Beam Wire Scanner for PS/SPS/PSB

Update on Motor Supplier Investigations

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Electric Motor Requirements

** - The motor currently used is obsolete and will not be available for purchasing*

Parameter	Value		Notes
Motor type	Frameless PMSM		Permanent Magnet Synchronous Motor
Rotor core material	Steel (should be approved by CERN)		
Permanent magnets material	Samarium-Cobalt (Sm_2Co_{17})		
Wire linear speed, m/s	20		
Angular speed, rad/s	110 (PS/SPS)	133 (PSB)	
Acceleration, rad/s^2	10672 (PS/SPS)	15711 (PSB)	Sin-profile is used, spec. coefficient 1.85
Inertia of the load, kg x m^2	8.6E-04* (PS/SPS)	7.29E-04* (PSB)	
Radial air gap (stator ID – rotor ED), mm	0.7		
Ionizing radiation dose, kGy/year	1		

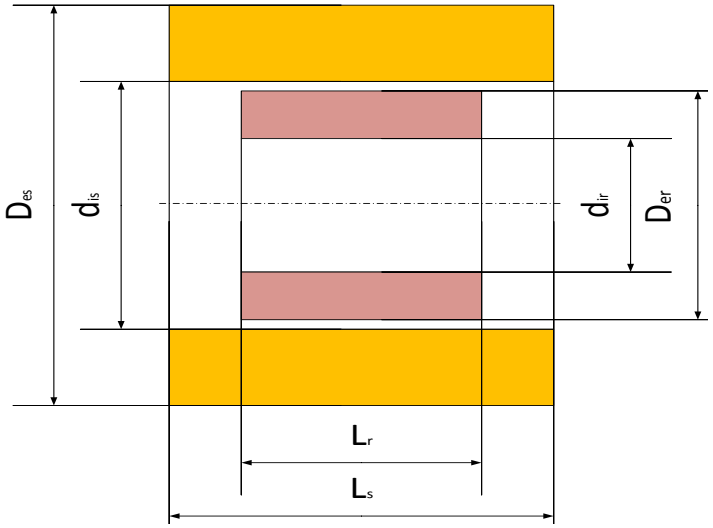
New motor will be the same in beam wire scanners for PS/SPS/PSB so should provide torque sufficient to accelerate the wire to linear speed 20 m/s in both configurations: 182.5 mm (PS/SPS) and 150 mm (PSB) mm forks;

- The desired motor should be based on the standard market solution which will be available for many years;
- The rotor will be located in vacuum and must be vacuum compatible; the use of any glue, other adhesives or insulating materials is not possible. Solid core rotor should be used.
- The moment of inertia of the rotor should be minimized in order to reduce the required acceleration torque;
- Features for mounting the rotor on the shaft (key-slots, holes, etc.) should be considered in the design;

*-values will be optimized during the next mechanical design phase

Potential suppliers and models

Supplier	Model	Rotor Inertia, kg x m^2	Peak torque, N x m	Required torque PS/SPS, N x m	Required torque PSB, N x m	Dimensions, $d_{ir}xD_{er}xD_{es}xL_rxL_s$
Alxion	145STK2M	1.28E-03	55.00	20.07	27.48	56x??x145x86x119
Kollmorgen	KBM-35X02	2.50E-03	58.4	35.86	50.73	65x??x140x76x109
Parker	NK620	9.80E-04	26.60	18.63	25.57	26x71x111x60x106



3 companies are interested

Potential suppliers and models

Supplier – Model	Price, EUR	Additional cost
Parker - NK620	1700.0	-
Kollmorgen - KBM-35X02	5294.0 (quantity 1..5) 3566.6 (quantity 6+)	3700 (non recurring engineering cost)
Alxion - 145STK2M	Did not send yet	Did not send yet

Parker - NK620

Rotor banding
(done by Alxion)

Conclusions

- Three out of six contacted suppliers confirmed their interest in fulfilling our needs
- So it seems possible to have the entire product (Stator + rotor) from the shelf
- Price difference is quite high (Kollmorgen vs. Parker)
- Not all the suppliers sent their quotation, waiting by end of this week
- Some companies ask for NRE (non recurring engineering cost) compensation

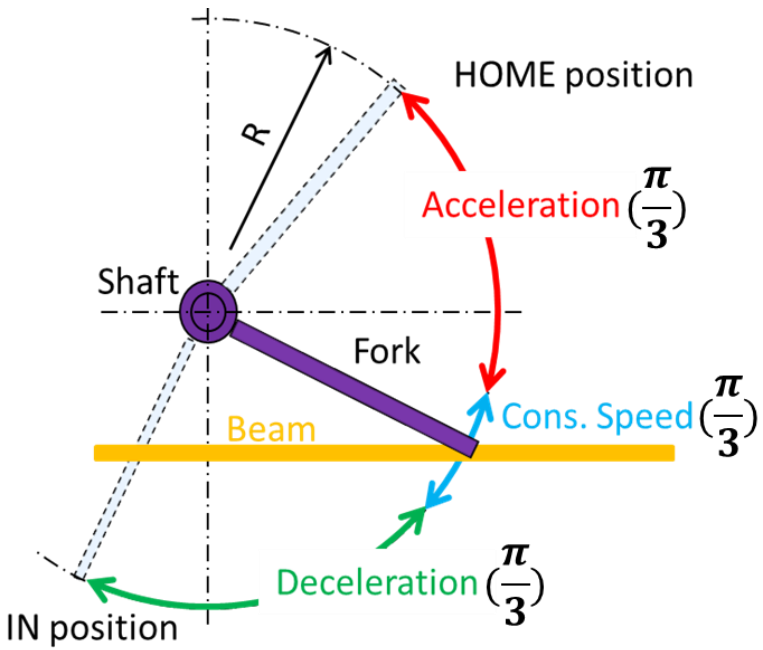
Thank you for your attention!

Questions?

…Discussion...

Extra slides

Torque required for acceleration of the wire scanner forks in order to achieve the velocity of 20 m/sec on the distance of 60° ($\frac{\pi}{3}$)



3 different lengths of the fork have been considered:

Option 1: **R1 = 182.5 mm**

Option 2: **R2 = 150.0 mm**

Option 3: **R3 = 100.0 mm**

Equations used for calculation:

$$\omega_f = \omega_i + \alpha t \qquad (1)$$

$$\theta = \omega_i t + \frac{1}{2}\alpha t^2 \qquad (2)$$

$$\omega_f^2 = \omega_i^2 + 2\alpha\theta \qquad (3)$$

$$\theta = \frac{1}{2}(\omega_f + \omega_i)t \qquad (4)$$

Angular speed and acceleration

	Length of the fork, m	Linear speed of the wire, m/s	Angular speed of the wire, rad/s	Acceleration (constant), rad/s^2	Peak acceleration (variable profile, k=1.85*), rad/s^2
Option 1 (R1)	0.182	20	110	5790	10711.5
Option 2 (R2)	0.150	20	133	8471	15671.4
Option 3 (R3)	0.100	20	200	19108	35350.0

** - the coefficient used for calculations of the peak acceleration by C. Grosjean*

Moment of inertia of the shaft and components installed on it (based on data from S. Samuelsson)

Component	J ($kg \times m^2$) for R1 (182.5 mm)	J ($kg \times m^2$) for R2 (150 mm)	J ($kg \times m^2$) for R3 (100 mm)
Bearing 1	1.96E-05	1.96E-05	1.96E-05
Bearing 2	2.45E-06	2.45E-06	2.45E-06
Disc	1.45E-04	1.45E-04	1.45E-04
Disc holder	2.01E-05	2.01E-05	2.01E-05
Fork with fixation ring and screws	**1.56E-04**	**9.03E-05**	**3.81E-05**
Fork with fixation ring and screws	**1.56E-04**	**9.03E-05**	**3.81E-05**
Resolver	4.00E-06	4.00E-06	4.00E-06
Magnetic lock	6.61E-05	6.61E-05	6.61E-05
Rotor	3.46E-04	3.46E-04	3.46E-04
Shaft	2.91E-04	2.91E-04	2.91E-04
Total (J_{total})	**1.21E-03**	**1.07E-03**	**9.70E-04**

Summary table of calculated data for torque and acceleration

	Length of the fork, m	Required torque, Nm	Peak acceleration*, rad/s^2
Option 1 (R1)	0.182	**12.96**	10711.5
Option 2 (R2)	0.150	**16.77**	15671.4
Option 3 (R3)	0.100	**34.31**	35350.0

** - calculated by multiplication of constant acceleration by k = 1.85*