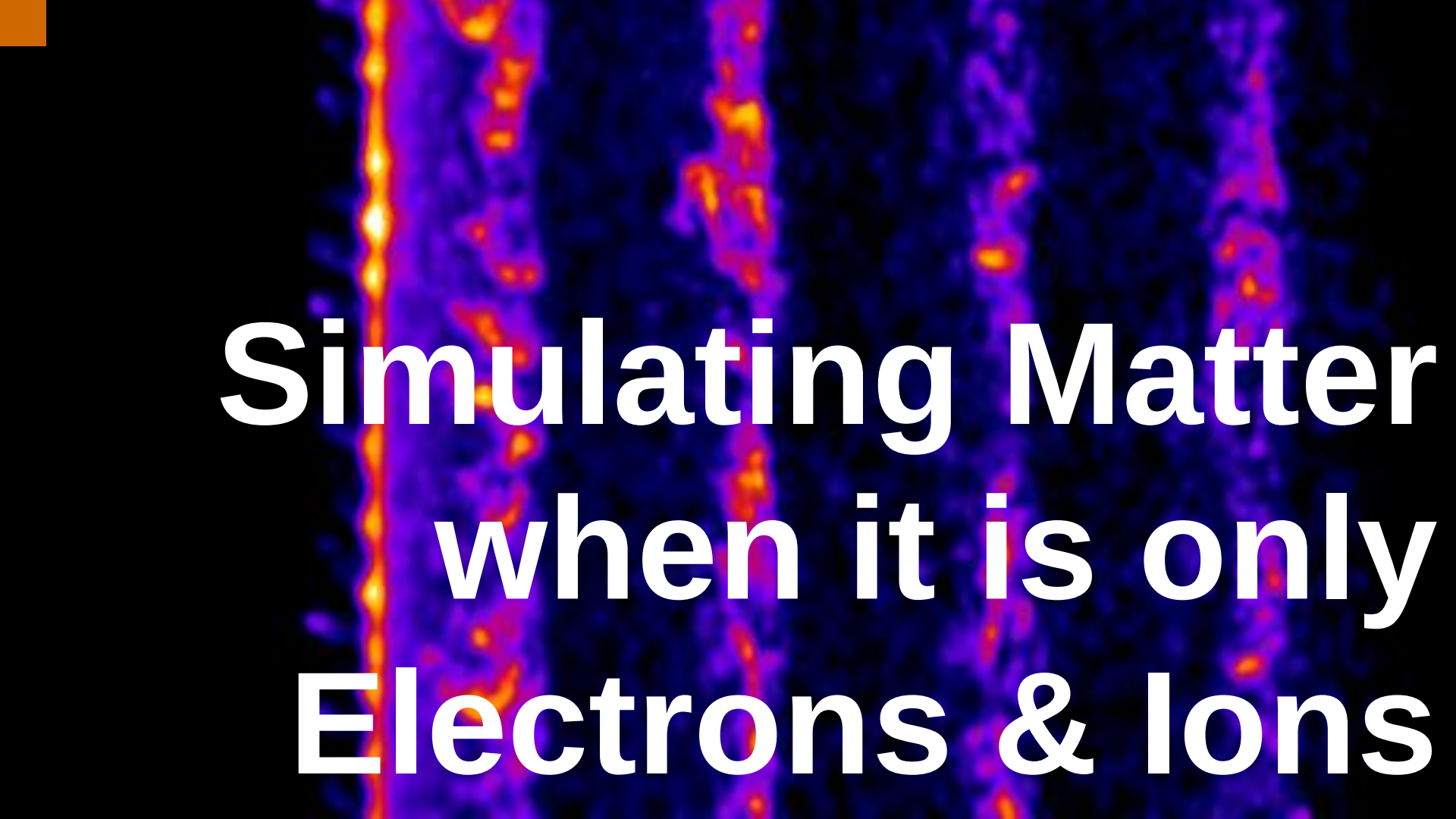
Simulating What is Measured — Closing the Loop between Experiment and Simulation

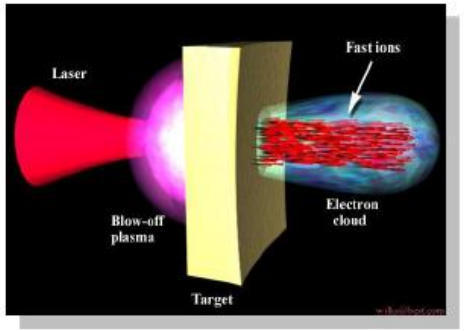
Michael Bussmann, Axel Huebl

Computational Radiation Physics
Helmholtz-Center Dresden Rossendorf

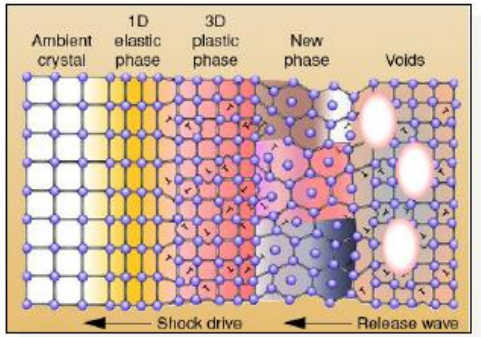

Simulating Matter
when it is only
Electrons & Ions

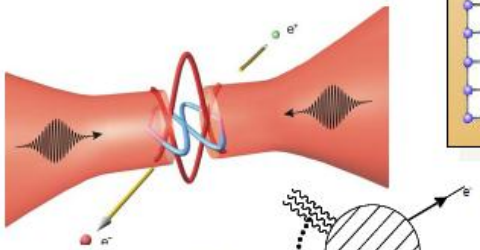
Matter under Extreme Conditions

Extreme particle beams

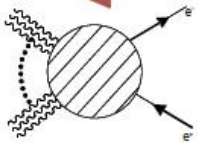


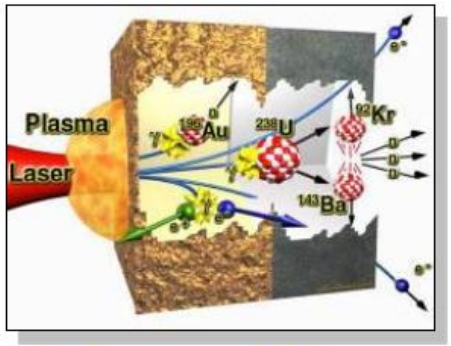
Extreme pressures





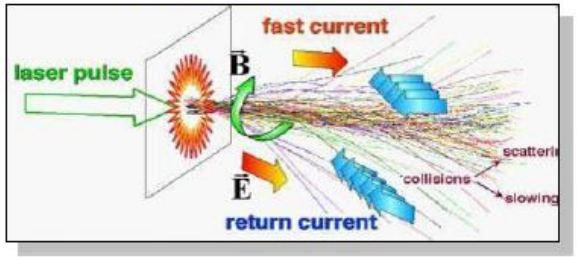
Strong Fields





Extreme radiations

Extreme currents



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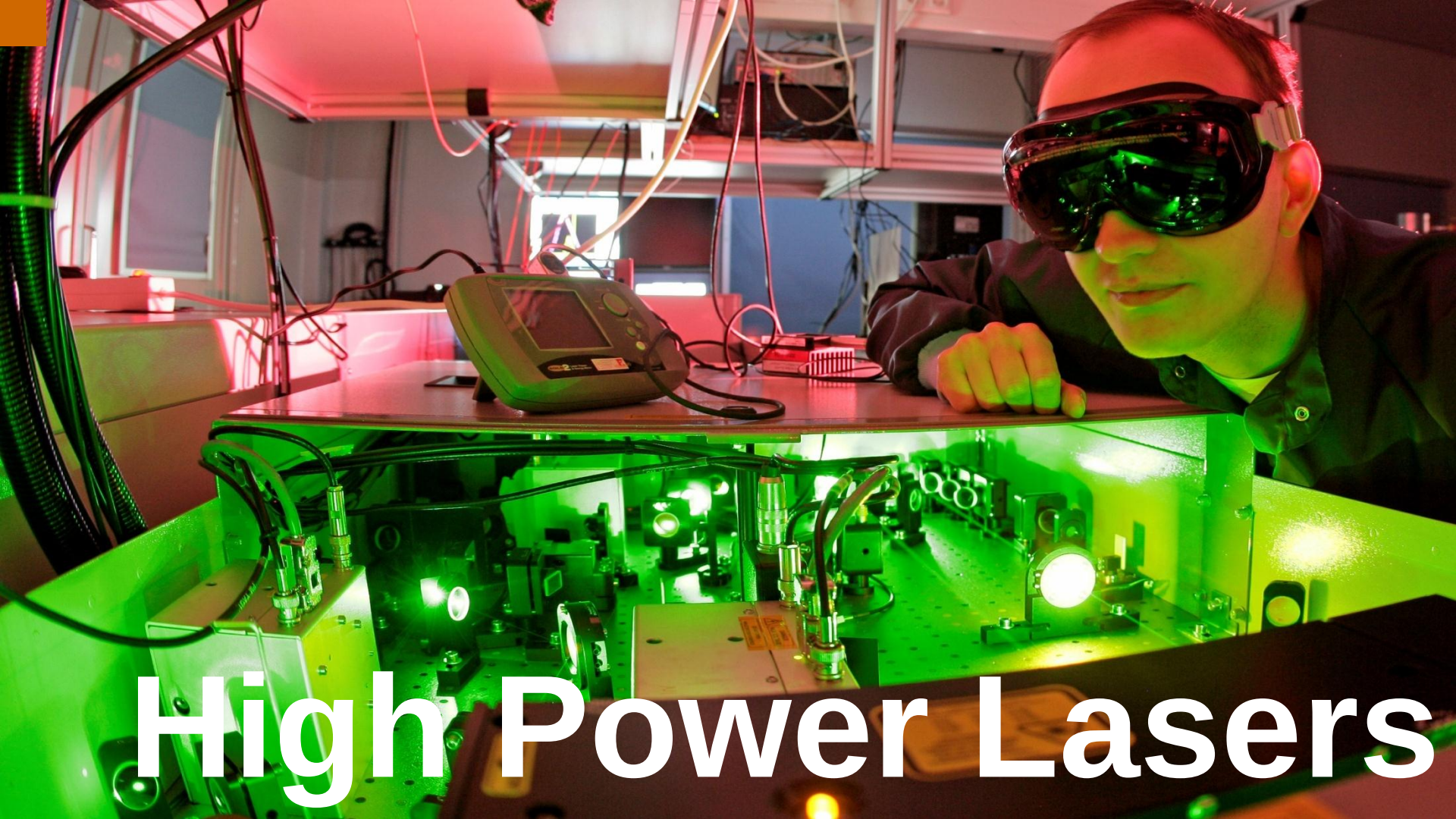
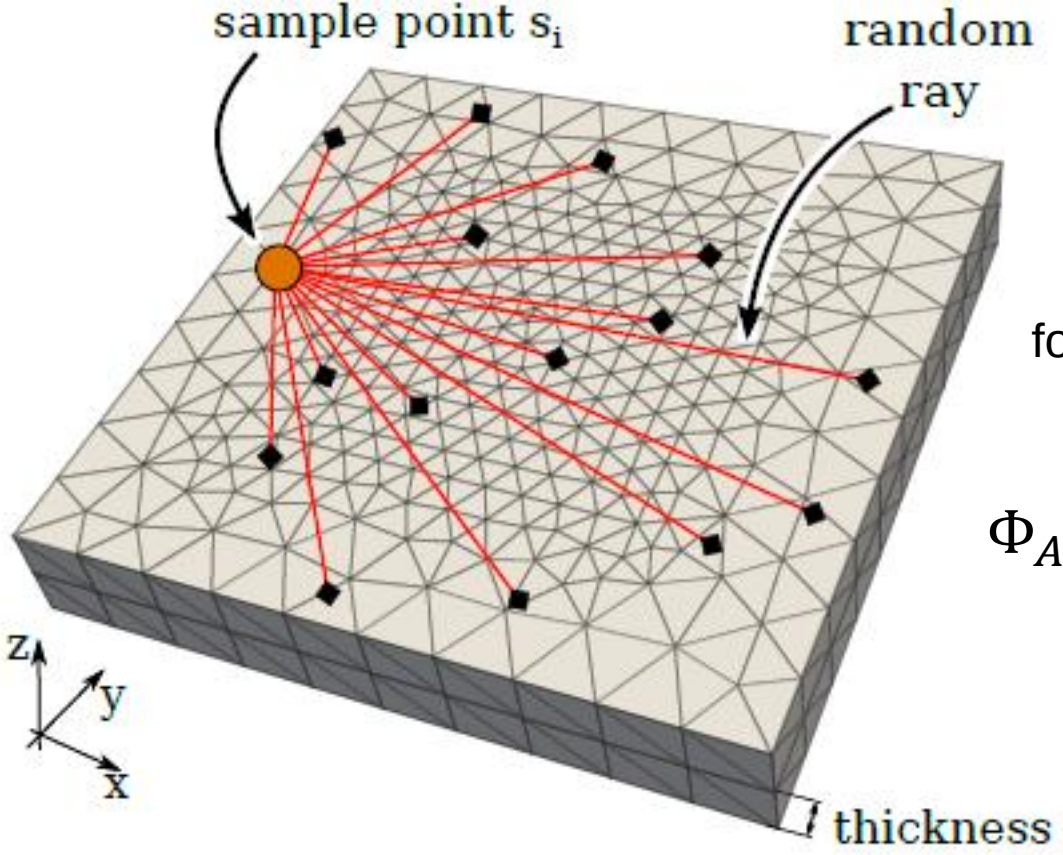
m.bussmann@hzdr.de

Laser-Matter Interaction at Solid Densities in Experiment


High Power Lasers

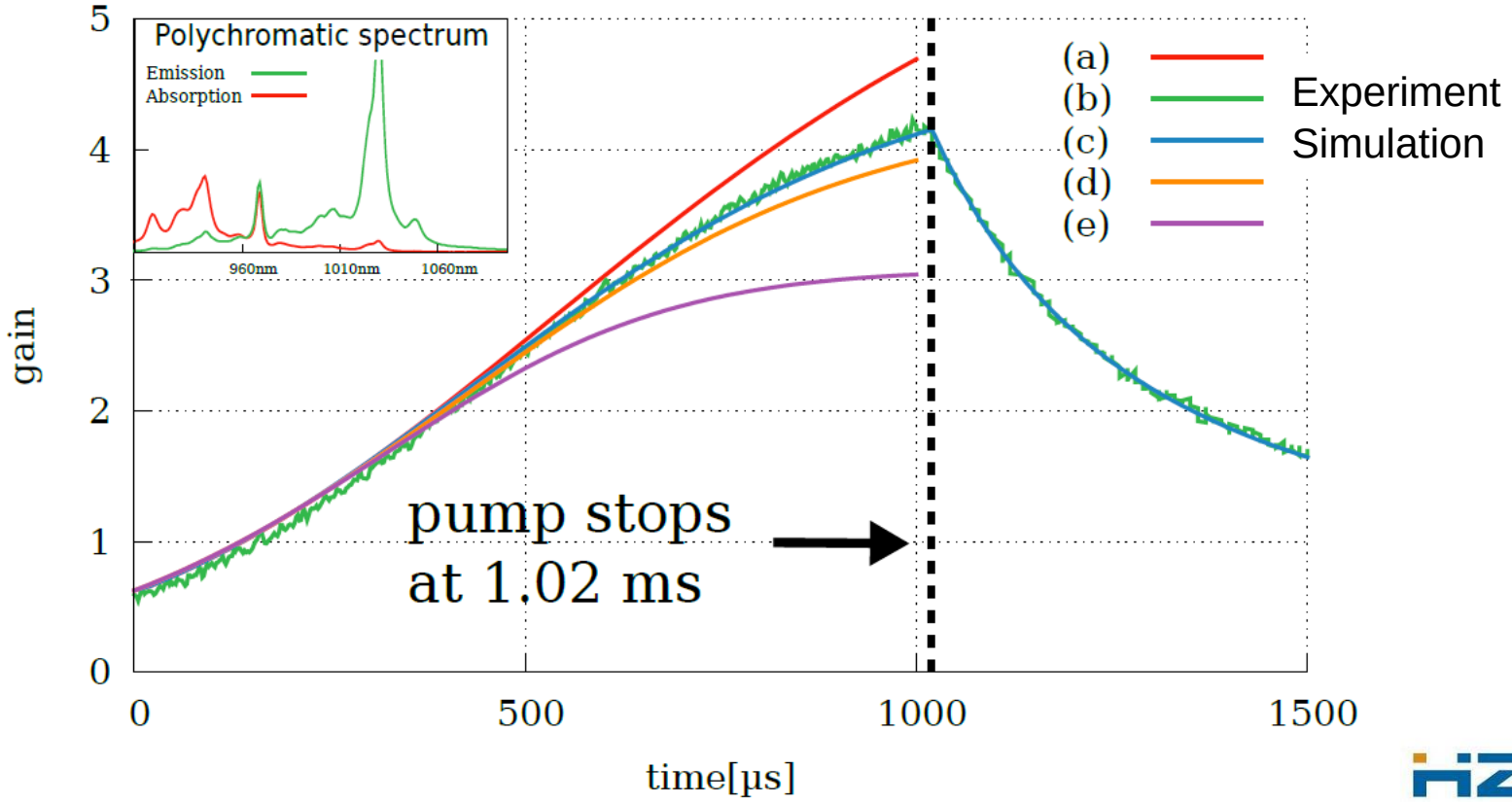
Modelling Amplified Spontaneous Emission (ASE) with GPUs



Monte-Carlo Raytracing
+ Sampling
for directly solving the ASE Integral

$$\Phi_{ASE} \propto \sum_{u=0}^{N-1} \hat{n}(r_{i,u}) \cdot G(\overrightarrow{r_{i,u}s})$$

Simulation agrees perfectly with Measurement



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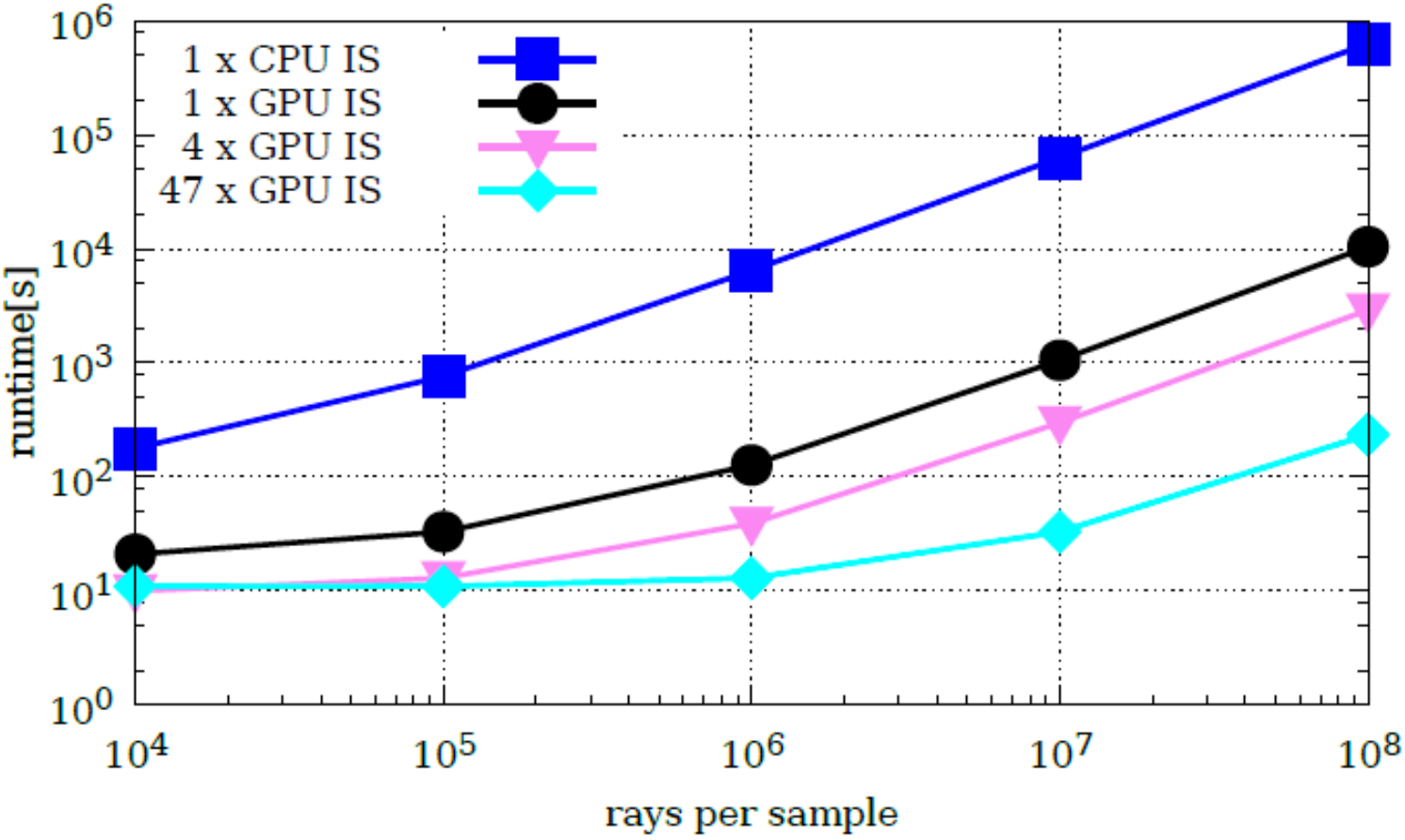
m.bussmann@hzdr.de

With GPUs, ASE can now be computed in Minutes instead of Weeks



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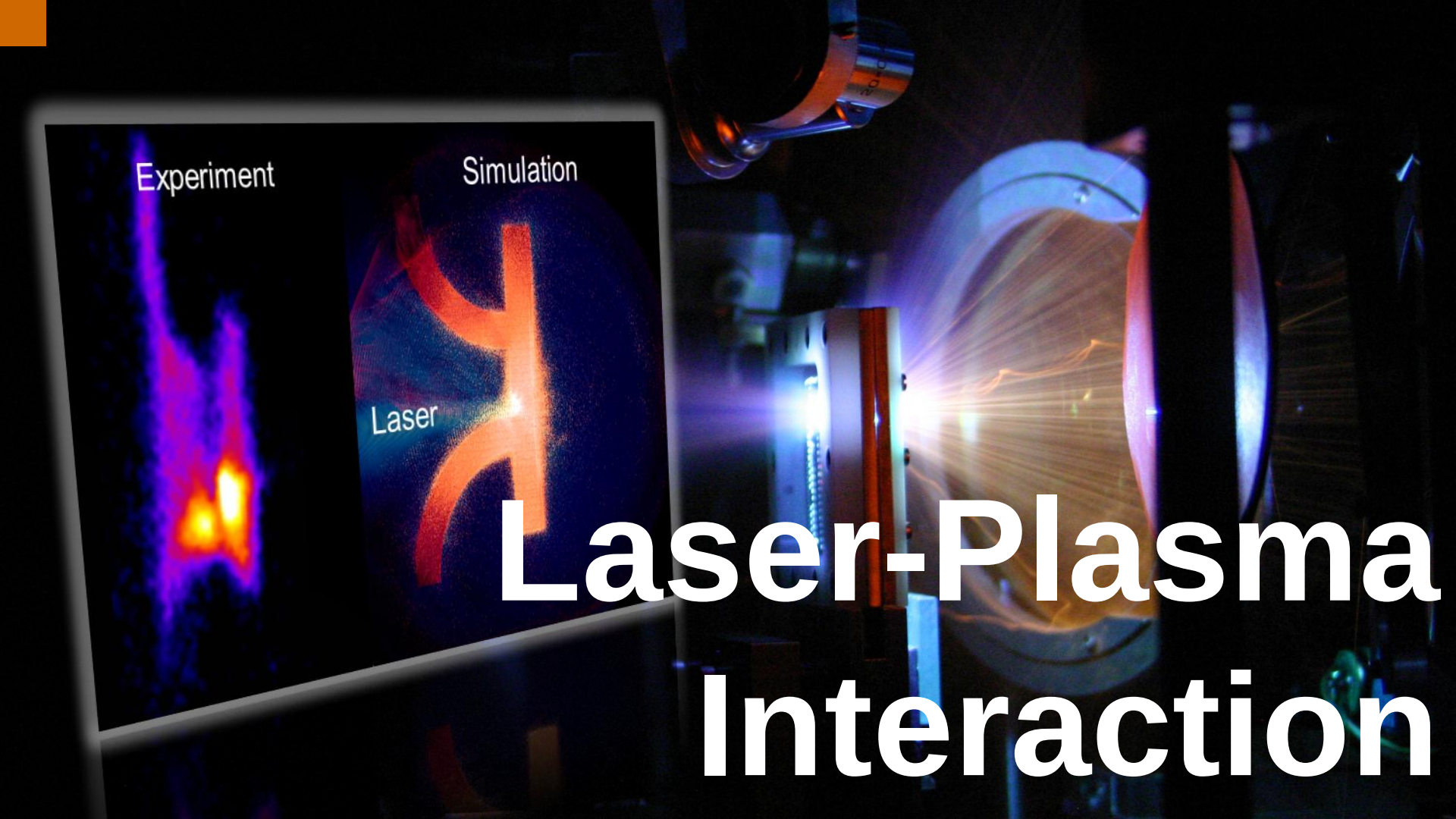
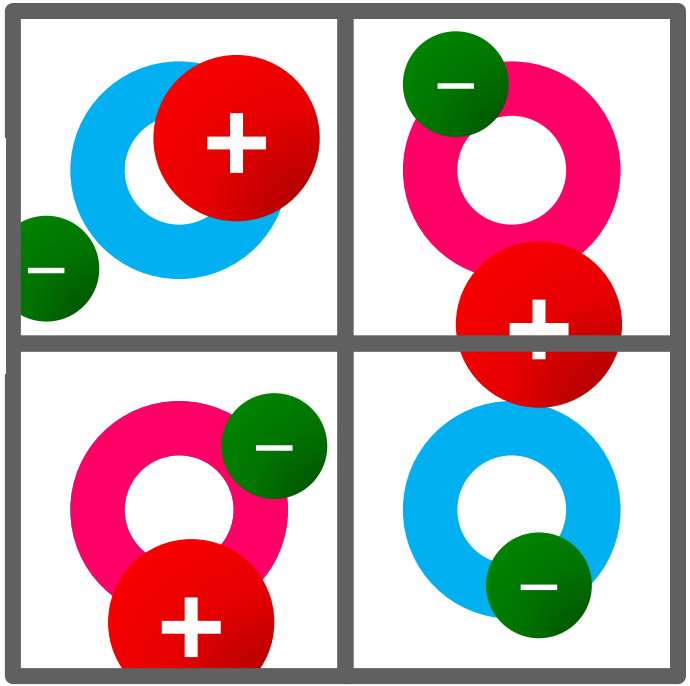
See Poster P5122 on HASEonGPU by Axel Huebl



Laser-Plasma Interaction

Plasma Simulation using the Particle-in-Cell Technique



Field Domain **Particle Domain**

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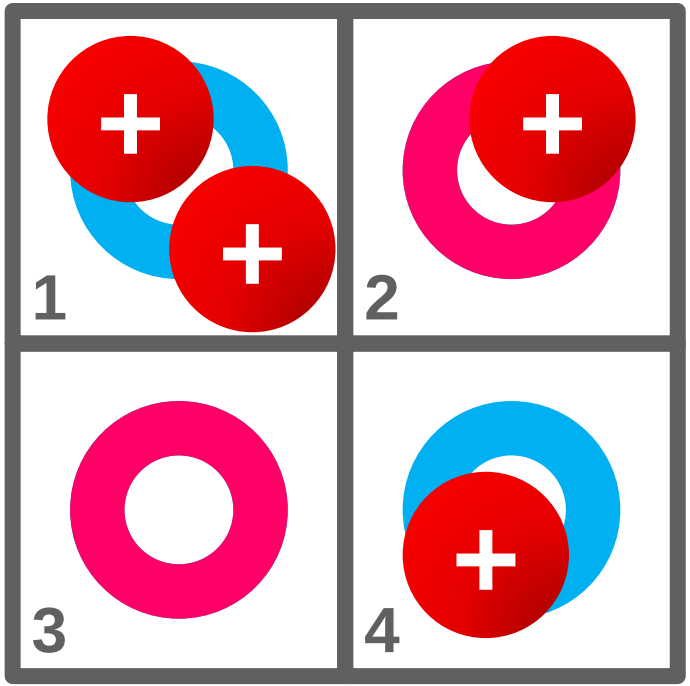
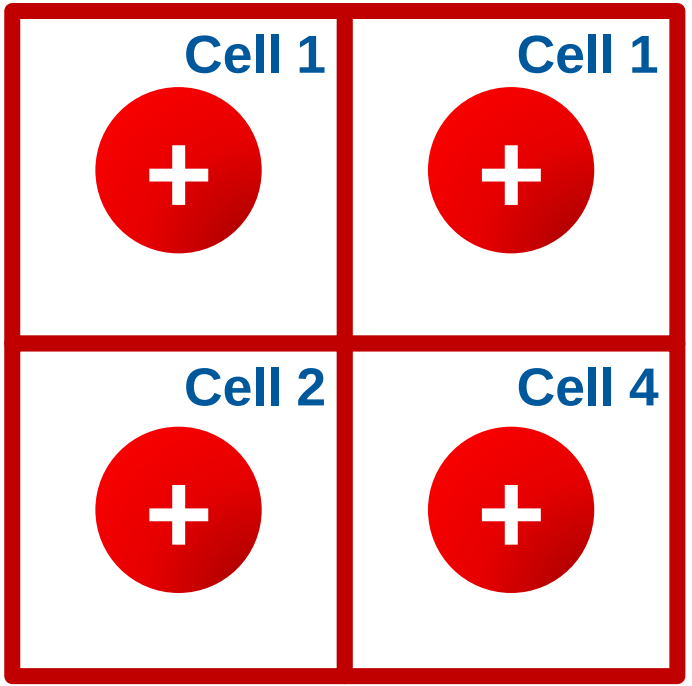
Creating vectorized Data Structures for Particles and Fields





Field Domain **Particle Domain**

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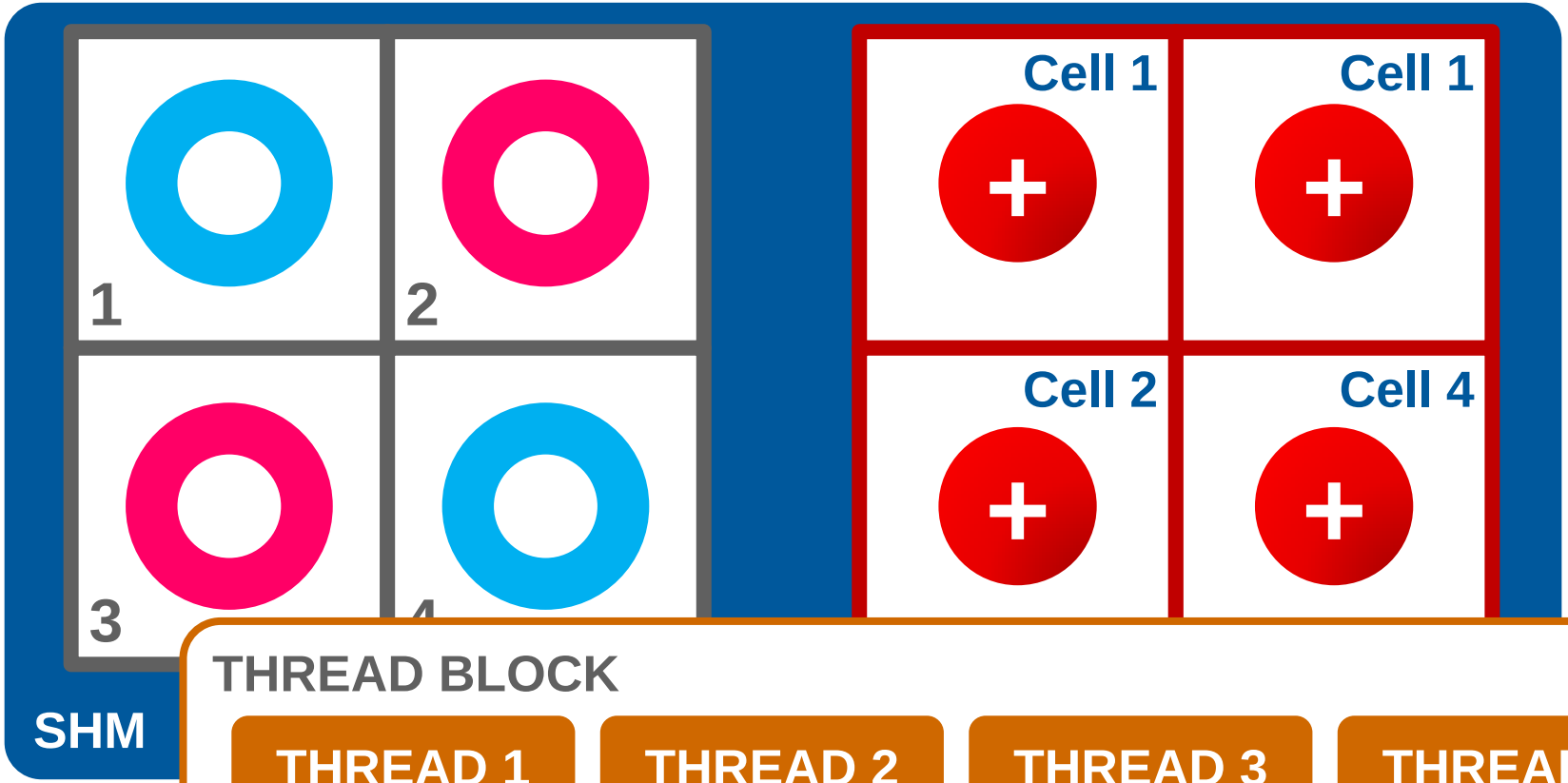
Thread-wise Operations on Fields and Particles in Shared Memory



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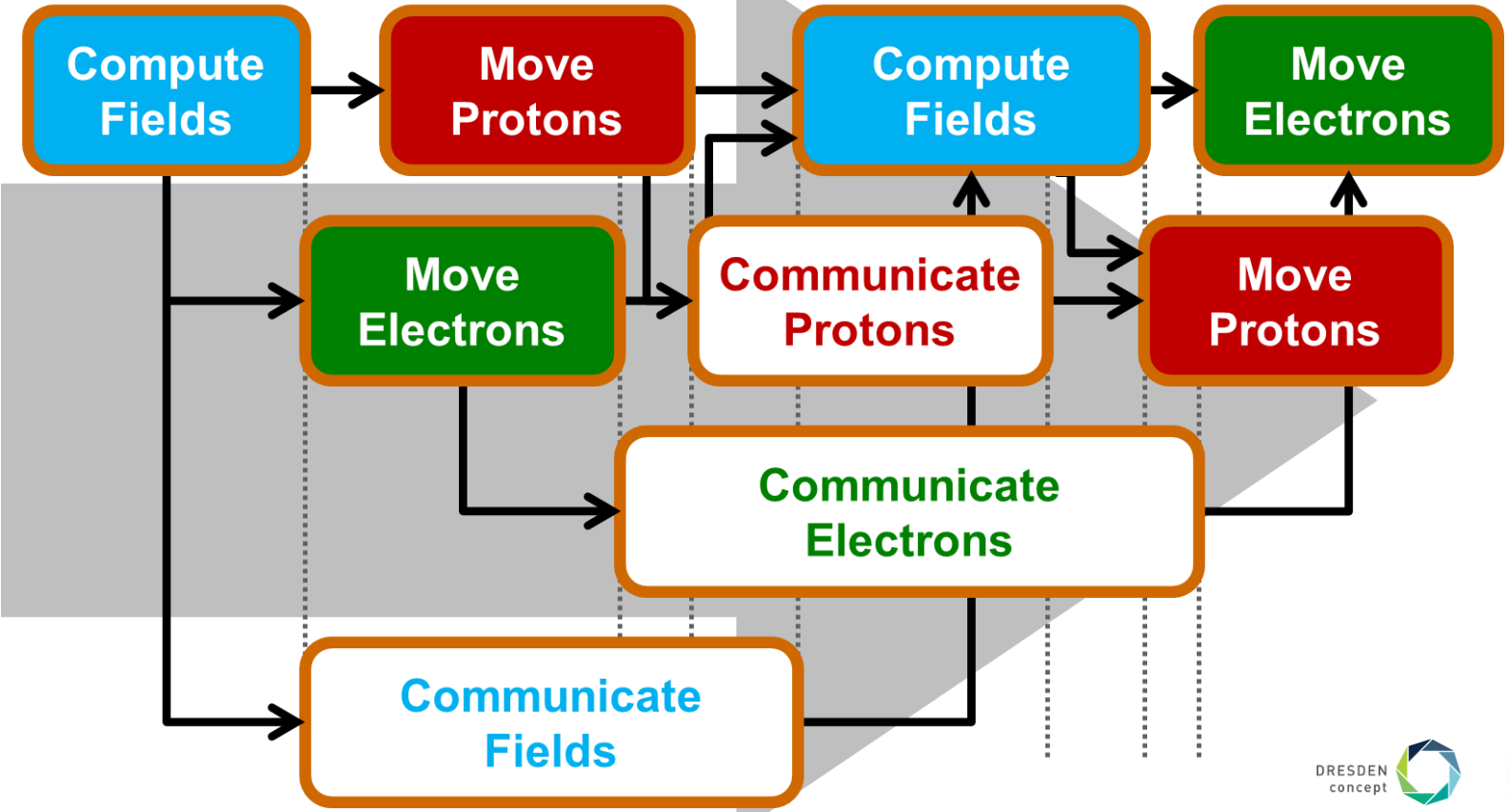
m.bussmann@hzdr.de

Task-Parallel Execution of Kernels + Asynchronous Communication



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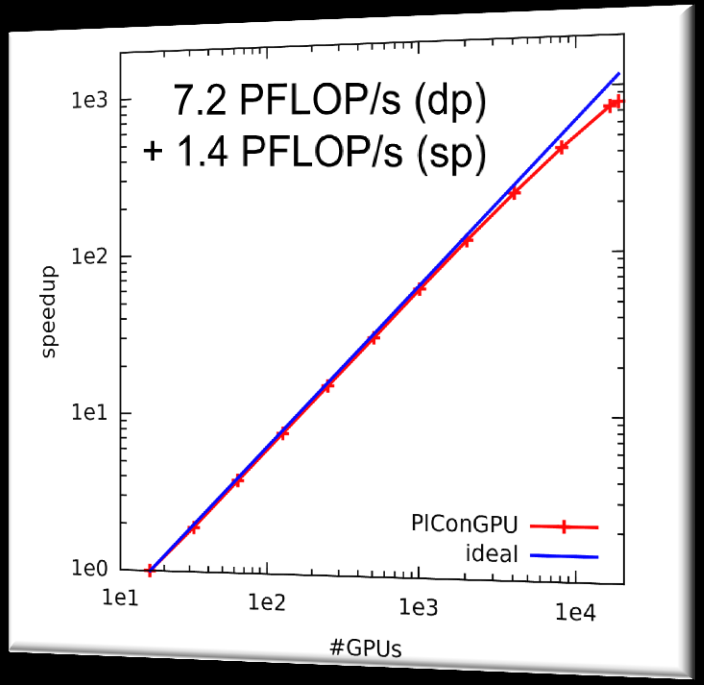
PIConGPU

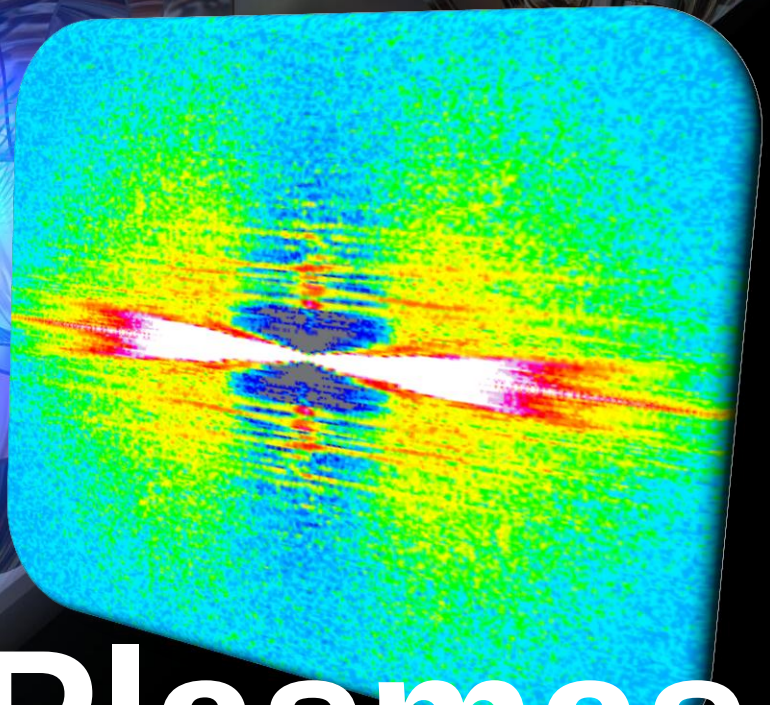
PIConGPU

See S5193
at 2:30 pm today

- **3D3V Particle-in-Cell Code**
- **Fully GPU-accelerated C++**
- **Open Source**
- **See picongpu.hzdr.de**

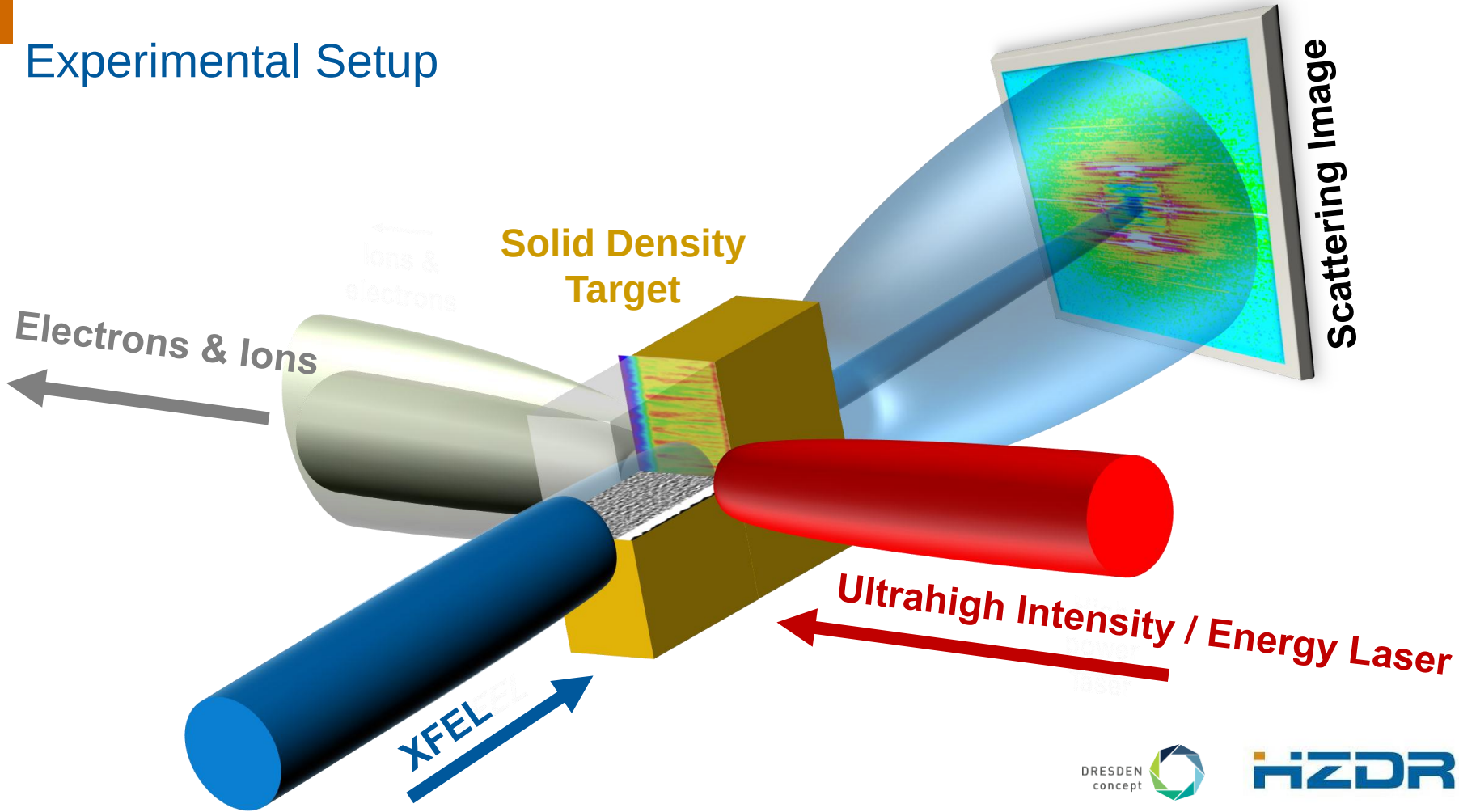


European XFEL

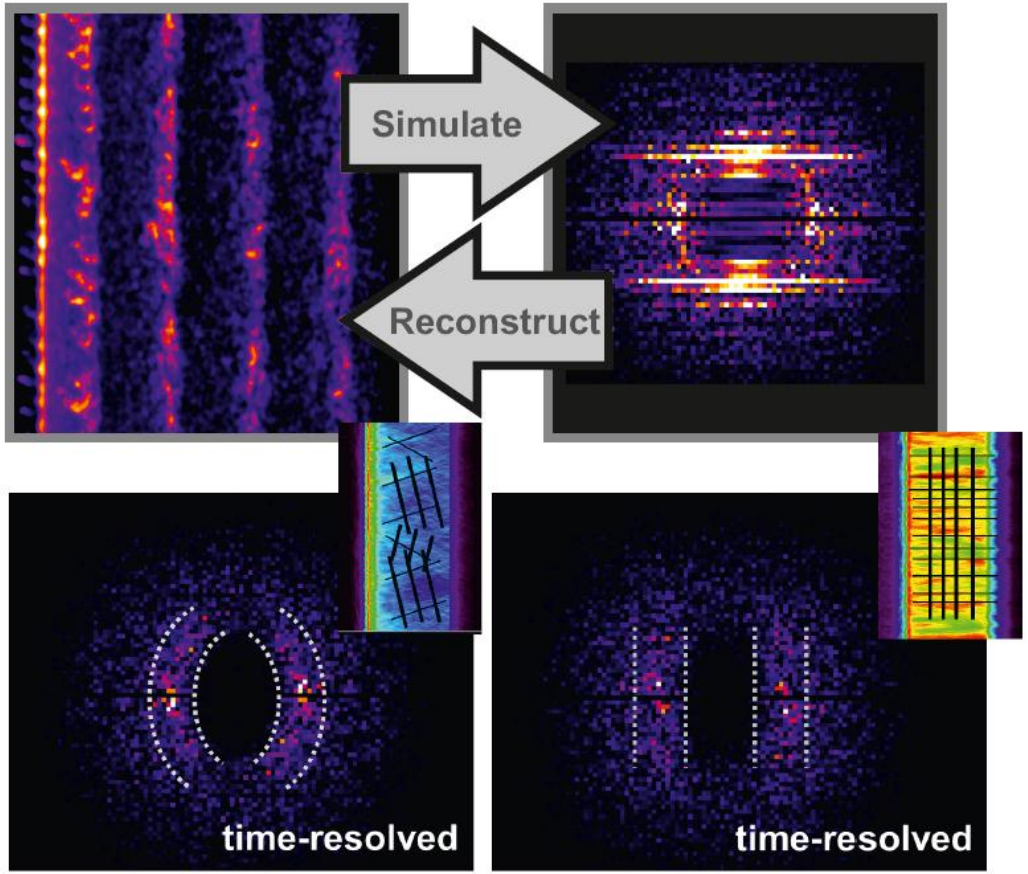


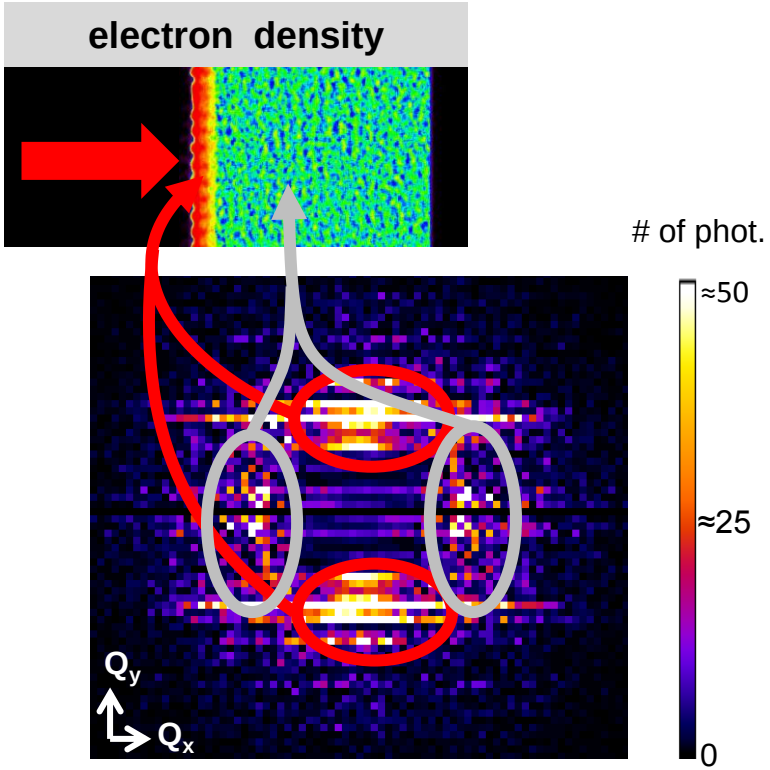
Probing Plasmas with X-ray Lasers

Experimental Setup



Synthetic X-Ray Scattering Images from Simulations





DRESDEN concept

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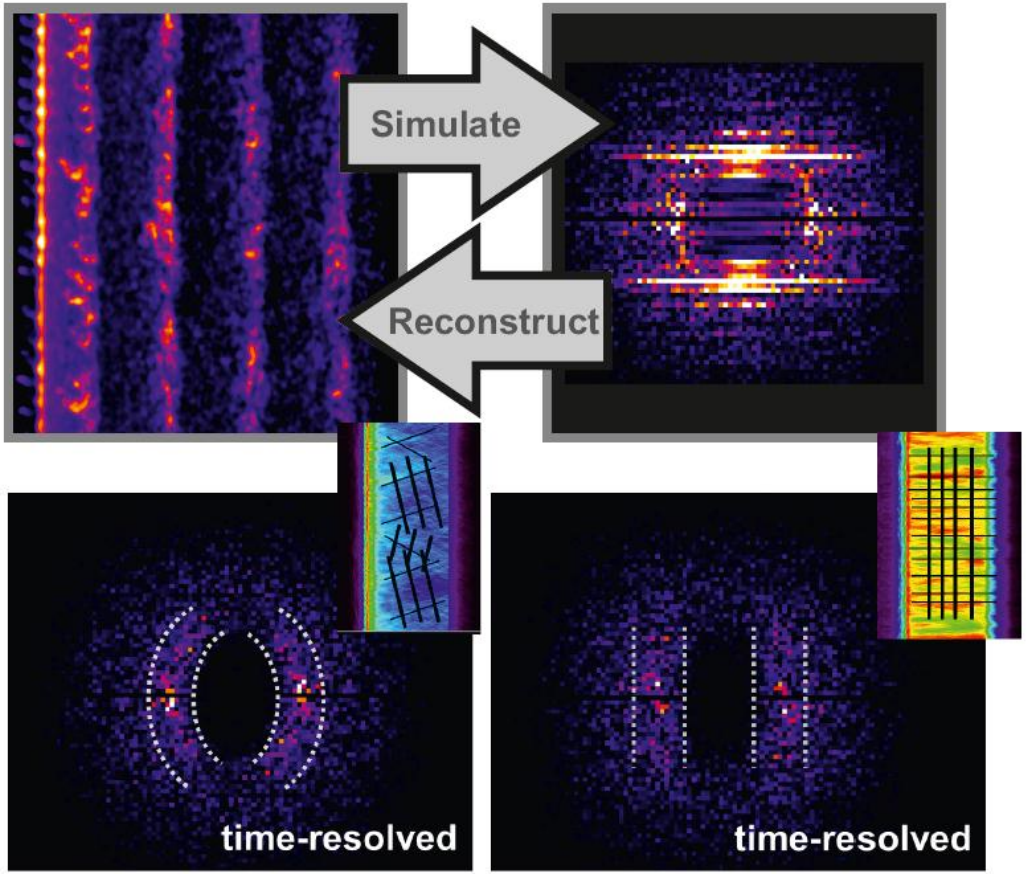
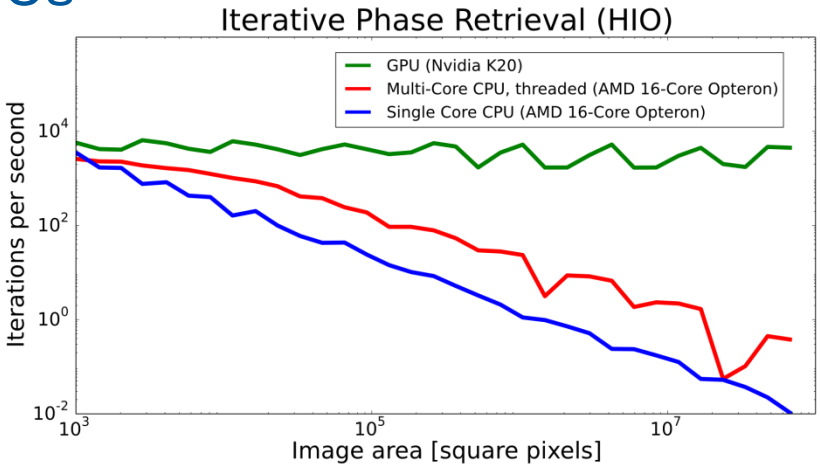
Accelerate the Reconstruction with GPUs





We need to include all relevant Atomic Physics Processes

to be fully integrated into PIConGPU

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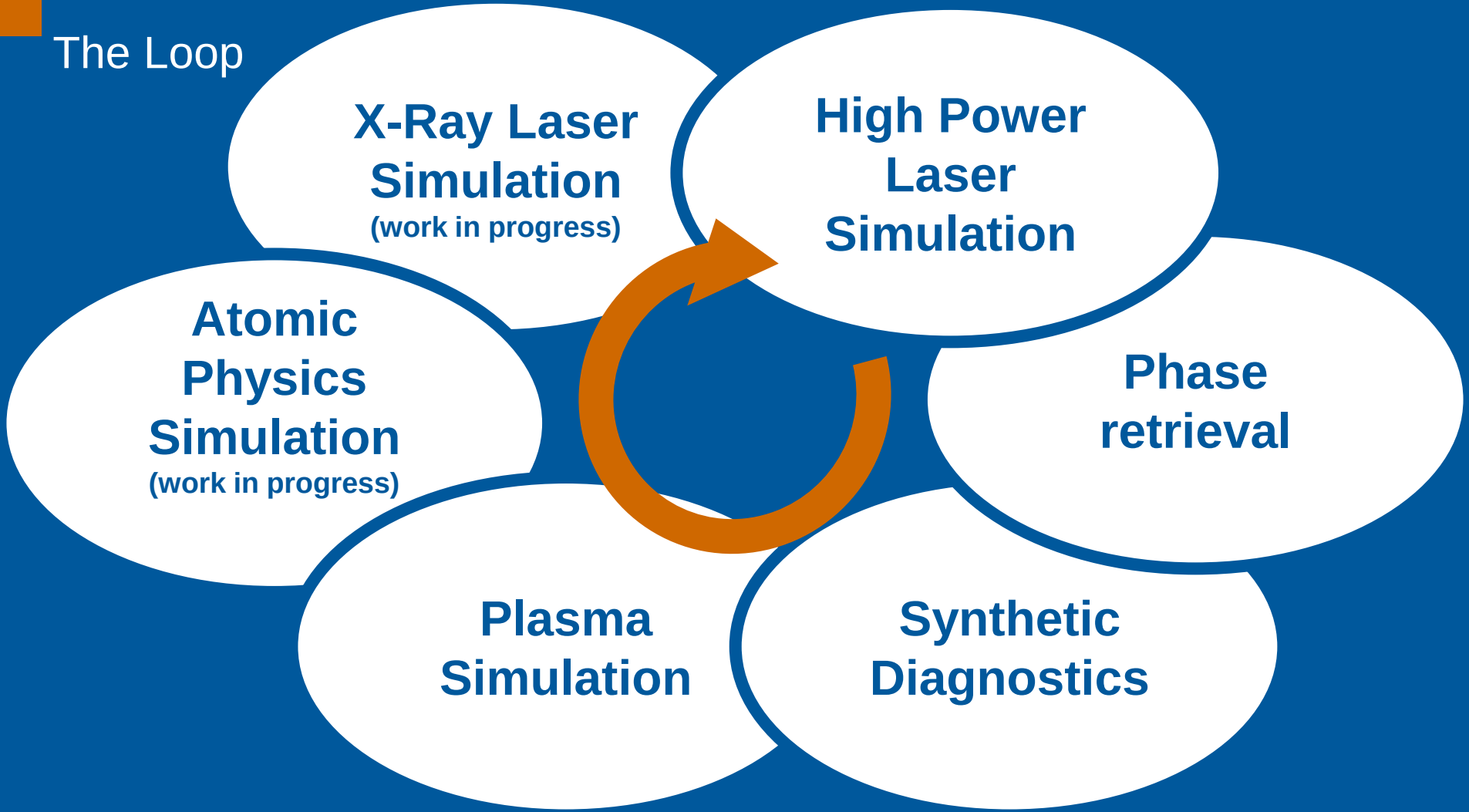
The Loop


X-Ray Laser Simulation
(work in progress)
High Power Laser Simulation
Atomic Physics Simulation
(work in progress)
Phase retrieval
Plasma Simulation
Synthetic Diagnostics


Won‘t this take
AGES?