NGAO OSM

Design Study

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Version 7

Conceptual design and operation

The Ø 5" (3.635 mm) probe covers the entire Ø 120" (87.24 mm) Field of View.

The 2 degrees of freedom probe arm consists of 2 individual arms: A crank arm and a lever arm, driven by 2 corresponding rotation motors: The crank and lever motors.

Any position in the OSM field of view can be acquired by calculating appropriate values for theta and phi, noting that due to a mirror reflection there are always 2 possible solutions.

The crank motor is secured to the Sensor and rotates the crank arm, precisely about the rotation axis of the crank motor referred to as the theta axis. The lever arm motor provides the necessary second degree of freedom by rotating the lever arm and all associated optics, about the phi axis.
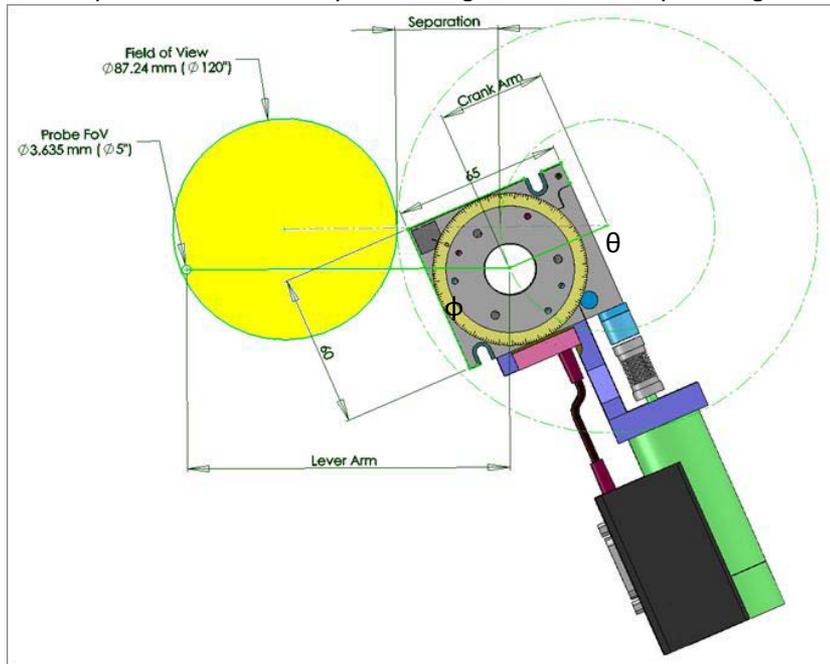
Basic Design requirements:

Mechanism Type: φ/θ

Patrolled Field: Ø 120" (87.24mm)

Probe FoV: Ø 5" (3.635mm)

Acquisition accuracy: 40 mas (30µm)

Stability: 5 mas / 3600s (1 µm)

Position knowledge: < 1 µm (TBC)

Minimum Incremental motion: TBD

Operating Temperature: -10°C +/- 0.3

Note: Separation is a distance determined by the Lever Arm motor envelope to clear the Field of view at any angle of Crank rotation.

Position Accuracy

Probe Position within the field shall be measured according to the level of desired accuracy: Direct or indirect.

Indirect measurement:

Total Position Accuracy of 30µm at the furthest position across the 144mm field requires a minimum crank rotation accuracy of:

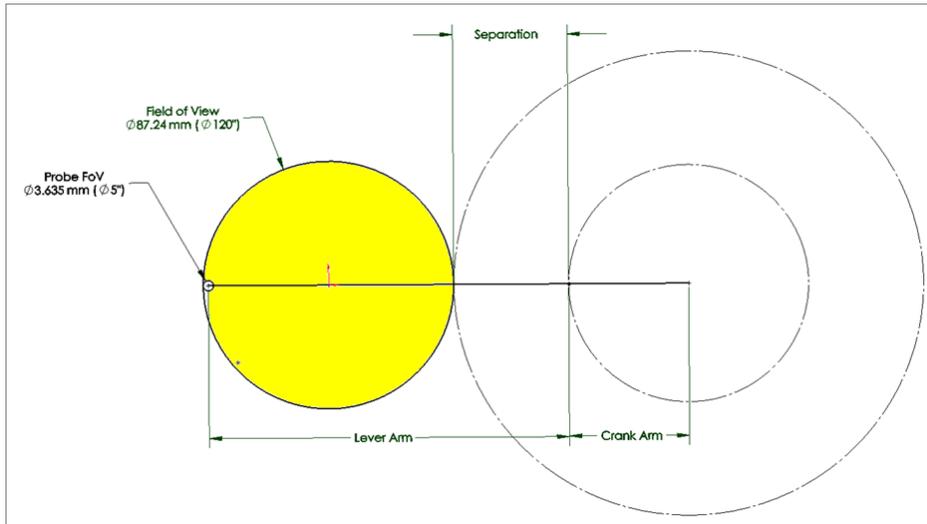$\sin \alpha$ = 30µm / 144 mm ➔ α = 0.012° = .012 π / 180 = .00021 rad = 210 µrad

And the 100 mm lever arm motor is 60 % longer than the 40mm Crank arm

Crank motor rotation accuracy: 210 µrad x 60% = 126 µrad

Lever motor rotation accuracy: 210 µrad x 40% = 84 µrad

Arms Size Equation

Arm fully extended Equation:
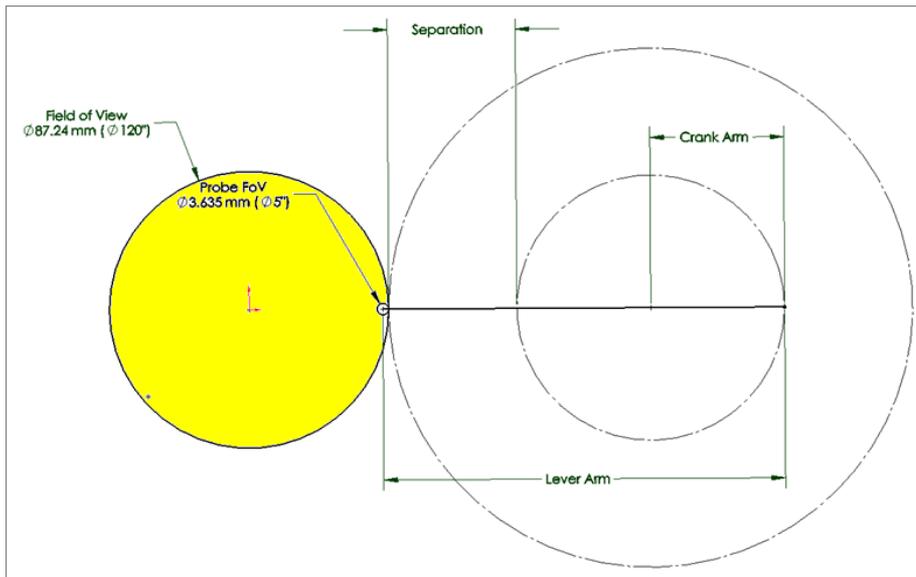

1) Using 40 mm separation for the PI M-038 and M-037

Lever Arm + Crank Arm + 1.8175 Probe = 87.24 Fov + 40 Separation + Crank Arm

Lever Arm + 1.8175= 87.24 + 40 ➜   Lever Arm = 125.42 mm

2) Using 63.5 mm separation for the Newport URS75B

Lever Arm + 1.8175 = 87.24 + 63.5 ➜   Lever Arm = 148.9225 mm

Arm fully retracted Equation:

1)   Using 40 mm separation for the PI M-038 and M-037

Lever Arm - Crank Arm = Separation + Crank Arm + Probe

➜Crank Arm = 41.30 mm

2) Using 63.5 mm separation for the Newport URS75B

148.9225 - Crank Arm = 63.5 + Crank Arm + 1.8175

➜ Crank Arm = 41.8025 mm

Servo Motors Vs Stepper Motors

| Motion Characteristics	Servo Motors	Stepper Motors
High Torque, Low Speed	Can be considered if cost/ complexity is not an issue.	Continuous duty applications requiring high torque and low speed.
High Torque and high speed (>2000 rpm)	Continuous duty applications requiring high torque and high speed. DC servomotor can deliver greater continuous shaft power at high speeds compared to steppers. High speed up to 12000 rpm is possible. AC servo motors can handle higher current surges compared to DC servos. Can get lot stronger AC servo compared to either DC servo or DC stepper.	If speeds are less than 2000 rpm stepper may be economical. Stepper becomes bulky at high torque.
Short, Rapid Repetitive Moves	Use servo if need high dynamic requirements.	Stepper will offer more economic solution when requirements are more modest.
Positioning Applications	Servo can handle effectively when load is mostly inertia instead of friction. The ability to overdrive servo motor in intermittent duty allows a smaller motor to be used. **If positioning is critical in micron level use servo.**	Use stepper motor if torque is lower than 500 oz-in, less 2000 rpm, low to medium acceleration rates.
Applications in Hazardous Environments	Use brushless servo motor.	Use step motor.
Low Speed, High Smoothness	**Use DC servo**.	Use microstepping.
Control Method	**Closed loop**.	Preferred to be used in open loop applications.

Potential Lever Motor

PI M-037.DG Rotation stage

M-037 rotation stages are equipped with ultra-precise worm gear drives allowing unlimited rotation in either direction.
An integrated spring preload eliminates backlash.
Double-row ball bearings allow zero backlash, high load capacity and extremely low wobble.

Model M-037.DG is closed-loop DC motors with shaft-mounted position encoders and precision gearheads providing 3.5 µrad at a design resolution of 0.6 µrad.

Model M-037.2S models feature a cost-effective directdrive, 2-phase stepper motor, providing very smooth operation and a resolution of 5.45 µrad at a minimum incremental motion of 21 µm.
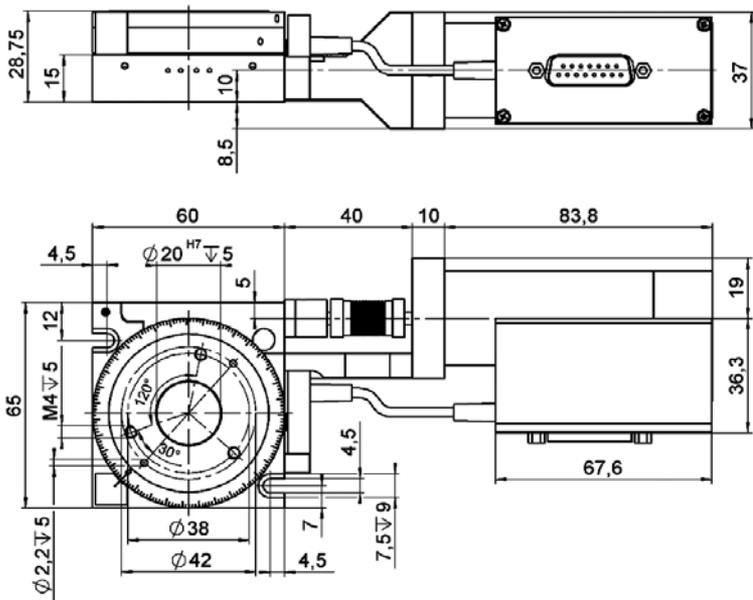
Technical Data

Model	M-037.00	M-037.DG	M-037.PD	M-037.2S	
Active axes	Rotation	Rotation	Rotation	Rotation	
Motion and positioning					
Rotation range	>360	>360	>360	>360	°
Integrated sensor	–	Rotary encoder	Rotary encoder	–	
Sensor resolution	–	2000	4000	–	cts./rev.
Design resolution	–	0.59 (34 x 10⁻⁶)	3.75 (0.0005)	5.45* (0.00031)	µrad (°)
Min. incremental motion	–	3.5	27	21	µrad
Backlash	–	200	200	200	µrad
Unidirectional repeatability	–	30	30	30	µrad
Wobble	<150	<150	<150	<150	µrad
Max. velocity	–	6	45	10	°/s
Mechanical properties					
Worm gear ratio	180:1	180:1	180:1	180:1	
Gear ratio	–	(28/12)⁴ ≈ 29.6:1	–	–	
Motor resolution	–	–	–	6400*	steps/rev.
Load capacity/axial force, self-locking	±300	±300	±300	±300	N
Max. torque (θ$_X$, θ$_Y$)	±3	±3	±3	±3	Nm
Max. torque clockwise (θ$_Z$)	1	1	1	1	Nm
Max. torque counter clockwise (θ$_Z$)	0.5	0.5	0.5	0.5	Nm
Drive properties					
Motor type	–	DC motor, gearhead	ActiveDrive™ DC Motor	2-phase stepper motor*	
Operating voltage	–	0 to ±12	24 (PWM)	24	V
Electrical power	–	3	30		W
Reference switch	–	Hall-effect	Hall-effect	Hall-effect	
Miscellaneous					
Operating temperature range	-20 to +65	-20 to +65	-20 to +65	-20 to +65	°C
Material	Aluminum	Aluminum	Aluminum	Aluminum	
Mass	0.3	0.65	0.62	0.64	kg
Recommended controller/driver	–	C-863 (single-axis) C-843 PCI-Karte (for up to 4 axes)	C-863 (single-axis, p. 4-114) C-843 PCI-Karte (p. 4-120) (for up to 4 axes)	C-663 (single-axis, p. 4-112)	

incl. motor cable, 3 m, sub-D connector 15-pin
*2-phase stepper motor, 24 V chopper voltage, max. 0.8 A/phase, 400 full steps/rev., motor resolution with C-663 stepper motor controller

M-037.DG rotation stage with DC Motor and gearhead

PI M-038.DG Rotation stage

Model M-038.DG1 equipped with a closed-loop DC motor with shaft-mounted position encoder and precision gearhead providing minimum incremental motion of 3.5 μrad at a design resolution of 0.6 μrad.

Model M-038.2S1 models feature a cost-effective directdrive, 2-phase stepper motor, providing very smooth operation and a resolution of 5.45 μrad at a minimum incremental motion of 21 μm.

ActiveDrive™

Model M-038.PD is equipped with the highly efficient Active Drive™ direct drive and reaches velocities up to 45°/s. The ActiveDrive™ design, developed by PI, features a high-efficiency PWM (pulse width modulation) servo-amplifier mounted side-by-side with the DC motor and offers several advantages: Increased efficiency, by eliminating power losses between the amplifier and motor. Reduced cost of ownership and improved reliability, because no external driver is required Elimination of PWM amplifier noise radiation, by mounting the amplifier and motor together in a single, electrically shielded case
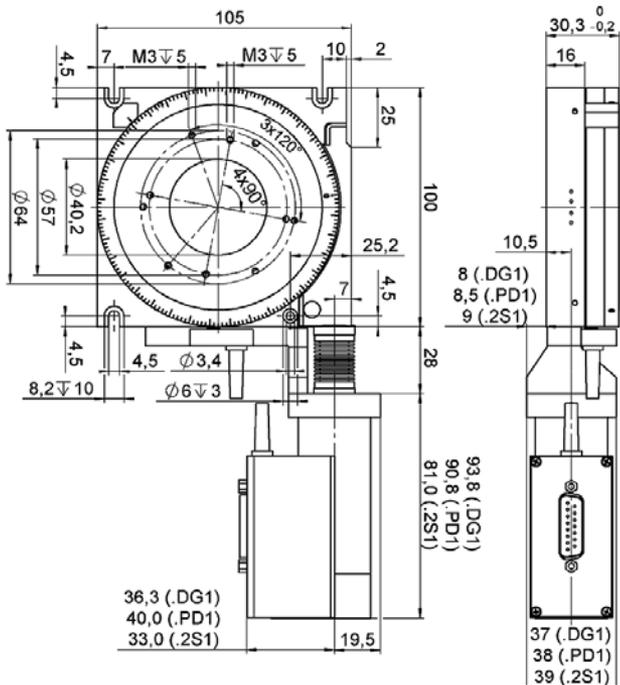
Technical Data

Model	M-038.001	M-038.DG1	M-038.PD1	M-038.2S1	Units
Active axes	Rotation	Rotation	Rotation	Rotation	
Motion and positioning					
Rotation range	>360°	>360°	>360°	>360°	
Integrated sensor	–	Rotary encoder	Rotary encoder	–	
Sensor resolution	–	2000	4000	–	steps/rev.
Design resolution	–	0.60 (35 x 10⁶)	8.95 (0.0005)	5.58* (0.00032)	μrad (°)
Min. incremental motion	–	3.5	27	21	μrad
Backlash	–	200	200	200	μrad
Unidirectional repeatability	–	20	20	20	μrad
Wobble	<75	<75	<75	<75	μrad
Max. velocity	–	6	90	10	°/s
Mechanical properties					
Worm gear ratio	176:1	176:1	176:1	176:1	
Gear ratio	–	2401:81 ≈ 29.6:1	–	–	
Motor resolution	–	–	–	6400*	steps/rev.
Max. load/axial force	±400	±400	±400	±400	N
Maximum torque (θ_X, θ_Y)	±6	±6	±6	±6	
Maximum torque CW**	2	2	2	2	Nm
Maximum torque CCW**	0.8	0.8	0.8	0.8	Nm
Drive properties					
Motor type	–	DC Motor, gearhead	ActiveDrive™ DC Motor	2-phase stepper motor*	
Electrical power	–	3	30		W
Reference switch	–	Hall-effect	Hall-effect	Hall-effect	
Miscellaneous					
Operating voltage	–	12 V differential	24 (PWM)	24	V
Operating temperature range	-20 to +65	-20 to +65	-20 to +65	-20 to +65	°C
Material	Aluminum	Aluminum	Aluminum	Aluminum	
Mass	0.9	1.25	1.35	1.25	kg
Recommended controller/driver		C-863 (single-axis) C-843 PCI board (for up to 4 axes)	C-863 (single-axis, p. 4-114) C-843 PCI board (p. 4-120) (for up to 4 axes)	C-663 (single-axis, p. 4-112)	

*2-phase stepper motor, 24 V chopper voltage, max. 0.8 A/phase, 400 full steps/rev., motor resolution with C-663 stepper motor controller
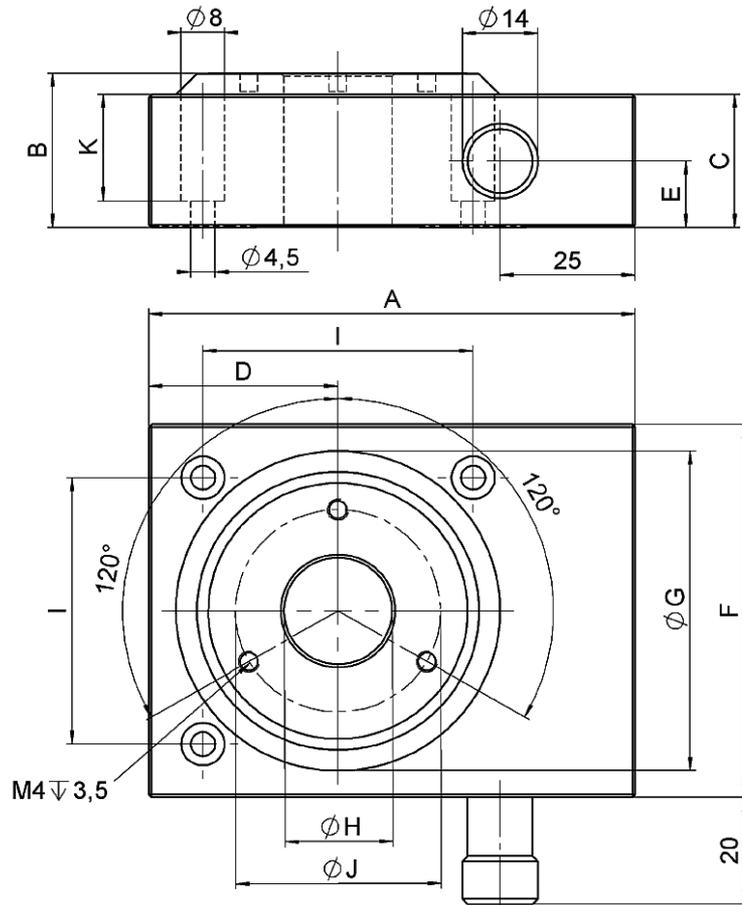**CW: clockwise; CCW: counter-clockwise

M-038.PD1 Rotation Stage

Custom M-038 with folded drive

Other Possible Crank motor: M-06X.DG Rotation stage

Dimensions	M-060.M0	M-061.M0	M-062.M0
A	90	130	150
B	29	34	42
C	25	30	38
D	35	55	65
E	12,5	15	21,5
F	70	110	130
G	60	100	120
H	20	35	45
I	50	90	110
J	38	50	60
K	20	20	28

Technical Data

Model	M-060.M0 / M-061.M0 / M-062.M0	M-060.PD / M-061.PD / M-062.PD	M-060.DG / M-061.DG / M-062.DG	M-060.2S / M-061.2S / M-062.2S	Units
Active axes	Rotation	Rotation	Rotation	Rotation	
Motion and positioning					
Rotation range	>360	>360	>360	>360	°
Integrated sensor	–	Rotary encoder	Rotary encoder		
Sensor resolution	–	4000	2000		Cts./rev.
Design resolution	–	32 (0.0018) / 17.5 (0.001) / 15 (0.0008)	2.1 (0.00012) / 1.2 (6.9 x 10^{-5}) / 0.96 (5.5x10^{-5})	19.7 (0.0011) / 10.9 (0.00063) / 8.9 (0.00051)*	μrad (°)
Min. incremental motion	–	32 / 17.5 / 15	6.3 / 6 / 5	40 / 20 / 18*	μrad
Backlash	–	200 / 200 / 240	200 / 200 / 240	200 / 200 / 240	μrad
Unidirectional repeatability	–	50 / 50 / 60	50 / 50 / 60	50 / 50 / 60	μrad
Max. velocity	–	90	16 / 9 / 7.3	36 / 20 / 16	°/s
Mechanical properties					
Worm gear ratio	50:1 / 90:1 / 110:1	50:1 / 90:1 / 110:1	50:1 / 90:1 / 110:1	50:1 / 90:1 / 110:1	
Gear ratio	–	–	(28/12)^4 :1 ≈ 29.6:1	–	
Motor resolution	–	–	–	6400*	steps/rev.
Axial force	±500 / ±550 / ±650	±500 / ±550 / ±650	±500 / ±550 / ±650	±500 / ±550 / ±650	N
Max. torque θ_X, θ_Y	±6 / ±6 / ±7	±6 / ±6 / ±7	±6 / ±6 / ±7	±6 / ±6 / ±7	Nm
Max. torque θ_Z	±4 / ±6 / ±8	±4 / ±6 / ±8	±4 / ±6 / ±8	±4 / ±6 / ±8	Nm
Drive properties					
Motor type	–	ActiveDrive™ DC-Motor	DC-Motor, gearhead	2-phase Stepper-Motor**	
Operating voltage	–	24 (PWM)	12 differential	24	V
Electrical power	–	30	3	–	
Reference switch	Hall-effect	Hall-effect	Hall-effect	Hall-effect	
Miscellaneous					
Operating temperature range	-20 to +65	-20 to +65	-20 to +65	-20 to +65	°C
Material	Aluminum	Aluminum	Aluminum	Aluminum	
Mass	0.42 / 1.36 / 2.24	0.94 / 1.88 / 2.76	0.94 / 1.88 / 2.76	0.96 / 1.9 / 2.78	kg
Recommended controller/driver		C-863 single-axis C-843 PCI board, for up to 4 axes	C-863 single-axis (p. 4-114) C-843 PCI board (p. 4-120), for up to 4 axes	C-663 single-axis (p. 4-112)	

*with C-663 stepper-motor controller
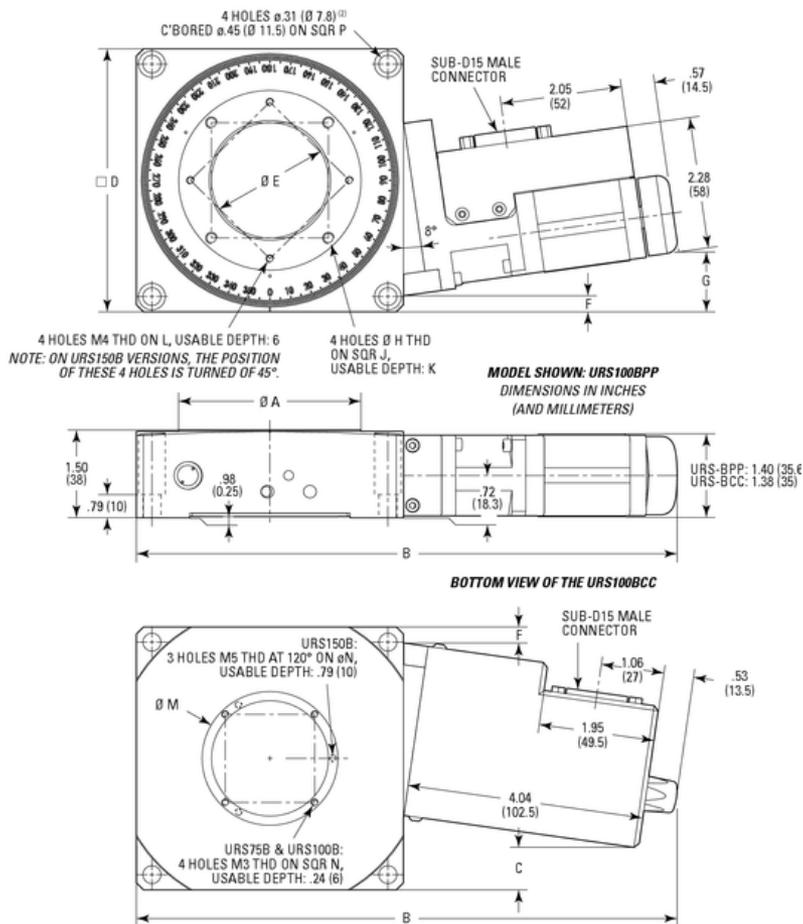**2-phase stepper-motor, 24 V chopper voltage, max. 0.8 A/phase, 400 full steps/rev

Potential Crank & Lever Motor

Newport URS Series Precision Rotation Stages

Dimensions
Dimensions in inches (millimeters)
MODEL URS100B

4 HOLES ø.31 (Ø 7.8)[1]
C'BORED ø.45 (Ø 11.5) ON SQR P

SUB-D15 MALE CONNECTOR

.57 (14.5)
2.05 (52)
2.28 (58)
8°

4 HOLES M4 THD ON L, USABLE DEPTH: 6
NOTE: ON URS150B VERSIONS, THE POSITION OF THESE 4 HOLES IS TURNED OF 45°.

4 HOLES Ø H THD ON SQR J, USABLE DEPTH: K

MODEL SHOWN: URS100BPP
DIMENSIONS IN INCHES (AND MILLIMETERS)

Ø A
1.50 (38)
.98 (0.25)
.79 (10)
.72 (18.3)
URS-BPP: 1.40 (35.6)
URS-BCC: 1.38 (35)
B

BOTTOM VIEW OF THE URS100BCC

URS150B:
3 HOLES M5 THD AT 120° ON øN, USABLE DEPTH: .79 (10)
Ø M

SUB-D15 MALE CONNECTOR
1.06 (27)
.53 (13.5)
1.95 (49.5)
4.04 (102.5)

URS75B & URS100B:
4 HOLES M3 THD ON SQR N, USABLE DEPTH: .24 (6)
B
C

	A	B	C	D	E	F	G	H	J	K	L	M	N	P
URS75B	1.97 (50)	8.19 (208)	-.20[1] (-5)[1]	3.54 (90)	1.18[0.051] (30)[1.3]	.08 (2)	.83 (21)	M3	1.26 (32)	.24 (6)	—	1.50 (38)	1.34 (34)	2.98 (75.6)
URS100B	3.07 (78)	9.13 (232)	.71 (18)	4.49 (114)	1.97[0.063] (50)[1.6]	.26 (6.5)	1.02 (26)	M6	1.97 (50)	.24 (6)	SQR 1.89 (SQR 48)	2.28 (58)	2.13 (54)	3.97 (100.8)
URS150B	5.18 (131.5)	11.14 (283)	2.56 (65)	6.50 (165)	3.54[0.067] (90)[1.7]	.41 (10.5)	1.14 (29)	M6	2.95 (75)	.31 (8)	ø4.92 (Ø 125)	4.13 (105)	3.86 (98)	5.91 and 6[2] (150 and 152.4)[2]

Notes:
[1] The drive box of the URS75BCC exceeds .20 in. (5 mm) from the body.
[2] URS150B: 4 slots counterbored.

Design Details

| Base Material	Hardened steel with aluminum body
Bearings	
Drive Mechanism	Ground worm gear with self-compensating preload. Additional 1:2.75 drive belt with URS-CC versions (no belt on URS-PP versions)
Worm Gear Ratio	1:90
Feedback	CC: Worm mounted rotary encoder, 8,000 cts/rev, index pulse. PP: None
Limit Switches	Two independently adjustable optical limit switches
Origin	Optical, fixed at position 0°. Typical 0.0005° repeatability for URS-CC and 0.04° repeatability for URS-PP
Manual Adjustment	Via allen wrench at the end of the worm screw. Allen wrench is included.
Motor	CC: UE34CC DC servo motor PP: UE34PP Two phase stepper motor, 1 full step = 0.02°
Cable	

Specifications

	PP		CC	
	Typical	Guaranteed	Typical	Guaranteed
Travel Range (°)	360 continuous[1]			
Resolution (°)	0.0002[2]		0.0005	
Minimum Incremental Motion (°)	0.0002		0.002	
Uni-directional Repeatability (°)	0.001	0.002	0.001	0.002
Reversal Value (Hysteresis) (°)	0.006	0.01	0.002	0.004
Absolute Accuracy (°)	0.016	0.030	0.012	0.023
Maximum Speed (°/s)	40		80	
Wobble (µrad)	20	50	20	50
Eccentricity (µm)		3		3
MTBF	20,000 h at 25% load and with a 30% duty cycle			

1) With disabled limit switches
2) Equal to 1/100 of a full step
See the Motion Control Metrology Primer section (see Motion Control Metrology Primer) for more information on typical and guara

Load Characteristics
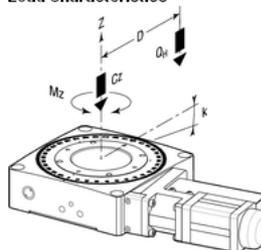
	URS75	URS100	URS150
Cz, Normal centered load capacity (N)	200	300	300
a, Construction parameter (mm)	25	35	55
kα, Transversal compliance (µrad/Nm)	30	10	5
Mz, Nominal Torque (Nm)	+/- 0.5	+/- 1	+/- 2
Q, Off-center load	Q ≤ Cz / (1 + D/a)		
D, Cantilever distance in mm			
Weight [lb (kg)]	3.7 (1.7)	4.4 (2)	7.5 (3.4)

Comparison between Potential Stages.

Specifications	URS75BPP Typ.	Guaranteed	URS75BCC Typ. Guaranteed		M-037.DG	M-038.DG1
Motor Type	Stepper		DC servo		DC servo	DC servo
Feedback	None		Worm mounted encoder		Shaft mounted encoder	Shaft mounted encoder
Worm Gear Ratio	1:90		1:90		180:1	176:1
Sensor Resolution (cts/rev)	None		8000		2000	2000
Resolution (°)	0.0002		0.0005		0.00003	.000003
Minimum Incremental Motion (°)	0.0002		0.002		.0002	.0002
Uni-directional Repeatability (°)	0.001	0.002	0.001	0.002	.0017	.0011
Reversal Value (Hysteresis) (°)	0.006	0.01	0.002	0.004	.01	.01
Absolute Accuracy (°)	0.016	0.030	0.012	0.023	TBD	TBD
Maximum Speed (°/s)	40		80		6	6
Wobble (µrad)	20	50	20	50	<150	<75
Eccentricity (µm)	3		3		TBD	TBD
Max Axial Load (N)	200		200		300	400
Max CW Torque (CCW)	0.5 (0.5)		0.5 (0.5)		1 (0.5)	2 (0.8)
Max Cantilever Torque (Nm)	5		5		6	6
Mass (N)	17		17		6.5	12.5
MTBF at 25% load and with a 30% duty cycle	20,000 h		20,000 h		TBD	TBD
Integrated limit switch	Adjustable		Adjustable		No	No
Price	$2940		$3436		$4178	$4724

Comparison between Potential Stages.

Mass on Lever motor: Tip Tilt Mirror (0.065 Kg) + TT Mirror Housing (0.100 Kg) + Probe Assy (0.120 Kg) + Collimator Assy (0.01 Kg) = 0.295 Kg

Mass on crank motor:

Mass on lever motor +Crank Adaptor (0.100 Kg) + Lever Adaptor (0.100 Kg) + Periscope Assy(0.015 Kg) + Counterweight (1 Kg) + Lever Motor = 1.215 Kg + Lever Motor

Distance between Crank Motor and center of Mass installed on Crank motor: 40mm

1) Using the PI Motors as follow: M-038.DG1 as Crank Motor and the M-037.DG as the Lever motor:

Mass on Crank motor: 1.215 Kg + 0.65 Kg = 2 Kg (20N)

Cantilever Torque at Crank motor: 0.04m X 20 = 0.8 Nm

2) Using the URS75BCC Newport Motor for both Crank and Lever motor:

Mass on Crank motor: 1.215 Kg + 1.7 Kg = 3 Kg (30N)

Cantilever Torque at Crank motor: 0.04m X 30 = 1.2 Nm

Off Center Load: Q < 200 / (1 + 40/25) = 77 N

CONCLUSION: The Newport URS75BCC is cheaper and faster than the PI Stages and comparatively as accurate.

The Newport URS75BCC is a bigger stage than the PI Stage: The Arm length will have to be proportionally longer.

Lever Arm + Crank Arm + Probe = Fov + Separation + Crank Arm

Lever Arm + 1.8175 = 87.24 + 63.5

➔ Lever Arm = 148.9225 mm

Lever Arm - Crank Arm = Separation + Crank Arm + Probe

148.9225 - Crank Arm = 63.5 + Crank Arm + 1.8175

➔ Crank Arm = 41.8025 mm

PI S-334 Miniature Piezo Fast Steering Tip/Tilt-Mirror
up to 120 mrad Deflection

S-334.2SL cable configuration
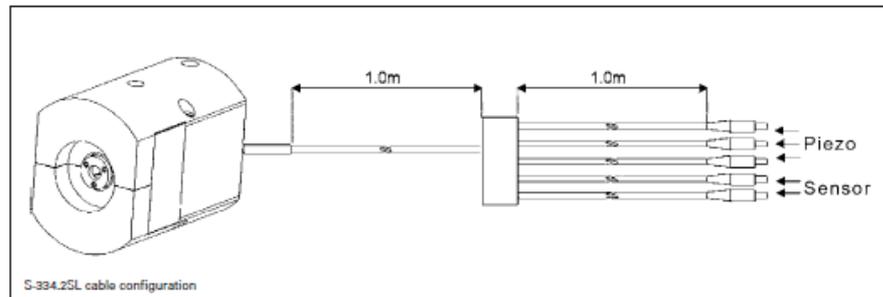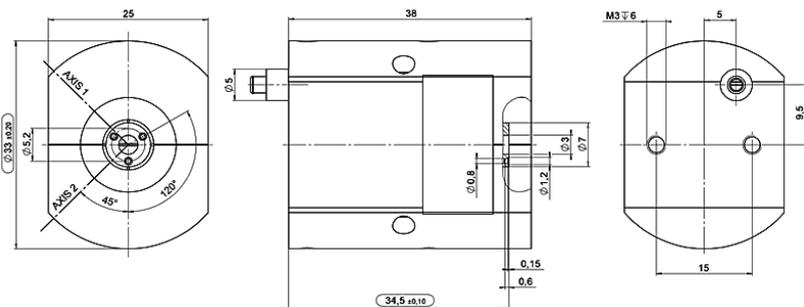
Technical Data

Model	S-334.2SL	S-334.2SD	Units	Tolerance
Active Axes	θ_X, θ_Y	θ_X, θ_Y		
Motion and positioning				
Integrated sensor	SGS	SGS		
*Open-loop tilt angle at -20 to +120 V	60	60	mrad	min. (+20 %/-0 %)
*Closed-loop tilt angle	50	50	mrad	
Open-loop resolution	0.5	0.5	µrad	typ.
Closed-loop resolution	5	5	µrad	typ.
Linearity	0.05	0.05	%	typ.
Repeatability	5	5	µrad	typ.
Mechanical properties				
Resonant frequency under load (with standard mirrors)	1.0	1.0	kHz	±20 %
Resonant frequency with 12.5 mm diam. x 2 mm glass mirror	0.8	0.8	kHz	±20 %
Load capacity	0.2	0.2	N	Max.
Distance of pivot point to platform surface	6	6	mm	±1 mm
Platform moment of inertia	1530	1530	g x mm²	±20 %
Standard mirror (mounted)	diameter: 10 mm, thickness: 2 mm, BK7, λ/5, R > 98 % (λ = 500 nm to 2 µm)	diameter: 10 mm, thickness: 2 mm, BK7, λ/5, R > 98 % (λ = 500 nm to 2 µm)		
Drive properties				
Ceramic type	PICMA® P-885	PICMA® P-885		
Electrical capacitance	6	6	µF	±20 %
Miscellaneous				
Operating temperature range	-20 to 80	-20 to 80	°C	
Material casing	Titanium	Titanium		
Mass	0.065	0.065	kg	±5 %
Cable length	2	2	m	±10 mm
Sensor / voltage connection	LEMO connector	25-pin sub-D connector		
Recommended controller / amplifier	Modular piezo controller system E-500 (p. 2-144) with amplifier module E-503.00S (three channels) (p. 2-146) or 1 x E-505.00S and 2 x E-505 (high speed applications) (p. 2-147) and E-509 servo controller (p. 2-152) Open-loop: E-663 three channel amplifier (p. 2-136)	E-616 controller for tip/tilt mirror systems (p. 2-132)		

11

Potential Tip / Tilt Mirror

PI S-330-2XX Miniature Piezo Fast Steering Tip/Tilt-Mirror

	L
S-330.2xx	37
S-330.4xx	55
S-330.8xx	91
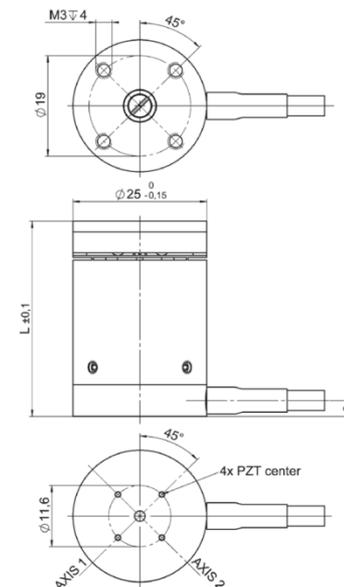
Technical Data

Model	S-330.2SL	S-330.4SL	S-330.8SL	S-330.2SD S-330.4SD S-330.8SD	S-330.20L S-330.40L S-330.80L	Units	Tolerance
Active axes	Θ_X, Θ_Y	Θ_X, Θ_Y	Θ_X, Θ_Y	Θ_X, Θ_Y	Θ_X, Θ_Y		
Motion and positioning							
Integrated sensor	SGS	SGS	SGS	SGS	–		
Open-loop tip/tilt angle, -20 to +120 V	3.5	7	15	as SL version	as SL version	mrad	min.
Closed-loop tip/tilt angle	2	5	10	as SL version	–	mrad	
Open-loop tip/tilt angle resolution	0.02	0.1	0.2	as SL version	as SL version	µrad	typ.
Closed-loop tip/tilt resolution	0.05	0.25	0.5	as SL version	–	µrad	typ.
Linearity in Θ_X, Θ_Y	0.1	0.2	0.25	as SL version	–	%	typ.
Repeatability Θ_X, Θ_Y	0.15	0.5	1	as SL version	–	µrad	typ.
Mechanical properties							
Unloaded resonant frequency (Θ_X, Θ_Y)	3.7	3.3	3.1	as SL version	as SL version	kHz	±20%
Resonant frequency loaded in Θ_X, Θ_Y (with 25 x 8 mm glass mirror)	2.6	1.6	1.0	as SL version	as SL version	kHz	±20%
Distance of pivot point to platform surface	6	6	6	6	6	mm	±1 mm
Platform moment of inertia	1530	1530	1530	1530	1530	g x mm²	±20%
Drive properties							
Ceramic type	PICMA®	PICMA®	PICMA®	PICMA®	PICMA®		
Electrical capacitance	3/axis	6/axis	12.5/axis	as SL	as SL	µF	±20%
Dynamic operating current coefficient	0.22/axis	0.4/axis	0.8/axis	as SL	as SL	µA//Hz • mrad)	±20%
Miscellaneous							
Operating temperature range	-20 to 80	-20 to 80	-20 to 80	-20 to 80	-20 to 80	°C	
Material case	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel		
Material platform	Invar	Invar	Invar	Invar	Invar		
Mass	0.2	0.38	0.7	as SL version	as SL version	kg	±5%
Cable length	1.5	1.5	1.5	1.5	1.5	m	±10 mm
Sensor / voltage connection	LEMO	LEMO	LEMO	Sub-D connector	LEMO		

Recommended controller / amplifier

Versions with LEMO connector: modular piezo controller system E-500 (p. 2-142) with amplifier module E-503.00S (three channels) (p. 2-146)
or 1 x E-505.00S and 2 x E-505 (high speed applications) (p. 2-147) and E-509 controller (p. 2-152) (optional)
Open-loop: E-663 three channel amplifier (p. 2-136)
Versions with Sub-D connectors: E-616 servo controller for tip/tilt mirror systems (p. 2-132)

Ordering Information

S-330.2SL
High-Dynamics Piezo Tip/Tilt
Platform, 2 mrad, SGS,
LEMO Connector

S-330.2SD
High-Dynamics Piezo Tip/Tilt
Platform, 2 mrad, SGS,
Sub-D Connector

S-330.20L
High-Dynamics Piezo Tip/Tilt
Platform, 2 mrad, Open-Loop,
LEMO Connector

S-330.4SL
High-Dynamics Piezo Tip/Tilt
Platform, 5 mrad, SGS,
LEMO Connector

S-330.4SD
High-Dynamics Piezo Tip/Tilt
Platform, 5 mrad, SGS,
Sub-D Connector

S-330.40L
High-Dynamics Piezo Tip/Tilt
Platform, 5 mrad, Open-Loop,
LEMO Connector

S-330.8SL
High-Dynamics Piezo Tip/Tilt
Platform, 10 mrad, SGS,
LEMO Connector

S-330.8SD
High-Dynamics Piezo Tip/Tilt
Platform, 10 mrad, SGS,
Sub-D Connector

S-330.80L
High-Dynamics Piezo Tip/Tilt
Platform, 10 mrad, Open-Loop,
LEMO Connector

# Preliminary Design Model With PI Stages

Periscope mirrors Assembly

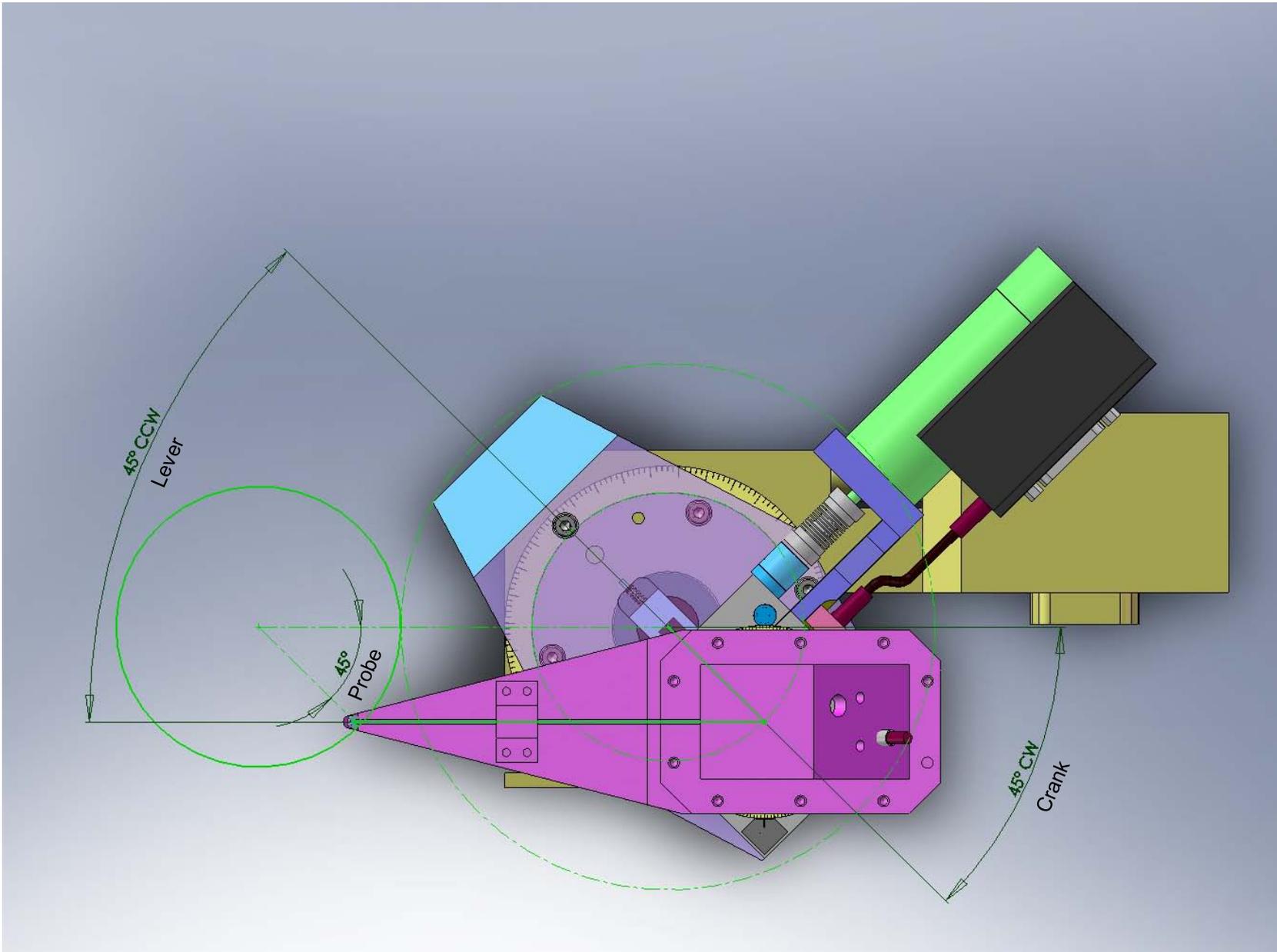Lever Motor
PI M-037.DG (0.65 Kg)

Tip/Tilt Mirror
PI S-334 (.065 Kg)

Tip/Tilt Housing (.100 Kg)

Collimator Assy (. 010 Kg)

Counterweight (1 Kg)

Light beam Entrance

Crank Motor
PI M-038.DG1

Probe Assy (.120 Kg)

Lever Adaptor (.100 Kg)
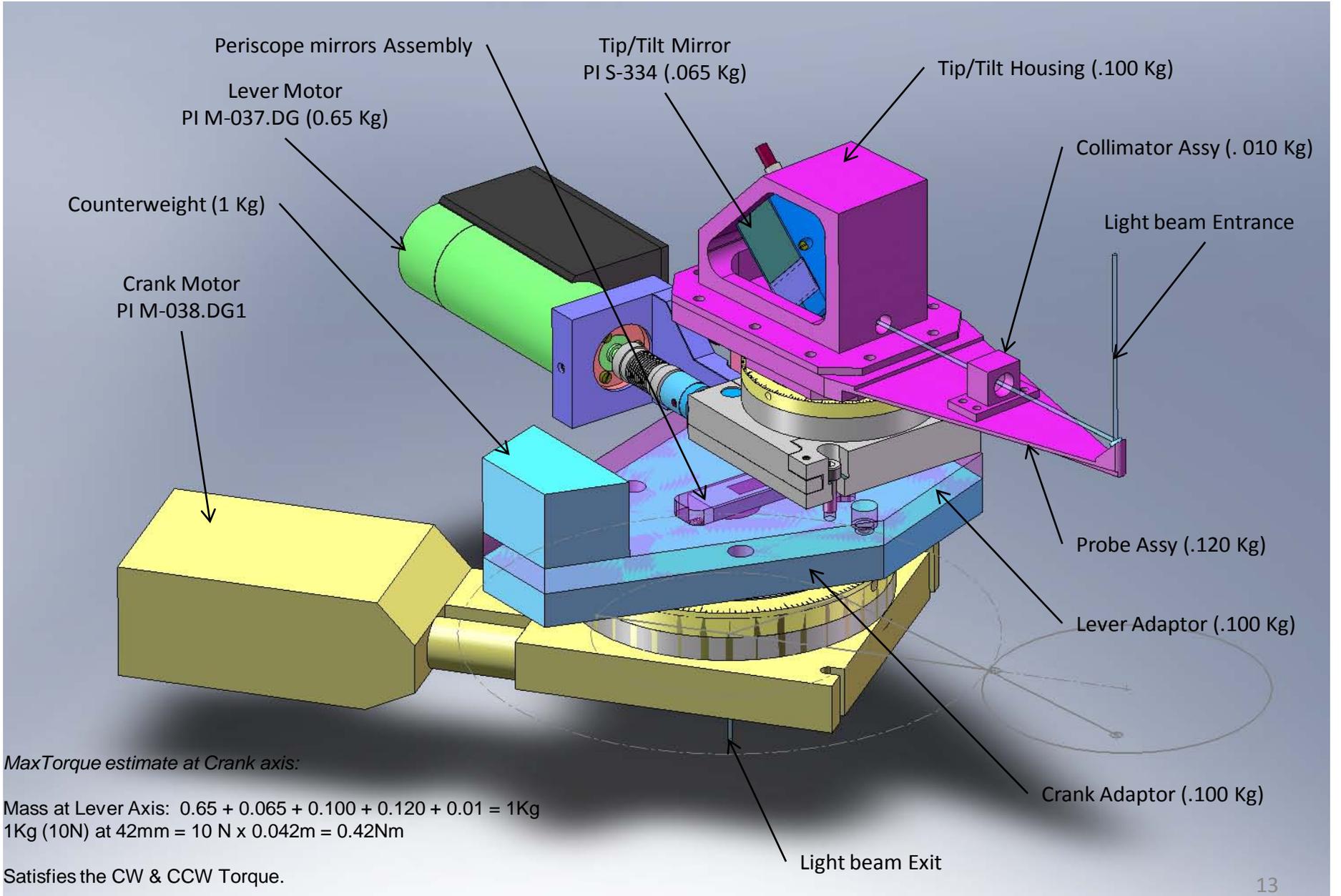
MaxTorque estimate at Crank axis:

Mass at Lever Axis: 0.65 + 0.065 + 0.100 + 0.120 + 0.01 = 1Kg
1Kg (10N) at 42mm = 10 N x 0.042m = 0.42Nm

Crank Adaptor (.100 Kg)

Satisfies the CW & CCW Torque.

Light beam Exit
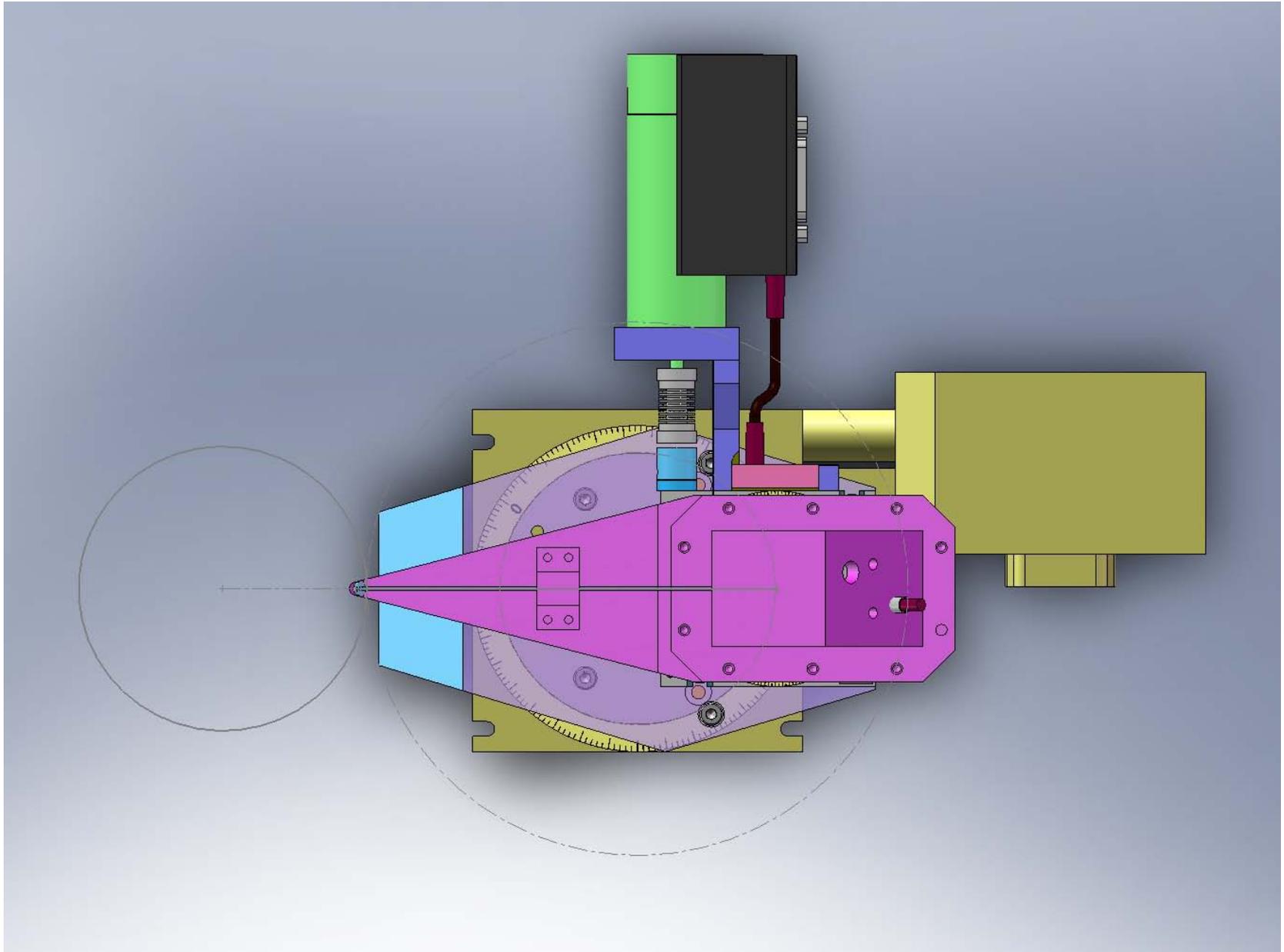
Crank @ 45° CW & Lever Motor @ 45° CCW° : Probe at 45° CW

Crank @ 90° CW & Lever Motor @ 90° CCW° : Probe at 90° CW
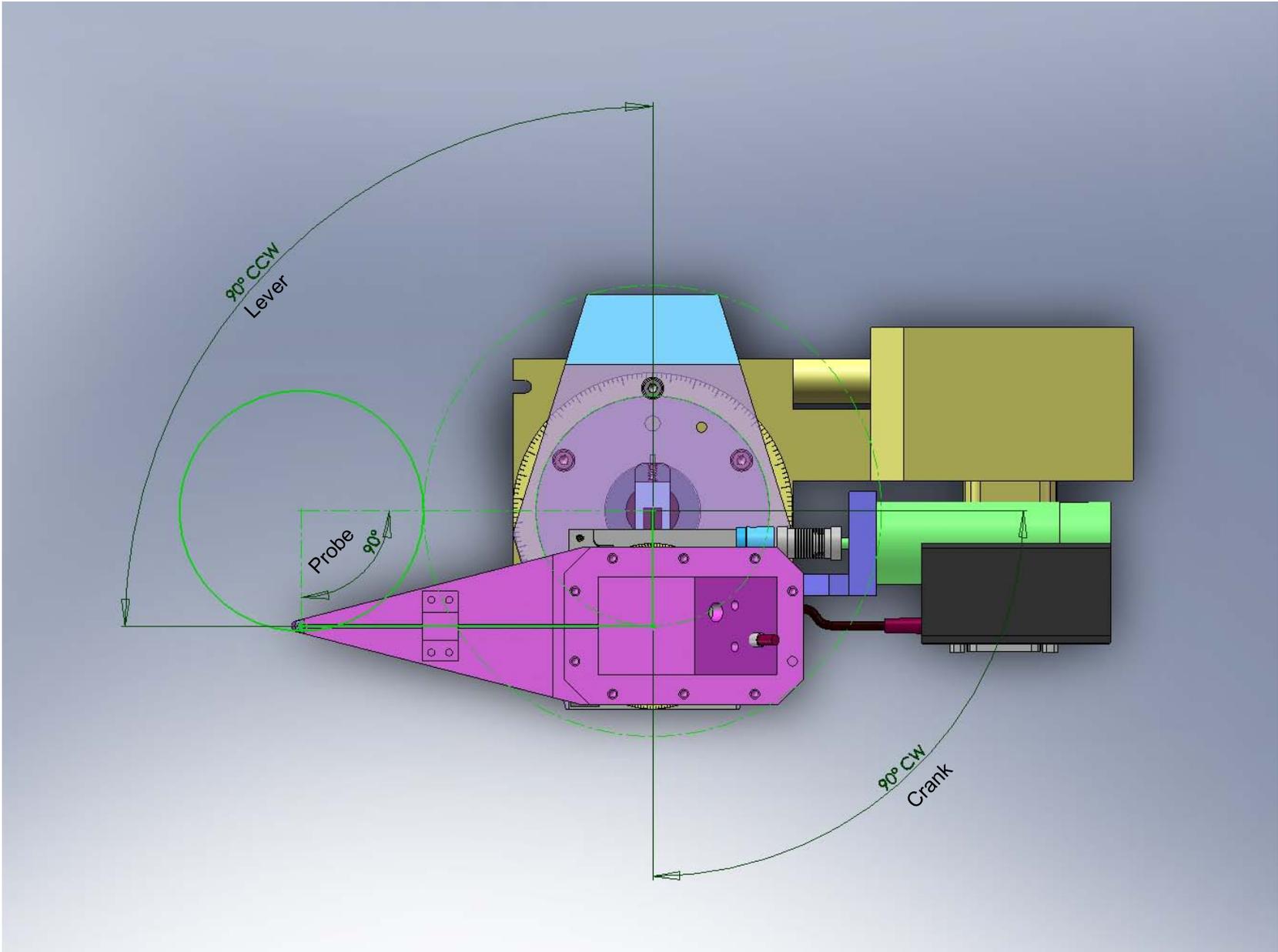
Crank @ 135° CW & Lever Motor @ 135° CCW° : Probe at 135° CW
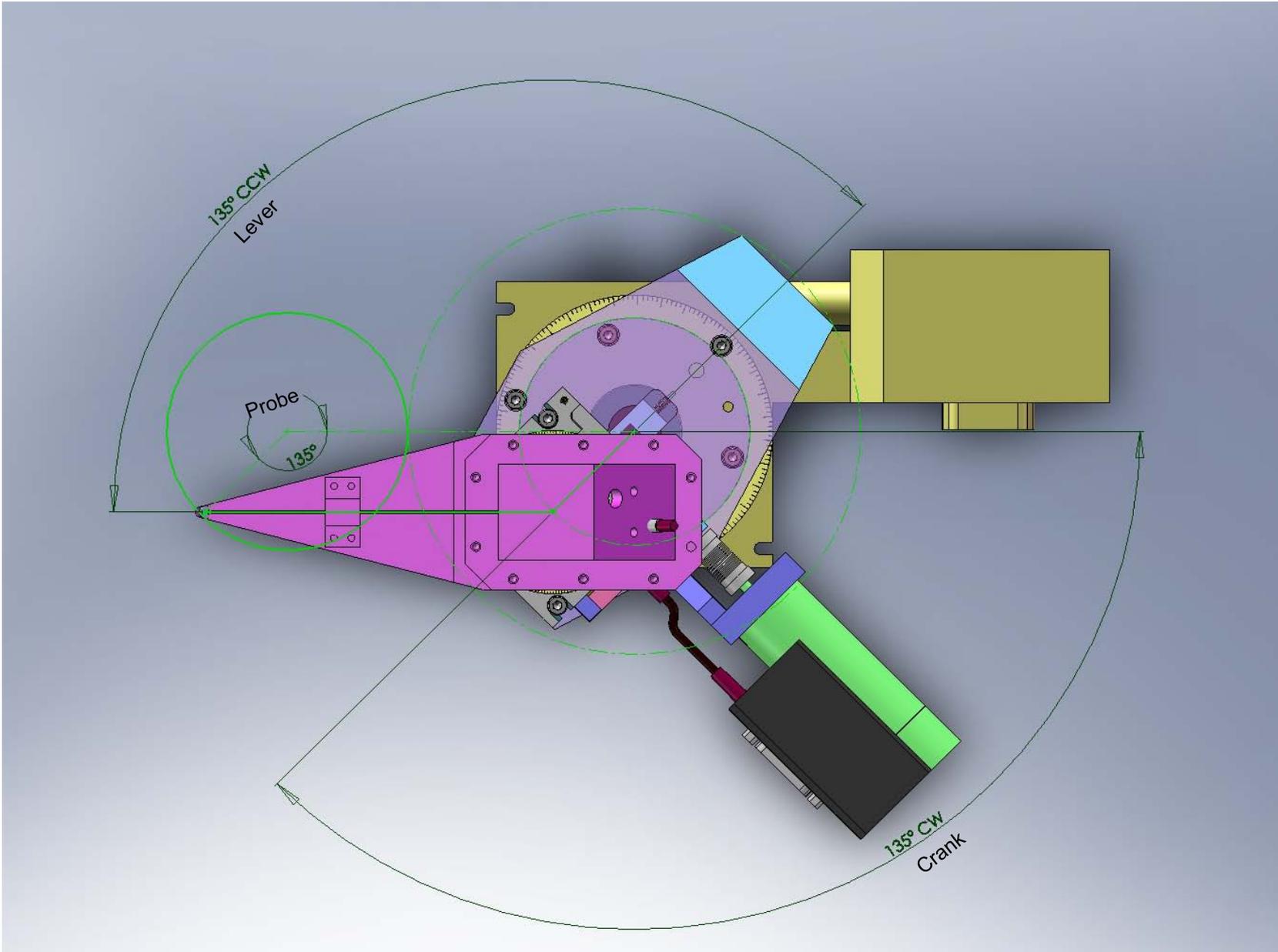
Crank @ 180° CW & Lever Motor @ 180° CCW° : Probe at 180° CW
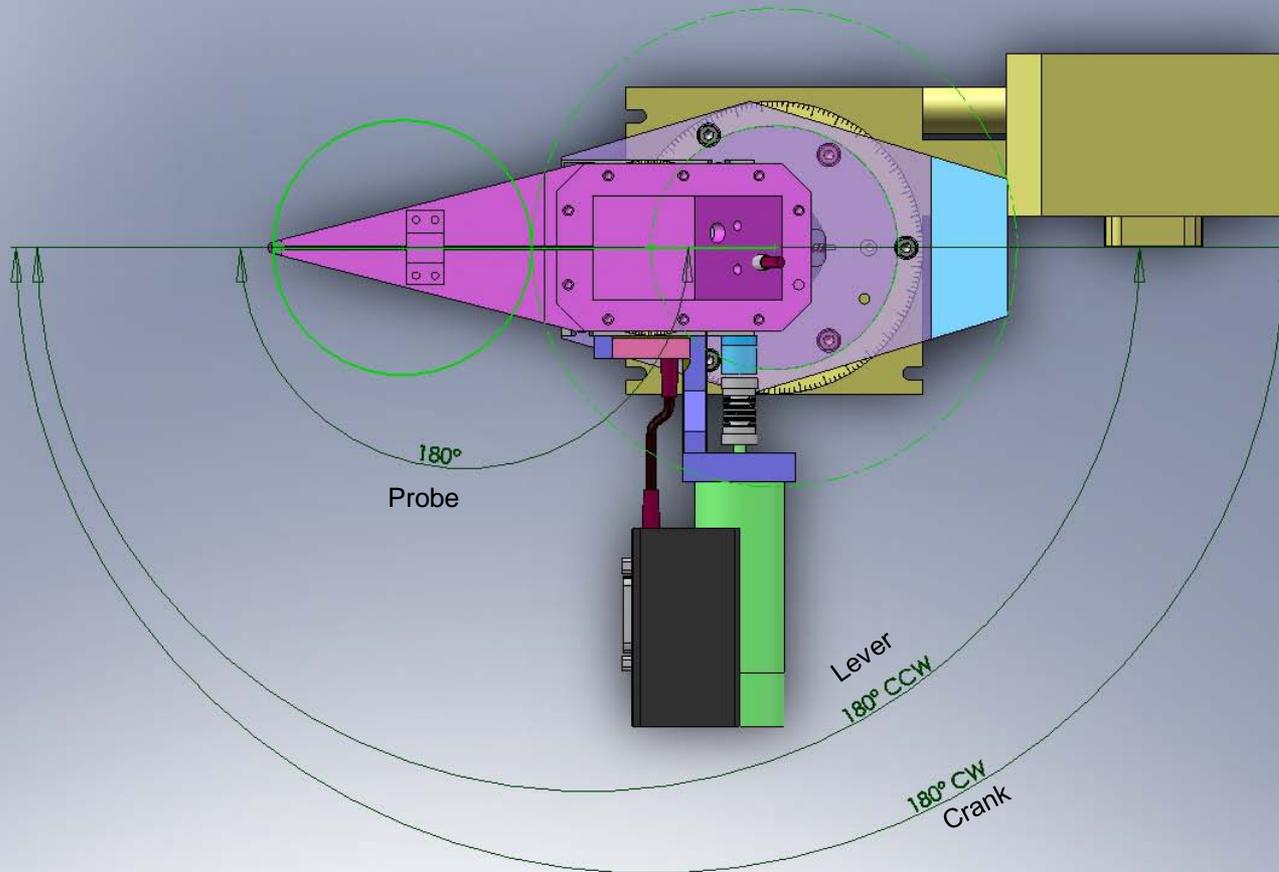
Conclusion:
The whole 120" field can be covered using 180° Rotation for each stages!...

OSM Situation and orientation in its Assembly

The OSM is designed to be used on both LOWFS and LGS independently.

Each OSM is installed vertically and at 120° from each other.

Ø87.24

120°
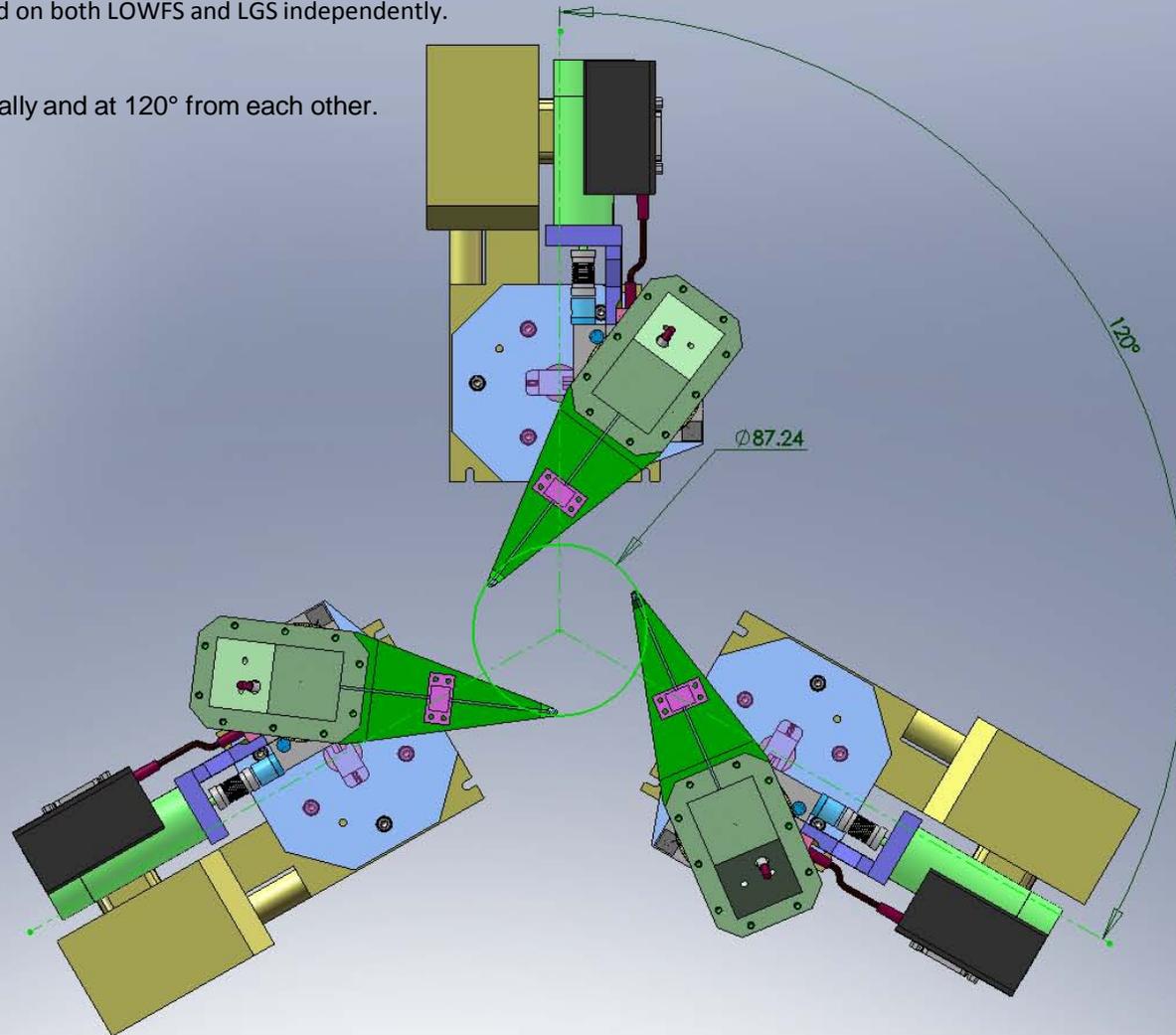
NOTE: This configuration seems to be challenging the LOWFS Pizza box model...

19

Lever Arm CG Location
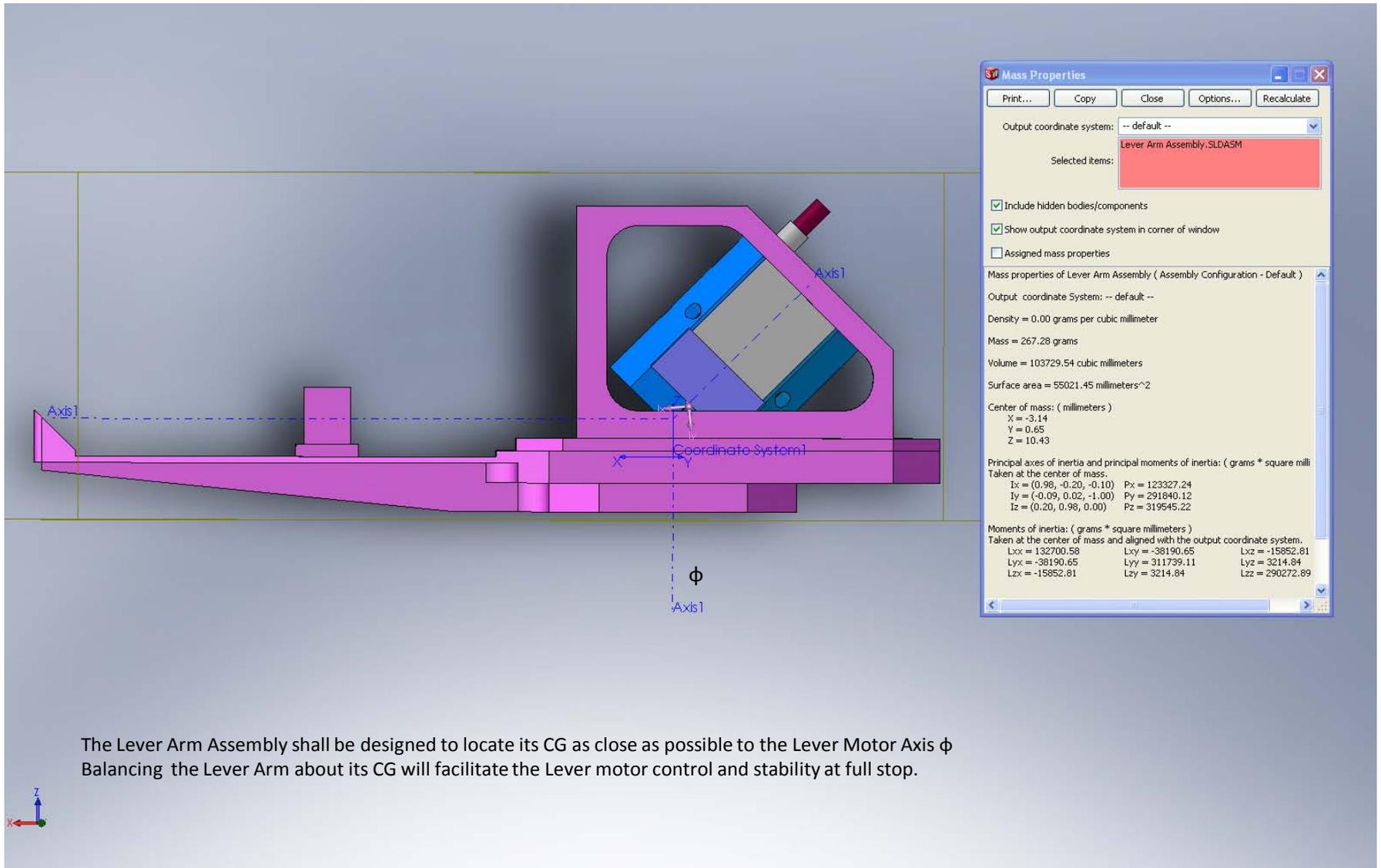
The Lever Arm Assembly shall be designed to locate its CG as close as possible to the Lever Motor Axis φ
Balancing the Lever Arm about its CG will facilitate the Lever motor control and stability at full stop.

Anti-Collision System

Sensors
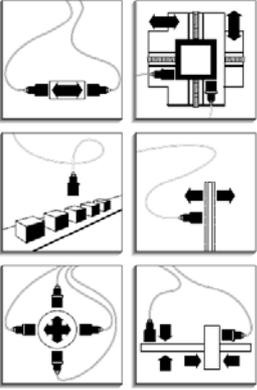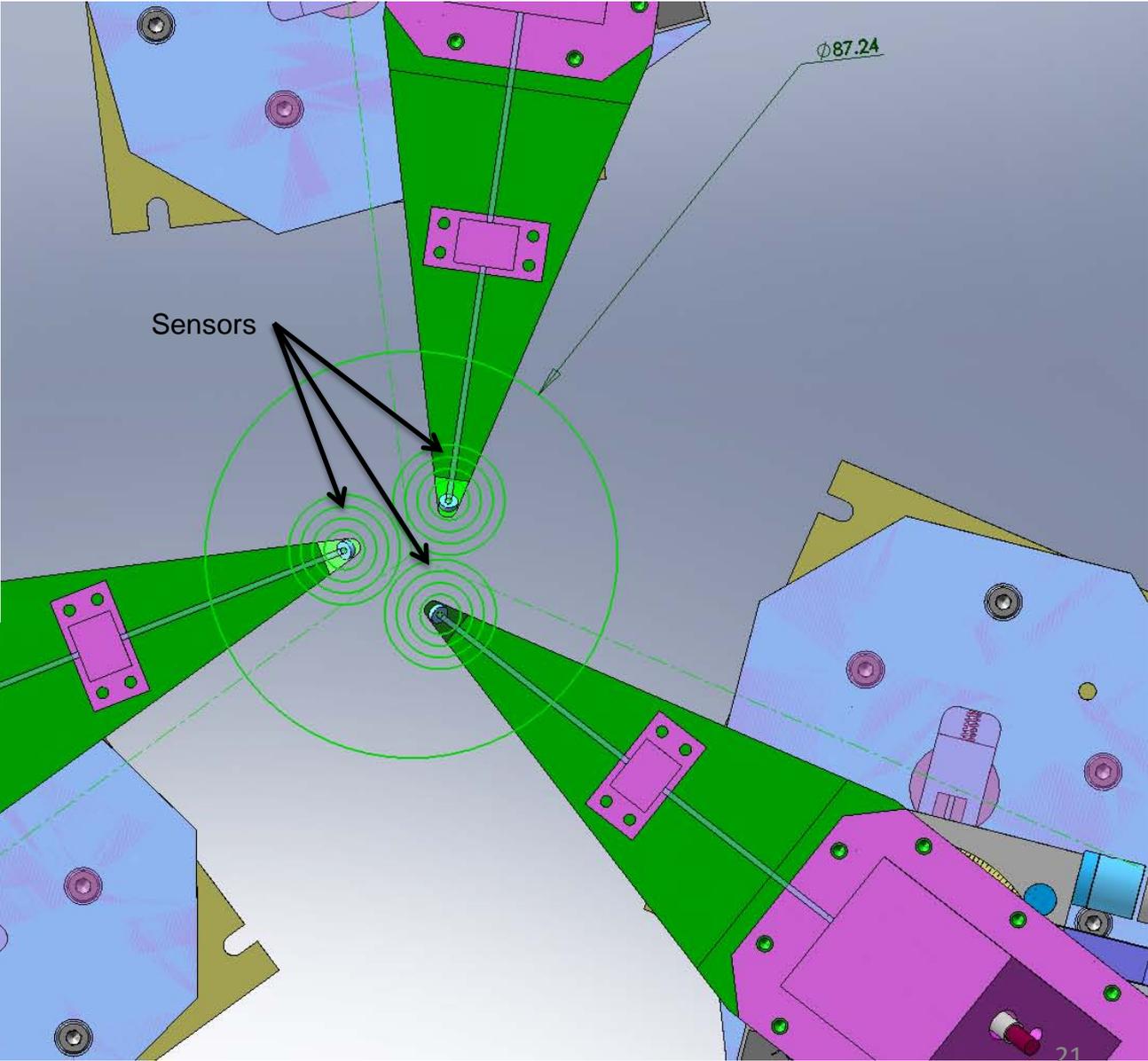
Remaining work to be done

- Choosing a probe Anti-collision System (Kaman?...)
- Analyze Tip/Tilt Mirror Vibrations and Impact on Probe stabilization.
- System rigidity Analysis
- System Integration within higher Assemblies
- Compare other motors and Tip / Tilt Mirrors.

Questions:

- Controller System: USB or RS232?
- Probe position Accuracy: 40 (KAON 562) or 70 mas (Contour)
- Minimum Incremental motion ?
- Max Wobble?
- Position Stability (5 mas / 3600 s) TBC
- TT Requirements (Deflection, response, resolution,…)

Remarks:

- Would Need Interface Solid model to verify dimensional assumptions?

Rejected Lever Motors

THORLABS

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Newton NJ 07860-0366

SALES: (973) 579-7227
FAX: (973) 300-3600
www.thorlabs.com

Motorized Rotation Stage

- ► Continuous 360° Motorized Rotation With 1arcsec Resolution
- ► Houses Ø1" Optics up to 0.50" Thick
- ► Compatible With Our SM1 Lens Tube Accessories

Application Idea

PRM1Z8

Overview

Features

- 1° Graduations on Main Dial
- Compact Design (23 mm Deep)
- Precision Home Limit Switch
- Post Mountable
- Ideal for SM1 (1.035"-40) Compatible Accessories
- Directly Accepts Ø1" Optics up to 0.50" (12.5 mm) Thick
- Fully Compatible with Our SM1 Lens Tube (1.035"-40 Thread) Accessories

Specification	Value
Bidirectional Repeatability	±0.1°
Backlash	±0.3°
Max Rotation Velocity	25 deg/sec
Horizontal On-Axis Load Capacity	1.5 kg
Vertical On-Axis Load Capacity	0.5 kg
Min Achievable Incremental Motion	25 arcsec
Min Repeatable Incremental Motion	0.03°
Absolute On-Axis Accuracy	0.1%
Max Percentage Accuracy	0.08%
Home Location Accuracy	±0.2°
Range	360° Continuous

With a depth of only 23 mm (0.9"), the PRM1Z8 is a small, compact, motorized rotation stage and mount that accepts Ø1" optics and is based on our popular PRM1 Rotation Mount. Rotation is driven via a DC servo motor that is equipped with a 67:1 gearbox and a rotary encoder for accurate closed-loop position control. The user can measure the angular displacement by using the Vernier dial in conjunction with the graduation marks that are marked on the rotating plate in 1° increments. The precision DC motor actuator provides 1 arcsecond of resolution over the entire 360° of rotation. This rotation stage/mount is also equipped with a precision home limit switch to facilitate automated rotation to the zero datum position, thus ensuring absolute angular positioning thereafter. The limit switch is designed to allow continuous rotation of the stage over multiple 360° cycles.

The **TDC0001 DC | Servo Controller** is the ideal companion for achieving smooth, continuous motion that can be automated via the software interface. The stage/mount and controller are sold together below with the item number PRM1Z8E and PRM1/MZ8E.

Normally the PRM1Z8 is mounted horizontally. The stage can be fixed directly to the work surface using the counter-bored holes in the main body. For complete flexibility, the stage/mount can be used vertically on a standard Ø1/2" post and has an option to mount in a vertical inclined orientation. When in the vertical orientation, the reduced thickness of the stage is extremely beneficial for optical path applications where space is limited.

The PRM1Z8 is supplied with 19.6" (0.5 m) of cable. An 8 ft (2.5 m) extension cable (**PAA632**) is available separately.

The rotating platform features several accessories. The central aperture has a standard SM1 internal thread, for
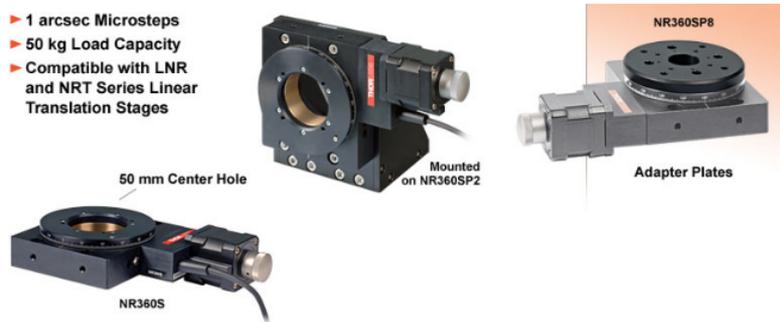
Done

Rejected Crank Motors