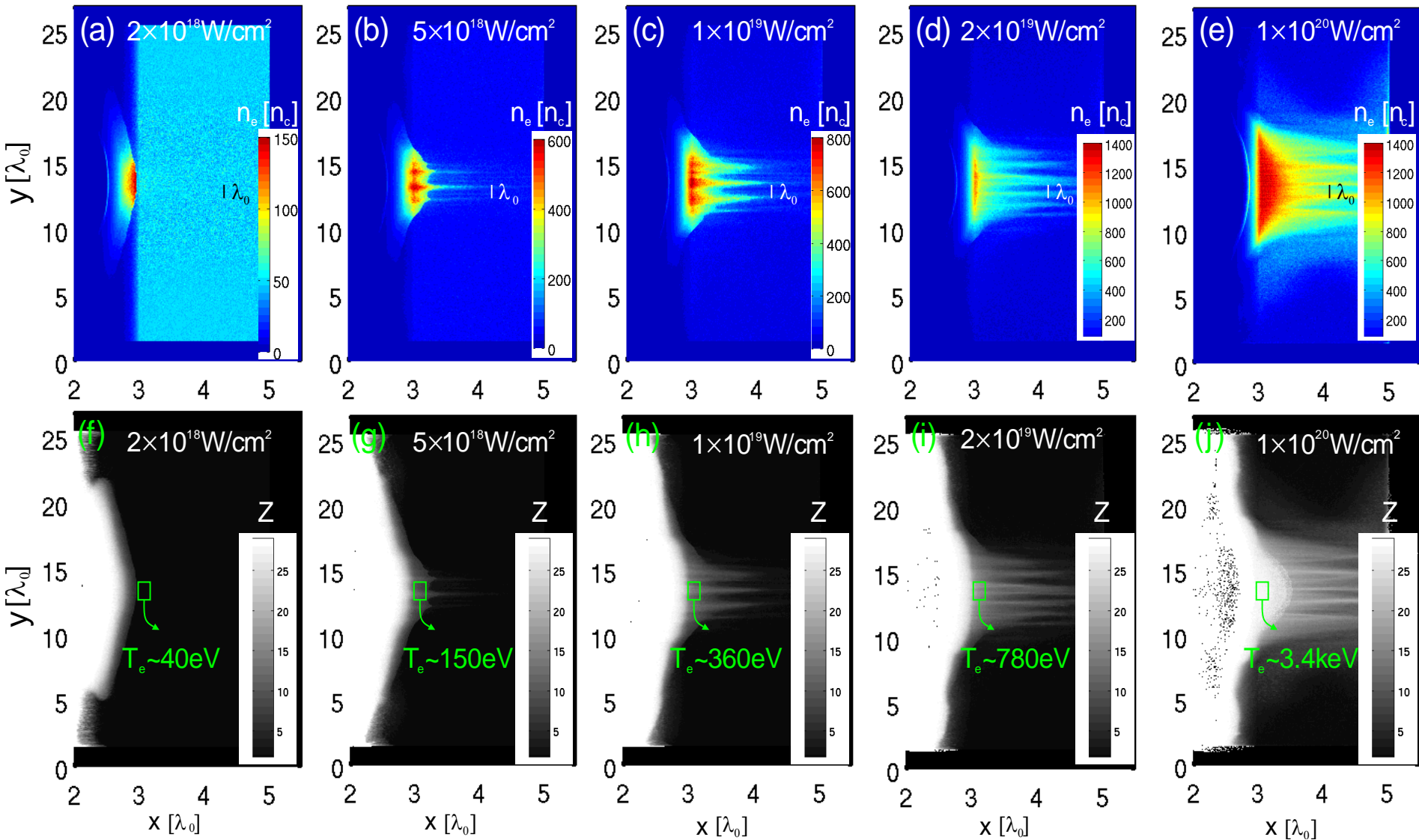
Carrier-envelope Phase influences Femtosecond Field Ionization



At best we know the Laser Contrast



Laser Intensity influences Electron Dynamics at the Critical Density



Repeat simulations

with varying microscopic setups

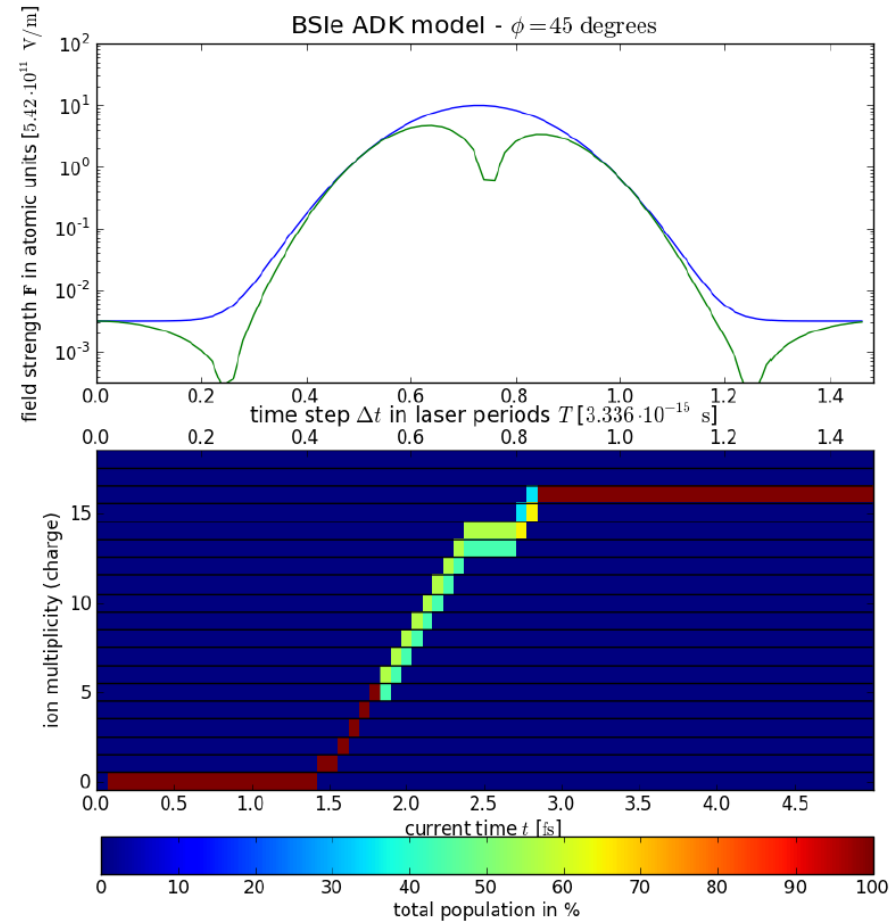
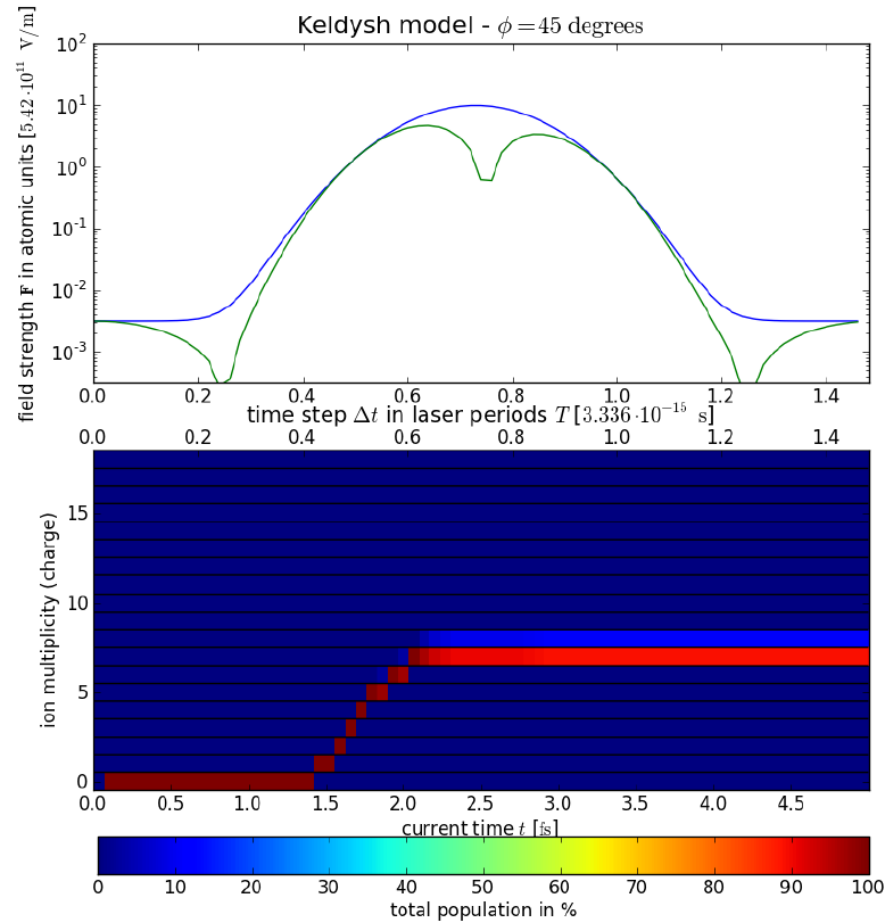
representing the same macroscopic conditions



Systematic Variations

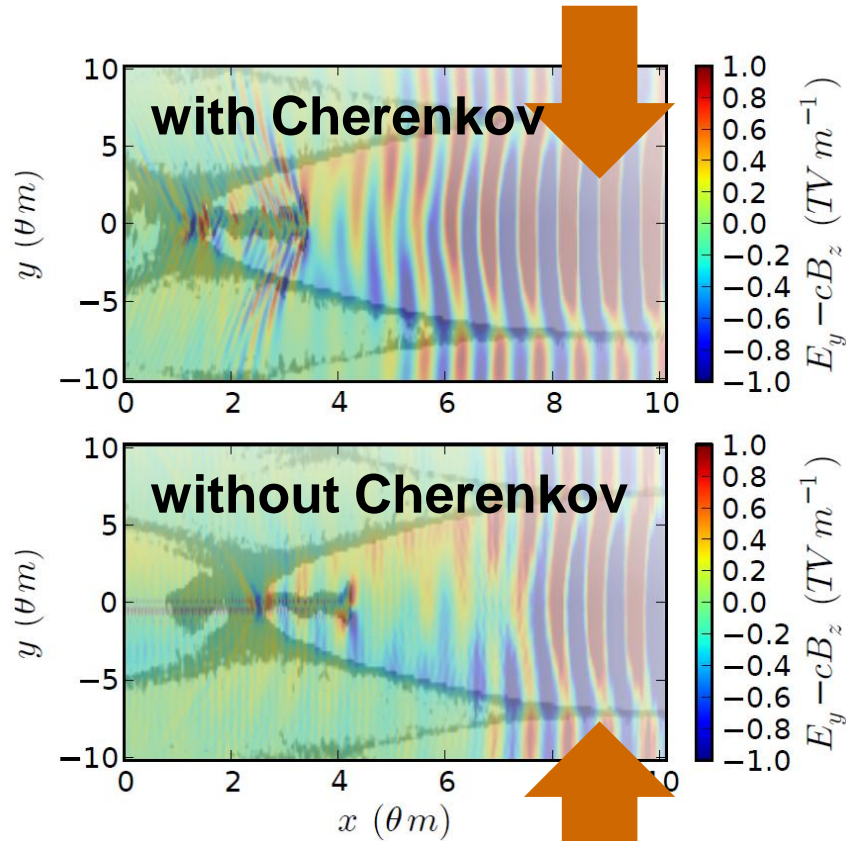
„The Theoreticians said they had field ionization included!“

Choice of Field Ionization Model determines Charge State

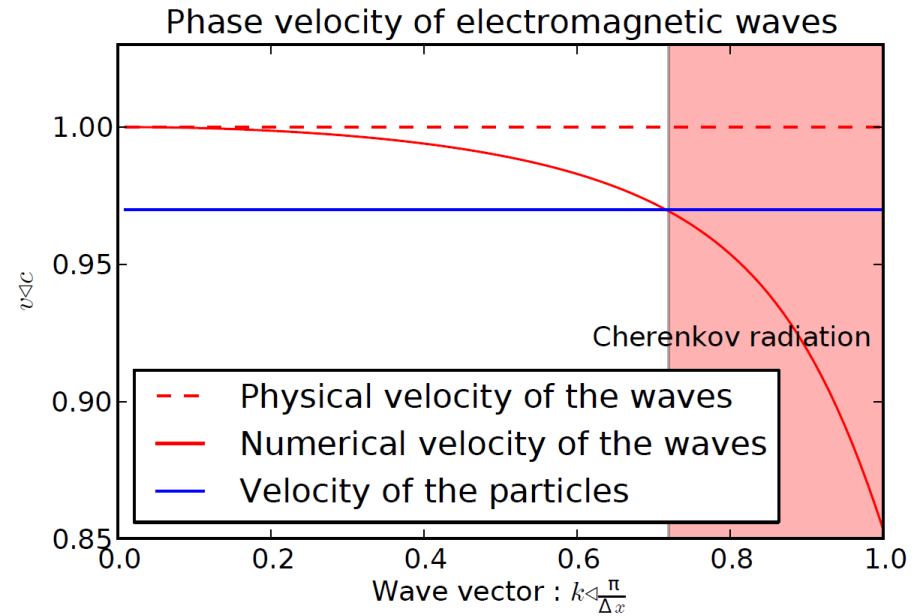


Choice of Field Solver determines Electron Beam Parameters

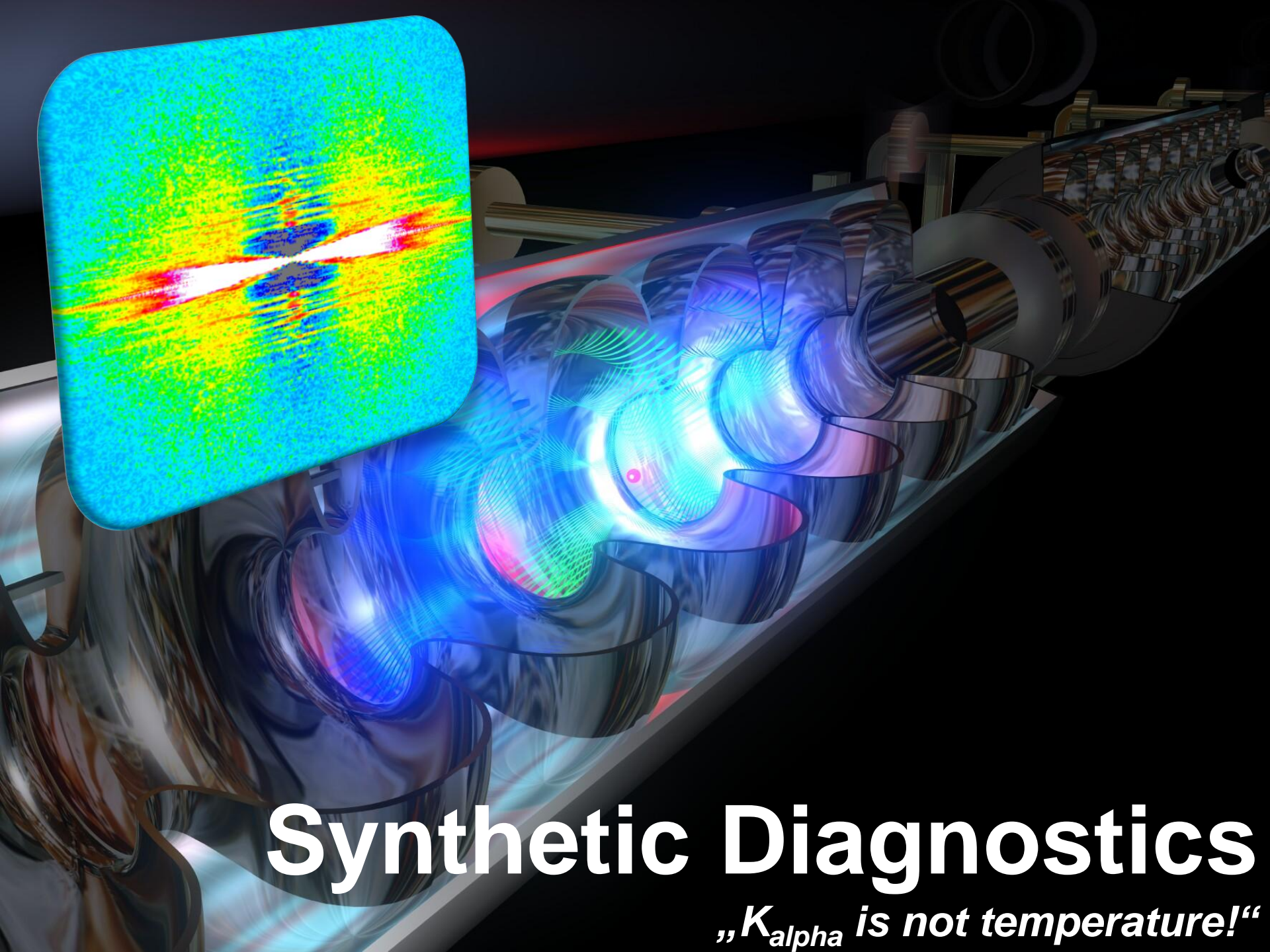
emittance is increased



temporal dynamics changed



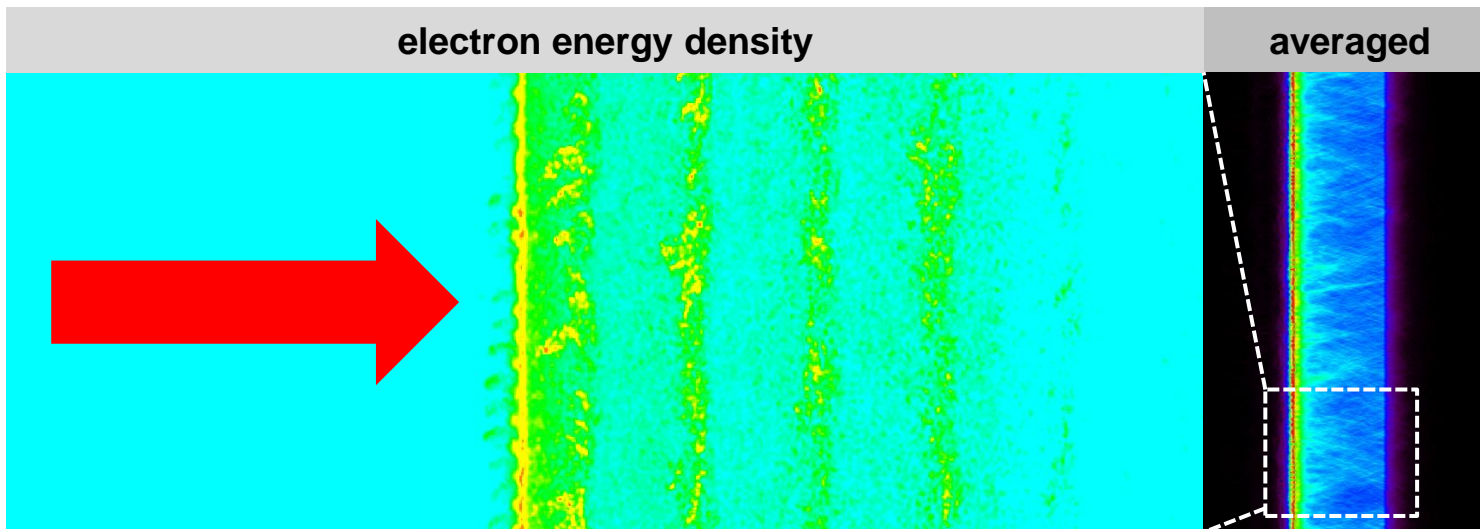
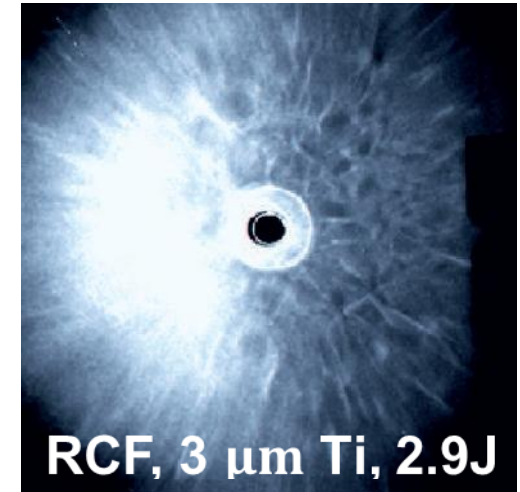
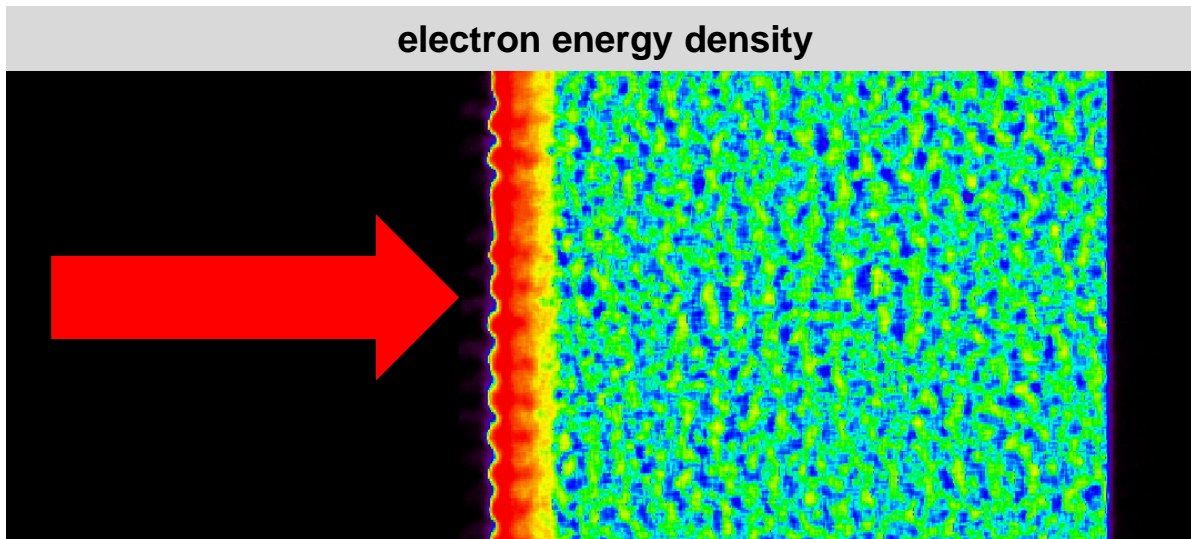
Repeat simulations
with varying numerical methods
to see systematic effects



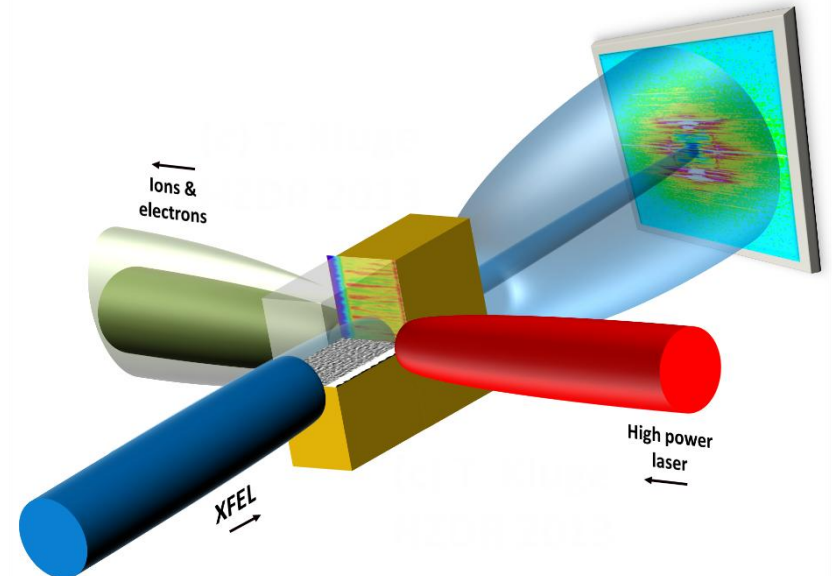
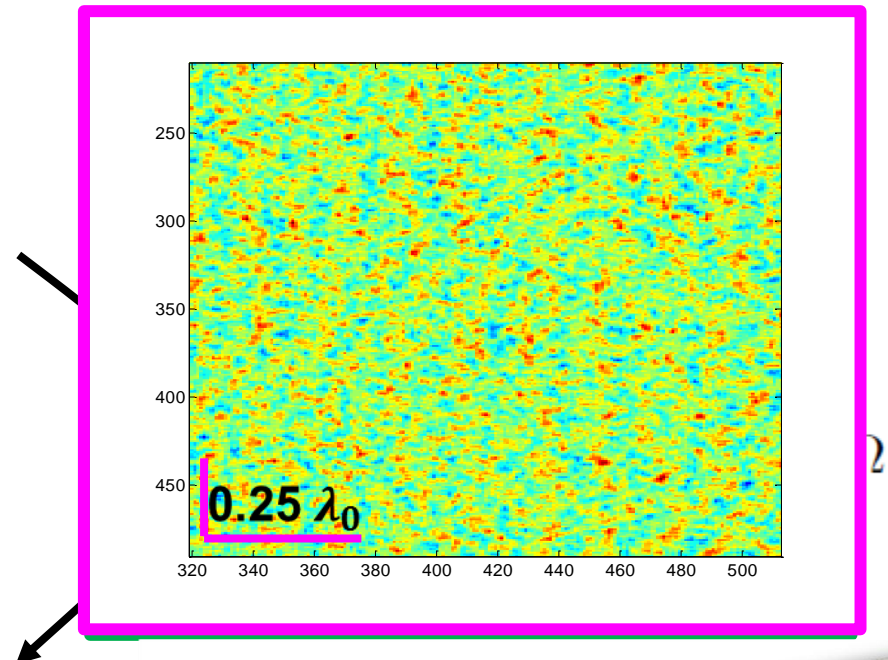
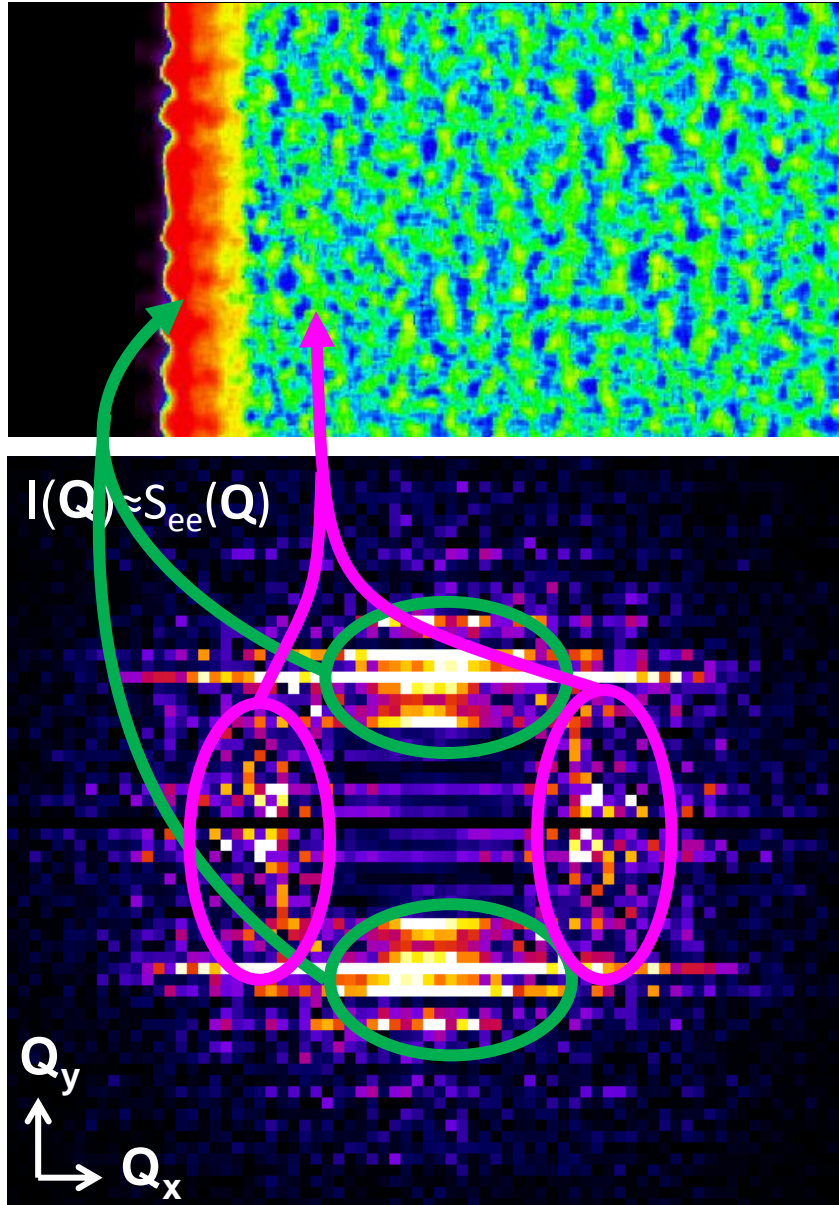
Synthetic Diagnostics

„ K_{α} is not temperature!“

Front-side Instabilities can change Proton Beam Structure



Computing the Small Angle X-Ray Scattering Signal of the Plasma



Simulate ALL physical effects
including those used for
experimental diagnostics



**The Power
of Many**

PICon

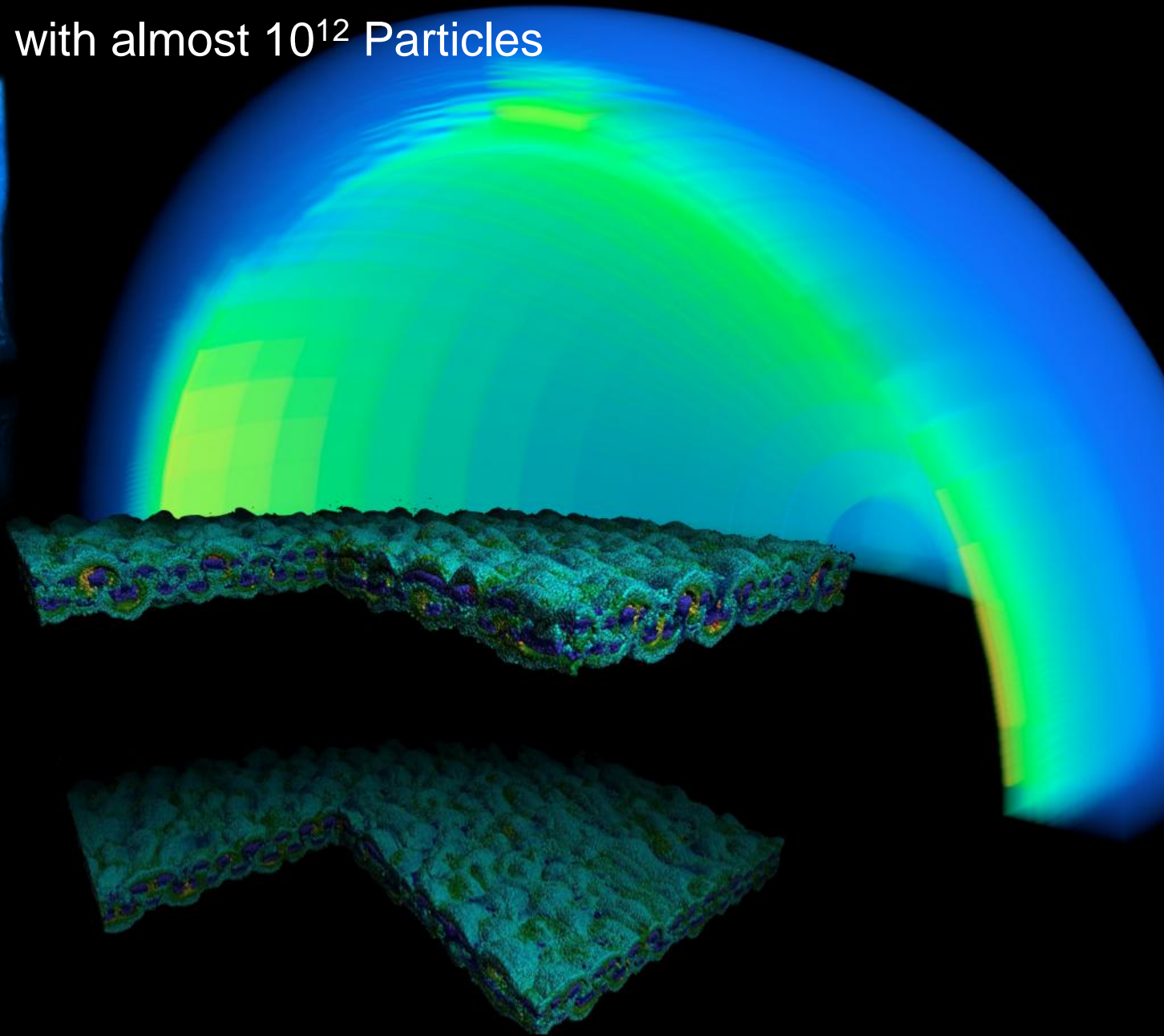
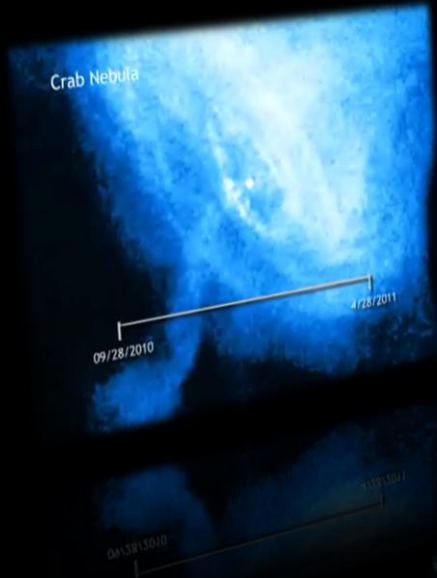
GPU



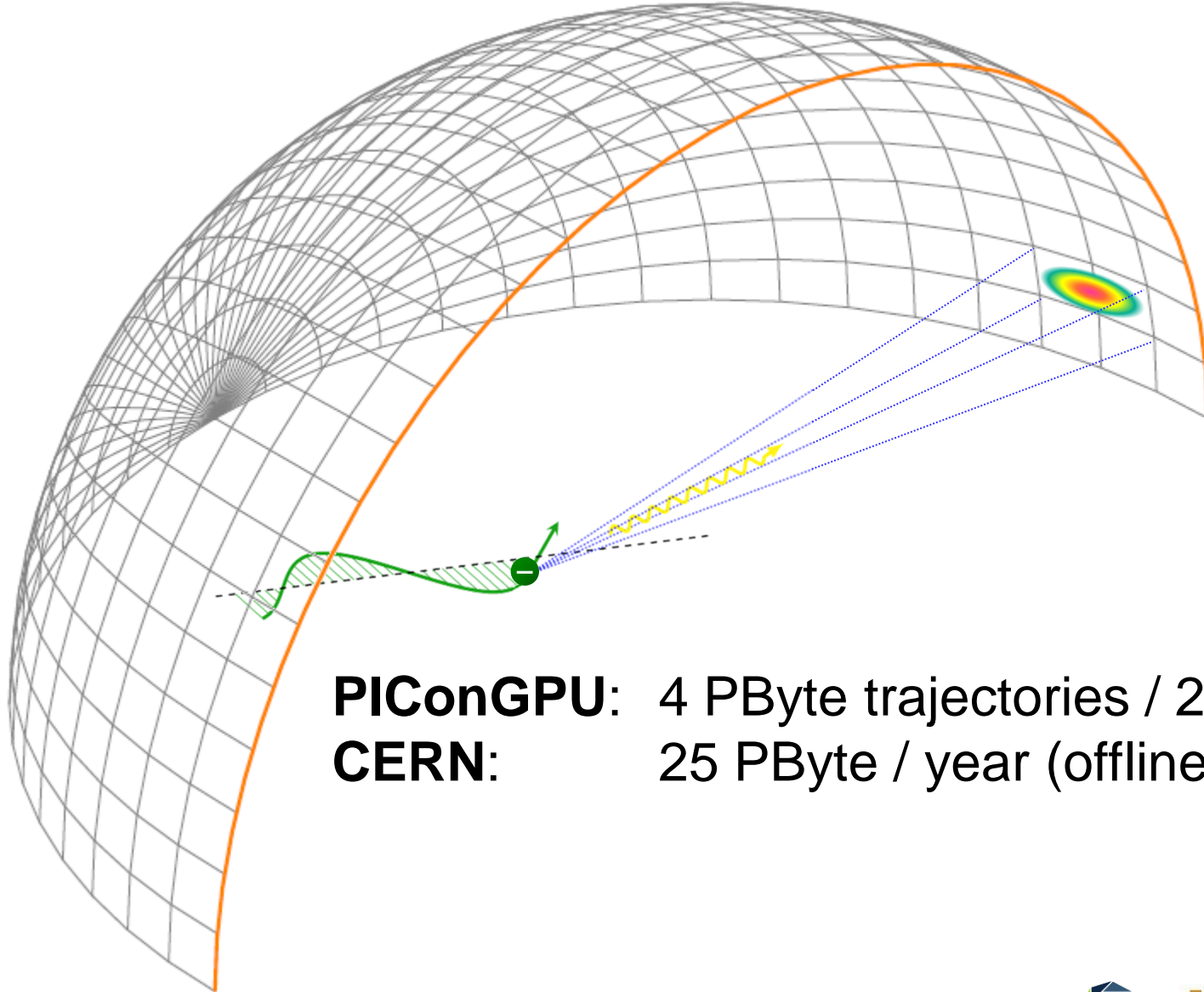
- *Built to simulate Laser-Plasma Interaction*
- *Built for the Community*
- *Free for Download*
- *Open Source (GPL, LGPL)*

<http://picongpu.hzdr.de>

Relativistic KHI with almost 10^{12} Particles

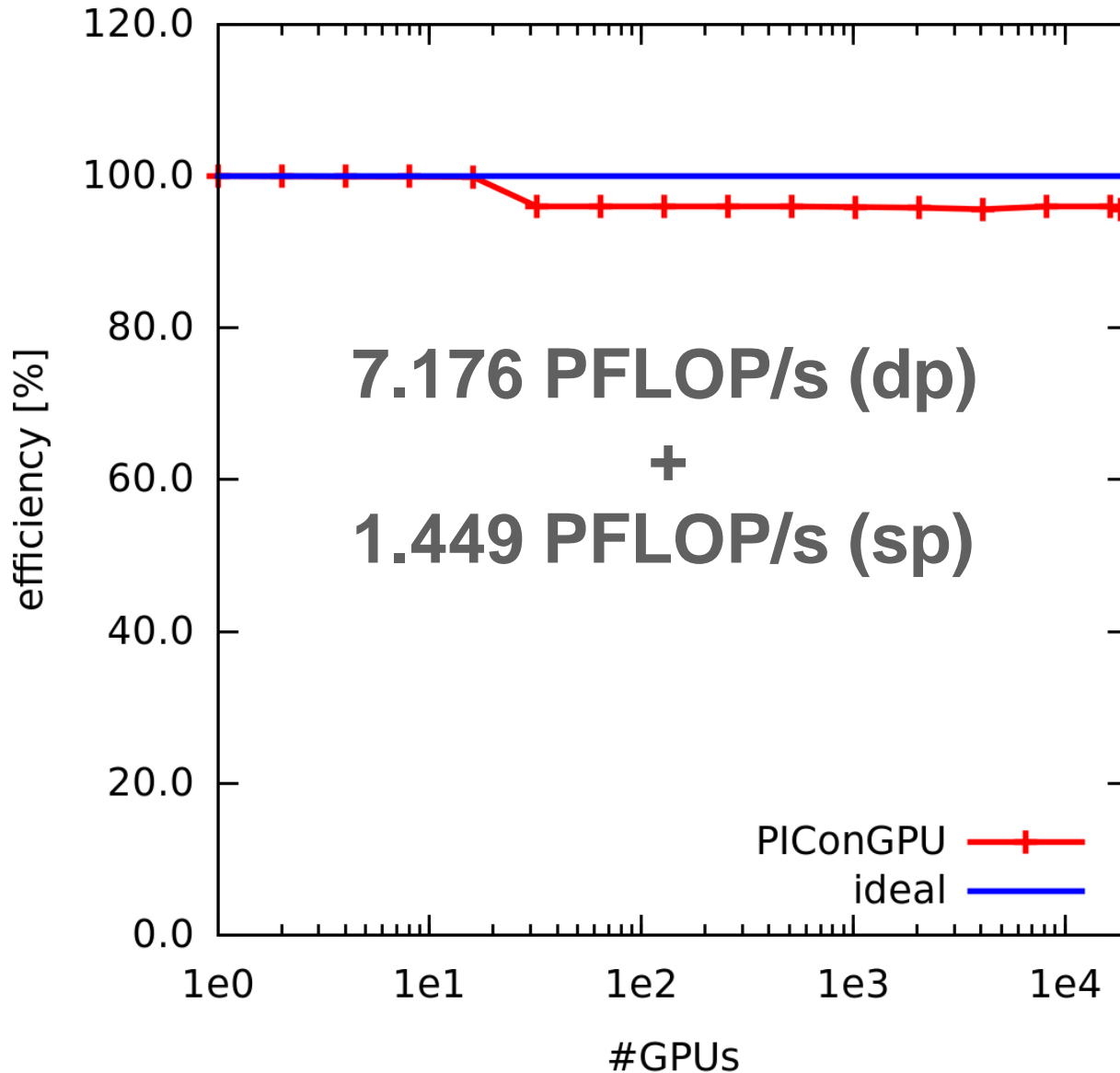


Radiation of EACH PARTICLE for 512 Frequencies, 481 Directions



PIConGPU: 4 PByte trajectories / 2 hours
CERN: 25 PByte / year (offline)

PIConGPU – Weak Scaling 1 to 18,432 Nodes

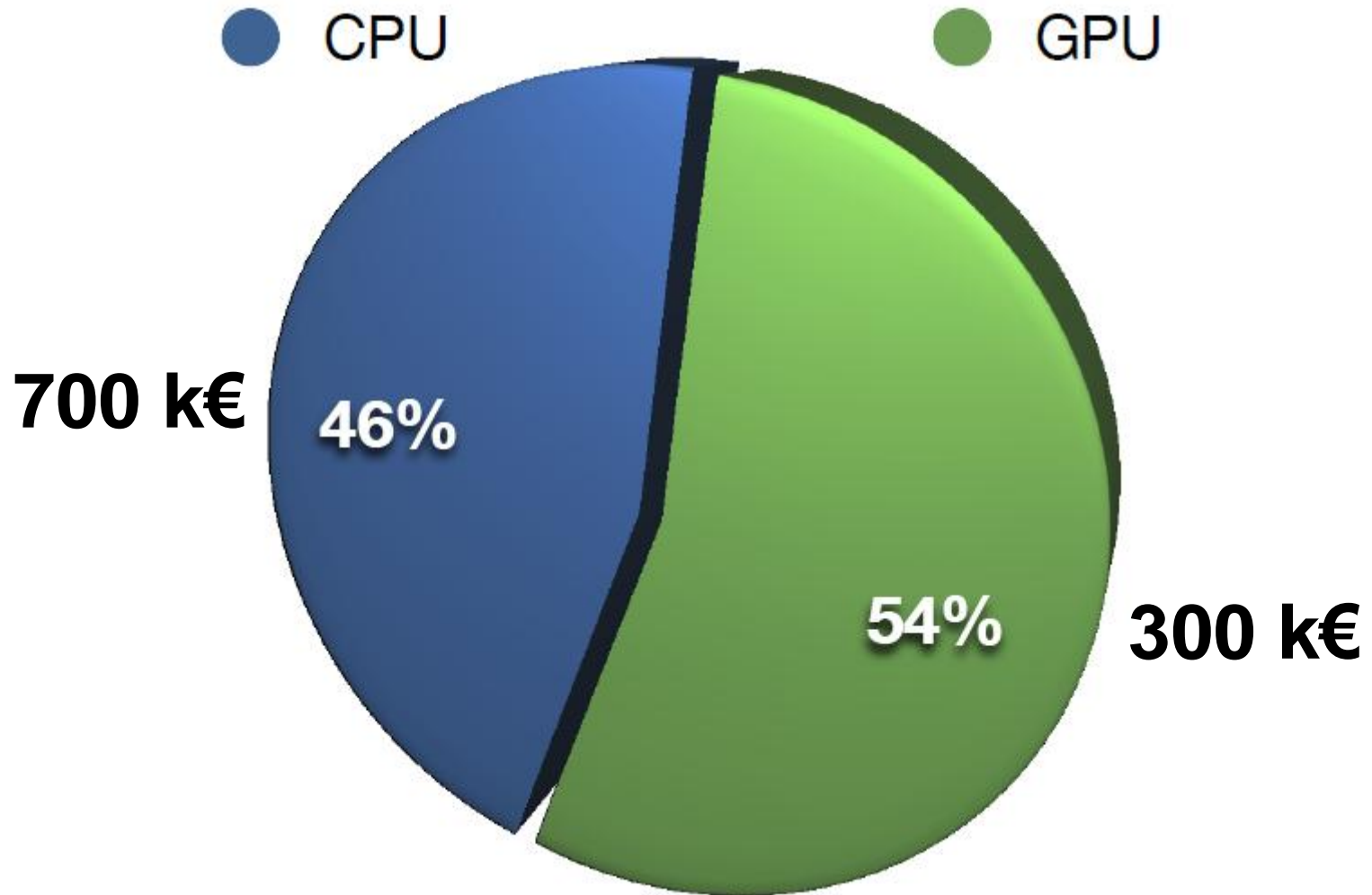


**Efficiency
96%**



Money, money, money....

Performance Hypnos @ HZDR



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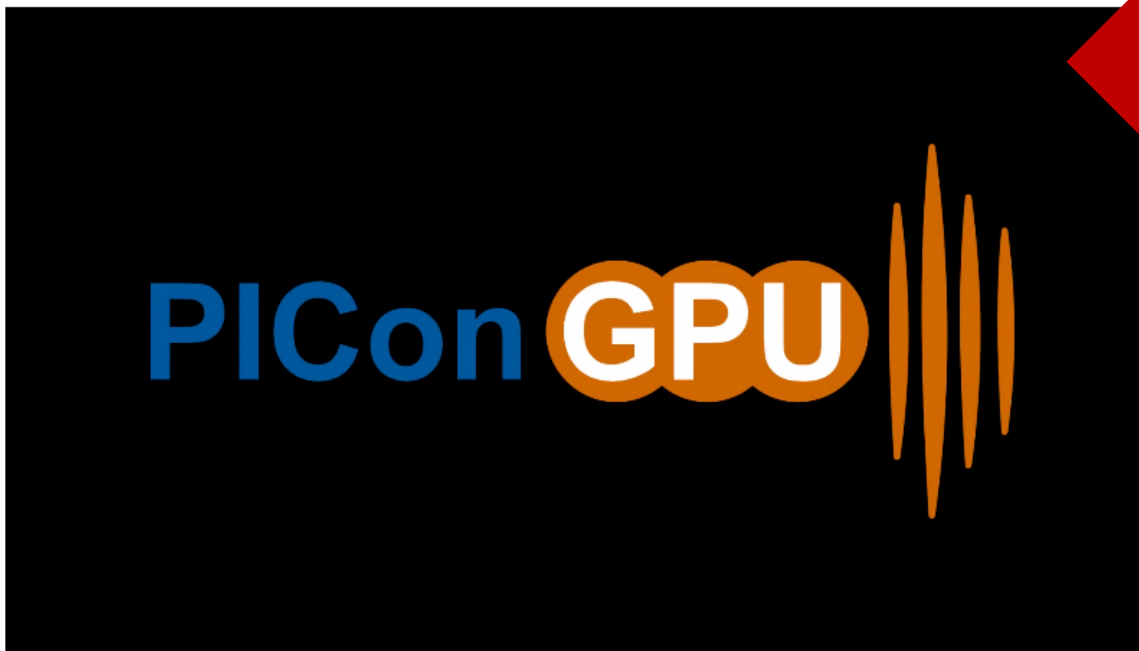
Mitglied der

Mitglied von

Mobile version: [On](#)



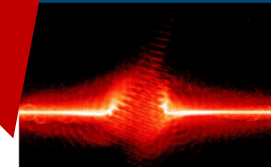
PICongGPU - A Many-GPGPU Particle-in-Cell Code



PICongGPU [1,2] is a relativistic *Particle-in-Cell* (PIC) code running on *graphic processing units* (GPUs). It is Open Source und is freely available for download [1]. PICongGPU is developed and maintained by the *Junior Group Computational Radiation Physics* at the *Institute for Radiation Physics* at *HZDR* in close collaboration with the Center for Information Services and High Performance Computing (*ZIH*) of the Technical University Dresden.



Computational Radiation Physics



Our group is interested in simulating advanced radiation sources on high performance computing systems. We are part of the research group Laser-Particle Acceleration at the Institute for Radiation Physics



HZDR Developer Team PICongGPU (from left to right): René Widera, Heiko Burau, Michael Bussmann, Richard Pausch, Axel Hübl

<http://picongpu.hzdr.de>