LaPlas-2018 report

M. Krasilnikov, O. Lishilin, I. Isaev
PPS, Zeuthen, 2018-02-15

The IV International Conference on Laser&Plasma researches and technologies – LaPlas-2018

- January 30 – February 01, 2018 at NRNU MEPhI, Moscow
- 270 participants
- Parallel sessions:
  - Laser physics and laser technology
  - Plasma physics and plasma technology
  - Controlled thermonuclear fusion
  - Extreme light fields
  - Modern problems of theoretical physics
  - Challenges in physics of solid state, functional materials and nanosystems
  - Modern trends of quantum metrology
  - Particle accelerators and radiation technologies

Particle accelerators and radiation technologies

Subheading, optional

- Invited “celebrities”: Pierluigi Campana and Massimo Ferrario
  - EuPRAXIA@SPARC_LAB (2 talks)
- 24 other talks and 25 posters
  - Posters are mostly made by students

M. FERRARIO
Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali di Frascati, Frascati, Italy

FROM SPARC_LAB TO EUPRAXIA

On the wake of the results obtained so far at the SPARC_LAB test-facility in Frascati, we are currently investigating the possibility to design and build a new multi-disciplinary user-facility, equipped with a soft X-ray Free Electron Laser (FEL) driven by a ~1 GeV high brightness linac based on plasma accelerator modules. This fundamental goal will be integrated in the LNF facility by using a X-band linac and/or the high power laser FLAME to drive Plasma Oscillations in the accelerator module. In this talk we report about the recent results obtained at the SPARC_LAB facility and the on going design study of the new facility named EuPRAXIA@SPARC_LAB.

P. CAMPANA
Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali di Frascati, Frascati, Italy

THE EUPRAXIA@SPARC_LAB INFRASTRUCTURE AT LNF-INFN

Novel acceleration techniques include the possible use of high fields inside plasmas. An European Study Group (Eupraxia) in the framework of H2020 program is studying the possibility of building a Free Electron Laser facility totally driven by a plasma accelerating cell. In this context, the INFN - Frascati Laboratory is preparing a proposal to host in its premises such an important infrastructure, which would make use also of a full scale Linac based on X-band technology.

I.A. ASHANIN[1,2], YU.A. BASHMAKOV[1,2,3], V.A. BUDKIN [2], A.G. VALENTINOV[1], M.A. GUSAROVA[1,2], D.K. DANILOVA[1,2], A.A. DEMENTEV[1,2], V.V.DMITRIYEVA[1,2], N.S. DUDINA[1], V.S. DYUBKOV[1,2], YU.D. KLUCHEVSKAIA[1,2], V.N. KORCHUGANOV[1], M.V. LALAYAN[1,2], YU.YU. LOZEEV[1,2], T.A. LOXEEVA[1,2], A.A. MAHORO[1,2], V.YU. MEKHANIKOVA[2], S.M. POLOZOV[1,2], A.I. PRONIKOV[1,2], V.I. PASHCHIKOV[1,2], A.A. SAVCHENKO[1,2], A.V. SAMOSHIN[2], A.S. SMYGACHEVA[1], V.A. USHAKOV[1], A.M. FESHCHENKO[1,2], E.A. FOMIN[1], V.A. SHATOKHIN[2], J.-C. BIASCI[4], S. LIUZZO[4], P. RAIMONDI [4], J.-L. REVOL[4], L. FARVAQUE[4], S.WHITE[4]
[1]*National Research Center «Kurchatov Institute»*
[2]*National Research Nuclear University MEPhI*
[3]*P.N. Lebedev Physical Institute of RAS*
[4]*European Synchrotron Radiation Facility*

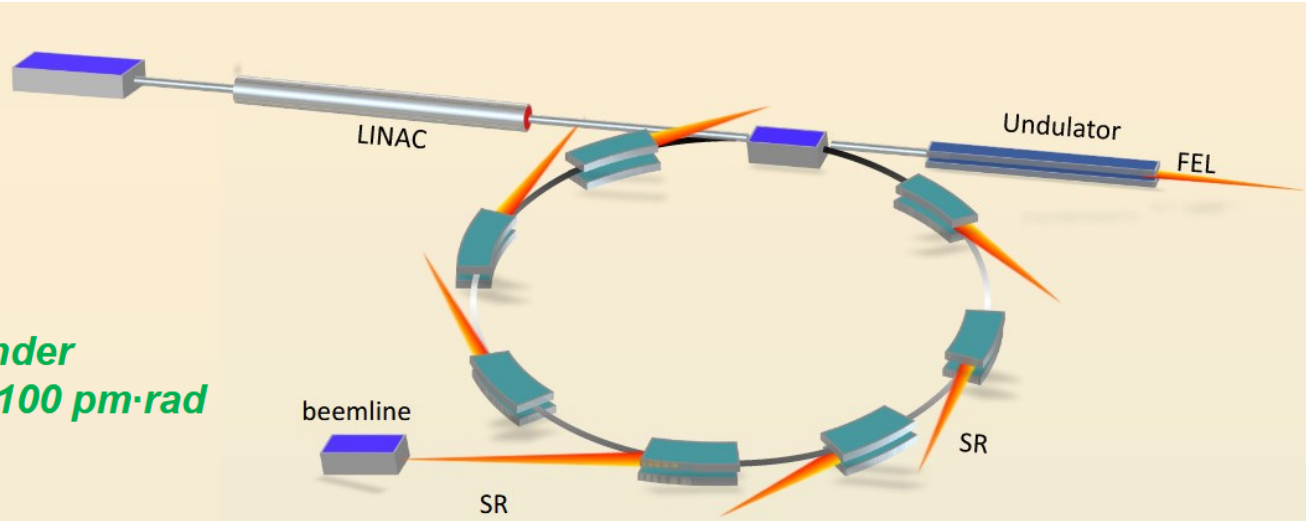
DEVELOPMENT OF RUSSIAN 4TH GENERATION SPECIALIZED SYNCHROTRON RADIATION SOURCE SSRS-4 CONCEPT AT NRC "KURCHATOV INSTITUTE"

The conceptual development of 4th generation Specialized Synchrotron Radiation Source SSRS-4 is under discussion today. This Project is supported by Ministry f Science and Education under Agreement No 14.616.21.0086 from 24/11/2017, Federal Program "Research and Developments in leading science and technological fields for 2014-20 years". European Synchrotron Radiation Facility, ESRF, Grenoble, France is the key foreign collaborator of project. Results of the first stage of the project will present in report. Main fields of research and fields of possible SR from SSRS4 will discussed. Current SSRS4 basic parameters look the following today: 6 GeV storage ring should have circumference of ~ 1300 m. The transverse emittance of 20-40 pm·rad can be for such storage ring. Two injection schemes are under discussion: i) full-scale booster synchrotron installed on the same tunnel with main ring and ii) full-energy linac which can be also used as electron beam driver for a FEL.

FUTURE CONTROL AND DIAGNOSTIC SYSTEMS FOR SPECIALIZED 4TH GENERATION SYNCHROTRON RADIATION SOURCE SSRS-4

DEVELOPMENT OF RUSSIAN 4TH GENERATION SPECIALIZED SYNCHROTRON RADIATION SOURCE SSRS-4 CONCEPT AT NRC "KURCHATOV INSTITUTE"

Presented by Sergey M. Polozov (MEPhI)



SSRS4 current discussed configuration:

- ***Beam energy in syncrotron - 6 GeV;***
- ***Beam current up to 300 mA;***
- ***Transverse emittance <100 pm·rad (two schemes are under simulation today: "user machine" with emittance of 70-100 pm·rad and "record machine" with 20-50 pm·rad);***
- ***Top-up injection from linac or booster;***
- ***MBA magnet structure with SR length ~1300 m and 40 superperiods;***
- ***Low energy (~1.5 – 2.0 GeV SR for UV stations) as an option;***
- ***Injection linac based FEL(s) as the second option (in the case of top-up linac);***
- ***Four groups of RF cavities (3 or 4 cavities/group) in fully symmetries periods, solid state RF power sources, operation frequency 500 or 700 MHz;***
- ***Not less than 40 stations for THz, soft, medium and hard photon energies and strongly-hard FEL on linac (as option);***

SSRS-4 concept

Plans for 2018:

- General complex scheme should be fixed;
- Beam dynamics for both schemes ("user machine" with emittance of 70-100 pm·rad and "record machine" with 20-50 pm·rad);
- Magnetic structure preliminary design;
- Linac and booster preliminary design;
- Injection scheme should be chosen;
- RF system and Insertion devices preliminary design;
- Diagnostic system preliminary design;
- Control system preliminary design;
- Vacuum system preliminary design.

Budker INP

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NRNU MEPhI

ESRF

Присоеди-няйтесь !

DESY

TPU

JINR

Физический институт имени П.Н. Лебедева Российской академии наук Ф И А Н

Lebedev PI

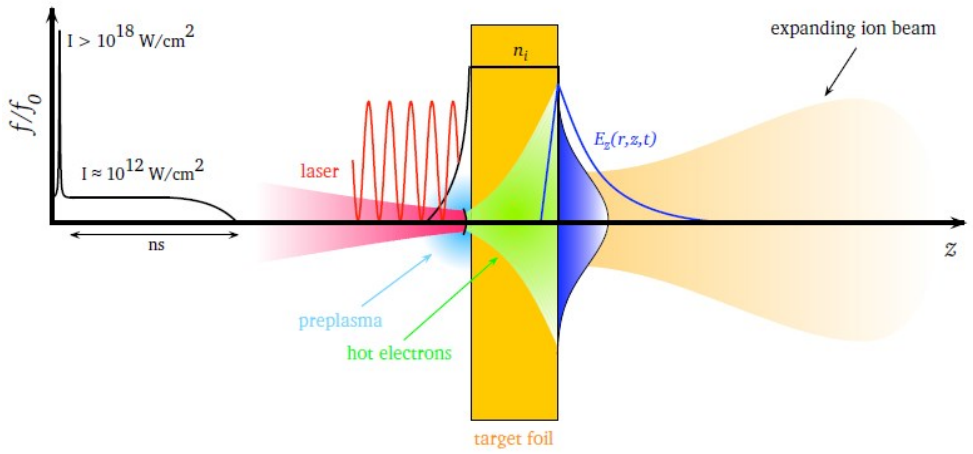
Inst. of Crystallography

Ion sheath acceleration: two reports

P.A. KSENOFONTOV, A.V. BRANTOV, V.YU.BYCHENKOV
P.N. Lebedev Physical Institute of the Russian Academy of Science, Moscow, Russia

ION ACCELERATION BY ULTRA-RELATIVISTIC LASER PULSE INTERACTION WITH LOW-DENSE TARGETS

In this paper we studied mechanisms of ion acceleration in laser-plasma interactions. Numerical simulations were performed by using 3D3VPIC Code MANDOR. The research is carried out using the equipment of the shared research facilities of HPC computing resources at Lomonosov Moscow State University. The dependence of proton maximum energy from target parameters has been obtained. New mechanism of synchronized ion acceleration from low-density targets has been discussed.



K.V. SAFRONOV, D.S. GAVRILOV, S.A. GOROKHOV, V.A. FLEGENTOV, A.G. KAKHSIN, E.A. LOBODA, D.A. VIKHLYAEV, A.V. POTAPOV
Russian federal nuclear center – VNIITF, Snezhinsk

EXPERIMENTAL INVESTIGATION OF ION ACCELERATION FROM THIN FOILS IRRADIATED BY ULTRA-INTENSE LASER PULSES

Ultraintense laser-driven heavy ion acceleration is hindered by hydrogenous contaminants which are present on surface of a solid target. The point is that protons from contaminants are accelerated faster than heavier ions in electrostatic field of hot electrons. Therefore protons move at the front of ion bunch and screen acceleration field for all particles moving behind them. This screening effect is so strong that even acceleration of light ions such as carbon and oxygen is suppressed.

To remove hydro contaminants from target surface and thus increase efficiency of laser driven heavy ion acceleration, an in situ method of target cleaning by heating action of CW laser radiation was developed. Experiments on ion acceleration from 1 μm Ta and Ti foils heated by CW laser were conducted on a 20 TW picosecond laser facility. Target heating allowed increasing light ion energies by more than 2.5 times. Carbon and oxygen ions with energies exceeding 5 MeV/n were detected. Ta ions with energies up to 0.3 MeV/n (LET exceeds 30 MeV mg/cm2) were registered in experiments with Ta foils.

In addition we carried out experiments on deuteron acceleration from heated TiD_2 foils. There were detected particles with energies up to 6 MeV. Conversion of laser pulse energy into fast deuterons constituted 0.04 %. This method can be used to accelerate tritium ions.

V. PARAMONOV[1], K. FLOETTMANN[2], A. SIMONYAN[3],
V. DANIELYAN[3], V. TSAKANOV[3]
[1]*INR of the RAS, 117312, Moscow, Russia*
[2] *DESY, Hamburg, Germany*
[3] *CANDLE SRI, Yerevan, Armenia*

CONSTRUCTION AND TUNING OF AN RF DEFLECTING CAVITY FOR THE REGAE FACILITY

I.V. RYBAKOV, V.V. PARAMONOV
Institute for Nuclear Research of the RAS, Moscow

COMPARISON OF THE TECHIQUES FOR MULTIPACTOR DISCHARGE DAMPING IN COUPLING CELLS OF CDS ACCELERATING STRUCTURE

In the new CDS structure for the first cavity of the main part of INR linac appearance of multipactor discharge (MP) in coupling cells on the operating level of accelerating field was detected. Previously an option for MP damping with alternating neighbor accelerating cells frequency detuning was considered. This option results to manufacturing control and pre-brazing tuning procedures complication. In this case an option for MP damping with changes in coupling cells geometry for MP electron phase stability destruction was considered. The analytical estimation and results of numerical simulations are presented. In conditions of the first cavity of INR linac the options considered were compared in efficiency of MP damping with increased secondary emission yield.

T.V. BONDARENKO, S.Y. ILYINSKY, S.A. POLIKHOV,
G.B. SHARKOV
Research institute of technical physics and automation, Moscow, Russia

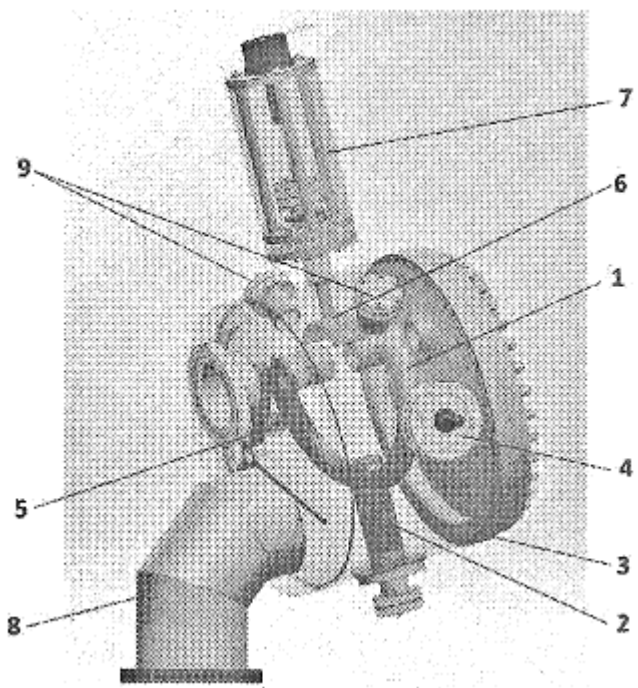
RF POWER COMBINING SYSTEM FOR SOLID-STATE RF POWER AMPLIFIER

The power combining system for high power RF amplifier is discussed. The system scheme together with results of modeling and measurements of key electrodynamic characteristics are presented.

A.A. ZAVADTSEV[2], N.I. BRUSOVA[1], A.V. BULANOV[2,4],
A.V. BUTENKO[3], M.A. GUSAROVA[2,4], D.A. ZAVADTSEV[1],
J.Z. KALININ[1], L.V. KRAVCHUK[1], V.V. PARAMONOV[1],
I.V.RYBAKOV[1], E.A. SAVIN[2,4], N.P. SOBENIN[2,4],
E.M. SYRESIN[3], D.V. CHURANOV[1]
[1]*Institute for Nuclear Research of RAS, Moscow, Russia*
[2]*Nano Invest, LLC, Reutov, Russia*
[3]*Joint Institute for Nuclear Research, Dubna, Russia*
[4]*National Research Nuclear University MEPhI, Moscow, Russia*

DEVELOPMENT OF THE DEBUNCHER FOR THE INJECTOR PART OF THE ACCELERATOR COMPLEX NICA

Developed and currently manufactured debuncher for the injector part of the accelerator complex NICA is designed to reduce ten times the energy spread in the ion bunches with Z/A=(0.33-1) at the output of the LU-20 linac and to exchange the existing unit. The debuncher includes Split-Ring cavity, vacuum system, solid-state RF amplifier and RF controller. The main design parameters are described.



D.A. OVSYANNIKOV, I.D. RUBTSOVA, N.V. LOMONOSOVA
St. Petersburg State University, Russia

INTENSE QUASIPERIODIC BEAM DYNAMICS INVESTIGATION IN ACCELERATING SYSTEM

The paper is devoted to intense quasiperiodic beam dynamics investigation on the basis of integro-differential mathematical model. Dynamic controlled process is considered to be a complex of central motion and particle motions. Numerical simulation and optimization results are presented for linear waveguide accelerator.

Рассмотрим динамику пучка, описываемую уравнениями:

$$d\mathbf{x}/d\tau = \mathbf{f}(\tau,\mathbf{x},\mathbf{x}_c,\mathbf{u}) = \mathbf{f}_1(\tau,\mathbf{x},\mathbf{u}) + \int_{M_{\tau,u}} \mathbf{f}_2(\tau,\mathbf{x},\mathbf{x}_c,\mathbf{y}_\tau)\rho(\tau,\mathbf{y}_\tau)d\mathbf{y}_\tau ,$$

$$d\mathbf{x}_c/d\tau = \mathbf{f}_c(\tau,\mathbf{x}_c,\mathbf{u}) = \mathbf{f}_{c1}(\tau,\mathbf{x}_c) + \int_{M_{\tau,u}} \mathbf{f}_{c2}(\tau,\mathbf{y}_\tau,\mathbf{u})\rho(\tau,\mathbf{y}_\tau)d\mathbf{y}_\tau ,$$

$$\partial\rho(\tau,\mathbf{x})/\partial\tau + \partial\rho(\tau,\mathbf{x})/\partial\mathbf{x}\, f(\tau,\mathbf{x},\mathbf{x}_c,\mathbf{u}) + \rho(\tau,\mathbf{x})div_{\mathbf{x}} f(\tau,\mathbf{x},\mathbf{x}_c,\mathbf{u}) = 0$$

с начальными условиями

$$\mathbf{x}(0) = \mathbf{x}_0 \in M_0,\ \mathbf{x}_c(0) = \int_{M_0} \mathbf{x}_0\rho_0(\mathbf{x}_0)d\mathbf{x}_0,\ \rho(0,\mathbf{x}(0)) = \rho_0(\mathbf{x}_0),\ \mathbf{x}_0 \in M_0 .$$

T.A. LOZEEVA, S.V. MATSIEVSKY, M.V. LALAYAN, M.A. GUSAROVA, G.S.POMOGAYBO
National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Moscow, Russia

INPUT POWER COUPLER FOR NICA INJECTOR COAXAL QUATER WAVE SC CAVITY

New coaxial power coupler research and development results are presented and discussed. Coupler is proposed for superconducting QWR cavities being under consideration now as option for planned Nuclotron-based Ion Collider fAcility (NICA) injector upgrade. The goal was to develop power coupler operating at 162 MHz and feeding SC cavity with about 30 kW RF power. It provides Qext tuning range by inner conductor movement. Conservative design with two identical disk ceramic windows was chosen. Electrodynamic and thermal simulations were carried out.

M.S. DMITRIEV[1], A.D. KOLYASKIN[1], A.A. RUHMAN[2], S.A. DMITRIEV[3]
[1] *National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Moscow, Russia*
[2] *Ultra-resonance, Ltd, Ekaterinburg, Russia*
[3] *Innovation and technology center for the «PRORYV» project, Moscow, Russia*

RADIATION PHYSICAL METHODS OF ELIMINATION OF PARAFFIN DEPOSITS IN OIL WELLS

Methods of paraffin deposits elimination in wells while oil production in the northern circumpolar fields are considered. The operational experience shows that the methods used are excessively expensive. To remove deposits it was proposed to use alpha-emitting radioisotopes with a high heat release.

P.A. BYSTROV[1], A.V. GORDEEV[2], A.Yu. GRACHEVA[3], M.A. ZAVYALOV[3], N.V. ILYUKHINA[3], A.A. MOLIN[2], Y.S. PAVLOV[1], S.P. POLYAKOVA[4], A.V. PROKOPENKO[5], V.P. FILIPPOVICH[3]
[1] *Frumkin Institute of Physical Chemistry and Electrochemistry of Russian Academy of Sciences (IPCE RAS)*
[2] *A.I. Burnazyan Federal Medical Biophysical Centre of Federal Medical Biological Agency*
[3] *All-Russia Research Institute of Preservation Technology*
[4] *All-Russian scientific research Institute of confectionery industry*
[5] *National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)*

PROSPECTS OF ELECTRON BEAM IRRADIATION TO ENSURE MICROBIOLOGICAL SAFETY OF FOOD PRODUCTS

The work is devoted to the study of the effectiveness of the application of electron beam irradiation in the food industry to reduce microbiological contamination of agricultural products and foodstuffs in the process of use and long term storage. Experiments results on irradiation of several cultures of microorganisms are presented.

Posters to mention

YU.D. KLIUCHEVSKAIA, S.M. POLOZOV
National Research Nuclear University - Moscow Engineering Physics Institute, Moscow, Russia

BEAM DYNAMICS OF THE LUCX RF-GUN

The beam dynamics analysis of the RF-gun in the LUCX facility at KEK, Japan, simulation of electrodynamics characteristics and fields distribution of 3.5-cell gun accelerating structure, influence of the current loading effect on the field amplitude and beam dynamics was the main purposes of study. The beam dynamics simulation results are discussed.

The beam dynamics analysis in the accelerator was done using of BEAMDULAC-BL code. The code was developed at the Department of the Electrophysical facilities of the NRNU MEPhI [1]. The program allows simulation of the beam dynamics taking into account the beam loading effect and quasi-static components of the beam self- field.

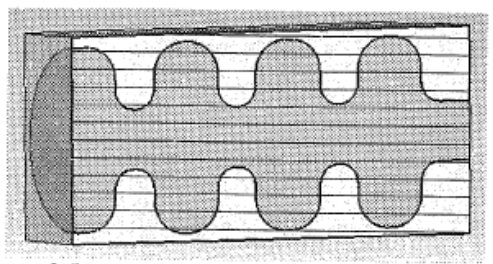


Рис. 1. Общий вид 3,5-ячеечной структуры фотопушки LUCX, фотокатод расположен в левой плоскости.

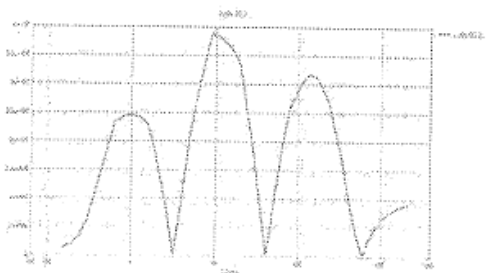


Рис. 2. Распределение амплитуды ускоряющего электрического поля вдоль продольной оси структуры без учета ввода мощности.

E. KHABIBULLINA[1,2], W. BARTH[3,4], T. KULEVOI[1,2], S. YARAMYSHEV[3,4]
[1]National Research Nuclear University MEPhI, Moscow, Russia
[2]NRC "Kurchatov institute" – ITEP, Moscow, Russia
[3]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany
[4]HIM, Helmholtzinstitut Mainz, Germany

DEVELOPMENT OF MEDIUM ENERGY BEAM TRANSPORT LINE FOR SC CW-LINAC

Different variants of the Medium Energy Beam Transport line for Heavy ion cw superconducting linear accelerator (SC CW-LINAC, HIM/GSI) were obtained. Beam focusing elements and its physical characteristics for a 6-dimensional matching at the output for a further acceleration in the following sections have been determined based on the beam dynamics simulation.