Collimator Design Meetings

Minutes of the meeting 74 (13/10/2005)

Present: O. Aberle, R. Losito, R. Perret, R. Chamizo, P. Gander, A. Masi, M.Mayer
Excused: Bertarelli, R. Assmann, Y. Kadi

MOTORS
Measurements of couple
A. Masi gave presentation concerning the measurements carried out with prototype motors and ex-LEP motors. See PresentationSteppingMotors(Masi051013).pdf
In conclusions, it was remarked that the motors, foreseen at the moment for the LHC installation, deliver only about ½ the couple which is indicated by the manufacturer as nominal. (i.e. 1.6 Nm [IN] and 1.4 Nm [OUT] instead of the 3.5 Nm). This seems to be the case for the LEP motors as well.

Is this enough for the required movement for the metal vertical jaws ?

The various tests and measurements on the prototype revealed a misalignment of the spindle to the motor, this influences strongly the ability of the automatic retrieval system, which does not function correctly in one case – even without the motor. Furthermore, it seams that the screw is under compressions at the present measurements – whereas in reality it is constantly under traction, which is more favorable and results in less friction.

WATER COOLING AND BAKEOUT

- Before the series connectors-plug-ins can be ordered, a test on #3 collimator with the 2 prototype couplings should be carried out. (Action Rocio urgent)
- The final drawings from Staubli will be requested -in parallel (Action Roger).

BAKE-OUT TEST FOR THE PROPOSED PROCEDURE

- It was proposed to carry out a heating test @300°C with Δp pressure of 15 bar in the circuit. This corresponds to the situation which we will have to expect in the tunnel. This test can be done with normal water. Ma. Proposed to copy the central heating of a house with a sufficiently large expansion tank and a safety valve adjusted at 15 bar. This is becoming **urgent**, as the whole bake-out philosophy depends on the success of this test and evacuation of the steam which will form under high temperature. (Action Oliver, Rocio). *After the meeting: the pressure was reduced to 6 bar = return pressure in the tunnel.*

Due to various absences, no information could be obtained for the following items:

- **TCDIM,** dates (after the meeting the installation dates were confirmed by Yacine (May/June 2006 for TI8 and Jan/Feb 2007 for TI2)
- **TCHS** (technical spec.) dates for ordering/installation
- **TCLAP** dates for ordering/installation
- WP document for phase 2 comments ? Ralph

2in1 collimators progress
Several studies were carried out for the 2in1 cases and sent to B. Goddard, who will study and discuss the next steps with Verena Kain and Ralph. Roger will have to wait for input from AB.

and our
ACTION LIST to be followed up:

Play between motor spindle and jaw to be checked on #3	#34 Rocio, Roger
New Fluka simulation for 7TeV accident case	#47 Vasilis
Installation of collimators and required “tooling” transport	#56 Keith

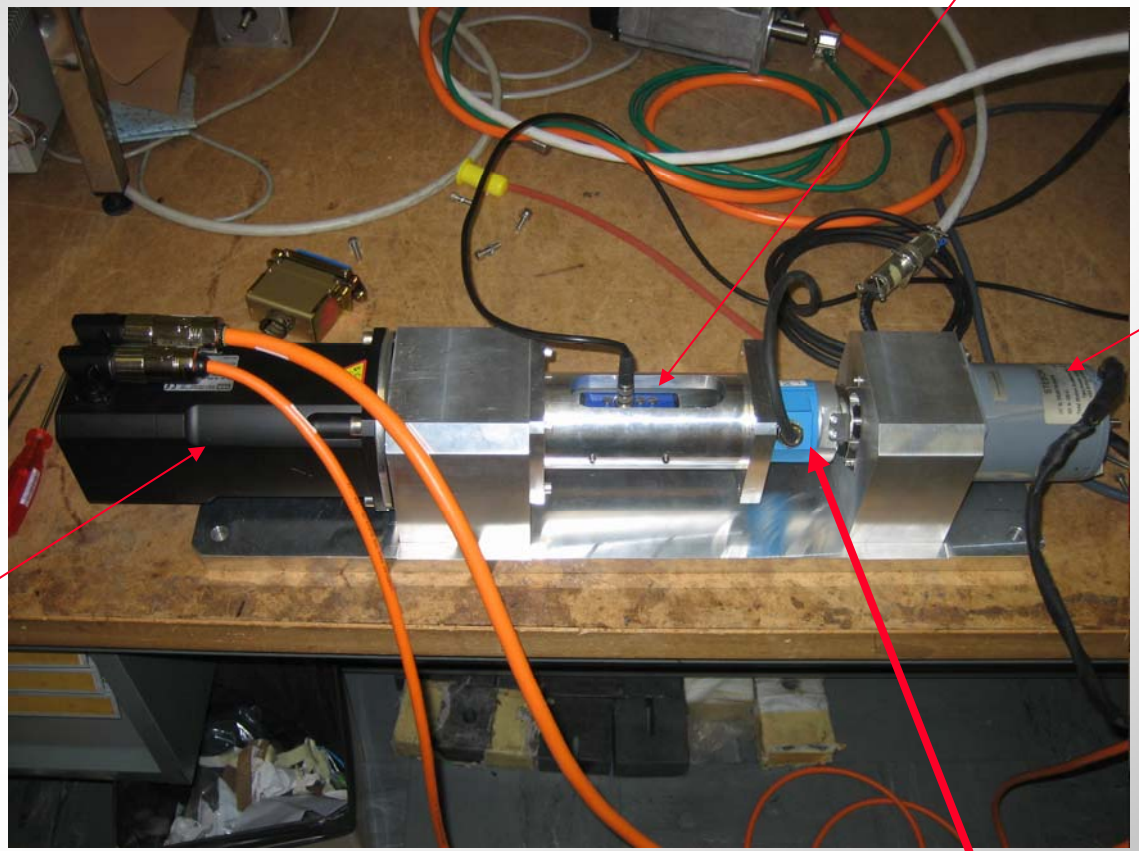
Manfred

Collimators stepping motors: Preliminary measurements

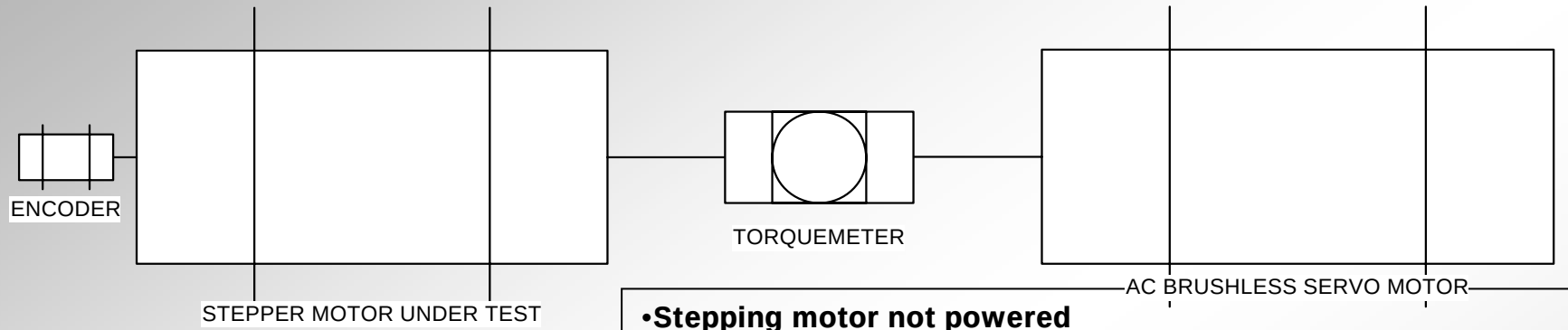
A. Masi

Contents

Stepping motors test bench solution 2



Parameters measured



Static Parameters

- **Detent torque:**

  - **Stepping motor not powered**
  - **Brushless AC motor turn at 0.1 rpm (works like motor)**
  - **torquemeter output is acquired over 1 turn and synchronised with the encoder**

- **Holding torque:**

  - **MUT powered on**
  - **Brushless AC motor turn at 1 rpm (works like motor). Its torque is changed till the stepping motor looses steps**
  - **torquemeter output is acquired for 2 s and the detent torque corresponds to the last torque acquired before loosing steps**

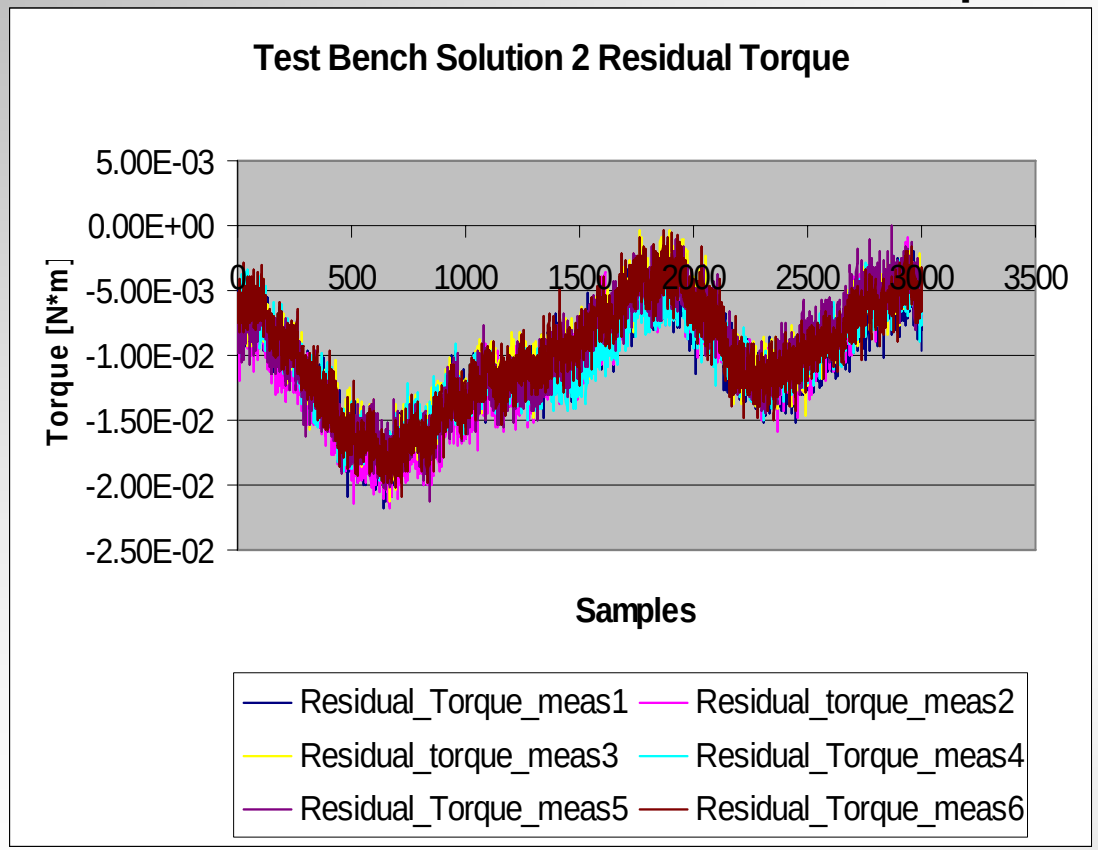
Dynamic Parameters

- **Pull-in/Pull-out torque:**

  - **MUT powered on**
  - **The brushless AC motor is controlled in torque (works like a brake)**
  - **On the MUT a specific frequency (speed) is tested**
  - **Pull-in: The Brushless torque is decreased until the MUT starts (checked with the encoder)**
  - **Pull-out: the torque of the brushless is raised till the stepper looses steps**

Test Bench Calibration

The residual torque over a complete turn has to be subtracted to the stepping motor detent torque measurement



Torquemeter Technical Characteristics:

- **Non linearity Error + Hysteresis:** <1%
- **Sensor Repeatability:** <0.1%

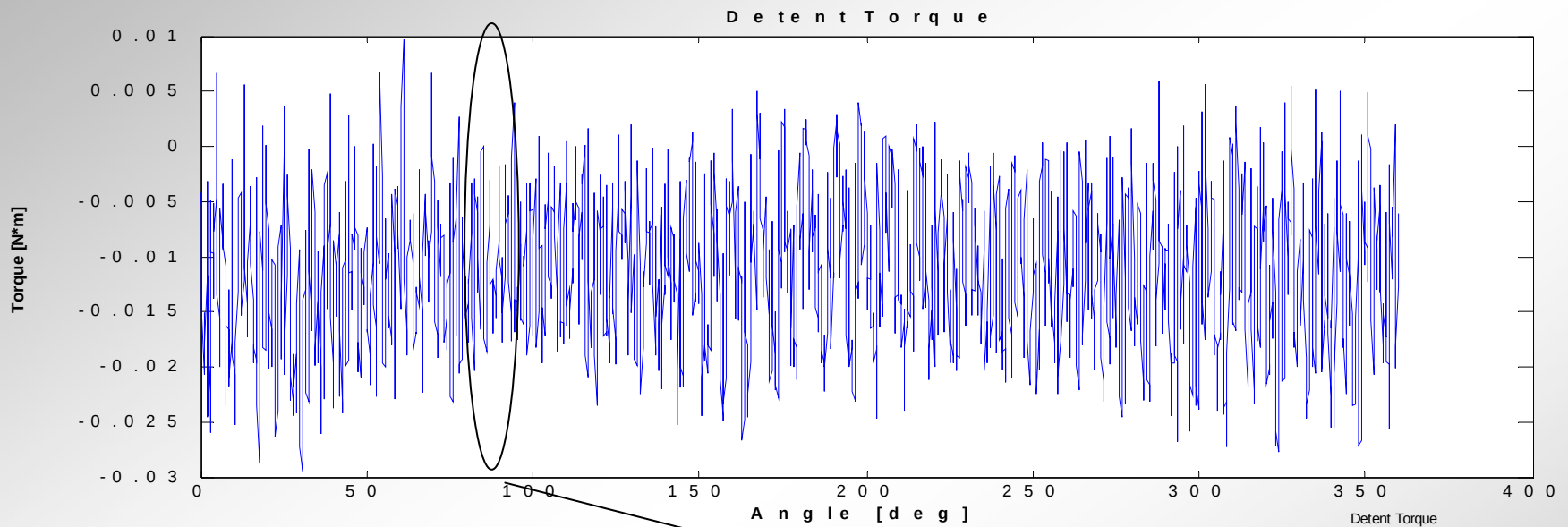
Improvements applied:

- Use of sensor calibration curve (10 points)
- 100 oversampling factor in the torque acquisition

Performances reached:

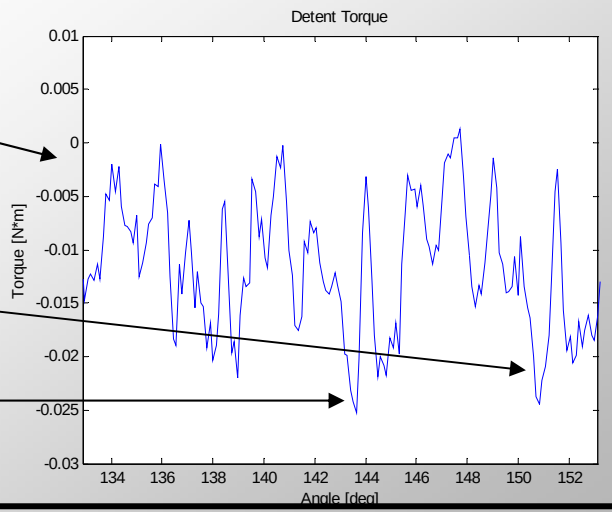
- **repeatability** : less than 1 mN*m
- **Sensitivity:** 5 mN*m
- **non-linearity :** In the range 0-200 mN*m the error is lowered to less than 0.1 %
- **Overall accuracy**: 5 mN*m on the detent torque

Detent Torque
Motor LEP 1 (S03362 - 1/19)



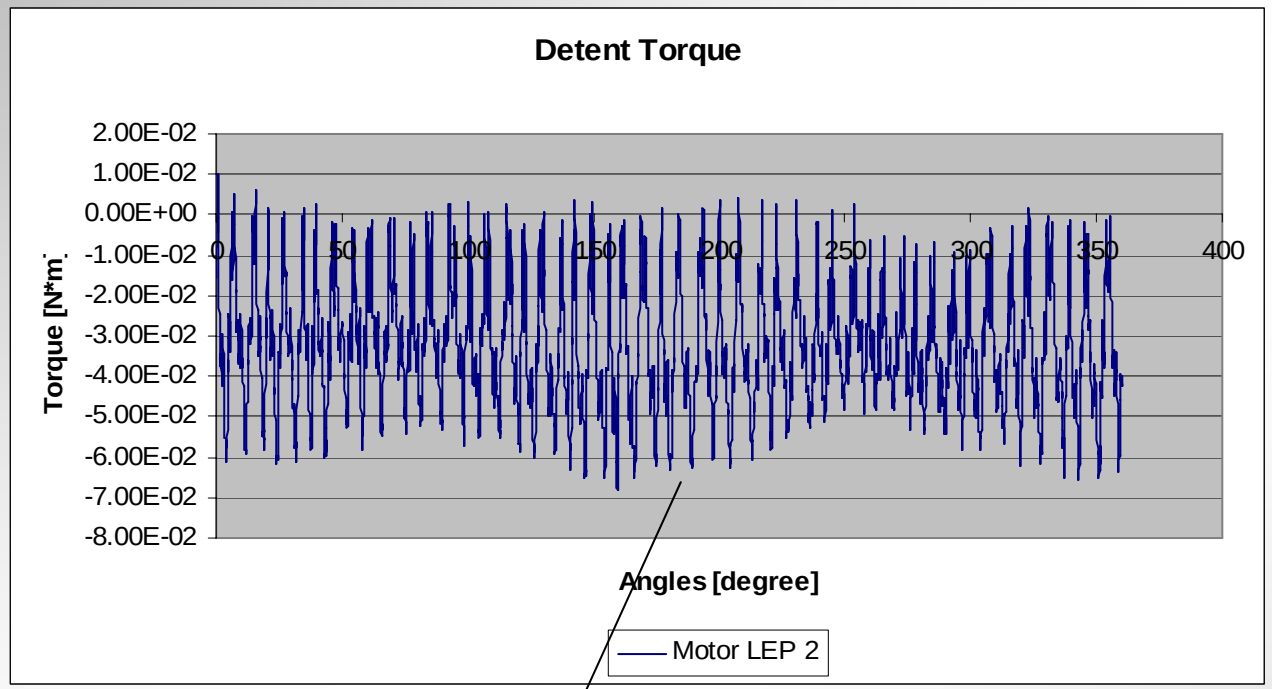
The max detent torque is 30 mN*m

Two consecutive magnetic poles equispaced of 7.2 degree (the rotor contains 50 magnetic poles)



Detent Torque

Motor LEP2 (D8L851-N1510 no …-1/3)

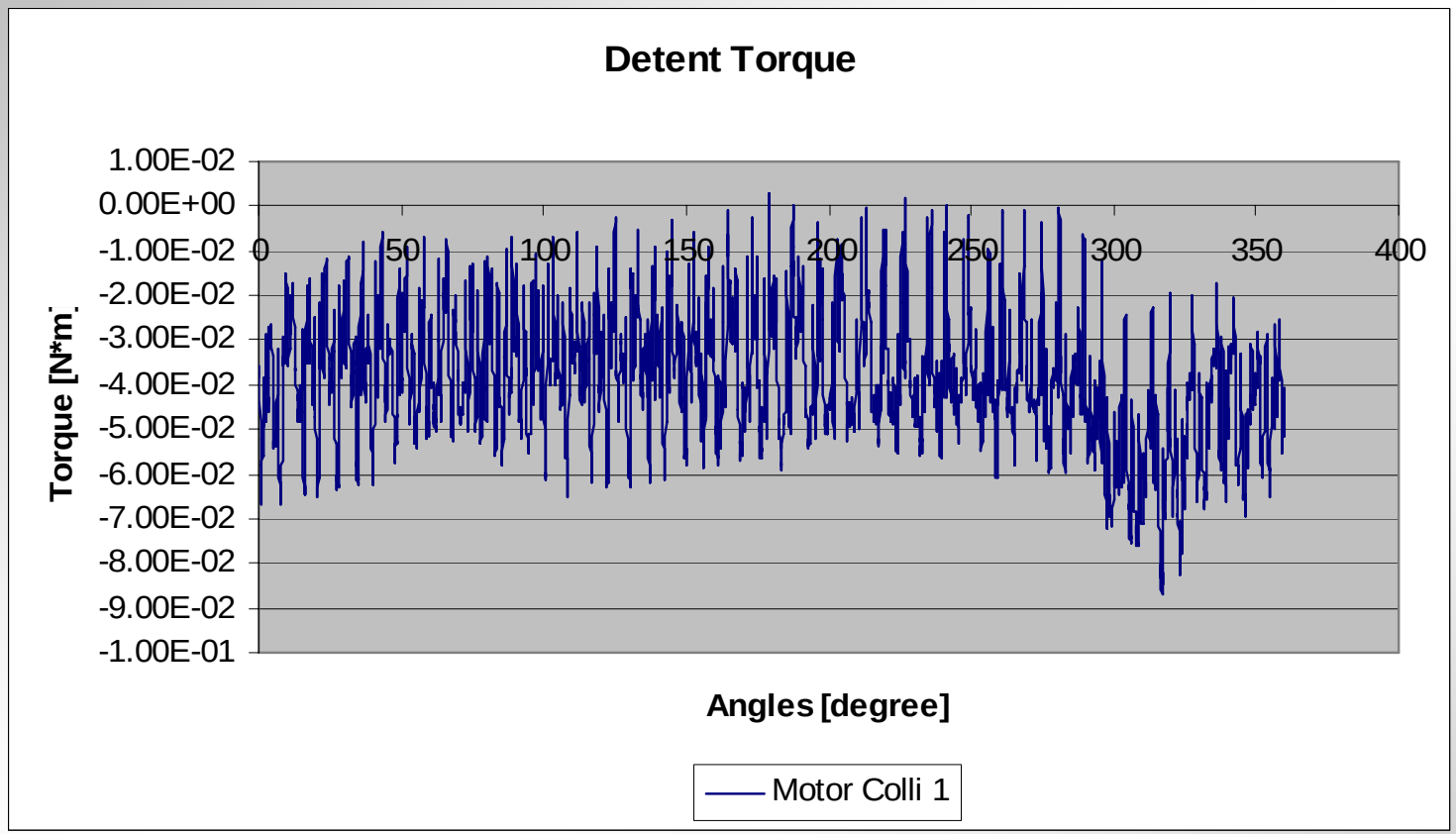


- Acquisition carried out over a complete revolution
- Test speed 0.1 rpm
- Sampling frequency torquemeter: 5 KS/s
- Acquisition decimation factor:100

For this motor (more radioactive than the other one) the max detent torque is 60 mN*m

Detent Torque

Motor 1 Colli 3nd Proto (SD8L851-740-39N2166 10341-01/4)

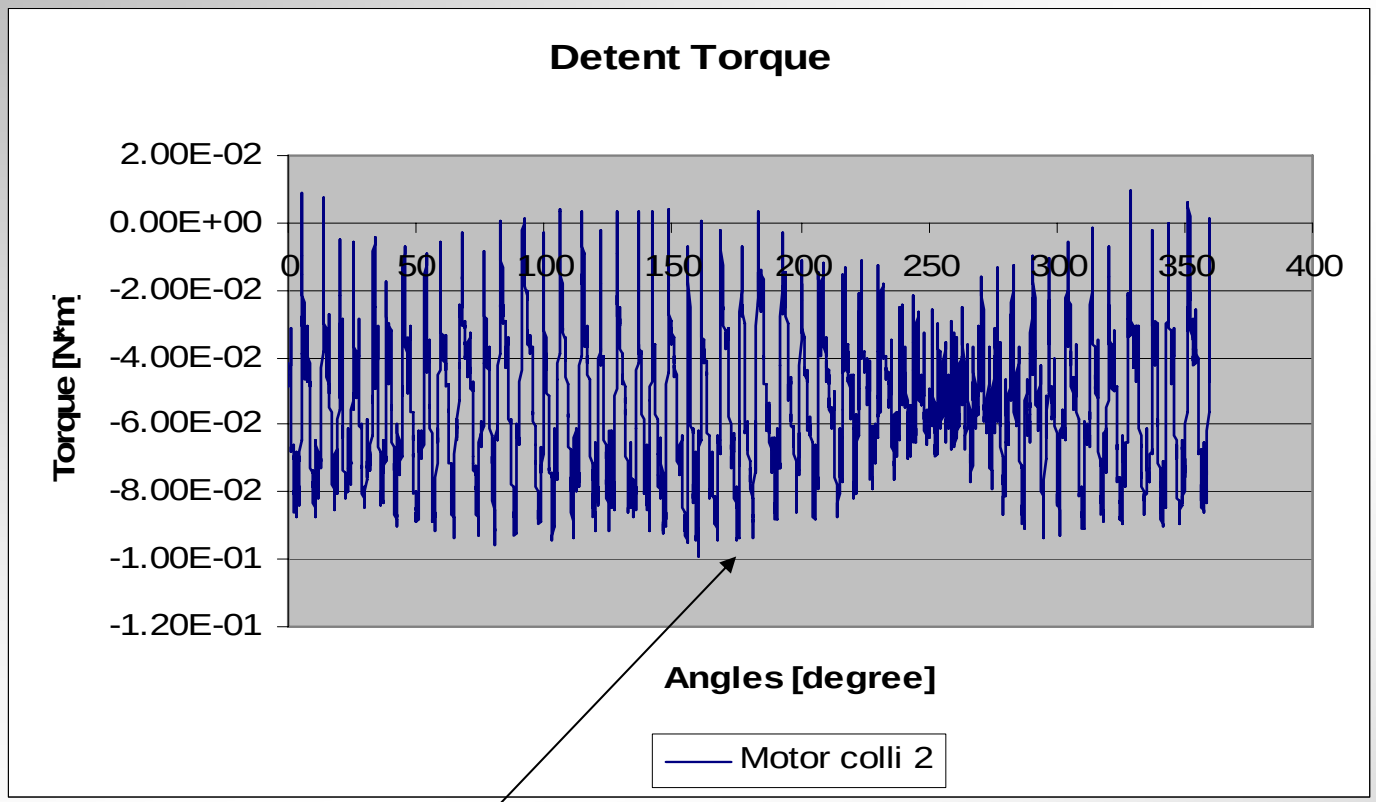


The detent torque is in agreement with the motor technical data (detent torque 80 mN*m)

Max Detent Torque=75 mN*m

Detent Torque

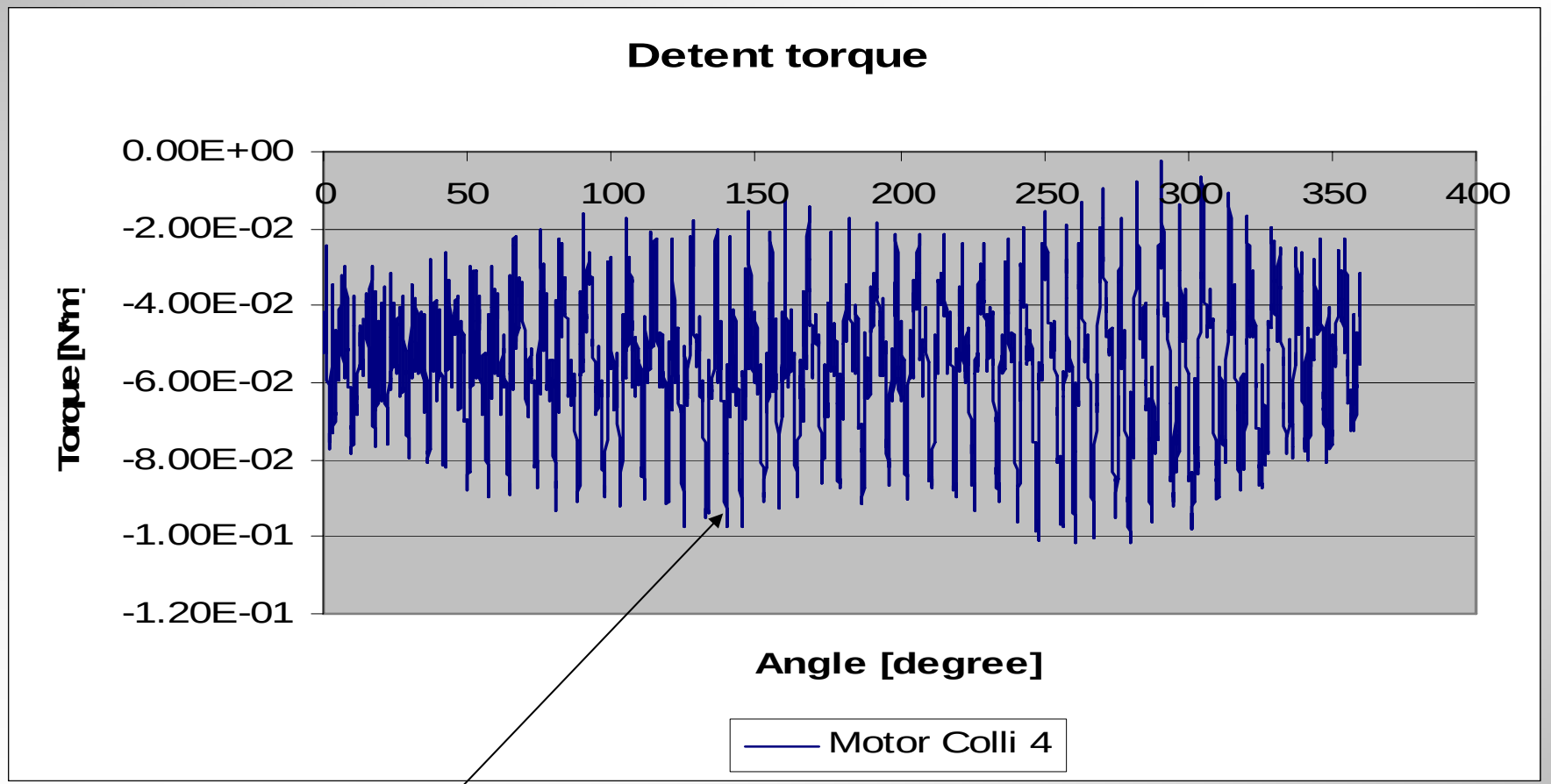
Motor 2 Colli 3nd Proto (SD8L852-740-39-N10287-01/2)



The detent torque is in agreement with the motor technical data (detent torque 80 mN*m)

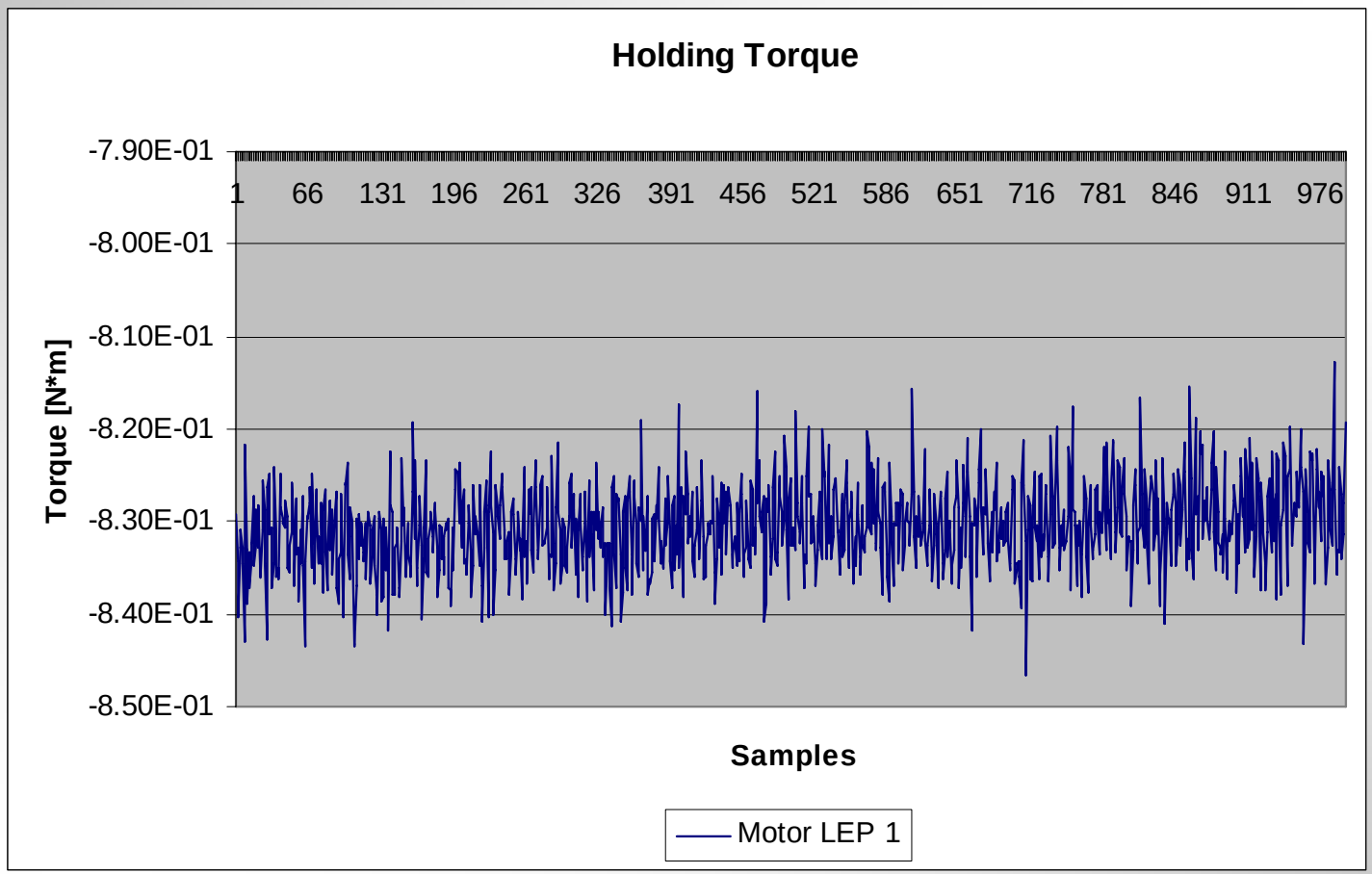
The detent torque is maximum under a magnetic pole: our motors have 50 poles on the rotor- Max value 90 mN*m

Detent Torque
Motor 4 Colli 3nd Proto



The detent torque is maximum under a magnetic pole: our motors have 50 poles on the rotor- Max value 90 mN*m

Holding Torque (1 Phases on)
Motor LEP 1 (S03362 - 1/19)

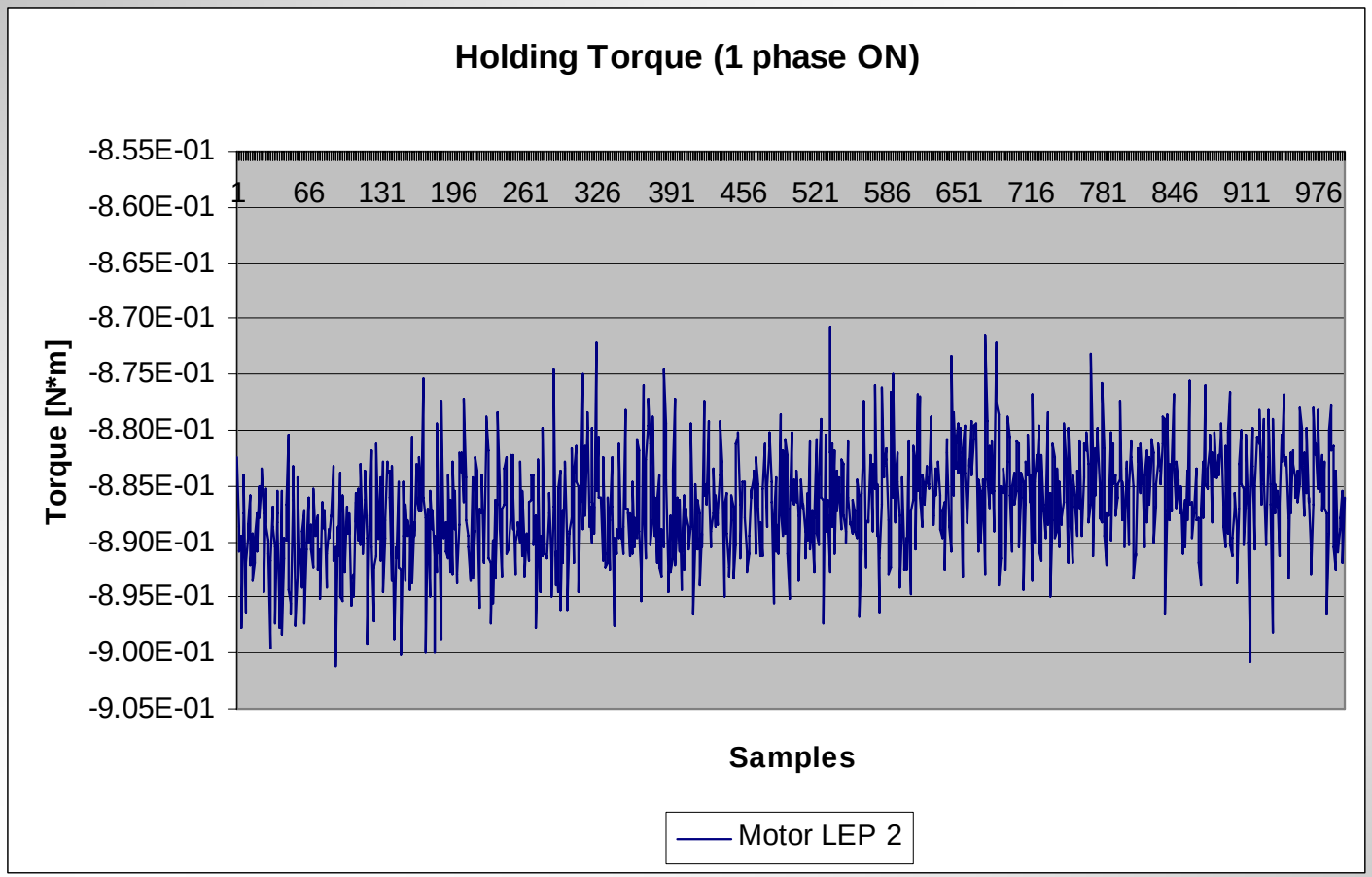


- **Time span: 2 s**

The Motor is powered at the same current value used for the test at TT40: 1.4 A (the motor nominal current is 1.2 A)

Holding Torque (1 Phase ON)

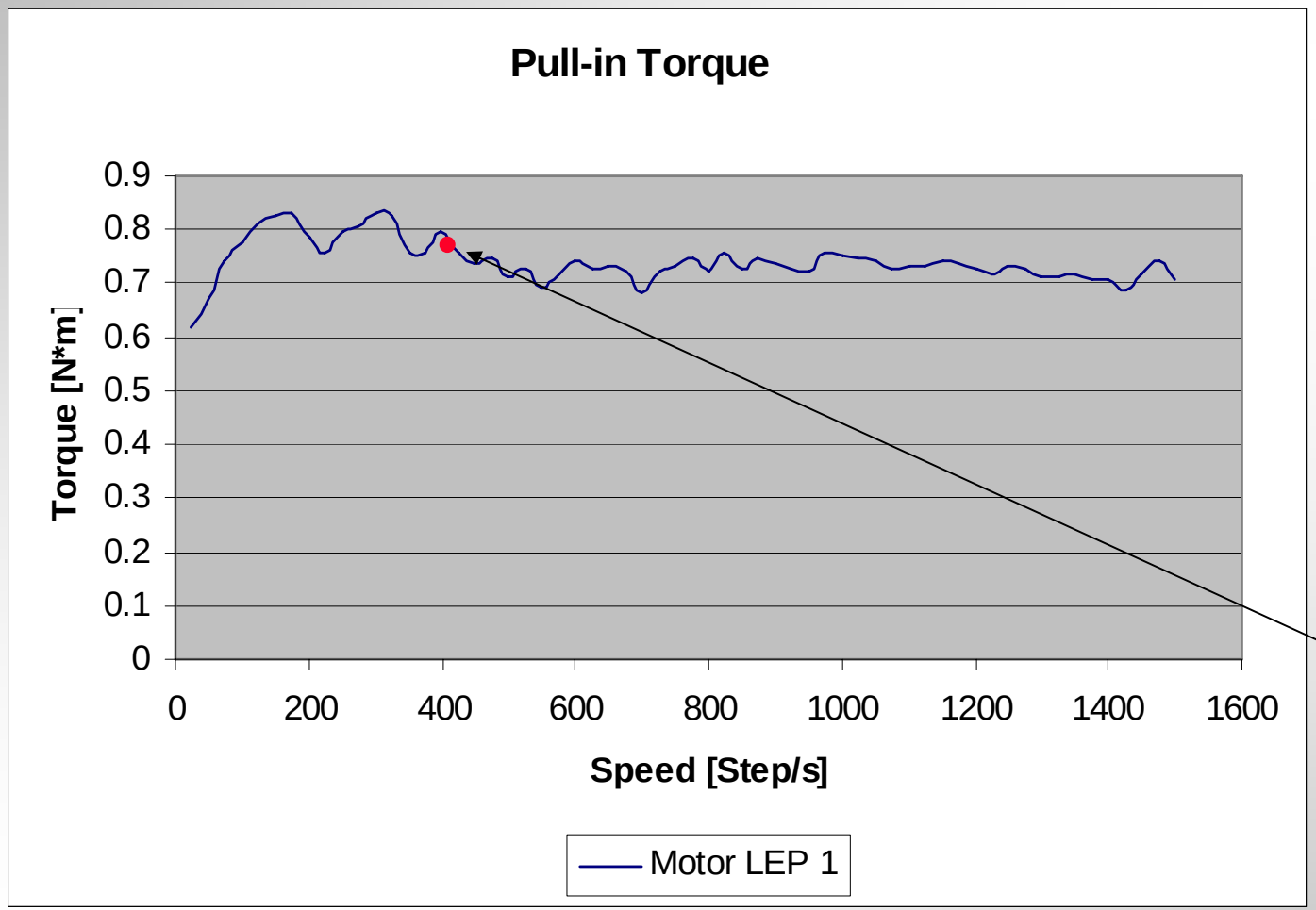
Motor LEP2 D8L851-N1510 no …-1/3



- **Time span: 2 s**

The Motor is powered at the same current value used for the test at TT40: 1.4 A (the motor nominal current is 1.2 A)

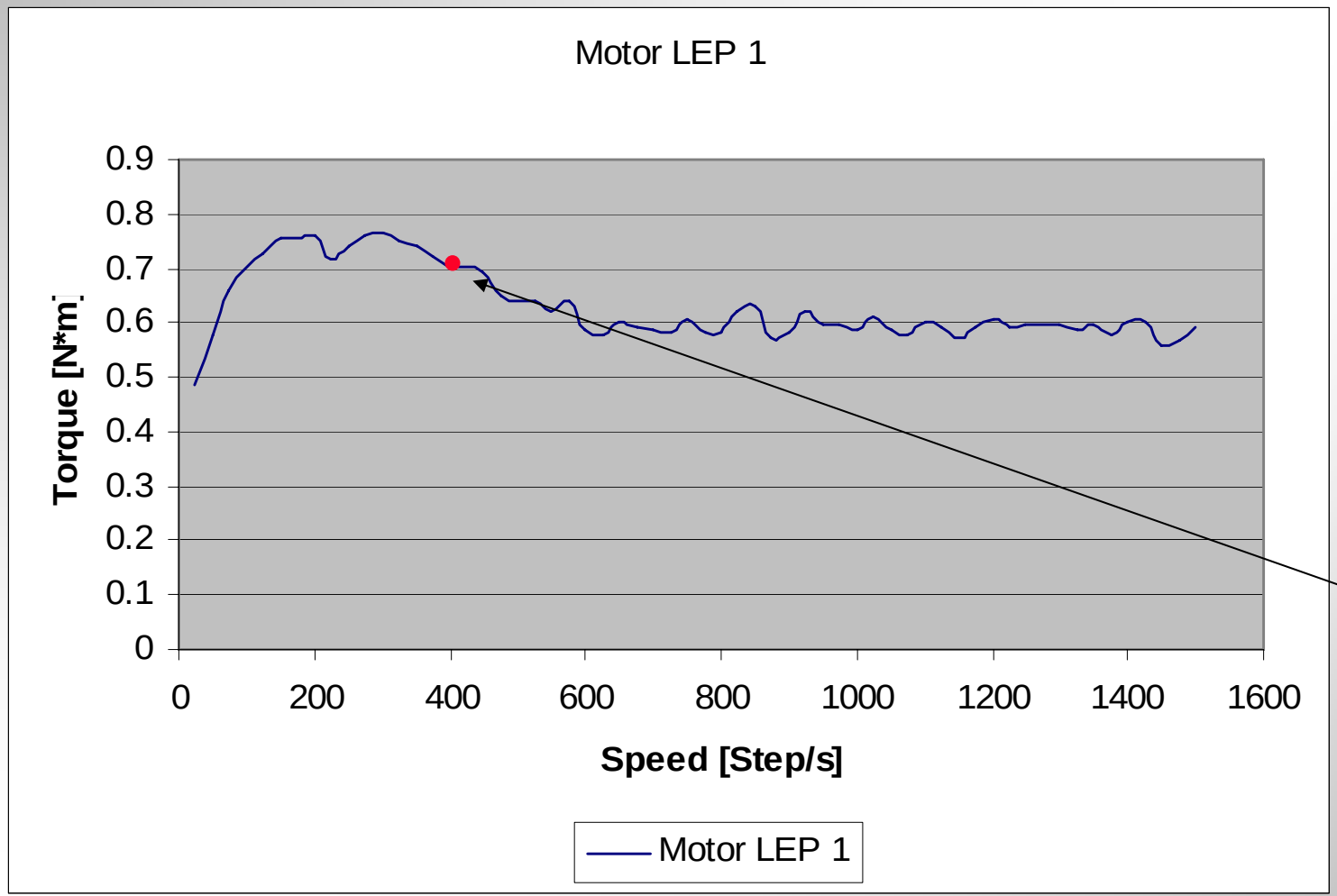
Pull-in
Motor LEP 1 (S03362 - 1/19)



The Motor is powered at the same current value used for the test at TT40: 1.4 A (the motor nominal current is 1.2 A)

At the collimator nominal speed (400 step/s) the dynamic torque is less than 0.8 N*m

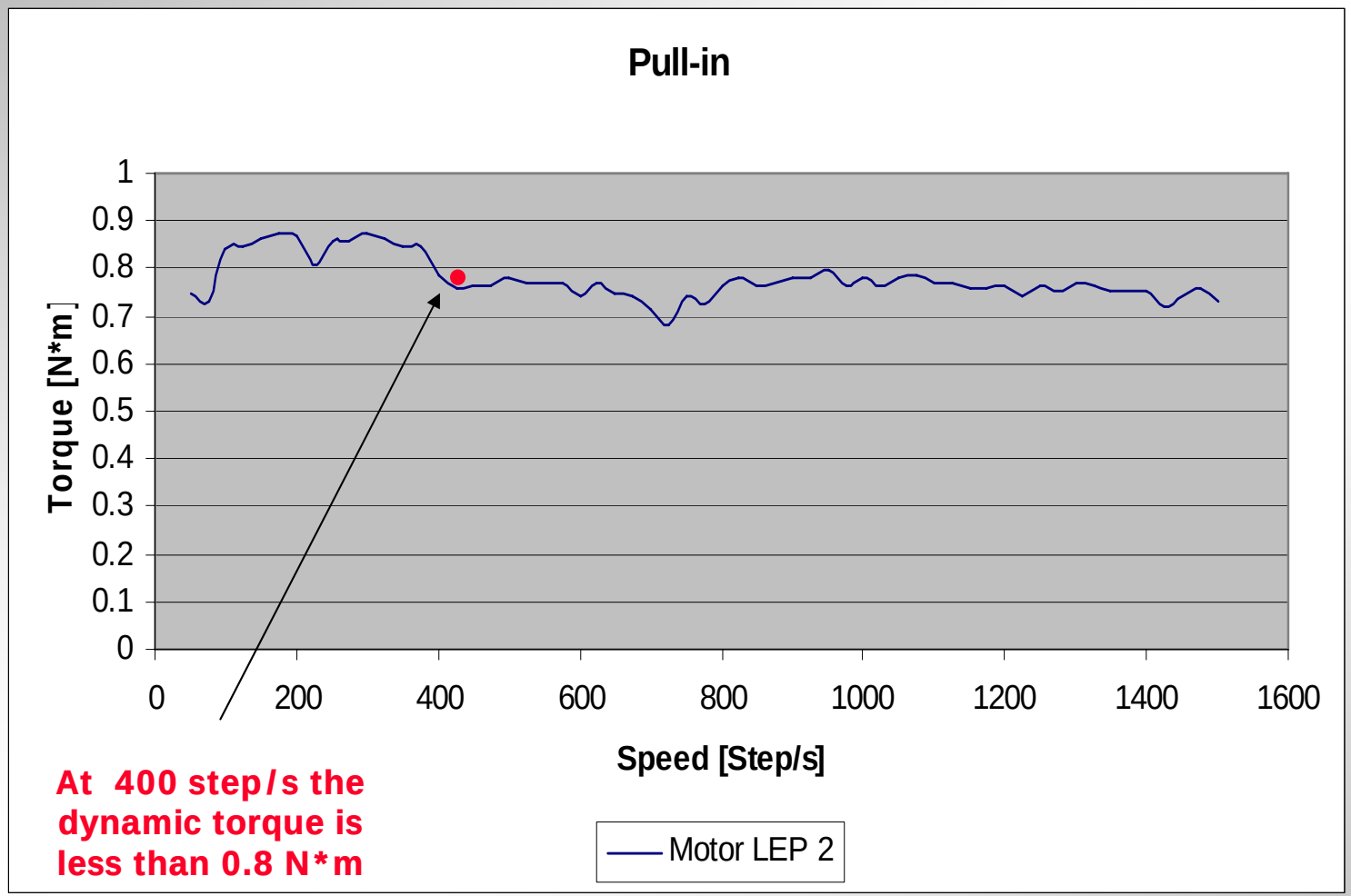
Pull-out
Motor LEP 2 (S03362 - 1/19)



Pull-out torque at 400 step/s around 0.7 N*m

Pull-in

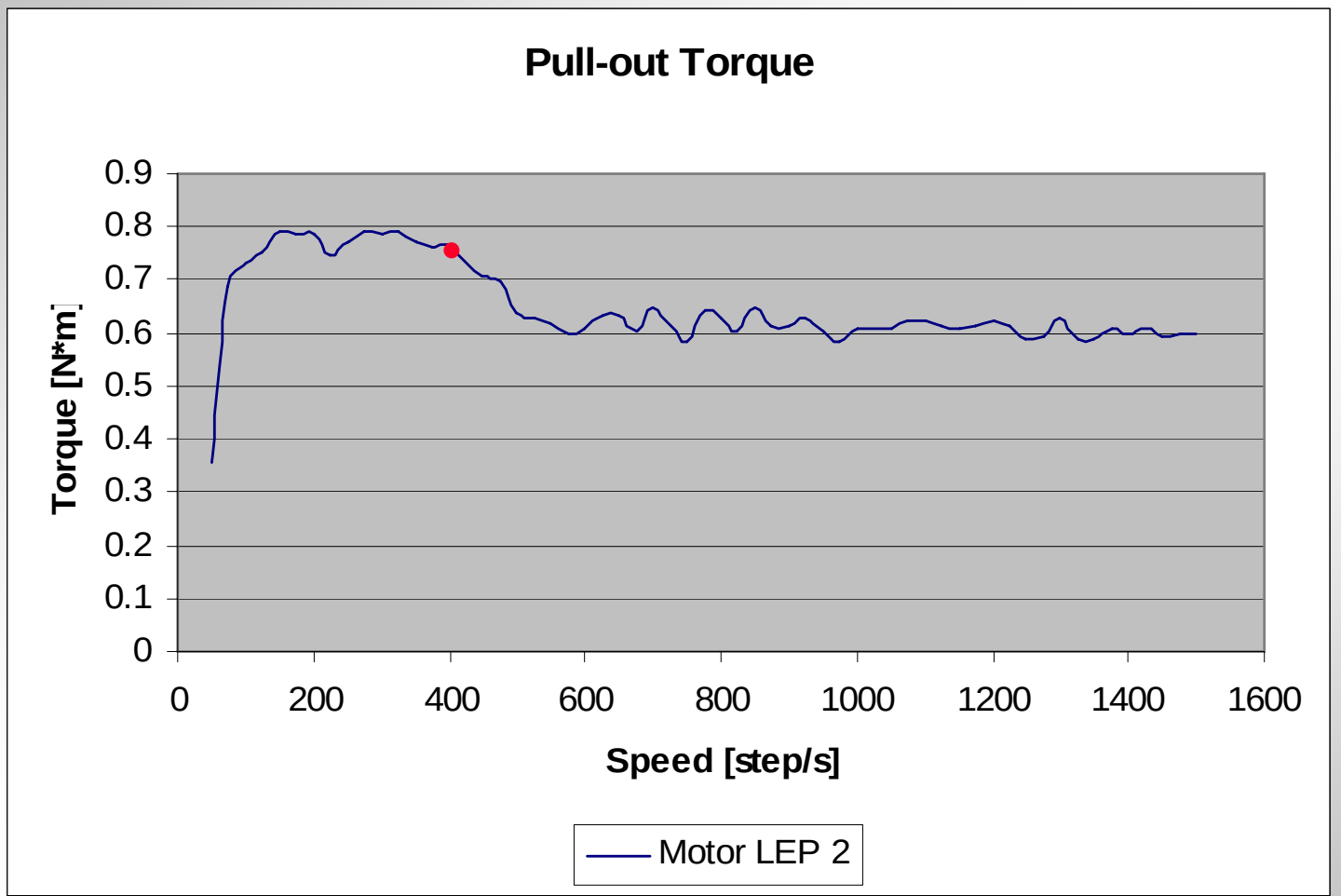
Motor LEP2 D8L851-N1510 no …-1/3



At 400 step/s the dynamic torque is less than 0.8 N*m

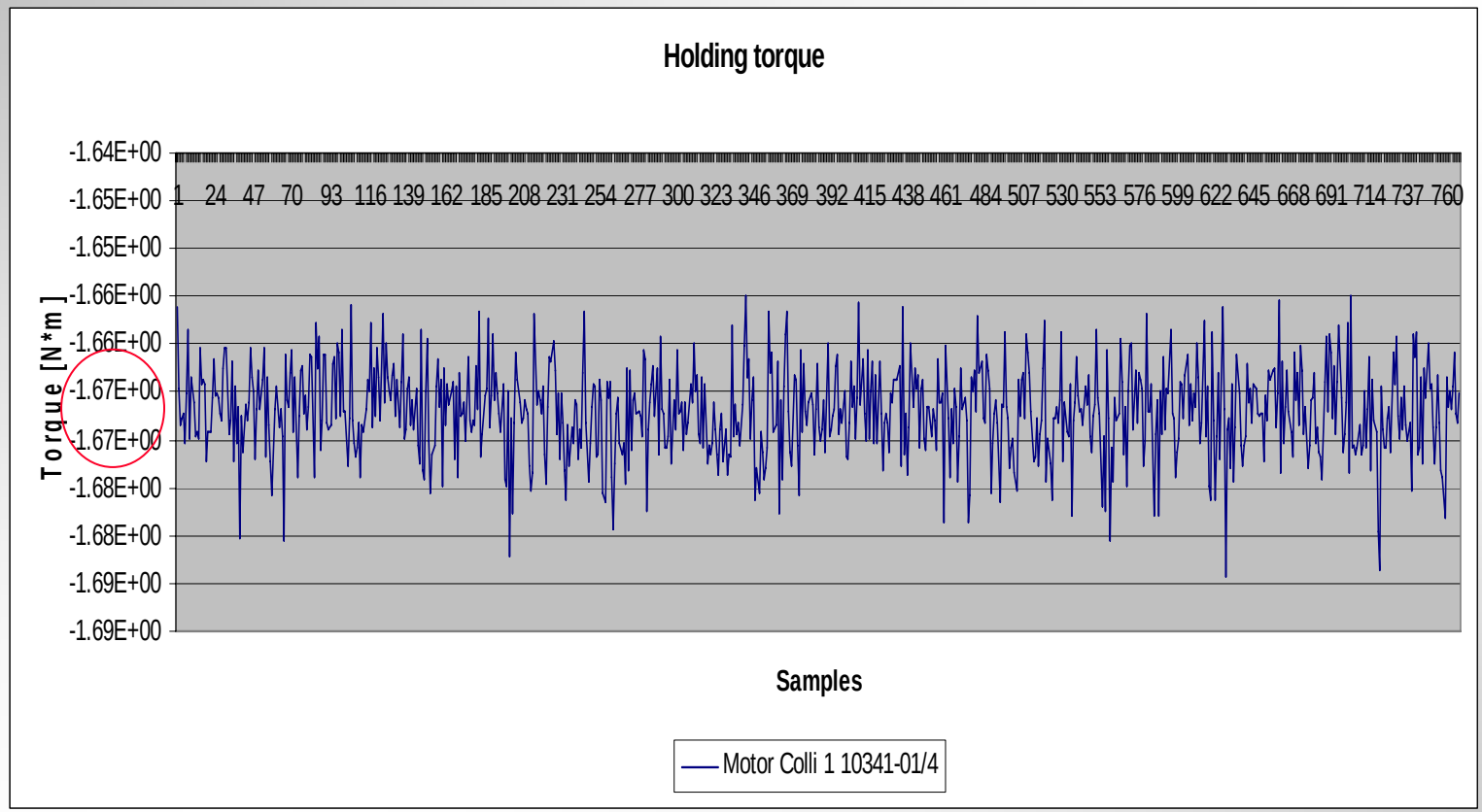
Pull-out

Motor LEP2 D8L851-N1510 no …-1/3



Holding Torque 1 Phase ON

Motor 1 Colli 3nd Proto (SD8L851-740-39N2166 10341-01/4)

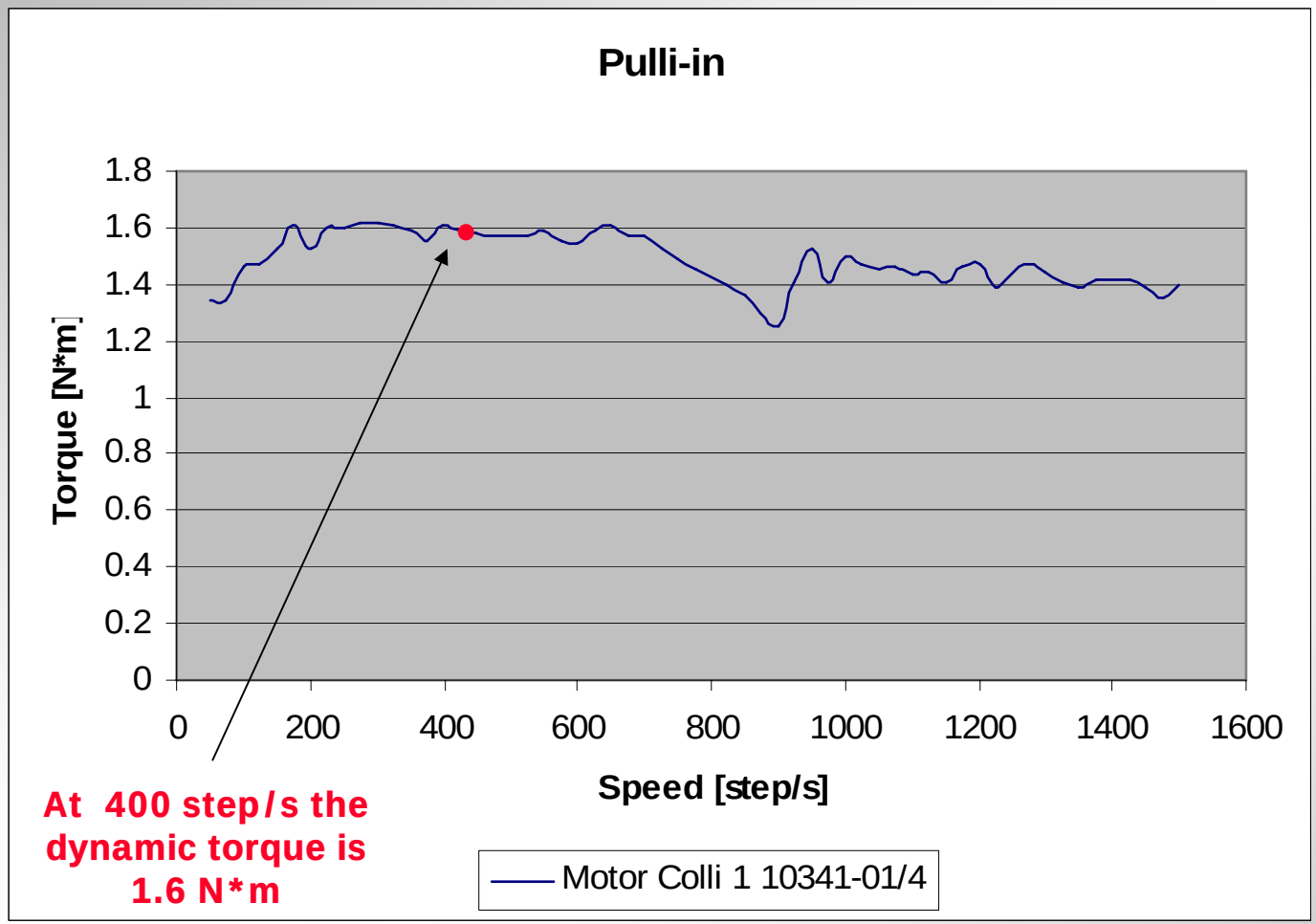


- **Acquisition time: 2 s**
- **Sampling frequency torquemeter: 5 KS/s**
- **Acquisition decimation factor:1**

Motor phases current: 2 A

Pull-in

Motor 1 Colli 3nd Proto (SD8L851-740-39N2166 10341-01/4)

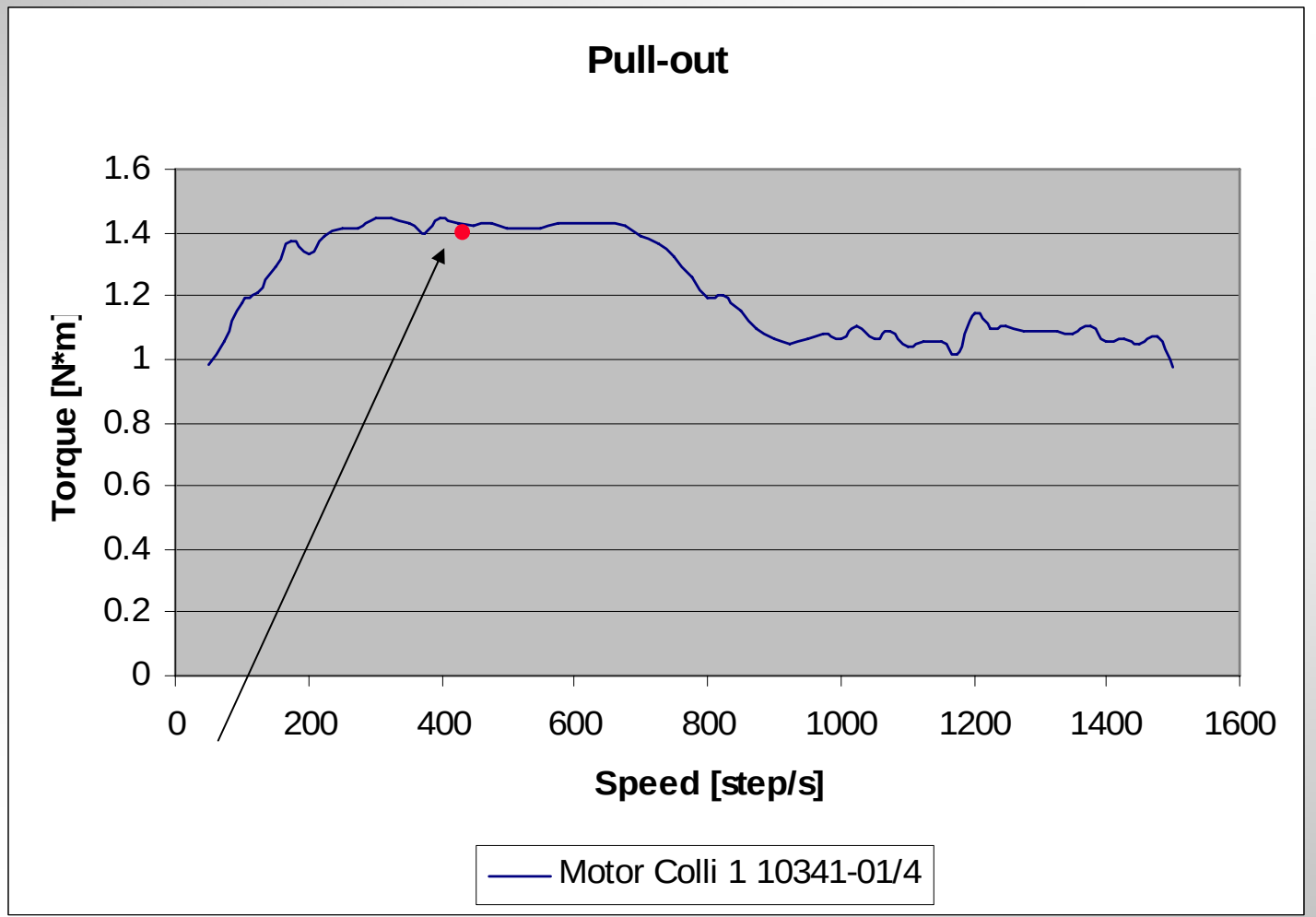


At 400 step/s the dynamic torque is 1.6 N*m

Motor phases current: 2 A

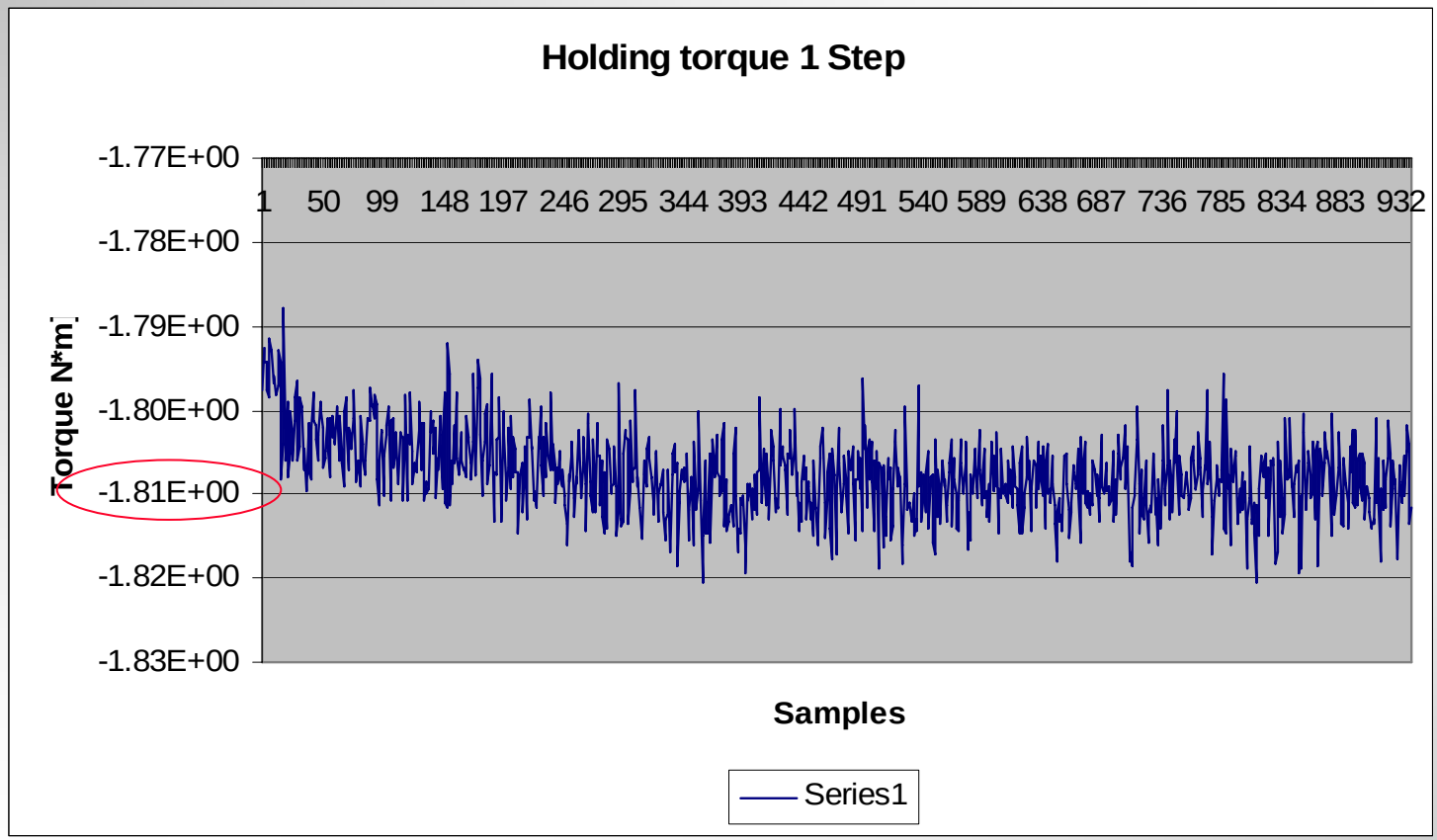
Pull-out

Motor 1 Colli 3nd Proto (SD8L851-740-39N2166 10341-01/4)



Motor phases current: 2 A

Holding Torque (1 Phase ON)
Motor 2 Colli 3nd Proto (SD8L852-740-39-N10287-01/2)

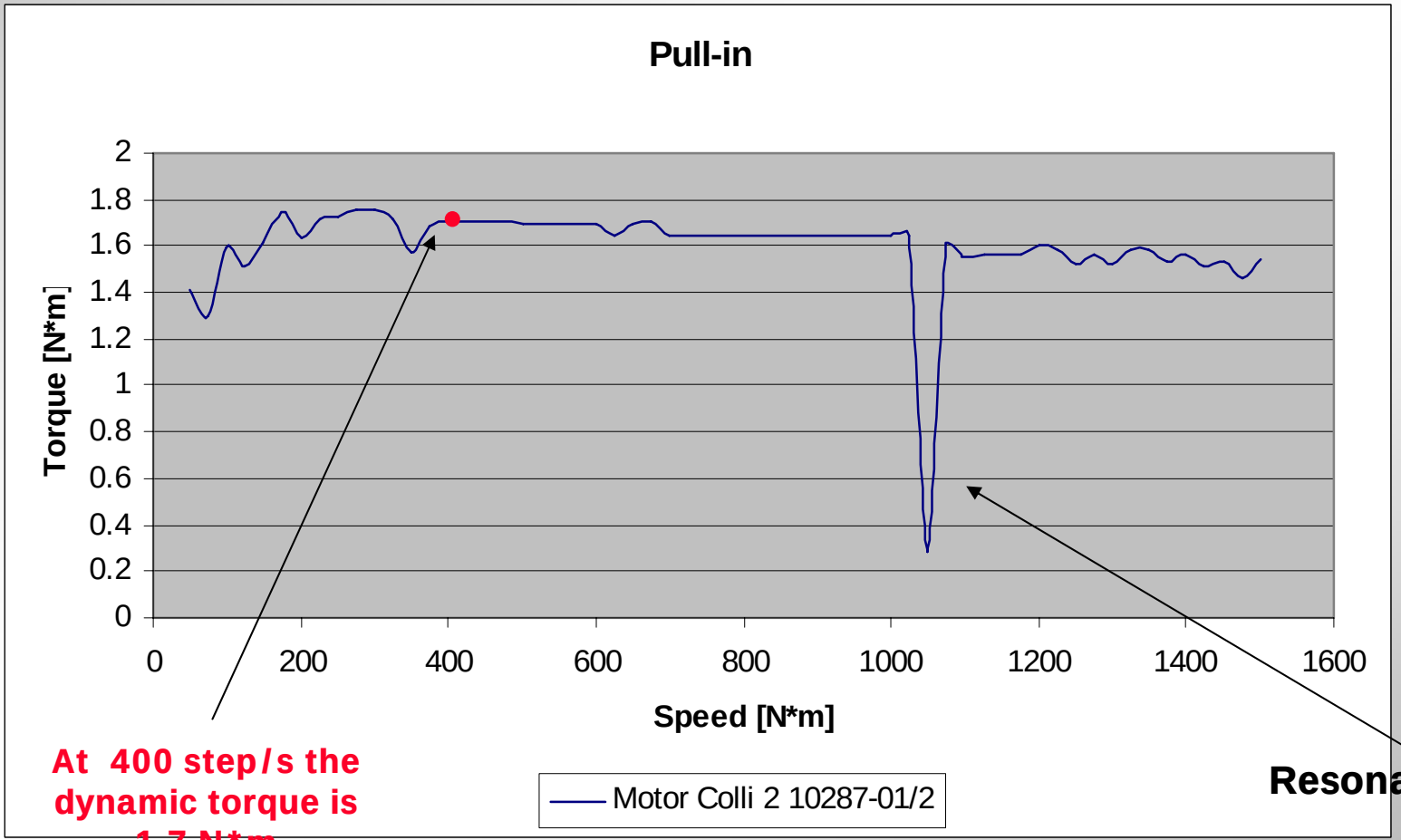


- **Acquisition time: 2 s**
- **Sampling frequency torquemeter: 5 KS/s**
- **Acquisition decimation factor:1**

Motor phases current: 2 A

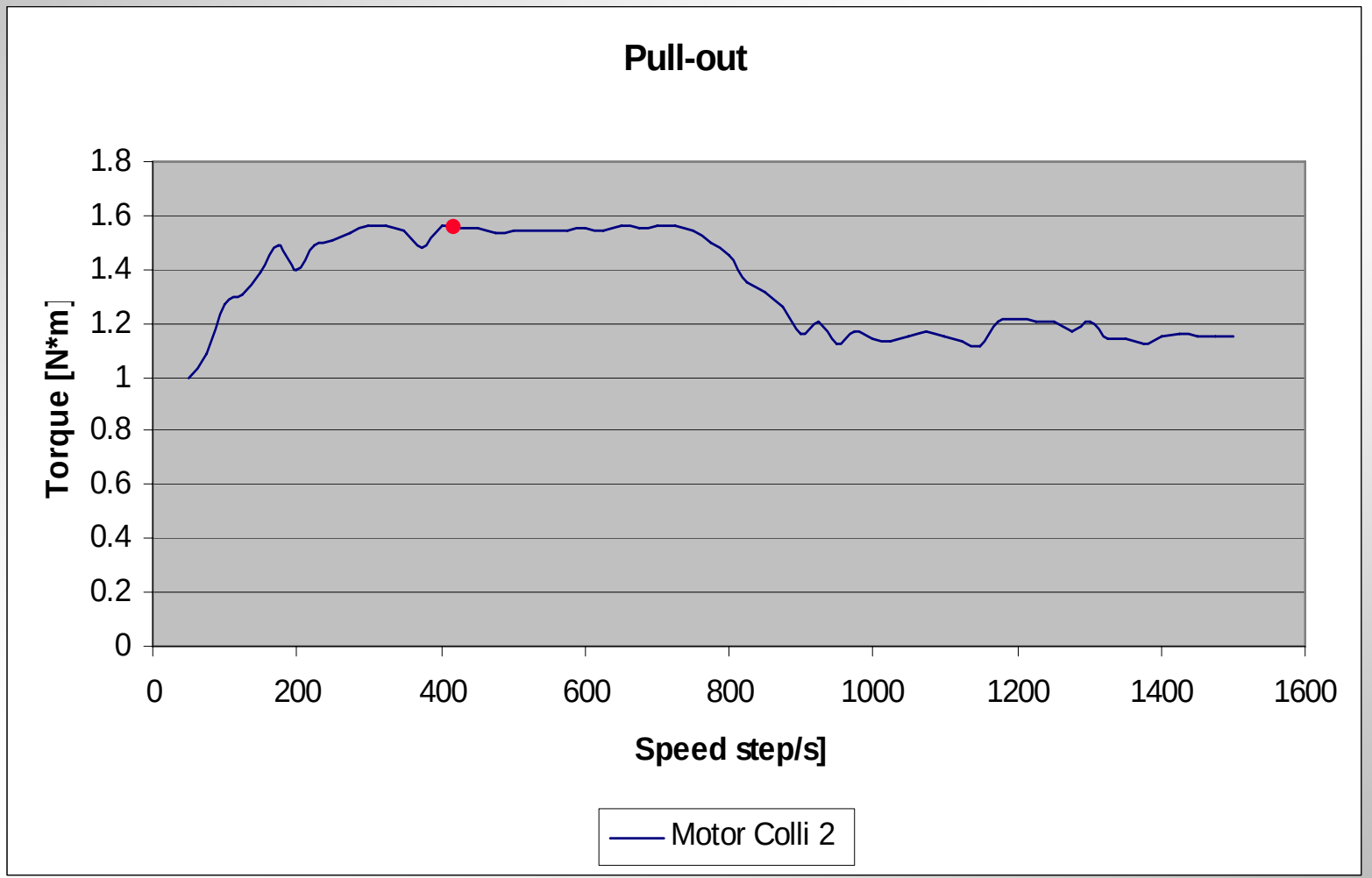
Pull-in

Motor 2 Colli 3nd Proto (SD8L852-740-39-N10287-01/2)



Pull-out

Motor 2 Colli 3nd Proto (SD8L852-740-39-N10287-01/2)



Conclusions

- The test bench solution 2 is now full operational and successfully working
- For accurate detent torque measurements an automatic calibration has been implemented in order to compensate the residual test bench torque
- The two old LEP motors used to move the upper jaw of the third collimator prototype as well as the Torque of new Stebon motors was measured. Even if the motors satisfy the detent torque spec. differences between motors of the same type up to 20-30 mN*m were measured
- At 400 Step/s the old LEP motors supplied in the same conditions of the TT40 tests have showed a dynamic torque less than 0.8 N*m

Conclusions

- A huge difference has been found between rated Torque and measured Torque. After discussions with several producers, this does not seem unusual.

Motor	Rated Torque	Measured torque
LEP collimators	1.5 Nm	0.7÷0.8 Nm
LHC prototype	3.5 Nm	~1.6 Nm

Acknowledgements

Many thanks for the support to:

- Giovanni
- Fabrice
- Patrice
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- Fredric
- Oliver
- Rocio
- Roberto