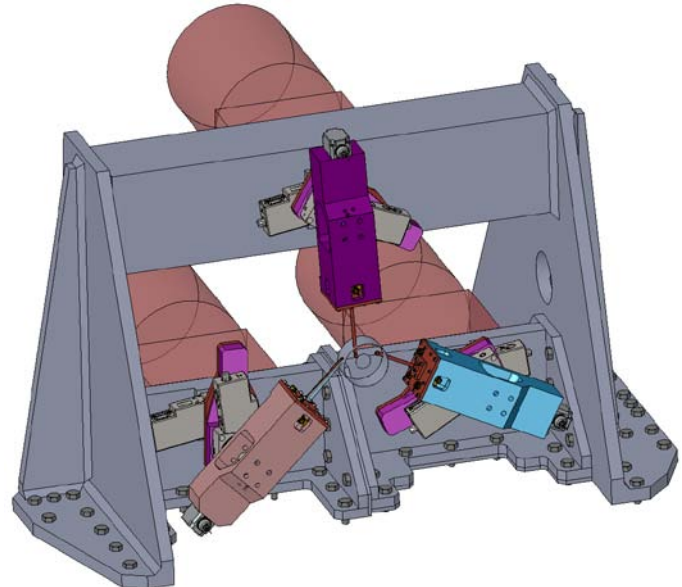
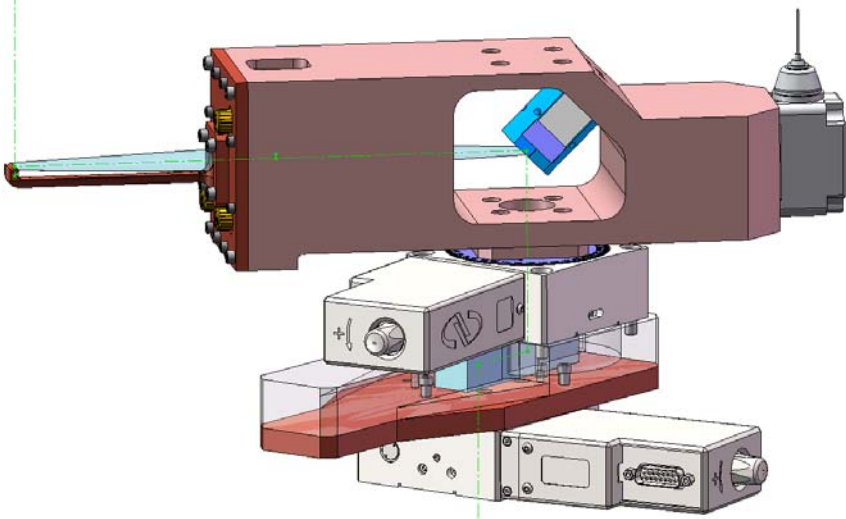




NGAO OSM

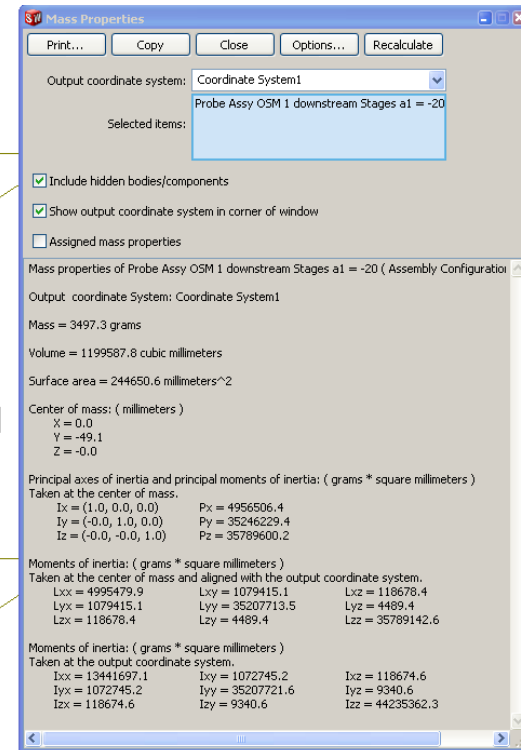
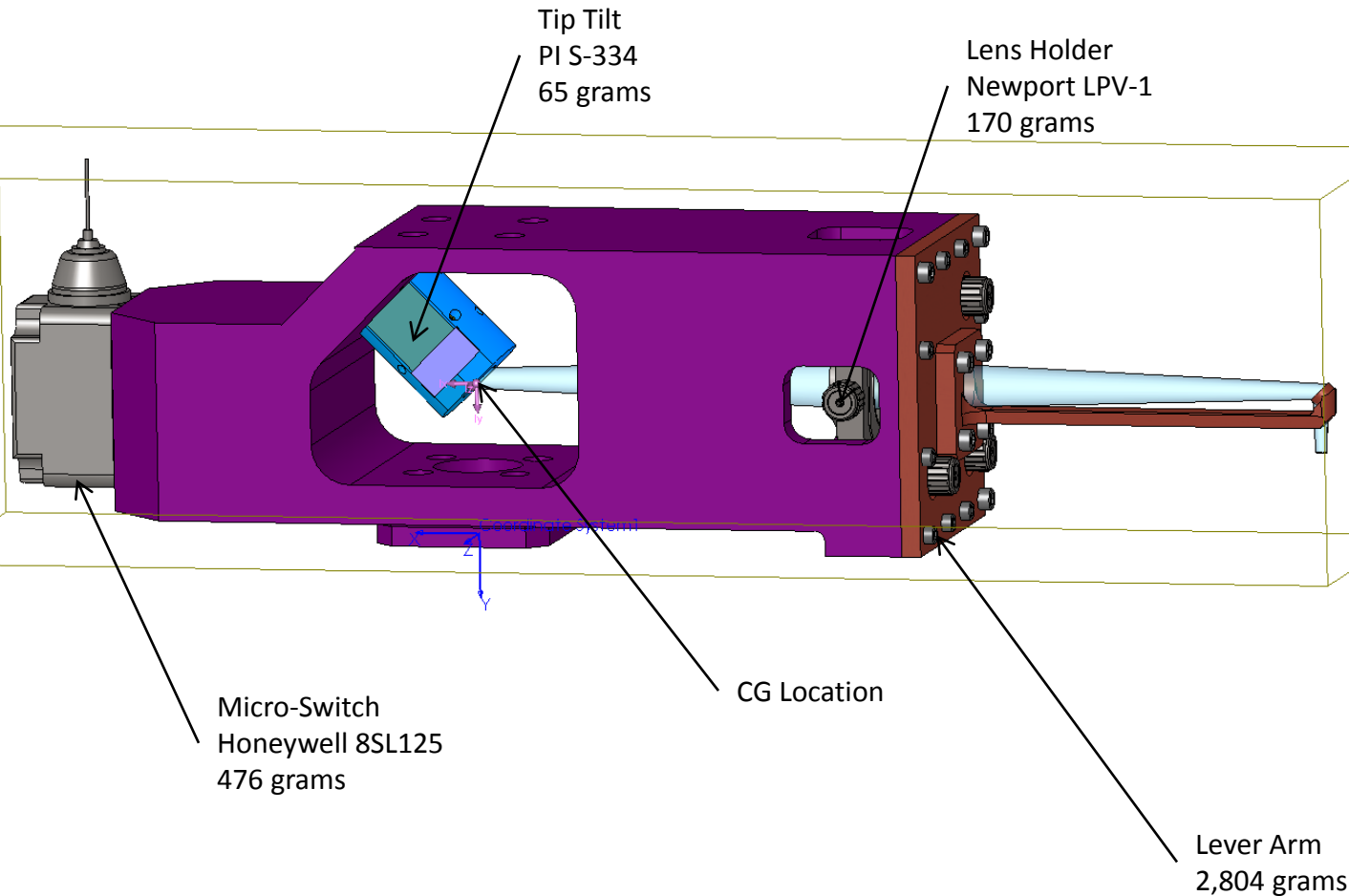
Design Study Update

Alex Delacroix
09/08/2009
Version 15

1) Mass and CG

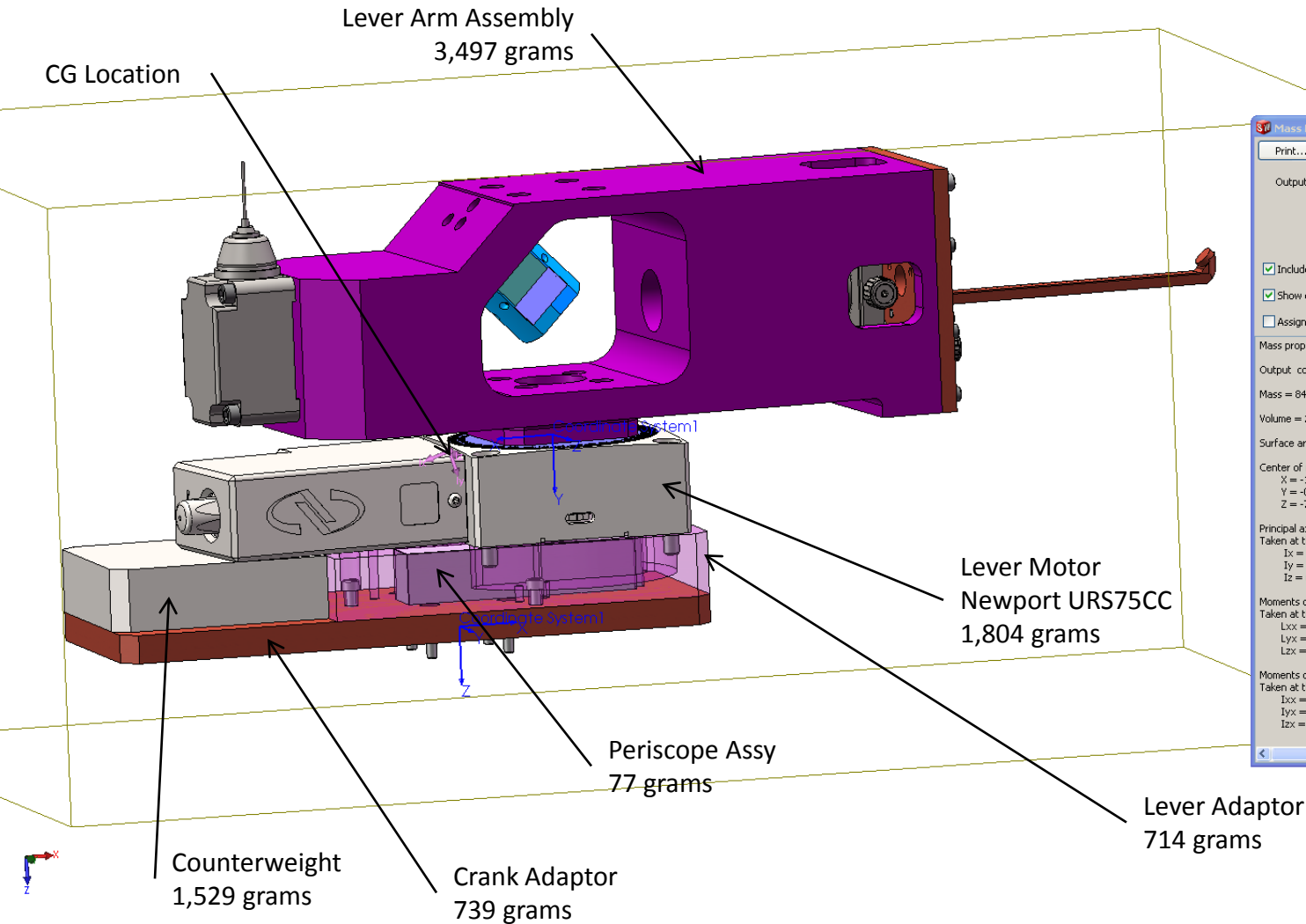
6.1) Lever Arm Assembly

Total Mass: 3,497 grams, CG located at the Axis of rotation, 49.1 mm above the Lever motor Interface.



6.2) OSM #1 Assembly

Total Mass: 8,358 grams, CG located at the Crank Axis of rotation, 71 mm above the Lever motor Interface.



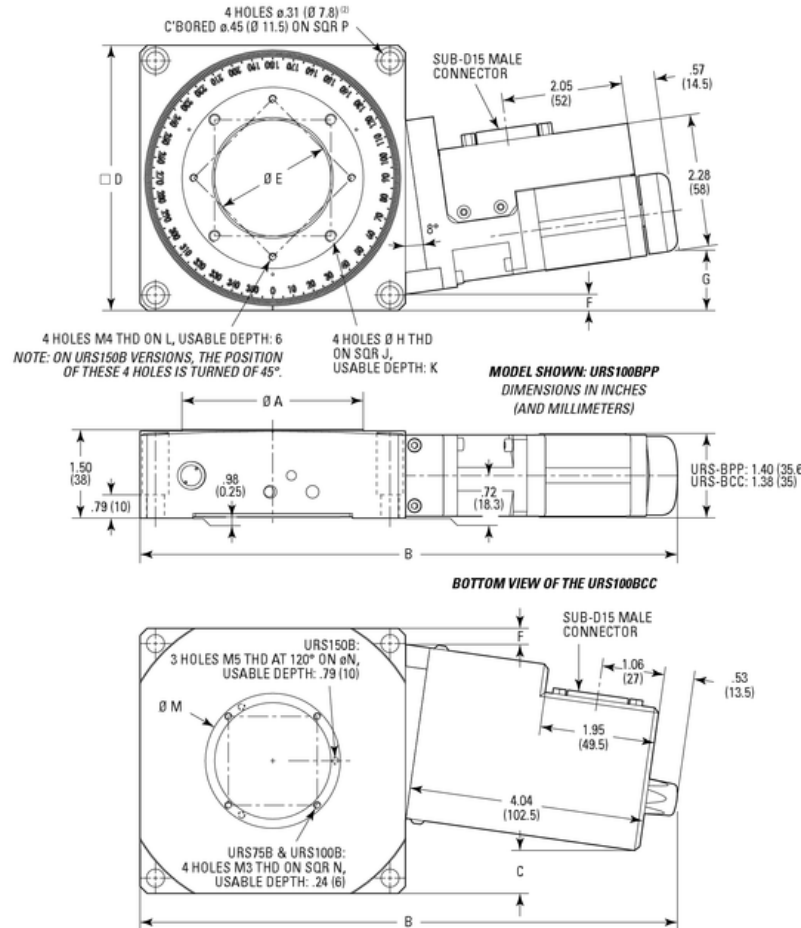
2)Newport Stage Specifications

Newport URS Series Precision Rotation Stages

Dimensions

Dimensions in inches (millimeters)

MODEL URS100B



	A	B	C	D	E	F	G	H	J	K	L	M	N	P
URS75B	1.97 (50)	8.19 (208)	~20 ⁽¹⁾ (511)	3.54 (90)	1.18 ⁽¹⁰⁰⁾ (30)	.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 ⁽⁵⁰⁾ (50)	.26 (6.5)	1.02 (26)	M6	1.97 (50)	.24 (6)	SQR 1.89 (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 ⁽⁹⁰⁾ (90)	.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 ⁽¹⁰⁾ (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

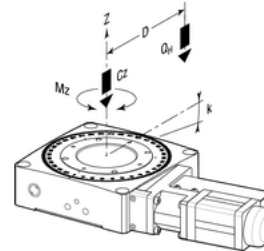
	PP		CC	
	Typical	Guaranteed	Typical	Guaranteed
Travel Range (°)	360 continuous ⁽¹⁾			
Resolution (°)	0.0002 ⁽²⁾		0.0005	
Minimum Incremental Motion (°)	0.0002		0.002	
Uni-directional Repeatability (°)	0.001	0.002	0.001	0.002
Reversal Value (Hysteresis) (°)	0.006	0.01	0.002	0.004
Absolute Accuracy (°)	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 guaranteed values.

Load Characteristics



	URS75	URS100	URS150
Cz, Normal centered load capacity (N)	200	300	300
a, Construction parameter (mm)	25	5	55
ka, Transversal compliance (µrad/Nm)	30	0	5
Mz, Nominal Torque (Nm)	+/- 0.5	+/- 1	+/- 2
Q, Off-center load	$Q \leq C_z / (1 + D/a)$		
D, Cantilever distance in mm			
Weight [lb (kg)]	3.7 (1.7)	4 (2)	7.5 (3.4)

STATIC LOAD ON CRANK MOTOR

3) Static Load Analysis on Crank Motor URS75

3.1) Load (Qh):

Qh = Tip Tilt Mirror (0.065 Kg) + Lens Holder Newport LPV-1 (0.170 Kg) + Lever Arm (2,8 Kg) + Micro-Switch Honeywell 8SL125 (0.476 Kg) + Lever Motor Newport URS75CC (1.804 Kg) +Crank Adaptor (0.739 Kg) + Lever Adaptor (0.714 Kg) + Periscope Assy(0.077 Kg) + Counterweight (1.529 Kg)

$$Q_h = 8.358 \text{ Kg} = 82.5 \text{ N}$$

3.2) Cantilever Torque:

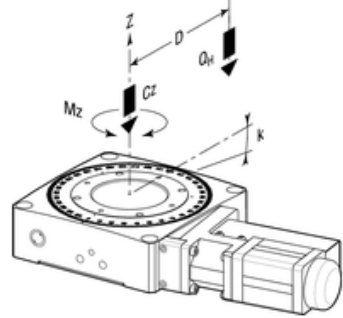
Distance between Crank Motor and center of Mass: $D = 71 \text{ mm} = .071 \text{ m}$

Cantilever Torque at Crank motor: $0.071 \text{ m} \times 82.5 = 5.8 \text{ Nm}$

Off Center Load Requirement: $Q < 200 / (2 / (1 + 71/25)) = 26 \text{ N}$

82N > 26N → THE LOAD IS TOO HIGH FOR THIS STAGE

Load Characteristics



Component	Manufacturer	P/N	Weight (Kg)	Mass (N)
TT Mirror	PI	S-334	0.065	
Lens Holder	Newport	LPV-1	0.17	
Microswitch	Honeywell	8SL125	0.476	
Lever Arm	Caltech	XXX	2.786	
Lever Arm Assy			3.497	
Rotation Stage	Newport	URS75CC	1.804	
Lever Adaptor	Caltech	XXX	0.714	
Periscope Assy	Caltech	XXX	0.077	
Crank Adaptor	Caltech	XXX	0.793	
Counterweight	Caltech	XXX	1.529	
Total Mass			8.414	82.54
D	71			
Cz	200			
a	25			
Max Off center load				52
K(urad/Nm)	30			
Torque (Nm)	5.86			
Deflection (urad) (rad)	175.81	0.0002		
Proj Dist (mm)	146			
Deflection at tip (mm)	0.03			
Tip Horiz disp (mm)	0.0257			
Tip Vert disp (mm)	0.0000			

	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	$Q \leq C_z / (1 + D/a)$		
D, Cantilever distance in mm			
Weight [lb (kg)]	3.7 (1.7)	4.4 (2)	7.5 (3.4)

4) Static Load Analysis on Crank Motor URS150

4.1) Load (Qh):

Qh = Tip Tilt Mirror (0.065 Kg) + Lens Holder Newport LPV-1 (0.170 Kg) + Lever Arm (2,8 Kg) + Micro-Switch Honeywell 8SL125 (0.476 Kg) + Lever Motor Newport URS75CC (1.804 Kg) +Crank Adaptor (0.739 Kg) + Lever Adaptor (0.714 Kg) + Periscope Assy(0.077 Kg) + Counterweight (1.529 Kg)

$$Q_h = 8.358 \text{ Kg} = 82.5 \text{ N}$$

4.2) Cantilever Torque:

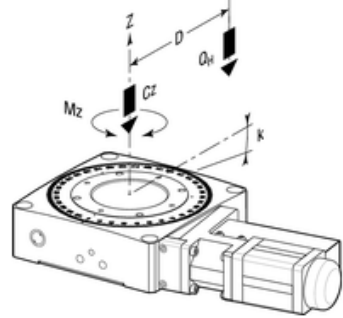
Distance between Crank Motor and center of Mass: $D = 71 \text{ mm} = .071 \text{ m}$

Cantilever Torque at Crank motor: $0.071 \text{ m} \times 82.5 = 5.8 \text{ Nm}$

Max Off Center Load: $300 / 2 / (1 + 71/55) = 65 \text{ N}$

82N > 65N → THE LOAD IS TOO HIGH FOR THIS STAGE

Load Characteristics



Component	Manufacturer	P/N	Weight (Kg)	Mass (N)
TT Mirror	PI	S-334	0.065	
Lens Holder	Newport	LPV-1	0.17	
Microswitch	Honeywell	8SL125	0.476	
Lever Arm	Caltech	XXX	2.786	
Lever Arm Assy			3.497	
Rotation Stage	Newport	URS75CC	1.804	
Lever Adaptor	Caltech	XXX	0.714	
Periscope Assy	Caltech	XXX	0.077	
Crank Adaptor	Caltech	XXX	0.793	
Counterweight	Caltech	XXX	1.529	
Total Mass			8.414	82.54
D	71			
Cz	300			
a	55			
Max Off center load				65
K(urad/Nm)	5			
Torque (Nm)	5.86			
Deflection (urad) (rad)	29.30	2.93022E-05		
Proj Distance (mm)	146			
Deflection at tip (mm)	0.0043			
Tip Horiz disp (mm)	0.0043			
Tip Vert disp (mm)	0.0000			

	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	$Q \leq C_z / (1 + D/a)$		
D, Cantilever distance in mm			
Weight [lb (kg)]	3.7 (1.7)	4.4 (2)	7.5 (3.4)

5) Static Load Analysis on Crank Motor RVS80CC

5.1) Load $Q_v = 8.358 \text{ Kg} = 82.54 \text{ N}$

Distance between Crank Motor and center of Mass: $D = 83 + 32 = 115 \text{ mm}$

Cantilever Torque at Crank motor: $0.115 \text{ m} \times 82 \text{ N} = 9.4 \text{ Nm}$

Max Off Center Load: $900/2 / (1 + 115/30) = 131 \text{ N} \rightarrow 82 \text{ N} < 131 \text{ N}$

Load Characteristics

	RVS80	RV120	RV160	RV240	RV350
C_z , normal centered load capacity (N)	900	1800	2700	4000	6500
a , construction parameter (mm)	30	40	50	70	100
b^* , (mm) except HAT & HAHLT	39	53	57	59	73
b^* , (mm) for HAT & HAHLT		71	75	77	91
k , radial compliance ($\mu\text{rad}/\text{Nm}$)	3.5	1.5	0.6	0.3	0.1
Q_H , Off-center load, vertical rotation axis	$Q_H C_z / (1+D/a)$				
Q_V , Off-center load, horizontal rotation axis	$Q_V C_z / 2 / (1+D/a)$				

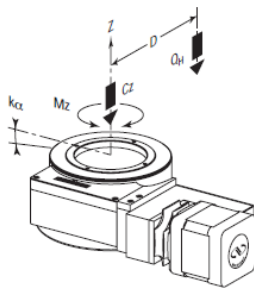
* Construction parameter = Distance between the top surface of the RV stage and the bearing center.

Example:

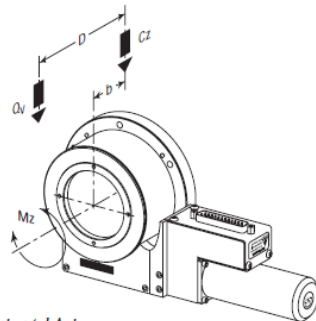
Q_V at a distance of 80 mm from the top surface for a RV160HAT rotation stage,
 $D = 80 \text{ mm} + 75 \text{ mm} = 155 \text{ mm}$:

$Q_V = 2700 \text{ N} / 2 / (1 + 155 \text{ mm} / 50 \text{ mm}) = 329 \text{ N}$

Load Rotation Axes



Vertical Axis



Horizontal Axis

Component	Manufacturer	P/N	Weight (Kg)	Mass (N)
TT Mirror	PI	S-334	0.065	
Lens Holder	Newport	LPV-1	0.17	
Microswitch	Honeywell	8SL125	0.476	
Lever Arm	Caltech	XXX	2.786	
Lever Arm Assy			3.497	
Rotation Stage	Newport	URS75CC	1.804	
Lever Adaptor	Caltech	XXX	0.714	
Periscope Assy	Caltech	XXX	0.077	
Crank Adaptor	Caltech	XXX	0.793	
Counterweight	Caltech	XXX	1.529	
Total Mass			8.414	82.54
D	115			
Cz	900			
a	30			
Max Off center load				186
K($\mu\text{rad}/\text{Nm}$)	3.5			
Torque (Nm)	9.5			
Deflection (μrad) (rad)	33.22	3.32229E-05		
Proj Distance (mm)	146			
Deflection at tip (mm)	0.0049			
Tip Horiz disp (mm)	0.0049			
Tip Vert disp (mm)	0.0000			

STATIC LOAD ON LEVER MOTOR

6) Static Load Analysis on Lever Motor URS75

6.1) Load (Qh):

$Q_h = \text{Tip Tilt Mirror (0.065 Kg)} + \text{Lens Holder Newport LPV-1 (0.170 Kg)} + \text{Lever Arm (2,8 Kg)} + \text{Micro-Switch Honeywell 8SL125 (0.476 Kg)}$

$$Q_h = 3.497 \text{ Kg} = 34.31 \text{ N}$$

6.2) Cantilever Torque:

Distance between Lever Motor and center of Mass: $D = 49.1 \text{ mm} = .049 \text{ m}$

Cantilever Torque at Lever motor: $0.049 \text{ m} \times 34.31 = 1.68 \text{ Nm}$

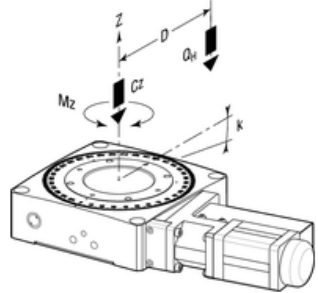
Off Center Load Requirement: $Q < 200 / 2 / (1 + 49/25) = 68 \text{ N} \rightarrow 34 \text{ N} < 68 \text{ N}$

Tip deflection angle K (urad) = $30 \times 1.68 = 50.4 \text{ urad}$:

Tip Resulting displacement = $L \tan k = 125 \tan .00289 = 0.0063 \text{ mm}$

Tip Horizontal displacement: $0.0063 \cos 0.00289 = 0.0063 \text{ mm}$

Load Characteristics



Component	Manufacturer	P/N	Weight (Kg)	Mass (N)
TT Mirror	PI	S-334	0.065	
Lens Holder	Newport	LPV-1	0.17	
Microswitch	Honeywell	8SL125	0.476	
Lever Arm	Caltech	XXX	2.786	
Lever Arm Assy			3.497	
Total Mass			3.497	34.31
D (mm)	49			
Cz (N)	200			
a (mm)	25			
Max Off center load (N)				68
K(urad/Nm)	30			
Torque (Nm)	1.68			
Deflection (urad) (rad)	50.43	5.04292E-05		
Proj Dist (mm)	125			
Twisting of the tip (mm)	0.0063			
Tip Horiz disp (mm)	0.0063			
Tip Vert disp (mm)	0.0000			

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

7) Static Load Analysis on Lever Motor RVS80CC

Load $Q_h = 3.497 \text{ Kg} = 34.31 \text{ N}$

Distance between Lever Motor and center of Mass: $D = 49 + 39 = 88 \text{ mm}$

Cantilever Torque at Lever motor: $0.088 \text{ m} \times 34.31 = 3.02 \text{ Nm}$

Max Off Center Load: $Q < 900/2 / (1 + 88/30) = 114 \text{ N} \rightarrow 34 \text{ N} < 114 \text{ N}$

Tip deflection angle K (urad) = $3.5 \times 3.02 = 10.57 \text{ urad} = 0.0006 \text{ deg}$

Tip Resulting displacement = $L \tan k = 125 \tan .0006 = 0.0013 \text{ mm}$

Load Characteristics

	RVS80	RV120	RV160	RV240	RV350
Cz, normal centered load capacity (N)	900	1800	2700	4000	6500
a, construction parameter (mm)	30	40	50	70	100
b*, (mm) except HAT & HAHLT	39	53	57	59	73
b*, (mm) for HAT & HAHLT		71	75	77	91
k, radial compliance (urad/Nm)	3.5	1.5	0.6	0.3	0.1
$Q_{H, \text{ Off-center load, vertical rotation axis}}$	$Q_H \text{ Cz} / (1+D/a)$				
$Q_{V, \text{ Off-center load, horizontal rotation axis}}$	$Q_V \text{ Cz} / 2 / (1+D/a)$				

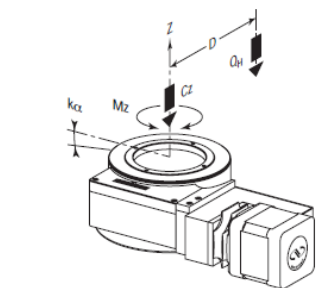
* Construction parameter = Distance between the top surface of the RV stage and the bearing center.

Example:

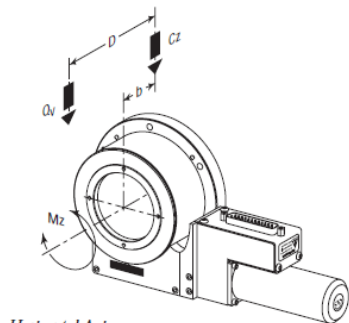
Q_V at a distance of 80 mm from the top surface for a RV160HAT rotation stage,
 $D = 80 \text{ mm} + 75 \text{ mm} = 155 \text{ mm}$:

$$Q_V = 2700 \text{ N} / 2 / (1 + 155 \text{ mm} / 50 \text{ mm}) = 329 \text{ N}$$

Load Rotation Axes



Vertical Axis



Horizontal Axis

Component	Manufacturer	P/N	Weight (Kg)	Mass (N)
TT Mirror	PI	S-334	0.065	
Lens Holder	Newport	LPV-1	0.17	
Microswitch	Honeywell	8SL125	0.476	
Lever Arm	Caltech	XXX	2.786	
Lever Arm Assy			3.497	
Total Mass			3.497	34.31
D (mm)	88			
Cz (N)	900			
a (mm)	30			
Max Off center load (N)				114
K(urad/Nm)	3.5			
Torque (Nm)	3.02			
Deflection (urad) (rad)	10.57	1.05661E-05		
Proj Dist (mm)	125			
Twisting of the tip (mm)	0.0013			
Tip Horiz disp (mm)	0.0013			
Tip Vert disp (mm)	0.0000			

CONCLUSION

- Newport Stage RVS80CC is more adapted to the imposed Cantilever load.
- The angular deflection, function of the Arm weight and Cantilever Distance, can be reduced 2 ways:
 - Using a smaller Collimator Lens holder (suppression of DoF adjustments,...)
 - Using smaller periscope mirrors (Elongated light beam,...)

