WELDING AND COPPER PLATING INVESTIGATIONS ON THE FAIR PROTON LINAC

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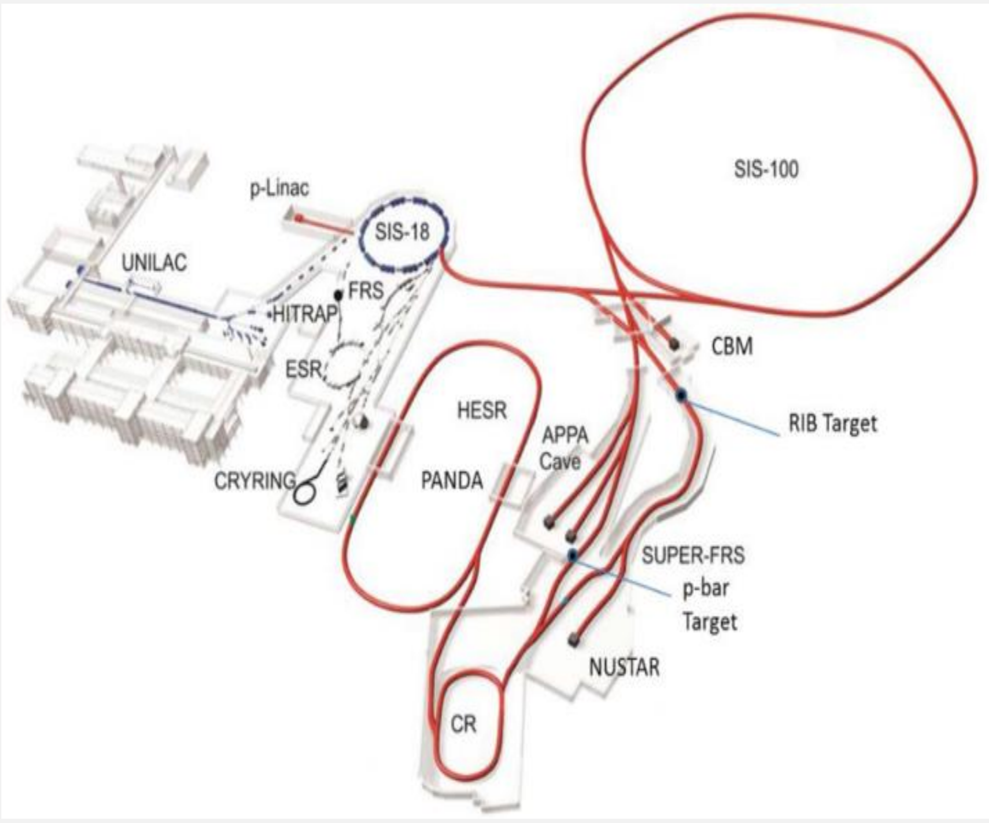
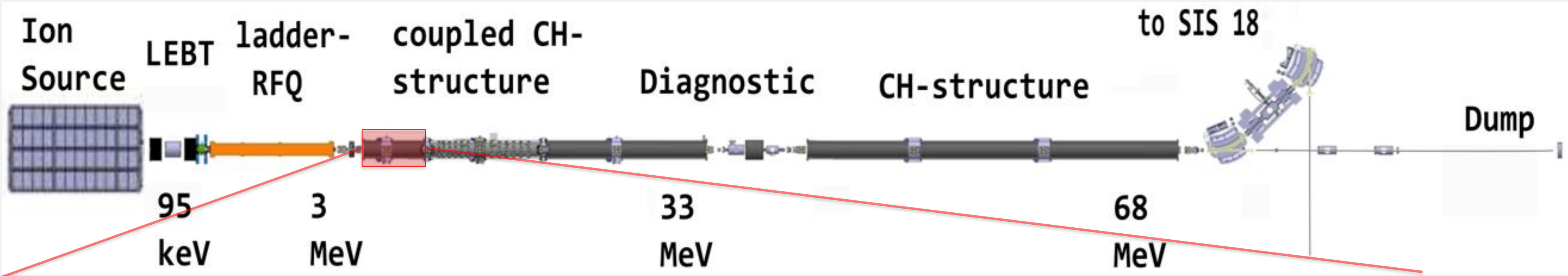
Abstract

A FAIR injector linac for the future FAIR facility is under construction. In order to meet the requirements for copper plating of the CH-cavities, a variety of tests with dummy cavities has been performed and compared to simulation. Further dummy cavities have been produced in order to improve the welding techniques. In addition, the results on 3d-printed stems with drift tubes will be presented.

p-Linac at FAIR

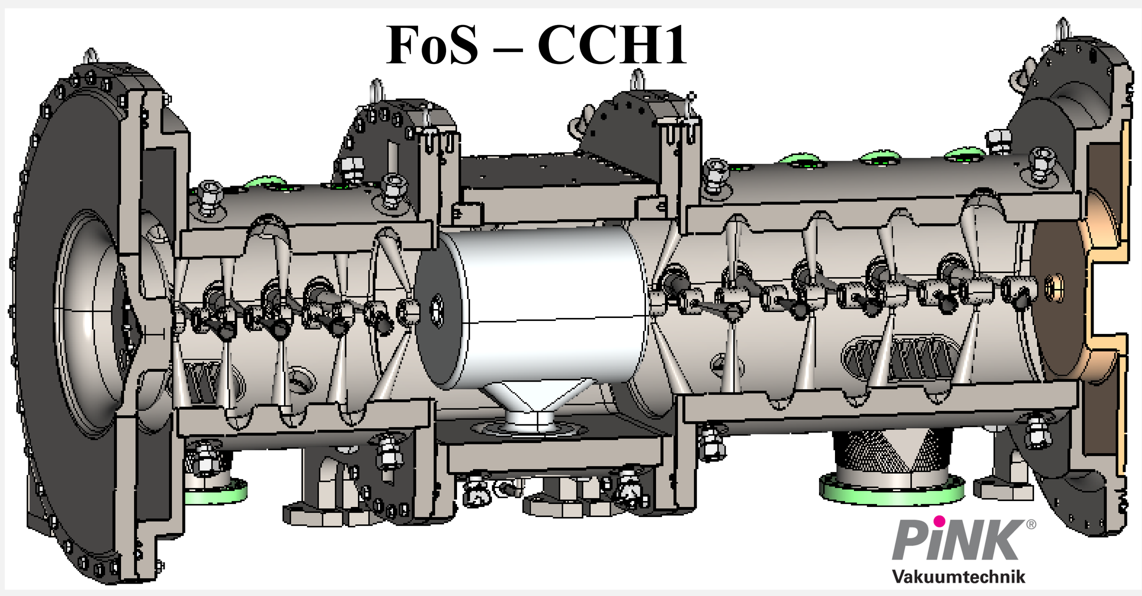
The proton linear accelerator will serve as pre-accelerator and injector for the new heavy ion synchrotron SIS100. The main acceleration from 3 MeV up to 33 MeV will be realized with three coupled CH-cavities (CCH) connected by a coupling tank housing a focusing magnetic quadrupole triplet lens, followed by a diagnostic section at 33 MeV and finalized up to 68 MeV by three single CH-modules. The cavity design of all six CH-type cavities has been developed by IAP University of Frankfurt. They operate at a resonance frequency of 325.224 MHz. It is required to provide a proton beam with a beam current up to 70 mA at a rf pulse prepetition rate of 2.7 Hz.





Parameter:

- first cavity of the p-Linac
- resonance frequency: 325.224 MHz
- inner length: 1,3m
- inner diameter: 307mm-316mm
- low energy part: 10 gaps
- coupling cell housing a triplet lens
- high energy part: 11 gaps
- 12 static tuners
- 3 dynamic tuners



FoS – CCH1

- stainless steel tank (usable for operation with beam) (1.4404 - V4A - 316L)
- **first step:** low level rf and tuning tests with clamped aluminium stems
- **second step:** 3d-printed stainless steel stems and drift tubes welded via e-beam from the outside into the tank
  → copper plating
  → high power rf-tests
  → commissioning
  → operation with beam

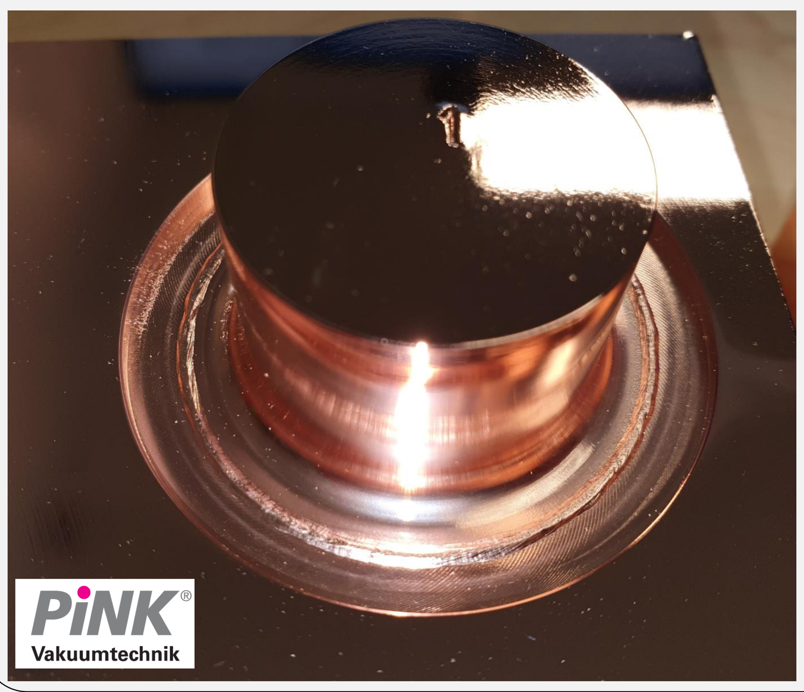
Welding and copper plating studies

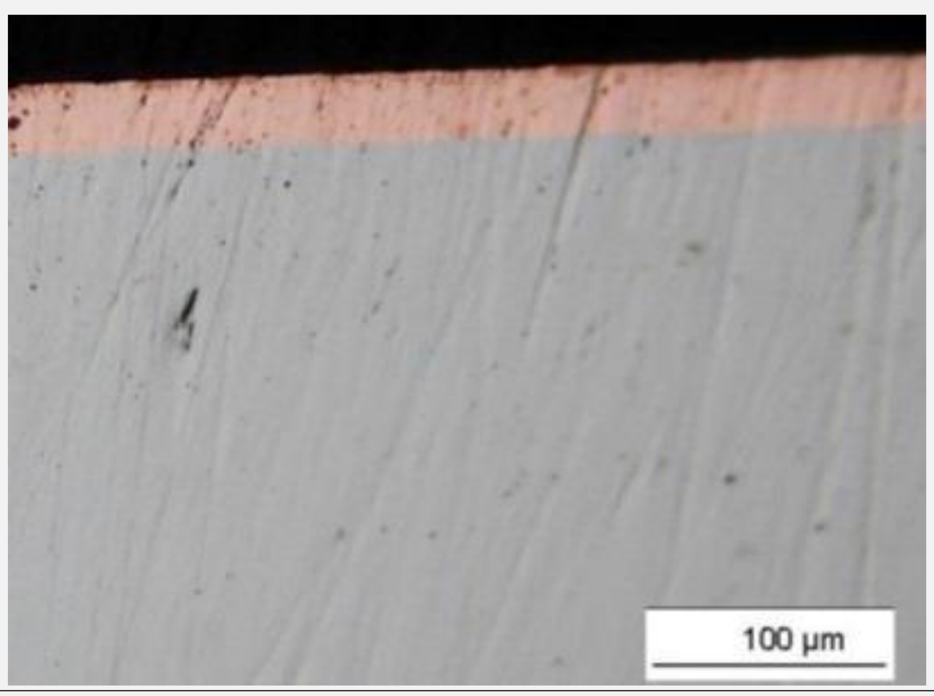
Due to these complex monolithic structures with tiny distances of the stems and aperture of the tank design there is no possibility of conventional welding from the inside. Other welding techniques (outside welding) are not well established at GSI. In addition, copper plating for these novel structures is particular challenging. Therefore, four types of test dummies are planned for CCH1, which can be considered as the most complex structure.

Dummy 1

Simple rolled steel sheet with straight stems tacked inside and successful copper plating.

Dummy 3





A stem end part (3d-printed 1.4404 stainless steel) was welded to a small plate made of stainless steel 1.4404 (V4A - 316L) from the outside via e-beam welding. These tests are performed at Pink GmbH Vakuumtechnik in Wertheim, Germany.

The copper plating could be characterized as intact, continuous and uniform (also the area of the e-beam weld). Only the area of the weld overlap from the beginning and end of the welding seam shows increased peaks, which need to be reworked.

Dummy 2

Rolled steel sheet tank with flanges, stems and drift tubes, tacked inside the tank. After successful copper plating at GSI, photomicrograph show that the copper layer is very uniform and continuous in the area of the tank wall and the stems. Adhesion to the base material is well-developed, and no cracks or other defects were detected in the copper layer. Except in the area of the drift tubes the copper layer thickness varies significantly. The front surfaces are then partly no longer parallel to each other, which would affect the electrical acceleration field negatively.

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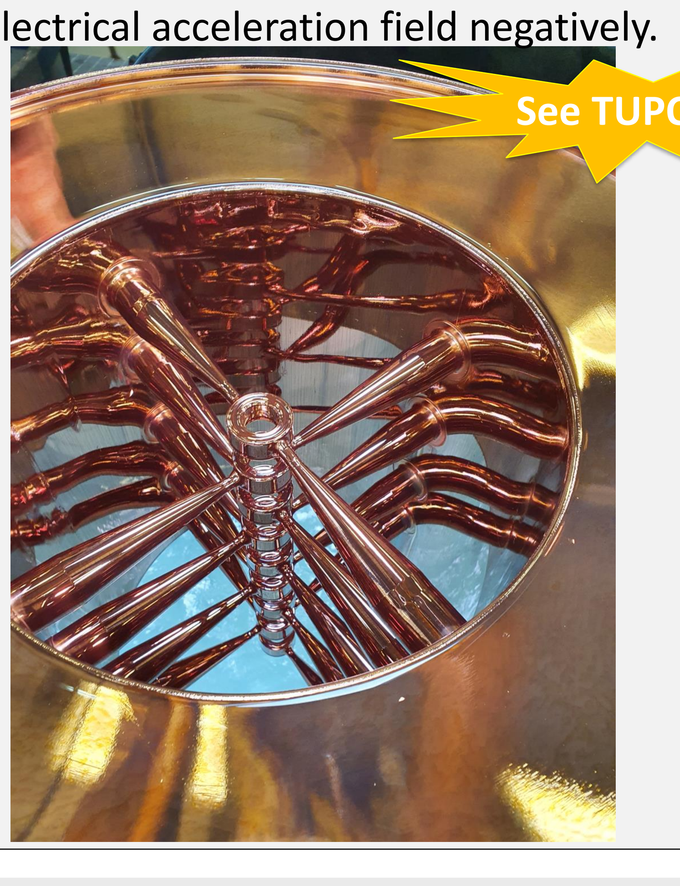
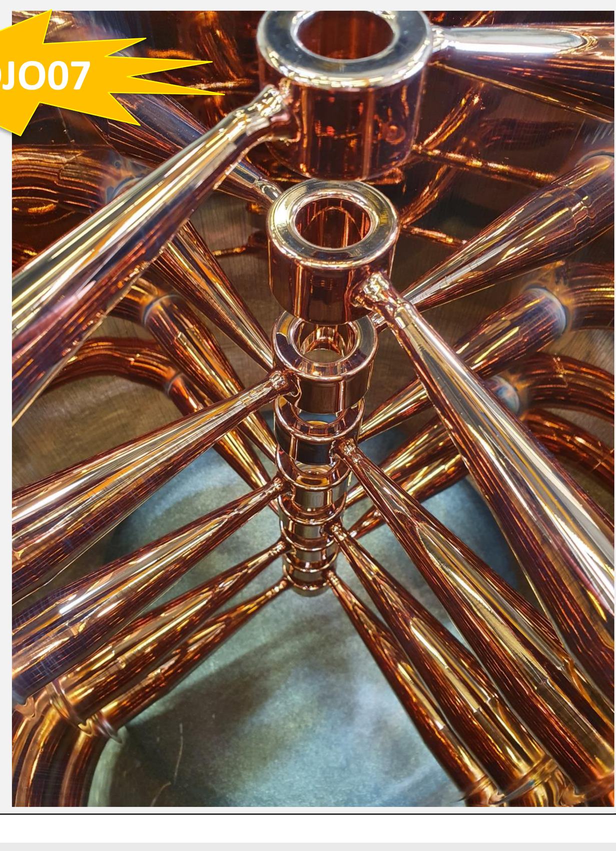
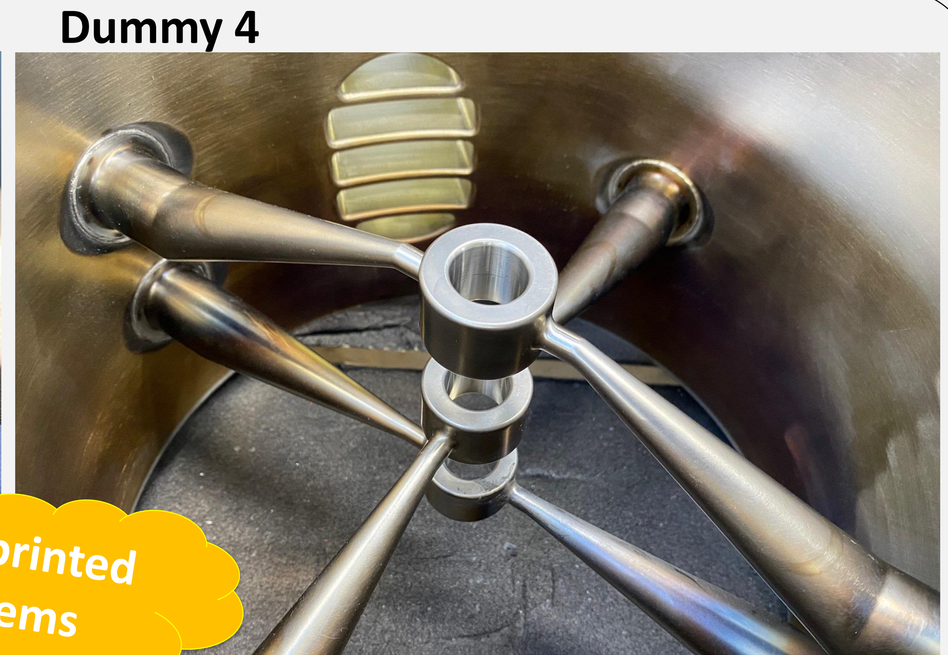




Dummy 4



3d-printed stems

A pretest tank with three angular stems of the first section from CCH1 to qualify the manufacturer (Pink GmbH Vakuumtechnik in Wertheim, Germany) for the CH cavities. The stems are 1.4404 3d-printed material, the tank is forged stainless steel 1.4404 (finishing via turning, grinding, milling, polishing). If the dimensional accuracy is given, this dummy will be copper plated at GSI in order to finally adjust the copper layer at the welding seams.