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MEBT Steerers' history

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Abstract: Tunes from 2023 and 2005 are compared. It makes the case that misalignments have changed, notably those into and out of the 90° bend section. They are now rather large, suggesting the 45° dipoles should be re-levelled.

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1 Introduction

Steerers in MEBT are listed in the table. The 'Stinson' steerers[1] were de-

Table 1: MEBT steerers

Name	Type	$\int Bds$/Gm@	I_{max}/A
X,YCB1	AECL	62.5	3
X,YCB3	Stinson	70	100
X,YCB5	AECL	62.5	3
YCB7A,B	Stinson	70	100
X,YCB9	Stinson	70	100
YCB11	in Q11	60(?)	3
XCB12	in Q12	60(?)	3

signed by Glen Stinson, are quite powerful, and are water-cooled. They can be powered up to 200 Amps but in MEBT have power supplies of 100 Amps. The 'AECL' steerers[2, Fig.2a] are air-cooled and have about 30 times as many turns as compared with the Stinson steerers, so at 5 Amps are as strong as the Stinson steerers at 100 Amps. But they are actually dangerously hot to the touch at that current.

Two steerers are built into the coils of MEBT:Q11,12. These also have maximum current of 3A, but little appears to be known about them. I am guessing they have the same strength per Amp as the AECL steerers.

2 How to scale

The steering strengths (currents I_{CB}) required in principle scale with rigidity $B\rho$, which depends upon A/Q, which is not known from the stored tunes. However, we can use the strength of the 45° dipoles (MEBT:MB1 CUR) as a proxy. The dipole has a $\rho = 0.30\,\mathrm{m}$ and a field of 25.5 G per Amp of current (I_{MB1}), so

$$B\rho = (7.65\,\mathrm{Gm/A})\, I_{\mathrm{MB1}} \tag{1}$$

The deflection θ due to a steerer is thus

$$\theta = \frac{\int Bds}{B\rho} = \frac{62.5 I_{\mathrm{CB}}/(3\,\mathrm{A})}{7.65\, I_{\mathrm{MB1}}/(1\,\mathrm{A})} = 2700\,\mathrm{mrad}\,\frac{I_{\mathrm{CB}}}{I_{\mathrm{MB1}}} \tag{2}$$

for AECL steerers, and

$$\theta = \frac{\int Bds}{B\rho} = \frac{70 I_{\mathrm{CB}}/(100\,\mathrm{A})}{7.65\, I_{\mathrm{MB1}}/(1\,\mathrm{A})} = 90\,\mathrm{mrad}\,\frac{I_{\mathrm{CB}}}{I_{\mathrm{MB1}}} \tag{3}$$

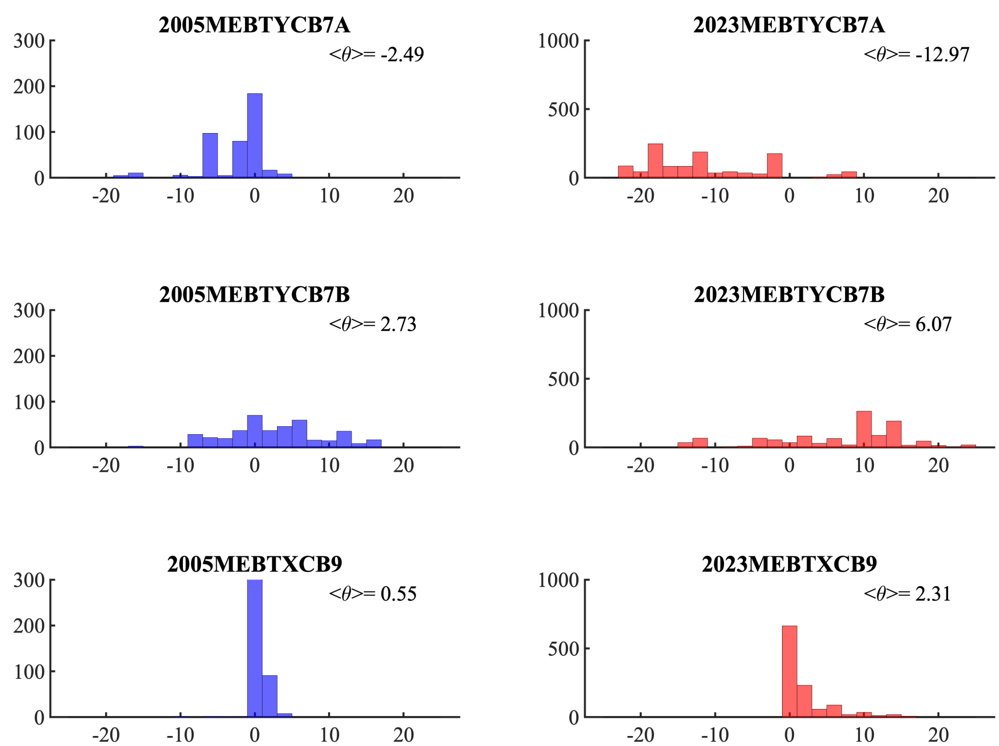
for Stinson steerers.

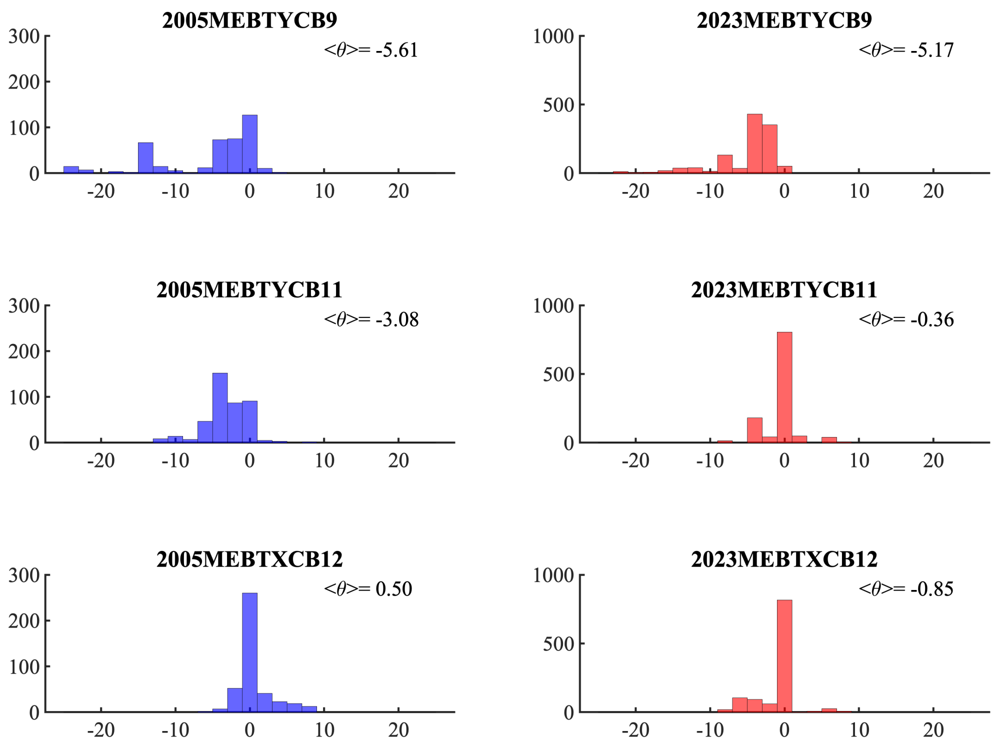
Unfortunately, this does not work for the steerers upstream of the stripper, since we do not know from the logged tune, what is the ratio of the charge state before and after the stripper. Thus we cannot apply it to steerers 1, 3, and 5.

3 Results

Histograms of the steerer tunes from 2023 are compared below with tunes from 2005. The 2023 are to the right in red, and the 2005 at left in blue. The x axis is the steerer deflection θ in milliradians. The average for the year is shown in upper right of each plot. Expected corrections due to construction tolerances are in the range of a few milliradians only, so corrections of order 20 milliradians indicate a serious alignment problem.

The largest such is YCB7A, the vertical steerer just upstream of the dipole MB1. Its 2023 average is 13 mrad, but had shifted by 10.5 mrad compared with the correction used in 2005. The YCB7B has changed also, but by obly 3.3 mrad. It indicates that something had changed over that time span. A previous study by Olivier Shelbaya[3] indicates that the change was gradual, not sudden. So a possible reason is that the dipole MB1 or possibly both MB1 and MB2 have tilted due to floor settling. The roll angle would be about 1°.





References

[1] G. Stinson, A design for a 4-in. x-y steerer for the MEBT beam line, Tech. Rep. TRI-DNA-99-02, TRIUMF (1999).

[2] G. Stinson, A simple 6-in. x-y steerer for the DRAGON facility, Tech. Rep. TRI-DNA-98-07, TRIUMF (1998).

[3] O. Shelbaya, Status of Model Coupled Accelerator Tuning at ISAC-I, Tech. Rep. TRI-BN-21-07, TRIUMF (2021).