



Experience in contracts with the central stores for vacuum CF gaskets and screws

Outline:

Vacuum Gaskets:

- Which gaskets are used at CERN?
- Where and why?
- Conflat® gaskets in copper
- Diamond gaskets in aluminium

UHV Fasteners:

- Where?
- Why A4L-100 from BUMAX?
- How?
- Technical Specification
- Example of Certificate 3.1

Future

A.Vidal
CERN/TE/VSC

Which gaskets are used at CERN?

- ❑ Conflat® gaskets in copper (OFHC/OFS)
- ❑ Diamond gaskets in aluminum
- ❑ Helicoflex® gaskets
- ❑ ISO K / ISO KF gaskets (O-ring)



Where and why?

PS	SPS	LHC	Others...
Diamond gaskets in aluminum	Diamond gaskets in aluminum	<p><i>For Beam vacuum:</i> Conflat® in copper (OFS)</p> <p><i>For Insulation vacuum:</i> ISO K-ISO KF (O-ring)</p> <p><i>For Experimental area:</i> Helicoflex®</p>	<p><i>For Linac 3&4:</i> Helicoflex & Conflat® in copper</p> <p><i>For AD:</i> Helicoflex®, Diamond gaskets in aluminum & Conflat® in copper</p> <p>...</p>

Conflat® gaskets



- History
- How it works?
- Sizes of CF flanges
- Dimensions of CF flanges & gaskets
- Grades of CF gaskets
 - Cu-OFHC (Standard)
 - Cu-OFS (CERN specification)
- Gasket clip



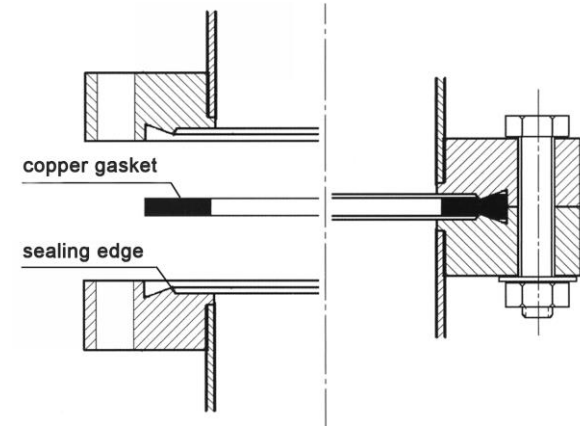
History

- ❑ In the early 1960's, Conflat® flanges and copper gaskets were originally invented by William Wheeler and other engineers at Varian Associates in an attempt to build a flange that would not leak after baking.
- ❑ A patent was applied for in 1961 and issued in 1965.
- ❑ The Conflat®-type (commonly called CF) became the most popular, robust and reliable of all of the metal gaskets.



How it works?

- The seal mechanism is a knife-edge that is machined below the flange's flat surface, which cuts into the softer metal gasket (copper ring), providing an extremely leak-tight, metal-to-metal seal.
- Deformation of the metal gasket fills small defects in the flange, allowing Conflat flanges operate down to 10^{-13} mbar pressure, and within the temperature range -196°C to 450°C (depending on material).
- The knife edge is recessed in a groove in each flange. In addition to protecting the knife edge, the groove helps hold the gasket in place, which aligns the two flanges and also reduces gasket expansion during bake-out.

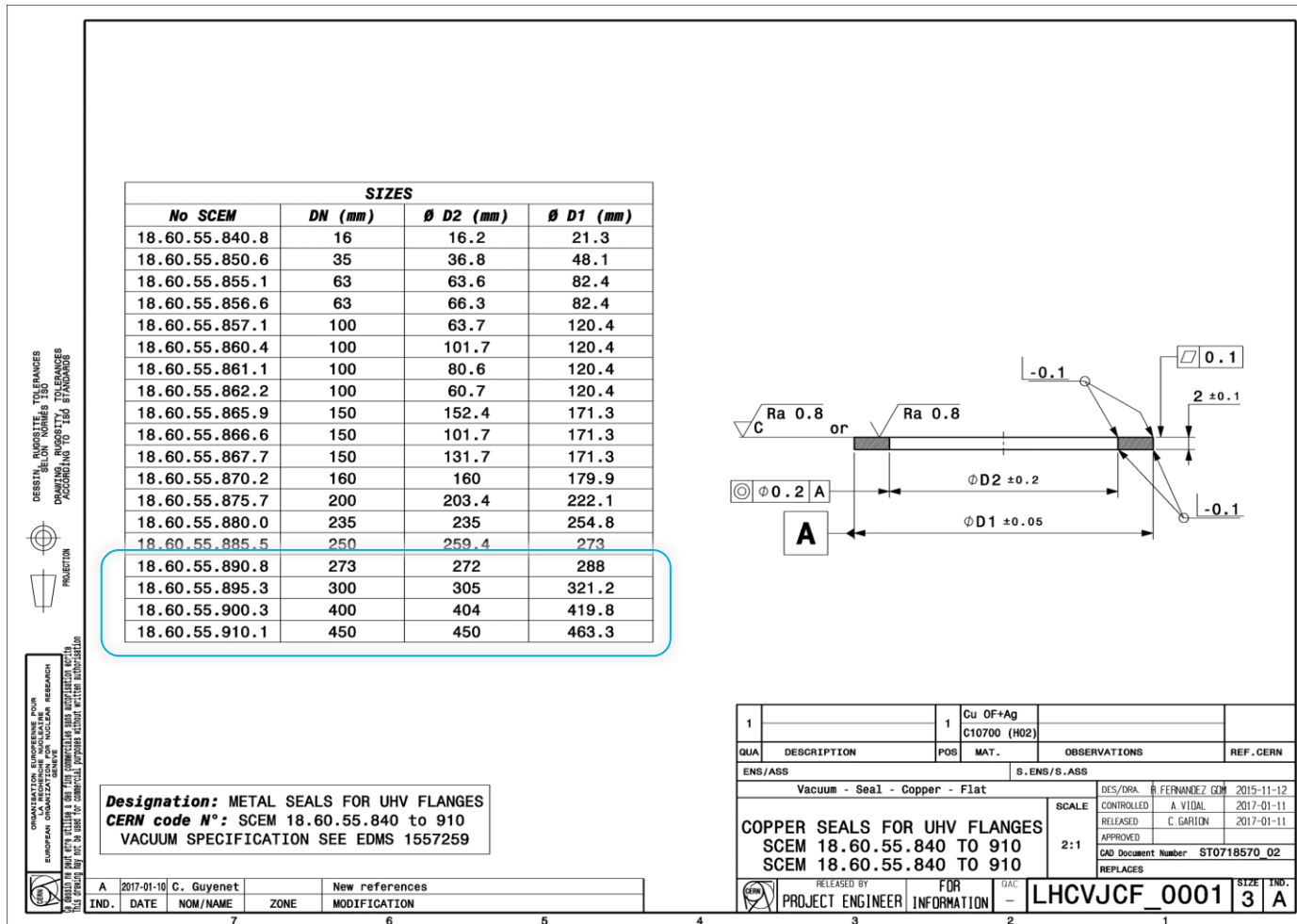


Sizes of CF Flanges

- ❑ In North America, flange sizes are given by flange outer diameter in inches, while in Europe and Asia, sizes are given by tube inner diameter in millimetres.
- ❑ Despite the different naming conventions, the actual flanges are the same.
- ❑ **Standard size DN Flanges from DN16 to DN250.**
- ❑ At CERN, we used CF flanges until DN450 (machine) & DN600 (laboratory)

CERN Reference SCEM 18.60.55.	DN (mm)	Internal Diameter (mm)	External Diameter (mm)
840.8	16	16.2	21.3
850.6	35	36.8	48.1
855.1	63	63.6	82.4
856.6	63	66.3	82.4
857.1	100	63.7	120.4
860.4	100	101.7	120.4
861.1	100	80.6	120.4
862.2	100	60.7	120.4
865.9	150	152.4	171.3
866.6	150	101.7	171.3
867.7	150	131.7	171.3
870.2	160	160.0	179.9
875.7	200	203.4	222.1
880.0	235	235.0	254.8
885.5	250	259.4	273.0
890.8	273	272.0	288.0
895.3	300	305.0	321.2
900.3	400	404.0	419.8
910.1	450	450.0	463.3

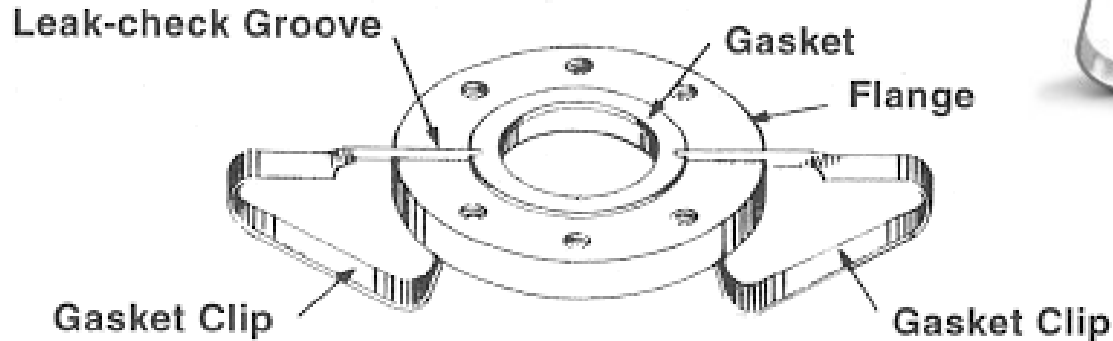
Dimensions of CF gaskets



DESIGN, RUDORITE, TOLERANCES
 SELON NORMES ISO
 PROJECTIONS
 PROJECTIONS
 ACCORDING TO ISO STANDARDS

ORGANISATION EUROPEENNE POUR
 LA RECHERCHE NUCLEAIRE
 EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
 LE GÉNÉRAL DE LA CERN VEILLER À CE QUE LES COMMUNICATIONS SONT RÉGULIÈREMENT RÉVISÉES
 THIS GROUP MAY NOT BE USED FOR COMMERCIAL PURPOSES WITHOUT AUTHORISATION

Gasket clip (Agilent product)



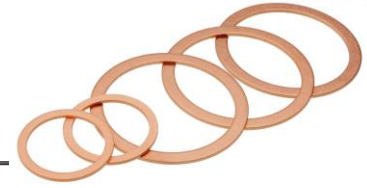
1. Use two gasket clips to hold a gasket in place during Conflat® flange assembly.
2. Insert each clip in the flange's leak-check groove, as shown. The tip of the clip should not extend over the gasket more than 1/32 inch
3. Bolt flanges together finger-tight before removing the gasket clips.

MODEL NO. 953-5052

Grades: OFHC (standard product)

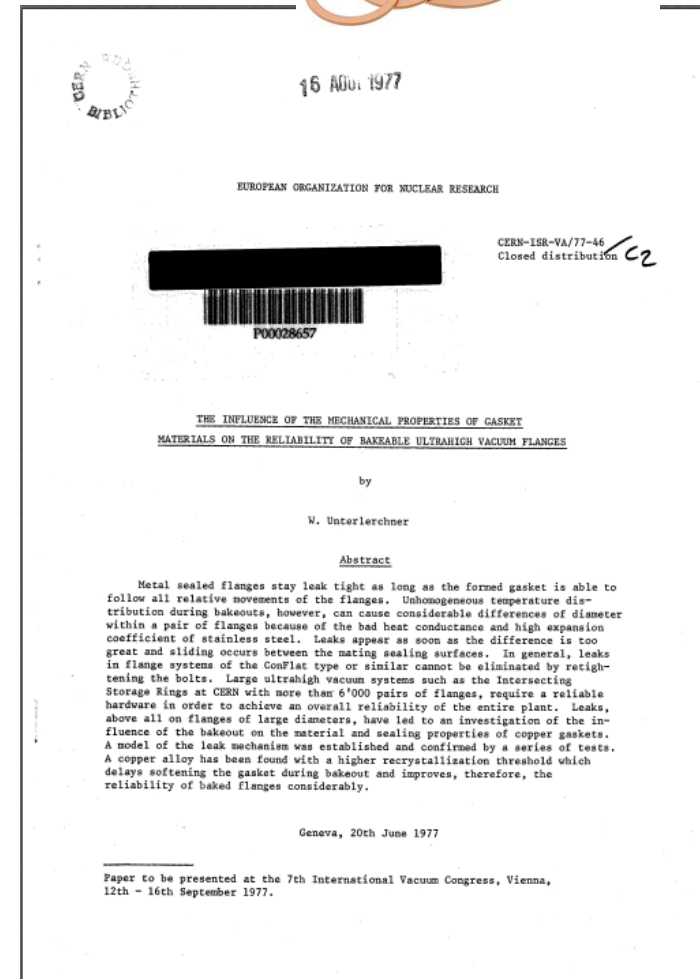
- ❑ The normal gaskets for stainless steel CF flanges are punched from 1/4 hard, high purity, oxygen-free (OFHC) copper. The gaskets are polished by tribofinishing to remove all the burrs, etched to remove surface skin, UHV cleaned and individually packed.
- ❑ Optionally, gaskets can be Silver Plated to provide extra protection against oxidation.
- ❑ Used at CERN from 2016 for test in labs with the labelling “Not bakeable”.
- ❑ No CERN technical specification available.

Grades: OFS (only at CERN)



- ❑ The CF gaskets used at CERN are produced from silver bearing oxygen-free copper Cu Ag 0.10 (Cu OFS C10700, EN CW019A).
- ❑ This copper alloy have higher recrystallization threshold which delays softening the gasket during bakeout and improves, therefore, the reliability of baked flanges considerably (see note CER-ISR-VA/77-46 published on 20th June 1977).
- ❑ Until 2016, the historic supplier was Garlock (Technetics). The gaskets are stamped from sheet, polished by tribofinishing, UHV cleaned and packed.
- ❑ From 2017, the CF gaskets in OFS are supplied by BOSTEC. The gaskets are fully machined from a sheet of 3mm thick. The gaskets are laser cut, rectified, machined, UHV cleaned and packed. To avoid oxidation, the gaskets are Silver Plated.
- ❑ Chemical composition shall be as follow:

Cu + Ag	Min. 99.98 %
Ag	0.09 – 0.12 %
Max. oxygen	0.001 %



<https://cds.cern.ch/record/314893/files/cer-000237677.pdf>

Technical Specification CF gaskets

- EDMS n°1557259
Revision 3 (08-11-2026)
- Needs to be reviewed
for the coming MS+IT
(2025)

1. TECHNICAL REQUIREMENTS

1.1. Dimensions

Dimensions are shown on drawing number LHCVJCF_0001. All tolerances, including surface finish, must be respected. The gaskets shall be free of burrs.

1.2. Material

The gaskets shall be manufactured from silver bearing oxygen-free copper Cu. Chemical composition shall be as follow:

Cu + Ag	Min. 99.98 %
Ag	0.09 – 0.12 %
Max. oxygen	0.001 %

Material certificates shall be provided by the manufacturer for all delivered batches.

1.3. Mechanical properties

a) At room temperature

- 0.2% proof stress (min.): 200 MPa.
- Vickers hardness (100 g load): 80-90 HV.

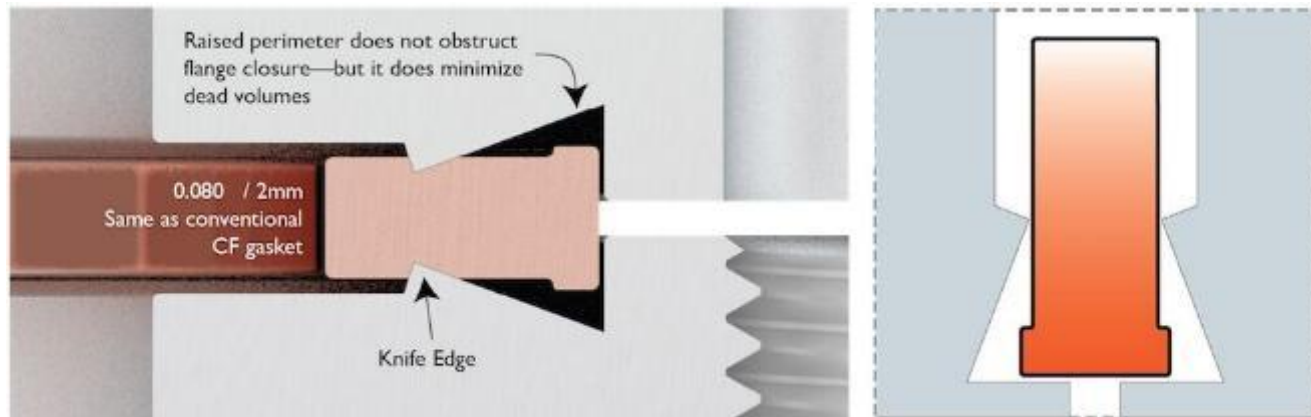
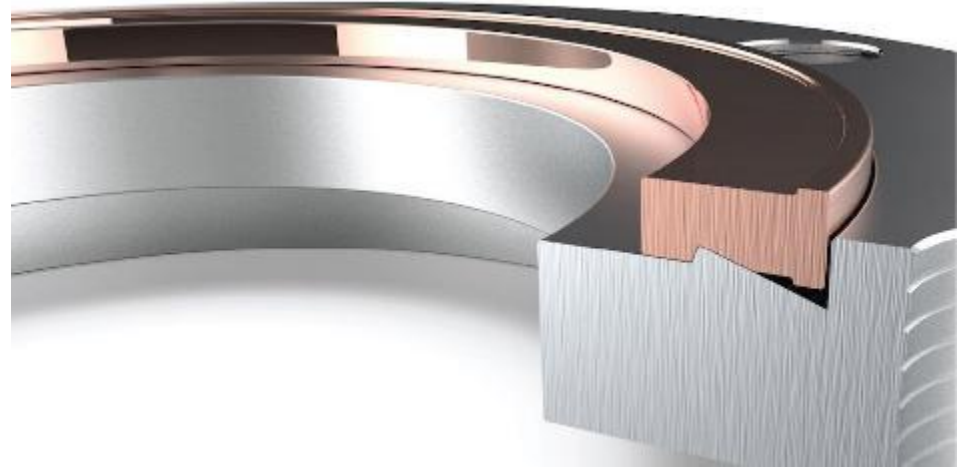
b) At elevated temperature

The gaskets will be baked at up to 350 °C. Recrystallization should not occur with such thermal treatment. Hardness measured at room temperature after such thermal treatment shall not be lower than 80 HV.

1.4. Surface finish

Proposed changes for CF gaskets

- ❑ The HiRim® CF Gasket from BOSTEC
- ❑ Interchangeable with conventional CF gaskets



Advantages of HiRim® CF Gaskets

- ❑ HiRim gaskets are self-protecting;
- ❑ Easy to install and remove;
- ❑ Self-centering and dimensionally identical to conventional CF gaskets;
- ❑ Drop them directly into your existing flanges—no alterations necessary!
- ❑ Lower prices.



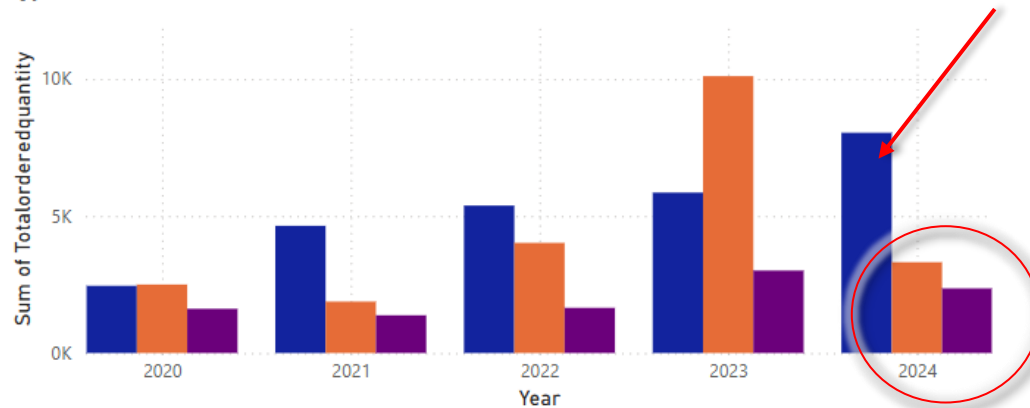
CERN catalogue

Size	CF gaskets Cu OFHC (CHF)	CF gaskets Cu OFS+Ag (CHF)	Ratio
DN16	0.7	7.7	11
DN35	0.91	10.5	11.54
DN63	2.5	16	6.4
DN100	3.6	22	6.1
DN150	5.0	30	6
DN200	5.1	38.5	7.55
DN250	26	85	3.3

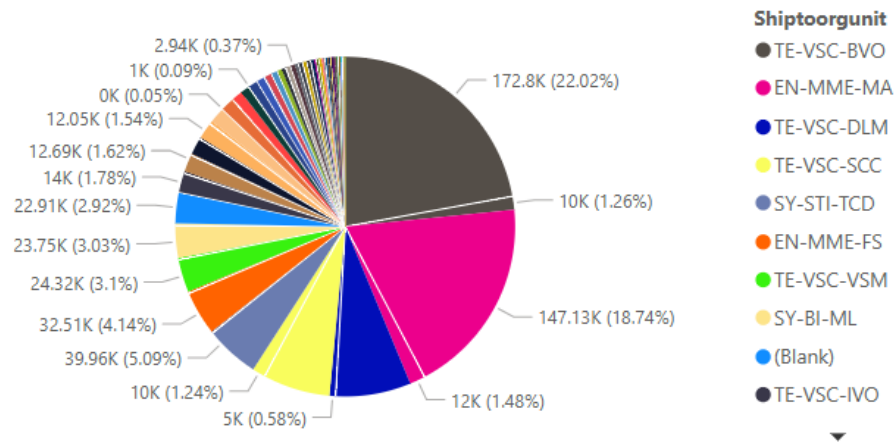
CF gaskets consumption

Sales Cu-OFHC Vs Cu-OFS vs Cu-OFS Silver coated

Type ● Cu-OFHC ● Cu-OFS ● Cu-OFS Silver coated

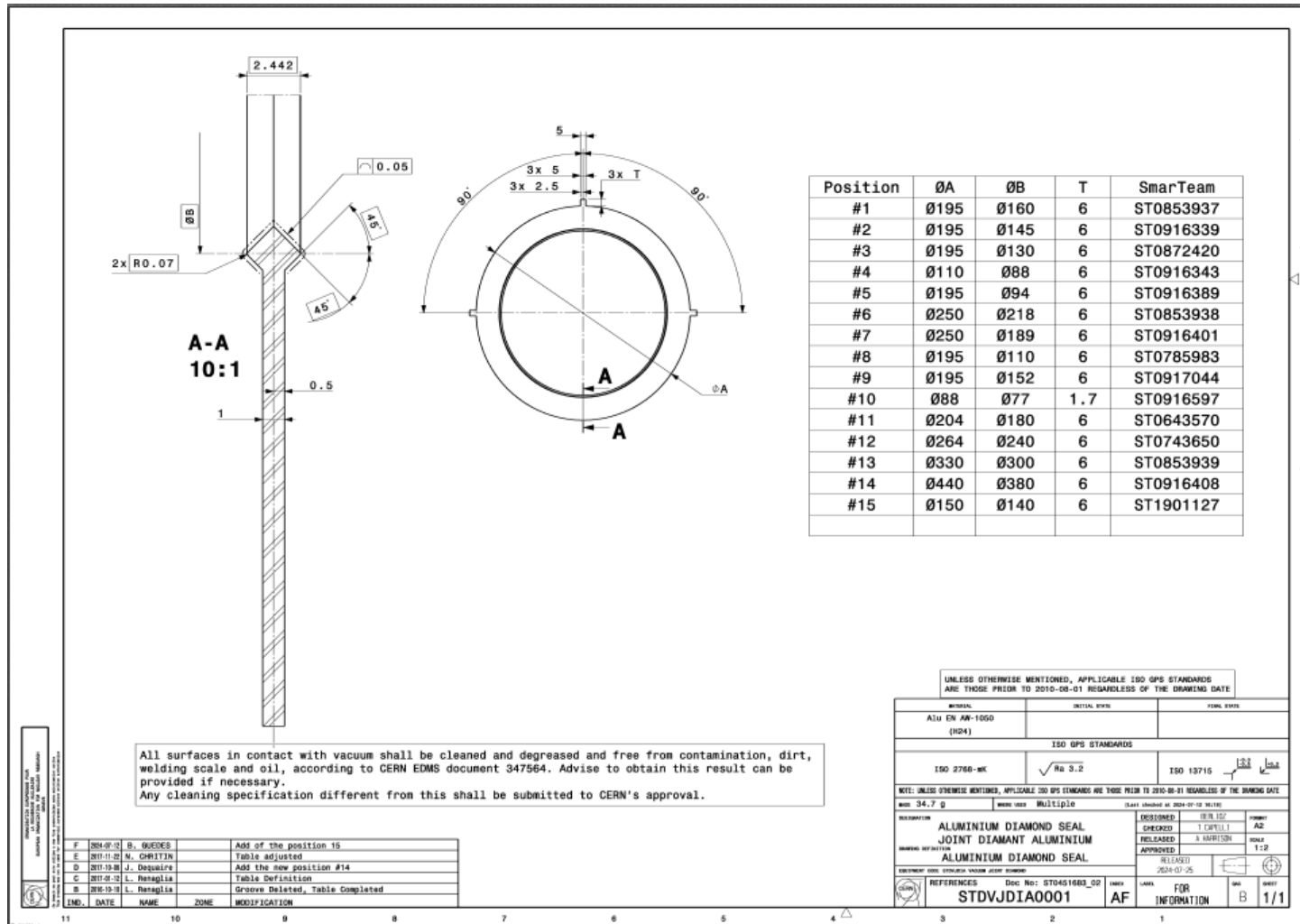


Sum of Total amount and Sum of Total ordered quantity by Shiptoorgunit



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Diamond gaskets in aluminium



Technical Specification

Diamond gaskets in aluminium



- ❑ EDMS n°1730623 (08-11-2026)
- ❑ Needs to be reviewed for the coming MS+IT (2025)

1. TECHNICAL REQUIREMENTS

1.1. Dimensions

Dimensions are shown on drawing number STDVJDIA0001. All tolerances, including those for surface finish, must be respected. The gaskets shall be free of burrs.

1.2. Material

The gaskets shall be manufactured from aluminium grade ISO Al 99.5 EN AW-1050. Material certificates shall be provided by the manufacturer for all delivered batches.

1.3. Mechanical properties

- 0.2% proof stress (min.): 75 MPa.
- Vickers hardness: 35-50 HV.

1.4. Surface finish

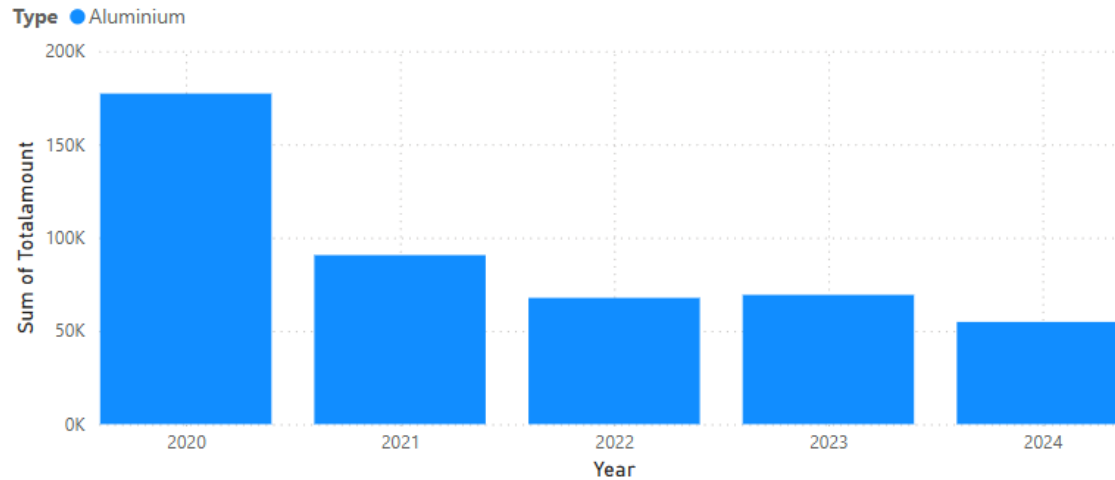
Should the gaskets be machined, machining grooves shall be in circumferential directions only. Special attention must be devoted to the machining of the knife edges. They must be without burrs. Deburring, if necessary, has to be done with cutting tools. The use of sand paper, polishing paste or any other abrasive is not accepted. The surfaces of the knife shall be smooth (Ra 0.8), free from perceptible scratches (fingernail test, depth < 1 µm), hard foreign material surface inclusions and other blemishes. They have to be visually homogeneous.

1.5. Cleaning

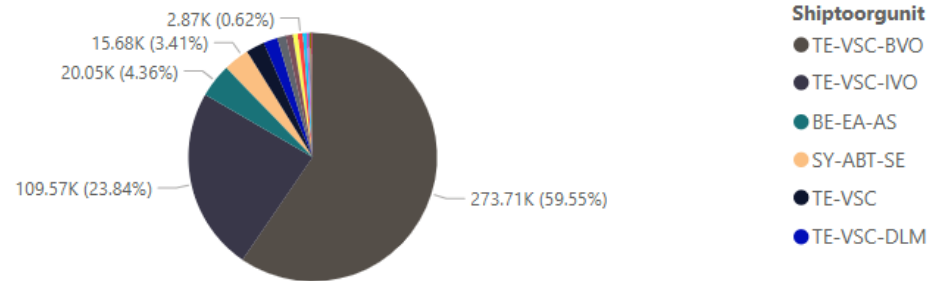
Gaskets shall be cleaned such that the surfaces are degreased and free from oxidation. The requirements for

Diamond gaskets consumption

Sales Diamond Gaskets/year



Sales total amount/Dept

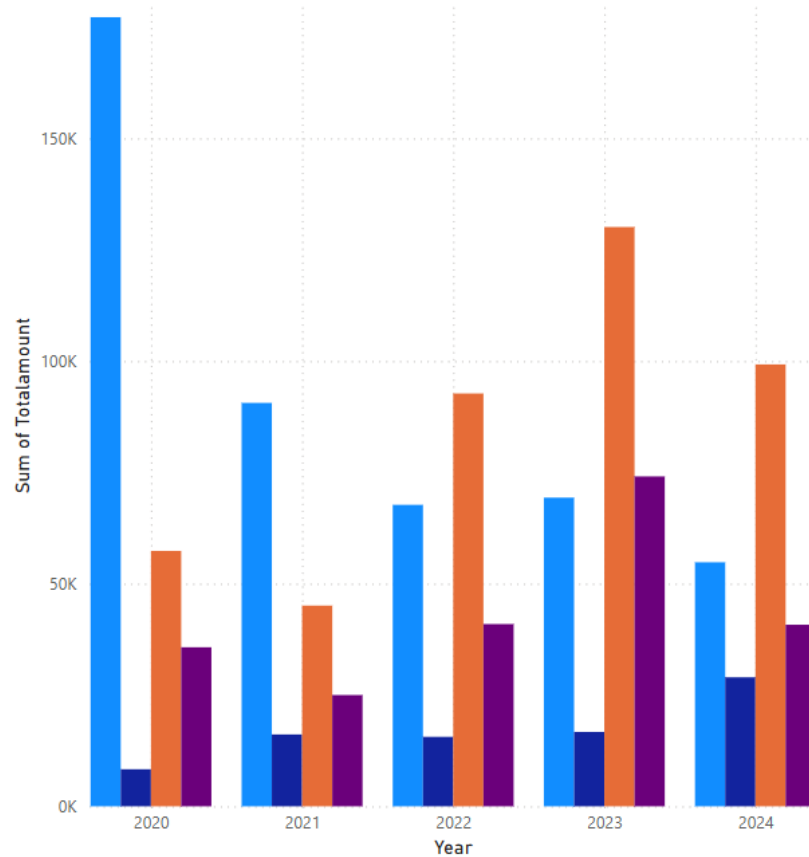


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Total cost for Metallic Gaskets

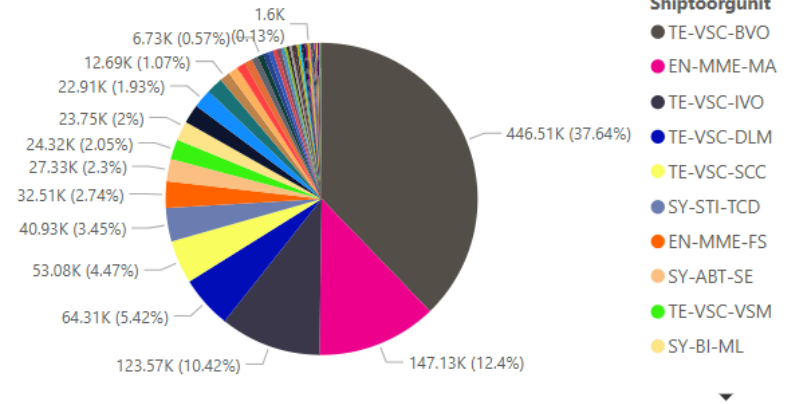
Sales Total amount CHF/Year/Type

Type ● Aluminium ● Cu-OFHC ● Cu-OFS ● Cu-OFS Silver coated



Sum of Totalorderedquantity	Sum of Totalamount	Type
7904	459,661.89	Aluminium
26366	85,731.63	Cu-OFHC
21812	424,489.1	Cu-OFS
10004	216,495.0	Cu-OFS Silver coated
66086	1,186,377.69	

Sales amount / Dept



By courtesy of Leila Akhouay SCE/SCC/SC

Contractual situation with BOSTEC

- ❑ High quality product (CF & Diamond gaskets);
- ❑ Many delivery delays;
- ❑ Substantial price increase;
- ❑ No visibility of raw material stock;
- ❑ Important delays for special orders.

UHV Fasteners

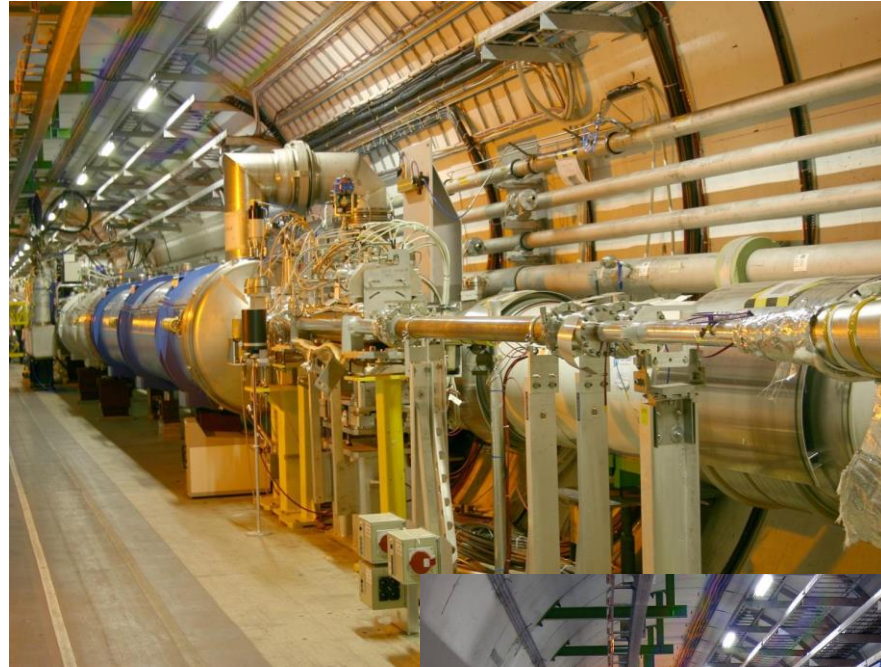


- ❑ UHV fasteners from BUMAX in stainless steel grade A4L-100 are mainly used at CERN for **Ultra-High Vacuum** applications and magnetic field.
- ❑ The fasteners are used to assemble stainless steel flanges (Conflat® type) on the vacuum chambers of the particle accelerators at CERN.
- ❑ The fasteners must support temperature bake out in the range of **150°C to 300°C** for periods of 24 hours.



Where ?

- ❑ Accelerators:
- ❑ Linac 2&3
- ❑ ISOLDE
- ❑ LEIR
- ❑ AD
- ❑ LHC machine
- ❑ Laboratories



Why A4L-100 (BUMAX® 109) ?

BUMAX® 109 has been selected for:

- ❑ Yield strength
- ❑ Mechanical properties at elevated temperature (95% at 150°C – 90% at 300°C)
- ❑ Low magnetic permeability
- ❑ Fatigue resistance
- ❑ High level of quality



How ?



External use:

- ❑ Nuts are **silver plated (3-5 μ m)** or coated with Molykote® lubrication;
- ❑ Studs are silver plated.

Internal use:

- ❑ Nuts, Screws and Studs are silver plated;
- ❑ Some applications required screws vented with through hole.

Tightening:

- ❑ No torque wrench;
- ❑ The tightening is done manually, flange against flange;
- ❑ Favorite sizes, M6 (DN40) and M8 (DN63, DN100, DN150 & DN250);
- ❑ Fasteners are replaced after 2 or 3 utilizations.

Technical Specification Fasteners

- ❑ EDMS n°2026240
Edition 4 (20-11-2024)
- ❑ Up-to-date
- ❑ New contract from
January 2025 (5
years)
- ❑ Certificate 3.1
delivered for each
batch



European Organization for Nuclear Research
Organisation européenne pour la recherche nucléaire

Technical Annex

**N°507 – Ed.4
EDMS No: 2026240**

FASTENERS

**For Ultra-High Vacuum Applications and Magnetic Field
Stainless Steel grade A4L-100**

Example of Certificate 3.1

Certificate Submission

BUFAB FRANCE has sent a Certificate for the following order:

Fastener test report ISO 16228 F3.1 (EN 10204 3.1)

Certificate Number: HFP-250219-3WSH

Delivery Date: 19 February 2025

Your Order Number: 001201913

Your Product Number: 4014A408055109

Our Order Number: 958772

Our Product Number: 4014A408055109

Our Product Description: ISO4014 A4 M8x55 BUMAX109

Lot/Reference Number: 130712-10_569340

BUFAB

Report No.
HFP-250219-3WSH

Fastener test report ISO 16228 F3.1 (EN 10204 3.1)

Order Information

Customer CERN	Customer order No. / Line No. 001201913 /	Supplier order No. / Line No. 958772 /	Supplier BUFAB FRANCE 36, Route de Lyon 69960, CORBAS France
CH1211 , GENEVE 23	Customer Item No. 4014A408055109	Supplier Item No. 4014A408055109	
Switzerland	Manufacturing lot No. 130712-10_569340	Quantity 350	
Product designation ISO4014 A4 M8x55 BUMAX109	Product marking BUMAX A4-316L 100		

Material properties

Material charge No. 569340	Applied standard BUMAX 109 (1.4432, 1.4436 or 1.4435)							Test facility S			
Substance(%)	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N	
Min limit						16.5	10.5	2.50			
Max limit	0.030	1.00	2.00	0.045	0.030	18.5	15.0	3.00	0.60	0.10	
Result	0.013	0.54	1.38	0.031	0.007	16.70	11.12	2.59	0.28	0.036	
Substance(%)	Co										
Min limit											
Max limit	0.50										
Result	0.11										

Mechanical, physical and functional properties

Applied standard BUMAX 109 Tensile test according to ISO 3506-1:2020						
Characteristic	Facility	Tests	Req.	Unit	Results	
Tensile strength Rm	M	2	Min: 1000	MPa	1137 - 1140	
Yield strength Rp0.2	M	2	Min: 900	MPa	958 - 958	
Elongation after fracture	M	2	Min: 2.4	mm	3.5 - 3.3	
Thread acceptance		2	PASS		PASS - PASS	
PMI test		2	PASS		PASS - PASS	

Validation by Authorized representative

The inspection/tests were performed on samples representative of this manufacturing lot number. The products delivered are in compliance with the order and have been manufactured in accordance with the relevant standards.

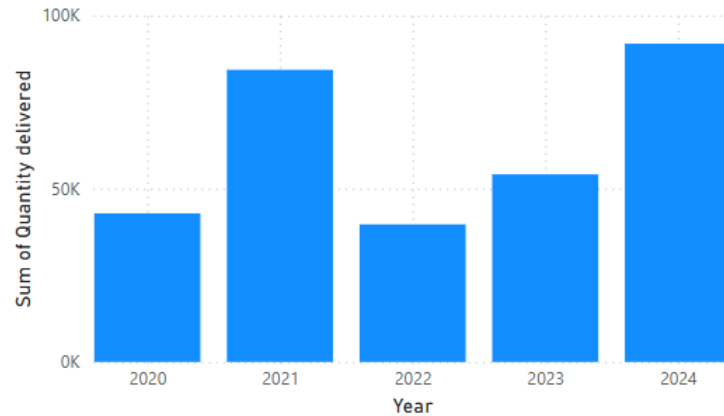
Name	Function	Date
Alexis Lopez	Quality Manager	2025-02-19



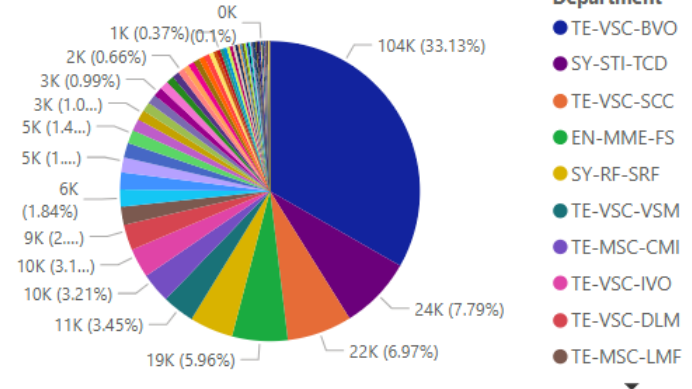
Page 1/1
Validation ID: 4014A408055109-130712-10_569340-20250219-3WSH - Signed Alexis Lopez
This certificate can be validated and traced digitally through ChainTraced.com

Fasteners consumption

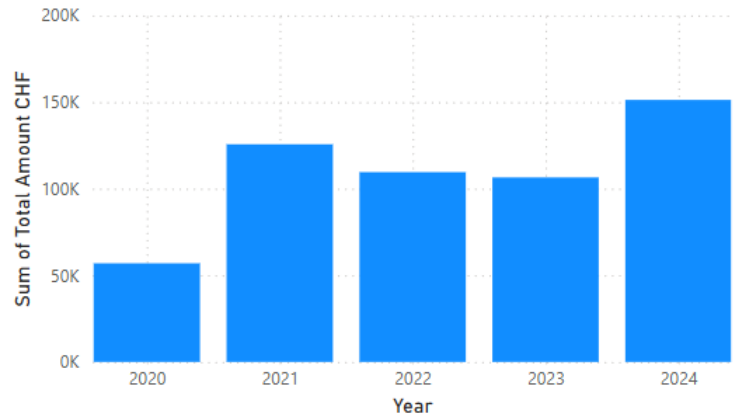
Total Quantity delivered by Year



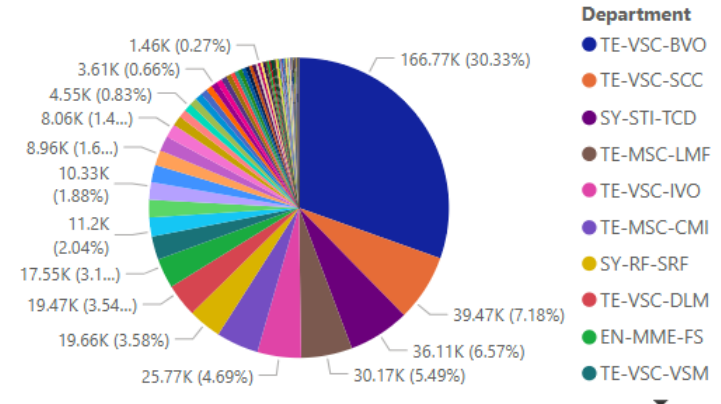
Total Quantity delivered by Department



Total Amount CHF by Year



Total Amount CHF by Department



By courtesy of Leila Akhouay SCE/SCC/SC

Future

- Technical specification revision for:
 - CF gaskets (OFS)
 - Diamond gaskets
- Technical specification for CF gaskets OFHC
- New potential supplier
- Possibility to manufacture CF gaskets at CERN (special size – low quantity)



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