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MOSCOW MESON FACTORY LINAC FOR THE PULSED NEUTRON SOURCE

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Introduction

Pulsed Neutron Source IN-06 based on the Moscow Meson Factory (MMF) Linac is under construction now. The first stage of Neutron Source IN-06 is planned to be put into operation in 1996. The watercooled neutron target of silicious uranium will be exposed to the 500 MeV proton beam. The IN-06 disign parameters (thermal neutron peak flow of $5 \cdot 10^{15} n/cm^2 \cdot s$, 35 μs pulse, 50 Hz repetition rate, average flow of $8 \cdot 10^{12} n/cm^2 \cdot s$) may be achived after storage-compressor ring (PSR) comissioning in 1998.

We studied the possibilities of IN-06 upgrade by means of MMF Linac modernization using existing building areas, shielding and net power consumption. Our analyses have shown that peak flow of $10^{17} n/cm^2 \cdot s$ and average flow of $10^{14} n/cm^2 \cdot s$ could be achievd with the pulse length of 30 μs and repetition rate 25 Hz using PSR and neutron multiplication iøn target. All necessary linac innovations are not overstep the limits of the contemporary state of art. To get the above mentioned parameters we need to increase the energy of the linac up to 700 MeV and beam pulse length up to 300 μs with repetition rate 25 Hz. Thus neutron multiplication target will be exposed to 10^{14} proton per pulse which corresponds to 10 MW power dissipation in target [1].

MMF Linac was designed with following parameters: maximum energy of protons and H^- ions 600 MeV; average beam current 500 μA; pulse current 50 mA; beam pulse length 100 μs; repetition rate 100 Hz. Recently the proton energy of 423 MeV was achived which is determined with the number of klystrons on hand which are used for DAW Linac RF power supply. By the end of 1995 6 more klystrons will be manufactured that provide the beam energy of 500 MeV. Regular linac operation take place with the average current of 60 μA (demonstrated 75 μA). Total beam losses are not exceed design value (0,1 $\div$ 0,2)% [2]. Beam pulse length of 70 μs; and repetition rate 50 Hz are determined with experimental requirements as well as with power consumption expenditures.

Linac Upgrade Possibilities

The following linac system must be upgrated to get 700 MeV proton energy and 300 μs beam pulse length [3]:

Accelerating system. RF pulse length increase up to 300 μs leads to thermal heat growth in DTL as well as in DAW (disk and washer) cavities. It seems that necessary heat transfer could be provided with the water flow increase as well as with water temperature lowering in the secondary loop. Addtional expenditure of electric power could be compensated due to elemination existing heaters and reduction of the water pumps number in the modernized cavity resonant frequency control system.

Energy upgrade from 600 MeV to 700 MeV could be fulfilled due to addition of one more 4-section DAW module onto existing girder at the end of accelearting tunnel. This module has to provide the accelearting gradient of 7 MeV/m. Our experience shows that is fully guaranted in DAW accelerating structure.

DTL RF Power Supply. To meet 300 μs beam pulse we need to increase the modulator pulse length from 360 μs to 500 μs. It requires to increase the number of cells in delay line, to modify the pulsed transformer in the GMI-44A anode circuit, to increase the pulse length of the submodulator. Similar modifications have to be done in modulator of the powerful driver amplifier to increase its pulse length from 420 μs to 550 μs.

DAW Linac RF Power Supply. There are 28 991 MHz 4,75 MW power supply channels (one for each 4-section DAW cavity) in the DAW Linac. For 300 μs 50 mA beam pulse operation we need to modify the klystron driver amplifiuer together with its modulator as well as the output powerfull klystron itself. The number of cells in the delay line of the driver amplifier modulator must be increased twice. The pulsed transformer must be redesigned to eliminate the iron saturation due to longer pulse.

To provide 300 μs operation with the same net power consumptionand equipment sizes unchanged we have three options:

- powerfull klystron modulator is reconstructed using the same elements of the delay line. The KIU-40 old klystron may be utilized.
- powerfull klystron modulator is modified for the operation with low volatge (50 kV) high efficient 42 beam klystron "Atlant", which was developed recently by the scientific and technical firm "Thorium".
- completely new delay line has to be developed and constructed.

After some modelling and testing one of those three options has to be choosen taking into account its reliability. The RF channel for the last high accelearting gradient cavity differs from those regular ones significantly. It must be developed separately and needs additional net power.

Ingection system. Existing injectors on the base of accelerating tube and 750 kV pulsed transformer have to be substitutde with RFQ section designed to provide 50 mA in the pulse length of 300 μs with 25 Hz repetition rate. 198,2 MHz RFQ injector must be placed close to the first DTL cavity.

Conclusion

The fulfilment of the above mentioned steps of the MMF Linac upgrade together with PSR comissioning and neutron multiplication target insted of silicious uranium one instalation make the Pulsed Neutron Source based on the MMF Linac beam highly competitive.

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References

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