Working group on the use of novel accelerator techniques
Status report

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Mandate

Mandate for working group on use of novel accelerator schemes

- Look at interesting long term perspectives for LC installations
  - potential use of these in Linear Collider implementations as future stages of the existing plans for Higgs factory
  - Could be everything from reuse of tunnel, extend linac, afterburner, improvements of BDS ...
- The studies can also help to identify R&D priorities for novel accelerator schemes by considering their compatibilities with CLIC and ILC technologies.
- Input to European Strategy (end 2018)

Meetings so far

17/2 :

Daniel Schulte, Requirements for linear colliders

24/3 :

Patric Muggli, An overview of novel accelerator technologies

21/4 :

Philipp Roloff, Physics considerations for multi-TeV collisions

From Daniel's slides

Luminosity Challenge for Linear Colliders

$$\mathcal{L} \propto H_D \frac{n_\gamma^{\frac{3}{2}}}{\sqrt{\sigma_z}} \frac{1}{\sqrt{\epsilon_y \beta_y}} \frac{R+1}{R} \frac{\eta P_{wall}}{mc^2}$$

Efficiency will limit beam power in plasma-based colliders

- Likely find practical efficiency to be smaller in plasma-based colliders than assumed now

⇒ Have to improve luminosity per beam current

⇒ Could be useful for linear colliders in general, but also means no low-hanging fruit known

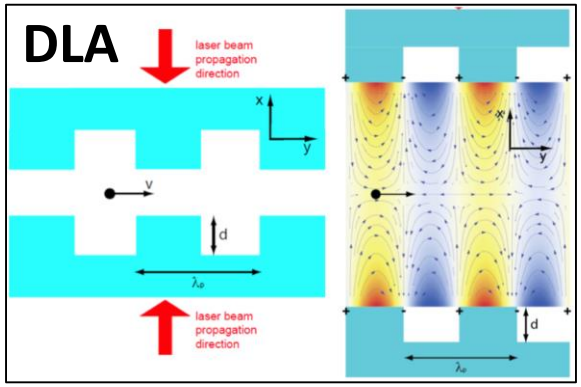
⇒ Still have to push efficiency as much as possible

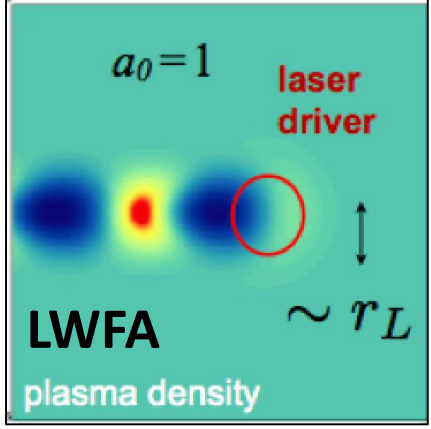
Reduce the vertical beamsize (betafunction and emittance) as much as possible

- Smaller emittances needs
  - better emittance preservation in main linac (but more difficult than in LC)
  - better sources
    - e.g. undulator-based damping?

- Smaller betafunction could be achieved using novel beam delivery system design

Patric's talk :





Materials with higher damage threshold:

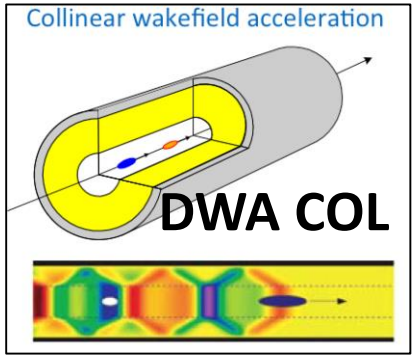
- ✧Dielectrics (~GV/m)
- ✧Plasmas (10-1000GV/m)

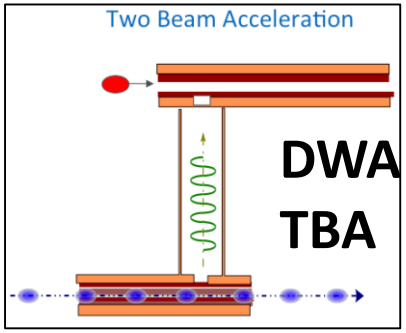
Systems powered/driven by:

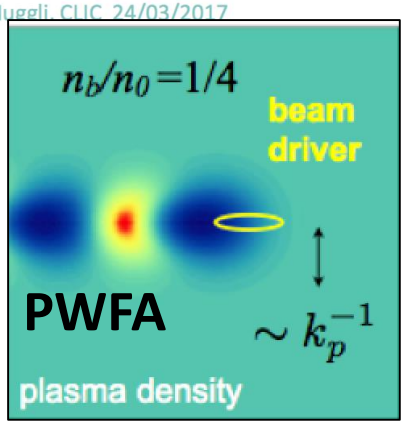
- ✧Laser pulse(s)*
- ✧Relativistic, charged particle bunch(es)

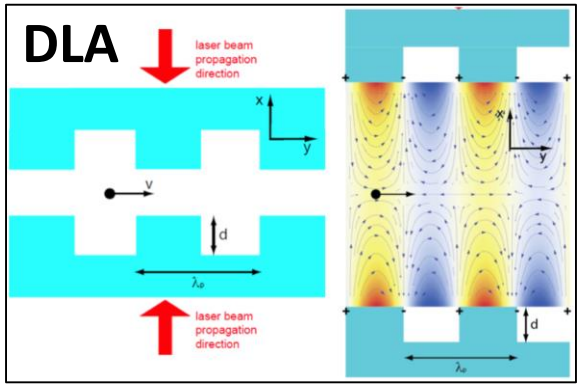
Driver \ Medium	Dielectric	Plasma
Laser Pulse	Dielectric Laser Accelerator DLA	Laser Wakefield Accelerator LWFA
Particle Bunch	Dielectric Wakefield Accelerator DWA	Plasma Wakefield Accelerator PWFA

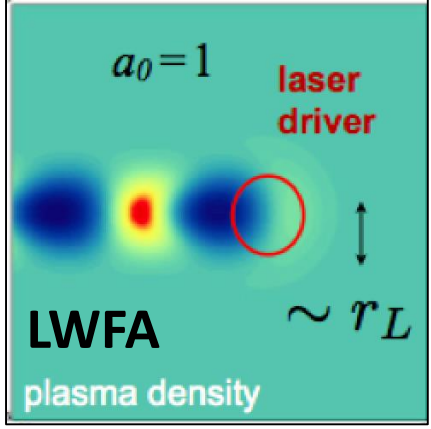
 *do not include laser vacuum/direct acceleration









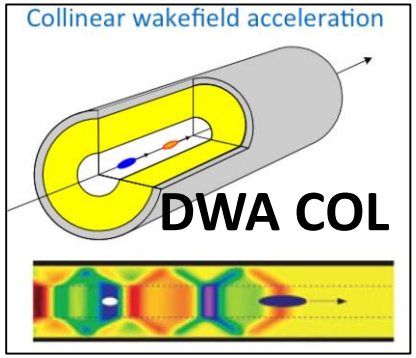


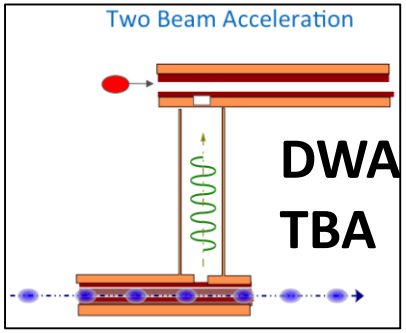
Charge symmetric

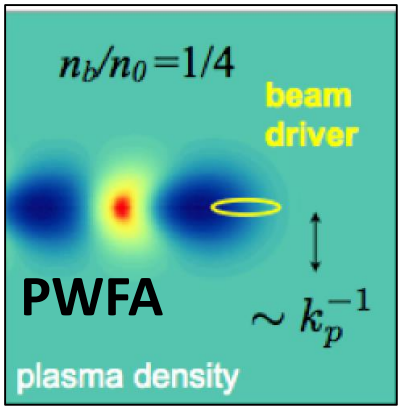
- same acceleration mechanism for e- and e+

Charge asymmetric in the non-linear regime (blow-out)

- e-: promise of good emittance preservation during acceleration
- e+: less clear







Philipp's talk, some conclusions :

Assume TeV e- beams are available, but not e+ beams (potential case for plasma) :

- TeV-scale e- e- colliders: limited interest

- Asymmetric collisions (e.g. E_{com} = 3 TeV using e- at 11 TeV, e+ at 200 GeV) : limited interest;
  - requires new detector concepts to catch strongly boosted physics (< 10 deg)
  - beam power would increase as E^2_{com} -> poor efficiency

- TeV-scale gamma-gamma colliders: while not as good as e- e+, could be of interest. Topic will be revisited by Philipp; he needs input in form of photon spectrum

Luminosity needs for 10-30 TeV machines :

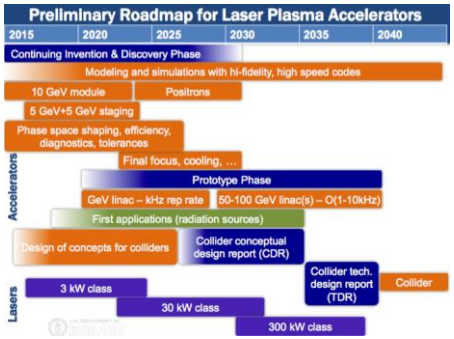
- For Higgs physics a luminosity similar to CLIC 3 TeV would give interesting physics
- Reach for new physics increases with energy
- luminosity needs for new physics increase with energy, but to say how high luminosity is needed.

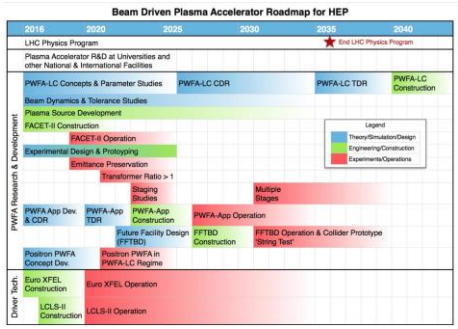
Time structure:

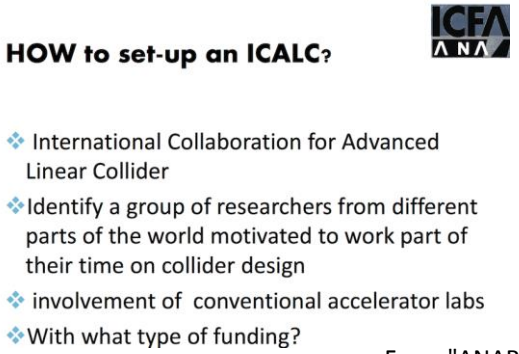
- Both pulsed (CLIC) or continuous (LHC) bunch time structure is OK

Community

- The novel accelerator community is large; US traditional leader.
- They have their own HEP-collider roadmaps; in the US formally adopted by DOE after years of consultation).
  - They are interested in developing the technology; seems less interest in developing linear collider designs (too early, also according to their road maps)
  - They are not interested in being constrained or down-selecting technology at this point.
  - They plan to provide their own, independent, input on to the HEP-strategy







From "ANAR"

- Still, I think both parts (CLIC and NAT) would benefit from cooperation :
  - how can NAT contribute to the CLIC project
  - how can we contribute to the NAT community
- "ANAR" workshop (last week) : planning for Europe, good time to discuss

Next steps

- Start collaboration with Argonne on TBA-DWA (dielectrics): technology close to CLIC, and can easier be evaluated (next meeting, Friday May 12th, 14h00)

- Start studies on plasma colliders concepts within CLIC, in order to better understand promises and challenges ourselves
  - To develop collider concepts further does not imply need for more experiment; design activities are "lagging" behind

- Find best strategy to cooperate within HEP-roadmap of the NAT community