Development of Automatic LLRF control system for KIRAMS-30 Cyclotron

Yeun-Soo Park, Kun-Uk Kang, Seong-Seok Hong, In-Su Jung

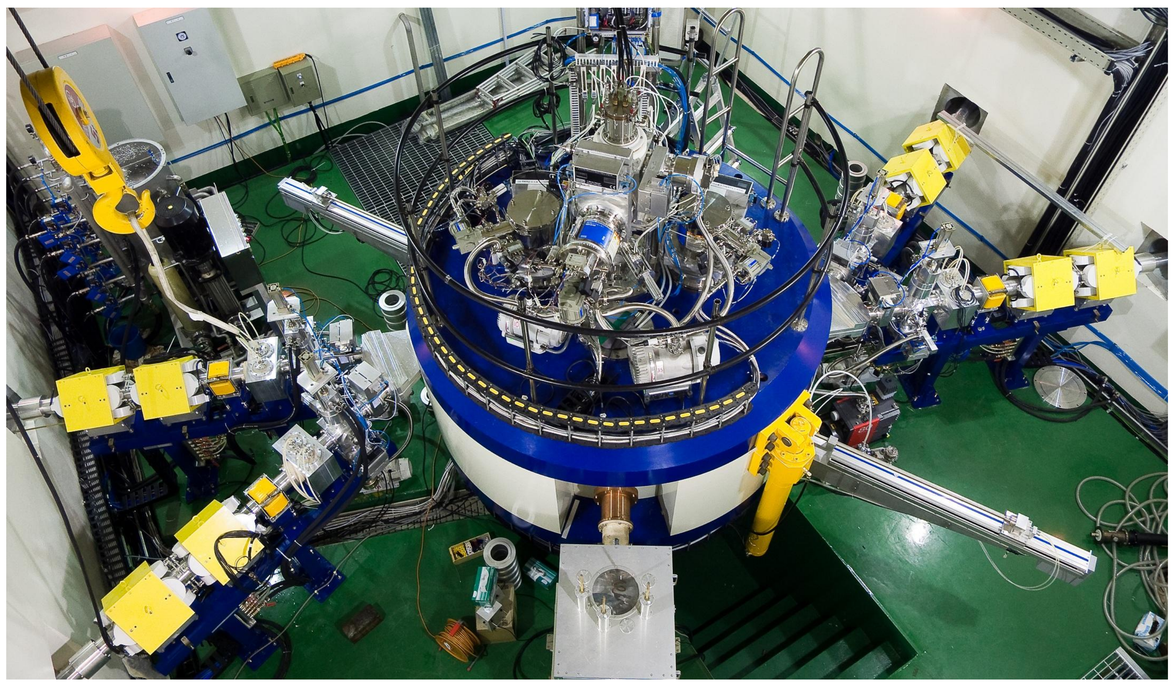
KOREA HEAVY ION MEDICAL ACCELERATOR

ABSTRACT

We have developed and installed KIRAMS-30 cyclotron at KAERI-ARTI(Korea Atomic Energy Research Institute / Advanced Radiation Technology Institute) of Jeongeup city area. KIRAMS-30 is able to accelerate proton particles from 15 to 30MeV, which will be primarily used for high current beam extraction. RF power with 63.96MHz frequency and max. 50kW at KIRAMS-30 is supplied to the 'push-push' type two Dees, and a cavity tuner automatically tunes to maintain the resonance.

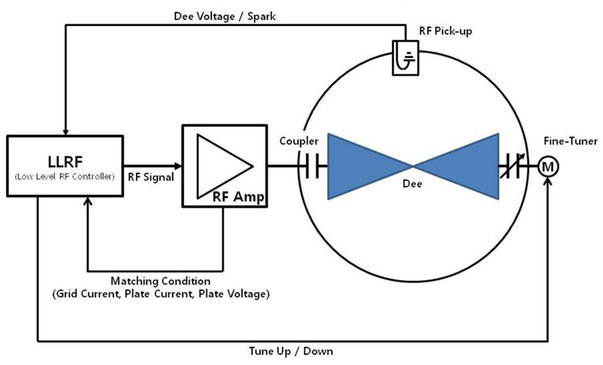
We have been now commissioning and testing it to arrange and meet the required beam conditions after moving it to the main cyclotron building from temporary one. In this work, we developed automatic RF low-level control system for KIRAMS-30 cyclotron. RF low-level signal is constantly controlled during beam extraction by adjusting the motorized fine tuner automatically considering the feedback grid voltage signal of RF power amplifier. At this system, even if RF resonance condition is broken due to the unstable RF status like various fault occasion, it can be recovered automatically. Meanwhile, Automatic RF low-level control part has been realized as an application of software program using LabVIEW graphical language.

KIRAMS-30 Cyclotron

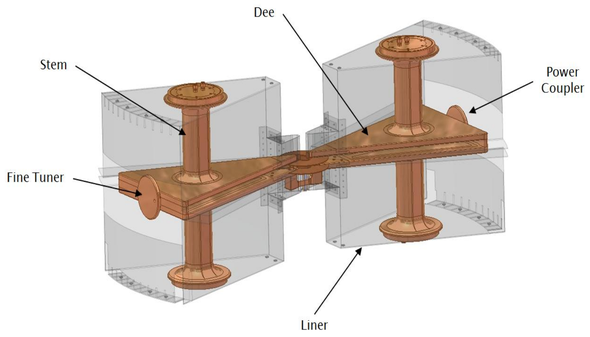


RF system of KIRAMS-30

Block Diagram of RF system



RF Resonance Cavity Structure



Parameters of RF system

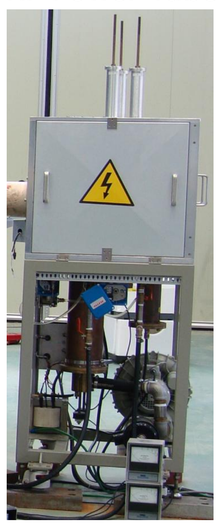
Number of Sector / Dee	4 / 2
Dee Angle	39 degree
RF Frequency	63.96 MHz
Harmonic Number	4th
Resonant Mode	λ/2 mode
Coupling Type	Capacitive
Q Value	7525
Dee Voltage	58 kV
RF Amp Output	50 kW
Characteristic Impedance	50 Ω

Specifications of RF amplifier

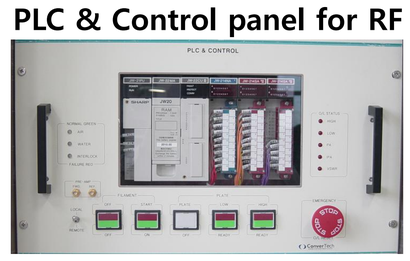
Rated Power Output (nominal)	50,000 watts
Frequency Range	63.96MHz±05MHz
RF Output Impedance	50 Ohms
RF Output Fitting	6-3/8"
AM Noise, RMS	-55 dB
Harmonic Attenuation (Ratio of any Single Harmonic to Carrier)	at least 80 dB
Harmonic and Spurious Emissions	-80 dB
Power Requirement Line Variation	380 VAC, 50/60 Hz, 3 Phase 2.5%
Ambient Temperature	0℃ to 50℃
RF Power Amplifier Tube	3CW40000A7
Intermediate Power Amp. Tube	5CX1500B

RF Power amplifier

RF Power Tube



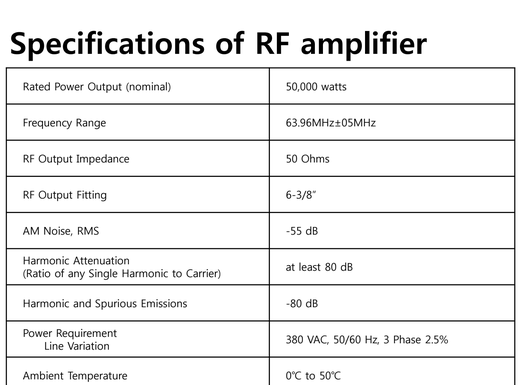
PLC & Control panel for RF Power amp.



Low-Level RF Control

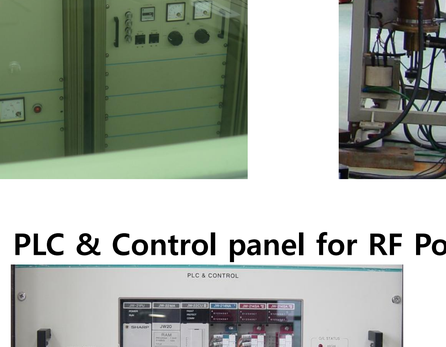
LLRF Connection Diagram

LLRF Feedback Controller



- Control of pulse duty cycle
- Maintaining of cavity resonance using
  - control of motorized fine-tuner
  - feedback of PA Grid voltage
- Recovery of cavity resonance condition from fault occasion

View of LLRF Controller



PWM & Motorized Tuner Controller

RF Source Generator

Measured beam current while automatic LLRF control