

# A NEW SEALING TECHNOLOGY FOR HIGH PRECISION WIDE OPEN UHV VACUUM FLANGE OR WAVEGUIDE CONNECTIONS WITH METAL GASKETS

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## Abstract

The European-XFEL, the X-Ray laser facility is located in Hamburg. Since September 2017, this large X-ray laser opens up new research opportunities for industrial users and scientists. For the diagnostics ultra-high vacuum components with high mechanical precision and additional strict requirements on particle cleanliness had to be produced. A bunch compressor (BC) has been installed with a cross section of 400 mm\*40.5 mm made by stainless steel blocks 1.4429 (316 LN). These chambers have integrated flange-connections for large VATSEAL® gaskets. The tolerances are extremely tight.

This contribution will report of a new technology of final large rectangular or other big flange surfaces. It will also describe the influences of material properties of the sealing area. The dependence of tightening forces and surfaces structure is reported. Further this contribution will compare the present procedure with this new technology. This technology can be used for other vacuum flange metals like aluminium or titanium. Using of this technology for applications under special conditions, like particle free applications due to the non-lubricated conditions, are conceivable.

## Introduction

The XFEL bunch compressor (BC) incorporated three magnetic chicanes. The E-XFEL BC's are equipped with non-movable vacuum chambers. The BC 1 and BC 2 are centered in the straight section beam diagnostic elements, namely 'Energy' BPM (BPMS) and Optical Transition Radiation (OTR) station. Started from a round diameter of 40.5 mm, the chambers had to be extended to a rectangular cross section of 400 mm \* 40.5 mm. This circumstance led to a complete design change of the vacuum chambers. The flange connections have to be fitted and leak tight up to Ultra-High-Vacuum (UHV) properties better than  $1 \cdot 10^{-10}$  mbar.

## The new technology

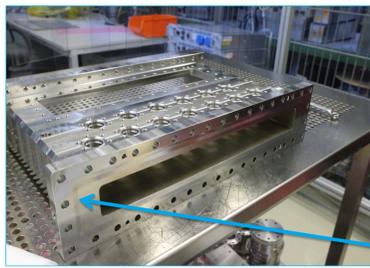
The new technology should cover the following requirements:

- Easily repeatable, easy feasibility
- High processability and well documented
- UHV suitable and low particle emission
- No hydrocarbons produce
- Long-time stability and suitable for VATSEAL gaskets and wide flange apertures
- For multi-use designed and re-machinable
- And at least non-abrasive process



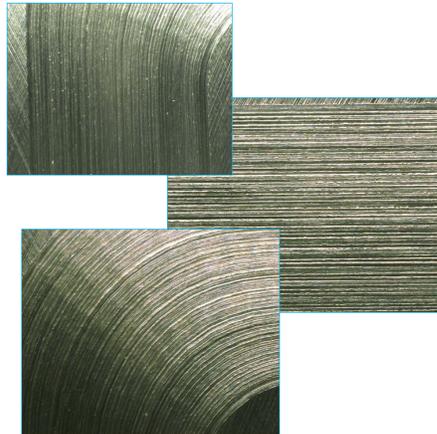
Preparing of sealing rill with the pin tool

## The vacuum chamber

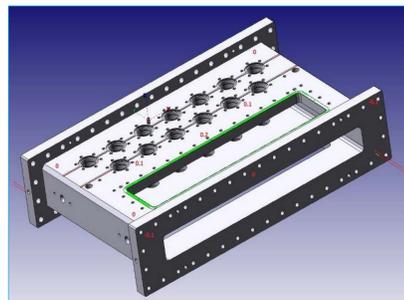


A EBPM vacuum chamber ready for assembling in clean room

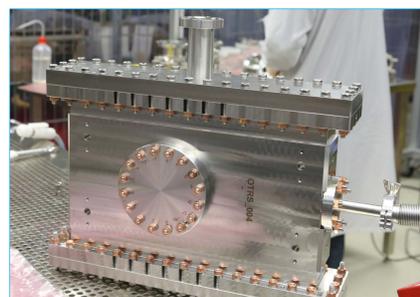
Sealing gasket „rill“



Micro images for sealing rill



3 D view of E-BPM vacuum chamber



Last final leak test before installation in XFEL

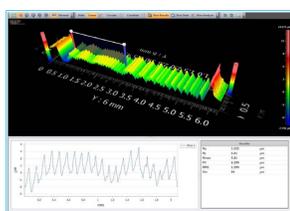
Following **positive aspects** came out:

- Easily repeatable, well documented, high processability and easy feasibility by used well-known machining processes and CNC technology
- UHV suitable, no oil, no lubrication or other liquids
- Low particle emission instead of using an abrasive technique low cost technique and reducing of production time
- Higher vacuum tightness due to this long-playing-record rill
- Easy to apply to all flange geometrics and flange designs and suitable for all flange metals (Titanium, SST, copper, aluminium...) and gasket materials
- Increased of surface hardness up to a considerable value
- Smoothing of sealing surfaces in one step, no further manufacturing steps necessary (no pre-smoothing the surfaces or getting highly flatness)
- Eliminated the manual process steps of finishing sealing surface, reducing of failure rate
- Re-machinable and non-abrasive process
- Resistant to radiation

## Quality Tests

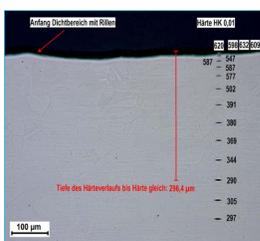


Investigation of leak tightness



Special white light interferometry profile. (BAM, Berlin, Germany)

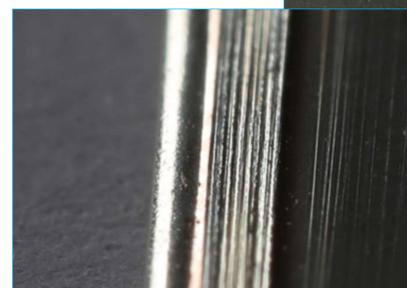
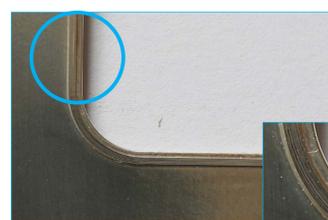
The micro hardness (HK 0.01) profile measurement. (BAM, Berlin, Germany)



## XFEL EBPM/OTRS VATSEAL gasket



VATSEAL gaskets from VAT, CH



## Results and Conclusion

This new technology is created and worked out for easily repeatability, high processability and easy feasibility by using well-known machining process of CNC technology. This method can be used for all flange materials like SST, aluminium or titanium without any finalizing, manual abrasive process. The gasket materials can be metal or non-metal materials. All flange profiles are possible. This technique worked for vacuum, fluids and solid particles too. The patent for this technology is pending

For wide open or non-symmetrically flange apertures instead of normal Conflat (CF) with copper gasket rings, flange connections with VATSEAL gaskets are used. VATSEAL connections are made for special vacuum connections, RF structures and as well as synchrotron beamlines. Further requirements for all-metal seal connections with VATSEAL gaskets are low permeation, low outgassing, baked-able, no hydrocarbons, low particle emission and radiation resistive.

Thanks a lot to Dr. Dirk Nölle (DESY) for take most of these photos!