RFQ couplers, working for the bugs.

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Left ceramic window was broken.
What are the possible reasons of window crack?

- Initial defect?
- Overheating of inner conductor because of lack of cooling?
- Overheating of ceramics because of multipactor (not enough level of bias)?
- Sharp cold start and sharp starts after trips?

Initial defect?

Window had a small leak at the beginning.
Bad vacuum can provoke multipactor or local discharge at leak area.
Overheating of inner conductor because of lack of cooling?

Cooling:
It was assumed to provide an air flow 3g/s for 80 kW CW.

Max .Temperature of loop is ~ 104C (dT ~84C).
Ceramic temperature near inner conductor ~ 40C (dT = 20C).

Air flow was ~ 1g/s.

We can expect max. loop temperature ~ 200C and ceramic T ~ 60C. Gradient can be ~ 1-1.5 C/mm). Spots of discoloration was noted at air side of inner conductors. It can indicate that temperature was > 200C (?).
Overheating of ceramics because of multipactor (not enough level of bias)?

Surface of ceramics changed the color – grey areas appeared. It indicates that some processes occurred at the surface. The grey areas can be pure Ti as results of decomposition of TiN under electron bombardment. Another indication - the ceramic surface became conductive. There was several mA DC current under 1 kV voltage bias. Conductivity disappeared at the air. Probably Ti film was partly oxidized in air.

![Graph showing Bias voltage, Bias current, Forward power, and Pressure on August 25 with Current and no RF highlighted]
Overheating of ceramics because of multipactor (not enough level of bias)?
Simulations show that multipacor exists at 4 kV – 60 kV range of vanes voltage (in input coaxial and cavity volume)
Reflected power causes multipactor easier then direct power.

Pin = 20 kW
Pout = 0 kW,

Pin = 0 kW
Pout = 20 kW,
Threshold bias is $\sim 1$ kV

Pin = 0 kW
Pout = 40 kW,
Bias = -0.9 kV

Pin = 0 kW
Pout = 40 kW,
Bias = -1.0 kV
Working without bias or with low bias:

RF power exists, bias does not.
Working without bias or with low bias:
Sharp cold start and sharp starts after trips?

Start after 1 hour break

August 24
Start after night break

Chinese experience: cold start takes ~30min.
Works on the bugs:

- 18mm spacers are installed between cavity and couplers window. It reduces the loop heating ~ 15%.
- Air flow is increased from 1g/s to 2g/s
- Bias is increased from 0.9 kV to 3.7 kV
- No RF without bias (?)
- No sharp starts

Windows are still alive.
New idea from Linac 2016: ceramic RF window with Viton o-ring vacuum sealing.

TH1A04, Linac 2016
100 kW, CW window. OD ~ 4” (100mm)

TUPP093, Linac 2014 and TH1A05, Linac 2016
200 kW, CW window, OD ~ 6.125” (156mm)

(Temporary window)
Let’s try?

Advantages:

- Less expensive, no complicated brazing
- Easy to change ceramics
- Ceramics can move relatively metal (no problem with thermal expansion)
- Ceramics is accessible and easy can be clean/coated/uncoated

Possible problems:
RF losses in O-rings (can be burned). Preliminary test are necessary.

Possible test configuration.