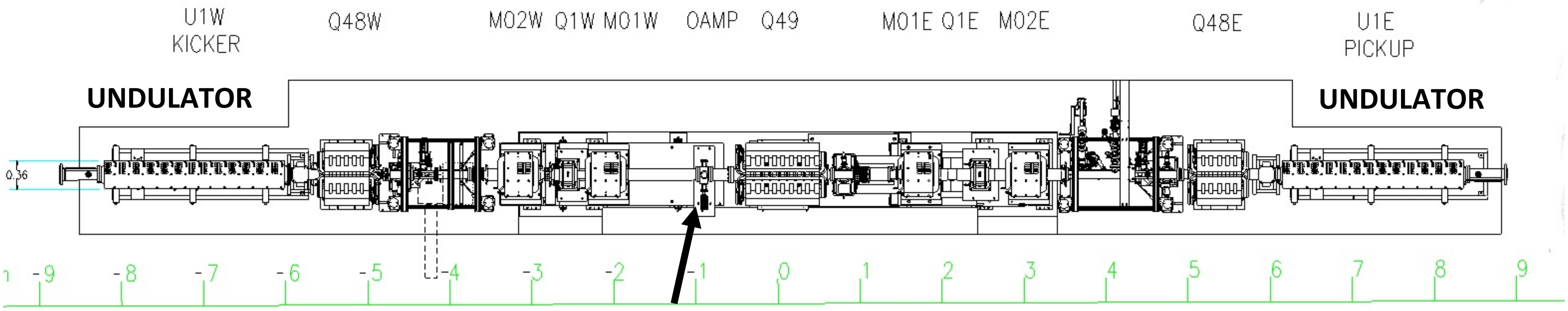
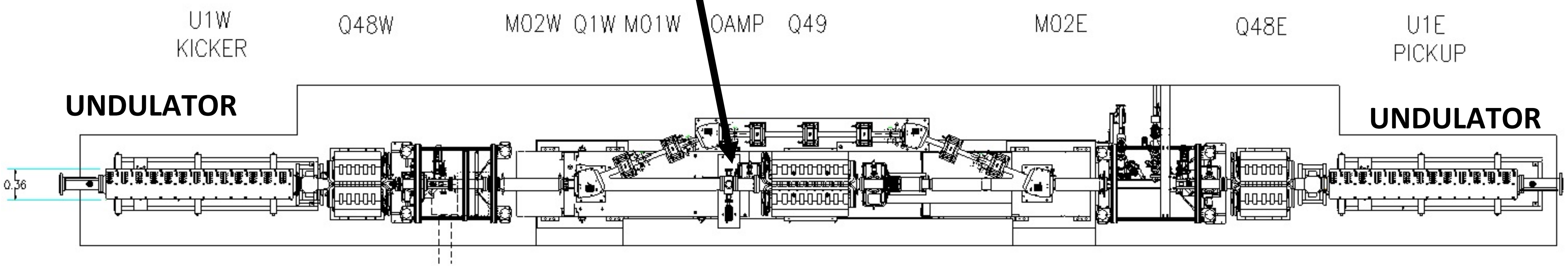
Alexander Mikhailichenko, Jan 5 2018

UNDULATORS FOR OSC (1)

Variant 1: WIDE CHAMBER

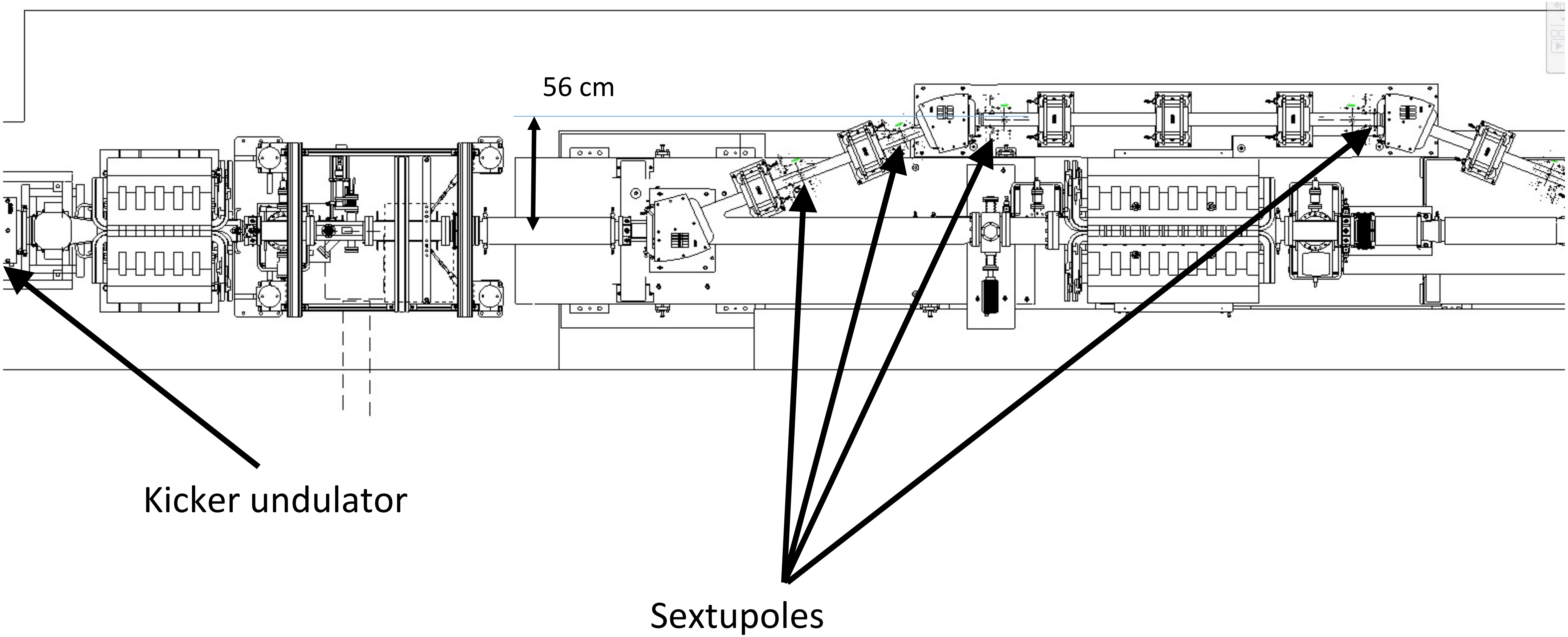


OPTICAL AMPLIFIER

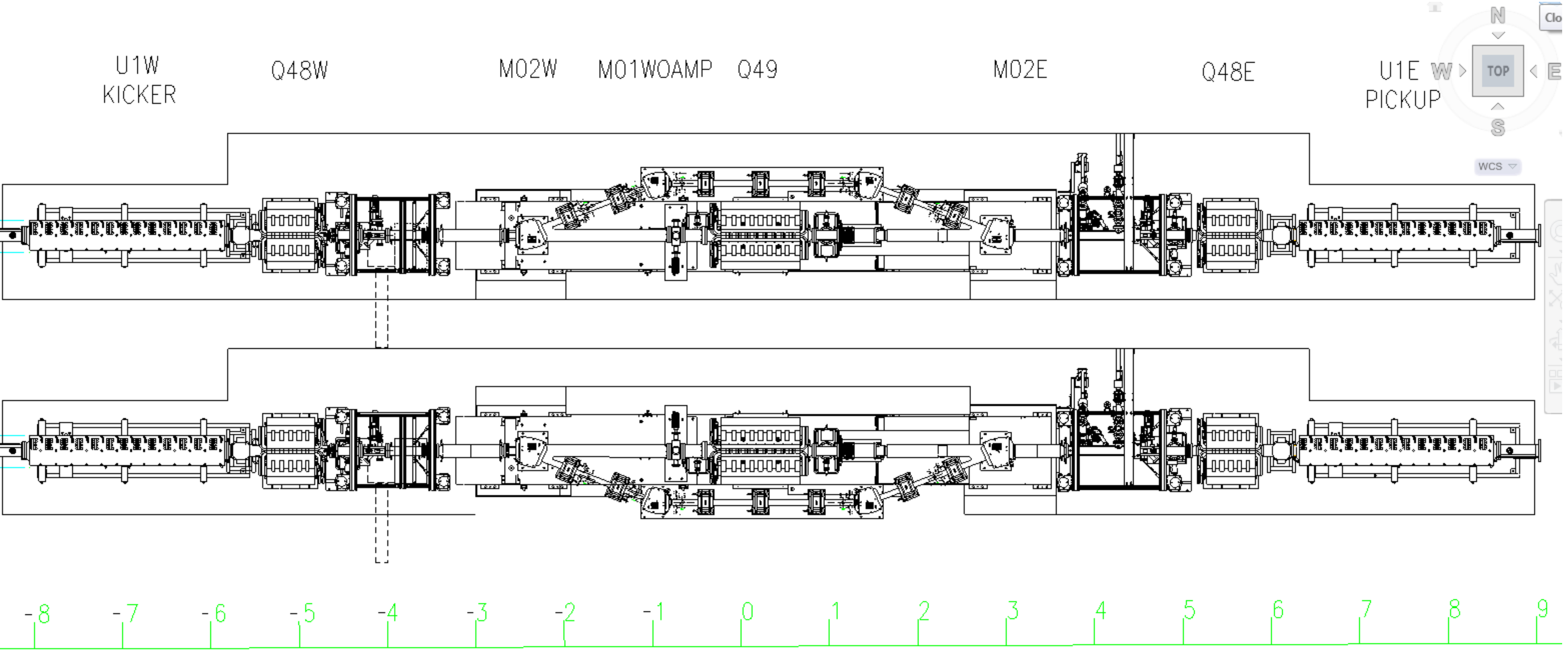


Variant 2: SEPARATE CHAMBER

ZOOMED…

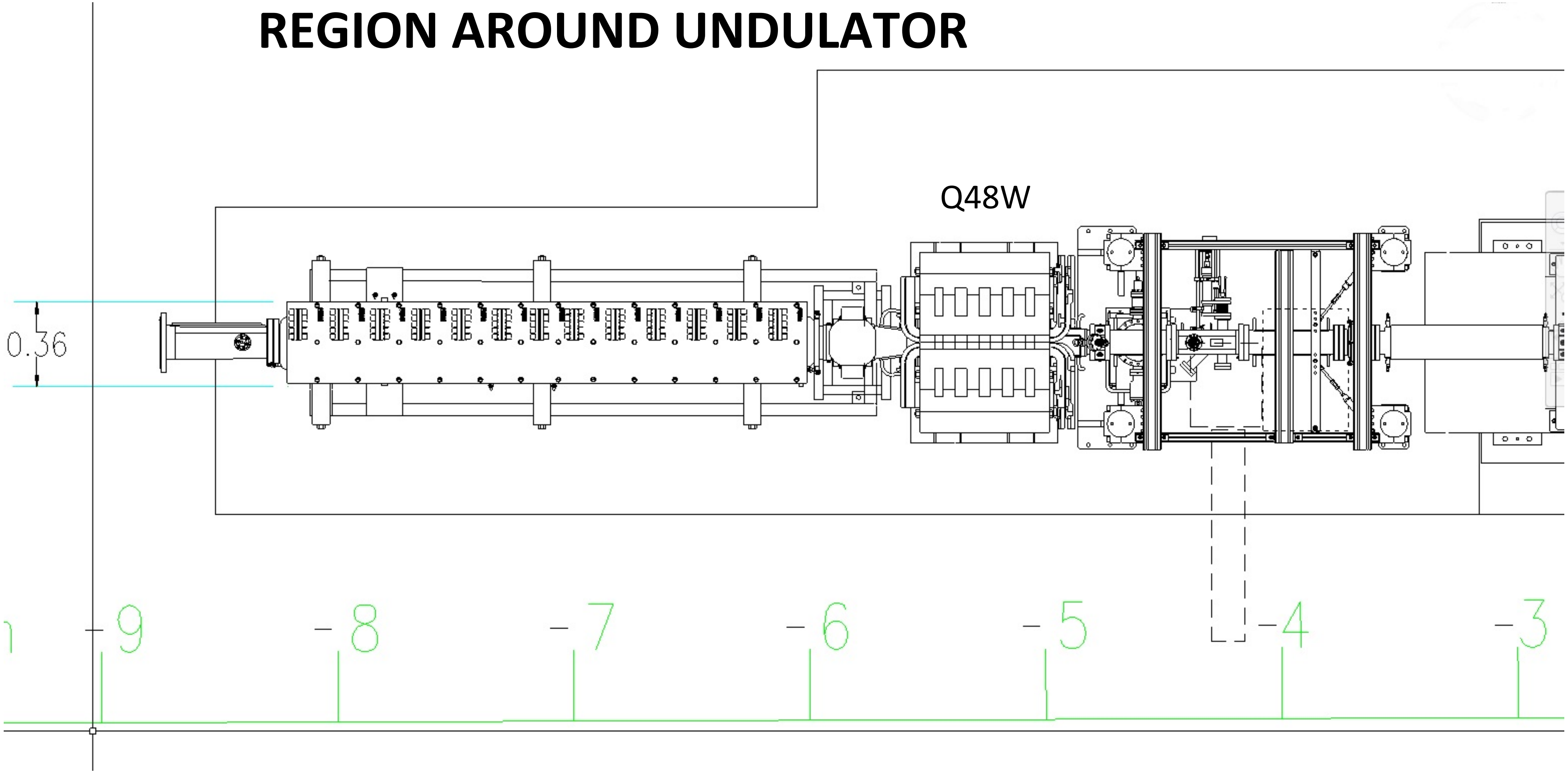


TWO ORIENTATIONS OF BYPASS- INSIDE OR OUTSIDE…



Inside allocation might give some relief for design of crotch

REGION AROUND UNDULATOR



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;

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

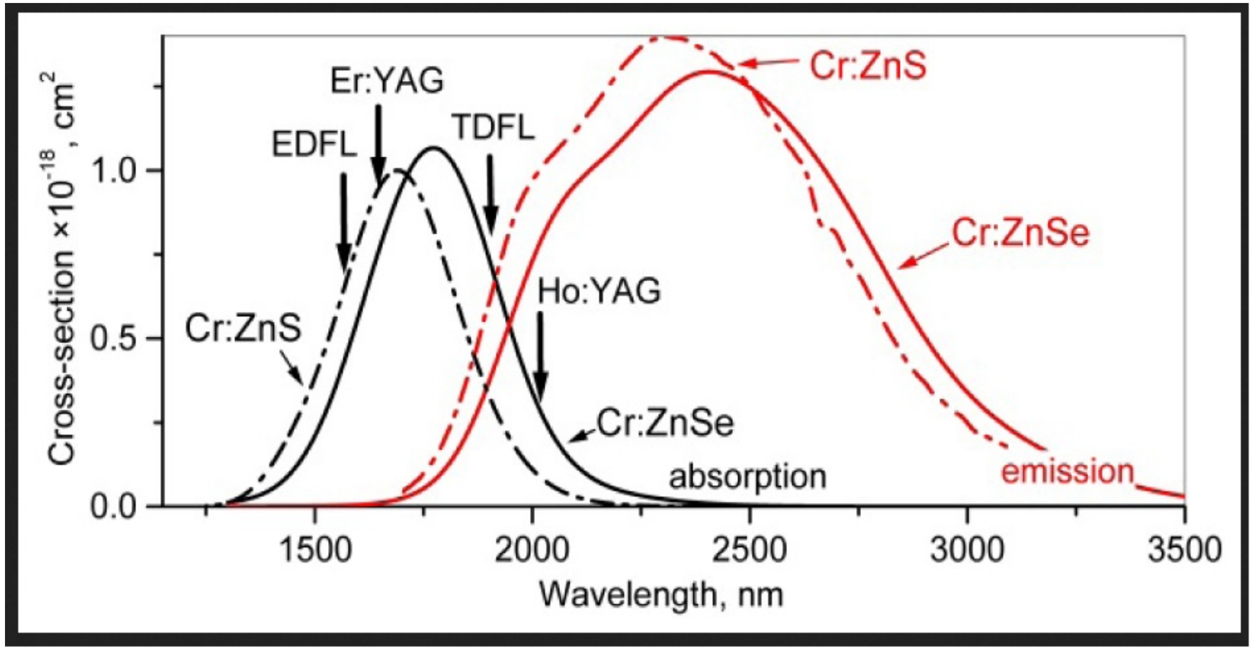
$$\lambda^1_{Uplanar} \cong \frac{\lambda_{planar}2\gamma^2}{1+K^2/2}; \qquad \lambda^1_{Uhelical} \cong \frac{\lambda_{helical}2\gamma^2}{1+K^2}$$

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

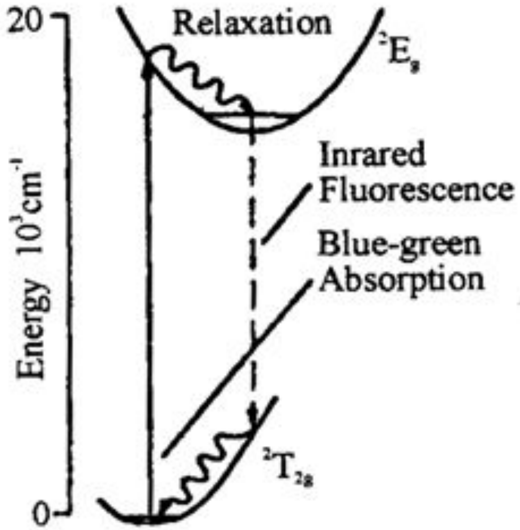
Dependence on the K-factor is favorable for a helical undulator;

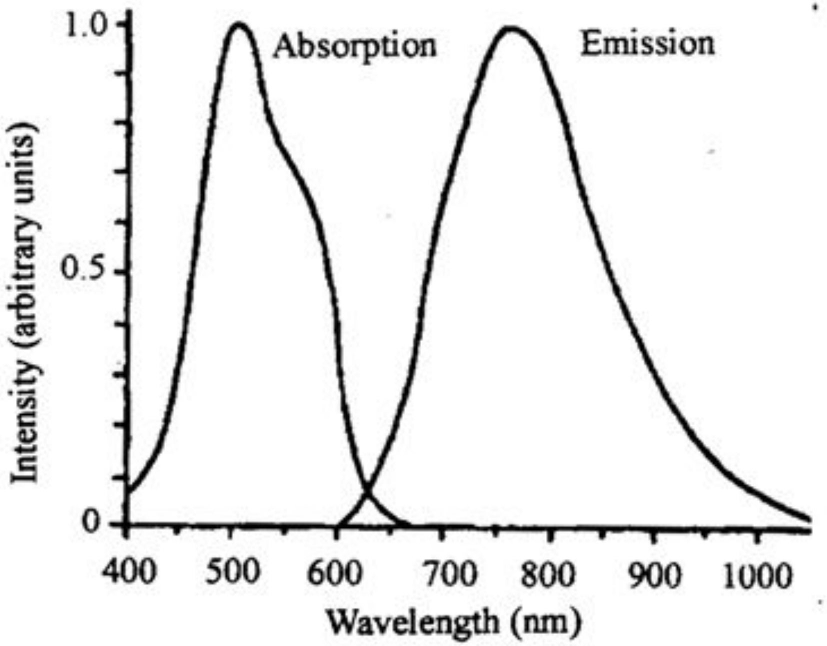
$K \leq 1, \;\; \gamma \approx 800 \; (for\ now)$

Cr:ZnSe



Ti:Al_2O_3





So, two wavelengths are:

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

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

$$\lambda_{Uplanar}^{Ti:Al_2O_3} \cong 0.64m; \qquad \lambda_{Uplanar}^{Cr:ZnSe} \cong 2.13m;$$

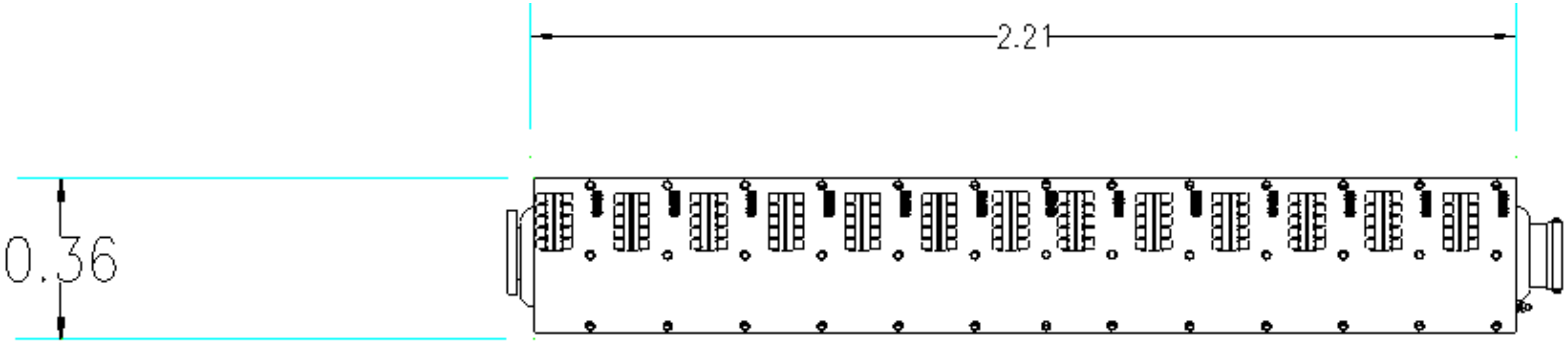
$$\lambda_{Uhelicalr}^{Ti:Al_2O_3} \cong 0.48m \qquad \lambda_{Uhelical}^{Cr:ZnSe} \cong 1.6m$$

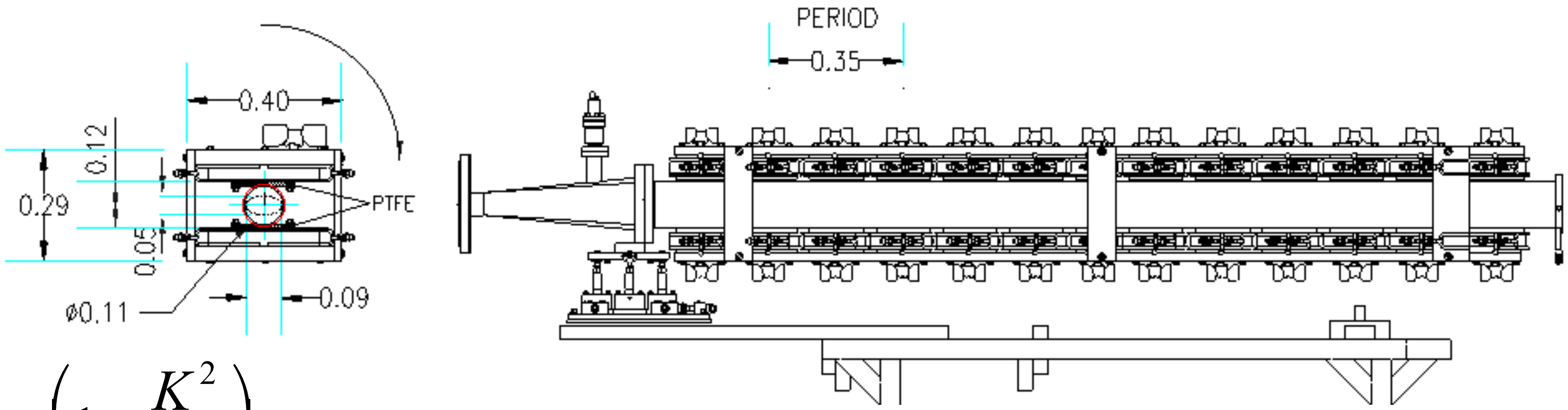
With $K \approx 1, \ \gamma \approx 600 \ (300 MeV)$ this yields:

$$\lambda_{Uplanar}^{Ti:Al_2O_3} \cong 0.36m; \qquad \lambda_{Uplanar}^{Cr:ZnSe} \cong 1.2m;$$

$$\lambda_{Uhelicalr}^{Ti:Al_2O_3} \cong 0.27m \qquad \lambda_{Uhelical}^{Cr:ZnSe} \cong 0.68m$$

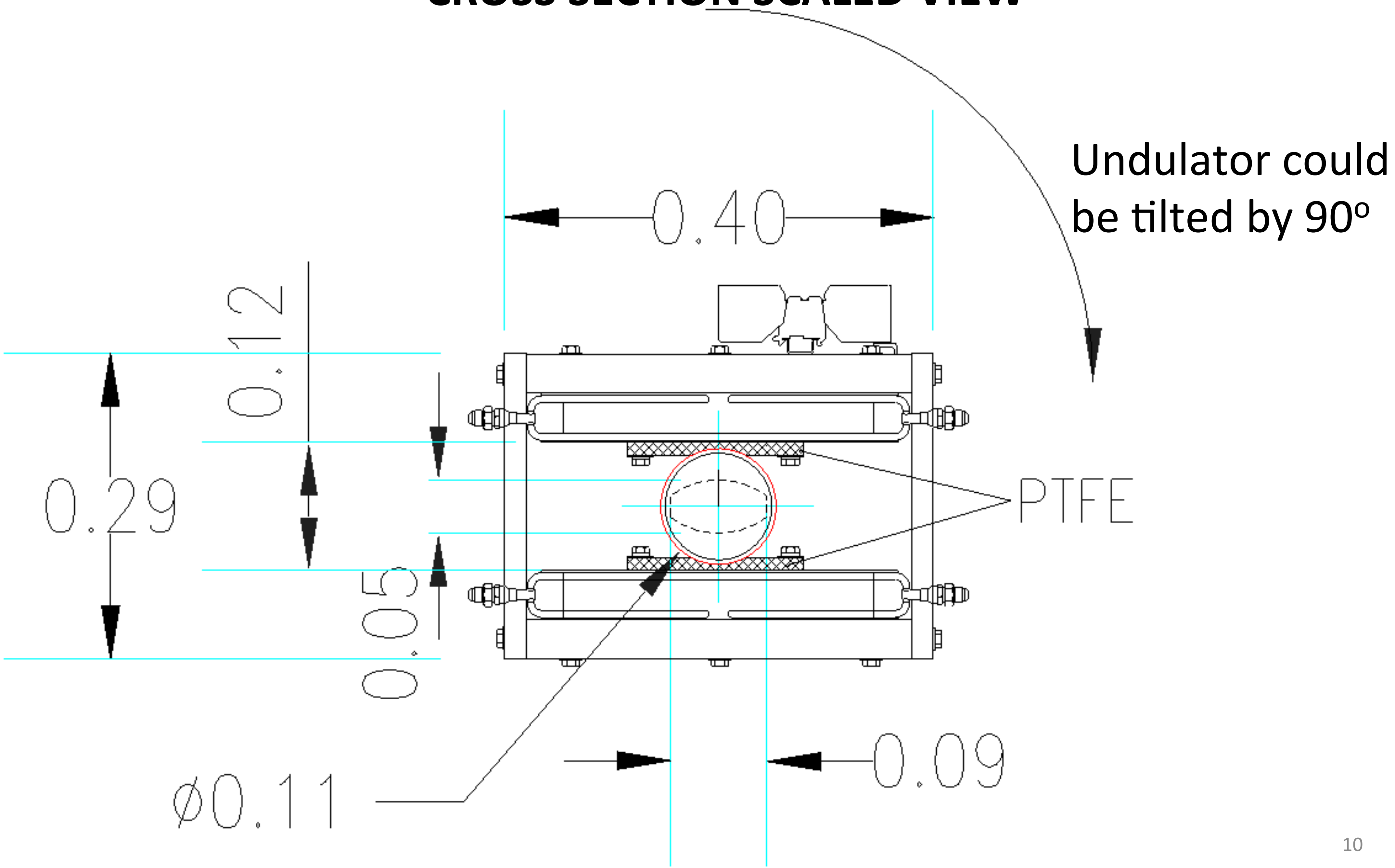
PLANAR UNDULATOR



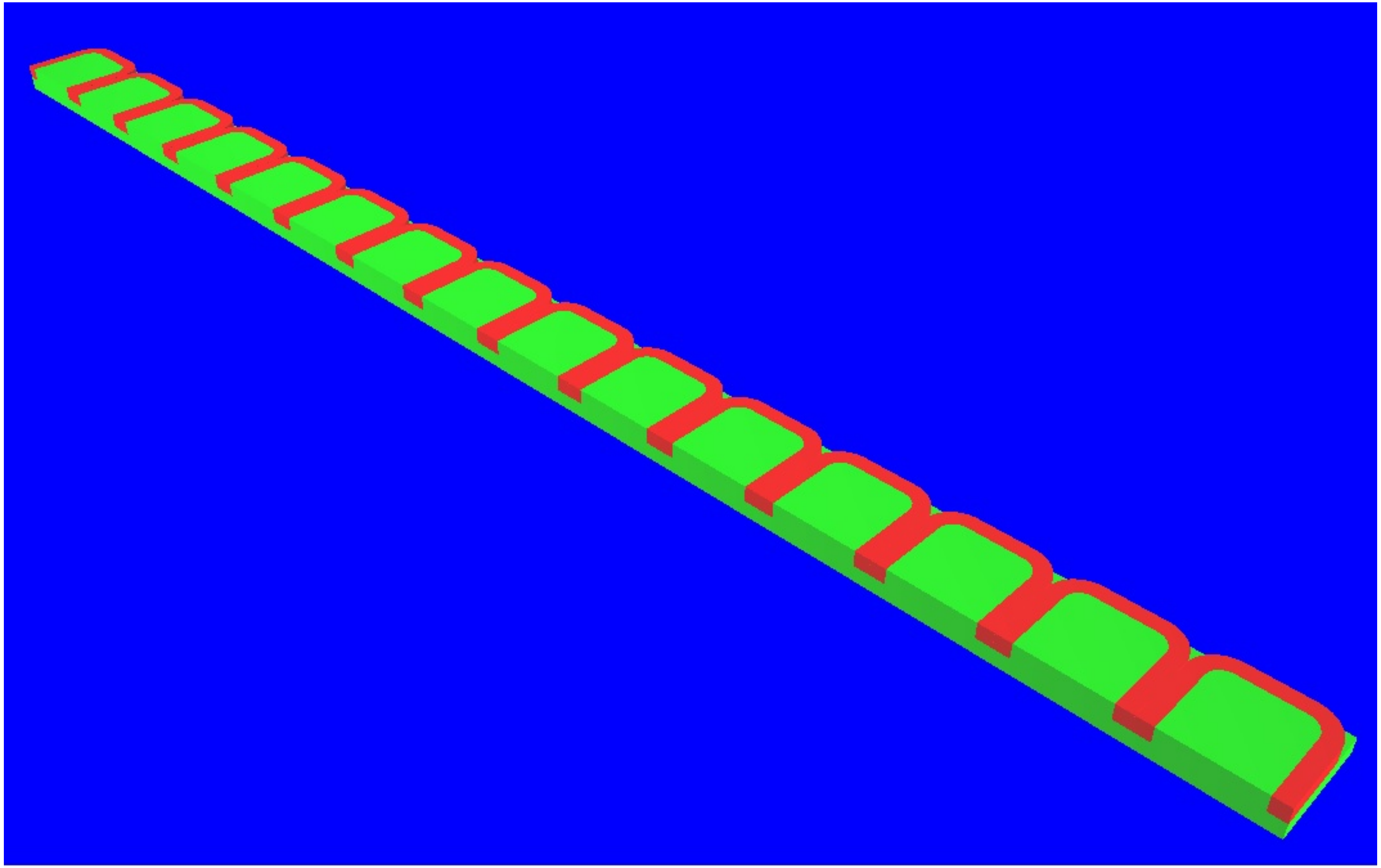


$$\lambda_U \cdot \left(1 + \frac{K^2}{2}\right)$$ --keep constant, while tapering at the edge with K=1/4; 3/4; 1

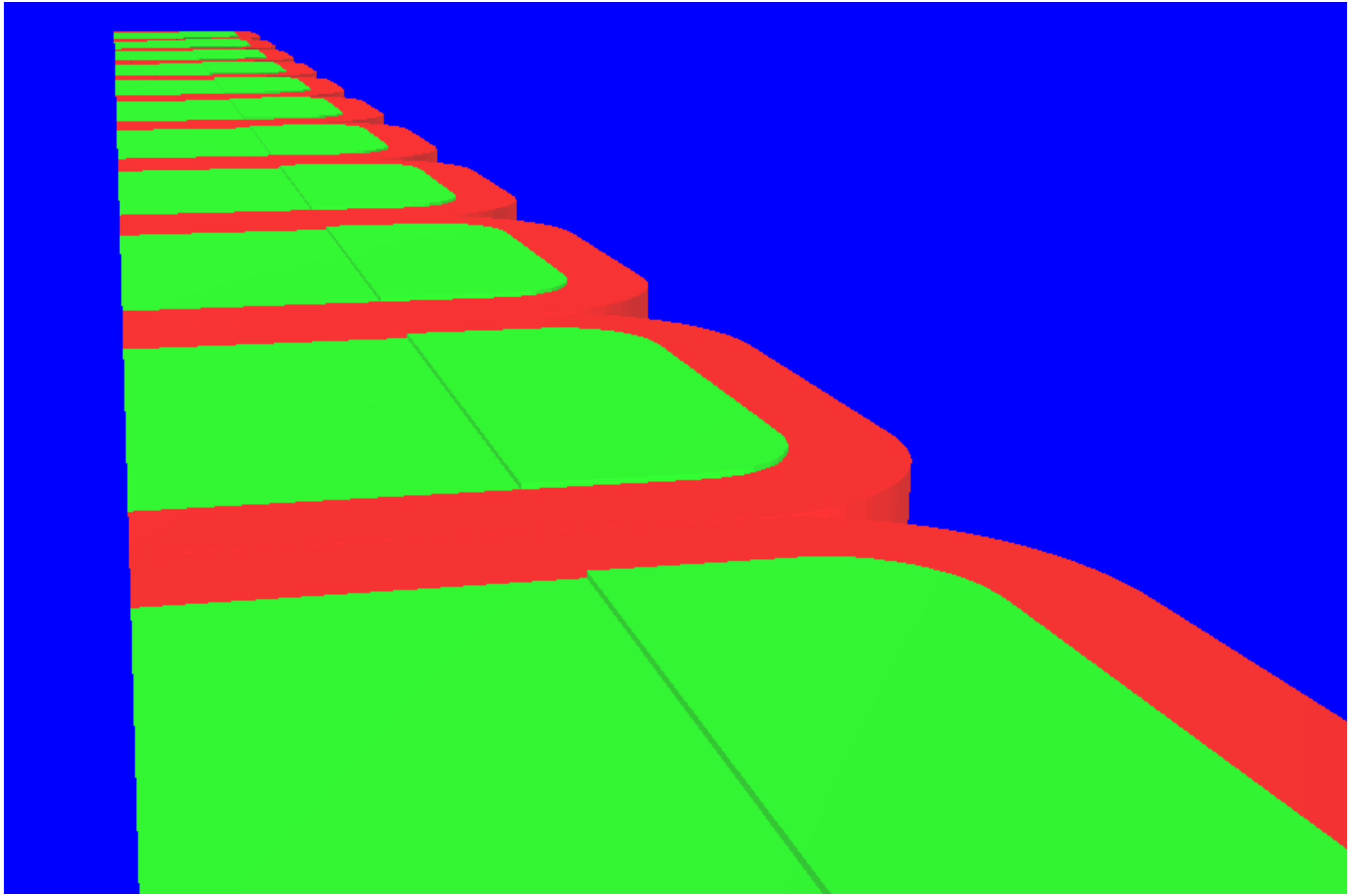
CROSS SECTION SCALED VIEW

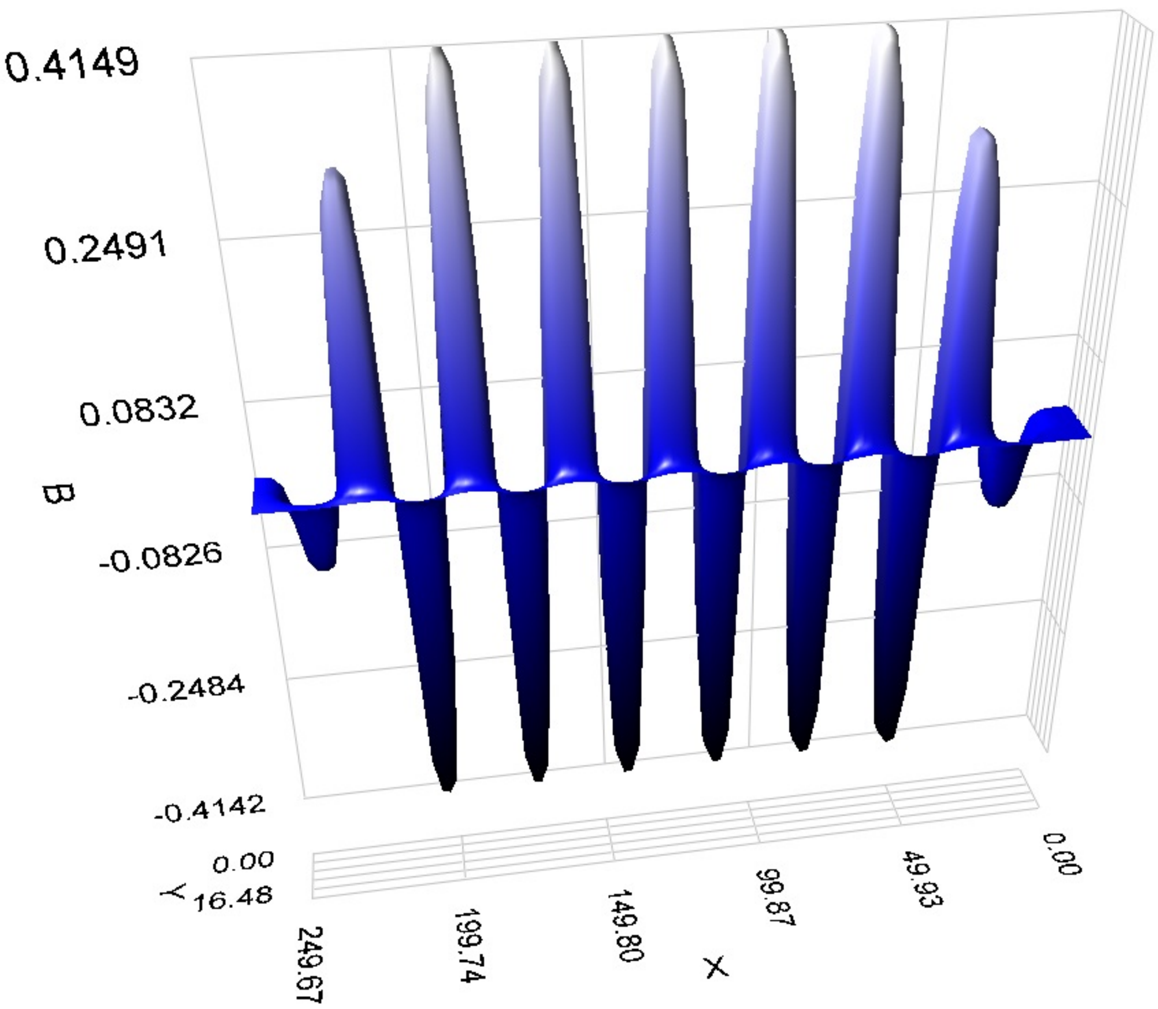


¼ of undulator



More detailed view…

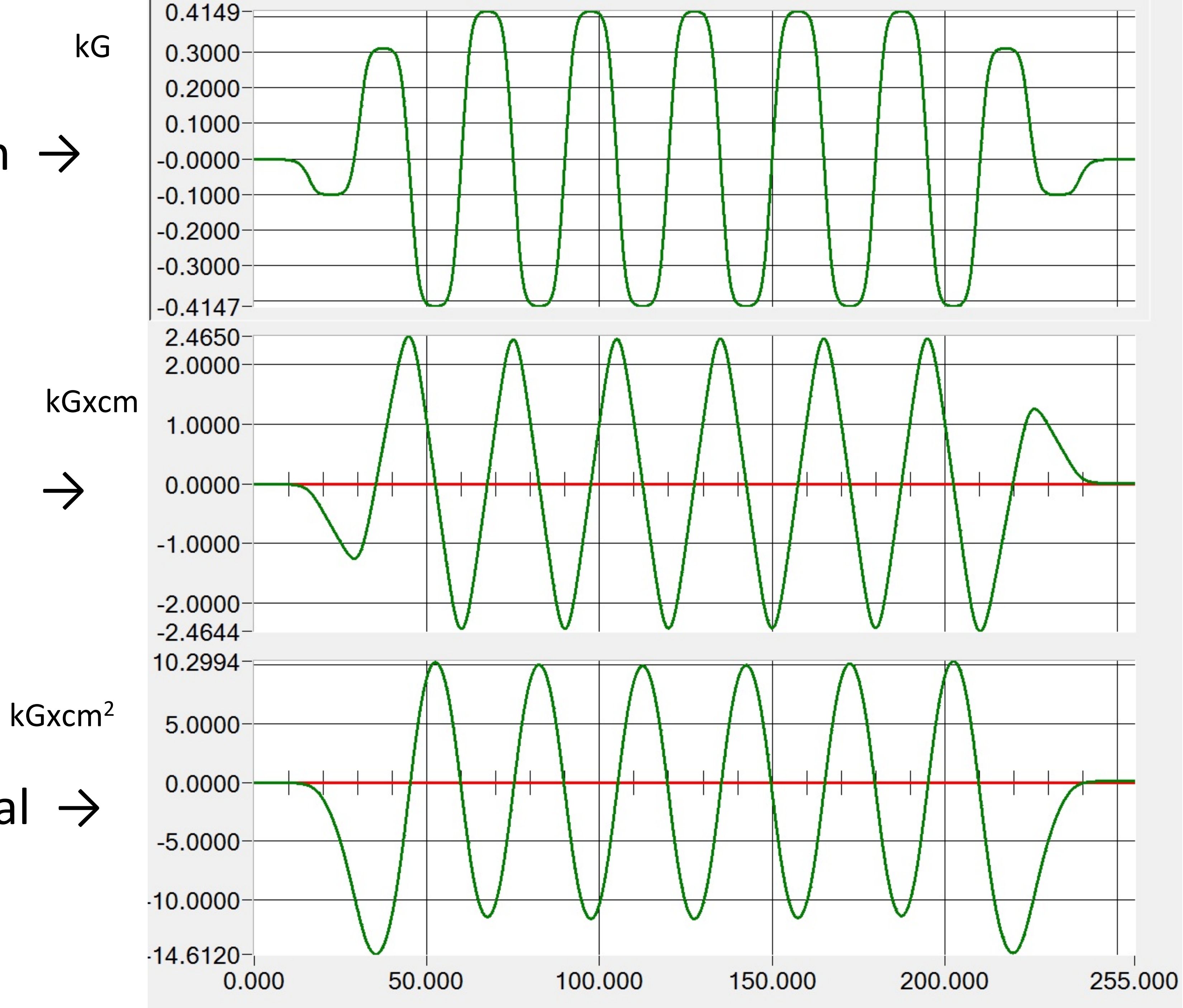



0.4149
0.2491
0.0832
B
-0.0826
-0.2484
-0.4142
0.00
Y
16.48
249.67
199.74
149.80
99.87
49.93
0.00
X

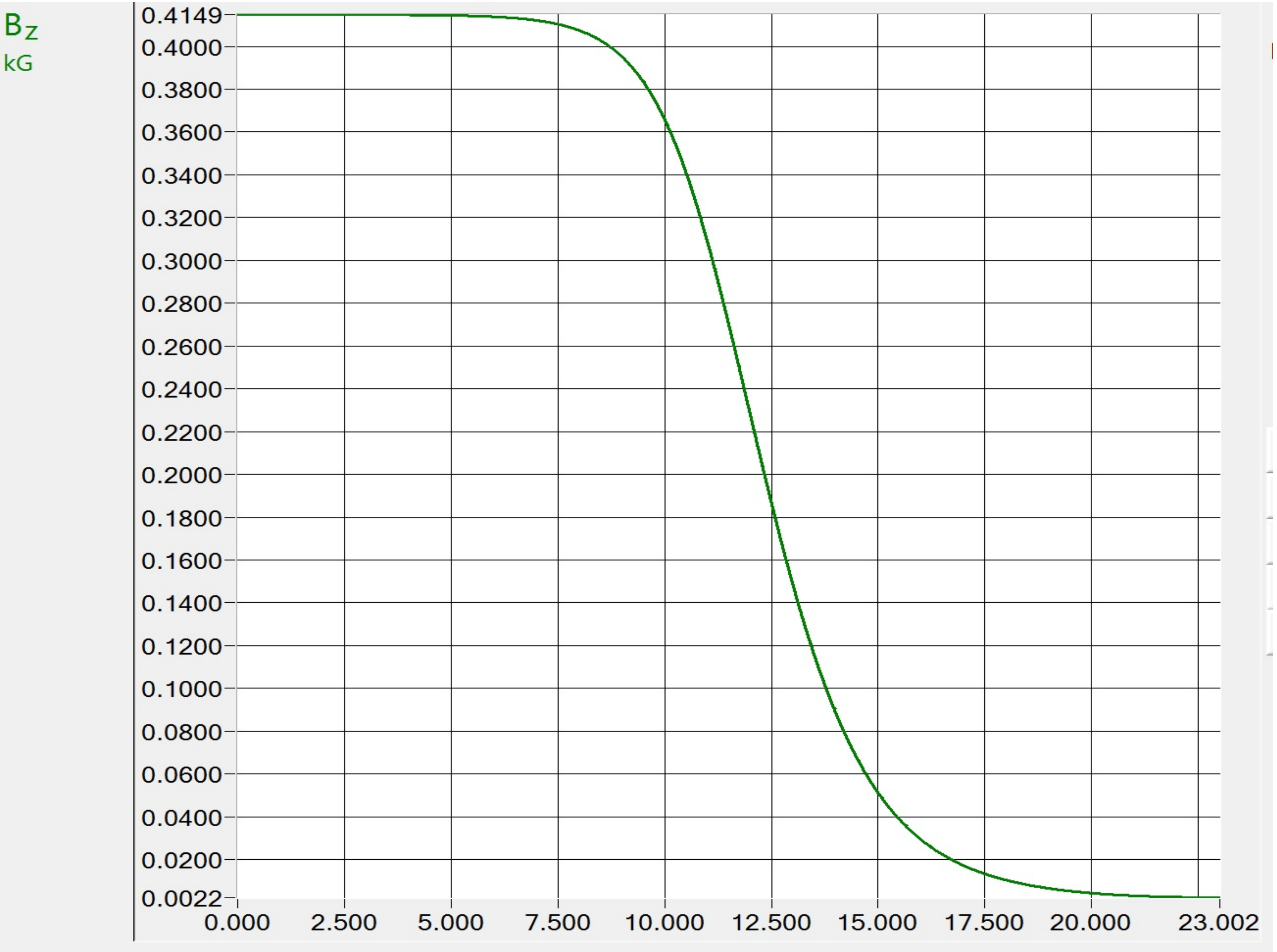
Field elevation →

First integral →

Second integral →



Field elevation across the pole apart from center

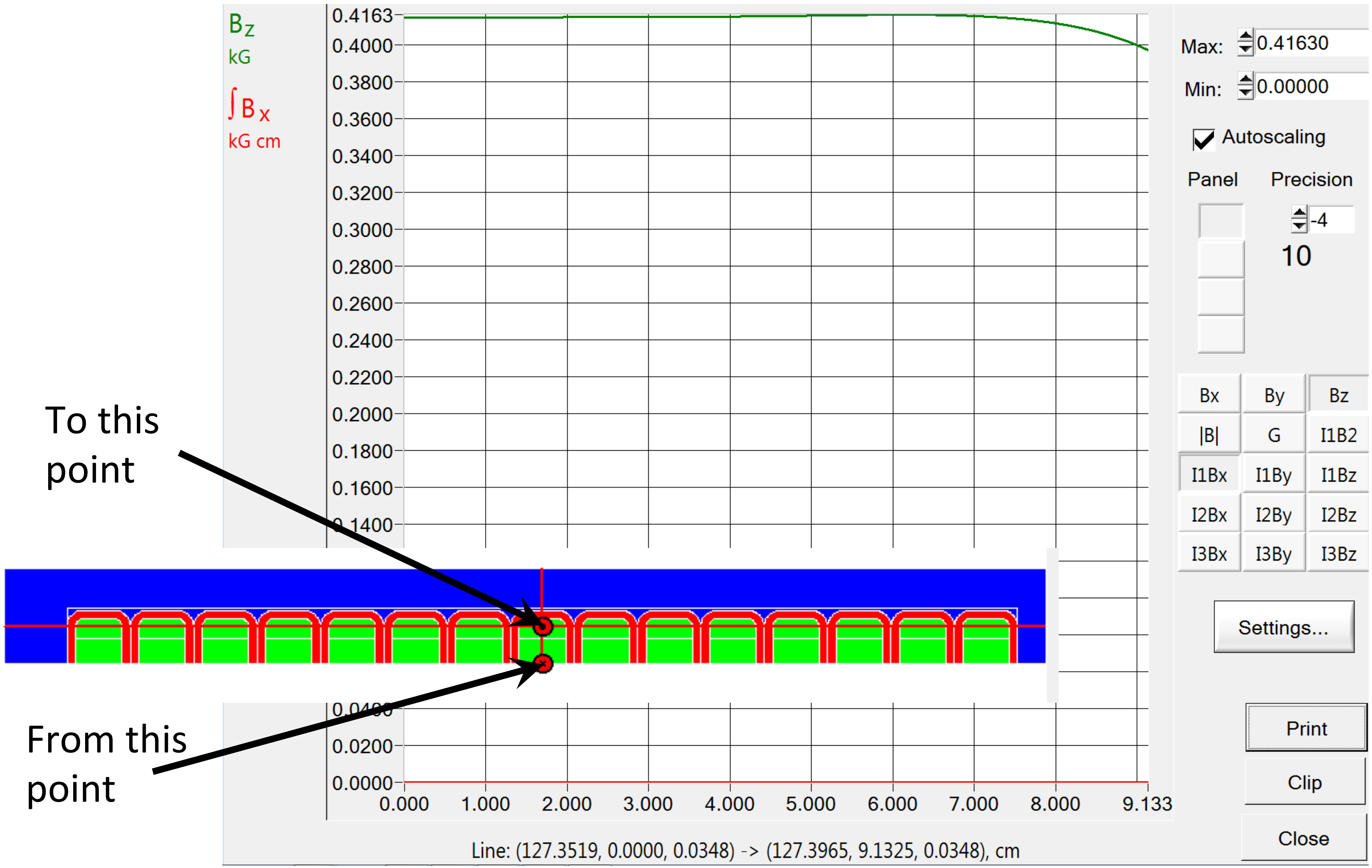


Current density is 2.5 A/mm^2 ;

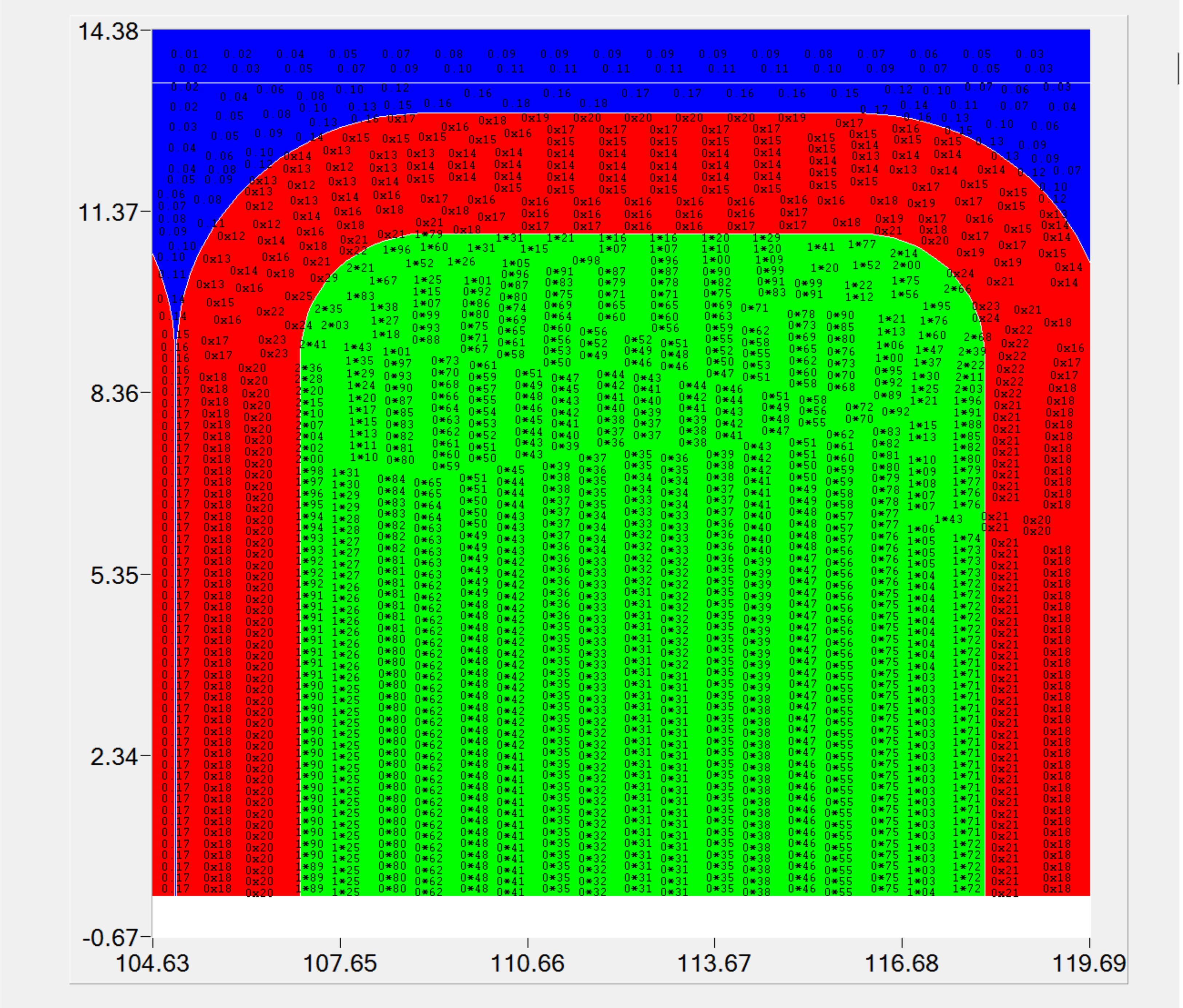
1kA total;

K≈1.15

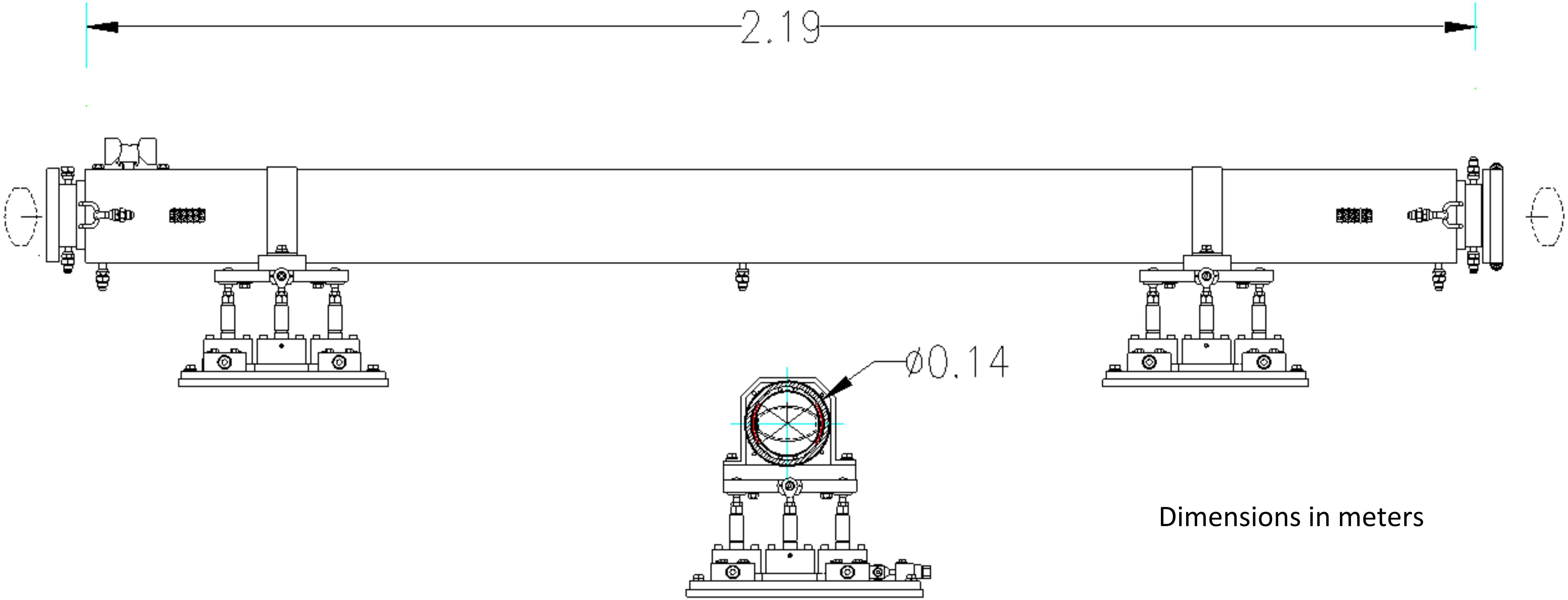
Central region zoomed…



Digital map across the pole

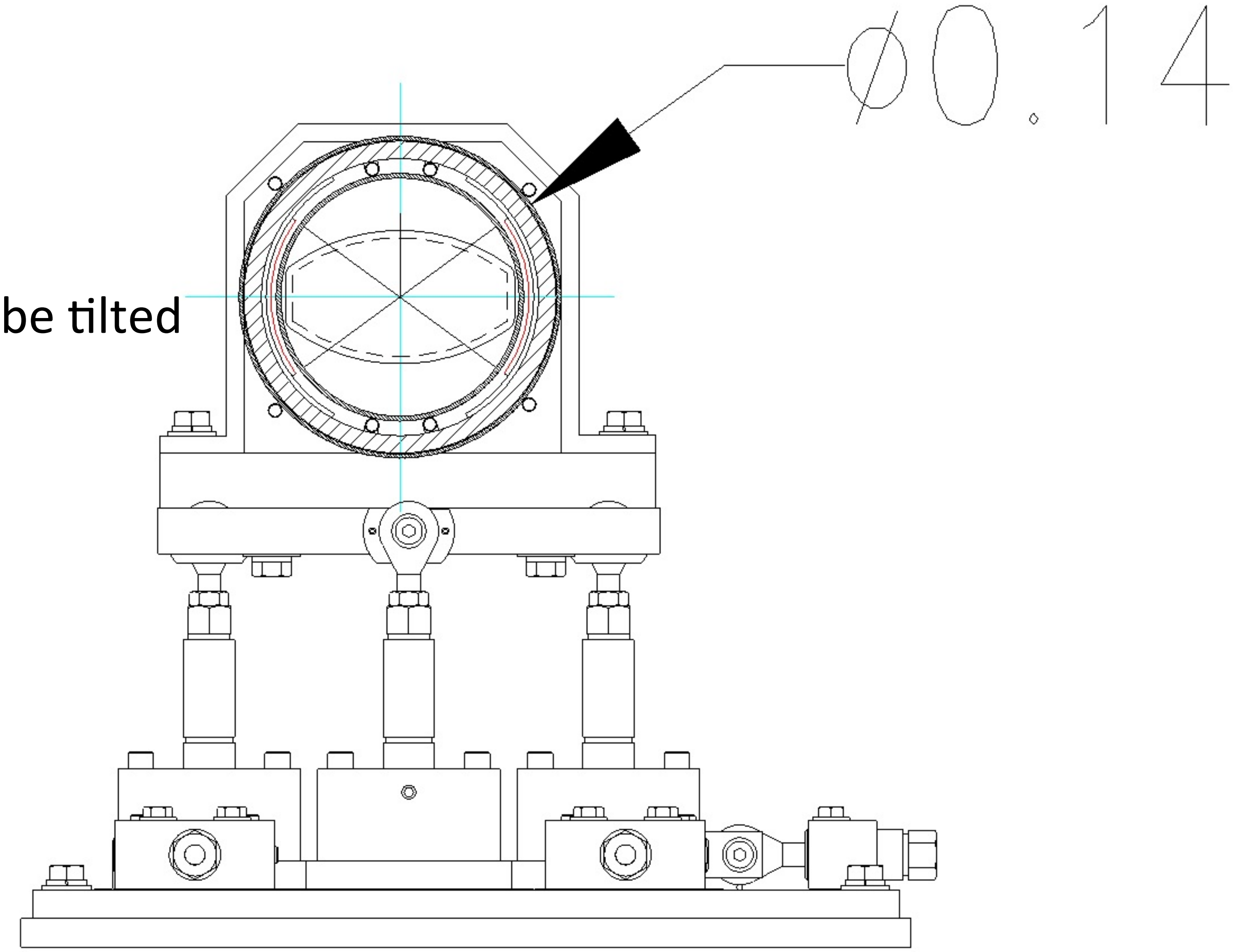


HELICAL UNDULATOR



Dimensions in meters

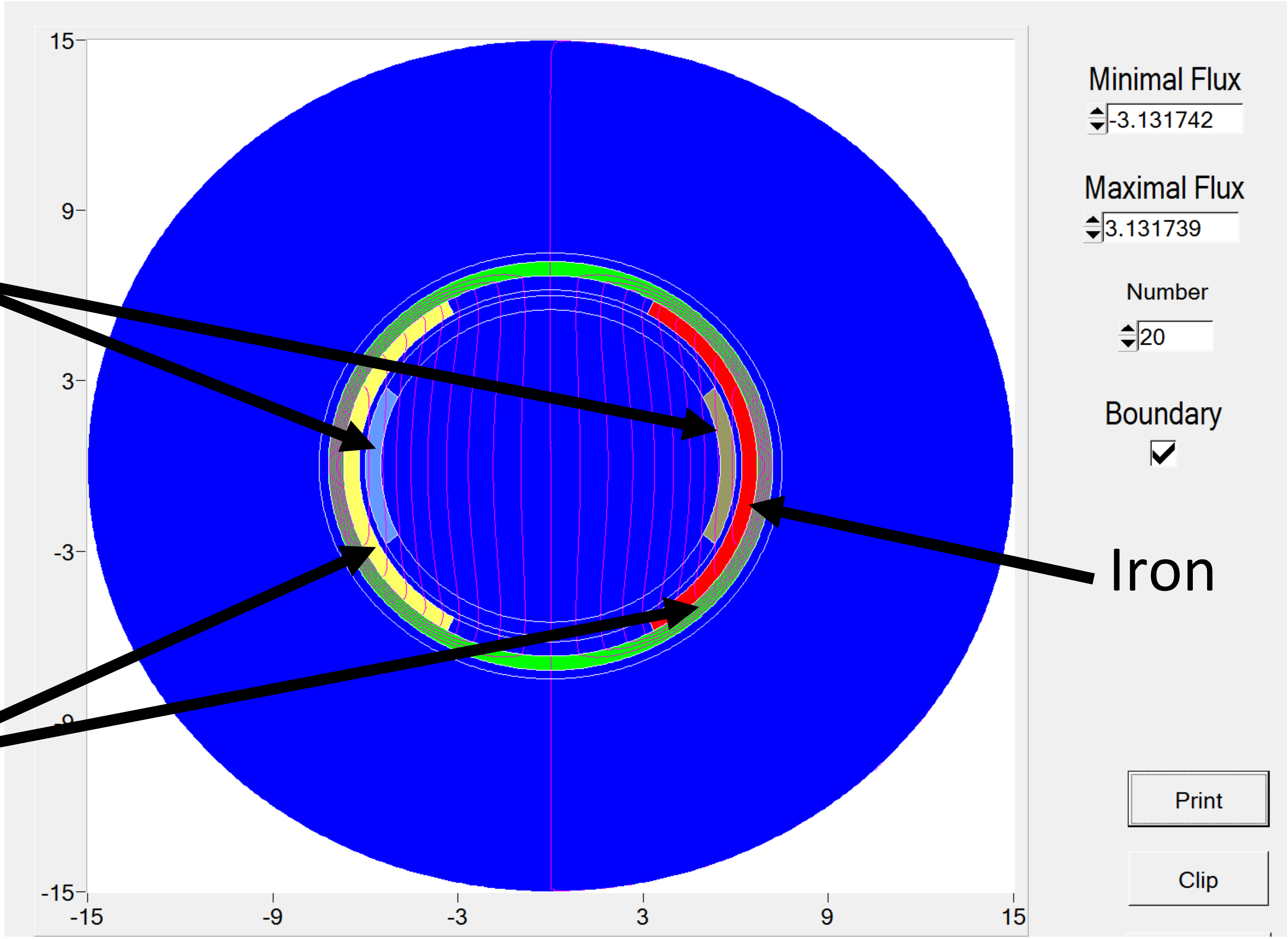
Could have an option to be tilted



I=±0.75 kA

$\lambda_U = 35\ cm$

I=±3 kA



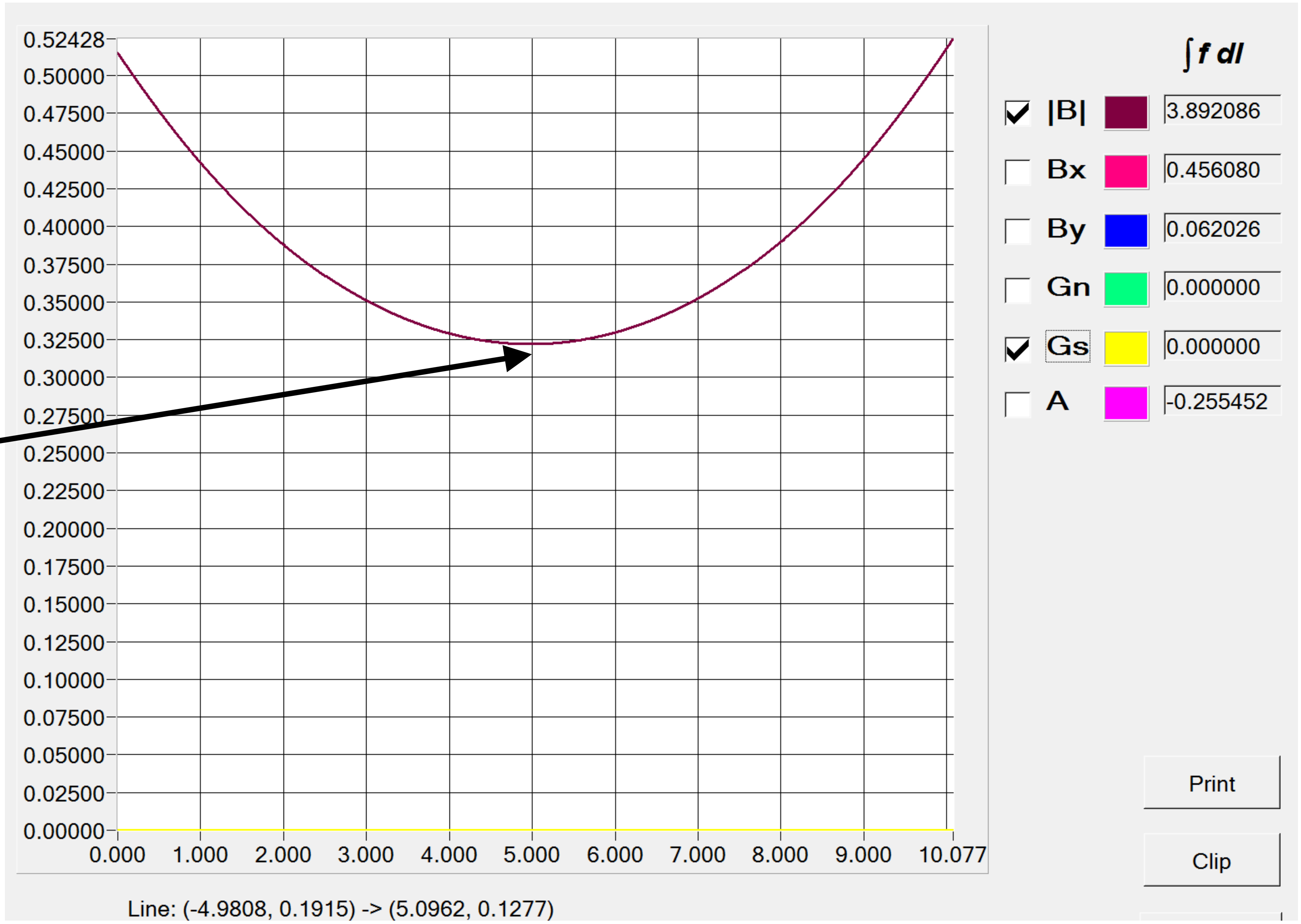
Iron

Dipole mode

$\lambda_U = 35\ cm$

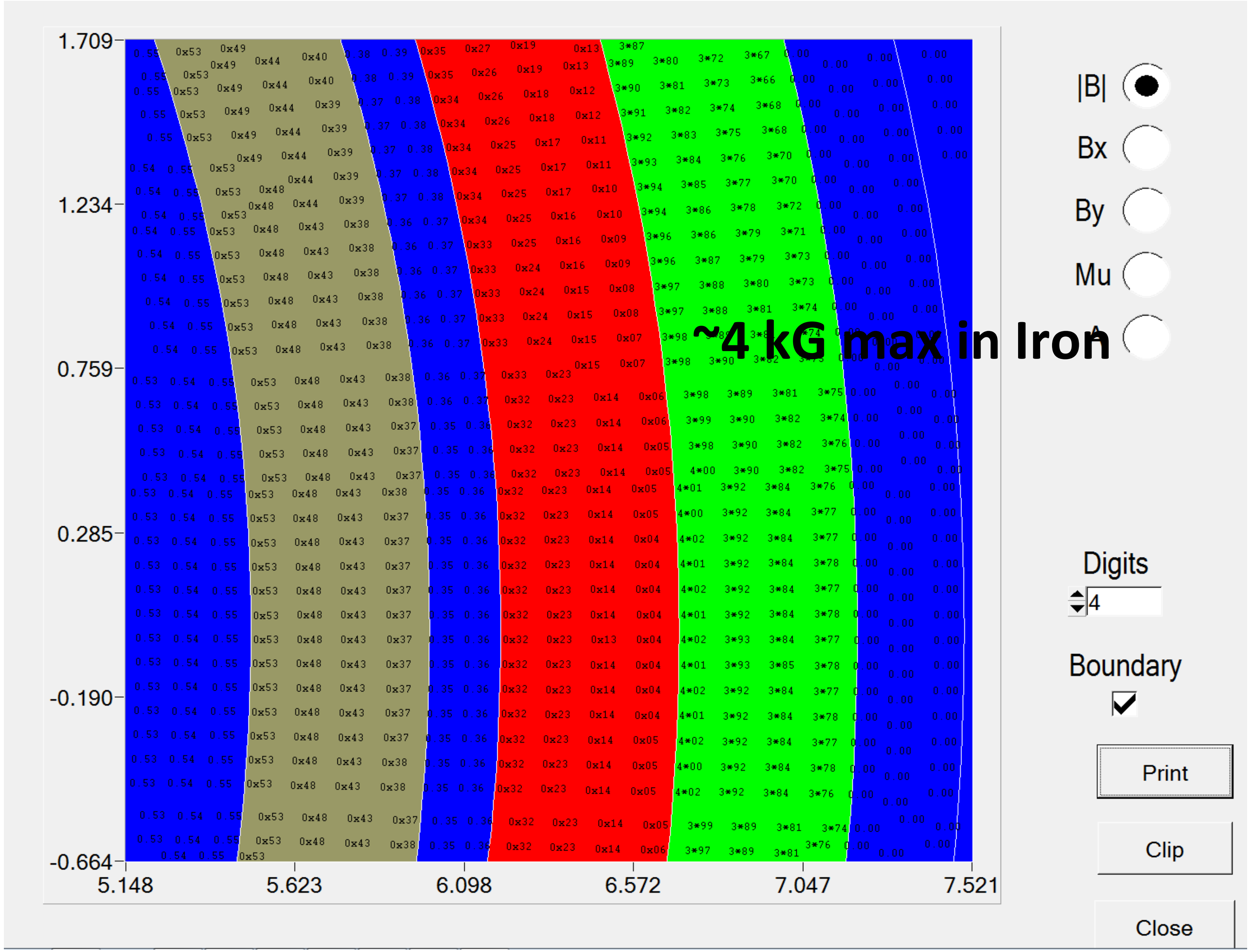
I=3+0.75 kA (total)

K=1.06



For current density 15 A/mm², the cross section comes to be

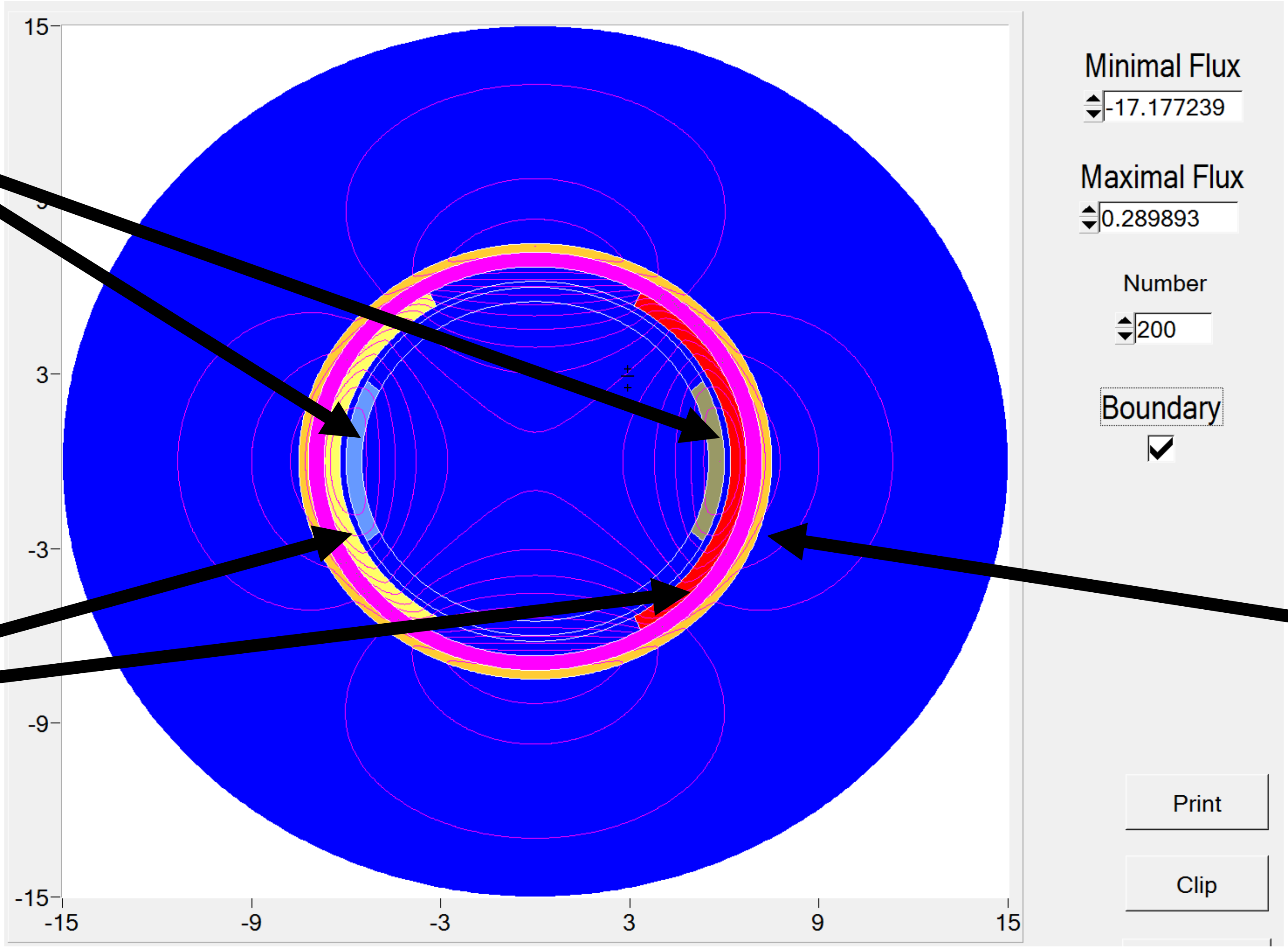
Area≈250 mm²



~4 kG max in Iron

HELICAL UNDULATOR IN A QUADRUPOLE MODE

$I = \pm 0.75kA$

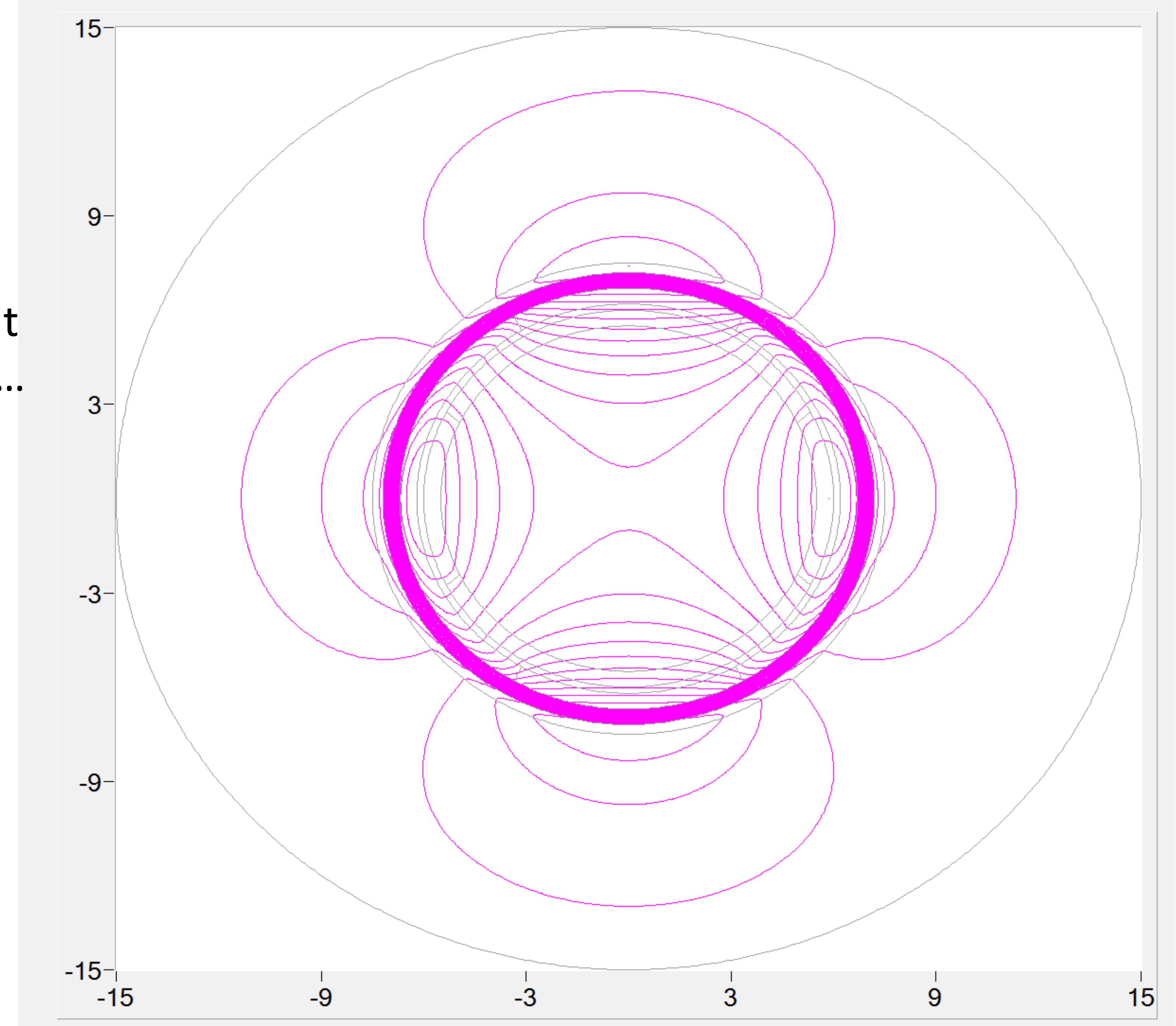


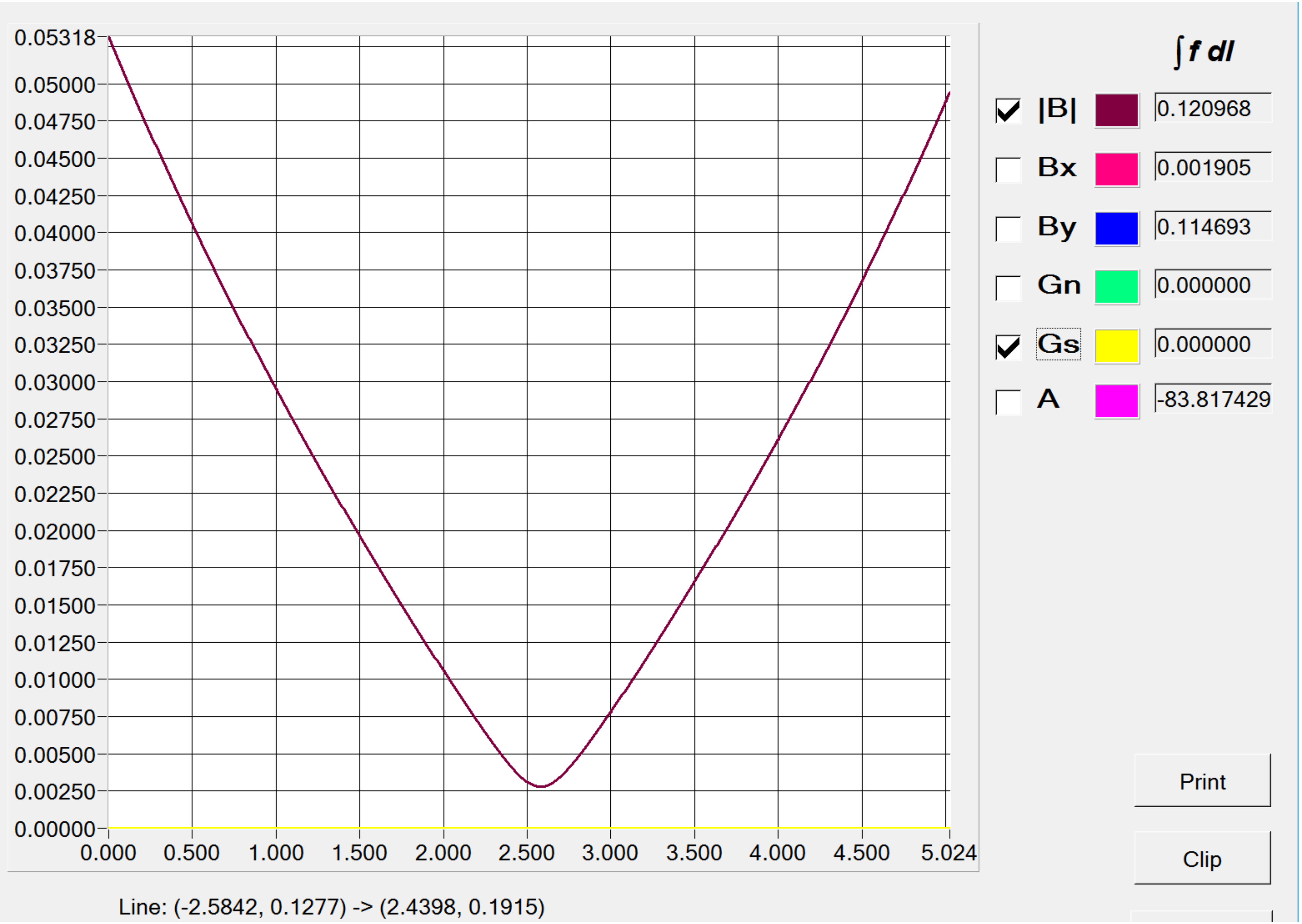
$I = \pm 3kA$

I=-7.5 kA

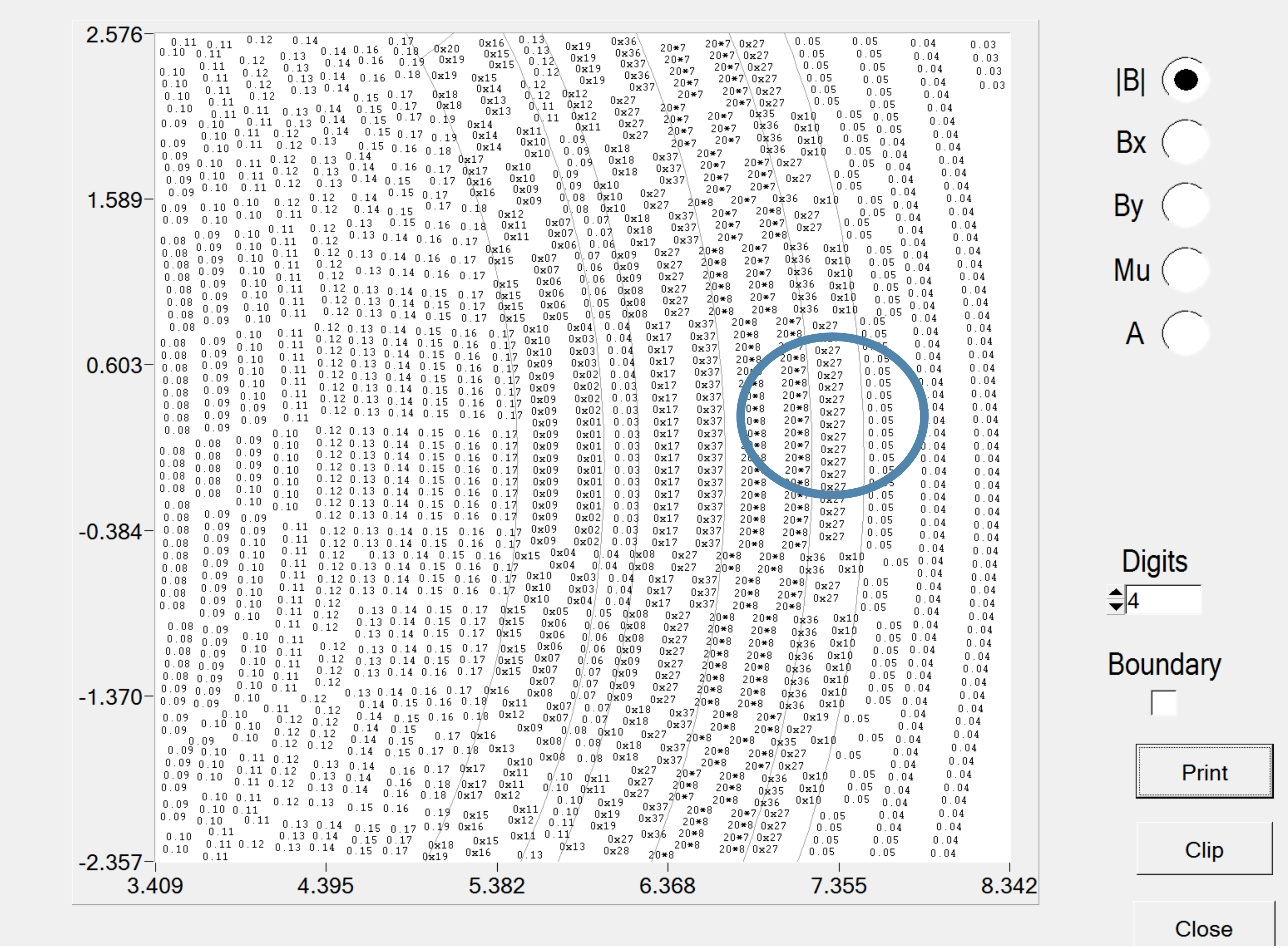
The same as in previous slide, but without painting the boundaries…

Period of helix=35 cm




0.05318
0.05000
0.04750
0.04500
0.04250
0.04000
0.03750
0.03500
0.03250
0.03000
0.02750
0.02500
0.02250
0.02000
0.01750
0.01500
0.01250
0.01000
0.00750
0.00500
0.00250
0.00000
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.024
∫f dl
|B| 0.120968
Bx 0.001905
By 0.114693
Gn 0.000000
Gs 0.000000
A -83.817429
Print
Clip
Line: (-2.5842, 0.1277) -> (2.4398, 0.1915)

20 kG in few places…



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

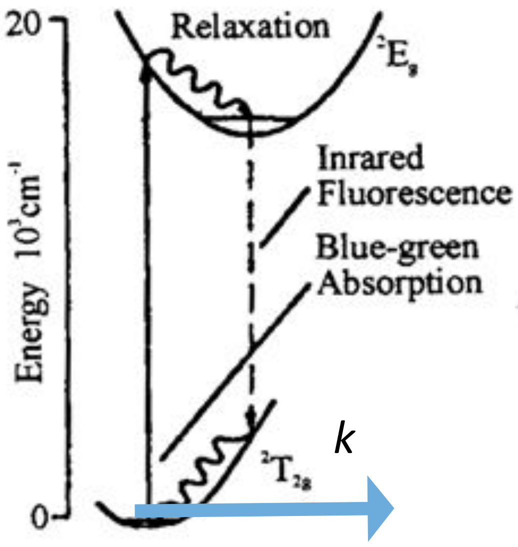
Helical dipole undulator is the same

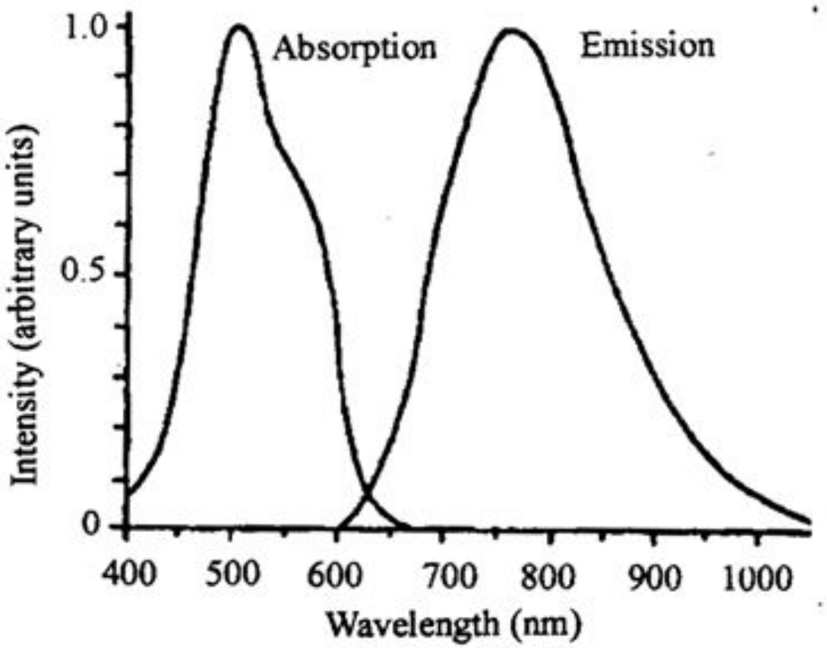
Smallest operational energy of CESR is a decisive parameter…

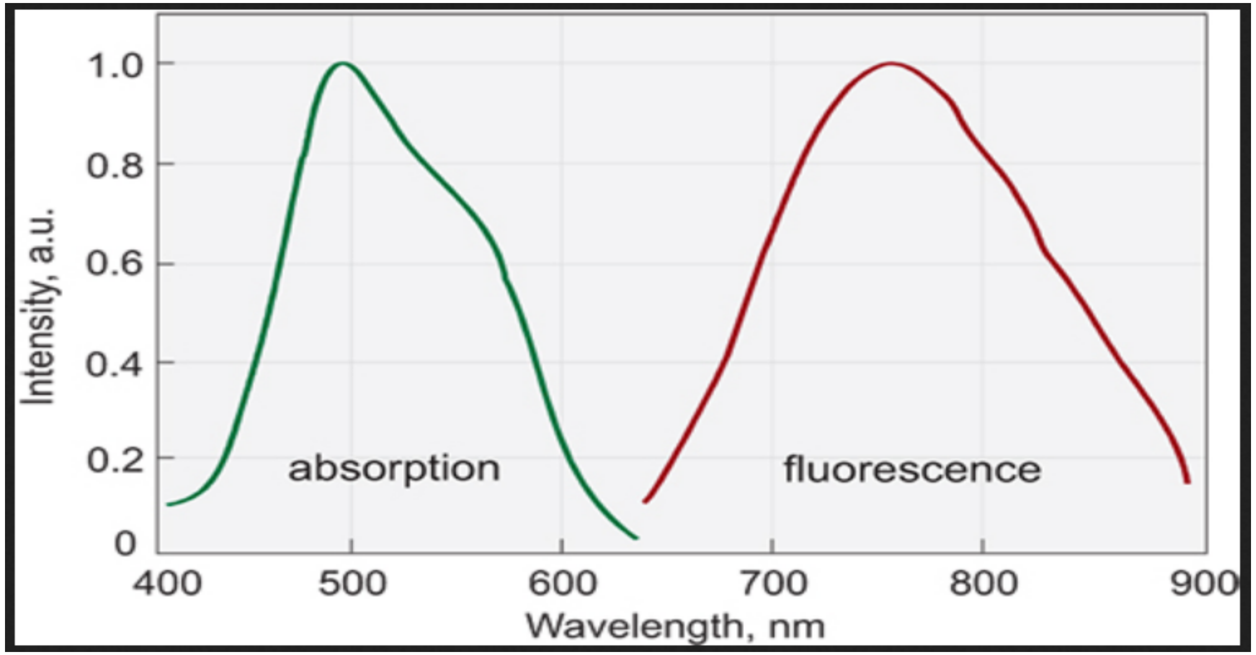
Drawings could be made in one month after the final version is chosen

THE END

Titanium Sapphire $Ti^{3+}: Al_2O_3$






Intensity, a.u.
1.0
0.8
0.6
0.4
0.2
0
absorption
fluorescence
400
500
600
700
800
900
Wavelength, nm