**TESLA REPORT**
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# Connections between TESLA cavities

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**Abstract :**

*A proposal is made to undertake a development procedure in order to simplify the design of the connections between cavities. Mechanical flexibility would come from niobium bellows integrated into the beam pipes of the cavities. The RF connection would be given by the niobium pipes without internal superconducting shielding. Vacuum seal could be obtained by cold working.*

## 1.SPECIFICATIONS

A *longitudinal flexibility* must be provided between two successive cavities to take care of several effects :

| | |
|---|---|
| - dispersion of cavity length after field flatness procedure : | ± 5 mm |
| - differential thermal shrinkage of cavity versus helium vessel : | - 1,5 mm / cav. |
| - separate cold tuning of cavities : | ± 1.5 mm |

The change of length between two cavities must then be supported by a bellow within **a range of 13 mm**. The deformation effort on the bellow must remains lower than **100 N.**

The required *transversal* and *angular flexibility* due to non ideal shape of cavities will be provided by the same bellow.

A dust-free and pollution-free *vacuum tight sealing* must be provided between cavities.

*RF power coming from high order modes* must cross without heat losses the junction between cavities.

## 2. PRESENT DESIGN

The present TTF design shows a stainless steel bellow ended by two flanges requiring equivalent flanges at each end of the cavities.

One of us (A.M.) is developing a type of very simple niobium flange on the cavity in order to reduce its cost. If this effort does not succeed, we will have to use more classical and more expansive flanges. The problem is made more complicated by the requirement on the heat treatment of the cavities.

More, this stainless steel bellow does not fit the free propagation requirement of the high order modes power toward the end of the cryomodule where it must be damped at 70K. An inner superconducting sheet is supposed to bring the required shielding and to preserve the flexibility. has been designed for this purpose. Efficient electrical connections have then to be provided.

The present design is then a rather expensive device and sliding parts can generate dust particles. This could jeopardise the success of the project. For the TTF project, we could leave the shield out, if there is trouble.

## 3. PROPOSAL

Suppress the stainless steel bellow.

Provide the flexibility by niobium bellows as part of the cavity beam pipes. The HOM power is thus propagated provided that the loss factor remains within acceptable limits (see attached technical note).

Find and qualify a direct sealing of the cavities by cold working or welding the niobium ends together.

## 4. METHOD

Such a proposal requires more development time than what is allowed by the TTF planning. It is then recommended to start independently, in parallel, a program on this subject. The responsibility of such a program could be taken by a partner of the TTF collaboration which could finance it. It could reach its goal within 2 or 3 years and provide a substantial saving on the cost of the TESLA project.

Such a proposal could be submitted to the technical committee of the TTF collaboration.

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### Note concerning the loss factor of a Niobium bellow

*(by A Mosnier)*

The following diagram shows the value of the loss factor (V/pC) as a function of the number of waves of the bellow for 2 values of the gap between two successive waves. This loss factor must be compared to that of a Tesla cavity = 3.5 V/pC.

**N.B.:** Beyond 10 mm, the height of the bellow waves does not modify the value of the loss factor whereas the gap plays an important role : it must be kept as small as possible. So, if we take a 7 wave bellow ( acceptable for a flexibility range of ±6.5 mm) with a 3 mm gap, the loss factor is 1.05 V/pC. It represents an increase in the HOM losses of 1.05/8.5 = 12%, which is acceptable.