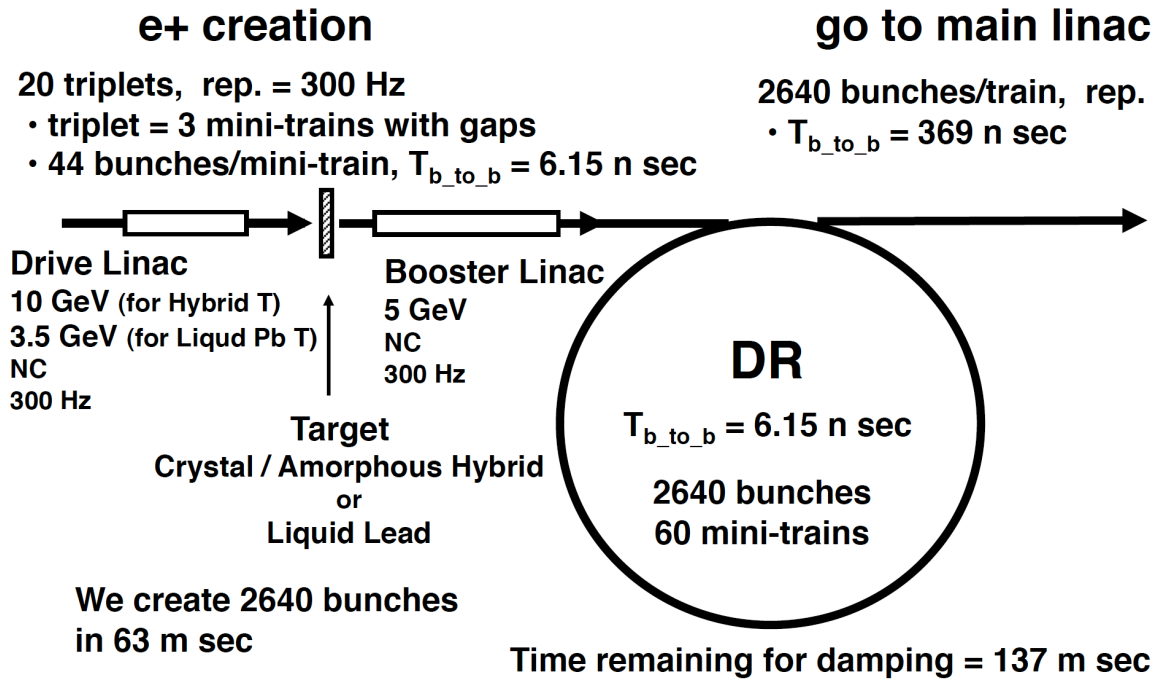
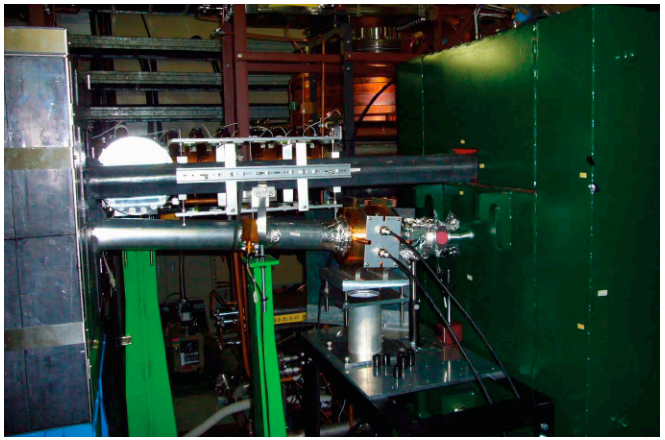
Preparation of a BN window test at KEKB ring





T. Omori (KEK)

ILC-CLIC e+ studies
phone meeting 06-Oct-2009

Many thanks to:

Chehab-san, Dadoun-san, Logachev-san, Bonder-san, Wanming-san, Wei-san, James-san, Ian-san, Susanna-san, Louis-san, Liu-san, Potylitsyn-san, Urakawa-san, Abhay-san, Kuriki-san, Takahashi-san, Suwada-sam, Kamitani-san, Furukawa-san, Umemori-san, Sugimura-san, Kawada-san, Akagi-san, Iida-san

300 Hz Generation

300 Hz generation

e+ generation in 63 ms (c.f. UND generate e+ in 1ms)

(a) Liquid Pb target + Flux concentrator(1 micro sec)

- Drive e- beam: 3.5 GeV, 5.9 nC, 300 Hz, NC Linac
- e+ booster : 5 Gev, 300 Hz, NC Linac

(b) Hybrid Target + Flux concentrator(1 micro sec)

- Drive e- beam: 10 GeV, 3.2 nC, 300 Hz, NC Linac
- e+ booster : 5 Gev, 300 Hz, NC Linac

- Aiming mature and low risk.
- Need R/D of targets

↑ Parameters meet x1.5 margin.

c.f. parameters with no margin (presented in TILC09)

(a) Liq. Pb target: Drive e- beam: 2.2 GeV, 5.9 nC

(b) Hybrid target: Drive e- beam: 10 GeV, 2.1 nC

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Advanced Conventional e+ Source for ILC

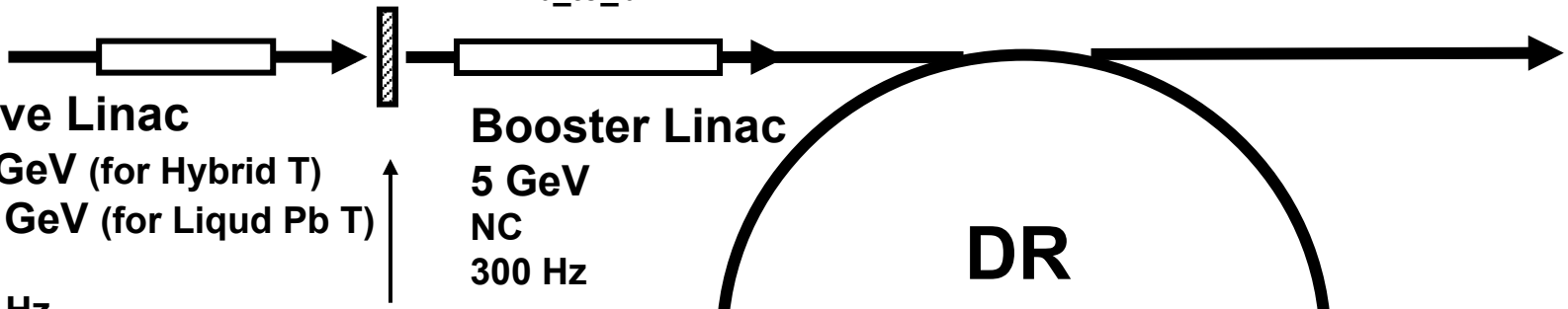
Crystal/Amorphous Hybrid Target or Liquid Lead Target
Normal Conducting Drive and Booster Linacs in 300 Hz operation

e+ creation

20 triplets, rep. = 300 Hz
- triplet = 3 mini-trains with gaps
- 44 bunches/mini-train, $T_{b\_to\_b}$ = 6.15 n sec

go to main linac

2640 bunches/train, rep. = 5 Hz
- $T_{b\_to\_b}$ = 369 n sec



Drive Linac
10 GeV (for Hybrid T)
3.5 GeV (for Liqud Pb T)
NC
300 Hz

Booster Linac
5 GeV
NC
300 Hz

Target
Crystal / Amorphous Hybrid
or
Liquid Lead

DR
$T_{b\_to\_b}$ = 6.15 n sec
2640 bunches
60 mini-trains

We create 2640 bunches in 63 m sec

Time remaining for damping = 137 m sec

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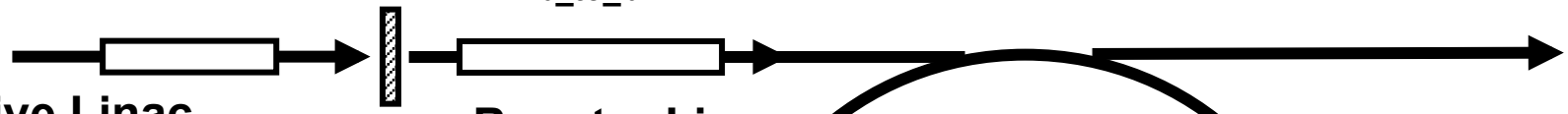

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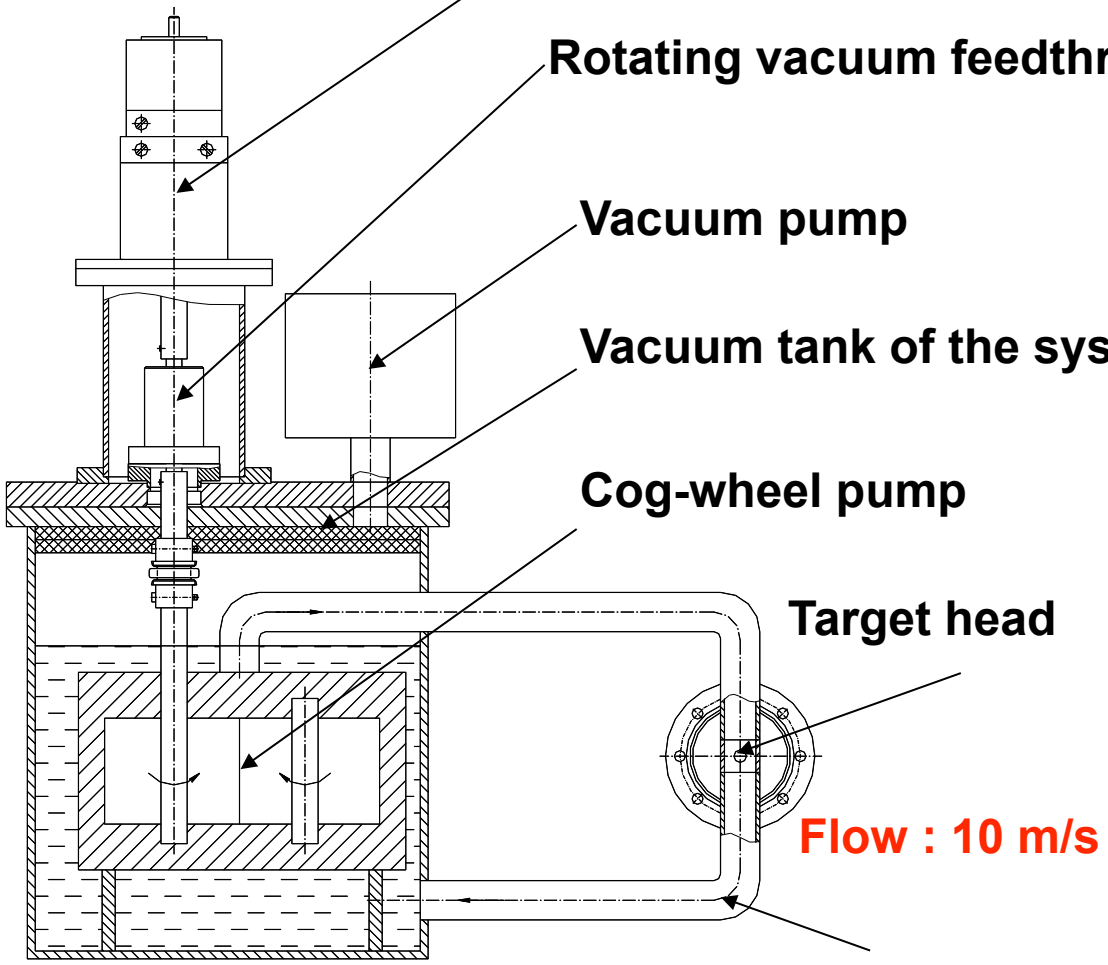
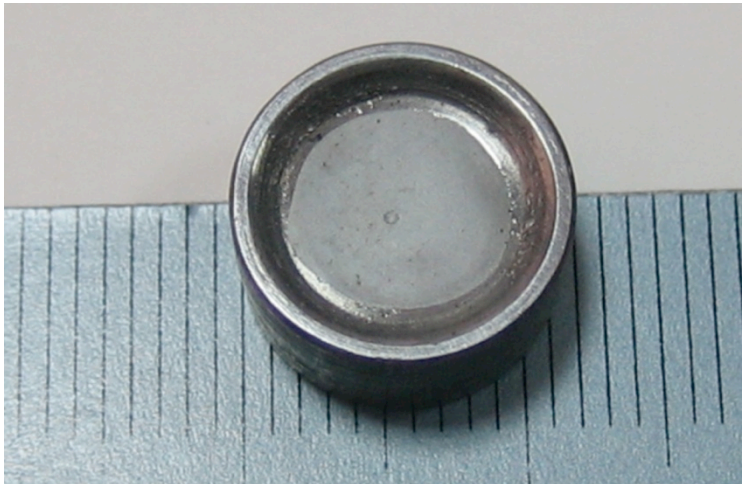
Liquid Lead Target

Prototype of Liquid Lead Positron Production Target

Logachev-san et al, BINP

Operation experience 20000 h with NO beam

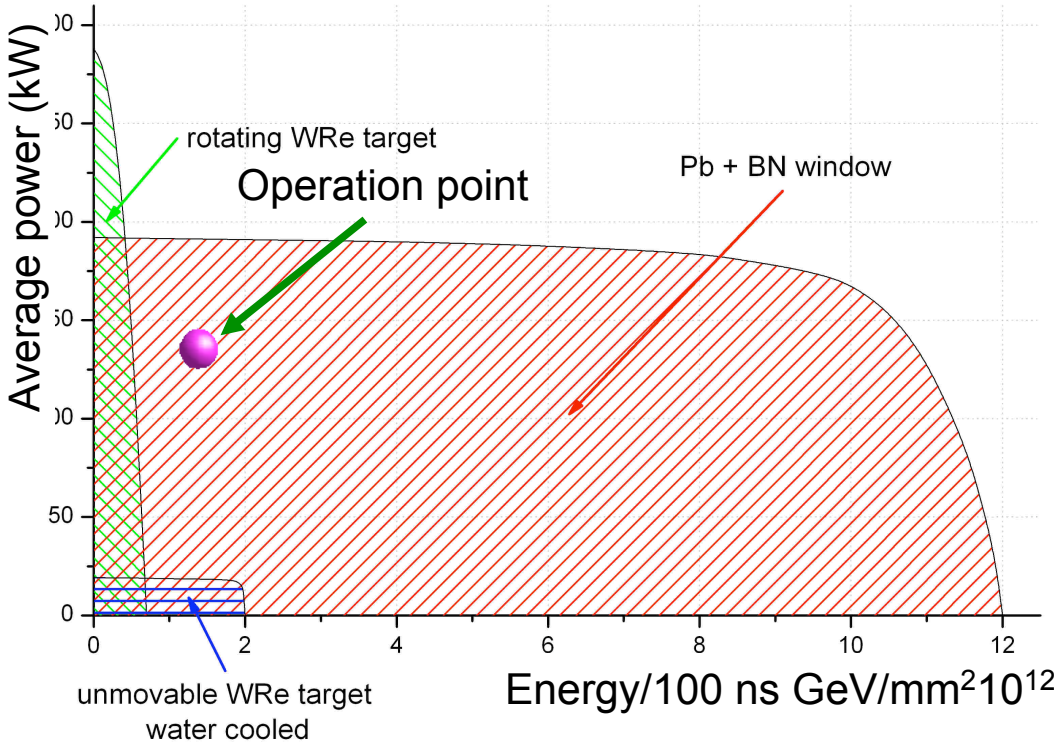




Window thickness 4mm
BN disks for windows
Diameter 12mm

Liquid Pb-Sn Target

- Liquid Pb target + BN window is very strong against high peak power, but less average power.
- Pulsed operation (e.g. 100 bunches with 6.2ns spacing, 0.6μs, 150Hz) moderates thermal effects.
- In the pulse operation, capture efficiency is higher and incident electron can be fewer.



P. Logachov et al. in APAC2007

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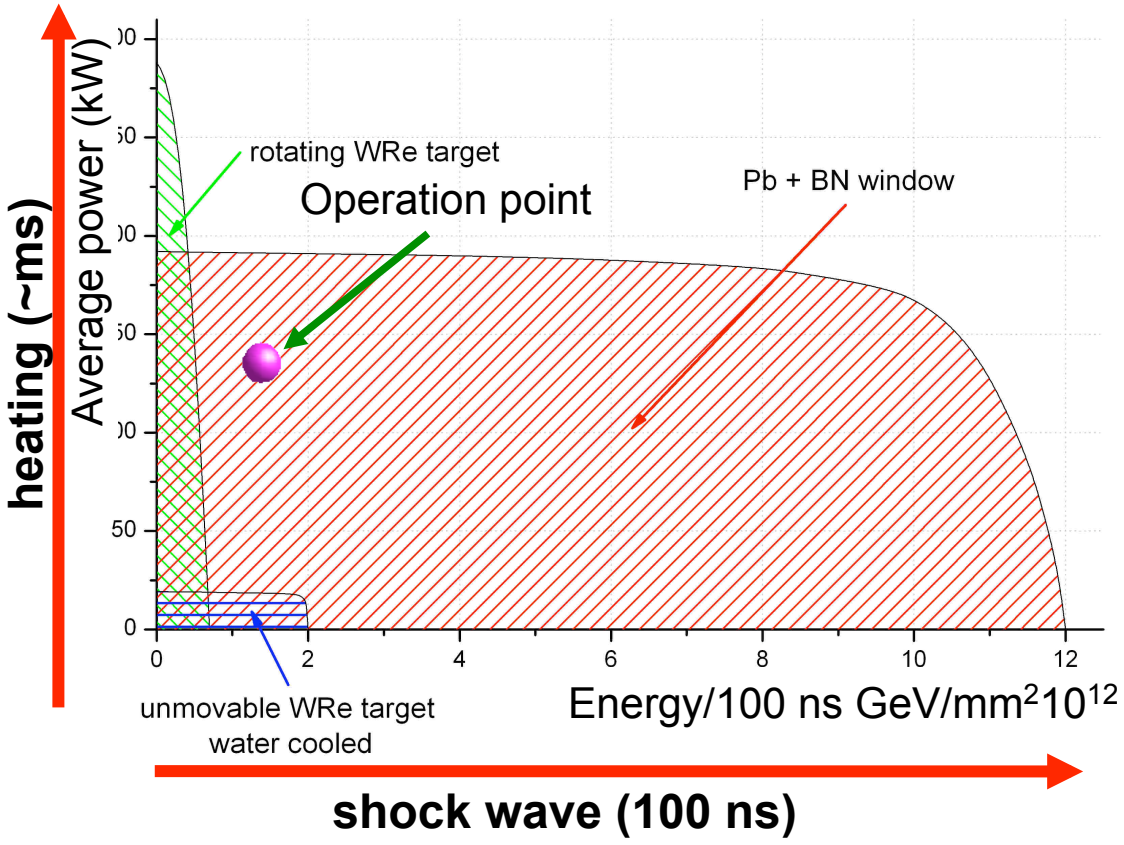
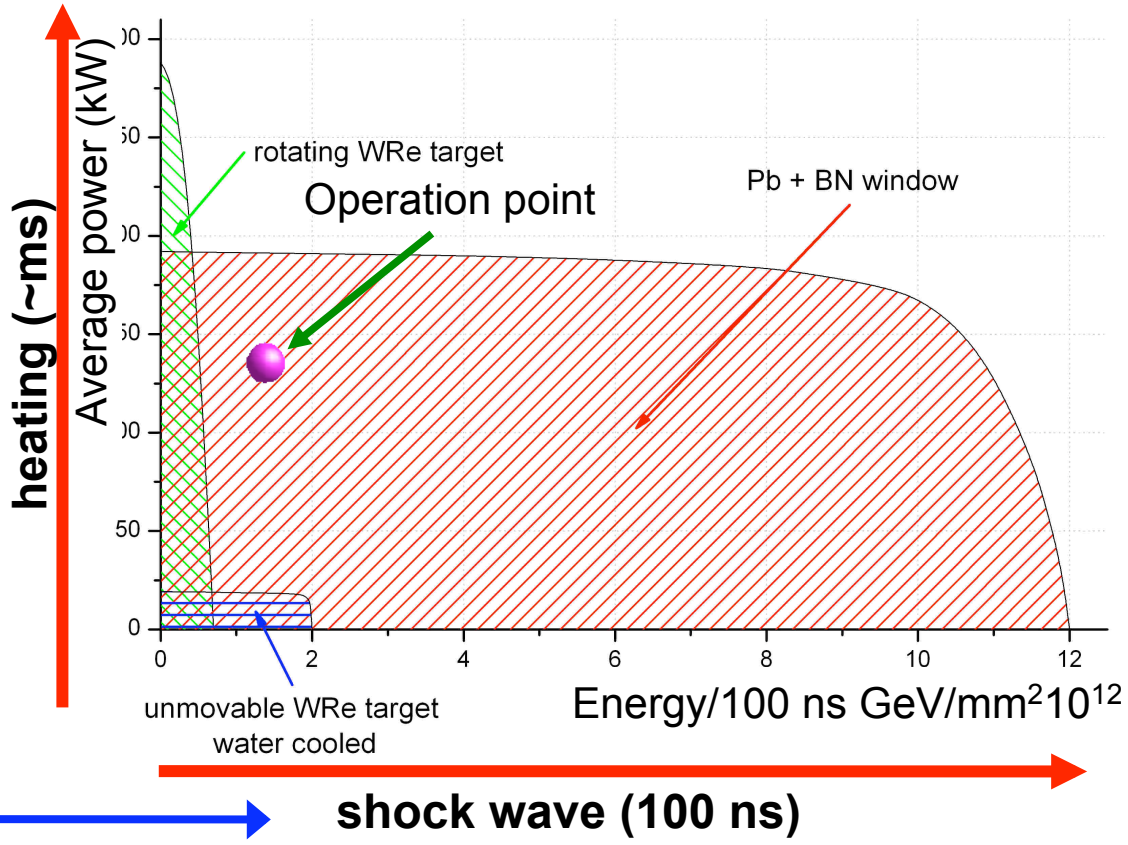


P. Logachov et al. in APAC2007

Liquid Pb-Sn Target

Simulation (ANL) shows OK



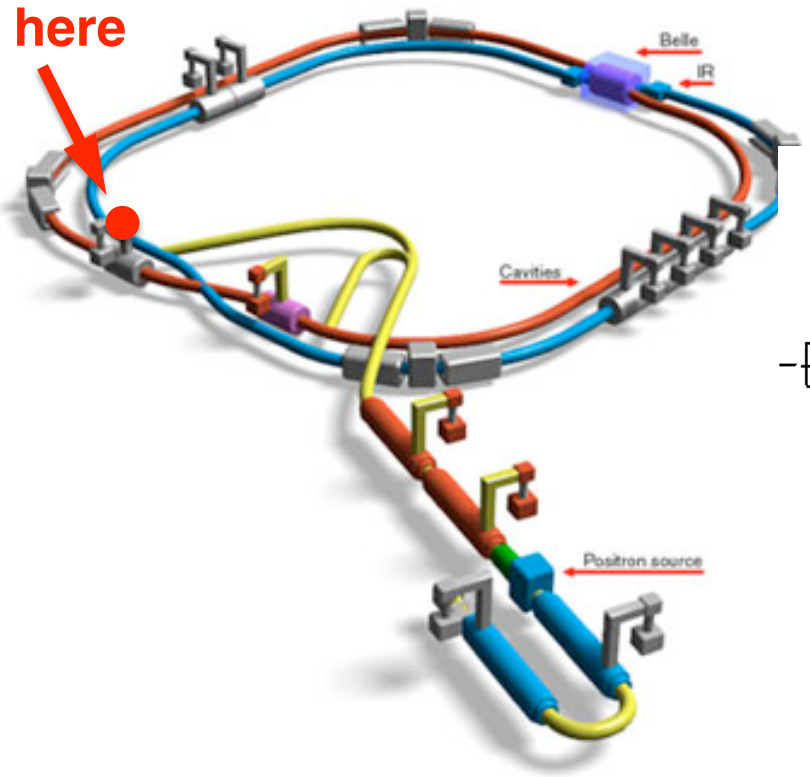
We are preparing a beam test at KEKB ring

P. Logachov et al. in APAC2007

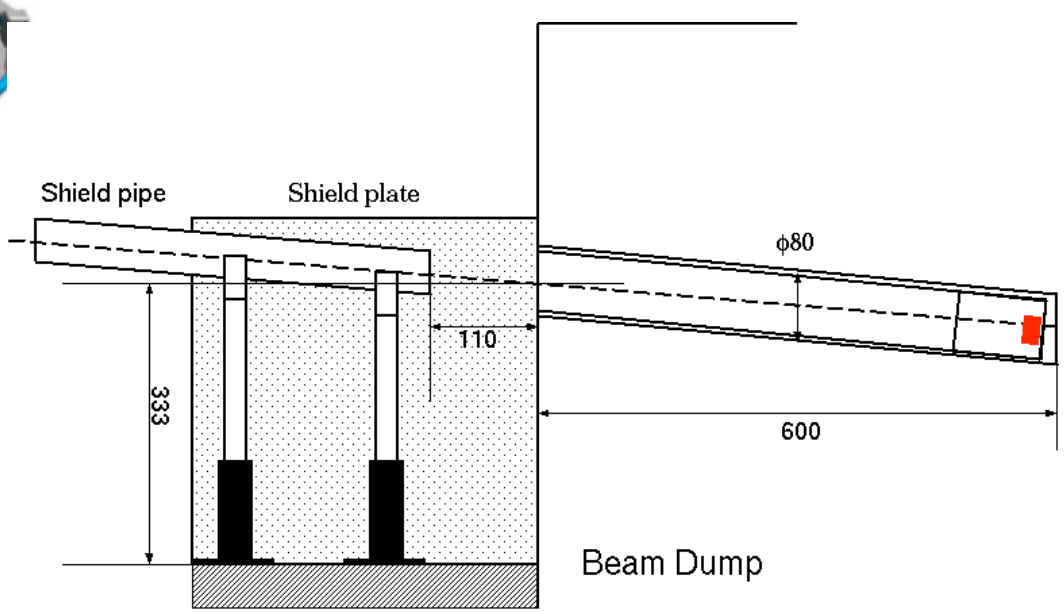
e+ target R/D

Liquid Pb target
BN window test at KEKB ring
for Shock Wave Issue

BN Window (for Liquid Pb target) Test at KEKB Ring



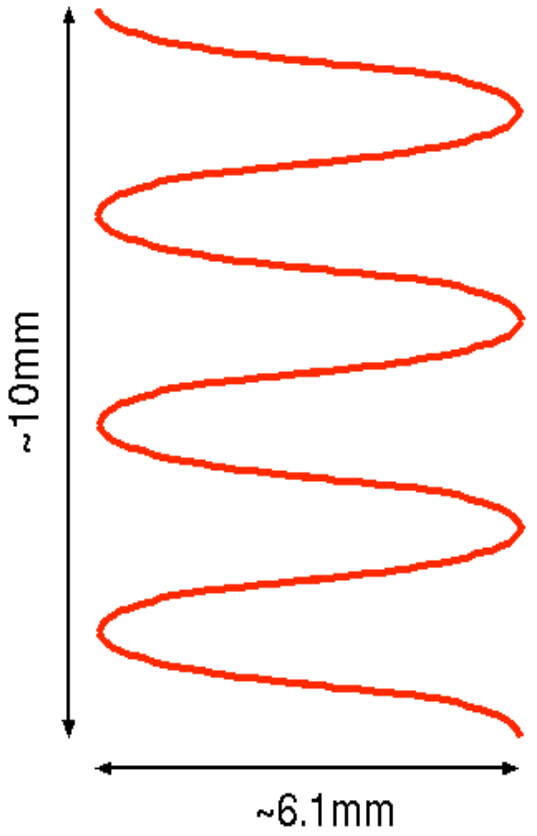
Stored beam and dump



- KEKB-HER: 8GeV, 10nC, 1300 bunches (1300mA)
- The beam is deflected by the abort kicker as shown when it is dumped.
- Because of “Step size” variation, the enrgy density is varied from 1810 to 13700 J/mm2

Beam Condition

- 10nC, ~1300 bunches, 10μs
- Bunch-by-bunch impossible
- Unable to change beam size (~1mm rms?)
- Swept by kicker (protect extraction window)
- Moves 7μ ~ 45μ/bunch on target (0.9mm ~ 6mm over 132 bunches)



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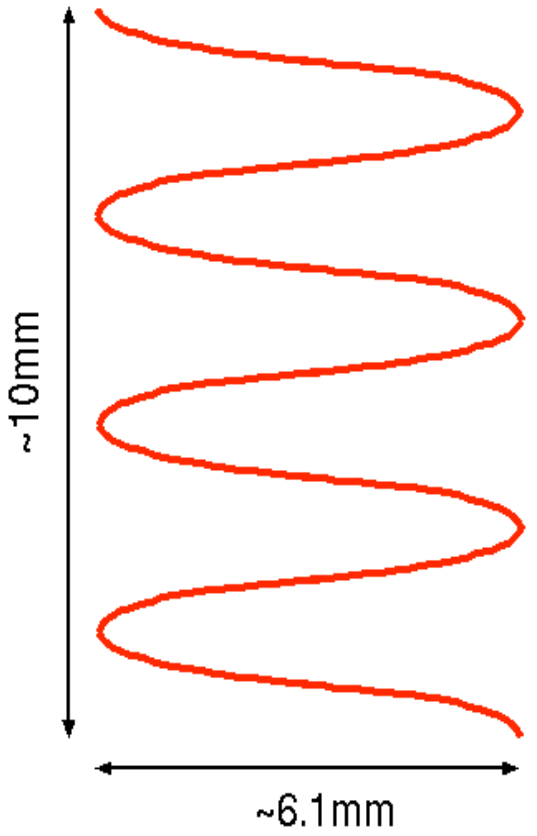

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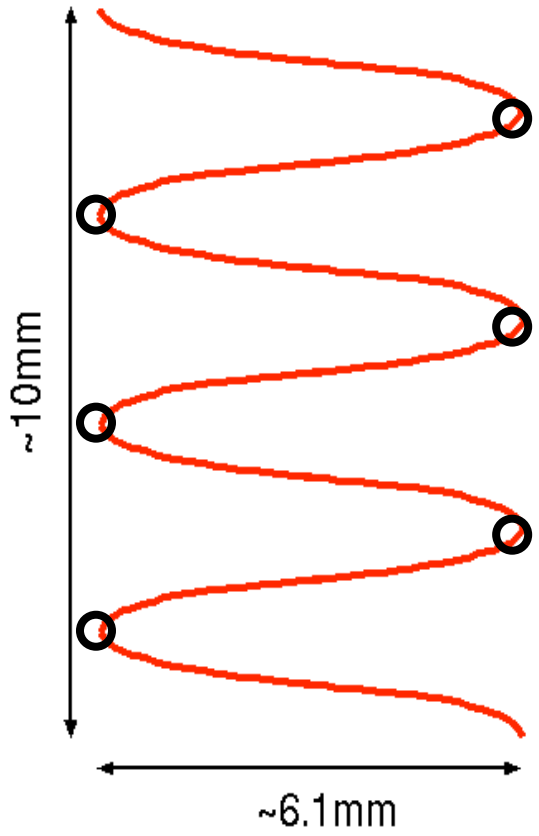
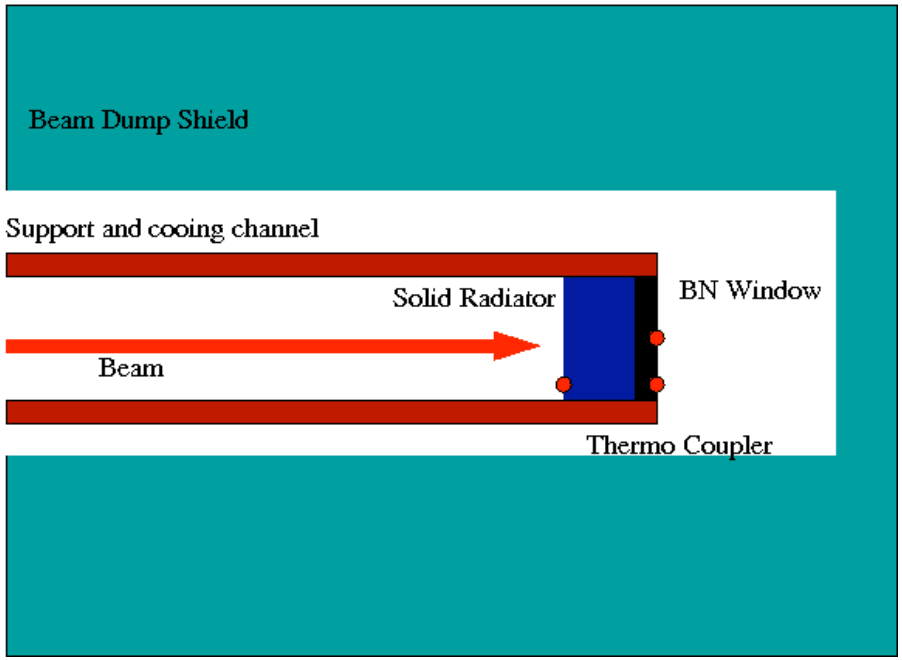


o 132 bunches in ~ 1mm

KEKB Beam Dump setup

- It is a test for isolation window material for liquid Pb target system.
- Space is very limited for KEKB BD.
- Solid Radiator (Solid Pb) is placed before BN plate, as a test material.
- Final investigation for damage is made by optical and laser microscopy.



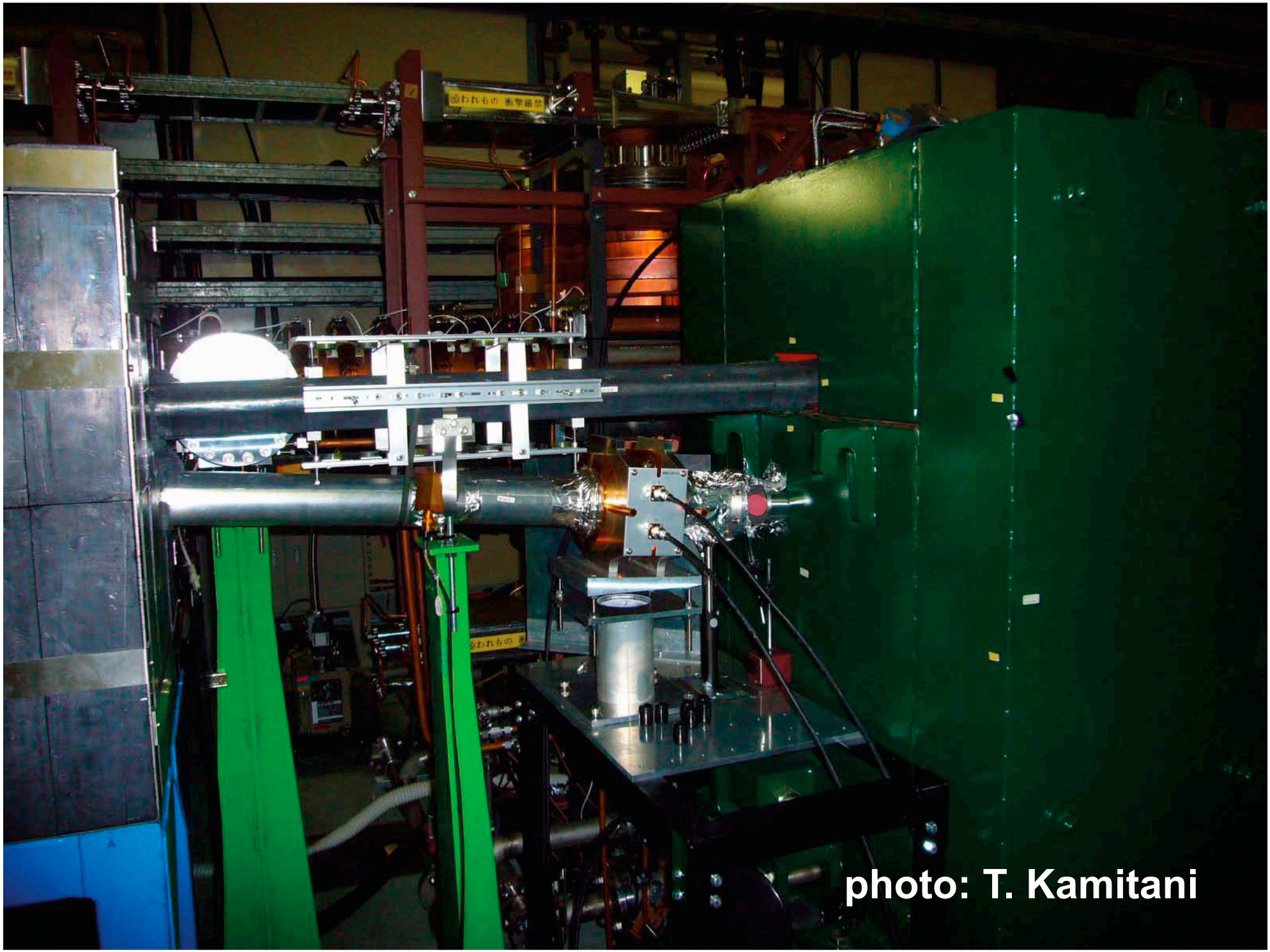
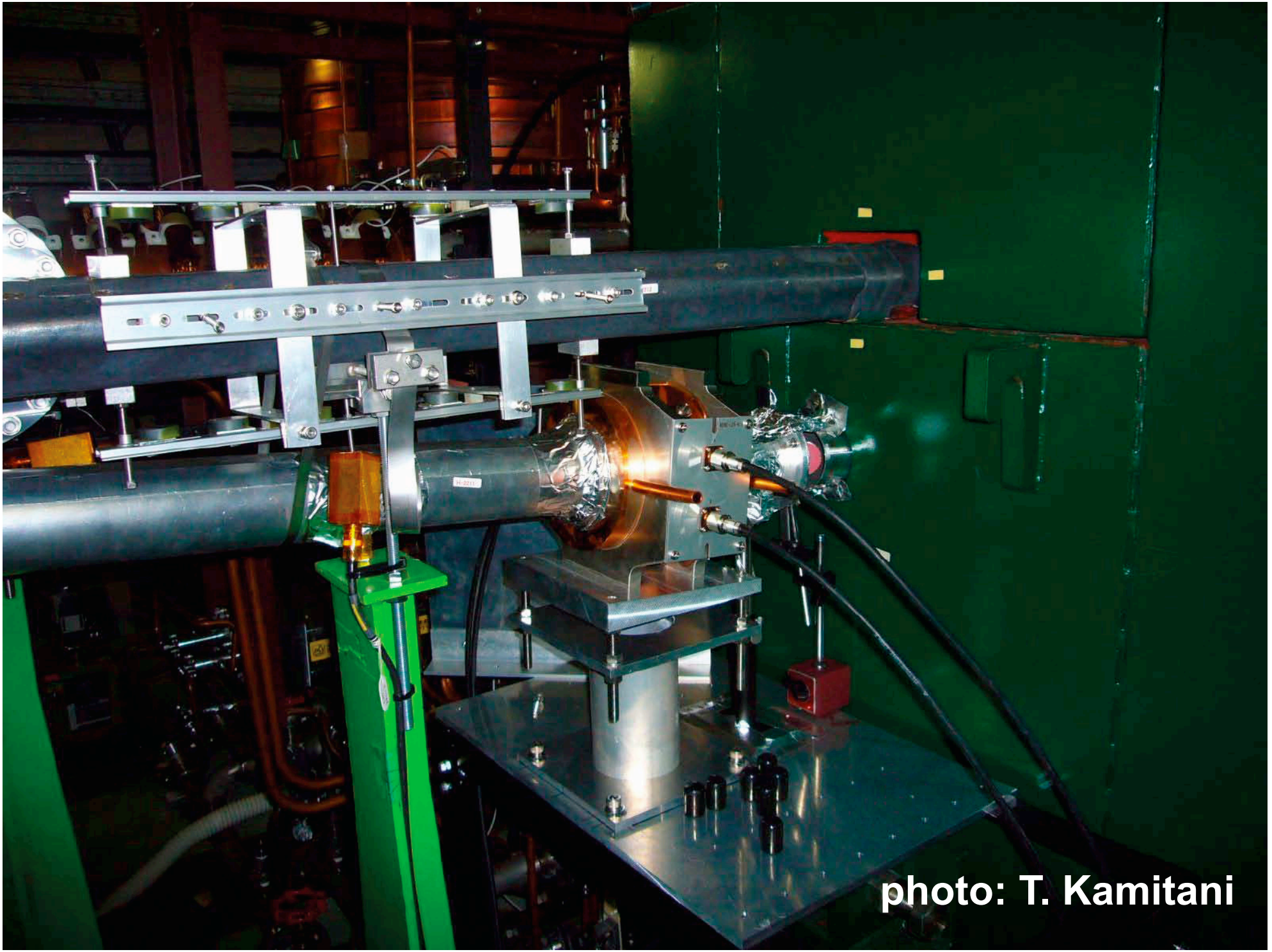


photo: T. Kamitani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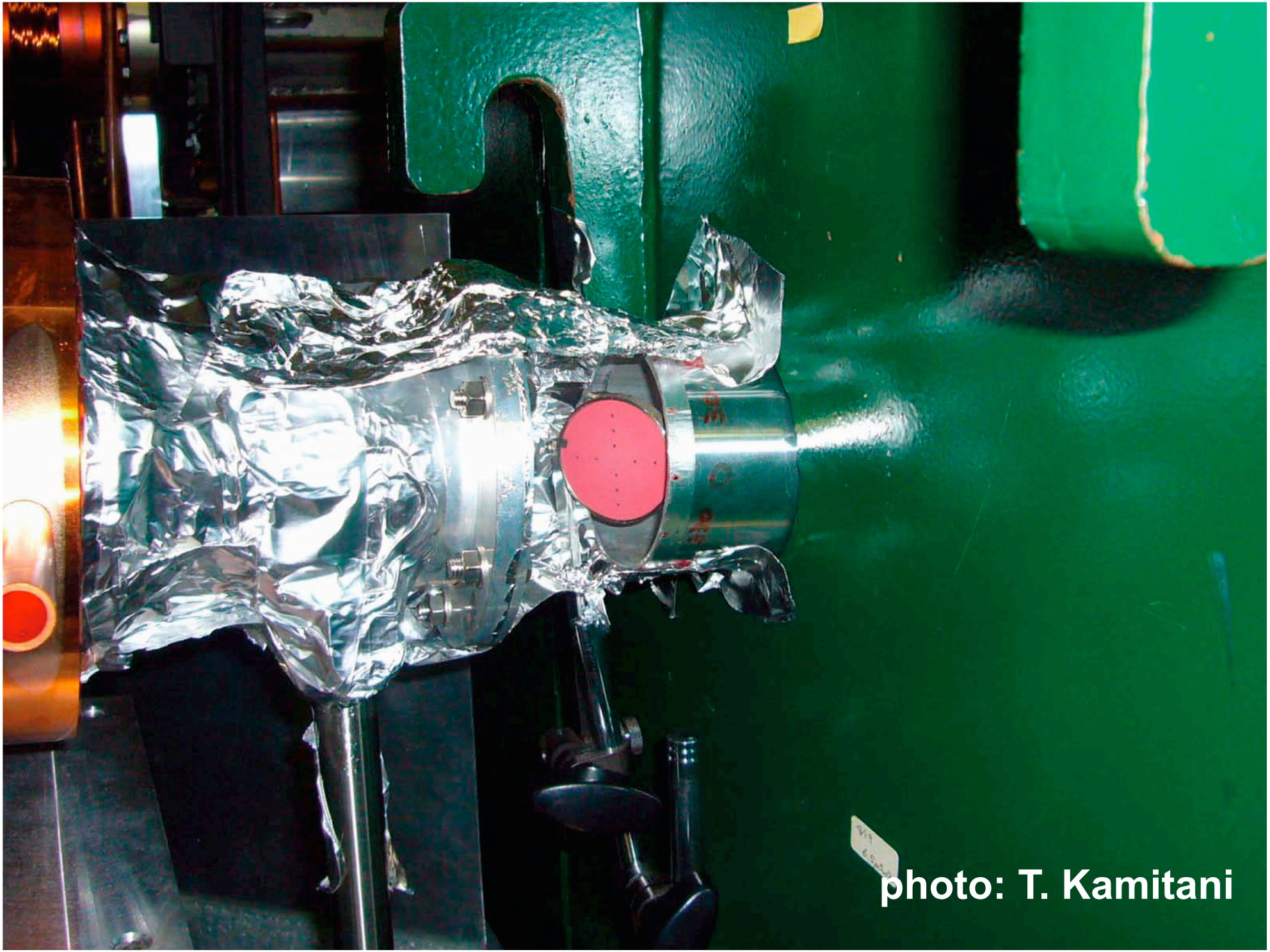
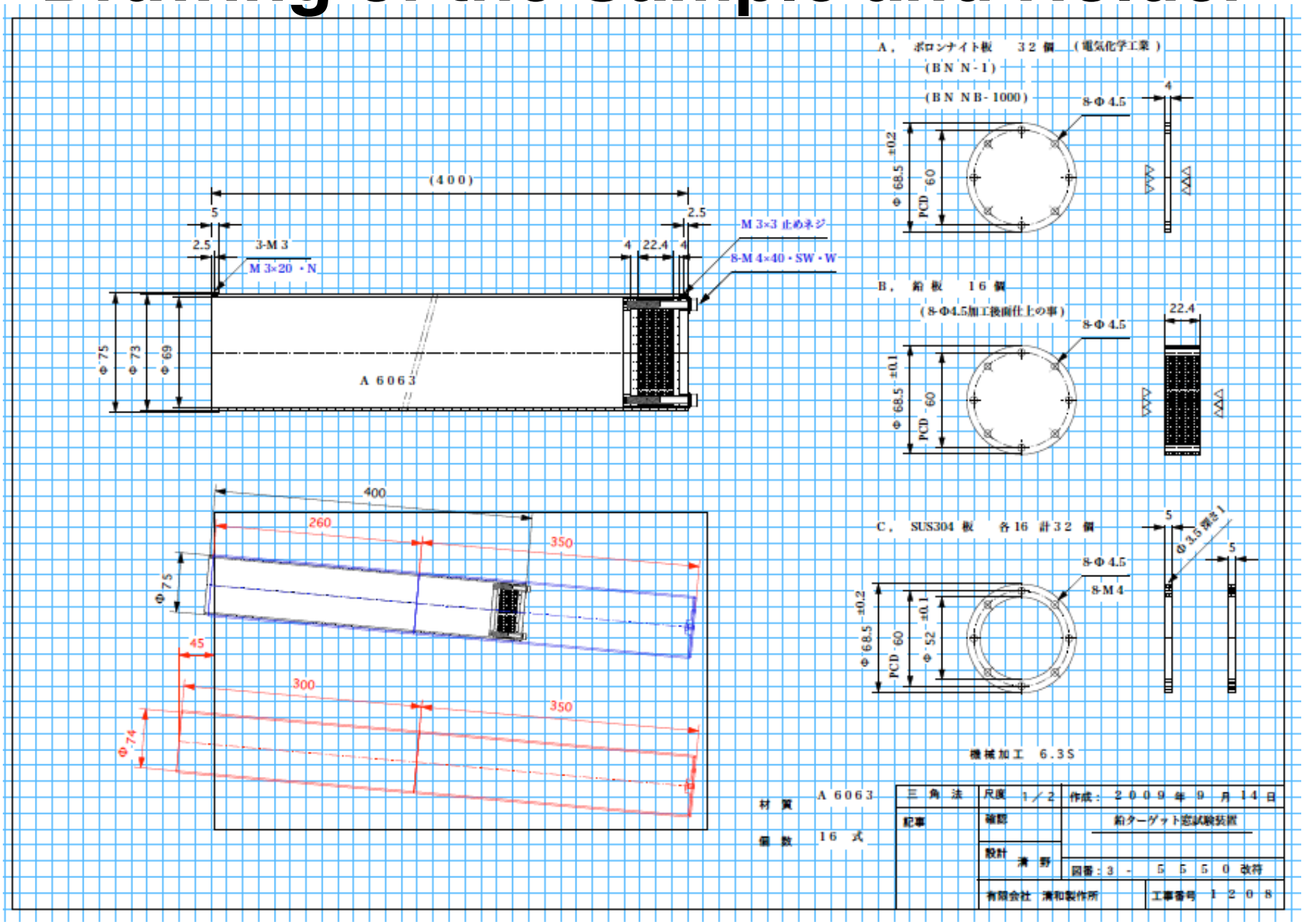


photo: T. Kamitani

Drawing of the Sample and Holder



Summary

Summary
Status of the BN window test at KEKB ring

1. Preparation is on going.
2. We will use a sandwich of BN-SolidPb-BN as a sample.
3. We started fabrication of samples and sample holders.
4. We will have 4 times of short machine time in Oct-Dec.
5. First test will be on October 22nd.

Backup Slides

Comparison to Warm Machines

GLC/NLC (warm LC)

Ne+/bunch = 0.7 x 10^{10}

Nbunch/tarin = 200

3 targets (conventional)

150 Hz (6.7 m sec train to train)

x 3

x 1/1.5

ILC (cold LC)

Ne+/bunch = 2 x 10^{10}

Nbunch/tarin = 1320 = 10 x 132

300 Hz generation: similar to warm machines

in view point of target thermal/shock issues (diff = x2)

Need 6 targets ?

1 target --> Hybrid or Liquid-Lead target

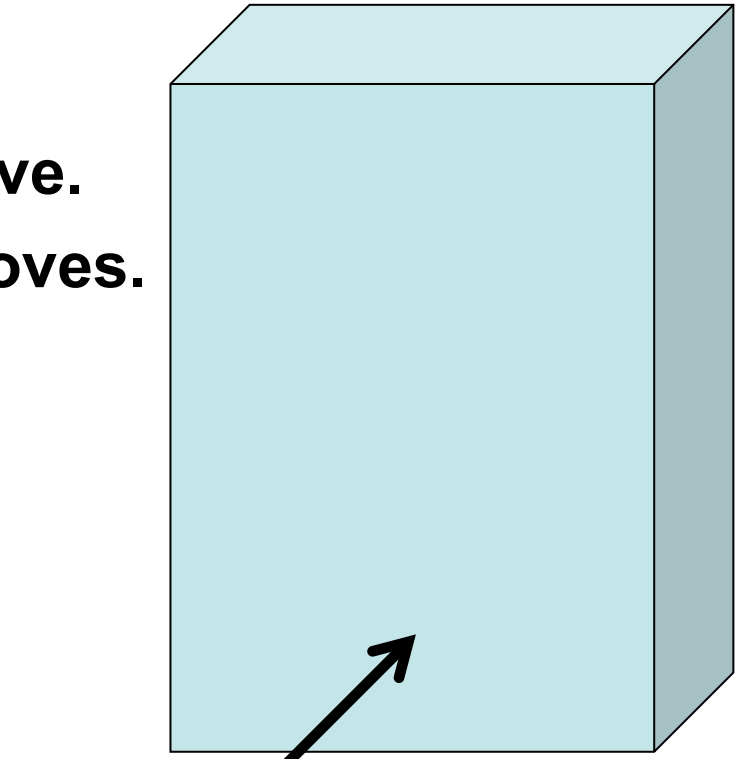
e+ target R/D

Liquid Pb target
(Simulation Study of Heat Issue)

Simulation of heating by beam (Wanming-san)

Model

- **Liquid Lead doesn't move.**
- **Beam injection point moves.**



liquid lead
(no move)

t ~ 18 mm

1st triplet

Temperature at "t = 16 mm" is monitored

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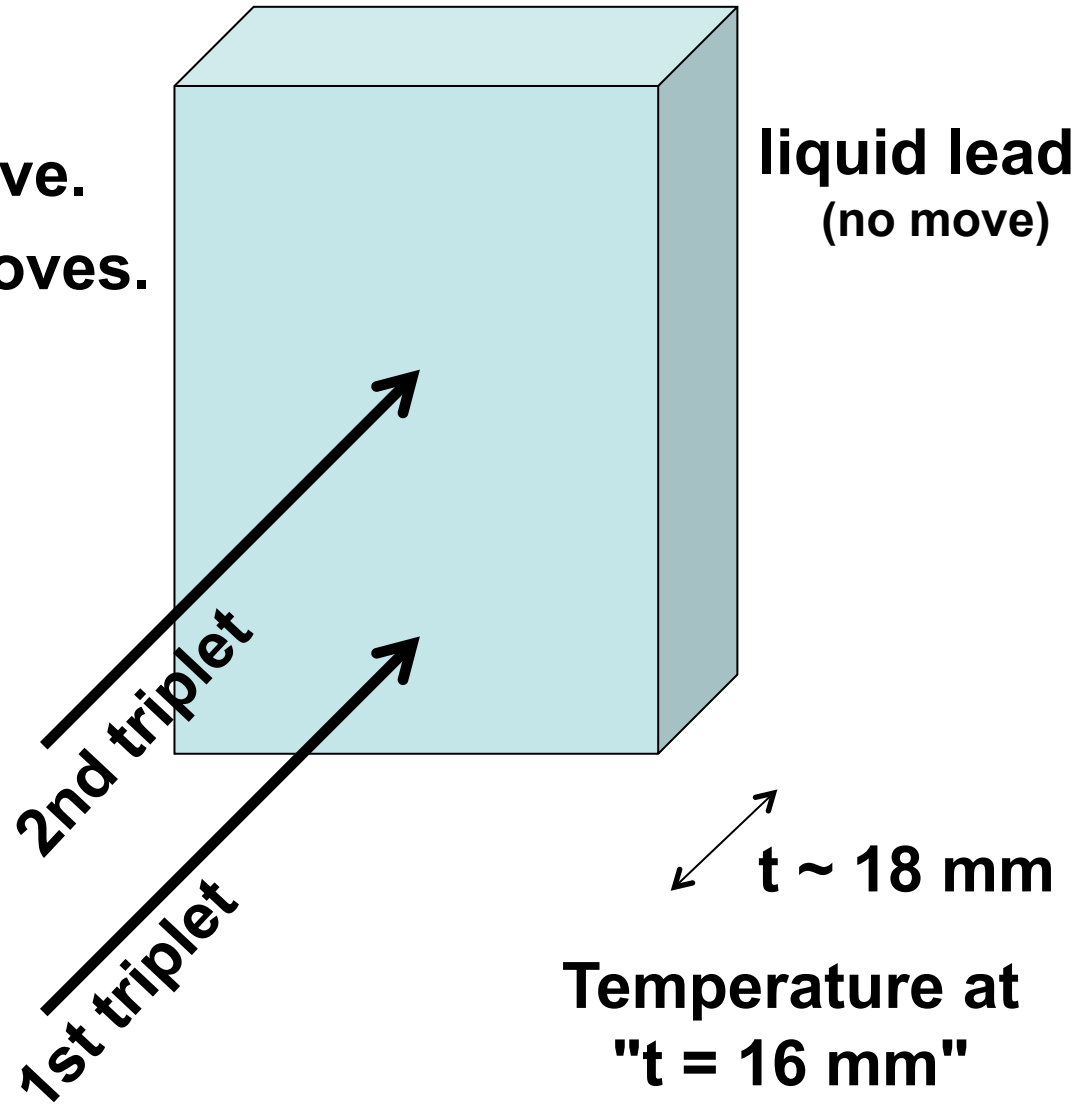

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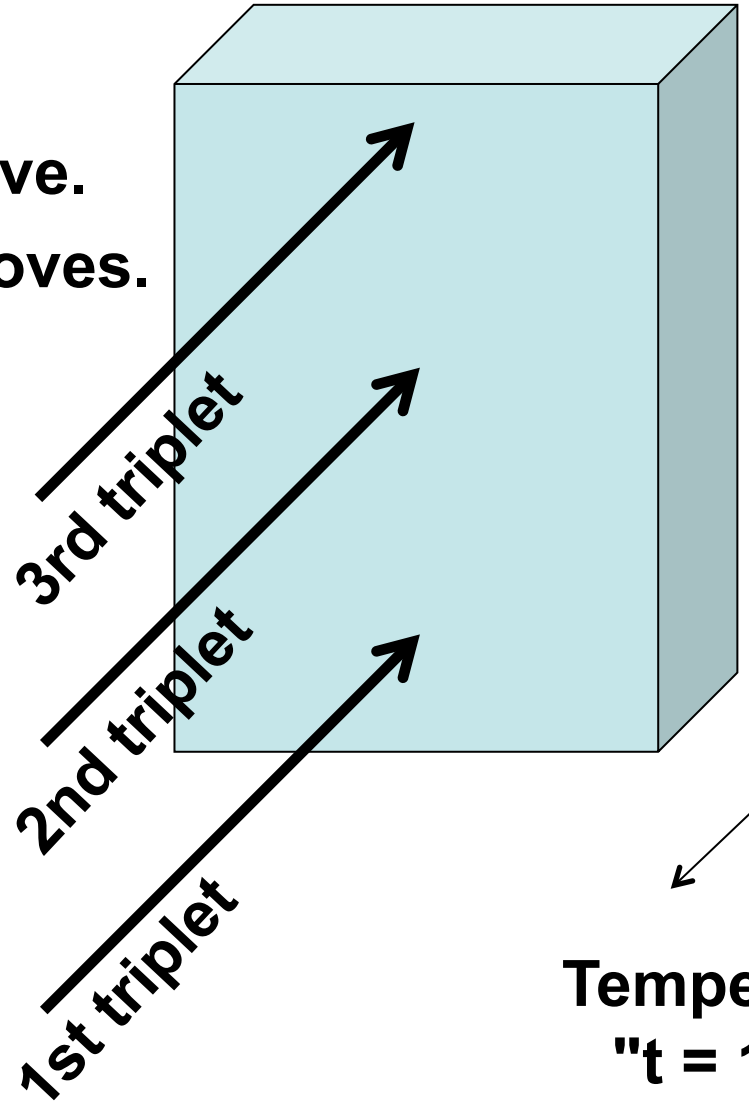

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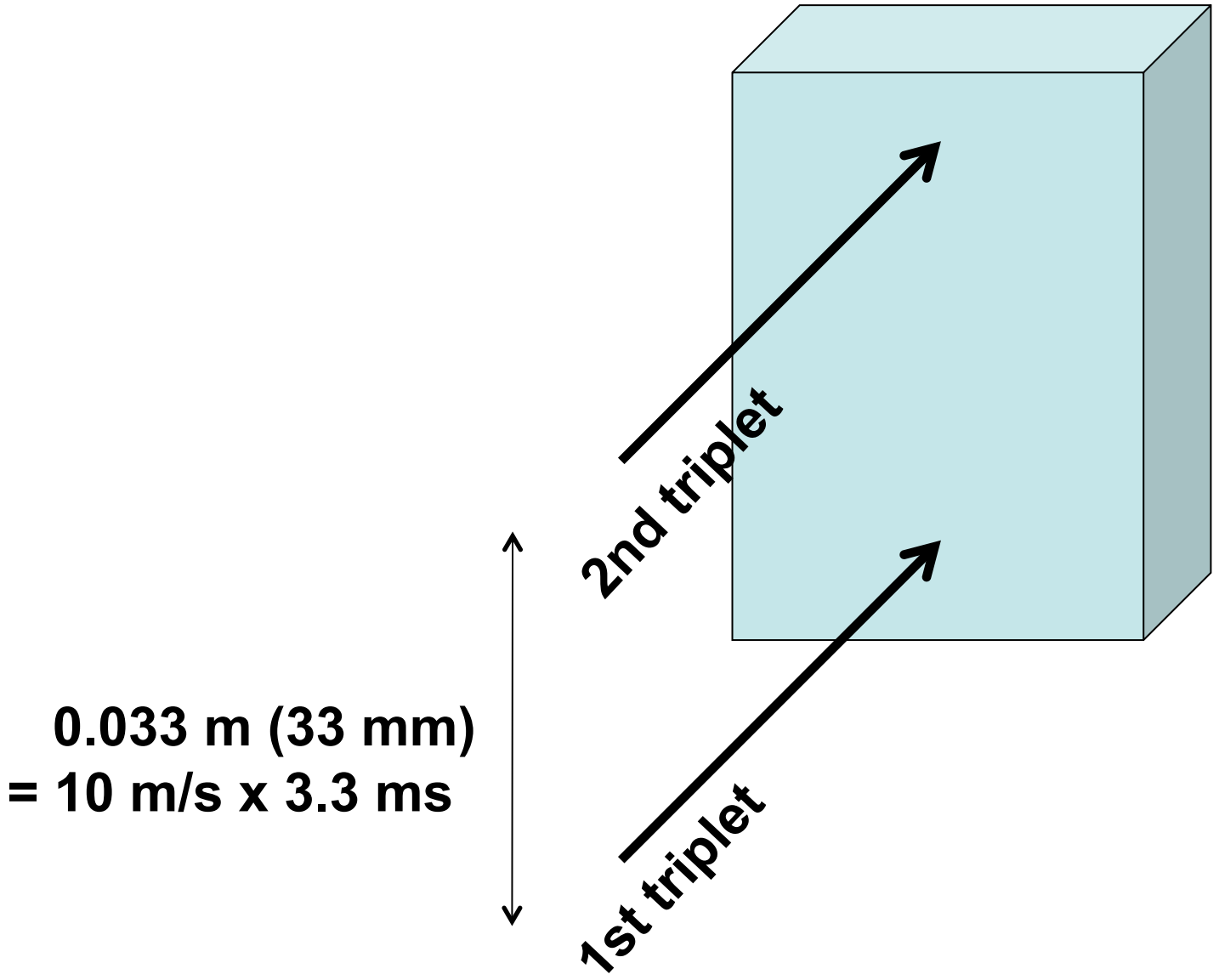
t ~ 18 mm

Temperature at "t = 16 mm" is monitored

10 m/s, after 2 triplets



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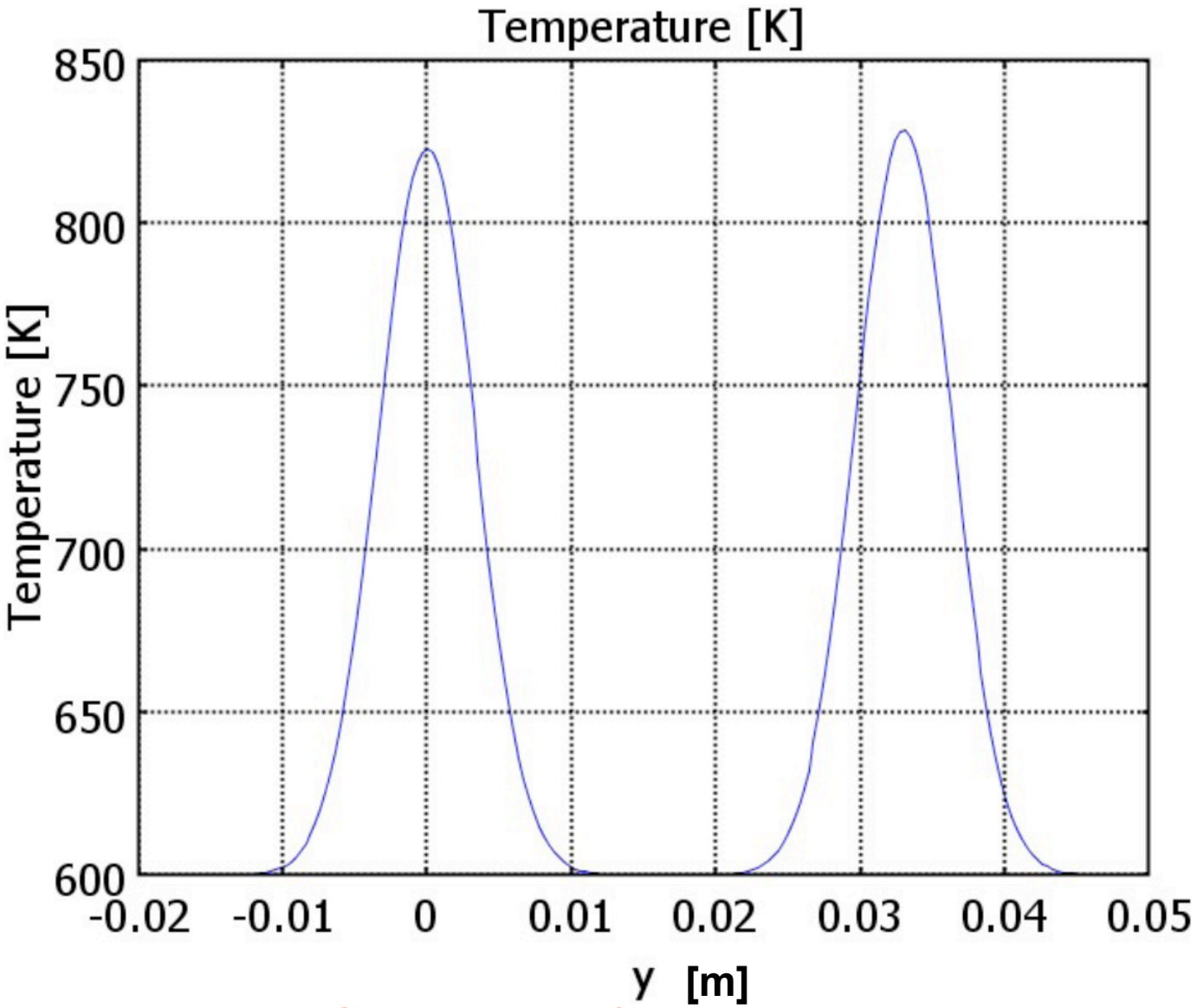
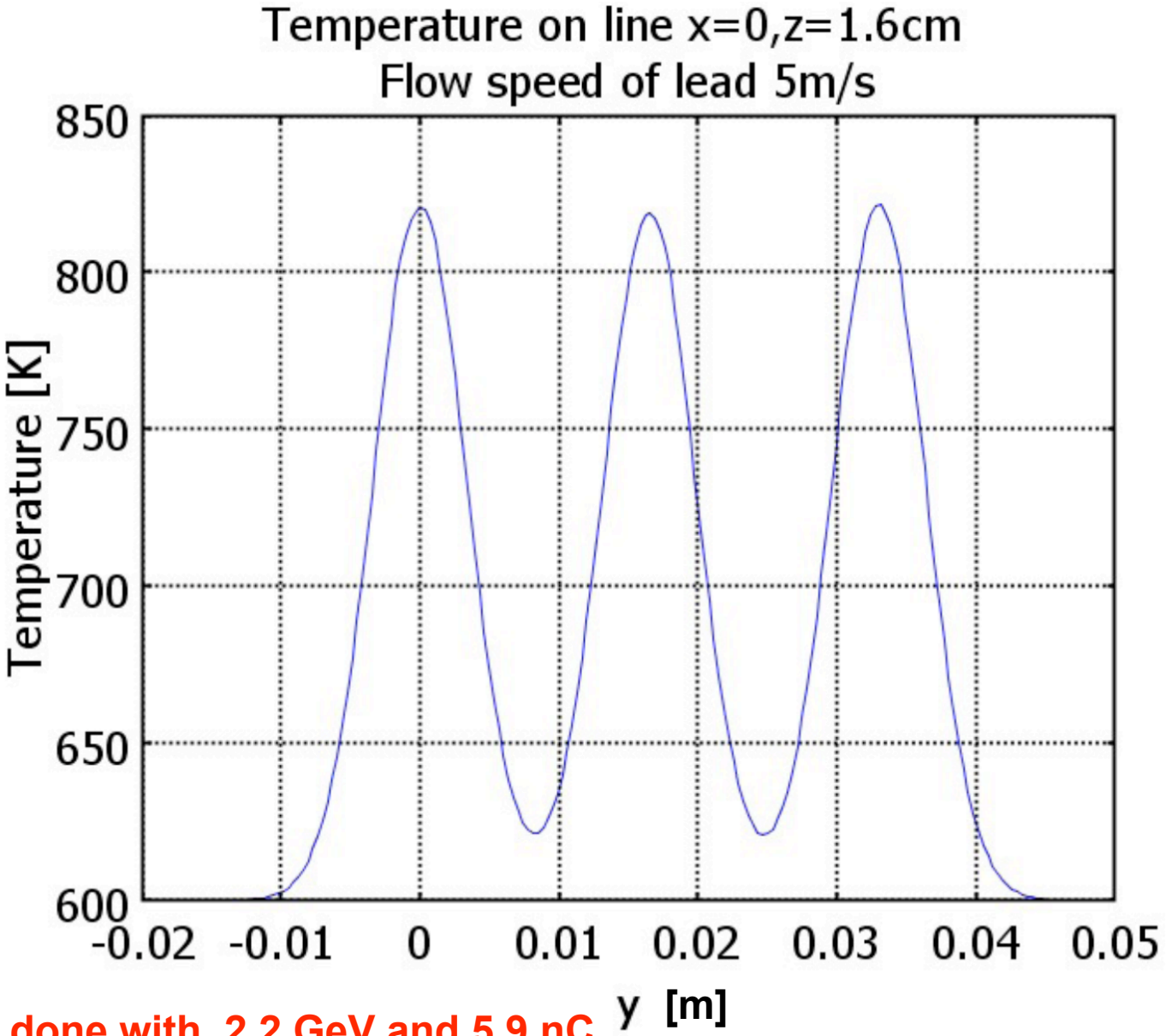


sim. was done with 2.2 GeV and 5.9 nC.

If 2.2 GeV --> 3.5 GeV, delta_T change 220 K --> 350 K

Wanming (ANL)

5 m/s, after 3 triplets



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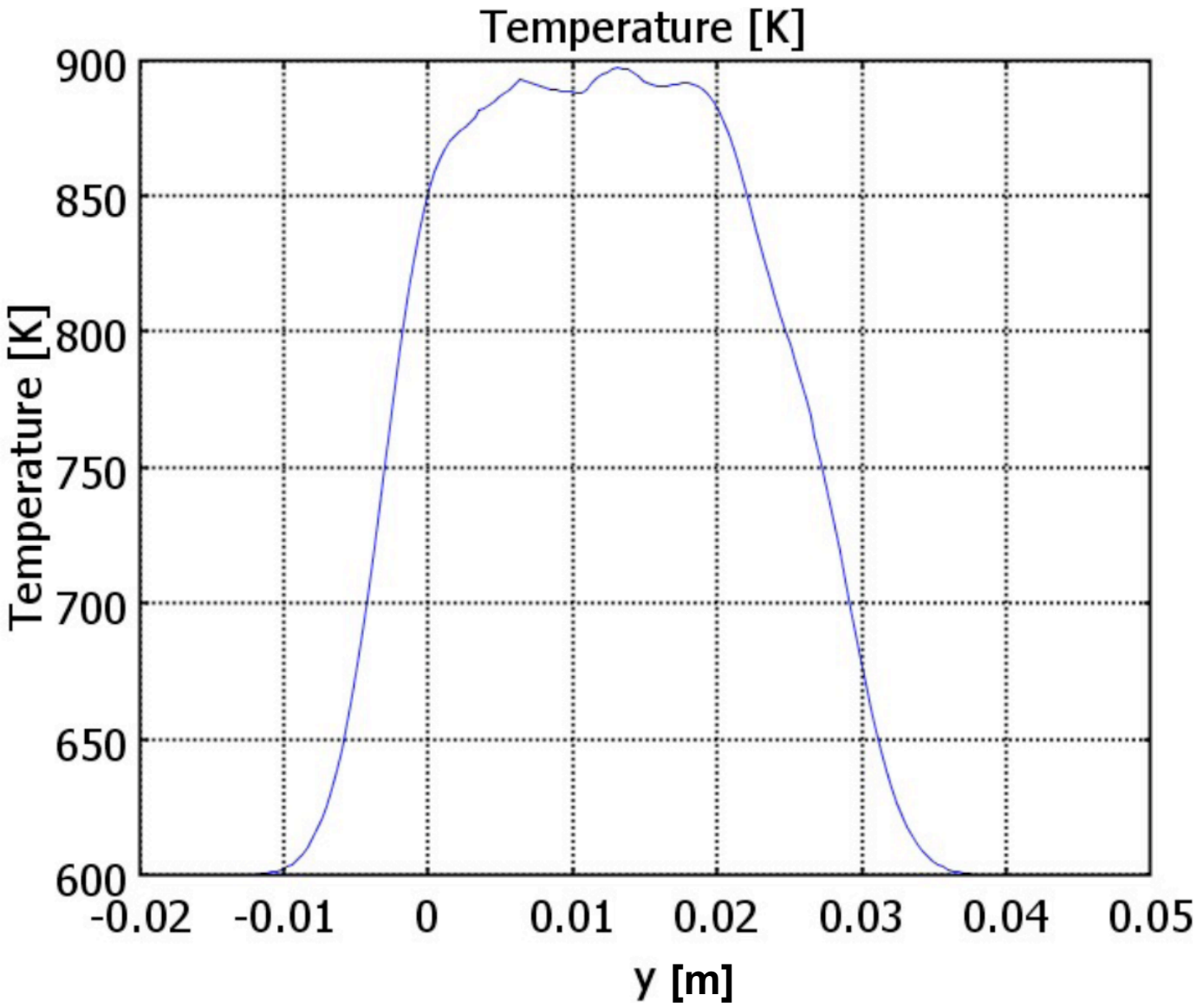
Wanming (ANL)

2 m/s, after 5 triplets



sim. was done with 2.2 GeV and 5.9 nC.

If 2.2 GeV --> 3.5 GeV, delta_T change 290 K --> 460 K

Wanming (ANL)

Simulation of heating by beam (Wanming-san)

- No heat problem in 300 Hz generation
- Flow speed can be low.
  10 m/s is not necessary.
  Probably 3 - 4 m/s is OK.
- Temperature is 950 K (= 650 C)
  if flow speed = 3 - 4 m/s.
  Lower than brazing melting temp. (800-900C).