RFQ Tuning

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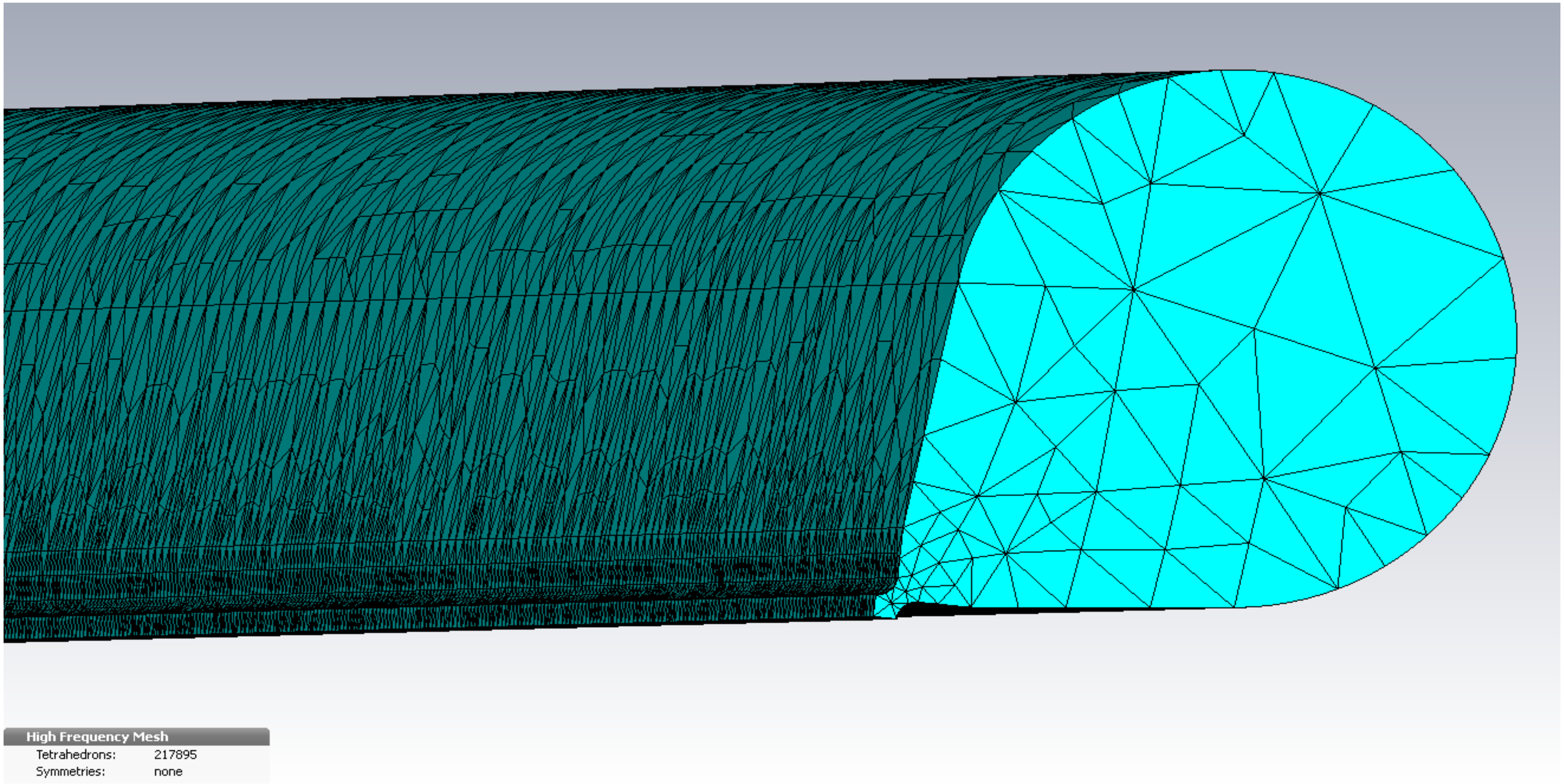
Motivation:

Develop a model of the RFQ to help understand the effects of frequency errors/tuners and check the tuning/flattening algorithm.

The modulations cause a frequency shift along the RFQ which are compensated by tuning grooves.

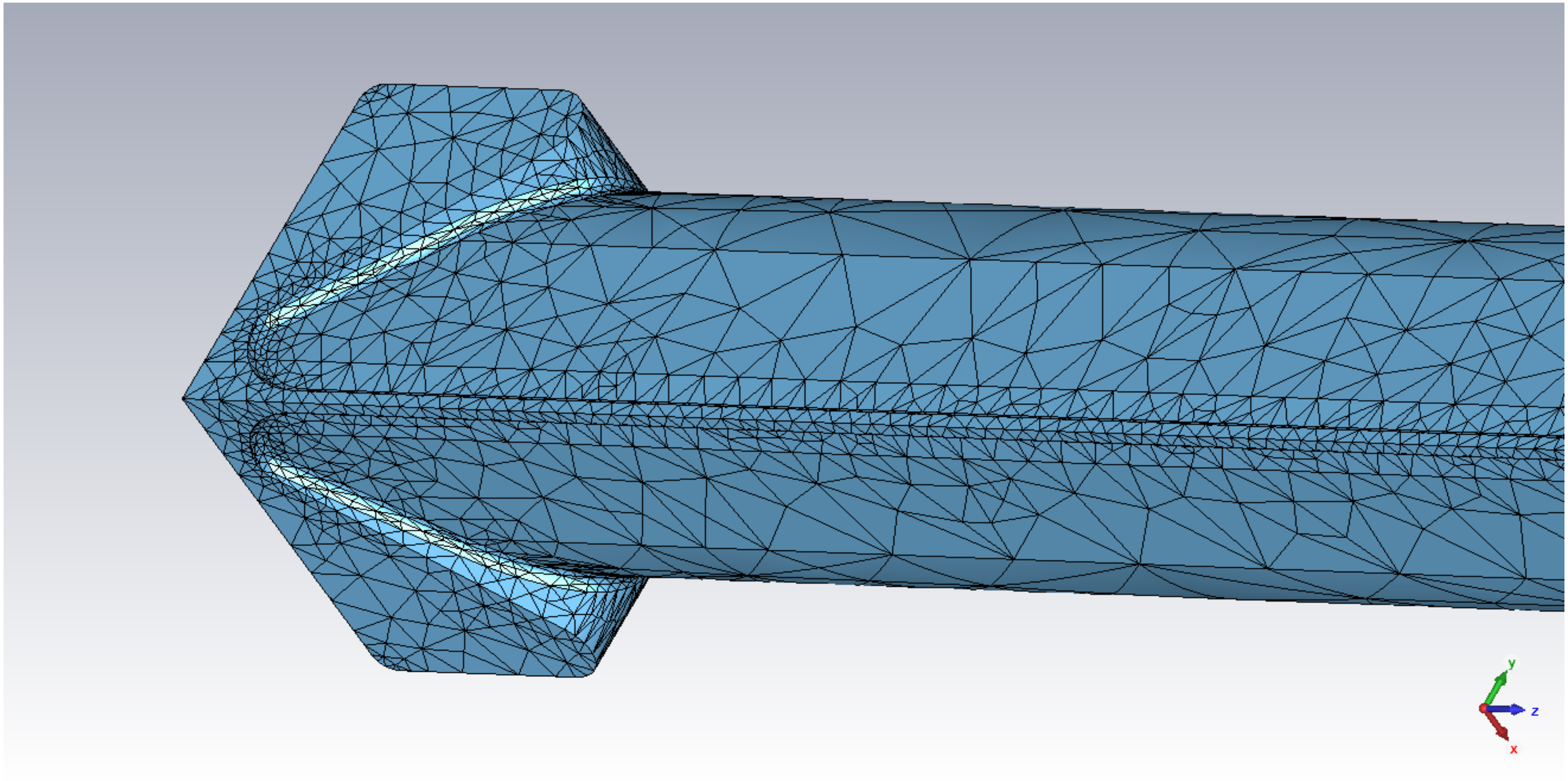
Together with the end regions these effects complicate the model.

Step 1: A simple unmodulated vane with open waveguide boundary conditions.



Frequency = 323.296 MHz

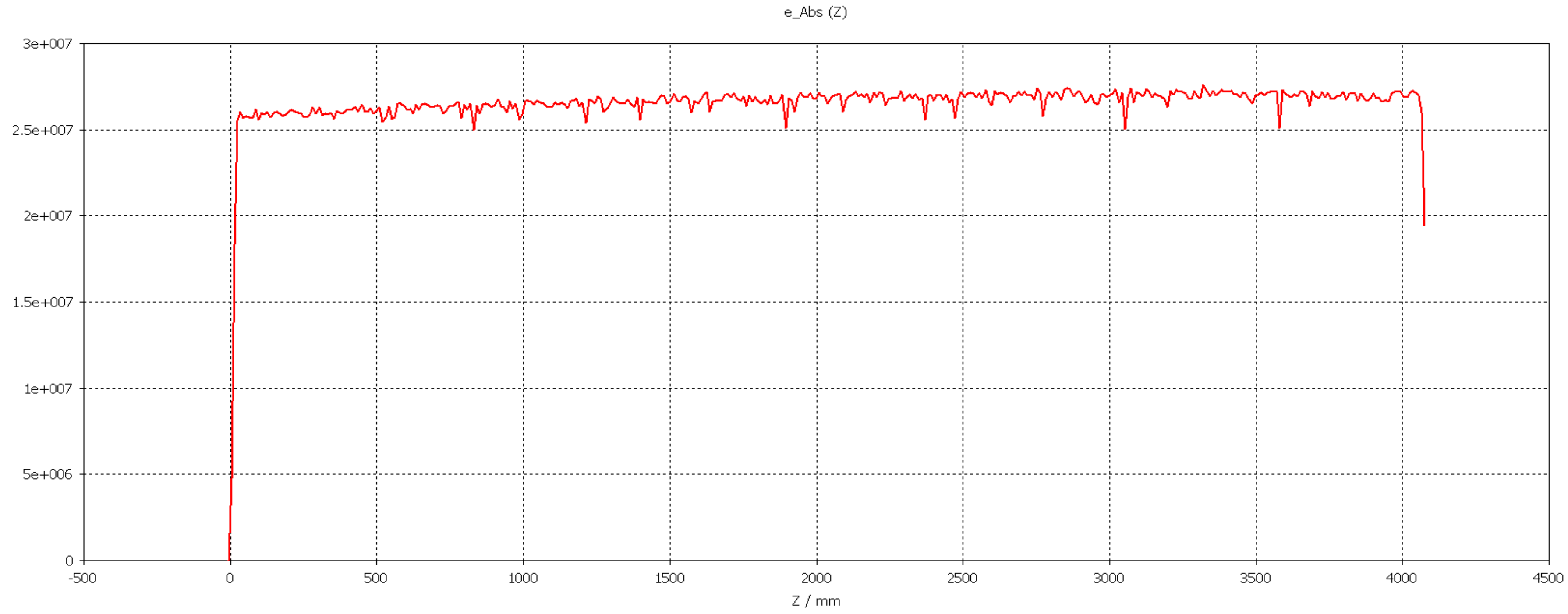
Step 2: Add the end regions.



Frequency = 323.296 MHz

Adding the end regions has negligible effect on the frequency.

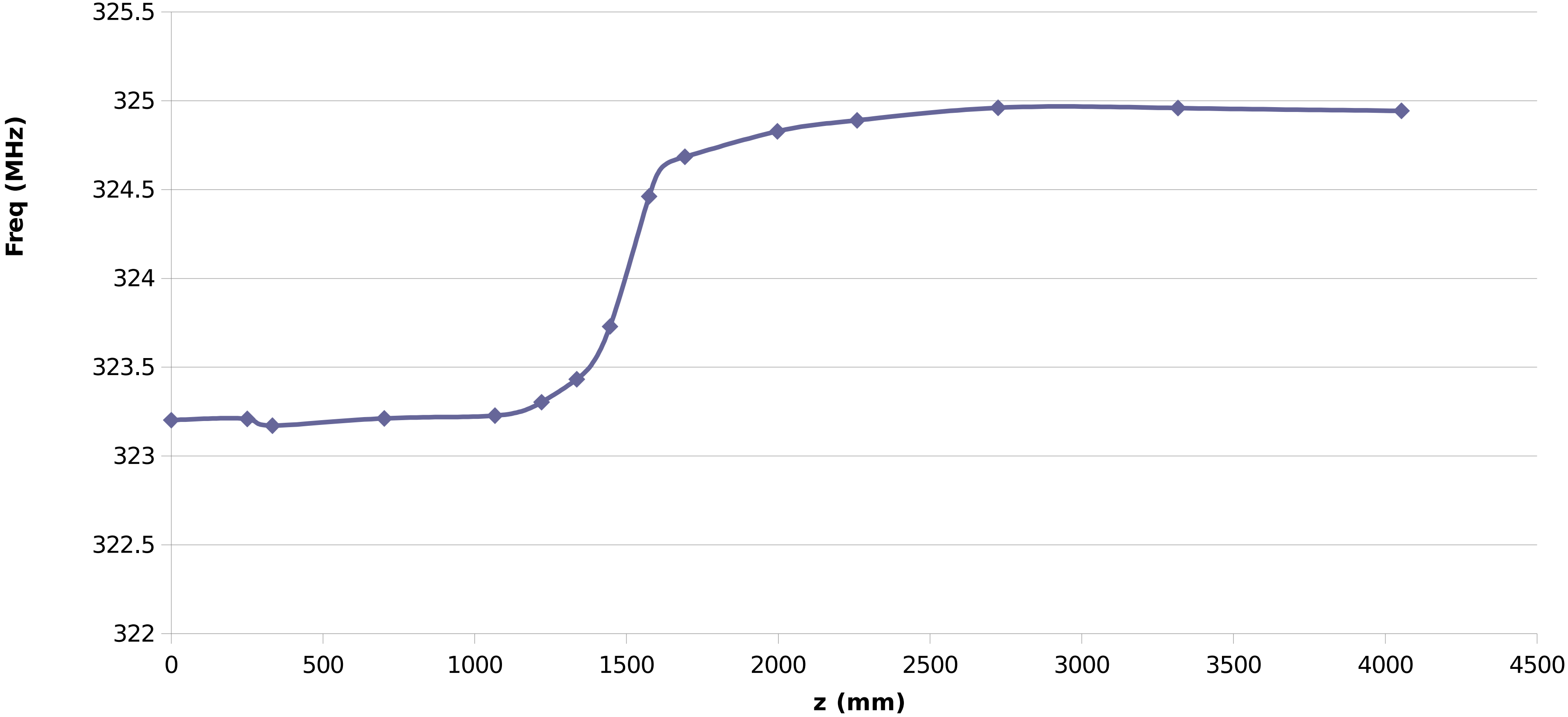
The field along the RFQ is pretty flat confirming that the ends are well tuned.



Nice work Scott!

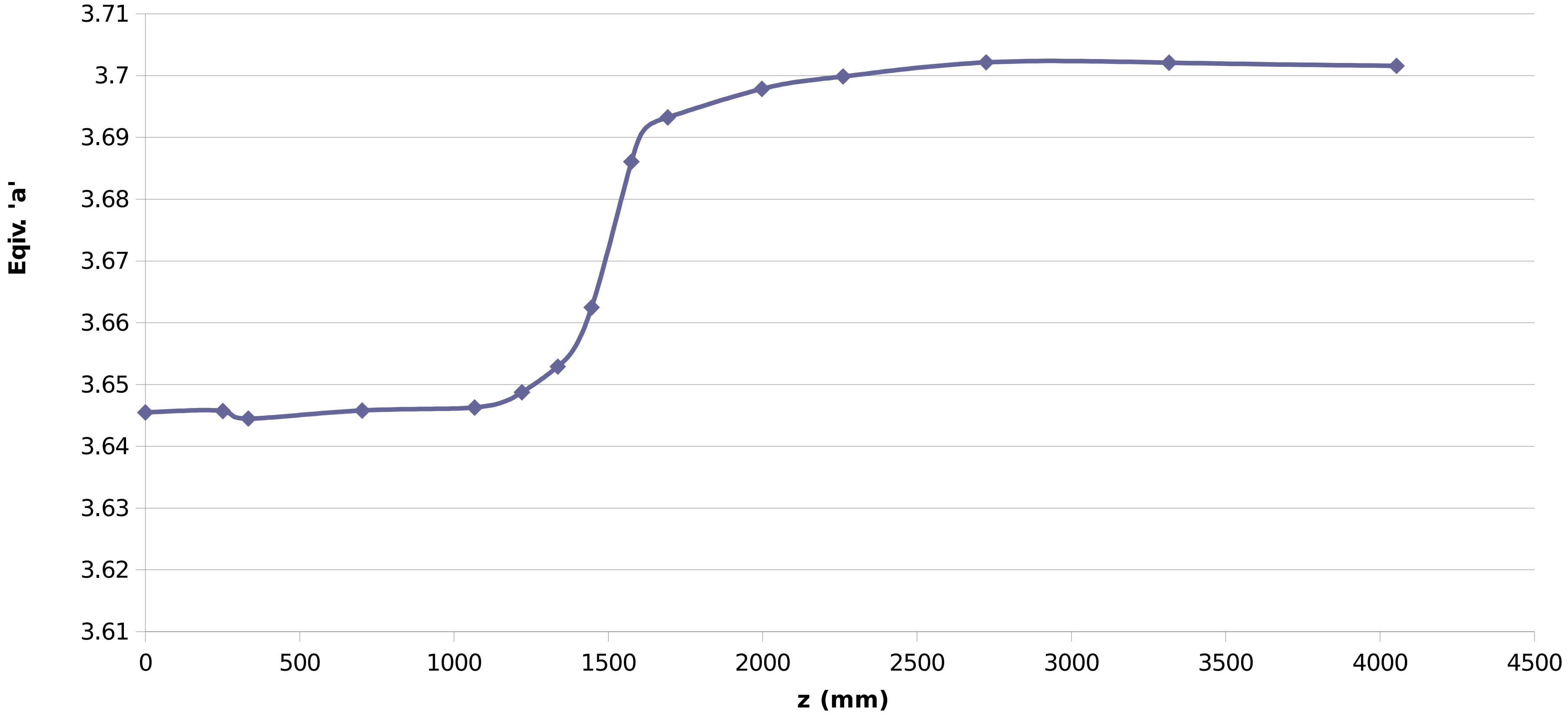
Step 3: Add the modulations.

The modulation shape causes a non uniform frequency.



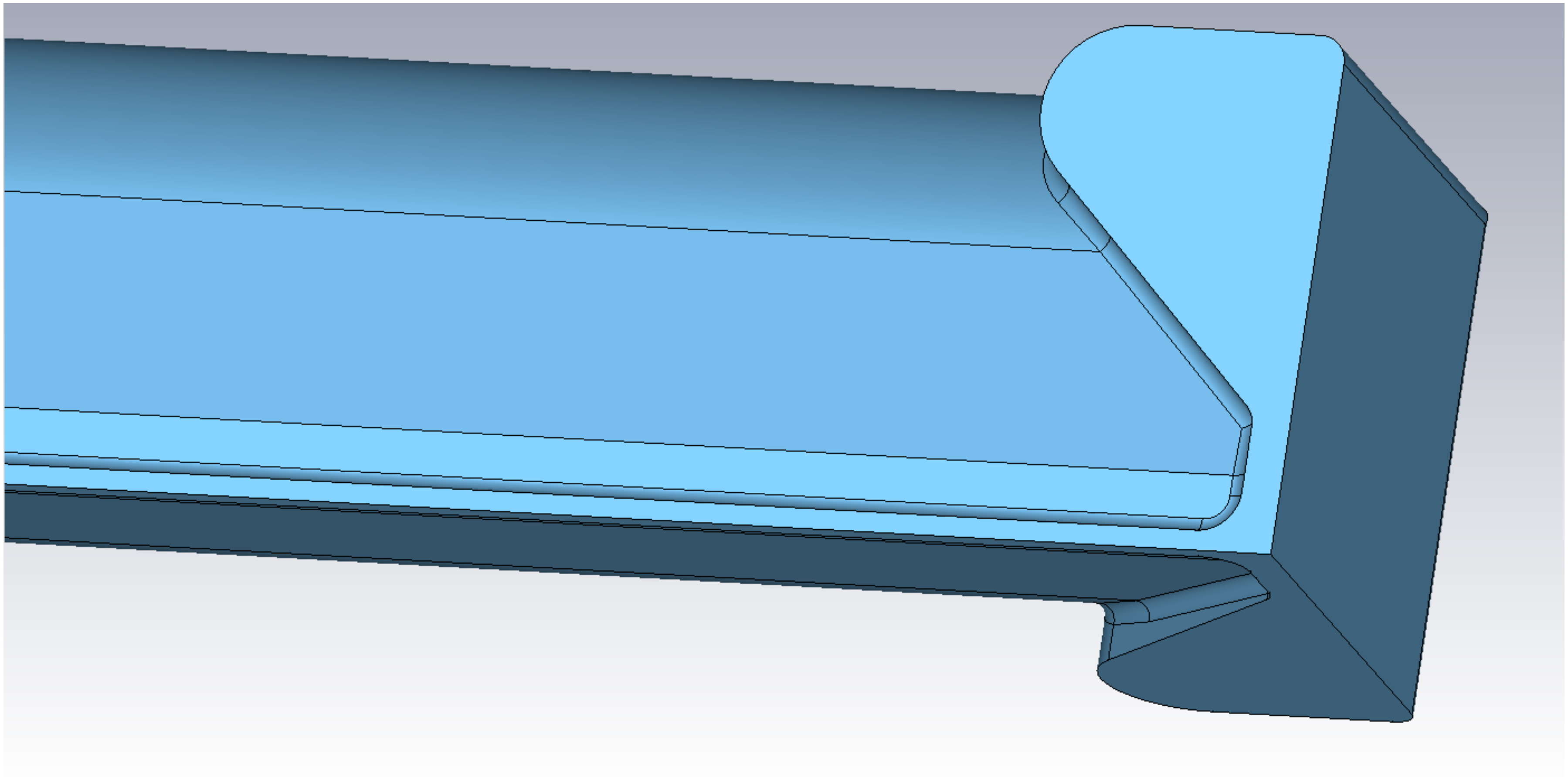
However meshing all the modulations is not feasible.

The effect can be duplicated by having a tapering, unmodulated vane to match the local frequency deviation.



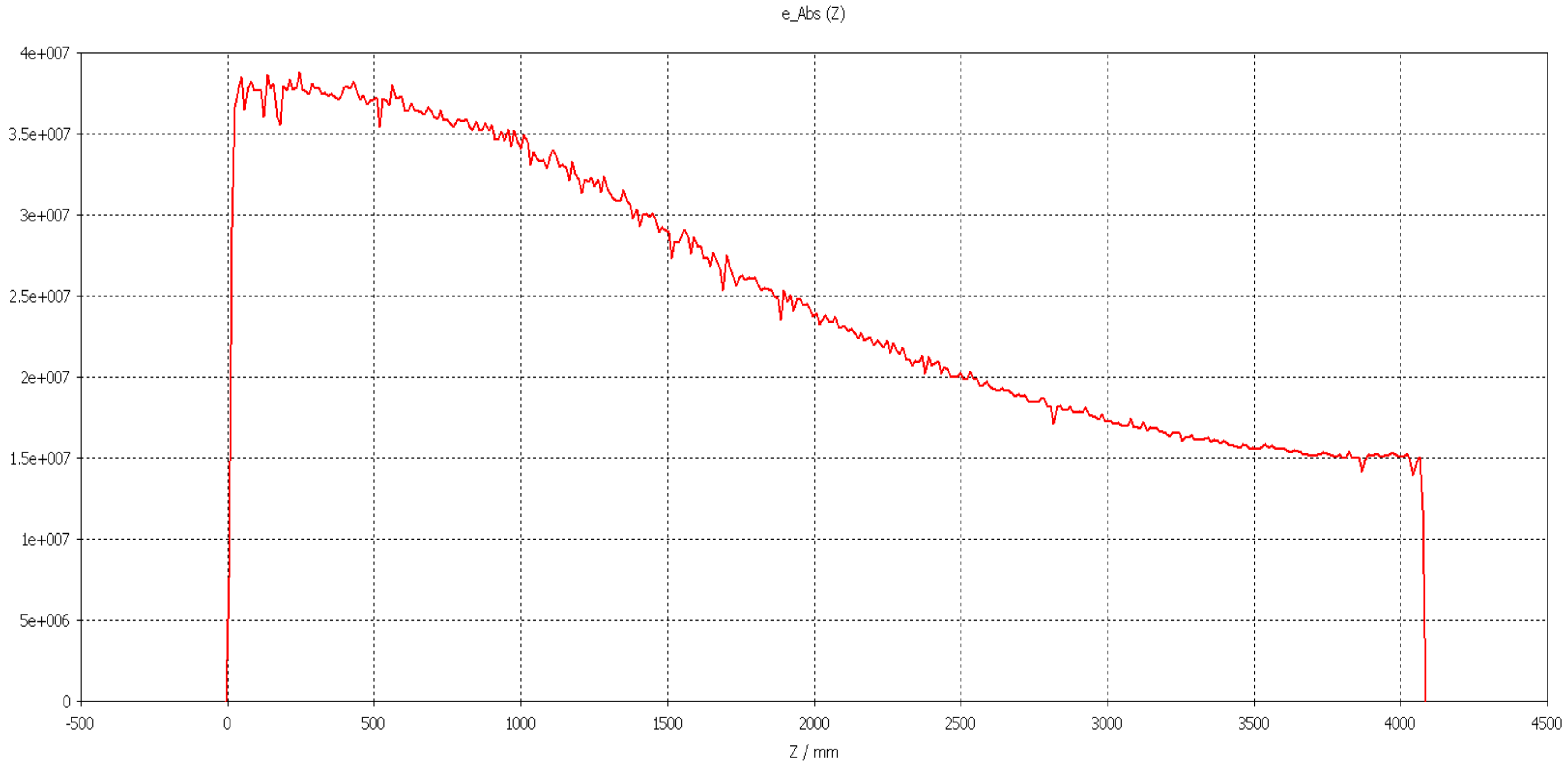
The equivalent shift of the vane tip is <60µm!

As expected the frequency increases ...

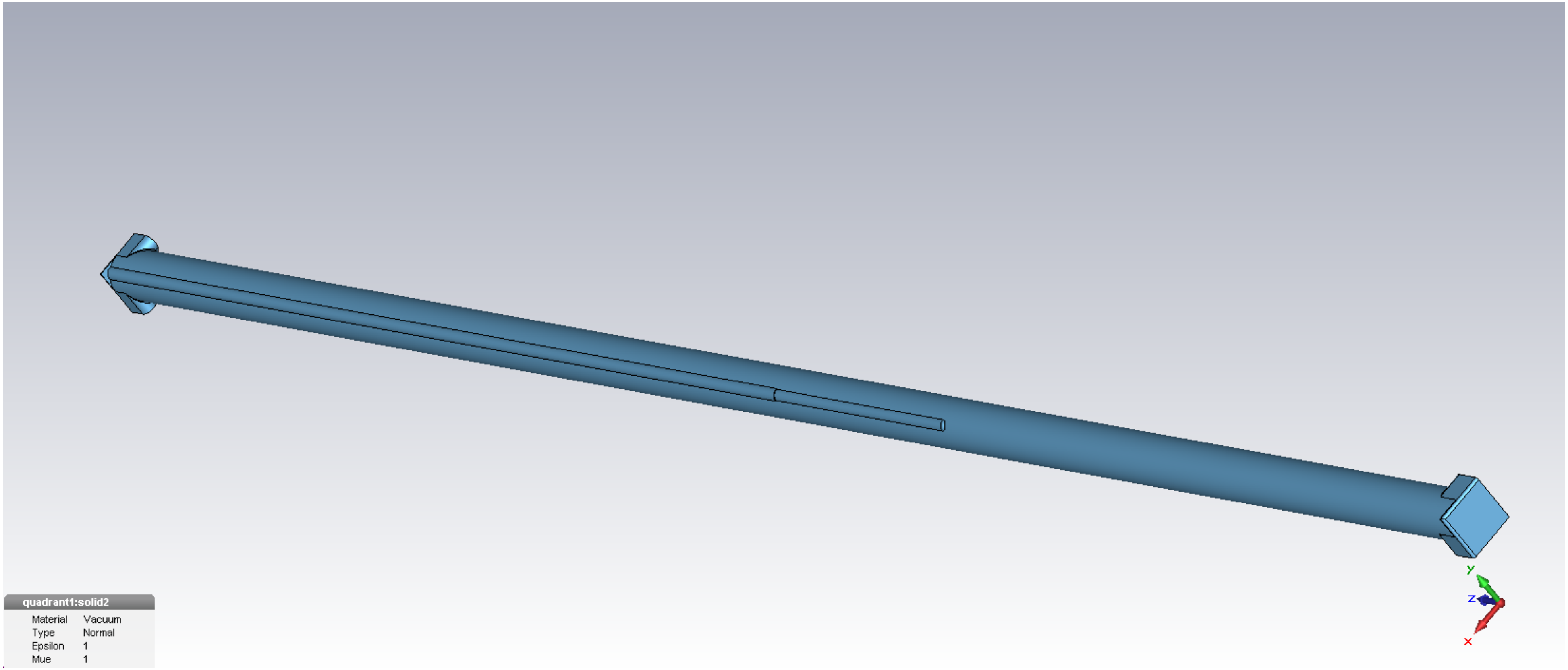


Frequency = 324.196 MHz

... and the field is anything but flat.



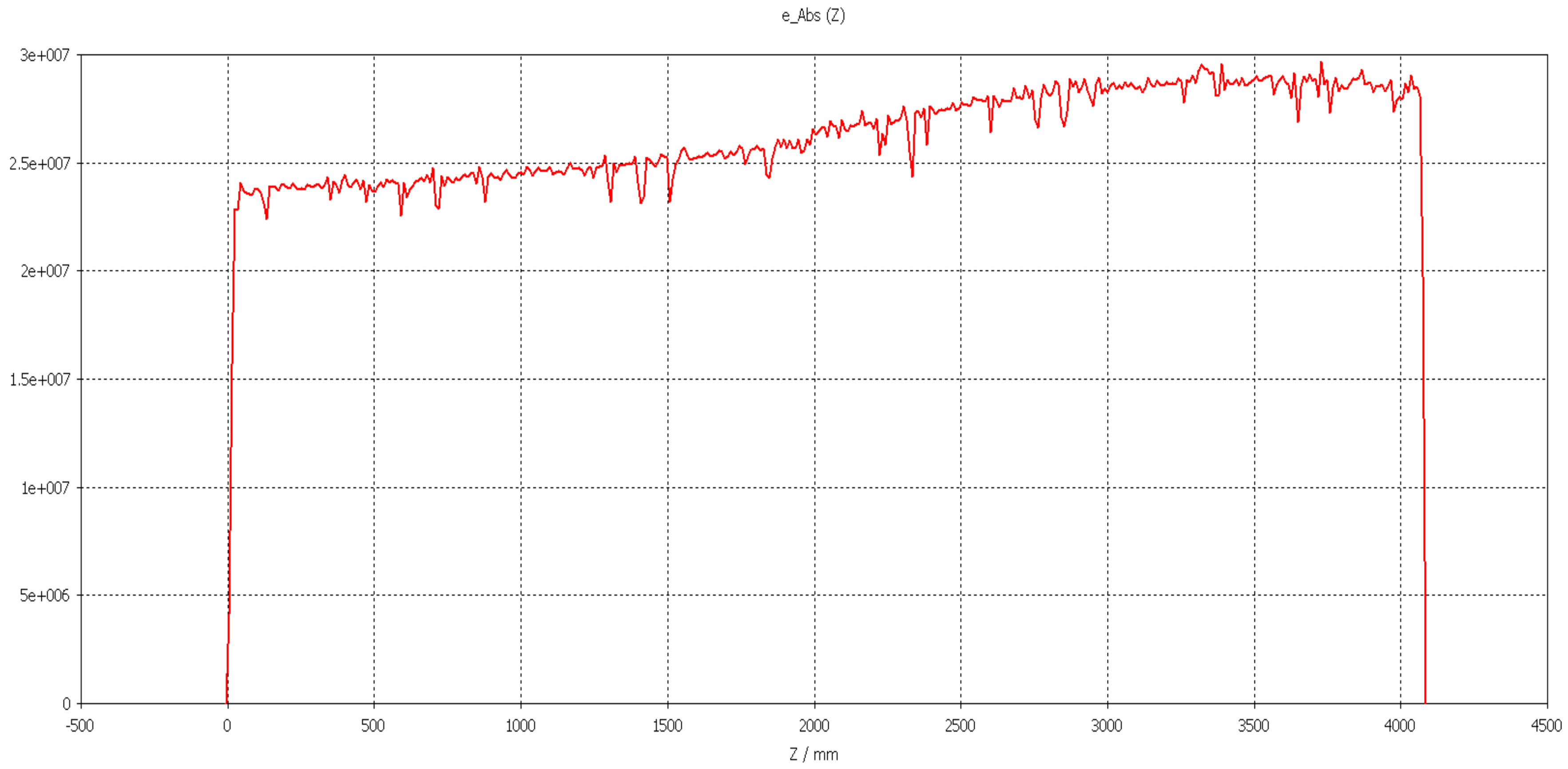
Step 4: Add the tuning grooves.



Frequency = 323.194 MHz.

Slightly lower than the 'untuned' model.

The field is not quite flat consistent with a low frequency at the high energy end.



The tuning grooves may be slightly too deep.

Next steps:

- Add tuners to the model
- Raise the frequency to 324.0 MHz
- Check tuning algorithm to see if it can take out the field tilt introduced by the grooves
- Evaluate the possible range of tuning/flattening