# Preliminary Test for Improving Plasma Chamber Cooling of Microwave Ion Source at KOMAC

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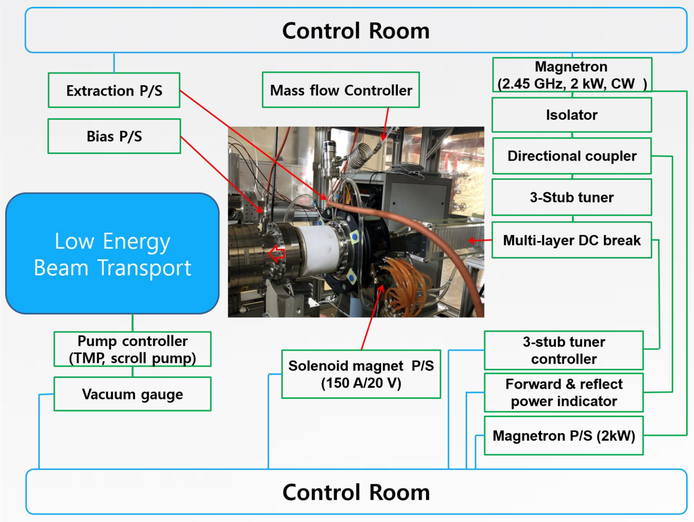
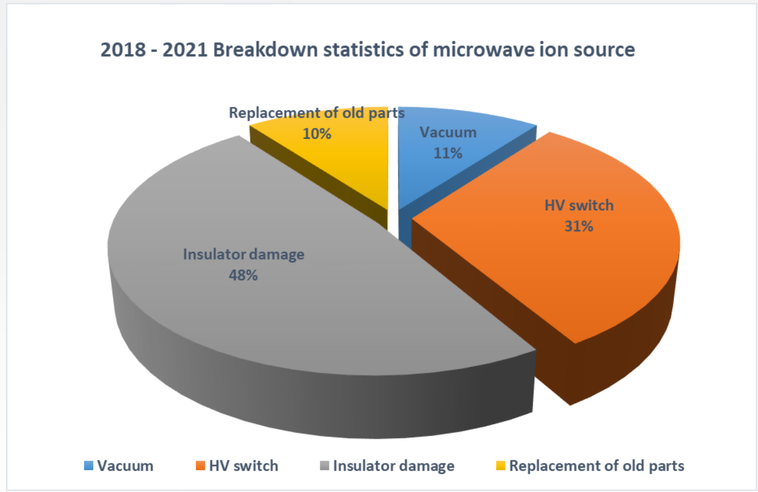
## Microwave Ion Source for 100 MeV Proton Linac

### System Block Diagram



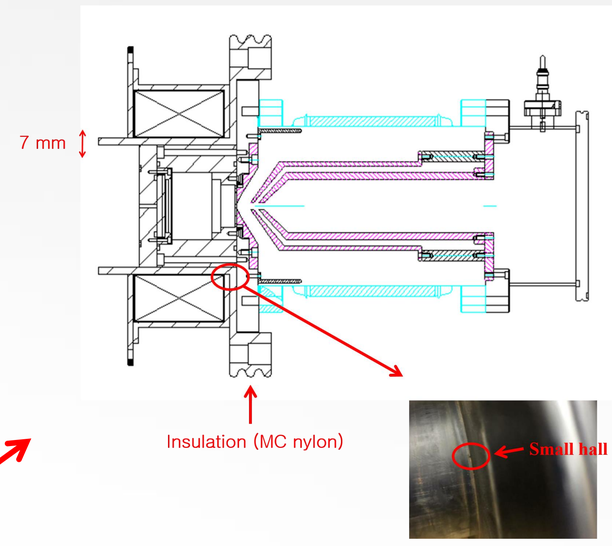

- Particle : proton
- Beam energy: 50 keV
- Operating current : ~ 20 mA
- Emittance(Normalized rms) : 0.2 π mm mrad
- Proton fraction : > 80%
- Microwave frequency : 2.45GHz

### Breakdown statistics of microwave ion source




- Breakdown for 3 years
  1. Insulator damage: 48% (refer to the picture on the right)
  2. High voltage switch breakdown: 31%
     (for extraction voltage and bias voltage)
  3. Vacuum leak: 11% (in microwave window)
  4. Etc.: 10% (arc due to the aging)

### High voltage insulator breakage location

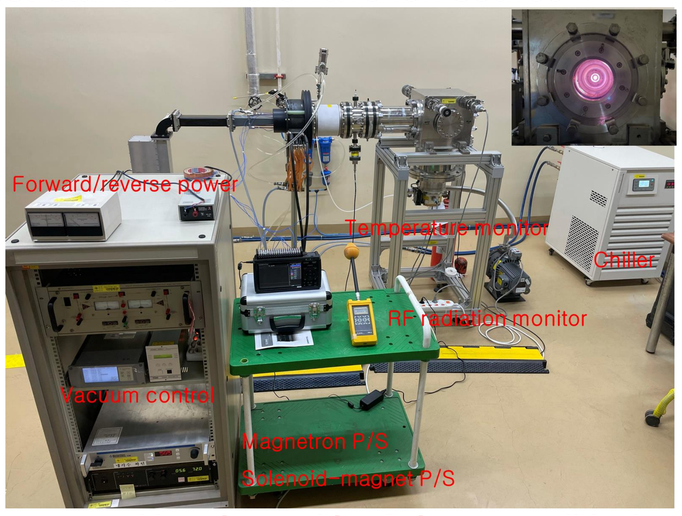



- Reason
  1. Insulation breakdown due to accumulated fatigue(arcing)
  2. Reduced insulation strength of insulators due to the heat generation source of plasma chamber

## Preliminary Tests

© : for revision comment

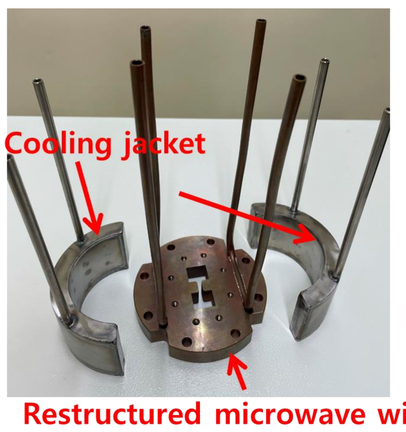
### Test-stand for microwave ion source




- The test-stand is only capable of plasma conditioning. ©
- Temperature measurement locations :
  1. plasma chamber outer wall
  2. high voltage flange
  3. microwave window
  4. ridge waveguide

### Cooling jacket

: In order to insert a cooling jacket for water cooling in the existing plasma chamber, the structure of the plasma chamber was changed and manufactured

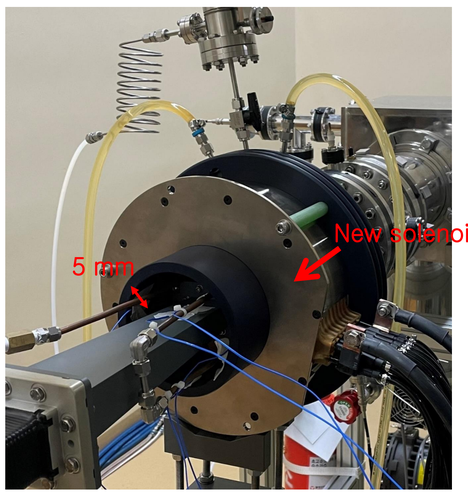



Restructured microwave window

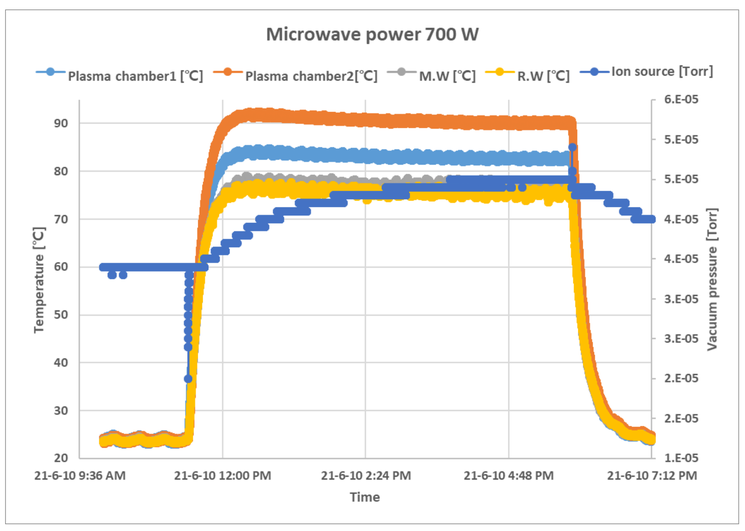
Restructured plasma chamber

### New Solenoid electromagnet

- Air cooling of the plasma chamber was made possible by increasing the inner diameter of the solenoid electromagnet.
- A space of 5 mm was created between the outer wall of the plasma chamber and the high voltage insulator.
- Air cooling was performed there.
- There is no separate water cooling between plasma chamber and solenoid electromagnet . ©
- It is an solenoid electromagnet with only the inner diameter increased, which has the same characteristics as the field distribution of the previous solenoid electromagnet. ©

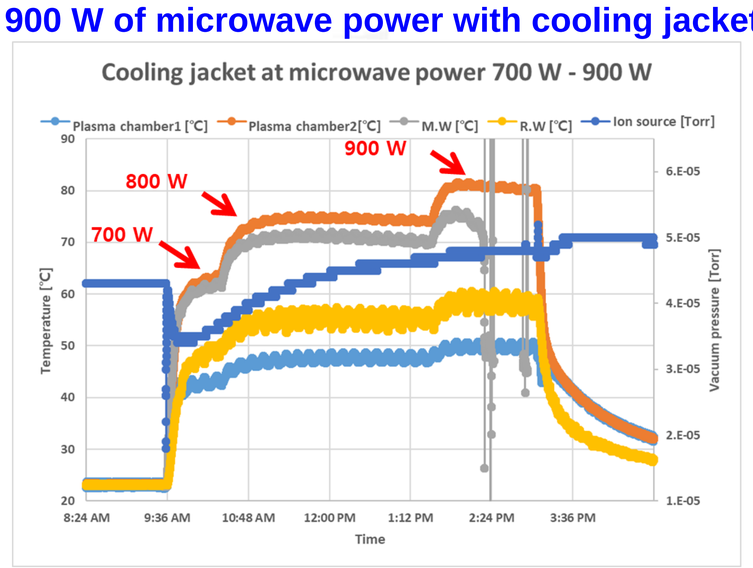



### the temperature for each location at 700 W



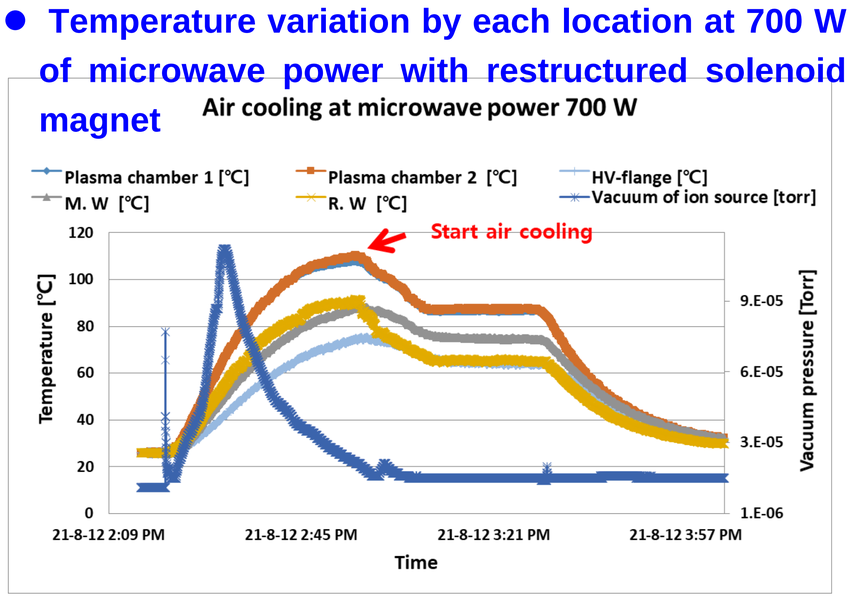

: The temperature of the plasma chamber outer wall increased to about 93℃. (The room temperature is 23℃.)

### Temperature variation by each location at 700 W – 900 W of microwave power with cooling jackets




: The temperatures of the plasma chamber outer wall converge at about 63°C, about 74°C, and about 81°C. (The room temperature is 23℃.)

### Temperature variation by each location at 700 W of microwave power with restructured solenoid magnet




: The temperatures of the plasma chamber outer wall in the microwave power 700 W operation was started without air cooling, and air cooling was started at an equilibrium temperature of about 108°C and converged to about 87°C. (The room temperature is 26.5℃.)

## In Future

For dielectric breakdown of high voltage insulators, two tests were performed to improve the cooling of the plasma chamber against dielectric breakdown of high voltage insulators. Using the cooling jacket, it was possible to operate at a temperature of about 63°C at a microwave power of 700 W. Through this, it was possible to confirm the temperature compensation of about 30°C. In the case of air cooling, temperature compensation of about 20°C was confirmed. In the future, based on the experimental results, it is necessary to optimize the structure for cooling the ion source in the direction of minimizing the change in the existing structure.