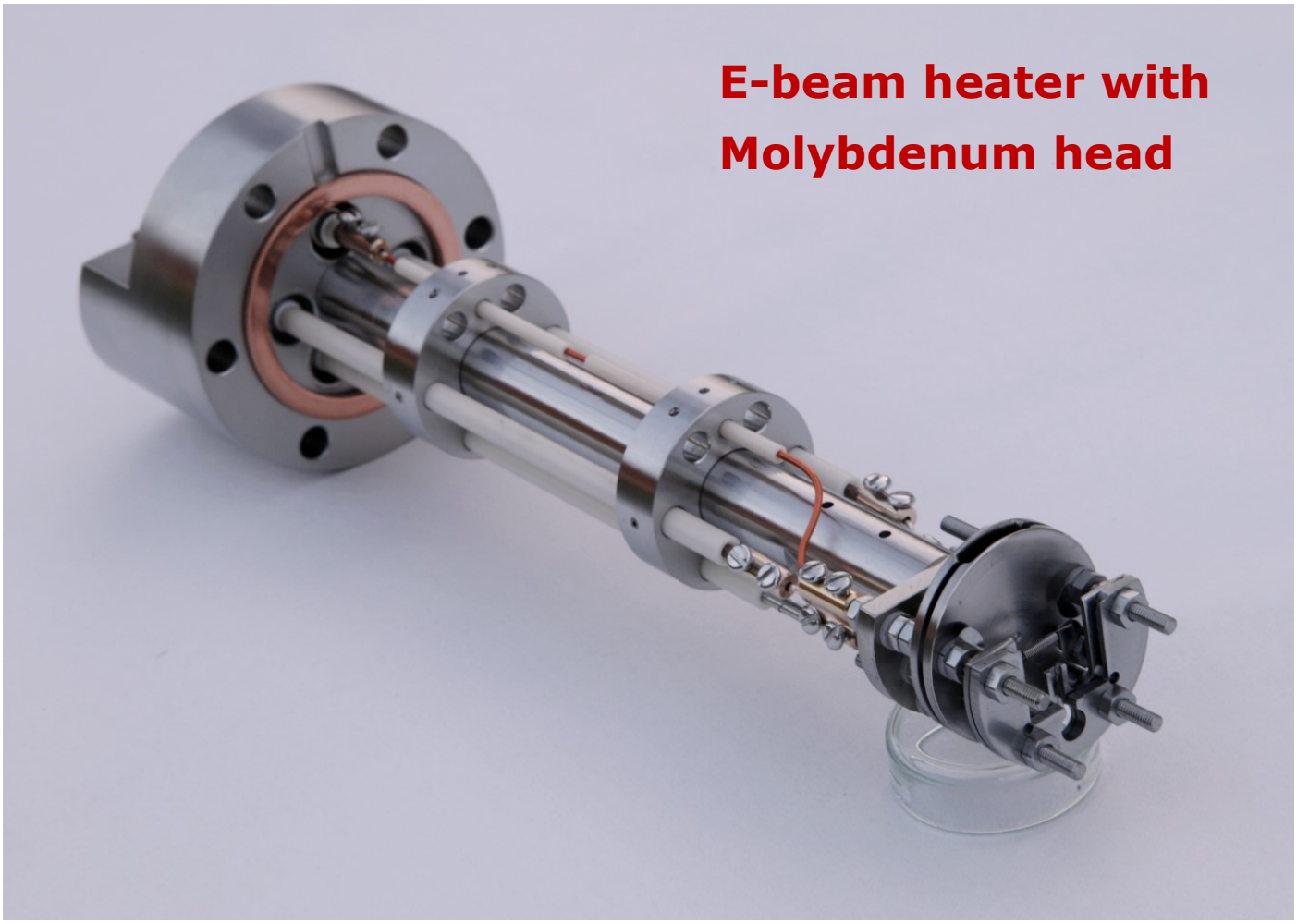
Operating instructions for

Single stage e-beam heater based on CF38



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1 e-beam heater

1.1 Important Warning

Attention

Danger to life

E-beam heater operation only after introduction from authorized person.

During operation the feedthroughs must be covered by the plugs.

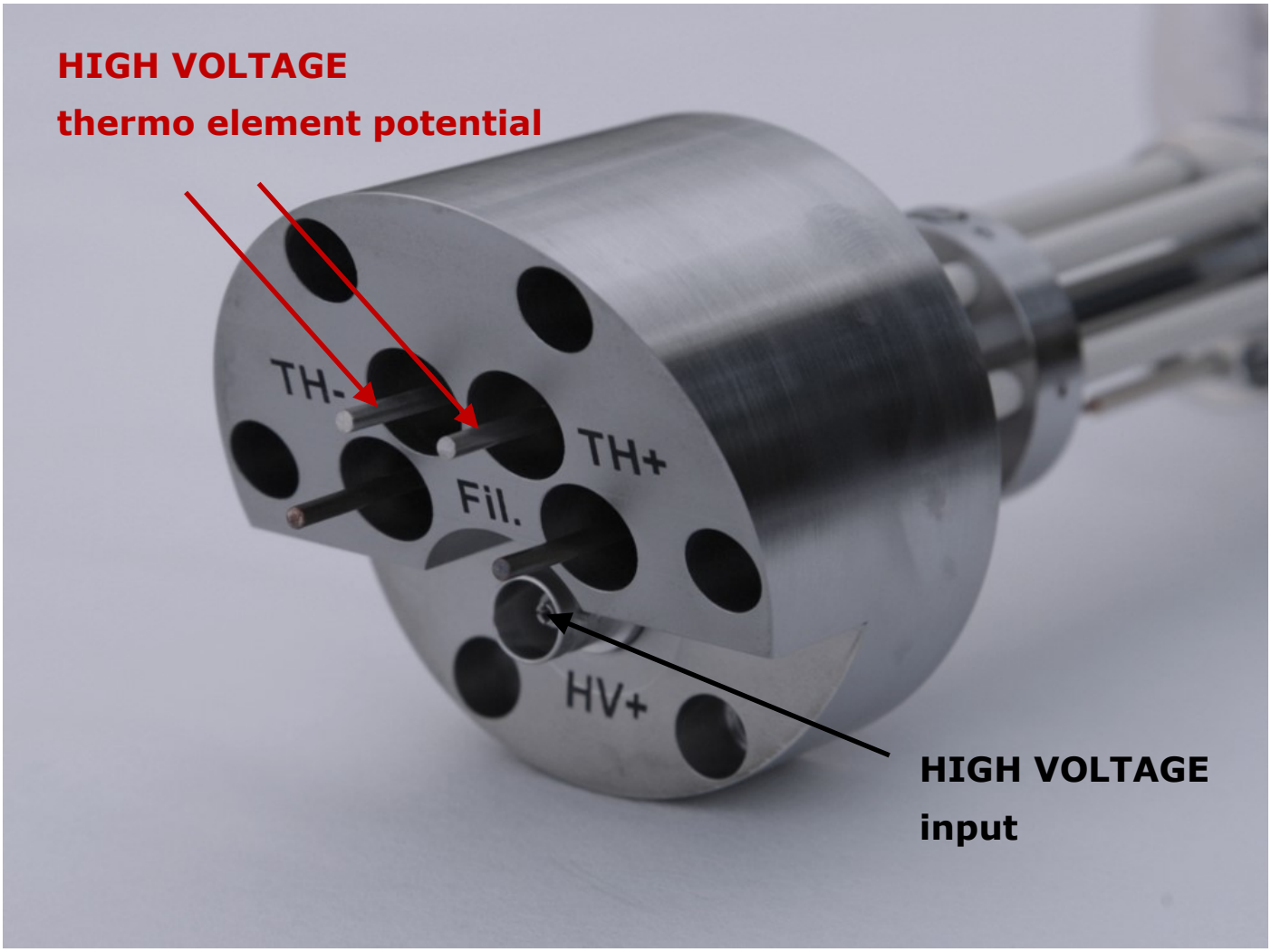

Fig.1

Never use the e-beam heater unplugged !

1.2 Description

The e-beam heater with a head made from Molybdenum allows heating of samples up to 2500 K.

The intermediate disk allows transfer as used in the in Omicron manipulator system. Inside the filament chamber, tungsten sheets cover the isolators to prevent coating from the filament. This leads to an extension of lifetime.

The temperature is measured by a W/Re Thermocouple that is placed in the same distance to the filament as the sample holder. The thermocouple is spot welded on 1mm thick Molybdenum (same thickness as the Mo sample holder).

Nevertheless the Thermocouple voltage differs from the "real" temperature (measured with a pyrometer (Fig. 4).

This is caused by small deviation in the position of the filament. The filament position should not cause a higher temperature of the thermocouple web compared with the sample holder. In such a case the web can be melt before the sample holder reach the final temperature.

Fig. 2 shows the e-beam head with basic explanation of the details.

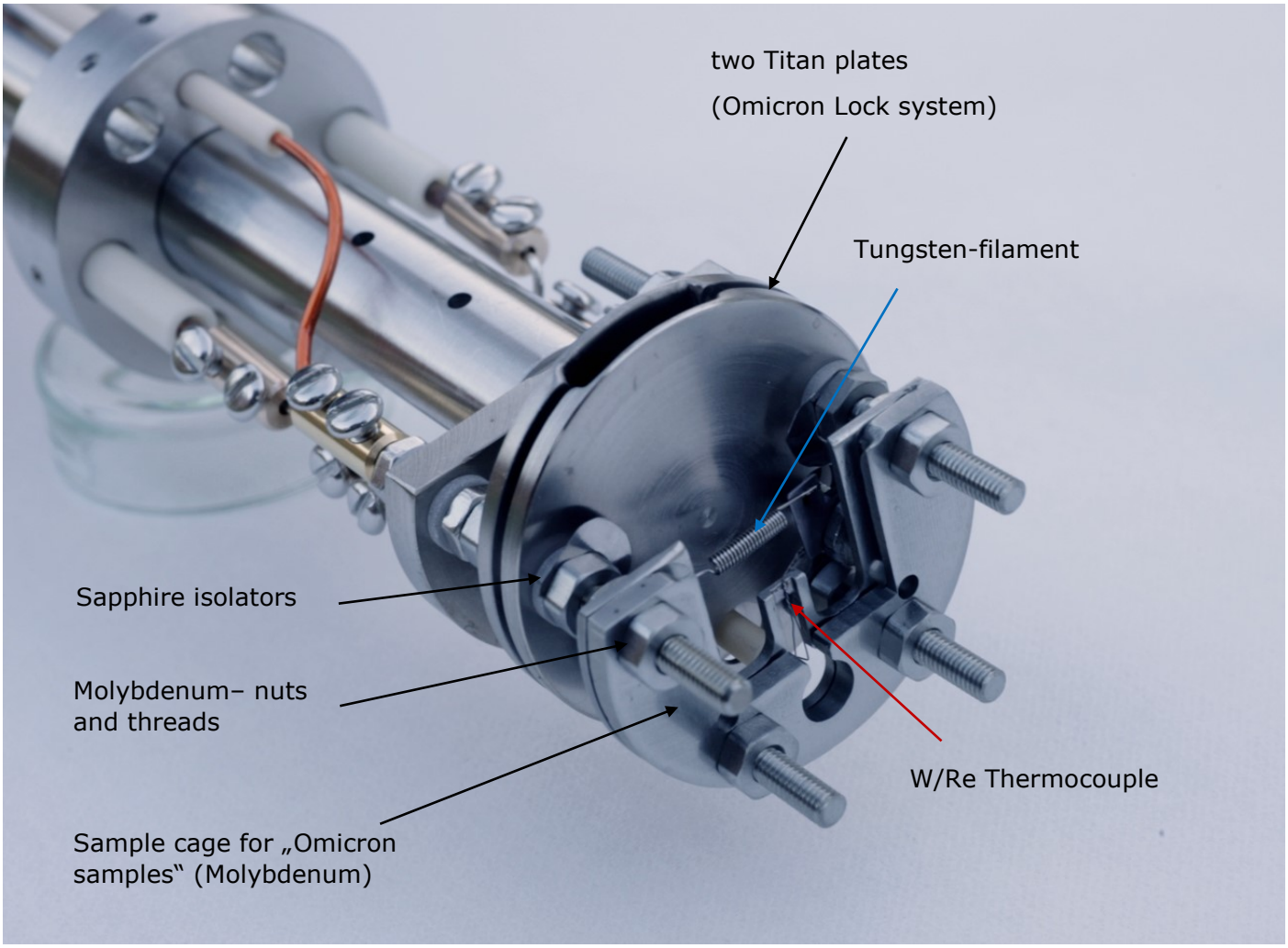

Fig. 2 e-beam head with Sapphire isolators without sample holder

1.3 External connection diagram

Fig. 3 shows how the e-beam heater should be connected to the power supplies. Please consider that the gauge measuring the Thermocouple Voltage is on high Voltage.

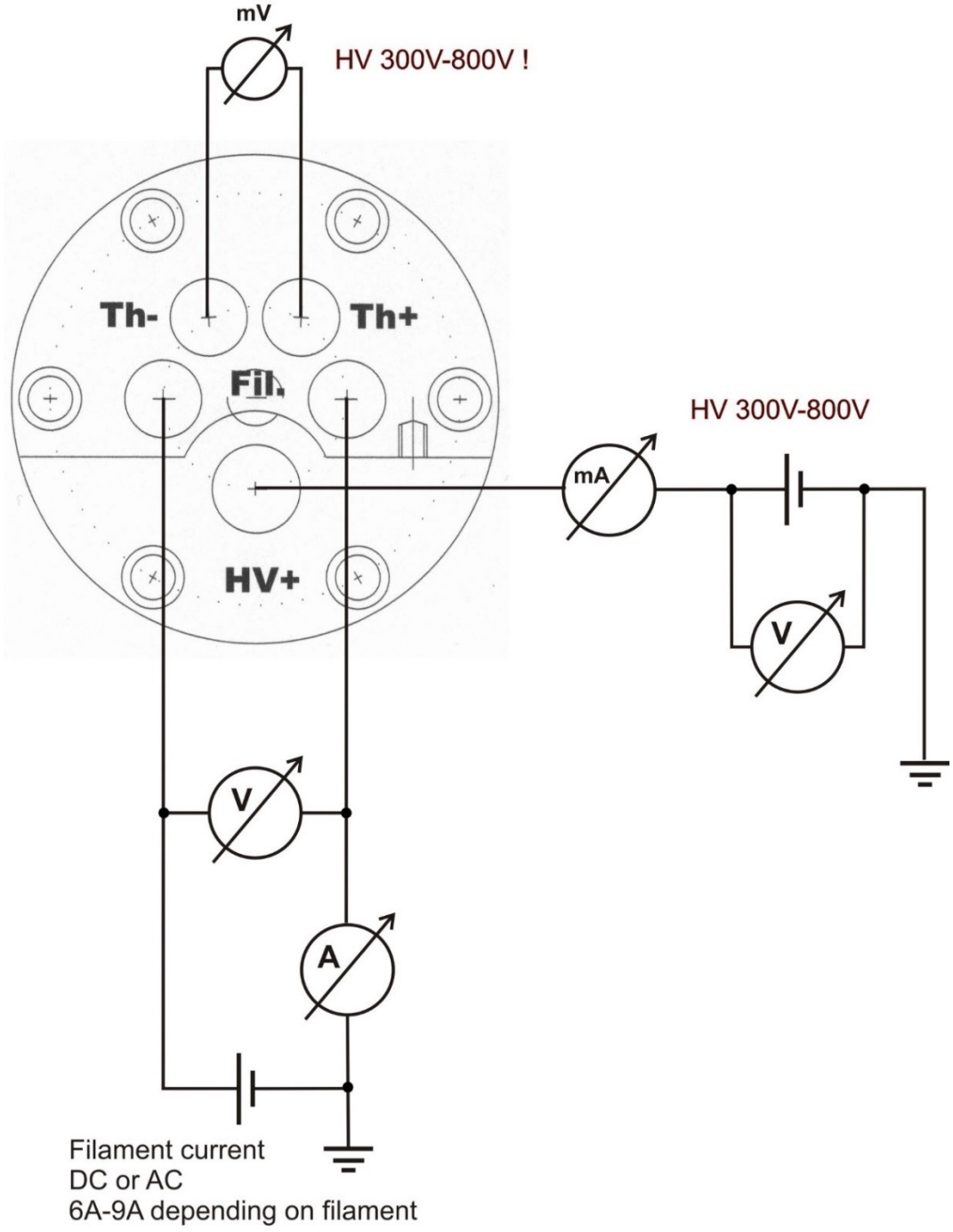

Fig. 3 Connection diagram in relation to the basic flange

This gauge needs for the input a decoupling of the high Voltage (p. E. optic coupler) or must be isolated completely.

A common us is to set the High Voltage (300V-800V) and increase the filament current until the final temperature is reached.

1.4 Temperature curve

A typical heating cycle shown in Fig. 4 can be divided in three sections: Heating of the filament, applying of the high Voltage and cooling down. In this temperature regime only the sample holder.

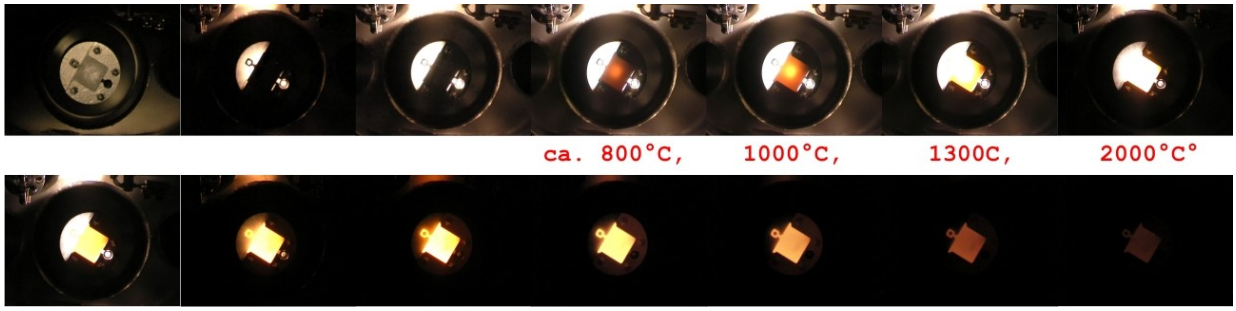

Fig. 4 Heating cycle starting from room temperature up to 2000°C.

From image 4 to 8 high voltage is applied. Image 9 to 14 shows the constant decrease in temperature.

The relation between Thermo element Temperature, Pyrometer Temperature and input power show the curves of Fig. 5.

This diagram shows the big deviation of the thermocouple temperature and the "true" temperature of the Pyrometer.

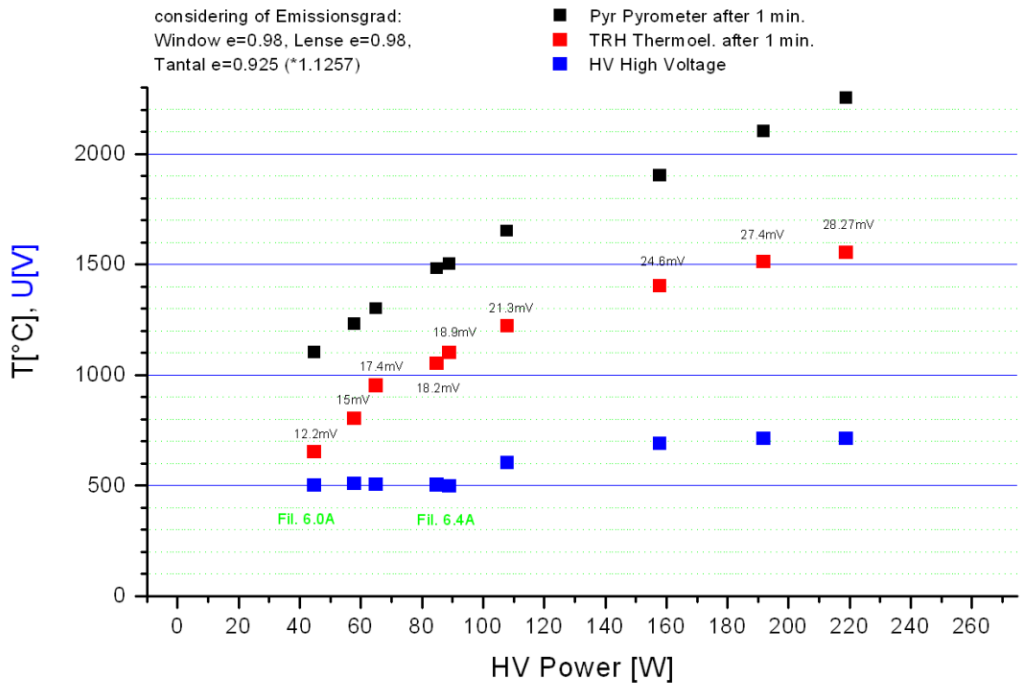

Fig. 5 Temperature versus HV power of the e-beam heater

This means that the thermocouple voltage can be only used for reproduction of heating cycles. For accurate temperature measurements a pyrometer is needed.

The heating sequence (Fig. 4) shows that nearly the complete e-beam power will be absorbed by the sample holder. Thereby the input power gives logically a useful value for the final temperature at given heating time.

Fig. 6 shows the common relation between Thermovoltage and Temperature in Celsius [°C] special for W4Re/W26Re Thermocouple.

CALIBRATION TABLE W5Re/26Re
REFERENCE JUNCTION 0°C

°C.	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
0°	0.000	0.135	0.272	0.412	0.554	0.698	0.845	0.993	1.144	1.296
100°	1.451	1.607	1.765	1.925	2.087	2.250	2.415	2.581	2.749	2.918
200°	3.089	3.261	30434	3.609	3.785	3.962	4.140	4.319	4.500	4.681
300°	4.863	5.047	5.231	5.416	5.601	5.788	5.975	6.163	6.352	6.541
400°	6.731	6.921	7.112	7.304	7.496	7.688	7.881	8.047	8.267	8.461
500°	8.655	8.849	9.044	9.239	9.434	9.629	9.824	10.019	10.215	10.410
600°	10.606	10.801	10.997	11.192	11.388	11.583	11.778	11.974	12.169	12.364
700°	12.558	12.753	12.947	13.142	13.336	13.529	13.723	13.916	14.109	14.302
800°	14.494	14.686	14.877	15.069	15.260	15.450	15.640	15.830	16.020	16.208
900°	16.397	16.585	16.773	16.960	17.147	17.333	17.519	17.704	17.889	18.073
1000°	18.257	18.440	18.623	18.805	18.987	19.168	19.349	19.520	19.709	19.888
1100°	20.066	20.224	20.421	20.598	20.774	20.950	21.125	21.299	21.473	21.647
1200°	21.819	21.991	22.163	22.334	22.504	22.674	22.843	23.012	23.180	23.347
1300°	23.514	23.680	23.846	24.010	24.175	24.339	24.502	24.664	24.826	24.988
1400°	25.148	25.308	25.468	25.627	25.785	25.943	26.100	26.256	26.412	26.568
1500°	26.722	26.876	27.030	27.183	27.335	27.486	27.637	27.788	27.938	28.087
1600°	28.236	28.384	28.531	28.678	28.824	28.969	29.114	29.259	29.402	29.546
1700°	29.688	29.830	29.971	30.112	30.252	30.391	30.530	30.668	30.805	30.942
1800°	31.078	31.214	31.349	31.483	31.617	31.749	31.882	32.013	32.144	32.274
1900°	32.404	32.533	32.661	32.788	32.915	33.041	33.166	33.291	33.415	33.538
2000°	33.660	33.782	33.902	34.022	34.142	34.260	34.378	34.494	34.610	34.725
2100°	34.839	34.953	35.065	35.177	35.288	35.397	35.506	35.614	35.721	35.827
2200°	35.932	36.036	36.138	36.240	36.341	36.441	36.539	36.637	36.733	36.828
2300°	36.922	37.015	37.107							

Fig. 6 Common Thermocouple diagram for transfer of the Thermovoltage into Celsius Temperature

1.5 Flanging

The e-beam heater with Omicron sample holder (or compatible) should be mounted according the sample transfer (Wobble Stick or magnet manipulator). All orientations are suitable unless sample holder can fall off. Fig. 7 shows the basic flange with a bolted rod which relieved handling.

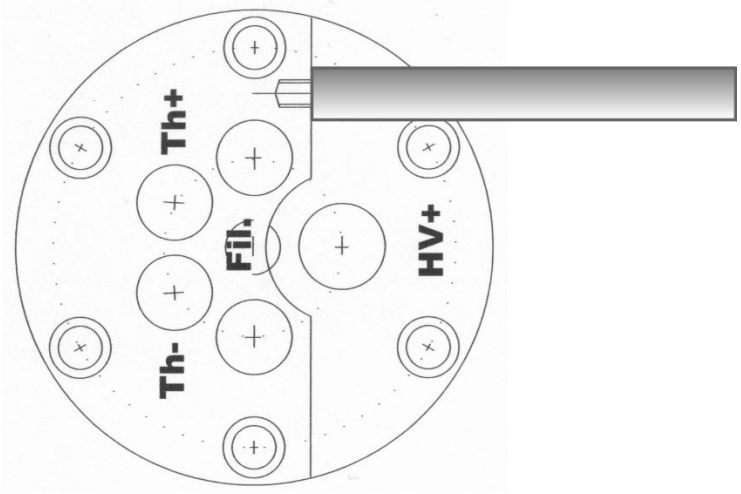

Fig. 7 A rod with M4 screw helps mounting on a UHV chamber

1.6 Filament exchange

The filament is mounted with two small M3 nuts.

Front view with sample holders eyelet on top (Fig. 2).

The left nut has to be mounted first. The half cage on the left side should be mounted in line with the sample holder.

Then the nut on the right side has to be tightening up slightly.

Optimal mounting result in a small tension of the filament, that prevents moving during fist heating.