

IMMW12 Grenoble Oct 2001

Final Version of Magnetic axis measurement device in Industry

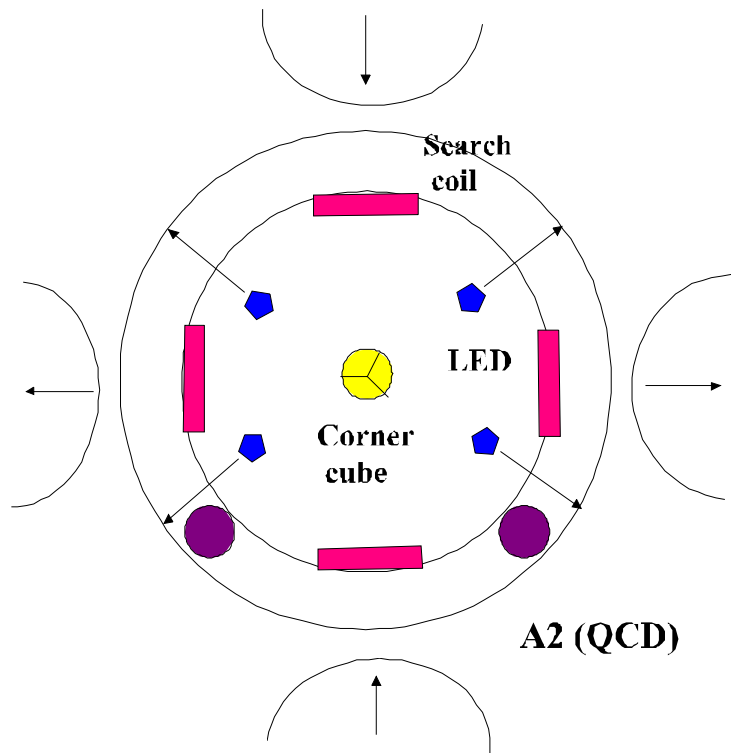
Aznar S., Billan J., Fischer F., Galbraith P., Garcia-Perez J.,
Goy S., Mermillod N., Peiro G., Patti G., Rathjen C.
CERN

Overview

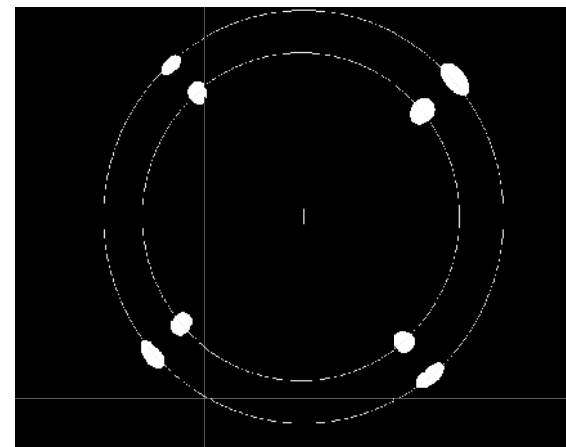
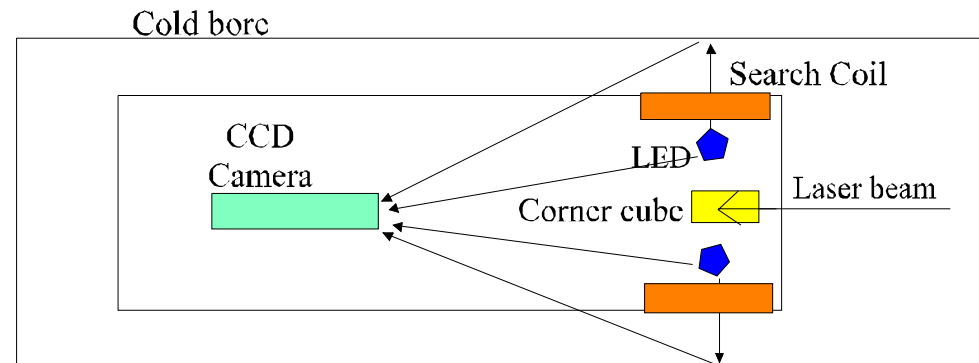
- Measurement Principle
- Instruments + LTD
- Mole positioning system & measurement
- Mechanical and Magnetic axis measurement
- Calibration system & method
- Optical mole Performance
- Axis measurements performance
- Results from prototypes and preseries
- Conclusions

Measurement principle

- Measure the offset between cold bore tube axis (geometry for assembling) and magnet axis (QCD for dipole)
 - LTD retroreflector for X,Y, Z in space (Leica measurement) => **cold bore axis**
 - 4 * 100 mm fixed tangential coils => local magnetic offset w.r.t. old bore axis
 - 0.5 Amps AC current at 25 Hz for synchronous detection of induced current
 - Cold bore position w.r.t. mole: mechanical autocentring or LED's measure (cold bore diameter and its centre)



Grenoble IMMW12

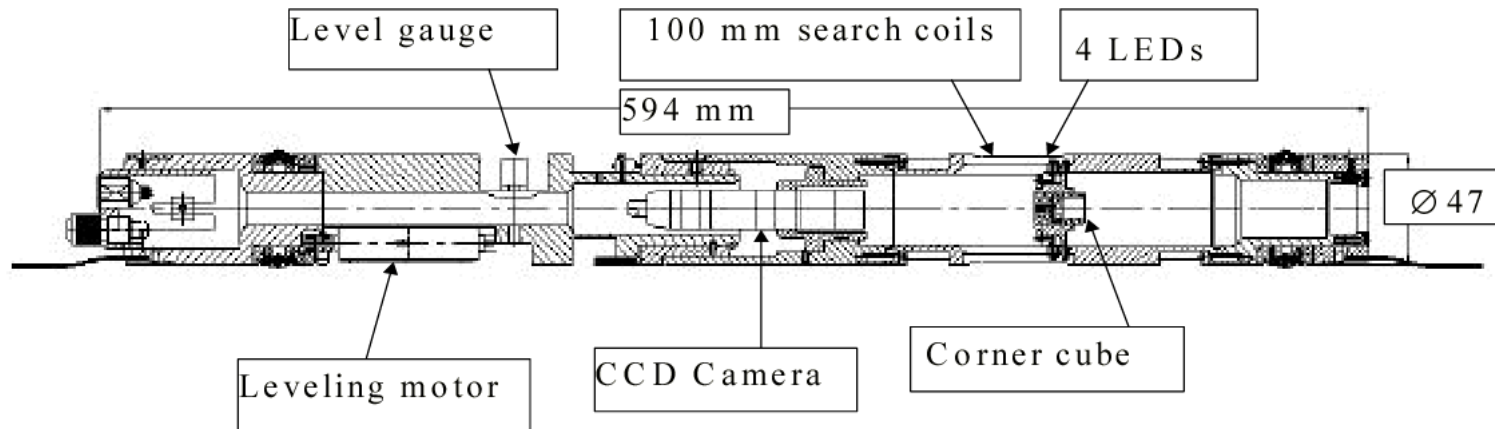


J. Garcia - CERN

Instruments

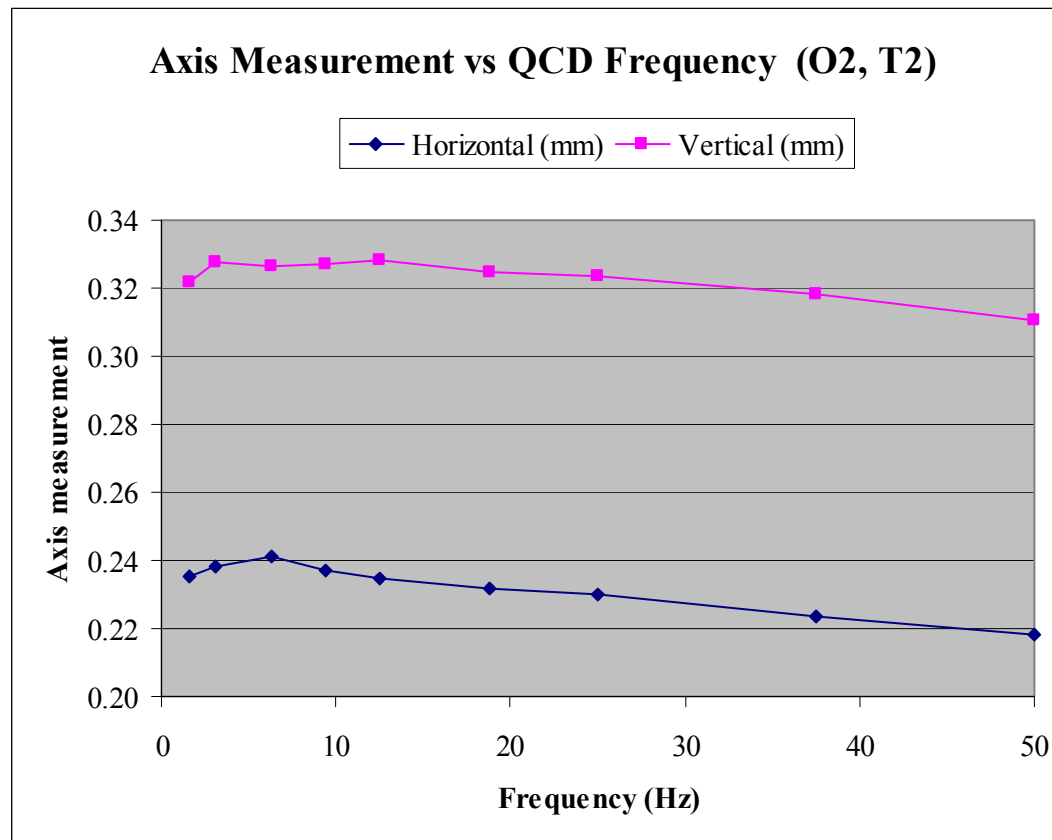
- 2 mole versions (global mechanic & global optic)
 - global mechanic, auto centring and ballast for level
 - global optic, LED's and motorised levelling
- LTD 500 Leica for 3D mole position measurement
- Synchronous detection electronics and positioning (angular and longitudinal) motors
- Software: AXYZ™ and Labview™

Optic Mole

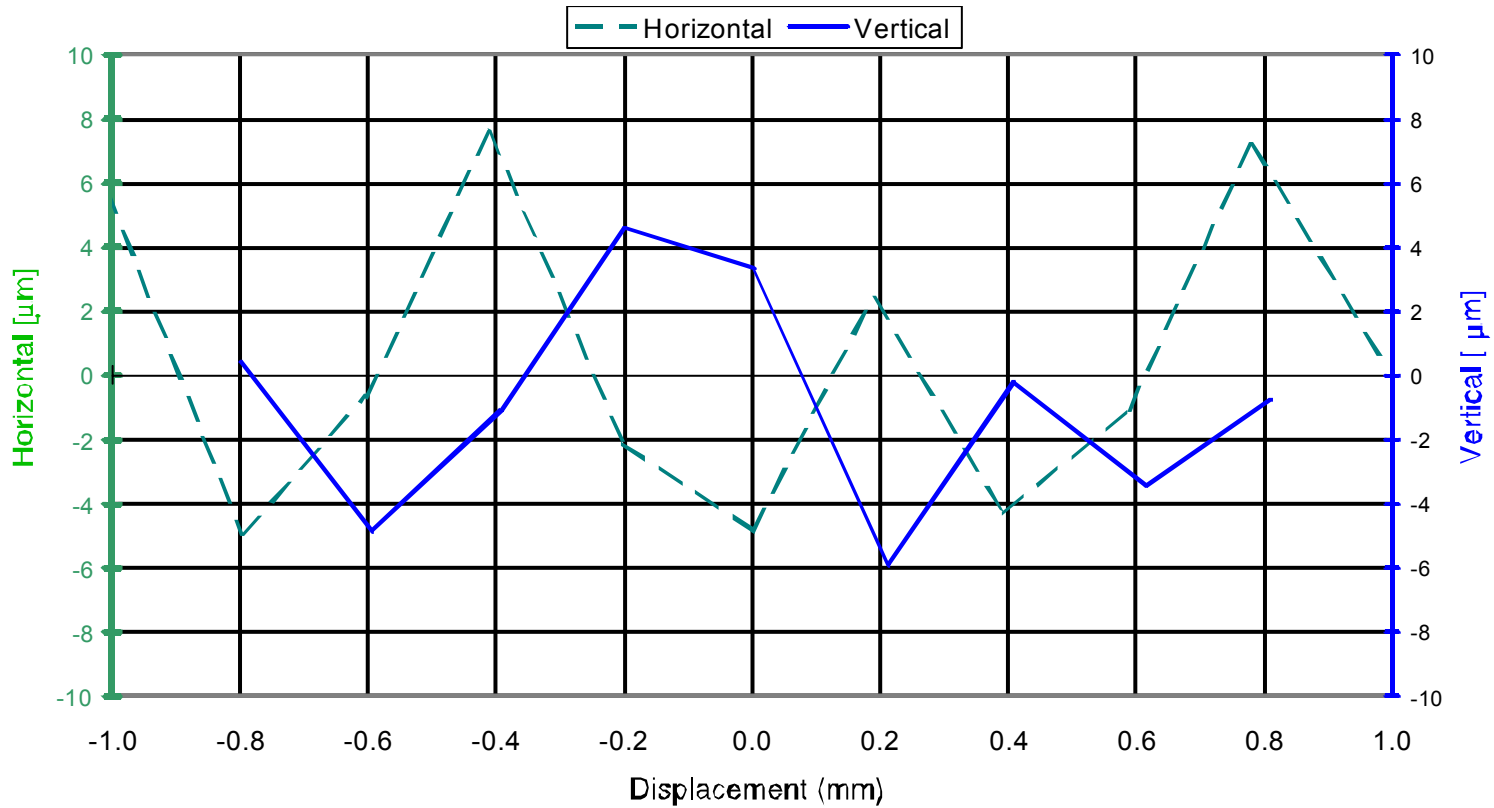


Sensitivity & Frequency check

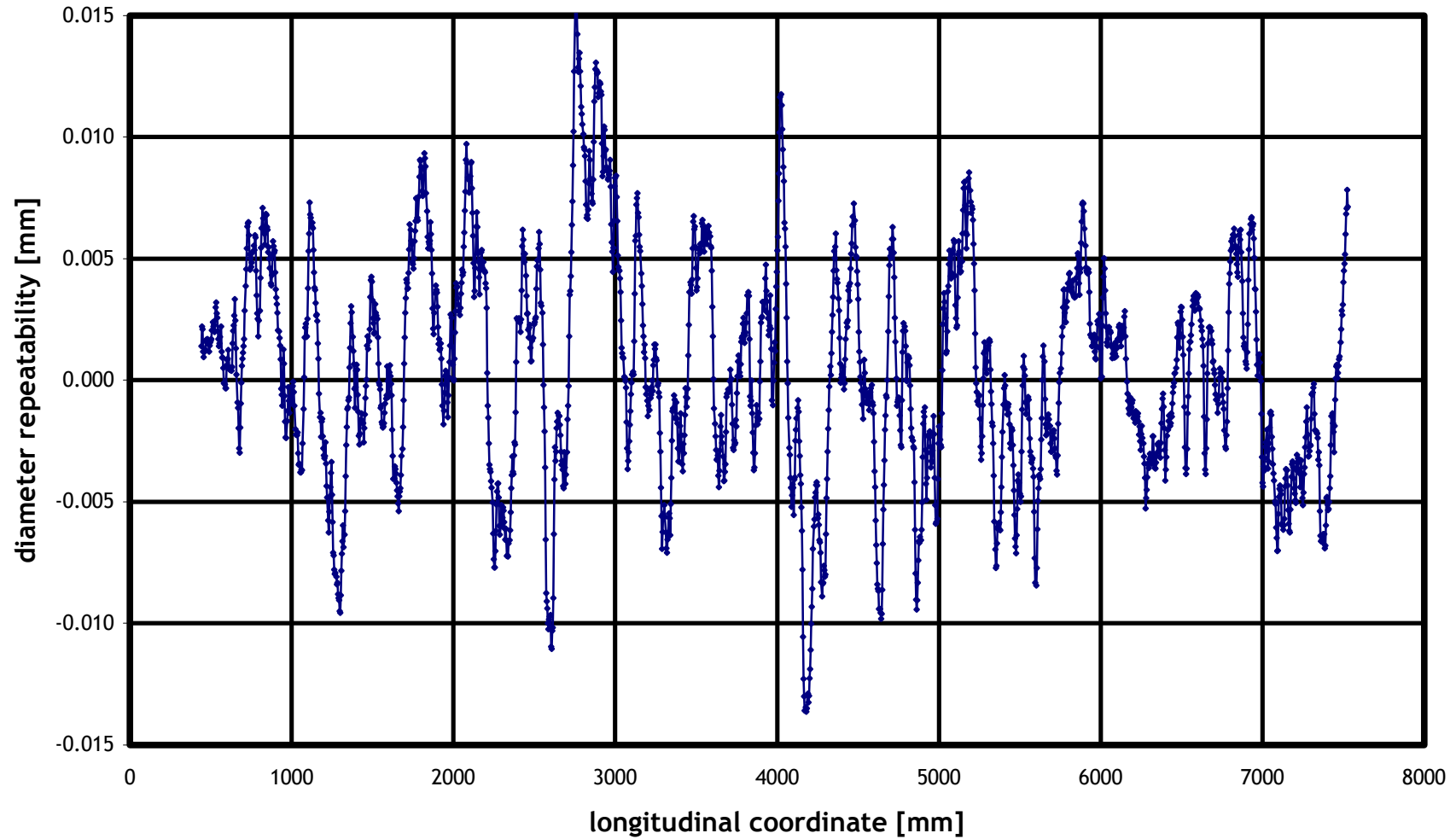
Coil Voltage (mV)	Input Current (mA)	Field at r=17 mm (T)	Sensitivity (μm)
37	100	$3 \cdot 10^{-4}$	<1
3.7	10	$3 \cdot 10^{-5}$	2
0.37	1	$3 \cdot 10^{-6}$	10



Sextupole calibration residuals



Repeatability of diameter measurement



Calibration method

We aim to have the three key centres, namely:

- Reflector centre
- Centre of gravity of search coils
- Cold bore tube centre (Centring of mechanical mole fingers or Centring of LED's)

well aligned, starting with the best mechanical precision from fabrication, but there are limits to that. In reality we have offsets between these centres. So we try to measure them. For that we use the following ingredients:

- turning by 180° in a 50 mm ➤ calibrated tubes
- turning by 180° in a calibrated quadrupole
- displacing transversally the mole inside a 50 mm ➤ tube to calibrate the LED's behaviour
- special device to calibrate the mechanical mole fingers

Calibration bench

VUE OUTILLAGE TAUPE JUMELLE

REFLECTEUR OPTIQUE LEICA
TAUPE GEOMETRIQUE JUMELLE LHCMMW0240

VUE OUTILLAGE TAUPE GLOBALE

TAUPE GLOBALE OPTIQUE LHCMMW0173
REFLECTEUR OPTIQUE LEICA

MASSE : 10 Kg

4	Screw M6x40	Steel	47.62.70
14	Vs Chc M6x40	Acier	313.5
20	Screw M6x20	Steel	47.62.70
13	Vs Chc M6x20	Acier	258.0
17	Groove screw M6	Steel	Ref. 080 150
20	Ecrrou de rainure M6	Acier	Micro-Contrôle
11	Internal square	Ref. EG00-1	
11	Equerre inférieure	6060	Micro-Contrôle
2	Mobile plate + stop	Ref. M-UmbE-25 + DM17-25	
1	Platine de translation + bulle		Micro-Contrôle
1	Plaque T200 Lg. 500	Ref. 170 360	
9	Profilé T200 Lg. 500	6060	Micro-Contrôle
1		8	
1		7	
1	Gauge support plate	Antico	LHCMMWHB0361
1	Plaque support calibre		
1	Geometric mole support	Antico	LHCMMWHB0360
1	Support taupe géométrique		
2	Clamp	5	
2	Bride	Antico	LHCMMWHB0359
1	Optical mole support		
2	Support taupe optique	Antico	LHCMMWHB0358
1	Table support plate	3	
1	Platine support table	Antico	LHCMMWHB0357
1	Mobile gauge support plate	2	
1	Plaque support calibre mobile	Antico	LHCMMWHB0356
2	Gauge #50	Stainless steel	
1	Calibre #50	Inox	LHCMMWHB0355
1	DESCRIPTION	POI	MAT. OBSERVATIONS
1	REF.CERN		

16					
15					
14					
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A	REV.01-M	N.Merrill	Mise à jour nomenclature	
END.	DATE	NOM/NAME	ZONE	MODIFICATION

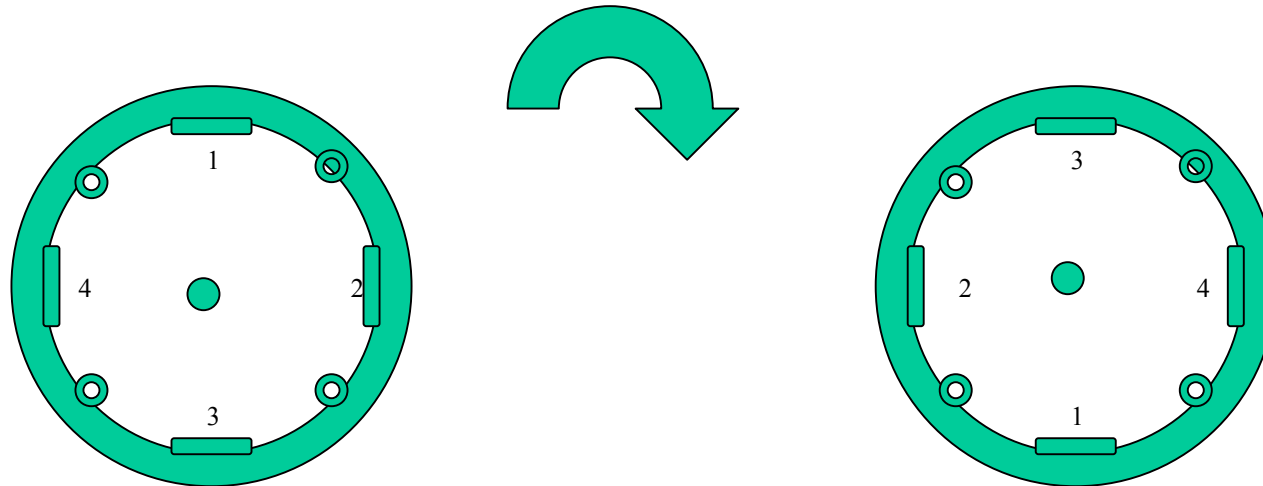
MEASURE / GEOMETRIC MEASUREMENT
GEOMETRIC CALIBRATION TOOL
ASSEMBLY
OUTILLAGE CALIBRATION GEOMETRIQUE
ENSEMBLE

PROJECT ENGINEER INFORMATION

REF.CERN
LHCMMWHB0354

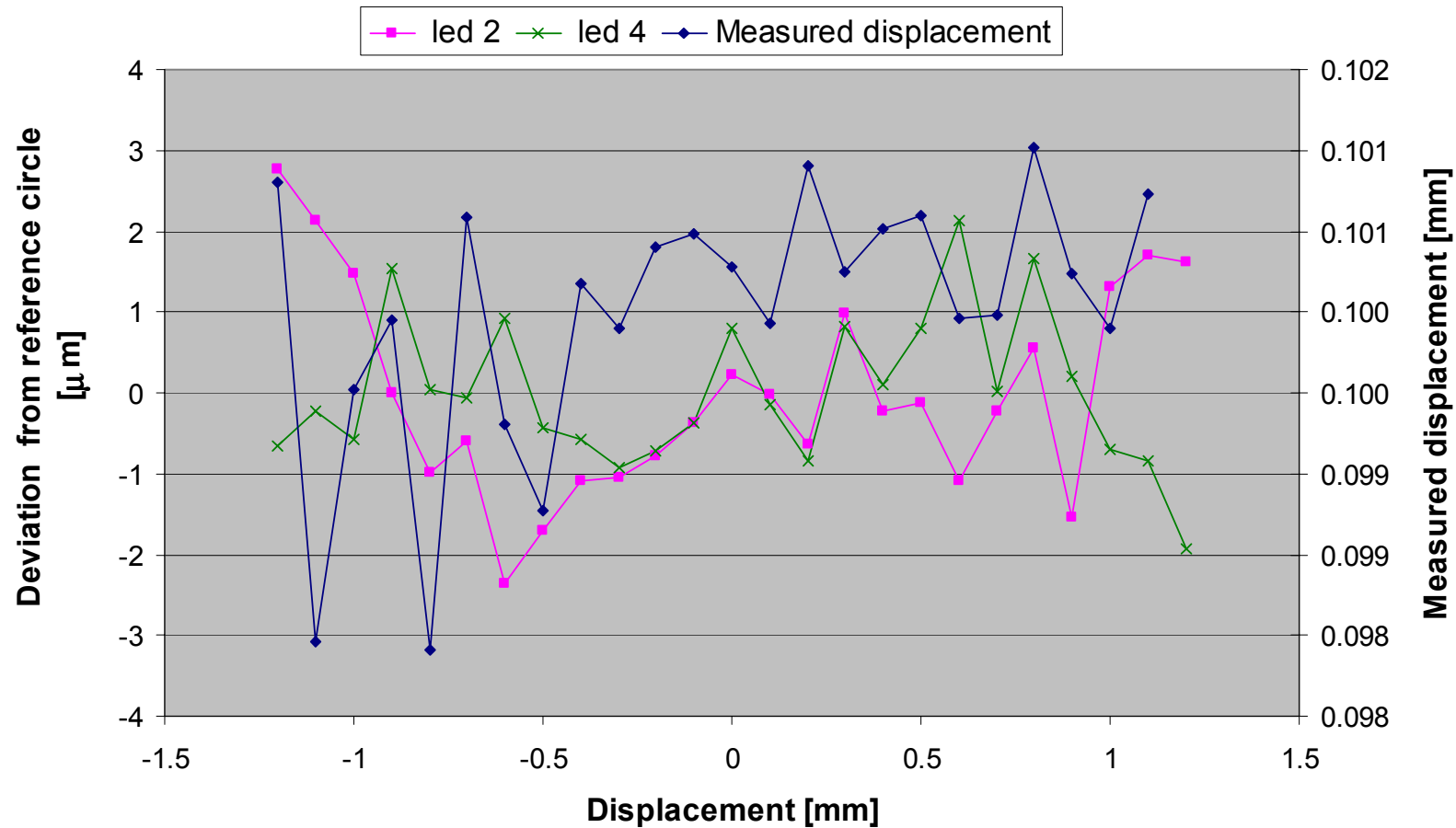
Calibration method

180 ° rotations



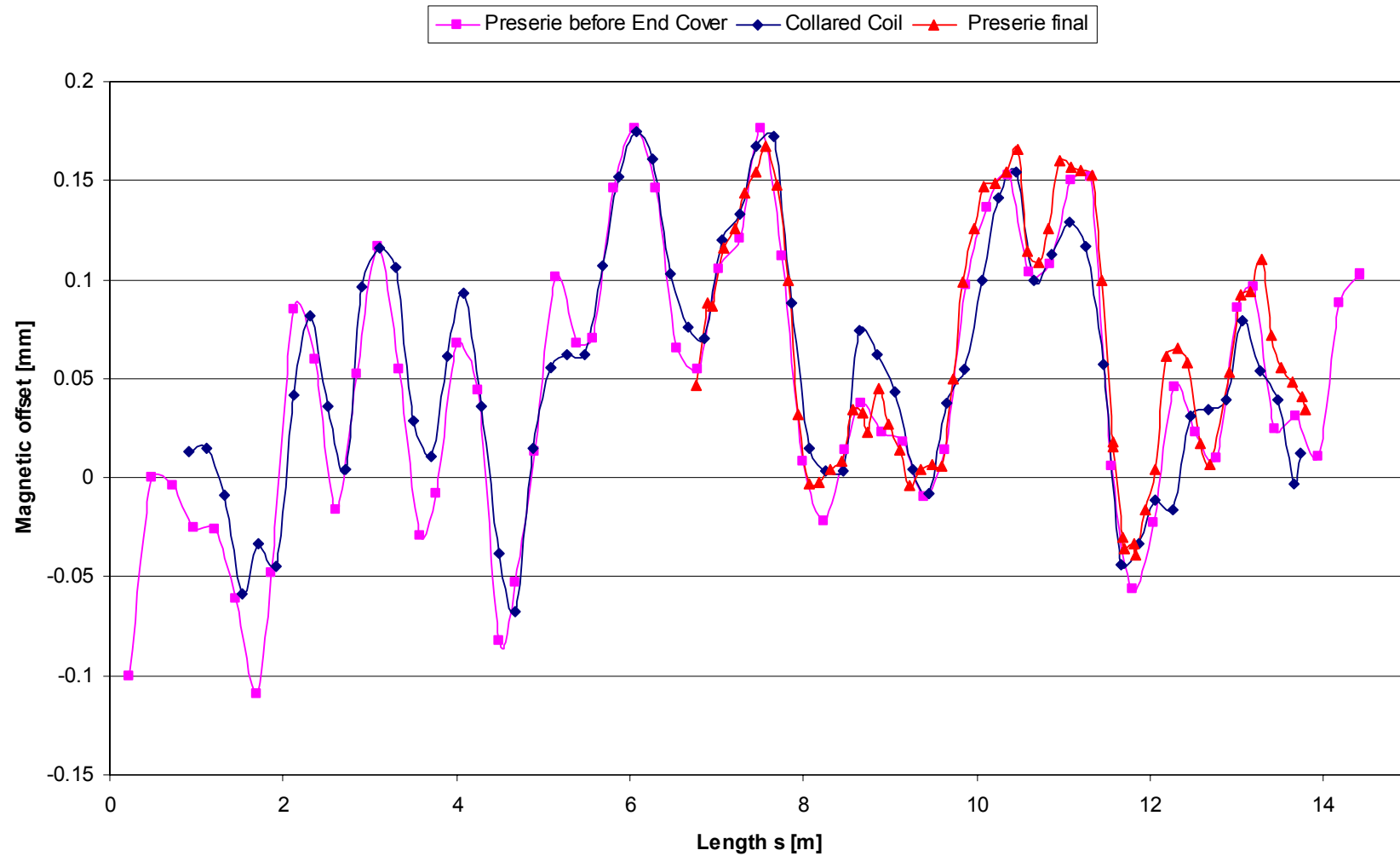
Optical Mole (Calibration)

Displacement of etalon in horizontal direction



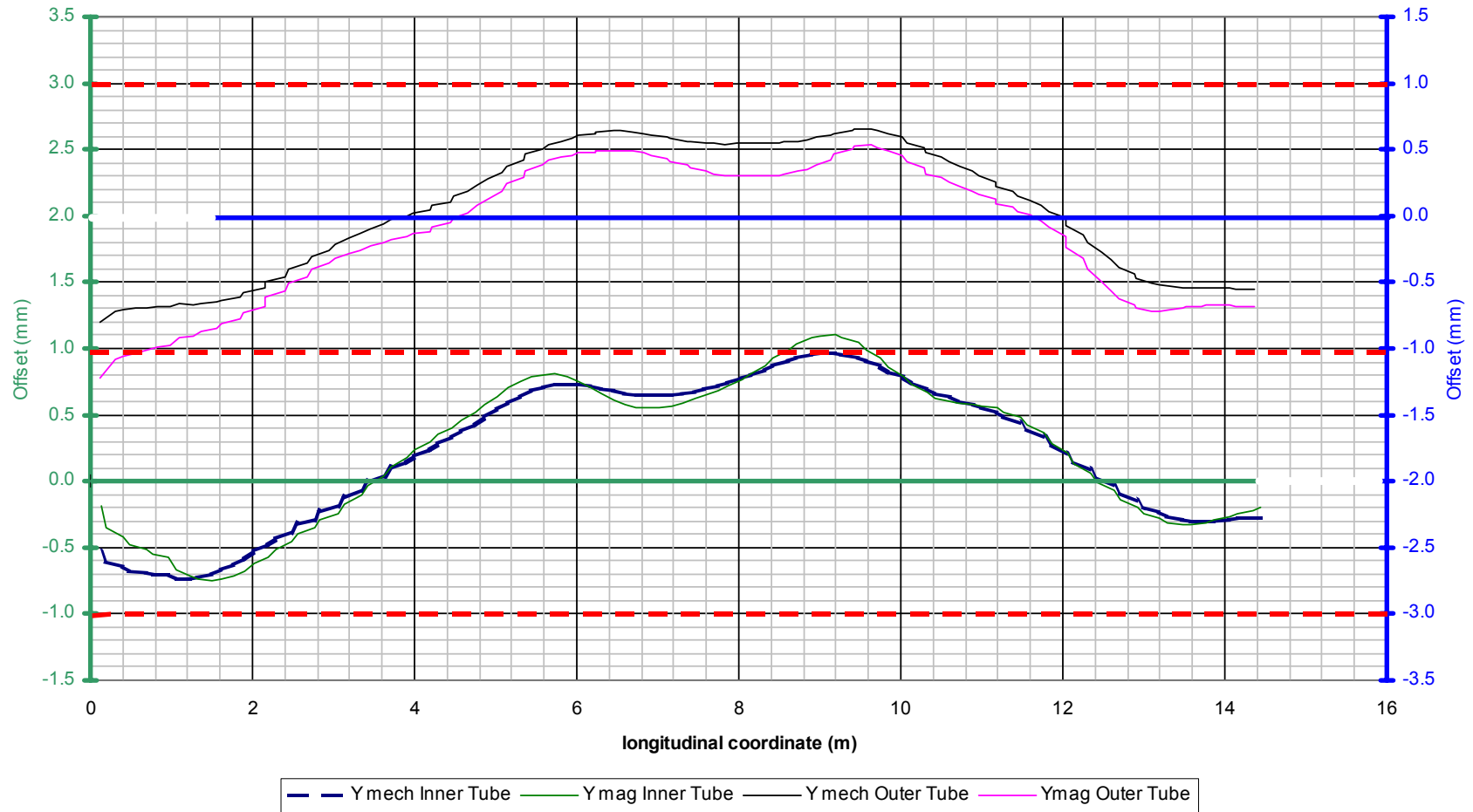
Magnet Axis measurements

Preserie O1-Magnetic Offset Repeatability (external tube, vertical offset)



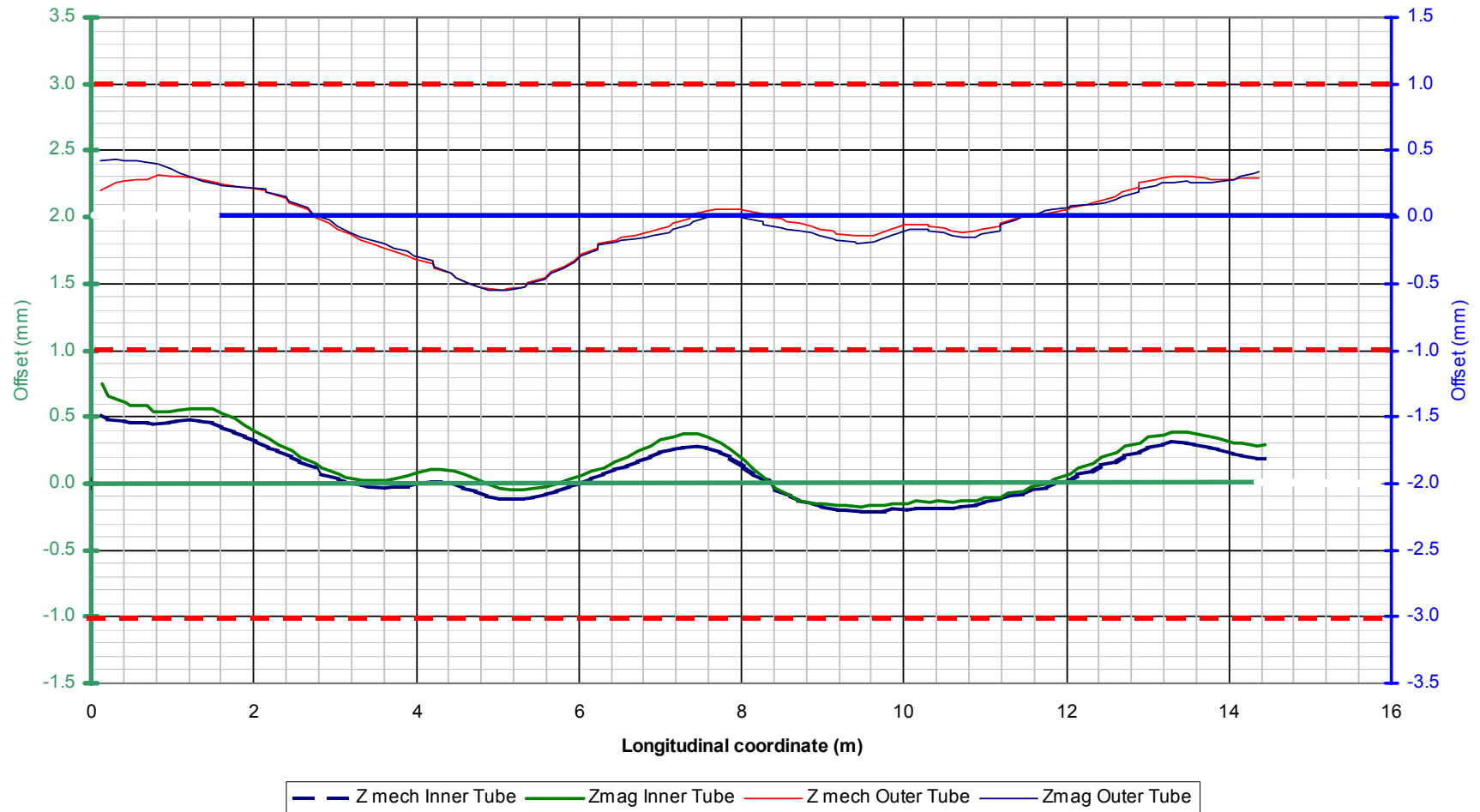
Magnet Axis measurements

NOELL1 - Horizontal FITTED



Magnet Axis measurements

NOELL1 - Vertical FITTED



Results from prototypes and preseries

Magnet	Mechanical-Magnetic Axis[mm]							
	Internal Tube				External Tube			
	horizontal		vertical		horizontal		vertical	
	mean	σ	mean	σ	mean	σ	mean	σ
MBP2A2	-0.09	0.03	0.02	0.02	0.05	0.03	0.08	0.03
MBP2O1	-0.25	0.06	-0.01	0.02	-0.20	0.07	-0.01	0.03
MBP2O2	0.04	0.03	0.06	0.03	-0.02	0.06	0.06	0.06
PSO1	-0.16	0.05	0.07	0.03	-0.20	0.04	0.05	0.02
Global	0.12	0.05	-0.04	0.02	0.09	0.06	-0.04	0.04

Conclusions

- We can measure the Magnetic axis of dipoles and correctors of LHC magnet with good accuracy, 0.03 mm in a very short time in parallel with the Mechanical axis measurements
- The Optical mole gives the diameter measurement
- The calibration bench and method are ready
- The results show a good agreement between both Magnetic and Mechanical axis