

# Dynamic aperture tracking results for the insertion quadrupole magnets

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- Results for MQM-type quadrupoles
- Results for MQY quadrupoles

# Summary of previous studies for MQM-type quadrupoles

Influence of MQMs on DA was first checked using an MQ-like field quality (as of 9901 error tables for MQs): visible effect on DA found (about  $1\sigma$  - see Chamonix 2004).

When results of warm magnetic measurements were made available, these values were used as estimates of field quality: a less pronounced effect was found (marginal on minimum DA - see FQWG 21/09/04).

MQM (geometric at 17 mm, units) $b_6(\text{persistent at inj})=-7.4$				
n	$b_n$	$\sigma_{bn}$	$a_n$	$\sigma_{an}$
3	-0.19	1.09	-0.10	1.56
4	0.24	0.57	0.38	0.98
5	0.02	0.45	0.25	0.40
6	5.31	0.84	-0.09	0.21
7	0.01	0.12	0.00	0.13
8	0.01	0.07	-0.05	0.11
9	-0.01	0.05	0.00	0.05
10	0.30	0.09	0.02	0.02

See **LHC-PR 735**

# New tracking studies - I

- Aim: to evaluate target error tables
- Tracking setting-up:
  - Injection energy
  - Measured errors in MBs
  - Target errors for MQs (AL)
  - Shift of  $b_6$  for MQs in two sectors
  - New measured error tables for MQWs (based on measurement results of 22 MQWs)
  - Expected error tables for cold D1s, D2s, D3s and D4s
  - New signs for the error routines (AL)
  - Initial field quality for MQMs: measured multipoles (systematic and random)

# New tracking studies - II

## ● Procedure:

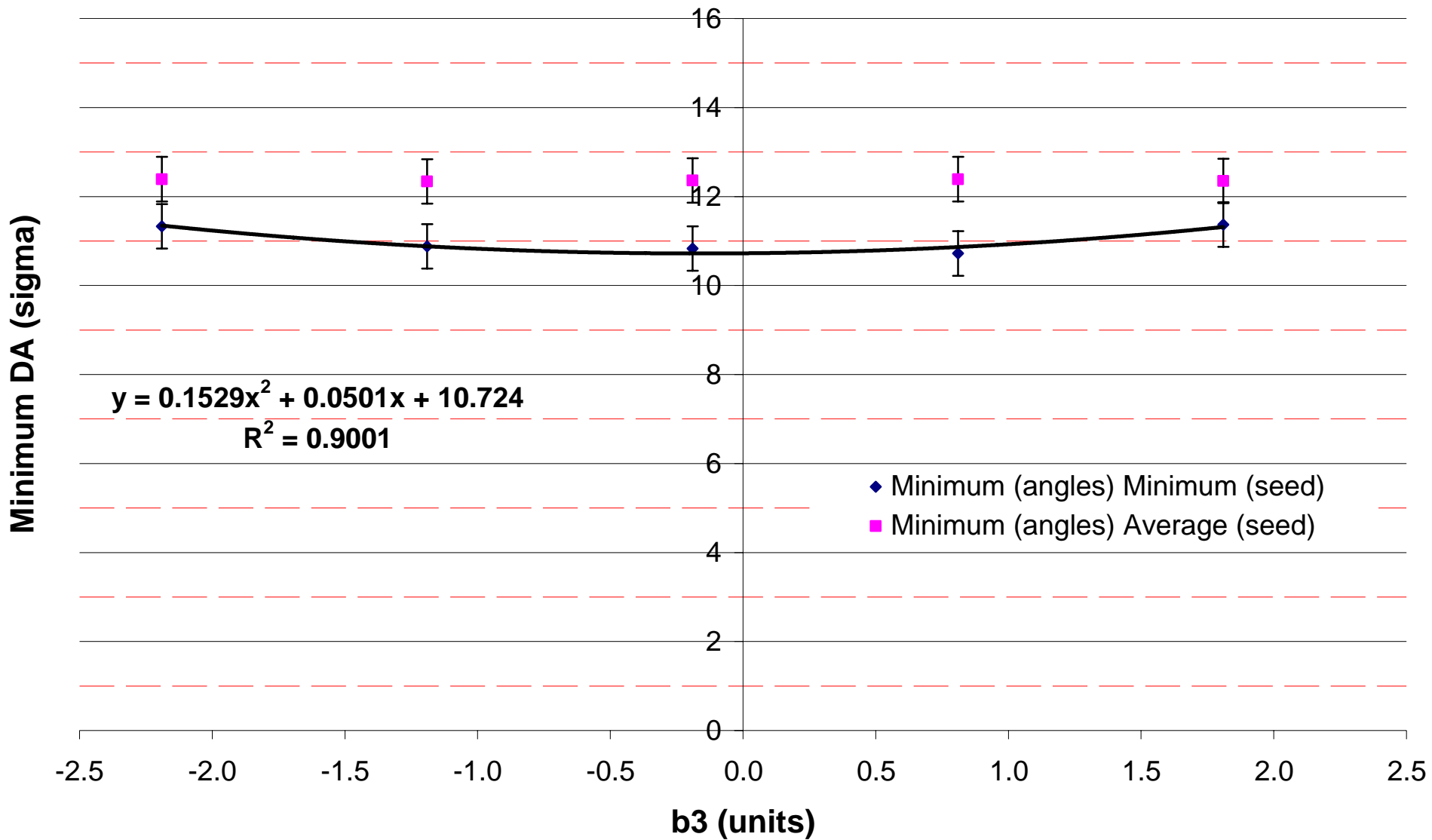
### ● Random errors in MQMs:

- assumed constant and equal to measured ones

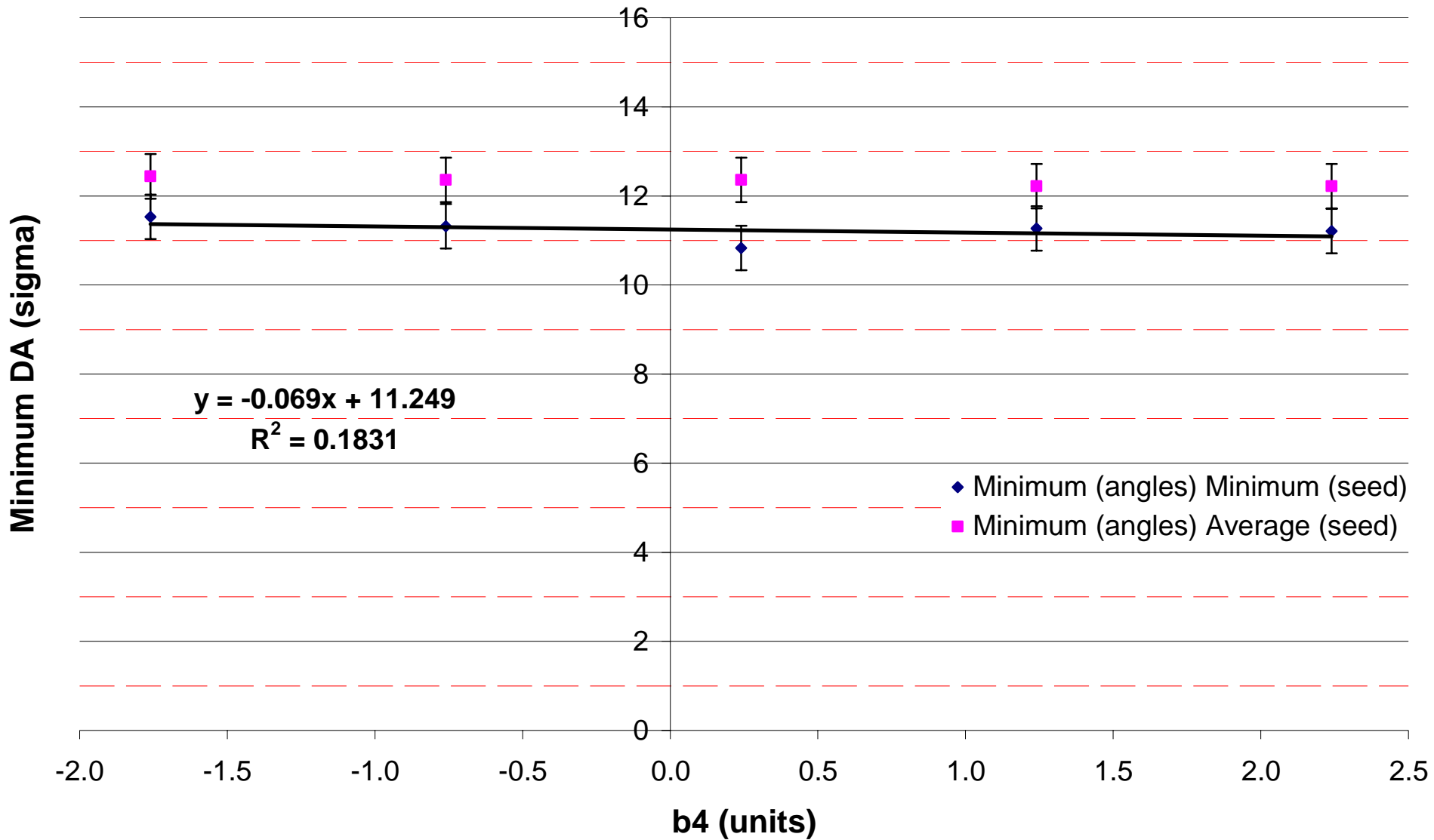
### ● Systematic multipoles in MQMs:

- changed one by one. Five values considered (including nominal one). Step is 1 unit
- Multipoles from b3 to b10 are varied

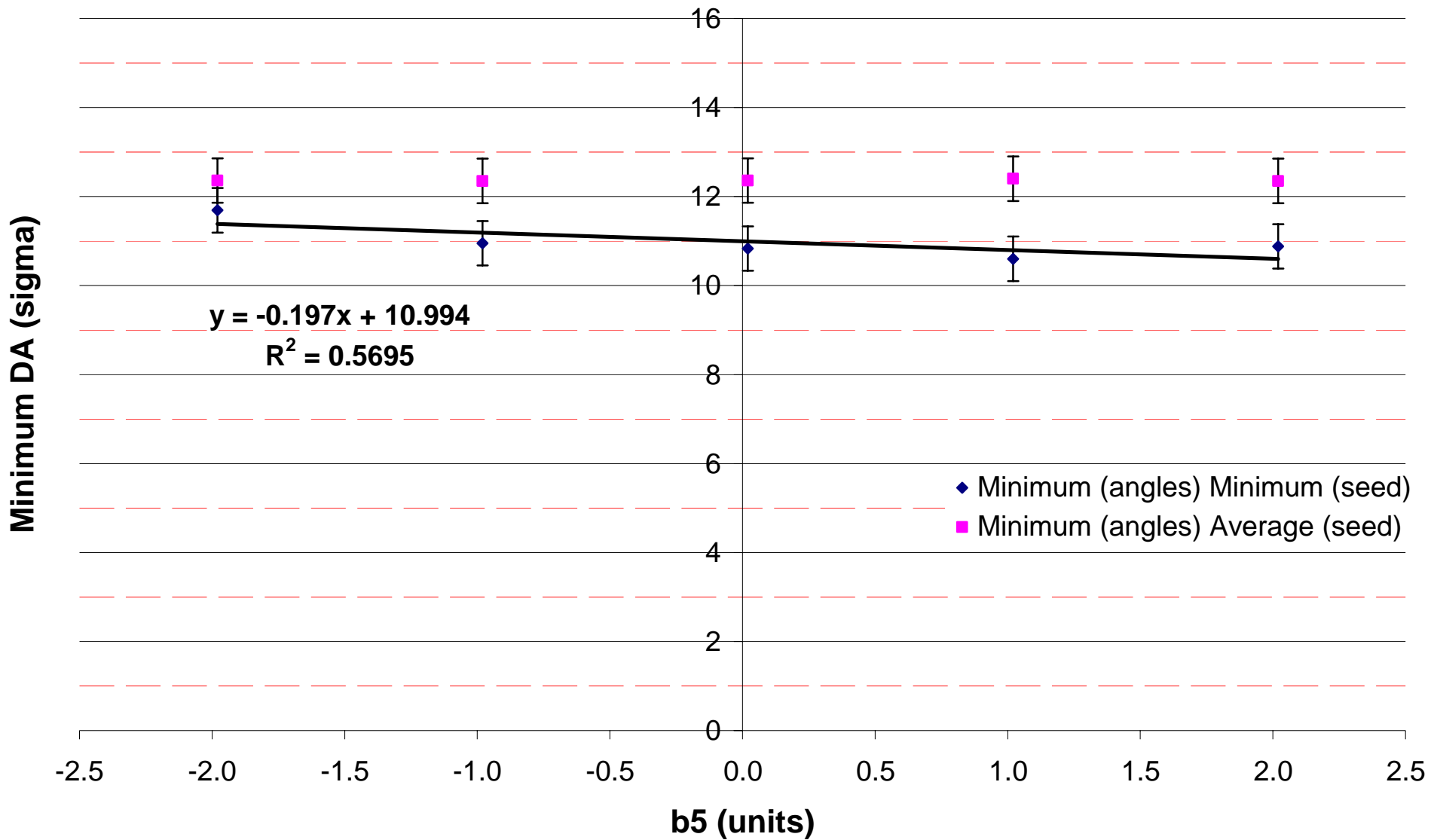
# MQMs tracking results - I



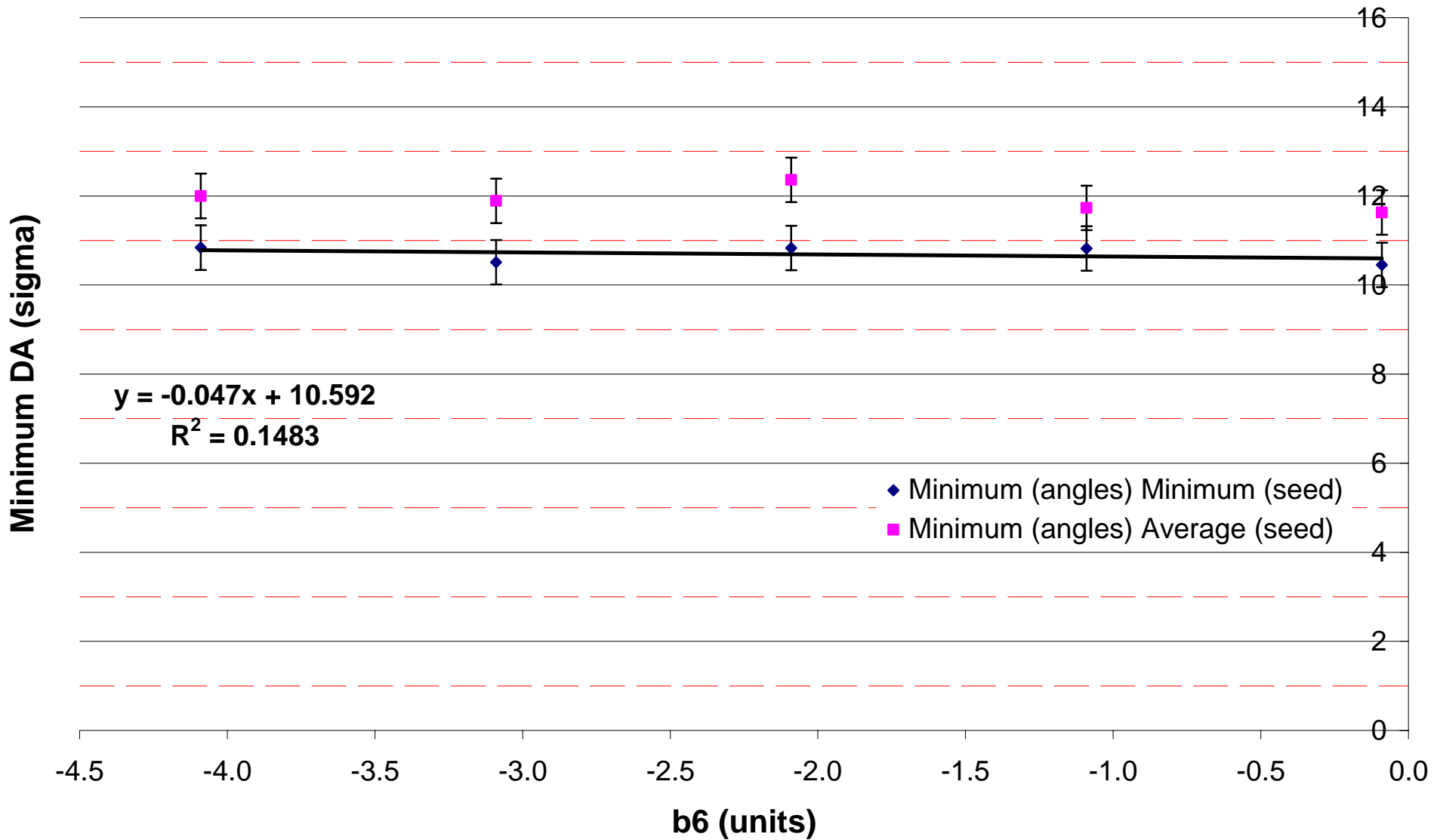
# MQMs tracking results - II



# MQMs tracking results - III

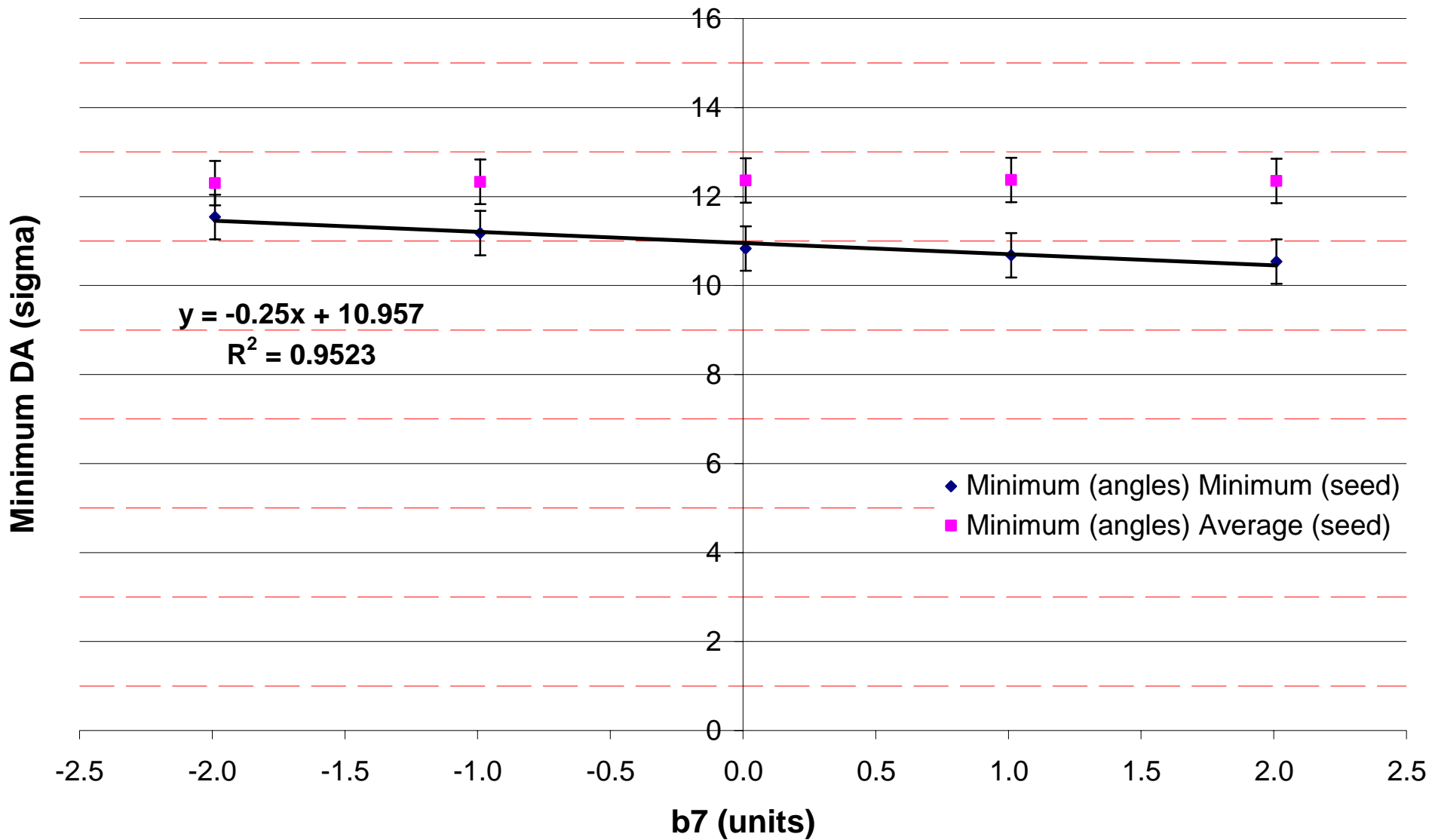


# MQMs tracking results - IV

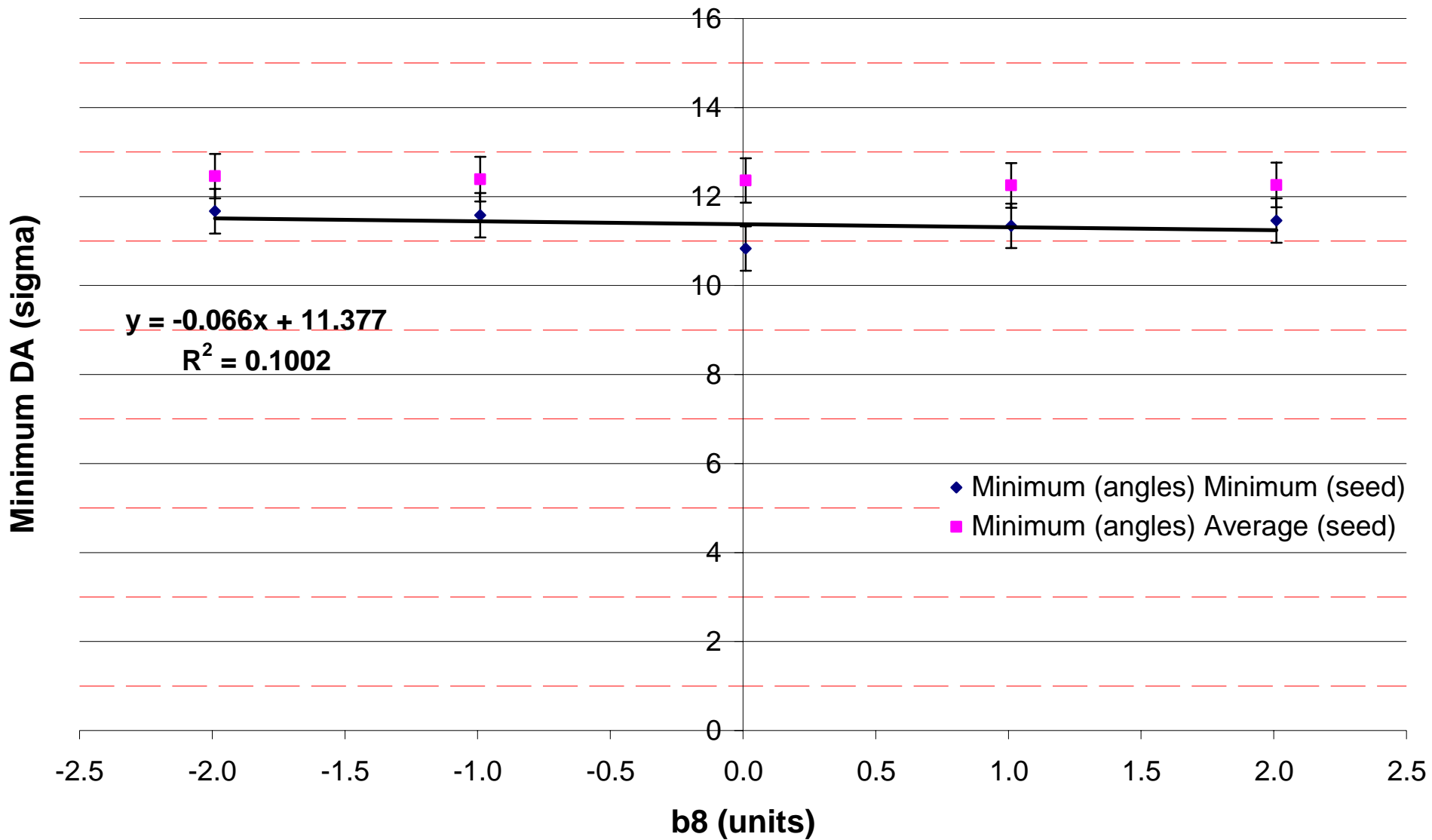




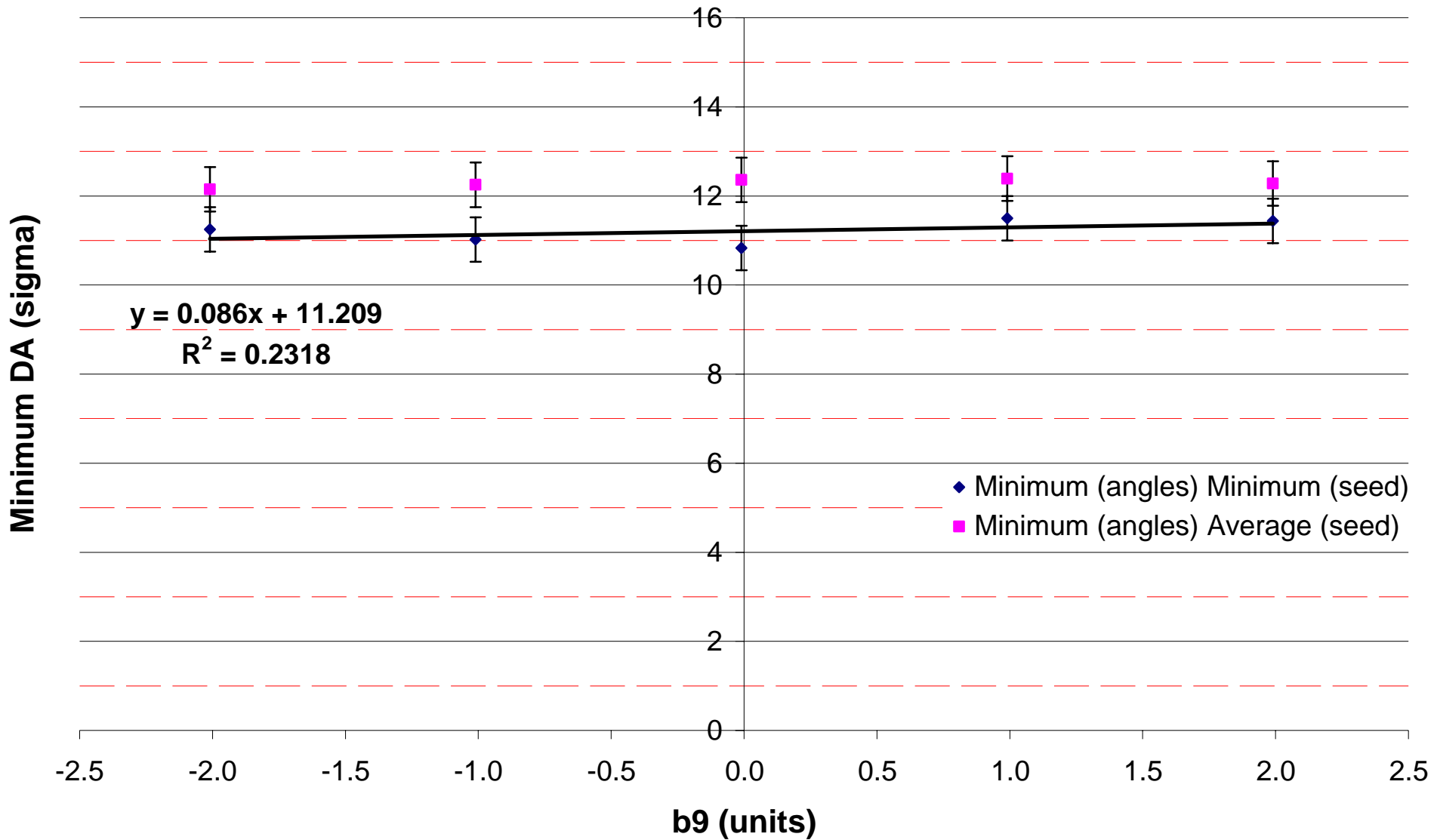
# MQMs tracking results - V



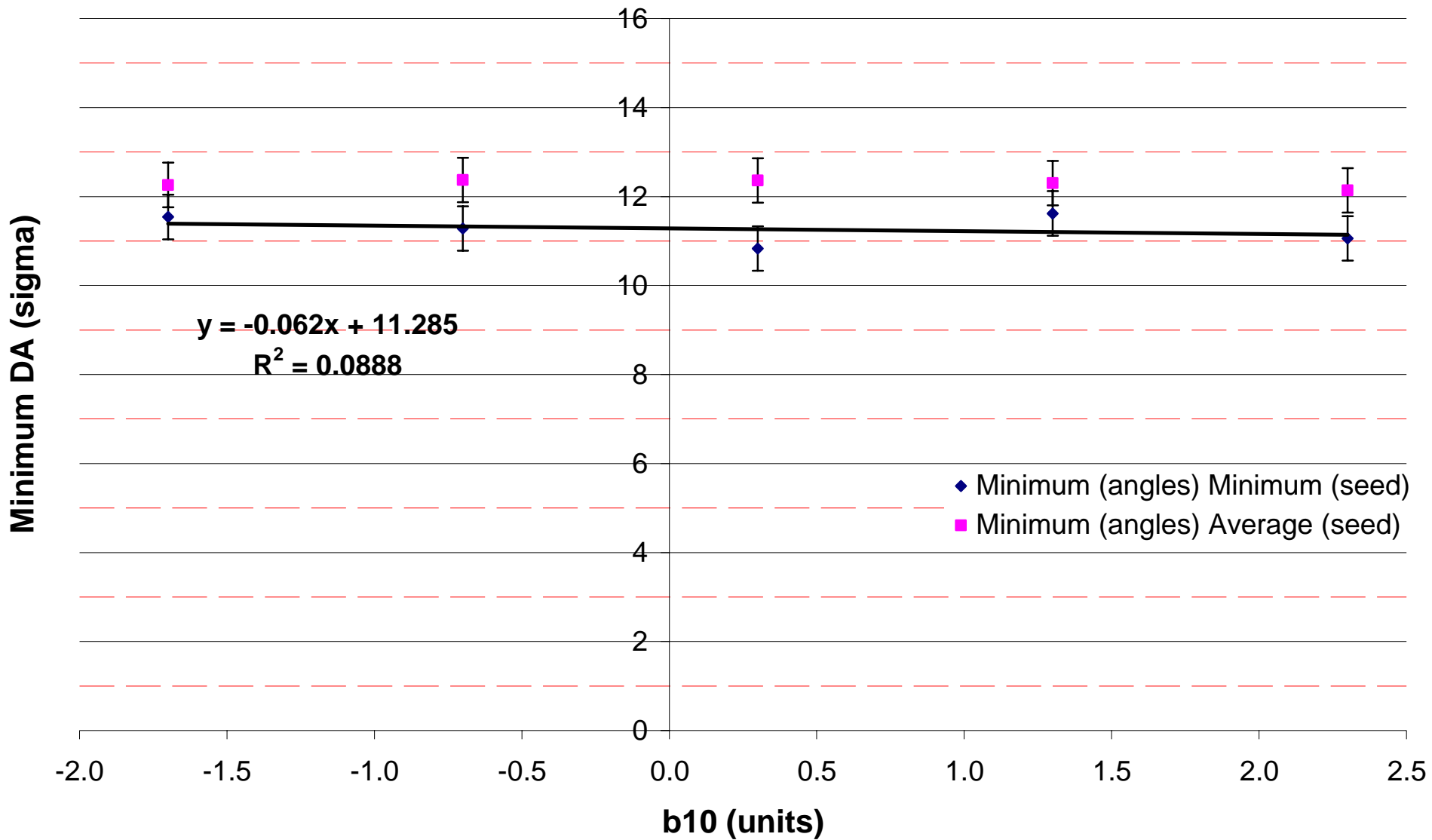
# MQMs tracking results - VI



# MQMs tracking results - VII



# MQMs tracking results - VIII



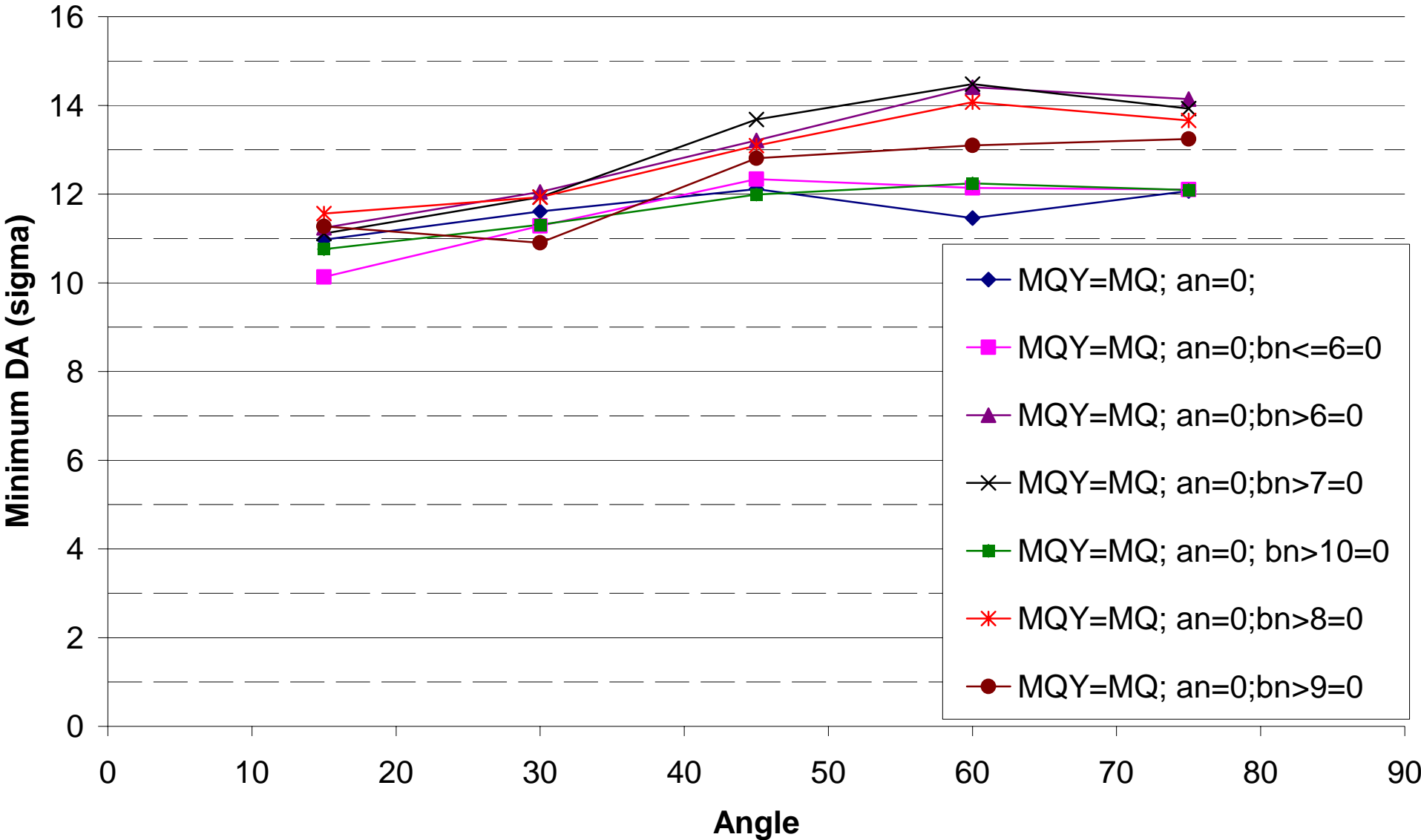
# Summary of studies for MQMs

- Minimum DA with measured field quality is  $10.8 \sigma$
- Almost no dependence on systematic multipoles, but b7.
- Based on previous observation, an uncertainty of 1 unit (corresponding to a variation of bn of  $\pm 0.5$  units) has been assumed.
- Tracking with such field quality, i.e. measured multipoles+uncertainty, done: results to be analysed.
- Tracking taking into account hysteresis effects to be done.
- Effect of beam screen?

# First part of tracking studies for MQY quadrupoles

- Aim: To determine harmful multipole(s)
- Errors used in the tracking campaign (to be compatible with previous studies - see **LHC-PR-771**):
  - Measured errors for MBs
  - 0210 errors for MQs
  - Expected errors for D1s, D2s (see **LHC-MBR-ES-0001 rev 2** and also **BNL Magnet Division Note 598-32**)
  - MQs-like errors for MQMs
  - MQs-like errors for MQYs
  - Old signs for error routines

# MQYs tracking results



# Summary of studies for MQYs and outlook

- Assuming MQ-like field quality for MQYs quadrupoles:
  - Skew multipoles have critical impact on DA.
  - High-order normal multipoles have a critical impact on DA.
- Target field quality will be determined starting from measured multipoles (same approach as for MQMs):
  - Scan over skew multipoles
  - Scan over normal multipoles

MQY (geometric at 17 mm, units) $b_6(\text{persistent at inj})=-1.6$			
$b_n$	$\sigma_{bn}$	$a_n$	$\sigma_{an}$
-0.02	1.13	-0.10	0.60
0.03	0.16	0.00	0.31
0.01	0.17	-0.01	0.18
1.22	0.22	-0.16	0.07
-0.01	0.02	0.00	0.02
0.03	0.05	-0.01	0.04
0.01	0.01	0.00	0.01
-0.37	0.01	0.01	0.01

See **LHC-PR 735**