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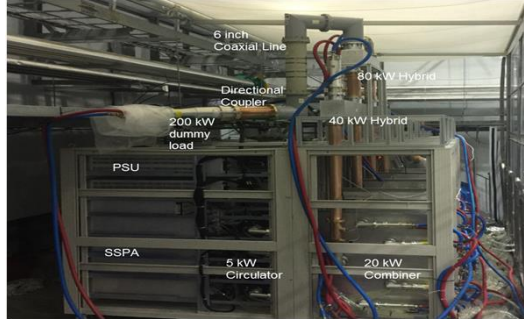
## Abstract

The RF (Radio-frequency) system in the RAON (Rare isotope Accelerator complex for On-line experiment) is constructed as an HPRF systems supplying high RF power to the cavity, LLRF systems for controlling HPRF, and reference line system synchronizing every RF systems. 80 kW RF system for RFQ cavity have been designed to supply RF field in the RFQ cavity. In this paper, we will describe details of High power test for RFQ cavity and construct of the 80 kW SSPA.

## 80 kW HPRF system for RFQ cavity

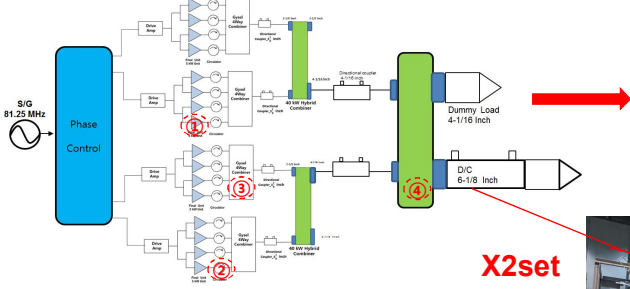
### RF power for RFQ cavity

parameter	Unit	value
RFQ Cavity	MHz	81.25
Power(CW)	W	150 kW (include margin)
Port	EA	2(each 80kW power)



### Specification

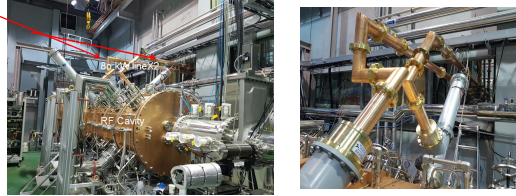
parameter	Unit	value
Freq	MHz	81.25
Power(CW)	W	80 k
Efficiency	%	> 55
In/Out Impedance	$\Omega$	50



X2set

### High Power RF Component

- ① 5 kW SSPA(Solid State Power Amplifier)
- ② 5 kW Circulator
- ③ 20 kW Combiner
- ④ 2way Hybrid Coupler

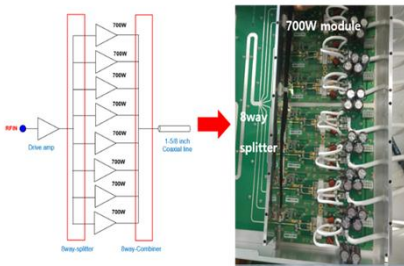


To supply more than power of 150kW

### RFQ Cavity

- 2 EA RF port (6-1/8 inch)
- Supplying RF power to RFQ cavity
- Using the directional coupler to detect the RF power(forward, reflected)

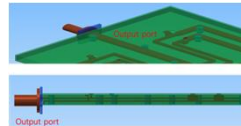
## 5 kW SSPA(Solid State Power Amplifier)



- 5 kW of 8 modules
- Use the 8 way Combiner /Splitter
- To use the directional coupler for detect the RF power

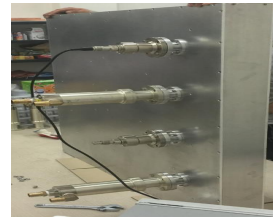
## 20 kW Combiner

### 20 kW combiner drawing



- A trace pattern and a cover mechanism were designed by using a 3D drawing tool with the simulation values. The inner plate of the combiner was made of silver-plated plate to improve the conductivity. An insulator was used to fix the gap between the silver-plated plates.

### Fabricated 20 kW combiner



- The measured S21 (Insert loss) of the fabricated combiner was similar to the simulation value. The combiner verified in the cold-test was applied to the SSPA system to provide the RF power to the RFQ cavity.

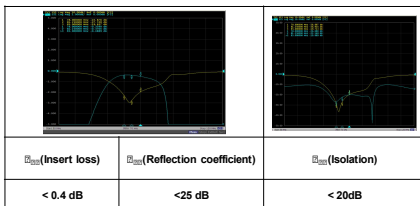
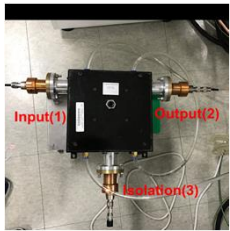
### Simulation and fabricated Combiner S21

Input port	Simulation(dB)	fabricated(dB)
1 port	-6.12	-6.14
2 port	-6.18	-6.21
3 port	-6.18	-6.1
4 port	-6.12	-6.11

- The tables summarize the comparison between the simulation values for S21 and values for S21 of the fabricated combiner.

## 5 kW Circulator

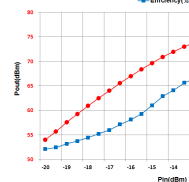
### S parameter Measure



- 81.25 MHz Y-junction Type
- 5 kW handing power

## Conclusion

### Power Meter

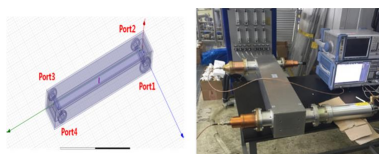


80 kW SSPA system for RAON RFQ was developed and tested. It consists of 4\*20 kW rack.(include circulator, DC power supply unit, and combiner.) Every 20 kW RF system was tested with full power. Also a movable short device was used to check the amplifiers with various operation condition such as full reflection. Finally, 80 kW full power test was performed by using hybrid combiner.

## Acknowledgement

This work is supported by the Rare Isotope Science Project of Institute for Basic Science funded by Ministry of Science, ICT and Future Planning and National Research Foundation of Korea (2013M7A1A1075764)

## 2way Hybrid Coupler



### S parameter Measure

Port1		Port2		ISO
S21(dB)	S11(dB)	S21(dB)	S11(dB)	dB
typically 3.02	< -20	typically 3.02	< -20	< -25

- 90° phase difference between port1 and port2
- Simple structure and low insert loss
- Useful to combine high power