2014/June/18 IPAC2014
02 Synchrotron Light Sources and FELs: WEOAA02

Development of the Very Short Period Undulators

1. Target & Circumstances
2. Formation of a "very short period" undulator field
3. Field measurement & characterization
4. Summary

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1. Target & Circumstances

Hard x rays by shorter λu & the 1-st (lower) harmonic
@ lower energy LS (~3GeV)

In KEK we constructed:
In-vac Us (λ_u=4cm) @ 6.5GeV PF-AR (1989)
In-vac Short Gap Us (λ_u=1-2cm) @ 2.5GeV PF (2003-08)

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

1. Target & Circumstances

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 λ_u?

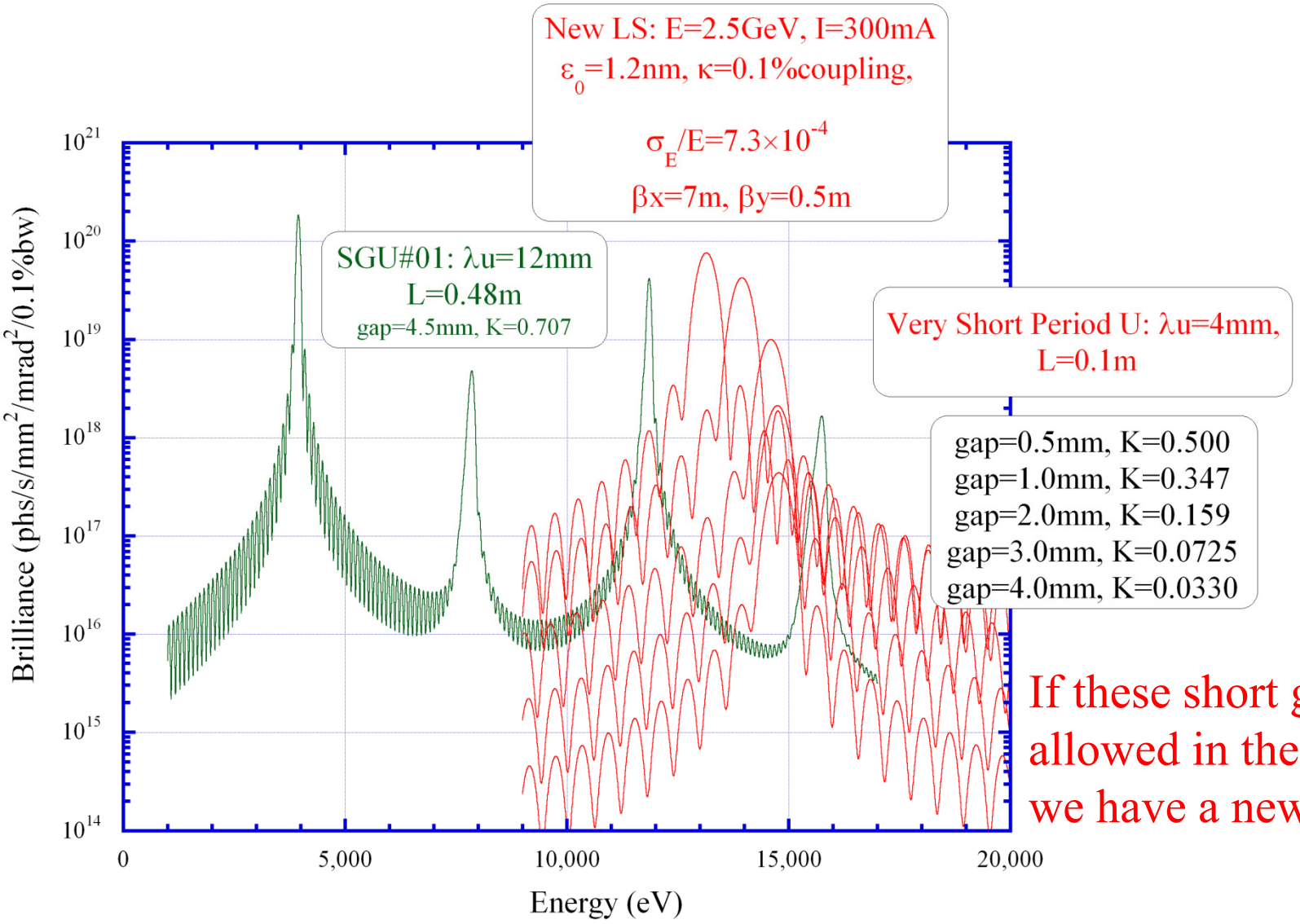
Target:

Very short λ_u = several cm (ordinary type) x 1/10

= several mm (4mm)

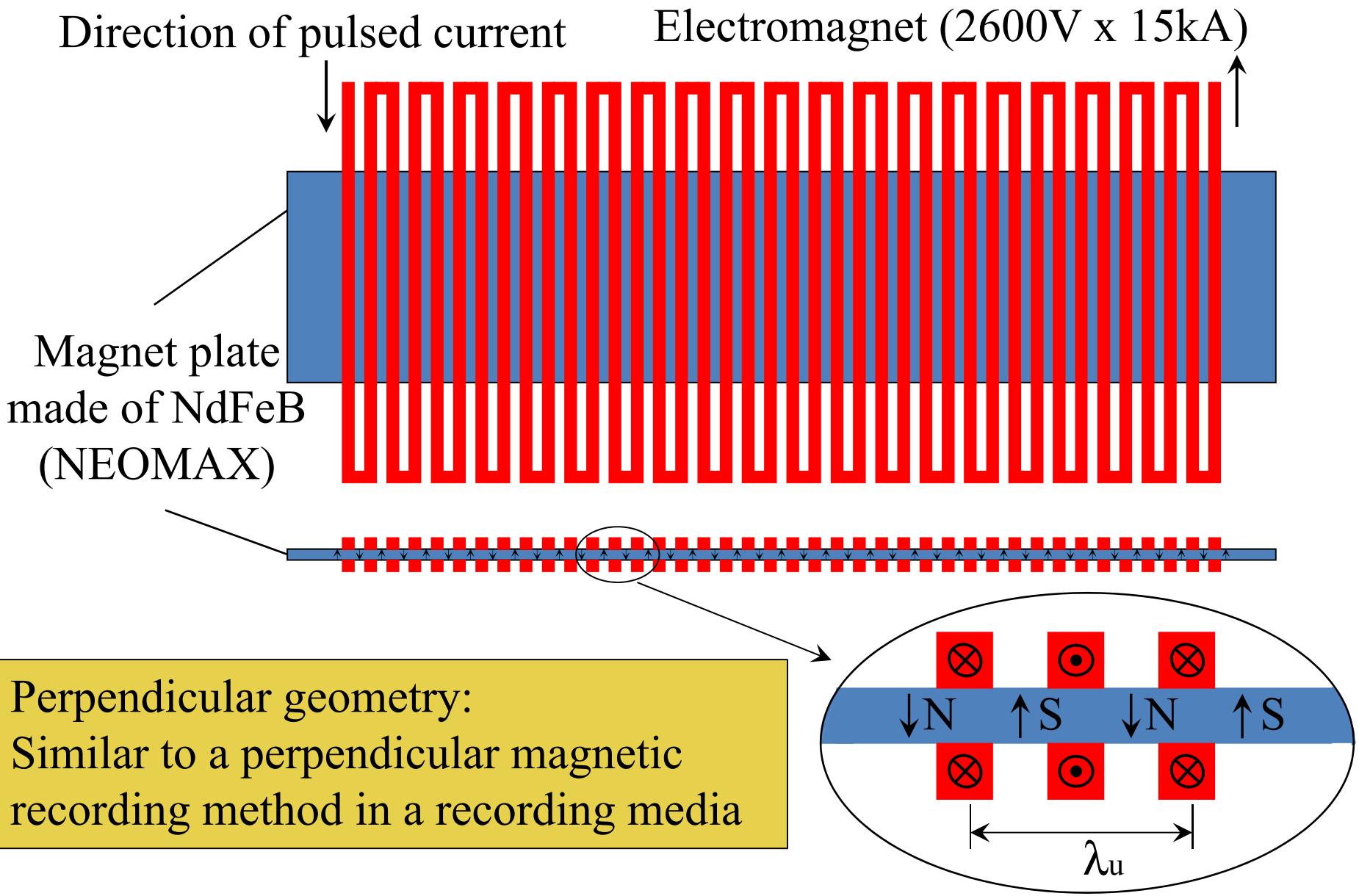
1. Target & Circumstances

Very short period undulators @ 2.5GeV LS



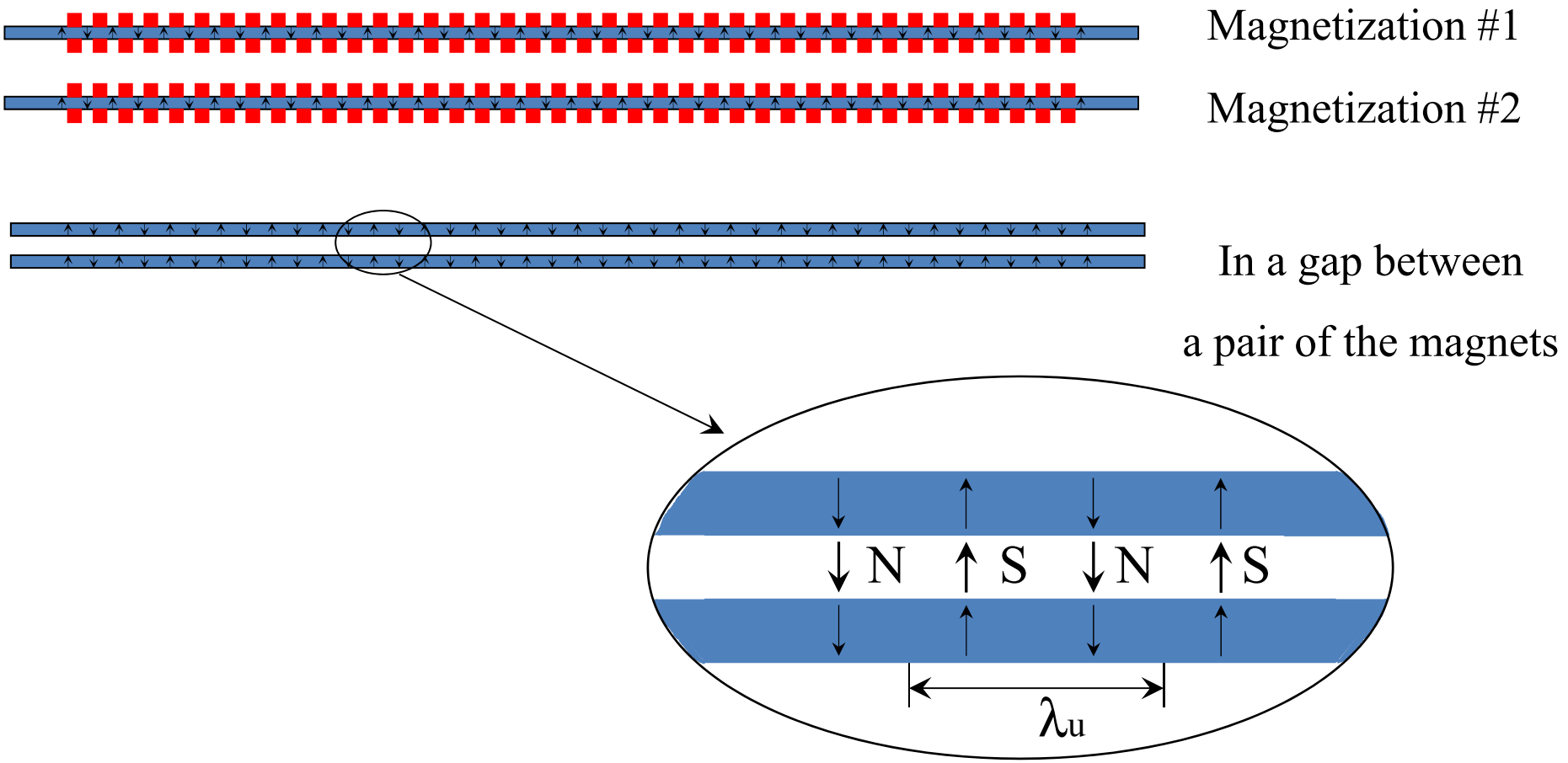
If these short gaps are allowed in the accelerator, we have a new possibility.

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

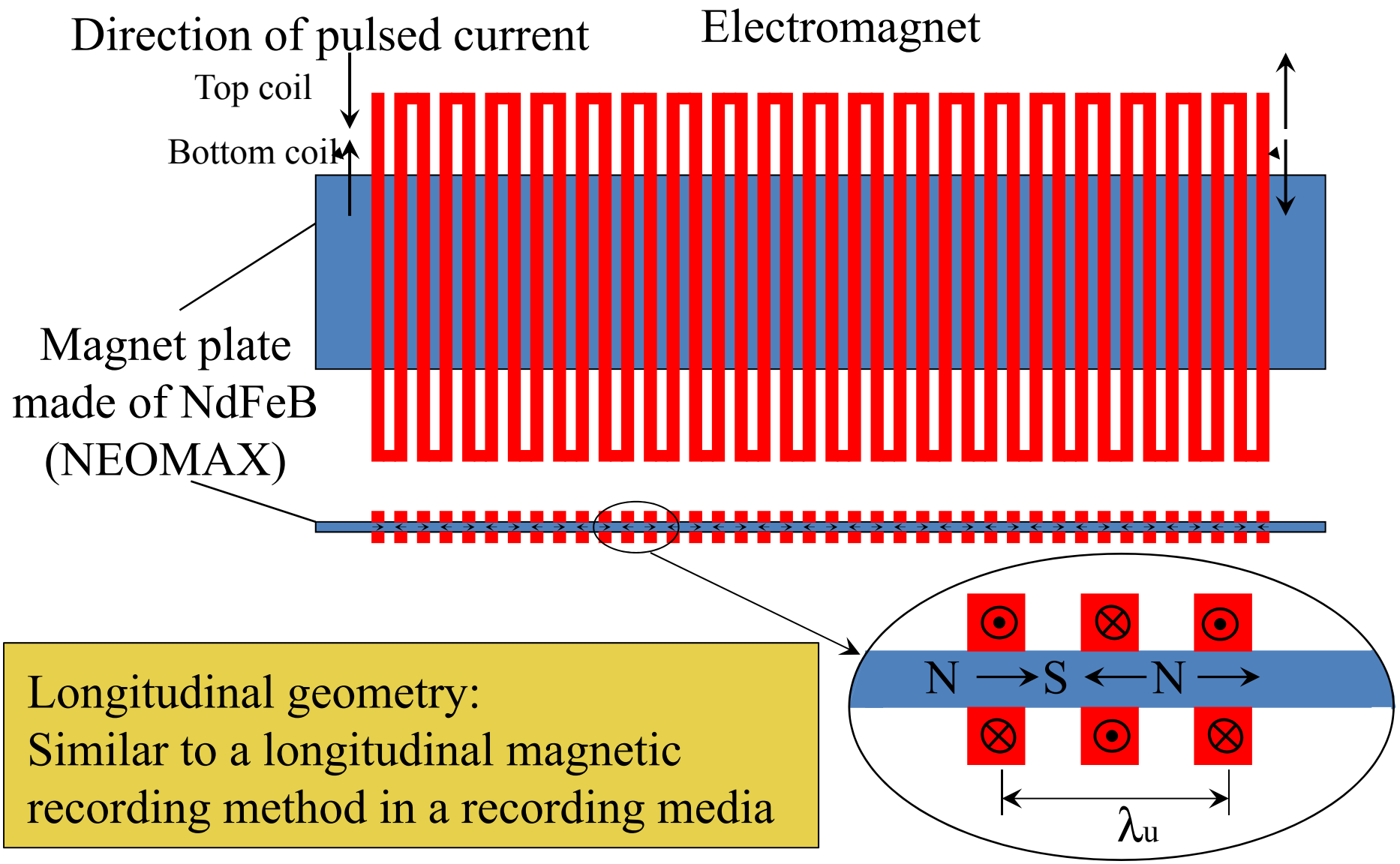


Perpendicular geometry:
Similar to a perpendicular magnetic recording method in a recording media

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

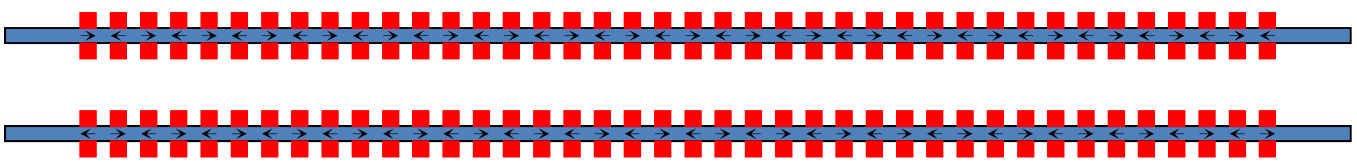


2. Formation of a "very short period" undulator field: longitudinal geometry



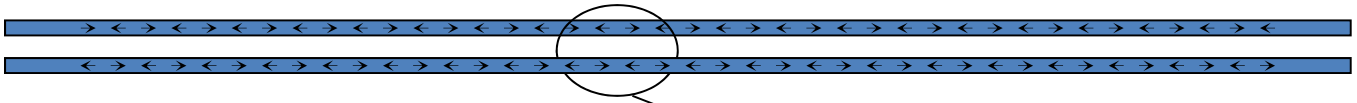
Longitudinal geometry:
Similar to a longitudinal magnetic recording method in a recording media

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



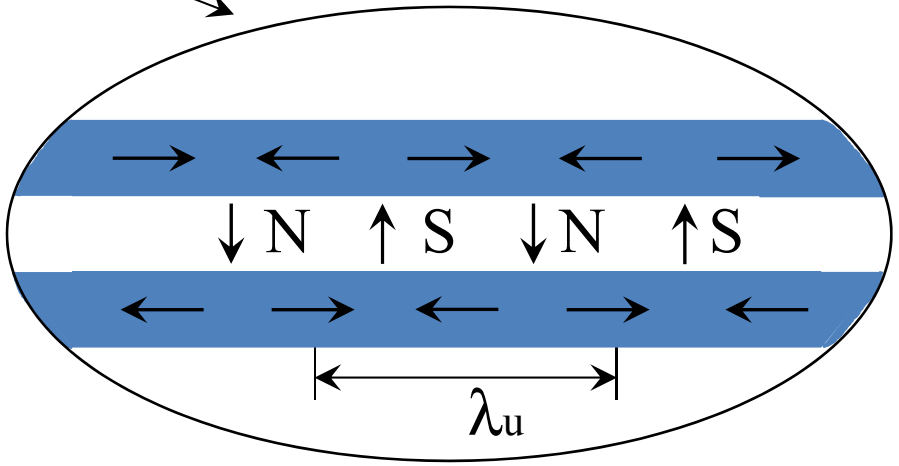
Magnetization #1

Magnetization #2

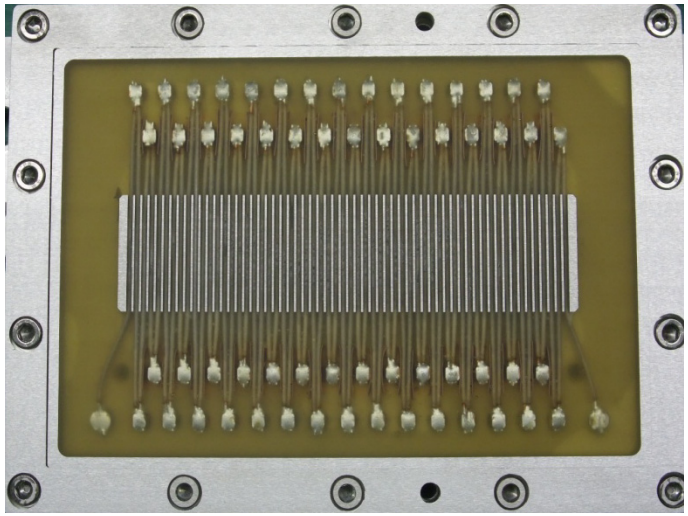


In a gap between

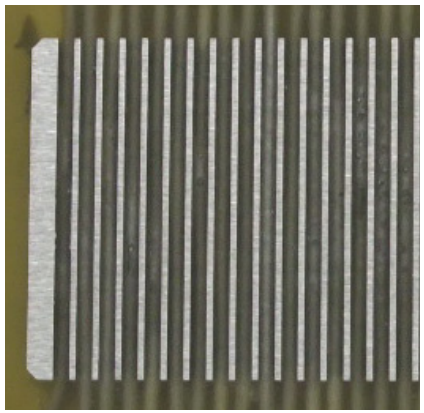
a pair of the magnets



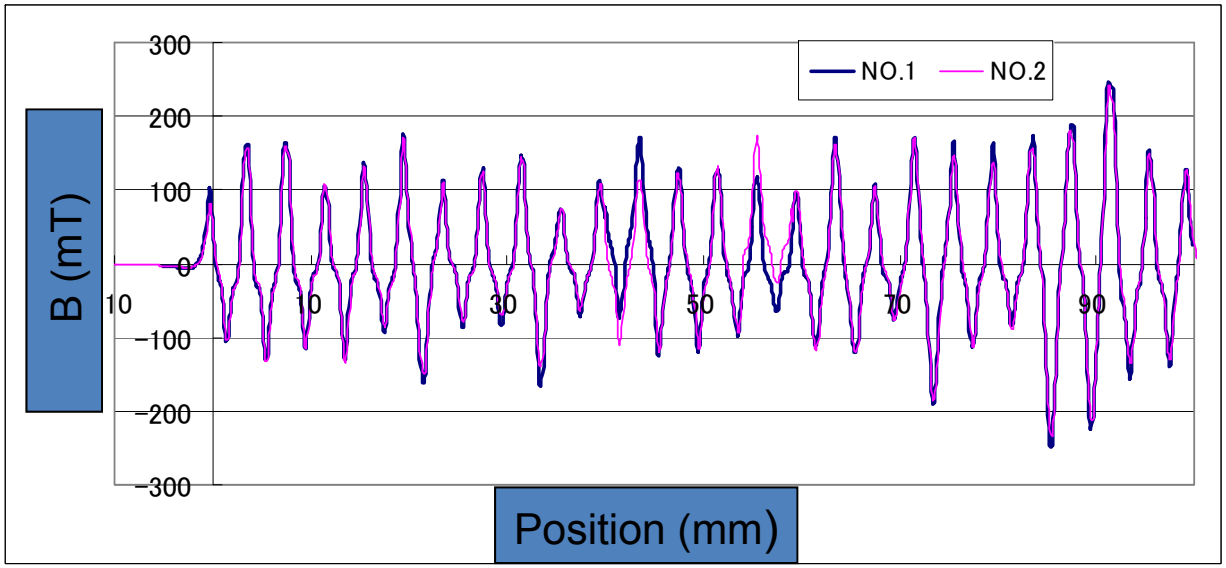
2. Formation of a "very short period" undulator field: A result of early stage attempts



Magnetizing head



Pole piece (expanded)



Magnetization test with NEOMAX-48BH plate

Magnet size:

100mm x 20mm x 2mm

$\lambda u = 4mm$

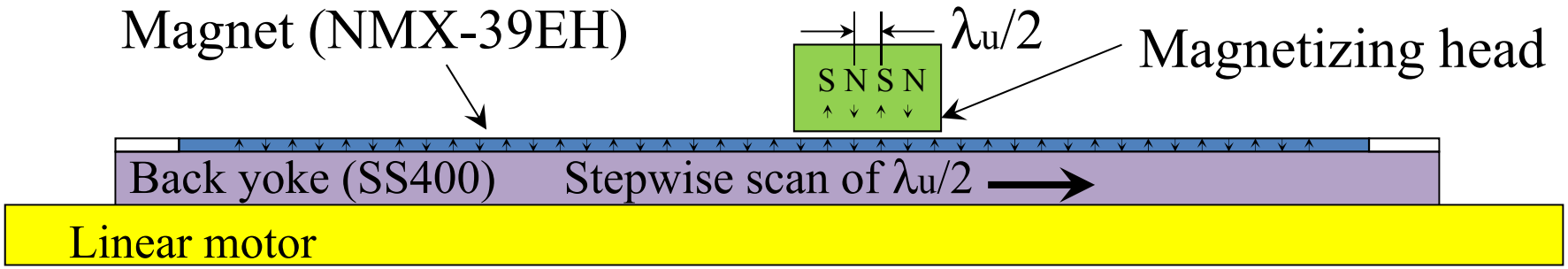
Unsatisfactory !

B ~ 150mT +/- 50mT

$\lambda u/2$ ~ 2mm +/- 0.6mm

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

Magnetizing a magnet plate driven stepwise
in the perpendicular geometry



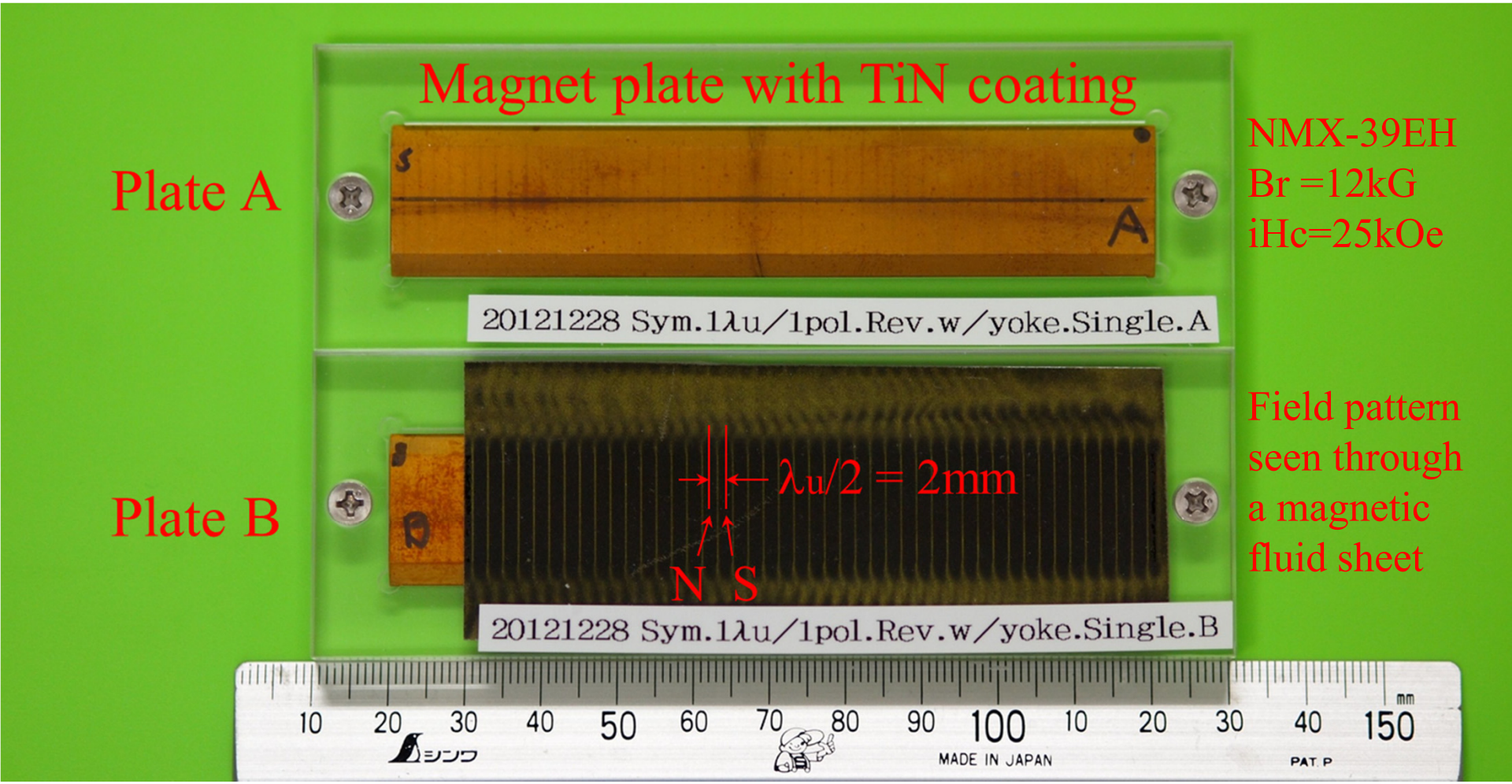
λ_u scan = 1st step of $\lambda_u/2$ S N S N + 2nd step of $\lambda_u/2$ N S N S

Accuracy in λ_u: Wire spacing & step width

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

Linear motion is cntl'd by a closed loop scheme (+/- 3μm)

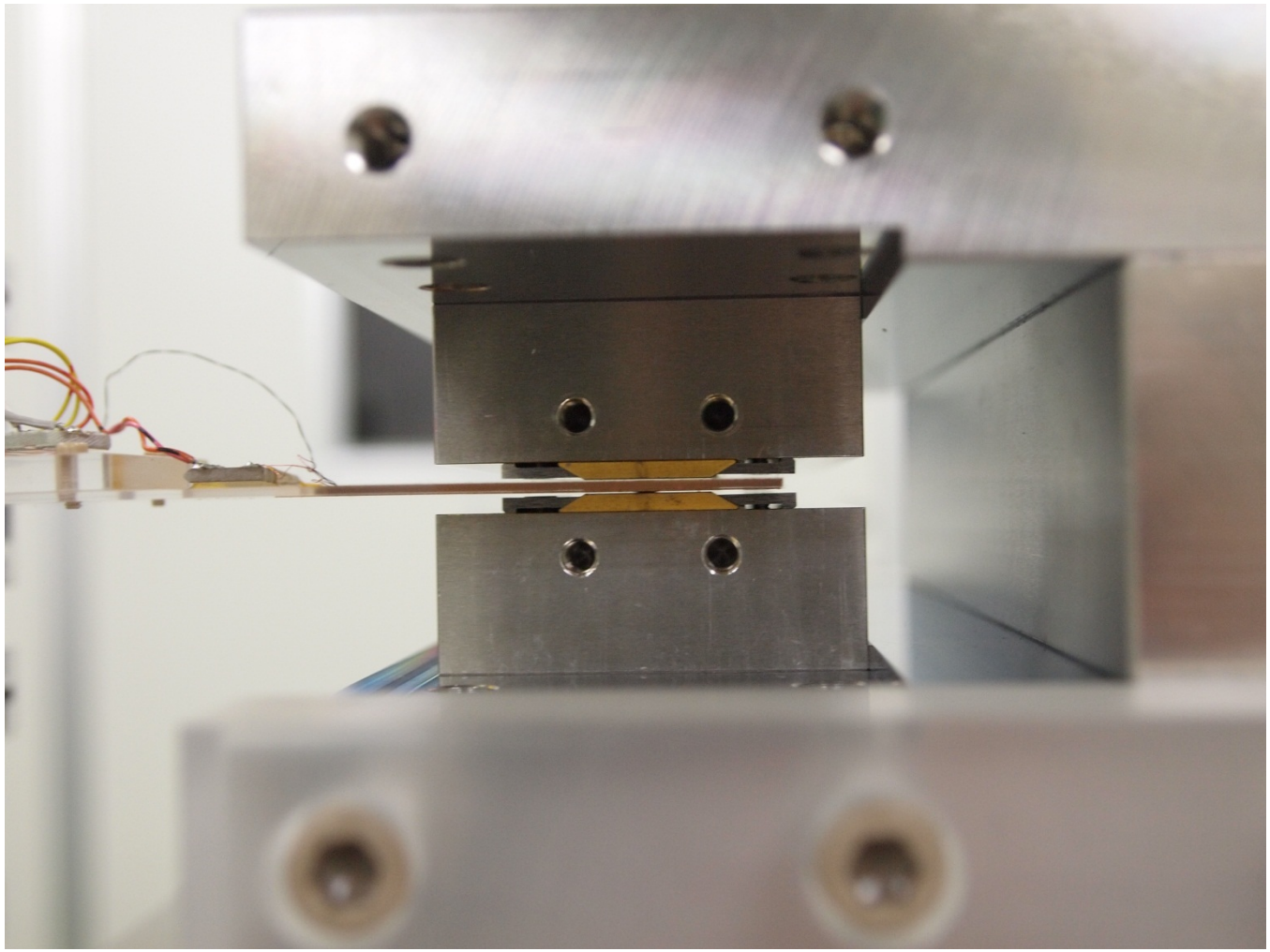
2. Formation of a "very short period" undulator field: fabrication of undulator magnets



A pair of Nd-Fe-B magnets (TiN coated):

100mm long, 20mm wide, 2mm thick

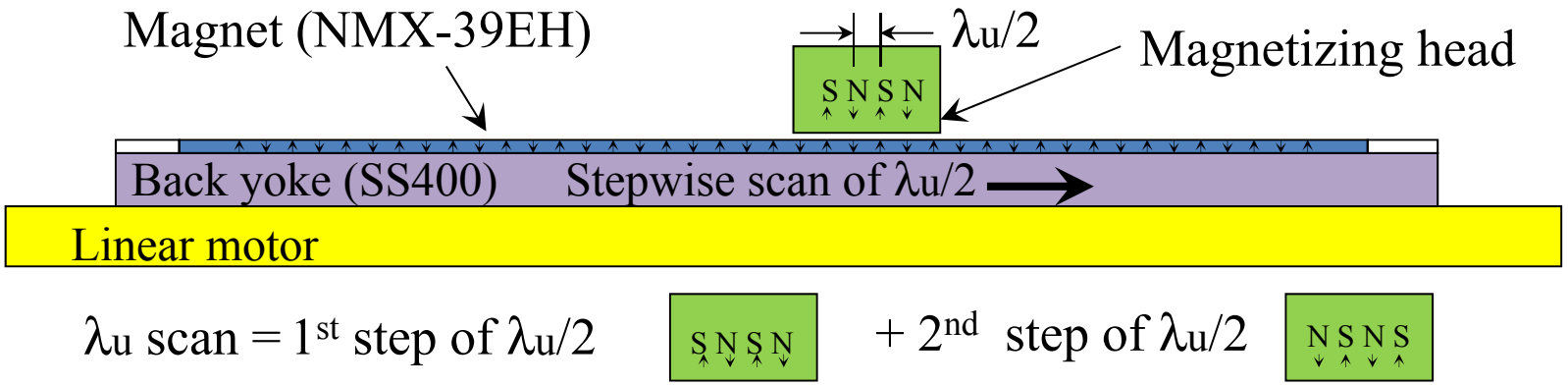
Measurement @ fixed gap=1.6mm



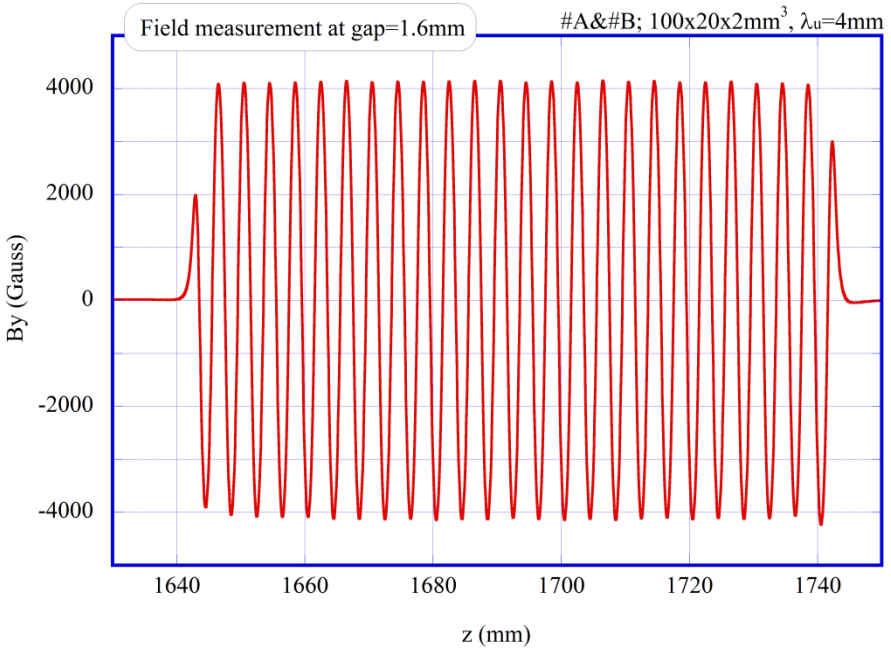
Hall probe ~1.3mm thick with 0.05 x 0.05 mm^2 resolution

Gap > 1.6mm

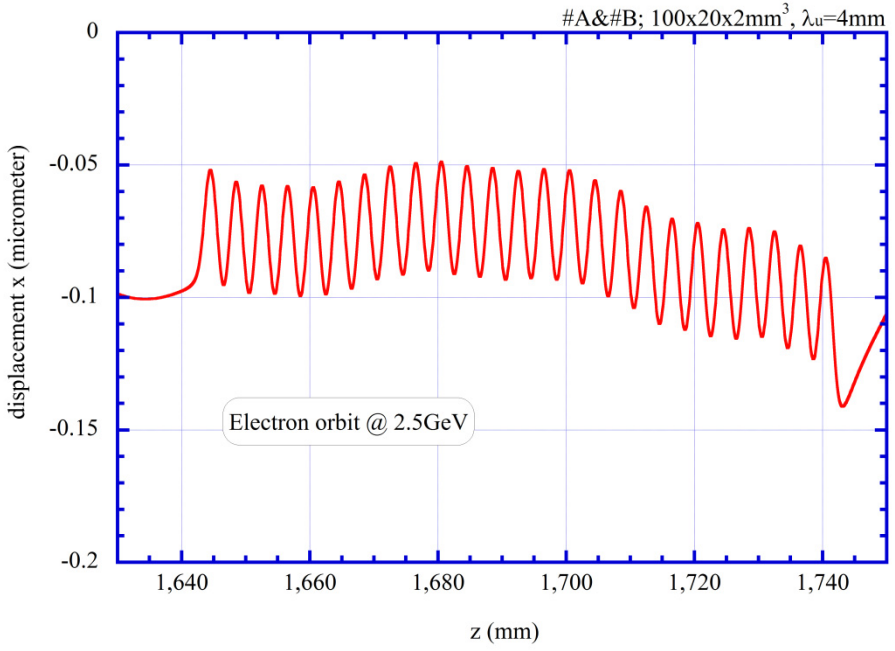
3. Field measurement & characterization: continued



Measured undulator field (λ_u=4mm) @ gap =1.6mm

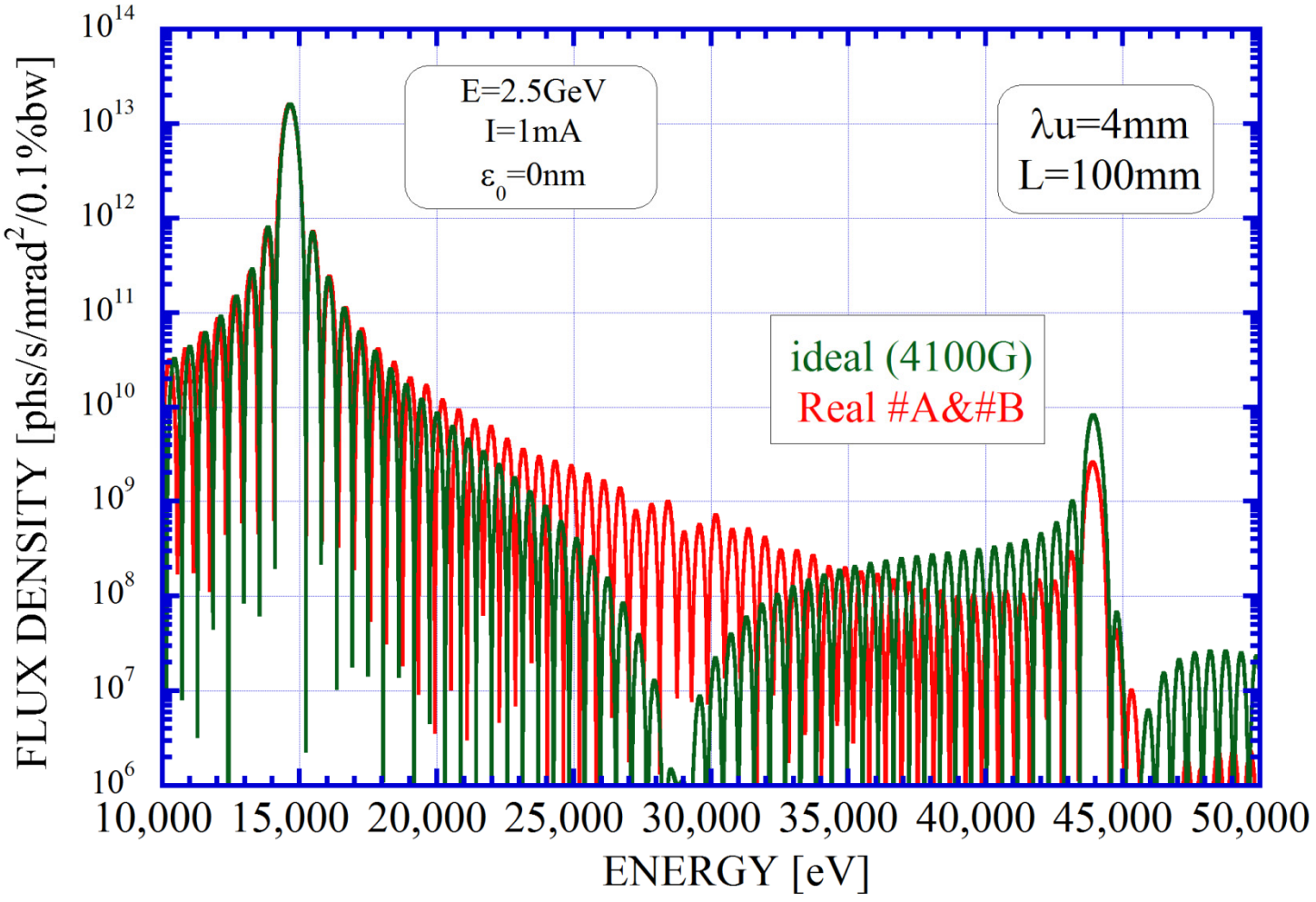


Electron orbit @ 2.5GeV: end correction not made



3. Field measurement & characterization: continued

Undulator field (λ_u = 4mm) of 4100G @ gap=1.6mm



Measured field is compared to ideal field with the same strength

4. Summary

We have been resolving major subjects and taking the right direction to develop the very short period undulaotrs.

Further we have a lot of items to do:

improvements in the magnetization intensity and accuracy,

developments of magnetization method at the both ends,

and

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

However, we believe that evaluation experiments of the very short period undulator based on the real electron beams will take place in the near future.