ILC-HiGrade program at DESY

Some infrastructure for cavities repair and retreatment

- R&D program
- Centrifugal barrel polishing
- Replica
- Summary

Yegor Tamashevich
yegor.tamashevich@desy.de

University of Hamburg

Goal of the R&D program

800 EXFEL cavities

possibly with 10% hard limitation

⇩

Understand

failure reasons

⇩

Feedback

to production

24 ILC-HiGrade cavities

standard EXFEL cavities without tank

⇩

Quality control

of EXFEL cavity fabrication

⇩

Understand

failure reasons and field limitations

↙ ↘

Develop

repairing technology

achieve

High gradient

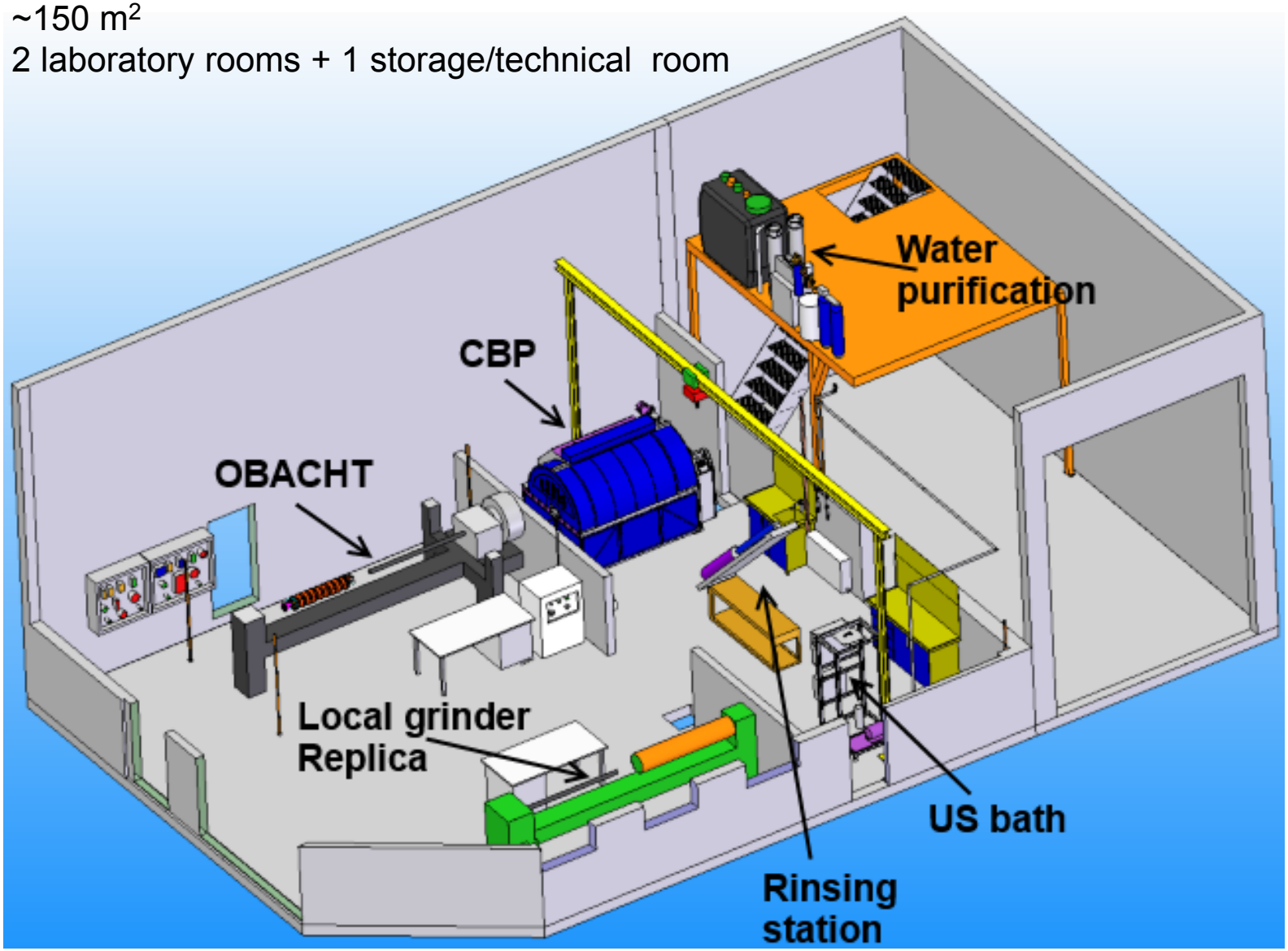
⇩

Elaborate

technology meeting ILC specs.

ILC-HiGrade Lab

~150 m^2
2 laboratory rooms + 1 storage/technical room



Centrifugal Barrel Polishing (CBP) of Nb cavities

How to repair cavities?

- Which kind of defects can be removed by CBP?
- How does CBP influence on cavities performance?

Can we replace bulk EP?

- Can CBP be used to remove Nb damaged layer (~150 μm) instead of bulk EP?
- Can we easily integrate CBP in existing production flow?

The CBP machine is being commissioned based on the polishing recipes derived from best FNAL, JLAB, and previous DESY experience

CBP parameters control

Cavity measurements	CBP parameters	CBP optimization
Length Eccentricity	Mechanics of CBP	Cavity bending during tumble ↓ **Frame assembly** changed
Field profile		
Weight RF modes Wall thickness	Material removal rate	Degradation of Field Flatness ↓ Procedure for **homogeneous distribution of media** developed
Optical inspection Replica Surface roughness SEM and EDX	Surface quality	Residual scratches and defects ↓ **Optimization of polishing steps**

Polishing media and processing time

Step 1
Cutting,
~8 hours

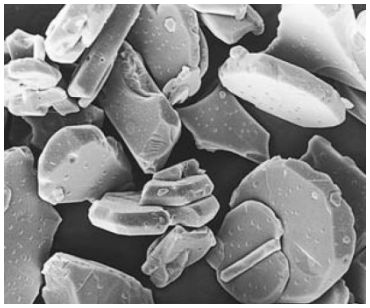
+ Soap &
Ultrapure
Water

Step 2
Intermediate
polishing, ~15 hours

+ Soap &
Ultrapure
Water

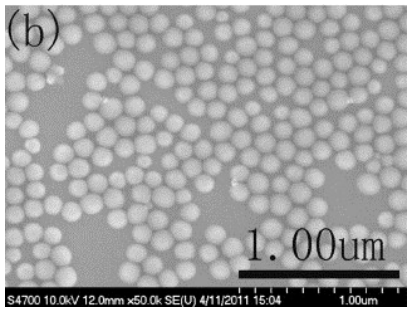
Step 3
Intermediate polishing,
~30 hours

UPW + Alumina
15 μm



Step 4
Final polishing,
40+ hours

Colloidal Silica
0.04 μm



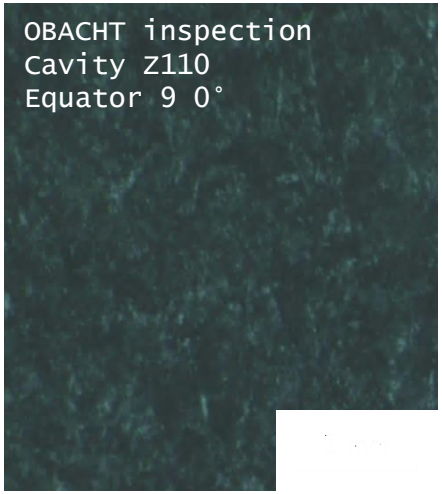
119 nm SiO_2,
Example from
L. Zhang et.al. ASS,
258, (2011) p.1217.

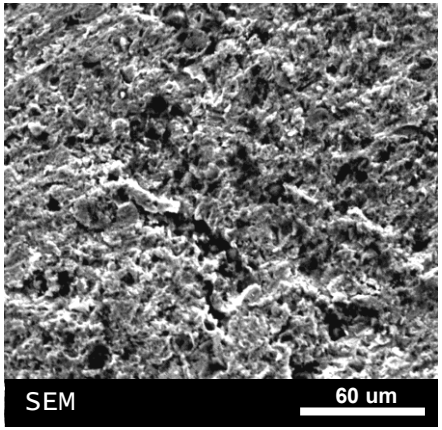
Step 5
Final EP
>10 μm after
800^{0}C bake

HF : H_2SO_4
1 : 9

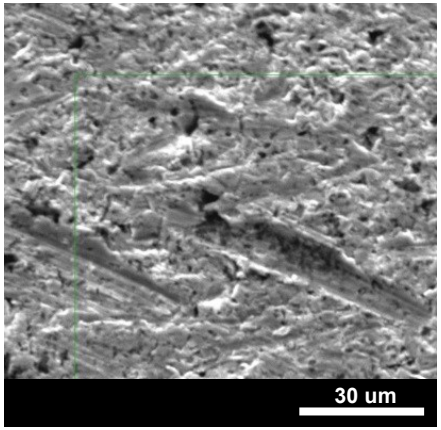
Surface after different CBP steps

Step 1

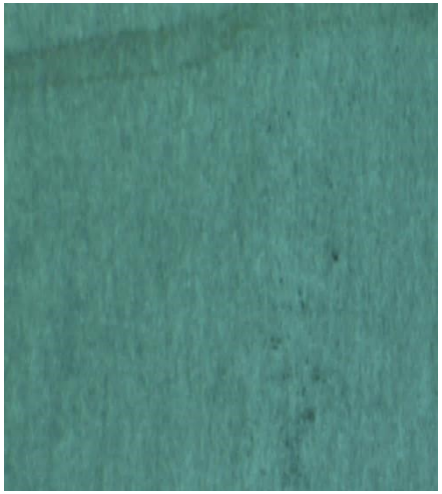


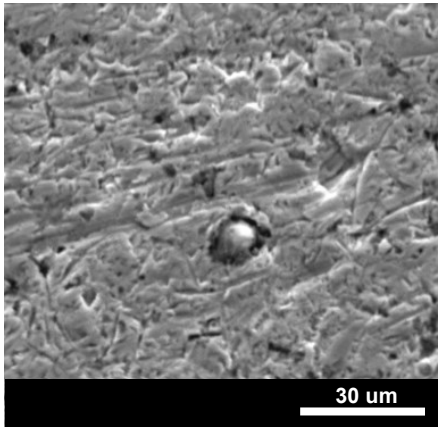


Step 2

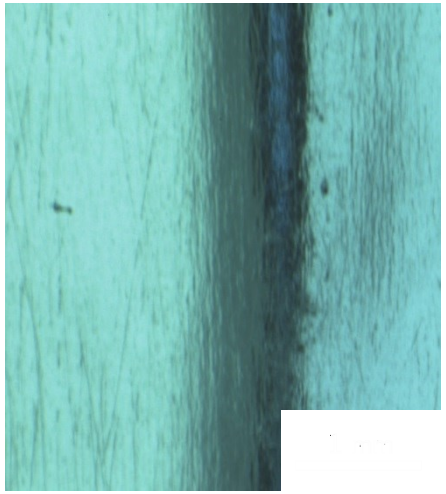


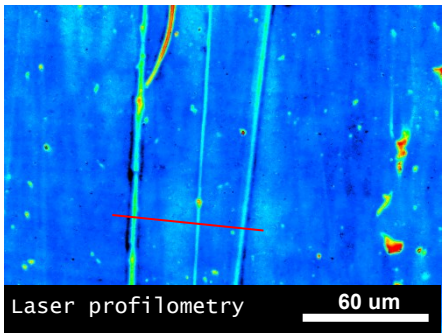
Step 3

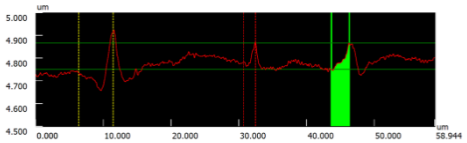




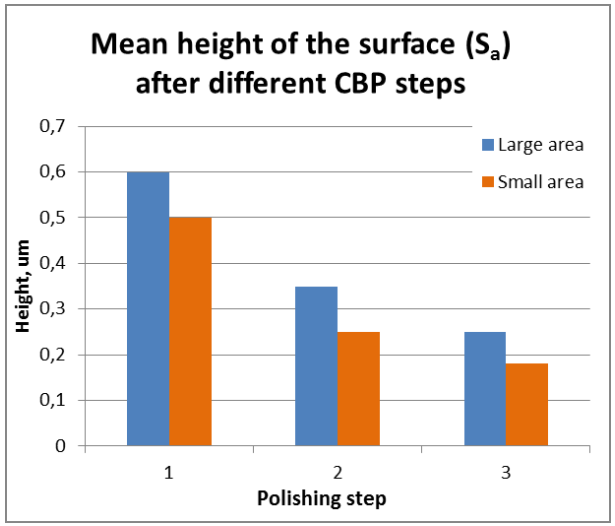
Step 4

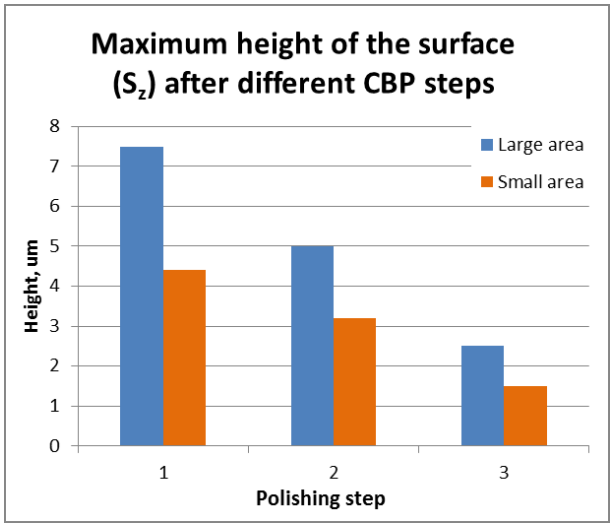


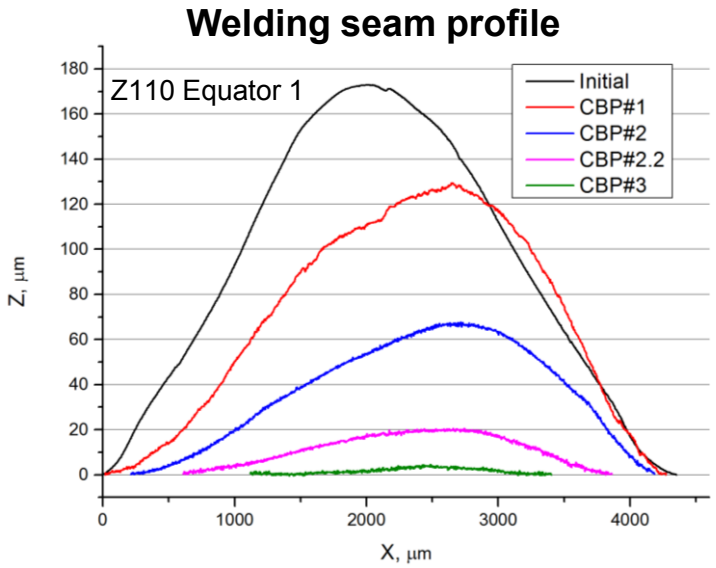


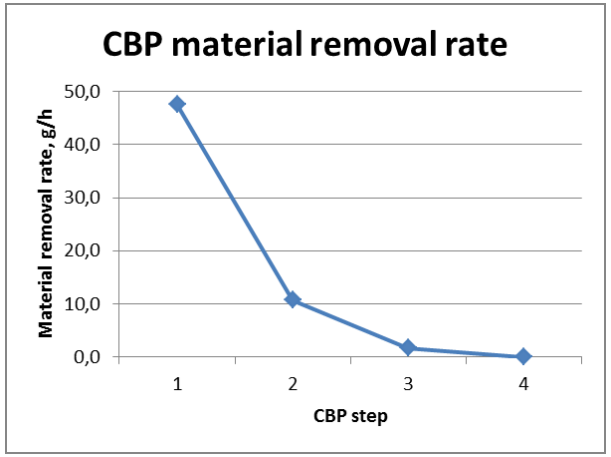


CBP process analysis



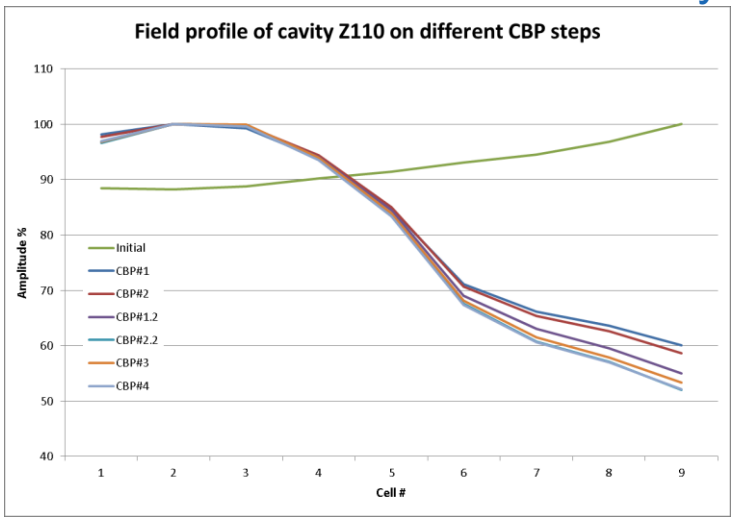




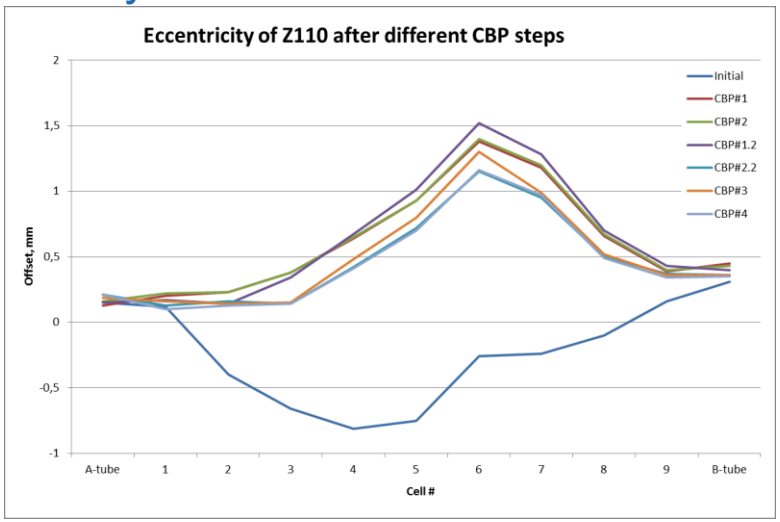


CBP process analysis

Cavity geometry

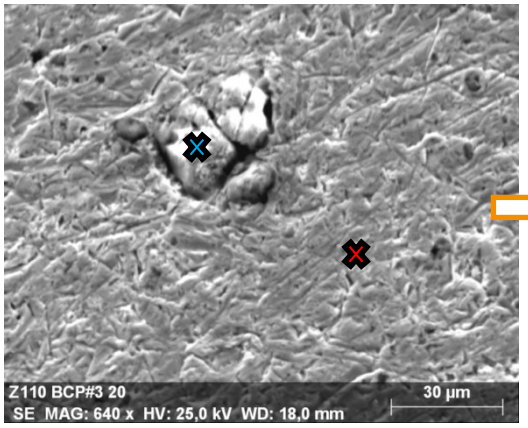


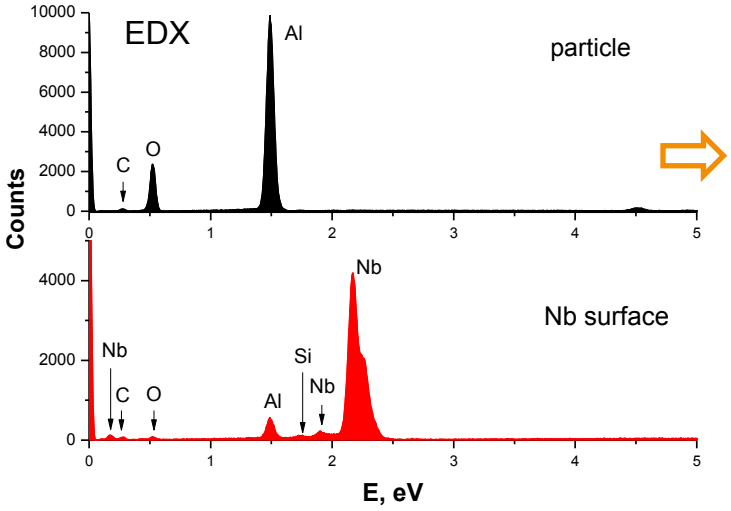
1st try - Field flatness degradation due to inhomogeneous media distribution



1st try – Cavity was bent due to imperfect frame assembly

Inclusions of polishing media

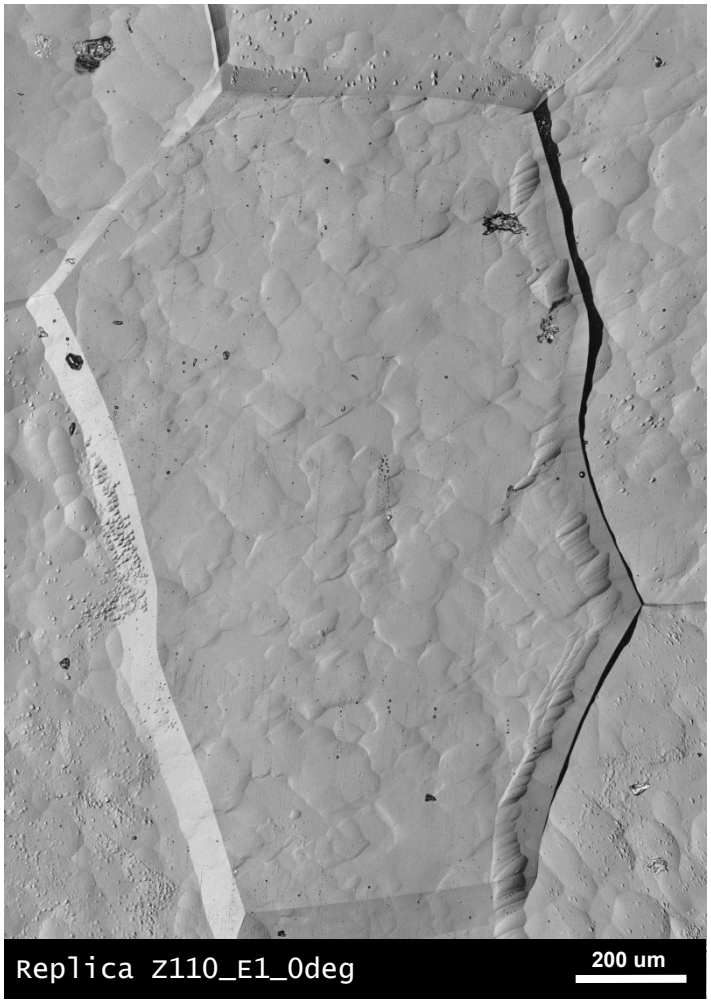


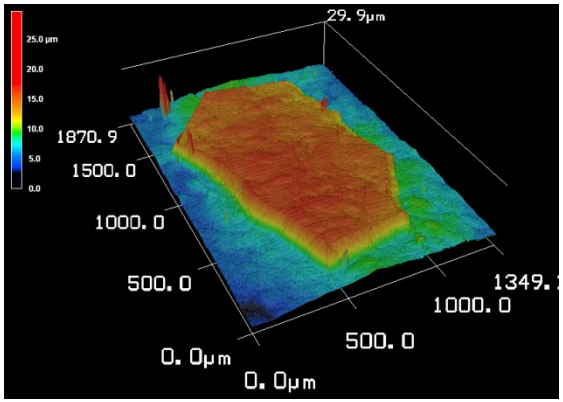


Embedded particle of polishing media after Step 3 (Al_2O_3)

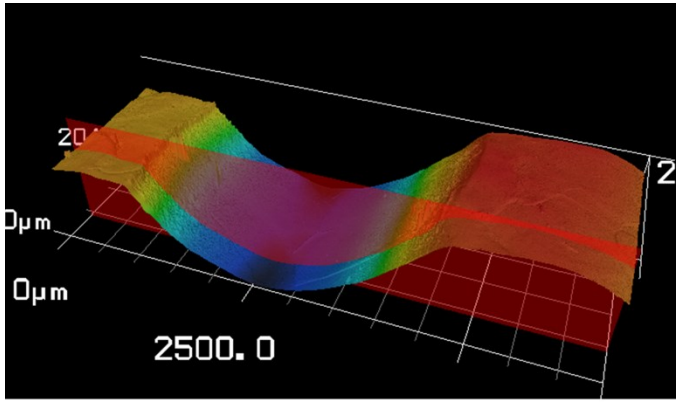
Replica: surface structure

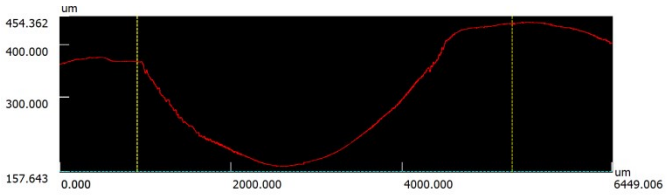
Grain structure



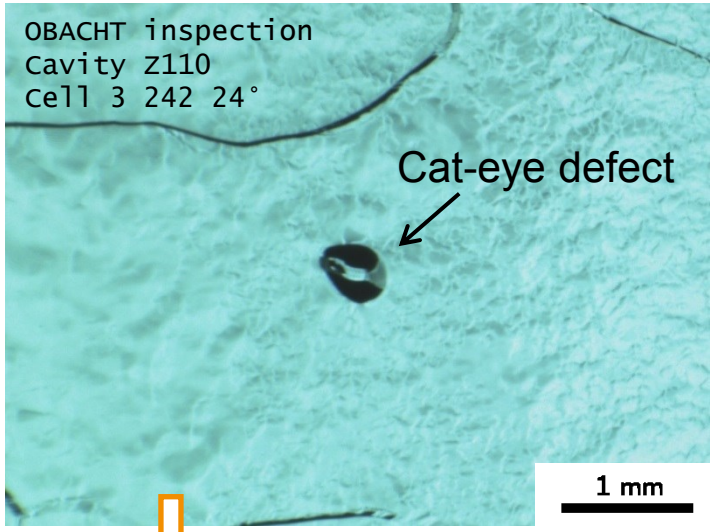


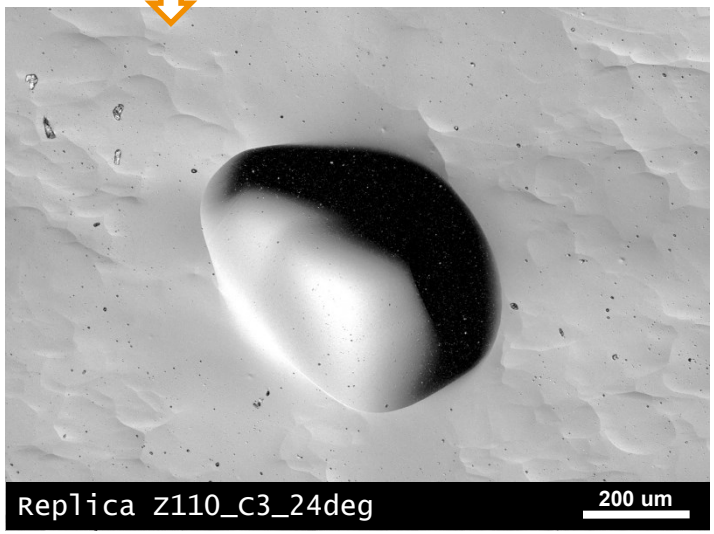
Welding seam profile

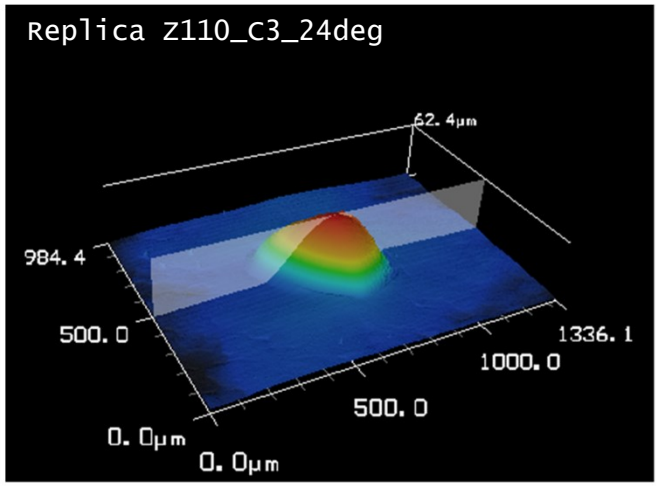


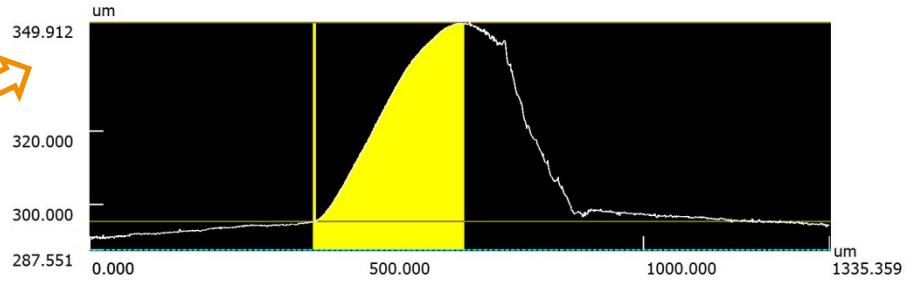


Replica: defects investigation









Profile1	Horz. dist.	Hght. diff.	Hght. ave.	Angle	C.S. length	C.S. area	R	Comment
All	1335.359um	3.733um	306.016um	0.160°	1408.183um	24670.176u...		
Seg.1	268.152um	54.050um	325.731um	11.396°	278.242um	10276.218u...		

Pit in the surface. Depth 55 um

Summary

- CBP is being commissioned, issues to be still worked out:
  - embedded polishing media
  - Mechanical stability / eccentricity of the cavity
  - Removal homogeneity / field flatness
- Replica
  - Very useful non-destructive surface analysis method
  - A new sample tacking tool has been developed
  - 3D confocal microscope is applied for the sample analysis

Acknowledgements:
A. Navitski, A. Prudnikava and FLA colleagues
W. Singer, X. Singer, A. Sulimov, A. Ermakov, M.Lengkeit
DESY colleagues participating in the XFEL cavity fabrication, treatment and tests