

## Analysis of the Archived Data of the BTS and Pulse Magnet Settings

November 24, 2003

Hiroshi Nishimura  
Advanced Light Source  
LBNL, CA 94720

### 1. Objectives

There are two purposes of this note:

- (1) Back up the engineering calculation for the BR update, and
- (2) Help to establish the setting for lower energy operation for CIRCE studies.

BTS magnets and pulse magnets for BR extraction and SR injection are covered. The timing settings of these pulse magnets are not included.

Needless to say, the empirical formulas we provide later are to be optimized carefully before any real operation.

### 2. Input Data

There are data files on W: containing the set values of these magnets accumulated over ten years of machine operation.

The BTS magnet settings have been taken care of by the **BTSmag** program. Its data files are stored in **w:\pbblic\BTSmag** directory with the file name extension BTS. There are 110 BTS magnet settings files accumulated for over 10 years of operation as of 11/21/2003.

On the other hand, the pulse magnet settings have been taken care of the **Pulse** program. Its data directory is **w:\public\Pulse**. There are 20 files as of 11/21/2003. ( Caution: timing settings are not covered. They are only for current settings.)

Currently, two programs, **BTSmag** and **Pulse**, are being upgraded to be one. The new program is under testing for a few months. It keeps the fully compatibility of data file usages, which will be replaced by the near future to make the variable energy operation easier.

Caution: The saved data files may or may not contain fully qualified data. We might have saved some of them only for temporary. Therefore, it

### 3. BTS Magnet Settings

#### BTS B Settings

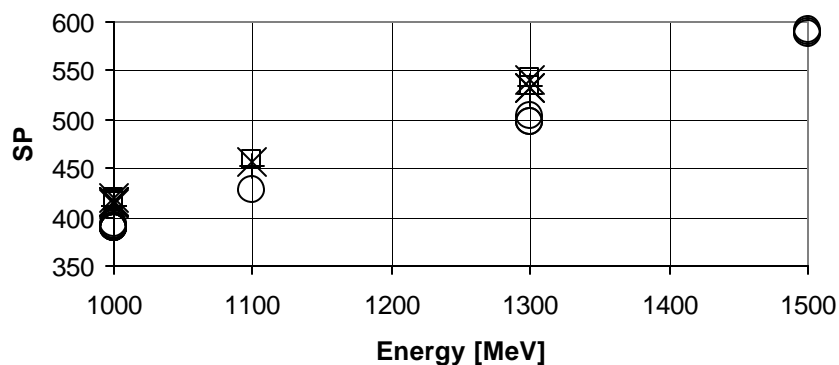
Among 110 BTS data files, 16 files have file names indicating the beam energy. We use these files to extract the energy dependency of BTS bending magnet settings:

File Name	Energy	B1	B2	B3	B4
13GEV.BTS	1300	532.99	534.70	527.14	497.00
13NEW.BTS	1300	532.99	534.70	527.14	497.00
1GEV.BTS	1000	415.71	417.41	411.48	389.11
1GEV0613.BTS	1000	415.61	417.91	411.38	389.51
1GEV0620.BTS	1000	415.61	417.91	411.68	388.61
1GEV0622.BTS	1000	415.61	417.91	411.68	388.61
1GEV0624.BTS	1000	416.21	417.51	411.28	388.81
1GEV0726.BTS	1000	414.51	419.21	410.88	392.11
1GEV0802.BTS	1000	416.41	416.91	410.98	390.41
1GEV0803.BTS	1000	416.41	416.91	410.98	390.41
1GEV0804.BTS	1000	418.71	415.01	411.78	388.31
1_1GEV.BTS	1100	456.80	458.90	451.96	427.36
1_3GEV.BTS	1300	539.79	541.90	534.44	504.60
1_5GEV.BTS	1500	633.90	633.80	634.41	589.18
1_5PLUS.BTS	1500	633.80	636.60	626.01	591.58
INITIAL.BTS	1500	630.90	633.20	632.00	588.40

The energy dependencies are below assuming the linearity.

#### BTS Bend Settings

$\times B1 = 0.4273 * E - 10.885$	$\square B2 = 0.4273 * E - 10.885$
$+ B3 = 0.4301 * E - 20.145$	$\circ B4 = 0.3937 * E - 5.1819$

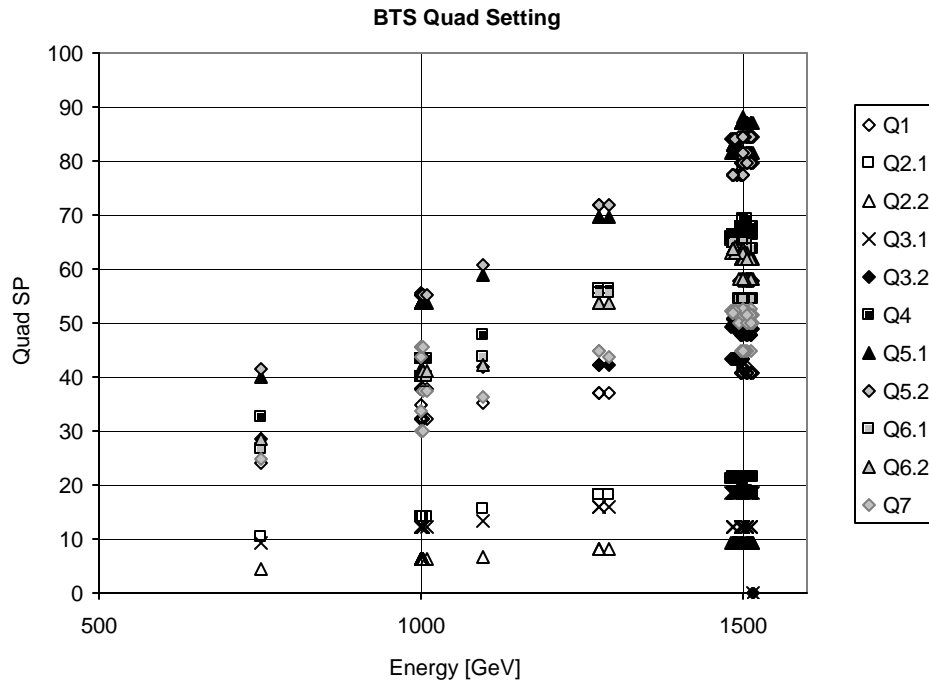


By using the fitting function for B1 to estimate the beam energy, all the BTS setting files are used to plot the bending values. Notice that the 1.9 GeV operation requires  $SP=798.79 \sim 800$  if the saturation is negligible.

## BTS Quad Settings

There are 95 meaningful data files to plot BTS quad settings. The energy dependencies are as follows:

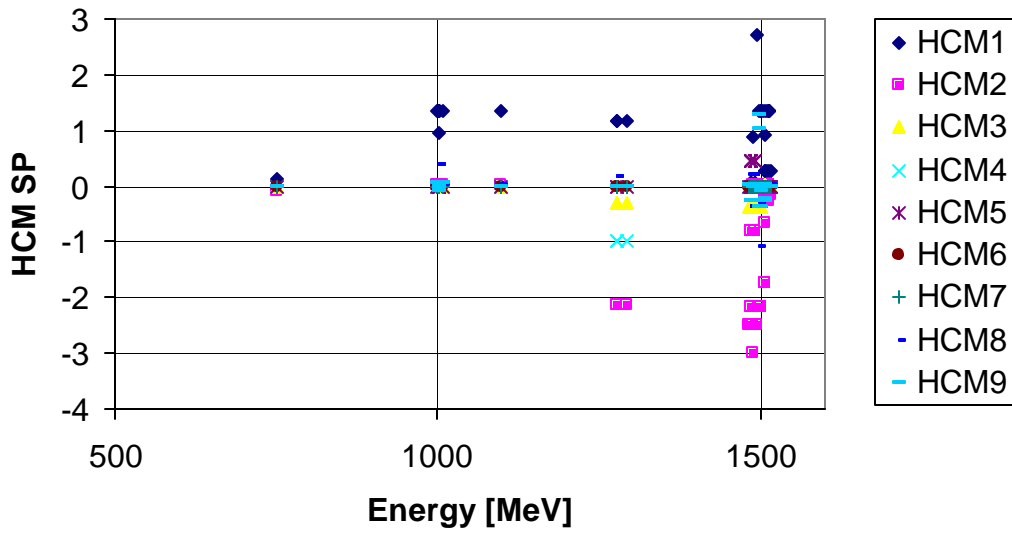
$$\begin{aligned} Q1 &= 0.0249 * E + 6.9066 \\ Q2.1 &= 0.0132 * E + 0.9064 \\ Q.2.2 &= 0.0063 * E - 0.1695 \\ Q3.1 &= 0.0071 * E + 5.2791 \\ Q3.2 &= 0.0269 * E + 10.307 \\ Q4 &= 0.0465 * E - 3.019 \\ Q5.1 &= 0.0585 * E - 4.9635 \\ Q5.2 &= 0.052 * E + 3.403 \\ Q6.1 &= 0.044 * E - 3.7096 \\ Q6.2 &= 0.0417 * E - 0.7085 \\ Q7 &= 0.0264 * E + 11.61 \end{aligned}$$



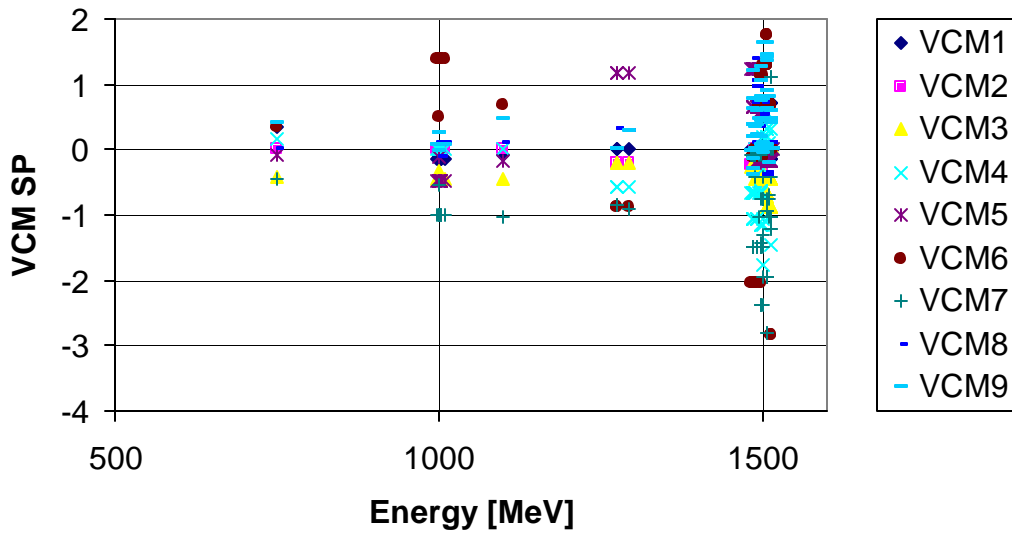
They are basically linear. The real setting should be established to fit the beam spot on the screens.

# BTS HCM and VCM

## BTS HCM Setting



## BTS VCM Setting

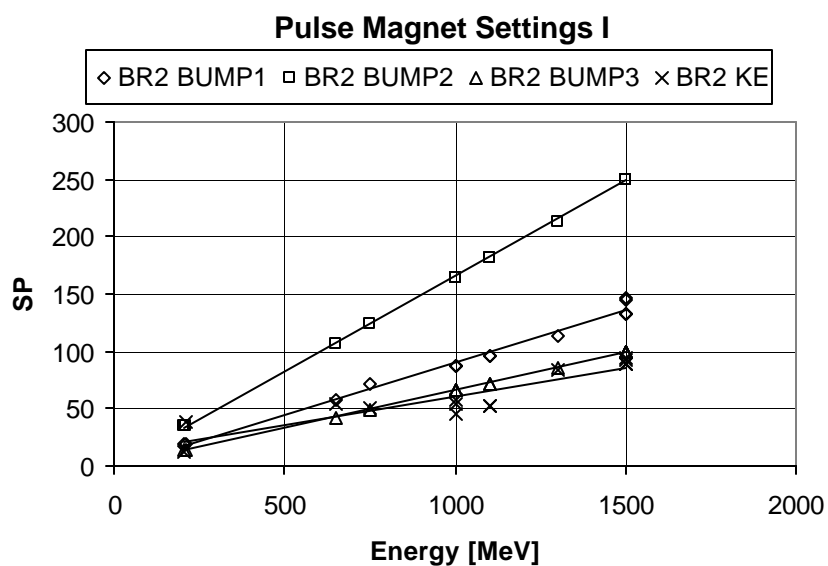


We can roughly say that they are within  $\pm 3.0$  at 1.5 GeV, which can be  $\pm 4.0$  at 1.9 GeV.

## Pulse Magnets I

There are 4 BR pulse magnets that have lower SP.

File Name	Energy	BR2 BUMP1	BR2 BUMP2	BR2 BUMP3	BR2 KE
208MEV.PLS	208	18.47	34.72	13.89	12.82
210MEV.PLS	210	18.47	34.72	13.89	38.34
650MEV.PLS	650	56.84	106.80	42.72	54.24
750MEV.PLS	750	71.00	123.00	49.00	50.01
1GEV.PLS	1000	87.34	164.23	65.70	53.57
1GEV0726.PLS	1000	87.34	164.23	65.70	57.08
1GEV0804.PLS	1000	87.34	164.23	65.70	45.63
1_1.PLS	1100	96.03	180.57	72.27	52.26
1_1GEV.PLS	1100	96.03	180.57	72.27	52.26
1_3GEV.PLS	1300	113.00	213.00	85.00	82.89
1025.PLS	1500	133.00	250.00	100.00	88.76
1_5GEV.PLS	1500	144.28	250.05	100.00	89.45
1_5GEV10.PLS	1500	133.00	250.00	100.00	88.76
1_5TEMP.PLS	1500	147.29	250.00	100.00	93.58



Energy dependencies are here assuming the linearity:

$$\begin{aligned}
 \text{BR2 BUMP1} &= 0.0923 * E - 2.4883 \\
 \text{BR2 BUMP2} &= 0.1669 * E - 1.6121 \\
 \text{BR2 BUMP3} &= 0.0668 * E - 0.6661 \\
 \text{BR2 KE} &= 0.05 * E + 10.668
 \end{aligned}$$

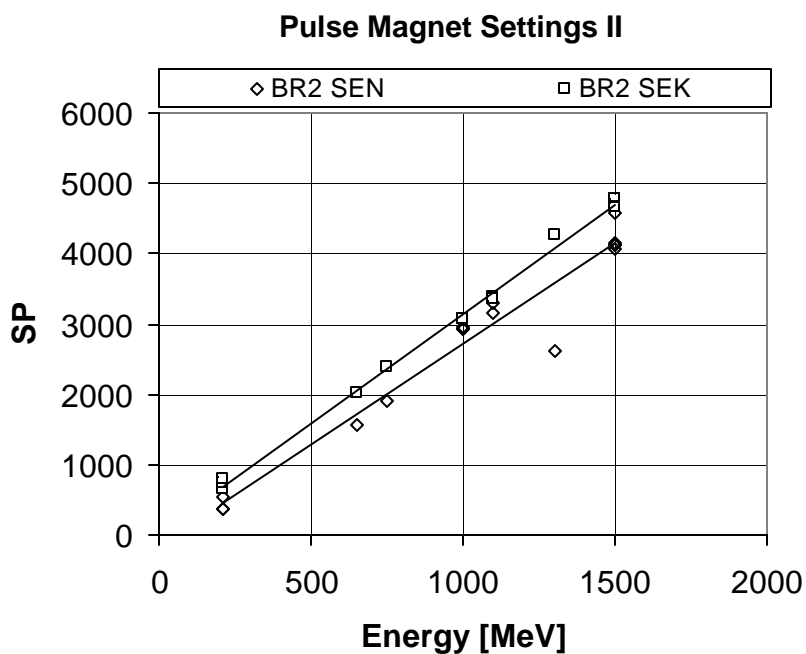
Compare these settings with their maximum values, there seems to be no problem to operate at 1.9 GeV.

	Max	1.9GeV
BR2 BUMP1	400	173
BR2 BUMP2	400	315
BR2 BUMP3	400	126
BR2 KE	210	106

## Pulse Magnets II

There are 2 BR septum magnets that seem to have problems at 1.9 GeV.

File Name	Energy	BR2 SEN	BR2 SEK
208MEV.PLS	208	540.60	653.95
210MEV.PLS	210	378.42	739.13
210MEV01.PLS	210	378.42	807.74
650MEV.PLS	650	1561.50	2010.97
750MEV.PLS	750	1891.43	2379.31
1GEV.PLS	1000	2935.30	3062.67
1GEV0726.PLS	1000	2926.12	3063.26
1GEV0804.PLS	1000	2943.97	3064.44
1_1.PLS	1100	3150.00	3390.00
1_1GEV.PLS	1100	3299.24	3364.54
1_3GEV.PLS	1300	2621.24	4255.88
1025.PLS	1500	4113.01	4683.70
1_5GEV.PLS	1500	4059.04	4766.63
1_5GEV10.PLS	1500	4113.01	4693.76
1_5TEMP.PLS	1500	4155.12	4782.25
REF.PLS	1500	4565.00	4659.00



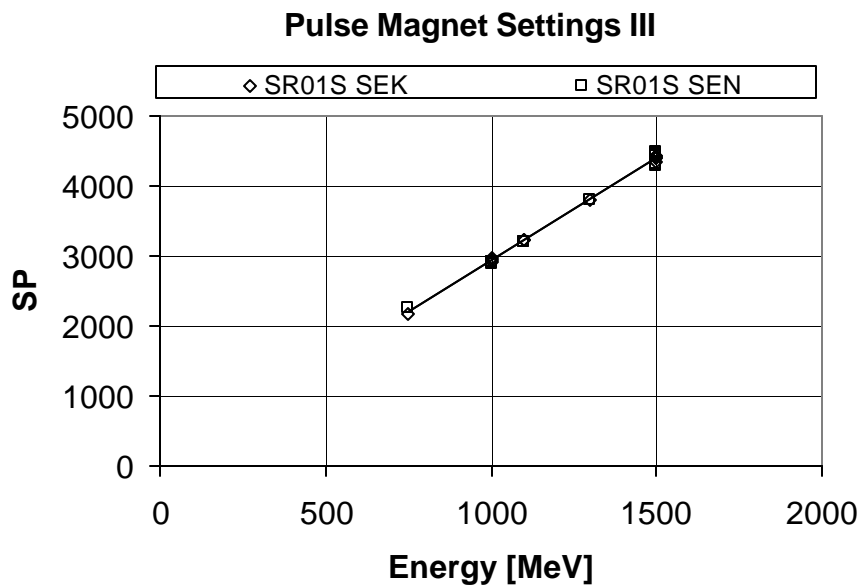
The linear energy dependencies give higher set values that their maximum at 1.9 GeV.

		Max	1.9GeV
BR2 SEN =	$2.8687 * E - 146.74$	4200	5300
BR2 SEK =	$3.1043 * E + 38.812$	4800	5940

### Pulse Magnets III

There are 2 SR septum magnets that line up on the same line.

File Name	Energy	SR01S SEK	SR01S SEN
750MEV.PLS	750	2157.16	2261.86
1GEV.PLS	1000	2927.31	2923.43
1GEV0726.PLS	1000	2957.48	2890.35
1GEV0804.PLS	1000	2942.09	2910.97
1_1.PLS	1100	3226.00	3212.12
1_1GEV.PLS	1100	3218.31	3212.00
1_3GEV.PLS	1300	3791.70	3786.00
1025.PLS	1500	4430.00	4434.00
1_5GEV.PLS	1500	4350.98	4494.61
1_5GEV10.PLS	1500	4403.98	4466.61
1_5TEMP.PLS	1500	4435.31	4299.98
REF.PLS	1500	4389.00	4325.00



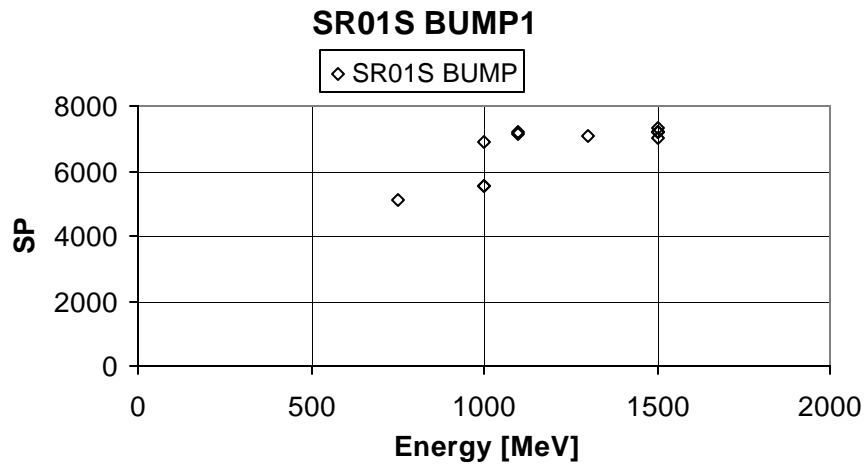
The linear energy dependencies give higher set values that their maximum at 1.9 GeV.

		Max	1.9GeV
SR01S SEK =	$2.9542 * E - 28.728$	5485	5584
SR01S SEN =	$2.9269 * E + 3.7494$	4600	5564

## Pulse Magnet IV

There is only SR01S BUMP with the maximum of 7400.

File Name	Energy	SR01S BUMP
750MEV.PLS	750	5100.00
1GEV.PLS	1000	6900.00
1GEV0726.PLS	1000	5539.00
1GEV0804.PLS	1000	5539.00
1_1.PLS	1100	7199.72
1_1GEV.PLS	1100	7149.68
1_3GEV.PLS	1300	7078.13
1025.PLS	1500	7200.00
1_5GEV.PLS	1500	7000.00
1_5GEV10.PLS	1500	7200.00
1_5TEMP.PLS	1500	7300.00
REF.PLS	1500	7200.00



Notice that **the maximum of this magnet is 7400.**