Referee Report to the 52nd N.P. PAC at JINR (June 25, 2020)

Concerning: 4. Report on the concluding theme

"Improvement of the JINR Phasotron and design of cyclotrons for fundamental and applied research"

ad 1. Improvement of the JINR Phasotron and beam channels

A number of successful improvements on the aged JINR Phasotron with respect to the control systems, power supplies, field correction systems, etc. were performed which resulted in more reliable operations and in a reduction of power consumption by 900 kW. In 2020 the phasotron will mainly be used for radiobiological research and applications (~500 h/y).

ad 2. Design and Modernization of the cyclotrons for medical purposes

The Dubna accelerator experts have spent a great effort in the magnet designs and modernization work of the multi-purpose AIC-144 cyclotron of INP PAS, Krakow, including a new beam transport line for the extracted 60 MeV protons. The facility will especially be used for proton therapy of eye melanoma. - Another effort went into field studies and the beam extraction system of the U-120M cyclotron of Rez (Czechian Republic).

ad 3. Research and Development of the superconducting cyclotron SC202 for Proton Therapy at IPP CAS in Hefei (China).

The joint collaboration of JINR with IPP CAS, Hefei in development of two 200 MeV fixed energy isochronous superconducting cyclotrons for proton therapy is a very important project for the future medical programs of China and Russia. The design of the chineese cyclotron SC202 is now completed and most components are in production or already in testing phase. The Dubna team has put much effort in developing improved beam extraction channels for the second cyclotron SC200 (Dubna), which is foreseen to replace the old DLNP Phasotron for medical irradiations.

The Dubna team has recently invested much time to think about the development of improved versions of proton therapy cyclotrons, this in view of the competition with the worlds leading manufactorers Varian (supercoducting coils) and C235 (IBA Belgium, classic design). The SC-230 cyclotron (superconducting) is one impressive result of these studies. On the other hand, RC240 is a cyclotron designed for resistive coils. Lower magnetic fields seem to be the solution for improved extracted proton beams. The design of SC-240 is smaller and cheaper than C235.

Ad 4. Development of the cyclotron method for high-current beam acceleration

Several more projects are described pushing the cyclotron developments towards new frontiers:

- construction stage simulations for the ProNova K230 superconducting cyclotron for proton therapy (Ionetix Corporation, Lansing USA). The cyclotron is now in construction.

- improvements of the Ionetix ION-12SC 12.5 MeV very compact superconducting proton cyclotron for production of medical isotopes.

- further developments of the LINAC-200 JINR linear electron accelerator at the DLNP laboratory, with beam lines of 60, 120 and 200 MeV, peak current 25 mA, to test and study particle detectors. Expected start in 2020. In the future, the electron energy could be increased to 2 GeV.

Recommendations:

The expertise and the efforts of the Dubna accelerator specialists are very impressive! However, it is unclear in which direction JINR will go toward the realization of a modern proton therapy facility.

Is the realization of the China built superconducting cyclotron SC200 the next step for replacement of the old phasotron? Or will it be one of the new designs RC230 or RC240?

JINR should soon make a decision and force with highest priority the realization of an optimized facility for proton therapy. Criteria need to be formulated according to which the choice of the medical accelerator can be made.

Villigen-PSI, June-22-2020

Dr. Claude Petitjean

e-mail claude.petitjean@psi.ch