working group 3
workshop outputs, preparation of documents

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PWFA/LWFA

Tools to model the *acceleration* in the plasma are outlined for each stage of a future PWFA or LWFA based collider:
- full-PIC
- quasi-static
- boosted frame
- hybrid PIC fluid
- quasi-3D, envelope
- …

Full PIC simulations of a single multi-TeV stage are extremely (prohibitively) expensive. Strong efforts to:
- develop reduced models
- improve accuracy of existing plasma physics models

Efforts to optimise numerical calculations and to take advantage from most recent hardware architectures:
- multi level parallelism
- GPU, KNL, vectorisation, etc
- AMR
- load balance
- …

PWFA/LWFA (continued)

The understanding of the physics beyond the plasma is limited
- ionisation
- polarisation
- physics at the IP
- coupling between different stages
- long term plasma hydrodynamics, high repetition rate, plasma relaxation
- tolerances, misalignments, non-idealities
- …

Start to end simulation tools not ready.

DLA/SWFA

Tools to model collider relevant scenarios are not ready
- beam tracking dynamics OK
- strategy to compute the beam dynamics for very large (e.g. TeV) energy gains has been outlined
- however, 3D numerical models of photonics structures not available
- input from material science experiments required

There are potential overlaps and synergies between DLA/SWFA
beam tracking

Computing resources
- unlike other fields (e.g. conventional accelerators codes like elegant or geant4), plasma based linear colliders will be computationally (very) expensive.
- establish mechanisms to grant access to large supercomputing resources for the whole community (e.g. equivalent to laserlab)

Human resources
Need for funding for dedicated research positions for code validation, code optimisation, adaptation to new architectures, detailed analysis is important for a collider roadmap.

Technical resources
Need for open source 3D photonics structure calculation codes (DLA and SWFA)

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PWFA/LWFA

Plasma physics algorithms for a single stage
- demonstrate that reduced models can be used to make accurate predictions for single stage GeV-TeV acceleration production runs (linear, mildly nonlinear, nonlinear regimes)
- demonstrate that the PIC algorithm can systematically reproduce current experimental results (coordinated efforts with experiments)
- tolerance studies and role of misalignments

Integrate physics models beyond plasma physics in current numerical tools
- plasma hydrodynamics for long term plasma/gas evolution and accurate plasma/gas profiles
- ionisation, recombination
- coupling with conventional beamlines
- production of secondary particles
- QED physics at the interaction point
- spin polarisation

PWFA/LWFA (continued)

Open to innovative ideas that might provide new solutions and applications in the context of HEP
- new wakefield structures (positron acceleration, plasma based polariser…)
- novel accelerated beam structures
- …

DLA/SWFA

Physics models for 3D photonic structures
- determine the material response to 10's as long electron bunches
- develop computational models based on material science experiments
- include material erosion into available models
- automated and non-invasive mechanisms to determine which photonics structures are useful for acceleration after being produced

Tentative report outline

State-of-the-art tools and models

- quasi-static & envelope
- boosted frames
- reduced dimensions
- …

State-of-the-art algorithms

- parallelisation
- load balance
- multi-scale parallelism
- …

Future algorithmic needs

- mitigation of numerical instabilities
- advanced solvers
- amr
- …

Tentative report outline

Modelling needs for a collider and start-to-end simulations
- plasma hydrodynamics, long term plasma evolution, high repetition rate
- spin polarisation
- qed at the final focus
- integration with beam-lines
- secondary particles
- ionisation and recombination
- tolerance studies
- …

Code portability to new architectures
- prospective hardware architectures
- novel programming models

Prospective innovate advances
- new wakefield structures (e.g. positron acceleration)
- new potential applications related to new physics models (e.g. plasma polariser)

Tentative report outline

State-of-the-art tools for DLA/SWFA

- 3D beam tracking
- photonics structures modelling for DLA
- photonics structures modelling for SWFA

Future needs for DLA/SWFA

- material science input for material response
- automatic, non-invasive schemes to test photonic structures
- material erosion into the models
- …

Tentative contribution process

1. circulate list of topics outlined above to make sure all key topics are included and that all topics are relevant
2. ask for contributions among invited speakers, those that rose the topics at this workshop, and experts
3. combine contributions into a single document