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INR linear accelerator and the compressor ring project for the neutron spallation sources.

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ABSTRACT

Status of the INR linear accelerator, the proton storage ring as a compressor ring of the Moscow meson factory are discussed.

I. INTRODUCTION

The neutron scattering facility is included in the first stage of the experimental area of Moscow Meson Factory. This facility is proposed using the complex of the proton driven spallation neutron sources. At present time the proton driven spallation neutron sources are preferable to the reactors because they are ecology safe and can be optimized for the kind of the neutron scattering experiments.

The neutron sources will be described in detail at another paper /1/. Here is the description of the facility for proton driving only.

The facility for proton driving consists of a 600 MeV proton/H^- linac and a compressor ring (Fig. 1). It is possible to use the linac proton beam for driving the neutron sources with the designed peak beam current and it is possible to use the proton beam with increased peak beam current from the compressor ring after multiturn charge-exchange injection of H^- beam from the linac.

II. PROTON/H^- LINAC

Proton/H^- linac has been designed under the guidance of the Moscow Radiotechnical Institute /2, 3/.

The main linac parameters are :

the energy	600	MeV
summary peak beam current of the protons and H^-	50	mA
the pulse duration (1-st stage)	10^{-4}	s
number of particles per pulse	$3 \cdot 10^{13}$	ppp
the repetition rate	100	s^{-1}.

The linac consists of the injector system, the initial part of the

Alvarez type up to the energy 100 Mev (5 cavities with drift tubes) operating at frequency 198.2 MHz, and the main part with the maximum energy of 600 MeV (27 disc and washer cavities) at the frequency of 991.0 MHz. The energy variation is foreseen to be stepwise below 160 MeV and then continuously up to 600 MeV, with intermediate beam extraction at 160 MeV.

Injector system has two ion sources:

(i) a conventional duoplasmptron with a directly heated cathode and continuous flow of hydrogen as a proton source,

(ii) the Dudnikov type H^- source /4/.

The accelerating tubes of the injector system has two gaps : 5 cm with 300 KV focusing voltage and 35 cm with a voltage of 450 KV.

The tuning and initial operation of the linac is being done with a proton injector.

Presently, the 750 KeV proton injector has been installed and checked at the repetition rate 50 s^{-1}. However, the pulse rate is kept 1 s^{-1} during the linac tuning procedure to decrease the irradiation of the equipment. In 1989, the proton beam of 110 mA pulse current was injected into the first accelerating cavity and accelerated to the energy 20.5 MeV. At the output of the first cavity, the pulse current of 29 mA without prebuncher and 46 mA with prebuncher was obtained. These parameters are reasonable close to the designed values. The tuning of the whole initial part of the accelerator with beam has been obtained for the first time. The output pulse current of 23 mA (without prebuncher) has been already reached, while the pulse parameters close to the design of the initial part are expected to be achieved by the end of this year. Encouraging is the fact that the pick-up monitors placed downstream of the 2nd and 5th cavities have shown no difference in the pulse current, that indicates that the losses in the whole initial part of the linac are small.

The equipment of the main part of the accelerator (from 100 MeV to600 MeV) is installed and partly tested. By the end of this year, the proton beam at energy 160 MeV is expected to be obtained and extracted to a small experimental room adjacent to this area. The acceleration to the maximum energy 600 MeV is planned for 1991.

III. COMPRESSOR RING

Proton storage ring /5/ (Fig.2) will be used as a compressor ring. It is being under construction.

Proton storage ring was designed for transformation of the time structure of the linac beam by the Leningrad Scientific Research Institute for Electrophysical Apparatus.

The essential characteristics of the compressor ring are as follows:

orbit circumference (circulation period)	106.7 m (450 ns)	
number of storage turns	240	
maximum intensity per pulse	$3\cdot10^{13}$	
stored beam emittance	3π	cm.mrad
max. incoherent tune shift (smooth approx.)	-0.09	
peak current	11	A
momentum compaction factor	0.371	
kicker-magnet strength	0.02	T·m
kicker-magnet rise time	100	ns

Time compression of the linac macropulse is achieved by multi-turn charge-exchange injection and single-turn extraction as soon as filling process is terminated. One has to provide an azimuthal void to exclude beam loss during the rise time of kicker magnet field. Beam structure needed will be carved by the chopper, installed in an initial part of the linac.

It is reasonable to use the isochronous magnetic ring. We intend to tune it so that transition energy of the ring will be equal to linac output energy. Circulation time does not depend on particle momenta. The storage ring lattice with the required circumference may be of isochronous design at rather low cost, and short storage time (100 μs) tolerates small deviations from the exact isochronism without considerable bunch lengthening during storage. RF bunching system is absent in an isochronous storage ring. The ring of this type (IKOR) was studied at paper /6/ and at the CERN PS experiments on long-term bunch confirmed near the transition point were carried out /7/. Authors confirmed the possibility of isochronous ring realization. In a linear approximation the revolution period depends on the particle momentum as

$$\Delta T/T_0 = \eta(\Delta p/p_0) , \qquad \eta = \alpha - \gamma_0^{-2} \qquad (1)$$

where γ_0 is the relative energy, α is the momentum compaction factor.

Thus, the isochronous storage is possible in the ring with

$$\alpha = \gamma_0^{-2} \qquad (2)$$

The proton storage ring lattice of Moscow meson facility consisting of two achromatic periods has a variable momentum compaction factor of $0.32 < \alpha < 0.42$; $\alpha = 0.3736$ corresponds to Eq.(2).

Fig. 3 shows dynamic functions on half of its circumference. More detailed view of the lattice, the descriptions of its components operation and arrangement of the rest of the equipment may be found elsewhere /5, 8, 9/. Quadruples K3 (Fig. 3) regulate the value of the dispersion function ψ and the factor α.

The recent investigations carried out /9, 10/ shows more strong, that the linac pulse may be compressed hundredfold using an isochronous storage ring without a R.F. bunching system. There is no need to maintain strictly isochronism conditions. For example at $| \eta | \le 0.02$ the bunch lightening during the storage period of 100 μs will not exceed 2.5 m, that seems quite tolerable, unless the goal is to obtain short bunches of several meters long. Equipment for all systems for the proton storage ring is under manufacture now. We hope it will be completed at 1992 and it will start to operate in whole at 1993.

References

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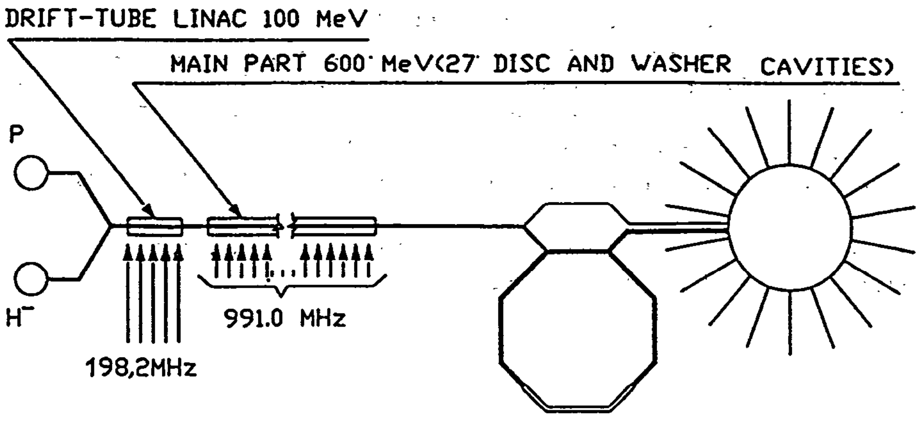

Fig. 1 The scheme of the protone driver.

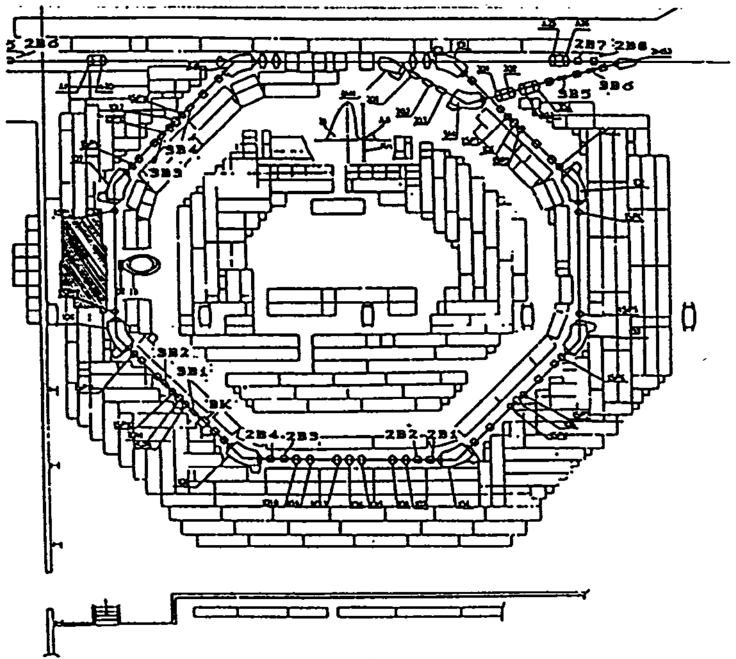

FIGURE 2 The proton storage ring. 1D1 - 1D8 - the mine dipole magnets: B = 1.45 T, aperture 20x12 cm HOR × VERT, bending angle = 45°; 1Q1 - 1Q15 - the quadrupoles: Ø = 20 cm, length = 0.4 m, G = 4.5 T/m; 1SP - the sextupoles: Ø = 20 cm; 2B1 - 2B8 - the bump magnets for injection; 3K - the kicker magnet for the one turn extraction ; DT - slov extraction target;

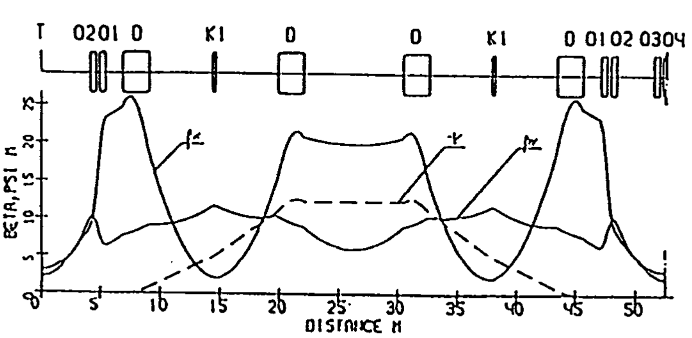

Fig. 3 The characteristic function of one half ring period for a isochronous regime.