MICRON

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1 Experiment overview

This research will be conducted in the context of the European [1] and U.S. (and international partners) Snowmass [2] Strategy for Particle Physics devoted to the "Advanced Accelerators Concepts and Technologies" for the next generation of cost effective, Dielectric (operating at optical wavelengths (1-5 μm) and Metallic (from Ka-band (36 GHz) to W-band (100-200 GHz)) High-frequency, High-gradients (>100 MV/m, beyond state of the art) Accelerating structures for research, industrial and medical applications.

For the Metallic structures, we proposed these objectives: • Design of metallic Ka-band and W-band accelerating structures at acceleration gradient >100 MV/m. "OPEN" (jointless) and "Four quadrants" RF cavity structures study. • Prototype manufacturing (R&D on material and welding techniques) • RF cold test at the RF Lab Latino [3], at INFN-LNF.

We performed the RF and beam dynamics (together with the INFN-Roma1 group) of the full structure made of 10 cells. The RF power is fed through a 4-port mode launcher [4], which was also optimized at 36 GHz. In tab.1 are reported the main RF parameters of the 10-cell Ka-band accelerating structure. In fig.1, it is shown the CAD model from CST Microwave studio [5] overlapped with the electric field distibution along the axis of the structure. The input power is roughly 6 MW in order to achieve an ccelerating gradient of 150 MV/m. In the figure, the color-plot E-filed distribution is also shown insied the whole structure and the mode launcher.

In fig.2, it is shown the reflection coefficient, S_{11}, at the input ractangular port of the waveguide of the mode launcher. The coupling with the operating mode is optimized to be about -27 dB.

The multicell structure and the mode-launcher device were machined and assembled in December 2023. In 2024, we acquired all RF components (e.g. coax-to-waveguide transition in Ka-band) and high-freqguency RF cables needed for the RF tests with low RF power at the RF Latino Lab in Frascati. The RF characterization of the whole structure is in-progress.

After receing some budget integration from CSN5, in 2024 we started the procurement for the production of samples made of different materials, i.e. copper-silver with low Ag concentration (0.4%-0.8%) that will be tested at KEK National Lab in Japan, within our international collaboration on high-gradient structures.

2 List of Conference Talks by LNF Authors

1. L. Faillace, F. Cardelli, M. Migliorati, V. Dolgashev and B. Spataro, The INFN MICRON project at LNF: Development of high-gradient metallic mm-wave accelerating structures, 15th Workshop on Breakdown Science and High Gradient Technology (HG2023), October 20, 2023.

Table 1: *Main RF parameters of the multi-ceel Ka-band accelerating structure.*

Parameter	Value
Radiofrquency, f [GHz]	35.982
Quality Factor, Q	5900
Shunt impedance, R_{sh} [MΩ/m]	130
Max Magnetic field, H_{max} [MA/m]	0.6
Max Electric field, E_{max} [MV/m]	400
Input RF power, P_{input} [MW]	6
iris aperture radius, a [mm]	2
a/λ	0.24
wall thickness, $t[mm]$	0.635
iris ellipticity	1.38
Accelerating Gradient, E_{acc} [MV/m]	150

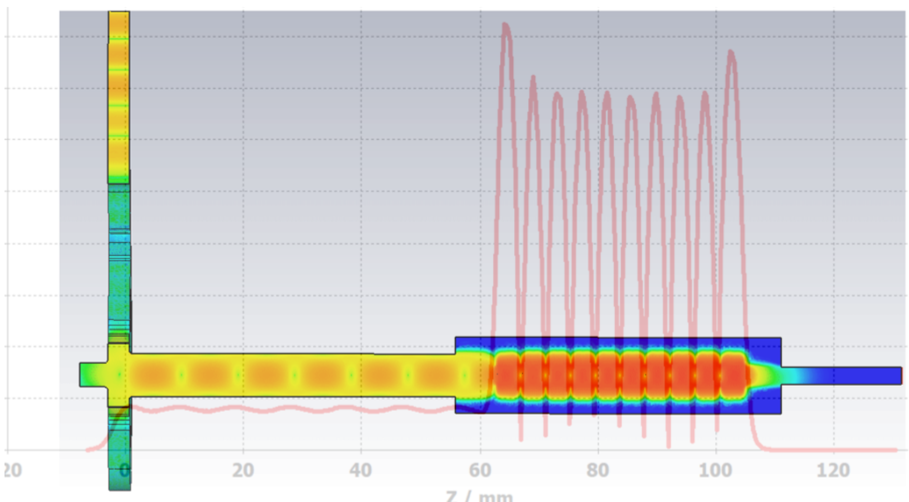

Figure 1: *CAD model from CST and electric field distribution inside the mode launcher and the RF structure.*

2. L. Faillace, G. Torrisi, MICRON - Opportunità e Applicazioni di strutture acceleranti miniaturizzate metalliche (banda Ka) e dielettriche (ottiche) Seconda Giornata Acceleratori, INFN-LNS, Catania, 02/03/2023.

3 Publications

- Faillace L., Bonifazi R., Carillo M, Dolgashev V., Giuliano L, Migliorati M, Mostacci A, Palumbo L and Spataro B., Design, Fabrication and Mechanical Tests of TIG-welded Ka-Band Accelerating Structures for Ultra-High gradient Applications, 14th International Particle Accelerator Conference,Venice, Italy, May 2023.

- Previous publications are reported in the References.

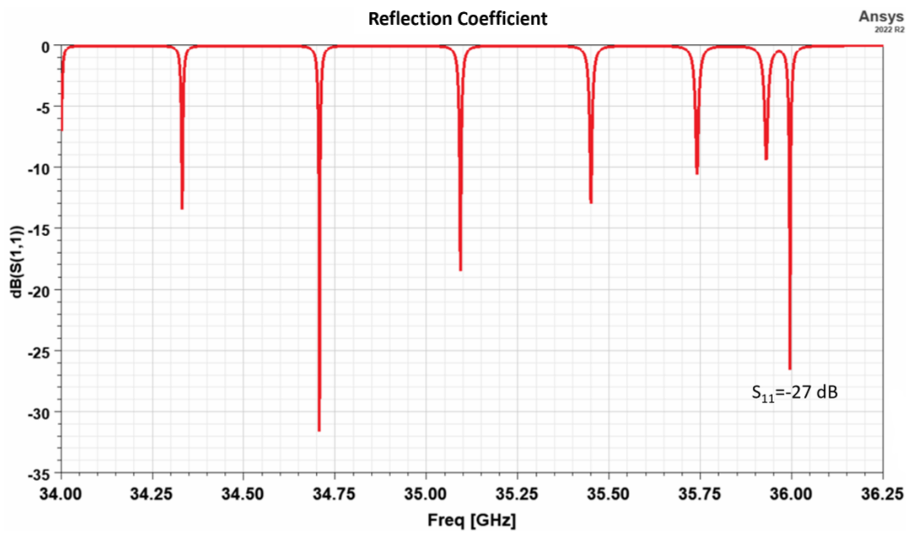

Figure 2: *Reflection coefficient, S_{11}, at the input ractangular port of the waveguide of the mode launcher.*

References

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5. https://www.3ds.com/products/simulia/cst-studio-suite
6. V. Dolgashev, B. Spataro, L. Faillace, R. Bonifazi, Innovative compact braze-free accelerating cavity, Jinst, September 19, 2018.
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8. Behtouei M, Faillace L, Migliorati M, Palumbo L, Spataro B. New Analytical derivation of Group Velocity in TW accelerating structures. InJournal of Physics: Conference Series 2019 Nov 1 (Vol. 1350, p. 012112). IOP Publishing.
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10. M. Behtouei, B. Spataro,' A SW Ka-Band linearizer structure with minimum surface electric field for the compact light XLS project', Nuclear Inst. and Methods in Physics Research, A 984 (2020) 164653

11. B. Spataro et al.,'A novel exact analytical expression for the magnetic field of a solenoid', Waves in Random Complex Media, 10 October 2020

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14. B. Spataro et al.,"The Ka-band High Power Amplifier Design Program of INFN', Vacuum 191 (2021) 110377

15. B. Spataro et al.,' Ka-band Linearizer for the Ultra-Compact X-Ray Free Electron Laser at UCLA', Nuclear Inst. and Methods in Physics Research, A 1013 (2021) 165643

16. M. Behtouei, B. Spataro et al, ' Relativistic Versus Nonrelativistic approaches to a low Perveance High Quality Klystron Matched Beam for a High Efficiency Ka-band Klystron', MDPI, 10 November 2021, Instruments 2021, 5, 33

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