# Report on field quality in the main LHC dipole collared coils and cold masses: March-April 2004

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This report gives data relative to field quality measured in collared coils and cold masses during the period March 1– April 30 2004, comparison to beam dynamics targets and status of the holding points. Updated graphs can be found in the LHC-MMS field quality observatory <a href="http://lhc-div-mms.web.cern.ch/lhc-div-mms/MMSPAGES/MA/Obs.html">http://lhc-div-mms/MMSPAGES/MA/Obs.html</a>.

EDMS n. 473453

#### The dashboard

- Available measurements: 386 collared coils, 322 cold masses, 86 cryodipoles<sup>1</sup>.
- In these two months, 67 collared coils: 24 from Firm1, 12 from Firm2 and 31 from Firm3.

#### What's new

- **Production rate** is at 33 collared coils per month. The problem of the previous months in Firm3 has been solved (see also Fig. 1 at pg. 3). Firm3 is now at 3.5 collared coils per week. A large increase of production rate is also observed in Firm1 (3 collared coils per week). Firm2 is at 1.5 collared coils per week.
- Length of feedback loop: The minimal delay between collared coil magnetic measurements and cold tests is 2.5 months (obtained for 3038).
- Cold tests: only three more magnets measured and analysed in these two months.
- Coil size: The situation at Firm1, where large coil sizes had to be compensated by non-nominal shims of larger thickness up to 0.2 mm, is improving. In these two months we only had a few cases of non-nominal shims.
- **Switch to cross-section 3:** the addition of 0.125 mm insulation (X-section 3) in the coil mid-plane is the baseline, and all manufacturers are producing X-section 3.
- Trends in main field: collared coil data of the more recent production show again an increase in spread of the transfer function (see Fig. 9, pg. 7). Integrated transfer function in cold masses is anyway well within targets (see Fig. 12, pg. 8).
- Trends in odd multipoles: we continue to have small positive trends in  $b_3$   $b_5$  and  $b_7$  (see Figs. 13-16, pg. 9 and 10).
- **Trends in even multipoles:**  $b_2$  is approaching the limit imposed by beam dynamics (see Figs. 17-18, pg. 11).
- **Trends in skews:** the situation for the systematic  $a_4$  in Firm2 is worsening (see Figs. 25, pg. 15). We have a systematic component of about 0.5 units in the more recent production.
- Assembly faults: we are facing a worrying increase of the assembly faults detected with magnetic measurements. In these two months, 4 decollarings have been asked and 2 additional measurements with the short mole are still to be done. At the same time, decollarings of 2035, 2065, 3175 have proved that the analysis was correct. The rate of assembly defects in the first four months of the year is 8%, which is clearly not acceptable for a mature phase of the production. Actions are being taken to understand this quality degradation.

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<sup>&</sup>lt;sup>1</sup> These numbers refer to complete measurements available in Oracle databases

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# The new format of the report

We changed the format of the report and of most of his plots to better adapt it to this phase of the production. This report and the following ones are organized as follows

- The first section deals with the number of measured magnets in the last two months and the assembly data (X-section type and shim size). Its structure is unchanged with respect to the previous reports.
- The summary of the measured field quality of all collared coils versus beam dynamics targets has been shifted to the second Section. This gives a quick overview of the status of field quality versus beam dynamics computed over all the collared coils.
- The largest section has been devoted to trends in field quality.
  - The previous plots, that were showing measured field quality versus magnet progressive number<sup>2</sup>, have been replaced by graphs with moving averages (one per firm). Each marker is the average of 5 measurements:
    - the collared coil characterized by the progressive number in the horizontal axis
    - the two collared coils previously produced by the same firm
    - the two collared coils produced afterwards by the same firm

With this smoothing of the data, we lose the detail of the individual magnet, but we gain a better visualization of trends in the production.

- We dropped the separation between apertures (except for the case of b2 and b4) since data of the previous reports show that the difference is negligible
- We added plots for the bending strength in cold masses, since these measurements are giving important additional information on this critical parameter. When comparing these plots to collared coils, one has to take into account that usually the last 70 collared coils have not yet become cold masses, and therefore a different pattern has to be expected in the end of the plot.
- We dropped the plot with the reduction to nominal shims for main field, b5 and b7 since in this phase of the production (shims nominal within 0.1 mm) the impact on non-nominal shims is relevant only for b3.
- Cold mass data are shown only for the bending strength, since for the multipoles they are adding little information to what measured in collared coils.
- The final Section is devoted to field quality used to detect a faulty assembly procedure. We added a summary plot of the faulty assemblies found with magnetic measurements, and the cases occurred during the two months are briefly discussed. The plot of coil waviness, previously in Section 1, is also given.
- A list of magnets and special topics (when present) are given in the Appendix.

<sup>&</sup>lt;sup>2</sup> We recall the definition of magnet progressive number, used as horizontal axis in most of our trend plots: it is a number running from 1 to 1232 which is associated to each magnet, according to the date of collaring.

#### PART I: MEASURED MAGNETS AND ASSEMBLY DATA

- 67 new collared coils have been measured (collared coils 320<sup>th</sup> to 386<sup>th</sup>).
  - o 24 of Firm1 (1101-2,1105-26).
  - o 12 of Firm2 (2065,2067, 2068, 2074-80,2082,2083)
  - o 31 of Firm3 (3135, 3150-52, 3154-58, 3160-68, 3170-81,3183)

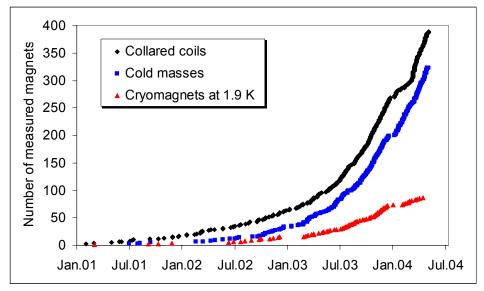


Fig. 1: Number of magnets measured at CERN at 1.9 K and at the manufacturers at room temperature at different stages of assembly procedure

- Cross-section: all the 67 collared coils have X-section 3.
- Shims are nominal in Firm2 and in Firm3. The situation of coil size is improving in Firm1: nominal shims are mostly used for outer layer and thinner shims of 0.05 mm are used for the inner layer (only one case of 0.1 mm thinner shim).

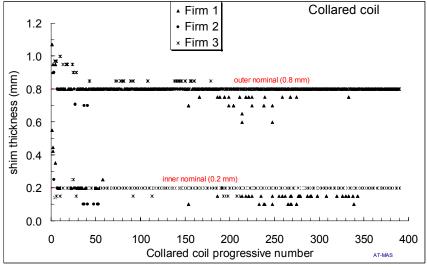


Fig. 2: Thickness of the polar shims used in the collared coils

#### PART II: MEASUREMENTS VERSUS BEAM DYNAMICS TARGETS

# 2.1 Summary of systematics components

Best estimates of skew and even normal systematics are given in Fig. 3, with an error at 95% confidence limit (two sigma). All the multipoles are within specifications. Details on trends are given in Part III.

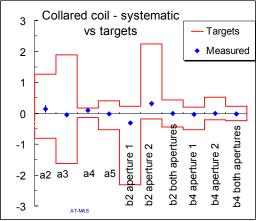
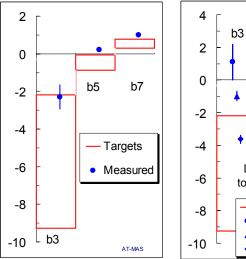


Fig. 3: Best estimate for systematic skew multipoles and even normal multipoles (markers) versus beam dynamics limits (red line). An error of two sigma (95% confidence limit) is associated to the best estimates of systematics.

- Best estimates for systematic odd normal multipoles are shown in Fig. 4. In the left part, raw data are plotted. This gives the actual situation for global values relative to all manufactured collared coils, which are slowly moving towards optimal ranges:  $b_3$  is now within target and  $b_5$  is larger than the upper target of 0.25 units.
- In the right part of Fig. 10, data are reduced to nominal shims and separated according to the three cross-sections (34 collared coils have cross-section 1, 138 have cross-section 2, 217 have cross-section 3, plus one hybrid 1-2). With cross-section 3,  $b_3$  is within targets, 1.15 units below the upper limit (i.e., 1.85 units at high field), and also  $b_5$  is within targets, at the edge of the upper limit (i.e., 1.1 units at injection). Finally,  $b_7$  is 0.25 units larger than the limits (i.e. 0.31 units at injection). A small positive drift is being observed for these three normal odd multipoles, see also Section 3.2



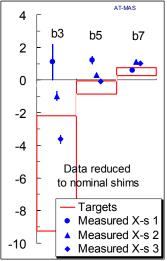


Fig. 4: Best estimate for systematic odd normal multipoles (markers) versus beam dynamics limits (red line). An error of two sigma (95% confidence limit) is associated to the best estimates of systematics. Raw data (left) and data reduced to nominal shims and separated according to different cross-sections (right).

# 2.2 Summary of random components

• We evaluate the standard deviation of the bending strength and multipoles for all Firms and separated according to different Firms. We analyse only magnets with cross-section 3 (217 collared coils). Standard deviation of multipoles in collared coil are divided by 1.18 to give the best estimate of the random due to geometric in the cold mass, and compared to the target for the beam dynamics (whose budget includes also the random components induced at 1.9 K). All values are well within targets, with the exception of main field in straight part B and b3 at Firm1, whose large spread is induced by non-nominal shims.

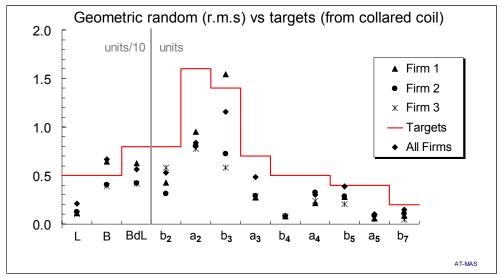


Fig. 5: Random component in the measured collared coils and rescaled to cold mass values, cross-section 3 only compared to targets for random at 1.9 K.

- We give an estimate of the actual spread due to the geometric component in the first two arcs. The first arc is made up of magnet with R polarity (141 collared coils available, 31 cross-section 1 and 110 cross-section 2) and the second of L polarity (25 cross-section 2 and the others of X-section 3)
- The spread of the first arc is out of target only for b3 and b5. This is mainly due to the use on non-nominal shims and to the change from X-section 1 to X-section 2.
- In the second arc all values are within targets. The situation for b3, which is on the edge (i.e. the geometric is eating all the budget for the random at 1.9 K), will improve for the next octants where magnets of cross-section 2 will not be present any more.

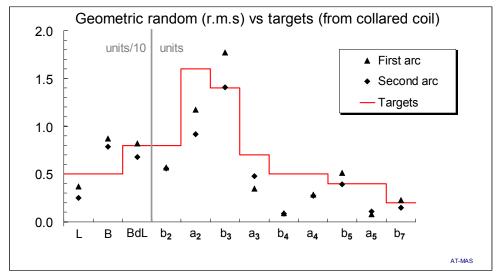


Fig. 5: Random component in the measured collared coils (rescaled to cold mass), for the first and second arc, compared to targets for random at 1.9 K.

#### PART III: TRENDS IN FIELD QUALITY

# 3.1 Trends in bending strength

#### 3.1.1 Trends in magnetic length

Magnetic length of the recent production of collared coils is extremely stable in all Firms (see Fig. 7).
 Magnetic length in Firm 1 is 3-4 units higher than in Firm2 and Firm3.

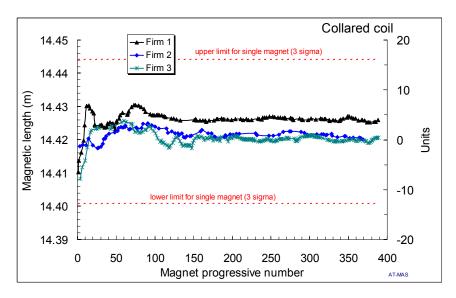


Fig. 7: Magnetic length of the measured collared coils, separated per Firm (each dot is average of 5 consecutive magnets of the same firm).

• Magnetic length of the recent production of **cold masses** is also extremely stable in all Firms (see Fig. 8). When iron laminations are added, magnetic length in Firm3 is getting smaller than in Firm1 and 2. The net result is that there are around 8 units of difference between Firm1 and Firm3, and Firm2 is in between.

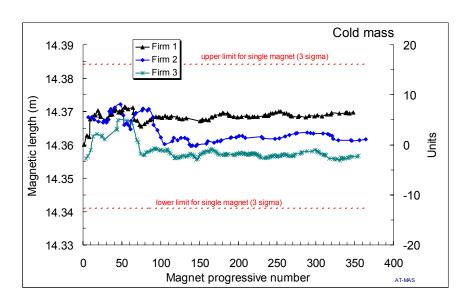


Fig. 8: Magnetic length of the measured **cold masses**, separated per Firm (each dot is average of 5 consecutive magnets of the same firm).

#### 3.1.2 Trends in transfer function

• Transfer function in collared coils 320<sup>th</sup> to 386<sup>th</sup> is decreasing at Firm1, and is rather stable in Firm2 and Firm3 (see Fig. 9). Firm1 transfer function in collared coils is around 10 units less than in Firm2 and Firm3.

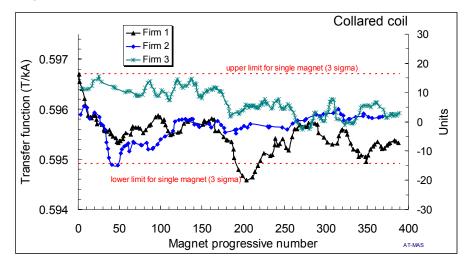


Fig. 9: Transfer function of the measured collared coils, separated per Firm (each dot is average of 5 consecutive magnets of the same firm).

 The systematic difference in transfer function between firms observed in collared coils is confirmed, but slightly reduced, in cold mass data (see Fig. 10).

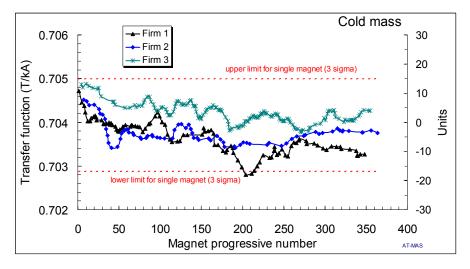


Fig. 10: Transfer function of the measured cold masses, separated per Firm (each dot is average of 5 consecutive magnets of the same firm).

#### 3.1.3 Trends in integrated transfer function

• Due to the compensation between the lower transfer function in Firm1, and the longer magnetic length, the integrated transfer function shows a rather low spread between firms (10 units) in recent production (see Fig. 11).

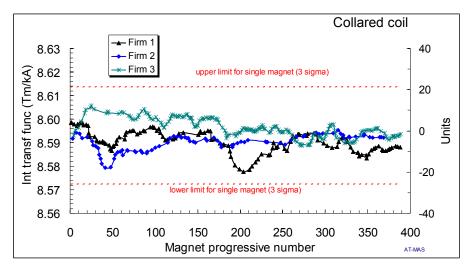


Fig. 11: Integrated transfer function of the measured collared coils, separated per Firm (each dot is average of 5 consecutive magnets of the same firm).

• In the **cold masses** data the spread of integrated transfer function between firms is further reduced (see Fig. 12). Trends in the more recent production are negligible.

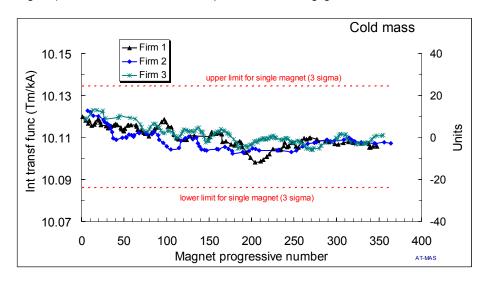


Fig. 12: Integrated transfer function of the measured cold masses, separated per Firm (each dot is average of 5 consecutive magnets of the same firm).

# 3.2 Trends in odd multipoles

- Normal sextupole is within targets in all Firms (see Fig. 13). Production is very stable in Firm2 and Firm3. Low values of b3 in Firm1 are mainly due to non-nominal shims (see Fig.14, where this effect is subtracted). Cross-section 3 has been introduced at magnet progressive number 170 approximately.
- Collared coils produced in March and April 2004 (320<sup>th</sup> to 386<sup>th</sup> in Figs. 13 and 14) have a b3 which is placed 1 to 2 units below the upper target, which is the optimal for beam dynamics.
- The last collared coils of Firm1 and Firm3 are approaching the upper target: this trend should be carefully monitored.

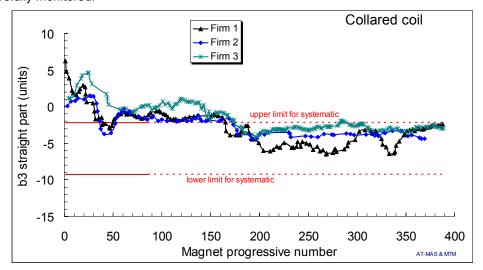


Fig. 13: Average b3 in straight part of the collared coils, separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

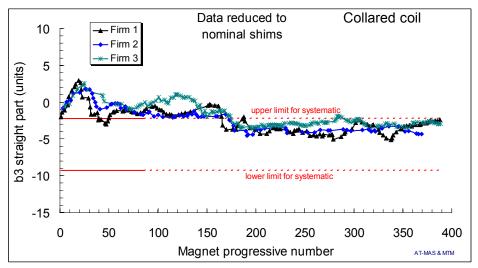


Fig. 14: Average b3 in straight part of the collared coils, separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles. Data reduced to nominal shims

- Firm2 and Firm3 have a normal decapole b5 within targets, whereas Firm1 is around 0.8 units larger than upper target (see Fig. 15).
- We observe an upward trend of b5 in Firm3 in the more recent production. As for b3, these trends should be carefully monitored.

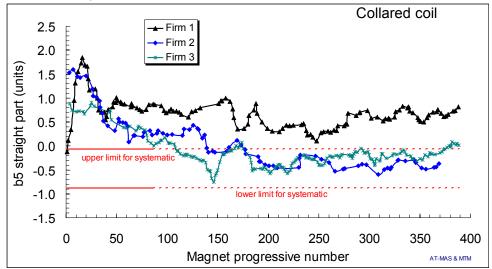


Fig. 15: Average b5 in straight part of the collared coils, separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

• Normal 14<sup>th</sup> pole b7 is larger than targets in Firm1 and Firm3, and on the upper target in Firm2 (see Fig. 16). It is stable in Firm3, and has upward trends in Firm2 and Firm3.

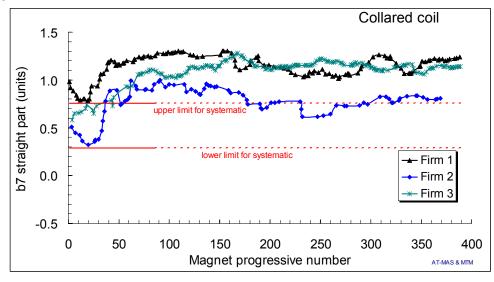


Fig. 16: Average b7 in straight part of the collared coils, separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

# 3.3 Trends in even multipoles

For each multipole being subject to beam dynamics specifications, we present two separated plots for the systematic per aperture, plus a plot of the systematic per beam, i.e. the average of both apertures (that should be zero due to two-in-one symmetry).

#### 3.3.1 Trends in normal quadrupole

- The systematic per aperture is drifting towards the limit (see Figs. 17 and 18). A corrective action could become necessary. A change of the insert shimming would be probably the easiest in this phase of the production. Some experience has been already acquired on 1002 and 1005, which had no "Chinese hat" between insert and yoke.
- We observe a strong correlation between the two apertures in Firm3 (firstly pointed out by I. Vanenkov).

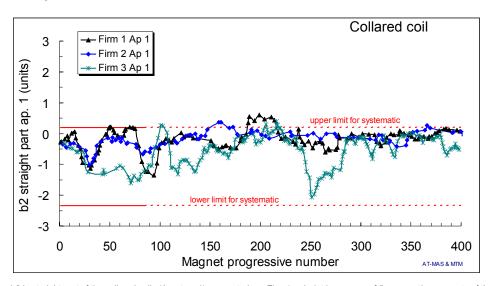


Fig. 17: Average b2 in straight part of the collared coils (Aperture 1), separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

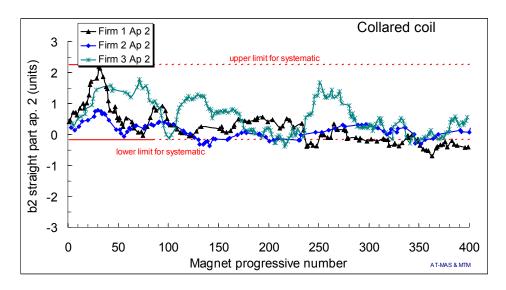


Fig. 18: Average b2 in straight part of the collared coils (Aperture 2), separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

• The systematic normal quadrupole per beam is within specifications (see Fig. 19).

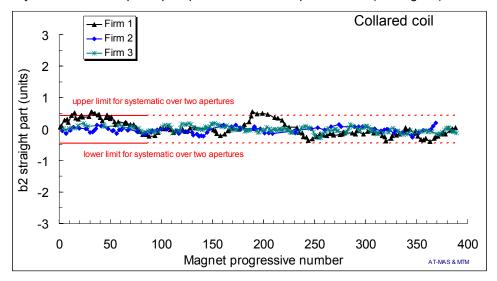


Fig. 19: Average b2 in straight part of the collared coils (both Apertures), separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

#### 3.3.2 Trends in normal octupole

- The systematic per aperture is within specifications in both apertures (see Figs. 20 and 21).
- The systematic per beam is also within specifications (see Fig. 22).

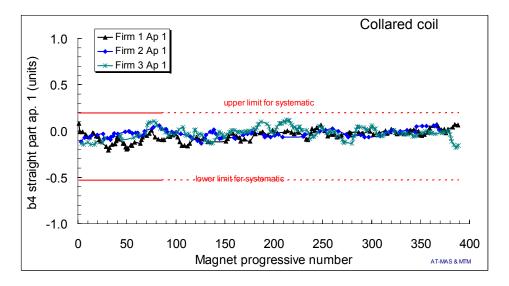


Fig. 20: Average b4 in straight part of the collared coils (Aperture 1), separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

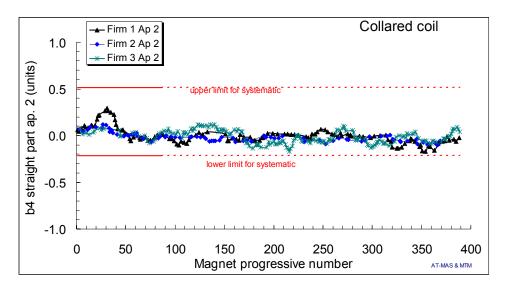


Fig. 21: Average b4 in straight part of the collared coils (Aperture 2), separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

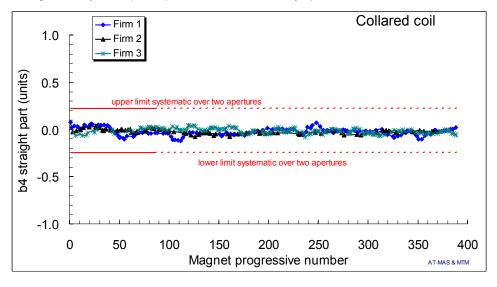


Fig. 22: Average b4 in straight part of the collared coils (both Apertures), separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

# 3.4 Trends in skew multipoles

• Skew quadrupole a2 is well within targets, and no trends are observed (see Fig. 23).

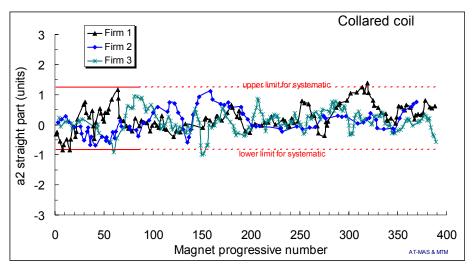


Fig. 23: Average a2 in straight part of the collared coils, separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

• Skew sextupole a3 is well within targets (see Fig. 24). There is a positive systematic component in Firm3 (around 0.8 units), and a slightly negative component (around 0.25 units) in Firm1 and Firm2. Indeed, beam dynamics targets are very loose, and therefore there is no concern on this multipole.

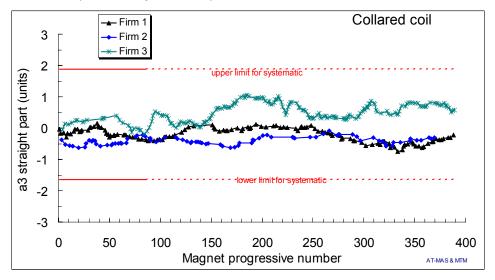


Fig. 24: Average a3 in straight part of the collared coils, separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

• Skew octupole a4 is within the tight beam dynamics targets for Firm1 and Firm3 (see Fig. 25). There is a positive systematic component in Firm2 (around 0.5 units) that could drive the systematic at the edge of the allowed range. Investigations about origins and possible cures are under analysis.

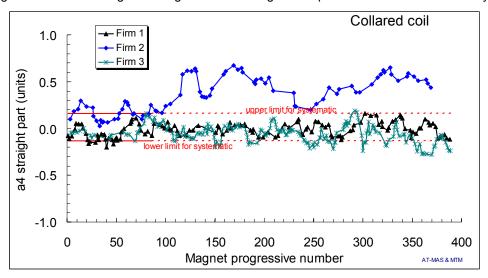


Fig. 25: Average a4 in straight part of the collared coils, separated per Firm (each dot is average of 5 consecutive magnets of the same firm), and beam dynamics targets for the systematic (red lines) based on correlations with 86 cryodipoles.

# 3.5 Trends in systematic differences between firms

The more relevant signature of Firms is in  $b_7$ .

• Normal 14<sup>th</sup> pole: *b*<sub>7</sub> at Firm2 is 0.5 units lower than Firm2 and Firm1 (see Fig. 16). This difference is four times the natural sigma within the same manufacturer measured in cross-section 3. Firm2 is within targets, whereas both Firm1 and Firm3 are outside.

We observe a small systematic difference between firms (from one to two times the natural sigma within the same manufacturer) in the following cases.

- Normal decapole  $b_5$ : Firm1 has a systematic  $b_5$  of 0.8 units larger than Firm2-3. This difference is two times the natural sigma within the same manufacturer (see Fig. 15). Firm2 and Firm3 are within targets, whereas Firm1 is outside.
- Skew sextupole  $a_3$ : Firm3 has a systematic  $a_3$  of 0.49 units, against -0.41 units in Firm2, Firm1 being at -0.16 units (see Fig. 24). This difference is two-three times the natural sigma within the same manufacturer. All Firms are within targets
- For the transfer function, Firm1 is showing values 10 to 15 units smaller than Firm2 and Firm3 (see Fig. 9). This difference is one to two times the natural sigma within the same manufacturer.
- Skew octupole  $a_4$ : Firm2 has a systematic  $a_4$  of 0.37 units, against 0.0 to -0.07 units in Firm3 and Firm1 (see Fig. 25). This difference is equal to the natural sigma within the same manufacturer. Firm1 and Firm3 are within targets, whereas Firm2 is outside.

Systematic differences between firms are small or negligible in a2, b2 b3 and b4.

#### PART IV: QUALITY CONTROL

# 4.1 Summary of assembly defects

The following 8 decollarings have been asked for anomalies in magnetic measurements that, according to simulations, could be traced back to defects in the assembly procedure or in the components. In all cases the defect has been found.

- 2002, collared in July 2001, opened in July 2001. Bad assembly: a double coil protection sheet;
- 1027, collared in October 2002, opened in November 2002. Bad assembly: a missing outer shim;
- 2032, collared in May 2003, opened in November 2003. Bad coil curing: block 6 not glued to the copper wedge;
- 2035, collared in July 2003, opened in April 2004. Bad coil curing: block 6 not glued to the copper wedge;
- 3135, collared in January 2004, opened in February 2004. Bad assembly: block 6 pushed inward by a folded outer shim;
- 1099, collared in February 2004, opened in March 2004. Bad coil curing: block 6 not glued to the copper wedge;
- 2065, collared in February 2004, opened in April 2004. Bad coil curing: block 6 glued in a wrong position (0.5 mm inward) to the copper wedge;
- 3175, collared in May 2004, opened in May 2004. Bad coil curing: block 6 not glued to the copper wedge.

Two more magnets from Firm2 and one from Firm1 have to be decollared. The plot in Fig. 26 summarizes these defects found along the production. From Fig. 27 one can observe that after a quiet period of the production (from collared coil 120<sup>th</sup> to 300<sup>th</sup>), where no defect were found, the recent manufactured collared coils have a very high rate of defects (around 8%). This worrying situation is under analysis.

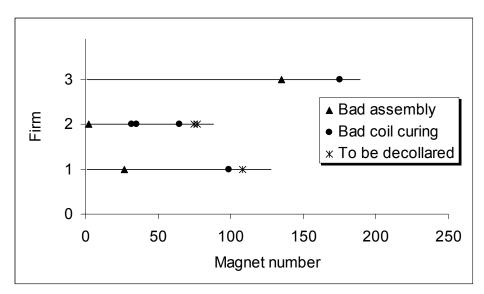


Fig. 26: Collared coils decollared for assembly defect or faulty component, divided according to Firm (y axis) and error type (markers), and total number of collared coils manufactured up to now (solid line).

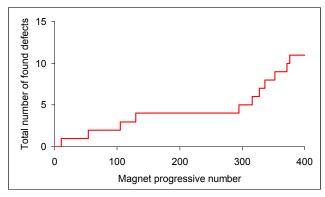


Fig. 27: Total number of defects found with magnetic measurements versus magnet progressive number.

# 4.2 Holding point results

In these two months, four collared coils have been not approved and de-collaring has been asked for assembly faults

- 2075, 2065, 2077 for estimated inward movements of block 6 of 0.5 to 1 mm in one or more section along the magnet axis
- 3175 for estimated inward movement of block 6 of 0.5 mm in two section along the magnet axis

Two collared coils are waiting for a measurement with the short mole to have more information on the defect.

- 1108 for a suspect missing thickness on outer layer pole
- 1122 for a suspect block 6 inward shift.

#### 4.3 Estimated coil waviness

• Coil waviness estimated from the variation of the multipoles along the axis is below 30 microns. The general situation of this parameter is very good in all firms (see Fig. 28).

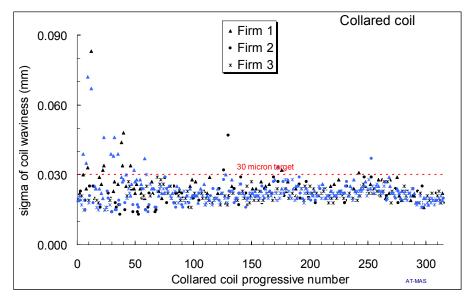


Fig. 28: Estimated coil waviness in the straight part of the measured collared coils (black dots: aperture 1, blue dots: aperture 2).

# Acknowledgements

We wish to acknowledge all colleagues involved in the measurements at room temperature and at 1.9 K, and all the firm personnel. We thank W. Scandale and L. Rossi for useful comments on the novel format of the manuscript, and P. Hagen and C. Vollinger for data analysis and fruitful discussions.

# Appendix A: collared coil assembly data

Table I: Magnet number, collared coil progressive number used in figures, and cross-section (data available on May 1 2004) for Firm1 and Firm2.

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Magnet name Progr. number						Progr. number				
1001 1 1002 2	1 1	1071 1072	214 238	3	2001 2002	3 11	1 1	2071 2072	315 276	3 3
			238	3					276 297	
1003 5 1004 8	1	1073 1074	239	3 3	2003 2004	7 20	1	2073 2074	321	3 3
	1						1			
	1	1075	221	3	2005	14	1	2075	352	3
1006 12	1 1	1076	248 225	3	2006	30 27	1 1	2076	346 328	3 3
1007 15 1008 16	1	1077 1078	235	3 3	2007 2008	26		2077 2078	329	3
			233	3			1			3
	1 1	1079	233 244		2009	34	1 1	2079	364	
1010 21 1011 22	1	1081	252	3 3	2010 2011	33		2080	366	3 3
		1082				56	1	2081	309	
1012 23 1013 29	1 2	1083 1084	259 255	3 3	2012 2013	37	2	2082 2083	345	3
	2					36	2		369	3
1014 31 1015 32	1	1085 1086	262 265	3 3	2014 2015	41 61	2	2084 2088	392 391	3 3
								2000	391	<u>ა</u>
1016 35	2	1087	268	3	2016	48	2	i		
1017 38	2	1088	269	3	2017	52	2	i		
1018 39	2	1089	275	3	2018	53	2	i		
1019 40 1020 64	2	1090	277	3	2019	59	2	i		
	2	1091	279	3	2020	62	2	i		
1021 42	2	1092	278	3	2021	67	2	i		
1022 47	2	1093	287	3	2022	68	2	i		
1023 49	2	1094	290	3	2023	76	2	i		
1024 50	2	1095	291	3	2024	126	2	i		
1025 51	2	1096	298	3	2025	77	2	i		
1026 46	2	1097	308	3	2026	83		i		
1027 54 1028 55	2	1098 1099	302 316	3	2027 2028	85 90	2	i		
				3		90 91		i		
1029 58	2	1100	314	3	2029		2	i		
1030 65 1031 66	2	1101	325	3	2030	96	2	i		
	2	1102	357	3	2031	100	2	i		
1032 70	2	1104	319	3	2032	105	3	i		
1033 73		1105	326	3	2033	131	2	i		
1034 75	2	1106	343	3	2034	117	2	i		
1035 79	2	1107	359 376	3	2035	130	3 2	i		
1036 82 1037 86	2	1108 1109	338	3 3	2036 2037	115 122	2	i		
1037 86	2	11109	320	3	2037	137	2	i		
	2	1111	333	3	2038	141	2	i		
	2					145		i		
1040 102 1041 99	2	1112 1113	339 330	3	2040 2041	139	3 2	i		
1041 99	2	1114	340	3	2041	135	2	i		
1042 100	2	1115	349	3	2042	147	3	i		
	2			3	2043		2	i		
1044 121	2	1116	348 351	3	2044	159 201	3	i		
1045 94 1046 104	2	1117		3		253		i		
	2	1118	363 354	3	2046 2047	232	3	i		
	2	1119	367		2047	161	2	i		
	2	1120		3				i		
1049 112 1050 114	2	1121 1122	371 378	3 3	2049 2050	190 177	3 2	i		
	2		378 374			247		i		
1051 154 1052 124	2	1123 1124	374 368	3 3	2051 2052	247 169	3 2	i		
	2							i		
1053 153 1054 162	2	1125 1126	385 383	3 3	2053 2054	178 173	3	i		
	2		388	3	2055			i		
	2	1128				191	3	i		
1056 181 1057 128		1130	396	3	2056	209 192	2	i		
	2				2057	192 197	3	i		
1058 165					2058		3	i		
1059 151	2				2059	231	3	i		
1060 166	2				2060	260	3	i		
1061 170	2				2061	205	3	i		
1062 188					2062	230	3	i		
1063 176	3				2063	289	3	i		
1064 180	3				2064	266	3	i		
1065 242 1066 189	3 2				2065	336 274	3	i		
	3				2066 2067	322	3	i		
	2							i		
1068 194	2				2068	356	3	1		
	2				2060	202	2			
1069 204 1070 199	3 3				2069 2070	293 318	3			

Table II: Magnet number, collared coil progressive number used in figures, and cross-section (data available on May 1 2004) for Firm3.

3001		Progr. number	X-section	Magnet name		X-section	Magnet name	Progr. number	X-section
3003									
3005   17									
30006   18									
3007									
3008									
3009							-		
3010									
3011									
3012									
3014   60		44	2						
3016   63	3013	45	2	3082	213	3	3153	313	3
3016   69   2   3085   196   3   3156   323   3   3017   72   2   3086   198   3   3157   337   3   3018   71   2   3087   207   3   3158   342   3   3019   74   2   3088   208   3   3158   342   3   3021   78   2   3099   210   3   3151   334   3   3021   78   2   3090   212   3   3162   344   3   3   3022   81   2   3091   215   3   3163   335   3   3023   84   2   3092   216   3   3164   341   3   3   3025   89   2   3094   217   3   3165   353   3   3   3025   89   2   3094   217   3   3165   353   3   3   3026   89   2   3094   219   3   3166   355   3   3   3   3027   92   2   3096   222   3   3168   362   3   3   3027   92   2   3096   222   3   3168   362   3   3   3029   95   2   3098   223   3   3171   361   3   3   3039   98   2   3099   226   3   3171   361   3   3   3   3   3   3   3   3   3	3014	60	2	3083	185	3	3154	350	3
3017   72   2   3086   198   3   3157   337   3   3018   71   2   3088   2007   3   3158   342   3   3019   74   2   3088   2008   3   3160   327   3   3020   80   2   3089   210   3   3161   334   3   3022   81   2   3091   215   3   3163   335   3   3022   81   2   3091   215   3   3163   335   3   3024   87   2   3093   217   3   3165   353   3   3   3024   87   2   3093   217   3   3165   353   3   3   3024   87   2   3094   219   3   3166   355   3   3   3026   108   2   3095   220   3   3167   358   3   3   3026   108   2   3095   220   3   3167   358   3   3   3028   93   2   3096   222   3   3167   358   3   3   3028   93   2   3097   224   3   3170   365   3   3   3030   96   2   3099   226   3   3171   361   3   3   3030   96   2   3099   226   3   3171   361   3   3   3   3   3   3   3   3   3									
3018									
3019									
3020 80 2 3089 210 3 3161 334 3 3 3021 78 2 3090 212 3 3162 344 3 3 3022 81 2 3091 215 3 3162 344 3 3 3023 84 2 3092 216 3 3163 335 3 3 3024 87 2 3093 217 3 3165 353 3 3 3026 89 2 3094 219 3 3166 355 3 3 3026 89 2 3094 219 3 3166 355 3 3 3027 92 2 3096 222 3 3167 358 3 3 3027 92 2 3096 222 3 3167 358 3 3 3029 95 2 3098 223 3 3170 365 3 3 3029 95 2 3098 223 3 3170 365 3 3 3029 95 2 3098 223 3 3170 361 3 3 3031 202 3 3100 227 3 3173 373 37 3 3 3032 203 3 3101 228 3 3174 379 3 3 3033 206 3 3 3101 228 3 3174 379 3 3 3033 206 3 3 3102 243 3 3175 372 3 3 3034 101 2 3103 229 3 3175 372 3 3 3035 347 3 3104 224 3 3177 375 3 3 3036 103 2 3105 226 3 3 3177 37 3 3 3 3036 103 2 3105 226 3 3 3177 37 3 3 3 3038 111 2 3105 226 3 3 3177 375 3 3 3038 111 2 3108 237 3 3109 321 3 3179 382 3 3038 111 2 3108 241 3 3177 375 3 3 3039 113 2 3108 241 3 3180 381 3 3 3040 187 3 3109 243 3 3180 381 3 3 3040 187 3 3109 243 3 3183 386 3 3 3041 100 2 3110 245 3 3 3183 386 3 3 3044 110 2 3110 245 3 3 3183 386 3 3 3041 110 2 3110 245 3 3 3183 386 3 3 3041 110 2 3110 245 3 3 3183 386 3 3 3041 110 2 3110 245 3 3 3183 386 3 3 3041 110 2 3110 245 3 3 3183 386 3 3 3044 118 2 3112 249 3 3185 389 3 3 3045 120 2 3114 251 3 3186 384 3 3 3046 123 2 3115 254 3 3183 386 3 3 3046 123 2 3115 254 3 3189 395 3 3 3047 125 2 3116 266 3 3199 397 3 3 3048 127 2 3117 267 3 3189 395 3 3 3059 148 3 3122 267 3 3 3059 148 3 3122 267 3 3 3050 149 2 3122 267 3 3 3050 149 3 3122 267 3 3 3050 149 3 3122 267 3 3 3050 149 3 3122 267 3 3 3050 149 3 3122 267 3 3 3050 149 3 3122 267 3 3 3050 149 3 3122 267 3 3 3050 149 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3050 149 3 3 3122 267 3 3 3060 149 3 3 3122 267 3 3 3060 149 3									
3021 78 2 3090 212 3 3 3162 344 3 3 3022 81 2 3091 215 3 3 3163 335 3 3 3023 84 2 3093 217 3 3163 335 3 3 3024 87 2 3093 217 3 3165 353 3 3164 341 3 3 3024 87 2 3093 217 3 3166 355 3 3 3026 108 2 3096 220 3 3167 358 3 3 365 33 3026 108 2 3096 220 3 3167 358 3 3 3002 3028 93 2 3096 220 3 3167 358 3 3 3002 3028 93 2 3097 224 3 3170 365 3 3 3002 95 2 3098 22 3098 22 3 3168 362 2 3 3003 98 2 3099 226 3 3177 361 3 3 3030 98 2 3099 226 3 3177 370 3 3 3031 202 3 3 3100 227 3 3173 373 3 3 3032 206 3 3102 403 3 3101 228 3 3174 379 3 3 3033 206 3 3 3102 403 3 3174 379 3 3 3033 206 3 3 3102 403 3 3175 372 3 3 3036 347 3 3 3104 224 3 3 3176 380 3 3 3036 347 3 3 3104 224 3 3 3176 380 3 3036 347 3 3 3104 224 3 3 3177 375 30 3036 347 3 3 3104 224 3 3 3178 377 375 3 3037 107 2 3106 237 30 3178 377 3 3 3039 113 2 3108 241 3 3181 384 3 3 3041 110 2 3 3109 243 3 3178 379 382 3 3041 110 2 3 3109 243 3 3180 381 3 384 3 3 3041 110 2 3 3109 243 3 3180 381 3 384 3 3 3041 110 2 3 3109 243 3 3183 386 3 3 3041 110 2 3 3102 249 3 3186 394 3 3041 110 2 3 3103 249 3 3180 381 3 3003 3039 113 2 3 308 241 3 3 3180 381 3 3042 116 2 3 3112 246 3 3 3183 386 3 3 3041 110 2 3 3109 243 3 3 3183 386 3 3 3041 110 2 3 3109 243 3 3183 386 3 3 3042 116 2 3 3112 249 3 3185 387 3 3 3044 118 2 3 312 249 3 3185 387 3 3 3044 118 2 3 312 249 3 3185 387 3 3 3046 123 2 3 315 250 3 3 316 338 3 3 304 3 30									
3022 81 2 3091 215 3 3163 335 3 3 3024 87 2 3092 216 3 3164 341 3 3025 89 2 3094 219 3 3165 353 3 3026 108 2 3095 220 3 3166 355 3 3027 92 2 3096 222 3 3167 33 3168 362 3 3029 95 2 3097 224 3 3170 365 3 3029 95 2 3098 223 3 3171 361 3 3030 8 2 3099 226 3 3171 361 3 3031 202 3 3100 227 3 3172 370 3 3031 202 3 3100 227 3 3173 373 3 3032 203 3 3101 228 3 3174 379 3 3033 206 3 3100 227 3 3175 372 3 3034 101 2 3103 229 3 3176 380 3 3034 101 2 3103 229 3 3176 380 3 3036 103 2 3105 236 3 3177 375 3 3037 107 2 3106 237 3 3178 377 3 3038 111 2 3107 240 3 3181 384 3 3040 187 3 3108 241 3 3181 384 3 3041 110 2 3110 245 3 3181 384 3 3041 110 2 3110 245 3 3181 384 3 3040 187 3 3108 241 3 3181 384 3 3041 110 2 3110 245 3 3183 386 3 3041 110 2 3110 245 3 3183 386 3 3041 110 2 3110 245 3 3181 384 3 3040 187 3 3188 305 3 3041 110 2 3110 245 3 3183 386 3 3041 110 2 3110 245 3 3183 386 3 3044 116 2 3117 240 3 3189 395 3 3044 118 2 3117 246 3 3181 384 3 3040 187 3 3188 2 3112 249 3 3185 387 3 3044 118 2 3117 257 3 3189 395 3 3045 120 2 3114 251 3 3189 395 3 3046 123 2 3118 256 3 3189 395 3 3047 125 2 3118 256 3 3189 395 3 3056 143 3 312 2267 3 3057 144 2 3126 271 3 3059 148 3 3122 267 3 3059 148 3 3122 267 3 3068 160 2 3133 286 3 3069 164 2 3123 285 3 3068 160 2 3133 286 3 3069 164 2 3133 286 3 3069 164 2 3138 288 3 3060 149 3 3129 282 3 3060 160 2 3133 286 3 3060 160 2 3133 286 3 3060 160 2 3133 286 3 3060 160 2 3133 286 3 3060 160 2 3133 286 3 3060 160 2 3133 286 3 3060 160 2 3133 286 3 3060 160 2 3133 286 3 3060 160 2 3135 295 3 3060 160 2 3135 295 3 3060 160 2 3139 282 3 3060 160 2 3139 282 3 3060 160 2 3139 282 3 3060 160 2 3139 285 3 3060 160 2 3139 285 3 3060 160 2 3139 286 3 3060 160 2 3139 285 3 3060 160 2 3139 286 3 3060 160 2 3139 282 3 3060 160 2 3139 282 3 3060 160 2 3139 286 3 3060 160 2 3139 282 3 3060 160 2 3139 286 3 3060 160 2 3139 286 3 3060 160 2 3139 285 3 3060 160 2 3139 285 3 3060 160 2 3139 285 3 3060 160 2 3139 300 300 3									
3023 84 2 3092 216 3 3164 341 3 3 3025 89 2 3093 217 3 3 3165 353 3 3 3025 89 2 3094 219 3 3166 355 3 3 3026 108 2 3095 220 3 3167 358 3 3 3027 92 2 2 3096 222 3 3168 362 3 3028 93 2 3097 224 3 3170 365 3 3 3030 88 2 3099 226 3 3 3171 361 3 3030 98 2 3099 226 3 3 3171 361 3 3030 98 2 3099 226 3 3 3171 361 3 3030 98 2 3099 226 3 3 3172 370 3 3 3031 202 3 3 3100 227 3 3 3173 373 3 3032 203 3 3101 228 3 3174 379 3 3 3033 206 3 3 3102 403 3 3175 372 3 3 3033 206 3 3 3102 203 3 3107 228 3 3176 330 3 3033 206 3 3102 203 3 3107 229 3 3 3176 330 3 3035 347 3 3 3104 224 3 3 3176 330 3 3035 347 3 3104 224 3 3 3176 330 3 3036 103 2 2 3105 236 3 3178 377 3 3 3037 107 2 3108 237 3 3180 3179 382 3 3039 111 2 3107 240 3 3180 381 3 3039 111 2 3107 240 3 3180 381 3 3040 187 3 3108 241 3 3181 384 3 3041 110 2 3110 245 3 3180 381 3 3044 110 2 3110 245 3 3180 381 3 3044 110 2 3110 245 3 3180 381 3 3044 110 2 3110 245 3 3 3184 390 3 3044 118 2 3111 246 3 3 3184 390 3 3044 118 2 3111 246 3 3 3184 390 3 3044 118 2 3111 246 3 3 3185 387 3 3044 118 2 3111 246 3 3 3185 387 3 3044 118 2 3111 246 3 3 3186 394 3 3044 118 2 3111 246 3 3 3186 394 3 3046 123 2 3118 250 3 3186 394 3 3047 125 2 3118 258 3 3059 148 3 3059 148 3 3059 148 3 3059 149 25 25 3118 258 3 3050 132 2 3119 261 3 3050 132 2 3131 284 3 3 3050 140 22 3132 265 3 3050 144 2 322 23 333 326 3 3061 155 2 3333 3266 3 3065 146 2 3333									
3024 87 2 3093 217 3 3166 353 3 3 3025 89 2 3094 219 3 3166 355 3 3 3027 92 2 3096 220 3 3167 358 3 3 3027 92 2 3096 222 3 3168 362 3 3 3029 95 2 3099 224 3 3170 365 3 3 3030 98 2 3099 226 3 3171 361 3 3 3031 202 3 3100 227 3 3172 370 3 3 3031 202 3 3 3101 228 3 3 3174 379 3 3 3032 203 3 3101 228 3 3 3174 379 3 3 3033 206 3 3102 403 3 3175 372 3 3 3034 101 2 3103 229 3 3176 380 3 3177 375 3 3 3036 103 2 3105 236 3 3177 375 3 3 3037 107 2 3106 237 3 3178 377 3 3 3038 111 2 3103 229 3 3178 377 3 3 3039 113 2 3108 241 3 3181 384 3 3 3040 187 3 3109 243 3 3181 384 390 3 3041 110 2 3110 245 3 3183 366 3 3 3044 118 2 3113 250 3 3184 390 3 3 3044 118 2 3113 250 3 3184 390 3 3 3044 118 2 3111 246 3 3 3184 390 3 3 3044 118 2 3113 250 3 3184 390 3 3 3044 118 2 3113 250 3 3186 347 3 3 3046 123 2 3116 254 3 3186 394 3 3 3047 125 2 3116 255 3 3 3048 127 2 3116 256 3 3 3049 129 2 3118 258 3 3 3041 12 3 2 312 249 3 3185 387 3 3044 118 2 3113 250 3 3186 394 3 3045 120 2 3110 245 3 3186 394 3 3046 123 2 3115 254 3 3186 394 3 3047 125 2 3116 256 3 3 3048 127 2 3117 257 3 3 3058 146 2 3122 267 3 3 3059 148 3 3122 267 3 3 3059 148 3 3122 267 3 3 3061 150 2 3130 283 3 3 3061 150 2 3132 285 3 3 3061 150 2 3133 266 3 3 3062 160 2 3133 266 3 3 3063 155 2 3133 266 3 3 3066 160 2 3133 266 3 3 3068 163 2 3137 296 3 3 3068 163 2 3137 296 3 3 3068 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3068 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 266 3 3 3069 164 2 3133 306 305 3 3 3069 164 2 3133 306 305 3 3 3069 164 2 3133 306 305 3 3 3069 164 2 3133 306 305 3 3 3069 164 2 3133 306 305 3 3 3069 164 2 3133 306 305 3 3 3069 164 2 3133 306 305 3 3 3069 164 2 3133 306 305 3 3 3069 164 2 3133 306 305 3 306 3 306 3 306 3 306 3 306									
3025 89 2 3094 219 3 3166 355 3 3026 108 2 3095 220 3 3167 358 3 3027 92 2 3096 222 3 3168 362 3 3028 93 2 3097 224 3 3170 365 3 3030 98 2 3099 226 3 3171 361 3 3030 98 2 3099 226 3 3172 370 3 3031 202 3 3100 227 3 3173 373 3 3032 203 3 3101 228 3 3173 373 3 3032 203 3 3101 228 3 3176 390 3 3033 206 3 3102 403 3 3175 372 3 3033 206 3 3102 228 3 3176 390 3 3033 206 3 3102 228 3 3176 390 3 3035 347 3 3104 224 3 3 3176 390 3 3036 103 2 3105 229 3 3176 390 3 3037 107 2 3106 237 3 3178 377 3 3038 111 2 3107 240 3 3180 3179 382 3 3038 111 2 3107 240 3 3180 381 3 3039 113 2 3108 241 3 3181 384 3 3040 187 3 3109 243 3 3182 389 3 3041 110 2 3110 245 3 3183 366 3 3041 110 2 3111 246 3 3181 384 3 3042 116 2 3111 246 3 3181 384 3 3044 118 2 3112 249 3 3185 396 3 3044 118 2 3112 249 3 3186 396 3 3045 120 2 3116 256 3 3187 393 3 3046 123 2 3116 256 3 3187 393 3 3047 125 2 3116 256 3 3189 395 3 3048 127 2 3116 256 3 3189 395 3 3049 129 2 3118 258 3 3051 134 2 3102 263 3 3157 393 3 3052 136 2 3117 264 3 3187 393 3 3056 142 2 3111 266 3 3187 393 3 3057 144 2 3120 263 3 3150 397 3 3058 146 2 312 264 3 3189 395 3 3059 148 3 3120 263 3 3 3056 144 2 3120 263 3 3 3056 144 2 3120 263 3 3057 144 2 3120 263 3 3058 166 2 3131 286 371 3 3068 166 2 3133 286 3 3069 164 2 3133 286 3 3069 164 2 3133 286 3 3068 166 2 3133 286 3 3068 166 2 3133 286 3 3069 164 2 3138 286 3 3069 164 2 3138 286 3 3068 166 2 3133 286 3 3068 166 2 3133 286 3 3068 166 2 3133 286 3 3069 164 2 3138 286 3 3069 164 2 3138 286 3 3069 164 2 3138 286 3 3069 164 2 3138 286 3 3069 164 2 3138 286 3 3069 164 2 3138 286 3 3069 164 2 3138 305 3									
3026 108 2 3095 220 3 3167 358 3 3027 92 2 3096 222 3 3168 362 3 3028 93 2 3097 224 3 3170 365 3 3029 95 2 3098 223 3 3171 361 3 3030 98 2 3099 226 3 3171 361 3 3031 202 3 3100 227 3 3173 373 3 3032 203 3 3101 227 3 3174 379 3 3033 206 3 3102 403 3 3175 372 3 3034 101 2 3103 229 3 3176 380 3 3036 103 2 3105 236 3 3177 375 3 3037 107 2 3106 237 3 3177 375 3 3038 111 2 3107 240 3 3180 381 3 3039 113 2 3108 241 3 3181 384 3 3039 113 2 3108 241 3 3181 384 3 3040 187 3 3109 243 3 3182 389 3 3041 110 2 3110 245 3 3180 381 384 3 3041 110 2 3110 245 3 3182 389 3 3041 110 2 3110 245 3 3180 381 380 381 3 3042 116 2 3111 246 3 3181 384 3 3044 118 2 3113 250 3 3186 394 3 3044 118 2 3113 250 3 3186 394 3 3046 123 2 3115 254 3 3186 394 3 3047 125 2 3116 256 3 3189 395 3 3048 127 2 3116 256 3 3189 395 3 3049 129 2 3118 258 3 3051 134 2 3122 267 3 3058 146 2 3122 267 3 3058 146 2 3121 264 3 3058 148 3 3122 267 3 3058 146 2 3122 267 3 3058 146 2 3122 267 3 3059 148 3 3129 282 3 3051 134 2 3122 267 3 3058 146 2 3121 264 3 3059 148 3 3129 261 3 3050 149 3 3129 261 3 3051 150 2 3131 284 3 3052 3055 142 2 3116 256 3 3 3056 143 3 3122 267 3 3057 144 2 3120 263 3 3058 146 2 3121 264 3 3059 148 3 3122 267 3 3058 146 2 3121 264 3 3059 148 3 3129 261 3 3050 149 3 3129 261 3 3051 150 2 3131 284 3 3052 3055 142 2 3116 256 3 3 3056 143 3 3122 267 3 3057 144 2 3120 263 3 3058 146 2 3121 264 3 3058 146 2 3122 267 3 3059 148 3 3129 262 3 3061 150 2 3130 283 3 3061 150 2 3130 283 3 3061 150 2 3130 283 3 3066 160 2 3133 286 3 3067 167 2 3131 284 3 3068 163 2 3137 296 3 3068 163 2 3137 296 3 3068 163 2 3138 305 3 3069 164 2 3138 305 3 3069 164 2 3138 305 3									
3028   93   2   3097   224   3   3170   365   3									
3029 95 2 3098 223 3 3171 361 3 3 3030 98 2 2 3099 226 3 3172 370 3 3 3031 202 3 3 3100 227 3 3173 373 3 3 3032 203 3 3101 228 3 3174 379 3 3 3033 206 3 3101 228 3 3174 379 3 3 3034 101 2 3103 229 3 3176 380 3 3035 347 3 3104 234 3 3177 375 3 3035 347 3 3104 234 3 3177 375 3 3037 107 2 3106 237 3 3179 382 3 3037 107 2 3106 237 3 3179 382 3 3039 111 2 3103 2 403 3 3180 381 3 3039 113 2 3108 241 3 3180 381 3 3039 113 2 3108 241 3 3181 384 3 3040 187 3 3109 243 3 3182 389 3 3041 110 2 3110 245 3 3183 386 3 3042 116 2 3111 246 3 3183 386 3 3042 116 2 3111 246 3 3183 386 3 3044 118 2 3113 250 3 3185 387 3 3044 118 2 3113 250 3 3185 387 3 3044 118 2 3113 250 3 3185 387 3 3045 120 2 3114 251 3 3187 393 3 3046 123 2 3115 254 3 3187 393 3 3047 125 2 3116 256 3 3187 393 3 3048 127 2 3117 257 3 3055 144 2 312 267 3 3055 144 2 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 144 2 3 312 267 3 3055 148 3 3 312 268 3 3 3055 148 3 3 312 288 3 3 3055 148 3 3 312 288 3 3 3055 148 3 3 312 288 3 3 3055 148 3 3 312 288 3 3 3055 148 3 3 312 288 3 3 3055 148 3 3 312 288 3 3 3055 148 3 3 312 288 3 3 3055 148 3 3 312 288 3 3 3055 148 3 3 312 288 3 3 3055 155 2 3 313 288 33 3 3066 160 2 3135 288 3 3 3066 160 2 3135 288 3 3 3066 160 2 3135 295 3 3355 295 3 3066 160 2 3135 295 3 3355 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160 2 3135 295 3 3066 160	3027	92	2	3096	222	3	3168	362	3
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