EDMS 2114211
DQW Pickup thermal evaluation
Hook and mushroom antennas

Eduardo Cano
CERN, EN-MME

Introduction

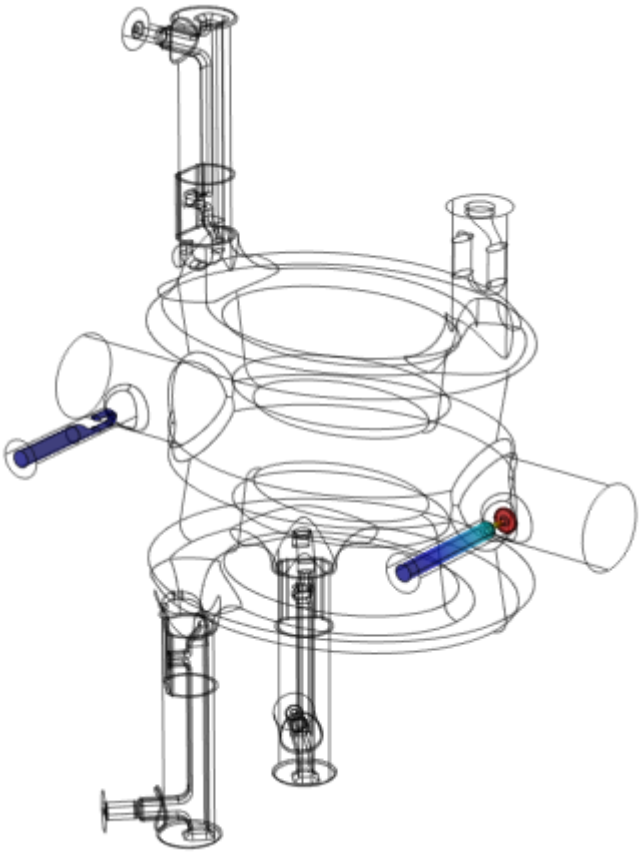
- Thermal studies on DQW pickup antennas.
  - Comparison of three software and pro/cons of each of them + Thermal performance of new design of DQW pickup antenna.

    Software compared:
    COMSOL, CST and ANSYS-HFSS

    EDMS 2053005 - Released

  - This work: Thermal performance of DQW antennas for different conditions.

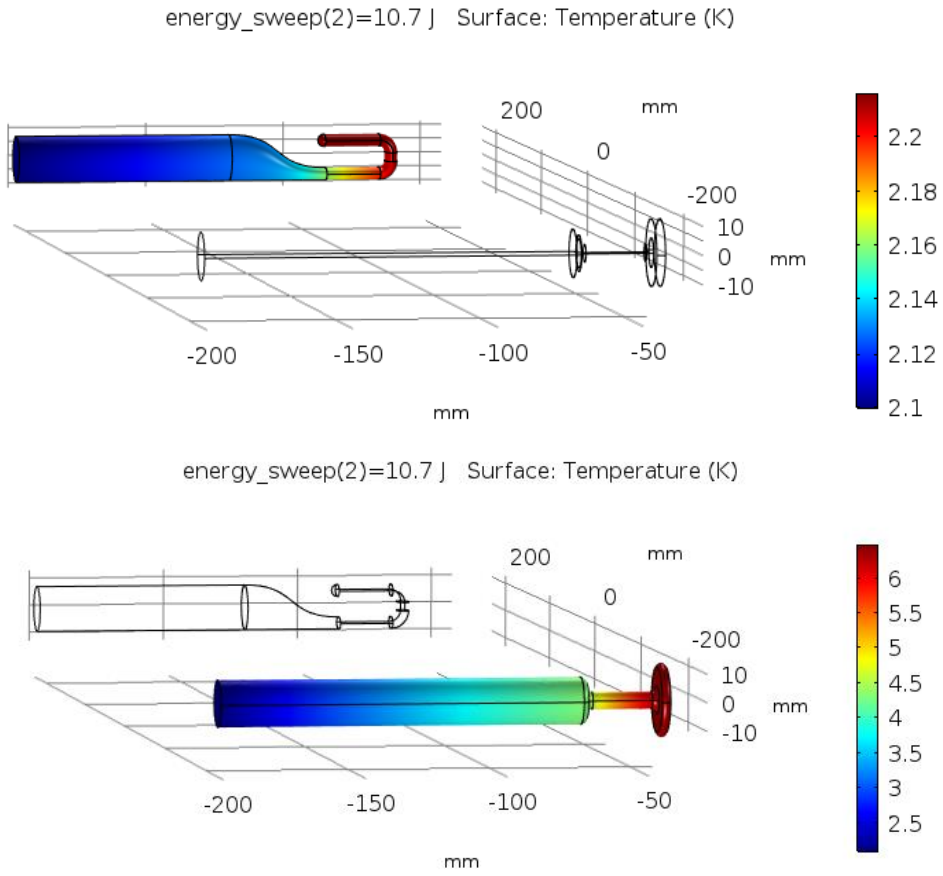
    3D model: EDMS1347072



Previous studies

Evaluation of the maximum temperature and heat loss as a function of the deflecting voltage with the two antennas in Cu. Solid antennas.

Copper RRR90: - Constant electrical conductivity,
- Thermal conductivity dependent with T

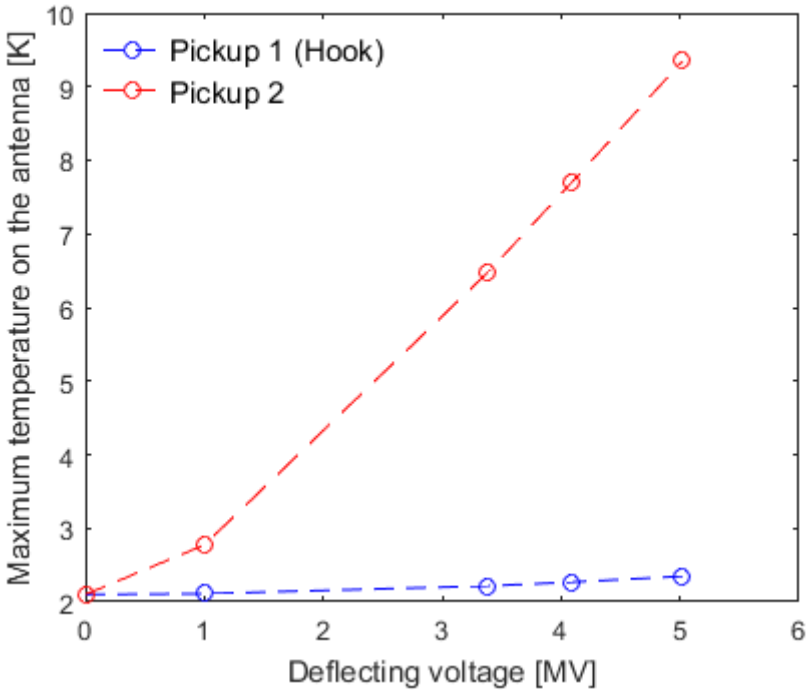


Evaluation of the second antenna

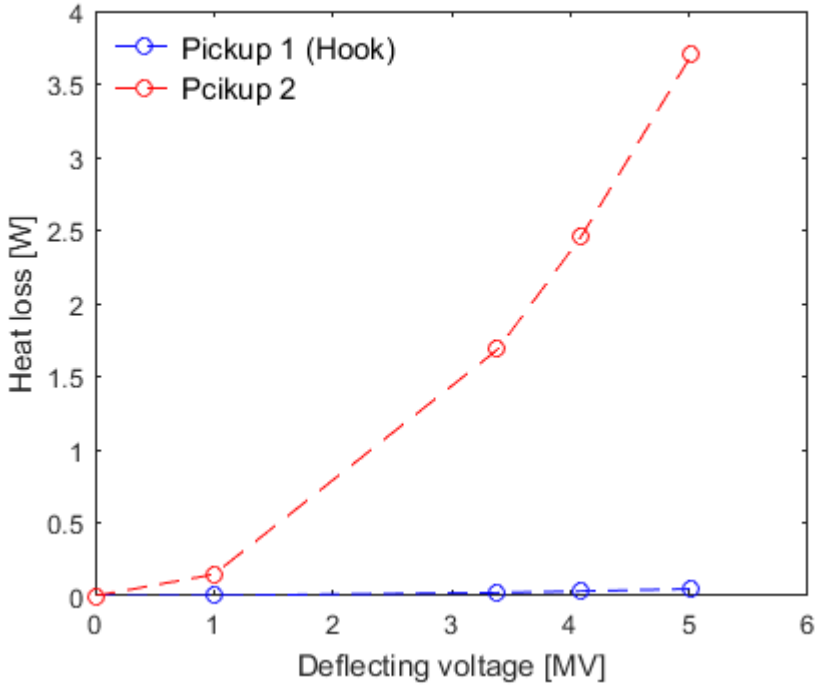
The heat loss if the mushroom antenna is done only in copper is at the level of Watts, whereas the other remains in mW.

Need to implement mushroom antenna in Nb + Cu

Maximum temperature on the antenna



Heat loss of the antennas



Numerical conditions

- Conditions tested in the present study:

  1. Hook in Cu, mushroom in Nb (39 mm) + Cu
  2. Effect of solid/hollow (1.5 mm wall) pickup antenna
  3. Effect of penetration of +5 mm inside the cavity
  4. Effect of hook in Cu + Nb (59 mm - until the end of the curvature of the hook)

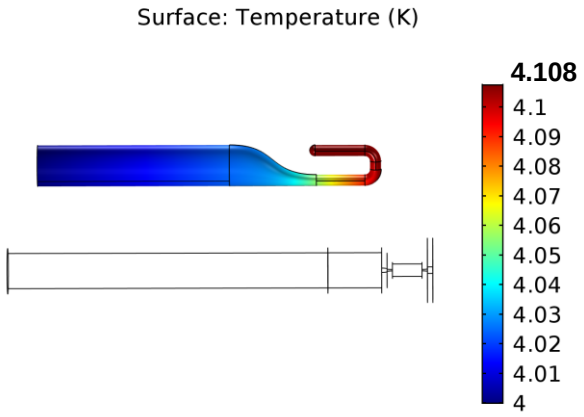
- Material properties – Electrical and thermal conductivities **dependent with temperature**

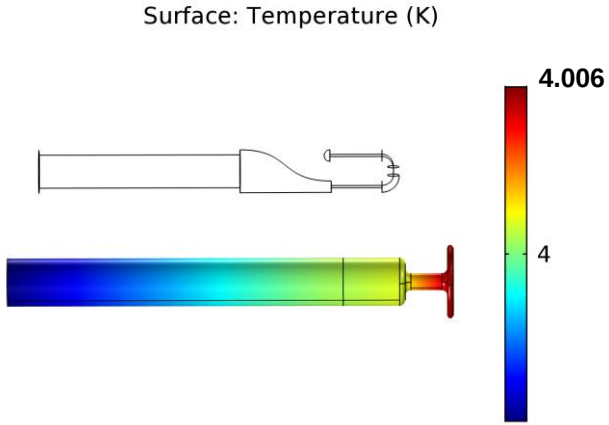
  - Initial temperature of 4 K
  - Energy 18.74 J ~ 4.5 MV
  - Niobium thermal conductivity: Padamsee
  - Niobium electrical conductivity: James Mitchell data – 20 nOhm
  - Copper thermal conductivity: Cryocomp RRR90
  - Copper electrical conductivity: Calculated so that Rs=1 mOhm **(constant** as it is constant in the 2 K – 9 K range)

Pickup thermal analyses – Solid pickup

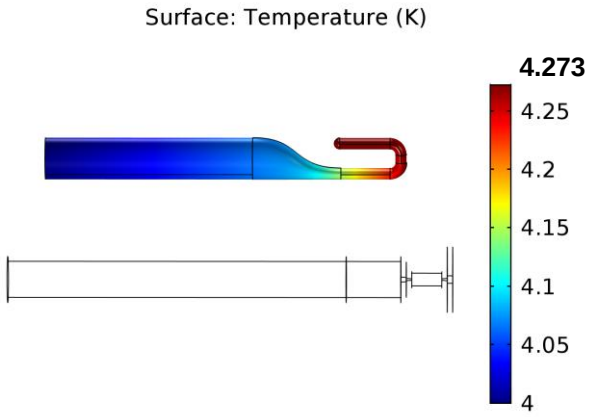
- Hook in Cu, mushroom in Nb (39 mm) + Cu (line in the figures below)

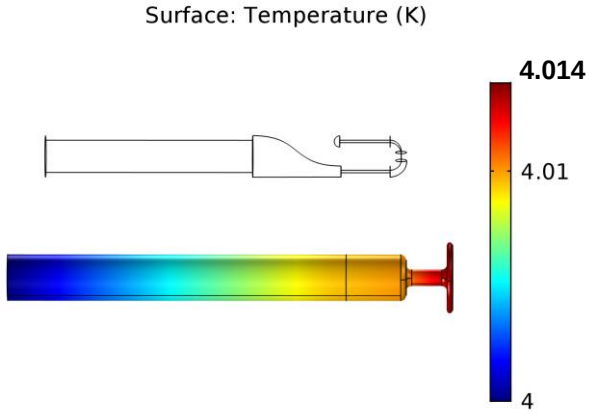
Nominal position





Additional penetration of 5 mm

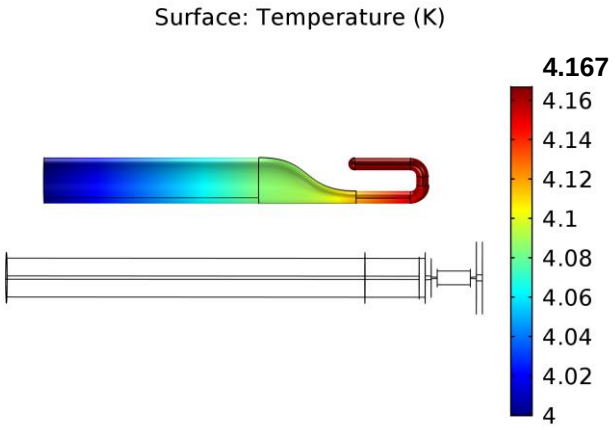


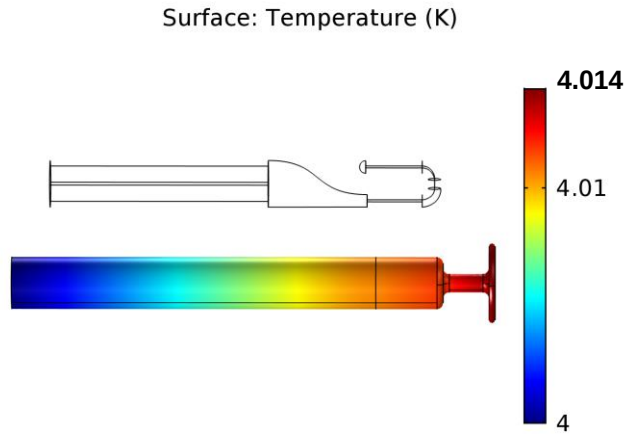


Pickup thermal analyses – Hollow pickup

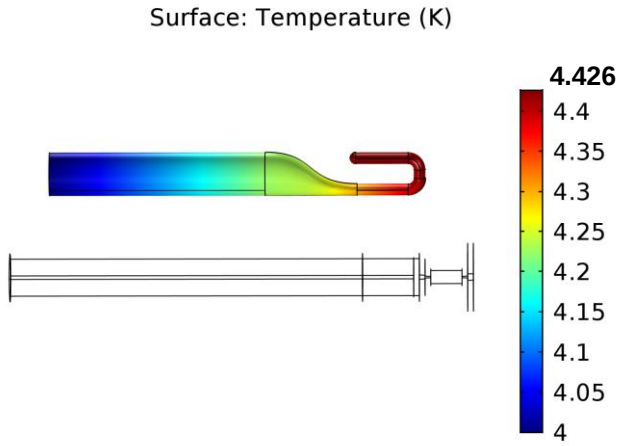
- Hollow pickups with 1.5 mm thickness in the wall
- Hook in Cu, mushroom in Nb (39 mm) + Cu

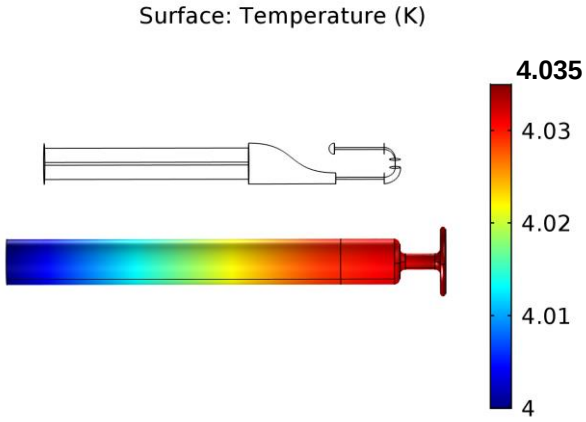
Nominal position





Additional penetration of 5 mm





Pickup thermal analyses – Hollow pickup

Nominal position

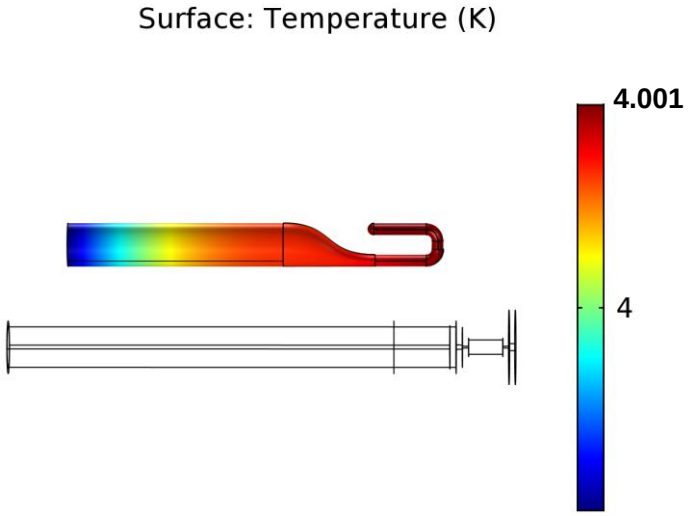
	Hook		Mushroom	
	Solid	Hollow	Solid	Hollow
Maximum Temperature [K]	4.108	4.167	4.006	4.014
Heat loss [mW]	37.7		4.3	

Additional penetration of 5 mm

	Hook		Mushroom	
	Solid	Hollow	Solid	Hollow
Maximum Temperature [K]	4.273	4.426	4.014	4.035
Heat loss [mW]	96.3	96.2	12	

Pickup thermal analyses – Hook in Nb + Cu

- Worst case conditions are those in which the hook is hollow and has an additional penetration of +5 mm. Hook in Nb until the end of curvature (59 mm), then Cu



Negligible temperature increase in the hook

Heat loss in the hook = 0.75 mW

Both the temperature increase and the heat loss are very reduced if the hook if its tip is done in Nb.

Conclusions

- The temperature distribution and heat loss in the hook and mushroom antennas of DQW was evaluated for different conditions:
  - Hook in Cu or Nb + Cu
  - Mushroom in Nb + Cu
  - Hollow and solid antennas
  - Additional penetration of 5 mm towards the cavity
- The worst case conditions are those in which the hollow antenna has an additional penetration towards the cavity axis of 5 mm.
- With antennas in Cu + Nb in the worst case conditions tested the maximum heat loss would take place in the mushroom with a value of 12 mW and a negligible temperature increase.