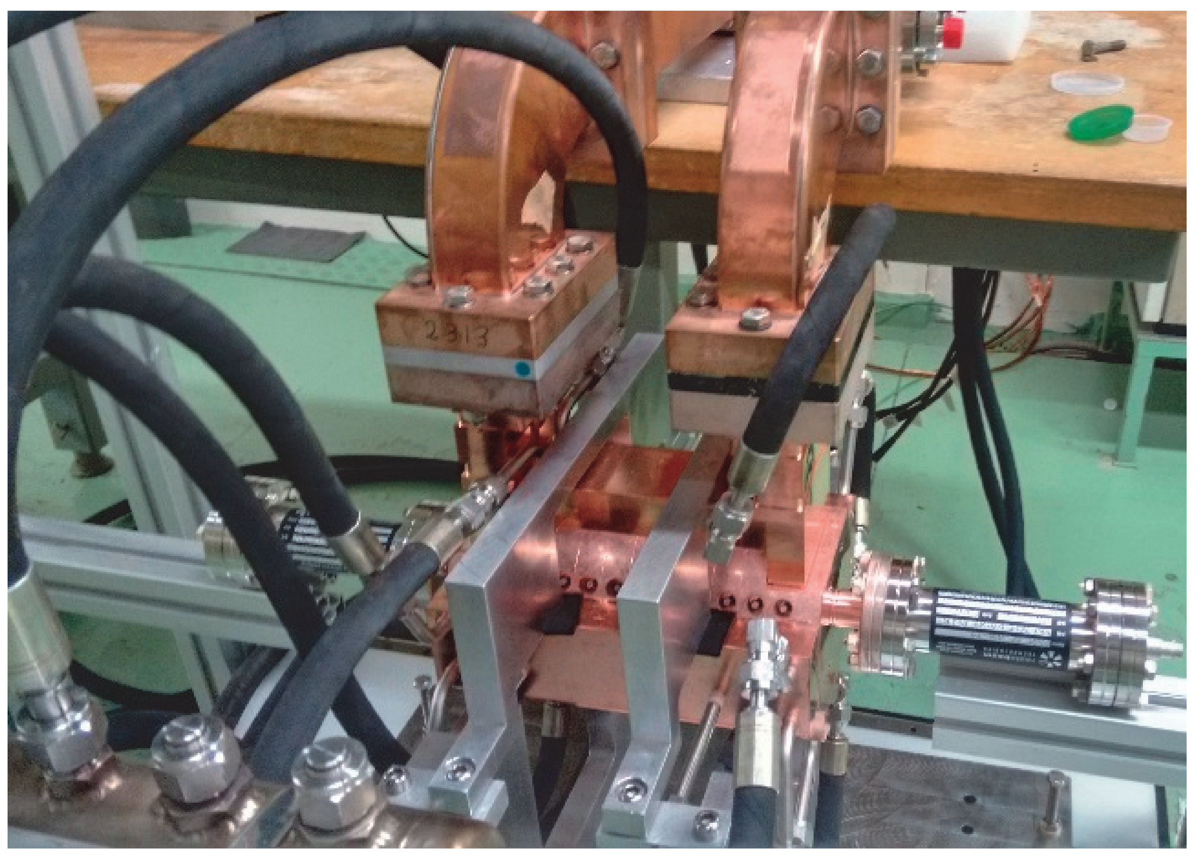
FABRICATION AND TESTING OF A NOVEL S-BAND BACKWARD TRAVELLING WAVE ACCELERATING STRUCTURE FOR PROTON THERAPY LINACS

S. Benedetti*, CERN, Geneva, Switzerland, and EPFL, Lausanne, Switzerland
T. Argyropoulos, C. Blanc Gutierrez, N. Catalan Lasheras, A. Degiovanni, D. Esperante Pereira, M. Garlasche', J. Giner Navarro, A. Grudiev, G. Mcmonagle, A. Solodko, M. Timmins, R. Wegner, B. Woolley, W. Wuensch,
CERN, Geneva, Switzerland
*email: stefano.benedetti@cern.ch



The prototype installed in CLIC CTF2

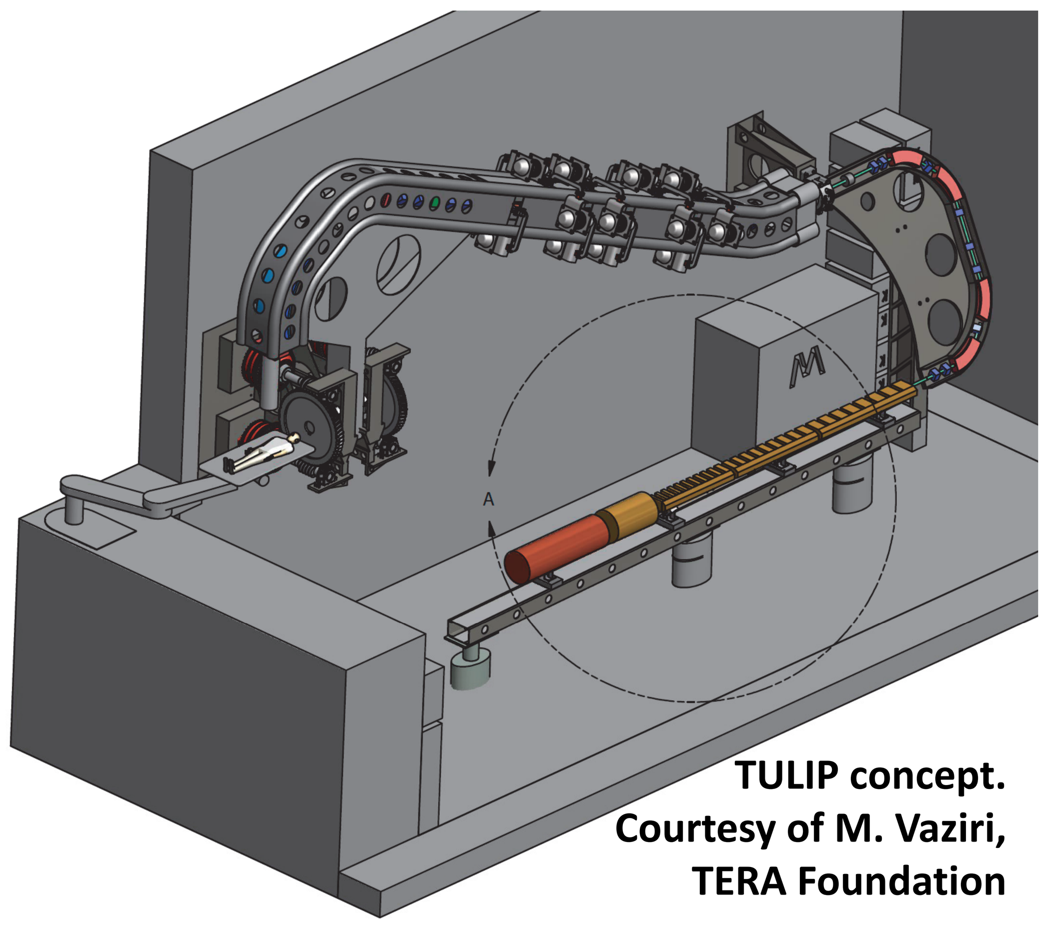
Introduction

A β=0.38 accelerating structure was designed and built to investigate the high gradient limits of S-band cavities

The RF design [1] followed a Modified Poynting Vector (S_c) model [2], that was experimentally verified by CLIC at 12 and 30 GHz

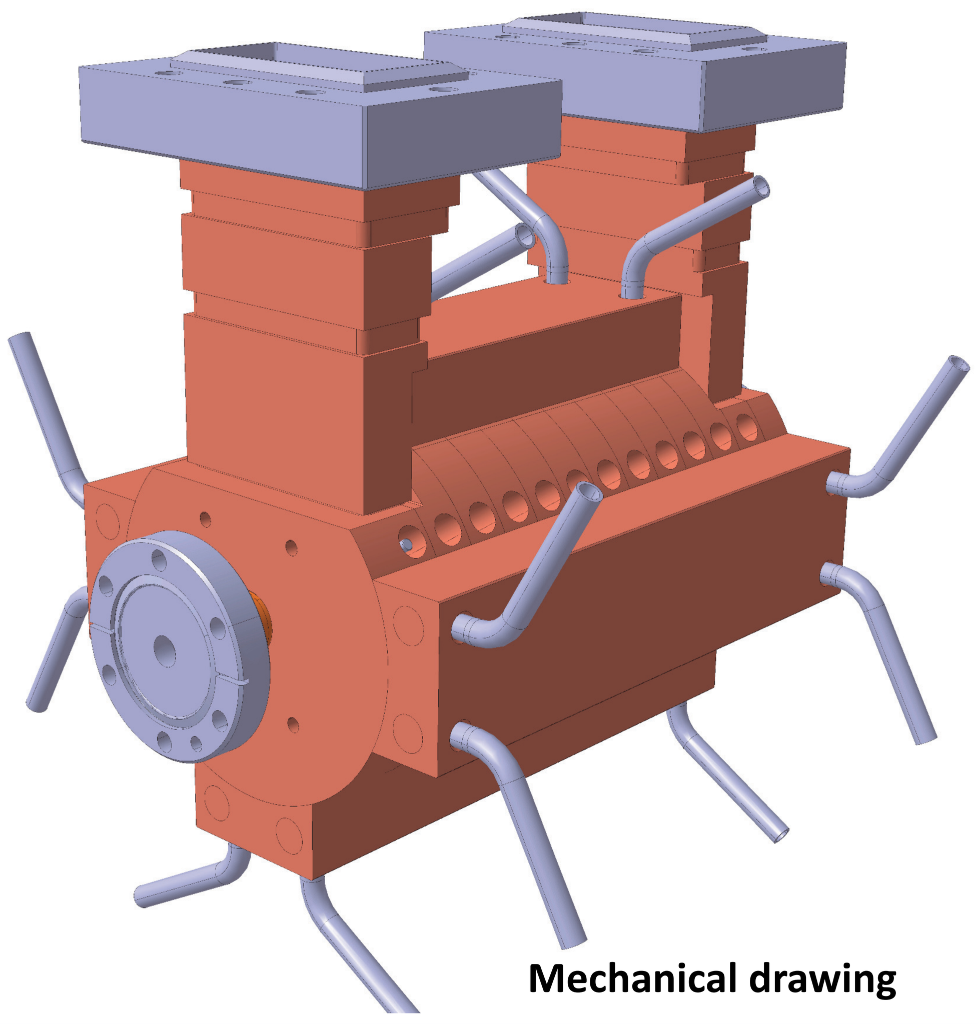
TERA Foundation addressed the issue at 3 GHz, showing preliminary validity of the S_c model at this lower frequency [3]

The prototype is installed in the test area and about to start the high power test



TULIP concept. Courtesy of M. Vaziri, TERA Foundation

Mechanical design

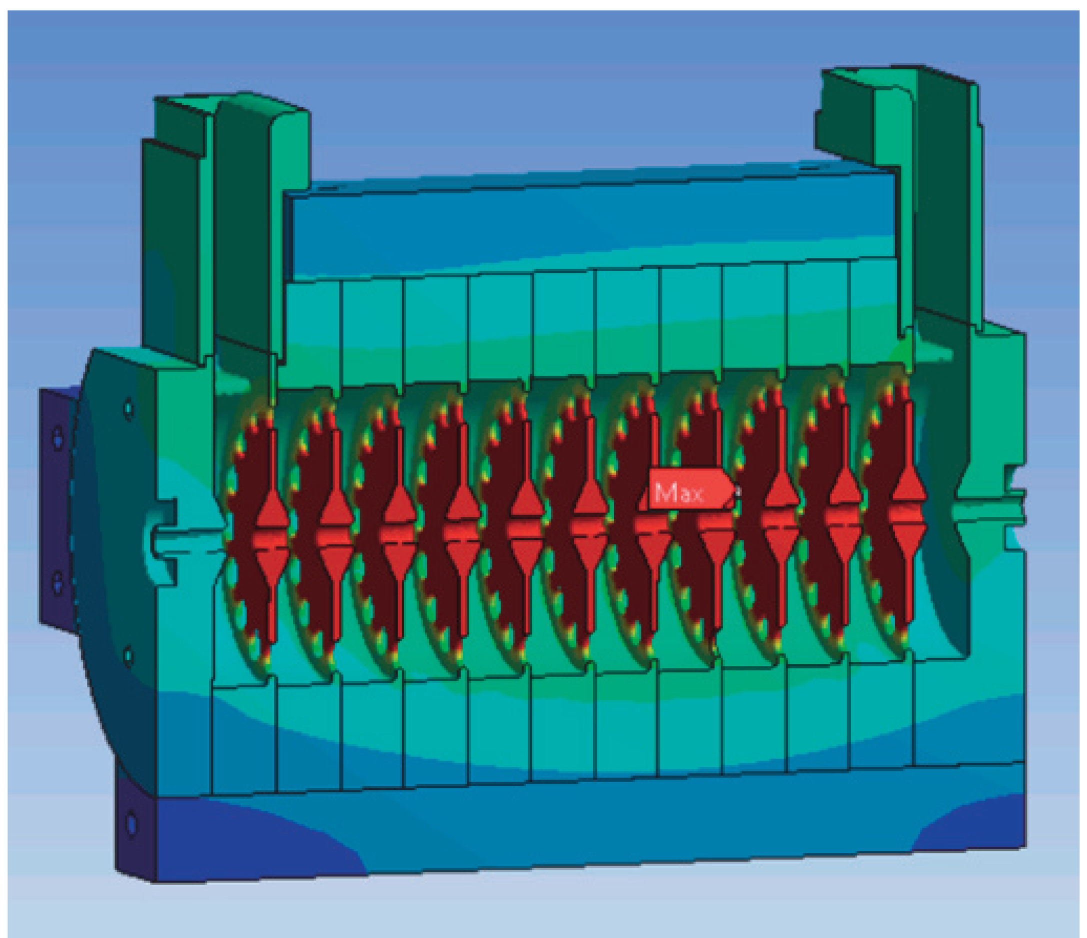


Mechanical drawing

An experimental campaign was performed to define the minimum inter-cell wall thickness to withstand the H2 bonding heat cycle creep-induced deformation

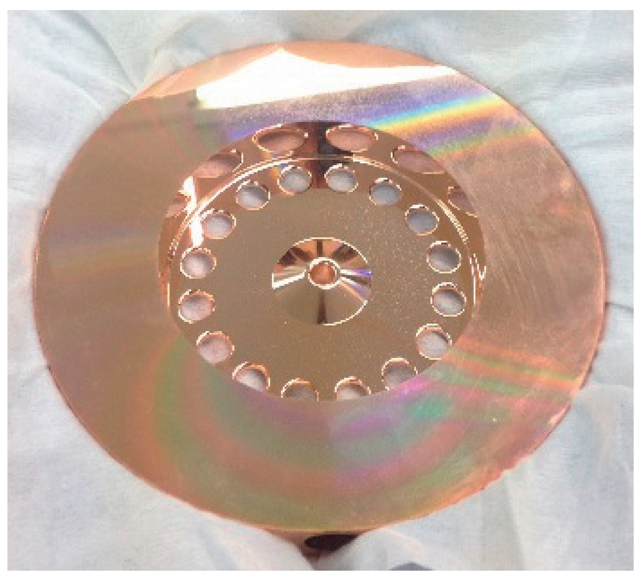
Each RF cell has four dimple tuners, following the RF sensitivity and tuning analysis. Diameter and wall thickness of dimple tuners was numerically computed and tested on mock-up cells

The heat dissipation is limited by the peculiar RF design. The maximum acceptable thermal load is 0.75 kW, mostly driven by coupling holes and wall thickness thermal resistance. Four cooling blocks were designed

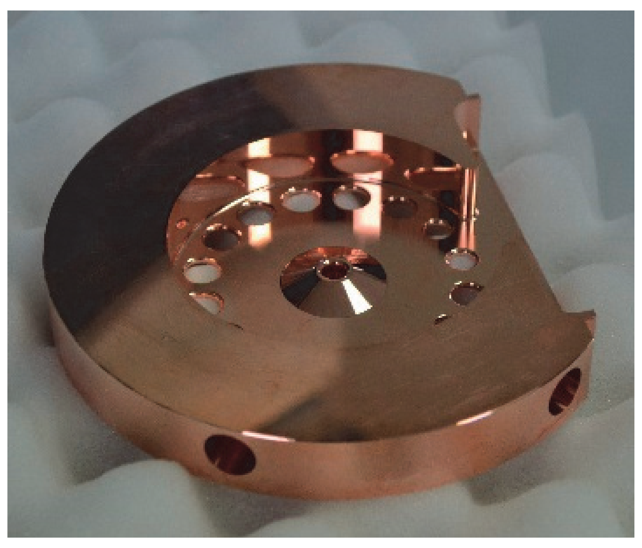


Coupled HFSS ANSYS thermal analysis

Fabrication



Regular cell



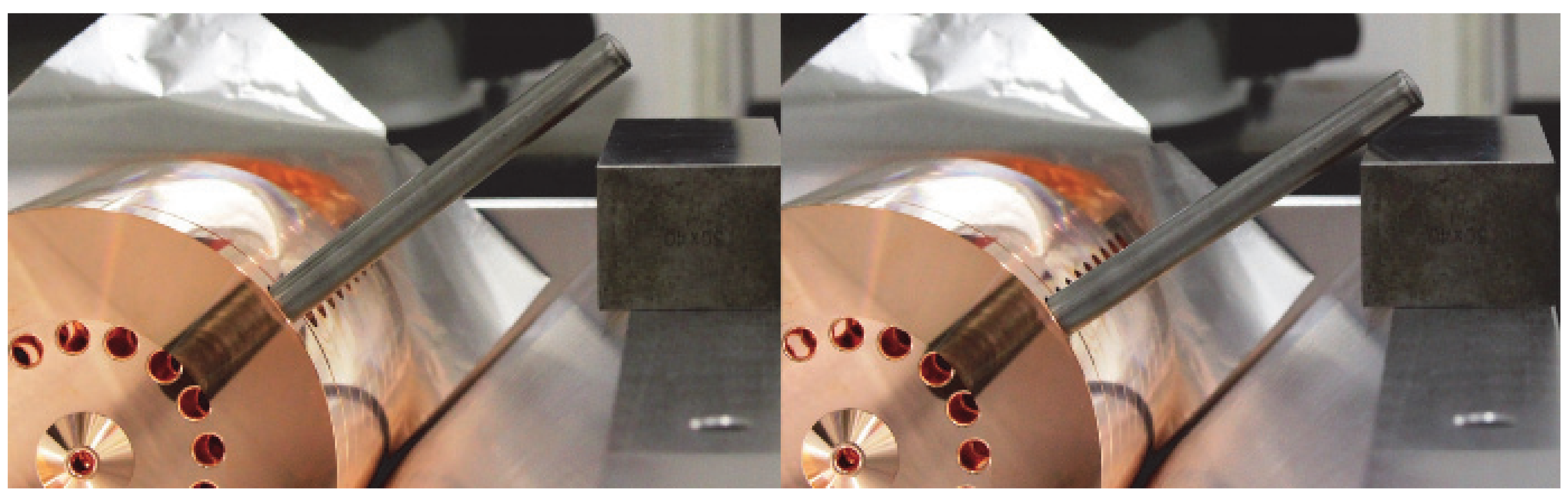
Input cell

Ultra-precision machined disks underwent visual and metrological inspection once they arrived at CERN

A LLRF test on clamped structure was performed to verify that the prototype was within the tuning range

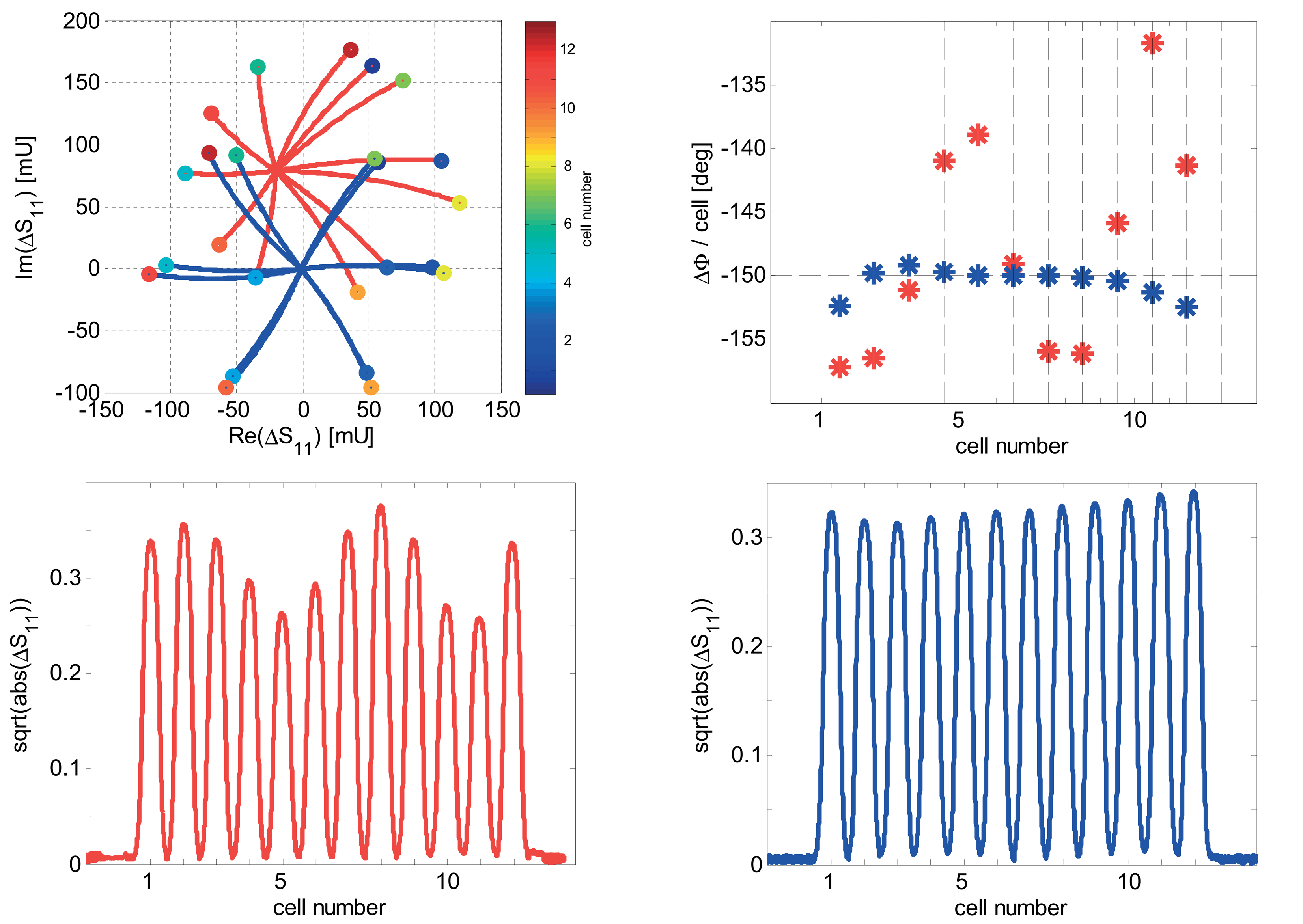
The alignment of the disks was ensured thanks to a V-shape support and by using the tuning holes

The disks were joined by diffusion bonding in partial hydrogen atmosphere, following the CLIC baseline fabrication procedure; input waveguides, cooling blocks and vacuum tubes brazing completed the structure assembly



Disks alignment procedure

Tuning



Electric field pattern along the structure, before (red) and after (blue) the tuning. Top left: in the complex plane; top right: in phase advance per cell; bottom: in magnitude

All cells were adjusted in frequency. Bead pull measurements were used to determine the electric field profile along the z-axis

The available tuning range per cell is ±3 MHz. Regular cell frequencies were increased of 0.3 MHz on average, output cell of 2.2 MHz, input cell was decreased of 0.6 MHz

Phase advance of 150±1.5 ° under vacuum at 32 °C was reached. The total reflection at the 2.9985 GHz operating frequency is -60 dB

REFERENCES:
[1] S. Benedetti et al, RF Design of a Novel S-Band Backward Travelling Wave Linac for Proton Therapy, in Proceeding of LINAC (2014)
[2] A. Grudiev, S. Calatroni and W. Wuensch, New Local Field Quantity Describing the High Gradient Limit of Accelerating Structures, Phys. Rev. ST Accel. Beams 12 (2009) 102001
[3] A. Degiovanni, High Gradient Proton Linacs for Medical Applications, EPFL PhD Thesis (2014)