RF design considerations for a vacuum cooling channel

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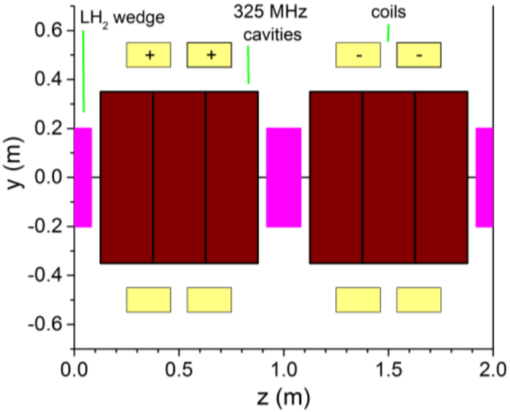
Overview

1. Waveguide considerations for vacuum cooling cells
2. Limitations on window simulations
3. Window R&D

- Many of us are interested in beryllium windows.
- What is involved in actually designing and building them? How can we constrain this design problem?

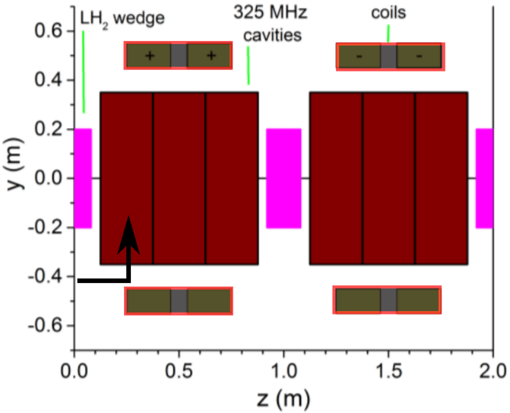
Waveguide considerations for vacuum cooling cells

How can we feed power to the RF in a cooling cell?



D. Stratakis, 5/13/2014.

How can we feed power to the RF in a cooling cell?



For this cooling cell in "Stage 1", *h* must be minimized.

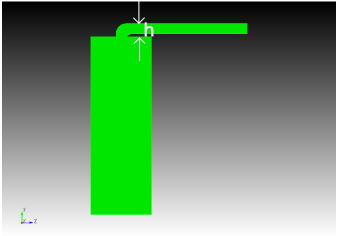


Figure : This is the way we usually sketch this. Terrible.

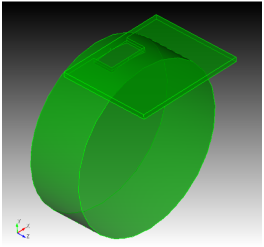


Figure : Better. Does it look familiar?

There are lower limits to h, imposed by. . .

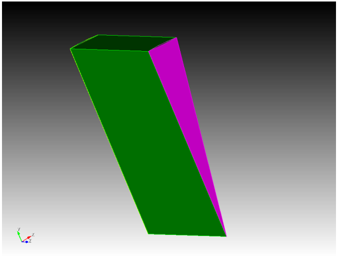
- Multipacting
- On-axis vs coupler E-field strength
- Transmission efficiency

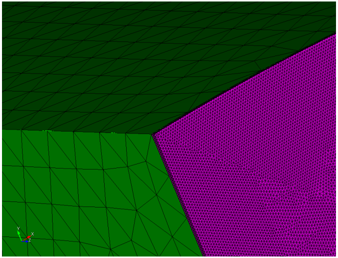
Possible values of h

- Verdict: $4 < h < 8$ cm. This includes assumptions of a 6.35 mm waveguide wall thickness, plus a 12.7 mm flange height.
- Final value of h depends on MP, field ratio optimization as discussed above.
- A question for Bob, Diktys, et al: How long must the feeder waveguide be? This has consequences for power required from the klystron, where an RF window might go, etc.
- Follow-up question: Can I put "jogs" in this feeder waveguide? If so, where?
- We had also discussed an RF window somewhere in here. This probably comes with a flange, which probably comes with extra headroom.
- This rapidly gets complicated. For the time being, where can we stop?

Limitations on window simulations

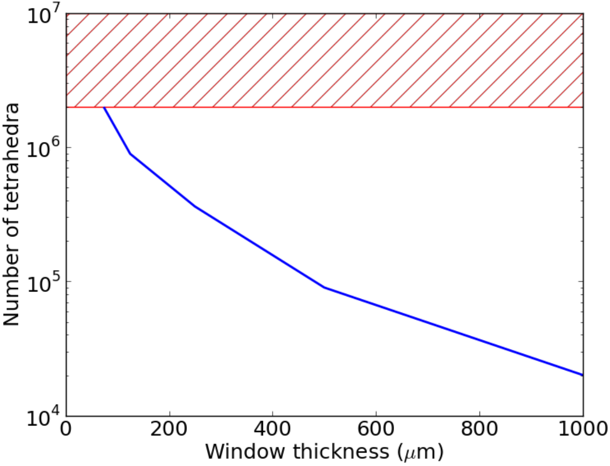
The scale of this problem imposes simulation limits.





Range of length scales $\rightarrow$ many tetrahedra required to model windows.

When using ACE3P to model 325 MHz windows, 75 μm is a rough lower limit on thickness.



ANSYS may give different results.

Materials R&D

Some results from our preliminary talks with Materion

- 125 μm is the lower limit on Be thickness for large windows unless we can tolerate "pinholes".
- 99% purity is as pure as we can get for 325 MHz windows. This has implications for material properties.
- They can give us more input on material properties during our upcoming phone conference.
- They can give us samples to evaluate.

One possible way to test Be material properties

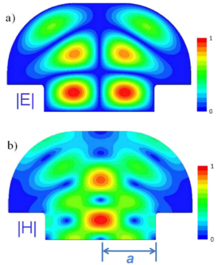


FIG. 1. Geometry of the pulsed heating test cavity and normalized color plots of the (a) E-field and (b) H-field patterns for the TE_{013}-like mode. The bottom edge is the face of the test sample.

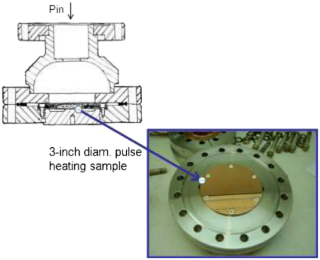


FIG. 4. The pulsed heating experiments are conducted using a TE_{01} cavity. The three-inch diameter samples are first mounted onto a cavity end cap (bottom right).

- SLAC might be able to help us with this.
- "Mushroom" cavity takes 3 cm diameter samples. **c.f. L. Laurent et al., PRST-AB 14, 041001 (2011).**
- Designed to study pulsed heating, but we could extract R_{S} from Q measurements.
- Cryogenic measurements possible.