RFD cavity antennae
Thermal and transport evaluation – New designs

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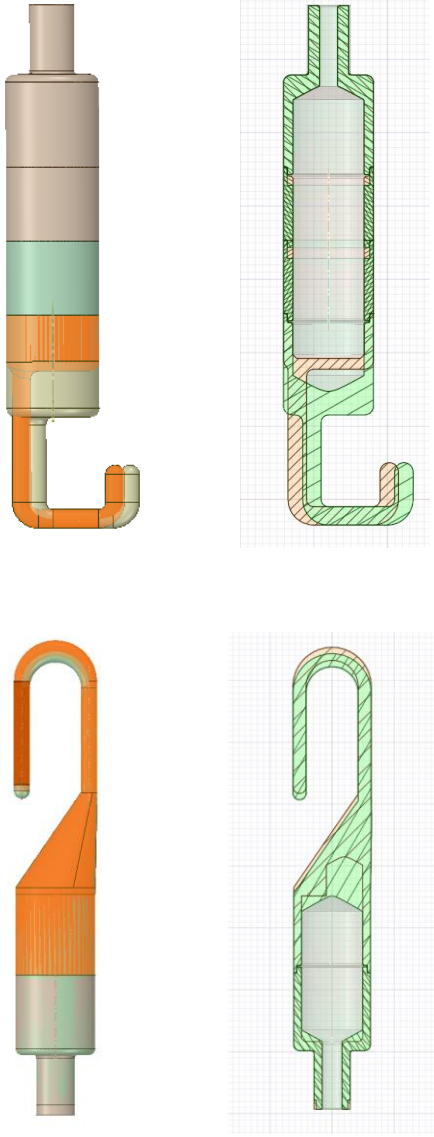
Introduction

- Thermal and transport evaluations of the PU, VHOM and HHOM antennas.

- Last models provided by Frida.
  - **New designs in orange.**
  - **Previous designs in green**

- Thermal evaluation:
  - Pickup in copper
  - VHOM in copper body + Nb hook – Effect of moving the Nb boundary
  - HHOM in Nb

- Thermal evaluation accounting for the temperature-dependency of material properties.



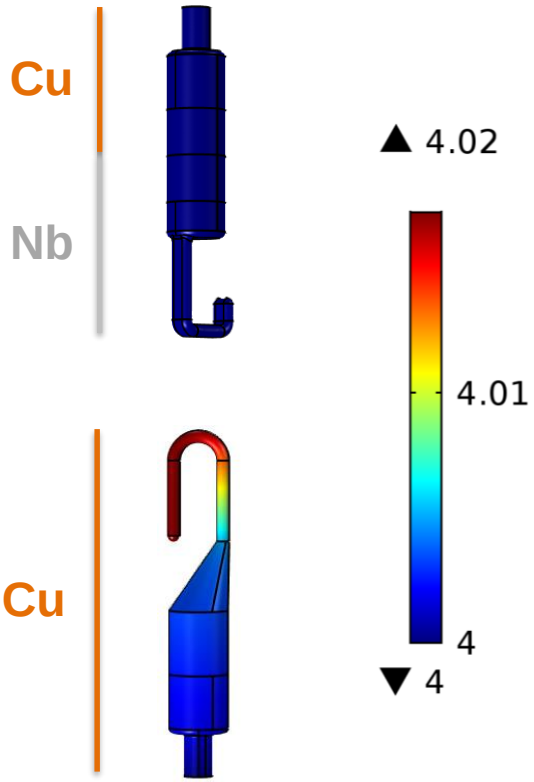
Numerical conditions

- Material properties – Electrical and thermal conductivities **dependent with temperature**
  - Initial temperature of 4 K
  - Energies: 0.93, 10.7, 15.6, 23.5 J – Corresponding to ~1, 3.4, 4.1, 5 MV
  - Niobium thermal conductivity: Padamsee (no phonon peak – conservative)
  - Niobium electrical conductivity: Jamie data with (BCS) and residual resistance – 20 nOhm
  - Copper thermal conductivity: Cryocomp RRR90
  - Copper electrical conductivity: Calculated so that Rs=1 mOhm (constant as it is constant in the 2 K – 15 K range) – Anomalous skin effect considered.

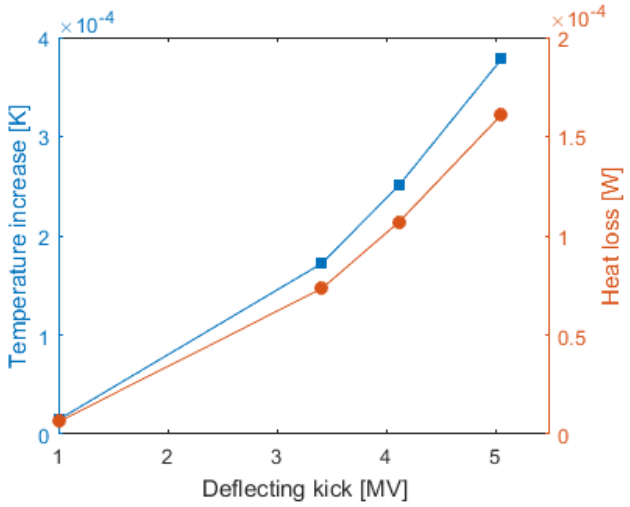
Thermal analyses – Nominal design

PU & VHOM

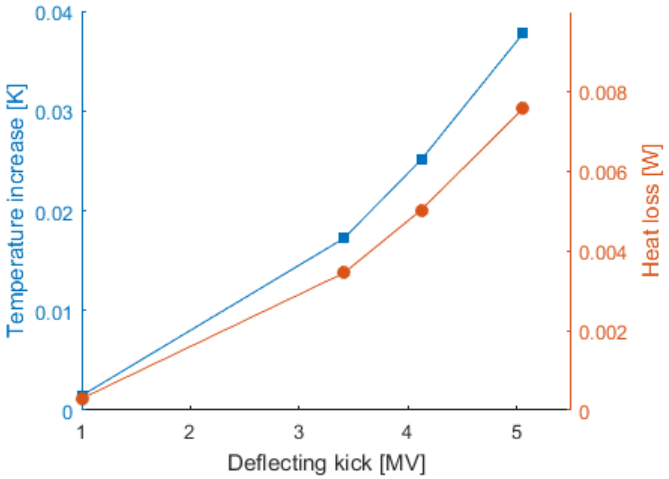
Surface temperature [K] – 3.4 MV



VHOM



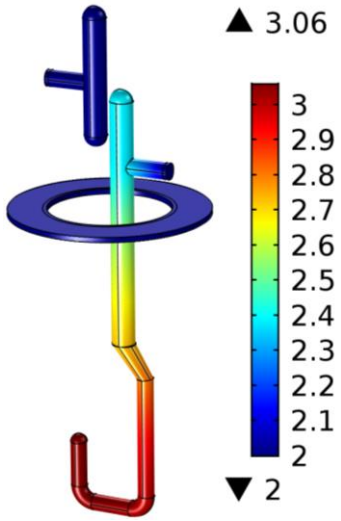
Pickup



Heat loss PU = 3.4 mW
VHOM = 0.07 mW

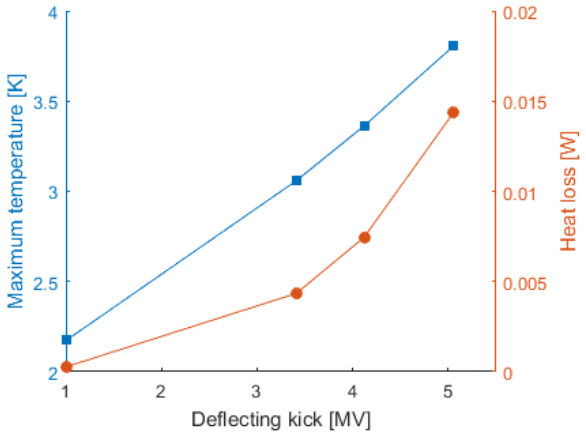
Thermal analyses – Nominal design

Surface temperature [K] – 3.4 MV

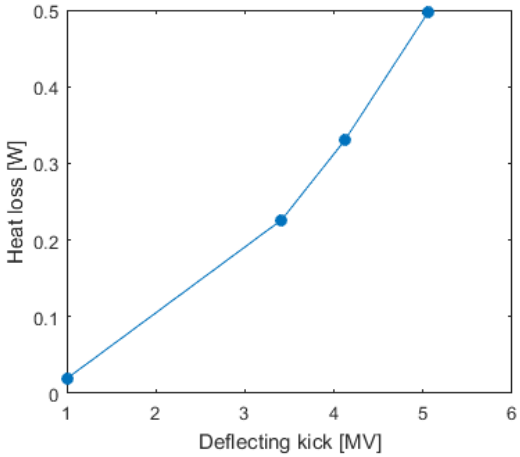


HHOM + 3 mm copper gasket

Nb antennas



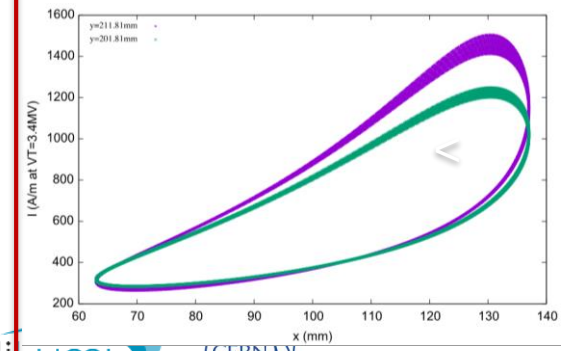
Copper gasket heat loss

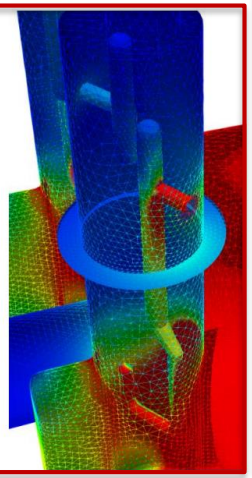


Heat loss = 4.3 mW (Nb hooks + can) + 226 mW (copper gasket)

by Z. Li

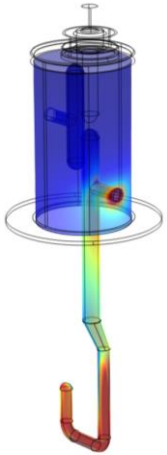
Current on gasket

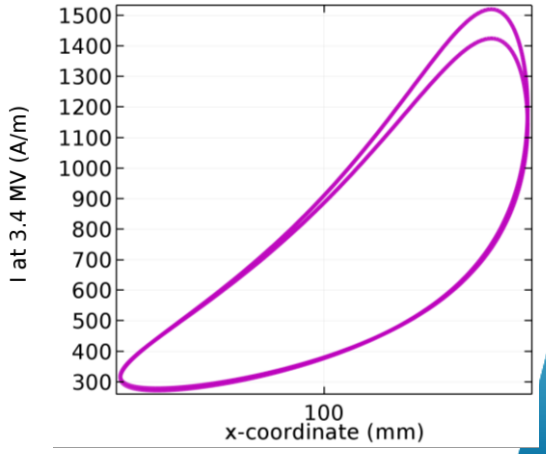




by E. Cano

Current on gasket

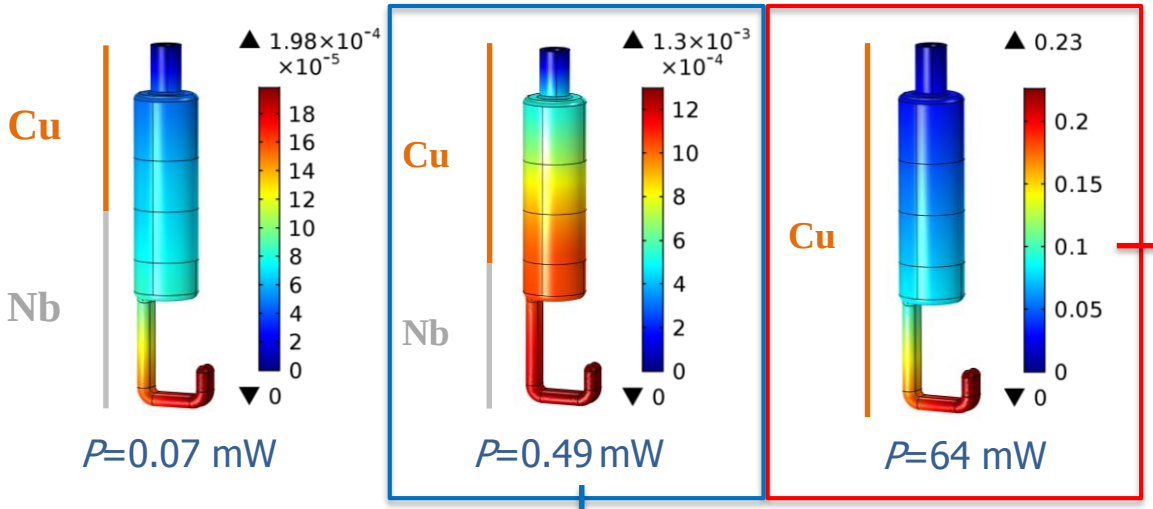


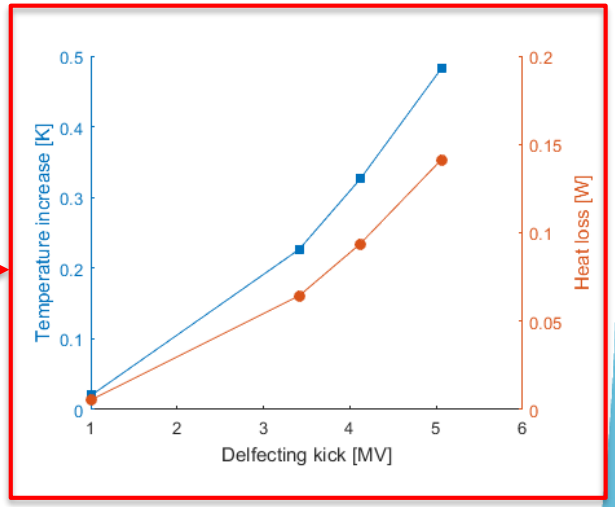


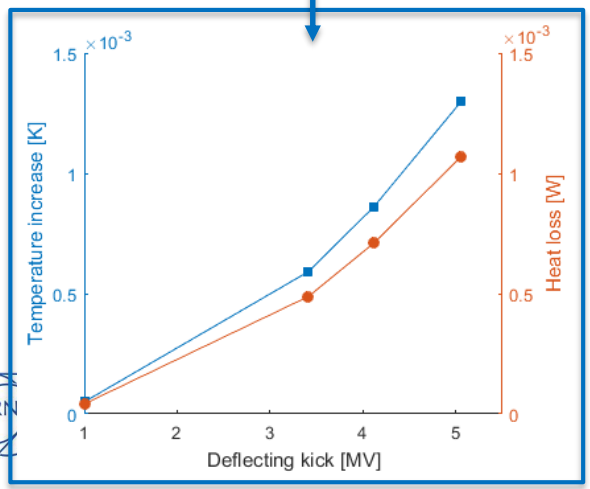
Thermal analyses – Nominal design

- VHOM sensitivity to Nb-Cu boundary position

Temperature increase distribution for 3.4 MV deflecting kick [K]







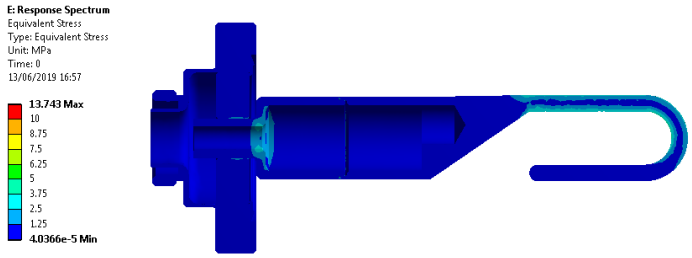
- Reducing the amount of Nb does not significantly affect the maximum temperature and heat loss.
- **A hook in Nb significantly reduces the heat loss necessary**

Transport analyses

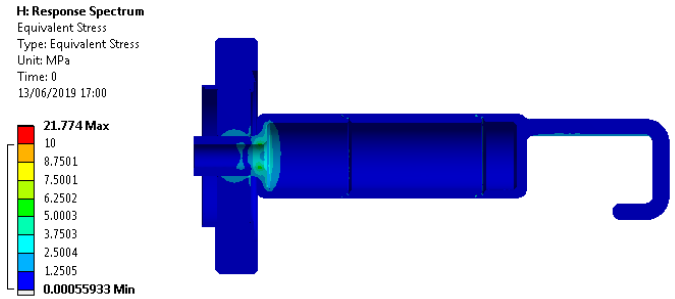
- Shock of 10g, 20 ms as previous analyses
- Random vibration as previous analyses

PU & VHOM

First mode: 367 Hz

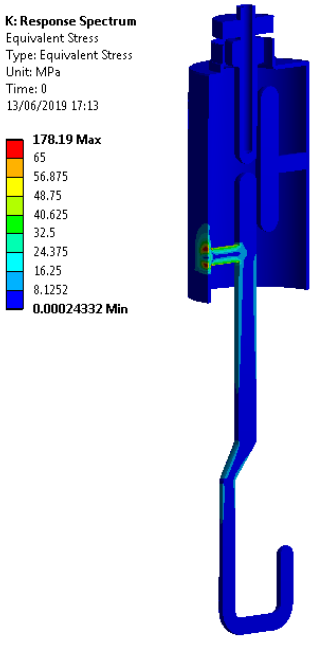


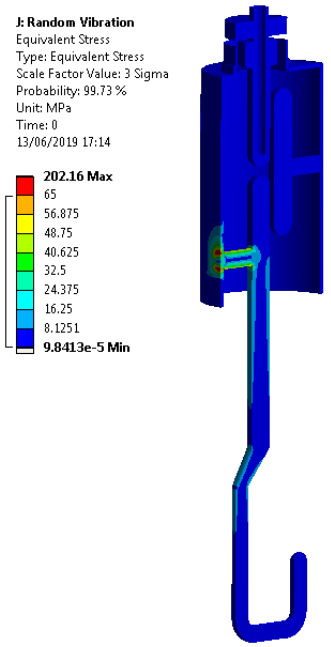
First mode: 385 Hz



- Maximum values in the Cu-Al2O3 border
- Random vibration presents values a factor of 3 smaller

HHOM

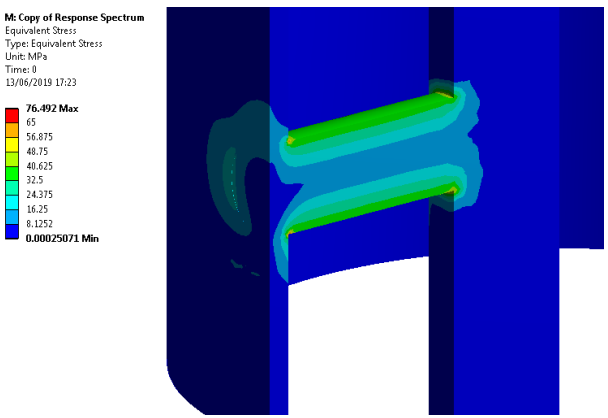




- First two modes: 66 Hz (parallel to the hook) and 70 Hz (perpendicular)
- Contact region of the antenna is critical

Results - HHOM

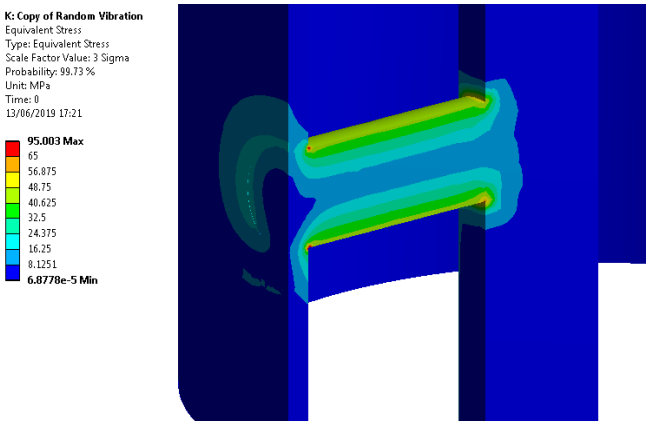
- Shocks in the direction parallel to the hook are more critical than in the perpendicular direction

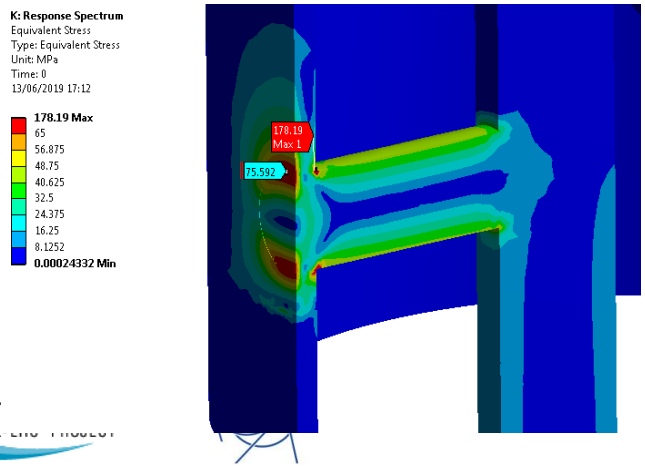


Parallel

Shock ←

Vibration →

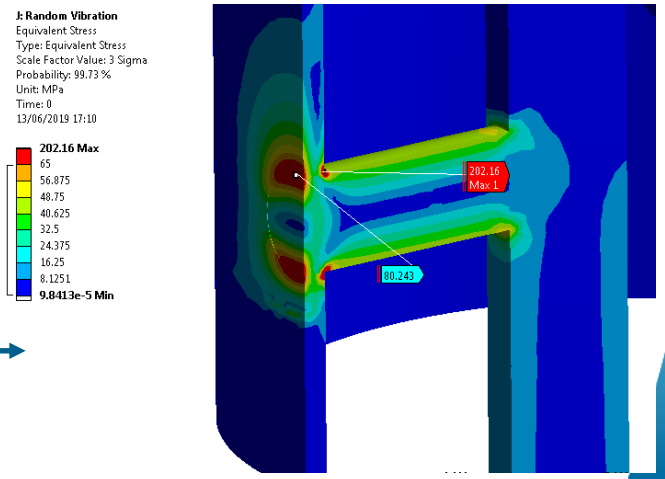




Perpendicular

Shock ←

Vibration →



Thank you for your attention!