# A SUPERCONDUCTING ACCELERATING TEST MODULE FOR THE EUROPEAN SPALLATION NEUTRON SOURCE

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*Abstract*

In 1993 a multinational study group started to evaluate the feasibility for a next generation pulsed European Spallation Neutron Source (ESS) [1]. The beam is specified to have an average power of 5 MW at the target point with a repetition rate of 50 Hz. The final energy of the accelerated negative Hydrogen ions is 1334 MeV. The high energy part of the accelerator will consist of 168 5-cell cavities arranged in 7 groups in the beta range from 0.37 to 0.91. For the high beta cavities a superconducting option is planned [2].

A first superconducting accelerating module was designed and is currently under construction at ACCEL Instruments. The objective is to study the performance of the cavity and the cryomodule. The completed module will be delivered ready for cryogenic RF testing at Forschungszentrum Jülich (FZJ) in the summer of this year.

At present the cryogenic and rf supply for the test area is installed at FZJ. Besides the measurement of the cavit performance it is planned to study the influence of microphonics on the cavity and the rf stabilisation in pulsed mode operation. In a second step the rf equipment for high power coupler tests will be installed.

## 1 THE CAVITY

The module is equipped with a 500 MHz 5-cell cavity. The cell shape is optimised for a relative particle velocit of beta=0.75. The mechanical stability of the cavity was analysed by finite element calculations. The lowest eigenfrequency is well above 50 Hz.

For the manufacturing of the cavity high purity niobium sheet material is used. The Residual Resistivity Ratio

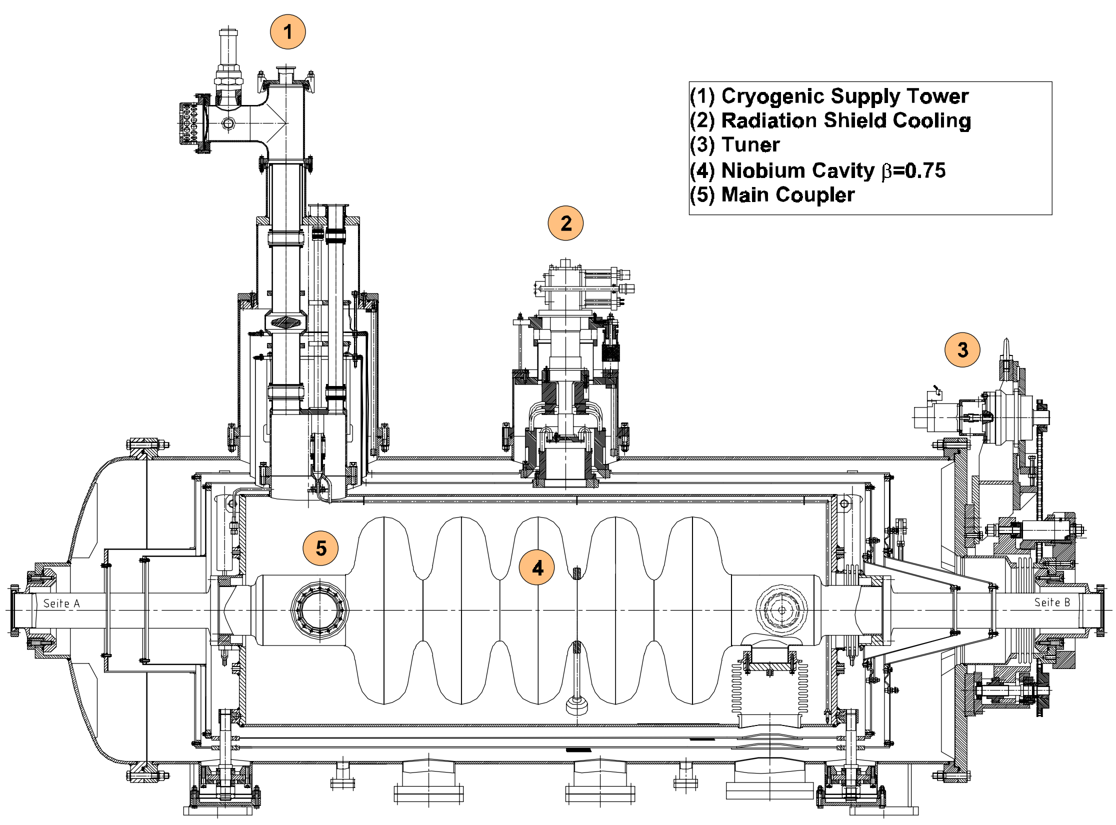


**Fig 1: Overview of the Cryomodule**

(RRR) is about 300. The individual half cells are formed by deep drawing from the niobium sheets. The half cells are joined together by electron beam welding.
All chemical preparation and assembly steps of the cavit are done at ACCEL facilities. The performance sensitive steps of the assembly will be carried out within a class 100 clean room.

Table 1: Cavity Parameters

| | |
|---|---|
| $f_0$ [MHz] | 500 |
| beta factor | 0.75 |
| Geometry factor [Ω] | 207 |
| $E_{peak}/E_{acc}$ | 2.6 |
| $H_{peak}/E_{acc}$ [mT/(MV/m)] | 5.6 |
| $ZT^2/Q$ [Ω/m] | 272 |
| Tuning range [KHz] | 600 |

## 2 THE CRYOMODULE

The cryostat (fig. 1) is based on ACCEL's design for the low loss cryomodules for the JAERI FEL Linac [3]. The two radiation shields are cooled by a Gifford Mc Mahon type refrigerator at the temperature levels of 20 K and 80 K. The static heat losses at 4.2 K temperature level are designed to be well below 3 Watt.
The tuner drive is mounted outside the cryostat. This simplifies the maintenance and increases the reliability of the tuning system. The tuning forces are transfered to the cavity by the beam tubes.

Table 2: Calculated Heat Load of the Cryomodule

| | Heat Load at Temperature (Watt) | | |
|---|---|---|---|
| | 4.2 K | 20 K | 80 K |
| beam tube A | 0.08 | 1.62 | 5.83 |
| beam tube B | 0.08 | 1.62 | 4.94 |
| main coupler | 0.74 | 3.90 | 5.69 |
| GF-UP support | 0.003 | 0.06 | 0.23 |
| radiation 80 K shield | | | 5.20 |
| radiation 20 K shield | | 0.32 | |
| radiation LHe tank | 0.1 | | |
| supply tower | 0.07 | 0.65 | 3.40 |
| rf cable | 0.42 | 1.65 | 1.70 |
| sum | 1.48 | 9.85 | 26.98 |

## 3 REFERENCES

[1] The ESS Technical Study Volume III, ESS-96-53-M
[2] Conceptual Design of the SC High Energy Linear H- Accelerator for the ESS, ESS-96-60-L
[3] M.Shibata, "Superconducting Rf Activities at JAERI", In Proc. of the 6th Workshop on Rf Superconductivity, Newport News, p. 124-130, 1993