

Inspection/Test Chart for the 4-circle UHV Diffractometer according to TECHNICAL SPECIFICATION CFT 2027

item	Parameters / Specification for item		conformity		Comment
	value [unit]	see section	yes	no	
Goniometer geometry					
number of axes	4+3		yes		
scattering geometry	horizontal		yes		
sphere of confusion SoC	50 μm		yes		44 μm , See separate test sheet
θ -axis to χ -axis orthogonality	< 100 μrad	3.3		no	Chi-axis cannot be determined, see measurement parallelism χ -plane to ϕ -axis
χ -plane to ϕ -axis parallelism	< 100 μrad				no
Tx-Tz orthogonality	< 150 μrad		yes		95 μrad
Ty - ϕ -axis parallelism	< 100 μrad		yes		15 μrad
Tx-Tz to ϕ -axis orthogonality	< 100 μrad		yes		95 μrad

Rotation stages						
theta Θ	resolution	360°				model 411, Stepper Motor: Phytron VSS57.200.2,5-E-UHVG-4Lp
	repeatability	0.001°			yes	Gear: 1° pitch, motor: 400half-steps/rev., 0.0025°/step
	accuracy	0.005°			yes	
		0.01°			yes	
2theta 2 Θ	resolution	360°			yes	model 411, Stepper Motor: Phytron VSS80.200.5-E-UHVG-4Lp
	repeatability	0.001°			yes	Gear: 1° pitch, motor: 400half-steps/rev., 0.0025°/step
		0.005°			yes	
chi χ	resolution	-45° +45°			yes	model 511.610, Stepper Motor: Phytron VSS57.200.2,5-E-UHVG-4Lp
	repeatability	0.01°		3.3.1	yes	Gear: 1° pitch, reduction gear: 1:10, motor: 400half-steps/rev., 0.00025°/step
	accuracy	0.02°			yes	
		0.02°			yes	
phi φ	resolution	360°			yes	model 409, Stepper Motor: Phytron VSS43.200.2,5-E-UHVG-4Lp
	repeatability	0.1° (0.01°)			yes	Gear: 2° pitch, motor: 400half-steps/rev., 0.005°/step
	accuracy	0.2° (0.02°)			yes	
For all rotations		0.2° (0.02°)				
	limit switches / home	yes			yes	
Translation stages						
Tx	resolution	±10 mm			yes	model 5102.10, Stepper Motor: Phytron VSS43.200.2,5-E-UHVG-4Lp
	repeatability	< 0.5 μ m			yes	Spindle: 1mm pitch, motor: 400half-steps/rev., 2,5 μ m/step
		2 μ m			yes	
Ty	resolution	±5 mm			yes	customized, Gear 2042.10, Stepper Motor: Phytron VSS43.200.2,5-E-UHVG-4Lp
	repeatability	< 0.5 μ m		3.3.2	yes	Spindle: 1mm pitch, reduction gear: 1:10, motor: 400half-steps/rev., 0,25 μ m/step
		2 μ m			yes	
Tz	resolution	±10 mm			yes	Model 5102.10, Stepper Motor: Phytron VSS43.200.2,5-E-UHVG-4Lp
	repeatability	< 0.5 μ m			yes	Spindle: 1mm pitch, motor: 400half-steps/rev., 2,5 μ m/step
for all 3 translations		2 μ m			yes	
	straightness/flatness	±2 μ m			yes	
	pitch and yaw	±50 μ rad		3.3.2	yes	
	speed	1 mm/s			yes	
	limit switches / home	yes			yes	

Stability			
Mechanical	first natural frequency	> 50Hz	
	along z	< 0.5 μm	yes
	along y	< 2 μm	yes
upon bake-out	goniometer alignment		peak-to-peak over 20-30 min, not tested
	preserved upon bake-out		peak-to-peak over 20-30 min peak-to-peak over 20-30 min
Vacuum and UHV compatibility			
base pressure	< $5 \cdot 10^{-9}$ mbar		yes
maximum leak rate	< 5×10^{-10} mb.l/s	3.6	
bake out temperature	> 120°C		yes
Other			
reliable design		3.1	Yes
easy maintenance		3.1	Yes
mounting points for alignment tools		3.8	Yes
all metric		3.1	Yes
Cabling layout		3.7.3	Yes
Control compatible with ESRF ICEPAPs		3.7	Yes
overall dimensions and weight compatible with chamber of ID 750 mm		3.3.2	Yes
			weight ca. 120kg

Test Sheet: Parallelism Phi-axis to Chi-axis

Plane parallel mirror aligned to Phi-axis

Deviation measured with a Moeller Wedel autocollimator

Chi in °	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	
Deviation Rz in μ rad	-315	-300	-200	-135	-155	-155	-90	-25	-40	35	65	135	125	95	100	125	160	180	165	
Deviation Ry in μ rad	50	85	100	65	55	30	5	30	75	50	-30	-60	-130	-195	-195	-220	-270	-365	-390	
Total Deviation: 495 μ rad																				

Test Sheet: Sphere of Confusion (SOC) measurement

Ceramic Reference Sphere (D=14mm) mounted on top of the xyz-translation stage

Digital Dial Indicator (Mahr) mounted in x-, y- and z-direction on 2Theta arm

Measurements:

SOC Phi: 3 μ m

SOC Theta: 3 μ m

SOC 2Theta: 4 μ m

Chi in °	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	
Deviation x in μ m	0	0	-1	-5	-8	-8	-5	-9	-14	-17	-9	-4	-6	-12	-14	-14	-12	-8	-6	
Deviation y in μ m	0	0	-1	-1	-8	-9	-11	-9	-5	-8	-9	-8	-13	-15	-15	-16	-16	-19	-21	
Deviation z in μ m	0	3	-4	-15	-7	-5	-13	-16	-8	-8	-21	-18	-15	-18	-23	-27	-29	-28	-21	
SOC Chi: 34 μ m																				

Total SOC: 44 μ m