Sorting of warm quadrupoles in IR3 and IR7

Acknowledgements: D. Cornuet, S. Fartoukh, J.-B. Jeanneret, S. Ramberger

- Present status of warm quadrupole magnets
- Analysis of magnetic measurements
- Impact on DA of b3
- Sorting of b2 and beta-beating
- Conclusions

Present status of warm quadrupole magnets - I

- 48 warm quadrupoles will be installed in IR3 and IR7.
- 52 have been produced: one prototype and 51 "good" magnets.
- Magnetic measurements have been performed on all of the 51 magnets: each magnet was measured both in the FF (MQWB) and DF (MQWA) configuration.
- The slot of each magnet has to be assigned based on: aperture, beta-beating, and field quality.

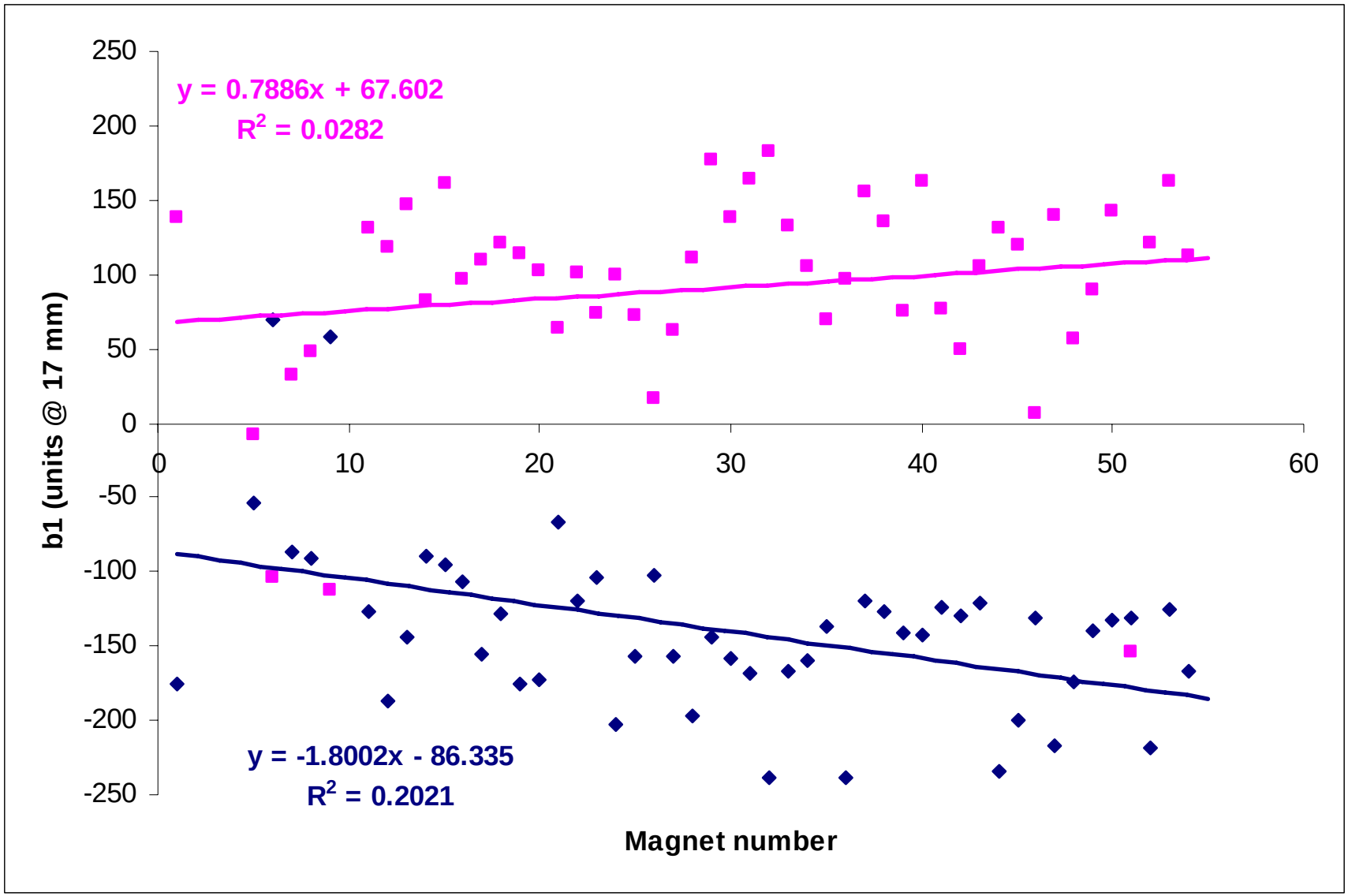
Present status of warm quadrupole magnets - II

- **Aperture**:
  - Critical locations have been identified (JBJ).
  - Vacuum chambers are not installed in the magnets -> perform sorting of vacuum chambers to maximise aperture. The sorting of the magnets can be performed independently choosing between the beta-beating and the field as quality factor.
- **Beta-beating**:
  - a random b2 of about 20 units generates a peak beta-beating of about 3 %.
- **Field quality**:
  - b3 component might have an impact on DA.

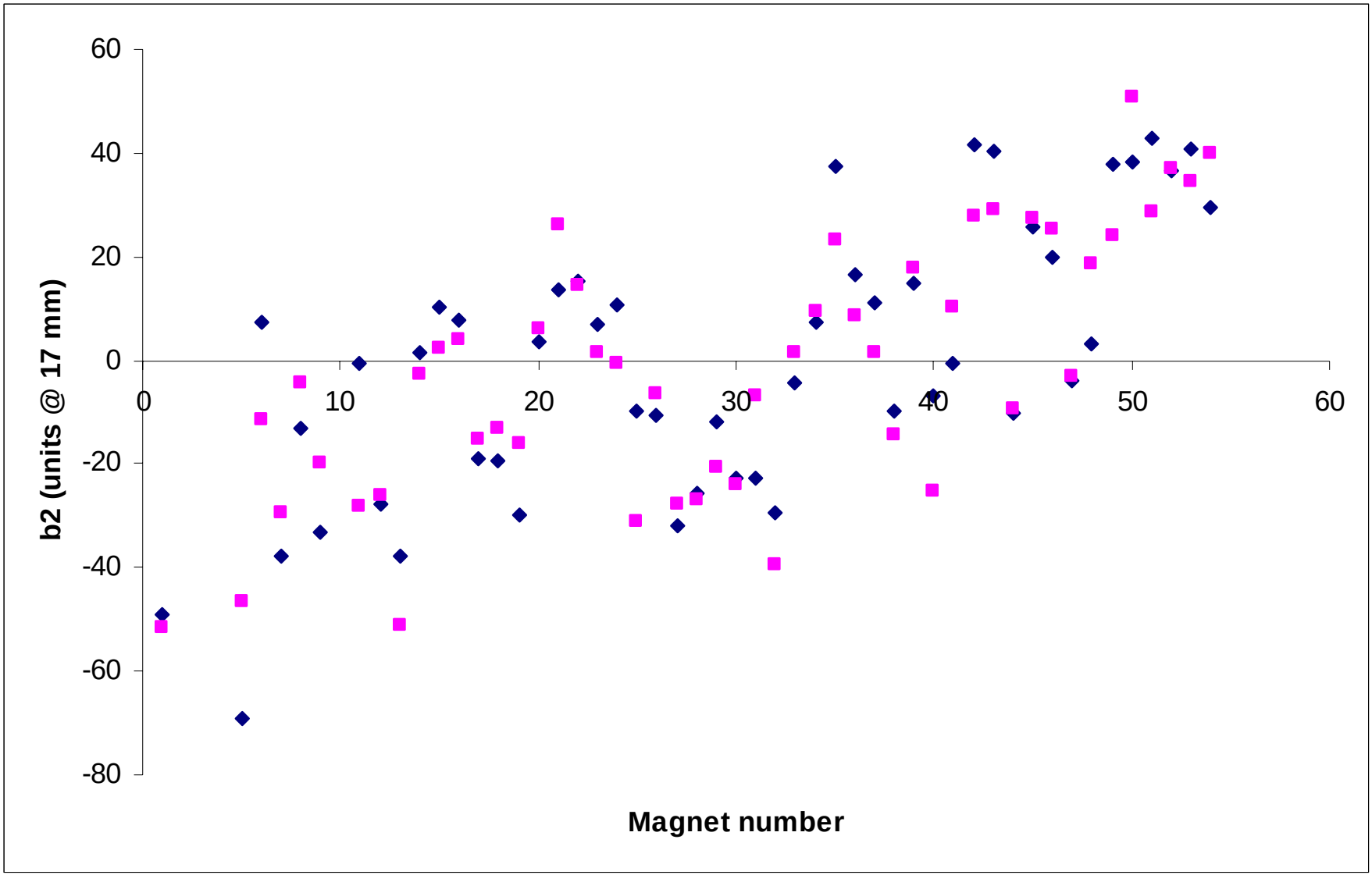
Analysis of results of magnetic measurements - I

- The aim:
  - Assess correlation between multipoles to define an effective sorting strategy.
  - Compute new error tables for **MQWA** and **MQWB** to be used in the tracking campaign.

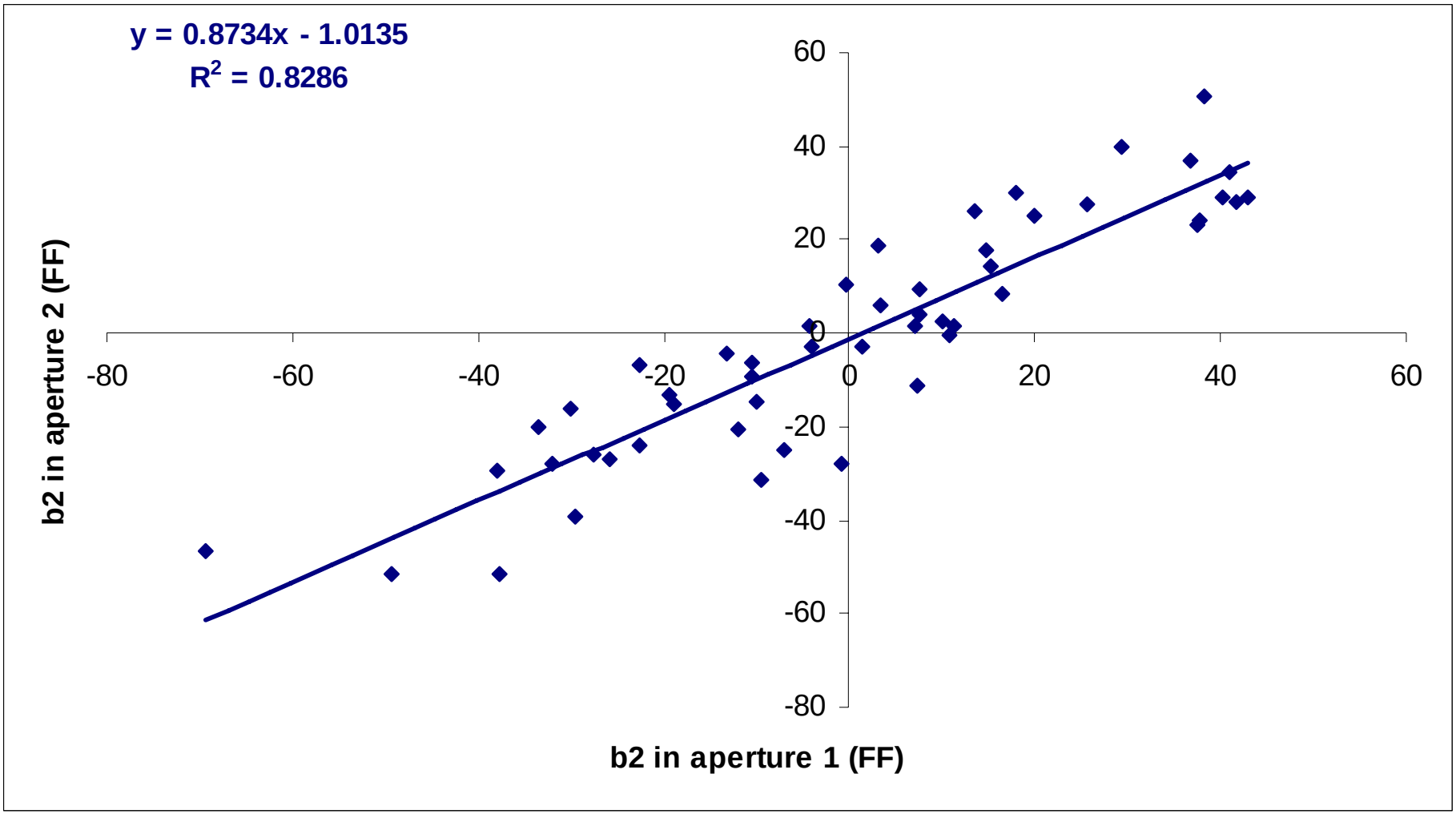
Evolution of dipole component for MQWB at injection



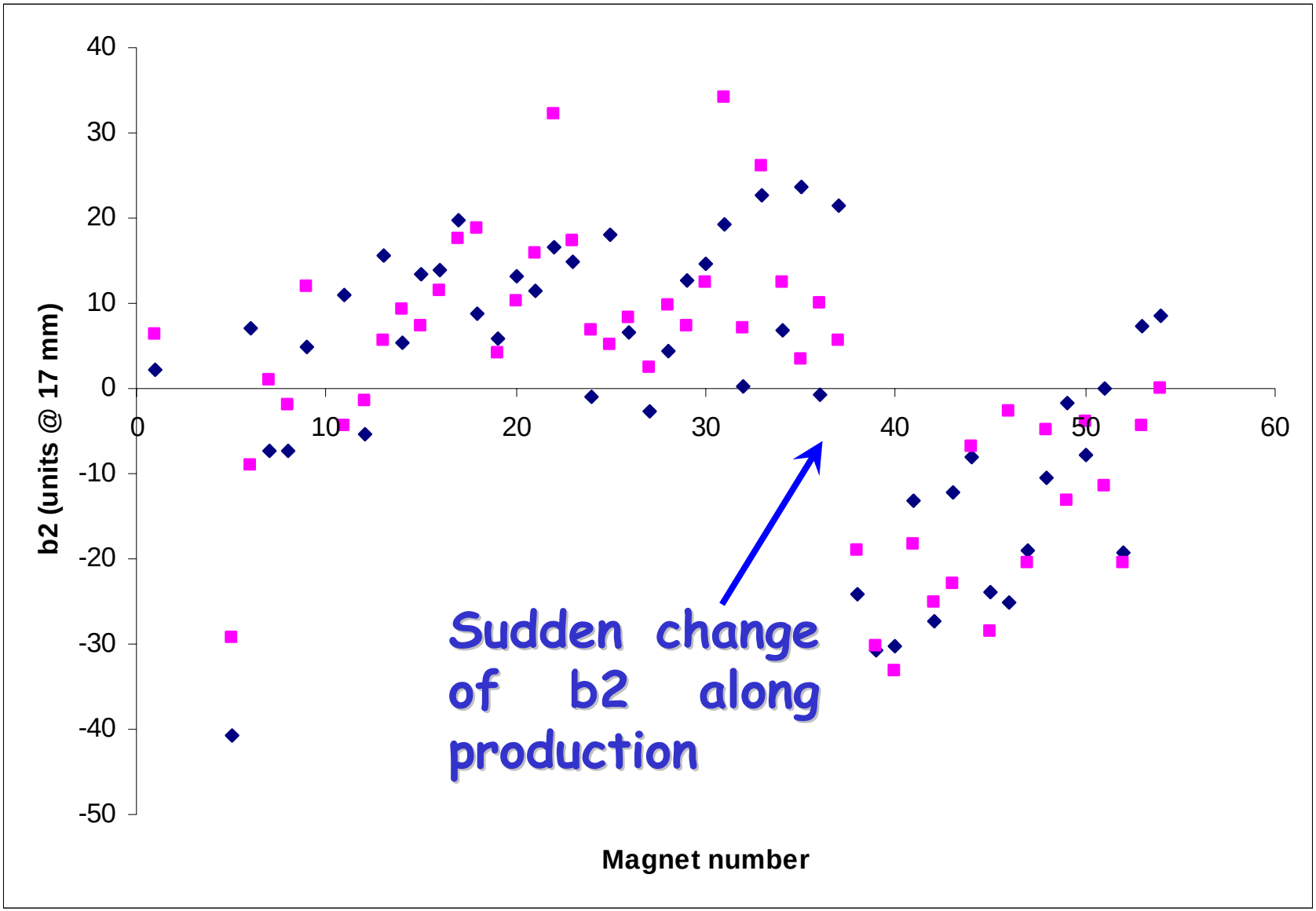
Evolution of quadrupole component for MQWB at injection



Correlation of quadrupole errors between apertures for MQWB at injection



Evolution of quadrupole component for MQWB in collision



Correlation between multipoles

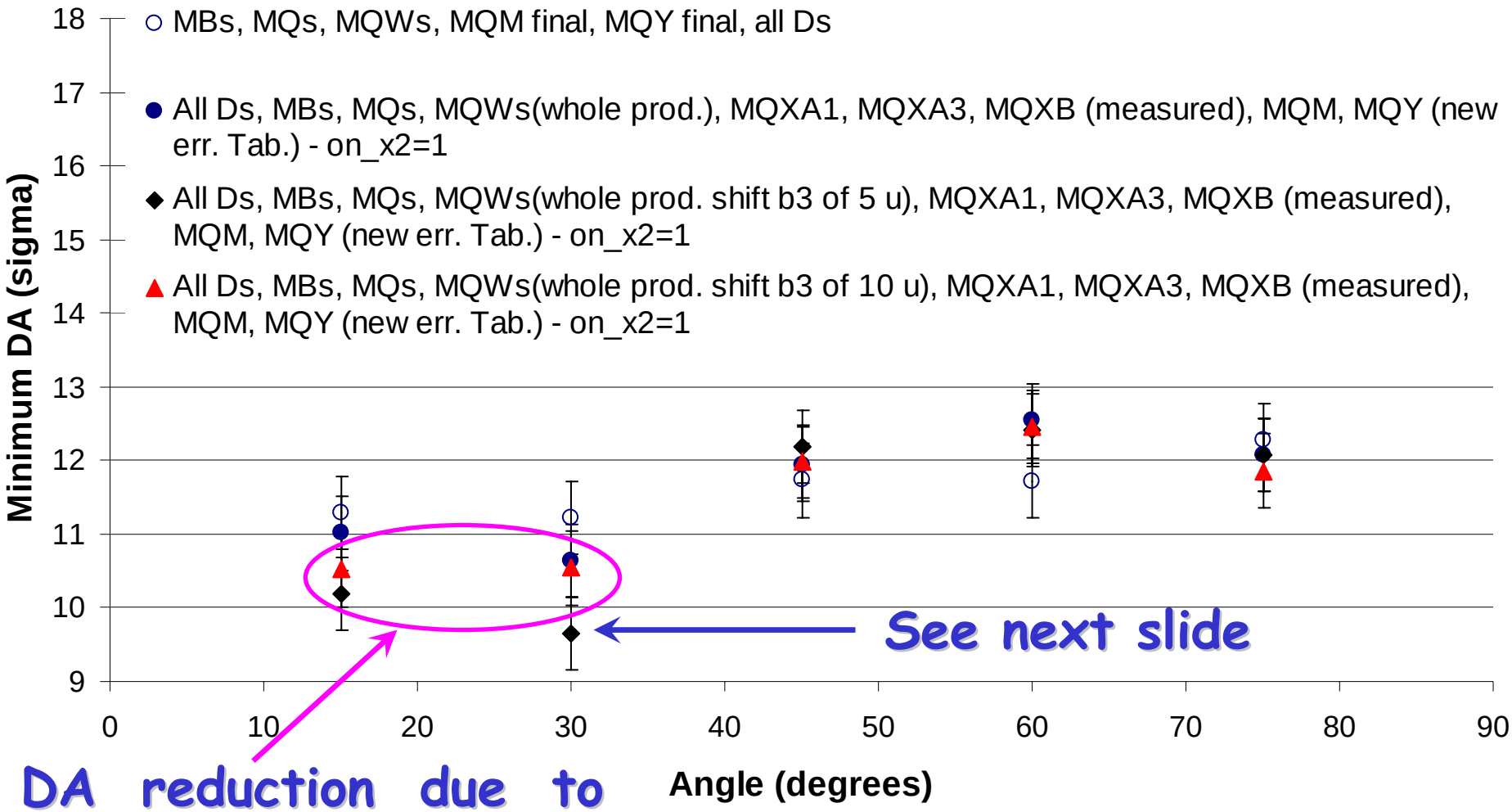
	b2 (ap1)	b1 (ap1)	a1 (ap1)	b3 (ap1)	b2 (ap 2)	b1 (ap 2)	a1 (ap 2)	b3 (ap 2)
b2 (ap1)	1.0000	-0.0693	0.2044	0.5438	0.9103	-0.0419	0.2659	-0.4664
b1 (ap1)		1.0000	0.0371	0.2072	-0.0558	-0.6265	-0.0681	-0.0970
a1 (ap1)			1.0000	0.1273	0.2266	-0.1232	0.0579	-0.1854
b3 (ap1)				1.0000	0.4329	-0.0512	0.1037	-0.5369
b2 (ap 2)					1.0000	-0.0784	0.1956	-0.5081
b1 (ap 2)						1.0000	-0.4158	0.3056
a1 (ap 2)							1.0000	0.0018
b3 (ap 2)								1.0000

Found a good correlation between b2 in ap1 and ap2…only

Tracking studies for MQWs - I

- Tracking setting-up:
  - V6.4 with Q3 moved
  - Injection energy
  - Measured errors in MBs
  - Target errors for MQs (AL)
  - Shift of b6 for MQs in two sectors
  - New measured error tables for MQWs (based on measurement results of 51 MQWs)
  - Expected error tables for cold D1s, D2s, D3s and D4s
  - New signs for the error routines (AL)
  - New target error tables for MQM and MQY quadrupoles.
  - Measured multipoles for MQX

MQWs tracking results – I

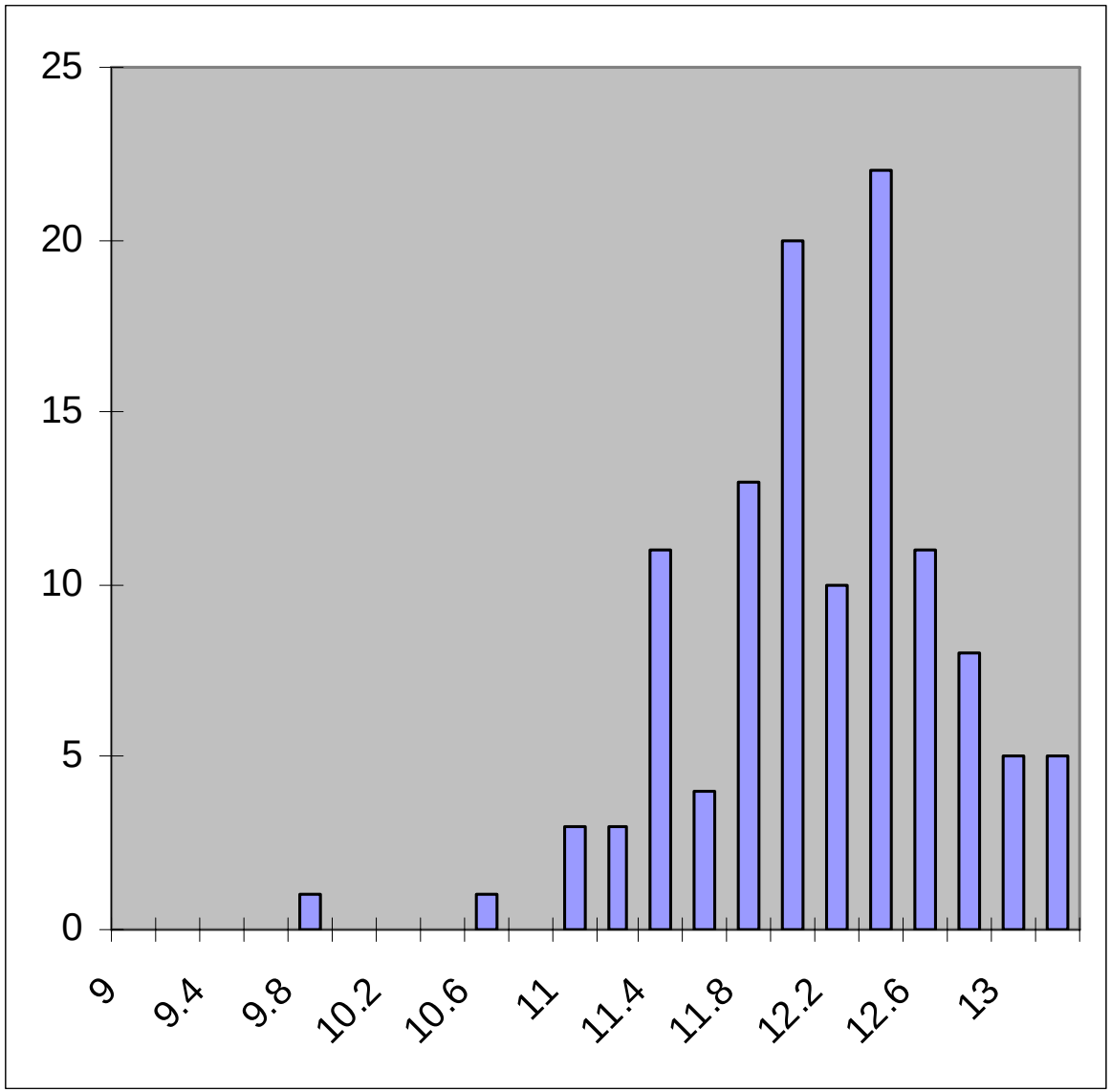


DA reduction due to MQX (see LOC 19/07)

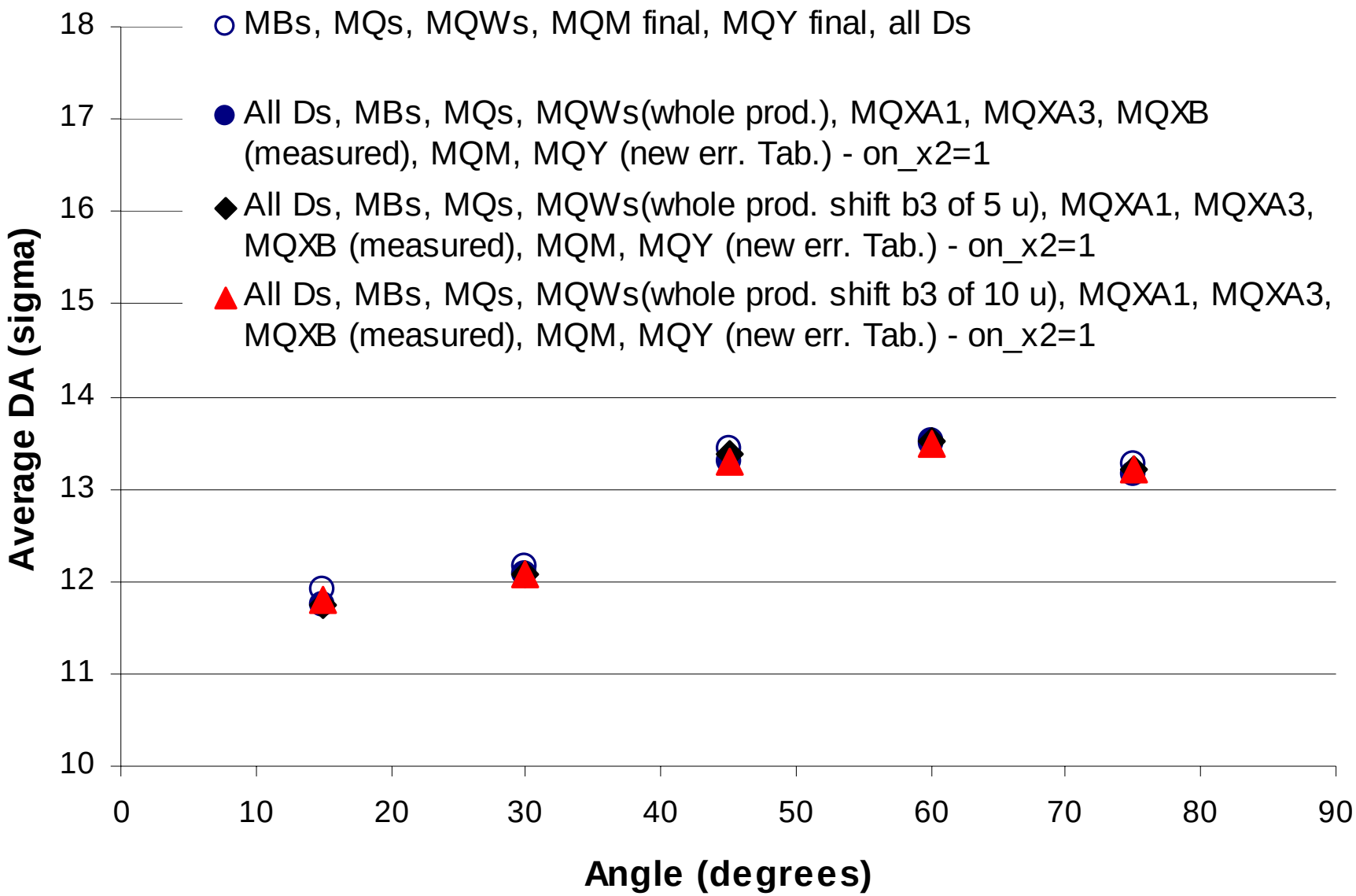
MQWs tracking results - II

Distribution of DA at 30 deg. for the configuration with b3 shifted by 5 units.

120 seeds have been used: only one is below 10 sigma.



MQWs tracking results - III



Sorting for MQWs - I

- Aim: minimise beta-beating by properly choosing the slot of each magnet.
- In previous slides:

$$b_{2,j} = (ITF_j - \langle ITF \rangle)/\langle ITF \rangle$$

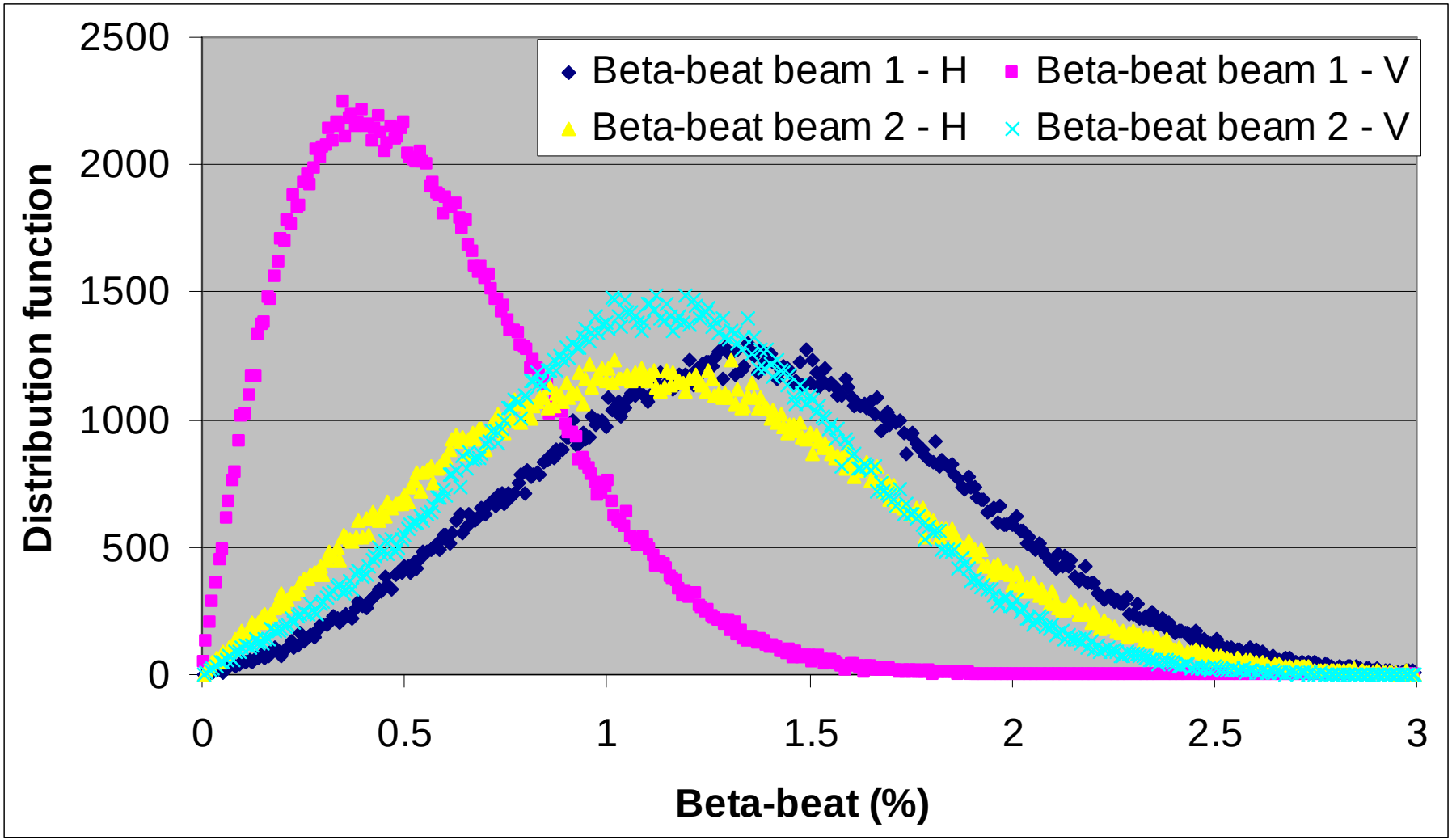
Where the average is computed over the whole set of magnets.

- For the sorting application <ITF> is computed over one circuit, hence unknown a priori.

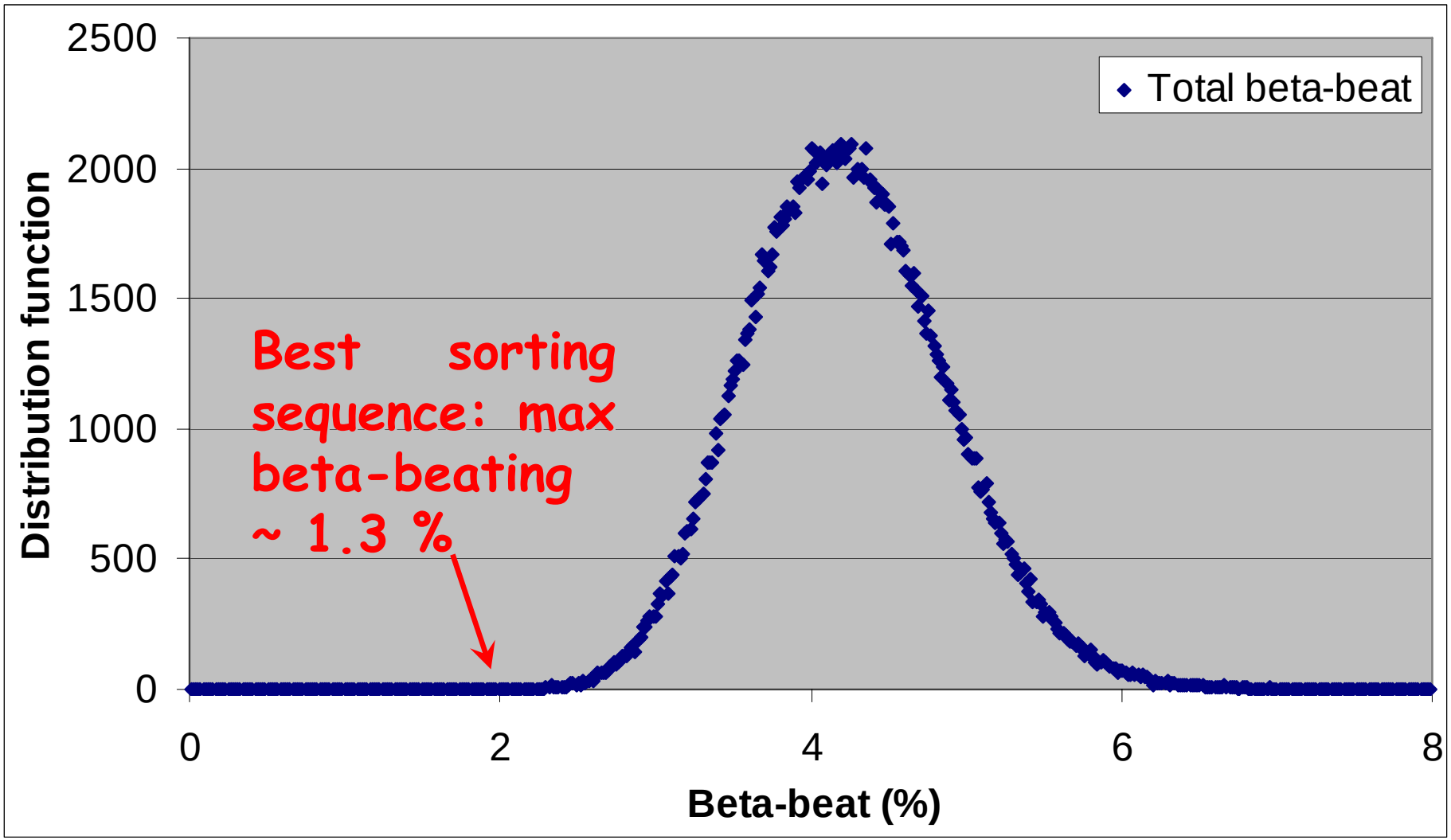
Sorting for MQWs - II

- Approach:
  - The beta-beating in both planes and for both beams is evaluated according to its definition.
  - The locations at which $\Delta\beta(s)/\beta(s)$ is computed are those corresponding to the pick-ups in the whole ring.
  - All the possible subsets of 48 magnets out of the 51 available have been generated (20825 sequences).
  - 10 random permutation of each sequence have been considered.

Sorting for MQWs - III



Sorting for MQWs - IV



Conclusions

- **Magnetic measurements**: correlation between b2 in both apertures.
- **Field quality**: almost no impact on DA.
- **Sorting**: best sequence found feature 2% of total beta-beating, i.e. sum of beta-beating in both planes and for both beams. The maximum beta beating occurs in the H plane for beam 1 and is 1.3 %.
- **Manual sorting (flip-flop) did not prove to be effective.**
- Best sequence found will be communicated to magnet Co-ordinator and it will be used for installation.