Commissioning and Upgrade of Automatic Cavity Tuning Machines for the European XFEL

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Introduction

Four new tuning machines were developed and built in a collaborating effort among FNAL, KEK and DESY. Two machines were commissioned at DESY in a close teamwork with FNAL. For several months, these machines have been used regularly for the automatic tuning of different types of cavities for FLASH. Due to this operating experience and the requirements for the European XFEL Cavity Specification, it was necessary to implement the following improvements:

- Improve the precision of the eccentricity measurement.
- Update of the mechanical parts developed by DESY.
- Update the electronics and software developed by FNAL.
- Review and change the machine access procedures according to the safety aspects of the EC Directive of Machinery.
- Change the tuning sequence according to the different production stages of cavities

Bead Pull Measurement

Can now be done on:

- Cavity
- Cavity with ring and bellow
- Cavity in helium tank

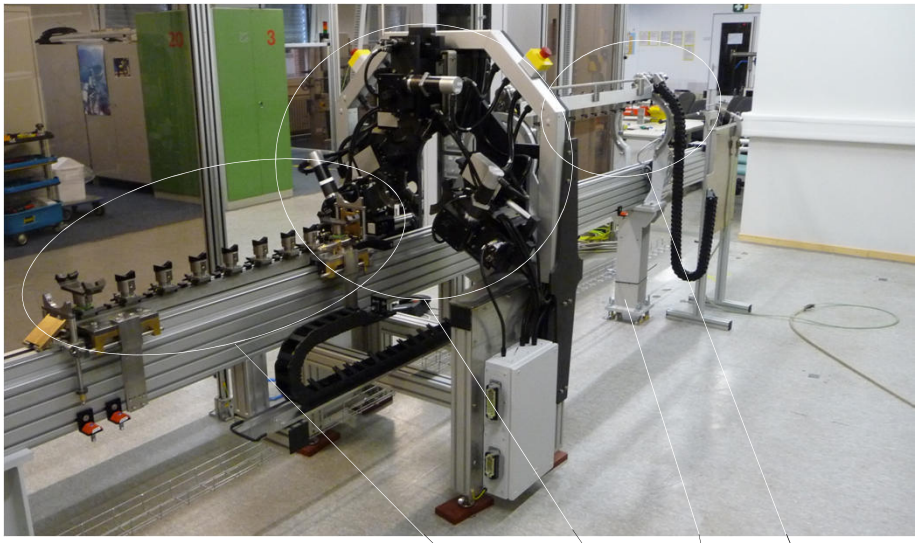

Figure 1. Entire Cavity Tuning Machine in new Design

Drive chassis with motor
Measurement bar with centering devicecs
Cavity train
Sturdy steel pilar
Tuning frame
Eccentricity measurement device

Figure 2. Cavity lifter with cavity in helium tank

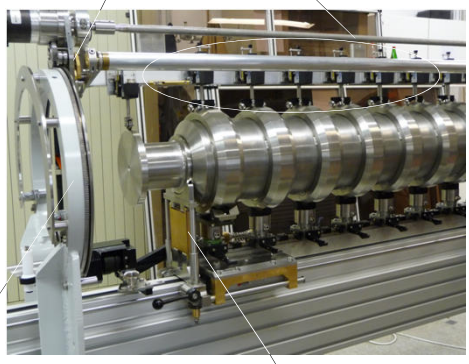

Figure 2. Eccentricity measurement unit and measurement bar.

Precision gearing
device with gearings, lift
Heavy duty lift unit

Upgrade Eccentricity Measurement Device (EMD)

- Heavy duty lift units for cavity positioning in EMD
- Sturdy full steel frame with precession bearing drive chassis
- Total measurement resolution increased from 0.4mm to 0.1mm
- Improved measurement bar with new automatic centering devices for all cell sensors
- Totally new EMD control software for continuous motion operation with simultaneous data acquisition and analysis related to measurement angle
- Sturdy steel construction fixed to the ground floor

Cavity Lifter and Gripper

Possible handling of:

- Cavity and cavity with ring and bellow
- Cavity in helium tank
- Dummy-cavity for calibration

Figure 3. Cavity dummy gripper (left) for cavity lifter.

Upgrade Entering Concept

- Increased number of necessary entering's into safety fence caused by different production stages of cavities
- Fully automatic tuning software controlled accesses with safety fence monitoring
- Software regulated motor current control
- Updated emergency trip system

Upgrade Cavity Train

- Compensating element for length deviation
- Updated RF-cable guiding system
- Improved cell supports for „floating“ cavity

Summary of the upgrade

- **Actually one of two cavity tuning machines for European XFEL Cavity production was mechanically updated and is under commissioning at DESY.**
- **Results of first tests are successful; measurement resolution of eccentricity measurement device was increased.**
- **New machine design is customized to all different production stages of cavities.**
- **Updated automatic cavity tuning machine software was successful tested according to different production stages of cavities.**
- **Reached Field flatness in automatic tuning mode was increased from 90% to 98% as well for cavity with ring and bellow after tuning.**

Outlook

- **The second machine will be updated in August 2011.**
- **In October 2011 reference cavities from industry will be tuned at DESY**
- **Tuning machines hand over to cavity vendors will be in early 2012 after training of company personal.**
- **After completition of entire machine documentation for mechanics, electronic devices and software, the declaration of conformity according to EC directive of machinery will be signed.**

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