Status of couplers for PIP-II

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RFQ couplers

Two new couplers with replaceable ceramics and Viton o-rings sealing were produced.

Ceramic diameter 6’’ (was 3’’), Ceramic thickness 4 mm (0.16’’) or 5mm (0.2’’)

![Diagram of RFQ coupler]
Coupler with new ceramic window unit

New unit
Total number of ceramic disks is 10: 6 disks of 4 mm thickness and 4 disks of 5 mm thickness

Current status:

Yesterday Dan achieved a vacuum leak tightness of both couplers.

Today he will check it aging with higher vacuum. If tests are successful, the new units will be ready to installation.
Interesting news from FRIB. They use (successfully) the RFQ couplers with Viton o-rings.

Ceramic thickness 10 mm (\( F = 80.5 \text{ MHz} \))
Ceramic \( D \sim 6'' \) (scaled from drawing), no TiN coating.
Input waveguide \( \sim 4\text{-1/16}'' \) (scaled from drawings).
Sealing: Viton o-rings 1/8''
325 MHz coupler

- 325 MHz coupler
- "5K" intercept
- "80K" intercept
- Ni-Cu bellows
- Ceramic window 3" x 0.0158"
- Stainless steel tube
- e-pickup port
- 3" x 0.0158" stainless steel tube
- Antenna
- Matching bump
- Cold flange
- Spring to compensate thermal expansion
- Cryomodule flange
- Arc detector
- Air inlet
- 3-1/8" coaxial input
- Heater
Total history of 325 MHz coupler production/testing

Three prototypes were produced by Omley.
Two antenna was successfully tested up to 30 kW, CW, full reflection.
One antenna was destroyed during test up to limit at 47 KW, CW, full reflection.
With one antenna SSR1 demonstrated design parameters.

Ten couplers were ordered to Mega Industries.
Only four coupler were received after great delay.
Two couplers were successfully tested at test stand up to 20 kW, CW, full reflection.
Mega Ind. faced difficulties with brazing and probably used Vacseal at some samples.

Ten new antennas were ordered to CPI and CoorsTek, five to CPI, five to CoorsTek.
CPI delivered all five antennas. Three with not good ceramics and two with good ceramics.
CoorsTek: first sample was send to sub-vendor for final welding. It was promised to deliver the first antenna in first week of February.

Two antenna made by CPI (with bad ceramics) were tested at test stand. One window was broken at power level 20 kW, CW, full reflection. Most probable reason – bed quality of ceramics.
Broken window from CPI. Vacuum part of antenna was oxidized (after crack). It means the temperature was rather high (~ 200°C). I could not get this temperature in simulation with measured loss tangent (at 100°C). Maybe the ceramics was even worse than we think.
We have for today:

- Three antenna form Mega (probably contaminated by vacseal)
- Four antenna from CPI, two with good ceramics and two with bad ceramics.
- Five antenna (all with good ceramics) are expected from CoorsTek. First sample are promised to be delivered in first week of February.

- Two CPI couplers with good ceramics are installed at coupler test stand and test will start today. The power limit of testing for all next couplers will be 10 kW, CW, Full reflection.

- Design coupler for SSR2 will be improved.
About testing SSR1 with high power couplers.

- We have one successful test and several unsuccessful attempts (multifactor and field emission).

- Successful test was done with cavity #108 and coupler made by Omley. It was the worst coupler of three made by Omley (considering the brazing quality), but test was successful.

- What is the reason?
  Cavity and coupler were prepared right way and in right place. Coupler was washed in MP9 JUST BEFORE installing to cavity (coupler was never tested at coupler test stand).

- I think we have to follow the same procedure: couplers must be re-washed after test and backed separately.
Two version of 650 MHz coupler were design: new one with electromagnetic shields and without copper coating and backup version with copper coating.

New version has about two times better cryogenic properties.
Two type of vacuum parts are ordered to CPI.

- Two pieces of new design (with electromagnetic shields, no copper coating)
- Two pieces of backup design (with copper coating)

Total number of vacuum parts is 4.
8 ceramic disks were produced.
Property of disks were measured in FNAL. All disks are good enough:

Results of measurements:

<table>
<thead>
<tr>
<th>Disk #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss T x 1e-5</td>
<td>1.86</td>
<td>1.79</td>
<td>1.83</td>
<td>1.90</td>
<td>1.91</td>
<td>1.92</td>
<td>1.95</td>
<td>1.86</td>
</tr>
</tbody>
</table>

CPI ceramics for 650 MHz coupler,
Loss Tangent vs Temperature,
absolute values

CPI ceramics for 650 MHz coupler,
Loss Tangent vs Temperature,
relative values
Two sets of air pats of 650 MHz coupler and test stand are in procurement department.

Test cavity wit two vacuum parts of coupler.

Test stand.

In nearest future we have to prepare the infrastructure in MDB for 650 MHz coupler testing: circulator, 6” coaxial waveguide lines, control system for 650 MHz IOT (2 IOT are in MDB).