

**YEREVAN PHYSICS INSTITUTE  
(BEAM & ACCELERATOR PHYSICS)**

13.05.09, 10-00

**1. ELECTRON SYNCHROTRON**

**Basic parameters**

**2. Injector 75 MeV S-band linac (LEA-50)**

**(can be used independently of synchrotron)**

Putting into operation	1967	Energy	15 – 75 MeV
Energy	6 GeV	Average current	~10 $\mu$ A @ energy spread $\pm$ 5%; ~1 $\mu$ A @ energy spread $\pm$ 0.5%
Beam pulse current	$(4\div 7) \cdot 10^{-3}$ A	Repetition rate **	50 Hz
Duty factor*	10% at 50 Hz	Energy	15 – 75 MeV
Operation mode (1967-1990)	Experiments: 7;	RF frequency	2797,2
Scheduled operation	5 months per year	MHz	
Status	Putting into operation requires 3-4 months	Status	Putting into operation requires 1-2 weeks

\*A new system for flat-topping of the magnetic field with a duration of 10 ms and duty factor 20% have been put into operation in 1995 – in collaboration with SRIEPA named after Efremov (St.Petersburg) and DESY.

\*\*The opportunity of increase the frequency of (LEA-50) operation up to 150 Hz is considered (ISTC grant)

Number of accelerator beamlines: gamma, electron, sr – 3, 1, 3 accordingly

**3. . Future's possible fulcrums (background)**

Feasibility study and conceptual design of the Proton Therapy Regional Center (PTRC) on the base of Yerevan Synchrotron (ISTC grant).

Proposed to create the PTRC on the base of Yerevan synchrotron. The main parameters of PTRC are

Proton's energy (MeV)	60 ÷ 250
Proton's intensity (protons/sec)	$\geq 10^{10}$
Proton's pulse spread (%)	(0.4-0.1)
Number of medical rooms	5 (3+2)
Number of patients/year and Preliminary cost of an user session (\$)	600, 10000
Preliminary cost of the PTRC creation including 5 medical rooms (M \$)	25 - 30
Preliminary duration of the PTRC creation (years)	3

Some Features of superpower variable-phase asynchronous cyclotrons (VPAC)

The main results from improving the concept of an asynchronous cyclotron, the latest version of which has been dubbed a variable-phase asynchronous cyclotron. Its characteristics are considered using the example of a six-cavity scheme. Its advantages are shown for the multistage acceleration of ultrahigh-power proton beams with energies of 2–1000 MeV and continuous currents of up to hundreds of milliamperes over ordinary isochronous and superconducting versions of cyclotrons with separated orbits. The main relationships for the preliminary selection of its calculation parameters are presented.

Parameters VPAC	SOC 6-r
RF frequency in cavities, MHz	50
Maximum of the accelerating field, MV/m	3,3
Average beam current, mA	100
Number of beam turns	8
Injection energy, MeV	2
Extraction energy, MeV	17,5

Wake wave excitation and electron acceleration in plasma. (M.Petrosyan, head of laboratory)

Experimental installation for research of formation of high-current electron bunches of the given configuration, necessary for wake field acceleration and acceleration of these bunches in plasma is created. The installation is intended for acceleration of electron bunches with a current of few tens amperes and up to energy 1-2 MeV. For excitation of wake waves in plasma the electron accelerator of direct action with use of high-voltage pulse transformer is used. Results of researches have revealed some properties of formation of high-current bunches, especially restrictions of a electron current because of space charge effects at sub-picoseconds duration of bunches.

Coherent interaction of relativistic electron beam and microwave-driven plasma. (G.Okszyan)

The interaction of an electron bunches' train and microwave-driven plasma have been experimental studied. The electron energy spectra after the interaction at energy 20 and 50 MeV were measured. It is shown that the strong electric field can be generated due to beam-plasma coherent interaction. The strong sensitivity of beam current vs microwave phase have been observed.

R&D, manufacturing and testing of original Vibrating Wire Sensors (VWS) and monitors for measurement of charged-particle/photon beam's transversal parameters. (S.Arutunian)

Developed and created the VWS. The VWS were tested at Yerevan, at PETRA (DESY), and at APS (ANL)

Design and creation of power supplies for accelerators (YerPhi-DESY collaboration) (H.Martirosyan)

In the frame of YerPhi-DESY collaboration designed, manufactured and delivered to DESY a number of power supplies, including the Digital Controlled Power Supplies, as well as the cost effective remote controlled heating power supplies for super conducting magnets to be used in the accelerator power supply systems at DESY (TTF/VUV – FEL, X FEL).

Precise measurement of the electron beam absolute energy using resonant absorption of photons in the magnetic field (YerPhi-DESY collaboration) (R.Melikyan).

It is suggested and developed the new method for measurement of electron beam absolute energy in the range of 0,3-500 GeV with accuracy  $10^{-4}$ .

Electron beam absolute energy measurement in the 50 MeV- 500 MeV energy range by resonance absorption method at Yerevan synchrotron ( Proposal of experiment, YerPhi-DESY collaboration) (A.Ghalumyan, V.Nikoghosyan).

Proposed to test the method in the 50 – 500 MeV energy range at Yerevan synchrotron by using the existing facilities and equipment.

Electron beam bunch-to-bunch absolute energy measurement by resonance absorption method (Proposal of experiment, YerPhi-DESY collaboration) (A.Ghalumyan, V.Nikoghosyan).

Proposed to test the method in the 0.5 GeV – 50 GeV energy range at DESY by using the existing facilities and equipment.

R&D, assembled 20-75 MeV beam transport channels for applied researches experiment at YerPhi (V.Nikoghosyan, A.Babayan)

Now it is in stage of operating.

R&D of a wiggler model with hybrid structure allowing to optimize design of wiggler, used in colliders and storage rings (YerPhi - DESY - INFN-LNF collaboration) (A.Babayan).

Permanent wiggler magnet for ILC damping rings is optimized, allowed essentially to improve of a field quality by relatively small overall dimensions of the wiggler.

**4. Synchrotron operation mode in 2010-2014 by request of experimental groups.**

There are the following requests of synchrotron operation modes @ electron beam energy:

25, 50, 75, ..., 500 MeV;

It is planned to R&D and creation of devices for the synchrotron operation in that given energy range.

1.5 GeV; 4.5 GeV

For putting synchrotron into operation needs 3-4 months of preparatory services.

## **5. R&D in the field of accelerators in 2010-2014**

Electron Bunch Charge Density Modulation by Laser Beam (theory + experiment's Proposal) (E.Gazazyan)  
R&D of the measurement schemes to study the efficiency of proposed method of the electron bunch charge density modulation by laser beam on the base of 7.5 MeV electron bunches of the microtron in YerPhi. Two different cases will be considered: a) the particles parallel motions to the wave propagation and b) the case of the opposite motion. For the first case it is expected to observe the "long" bunch slicing into ultrashort subbunches and the "long" bunch condensing effect for the second case.

The electrodynamic of toroidal cavity (theory) (E.Gazazyan)

It will be considered the strict solution of the problem based on the toroid's own functions which may be represented in the orthogonally form (the orthogonality with some weight). It is supposed that the charged particle is moving in the toroid for finite time and then is vanished having made the finite number of the circulations in it. We are planning to get the self-consistent solutions of this problem.

Implementation of design and building of cost effective remote controlled heating supplies for superconducting magnets to be used in the accelerator systems at DESY in accordance with the technical task of DESY.

R&D high average power (a few kW) THz FELs by using of the Yerevan synchrotron's existing systems (M.Petrosyan).

Proposed to use of the synchrotron's RF and magnet systems

R&D of quasy-monochromatic and polarized  $\gamma$ -radiation sources by using the inverse Compton effect on the base of the existing facilities and equipment (the electron synchrotron, electron microtron, 400 J pulse CO<sub>2</sub> laser and the periodic pulse laser with average power of 1 kW PPL-1) (M.Petrosyan).

R&D of THz sources (M.Petrosyan).

Proposed to create a source of THz radiation (100-300  $\mu\text{m}$ ) by using the undulator radiation on the base of microtron. These investigations have been begun in the frame of the ISTC project and the main devices were created.

R&D of a high current ( $\sim 1$  MeV) technological electron source (E.Laziev, V.Nikoghosyan)

It is proposed to use the existing electron gun (150 keV, 10 A) and 466 MHz accelerating module.

R&D of the electron bunch "Femtoslicing" Project (E.Gazazyan).

The Proposal of the "Femtoslicing" experiment at YerPhi will be presented.

## **6. YerPhi-DESY collaboration according to "2009-2011 Agreement of Cooperation" :**

- Investigation of beam dynamics problems;
- R&D of power supplies for magnets;
- Improvement and test of the control system DOOCS for its further usage in accelerators storage rings and colliders;
- Pre-feasibility of the THz FELs driven by the low energy electron beam;
- Testing and examination of equipment in different location, including radioactive zones;
- Assembling and commissioning of accelerator equipment such as vacuum, magnet & control systems.

*Let's note in addition we are planning to consider also a possibility to accelerate heavy ions (in particular, carbon) by Yerevan synchrotron taking into account a number of realistic prerequisites available in YerPhi:*

- *Possible production of the isotopes for medical purposes.*
- *Possibility to purchase the tomography (PET).*

*Yerevan Physics Institute is a unique scientific centre in the region, representing accelerator complex with the corresponding infrastructure and highly qualified staff members.*

*The indispensable condition of synchrotron reconstruction is preservation of the possibility of acceleration of electrons, which is necessary to continue conducting the adopted in YerPhi fundamental researches on the accelerated electron beams at the energy up to the 5 GeV.*

*As a result of realization of the proposed Project the regional centre of radiation therapy would be founded in Armenia.*