# INVESTIGATION ON HYPERSONIC STAGNATION POINT HEAT TRANSFER

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Space vehicles re-entering a planet atmosphere experience extreme hypersonic flight conditions; a bow shock is created and the high temperatures reached (around 10 000 K) can originate dissociation and ionization in the flow. Downstream the bow shock, closer to the wall of the space capsule - where the temperature is lower - a thermal boundary layer is formed and due to this, particles will recombine in the boundary layer and in the wall.

Particle recombination at wall must be avoided as much as possible: a proper material has to be designed in order to shield the space capsule – *TPS* (Thermal Protection System). The catalycity of these kinds of materials are as important as it is the design of the nose shape. The higher the catalycity material that covers the vehicle, the higher will be the particles recombination and therefore the values of heat transfer at the vehicle wall.

For accomplishing the target of designing a suitable heat shield for the space capsule, the stagnation point heat is one of the critical points of the *TPS* design that special attention had to be given. The *LHTS* methodology was applied; the facility used was the Plasmatron for being able to produce the same outer conditions. For determining the catalycity of the stagnation point is applied the *Minimax* method; for these computations heat flux measurements have an important role for the results to be obtained.

Thus, the aim for this project was to determine accurate heat flux measurements at stagnation point. For fulfil this target, it was used copper sensing elements: water cooled and non-water cooled to determine which was the most effective for heat flux measurements. Edge effects, ageing phenomena and different insulations configurations were also considered – lateral losses. The computation of uncertainties related to the different calorimeters was calculated as well it was observed the repeatability cases.

Several comparisons were made in order to determine the best configuration to be applied in future works with the aim of obtaining accurate heat flux measurements: calorimeters with different inside configuration and outside shape were compared with each others.

It was concluded that the best configuration for calibration to be applied is the copper slug (non water cooled) calorimeter without edges: the combination of higher heat-flux values measured with the fact of not having possible internal problems and the uncertainty related to the measurement been lower were fundamental for the choice of this calorimeter. A remark to mention that all the different insulators configurations tested were comparable with each others.

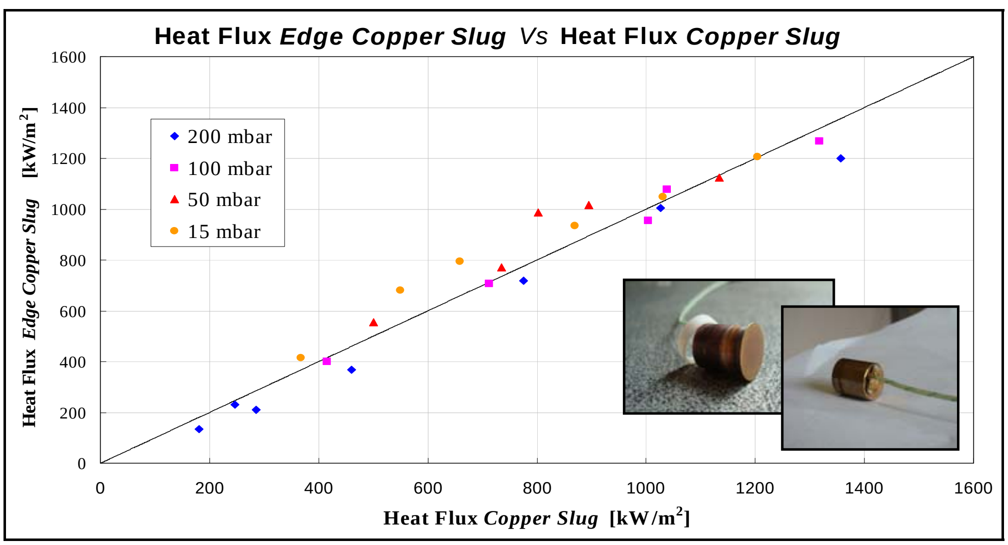


*Figure 1 – Example of a plotting for two calorimeters with different outside shape but the same inside configuration.*