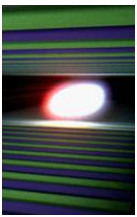


Mechanical Design of Automatic Cavity Tuning Machines

Jan-Hendrik Thie, A. Goessel, J. Iversen, D. Klinke, G. Kreps, W.-D. Moeller, C. Mueller, D. Proch, DESY, 22603 Hamburg, Germany
R.H. Carcagno, T.N. Khabiboulline, S. Kotelnikov, A. Makulski, R. Nehring, J. Nogiec, M. Ross, W. Schappert, Fermilab, Batavia, IL 60510 USA



Introduction

Since over 15 years a prototype machine to tune the field flatness and concentricity of tesla shape 9 cell cavities has been used at DESY.

For new projects like the European XFEL, the ILC or Project „X“ a machine with a higher level of automation is needed. Attention has also been paid to safety aspects as the machines are used in series production by cavity vendors. Four completely new designed Cavity Tuning Machines are developed in a collaboration among Desy, FNAL and KEK.

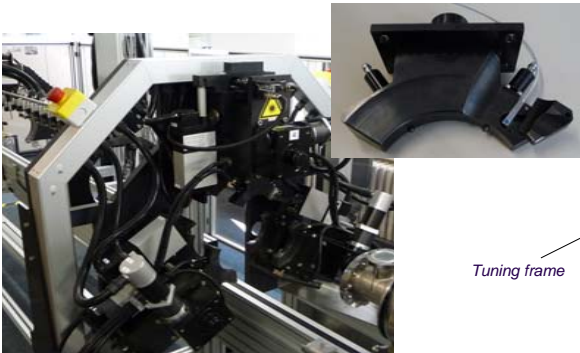


Figure 2. Tuning frame with 3 independent Vice Units.

New Tuning Frame: Mounted on compact base plate:

- Vice Units are free movable among beam axis
- Positioned by low pre-stressing spring cradles
- New design of jaws fit to normal- and end-cells
- Small exchange parts for end cells
- Modern sensor detection concept for cell positioning
- Stepper motor based squeeze actuation
- Vice units with high accuracy linear actuators

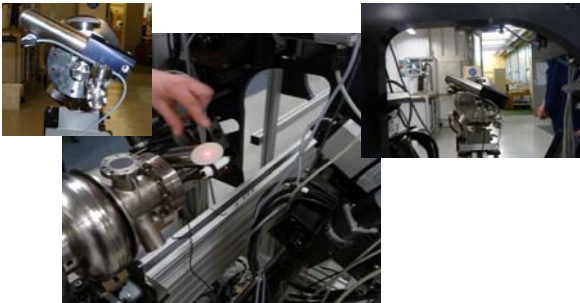


Figure 3. Laser based cavity alignment control



Figure 1. Entire automatic cavity tuning machine with safety fence

Overall concept of modular lightweight machine including:

- Tuning frame with three vice units
- Cavity train with support system and contactless celltype detection
- Excentricity measurement device including laser operated length measurement
- Integrated bead pull system
- Laser based cavity alignment control
- Overall safety-concept with machine fence

Laser based cavity alignment control:

- Restricted space in machine
- Key-fit to mounted Field Profile Measurement System (FMS)
- Integrated target with camera observatory
- Software operated image processing and alignment algorithm improved by FNAL

Bead Pull System:

- No string loop
- Gravity based string tension unit with brake system
- Actuation-string reservoir achieved as transmission gear
- Bead position acquisition with special sensors and stepp encoders

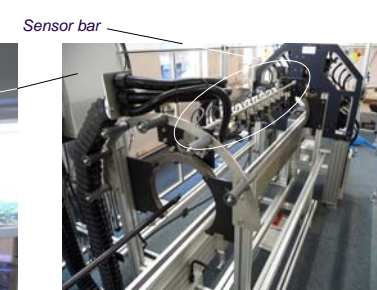


Figure 4. Excentricity Measurement Device



Figure 5. Cavity train with supports and lift unit

Excentricity Measurement Device (EMD):

- Fixed cavity, rotating sensor bar
- 9 cell sensors at equators, 2 flange sensor with high resolution
- Automatic mechanical centering of all sensors
- Two laser distance generators for end plate alignment
- Automatic mechanical lift units bring cavity in defined measuring position

Cavity Train:

- New support design: cavity is totally free in two axes
- Contactless positioning system based on black mirrors and laser detection
- Adjustable spring pre-stressing to setoff G-force and reaction force
- Selfadjusting pitch restrictions to get defined positions in EMD and Tuning Frame

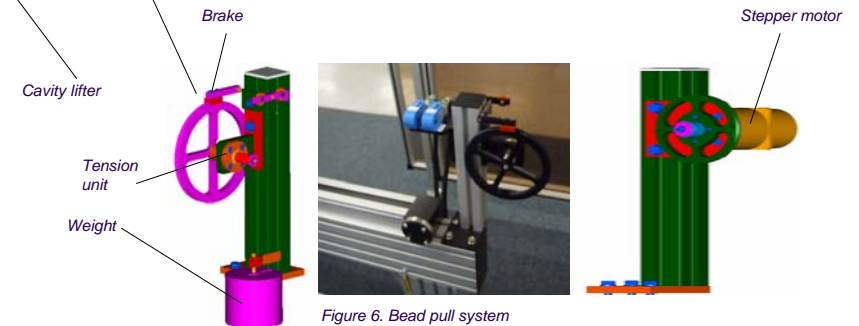


Figure 6. Bead pull system

Summary:

- Mechanical design finished
- Two machines delivered to FNAL; 2nd will be passed to KEK
- Two machines for series XFEL Cavity production under commissioning at DESY
- Development of Software and electronic devices at FNAL
- Machines are designed to fulfill requirements in accordance with EC directive of machinery; EC conformity operation is under way
- Machines will be operated by non RF experts at companies
- Clearly decreased duration time for tuning procedure