2012/July/30 #2 ERL workshop

極短周期アンジュレータのERLへの応用

Application of very short period undulators to ERLs

1. What is a very short period undulator?
2. Formation of a “very short period” undulator field
3. Field measurement & characterization
4. Application to ERLs
5. Conclusion

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1. What is a very short period undulator?

Hard x rays by shorter λu @ lower energy LS (~3GeV)

We proposed:
In-vac Us (λu=4cm) @ 6.5PF-AR
In-vac SGUs (λu=1-2cm) @ 2.5PF

In other institutes:
3G LS (ESRF, APS & SPring-8):
In-vac Us (λu~several cm)
Compact 3G LS (SLS, NSLS-II, MAX-IV, *etc*):
In-vac Us (λu~2 cm)

1. What is a very short period undulator?

Short Gap Undulators @ PF

Name	***Make***	***iH*$_c$** *	λ_u	***N***	***12-keV photon***	***K*$_{max}$** **
SGU#17	2003	25kOe	16mm	29	5th	1.374
SGU#03	2005	30kOe	18mm	26	5th	1.684
SGU#01	2008	28kOe	12mm	39	3rd	0.781

* Magnet: NEOMAX TiN coated

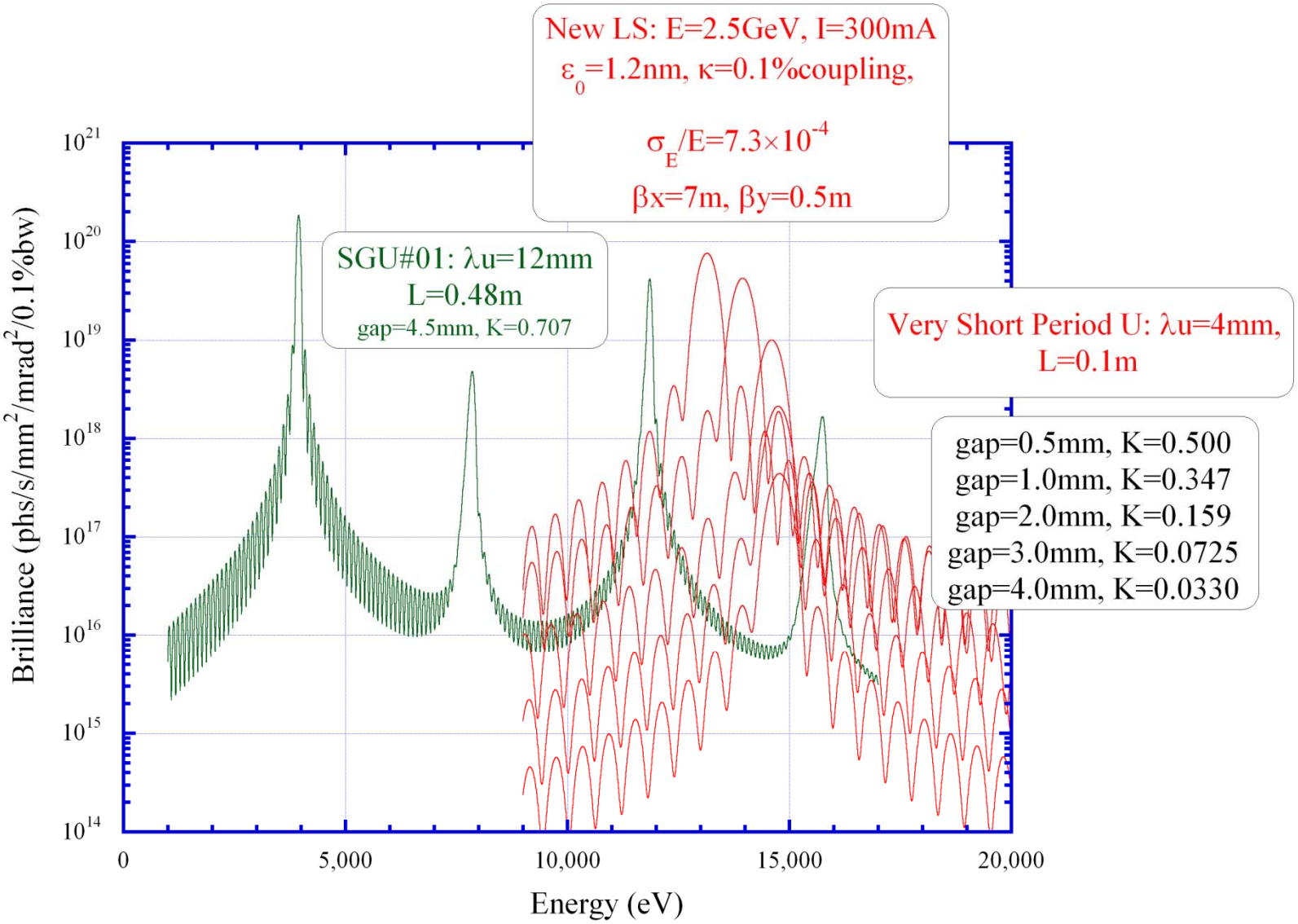
** @ Gap_{min}=4.0mm

What is the shortest λu?

What is the shortest undulator length?

1. What is a very short period undulator?

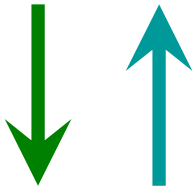
Very short period U @ 2.5GeV LS



1. What is a very short period undulator?

High quality LS accelerator

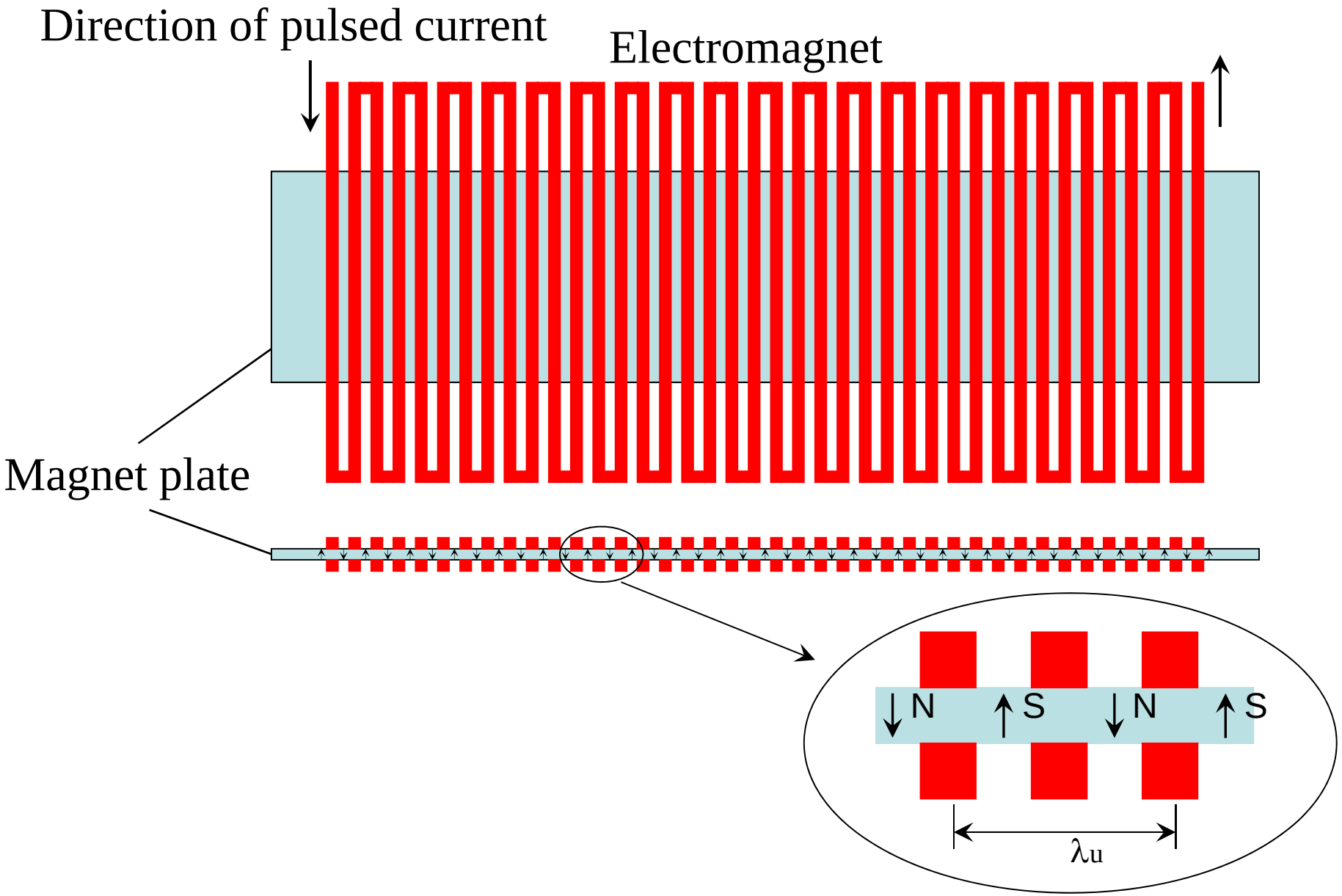
low ε, high $\mathcal{B}$, sharp e^-, *etc*



Very short period undulator

short *G*, short *L*, high energy phs, *etc*

2. Formation of a "very short period" undulator field: perpendicular geometry



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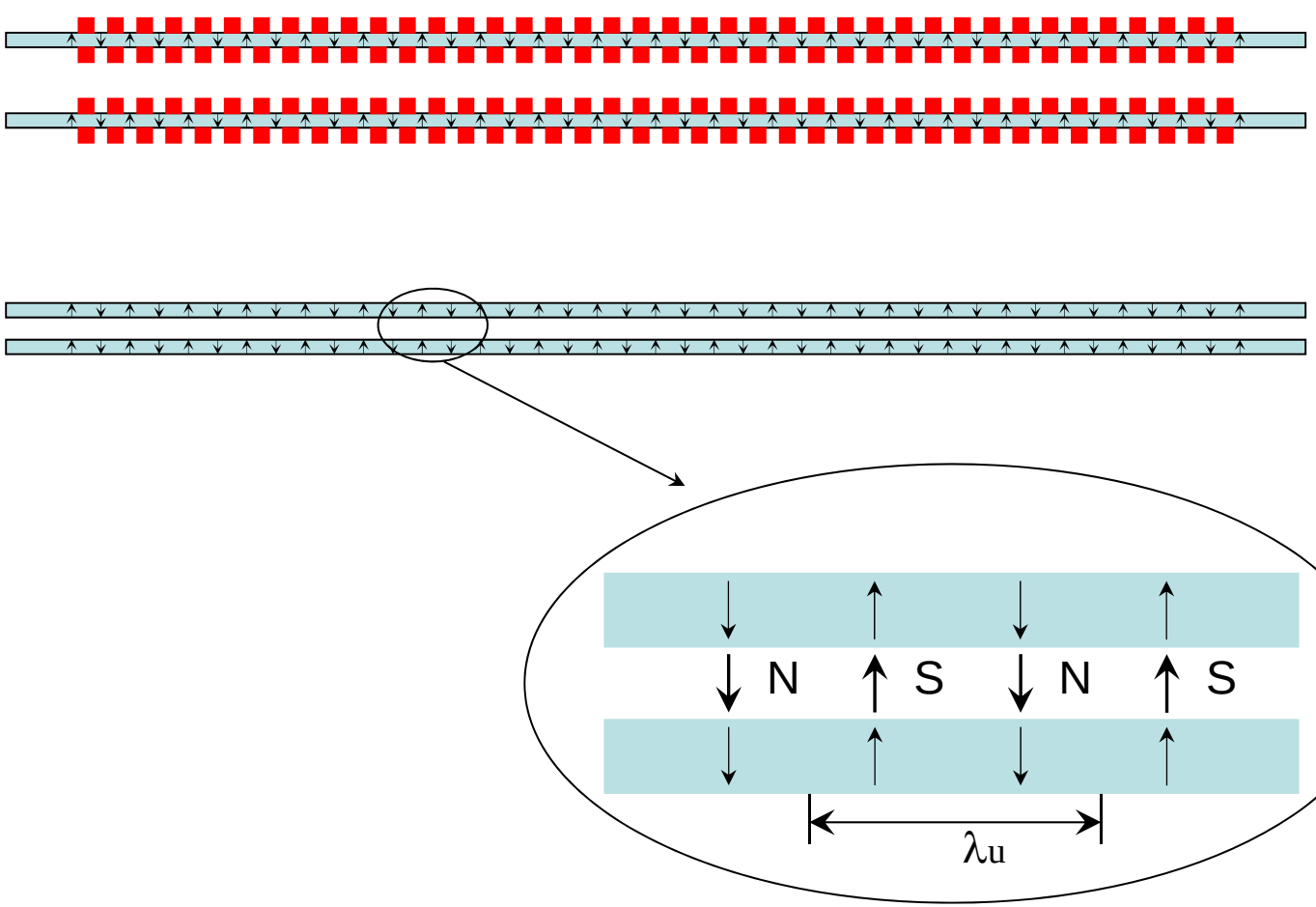


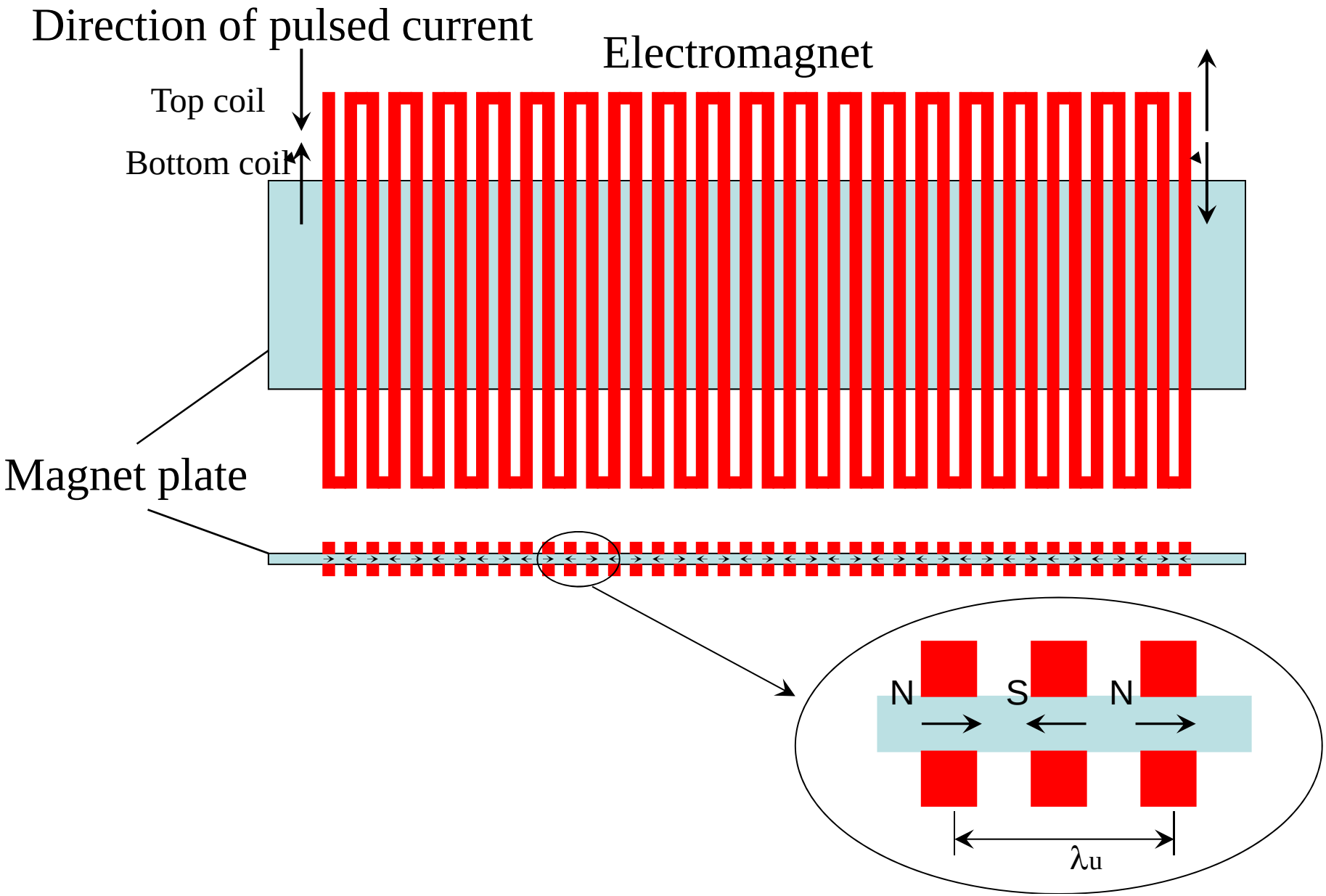
Magnetization #1

Magnetization #2

In a gap between

a pair of the magnets

2. Formation of a “very short period” undulator field: longitudinal geometry



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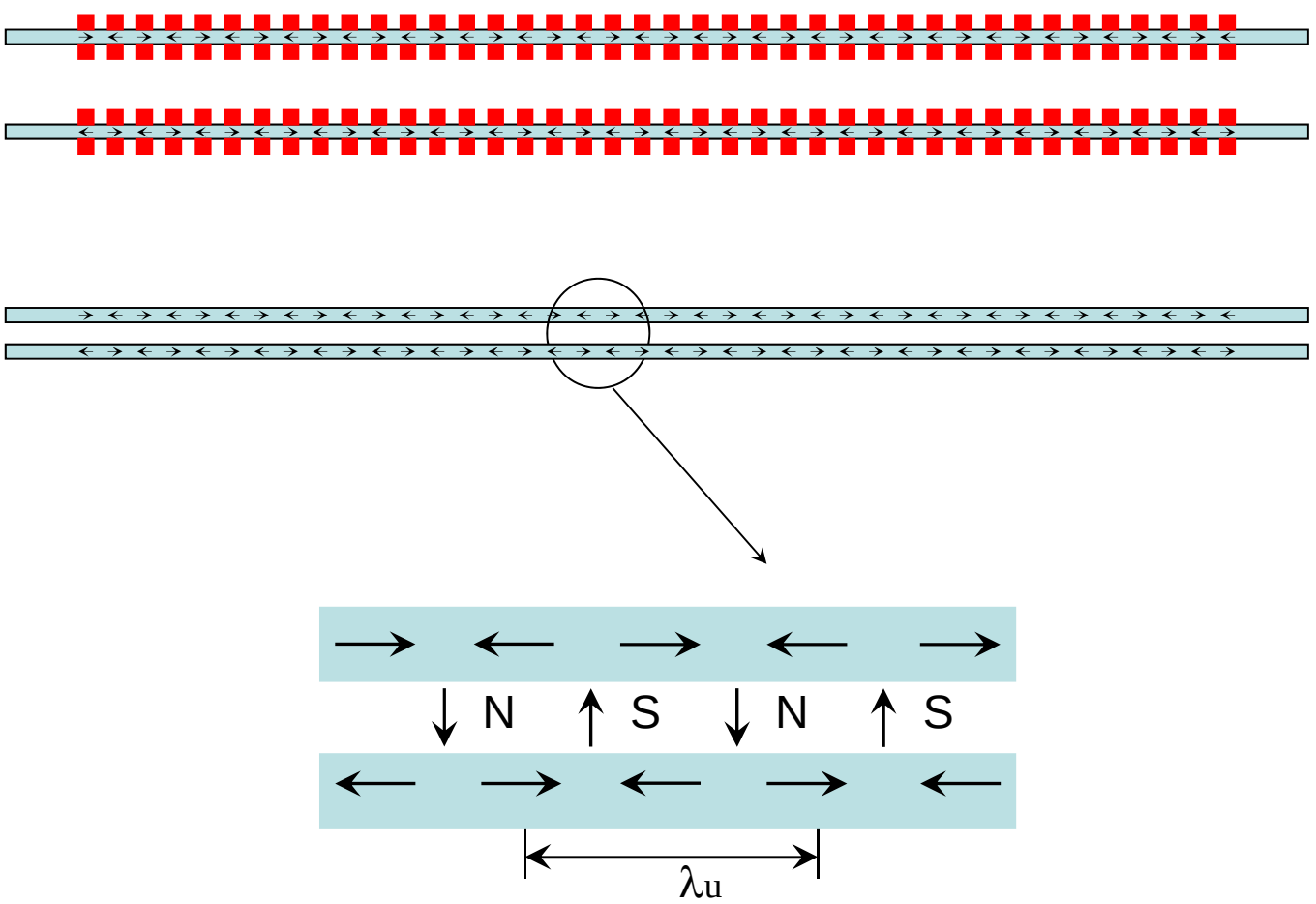


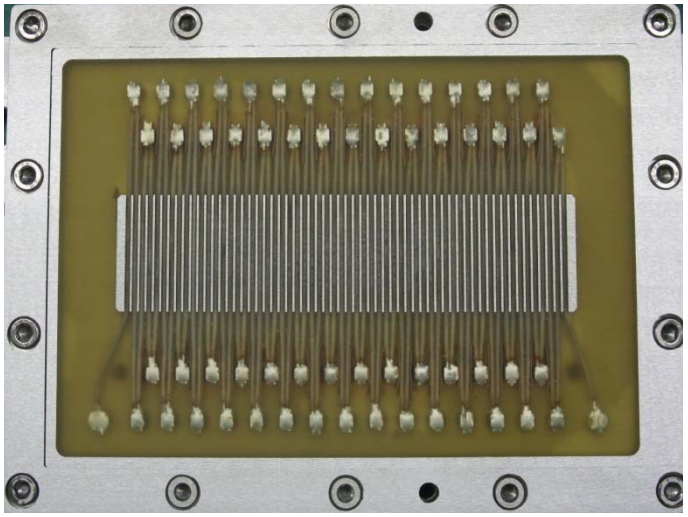
Magnetization #1

Magnetization #2

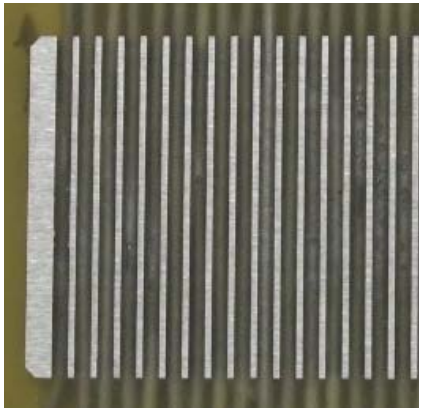
In a gap between

a pair of the magnets

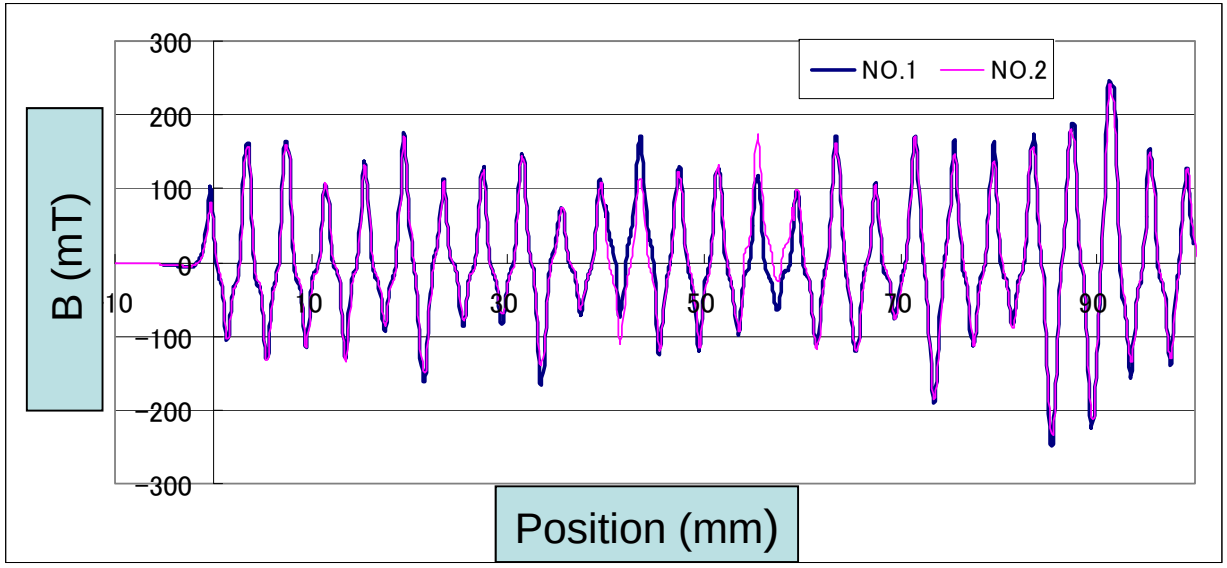
2. Formation of a “very short period” undulator field: A result of early stage attempts



Magnetizing head



pole piece (expanded)



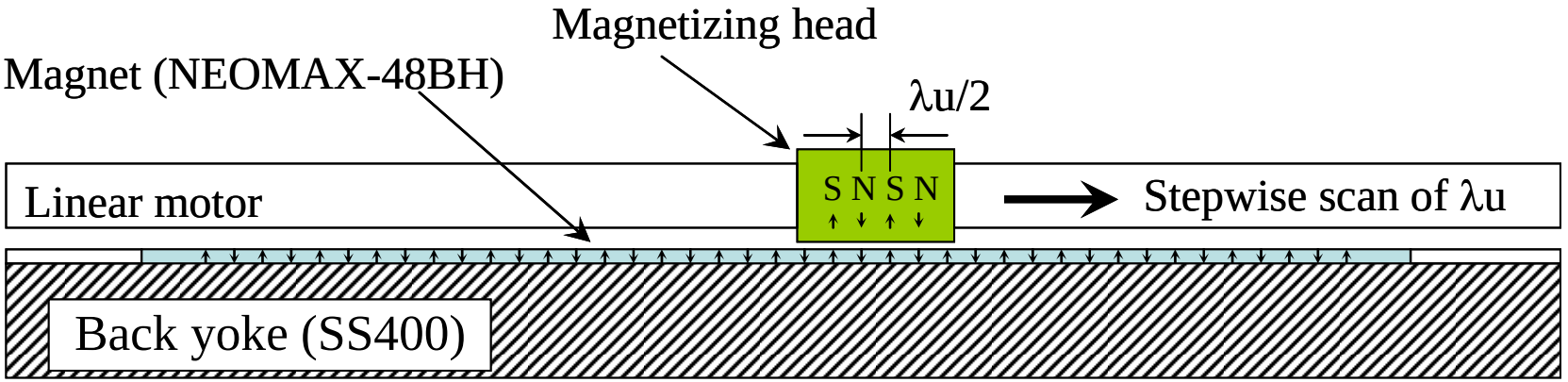
Unsatisfactory !

B ~ 150mT +/- 50mT

λu/2 ~ 2mm +/- 0.6mm

2. Formation of a "very short period" undulator field:

Stepwise scan of the magnetizing head
In the perpendicular geometry

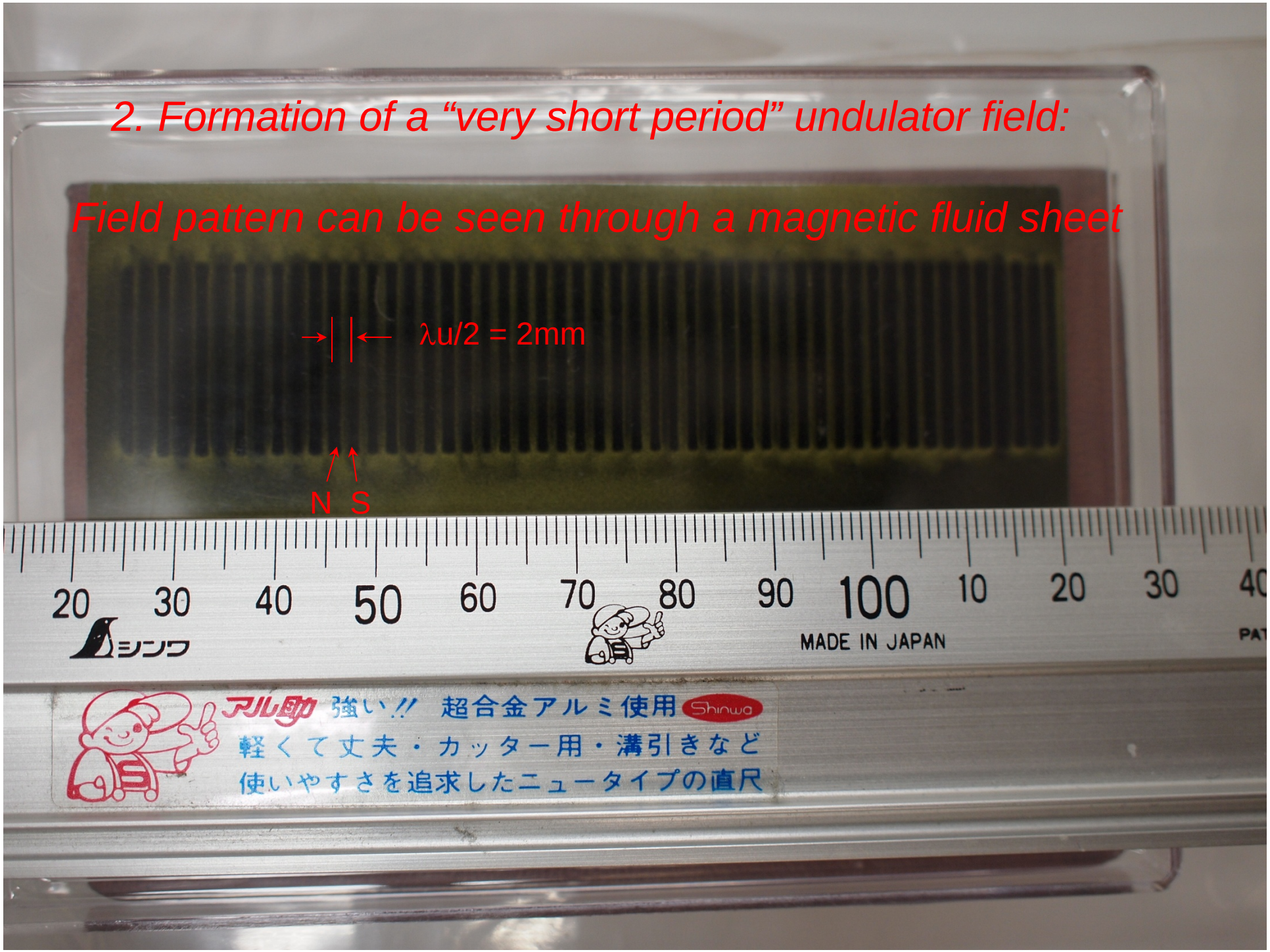


Accuracy in λu: Wire spacing & step width

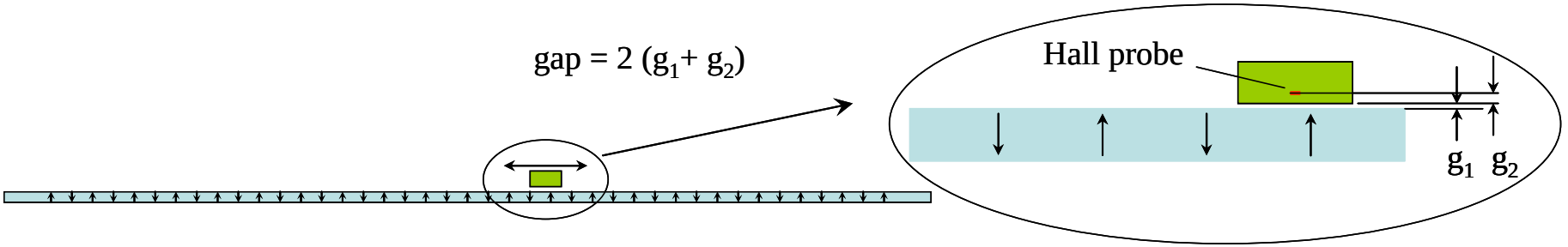
Accuracy in B: λu & e^- charge to the head

The head is cntl'd by a closed loop scheme on the linear motor (+/- 3μm)

2. Formation of a “very short period” undulator field:


2. Formation of a “very short period” undulator field:
Field pattern can be seen through a magnetic fluid sheet
λu/2 = 2mm
N
S
20
30
40
50
60
70
80
90
100
10
20
30
シンワ
MADE IN JAPAN
アル助 強い!! 超合金アルミ使用 Shinwa
軽くて丈夫・カッター用・溝引きなど
使いやすさを追求したニュータイプの直尺

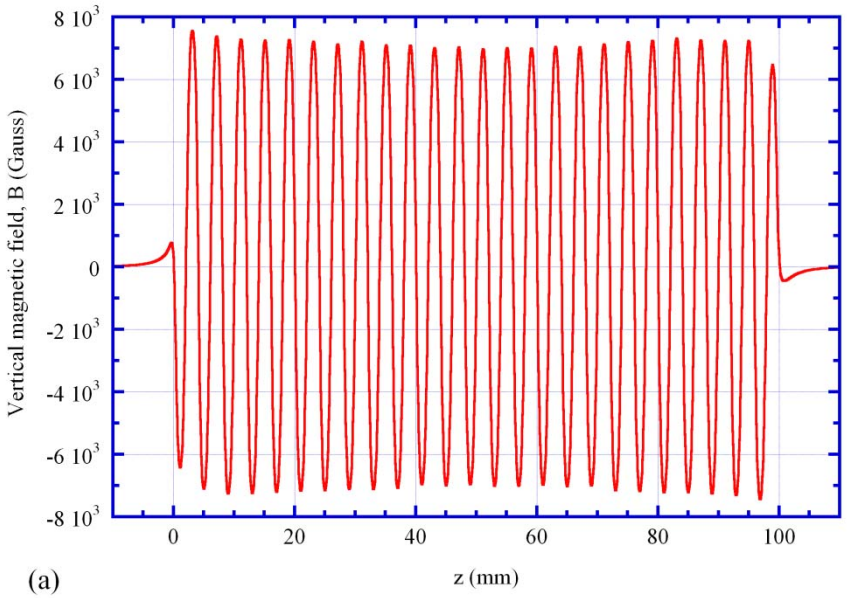
3. Field measurement & characterization



We use 2 x By as a measure of "virtual undulator field"

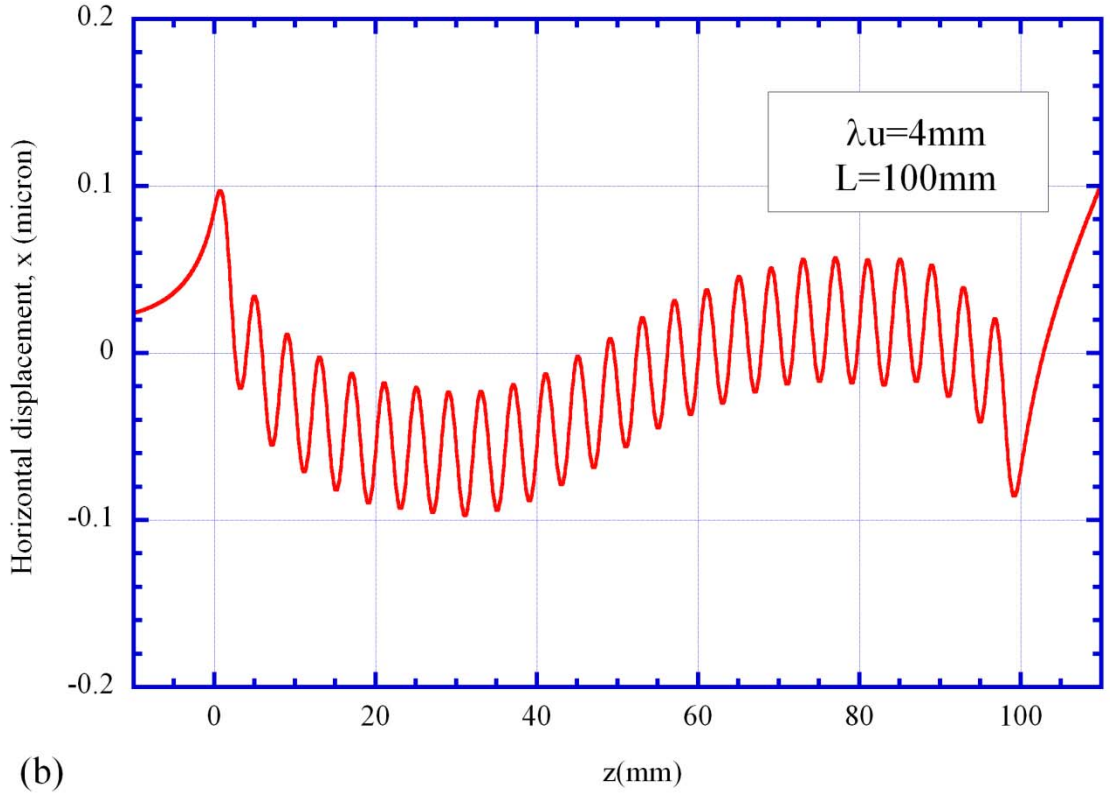
2 x By = superposition of By and its mirror image field

at a "virtual gap" g = 2(g1 + g2) = 2 x 0.6mm



"virtual field" = 7000G
at
"virtual gap" = 1.2mm

3. Field measurement & characterization

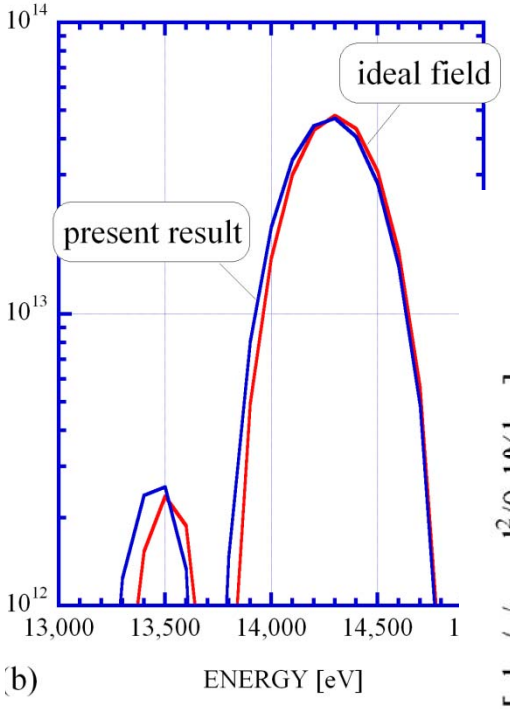


Undulator orbit @ 2.5GeV:

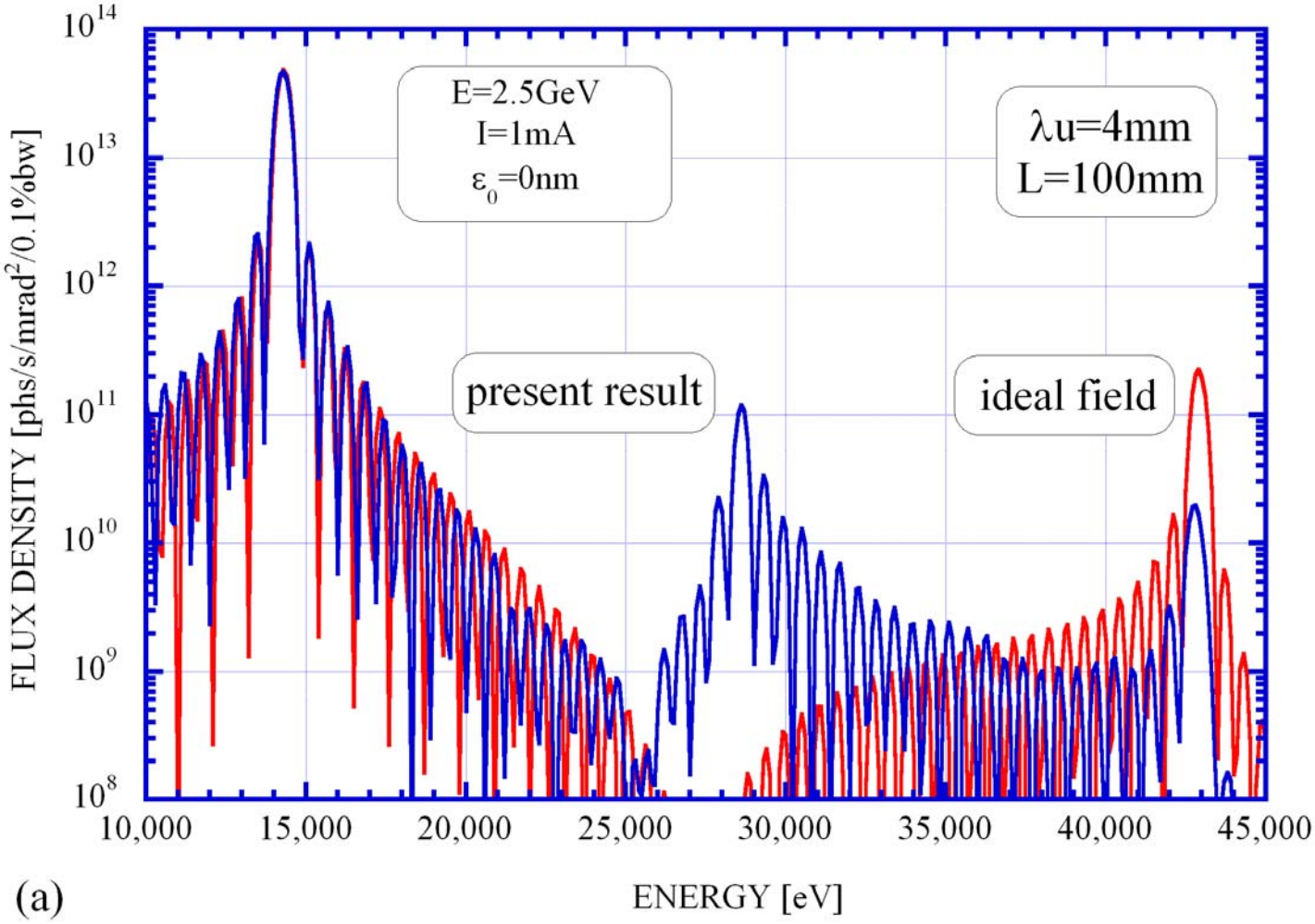
compensation is not sufficient at both ends

the orbit in this “virtual undulator” may be satisfactory

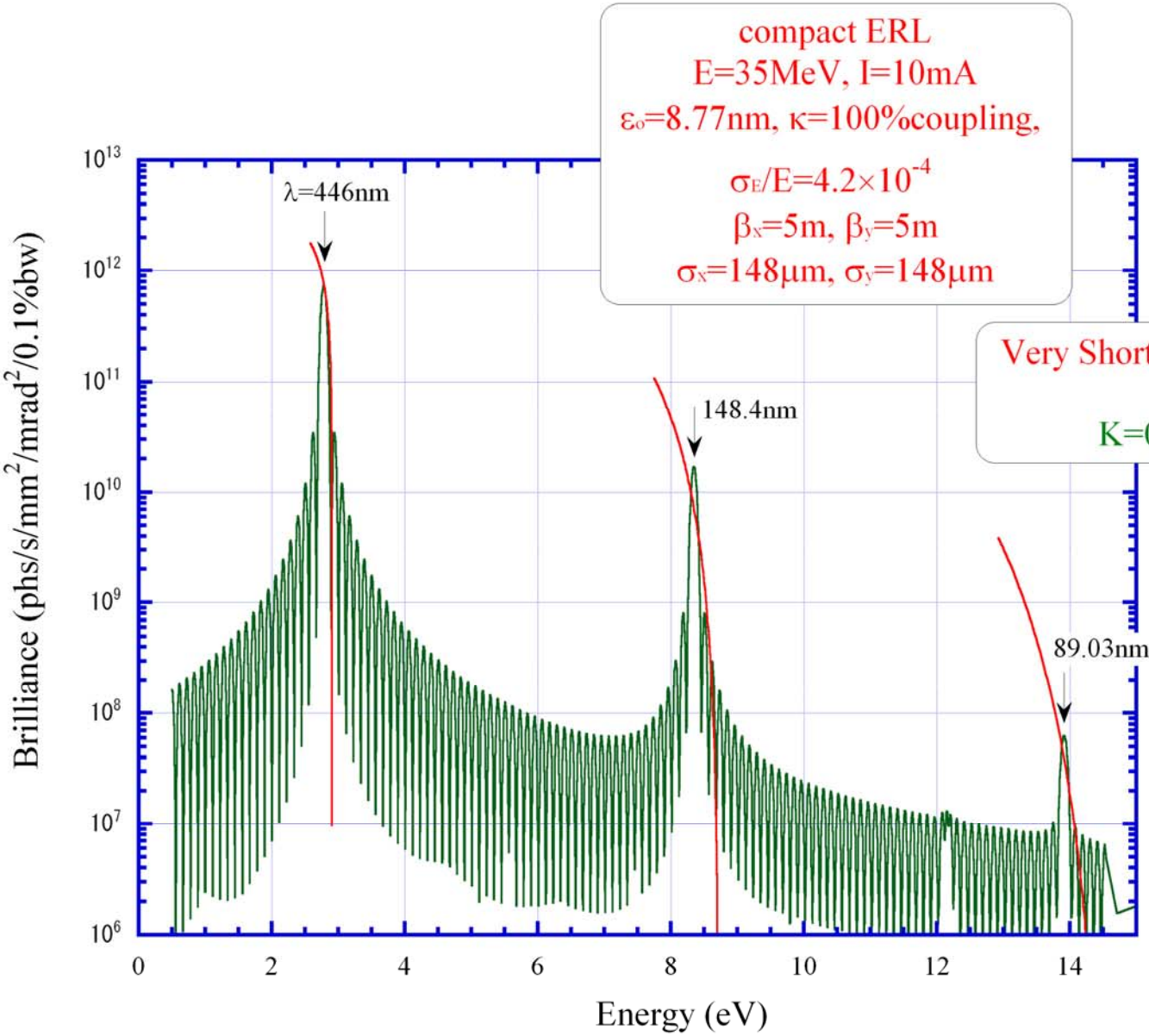
3. Field measurement & characterization



Radiation from the “virtual undulator field” is well compared to that from the ideal magnetic field in the region of the fundamental radiation



4．Application to ERLs



DL condition

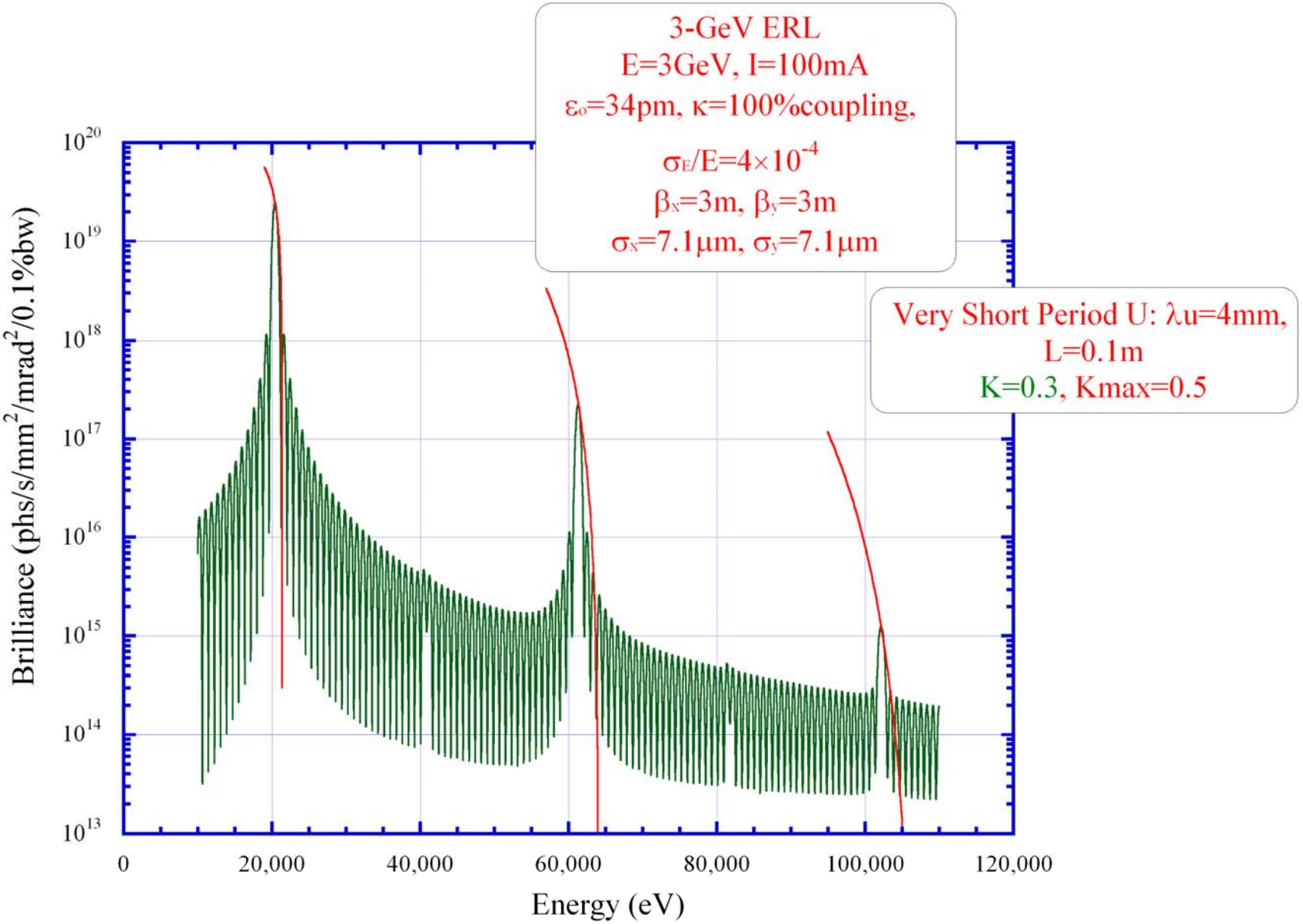
$\varepsilon_{x,y} < \lambda/4\pi$

L_g=1.0m, ρ=1.8x10^{-4}

@ I_p=1A

L_g=12.7cm, ρ=1.4x10^{-3}
if I_p=500A
SASE?

4 . Application to ERLs



5 . Conclusion

We are in the right direction for the development of the very short period undulators.

Application to cERL & 3GeV ERL seems promising.

Further we have:

improvements in the magnetization intensity and accuracy,

developments of magnetization method at the both ends of undulators, and

developments of precise field measurement methods at a very short gap, *etc*.

Also we have to investigate light-source accelerators which are able to accept this type of undulators with very short gaps intrinsically.

However, we believe that the very short period undulators give large degrees of freedom to pursue “ultimate” light sources, since the length of these undulators required for the accelerators are very short totally as a matter of course.