

Introduction

For the European XFEL superconducting cavity series production at both cavity vendors' four manufacturing machines for production key functions, Half Cell Measurement Machine (HAZEMEMA) and Cavity Tuning Machine (CTM), are supplied by DESY. Among three years of cavity production in two companies, Research Instruments GmbH (Germany) and Ettore Zanon Spa. (Italy) a lot of experience is gathered about influence of surroundings and production quality on cycle times, machine drop outs, general stability time of machines and parts subject to wear.



Figure 1. HAZEMEMA in use at Companies.

Well known and often presented HAZEMEMA:

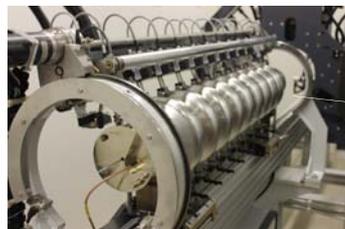
- Automatic machine to measure RF properties of Cavity components.
- RF Measurements for all cavity cells, end groups & dumb-bells.
- No calibration drifts found within 3 years.
- Helpful experience and statistics about production quality.
- Incredible number of 22.000 performed measurements.

Service & Repair concept:

- Regular maintenance & calibration all 6 Month.
- Complete spare machine available for exchange.
- No large defects within 3 years except wear-parts.
- Maximum drop out time 3 days!



Detail: Clamp Unit with Dumb-Bell



Detail: CTM Eccentricity Measurement Device

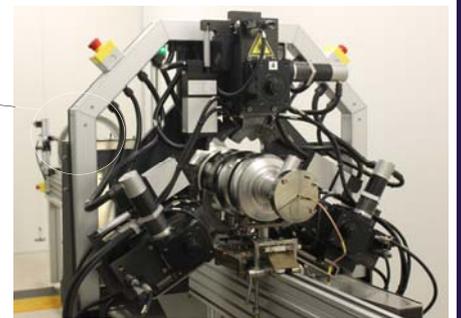


Figure 4. Tuning Sluice from Cavity Tuning Machine in use at Companies.



Fig. 6. Collection of spare & wear -parts with early wear-out or defect after accidental misuse.



Detail: CTM Spindle Gear defect after straightening non annealed cavities



Detail: CTM Stroke Unit after accidental Misuse

Well known and often presented Cavity Tuning Machine:

- Automatic machine to tune a cavity.
- All requirements from XFEL spec. fulfilled or exceeded.
- Standard cycle times could be reduced about 25% by surpassing required mechanical cavity production quality and good surroundings.
- Reuse for further projects like „LCLS-II“ possible.

Service & Repair concept:

- Regular maintenance & calibration all 6 month.
- No additional spare machine available.
- Large stock of spare parts & wear-parts .
- Longest machine drop out only 9 days.
- No production stop caused by machines.
- Shipment of parts & tooling's for repair and service-team on side within 3 days.

CTM Cycle Time: In average 4 hours is possible!

- Standard cycle time for tuning operation about 4 hours at both companies achieved.

Main elongation factor: ...up to infinite time for tuning...

- Temperature stability during tuning & measurement is most important surrounding factor!

Generally high mechanical production quality is necessary to hit targets for European XFEL cavity series production:

- Cavity straightness before tuning.
- Geometrical factors like deviations of cell shape.
- Inhomogeneous welding shrinkage distribution.

See: THPB066
RF Analysis of Equator Welding Instabilities for E-XFEL Cavities by A. Sulimov

95% Machinery Availability

■ 2500 Operating Days ■ 115 Drop Out

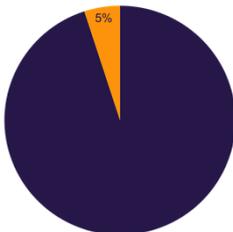


Fig. 2. Availability of Machines.

Types of Causes for Machinery Drop Out 's

■ Mechanical Defects ■ Electronics & Software ■ Accidental Misuse

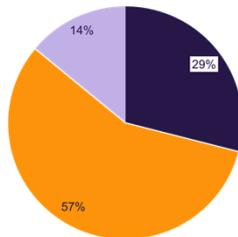


Fig. 3. Causes of Drop Outs.

Additional Measurements on CTM for quality control:

- TM011 Measurements performed.
- Full RF measurements on CTM before main electro polishing (EP).

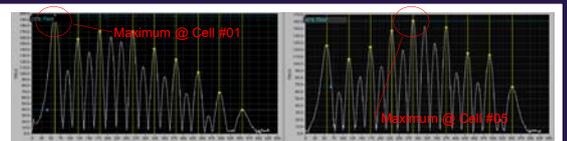


Figure 5 a) & b). TM011 Field Distribution Measurements on CTM.

Statements from measurements possible for future standard quality control:

- Inhomogeneous welding shrinkage distribution from equator cavity welding.
- Cavity geometry like shape deviations / deformations on Cavity cells.
- Precision of cell / dumb-bell trimming before welding.
- Good prediction for TM011 HOM suppression during cold RF test @ 2k.

Figure 5:

- a) Field distribution of TM011 (Zero-Mode) measured on CTM for asymmetrical Cavity.
- b) symmetrical cavity.

Summary

- About 95% machine availability within over 2500 operating days for entire European XFEL superconducting cavity production for all four machines together.
- No production "bottle Neck 's" by HAZEMEMA 's or Cavity Tuning Machines caused.
- About 22.000 successful measurement operations done on HAZEMEMA 's.
- More than 3500 tuning operations successful done on CTM 's.
- More than 1000 additional measurement operations performed on CTM 's.
- Over 150 "hard" cavities straightened without annealing by CTM.
- Well approved service- & repair concepts for all over machine mechanics, electronics and software support even via remote access on machines.
- All machines, service & repair concepts and service teams among the collaboration have proven their ability for large industrial series productions at first rate.

See: THPB023 & THPB068