# HIGH RF POWER TEST OF COUPLED RFQ-SFRFQ CAVITY

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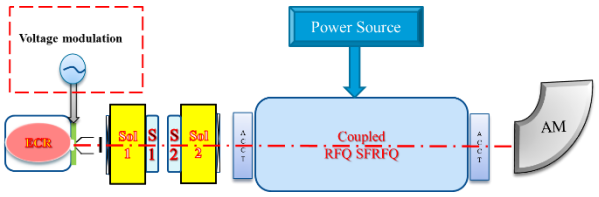
**A new combined accelerator that couples radio frequency quadrupole (RFQ) and separated function radio frequency quadrupole (SFRFQ) in a single cavity has been designed and manufactured. Recently, the performance of the cavity under high RF power was tested with an upgraded RF power source. The inter-vane voltages of both RFQ section and SFRFQ section were measured by using high purity germanium detector and the corresponding measurement system. The measured shunt impedance is about 546.9 kΩ•m, which means the cavity needs 19.5 kW for the designed inter-vane voltage of 65 kV. The results are well consistent with the cavity design.**

## INTRODUCTION

### Schematic layout of CRS accelerator complex

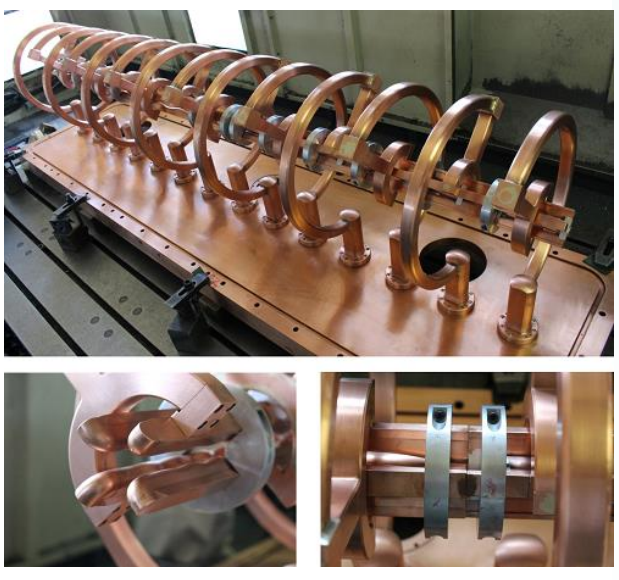



The coupled structure combines both the advantage of RFQ for better beam acceptance of low energy ions and the advantage of SFRFQ for higher accelerating efficiency, and will significantly shorten the length of the accelerator for the same beam energy gain in RFQ. The beam matching between RFQ and SFRFQ were realized not only for the transverse emittance also for the longitudinal synchronous phase and beam energy. Thus, the coupled RFQ-SFRFQ (CRS) cavity can accelerate 5 mA $He^+$ beam from 7.5 keV/u to 201.2 keV/u in 2.5 m cavity.

### Main Design Parameters of CRS Cavity

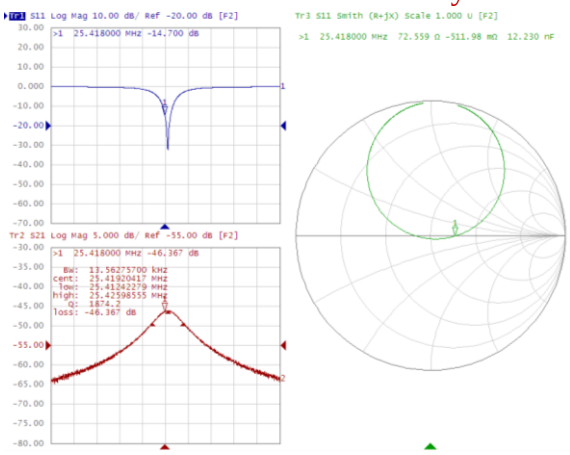
| | RFQ | SFRFQ |
|---|---|---|
| Frequency (MHz) | 25.5 | 25.5 |
| Inter-vane Voltage (kV) | 65 | 65 |
| Current (mA) | 5 | 5 |
| Duty Factor | 1/6 | 1/6 |
| Input Energy (keV/u) | 7.5 | 105.7 |
| Output Energy (keV/u) | 105.7 | 201.2 |
| Cells Number | 33 | 10 |
| Length (m) | 1.48 | 1.00 |

## CRS STRUCTURE



## BENCHMARKING THE MEASUREMENT

### RF Features of CRS Cavity



### RF Power Source Performance

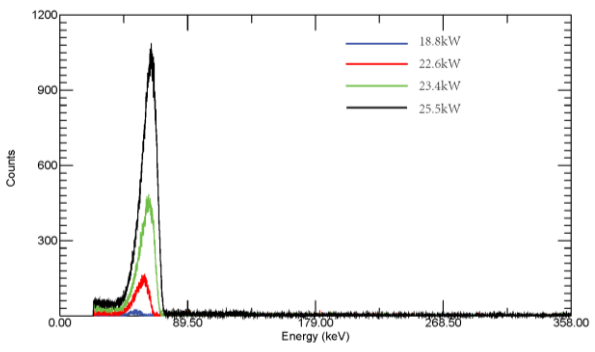
| | | |
|---|---|---|
| Duty Factor | 1/6 | CW |
| Power (kW) | 30 | 20 |
| SWR | 1.1 | 1.1 |
| DL △T (℃) | 2.6 | 10.7 |
| DL Absorption (kW) | 5.2 | 21.4 |

## HIGH RF POWER TEST

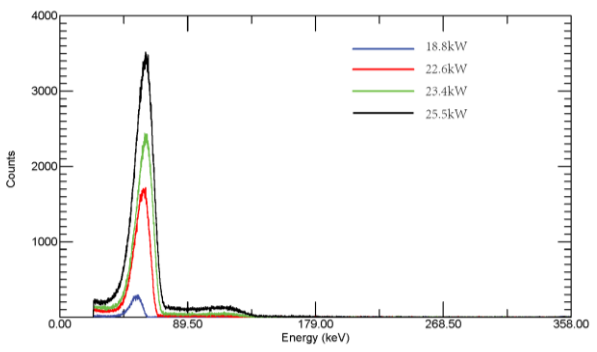
### Layout of the measurement system

CRS Observing Windows → CANBERRA high purity Ge detector → 2001C Pre-amplifier → 570 type Main amplifier → 926 type MCA and ADC → PC

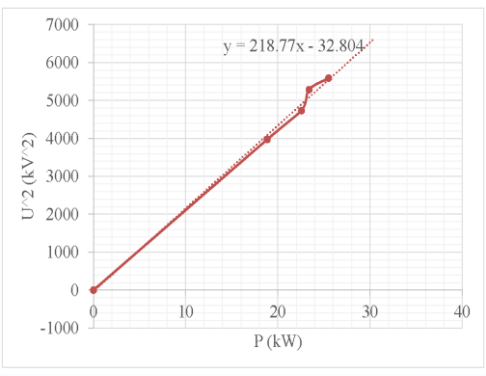
### Spectrums measured in RFQ section




### Spectrums measured in SFRFQ section




### Relation between inter-vane voltage and power consumption




### Comparisons of Simulation and Measurement Results of CRS Cavity

| | Simulation | Measurement |
|---|---|---|
| Frequency (MHz) | 25.350 | 25.418 |
| Q factor | 4326.3 | 3748.4 |
| Power (kW) | 16.2 | 19.5 |
| Shunt impedance (kΩ·m) | 651.0 | 546.9 |

## CONCLUSION

The high RF power test of the coupled RFQ-SFRFQ cavity are presented in this paper. The measured results verified that RFQ and SFRFQ can be coupled in the same resonant frequency in one cavity. Because of the situation of non-perfect electric conductor, the measured power loss was 20% higher than the simulation value, and the measured shunt impedance was 84% of the simulation value.