WG3 Summary: Electron beams from electromagnetic structures, including dielectric and photonics structures

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Abstract. This summary provides a brief overview of the presentations and discussions during the sessions of working group 3 at the EAAC2019 workshop.

1. Introduction

Working group 3 was devoted to the discussion of electron acceleration in novel concepts of electromagnetic structures, driven by microwave and THz sources or lasers. The WG3 sessions were structured into five categories, as shown in table 1. In total, 19 oral presentations were given in WG3 and 1 presentation was given in a joint session with WG4. Furthermore, 28 posters were related to WG3 topics.

Table 1. Overview of working group 3 sessions

Session	Number of presentations
Dielectric laser-driven acceleration	6
Dielectric beam-driven acceleration	3
THz	5
High gradient rf acceleration	3
Particle sources	2

2. Dielectric laser-driven acceleration (DLA)

Many of the studies performed on DLA are taking place within the framework of the ACHIP collaboration, in which 13 institutes have joined efforts to investigate acceleration in silicon microstructures at optical wavelength (0.8 – 2μm) [1]. The collaboration is coordinated by FAU-Erlangen and Stanford University and receives substantial financial support by the Gordon and Betty Moore Foundation. A major goal is the demonstration of a very compact "Shoebox" MeV-scale accelerator. The highlights of the presented recent progress include:

- A maximum gradient of 0.9GV/m and beam energy modulation of 0.3MeV in a 0.7mm long structure driven by a laser beam with optimised pulse front tilt
- Demonstration of sub-fs micro-bunching in a two-stage buncher-accelerator experiment
- First successful demonstration of alternating-phase focusing

Journal of Physics: Conference Series **1596** (2020) 012014 doi:10.1088/1742-6596/1596/1/012014

- Start of experiments with DLA structures using the high energy electron beam at SwissFEL.

The progress in several areas of DLA research is remarkable, still there are challenges on the way to a fully integrated accelerator which is capable of generating a usable, i.e. sufficiently high energy and intensity beam for applications of this technology.

3. Dielectric beam-driven acceleration

The Argonne Wakefield Accelerator Facility (AWA) is tailored to provide a broad flexibility for experiments with high gradient structures in two-beam acceleration schemes. A combination of short pulses with high shunt impedance can provide high gradient, efficient acceleration. The planned demonstration of a 500MeV unit with dielectric disc-loaded structures at 26GHz is a particularly promising development.

4. THz

The presented works on THz radiation have been oriented both towards generation and use of THz radiation for acceleration and diagnostics. They have shown extremely interesting experimental results. Concerning the generation of THz radiation it is important to remark that there are different possible solutions based on laser, Coherent Cherenkov Radiation (CCR), IFEL but all the achieved experimental results are still far from a generation of long, high power and usable THz pulses for stable beam acceleration. The work presented by T.H. Pacey [2], as example, illustrated the interesting and very promising results obtained in the CLARA facility on a source generated in a rectangular dielectric waveguide with variable gap. They demonstrated the possibility to produce pulses of 0.6 uJ with tunable frequency on a wide band 0.55–0.95 THz with a single mode operation.

The results on THz acceleration, up to now, are of few MV/m and there are still critical points related to the match of the group velocity of the THz pulses with the beam. The work presented by S.P Jamison [3] illustrated, as an example, the interesting results still obtained in the CLARA facility of relativistic long (several ps) electron bunches modulated in energy with THz pulses coupled with a DLW structure.

The use of the THz radiation for beam diagnostics, on the other hand, is now well consolidated [4,5] as also illustrated by T. Feurer. They used special deflectors that are able to couple the THz radiation with the beam (split ring resonators [6]) obtaining tens of MV/m deflecting field at 0.33 THz.

5. High gradient technology

In this framework an interest application of 36 GHz technology to a compact LINAC for industrial applications has been illustrated by L. Faillace. This type of structures, at very high frequencies, can be also used for linearization of the longitudinal phase space or longitudinal diagnostics. The presented works have been related only to simulation and it is important to remark that a strong R&D is still required not only on power sources but also on RF components. Other critical points that need investigations are related to the realizations of the structures because of the more stringent mechanical tolerances and on the tuning of multi cell geometries after realization since standard techniques (as bead pull, for example) are not straightforward to be implemented.

6. Particle sources

The presented works have been oriented to the design of new generation compact injectors for ultra high brightness electron sources for different type of applications (FEL injectors, UED, etc…).

Very interesting and promising simulation results have been presented by K. Floettmann on a possible use of an S band gun combined with a tapered DLW operating at 75 GHz for Electron Diffraction

applications. The achievable emittance is of few hundreds of nm with a 100 fC beam, while the bunch length is several hundreds of nm.
Also the simulation results presented by M. Croia, on the use of full C band injector for FEL applications showed extremely good performances in term of achievable emittance (~0.15 μm).
It is important to remark that all works have been only theoretical and experimental results are necessary to confirm the predicted performances.

References

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