Motor 2 electrical requirements test bench setups

J. Emery

Wire-Scanner Design meeting 24.07.2015

Motor 2 Preliminary characteristics validation

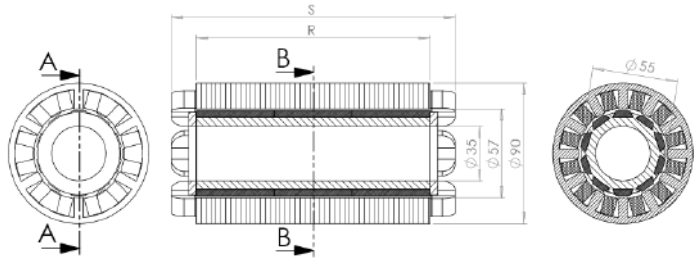
- Final proposal 145STK4M
- Length lose to full custom design (below)

Marque	N°	Modèle	L rotor $[mm]$	L tot. $[mm]$	D ext. stator $[mm]$	D ext. rotor $[mm]$	D int. rotor $[mm]$	e rotor $[mm]$
Parker	1	K500150	38.1	79.1	127.0	66.5	50.8	7.85
Parker	2	K500300	76.2	117.2	127.0	66.5	50.8	7.85
Parker	3	K178100	25.4	56.0	177.8	109.7	95.8	6.95
Parker	4	K178200	50.8	81.4	177.8	109.7	95.8	6.95
Etel	5	TMA0100-070	71.0	100.0	120.0	73.0	60.0	6.50
Etel	6	TMA0100-100	101.0	130.0	120.0	73.0	60.0	6.50
Etel	7	TMB0140-050	51.0	90.0	160.0	88.0	60.0	14.00
Etel	8	TMM0140-050	51.0	95.5	140.0	88.0	60.0	14.00
Etel	9	TMM0140-150	151.0	196.0	140.0	88.0	60.0	14.00
Danaher motion	10	RBE 3012	47.6	66.7	129.0	76.5	50.9	12.83
Danaher motion	11	RBE 3013	61.0	80.0	129.0	76.5	50.9	12.83
Danaher motion	12	RBE 3014	73.0	92.1	129.0	76.5	50.9	12.83
Danaher motion	13	RBE 3015	88.9	108.0	129.0	76.5	50.9	12.83
Danaher motion	14	RBE 3016	101.6	120.7	129.0	76.5	50.9	12.83
Alxion	15	145STK2M	86.0	119.0	145.0	77.5	56.0	10.75
Alxion	16	145STK4M	140.0	173.0	145.0	77.5	56.0	10.75
Alxion	17	145STK6M	194.0	227.0	145.0	77.5	56.0	10.75
Alxion	18	145STK8M	248.0	281.0	145.0	77.5	56.0	10.75
Harmonic drive AG	19	TorkDrive-100A 70-AA	72.0	102.0	99.7	73.2	52.0	10.60
Allied Motion	20	HT05005	61.8	80.9	127.0	76.4	63.5	6.45
Kollmorgen	21	KBM-25X03-X	93.9	124.7	110.0	64.0	50.0	7.00
Kollmorgen	22	KBM-25X04-X	124.8	155.7	110.0	64.0	50.0	7.00
Phase automation	23	TK85-140-01	140.0	172.0	85.0	57.6	44.0	6.80

Dimensions des moteurs disponibles sur le marché

C. Grosjean motor survey

Moteur synchrone à aimants permanents variante AT



Dimensions du moteur		Unité	AT-050	AT-100	AT-150
R	Longueur du rotor	$[mm]$	50	100	150
S	Longueur du stator	$[mm]$	82	132	182
Constantes de conception		**Unité**	**AT-050**	**AT-100**	**AT-150**
T_{max}	Couple maximal	$[Nm]$	23.7	47.5	71.2
$T_{c_{130°c}}$	Couple en continu (bobinage à 130 [°C])*	$[Nm]$	2.7	4.9	6.7
$P_{cu_{max}}$	Pertes cuivre maximales	$[kW]$	12.8	21.1	29.3
$P_{cu_{130°c}}$	Pertes cuivre en continu (bobinage à 130 [°C])*	$[W]$	90	116	134
K_m	Constante du moteur	$[Nm/\sqrt{W}]$	0.34	0.54	0.69
τ_e	Constante de temps électrique	$[ms]$	4.84	5.89	6.35
p	Nombre de paires de pôles	$[-]$	5	5	5
J	Moment d'inertie du rotor	$[kg \cdot cm^2]$	2.91	5.83	8.74
M_m	Masse du moteur	$[kg]$	2.38	4.17	5.97
T_d	Couple de détente (valeur typique)**	$[mNm]$	5	10	15
Constantes d'enroulement		**Unité**	**AT-050**	**AT-100**	**AT-150**
K_T	Constante de couple	$[Nm/A]$	0.40	0.81	1.21
K_u	Constante de tension induite	$[V/(rad/s)]$	0.13	0.27	0.40
$R_{130°c}$	Résistance de phase à 130 [°C]	$[\Omega]$	0.65	1.07	1.48
$R_{20°c}$	Résistance de phase à 20 [°C]	$[\Omega]$	0.45	0.74	1.03
L	Inductance de phase	$[mH]$	2.18	4.36	6.54
I_{max}	Courant maximal	$[A]$	97.4	97.4	97.4
$I_{c_{130°c}}$	Courant en continu (bobinage à 130 [°C])*	$[A]$	6.8	6.0	5.5

C. Grosjean design thesis

Motor 2
Preliminary characteristics validation

145STK4M (N°16)

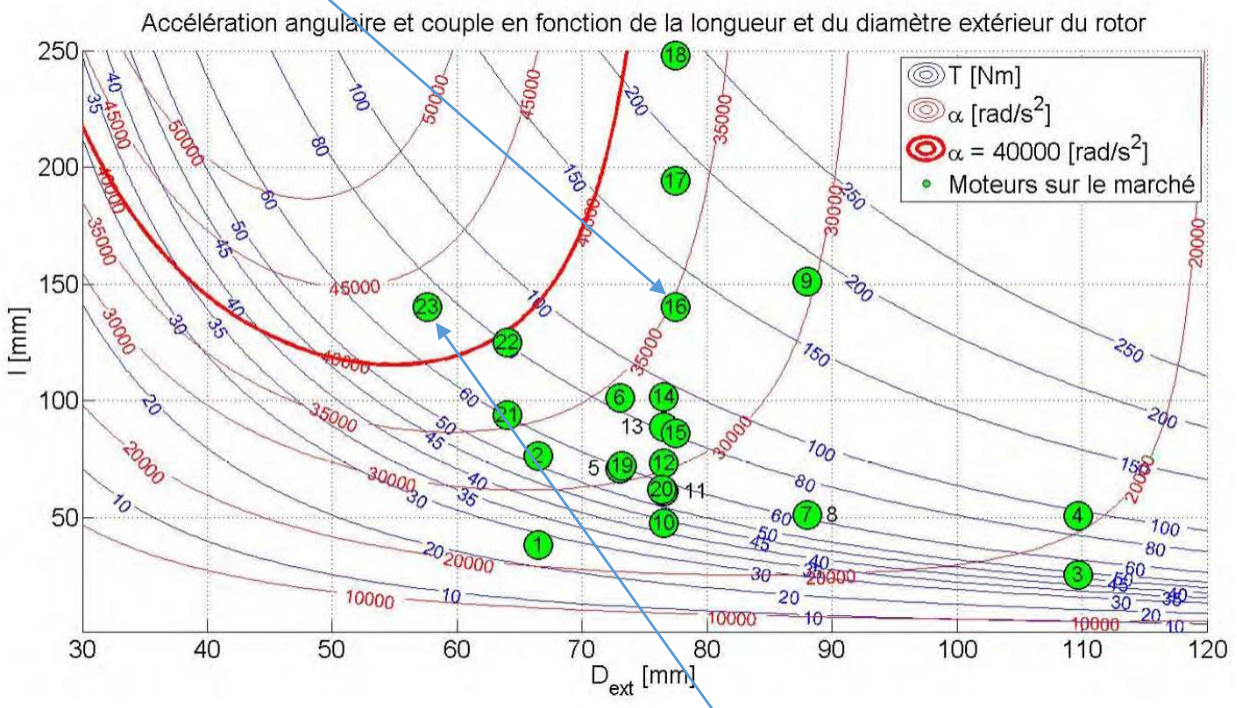


figure 5.8 : Emplacement des moteurs issus de la liste des moteurs disponibles sur le marché (annexe 3)

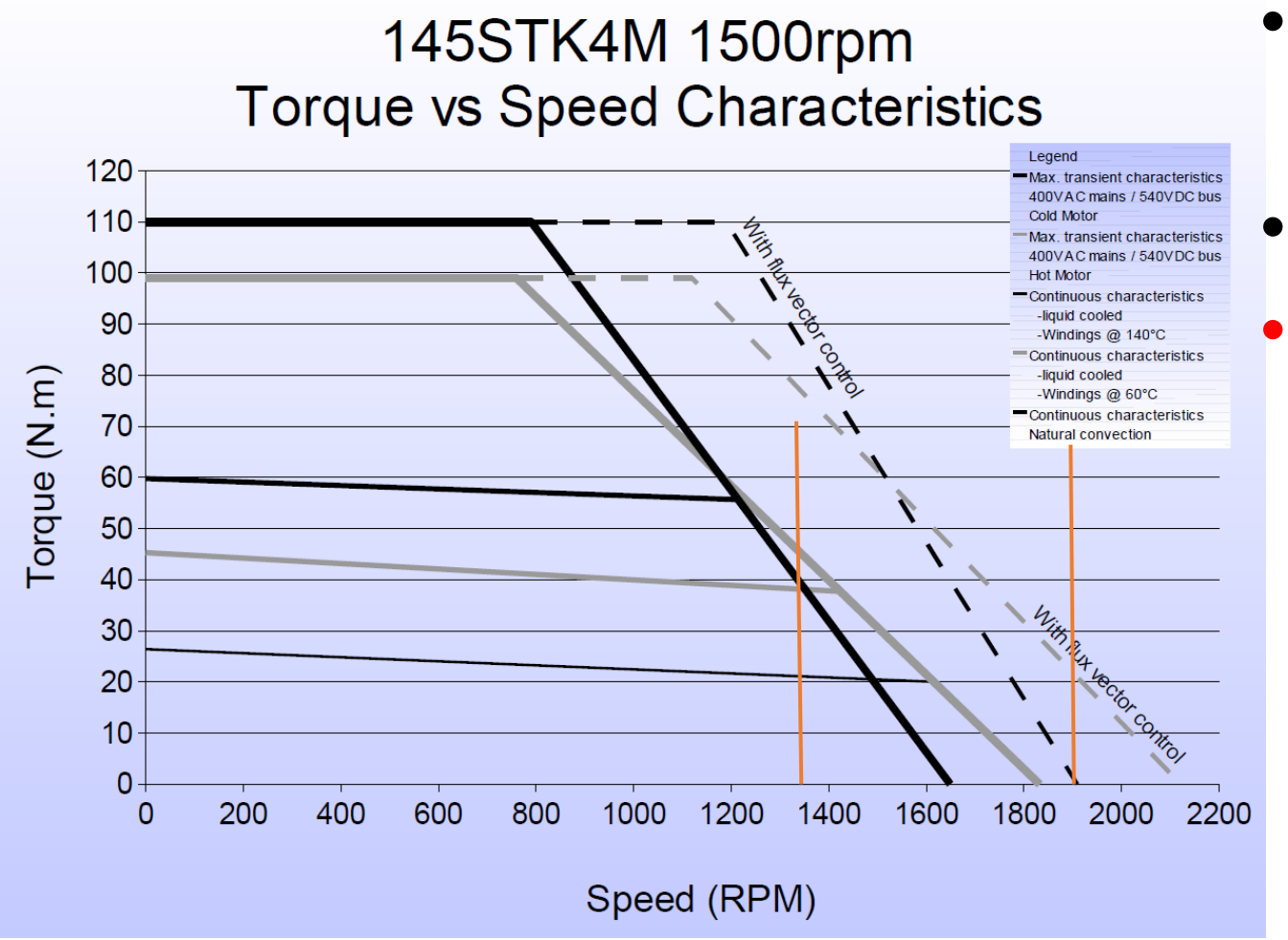
C. Grosjean thesis

Phase automation
TK85-140-01 (N°23)

- 145STK4M MOTOR KIT

<u>35krad*s^-2</u>
Suitable injectors
Issue for the LHC with short forks

Motor 2
Preliminary characteristics validation



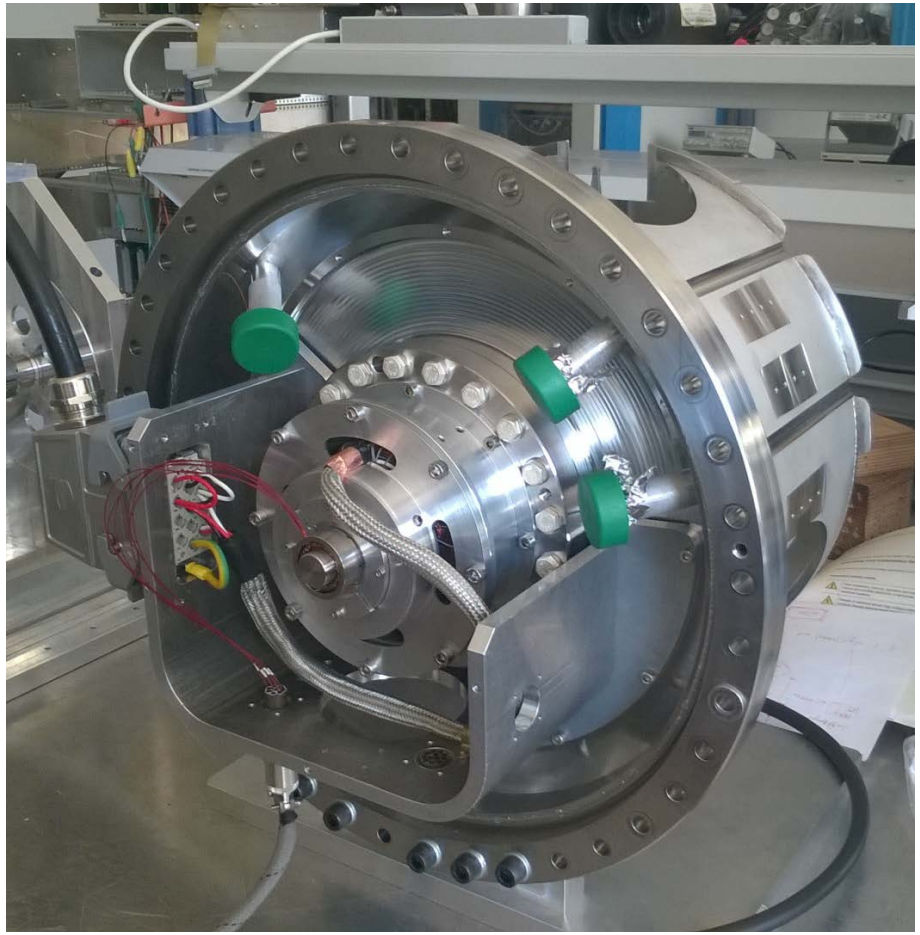
- We must use the 1500 rpm version
- 140 [rad/s] => 1337 RPM
- 200 [rad/s] => 1910 RPM

Motor 2
Preliminary characteristics validation

NATURAL CONVECTION				145STK2M		145STK4M	
Rated speed		rpm	500	1500	500	1500	
Continuous torque	(1)(4)	N.m	14.6		26.4		
Current at continuous torque	(1)	A	2.3	5.2	3.7	9.2	
Peak torque	(2)(3)	N.m	55		110		
Current at peak torque	(2)	A	10.2	23.1	17.8	45.5	
Rated power	(1)	W	735	2032	1247	3134	
Inertia		10^{-3}kg.m²	1.28		2.24		
Weight		kg	6.2		10.4		
Thermal time constant	(1)	s	1012		1399		
Thermal resistance	(1)	°C / W	0.394		0.324		
Phase resistance at 20°C	(2)	Ω	12.9	2.55	6.2	0.95	
Phase inductance at I continuous		mH	66.7	12.4	44.5	6.8	
Electrical time constant	(2)	ms	5.1		7.2		
Back emf constant (line to line)	(2)	V/rad.s	4.25	1.91	4.88	1.91	
Power cable square section		nxmm²	4x1.5		4x1.5		
Power cable diameter		mm	Ø8		Ø8		
Number of poles							12

- Windings for 400V DC
- Relative low current
- Large inertia
- Large number of poles, to evaluate impact (resulting in higher Di/Dt) than now
- Further evaluation needed since we drive the motor along long cables

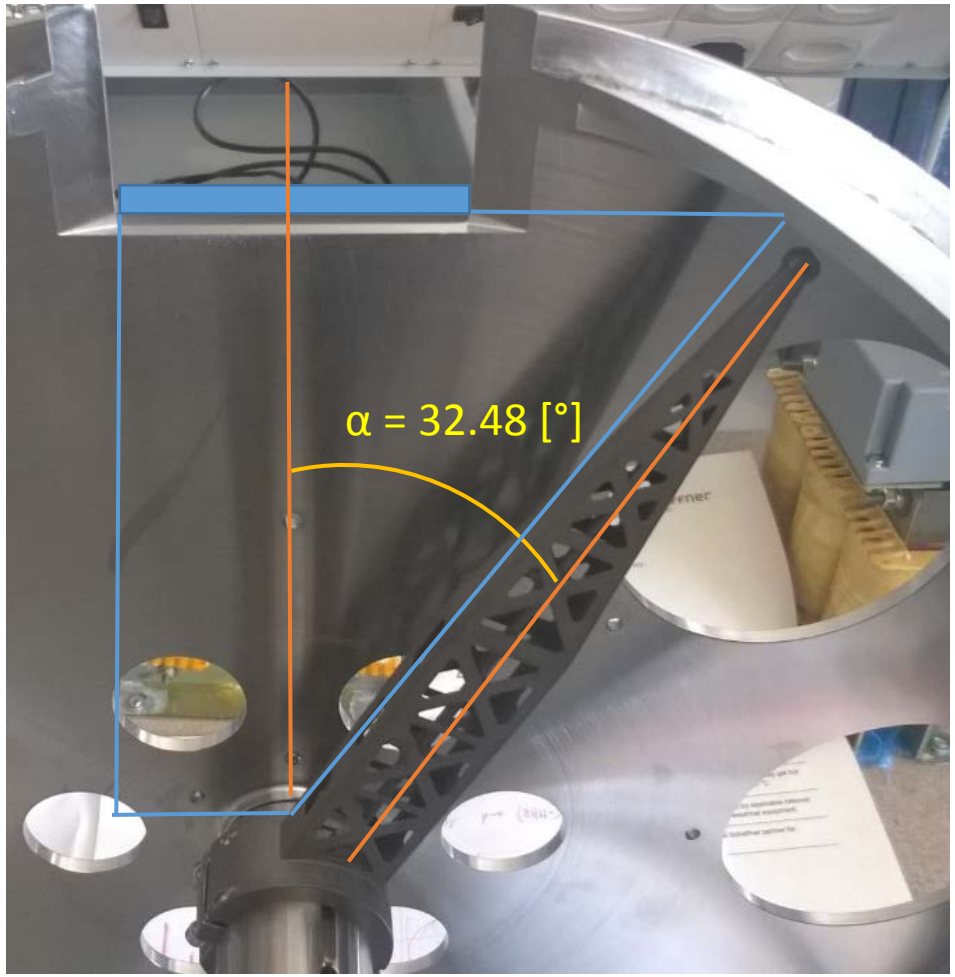
Prototype 2
Pieces missing for calibration under vacuum 1/2



- New resolvers stators need to be machined (alesage), I use the pre-proto at the moment.
- Brake stator missing
- Optical disk for the incremental encoder

- Wires routing to the C-Wire, C-Wire mounting
- Optical and electrical feedthroughs
- Optical focusers installation and alignment

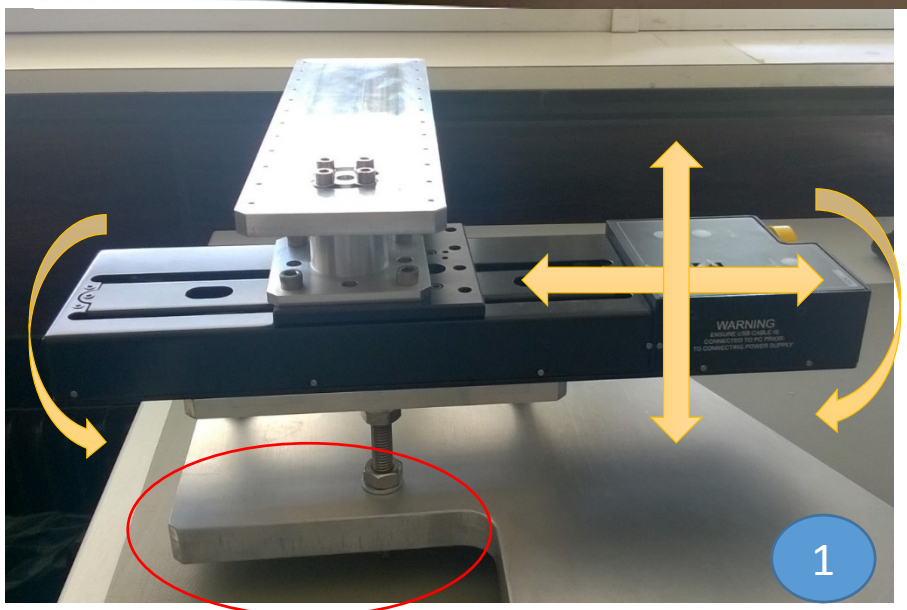
Prototype 2
Pieces missing for calibration under vacuum 2/2



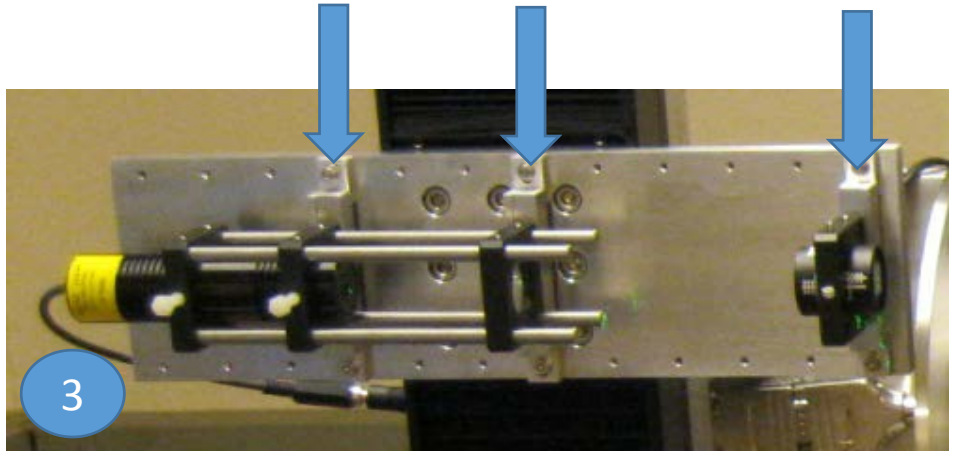
- I am missing tooling to ‘precisely’ align the fork at the home position
(@ 32.5° from vertical position)

- Can we produce a piece fixed on the drum where the fork can touch to give the good angle (blue lines on my drawing)

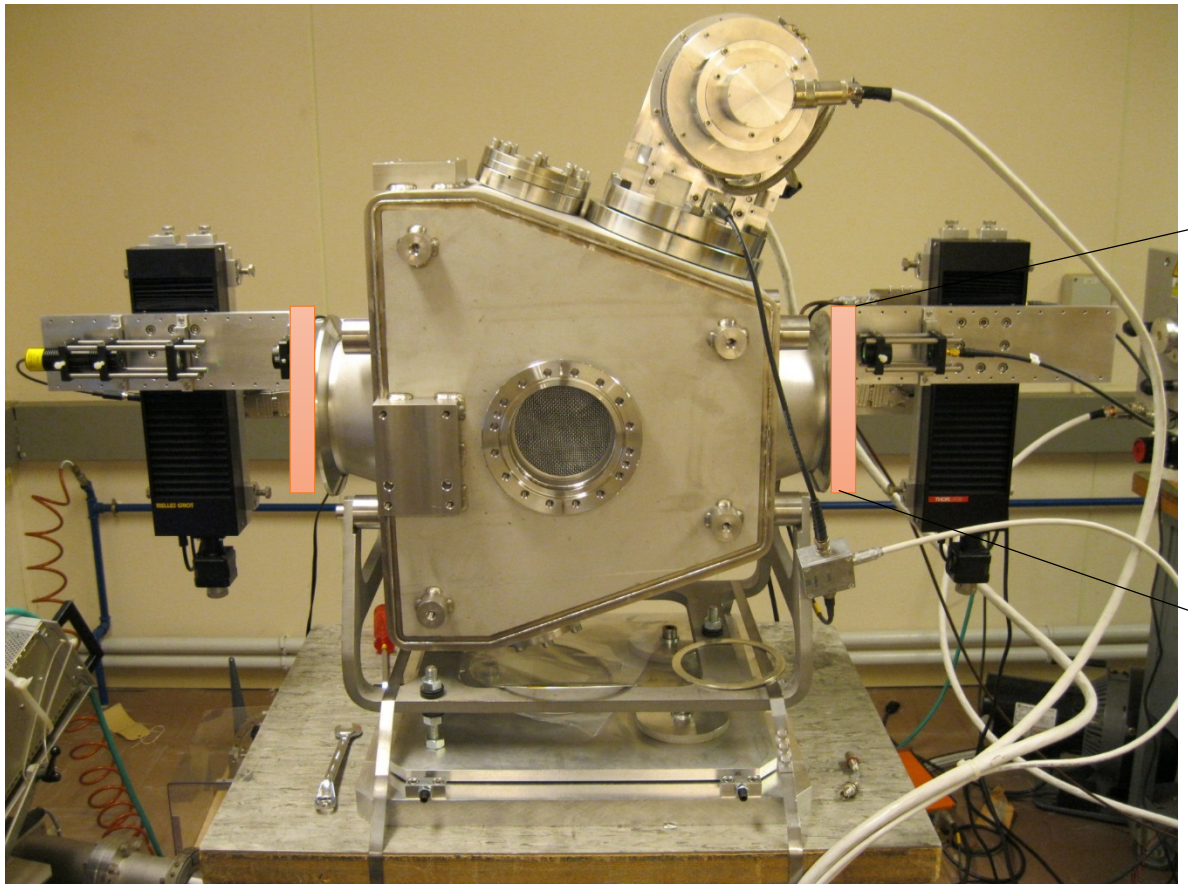
Calibration bench

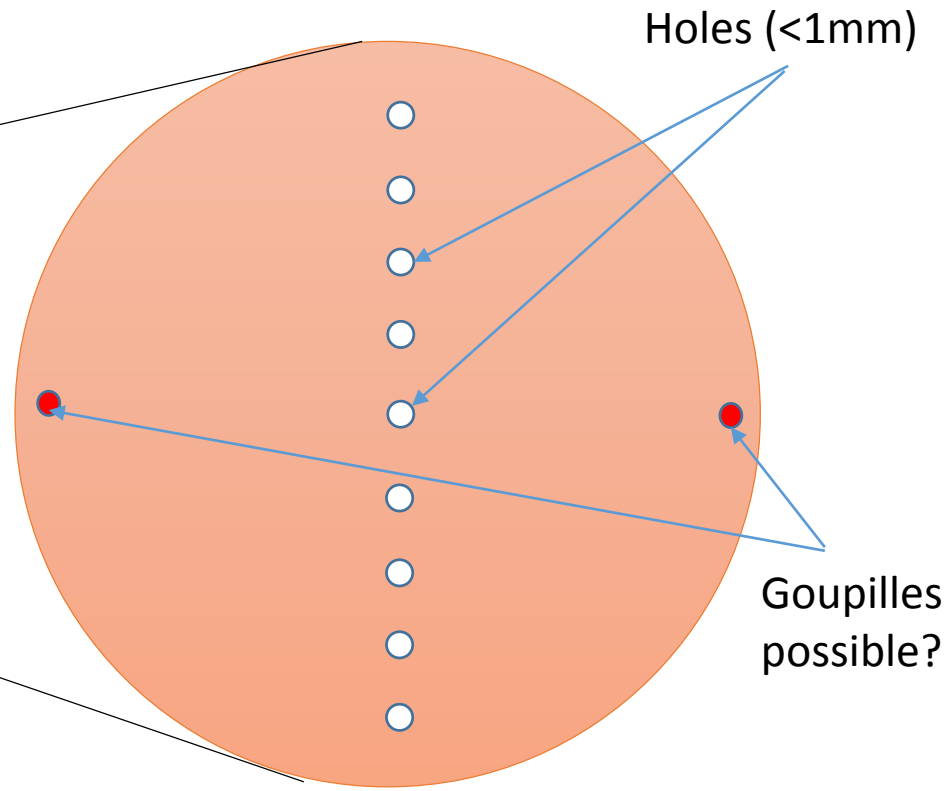


1) Support needed for the table (unstable)
2) Rotate linear stage A, to be same pos a B
3) Pieces to install optical parts on the plates
4) Alignment procedure of mechanical parts
   3 screws (height + tilt), sliding and rotation of the optical plate per linear stages



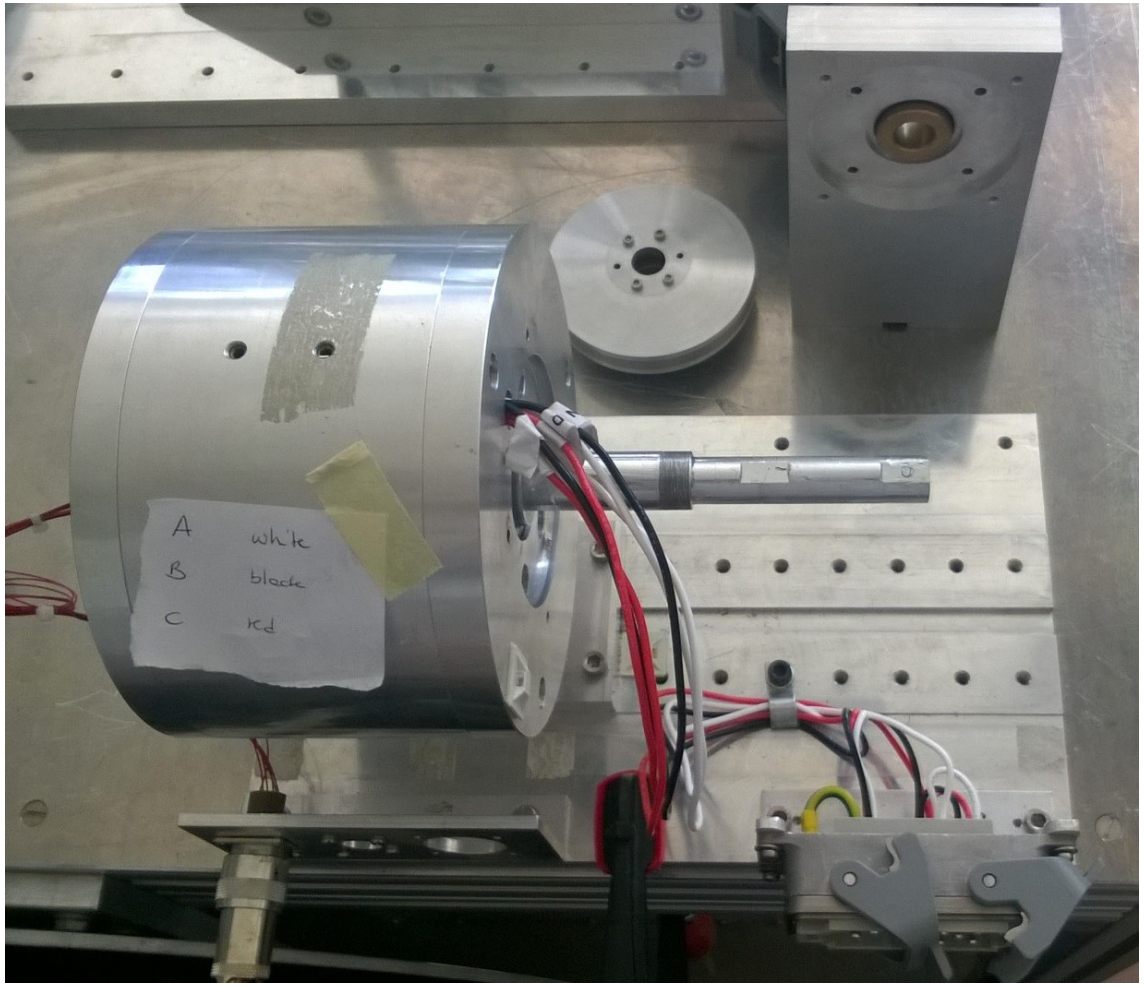
Calibration bench optical alignment flanges request



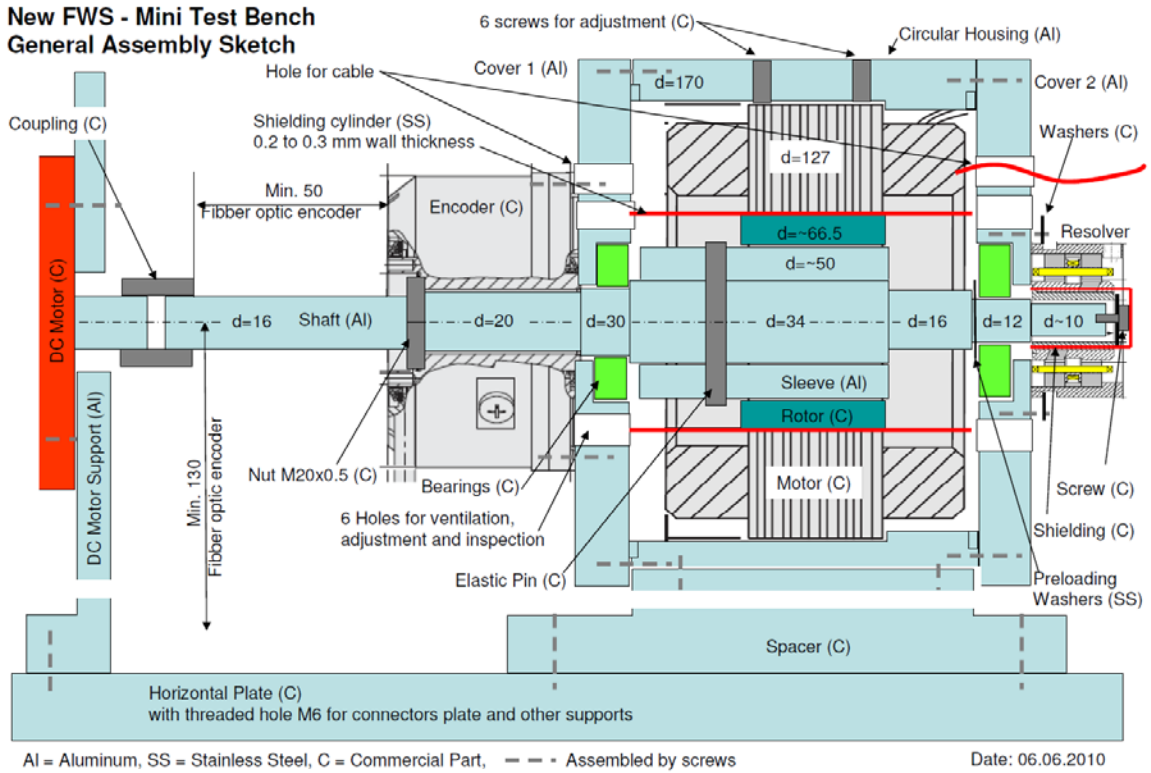


PS calibration bench

Test bench for the Motor 2



- Compatibility with Juan's bench systems for the motor and optical encoder (shaft diameter shaft height, hole spacing, etc…)



Courtesy of Juan Herranz Alvarez

List of open tasks

- Finalise evaluation of the motor.
- Plan the test bench construction for lab validation.

- Modification needed to test bench to start working with it.
- Additional design for aligning the fork and the laser test bench.
- Prototype 2 needs optical disk and brake.