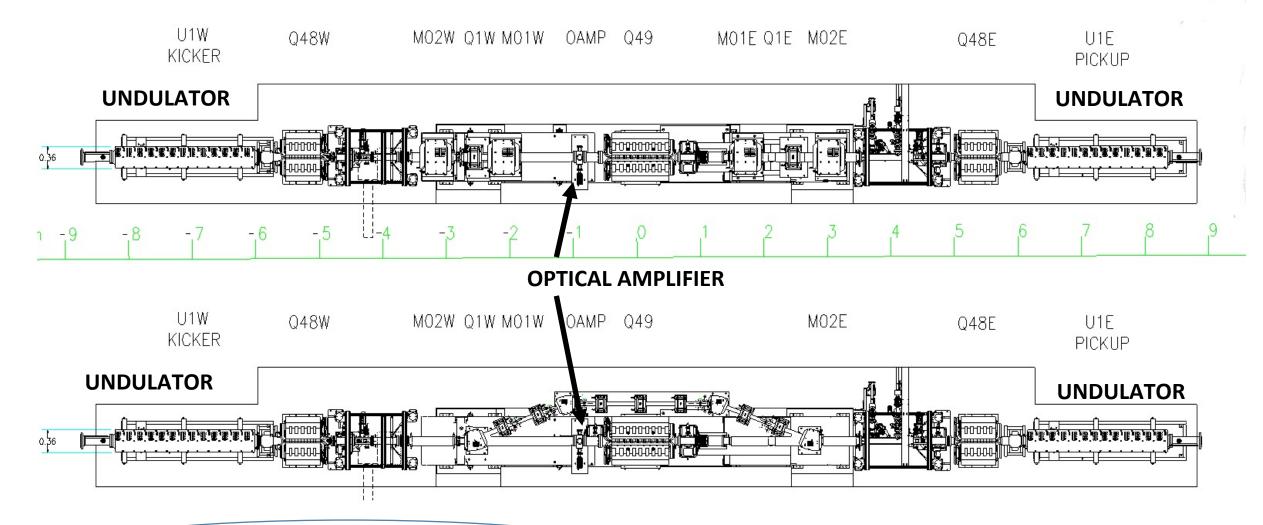
Alexander Mikhailichenko, Jan 5 2018

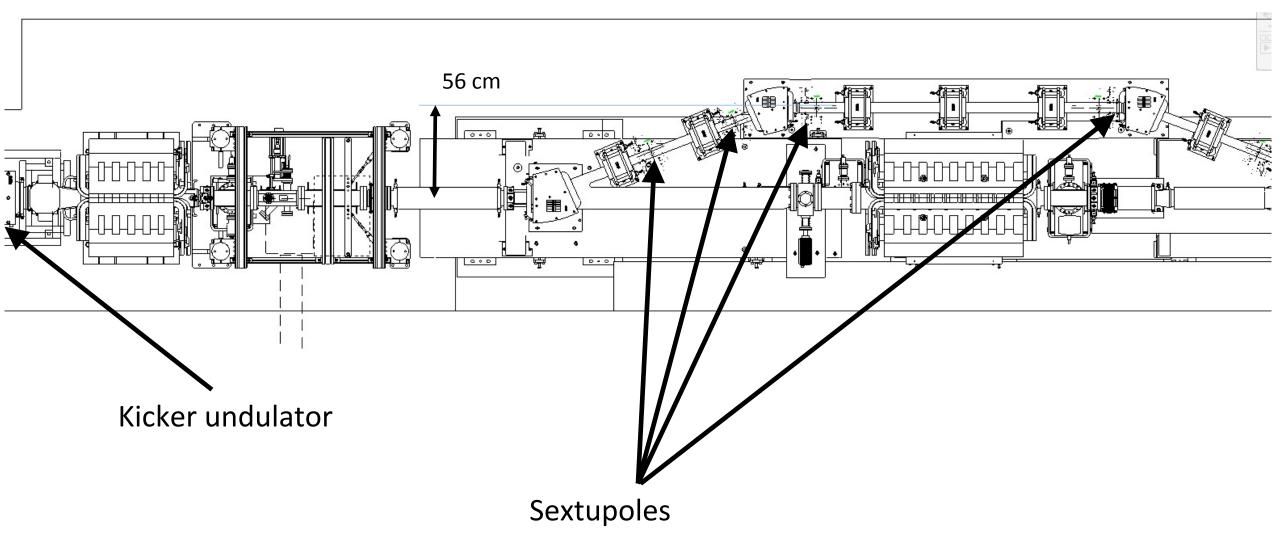
UNDULATORS FOR OSC (1)

Variant 1: WIDE CHAMBER

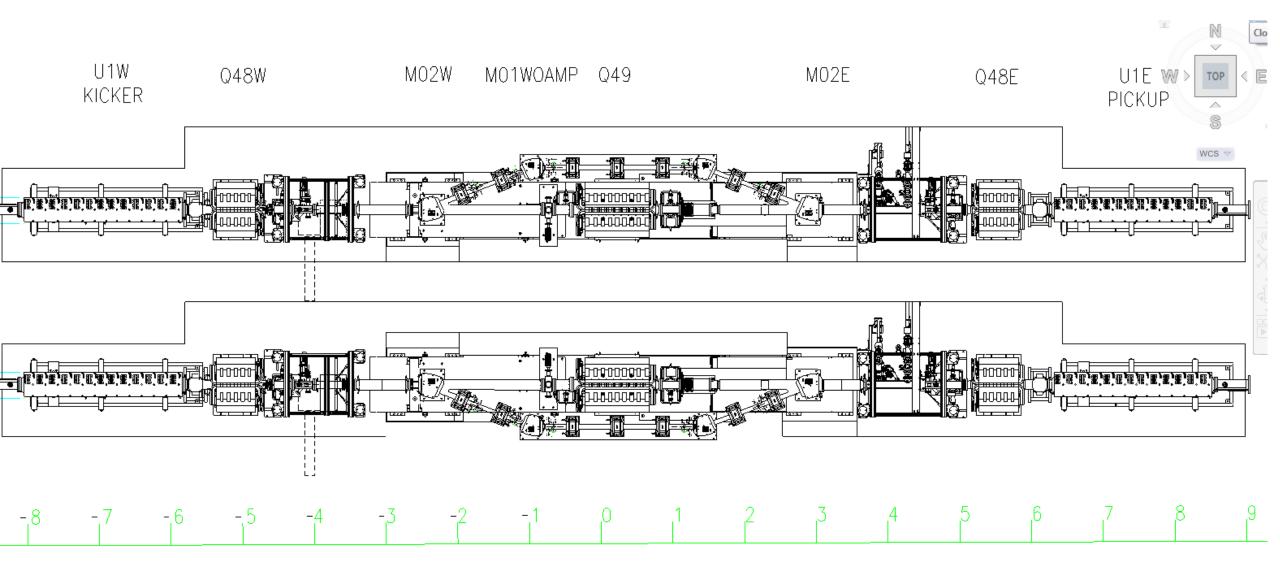




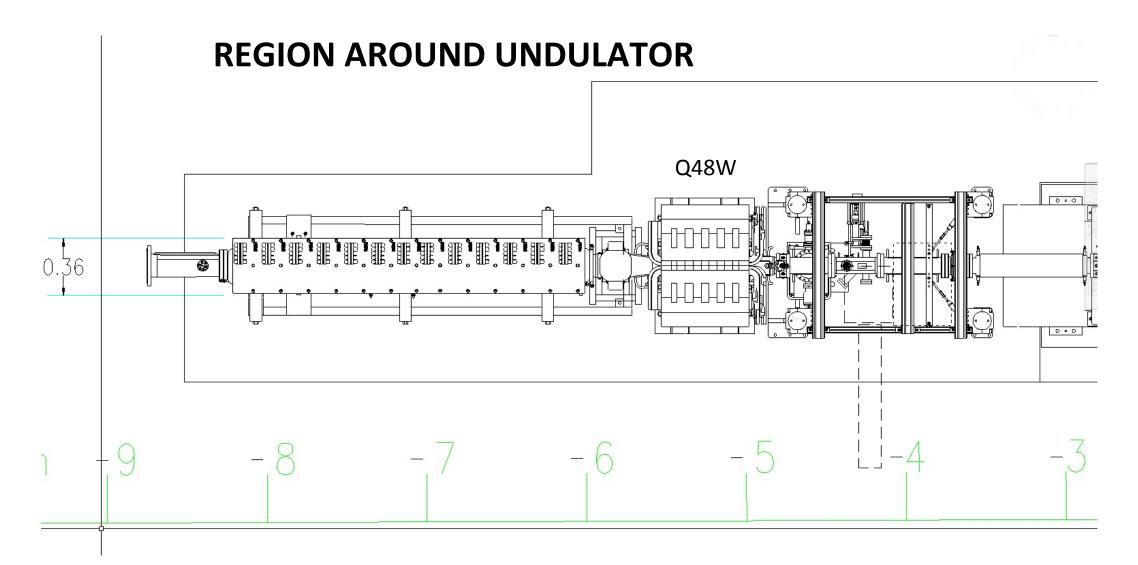
ZOOMED...



TWO ORIENTATIONS OF BYPASS- INSIDE OR OUTSIDE...



Inside allocation might give some relief for design of crotch



Numbers in meters from center of Q49

Two types of undulators are possible: the **planar** one and the **helical** one

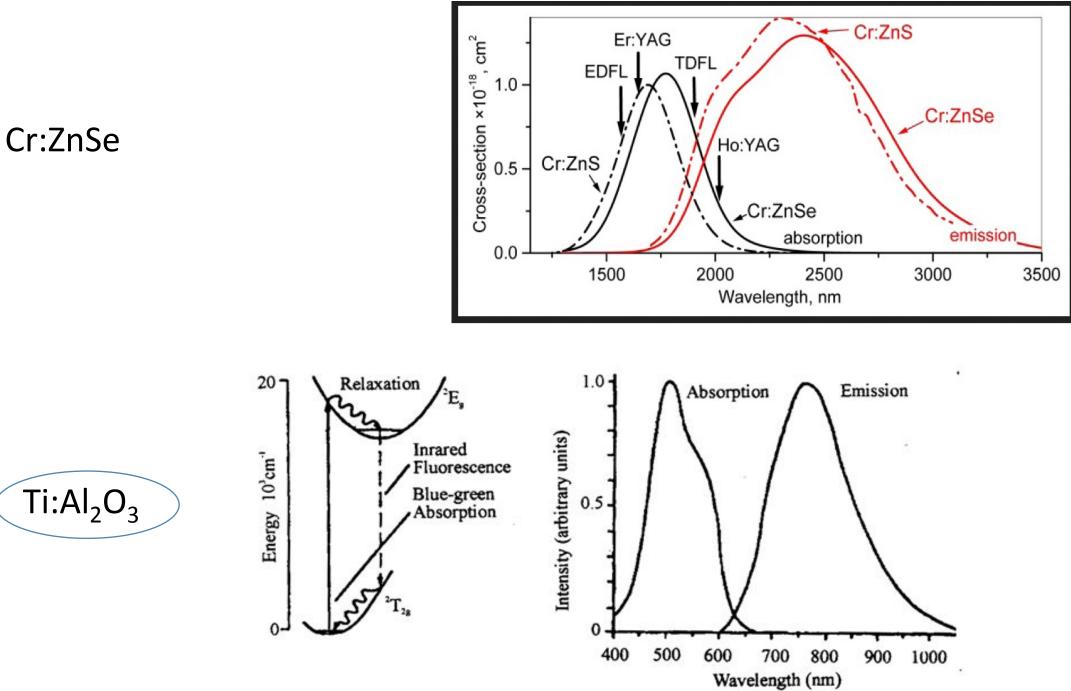
In **planar** undulator the odd harmonics only have nonzero intensity in straightforward direction In **helical** undulator the first harmonic only has nonzero intensity in a straightforward direction;

$$\lambda_{planar}^{n} \cong \frac{\lambda_{Uplanar}^{1}}{2\gamma^{2}n} \cdot \left(1 + K^{2}/2\right), \qquad \lambda_{helical}^{n} \cong \frac{\lambda_{Uhelical}^{1}}{2\gamma^{2}} \cdot n \left(1 + K^{2}\right), \quad n = 1, 2, \dots$$
$$\lambda_{Uplanar}^{1} \cong \frac{\lambda_{planar}}{1 + K^{2}/2}; \qquad \lambda_{Uhelical}^{1} \cong \frac{\lambda_{helical}}{1 + K^{2}}$$

When the energy is higher, period of undulator should be bigger or amplifier should work at higher frequency;

Dependence on the *K*-factor is favorable for a helical undulator;

$$K \le 1$$
, $\gamma \approx 800$ (for now)



So, two wavelengths are:

$$\lambda_{\text{Ti:AIO}} \approx 750 \text{nm}$$
 and $\lambda_{\text{Cr:ZnSe}} \approx 2500 \text{nm}$

With $K \approx 1$, $\gamma \approx 800$ (400*MeV*) this yields:

$$\lambda_{Uplanar}^{Ti:Al_2O_3} \cong 0.64m;$$

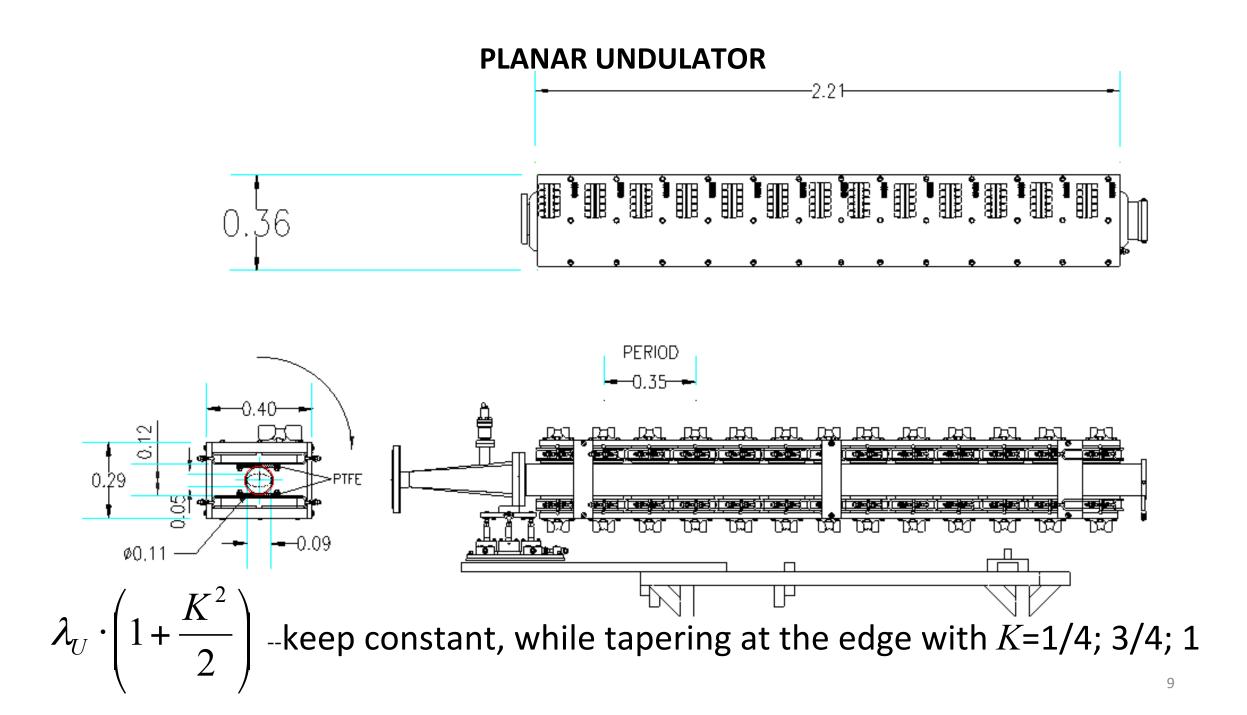
$$\lambda_{Uhelicalr}^{Ti:Al_2O_3} \cong 0.48m$$

 $\lambda_{Uplanar}^{Cr:ZnSe} \cong 2.13m;$ $\lambda_{Uhelical}^{Cr:ZnSe} \cong 1.6m$

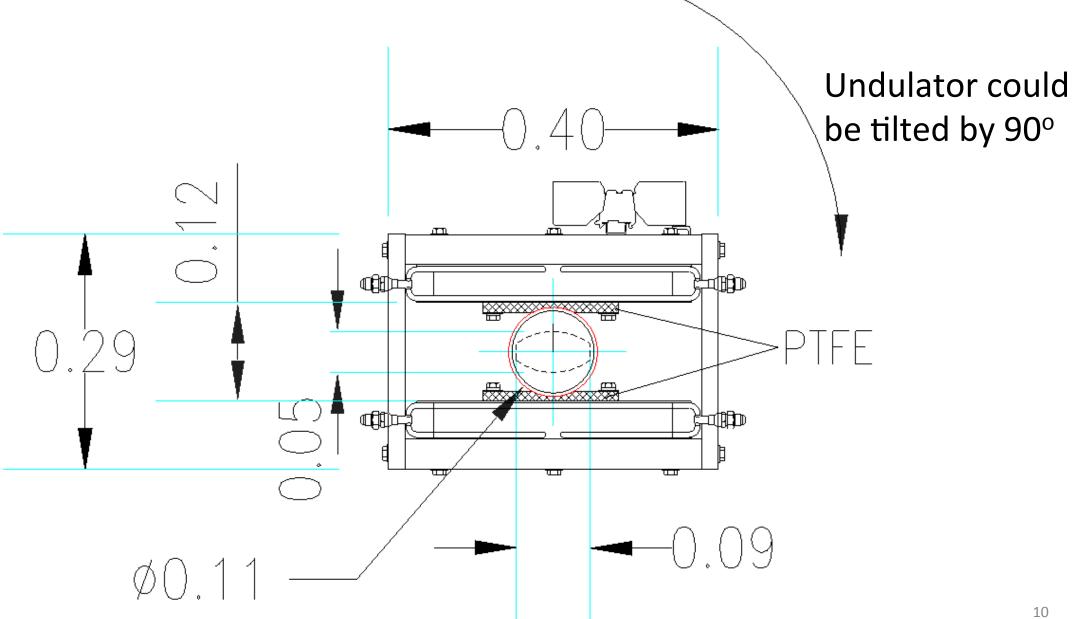
With $K \approx 1$, $\gamma \approx 600$ (300*MeV*) this yields: $\lambda_{Uplanar}^{Ti:Al_2O_3} \approx 0.36m;$ $\lambda_{Uplanar}^{Ti:Al_2O_3} \approx 0.27m$

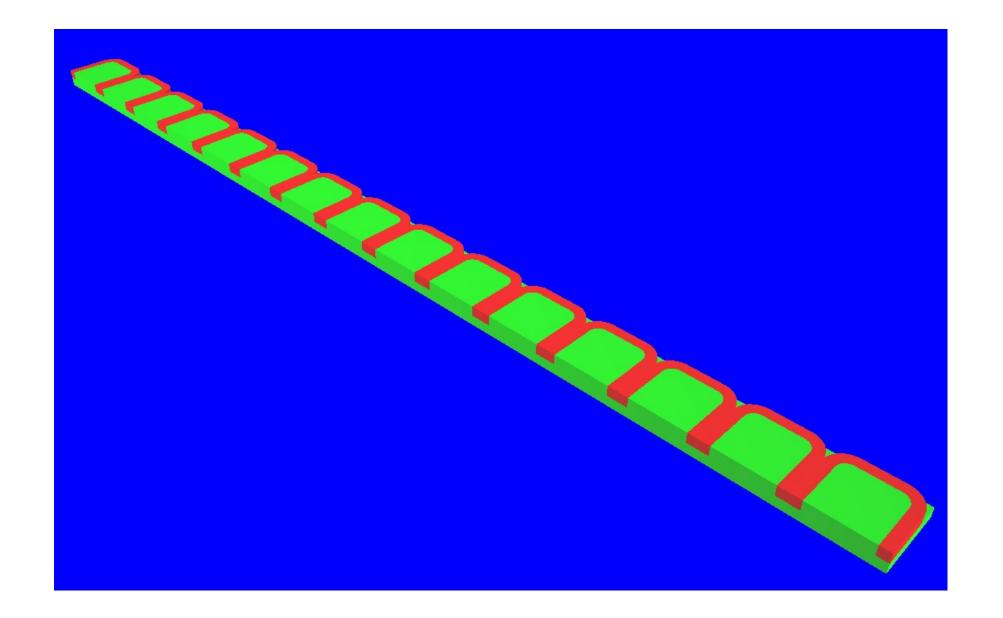
$$\lambda_{Uplanar}^{Cr:ZnSe} \cong 1.2m;$$

 $\lambda_{Uhelical}^{Cr:ZnSe} \cong 0.68m$



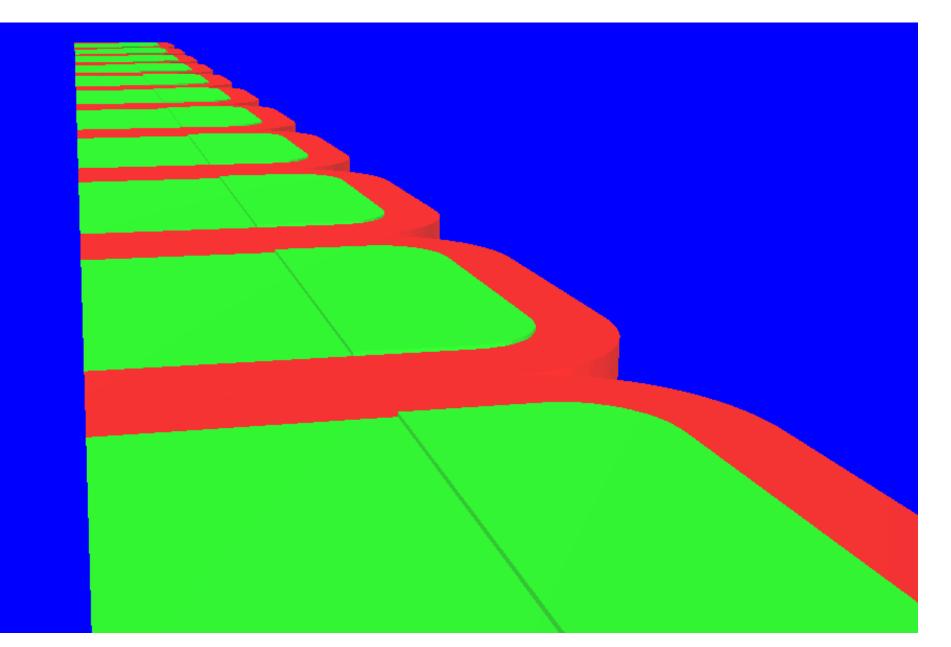
CROSS SECTION SCALED VIEW

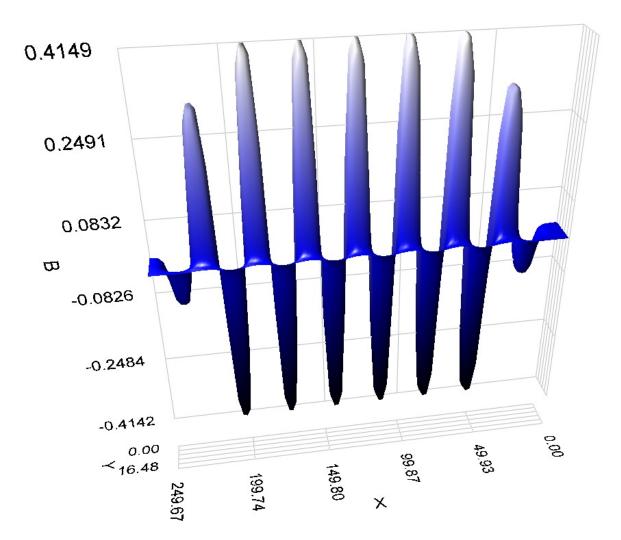


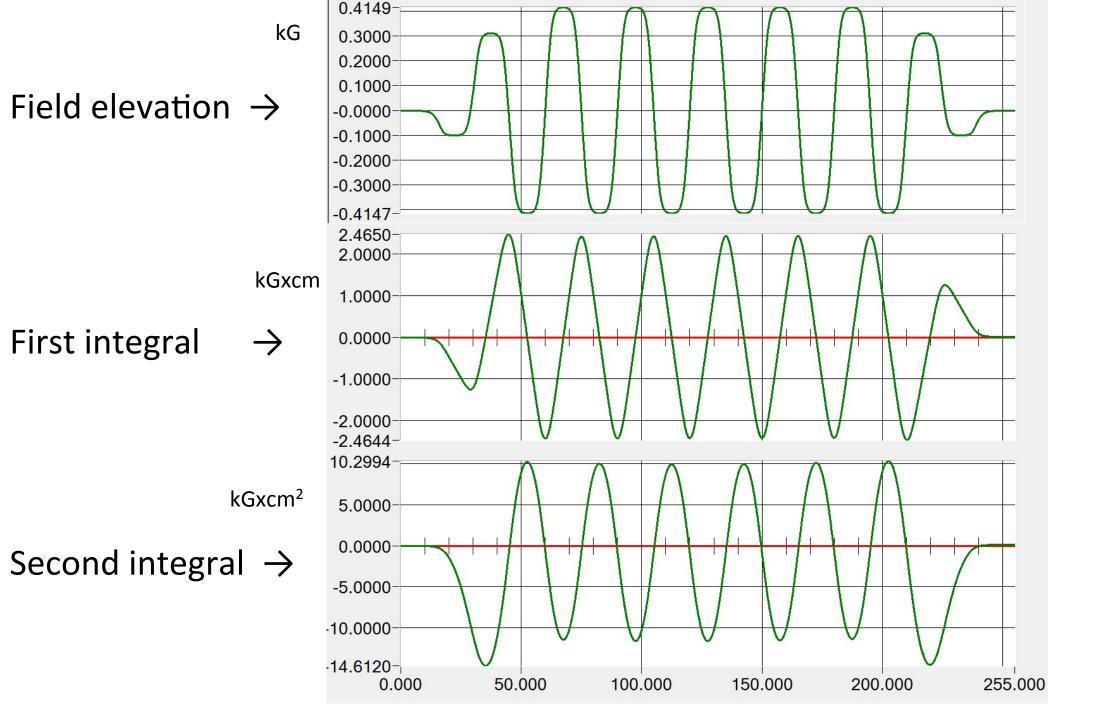


¼ of undulator

More detailed view...







Field elevation across the pole apart from center

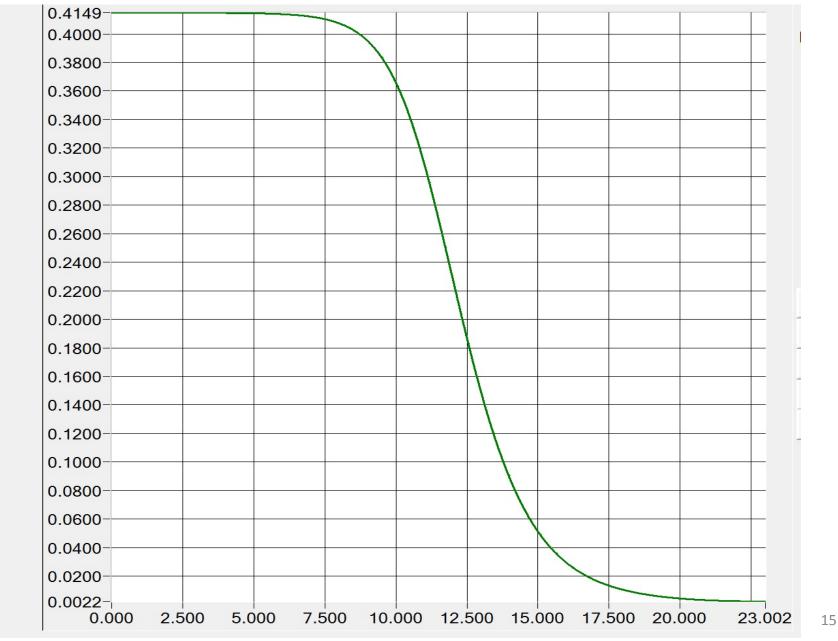
Current density is 2.5 A/mm² ;

Bz

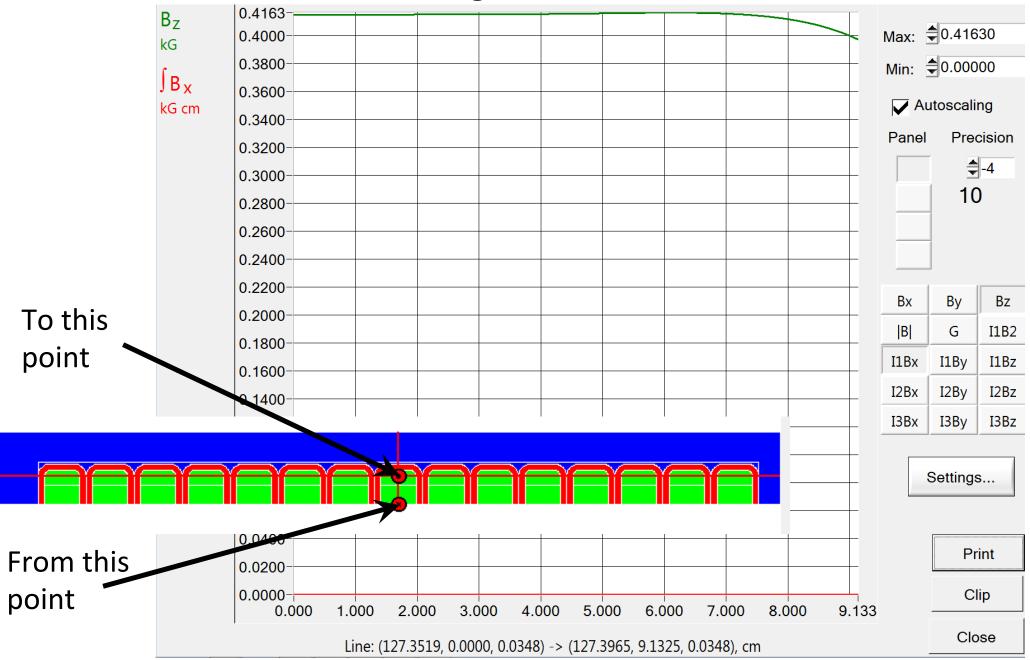
kG

1kA total;

K≈1.15



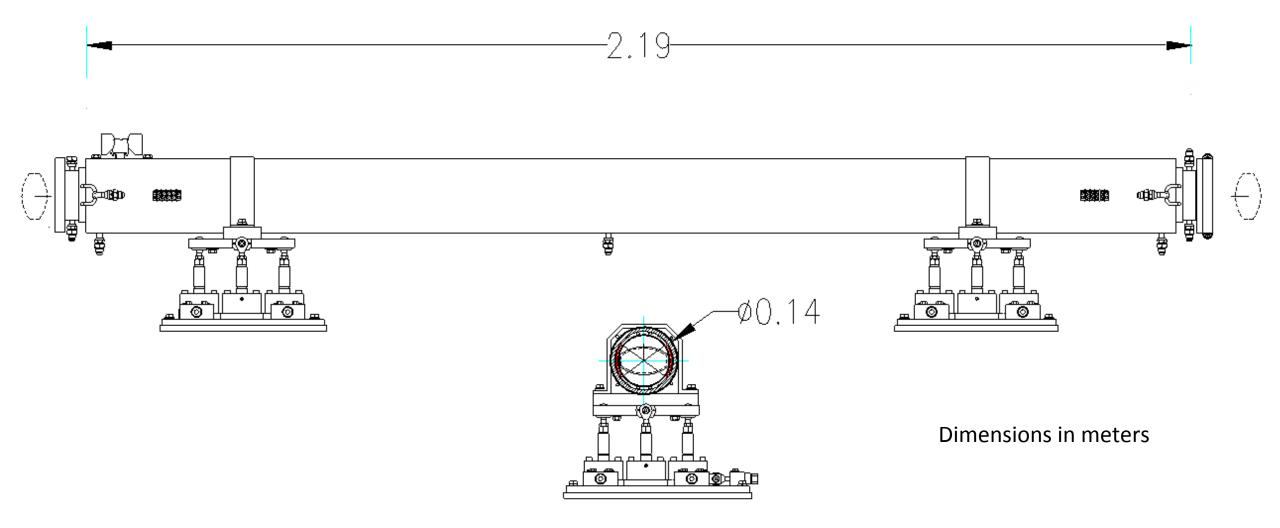
Central region zoomed...

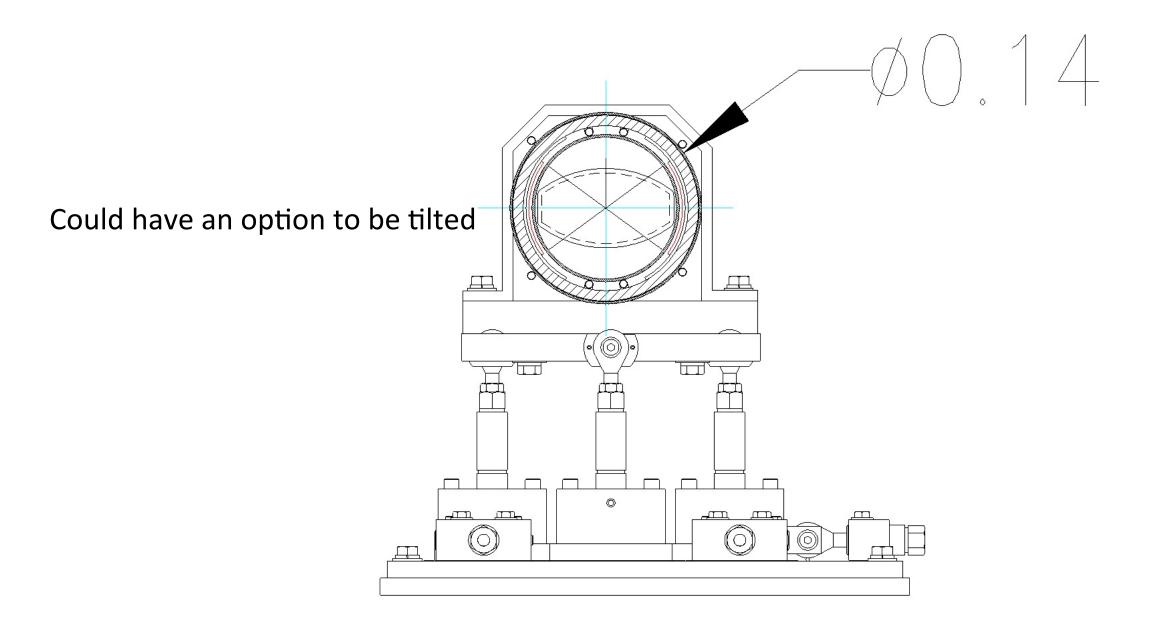


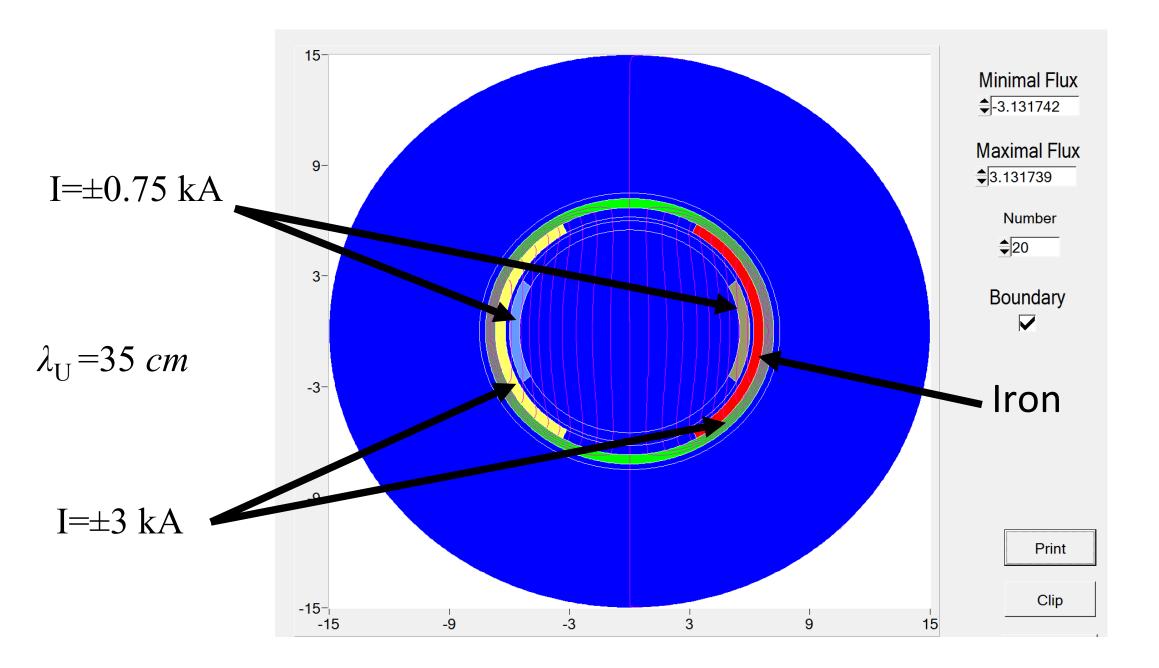
Digital map across the pole

14.38-										
0.										0.03
	.02 0.04 0.06 02	$\begin{array}{ccccccc} 0.10 & 0.10 \\ 0.08 & 0.10 & 0.13 & 0.1 \end{array}$	0.16 0 5 0.16 0.18	.16 0.1	7 0.17 0	.16 0.	16 0.15	; 0.12 0.1 0.17 0.14	0.07 0.11	0.06 0.03 0.07 0.04
0.		0.13 0.16 0x. 0.14 0x15 0x1		0x20 0x2)x17 0x17)x15 0x15	20 0x20 0 0x17 0x17 0x15 0x15	x20 0x 0x17 0x15		7 0.16 0 x15 0x16 x14 0x15 0x).13 0.15 15 0.1	10 0.06
0. 0.	04 0.08 0.12 0x	14 0x13 0x13 13 0x12 0x13	0x13 0x14 0x14 0 0x14 0x14 0x14 0)x14 0x14)x14 0x14	0x14 0x14 0x14 0x14	0x14 0x14	0×14 0	x13 0x14 0x	15 0 1 14 0 14 0x1	³ 0.09 13 0.09 4 0.12 0.07
0.0 0.0 11 07 0.0	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	x12 0x13 0x14 x13 0x14 0x16	0x15 (0x17 0x16 0x16)x14 0x14)x15 0x15 0x16 0x1	0x14 0x14 0x15 0x15 16 0x16 0	0x14 0x15 x16 0x	0x15 0 16 0x16	x15 0x17 0x18 0x19	0x15 0x17	0x15 0.10 0x15 0.12
11.37- <mark>0.0</mark>	0.11 0x12	0x14 0x16 0x18 0x16 0x18 0x16 0x21 0x21	0x18 0x17 0x16 0x21 0x18 0x17 1*79 0x18 1*21	0x16 0x1 0x17 0x1 *21 1*16	l6 0x16 0 l6 0x16 0	x16 0x x17 0x 1*29	x17	0x19 0x17 0x21 0x18	0x16 0x17	0x15 0x15 0x14 0x15 0x14
0.1	0 0x13 0x16		1 <u>∞</u> ⊑2 1¥26 1∞∩⊑	1*07 0*98	1×07 1×10 0×96 1×00	1*29 1*20 1*09 0*99	1*41 ¹ * 1*20 1	*77 0x2 2*14 .*52 2*00	0x19	0x17 0x15 1x19 0x14
0.1	1 0x14 0x18 0x13 0x16 0x15 0x	0x29 1*67 25 1*83	1*15 0*92 0*80 0	*91 0*87 *83 0*79 *75 0*71	0*87 0*90 0*78 0*82 0*71 0*75	0*91 0*83	0*99 1*	22 1 * 75	2*60	21 0x14
0.1	0x15 0x22 4 0x16 0x22	2*35 1*38 24 2*03 1*27 1*18	1*07 0*06 0*74 U 0*99 0*80 0*69 0 0*93 0*75 0*69 0	*69 0*65 *64 0*60 *60 0*56	0*65 0*69 0*60 0*63 0*56 0*59	0.200 ()*78 0*90)*73 0*85	1*9 1*21 1*76	; 0 <mark>x</mark> 24	0x21 0x22
0.1	6 0x17 0x23 6 0x17 0x23	2*41 1*43 1*0 1*35 0*0	0*88 0*/1 0*61 0 L 0*67 0*58 0 7 0*73 0*61 0	*56 0*52 0*9 *53 0*49 0*4 *50 0*4	19 0*51 0*52	0*58 ()*69 0*80 0*65 0*76 0*62 0*73	1*06 1*47 1*00 1*37	2 * 39	0x22 0x16 0x22 0x17
8.36-	6 0x20 2 7 0x18 0x20 2 7 0x18 0x20 2	*28 1*29 0*9 *28 1*24 0*9	3 0*70 0*59 0*51 0 0*68 0*57 0*49	0*47 0*44 0 0*45 0*42 0	*43 0*47 *41 0*44 0*4	0*51	0*60 0*70 0*58 0*68 0*58	0*95 1*30 0*92 1*25	2*11 2*03	0x22 0x17 0x22 0x18
	7 0x18 0x20 7 0x18 0x20 7 0x18 0x20 7 0x18 0x20	*10 1*17 0*8 *07 1*15 0*8	5 0*64 0*54 0*46 3 0*63 0*53 0*45	0*42 0*40 0 0*41 0*38 0	*39 0*41 0*4 *37 0*39 0*4	13 0*49 12 0*48	0*56 0* 0*55 0*	*72 0*92 *70		x21 0x18 x21 0x18 x21 0x18 x21 0x18
0.1	7 0x18 0x20 7 0x18 0x20	*04 1*13 0*8 *02 1*11 0*8 *00 1*10 0*8	1	0*39 0*36 0*37 0*3	*37 0*30 0*4	11 0*47 0*43 0*42	0*62 0*51 0*61 0*51 0*60	0*82 1*13 0*81 1*10	1*85 1*82 1*80	x21 0x18 x21 0x18 x21 0x18
0.1	7 0x18 0x20 7 0x18 0x20 7 0x18 0x20	*98 1*31 *97 1*30 0*84	0*57 0*45 0 0*65 0*51 0*44 0	*39 0*36 0*3 *38 0*35 0*3 *38 0*35 0*3	35 0 * 35	0 * 42 0 * 41	0*50 0*59 0*50 0*59 0*49 0*58	0*00 1*09 0*79 1*08	1*79 0 1*77 0 1*76 0	x21 0x18 x21 0x18 x21 0x18 x21 0x18
0.1	7 0x10 0x20 7 0x18 0x20 7 0x18 0x20	.*96 1*29 0*84 .*95 1*29 0*83 .*94 1*28 0*83 .*94 1*28 0*82	0*64 0*50 0*44 0 0*64 0*50 0*43 0	*37 0*35 0*3 *37 0*34 0*3	33 0*34 0*37 33 0*33 0*37	0*41 0*40	0*49 0*58 0*48 0*57	0*78 1*07 0*77 1*07	1*76 43 Q <mark>x</mark>	0x18 1 0x20
0.1	7 0x18 0x20 7 0x18 0x20 7 0x18 0x20	*93 1*27 0*82 *93 1*27 0*82	0*63 0*49 0*43 0 0*63 0*49 0*43 0 0*63 0*49 0*43 0	*37 0*34 0*3 *36 0*34 0*3	32 0*33 0*36 32 0*33 0*36	0×40 0×40	0*48 0*57 0*48 0*57	0*76 1*05 0*76 1*05	1*74 0 1*73 0	²¹ 0x20 x21 x21 0x18
5.35-	7 0x18 0x20 7 0x18 0x20 7 0x18 0x20	*92 1*27 0*81 *92 1*27 0*81 *92 1*26 0*81	0*63 0*49 0*42 0 0*62 0*49 0*42 0 0*62 0*49 0*42 0	*36 0*33 0*3 *36 0*33 0*3	32 0*32 0*35 32 0*32 0*35 32 0*32 0*35	0*39 0*39	0*47 0*56 0*47 0*56	0*76 1*05 0*76 1*04 0*76 1*04	1*73 0 1*73 0 1*72 0	x21 0x18 x21 0x18 x21 0x18 x21 0x18
0.1 0.1 0.1	7 0x18 0x20 7 0x18 0x20	*91 1*26 0*81 *91 1*26 0*81 *91 1*26 0*81	0*62 0*48 0*42 0 0*62 0*48 0*42 0 0*62 0*48 0*42 0	*36 0*33 0*3 *36 0*33 0*3 *36 0*33 0*3	31 0*32 0*35 31 0*32 0*35 31 0*32 0*35	0*39 0*39	0*47 0*56 0*47 0*56 0*47 0*56	0*/5 1*04 0*75 1*04 0*75 1*04	1*72 0 1*72 0 1*72 0	x21 0x18 x21 0x18 x21 0x18
0.1	7 0x18 0x20 7 0x18 0x20 7 0x18 0x20	*91 1*26 0*81 *91 1*26 0*80	0*62 0*48 0*42 0 0*62 0*48 0*42 0 0*62 0*48 0*42 0	*35 0*33 0*3 *35 0*33 0*3	81 0∗32 0*35 81 0∗32 0*35	0*39 0*39	0*47 0*56 0*47 0*56 0*47 0*56	0*75 1*04 0*75 1*04	1*72 0 1*72 0 1*72 0	x21 0x18 x21 0x18 x21 0x18 x21 0x18
0.1	7 0x18 0x20 7 0x18 0x20 7 0x18 0x20	*91 1*26 0*80 *91 1*26 0*80	0*62 0*48 0*42 0 0*62 0*48 0*42 0 0*62 0*48 0*42 0	*35 0*33 0*3 *35 0*33 0*3	81 0*32 0*35 81 0*31 0*35	0*39 0*39 0*39	0*47 0*55 0*47 0*55	0*75 1*04 0*75 1*04 0*75 1*03	1*71 0 1*71 0	x21 0x18 x21 0x18 x21 0x18
0.1	7 0x10 0x20 7 0x18 0x20 7 0x18 0x20	1*90 1*25 0*80 *90 1∗25 0*80	0*62 0*48 0*42 0 0*62 0*48 0*42 0 0*62 0*48 0*42 0	*35 0*33 0*3 *35 0*33 0*3	81 0*31 0*35 81 0*31 0*35	0*39 0*38 0*38	0*47 0*55 0*47 0*55 0*47 0*55	0*75 1*03 0*75 1*03	1*71 0 1*71 0 1*71 0	x21 0x18 x21 0x18 x21 0x18 x21 0x18
0.1 0.1 0.1	7 0x18 0x20 7 0x18 0x20 7 0x18 0x20	*90 1*25 0*80 *90 1*25 0*80 *90 1*25 0*80	0*62 0*48 0*42 0 0*62 0*48 0*42 0 0*62 0*48 0*42 0 0*62 0*48 0*42 0	*35 0*32 0*3 *35 0*32 0*3		0*38 (0*39 ()*47 0*55)*47 0*55)*47 0*55	0*75 1*03 0*75 1*03 0*75 1*03	1*71 0 1*71 0 1*71 0	x21 0x18 x21 0x18 x21 0x18 x21 0x18
2.34-	7 0x18 0x20 7 0x18 0x20 7 0x18 0x20	*90 1*25 0*80 *90 1*25 0*80 *90 1*25 0*80	0*62 0*48 0*41 0 0*62 0*48 0*41 0 0*62 0*48 0*41 0	*35 0*32 0*3 *35 0*32 0*3	31 0*31 0*35	0*38 ^l 0*38 ⁽)*47 0*55)*46 0*55)*46 0*55	0*75 1*03 0*75 1*03 0*75 1*03	1*71 0 1*71 0 1*71 0	x21 0x18 x21 0x18 x21 0x18 x21 0x18
0.1	7 0x18 0x20 7 0x18 0x20 7 0x18 0x20	*90 1*25 0*80 *90 1*25 0*80 *90 1*25 0*80	0×25 0×48 0×11 0	*35 0*32 0*3 *35 0*32 0*3	31 ∩ <mark>*</mark> 31 0*35	0*38 (0*38 ()*46 0*55)*46 0*55)*46 0*55	0*75 1*03 0*75 1*03 0*75 1*03	1*71 0 1*71 0 1*71 0	x21 0x18 x21 0x18 x21 0x18
0.1 0.1	7 0x10 0x20 7 0x18 0x20 7 0x18 0x20	*90 1*25 0*80 *90 1*25 0*80 *90 1*25 0*80 *90 1*25 0*80	0*62 0*48 0*41 0 0*62 0*48 0*41 0 0*62 0*48 0*41 0	*35 0*32 0*3 *35 0*32 0*3	81 0*31 0*35 81 0*31 0*35	0*38 0*38)*46 0*55)*46 0*55)*46 0*55	0*75 1*03 0*75 1*03	1*71 0 1*71 0 1*72 0	x21 0x18 x21 0x18 x21 0x18 x21 0x18
0.1	7 0x10 0x20 7 0x18 0x20 7 0x18 0x20	*90 1*25 0*80 *90 1*25 0*80 *89 1*25 0*80 *89 1*25 0*80	0*62 0*48 0*41 0 0*62 0*48 0*41 0 0*62 0*48 0*41 0	*35 0*32 0*3 *35 0*32 0*3	81 0*31 0*35 81 0*31 0*35	0*38 (0*38 ()*46 0*55)*46 0*55	0*/5 1*03 0*75 1*03 0*75 1*03 0*75 1*03	1*72 0 1*72 0 1*72 0	x21 0x10 x21 0x18 x21 0x18 x21 0x18 x21 0x18
0.1	$7 0 \times 10 0 \times 20$: 7 0 \times 18 0 \times 20	*89 1*25 0*80 *89 1*25 0*80	0*62 U*48 0*41 U 0*62 0*48 0*41 U	*35 0*32 0*3 *35 0*32 0*3	31 0*31 0*35 31 0*31 0*35	0*38 (0*38 ()*46 0*55)*46 0*55	0*75 1*03 0*75 1*04	1*72 0	x21 0x18 x21 0x18
-0.67-										
104.6	3	107.65	110.6	6	113.6	37		116.68		119.

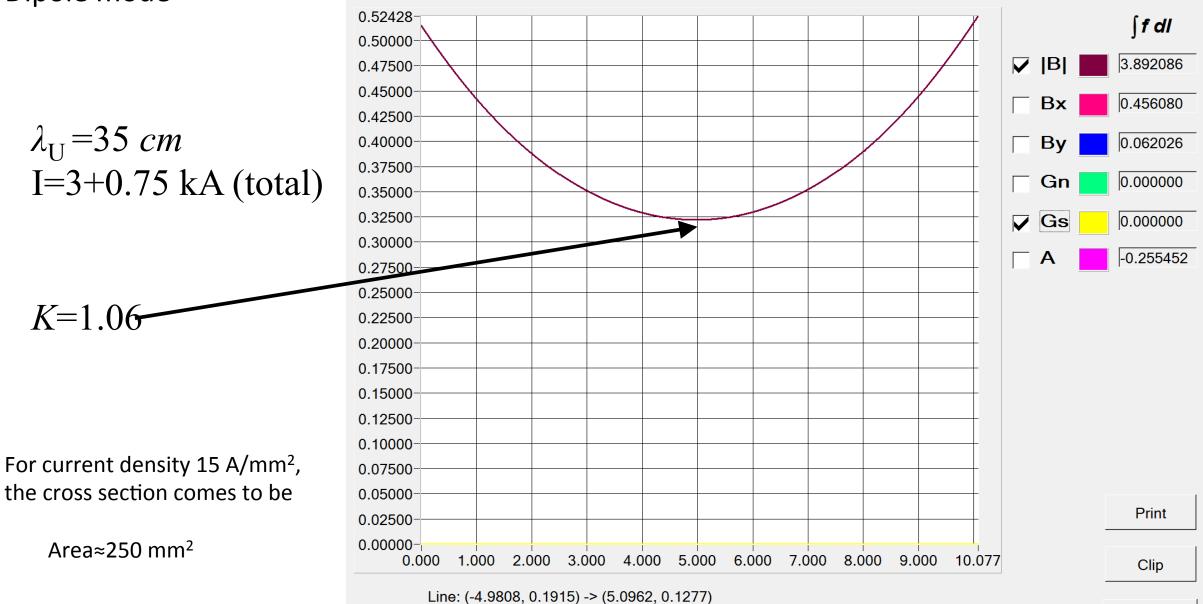
HELICAL UNDULATOR

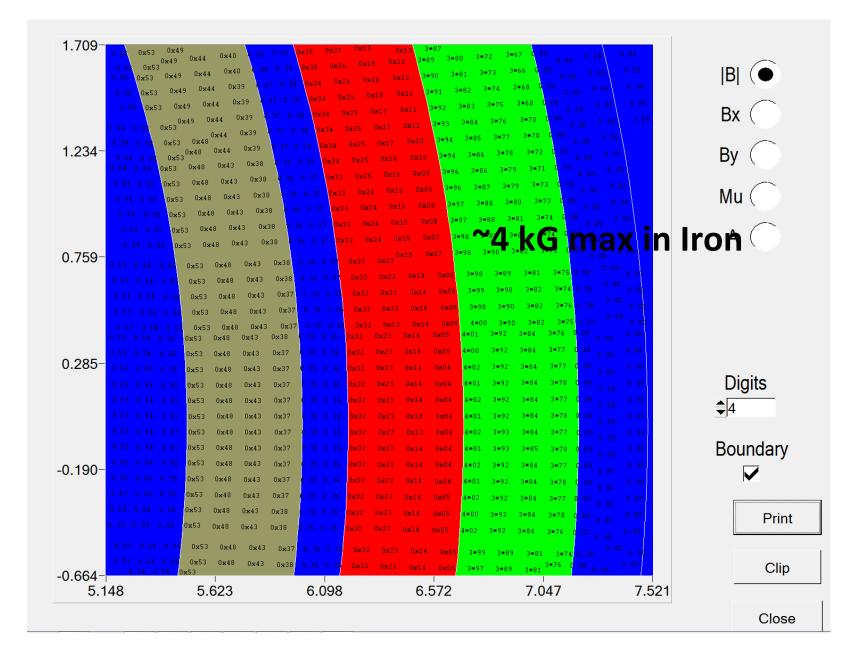




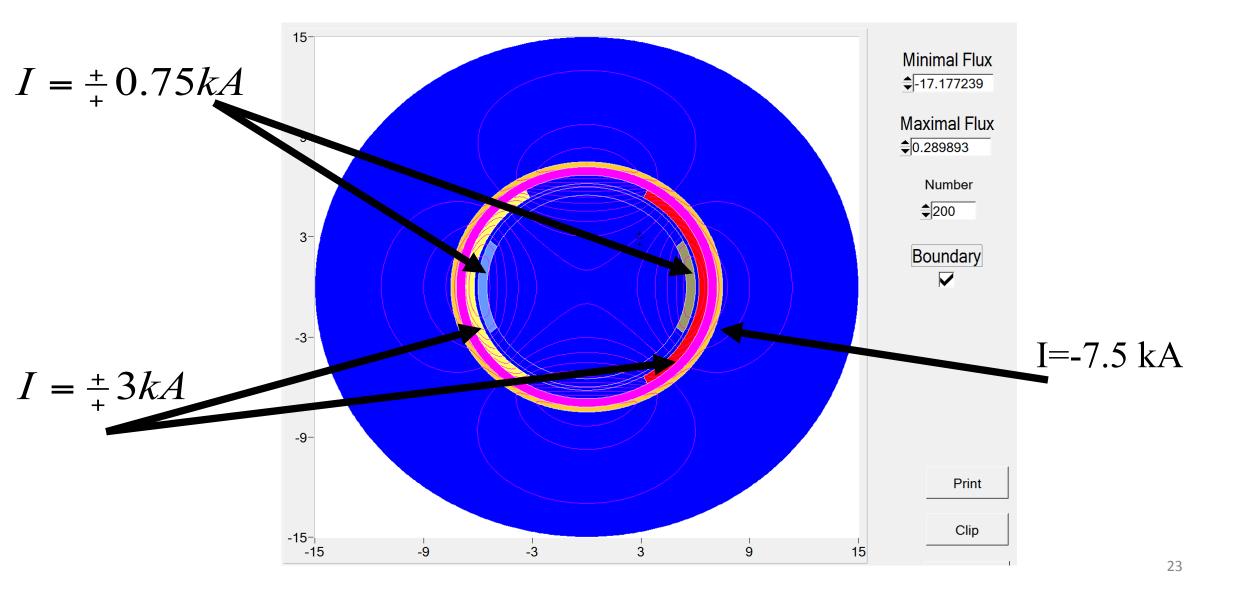


Dipole mode



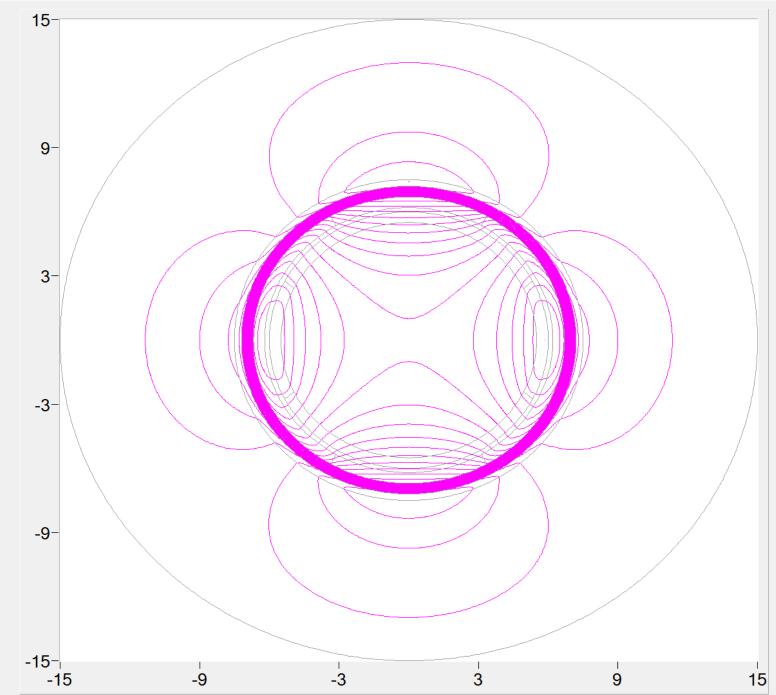


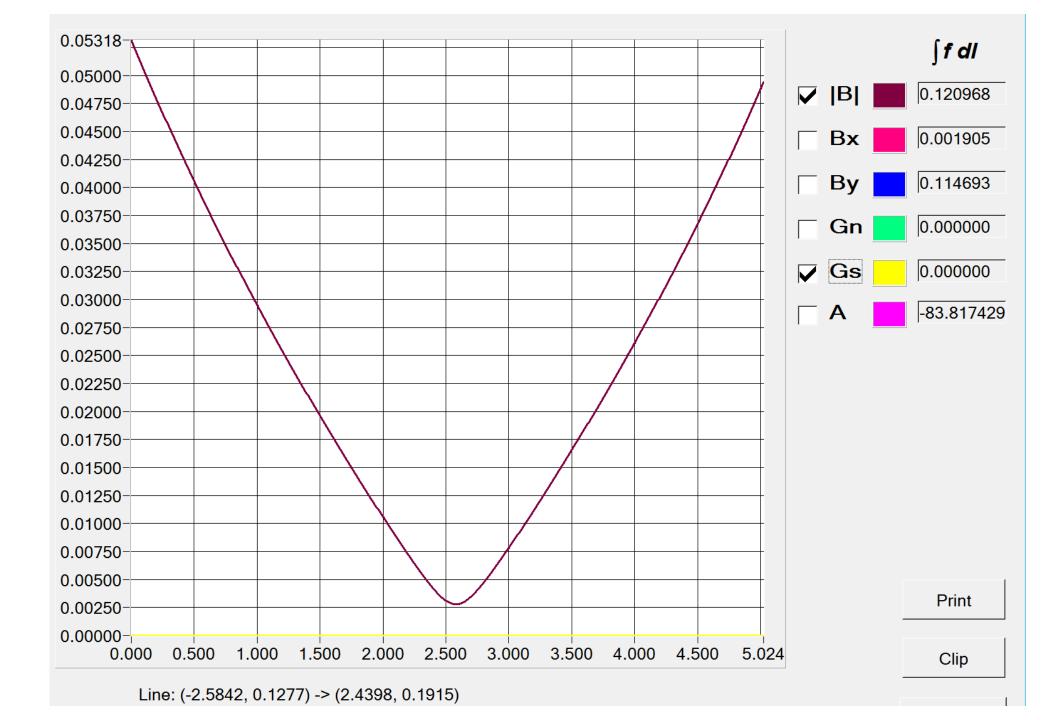
HELICAL UNDULATOR IN A QUADRUPOLE MODE



The same as in previous slide, but without painting the boundaries...

Period of helix=35 cm





20 kG in few places...

5.40	19	4.595	0.002	0.300	7.555	0.342	
2.357- 3.40	0	4.395	5.382	6.368	7.355	8.342	
0 0 0 0 0	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	Ix27 20*7 20*8 0x36 x27 20*8 20*8 0x35 (27 20*7 20*8 0x35 0x37 20*8 20*3 0x36 0x37 20*8 20*7 0x27 0x37 20*8 20*8 0x27	$\begin{array}{cccccccccccccccccccccccccccccccccccc$		Prin
1.370-0	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0x27 20*8 20*8 0x3 0x27 20*8 20*8 0x3 0x27 20*8 20*8 0x36 18 0x37 20*8 20*7 0x27 20*8 20*8 0x36 0x27 20*8 20*8 0x35 8 0x37 20*8 20*8 0x25 3 0x37 20*8 20*8 0x25 3 0x37 20*8 20*8 0x25	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	04 04 04 4 4 4	
	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0.17 0x15 0x06 0.05 0x 0.17 0x15 0x06 0.06 0x 0.17 0x15 0x06 0.06 0x 0.17 0x15 0x06 0.06 0x0 0.17 0x15 0x07 0.06 0x0 0.17 0x15 0x07 0.06 0x0 0.17 0x15 0x07 0.07 0x0	08 0x27 20*8 20*8 03 08 0x27 20*8 20*8 04 08 0x27 20*8 20*8 04 9 0x27 20*8 20*8 04 9 0x27 20*8 20*8 04 9 0x27 20*8 20*8 04 9 0x27 20*8 20*8 04 0 0x27 20*8 20*8	(0.05 0.04 0 x36 0x10 0.05 0.04 0 x36 0x10 0.05 0.04 0 x36 0x10 0.05 0.04 0 36 0x10 0.05 0.04 0 36 0x10 0.05 0.04 0.	. 04 . 04 . 04 . 04 . 04 . 04 . 04 . 04	• ^{]₄} Boundary
	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0x17 0x37 20*8 20* x08 0x27 20*8 20*8 20 x08 0x27 20*8 20*8 0 0x17 0x37 20*8 20*8 0x17 0x37 20*8 20*8	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	0.04 0.04 0.04 0.04 0.04	Digits ▲⊿
0 0 0 0	.08 0.08 0.09 0.1 .08 0.08 0.09 0.1 .08 0.08 0.09 0.1 .08 0.08 0.09 0.1 .08 0.08 0.10 0.1 0.08 0.09 0.10 0.1 0.08 0.09 0.09	$\begin{smallmatrix} 10 & 0.12 & 0.13 & 0.14 & 0.15 & 0 \\ 10 & 0.12 & 0.13 & 0.14 & 0.15 & 0 \\ 10 & 0.12 & 0.13 & 0.14 & 0.15 & 0 \\ 10 & 0.12 & 0.13 & 0.14 & 0.15 & 0 \\ 10 & 0.12 & 0.13 & 0.14 & 0.15 & 0 \\ 0.12 & 0.13 & 0.14 & 0.15 & 0 \\ 0.12 & 0.13 & 0.14 & 0.15 & 0 \\ \end{smallmatrix}$	1.16 0.17 0x09 0x01 0.0 1.16 0.17 0x09 0x01 0.0	0x17 0x37 20.8 20.8 0x17 0x37 20.* 20.* 0x17 0x37 20.*8 0x37 0x17 0x37 20.*8 20.*	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04	
0 0 0 0 0).08 0.09 0.10 0.).08 0.09 0.10 0.).08 0.09 0.09 0).08 0.09 0.09 0).08 0.09 0.09 0).08 0.09 0.09 0.1		$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0x17 0x37 20* 20* 0x17 0x37 20*8 20* 0x17 0x37 1*8 20* 0x17 0x37 0*8 20* 0x17 0x37 0*8 20* 0x17 0x37 0*8 20* 0x17 0x37 0*8 20*	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	I, 04 I, 04 I, 04 I, 04 I, 04 I, 04 I, 04 I, 04	
0	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	11 0.12 0.13 0.14 0.15 0	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	08 0x27 20*8 20*7 0x 08 0x27 20*8 20*8 0x	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	04 04 .04 .04 .04 .04	A (
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Close

Planar dipole undulator is a no risk option (design and construction)

Helical dipole undulator is the same

Smallest operational energy of CESR is a decisive parameter...

Drawings could be made in one month after the final version is chosen

THE END

Titanium Sapphire Ti³⁺: Al₂O₃

