Development and Adjustment of Tools for Superconducting RF Gun Cavities.

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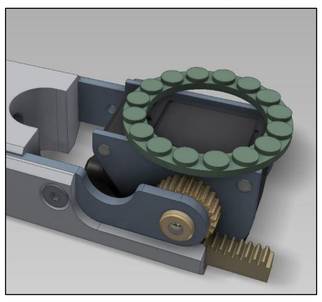
Abstract:

For the superconducting radio frequency (SRF), 1.6-cell gun cavities (CV) developed at DESY, a similar fabrication and treatment process, as for the European XFEL 9-cell cavities is foreseen. The different length and geometry of these cavities lead to a number of adjustments to existing and the development of new tools. This paper covers the new designs and adaptations of a tuning tool, chemistry flanges, a wall thickness measurement device, as well as a new high-pressure rinsing spray head and an optical inspection camera for the 1.6-cell, 1.3 GHz DESY SRF gun cavities.

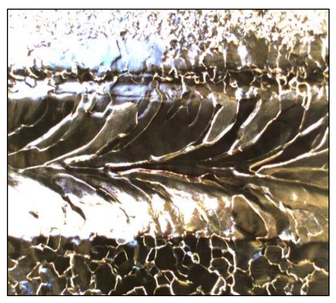
Keyence IV2

The IV2 from Keyence is a far-reaching upgrade to the previously used See3Cam CU
The changes include an improvement of the lighting concept and increases the flexibility of the camera system, which avoid the disassembly of the mirror components as at V1.0

See3Cam

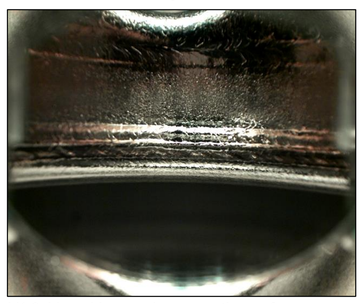


Keyence IV2 sensor with new lighting system

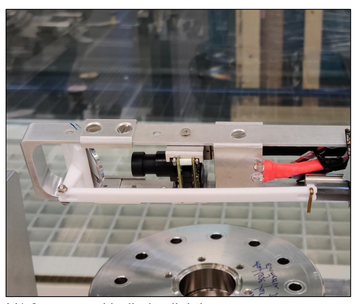


Keyence IV2: iris weld

- Resolution 752 x 480
- Autofocus (20-500 mm distance)
- 16 RGBW LED ring radial to lens (movable)
- Flexibility 360° rotational, 210° tilting (camera)
- Change of perspective via camera tilt
- Polarizing screen
- Additional int. 4 LED (dimmable)

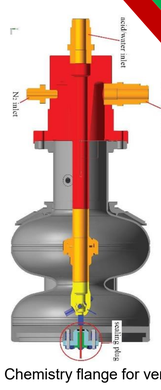


V1.0: iris weld,-same image section as from Keyence IV2



V1.0 sensor with diodes lighting

- Resolution 640 x 480
- Fixed focus
- 2 LED coaxial to lens (fix)
- Flexibility 360° rotational, 60° tilting (camera)
- Change of perspective via mirror tilt
- Necessity to dismount the mirror in order to inspect the cover plate



Chemistry flange for vertical treatment

The UT measurement strongly illustrated the inhomogeneous surface removals during etching and led to comprehensive adjustments.

Cavity dummy with chemistry head

- The transparency of the dummy cavity allowes a detailled view to the adapted nozzle head and its fluid distribution during the filling procedure
- Seven nozzles at the etching head enable a uniform filling of fluids into the resonator

Plug to seal the cathode hole

- High attention is paid to the diameter of the cathode hole, as it should not change during the etching

Optical Inspection

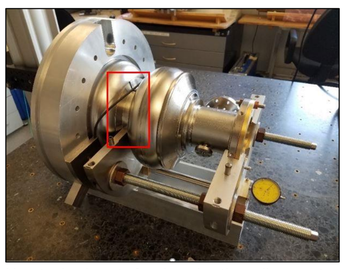
Chemical Treatment

HP Rinsing

Tuning Tool

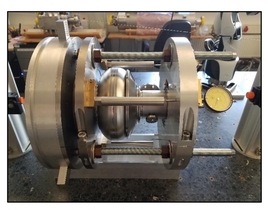
UT Measurement

The upgrade of the gun tuning device enables to change different cell geometries without disassembling the cavity out of the tuning system and even perform bead-drop measurements without cathode hole.



New tuning inserts for changing the cell geometry

- Changes in the cell geometries can now easily be adapted with the new tuning inserts



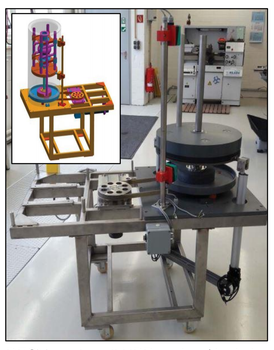
New gun tuning device

- The tuning device allows to tune the cells in horizontal and vertical position as well as cavities without cathode hole

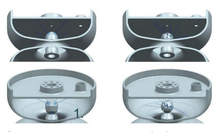
A weak point of the old design is a not properly rinsible back wall. The new design is intended to show, if the surfaces can be cleaned thoroughly. For this purpose, a high pressure rinsing (HPR) test stand is under construction, in which different movements, rinsing patterns, nozzle diameters and treatments can be tested.

Comparasion standard vs. new spray head design

	Number of nozzles	Nozzle diameter (mm)	Water pressure (bar)	Water flow (l/min * 1 nozzle)	Water flow (l/min * 8 nozzles)	Water flow (l/min * 12 nozzles)	Force impact * 1 nozzle (N)
DESY standard spray head	8	0,4	100	0,72	5,76	0	1,7
New spray head design	12	0,3	100	0,41	0	4,92	1



DESY single cell HPR system/ test stand



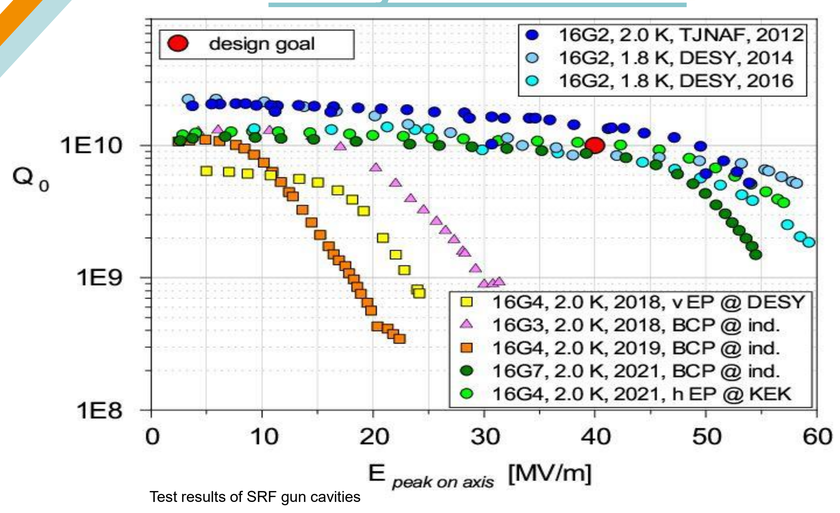
Standard spray head (1.) vs. new design

Standard DESY spray head

New head design

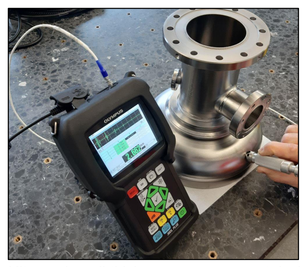
- The current design combines a rotational and transversal movement
- The new one will operate with both movements separately

Cavity Performance



Test results of SRF gun cavities

The ultrasonic wall thickness measurement device (UT) is an important instrument to obtain information about local removal rates during etching and thus to gain helpful adjustments to the applications.



Ultrasonic wall thickness measurement device

- The measurements of the sheet thicknesses with the UT device shows different removal rates on the cells and the back walls while etching, which led to significant adjustments of the etching head

Crown shaped probe

- The crown shaped contact surface of the probe, together with a designed former plate allows a precise vertical and local reproducible measurement to rounded surfaces

- 16G2 met our requirements, but had a weak back wall, susceptible to leaks at the cathode plug sealing
- 16G3 and 16G4 have a mechanically improved back wall, but showed initially poor performances due to an immature surface treatment, which blemished the surface of the back wall
- Investing quite some effort, we learned how to apply the surface treatments at the special geometry of these cavities
- All recent prototypes, like 16G7, show the desired gradients after BCP, likewise 16G4 after mechanical grinding and horizontal EP

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