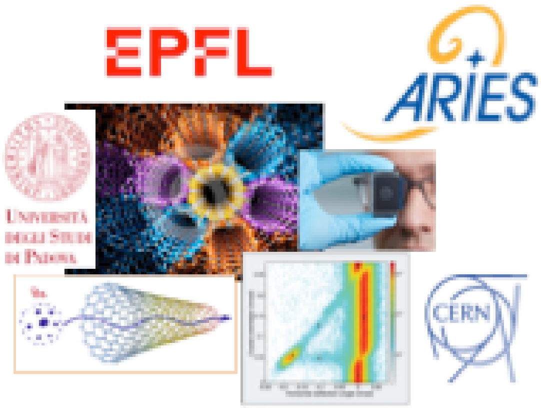
ACN2020

Tuesday 10 March 2020 - Wednesday 11 March 2020

EPFL



Book of Abstracts

Contents

Session 2 / 1

Channeling and volume reflection in bent crystals at UA9 Experiment

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Session 3 / 2

Studies of ultra-high gradient acceleration in carbon nanotube arrays

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Session 1 / 5

Channeling highlights, lessons and directions

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Session 2 / 6

Novel light sources based on charged particles channeling in crystalline undulators

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Session 2 / 7

Application of crystals for beam collimation at the Large Hadron Collider

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Session 1 / 8

First measurements toward laser driven acceleration inside dielectric structures at the SWISSFEL

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Session 2 / 9

Nanomodulated electron beams via electron diffraction and possible use in accelerators.

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Session 1 / 10

CNT accelerator - path toward TeV/m acceleration: dynamics of plasmon-assisted acceleration in CNTs

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Session 1 / 11

Fiber Accelerator: TV/m Atomic-scale Crunch-in Wakefields

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Atomic-scale TV/m wakefields in fiber-like nanostructured tubes are elucidated to be realizable using nonlinear tube surface electron “crunch-in”oscillations. Effective excitation of surface crunch-in oscillations as tube wakefields can sustain electron density waves with wavebreaking fields that offer many GeV energy gain in sub-millimeter nanostructured tube modules. A proof-of-principle prototype is now within reach using the convergence of recently demonstrated near solid density submicron particle beams and the emergent attosecond x-ray lasers with the advances in nanofabrication. Atomic wakefield module not only accelerates solid-density beams which stimulate the realization of “TeV on a chip”but also opens up controlled radiation production using nanometric beam oscillations in TV/m focusing tube wakefields.

Session 3 / 12

Advanced carbon materials and carbon nanotubes: production, properties, radiation damage, and applications

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Session 2 / 14

Crystal-assisted collimation tests at the CERN SPS UA9 experiment report

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Welcome / 16

Welcome to EPFL

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Welcome / 17

ARIES ACN2020 workshop

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Closing Remarks / 18

Closing Remarks

Session 3 / 19

Crystal-assisted positron source

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Session 2 / 20

Crystal shadowing for slow extraction loss reduction

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Session 3 / 21

Numerical investigation of beam-driven wakefields in hollow plasma channels modelled with carbon ions

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Hollow plasma channels can be modelled as shells of heavy ions, populated by pre-ionised electrons. Although this model does not take into account the crystalline structure of a solid, hence neglecting the properties emerging from such structure, it is adopted here as a simplistic approximation of a carbon nanotube (CNT). This approach allows for the investigation of beam–driven wakefields using conventional particle-in-cell (PIC) codes. Simulation results for a single hollow-plasma-channel show how such wakefields are affected by the hollow plasma radius and wall thickness. Moreover, wakefield excitation in an array of hollow plasma channels is investigated. In this case, the effect of changing the spacing between consecutive hollow plasma channels is also evaluated.

Session 2 / 22

Insight into axial channeling for particle steering

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Axial channeling consists of coherent orientational interaction of charged particles with the strings of a crystal. In contrast to more known planar channeling, for which particle interaction occurs with the planes, axial channeling occurs with particle trajectory is nearly aligned with the lattice strings. In the case of a bent crystal, chaotic scattering on atomic strings is the basis of stochastic mechanism of particle deflection.
The advantages of these effects w.r.t. the planar coherent effects are:
1) The axial field is several times stronger than the planar one, providing larger angle of deflection, larger angular acceptance for the incident beam and increasing the intensity and hardness of radiation;
2) Most of the particles under axial channeling are over-barrier (except a small percentage under hyperchanneling). Thereby, being mostly over-barrier, axial effects are effective not only for positive but also for negative particles unlike the planar channeling effect.
We review the basic of axial channeling, highlight some newly achieved results and draw some conclusions.

Session 2 / 23

Channeling radiation and related phenomena in straight and bent crystals as a tool for intense e.m. radiation generation

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Channeling and coherent interactions of charged particles in crystals have been known since the 60s and used as a tool for material analysis by low-energy ion channeling and for the generation of linearly polarized γ-beams through coherent bremsstrahlung at electron accelerators. Here, we report on a series of experiments carried out at the MAinzer MIkrotron with the aim of investigating the electromagnetic radiation generated by 855 MeV electrons in straight and bent crystals [1,2]. The results have been critically compared to Monte Carlo simulations, showing a strong enhancement of emitted radiation if compared with standard bremsstrahlung. These results are relevant for crystal-based intense gamma sources, beam steering as well as for the generation of e.m. radiation in bent and periodically bent crystals, i.e. crystalline undulators. Furthermore, the intense channeling radiation could be exploited for the realization of crystal-based positron source for future colliders [3].

References

[1] L. Bandiera et al., Nucl. Instrum. Methods Phys. Res. B 355 (2015) 44.
[2] A. Sytov, L. Bandiera et al., Eur. Phys. J. C 77 (2017) 901.
[3] R.Chehab et al., Phys. Lett. B 525 (2002) 41.

Session 2 / 24

Silicon crystals for steering of high-intensity particle beams at ultra-high energy accelerators

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Simulation models and worldwide experimental campaigns shows that coherent interactions between charged particle beam and crystals can be exploited at high-intensity particle beams at ultra-high energy accelerators for efficient particle beam steering. Indeed, a properly shaped tiny silicon

crystal can deliver the same steering effect which would be delivered by a multi hundred Tesla dipole. As a result, crystals might play a relevant role for the development of new generations of high-energy and high-intensity particle accelerators, and might disclose innovative possibilities at existing ones. We describe the most advanced manufacturing techniques of crystals suitable for operations at ultra-high energy and ultra-high intensity particle accelerators.

Session 2 / 25

Application of low energy channeling

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Poster / 28

Towards High-gradient Particle Accelerators from Carbon Nanotube Arrays

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29

Workshop Summary