New μE4: Calibration and DAC calculations for slits and magnets

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For additional information, see also the logbook "*New μE4 beam line, 18.8.2004 –*" pages two and five, and the folder *new μE4: Beamline Components*.

1 The slits FS61LR, FS61V, FS62LR, FS63LR, FS63V

The calibration of the slits is according to the reference numbers given at the slit control boards on the μE4 gallery. The slits are closed at DAC values between 44 and 46. The vertical slits have there open position at DAC values of about 880, the horizontal slits at 520 (FS61,63) and 580 (FS62).

FS61LR	$x_h = 20\text{ cm} \cdot \frac{\text{DAC}-45}{525-45}$	$\text{DAC} = \frac{x_h}{20\text{cm}} \cdot (525-45)+45$
FS61V	$y_f = 40\text{ cm} \cdot \frac{\text{DAC}-46}{886-46}$	$\text{DAC} = \frac{y_f}{40\text{cm}} \cdot (886-46)+46$
FS62LR	$x_h = 20\text{ cm} \cdot \frac{\text{DAC}-45}{582-45}$	$\text{DAC} = \frac{x_h}{20\text{cm}} \cdot (582-45)+45$
FS63LR	$x_h = 20\text{ cm} \cdot \frac{\text{DAC}-44}{520-44}$	$\text{DAC} = \frac{x_h}{20\text{cm}} \cdot (520-44)+44$
FS63V	$y_f = 40\text{ cm} \cdot \frac{\text{DAC}-45}{880-45}$	$\text{DAC} = \frac{y_f}{40\text{cm}} \cdot (880-45)+45$

Table 1: Note, that x_h denotes the *half* opening of the slits, whereas y_f is the full opening.

2 The bending magnets ASR61, ASR62 and ASR63

According to the calibration of the magnet group the magnetic fields of the bending magnets are calculated and summarized in Tab. 2. The bending angles are 40^o to the left for ASR61, which has a pole face rotation of 35^o, and 34^o for ASR62 and ASR63 with 17^o pole face rotation each (ASR62 bends to the right and ASR63 to the left). The output current of the power supply for

`ASR61`	$B(I) = 6.4 + 2.8876 \cdot I$	$I = \frac{B(I)-6.4}{2.8876}$	$\text{DAC} = I/500 \cdot 4095$
`ASR62`	$B(I) = 10.0 + 2.8596 \cdot I$	$I = \frac{B(I)-10.0}{2.8596}$	$\text{DAC} = I/500 \cdot 4095$
`ASR63`	$B(I) = 5.9 + 2.8993 \cdot I$	$I = \frac{B(I)-5.9}{2.8993}$	$\text{DAC} = I/500 \cdot 4095$

Table 2: Field and current values for the `ASR` bending magnets, field in Gauss, current in A.

`ASR62` does not properly scale with the DAC values. Therefore, when scaling the beam momentum, the DAC values of `ASR62` have to be slightly changed. It is anyway a good idea to check the bending magnets with closed slits before momentum scans over a large momentum range: try to find proper ASR settings by switching off WSXs and QSMs, and setting horizontal slits to ± 1 cm:
FS61-LR = 69, FS61-V=100
FS62-LR = 72
FS63-LR = 68, FS63-V=100.

For $p0$ = 28 MeV/c the following scaling of ASR power supplies has been found experimentally (within PSI intranet check http://lem00:8000/BeamScanner_Experiment/77 and http://lem00:8000/BeamScanner_Experiment/80 for more details):

beam momentum	DAC `ASR61`	DAC `ASR62`	DAC `ASR63`	scale DAC
$0.80 \cdot p0$	2548	2278	2183	$\times 0.80$
$0.90 \cdot p0$	2548	2276	2183	$\times 0.90$
$0.92 \cdot p0$	2548	2278	2183	$\times 0.92$
$0.94 \cdot p0$	2548	2280	2183	$\times 0.94$
$0.96 \cdot p0$	2548	2282	2183	$\times 0.96$
$0.98 \cdot p0$	2548	2282	2183	$\times 0.98$
$1.00 \cdot p0$	2548	2282	2183	$\times 1.00$
$1.05 \cdot p0$	2548	2285	2183	$\times 1.05$
$1.50 \cdot p0$	2548	2295	2183	$\times 1.50$

Table 3: ASR DAC values when scaling beam momentum. $p0$ = 28 MeV/c.

3 The quadrupole magnets QSM

QSM(601 – 610)	$B_{pole}(I) = 7.24 \cdot I$	$I = B_{pole}/7.24$	DAC $= I/250 \cdot 4095$
QSM(611 – 612	$B_{pole}(I) = 7.24 \cdot I$	$I = B_{pole}/7.24$	DAC $= I/500 \cdot 4095$

Table 4: Pole tip field B_{pole} and current values I for the QSM quadrupoles, field in Gauss, current in A. A current of 250 A corresponds to a pole tip field $B_{pole} = 1810$ G (instead of 1975 G, used before 04-Nov-2004). Note, that the real pole tip field is 2.26 kG, because the QSM is not a "real" quadrupole but it has higher order components to correct for geometric abberations. The value of 1810 G corresponds to the measured field gradient of 90.5 G/cm close to the beam axis (20 cm aperture).

4 The solenoids WSX61 and WSX62

Since the two solenoids are close together a current in one solenoids generates a magnetic field in the centre of the other solenoid. The calibration is summarized in Tab. 5.

WSX61	$B_{61}(I) = a \cdot I_{61} + b \cdot I_{62}$	$I_{61} = \frac{a \cdot B_{61} - b \cdot B_{62}}{a^2 - b^2}$	DAC $= I_{61}/375 \cdot 4095$
WSX62	$B_{62}(I) = b \cdot I_{61} + a \cdot I_{62}$	$I_{62} = \frac{a \cdot B_{62} - b \cdot B_{61}}{a^2 - b^2}$	DAC $= I_{62}/300 \cdot 4095$

Table 5: Magnetic fields $B_{61,62}$ in Gauss in the centre of each solenoid with the constants $a = 8.905$ G/A and $b = 0.241$ G/A, currents $I_{61,62}$ in Ampere.