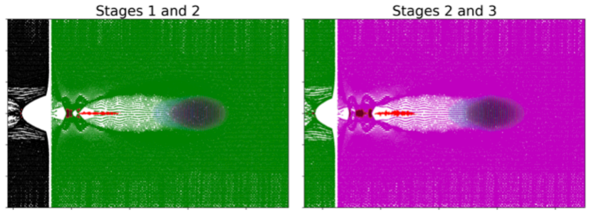
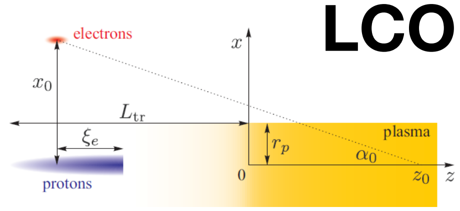


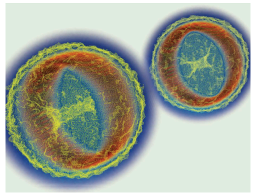
WarpX

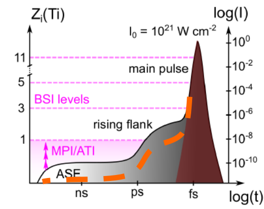
WAKE

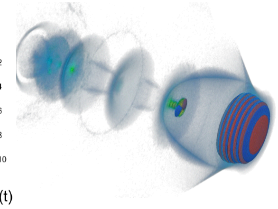


LCODE

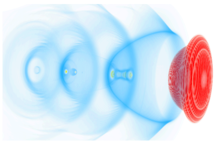
Osiris 4.0

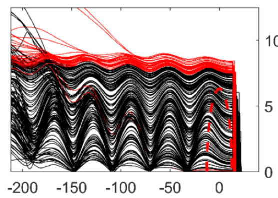


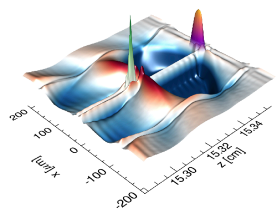


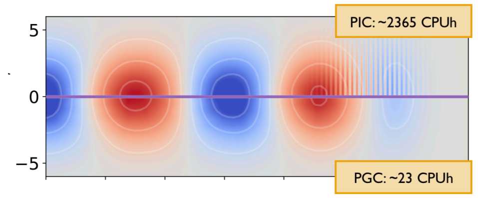


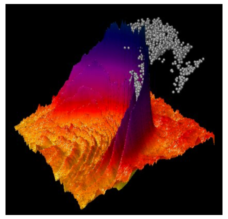
Smilei



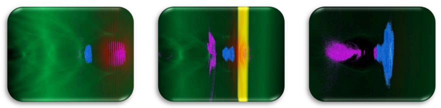


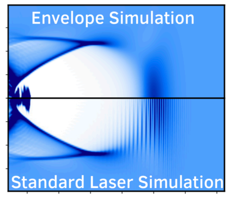




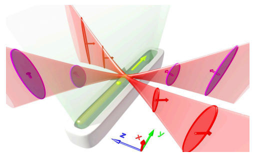


PIConGPU



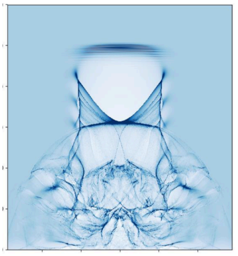


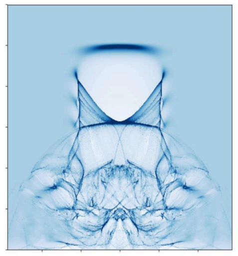
Summary of WG 6: Theory and Simulations



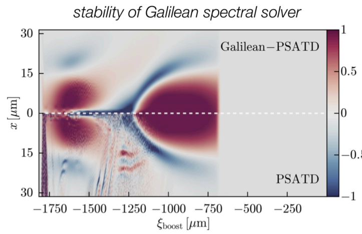
ALaDyn

Vsim

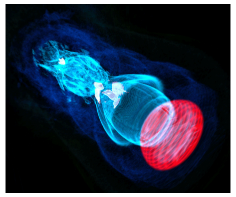




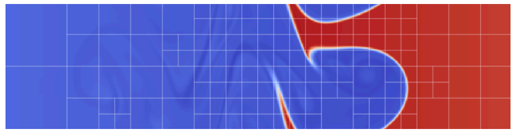
HiPACE

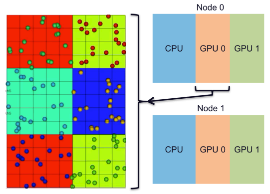


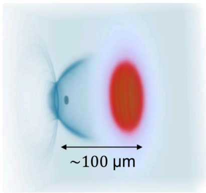
FBPIC

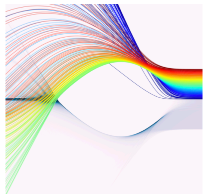


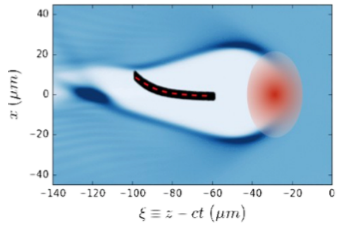
FLASH





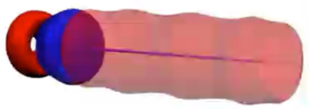






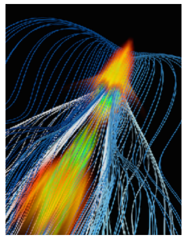
EAAC 2019

QV3D



QuickPIC

QPAD



4th European Advanced Accelerator Concepts Workshop

Topics of WG 6 sessions

- Analytical models
- Updates on existing PIC codes
- Solvers, reduced models for PIC codes
- Experiment modeling
- New Experimental setups
- Performances, architectures and libraries

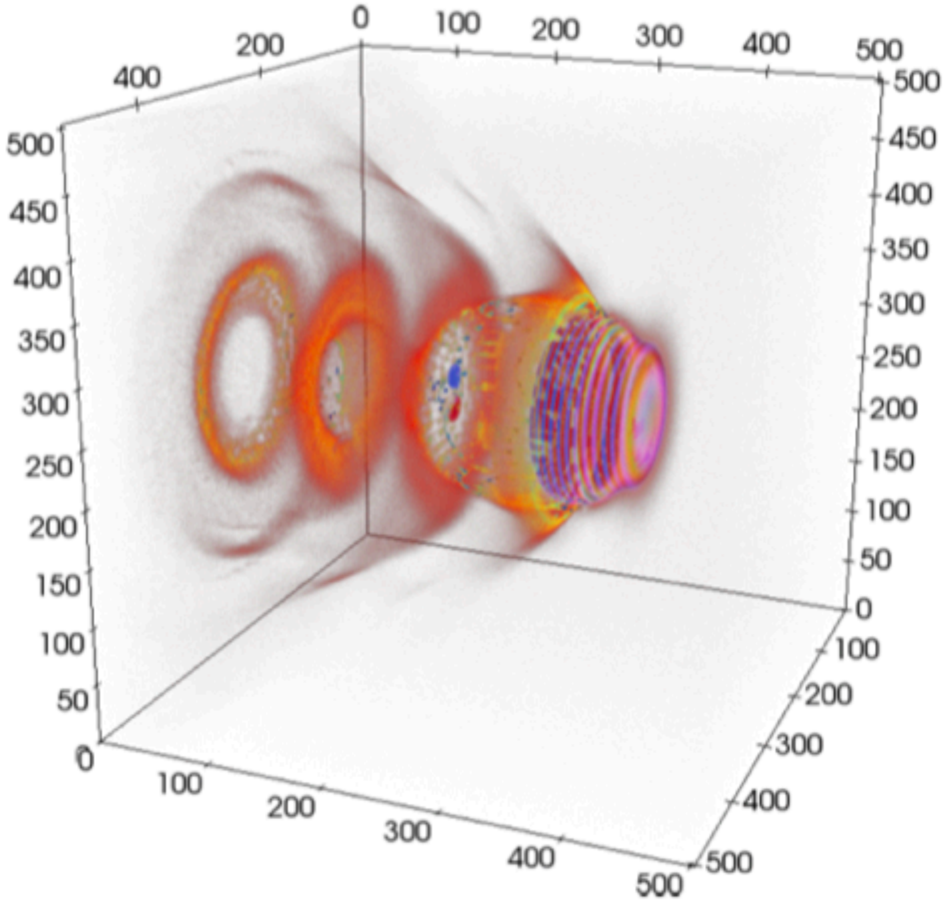
Some statistics from the abstracts

Talks	Number
WG 6	16
Joint sessions	11

Some statistics from the abstracts

Word(s)	Occurrences
Experiments/Experimental	15
PIC, GPU	13
Envelope/PGC	10
Hollow channel, hybrid, positron(s)	8
Architectures, cylindrical, efficient, realistic	6
Spectral	5

PIC simulations are expensive!



3D Simulations of standard LWFA

1 mm plasma ~ 320 kcpu-hours ~ 10.2 k€

(36 years on 1 cpu)

Parallelisation mandatory

Still 320 kcpu-hours ~ 13 days on 1000 cpus …

Any technique to speed up simulations is welcome (if physics of interest is retained)

High Performance Computing (HPC) techniques, e.g.

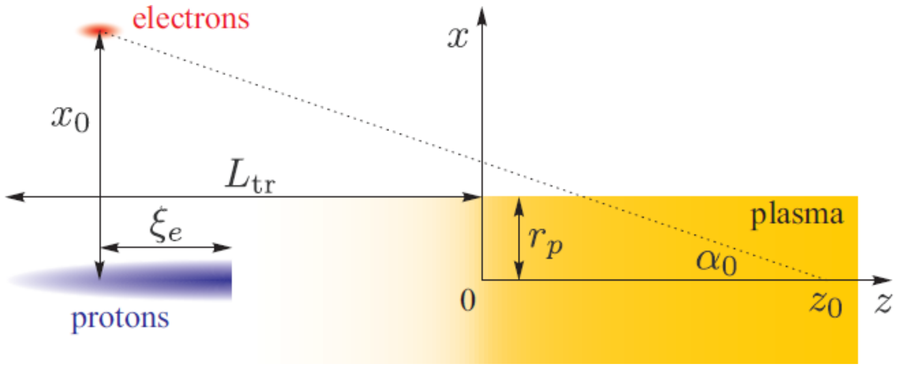
- GPU programming
- Parallelization
- Load balancing

Techniques based on physical approximations, e.g.

- Azimuthal Fourier decomposition
- Quasi-static approximation
- Hybrid models, envelope/PGC

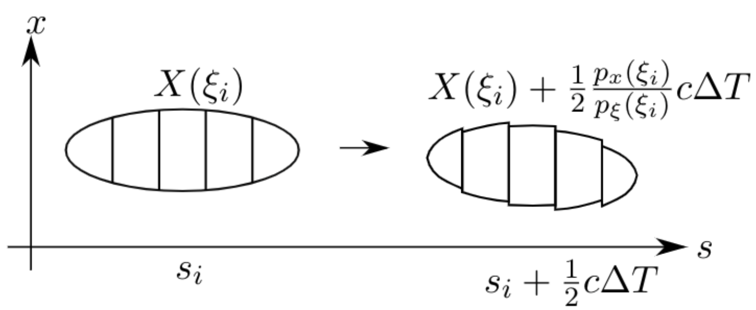
Analytical models: a rare gift

K. Lotov



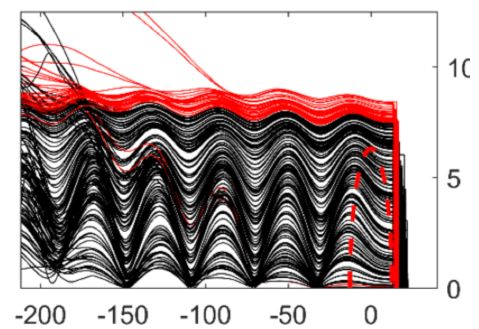
Force exerted on particle bunch propagating near plasma-vacuum boundary

J. B. Ben Chen



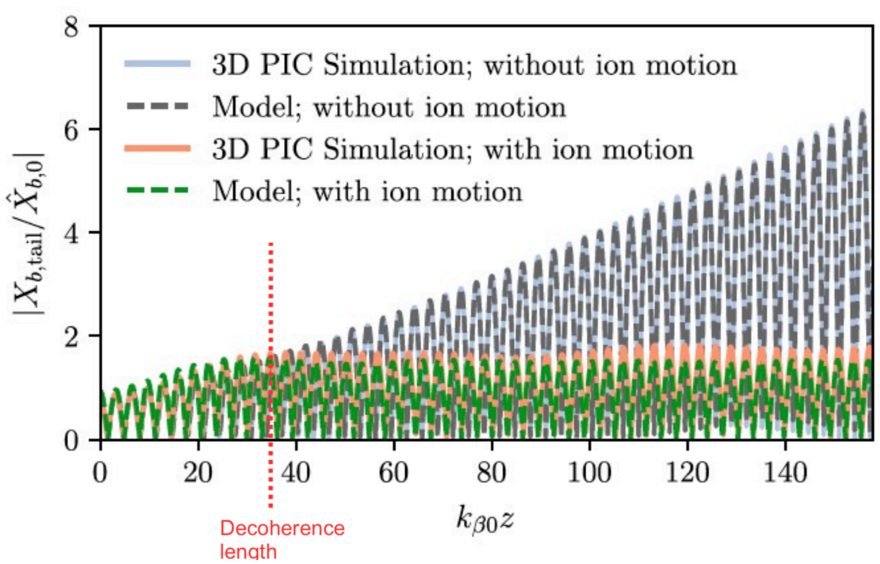
Transverse wakefields in PWFA

S. Kalmykov



Single cycle THz Generation

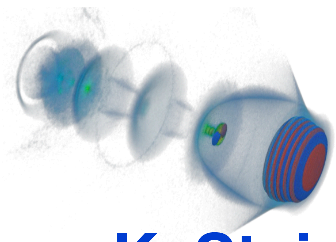
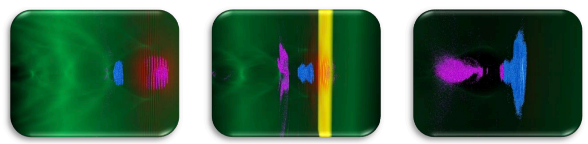
C. Benedetti



Model including ion motion in plasma accelerators to study hosing instability

PIC codes updates

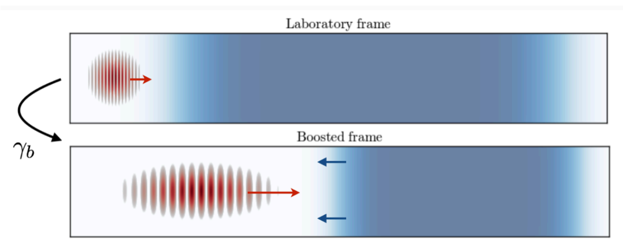
PIConGPU

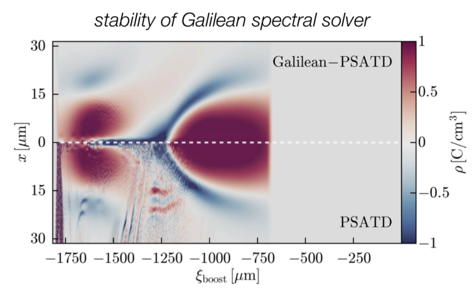



K. Steiniger, A. Debus

- In situ visualisation
- Multiple libraries for output, etc
- GPU

FBPIC

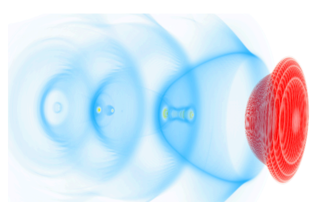
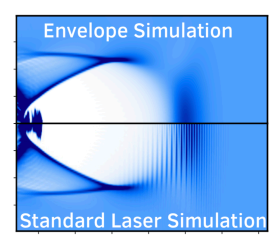




M. Kirchen, S. Jalas

- Azimuthal Fourier decomposition
- Boosted frame
- Galilean transformation
- Runs on CPU, GPU

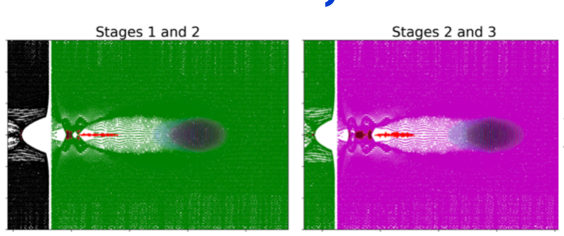
Smilei)

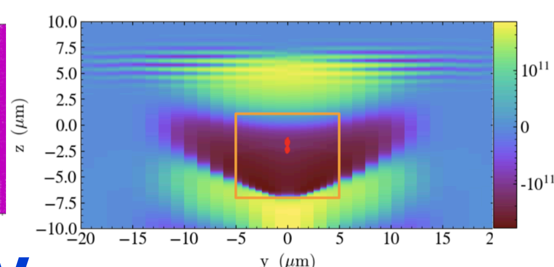



A. Beck, I. Zemzemi, F. Massimo

- SDMD decomposition, SIMD
- Azimuthal Fourier decomposition
- Envelope model

WarpX

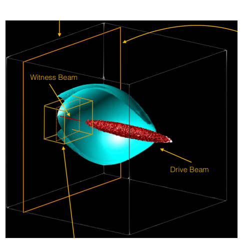




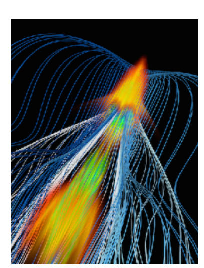
J.-L. Vay

- Adaptive mesh refinement
- Advanced solvers
- Runs on CPU, GPU

QuickPIC
QPAD



W. An

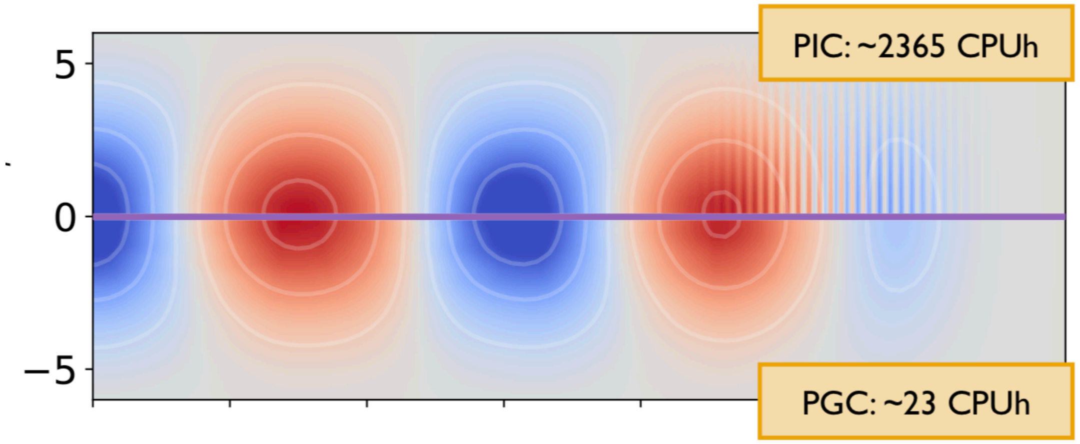


- Quasi-static
- Adaptive mesh refinement
- Azimuthal Fourier decomposition

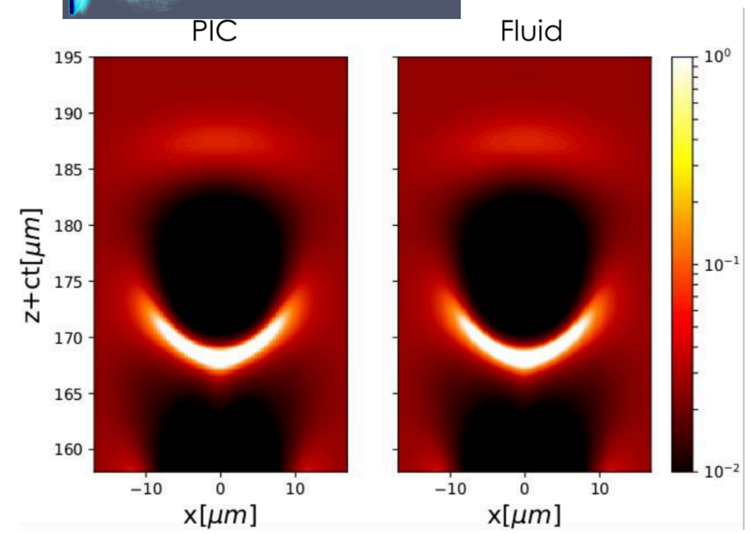
Solvers, reduced models for PIC codes

Ponderomotive guiding center / Envelope models

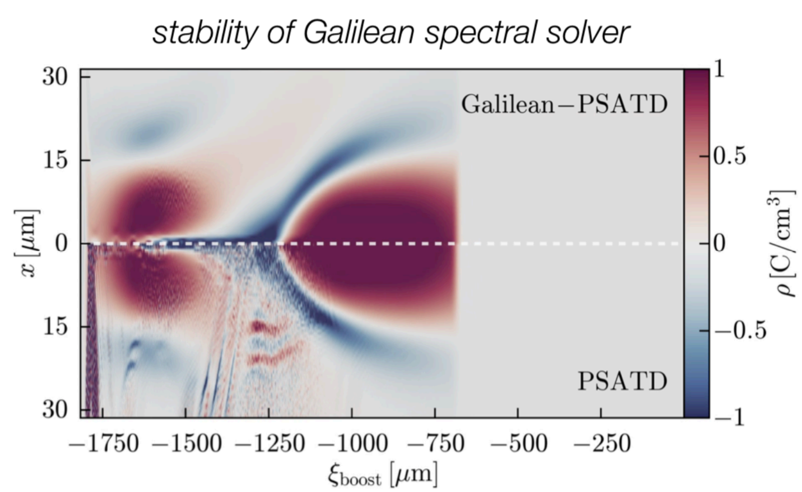
Osiris 4.0 **A. Helm**



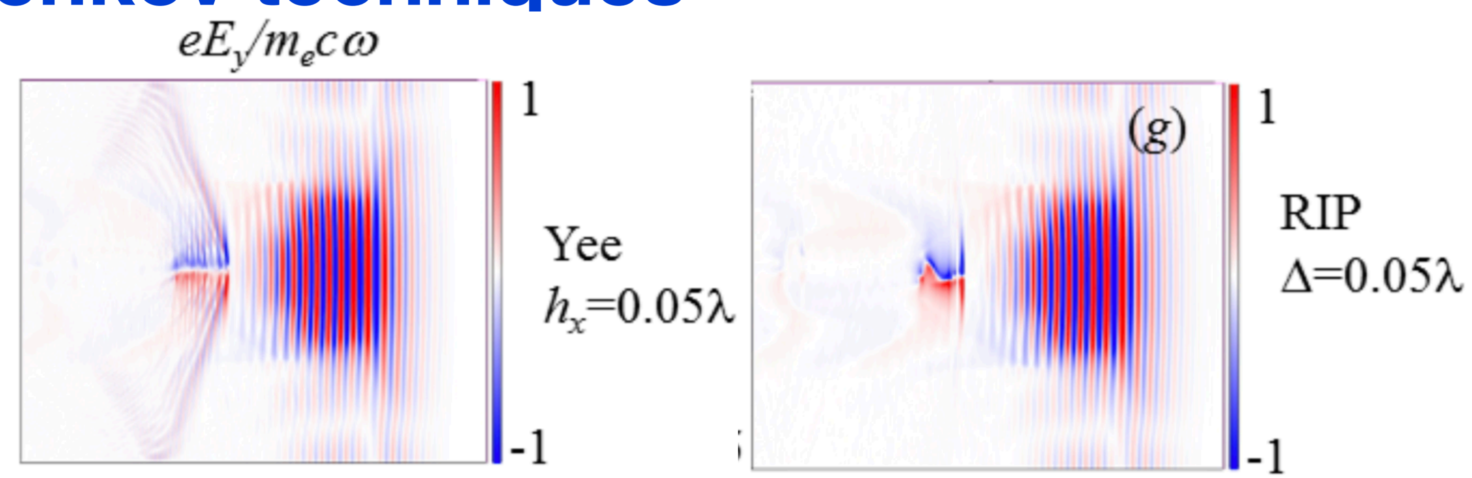
ALaDyn **D. Terzani**



Anti-Cherenkov techniques



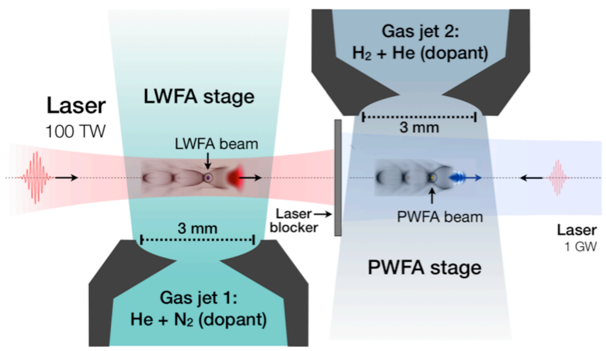
M. Kirchen, FBPIC
Galilean transformation



A. Pukhov, New Maxwell solver

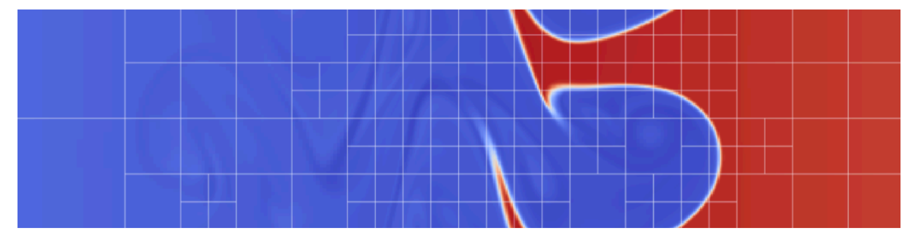
Experiment modeling

A. Debus — PIConGPU



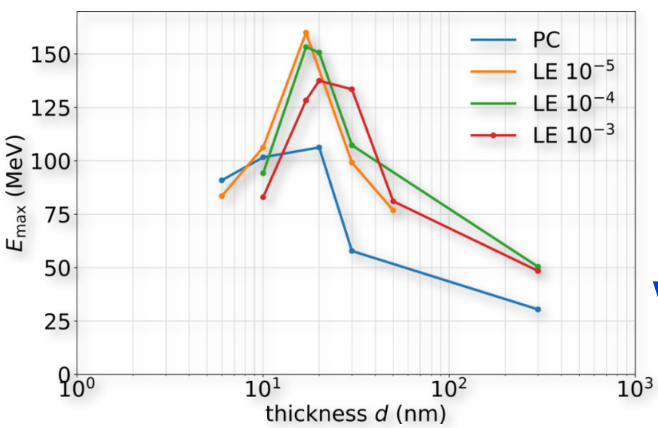
Hybrid L|PWFA experiment

N. Cook — **Multiphysics code FLASH**



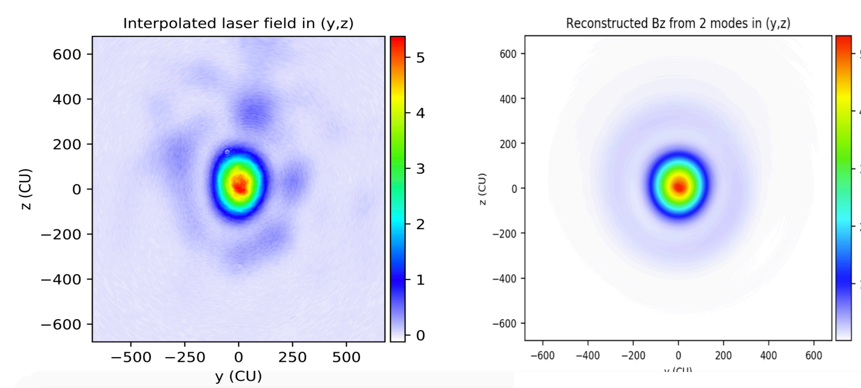
Capillary discharge plasmas

M. Garten



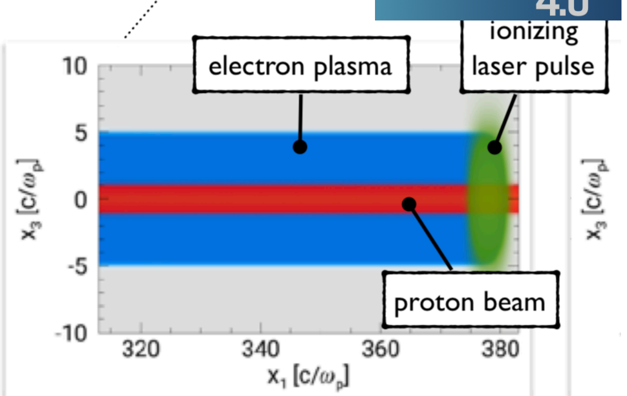
Simulations and experiments of ion acceleration with non ideal laser contrast

I. Zemzemi — Smilei



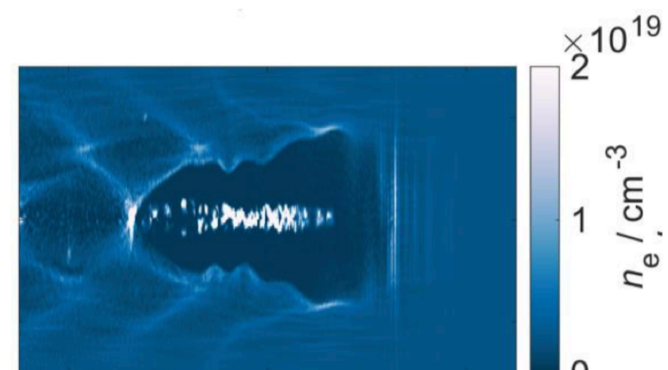
Apollon LWFA experiments

A. Helm — Osiris 4.0



AWAKE experiment

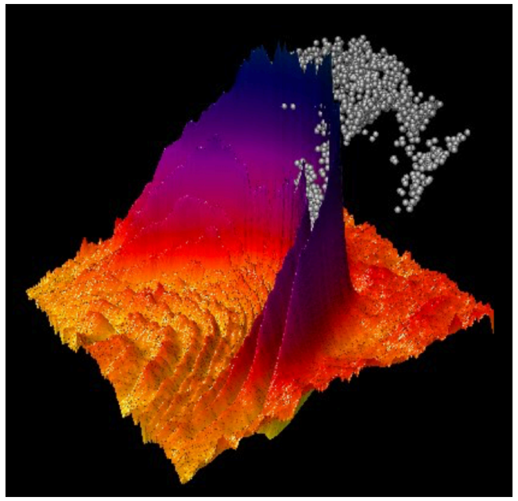
J. Wood — **FBPIC**



High flux X Rays from injection after Significant pulse compression

Proposing Experimental setups / new regimes

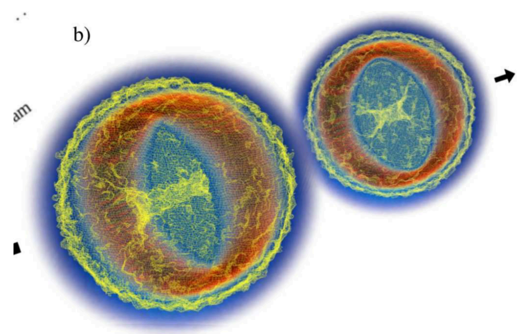
E. Boella



Collisionless ion shock acceleration in near-critical and underdense plasmas

Osiris 4.0

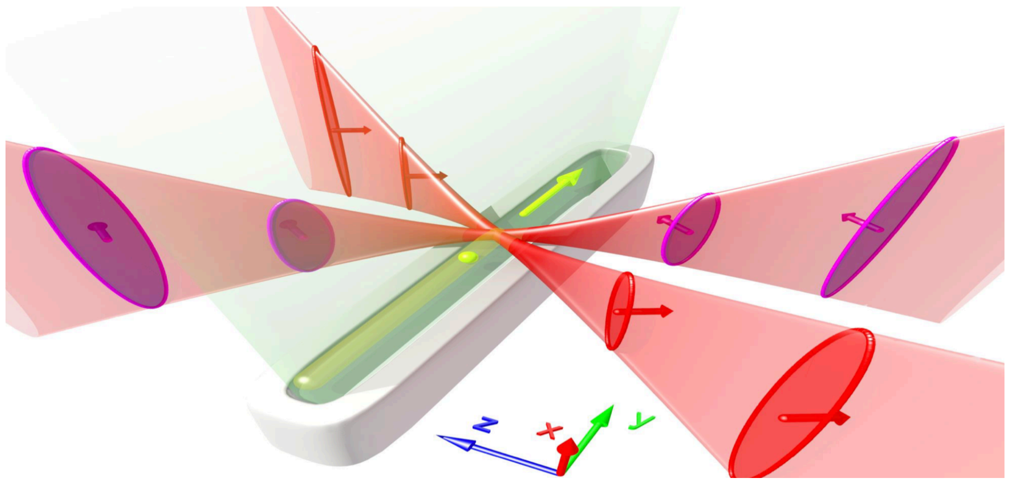
V. Yakimenko



Physics Opportunities at a Lepton Collider in the Fully Nonperturbative QED Regime

A. Debus

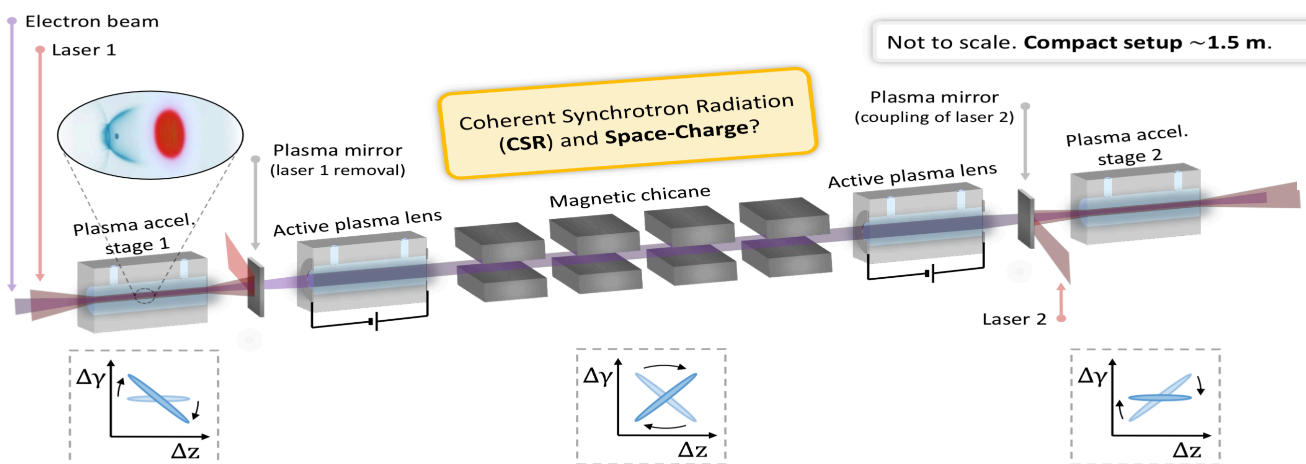
PIConGPU



TWEAC: a dephasing and depletion free scheme for LWFA

A. F. Pousa

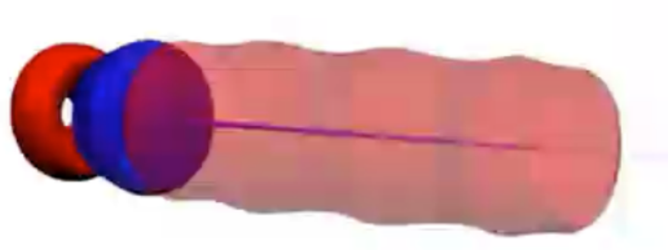
FBPIC



Multistage Plasma Accelerator for GeV, ultra-low energy spread beams

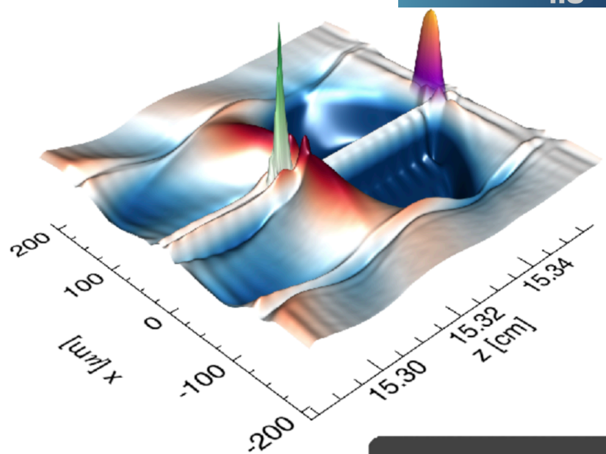
Proposing Experimental setups / new regimes

A. Pukhov **QV3D**



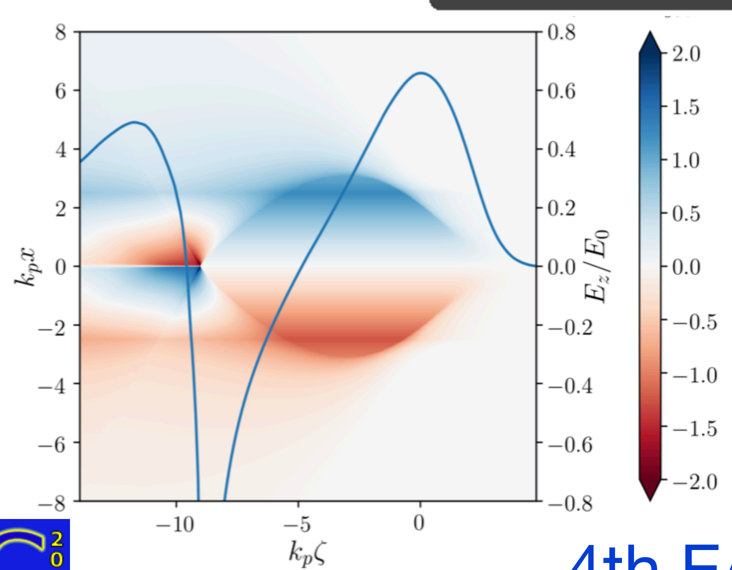
Particle acceleration in co-axial plasma channels

T. Silva Osiris 4.0



Stable positron acceleration in self-generated hollow channels

S. Diederichs HiPACE

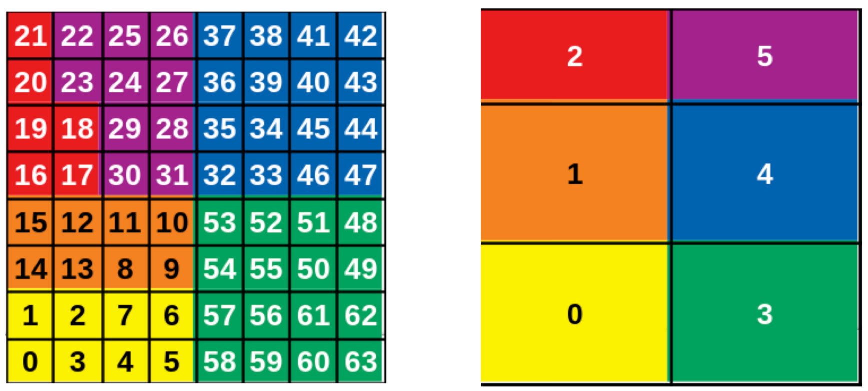


Positron transport and acceleration in beam-driven plasma accelerators using a plasma column

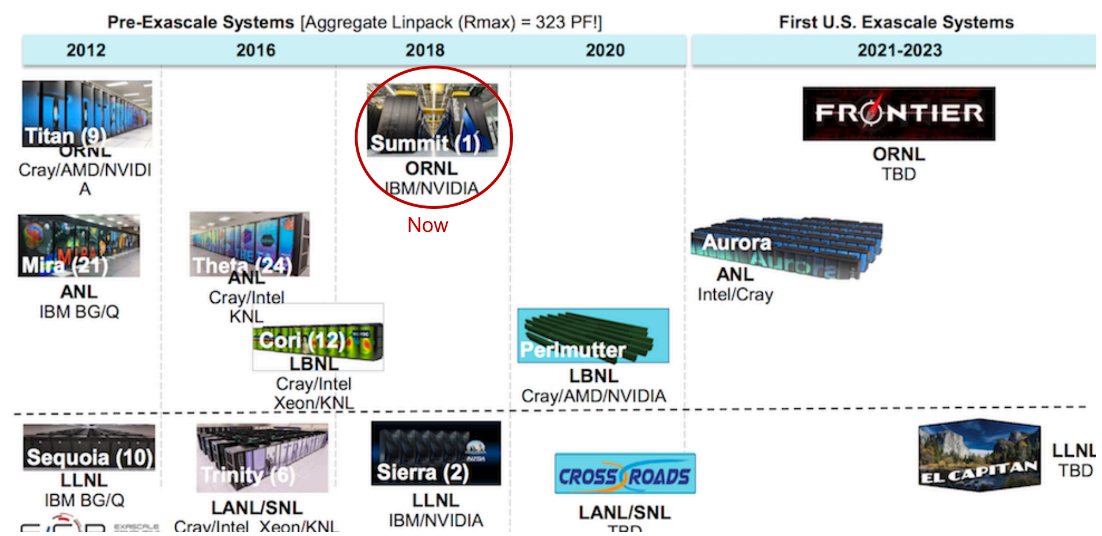
Performances, architectures and libraries

Vectorisation, Decoupling of particle and fields grids, ...

Smilei



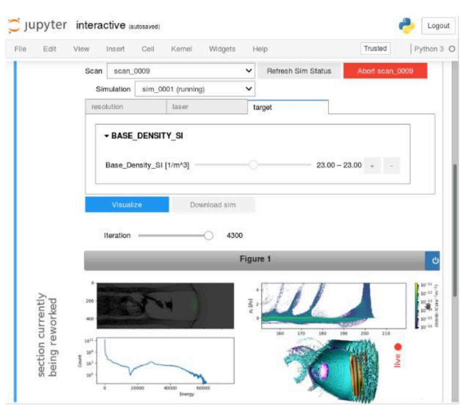
Transition to the exascale



WarpX

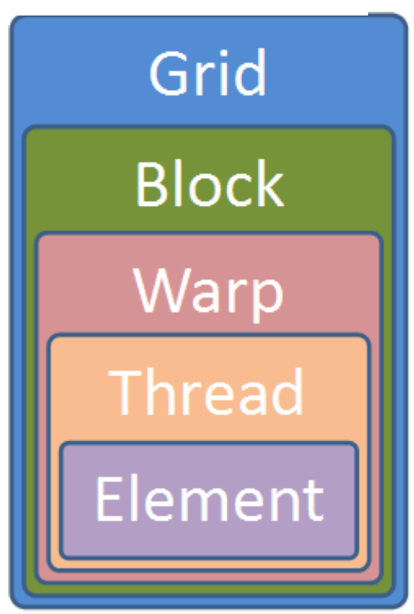
Vsim

"One interface to rule them all" (CPUs, GPUs) cit. K. Steiniger

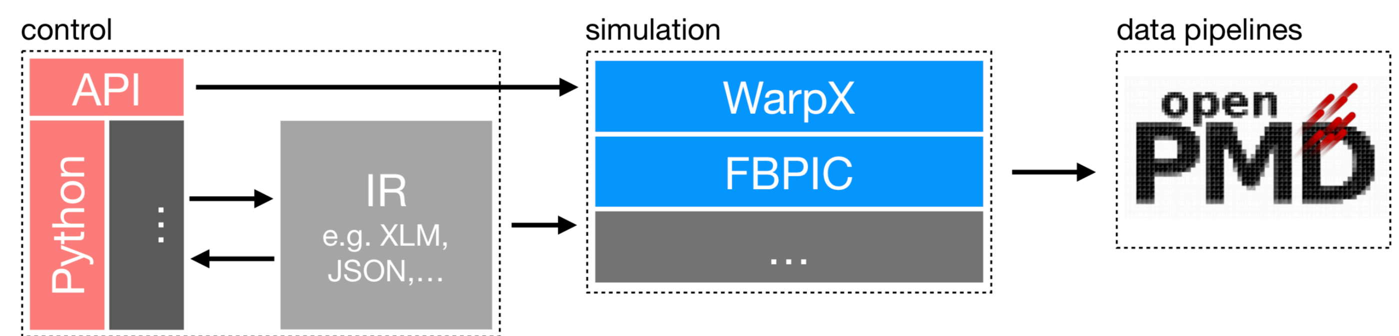


Graphic interfaces for PIC codes

PIConGPU



alpaka



Input and Output standards for PIC codes

FBPIC

Back in 

...

Exascale approaches : future of PIC codes

Numerical methods

- Improvements of (pseudo) spectral solvers implementation
- Fighting Cherenkov radiation and instability
- Adaptative Mesh Refinement (AMR)
- Dynamic Load Balancing
- Reduced models (envelope, symplectic, hybrid ...)
- Continuous integration, robustness tests

Diagnostics and data

- In situ visualization
- Radiation diagnostics
- Data reduction

Conclusions EAAC 2019

- Analytical models still under development for real-life situations (e.g. hosing)
- New schemes (e.g. anti-Cherenkov schemes), techniques (e.g. adaptive mesh refinement, spectral solvers), models (e.g. modes decomposition, PGC/envelope), capabilities (e.g. in situ visualisation) once outlined as future developments are now reaching a high level of maturity
- Still many surprises (e.g., new Maxwell solvers, new experimental setups, decoupling particle and field grids)
- Taking advantage of GPU and modern computer architectures becomes more and more essential to develop efficient codes
- Optimised and high performance codes allow to perform once out-of-reach simulations